

# 650MHz High Power High Efficiency Klystron

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# Outline

## ◆ R&D status

- 1<sup>st</sup> klystron prototype
- High efficiency klystron(2<sup>nd</sup> klystron)
- MBK(Multi-beam klystron)

## ◆ Future plan

# 1<sup>st</sup> 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)**
- ◆ **Mar. 2021 High power test (700kW CW)**

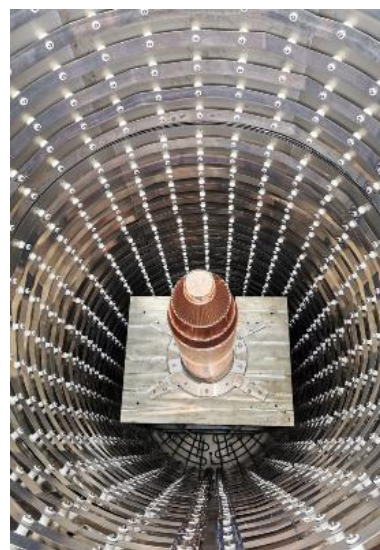
# Fabrication processing



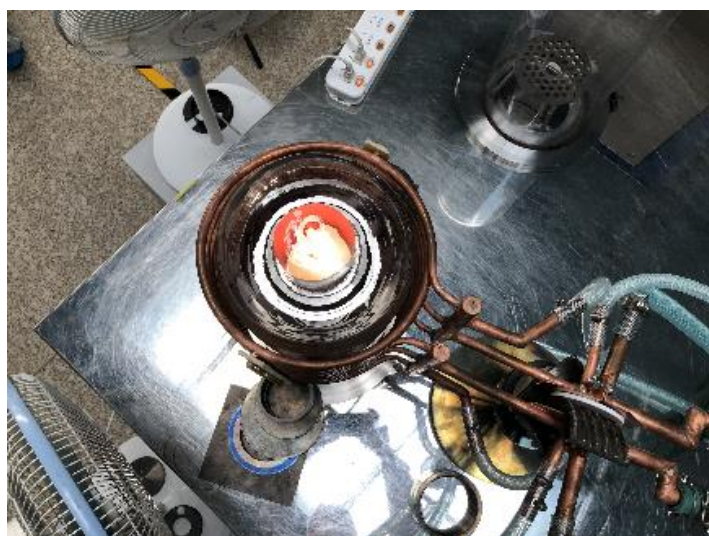
Cavity cold



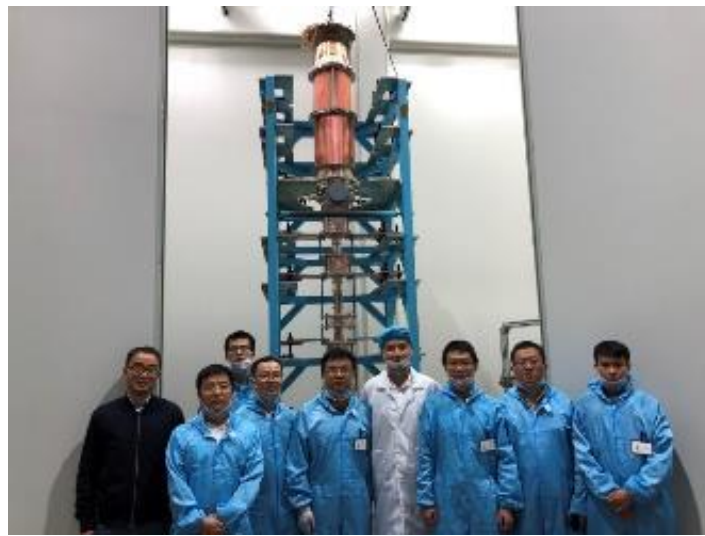
Collector brazing



Baking out



Gun processing



Vacuum Ass'y assembly



Before delivery

# High power test

## ◆ Phase I:

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

## ◆ Phase II:

Test is started from Aug. 24 2020, CW power is up to **490kW** on Sep.1 2020.  
Arc happened on load, conditioning is stopped.

