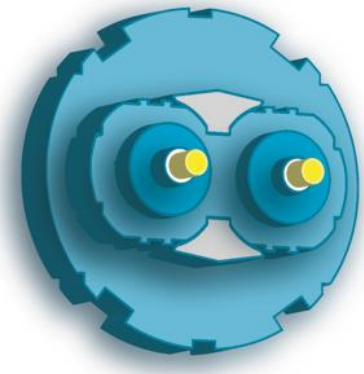

High Luminosity LHC

800 MHz 2-Cavity module simulations

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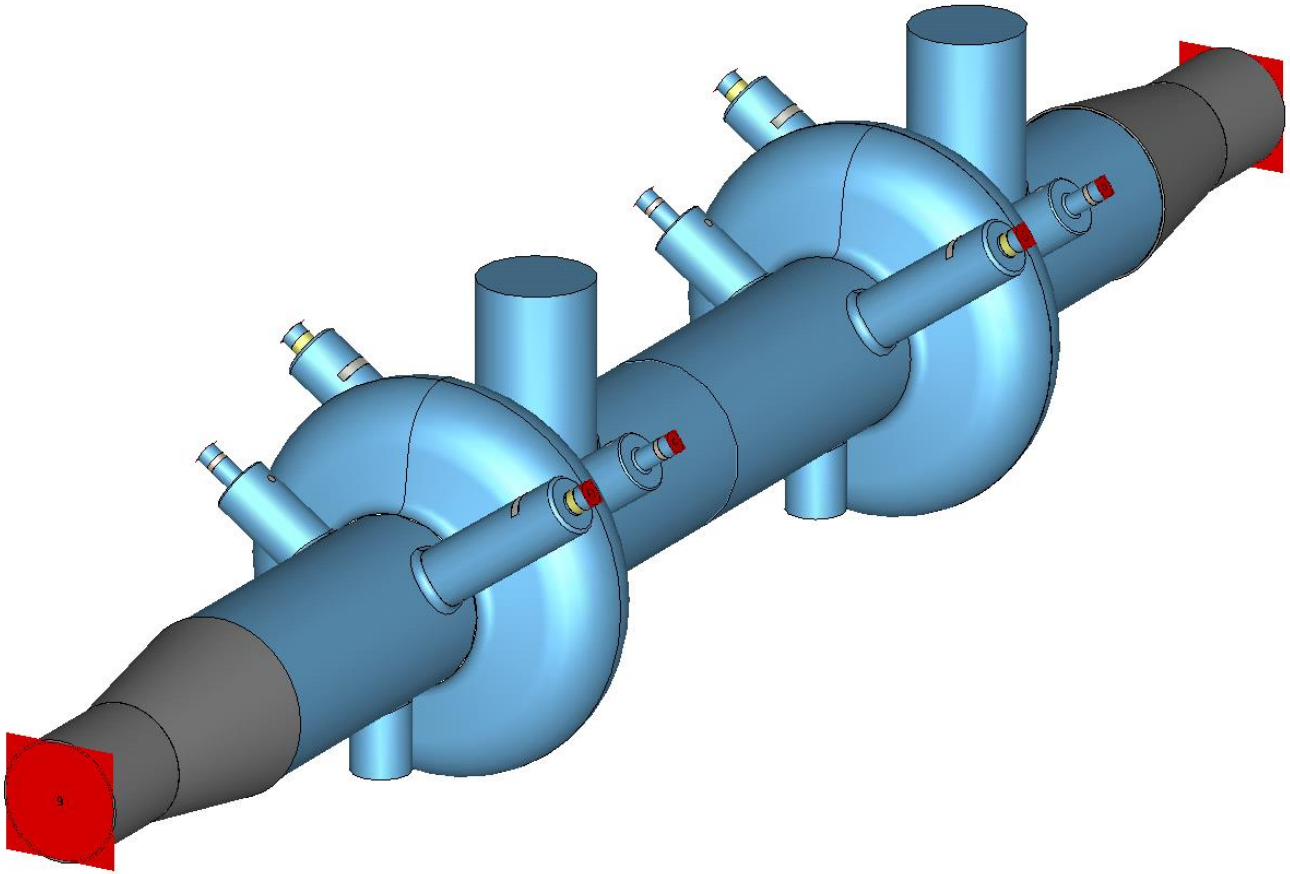
With input from:
R. Calaga
T. Roggen
N.P. Sobenin
M. Zobov

