IMP and collaboration with ESS

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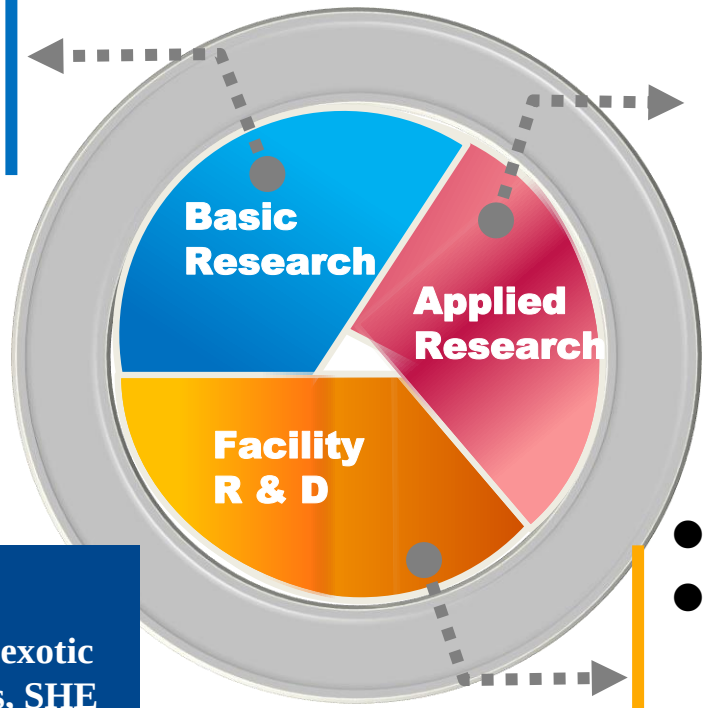
IMP and research fields

IMP is the biggest nuclear physics research center in China for heavy ion basic-science and nuclear technology application

- Nuclear physics
- Atomic physics
- Nuclear chemistry
- Radiation chemistry
- Material science
- Hadron physics
- High Energy Density physics
- Accelerator physics



- Radiation biology
- Radiation medical science
- Radiation material
- Advanced nuclear energy
- Nuclear-detector technology

- Ion Accelerator
- Large-scale experiment facilities
- Special experiment facilities

High Priorities at IMP

- Precision mass measurement of exotic and stable nuclides, RIB physics, SHE
- CIADS and HIAF project, ADANES
- Tumor therapy
- Irradiation Material sciences

- 850 staff+400 students
- > 1.0 B RMB Yuan/per year since 2018

IMP Existing Facility: HIRFL

Heavy Ion Research Facility in Lanzhou (HIRFL)

SSC (K=450)
100 AMeV (H.I.), 110 MeV (p)

SFC (K=69)
10 AMeV (H.I.), 17~35 MeV (p)

Heavy Ion Therapy at IMP

Heavy ion application

Industrialization

Construction of demo facilities.

2012-2016

Clinical trial of deap-seated tumor: 110

2009-2013

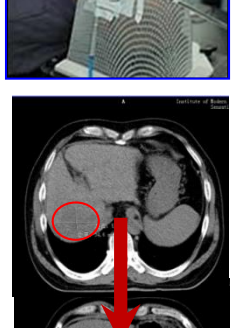
Development of treatment technology

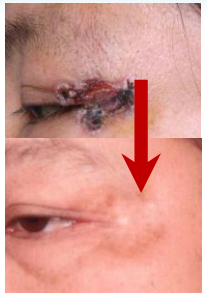
Clinical trial of superficial tumor: 103

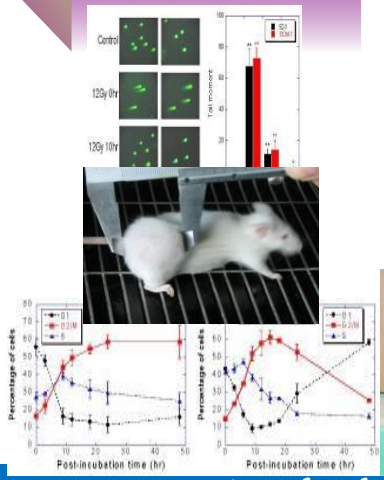
2006-2009

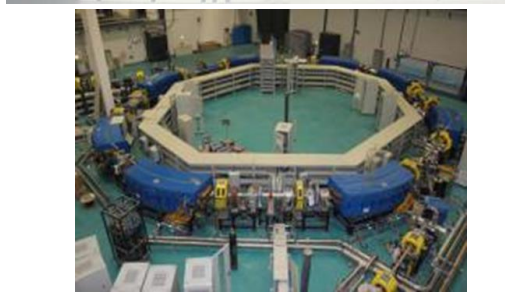
Basic research with cells and animals.

