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Introduction

WorldWide Telescope (WWT) is a free program designed to give users the ability to explore the universe in a simple easy to use interface. Recently support has been developed to include a variety of playback mediums. This document will detail the steps required for a multi-channel display setup for use in a dome or frustum environment.

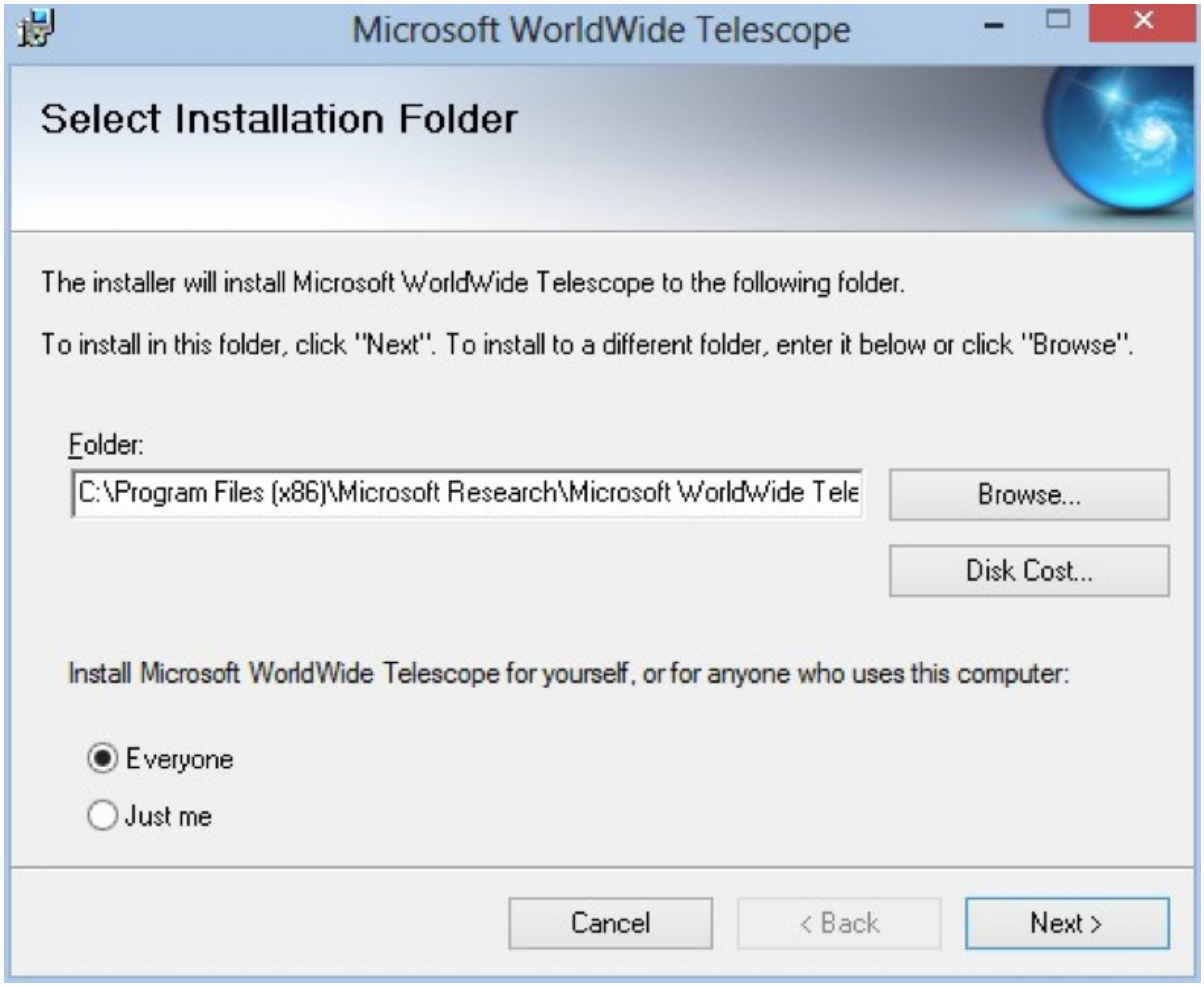
It is recommended before attempting to setup a multi-channel system that you familiarize yourself with WWT as a system. There are many introductory tours that will help in this process that are included with the software.

WWT is an ever evolving program and the steps, descriptions, and information contained in this guide is subject to change at any time.

Parts of this guide work on the premise that you have the required data regarding projector positioning and field of view/aspect ratio. Please obtain these data before attempting to start this process.

Software Installation

1. Install WWT Windows Client on all Servers both Master and Projector servers, http://www.worldwidetelescope.org



   - Install with default folder path `C:\Program Files (x86)\Microsoft Research\Microsoft WorldWide Telescope`
   - The GUI or Master control channel needs to be a separate server from the projection channels

2. Install Remote Control for Cluster Operation
   - Remote can:
     - Wake and shutdown projector server
     - Shutdown WWT on projector server
     - Startup WWT on projector server
   - Record IP and MAC address for each node
   - Turn off screen saver and energy saver settings for each node

- Both WWT and WWTRemote Control should be running on each slave/node for the projection to work correctly

3. Install Excel Add-In for WWT
4. Run WWT on each server independently before attempting to setup cluster.
   - Run a tour or navigate around to load data into the cache
   - WWT needs the cache folder populated to run smoothly
5. Populate cluster configuration files

   - Create a wwtconfig folder in the root directory of *each* server including Master controller (`C:\wwtconfig`)
   - Start WWT on each node – master and projection servers
   - After WWT has fully started, exit program. This will cause a `config.xml` file to be created in the folder `C:\wwtconfig`
   - Using a text or XML editor, change the `config.xml` file as follows for *each* of the projector nodes

     Example config.xml for projector nodes.

config.xml

<?xml version="1.0" encoding="utf-8"?>	Change the following entries:
<DeviceConfig>	Create a **CluserID** for the whole setup (say, 101).
<Config>	
<Device	Create a unique **NodeID** for this slave (say, from 1 to N - the number of slaves).
ClusterID="101"	
NodeID="1"	
NodeDiplayName="Projector 1"	Give the node a suitable name.
MonitorCountX="3"	
MonitorCountY="3"	Set **Master** to **False**.
MonitorX="2"	
MonitorY="2"	Set **MultiChannelDome** to **True**.
Master="False"	
Width="1920"	Ensure the **Width**, **Height** and **Aspect** ratio are correct for the projector.
Height="1200"	
Bezel="1.07"	
ConfigFile=""	
BlendFile=""	
DistortionGrid=""	
Heading="0"	
Pitch="0"	
Roll="0"	
UpFov="0"	
DownFov="0"	
MultiChannelDome="True"	
DomeTilt="0"	
Aspect="1.390531">	
</Device>	
</Config>	
</DeviceConfig>	

     i. Create a unique cluster ID

ii. Create a node ID
iii. Change node Display name (such as dome orientation – where it is aimed)
iv. Set Master to False
v. Enter actual resolution for your display in Width, and Height
vi. Set MultiChannelDome to True
vii. Save file and close editor

- Using a text or XML editor, change the config.xml file as follows for the Master node *Example config.xml for Master node.*

config.xml

```
<?xml version="1.0" encoding="utf-8"?
>
<DeviceConfig>
<Config>
<Device
  ClusterID="101"
  NodeID="-1"
  NodeDiplayName=""
  MonitorCountX="3"
  MonitorCountY="3"
  MonitorX="2"
  MonitorY="2"
  Master="True"
  Width="1920"
  Height="1200"
  Bezel="1.07"
  ConfigFile=""
  BlendFile=""
  DistortionGrid=""
  Heading="0"
  Pitch="0"
  Roll="0"
  UpFov="0"
  DownFov="0"
  MultiChannelDome="True"
  DomeTilt="0"
  Aspect="1.390531">
</Device>
</Config>
</DeviceConfig>
```

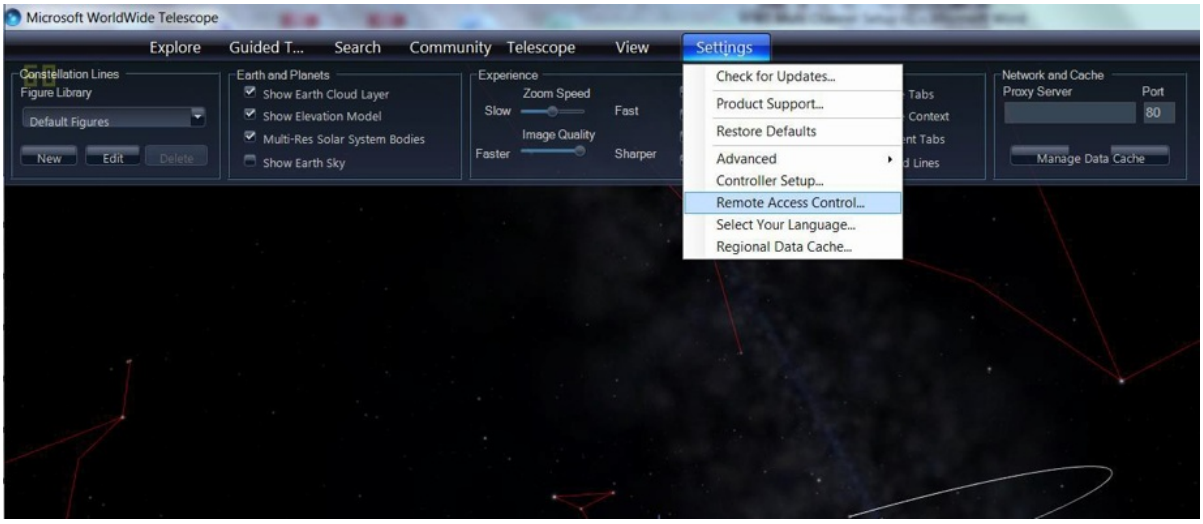
Change the following entries:

Create a **CluserID** for the whole setup (say, 101).

