A Beijing Radio-activity ion-beam facility (BRIF)

&

Compact pulsed hadron source

Guan Xialing（CIAE & TU)

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content

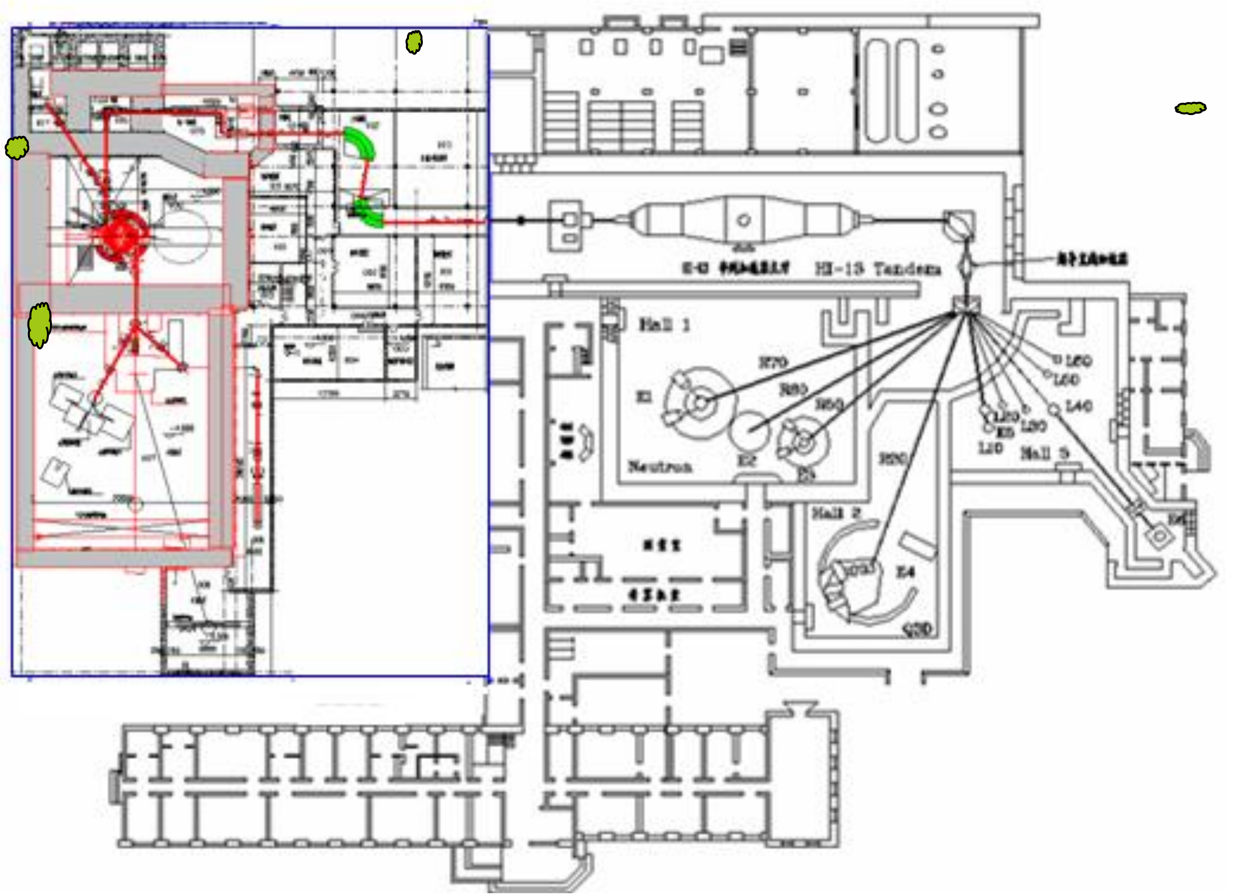
- **A Beijing Radio-activity ion-beam facility (BRIF) at China Institute Atomic Energy**
- A Compact Pulsed Hadron Source (CPHS)at Tsinghua university

Beijing Radio-activity ion-beam facility BRIF Status

- A project of Beijing Radioactive Ion-beam Facility is under constructed in China Institute of Atomic Energy (CIAE), which is composed of a compact proton cyclotron, a on-line isotopic separator and a superconducting linac booster.
- The first beam will be get in the end of 2013.
- The total budget of this project is about 400million yuan (60M$)

A Beijing Radio-activity ion-beam facility (BRIF)
At China Institute Atomic Energy

1. A 100 MeV/200uA proton cyclotron
2. An isotope separator on line system
3. A super conducting Linac booster model



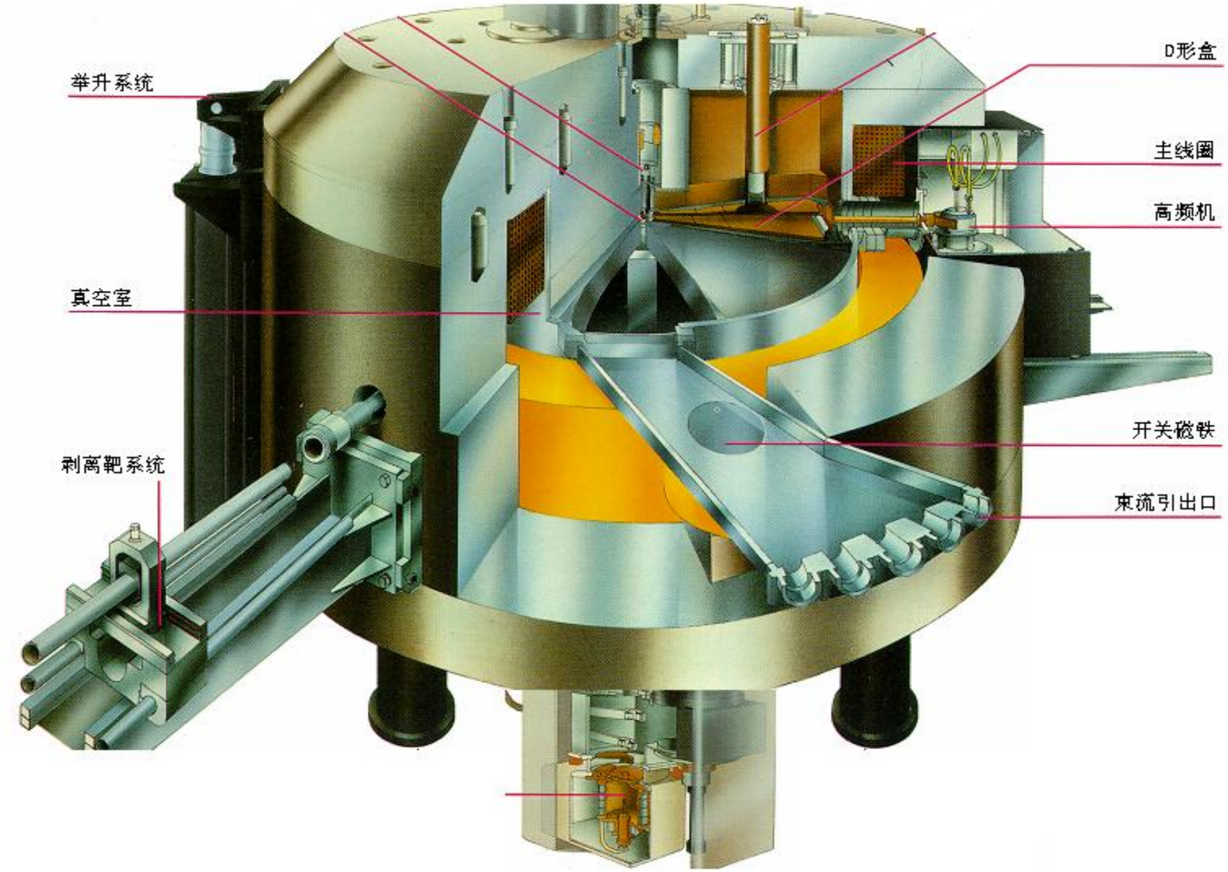
CPHS

Driving cyclotron accelerator

Proton

Energy: 100 MeV

Intensity 200 μA



CYC main magnet under construction

100MeV cyclotron is under construction

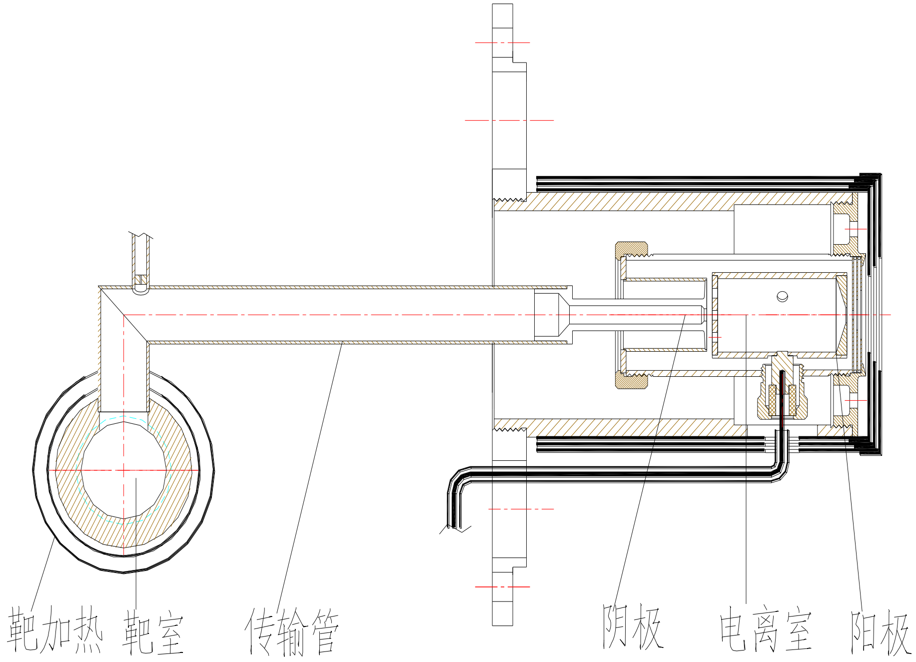
ion source

At the ISOL system, RNB are produced in a thick high temperature target via spallation, fission or fragmentation reaction.

The reaction products are released from the target via diffusion and effusion and bass through a tube to ion source.

