

Upgrade Status of S-band Accelerating Structure

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on behalf of the accelerating-structure and positron group

KEK Injector Linac division

- **Problems in stabilizing beam acceleration**
- **Upgrade work and countermeasures against the problems**
 - ▶ Accelerating structure
 - ▶ Pulse compressor
- **Remaining problems**
- **Summary**

Problems in stabilizing beam acceleration : Accelerating structure

A lot of S-band accelerating structures of PF type
fabricated about 40 years ago as the injector for the PF ring

don't work well



Mean RF parameters of five kinds of the PF-type

r_a [MΩ/m]	57.8
τ [neper]	0.335
T_f [us]	0.51
$V_a/P^{1/2}$ [MV/MW $^{1/2}$]	7.29
P_{in} [MW]	40

Problems in stabilizing beam acceleration : Accelerating structure

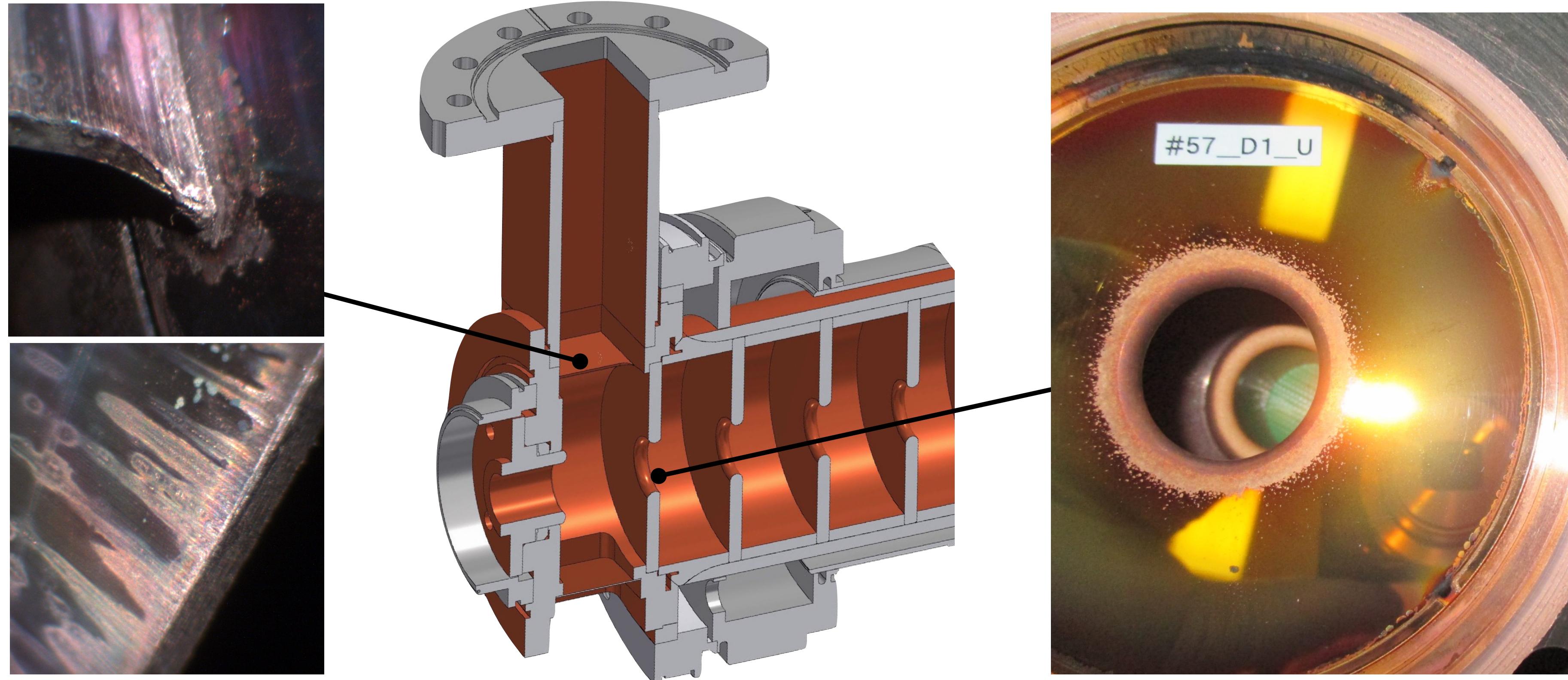
Problems : Water leaks, power reflection, discharge limiting the operation of the beam acceleration

Recently 3 structures every year



Problems in stabilizing beam acceleration : Accelerating structure

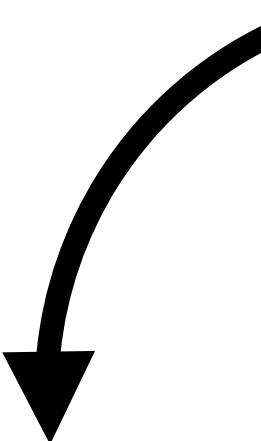
Problems : Water leaks, **power reflection**, **discharge** limiting the operation of the beam acceleration



Limit power operation and lower accelerating voltage

Upgrade : Accelerating structure

- 21/142 structures suffering from these problems
- Severe problems beyond repair
- No sound spare



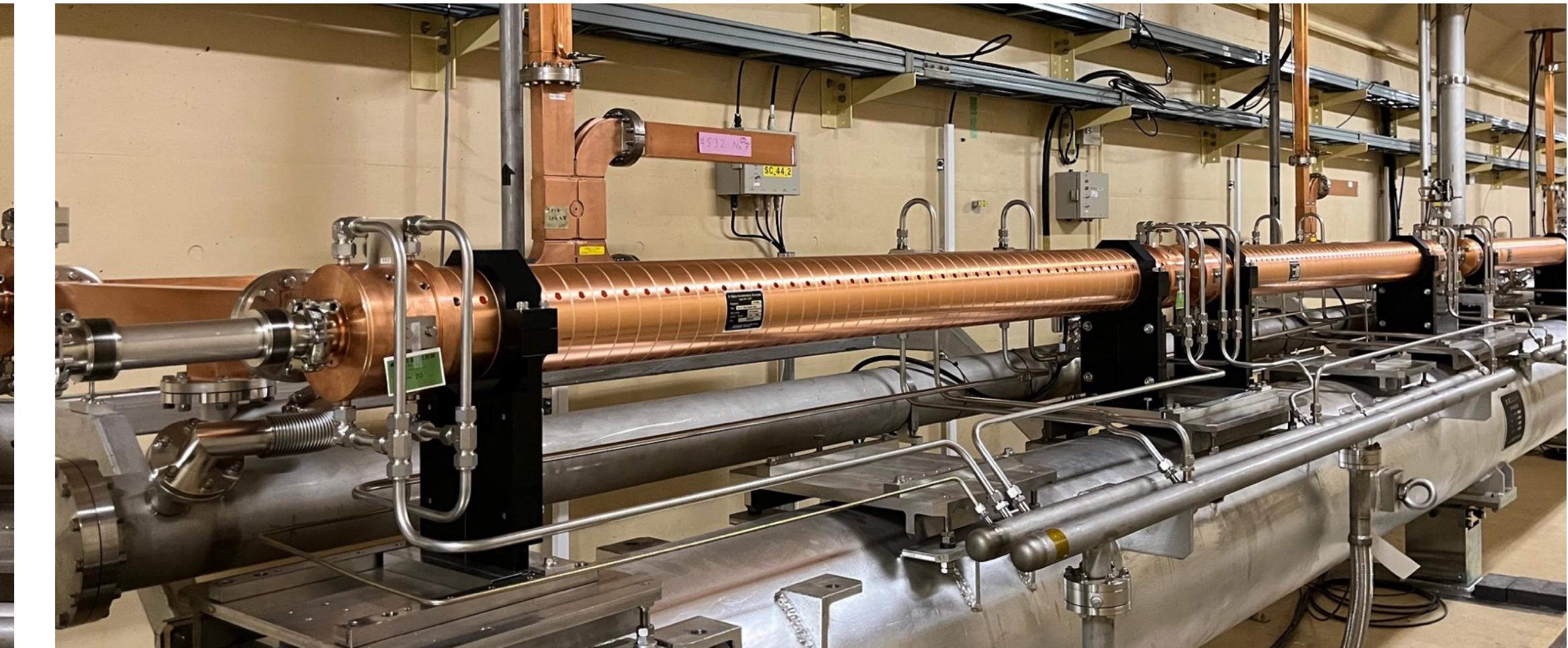
Countermeasures : New S-band accelerating structures

with following upgrades !

- Higher accelerating gradient
- Simple and sure fabrication
- Reduction in discharge
- Suppression for long-range wake instabilities

Upgrade : Accelerating structure

Higher accelerating gradient

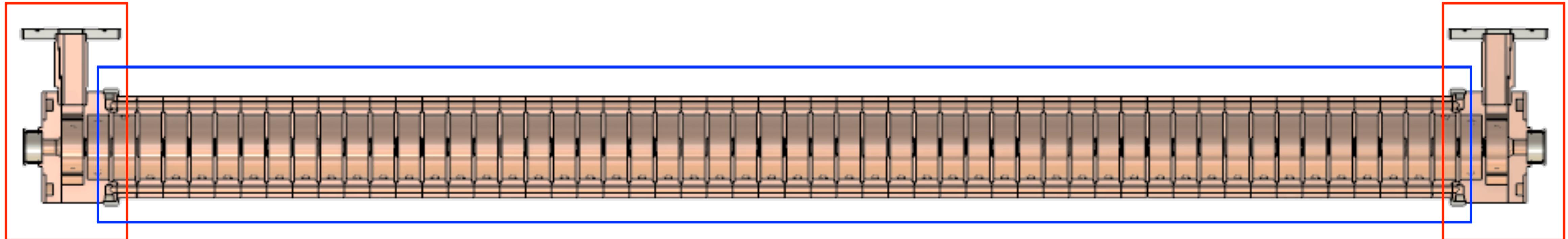


RF parameters

PF-type

r_a [MΩ/m]	61.8	57.8
τ [neper]	0.36	0.335
T_f [us]	0.57	0.51
$V_a/P^{1/2}$ [MV/MW ^{1/2}]	7.8	7% up

