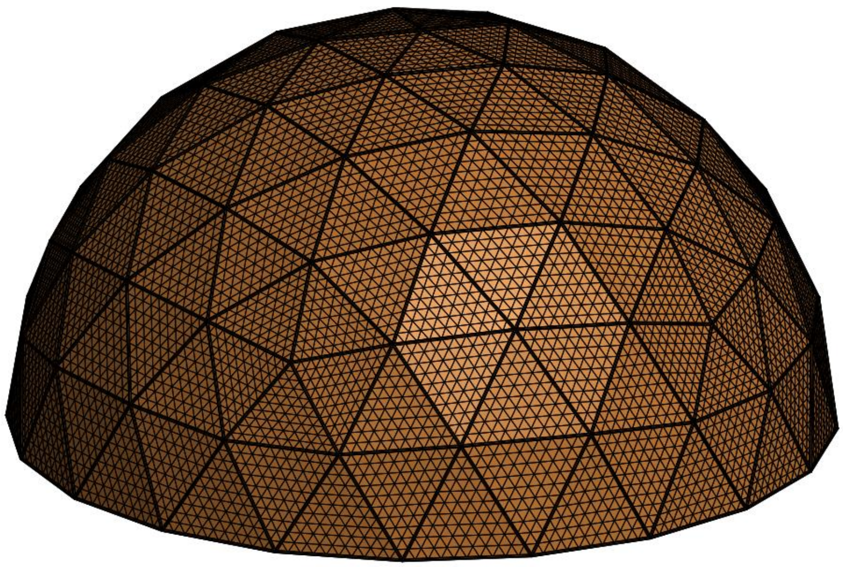
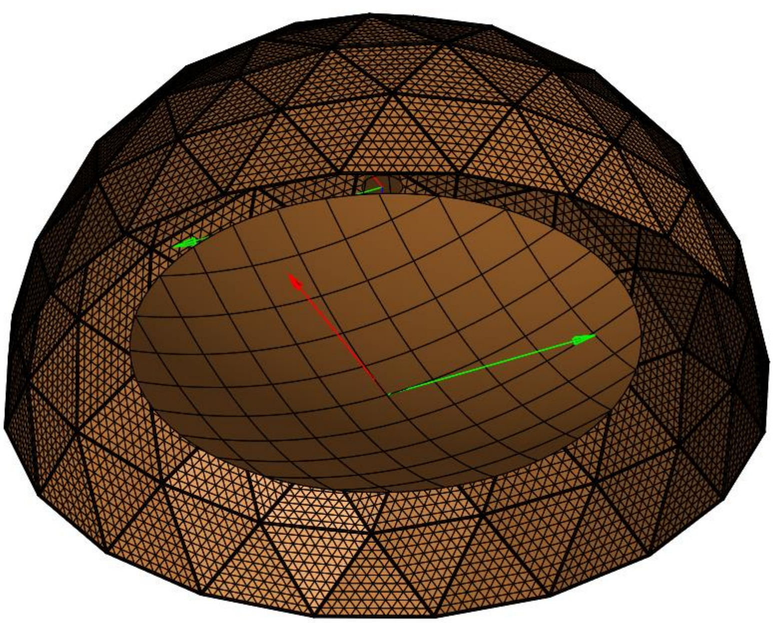
8-24 Metal Space Radome

A metal space frame radome has metal members forming a geodesic dome over the antenna with dielectric panels stretched in triangles.



