

CEPC Klystron Development

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◆ R&D status

- 1st klystron prototype
- High efficiency klystron(2nd klystron)
- MBK(Multi-beam klystron)

◆ Future plan

1st klystron prototype

Milestone

- ◆ Oct. 2017 Design report
- ◆ May. 2018 Mechanical design review
- ◆ Oct. 2019 Parts processing
- ◆ Nov. 2019 Baking out
- ◆ Dec. 2019 Delivery to IHEP
- ◆ Mar. 2020 High power test (400kW CW and 800kW pulsed)
- ◆ Sep. 2020 High power test (490kW CW)

Parts processing



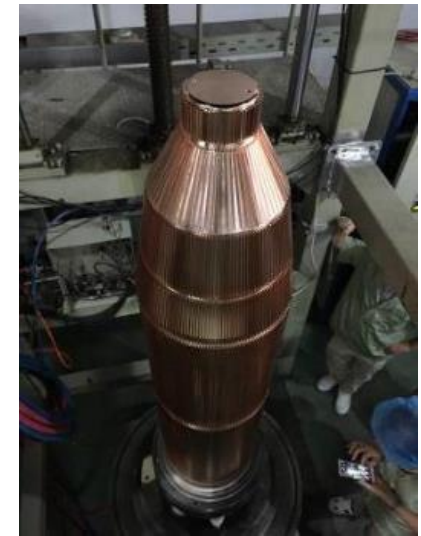
Cavity part



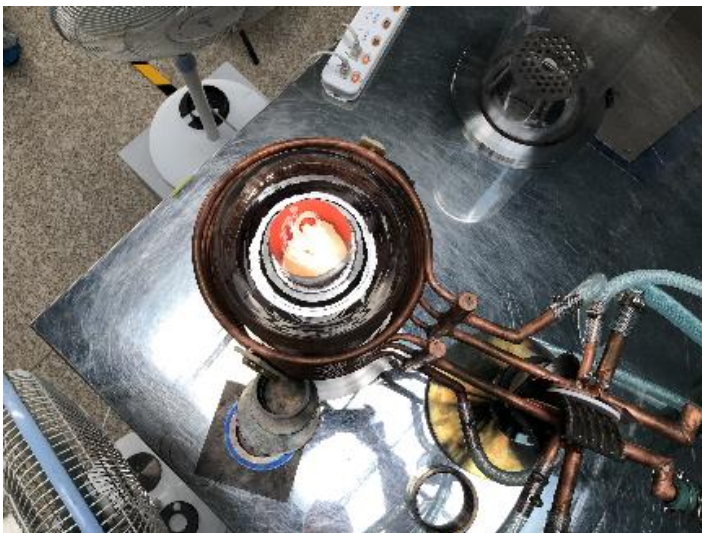
Cavity



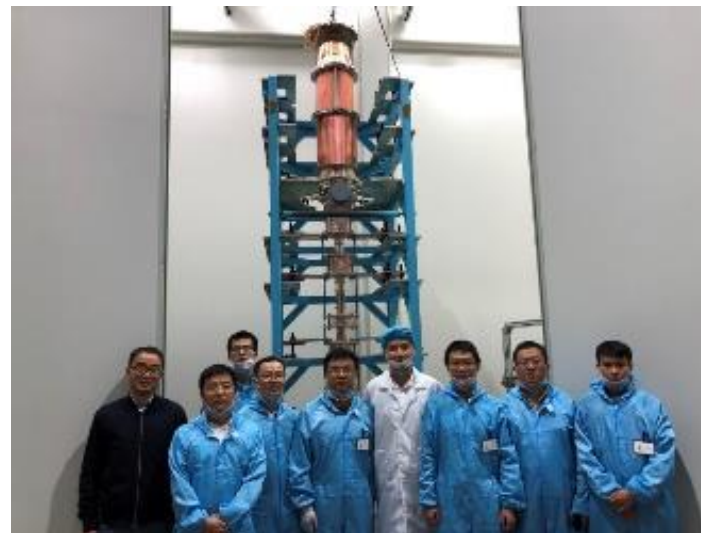
Cold test



Collector brazing



Gun processing



Vacuum Assy assembly

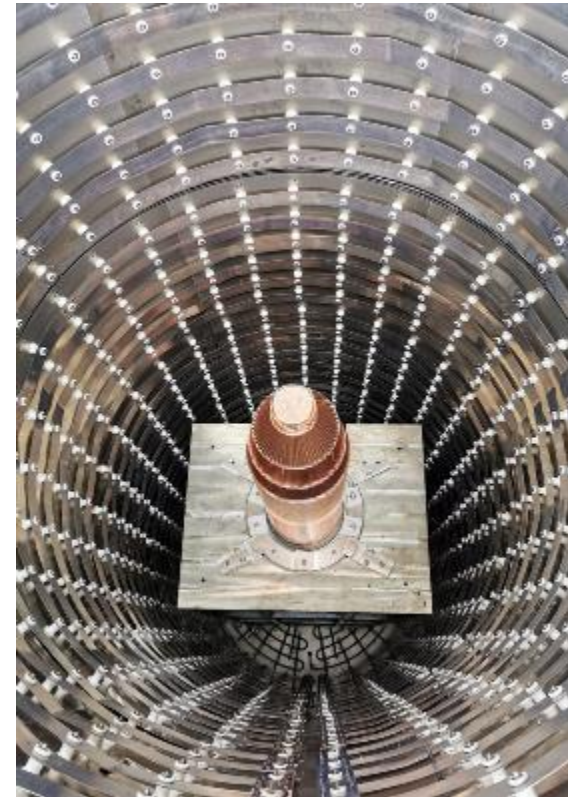


Coil&Gird

Baking out



Prototype installation



Top view

