

CEPC high efficiency klystron status

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On behalf of CEPC RF power source team

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◆ Design consideration

◆ R&D Status

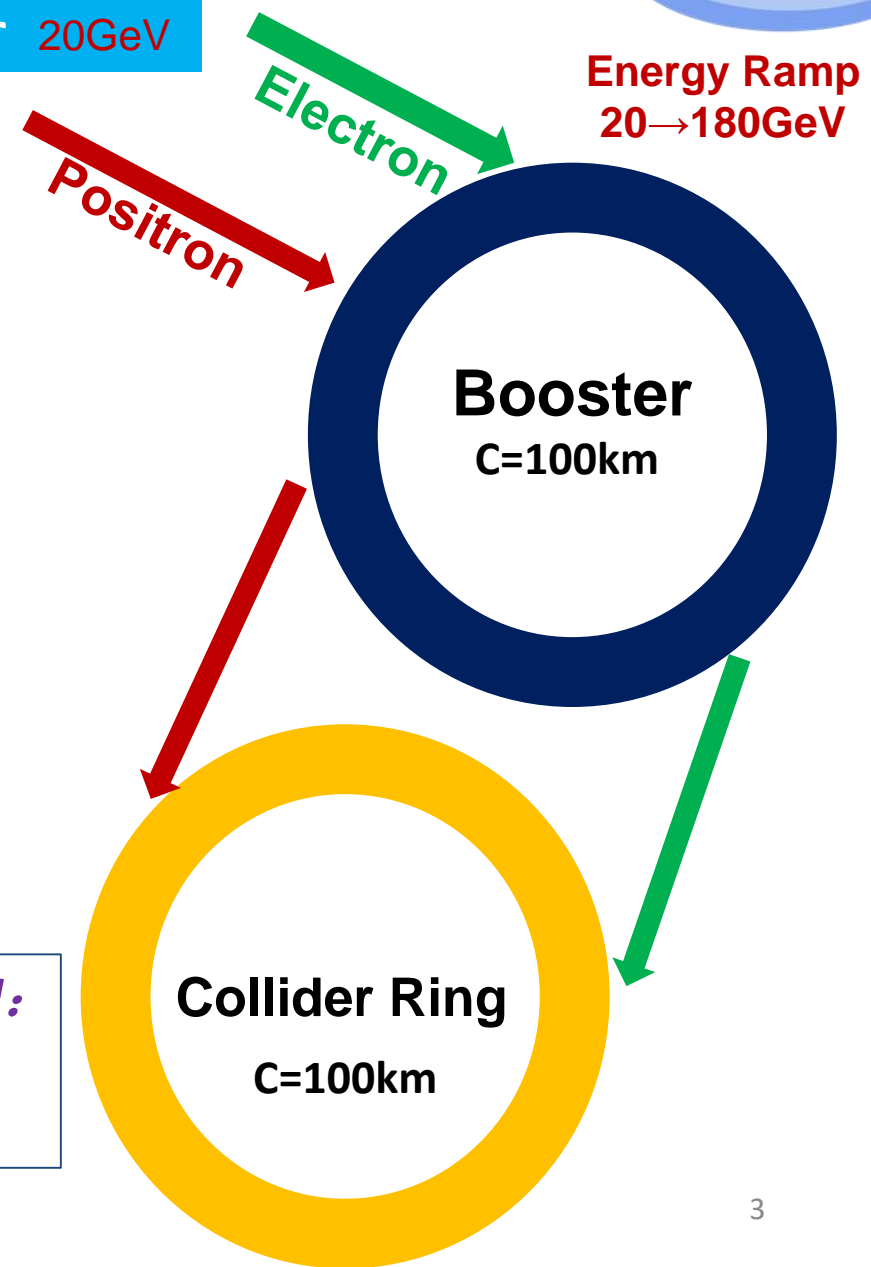
- HE klystron conditioning
- MBK design and fabrication progress