1993-

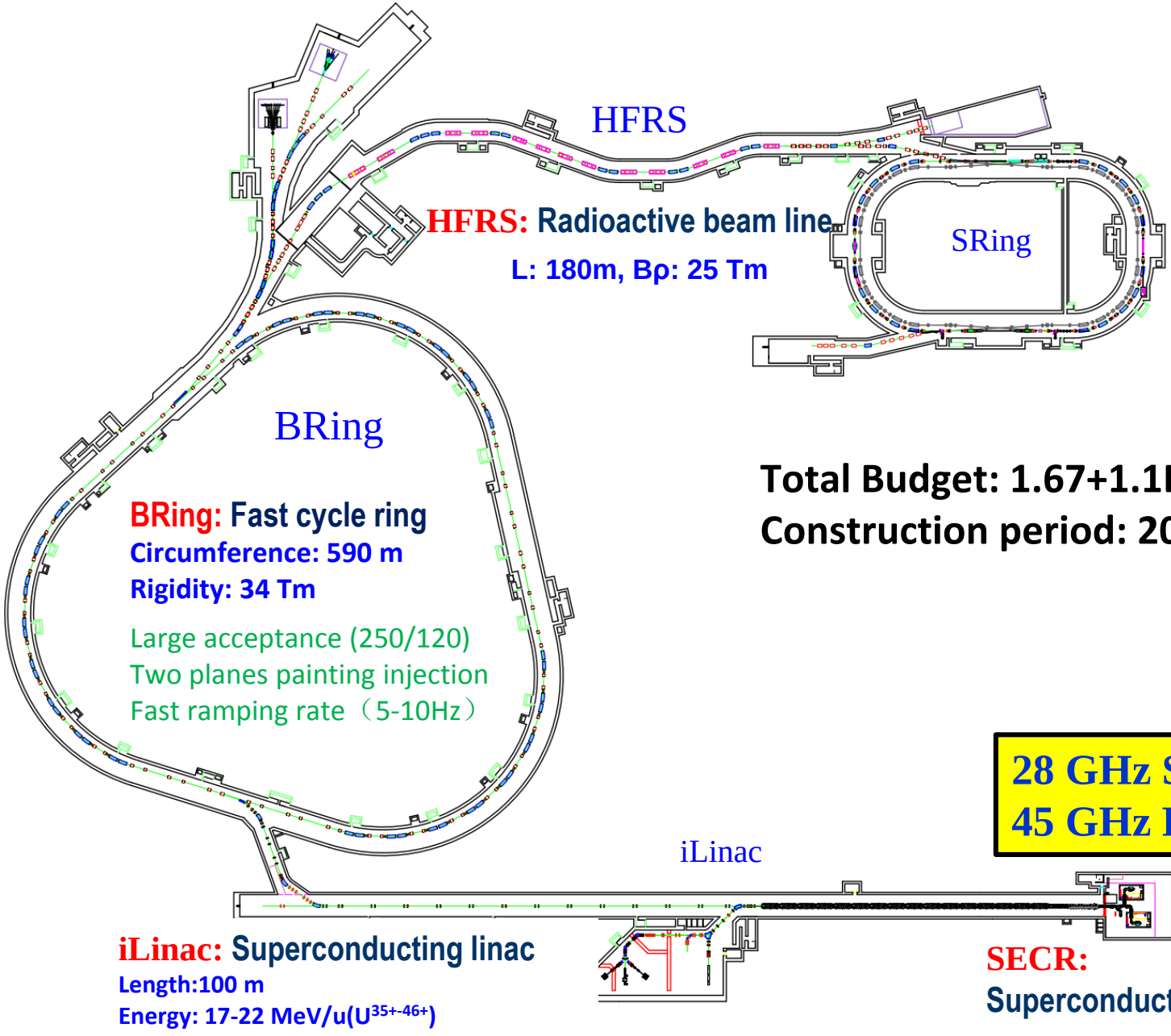








HIAF Facility



SRing: Spectrometer ring
Circumference: 273m
Rigidity: 13-15 Tm

Electron/Stochastic cooling
Two TOF detectors
Four operation modes

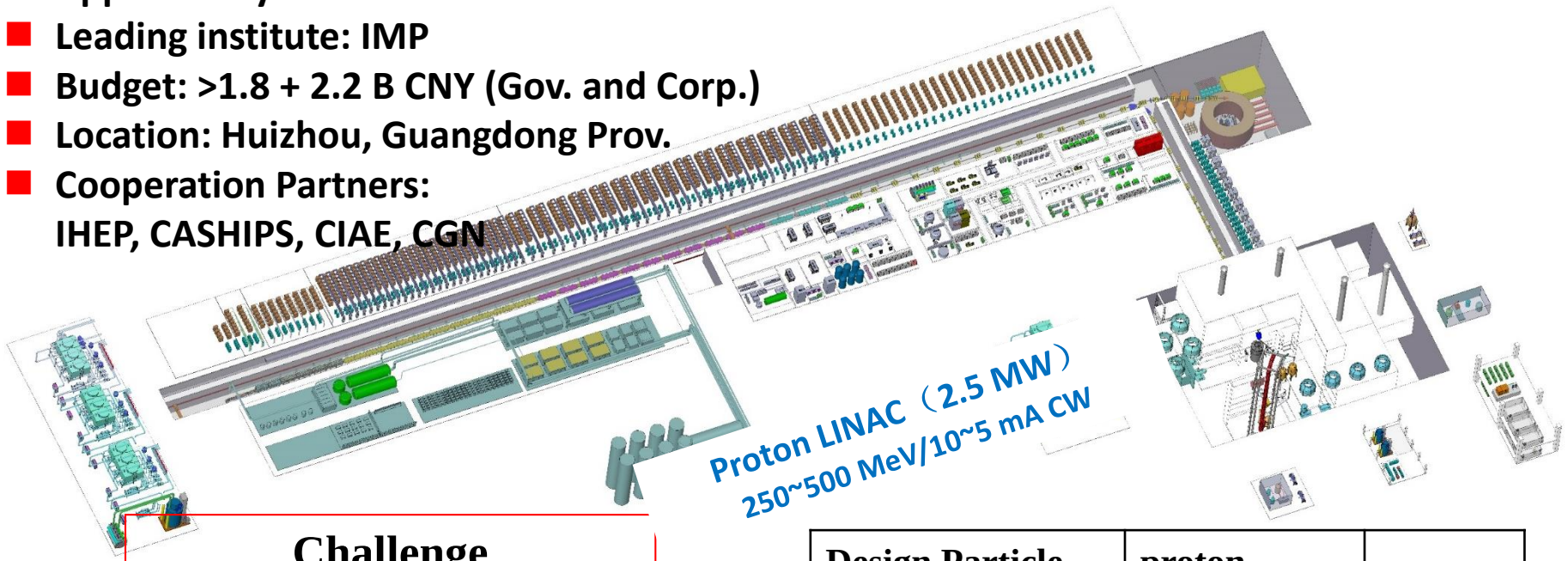
Total Budget: 1.67+1.1B CNY
Construction period: 2018-2025

28 GHz SECRAL-II
45 GHz FECR

CiADS Facility

The first demonstration of ADS for nuclear waste transmutation

- Approved by central Gov. in Dec. 2015
- Leading institute: IMP
- Budget: >1.8 + 2.2 B CNY (Gov. and Corp.)
- Location: Huizhou, Guangdong Prov.