Delivery to IHEP



Before delivery



Packing



Loading



Arrived IHEP



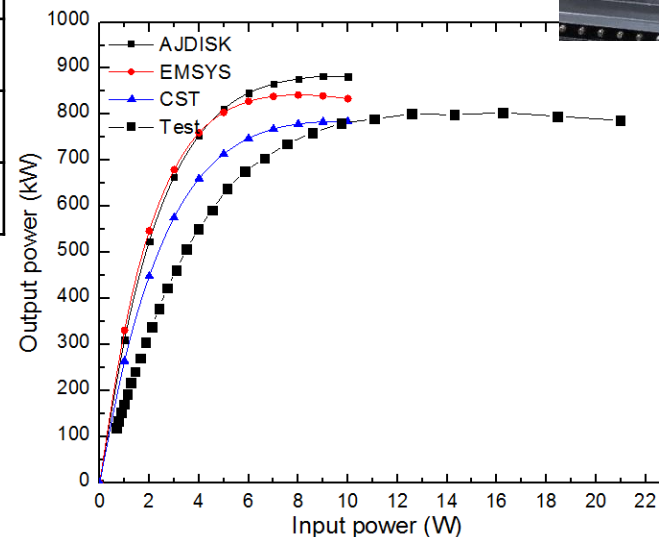
In place at test stand

High power test status

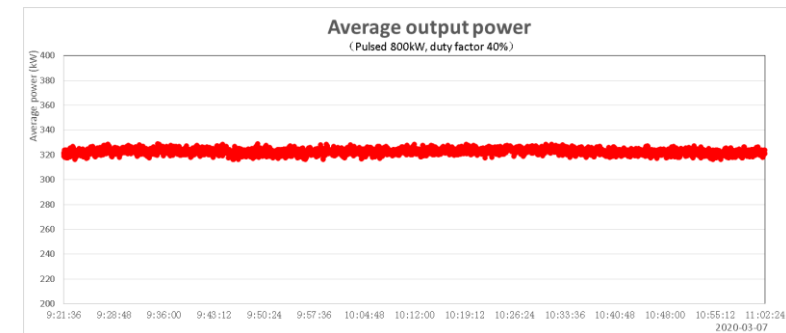
◆Phase I:

◆400 kW CW test and 800kW pulsed conditioning from Jan.3-Mar.9 2020

Parameters	Design	Test
Operating frequency (MHz)	650	650
Beam Voltage (kV)	81.5	80
Beam Perveance ($\mu\text{A}/\text{V}^{3/2}$)	0.65	0.7
Efficiency(%)	65	62
Saturation Gain(dB)	≥ 45	47
Output power(kW)	800	800
1 dB Bandwidth(MHz)	≥ 1	1.8



High power test stand



Pulsed 800kW⁸

High power test status

◆Phase II:

- a) Phase II test is started from Aug. 24 2020, CW power is up to 490kW on Sep.1 2020.



Cold test for waveguide system



Test stand



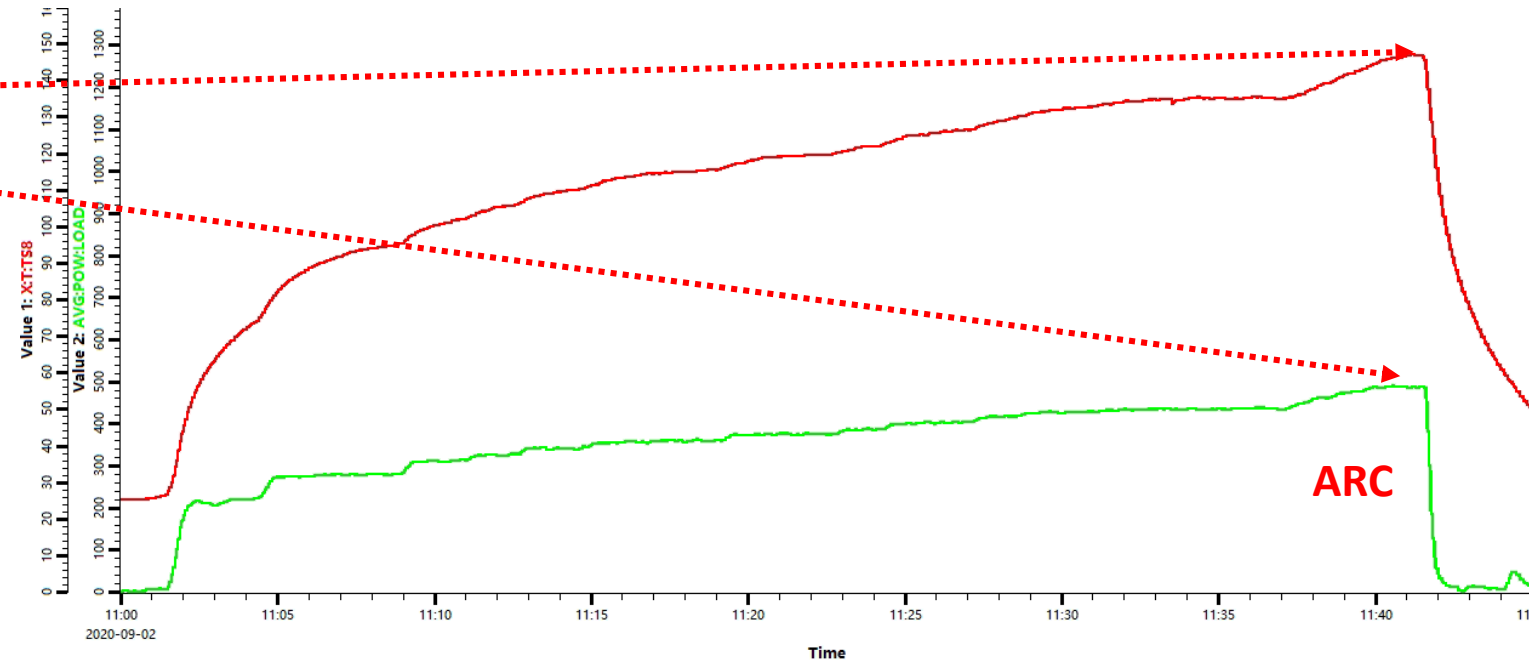
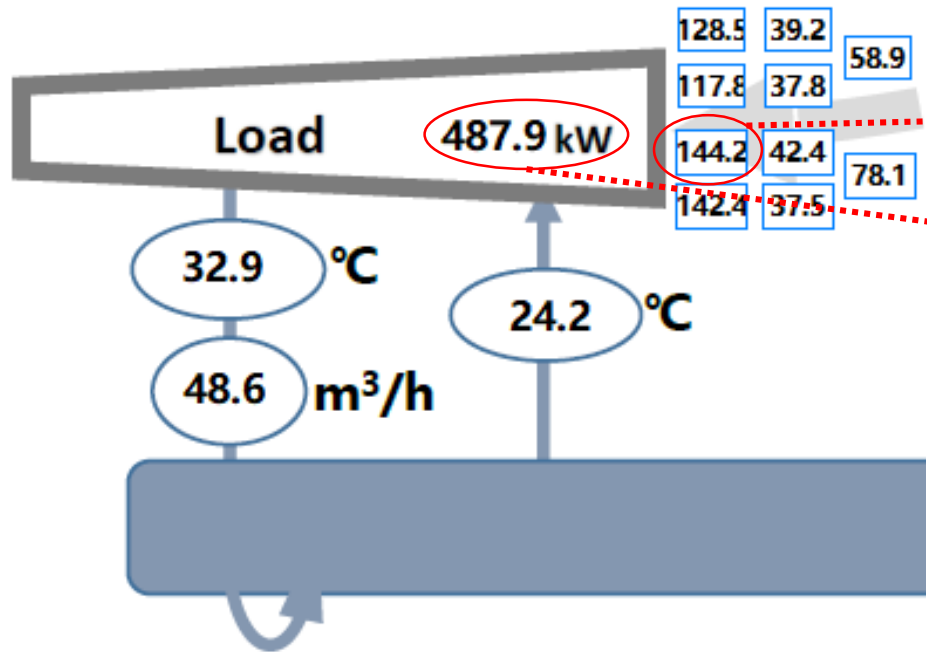
800kW Load