The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

Content

- Probe and Hook couplers
- Hybrid coupler
- Grooved beam pipe
- Comparison

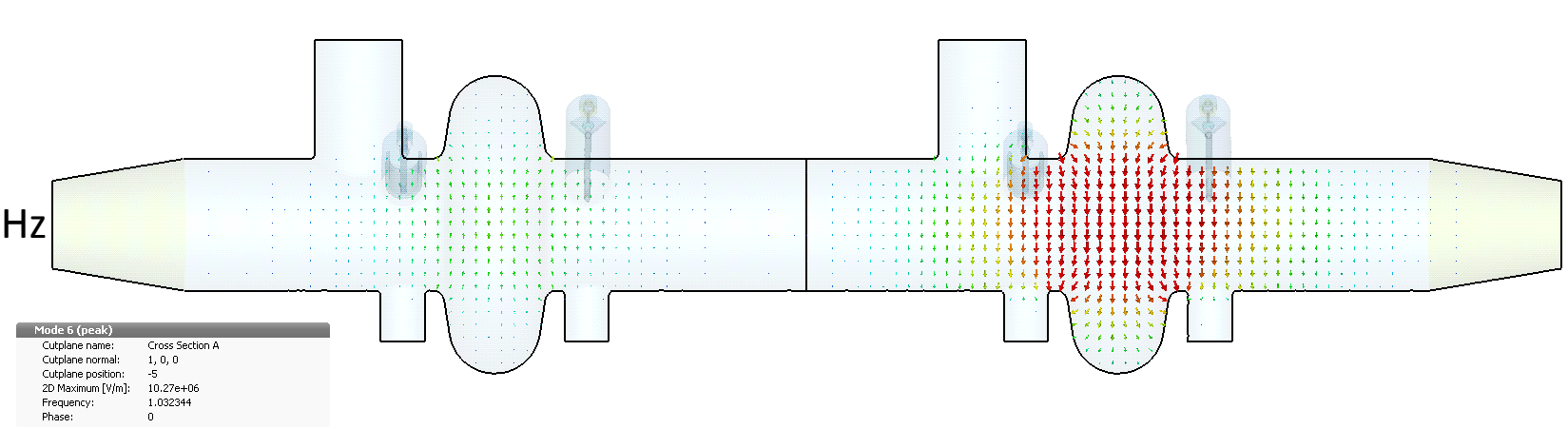
Array of 2 cells



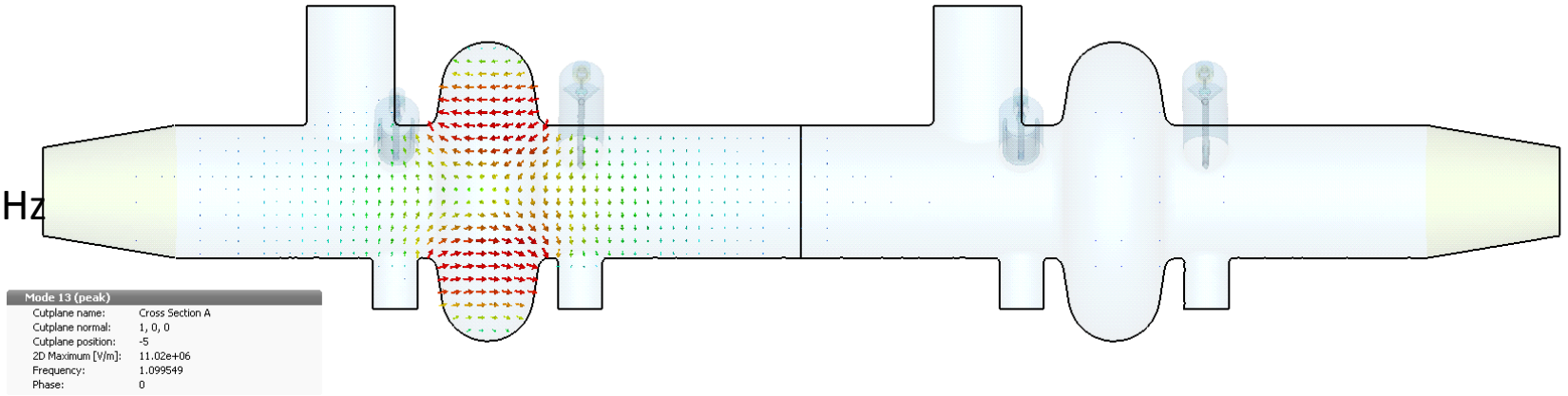
High Luminosity LHC

2 cell cavity simulation

1032 MHz



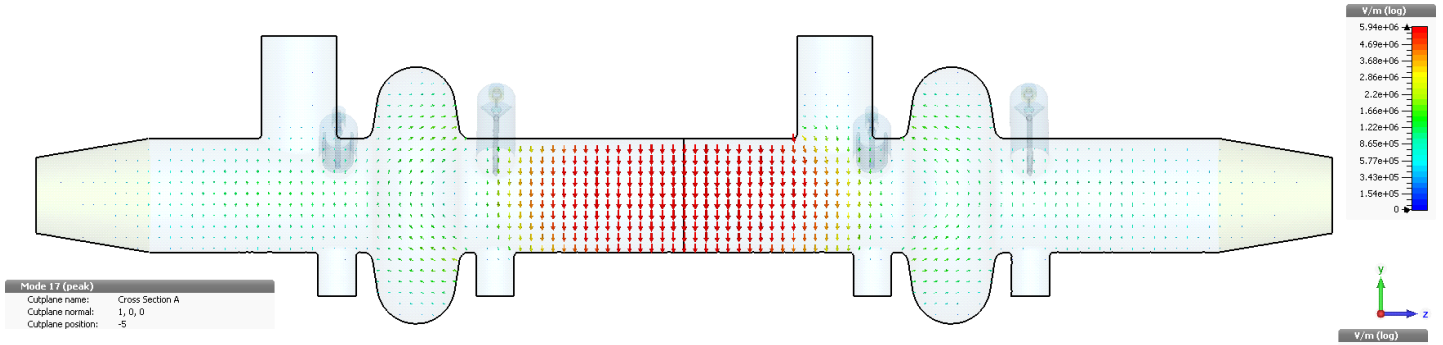
1099 MHz



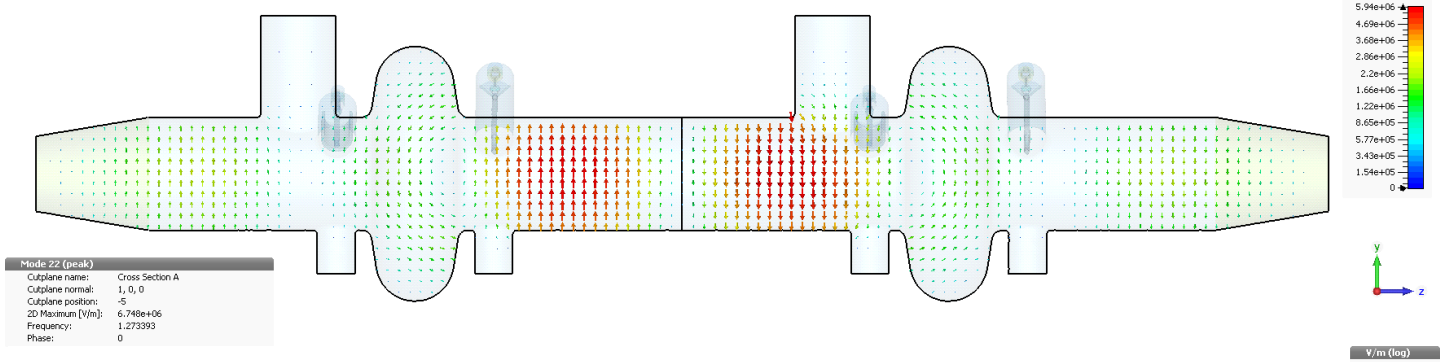
High Luminosity LHC

Coupled modes or 1+1≠2

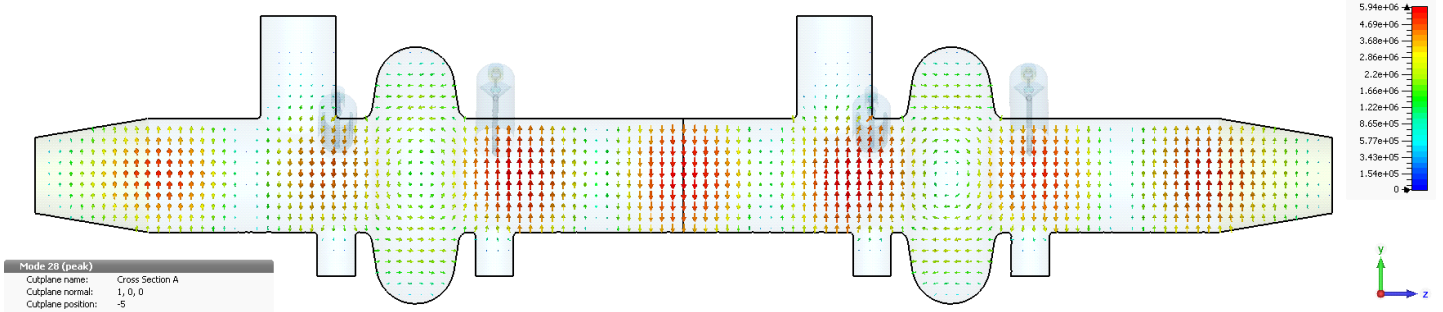
1200 MHz



1276 MHz

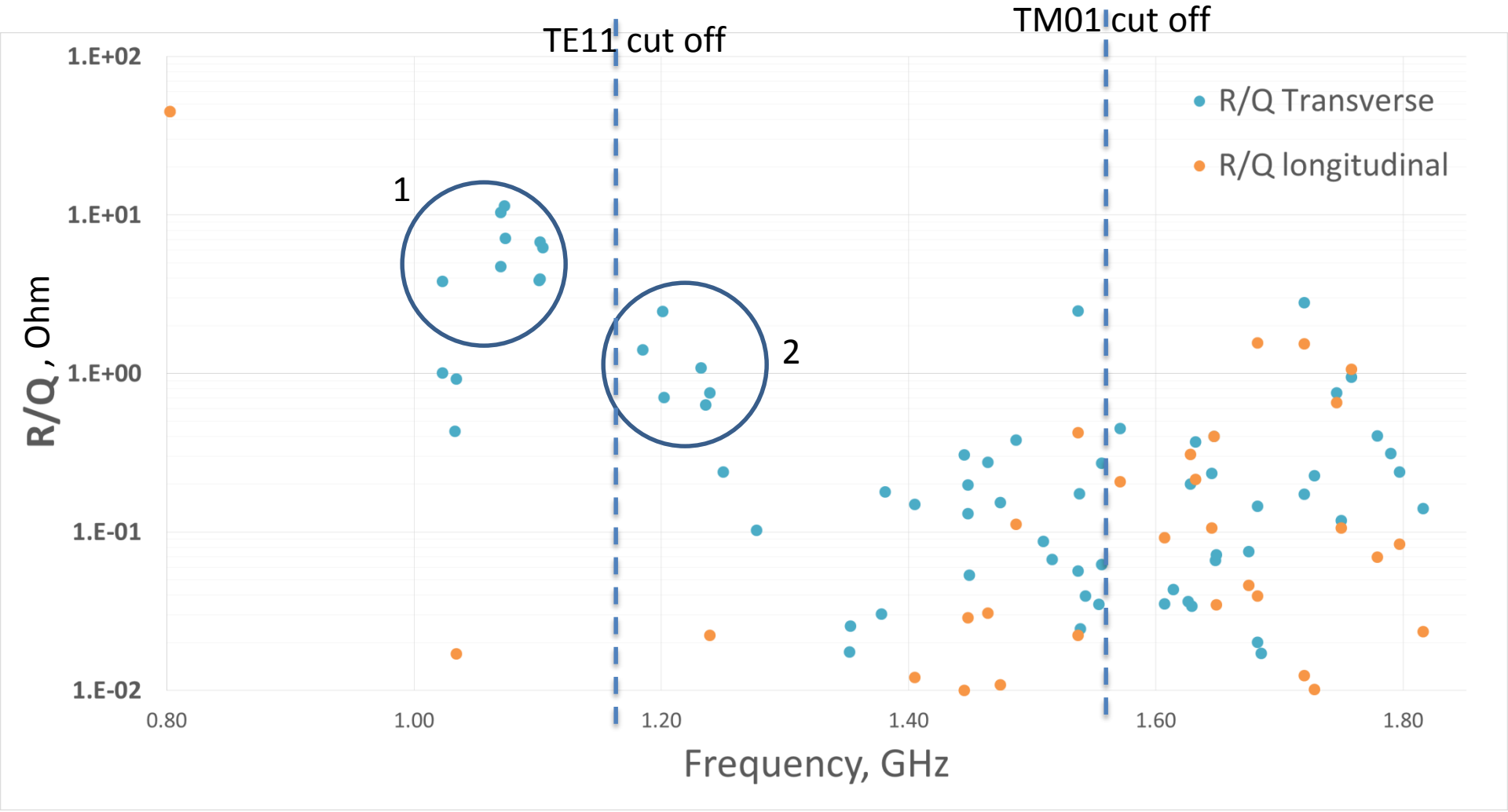


1350 MHz



High Luminosity LHC

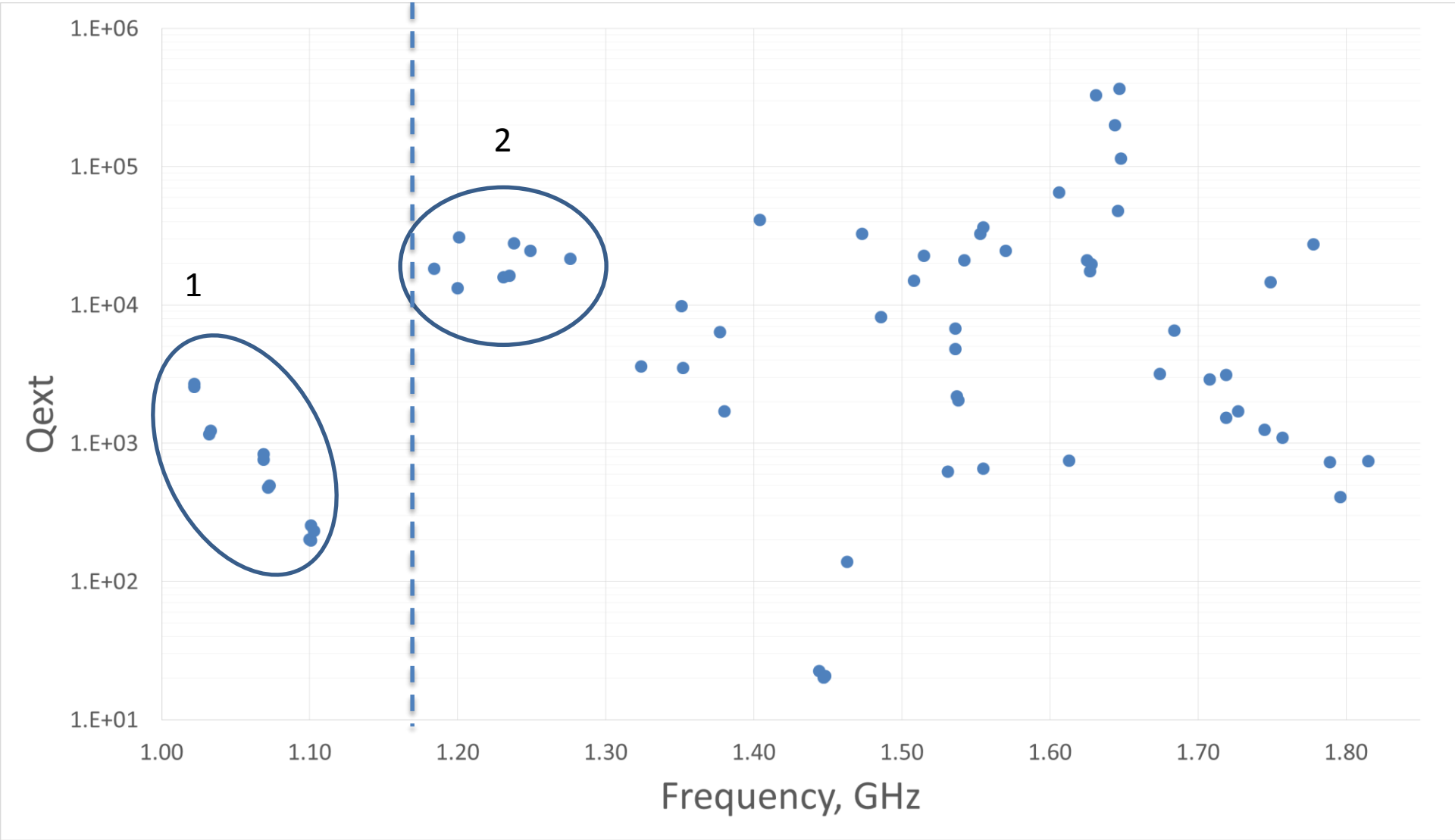
R/Q



1 – First dipole modes (TE111, TM110)

2 – Coupled modes

Qext

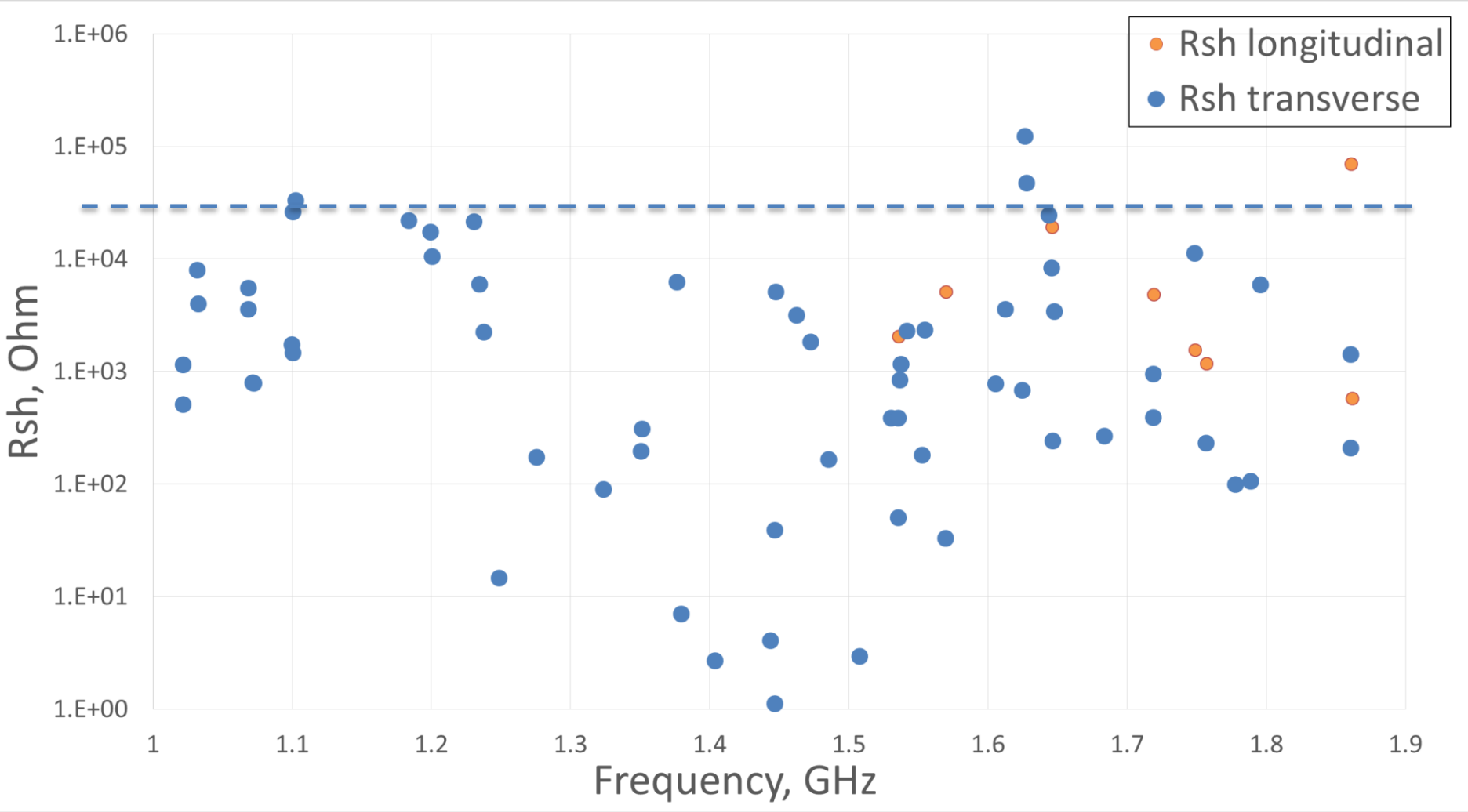


1 – First dipole modes (TE111, TM110)

