CEPC 650MHz Klystron Status

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Outline

◆**1st prototype tube**

- Phase 1 test is completed
- Phase 2 test conditioning preparation

◆**High efficiency design**

- High voltage klystron
- Multi-beam klystron

◆**2nd prototype tube and key components R&D**

- Mechanical design & process design status
- Window design consideration

◆**Future plan**

1st prototype tube

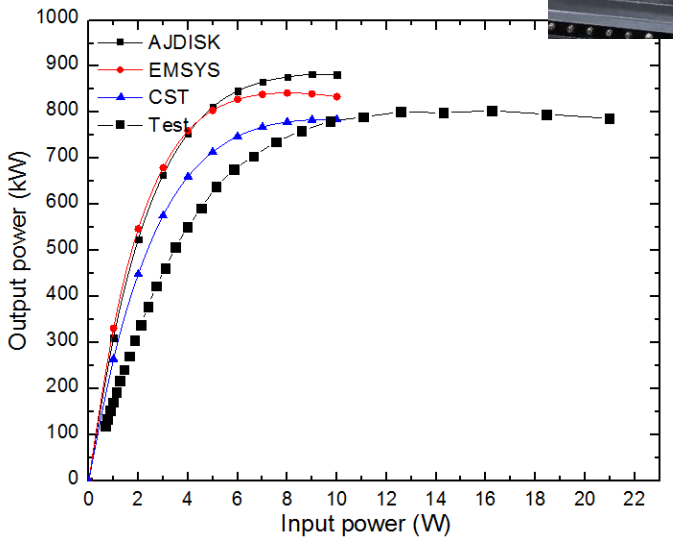
Phase 1 test

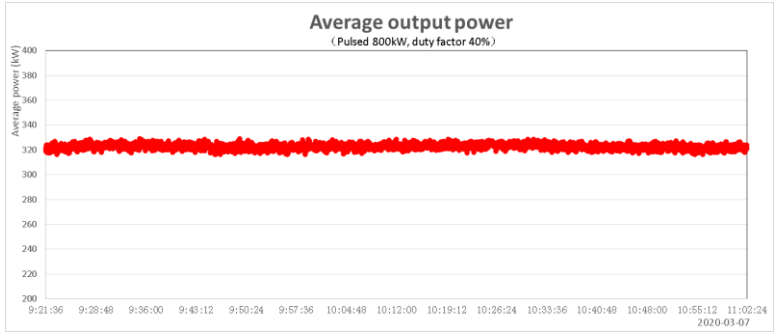
◆Jan.3-Mar.9 2020

400 kW CW test and 800kW pulsed conditioning @40% duty factor

Parameters	Design	Test
Operating frequency (MHz)	650	650
Beam Voltage (kV)	81.5	80
Beam Perveance ($\mu A/V^{3/2}$)	0.65	0.7
Efficiency	≥60%	62
Saturation Gain(dB)	≥45	47
Output power(kW)	800	800
1 dB Bandwidth(MHz)	≥1	1.8

High power test stand





Pulsed 800kW

Phase 2 test condition preparation

◆New 800kW load

New load is arrived and complete cold test this week.

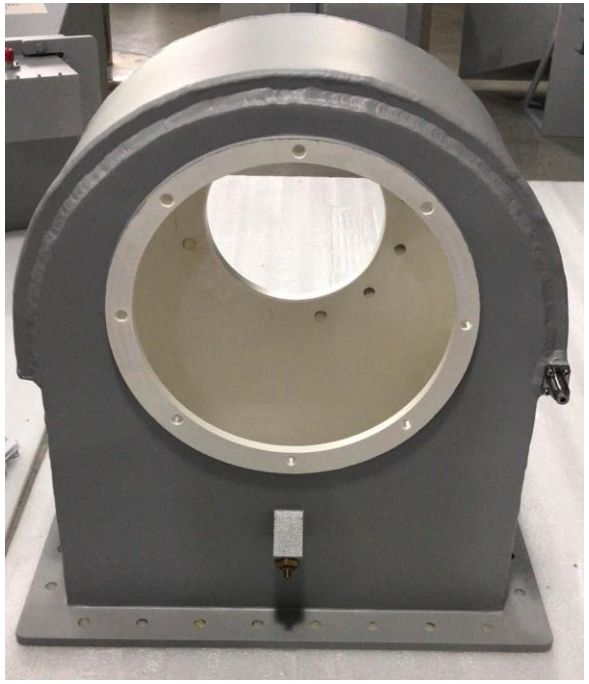
Phase 2 test condition preparation

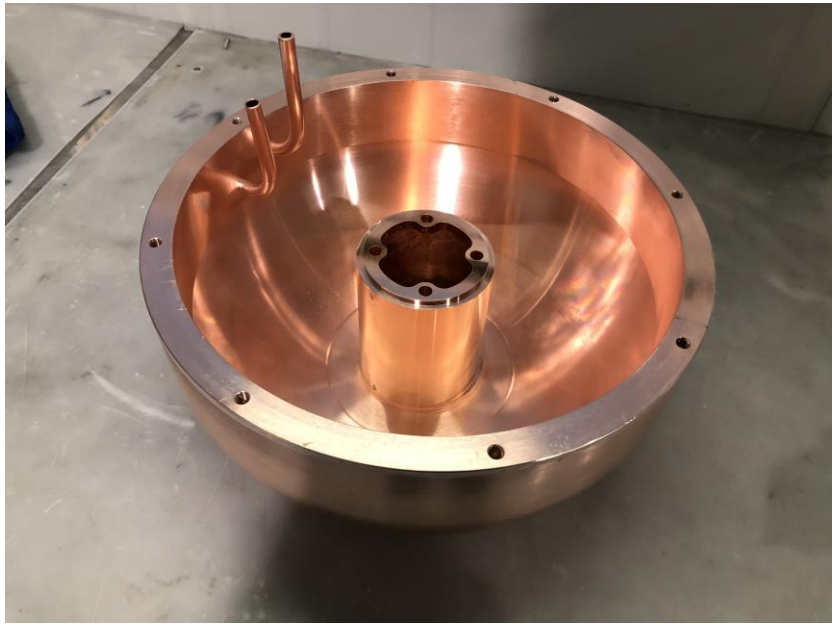
◆New door knob and waveguide system

① Door knob with cooling pipe is ready and waiting for assembly with new waveguide.

② New waveguide will arrived at the end of this month.

③ The full power test will be started next month.

