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Engineering System Integration and Experimental Progress of the Spherical Tokamak EXL-50U

Yuanming Yang

Yu Wang, Hong Zang, Bo Chen, Pengmei Jia, Xiankun Bo,Shuo Liu,Wenwei Zhang, Hongfeng Zhu, Yudan Jia, Yunhong Wang, Jidong Liu, Lei Han, Wenwu Luo, Xin Zhao, Enwu Yang, Yumin Wang, Xiang Gu, Dong Guo, Yuejiang Shi, Minsheng Liu, Yunfeng Liang and EXL-50U team

Beijing ENN Fusion Energy Science and Technology Co., Ltd.

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About ENN Fusion

Since 2006, ENN Group has pioneered innovation in clean energy technologies, achieving major breakthroughs in low-carbon solutions.

In 2017, ENN shifted its focus to zero-carbon technologies and launched its fusion program, pursuing neutron-free, cost-effective, and commercially viable fusion energy. ENN was the first Chinese private company to pursue commercial fusion energy.

In 2025, ENN established Beijing ENN Fusion Energy Science and Technology Co., Ltd. (ENN Fusion) , dedicated to advancing fusion R&D and the commercialization of fusion energy.

Team

- 300+ staff members

Intellectual Properties

- Patents Filed 2400+
- Patents authorized 1900+

State-funded R&D Projects

- Domestic R&D projects 20
- International R&D cooperation programs 10

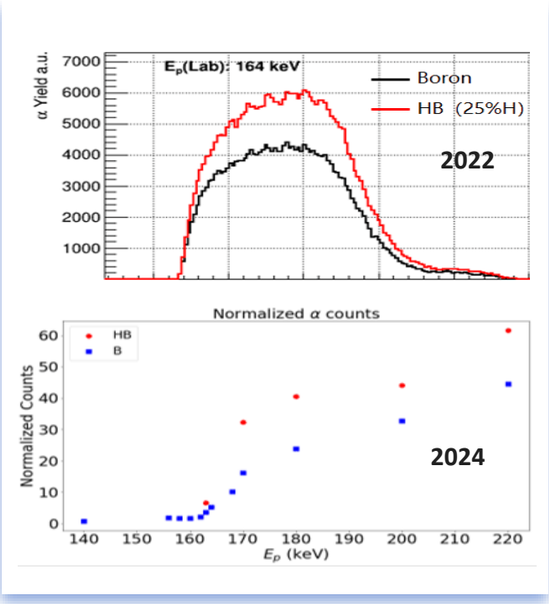
R&D Platforms

- Beijing Key Laboratory of High Magnetic Field Spherical Torus Fusion Energy
- Hebei Key Laboratory of Compact Fusion
- Internatioanl Science and Technology Cooperation Base
- Overseas High-level Talent Innovation and Entrepreneurship Base

(As of Dec 2025)

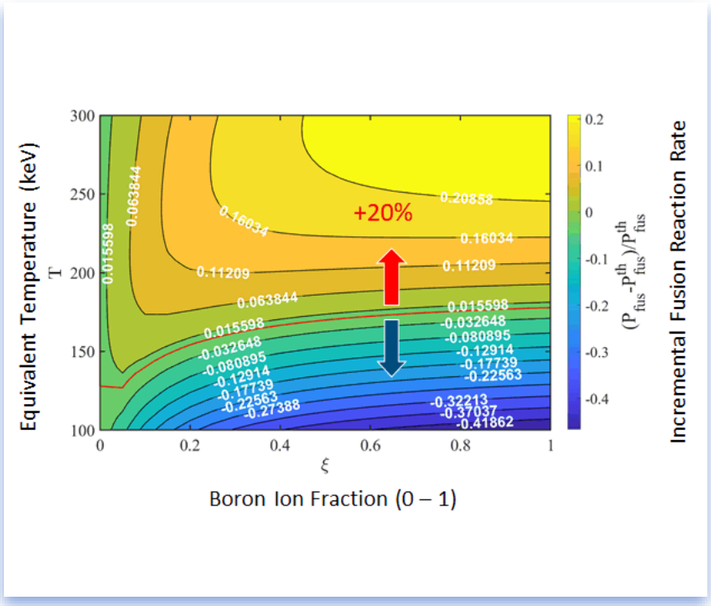
Innovative Ideas Raise the Prospective Feasibility of p-^{11}B Fusion Burn

H-B vs. B Target



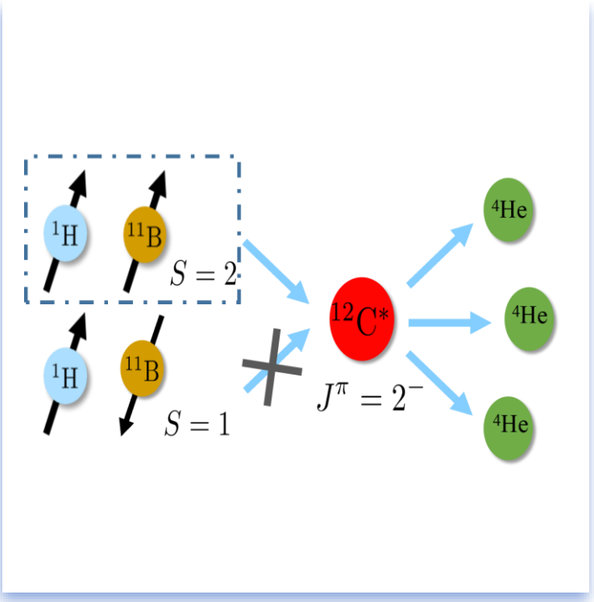
α yield from hydrogen-boron target is ~30% higher than that from boron-only target

Suprathermal + Thermal



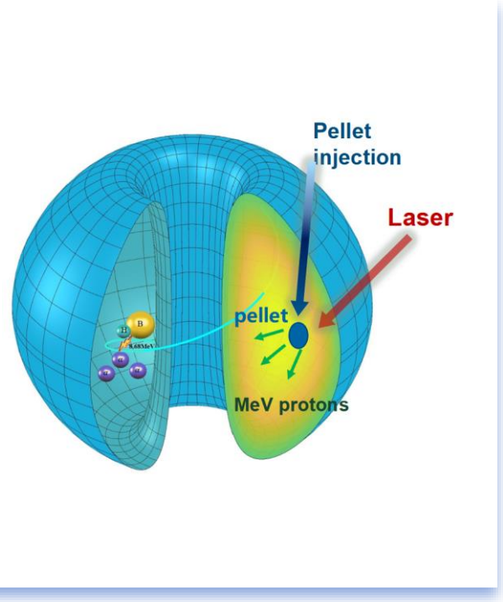
Reaction rate raised ~20% in 0-D model

Spin Polarization



Reaction rate can increase ~60% under ideal conditions; polarizing boron target

Laser-Pellet Protons in MC Plasmas



Depositing energetic proton streams in MC plasma?

ENN Roadmap for Spherical Torus p-^{11}B Fusion Power Demonstration

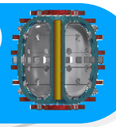
2035 Fusion power demonstration

Commercial Demo
2035-

- Deliver commercially viable fusion energy at competitive cost

T_i>100keV

p-^{11}B Burn (EHL-3A&3B)
2027-



- **Achieve p-^{11}B plasma ignition and demonstrate net electricity generation**
  - ➢ Optimize parameters for engineering scale-up
  - ➢ Achieve a target gain of Q>3

T_i~ 30-50keV

p-^{11}B Reaction (EHL-2)
2023-



- **Validate all critical aspects of ST p-^{11}B fusion**
  - ➢ Experimental verification of high-temperature plasma technologies
  - ➢ Feasibility assessment of boosted p-^{11}B fusion reaction rates

T_i~10keV

EXL-50U
2022-



- **Develop key technologies for ST p-^{11}B fusion**
  - ➢ Enhance plasma performance parameters
  - ➢ Achieve boron fueling and robust operation control

T_i~1keV

EXL-50
2018-2023



- **Established the basis of ST p-B fusion**
  - ➢ CS-free non-inductive current drive
  - ➢ ST device design, assembly, and operation

- ➢ **TORUS COIL**：**Room-temperature vs. cryogenic-temperature copper conductor magnet 3T@2.3s**
- ➢ **Heating system(31MW)：：ECRH，ICRF，PNBI&NNBI**

- ✓ **TORUS COIL:** Room-temperature copper conductor magnet **1.2T@1.6s，CS:1.2V•s**
- ✓ **Heating system(10MW)：ECRH 28GHz/300kW, 50GHz/360kW，ICRF 22-50MHz/1MW，PNBI 50keV/1.5MW, 30keV/1.5MW, 80keV/4MW**

- ✓ **TORUS COIL:** Room-temperature copper conductor magnet, 0.5 T @ 5 s
- ✓ **Heating system：ECRH 28GHz/50GHz，LHCD 0.2MW，ICRF 3-26MHz/0.14MW，PNBI 50keV**

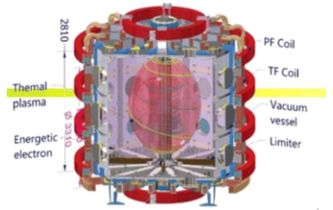
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*1 M. S. Liu, H. S. Xie, Y. M. Wang, et al., ENN's Roadmap for Proton-Boron Fusion Based on Spherical Torus, Phys. Plasmas 31 (2024) 062507 (2024)
*2 Y.F.Liang, H. S. Xie, Y.J.Shi, et al., Overview of the physics design of the EHL-2 spherical torus, Plasma Sci. Technol. 27 (2025) 024001.
*3 Y.J.Shi, X.M.Song, D.Guo, et al., Strategy and experimental progress of the EXL-50U spherical torus in support of the EHL-2 project, Plasma Sci. Technol. 27 (2025) 024003

Timeline of EXL-50, EXL-50U and EHL-2

EXL-50

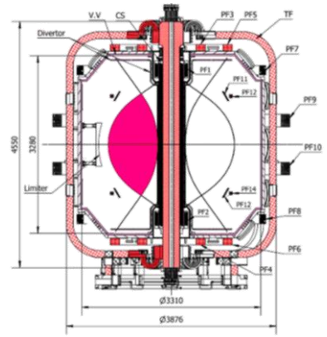
- 2018.10 — Start EXL-50 Project
- 2018.12 — Construction — Physics and Engineering design
- 2019.07 — Experiment — First Plasma
- 2023.06 — Shutdown



EXL-50: R_0=0.5, A=1.5
IP=0.5MA, P_{heat}=2MW

EXL-50U

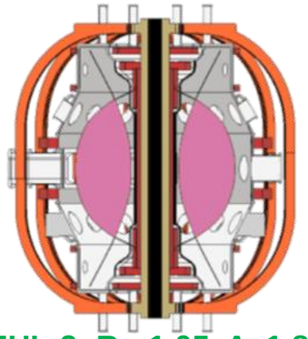
- 2022.07 — Start EXL-50U Project
- 2022.12 — Physics design — Engineering design
- 2023.10 — Manufacture of Main Components — Upgrade of Power supply, Heating and Diagnostics
- 2023.12.31 — Vacuum Pumping Baking — Machine Assembly
- 2024.01.20 — First Plasma Ip ~120kA — Testing of Power supply
- 2024.05.25 — Ip~300kA with 1s flat-top
- 2024.6.28 — T_{i0} ~ 1keV, $<n_{e0}>$ 1~4×$10^{19}m^{-3}$
- 2024.07.08 — Divertor Plasma Offline EFIT
- 2024.08.07 — Machine Maintenance
- 2024.08.28 — 500kA@n_{e0}>2 ×$10^{19}m^{-3}$
- 2025.04.16 — Ip~1MA
- 2025.05.25 — B_T -1.2T
- 2025.10.01~2025.10.30 — Machine Maintenance
- 2025.12.31 — p-B H-mode
- 2026 — **1.5MA, 10keV, p-B fusion experiments**



EXL-50U: R_0=0.8, A=1.85
IP=1.0MA, P_{heat}>7MW

EHL-2

- 2023 — Physics and Engineering Design
- 2025 — Long-lead Procurement Launched Site Selection
- 2026 — **Civil Construction Systems Fabrication**
- 2027 — **Machine Assembly and Commissioning First Plasma**



EHL-2: R_0=1.05, A=1.85
IP=3.0MA, P_{heat}=31MW

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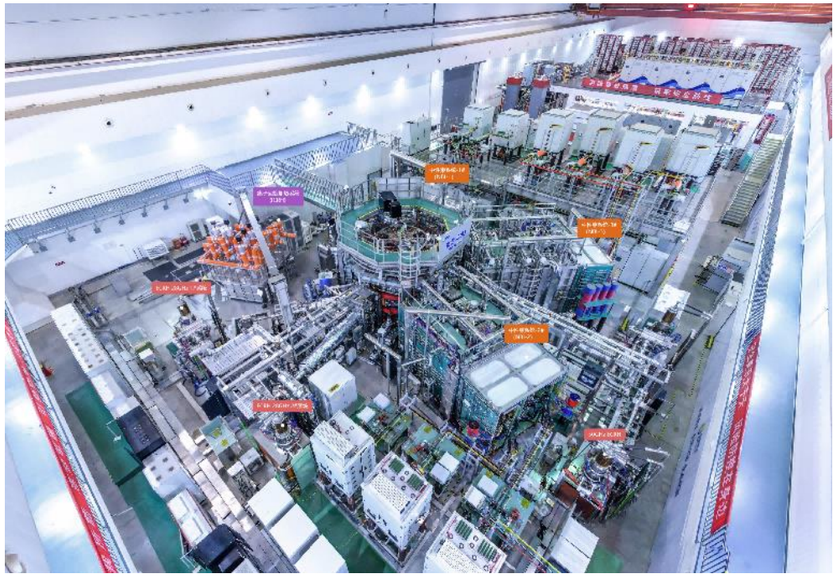
Timeline of EXL-50U



