Ohio University NAVAID Performance Prediction Model User Manual

Dr. Simbo Odunaiya, Dr. Chad Mourning, Dr. Scott Nykl

February 9, 2017

Contents

I Preface and Disclaimer **11**

II Installation Instructions **13**

1 Obtaining the Software **14**

2 Flash Drive During Training with pre-extracted directory **14**

2.1 Begin Installation 14
2.2 Running OUNPPM 14

3 Flash Drive During Training with Installer (deprecated) **14**

3.1 Begin Installation 15
3.2 Slide One 15
3.3 Slide Two 15
3.4 Slide Three 16
3.5 Slide Four 16
3.6 Slide Five 16
3.7 Slide Six 17
3.8 Install Complete 18
3.9 Running OUNPPM Directly 18

4 Installer from Website **18**

4.1 Acquiring Installer 18
4.2 Begin Installation 19
4.3 Slide One 19
4.4 Slide Two 20
4.5 Slide Three 21
4.6 Slide Four 21
4.7 Slide Five 21
4.8 Slide Six 22
4.9 Install Complete 22
4.10 Running OUNPPM Directly 22

5 .zip from Website 23
5.1 Acquiring .zip 23
5.2 Begin Extraction 25
5.3 Choose Location 25
5.4 Extraction Compete 25

III Preliminaries 28

6 OUNPPM Overview 29

7 System Requirements 29

8 Coordinate Frames 30
8.1 Localizer / Glideslope 30
8.2 VOR 31

IV Graphical User Interface (The Inputs) 32

9 General Input 33

10 Localizer Model 34
10.1 Facility Parameters 34
10.1.1 Array Type 34
10.1.1.1 Overview 34
10.1.1.2 Effect on the Model 35
10.1.1.3 Effect on the GUI 35
10.1.1.4 Effect on the Virtual World 36
10.1.2 Center Frequency 36
10.1.2.1 Overview 36
10.1.2.2 Effect on the Model 37
10.1.2.3 Effect on the GUI 37
10.1.2.4 Effect on the Virtual World 37
10.1.3 CLR Frequency 37
10.1.3.1 Overview 37
10.1.3.2 Effect on the Model 38
10.1.3.3 Effect on the GUI 38
10.1.3.4 Effect on the Virtual World 38
10.1.4 Runway Heading 38
10.1.4.1 Overview 38
10.1.4.2 Effect on the Model 38
10.1.4.3 Effect on the GUI 38
10.1.4.4 Effect on the Virtual World 38
10.1.5 Runway Length 39
10.1.5.1 Overview 39
10.1.5.2 Effect on the Model 40
10.1.5.3 Effect on the GUI 40
10.1.5.4 Effect on the Virtual World 40
10.1.6 Runway Width 40
10.1.6.1 Overview 40
10.1.6.2 Effect on the Model 41
10.1.6.3 Effect on the GUI 41
10.1.6.4 Effect on the Virtual World 41

10.2 Modeling Parameters 41
10.2.1 Datasheet 42
10.2.1.1 Overview 42
10.2.1.2 Effect on the Model 43
10.2.1.3 Effect on the GUI 44
10.2.1.4 Effect on the Virtual World 44
10.2.2 Field 44
10.2.2.1 Overview 44
10.2.2.2 Effect on the Model 45
10.2.2.3 Effect on the GUI 45
10.2.2.4 Effect on the Virtual World 45
10.2.3 DU Error 46
10.2.3.1 Overview 46
10.2.3.2 Effect on the Model 46
10.2.3.3 Effect on the GUI 46
10.2.3.4 Effect on the Virtual World 46
10.3 Array Parameters 46
10.3.1 Element Type 47
10.3.1.1 Overview 47
10.3.1.2 Effect on the Model 47
10.3.1.3 Effect on the GUI 47
10.3.1.4 Effect on the Virtual World 48
10.3.2 Main Setback 48
10.3.2.1 Overview 48
10.3.2.2 Effect on the Model 48
10.3.2.3 Effect on the GUI 48
10.3.2.4 Effect on the Virtual World 48
10.3.3 Main Offset 48
10.3.3.1 Overview 48
10.3.3.2 Effect on the Model 49
10.3.3.3 Effect on the GUI 49
10.3.3.4 Effect on the Virtual World 49
10.3.4 Main Height 49
10.3.4.1 Overview 49
10.3.4.2 Effect on the Model 49
10.3.4.3 Effect on the GUI 49
10.3.4.4 Effect on the Virtual World 49
10.3.5 Array Rotation 49
10.3.5.1 Overview 49
10.3.5.2 Effect on the Model 49
10.3.5.3 Effect on the GUI 49
10.3.5.4 Effect on the Virtual World 49
10.3.6 Antenna Rotation 49
10.3.6.1 Overview 49
10.3.6.2 Effect on the Model 49
10.3.6.3 Effect on the GUI 49
10.3.6.4 Effect on the Virtual World 49
10.3.7 Clearance Width 49
10.3.7.1 Overview 49
10.3.7.2 Effect on the Model 49
10.3.7.3 Effect on the GUI 49
10.3.7.4 Effect on the Virtual World 49
10.3.8 CLR / CRS Separation 49

10.3.8.1 Overview 49
10.3.8.2 Effect on the Model 50
10.3.8.3 Effect on the GUI 50
10.3.8.4 Effect on the Virtual World 50
10.3.9 Course / Clearance Lock 50
10.3.9.1 Overview 50
10.3.9.2 Effect on the Model 50
10.3.9.3 Effect on the GUI 50
10.3.9.4 Effect on the Virtual World 50

11 Glide Slope Model **50**
11.1 Facility Parameters 50
11.1.1 Array Type 51
11.1.1.1 Overview 51
11.1.1.2 Effect on the Model 51
11.1.1.3 Effect on the GUI 52
11.1.1.4 Effect on the Virtual World 52
11.1.2 Center Frequency 52
11.1.2.1 Overview 52
11.1.2.2 Effect on the Model 52
11.1.2.3 Effect on the GUI 53
11.1.2.4 Effect on the Virtual World 53
11.1.3 CLR Frequency 53
11.1.3.1 Overview 53
11.1.3.2 Effect on the Model 54
11.1.3.3 Effect on the GUI 54
11.1.3.4 Effect on the Virtual World 54
11.2 Modeling Parameters 54
11.2.1 Datasheet 55
11.2.1.1 Overview 55
11.2.1.2 Effect on the Model 56
11.2.1.3 Effect on the GUI 56
11.2.1.4 Effect on the Virtual World 57
11.2.2 Field 57
11.2.2.1 Overview 57
11.2.2.2 Effect on the Model 57
11.2.2.3 Effect on the GUI 57
11.2.2.4 Effect on the Virtual World 57
11.3 Array Parameters 57
11.3.1 Element Type 58
11.3.1.1 Overview 58
11.3.1.2 Effect on the Model 58
11.3.1.3 Effect on the GUI 59
11.3.1.4 Effect on the Virtual World 59
11.3.2 Main Setback 59
11.3.2.1 Overview 59
11.3.2.2 Effect on the Model 59
11.3.2.3 Effect on the GUI 59
11.3.2.4 Effect on the Virtual World 59
11.3.3 Main Offset 59
11.3.3.1 Overview 59
11.3.3.2 Effect on the Model 59
11.3.3.3 Effect on the GUI 59

11.3.3.4 Effect on the Virtual World 59
11.3.4 Array Rotation 59
11.3.4.1 Overview 59
11.3.4.2 Effect on the Model 60
11.3.4.3 Effect on the GUI 60
11.3.4.4 Effect on the Virtual World 60
11.3.5 Clearance Width 60
11.3.5.1 Overview 60
11.3.5.2 Effect on the Model 60
11.3.5.3 Effect on the GUI 60
11.3.5.4 Effect on the Virtual World 60
11.3.6 CLR / CRS Separation 60
11.3.6.1 Overview 60
11.3.6.2 Effect on the Model 60
11.3.6.3 Effect on the GUI 60
11.3.6.4 Effect on the Virtual World 60
11.4 Array Auto-Adjust 61
11.4.1 Glide Path Angle 61
11.4.1.1 Overview 61
11.4.1.2 Effect on the Model 61
11.4.1.3 Effect on the GUI 61
11.4.1.4 Effect on the Virtual World 61
11.4.2 Antenna Height Ratio 61
11.4.2.1 Overview 61
11.4.2.2 Effect on the Model 62
11.4.2.3 Effect on the GUI 62
11.4.2.4 Effect on the Virtual World 62
11.4.3 'As-Is' Button 62
11.4.3.1 Overview 62
11.4.3.2 Effect on the Model 62
11.4.3.3 Effect on the GUI 62
11.4.3.4 Effect on the Virtual World 62
11.4.4 'Adjust' Button 62
11.4.4.1 Overview 62
11.4.4.2 Effect on the Model 63
11.4.4.3 Effect on the GUI 63
11.4.4.4 Effect on the Virtual World 63
11.4.5 Automatically Adjust Antenna Offsets for Main Offset Button 63
11.4.5.1 Overview 63
11.4.5.2 Effect on the Model 63
11.4.5.3 Effect on the GUI 63
11.4.5.4 Effect on the Virtual World 63

12 VOR Model **63**

13 Scatterers **64**
13.1 Scatterer Group 64
13.1.1 Plate Group Editor 64
13.1.1.1 The Toolbar 65
13.1.1.1.1 Open 65
13.1.1.1.2 Save 65
13.1.1.1.3 Presets 65
13.1.1.1.3.1 Ellipse 66

13.1.1.1.3.2 Windmill 67
13.1.1.1.4 Horizontal Pull From Image 74
13.1.1.1.5 Vertical Pull From Image 75
13.1.1.1.6 3D Navigator 75
13.1.1.1.7 Capture 3D 75
13.1.1.2 The Table 75
13.1.1.2.1 For All Types 75
13.1.1.2.2 Localizer and Glideslope 75
13.1.1.2.3 VOR 78
13.1.1.3 Local Plate Operations 78
13.1.1.4 The 3D World 80
13.1.2 Wire Group Editor 81
13.2 Scatterer Point of Rotation 81
13.3 Iteration Operations 81
13.3.1 Iterate Individually 81
13.3.2 Iterate as Group 81
13.4 Group Scatterers (Table) 81
13.4.1 Add 81
13.4.1.1 Effect on the Simulation 82
13.4.1.2 Effect on the 3D World 83
13.4.2 Remove 83
13.4.3 Edit 83
13.4.4 The Table 83
13.4.4.1 In Use 83
13.4.4.2 Type 83
13.4.4.3 Scatterer 83
13.4.4.4 Description 84
13.4.4.5 X Offset 84
13.4.4.6 Y Offset 84
13.4.4.7 Z Offset 84
13.4.4.8 Angle 84
13.4.4.9 Iterate 84

14 Flight Parameters **85**
14.1 Localizer Flight Paths 85
14.1.1 Localizer ILS 3 / Approach 85
14.1.2 Localizer ILS 2 / Level Run 88
14.1.3 Localizer ILS 1 / Orbit 90

15 Array Editor **92**
15.1 Localizer Array Editor 92
15.2 Glideslope Array Editor 93
15.3 Azimuthal Element Pattern 93
15.3.1 Drawing a pattern 93

16 Iterators **96**
16.1 Strategy 96
16.2 Iteration Tab 96
16.3 Iteration Table 96
16.4 CAS (Lower) Toolbar 96
16.5 ITL (Upper) Toolbar 96
16.6 Sidebar 97
16.7 Plots 97

17 Traces 98
17.1 Localizer Traces 98
17.1.1 Output Parameter 98
17.1.1.1 Descriptions 98
17.1.1.2 Units 98
17.1.2 Switches 98
17.1.2.1 Filtering 98
17.1.2.2 Fields 98
17.1.3 Course Parameters 98
17.1.3.1 Course Width 98
17.1.3.2 Mod. Balance 99
17.1.3.3 SBO Phase 99
17.1.4 Clearance Parameters 99
17.1.4.1 Course Width 99
17.1.4.2 Mod. Balance 99
17.1.4.3 SBO Phase 99
17.1.4.4 Clr/Crs Sep. 99
17.1.4.5 Capture Ang. 99
17.2 Glideslope Traces 99
17.3 VOR Traces 99
17.3.1 Flight Type 99
17.3.2 SS Units 99
17.3.3 Output 99
17.3.4 Model Type 99
17.3.5 Trace Name 99

18 Software Updater 100

19 JCCBI Database 103

20 Authentication Information 104

V The Outputs (Plots) 106

21 Localizer 107
21.1 The Plot 107
21.1.1 Axes 107
21.1.1.1 X-Axis 107
21.1.1.2 Y-Axis 107
21.1.2 CAT III 107
21.1.3 CATII 107
21.1.4 CATI 108
21.1.5 Context Menu 108
21.1.5.1 Properties 108
21.1.5.2 Change Trace Colors 109
21.1.5.3 Adjust Axes 109
21.1.5.4 Save to File 110
21.1.5.5 Copy 110
21.1.5.6 Save As 110
21.1.5.7 Print 110
21.1.5.8 Zoom In 110
21.1.5.9 Zoom Out 110

21.1.5.10 Auto Range 110
21.2 The Report 110
21.3 Keyboard Interaction 110
21.4 Mouse Interaction 111
21.5 Localizer Iterator Plots 111
21.5.1 Overview 111
21.5.2 Structure Plots 111
21.5.2.1 Decimal 112
21.5.3 Percentage 112
21.5.4 Contour 112
21.5.5 Angle Plots 113
21.5.5.1 Degree 113
21.5.5.2 μAmps 114
21.5.6 Percentage 114
21.5.7 Contour 115

22 Glideslope **116**
22.1 ILS3 116
22.1.1 Axes 116
22.1.1.1 X-Axis 116
22.1.1.2 Y-Axis 116
22.1.2 The Plot 116
22.1.2.1 ILS3 116
22.1.2.2 CATII 117
22.1.2.3 CATI 117
22.1.2.4 Context Menu 117
22.1.3 The Report 119
22.1.4 Keyboard Interaction 119
22.1.5 Mouse Interaction 120
22.2 ILS2 120
22.2.1 The Report 120
22.3 ILS1 120

23 VOR **120**
23.1 Axes 120
23.1.1 X-Axis 120
23.1.2 Y-Axis 121
23.2 Source 121
23.3 The Plot 121
23.4 The Report 121
23.5 Context Menu 122
23.5.0.1 Properties 122
23.5.0.2 Change Trace Colors 123
23.5.0.3 Adjust Axes 123
23.5.0.4 Save to File 124
23.5.0.5 Copy 124
23.5.0.6 Save As 124
23.5.0.7 Print 124
23.5.0.8 Zoom In 124
23.5.0.9 Zoom Out 124
23.5.0.10 Auto Range 124
23.6 Keyboard Interaction 124
23.7 Mouse Interaction 125

VI The Virtual World 126
23.8 Navigating the Virtual World . . . 127
23.9 Resetting the Virtual World . . . 127
23.10 Elements of the Virtual World . . . 128
23.10.1 Shared Elements . . . 128
23.10.1.1 The Grid . . . 128
23.10.1.2 The Runway . . . 128
23.10.2 Localizer Elements . . . 128
23.10.2.1 The Array . . . 128
23.10.3 Glideslope Elements . . . 128
23.10.3.1 The Array . . . 128
23.10.4 VOR Elements . . . 128
23.10.4.1 The Array . . . 128

VII Examples 129

VIII Solutions 169

24 Exercises 170
24.1 Exercise 1 . . . 170
24.1.1 Setup Exercise 1 . . . 170
24.1.2 Results Exercise 1 . . . 178
24.2 Exercise 2 . . . 179
24.2.1 Setup Exercise 2 . . . 179
24.2.2 Results Exercise 2 . . . 184
24.3 Exercise 3 . . . 185
24.3.1 Setup Exercise 3 . . . 185
24.3.2 Results Exercise 3 . . . 191
24.4 Exercise 4 . . . 192
24.4.1 Setup Exercise 4 . . . 192
24.4.2 Results Exercise 4 Small Boat . . . 200
24.4.3 Results Exercise 4 Large Boat . . . 204
24.5 Exercise 5 . . . 208
24.5.1 Exercise 5 Setup . . . 208
24.5.2 Exercise 5 Results . . . 214
24.6 Exercise 6 . . . 215
24.6.1 Exercise 6 Setup . . . 215
24.6.2 Exercise 6 Results . . . 221
24.7 Exercise 7 . . . 222
24.7.1 Exercise 7 Setup . . . 222
24.7.2 Exercise 7 Results . . . 228
24.8 Exercise 8 . . . 229
24.8.1 Exercise 8 Setup . . . 229
24.8.2 Exercise 8 Results . . . 229
24.9 Exercise 9 . . . 229
24.9.1 Setup Exercise 9 . . . 229
24.9.2 Results Exercise 9 . . . 232
24.10 Exercise 10 . . . 233
24.10.1 Setup Exercise 10 . . . 233
24.10.2 Results Exercise 10 . . . 234

IX Glossary **235**

X Appendix A: Unit Conversions **237**

25 Introduction **238**

26 Distance Units **238**
26.1 Feet 238
26.1.1 Feet 238
26.1.2 Meters 238
26.1.3 Nautical Miles 238
26.1.4 Wavelengths 238
26.2 Meters 238

XI Appendix B: Files **239**

27 File Extentions **240**

28 File Contents **240**
28.1 Input Files 240
28.1.1 Localizer 240
28.1.1.1 LDU 240
28.1.2 Glideslope 240
28.1.2.1 GDU 240
28.2 Intermediate Files 240
28.2.1 Localizer and Glideslope 240
28.2.1.1 DAT 240
28.3 Output Files 240
28.3.1 PTS 240

XII Appendix C: Troubleshooting **241**

29 FAQ **242**

30 Issue Reporter **242**

31 Log Files **242**
31.1 Java Log File 242
31.2 Visualization Log File 242
31.3 VOR Output File 242

XIII Appendix D: Known Issues **243**

Part I

Preface and Disclaimer

This is a living document and may be updated frequently. Figures will attempt to be updated between versions, but may reflect a prior version. The information in this document are correct to the best of the authors' abilities, but bugs may be present. Claims which may not be correct and need validated or features marked for further review will be marked with a *. Known bugs in the code that contradict the description in this manual are marked with a $\sharp$. Intended but incomplete features are marked with a $\diamondsuit$. Deprecated features intended to be removed, which may or may not ever occur, will be marked with a †.

This document is not intended to be a replacement for thorough OUNPPM training, but a supplement and refresher on the skills learned during that class.

Part II

Installation Instructions

1 Obtaining the Software

There are three ways to obtain the OUNPPM software.

1. Flash Drive during training with pre-extracted directory.
2. Flash Drive during training with installer (deprecated)
3. Installer .exe from ounppm.eecs.ohio.edu/ounppm/
4. .zip from ounppm.eecs.ohio.edu/ounppm/updates

The following four chapters describe various ways to install the software. Only one applies to whichever setup you chose, but you may wish to familiarize your others for the future.

After installing the software, it is highly recommended (and you should be prompted) to install updates.

2 Flash Drive During Training with pre-extracted directory

2.1 Begin Installation

When you receive your flash drive there should be four directories similar to figure 1, it is recommended that you copy and paste the "OUNPPM" folder to some location on your hard drive where you have write permissions. Technically, the software should run from the flash drive, but the performance will be significantly slower. For training purposes, it is also advisable to copy all four directories to your hard drive, but this is not strictly necessary.

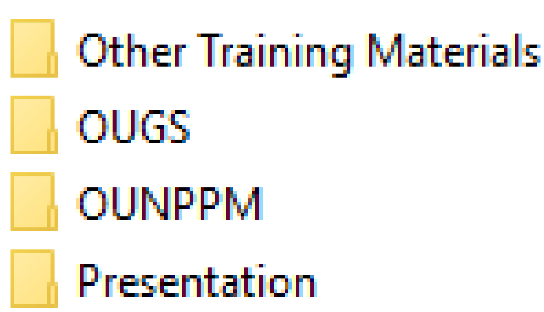


Figure 1: The directories on your flash drive.

2.2 Running OUNPPM

You can run the program by browsing to the install directory and running "Run OUNPPM.bat" as seen in figure 2.

3 Flash Drive During Training with Installer (deprecated)

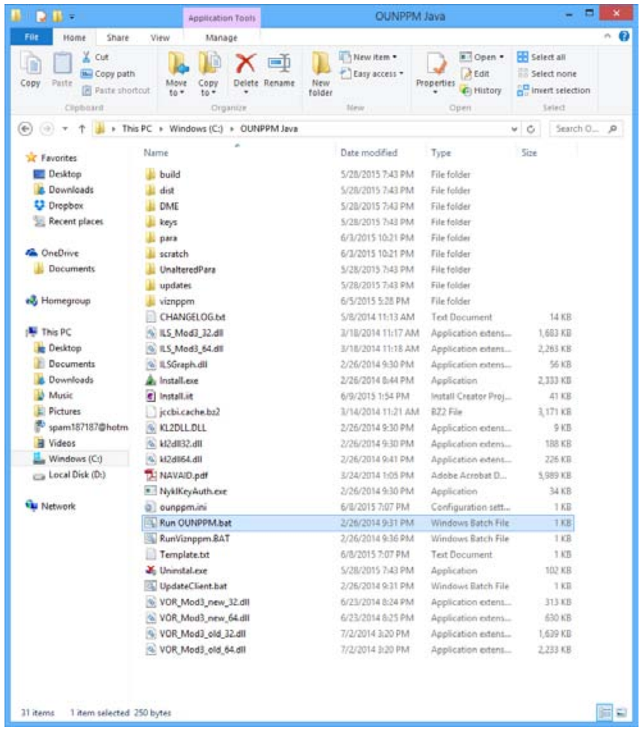


Figure 2: How to run OUNPPM directly.

3.1 Begin Installation

The installation file, should be of the format "OUNPPM Installer *DATE*.exe".

From your flash drive, double click the file as shown in figure 13. Note: the date will change with future updates, and additional files may be present.

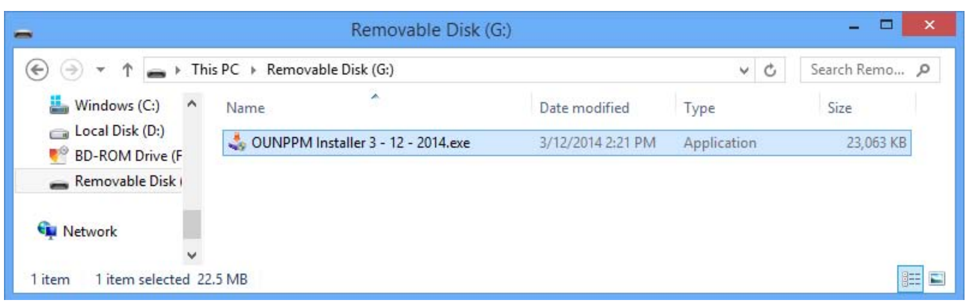


Figure 3: The installation file, as found on your flash drive.

This will launch a standard installer wizard.

3.2 Slide One

Click Next to continue, as seen in figure 14.

3.3 Slide Two

Here, accept the terms of service, as shown in figure 15, and click next to continue.

Figure 4: Click next to continue.

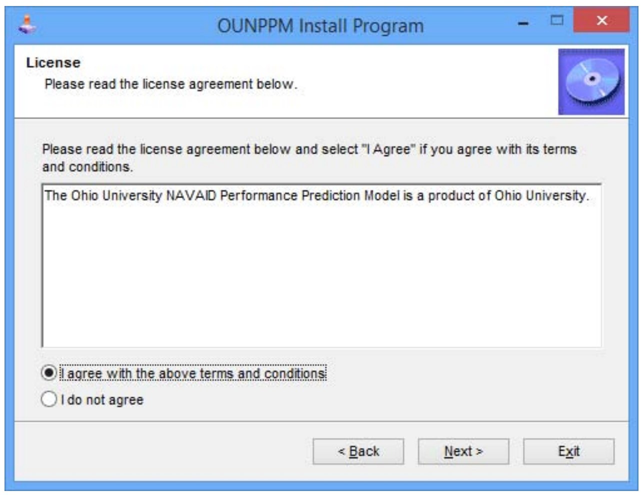


Figure 5: Accept the terms of service.

3.4 Slide Three

Here, as shown in figure 16, browse to choose the installation directory of the software. If you do not have administrator access to your computing device, then you should chose a subdirectory of your user directory, such as My Documents, or your desktop.

3.5 Slide Four

This is your last chance to change the install directory, once you click "Start", as shown in figure 17, the installation will begin.

3.6 Slide Five

If you see the screen depicted in figure 18, the installation completed successfully.

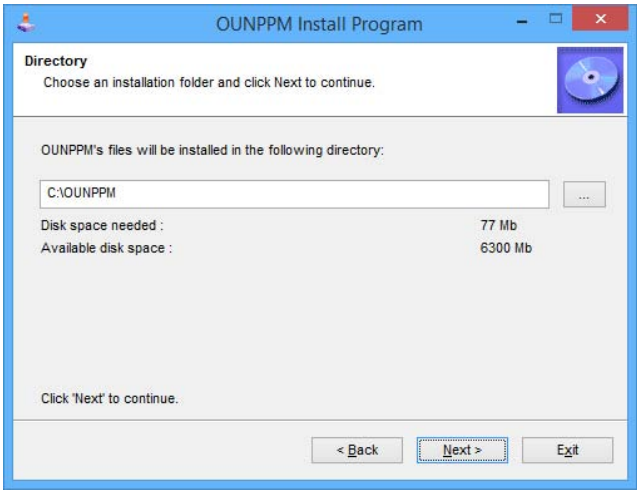


Figure 6: Choose the install location.

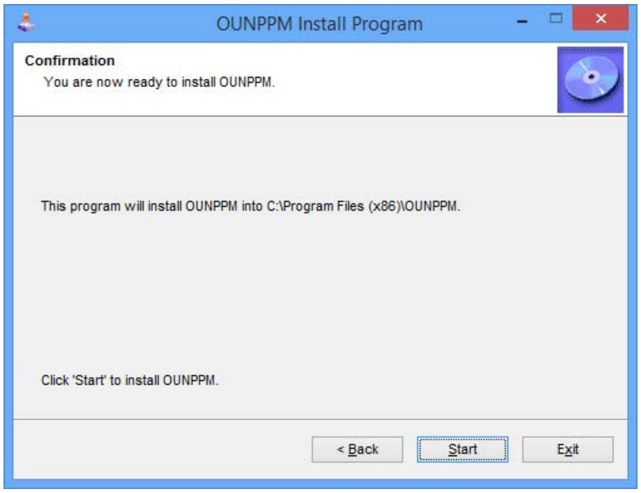


Figure 7: Press start to install.

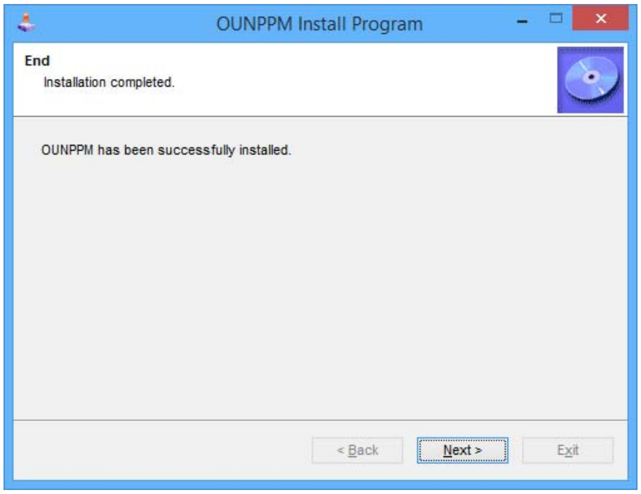


Figure 8: Press start to install.

3.7 Slide Six

Click the exist button, as seen in the lower right corner of figure 19, to exit the installer.

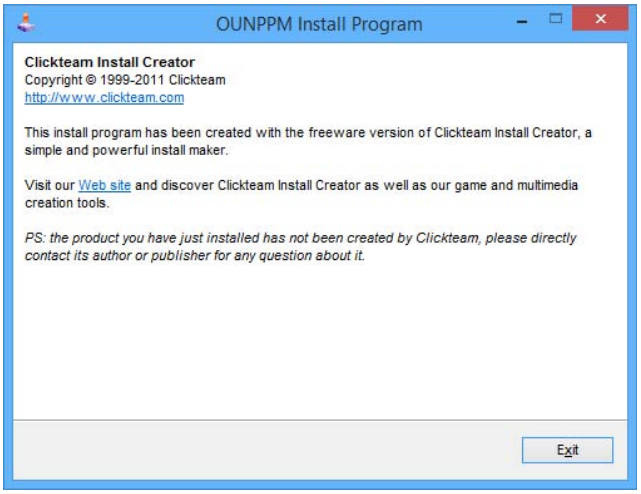


Figure 9: Press start to install.

3.8 Install Complete

Now that the OUNPPM installation is complete, you should be able to run the program. By default, the installer will create a shortcut in your start menu under the directory OUNPPM to run the program, as seen in figure **??**.

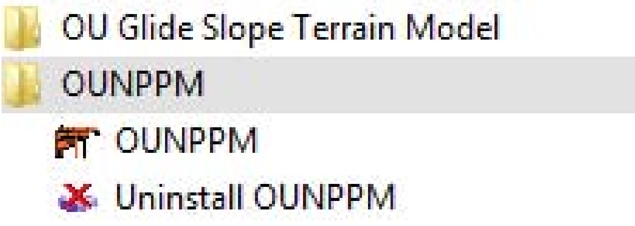


Figure 10: OUNPPM in the start menu.

3.9 Running OUNPPM Directly

You can also run the program by browsing to the install directory and running "Run OUNPPM.bat" as seen in figure **??**.

4 Installer from Website

4.1 Acquiring Installer

The executable installers can be acquired from the following url, which looks like figure 12:

`http:\ounppm.eecs.ohio.edu/ounppm/install/`

The recommended installer will be called: "Install.exe".

All other installation files should be of the form, "OUNPPM Installer *DATE*.exe".

Installers of various versions will appear on this website. The recommended installer should appear at the top of the list,and the remaining versions will be presented lexicographically.

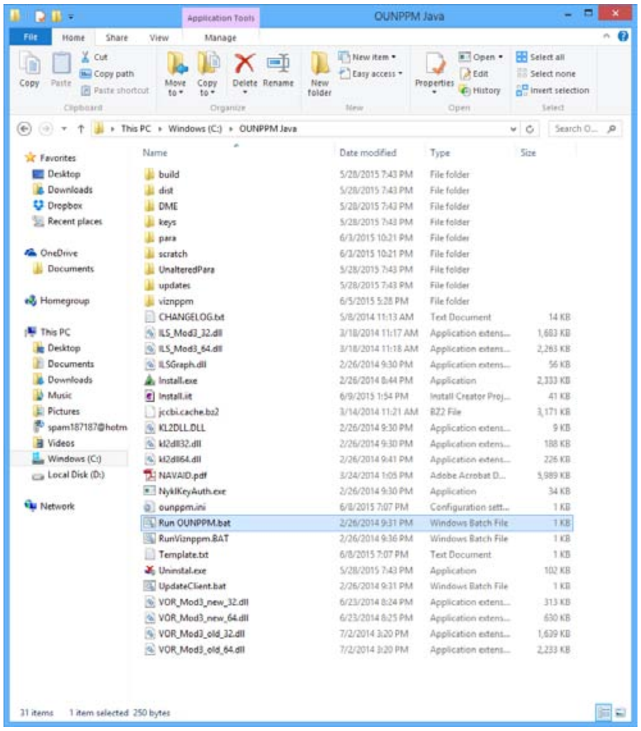


Figure 11: How to run OUNPPM directly.

Figure 12: The installation file, as found on your flash drive.

4.2 Begin Installation

The installation file, should be of the format "OUNPPM Installer *DATE*.exe".

From your flash drive, double click the file as shown in figure 13. Note: the date will change with future updates, and additional files may be present.

This will launch a standard installer wizard.

4.3 Slide One

Click Next to continue, as seen in figure 14.

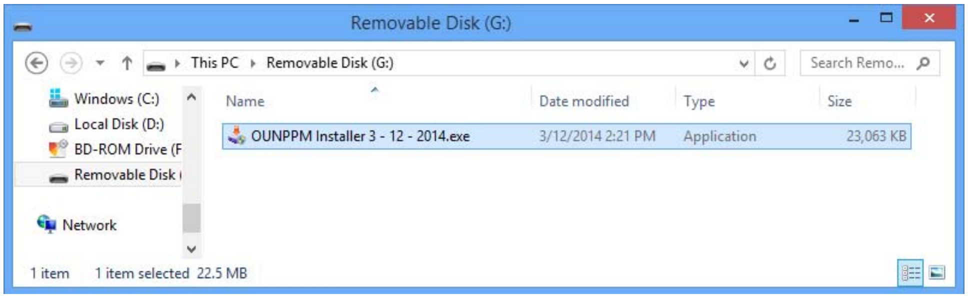


Figure 13: The installation file, as found on your flash drive.

Figure 14: Click next to continue.

4.4 Slide Two

Here, accept the terms of service, as shown in figure 15, and click next to continue.

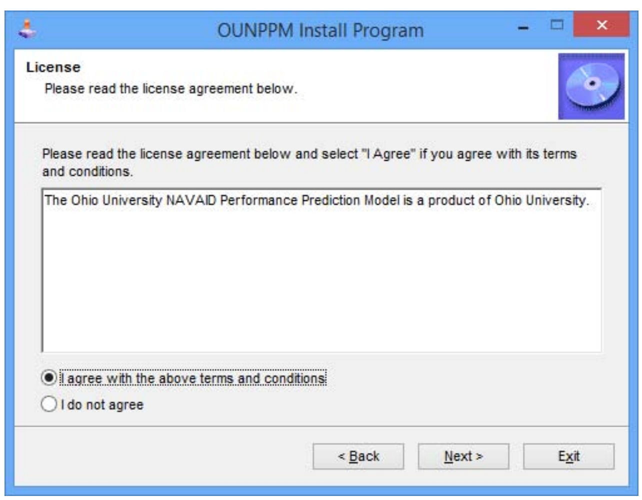


Figure 15: Accept the terms of service.

4.5 Slide Three

Here, as shown in figure 16, browse to choose the installation directory of the software. If you do not have administrator access to your computing device, then you should chose a subdirectory of your user directory, such as My Documents, or your desktop.

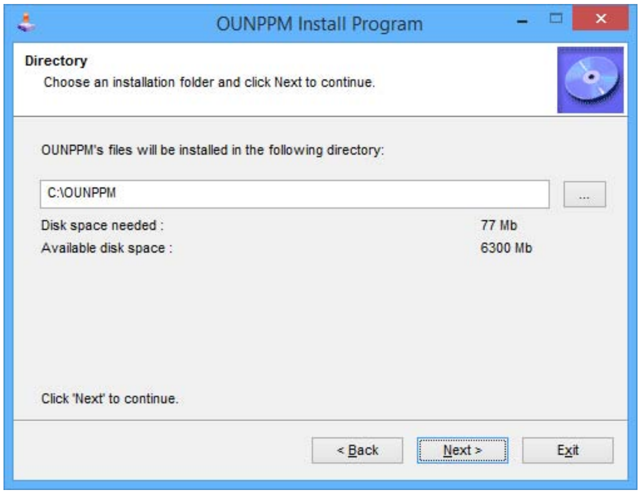


Figure 16: Choose the install location.

4.6 Slide Four

This is your last chance to change the install directory, once you click “Start”, as shown in figure 17, the installation will begin.

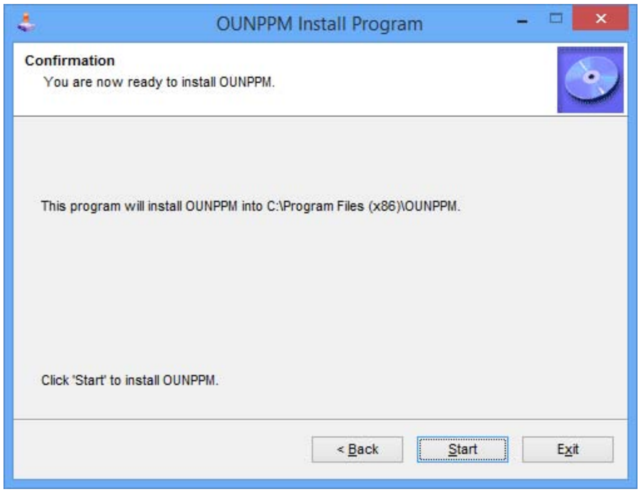


Figure 17: Press start to install.

4.7 Slide Five

If you see the screen depicted in figure 18, the installation completed successfully.

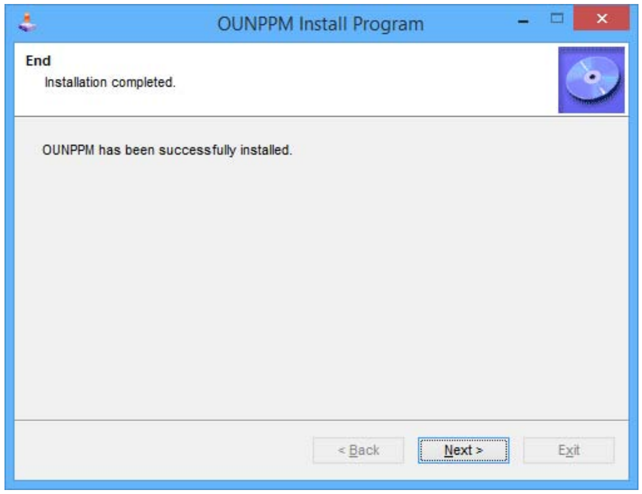


Figure 18: Press start to install.

4.8 Slide Six

Click the exist button, as seen in the lower right corner of figure 19, to exit the installer.

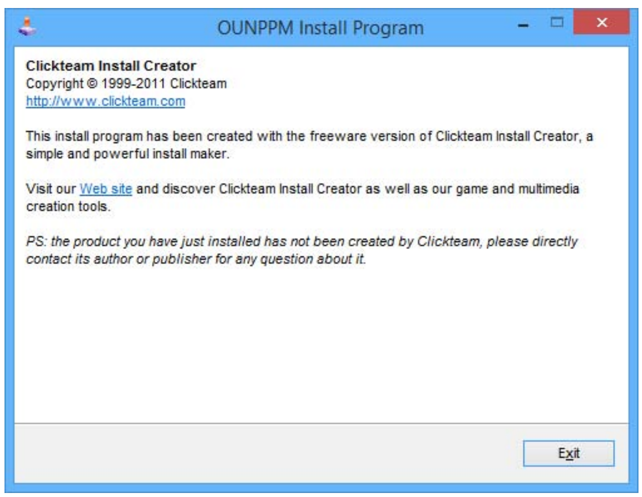


Figure 19: Press start to install.

4.9 Install Complete

Now that the install is complete, a new folder, "OUNPPM", should appear in your Start Menu, with two items, as shown in figure 18. Click the "OUNPPM" item to start the application.

4.10 Running OUNPPM Directly

You can also run the program by browsing to the install directory and running "Run OUNPPM.bat" as seen in figure **??**.

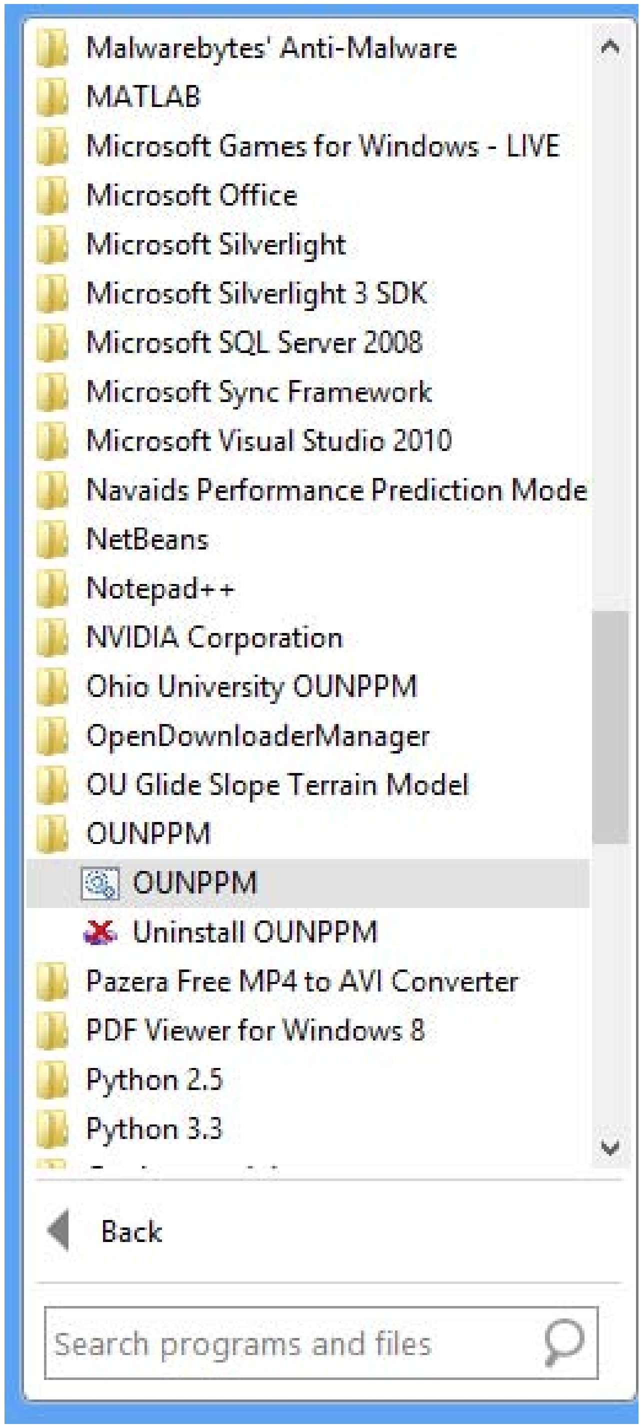


Figure 20: OUNPPM in the start menu.

5 .zip from Website

5.1 Acquiring .zip

Ohio University hosts all previous version of OUNPPM at:

http:\ounppm.eecs.ohio.edu/ounppm/updates

A user can select any of the versions of the software by downloading a .zip from this website, as seen in figure 22. The highest build number and date are the rec-

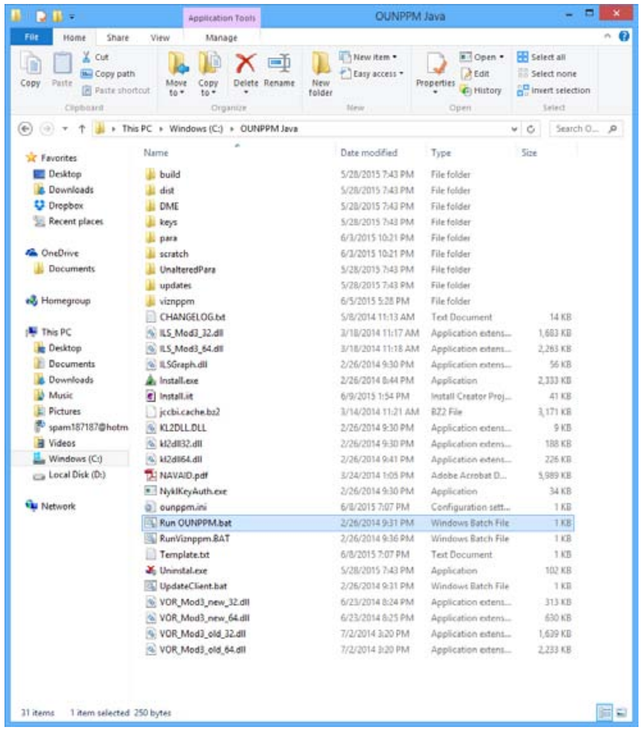
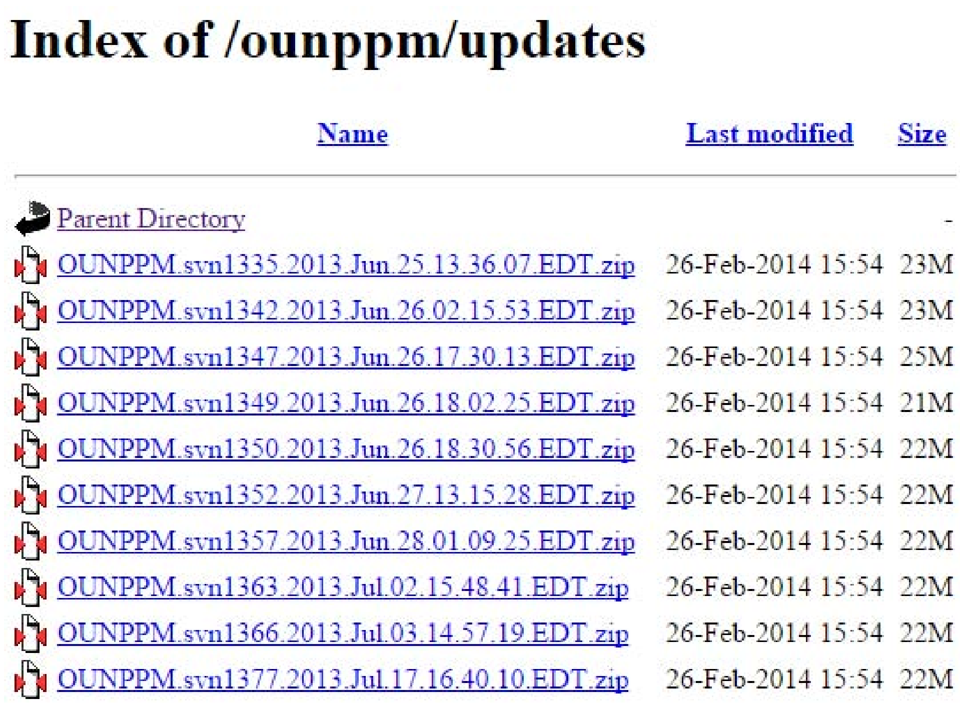


Figure 21: How to run OUNPPM directly.

ommended version. Download the .zip of your choosing, and continue to the next section.



Index of /ounppm/updates

Name	Last modified	Size
Parent Directory		-
OUNPPM.svn1335.2013.Jun.25.13.36.07.EDT.zip	26-Feb-2014 15:54	23M
OUNPPM.svn1342.2013.Jun.26.02.15.53.EDT.zip	26-Feb-2014 15:54	23M
OUNPPM.svn1347.2013.Jun.26.17.30.13.EDT.zip	26-Feb-2014 15:54	25M
OUNPPM.svn1349.2013.Jun.26.18.02.25.EDT.zip	26-Feb-2014 15:54	21M
OUNPPM.svn1350.2013.Jun.26.18.30.56.EDT.zip	26-Feb-2014 15:54	22M
OUNPPM.svn1352.2013.Jun.27.13.15.28.EDT.zip	26-Feb-2014 15:54	22M
OUNPPM.svn1357.2013.Jun.28.01.09.25.EDT.zip	26-Feb-2014 15:54	22M
OUNPPM.svn1363.2013.Jul.02.15.48.41.EDT.zip	26-Feb-2014 15:54	22M
OUNPPM.svn1366.2013.Jul.03.14.57.19.EDT.zip	26-Feb-2014 15:54	22M
OUNPPM.svn1377.2013.Jul.17.16.40.10.EDT.zip	26-Feb-2014 15:54	22M

Figure 22: The version repository containing .zips of all versions.

5.2 Begin Extraction

The next step is to extract the .zip file. Windows 7 and above include ways to extract .zip files automatically. An example using Windows 8.1 is shown below in figure 23.

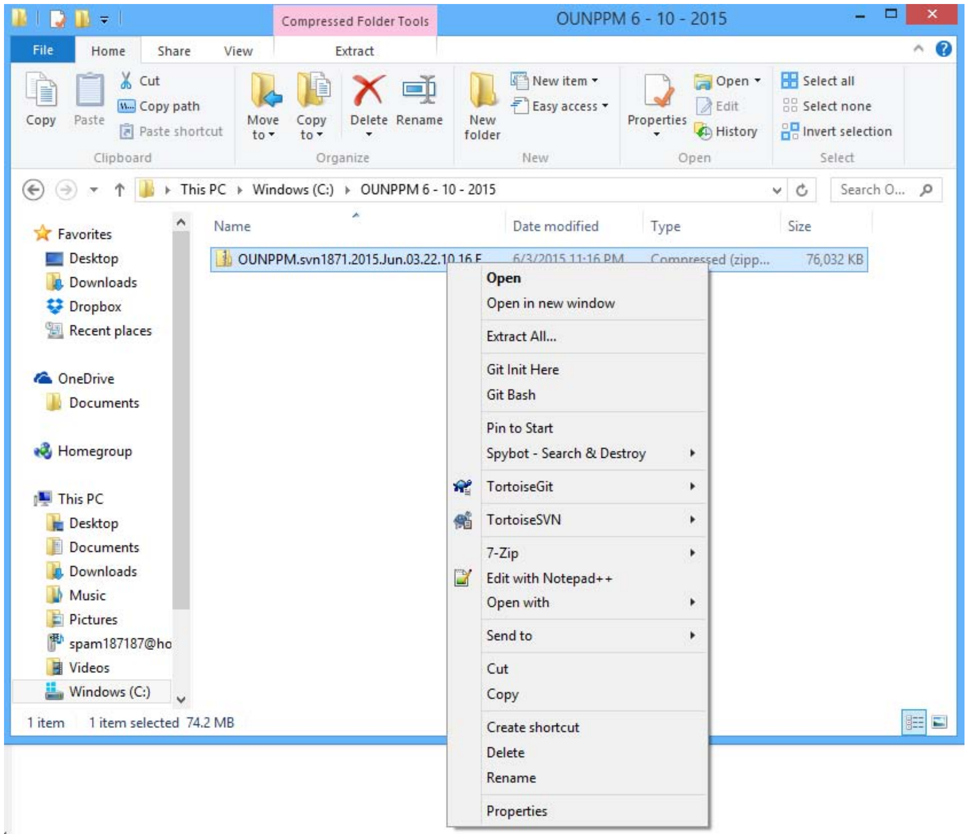


Figure 23: How to extract a .zip.

5.3 Choose Location

You will be prompted to chose a location for where extracted files should be placed, as seen in figure 24. This will default to a subdirectory in the directory where the file presently is.

5.4 Extraction Compete

When the extraction is complete, the files should look similar to the layout in figure 25.

Note: this method does not make a shortcut in the start menu like the installer does. The user can add one themselves.

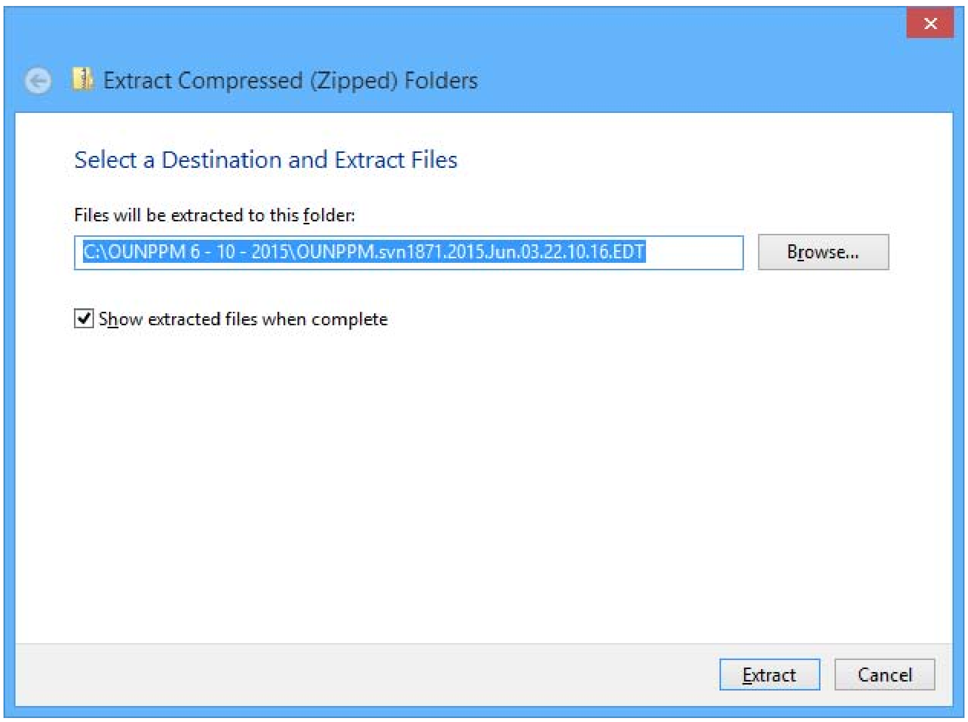


Figure 24: How to chose a location for the contents of the .zip.

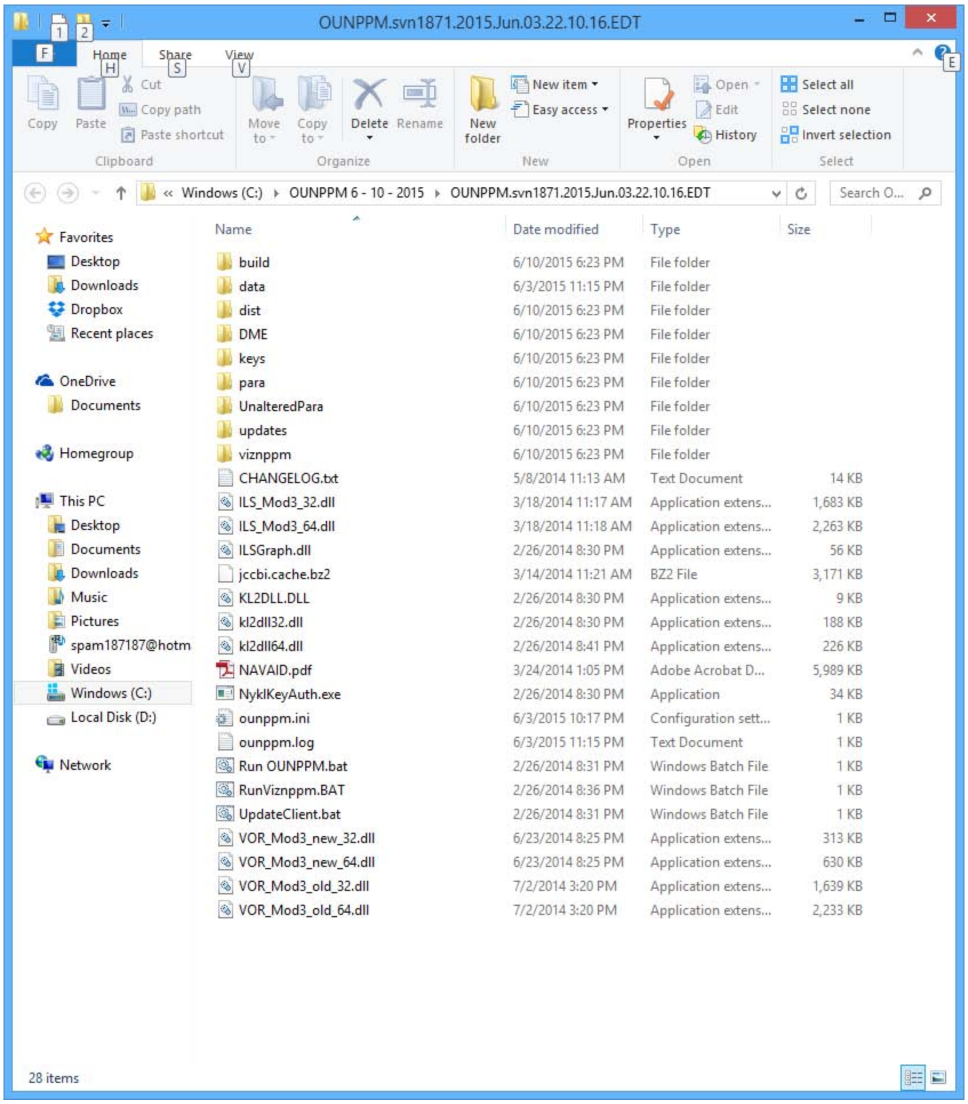


Figure 25: The files extracted from the .zip.

Part III

Preliminaries

6 OUNPPM Overview

Ohio University Navaids Performance Prediction Model (OUNPPM) can simulate three types of systems:

- Localizer
- Glideslope
- VHF Omnidirectional Ranging system (VOR)

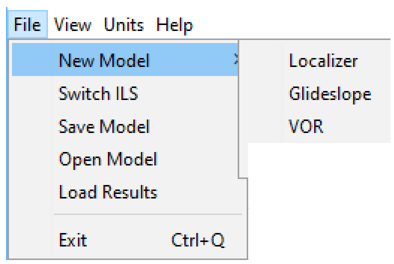


Figure 26: The available models supported by OUNPPM.

One type of system may be modeled at anytime. Figure 26 shows how one creates a new Model. The state of a simulation can be saved at any time to a data file, referred to in this document as the *.dat*. The current .dat file being referenced, or the lack of one is shown at the bottom of the application, as seen in figure 27.

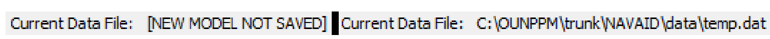


Figure 27: Examples of the .dat file indicator. Left) the default, Right) a file saved as temp.dat.

7 System Requirements

- Windows 32-bit/64-bit OS: Windows XP SP3, Vista, 7, 8, 8.1, or 10
- Java SE Runtime Environment (JRE) 7.0 or greater. Free Download at: `http://www.oracle.com/technetwork/java/javase/downloads/index.html`
- 1GB RAM
- 100MB Disk pace

Note: The default run scripts expect Java 7 or higher to be the first Java installation in your path. The program can still be run by editing the scripts if for some reason Java 7 cannot be the first Java in your path.

8 Coordinate Frames

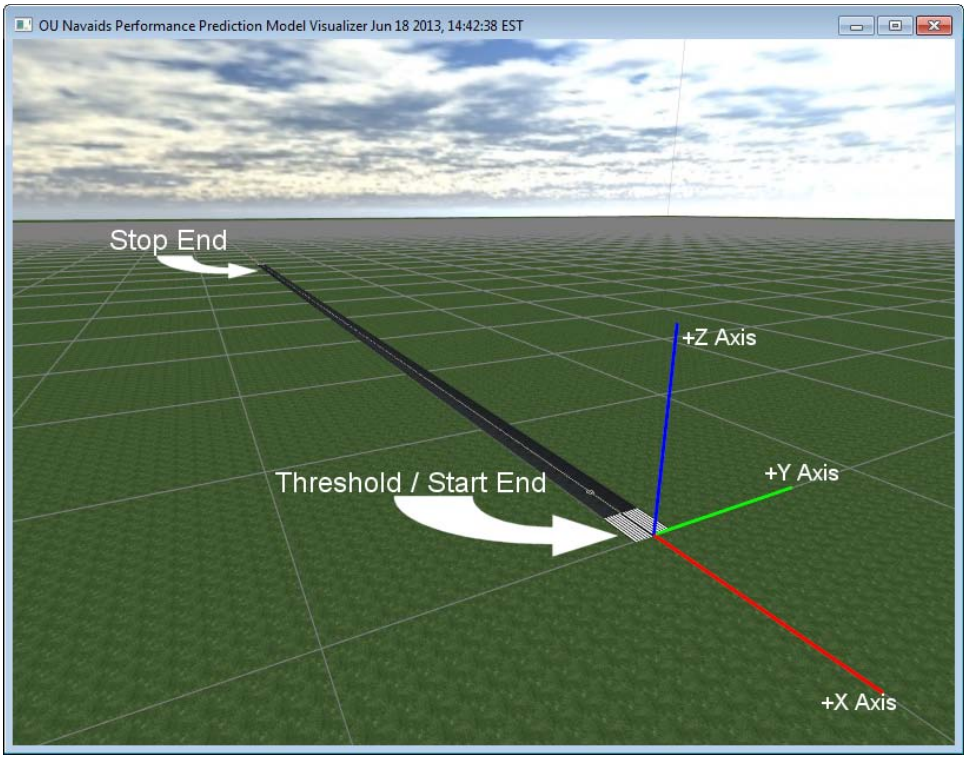


Figure 28: The Localizer / Glideslope reference frame used by OUNPPM.

8.1 Localizer / Glideslope

See Fig.28 for illustration.

Origin is located at *threshold*, also called *start end*. The positive x-direction extends from threshold away from stop end. This means an aircraft with a front approach will start at some positive x value and proceed in a decreasing x-direction. The positive z-direction is upwards out of the earth. We use a right-hand coordinate system, so the y-direction can be derived from these two vectors. Positive rotations (as viewed looking in a negative z-direction, i.e. top-down), are counter-clockwise.

8.2 VOR

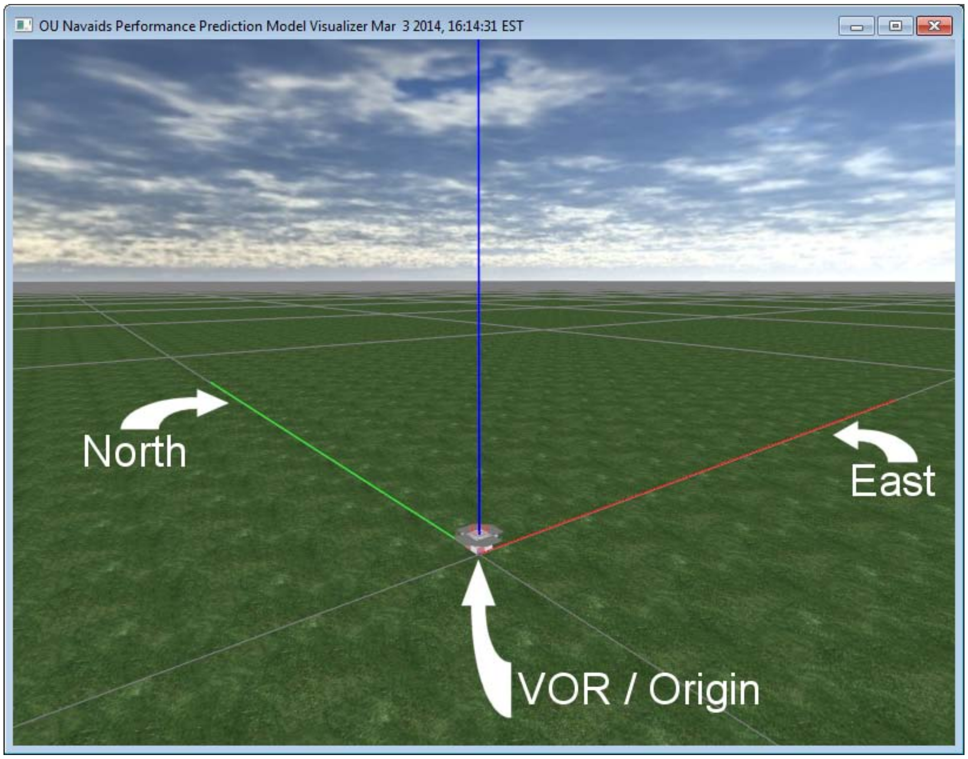


Figure 29: The VOR reference frame used by OUNPPM. The Green Axis is North and the Red Axis is East.

The VOR does not need to have a runway, it simply is positioned relative to some origin, shown in Fig.29, where the red, green, and blue axes intersect. The VOR uses a *Left handed* coordinate frame where positive rotations are clockwise. The Green Axis points North and the Red Axis points East.

Part IV

Graphical User Interface (The Inputs)

This section will discuss the input to the model via the graphical user interface (GUI). It will first cover how to use the input forms, followed by features unique to each model type, followed by the remaining features that are the same across all types.

9 General Input

Figure30 shows a common input box. An input box is typically a numeric value followed by a unit. For example, the Runway Length is set to 10000.0 ft. Some input boxes require a distance or length argument, some require an angular argument, some require a decibel argument, some require a unitless ratio, etc. When a user enters an argument with no unit, the input will be automatically converted to the *Default* unit. The *Default* unit may either be set to *Feet* or *Meters*. One may enter an argument with *any desired unit* (see list below) and OUNPPM will automatically convert this value to the *Default* units. For example, if the *Default* unit is 'Feet' a user may enter '1000m' or '1000 m' or '1km' or '1 km', and the corresponding box will change to '3280.84 ft'. Figure 31 shows how to change the *Default* unit type.

For distance inputs, one may choose to enter any valid numeric value followed by optional white space and then an optional unit. Valid distance types are feet, meters, kilometers, nautical miles, and wavelengths. The following list denotes valid unit suffixes:

- Feet: 'ft', 'f', 'foot', 'feet'
- Meters: 'm', 'meter', 'meters'
- Kilometer: 'km', 'kilometer', 'kilometers'
- Wavelengths: 'w', 'wavelength', 'wavelengths'
- Nautical Miles: 'nm', 'nmi', 'NM', 'nautical mile', 'nautical miles'

Similarly, for other unit types, valid suffixes include:

- Micro Amperes: 'ua', 'uA', 'microamp', 'microamps', 'uAmps', 'uamps'
- Degrees: 'deg', 'degs', 'degree', 'degrees'

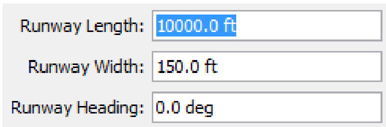


Figure 30: A typical input box.

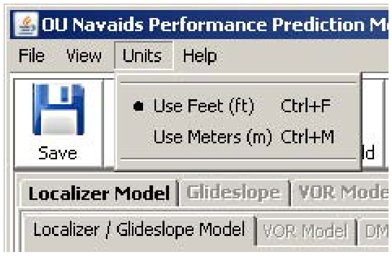


Figure 31: Default Units are either English or Metric.

10 Localizer Model

This section discusses the localizer tab, as seen in figure 32. This tab is only enabled for Localizer models; therefore, it is mutually exclusive with glide slope and VOR models. This chapter will be divided into three sections matching the 3 panels of the localizer tab seen in figure 32: Facility Parameters, Modeling Parameters, and Array Parameters.

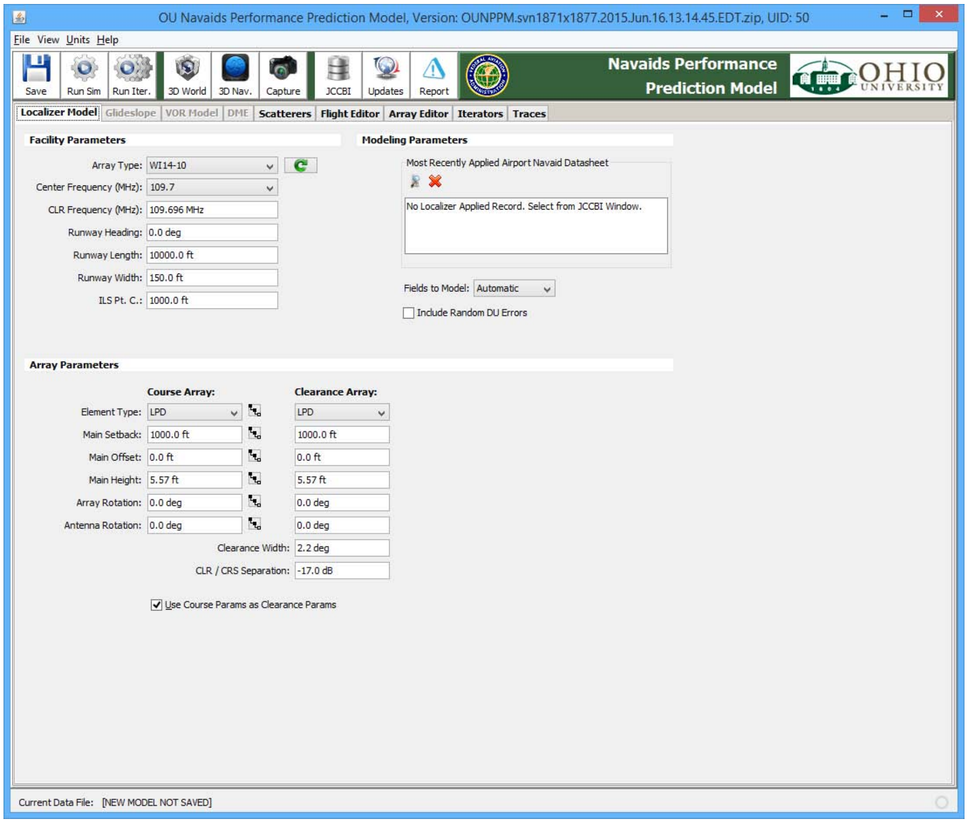


Figure 32: The localizer tab.

10.1 Facility Parameters

This section discusses the *facility parameters*, as shown in figure 59. This section is divided into 6 subsections describing the component groups found in figure 59: Array Type, Center Frequency, CLR Frequency, Runway Heading, Runway Length, and Runway Width.

10.1.1 Array Type

10.1.1.1 Overview

The array type selection consists of two main components, as seen in figure 60: the combo (drop down) box, and the refresh button. The combo box for the localizer array type facility parameter is populated from the list of all *.ldu* files in the *para* folder.

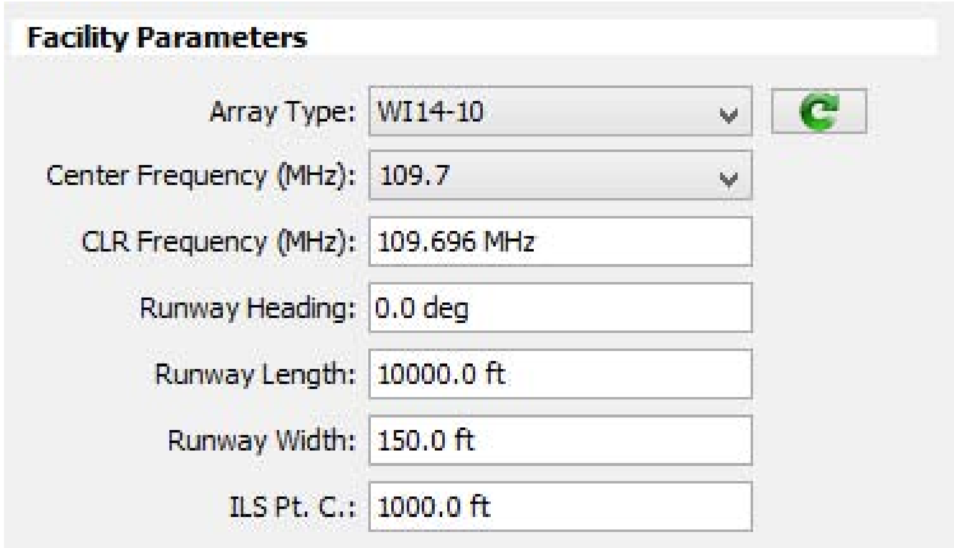


Figure 33: The facility parameters component group.

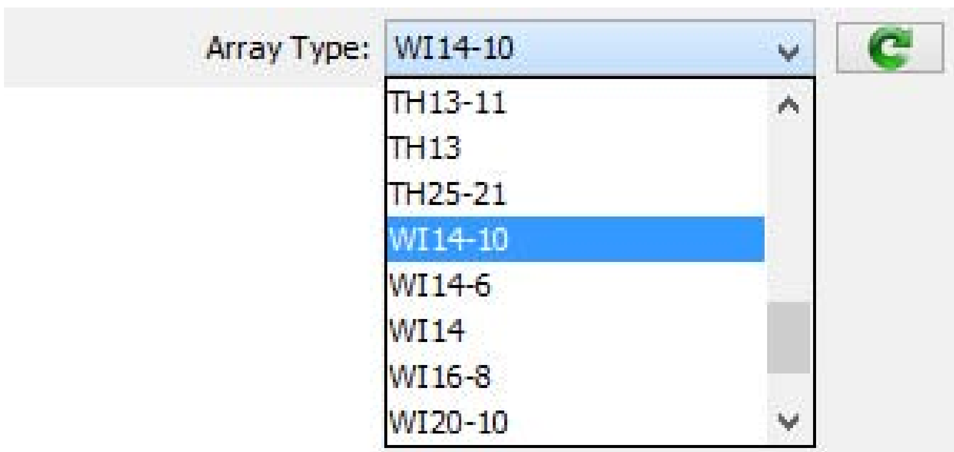


Figure 34: The array type components.

