中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

Klystron & Electron Gun R&D@IHEP

Zusheng ZHOU

Accelerator research center, IHEP

LAL@9.28 2010

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

OUTLINE

- 65MW klystron R&D
- 200MW Resonant ring
- 1A Electron Gun for irradiation accelertor

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW Klystron R&D

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

Key Points

① : IHEP&4404 close cooperation

② : Prototype from BEPCII klystron

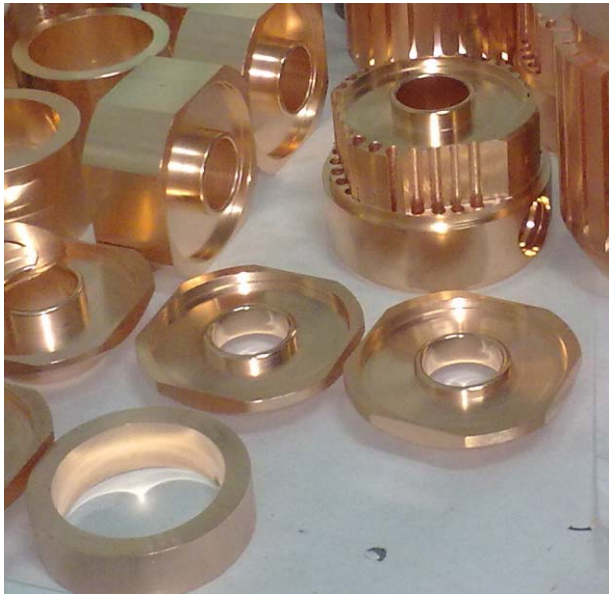
③ : Main parts (cathode, window slice, ceramic seal) imported

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

Fabrication&Processing 6.2009 ~12.2009

Part fabrication and cavity cold test



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

Fabrication&Processing

Gun processing schedule

1. RF on, raise temp to 980 °C, keep pressure < 10-6torr
2. Stabilize at 980 °C until pressure drops < 5x10-8torr
3. Raise temp to 1030 °C, hold until pressure slope flattens
4. Lower temp to 980 °C, hold until pressure slope flattens
5. RF off, maintain 980 °C until pressure slope flattens
6. Raise temp to 1030 °C, wait 1 hour after pressure peak, cool

