HOM filter design for double quarter wave crab cavity

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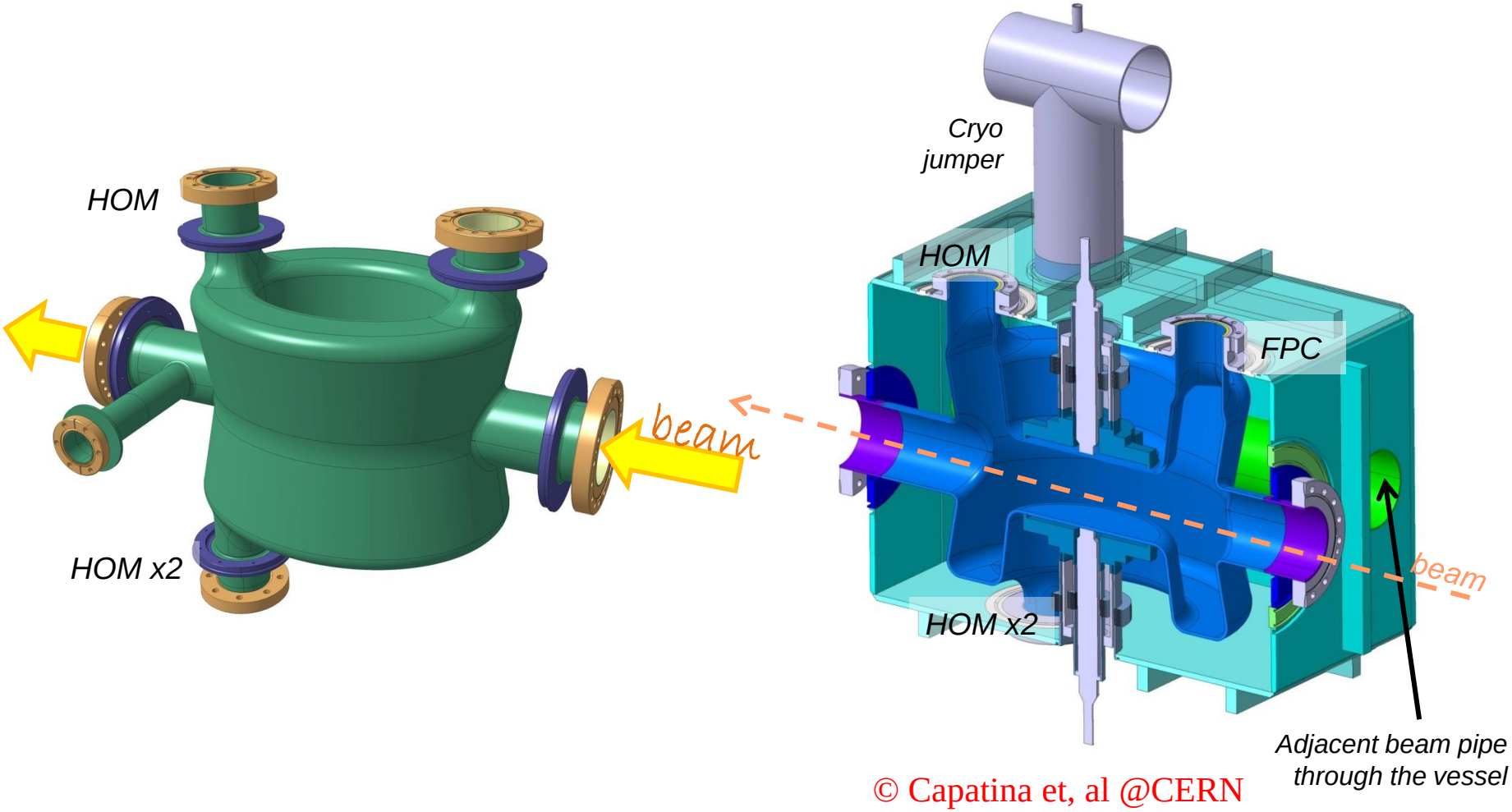
SPS double quarter wave



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Constraint in the HOM filter design

