

Upgrade Status of S-band Accelerating Structure

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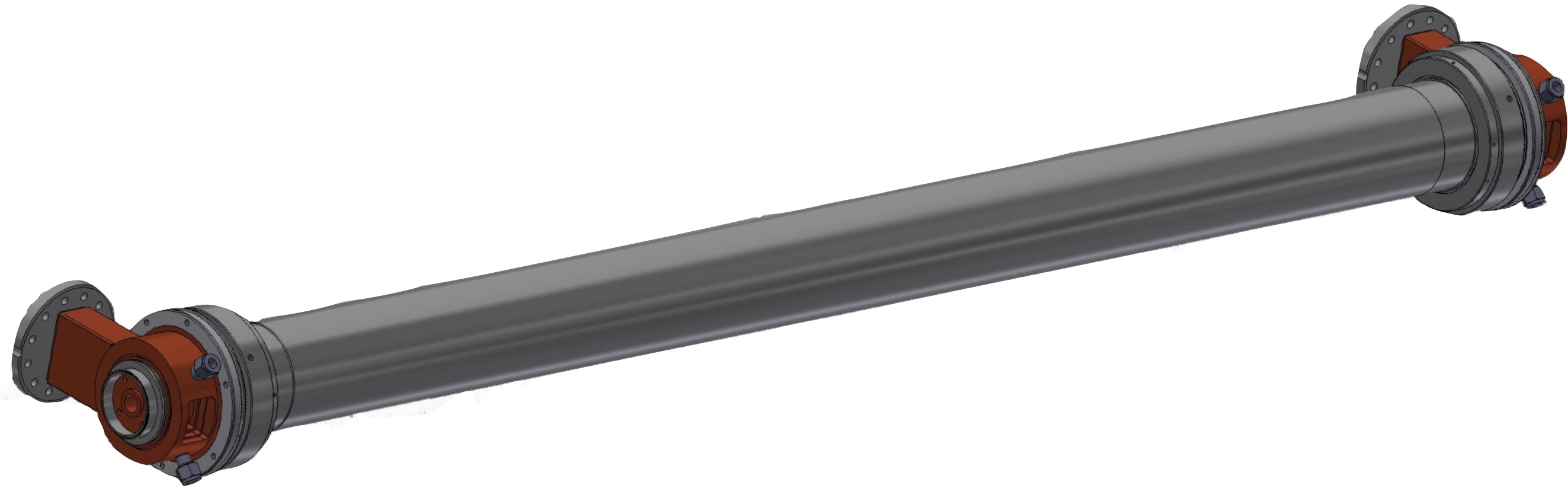
on behalf of the accelerating-structure and positron group

KEK Injector Linac division

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

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

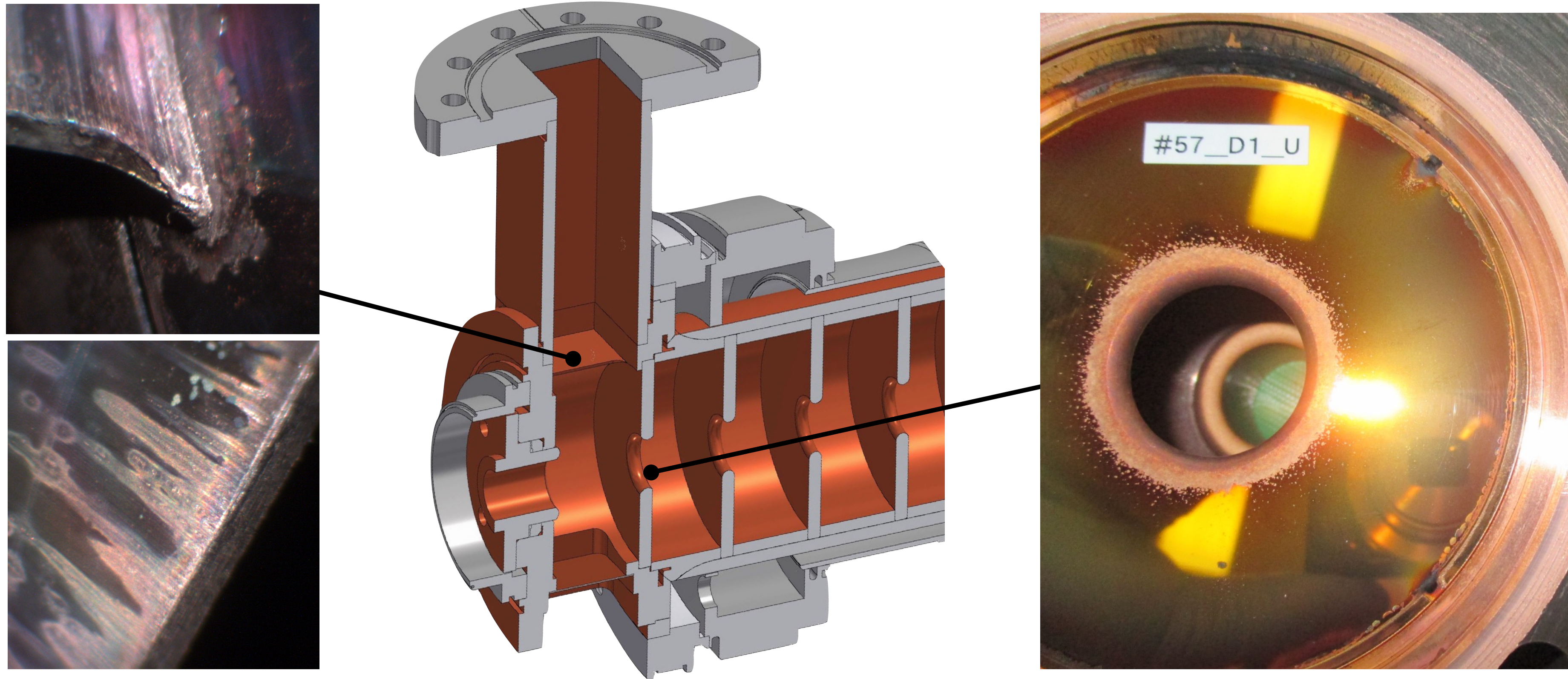
Recently 3 structures every year



Unavailable to beam acceleration

Problems in stabilizing beam acceleration : Accelerating structure

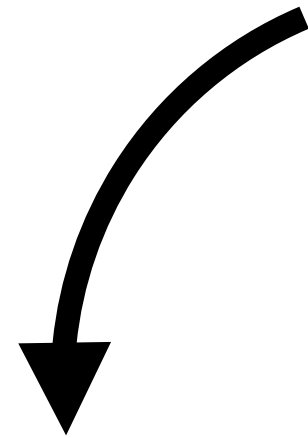
Problems : Water leaks, **power reflection, discharge** limiting the operation of the beam acceleration



Limit power operation and lower accelerating voltage

Upgrade : Accelerating structure

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



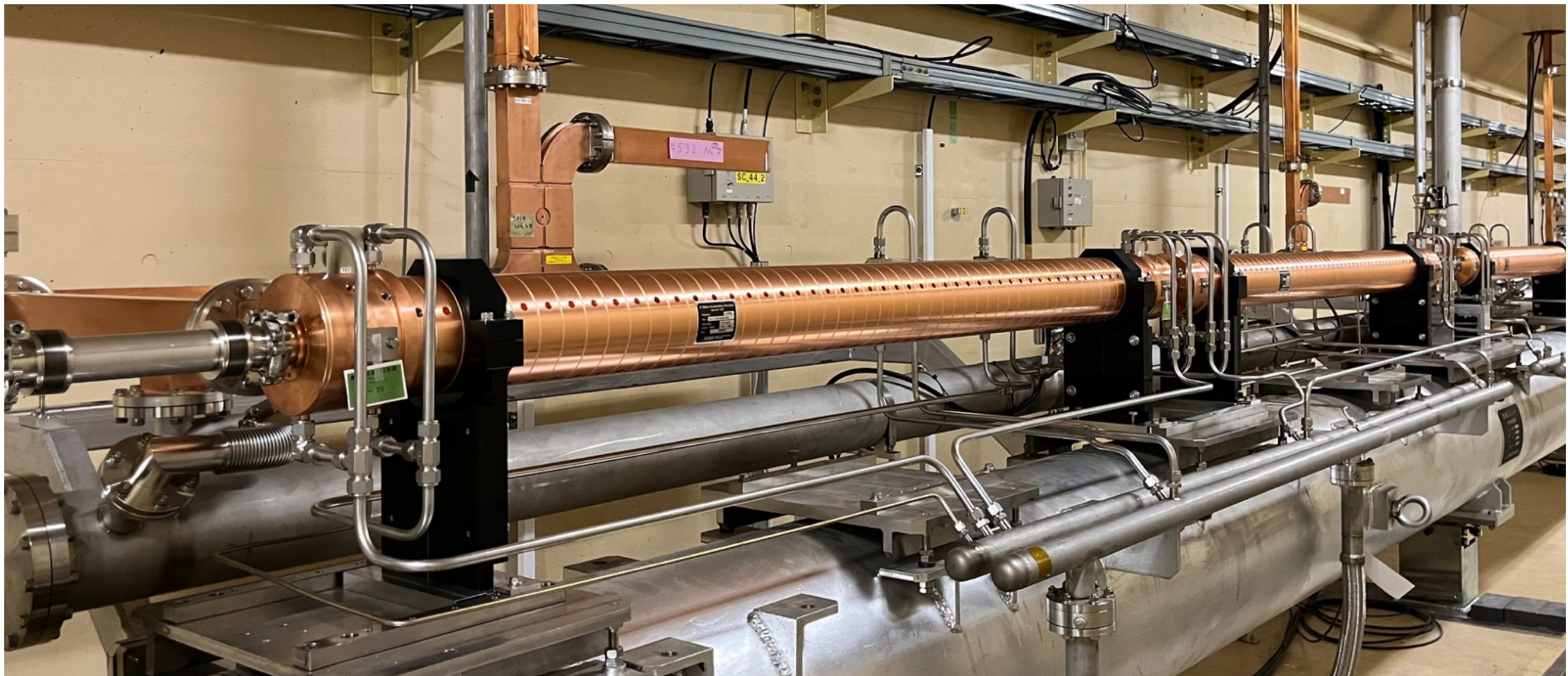
Countermeasures : New S-band accelerating structures

with following upgrades !

