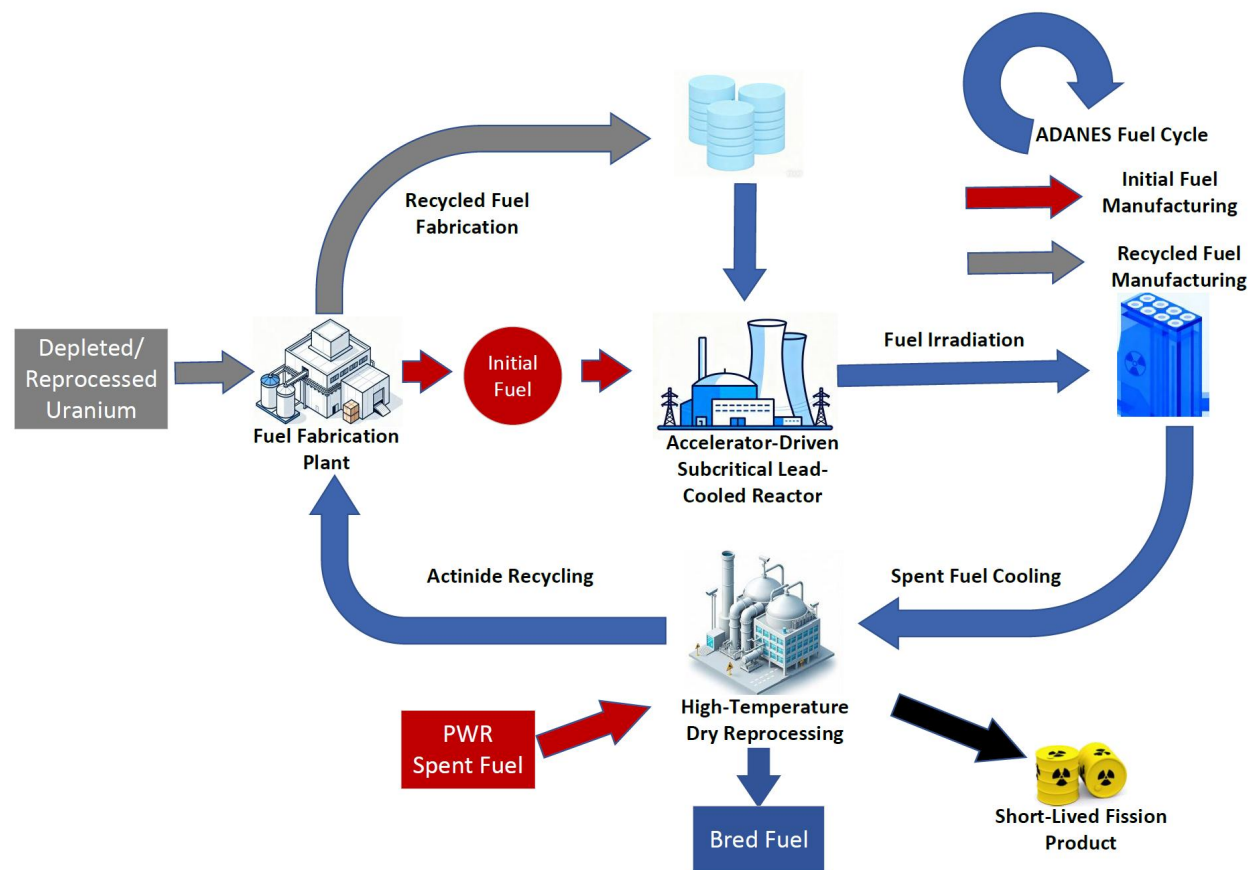




Short Overview of Possible ADS and CANS in IMP

Yuan HE

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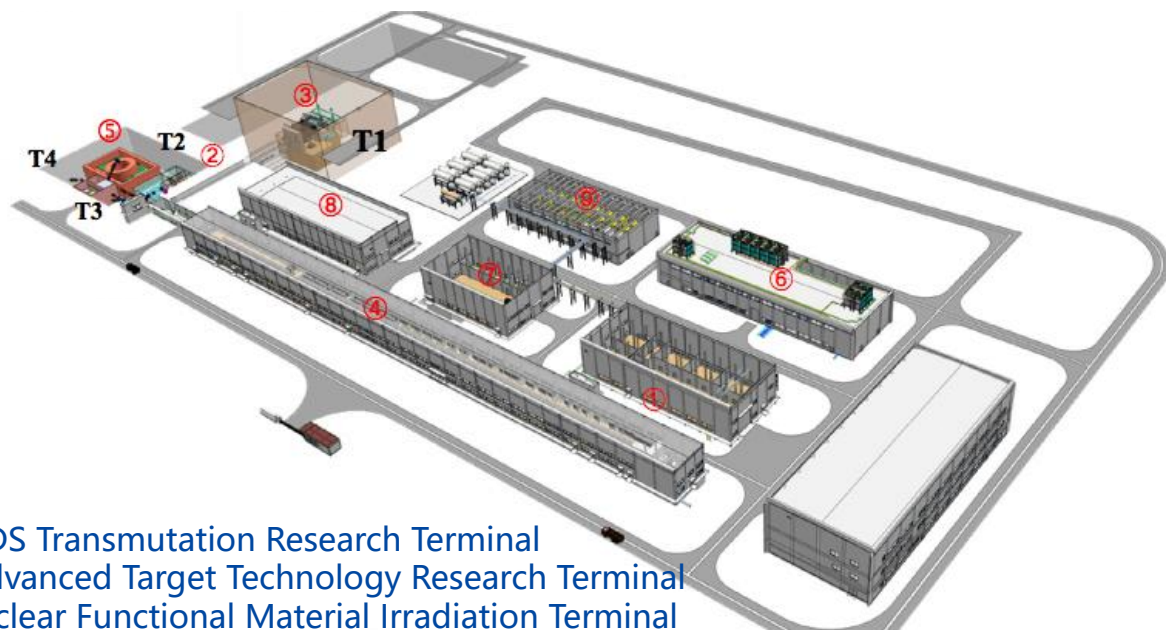
- **High-power proton beam generates intense neutron flux to drive subcritical reactor**
 - Transmutation + breeding + power generation
- **Challenge 1: Criticality safety**
 - Subcritical core driven by external neutrons poses no supercriticality risk
- **Challenge 2: Resource utilization**
 - Fuel utilization: 0.6% → 95%
 - Uranium reserves: decades → millennia
- **Challenge 3: Waste burden**
 - Waste volume reduced to 1/30
 - Waste half-life reduced to 1/1000

Accelerator Driven Advanced Nuclear Energy System (ADANES)

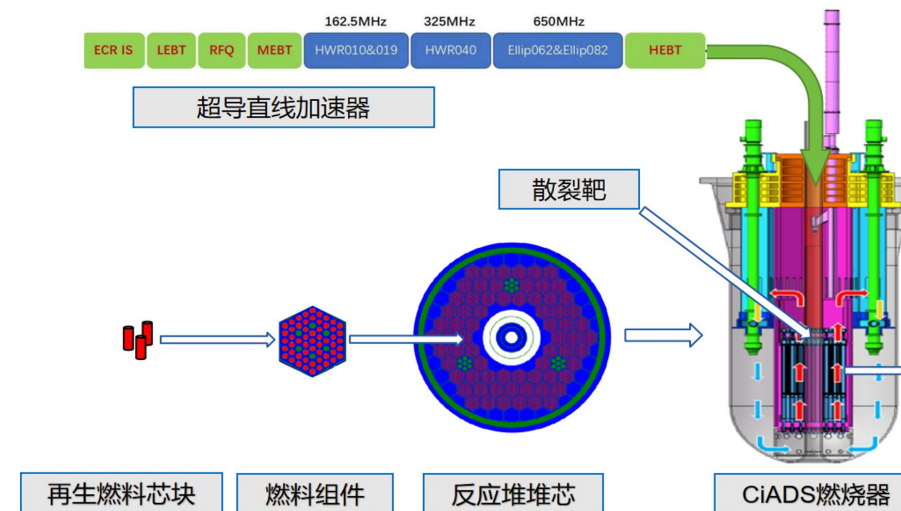