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

Fabrication&Processing

Gun processing

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

Fabrication&Processing

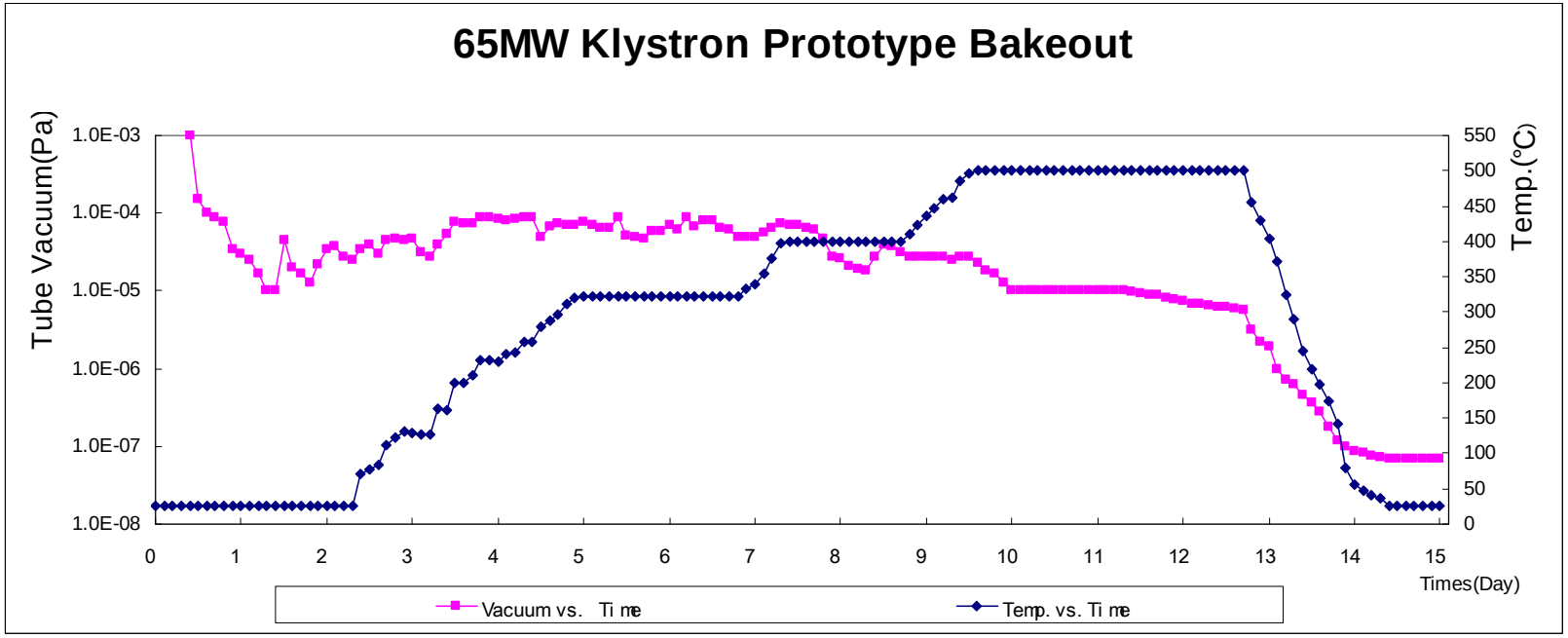
Tube bakeout

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

Fabrication&Processing

Tube bakeout



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

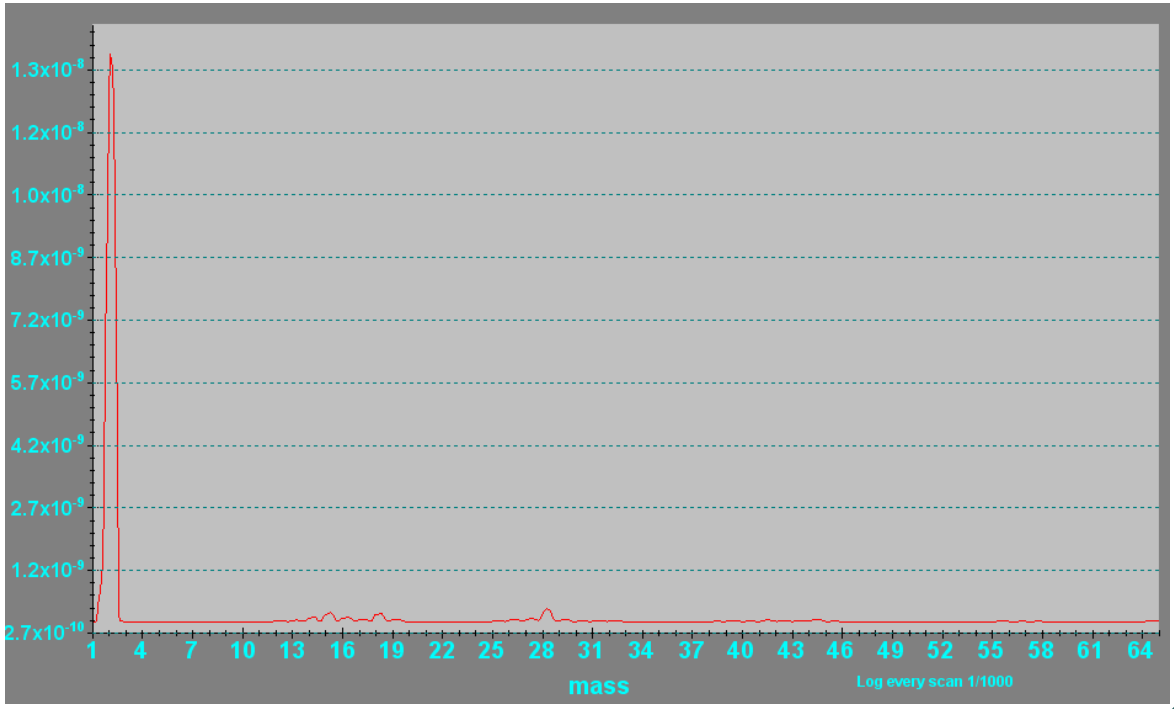
Fabrication&Processing

Tube bakeout

Pinch off:

RGA Results:

hydrogen molecule



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

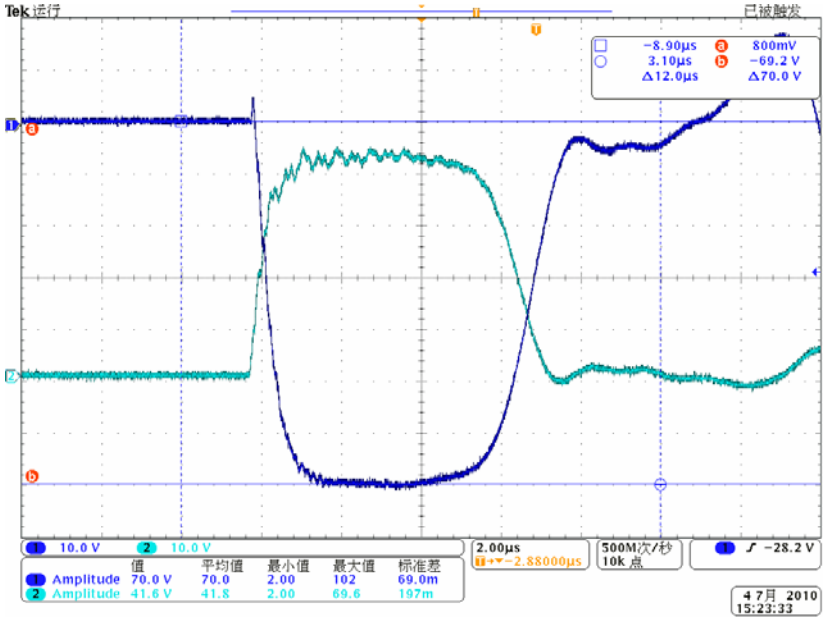
65MW klystron R&D

High Power Test (2010.7)

DC Conditioning-no RF input

Short pulser-Long pulse
Low repetition rate-high

Pulsed voltage: 350kV(max)
Pervence: 2up

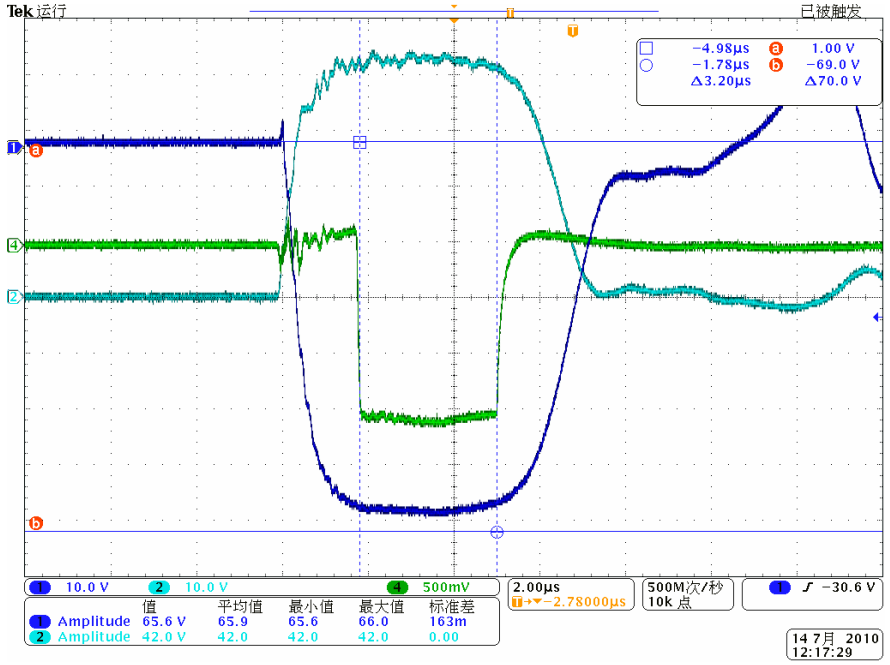


中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

High Power Test (2010.7)

RF Conditioning



Short pulser-Long pulse
Low repetition rate-high

Pulsed voltage: 350kV(max)
Output power: 66MW
Pulse width: 3.2us
Rep.Rate: 12.5Hz