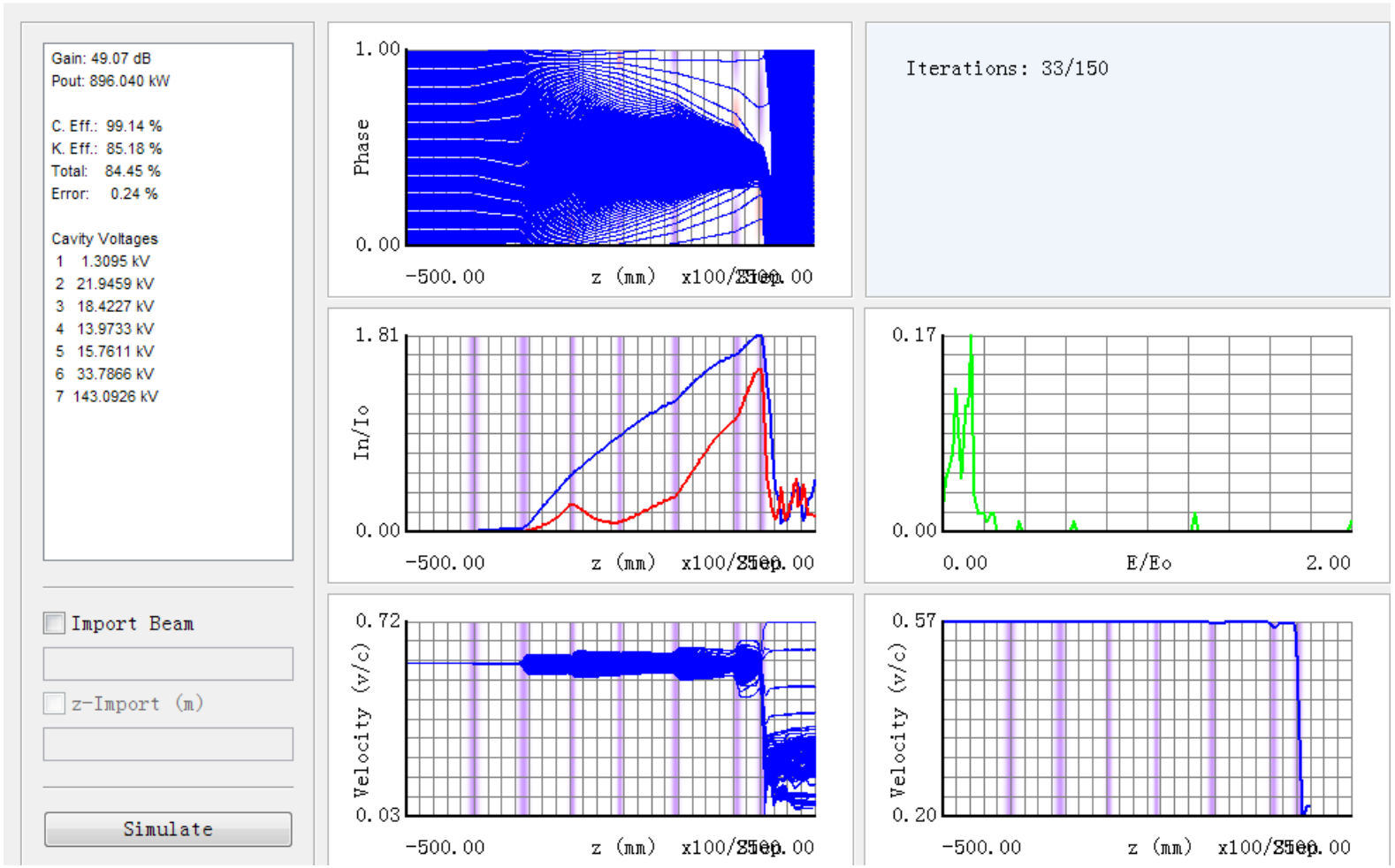




High efficiency design

High voltage klystron (final)

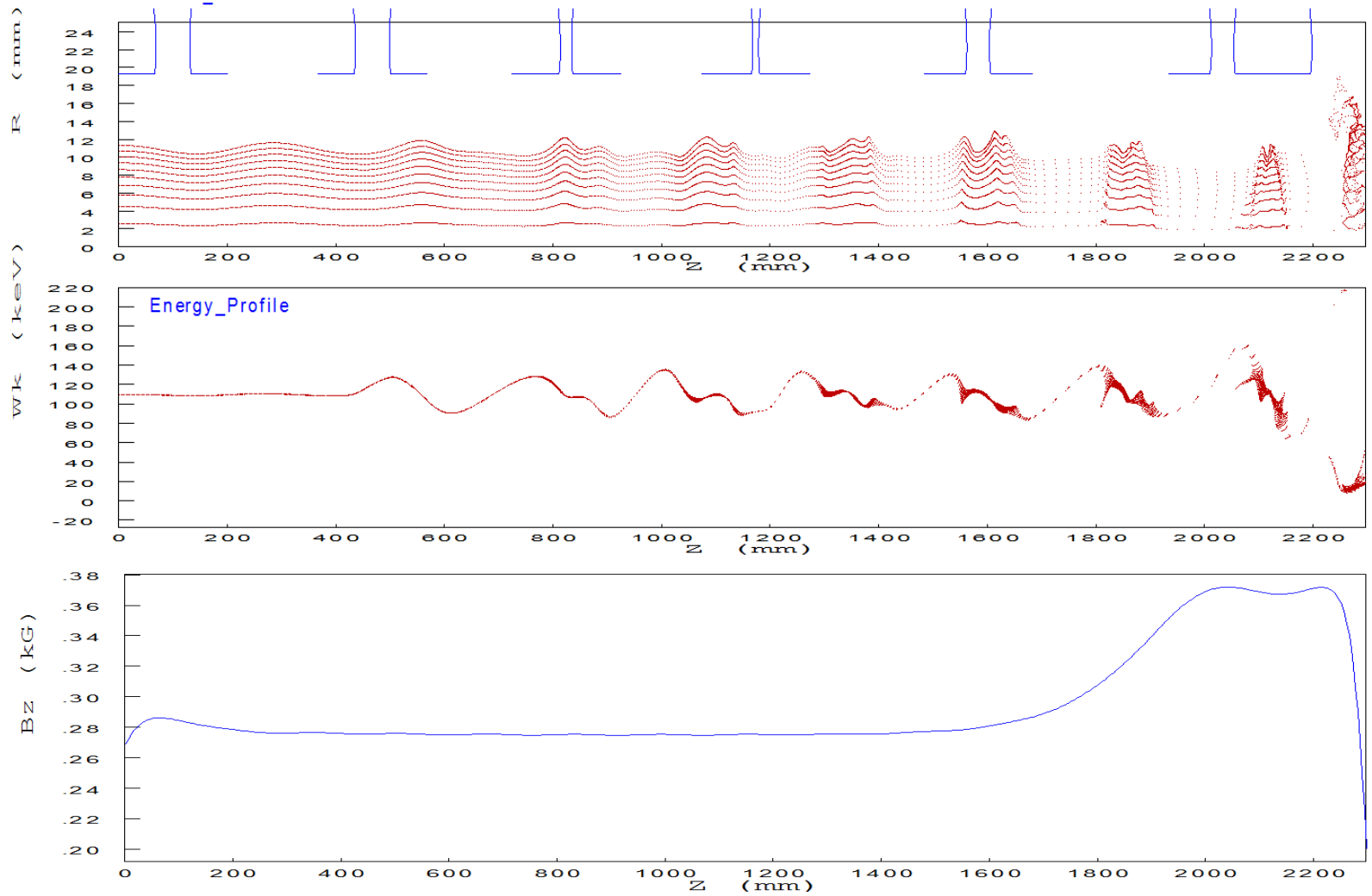
■ *High efficiency design*



AJDISK(1D) EFF: 84.5%

High voltage klystron (final)