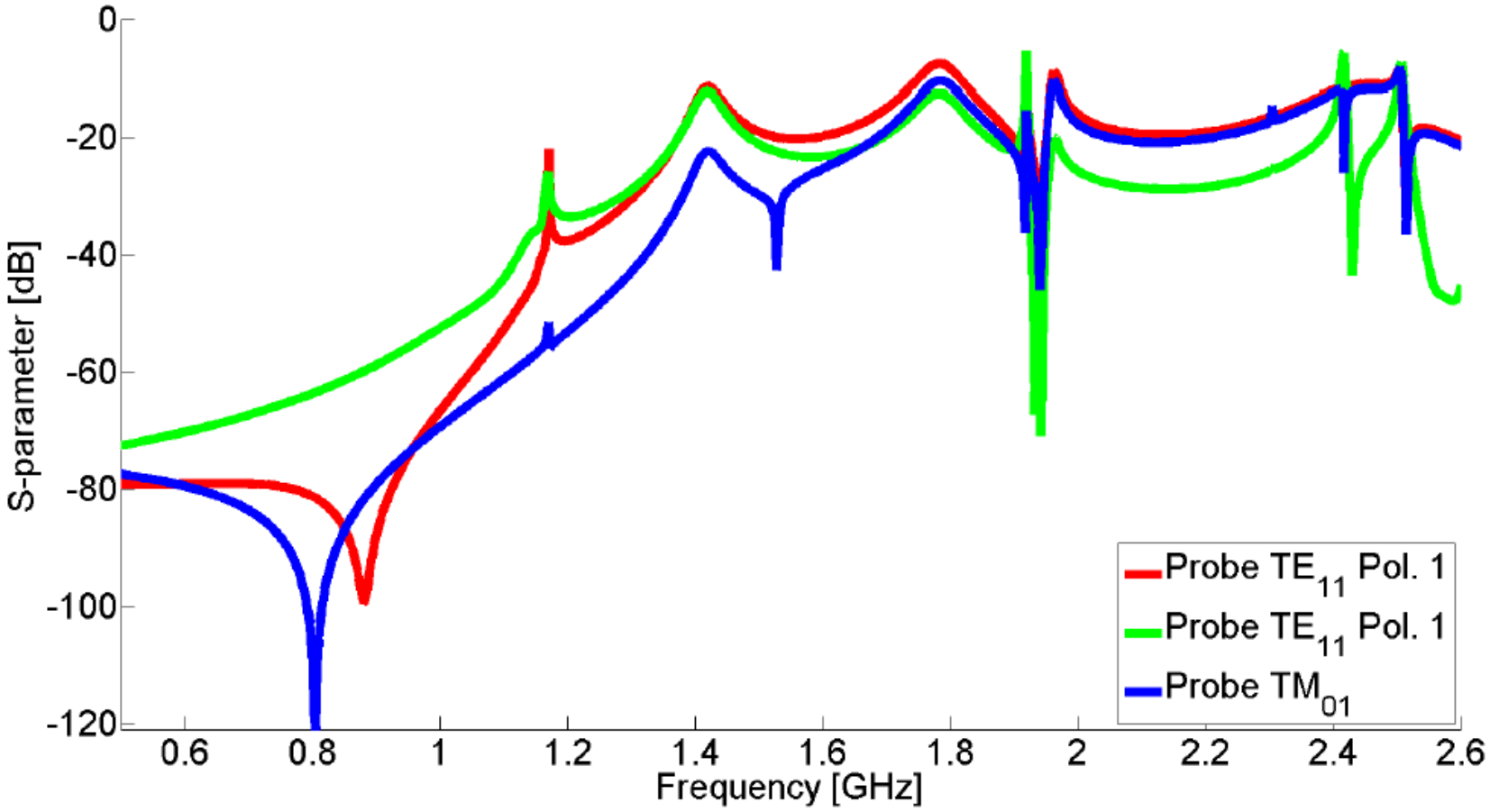
2 – Coupled modes Qext is little bit too high

High Luminosity LHC

Rsh

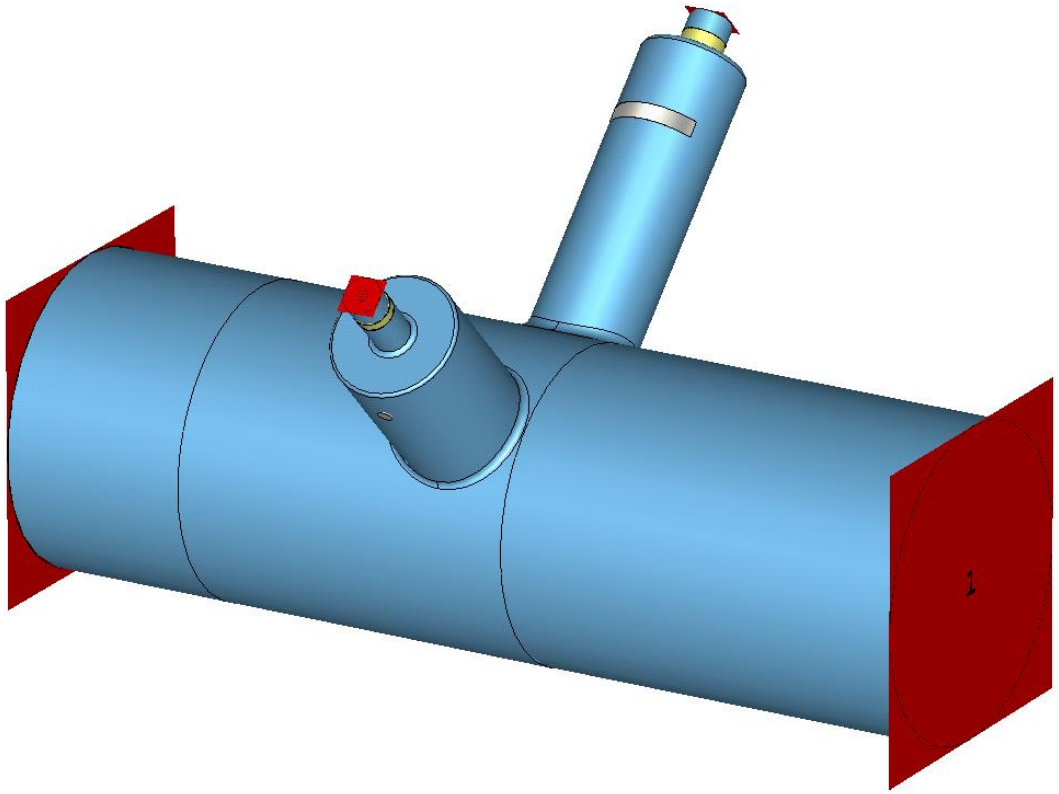

Rsh longitudinal
Rsh transverse
Rsh, Ohm
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
Frequency, GHz