## ◆ Phase III:

Test is started from March. 2021, CW power is up to about **700kW** on March. 31 2021 with new 800kW load. Window is cracked at 700kW power and higher power conditioning is stopped.



# High efficiency klystron (2<sup>nd</sup> klystron)

# Milestone

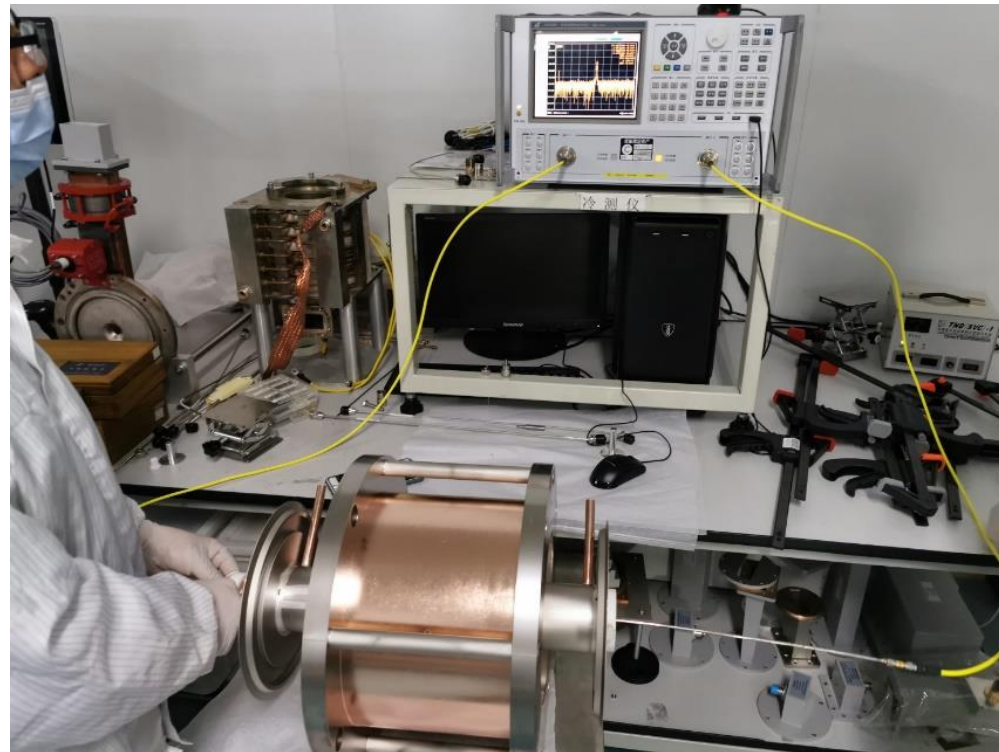
- ◆ **Dec. 1, 2020: Mechanical design review**
- ◆ **Jan. 27, 2021: Mechanical drawing completed**
- ◆ **Mar. 18, 2021: First cavity completed fabrication**
- ◆ **Jul. 1, 2021: Collector brazed and leak detection**
- ◆ **Nov.15, 2021: Gun processing**
- ◆ **Nov.22, 2021: Klystron baking out**
- ◆ **Dec. 30, 2021: Klystron delivered to IHEP**