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

Upgrade : Accelerating structure

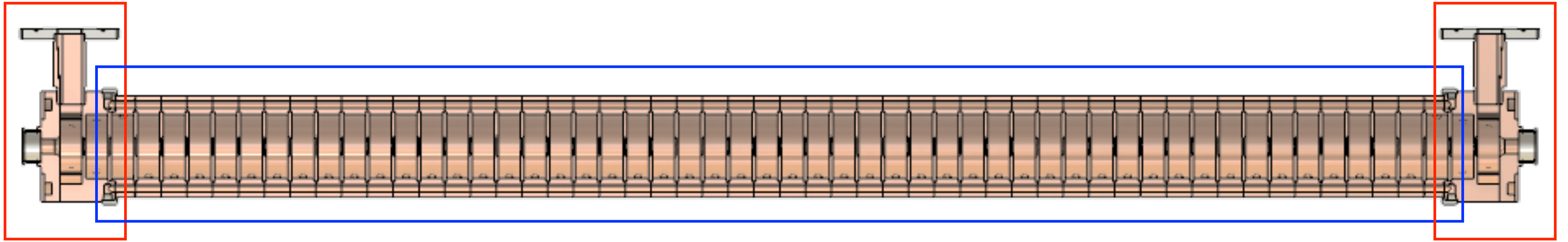
Higher accelerating gradient



	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	7.29

Upgrade : Accelerating structure

Simple and sure fabrication



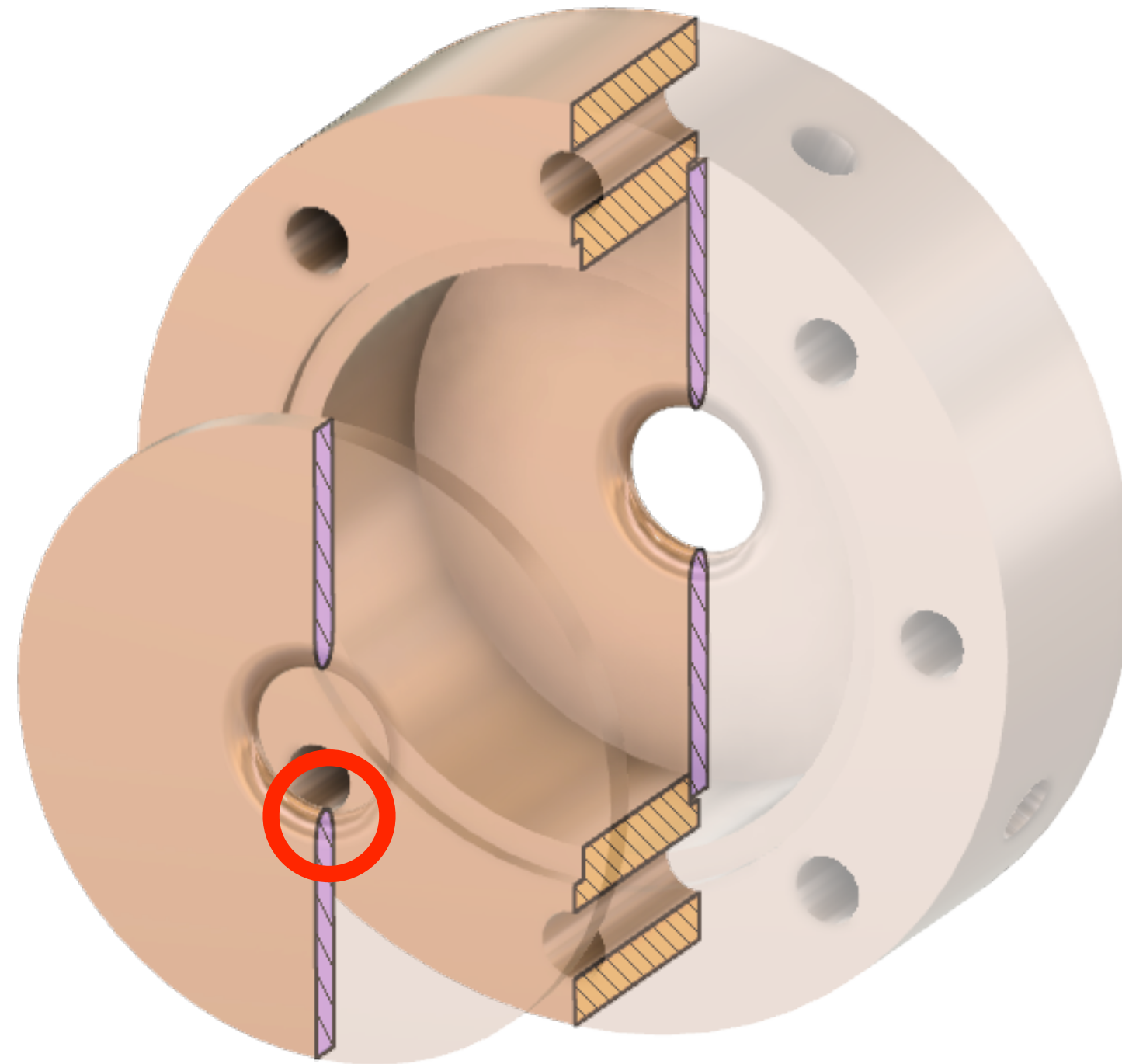
Fabrication by 2-step brazing of simply stacked cells

1) **Au-brazing** for coupler assembly

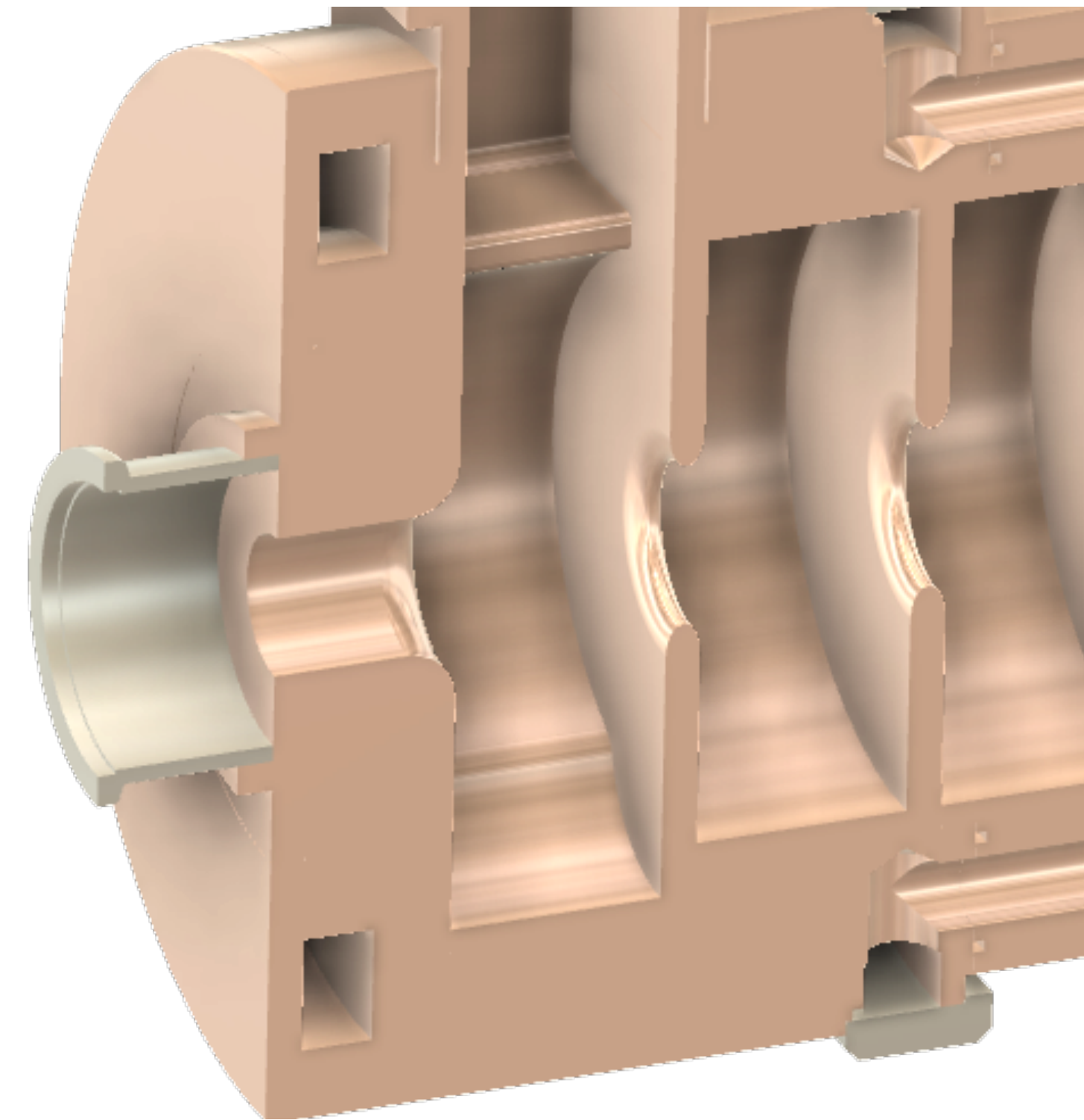
2) **Ag-brazing** for coupler-assembly, cylinders and discs stacked alternately