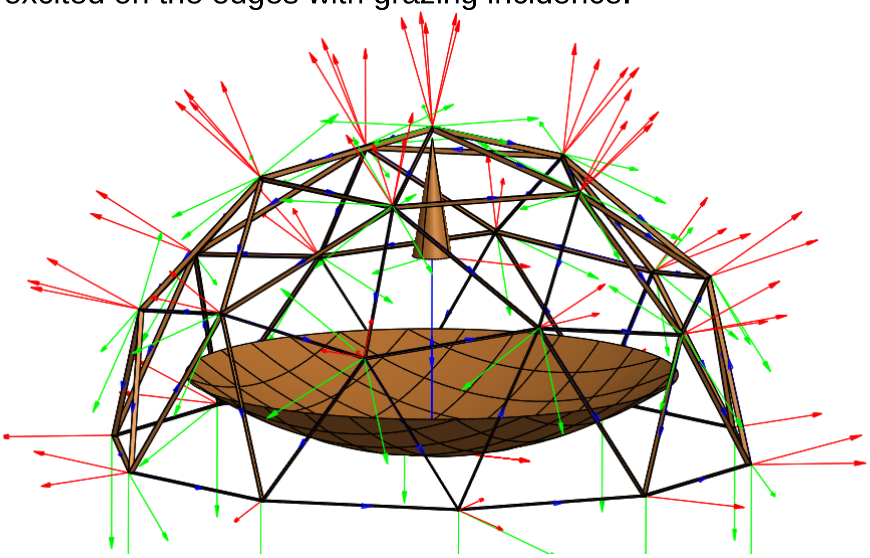
Dome using circular metal members (struts) and dielectric panels



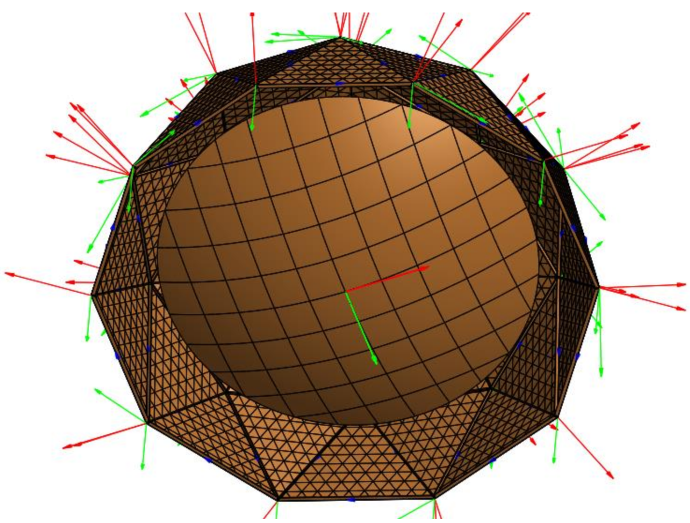
Radome from below showing the reflector located in the dome

When analyzed in GRASP (TICRA), the metal members are clustered together as a series of circular struts. The dielectric panels are entered one at a time and then gathered into a scatter_cluster so that all panels can be operated as a single entity in the command list. Both the series of circular struts and dielectric panels are referenced to a dome coordinate system which allows rotation of the dome over the antenna. This rotation allows determination of reflector beam changes as it is scanned while keeping the antenna boresight on the z-axis.

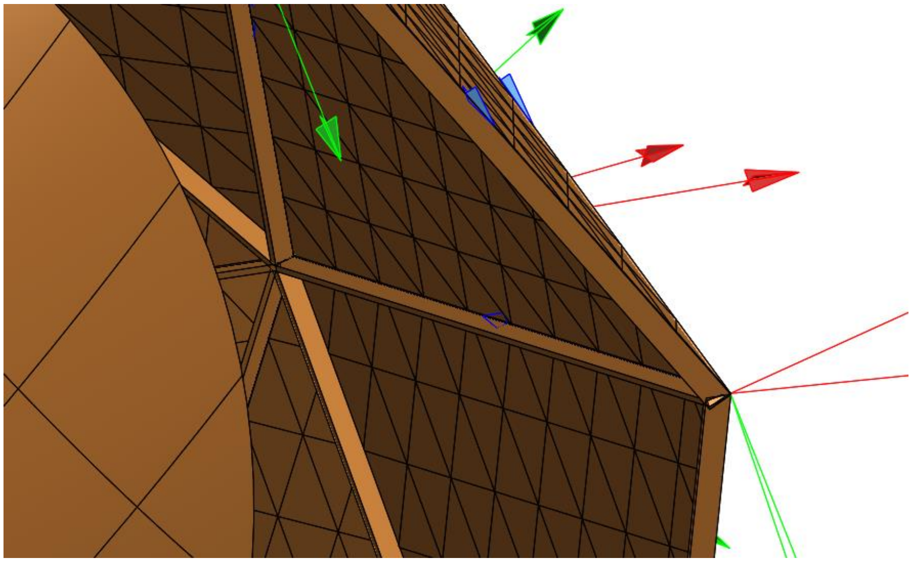
A second type of space frame radome uses rectangular strut members. These require that each strut have its own coordinate system in GRASP. This radome rotates the rectangular struts so that the narrow edge points radially to the center of the radome to reduce blockage. The actual struts are trapezoidal which means the inner edge can be larger than the outer edge and reduce GRASP run-time, because currents are not excited on the edges with grazing incidence.