- Cooperation Partners:
  IHEP, CASHIPS, CIAE, CGN



Challenge

-High intensity CW

-Long-term high reliability

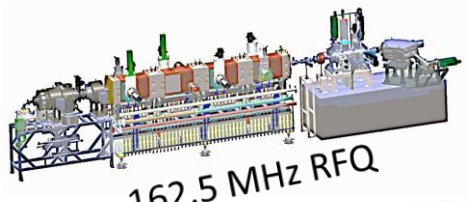
Beam trips goal:

<10s,	-
10s～5min,	2500/y
>5min,	300/y

Design Particle	proton	
Energy	500 (250)	MeV
Beam current	5 (10)	mA
Beam power	2.5	MW
Operation mode	CW&Pluse	
Beam loss	＜0.1	W/m
Reactor power	7.5	MWt

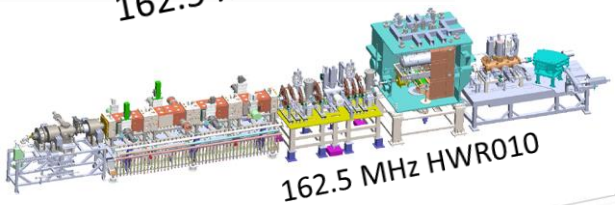
Key technology R&D for CIADS Linac

1



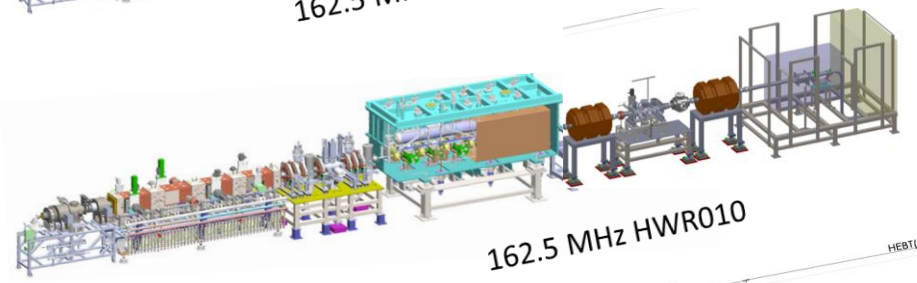
- ECRIS + RFQ
- Energy is ~2.1 MeV
- First beam Jun. 6th, 2014

