



Full Analysis of a buoy.

In this example it will be shown how to make a full RCS analysis of a buoy with cadRCS. The buoy is floating on the sea surface and fixed to the ground by a line; then it will tilt with the waves. In the full analysis mode all azimuth angles and elevation angles between 0 and 30 degrees will then be calculated. The buoy is symmetric so you will get the same results from minus 30 to 0 degrees, as no sea surface is included in this example.

The CAD file of the buoy can be downloaded here:

<http://www.cadrcs.com/Downloads/buoy/seabuoy.zip>

Start cadRCS and accept the license terms, then go to: File -> Open CAD file. Open the seabuoy.stl file. Go to File -> Project name and working directory. In Windows it is important that you create the working directory here otherwise the system can block the code cadRCS from writing files on it. Select Full analysis, different angles. As you see the aiming point and the default aiming point are both (0,0,0), so this is OK, otherwise you need to go to: Settings -> Change CAD position etc. and move the object so default aiming point = (0,0,0).

Set Start evaluation to 0.0 and Stop evaluation to 30.0. Set Framesize width to 1.0 and Framesize Height to 1.0. As this is a simple object you can make the calculation with less rays than normally so change both Number of columns and Number of rows to 256. Go to Settings -> RCS settings and set the values as below:

RCS settings. Special built to MAXrad SOFTWARE(India)

Transmitter polarization: ☒ Horizontal ☐ Vertical ☐ Right Circular ☐ Left Circular 1.000 +j 0.000 X+ 0.000 +j 0.000 Y

Receiver 1 Polarization: ☒ Horizontal ☐ Vertical ☐ Right Circular ☐ Left Circular 1.000 +j 0.000 X+ 0.000 +j 0.000 Y

☐ Receiver 2 active

Main frequency in GHz: 3.000000 ☒ Discrete frequencies ☒ Use auto minimum and maximum values for mono pulse