10.1.1.2 Effect on the Model

Selecting an array from this drop down list will update the internal state of the model for subsequent runs to use the array defined by the .ldu file. In general, arrays with more elements have lower error. The refresh button, assigns the previous state of the run to the array paremters. This is either the default values, or the values stored in the .dat file indicated in the current data file indicator, as seen in figure 27.

10.1.1.3 Effect on the GUI

Selecting a new array from this drop down list might also modify the enabled array modeling components, as described in section 10.3. If an array is selected containing only one (1) set of elements, the clearance components will become deactivated, as seen in figure 56; if an array is selected containing both sets of elements all components will be active, as seen in figure 71. Similarly, the CLR Frequency component will also be deactivated when only the course array is used, as seen in figure 64; if an array is selected containing both sets of elements all the CLR Frequency will be active, as seen in figure 63.

10.1.1.4 Effect on the Virtual World

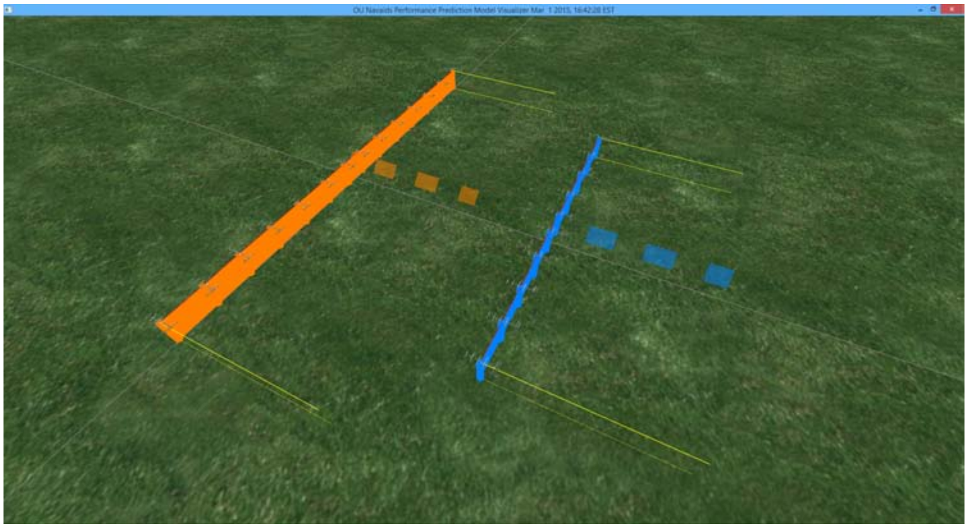


Figure 35: The array in the virtual world.

The depiction of the array in the virtual world is shown in figure 61. The elements of the course and clearance arrays are represented by vertical hexagons of the array element height; there will be one hexagon for each element. The direction of propagation of the arrays are represented by yellow normal lines and an animated propagation pattern. The course array is connected through its local origin by an orange plane perpendicular to its propagation direction. The clearance array is connected through its local origin by a blue plane perpendicular to its propagation direction.

10.1.2 Center Frequency

10.1.2.1 Overview

When a course and clearance array are both present their frequencies are separated by 8kHz. The frequency they are centered around can be selected from the combo box as seen in figure 62.

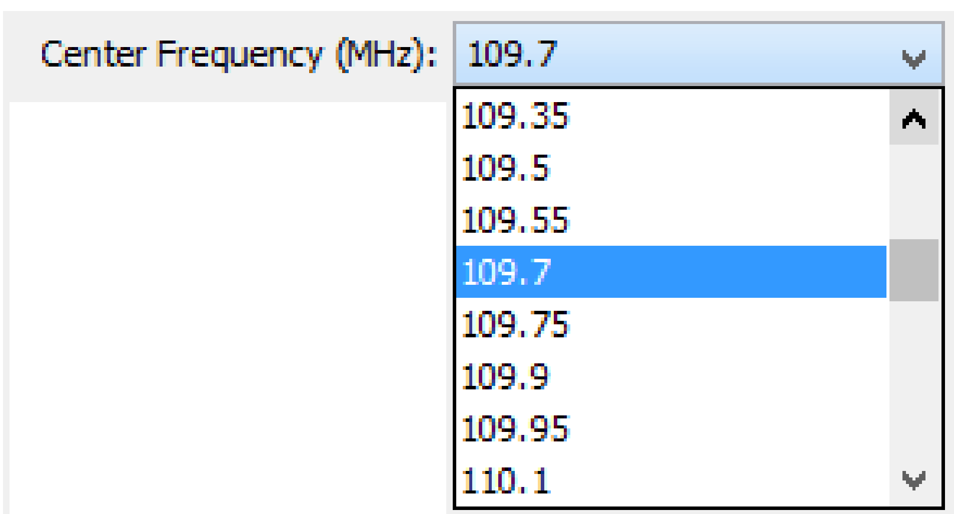


Figure 36: The center frequency component.

10.1.2.2 Effect on the Model

Selecting a frequency from this drop down list will update the internal state of the model for subsequent runes.

10.1.2.3 Effect on the GUI

If the course and clearance arrays are locked, as indicated by the checkbox in the array parameters, as described in section 10.3, as seen in figure 37, then the CLR frequency as described in section 10.1.3 will be updated to be 4kHz less than the center frequency.

Figure 37: The course clearance checkbox.

10.1.2.4 Effect on the Virtual World

This component has no effect on the virtual world.

10.1.3 CLR Frequency

10.1.3.1 Overview

By default, a course and clearance array are both present their frequencies are separated by 8kHz. This separation is adjustable within the model using the CLR Frequency component. This component is only editable

Figure 38: The clearance frequency component.

Figure 63 shows the CLR Frequency component when it is active. Figure 64 shows the CLR Frequency component when it is deactivated.

Figure 39: The clearance frequency component deactivated.

If the course and clearance arrays are locked, as indicated by the checkbox in the array parameters, as described in section 10.3, as seen in figure 37, then the CLR frequency cannot be set manually. If the arrays are not locked any value can be entered.

Note: Values entered into this component are always treated as MHz, no matter the extension.♯

10.1.3.2 Effect on the Model

Setting this component implicitly increase the separation of the course and clearance arrays. The center frequency, ν_c, is specified by the value in the center frequency component, as described in section 10.1.2. The clearance frequency, ν_- is specified by the value in this component. Equations (4) and (5) provide two (2) separate derivations for the course frequency, ν_+.

$$\nu_+ = \nu_c + (\nu_c - \nu_-) \tag{1}$$

$$\nu_+ = 2\nu_c - \nu_- \tag{2}$$

10.1.3.3 Effect on the GUI

This component has no effect on the other GUI widgets.

10.1.3.4 Effect on the Virtual World

This component has no effect on the virtual world.

10.1.4 Runway Heading

10.1.4.1 Overview

The runway heading component, as seen in figure 40, is used to update the heading of the runway.

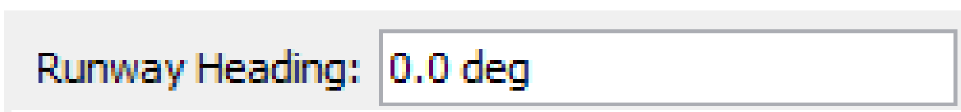


Figure 40: The runway heading component.

Because the localizer coordinate system, as described in section 8.1, and shown in figure 28 is based on the runway direction, very few parameters are affected by this setting. Any data referenced *from north* would necessarily be affected by this value.

10.1.4.2 Effect on the Model

This has no known effect on the model.

10.1.4.3 Effect on the GUI

This has no effect on other GUI components.

10.1.4.4 Effect on the Virtual World

The runway number will change to reflect the new heading, as seen in figures 41 and **??**. Figure 41 shows a runway with a heading of 40°; figure 42 shows a runway with a heading of 120°.

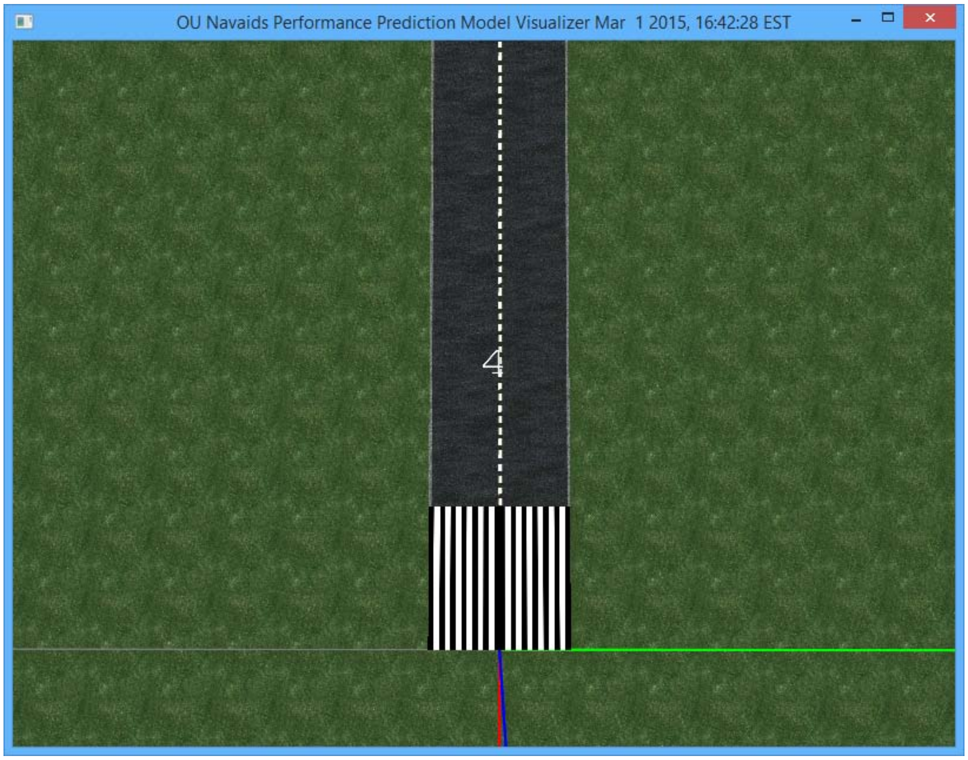


Figure 41: The runway with a heading of 40 degrees.

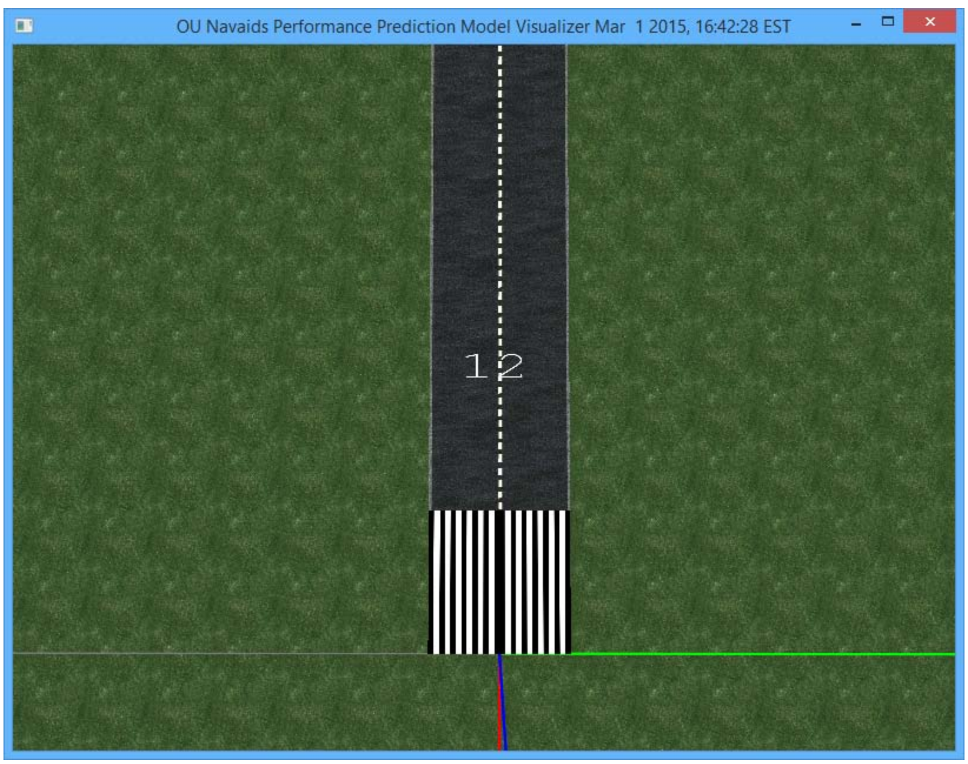


Figure 42: The runway with a heading of 120 degrees.

10.1.5 Runway Length

10.1.5.1 Overview

The runway heading component, as seen in figure 43, is used to update the length of the runway.

Figure 43: The runway length component.

10.1.5.2 Effect on the Model

The length of the runway will affect the default values of some flight approaches effecting the domain of some output plots. Runway length also affects the calculation of the default course width.

10.1.5.3 Effect on the GUI

The component should not have any effect on other components.

10.1.5.4 Effect on the Virtual World

This component effects the runway model in the virtual world. Figure 44 shows a runway with a length of 10000 feet; figure 45 shows an 8500 foot runway. One should notice that the runway in figure 44 extends the length of 10 grid units exactly, whereas the runway in figure 45 ends in the center of a grid cell.

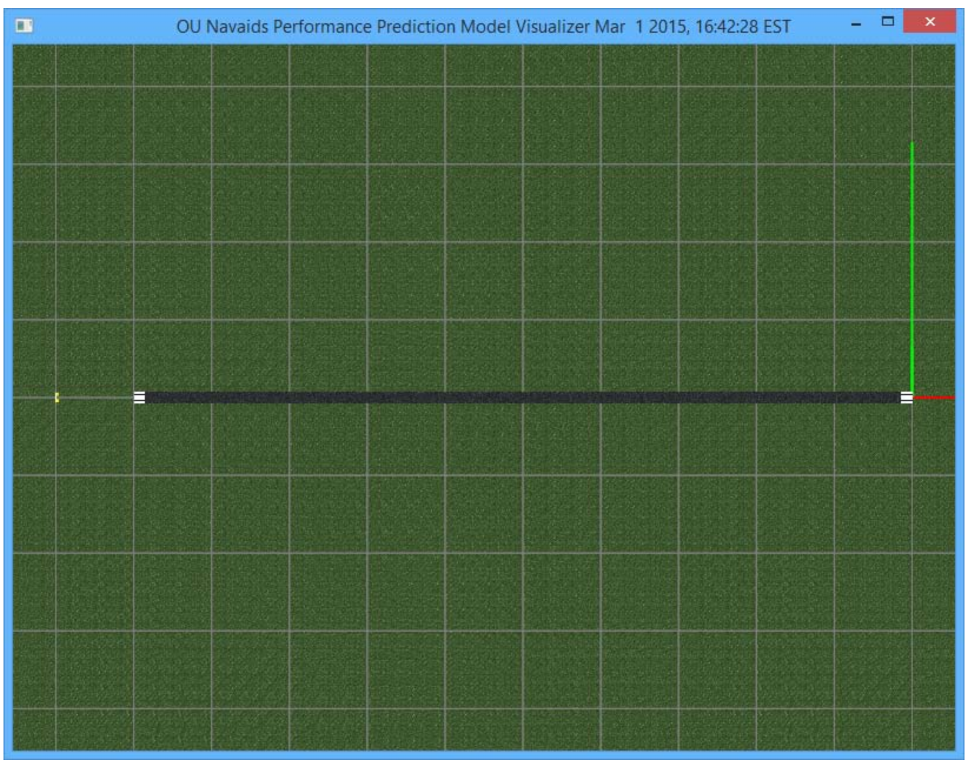


Figure 44: A runway with length 10000ft.

10.1.6 Runway Width

10.1.6.1 Overview

The runway heading component, as seen in figure 46, is used to update the width of the runway.

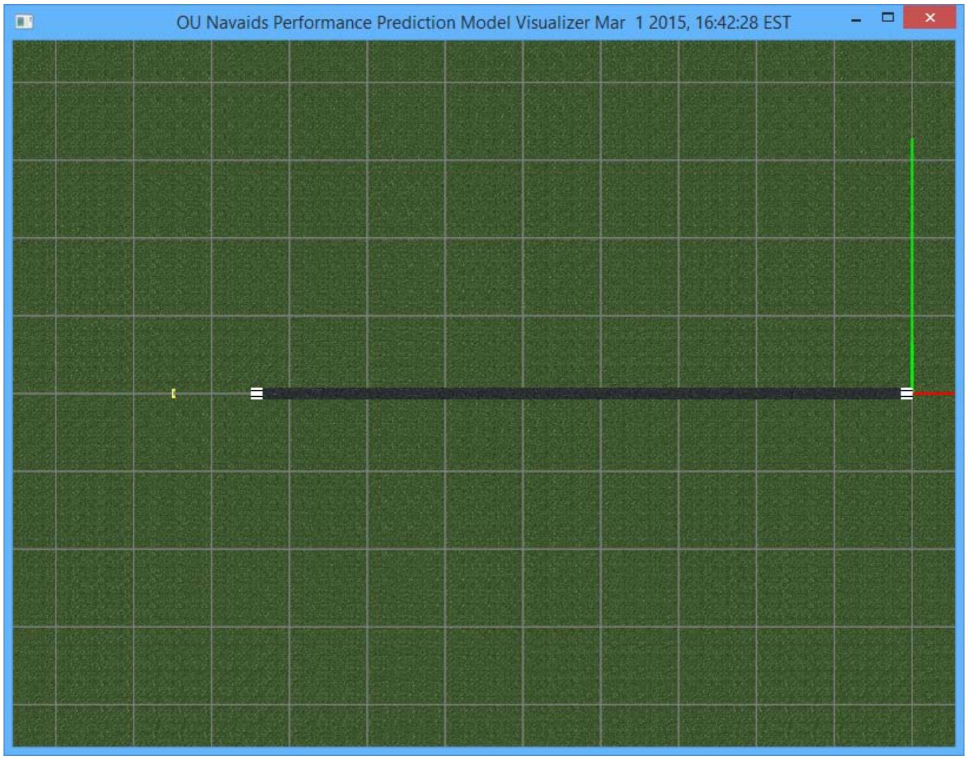


Figure 45: A runway with length of 8500ft.

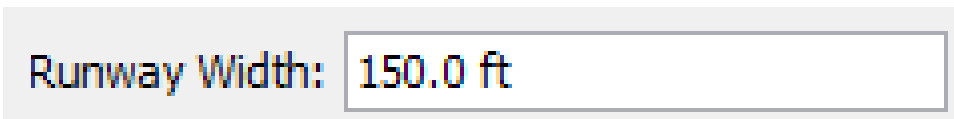


Figure 46: The runway width component.

10.1.6.2 Effect on the Model

This component has no effect on the model.

10.1.6.3 Effect on the GUI

This component has no effect on other components.

10.1.6.4 Effect on the Virtual World

This component effects the runway model in the virtual world. Figure 44 shows a runway with a width of 150 feet; figure 45 shows a runway with a width of 450 feet.

10.2 Modeling Parameters

This section discusses the *modeling parameters*, as shown in figures 65 and 66. Figure 65 shows the modeling parameters group if no JCCBI datasheet is loaded; figure 66 shows the modeling parameters group if a JCCBI datasheet has been loaded. See chapter 19 for more information about OUNPPM's interface to the JCCBI. This section is divided into 3 subsections describing the component groups found in figure 59: Datasheet, Field, and DU Error.

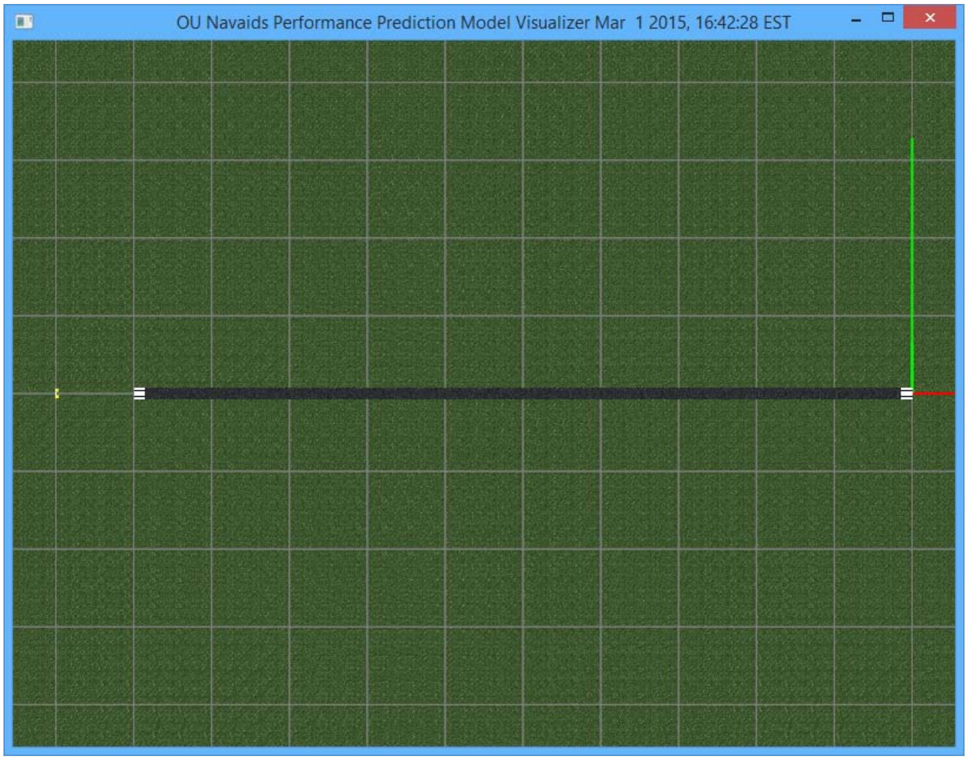


Figure 47: A runway with width 150ft.

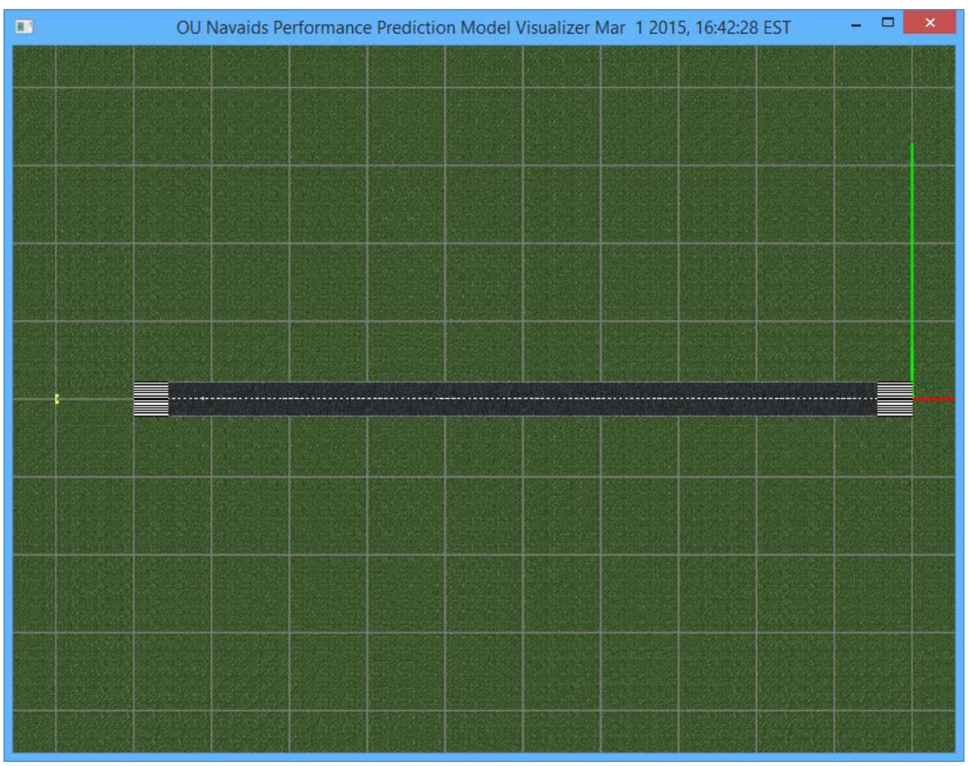


Figure 48: A runway with width of 450ft.

10.2.1 Datasheet

10.2.1.1 Overview

The JCCBI datasheet display consists of three main components, as seen in figures 67 and 68: the view button, cancel button, and the summary box. Figure 67 shows

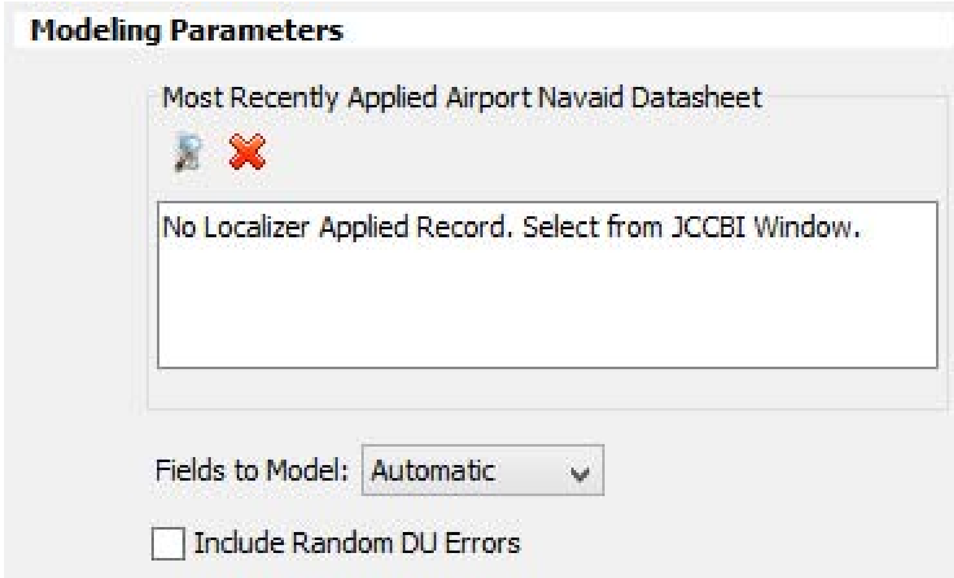


Figure 49: The localizer tab.

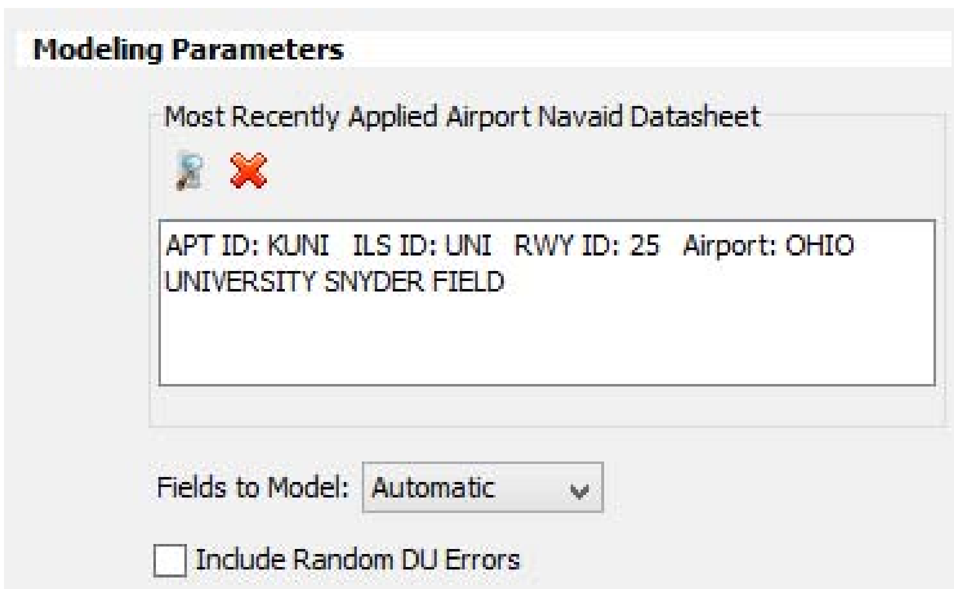


Figure 50: The localizer tab.

the summary box if a no datasheet has been loaded.

Figure 68 shows an example summary box if a databox had been loaded with the KUNI JCCBI datasheet.

The view button opens the datasheet for the currently loaded JCCBI entry in a new window, as seen in figure 69. If no JCCBI entry is currently loaded this button has no effect.

The cancel button unloads the currently selected JCCBI entry. Note: This currently has a side effect of resetting the center frequency.

10.2.1.2 Effect on the Model

The JCCBI interface itself, as described in chapter 19, will affect many aspects of the model, but these components are intended to simply view that data, not manipulate

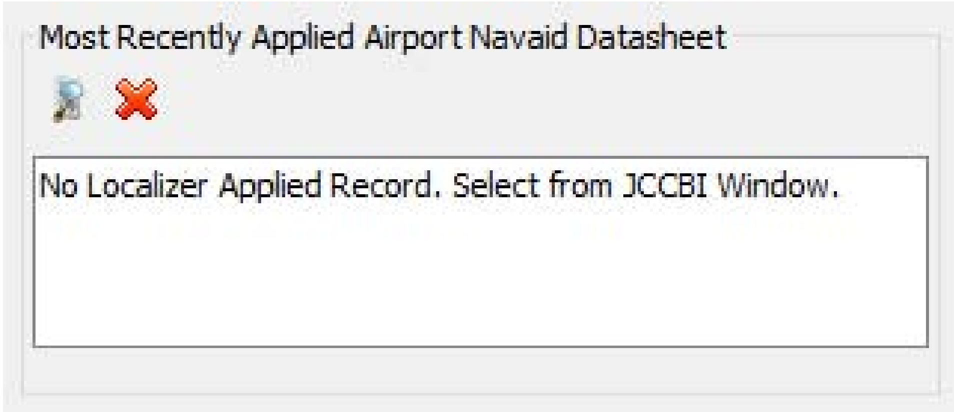


Figure 51: The datasheet group without a JCCBI datasheet loaded.

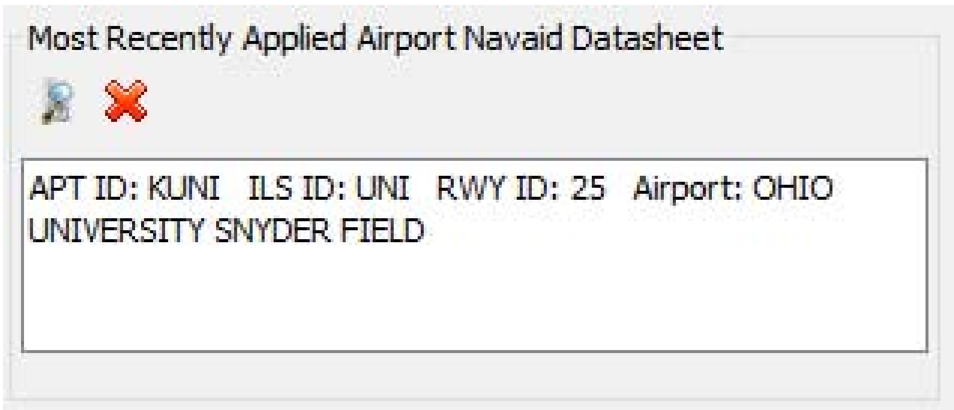


Figure 52: The datasheet group with a JCCBI datasheet loaded.

it. Note: "cancel" currently has a side effect of resetting the center frequency, which does effect the model.

10.2.1.3 Effect on the GUI

Viewing the existing JCCBI state through this summary should not affect other components.

10.2.1.4 Effect on the Virtual World

Altering the attached datasheet via The JCCBI interface itself, as described in chapter 19, will have several possible changes on the virtual world state, but viewing the JCCBI summary through these components should have no effect.

10.2.2 Field

10.2.2.1 Overview

There are two different models of scatterer field interaction: near and far. The combo box shown in figure 70 has three options: near, far, and automatic. It defaults to automatic, which will use the nearfield equations when less than some fixed number of wavelengths from the NAVAID, and uses the far field equations beyond that distance. However, a user may choose to always use the near or far field equations.

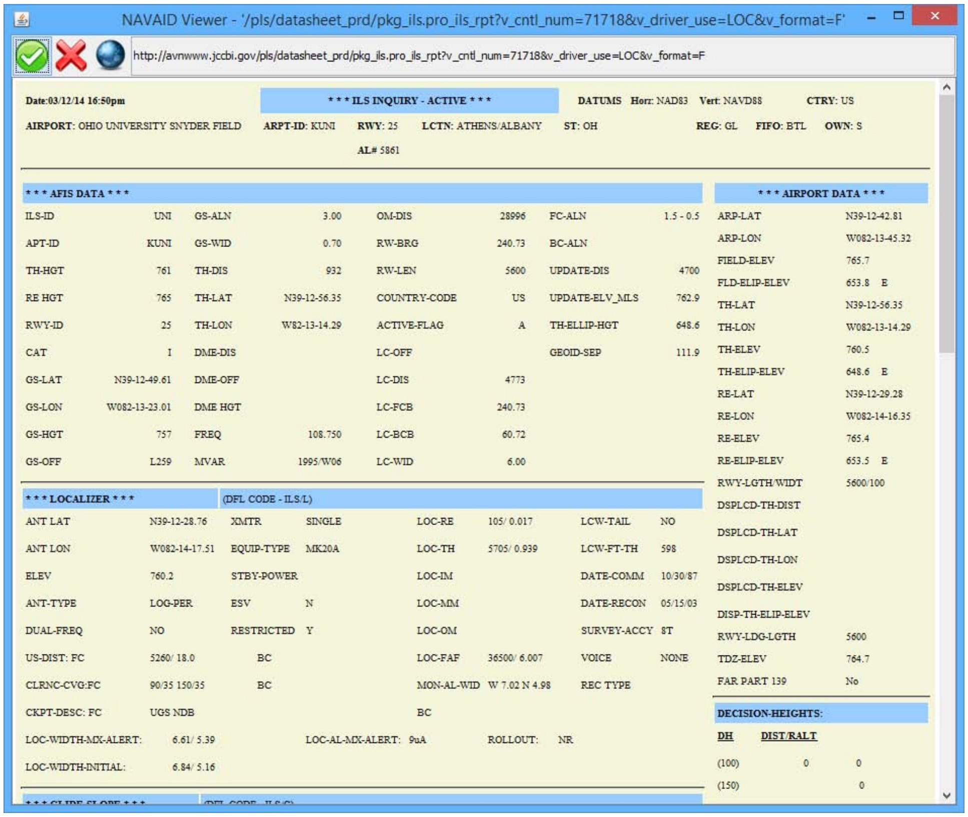


Figure 53: The datasheet for KUNI loaded view the datasheet view button.

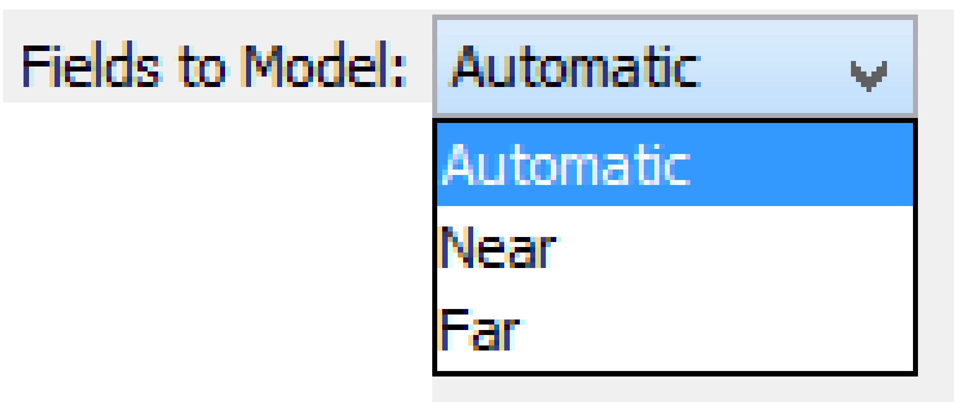


Figure 54: The field combo box options.

10.2.2.2 Effect on the Model

Can be used to force the model to use near field, or far field calculations. When set to "automatic" the model will automatically choose near or far field calculations based on a distance heuristic.

10.2.2.3 Effect on the GUI

This component has no effect on other GUI components.

10.2.2.4 Effect on the Virtual World

This selection has no effect on the virtual world.

10.2.3 DU Error

10.2.3.1 Overview

TODO

10.2.3.2 Effect on the Model

TODO

10.2.3.3 Effect on the GUI

No effect on the GUI.

10.2.3.4 Effect on the Virtual World

No effect on the virtual world.

10.3 Array Parameters

This section discusses the *array parameters*, as shown in figure 56. This section is divided into 9 subsections describing the component groups found in figures 71 and 56: Element Type, Main Setback, Main Offset, Main Height, Array Rotation, and Antenna Rotation. Figure 71 shows the array parameters when both a course and clearance array are active; figure 56 show the array parameters when using an array type with only a course array.

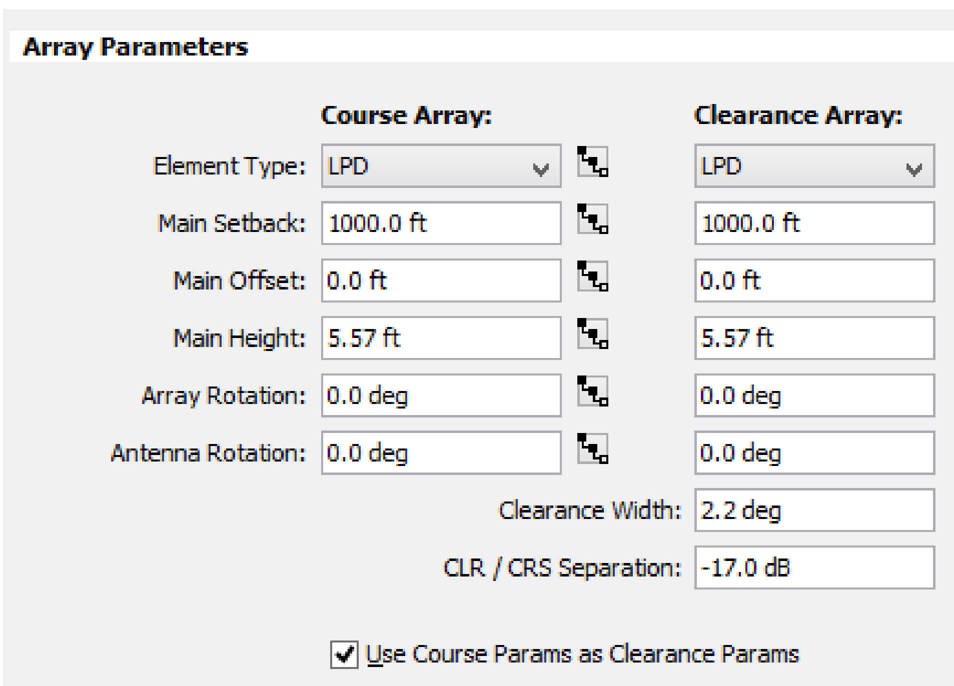


Figure 55: The array parameters components fully activated.

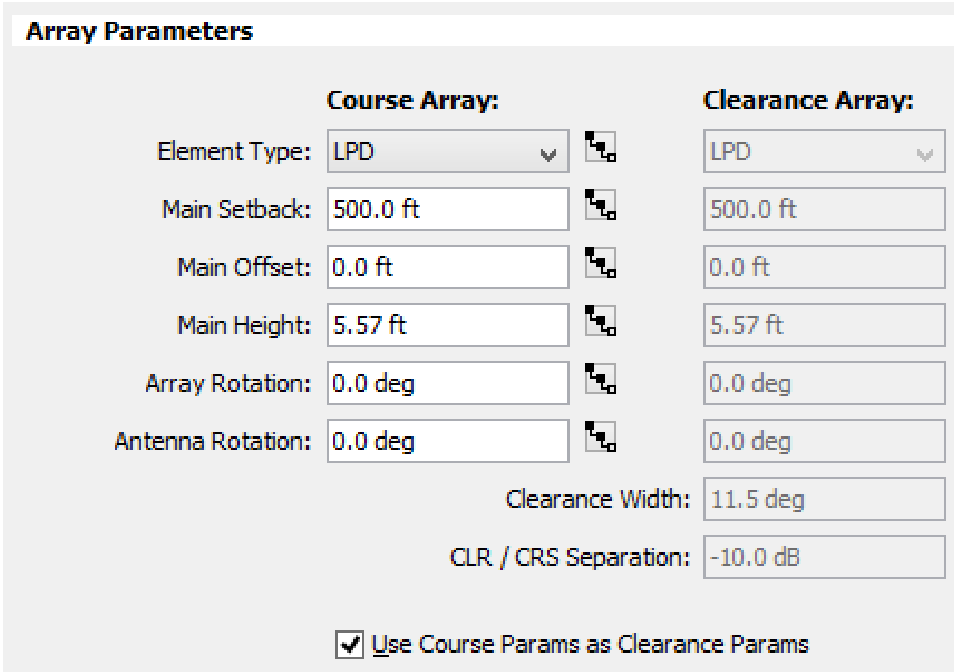


Figure 56: The array parameters components with course array components activated only.

10.3.1 Element Type

10.3.1.1 Overview

The element type affects the element pattern which affects the directionality of the signal. Figure 57 shows the example of two different patterns. By default, the model contains 6 element types for localizers:

- LPD
- Bi-LPD
- ISO
- O-Ring
- Twin_T
- V-Ring

The user is able to create their own element type with its own pattern using the element editor discussed in chapter 15.3.

10.3.1.2 Effect on the Model

Changing the element changes the directionality of the signal which can increase or decrease the effect of the clearance array, for instance.

10.3.1.3 Effect on the GUI

This has no effect on other widgets.

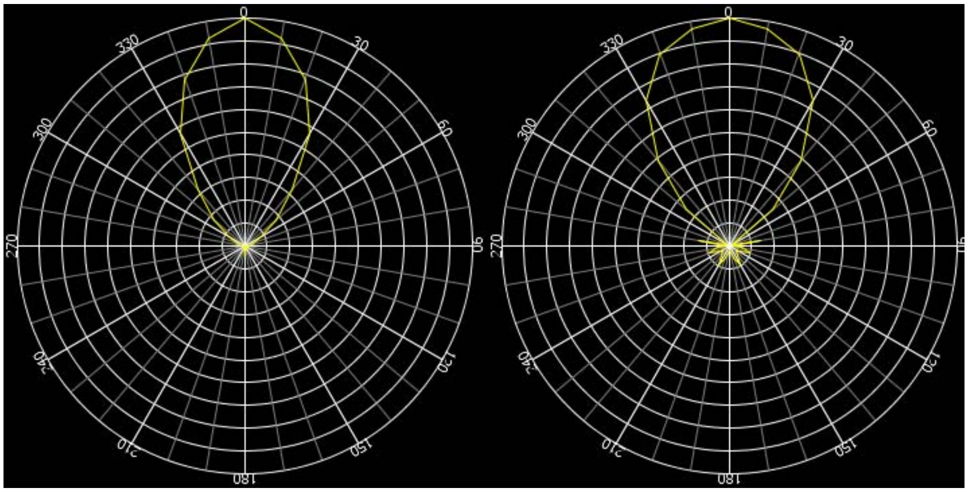


Figure 57: Left) the LPD pattern. Right) The O-Ring pattern.

10.3.1.4 Effect on the Virtual World

None at this time.

10.3.2 Main Setback

10.3.2.1 Overview

The setback affects the x-coordinate of the antenna array. Because of the nomenclature, a positive "setback" is actually a translation in the negative-x direction. The array x-coordinate, A_x, can be found using equation 3.

$$A_x = -1 * (length_{runway} + setback) \tag{3}$$

10.3.2.2 Effect on the Model

Adjusting the setback will also affect the value of a tailored course width.

10.3.2.3 Effect on the GUI

If the arrays are locked, changing the course setback will change the clearance setback.

10.3.2.4 Effect on the Virtual World

This changes the position of the corresponding array in the virtual world. Figures **??** and **??** show the virtual world with a 10,000 foot runway and an array with 2 different setbacks. Figure **??** shows a setback of 1000 feet, and figure **??** shows a setback of 1500 feet. You will notice that the 1000 foot setback (plus 10,000 foot runway) is grid cell aligned, whereas the 1500 setback is half way between cells.

10.3.3 Main Offset

10.3.3.1 Overview

TODO

10.3.3.2 Effect on the Model

10.3.3.3 Effect on the GUI

10.3.3.4 Effect on the Virtual World

10.3.4 Main Height

10.3.4.1 Overview

TODO

10.3.4.2 Effect on the Model

10.3.4.3 Effect on the GUI

10.3.4.4 Effect on the Virtual World

10.3.5 Array Rotation

10.3.5.1 Overview

TODO

10.3.5.2 Effect on the Model

10.3.5.3 Effect on the GUI

10.3.5.4 Effect on the Virtual World

10.3.6 Antenna Rotation

10.3.6.1 Overview

TODO

10.3.6.2 Effect on the Model

10.3.6.3 Effect on the GUI

10.3.6.4 Effect on the Virtual World

10.3.7 Clearance Width

10.3.7.1 Overview

TODO

10.3.7.2 Effect on the Model

10.3.7.3 Effect on the GUI

10.3.7.4 Effect on the Virtual World

10.3.8 CLR / CRS Separation

10.3.8.1 Overview

TODO

10.3.8.2 Effect on the Model

10.3.8.3 Effect on the GUI

10.3.8.4 Effect on the Virtual World

10.3.9 Course / Clearance Lock

10.3.9.1 Overview

TODO

10.3.9.2 Effect on the Model

10.3.9.3 Effect on the GUI

10.3.9.4 Effect on the Virtual World

11 Glide Slope Model

This section discusses the glideslope tab, as seen in figure 58. This tab is only enabled for Glideslope models; therefore, it is mutually exclusive with the localizer and VOR models. This chapter will be divided into four sections matching the 4 panels of the glideslope tab: Facility Parameters, Modeling Parameters, Array Parameters, and Array Auto-Adjust.

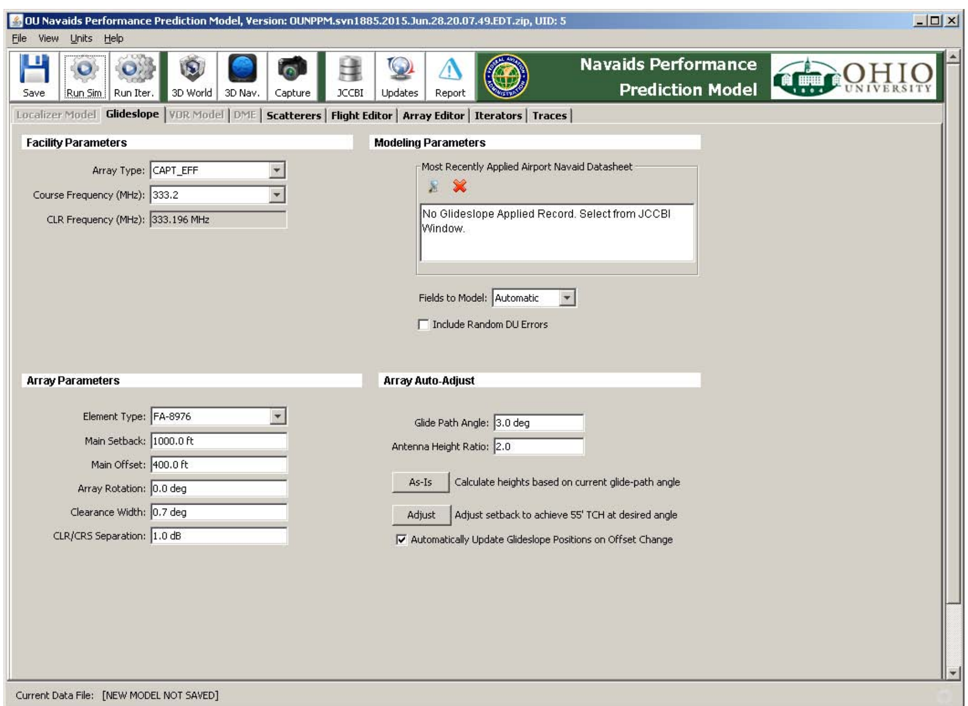


Figure 58: The glideslope tab.

11.1 Facility Parameters

This section discusses the *facility parameters*, as shown in figure 59. This section is divided into 3 subsections describing the component groups found in figure 59: Array Type, Course Frequency, and CLR Frequency.

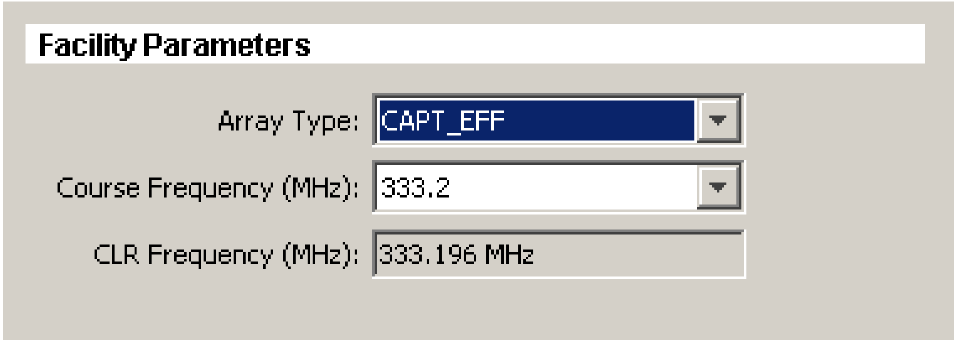


Figure 59: The facility parameters component group.

11.1.1 Array Type

11.1.1.1 Overview

The array type selection consists of two main components, as seen in figure 60: the combo (drop down) box, and the refresh button. The combo box for the glideslope array type facility parameter is populated from the list of all *.gdu* files in the *para* folder.

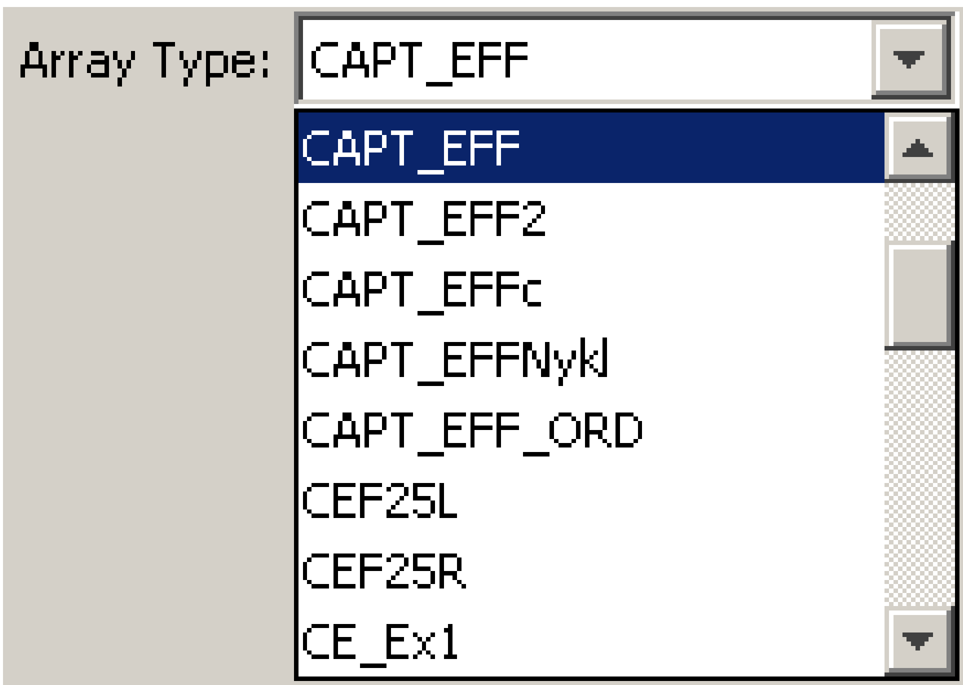


Figure 60: The array type components.

11.1.1.2 Effect on the Model

Selecting an array from this drop down list will update the internal state of the model for subsequent runs to use the array defined by the .gdu file. In general, arrays with more elements have lower error. The refresh button, assigns the previous state of the run to the array parameters. This is either the default values, or the values stored in the .dat file indicated in the current data file indicator, as seen in figure 27.

11.1.1.3 Effect on the GUI

Selecting a new array from this drop down list might also modify the enabled array modeling components, as described in section 11.3. If an array is selected containing only one (1) set of elements, the clearance components will become deactivated, as seen in figure 56; if an array is selected containing both sets of elements all components will be active, as seen in figure 71. Similarly, the CLR Frequency component will also be deactivated when only the course array is used, as seen in figure 64; if an array is selected containing both sets of elements all the CLR Frequency will be active, as seen in figure 63.

11.1.1.4 Effect on the Virtual World

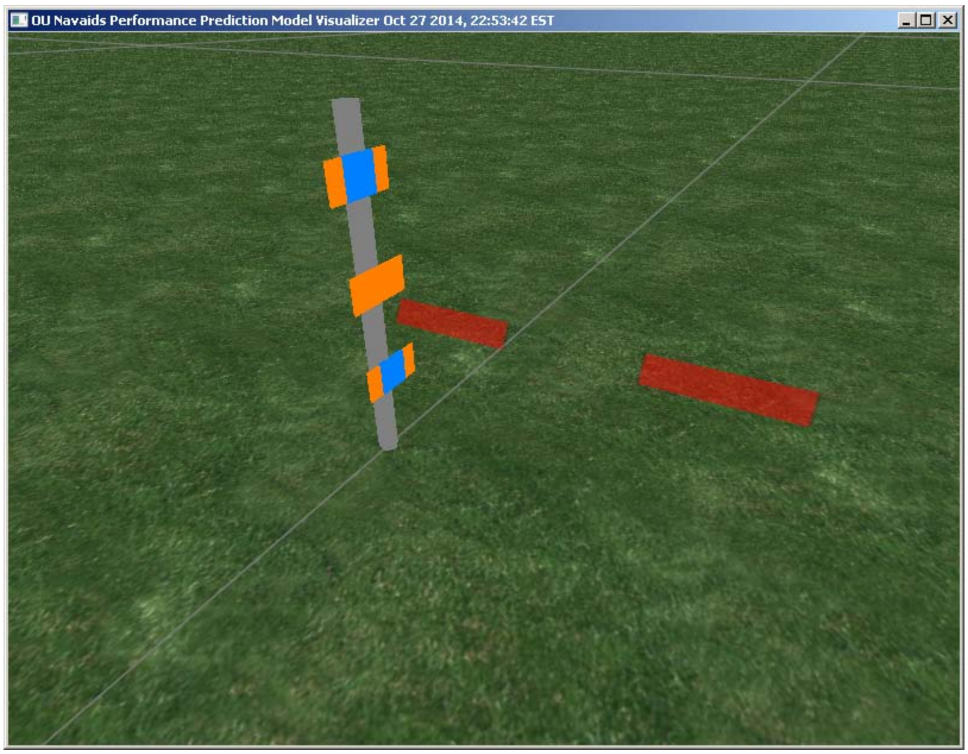


Figure 61: The array in the virtual world.

The depiction of the array in the virtual world is shown in figure 61. The antennae are drawn as orange rectangles on a grey rectangle depicting the tower. The direction of propagation of the glideslope signal is represented by an animated red propagation pattern.

11.1.2 Center Frequency

11.1.2.1 Overview

When a course and clearance array are both present their frequencies are separated by 4kHz. The frequency they are centered around can be selected from the combo box as seen in figure 62.

11.1.2.2 Effect on the Model

Selecting a frequency from this drop down list will update the internal state of the model for subsequent runes.

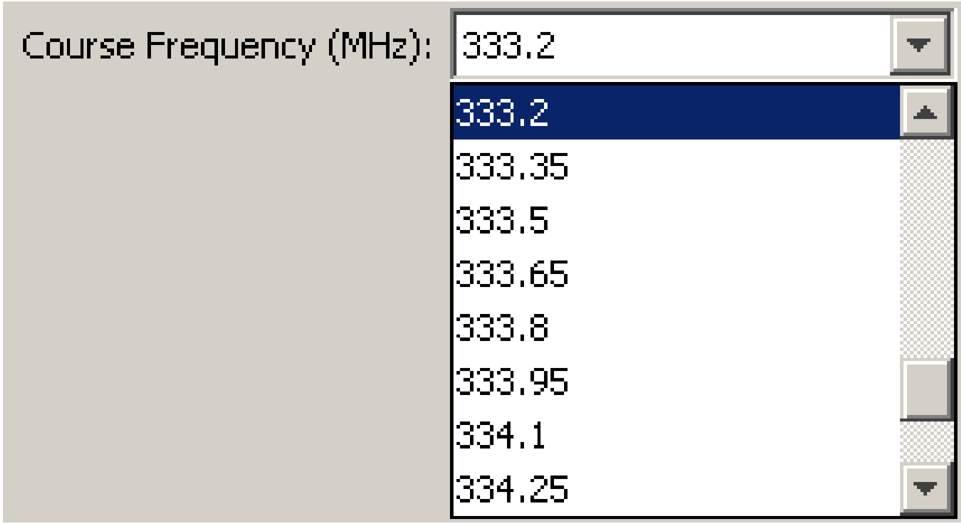


Figure 62: The center frequency component.

11.1.2.3 Effect on the GUI

When the course frequency is changed, the clearance frequency will be updated to be 4kHz less than the course frequency.

11.1.2.4 Effect on the Virtual World

This component has no effect on the virtual world.

11.1.3 CLR Frequency

11.1.3.1 Overview

By default, a course and clearance array are both present their frequencies are separated by 8kHz. This separation is adjustable within the model using the CLR Frequency component. This component is only editable

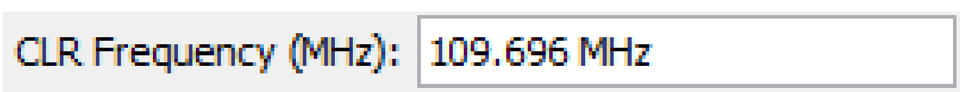


Figure 63: The clearance frequency component.

Figure 63 shows the CLR Frequency component when it is active. Figure 64 shows the CLR Frequency component when it is deactivated.

Figure 64: The clearance frequency component deactivated.

If the course and clearance arrays are locked, as indicated by the checkbox in the array parameters, as described in section 10.3, as seen in figure 37, then the CLR frequency cannot be set manually. If the arrays are not locked any value can be entered.

Note: Values entered into this component are always treated as MHz, no matter the extension.♯

11.1.3.2 Effect on the Model

Setting this component implicitly increase the separation of the course and clearance arrays. The center frequency, ν_c, is specified by the value in the center frequency component, as described in section 10.1.2. The clearance frequency, ν_- is specified by the value in this component. Equations (4) and (5) provide two (2) separate derivations for the course frequency, ν_+.

$$\nu_+ = \nu_c + (\nu_c - \nu_-) \tag{4}$$

$$\nu_+ = 2\nu_c - \nu_- \tag{5}$$

11.1.3.3 Effect on the GUI

This component has no effect on the other GUI widgets.

11.1.3.4 Effect on the Virtual World

This component has no effect on the virtual world. s

11.2 Modeling Parameters

This section discusses the *modeling parameters*, as shown in figures 65 and 66. Figure 65 shows the modeling parameters group if no JCCBI datasheet is loaded; figure 66 shows the modeling parameters group if a JCCBI datasheet has been loaded. See chapter 19 for more information about OUNPPM's interface to the JCCBI. This section is divided into 3 subsections describing the component groups found in figure 59: Datasheet, Field, and DU Error.

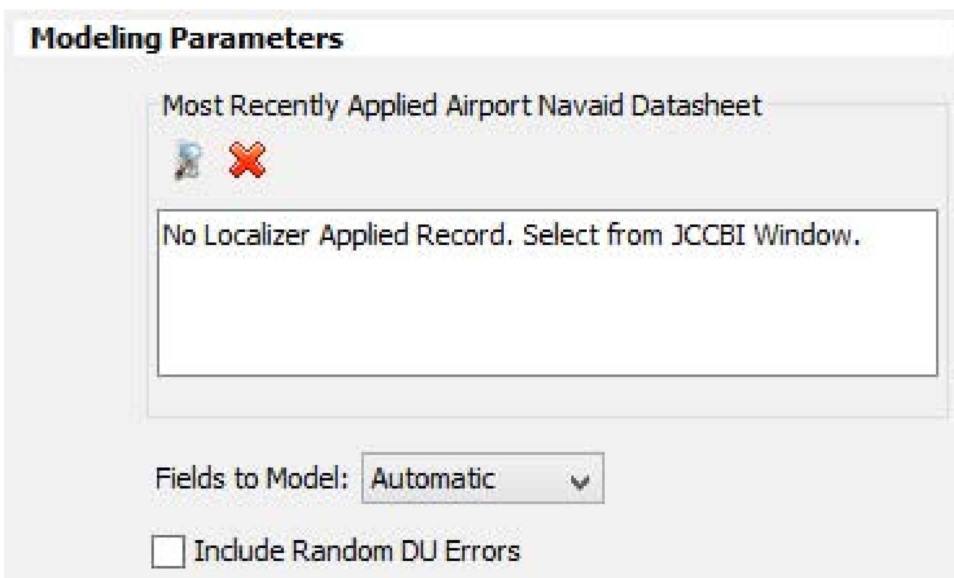


Figure 65: The localizer tab.

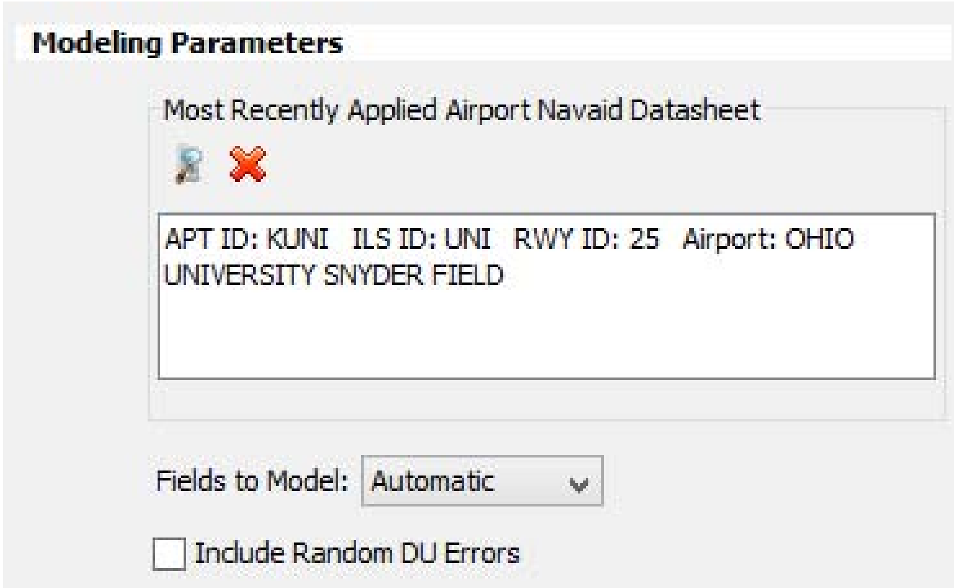


Figure 66: The localizer tab.

11.2.1 Datasheet

11.2.1.1 Overview

The JCCBI datasheet display consists of three main components, as seen in figures 67 and 68: the view button, cancel button, and the summary box. Figure 67 shows the summary box if a no datasheet has been loaded.

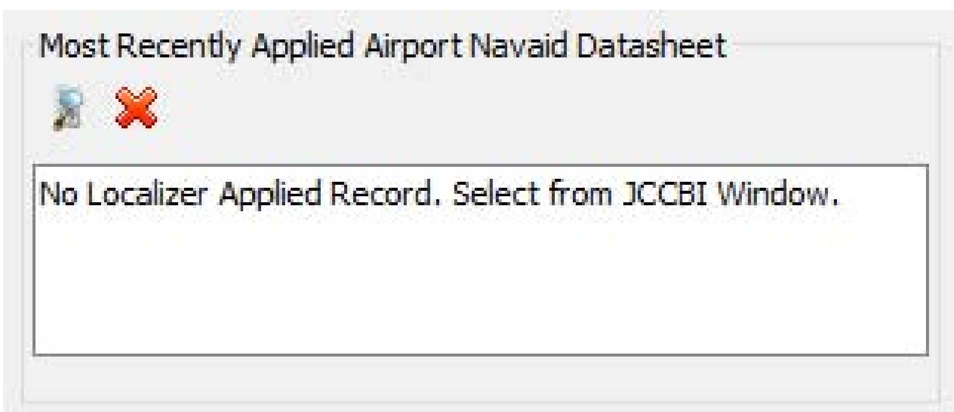


Figure 67: The datasheet group without a JCCBI datasheet loaded.

Figure 68 shows an example summary box if a databox had been loaded with the KUNI JCCBI datasheet.

The view button  opens the datasheet for the currently loaded JCCBI entry in a new window, as seen in figure 69. If no JCCBI entry is currently loaded this button has no effect.

The cancel button  unloads the currently selected JCCBI entry. Note: This currently has a side effect of resetting the center frequency.

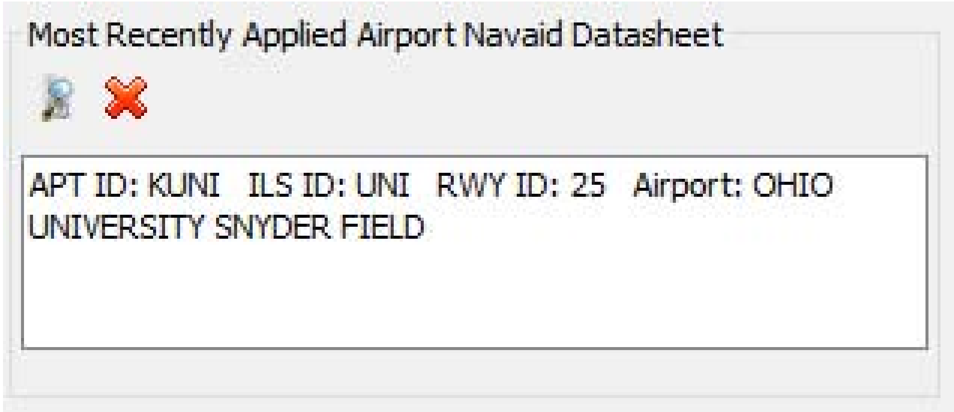


Figure 68: The datasheet group with a JCCBI datasheet loaded.

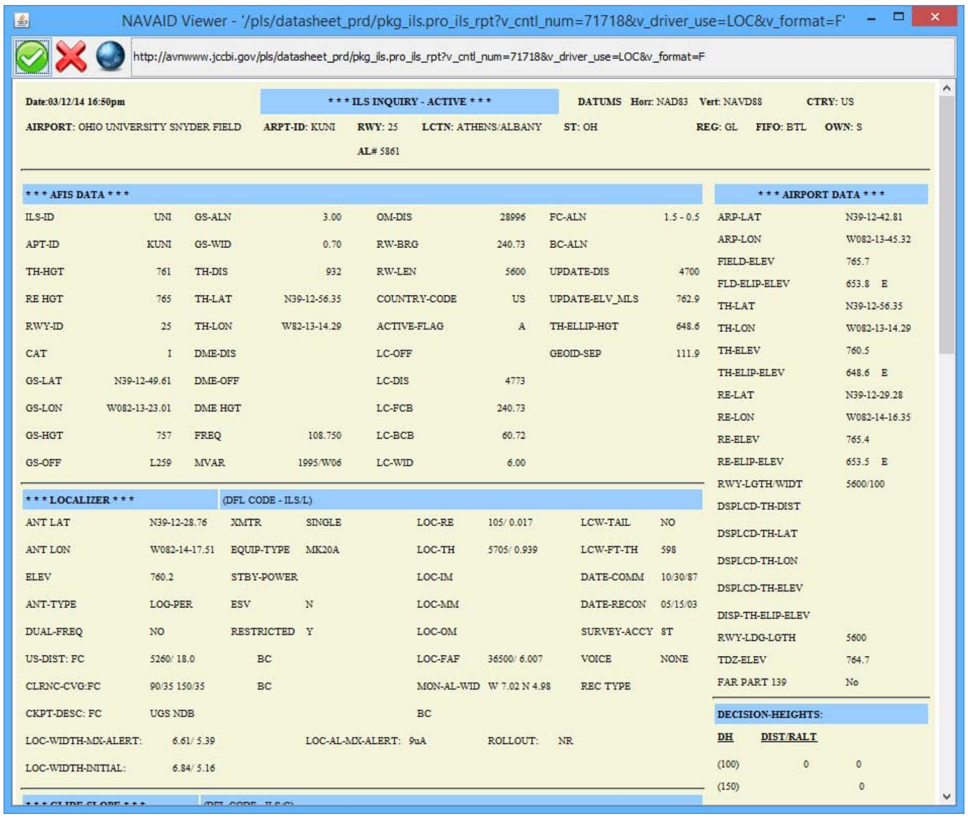


Figure 69: The datasheet for KUNI loaded view the datasheet view button.

11.2.1.2 Effect on the Model

The JCCBI interface itself, as described in chapter 19, will affect many aspects of the model, but these components are intended to simply view that data, not manipulate it. Note: “cancel” currently has a side effect of resetting the center frequency, which does effect the model.

11.2.1.3 Effect on the GUI

Viewing the existing JCCBI state through this summary should not affect other components.

11.2.1.4 Effect on the Virtual World

Altering the attached datasheet via The JCCBI interface itself, as described in chapter 19, will have several possible changes on the virtual world state, but viewing the JCCBI summary through these components should have no effect.

11.2.2 Field

11.2.2.1 Overview

There are two different models of scatterer field interaction: near and far. The combo box shown in figure 70 has three options: near, far, and automatic. It defaults to automatic, which will use the nearfield equations when less than some fixed number of wavelengths from the NAVAID, and uses the far field equations beyond that distance. However, a user may choose to always use the near or far field equations.

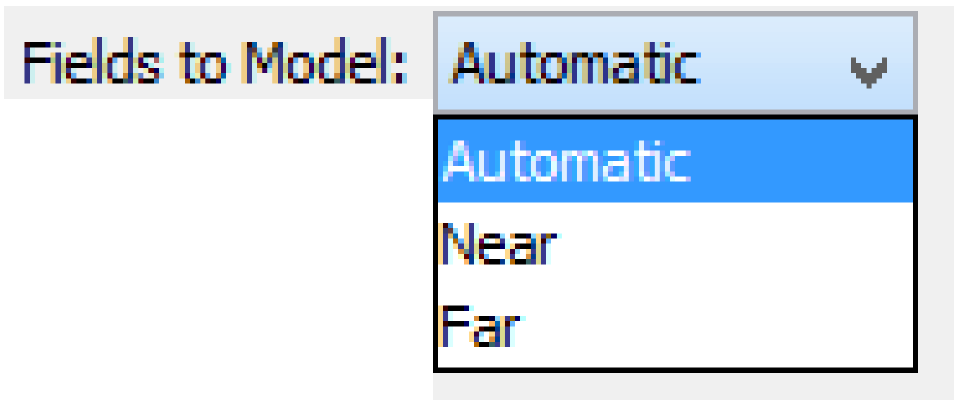


Figure 70: The field combo box options.