◆ Summary

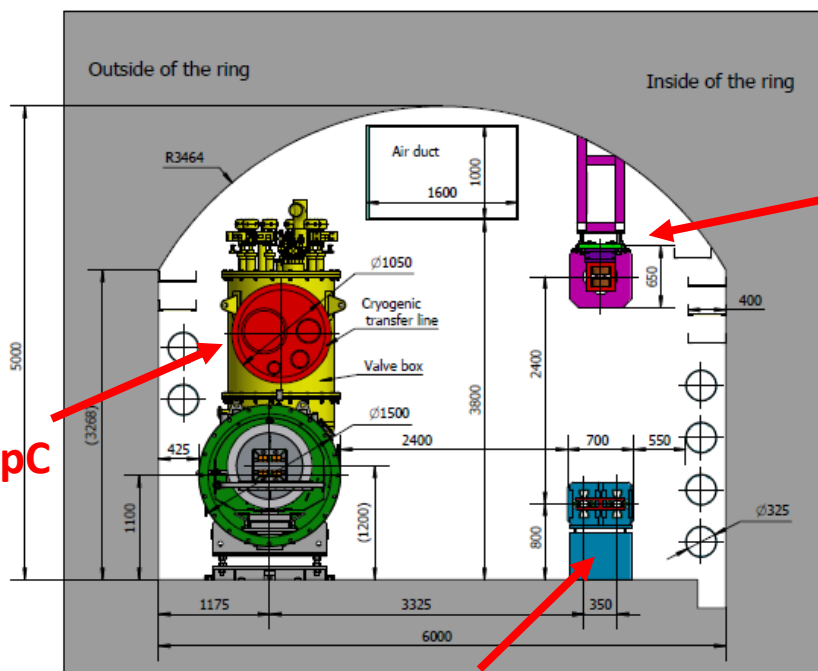
Design consideration

High power RF sources are required to provide the energy needed to accelerate particles or keep particles energy stable.

Injector 20GeV



TUNNEL CROSS SECTION OF THE ARC AREA



CEPC Booster

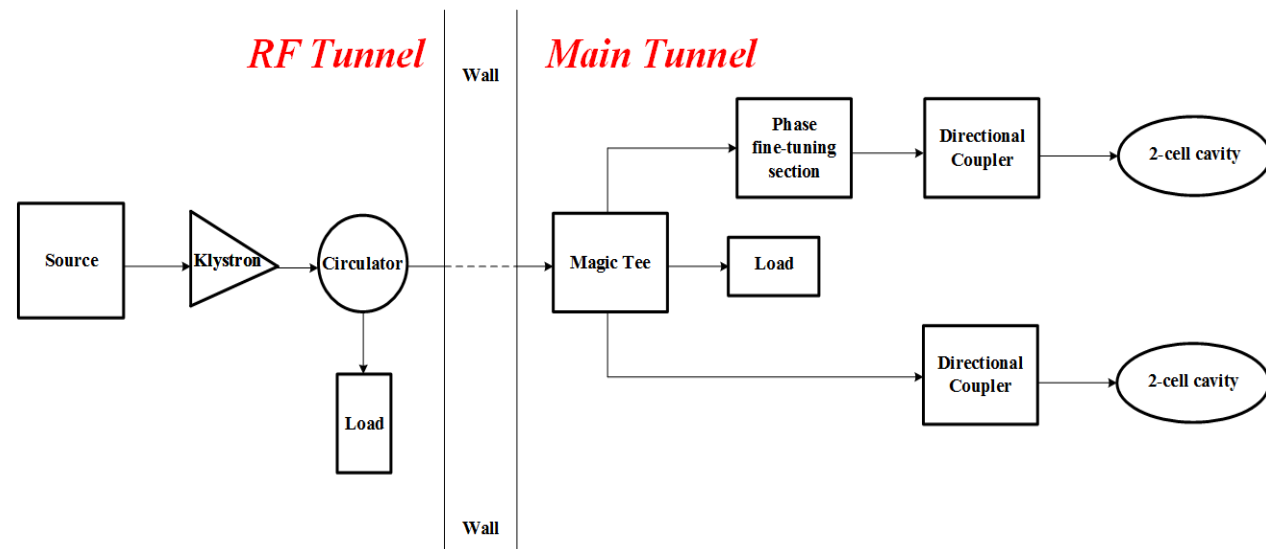
Three rings in the same tunnel:

- CEPC Collider & Booster
- SppC

CEPC Collider

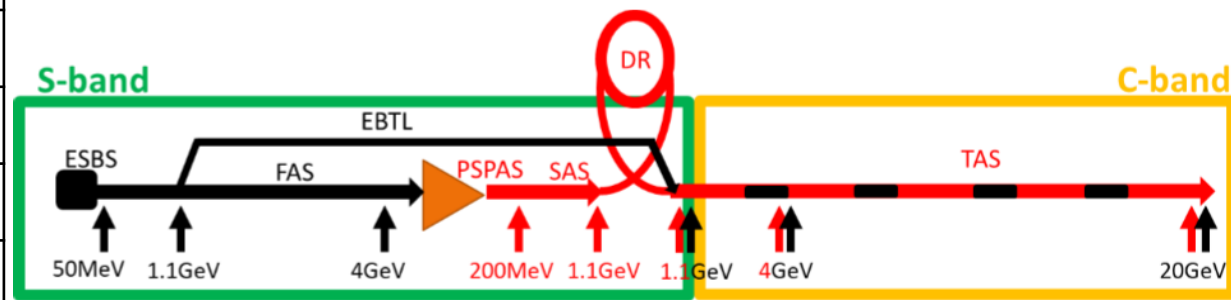
P band klystron for CEPC Collider

Parameters	Value
Freq.(MHz)	650
Klystron QTY.	120
Klystron power(kW)	800
1 to 2 SC cavity	



C&S band klystron for CEPC Linac

Parameters	S	C
Freq.(MHz)	2860	5720
Klystron QTY.	35	147
Klystron power(MW)	80	50
RF structure distribution	1-to-2&1-to-4	1-to-2