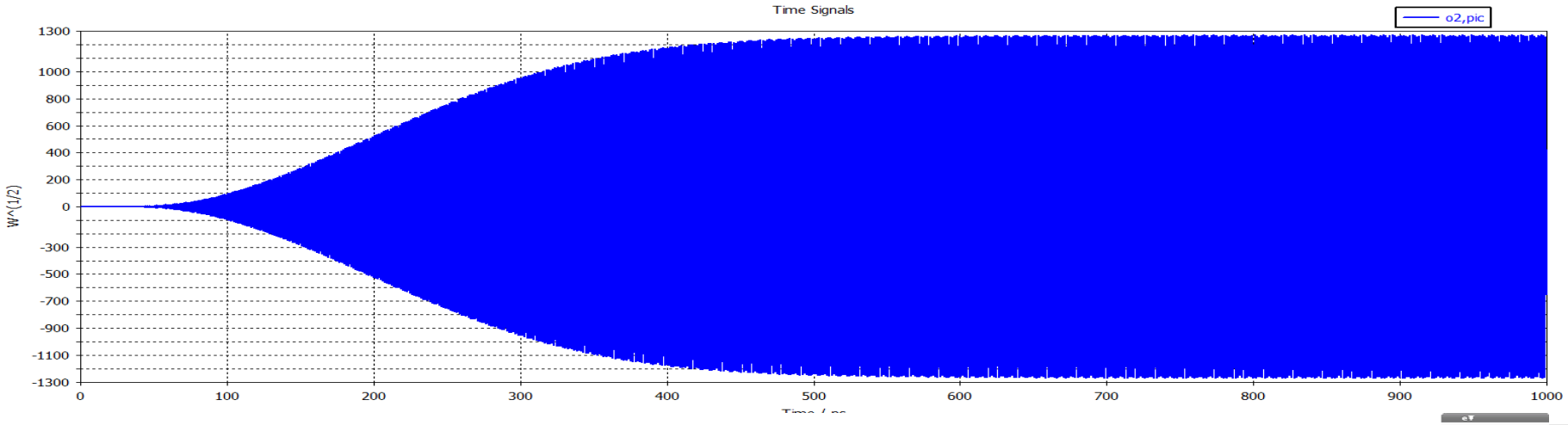
- *High efficiency design*

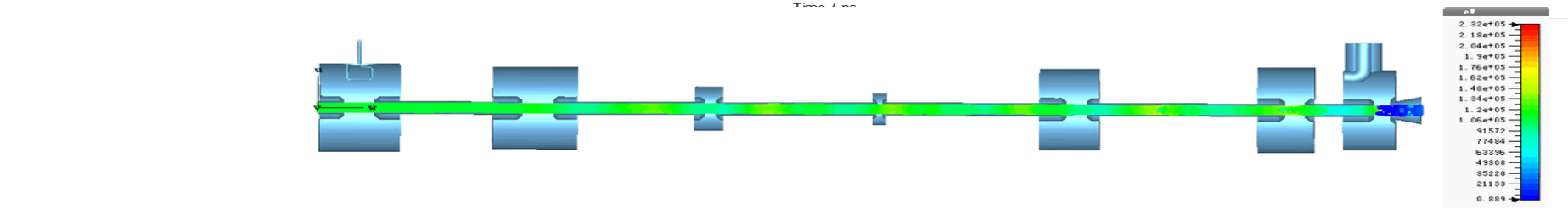


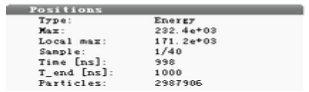
EMSYS(2.5D) EFF: 79.3%

High voltage klystron (final)

