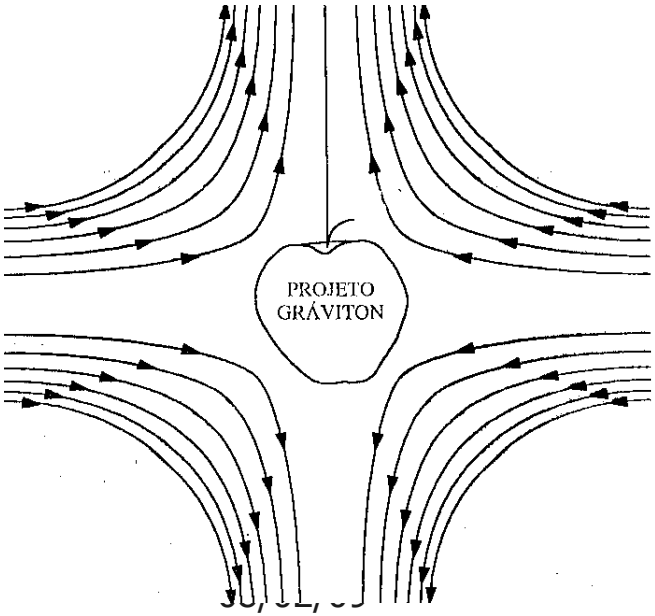
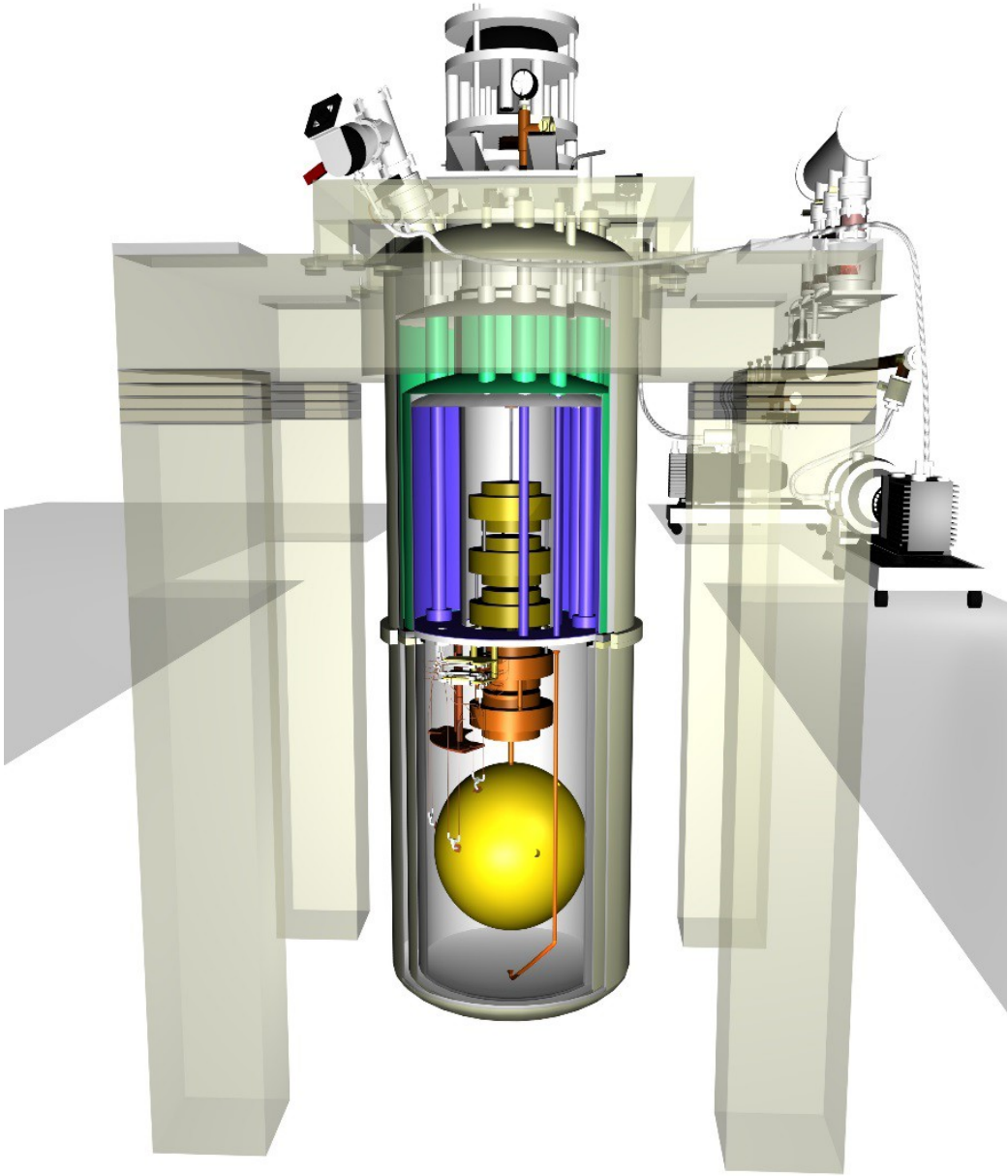
Schenberg microwave cabling seismic isolation

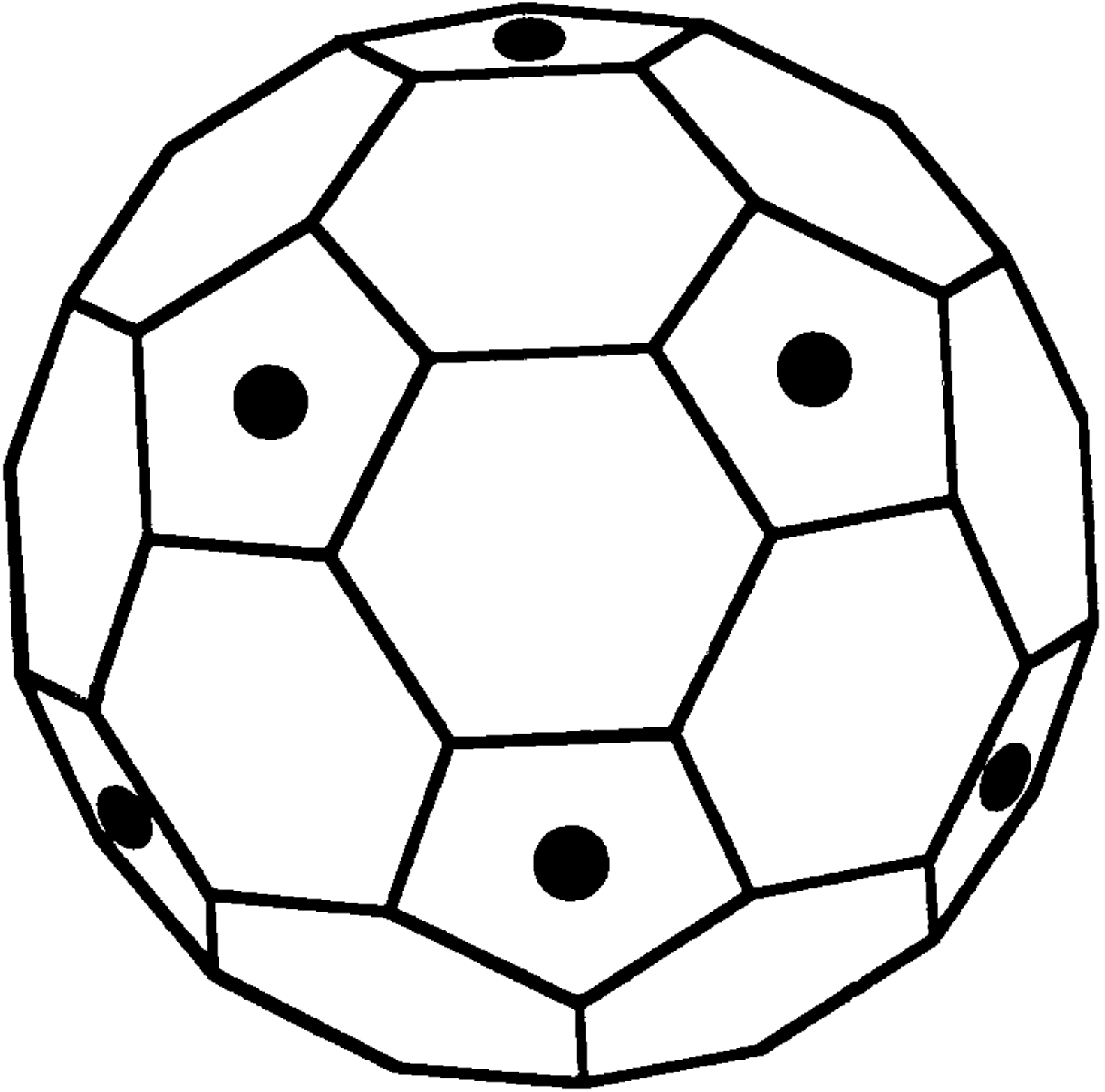
Carlos Frajuca
Fábio da Silva Bortoli
São Paulo Federal Institute
Odylio D. Aguiar
Space Research National Institute
Nadja Simão Magalhães
São Paulo Federal University