Simple and sure fabrication

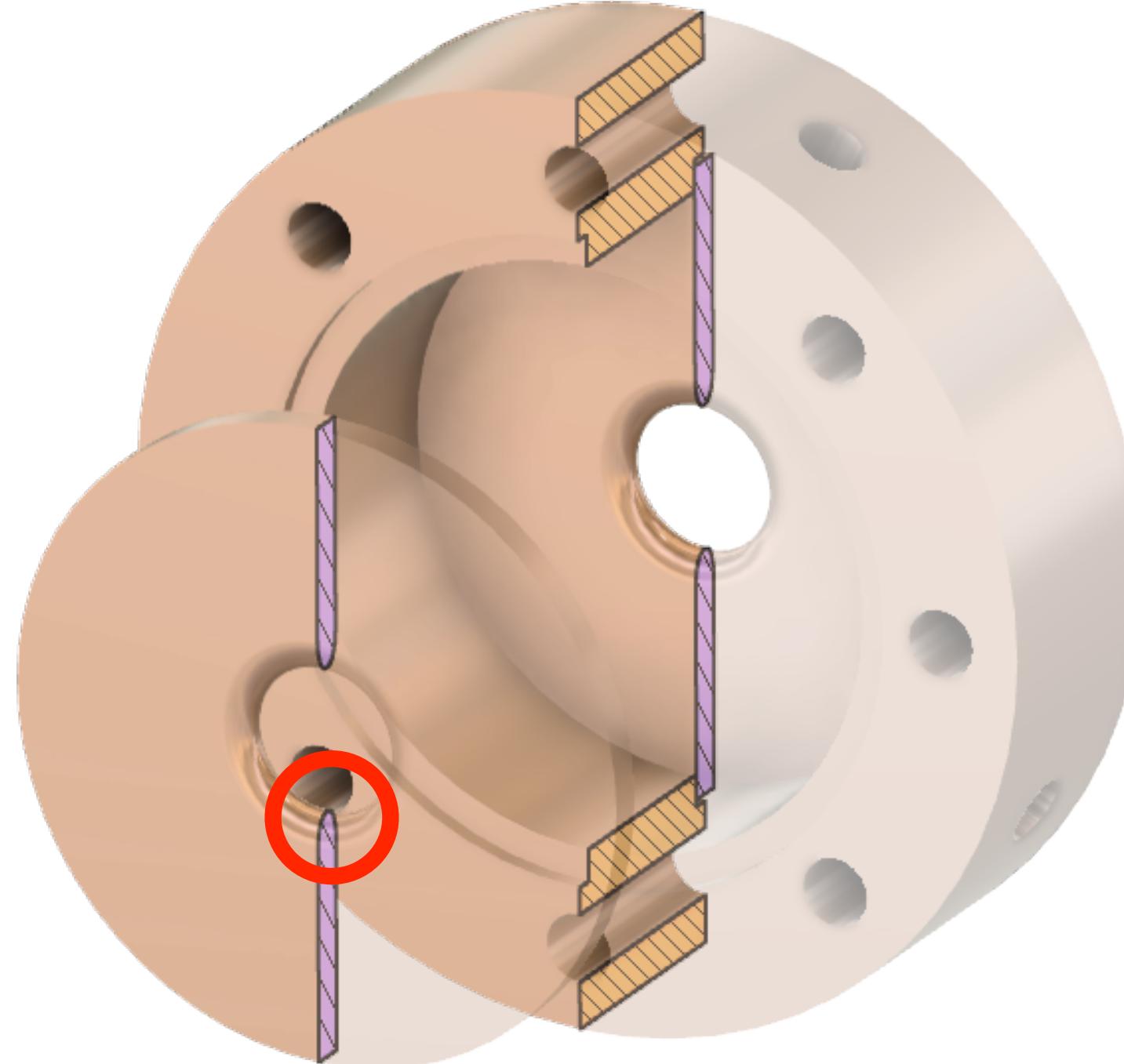


Fabrication by 2-step brazing of simply stacked cells

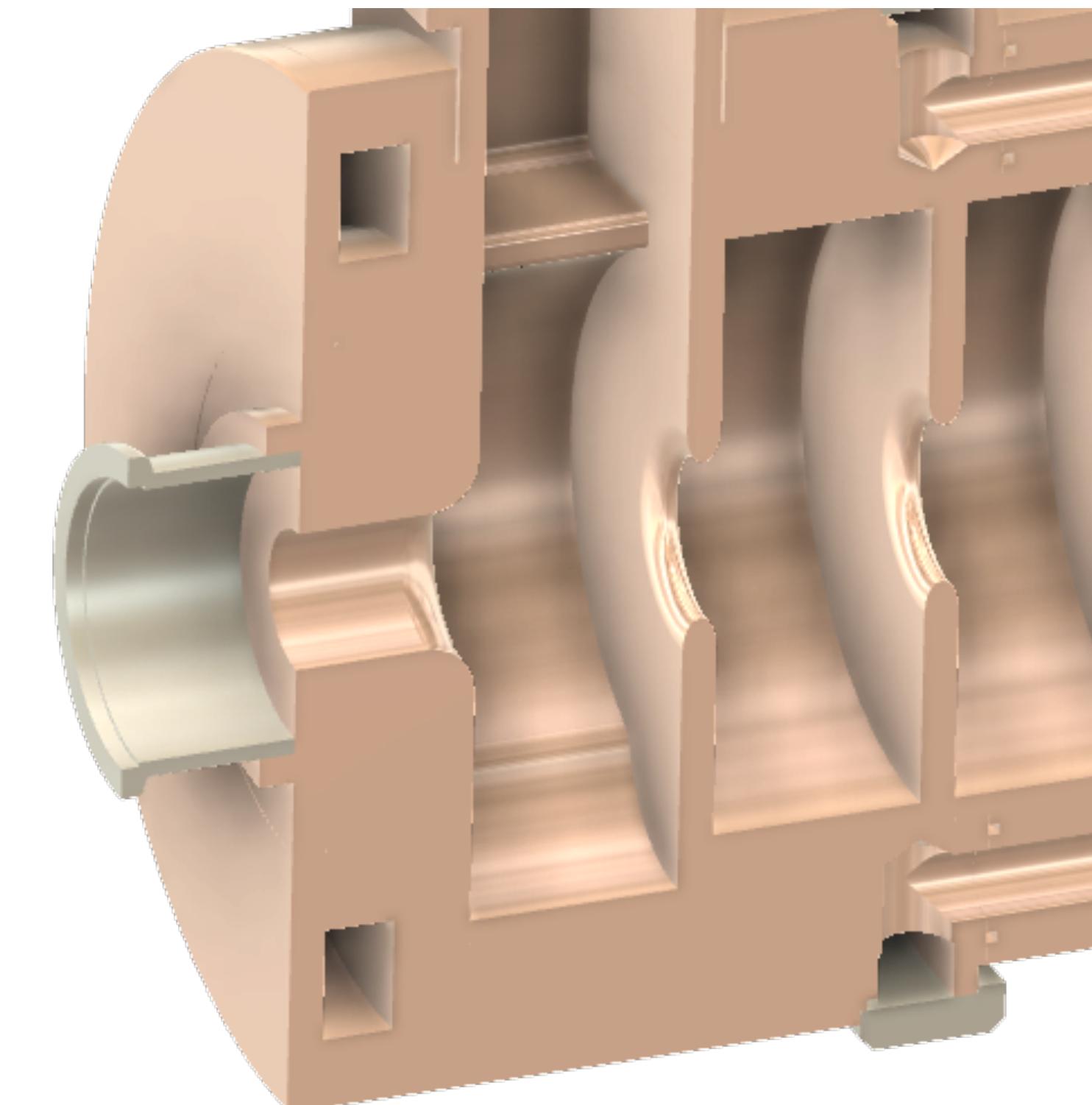
- 1) **Au-brazing** for coupler assembly
- 2) **Ag-brazing** for coupler-assembly, cylinders and discs stacked alternately

Upgrade : Accelerating structure

Reduction in discharge



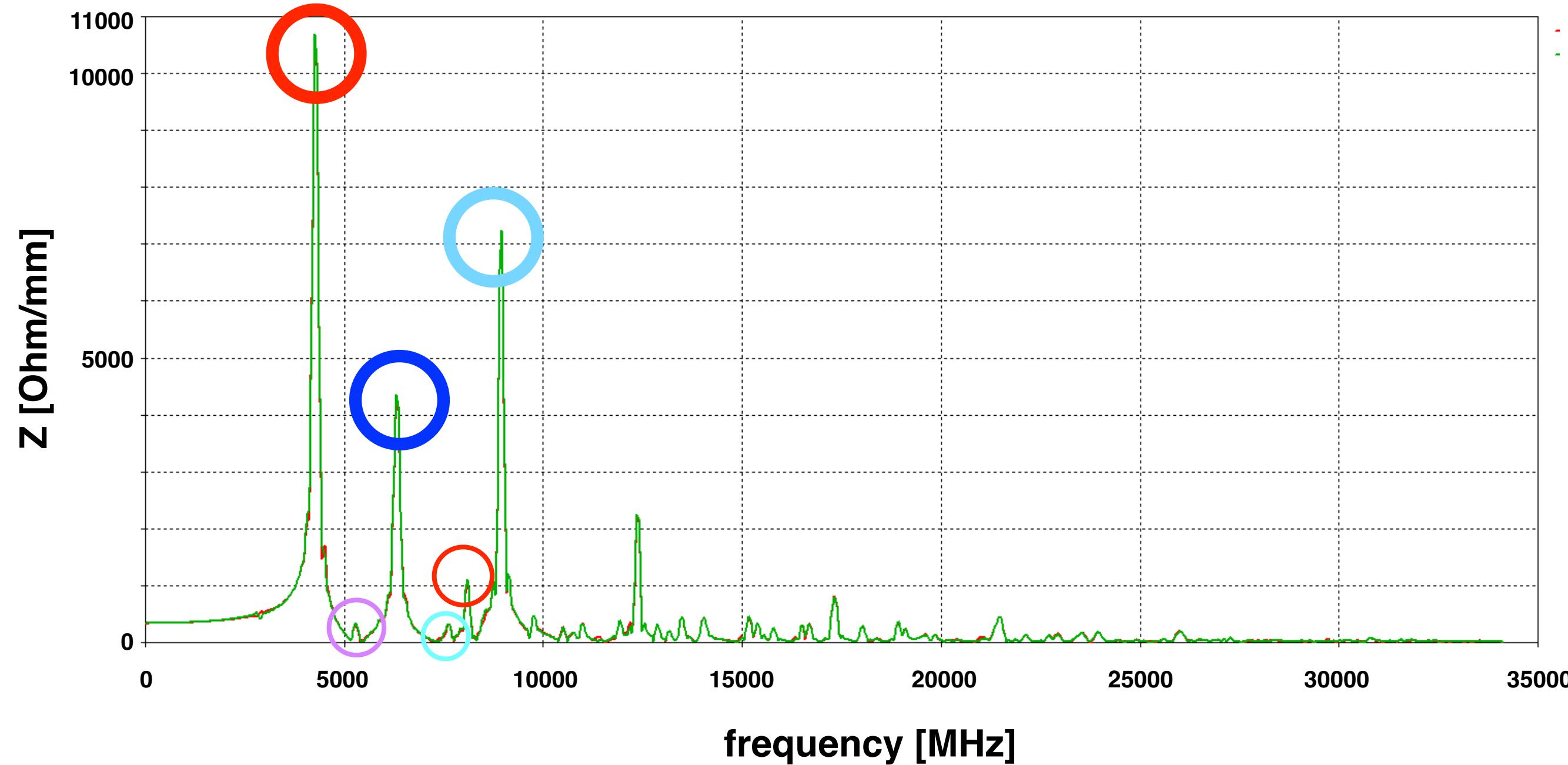
1:2 oval fillet of disc iris
reducing the strength of peak surface
field by **20%**