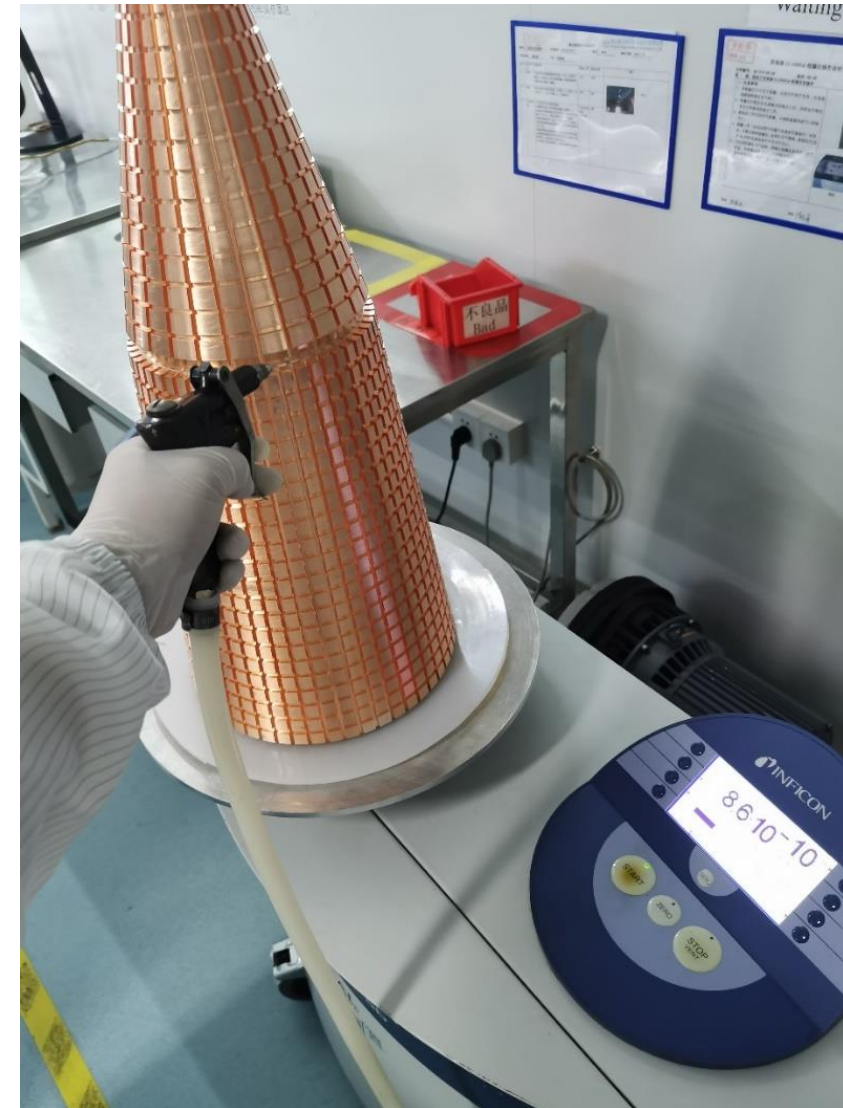
# Fabrication processing



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

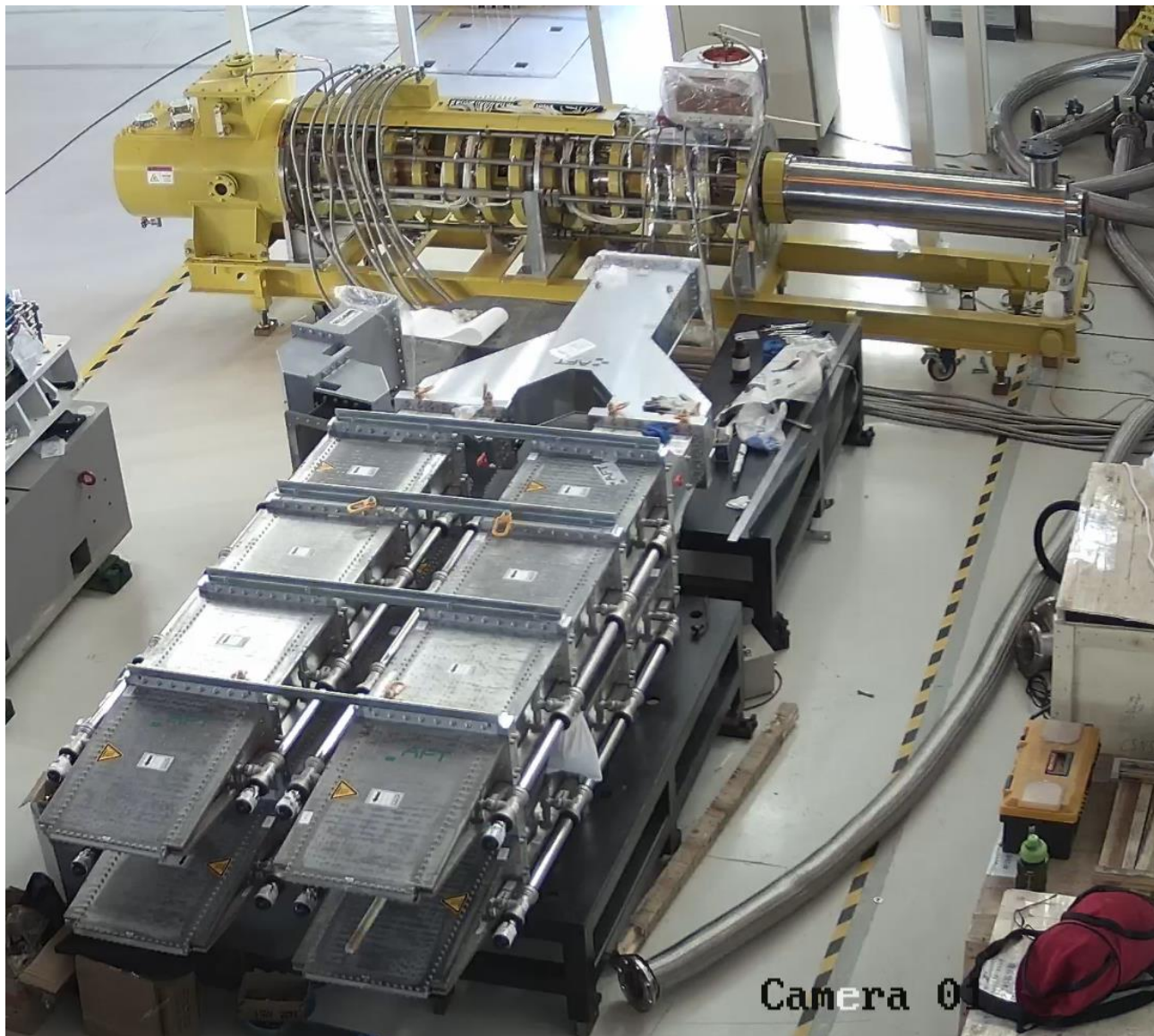


# High power test preparation



**Klystron is in place in IHEP PAPS site