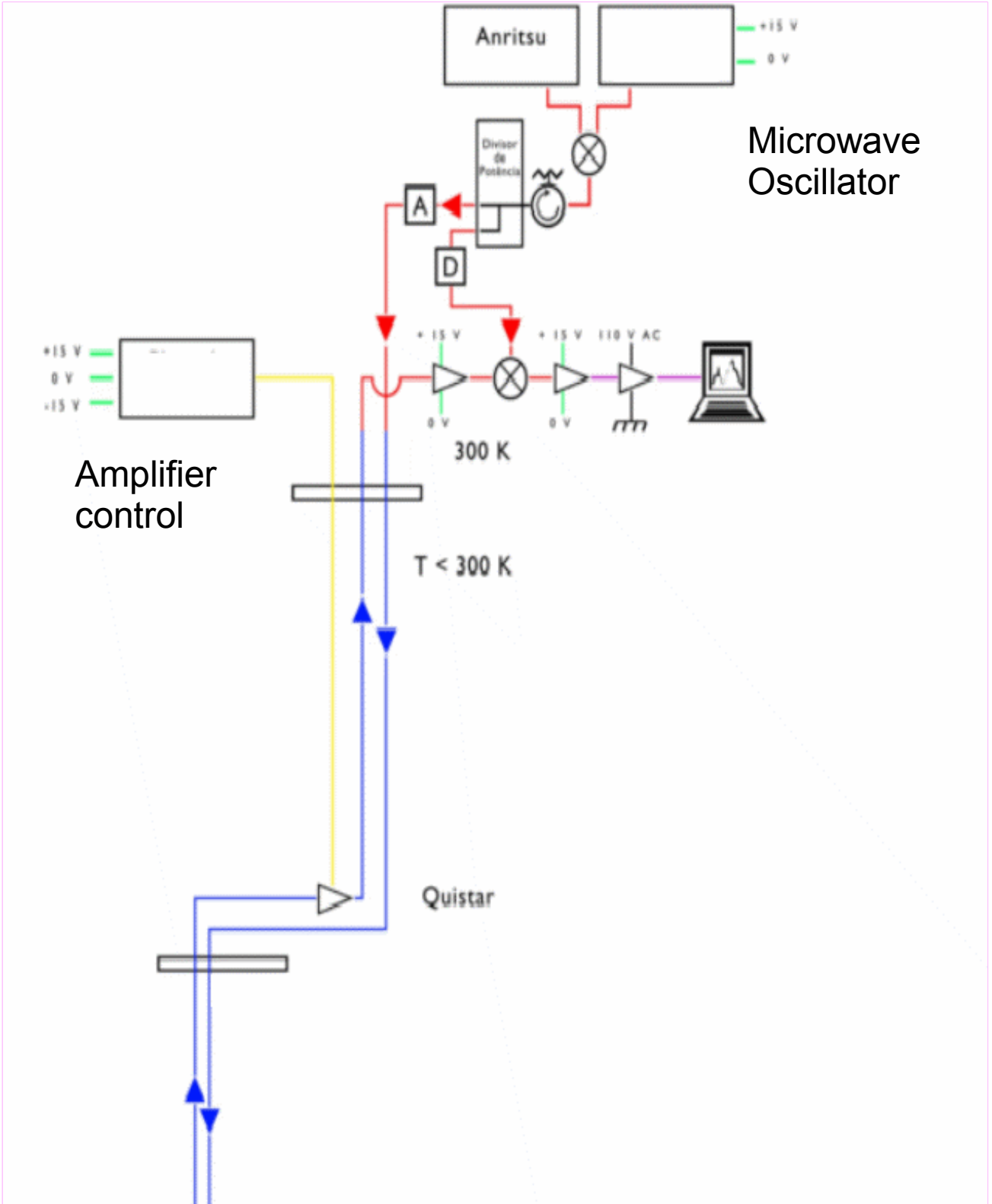
SCHENBERG CHARACTERISTICS

- Mass 1.15 metric ton
- Diameter 65 cm
- Alloy 94% Cu-6%Al
- Temp. 50mK -->4K
- Parametric μwave transducer