2025.06 1st NBI&4 ECRH



2025.12 +2nd NBI, ICRF



2026.08 +3rd NBI, CFC divertor

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EXL-50U Experimental Hall Floor Plan

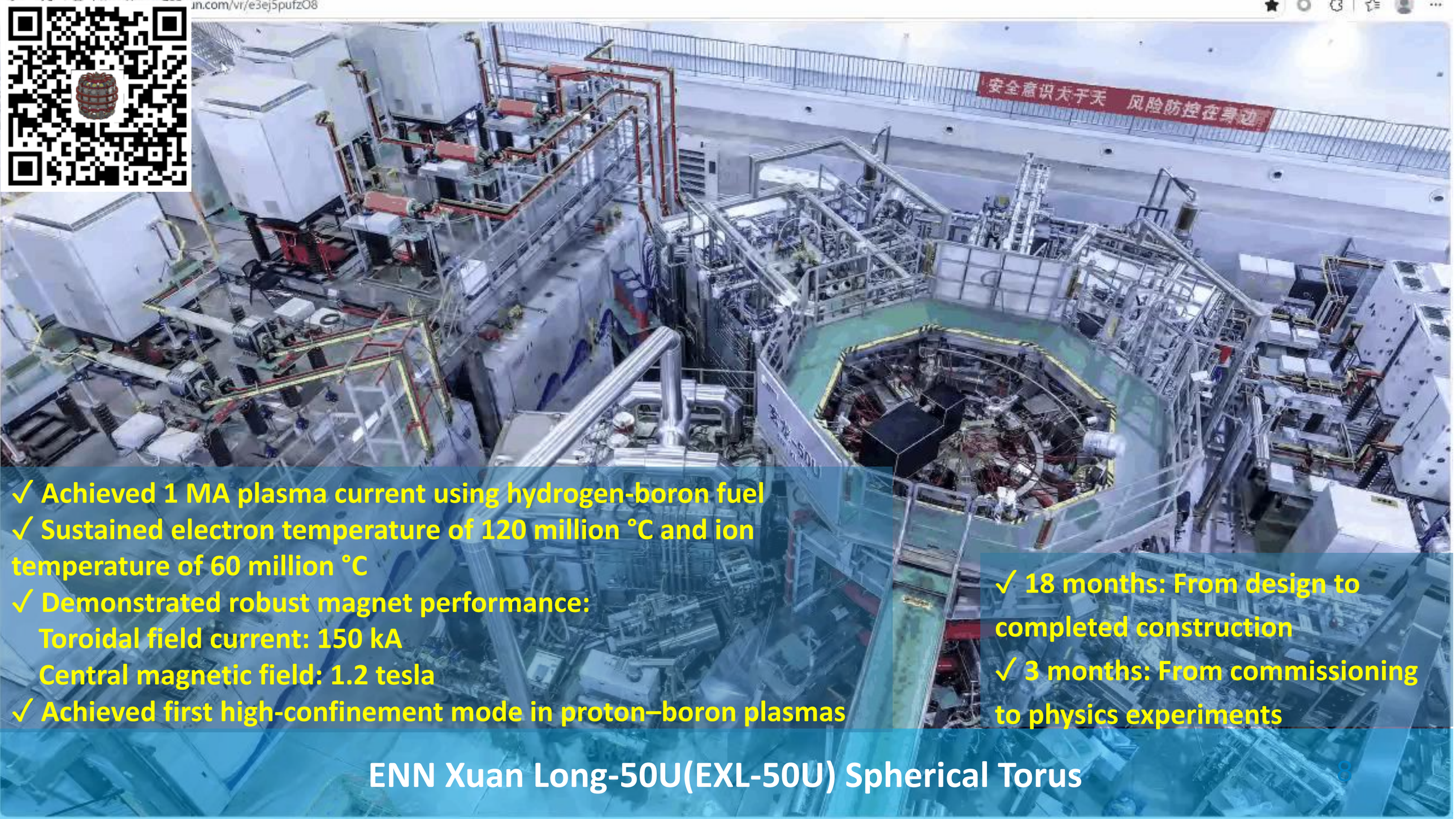


主机系统

- 等离子体电流:0.5-1.5 MA
  Plasma current
- 大半径:60 -80 cm
  Major radius
- 纵场磁场强度/环向磁场:1.2T
  Toroidal magnetic field (R = 60 cm)
- 中心螺线管磁通量:1.2 Wb
  Magnetic flux of CS
- 环径比:1.4- 1.85
  Aspect ratio
- 拉长比:2
  Elongation
- 纵场放电平顶区时长:2s@1.2T，8s@0.6T
  Discharge TF flattop duration

加热系统

- 中性束注入系统(NBI):1#50keV/1.5MW/1s，2#30keV/1.5MW/1s，3#80keV/4MW/1s
  Neutral Beam Injection System
- 电子回旋共振加热系统(ECRH):2×28GHz/300kW/2s，2×50GHz/360kW/1s
  Electron Cyclotron Resonance Heating System
- 离子回旋共振加热系统(ICRH):22-50MHz/1MW/1s
  Ion Cyclotron Resonance Heating System

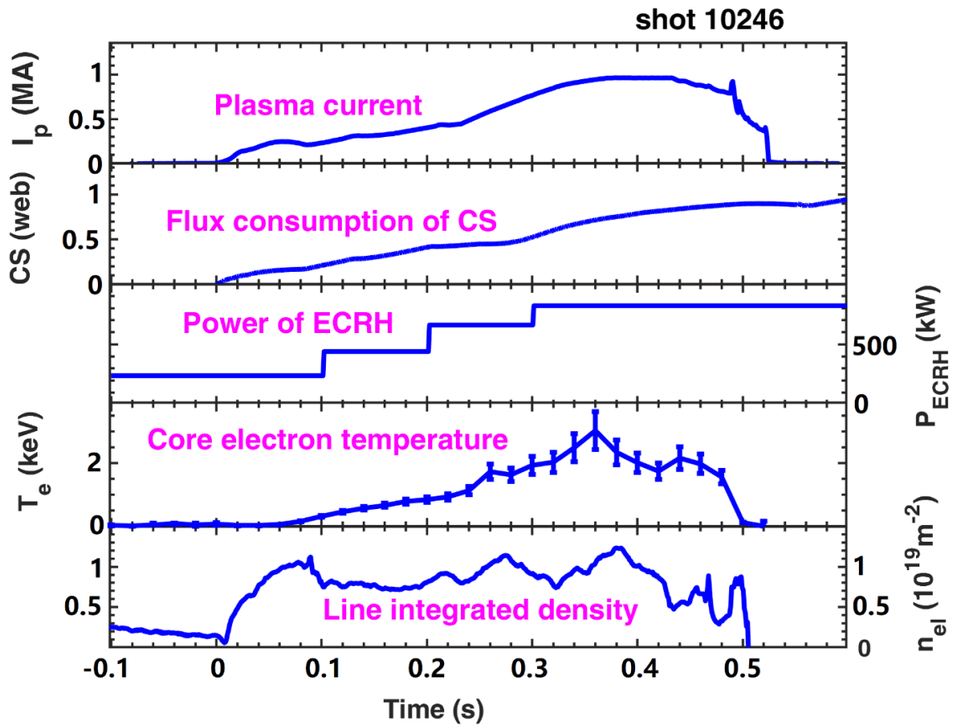


✓ Achieved 1 MA plasma current using hydrogen-boron fuel
✓ Sustained electron temperature of 120 million °C and ion temperature of 60 million °C
✓ Demonstrated robust magnet performance:
Toroidal field current: 150 kA
Central magnetic field: 1.2 tesla
✓ Achieved first high-confinement mode in proton–boron plasmas

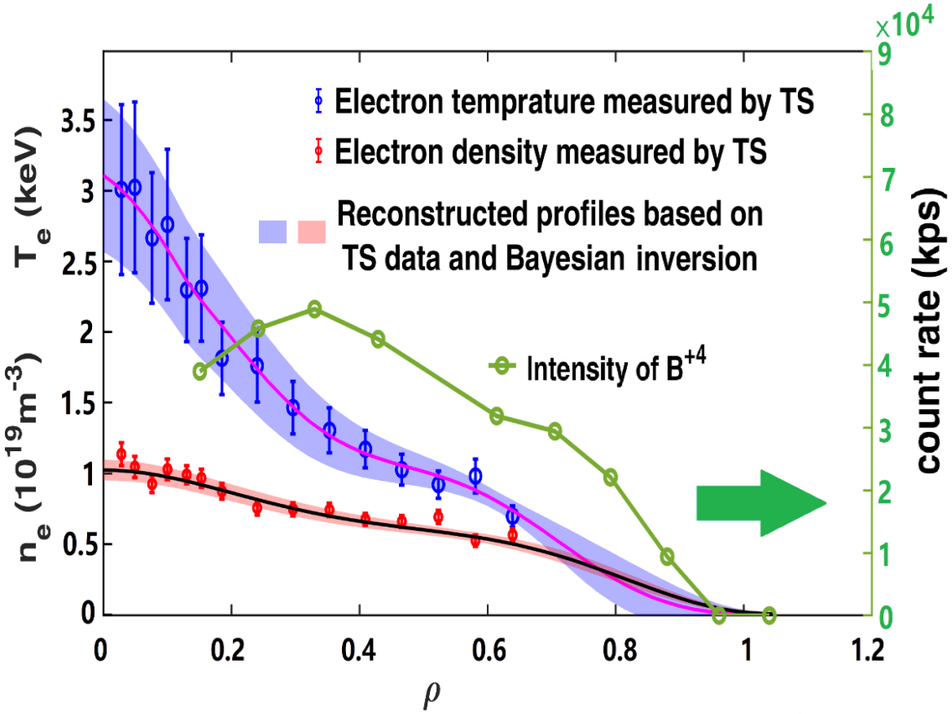
✓ 18 months: From design to completed construction
✓ 3 months: From commissioning to physics experiments

ENN Xuan Long-50U(EXL-50U) Spherical Torus

1 MA Discharge in Proton-Boron Plasmas



The waveforms of 1MA discharge in EXL-50U.



The electron temperature, density, and B^{+4} line intensity profiles at t = 0.36s in shot 10246.

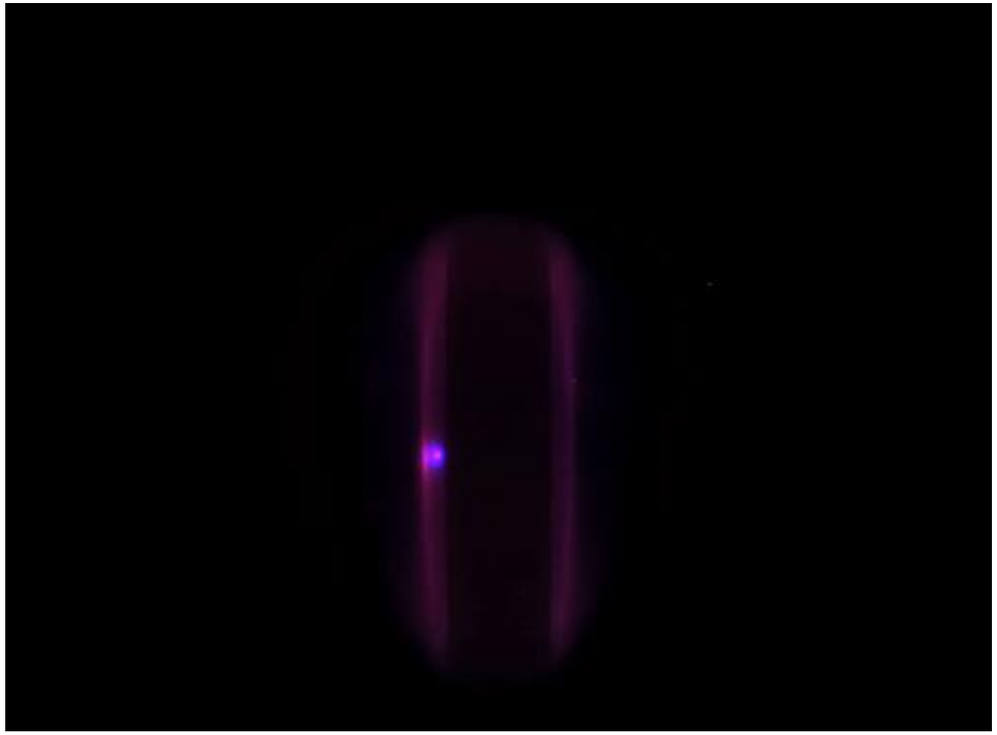
- **Filling gas for the entire discharge duration was a diborane-hydrogen mixture (30% B_2H_6: 70%H_2).**
- **The boron content (ion ratio) in the working fuel exceeds 15%.**