2



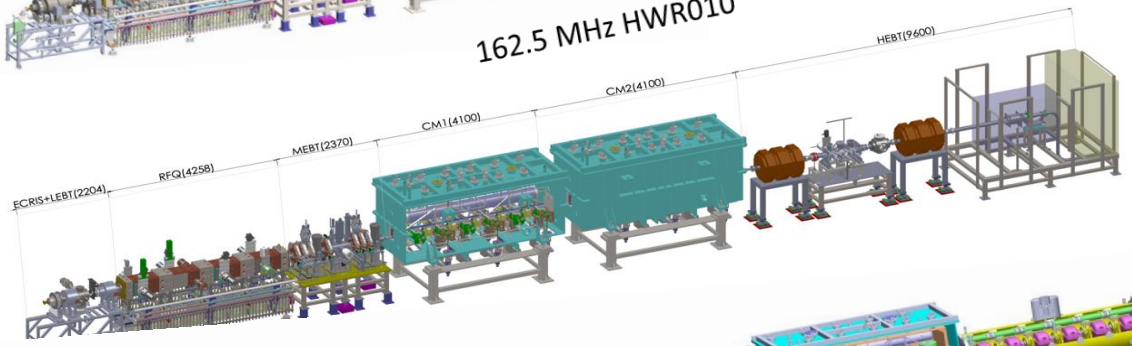
- ECRIS + RFQ + MEBT + TCM1 (single HWR)
- Energy is ~2.5 MeV
- First beam October 1st, 2014

3



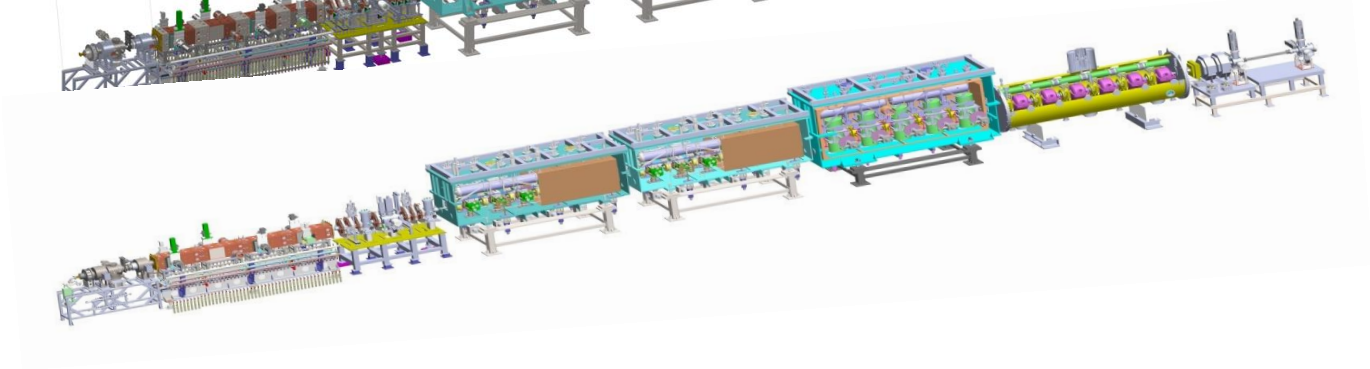
- ECRIS + RFQ + TCM6
- Energy is ~5 MeV
- First beam June 6th, 2015

4



- ECRIS + RFQ + CM1 + CM2
- Energy is ~10 MeV
- First beam September 15th, 2016

5



- ECRIS + RFQ + CM1 + CM2 + CM3 + CM4
- Energy is ~25 MeV
- First beam May 28th, 2017