High power test status

◆Phase II:

b) Arc happened on load at CW 490kW On Sep.2 2020

- 1) Temp. at load end is more than **140** degree C.
- 2) **Arc** happened on 2 load branches.
- 3) The RF conditioning is stopped on Sep.2 morning.



High power test status

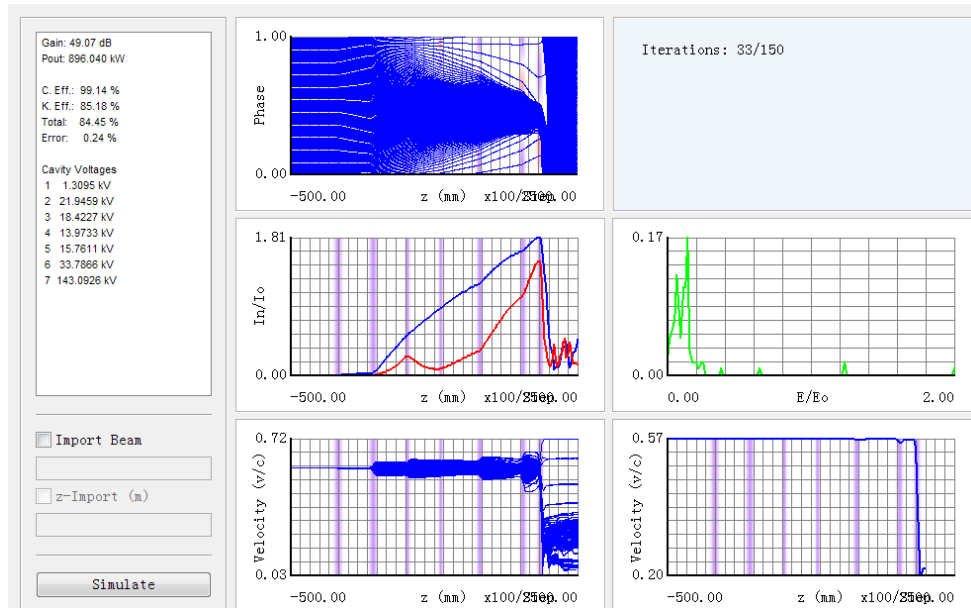
◆Phase II:

c) 400kW and 800kW are both send back Germany for repair on Sep.18 2020.

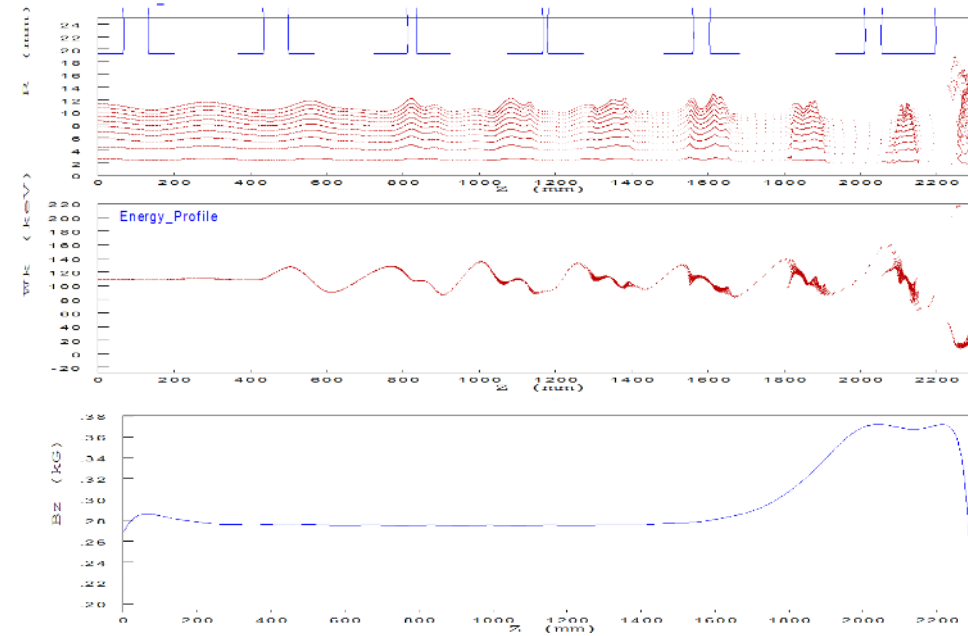


High efficiency klystron (2nd klystron)