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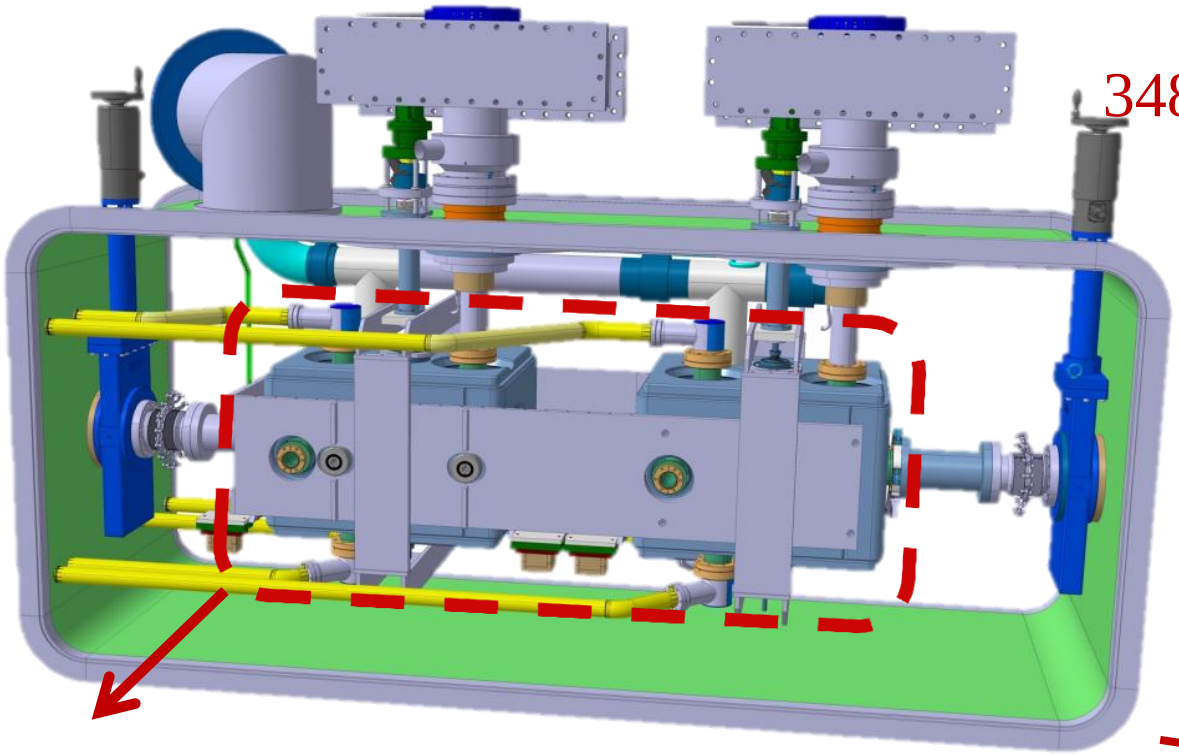
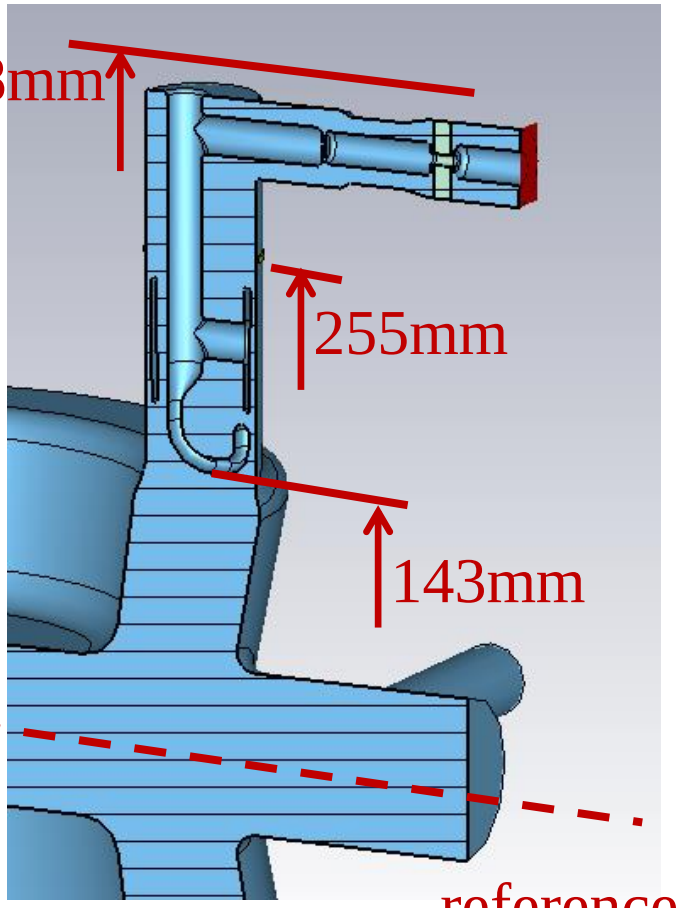
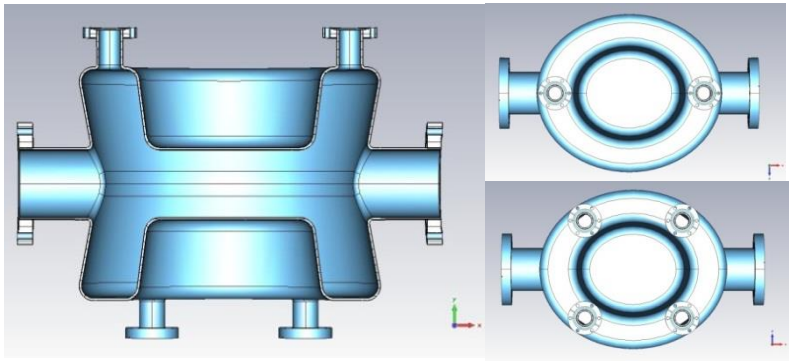


Magnetic & thermal shielding

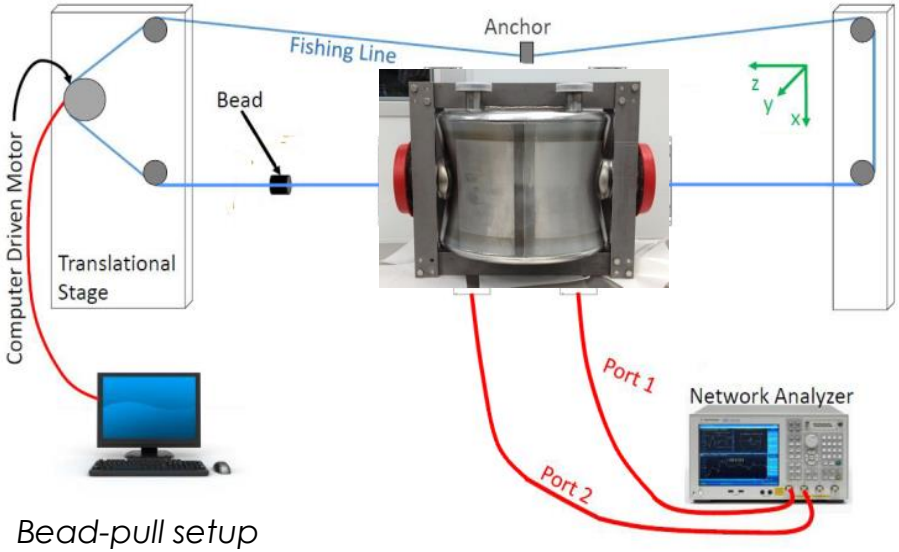
A liquid helium vessel for the HOM filter was not shown here



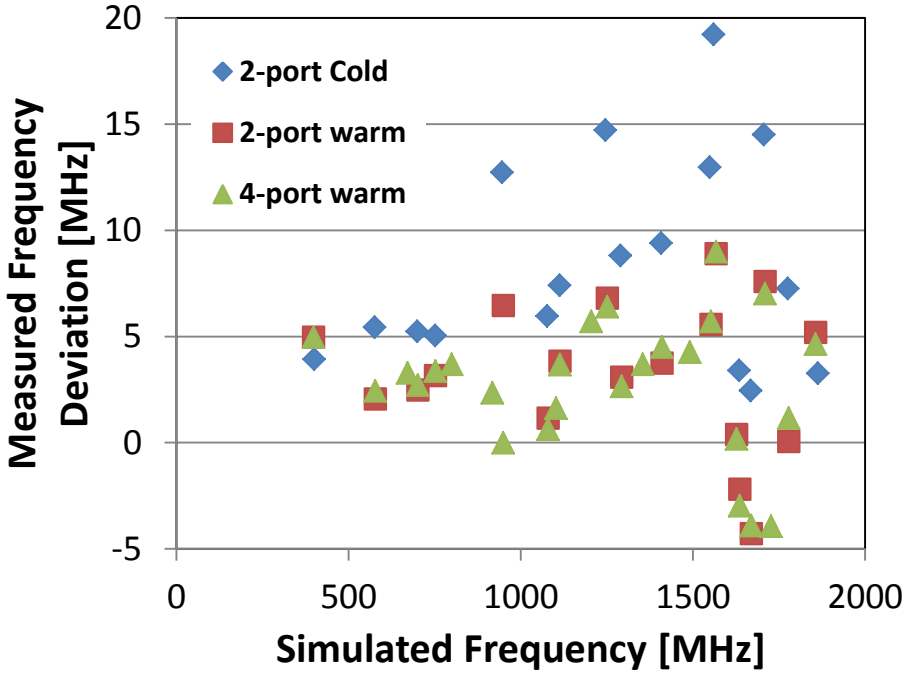
Identify HOMs: Bead Pulling



Proof-of-Principle (PoP)
Double-Quarter Wave Crab Cavity (DQWCC)