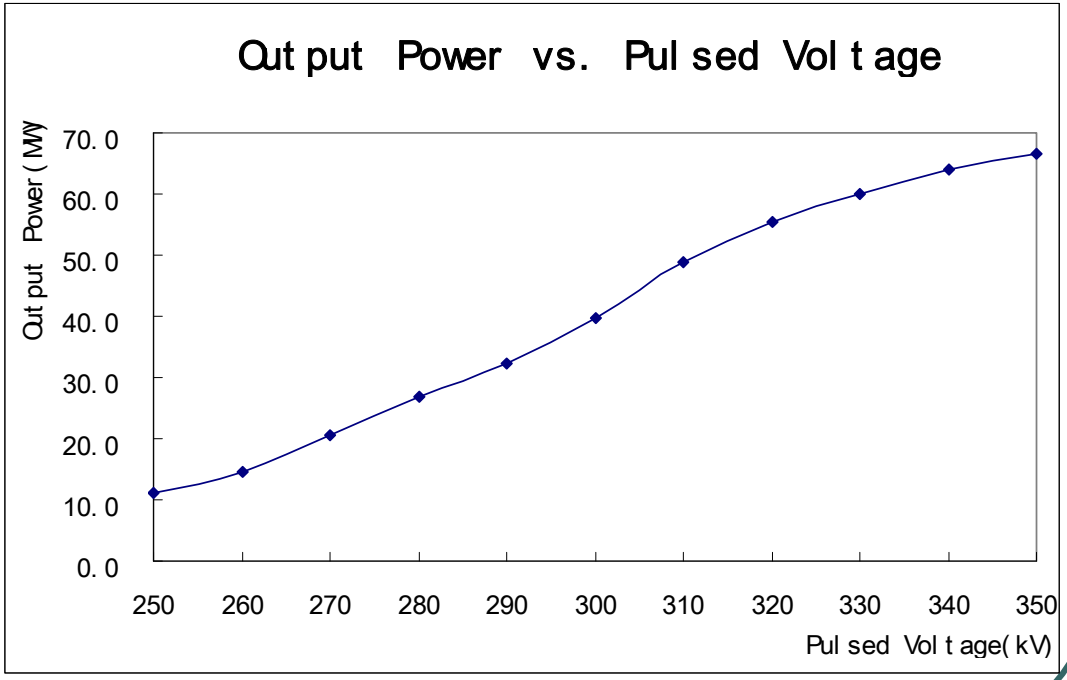
中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

High Power Test (2010.7)

Test Results

Pulsed voltage: 350kV(max)
Output power: 66MW
Pulse width: 3.2us
Rep.Rate: 12.5Hz
Gain: 51dB
Efficency: 45.2%



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

Further work

Window breakdown

Unfortunately it suffered a major breakdown event @morning 7.14,2010

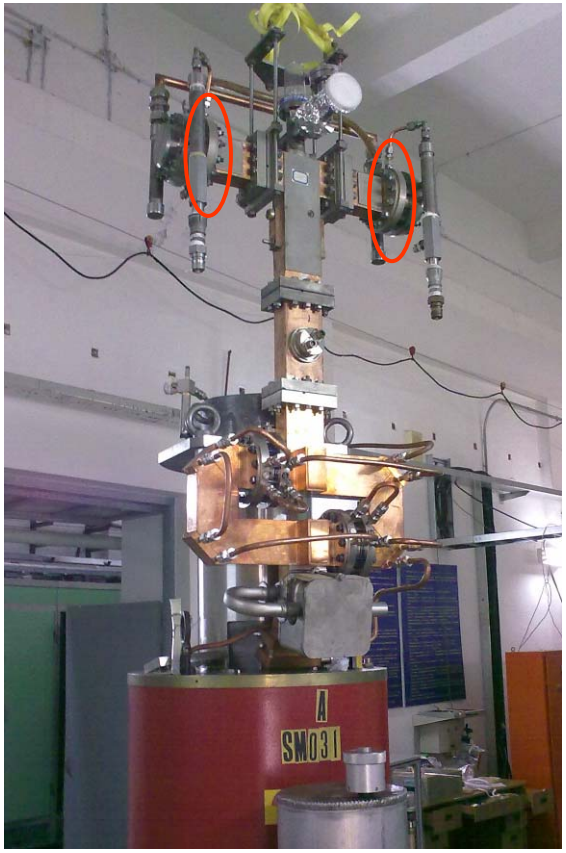
中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

Further work

Window breakdown

Because of the window breakdown on the water load.



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

65MW klystron R&D

Further work

Repair&Reconditioning

The repaired work will be completed on this August.

The 2rd high power test will be done on October.