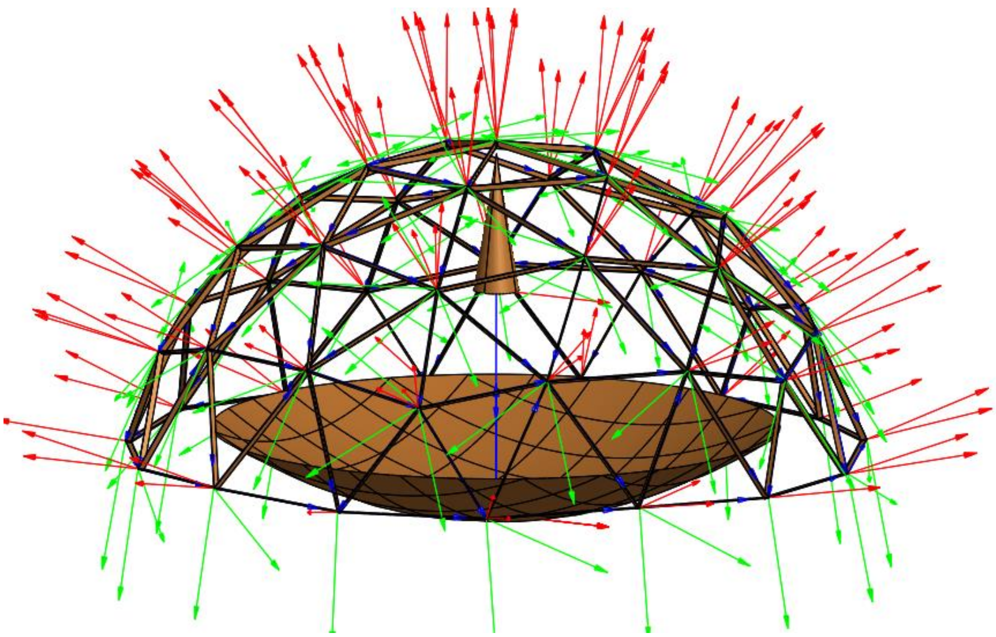


Two triangular subdivision geodesic dome using rectangular members in GRASP



Dielectric panels added between rectangular cross-section struts


Dielectric panels added to outside of struts


Rectangular strut geodesic dome using 3 subdivisions

The following download contains DOS executables to generate GRASP tor file additions to modify the tor file of reflector for the metal space frame radomes: geodesic_domes. The download includes files of a GRASP example of a 200λ diameter reflector under a 300λ diameter geodesic dome radome.

geodesr.exe generates geodesic dome using circular struts where the vertices location can be randomized.
geodespr.exe generates geodesic dome using trapezoidal struts with the narrow edge rotated toward the center of the dome including randomized vertices locations.

domecst.exe generates a dome using circular struts by using an input list of vertices location, strut endpoint list, and dielectric triangular panel endpoint list.
domerst.exe generates a dome using trapezoidal struts from an input list of vertices location, strut endpoints list, and dielectric triangular panel endpoints list.

The executables geodesr.exe and geodespr.exe output list files suitable for use in both domecst.exe and domerst.exe for input of geometry.

Below is an example of tor addition file insertion.