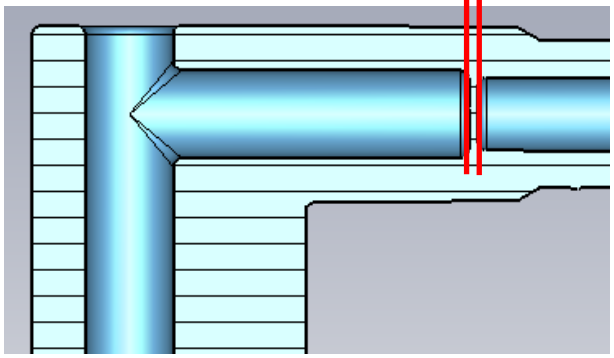
Bead-pull setup



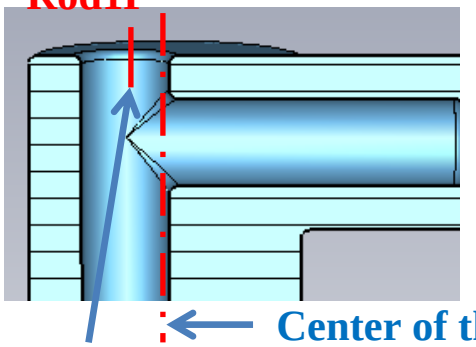
- **Cavity prototype smaller than RF model cause frequencies shifting up.**
- **HOM frequencies deviated from designed values due to unspecified tolerances for PoP cavity.**

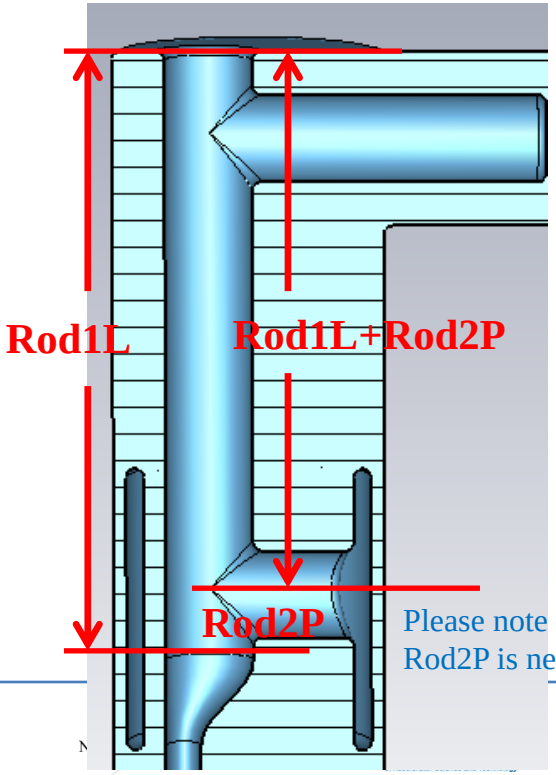
Tolerance study

Gap2 ranges from 1.5 to 2.5 mm.

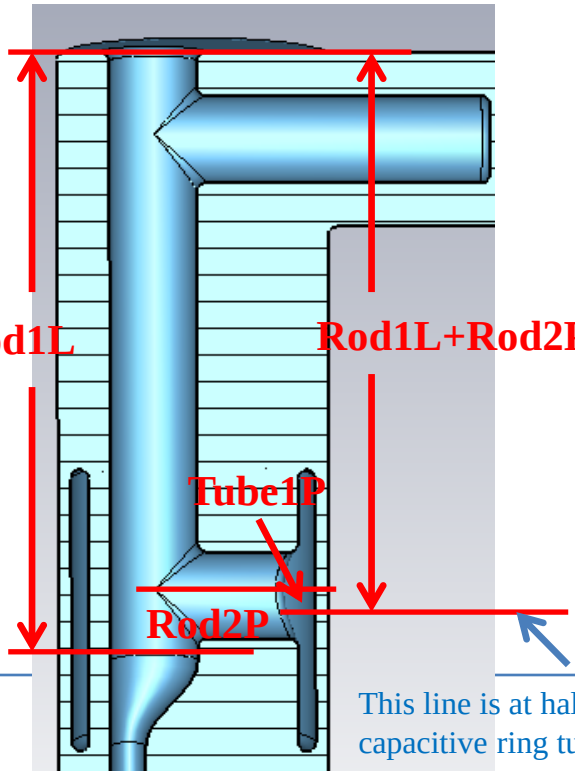


Rod1P at -9 means it is on the left of the center of the 62mm dia. can with a distance at 9mm.





Please note the parameter Rod2P is negative

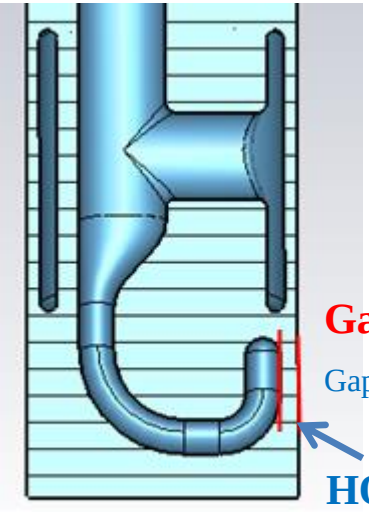


This line is at half of the capacitive ring tube

Tolerance study

Unit: mm

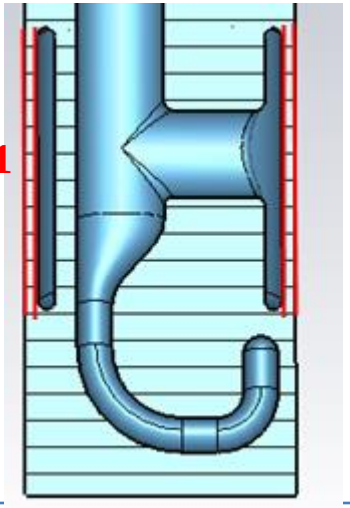
Parameter	Nominal	error	
Gap0	4	Left 0.4	Right 0.5
Gap1	3	Left 0.4	Right 0.5
Gap2	2	Left 0.5	Right 0.5
Rod1P	-9	Left 0.4	Right 0.5
Rod1L+Rod2P	125	Down 0.5	Up 0.5
Rod1L+Rod2P +Tube1P	128.5	Down 0.5	Up 0.5
Insertion	143	Down 0.5	Up 0.5
Rotation		Clockwise 1 degree	Counter clockwise 1degree



Gap0

Gap0 ranges from 3.5 to 4.4 mm.