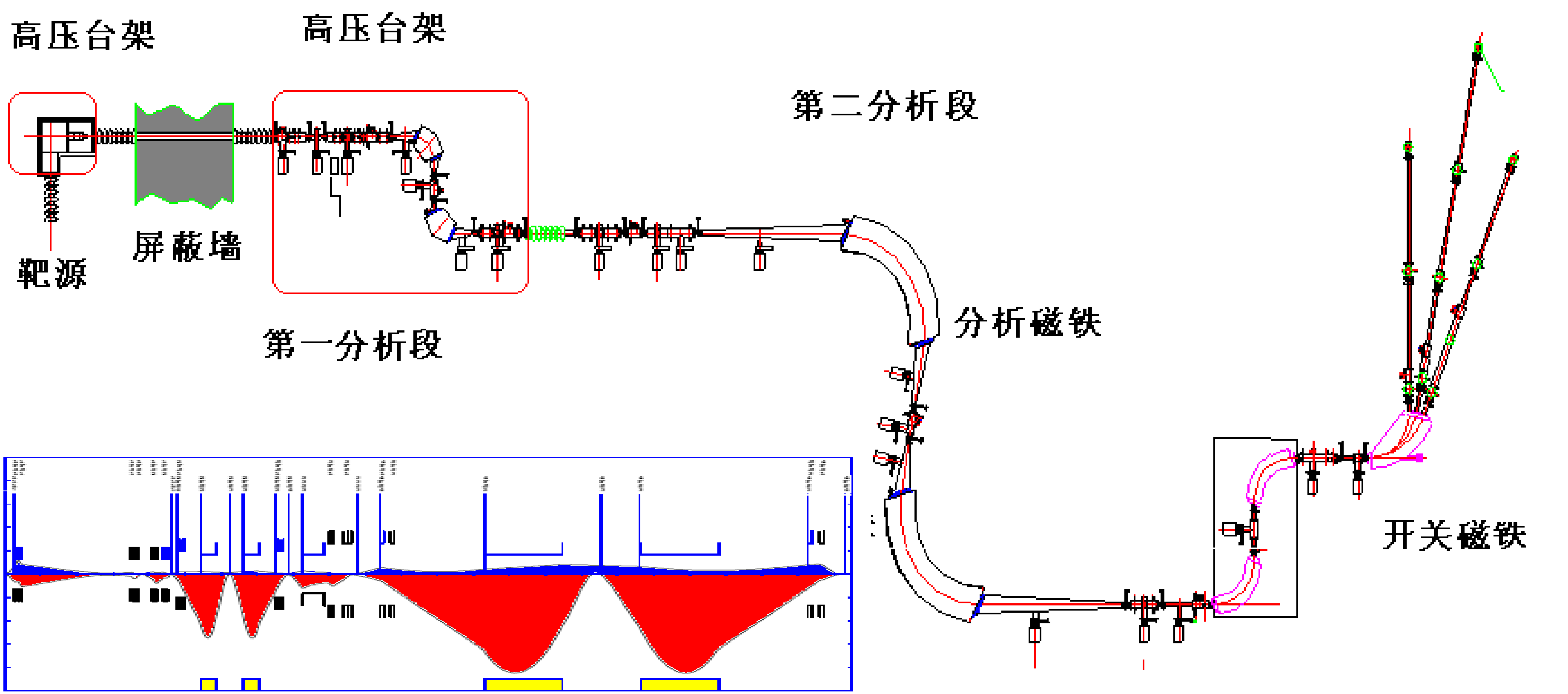
The ion source of our ISOL are electron beam plasma ion source,

A prototype radioactive target/ion source has been developed at CIAE.

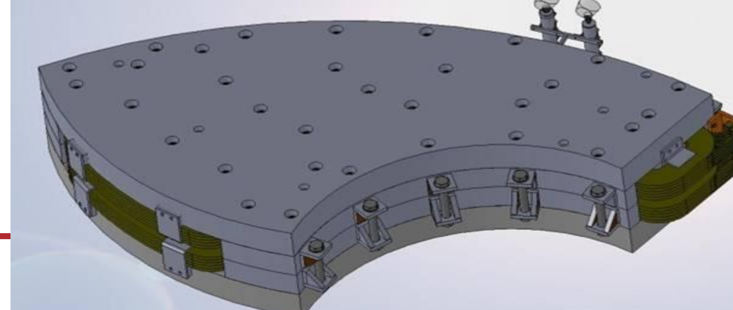


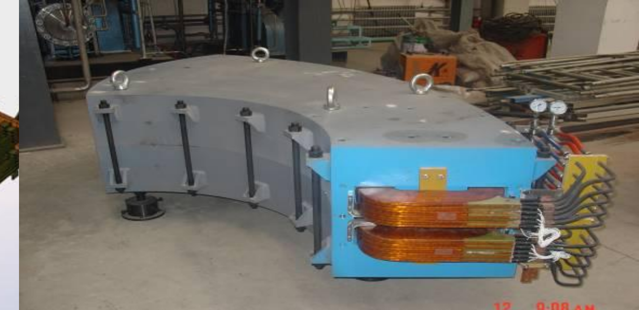
Isotopic separator
two isotopic magnetic analyzers 90°
ρ= 0.6 m
mass resolution: 1000;

Isobar separator.
high-voltage platform with potential up to 300 kv
two isobar magnetic separation: 100°
ρ=2.5m
mass resolution :20000



ISOL magnets





The target process chamber 2012.6.

ISOL magnet 100 Deg.