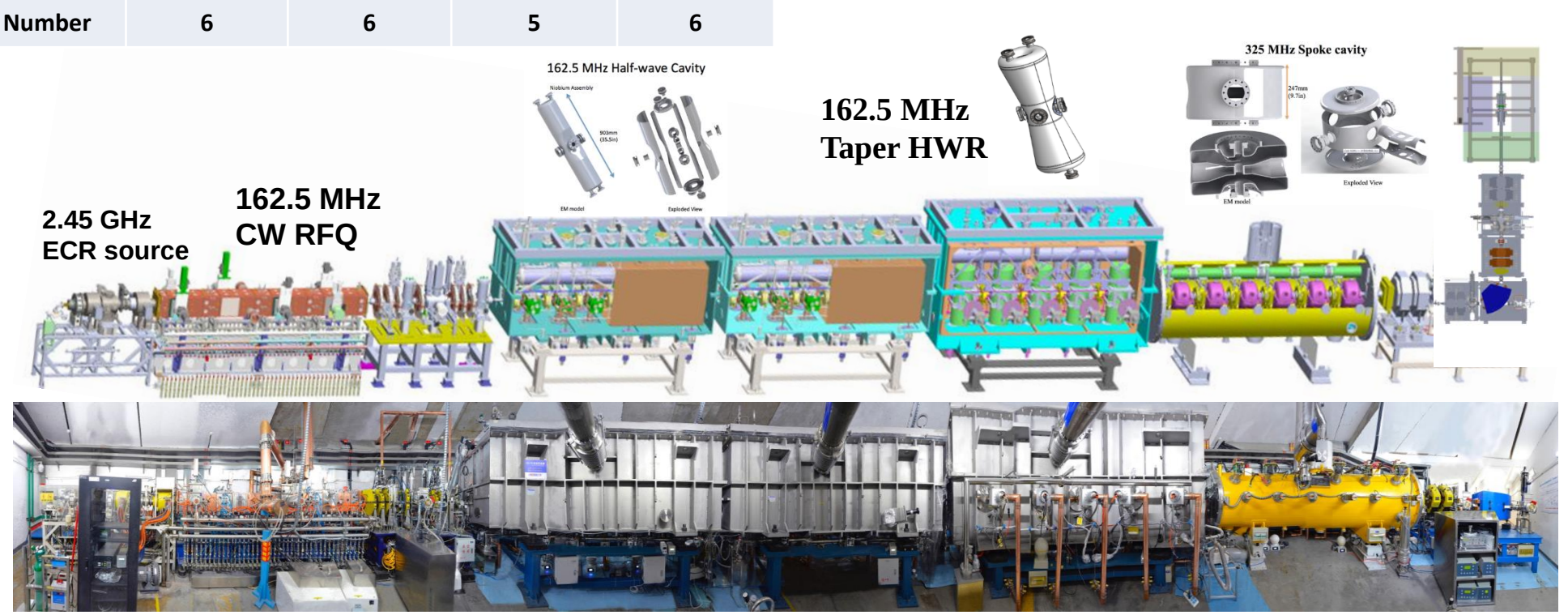
25 MeV SC Linac: CIADS linac prototype

The world's first 10-25 MeV CW superconducting proton linac

	CM1/IMP	CM2/IMP	CM3/IMP	CM4/IHEP
Frequency	162.5 MHz	162.5 MHz	162.5 MHz	325 MHz
Energy	6 MeV	11 MeV	18.6 MeV	26.2 MeV
Type	HWR010	HWR010	HWR015	Spoke021
Number	6	6	5	6

IMP+IHEP

- First beam was achieved on May, 2017.
- Achieved CW proton beam 0.2-2.3 mA, 18-25 MeV



A platform for high power proton beam commissioning and tests for BI , MPS and LLRF