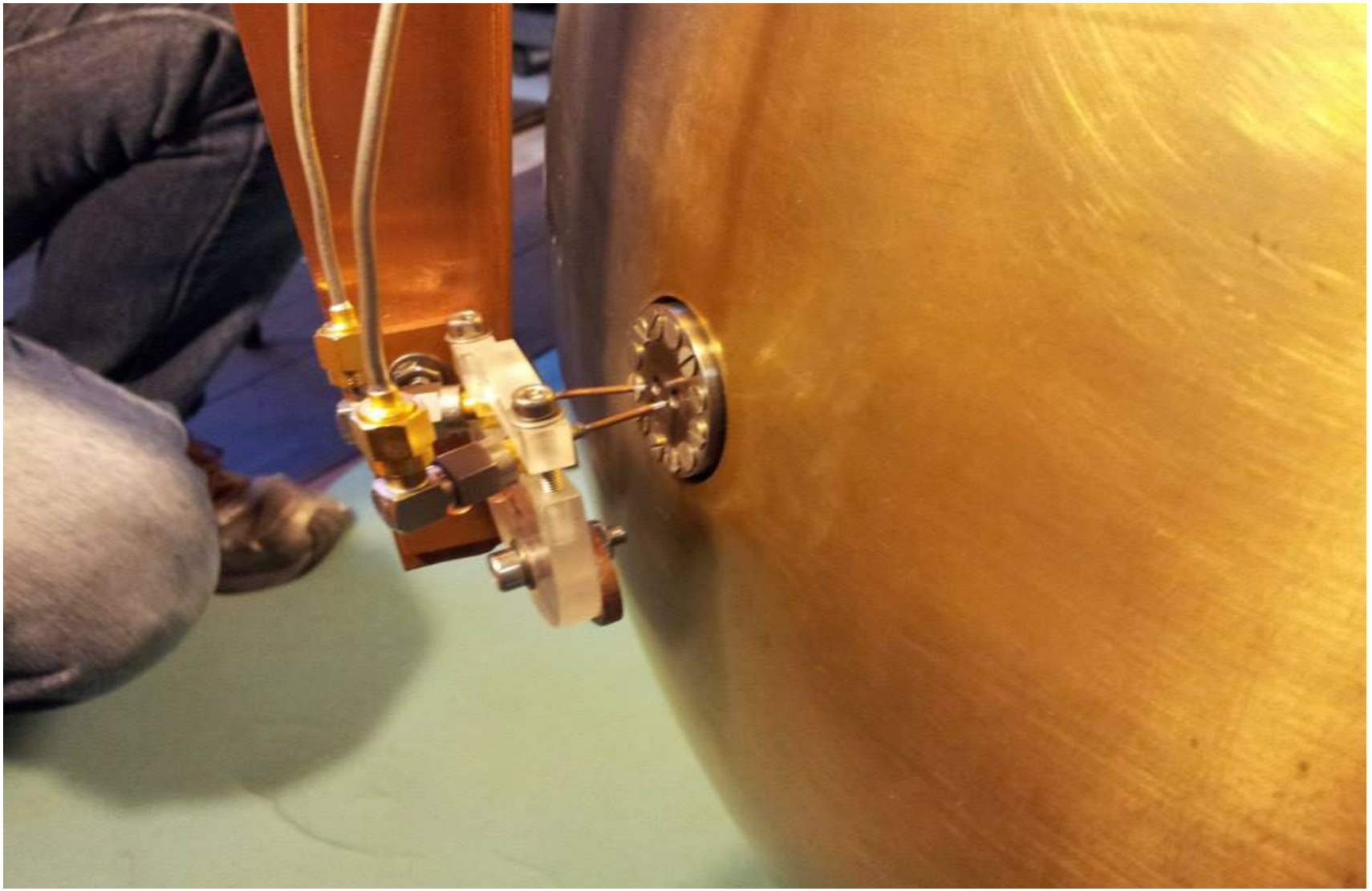


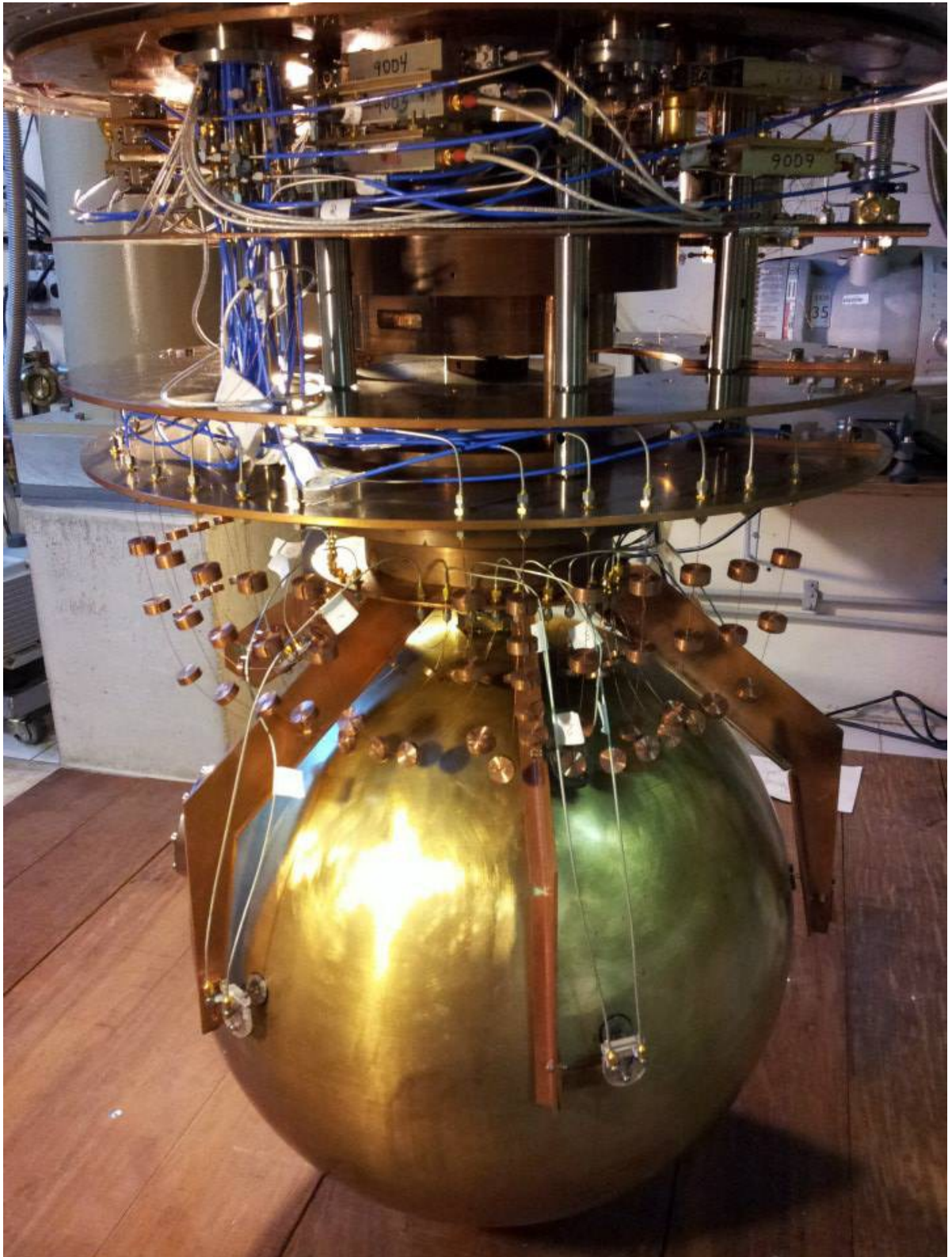


Schenberg Electronics



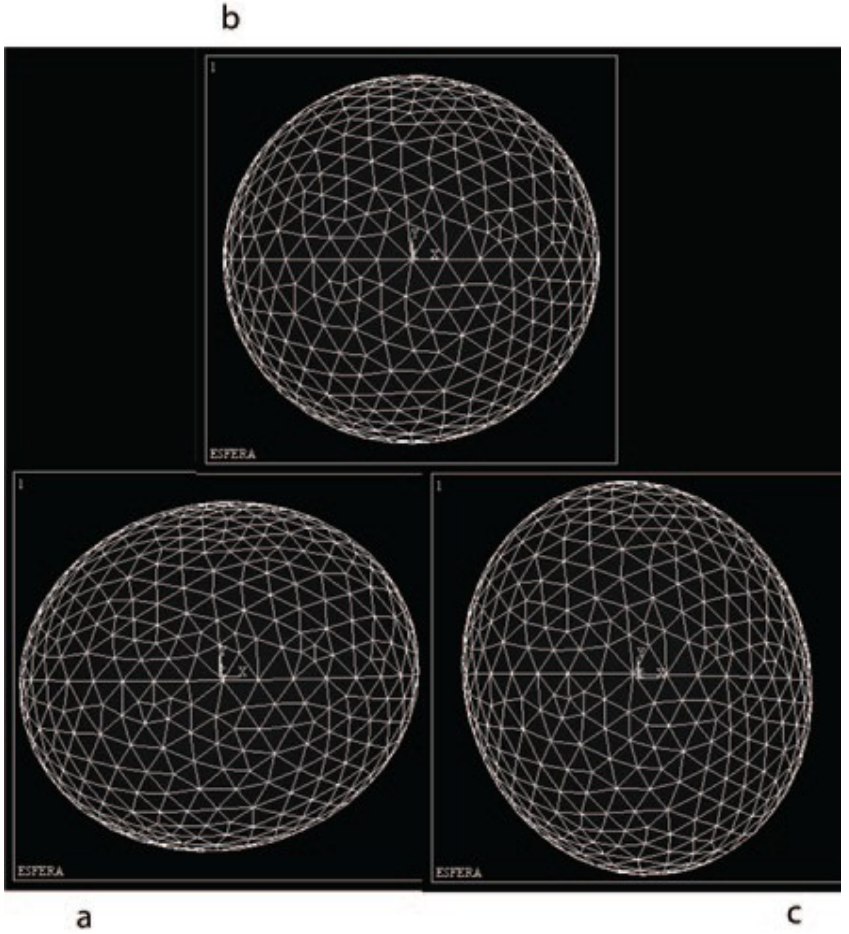
Two mechanical mode transducer on the sphere surface



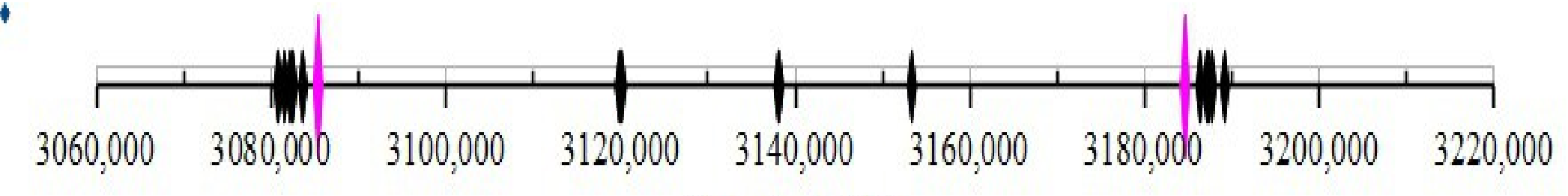

9004
9009

The sphere by itself in FEM

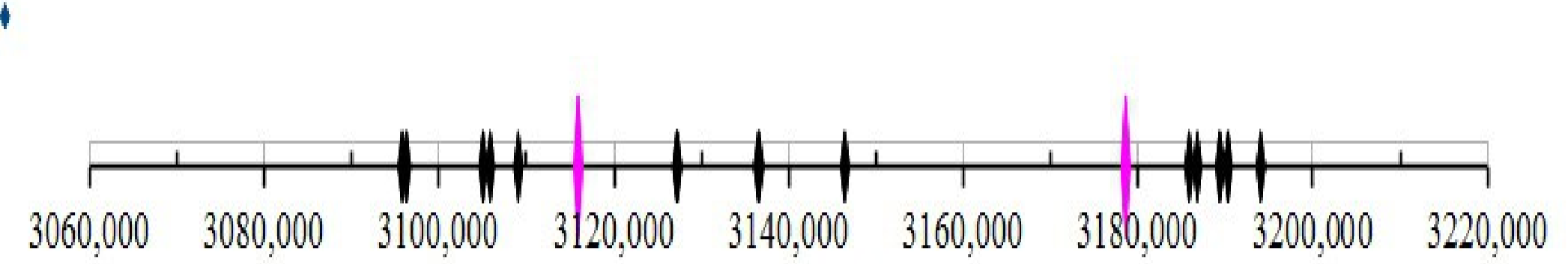
The frequencies for the five quadrupole modes were 3189.7, 3190.0, 3190.8, 3191.2 and 3192.1 Hz.



Mode frequencies

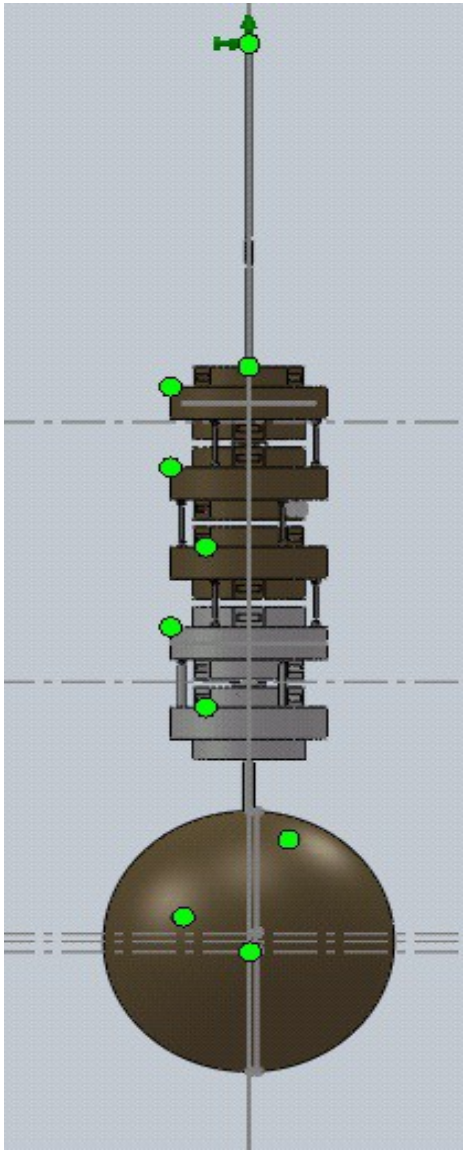


Frequency (Hz)

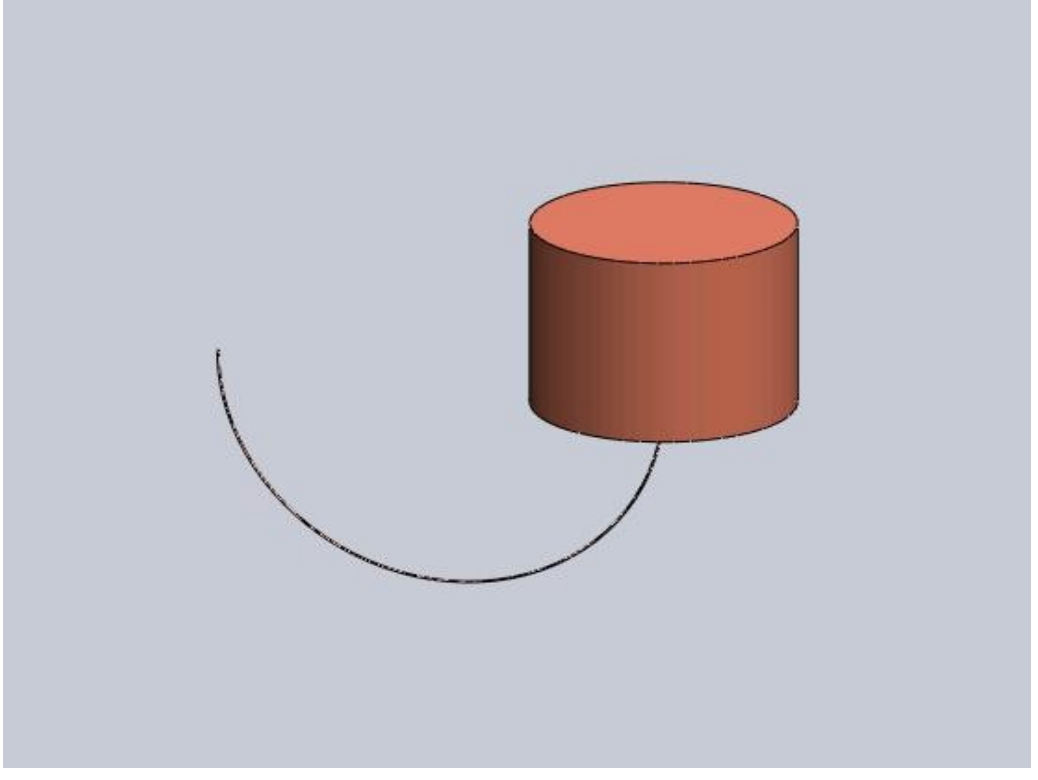


Frequency (Hz)