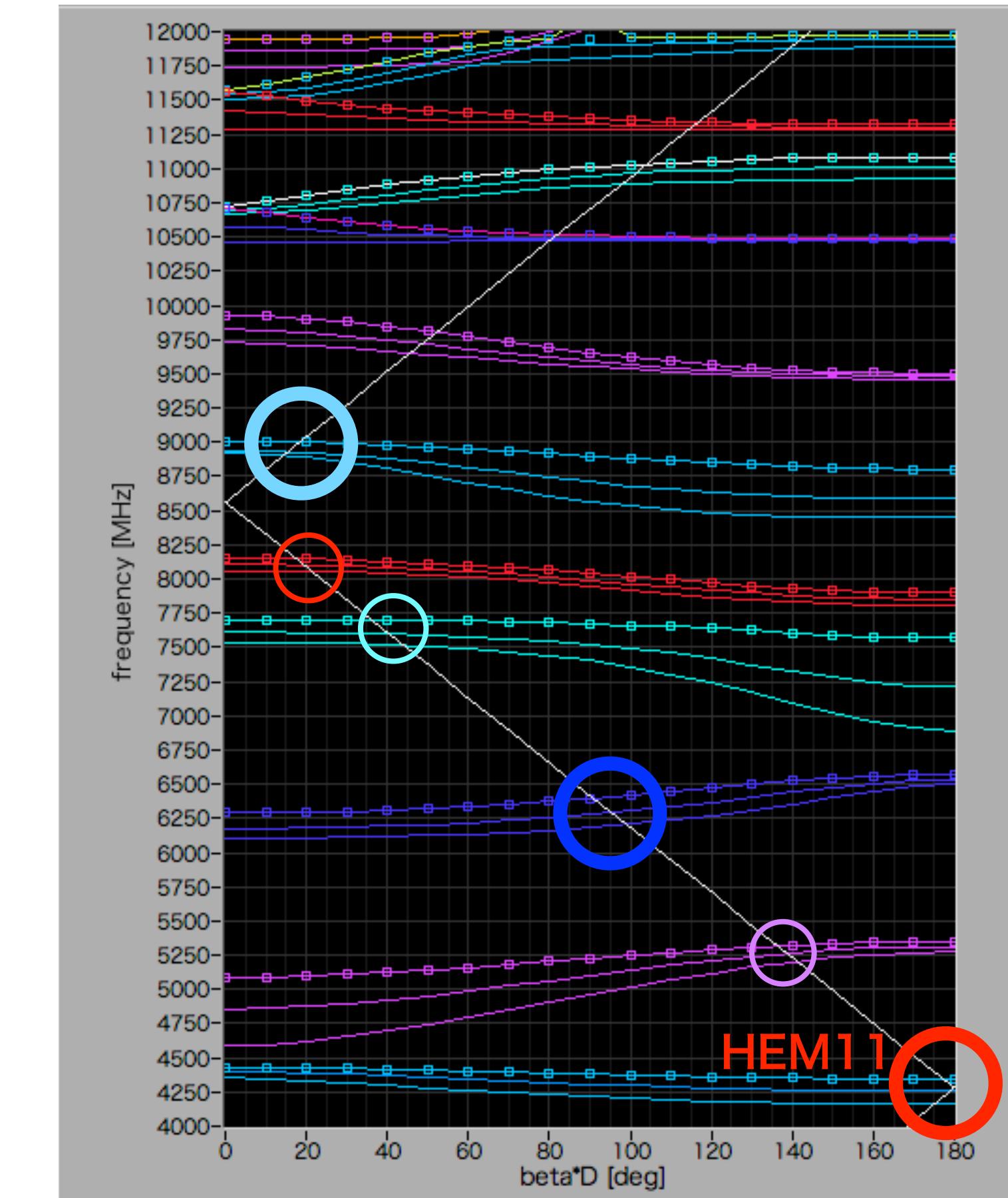
No sharp edge inside of the structure

Suppression of long-range wake instabilities for 2-bunch operation

HEM11- π (standing wave-like) with highest transverse impedance



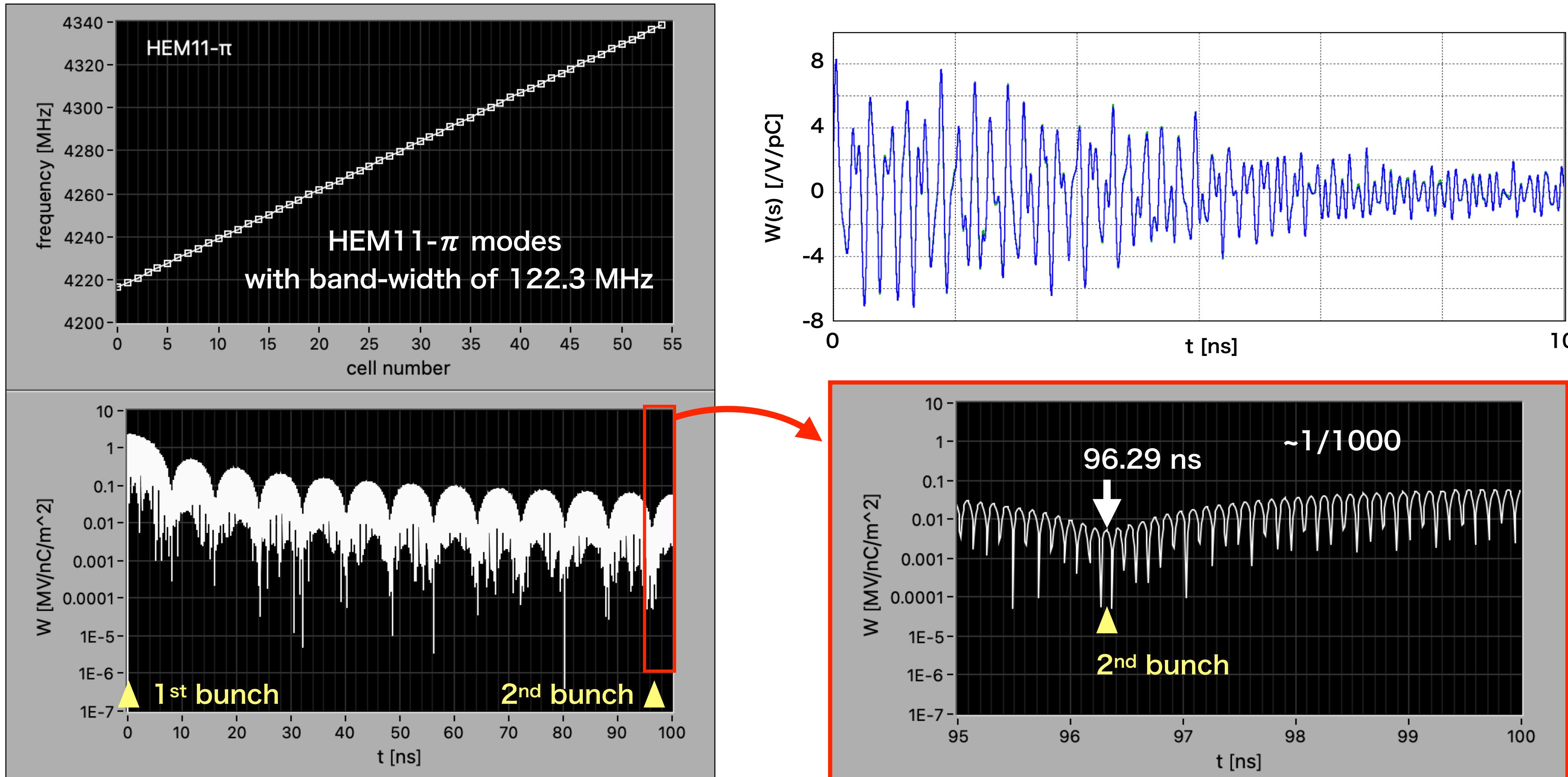
Transverse impedance distribution



Dispersion diagram

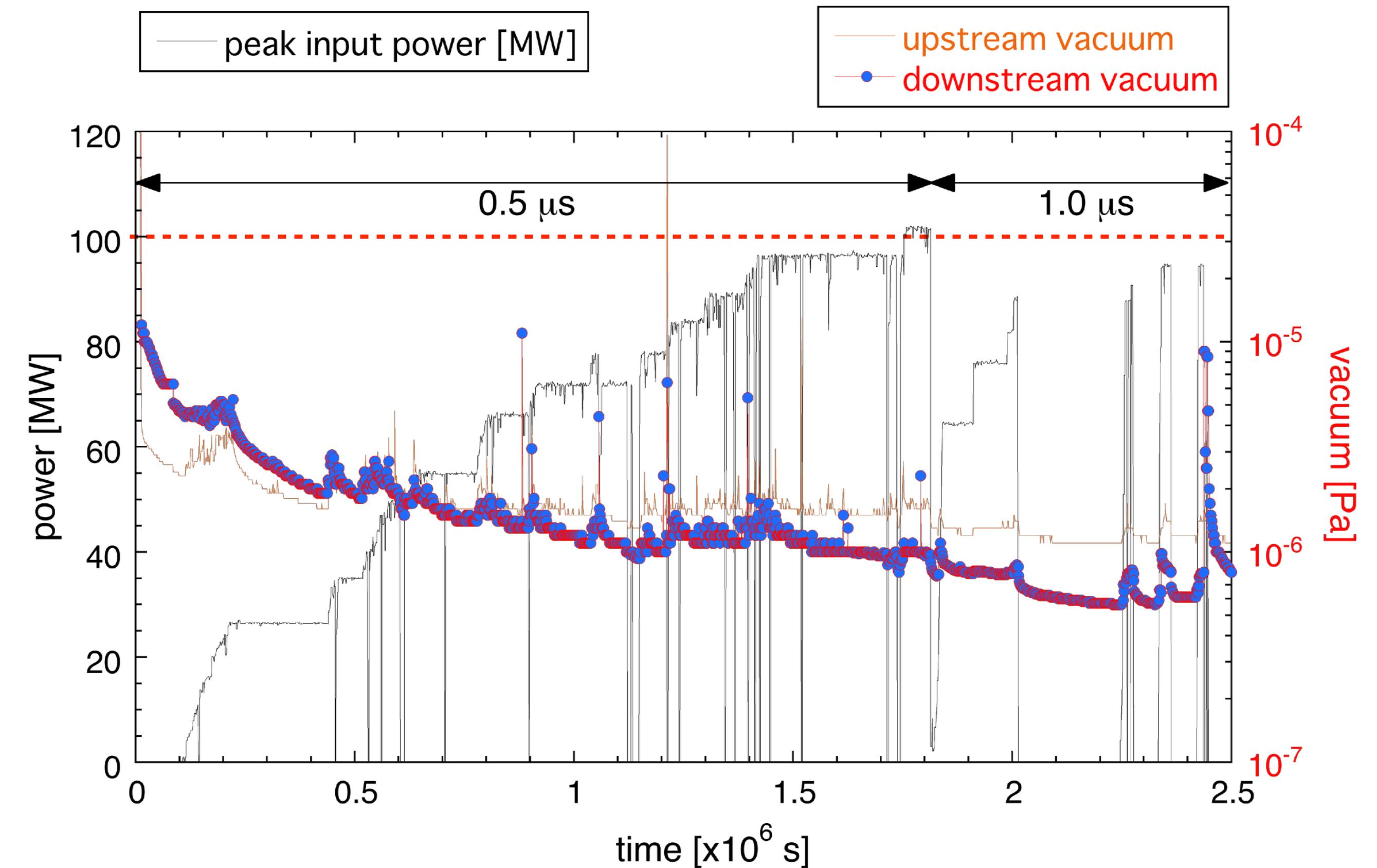
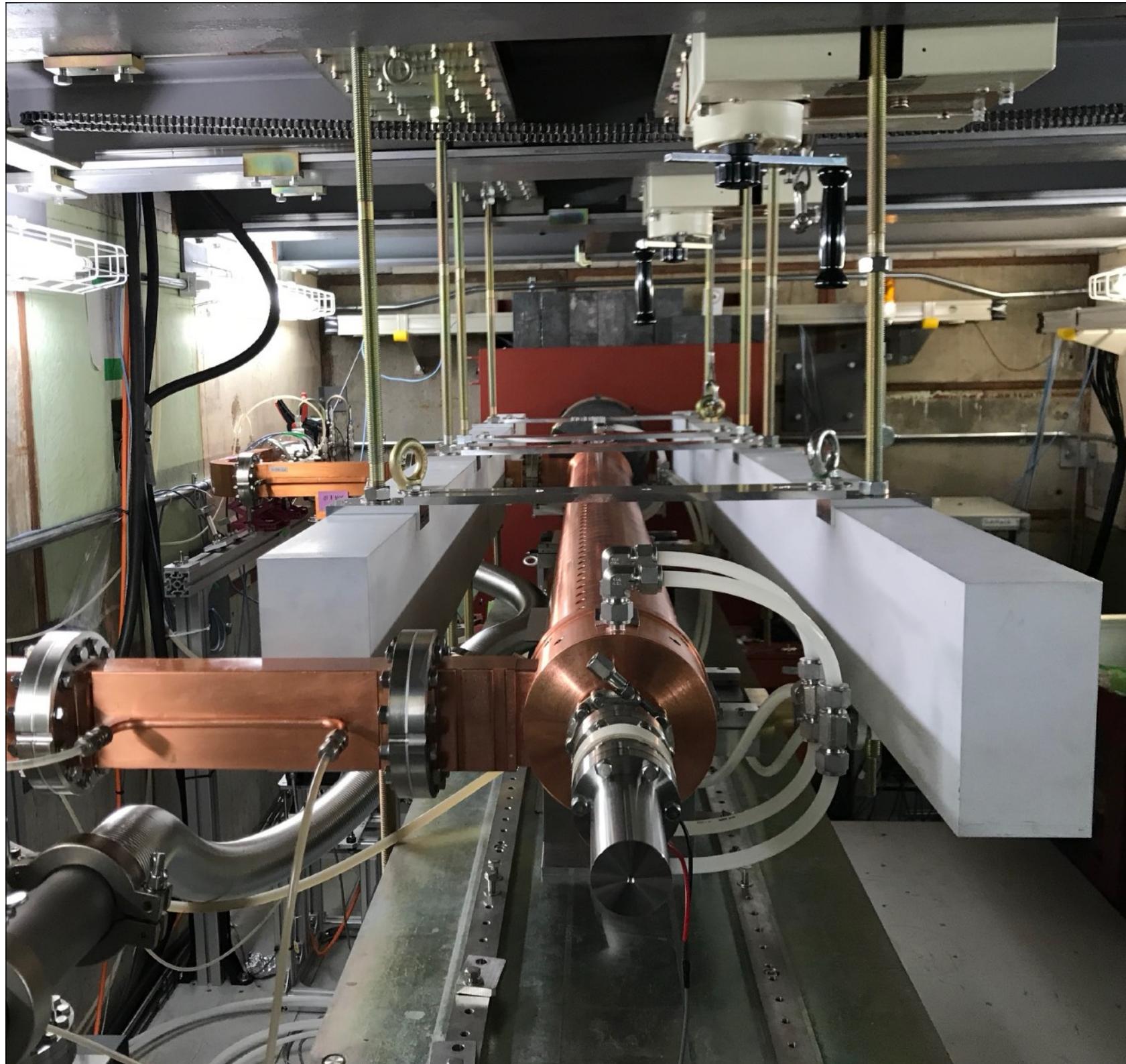
Suppression of long-range wake instabilities for 2-bunch operation

Linear-detuning of the HEM11- π mode to make beat oscillation
by setting adequate disc-iris aperture distribution



Upgrade : Accelerating structure

