Compact HOM-damped RF Cavity for a Next Generation Light Source

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- HOM-damping structure by using TM020 mode
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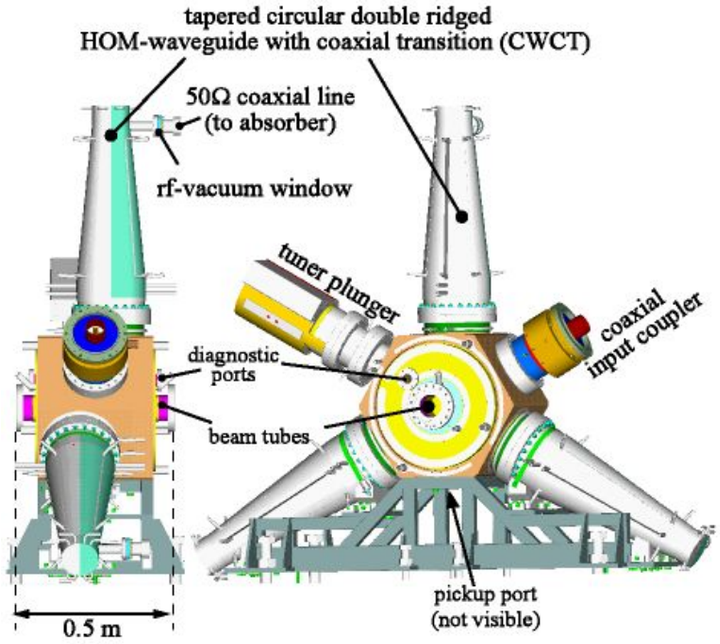
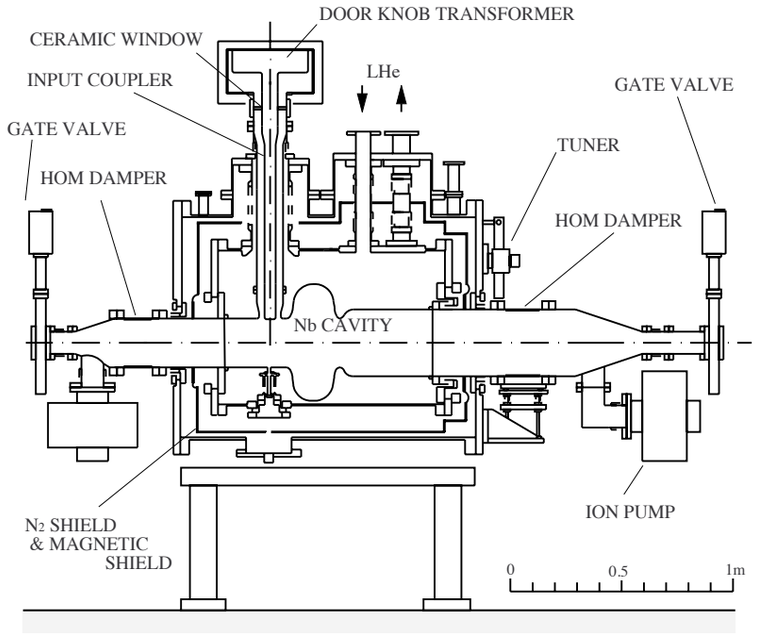
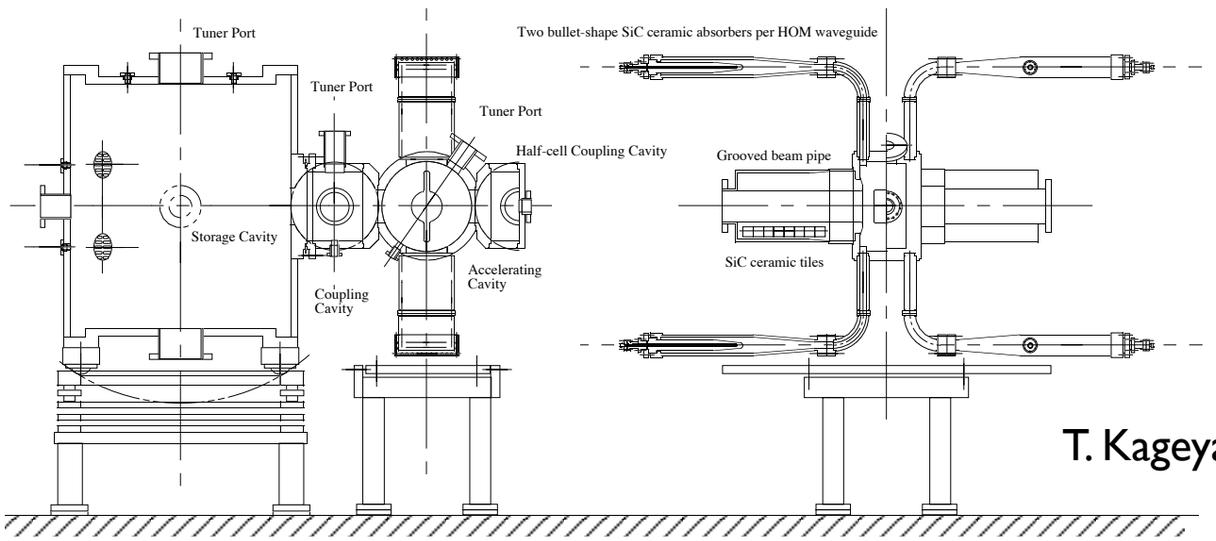
Existing HOM-damped cavities