High efficiency klystron conditioning

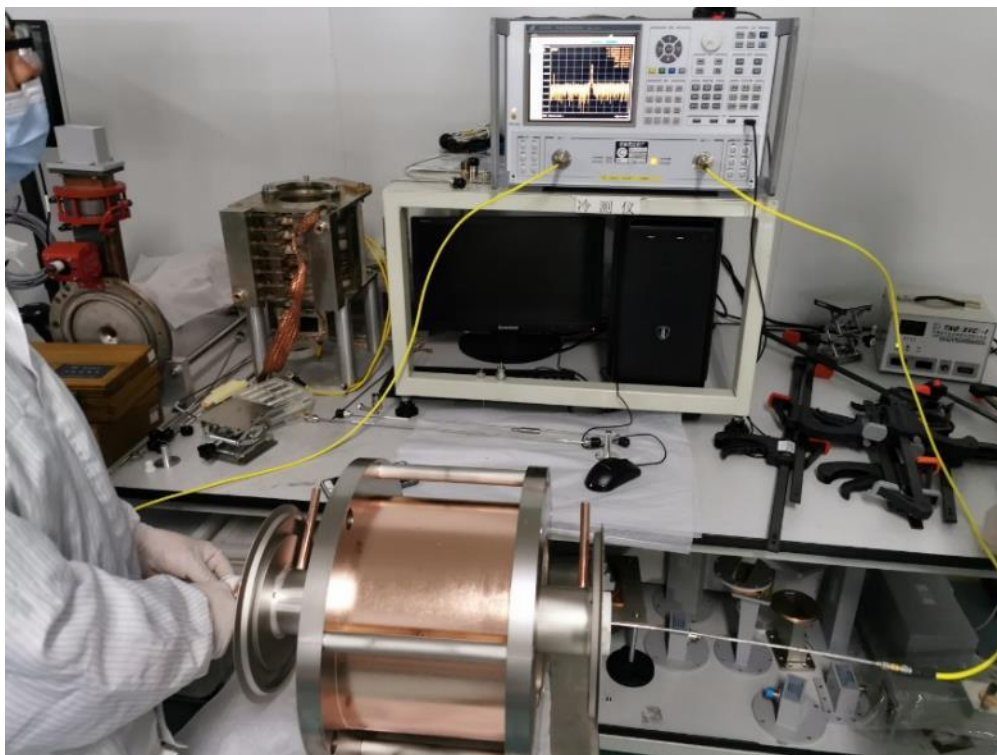
Milestone

- ◆ **Jan., 2021: Klystron manufacture started**
- ◆ **Jul., 2021: Parts fabrication completed**
- ◆ **Nov., 2021: Gun processing and klystron baking out**
- ◆ **Dec., 2021: Klystron delivered to IHEP**
- ◆ **Mar., 2022: Klystron conditioning started**
 - ① **Cold high voltage conditioning**
 - ② **Cathode activation**
 - ③ **High voltage conditioning**
 - ④ **RF Conditioning(Pulsed and CW)**