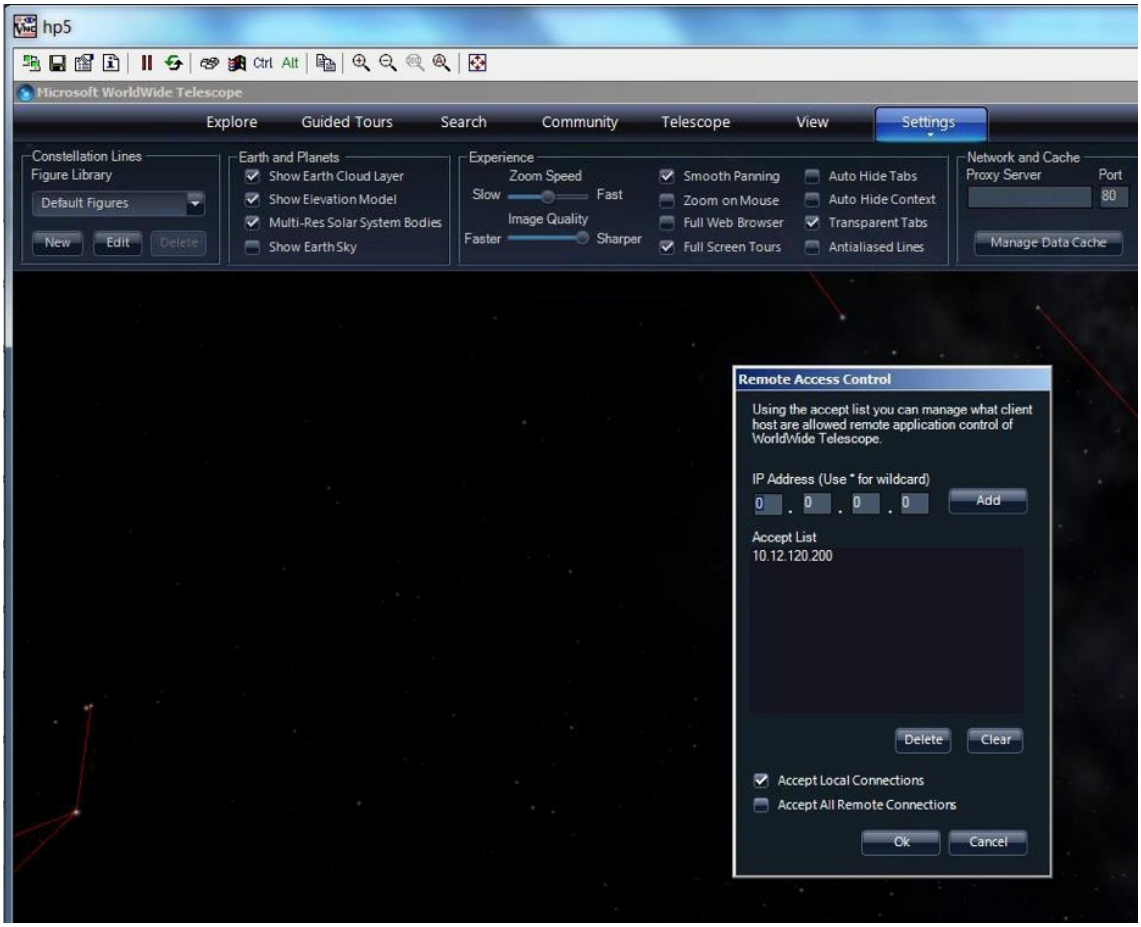
Set **MultiChannelDome** to **True**.

i. Enter your unique cluster id
ii. Change Node Id to -1
iii. Check and ensure Master is set to True
iv. Enter actual resolution for your display in Width, and Height
v. Set MultiChannelDome to True
vi. Save file and close editor

6. Open Remote Access Control under Settings>Remote Access Control on *each* node
   Select Remote Access Control.



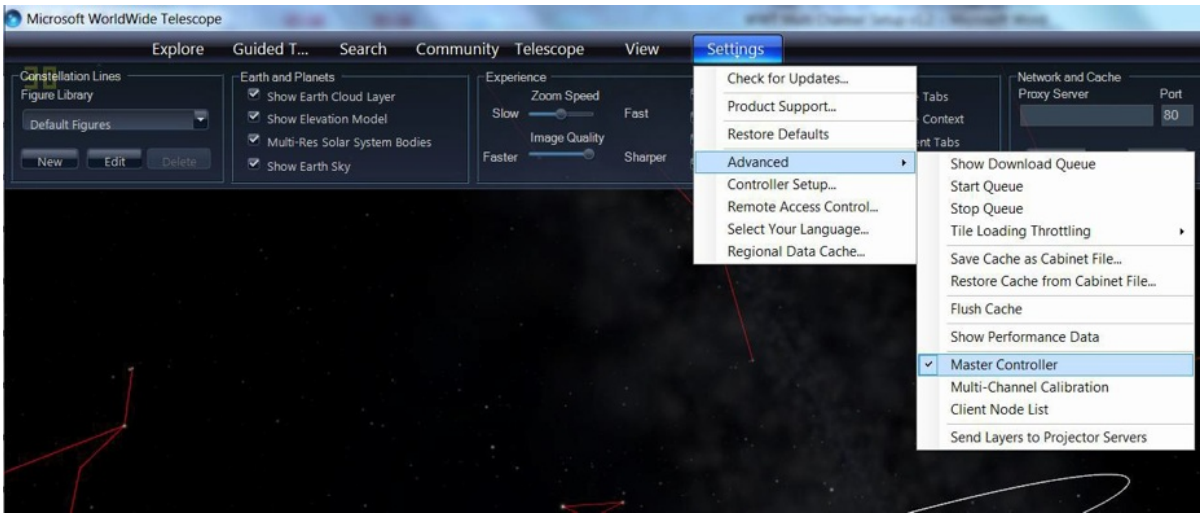
   - Enter the IP address of your Master Controller Node. This ensures only you will have control of your nodes at all times.
   - Check Accept Local Connections.
     Setting IP address for Remote Access Control.



7. Launch WWT on Master Controller node

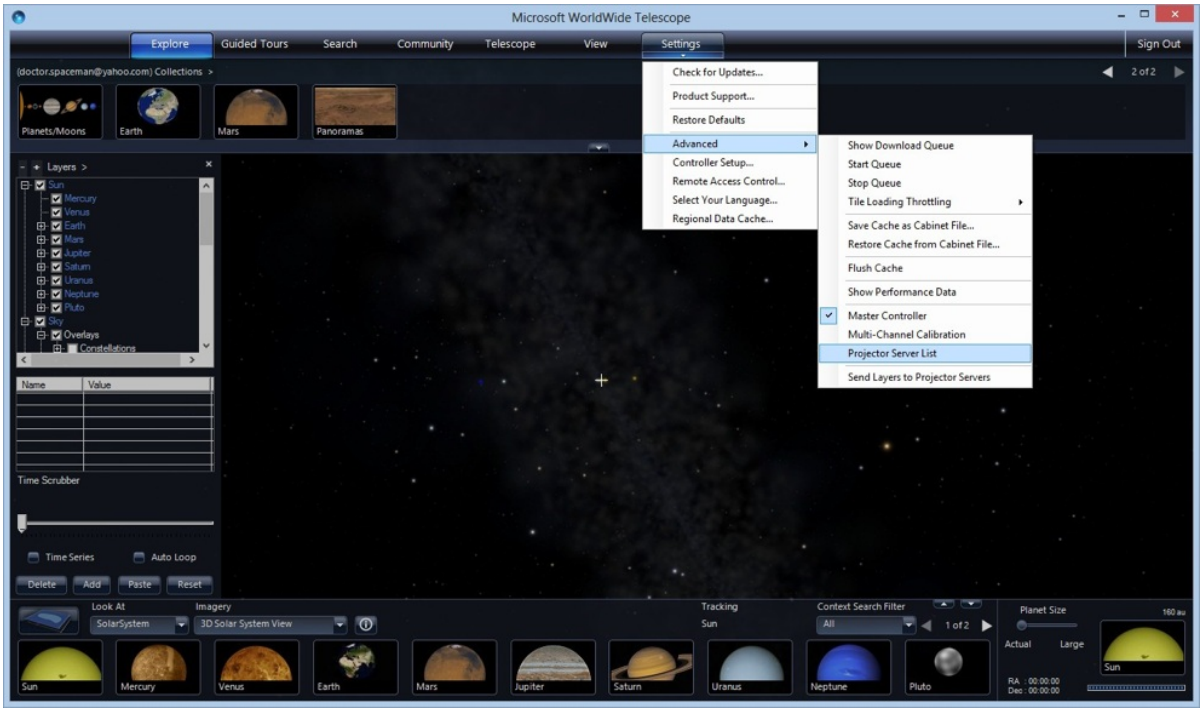
8. On Master Controller Node Ensure under `Settings>Advanced` that Master Controller is checked

   Setting a node as Master Controller.



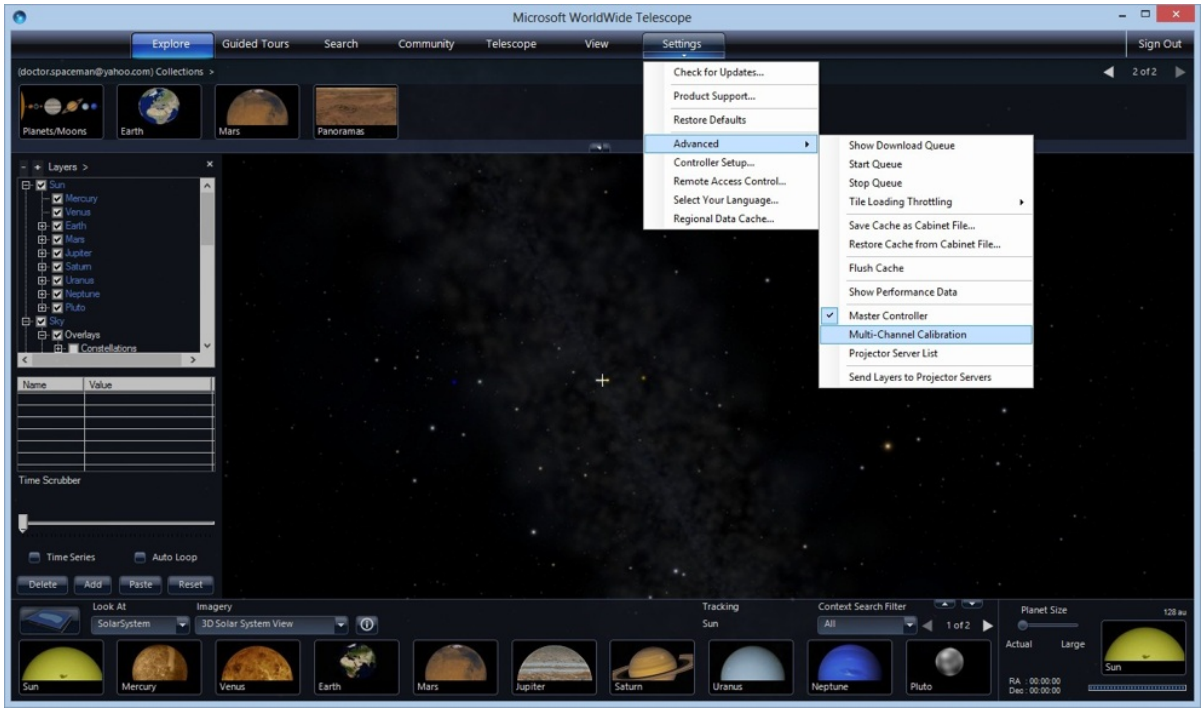
9. Open Projector Server List under `Settings> Advanced` to ensure you can see all nodes, and they are green. This pane will also tell you frame rates and other useful information for each node.