11.2.2.2 Effect on the Model

Can be used to force the model to use near field, or far field calculations. When set to "automatic" the model will automatically choose near or far field calculations based on a distance heuristic.

11.2.2.3 Effect on the GUI

This component has no effect on other GUI components.

11.2.2.4 Effect on the Virtual World

This selection has no effect on the virtual world.

11.3 Array Parameters

This section discusses the *array parameters*, as shown in figure 71. This section is divided into 6 subsections describing the component groups found in figure 59: Element Type, Main Setback, Main Offset, Array Rotation, Clearance Width, CLR/CRS Separation.

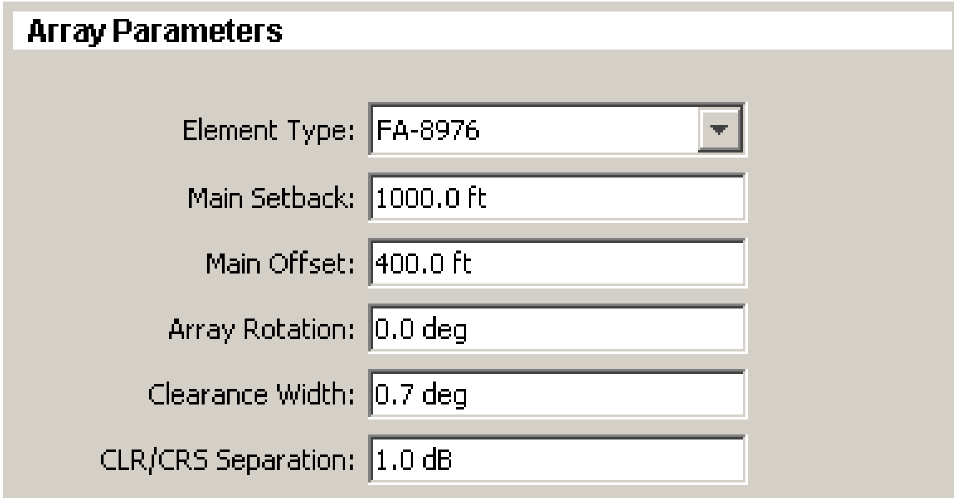


Figure 71: The array parameters components.

11.3.1 Element Type

11.3.1.1 Overview

Select the glideslope element type to be used for all glideslope antennas from the drop-down list as shown in figure 72.

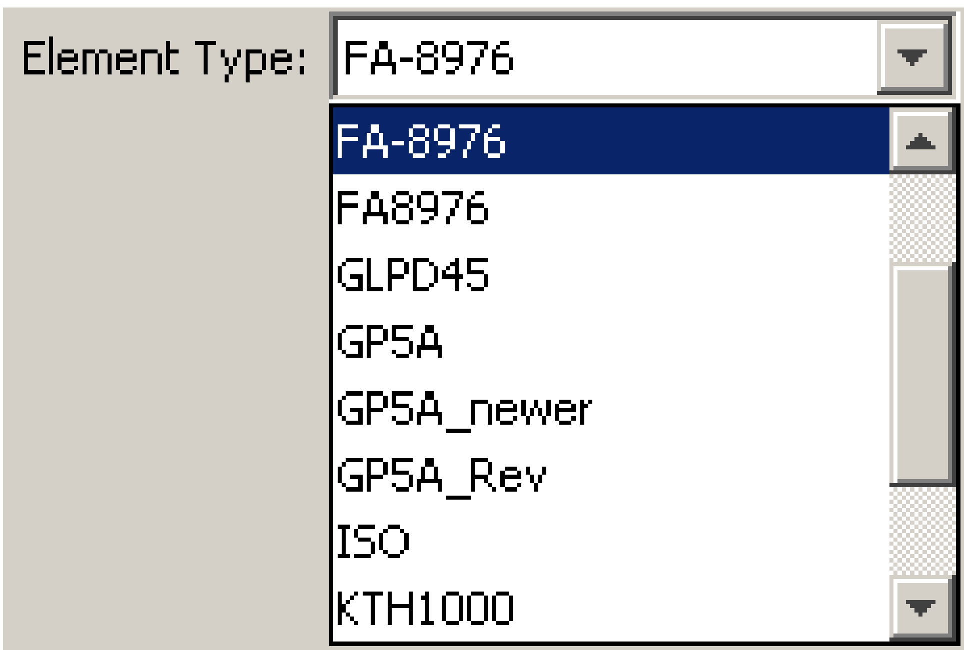


Figure 72: The Element Type component.

11.3.1.2 Effect on the Model

The element type chosen can drastically affect the shape of the glideslope signal. Elements with wider apertures can be chosen to reduce the lateral beam width of the glideslope signal.

11.3.1.3 Effect on the GUI

This component has no effect on other GUI components.

11.3.1.4 Effect on the Virtual World

This component has no effect on the virtual world.

11.3.2 Main Setback

11.3.2.1 Overview

The Main Setback is the setback of the base of the glideslope mast (or phase center for Endfire arrays) from the runway threshold

11.3.2.2 Effect on the Model

The setback of the glideslope can be used to modify the runway Threshold Crossing Height (TCH).

11.3.2.3 Effect on the GUI

This component has no effect on other GUI components.

11.3.2.4 Effect on the Virtual World

A change in the main setback will be noticeable in the graphic representation of the glideslope mast

11.3.3 Main Offset

11.3.3.1 Overview

The Main Offset is the offset of the base of the glideslope mast (or phase center (PC) for Endfire arrays) from the runway centerline. The offset of the glideslope must be chosen properly to ensure that the mast stays within obstacle clearance limits for the runway.

11.3.3.2 Effect on the Model

Setting the main offset to be too far off the runway centerline can have derogatory effects on the approach within Zone 3.

11.3.3.3 Effect on the GUI

This component has no effect on other GUI components.

11.3.3.4 Effect on the Virtual World

A change in the main offset will be noticeable in the graphic representation of the glideslope mast.

11.3.4 Array Rotation

11.3.4.1 Overview

Array rotation is the angular rotation of the glideslope propagation direction from being parallel to the runway centerline.

11.3.4.2 Effect on the Model

A positive value for the Array Rotation will rotate the entire array counter-clockwise, while a negative value will rotate the array clockwise.

11.3.4.3 Effect on the GUI

This component has no effect on other GUI components.

11.3.4.4 Effect on the Virtual World

A change in the array rotation will be noticeable in the graphic representation of the glideslope mast

11.3.5 Clearance Width

11.3.5.1 Overview

This box sets the width for the clearance portion of the array.

11.3.5.2 Effect on the Model

Initial value for the clearance width is 0.7deg.

11.3.5.3 Effect on the GUI

This component has no effect on other GUI components.

11.3.5.4 Effect on the Virtual World

This component has no effect on the virtual world.

11.3.6 CLR / CRS Separation

11.3.6.1 Overview

This box sets the power separation between the course and the clearance signals. A positive value indicates that the clearance signal should be that much weaker than the course signal.

11.3.6.2 Effect on the Model

Changing the power separation between the two arrays can change the points at which the clearance signal is captured over the course signal. Reducing the CLR power can cause weak signal and 'holes' in the CDI beyond the capture points.

11.3.6.3 Effect on the GUI

This component has no effect on other GUI components.

11.3.6.4 Effect on the Virtual World

This component has no effect on the virtual world.

11.4 Array Auto-Adjust

This section discusses the *array auto-adjust* This section is divided into 6 subsections describing the component groups found in figure 59: Element Type, Main Setback, Main Offset, Array Rotation, Clearance Width, CLR/CRS Separation.

This section discusses the Array Auto-Adjustment feature of the model, as shown in figure **??**. This feature is used to automatically adjust certain array parameters based on certain others

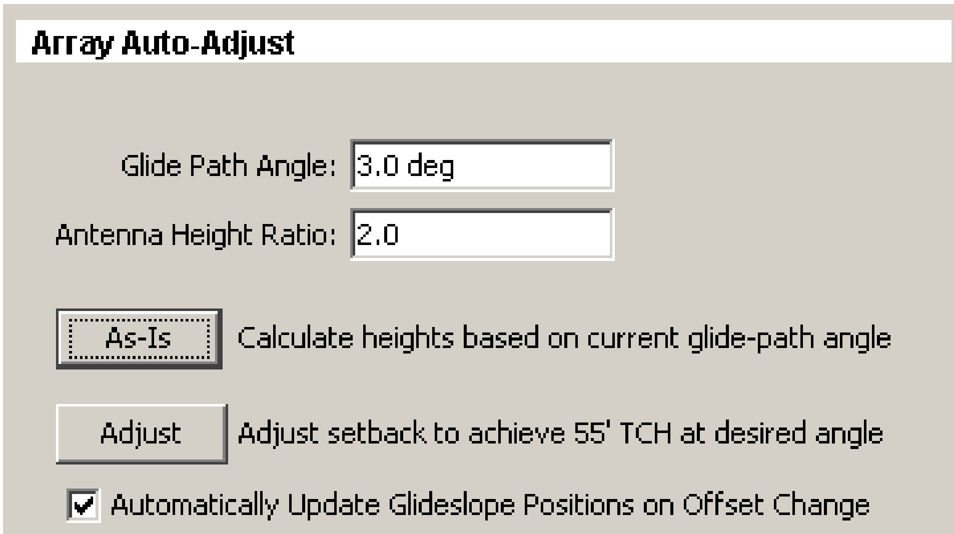


Figure 73: The array auto-adjust components.

11.4.1 Glide Path Angle

11.4.1.1 Overview

This box sets the desired glide path angle to be used in the array adjustment calculations.

11.4.1.2 Effect on the Model

Changes the glide path angle used in the auto-adjustment calculations.

11.4.1.3 Effect on the GUI

This component has no effect on other GUI components.

11.4.1.4 Effect on the Virtual World

Changes to this field will only be obvious in the VirtualWorld if they are applied using the As-Is or Adjust buttons.

11.4.2 Antenna Height Ratio

11.4.2.1 Overview

This box sets the antenna height ratio to be used in the array adjustment calculations.

11.4.2.2 Effect on the Model

This value is the desired ratio between the Upper and Lower antennae in two-antenna systems (ex. SRGS), and between the Middle and Lower antennae in three-antenna systems (ex. CEGS). In the latter case, The Upper antenna height $H_u a$ will be set based on the Lower antenna height $H_l a$ and the Antenna Height Ratio $R_a h$ according to the following formula:

$$H_{ua} = H_{la} * (3 * \frac{R_{ah}}{2}) \tag{6}$$

11.4.2.3 Effect on the GUI

This component has no effect on other GUI components.

11.4.2.4 Effect on the Virtual World

Changes to this field will only be obvious in the VirtualWorld if they are applied using the As-Is or Adjust buttons.

11.4.3 'As-Is' Button

11.4.3.1 Overview

This button will cause the heights of the glideslope antennae to be adjusted given the Glide Path Angle and Antenna Height Ratio entered above the button, as well as the array setback and offset from the Array Parameters section.

11.4.3.2 Effect on the Model

The height of the lower antenna is set to achieve the desired path angle and then the rest of the the antennae are set depending on the type of glideslope array chosen.

For a Null-Reference, or Sideband-Reference system, the Upper antenna height $H_u a$ will be set as follows:

$$H_{ua} = H_{la} * R_{ah} \tag{7}$$

For a Capture-Effect system, the Middle $H_m a$ and Upper $H_u a$ antenna heights will be set as follows:

$$H_{ma} = H_{la} * R_{ah} \tag{8}$$

$$H_{ua} = H_{la} * (3 * \frac{R_{ah}}{2}) \tag{9}$$

11.4.3.3 Effect on the GUI

This component has no effect on other GUI components.

11.4.3.4 Effect on the Virtual World

Changes to the Antenna heights will be visible in the VirtualWorld after clicking this button

11.4.4 'Adjust' Button

11.4.4.1 Overview

This button will cause the main setback of the entire array to be moved to ensure a 55 TCH given the default heights of the glideslope antennae, and the Glide Path Angle and Antenna Height Ratio entered above the button.

11.4.4.2 Effect on the Model

The new glideslope tower location is calculated as follows:

$$SB = \frac{55'}{tan(\theta_{gp})} \tag{10}$$

(Where SB = Array Setback, and θ_{gp} = Glide Path Angle)

11.4.4.3 Effect on the GUI

This component has no effect on other GUI components.

11.4.4.4 Effect on the Virtual World

Changes to the antenna locations will be visible in the VirtualWorld after clicking this button

11.4.5 Automatically Adjust Antenna Offsets for Main Offset Button

11.4.5.1 Overview

This checkbox will ensure that when the As-Is or Adjust buttons are pressed, the model will set the correct offset values for each individual antenna based on the current array Main Offset from centerline.

11.4.5.2 Effect on the Model

For two-antenna systems, the lower antenna will be set at an offset of 0 while the upper antenna will be offset closer to runway centerline. For three-antenna systems, the middle antenna offset will be set at an offset of 0 while the upper antenna will be offset closer to antenna centerline and the lower antenna will be offset further from runway centerline.

11.4.5.3 Effect on the GUI

This component has no effect on other GUI components.

11.4.5.4 Effect on the Virtual World

Changes to the antenna offsets will be visible in the VirtualWorld after clicking the 'As-Is' or 'Adjust' button.

Things specific to the glide slope model. This tab is only enabled for Glide slope models; therefore, it is mutually exclusive with the localizer and VOR models.

12 VOR Model

Things specific to the VOR model. This tab is only enabled for VOR models; therefore, it is mutually exclusive with the localizer and glide slope models.

13 Scatterers

This section describes the widgets on the scatterers tab.

13.1 Scatterer Group

13.1.1 Plate Group Editor

There are two ways to access the plate editor. To edit a scatterer group, such as the Boeing 707, one may click the *Plate Group Editor* Button located in this section as shown in Fig. 74. Alternatively, one may click the *Edit Selected* button when the desired scatterer group is selected within the main table, see Fig. 74.

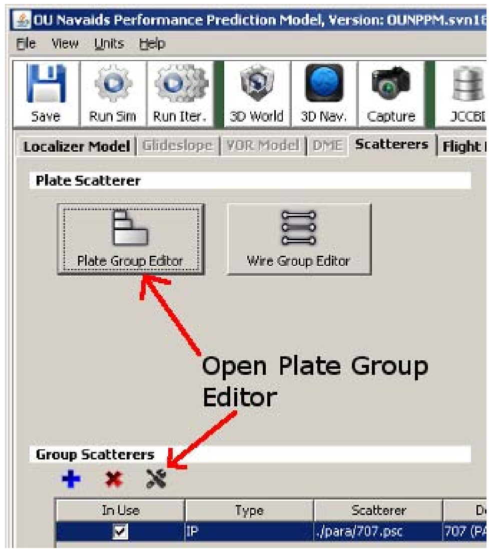


Figure 74: The *Scatterer Group Editor* opens a window enabling creation/modification of Scatterer groups.

One may manually create a set of plates or choose to Open an existing file. Figure 75 shows a Boeing 707 loaded in the editor. Each plate composing each part of the 707 is shown. Each plate may be modified. The desired *reference frame* may also be selected. Any Scatterer Type, be it, ILS (Localizer/Glideslope), or VOR, may be converted to any other Scatterer Type using the *Scatterer Type* radio buttons.

NOTE: When loading a plate file that was saved as an alternative Scatterer Type, the user will be prompted to automatically save the newly converted Scatterer Type to the native version. For example, if “707.psc” was originally a LOC/GS plate, and a user chooses to open that while running a VOR model, a popup box will automatically appear asking the user to resave the file as a VOR scatterer such as “707_VOR.psc”. *Take care not to accidently overwrite existing scatterers. Saving each scatterer using a unique filename will ensure this.*

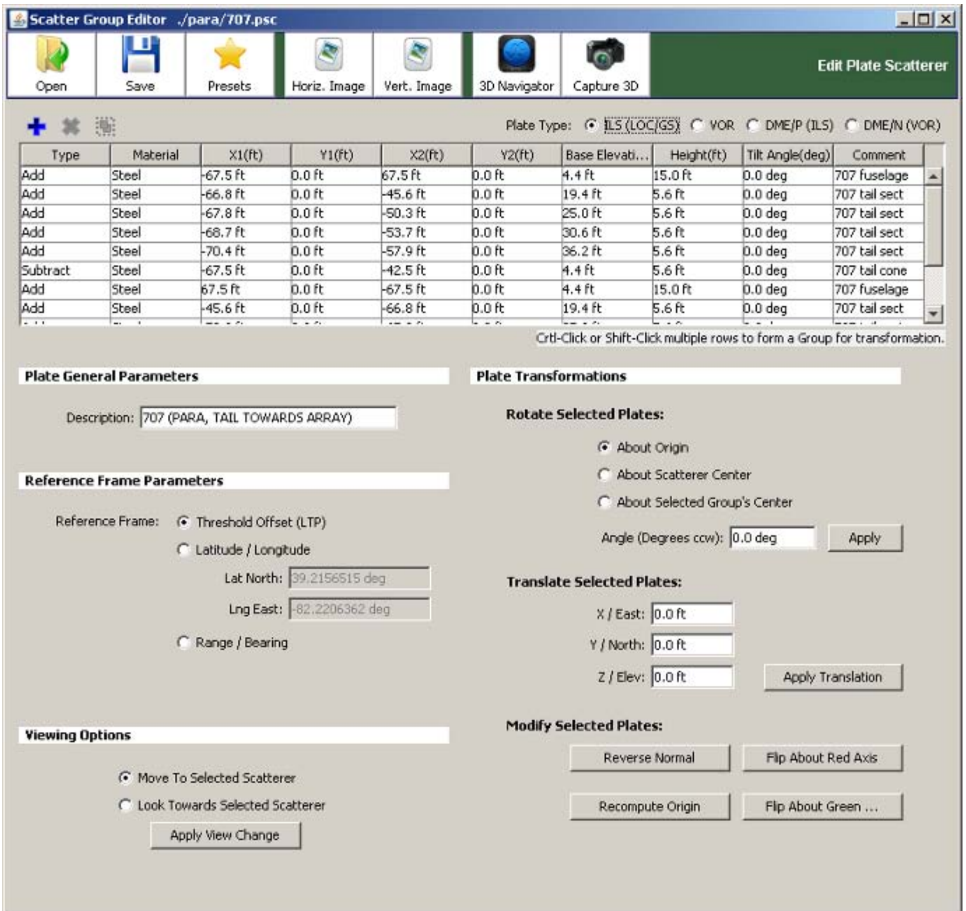


Figure 75: The *Scatterer Group Editor* opens a window enabling creation/modification of Scatterer groups.

13.1.1.1 The Toolbar

13.1.1.1.1 Open

Pressing the  button will open a file browser as shown in figure 78. When you select a .psc file to open, one row will be added to the scatterer editor table for each each scatterer plate in the scatterer group. If there are already scatterer plates in the table when a file is loaded, the new plates will be appended into the tables bottommost rows.

13.1.1.1.2 Save

Pressing the  button will open a file browser as shown in figure **??**.

You can select an existing plate scatterer to save over it; you will be prompted to confirm as seen in figure **??**. Selecting "Yes" or (pressing Alt+Y) will overwrite the existing file, which is an irreversible operation; selecting "No" will return to the save dialog. Alternatively, you can enter a new name into the dialog box; if the manually entered name does not end in .psc, it will be appended.

13.1.1.1.3 Presets

There are two "cookie cutter" scatterers that can be created to model advanced objects: the ellipse and the wind turbine.

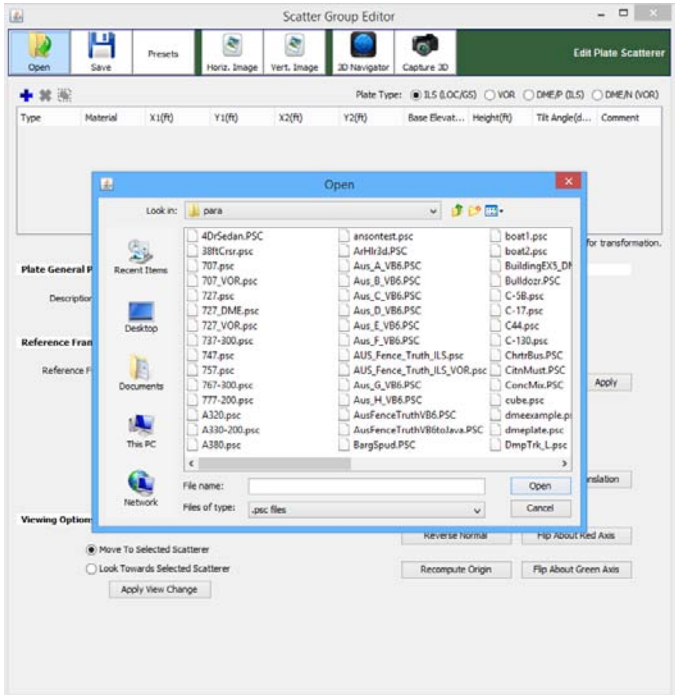


Figure 76: Open scatterer dialog.

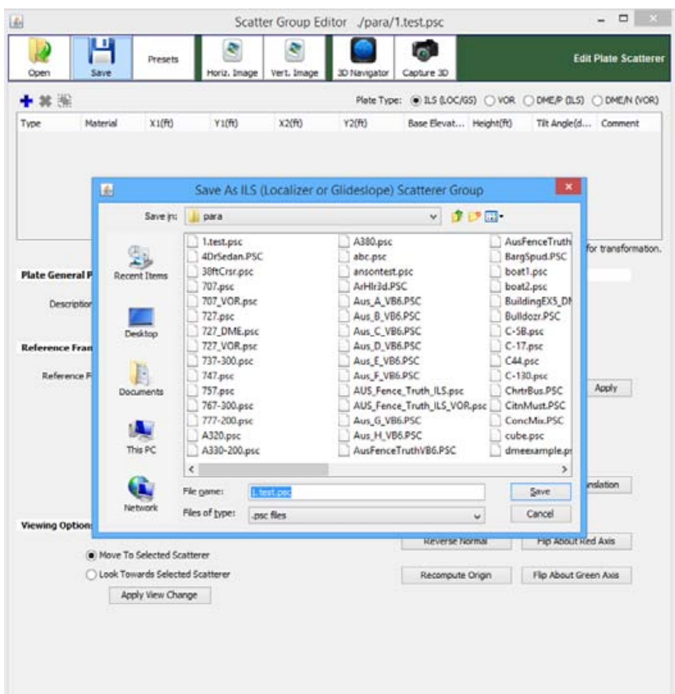


Figure 77: Open scatterer dialog.

13.1.1.1.3.1 Ellipse

The lefthand tab, as seen in Figure 79, controls the creations of ellipses. Like other scatterer groups this group does not have to be centered around its local origin. This preset has support for both simple and complex ellipses. As indicated by the following figure:

A is the length of the semimajor axis, and B is the length of the semiminor axis. If A2 is non-zero then a complex ellipse will be used. The plate height, elevation, tilt,

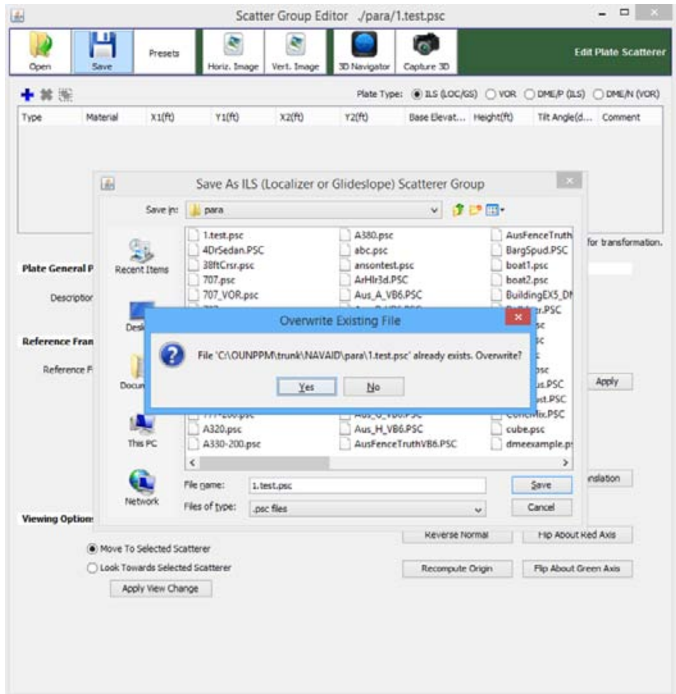


Figure 78: Open scatterer dialog.

and rotation fields function analogously to the plate scatterer counterparts. Incomplete ellipses are created by setting an interval other than 0..360 in the angle start and angle stop fields. Ellipses are approximated by a series of plates. The default value is 2, fidelity can be increased by increasing this number. There are three additional checkboxes that alter the plate configuration.

13.1.1.1.3.1.1 Height is vertical regardless of angle Normally the plate height is the length of the plate in the vertical direction before rotation. In this case the height represents the vertical distance the plate will cover, i.e. the closer the tilt is to 90 degrees, the longer the plate will become for a fixed height.

13.1.1.1.3.1.2 Illuminate outside This is checked by default. Since the normal of the plate affects whether or not it is included in the model calculation, it is important to note whether the inner faces or outer facts of the cylinder is illuminated.

13.1.1.1.3.1.3 Make Horizontal Cylinder Effectively rotates the entire cylinder 90 degrees.

13.1.1.1.3.2 Windmill

The righthand tab, as seen in Figure 90, controls the preset that allows for easy creation of windmills. The following describe each text box and check box on this page.

13.1.1.1.3.2.4 Preset Wind Turbine The model contains several built-in windmills based on publicly released specifications. You can select an entry from the drop down list to populate all the parameters in the following sections.

Not all specifications were complete and this section contains notes on assumptions made for each model.

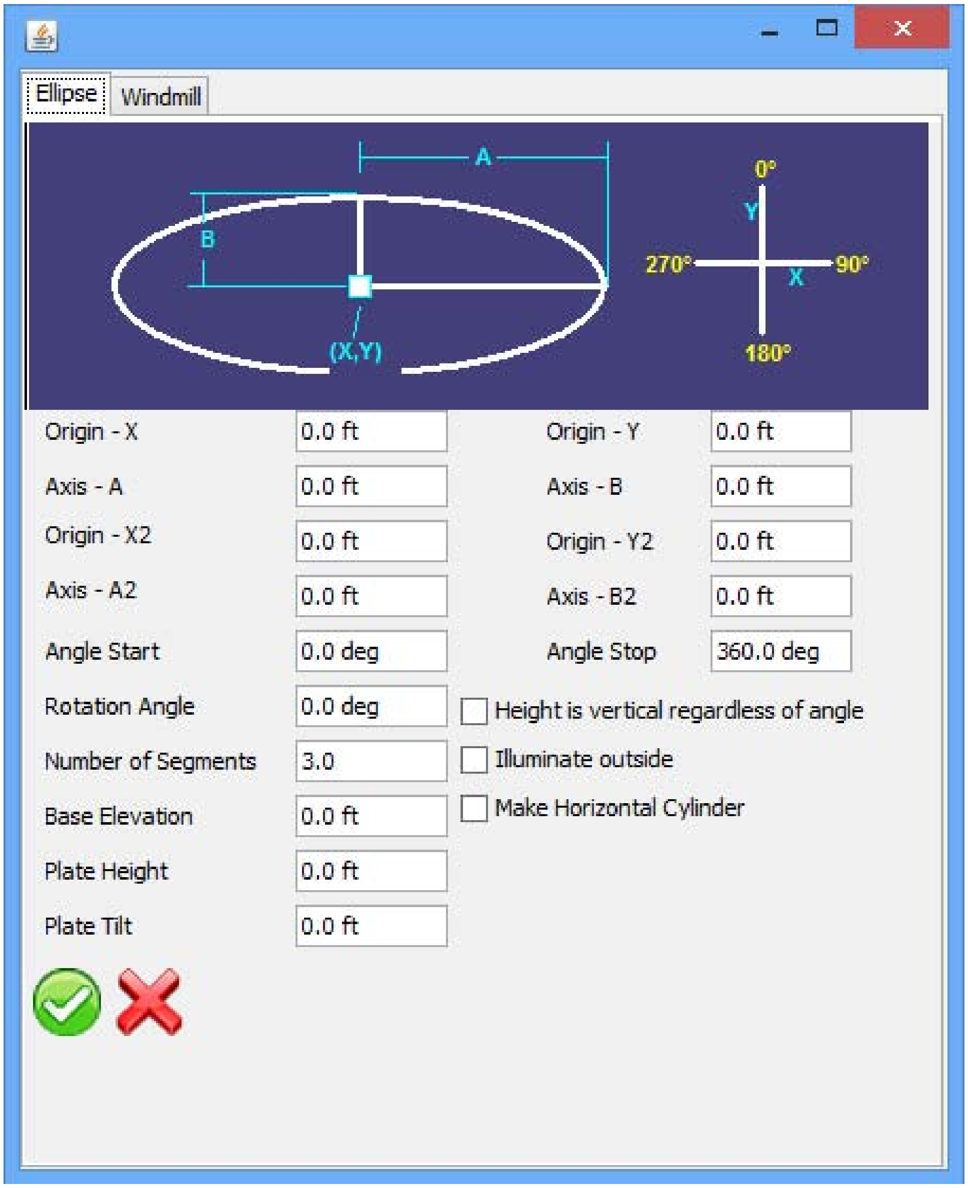
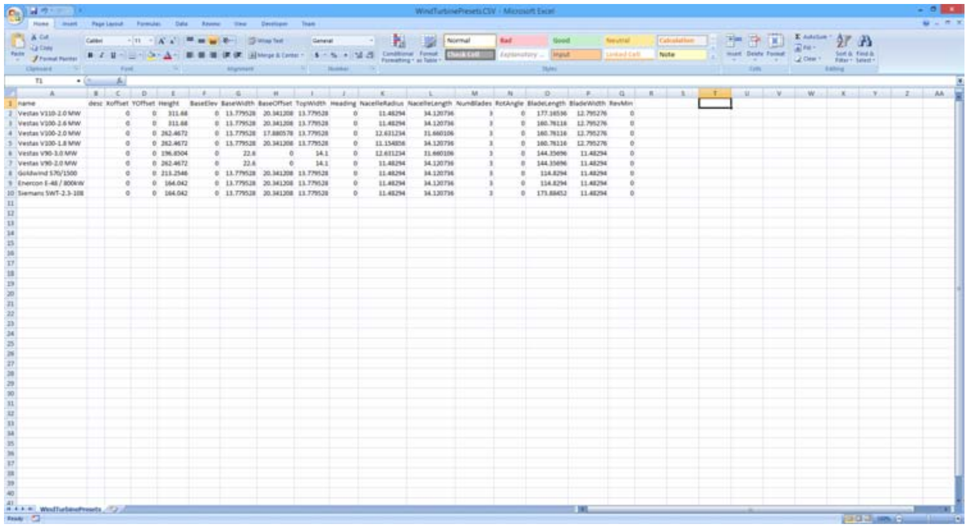


Figure 79: The ellipse preset window.

- Vestas V110-2.0MW - Missing tower width, uses width of Vestas V100-1.8MW. 4 published hub heights, uses 50Hz low profile height.
- Vestas V100-2.6MW - Missing tower width, uses width of Vestas V100-1.8MW. Missing hub height, uses height of Vestas V110-2.0MW 50Hz low profile.
- Vestas V100-2.0MW - Missing tower width, uses width of Vestas V100-1.8MW. 3 published hub heights, uses lowest.
- Vestas V100-1.8MW - 2 published hub heights, uses lowest.
- Vestas V90-3.0MW - 3 published hub heights: 65, 80, and 105m (wind class). Uses 60m.
- Vestas V90-2.0MW - 12 published hub heights, uses lowest.
- Goldwind S70/1500 - Missing tower width, uses width of Vestas V100-1.8MW. Hub height 65-80m, uses 65. Missing blade width, uses width of Vestas V90-2.0MW (probably too big).



name	desc	XOffset	YOffset	Height	BaseElev	BaseWidth	BaseOffset	TopWidth	Heading	NacelleRadius	NacelleLength	NumBlades	RotAngle	BladeLength	BladeWidth	RevMin
Vestas V110-2.0 MW		0	0	311.68	0	13.779528	20.341208	13.779528	0	11.48294	34.120736	3	0	177.16536	12.795276	0
Vestas V100-2.6 MW		0	0	311.68	0	13.779528	20.341208	13.779528	0	11.48294	34.120736	3	0	160.76116	12.795276	0
Vestas V100-2.0 MW		0	0	262.4672	0	13.779528	17.880578	13.779528	0	12.631234	31.660106	3	0	160.76116	12.795276	0
Vestas V100-1.8 MW		0	0	262.4672	0	13.779528	20.341208	13.779528	0	11.154856	34.120736	3	0	160.76116	12.795276	0
Vestas V90-3.0 MW		0	0	196.8504	0	22.6	0	14.1	0	12.631234	31.660106	3	0	144.35696	11.48294	0
Vestas V90-2.0 MW		0	0	262.4672	0	22.6	0	14.1	0	11.48294	34.120736	3	0	144.35696	11.48294	0
Goldwind S70/1500		0	0	213.2546	0	13.779528	20.341208	13.779528	0	11.48294	34.120736	3	0	114.8294	11.48294	0
Enercon E-48 / 800kW		0	0	164.042	0	13.779528	20.341208	13.779528	0	11.48294	34.120736	3	0	114.8294	11.48294	0
Siemans SWT-2.3-108		0	0	164.042	0	13.779528	20.341208	13.779528	0	11.48294	34.120736	3	0	173.88452	11.48294	0

Figure 80: The windmill preset file being edited in Microsoft Excel.

- Enercon E-48 / 800kW - Missing tower width, uses width of Vestas V100-1.8MW. Hub heights 50, 55, 60, 76m, uses 50. Missing Nacelle sizes, uses Vestas V110-2.0MW.
- Siemans SWT-2.3-108 - Missing tower width, uses width of Vestas V100-1.8MW. Missing hub height, uses 50m. Missing Nacelle sizes, uses Vestas V110-2.0MW. Missing blade width, uses uses width of Vestas V90-2.0MW (probably too small).

This list can be extended by the user by editing the file located at "/para/WindTurbinePresets.CSV". This file can be edited via any text editor, or in Microsoft Excel. Figure 80 shows an example of this file on in Microsoft Excel.

NOTE: This file is currently overwritten on updates so any additions will not be saved. This will be resolved in a future update.

There is one entry for each of the following sections, as well as two for organizational purposes.

Name The name that appears in the drop down list; uniqueness is not enforced, but is recommended.

Description This section incomplete.

13.1.1.1.3.2.5 Go Pressing this button will populate the field below.

This action needs confirmed.

13.1.1.1.3.2.6 + Pressing this button will add the current values to the preset spreadsheet.

This action needs confirmed.

13.1.1.1.3.2.7 X Offset This value embeds as X offset into the model. It is recommended that a scatterer be positioned around (0,0), but in case you want an x offset it can be put here.

Figure 81 shows the difference between a windmill with an x offset of 0, and a windmill with an x offset of 100.

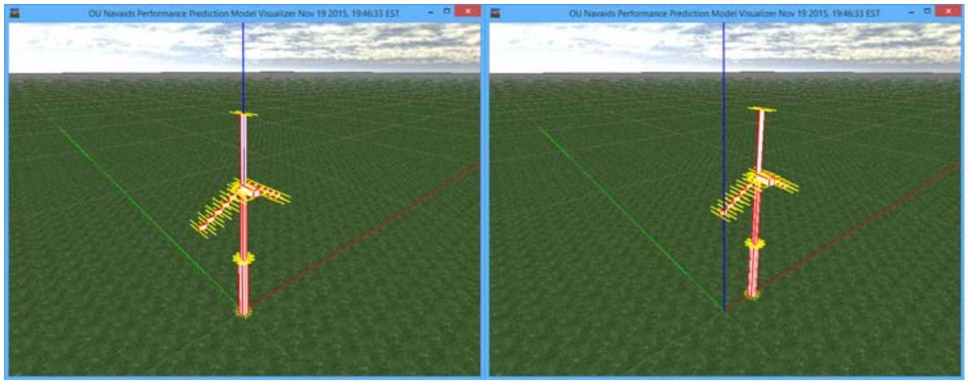


Figure 81: Left) A Windmill at the origin. Right) A windmill with an embedded x offset of 100.

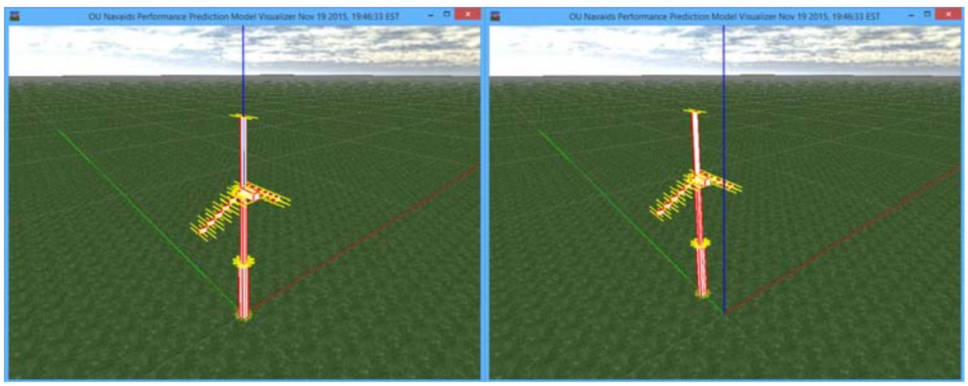


Figure 82: Left) A Windmill at the origin. Right) A windmill with an embedded y offset of 100.

13.1.1.1.3.2.8 Y Offset This value embeds as X offset into the model. It is recommended that a scatterer be positioned around (0,0), but in case you want an x offset it can be put here.

Figure 82 shows the difference between a windmill with an y offset of 0, and a windmill with an y offset of 100.

13.1.1.1.3.2.9 Height The height value represents the z-axis height of the base from ground to bottom of the nacelle (the model assumes the nacelle rests strictly on top of the base).

Figure 83 shows the difference between the default windmill with height 344.5ft (105m) and one with half the height. Notice, this effects only the height of the base, the blade lengths and nacelle size are the same.

13.1.1.1.3.2.10 Base Elevation The base elevation moves the lowest point of the windmill model up (positive values) or down (negative values) in the z direction.

Figure 84 shows the difference between a windmill with a base elevation of 0, and a windmill with a base elevation of 100.

13.1.1.1.3.2.11 Base Width The base width of the bottom half of the vertical support. The main support structure is split into two halves, this value only controls the bottom half. To adjust the top half refer to the “top width” values (section 13.1.1.1.3.2.13).

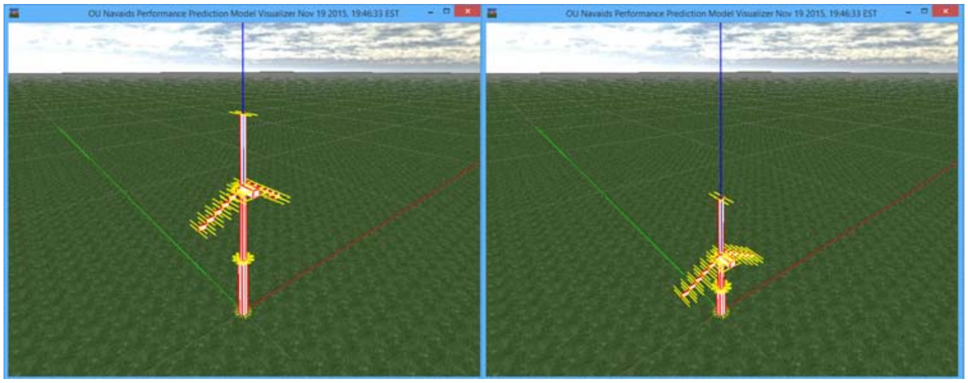


Figure 83: Left) The default windmill. Right) A windmill with half height.

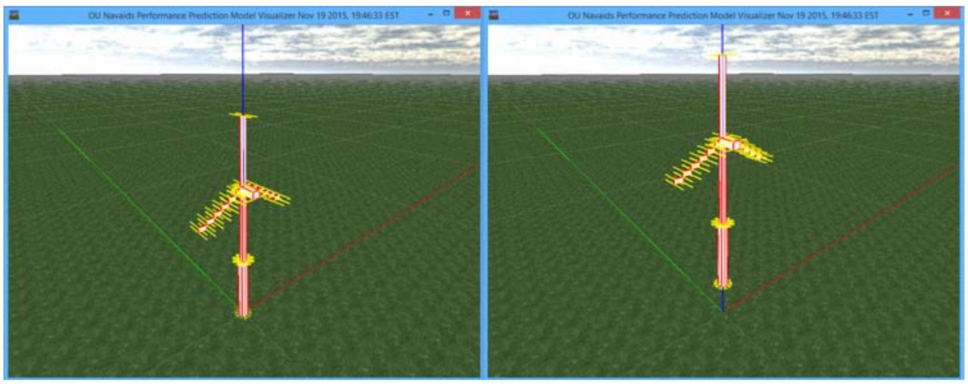


Figure 84: Left) The default windmill at base elevation 0. Right) A windmill with base elevation 100.

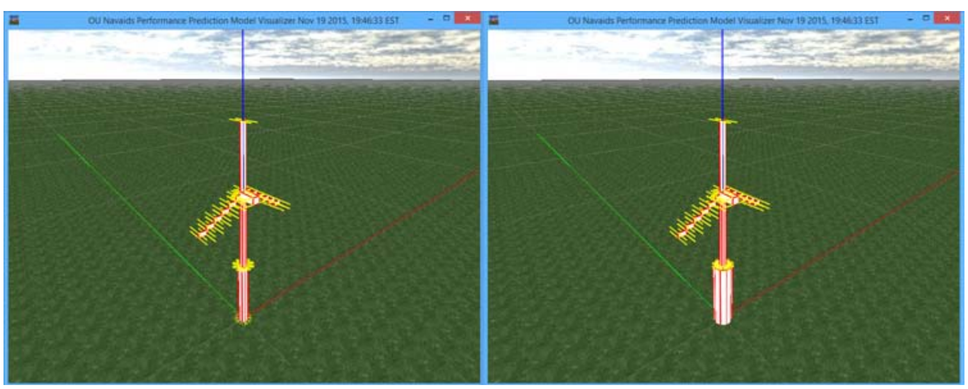


Figure 85: Left) The default windmill with base width of 22.6ft. Right) A windmill with base width of 45.2ft.

Figure 85 shows the difference between a windmill with a base width of 22.6ft (6.89m), and a windmill with a base width of 45.2ft.

13.1.1.1.3.2.12 Base Offset This value adds a -y offset to the vertical support. This will create a separation between nacelle and the support unless the nacelle length is also changed. This also means that the support will no longer be at the world space point specified in the main scatterer table, unless an equal and opposite y offset is embedded.

Figure 86 shows the difference between a windmill with a base offset of 0, and a windmill with a base width of 100.

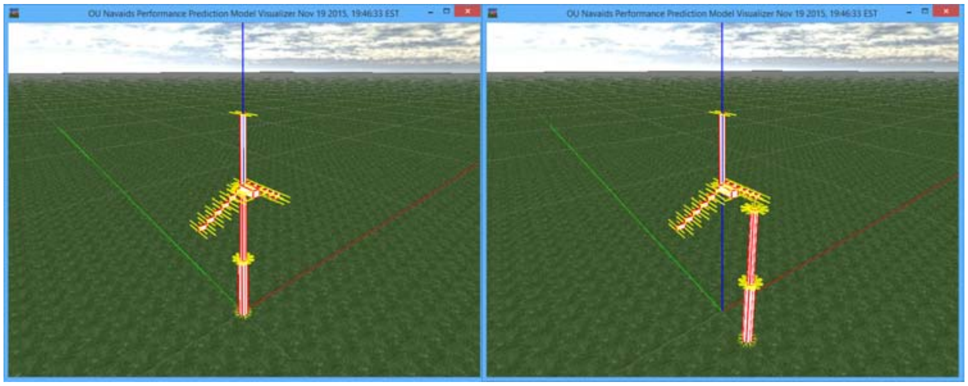


Figure 86: Left) The default windmill with base offset of 0. Right) A windmill with base offset of 100.

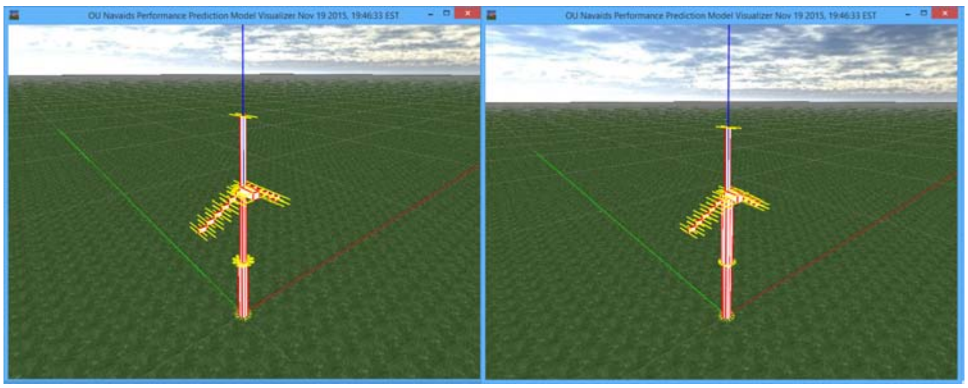


Figure 87: Left) The default windmill with top width of 14.1ft. Right) A windmill with top width of 28.2ft.

13.1.1.1.3.2.13 Top Width This value adjusts the width of the top half of the vertical support. The main support structure is split into two halves, this value only controls the top half. To adjust the bottom half refer to the "base width" values (section 13.1.1.1.3.2.11).

Figure 87 shows the difference between a default windmill with a top width of 14.1ft (4.3m), and a windmill with a base width of 28.2ft (8.6m).

13.1.1.1.3.2.14 Heading This value adjusts the rotation angle of the windmill. Rotations are counter-clockwise.

Figure 89 shows the difference between a default windmill and a windmill rotated 45°.

13.1.1.1.3.2.15 Nacelle Radius This value adjusts the width of the nacelle of the windmill (the horizontal portion). The main support structure is split into two halves, this value only controls the top half. To adjust the bottom half refer to the "base width" values (section 13.1.1.1.3.2.11).

Figure 89 shows the difference between a default windmill and a windmill rotated 45°.

13.1.1.1.3.2.16 Nacelle Length This section incomplete.

13.1.1.1.3.2.17 Number of Blades This section incomplete.

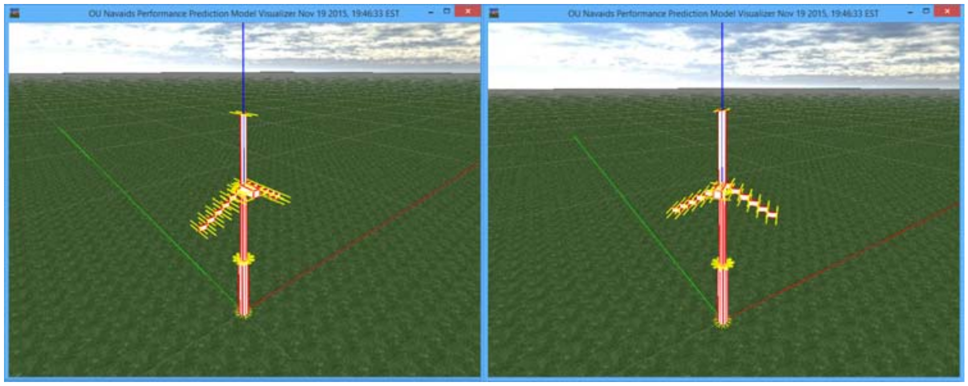


Figure 88: Left) The default windmill position. Right) The windmill rotated 45°.

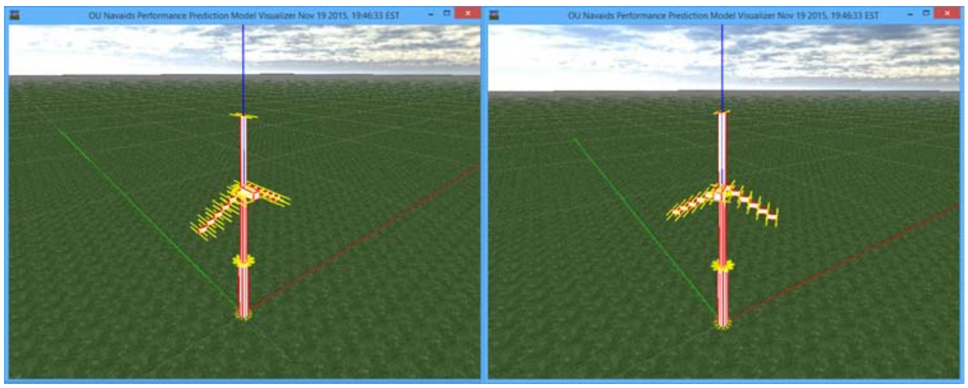


Figure 89: Left) The default windmill with nacelle radius . Right) The windmill rotated 45°.

13.1.1.1.3.2.18 Rotation Angle This section incomplete.

13.1.1.1.3.2.19 Blade Length This section incomplete.

13.1.1.1.3.2.20 Blade Width This section incomplete.

13.1.1.1.3.2.21 Revolutions per Minute This section incomplete.

13.1.1.1.3.2.22 Draw both sides of rotor blades Recall that plates are directional. Only one side illuminated, hence if you want to ensure that a blade is taken into account for the model, this box should be checked. It is selected by default.

13.1.1.1.3.2.23 Use cylindrical base If this is checked a cylindrical base is used, otherwise it is rectangular.

13.1.1.1.3.2.24 Facing Array This check box is mutually exclusive with the box in section 13.1.1.1.3.2.25. Rotates the windmill such that the nacelle point along the vector from the antenna array towards the windmill offset.

13.1.1.1.3.2.25 Parallel to flight path This check box is mutually exclusive with the box in section 13.1.1.1.3.2.24. Rotates the windmill such that the blades are parallel with the flight path. This only includes "straight" flight paths; ILS2 & 3 for localizer & glideslopes and radial for VOR.

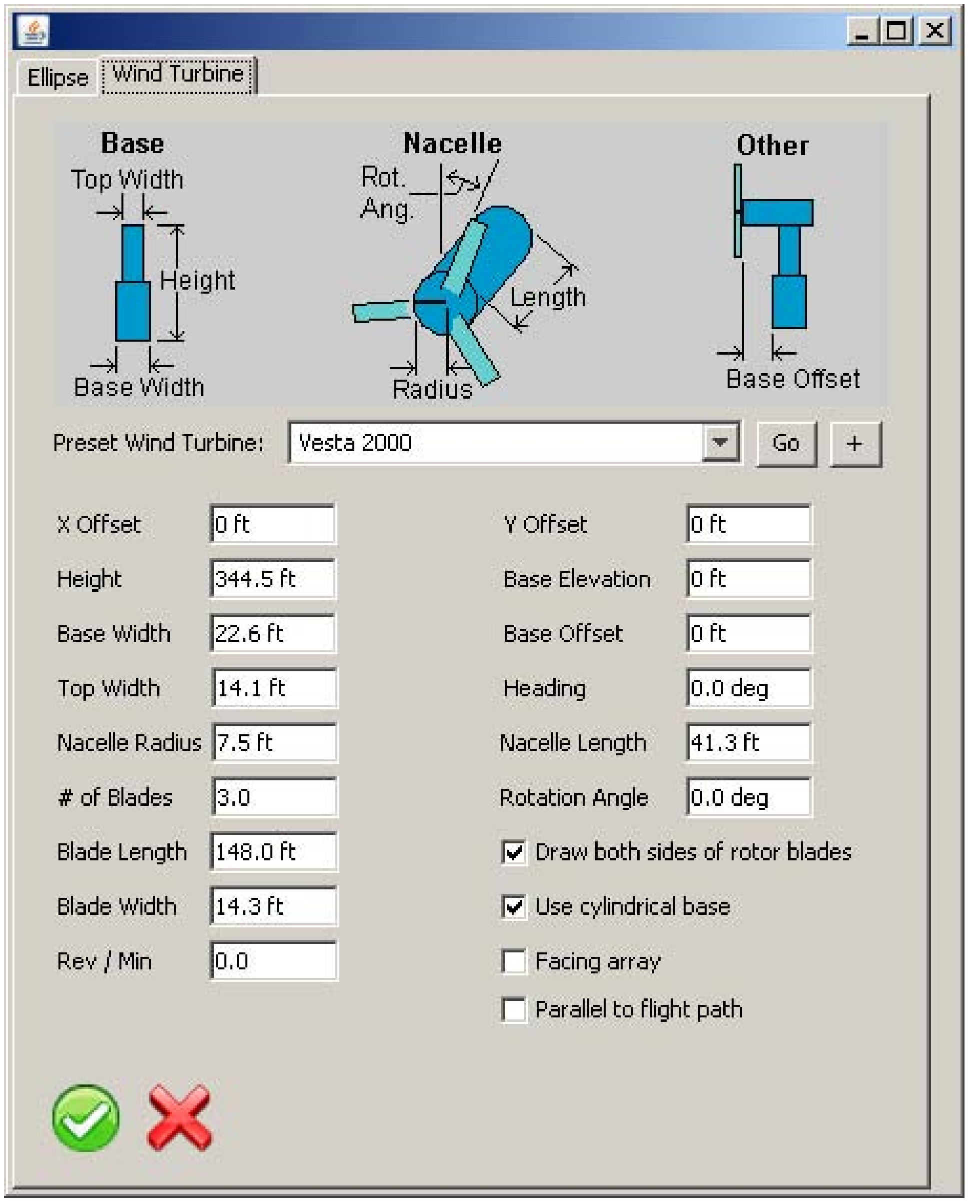


Figure 90: The windmill preset window.

13.1.1.1.4 Horizontal Pull From Image

A scatterer group can also be created based on positions relative to an image. This is a 4 step process.

1. Load image - most image types are supported. When you click this button you will be prompted to select an image file which will then be opened and displayed on the panel. It will maintain its original size in pixels.

2. Set scale - Enter a length into the field and then click and drag a length you intend to represent that length. The label next to the length field should now be populated with that number of pixels.

3. Orient x-axis - in order to get a coherent reference frame, the user will define the positive x-axis. We use a right-handed coordinate system, and the y-axis will also fall in the plane of the image, so it is defined.

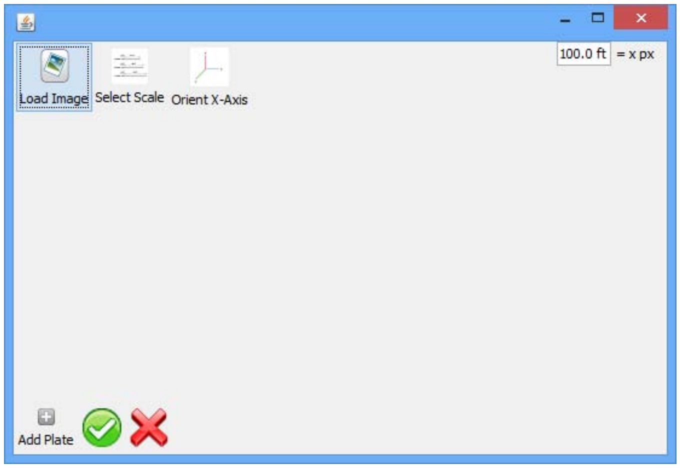


Figure 91: Add plates by pulling from image.

4. Now that we have a complete system in which to define the plates , you can add plates by using the add plate button and selecting the two end points.

13.1.1.1.5 Vertical Pull From Image

This section is incomplete.

13.1.1.1.6 3D Navigator

This section is incomplete.

13.1.1.1.7 Capture 3D

This section is incomplete.

13.1.1.2 The Table

This section

13.1.1.2.1 For All Types

13.1.1.2.2 Localizer and Glideslope

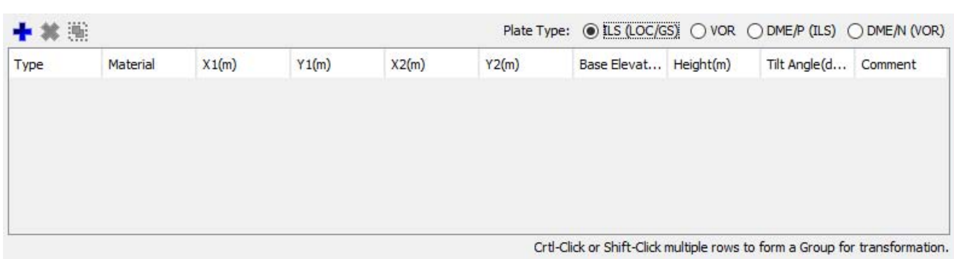


Figure 92: The scatterer plate editor table for localizer and glideslope scatterers.

13.1.1.2.2.0.1 Type Possible values are:

1. IP

13.1.1.2.2.0.2 Material The following materials are selectable for scatterers.

- Steel
- Aluminum
- Concrete
- Brick
- Vinyl
- Glass
- Plexigas
- Wood
- Trees
- Rock
- Soil

Each material specifies a relative permeability (μ), relative permittivity (ε), and slab conductivity (σ), which can be found below.

- μ_{Steel} - 2000.0
- $\mu_{Aluminum}$ - 1.00002
- $\mu_{Concrete}$ - 1.0
- μ_{Brick} - 1.0
- μ_{Vinyl} - 1.0
- μ_{Glass} - 1.0
- $\mu_{Plexigas}$ - 1.0
- μ_{Wood} - 1.0
- μ_{Trees} - 1.0
- μ_{Rock} - 1.0
- μ_{Soil} - 1.0
- ε_{Steel} - 1.0
- $\varepsilon_{Aluminum}$ - 1.0
- $\varepsilon_{Concrete}$ - 10.0
- ε_{Brick} - 10.0
- ε_{Vinyl} - 2.8
- ε_{Glass} - 6.0
- $\varepsilon_{Plexigas}$ - 3.4

- ε_{Wood} - 2.1
- ε_{Trees} - 12.0
- ε_{Rock} - 10.0
- ε_{Soil} - 5.0
- σ_{Steel} - 2.0e+6
- $\sigma_{Aluminum}$ - 3.96e+7
- $\sigma_{Concrete}$ - 1.0e-4
- σ_{Brick} - 0.5e-5
- σ_{Vinyl} - 1.0e-14
- σ_{Glass} - 1.0e-12
- $\sigma_{Plexigas}$ - 5.1e-3
- σ_{Wood} - 8.0e-3
- σ_{Trees} - 2.0e-3
- σ_{Rock} - 2.0e-3
- σ_{Soil} - 1.0e-3

13.1.1.2.2.0.3 Scatterer This element shows the path to the scatter information for this row.

This section is incomplete.

13.1.1.2.2.0.4 Description The user-entered description for this scatterer. This can be

This section is incomplete.

13.1.1.2.2.0.5 X Offset This section is incomplete.

13.1.1.2.2.0.6 Y Offset This section is incomplete.

13.1.1.2.2.0.7 Z Offset This section is incomplete.

13.1.1.2.2.0.8 Angle This section is incomplete.

13.1.1.2.2.0.9 Iterate This section is incomplete.

13.1.1.2.3 VOR

Figure 93: The scatterer editor table for VOR scatterers.

13.1.1.3 Local Plate Operations

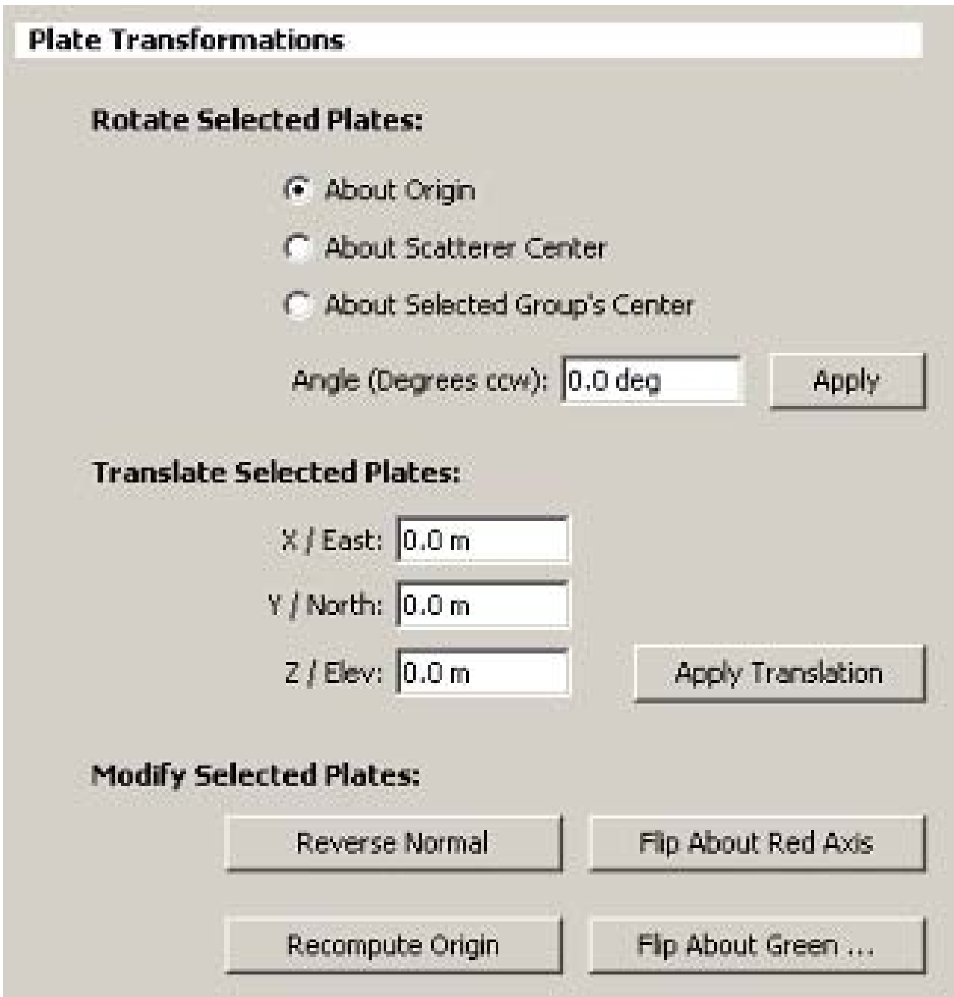


Figure 94: The operations that may be applied to a plate or group of plates.

Figure 94 shows the operations that may be applied to any single plate or group of selected plates. A group of scatterer plates may be formed by CTRL-clicking or SHIFT-clicking the desired plates in the Editor List. Once selected, clicking on operation button will perform that operation on all selected plates.

Rotation enables a clockwise rotation, specified in degrees, of a specific scatterer plate or group of scatterer plates about one of the following points: 1) The origin, 2) The center of the scatterer, 3) The center of the group of selected plates.

Rotation *About Origin* will rotate all selected plates about the origin.

Rotation *About Scatterer Center* will rotate each selected plates about its own center point.

Rotation *About Selected Group's Center* will rotate each selected plate about the point computed to be the center of all selected plates.

Figure 95 shows an example of a VOR scatterer. VOR scatterers have an additional parameter that lets the user set a ground plane for terrain differences near the VOR itself. These are indicated by the small green planes beneath the white scatterer plates.

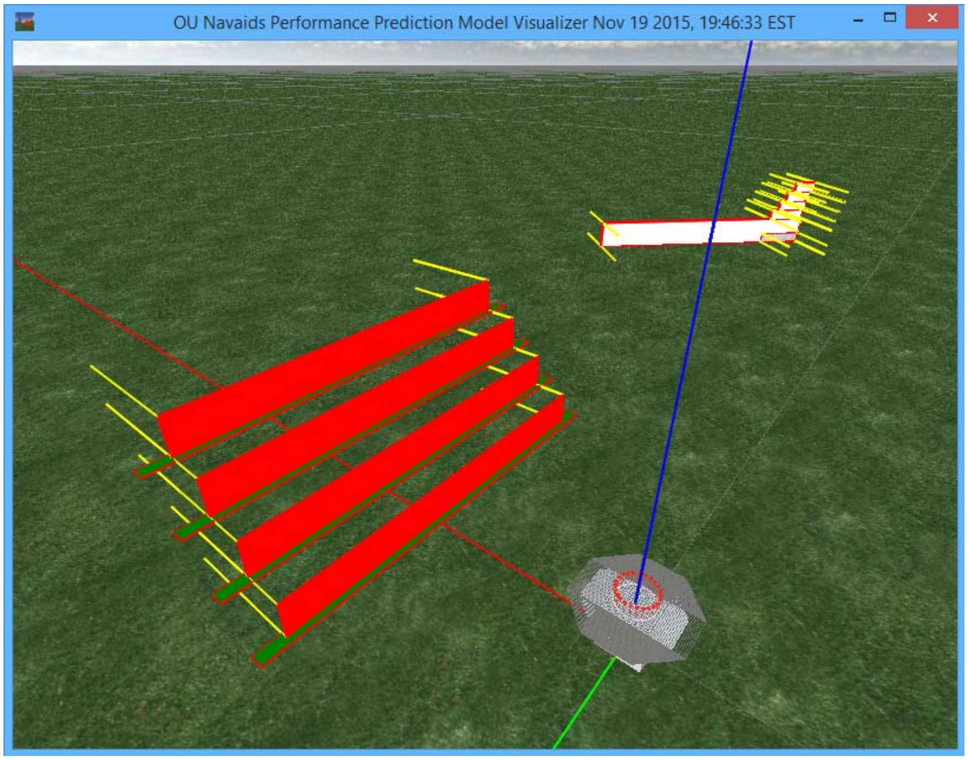


Figure 95: An example of a VOR scatterer with ground planes.

1. *Reverse Normal* will invert the direction of the normals of the selected plates; this is achieved by swapping the X1,Y1 and X2,Y2 values for the selected plates.

2. *Flip About Red Axis* will flip each selected plate about an axis parallel to the global red axis, but passing through each plate's center. This is achieved by swapping the X1 and X2 values for each selected plate.

3. *Flip About Green Axis* will flip each selected plate about an axis parallel to the global green axis, but passing through each plate's center. This is achieved by swapping the Y1 and Y2 values for each selected plate.

4. *Look At Selected Center* will move the camera such that it is looking at the selected plate (*Look Towards Selected Scatterer*) or move the camera such that it travels to and looks at the selected plate (*Move To Selected Scatterer*).

5. *Recompute Origin* will compute the center point of the volume generated by any selected plates and recenter the plates about that local origin. This is useful, for example, if a scatterer was created but centered about $(100,\vec{1}00,0)$; pressing *Recompute Origin* will then adjust the corresponding scatterer group points such that they are centered about $0,\vec{0},0$. Another way of thinking about this is that after pressing *Recompute Origin*, performing a rotation about the origin will be equivalent to performing a rotation about the Selected Group's

Center. Multiple rows / plates may be selected by CTRL-clicking or SHIFT-clicking on multiple rows within the Scatterer Group Editor.

Once editing of a Scatterer Group is complete, click the *Save* button and type a unique filename to save the scatterer. Then from the main Scatterer Editor window, see Fig.98, one may choose to *Open* the newly created/modified Scatterer Group.

13.1.1.4 The 3D World

Once inside the *Scatterer Group Editor*, the 3D Visualization changes to show only the currently edited Scatterer Group. The default 3D view is a top-down view as shown in Fig.96.

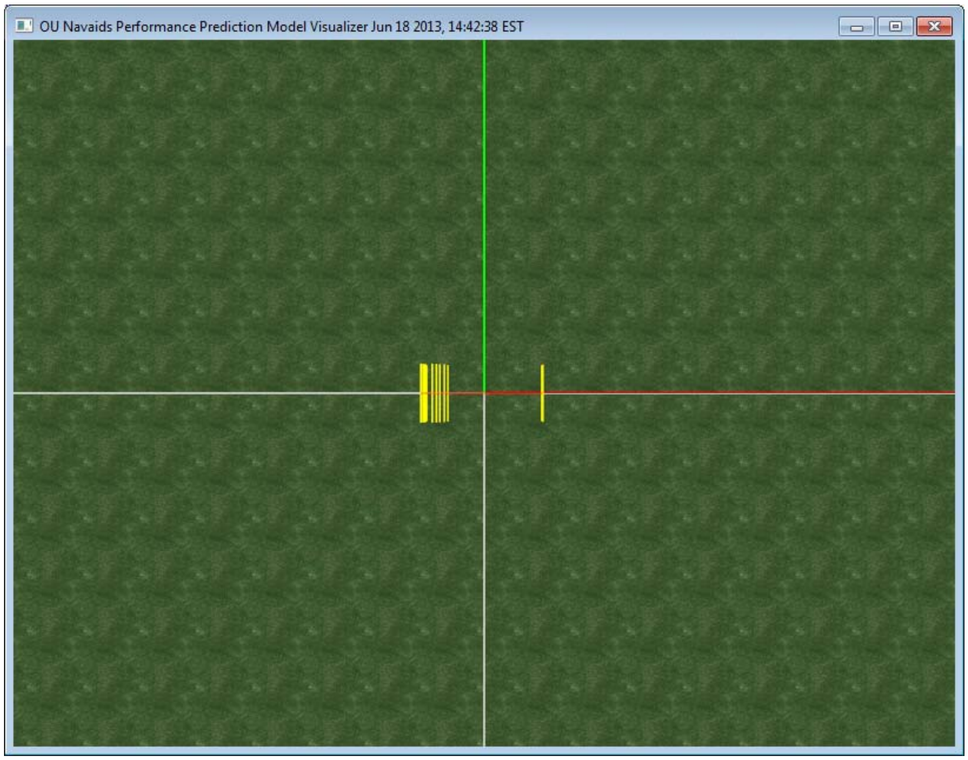


Figure 96: The default top-down *Scatterer Group Editor* 3D Visualization. The user may navigate the camera to any desired orientation.

The user may navigate the 3D Visualization to place the camera at any desired position. See Fig.97. See Chapter VI for a description about using and navigating the 3D Virtual World.

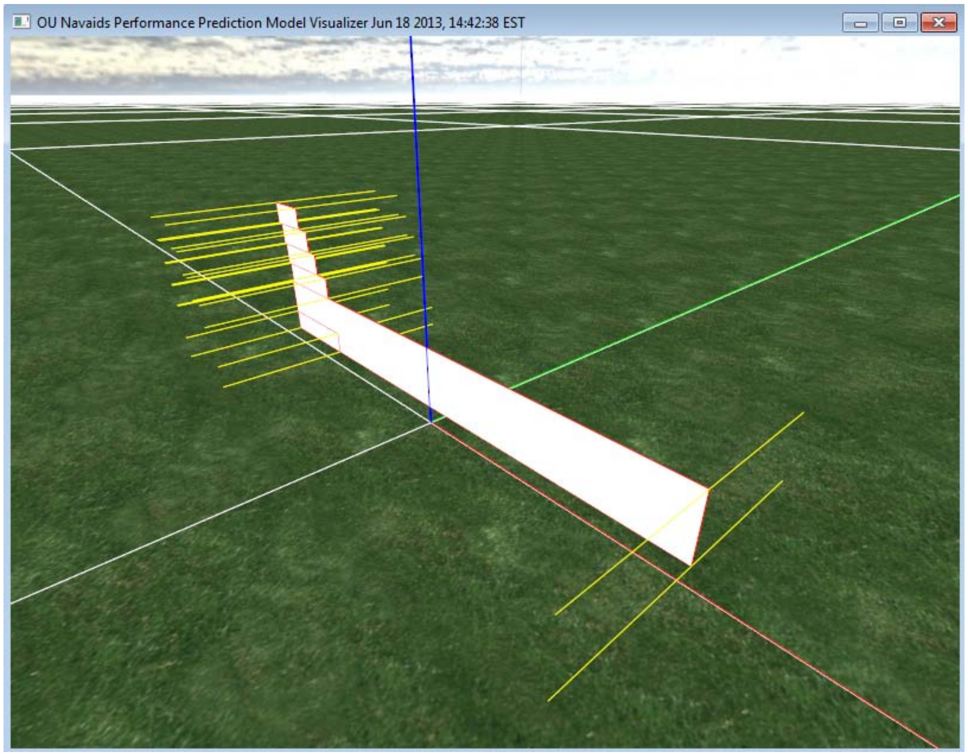


Figure 97: The user has navigated from the top-down view to a different view. Exact same Scatterer Group as shown in Fig.96.