Target test table： 2010 12

High intensity neutron beam line

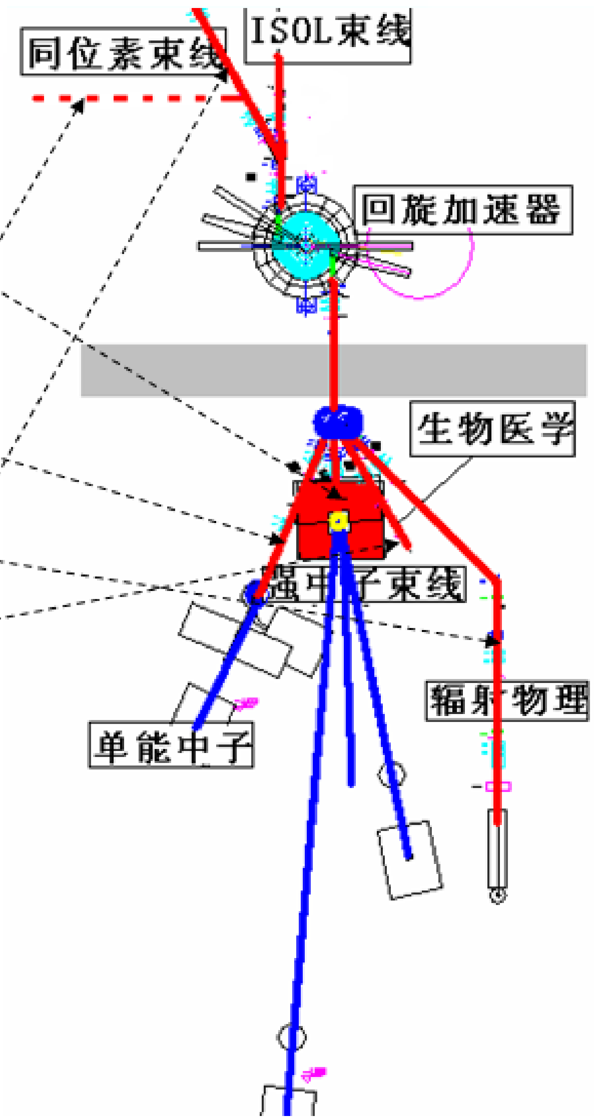
Single energy neutron line

Irradiation physics beam line

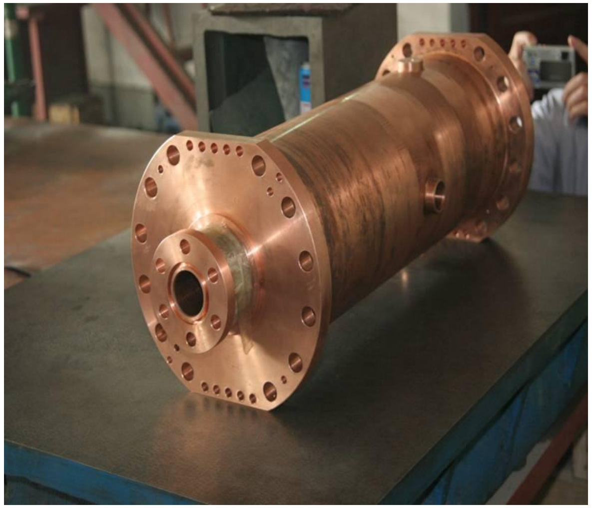
Biomedical beam line

Radiation isotopic beam line

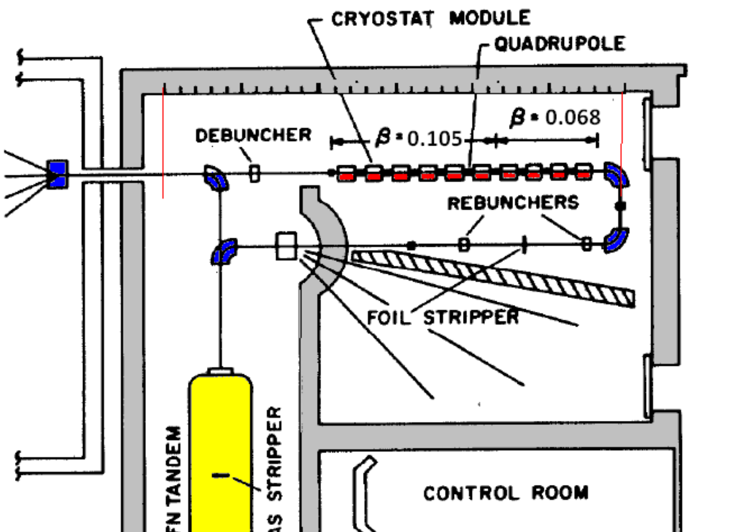
ADS test beam line

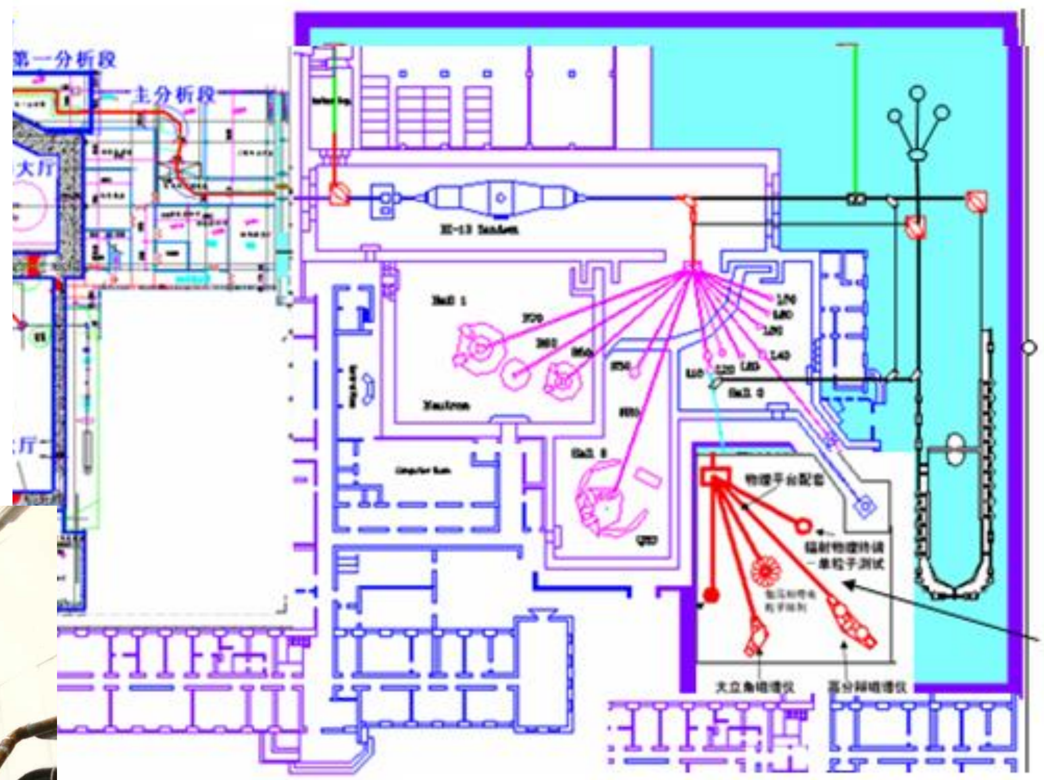


QWR sputtering



A Beijing Radio-activity ion-beam facility (BRIF)
At China Institute Atomic Energy





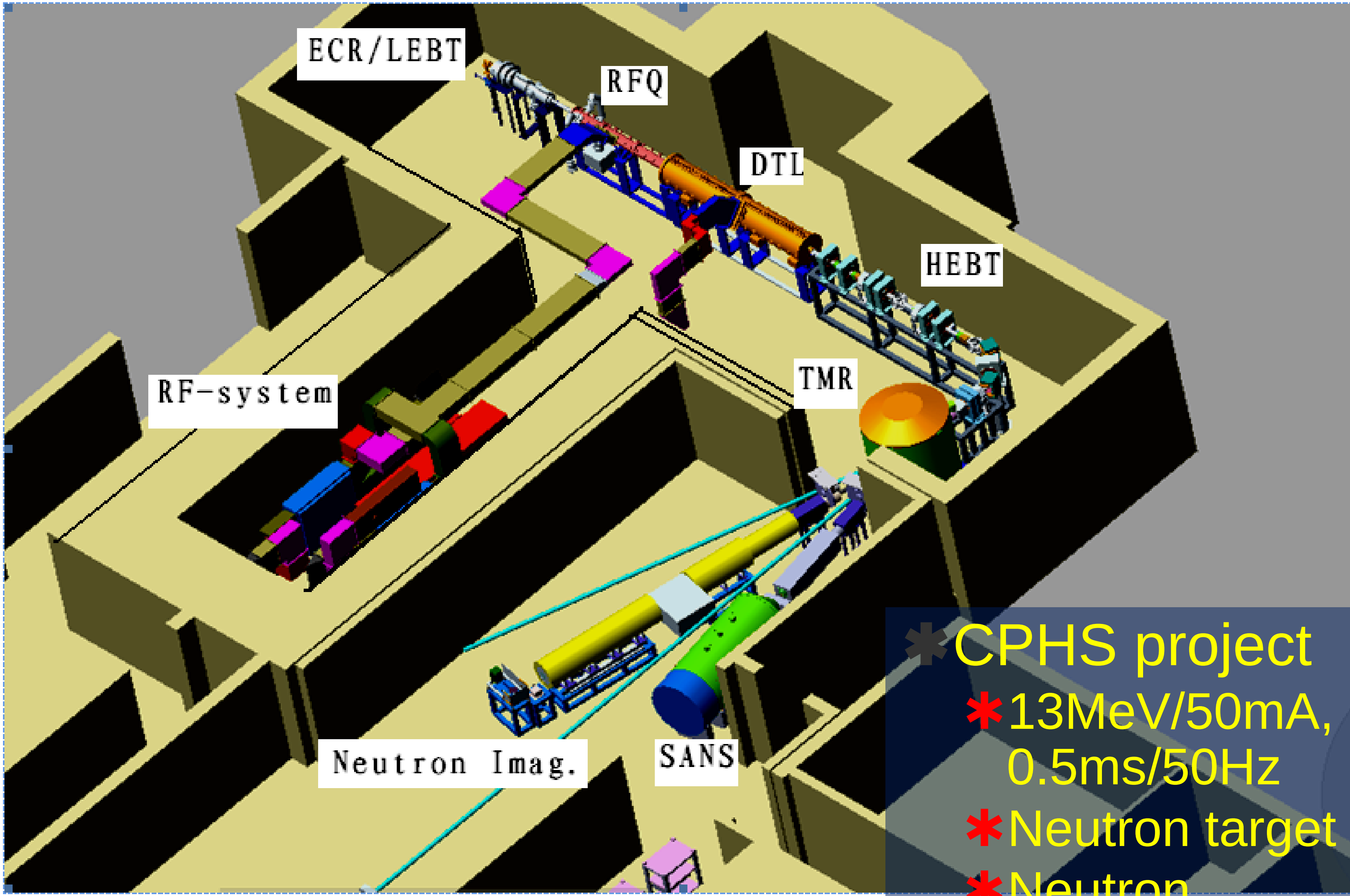
Compact Pulsed Hadron Source (CPHS)

status

A Compact Pulsed Hadron Source (CPHS) has been developed in Tsinghua University Beijing.

The Accelerator parts consists of

- A high-intensity ECR ion source and lebt
- A 3 MeV radiofrequency quadrupole linac (RFQ),
- A 13 MeV drift-tube linac (DTL),
- HEBT and neutron target .



- CPHS project
  - 13MeV/50mA, 0.5ms/50Hz
  - Neutron target
  - Neutron instrument

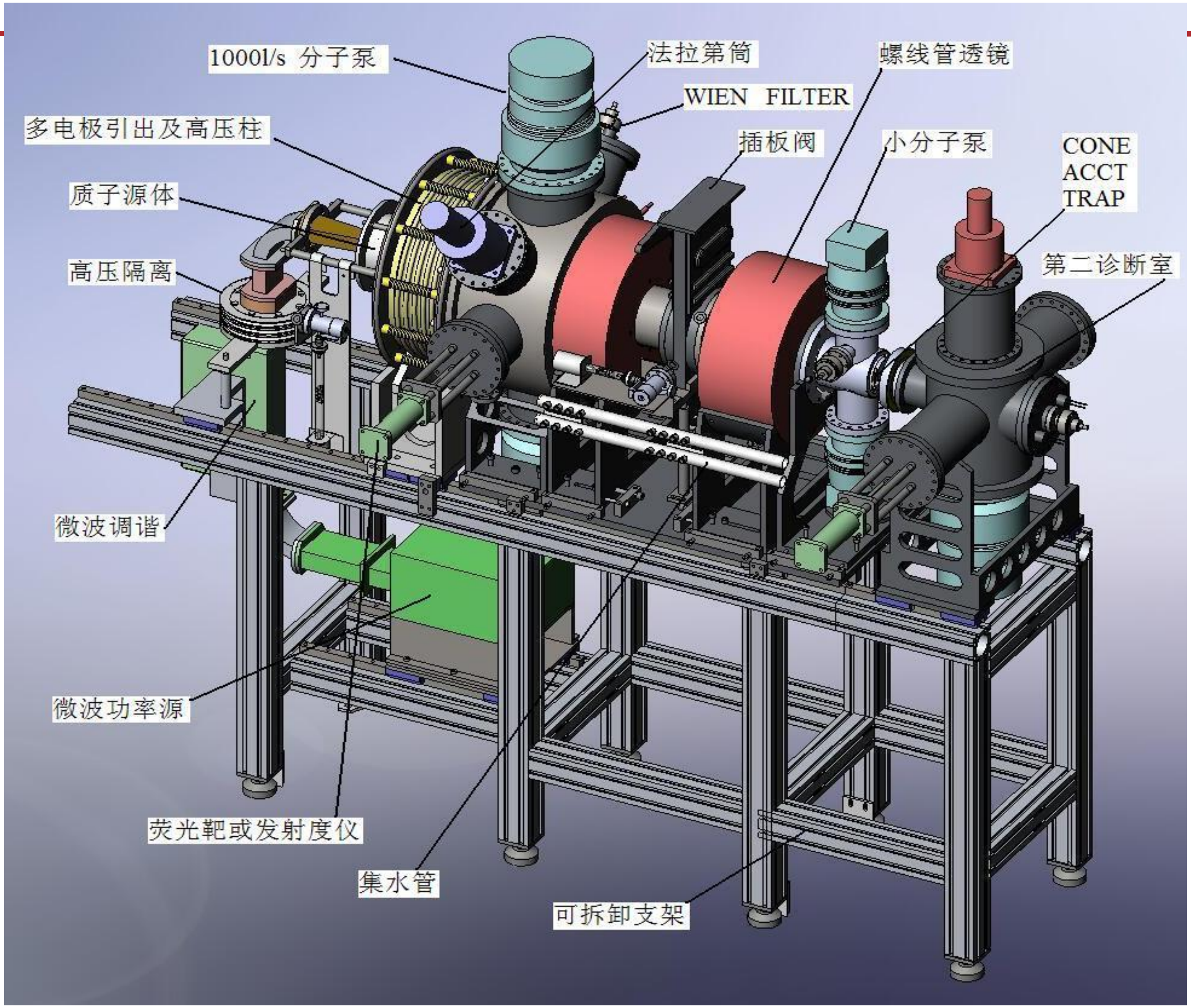
Main parameters of CPHS

Species	proton	
Beam power	16	kW
Output energy	13	MeV
Average Current	1.25	mA
Repeat. frequency	50	Hz
Particle per pulse	1.56×10^{14}	Protons
Duration of pulse	500	µs
Peak current	50	mA
Beam duty factor	2.5	%
RF frequency	325	MHz
Ion source extraction energy	50	keV
RFQ output energy	3	MeV
DTL output energy	13	MeV