HIAF and CiADS: Present status

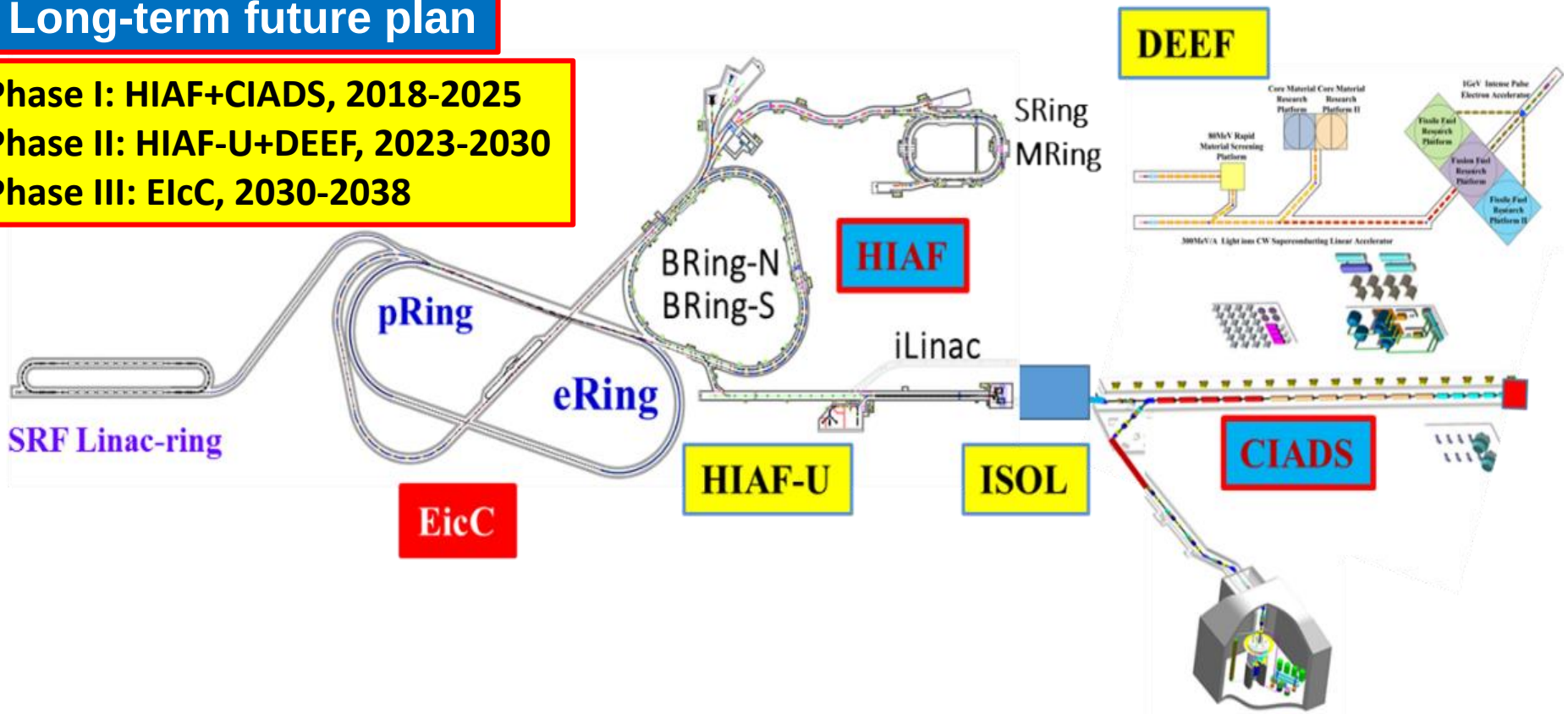
HIAF and CiADS are located at the same new campus in the south of China: Huizhou, Guangdong

Key components under engineering design and some parts under fabrications

General Layout of BEIF Facility to be built in 2018-2038

Long-term future plan

Phase I: HIAF+CIADS, 2018-2025
Phase II: HIAF-U+DEEF, 2023-2030
Phase III: EIcC, 2030-2038



HIAF: High Intensity heavy Ion Accelerator Facility. Under construction. 2018-2025

CIADS: China Initiative Accelerator Driven System. Under construction. 2019-2025

HIAF-U: HIAF upgrade project. 2024-2029 .

DEEF: Dense Energy Experimental Facility. 2023-2030

EIcC: Electron Ion collider in China. 2030-2038

Collaboration with ESS

(Common scientific interest and technical challenges)

Existing collaboration

	Stay in ESS Group (supervisor)	Duration of Stay at ESS / years	Type of Work	Funding by
Yuanshuai Qin	Beam Dynamics (Mamad)	2	Joint PhD	CSC
Zhijun WANG	Linac Group (Håkan)	0.5	Visiting researcher	CSC
Weiming YUE	Test Stand II (Wolfgan)	1	Visiting researcher	CSC
Hongming XIE	Beam diagnostics (Thomas Shea)	1	Visiting researcher	CSC
Zheng GAO	RF Group (Morten Jensen)	0.5	Visiting researcher	CSC
Haitao Liu	ICS	0.5	Visiting researcher	CSC

SLHIiPP-9 in Lanzhou

EUROPEAN SPALLATION SOURCE

SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

9th Open Collaboration Meeting on Superconducting Linacs for High Power Proton Beams (SLHiPP-9)

25-27 September 2019
IMPCAS Campus
Europe/Stockholm timezone

WELCOME TO THE 9th SLHiPP MTG

- Overview
- Timetable
- Registration
- Payment instructions
- Accommodation
- Weather - the National Meteorological Center of CMA's website
- Transport from Lanzhou Zhongchuan Airport to IMPCAS or Legend hotel. Detailed info in PDF under Material
- Invitation letter,

Dear all

We are happy to invite you to the 9th Open Collaboration Meeting on Superconducting Linacs for High Power Proton Beams (SLHiPP-9), which will take place at Institute for Modern Physics, Chinese Academy of Science (IMPCAS) in Lanzhou, China.

The meeting will start at 09.00 on Thursday the 26th of Sept, and finish around 6pm on the 27th.