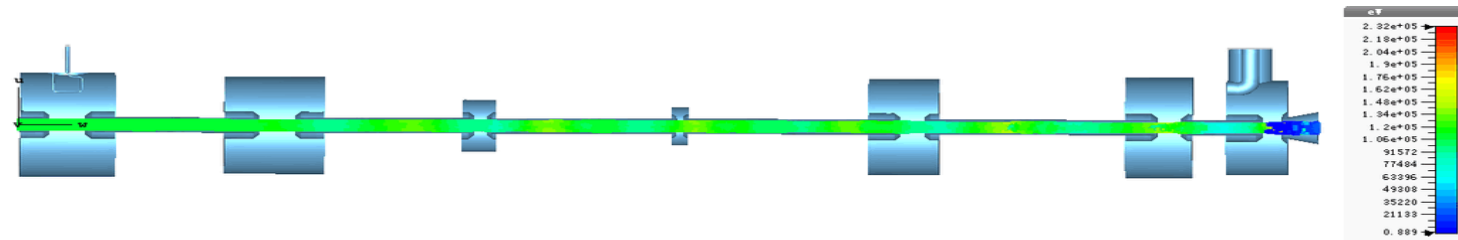
High efficiency design (final)



AJDISK(1D) EFF: 84.5%



EMSYS(2.5D) EFF: 79.3%



CST(3D) EFF: 77%

Positions	
Type:	Energy
Max:	232.4e+03
Local max:	171.2e+03
Sample:	1/40
Time [ns]:	998
T_end [ns]:	1000
Particles:	2987906

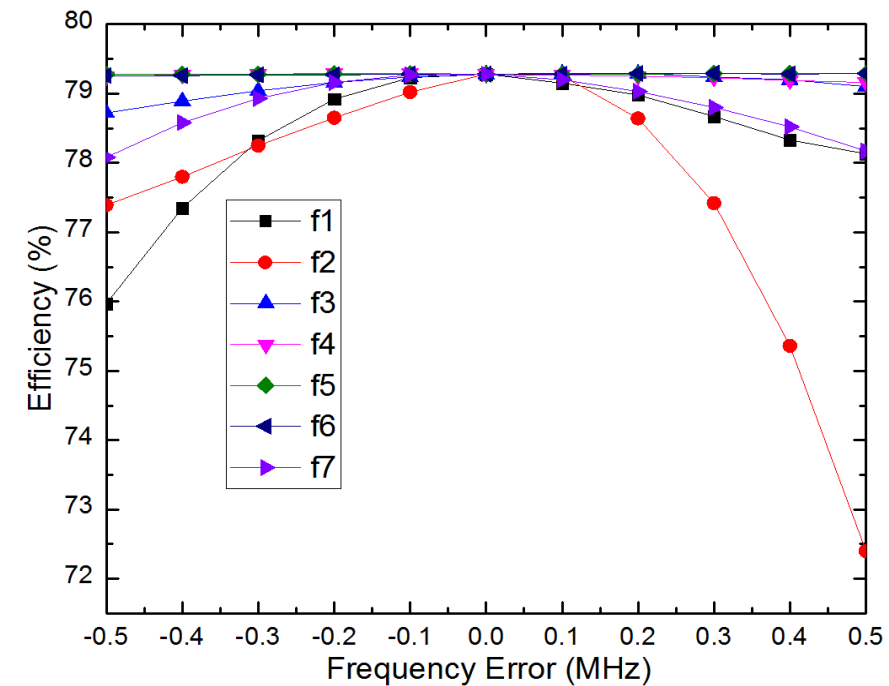
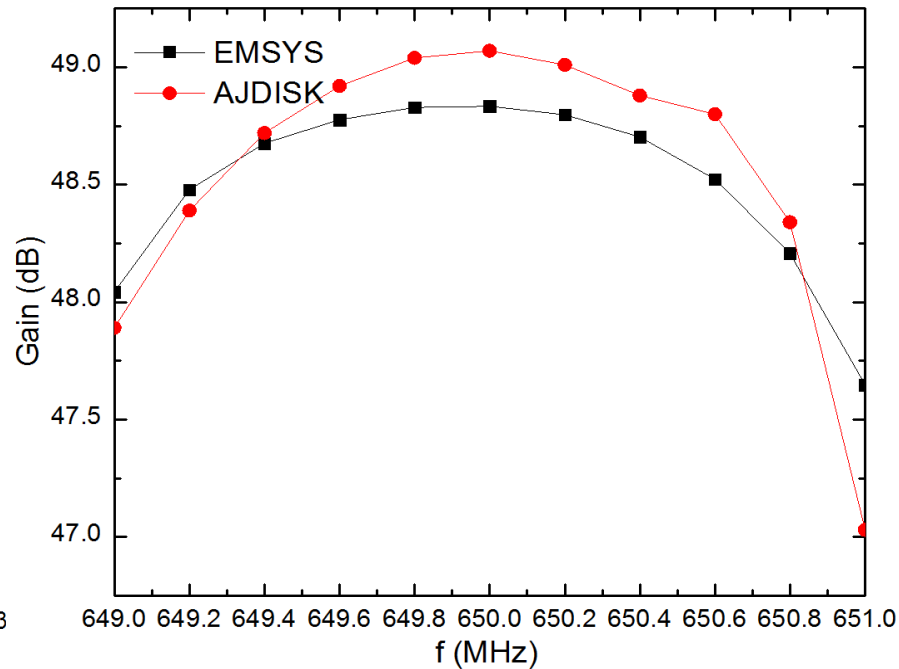
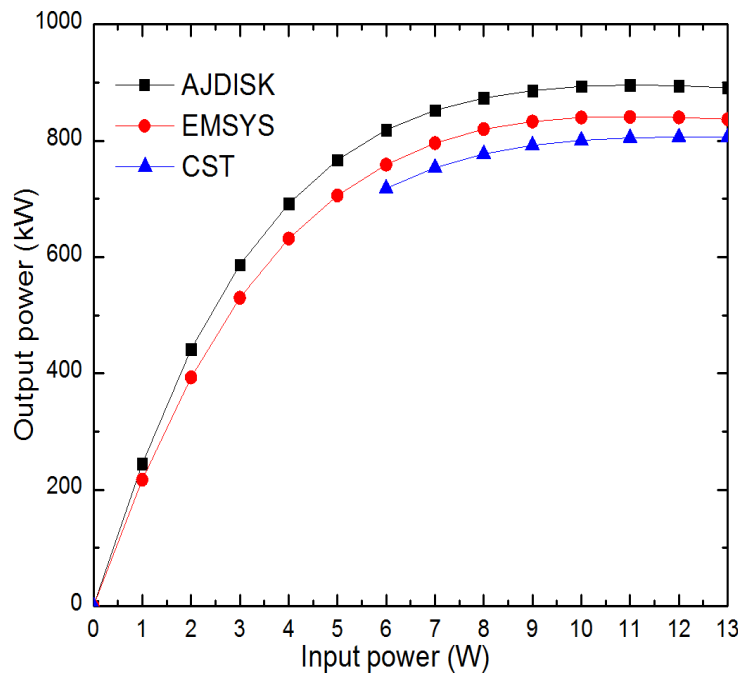