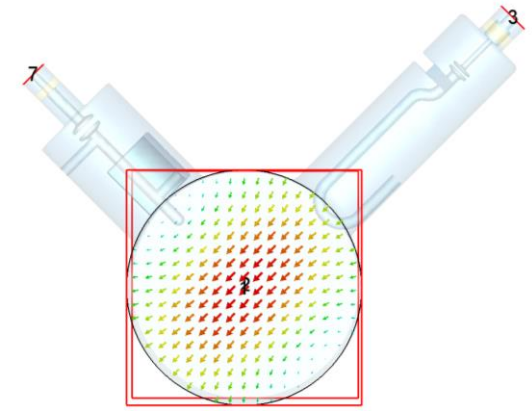
S-parameters before tuning

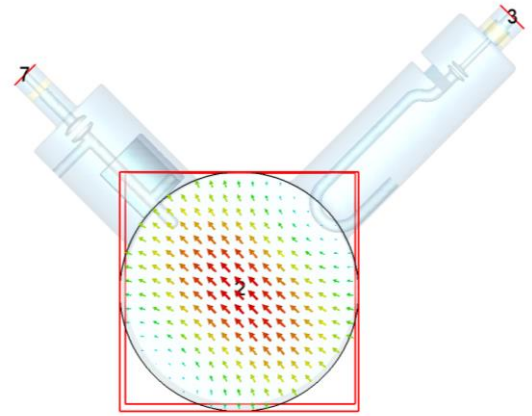


High Luminosity LHC

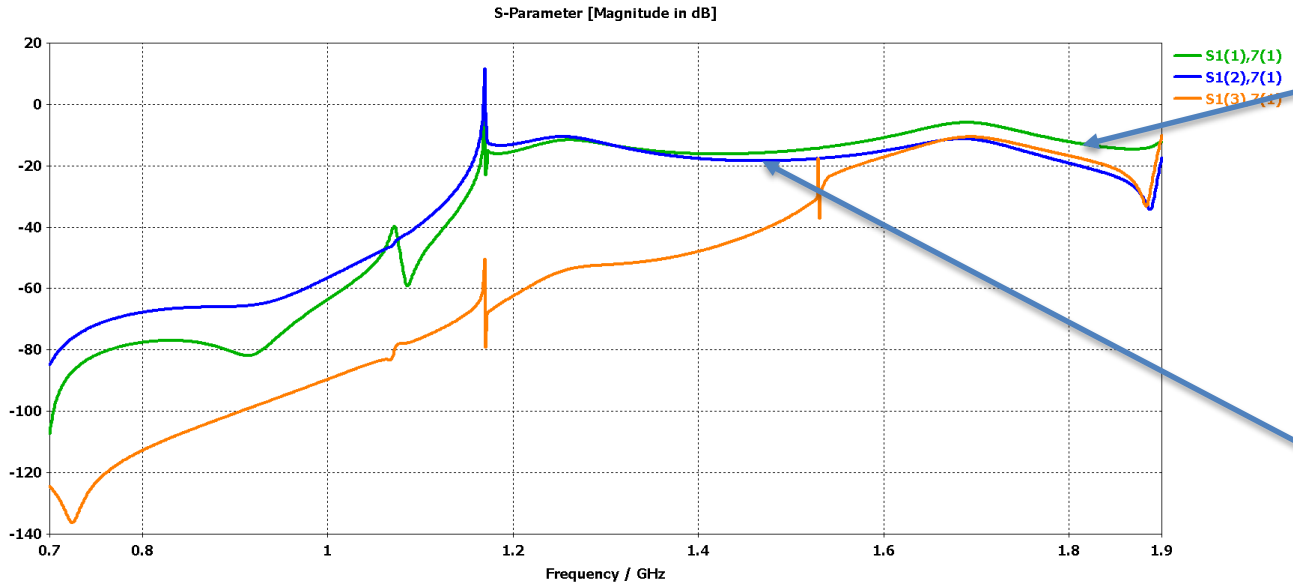
Tuning

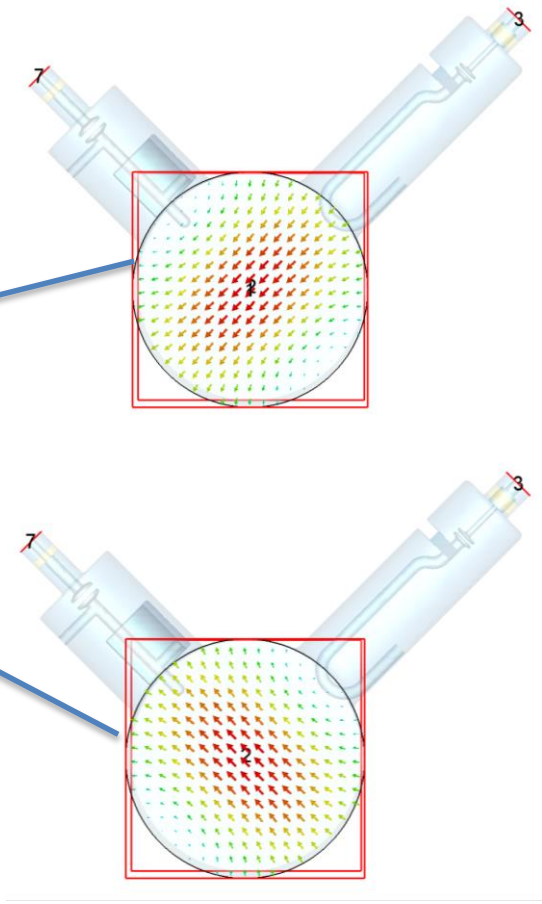




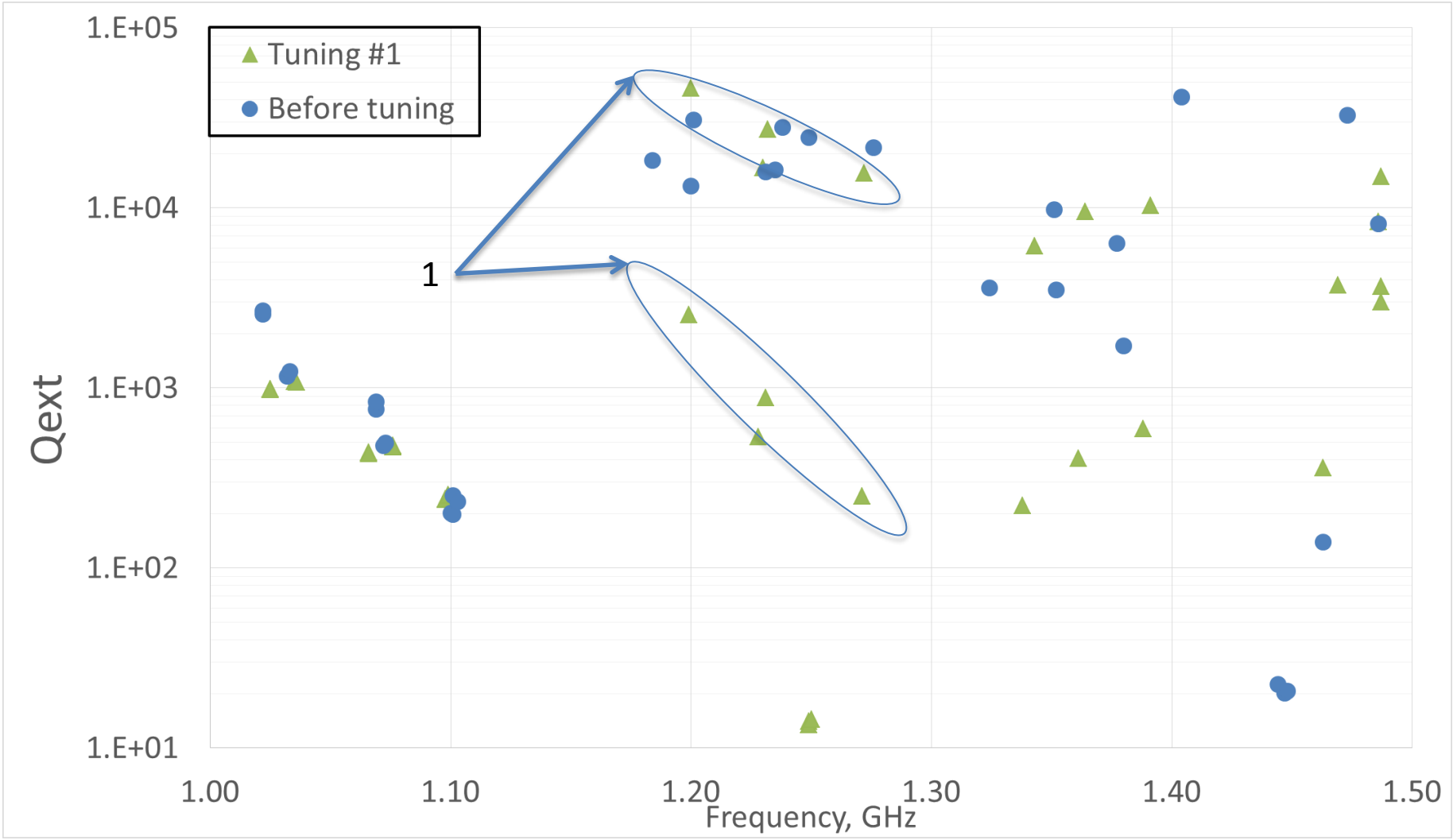


S-parameters after tuning



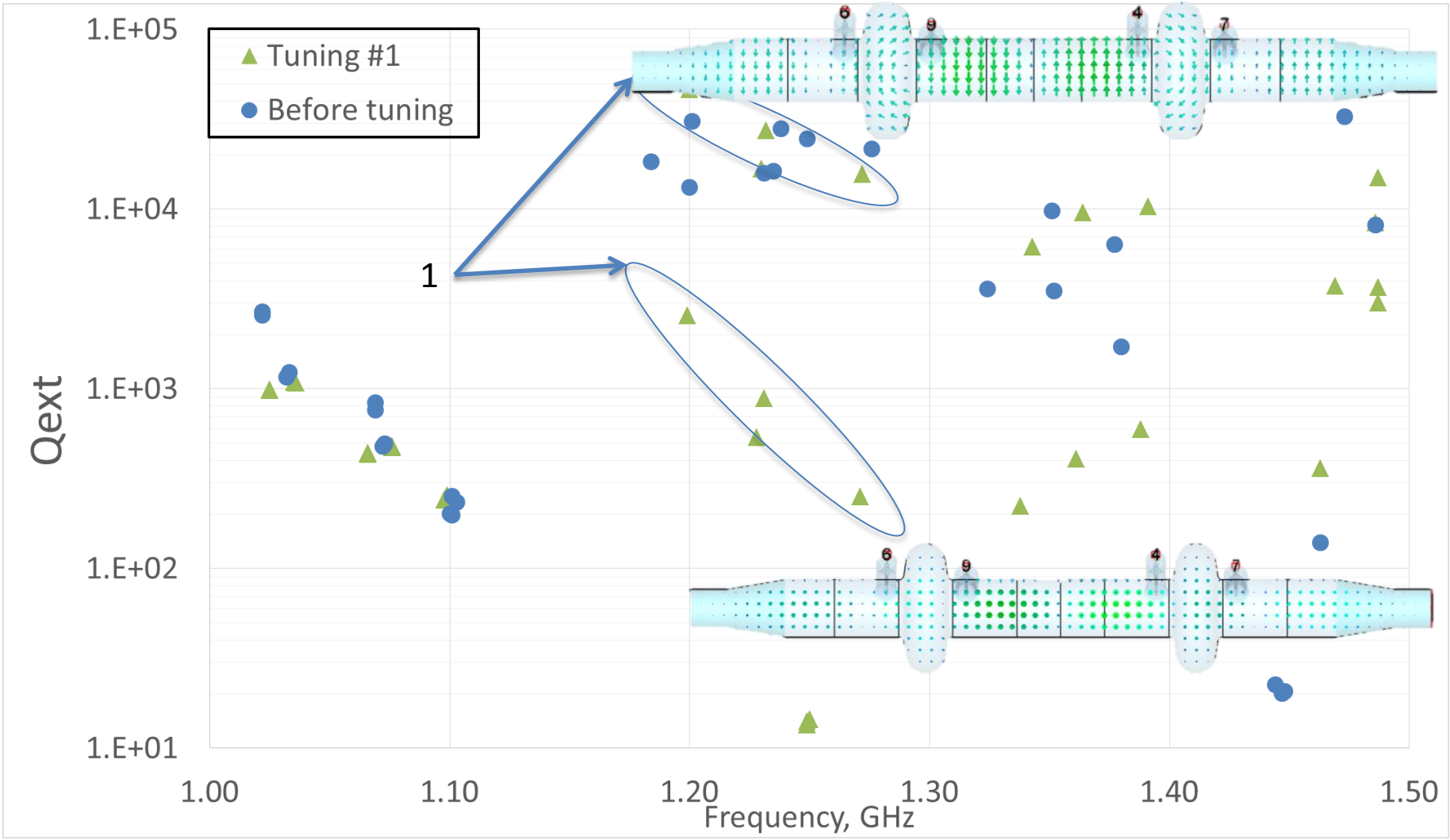


Qext after first tuning attempt



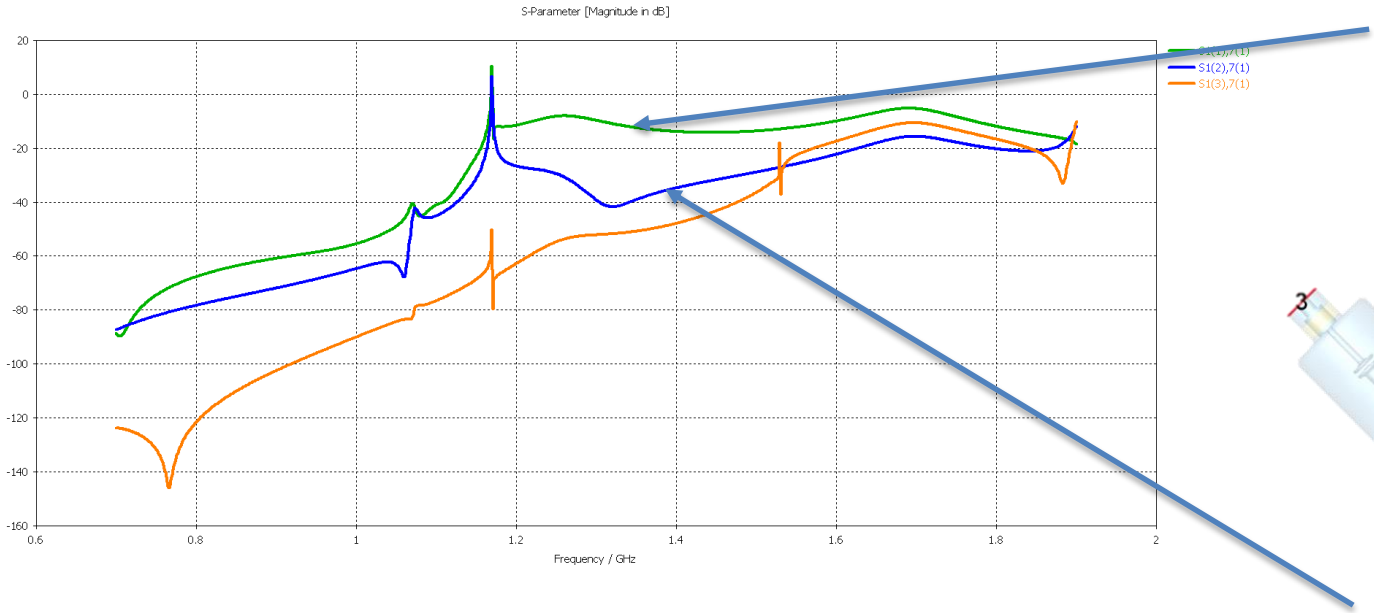
1 – same modes but different polarizations