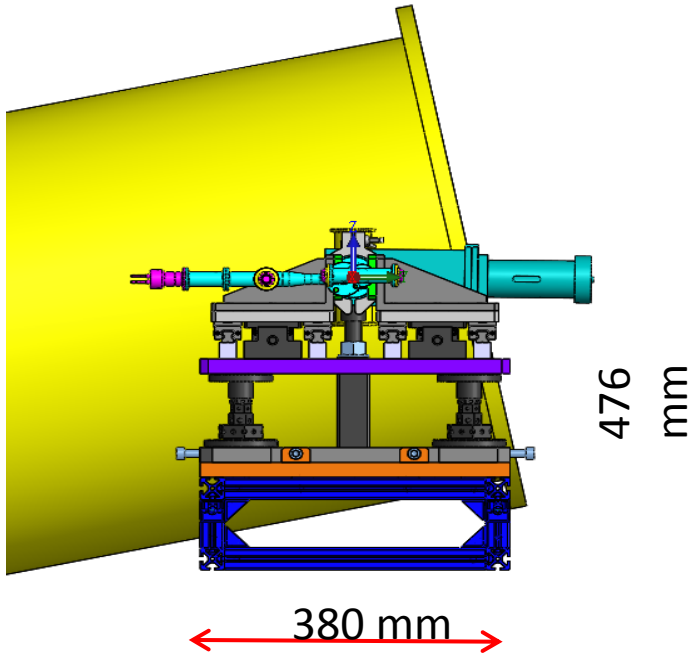
For accommodation, IMPCAS has pre-booked rooms at a hotel close to the institute. You have to confirm your hotel room directly with the hotel. See more detailed info under the Accommodation tab on the left hand side.

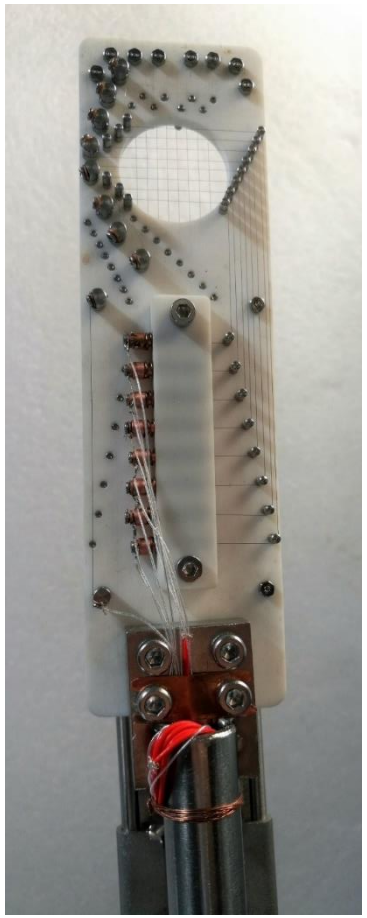
IMPCAS will have a registration desk open at the hotel reception from 4pm on Wednesday the 25th. From 6-8 pm they offer a welcome reception with a light buffé and drinks.

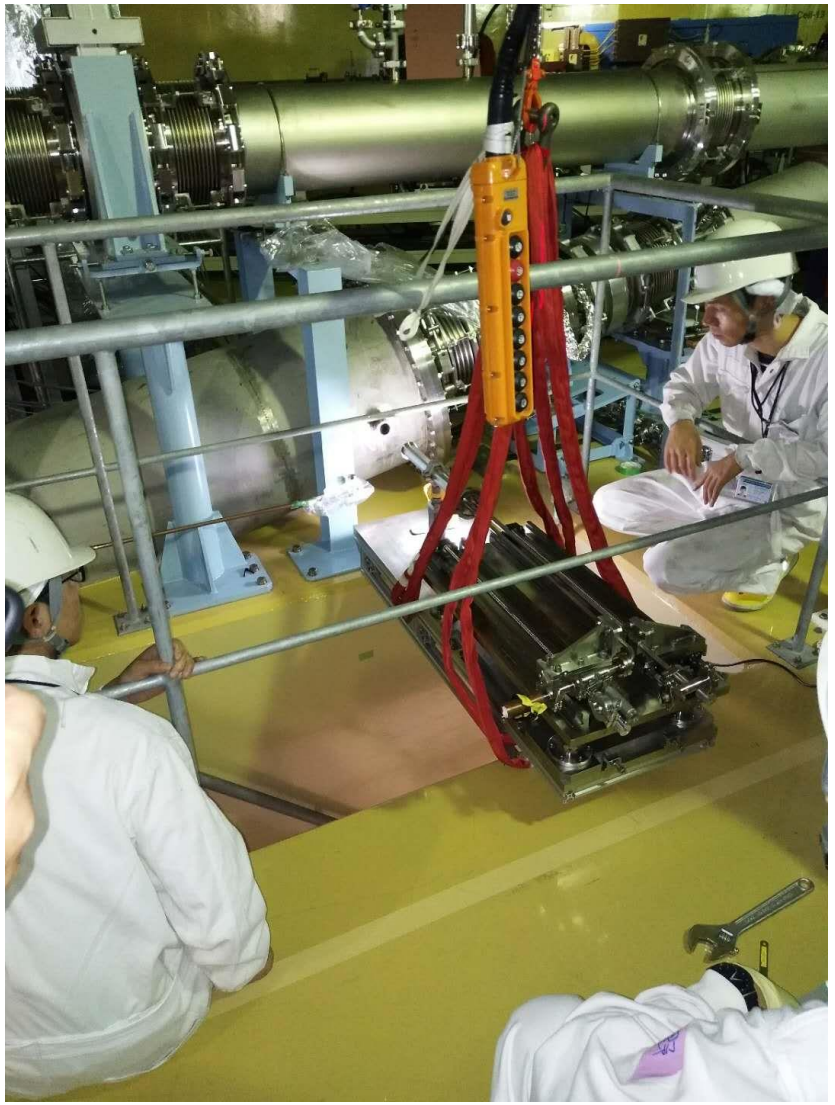
There will be a labtour at IMPCAS in the end of the conference. The labtour will be around 40 mins.