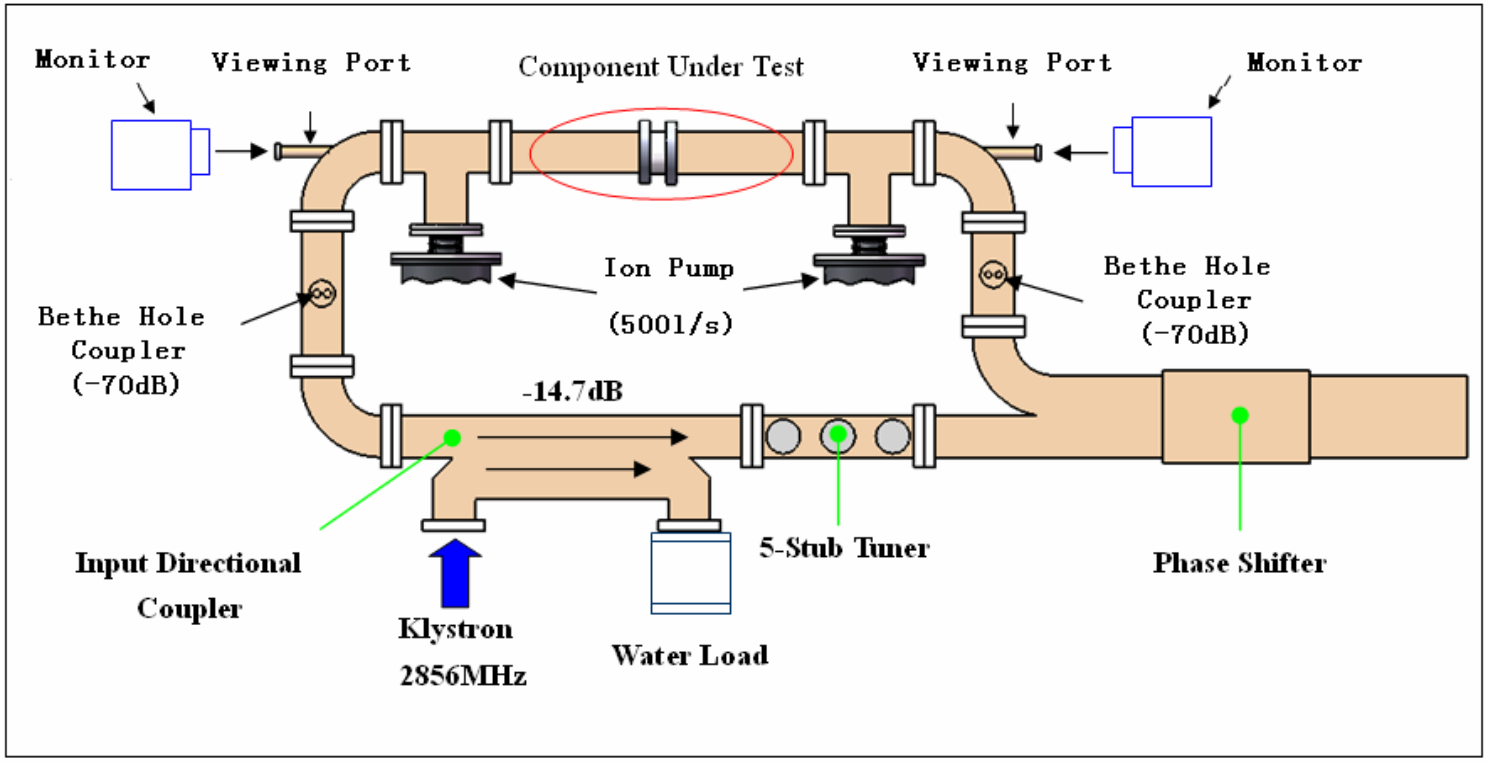
中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

Sketch map :



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

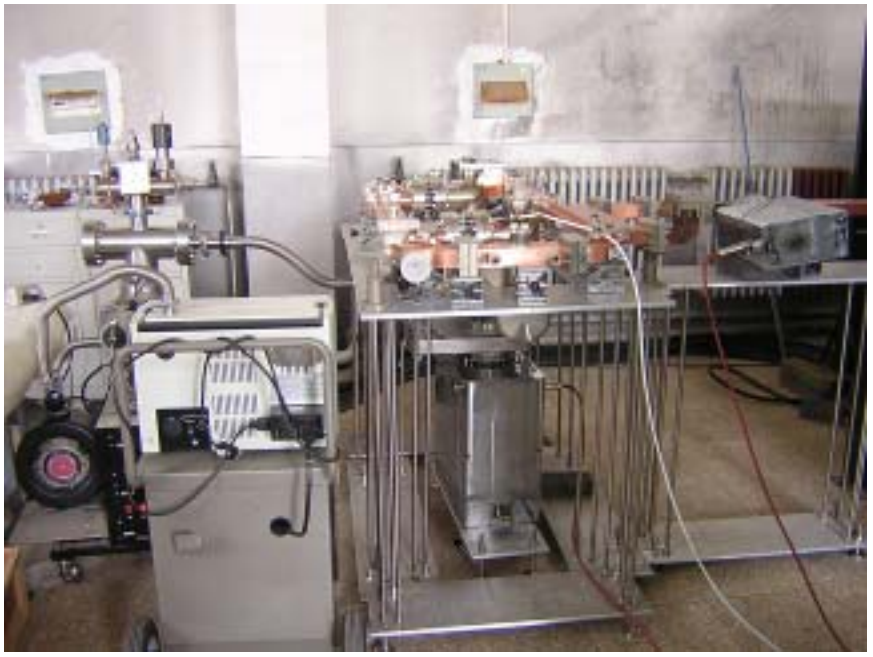
Main parameters:

Pulsed Power (MW)	200
Pulsed Width (us)	2
Rep. Rate (Hz)	25
Resonant coefficient	14
Length of ring (m)	about 3.7
Attenuation of ring (dB)	0.15