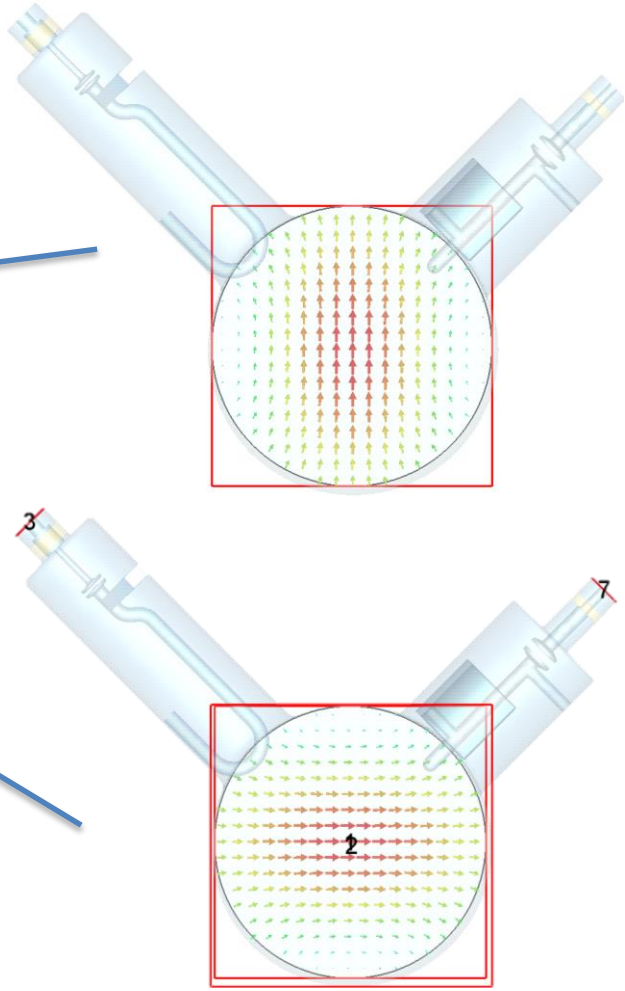
Qext after first tuning attempt



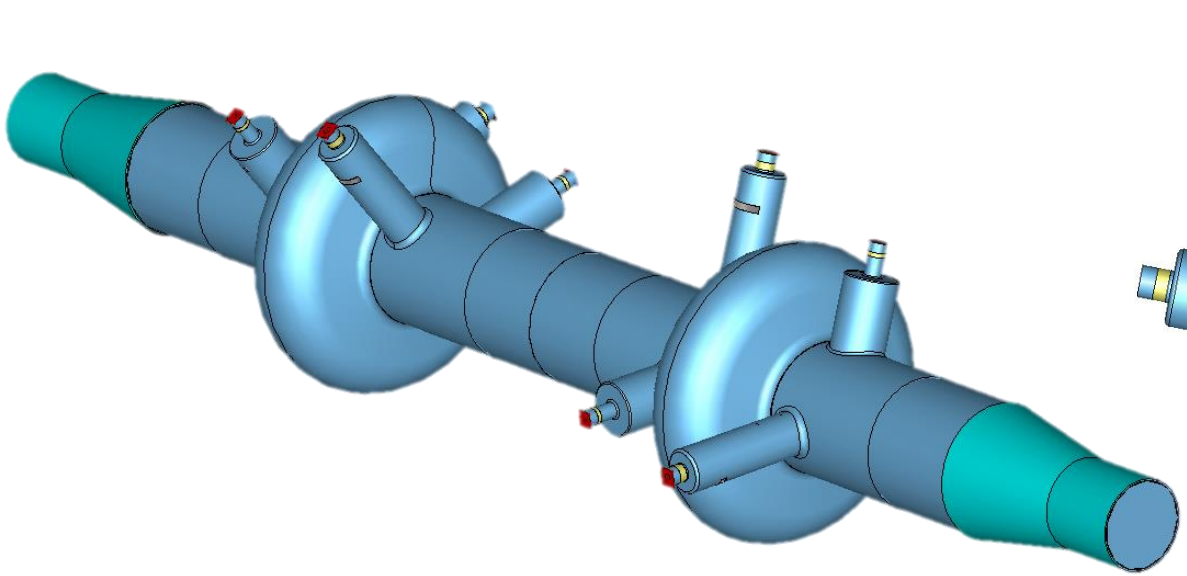
1 – same modes but different polarizations