- **MA-level discharges achieved on the EXL-50U demonstrated the scientific feasibility of generating high-performance hydrogen-boron plasmas.**

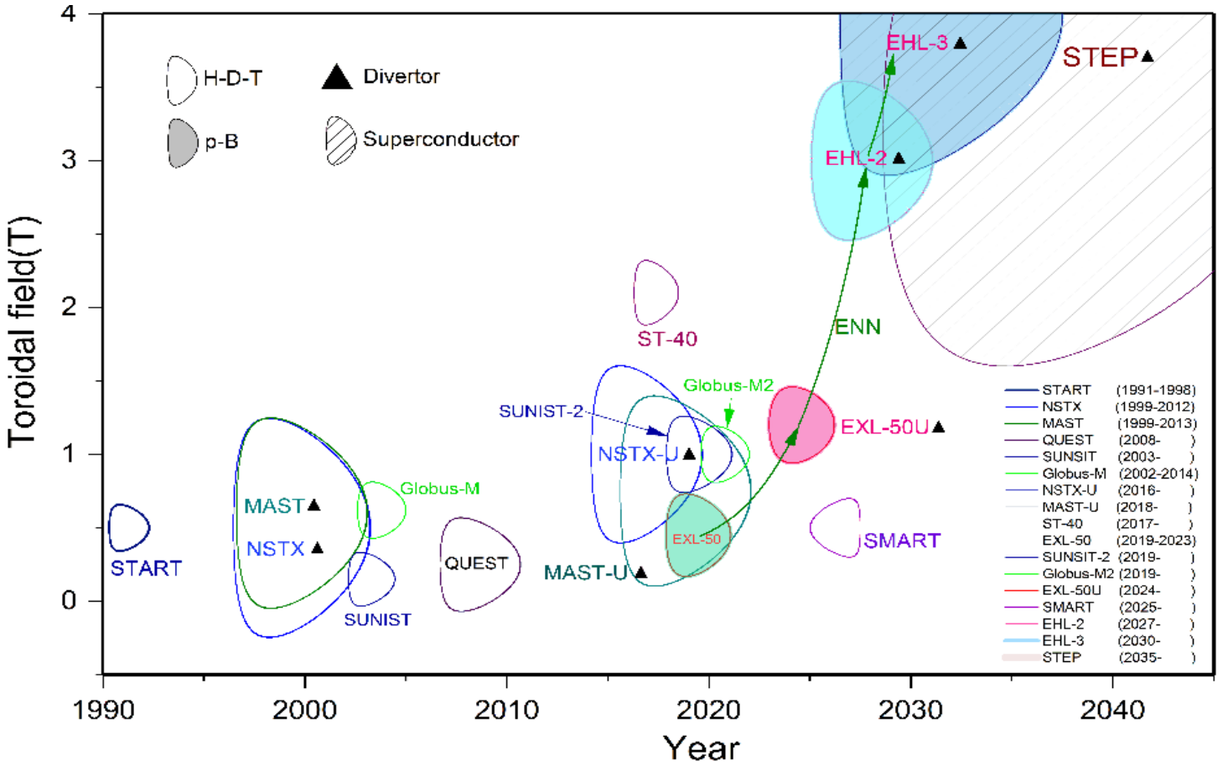
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* Shi Y, Song X, Guo D, et al. Achievement of 1 MA discharges in hydrogen–boron plasmas in the EXL-50U. Plasma Science and Technology, 2025, 27(9): 092002.

1-MA Plasma Discharge: A Step Toward Higher-Performance Spherical-Torus Fusion



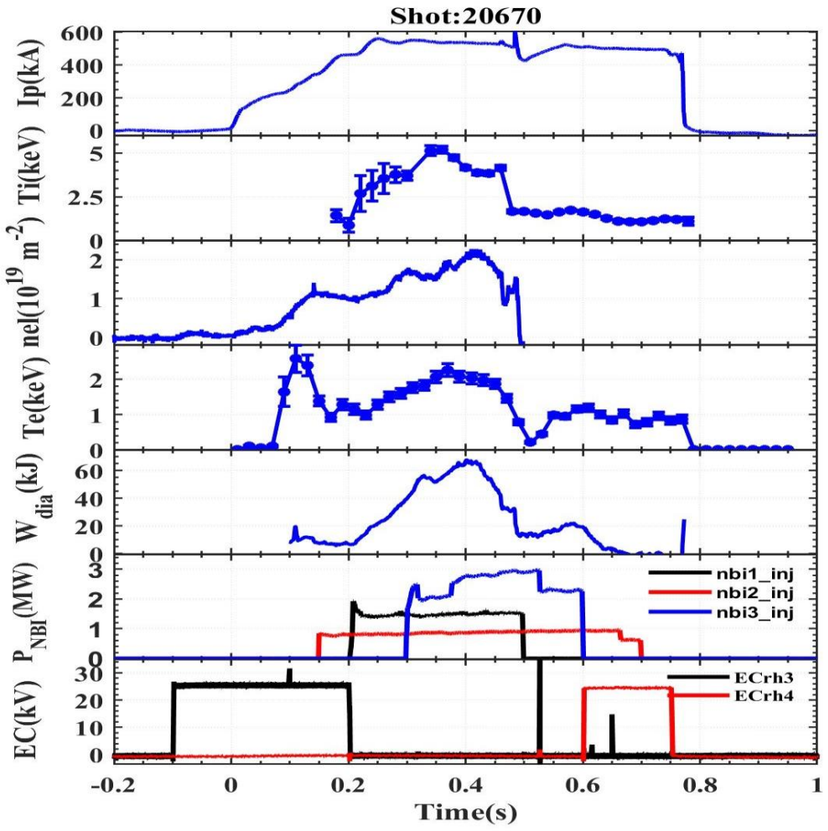
Plasma Discharge in EXL-50U



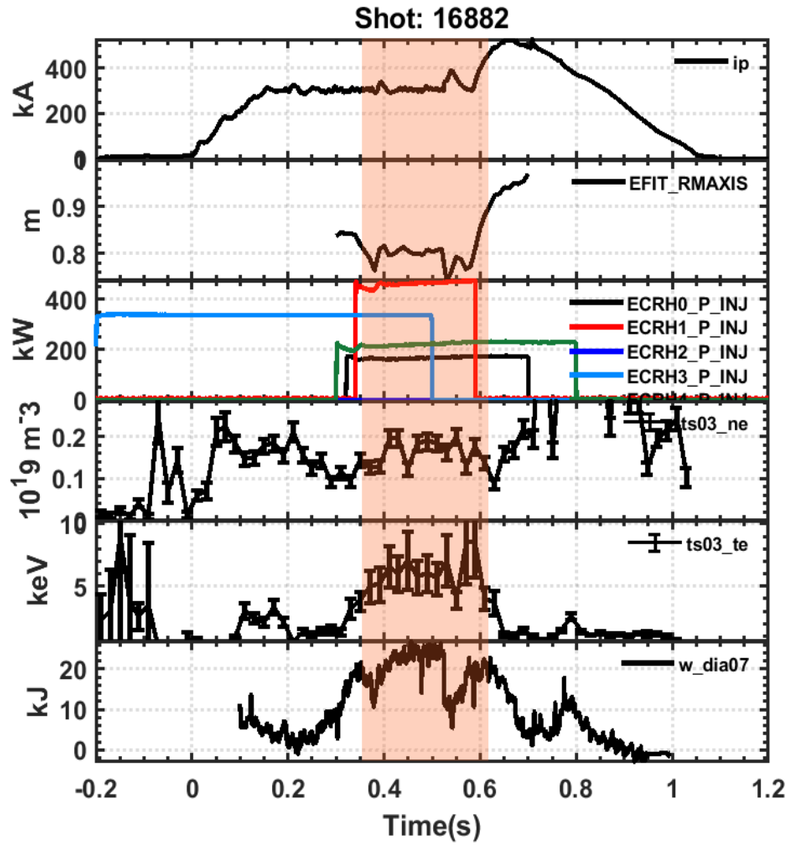
Spherical torus fusion power DEMO by 2035-2040

Significant Increase in Ion and Electron Temperatures

- Ion temperature increased to 5.2 keV (core chord-averaged ion temperature~ 60 million °C).
- Electron temperature increased to 10.7 keV (~ 120 million °C).



Discharge waveforms for the high-ion-temperature discharge



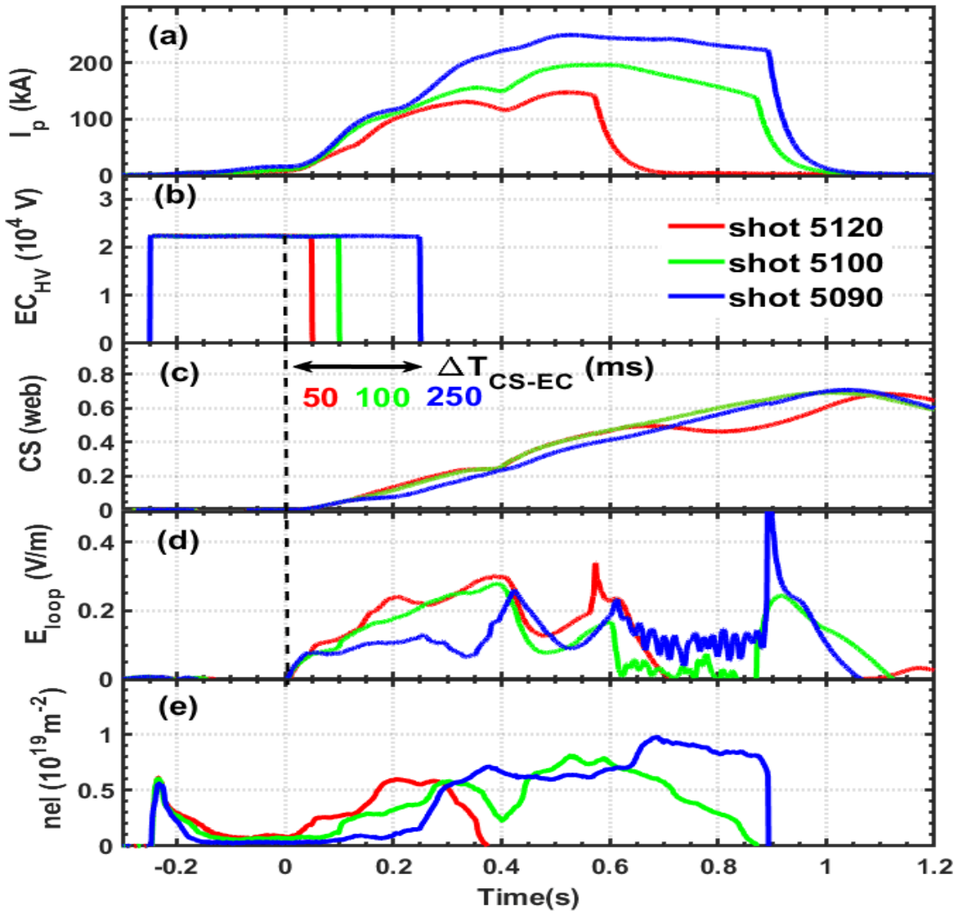
Discharge waveforms for the high-electron-temperature discharge

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Current Start-up and Ramp-up Scenario in EXL-50U

- Start-up by EC
- Ramp-up by EC+CS
- Synergistic use of EC and CS is key to sustaining the flat-top phase