CiADS (China initiative Accelerator Driven System): the world's first MW-class research facility & fuel cycle capable of high-power coupling operation.

ADS thermal power = 10 MW:

- Accelerator beam power = 2.5 MW
- Pb-Bi spallation target power = 2.5 MW
- Subcritical Pb-Bi reactor power = 7.5 MW



T1: ADS Transmutation Research Terminal
T2: Advanced Target Technology Research Terminal
T3: Nuclear Functional Material Irradiation Terminal
T4: ADS Nuclear Database Terminal



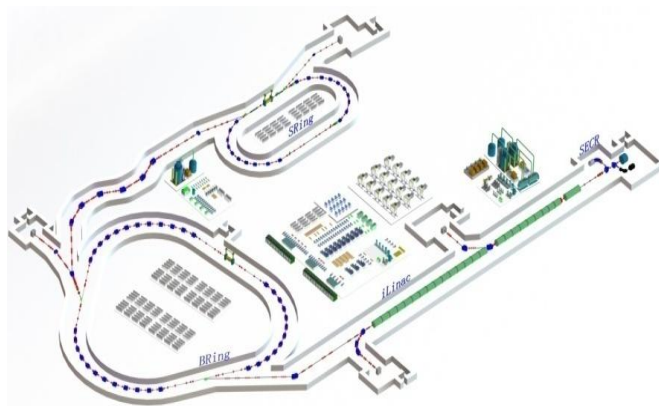
Validation of spent fuel regeneration technology enabling 30% of U-utilization:

- Conduct breeding/transmutation experiments of **high-temp dry-processed fuel** in the ADS burner to verify **30% U-utilization cycle**