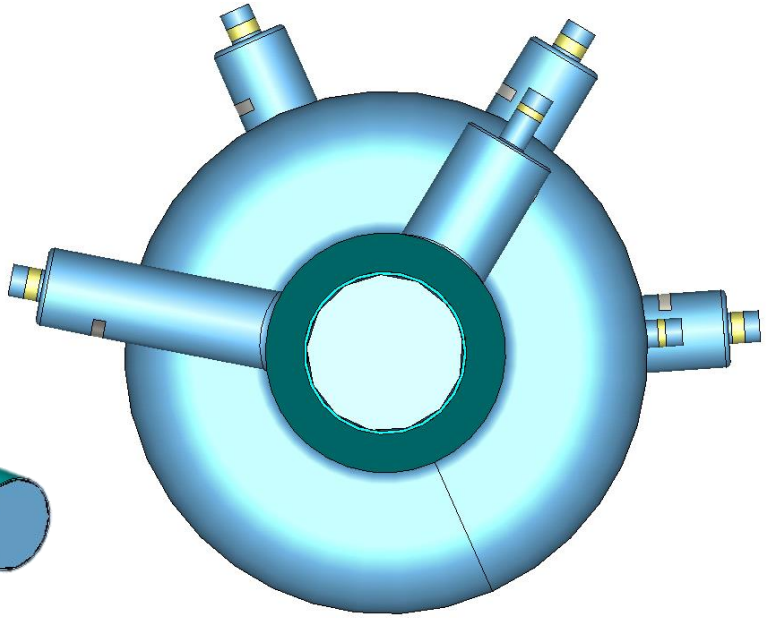
S-parameters after tuning



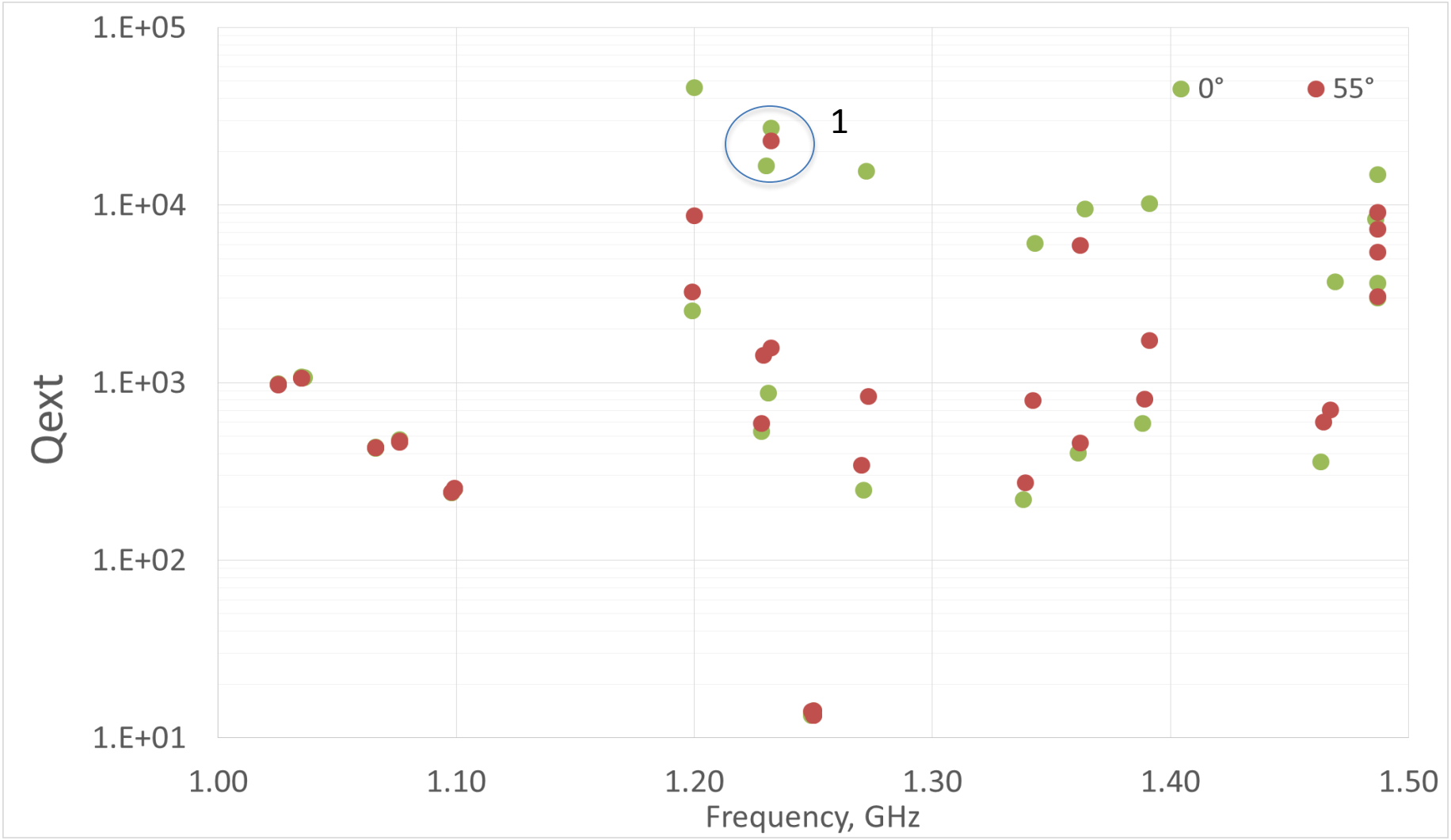


Rotation of cavities for damping polarized modes



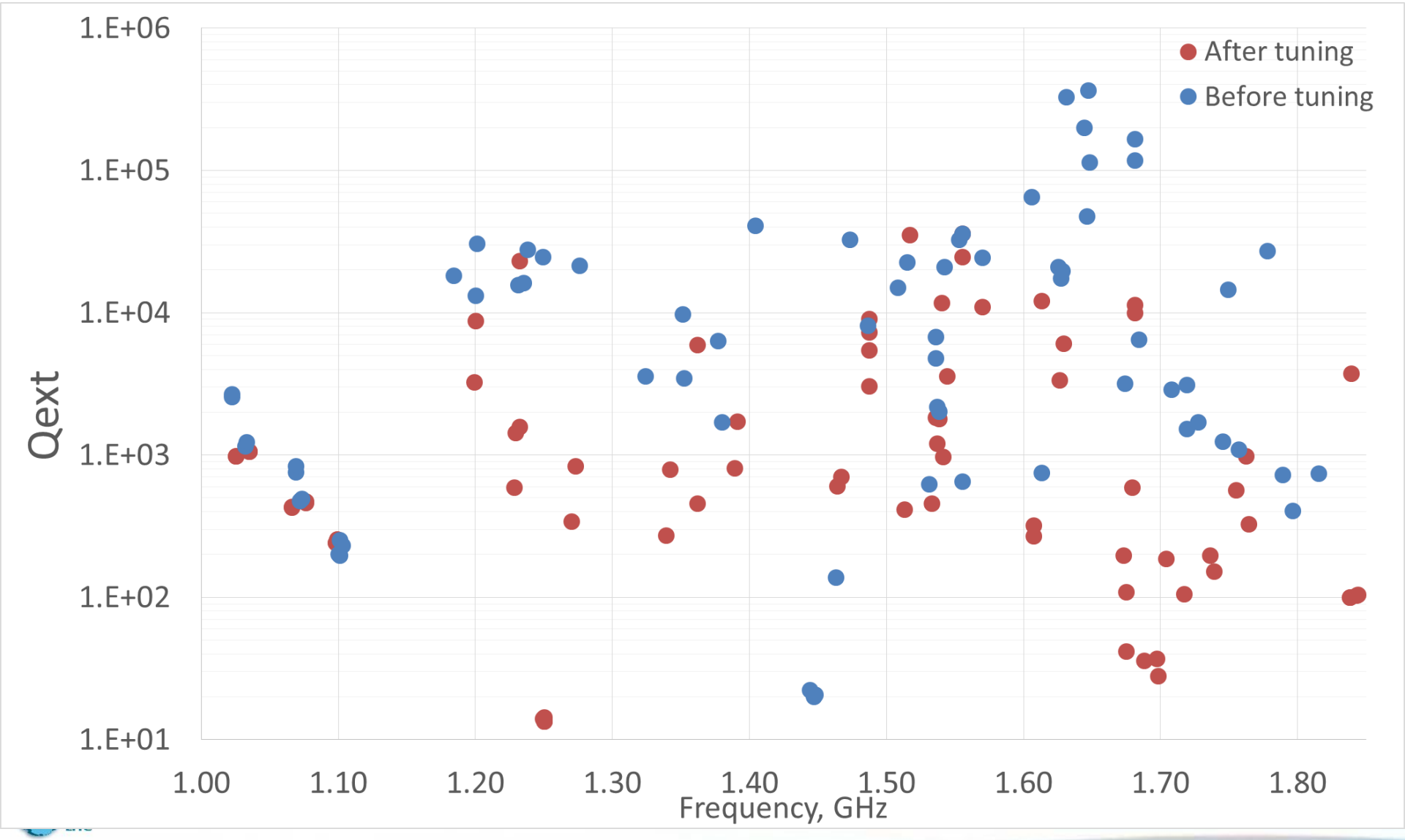


Qext after rotation

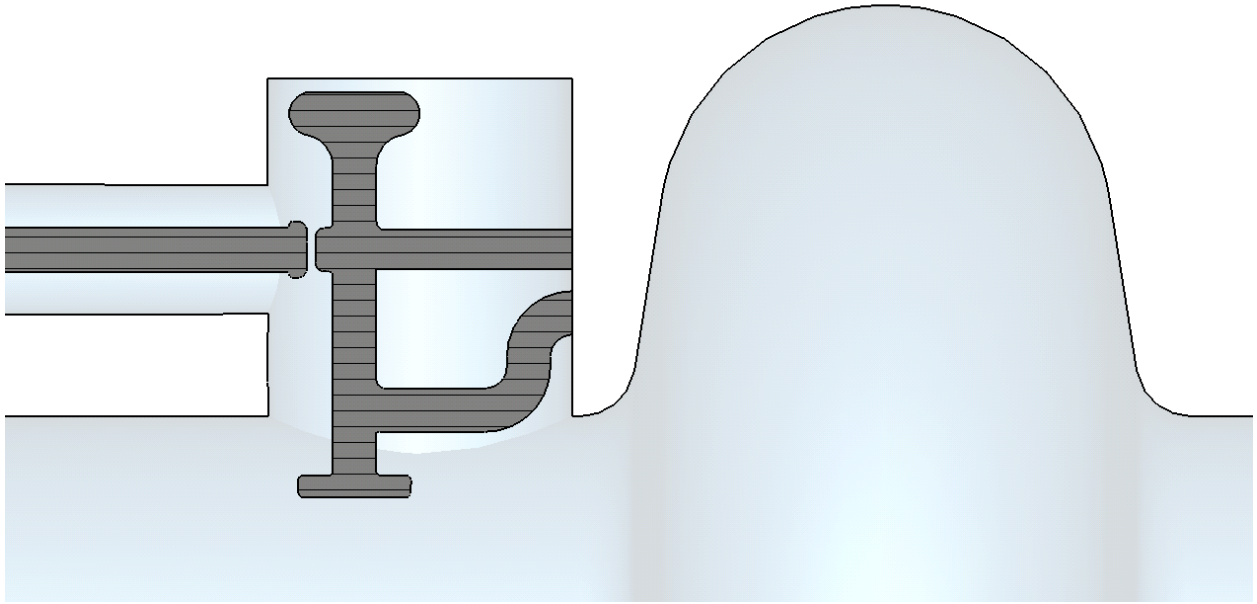


Qext are one order of magnitude lower except for the strange mode *1 which has R/Q of 0.8 Ohms

Qext After tuning



“Tesla” couplers



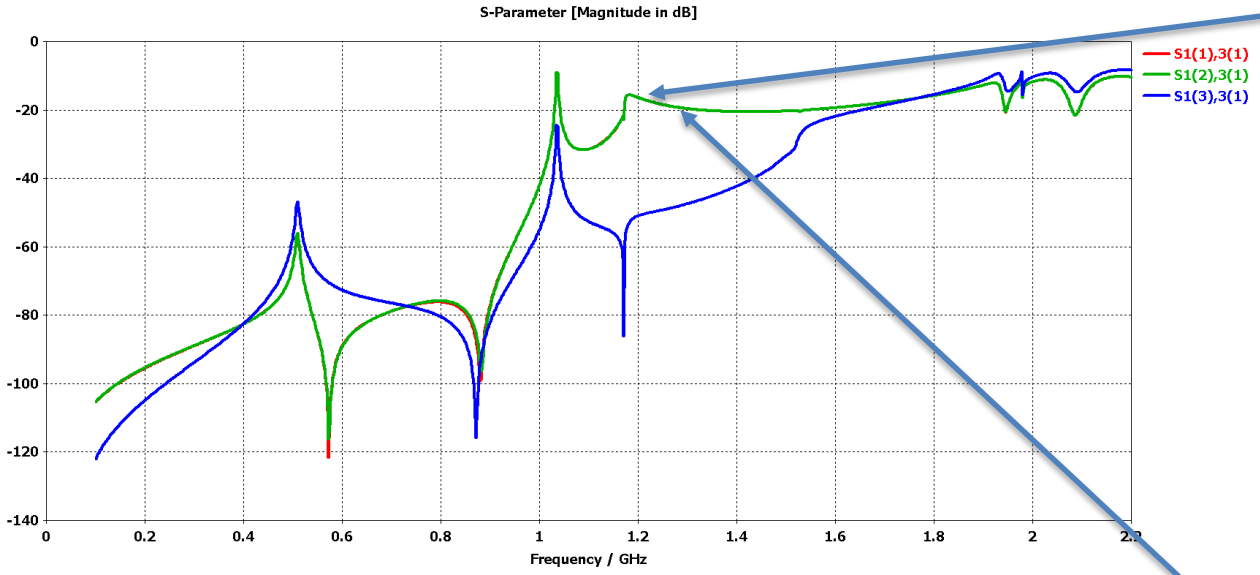
Pros:

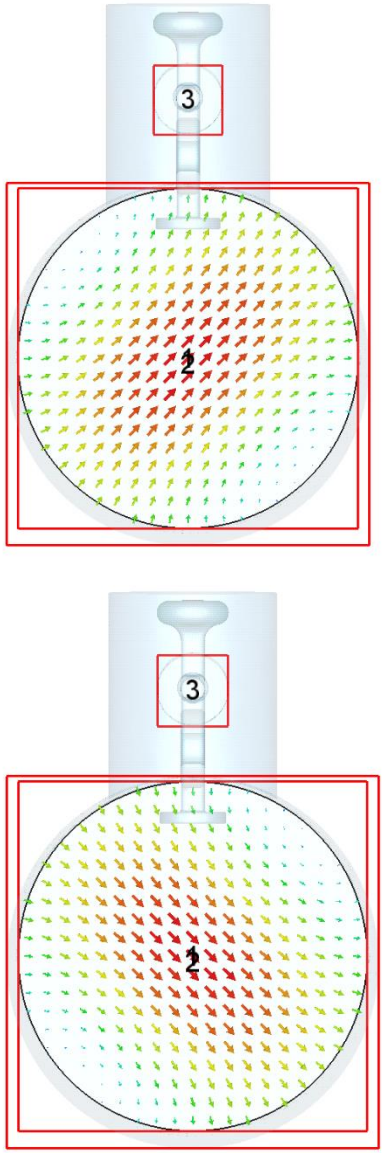
- **Widespread well known technology**
- **Could be easy in manufacturing**
- **Just 2 couplers required for each cell**

Cons:

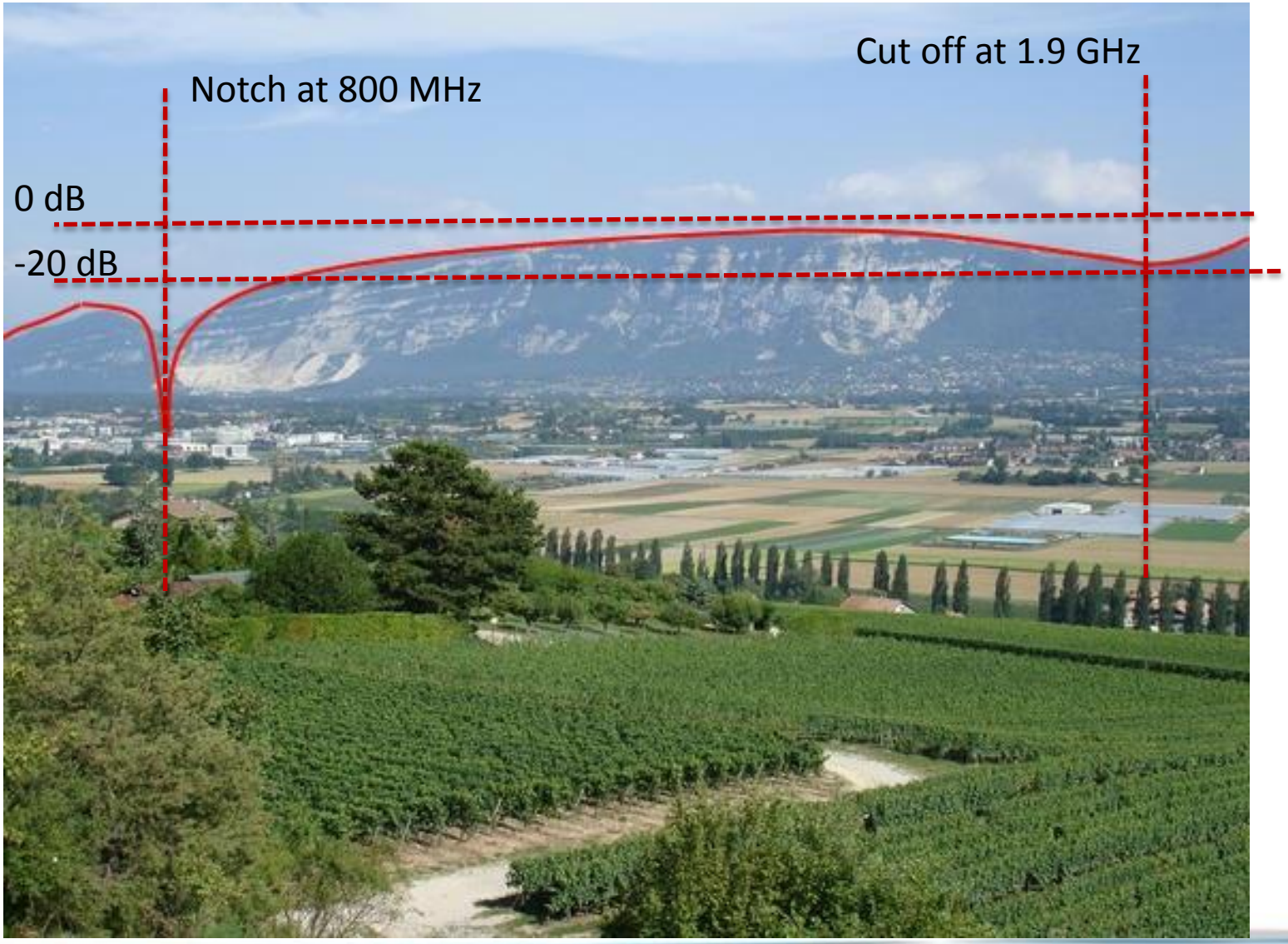
- **Non demountable**

S-parameters for Tesla coupler

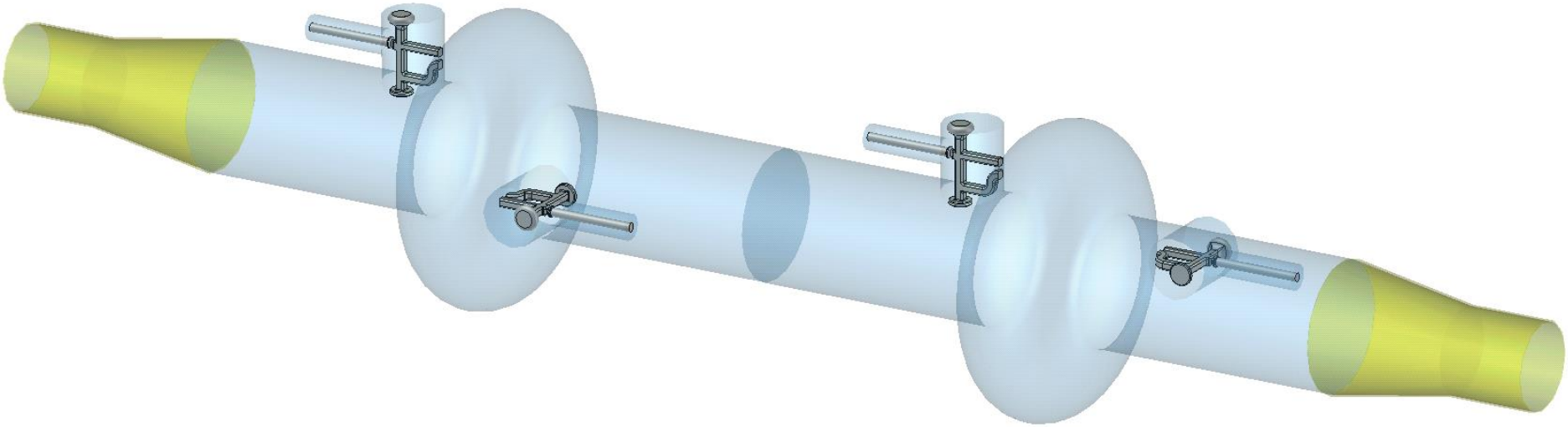




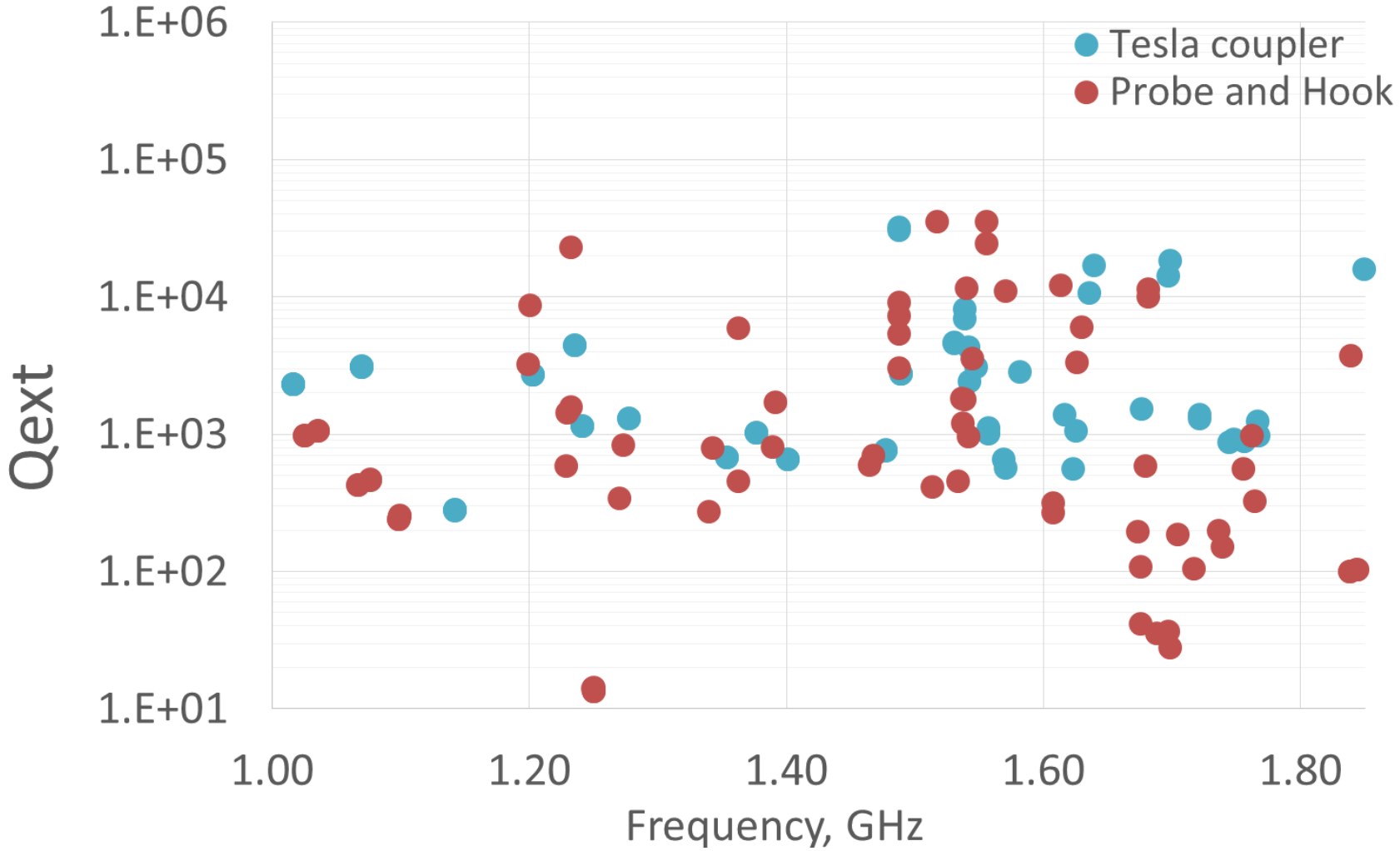
High Luminosity LHC


Cut off at 1.9 GHz
Notch at 800 MHz
0 dB
-20 dB

Hybrid coupler

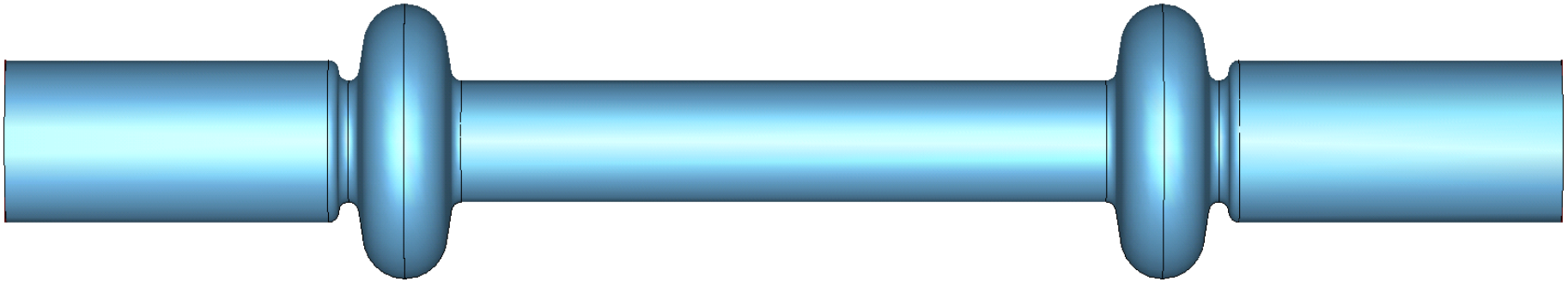


Qext



Qext are of the same order for both types of couplers

Grooved beam pipe



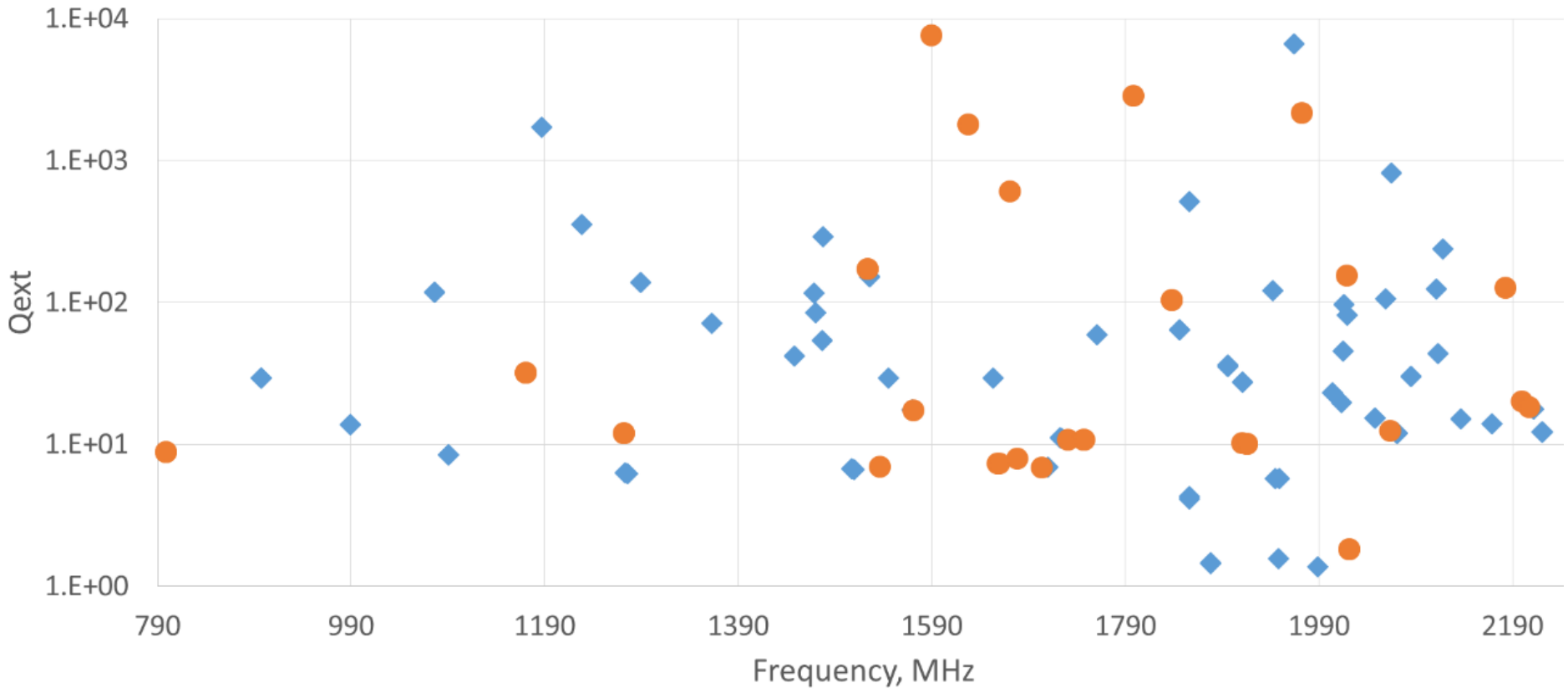
Pros

- High HOM damping rates
- No complains on operation for similar designs (KEKB, CESR-B, etc.)