Upgrade : Accelerating structure

Reduction in discharge



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

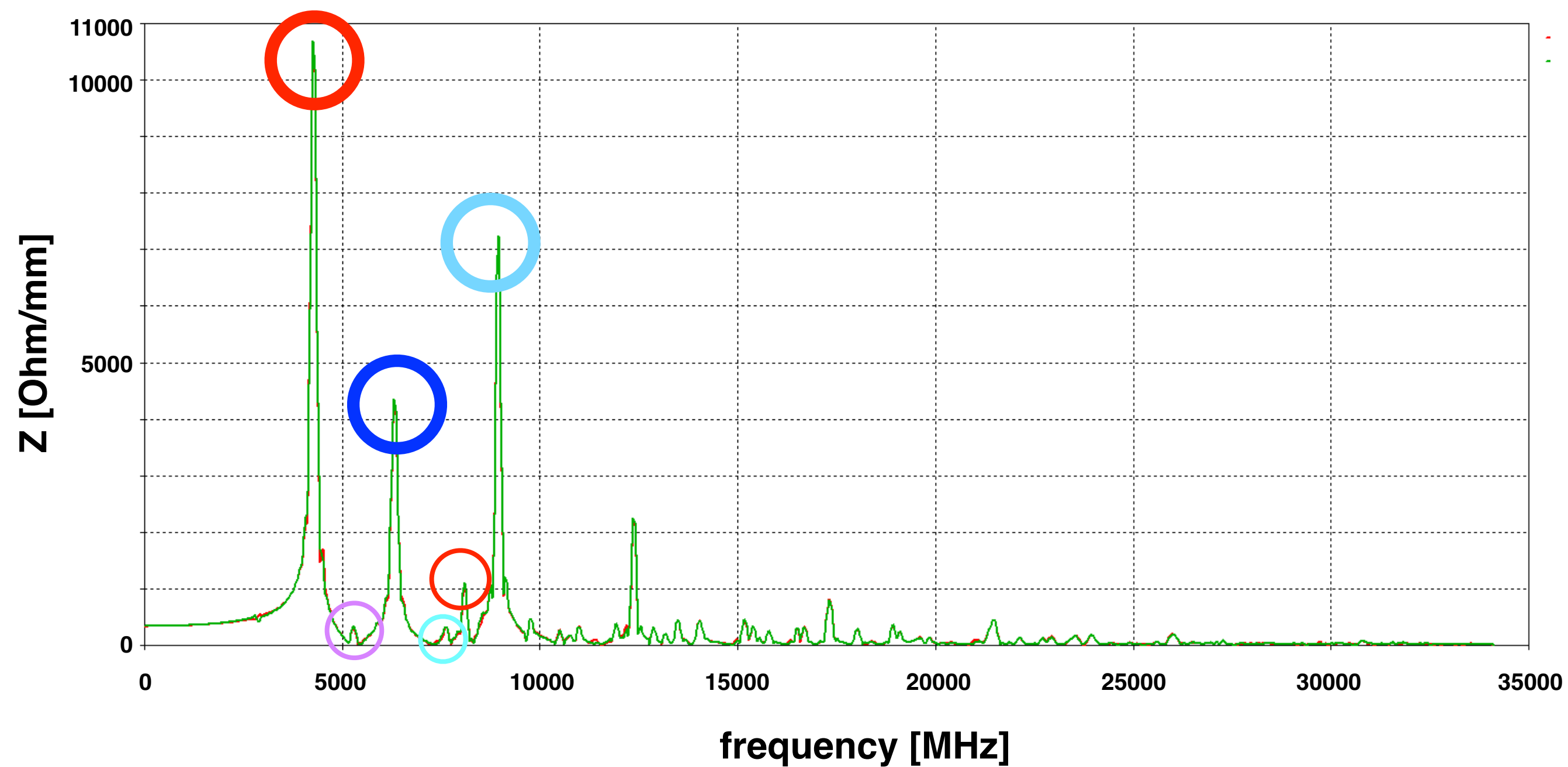


No sharp edge inside of the structure

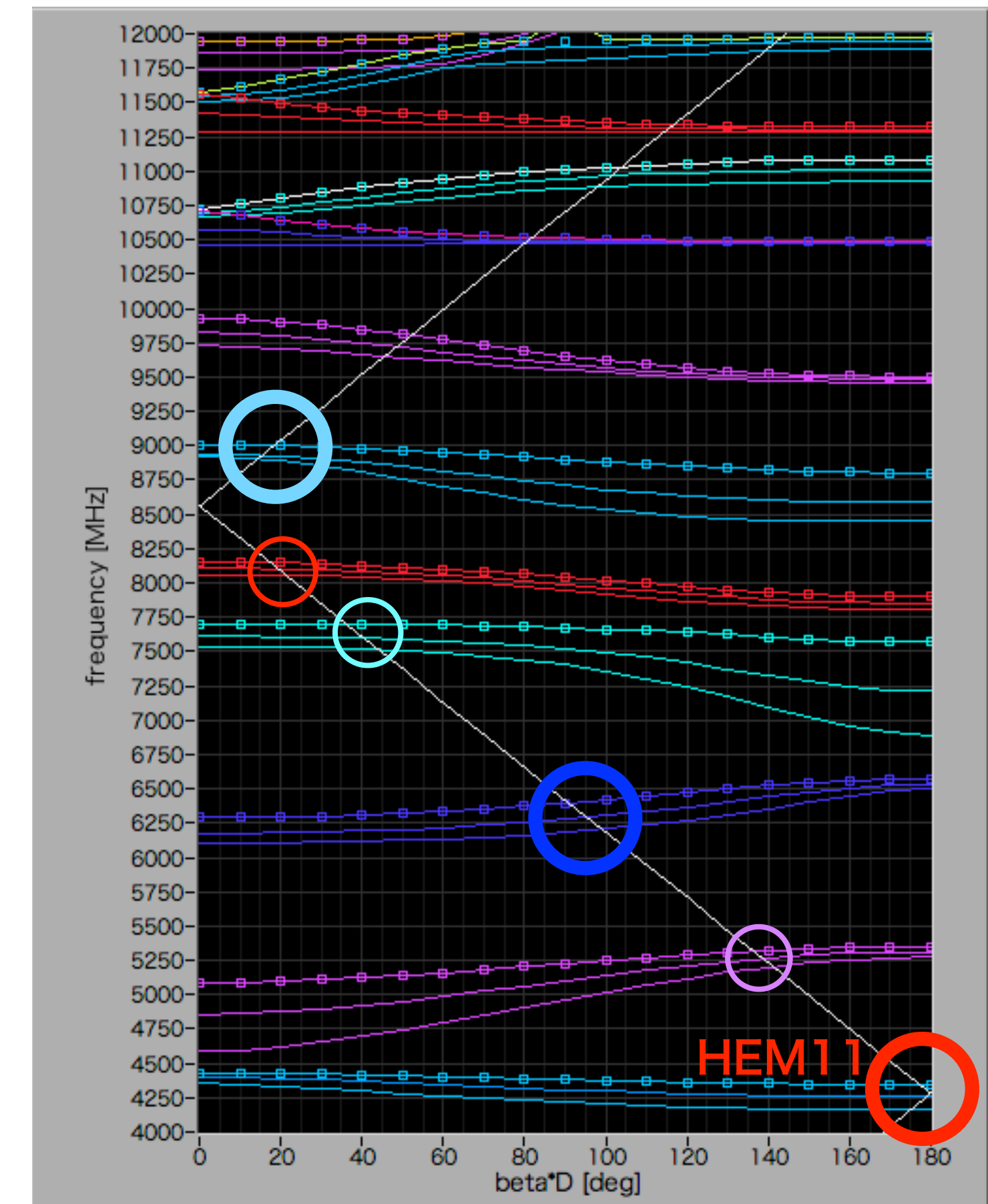
Upgrade : Accelerating structure

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

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



Transverse impedance distribution

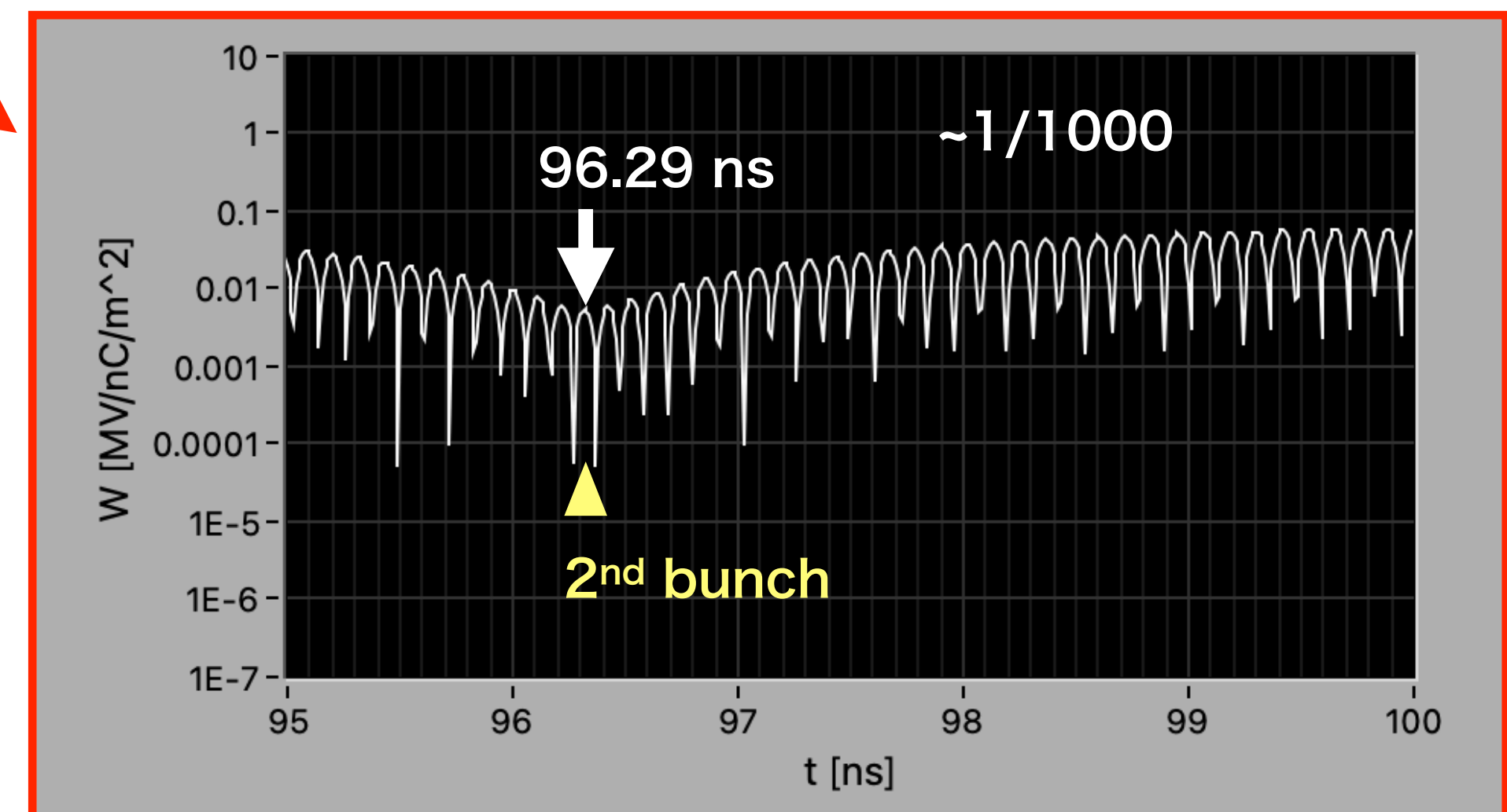
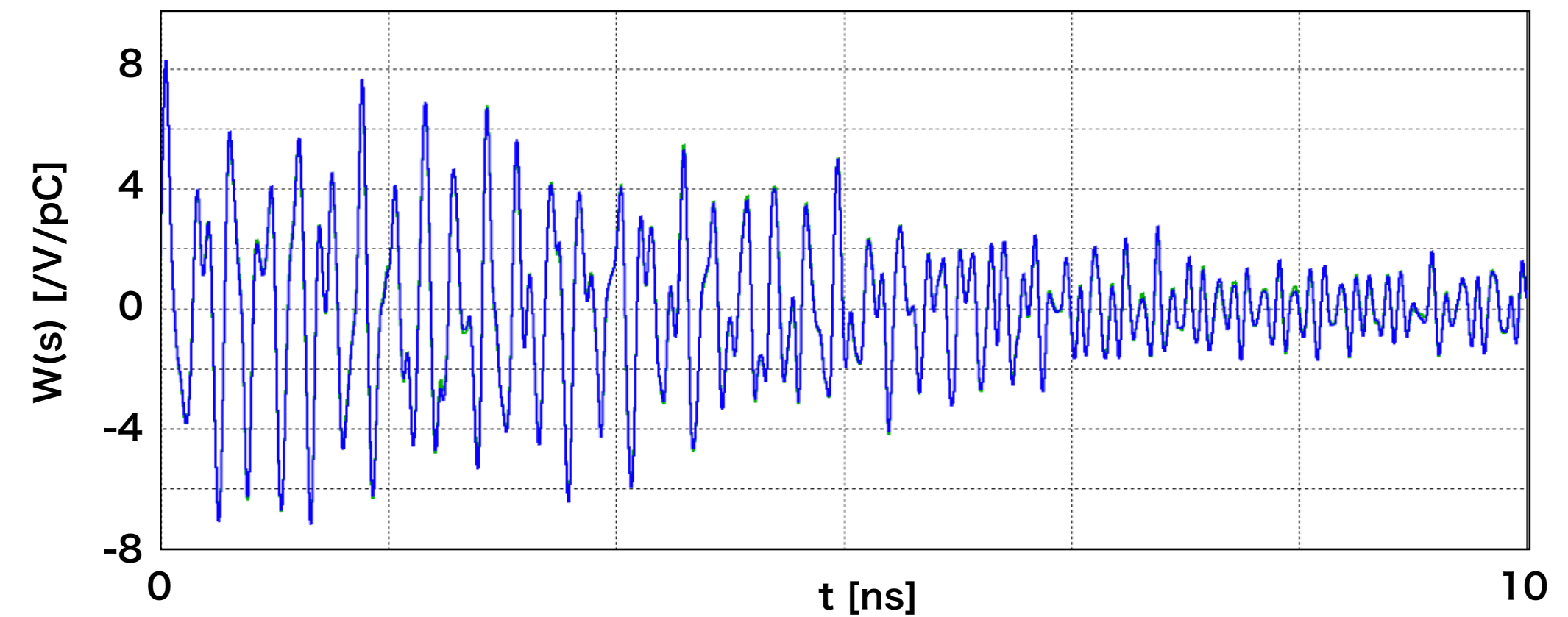
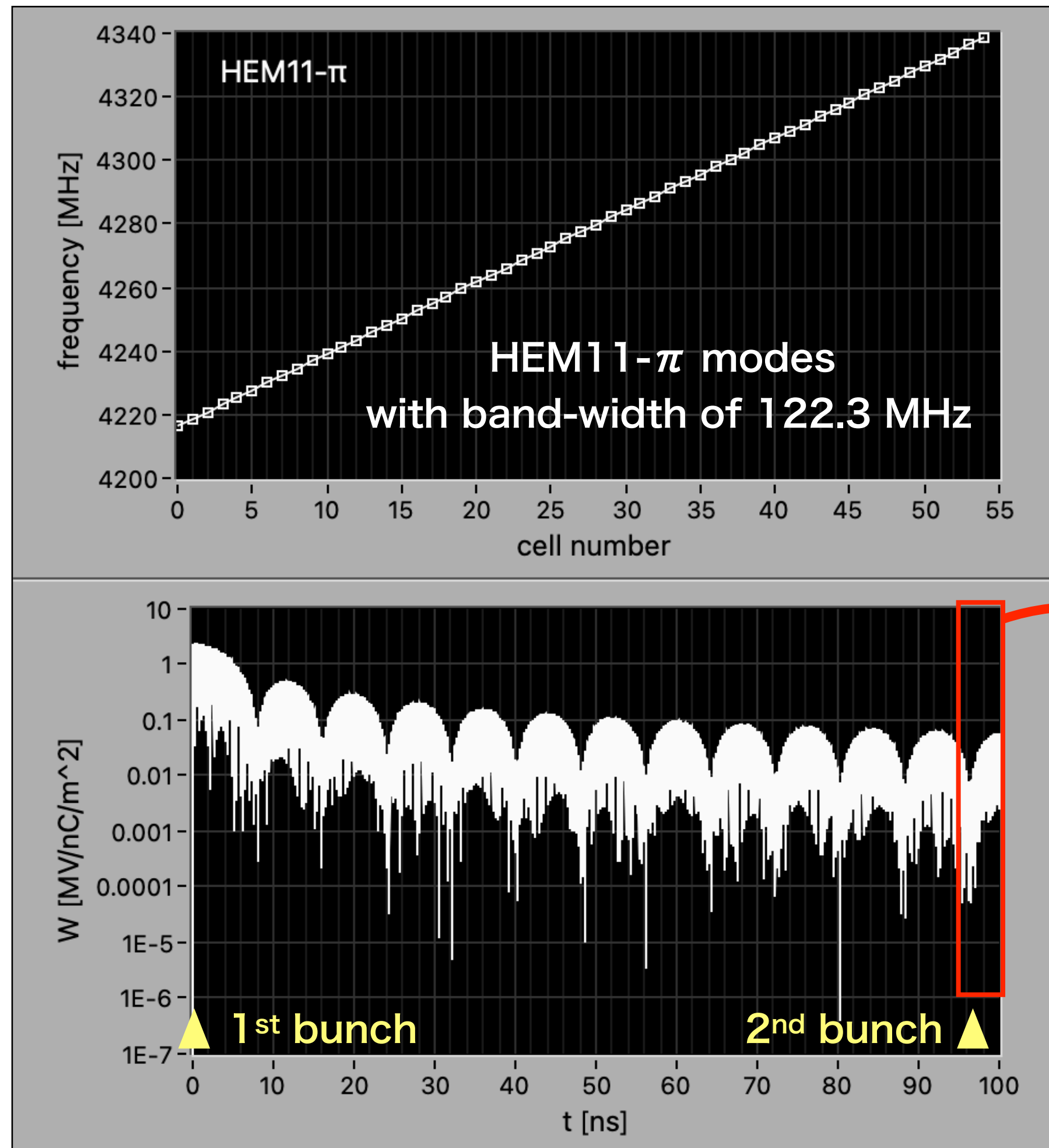