High-power operation



New structure in the test bench

Successful operation of 100 MW

**All fabricated structures were installed in the beam-line after conditioning
and accelerate beams stably now**

Problems in stabilizing beam acceleration : Pulse compressor

- SLED-type pulse compressors (KEK-SLED) in operation about 30 years
 - No spare
 - Expensive fabrication cost over 1/3-million dollar

Countermeasures : New pulse compressor

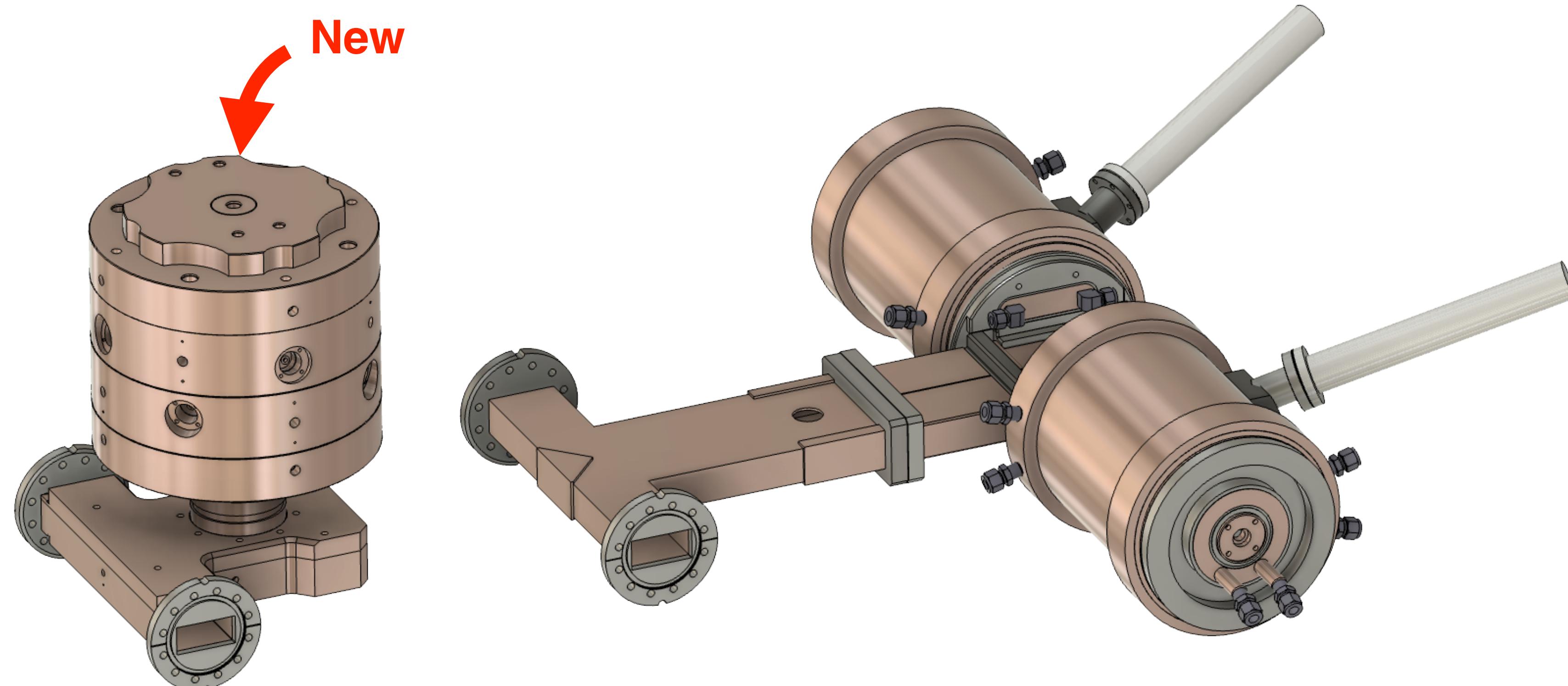
with following features

- Low-cost fabrication
- Pulse-compressing performance same as KEK-SLED's
- Compatible with KEK-SLED