Cons

- More longitudinal space required
- Scaling to 4 cavities is complicated

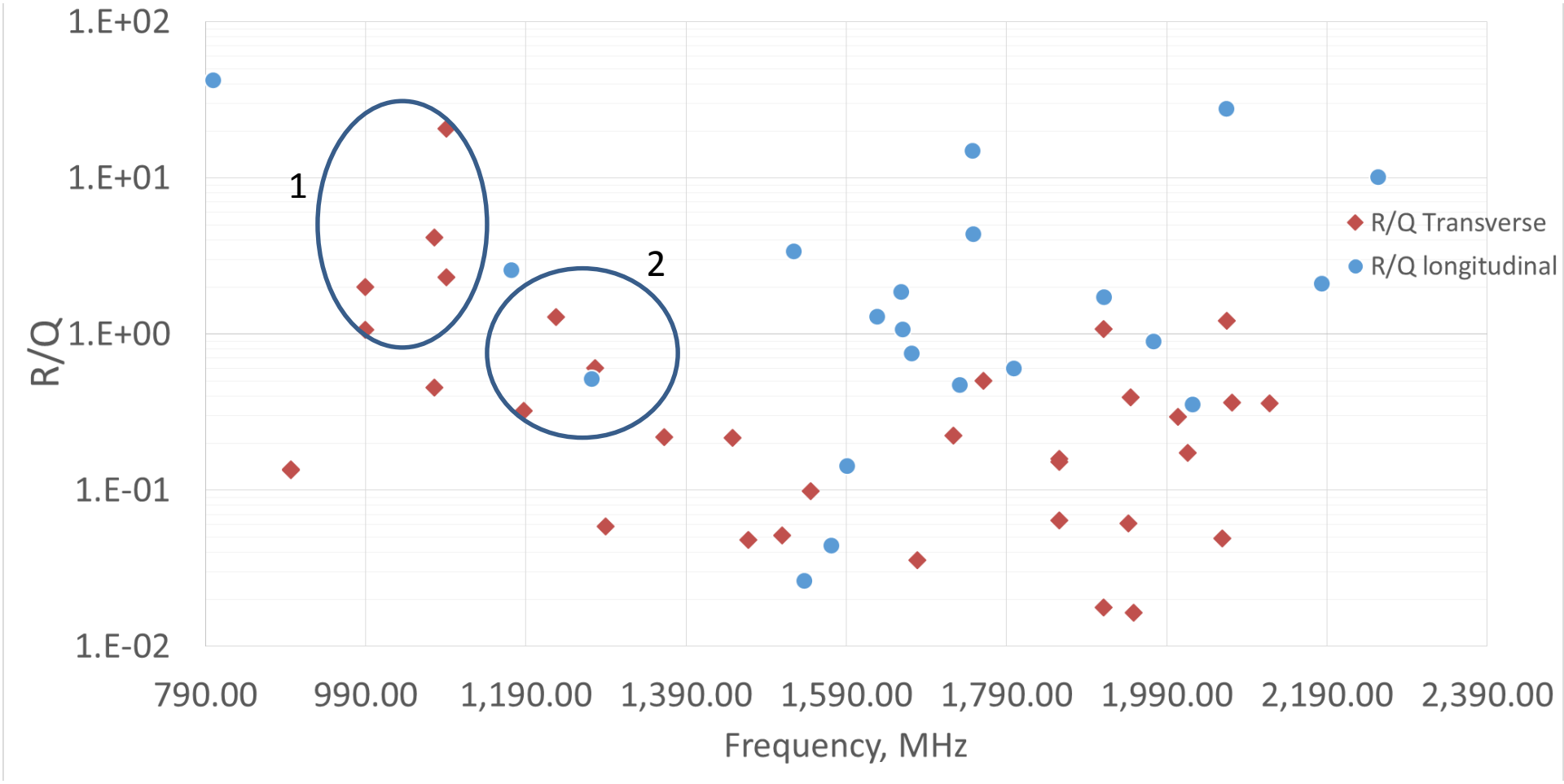
Qext



Orange – monopole modes
Blue – Dipole, quadrupole, etc

High Luminosity LHC

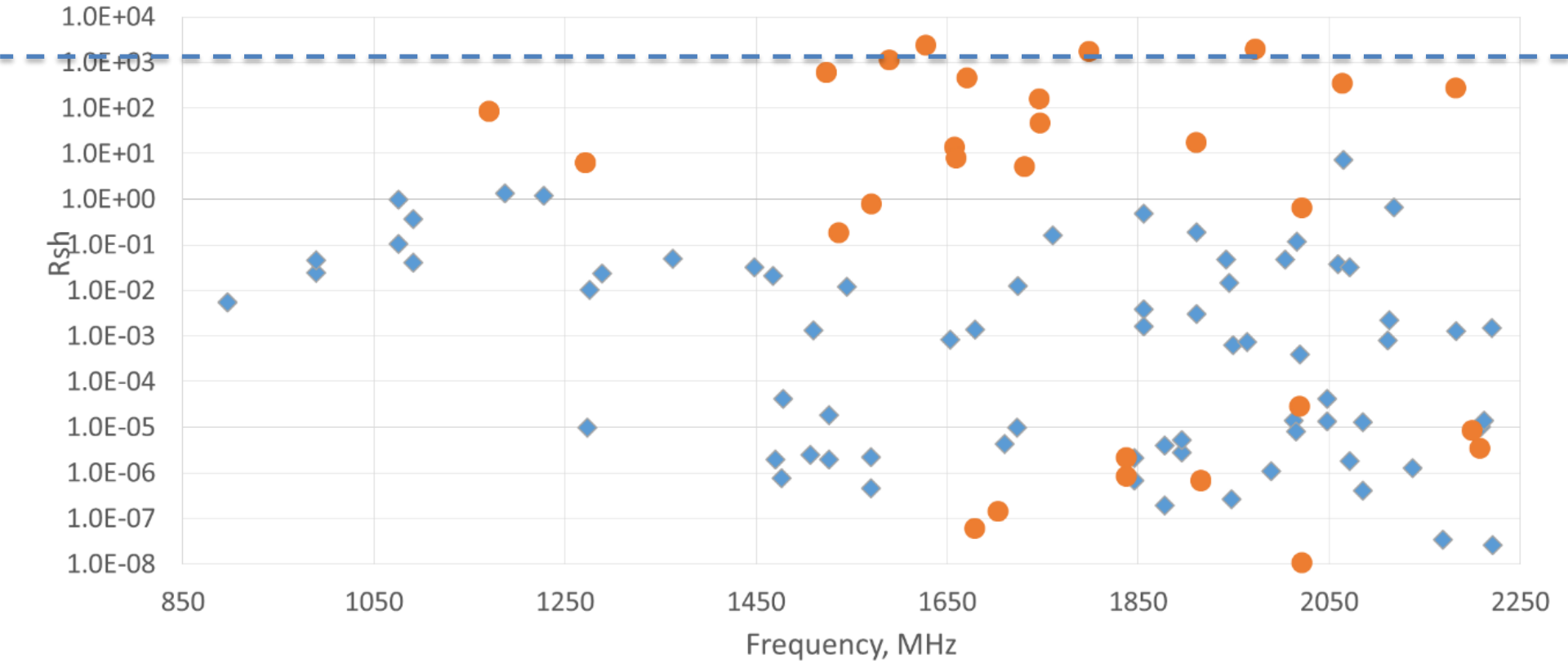
R/Q for grooved cavity



1 – First dipole modes (TE111, TM110)

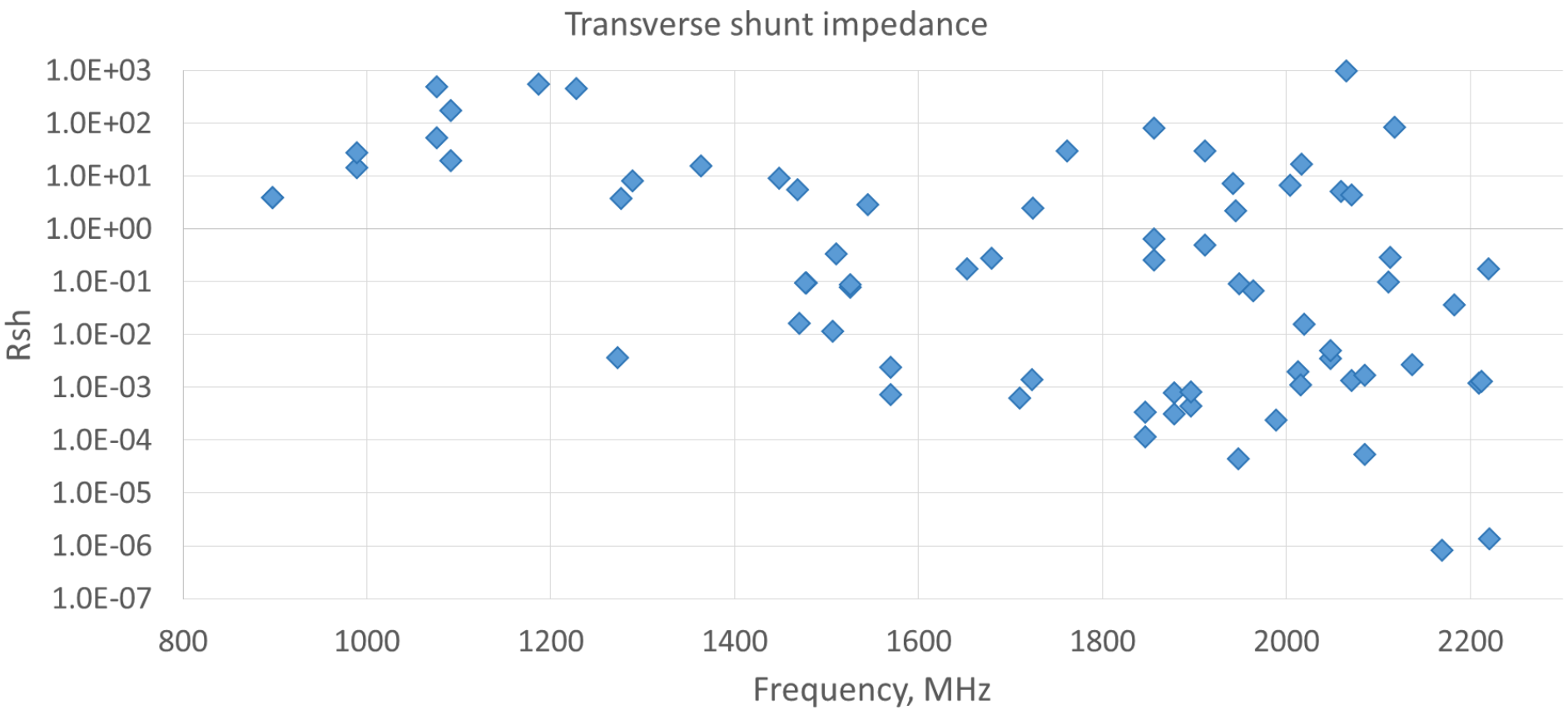
2 – Coupled modes

Longitudinal Rsh



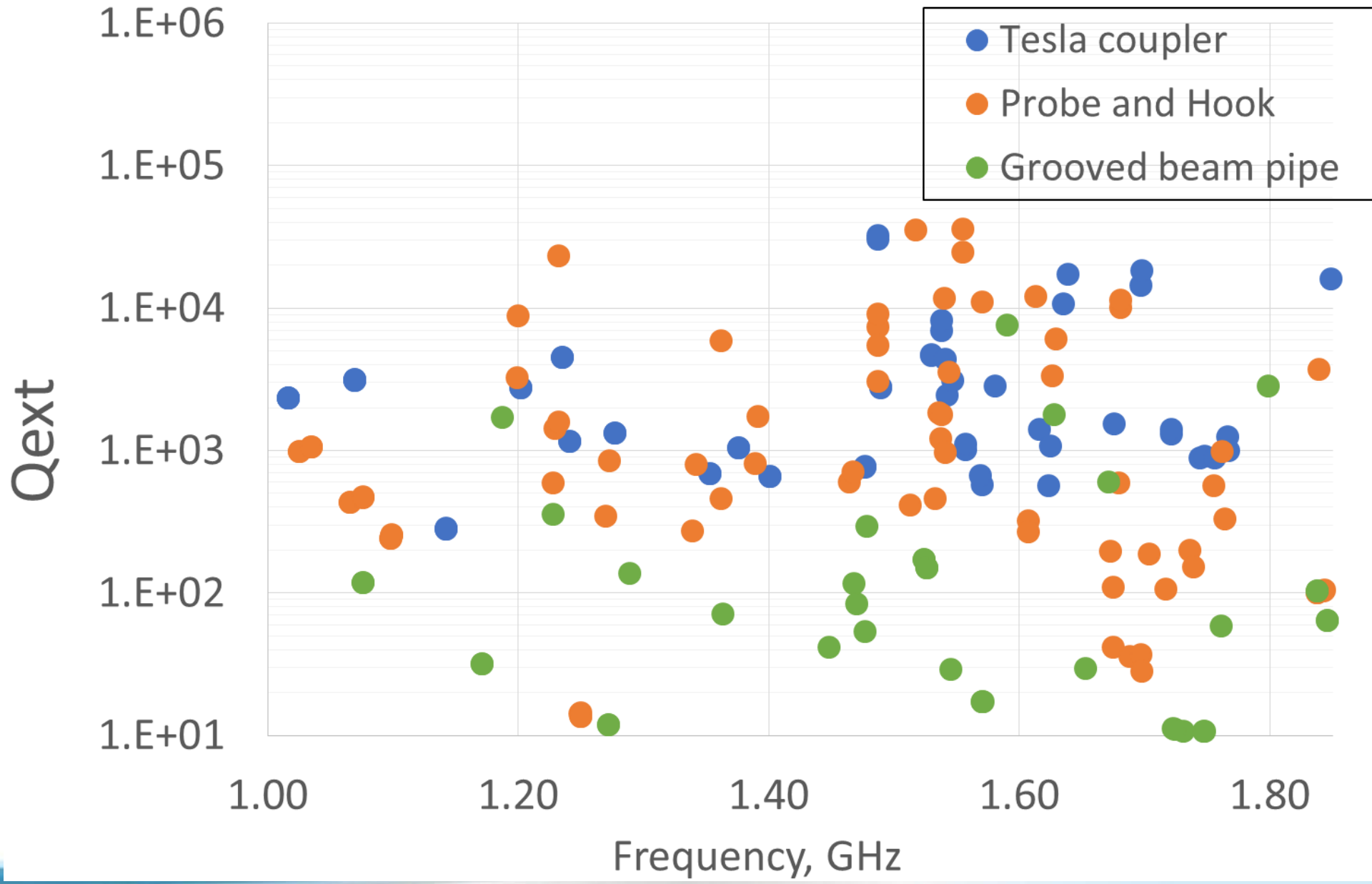
Longitudinal Rsh is lower than 10^3 Ohms

Transverse Rsh



Longitudinal Rsh is lower tha 10^3 Ohms

Comparison of Qext



Conclusion

- Tesla type coupler shows similar results on HOM damping comparing to Probe and Hook and the decision on which technology to use should be dictated from technological point of view
- The grooved beam pipe design shows very good results on HOM damping but it requires more longitudinal space and cryomodules. However this design could be attractive for the schemes that requires less than 4 cavities

Thank you for attention