ECR Ion source

1.	Species	p
2.	Energy	50 keV
3.	Current	60 mA
4.	Emittance	<0.20 πμ, norm, rms
5.	Lifetime	>120 hours
6.	Frequency :	2.45GHz
7.	Power :	1.5～2.0kW
8.	Proton ratio :	>90%

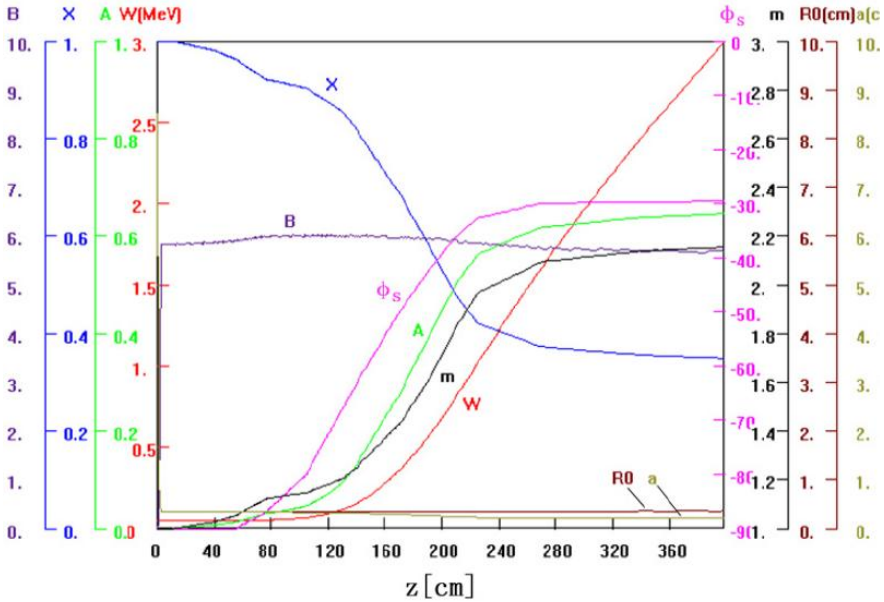
LEBT solenoids with H+V steerers inside:

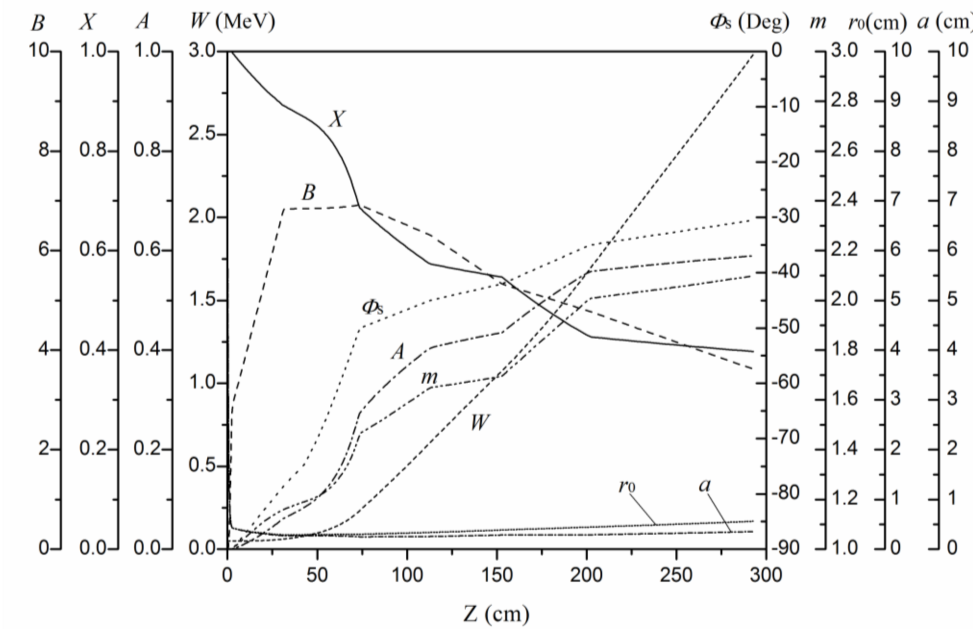


Physical design

- Main parameters for CPHS RFQ

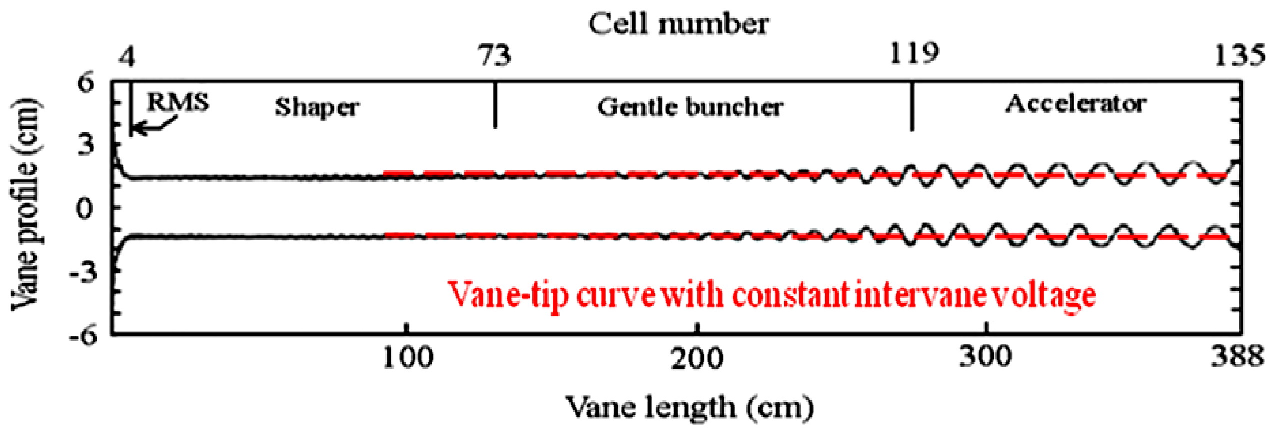
Species	Proton
Type	Four-vane
Frequency	325 MHz
Input beam energy	50 keV
Output beam energy	3.0 MeV
Peak current	50 mA
Emittance (norm. rms)	0.2π mm•mrad
Maximum surface field	32 MV/m (1.8Ek)
Pulse length	0.5 ms
Pulse repetition rate	50 Hz
RF peak power	538 kW
Beam duty factor	2.5%
Section number	3
Total length	296.87 cm

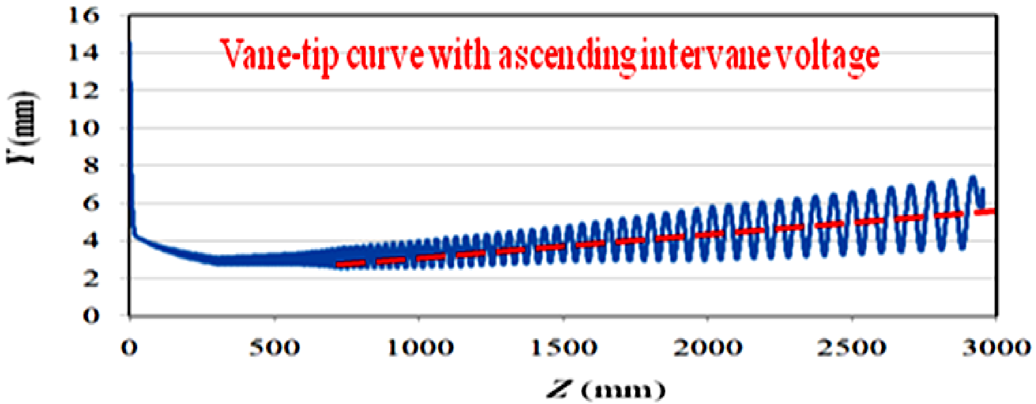


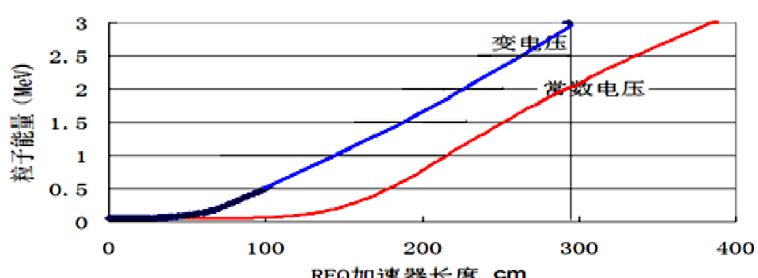


Distribution of main parameters for tow design version (left: constant V; right: vary V)