High efficiency design (final)

Gain(3D):48.3dB

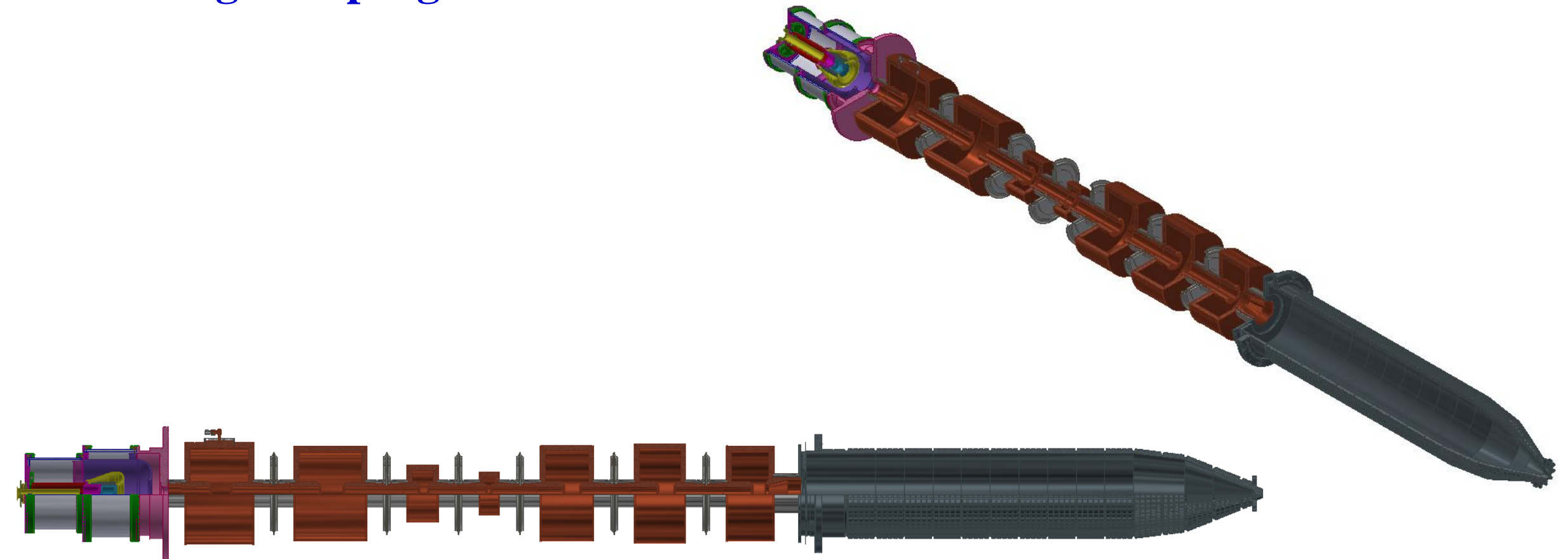
Bandwidth(2.5D): $\geq 0.8\text{MHz}$

Frequency tolerance : f1, f2, f7 $\pm 0.2\text{MHz}$, others $\pm 0.5\text{MHz}$



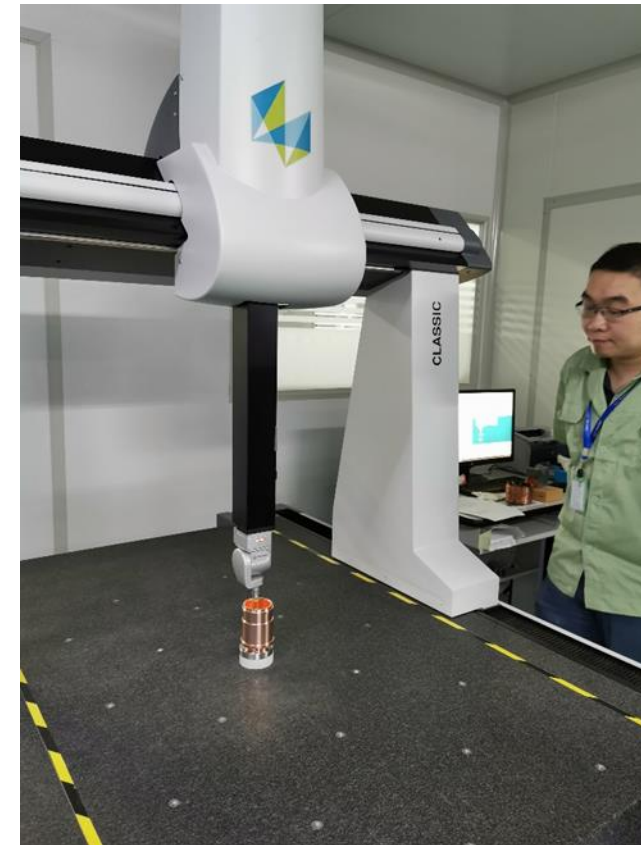
Mechanical design

2) Mechanical drawing of gun part is almost finished and cavity part drawing is in progress.