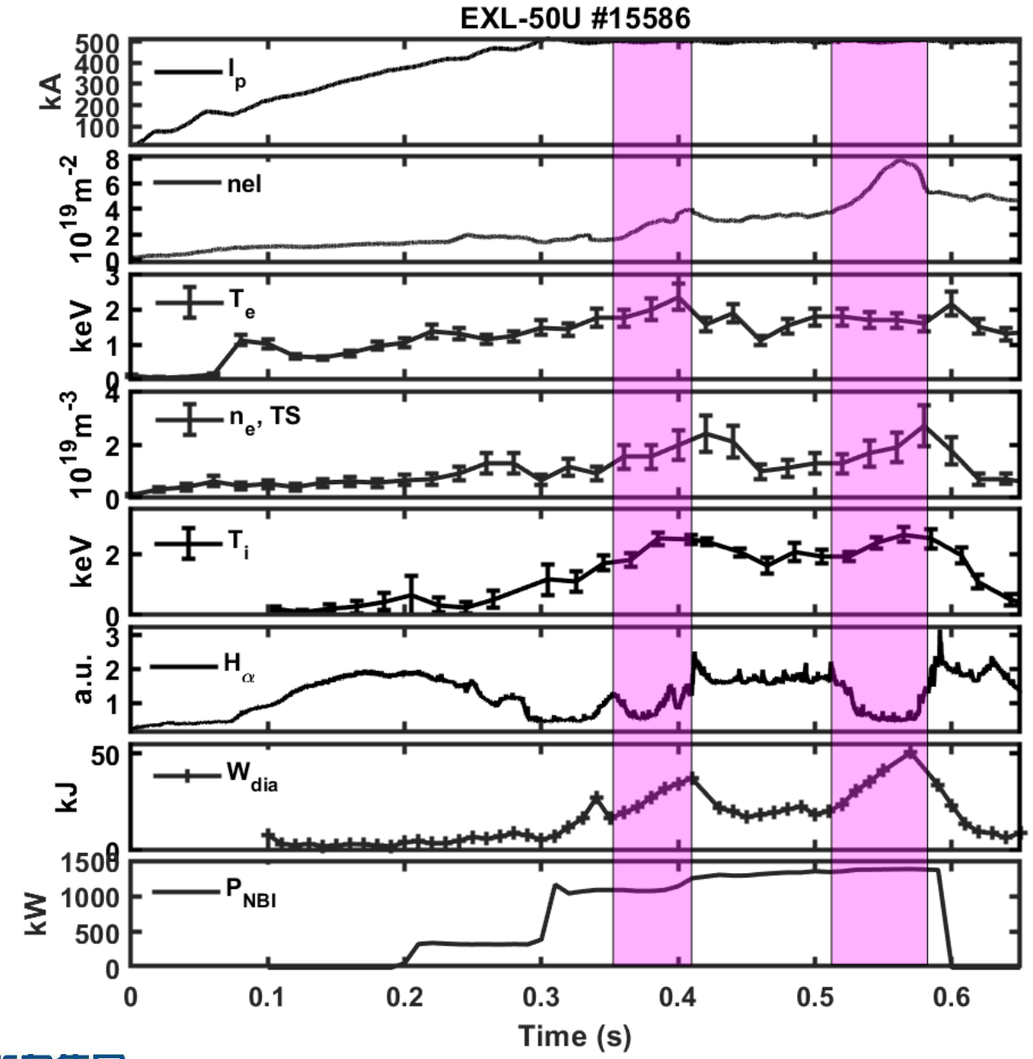
- Low loop voltage
- Low consumption of CS flux
- Potential applications to ST reactors and superconducting fusion devices such as ITER



I_p at flattop phase is proportional to ΔT_{CS-EC}

Xinchen Jiang, Yuejiang Shi, et al. Non-Inductive Current Start-Up Using Multi-Harmonic Electron Cyclotron Wave and Current Ramp-Up Through Combined Electron Cyclotron Wave and Ohmic Heating in EXL-50U Spherical Torus. arXiv:2512.18941 [physics.plasm-ph], 2025.

First Demonstration of High-Confinement Mode in Proton–Boron Plasma



Key Characteristics of the H-mode

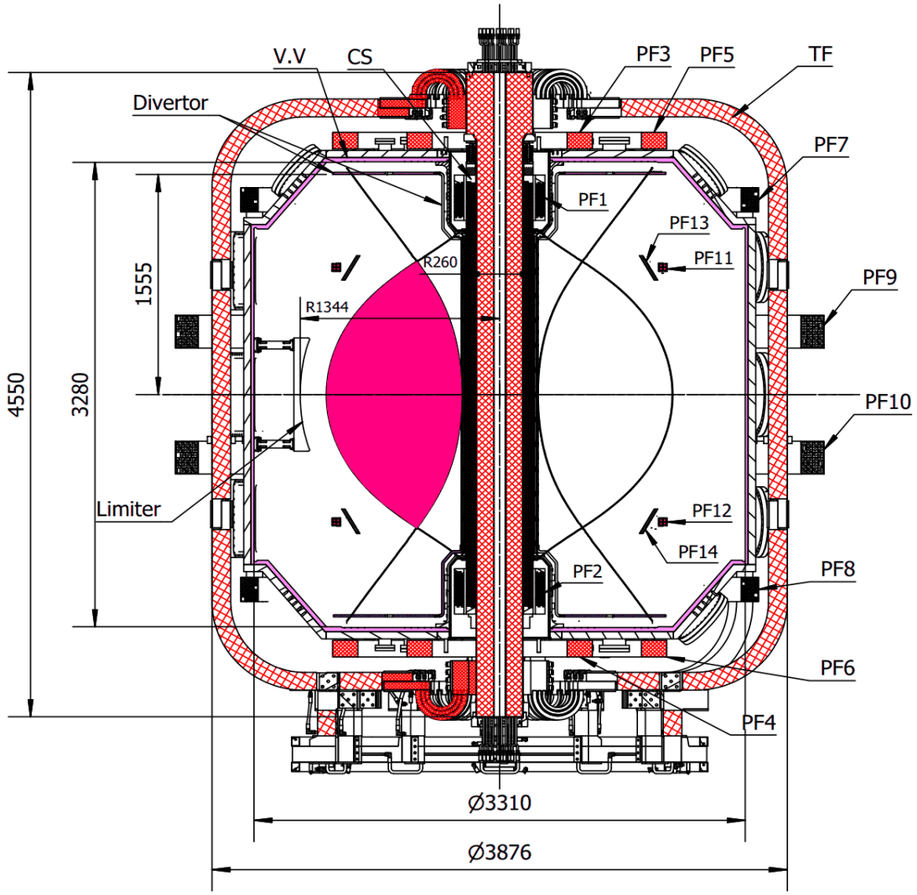
- ✓ **Electron density and electron temperature** are approximately **twice** those of the low-confinement mode (L-mode).
- ✓ **Plasma stored energy** increases from **20 kJ** to **50 kJ**.
- ✓ **Plasma energy confinement time** increases from **16 ms** to **40 ms**.
- ✓ **Plasma triple product** increases by approximately **one order of magnitude**.
- ✓ Boron ion concentration is approximately **10%.**

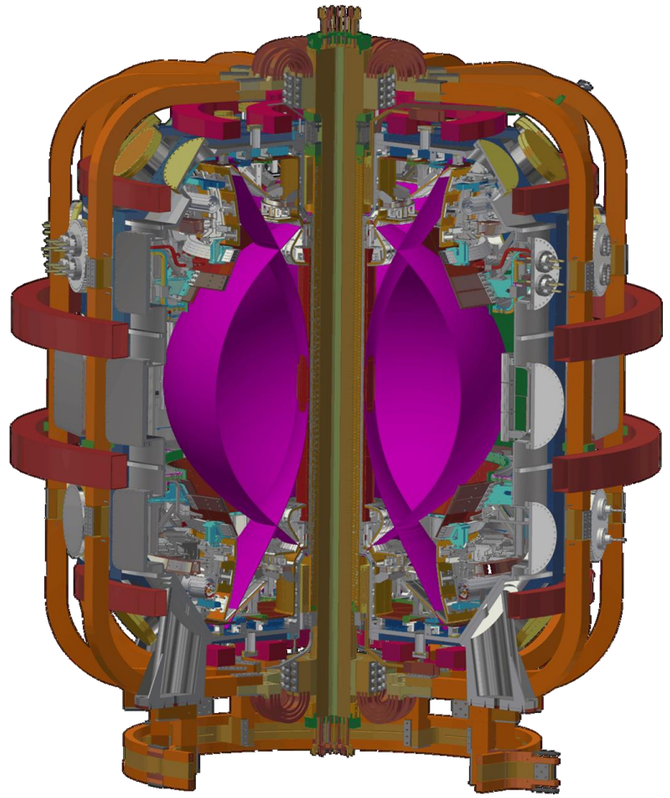
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Yumin Wang, Yuejiang Shi, Dong Guo, et al. First achievement of high-confinement mode in proton-boron plasmas. The Innovation, 2026, 7(7): 101458.

Torus Design

Routine operation at a plasma current of 500kA; ＞22,000 discharges.





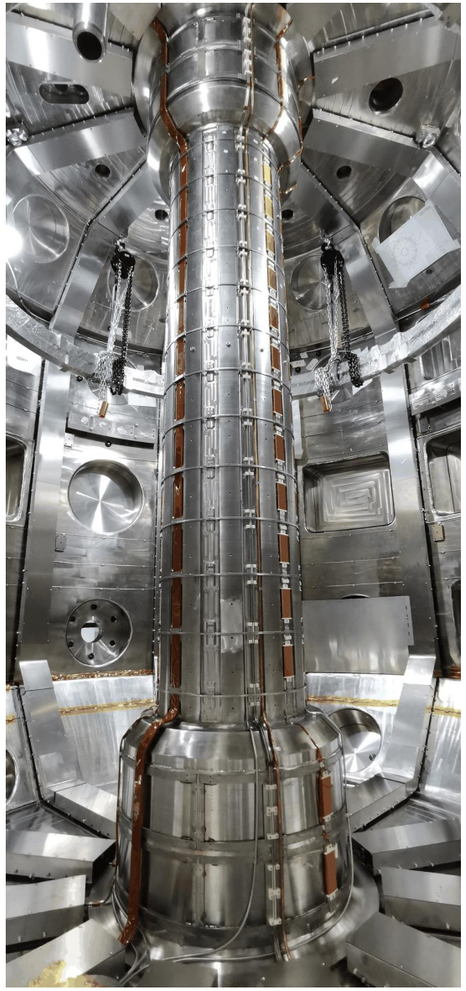
Parameter	Value
Major radius R_o (m)	0.6
Minor radius a (m)	0.32
Aspect ratio A	1.85
Elongation k	2.0
Plasma current I_p (MA)	1
Toroidal magnetic field B_o (T)	1.2@R=0.6m
Heating power P_{heat} (MW)	~10
Discharge duration t_d (s)	1.6/150kA

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Torus Design



VV, magnet and support



VV Center tube

Torus Features

•**Integrated structure**— The magnet and the support are fixed to the vacuum vessel.; VV carries EM force, gravity & disruption loads.

•**TF center column**— Cu foil flexible joints for EM force transmission & thermal stress relief.

•**VV Center tube**— Single/double-layer alternating for cooling channels and diagnostic detector installation

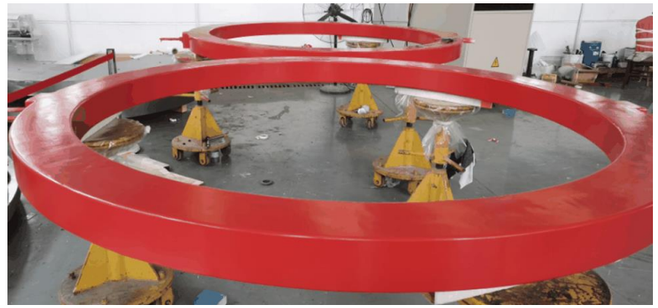
•**VV fabrication**— Full welding; diagnostic ports and interface flange prefabricated; active coils installed before final assembly

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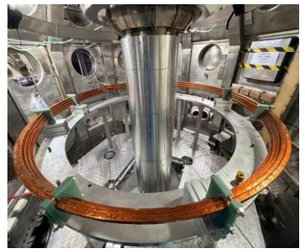
TF & PF Coils



TF coil (single assembly)



PF coil

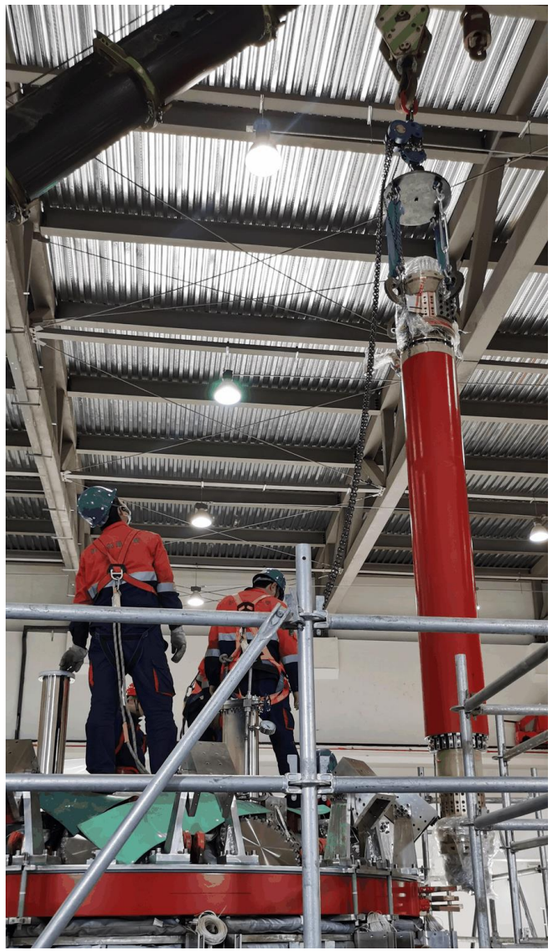




Fast control coil and passive plate



RMP coil

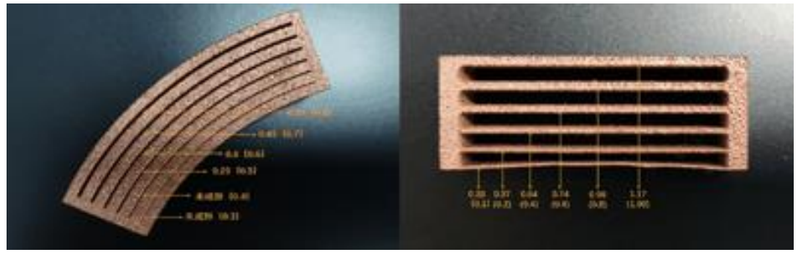


TF coil center column

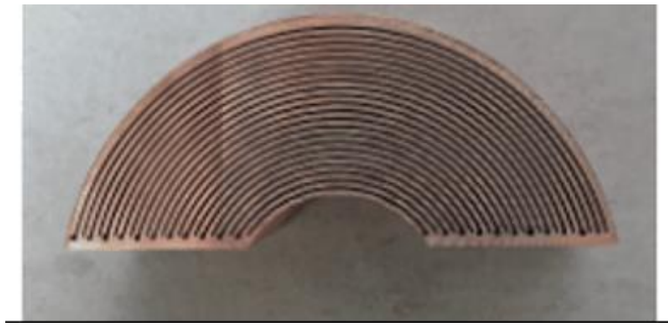
Design parameters of the EXL-50U magnet coils	
Magnet dimensions	Height: 4.6 m; width: 3.9 m
Bt@R=0.6m	1.2T
Maximum flattop duration	1.6s
Toroidal-field coil ampere-turns	2 × 12 = 24 turns; current per turn: 150 kA
OH coil ampere-turns	306 turns; maximum current: 40kA
Flux swing	≥1.2V·s
Operating temperature range	≤100℃
Coolant	Deionized water
Conductor material	Copper-silver alloy ; Copper–chromium–zirconium alloy