13.1.2 Wire Group Editor

Similar to plate group editor.

This section is incomplete.

13.2 Scatterer Point of Rotation

These ten

This section is incomplete.

13.3 Iteration Operations

13.3.1 Iterate Individually

This section is incomplete.

13.3.2 Iterate as Group

This section is incomplete.

13.4 Group Scatterers (Table)

13.4.1 Add

Figure 98 shows how to insert a scatterer group into the model. In this case a Boeing 707 is being loaded.

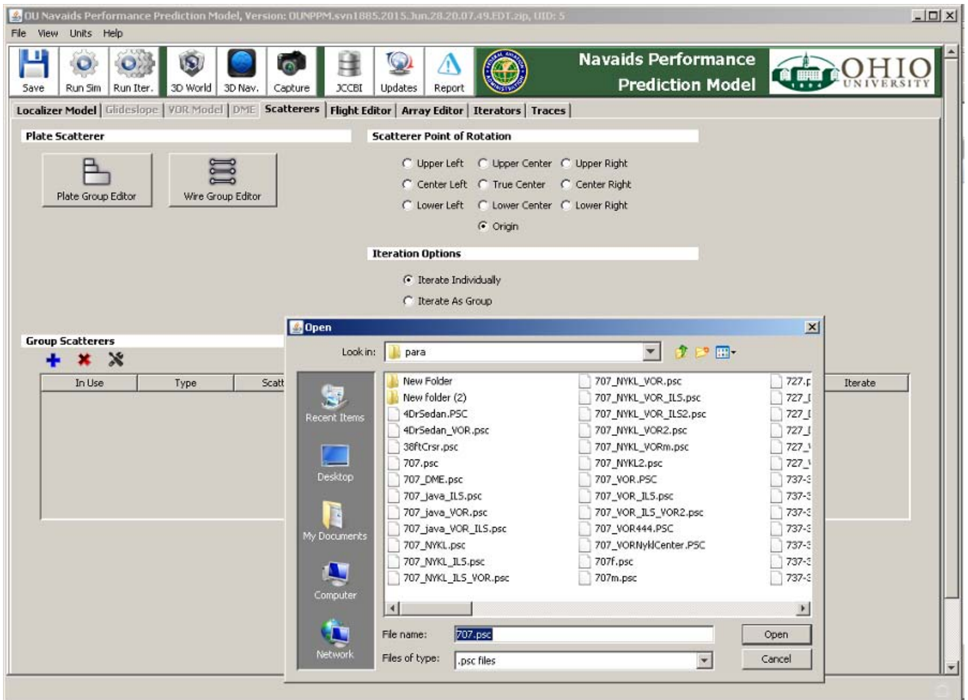


Figure 98: The main scatterer editor window. Groups of scatterer plates are loaded here.

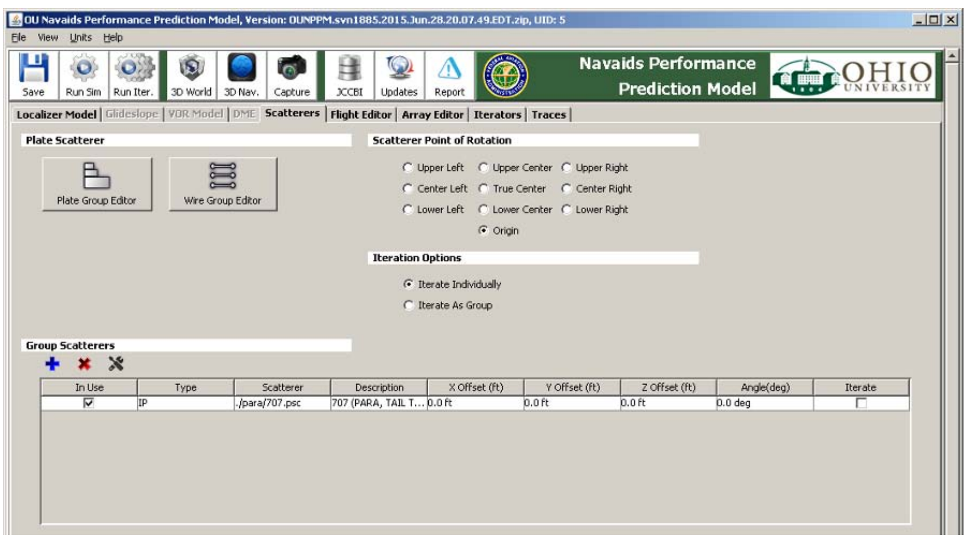


Figure 99: A Boeing 707 has been loaded and positioned at $(0, 20\vec{0}, 50)$ with a rotation of 45°.

Figure 100 shows a Boeing 707 has been loaded and positioned at $(0, 20\vec{0}, 50)$ with a rotation of 45°.

13.4.1.1 Effect on the Simulation

This section is incomplete.

13.4.1.2 Effect on the 3D World

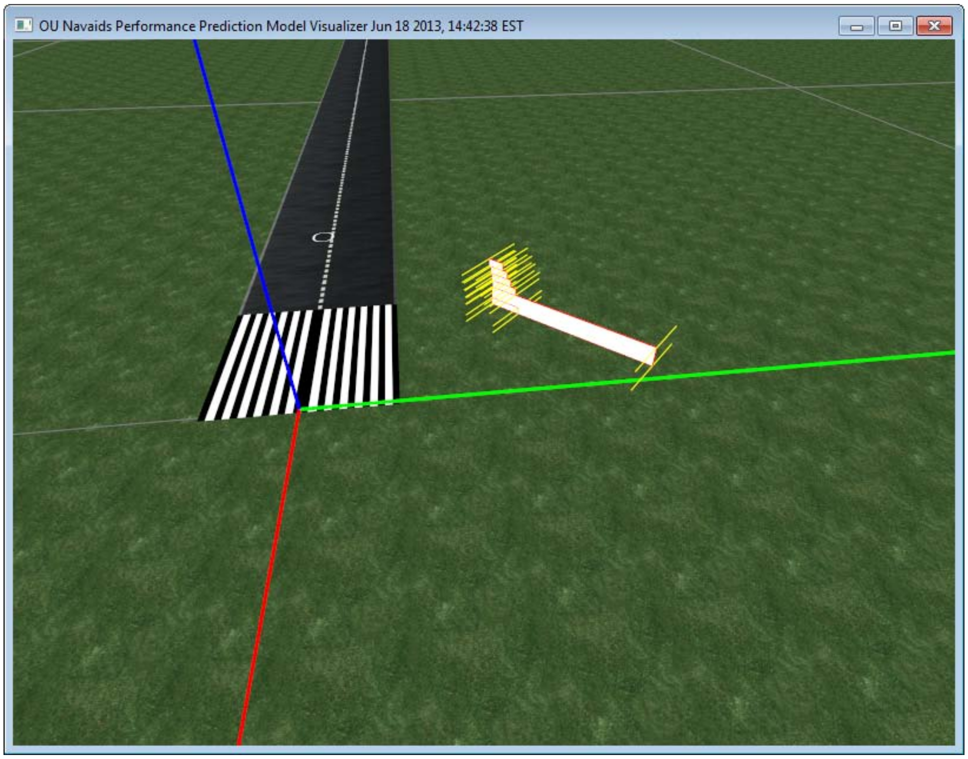


Figure 100: The 3D Visualization of the Boeing 707 positioned at $(0, \vec{200}, 50)$ with a rotation of 45°. Notice its position relative to the *threshold / start end / origin*.

Figure 100 shows the 3D Visualization of the Boeing 707 positioned at $(0, \vec{200}, 50)$ with a rotation of 45°. Notice its position relative to the *threshold / start end / origin*.

13.4.2 Remove

This section is incomplete.

13.4.3 Edit

This section is incomplete.

13.4.4 The Table

This section is incomplete.

13.4.4.1 In Use

This section is incomplete.

13.4.4.2 Type

This section is incomplete.

13.4.4.3 Scatterer

This section is incomplete.

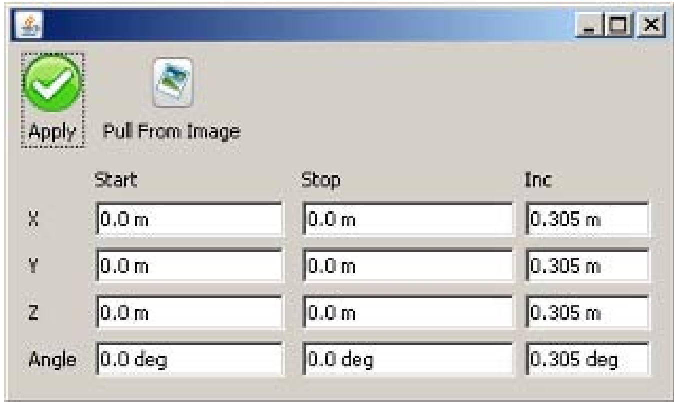


Figure 101: A panel that lets the user set the start, stop, and increment for iteration for scatterers.

13.4.4.4 Description

This section is incomplete.

13.4.4.5 X Offset

This section is incomplete.

13.4.4.6 Y Offset

This section is incomplete.

13.4.4.7 Z Offset

This section is incomplete.

13.4.4.8 Angle

This section is incomplete.

13.4.4.9 Iterate

The scatterer group table has a column that allows the user to iterate the positions and rotation of a scatterer group. When the column is checked a window will appear, as seen in Figure 101

Each of the three position coordinates (X, Y, and Z) and the rotation of a scatterer can have a minimum and maximum bound set for their iteration. The user will also set a non-zero increment value. Iterators with a zero increment value are ignored. The iterators will start with the lower bound and increase to the upper bound by units of increment. When the current value surpasses the maximum value, iteration will cease.

Pressing the “pull from image” button

Pressing the apply button will save these changes.

If the box is unchecked, iteration will not be applied during the run, but the values should be ”remembered” next time the box is checked.

14 Flight Parameters

14.1 Localizer Flight Paths

The section describes the supported Localizer Flight Paths.

14.1.1 Localizer ILS 3 / Approach

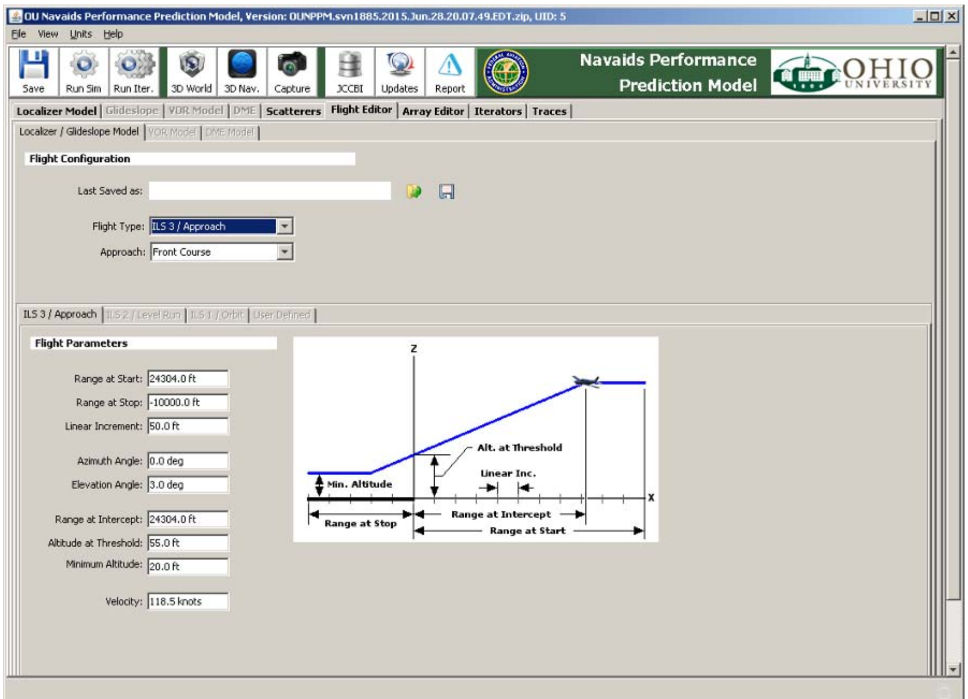


Figure 102: The default ILS 3 / Approach Flight Path for a Localizer.

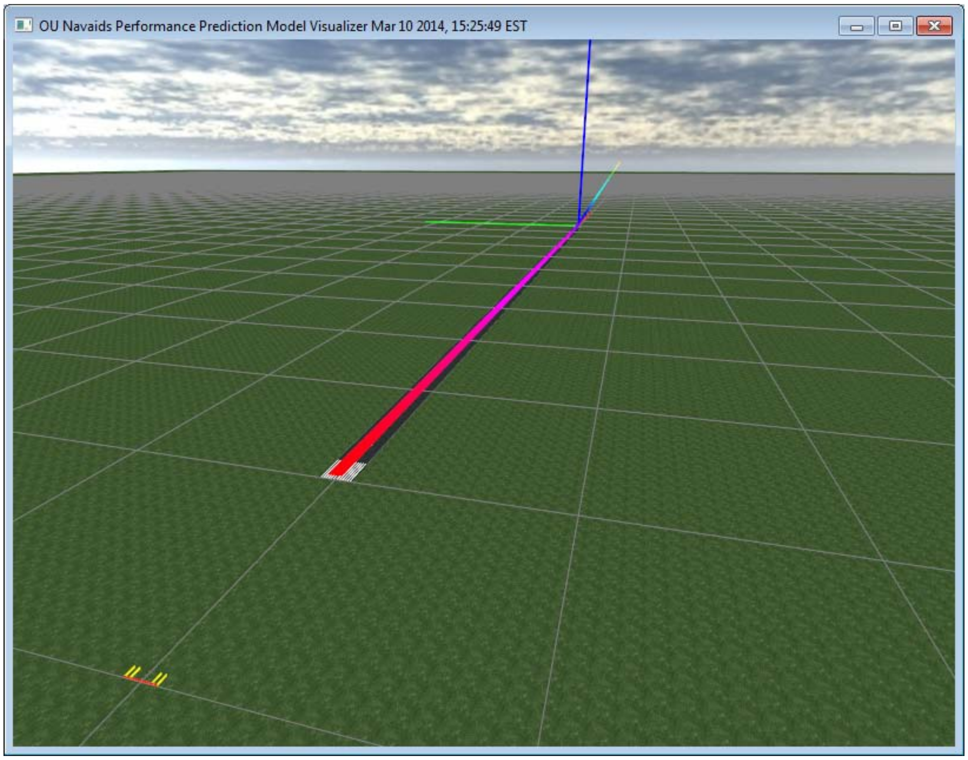


Figure 103: The 3D Virtual World depicting the ILS 3 / Approach Flight Path in Fig.102.

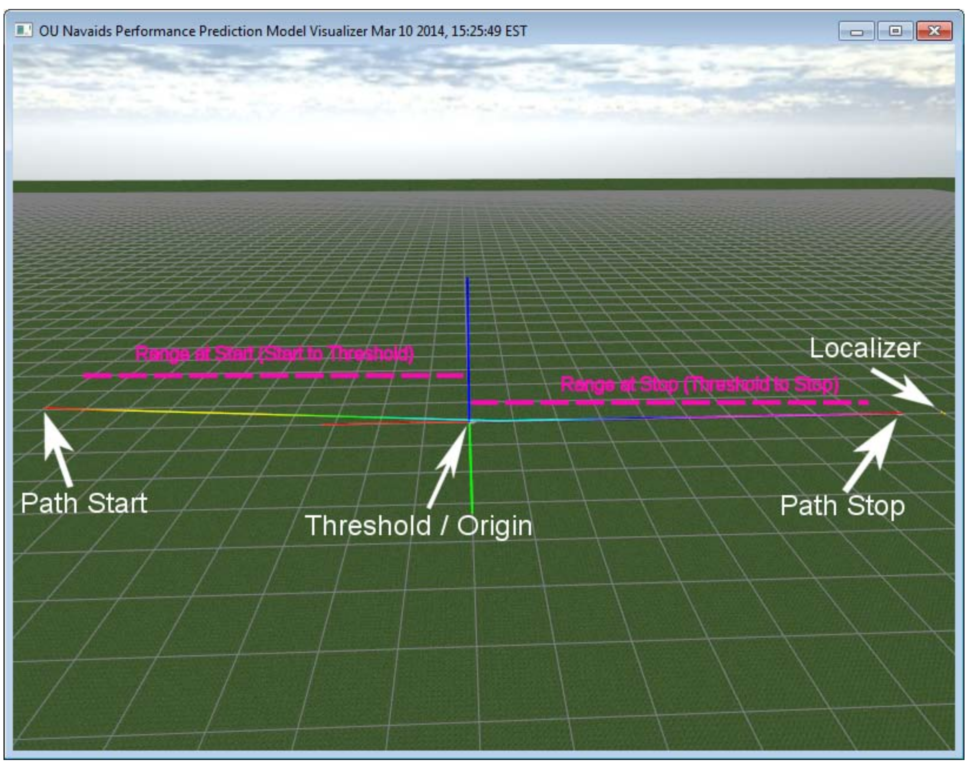


Figure 104: ILS 3 / Approach Flight Path Nomenclature.

The Localizer's ILS 3 approach is a straight flight path specified by the following inputs: 1) *Elevation Angle* (defaulting to 3°), 2) *Altitude at Threshold*, 3) *Minimum Altitude*, 4) *Azimuth Angle*, 5) *Range at Start*, and 6) *Range at Stop*. As shown in

Fig.104, the flight path begins at a distance *Range at Start* from Threshold along the $+X$ (red axis) direction towards Threshold. The flight path's slope is *Elevation Angle* with an initial altitude such that the path's altitude as it intersects Threshold is *Altitude at Threshold*. After reaching Threshold, the flight path's slope remains constant at *Elevation Angle* until *Minimum Altitude* is reached. At this point the flight path's slope becomes 0° and it continues until it is *Range at Stop* distance from Threshold along the $-X$ (red axis) direction.

The *Azimuth Angle* will simply rotate the above described path about the localizer's position by *Azimuth Angle*° in a counter-clockwise direction. The flight path is also aligned to the localizer when the localizer is offset along the $\pm Y$ axis (green axis). Figure 105 shows a rotated ILS 3 Approach.

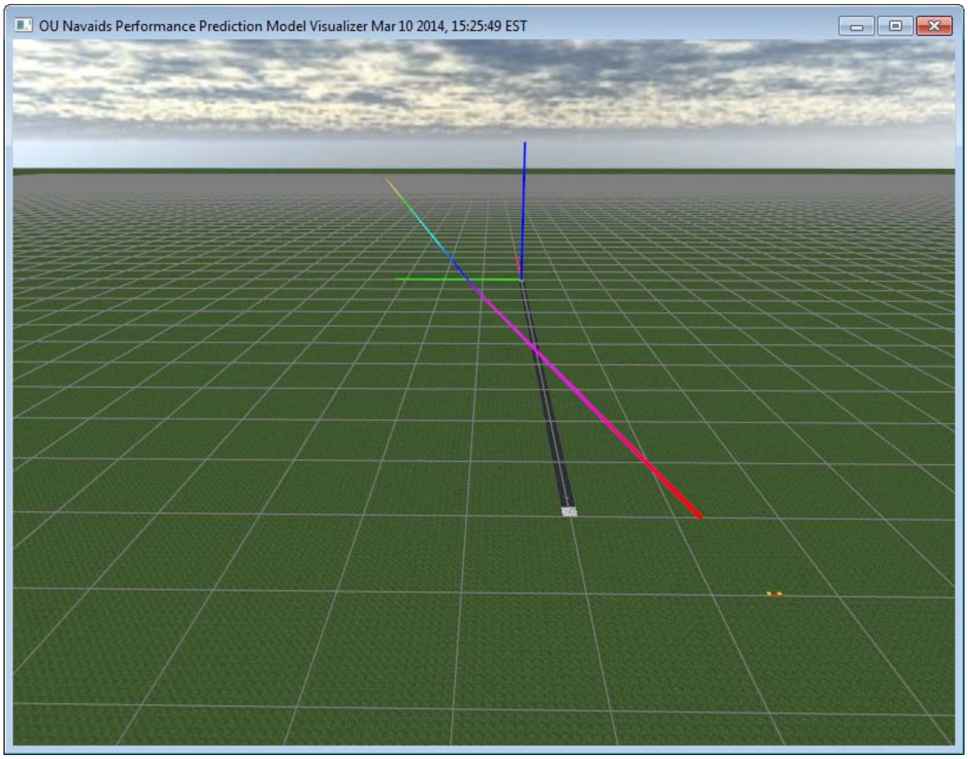


Figure 105: ILS 3 Flight Path with an *Azimuth Angle* of 15° and a Localizer *Main Offset* of $-1500ft$ and an *Ant. Setback* of $1000ft$.

14.1.2 Localizer ILS 2 / Level Run

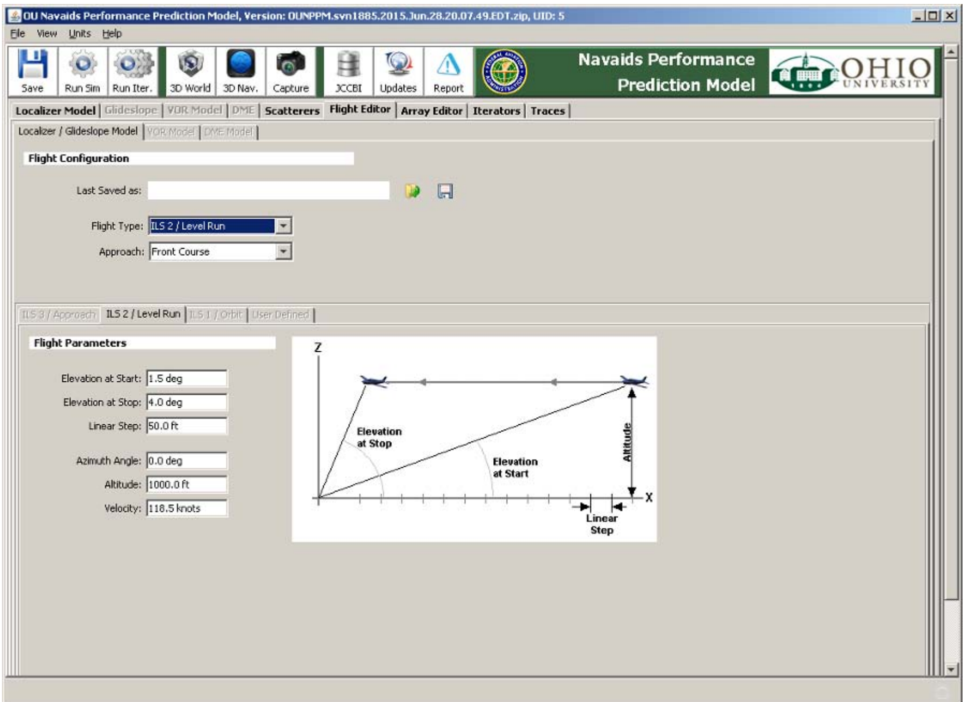


Figure 106: ILS 2 / Level Run Flight Path for a Localizer.

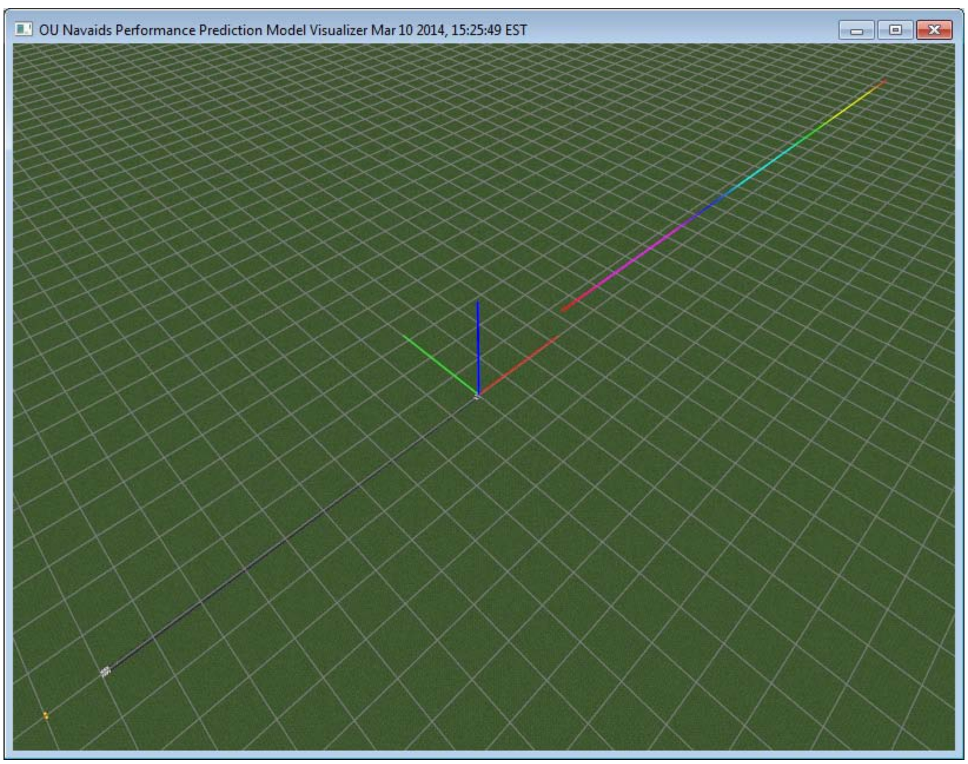


Figure 107: ILS 2 / Level Run Flight Path visualizing the parameter from Fig.106.

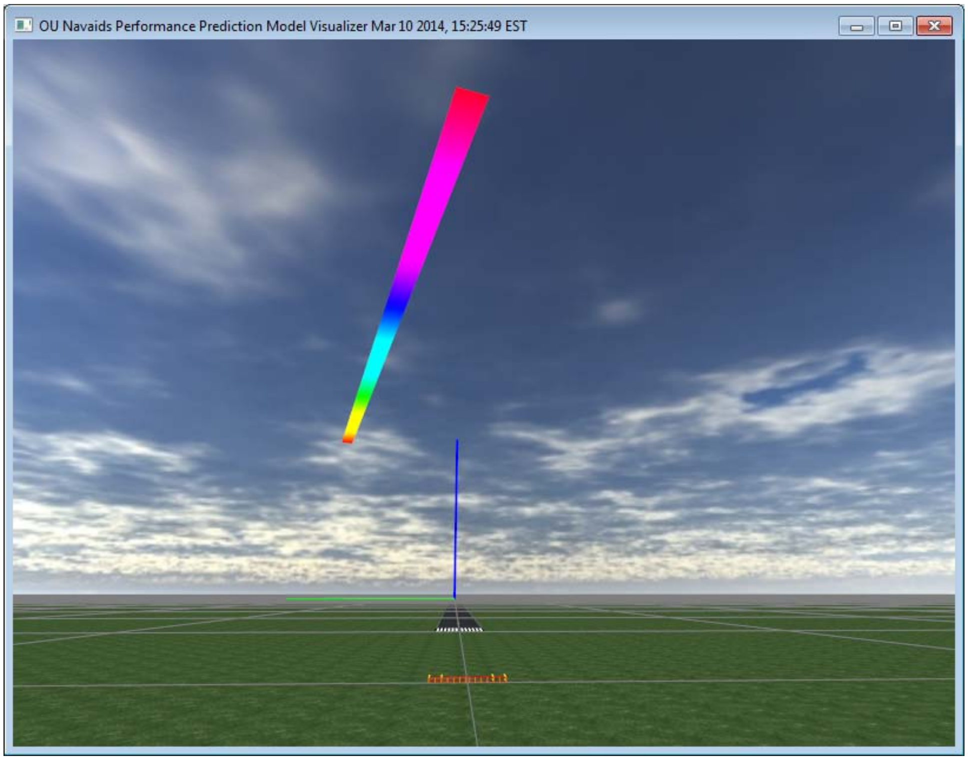


Figure 108: ILS 2 / Level Run Flight Path with a *Elevation at Start* of 20°, an *Elevation at Stop* of 90° at an *Altitude* of $1000ft$ with an *Azimuth Angle* of 15°.

The Localizer's ILS 2 / Level Run approach is a straight flight path specified by the following inputs: 1) *Elevation at Start* (defaulting to 1.5°), 2) *Elevation at Stop (defaulting to* 4°), 3) *Altitude* (defaulting to $1000ft$), and 4) *Azimuth Angle*. As shown in Fig.106, the flight path begins at the point originating from the localizer, parallel to $+X$, with a slope of *Elevation at Start* extending until it reaches a height of *Altitude*. The *Linear Step* size denotes the distance between inspection points along the flight path. The corresponding 3D Virtual World is shown in Fig.107.

The *Azimuth Angle* will simply rotate the above described path about the localizer's position by *Azimuth Angle*° in a counter-clockwise direction. The flight path is also aligned to the localizer when the localizer is offset along the $\pm Y$ axis (green axis). Figure 108 shows a rotated ILS 2 Approach.

14.1.3 Localizer ILS 1 / Orbit

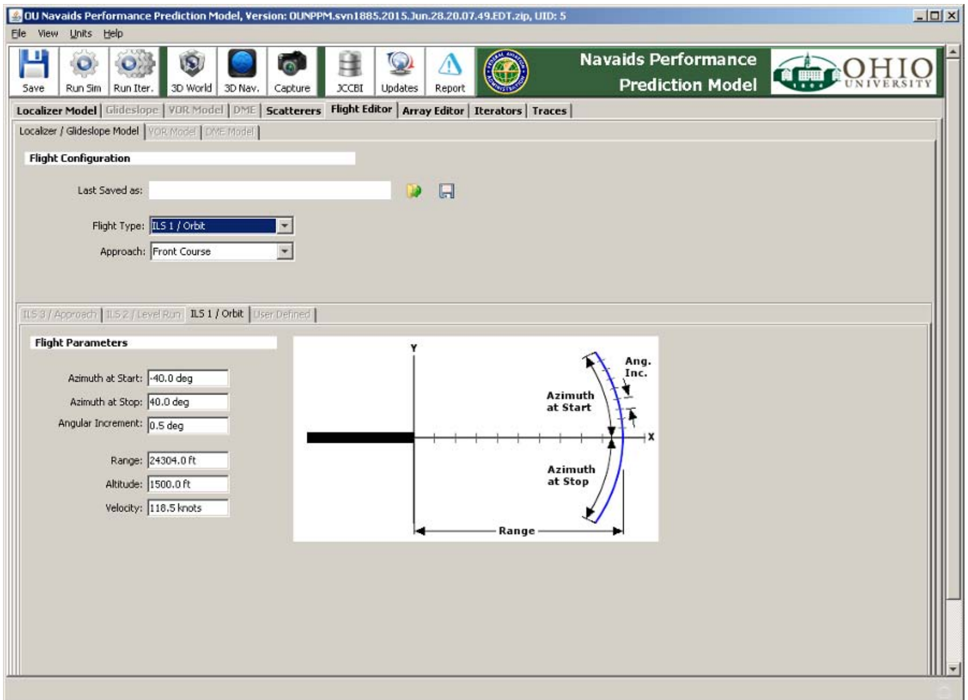


Figure 109: ILS 1 / Orbit Flight Path for a Localizer.

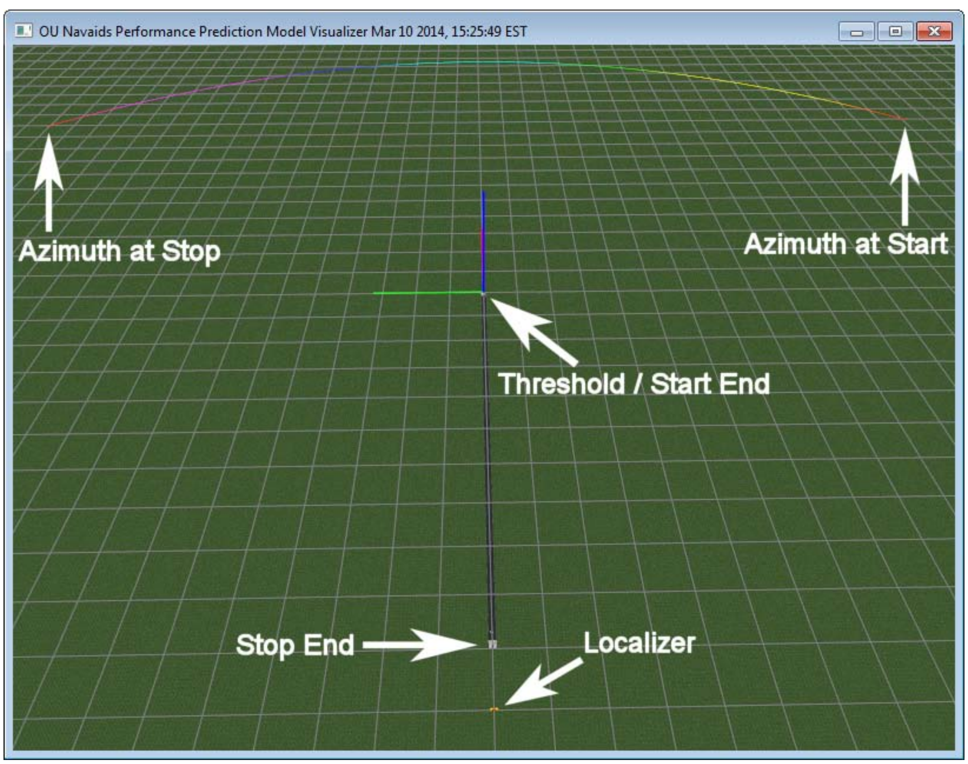


Figure 110: 3D Virtual World corresponding to the ILS 1 / Orbit Flight Path parameters from Fig.109.

Figure 109 shows the parameters for an ILS 1 / Orbital Flight Path. Figure 110 shows the corresponding visualization. The *Range* specifies the distance from the Localizer to the flight path at each point along the curve. Typically values outside $[-40°, 40°]$ cannot sense the Localizer signal (unless the Localizer is rotated off of center line).

Localizer/Glideslope. ILS1/2/3 maximum orbit width

VOR Orbital/Radial/RNAV/Fixed Cone of silence ; orbits can spiral, fixed are fixed distance orbits

15 Array Editor

The Array Editor Tab allows one to create, open, modify, and save any Localizer Array (.LDU), Glideslope Array (.GDU), Localizer Azimuthal Element Pattern (.LEL), or Glideslope Azimuthal Element Pattern .GEL file. This tab may be accessed at any time, and does not affect the current model. This tab simply enables a user to modify or create arrays and patterns that can be loaded in a Localizer or Glideslope model within the *Facility Info* Tab via *Array Type* and *Element Type* dropdown boxes.

15.1 Localizer Array Editor

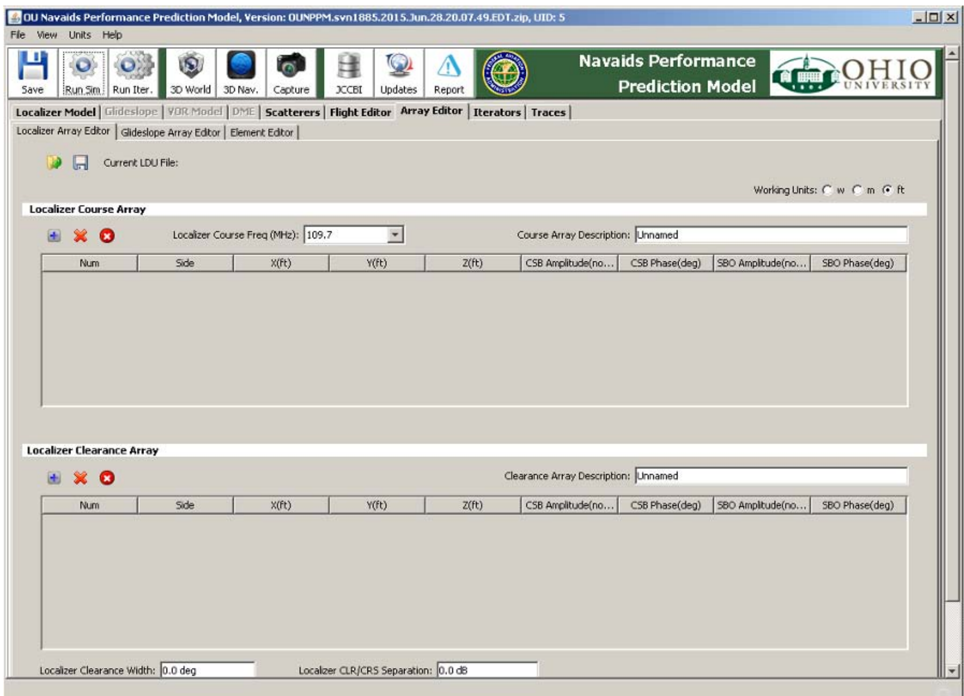


Figure 111: The Localizer Array Editor.

Figure 111 shows the Array Editor for all Localizer arrays. Clicking the will open a File Chooser where any .LDU file may be selected. Figure 112 shows an opened "WI14-10.LDU" array. Both the Course and Clearance array are shown.

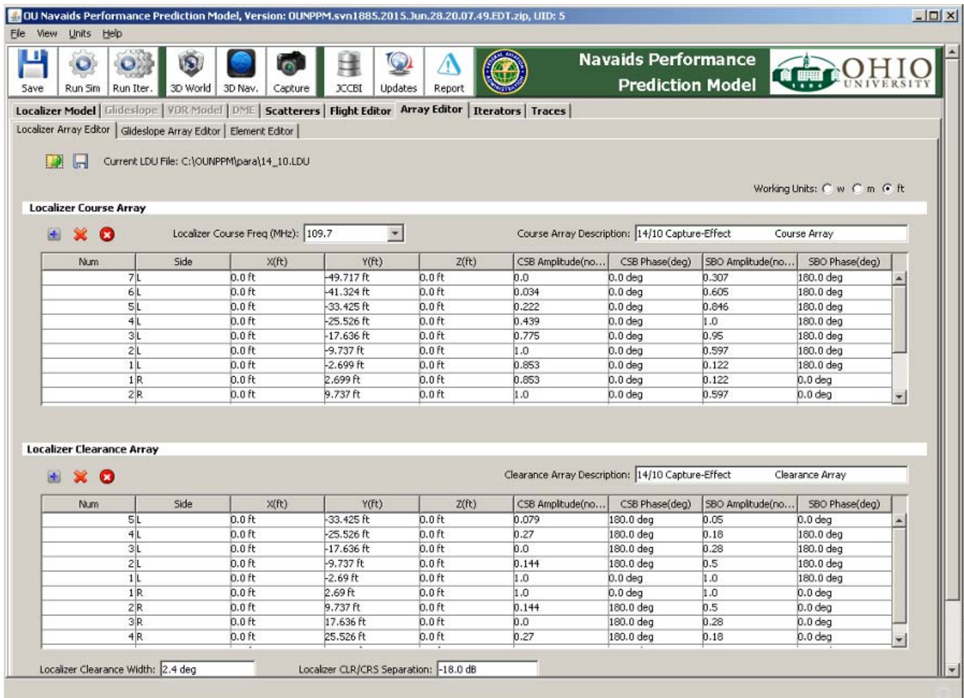


Figure 112: The Localizer Array Editor.

The course and clearance parameters may be modified directly via the table, new rows may be appended and existing rows may be removed or modified. Once modifications are complete, click the will open a File Chooser where the modified LDU file may be saved. *Caution: Do not override existing LDU files. This will replace the existing LDU file with the modified version. Please save all LDU files using a unique name that does not over write the originals.*

15.2 Glideslope Array Editor

15.3 Azimuthal Element Pattern

To draw your own pattern, click the icon.

15.3.1 Drawing a pattern

A scatterer group can also be created based on positions relative to an image. This is a 4 step process.

1. Load image (upper toolbar) - most image types are supported. When you click this button you will be prompted to select an image file which will then be opened and displayed on the panel. It will maintain its original size in pixels.
2. Set scale (upper toolbar) - Optionally, enter a length into the field and then click and drag a length you intend to represent that length. The label next to the length field should now be populated with that number of pixels. When drawing an element pattern, correct results can still be achieved without knowing the correct distance, simply use the scale to set the radius of the pattern.

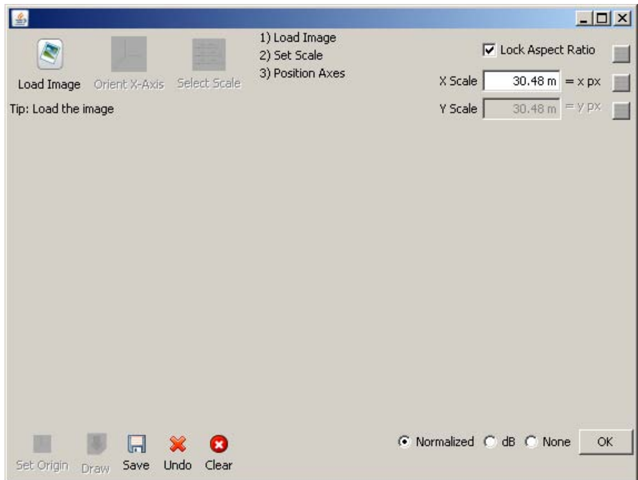
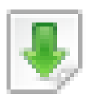
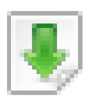


Figure 113: A freshly opened draw element pattern pane.

3. Orient x-axis (upper toolbar) - in order to get a coherent reference frame, the user will define the positive x-axis. We use a right-handed coordinate system, and the y-axis will also fall in the plane of the image, so it is defined.

4. Click the "set origin" button on the lower toolbar to select where the center of the pattern will be.

5. Now that we have a complete system in which to define the pattern, you can start drawing your pattern.

Click the draw button , and then click the points you wish to use starting at 0 degrees continuing in increasing azimuthal value. The pattern will form a closed line loop until click the draw button  again.

If you make an error and wish to undo the last point, click the undo button (lower toolbar). If you wish to start over, you can clear the entire pattern by clicking the clear button (lower toolbar).

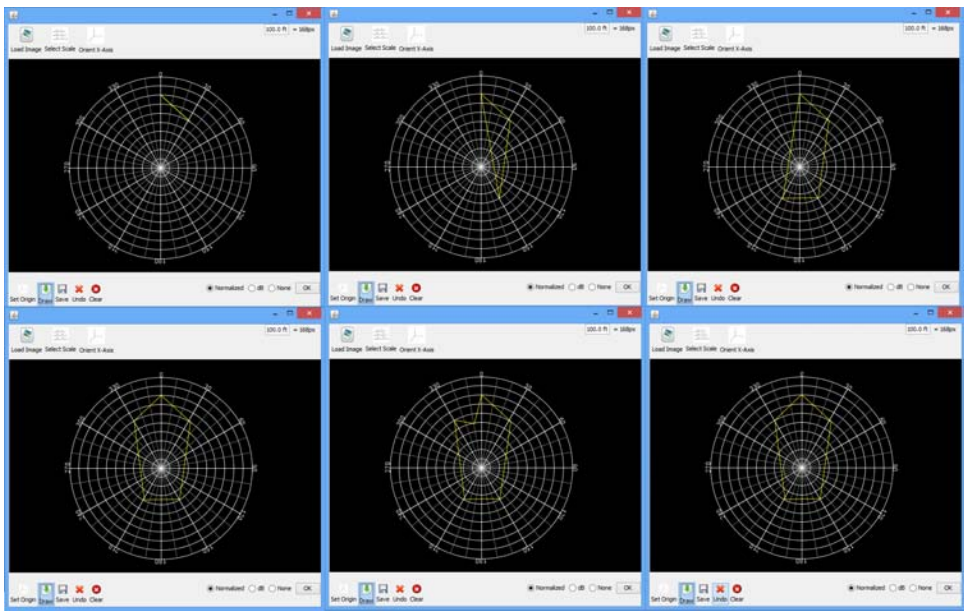


Figure 114: An example of a 5 point element pattern, and using the undo button to fix a mistake.

16 Iterators

Iterators are the system OUNPPM uses to run multiple related simulations at once. They allow the user to vary attributes of the simulation in a combinatorial manner.

16.1 Strategy

The paradigm for iterators in this software is as follows. Each iterator will have n different possible values. Typically, these will be numeric values starting with a *start* value, ending with a *stop* value, and incrementing by an *inc* value; although these could just as easily be n different types of localizer. When the iterative analysis is performed every permutation of all things being iterated are tested.

To determine how many iterations, X will be run, take the product of the number (n) of options each of the x iterators have. See Equation 11.

$$X = \prod_{i=1}^{x} i_n \tag{11}$$

While running, the completion bar should increment in steps of 100 / X percent. Once all X runs have completed there will be two different forms out output. The first is the table, which outlines every iteration and it's outputs. The second is the plot, which is limited to graphing only the results of 1 or 2 of the iterators. If it is 1, then the x-axis will be the values of thing being iterated and the y axis will be the output of the analysis. If two iterators are selected, then both axis are iterator values, and analysis results are shown as points on the plots. More information these outputs can be found on in sections **??** and **??**.

16.2 Iteration Tab

The iteration tab is a top level tab and provides the user a way to run, save, and load iterations, as well as an overview of all currently enabled iterators.

16.3 Iteration Table

This table contains a list of all the active iterators that will be used during the next run. Each specific iterator has a specific string that describes the conditions that that iterator will manipulate. Often this will be the minimum and maximum values and an increment.

16.4 CAS (Lower) Toolbar

This toolbar, located beneath the iterator table, contains functionality for loading and merging iteration plots. "Open" (lower toolbar) – Opens a CAS file and shows the resulting plot. "Merge" (lower toolbar) – Merges two CAS files.

16.5 ITL (Upper) Toolbar

This toolbar, located above the iterator table, has three buttons. "Iterate / Run Full" (upper toolbar) – This button will run all of the existing iterations, but will not immediately plot results. "Get Iterative Results" (upper toolbar) – This button will open the plots for an existing run of iterations. Whenever iterations are run, an

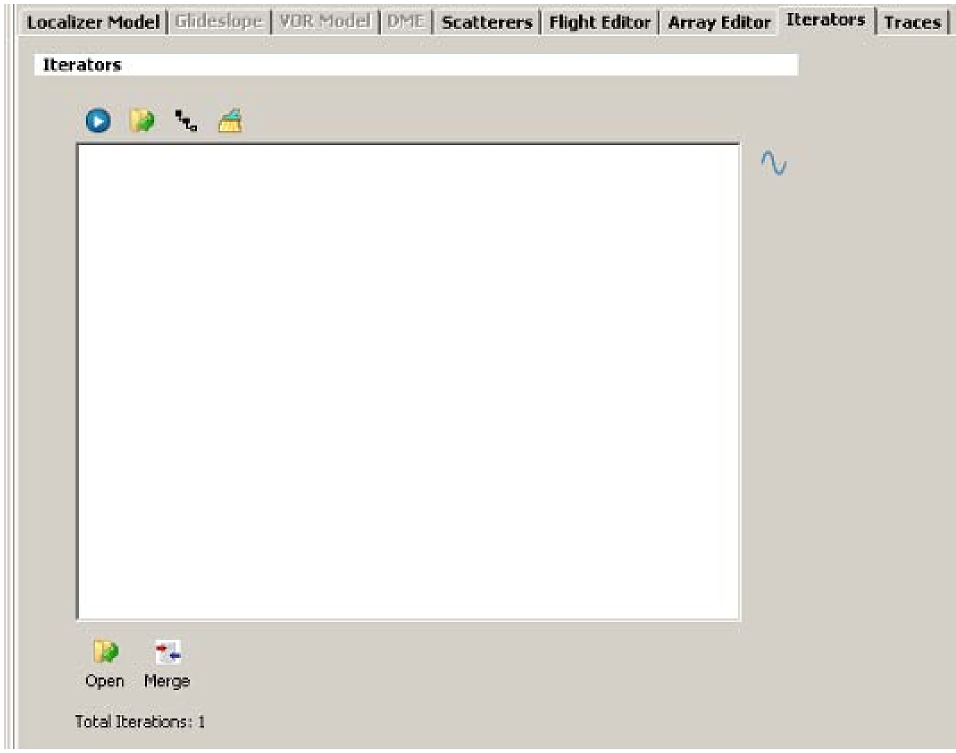


Figure 115: The iteration tab.

.itl file will be created. "Run and Get Results" (upper toolbar) – This button is functionally equivalent to the icon on the main toolbar.

16.6 Sidebar

The sidebar contains access to iterators that do not fall under the scope of any other area. ∿ - Iterate DU Parameters - This button spawns the Iterate DU Window that allows the user to manipulate the DU Phase, Amplitude, and X positions of the antenna elements. Iterate DU Windows: This window contains two tabs. The lefthand tab "Individual Antennae" allows the user to manipulate the phase, amplitude, and x position of each antenna element separately, or all of the selected elements as a group. The righthand tab allows pairs of both left and right elements be iterated in the same way. If the individual elements are chosen a single iterator is created for each element and attribute (phase, amplitude, x position). If the "Iterate As Group" box is checked, then of all the selected elements will be iterated individually as opposed to combinatorically. That is, if 5 elements are selected and asked to iterate over 2 phase values, then 10 iterations will be performed, not 32.

Iterators for individual antenna elements for the course array for phase are working at this time. This is sufficient to finish exercise 3.

Iterators for pair-to-pair, clearance array, position, and amplitude to be implemented soon.

16.7 Plots

Iterator plots are discussed later in section **??**.

17 Traces

17.1 Localizer Traces

17.1.1 Output Parameter

17.1.1.1 Descriptions

1. CDI Digital - Course deviation indicator
2. CDI Analog - Course deviation indicator
3. Flag - Flag Current.
4. CSB Signal Strength - Carrier plus Side Band
5. SBO Signal Strength - Side Band Only

17.1.1.2 Units

1. CDI Digital - microamps or degrees.
2. CDI Analog - microamps or degrees.
3. Flag - microamps or degrees.
4. CSB Signal Strength - decibels.
5. SBO Signal Strength - decibels.

17.1.2 Switches

17.1.2.1 Filtering

17.1.2.2 Fields

For signal strength output parameters, you can isolate either the incident or scattered fields, or use the total. Total should equal incident plus scattered.

17.1.2.2.0.0.1 Use Course Clearance This switch allows you to run the calculations using only the course array, only the clearance array, or both.

17.1.3 Course Parameters

17.1.3.1 Course Width

Recommended values fall between 3 and 6 degrees.

17.1.3.1.0.0.1 Calc The calc button near the course width will automatically calculate a value using the following equation:

17.1.3.2 Mod. Balance

17.1.3.3 SBO Phase

17.1.4 Clearance Parameters

17.1.4.1 Course Width

17.1.4.2 Mod. Balance

17.1.4.3 SBO Phase

17.1.4.4 Clr/Crs Sep.

17.1.4.5 Capture Ang.

17.2 Glideslope Traces

17.3 VOR Traces

17.3.1 Flight Type

17.3.2 SS Units

1. dB - deciBels
2. Relative - relative power

17.3.3 Output

1. Brg Error - Bearing Error, the difference between the actual bearing of the aircraft and where the receiving would interpret it to be.
2. Total SS -
3. Direct SS -
4. Reflected SS -

17.3.4 Model Type

There are two options for which VOR model to use. The Physical Alford Loop Model is more accurate, but takes longer to run than the Ideal Point Source model.

17.3.5 Trace Name

This is the name that will appear in the legend for this trace.

18 Software Updater

The OUNPPM program can be easily updated. Updates include new features, bug fixes, and other improvements over that are made to the software code base over time. These updates are released to the OUNPPM update web server at http://ounppm.eecs.ohio.edu/ounppm/updates/.

The current version of OUNPPM is always displayed at the top of the OUNPPM Window as shown below in Fig.116.

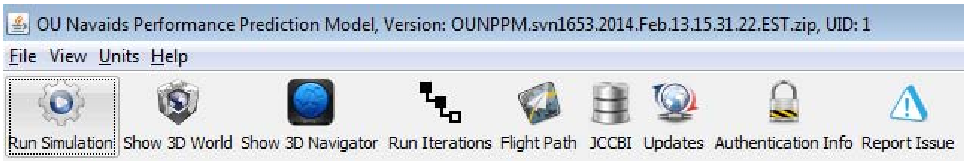


Figure 116: The Title Bar always displays the current version of OUNPPM. The version above is OUNPPM.svn1653.2014.Feb.13.15.31.22.EST.zip. This version number is 1653 and was built on February 13, at 3:31:22 PM EST.

When opening OUNPPM, the software checks for available updates. If an update is available, a notice informing the user occurs, as shown below:

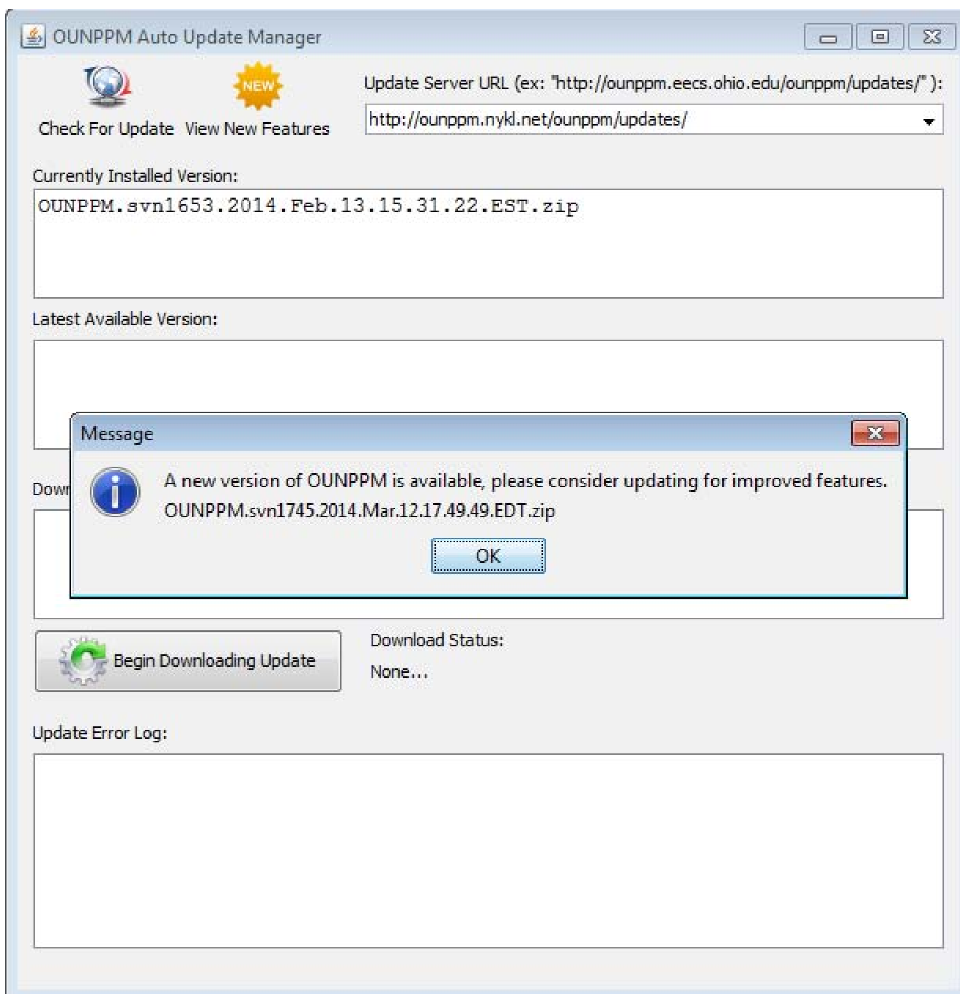


Figure 117: OUNPPM Checks for updates on startup. If a new version is available, the user is notified.

As long as the client machine has an internet connection (IPv4 or IPv6) *and* no firewall is blocking an outbound connection to TCP:80 (*http get* request) between the client and the server at `ounppm.eecs.ohio.edu`, then updates can be achieved as follows:

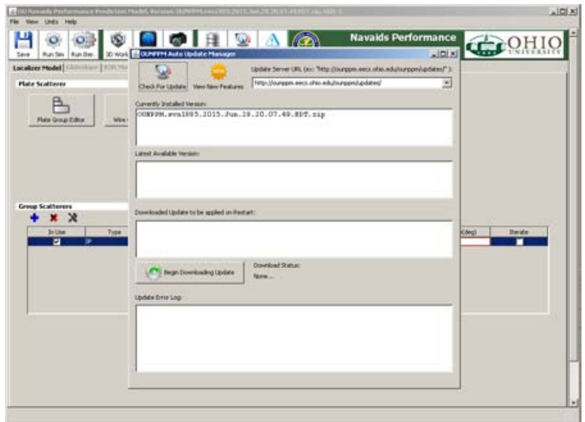


Figure 118: Clicking on the *Update* button from the main tool bar at the top of OUNPPM will open the Updater Window.

1. Click on the *Update* button from the main tool bar at the top of OUNPPM. This will open the Updater Window as shown in Fig.118.
2. Click on the *Check For Update* button in the upper left to query the OUNPPM Server for the latest version. The current version will appear in the *Latest Available Version* window.
3. If a newer version is available and the user would like to upgrade, click on the *Begin Downloading Update* button in mid/lower left part of the screen, as shown in Fig.119.
4. After the download completes successfully, the user must exit OUNPPM and restart it for the updates to take effect.
5. After restarting OUNPPM, notice the Version has changed in the Title Bar of the OUNPPM Window as shown in Fig.120.

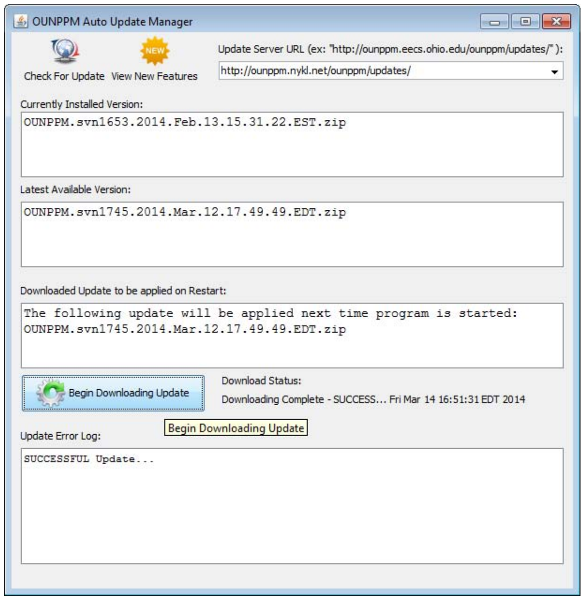


Figure 119: After a successfully downloaded update, OUNPPM must be exited and reopened for the updates to take effect.

Figure 120: Upon restarting OUNPPM, the new Version is displayed.

19 JCCBI Database

Stuff about JCCBI.

20 Authentication Information

OUNPPM requires the provided USB dongle is inserted into the client machine throughout the duration OUNPPM is used. If the USB dongle is removed, OUNPPM will ask the user to reinsert the dongle. OUNPPM will not run without the dongle attached. The dongle is provided during the OUNPPM training sessions.

If a dongle is lost or damaged, please contact Simbo Odunaiya at odunaiya@ohio.edu, or call 1-740-593-1534 8:00am - 5:00pm Monday Thru Friday.

OUNPPM must also authenticate with the update server ounppm.eecs.ohio.edu once every 30 days. By default, this happens each time OUNPPM starts. However, if no internet connection is available, a 30-day grace period exists where OUNPPM will continue to run (as long as the USB dongle is inserted).

If the 30-day grace period lapses, OUNPPM will not start until it can authenticate with the update server. Upon connection, the 30-grace period immediately resumes. In other words, if a user will be travelling and may not have internet connectivity, the user is strongly encouraged to run OUNPPM while connected to the internet before leaving.

Figure 121 shows the OUNPPM Authentication Window and provides the user with specific client information including the *Remaining Grace Period*.

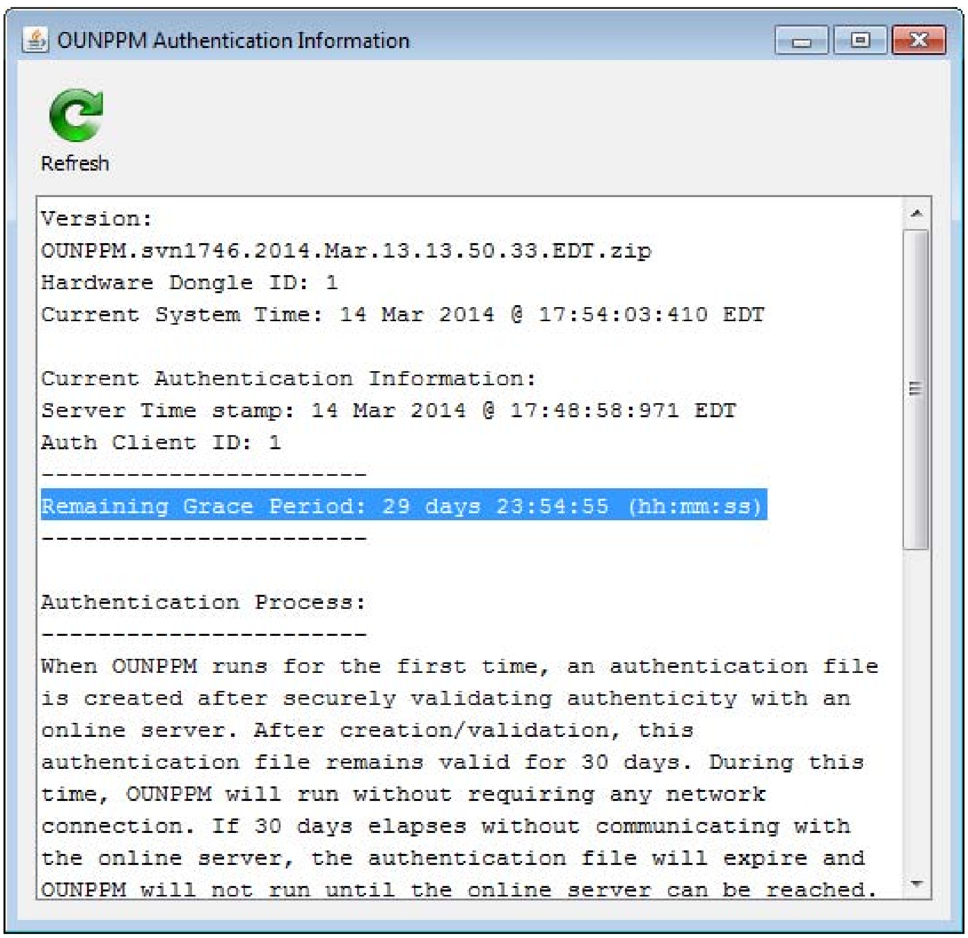


Figure 121: Clicking *Authentication Info* displays client-specific information including the *Remaining Grace Period* before contacting the update server. Clicking the *Refresh* button updates the *Grace Period Remaining* to the nearest Day Hour:Minute:Second.

The following text is taken from the *Authentication Information* Window and describes, in detail, how the authentication system works.

```
------------------------------------------------------------------------------
Version:
OUNPPM.svn1755.2014.Mar.14.18.02.51.EDT.zip
Hardware Dongle ID: 1
Current System Time: 14 Mar 2014 @ 18:03:12:609 EDT

Current Authentication Information:
Server Time stamp: 14 Mar 2014 @ 18:02:56:864 EDT
Auth Client ID: 1
-----------------------
Remaining Grace Period: 29 days 23:59:44 (hh:mm:ss)
-----------------------

Authentication Process:
-----------------------
When OUNPPM runs for the first time, an authentication file is created after
securely validating authenticity with an online server. After creation /
validation, this authentication file remains valid for 30 days. During this
time, OUNPPM will run without requiring any network connection. If 30 days
elapses without communicating with the online server, the authentication file
will expire and OUNPPM will not run until the online server can be reached.
The 'Grace Period Remaining', shown above indicates the time remaining.

This grace period enables OUNPPM to run without an internet connection for 30
days. If a user will be unable to access the internet for a prolonged period,
they may wish to verify OUNPPM immediately before disconnecting, thereby
achieving up to 30 days of OUNPPM operation. This verification can be
performed by simply running OUNPPM with a valid internet connection. Ensure
the 'Grace Period Remaining' says ~29-30 days remaining. This indicates
successful authentication.

OUNPPM attempts to validate with an online server each time it starts. If
successful, the 30 day grace period restarts.

Hardware Dongle Information:
----------------------------
OUNPPM requires that the included USB Hardware Dongle be inserted in order
for OUNPPM to operate. Once inserted and validated, the hardware dongle
becomes `keyed' with the particular installation. The same hardware dongle
must be used throughout the remainder of the grace period.
------------------------------------------------------------------------------
```

Part V

The Outputs (Plots)

There are two kinds of output plots in the OUNPPM. Plots for a single run, and iterator plots encompassing multiple runs.

Single run plots are generally created by clicking on the "Run Simulation" button or using the File -¿ Load Results dialogue.

Iteration plots are generally created by clicking on the "Run Iterations" button or using the open button in the iterator tab.

21 Localizer

21.1 The Plot

21.1.1 Axes

21.1.1.1 X-Axis

The localizer has three inspection types. The meaning of the x-axis is described below:

1. ILS3 - This is a fixed, descending approach along centerline. The x-axis of the plot will be distance from threshold in distance units, defaulting to nautical miles.

2. ILS2 - This is a level run at a fixed azimuth. The x-axis of the plot will be an elevation angle, defaulting to degrees.

3. ILS1 - This is an orbit. The x-axis of the plot will be a heading.

21.1.1.2 Y-Axis

For each trace a value can be plotted, refer to section 17.1 for more details on what each option means. You can find the units for each section below:

1. CDI Digital - Course angle: microamps or degrees

2. CDI Analog - Course angle: microamps or degrees

3. Flag - Course angle: microamps or degrees

4. CSB Signal Strength - Signal Strength: deciBels or normalized power

5. SBO Signal Strength - Signal Strength: deciBels or normalized power

Note: In the future we plan to add support for logarithmic axes for units like deciBels.

21.1.2 CAT III

Figure 136 shows an example of a CAT III plot.

21.1.3 CATII

Figure 137 shows an example of a CAT II plot.

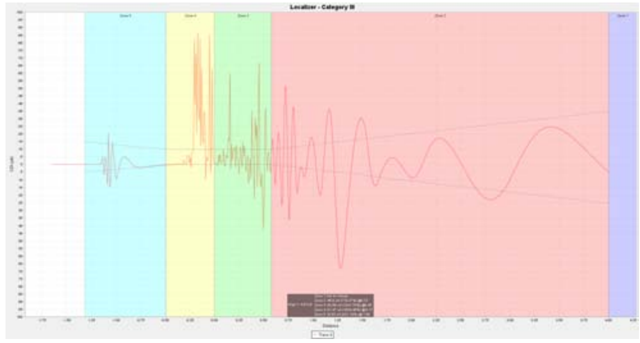


Figure 122: An example of a CATIII analysis.

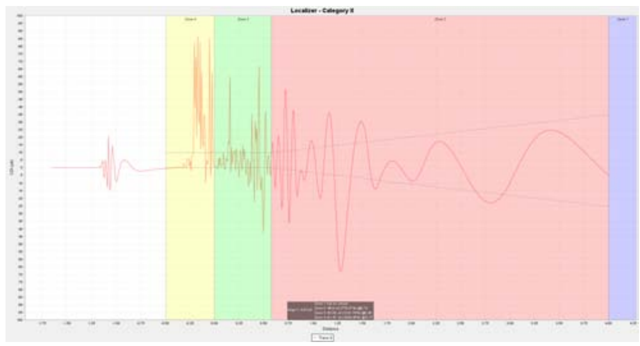


Figure 123: An example of a CATII analysis.

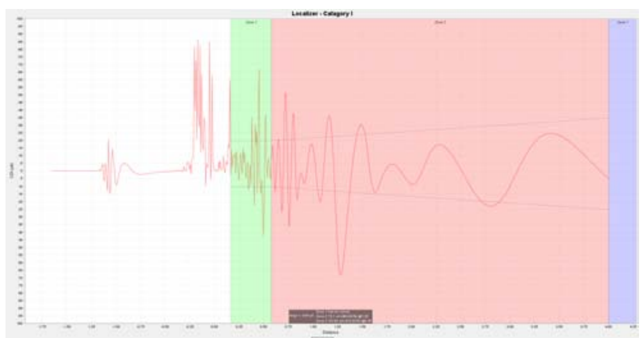


Figure 124: An example of a CATI analysis.

21.1.4 CATI

Figure 138 shows an example of a CAT I plot.

21.1.5 Context Menu

The context menu, as seen in figure 139, spawns when you right click on a plot. It has the following options:

21.1.5.1 Properties

The chart properties window has three tabs that allow one to edit the title, plot, and miscellaneous features of the plot. Note: the axes adjustment features of the plot in this window only allow one to adjust the extents and tick markings for the axes. If one wishes to adjust the units, one will need to need to use the “Adjust Axes” feature described in section 23.5.0.3.

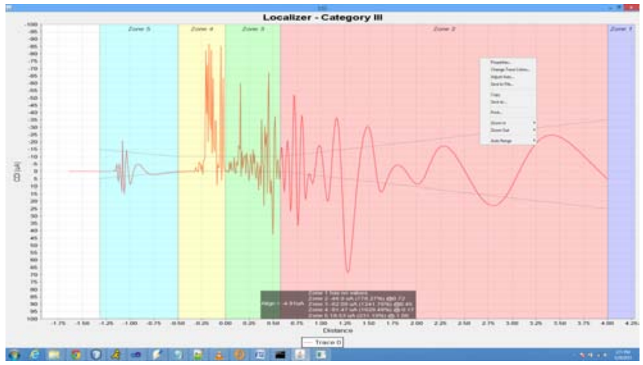


Figure 125: An example of the context menu displayed on a plot.

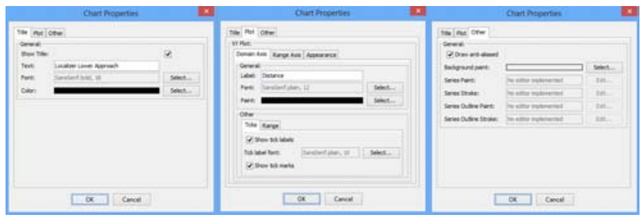


Figure 126: Features supported by the context menu.

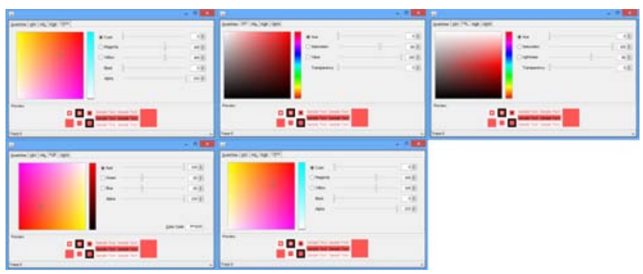


Figure 127: The different color types that are supported.