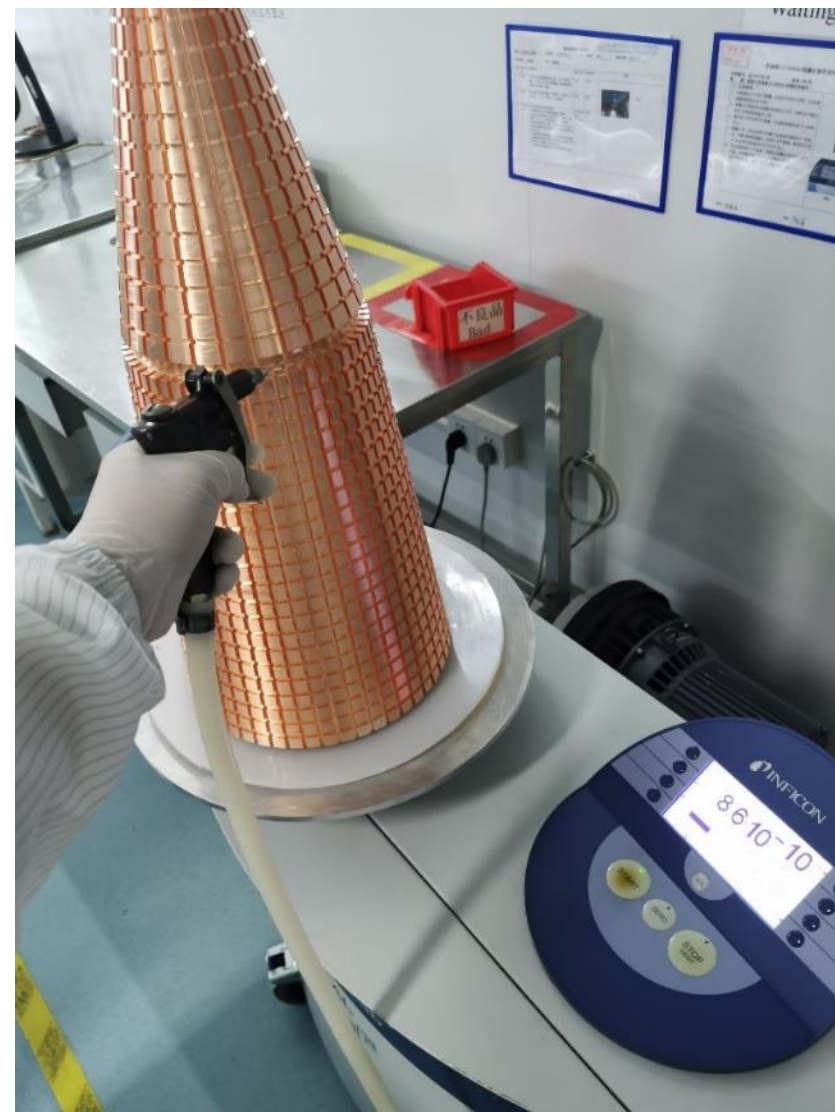
Fabrication processing



Electron gun



Cold test



Collector body

Electron gun processing

Cathode Temp. 975 degree C @Fil. 27V/6A



Klystron final assembly

Klystron final assembly



Klystron baking out



High power test preparation



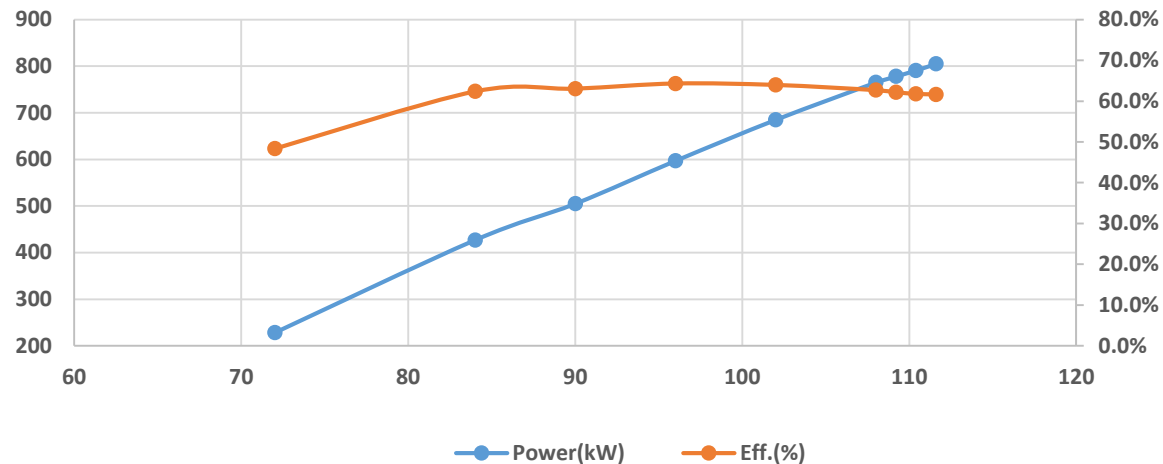
Klystron is in place in IHEP PAPS site

Latest conditioning status until May. 13

Pulsed RF Mode (30% duty factor, 60ms/5Hz)