Upgrade : Pulse compressor

Low-cost Fabrication

Simple structure required



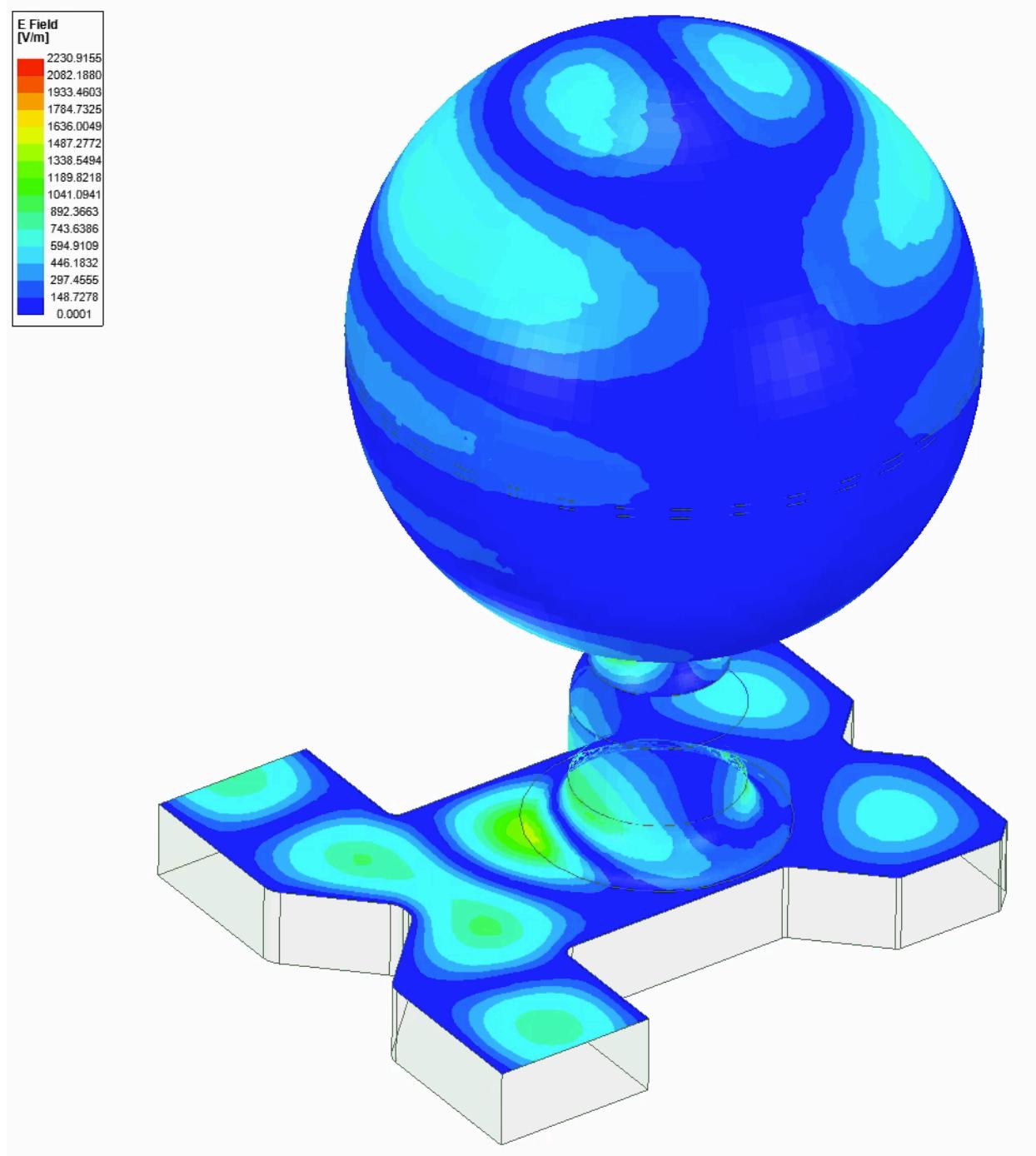
Spherical-cavity-type pulse compressor (SCPC)

Approximately half cost of SLED-type

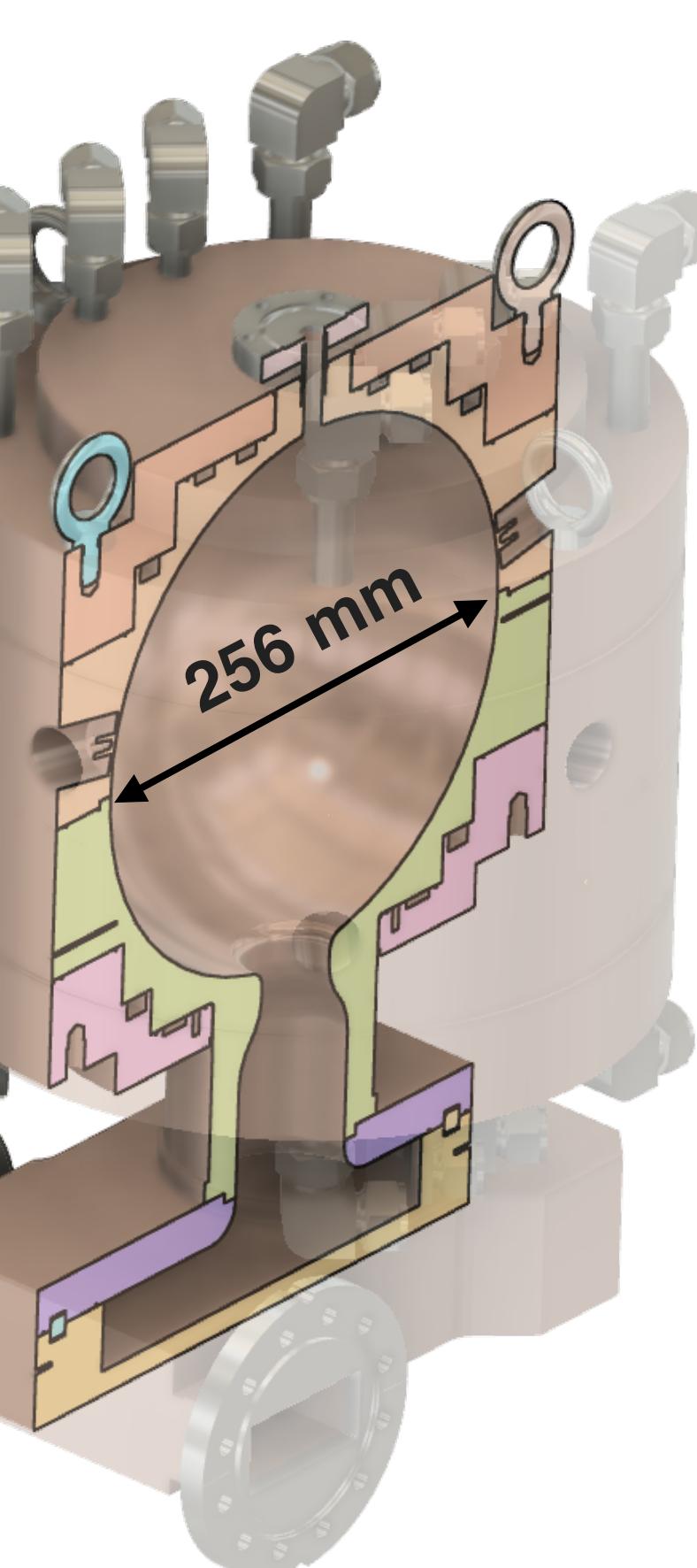
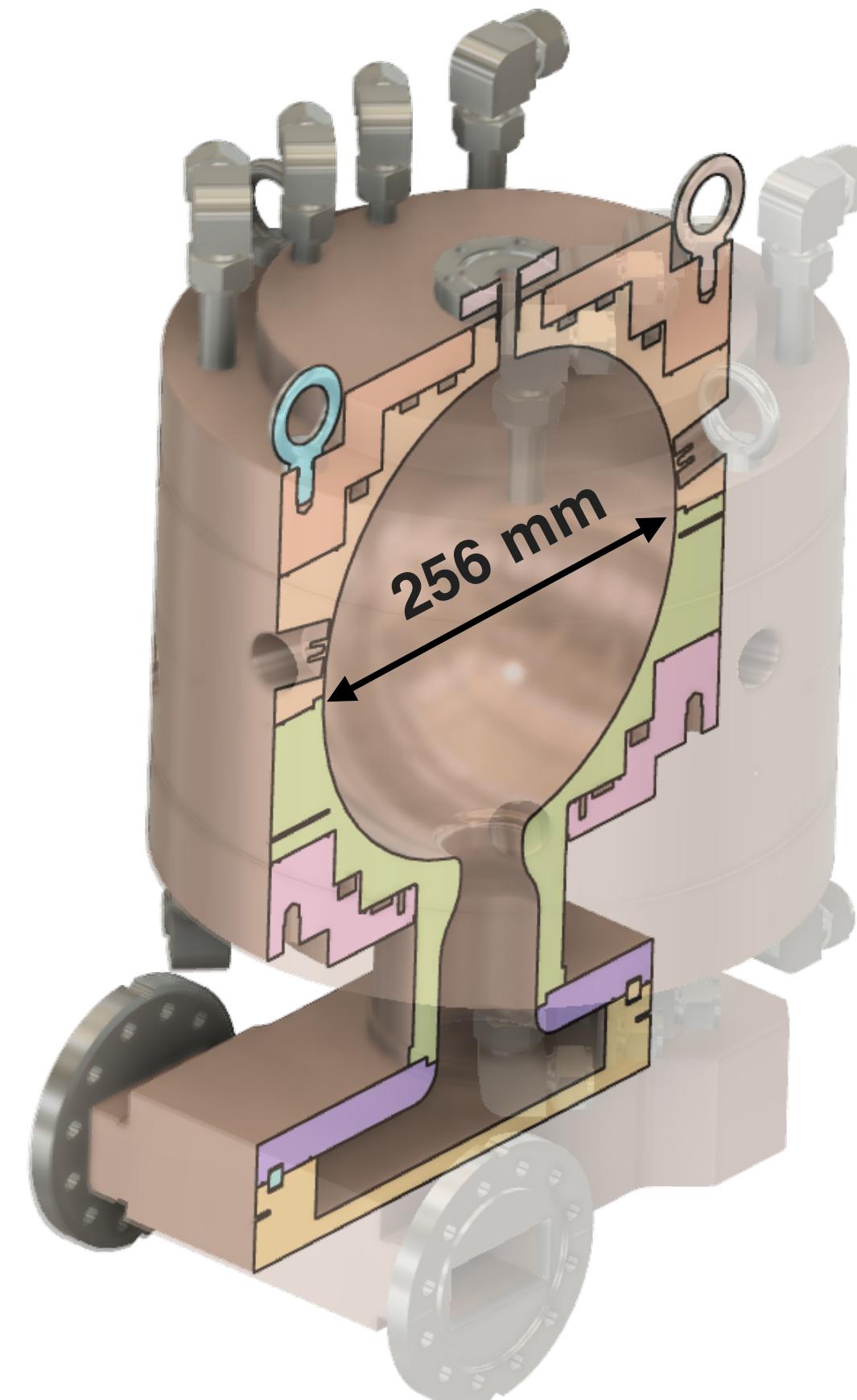
KEK-SLED