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TF Flexible Joints Development



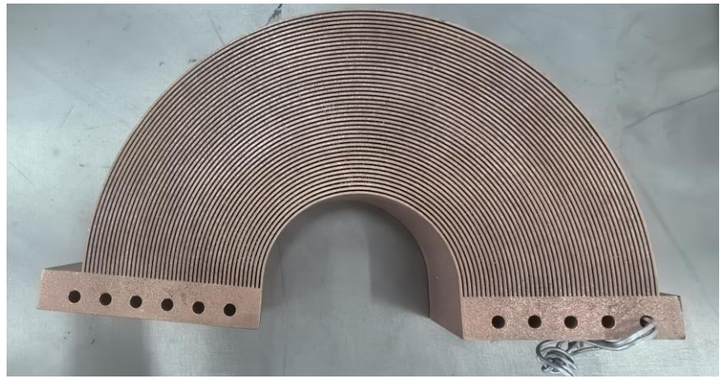
3D printing: thickness 0.3 mm;
minimum gap 0.5 mm



Wire EDM: thickness 0.8 mm; gap 0.35 mm



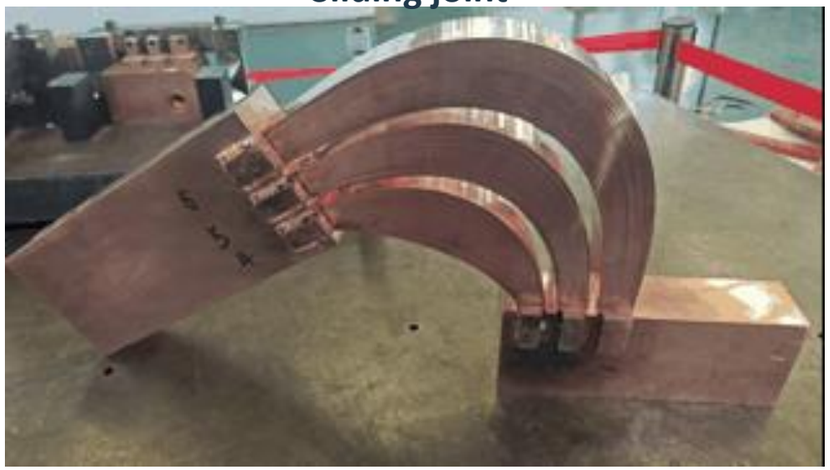
Sliding joint



3D printing: CuCrZr



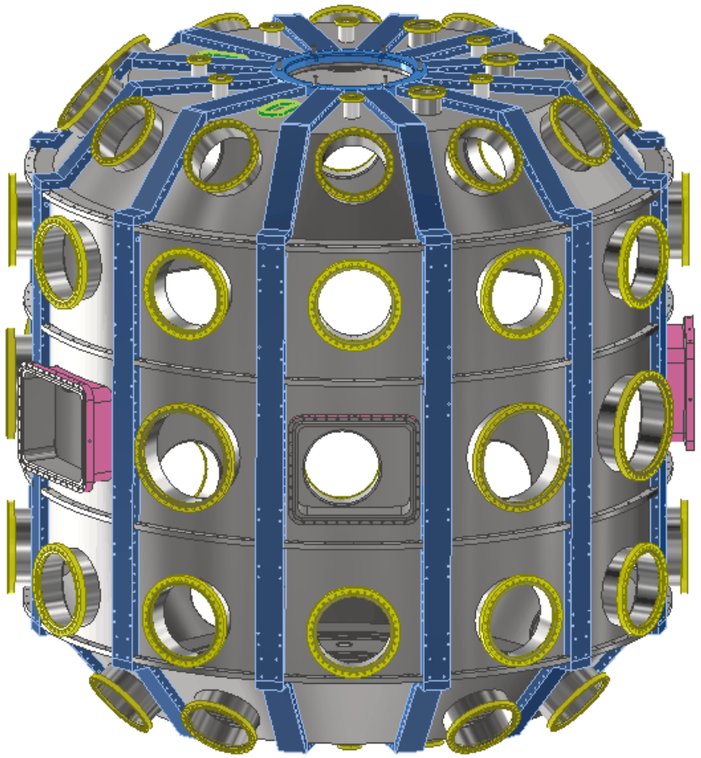
Wire EDM: thickness 1.9 mm; gap 0.35 mm



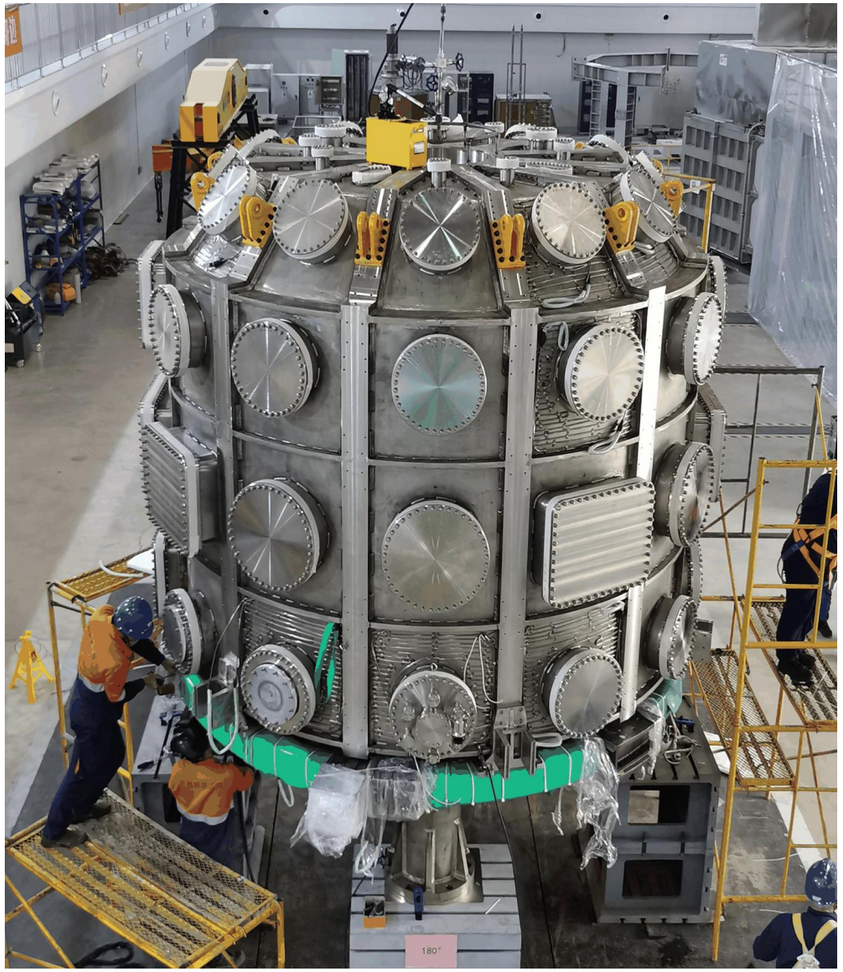
Electron-beam-welded joint

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Vacuum Vessel



Vacuum vessel model

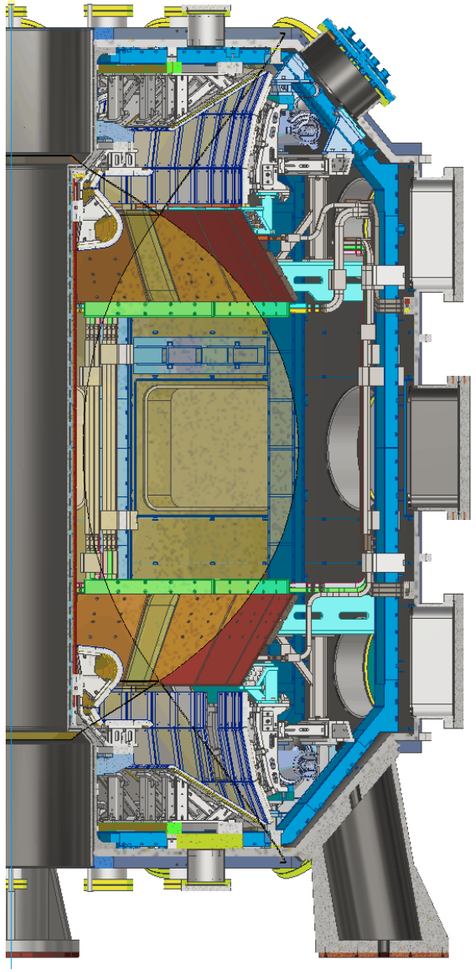


Vacuum vessel

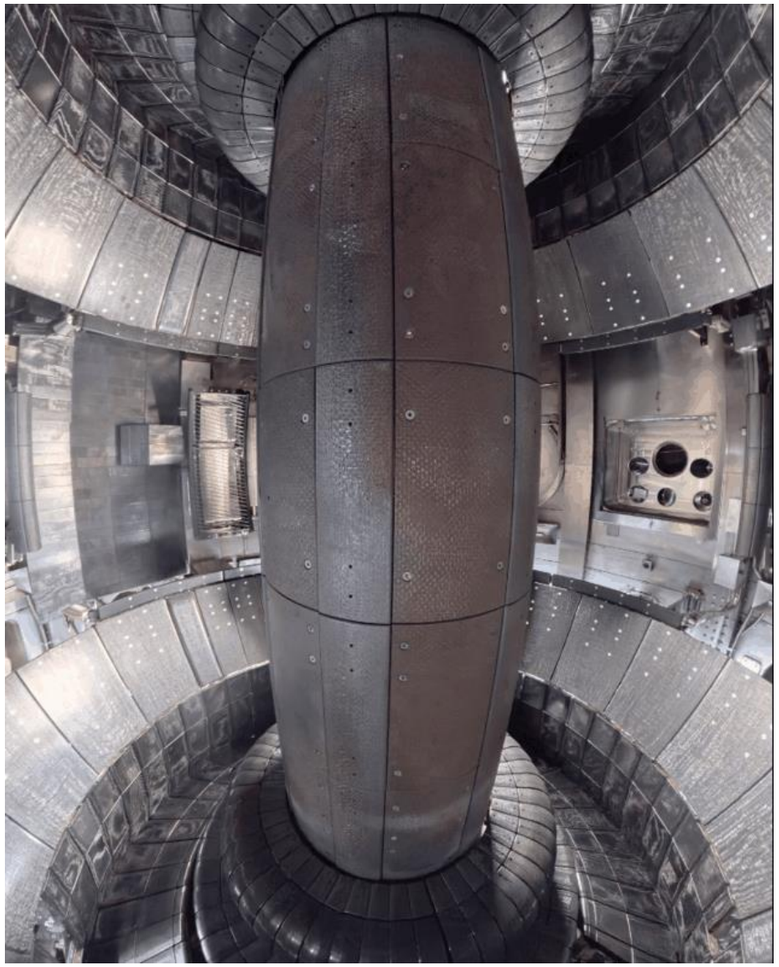
Parameter	Unit	Value
Vacuum vessel structure	/	Thin-walled, single-wall, fully welded construction
Inner diameter of the outer shell	mm	3310
Center tube diameter	mm	500
Vacuum vessel height	mm	3885
Inner and outer shell thickness	mm	8-20
Inner surface roughness	μm	0.63
Material	/	Inconel 625 (center tube) & 316L
Relative magnetic permeability	/	1.05 (1.1 at welds)
Design pressure	MPa	-0.1
Design temperature	℃	250
Center tube design temperature	℃	100
Baking temperature	℃	160
Design life	10^4 cycles	5
Number of baking cycles	Cycles	100
Ultimate pressure	Pa	10^{-6}
Total leak rate	Pa*m3*s-1	10^{-9}

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In-vessel Component (Divertor, Limiter & RMP)