   Opening Projector Server List.



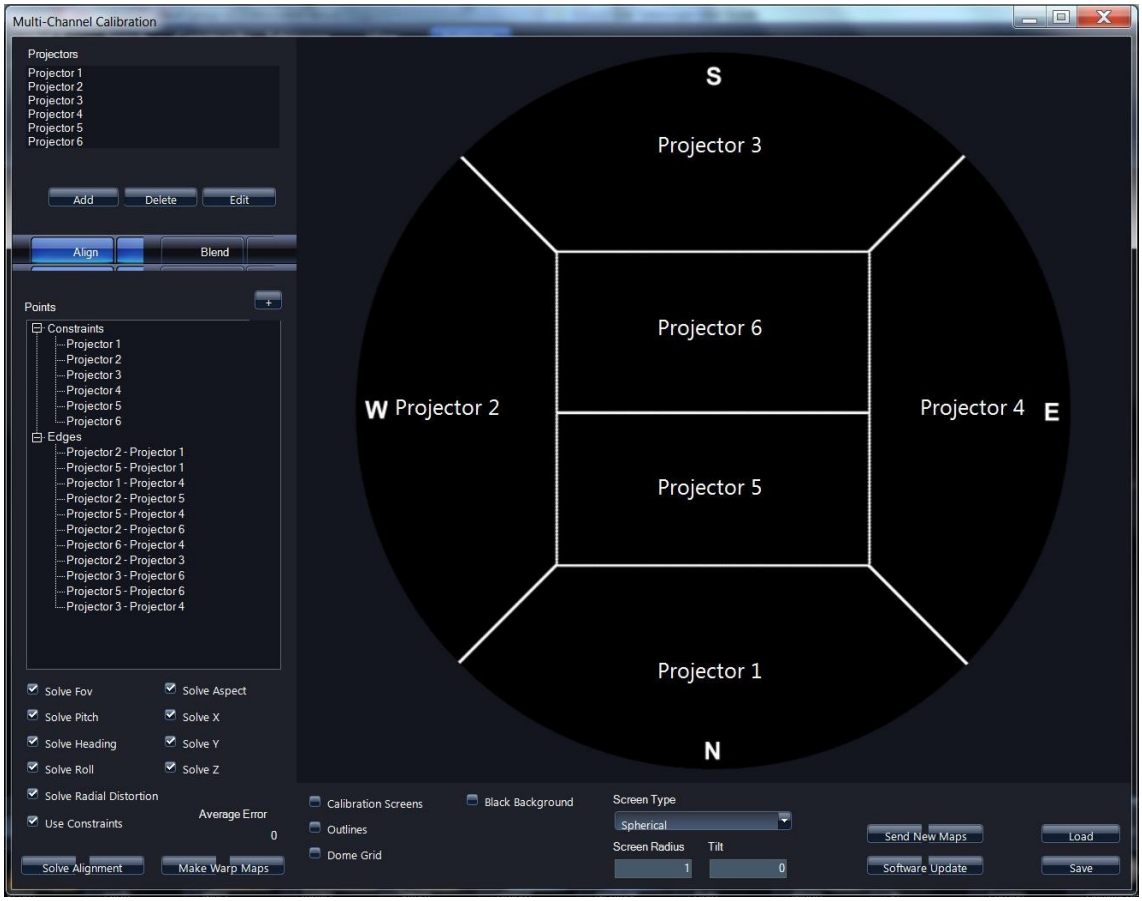
10. Open `Settings>Advanced>Multi Channel Calibration`

    Selecting Multi-channel calibration.

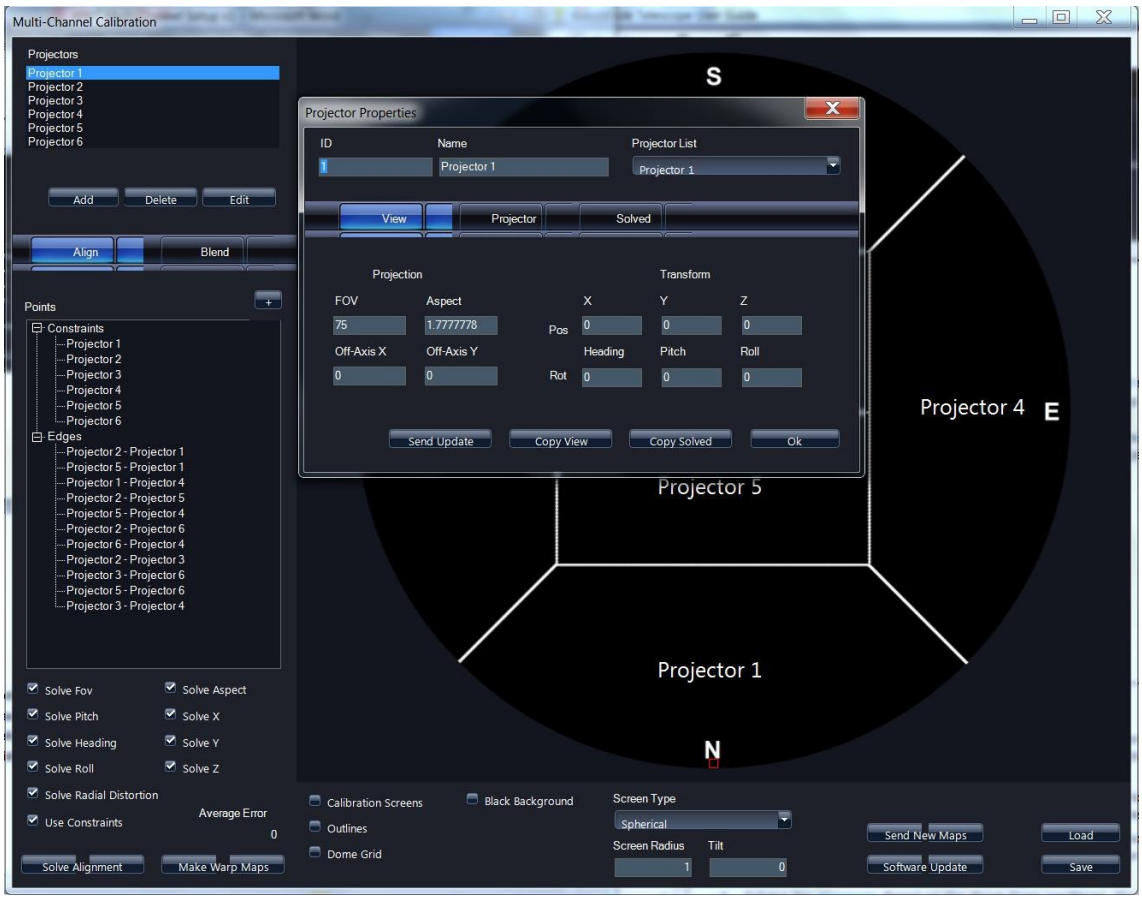


11. Set specifics for the projection area

    - Select the type of screen as Spherical
    - Set Screen Radius in meters
    - Set Tilt to locate center of interest in the display. (example: A value of 60 indicates that main focus of most viewers will be on a point 60 degrees up from the spring-line)