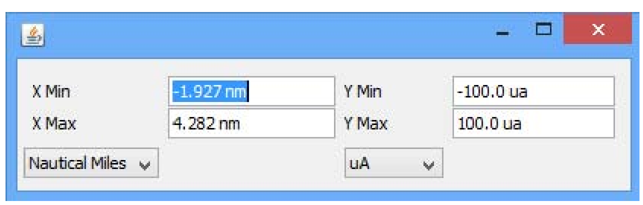


Figure 128: The different color types that are supported.

21.1.5.2 Change Trace Colors

This allows the user to change the trace colors to whatever color they desire. It supports HSV, HSL, RGB, and CMYK color specifications.

21.1.5.3 Adjust Axes

This window allows the user to adjust the extents and the units for the axes. When units are changed, the real value of the extents are preserved.

21.1.5.4 Save to File

This will save the file to a .gph file of the users choosing. This can be reopened at a later date, so one can view a plot without having to re-run an entire simulation.

21.1.5.5 Copy

Copies the contents of the graph to the clipboard.

21.1.5.6 Save As

Saves the plot as a .png image.

21.1.5.7 Print

Brings up the default print menu to print an image of the plot.

21.1.5.8 Zoom In

Zooms in one or both axes.

21.1.5.9 Zoom Out

Zooms out one or both axes.

21.1.5.10 Auto Range

Reverts one or both axes to their default values.

21.2 The Report

Given the evaluation of all points inspected and those linearly interpolated between inspected points residing at the boundary of a zone, a report is generated. At the bottom of each plot is a report that shows the following:

1. The Alignment error in μA
2. For each zone, the error in μA at the point with the highest percentage of tolerance error. Note: there may exist a point with a higher absolute error in that zone, but the report reports the evaluated point with the highest percentage relative to the tolerance at that point.
3. For each zone, the maximum percentage of tolerance at an evaluated point, in percent.
4. For each zone, the x-axis value value at which the maximum percentage of tolerance error occurs, in x-axis units.

21.3 Keyboard Interaction

The following Key Presses affect localizer plots:

1 - If support for Category I inspection exists for this configuration, the report mode will switch to Category I.

2 - If support for Category II inspection exists for this configuration, the report mode will switch to Category II.

3 - If support for Category III inspection exists for this configuration, the report mode will switch to Category III.

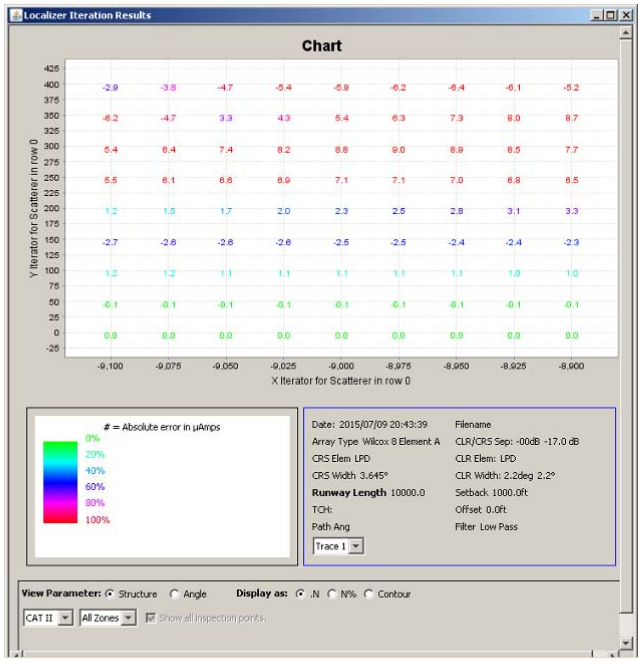


Figure 129: The default iteration plot, a structure plot showing decimal values.

21.4 Mouse Interaction

The right mouse button will spawn the context menu which is to be covered in section 23.5.

The left mouse button activates the zoom feature. Click and drag the mouse rightwards and downwards while holding down the left mouse button; this will replace the plot area with the region inside the highlighted area (aspect ratio is not necessarily preserved). Dragging the mouse in any other direction will reset the plot to its original bounds.

Hovering over a data point on a plot will display the x and y coordinates of that coordinate on the screen.

21.5 Localizer Iterator Plots

21.5.1 Overview

There are two categories of iteration plots of the localizer: structure and angle. The default plot will be a structure - decimal plot as shown in figure 129. In addition to the plot itself, this frame contains contains several useful GUI components: the title, the legend, the trace panel, and the selection panel at the bottom. The title is customizable via the property menu; the legend will change based on current plot. The trace panel has a selector that chooses which trace information to put on the plot$^{\diamond}$ and to populate the labels of the trace panel. The selection panel at the bottom lets the user change people iteration plot types, as well as select which category and analysis dataset to use.

21.5.2 Structure Plots

There are three variations of the structure iteration plot, described below: decimal, percentage, and contour.

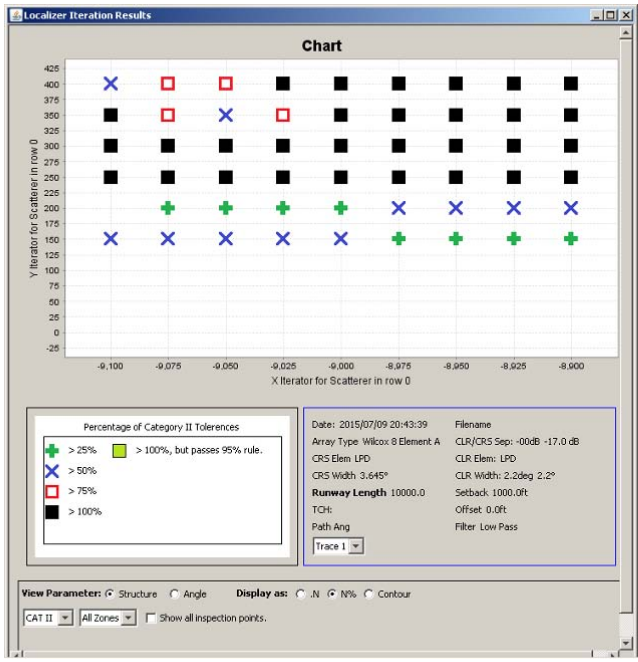


Figure 130: The default iteration plot, a structure plot showing decimal values.

21.5.2.1 Decimal

The decimal structure plot is shown in figure 129. The plot and legend are described below.

21.5.2.1.0.0.1 Plot The plot contains one value at the X,Y location for each datapoint. How iteration cooridinates are determined are explained in more detail in chapter 16. Each of these datapoints shows a decimal value representing

21.5.2.1.0.0.2 Legend The legend here shows the hue indicator coloring tolerence percentages from green at 0% to red at 100% or higher.

21.5.3 Percentage

The decimal structure plot is shown in figure 134. The plot and legend are described below.

21.5.3.0.0.0.3 Plot

21.5.3.0.0.0.4 Legend

21.5.4 Contour

The decimal structure plot is shown in figure 135. The plot and legend are described below.

21.5.4.0.0.0.5 Plot

21.5.4.0.0.0.6 Legend

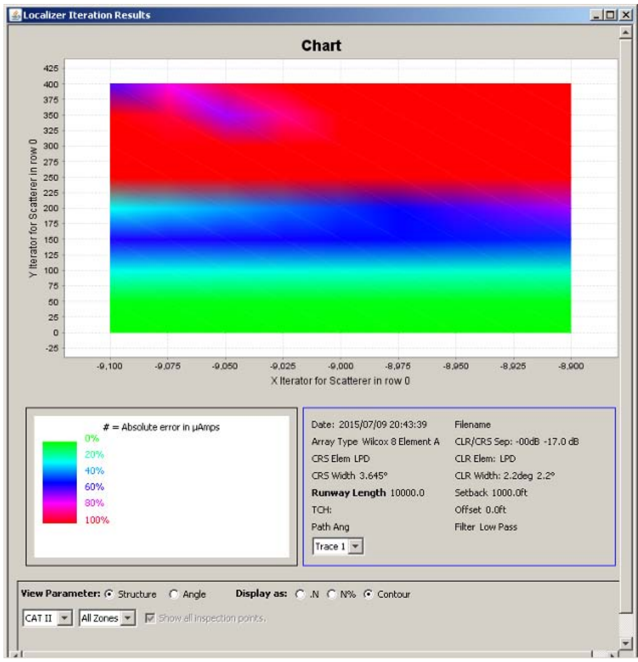


Figure 131: The default iteration plot, a structure plot showing decimal values.

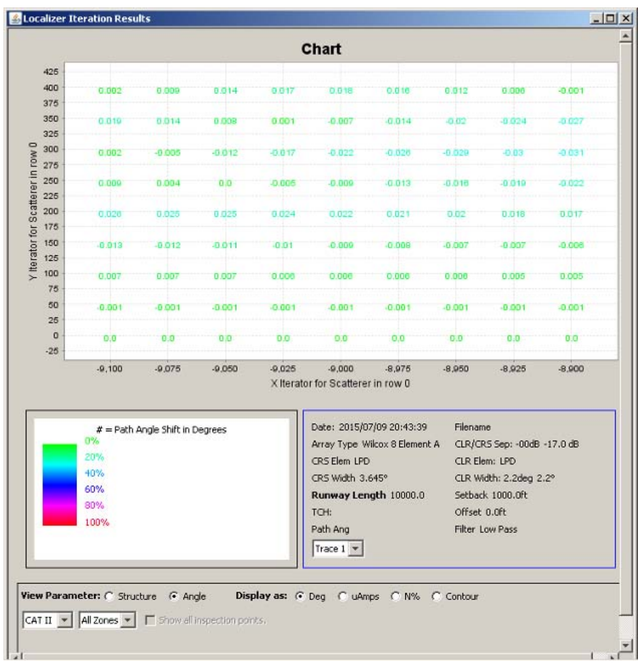


Figure 132: The default iteration plot, an angle plot showing decimal values.

21.5.5 Angle Plots

Iterator plots use calculated course width for angles, since they can't rely on a specific trace.

21.5.5.1 Degree

The decimal structure plot is shown in figure 129. The plot and legend are described below.

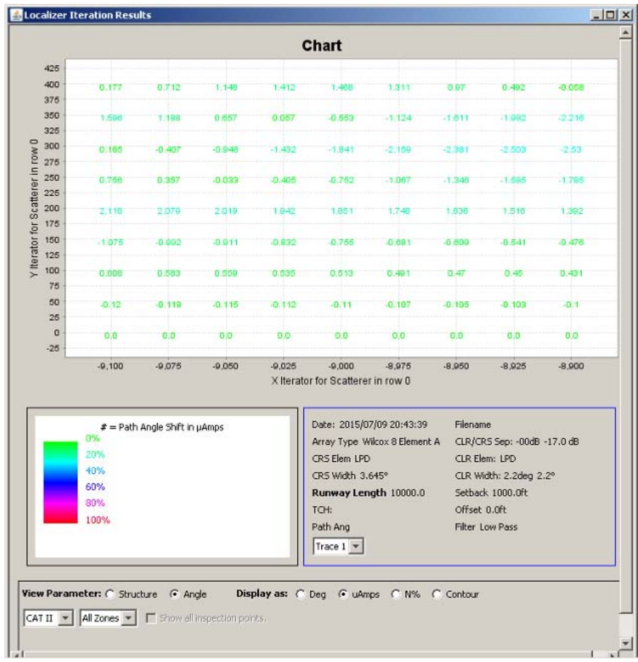


Figure 133: The default iteration plot, an angle plot showing decimal values.

21.5.5.1.0.0.1 Plot The plot contains one value at the X,Y location for each datapoint. How iteration cooridinates are determined are explained in more detail in chapter 16. Each of these datapoints shows a decimal value representing

21.5.5.1.0.0.2 Legend The legend here shows the hue indicator coloring tolerence percentages from green at 0% to red at 100% or higher.

21.5.5.2 μAmps

The decimal structure plot is shown in figure 129. The plot and legend are described below.

21.5.5.2.0.0.1 Plot The plot contains one value at the X,Y location for each datapoint. How iteration cooridinates are determined are explained in more detail in chapter 16. Each of these datapoints shows a decimal value representing

21.5.5.2.0.0.2 Legend The legend here shows the hue indicator coloring tolerence percentages from green at 0% to red at 100% or higher.

21.5.6 Percentage

The decimal structure plot is shown in figure 134. The plot and legend are described below.

21.5.6.0.0.0.3 Plot

21.5.6.0.0.0.4 Legend

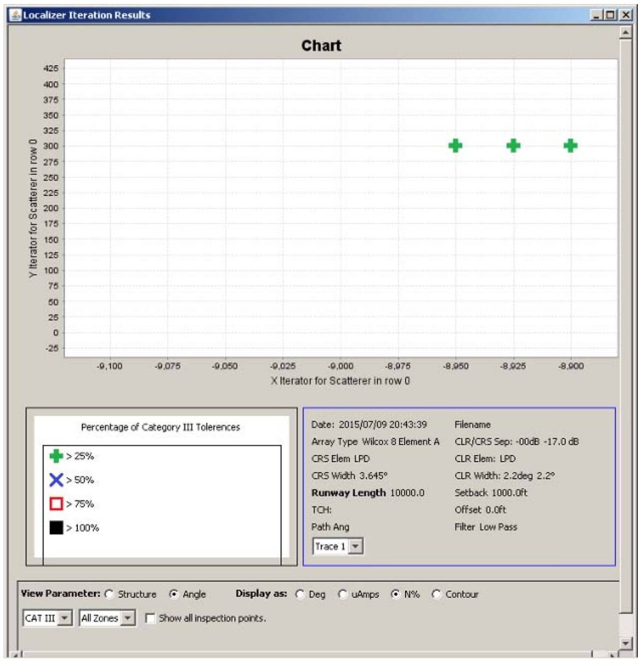


Figure 134: The default iteration plot, an angle plot showing decimal values.

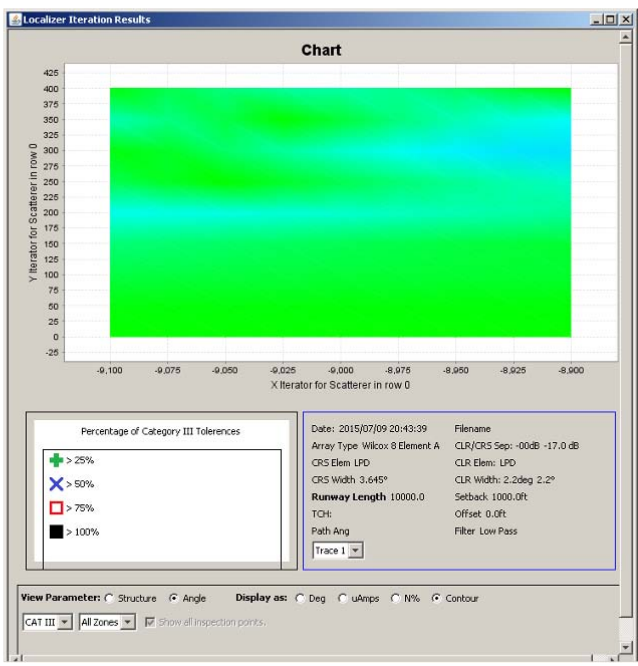


Figure 135: The default iteration plot, an angle plot showing decimal values.

21.5.7 Contour

The decimal structure plot is shown in figure 135. The plot and legend are described below.

21.5.7.0.0.0.5 Plot

21.5.7.0.0.0.6 Legend

22 Glideslope

The localizer has three inspection types. The parameters of these flight paths are described

1. ILS3 - This is a fixed approach along centerline. The x-axis of the plot will be distance from threshold and the y-axis will be error in degrees/μAmps.

2. ILS2 - This is an orbital approach. The x-axis of the plot will be an elevation angle and the y-axis will be an error in degrees/μAmps.

3. ILS1 - This is an orbital approach. The x-axis of the plot will be a heading and the y-axis will be an error in degrees/μAmps.

22.1 ILS3

22.1.1 Axes

22.1.1.1 X-Axis

The glide slope has three inspection types. The meaning of the x-axis is described below:

1. ILS3 - This is a fixed, descending approach along centerline. The x-axis of the plot will be distance from threshold in distance units, defaulting to nautical miles.

2. ILS2 - This is a level run at a fixed azimuth. The x-axis of the plot will be an elevation angle, defaulting to degrees.

3. ILS1 - This is an orbit. The x-axis of the plot will be a heading.

22.1.1.2 Y-Axis

For each trace a value can be plotted, refer to section 17.1 for more details on what each option means. You can find the units for each section below:

1. CDI Digital - Course angle: microamps or degrees

2. CDI Analog - Course angle: microamps or degrees

3. Flag - Course angle: microamps or degrees

4. CSB Signal Strength - Signal Strength: deciBels or normalized power

5. SBO Signal Strength - Signal Strength: deciBels or normalized power

Note: In the future we plan to add support for logarithmic axes for units like deciBels.

22.1.2 The Plot

Note: CATII and CATIII plots for glideslopes are very similar.

22.1.2.1 ILS3

22.1.2.1.0.0.1 CAT III Figure 136 shows an example of a CAT III plot.

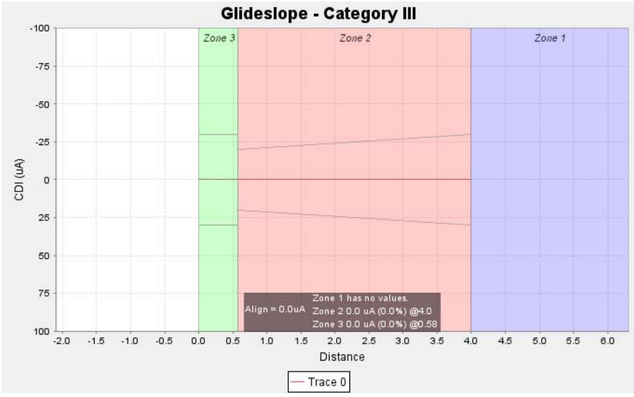


Figure 136: An example of a CATIII analysis.

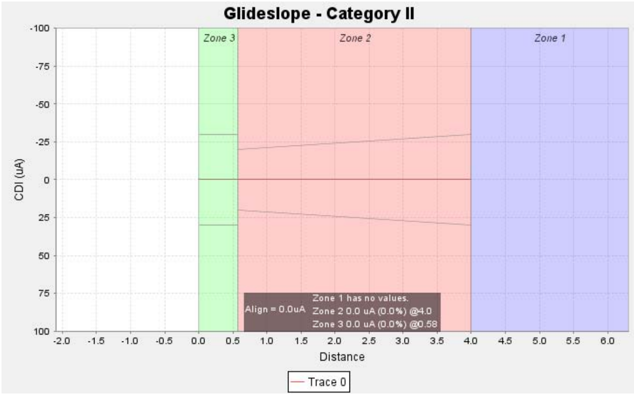


Figure 137: An example of a CATII analysis.

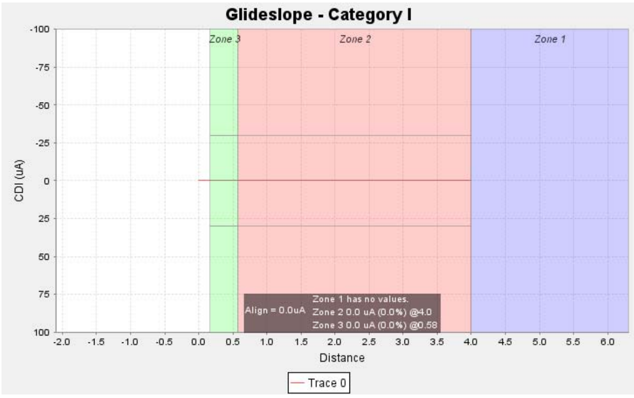


Figure 138: An example of a CATI analysis.

22.1.2.2 CATII

Figure 137 shows an example of a CAT II plot.

22.1.2.3 CATI

Figure 138 shows an example of a CAT I plot.

22.1.2.4 Context Menu

The context menu, as seen in figure 139, spawns when you right click on a plot. It has the following options:

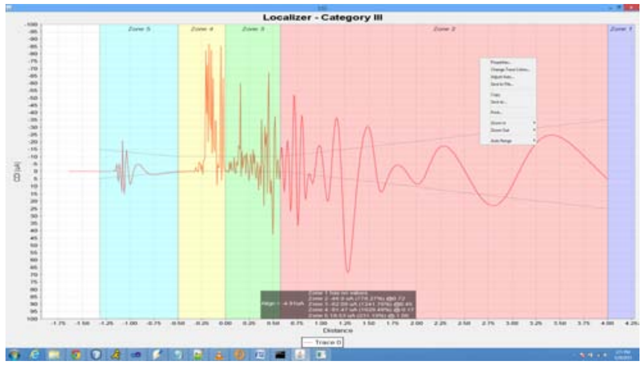


Figure 139: An example of the context menu displayed on a plot.

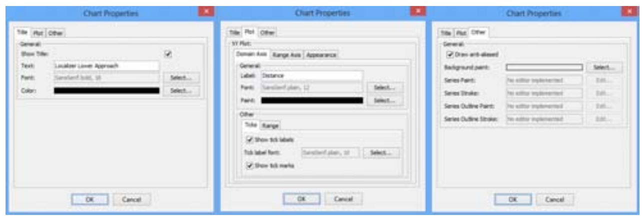


Figure 140: Features supported by the context menu.

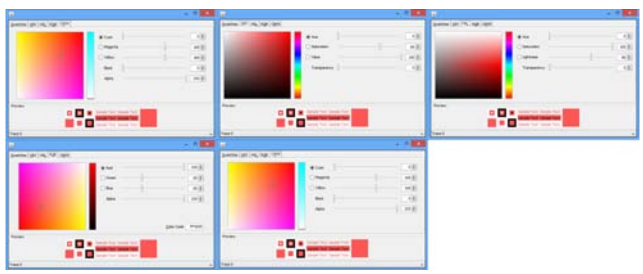


Figure 141: The different color types that are supported.

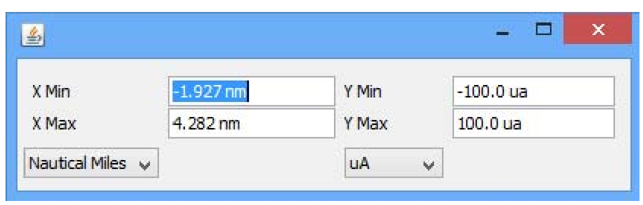


Figure 142: The different color types that are supported.

22.1.2.4.0.0.1 Properties The chart properties window has three tabs that allow one to edit the title, plot, and miscellaneous features of the plot. Note: the axes adjustment features of the plot in this window only allow one to adjust the extents and tick markings for the axes. If one wishes to adjust the units, one will need to need to use the "Adjust Axes" feature described in section 23.5.0.3.

22.1.2.4.0.0.2 Change Trace Colors This allows the user to change the trace colors to whatever color they desire. It supports HSV, HSL, RGB, and CMYK color specifications.

22.1.2.4.0.0.3 Adjust Axes This window allows the user to adjust the extents and the units for the axes. When units are changed, the real value of the extents are preserved.

22.1.2.4.0.0.4 Save to File This will save the file to a .gph file of the users choosing. This can be reopened at a later date, so one can view a plot without having to re-run an entire simulation.

22.1.2.4.0.0.5 Copy Copies the contents of the graph to the clipboard.

22.1.2.4.0.0.6 Save As Saves the plot as a .png image.

22.1.2.4.0.0.7 Print Brings up the default print menu to print an image of the plot.

22.1.2.4.0.0.8 Zoom In Zooms in one or both axes.

22.1.2.4.0.0.9 Zoom Out Zooms out one or both axes.

22.1.2.4.0.0.10 Auto Range Reverts one or both axes to their default values.

22.1.3 The Report

Given the evaluation of all points inspected and those linearly interpolated between inspected points residing at the boundary of a zone, a report is generated. At the bottom of each plot is a report that shows the following:

1. The Alignment error in μA
2. For each zone, the error in μA at the point with the highest percentage of tolerance error. Note: there may exist a point with a higher absolute error in that zone, but the report reports the evaluated point with the highest percentage relative to the tolerance at that point.
3. For each zone, the maximum percentage of tolerance at an evaluated point, in percent.
4. For each zone, the x-axis value value at which the maximum percentage of tolerance error occurs, in x-axis units.

22.1.4 Keyboard Interaction

The following Key Presses affect localizer plots:

1 - If support for Category I inspection exists for this configuration, the report mode will switch to Category I.

2 - If support for Category II inspection exists for this configuration, the report mode will switch to Category II.

3 - If support for Category III inspection exists for this configuration, the report mode will switch to Category III.

22.1.5 Mouse Interaction

The right mouse button will spawn the context menu which is to be covered in section 23.5.

The left mouse button activates the zoom feature. Click and drag the mouse rightwards and downwards while holding down the left mouse button; this will replace the plot area with the region inside the highlighted area (aspect ratio is not necessarily preserved). Dragging the mouse in any other direction will reset the plot to its original bounds.

Hovering over a data point on a plot will display the x and y coordinates of that coordinate on the screen.

22.2 ILS2

22.2.1 The Report

Given the evaluation of all points inspected and those linearly interpolated between inspected points residing at the boundary of a zone, a report is generated. At the bottom of each plot is a report that shows the following:

1. The Alignment error in μA
2. For each zone, the error in μA at the point with the highest percentage of tolerance error. Note: there may exist a point with a higher absolute error in that zone, but the report reports the evaluated point with the highest percentage relative to the tolerance at that point.
3. For each zone, the maximum percentage of tolerance at an evaluated point, in percent.
4. For each zone, the x-axis value value at which the maximum percentage of tolerance error occurs, in x-axis units.
5. BP Stuct: The point at which the value will hit a CDI of 190 uA

22.3 ILS1

23 VOR

23.1 Axes

23.1.1 X-Axis

The VOR has four inspection types. The meaning of the x-axis is described below:

1. Orbital - This is a orbit about the VOR. The x-axis of the plot will be the current azimuth of the aircraft, defaulting to degrees.
2. Radial - This is a straight flight path heading towards the VOR. The x-axis of the plot will be distance from VOR, defaulting to nautical miles.

3. RNAV - This is a straight segment from two arbitrary end points. The x-axis of the plot will the distance travelled from the start point towards the stop point, defaulting to nautical miles.

4. Fixed - This is a fixed radius, fixed altitude, fixed step size orbit. The x-axis of the plot will be the current azimuth of the aircraft, defaulting to degrees.

23.1.2 Y-Axis

If a VOR Trace is selected to show the bearing error, it will always be the primary (left-hand) range axis. If additional VOR traces are added for signal strengths they will appear on the secondary (right-hand) axis. If only signal strengths are plotted they will appear on the primary (left-hand) range axis.

For each trace a value can be plotted, refer to section 17.3 for more details on what each option means. You can find the units for each section below:

1. Brg Error - Angle: degrees

2. Direct SS - Signal Strength: deciBels or normalized power

3. Reflected SS - Signal Strength: deciBels or normalized power

4. Total SS - Signal Strength: deciBels or normalized power

Note: In the future we plan to add support for logarithmic axes for units like deciBels.

23.2 Source

The original source of all VOR plots is from a .prn file generated by the software, this can be found in the same directory as your .dat file.

23.3 The Plot

The bearing error generated by the .dll is a signal that can be thought of as being composed of three distinct parts. These parts (roughness, scalloping, bends) are outlined in figure 143, and can be isolated and displayed.

An example of a VOR plot is shown in figure 144. The red line is the original values. The green line is the scalloping (original passed through a high pass filter). The blue line are the bends (original passed through a low pass filter).

23.4 The Report

Given the evaluation of all points inspected and those linearly interpolated between inspected points residing at the boundary of a zone, a report is generated. At the bottom of each plot is a report that shows the following:

1. Roughness/Scalloping - maximum error value, percentage of tolerance, and location (bearing or distance)

2. Alignment Error - average value and percentage of tolerance

3. Maximum Bend - maximum value of the signal passed through a low pass filter, the maximum percentage of tolerance, and location (bearing or distance)

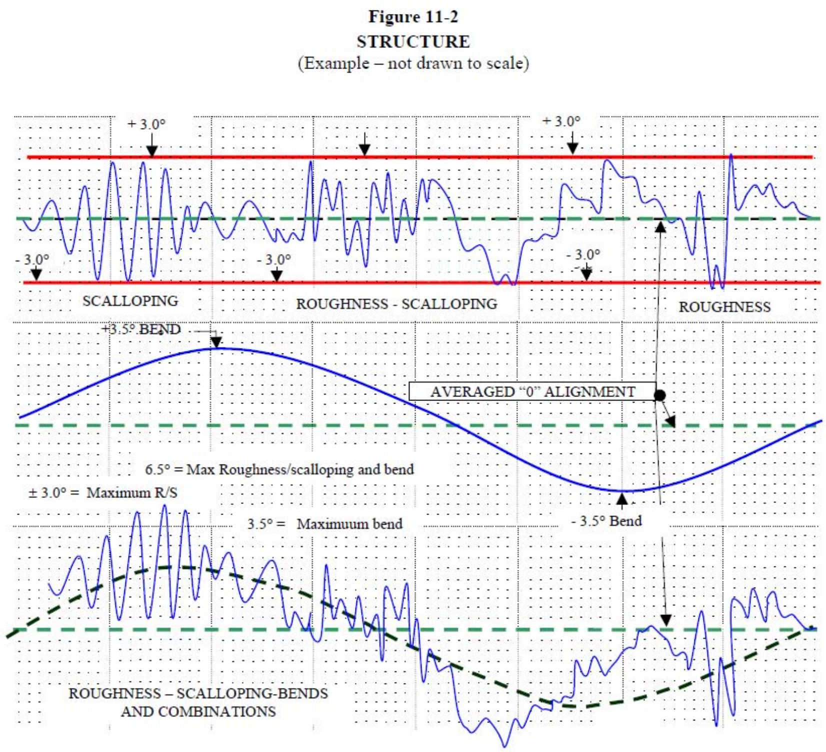


Figure 143: An example of roughness, scalloping, and bends. Taken from FAA 8200.1C page 11-18.

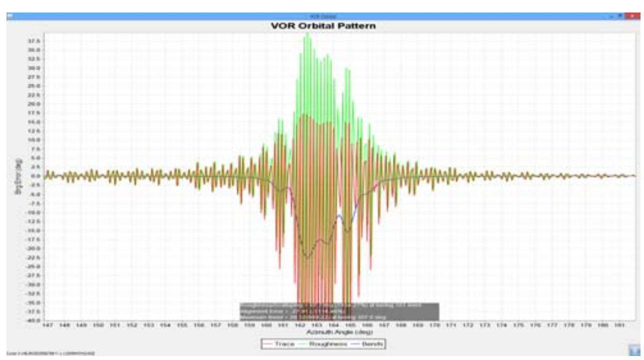


Figure 144: An example of a VOR plot.

23.5 Context Menu

The context menu, as seen in figure 145, spawns when you right click on a plot. It has the following options:

23.5.0.1 Properties

The chart properties window has three tabs that allow one to edit the title, plot, and miscellaneous features of the plot. Note: the axes adjustment features of the plot in this window only allow one to adjust the extents and tick markings for the axes. If one wishes to adjust the units, one will need to need to use the "Adjust Axes" feature described in section 23.5.0.3.

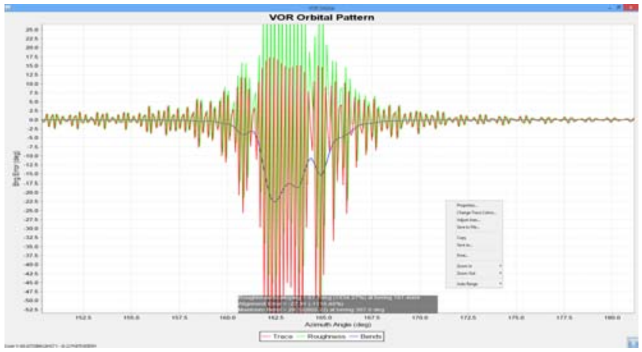


Figure 145: An example of the context menu displayed on a plot.

Figure 146: Features supported by the context menu.

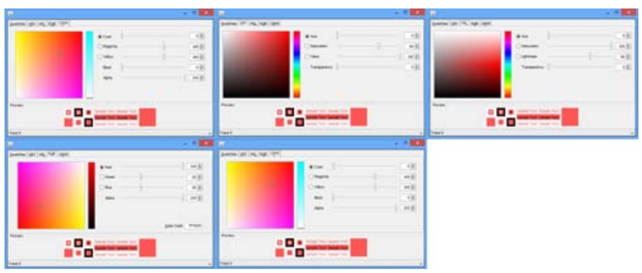


Figure 147: The different color types that are supported.

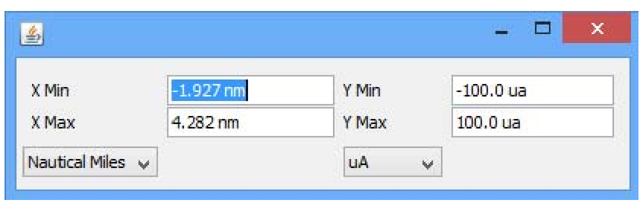


Figure 148: The different color types that are supported.

23.5.0.2 Change Trace Colors

This allows the user to change the trace colors to whatever color they desire. It supports HSV, HSL, RGB, and CMYK color specifications.

23.5.0.3 Adjust Axes

This window allows the user to adjust the extents and the units for the axes. When units are changed, the real value of the extents are preserved.

23.5.0.4 Save to File

This will save the file to a .gph file of the users choosing. This can be reopened at a later date, so one can view a plot without having to re-run an entire simulation.

23.5.0.5 Copy

Copies the contents of the graph to the clipboard.

23.5.0.6 Save As

Saves the plot as a .png image.

23.5.0.7 Print

Brings up the default print menu to print an image of the plot.

23.5.0.8 Zoom In

Zooms in one or both axes.

23.5.0.9 Zoom Out

Zooms out one or both axes.

23.5.0.10 Auto Range

Reverts one or both axes to their default values, listed below:

1. Domain Axes
   a) Orbital - $0°$ to $360°$
   b) Radial - 0 to 20 nautical miles
   c) RNAV - 0 to 20 nautical miles
   d) Fixed - $0°$ to $360°$
2. Range Axes
   a) Bearing Error - $40°$ to $-40°$
   b) Signal Strength
      i. DeciBels - -140 dB to 0dB
      ii. Normalized - 0 to 10

23.6 Keyboard Interaction

The following Key Presses affect localizer plots:
1 - Toggles the trace for the bends (low frequency)
2 - Toggles the trace for the roughness (bandpass)

23.7 Mouse Interaction

The right mouse button will spawn the context menu which is to be covered in section 23.5.

The left mouse button activates the zoom feature. Click and drag the mouse rightwards and downwards while holding down the left mouse button; this will replace the plot area with the region inside the highlighted area (aspect ratio is not necessarily preserved). Dragging the mouse in any other direction will reset the plot to its original bounds.

The plot constantly updates the X and Y values at the location of the mouse cursor.

Part VI

The Virtual World

OUNPPM is composed of two main windows: 1) The typical GUI window used for inputs and 2) The 3D Visualization window corresponding to the current model represented in the GUI. The 3D Visualization graphically depicts the current model described numerically by the GUI window. Figure 149 shows an example. The 3D world consists of 3D Objects, such as scatterers, a runway, flight paths, visual indicators, etc, see Fig. 28. Lastly, the 3D World also contains a virtual camera; this camera represents the virtual *eyeball* that views the world. The eyeball is always located at some position in the world and always looks in some direction, it uses the same reference frame as shown in 28. By moving this eyeball around the world, one may traverse through the visualization.

23.8 Navigating the Virtual World

The camera moves *forward* by clicking and holding the *right mouse button*. The *forward* direction is defined by the direction in which the camera is looking. Therefore, if the camera is looking at an object, such as a scatterer, right clicking and holding will move the camera towards the scatterer. This is not the same as zooming in, but reducing the geometric distance between the camera and viewed object.

One may change / rotate the direction in which the camera looks by clicking and holding the *left mouse button* while dragging the mouse up/down/left/right to look up/down/left/right, respectively.

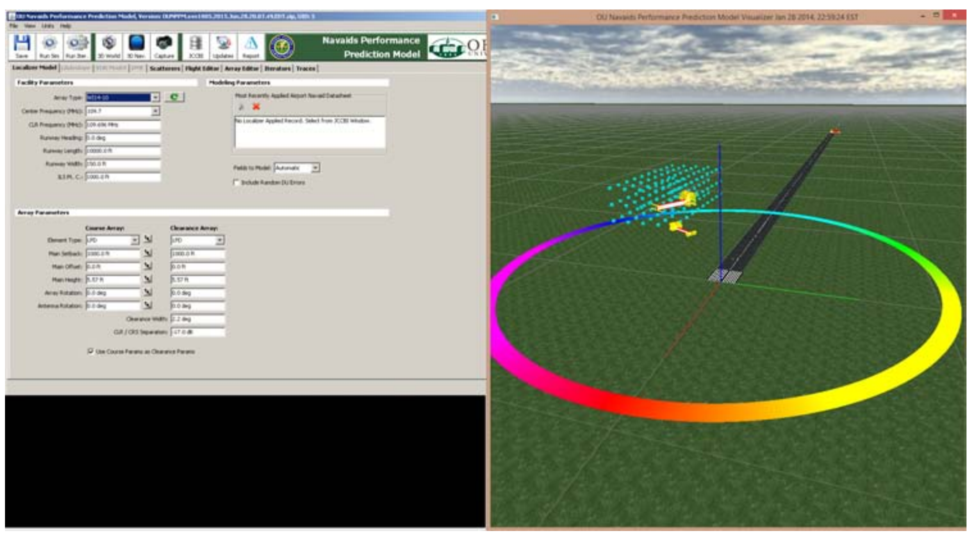


Figure 149: The GUI window used for inputting a navaid model (left). The 3D Visualization graphically depicting the navaid model (right).

23.9 Resetting the Virtual World

At any time, the user may close the 3D Visualization by clicking on the Red X in the upper right corner. The 3D Visualization may be restarted by clicking on the *Show 3D World* button in the top tool bar (top left), as shown in 149. This will reopen the world. One may want to do this if, one becomes lost within 3D world and cannot find a way to return to the area of interest.

23.10 Elements of the Virtual World

23.10.1 Shared Elements

23.10.1.1 The Grid

23.10.1.2 The Runway

Present in Localizer and Glideslope.

23.10.2 Localizer Elements

23.10.2.1 The Array

23.10.3 Glideslope Elements

23.10.3.1 The Array

23.10.4 VOR Elements

23.10.4.1 The Array

Part VII

Examples

Exercise 1
Vertical Pattern of CEGS

- Calculate the vertical radiation and DDM patterns for a CEGS
- Path Angle 2.6-degrees
- Glide Slope Frequency 331.4 MHz
- Glide Slope Offset 380’, Setback 1010’
- Flight Profile
  – Range=20,000’; Elevation Angle - 0.1-10-degrees

Exercise 2
Transmitter Adjustments

- Determine the maximum CRS-CLR ratio on centerline to obtain acceptable clearance (> 200 uA) throughout the required coverage for the following:
- Localizer Array: RECA (Redlich Array)
- Runway Length: 10,500’
- Localizer Setback: 1,200’

Exercise 3
Antenna Distribution Modification

- System Configuration:
  - 8-element V-ring operating at 111.9 MHz
  - Localizer setback: 1,102’
  - Runway length: 6,001’

Exercise 3 (cont'd)

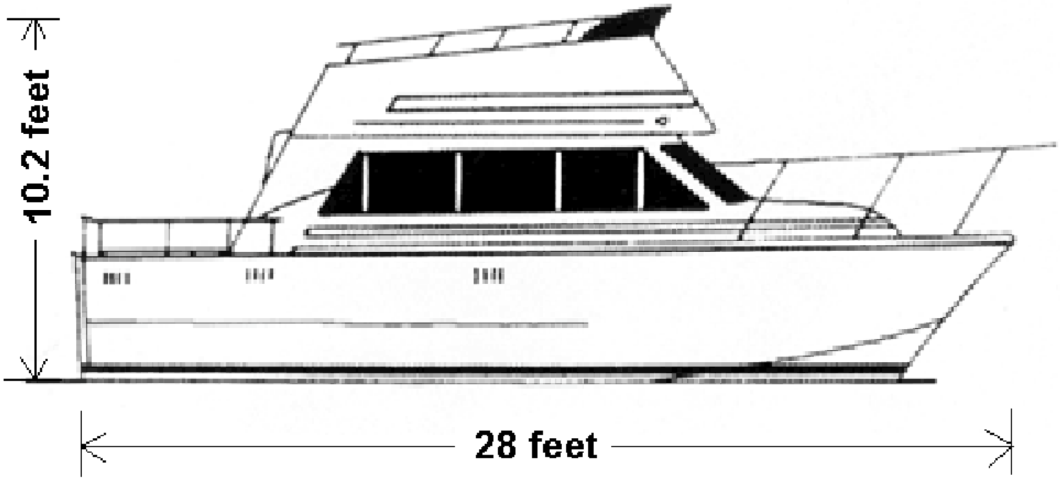
- Determine the localizer shift for the following antenna feed line phase faults
  - 10-degrees 1 Left
  - 10-degrees 2 Right
  - 20-degrees 3 Left
  - 20-degrees 3 Right

Exercise 4
FLL Rwy 27L

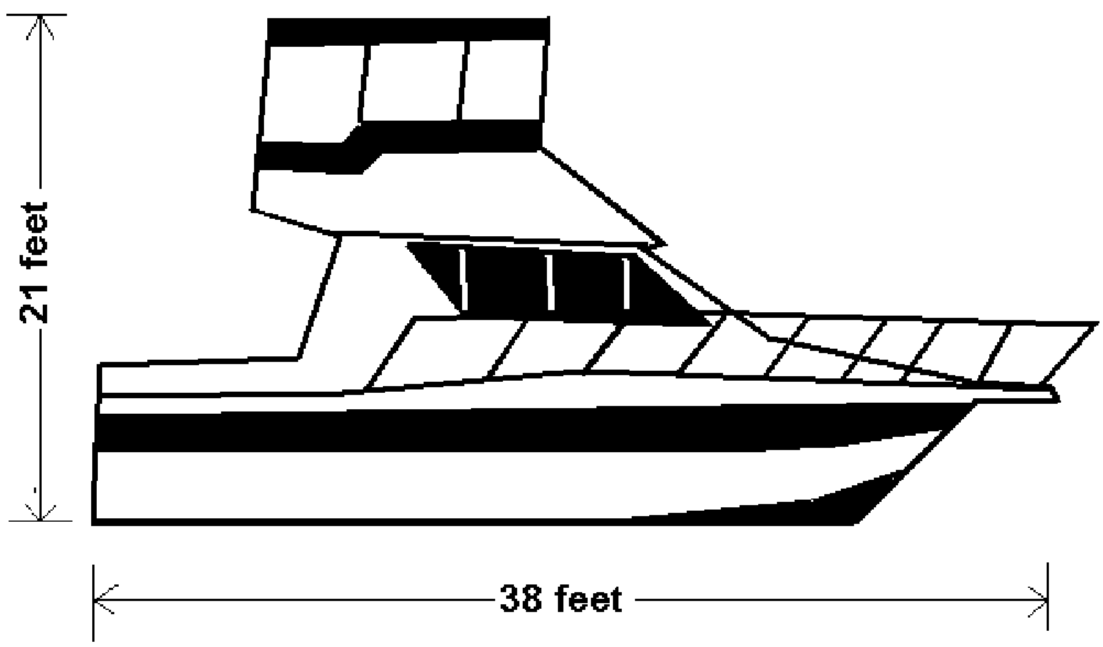
- Runway 27L at FLL will be extended requiring the existing localizer to be relocated across a canal. The canal is a navigable channel and penetrates the localizer critical area. The crafts are limited in height based on bridges. The FAA had concerns that the crafts could degrade the localizer performance.

Exercise 4 (cont'd)
FLL Small Boat Club

Exercise 4 (cont'd)
28-Foot Boat



Exercise 4 (cont'd)
38-Foot Boat



Exercise 4 (cont'd) Parameters

- Array: 8 Element Array
- Element: LPD
- Frequency: 108.55 MHz
- Setback: 775'
- Runway Length: 7218

Exercise 4 (cont'd)
Canal

- Canal is located between localizer array and runway stop end, 150 feet in front of localizer and it is 225 feet wide.
- The canal transverses the entire width of the localizer
- Water level varies. Worst case: water level with the bank

Exercise 4 (cont'd) Assignment

- Modeling the worst case scenario, will either boat cause degradation to the localizer signal??
- Note: Analyze the Boats at several different locations

Exercise 5
Max Building Height

Determine the acceptable locations near a runway which will not degrade the ILS service.

Exercise 5 (cont’d)
ILS Information

- Loc Arrays: 14_10, 20_10
- Runway Length: 9,000 ft
- Setback from SE: 1000 ft
- Frequency: 110.1MHz
- Service: Category II/III

Exercise 5 (cont'd)
Building Information

- Building length: 500 ft
- Building height: 120 ft

Exercise 5 (cont'd)

- At what locations near the runway can this building be constructed?
  - Use iteration method
    - [0,-8000,-1000],[200,800,50]

OHIO UNIVERSITY 1804

Exercise 6
Limo Service Center

- City of Chicago plans to lease a parcel of land to a developer to construct a limo service center. This facility will consist of a main building, carwash facility, and security fence. The land is approximately 1,000' of ORD Runway 27R threshold. Will this proposed development cause any degradation to the existing glide slope?

Exercise 6 (cont'd) Limo Center Information Distance from Rwy 27R Threshold

X1	Y1	X2	Y2	Height
28.06	866.81	177.1	666.7	18
2.61	962	119.34	963	26
-526.9	879.31	-340.64	879.31	11
-340.69	879.31	28.06	854.31	11
28.06	854.31	253.06	860.56	11

Exercise 6 (cont'd)
GS Information

Parameter	Data
GS Type	CEGS
Path Angle	3-degrees
Mast Setback	1,040
Mast Offset	463
TCH	55'
Category of Service	I and II/III

Exercise 7
Evaluating Airport Environments
IND 23R

- *Background:* Indianapolis constructed a new runway and required ILS systems for both ends (Rwy 05L - Cat III, &

  23R - Cat I). An 8-element LPD array was installed on Rwy 23R. This facility would not pass commissioning flight inspection because of excessive structure roughness

Exercise 7
Evaluating Airport Environments
IND 23R

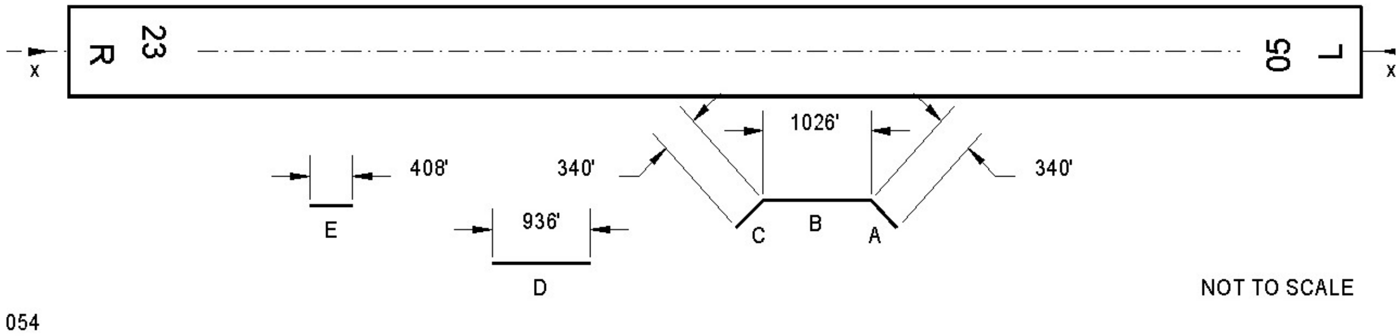
- Determine possible solutions to obtain satisfactory Category I course quality.

- Note: Please use the pull from image data acquisition approach for this example

Exercise 7
Evaluating Airport Environments
IND 23R

- Localizer Configuration:
  – Array: 8-element LPD
  – Setback: 1,010’
  – Frequency: 109.7 MHz
  – Length: 11,200’
  – Threshold crossing height: 55’

Exercise 7
Evaluating Airport Environments
IND 23R – Layout



Exercise 7
Evaluating Airport Environments
IND 23R – Structure Dimensions

Table 1. Scatterer Dimensions as Modeled.

Scatterer Reference	Position of Scatterer Relative to 23R Loc. (ft)			Dimensions of Scatterer (ft)	
	X	Y	Z	Length	Height
A	5528	1440	0	340	72
B	6160	1320	0	1026	72
C	6800	1440	0	340	72
D	8776	1880	0	936	80
E	10768	1368	0	408	75

Note: A,B,C United Airlines MOC II Facility
D U.S. Postal Service Eagle Facility
E USAir Maintenance Hangar

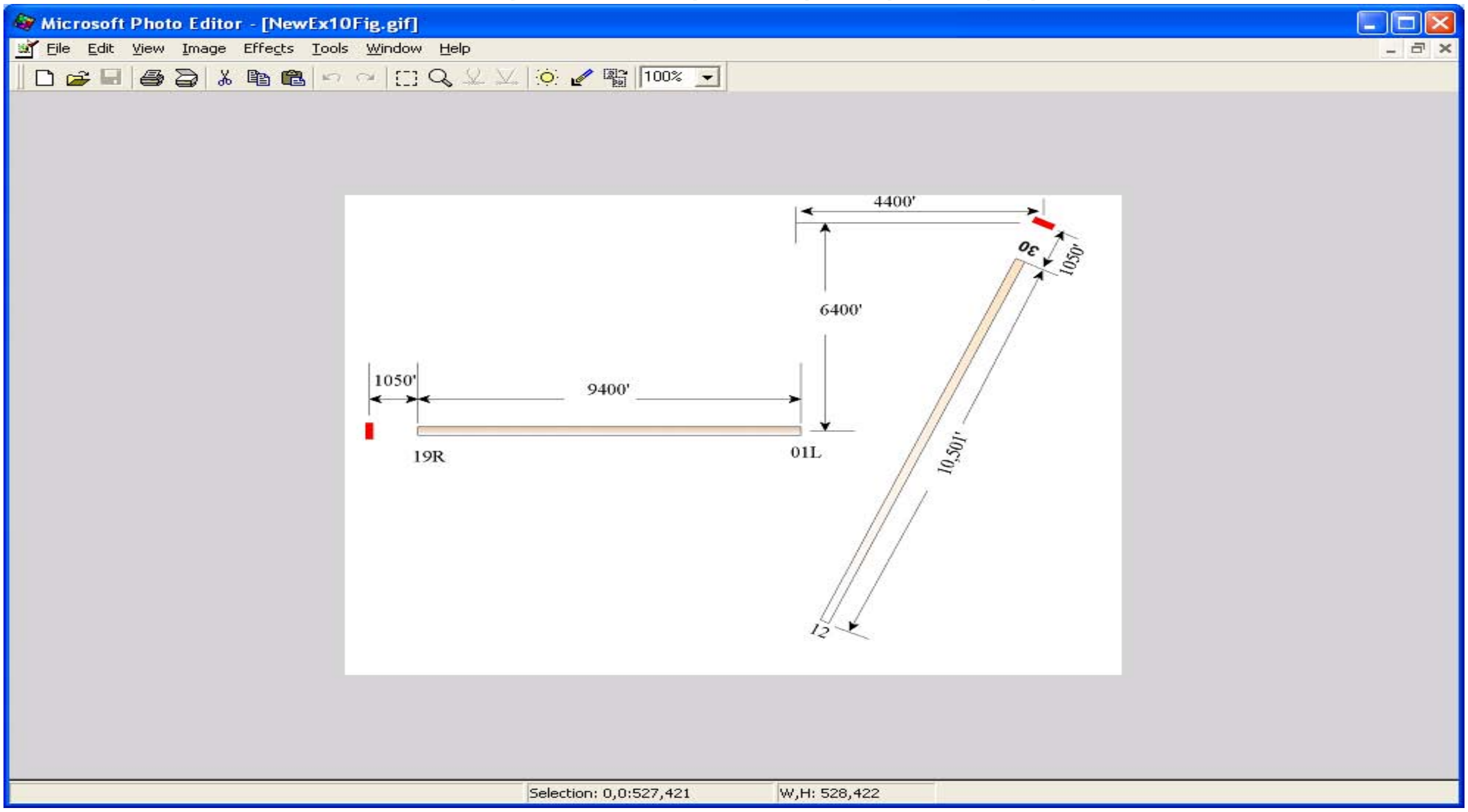
Exercise 8
ILS Interference
IAD

- *Background*: The MWAA has proposed a fourth runway at IAD. The orientation of the new Runway 12 will cross in-front of existing Runway 01L. Will unacceptable guidance be given if both ILS localizers are radiating at the same time?

OHIO UNIVERSITY 1804

RUSS COLLEGE OF ENGINEERING AND TECHNOLOGY

Exercise 8
ILS Interference



Exercise 8
ILS Interference
IAD

Desired Localizer 01L

- Setback: 1050’
- Offset: 0.0’
- Runway Length: 9,400’
- Array: 14-10

- Interfering Localizer 12
  - Setback: 13,800
  - Offset: 6,400
  - Width: 3.0 degrees
  - Array: 14-10

Exercise 9
Fort Lauderdale VOR

- Planned future developments for the Fort Lauderdale International Airport (FLL) requires the construction of a consolidated rental car facility (CRCF) to be constructed near the terminal complex. This facility was initially approved by the Federal Aviation Administration (FAA) to 7-stories. Current planning is to have ten floors for this facility; which is three floors higher than the approved 7-story structure. Concern has arisen that this taller structure may cause unacceptable degradation to the VOR serving the Airport.
- ?Evaluate the Impact of the CRCF on the VOR

Exercise 9 (cont'd)
Fort Lauderdale VOR

- VOR Model Input Parameters -- Input File

- VOR Parameters
- Conventional VOR
- Frequency (MHz) = 114.40 CP Radius (Ft) = 26.0
- Antenna Height (Ft) = 4.00 CP Height (Ft) = 12.0
- Offset North (Ft) = 0.0 Offset East (Ft) = 0.0
- Ground Elevation (Ft) = 0.0 Ground is Perfectly Conducting

- Flight Path
- Segment 1: Orbital
- Base Range (NMi) = 40.00 Radial Start (Deg) = 0.0
- Altitude (Ft MSL) = 1000.0 Radial End (Deg) = 360.0
- Radial Step (Deg) = 1.000

Exercise 9 (cont'd)

- Scatterers
- Scatterer 1: Rectangle
- Range (Ft) = 4381.0 Azimuth (Deg) = 106.70
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 449.6 Height (Ft) = 104.8
- Rotation (Deg) = 0.40 Tilt (Deg) = 0.00
- Material is Steel Ground Plane Present

- Scatterer 2: Rectangle
- Range (Ft) = 4820.3 Azimuth (Deg) = 102.50
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 1020.0 Height (Ft) = 104.8
- Rotation (Deg) = 90.40 Tilt (Deg) = 0.00
- Material is Steel Ground Plane Present

Exercise 10:
Norfolk VOR

- *Background:* A new runway is planned for Norfolk airport. As a result, the VOR serving this airport, which is currently on airport grounds, needs to be relocated to a new area. A location has been selected; the new environment has trees, power lines, and some building structures which may degrade the performance. Determine the effects of the tree lines and how this can be mitigated to allow satisfactory performance.

Exercise 10 (cont'd)
Norfolk VOR

OHIO UNIVERSITY
32
RUSS COLLEGE OF ENGINEERING AND TECHNOLOGY

Exercise 10 (cont'd)

- ORF Model Input Parameters -- Input File

- VOR Parameters
- Conventional VOR
- Frequency (MHz) = 113.00 CP Radius (Ft) = 26.0
- Antenna Height (Ft) = 4.00 CP Height (Ft) = 12.0
- Offset North (Ft) = 0.0 Offset East (Ft) = 0.0
- Ground Elevation (Ft) = 0.0 Ground is Perfectly Conducting

- Flight Path
- Segment 1: Orbital
- Base Range (NMi) = 25.00 Radial Start (Deg) = 0.0
- Altitude (Ft MSL) = 3000.0 Radial End (Deg) = 360.0
- Radial Step (Deg) = 0.500

-

Exercise 10 (cont'd)

- Scatterers
- Scatterer 1: Rectangle
- Range (Ft) = 251.2 Azimuth (Deg) = 240.20
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 252.9 Height (Ft) = 60.0
- Rotation (Deg) = 113.90 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 2: Rectangle
- Range (Ft) = 233.8 Azimuth (Deg) = 201.20
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 91.4 Height (Ft) = 60.0
- Rotation (Deg) = 157.10 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 3: Rectangle
- Range (Ft) = 572.0 Azimuth (Deg) = 176.40
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 39.3 Height (Ft) = 64.0
- Rotation (Deg) = 36.30 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present

Exercise 10 (cont'd)

- Scatterer 4: Rectangle
- Range (Ft) = 589.7 Azimuth (Deg) = 166.50
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 184.7 Height (Ft) = 64.0
- Rotation (Deg) = 101.40 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 5: Rectangle
- Range (Ft) = 719.0 Azimuth (Deg) = 151.80
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 238.1 Height (Ft) = 95.0
- Rotation (Deg) = 110.60 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 6: Rectangle
- Range (Ft) = 734.7 Azimuth (Deg) = 131.80
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 418.1 Height (Ft) = 95.0
- Rotation (Deg) = 27.40 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present

Exercise 10 (cont'd)

- Scatterer 7: Rectangle
- Range (Ft) = 508.2 Azimuth (Deg) = 113.60
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 409.3 Height (Ft) = 64.0
- Rotation (Deg) = -60.40 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 8: Rectangle
- Range (Ft) = 367.5 Azimuth (Deg) = 108.80
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 124.4 Height (Ft) = 64.0
- Rotation (Deg) = 105.20 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 9: Rectangle
- Range (Ft) = 701.8 Azimuth (Deg) = 102.00
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 186.1 Height (Ft) = 64.0
- Rotation (Deg) = 17.20 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present

Exercise 10 (cont'd)

- Scatterer 10: Rectangle
- Range (Ft) = 653.4 Azimuth (Deg) = 85.50
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 122.7 Height (Ft) = 64.0
- Rotation (Deg) = 18.00 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 11: Rectangle
- Range (Ft) = 646.2 Azimuth (Deg) = 80.50
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 66.4 Height (Ft) = 64.0
- Rotation (Deg) = -95.60 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 12: Rectangle
- Range (Ft) = 594.6 Azimuth (Deg) = 78.90
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 46.5 Height (Ft) = 64.0
- Rotation (Deg) = -62.80 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present

Exercise 10 (cont'd)

- Scatterer 13: Rectangle
- Range (Ft) = 587.6 Azimuth (Deg) = 74.40
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 126.0 Height (Ft) = 64.0
- Rotation (Deg) = -5.40 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 14: Rectangle
- Range (Ft) = 415.4 Azimuth (Deg) = 339.60
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 997.4 Height (Ft) = 65.0
- Rotation (Deg) = -156.30 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
- Scatterer 15: Rectangle
- Range (Ft) = 811.1 Azimuth (Deg) = 32.50
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 608.7 Height (Ft) = 64.0
- Rotation (Deg) = -60.70 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present

Exercise 10 (cont’d)

- Scatterer 16: Rectangle
- Range (Ft) = 846.3 Azimuth (Deg) = 62.10
- Ground Elevation (Ft) = 0.0 Base Height (Ft) = 0.0
- Length (Ft) = 292.0 Height (Ft) = 64.0
- Rotation (Deg) = -18.60 Tilt (Deg) = 0.00
- Material is Trees Ground Plane Present
-

Part VIII

Solutions

24 Exercises

This section provides step-by-step instructions on how to complete the exercises assigned during the standard OUNPPM training. As revisions are made to the software, screenshots may become out of date. The version used to create the instructions can usually be seen in the first screenshot of each example in the titlebar of the application.

24.1 Exercise 1

This example demonstrates how to use the OUNPPM to model the elevation pattern of a glideslope array.

24.1.1 Setup Exercise 1

When the application beings, you should see something resembling figure 150.

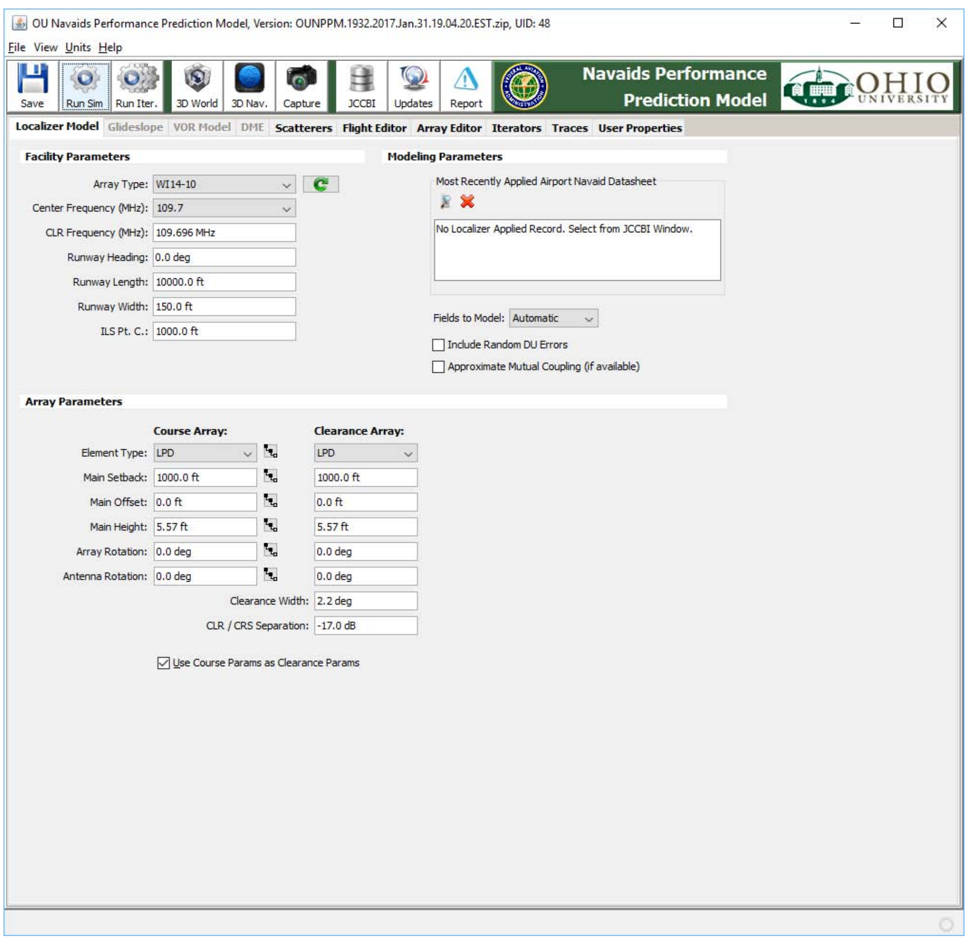


Figure 150: Exercise 1: Startup.

This is a glideslope example, so select File → New Model → Glideslope, as shown in figure 151, to change the model to a glideslope simulation.

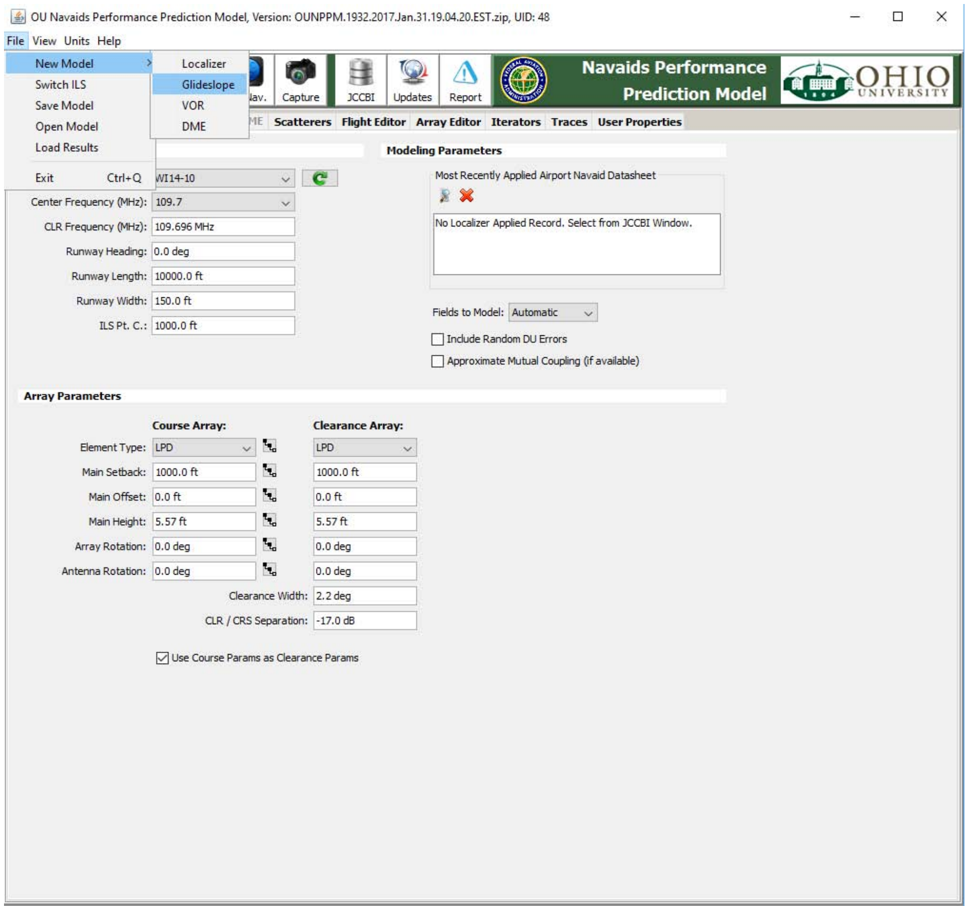


Figure 151: Exercise 1: Switching to glideslope.

Your interface should now resemble figure 152.

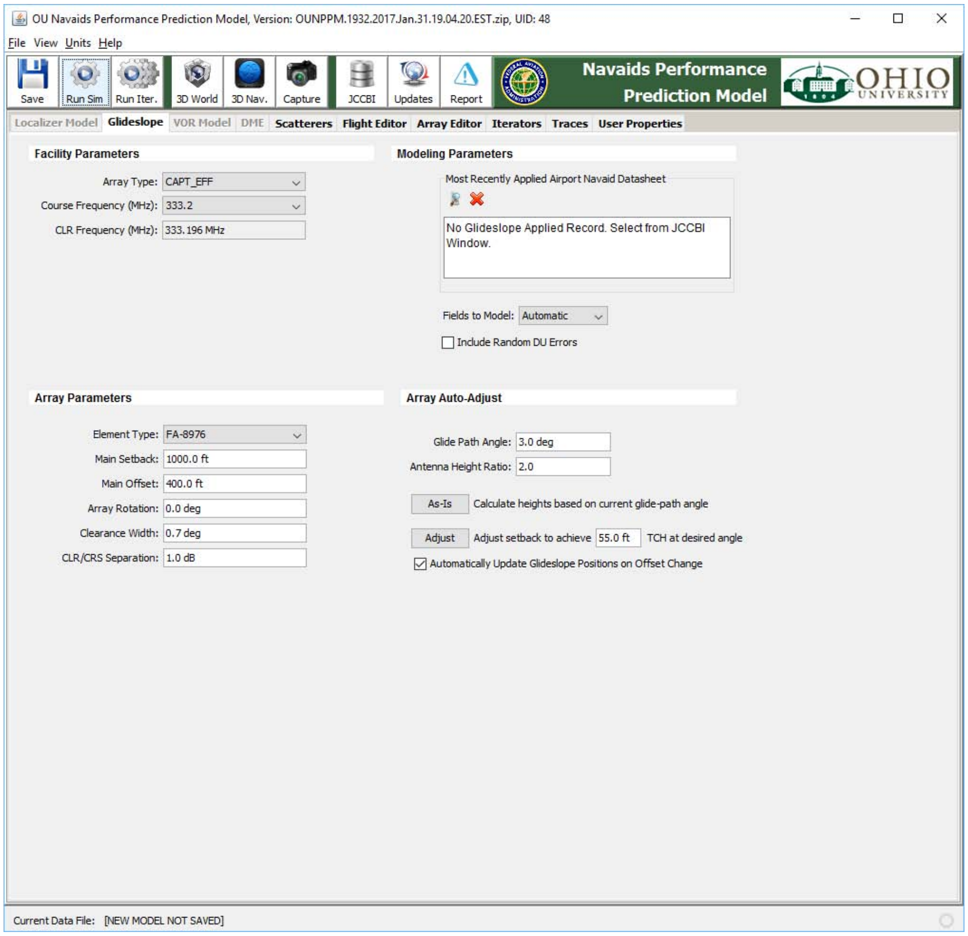


Figure 152: Exercise 1: Default Facility Info.

Using the description of the facility information in the slides, in the facility info tab adjust the glide slope frequency, glide slope offset, and setback. Because the setback is specified in the problem description, use the “As-Is” option when updating the glide path angle. The resulting facility information can be seen in figure 153.

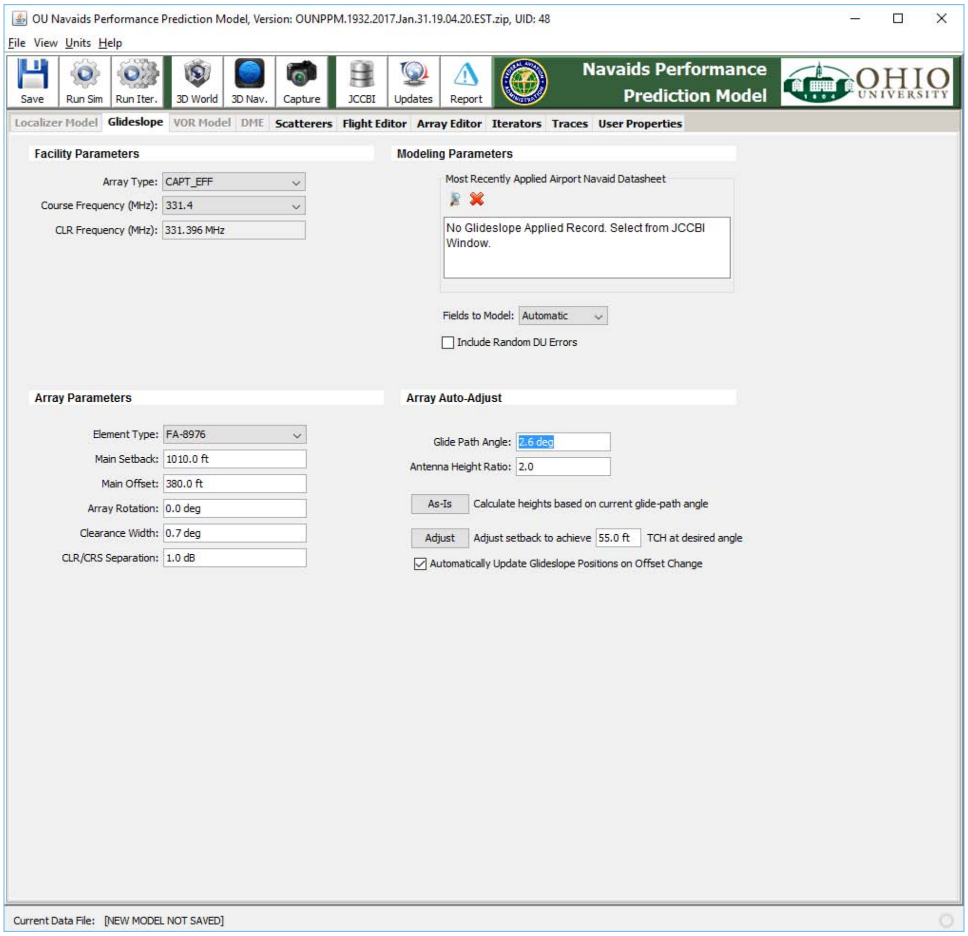


Figure 153: Exercise 1: Facility Info as Described in the Problem Description.