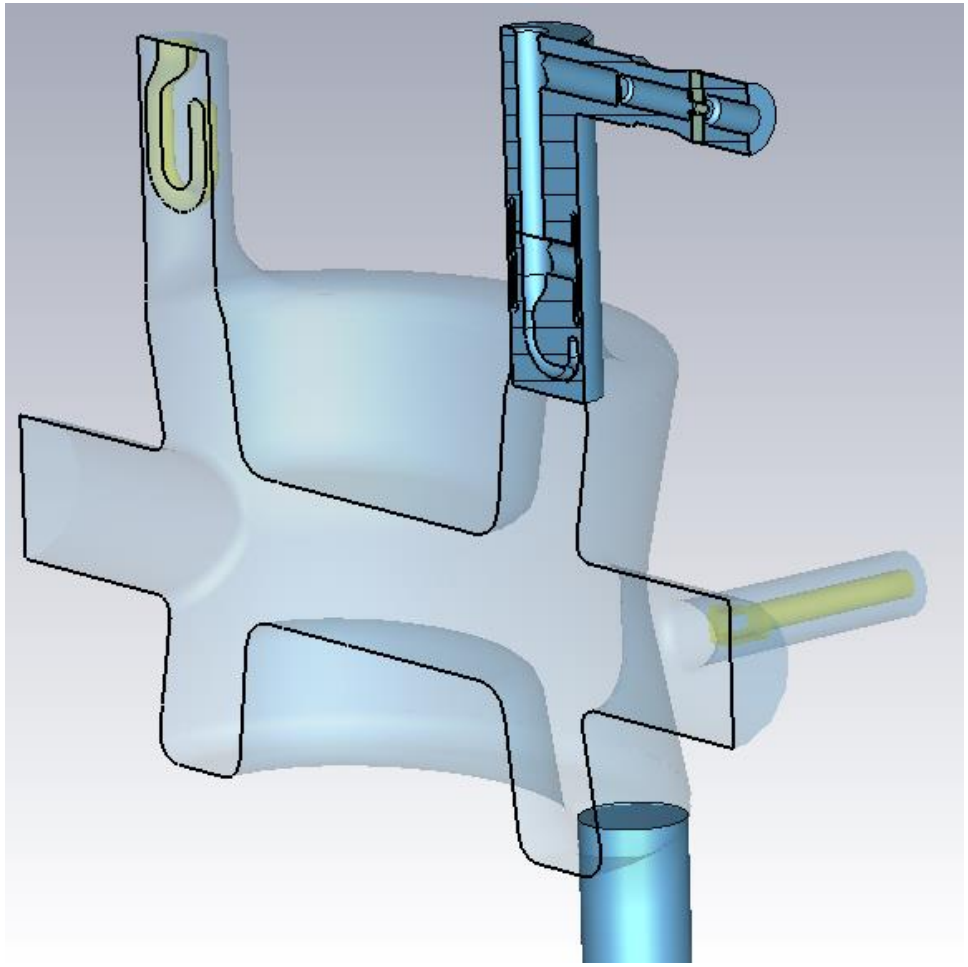
HOM port inner wall on cavity side



Gap1

-0.4 means the capacitive ring is shifted left, the gap on the left becomes smaller (to 2.6) and the gap on the right becomes bigger (to 3.4).
+0.5 means the capacitive ring is shifted right, the gap on the left becomes bigger (to 3.5) and the gap on the right becomes smaller (to 2.5).

Tolerance study



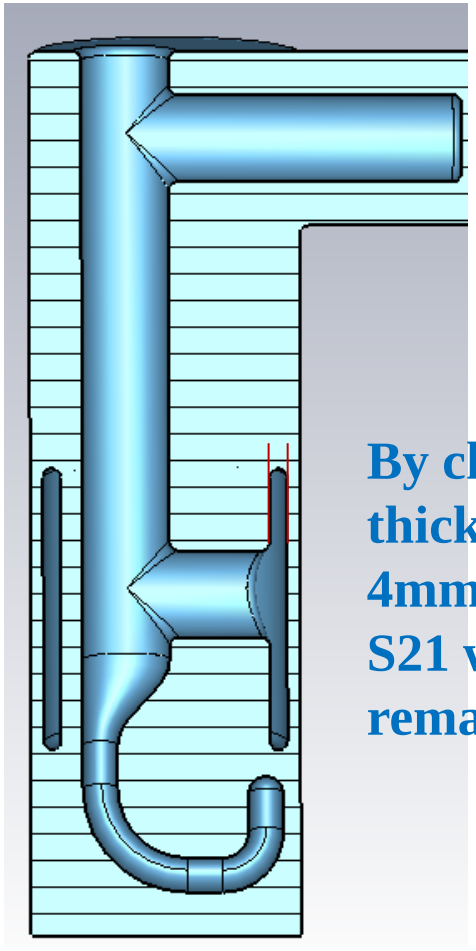
Q_{ext} of each HOM was calculated from cavity+HOM filter model, with 0.2~0.4M meshes.

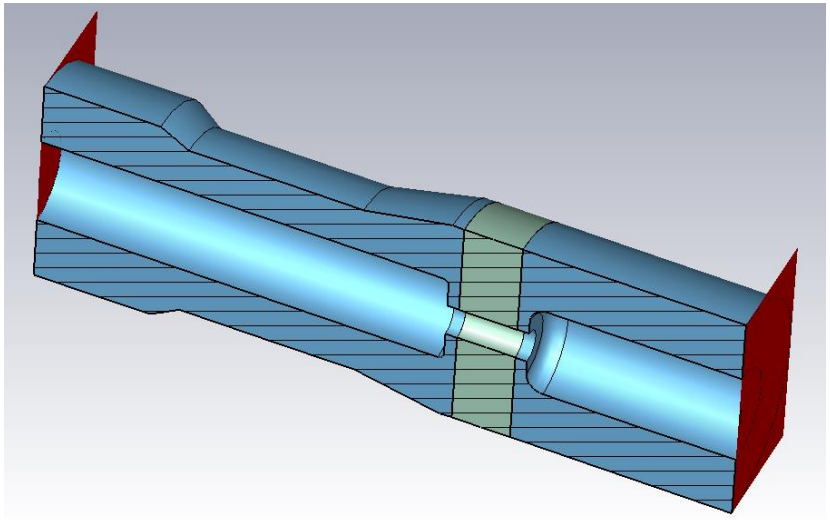
Q_{ext} of each HOM was then calculated from S21 difference of each filter and was compared with the previous results.