Mechanical design

3) Cavity research assembly experiments are being well done at collaboration company.

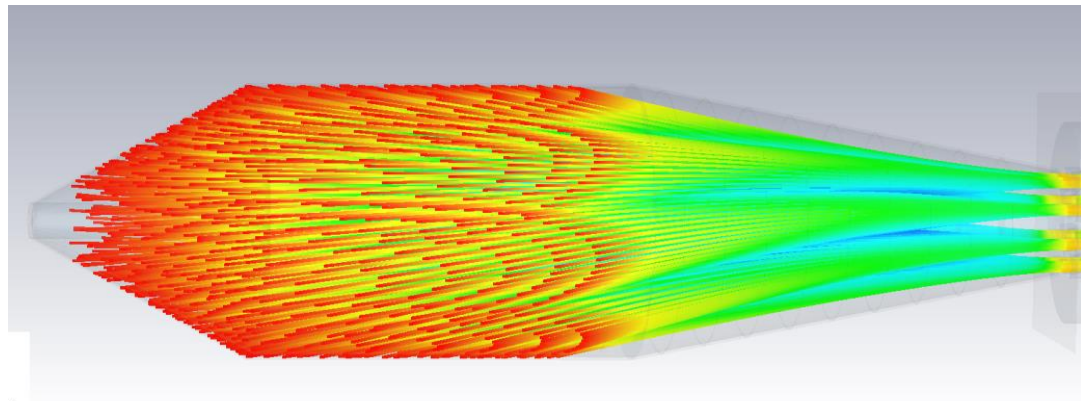
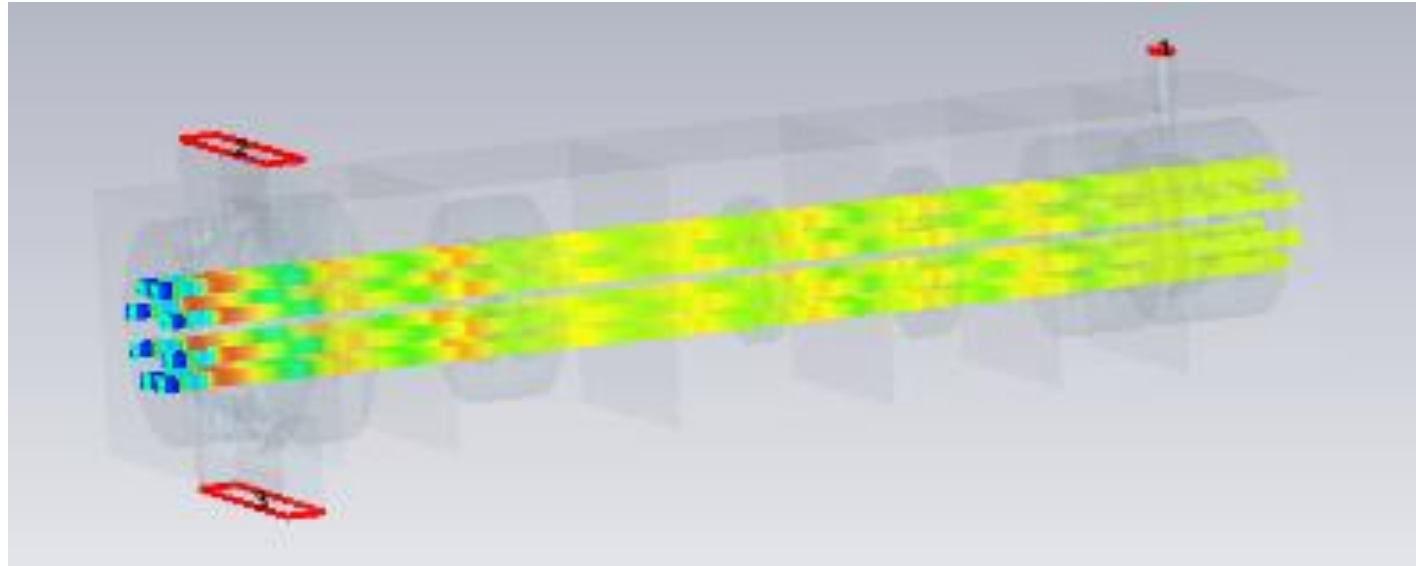