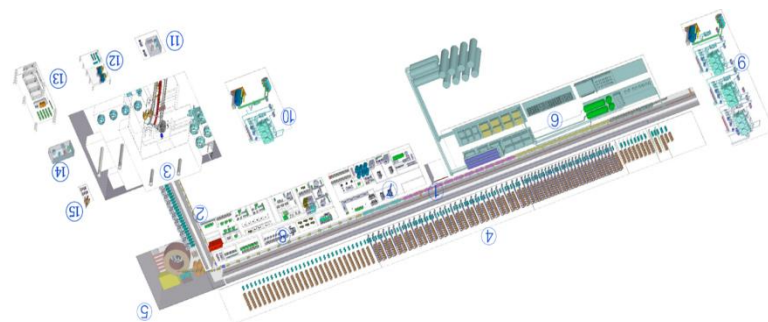
CiADS is One of Two Large-Scale Projects in Huizhou Branch of Institute of Modern Physics



**High Intensity heavy ion
Accelerator Facility (HIAF)**
Nuclear physics research
Beam commissioning in 2025

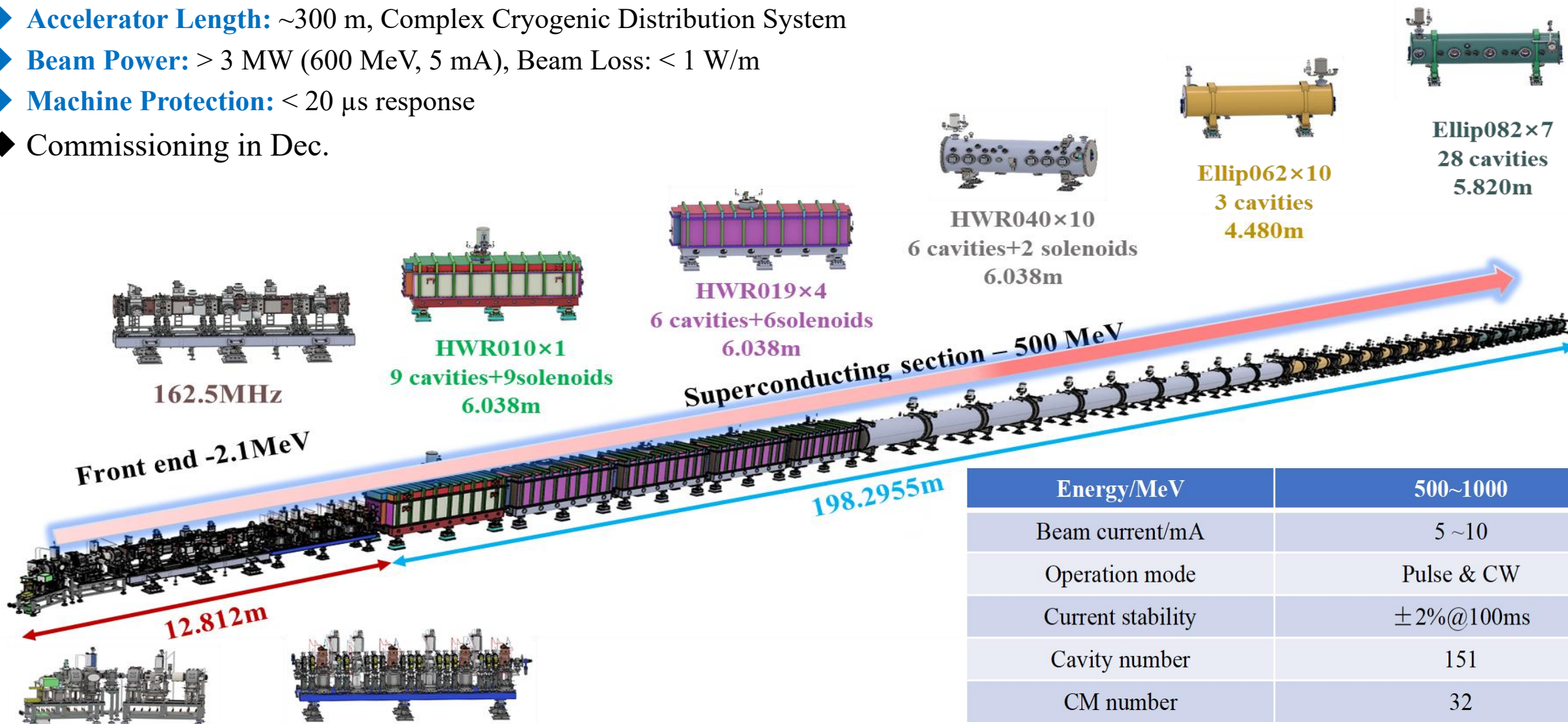


**China initiative Accelerator
Driven System (CiADS)**
Nuclear waste transmutation
Complete linac installation in
2026



Key Performance Specifications:

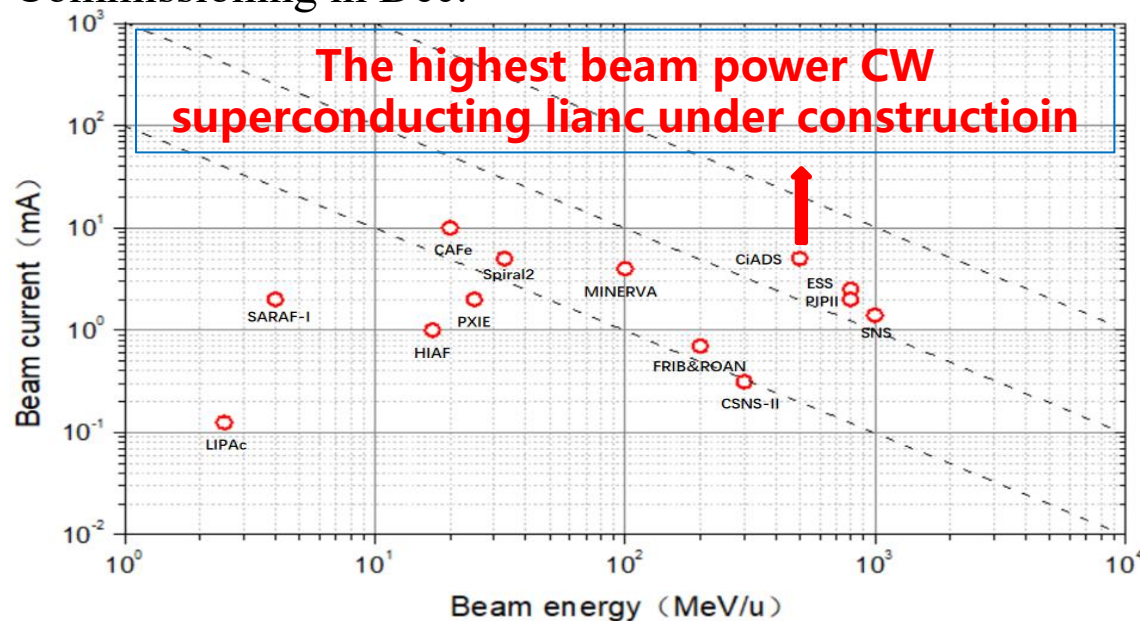
- ◆ **Accelerator Length:** ~300 m, Complex Cryogenic Distribution System
- ◆ **Beam Power:** > 3 MW (600 MeV, 5 mA), Beam Loss: < 1 W/m
- ◆ **Machine Protection:** < 20 μ s response
- ◆ Commissioning in Dec.



Energy/MeV	500~1000
Beam current/mA	5 ~10
Operation mode	Pulse & CW
Current stability	$\pm 2\%$ @100ms
Cavity number	151
CM number	32

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- ◆ **Commissioning in Dec.**



Beam Trip Duration	Industrial Scale Transmutation	Remarks
$T < 1\text{sec}$	<25000	Target window lifetime
$1\text{sec} < T < 10\text{sec}$	<2500	Fatigue failure of fuel cladding
$10\text{sec} < T < 5\text{min}$	<2500	Fatigue failure of inner barrel and reactor vessel
$T > 5\text{min}$	<50	System Availability

Critical physics challenges:

- ◆ **Ultra-low Beam Loss Control :** < 10^{-6}
- ◆ **Beam trip Availability:** > 85%

Progress of the CiADS Linac

- The horizontal test of prototype cryomodule was completed, with mass production initiated concurrently.

2024.10

2025.09

2026.05

2026.10

- 32 Cryomodules in 5 families, 4 types were installed
- Elliptical 082 cryomodules will be presented in Sept.
- 6 assembly lines in parallel, 25 days for dirty assembly