CW RF Mode

High Voltage vs. Power&Efficiency

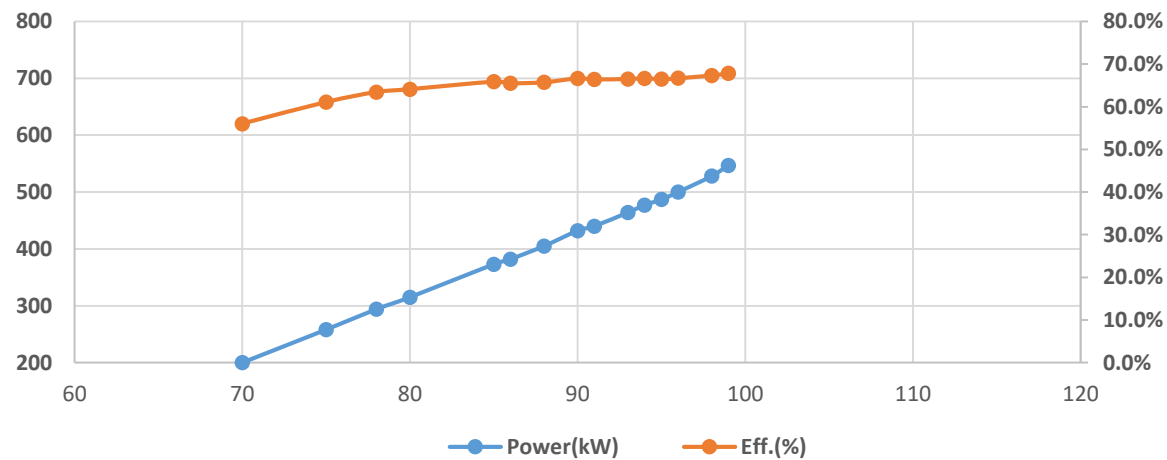


Power Max. 805kW, Eff. Max: 64%



CW RF Mode

High Voltage vs. Power&Efficiency



Power Max. 547kW, Eff. Max: 67.8%

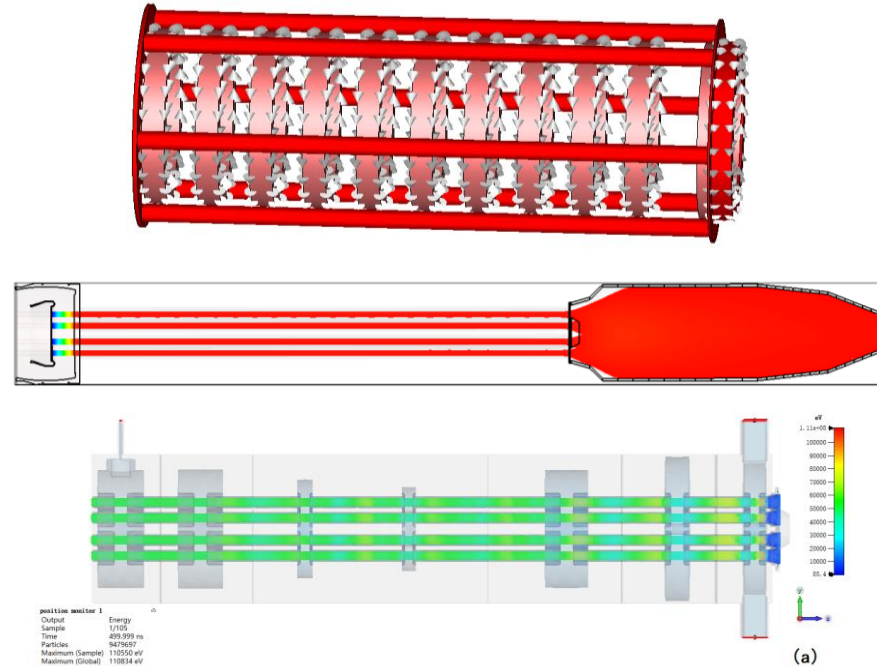
More time for conditioning and commissioning for higher power and higher efficiency.

MBK design and fabrication status

MBK physical design

- Final physical design was completed and reviewed on July 2021.

Parameters	Value
Frequency	650 MHz
Output Power	800 kW
Efficiency	80.5%
1dB bandwidth	± 0.75 MHz
Beam voltage	54 kV
Beam current	2.51*8 A
Beam number	8



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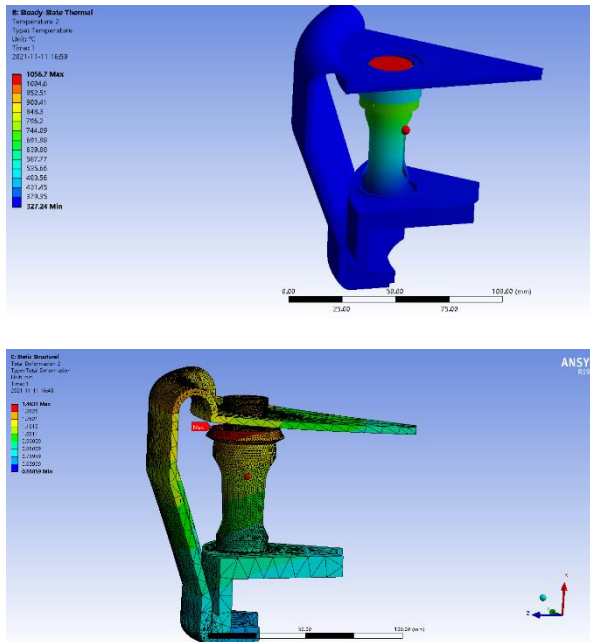
Design study and modeling of multi-beam Klystron for Circular Electron Positron Collider