Multi-beam klystron

Multi-beam klystron

1) Design Parameters

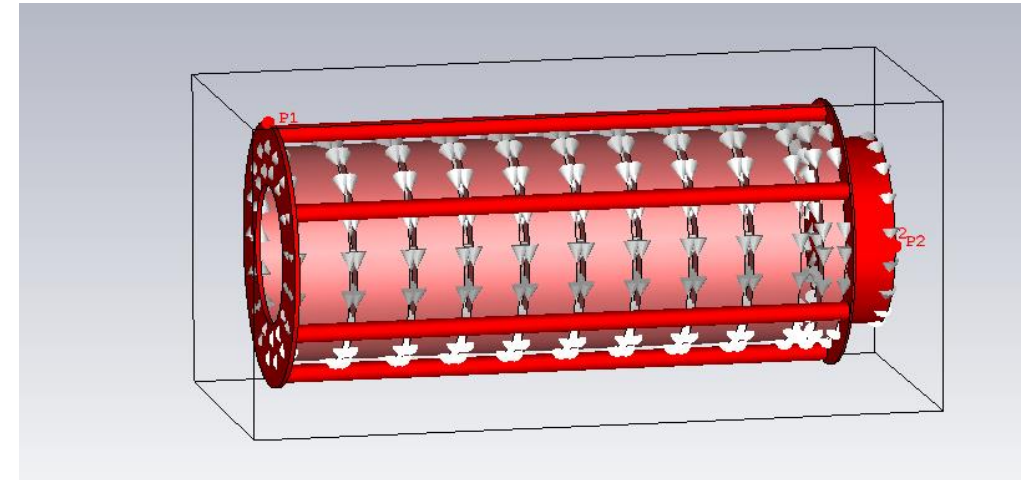
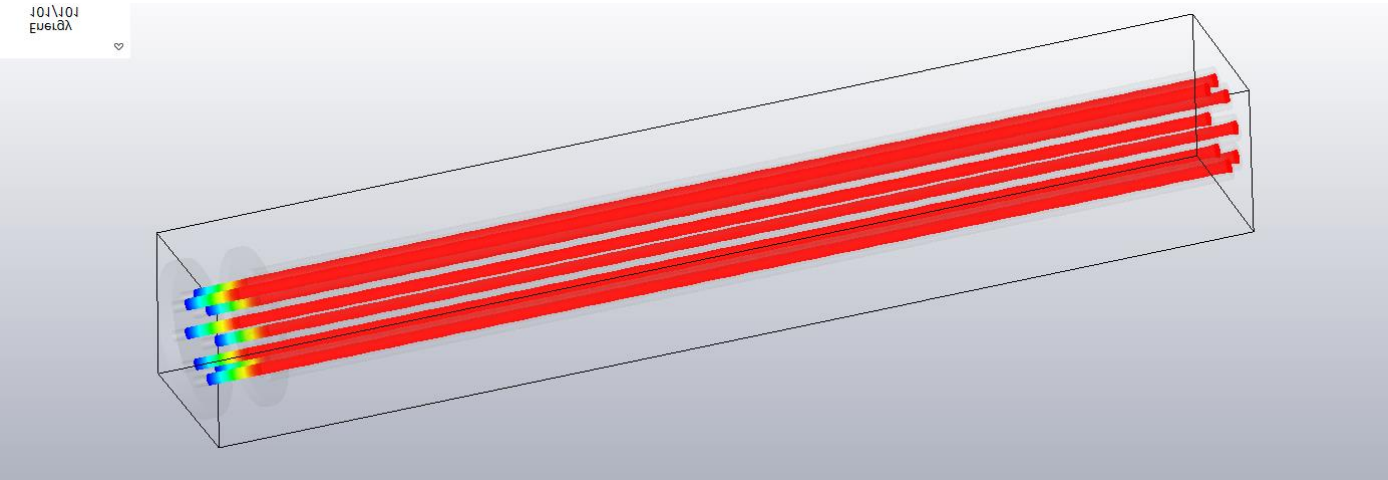
Parameters	Unit	Value
Gun Voltage	kV	54
Beam number		8
Beam perveance	μP	0.2
Output power	kW	800
1dB bandwidth (3-D simulation)	MHz	± 0.75
Efficiency(3-D simulation)	%	80.5



The major parts of MBK design are finished, including the interactive cavity, electron gun, focusing solenoid, window and collector.

Multi-beam klystron

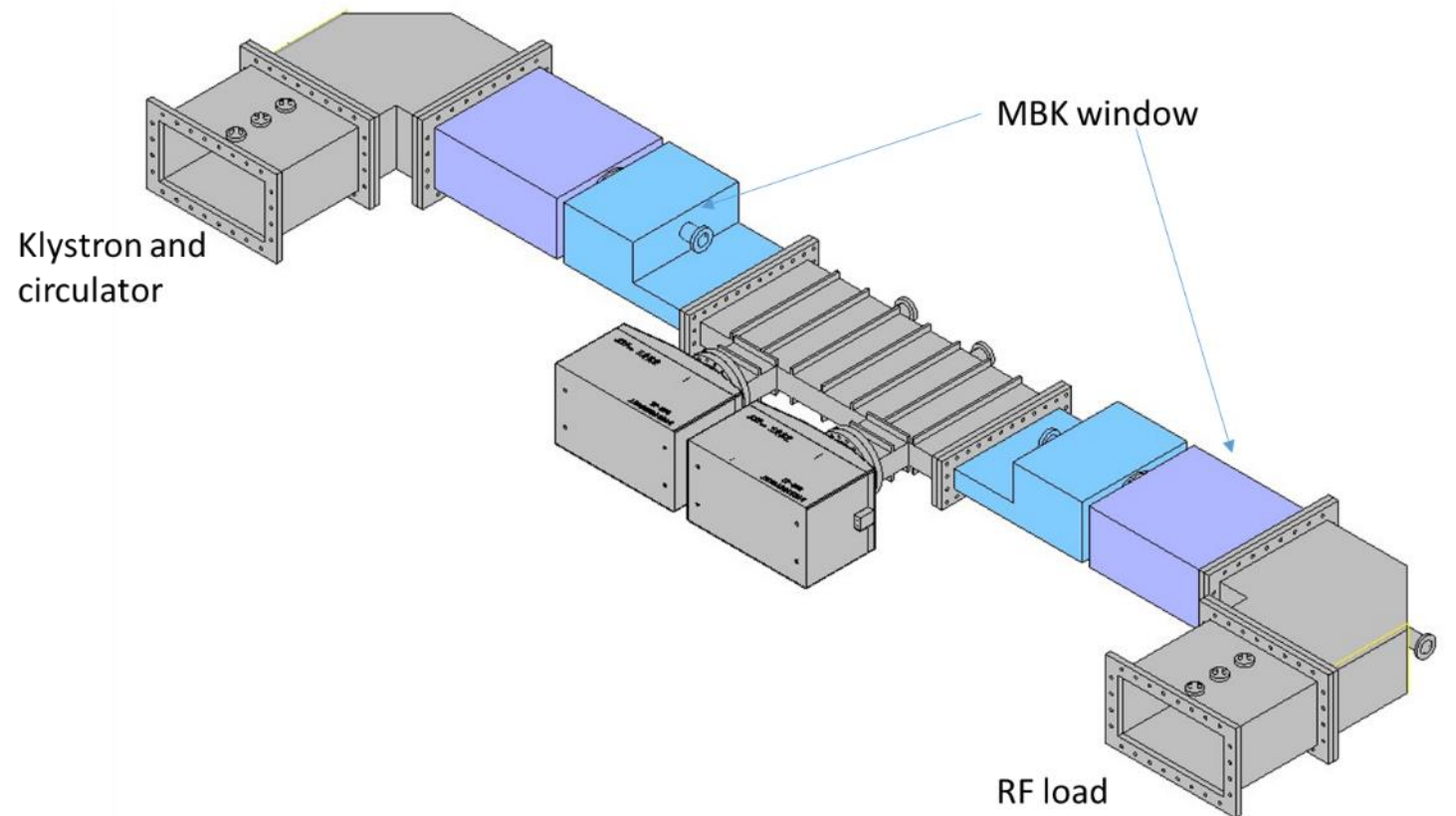
2) Design of electron gun and focusing solenoid is finished. Adopting flat-surface cathodes with diameter of 20mm.