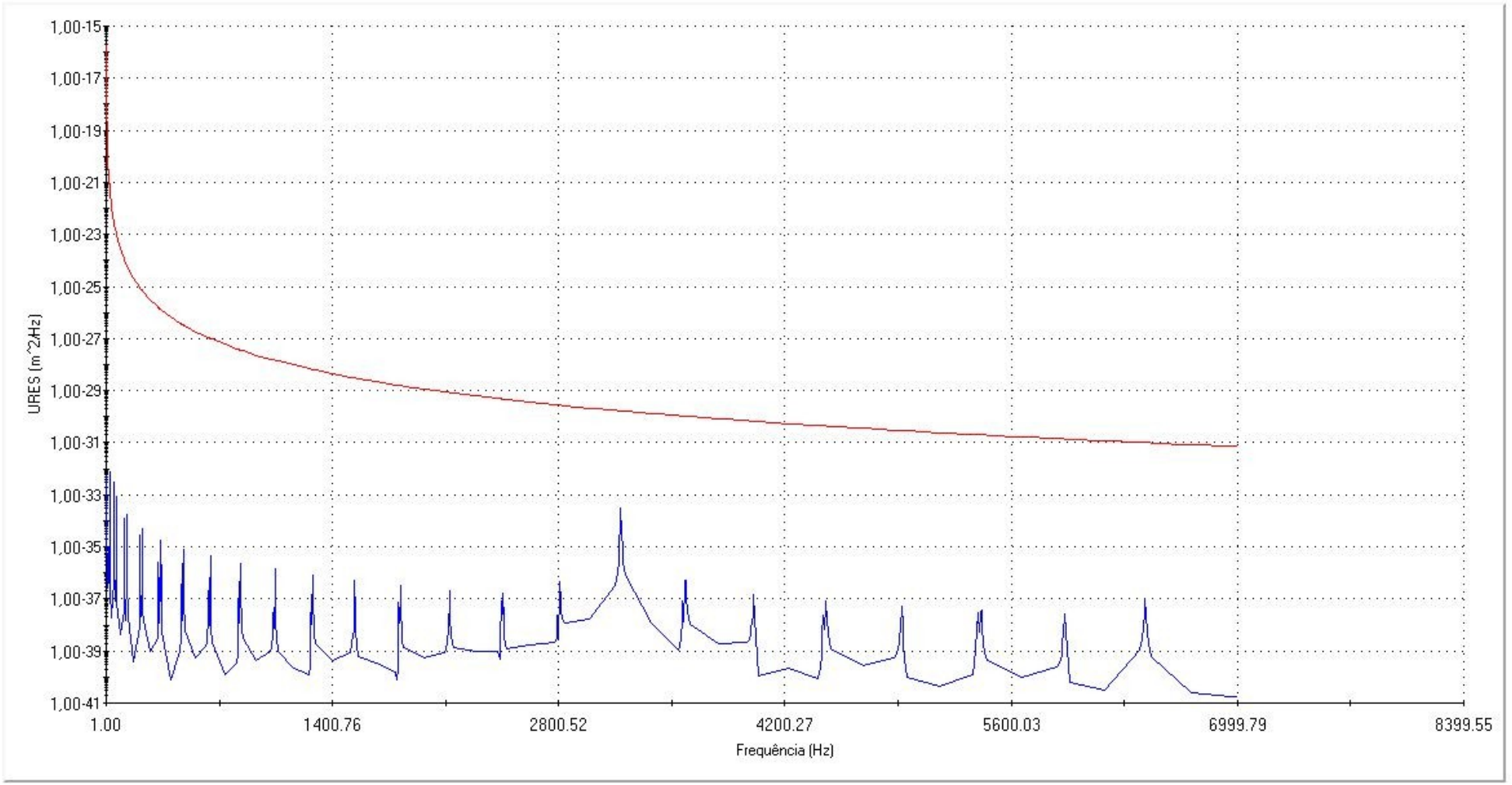
Seismic attenuation on the sphere surface



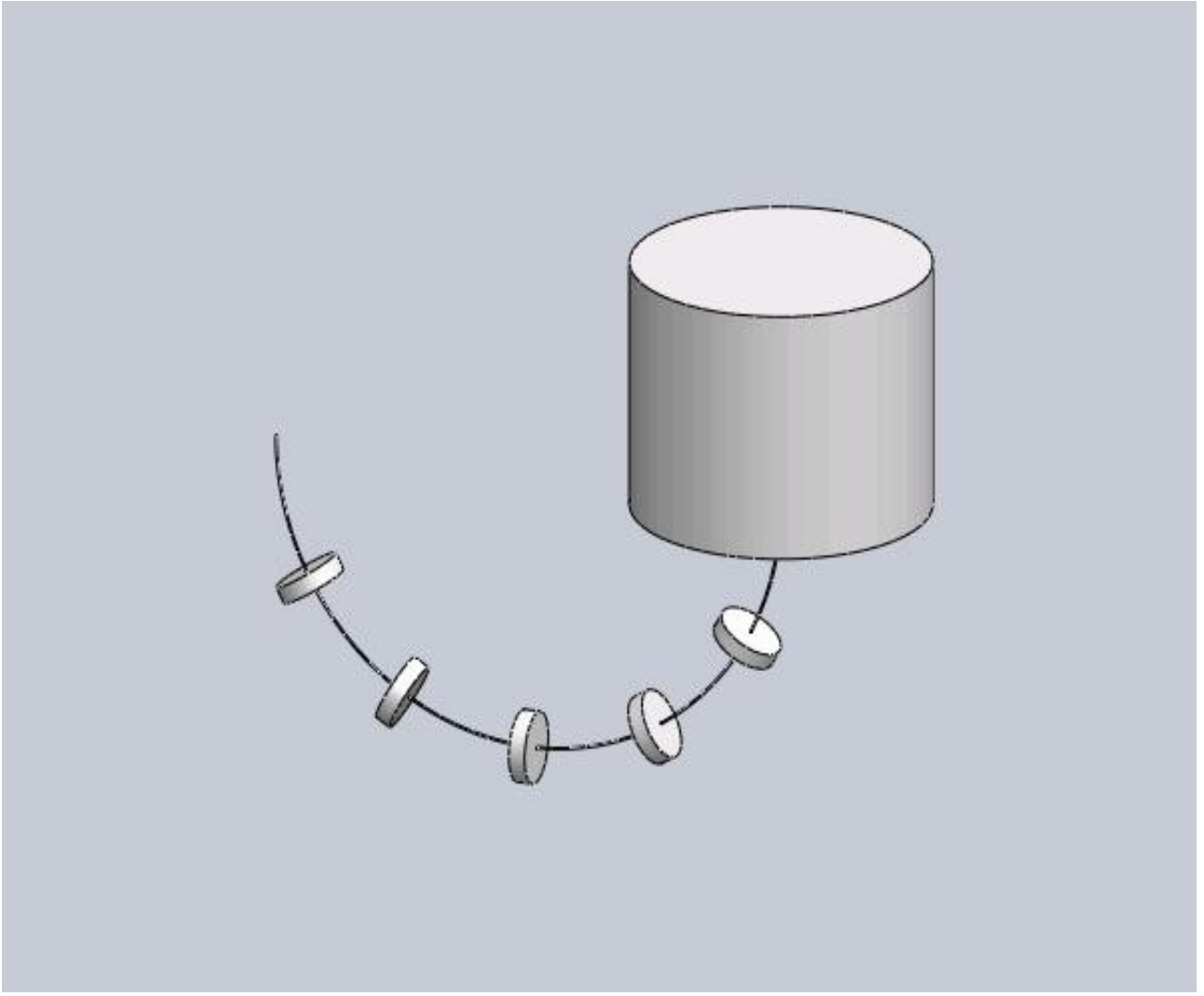
System composed of the copper cable with a diameter of 0.5 mm and a radius of 80 mm connected to a cylindrical mass, called a rigid mass. The rigid mass on the right is used in the model to take into account the effect of the sphere suspension on the cabling. The excitation considered acts on the left end of the cable.