Select the Flight Editor tab to change the flight to match the specifications of the problem description. Figure 154 shows the default Flight Editor tab.

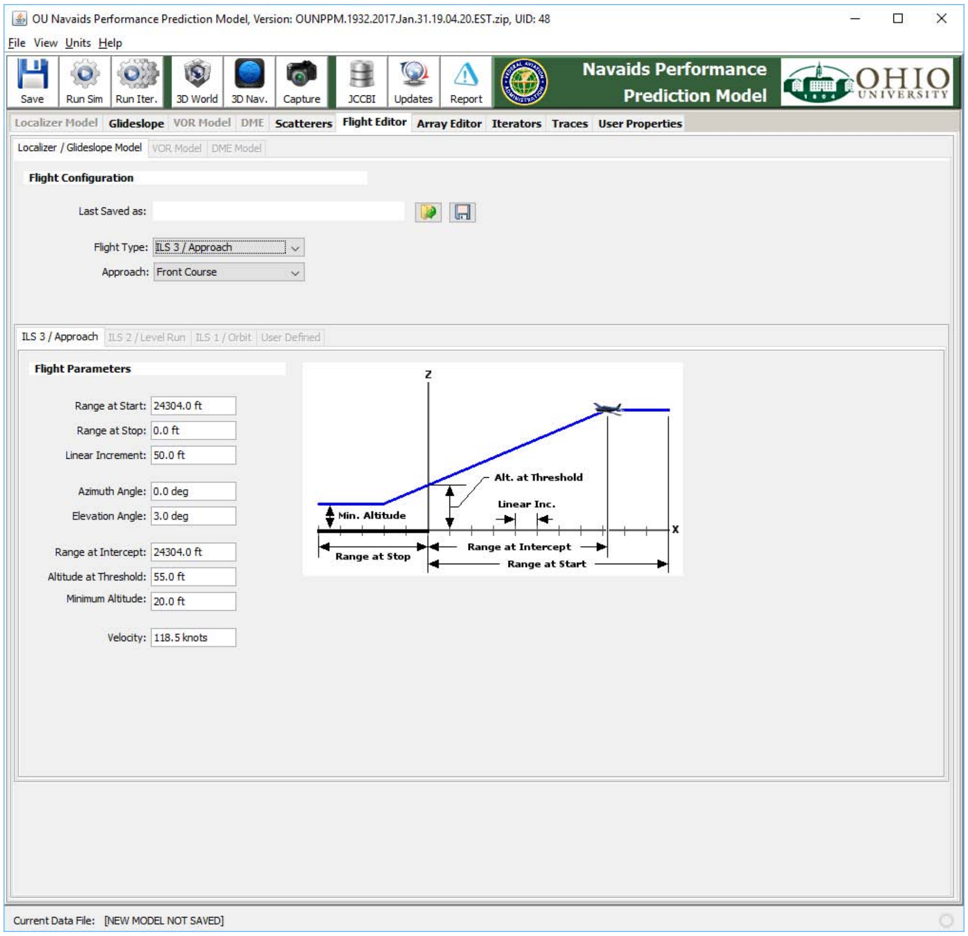


Figure 154: Exercise 1: Default Flight Path.

Using the “Flight Type” combo box, select the “User Defined” option, as shown in figure 155.

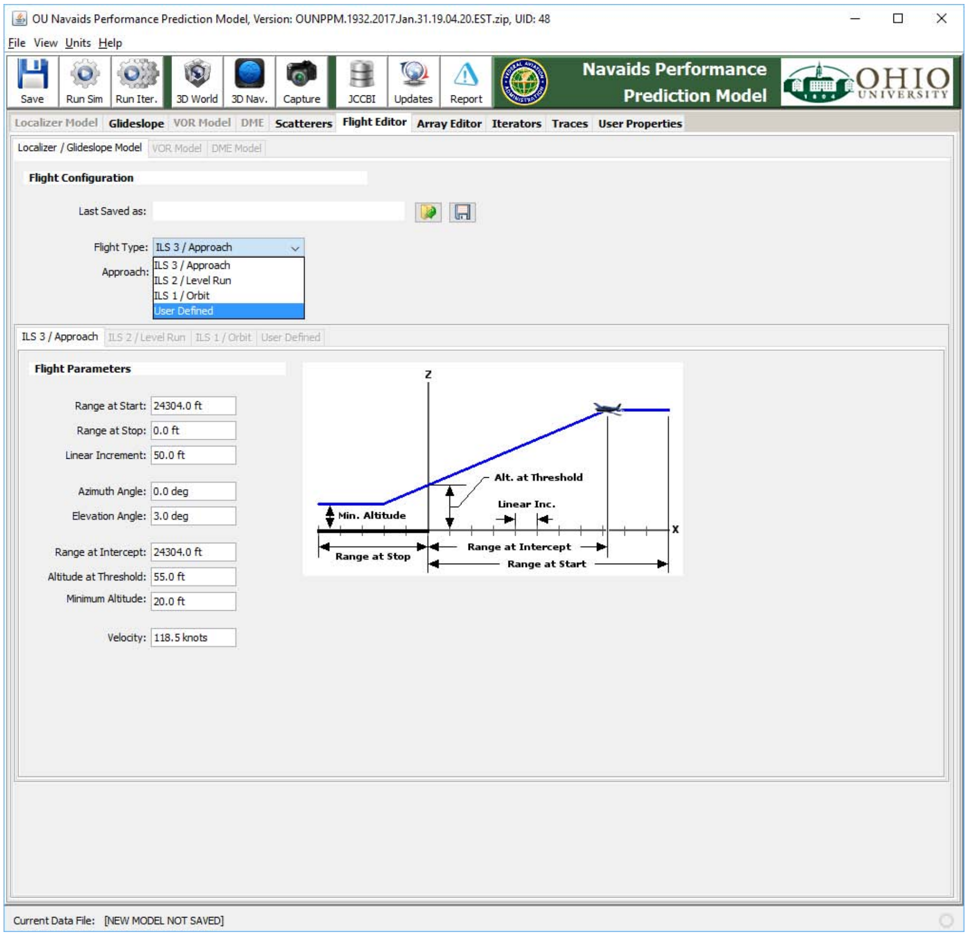


Figure 155: Exercise 1: Select User Defined.

Because the problem description specifies a constant range and elevation angle, a spherical coordinate system is ideal. The range and azimuth are constant, so we will use Elevation as the Domain Variable. Either a linear or angular increment can provide correct results, but this document will select an angular increment of .1 degrees. The three default ILS flight types are relative to the navaid, but by default User Defined flight paths are relative to origin (threshold). In order to analyze the elevation pattern relative to navaid, the X and Y offset must be set to the location of the navaid. Because the X parameter is an "offset" and not a "setback" the sign is inverted from the value on the facility info tab.

To test the elevation pattern, add two points to the flight path both with range 20000, and varying elevation from .1 to 10 degrees. The resulting flight path interface can be seen in figure 156. The virtual world representation of this flight path can be found in figure 157; this is not a realistic flightpath, but this example shows how the model can be used to simulated various other scenarios. Figure 158 shows the flightPath from the perspective of the navaid.

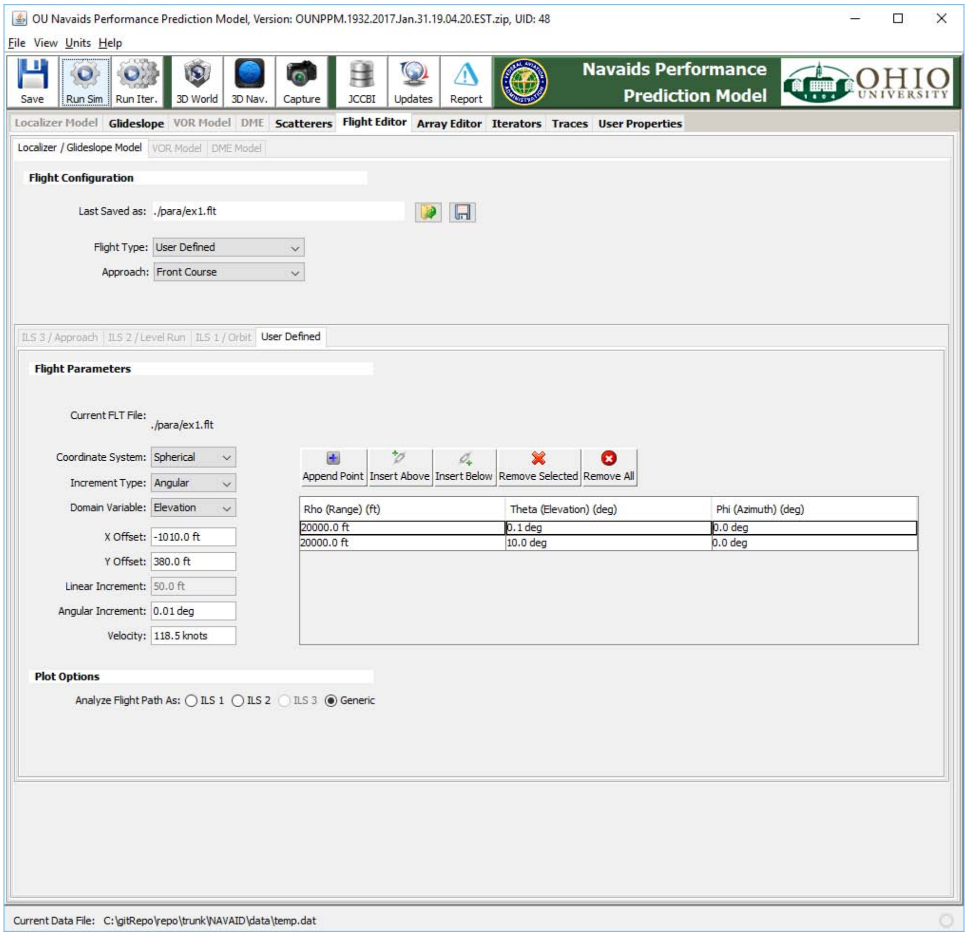


Figure 156: Exercise 1: Flight Path Matching the Problem Description.

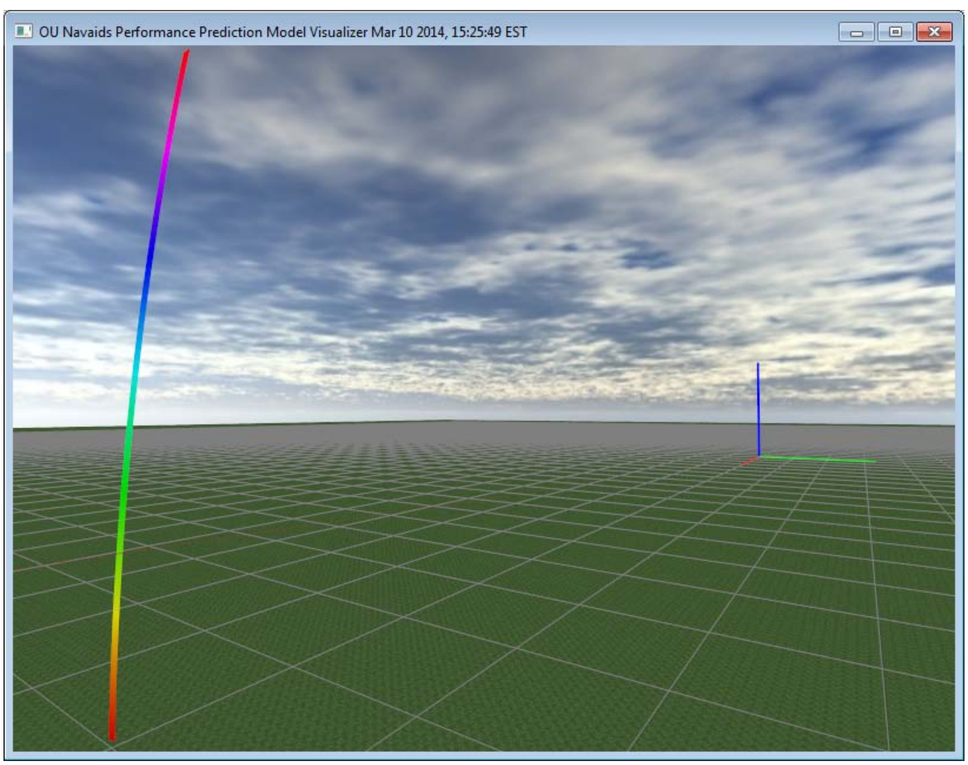


Figure 157: Exercise 1: Flight Path close up.

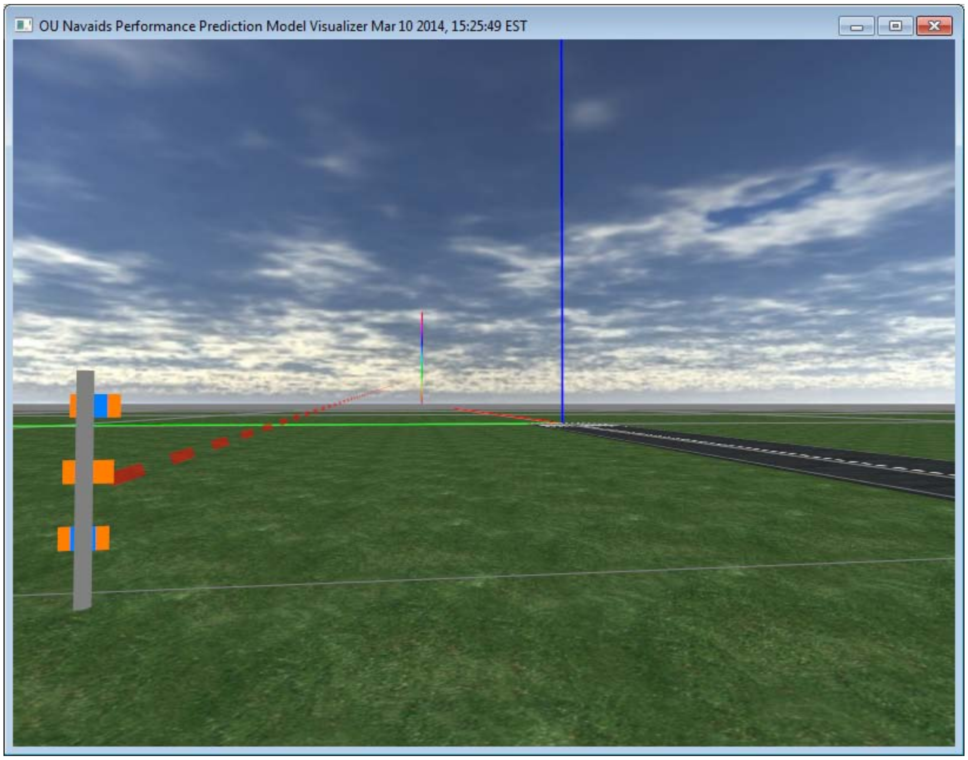


Figure 158: Exercise 1: Flight Path from the perspective of the navaid.

Finally, set up your traces to plot both the CSB and SBO of the course array. Your traces tab should resemble figure 159.

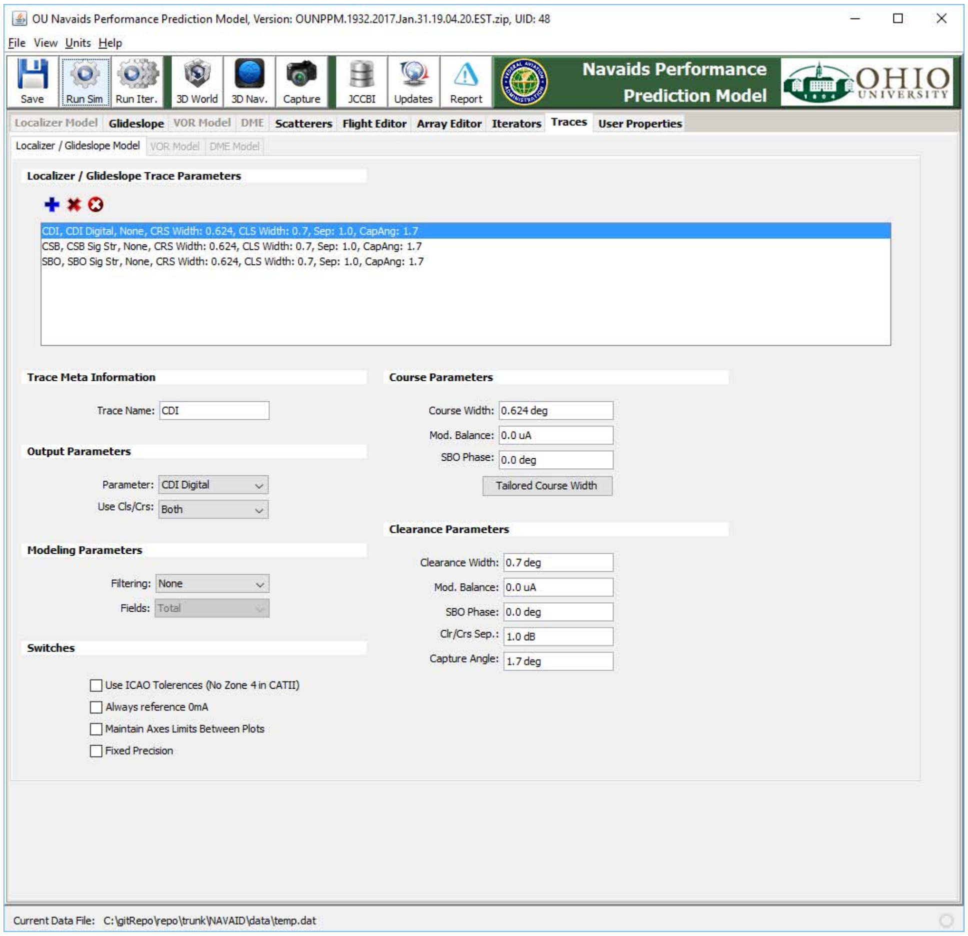


Figure 159: Exercise 1 Traces.

24.1.2 Results Exercise 1

Figure 160 shows the results for this exercise. If your chart does not look the same, try adjusting the axes. If you have one hump instead of two in your CDI, make sure it is using *both* for the "Use Crs/Clr".

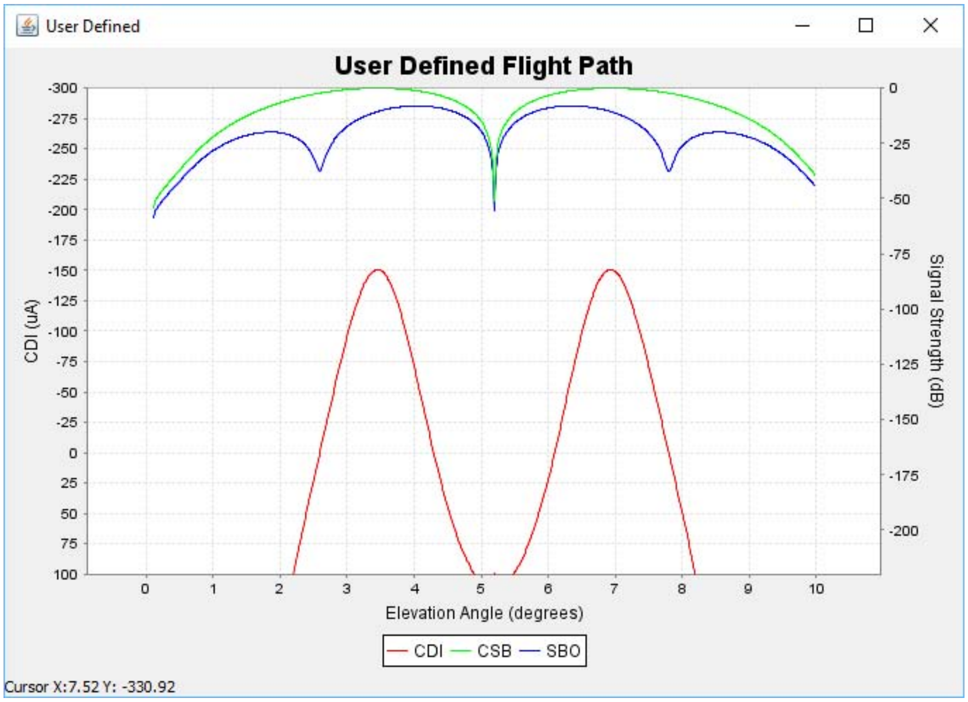


Figure 160: Exercise 1, Expected Results.

24.2 Exercise 2

This example demonstrates how to use the OUNPPM to optimize the CRS-CLR ratio to obtain acceptable clearance.

24.2.1 Setup Exercise 2

When the application beings, you should see something resembling figure 168.

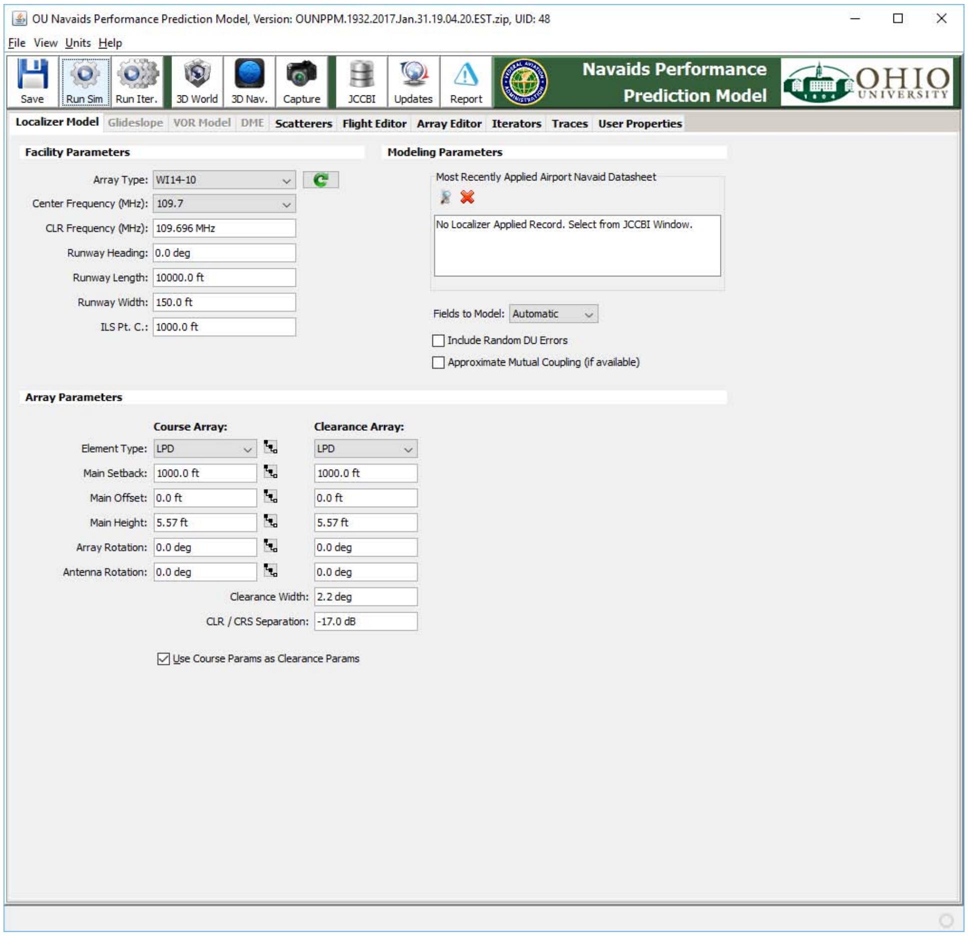


Figure 161: Exercise 2: Startup.

Using the problem description, set the array type, runway length, and localizer setback to the specified values. Your facility info should resemble figure 162.

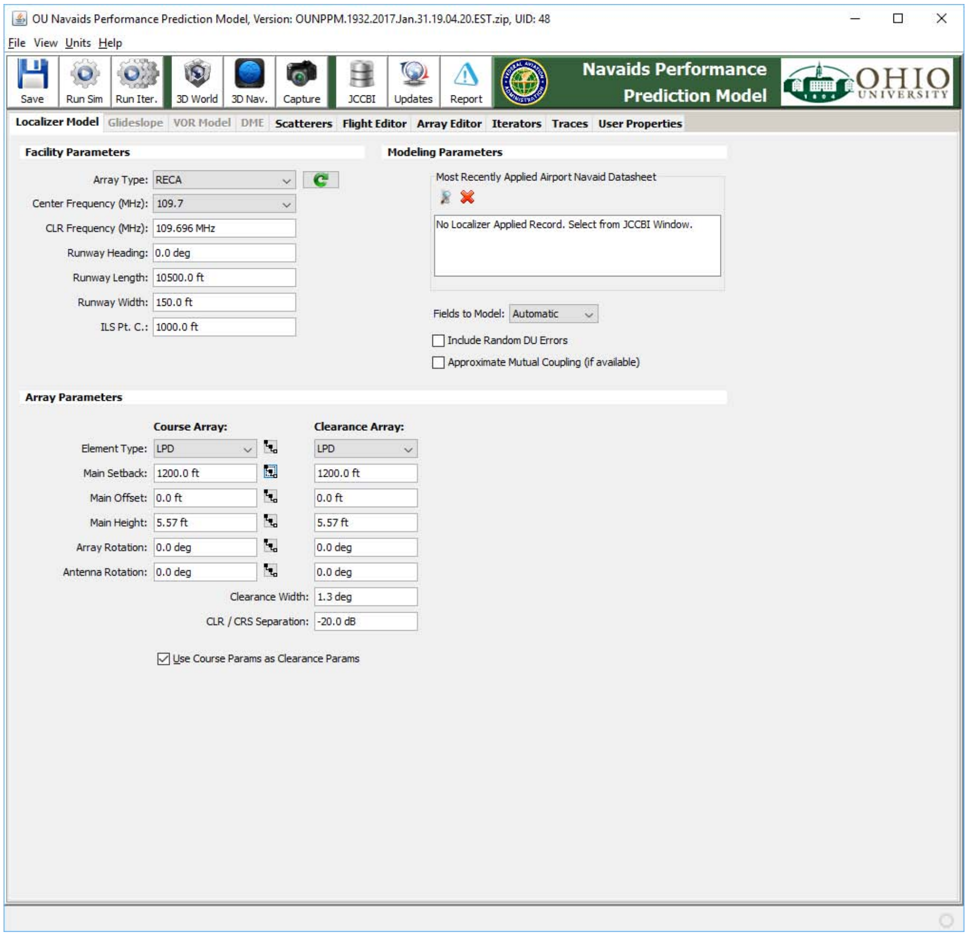


Figure 162: Exercise 2: Facility Info.

Because the clearance is constant for any (reasonable) range, an ILS1 (orbit) flight path is the correct approach for this problem. Go to the "Flight Editor" tab and select ILS 1 / Orbit from the "Flight Type" combo box. Your Flight Editor should resemble figure 163.

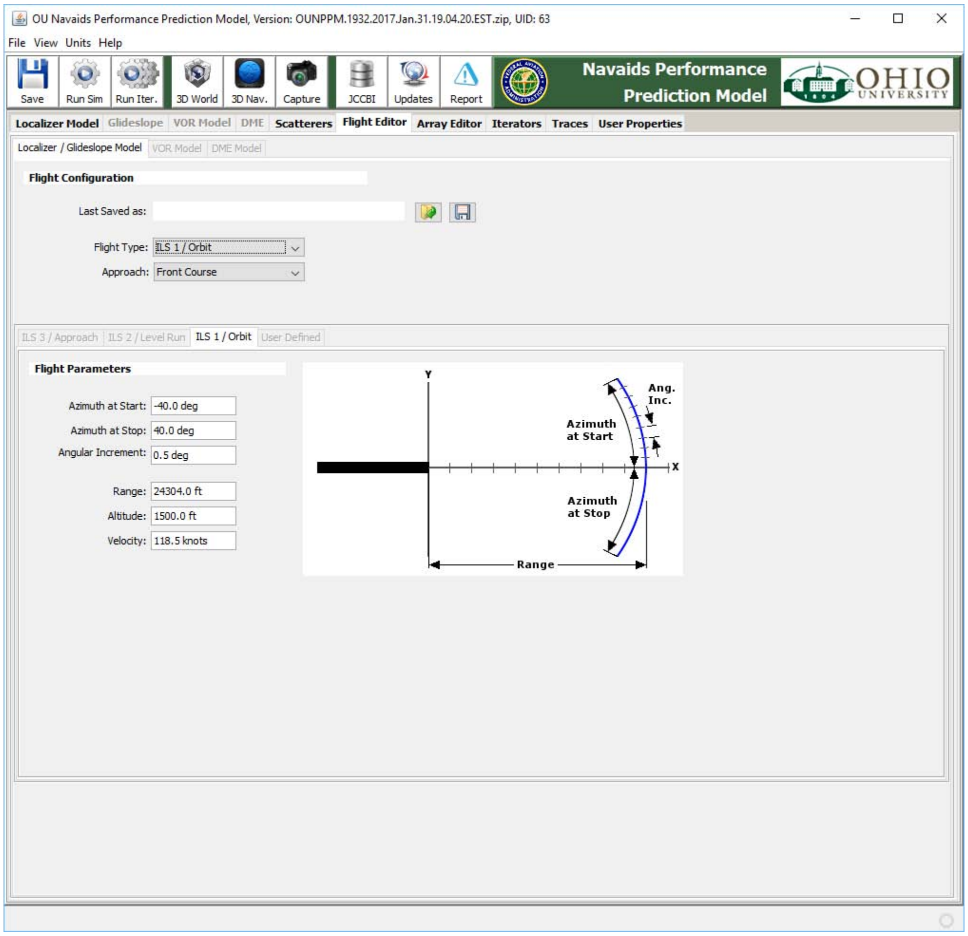


Figure 163: Exercise 2: Flight Path.

Because you are trying to find the maximum CRS-CLR ratio that provides acceptable coverage, start with the original value and and try incrementally higher values. We'll start with the default of -20, and try -19, -18, -17 (you are limited to 4 traces). Once the traces are added your Traces tab should resemble figure **??**.

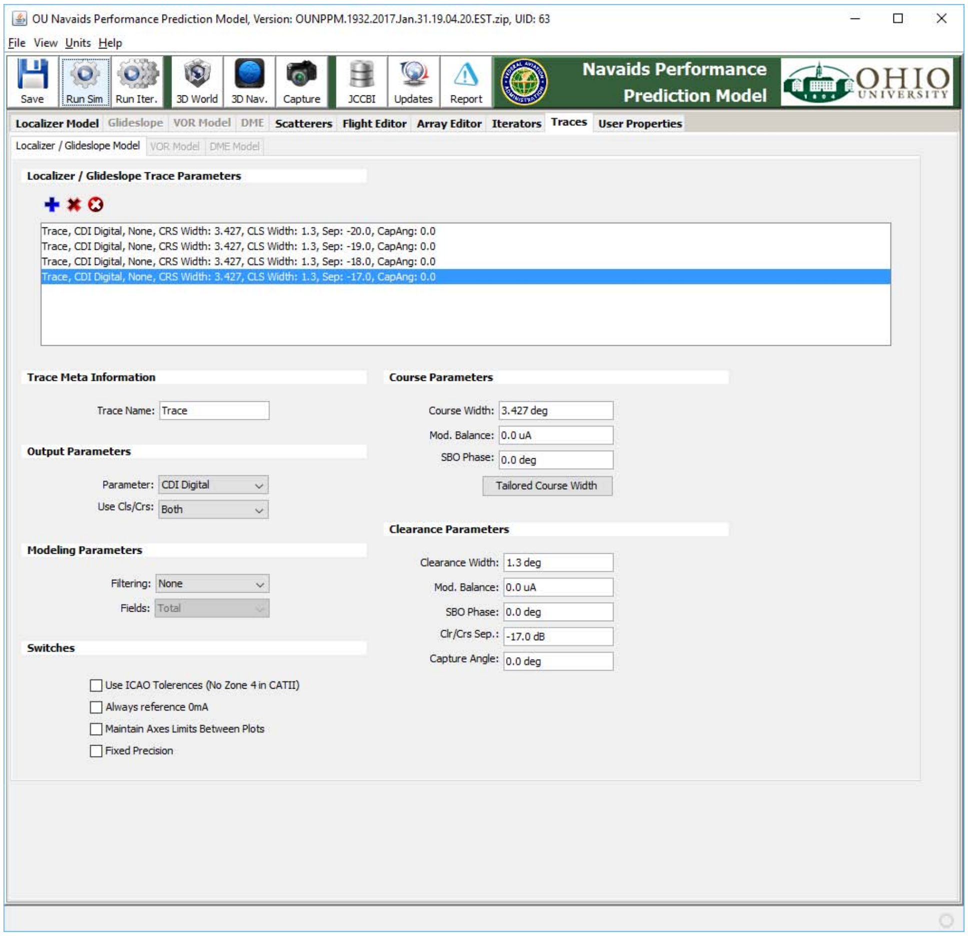


Figure 164: Exercise 2 Traces.

Figure 165 shows an example of the flight path in the virtual world.

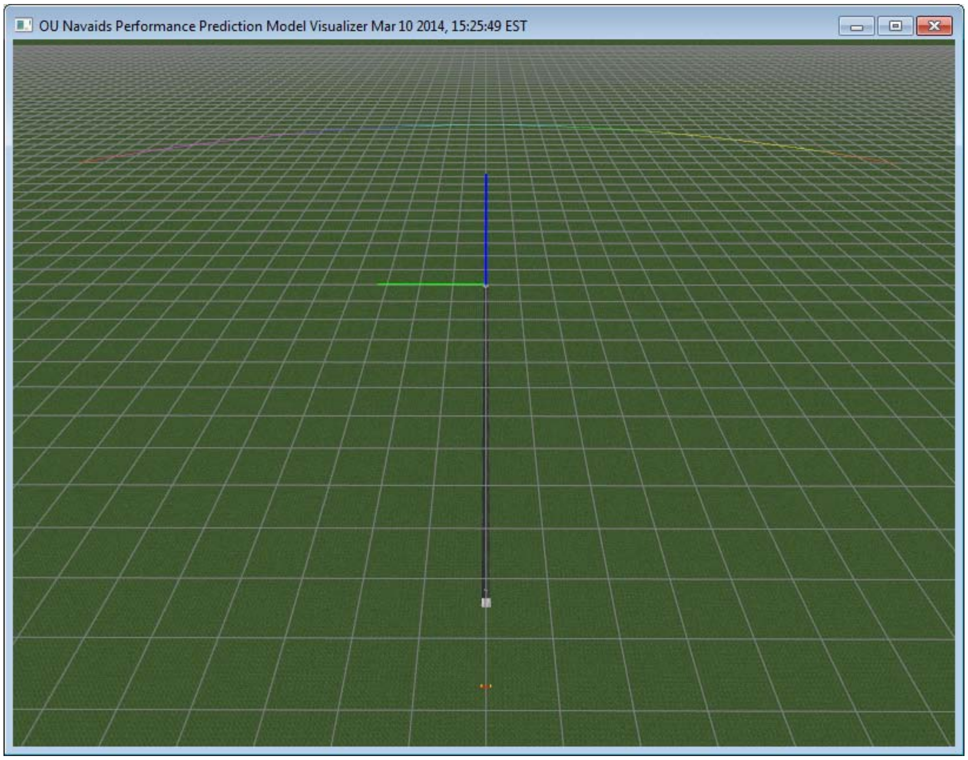


Figure 165: Exercise 2 Virtual World.

24.2.2 Results Exercise 2

Figure 167 shows an example of the 4 traces showing the CRS-CLR at various values.

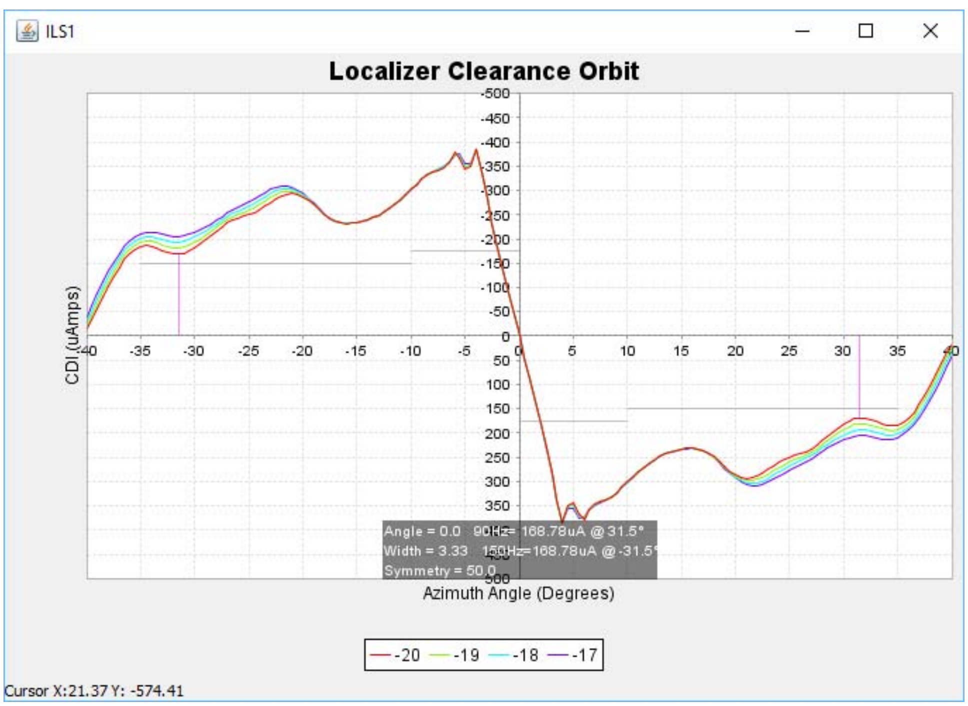


Figure 166: Exercise 2 Plot.

Figure **??** shows the results zoomed in near the 200μA line. As you can see, the correct values lies somewhere between -17 and -18.

Figure 167: Exercise 2 Plot.

24.3 Exercise 3

This example demonstrates how to determine the effects of various antenna distributions.

24.3.1 Setup Exercise 3

When the application beings, you should see something resembling figure 168.

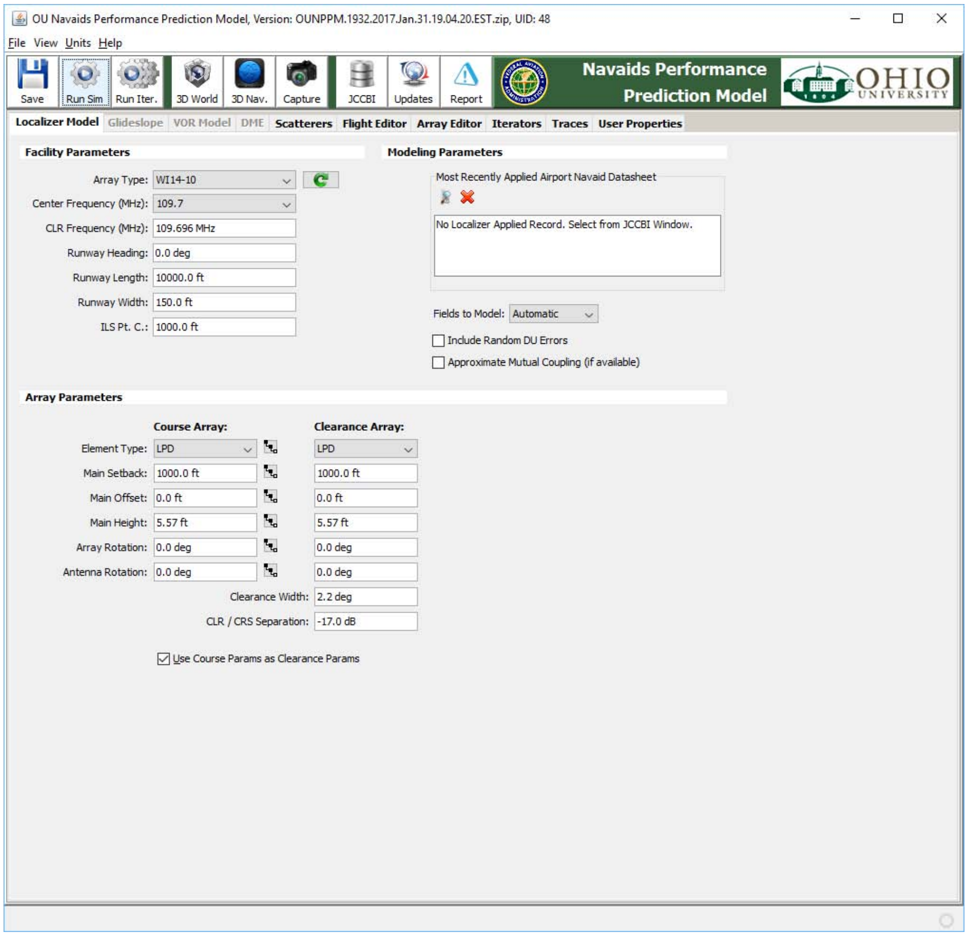


Figure 168: Exercise 2: Startup.

First we use the problem description to set up our facility information. Your facility information should resemble figure 169

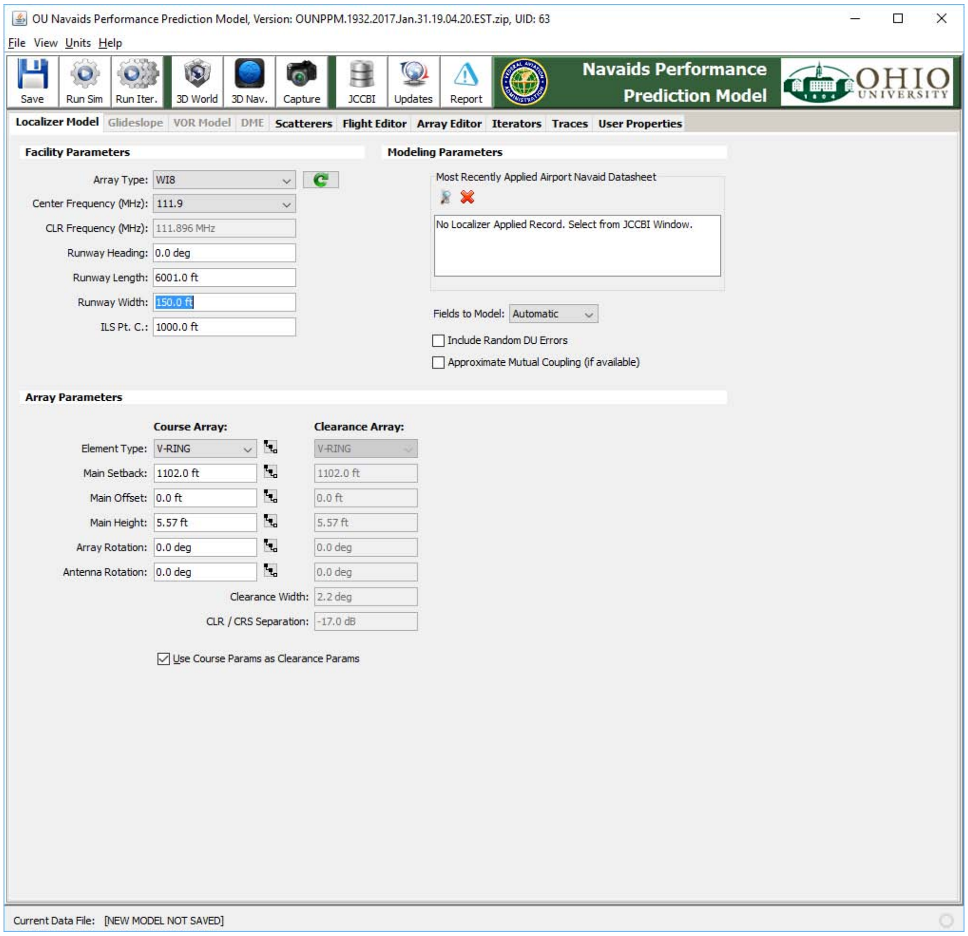


Figure 169: Exercise 3: Facility Info.

According to the problem description, we need to find the results of exactly 4 values. It would be perfectly acceptable to use the array editor and try each value individually, but you can accomplish this with less manual effort by using iterators. Using iterators we will try a superset of the required values. To iterate the DU Parameters, on the iterators tab, click the Iterate DU Parameters button (∿), as seen in Figure 170. This will open a new frame.

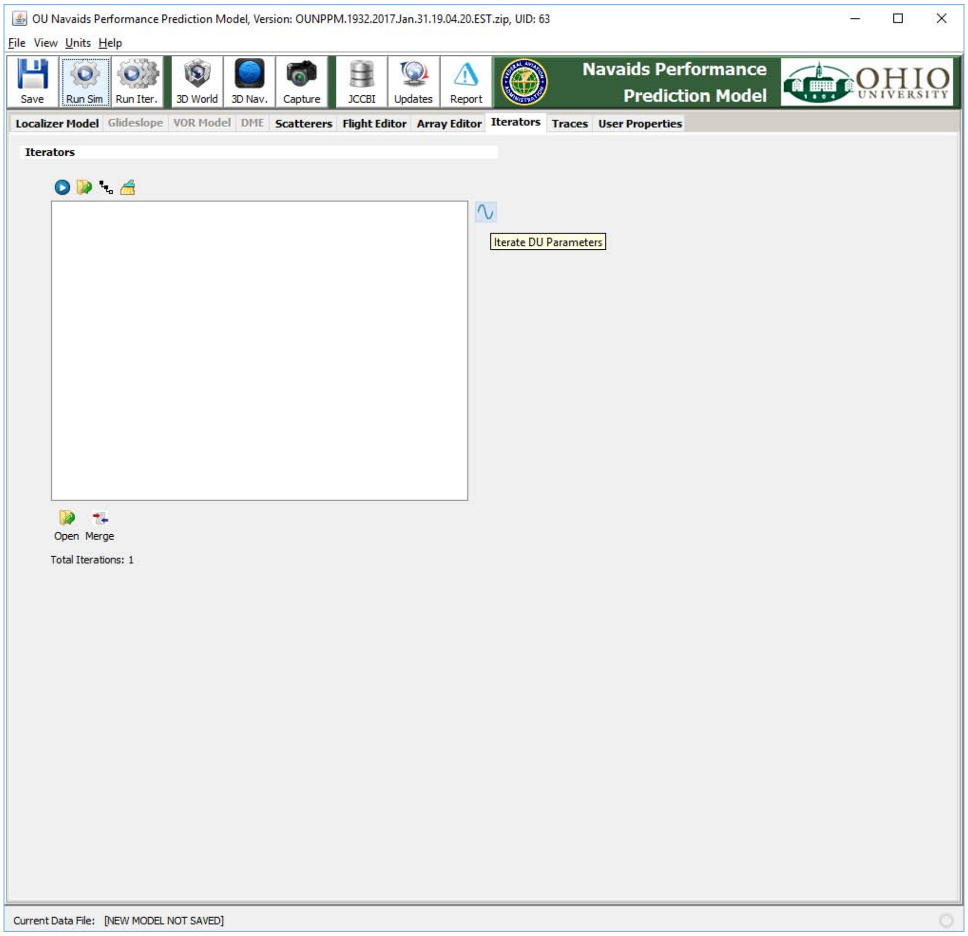


Figure 170: On the iterators tab, click the Iterate DU Parameters button.

In this window, shown in Figure 171, click the "Iterate As Group" checkbox. If you select each element individually, it will attempt to iterate over all combinations of each value of each element. Instead we treat them as a single group that does not combine with each other.

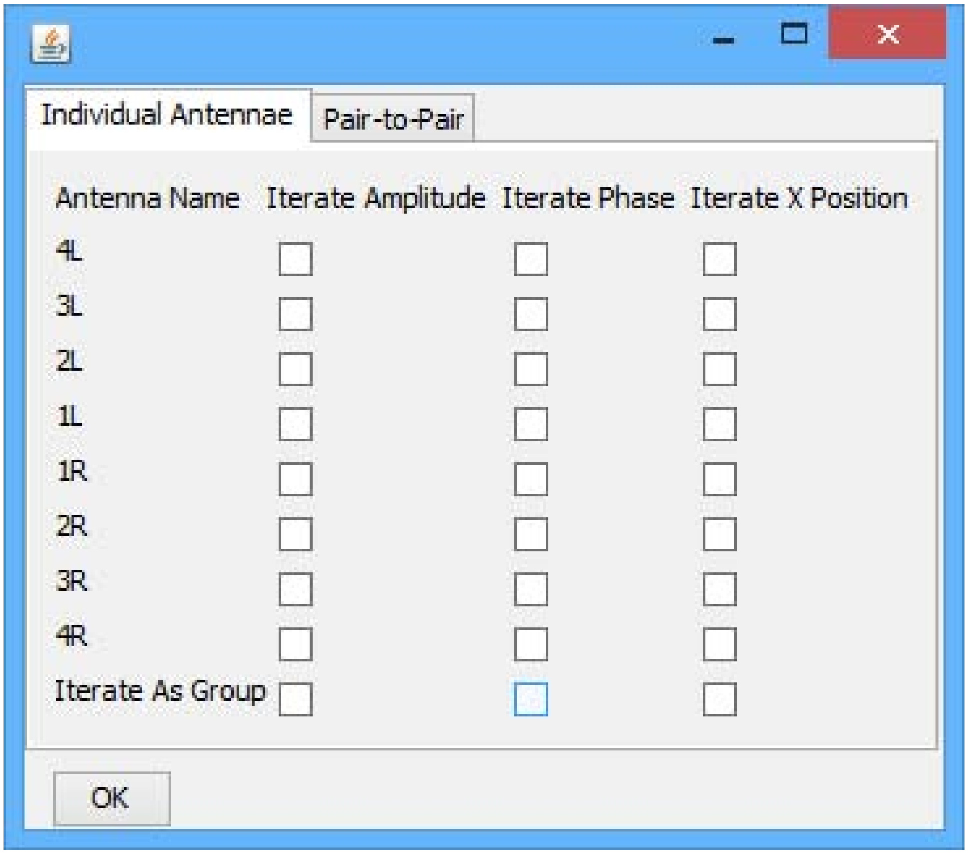


Figure 171: The DU iteration selection window.

If you set your iteration values to be like those shown in Figure 172 then you can test the selected elements at 0, 10, and 20 degrees. This covers all options in this example.

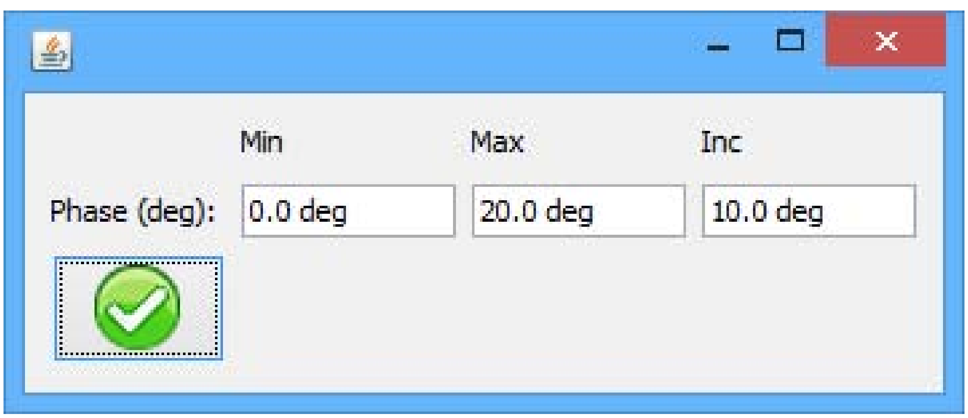


Figure 172: Values for the DU group iteration.

Select at least the elements needed for this example, as shown in Figure 173.

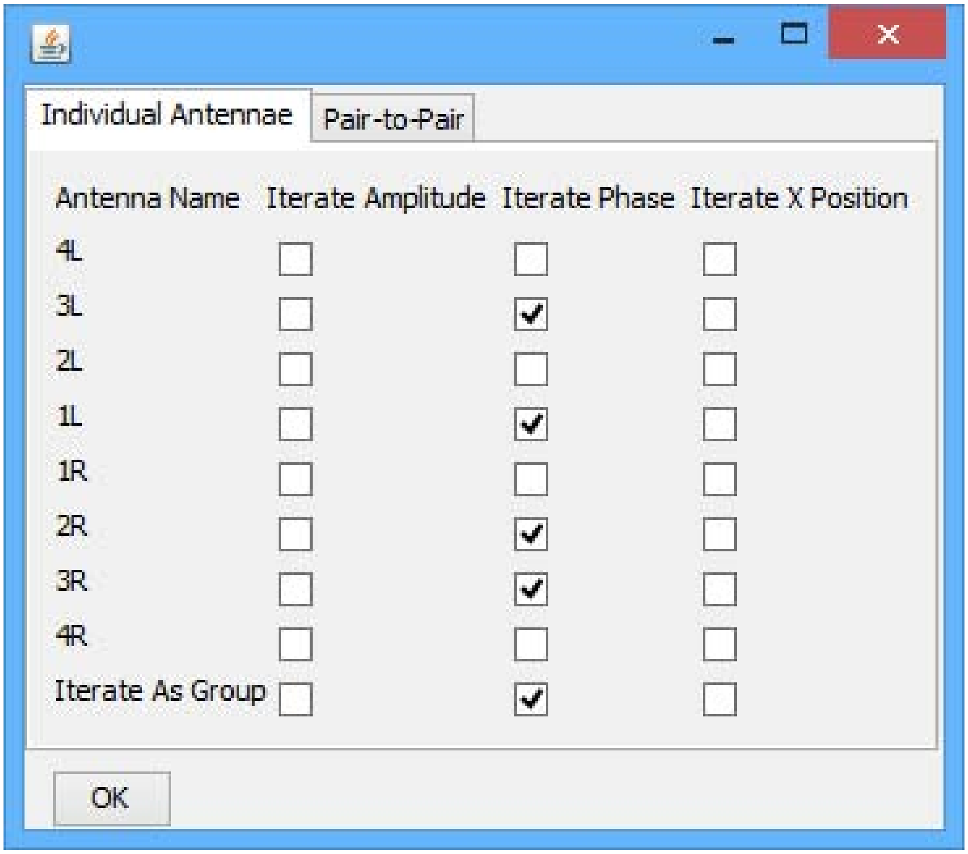


Figure 173: Exercise 3 elements.

Figure 174 shows the iterators tab after adding the DU iterators. Notice this will create 12 iterators total.

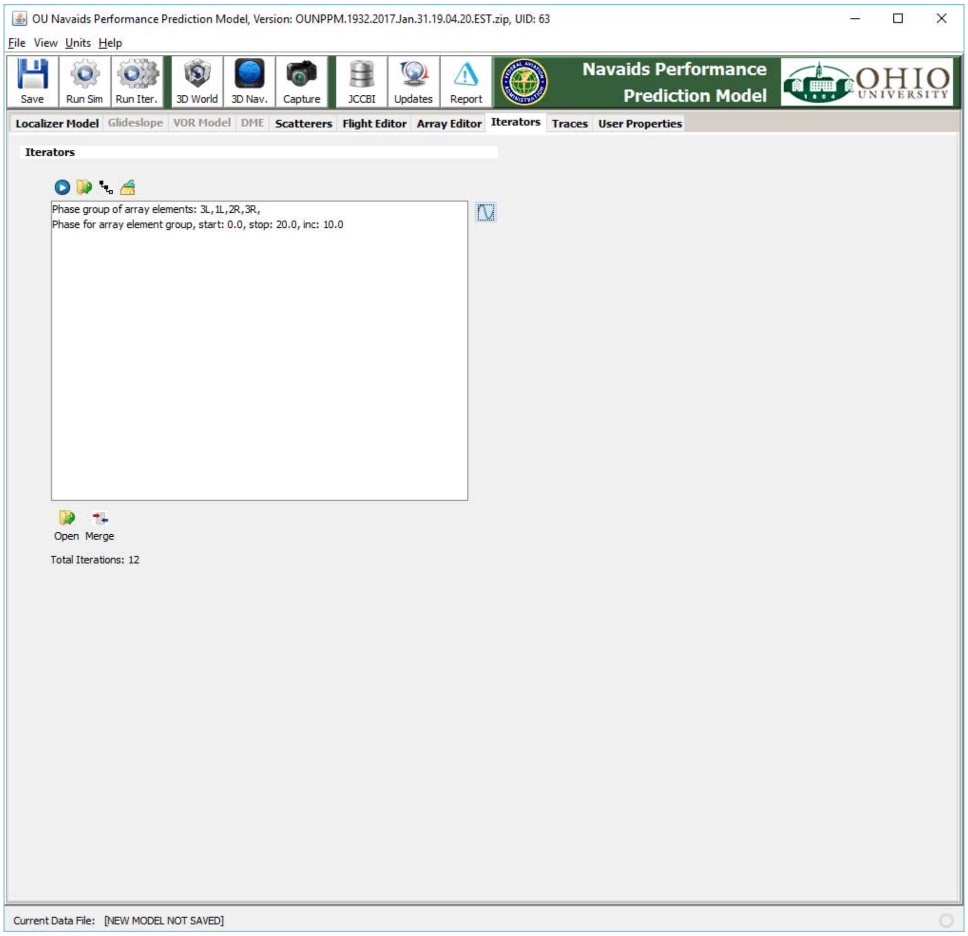
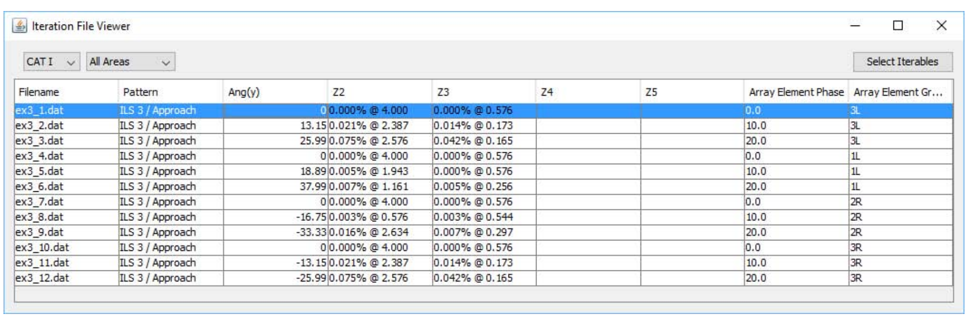


Figure 174: 12 total iterations.

Press the "Run Iteratations" button on the main toolbar to run the iterations. After running iterations a table of iterations will appear, as seen in Figure 175.



Filename	Pattern	Ang(y)	Z2	Z3	Z4	Z5	Array Element Phase	Array Element Gr...
ex3_1.dat	ILS 3 / Approach	0	0.000% @ 4.000	0.000% @ 0.576			0.0	3L
ex3_2.dat	ILS 3 / Approach	13.15	0.021% @ 2.387	0.014% @ 0.173			10.0	3L
ex3_3.dat	ILS 3 / Approach	25.99	0.075% @ 2.576	0.042% @ 0.165			20.0	3L
ex3_4.dat	ILS 3 / Approach	0	0.000% @ 4.000	0.000% @ 0.576			0.0	1L
ex3_5.dat	ILS 3 / Approach	18.89	0.005% @ 1.943	0.000% @ 0.576			10.0	1L
ex3_6.dat	ILS 3 / Approach	37.99	0.007% @ 1.161	0.005% @ 0.256			20.0	1L
ex3_7.dat	ILS 3 / Approach	0	0.000% @ 4.000	0.000% @ 0.576			0.0	2R
ex3_8.dat	ILS 3 / Approach	-16.75	0.003% @ 0.576	0.003% @ 0.544			10.0	2R
ex3_9.dat	ILS 3 / Approach	-33.33	0.016% @ 2.634	0.007% @ 0.297			20.0	2R
ex3_10.dat	ILS 3 / Approach	0	0.000% @ 4.000	0.000% @ 0.576			0.0	3R
ex3_11.dat	ILS 3 / Approach	-13.15	0.021% @ 2.387	0.014% @ 0.173			10.0	3R
ex3_12.dat	ILS 3 / Approach	-25.99	0.075% @ 2.576	0.042% @ 0.165			20.0	3R

Figure 175: Table of iteration values.

24.3.2 Results Exercise 3

If you click "Select Iterables" on the iteration file viewer, and the plot the two paramters you will generate a plot with phases on one axis and the element on the other. The DU adjustments will not affect structure, but will affect angle. If you select "angle" on the plot you should see the results in Figure 176.

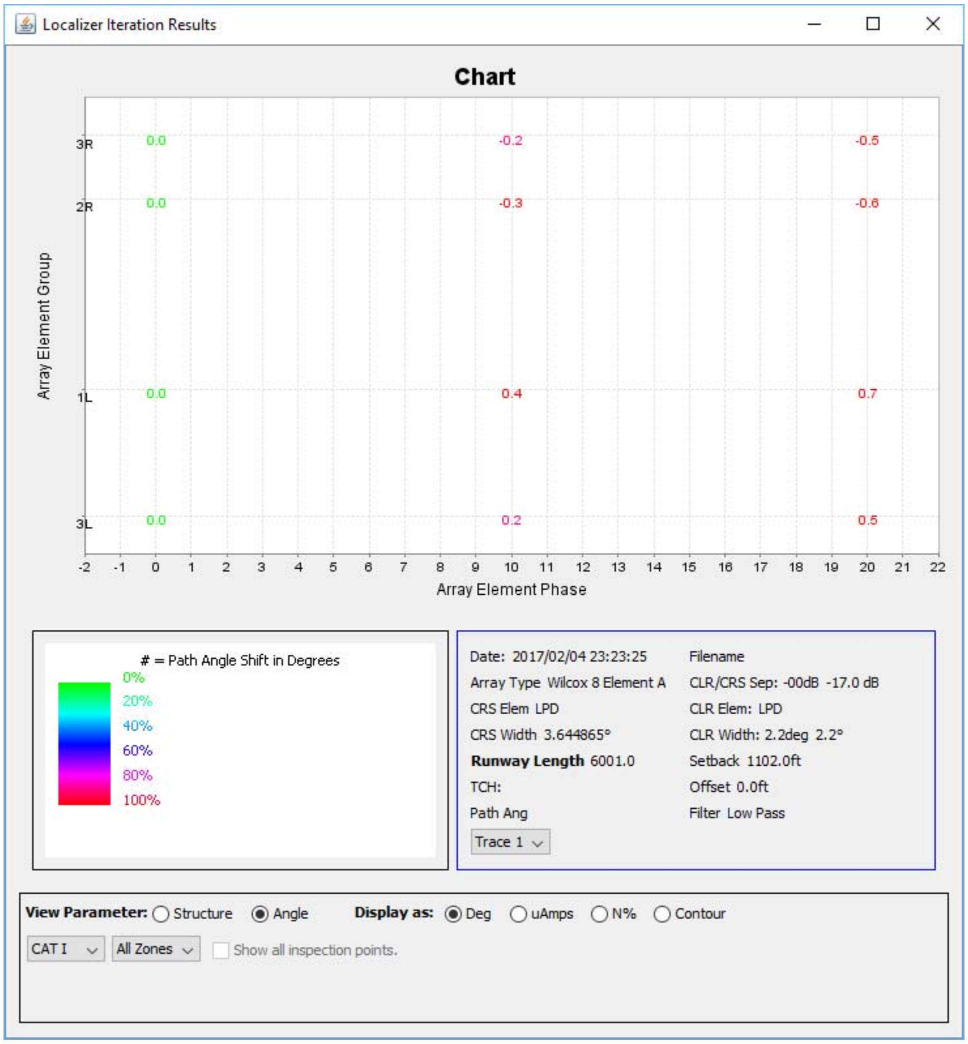


Figure 176: Exercise 3 Results.

24.4 Exercise 4

This example demonstrates how to use the vertical pull from image scatterer creation tool in a real scenario.

24.4.1 Setup Exercise 4

When the application beings, you should see something resembling figure 177.

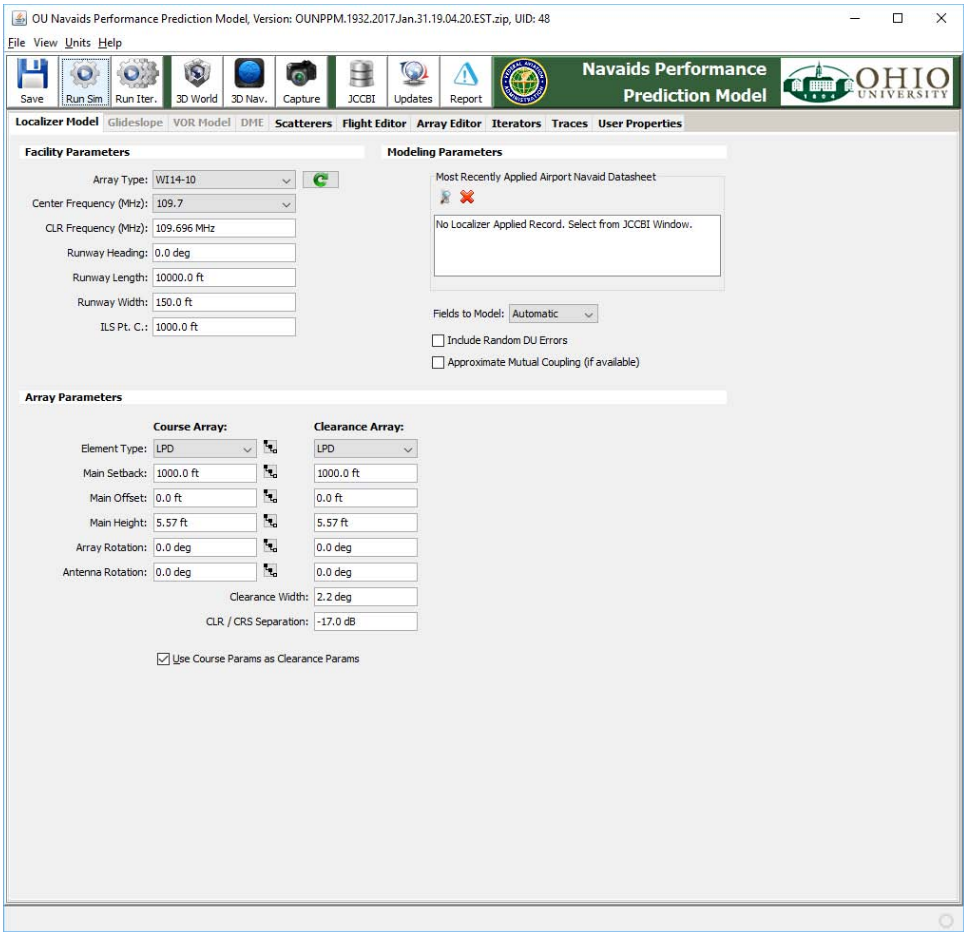


Figure 177: Exercise 4: Startup.

Using the problem description set up the facility information to resemble figure 178.

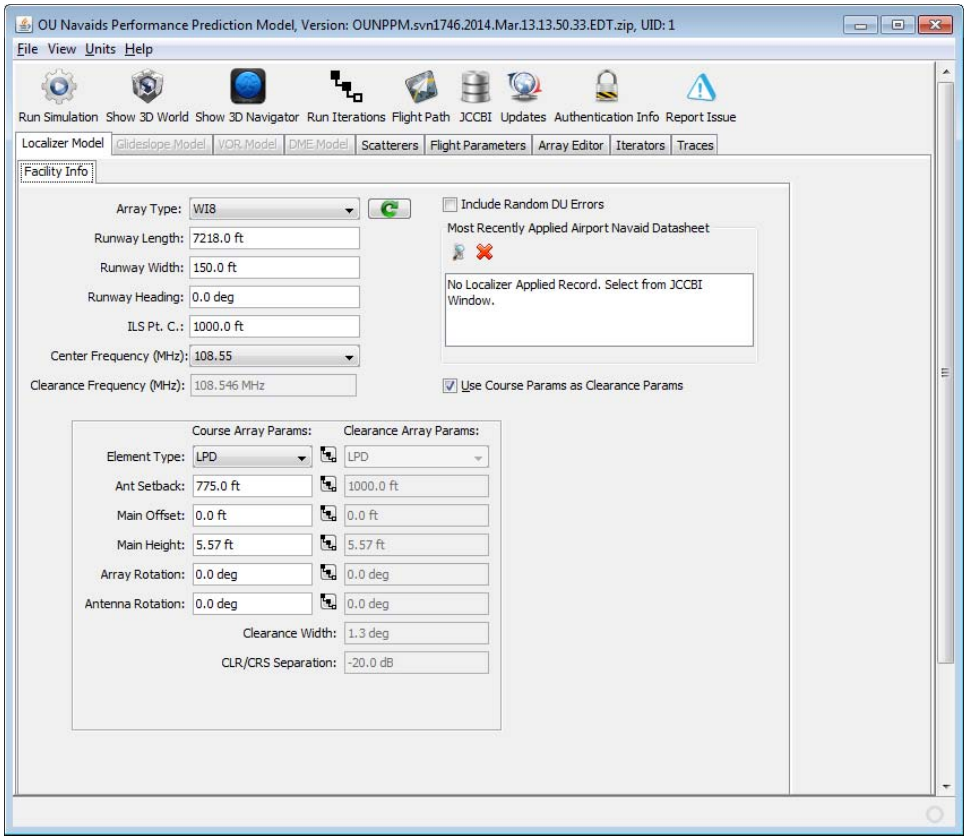


Figure 178: Exercise 4 Facility Info.

In your presentation materials on your training flash drive you should have a picture of the small boat. If not you can download the image directly from figure 179.

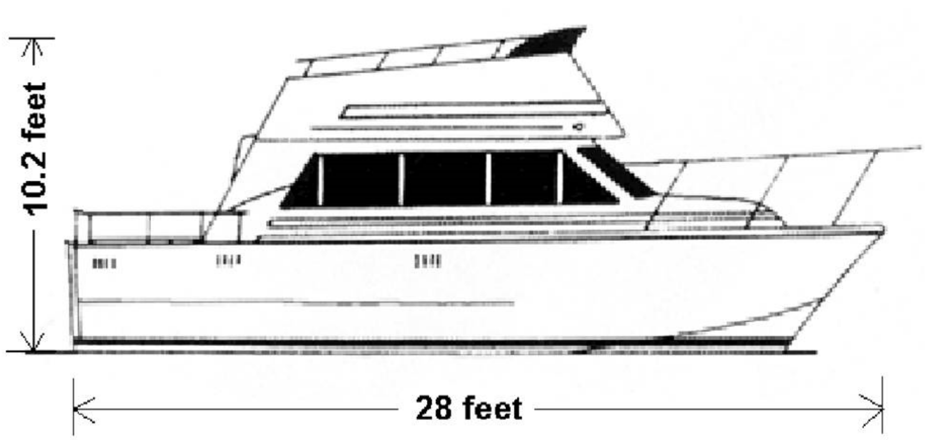


Figure 179: Exercise 4 Small Boat.