MBK solenoid and electron gun design

Multi-beam klystron

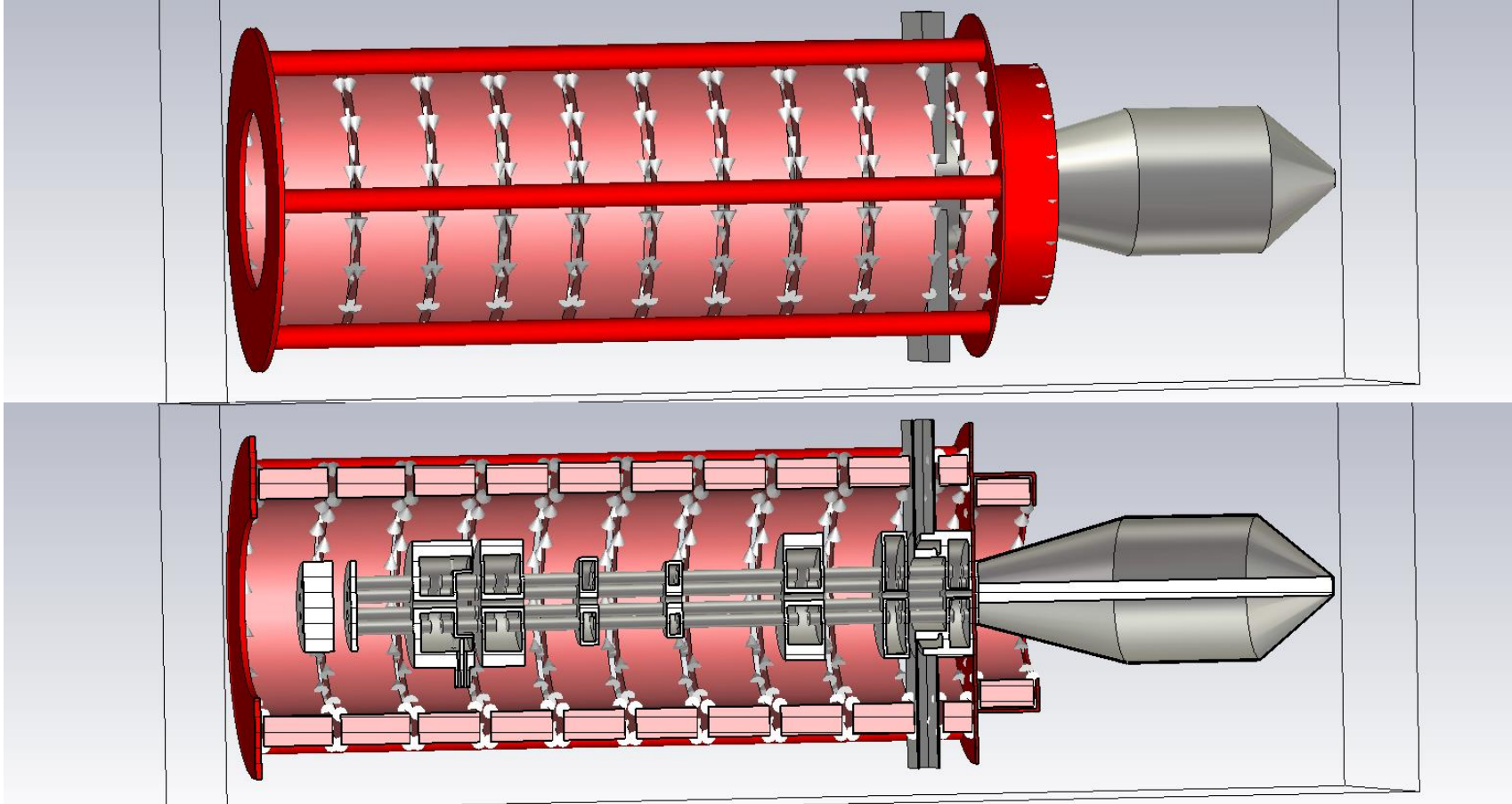
3) Design of MBK window prototype is finished and prototype manufactured is also processing.



Schematic diagram of MBK window test stand

Multi-beam klystron

4) Mechanical design will start soon



MBK physical model

Future plan

- ① We are waiting for 800kW load sent back for 1st klystron prototype high power test (>500kW, 800kW CW?)
- ② Take efforts to push manufacture of 2nd klystron.
- ③ Complete design of MBK and start mechanical design as soon as possible.

Thanks for your attention!