Second frequency in GHz: 6.000000

3rd frequency in GHz: 9.000000

4th frequency in GHz: 1.400000E+1

Number of additional frequencies: 3

High Resolution Range gate size in meters: 1.000000

Minimum RCS in HRR profile in sqm: 1.000000E-1

☐ Use theory of Physical Optics

☐ HRR data in phase

☐ RCS data in phase

Minimum number of reflections in images: 1

Maximum number of reflections in images: 10

Min RCS in color code (dB under total reflection): -3.000000E+1

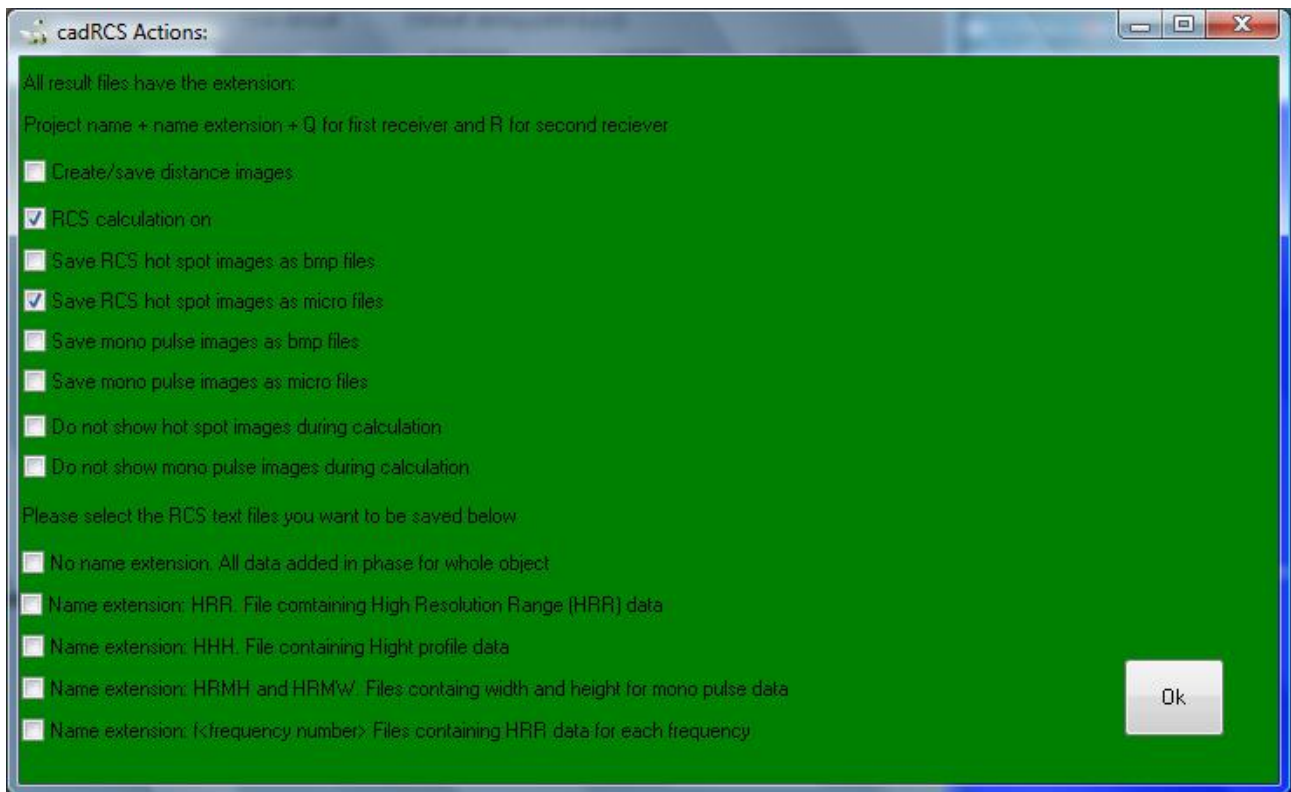
OK

Push OK.





On the main menu go to Actions and set the actions as below:



On the main menu you can see that cadRCS now are ready to do 2880 calculations, this will not take long time so as we selected less rays, so push Process. After calculation is done close cadRCS.

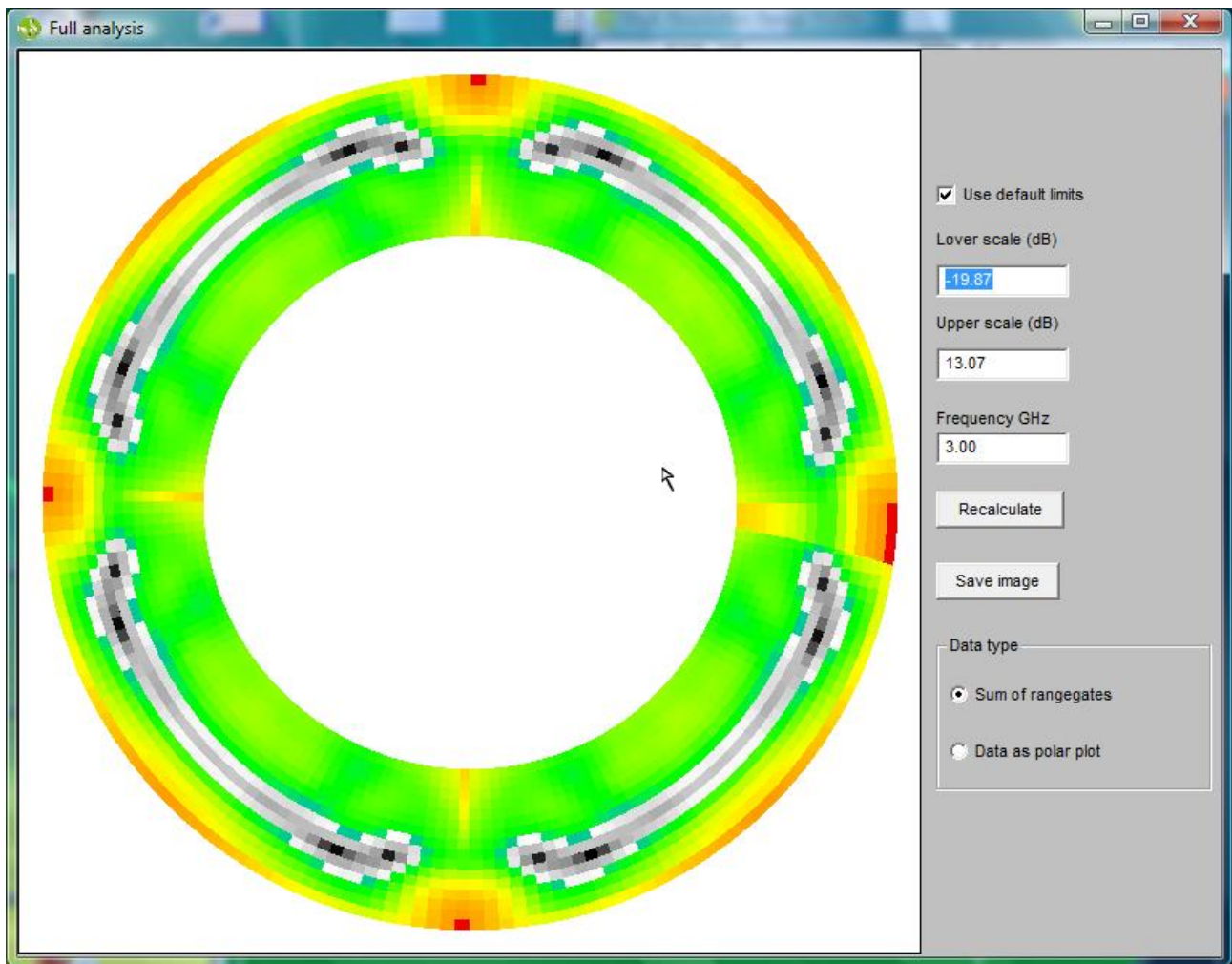
Open movie. Select all the mic files in movie. Push Pack micro files and save the file. This file can be downloaded here:

<http://www.cadrcs.com/Downloads/buoy/seabuoyrun.zip>





Push Make full picture and you get the Full analysis window:

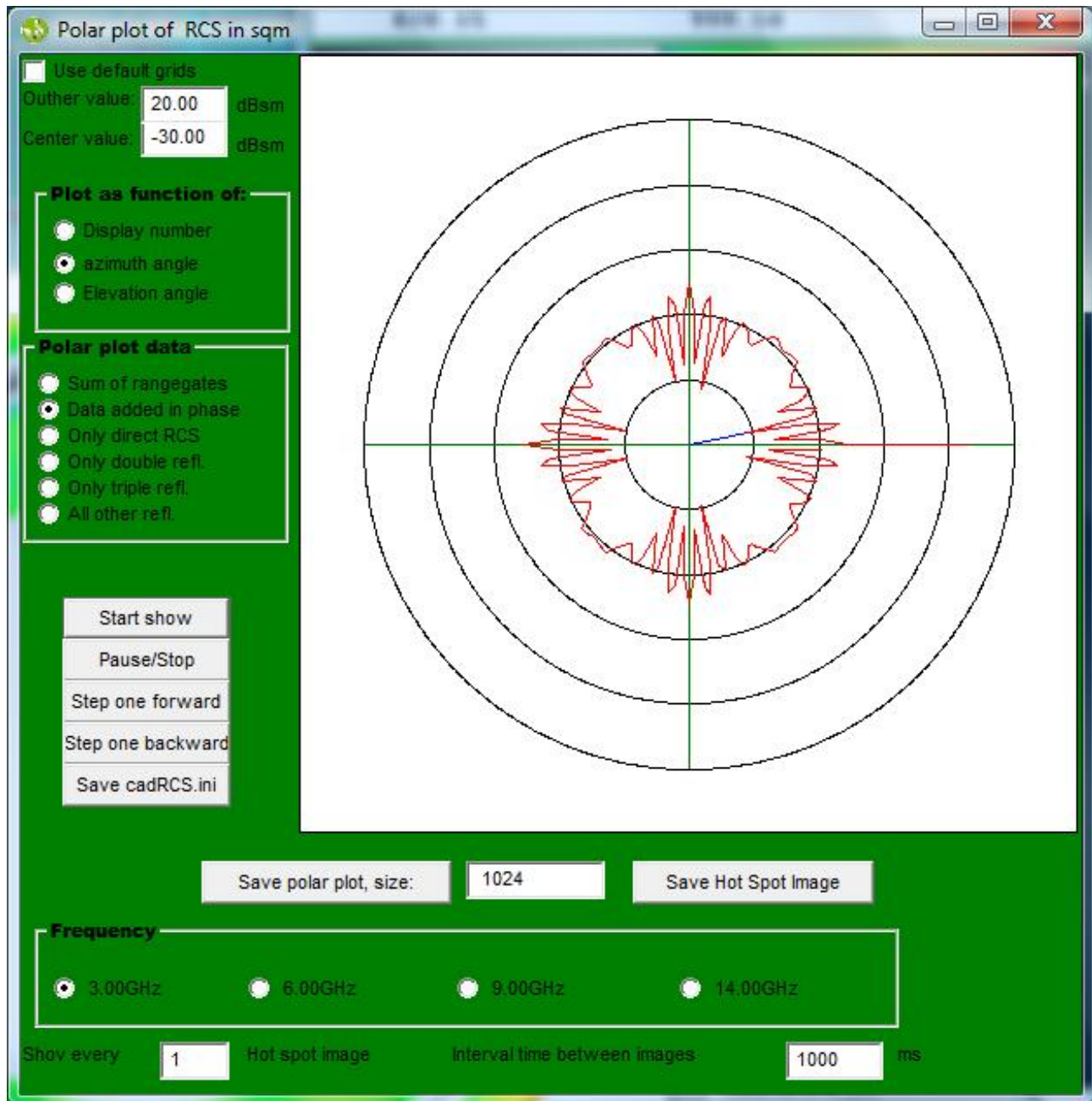


As seen from this plot, there are areas, where there is little reflection.





To check the elevations angles for this go to the main movie window: Polar plot of RCS in sqm. Do first change interval time between images to 100 ms – otherwise it goes too fast - and push Start show. Then go back on the window Full analysis and click with the mouse on the image just before an area with the low values and quickly after push Pause/Stop on the main movie window. On the main window now unselect Use default grids and change the window like this:

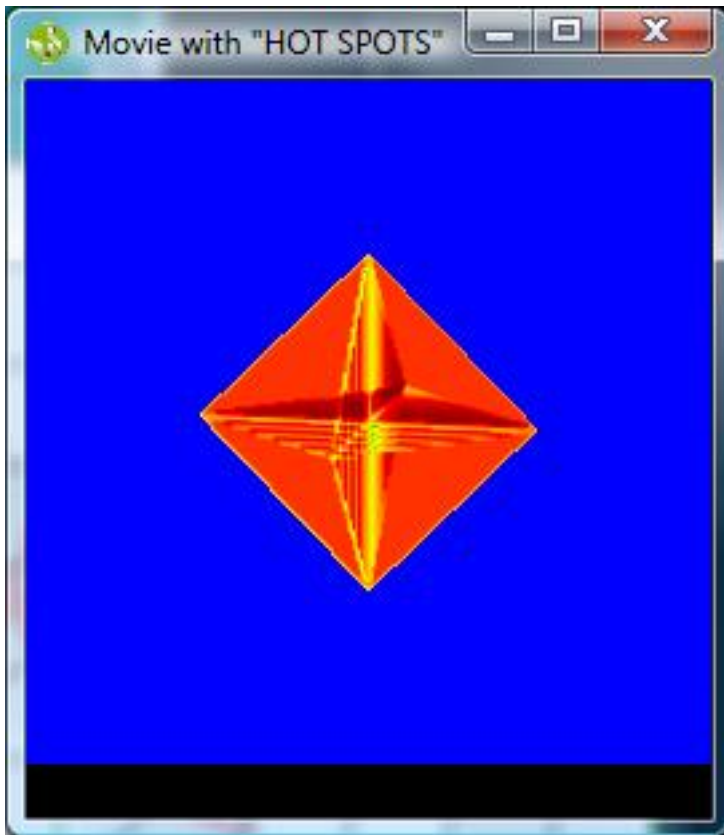


On the polar plot you see that the RCS for this elevation angle is very low about – 10dB/sqm. The elevation angle can you see on the window High Resolution Range Profile and in this case it is 12 degrees.