Dispersion diagram

Upgrade : Accelerating structure

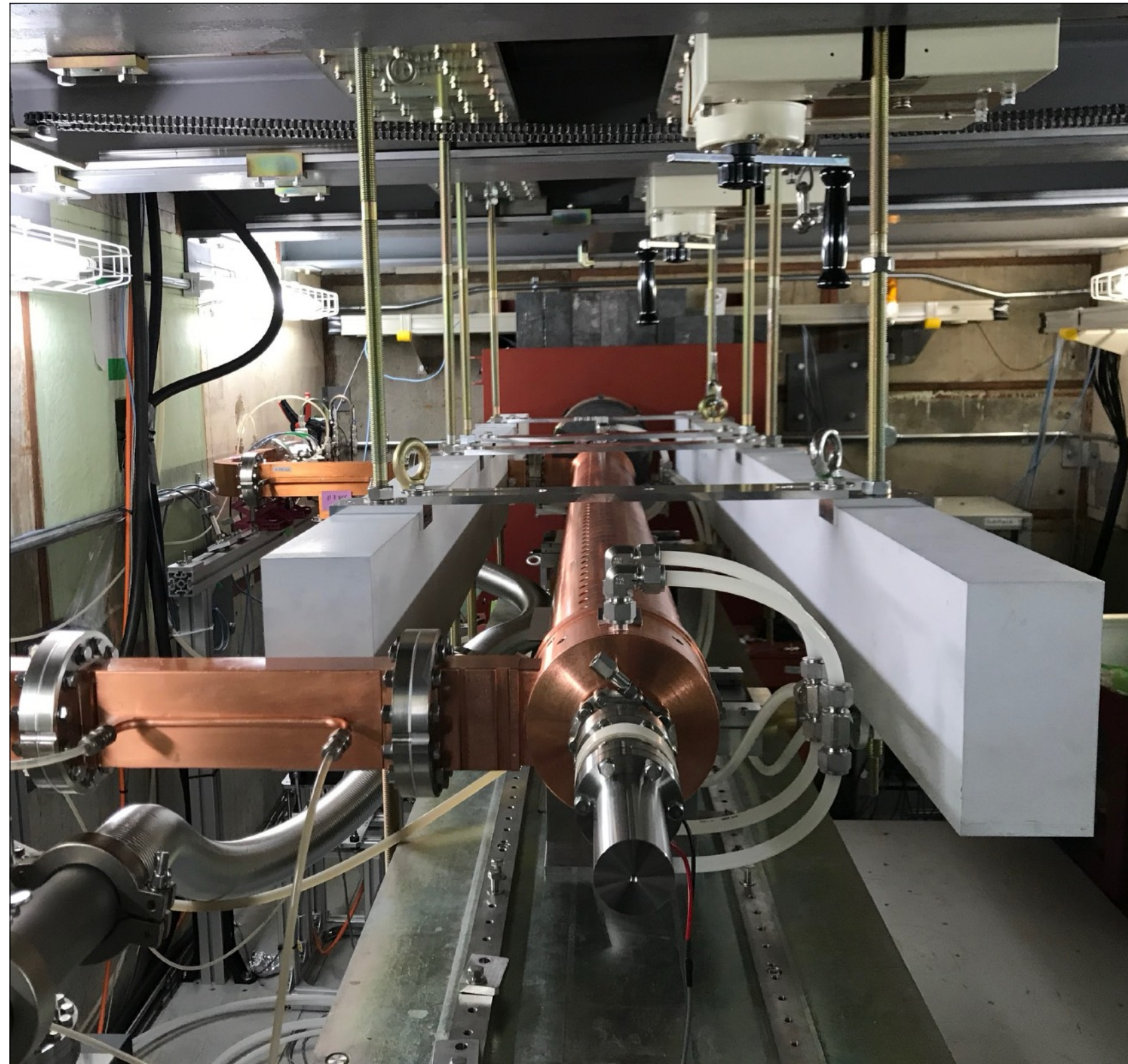
Suppression of long-range wake instabilities for 2-bunch operation