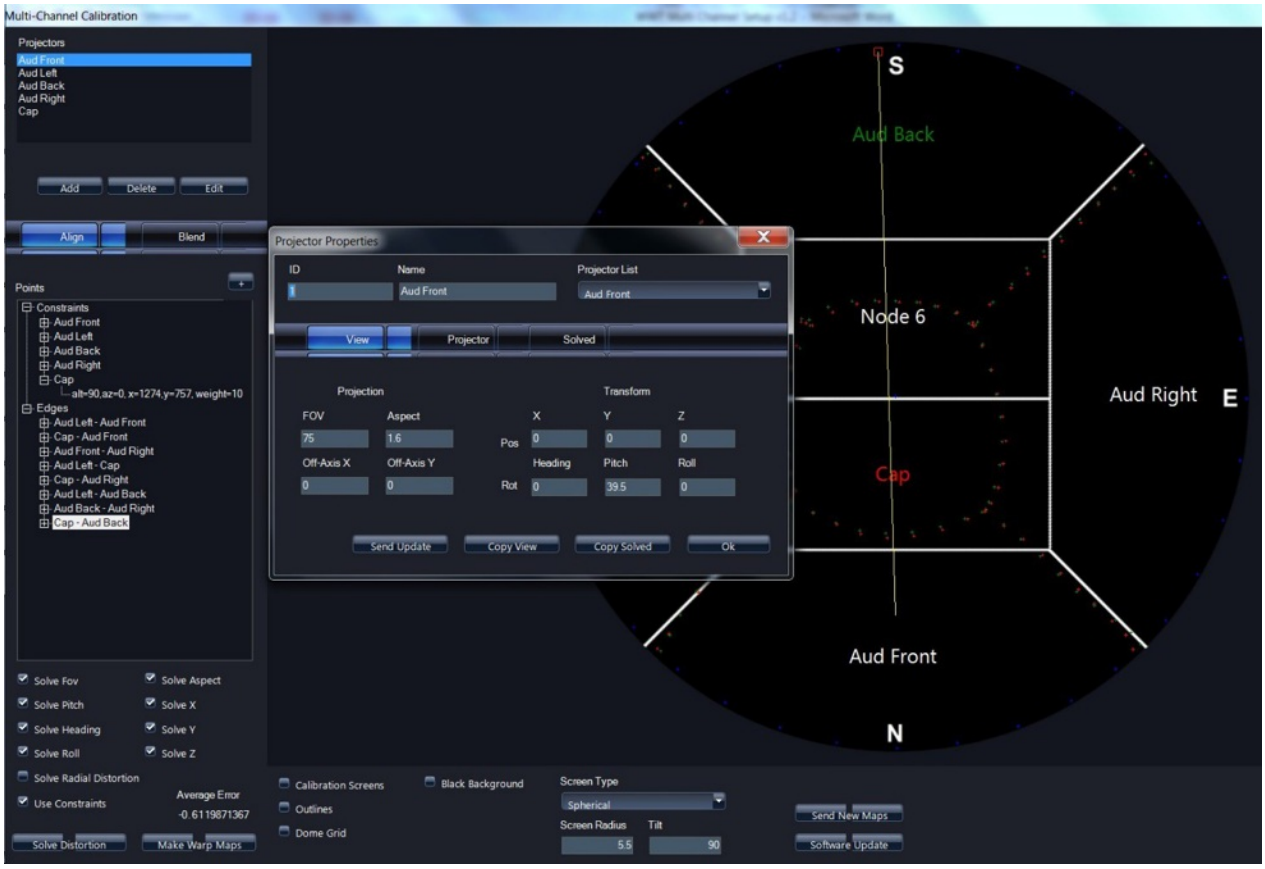


12. Set number of projectors in the top left panel
    - Left click to highlight a channel
    - The layout example is fixed and will not change from a six channel example
    - Five channels is considered the minimum for a dome setup
    - As you update your Projector names the text on the dome map will update
13. Change properties for each channel by left clicking the channel you wish to edit and click the edit button
    - Set each channel with the unique id, and name that was set earlier in the XML file
    - View tab contains the idealized settings for the projector if it was centered exactly in the middle of the dome
    - Projector tab pertains to the actual physical location of the projector
    - Solved tab contains the temporary output from a Solve Alignment calculation


Multi-Channel Calibration
Projectors
Projector 1
Projector 2
Projector 3
Projector 4
Projector 5
Projector 6
Add
Delete
Edit
Align
Blend
Points
Constraints
Projector 1
Projector 2
Projector 3
Projector 4
Projector 5
Projector 6
Edges
Projector 2 - Projector 1
Projector 5 - Projector 1
Projector 1 - Projector 4
Projector 2 - Projector 5
Projector 5 - Projector 4
Projector 2 - Projector 6
Projector 6 - Projector 4
Projector 2 - Projector 3
Projector 3 - Projector 6
Projector 5 - Projector 6
Projector 3 - Projector 4
Solve Fov
Solve Aspect
Solve Pitch
Solve X
Solve Heading
Solve Y
Solve Roll
Solve Z
Solve Radial Distortion
Use Constraints
Average Error
0
Solve Alignment
Make Warp Maps
Projector Properties
ID
Name
Projector List
1
Projector 1
Projector 1
View
Projector
Solved
Projection
Transform
FOV
Aspect
X
Y
Z
75
1.7777778
Pos
0
0
0
Off-Axis X
Off-Axis Y
Heading
Pitch
Roll
0
0
Rot
0
0
0
Send Update
Copy View
Copy Solved
Ok
S
Projector 4
E
Projector 5
Projector 1
N
Calibration Screens
Outlines
Dome Grid
Black Background
Screen Type
Spherical
Screen Radius
Tilt
1
0
Send New Maps
Software Update
Load
Save

FOV Values

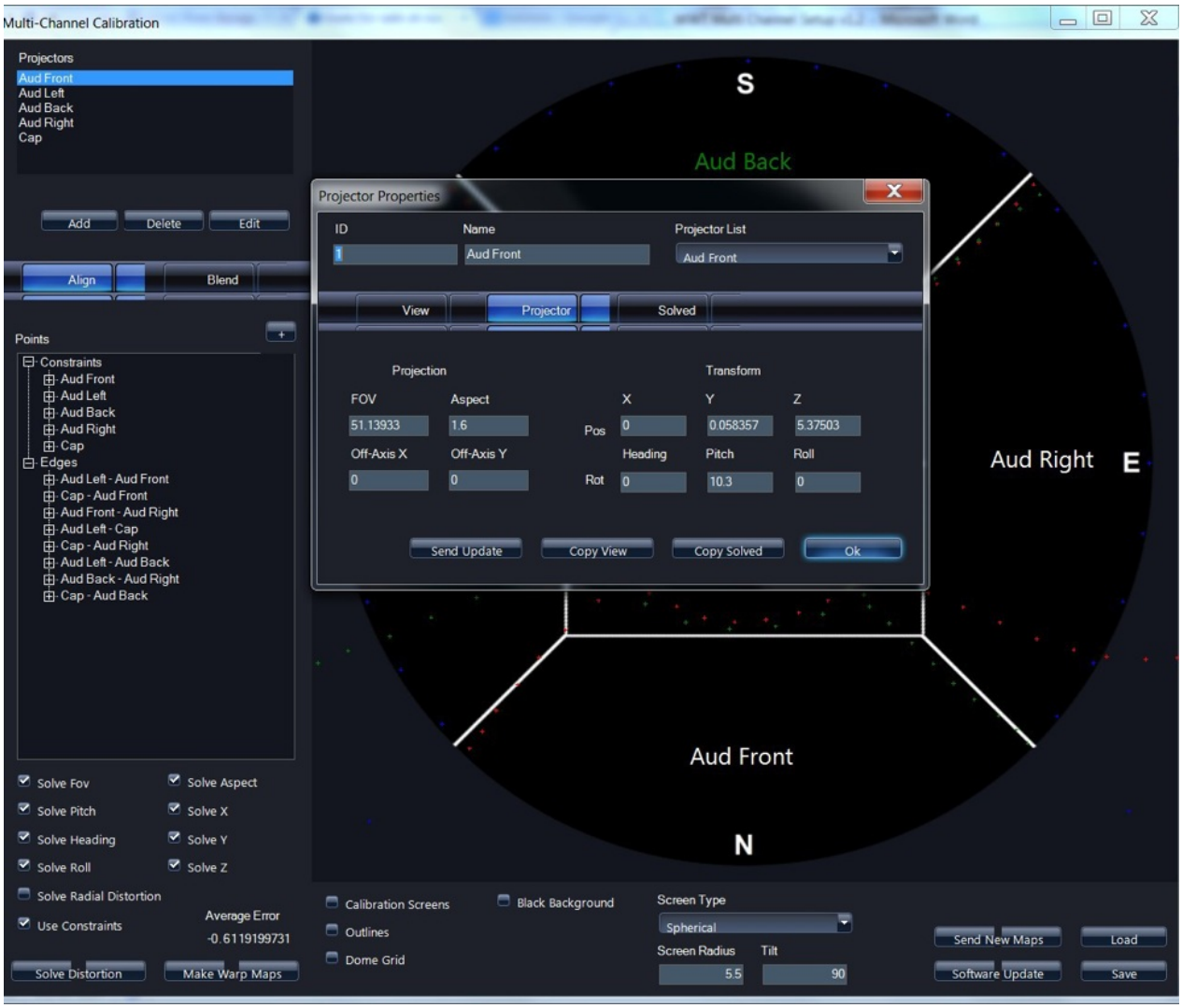
Setting Field of View Values.



1. Enter FOV Values for each projector.
    - This is the part of the dome the projector sees/ projects onto from the lens point
    - Enter actual FOV, and aspect
    - Leave Pos-X,Y,Z value at 0 in the view tab
    - Enter Rot- Heading, Pitch, and Roll (roll is generally 0) for each projector

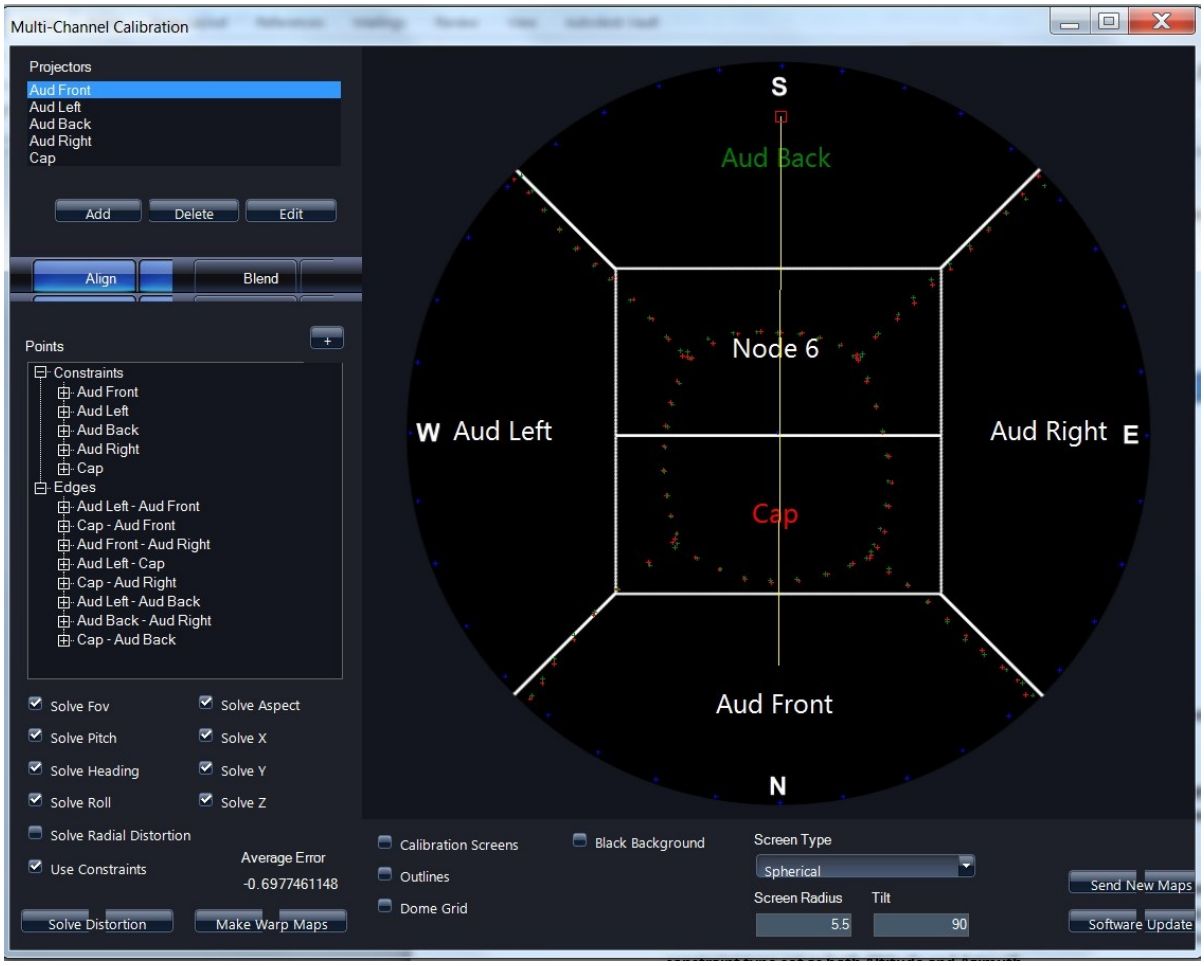
Projector Values

Specifying projector values.