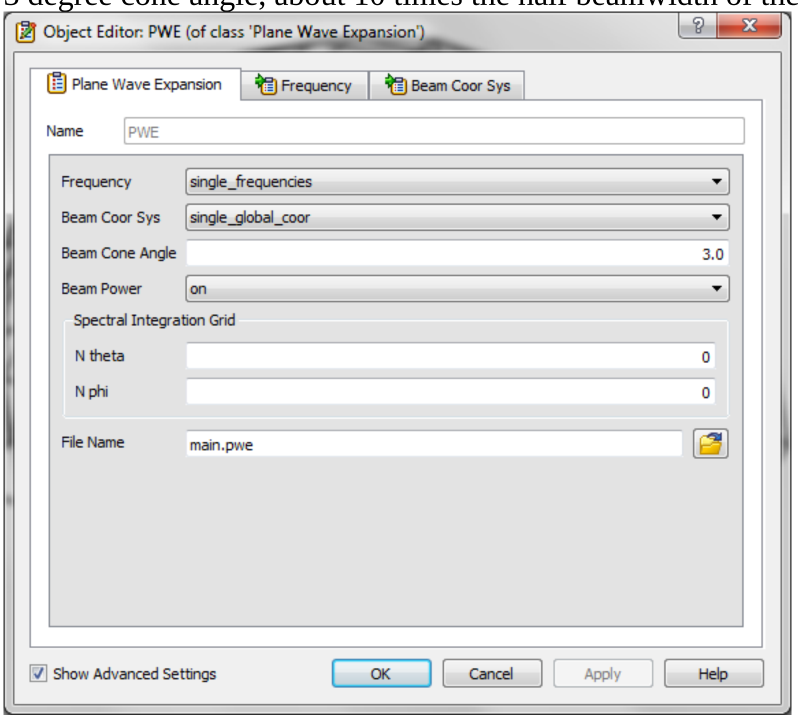
```
...

single_po  po_single_face_scatterer
(
  frequency        : ref(single_frequencies),
  scatterer        : ref(single_reflector),
  coor_sys         : ref(single_global_coor),
  file_name        : " "
)
---------------- generate dome coordinate system in GRASP and use in program input
dome_coor_sys  coor_sys
(
  base             : ref(single_global_coor)
)

-----------------------------   Start location tor additions
coor_sys_struts   coor_sys
(
  base            : ref(dome_coor_sys)
)

polygonal_struts   polygonal_struts
(
  position        : sequence
    (struct(coor_sys: ref(strut_coor_1), z1: 0.0  m, z2:  0.546533E+01  m),
    struct(coor_sys: ref(strut_coor_2), z1: 0.0  m, z2:  0.546533E+01  m),

...

    struct(coor_sys: ref(strut_coor_65), z1: 0.0  m, z2:  0.618034E+01  m)
    ),
  cross_section   : sequence
    ( struct(x: -0.150000E+00  m, y: -0.200000E-01  m),
     struct(x: 0.0  m, y: -0.100000E-01  m),
     struct(x: 0.0  m, y:  0.100000E-01  m),
     struct(x: -0.150000E+00  m, y:  0.200000E-01  m)
    )
)

strut_coor_1   coor_sys_euler_angles
(
  origin          : struct(x:  0.000000E+00  m, y:  0.000000E+00  m, z:  0.100000E+02  m),
  alpha           :  0.000000E+00,
  beta            :  0.105859E+03,
  gamma           :  0.180000E+03,
  base            : ref(coor_sys_struts)
)

...
```

```
strut_coor_65   coor_sys_euler_angles
(
  origin          : struct(x:  0.587785E+01  m, y: -0.809017E+01  m, z:  0.754979E-06  m),
  alpha           :  0.720000E+02,
  beta            :  0.317175E+02,
  gamma           : -0.121717E+03,
  base            : ref(coor_sys_struts)
)

 panel_diel  dielectric_layer
(
  thickness        :  0.50000E-02  m,
  dielectric_constant :  2.20,
  loss_tangent     :  0.10000E-02
)

dome_tri_1   triangular_plate
(
  coor_sys         : ref(dome_coor_sys),
  corner_1         : struct(x:  0.000000E+00  m, y:  0.000000E+00  m, z:  0.100000E+02  m),
  corner_2         : struct(x:  0.525731E+01  m, y:  0.000000E+00  m, z:  0.850651E+01  m),
  corner_3         : struct(x:  0.162460E+01  m, y:  0.500000E+01  m, z:  0.850651E+01  m),
  el_prop          : sequence(ref(panel_diel))
)

...

dome_tri_40  triangular_plate
(
  coor_sys         : ref(dome_coor_sys),
  corner_1         : struct(x:  0.688191E+01  m, y: -0.500000E+01  m, z:  0.525731E+01  m),
  corner_2         : struct(x:  0.951056E+01  m, y: -0.309017E+01  m, z:  0.754979E-06  m),
  corner_3         : struct(x:  0.894427E+01  m, y:  0.000000E+00  m, z:  0.447214E+01  m),
  el_prop          : sequence(ref(panel_diel))
)
dome_cluster    scatterer_cluster
(
  scatterers       : sequence(ref(dome_tri_1),
ref(dome_tri_2),
ref(dome_tri_3),

...

ref(dome_tri_40))
)

------------------------------------------- Input before this location

//DO NOT MODIFY OBJECTS BELOW THIS LINE.
//THESE OBJECTS ARE CREATED AND MANAGED BY THE
//GRAPHICAL USER INTERFACE AND SHOULD NOT BE
//MODIFIED MANUALLY!
view_1  view
(
  objects          :
sequence(ref(view_1_coor_sys_plot),ref(view_1_reflector_plot),ref(view_1_feed_plot),
ref(view_1_output_points_plot),ref(view_1_polygonal_struts_plot))
)

view_1_coor_sys_plot  coor_sys_plot
```