Shengchang Wang ^{a,b,*}, Shigeki Fukuda ^c, Zhijun Lu ^b, Zaib un Nisa ^b, Zusheng Zhou ^b, Ouzheng Xiao ^b, Guoxi Pei ^b

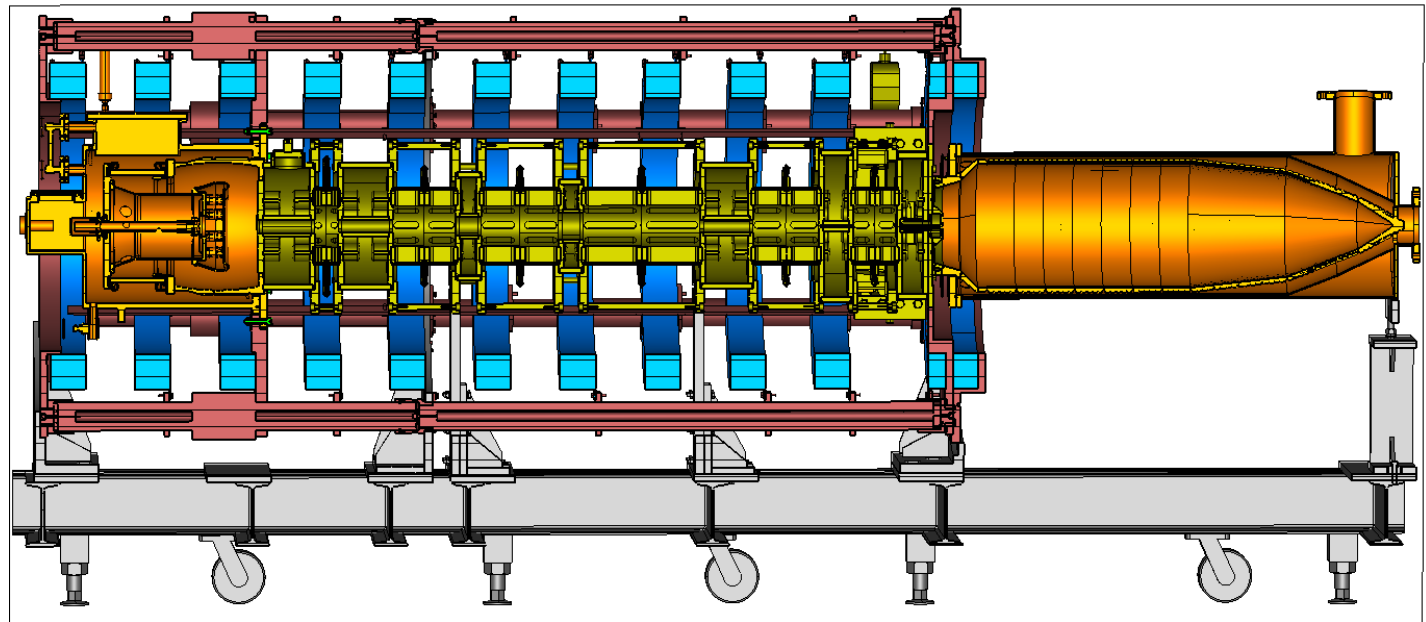


MBK mechanical design

- Mechanical design was also reviewed on December 2021. Some work was also done:
 - ① Cavities tolerance analysis
 - ② Water cooling system of cavity chain
 - ③ Engineering design for focusing coil and electron gun
 - ④ Tolerance analysis for magnet coil