E. Weihreter, EPAC08, p.2936



T. Furuya et al., PAC97, p.3087

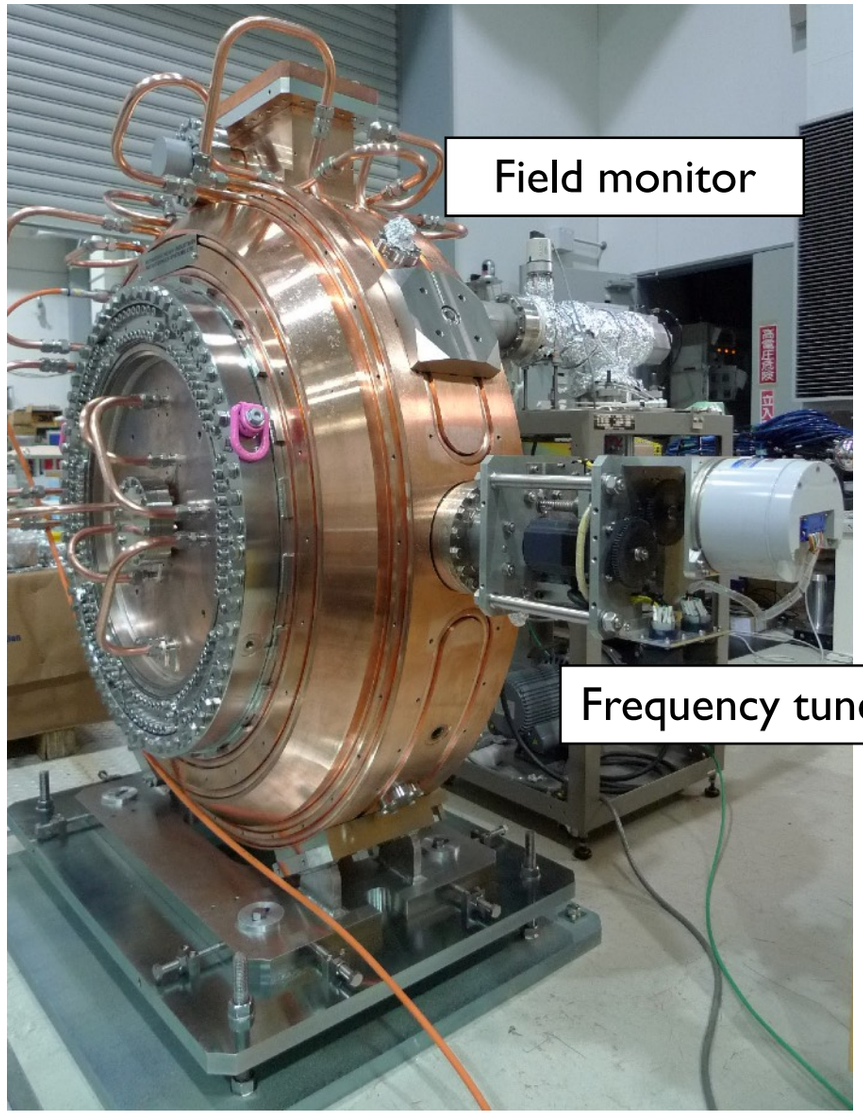


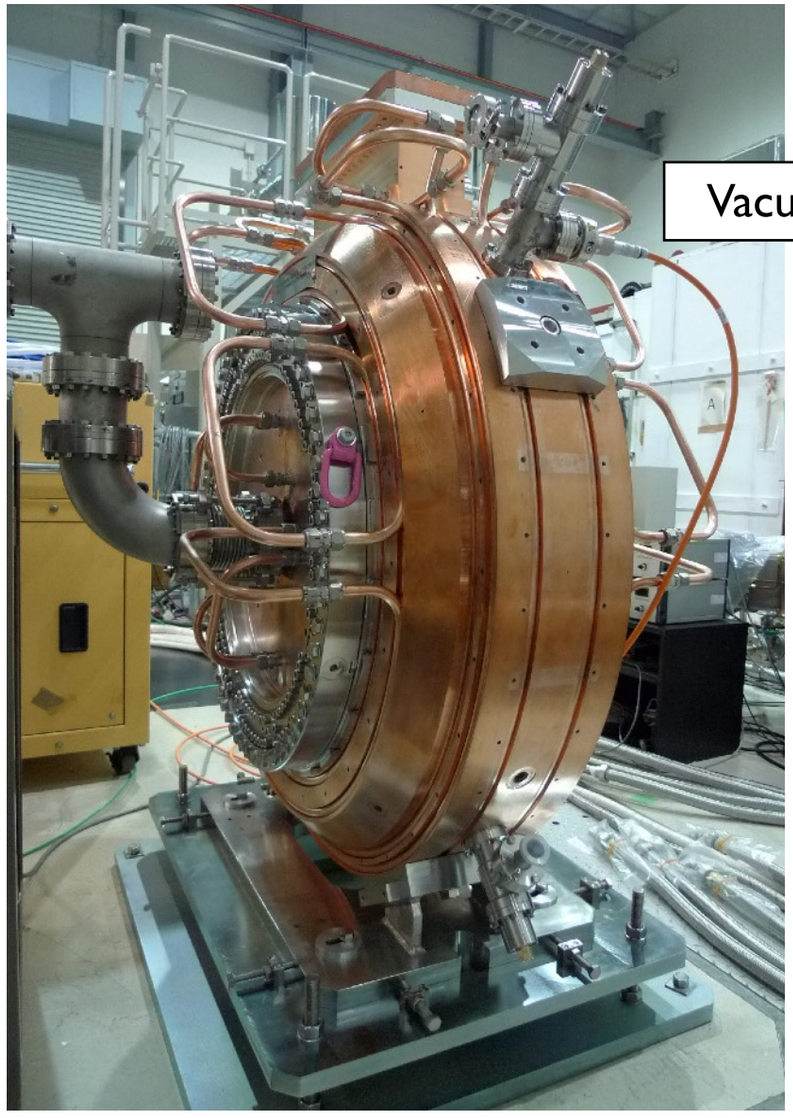
T. Kageyama et al., PAC97, p.2902

Figure 1: A schematic drawing of ARES96

Massive cavities
with HOM-damping waveguides or/and pipes

RF cavity with compact HOM-damping structure

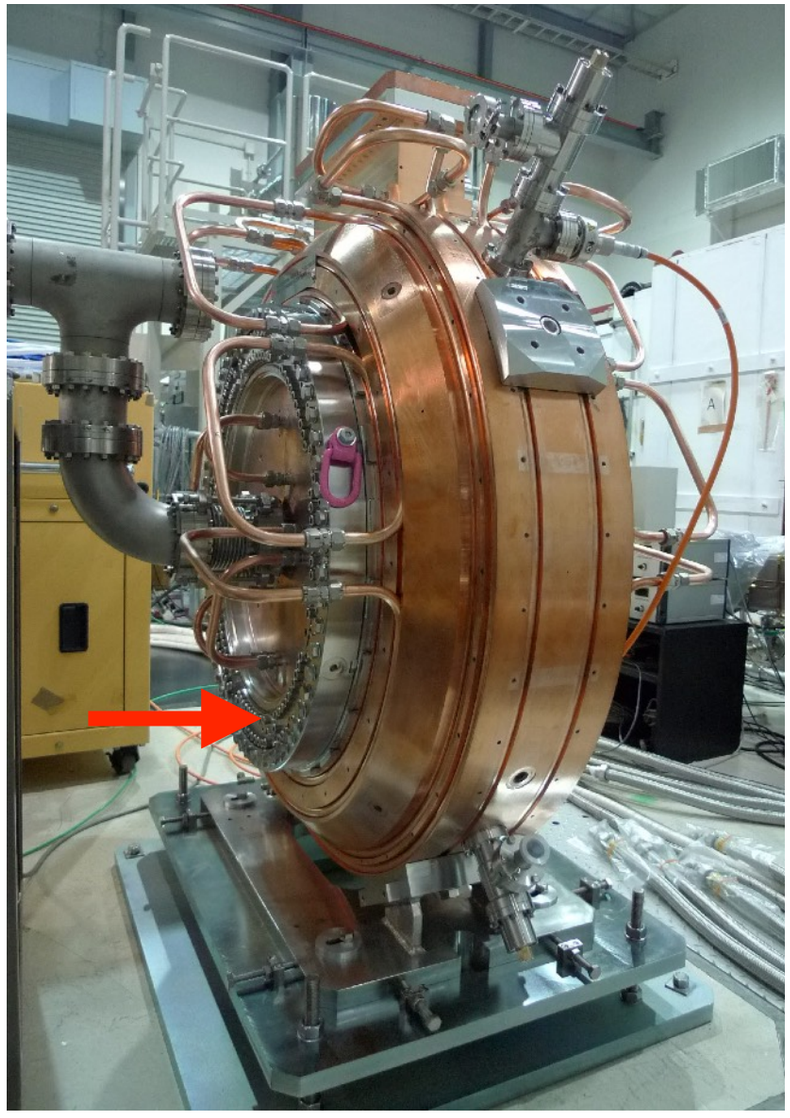




Where are HOM dampers?

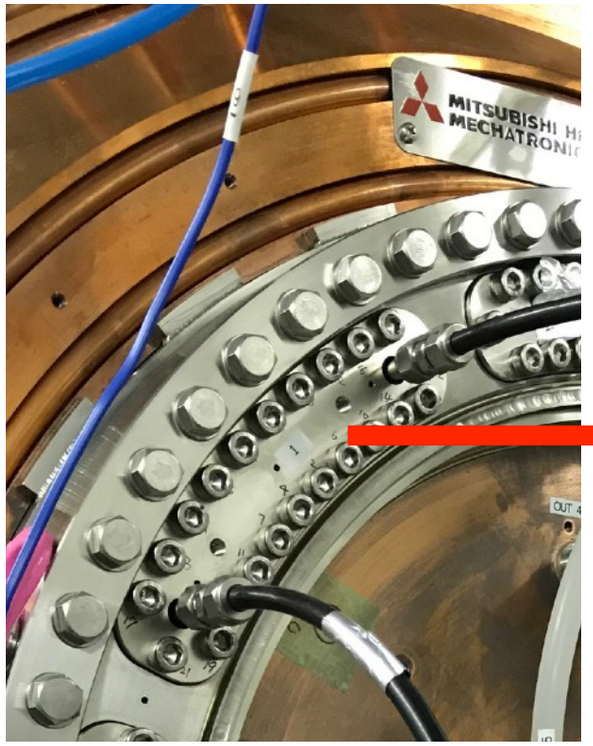
RF cavity with compact HOM-damping structure