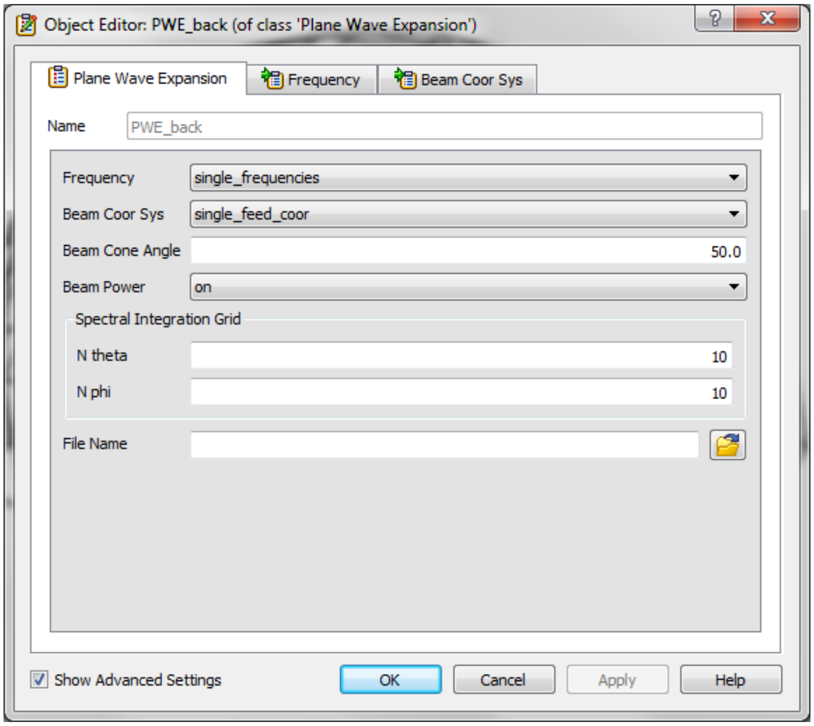
```
(
)

view_1_reflector_plot  reflector_plot
(
)

view_1_feed_plot  feed_plot
(
)

view_1_output_points_plot  output_points_plot
(
)

view_1_polygonal_struts_plot  polygonal_struts_plot
(
)

 //$$ Saved at 16:16:09 on 06.11.2013 by GRASP ver. 10.2.0 SN=003001
```