The Hot Spot window look like this:

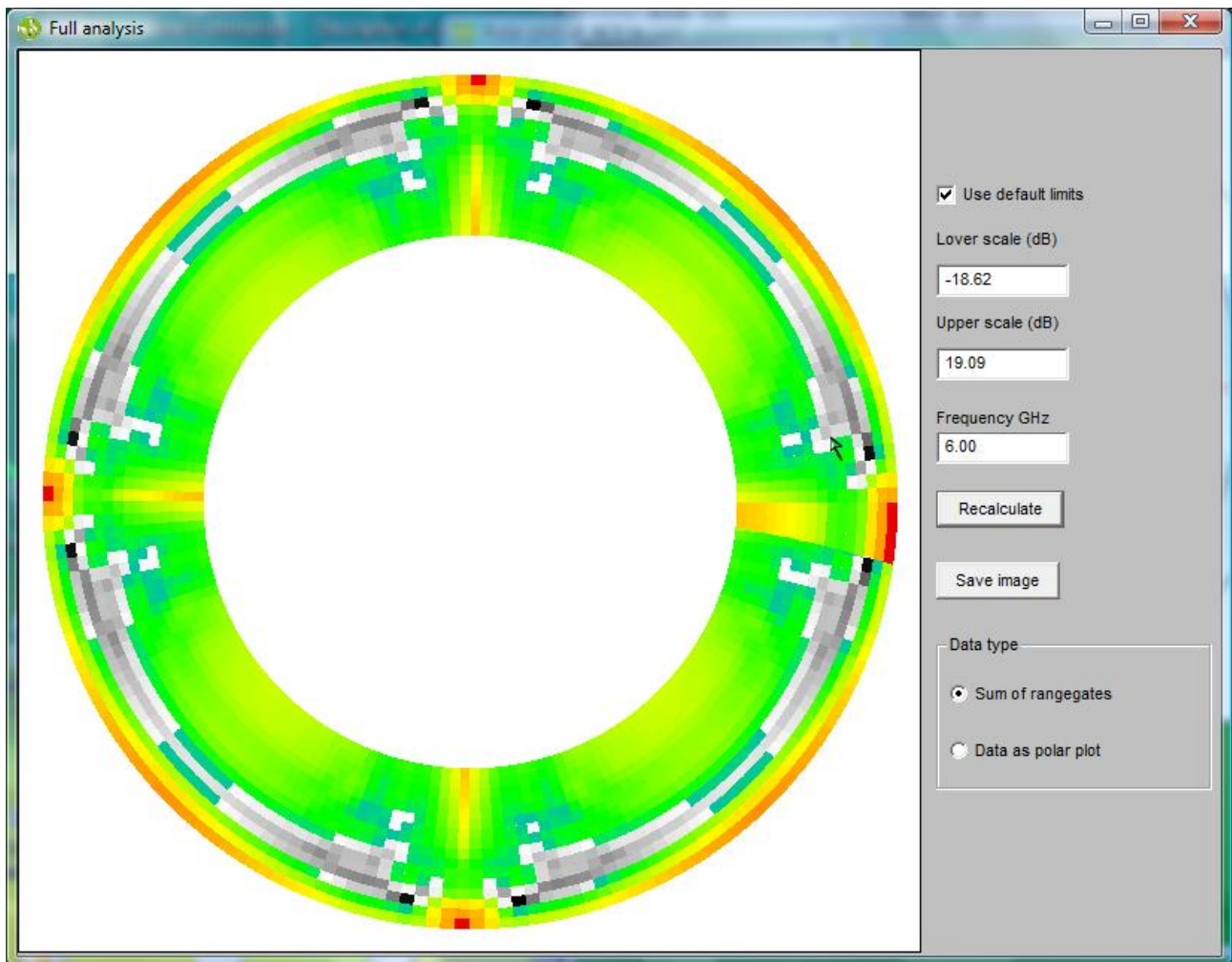


The conclusion is then that the small reflection in this elevation area is due to the fact that in this case the returned RCS energy from the different corners then is added in counter phase. We will then expect a total different image on the Full analysis window if we change the frequency.





Go to the main movie window and select now 6.0 GHz. Then push Recalculate on the Full analysis window. Then the full analysis window look like this:



As expected the area with low RCS is now in another elevation angles. Now you can repeat this for the other frequencies. As seen from all these plots, the reflection of the buoy will improve for all frequencies if we can put it to stay in level. This is not a good idea, as we did not include the reflection from the water surface. When we do this there will be distances where we will get very low RCS due to the reflection in the water surface and the direct reflection from the corner reflector add in counter phase. If we keep it as it is, the RCS of it will only be low occasionally and this is the radar on the ships prepared for.