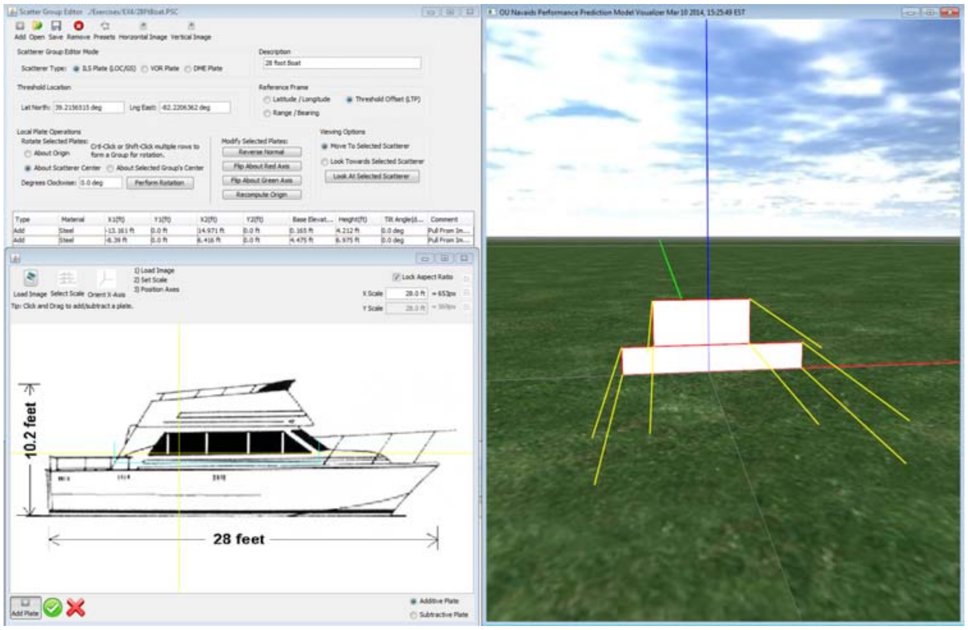


Figure 180: In the Scatterer Group Editor, click “XZ Image” to Pull from Image. 2) Load the 28 ft boat image. 3) Set the Scale. 4) Position the origin at the BOTTOM CENTER of the boat. The origin denotes the point about which the scatterer is locally rotated when manipulated in the editor. 5) Click the “Add Plate” button in the lower left to enter into *Add Plate* mode. 6) Drag box around lower hull of the boat. Notice the newly formed scatterer plate appears in the virtual world and in the Scatterer Group Editor. Repeat step 6 for the upper cabin of the boat. Notice a second plate appears in the virtual world and in the Scatterer Group Editor. Type a description of the boat in the Description window and click “Save” to save this small Boat to a *.psc* file.

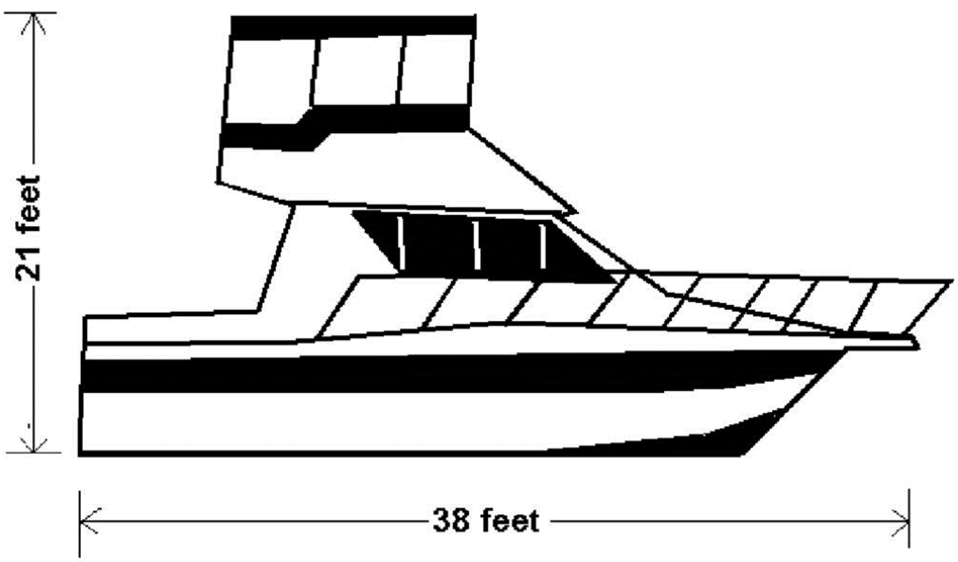


Figure 181: Exercise 4 Large Boat.

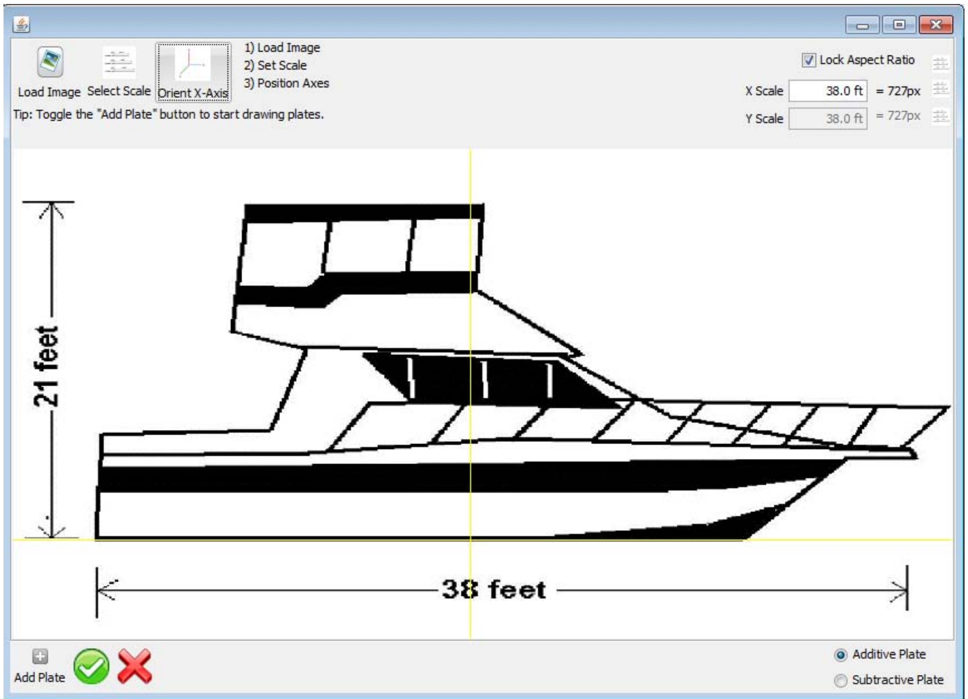


Figure 182: Setting origin of Large Boat to the boat's Bottom Center. This is the point of rotation for manipulations within the editor.

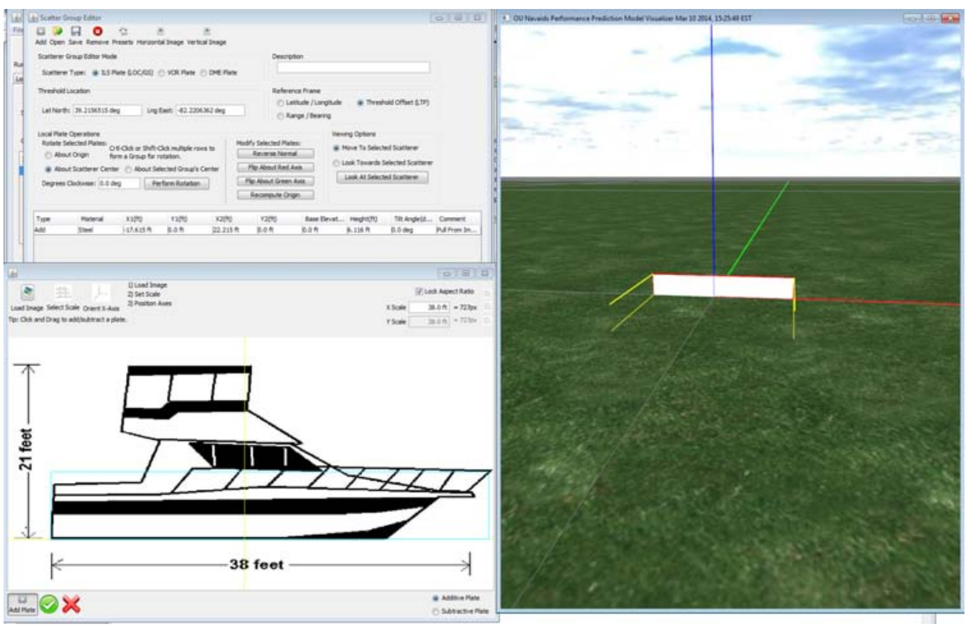


Figure 183: Creating Bottom Plate of Large Boat.

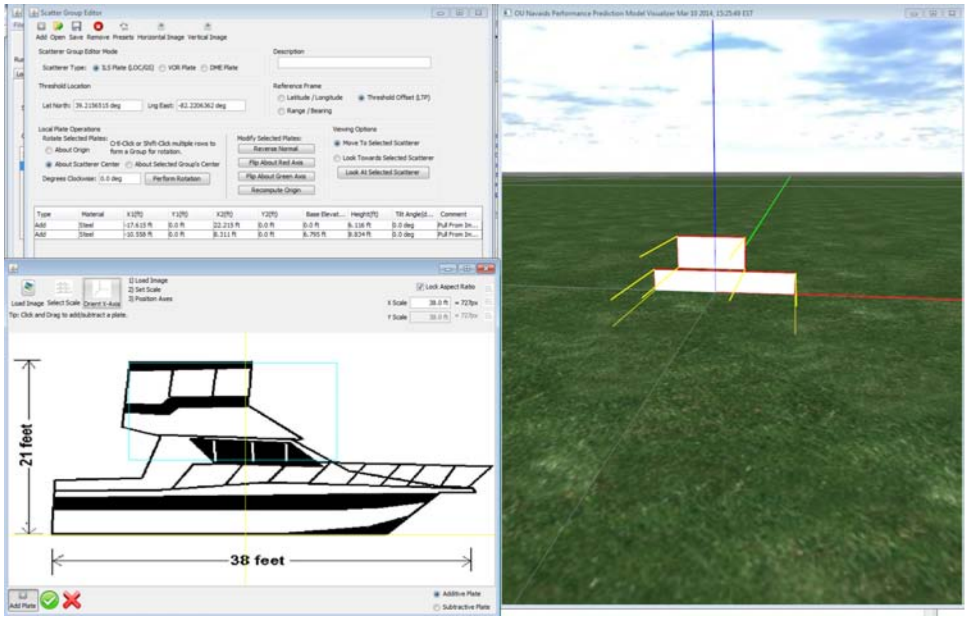


Figure 184: Creating Top Plate of Large Boat.

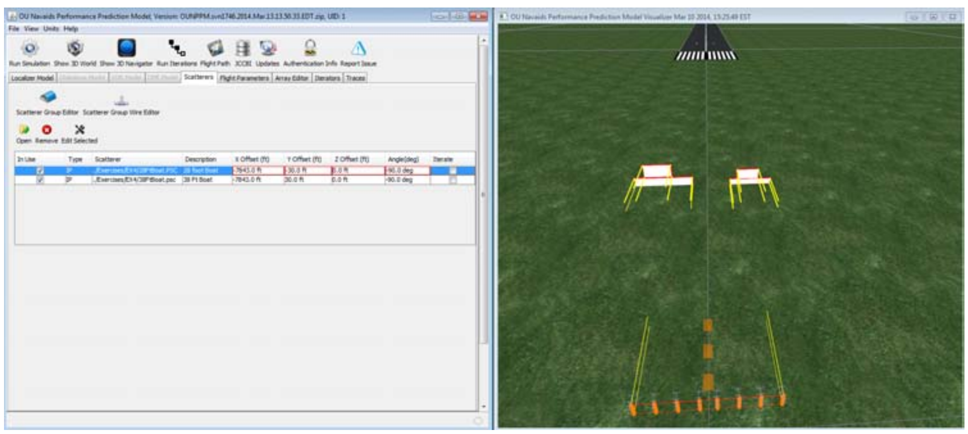


Figure 185: From the localizer's viewpoint, the large boat is on the left and the small boat is on the right. Notice the X Offset, Y Offset, and Angle specified within the *Scatterers* Tab.

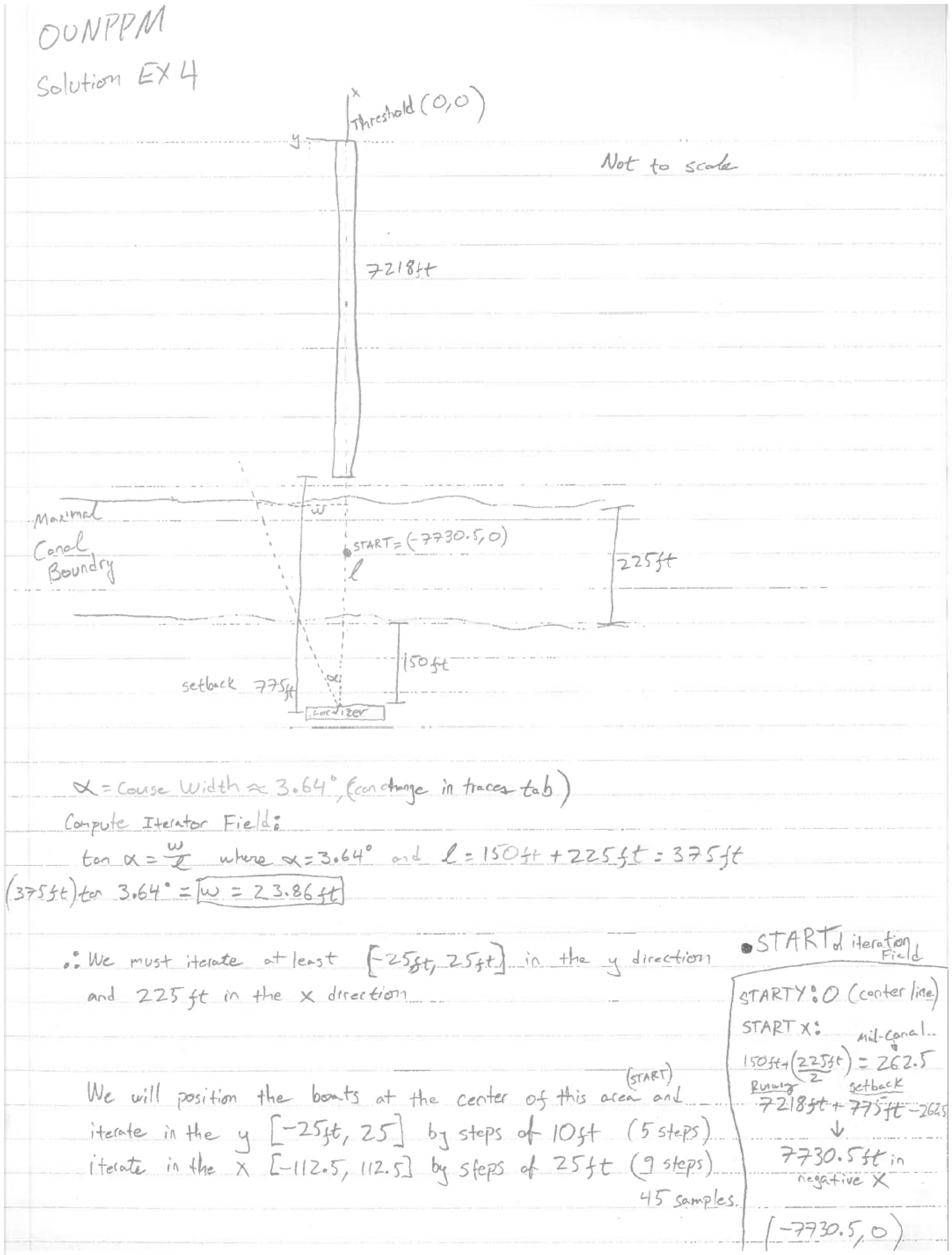


Figure 186: A pictoral representation of the model. The derivation of the requisite iterator field is shown given a course width of 3.64° and the aforementioned environmental dimensions.

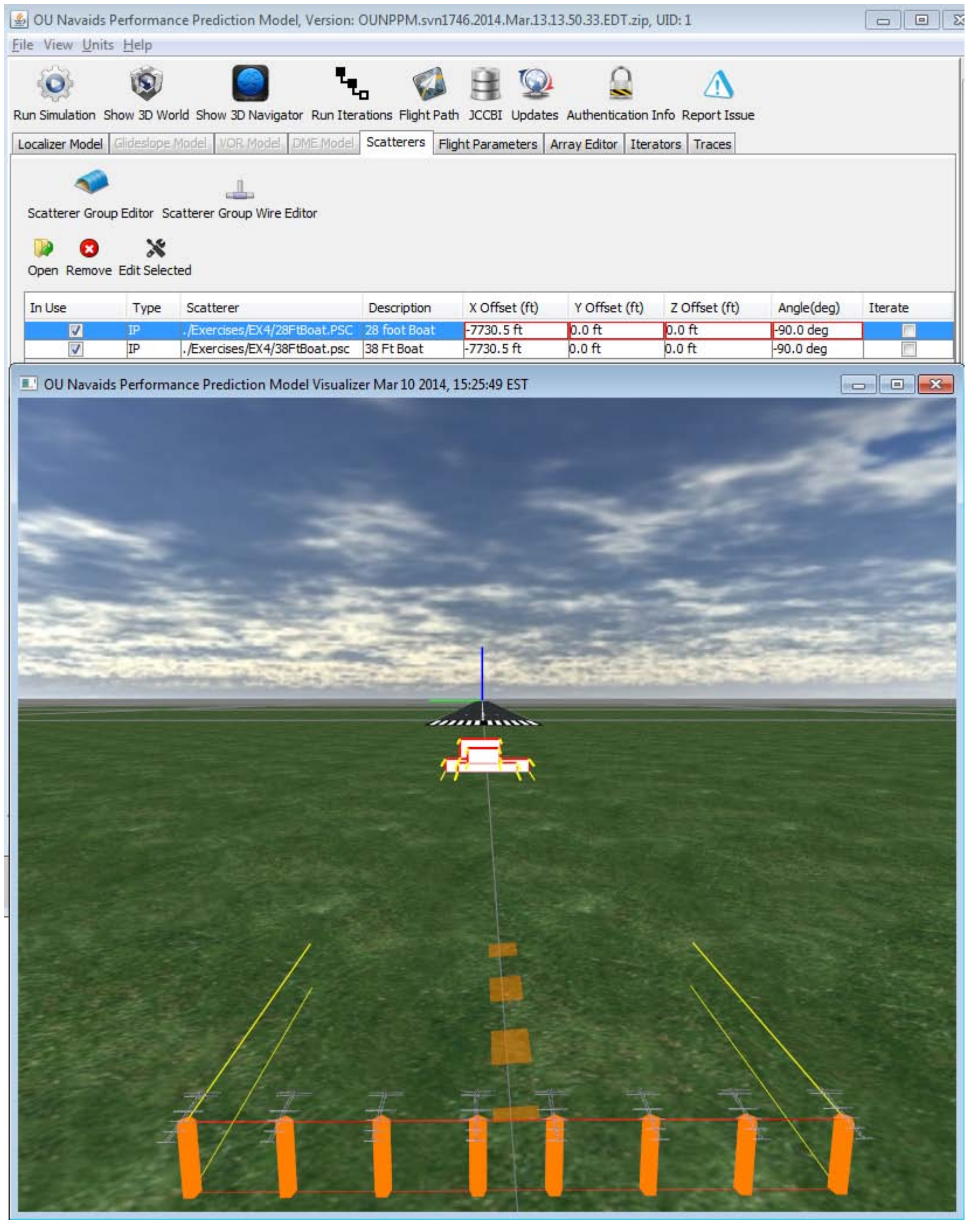


Figure 187: The boats have been positioned at the center of the iterator field derived in Fig.186.

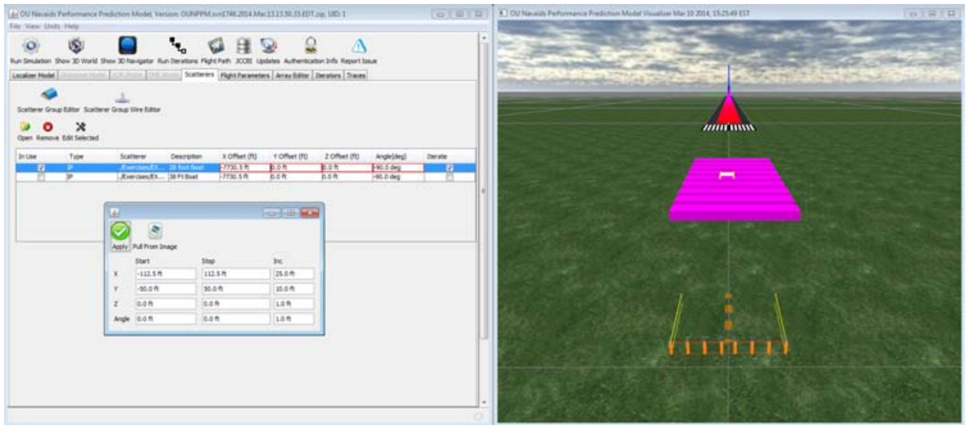


Figure 188: Small Boat: The iteration parameters have been set for the small boat. Using the diagram above, the Y iterator values were selected to be double the range computed in the diagram above (Fig.186. Click *Run Iterations* to simulate the model.

24.4.2 Results Exercise 4 Small Boat

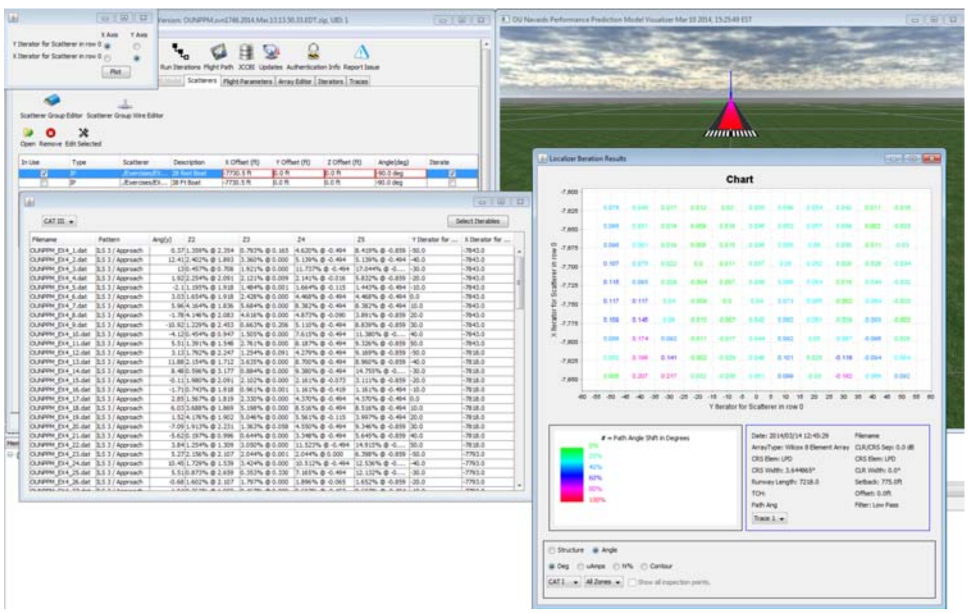


Figure 189: Small Boat: Plot results Table appears. Click *Select Iterables* to view the corresponding plot.

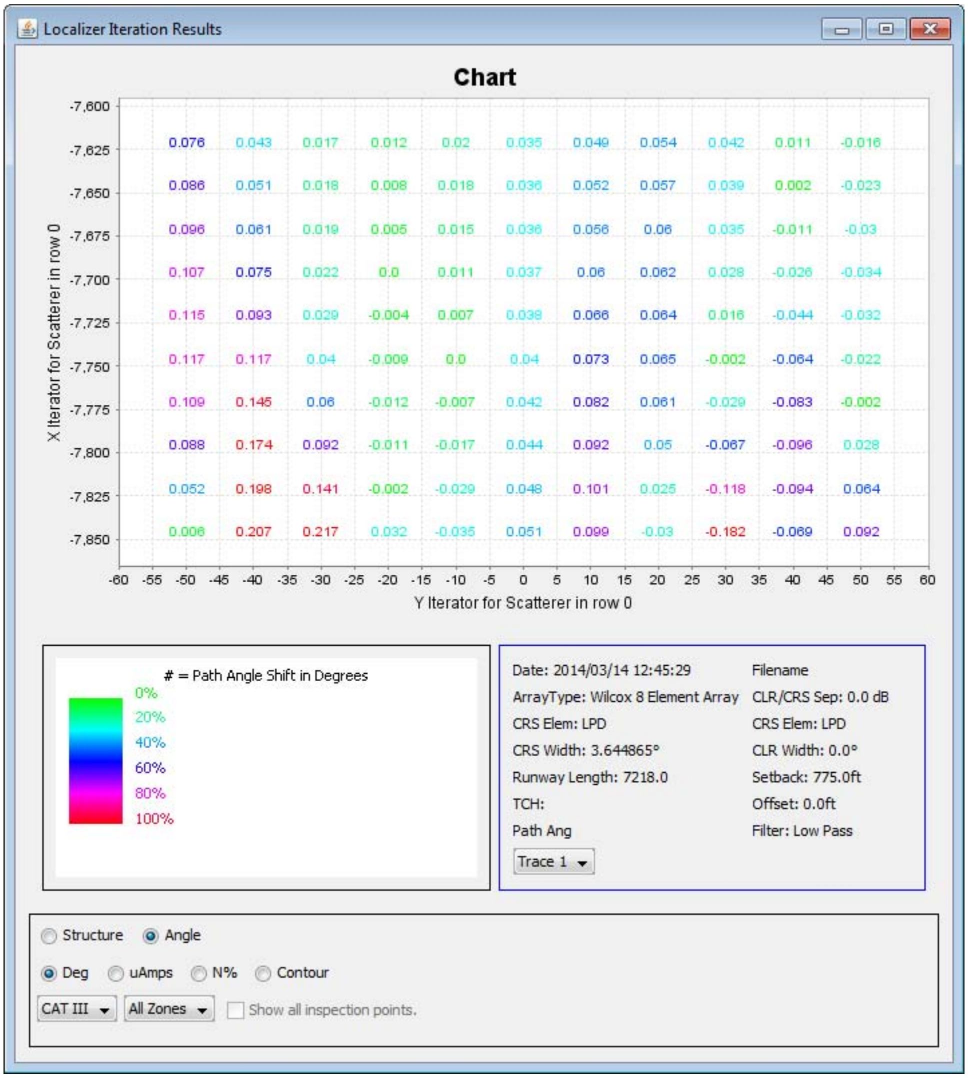


Figure 190: Small Boat: Cat III Angle plot results shown in Degrees. Very little is out of tolerance; if the size of the plates approximating the small boat were made a little smaller, then these areas may be within tolerance. Cat I is within tolerance.

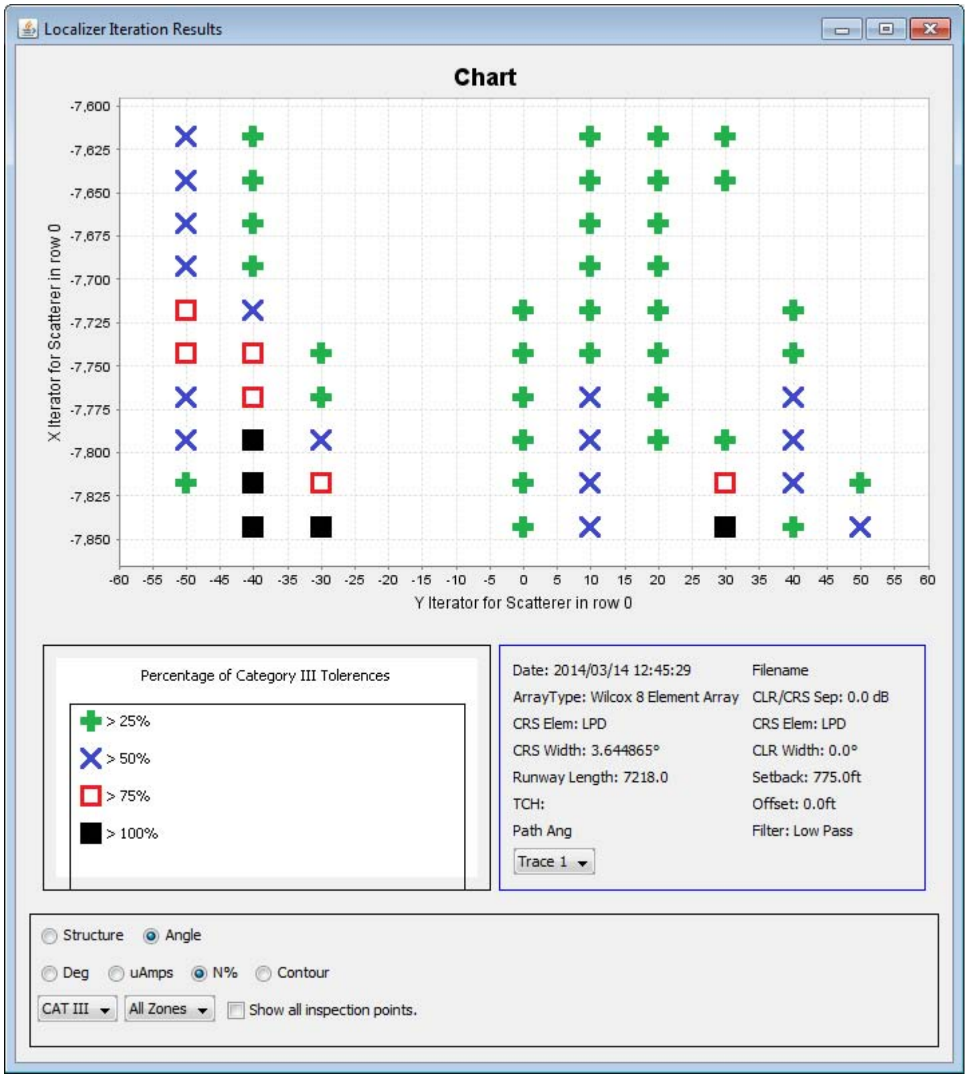


Figure 191: Small Boat: Cat III Angle plot results shown as a percent of tolerance. Very little is out of tolerance; if the size of the plates approximating the small boat were made a little smaller, then these areas may be within tolerance.

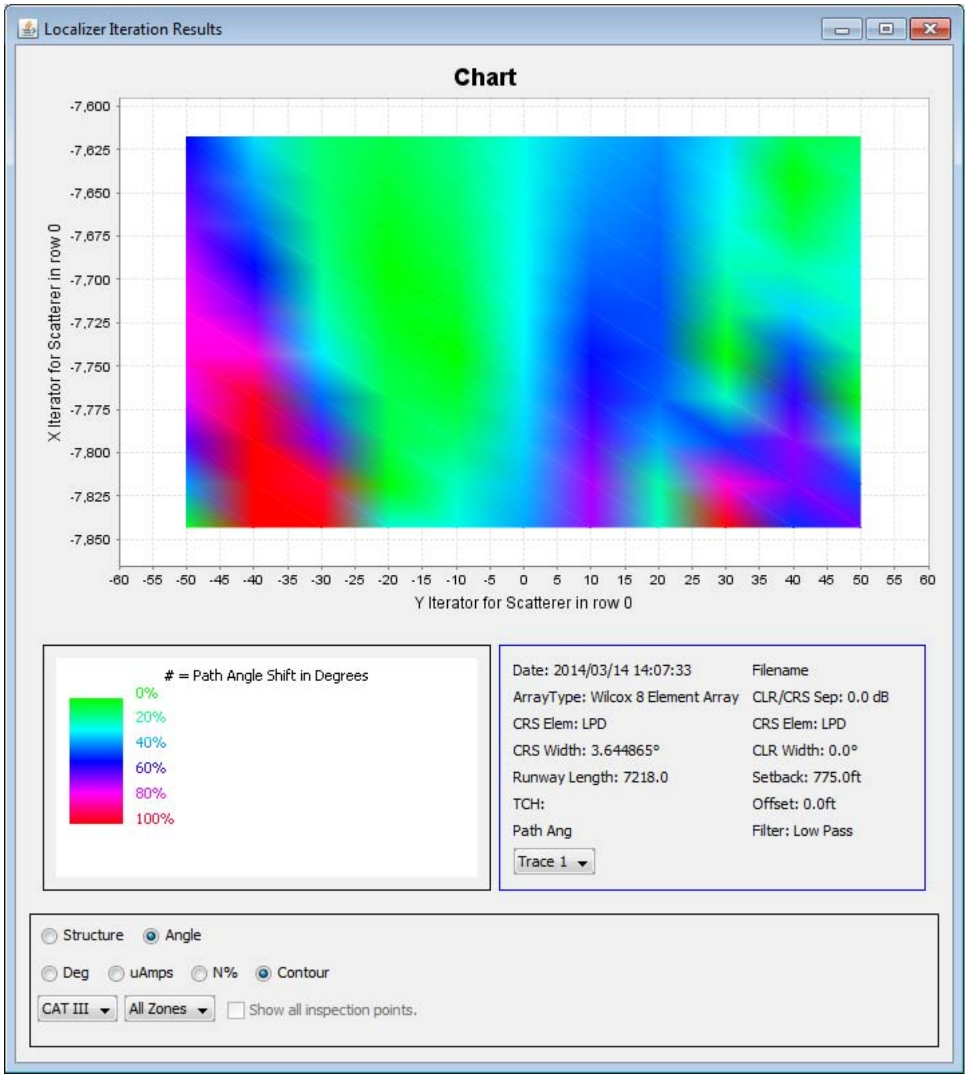


Figure 192: Small Boat: Cat III Angle plot results shown as a contour map of percent of tolerance. Very little is out of tolerance; if the size of the plates approximating the small boat were made a little smaller, then these areas may be within tolerance.

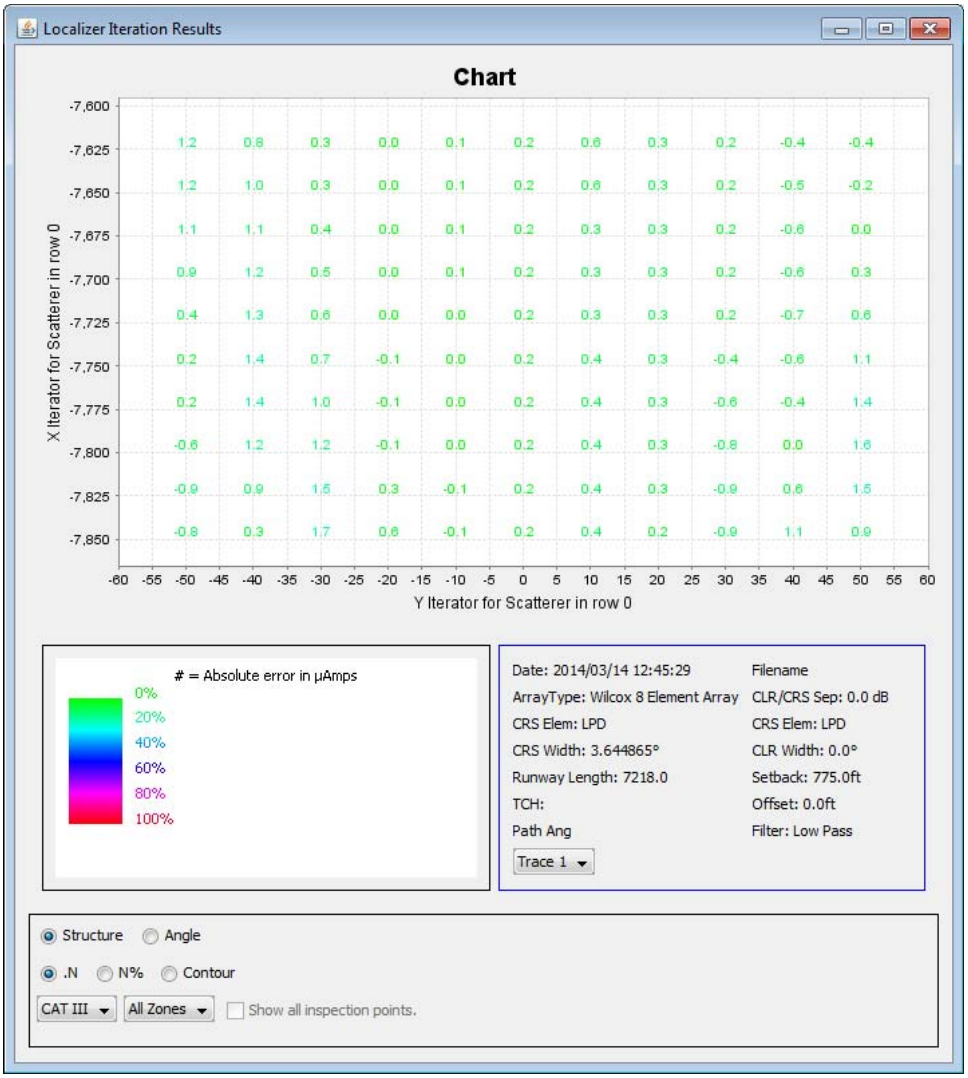


Figure 193: Cat III Structure plot shows very little error with nothing out of tolerance; the angle plot shows more error.

24.4.3 Results Exercise 4 Large Boat

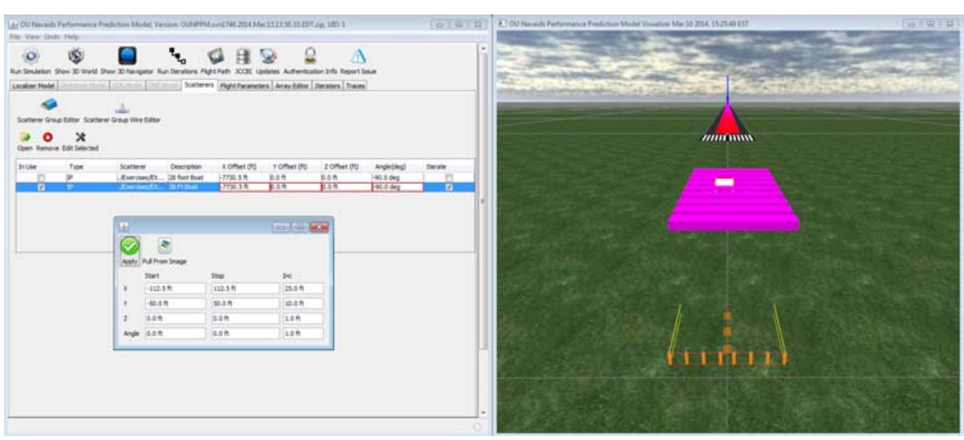


Figure 194: Large Boat: Iterator settings to model the large boat's effect on the localizer. Using the diagram show in Fig.186, the Y iterator values were selected to be double the range computed. Click *Run Iterations* to simulate the model.

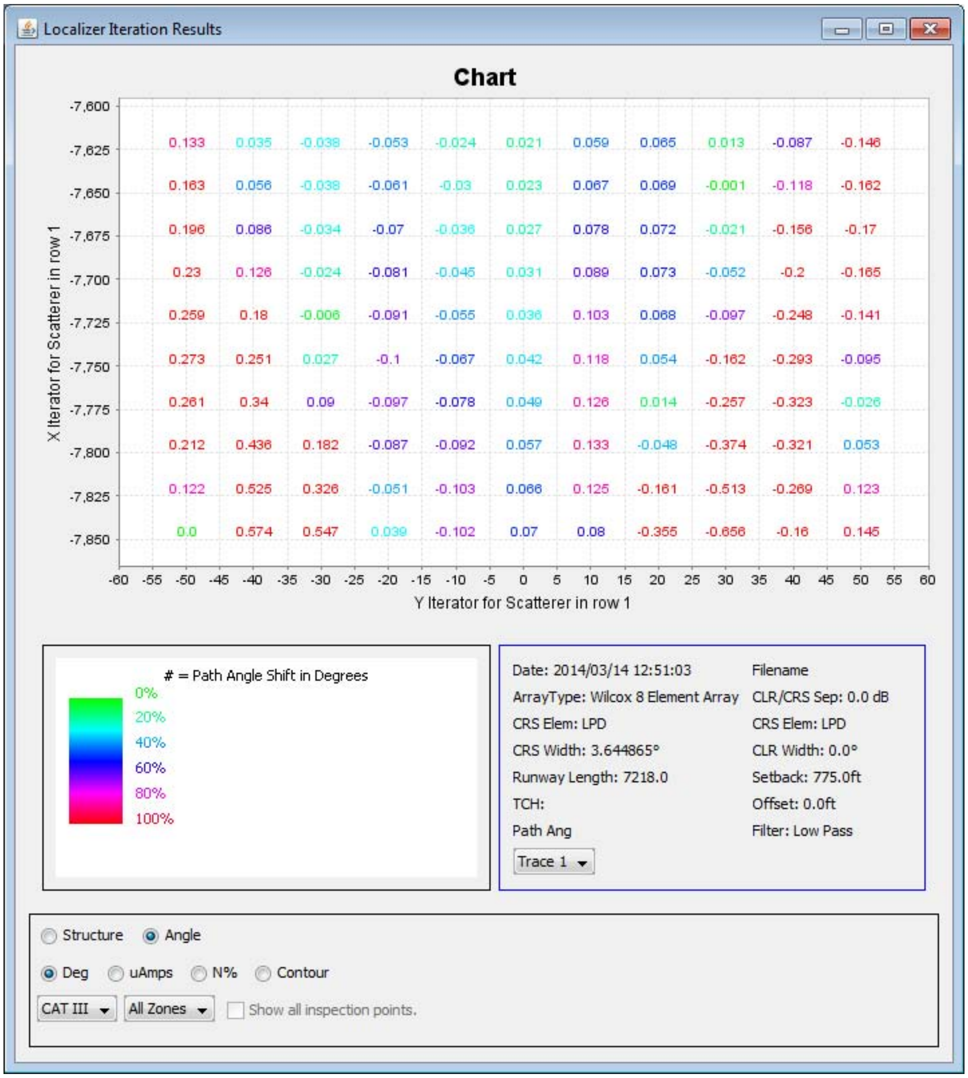


Figure 195: Large Boat: Cat III Angle plot results shown in Degrees. Areas shown in red are out of tolerance. The Angle tolerances of Categories I, II, and III are all out of tolerance, in contrast to the results shown with the small boat.

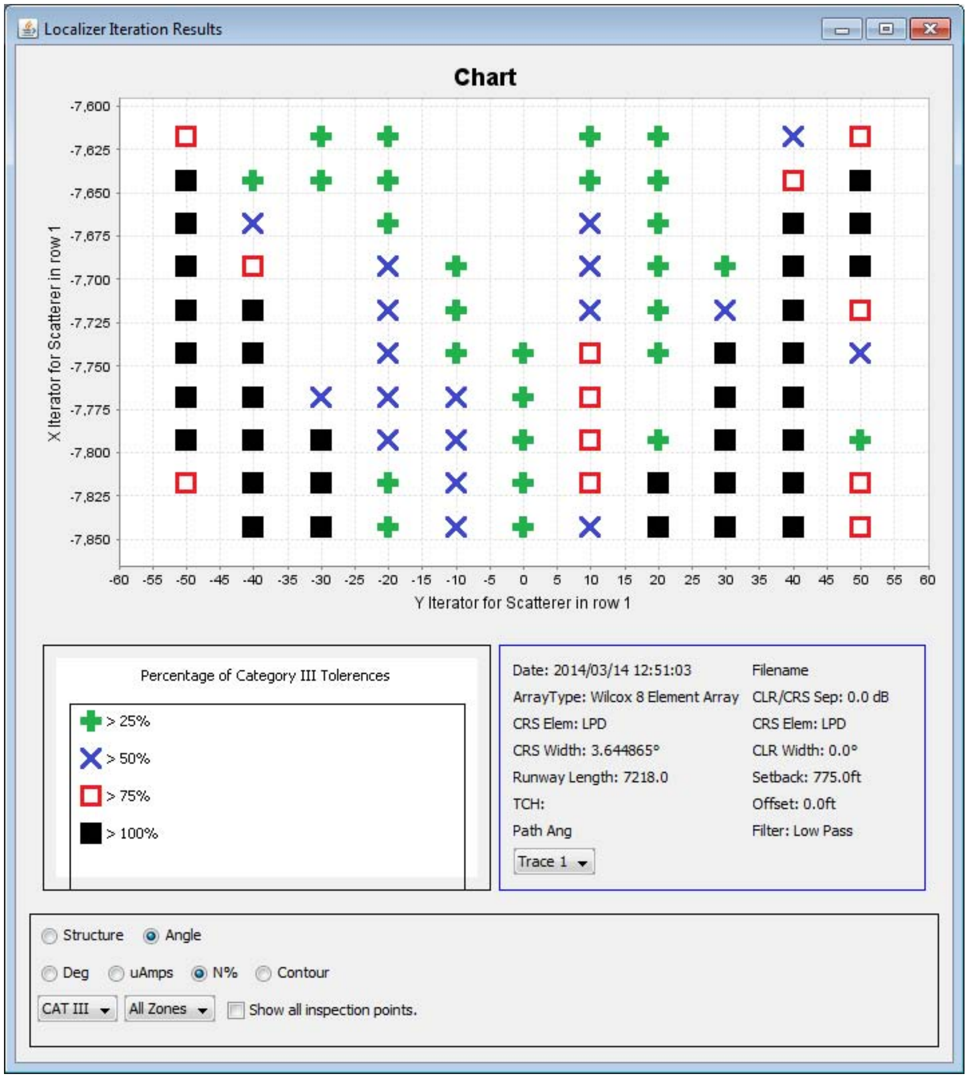


Figure 196: Large Boat: Cat III Angle plot results shown as a percentage of tolerance. Areas shown in black are out of tolerance.

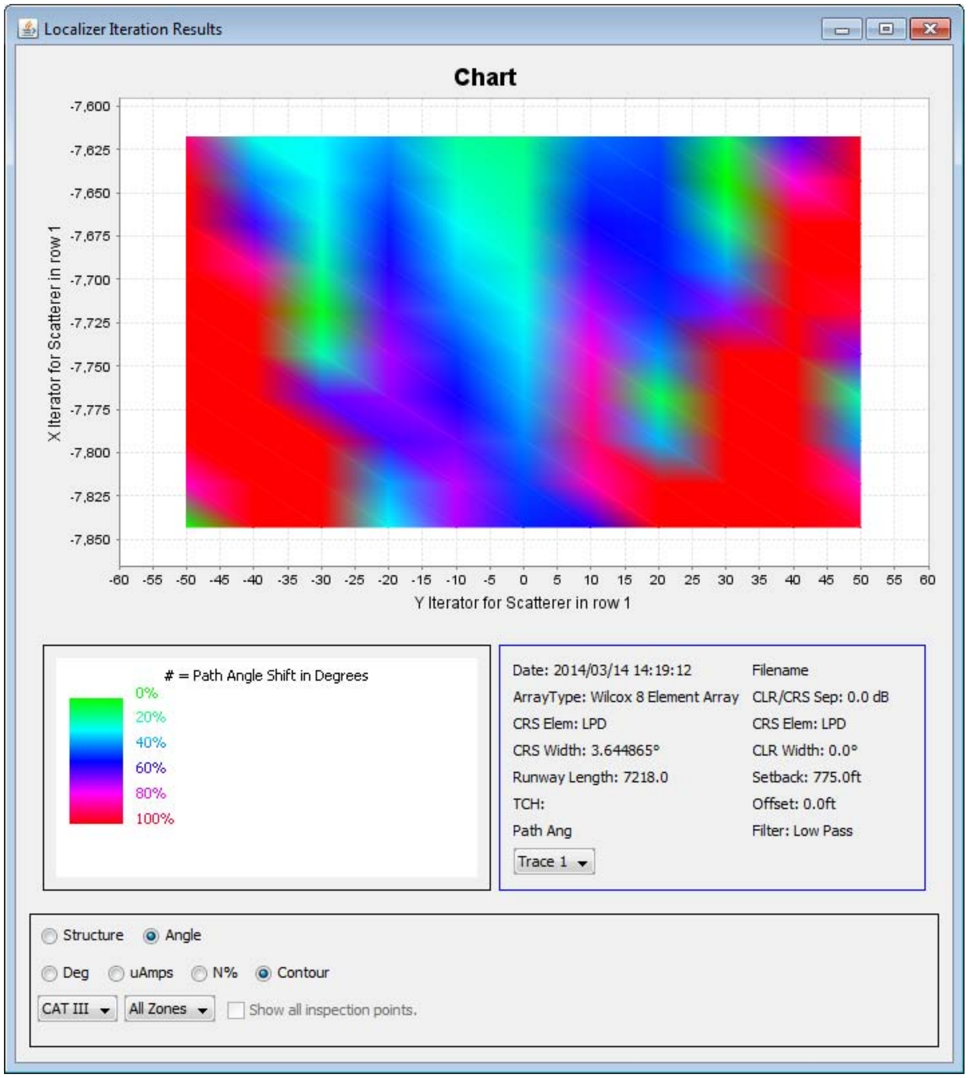


Figure 197: Large Boat: Cat III Angle plot results shown as a contour map of percent of tolerance.. Areas shown in red are out of tolerance.

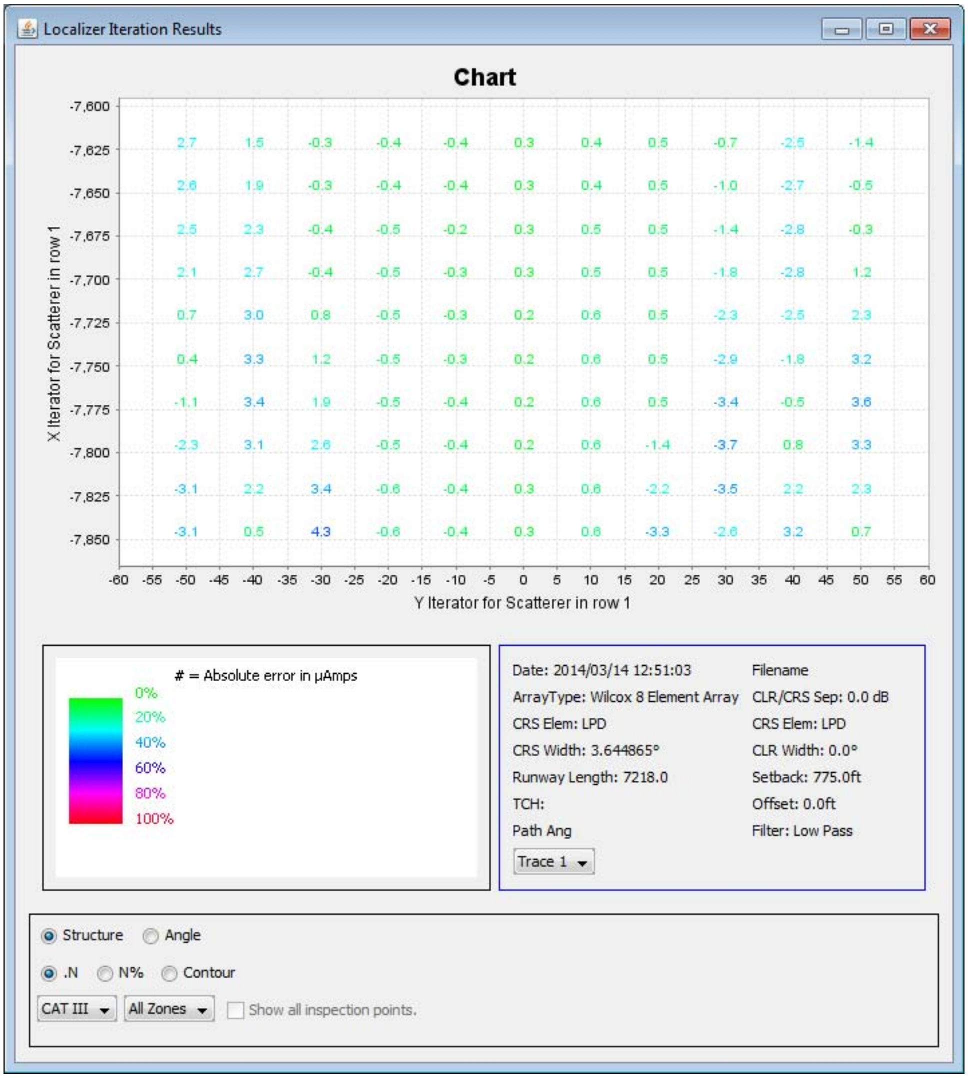


Figure 198: Large Boat: Cat III Structure plot shown in degrees. Notice the structure is well within tolerance whereas the angle is not.

24.5 Exercise 5

This example shows how to use the scatterer editor to model buildings by hand and iterate their locations.

24.5.1 Exercise 5 Setup

When the application beings, you should see something resembling figure 199.

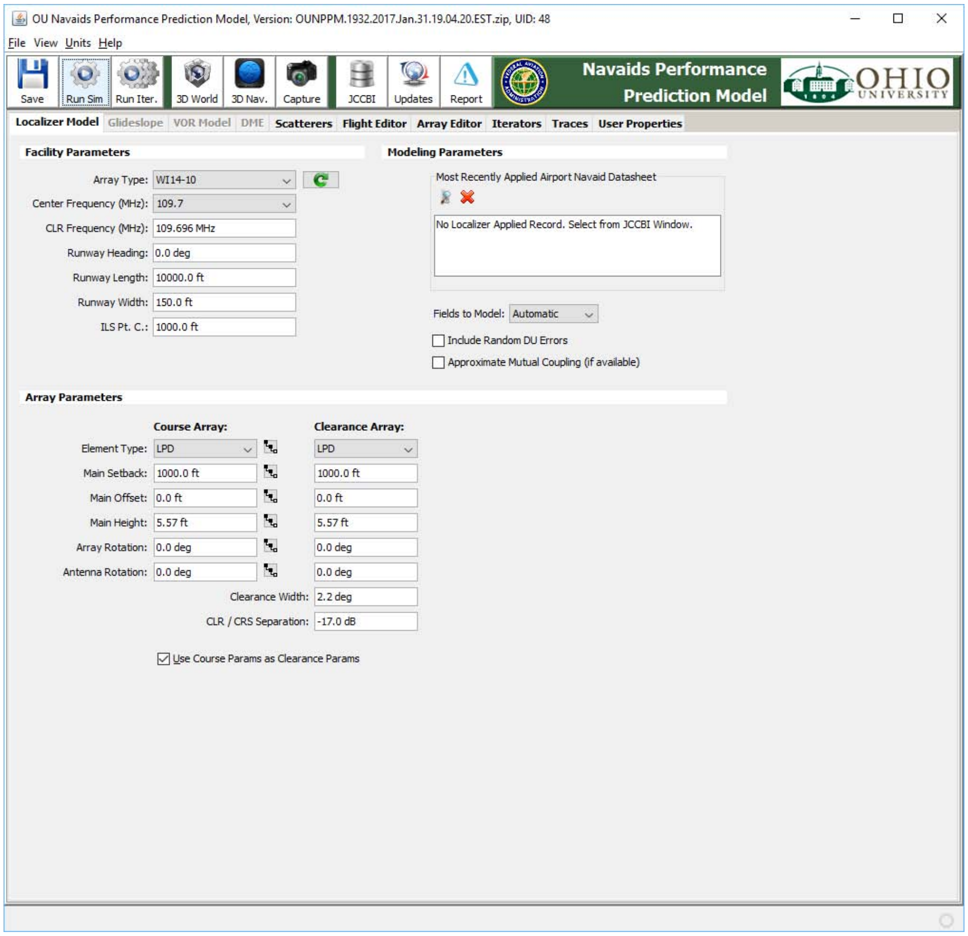


Figure 199: Exercise 5: Startup.

Using the problem description set up the facility information to resemble figure 200.

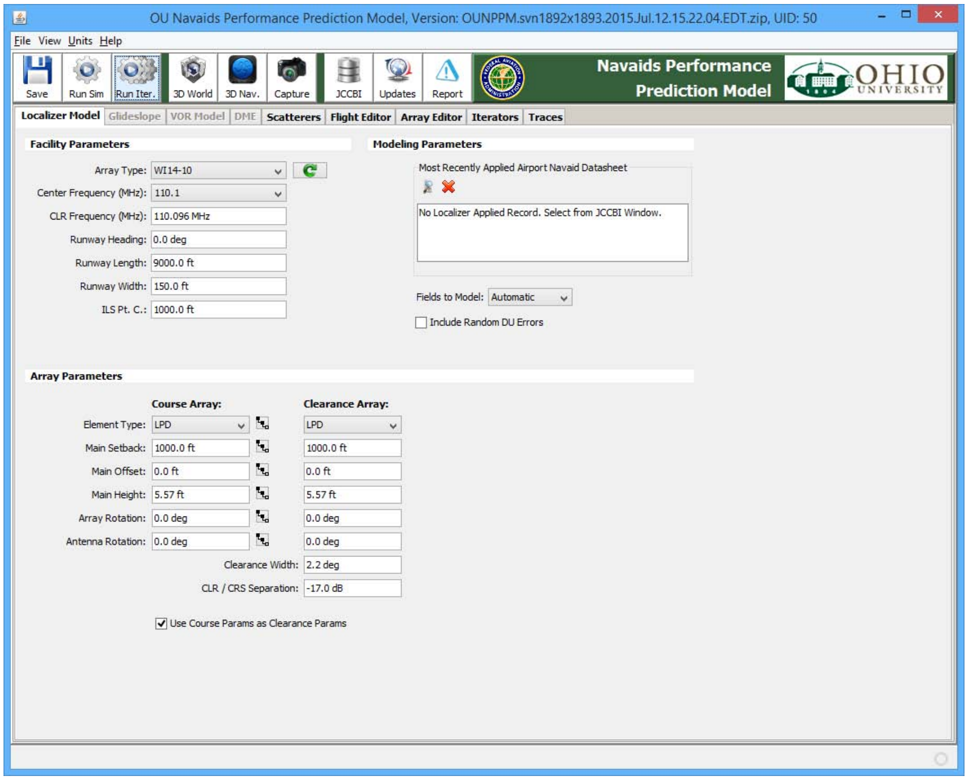


Figure 200: Exercise 5 Facility Info.

On the “Scatterers” tab, use the

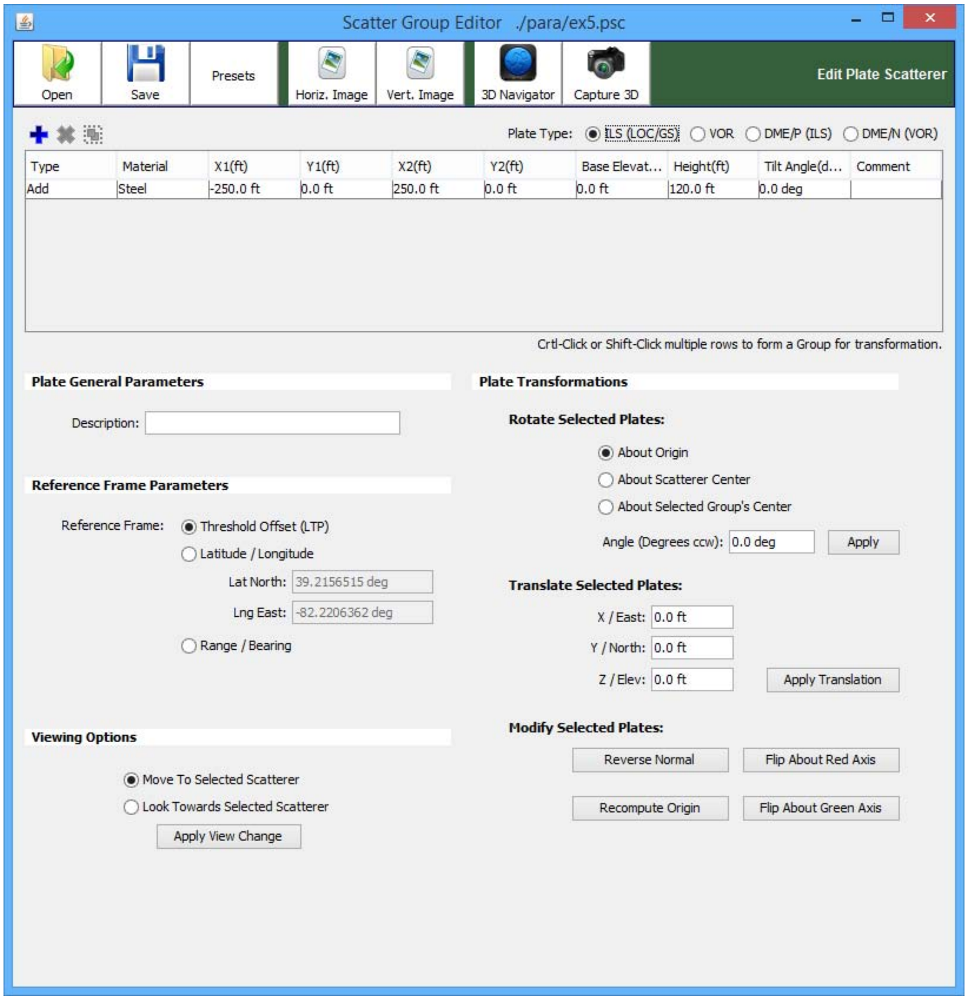


Figure 201: Exercise 5 Scatterer.

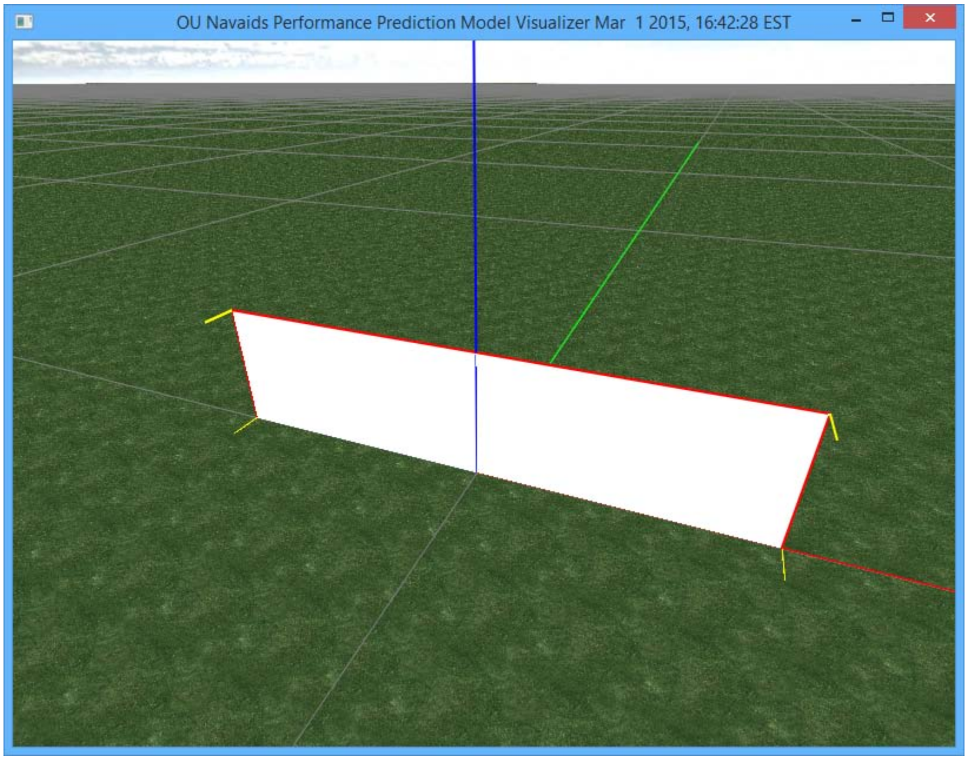


Figure 202: Exercise 5 scatterer in the virtual world.

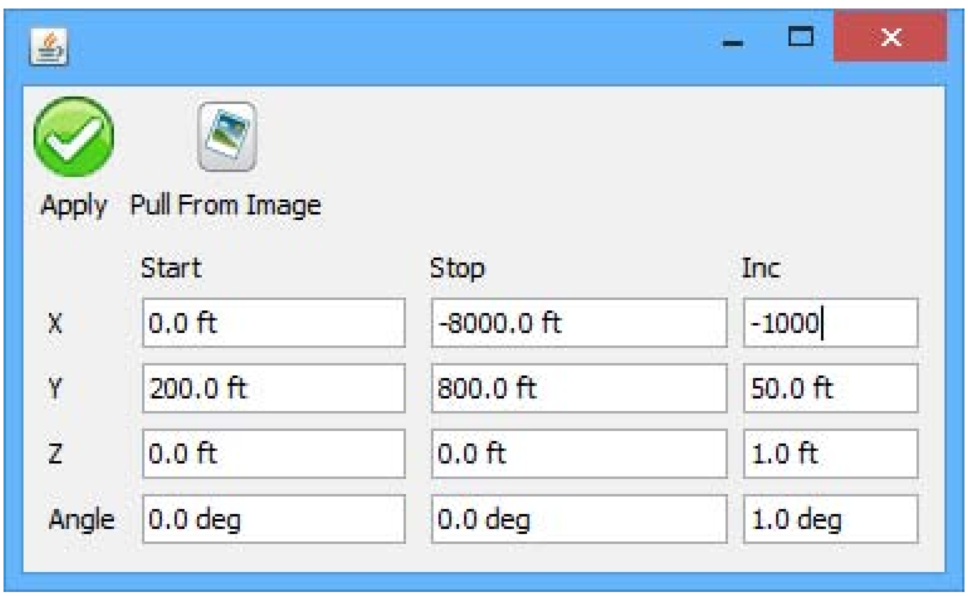


Figure 203: Exercise 5 iteration values.

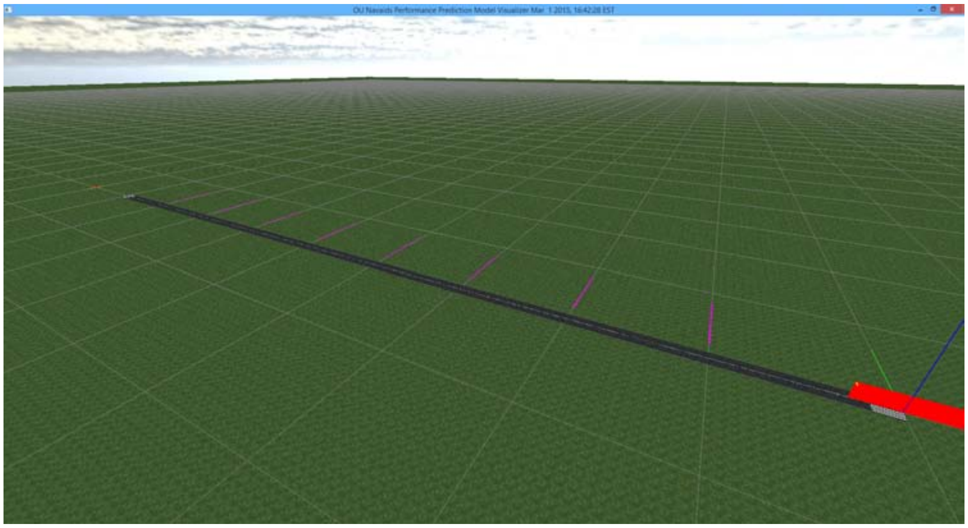


Figure 204: Exercise 5 iteration locations in the virtual world.

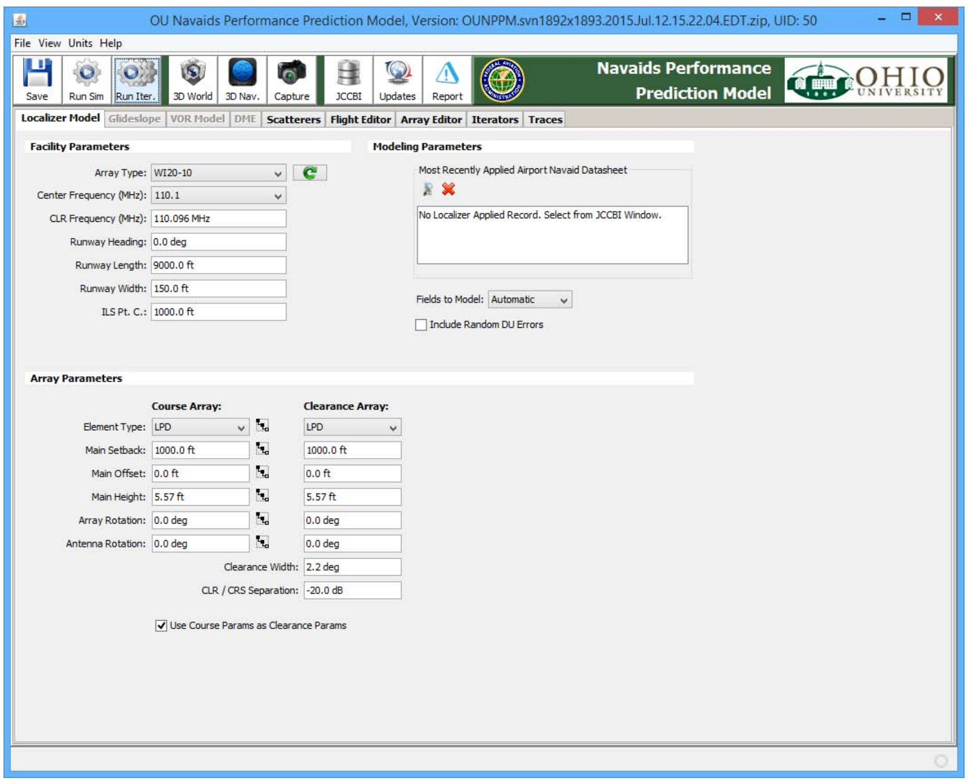


Figure 205: Exercise 5 Facility Info with better array.

24.5.2 Exercise 5 Results

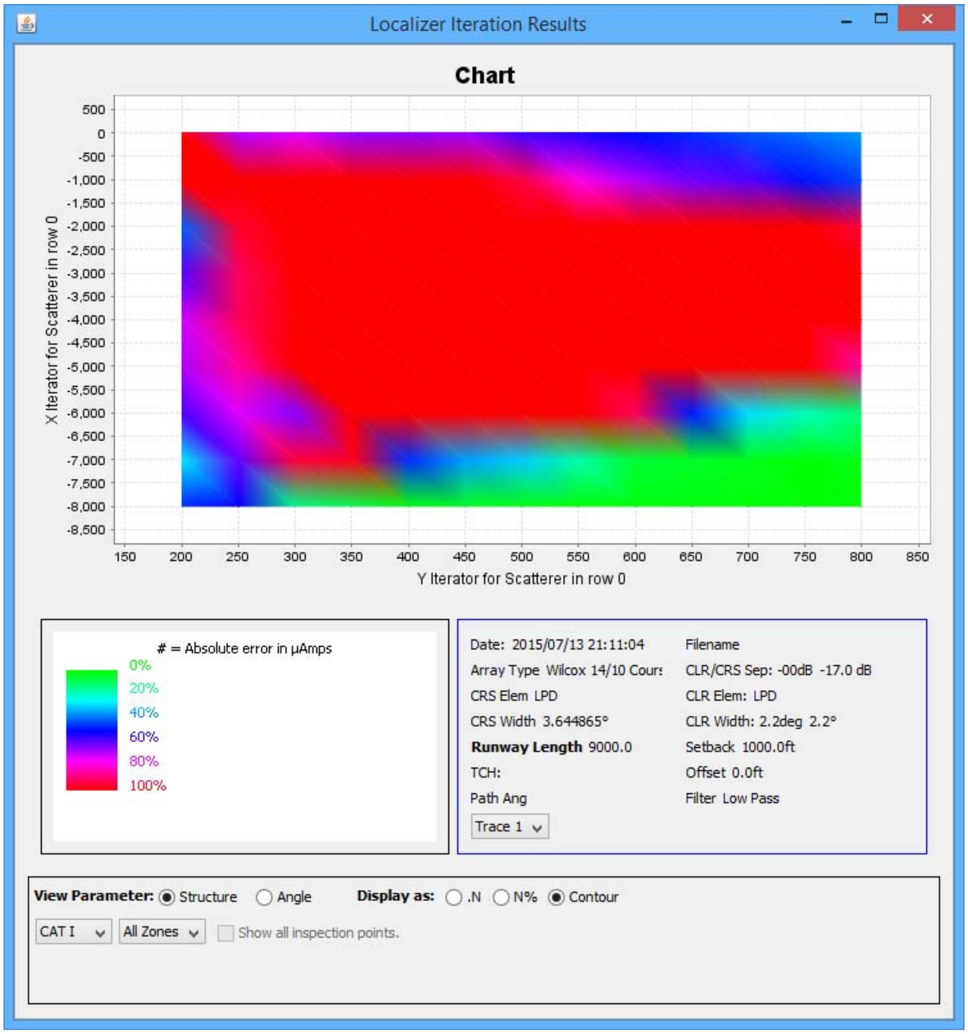


Figure 206: Exercise 5 Solution with WI 14-10.