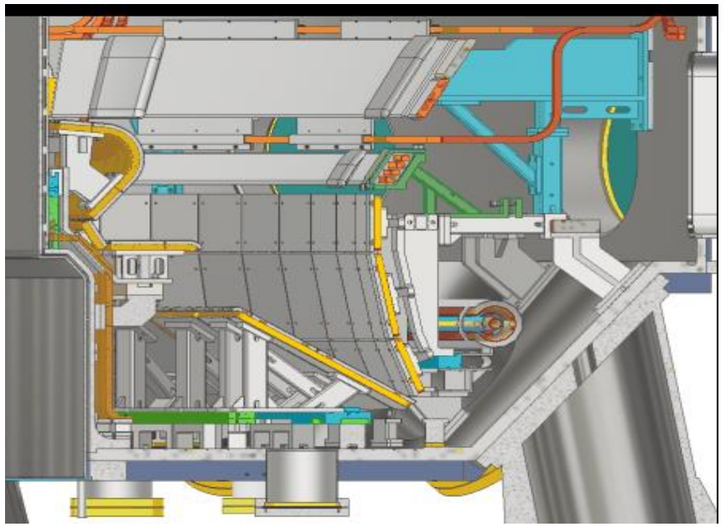
Integrated design of EXL-50U in-vessel components



Comprehensive upgrade of EXL-50U in-vessel components

Engineering challenges for in-vessel components:

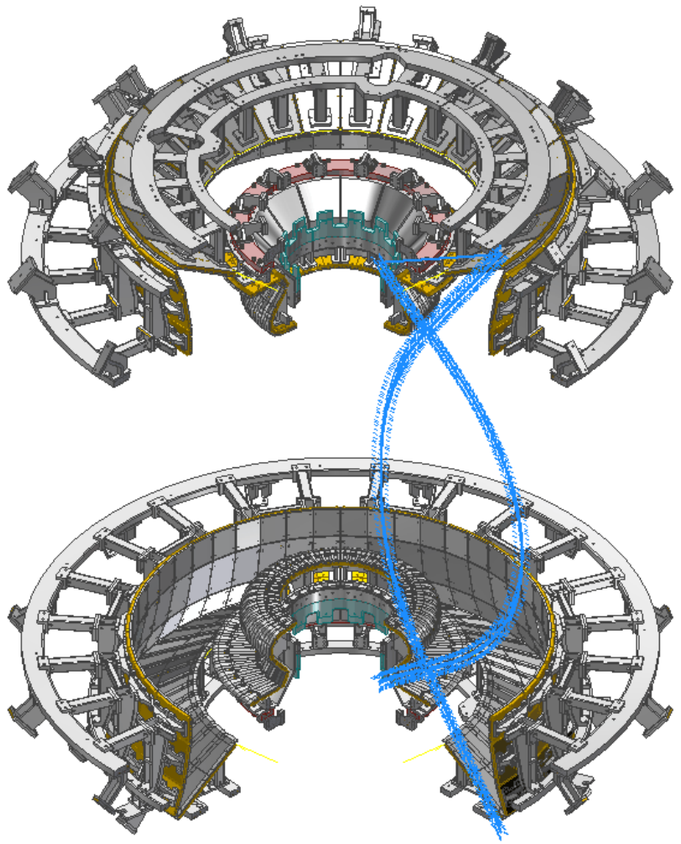
1. High power density and heat loads
2. Selection of materials that withstand extreme temperatures and offer improved plasma compatibility
3. Joining processes for dissimilar materials and control of joint stability
4. Physical sputtering and transient heat loads caused by energetic hydrogen and boron particles and electrons
5. Effects of particle distribution, erosion, and recycling on plasma purity and performance



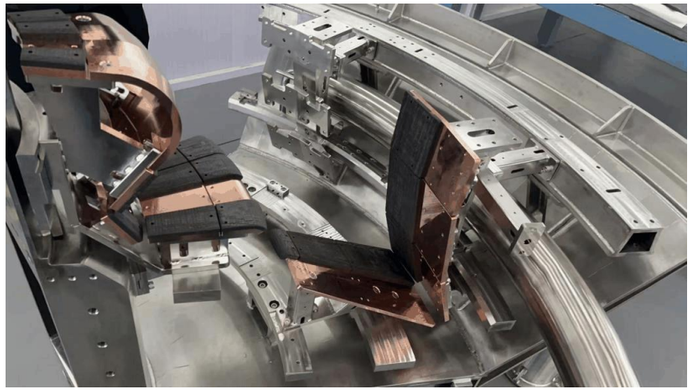
Integrated in-vessel components in the lower divertor region

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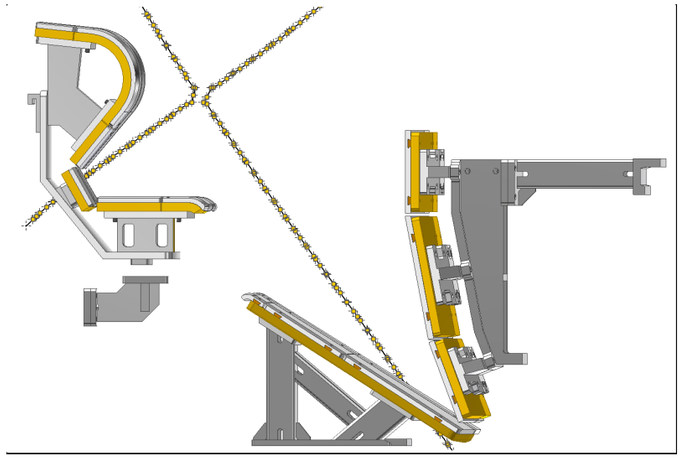
In-vessel Component (Divertor)



Divertor assembly



Divertor target mock-up sample



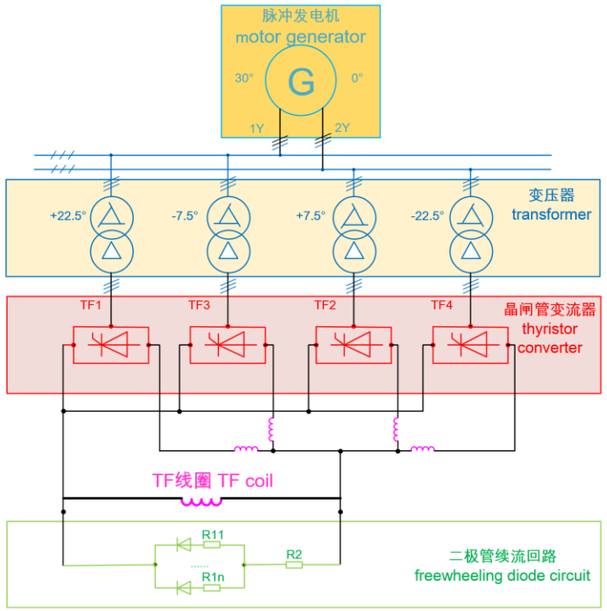
Divertor

EXL-50U Divertor Design Parameters		
Item		**Design description**
Overall configuration		Symmetric upper and lower assemblies, featuring independent toroidal modules and radial segmentation.
Heat load		q < 3 MW/m²; radiative cooling without water cooling
Material selection	**Plasma-facing material**	**CFC**
	Heat sink	**CuZrCr**
	Supports	**316L / Inconel 625**
Target structure		The main target profile is approximated by flat tiles, while the characteristic curved baffle profile is retained
Joining method		Dovetail grooves are machined at both ends of the CFC tiles, with embedded clamping blocks secured by bolts.
Support structure		Toroidal guide rails support an integrated in-vessel design accommodating the annular cryopump, active control coils, passive plates, RMP coils, and other components.
Baking method		Radiative heating from the vacuum vessel walls during baking

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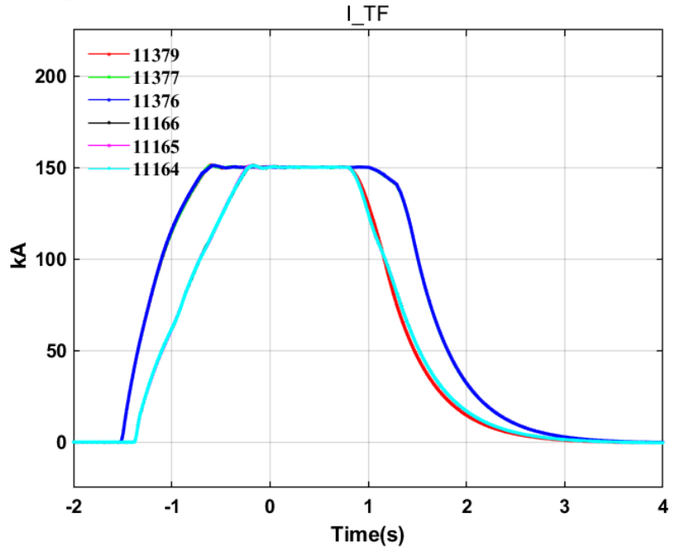
Power Supply

Toroidal-field magnet power supply configuration



- TF power supply: 500 V / 150 kA.
- An AC pulse generator set supplies pulsed power.
- Step-down transformers with sequential phase shifts provide 24-pulse rectification.
- Parallel-connected thyristors form a 40 kA rectifier unit.
- Four rectifier units connected in parallel deliver 150 kA

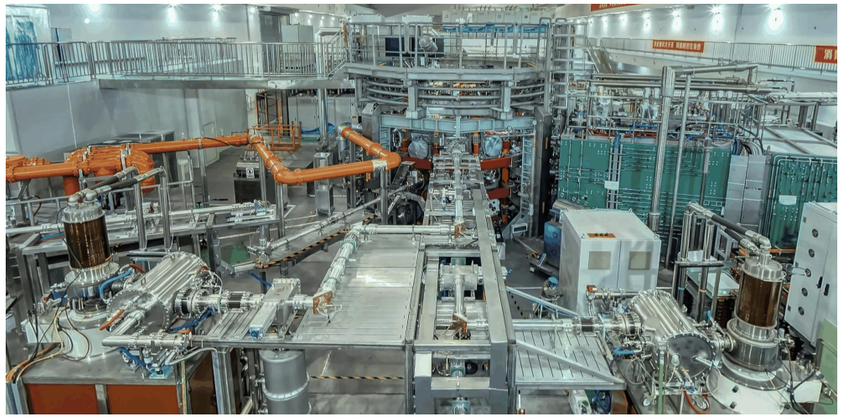
Commissioning progress of the EXL-50U toroidal-field magnet power supply



Powered by generator No. 1, the TF current reaches 150 kA with a 1.6 s flattop.

	EXL-50U	MAST-U	NSTX-U	ST-40
Pulse duration (s)	1.6	3	5	0.1
Toroidal-field coil current (kA)	150	133	130 (design value)	175 250 (design value)
Power supply configuration	Generator + thyristor rectification	Generator + thyristor rectification	Generator + thyristor rectification	Supercapacitors + IGBT chopper

ECRH System



Layout of the EXL-50U ECRH System

Current generation in operation

Frequency	Output power	Pulse duration	Quantity
28 GHz	400 kW	5 s	4
50 GHz	500 kW	1 s	2

Next generation under development

Frequency	Output power	Pulse duration	Quantity
50 GHz	1 MW	10 s（100 s）	2
105@140 GHz	1 MW	10 s（100 s）	6

Future generation under research

Frequency	Output power	Pulse duration	Quantity
175 GHz	2 MW	1000 s	1

01. Key Transmission Components

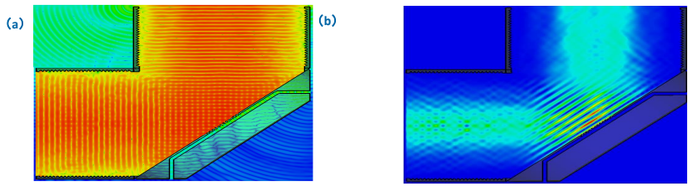
- 28 & 50 GHz polarizers & directional couplers
- Stable system integration

02. High-Precision ECRH Antenna

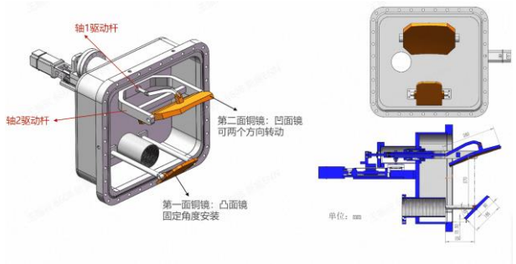
- Dual focusing mirrors
- Precise poloidal & toroidal angle control

03. High-Speed Control & Protection

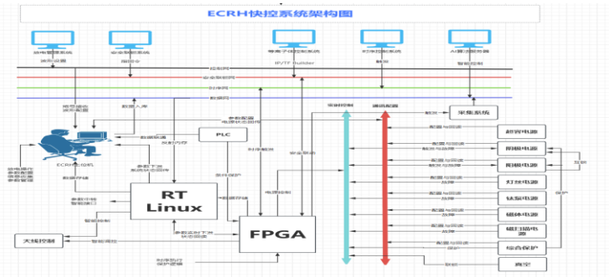
- Refined control & interlock logic
- <10 μs protection response



Cross-sectional distributions of (a) electric field and (b) power flux density in the 50 GHz directional coupler



Structural design of the antenna system



Architecture of ECRH control and protection system

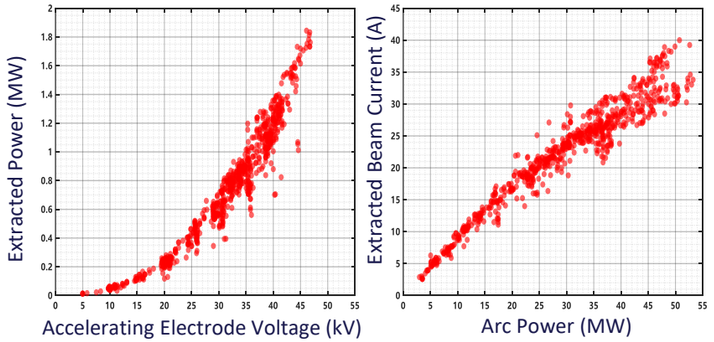
新奥集团 ENN GROUP

Neutral Beam Heating System: All design targets have been achieved

- Total ion-source power has reached 16 MW, and total injected power has increased to 6.3 MW, fully validating the in-house design capability.
- Single-ion-source performance has reached 25 keV / 0.5 MW, 46 keV / 1.85 MW, and 60 keV / 3.8 MW, among the highest performance levels achieved in China.