- ***High efficiency design*** **Output power:808.3kW(Beam power 1.05MW)**





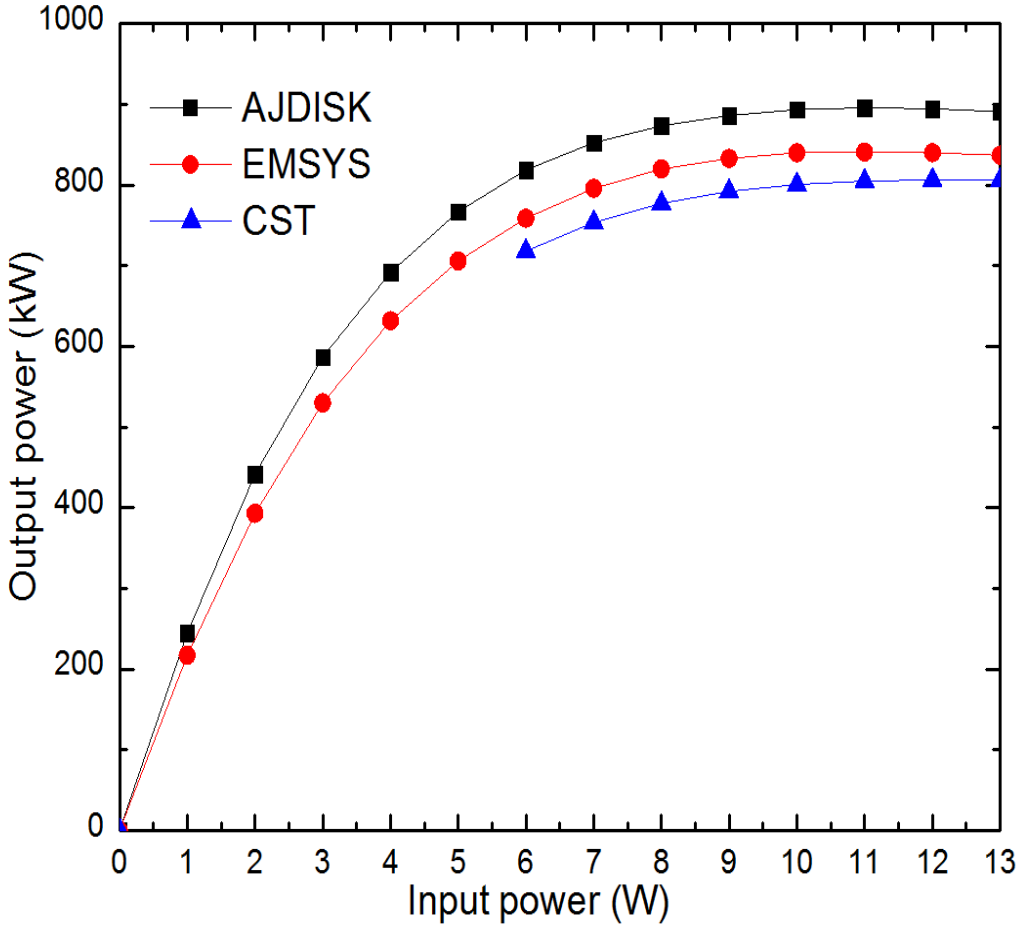


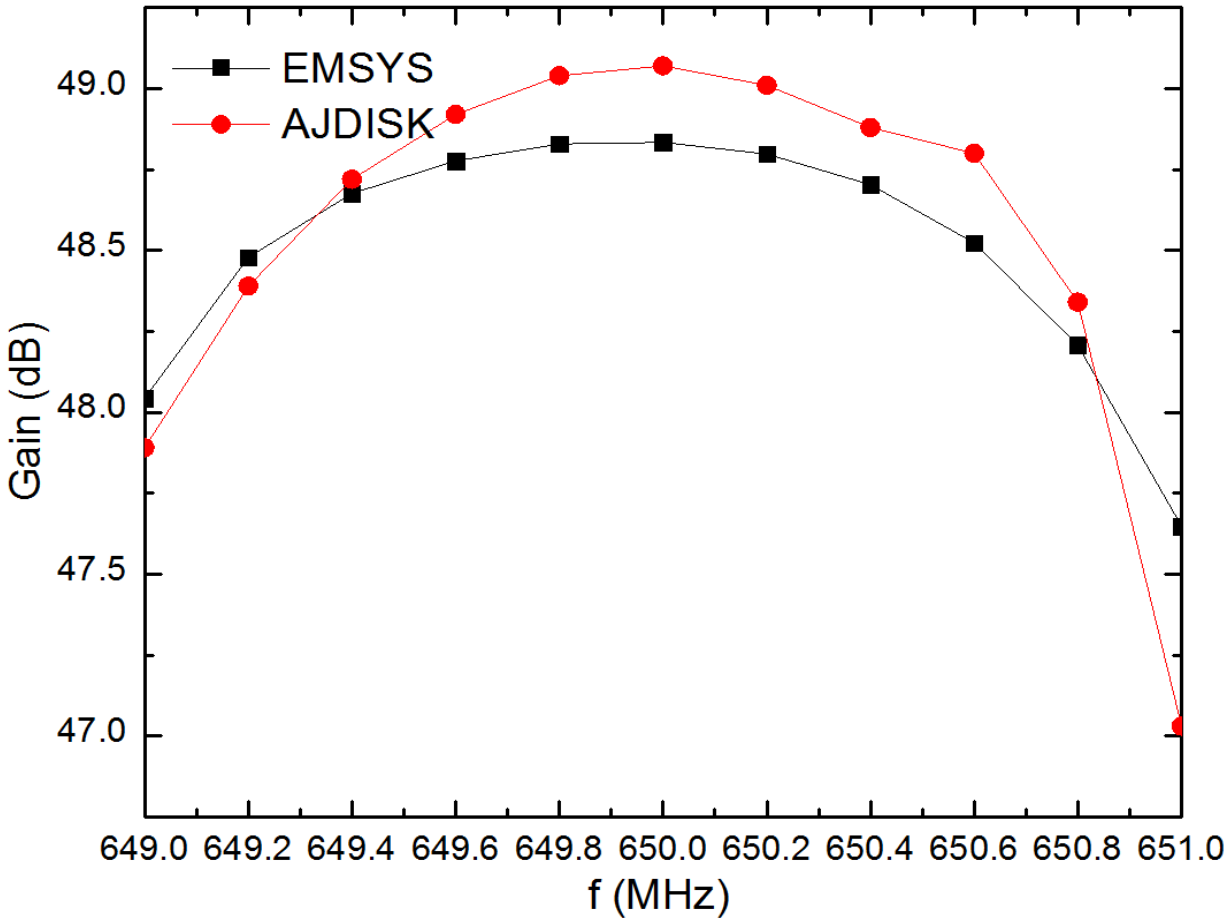
CST(3D) EFF: 77%

High voltage klystron (final)

Transfer curve and bandwidth

Gain(3D):48.3dB Bandwidth(2.5D):≥0.8MHz

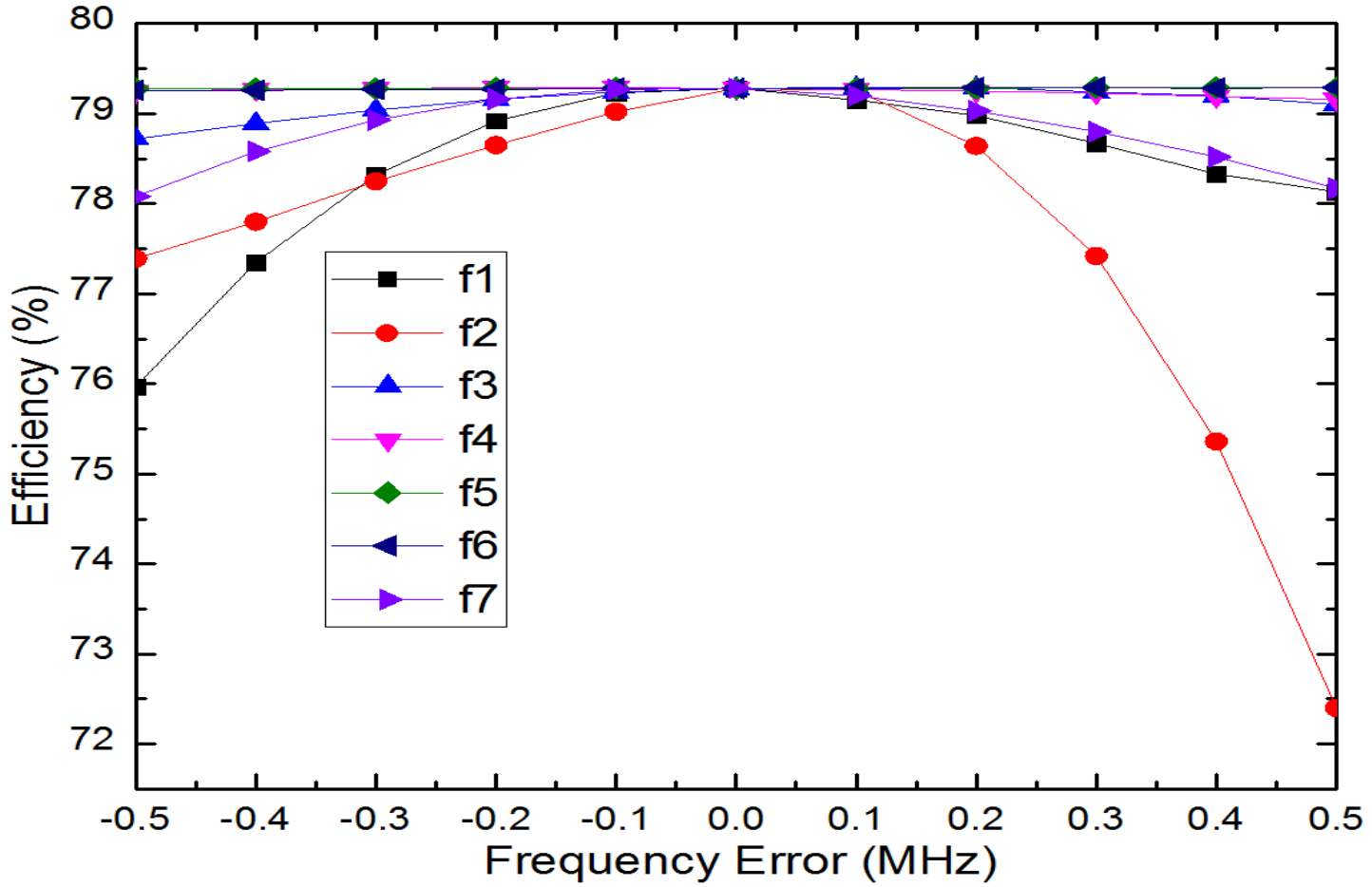




High voltage klystron (final)