APTM and GRID Prototypes for ESS

- ESS/J-Parc/IMP design
- Design review and support from J-Parc and from IMP
- Fabrication: IMP
- Input from and to LTH concerning signal and noise level, signal acquisition and processing
- Has tested at J-PARC







Specific Research Program Proposed by IMP

- Program Name
  - Cooperative research on the **stability of the high power superconducting linac and high power spallation target** for advanced energy system
- Expected collaboration program
  - IMP expects to study the following terms in the high power superconducting proton accelerator and the high power spallation target through the cooperation with ESS
    - **Beam loss**—— none linear space charge effects and low β wakefields
    - **Low level RF**—— ponderomotive effects, real-time synchronous phase measurement, state space controller,NMPC, NN algorithm
    - **Nondestructive beam diagnostics** and pre-target beam diagnostics
    - **Design of 2K cryogenic system** —— without local boiling， laminar flow, cavity wall power loss
    - **RAMI Analysis** and Complex System Design——lattice databank， topological relationship，RAMI index and the calculation code
    - **The integrated control system** of the high power superconducting proton accelerator and high power spallation target——**MPS**
    - **The critical technology of high power spallation target**

Selection of the People from IMP for the Program

- Number of the People and Place
  - 3 per year
    - 1 joint doctoral candidate to Lund University or Uppsala University
      - Duration 24 months
    - 1 postdoctoral fellow to ESS
      - Duration 6-24 months
    - 1 visiting scholar to ESS
      - Duration 6-12 months
- Start Date
  - January or September each year

Potential candidates

- AP
  - RAMI, 1 student, 2021
  - LLRF, beam loading, 1 staff Ran Huang, 2019
- BI
  - 1 staff, 2021, Beam loss monitor
  - 1 staff, Xie, continuous another 12 months, after his program in 2019, 2020, Beam diagnostic on target
- Cryogenic
  - 1 person for Cry-plant operation,
- Target
  - 1 staff, 2019, Target maitainance design
- IC
  - 1 staff, Jing Wang, 2019
- Mechanical integral

SRF and RF

- LLRF for diagnostic of MPS
- Adaptive self-exciting for high beam loading
- Rapid recovery mode of beam failure
- CM preparation and conditioning
- Preparation and conditioning of fundamental coupler
- Monitor of high power transmit line

Accelerator to Target

- beam target matching session radiation and thermal simulation.
- diagnostics before target and quality control.
- Collimation and beam loss control

Integral Control System

- Short time visit
- Control system framework design and implementation (best 2 people);
- network traffic analysis and IT framework design;
- GUI interface design and plug-in development; software test system construction and use (best 2 people);
- MPS system design and implementation. (Best 2 people)
- A total of 6-8 people are needed

- Long time collaborate
- Design and implementation of a highly reliable MPS system.
- Equipment information management application design.
- Design and construction of virtualized devices.
- Research on big data analysis and application.
- Machine learning and artificial intelligence are researches to improve the reliability of linear accelerator operation.

Radiation Safety and Security

- 1.Software and methods for radiation safety analyses and shielding design
- 2.Remote handling systems for radiation safety
- 3.Radioactive waste management
- 4.Radiation measurement and monitoring systems
- 5.Related experiments conducted for radiation safety research

Target

- 1. target maintenance, dismount, transport, and hot cell
- 2. target cool gas system
- 3. target protection, diagnostic
- 4. beam window