Now with this in mind we turn the lower part of the buoy reflector 45 degrees and run again. These data can be downloaded at:

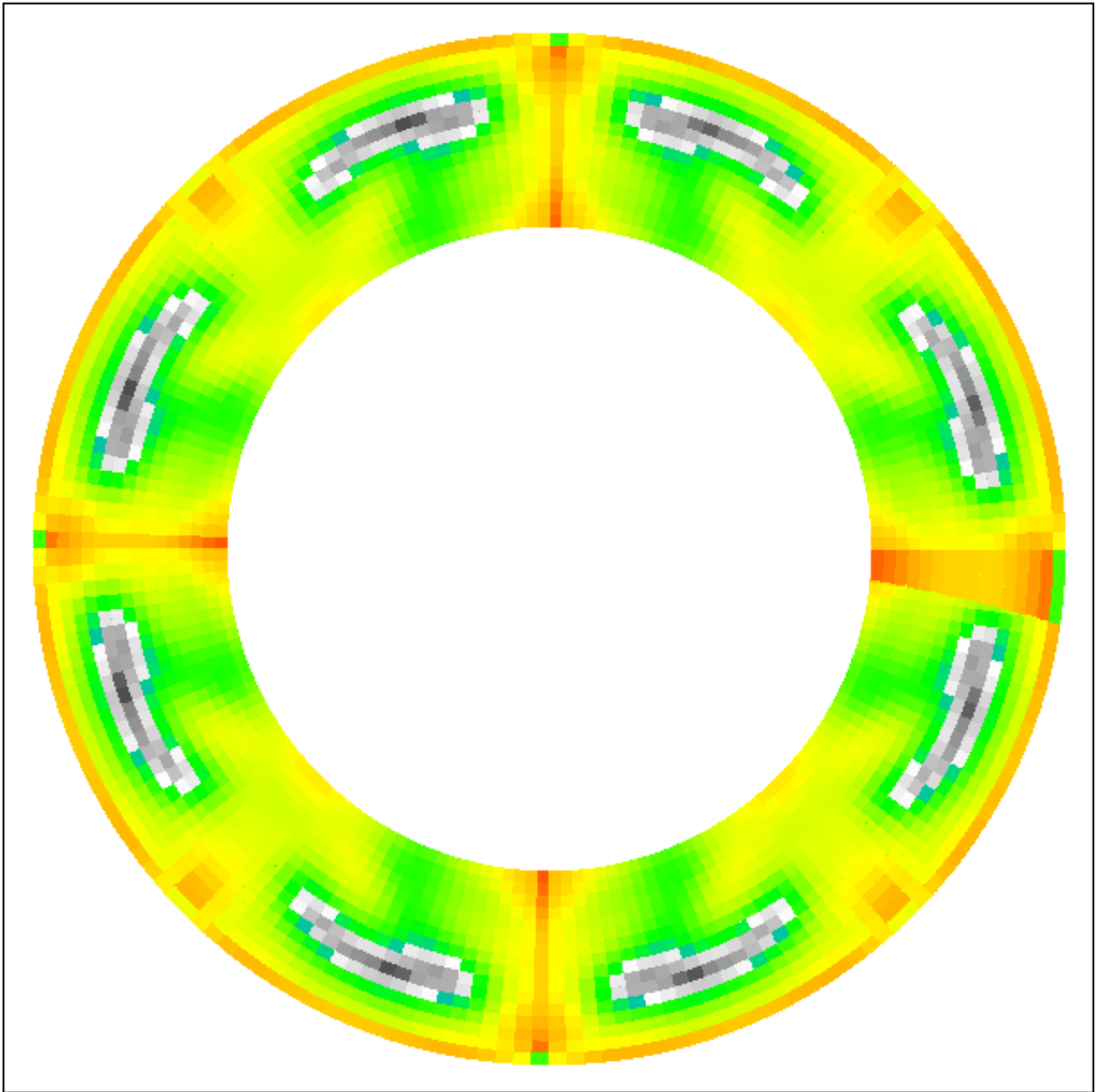
<http://www.cadrcs.com/Downloads/buoy/seabuoyturn45.zip>

We then run movie again and see the results on the full picture.