Most of the Qexts are consistent (50% to 200%) using two methods, there are a few modes that showed 25%~50%, or 200%~400% difference.

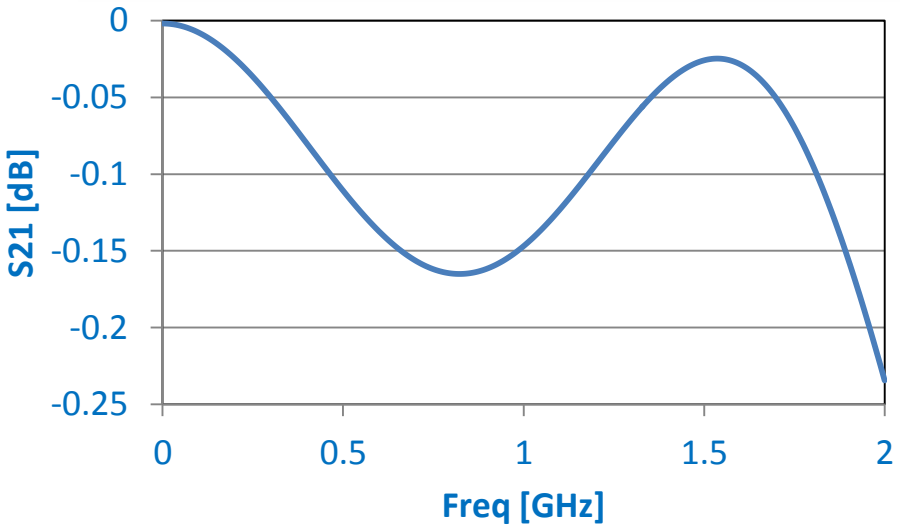
Discrepancy came from the insertion of the HOM filter into the cavity.

Nb thickness and HOM window

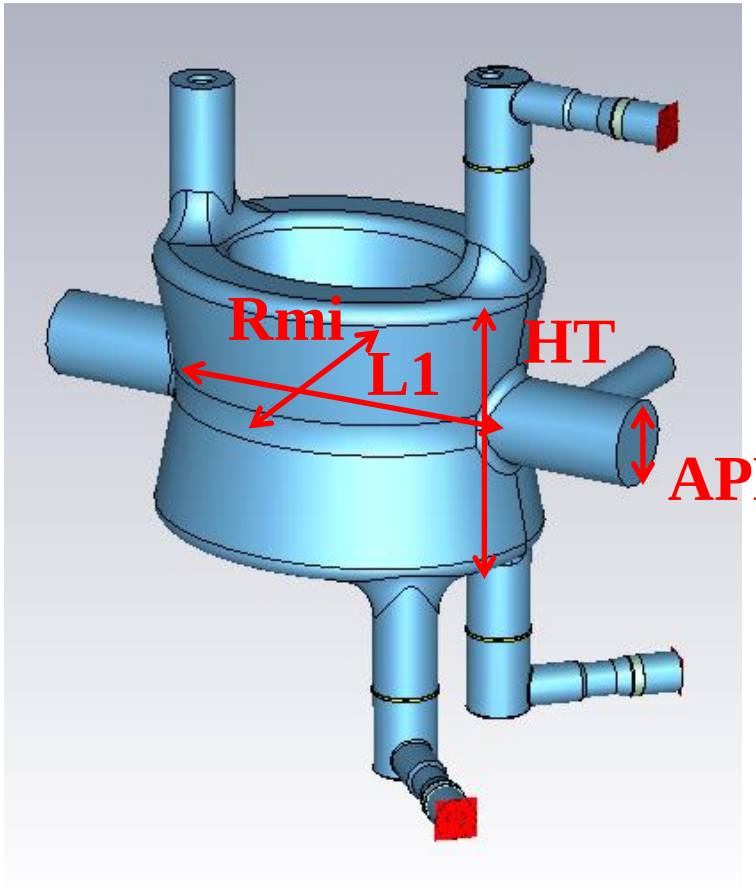




By changing this thickness from 4mm to 3mm, the S21 will basically remain the same.