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

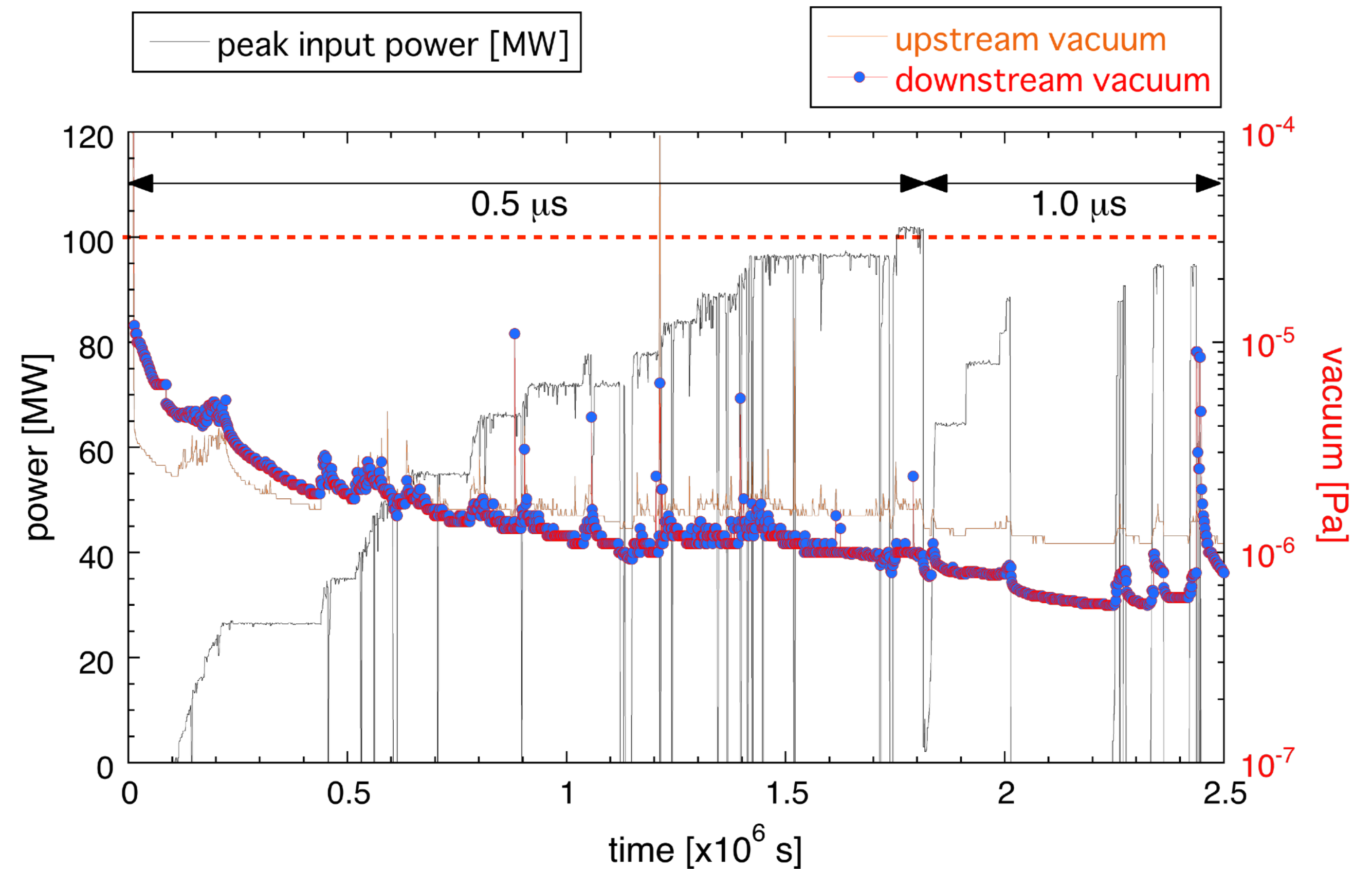


Upgrade : Accelerating structure

High-power operation



New structure in the test bench

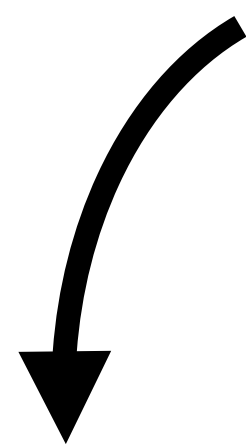


Successful operation of 100 MW

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

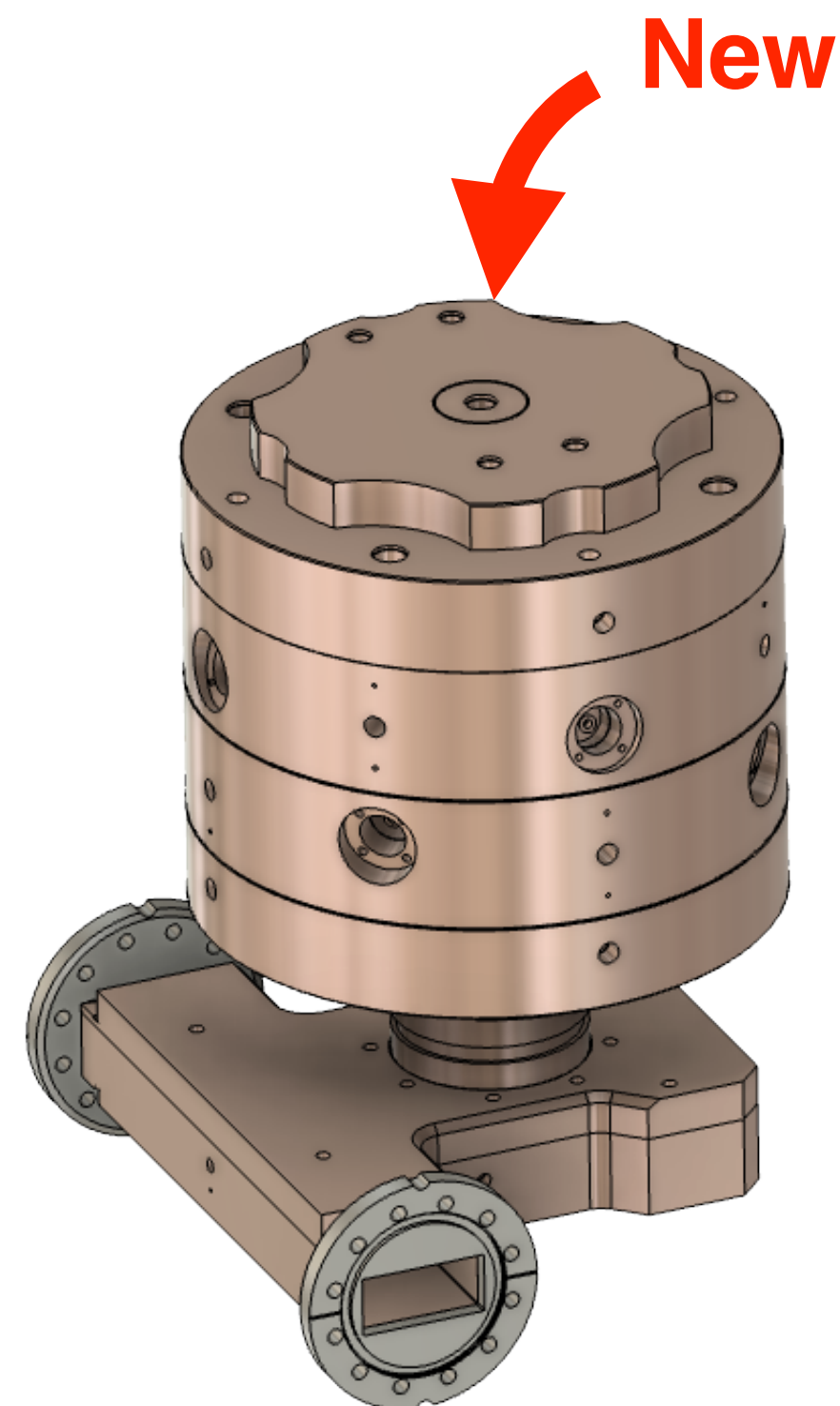
with following features

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

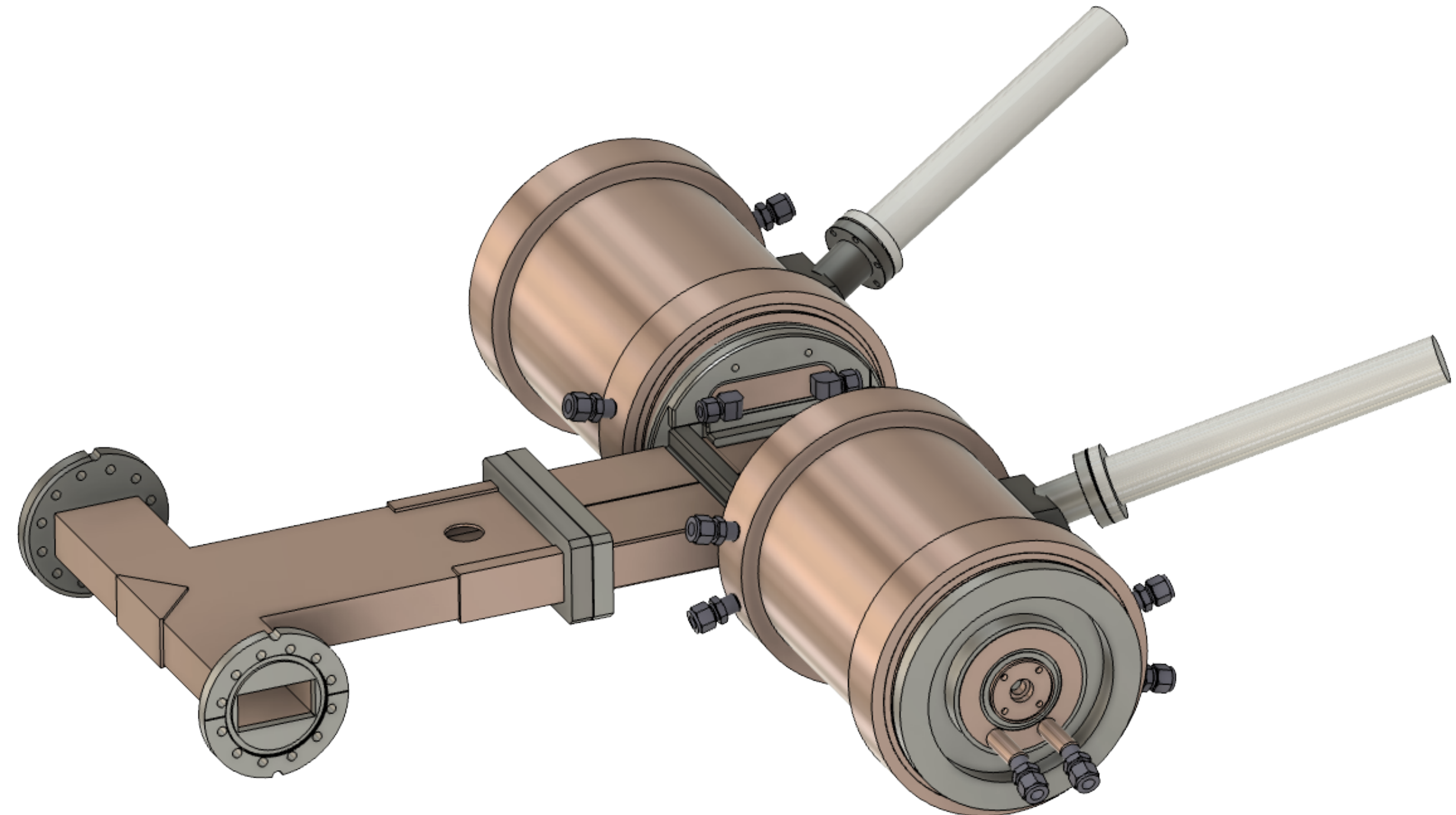
Upgrade : Pulse compressor

Low-cost Fabrication

Simple structure required



Spherical-cavity-type pulse compressor (SCPC)



KEK-SLED

Approximately half cost of SLED-type

Upgrade : Pulse compressor

Pulse compressing performance

Spherical single-cell cavity

2-fold degenerative spherical TE₁₁₂ mode

High Q : 100,000

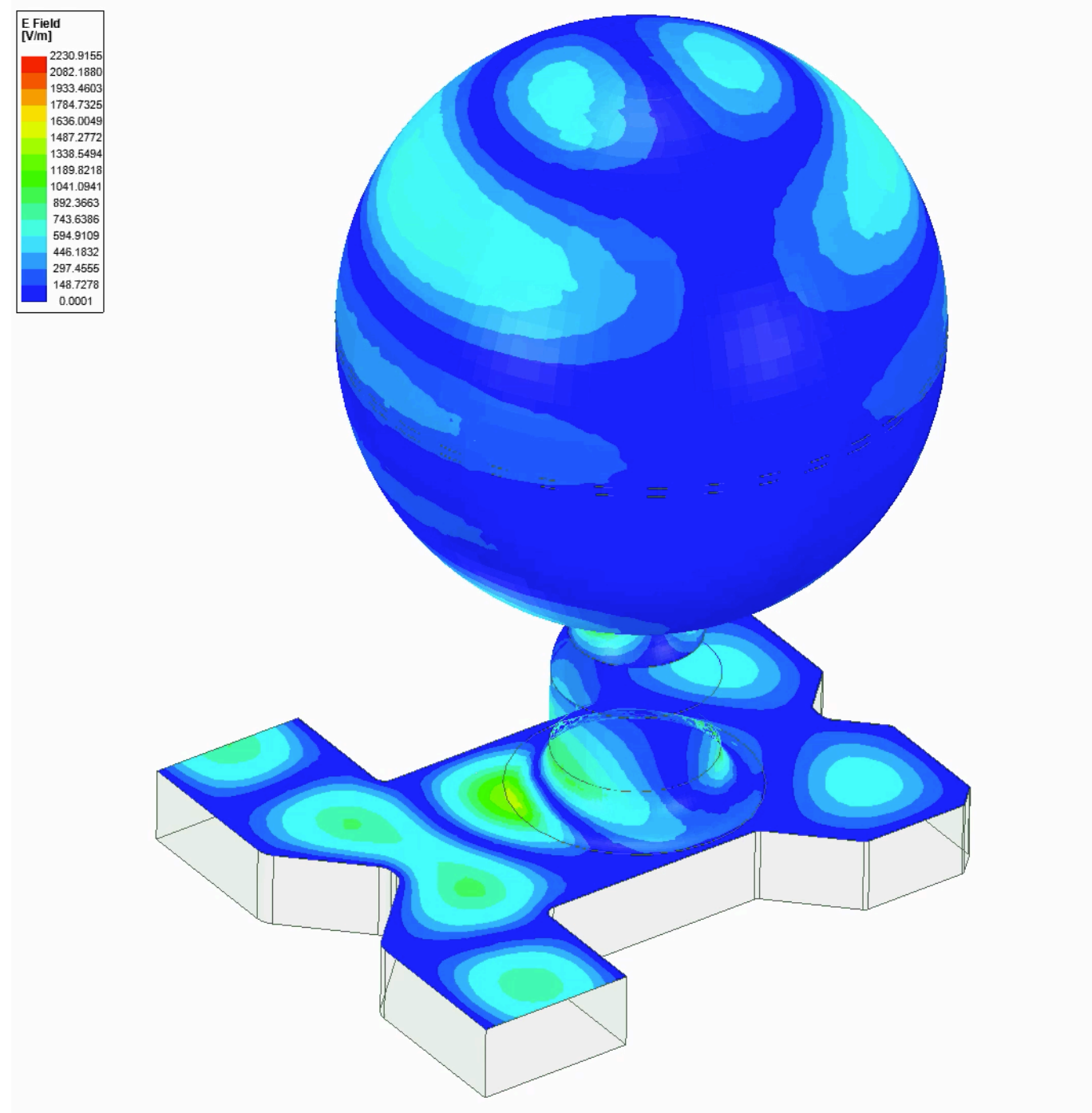
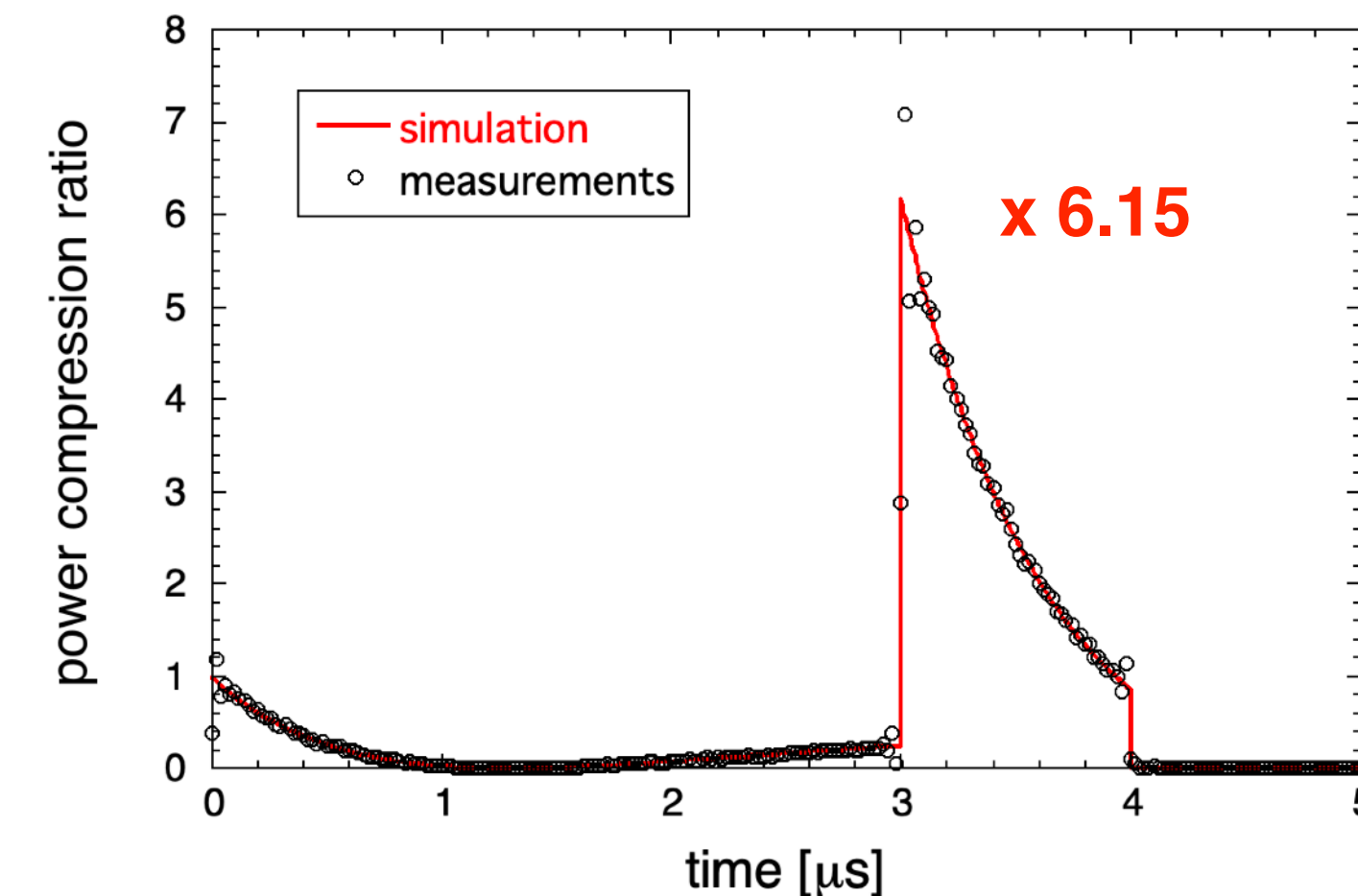
Coupling β : 6.4