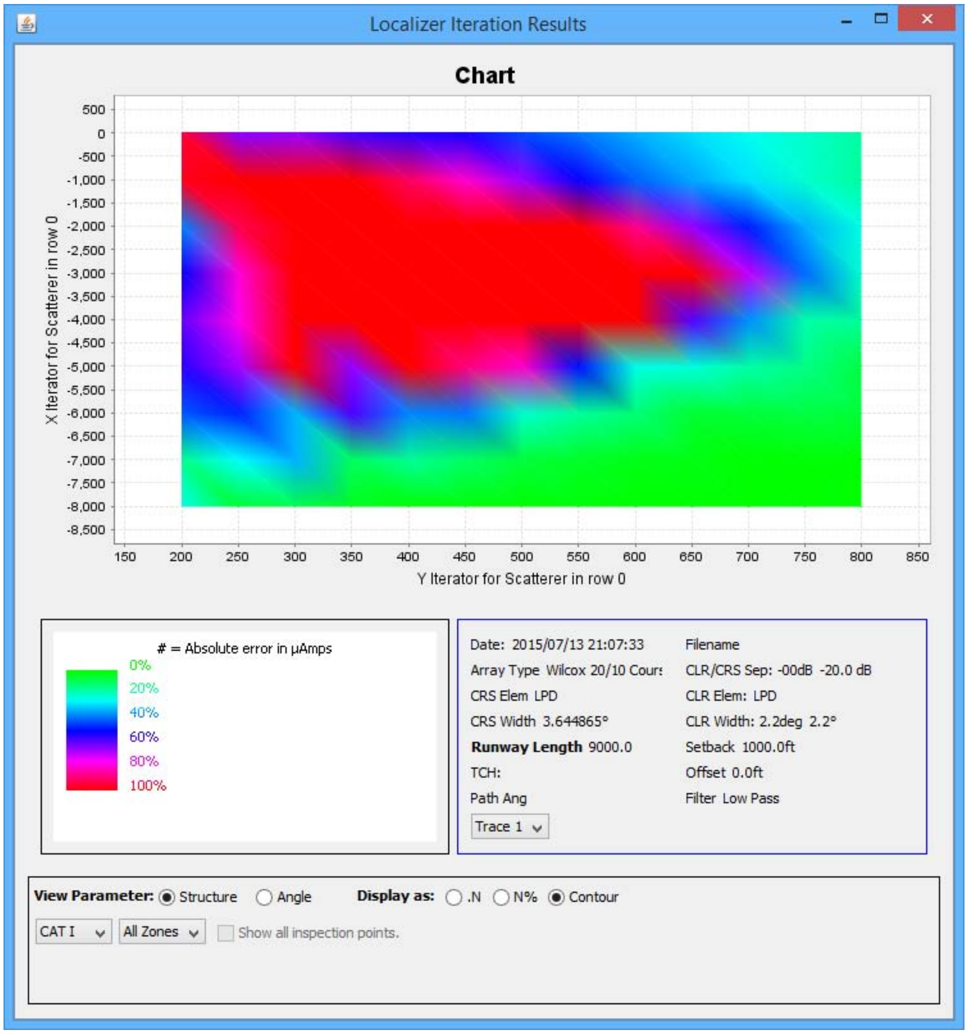


Figure 207: Exercise 5 Solution with WI 20-10.

24.6 Exercise 6

This example uses the scatterer editor in combination with a glideslope.

24.6.1 Exercise 6 Setup

When the application beings, you should see something resembling figure 208.

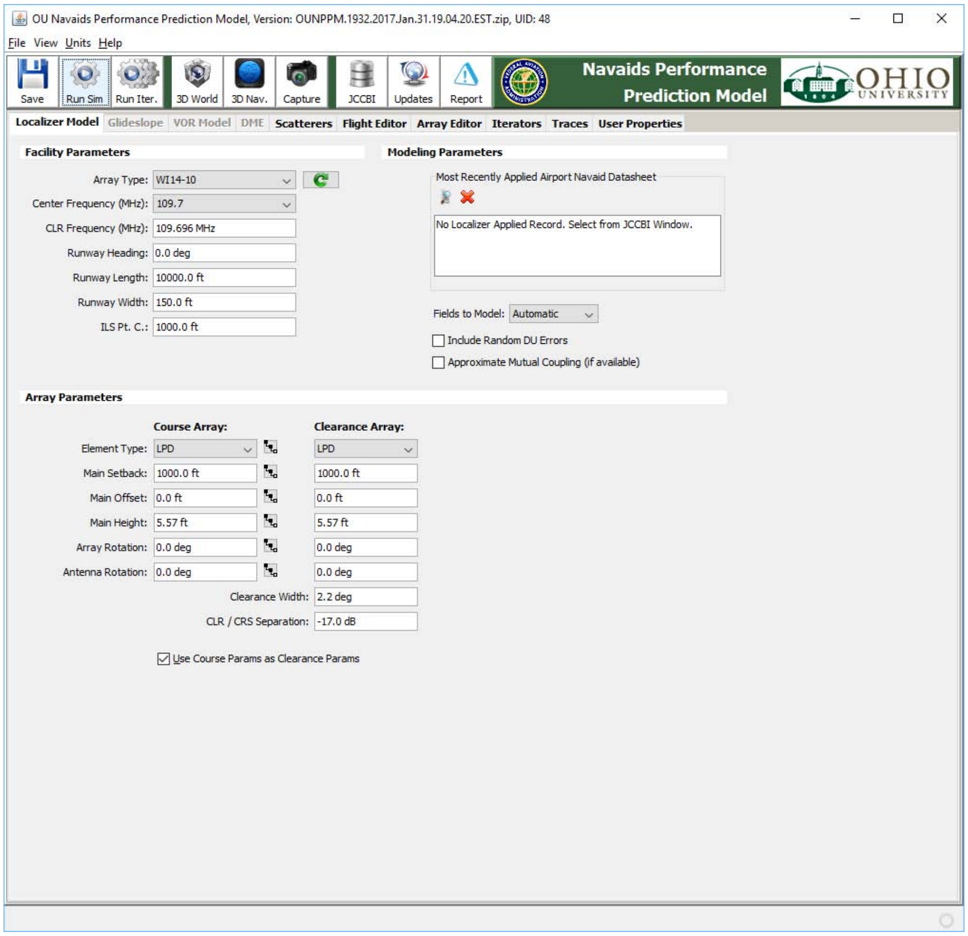


Figure 208: Exercise 6: Startup.

This is a glideslope example, so select File → New Model → Glideslope, as shown in figure 209, to change the model to a glideslope simulation.

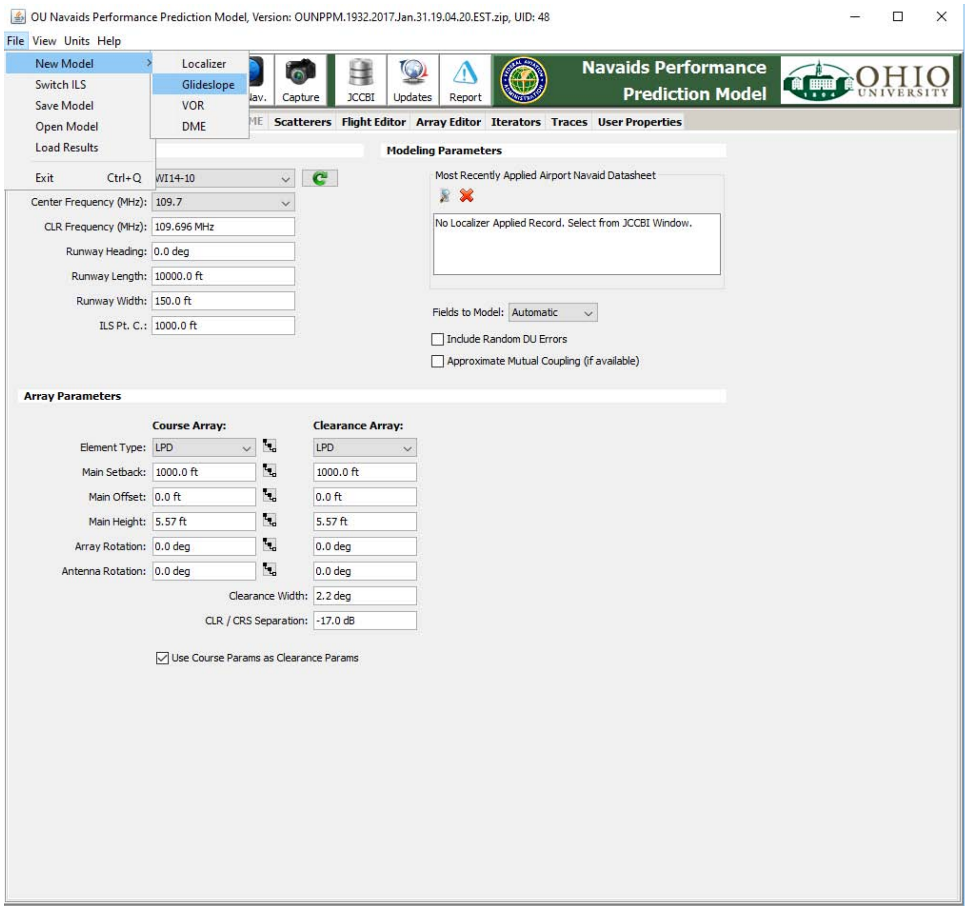


Figure 209: Exercise 6: Switching to Glideslope.

Your interface should now resemble figure 210.

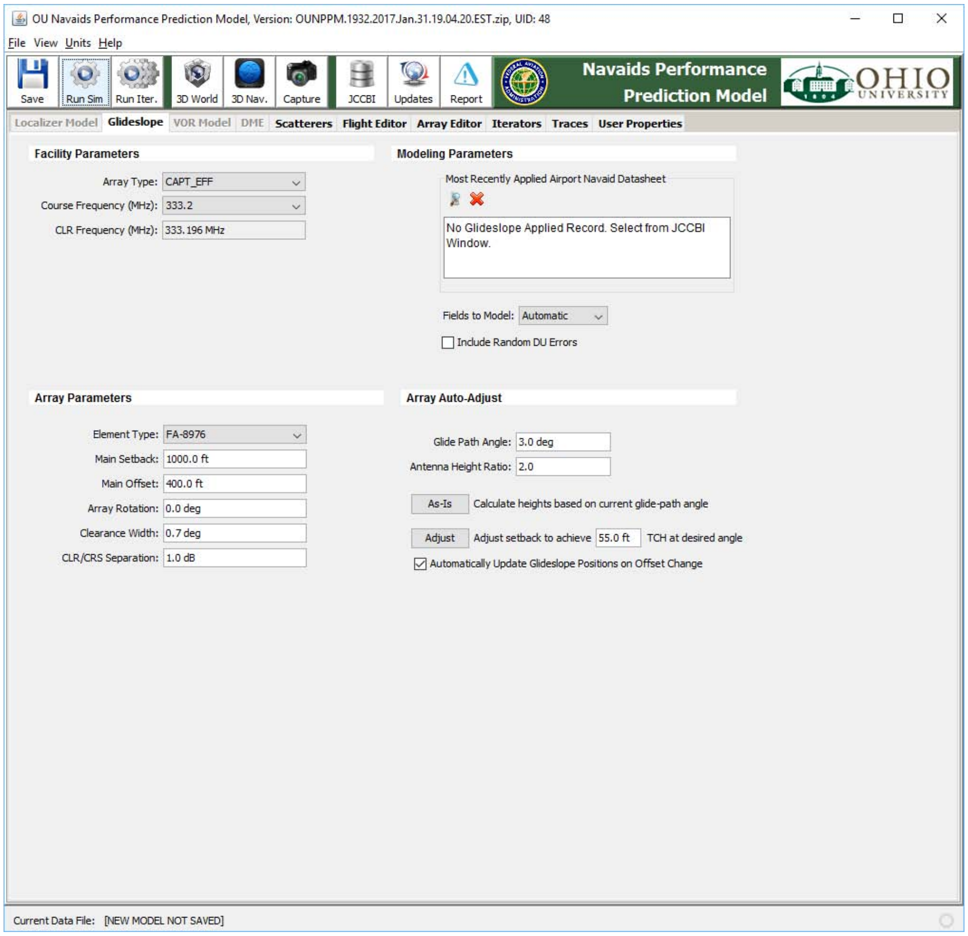


Figure 210: Exercise 6: Default Facility Info.

Using the problem description offset and setback.

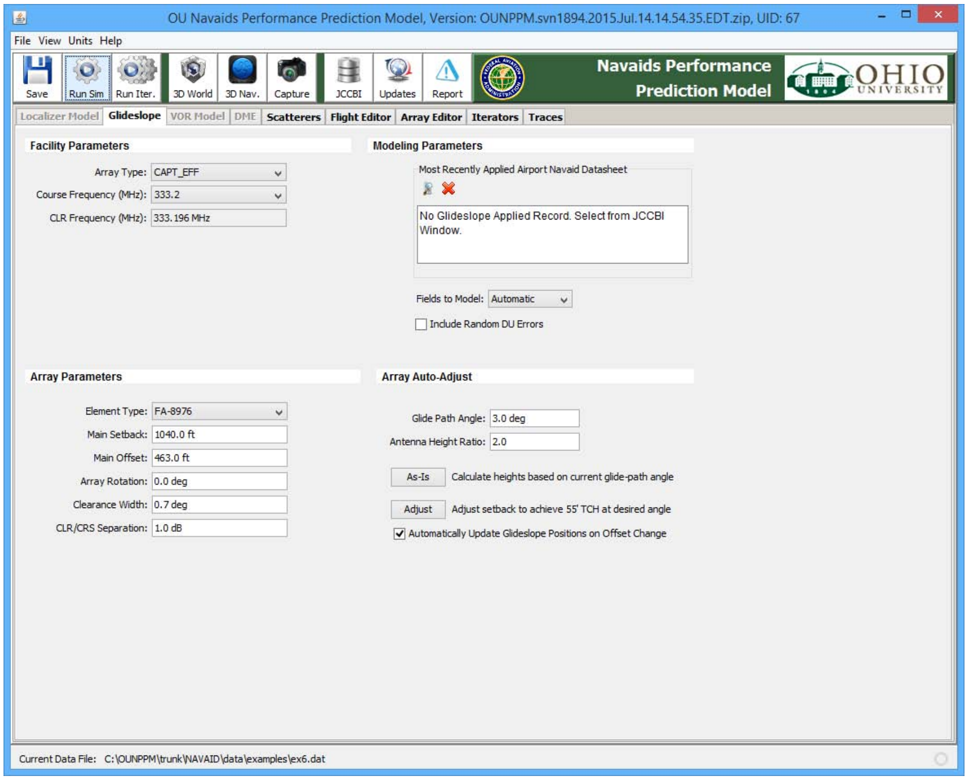
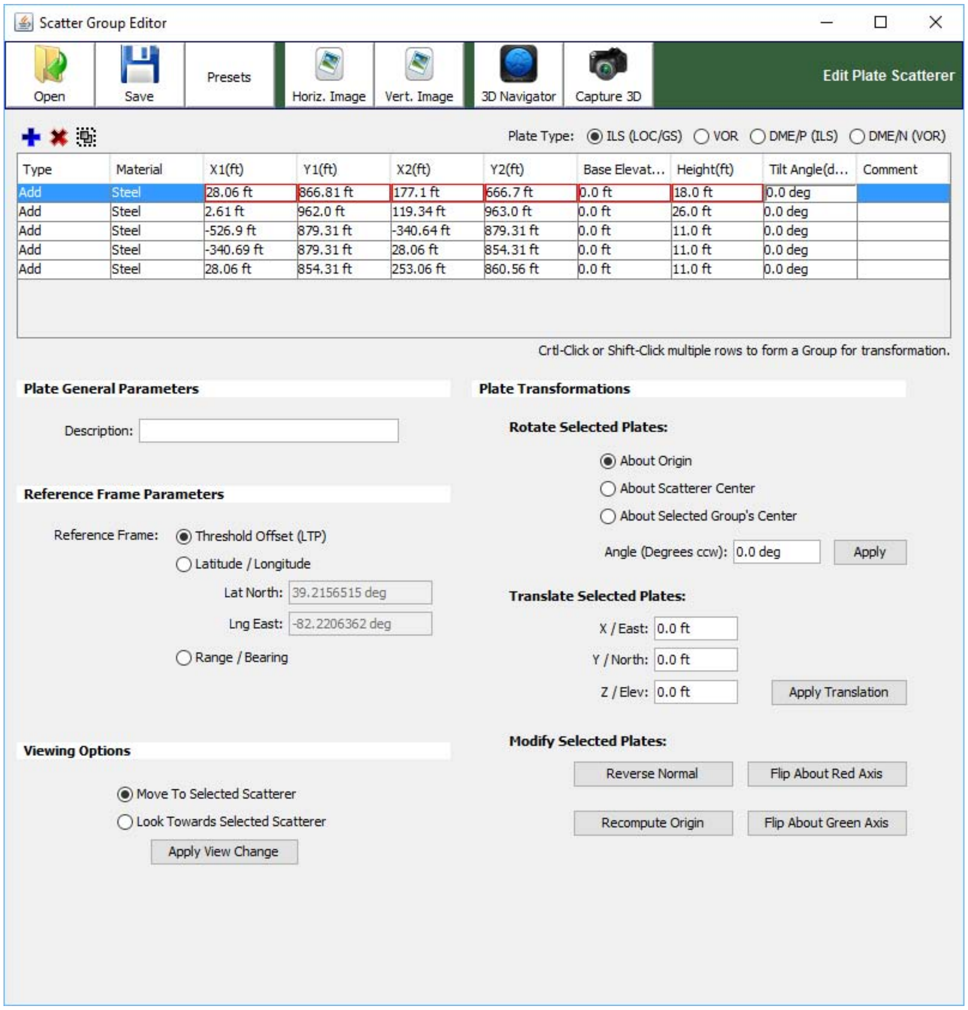


Figure 211: Exercise 6: Facility Info.

Using the table in the problem description, create the 5 scatterer plates using the scatterer editor. First go the “Scatterers” tab, and click the “Plate Group Editor” button to open the Scatterer Group Editor. Use the Add Plate Button to add 5 plates and enter the values from the table in the problem description to that it resembles figure 214, then save your scatterer.



Type	Material	X1(ft)	Y1(ft)	X2(ft)	Y2(ft)	Base Elevat...	Height(ft)	Tilt Angle(d...	Comment
Add	Steel	28.06 ft	866.81 ft	177.1 ft	666.7 ft	0.0 ft	18.0 ft	0.0 deg	
Add	Steel	2.61 ft	962.0 ft	119.34 ft	963.0 ft	0.0 ft	26.0 ft	0.0 deg	
Add	Steel	-526.9 ft	879.31 ft	-340.64 ft	879.31 ft	0.0 ft	11.0 ft	0.0 deg	
Add	Steel	-340.69 ft	879.31 ft	28.06 ft	854.31 ft	0.0 ft	11.0 ft	0.0 deg	
Add	Steel	28.06 ft	854.31 ft	253.06 ft	860.56 ft	0.0 ft	11.0 ft	0.0 deg	

Figure 212: Exercise 6: Scatterers.

Add your new scatterer group to the world using the table on the “Scatterers” tab, and your virtual world should resemble figure **??**.

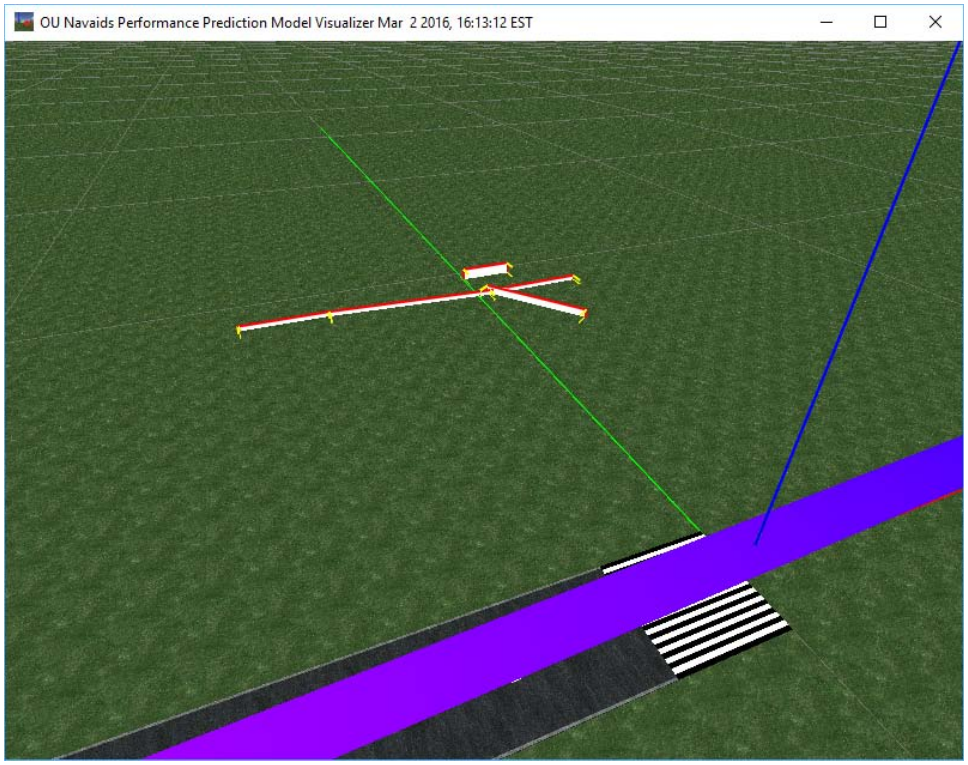


Figure 213: Exercise 6: Virtual World.

24.6.2 Exercise 6 Results

When you run your simulation, the results should resemble figure **??**.

Figure 214: Exercise 6: Virtual World.

24.7 Exercise 7

This example demonstrates how to use the horizontal pull from image scatterer creation tool in a real scenario.

24.7.1 Exercise 7 Setup

When the application beings, you should see something resembling figure 215.

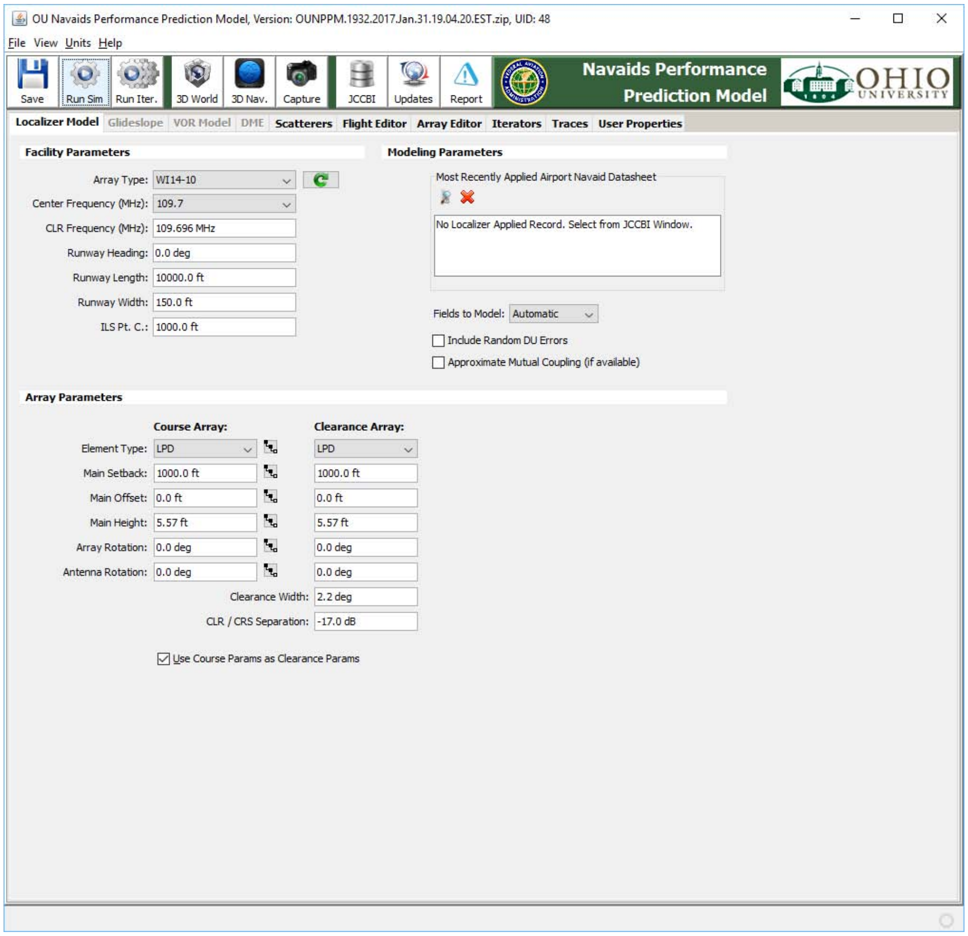


Figure 215: Exercise 7: Startup.

Using the problem description adjust the facility info to resemble figure 216.

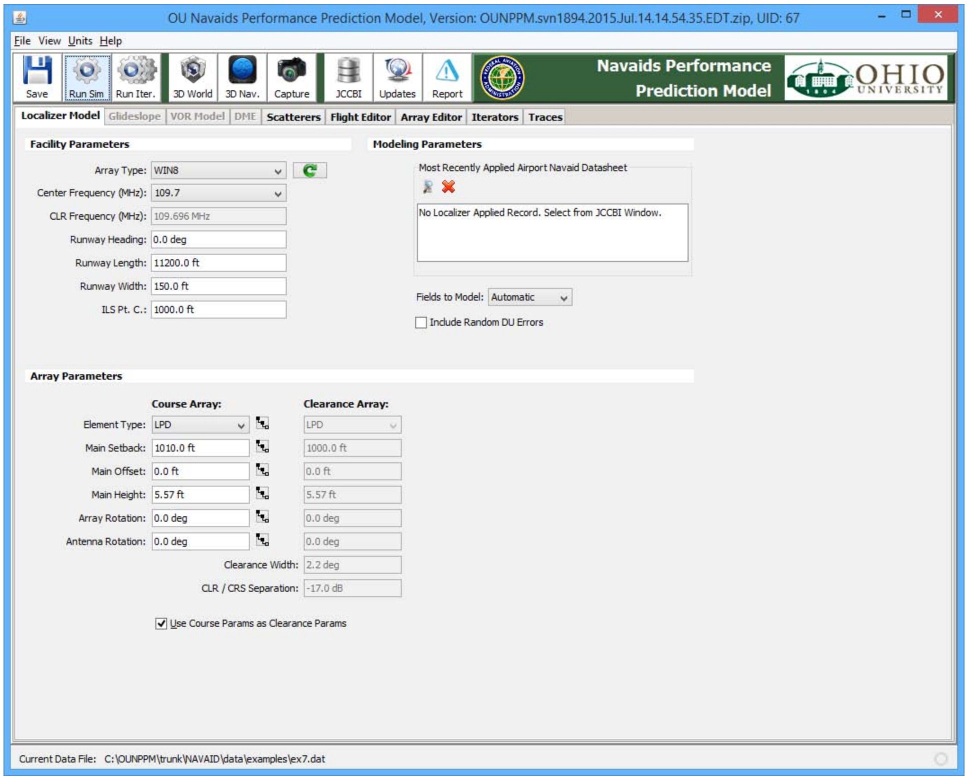


Figure 216: Exercise 7: Facility Info.

Under the “Scatterers” tab load the “Plate Group Editor” and select the “Horiz. Image”, and you should see an interface resembling figure 217.

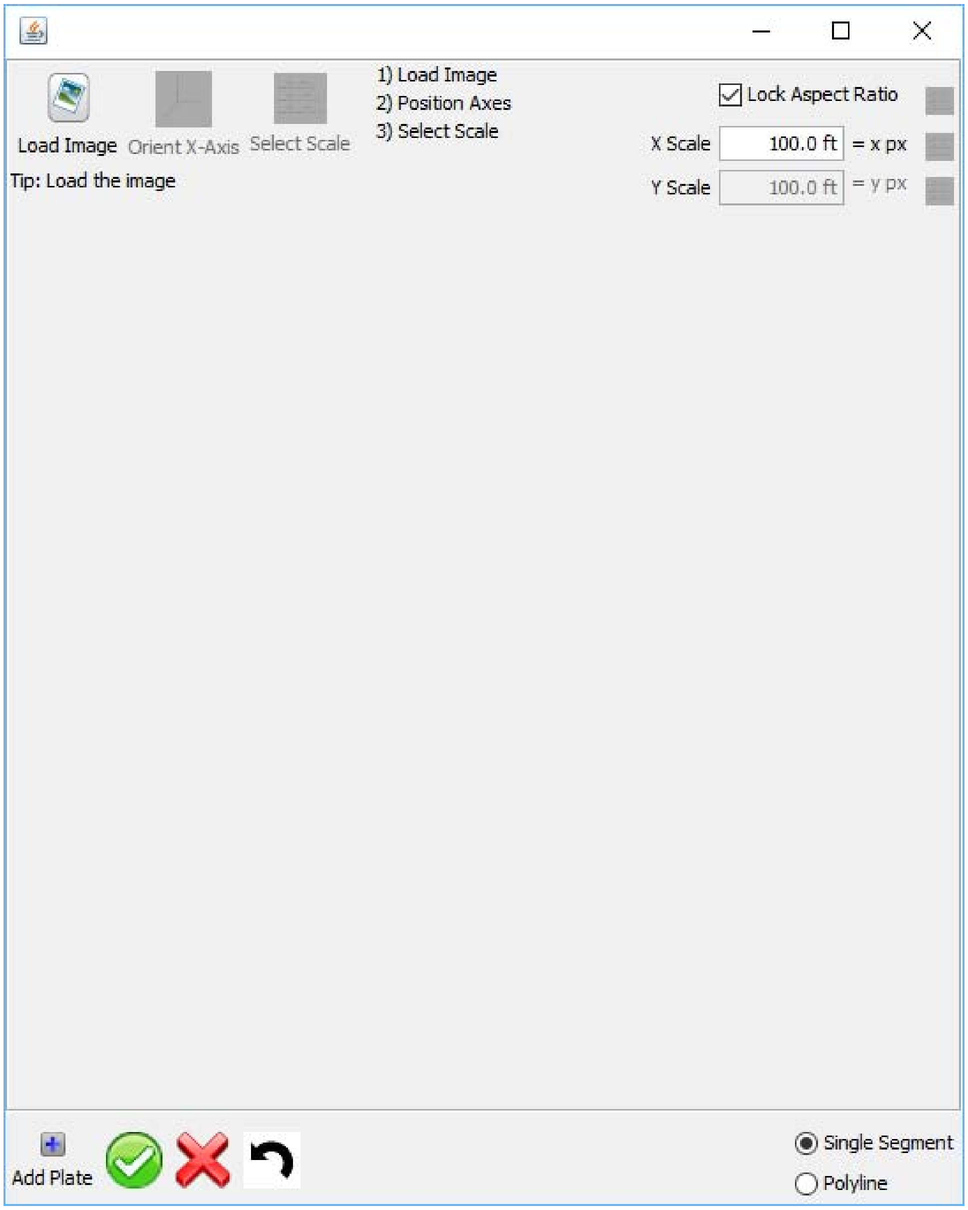


Figure 217: Exercise 7: Pull from Image Interface.

Load the “EX_7.jpg” file directly from your presentation materials, and your interface should resemble figure 218.

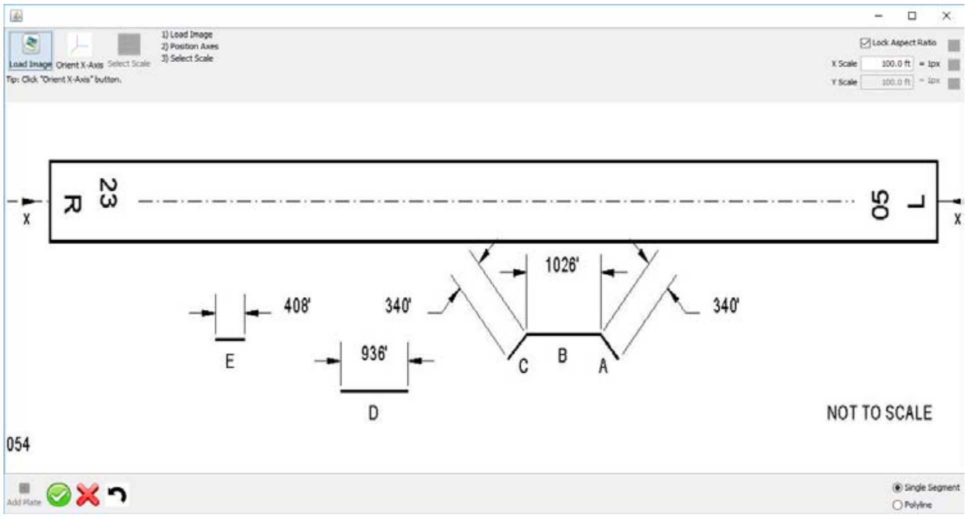


Figure 218: Exercise 7: Image Loaded.

If you no longer have access to your original file, you can get the image by re-saving figure 219.

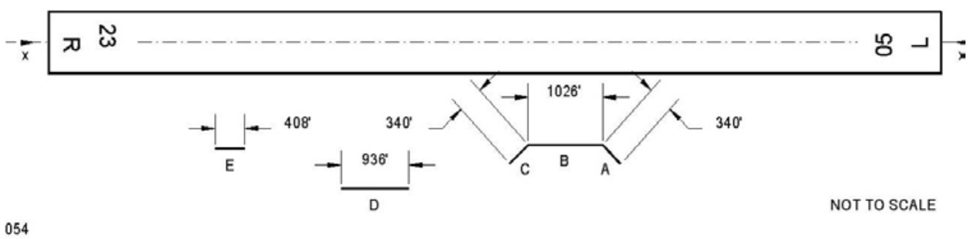


Figure 219: Exercise 7: Image to Use.

Next we need to orient our axes. Since the problem description this is an approach on 23R, the positive x-axis (red) should extent to the right from right end of the runway. Once positioned your interface should resemble figure 220.

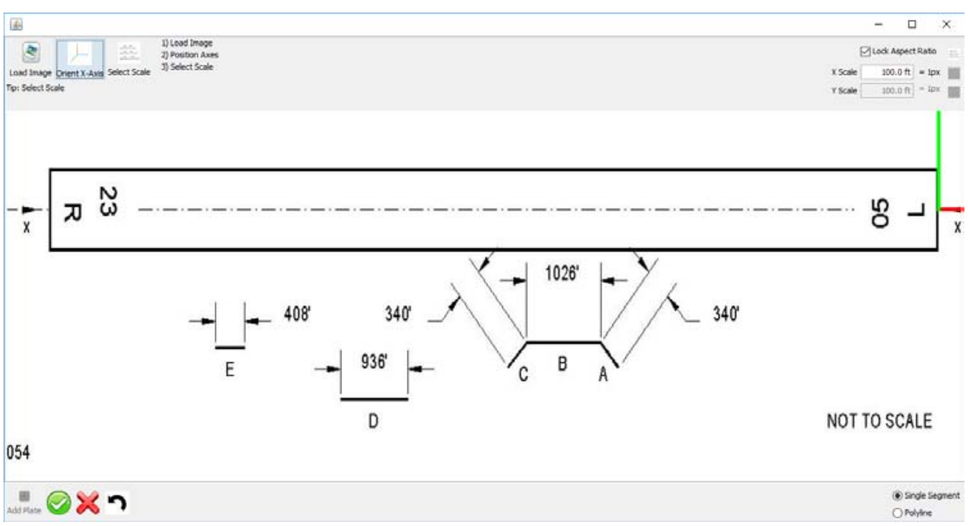


Figure 220: Exercise 7: Orient Axes.

Next we need to set our scale. We need to pick a reference object we know the length of, I chose building B, but you could just as easily have chosen the runway whose length is given in the problem description. You will see in the upper right corner that this is 98 pixels long which will represent 1026 feet. This is demonstrated in figure 221.

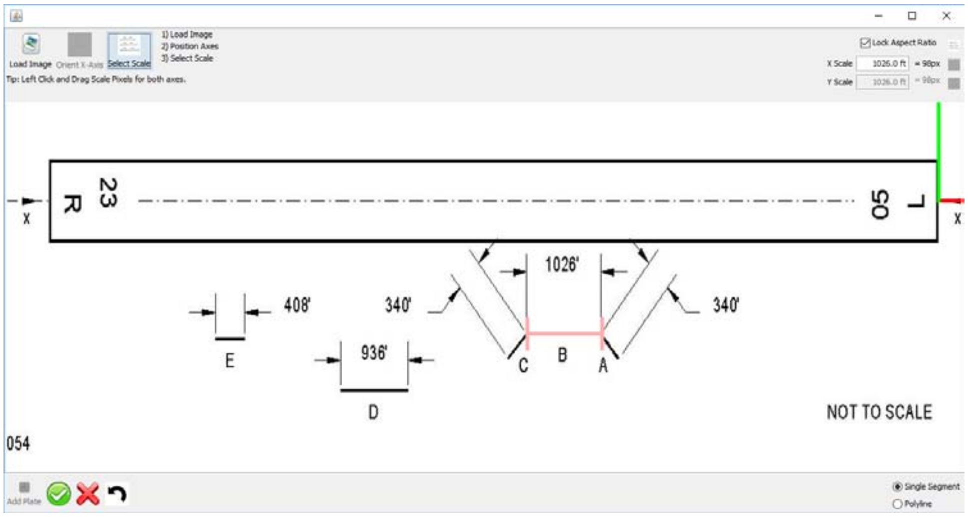


Figure 221: Exercise 7: Set Scale.

Now we need to add each of our plates, click the "Add Plate" button and drag from right to left on each plate. Optionally, try the polyline option so that the last 3 plates are meet coincidentally. Your result should look something like figure 222.

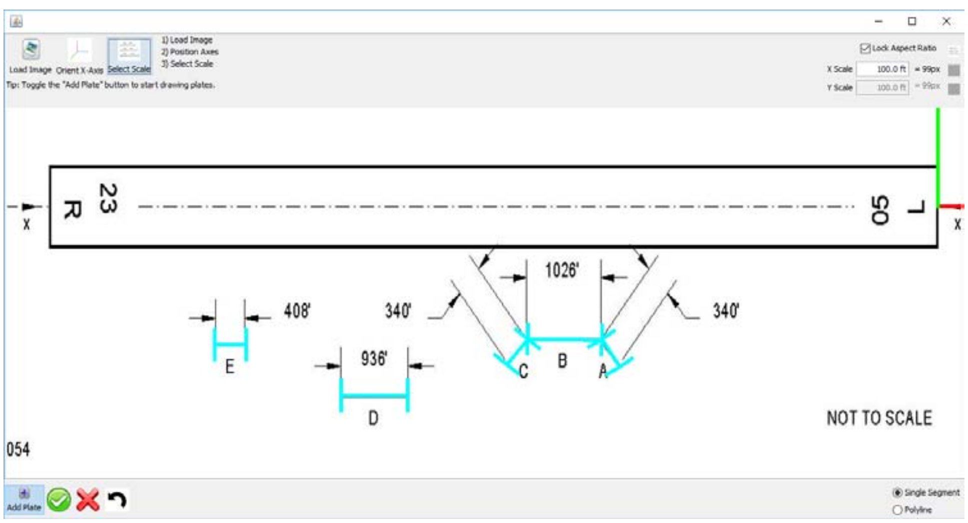
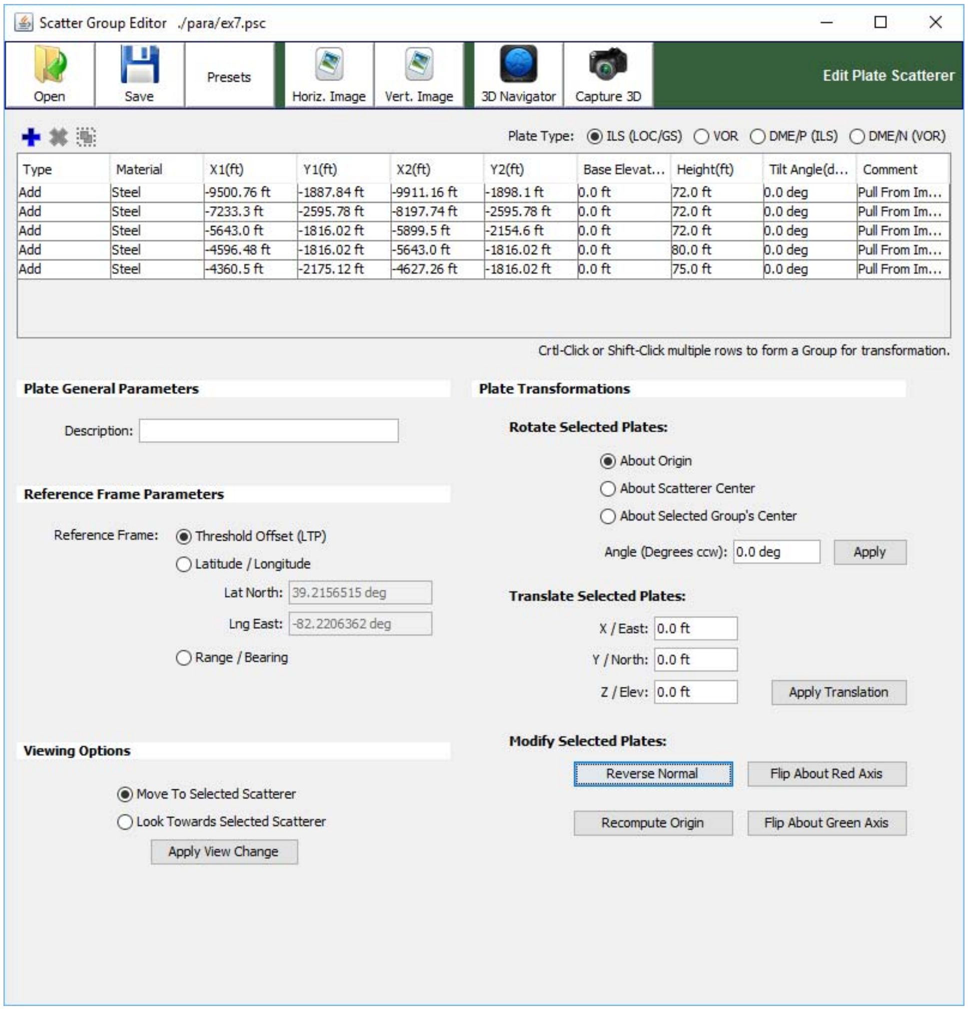


Figure 222: Exercise 7: Plates.

Once you manipulate the heights of the plates to match those in the problem description, you can safely exit the pull from image interface and should see 5 scatterers in your scatterer table, similar to those in figure 223. Save this scatterer group and add it to your scatterer group table on the scatterer tab of the main window.



Type	Material	X1(ft)	Y1(ft)	X2(ft)	Y2(ft)	Base Elevat...	Height(ft)	Tilt Angle(d...	Comment
Add	Steel	-9500.76 ft	-1887.84 ft	-9911.16 ft	-1898.1 ft	0.0 ft	72.0 ft	0.0 deg	Pull From Im...
Add	Steel	-7233.3 ft	-2595.78 ft	-8197.74 ft	-2595.78 ft	0.0 ft	72.0 ft	0.0 deg	Pull From Im...
Add	Steel	-5643.0 ft	-1816.02 ft	-5899.5 ft	-2154.6 ft	0.0 ft	72.0 ft	0.0 deg	Pull From Im...
Add	Steel	-4596.48 ft	-1816.02 ft	-5643.0 ft	-1816.02 ft	0.0 ft	80.0 ft	0.0 deg	Pull From Im...
Add	Steel	-4360.5 ft	-2175.12 ft	-4627.26 ft	-1816.02 ft	0.0 ft	75.0 ft	0.0 deg	Pull From Im...

Figure 223: Exercise 7: Final Scatterers.

When the scatter group has been added to the main table, your virtual world should look like figure 224, and it is safe to run your simulation.

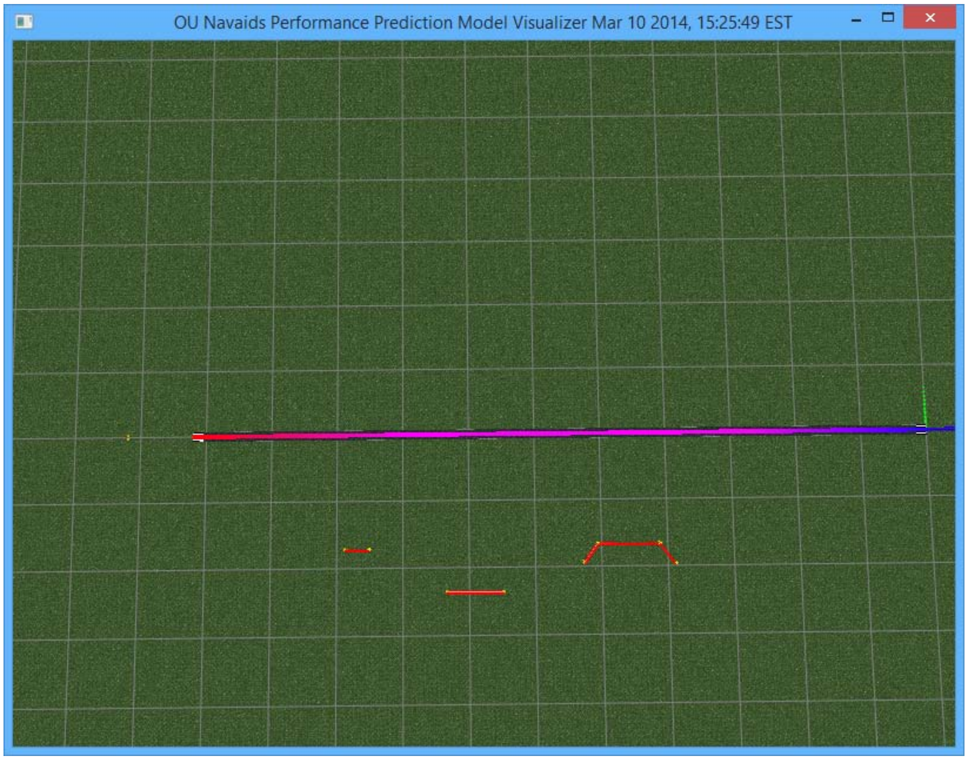


Figure 224: Exercise 7: Virtual World.

24.7.2 Exercise 7 Results

Figure 225 shows the results for this simulation. As you can see it would not pass inspection.

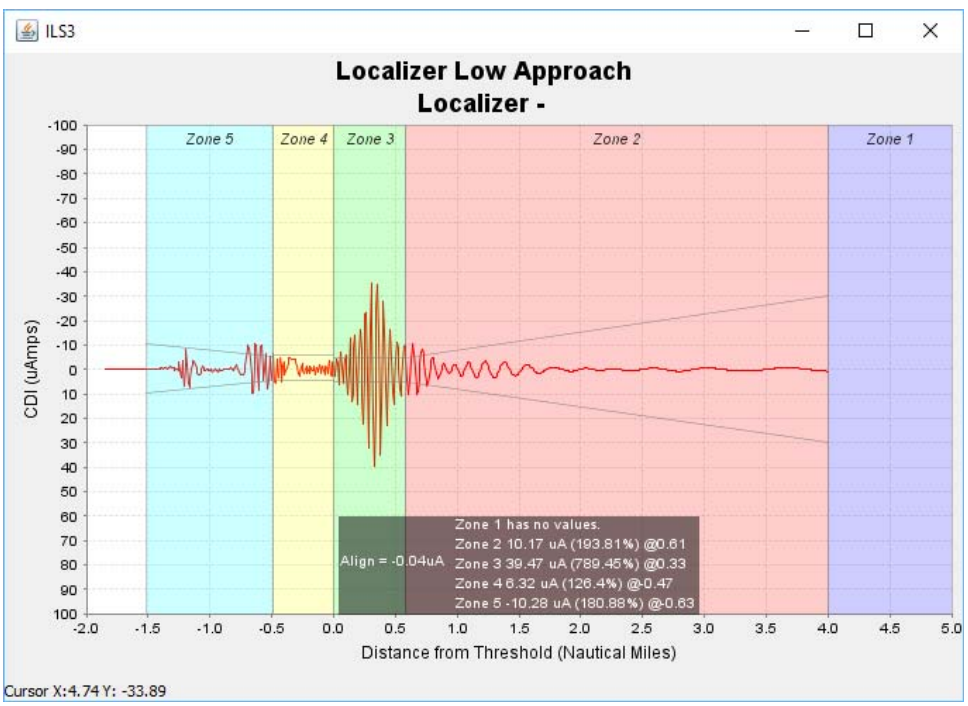


Figure 225: Exercise 7: Results.

24.8 Exercise 8

24.8.1 Exercise 8 Setup

24.8.2 Exercise 8 Results

24.9 Exercise 9

24.9.1 Setup Exercise 9

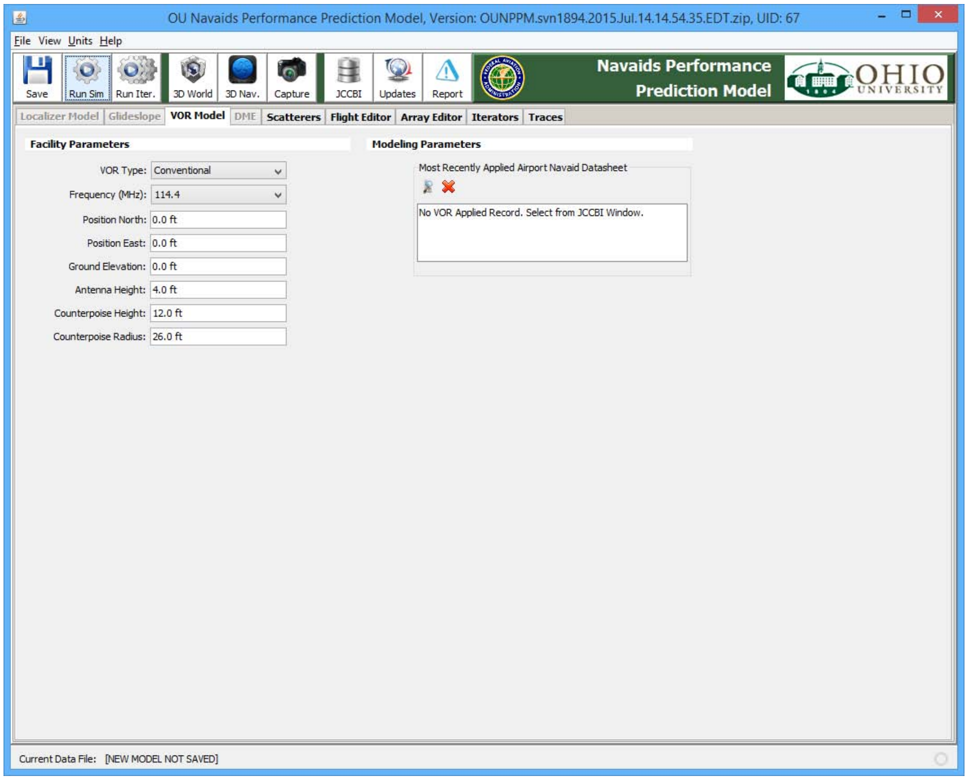


Figure 226: Facility Info for Exercise 9.

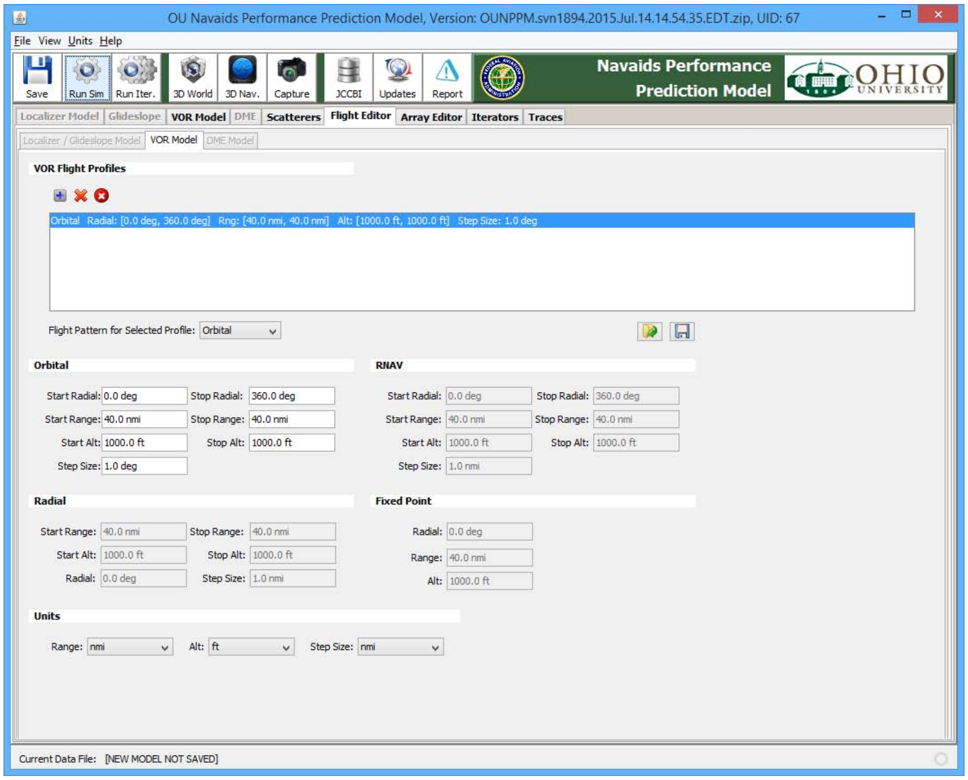


Figure 227: The flight for Exercise 9.

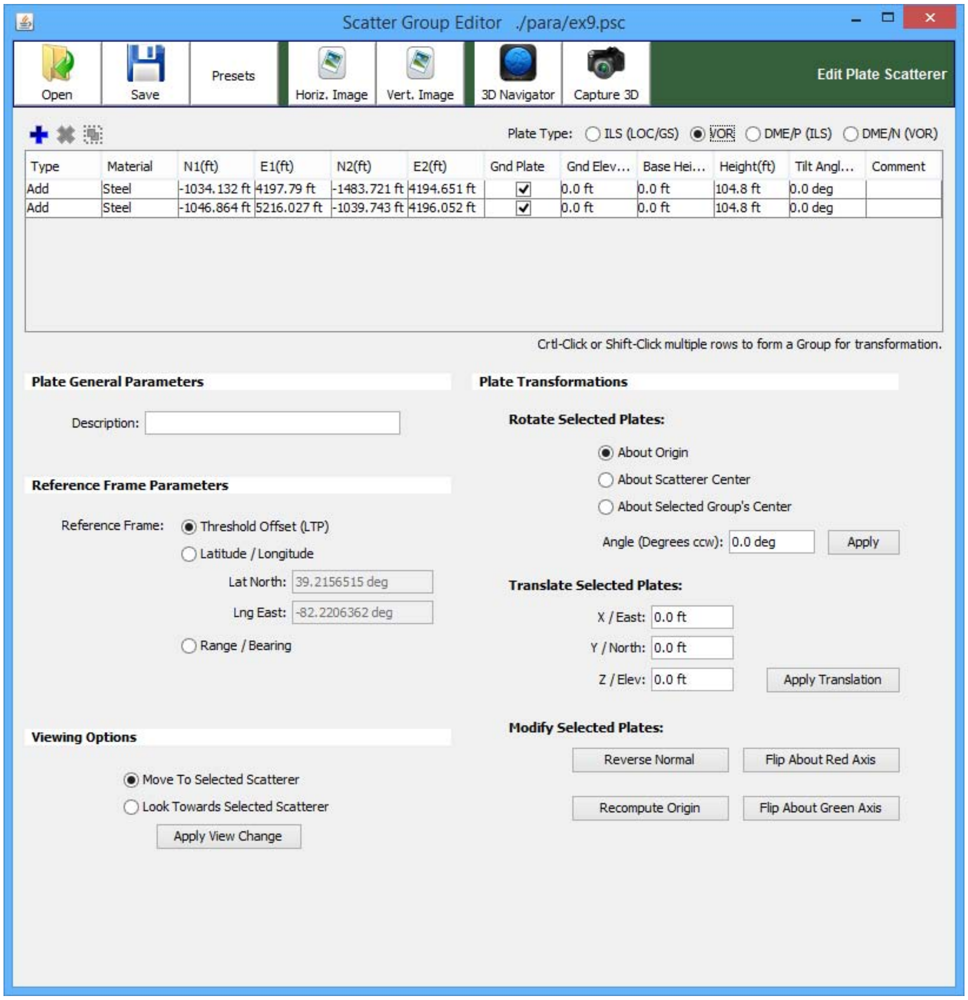


Figure 228: The scatterer (2 plates), for Exercise 9.

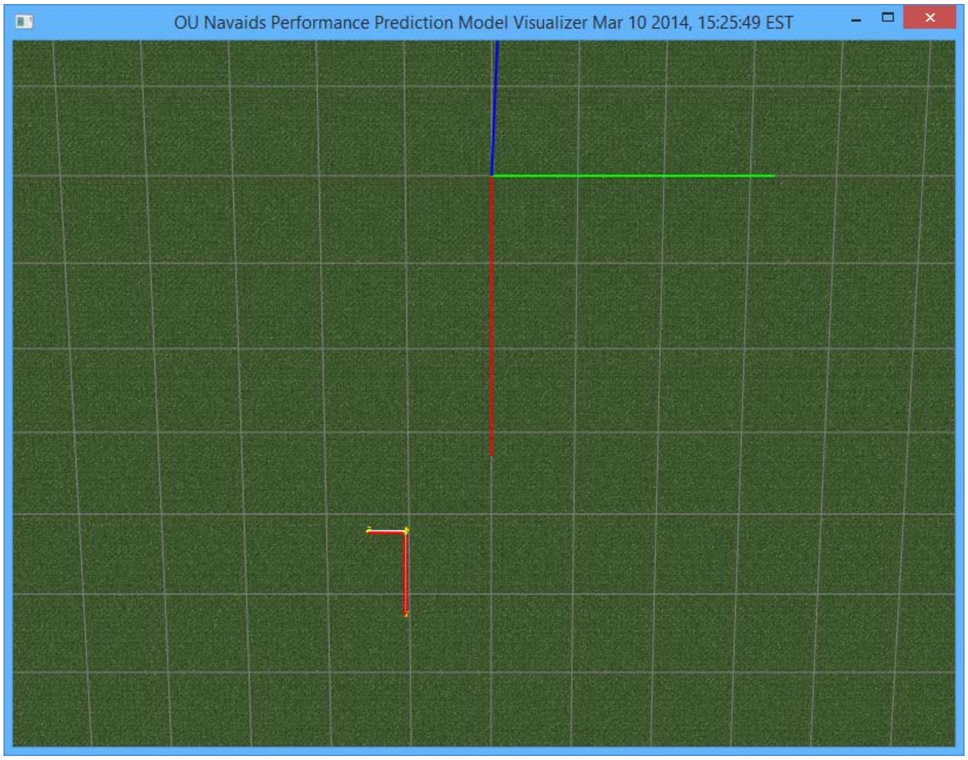


Figure 229: The scatterer (2 plates), for Exercise 9 in the virtual world.

24.9.2 Results Exercise 9

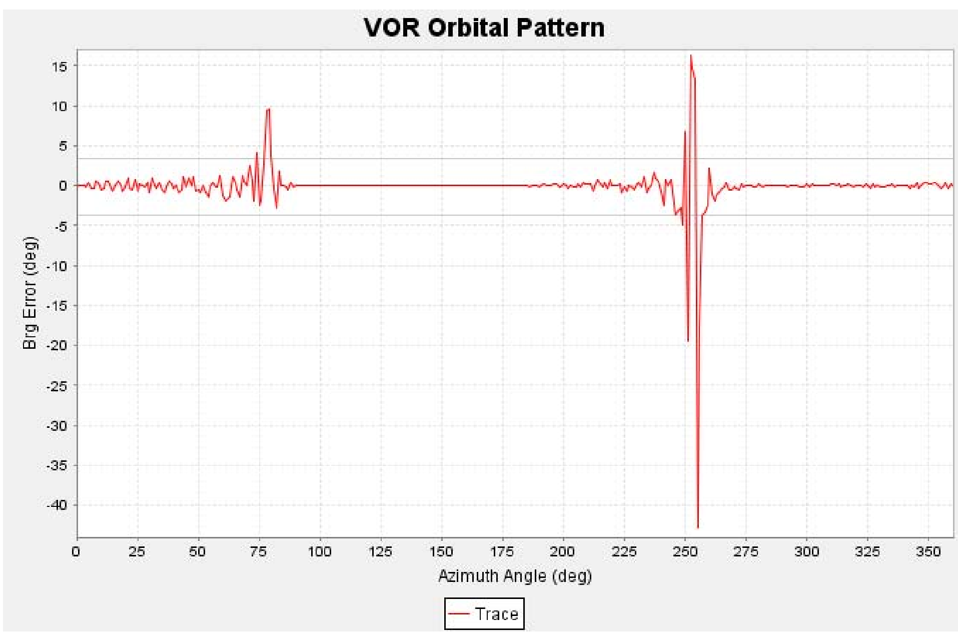


Figure 230: Results for Exercise 9 with both scatterer plates in place.

Extents of X-Axis, min: $-44°$, max: $17°$

24.10 Exercise 10

24.10.1 Setup Exercise 10

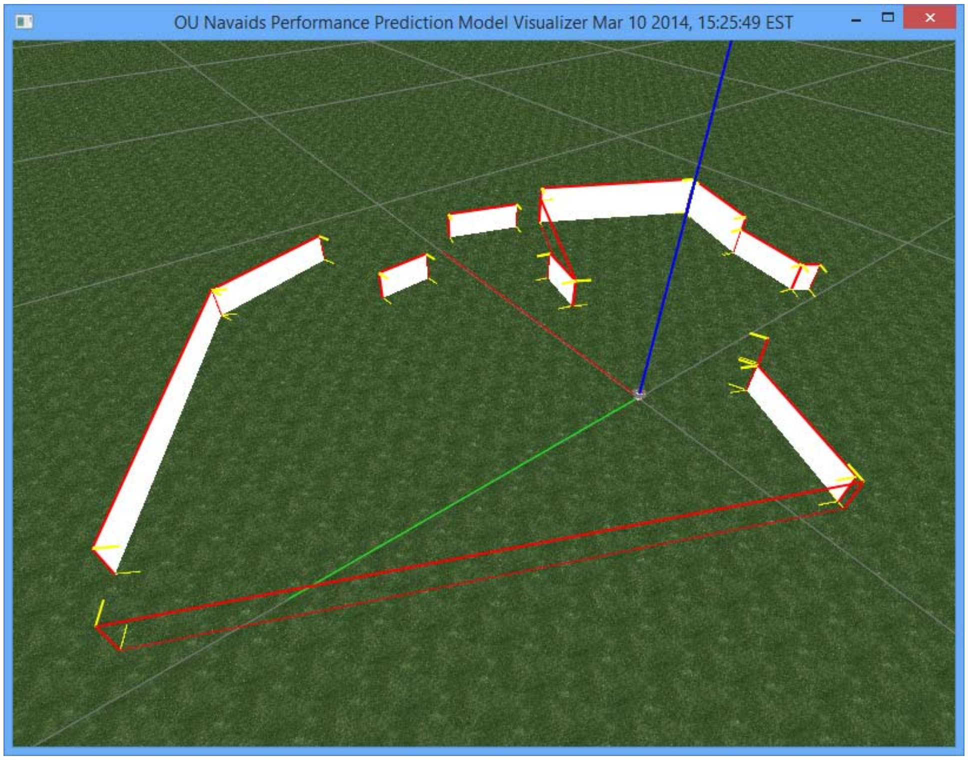
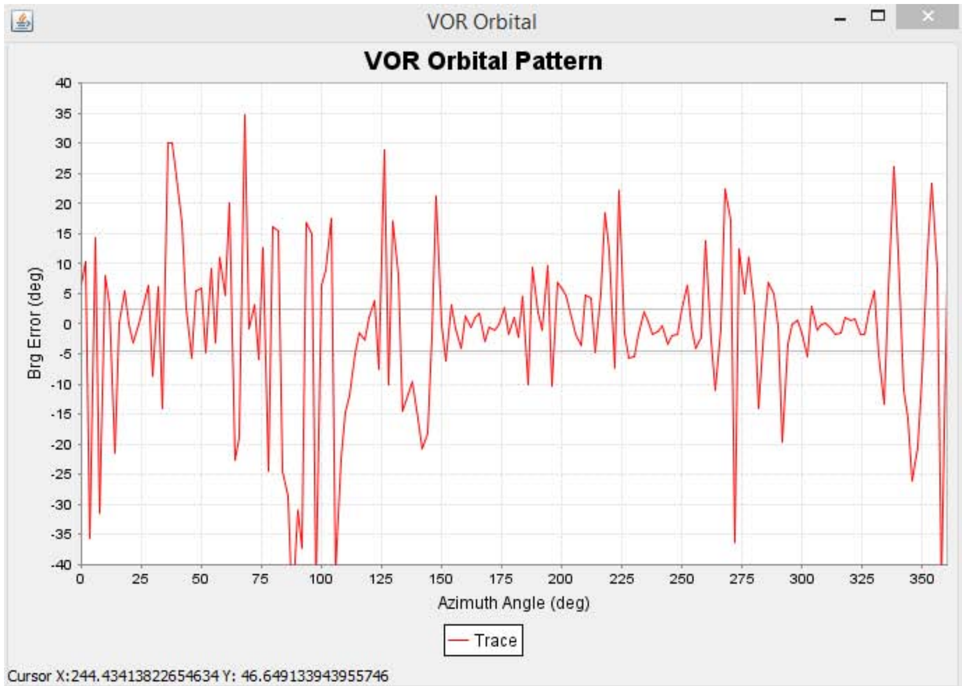


Figure 231: The plates for exercise 10 viewed from the northwest.

24.10.2 Results Exercise 10



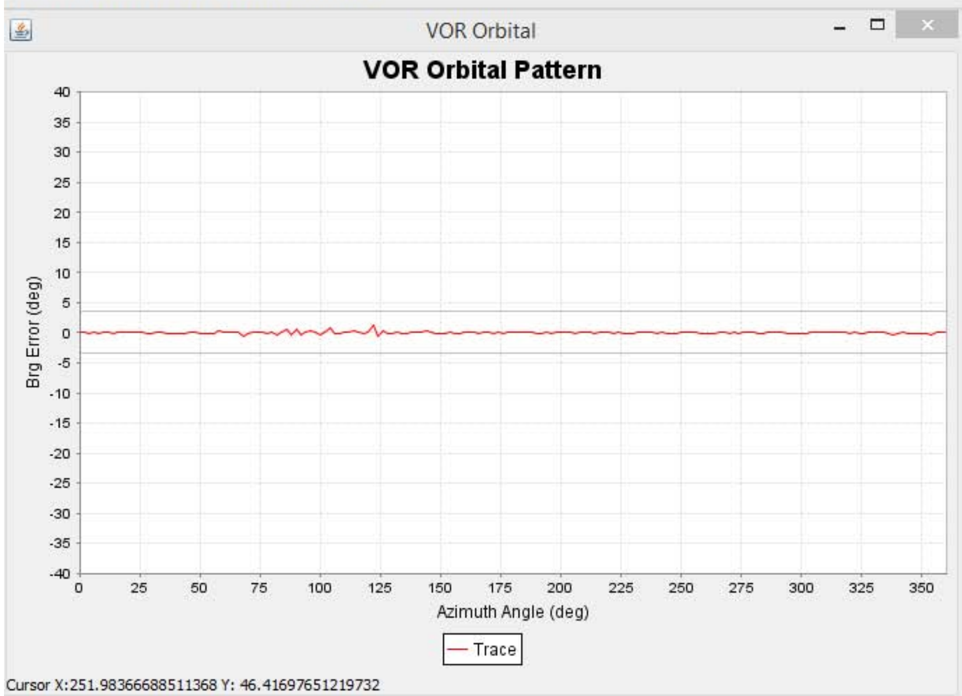


Figure 232: Results for Exercise 10 with all scatterer plates in place. Top is conventional VOR, bottom is doppler.

Part IX

Glossary

1. CDI - Course Deviation Indicator
2. CSB - Carrier plus side band.
3. SBO - Side band only.

Part X

Appendix A: Unit Conversions

25 Introduction

The layout of this appendix is as follows. There shall be 1 section for each unit. For each of these sections, there should be an entry for every other unit. If there is no valid conversion between the units, the value will be listed as "N/A". Some conversions rely on other configuration parameters. For instance, conversions to and from "wavelengths" require the frequency of the simulation to be known.

Full unit list:

1. Distance Units:
   a) Feet
   b) Meters
   c) Nautical Miles
   d) Wavelengths
2. Signal Strength Units:
   a) deciBels
   b) Normalized power
3. Course Angle Units:
   a) Degrees
   b) microAmps
4. Angle Units:
   a) Degrees
5. Time Units:

26 Distance Units

26.1 Feet

26.1.1 Feet

1 Foot to 1 Foot

26.1.2 Meters

1 Foot to .3048 Meters

26.1.3 Nautical Miles

1 Foot to $\frac{1}{6076.11549}$ Nautical Miles

26.1.4 Wavelengths

26.2 Meters

Part XI

Appendix B: Files

27 File Extentions

- .dat - The data file containing the state of a simulation.
- .gdu - The array parameter file for glideslope arrays.
- .ldu - The array parameter file for localizer arrays.
- .pts - The output files of the localizer and glideslope

28 File Contents

28.1 Input Files

x

28.1.1 Localizer

28.1.1.1 LDU

28.1.2 Glideslope

28.1.2.1 GDU

28.2 Intermediate Files

28.2.1 Localizer and Glideslope

28.2.1.1 DAT

28.3 Output Files

28.3.1 PTS

Part XII

Appendix C: Troubleshooting

29 FAQ

Q: Updates won't download.

A: Ensure that you are connected to the internet. Ensure that you can browse to the website containing the update repository. If these both work, check to make sure your Java security is not set to "highest", these prevents in-app downloads.

Q: The program ran, but the plot is all white.

A: If you are running a User Defined flightpath, ensure that the domain parameter is not constant between itinerary points.

30 Issue Reporter

31 Log Files

31.1 Java Log File

31.2 Visualization Log File

31.3 VOR Output File

Part XIII

Appendix D: Known Issues