Upgrade : Pulse compressor

Pulse compressing performance



E-field distribution



Spherical single-cell cavity

2-fold degenerative spherical TE112 mode

High Q : 100,000

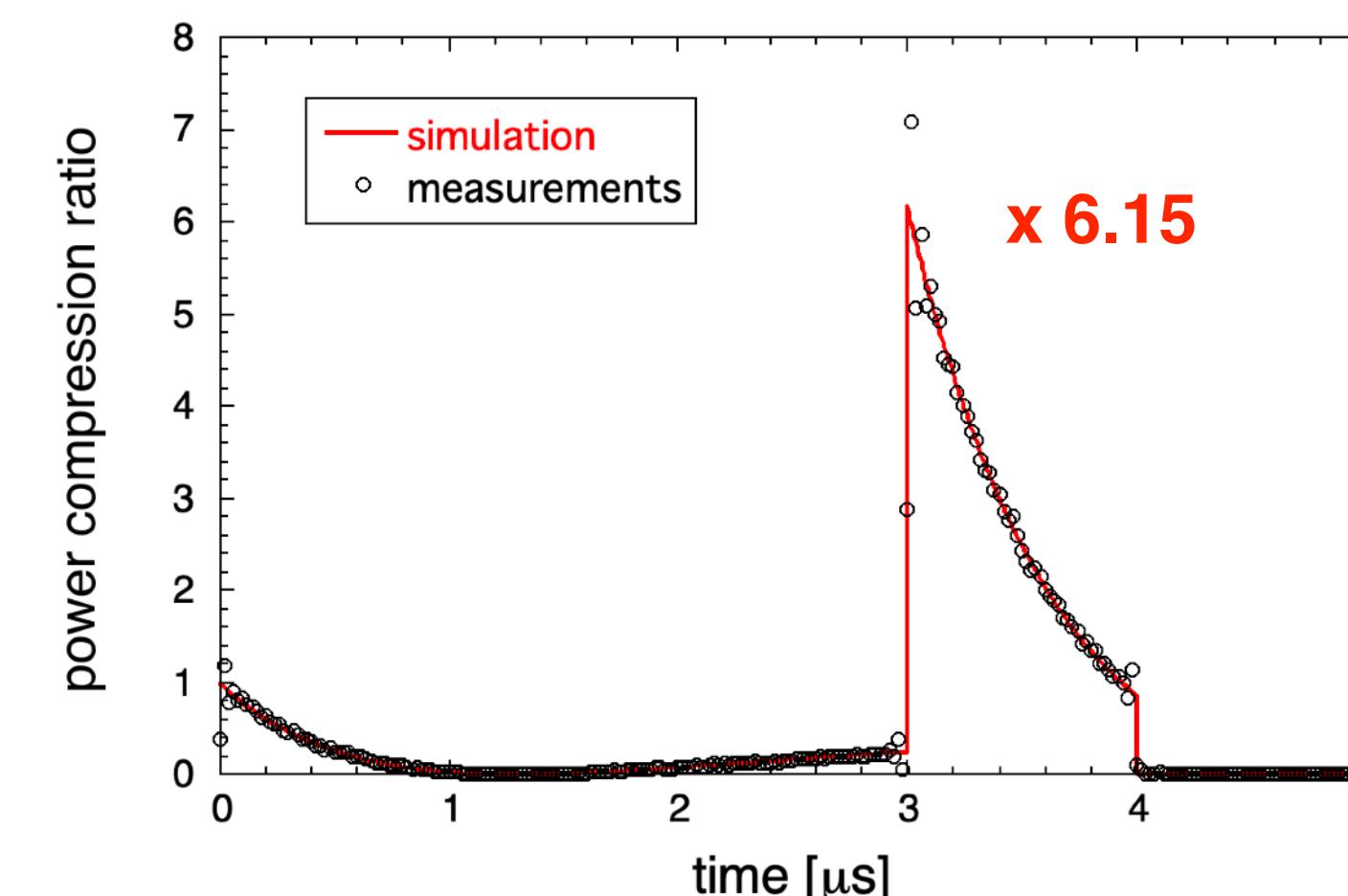
Coupling β : 6.4

3-port waveguide polarizer

Rectangular-to-cylindrical mode converter

Exciting the rotational TE11 mode in the cylinder port

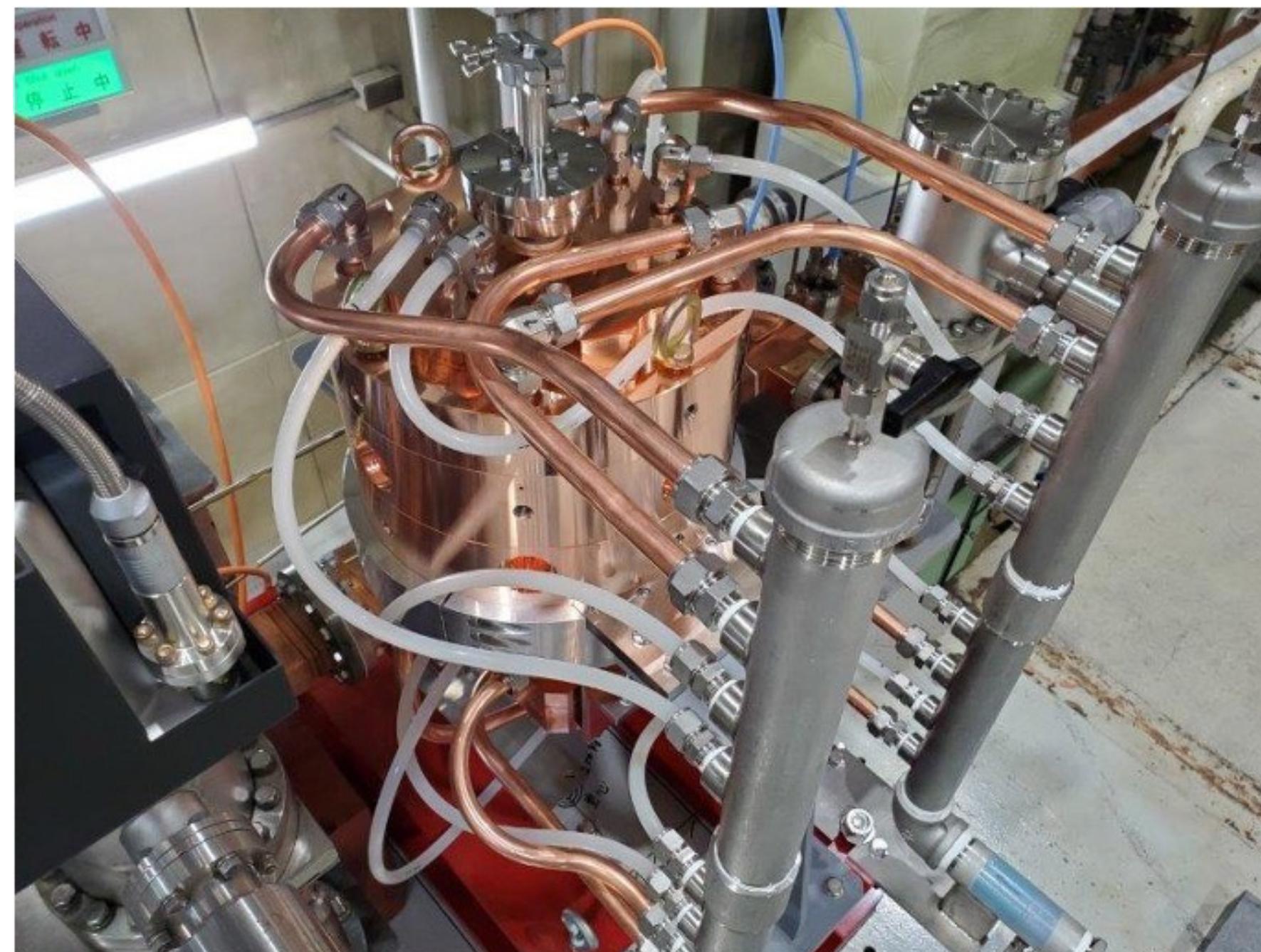
Pulse compression



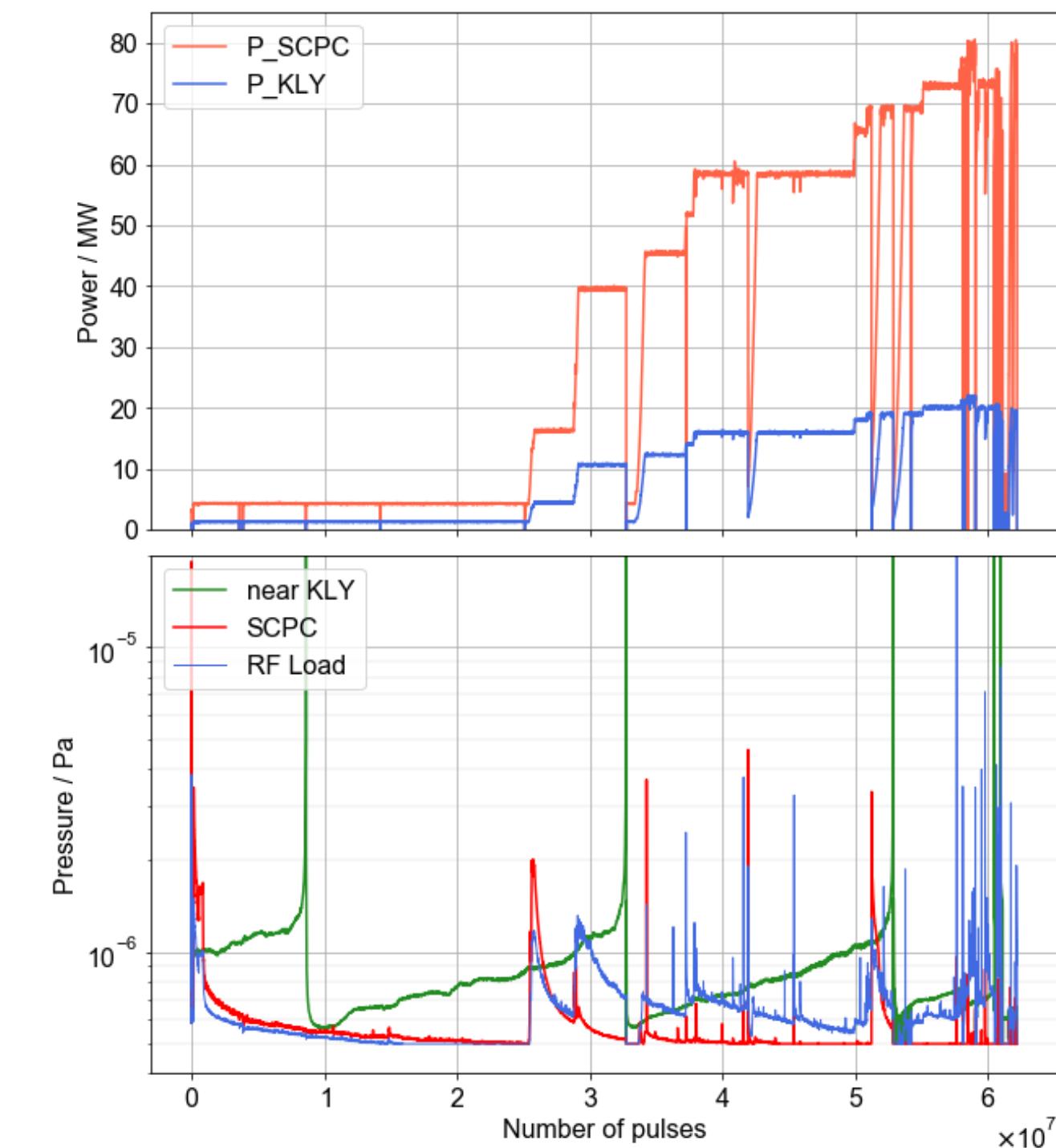