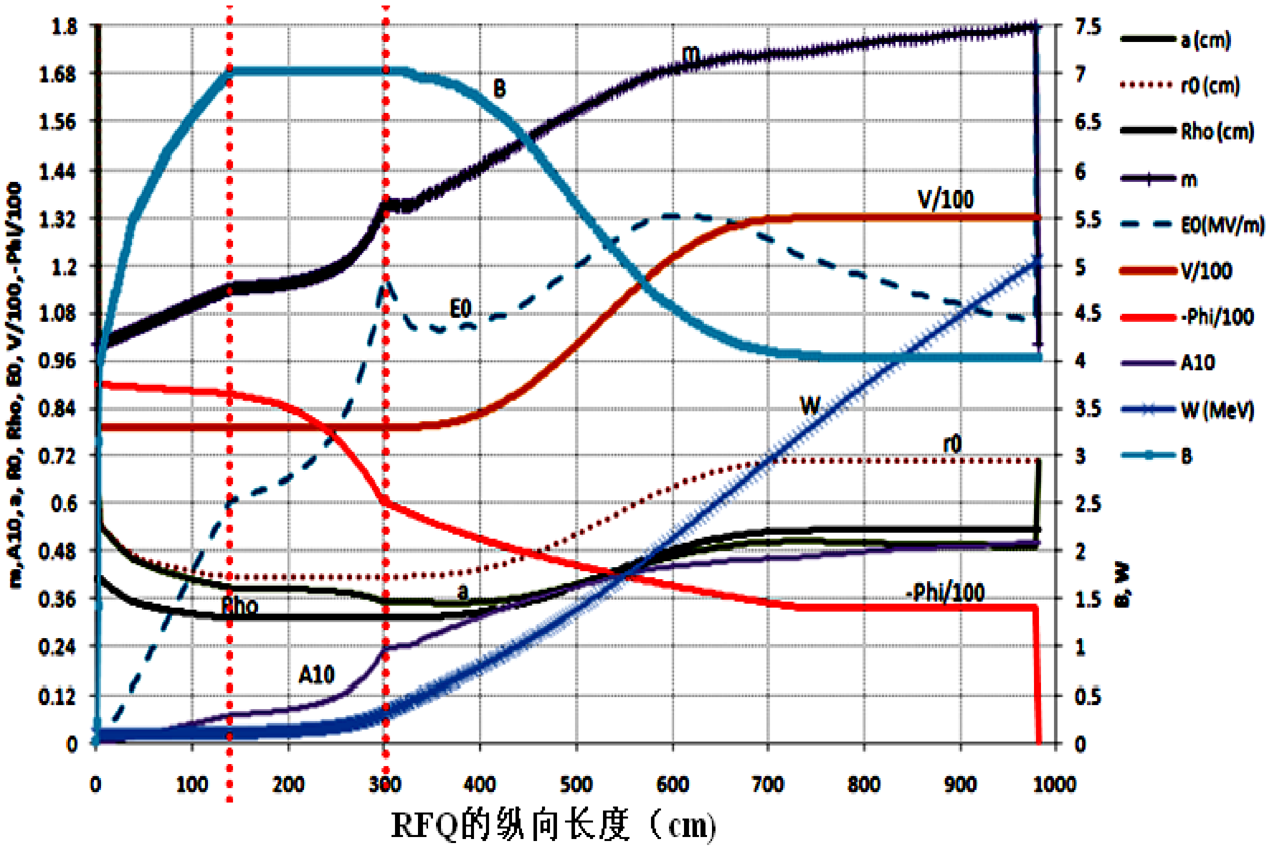
The length contrast for tow design version