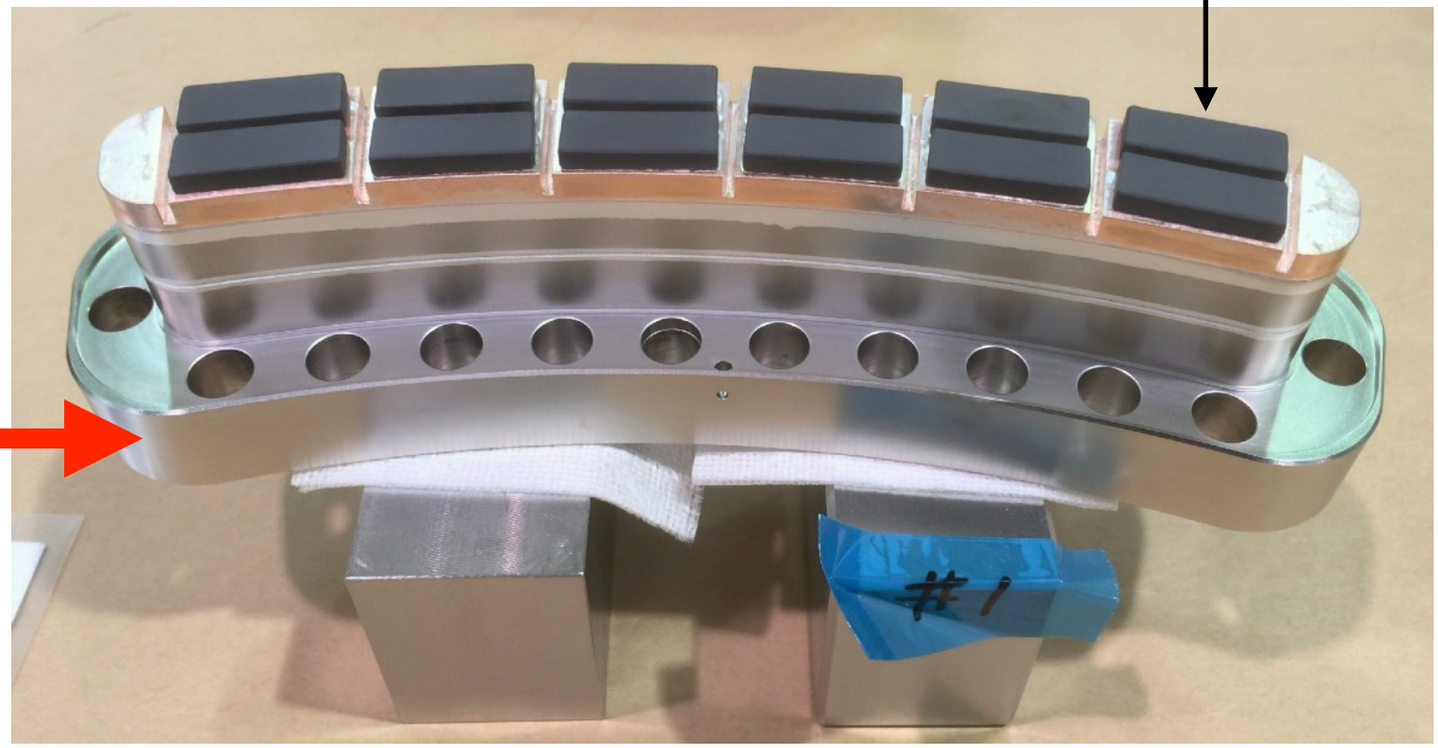
Here →



16 HOM dampers directly embedded into the cavity body

HOM damper



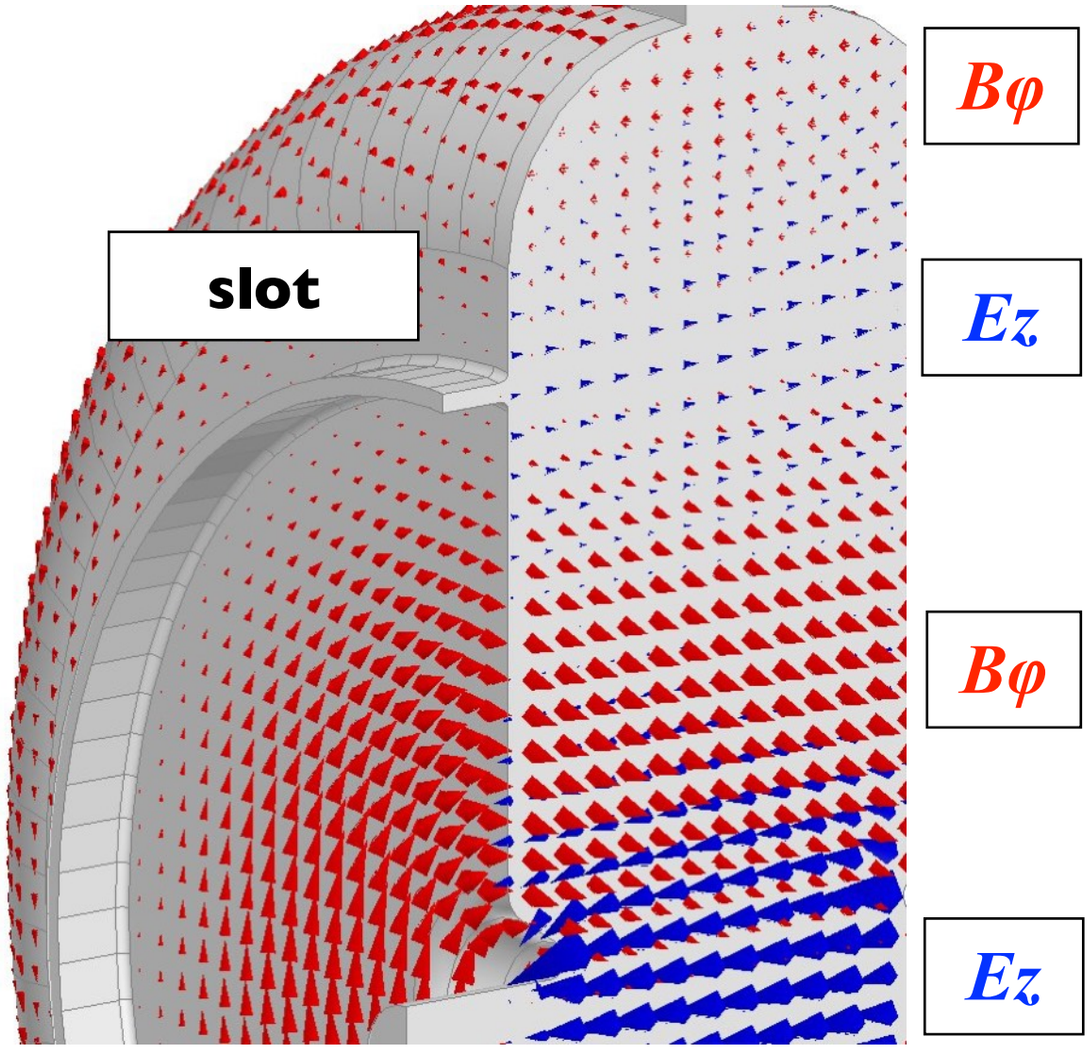


- **Ferrite bars brazed to the curving flange**
- **Water cooling channel provided in flange**
- **No change in cavity size by installing HOM dampers**

How to compact HOM-damping system

Use TM020 mode and slots

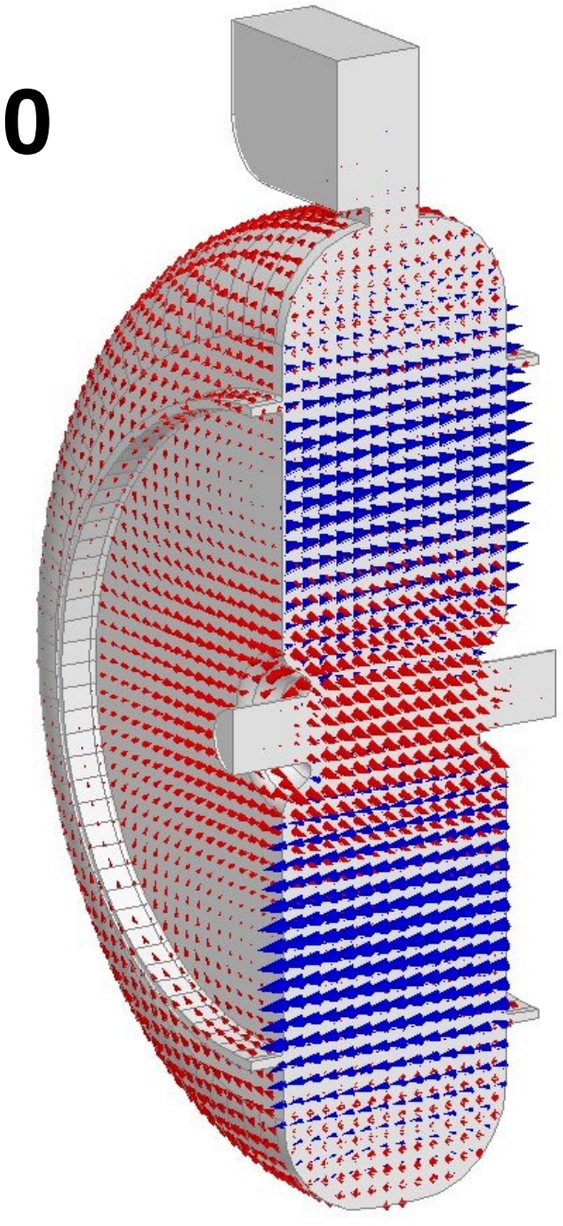
Field distributions of TM020 mode



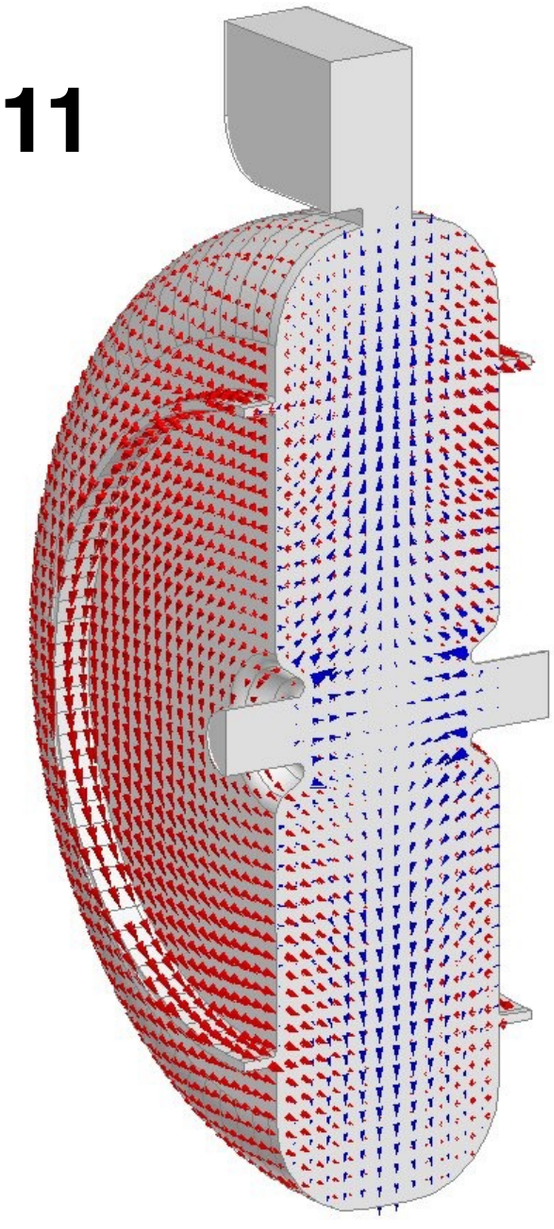
Slots along the nodes of magnetic fields and parallel to electric fields
→ No field intrusion of the TM020 mode