NBI No. 1 （50keV/1.5MW）

Beam injection: 50 keV / 1.5 MW



Ion source	Design beam current (A)	Measured beam current (A)	Extracted beam power (kW)
50kV-1#	40.7	40	1.85
50kV-2#		38.2	1.75

NBI No. 1 ion sources have achieved their design targets.

NBI No. 2 （25keV/1MW）

Beam injection: 25 keV / 1 MW



Ion source	Design beam current (A)	Measured beam current (A)	Extracted beam power (kW)
25kV-1	20.3	20.5	512.5
25kV-2		19.8	495
25kV-3		20.1	502.5
25kV-4		19.6	490

NBI No. 2 ion sources have achieved their design targets.

NBI No. 3 （80keV/4MW）

Beam injection: 60 keV / 3.8 MW, with a planned upgrade to 80 keV / 5 MW



80keV ion source



NBI No.3

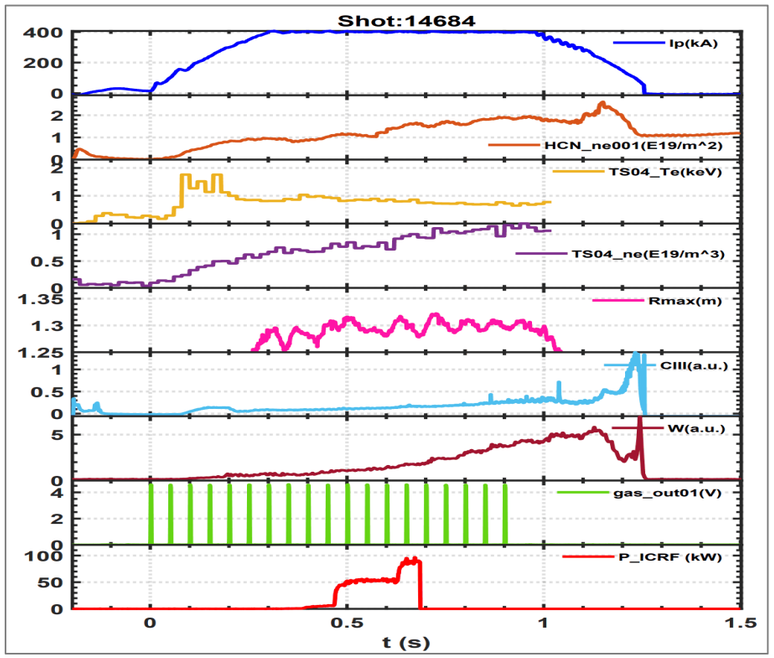
Ion source	Design beam current (A)	Measured beam current (A)	Extracted beam power (kW)
60kV-1	43.5	41.7	2.50
60kV-2		42.9	2.57
60kV-3		41.4	2.48
60kV-4		46	2.76

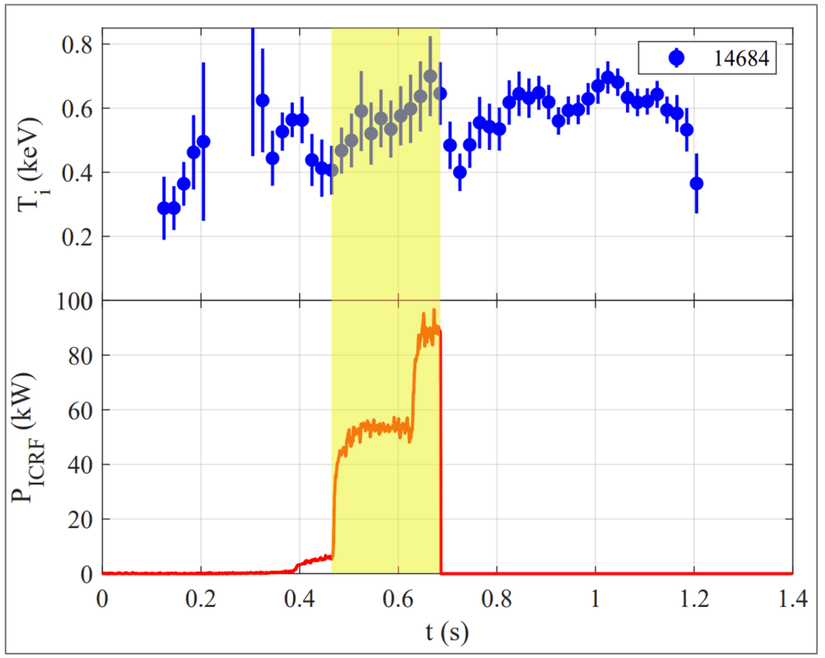
NBI No. 3 ion sources have achieved their interim design targets.

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Ion cyclotron heating system: stable ion cyclotron heating achieved

- The hundred-kilowatt-class ion cyclotron system provides stable heating, increasing ion temperature by 300 eV.
- Construction of the megawatt-class ion cyclotron system is complete, and engineering commissioning is underway.





A hundred-kilowatt-class system increases ion temperature

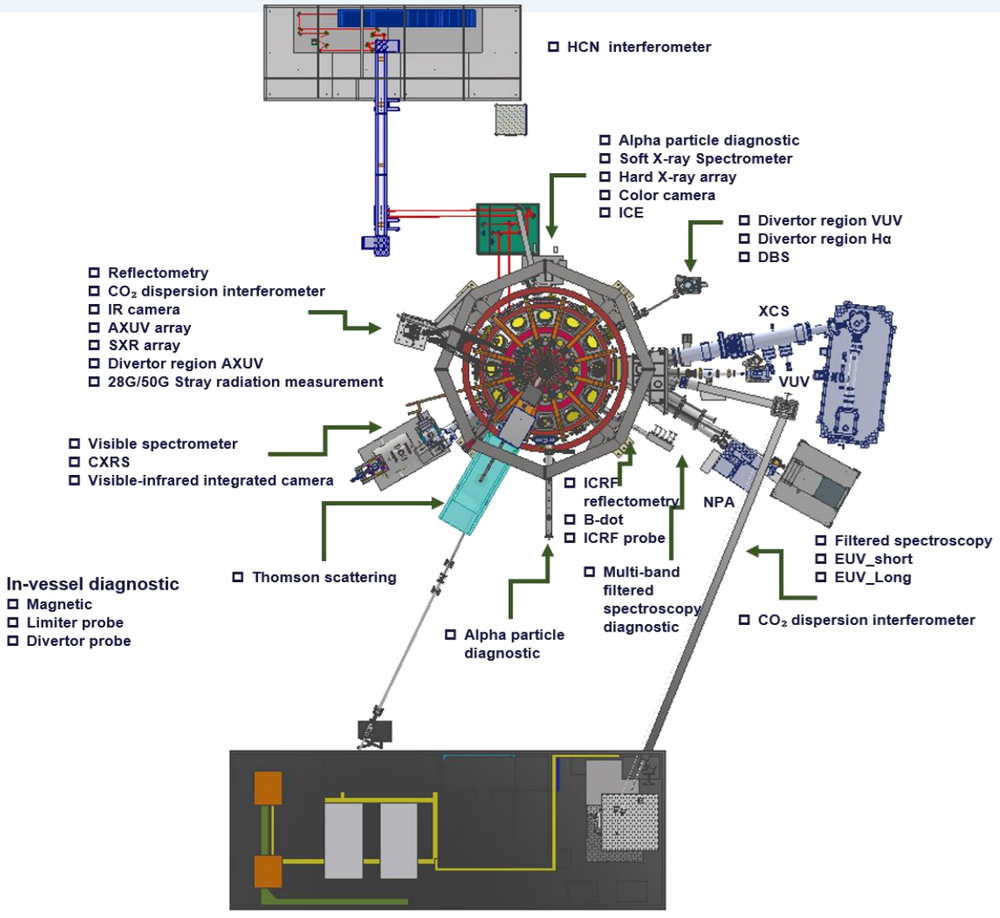


Megawatt-class ion cyclotron heating systems

新奥集团 ENN GROUP

Diagnostics: 25+ Systems Developed and Deployed

1. Strong stray-light suppression enables high-precision Thomson scattering diagnostics.
2. Fiber-optic current sensors fully replace Rogowski coils, enabling accurate measurements of long-pulse currents and eddy currents.
3. IMAS-standard data organization aligns diagnostic data processing with international practice.



- **Plasma feedback control**
  - magnetics
  - HCN interferometers
  - CO2 dispersion interferometers
- **First wall monitor**
  - Cameras
- **Profiles measurement**
  - Thomas Scattering
  - Visible spectroscopy
  - Microwave reflectometry
  - X-ray imaging crystal spectrometer (XCS)
- **Divertor related**
  - Divertor probe
  - Multi-band filtered spectroscopy
- **Radiation and impurities measurement**
  - AXUV array
  - SXR array
  - Soft X-ray spectrometer
  - Hard X-ray array
  - Soft X-ray spectrometer
  - Filter scope
  - VUV/EUV
  - Neutral particles analyzer (NPA)

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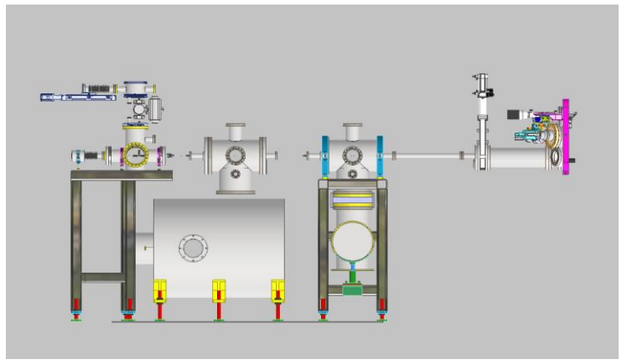
Pellet Injection

The pellet injection system uses a feeding scheme with an adjustable B/H ratio, featuring:

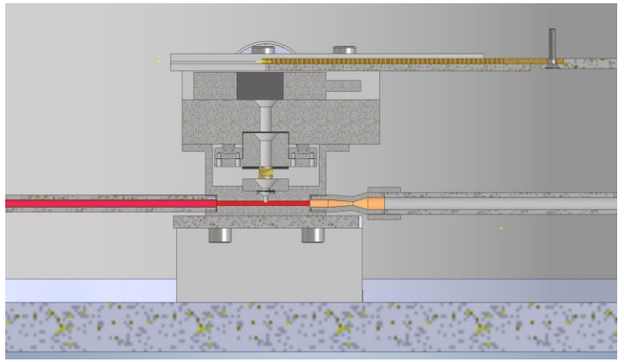
1. **High B/H ratio**
2. **Controlled feeding speed**
3. **Minimized introduction of impurities other than H and B**



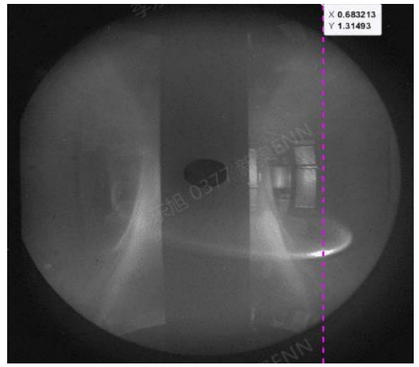
Pellet injection system



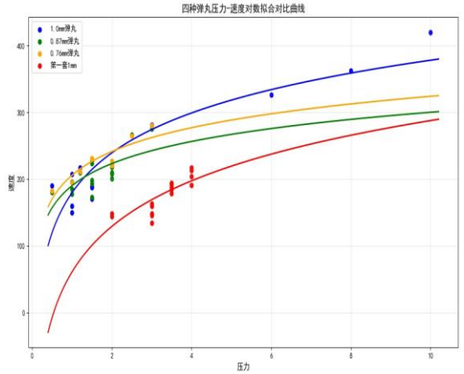
Pellet injection system schematic



Gas injection system and pneumatics



B injection on EXL-50U



Course of pellet velocities for size at 1.0, 0.87, 0.76 and 1.0 mm

- **Maximum achievable speed: 230 m/s.**
- **Hydrogen driving gas could increase flight speed by 20%.**
- **A second-generation launcher has been developed with an improved modular design.**