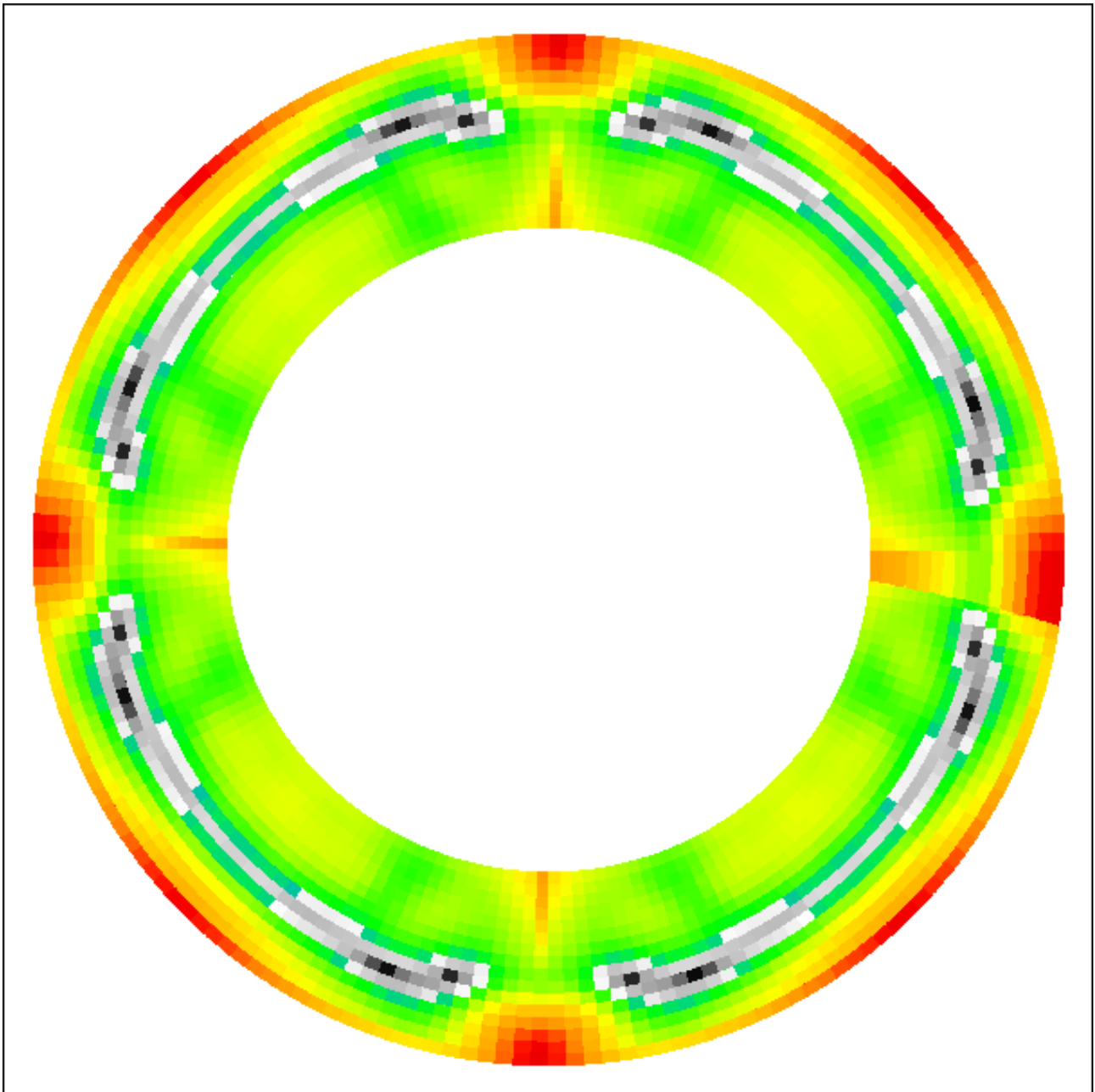


The result for 3 GHz when we unselect “Use default limits” on the movie window Full analysis and set the Lower scale to – 20 dB and the Upper scale to 10 dB will then be:





Then we do the same with the old data and then we get the result for 3 GHz:



When we compare the two results we see that we have improved the RCS of the sea buoy very much just by turning the lower part 45 degrees. Of course this must be analysed with a real CAD model of a buoy with a material thickness and also other turning angles can improve the RCS. This document however is a cadRCS training document and people having access to cadRCS and interested in the subject are welcome to do so themselves.