3-port waveguide polarizer

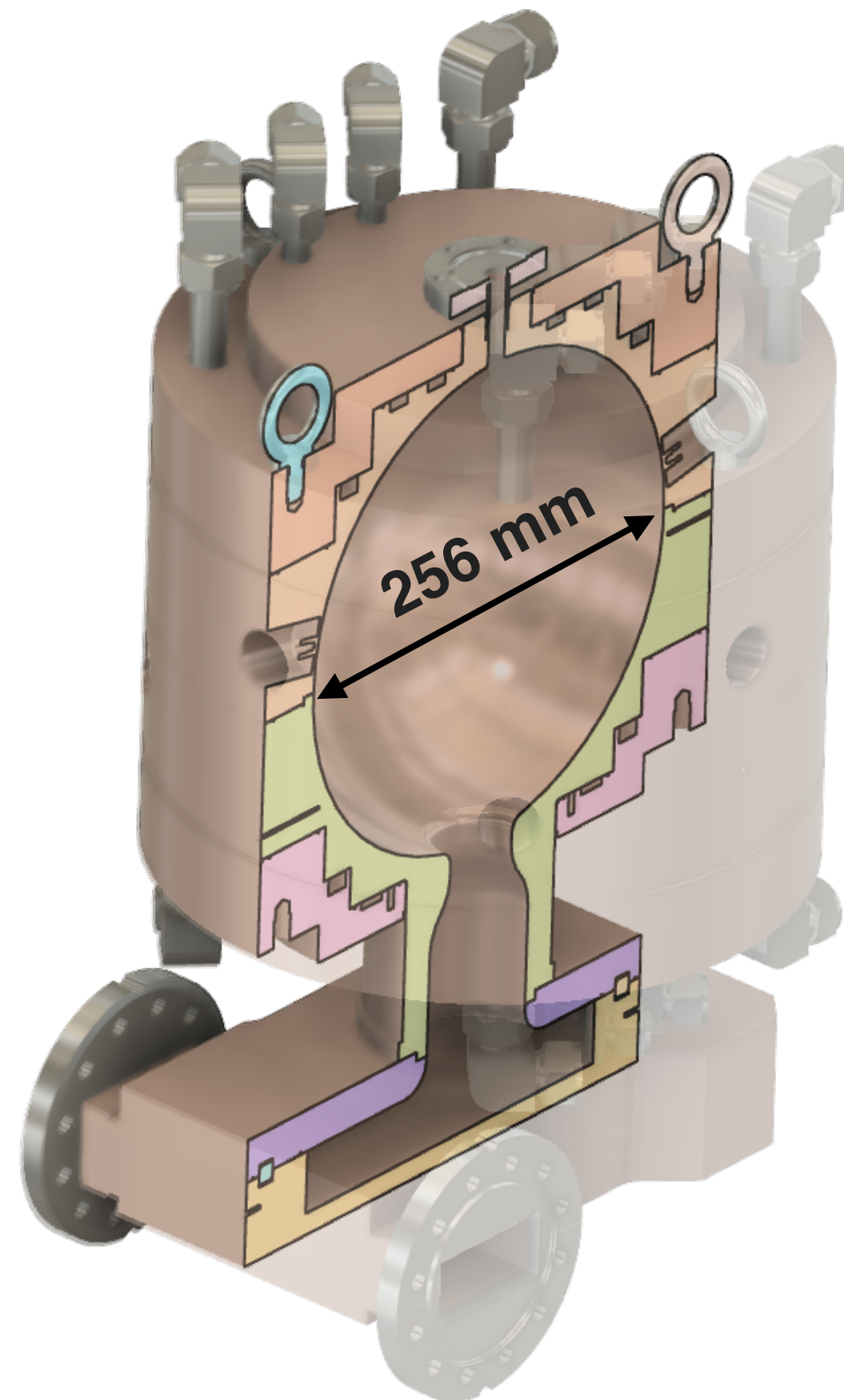
Rectangular-to-cylindrical mode converter