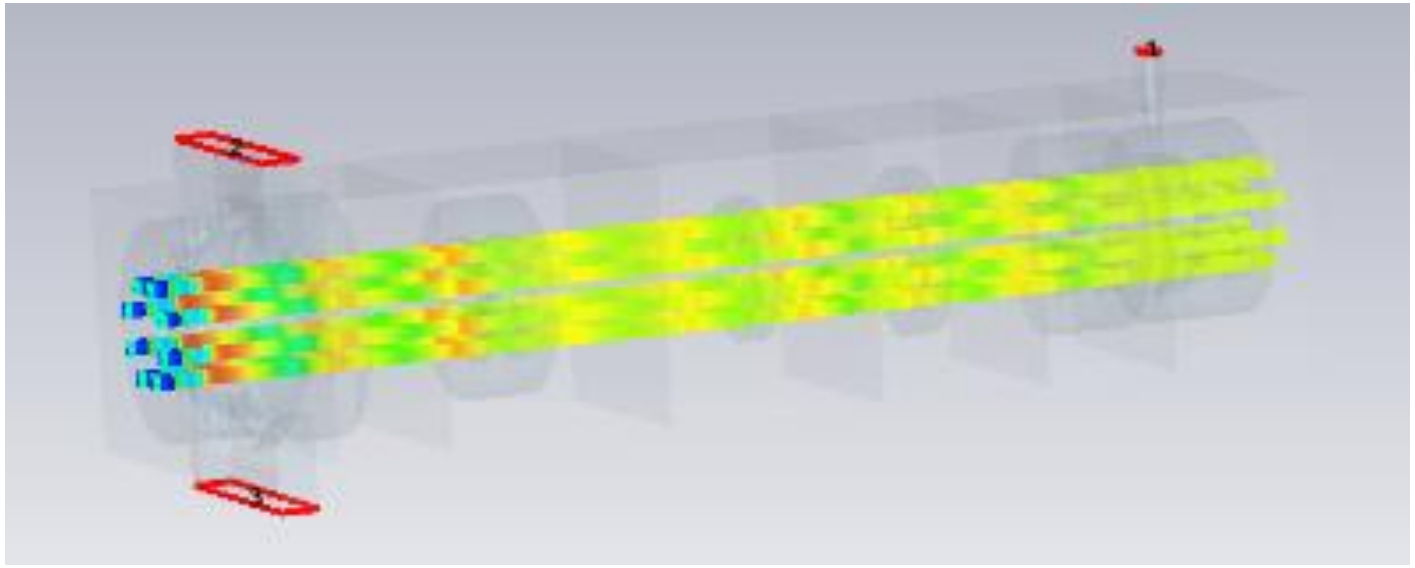
Frequency error analysis

Frequency tolerance : f1, f2, f7 ±0.2MHz, others ±0.5MHz



Multi-beam klystron

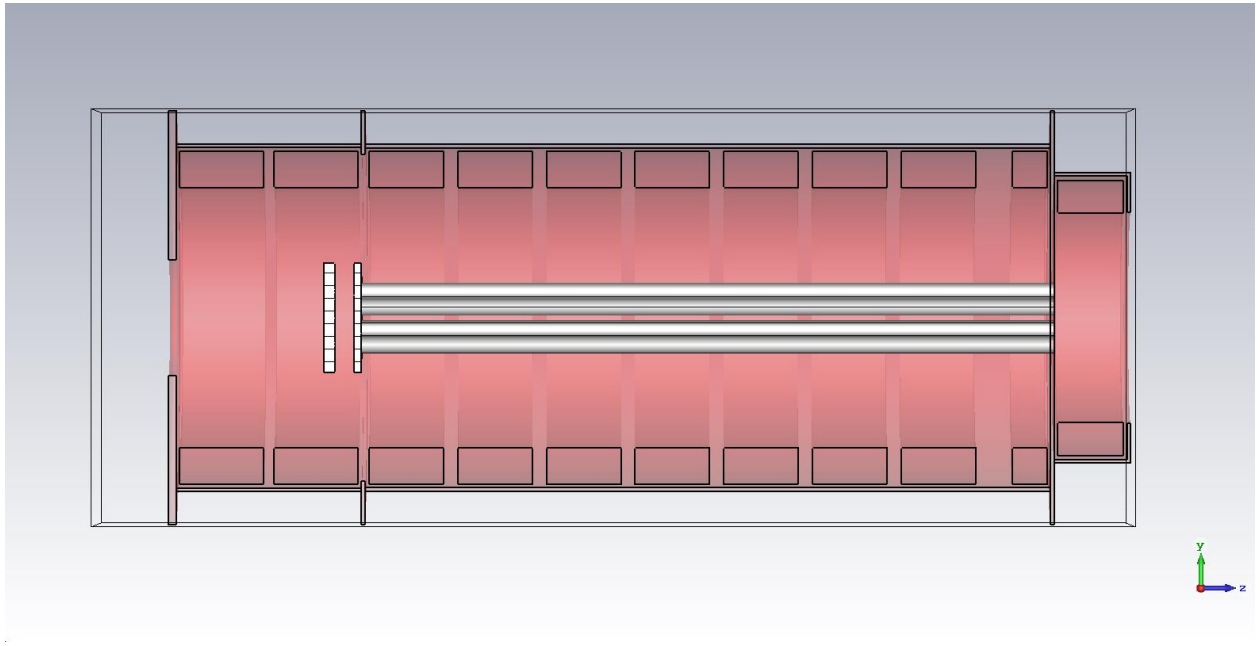
Parameters	Unit	Value
Gun Voltage	kV	54
Beam number		8
Beam perveance	μP	0.2
Output power	kW	875
Gain	dB	44.2
Efficiency(3-D simulation)	%	80.7



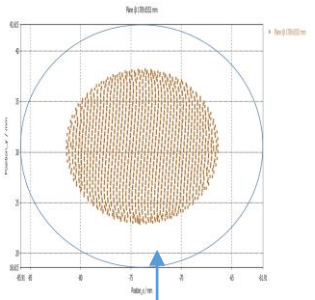
Design title	Status	
MBK beam dynamics	**Goal 1 : output power> 800kW**	**Goal 2 :efficiency >80%**
	Completed	Completed
Design on input and output cavity	Completed	
Gun design and solenoid design	In progress (remaining issue: emission density is too high)	
Design on output window	Completed	
MBK collector	Completed	

Multi-beam klystron

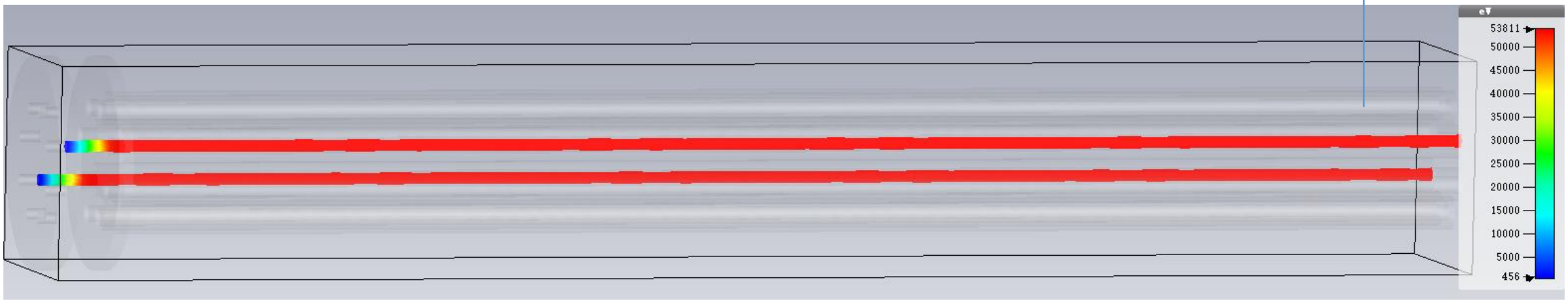
Gun design and solenoid design



Parameters	Value
Beam ripple	Less than 4%
emission density	1.42 A/cm^2, (too high for a CW tube)