and will be conditioning and test in the near future.**

# Latest test site

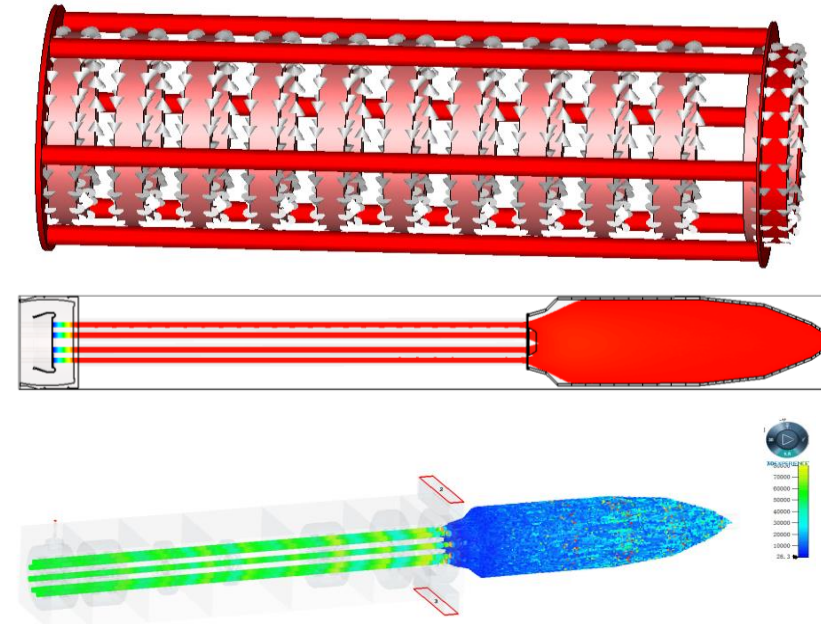


# Multi-beam klystron

# Physical design

Physical design is completed and reviewed by foreign and domestic experts.