Exciting the rotational TE₁₁ mode in the cylinder port

Pulse compression



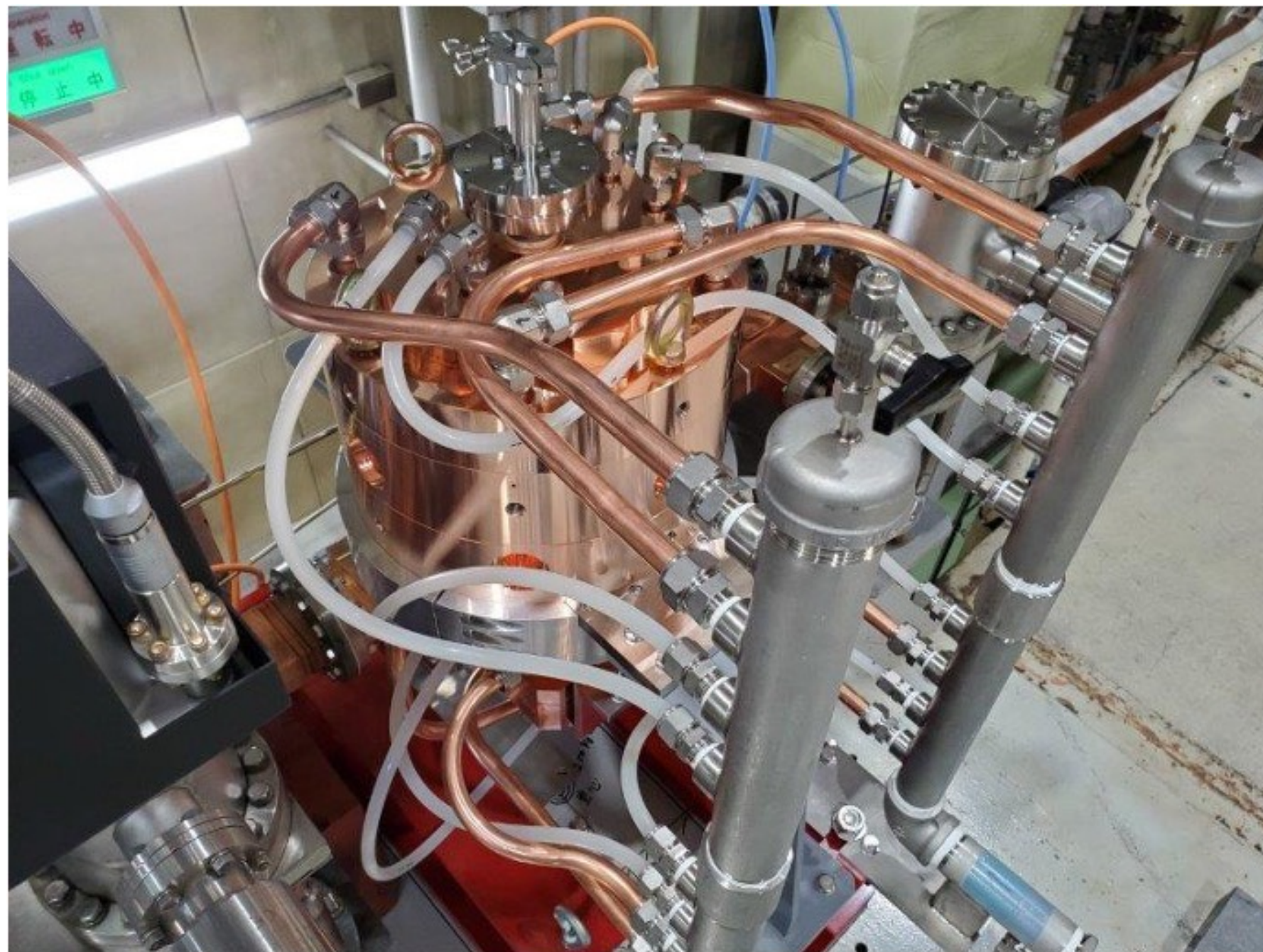
E-field distribution



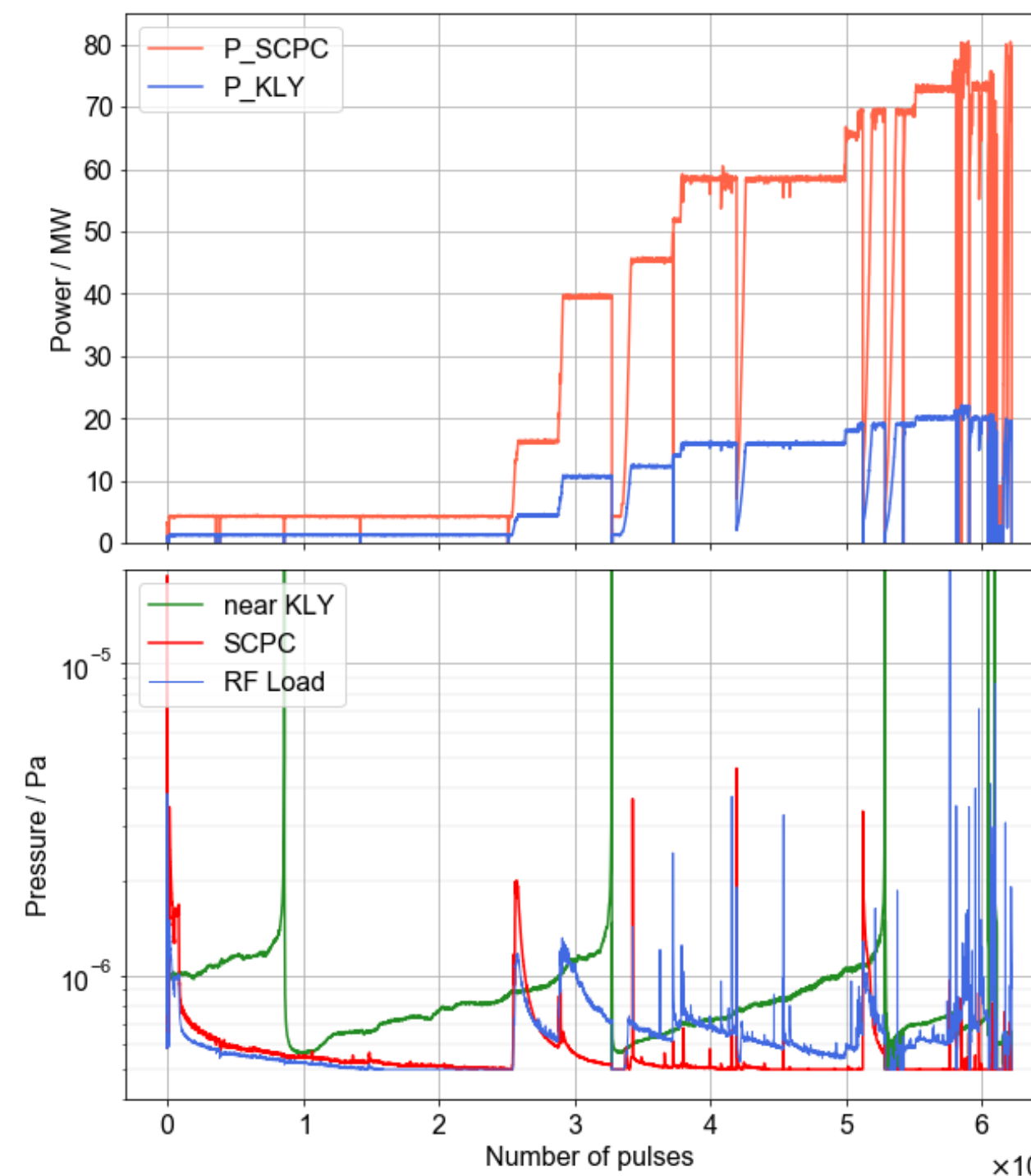
Upgrade : Pulse compressor

Pulse compressing performance

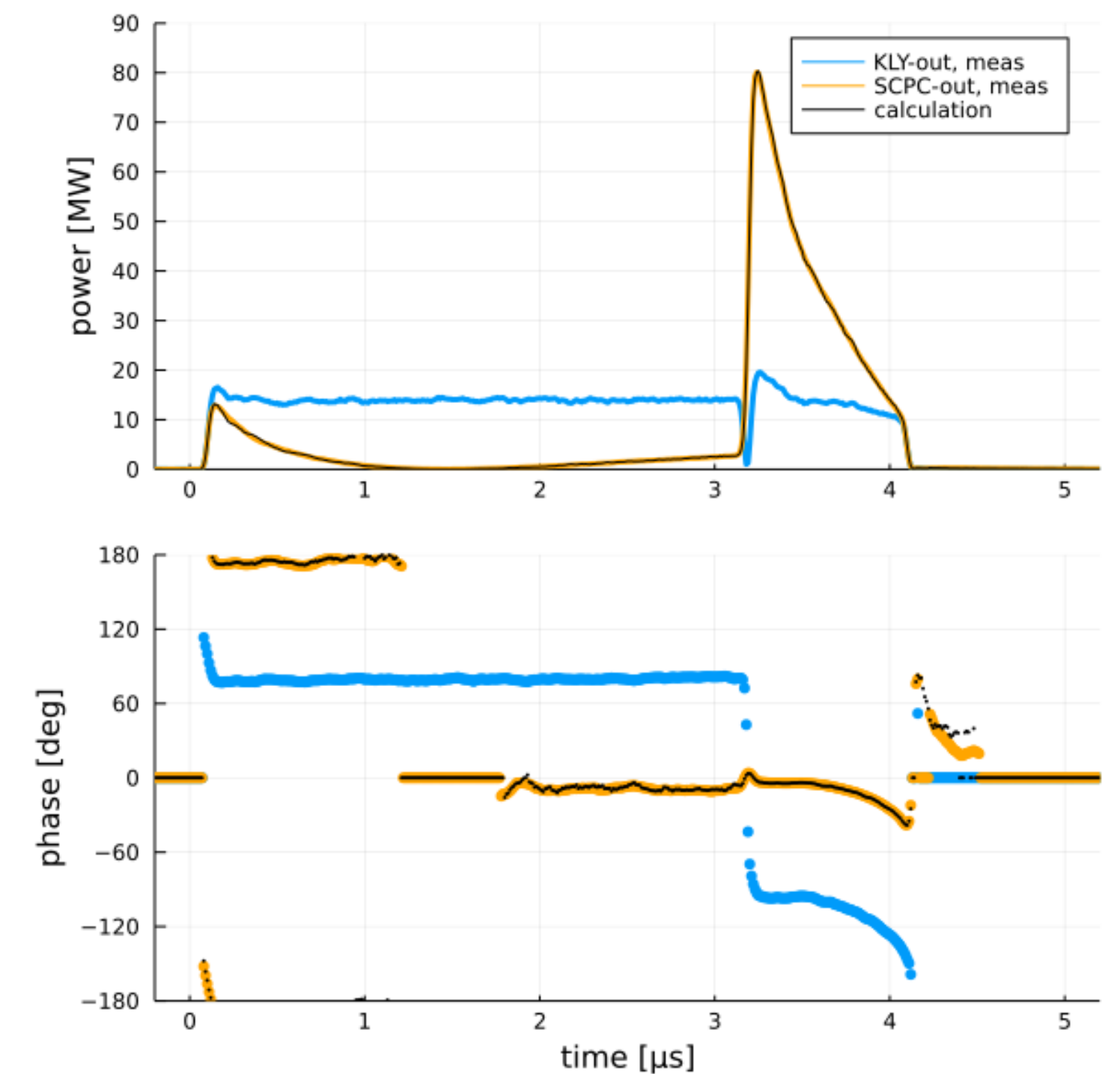
SCPC in the test bench



Successful 80 MW peak operation in the test bench



3-week test

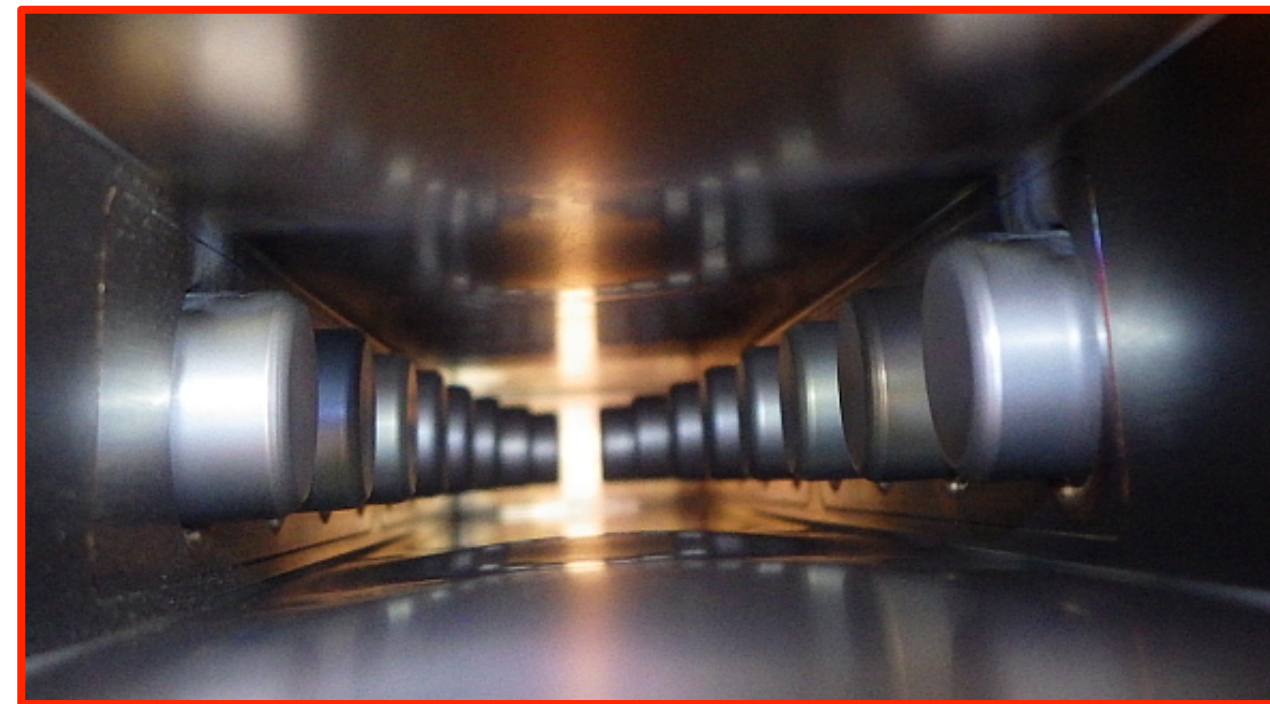
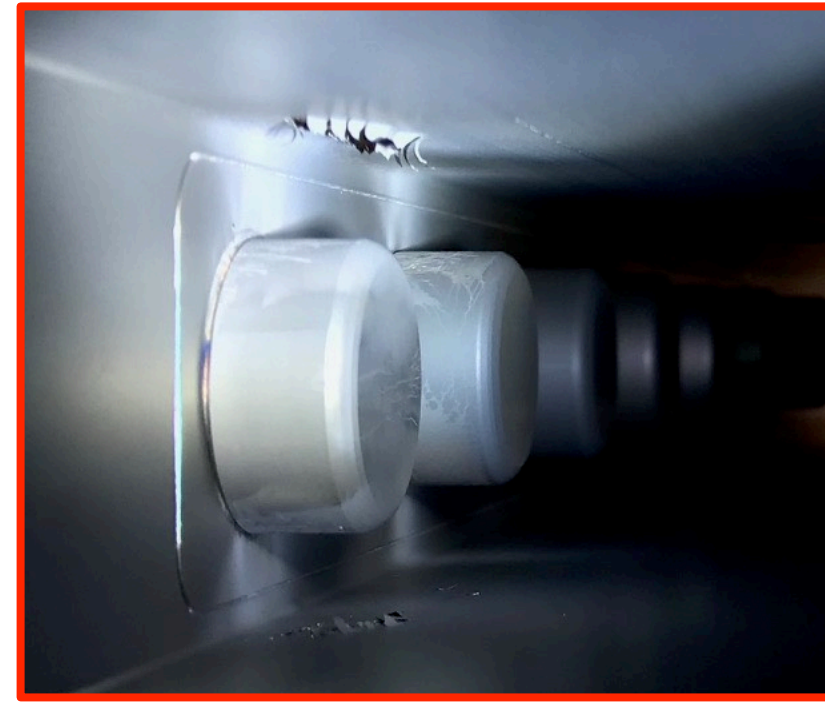


Currently available peak output power of 150 MW in the beam-accelerating unit of 44-B