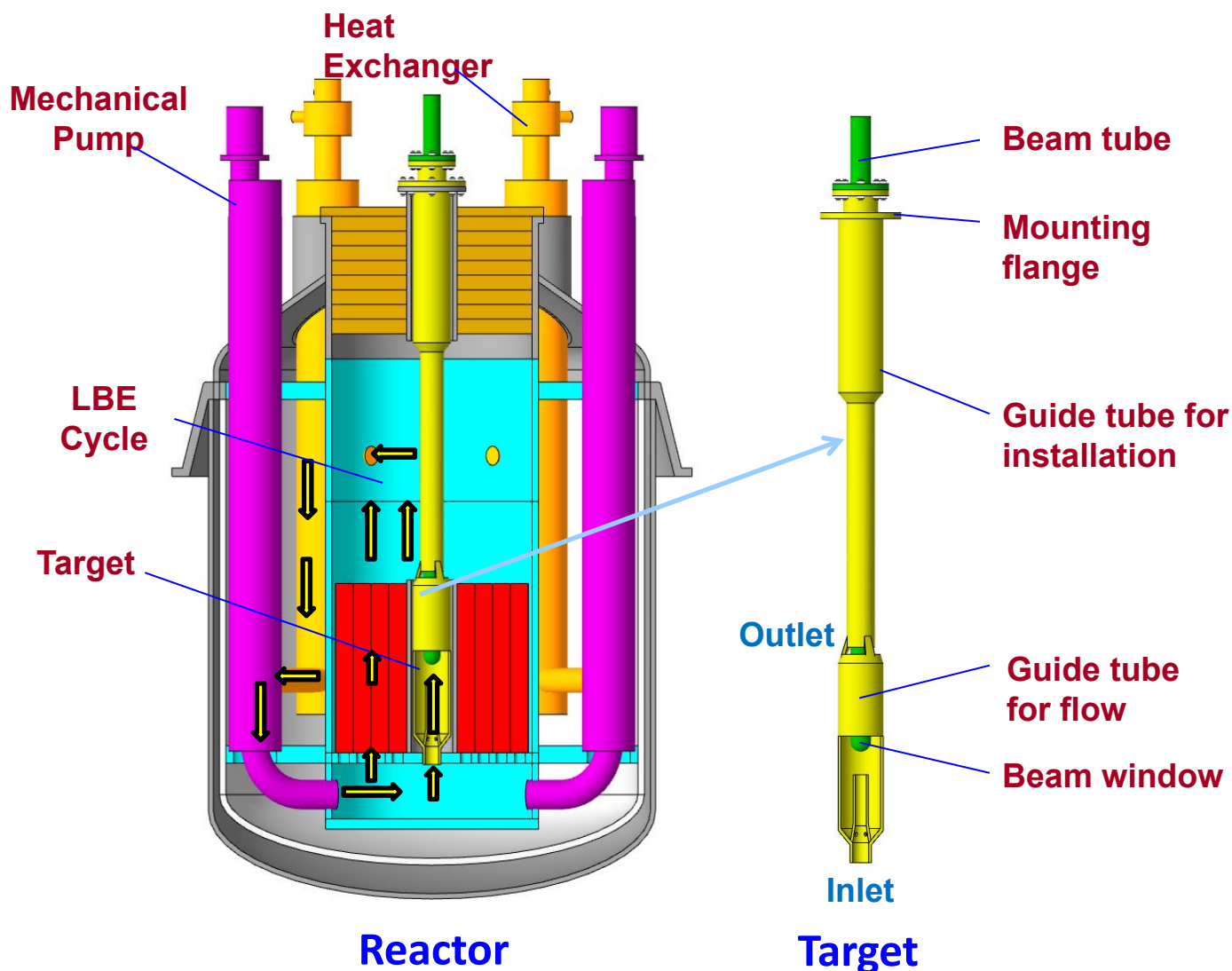
- HWR-type cryomodules have been installed in the tunnel (H010*1, H019*4, H040*10)

- The integration and assembly of cryomodule has commenced.

- E062*10 have installed and E082*7 will be ready in Oct.
- The CMs is cooling down, and the commissioning will be in Nov.
- Helium processing and plasma cleaning system will be online version.