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

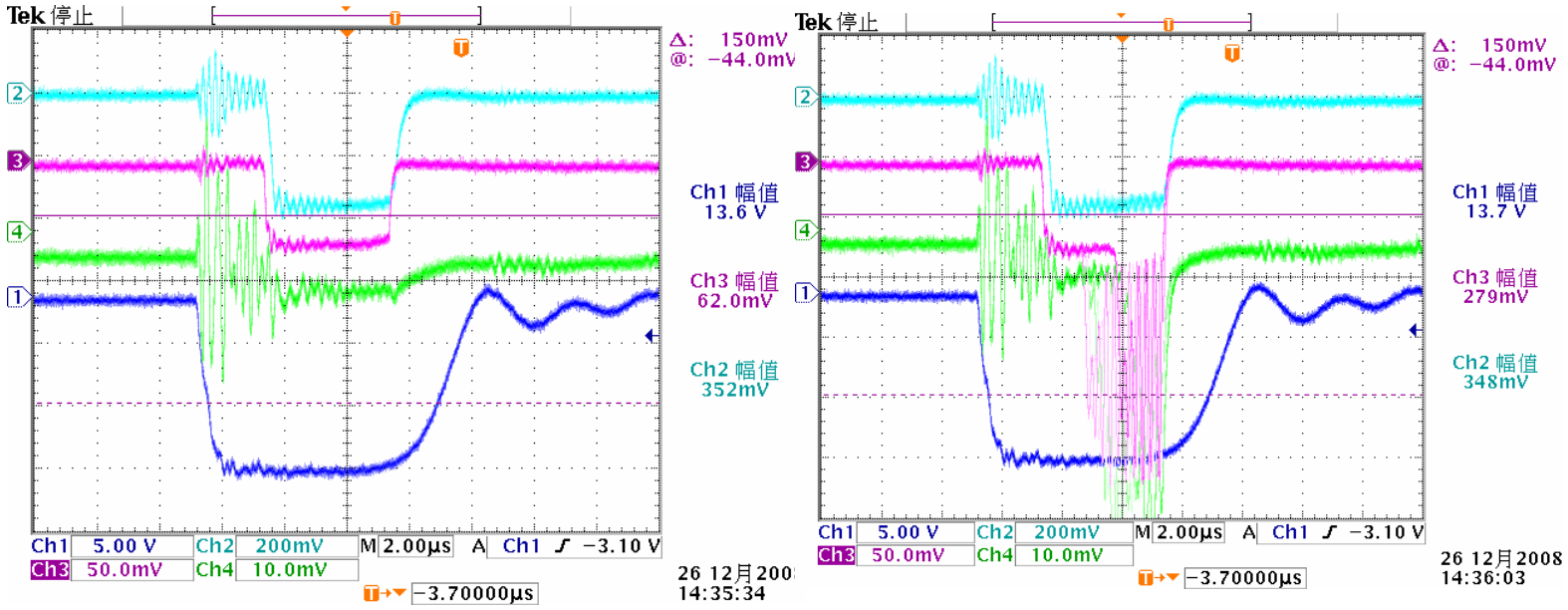
Installation



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

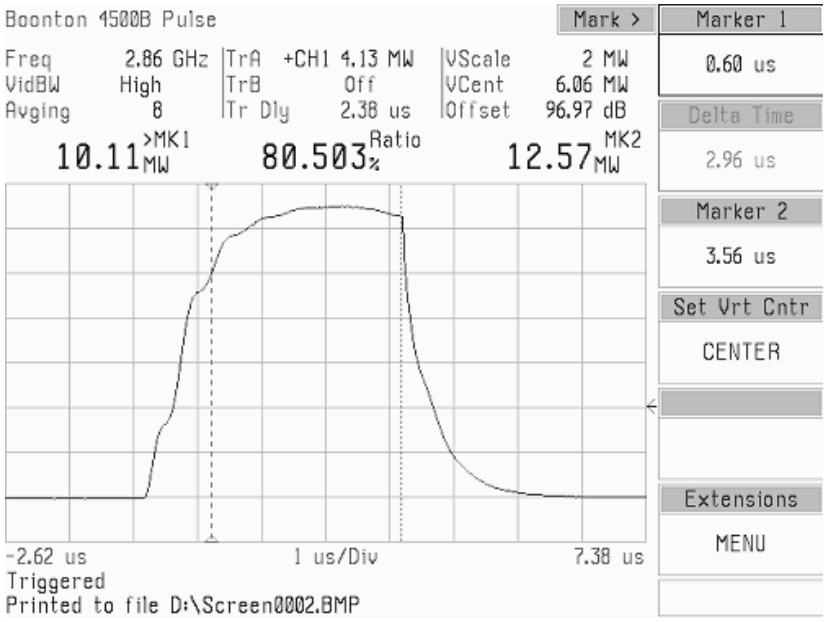
Commissioning



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

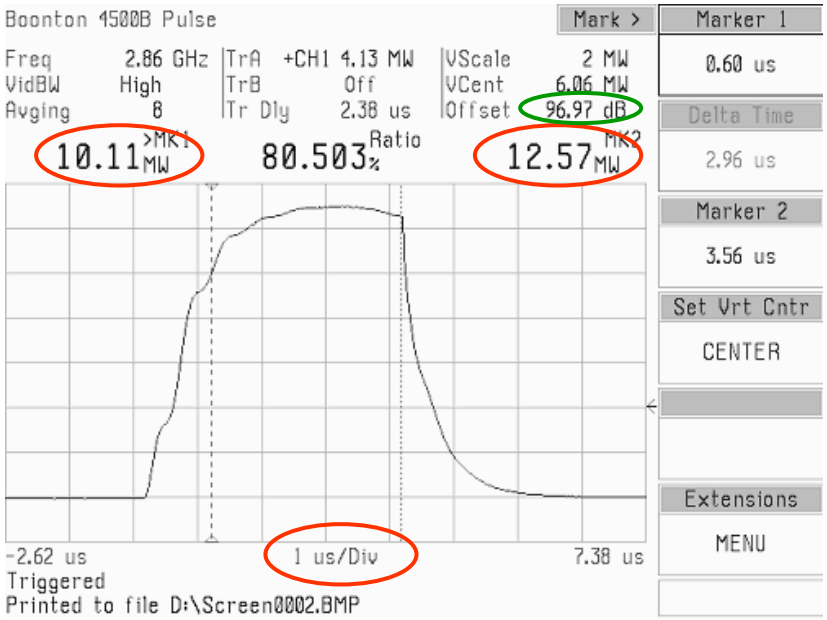
Test and operation (3 weeks later)



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

Test and operation (3 weeks later)

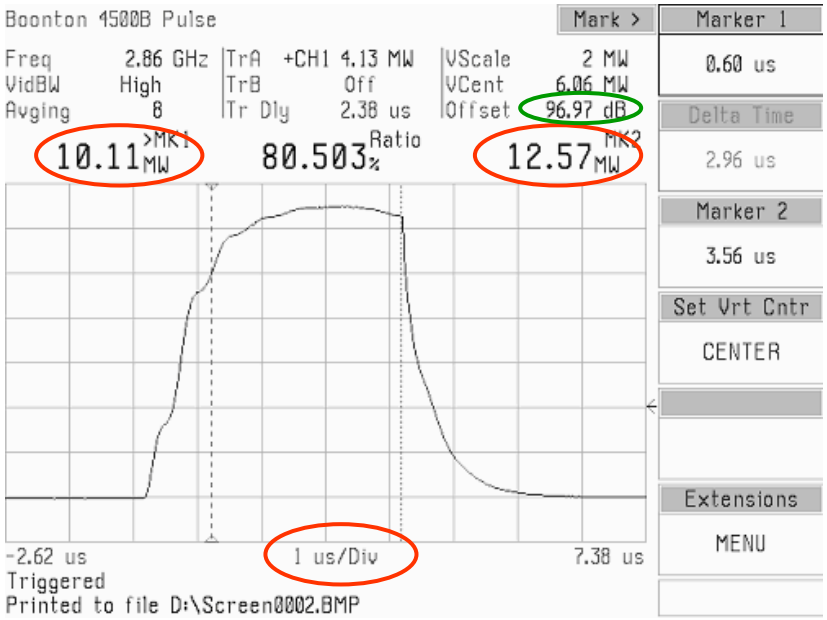


(@13dB attenuator)