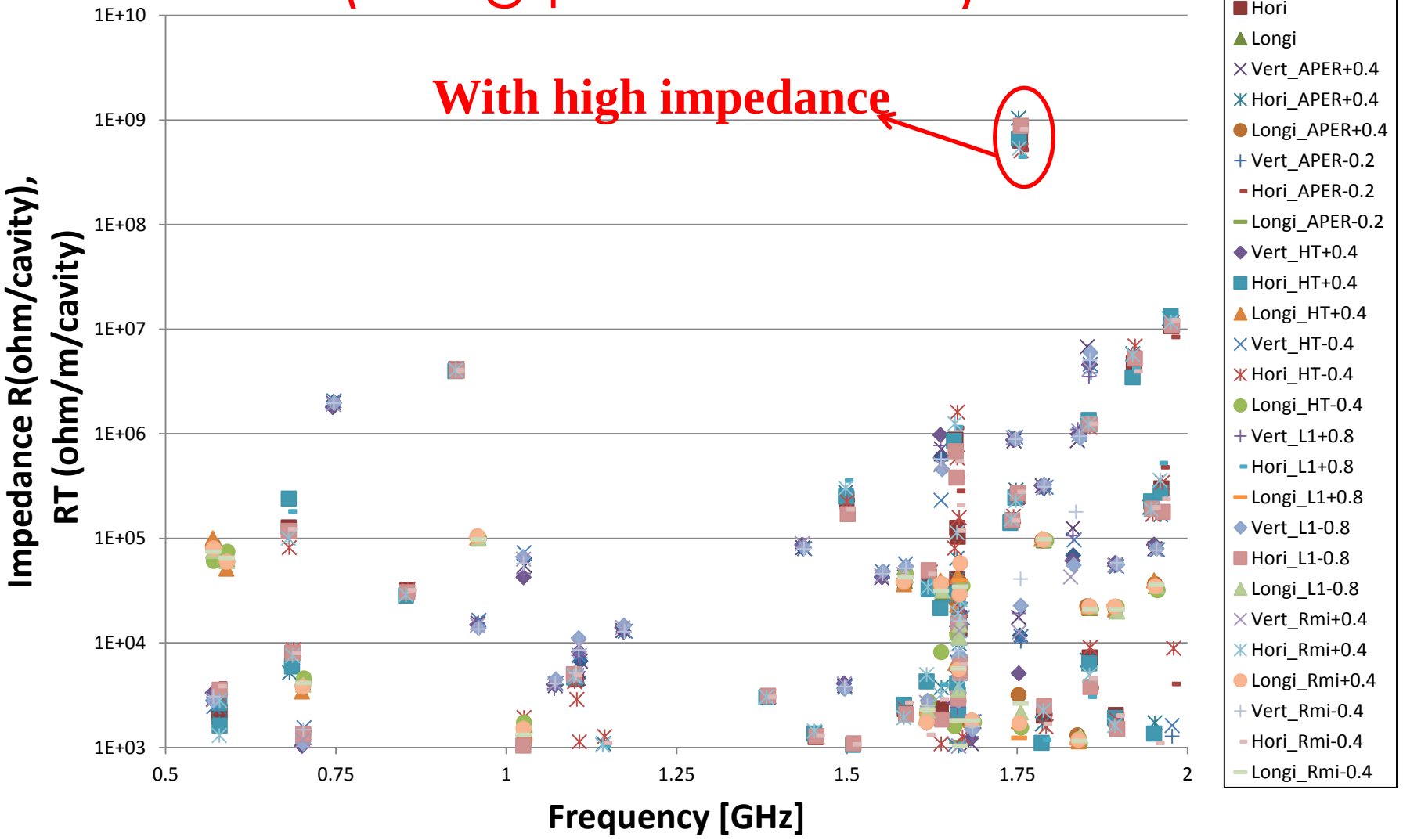


HOM with cavity fabrication errors



Parameter	Error [mm]
APER	+0.4 -0.2
HT	±0.4
L1	±0.8
Rmi	±0.4

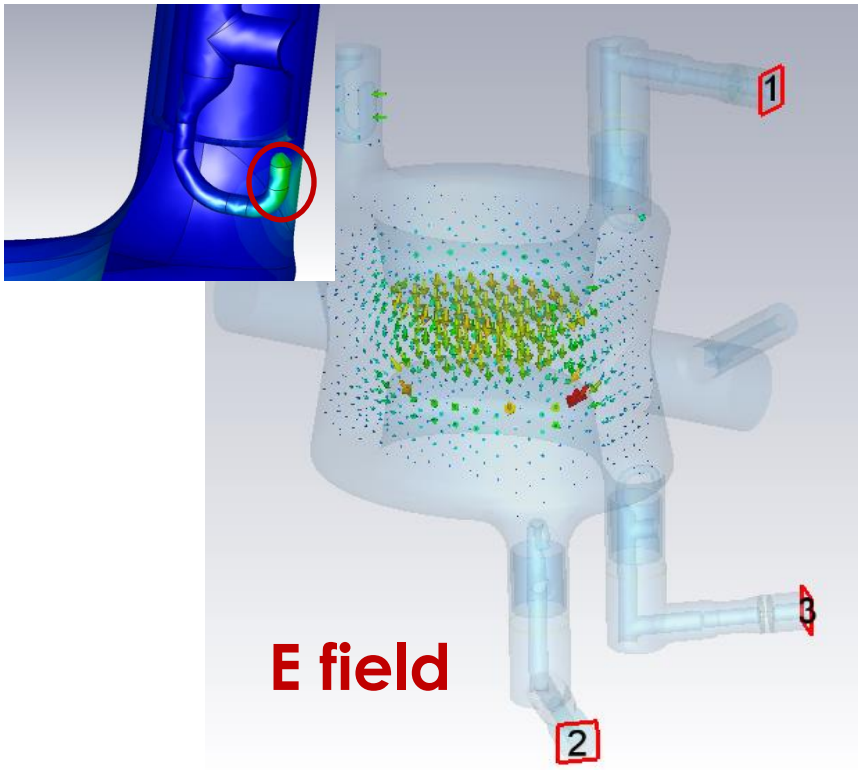
HOM with cavity fabrication errors (using ports models)

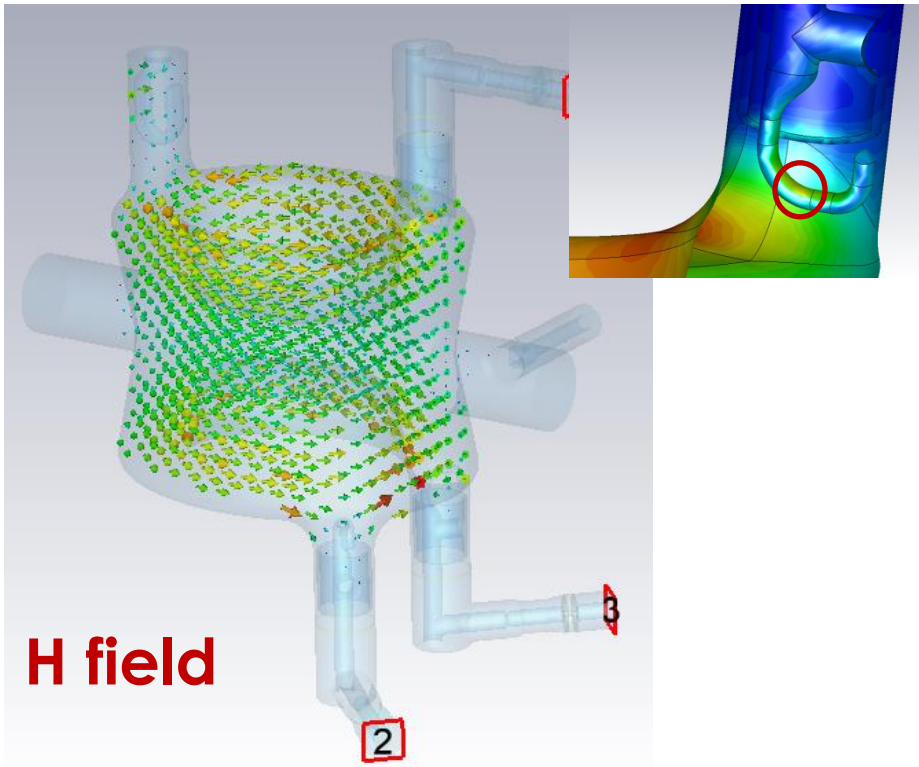


Possible solutions for 1.75GHz

- Change the coupling positions
- Improve filter S21 @ 1.75GHz
- Change length of inner conductor
- Change the direction of the HOM filter feedthrough with respect to the hook