Upgrade : Pulse compressor

Pulse compressing performance

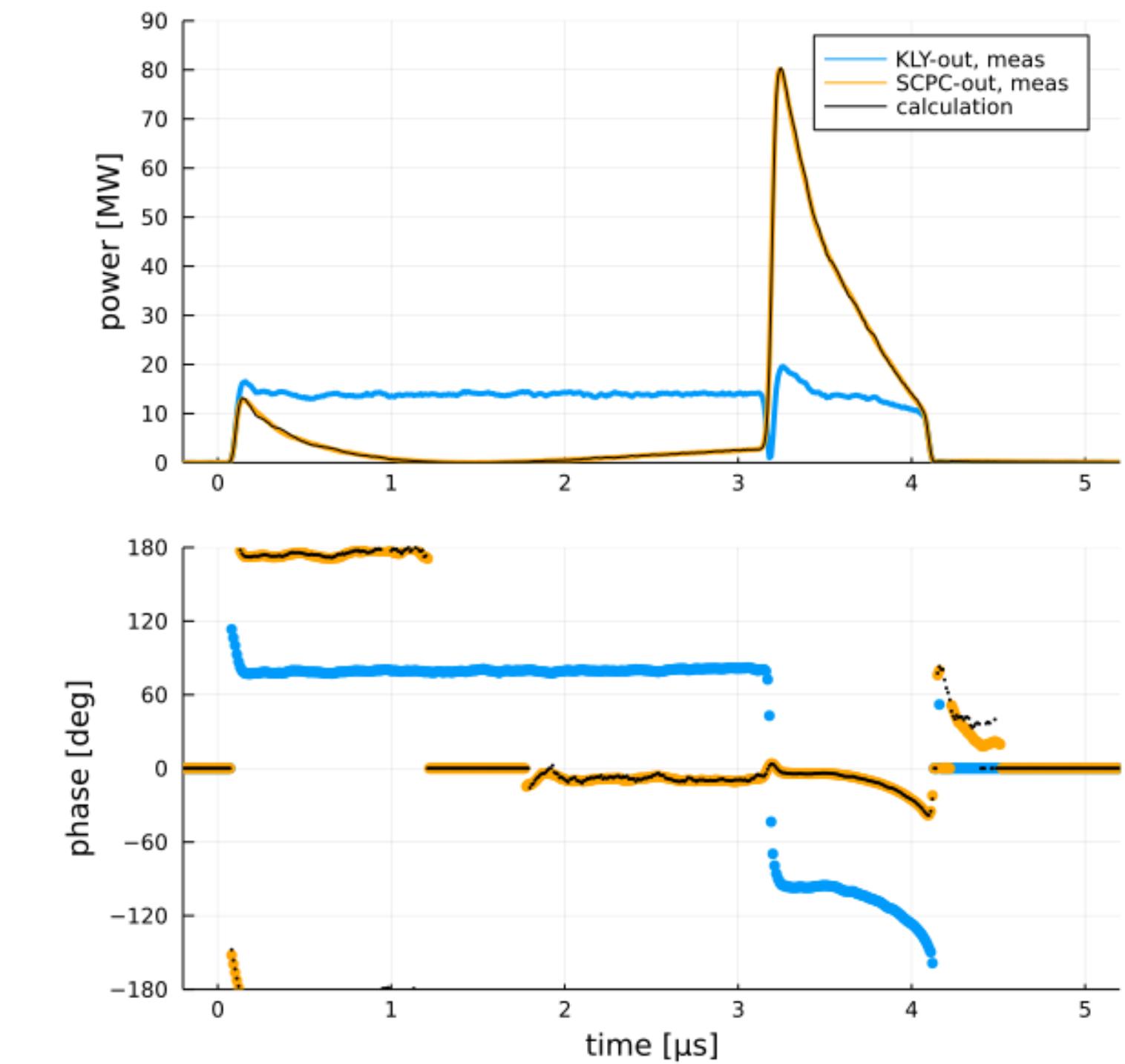
SCPC in the test bench



Successful 80 MW peak operation in the test bench



3-week test

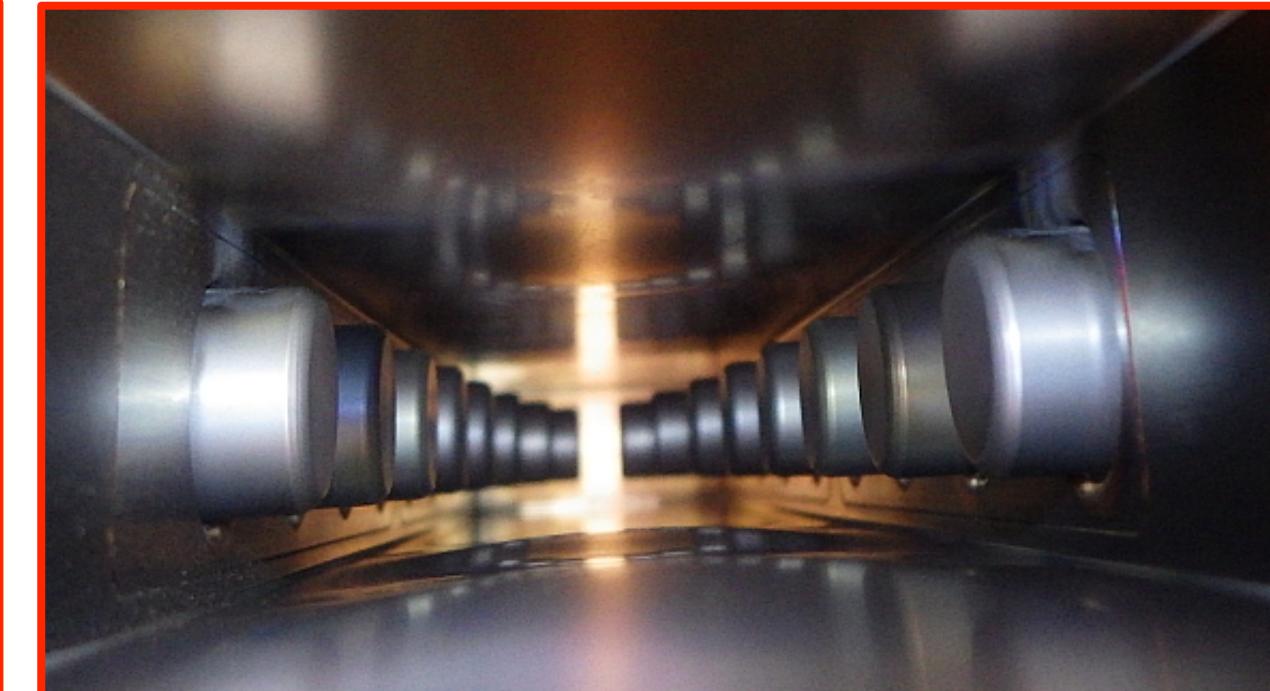


Currently available peak output power of 150 MW in the beam-accelerating unit of 44-B

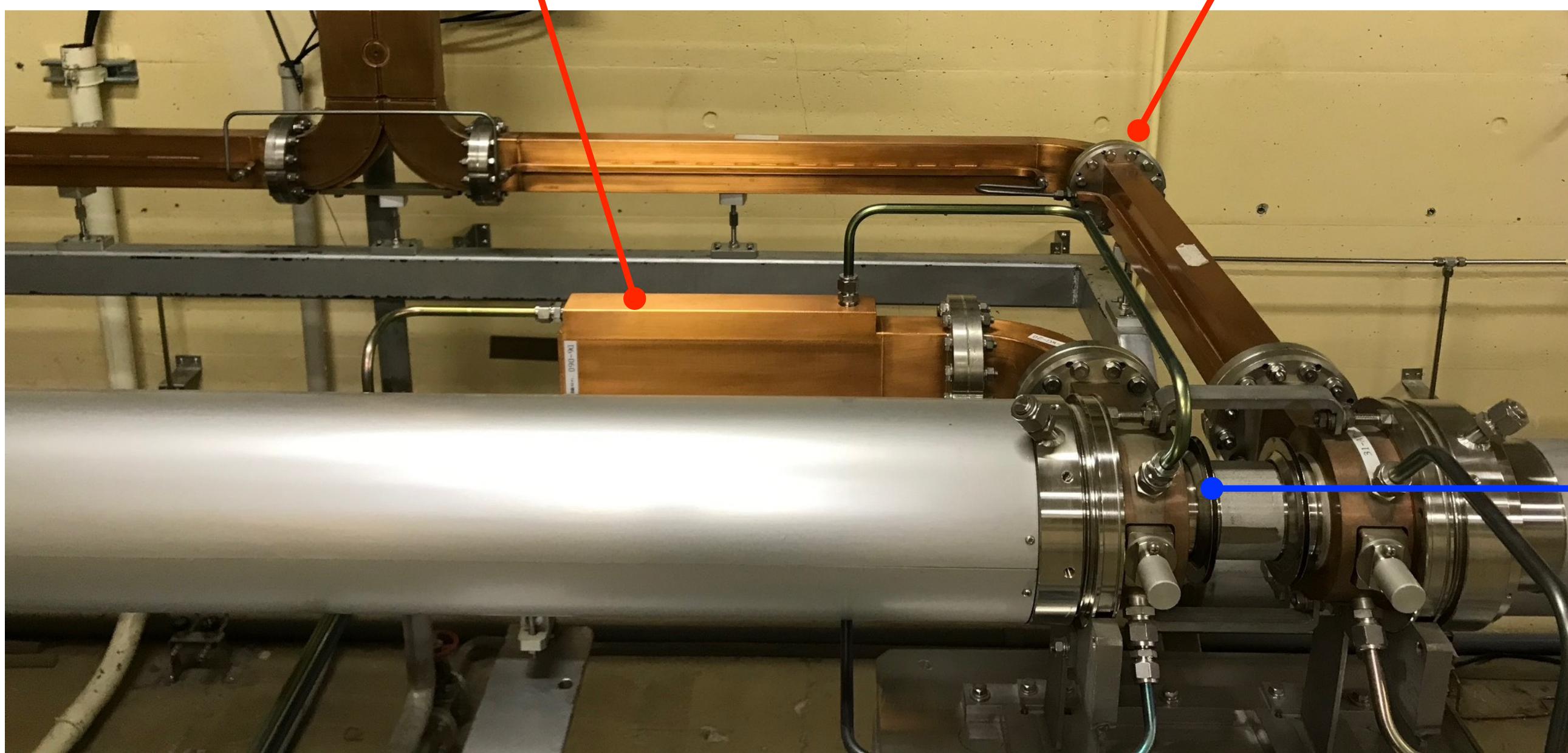
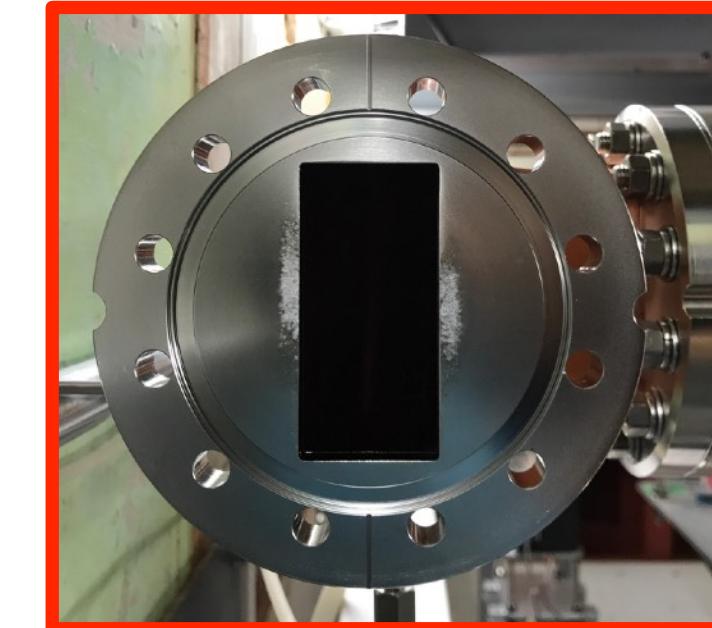
Remaining issues to be overcome