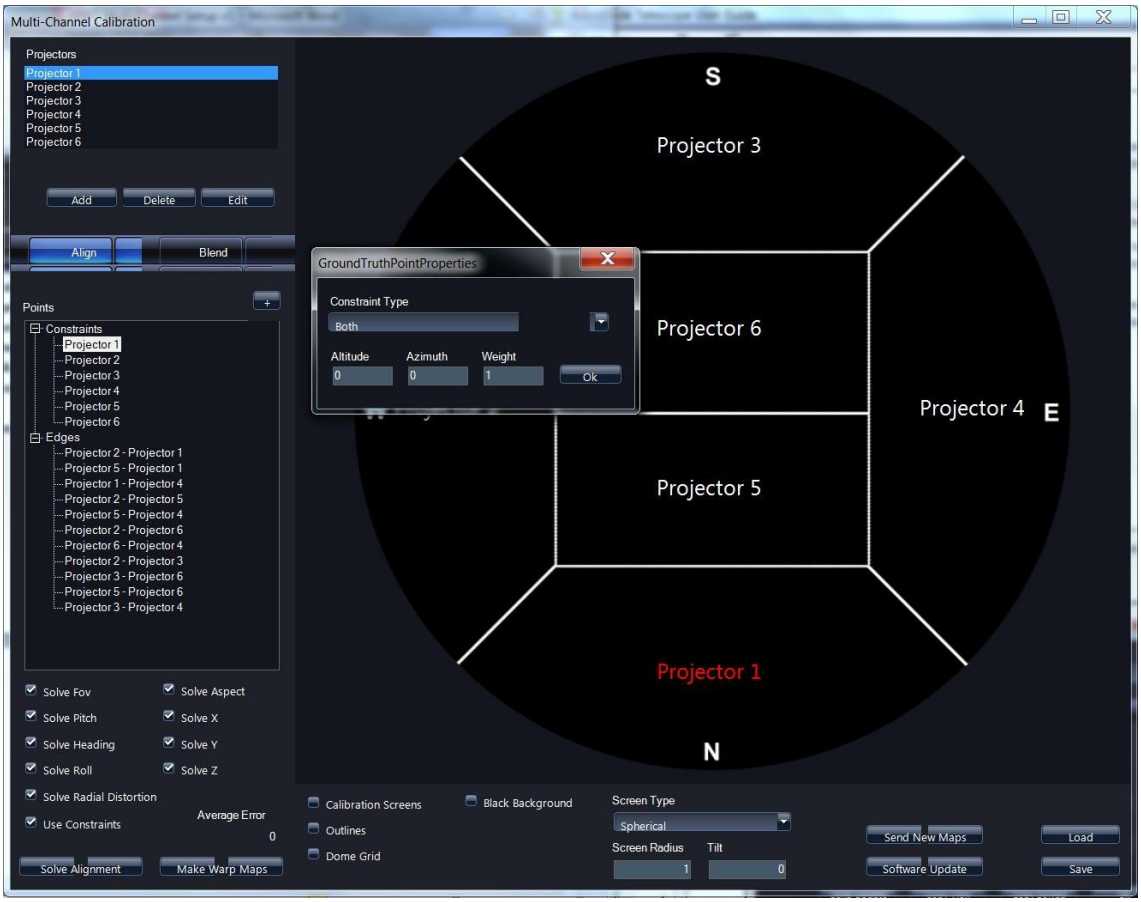
1. Enter Projector Values for each projector. This is where the projector is physically located in the dome.
    - Enter FOV and Aspect Values
    - Values for `Pos- X,Y,Z` are in meters
2. When you are finished entering in values for each projector, verify the orientation in the simulation pane for each projector and that it is correct
    - The red box indicates relative projector location
    - The yellow line represents the projection cone

In this example, my Audience front projection area is being projected from the rear of the dome, onto the front of the dome.



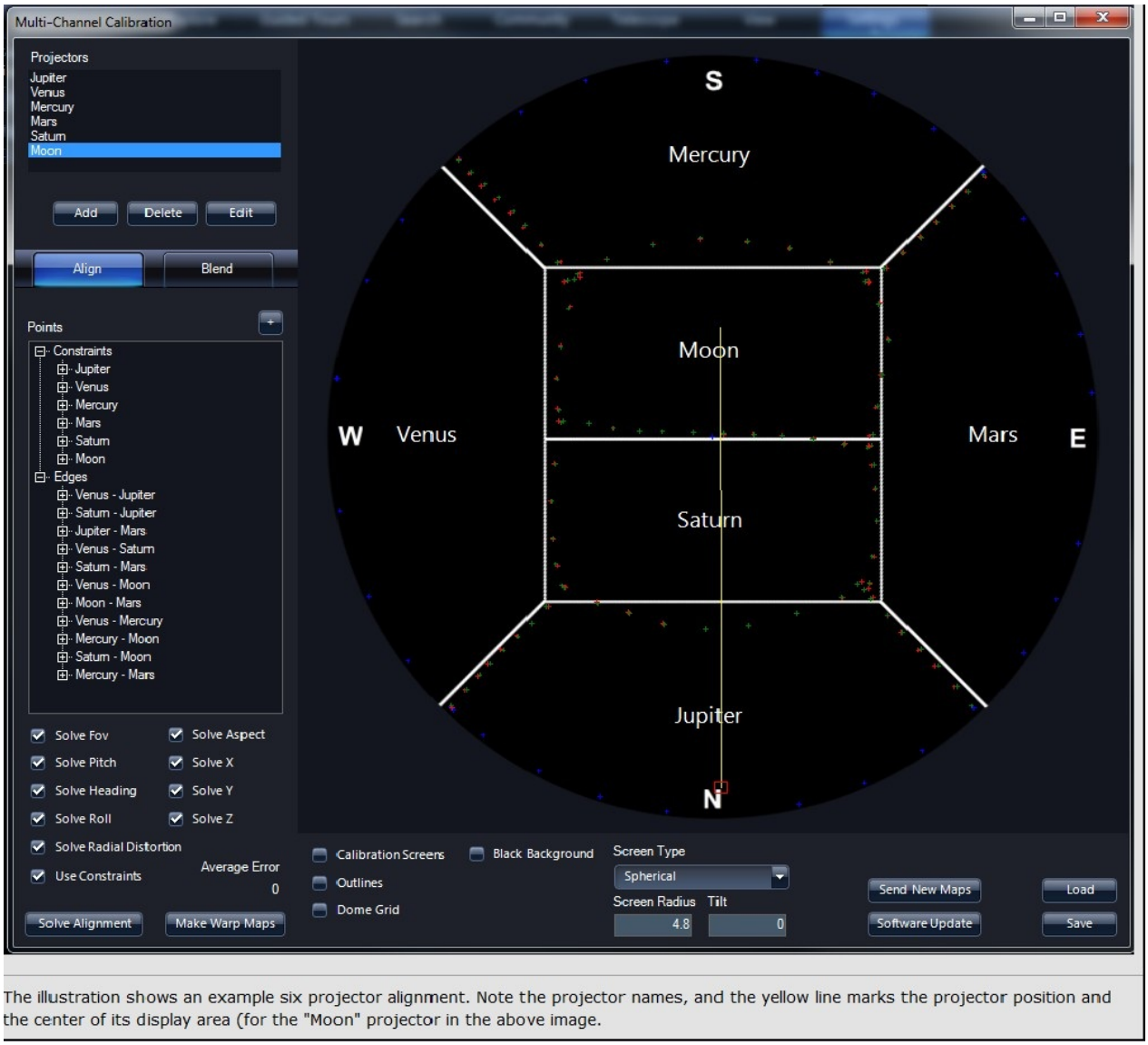
3. Set constraints (Spring-line, Zenith) by left clicking on the projection channel under points, and then right clicking to bring up properties.
    - Physical constraints on the dome that anchor the alignment (Zenith, spring line)
    - These points need to be placed as close as possible to each 10 degree physical mark on the dome.
    - While you are physically inside the dome, add a point and use left click to drag the point or “x” onto the corresponding 10 degree point in your dome.
    - Enter actual values for Altitude and Azimuth
        - Most constraints will only have altitude selected from the drop down constraint type with a value of 0 for 180 degree domes. For domes with a 160 degree radius you must enter the value for altitude as 10. North (AZ=0), South (AZ=180), East (AZ=90), and West (AZ=270) that will have a constraint type set as both Altitude and Azimuth.
        - The Cap Center Point or Zenith will have a constraint type set as Both in the dropdown menu with values of Alt=90, AZ=0, Weight of 10.
    - Weight refers to that points gravity, most points should be left at a value of 5, but absolute or North, South, East, West points can have a weight of up to 10