Filter at 400MHz with HOM & Cavity fab errors



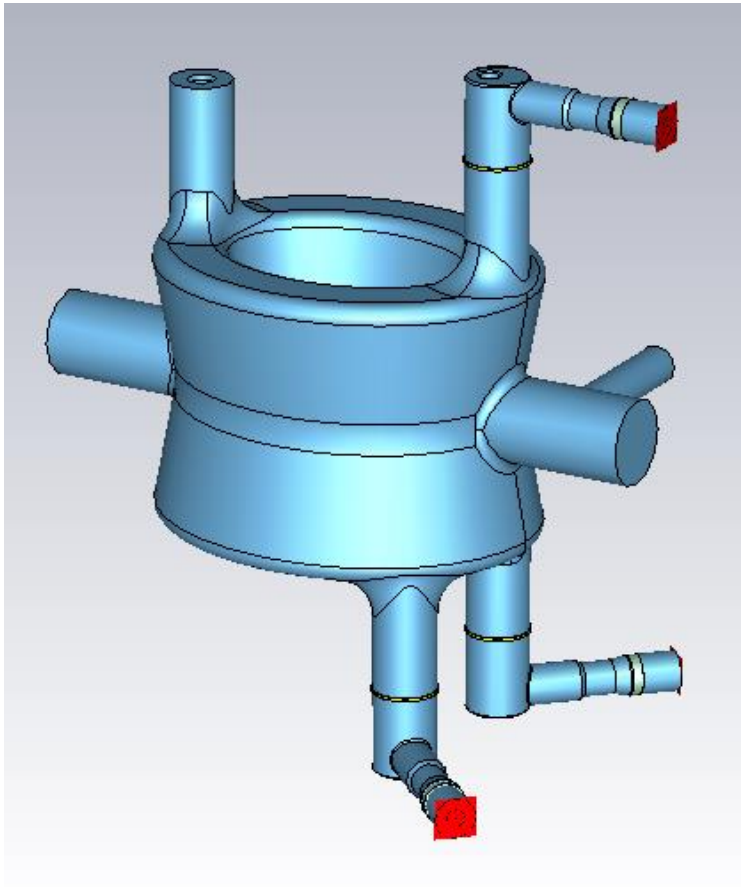


For 400MHz crabbing mode with V_t = 3.34MV:

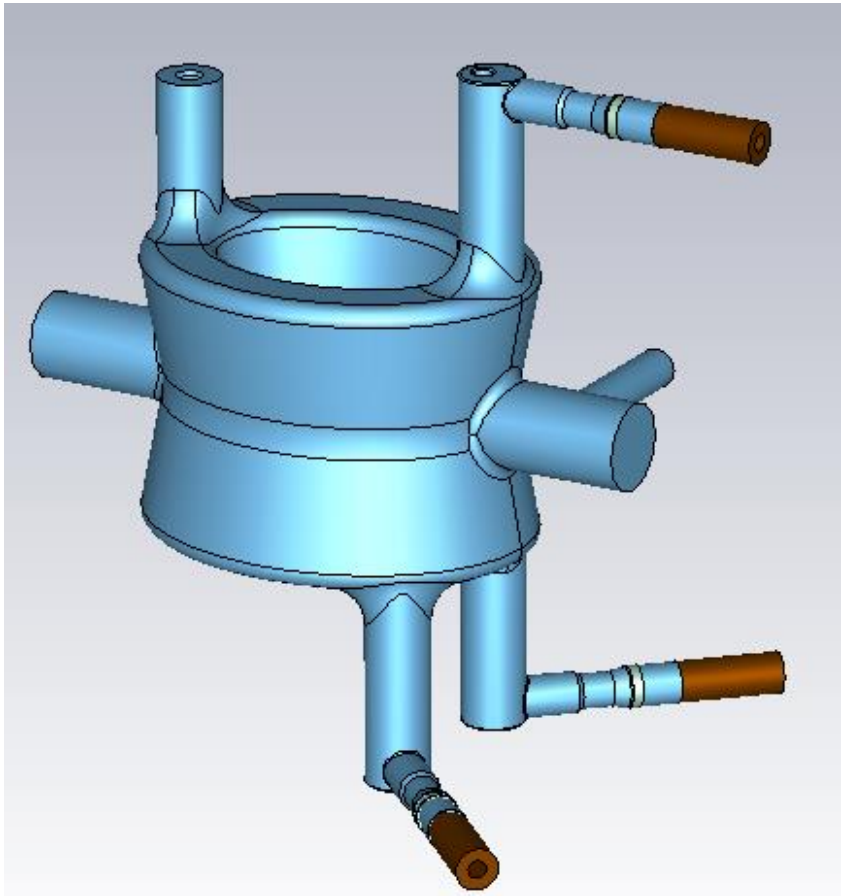
- Peak E field on the hook: 19.4~29.7MV/m, on the cavity: 37.0~38.8MV/m.
- Peak H field on the hook: 46.2~58.7mT, on the cavity: 70.4~71.6mT.
- Coupling to 400MHz: >6.3x10^9, <1.4 W at each port to outside load.