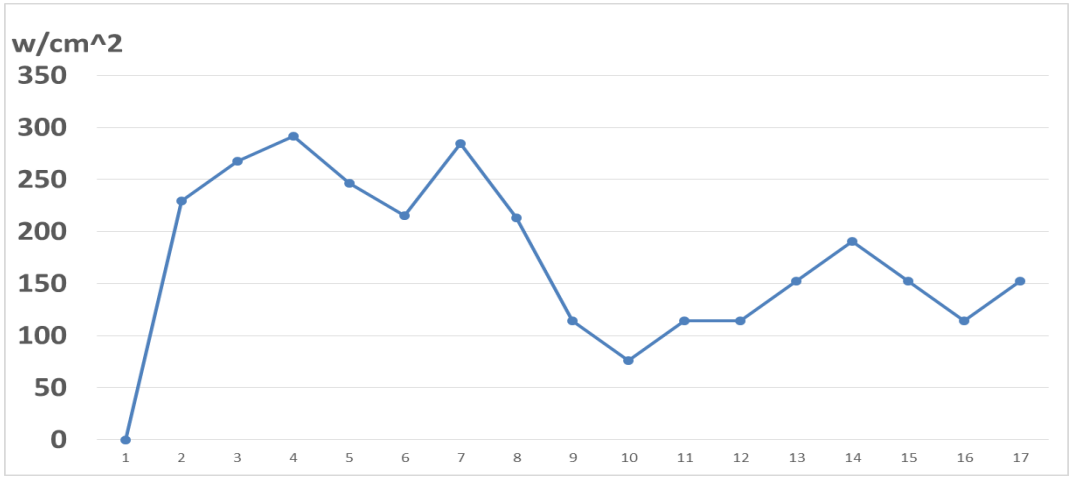
End-on view of the electron trajectory in a beamlet, there are no notable beam off-centering

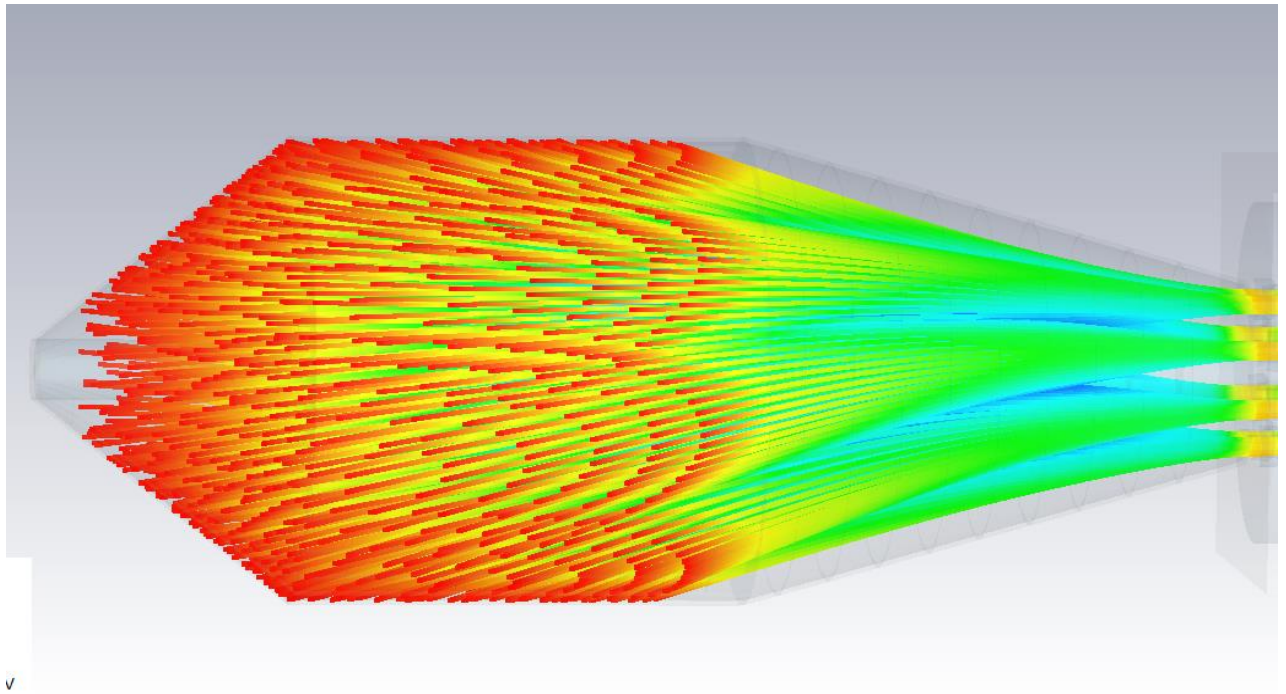


Multi-beam klystron

■Collector design

Heat loading along the beam-line





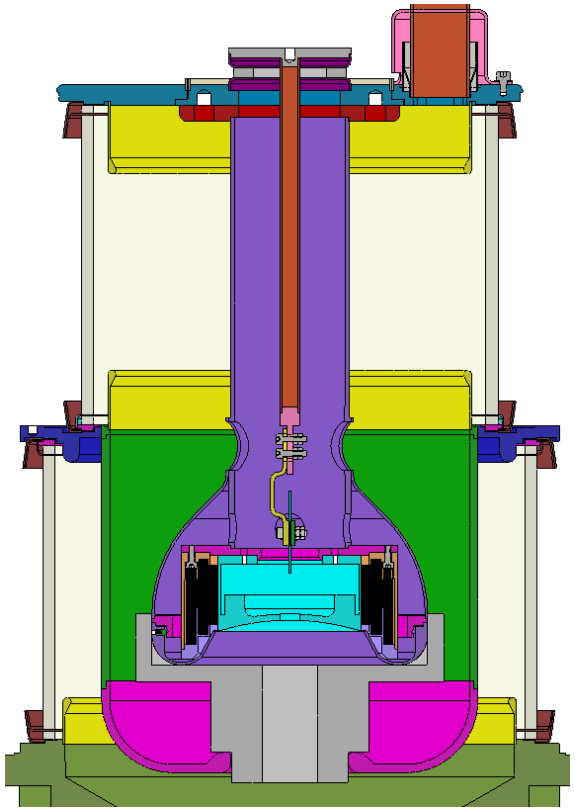
2nd prototype and key components R&D

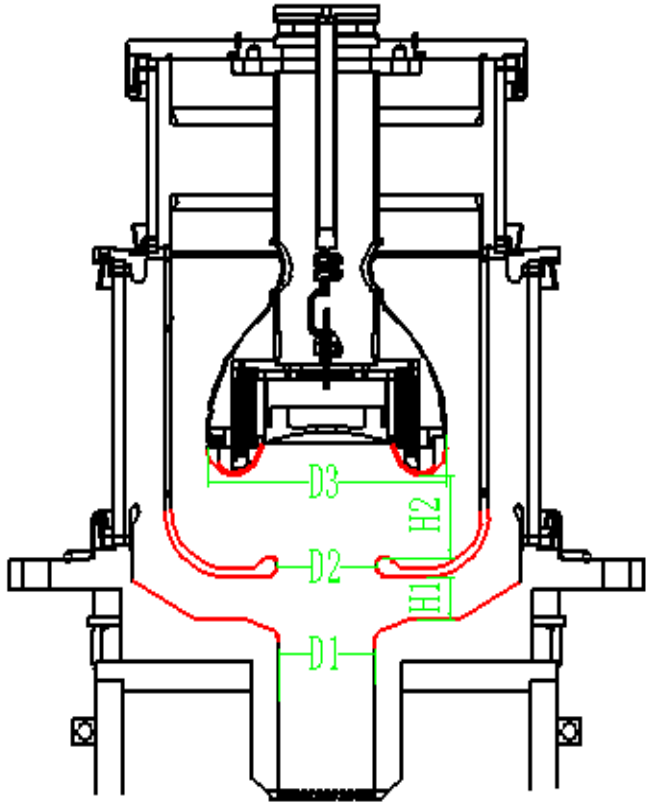
2nd prototype manufacture

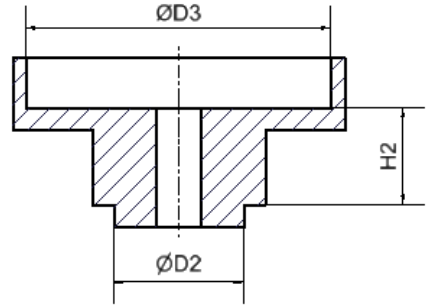
◆2nd prototype

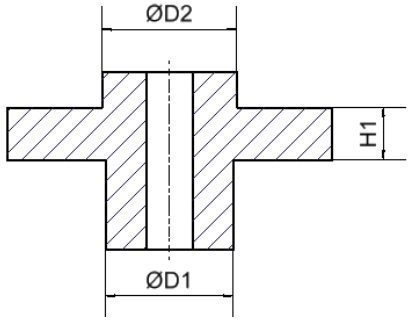
Mechanical design is start and design scheme has been optimized based on 1st prototype tube.