Setting constraints



Edge Points

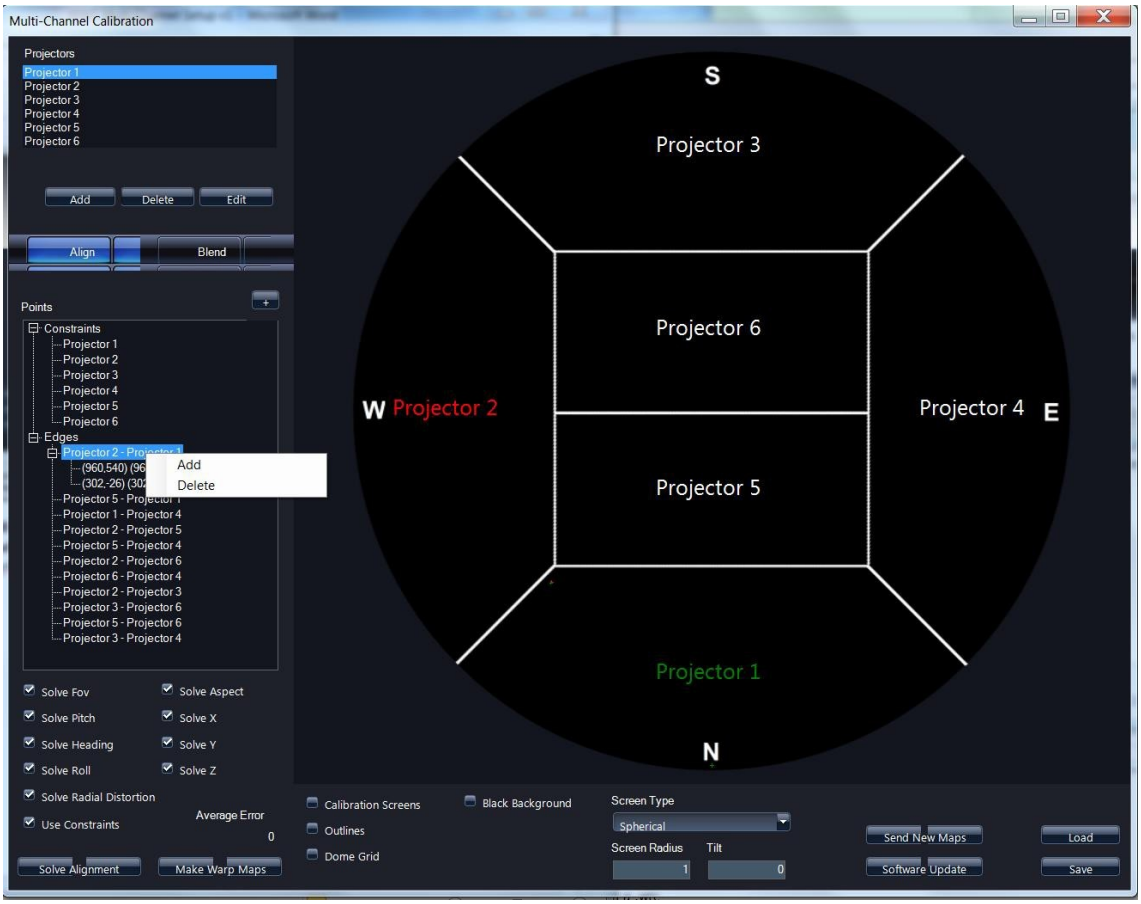
Setting Edge Points.



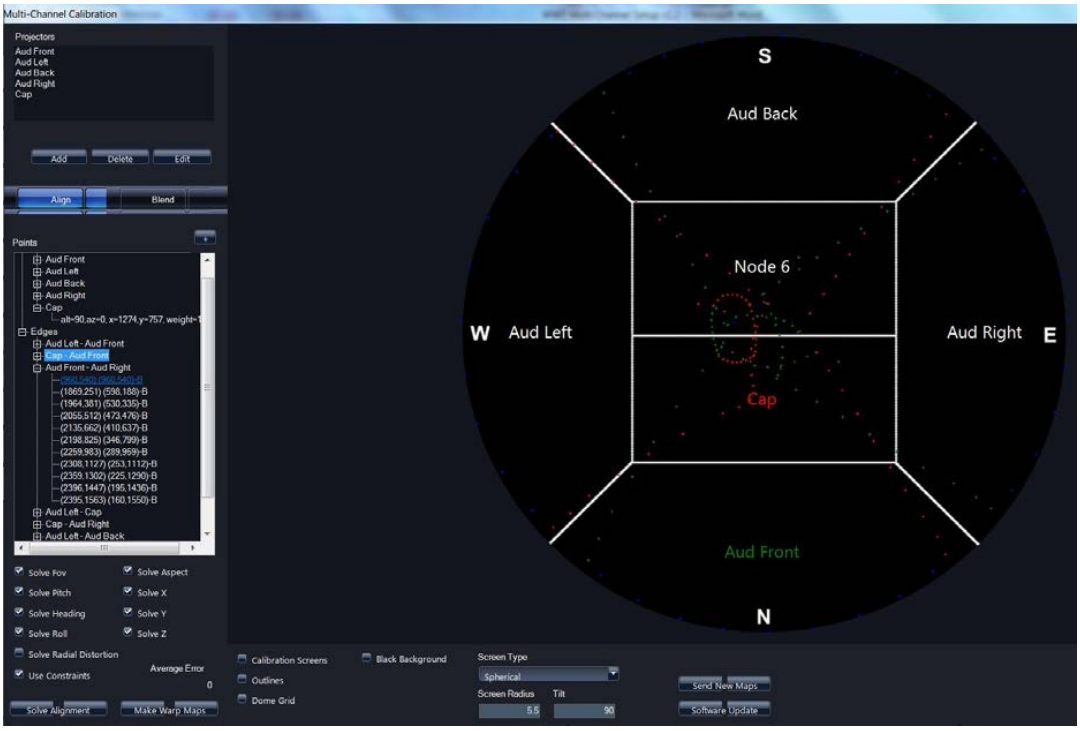
The illustration shows an example six projector alignment. Note the projector names, and the yellow line marks the projector position and the center of its display area (for the "Moon" projector in the above image.

1. Set edge points. These mark places on the dome where one projector overlaps another’s edge.
    - Turn on Calibration Screens
    - Toggling between Black and White background can be helpful for lining up points
    - Outlines will put a red outline around each channel in the dome. If you have physical masks installed you may not see these.
    - Select the edges you wish to work on in left Point Pane. After clicking on a point set the two edges will highlight in the example pane
    - Right click and select add
    - You will see two points populate, one for each edge in red and green
    - Left click will control a red point

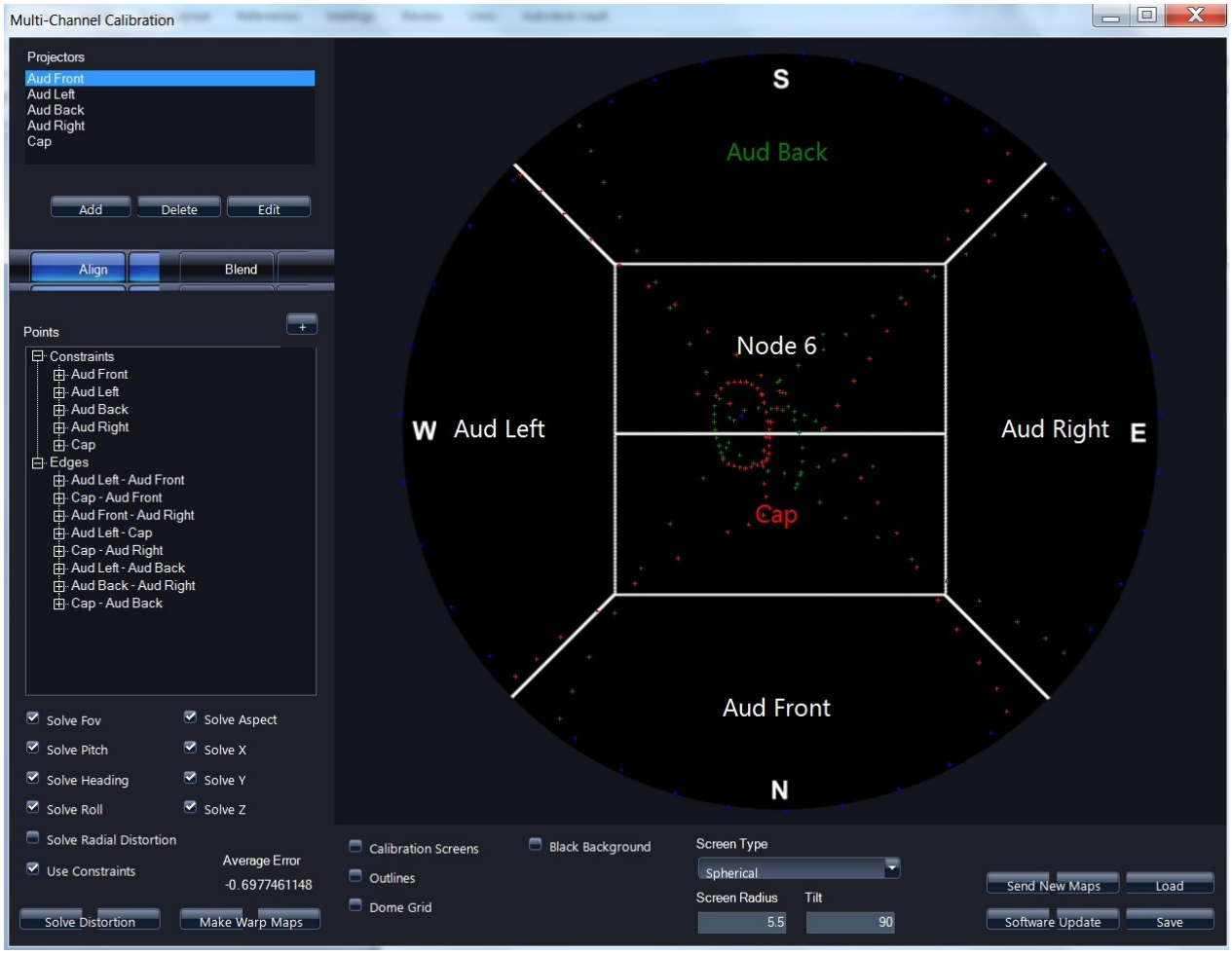
Selecting Calibration Scenes



- Right click will control a green point
- Align center X on top of each other in roughly the center of the blend region
- Must physically be inside dome with optical blends in place to see if placement is correct
- Complete this process for each edge, and add any edges that are not pre populated
- Ensure there are no incorrect points left
    i. These will have the same coordinates for each point (example: [960.540, 960.540])
    ii. These points will cause a singularity when trying to solve alignment.
    iii. Delete any points like this before solving alignment:

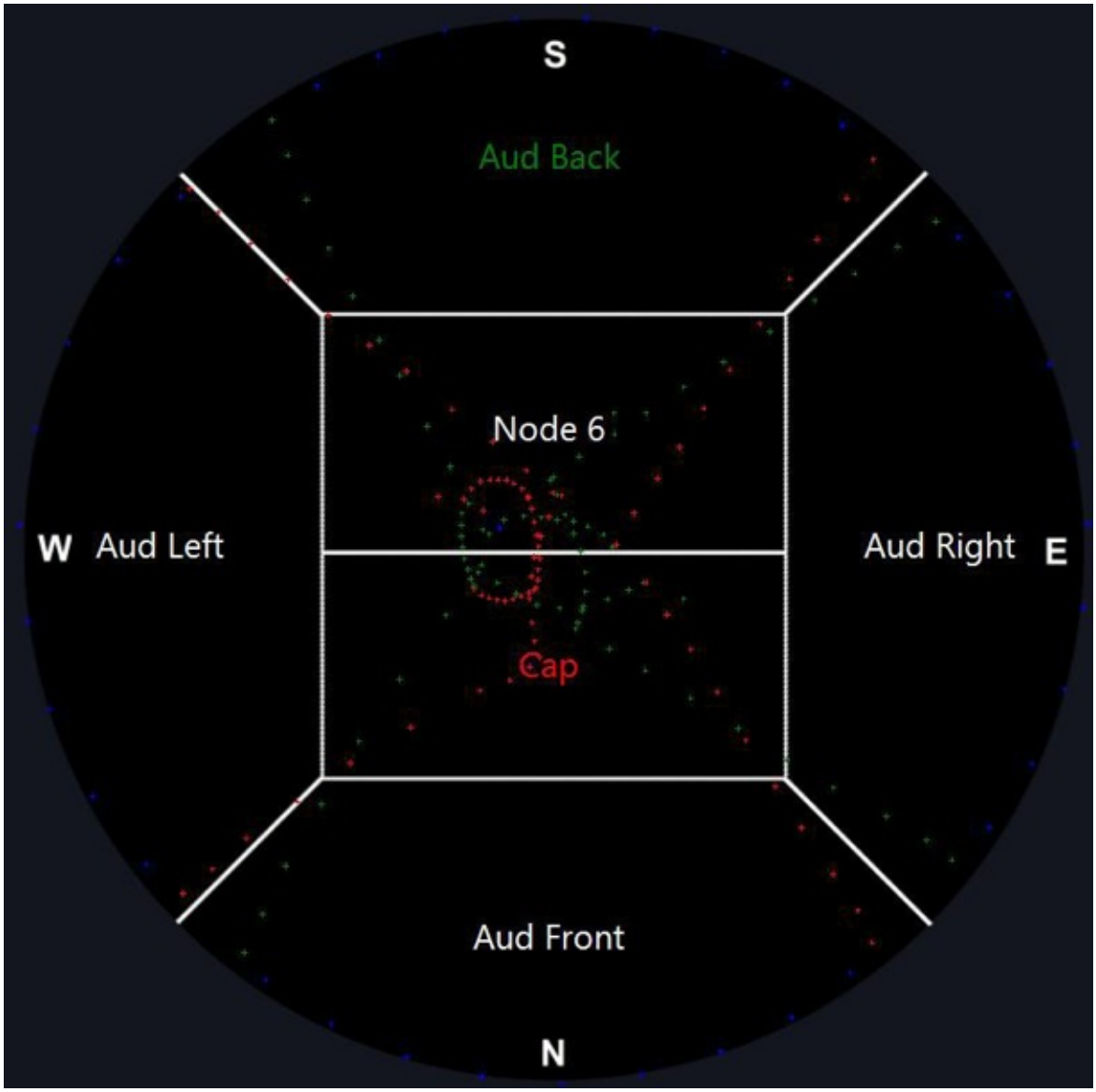

Multi-Channel Calibration
Projectors
Aud Front
Aud Left
Aud Back
Aud Right
Cap
Add
Delete
Edit
Align
Blend
Points
Aud Front
Aud Left
Aud Back
Aud Right
Cap
alt=90,az=0, x=1274,y=757, weight=1
Edges
Aud Left - Aud Front
Cap - Aud Front
Aud Front - Aud Right
(868,540),(868,540)-B
(1869,251) (598,188)-B
(1964,381) (530,335)-B
(2055,512) (472,476)-B
(2135,662) (410,637)-B
(2198,825) (346,799)-B
(2259,983) (289,959)-B
(2308,1127) (253,1112)-B
(2359,1302) (225,1290)-B
(2396,1447) (195,1436)-B
(2395,1563) (160,1550)-B
Aud Left - Cap
Cap - Aud Right
Aud Left - Aud Back
Solve Fov
Solve Aspect
Solve Pitch
Solve X
Solve Heading
Solve Y
Solve Roll
Solve Z
Solve Radial Distortion
Use Constraints
Average Error
0
Solve Alignment
Make Warp Maps
Calibration Screens
Outlines
Dome Grid
Black Background
Screen Type
Spherical
Screen Radius
5.5
Tilt
90
Send New Maps
Software Update
S
Aud Back
Node 6
W
Aud Left
Aud Right
E
Cap
Aud Front
N

Solve Alignment/Distortion

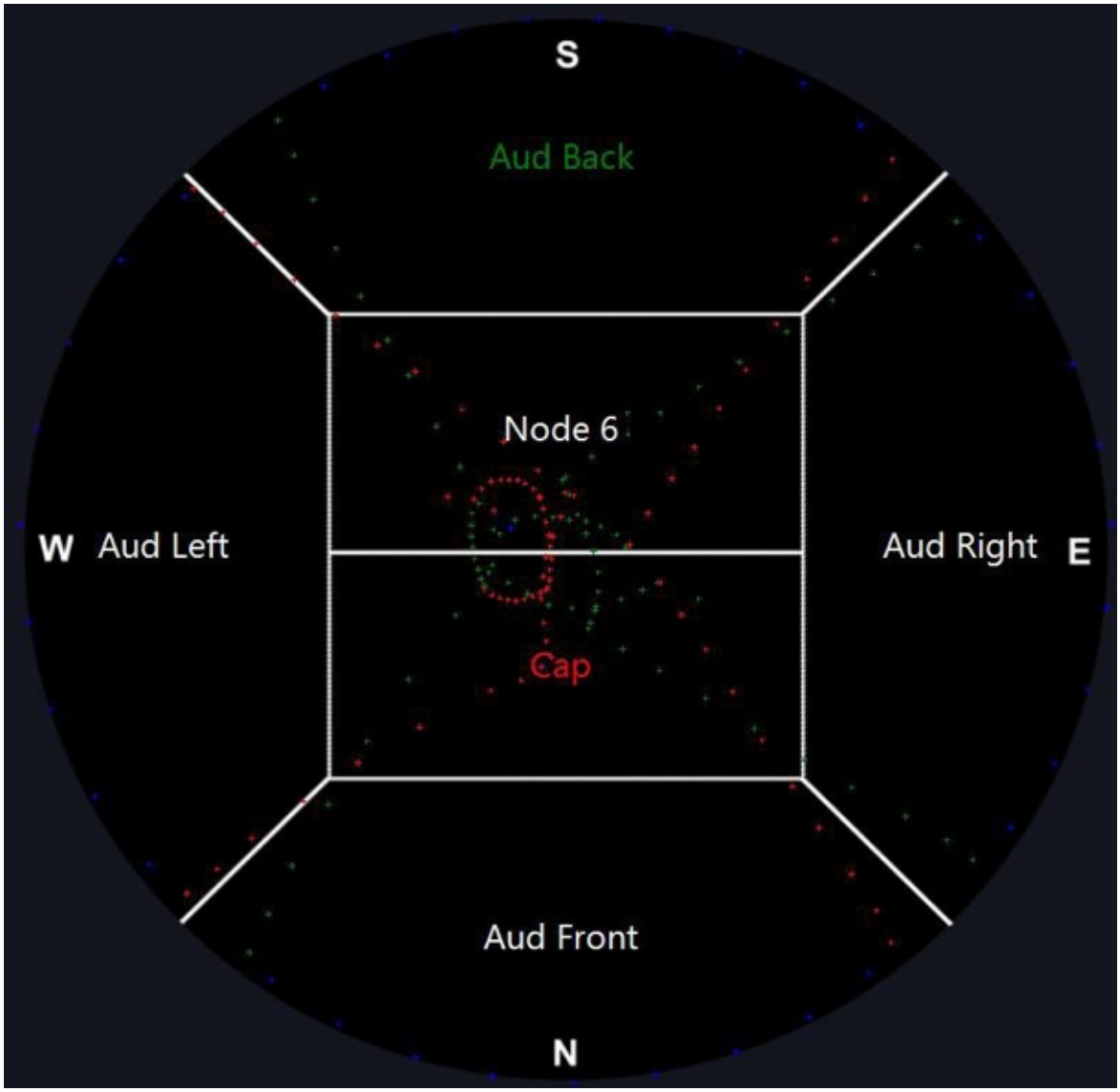


1. Use WWT to solve the alignment
    - Click Solve Distortion.
    - WWT will use algorithms to solve alignment showing its average error and keep cycling until there is no better solution.
    - 3.0 or better for an average error is preferred

An example of what a map looks like after distortion has been solved with incorrect edge points