IFMIF RFQ vary V design



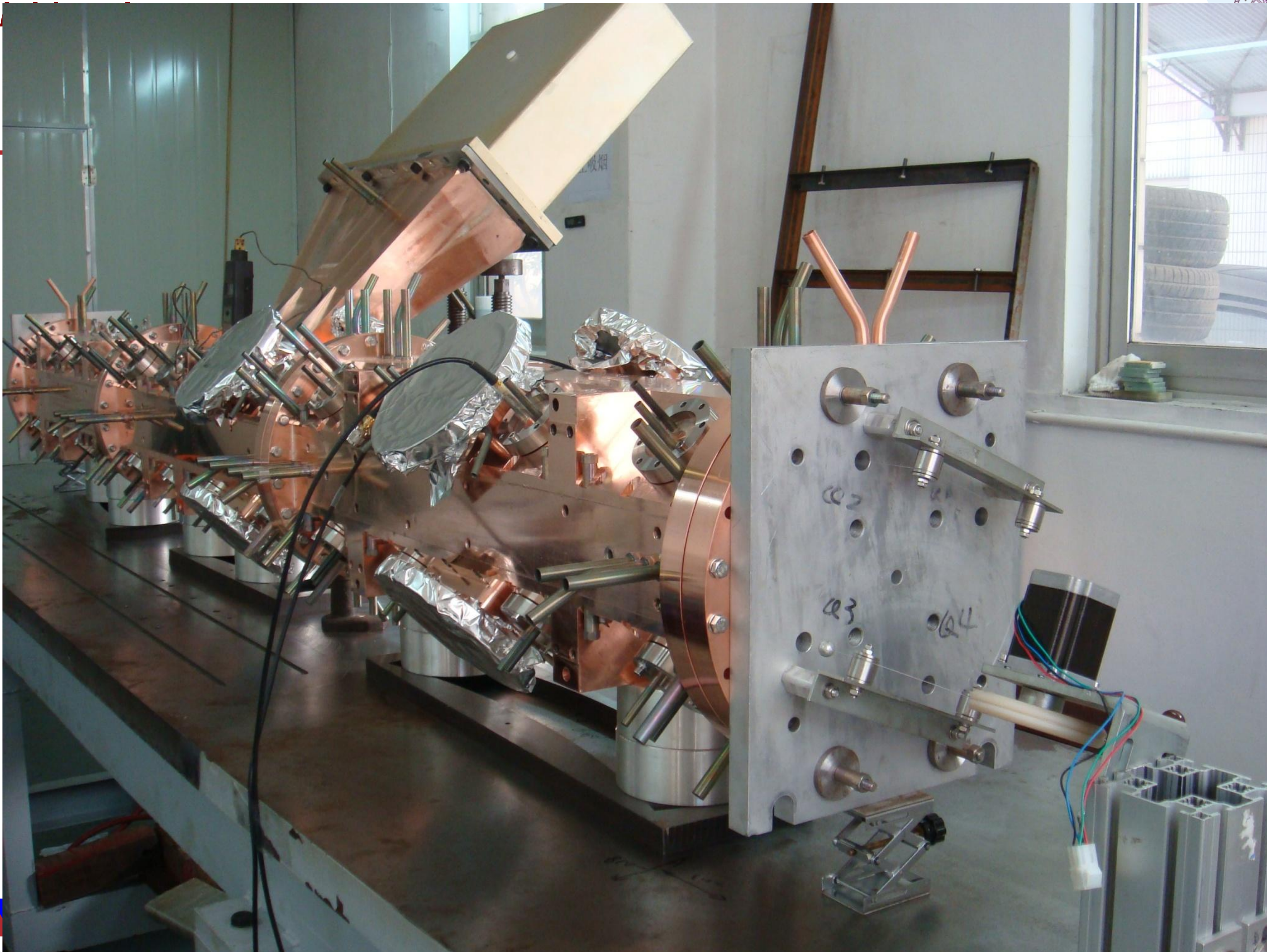
The Twiss parameters for CPHS

	Const B	Low B	
α	3.03	1.30	
β	0.135	0.109	m/rad

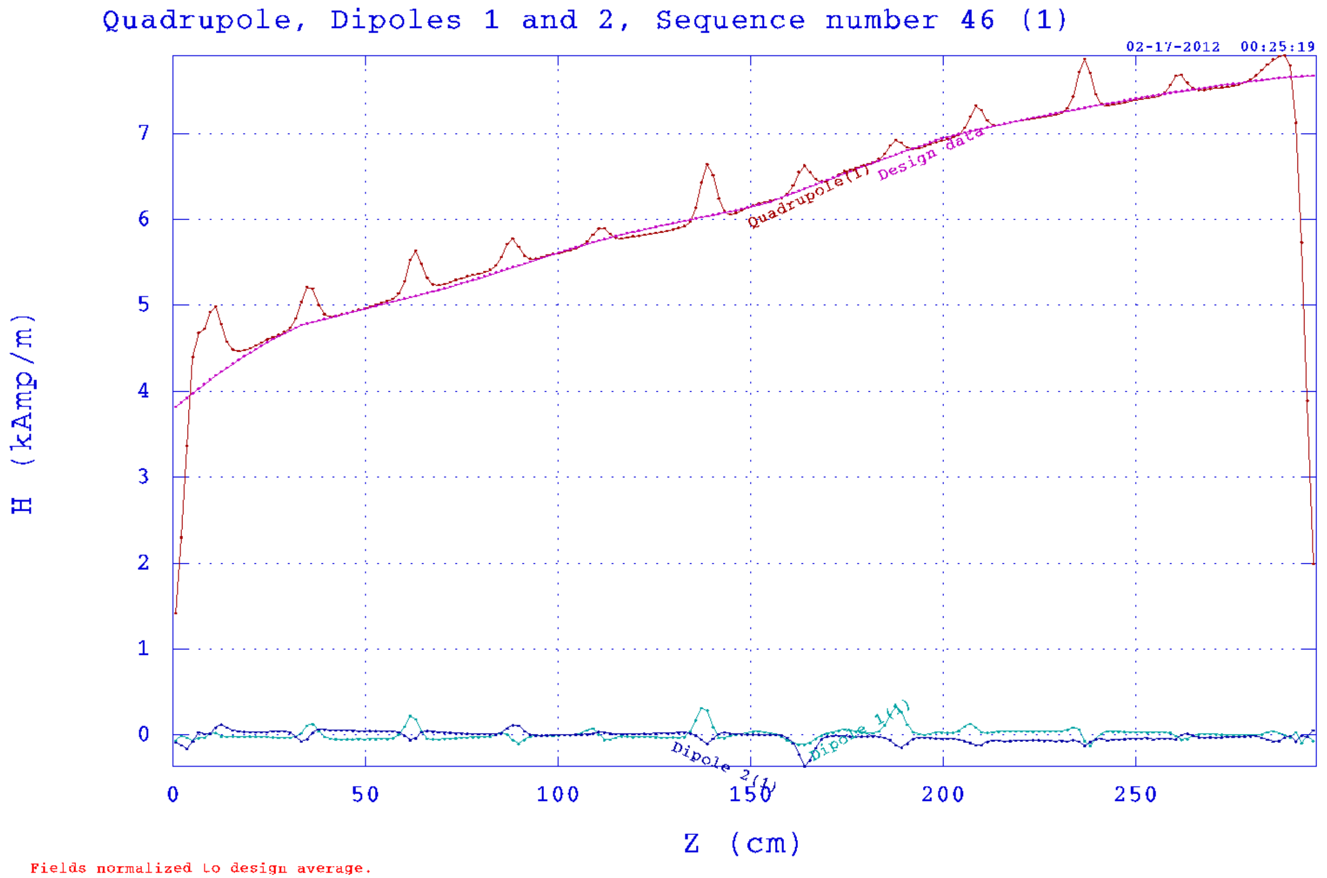
The Twiss parameters for IFMIF

	Const B	Low B	
α	2.10	1.35	
β	5.90 c	7.74	m/rad

Fi

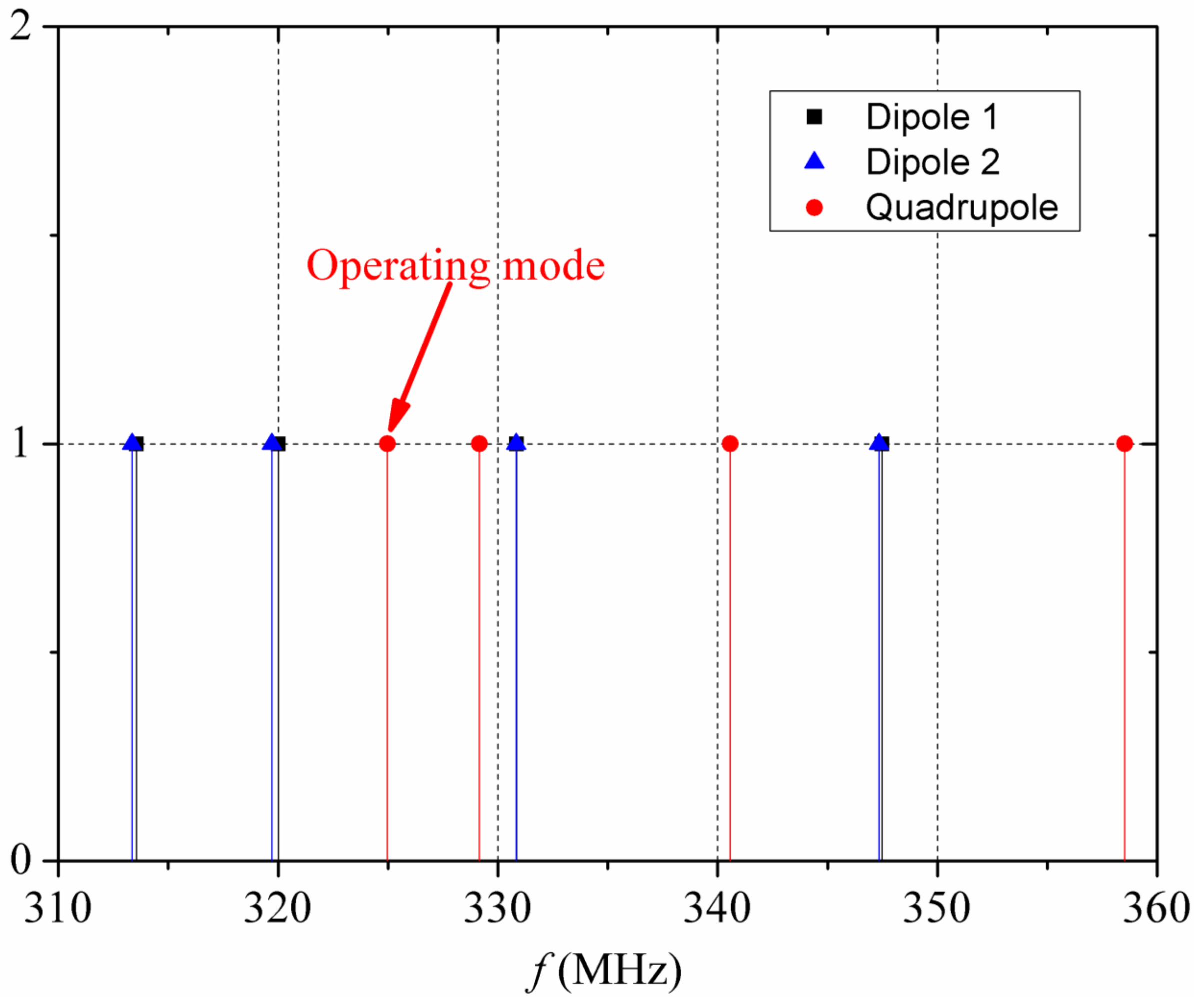


4. Field tuning



Quadrupole and dipole components after tuning

4. Field tuning

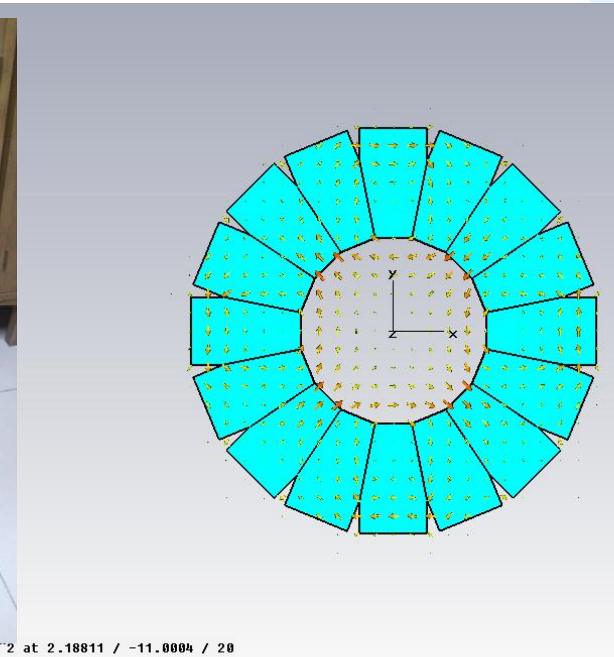


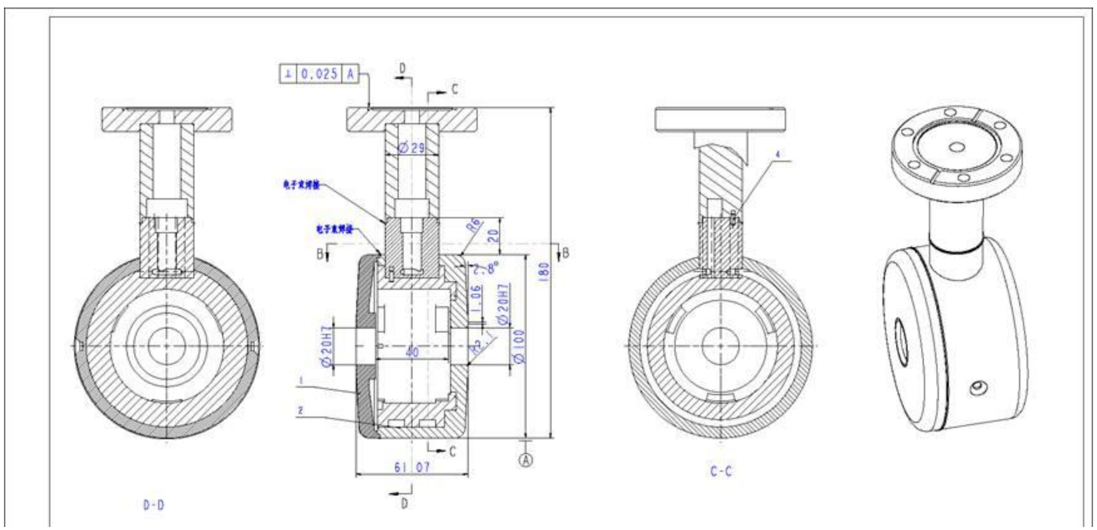
Frequency spectrum after tuning


1
2
3
4
2011 07 28

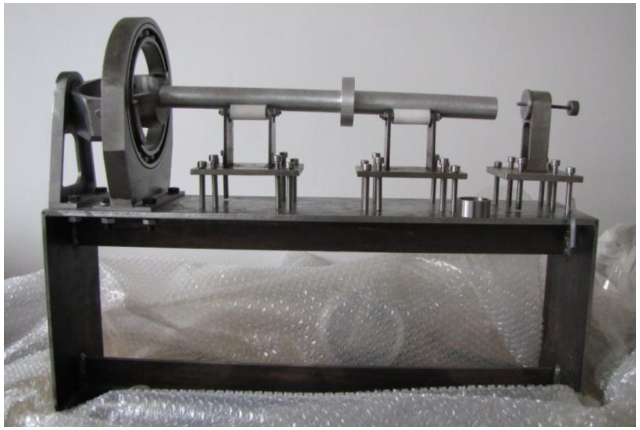
Design parameter DTL

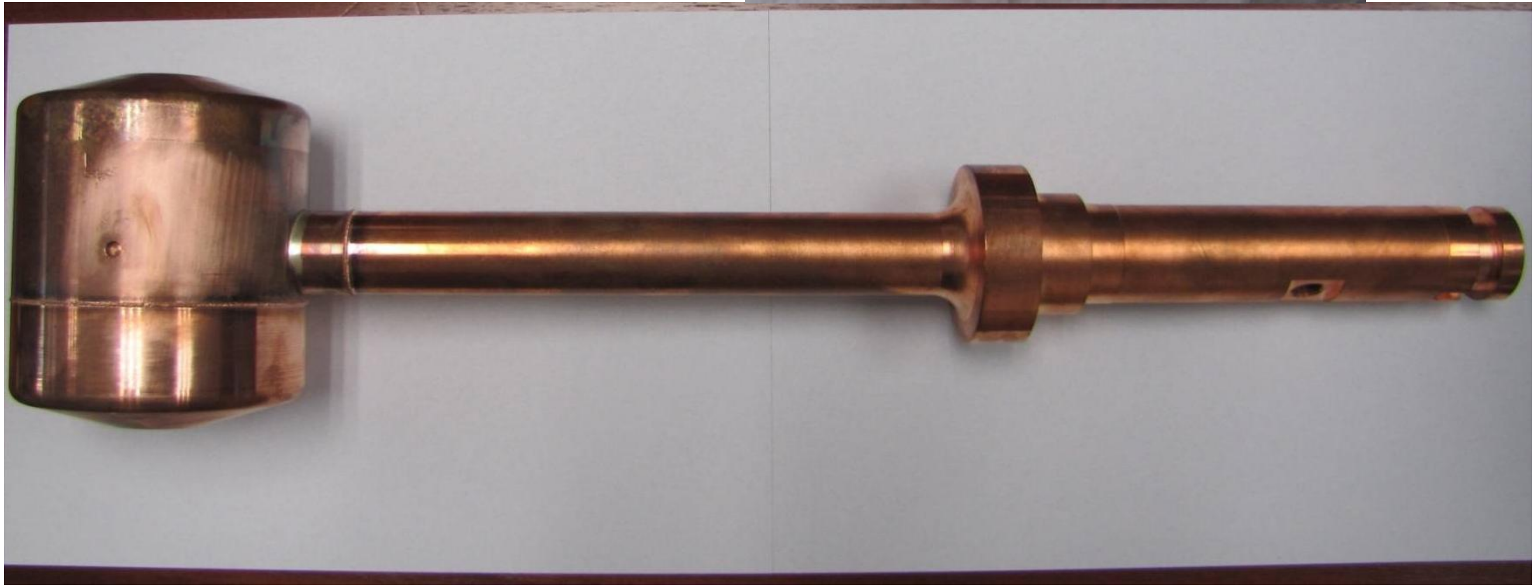
RF peak power	1.2	MW
RF duty factor	3	%
Synchronous phase	-30 to -24	degree
Accelerating field	2.2 to 3.8	MV/m
Focusing magnet type	PMQ	
Lattice type	FD	
Quad focusing gradient	8.34	kG/cm
Cell number	40	
Length	4.4	m