1st







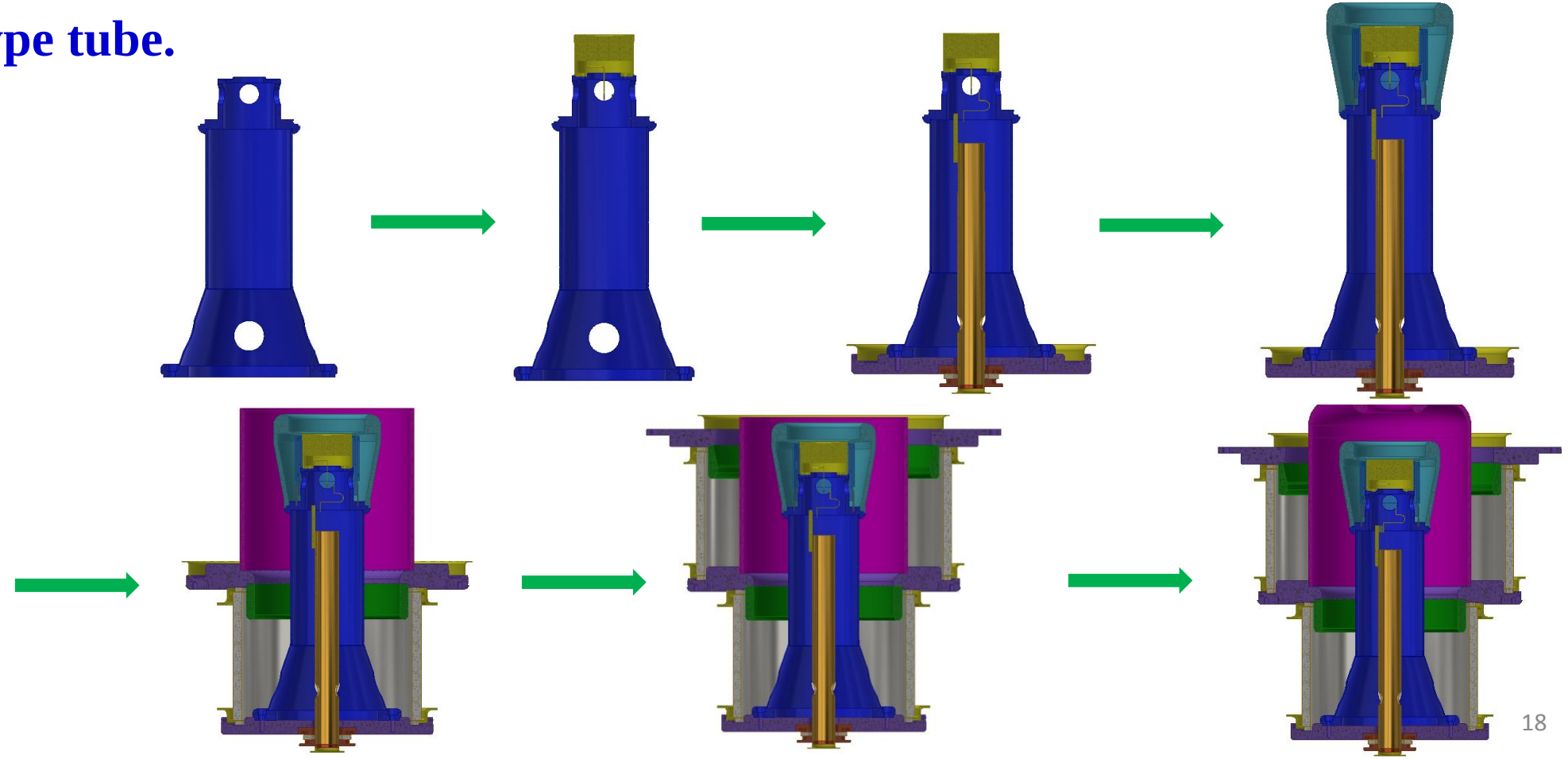


2nd prototype manufacture

◆2nd prototype

Mechanical design is start and design scheme has been optimized based on 1st prototype tube.