Parameters	Value
Freq.	650 MHz
Output power	800 kW
Efficiency	80.5%
1dB band width	$\pm 0.75$ MHz
Cathode Voltage	54 kV
Cathode beam	$2.51 \times 8$ A
Beam Number	8



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

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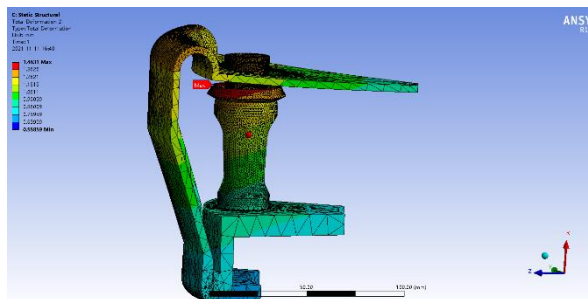
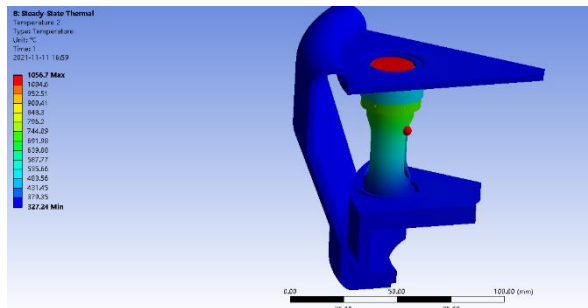