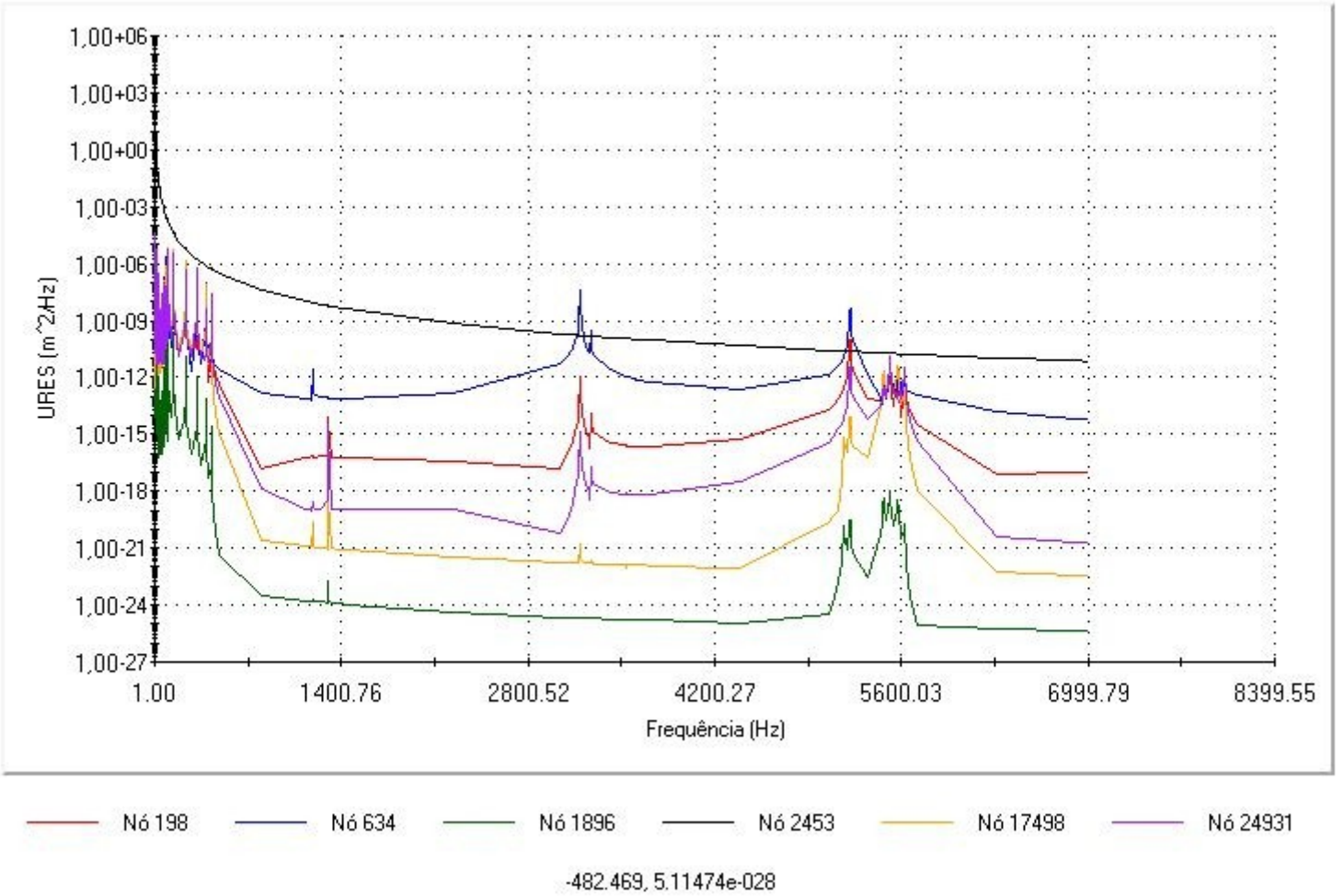
Frequency response curve for the system showed in the previous slide was calculated using SolidWorks Simulation 2011 version, using a dumping ratio of 0.0005.



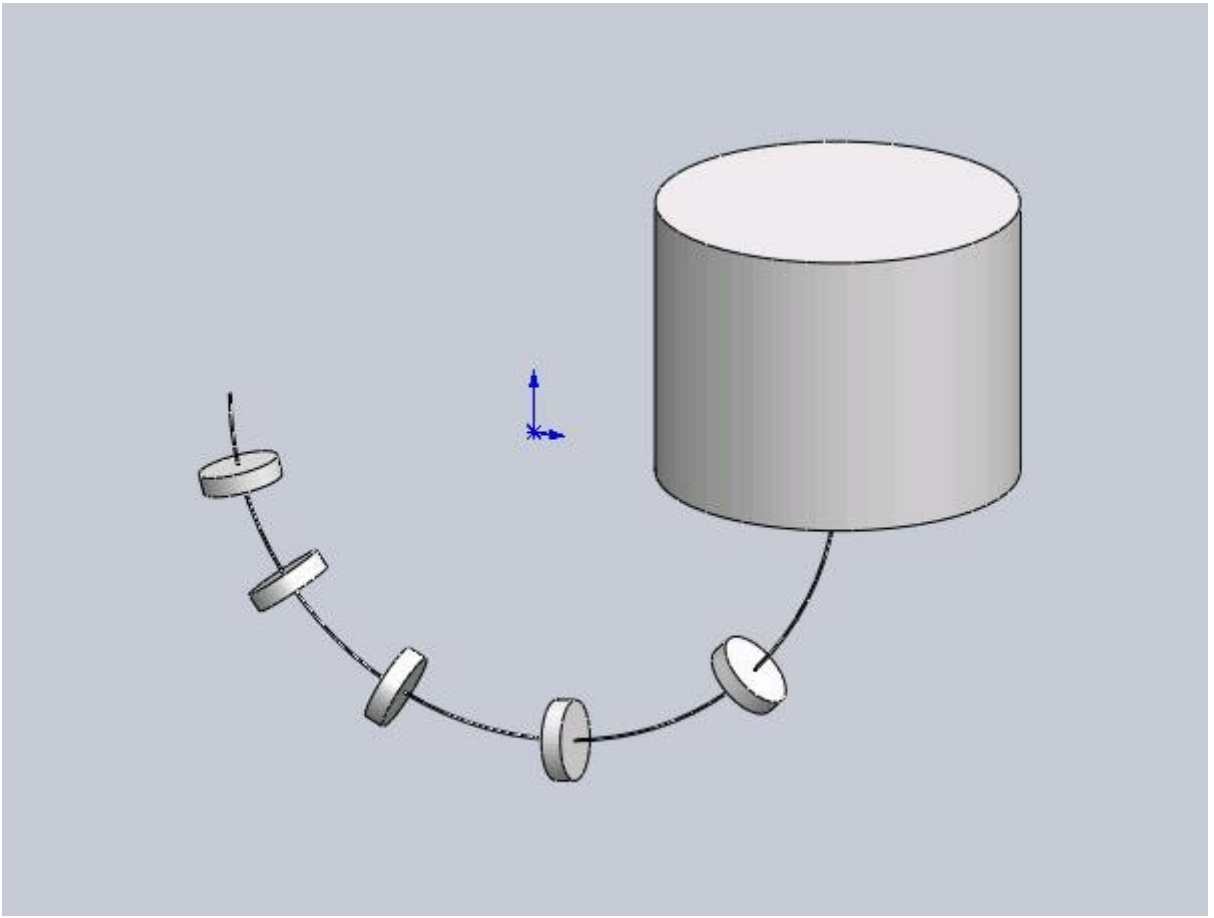
System composed of the copper cable, connected to five disks with a diameter of 20 mm and a thickness of 5 mm and the rigid mass.



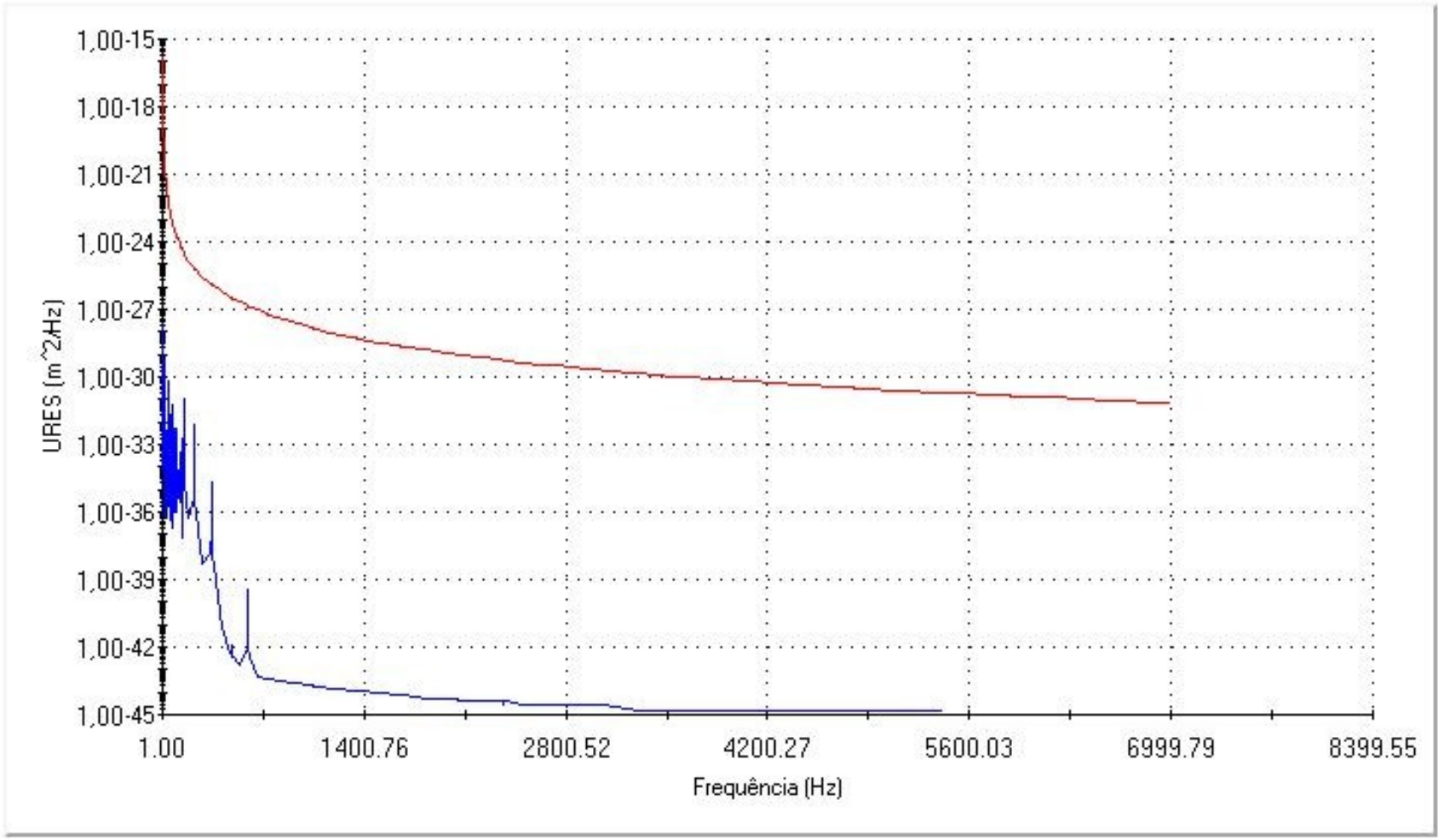
Frequency response curve for the system shown in previous slide.