How to compact HOM-damping system

TM110



TM011

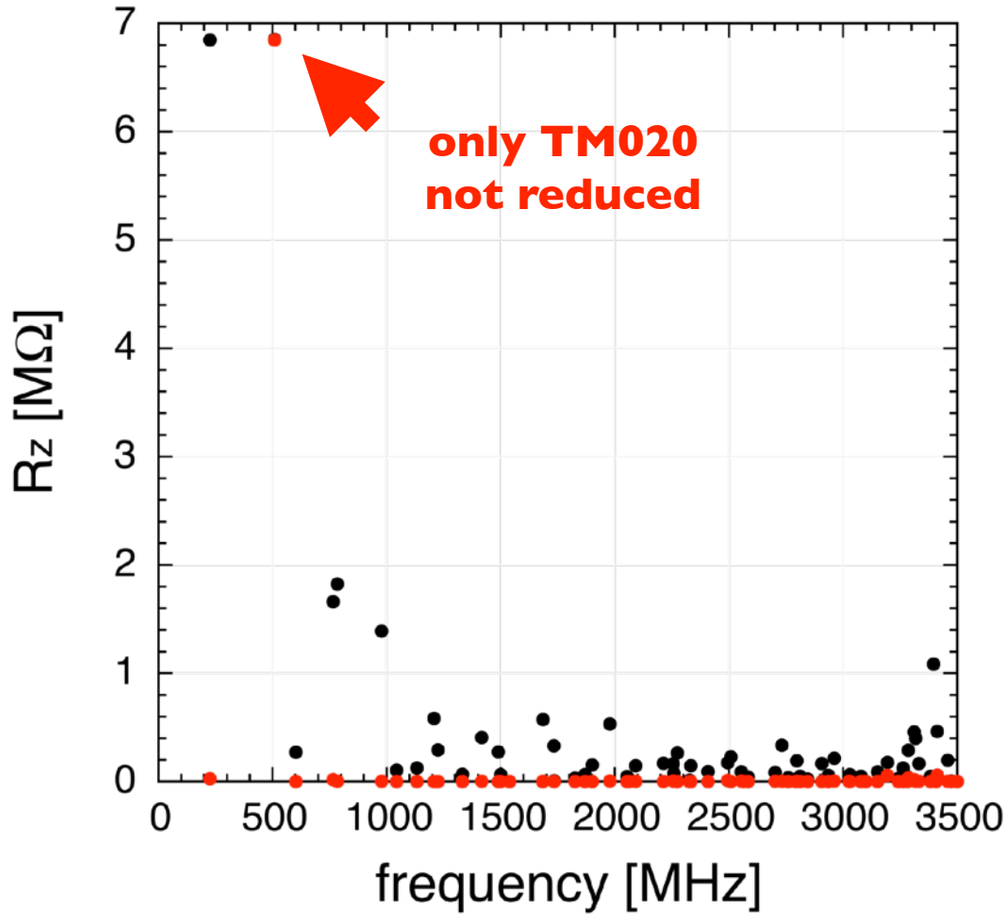


Fields of monopole and dipole modes except TM020 mode get into the slots

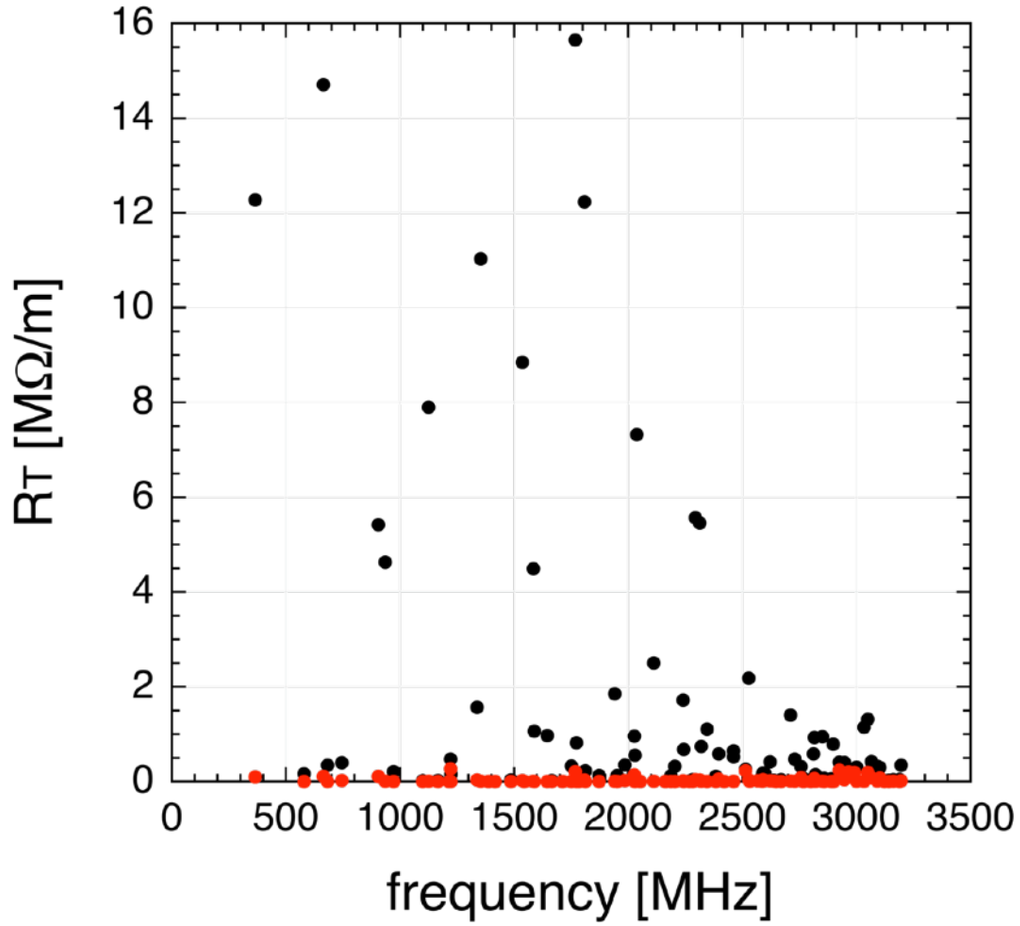
How to compact HOM-damping system

2D simulations with MAFIA

monopole



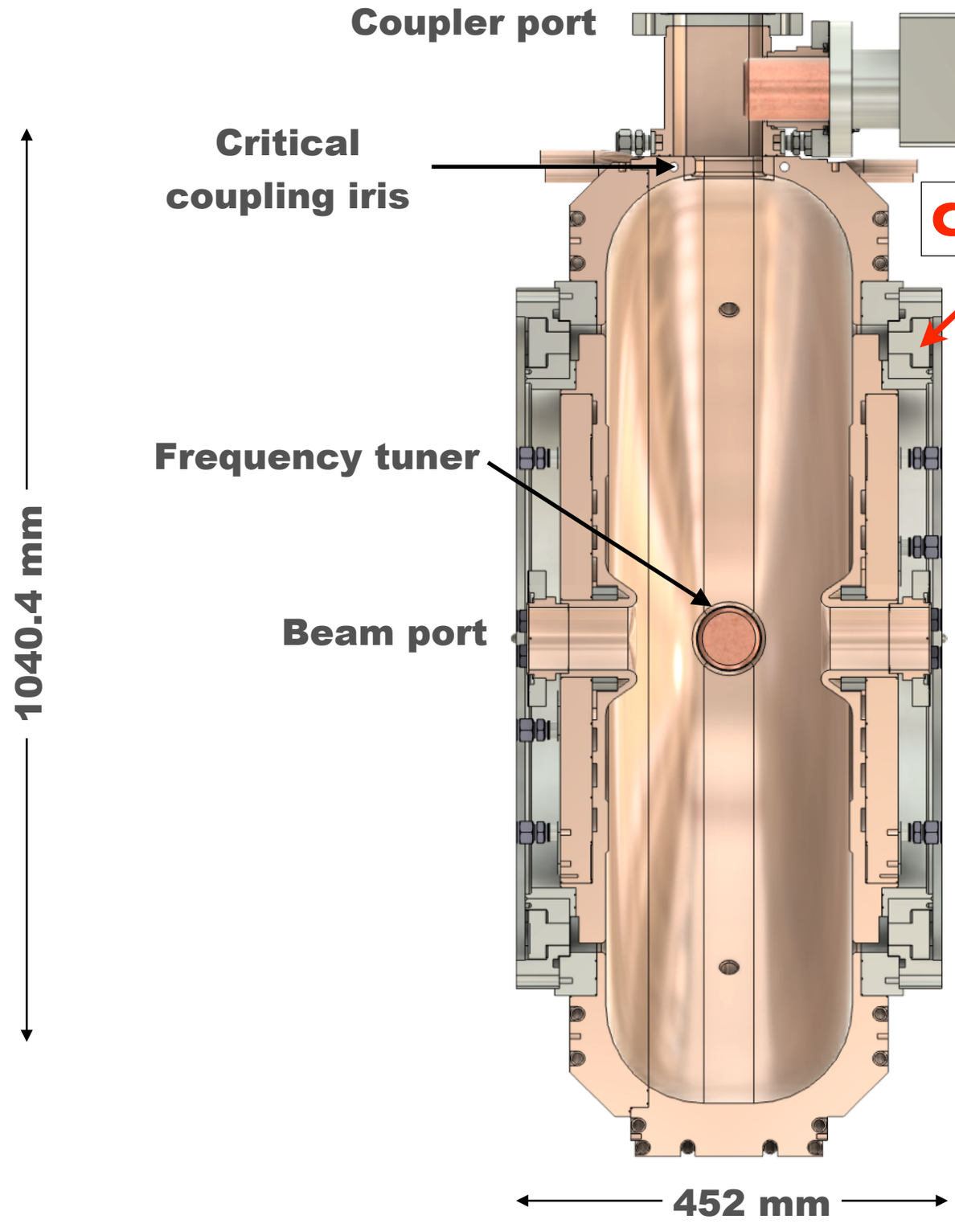
dipole



- **without HOM damper**
- **with HOM dampers**

HOM dampers directly installed in the cavity body !