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

Test and operation (3 weeks later)



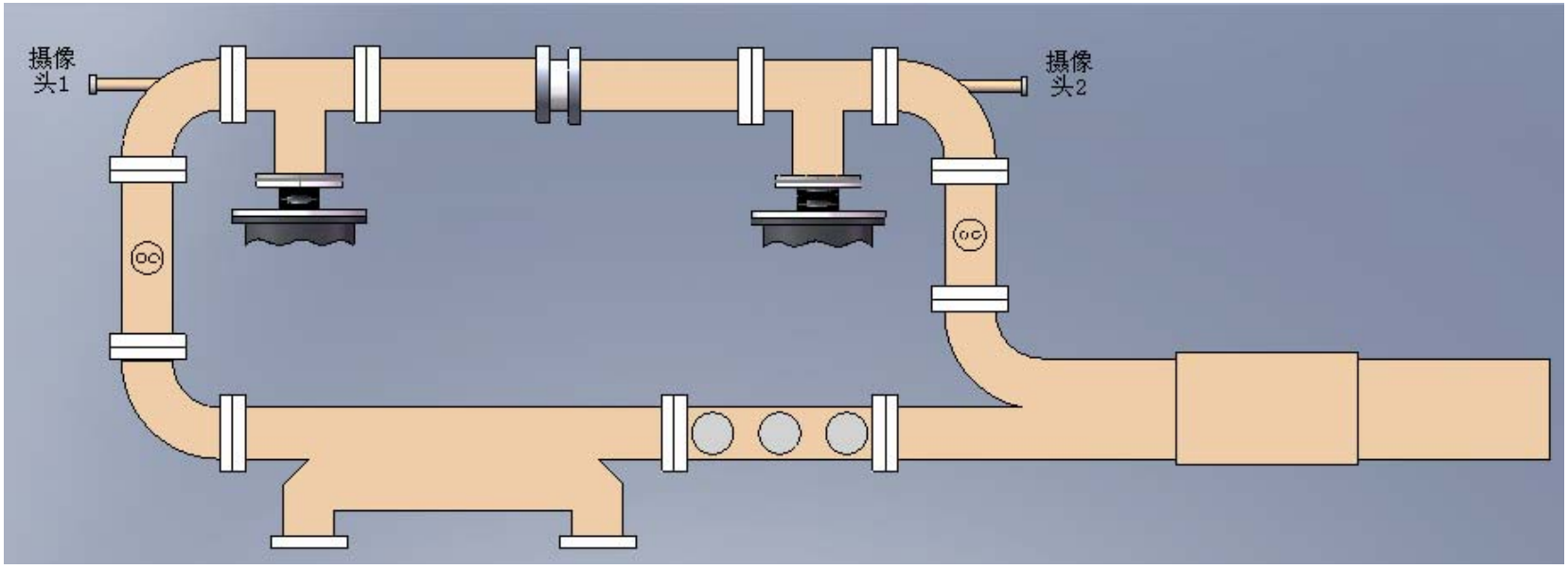
(@13dB attenuator)

> 240MW@2us, >200MW@3us

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

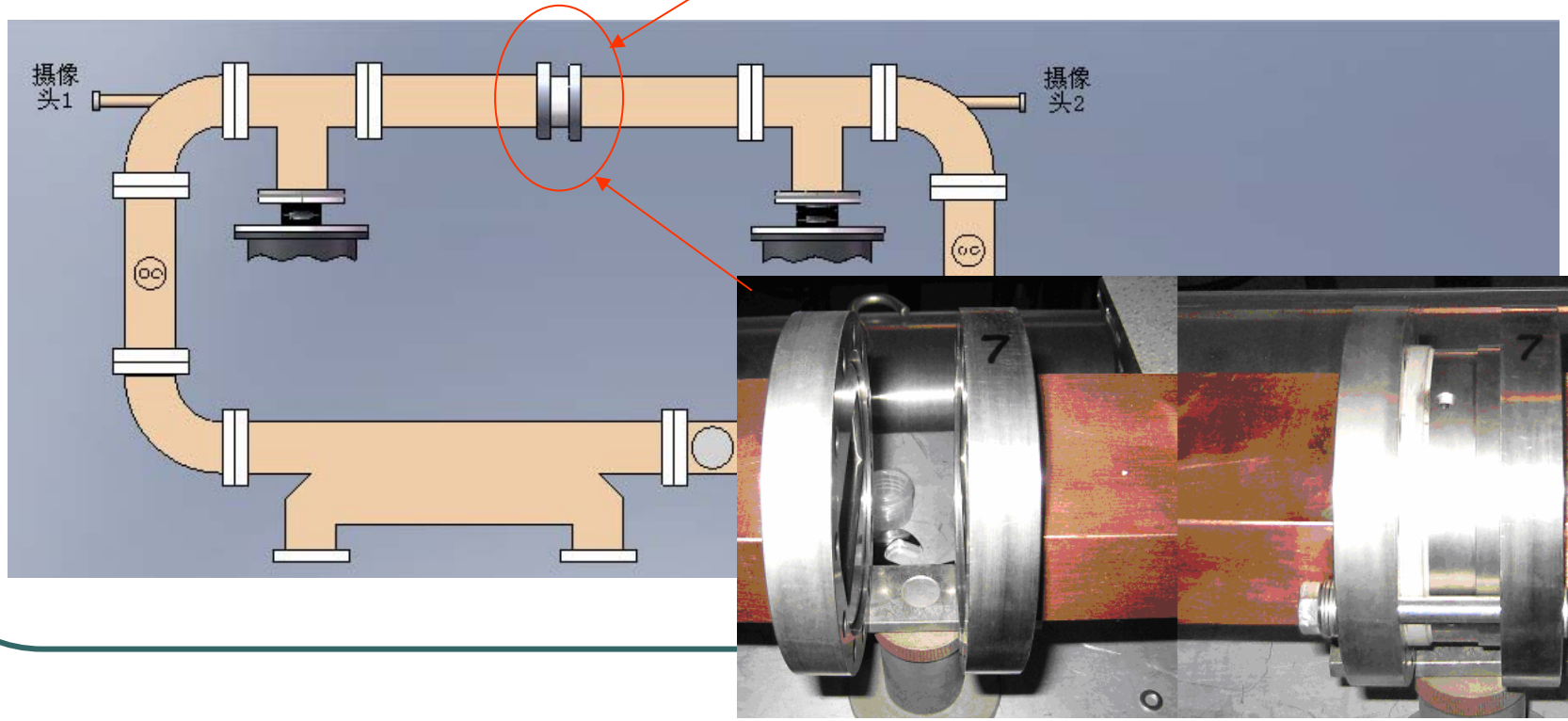
Experiment on ceramic window



200MW resonant ri

國科學院高能物理研究所
stitute of High Energy Physics
Chinese Academy of Sciences

Experiment on ceramic windo



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

200MW resonant ring R&D

There are seriously arcing on the surface of the window @Pulsed Power

~100MW

~50MW

200MW resonant ring R&D

Further work

Window fabrication:

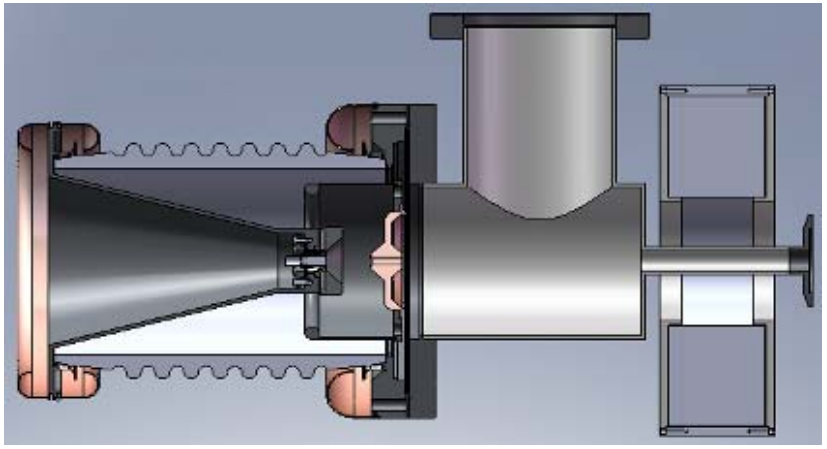
welding,
coating,
titanium nitride thickness

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

1A Gun for irradiation application

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

1A Gun for irradiation application

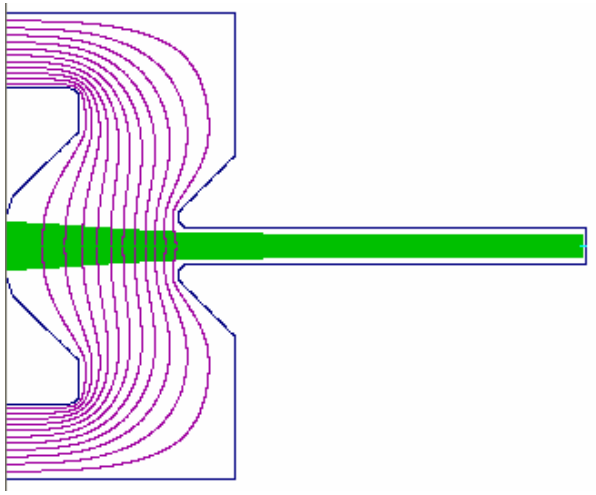


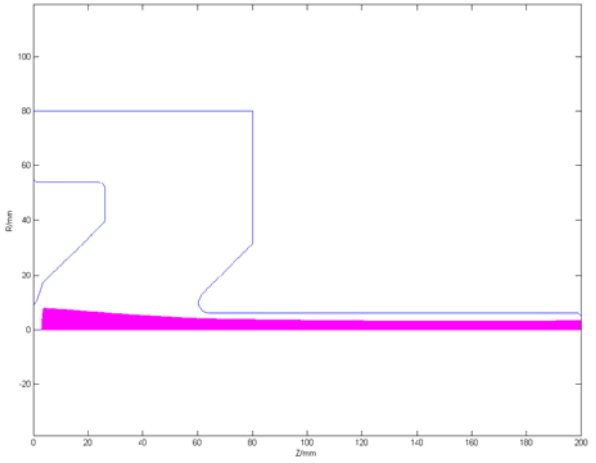
Application on irradiation accelerator for a Chinese Company

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

1A Gun for irradiation application

Pulsed Voltage: 80kV, Emission current: ~1A @22us, 360Hz





Cathode DIA: ~Φ8mm

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

2A Gun for irradiation application

Cathode & cathode grid selection (two-pole gun and triode gun)

EMIAC Y646B

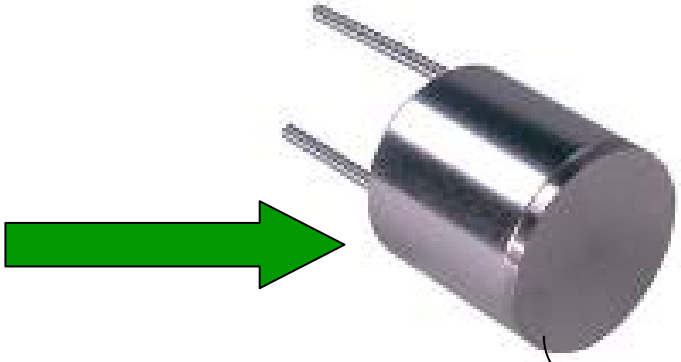
HeatWave 101103

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

2A Gun for irradiation application

Expensive price on Y646B

$: 6,000



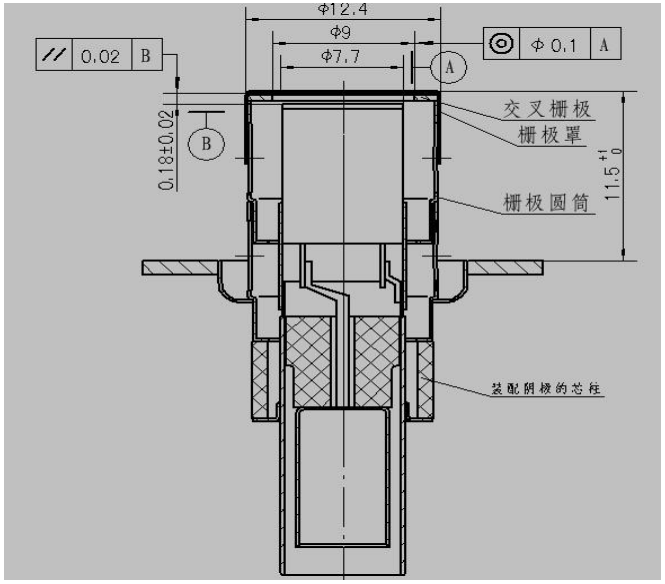
+ later processing costs

¥ : 8,000

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

2A Gun for irradiation application

China-made cathode grid supports:



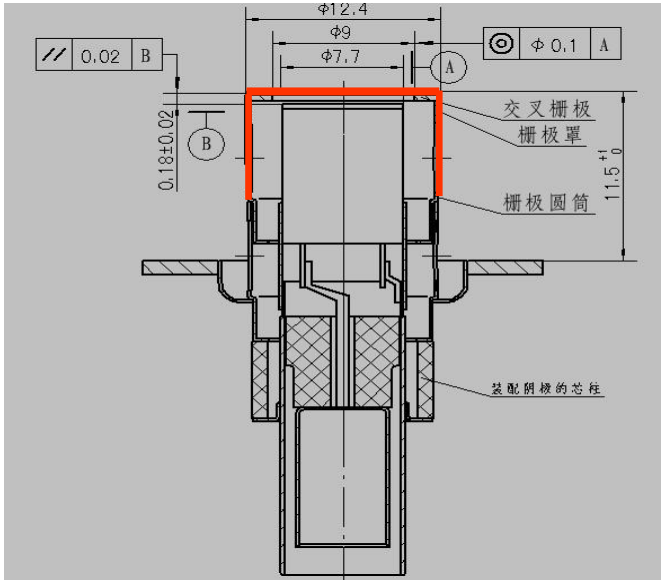
Cathode grid assembly for triode gun

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

2A Gun for irradiation application

China-made cathode grid supports:

grid



Cathode grid assembly for triode gun

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

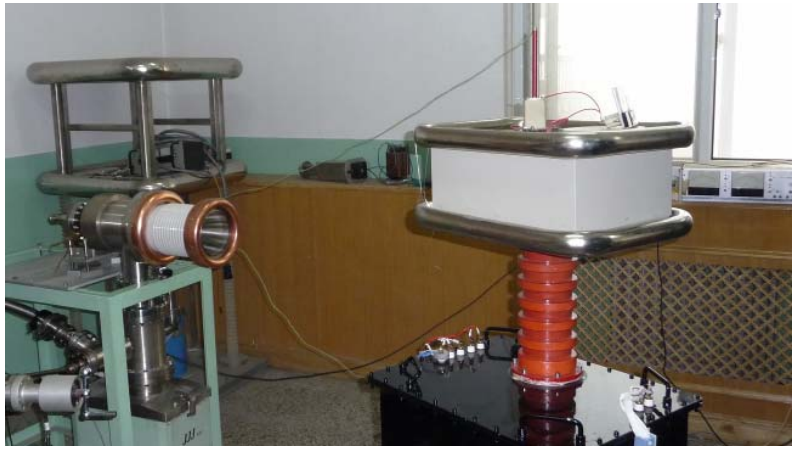
2A Gun for irradiation application

The cathode grid assembly and sealing ring

2A Gun for irradiation application

Gun conditioning @test stand

Installation



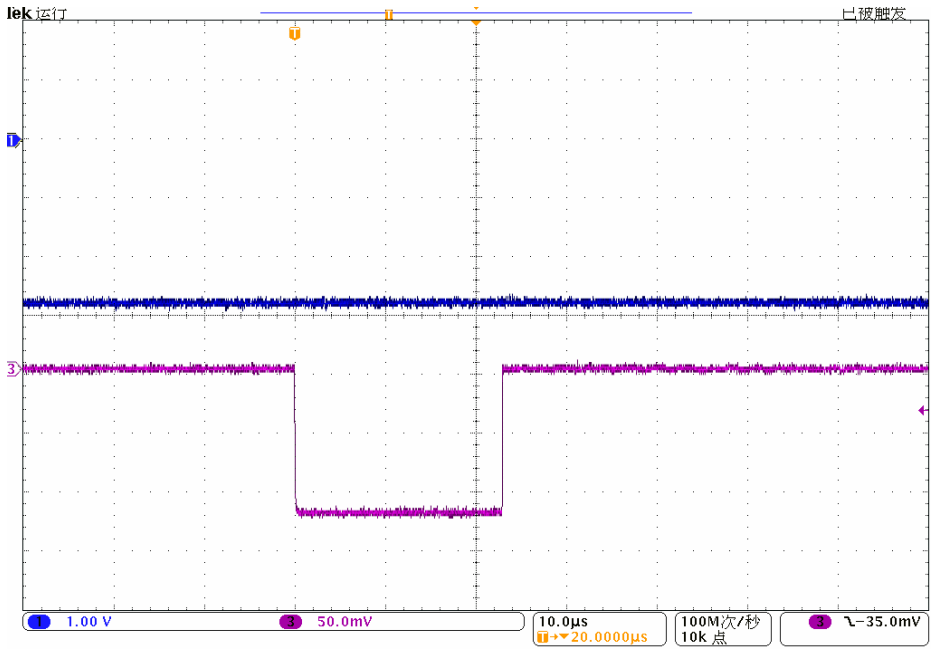
中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

2A Gun for irradiation application

Gun conditioning @test stand

Test Results:

High Voltage: 75kV
Emission Current: 2A
Cathode Filament: 1.9A/9V
Pulser Width: 22us
Repetition: 360Hz
Pulser Voltage: 300V
Bias Voltage: -35V



中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

2A Gun for irradiation application

Gun commissioning @Company tunnel

Installation

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

2A Gun for irradiation application

Gun commissioning @Company tunnel

Further commissioning about the gun maybe on the October, 2010

Depending on other system:
Klystron, modulator, vacuum, etc…

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

Summary

- **65MW klystron fabrication is well done. We hope the test results of the repaired prototype klystron will be okay on Oct. this year.**
- **Resonant ring operation well. It will be used for studies on klystron windows and other microwave devices.**
- **1A electron gun is completed test on test stand, the further site commissioning will be done in the near future.**

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

THANK YOU