Models of DQWCC with HOM filter

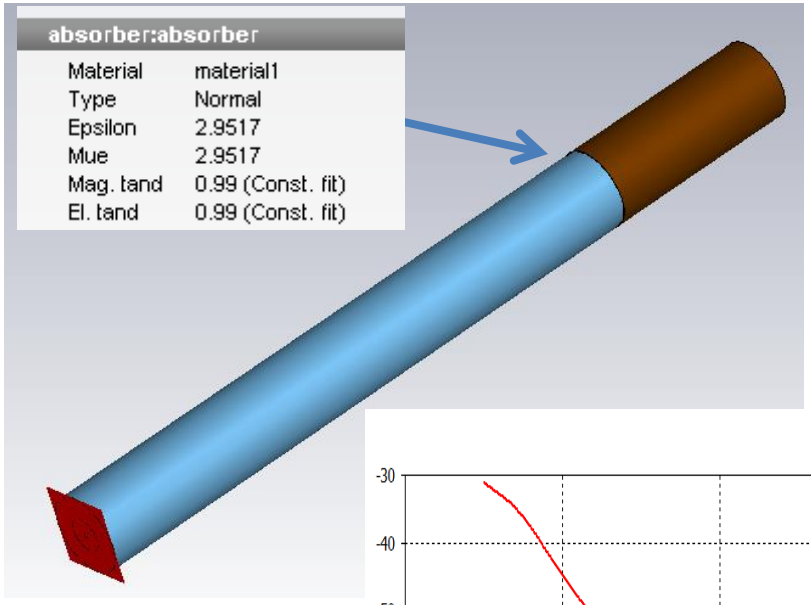
With waveguide ports



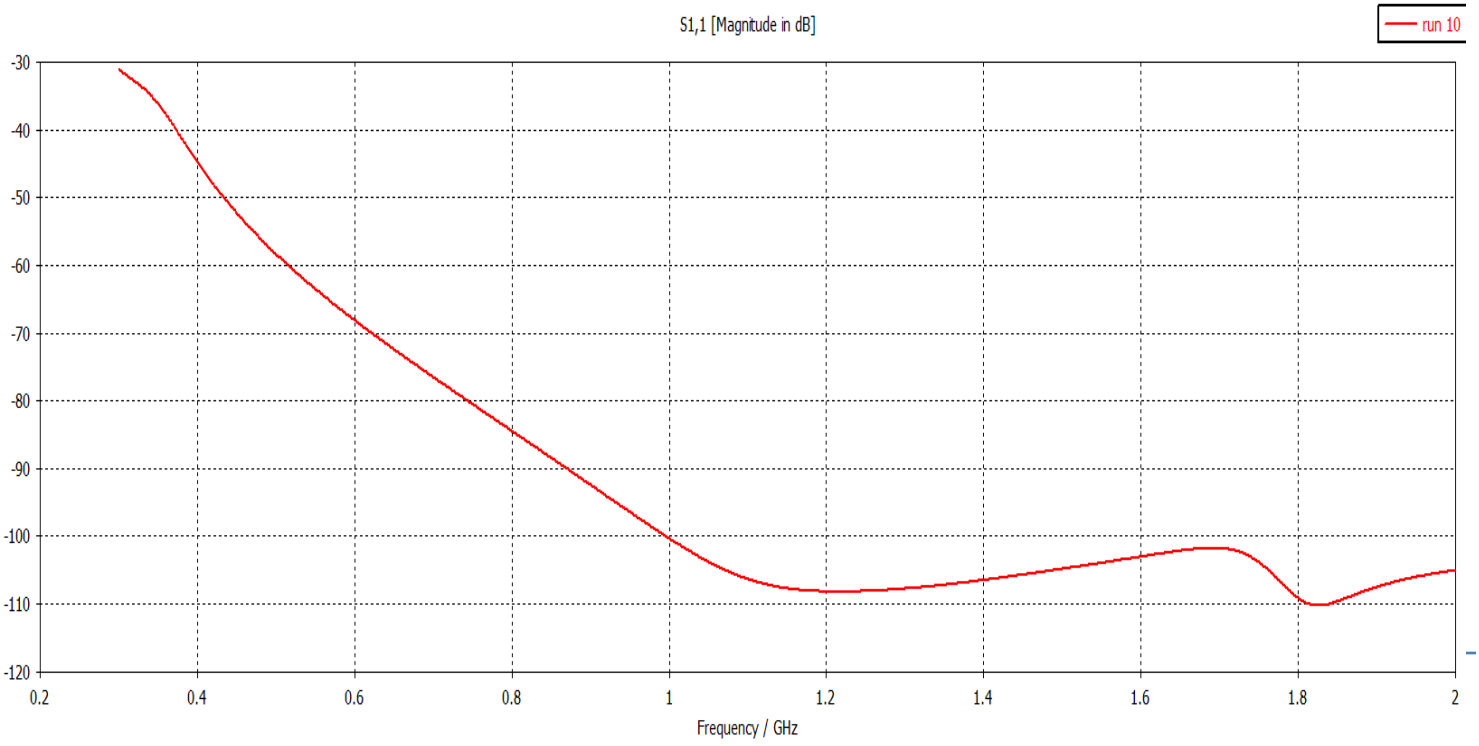
With 50 ohm



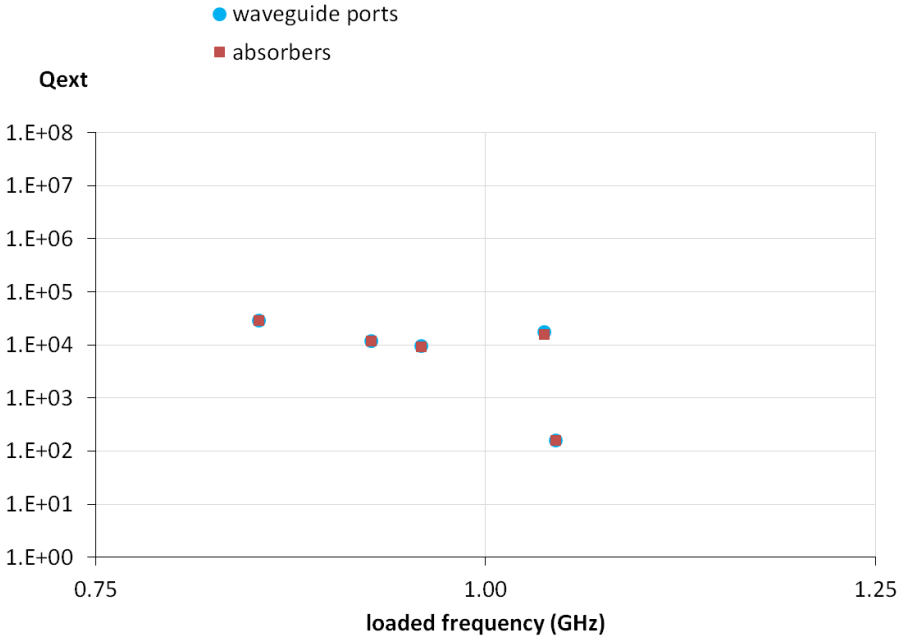
50 ohm load for DQWCC

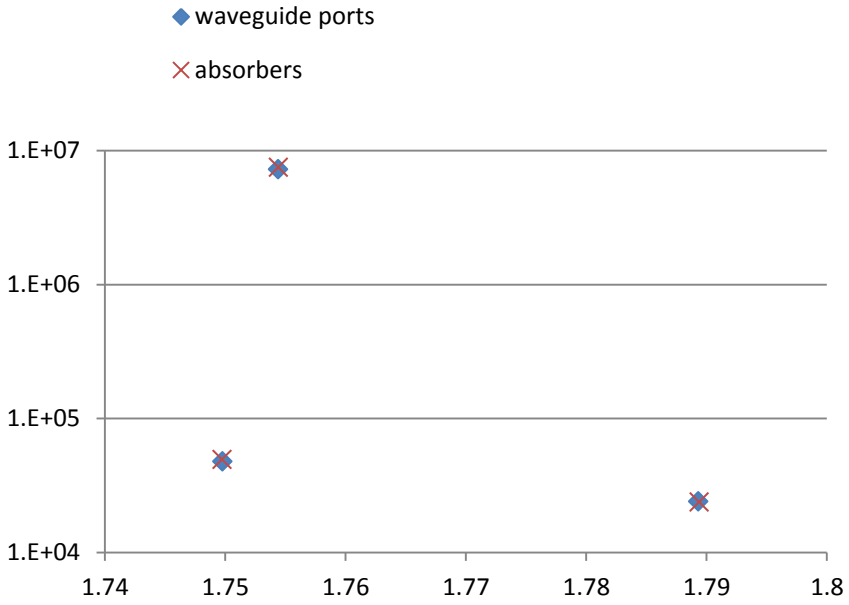


At frequency range 0.4~2GHz, most of the power will be dissipated on the absorber.



Impedances from the models





LARP

High Luminosity LHC

Thank you!