Integrated Spallation Target



Energy: 600 MeV

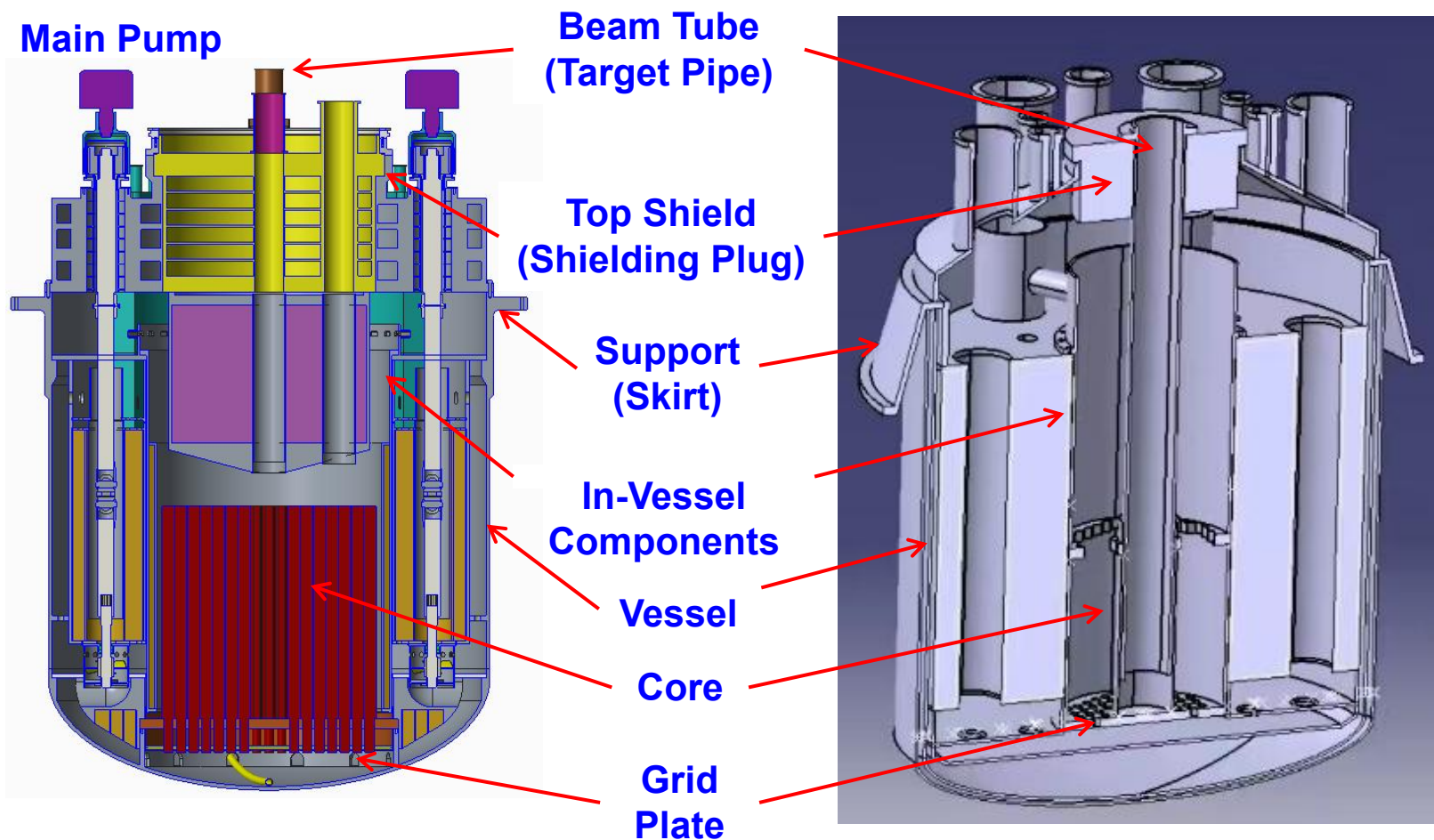
Power: 2.5 MW $\pm$ 10%

Medium: Lead-Bismuth Eutectic (LBE)

Configuration: Uses LBE from the reactor primary circuit as the target material. No dedicated target loop or active components

Structural features:

- Target fixed to the reactor vessel via a mounting flange
- Beam pipe secured to a positioning guide tube linked to the accelerator
- Beam pipe can be replaced independently
- Radial position of the guide tube bottom constrained by a grid plate



First nationally approved Pb-based fast reactor project in China

Pb-Bi Reactor	Overall Design Parameters
Type	LBE Fast Neutron Reactor
Power	10 MWt (inc. 2.5 MW target)
Fuel	UO ₂ (19.75%)
Primary Layout	Pool-type
Primary Drive	Forced Circulation
Primary Coolant	LBE
Primary Pressure	Atmospheric
Primary Temperature	260-360°C
Primary HX	Main type
Primary Pump	Mechanical×2
Secondary Coolant	LBE
Secondary Pressure	Atmospheric



- Licensing:
- Safety Design Criteria is on the first turn of Q&A.
 - The review of PSAR (priliminary safty analysis report) will start in months.



ADANES/CiADS Development Plan



2026

2027

2028~2029

2030~2031

Accelerator Acceptance

- Accelerator 25kW
- Target >25kW
- Thermal test terminal

- 600 MeV accelerator trial run
- 250 kW target trial run
- Model spent fuel separation & fabrication
- First regenerated pellet fabricated

Spallation Target Acceptance

- Accelerator 250kW
- Target 250kW
- $k_{eff} \sim 0.4$
- Reactor 30kW

- ADANES burner commissioning
- Pilot fuel assembly insertion
- Industrial validation of high-temperature dry processing
- First regenerated fuel rod fabricated

ADS System Acceptance

- Accelerator 0.25~2.5MW
- Target 0.25~2.5MW
- $k_{eff} \sim 0.4$
- Reactor Power Ramping

- Fuel loading license obtained
- Burner operates at full power
- Metallic FP separation thermal test
- First regenerated fuel assembly