Over-time deteriorations of high-power components

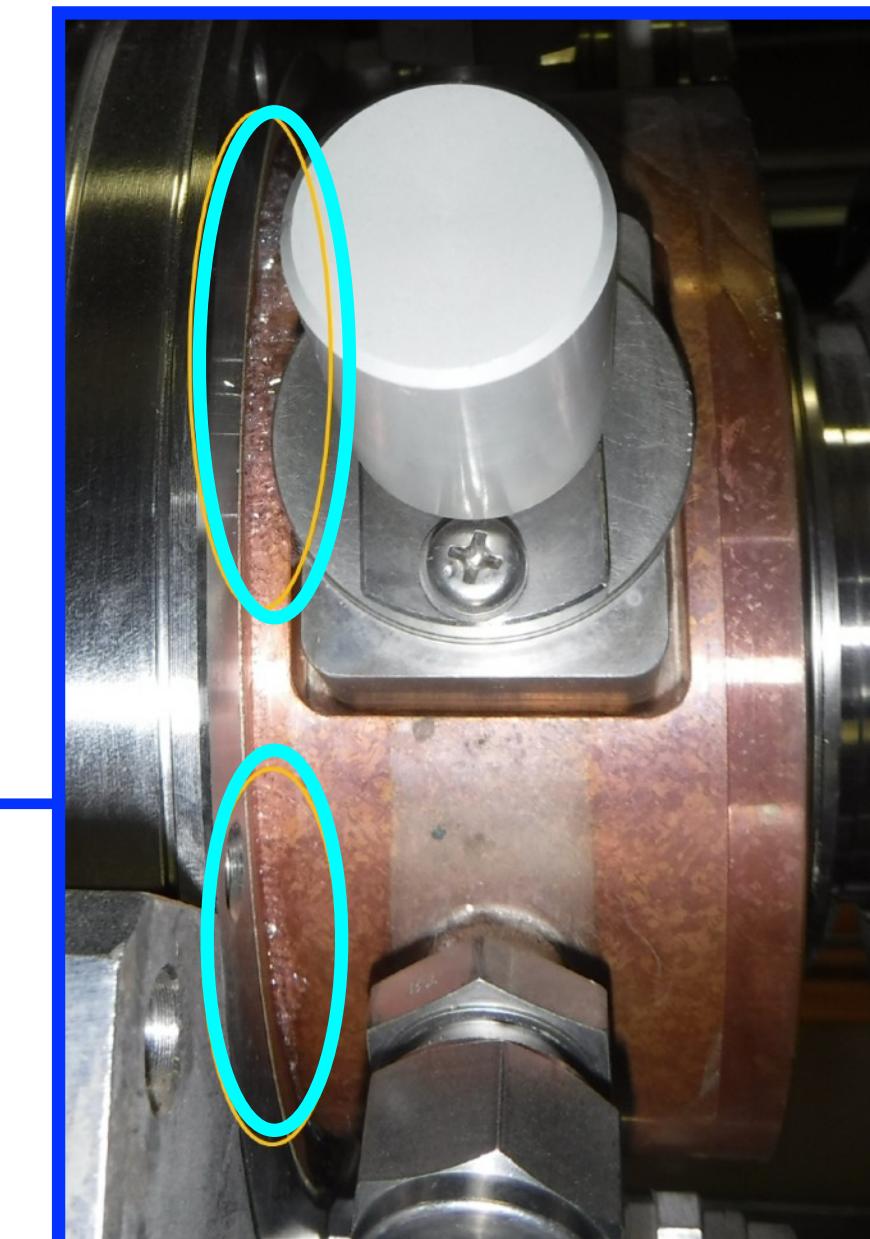
Bursts of RF absorbers in dummy loads



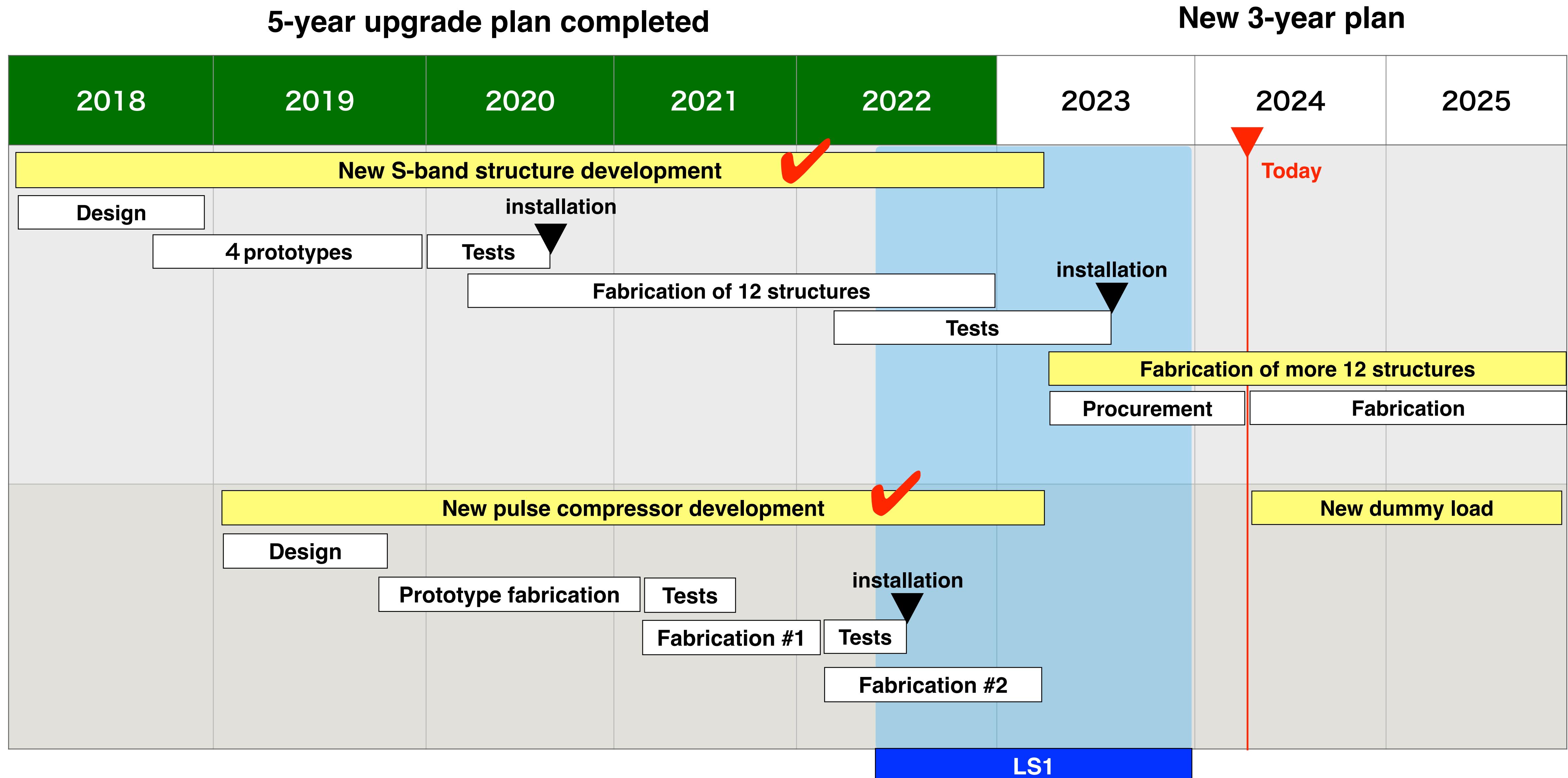
Discharges on waveguide flanges



Water leakage
3 structures / year



R&D plan



- 5-year upgrade development completed
 - ▶ 16 accelerating structures
 - * Higher accelerating gradient
 - * Simple and sure fabrication
 - * Reduction in discharge
 - * Suppression for long-range wake instabilities
 - ▶ Pulse compressor of new type
 - * Simple fabrication for low-cost
 - * Pulse-compressing performance same as KEK-SLED's
 - * Compatible with KEK-SLED
- Remaining problems
 - ▶ New 3-year plan of the structure fabrication against water leakage
 - ▶ Development of new dummy load to carry out the stable high-power operation

Thank you