Cavity structure -prototype-

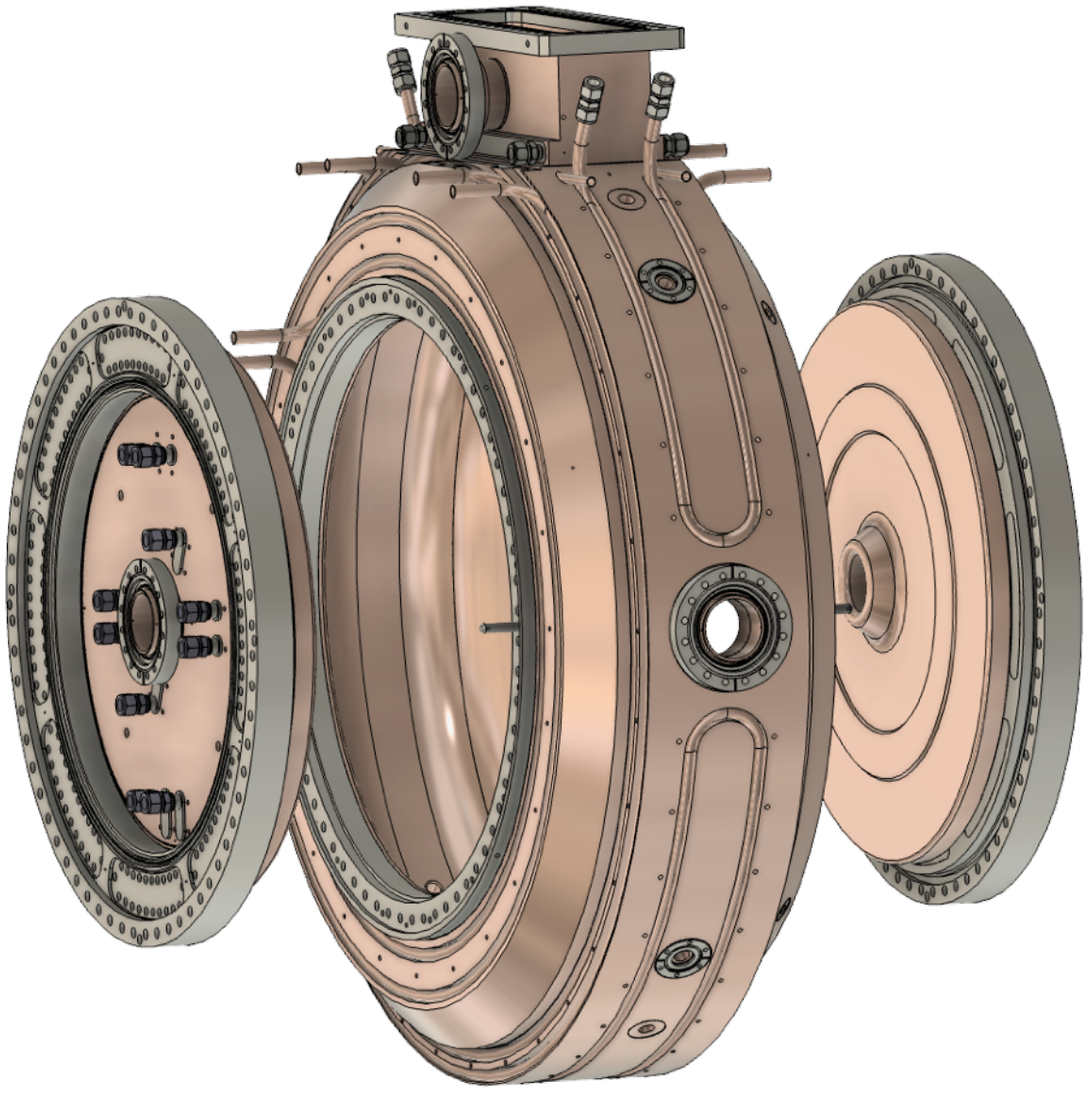


RF simulations

mode	TM020
f_a	508.58 MHz
R_a	6.8 MΩ
Q_0	60,300
R_a / Q_0	113 Ω
V_a @ 120 kW	900 kV