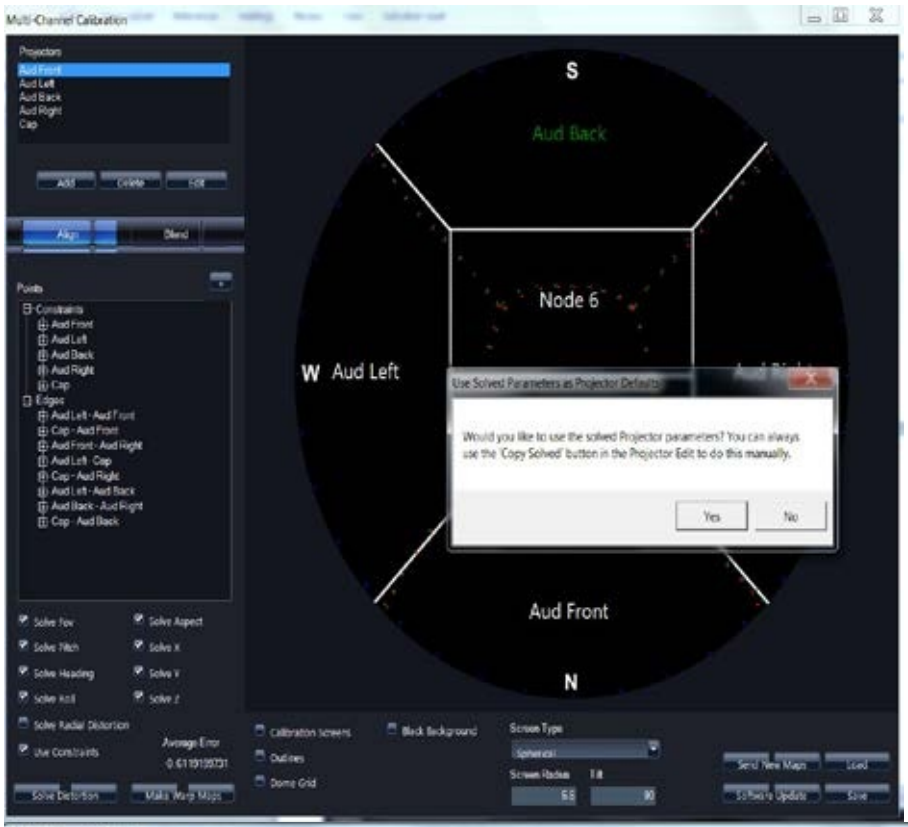


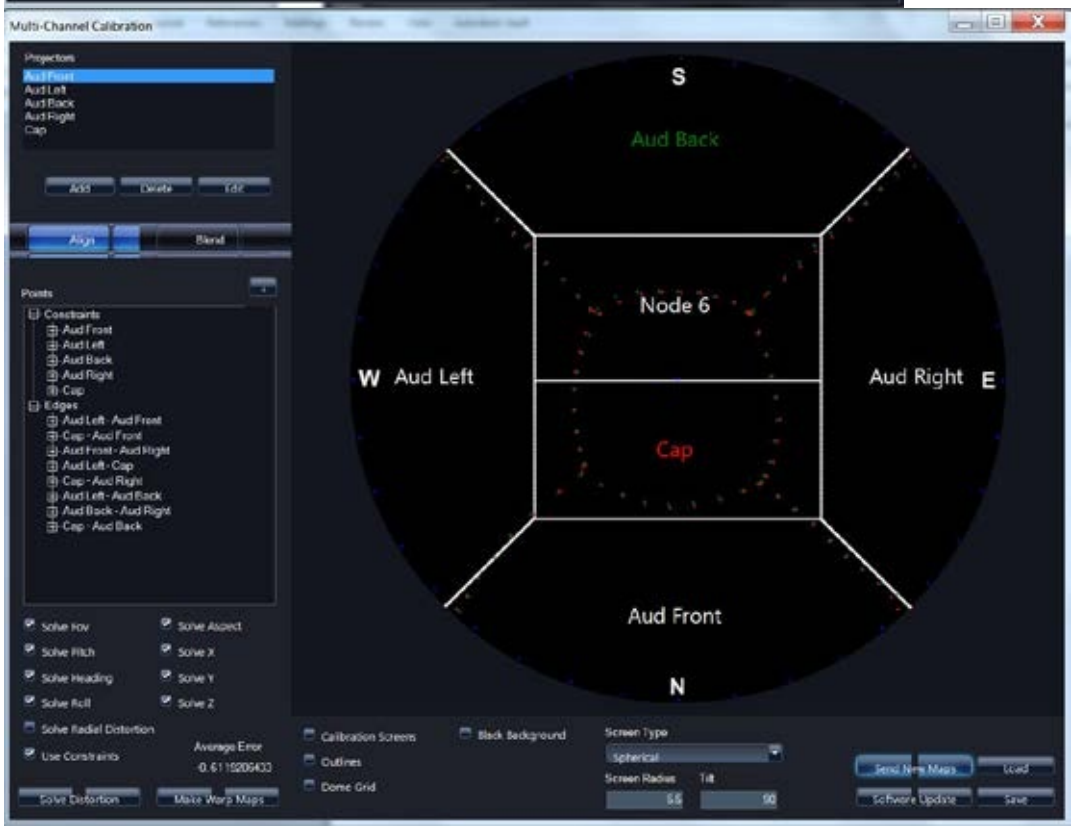
An example of what a map should look like after distortion has been solved and correct constraint and edge points



2. If you are happy with the distortion solved, click yes to send solved projector parameters to each node

3. Save. Save different versions often.



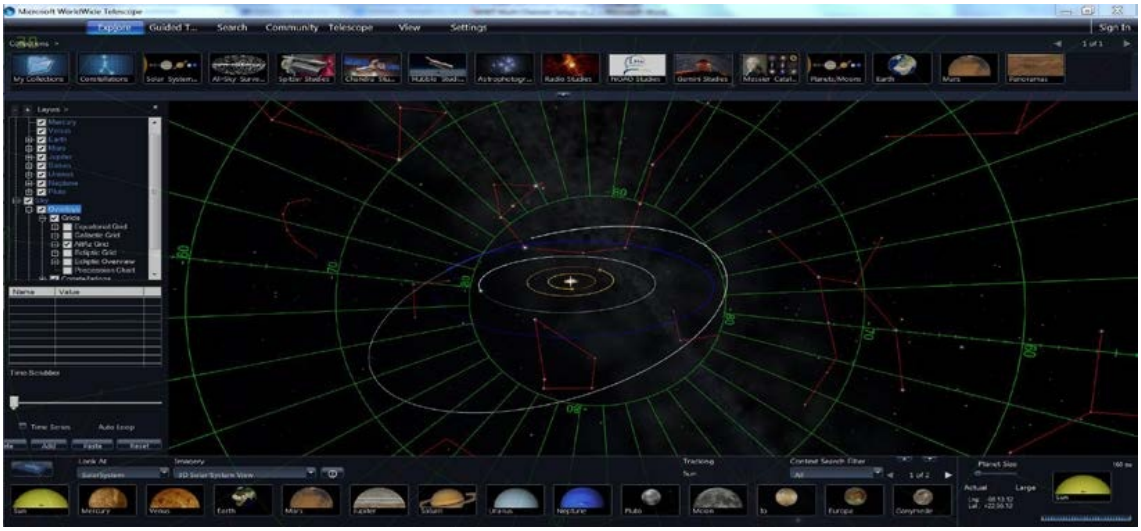


Warp Maps

1. Make Warp Maps and Send to Nodes
    - Click Make warp maps
    - Click Send New Maps – this will send new maps to all nodes

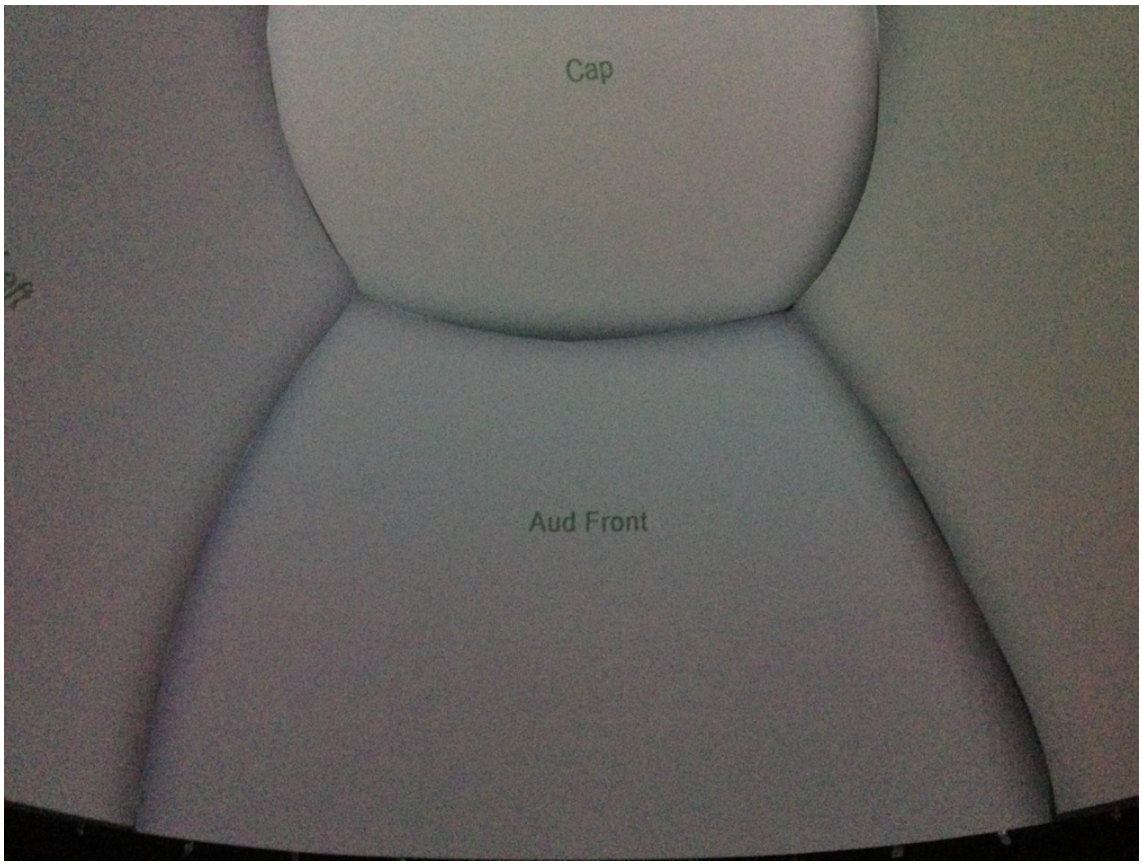
Confirm Alignment

1. Confirm alignment
    - Close Multi Channel Setup Window
    - Open `Layers>Sky>Overlays>Grids` and turn on Alt-Az Grid to confirm grid alignment. This will bring up a grid on all the nodes.
    - Turn off grid when done
    - Open a Scene Such as “Look at Earth” or “Solar System”
    - Fly in and out and confirm alignment



Blending

1. Setup blending
    i. Open Multi-Channel Setup Screen
    ii. Click on the Blend Tab
    iii. Click Transfer from edges – this will import the edge points you created before
    iv. Turn on Calibration Screens
    v. You will see a screen similar to this representing blend regions and overlap based on your edge points. This is just the starting point for blending. The goal is to get the blends regions with no black, and as small of an overlap as possible



    vi. Go through each edge blend point and narrow or widen the overlap.
    vii. Add points as needed. Example below
    viii. Pull your bottom edge down to spring line
    ix. Add a center point to assist
    x. After you have completed all blend edge regions, save your blend map

xi. Click Make New Maps and then Send Maps to send updated blend maps to each node
xii. View your progress with a planet or sun to see blend regions clearly
xiii. This process takes time and many passes to get perfect
xiv. Use Blur size, iterations, and Gamma to fine tune blend region

Example of a nearly blended system