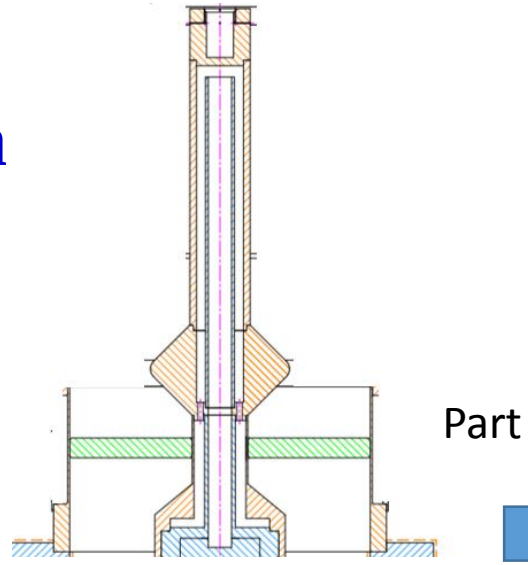
2nd



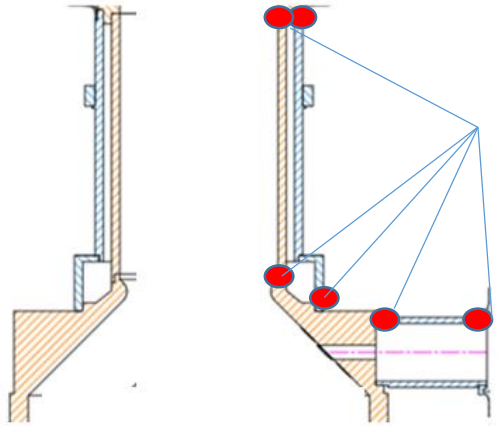
Key components R&D

◆ Window system

Single beam klystron

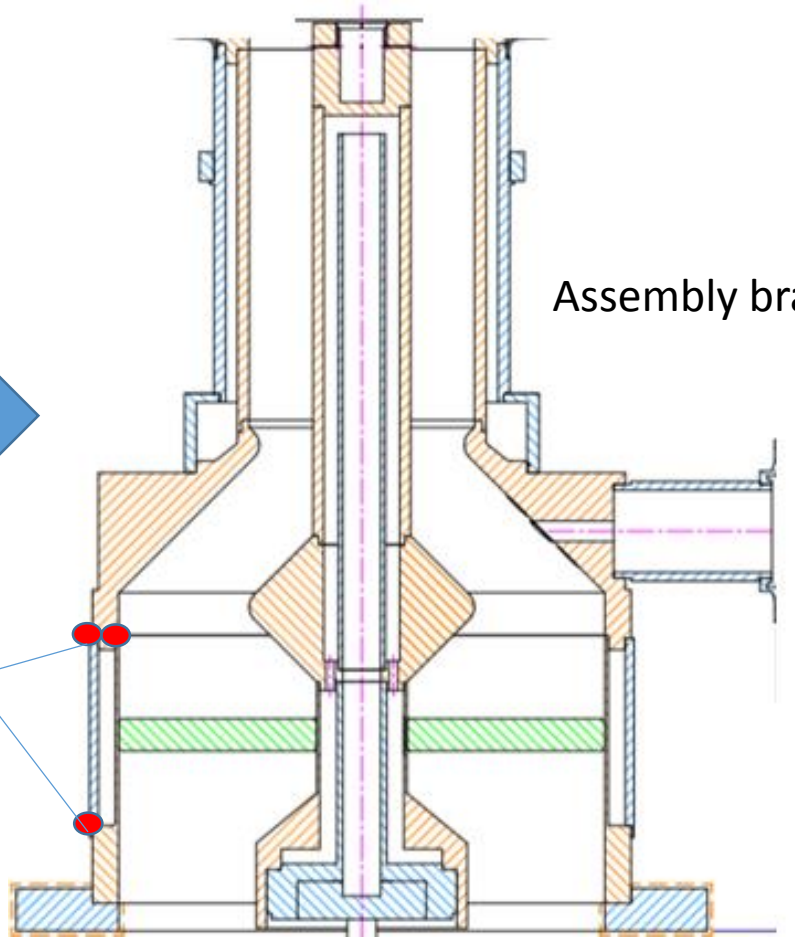


Part brazing



Solder

Solder



Assembly brazing

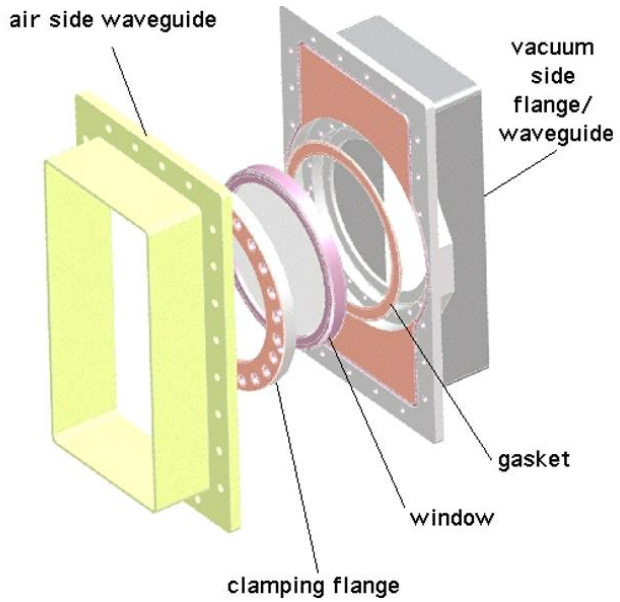
Gold Solder: Au40Cu60(**950℃**)

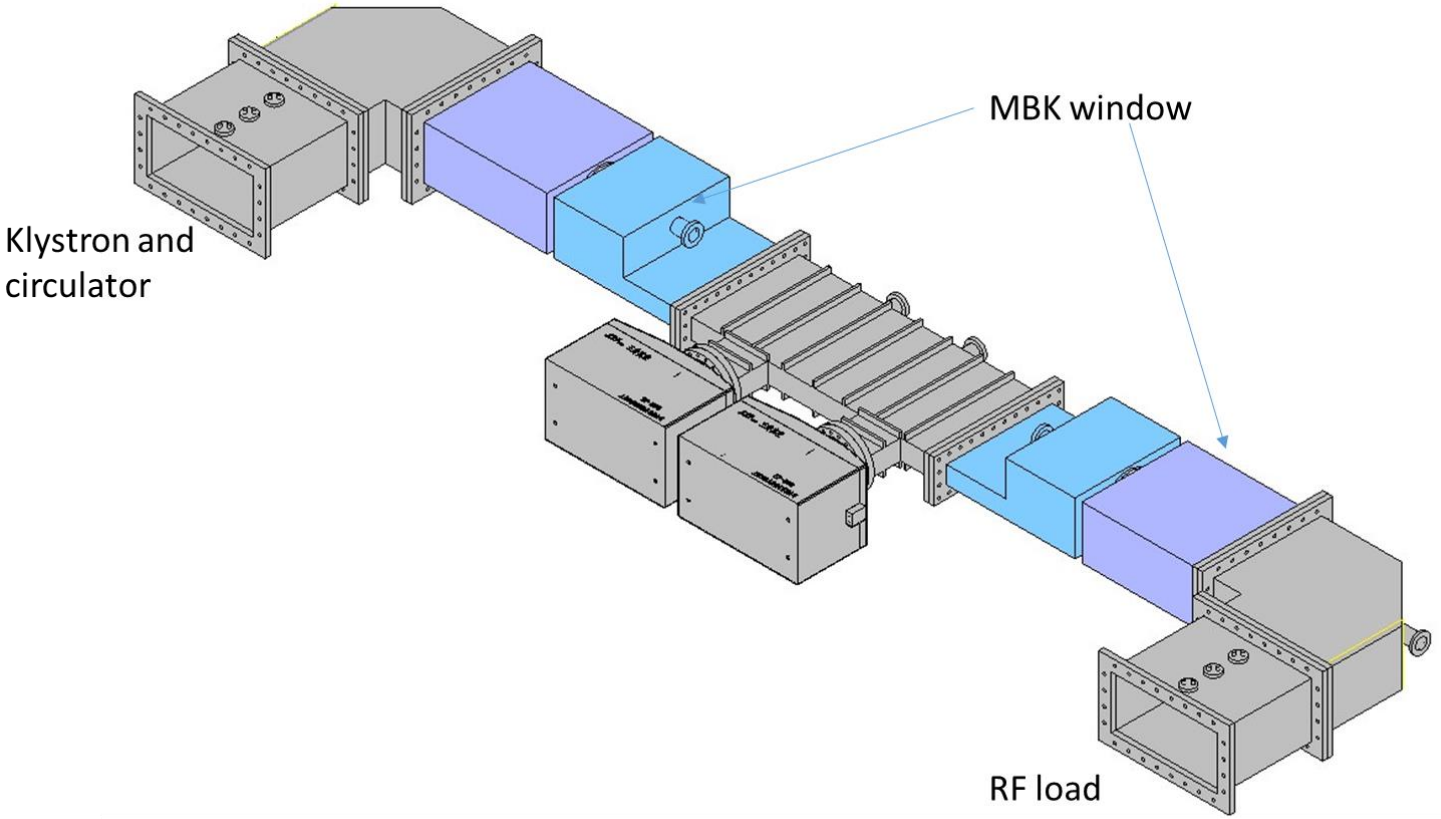
Silver Solder: Ag72Cu28(**780 ℃**)

Key components R&D

◆ Window system

Multi-beam klystron





Future plan

- The 1st prototype tube will be full power tested on next month with new 800kW load and related waveguide system.
- The design for 2nd prototype tube is almost finished and starting mechanical design based on 1st prototype tube and optimization as well.
- The mechanical design for MBK will be start after completion of the high efficiency design.
- The development for klystron key technologies is also considered including window system for single beam klystron and MBK.

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Thanks for your attention!