Example using 200λ diameter reflector

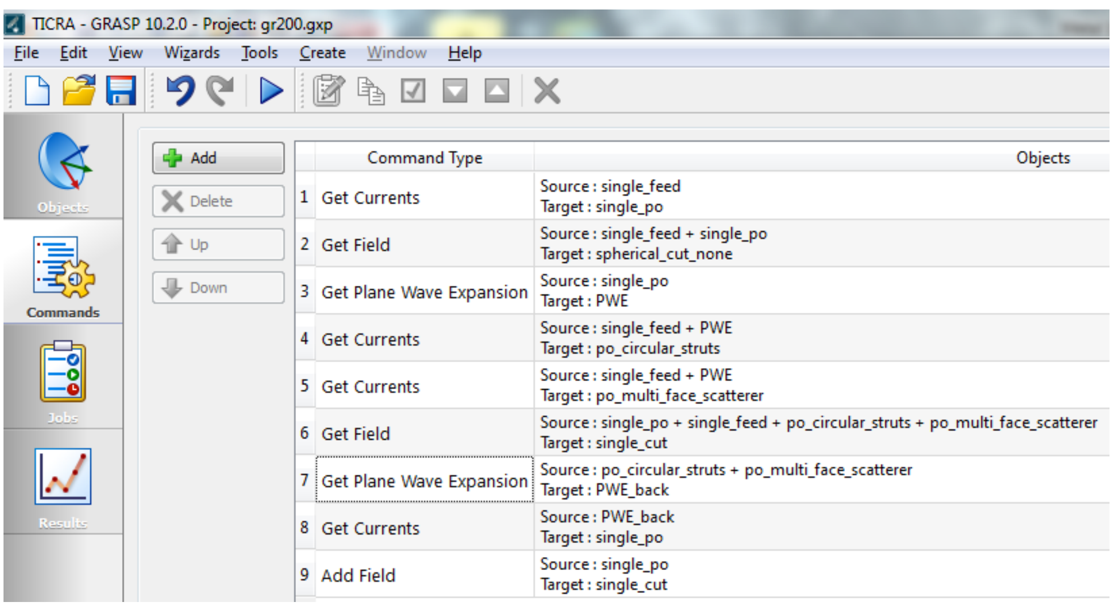
The command list uses a plane wave expansion (PWE) of the radiation from the reflector to excite currents on the struts and dielectric panels. The following PWE has been generated with a 3 degree cone angle, about 10 times the half beamwidth of the reflector: 35/200 = 0.18°.



A second PWE is used for the radiation from the struts and dielectric panels to the main reflector to account for the reflected wave. However since the radiation from the combination of struts and dielectric plates is not well focused the PWE may not give a significant reduction in runtime relative to using the currents directly to compute additional currents on the main reflector.



The following shows the commands for the analysis.



Command 1 uses the feed to excite currents on the main reflector. For a small reflector this command would be preceded by a command to excite currents on the struts from the feed. The combination of the feed and strut currents would be used to excite currents on the main reflector. The sum of main reflector currents and feed (strut currents) would be used to compute the pattern with further pattern contributions as "Add Field".

Command 2 uses the feed and reflector currents to compute the reflector radiation without the radome.

Command 3 uses the reflector currents to compute a PWE.

Commands 4 and 5 both use the PWE to excite currents on both the struts and the dielectric panels. (Note if the feed had excited currents on the struts, the radiation of these currents had already been computed and the currents can be replaced.)

Command 6 computes the far-field using the combination of all currents.

Command 7 uses the combination of the strut and dielectric panel radiation to compute a second PWE. (an optional command)

Command 8 uses the new PWE or the radiation from sum of currents used to generate the PWE in Command 7 to compute currents on the reflector due struts and dielectric panels which replaces the old currents due to the feed radiation.

Command 9 adds the radiation of the new main reflector currents that block the radiation of the struts and dielectric panels behind the main reflector. It also adds this reflected radiation to the boresight pattern, although it is a small term.