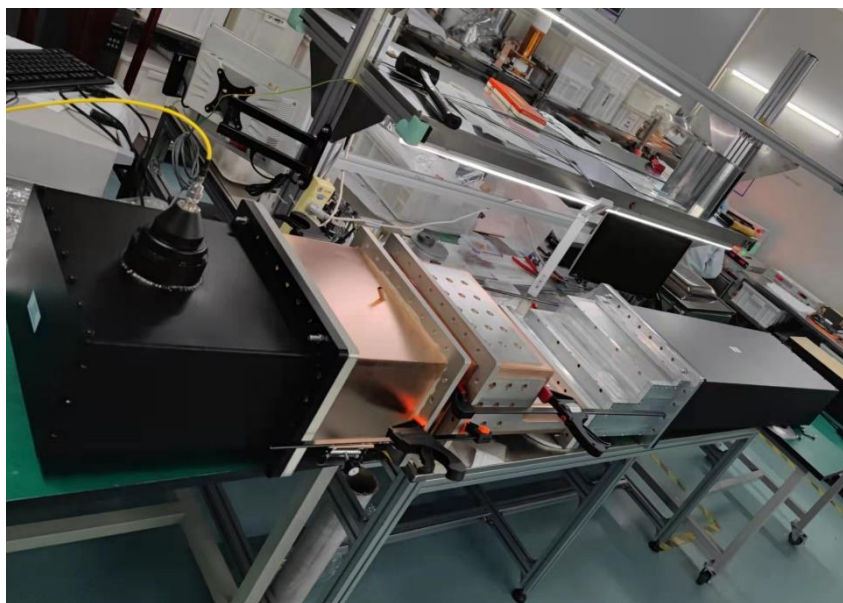
Gun thermal analysis



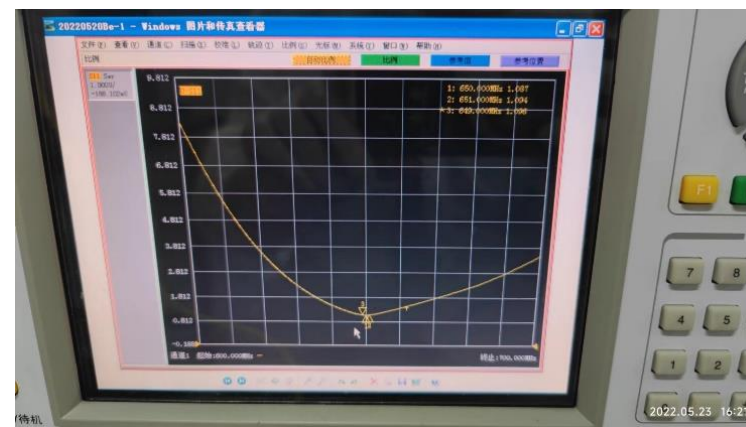
MBK Mechanical design

MBK Fabrication Status

- Complete processing and cold test of two types of output window prototype (alumina window, beryllium oxide window).
- The cold test results (center frequency, VSWR, bandwidth) of the two windows meet the design requirements.



Output window prototype



Test result	Alumina	Beryllium oxide
VSWR@651MHz	1.048	1.089
VSWR@650MHz	1.034	1.084
VSWR@649MHz	1.052	1.096

MBK Fabrication Status

- The machining process of experimental cavity is more than half done.
- Fabrication of electron gun, collector, focusing coil is also in progress.



experiment cavity

Summary

- HE klystron conditioning is in progress and will be completed in the near future.
- Fabrication of MBK is also in progress and will be completed at the end of this year.

Thanks for your attention!