Cavity Assembling

Nose-cone plate



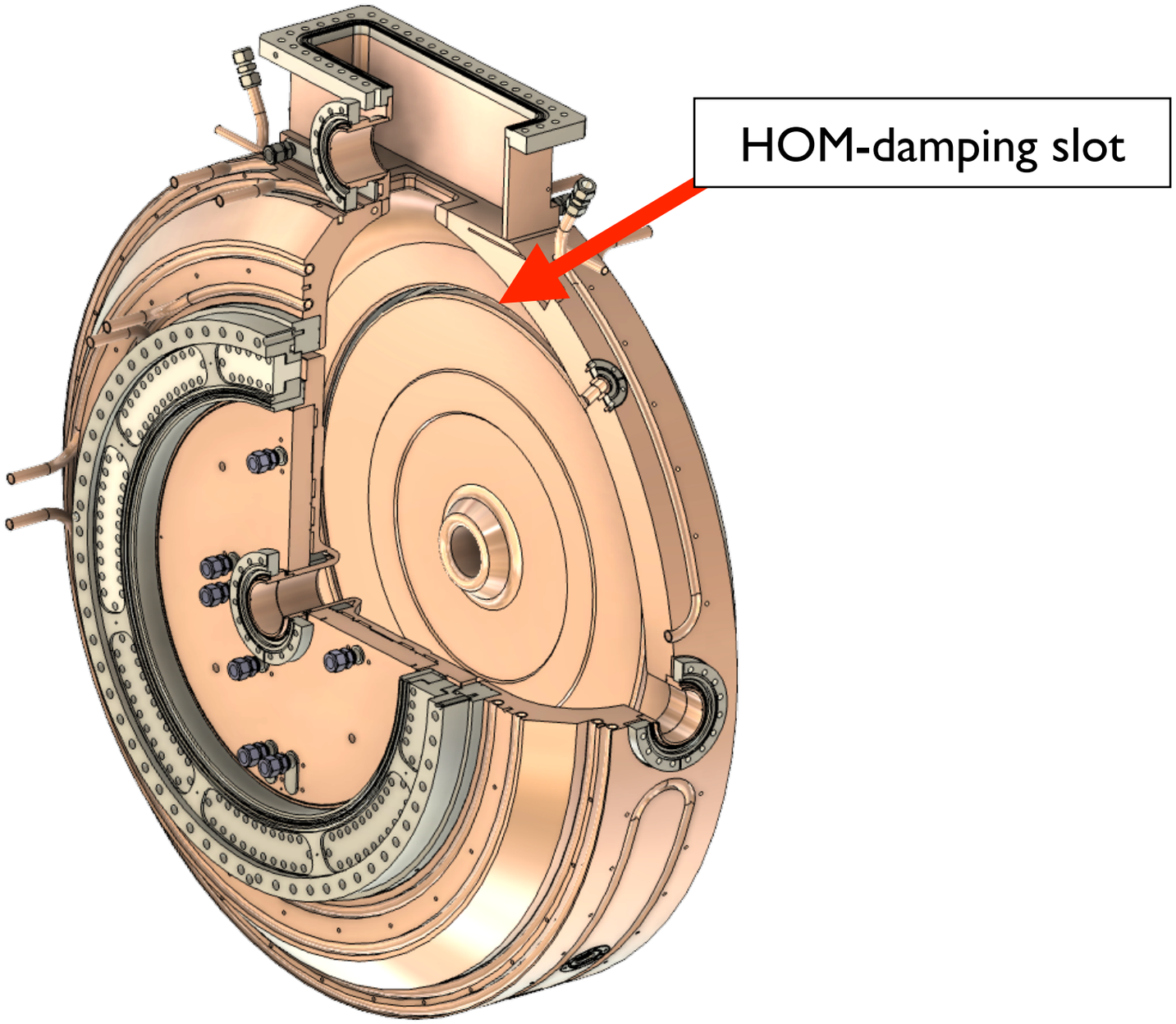
Nose-cone plate

Bolt-fastened three-part structure

nose-cone plate + main body + nose-cone plate

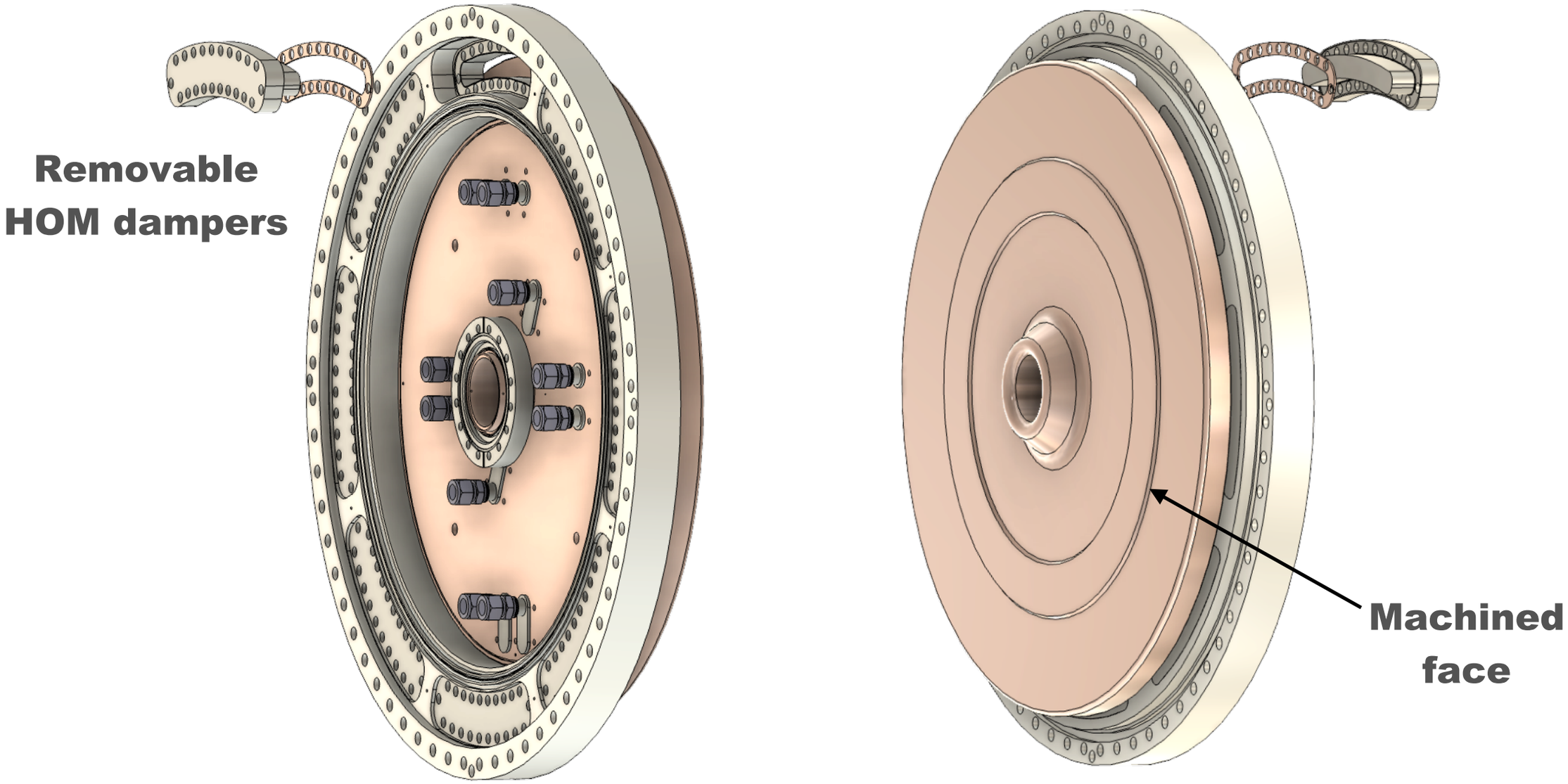
made of Class I copper

HOM-damping structure



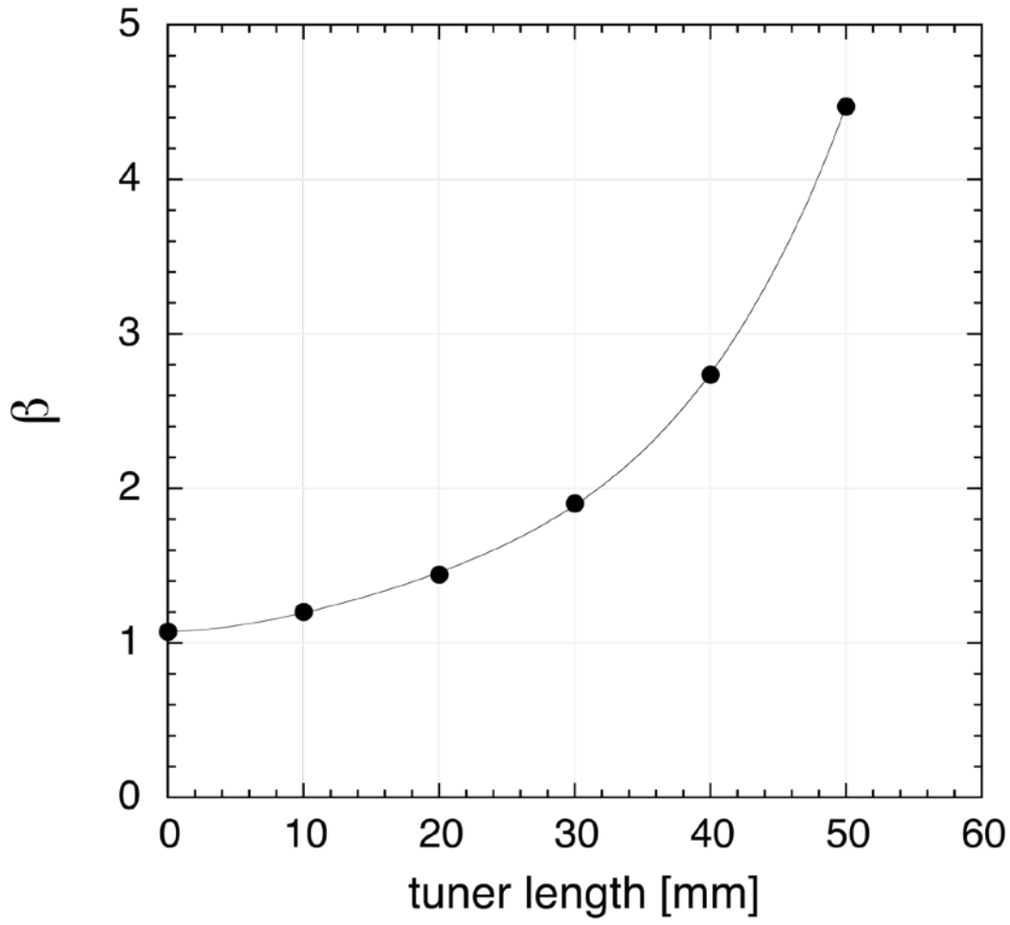
HOM-damping slot
= Gap between the nose-cone plate and main body

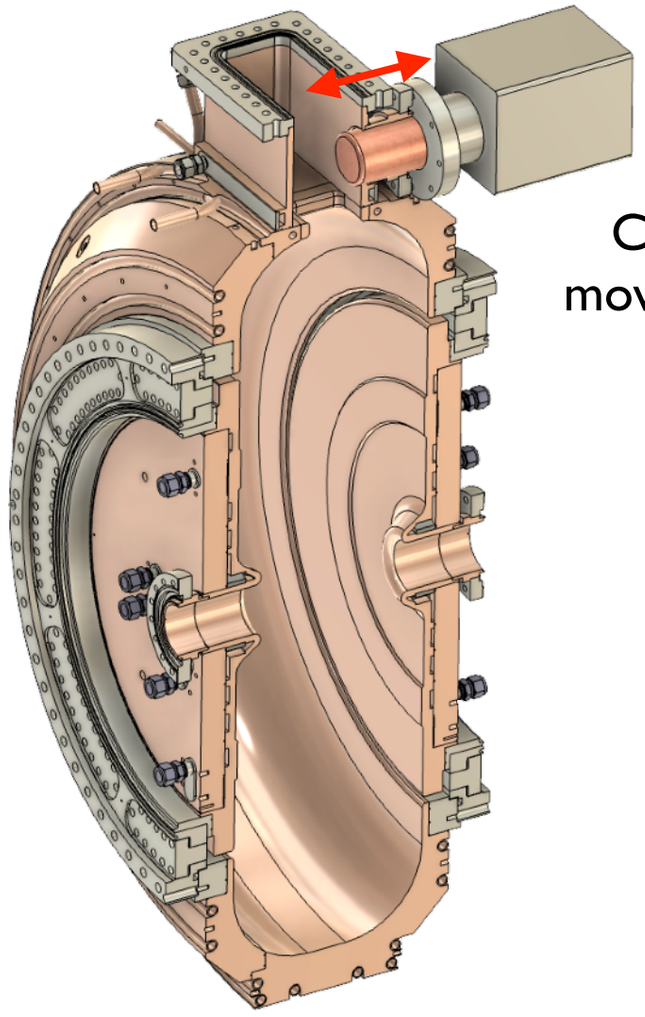
Nose-cone plate



- **Easily removable nose-cone plate enabling frequency adjustment by machining the face**
- **Mount for removable HOM dampers**

New coupler with coupling tuner



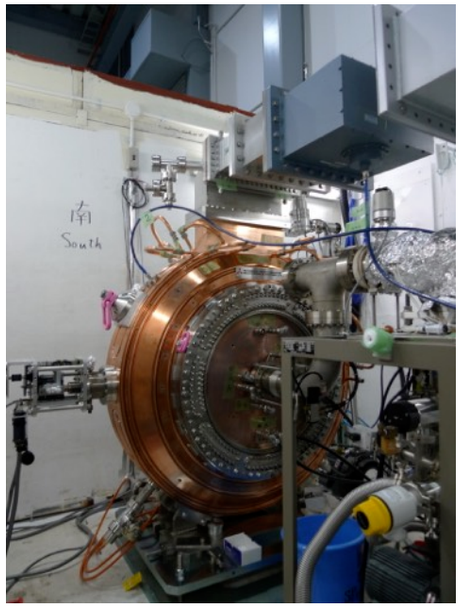


Coupling tuner moving a cylindrical plunger

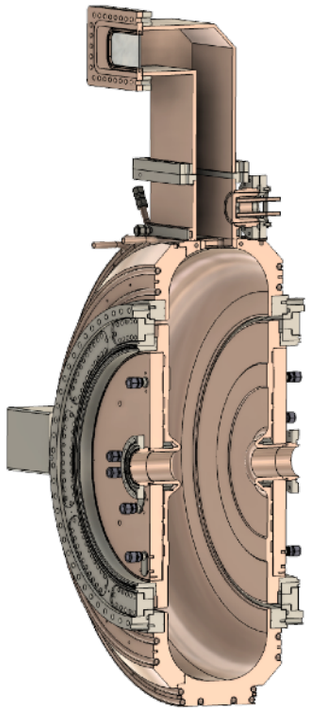
Coupling β adjustable to the value best for beam loading during high-power operation in vacuum

Measurements on RF properties

TM020 properties of the prototype without HOM damper



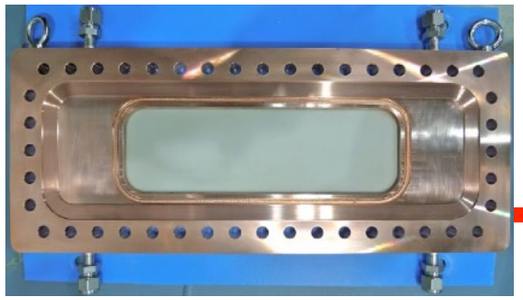
frequency [MHz]	508.550
Q_0	59,960
Q_{ex}	54,150
β	1.1