Fuel Cycle Validation

- Accelerator ~2.5MW
- Target ~2.5MW
- $k_{eff} \sim 0.75$
- Reactor ~7.5MW

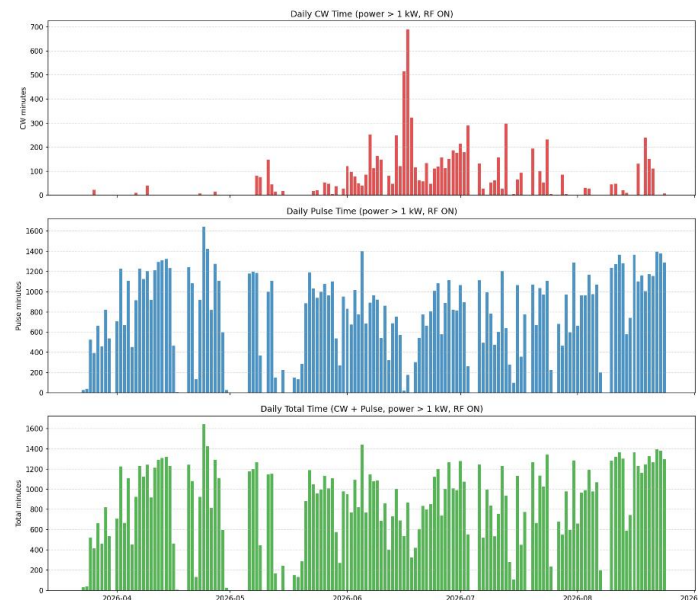
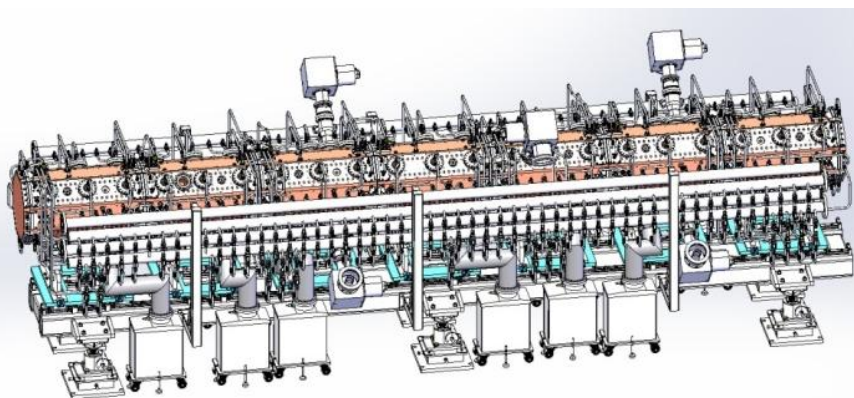
- Regenerated fuel loading license obtained
- First loading of regenerated fuel
- Full- power breeding and transmutation testing
- Verified key technology integration for 100- MW- class ADANES facility

- ADS front-end development has matured CW, high-current RFQ technology, enabling these RFQs to serve directly as compact accelerator neutron sources (CANS)
- High-current CW RFQ experiment at IMP:

3 MeV, 60 mA, 93.7% transmission

Cumulative operation time 2012 hours

- CW mode: 141 hours
- High-rep-rate pulsed mode: 1871 hours



Commissioning and operation records



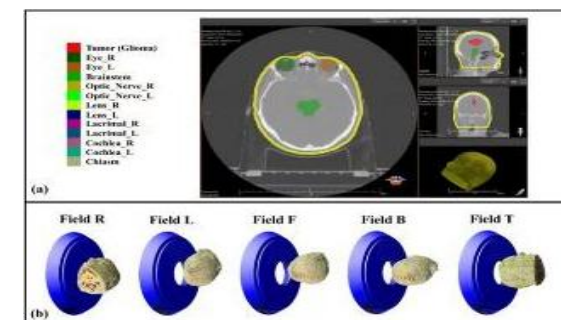
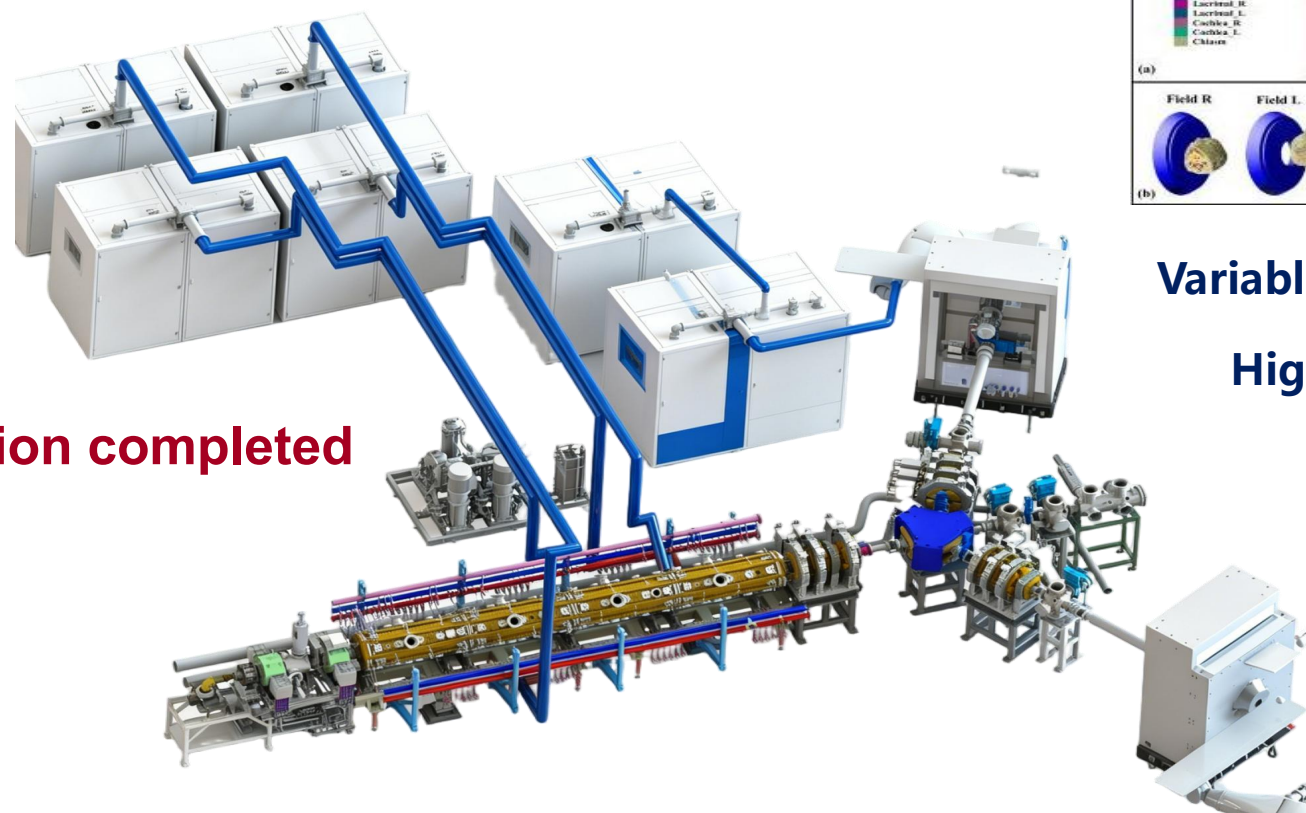
Beam current measurements