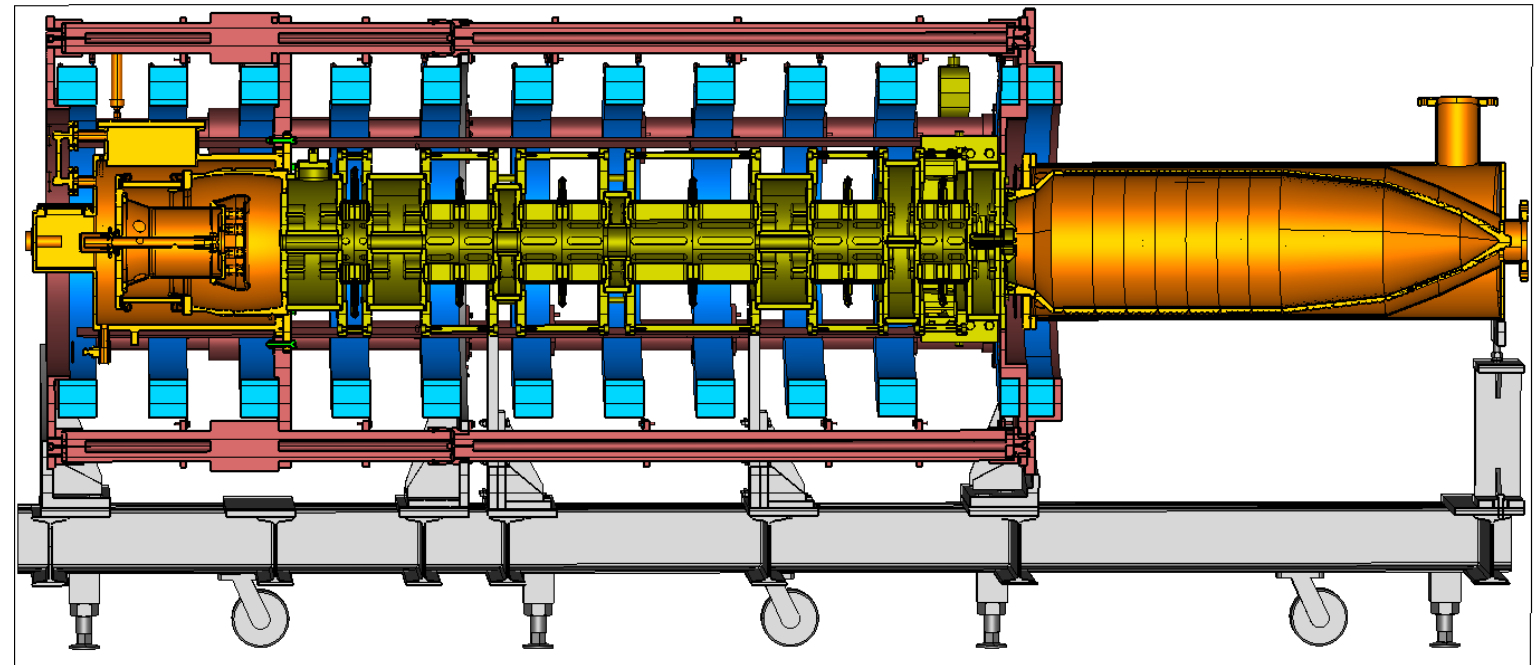
# MBK mechanical design

**Mechanical design is completed and reviewed by experts.**

- **Cavity frequency and efficiency error analysis and also cavity cooling design.**
- **Engineer design of focusing magnet and electron gun and error analysis of magnet field.**



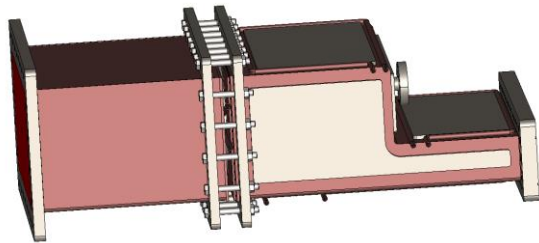
Gun thermal analysis



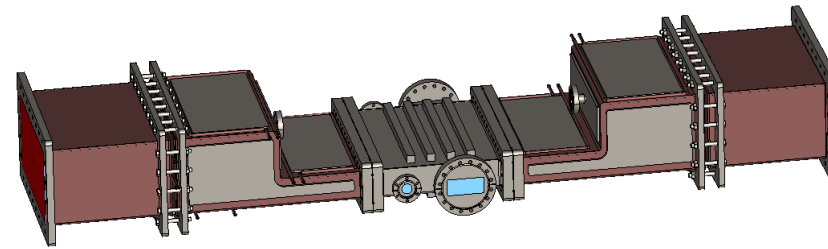
MBK Mechanical design

# MBK key components fabrication

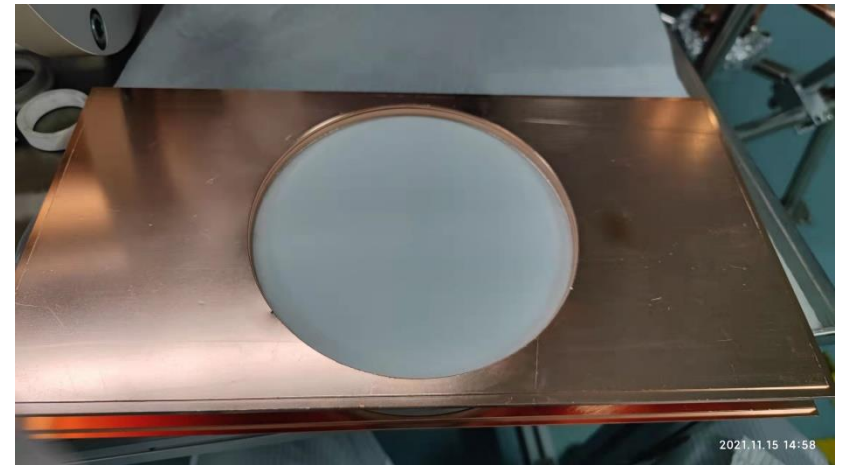
- Experiment cavity is starting to be fabricated.
- Fabrication of output window prototype is processing.



Output window drawing



High power test scheme of output window



Window processing

# Future plan

- ① Start high power test for high efficiency klystron as soon as possible.
- ② Take efforts to promote manufacture of MBK.
- ③ Seeking higher efficiency design method for next klystron.

***Thanks for your attention!***