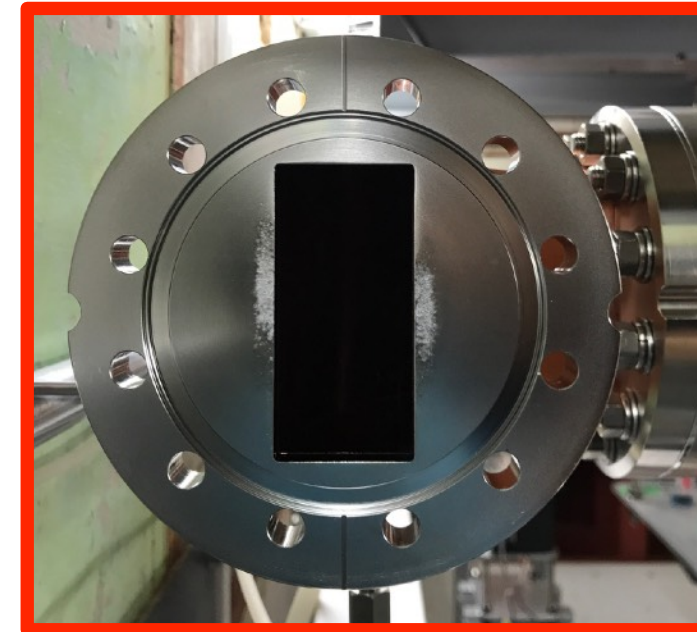
Remaining issues to be overcome

Over-time deteriorations of high-power components

Bursts of RF absorbers in dummy loads

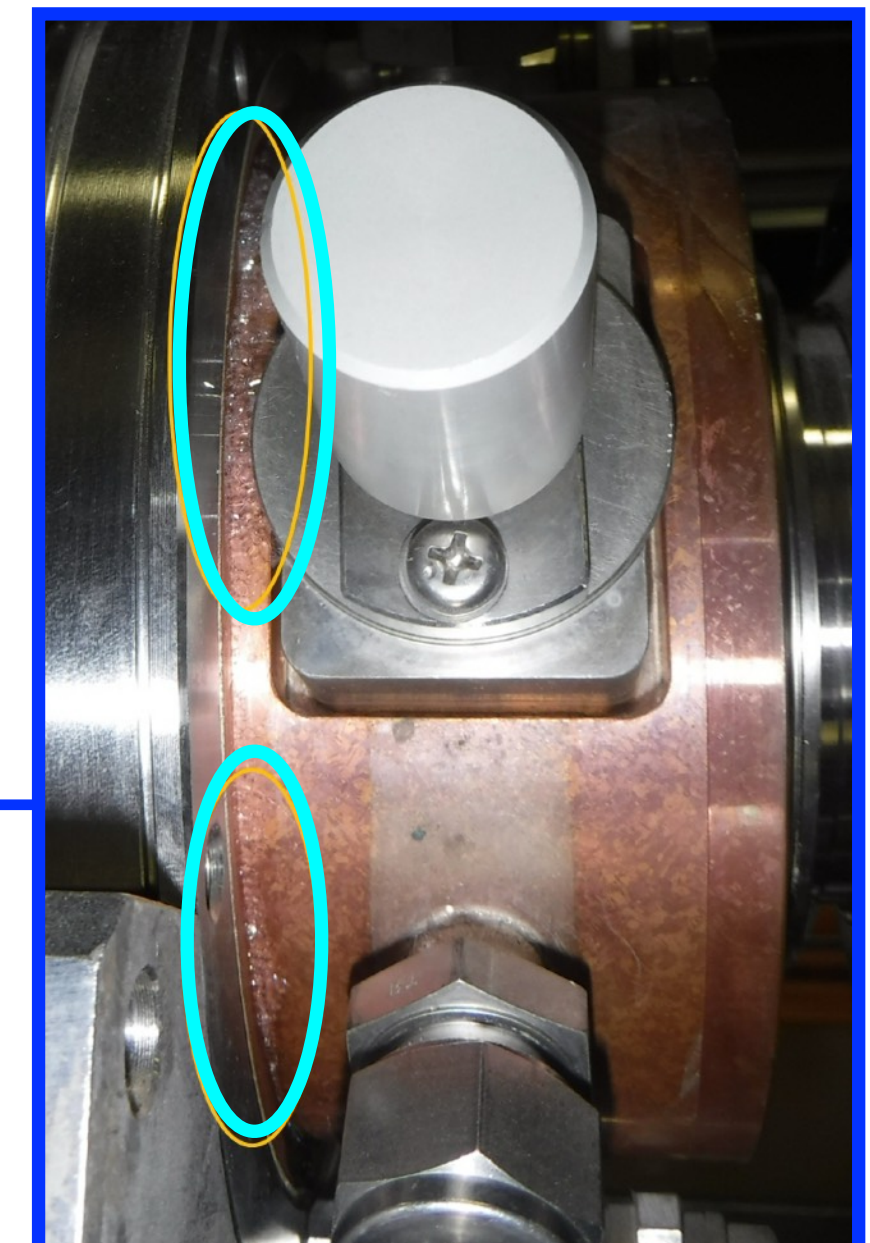
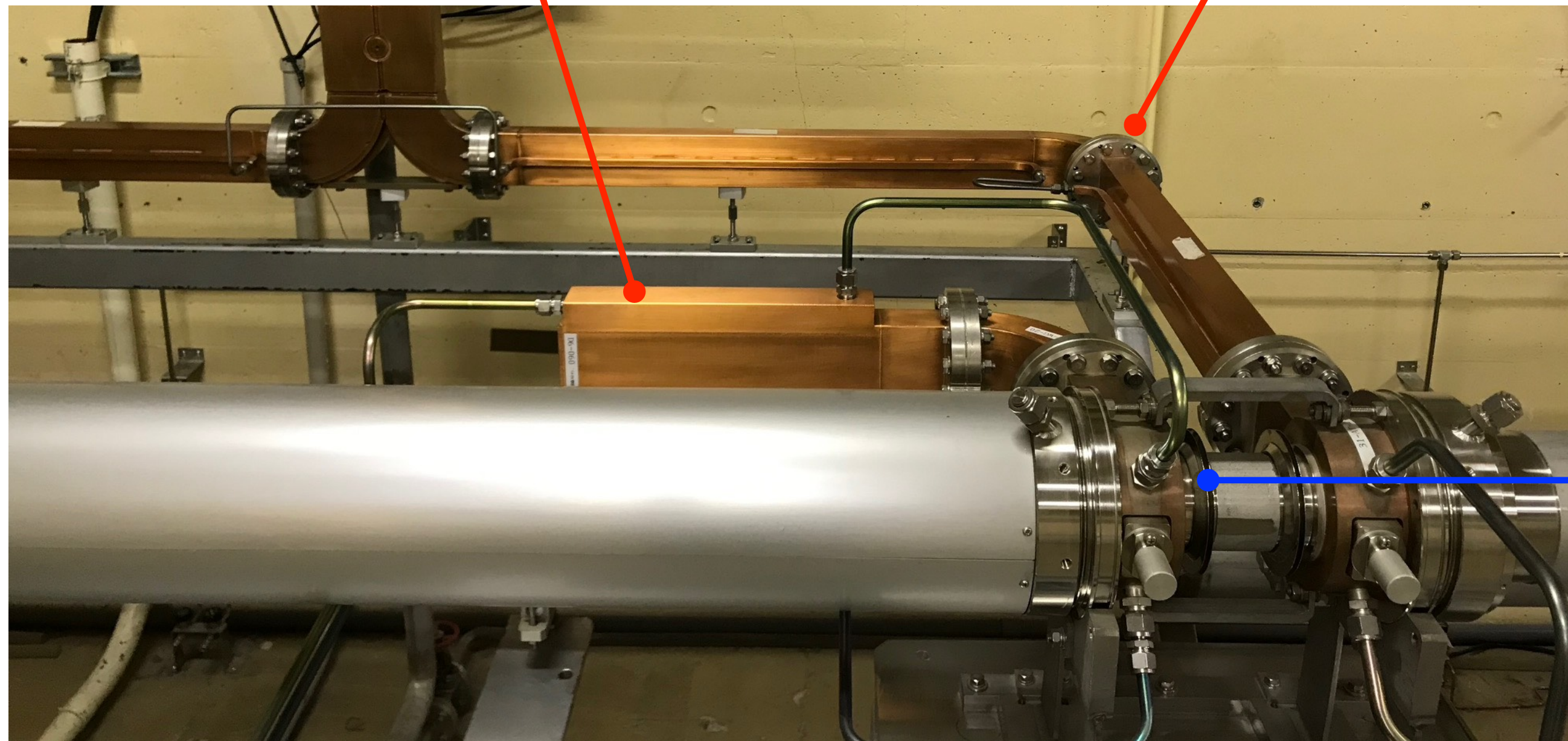


Discharges on waveguide flanges



Water leakage

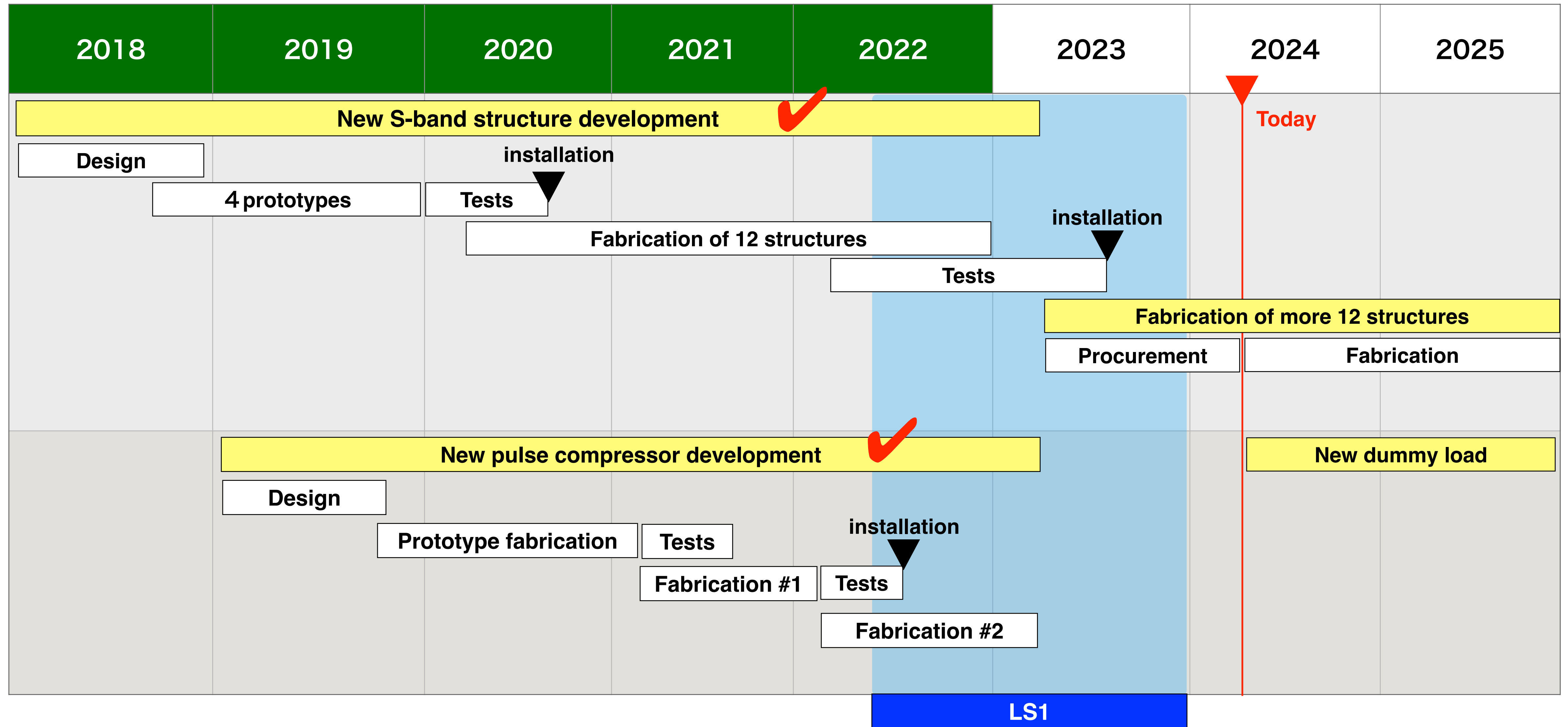
3 structures / year



R&D plan

5-year upgrade plan completed

New 3-year plan



Summary

- **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