- ADS front-end development has matured CW, high-current RFQ technology, enabling these RFQs to serve directly as compact accelerator neutron sources (CANS)
- CANS test facility at IMP:

2.7 MeV, 30 mA CW RFQ

Real-time neutron monitoring

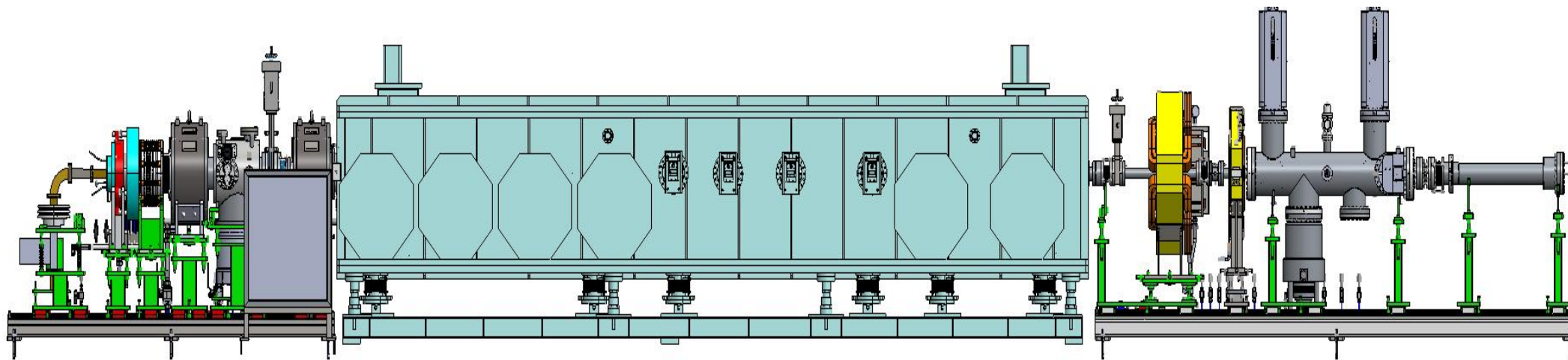
End-to-end technical verification completed



Variable irradiation field

High adaptability

- Expertise from the ADS programme also supports development of compact high-frequency structures for CANS
- Ongoing tests for 20 MeV prototype:



First prototype of a 20 MeV, mA-class, 3 GHz proton linac

- Proves the feasibility of stable mA-beam acceleration at high frequency

- **Mission:** global sharing of nuclear research infrastructure, for a sustainable future
- Initiated by the Chinese Nuclear Society together with global partner institutions
- Formal establishment expected in 2027
- **Milestone:** key initiative launched in Sep 2026 at the 70th IAEA General Conference in Vienna
 - International Cooperation Initiative on Nuclear Research Infrastructure



- **ADS and CANS fit naturally within INRIO's scope**
- **CiADS among open-access facilities under INRIO**
- **Possible role of INRIO as a common platform**
 - Connects ADS / CANS activities worldwide and facilitates information exchange
 - Creates opportunities for collaboration and shared access
 - Supports longer-term joint development and broader global sharing of these technologies



Thank you for your attention!