System composed of the copper cable connected to five disks with a diameter of 20mm and a thickness of 5mm and the rigid mass. This system is similar to previous one, but here the distance between the disks is increasing.



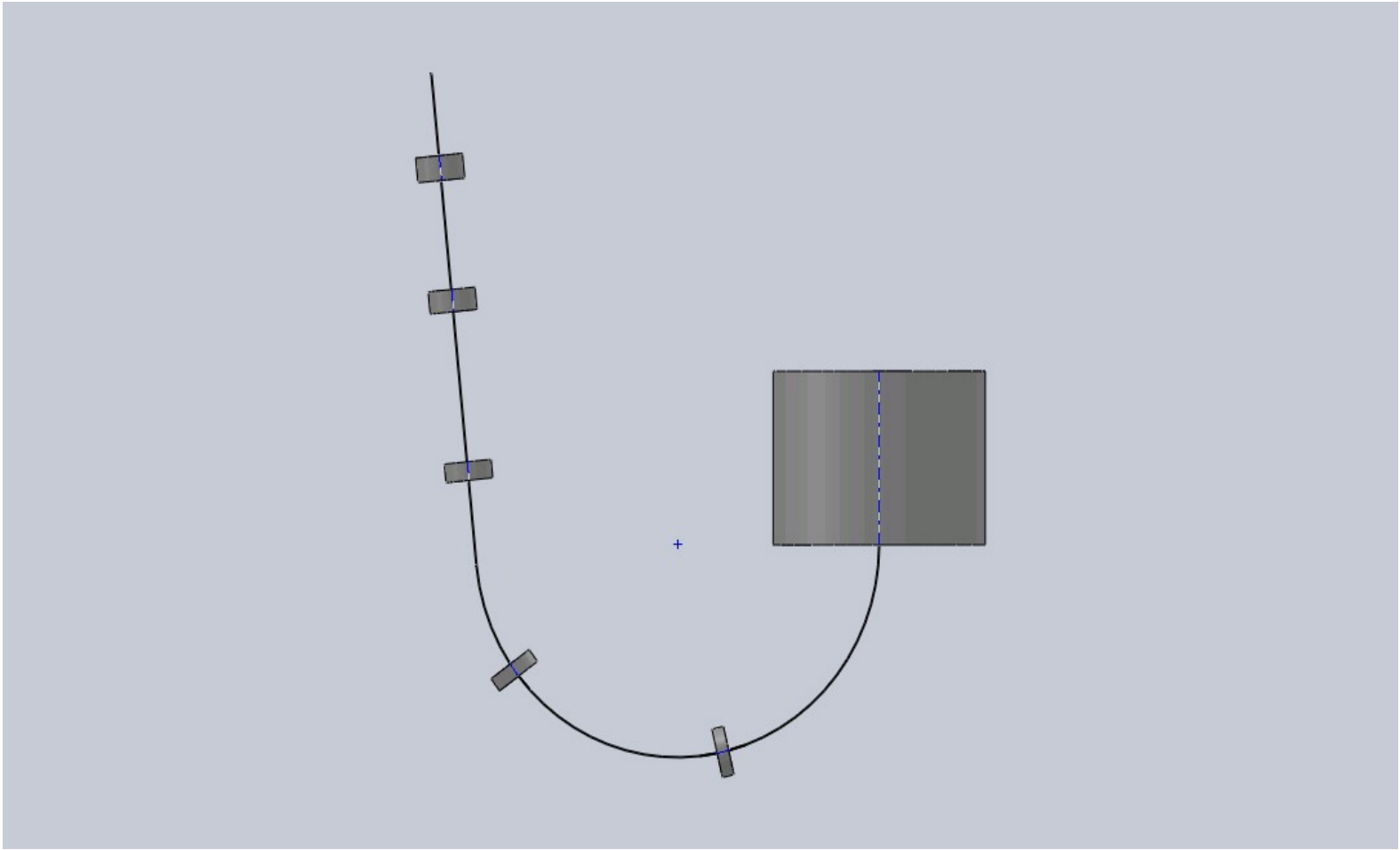
Frequency response curve for the system shown on previous slide.



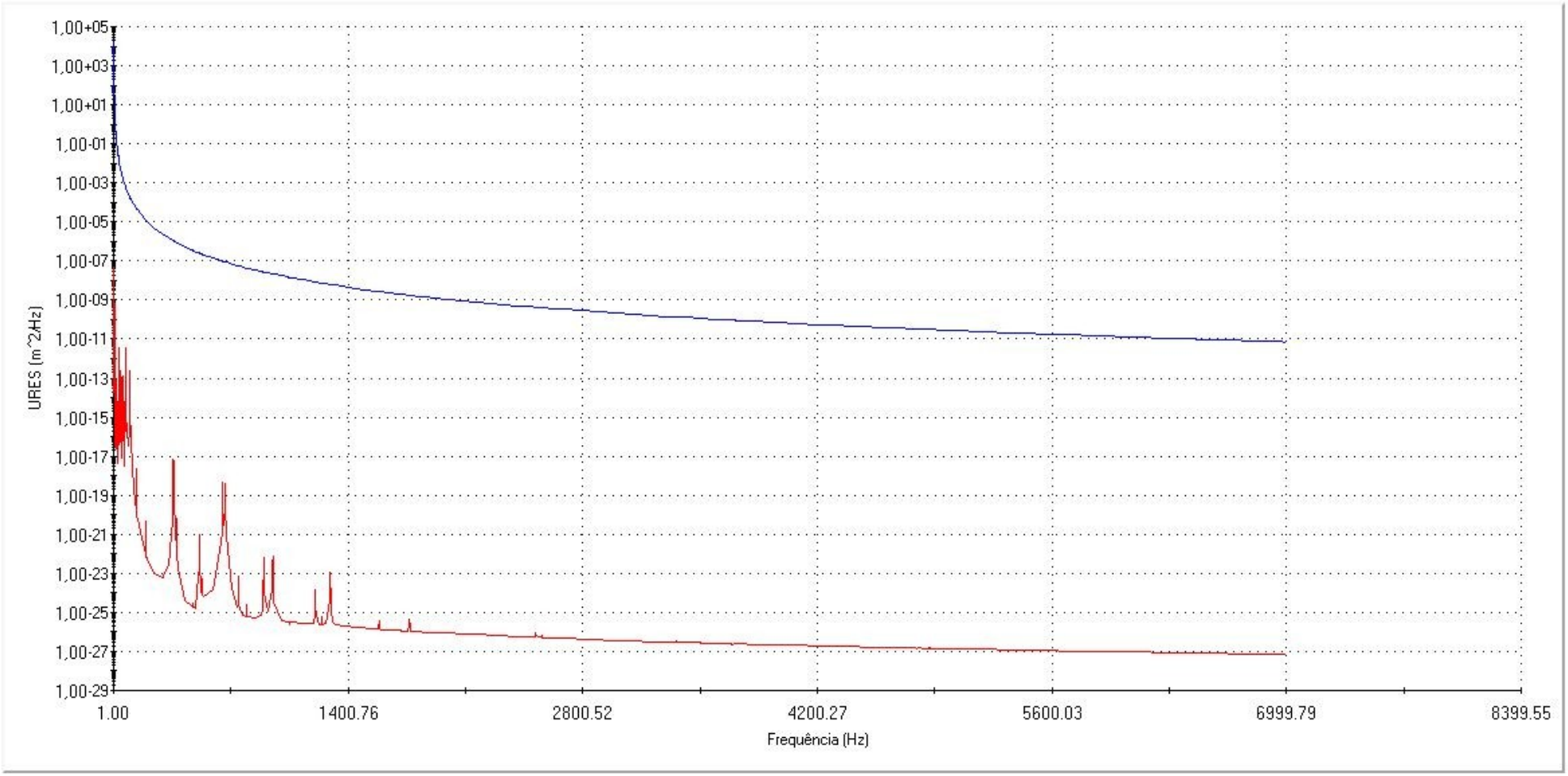
Taking into account these criteria, the analysis of the frequency response curves obtained in this stage led to the following conclusions:

- the addition of equal discs increases the attenuation, but this is only representative up to the fifth mass added,
- the quality of the attenuated curve is improved by decreasing the masses of the discs,
- the quality of the attenuated curve is improved by increasing the distances between the disks,
- increasing the size of all masses connected to the cable does not produce a significant increase in attenuation, although slightly improving the quality of the attenuated curve,
- the increase of the radius of curvature improves the attenuation, but as there is space constraint inside the dewar, it is not possible to freely increase the cable radius to improve the attenuation.