Maximum-2d 1.42957 Vs/m^2 at 2.18811 / -11.0004 / 20


⊥ 0.025 A
D-D
C-C
Ø29
Ø20H7
Ø100
180
40

DT picture





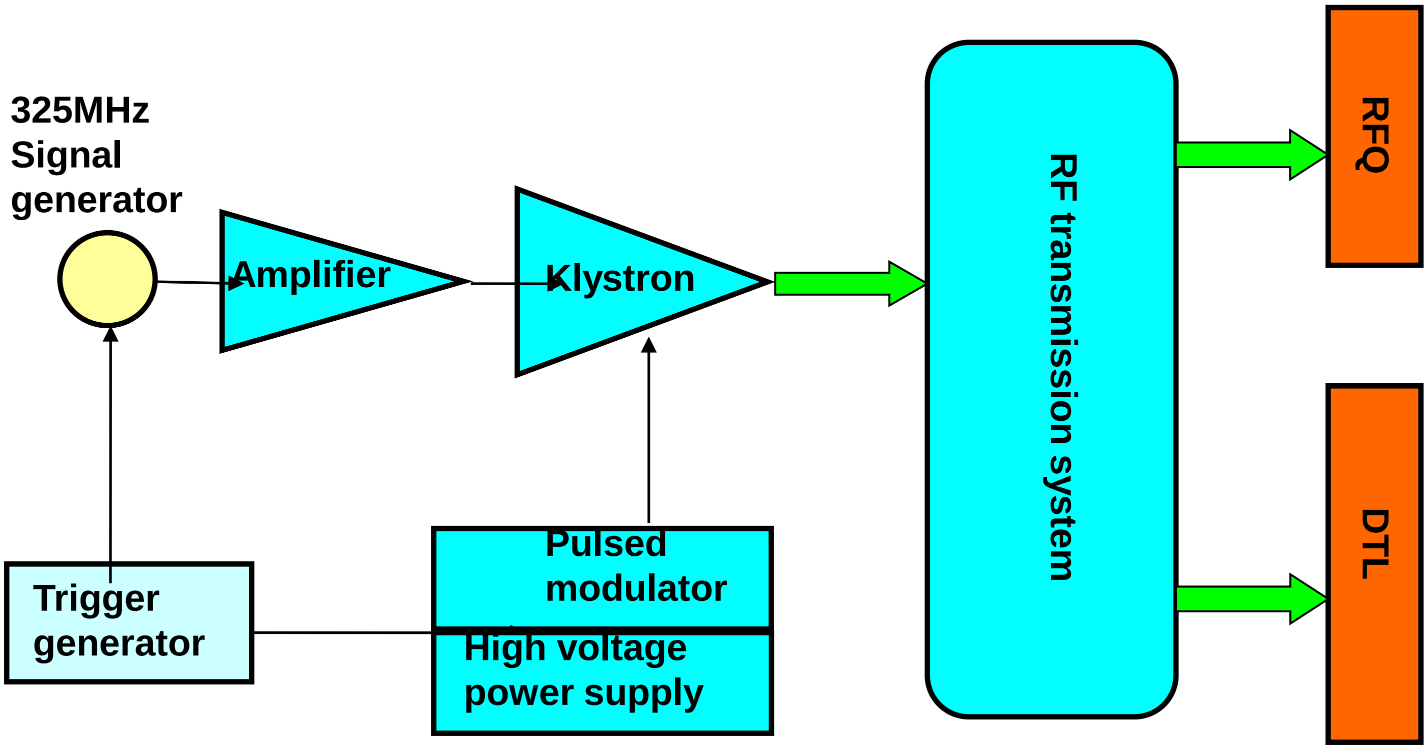
CPHS RF SYSTEM

Basic parameters

■ **Frequency:**	**325 MHz**
■ **Klystron output power :**	**2.5 MW**
■ **Repetition rate:**	**50 Hz**
■ **RF pulse width:**	**0.7ms.**
■ **RF amplitude error:**	**±1%**
■ **RF phase error:**	**±1 deg.**

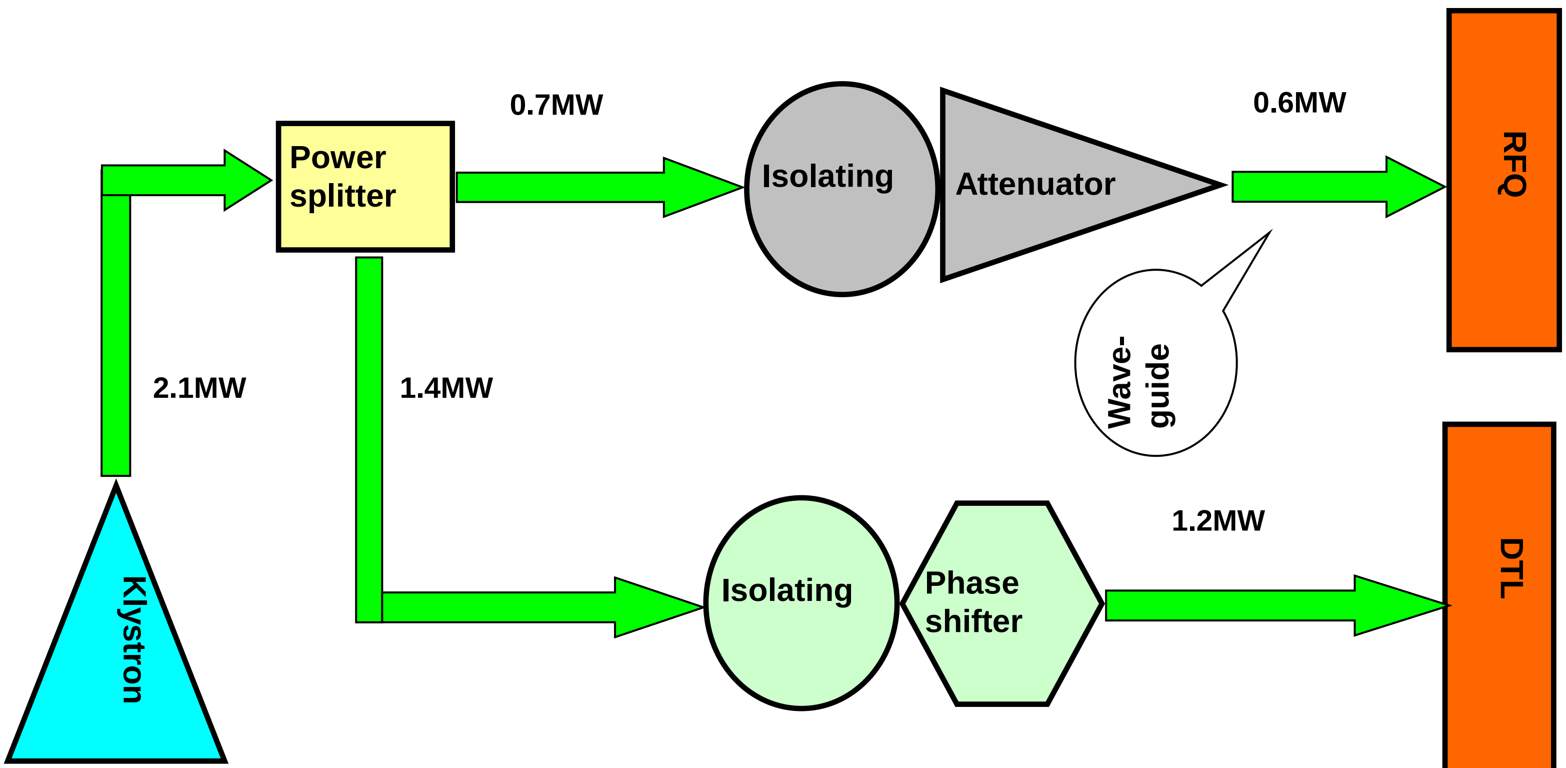
RF power system

- RF power system consists of signal generator (325MHz), amplifier, klystron, pulsed high voltage power supply, modulator, crowbar, RF transportation subsystem, control and interlock subsystem.