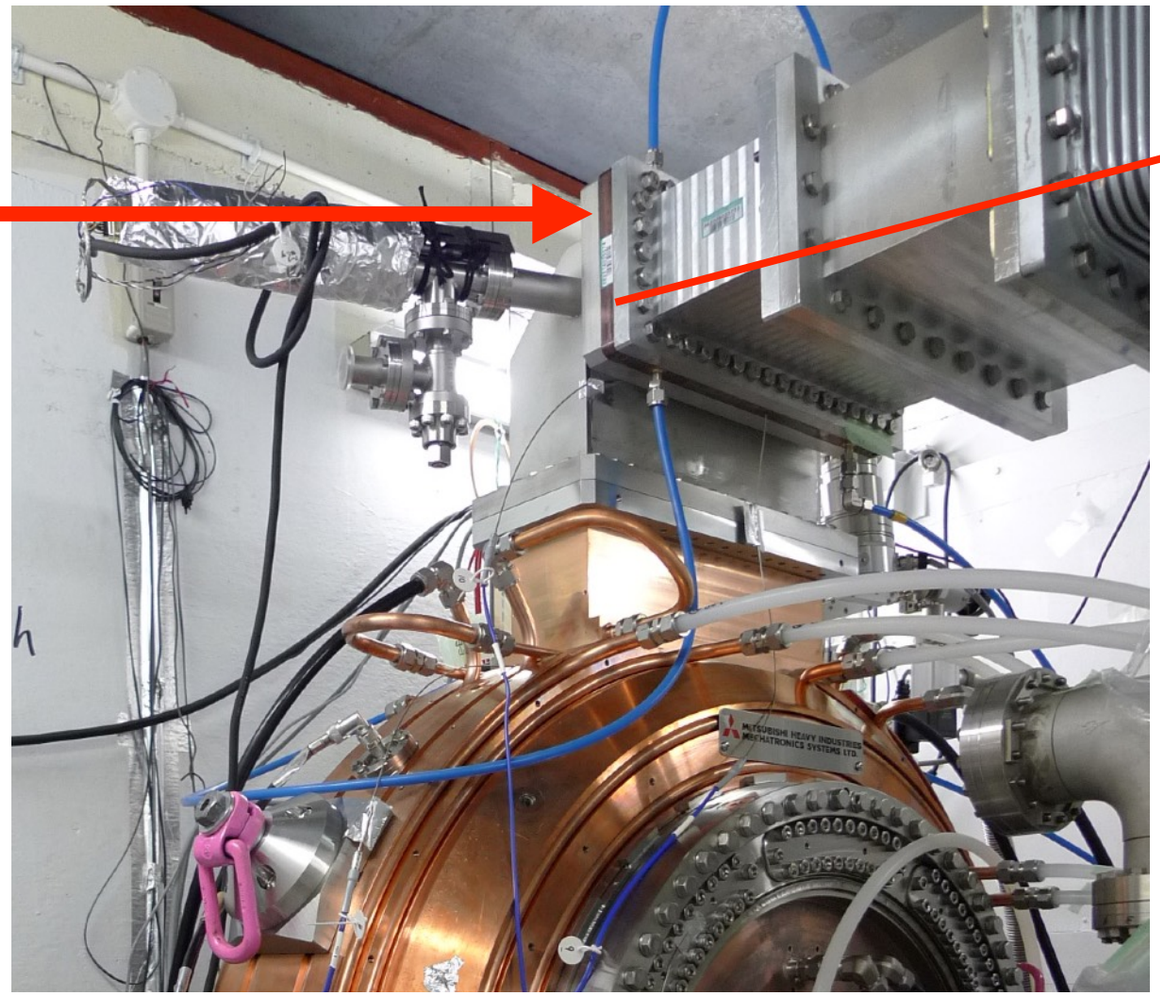


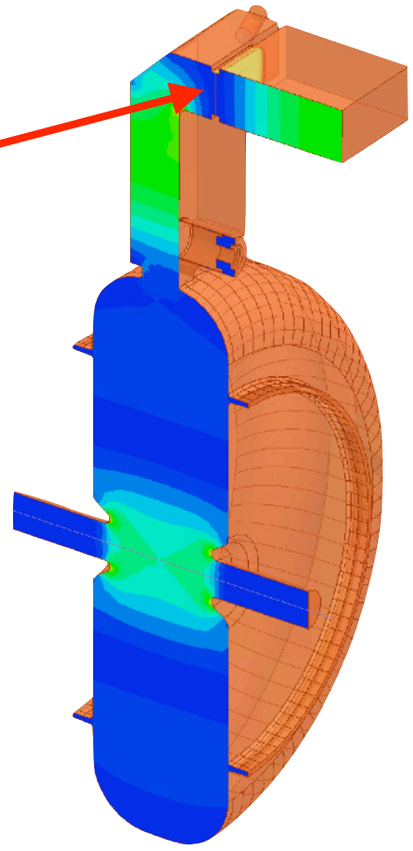
Q values of the cavity with eight HOM dampers

TM020	59,150	
TM010	420	**monopole**
TM110	760	**dipole**

Ceramics window







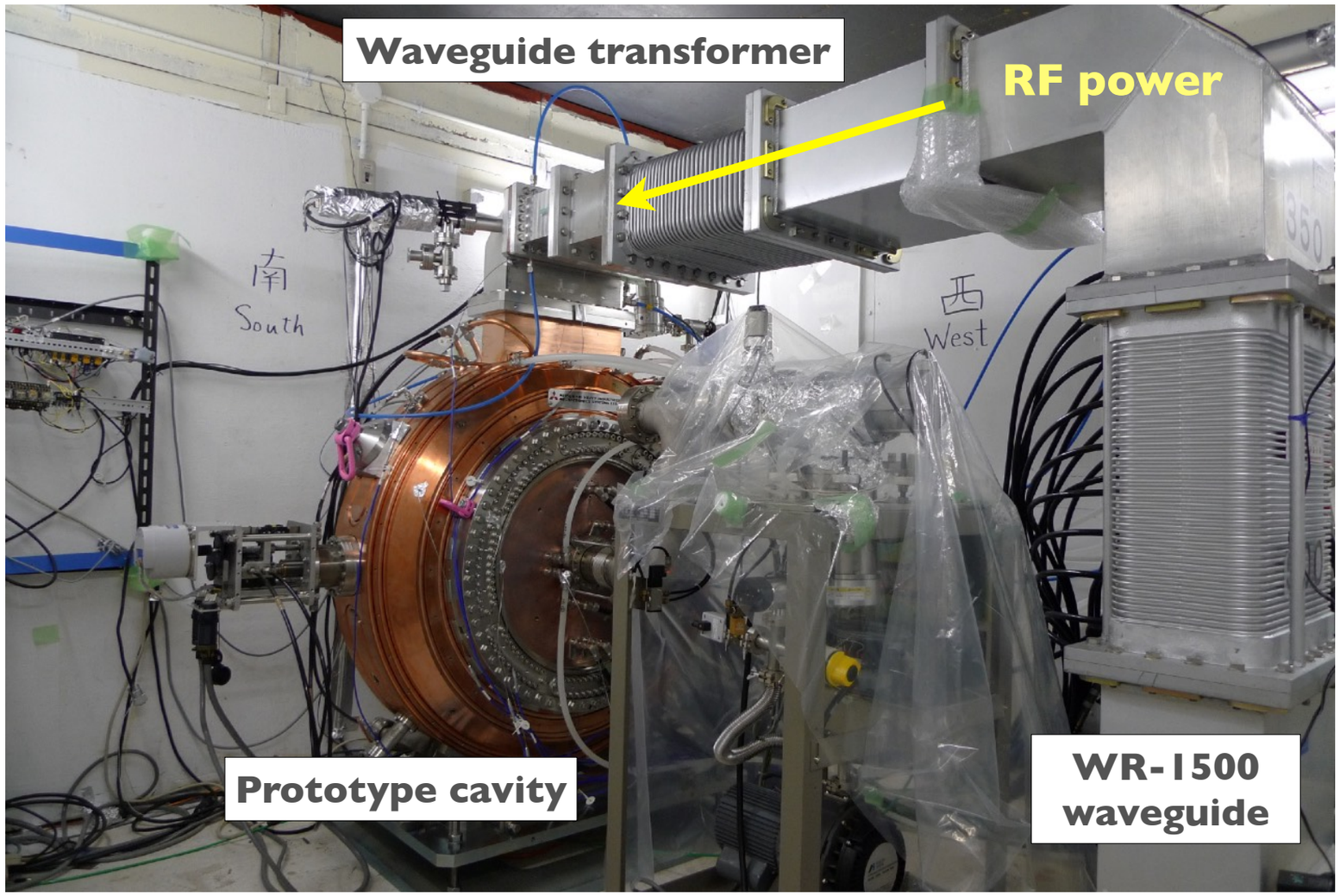
Electric node position at maximum reflection

- **Low height of WR-1500 (381x100)**
- **Capable power transmission of 600 kW**
- **Set to the waveguide at the electric node when reflection**
- **Easily exchangeable**