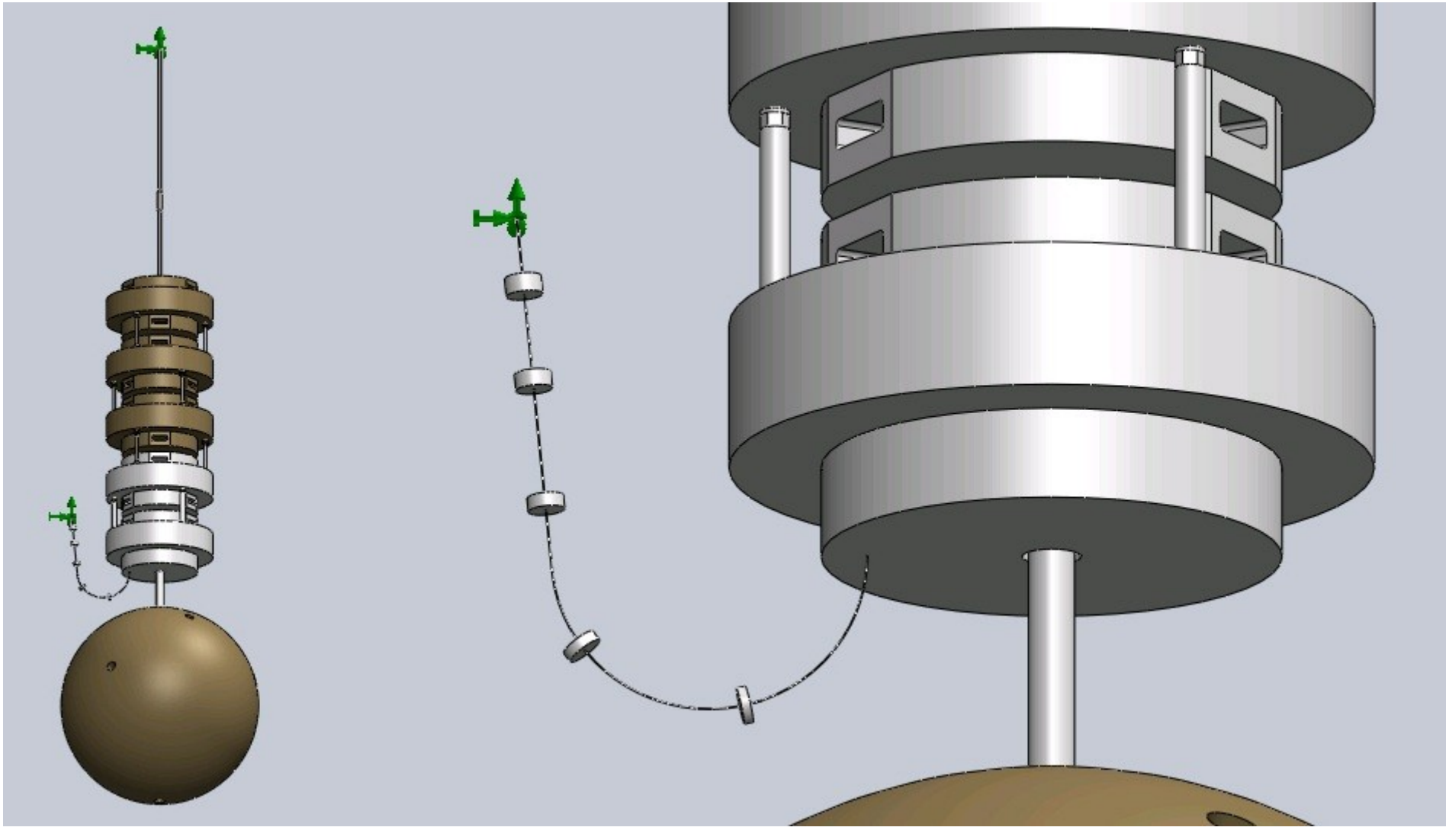
System composed of the remote mass, the copper cable with a total length of 490 mm, a horizontal spacing of 190 mm and a 190 mm difference between the ends of the cable. The five discs with a diameter of 20mm and thicknesses of 10, 9, 7.5, 6.0 and 5.0 mm were connected to the cable with increasing distances.



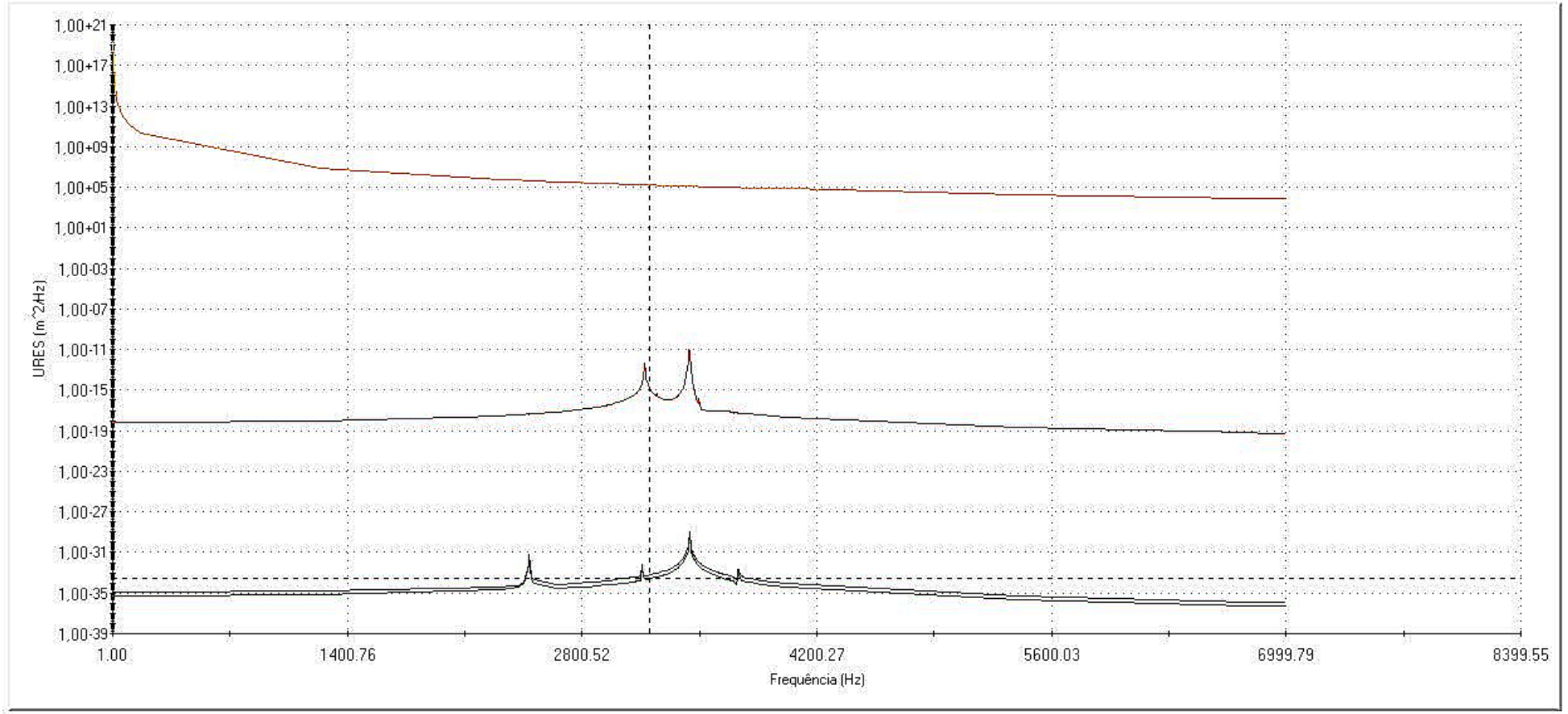
Frequency response curve.



Cabling model using the best mass-connected configuration.



Frequency response curve for cabling model connected to the mass located at the bottom of the suspension.



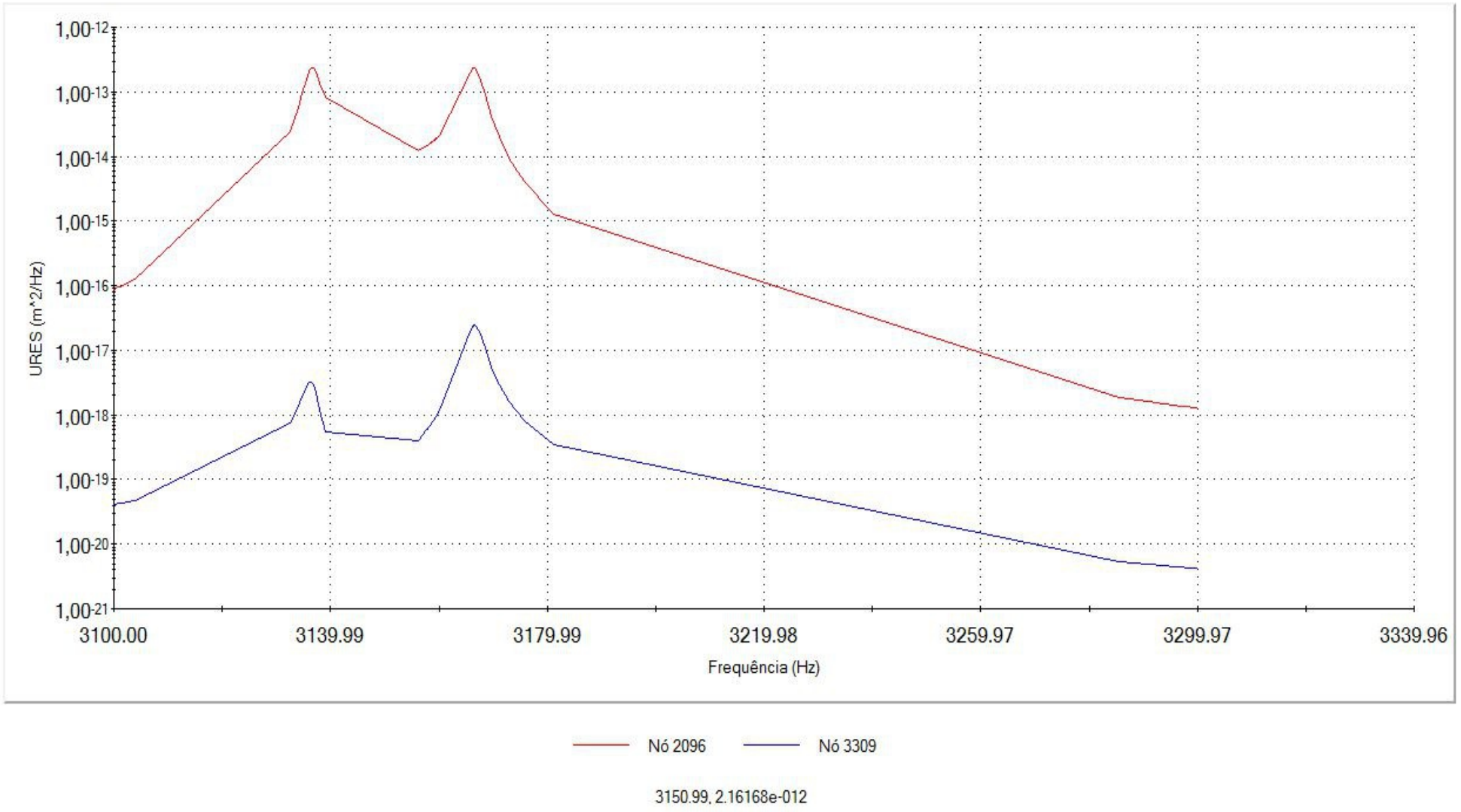
The effect produced by the seismic noise that is transported by the cabling, on the places where the transducers will be connected, was obtained in the simulation. In the model the excitation was made only at the end of the cabling, to consider only the effect of the cables. It is estimated that the addition of the other cables will not result in a significant increase in noise. In the response graph of this analysis it can be observed that:

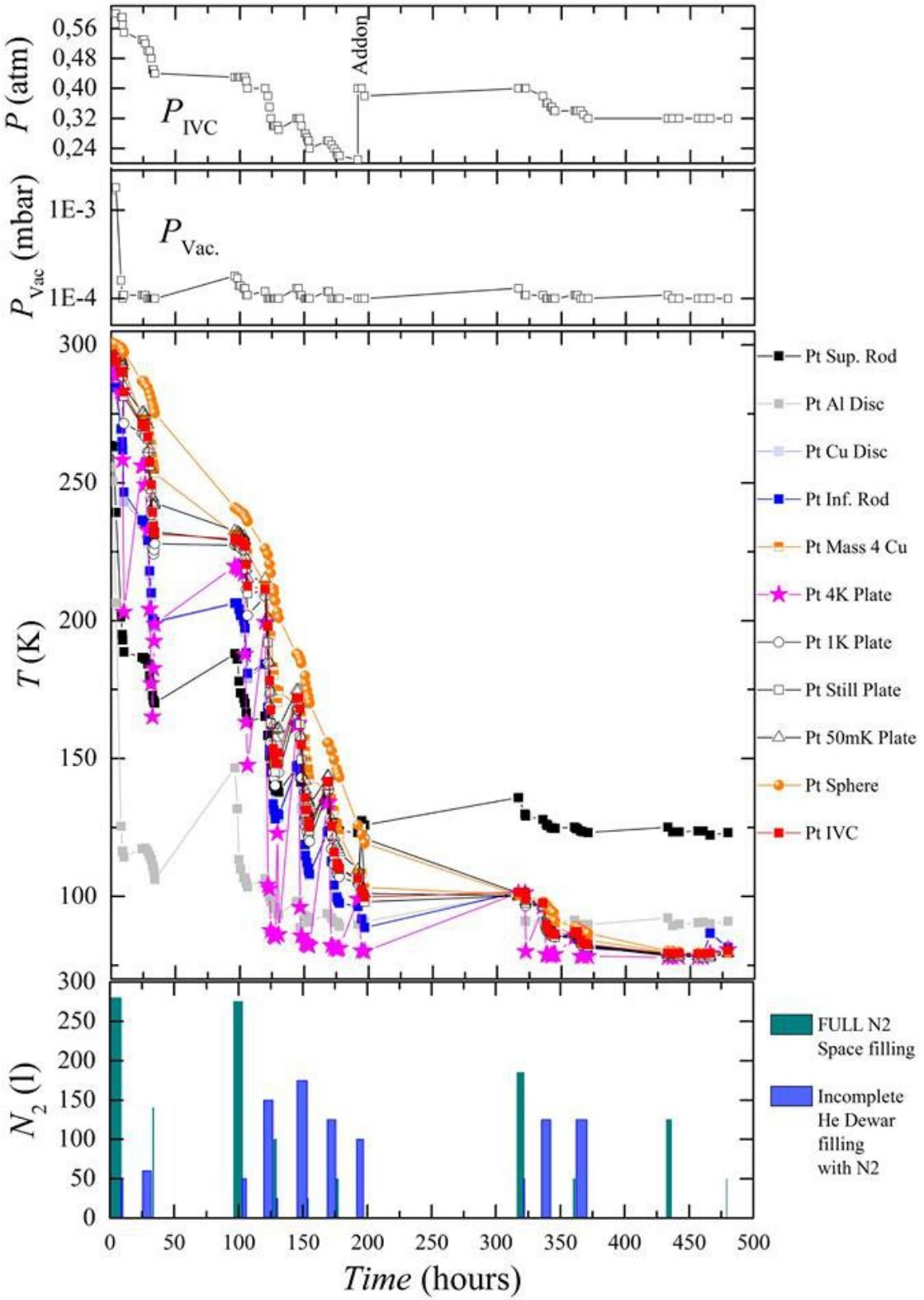
- an attenuation of the order of 20 decades (10 ^ 20) between the excited end of the cable and the lower face of last suspension mass,
- an additional 19 decades attenuation between the lower face of the last suspension mass and the cavities on sphere surface.

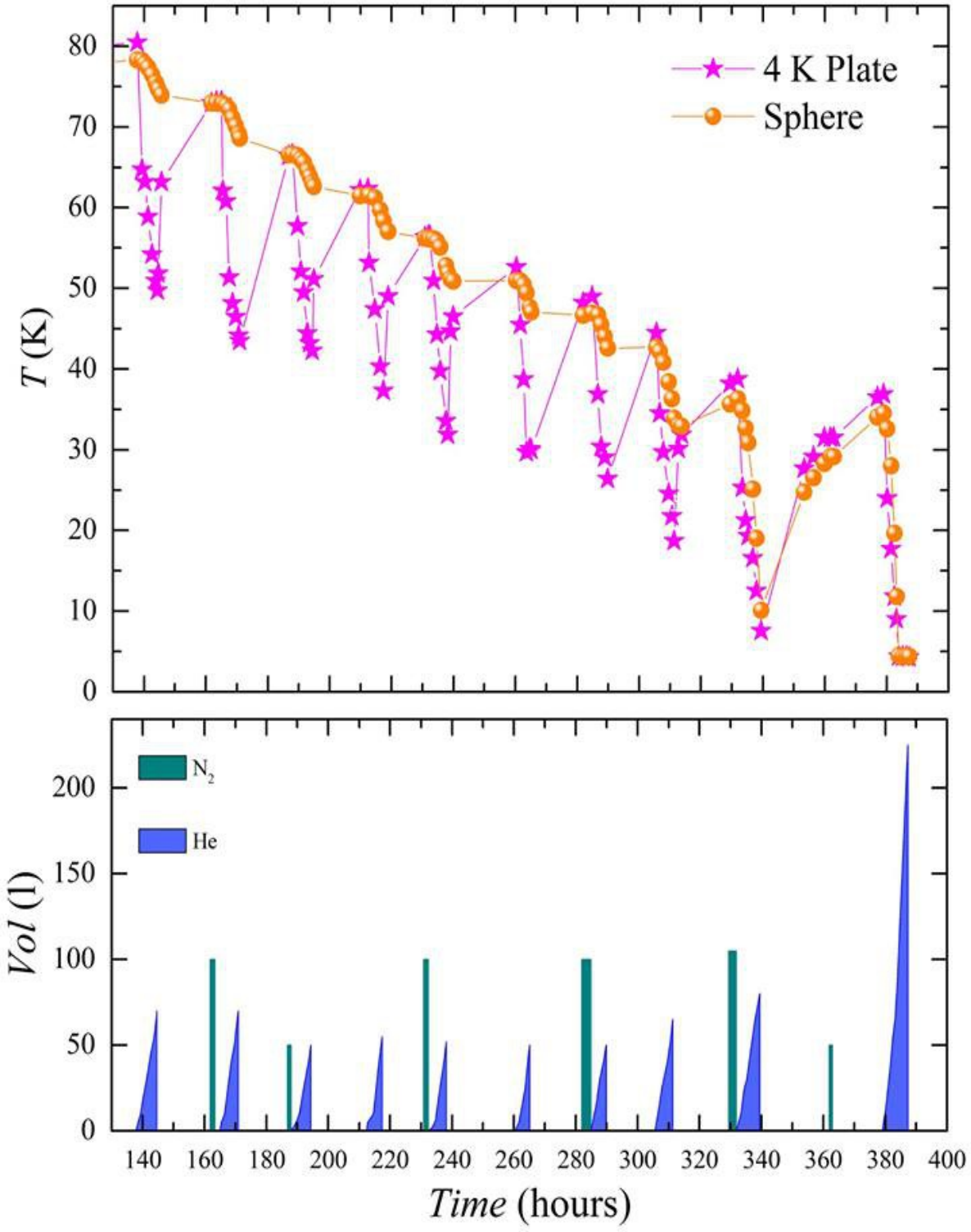
Thus the attenuation between the excited end of the cabling and the transducer locations has been estimated at 39 decades at frequencies of the order of 3200Hz, attenuation is sufficient so that the sensitivity designed for the detector can be achieved.

Thank you.

Frequency response close to the detection band




P (atm)
0,56
0,48
0,40
0,32
0,24
P IVC
Addon
P Vac (mbar)
1E-3
1E-4
P Vac.
T (K)
300
250
200
150
100
Pt Sup. Rod
Pt Al Disc
Pt Cu Disc
Pt Inf. Rod
Pt Mass 4 Cu
Pt 4K Plate
Pt 1K Plate
Pt Still Plate
Pt 50mK Plate
Pt Sphere
Pt IVC
N2 (l)
300
250
200
150
100
50
0
FULL N2
Space filling
Incomplete
He Dewar
filling
with N2
0
50
100
150
200
250
300
350
400
450
500
Time (hours)


4 K Plate
Sphere
T (K)
0
10
20
30
40
50
60
70
80
N2
He
Vol (l)
0
50
100
150
200
140
160
180
200
220
240
260
280
300
320
340
360
380
400
Time (hours)