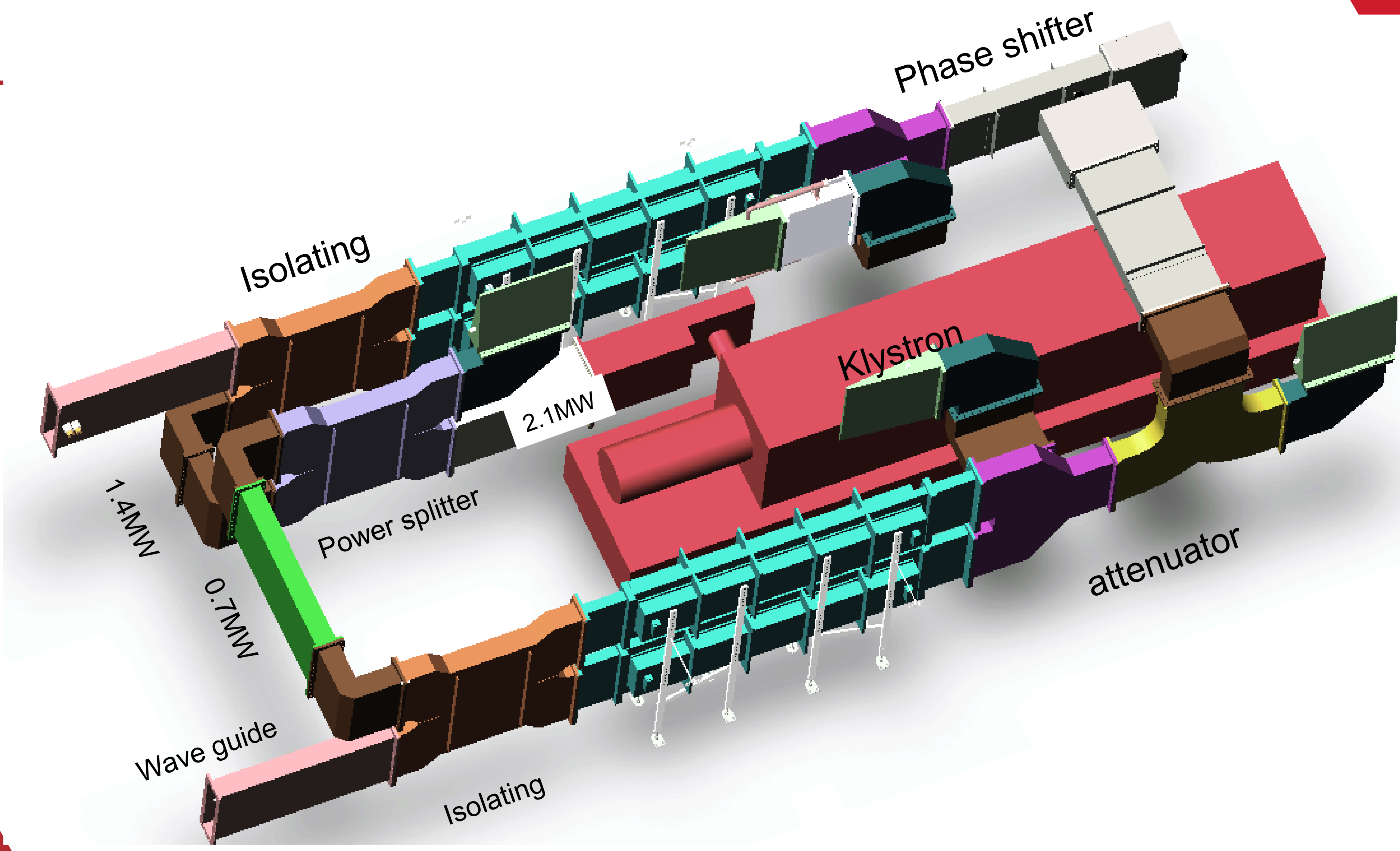


Block diagram of RF power system

Design of RF transmission



Block diagram of RF power transmission subsystem


Phase shifter
Isolating
Klystron
2.1MW
1.4MW
0.7MW
Power splitter
attenuator
Wave guide
Isolating

TMR

Target: beryllium

- 13MeV Be(p,n) reaction, 6.2e-3 n/p, ~3.3MeV
- 16kW heat deposition, water cooling

Moderator: solid methane

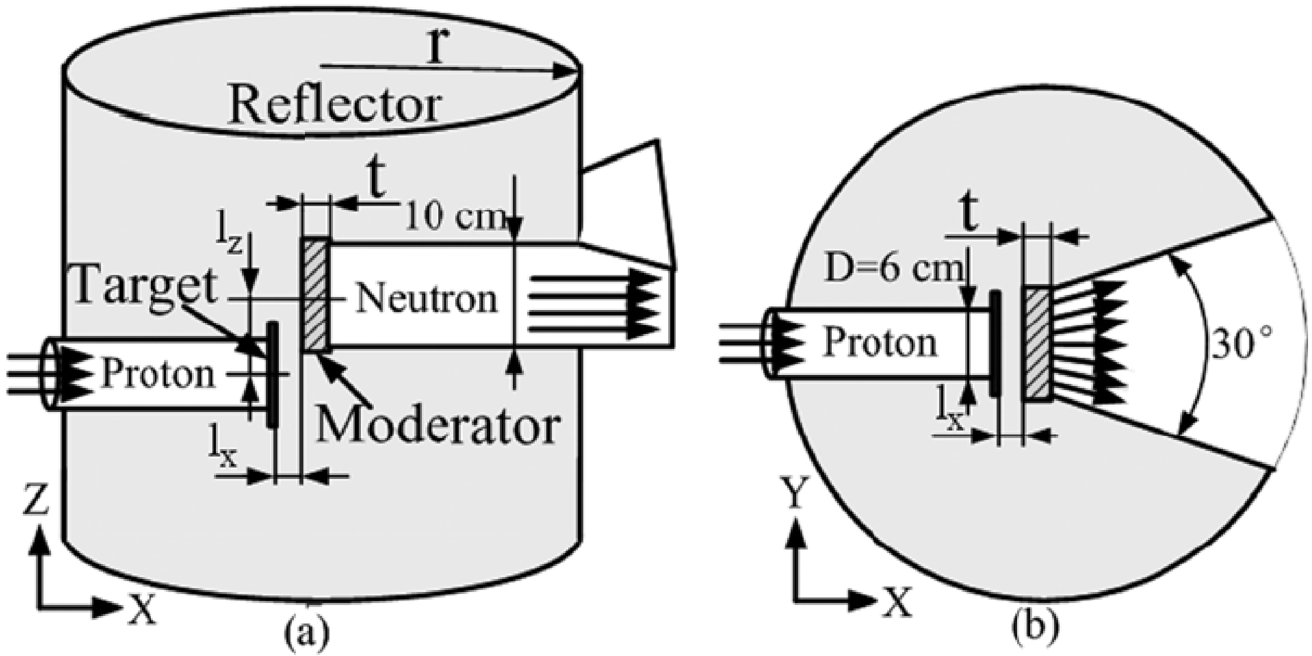
- PT410 refrigerator +pure Al rod for cooling

Reflector: light water

Shielding: borated poly. + lead

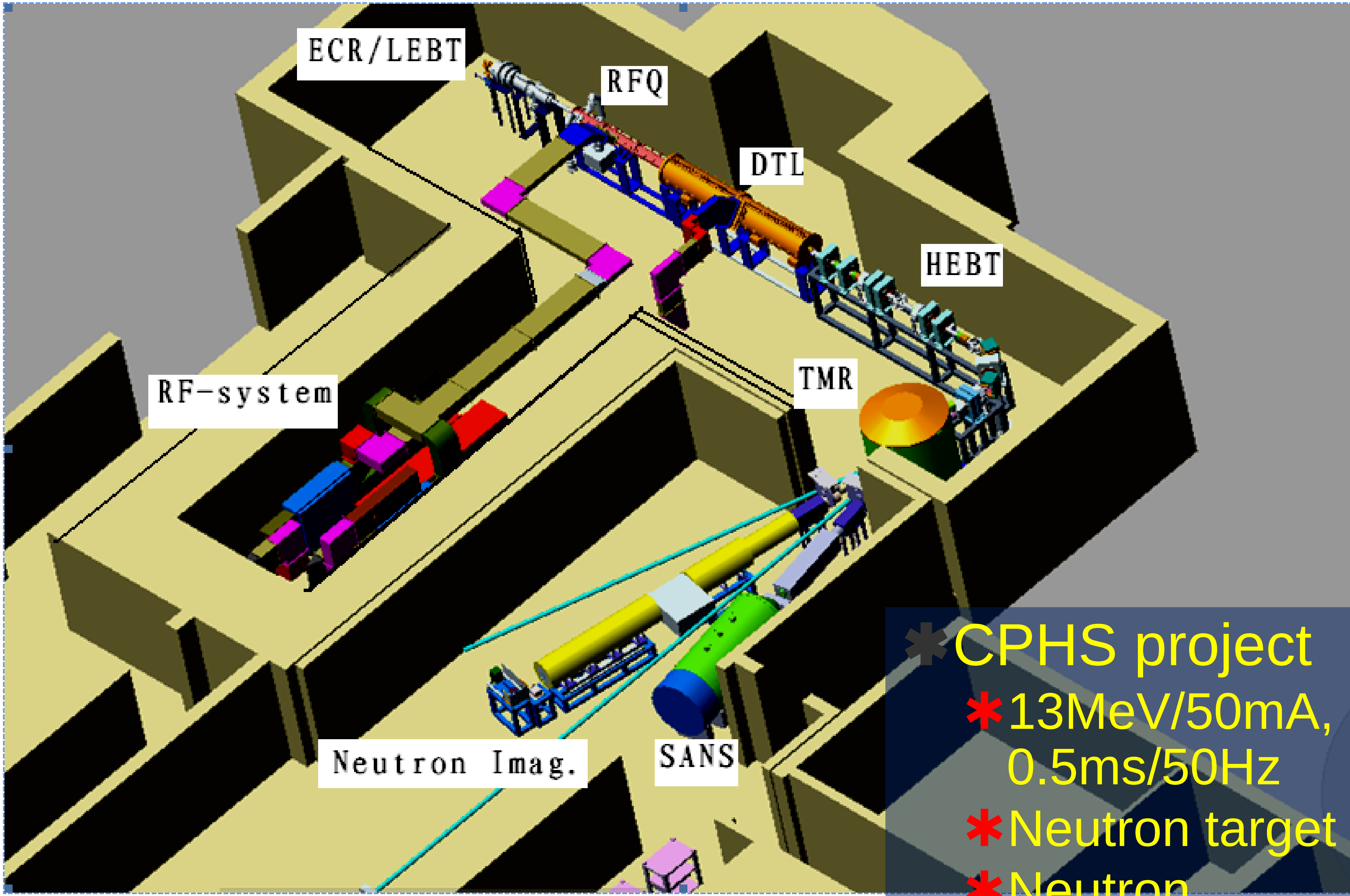
TMR Assembly

Proton beam : 13MeV, 16KW, average I=1.25 mA, 50Hz, 500μs
Target : Be, D=63.5mm, t=1.2mm
Moderator : solid methane, 20K, 110*110*18 mm
Reflector : light water, 300K



SLAB geometry of the TMR assembly

Thank Mr. B.Zhong and Mr. Q.X. Feng for providing the design documents of TMR and the following MCNP simulations



* CPHS project
  * 13MeV/50mA, 0.5ms/50Hz
  * Neutron target
  * Neutron instrument

ject
0mA,
Hz
arget
instrument

Thank You