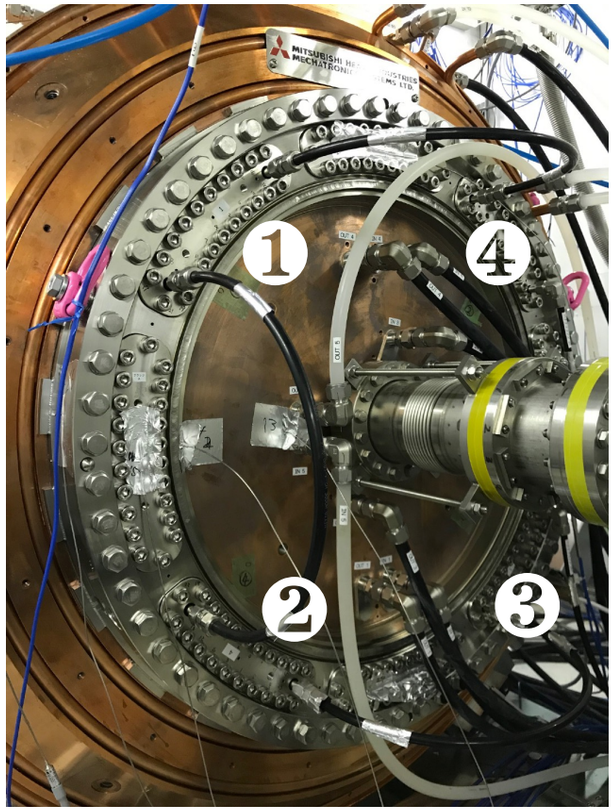
Set-up for high-power operation

2 stage tests were performed

without / with HOM dampers

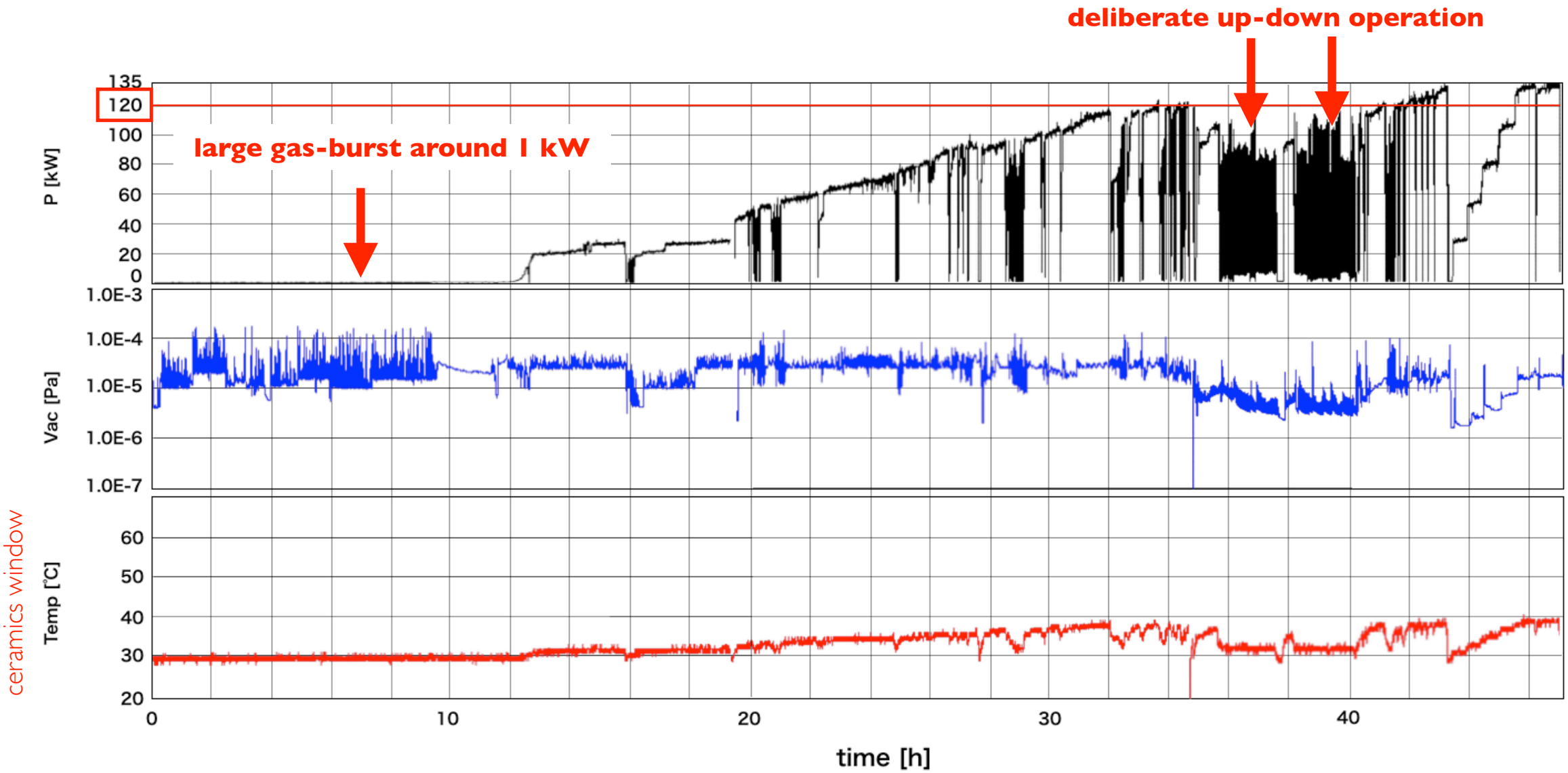


No HOM damper



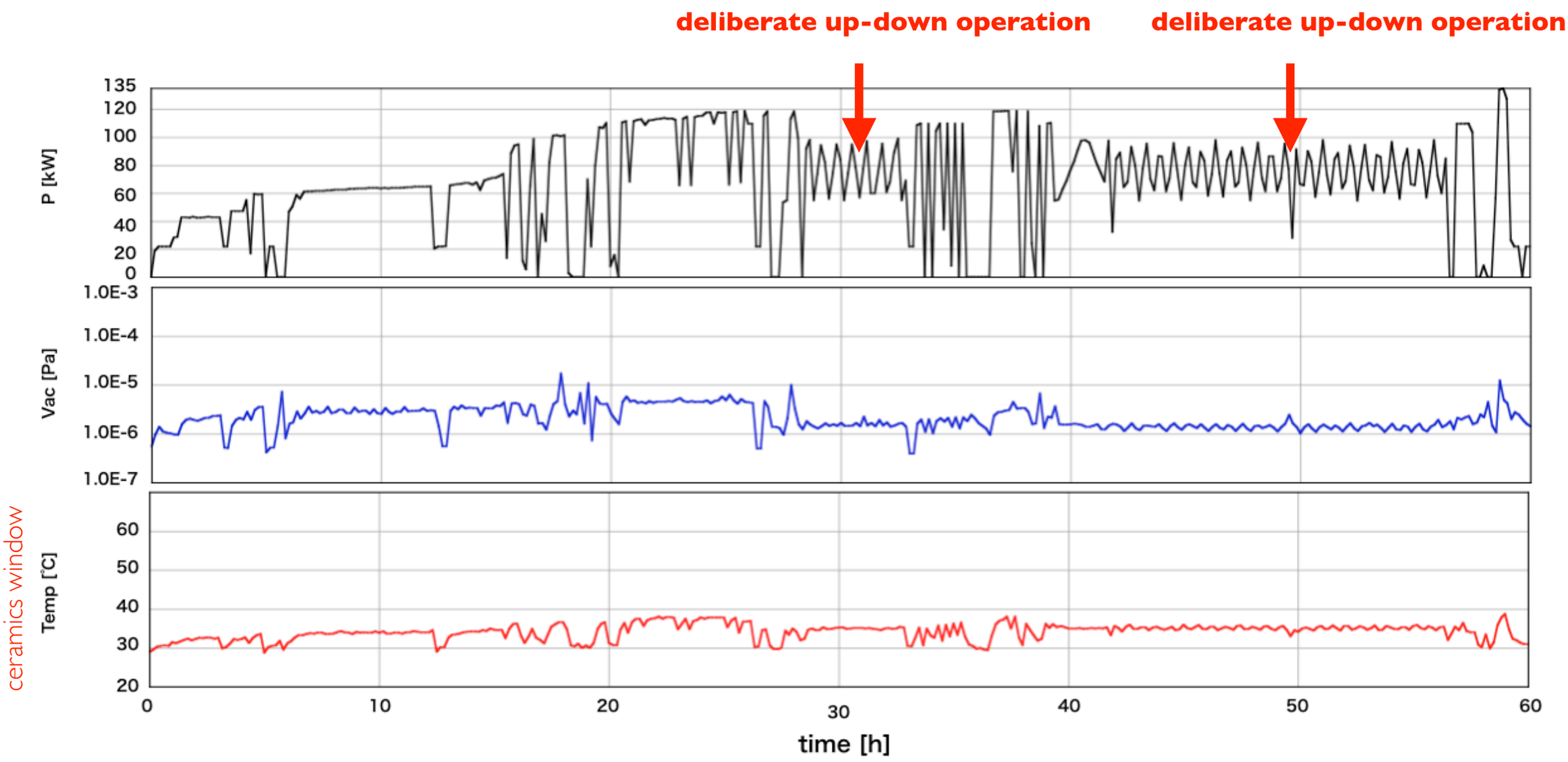
Installed 4 HOM dampers in each nose-cone section

135kW high-power test for the cavity without HOM damper



50 hours up to135 kW
over the rated power of 120 kW

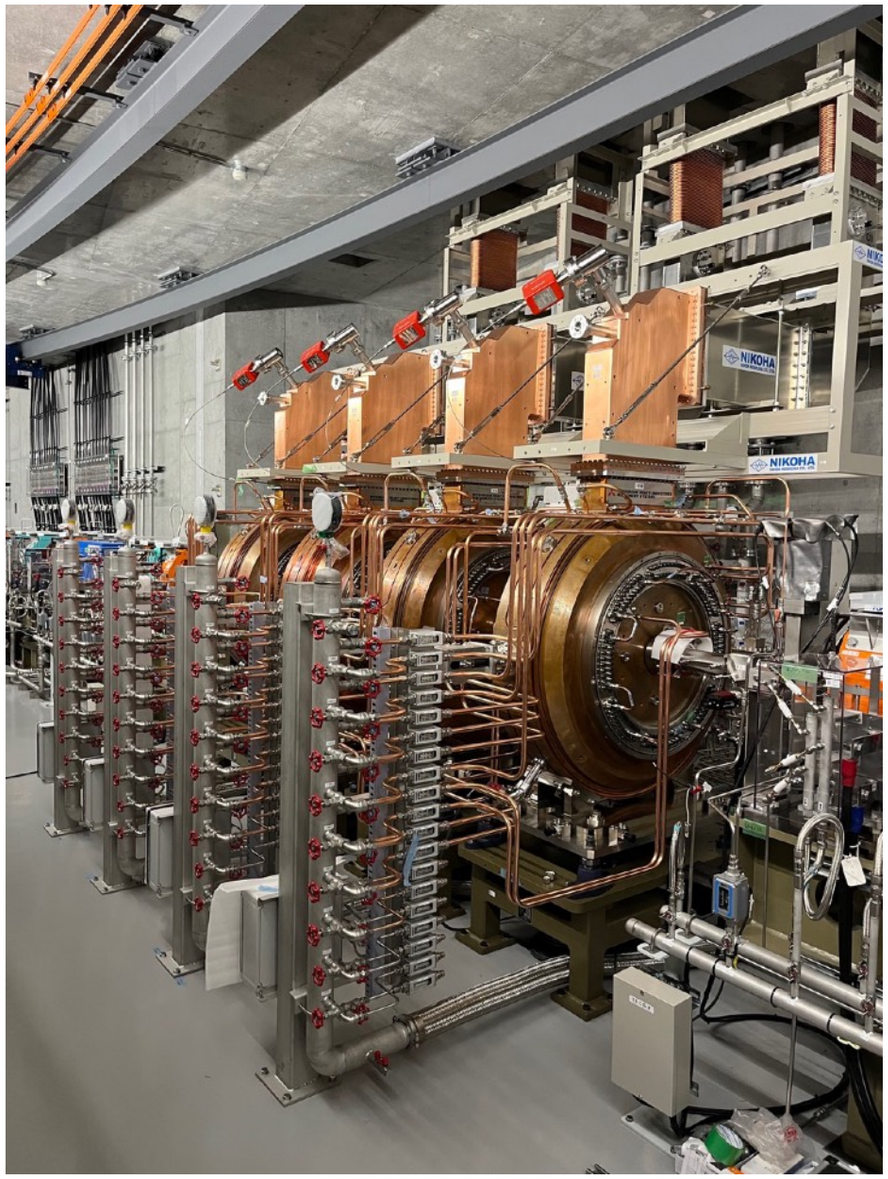
135kW high-power test for the cavity with HOM dampers



58 hours up to135 kW
(finally up to 150 kW)

Cavities in NanoTerasu

NanoTerasu : 3 GeV Next Generation Light Source in Japan



Four cavities have begun to accelerate a beam

Summary

- **Compact HOM-damping system working well by using TM020 mode**
- **Feasible prototype cavity and HOM dampers**
- **Successful high-power operation up to 135 kW**
- **Beam acceleration in NanoTerasu**

Thank you for your attention.