新奥集团 ENN GROUP

Fusion + AI: Pioneering a New Path to Rapid Commercialization

【AI-Powered Routine Plasma Control】

Stable Ip, position & shape control at 400–600kA Ip

400+ takeovers | 900+ ms | 2 cm | 10 kA

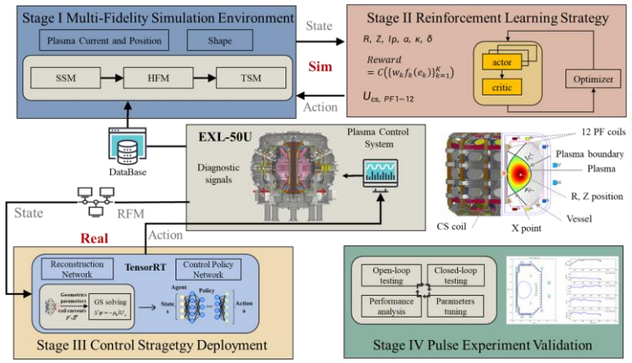
Flexible targets and robust real-time RL/PID/MPC control

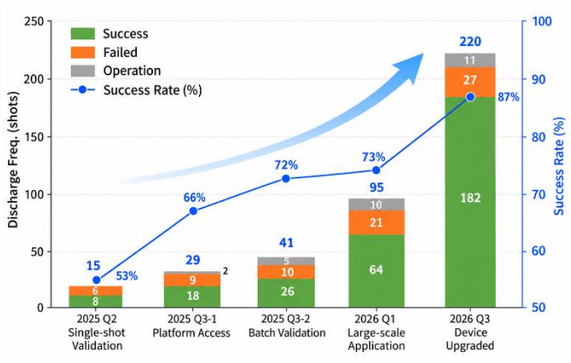
【Fusion AI Agents for R&D】

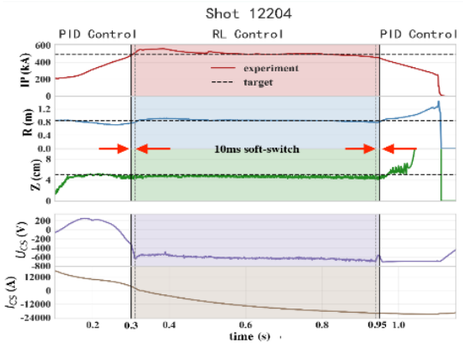
Autonomous optimization of experiments and controllers

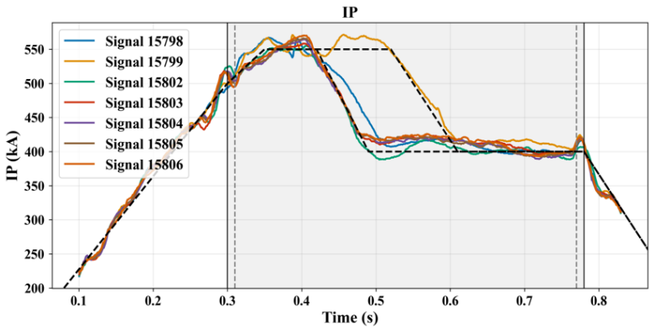
Param Auto-Tuning | 100×+ MPC speedup

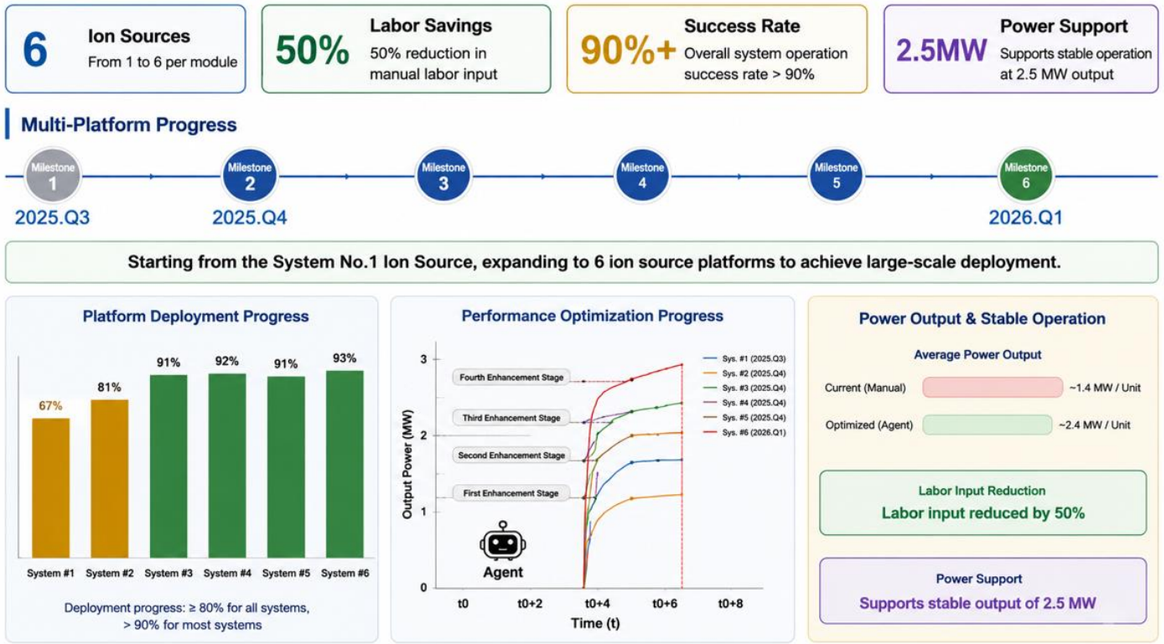
6 ion sources | 50% less labor | >90% success | 2.5 MW







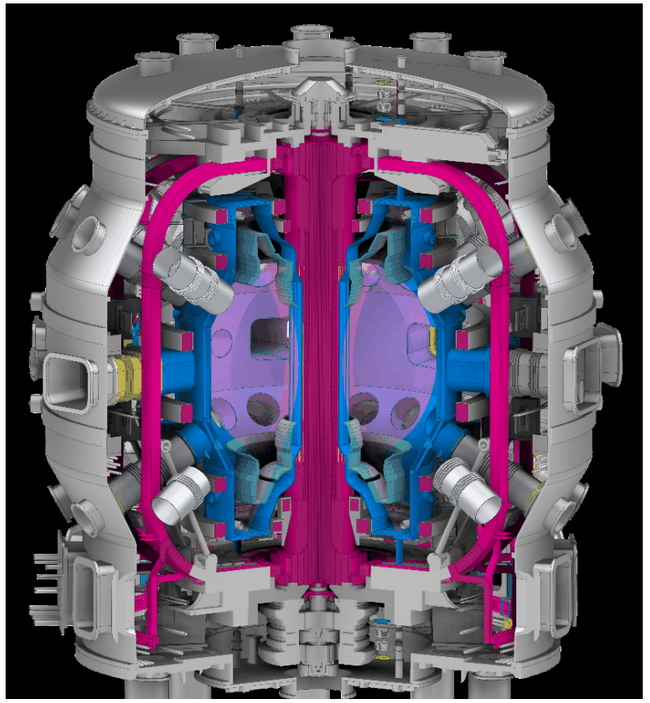


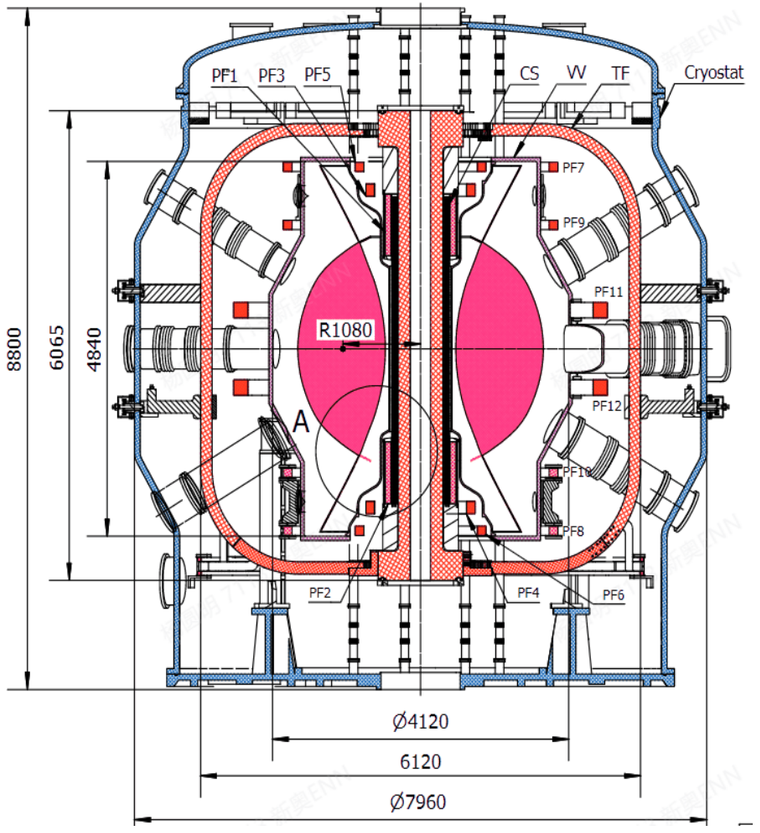


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New-generation ST p-^{11}B Experiment EHL-2 with Advanced Parameter Targets

- The physics design and critical engineering design are complete.
- The main machine assembly is scheduled to be completed and to begin commissioning by the end of 2027.

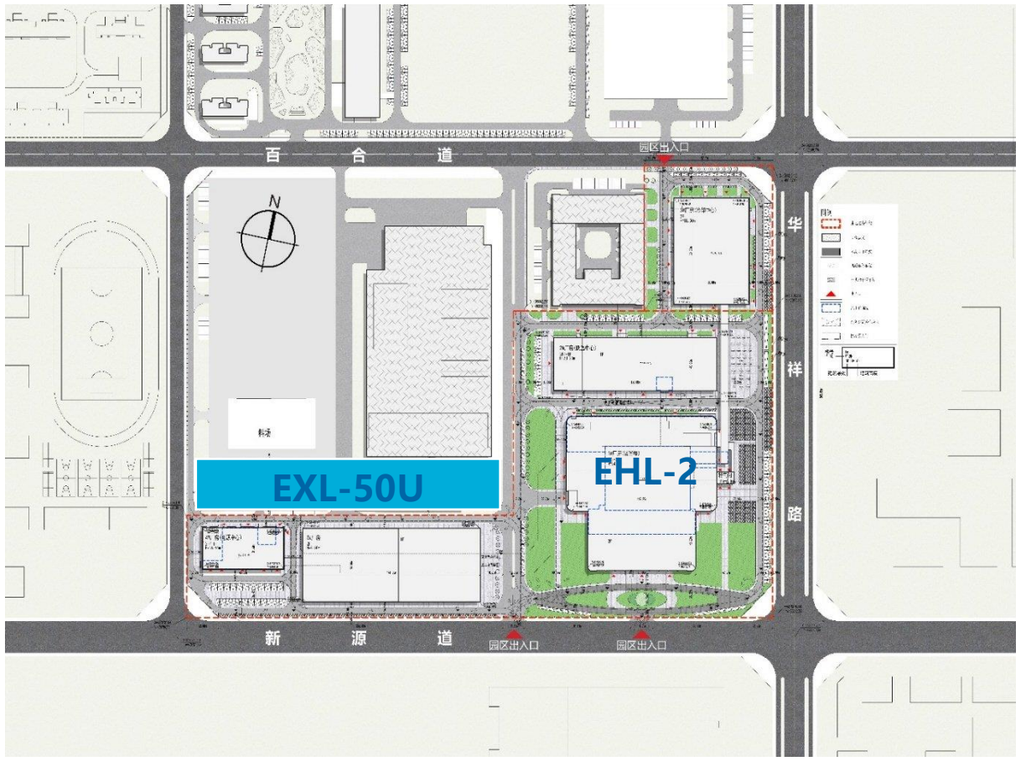




Parameters	
Peak ion temperature T_i(keV)	30
Peak density n_e(m^{-3})	1.3×10^{20}
Confinement time τ_E(s)	0.5
Beta β	0.11
Magnetic field B_0(T)	3.0
Major radius R_0(m)	1.05
Aspect ratio A	1.85
Temperature ratio T_i/T_e	2.5
Plasma current I_p(MA)	3.0
Heating power P_{heat}(MW)	31

新奥集团 ENN GROUP

EHL-2 Experimental Platform: Infrastructure and System Architecture



EHL-2 layout



EHL-2 3D Rendering

Site area: 8 hectares
Total gross floor area: 73,300 m², including the EHL-2 tokamak Building, Cooling Center, Cryogenic Center, and other supporting facilities.

The facility integrates **10+** major subsystems, including the torus system, magnet systems, mechanical support structures, heating systems, power systems, plasma diagnostics, and control systems.

Objectives

- ✓ Comprehensively validate p-^{11}B thermonuclear fusion reactions and energy gain;
- ✓ Establish the scientific foundation for proton–boron fusion energy;
- ✓ Achieve the first demonstration of electricity generation from p-^{11}B fusion.

EHL-2 Enters Full-Scale Construction



3D schematic of the overall planning for the core buildings



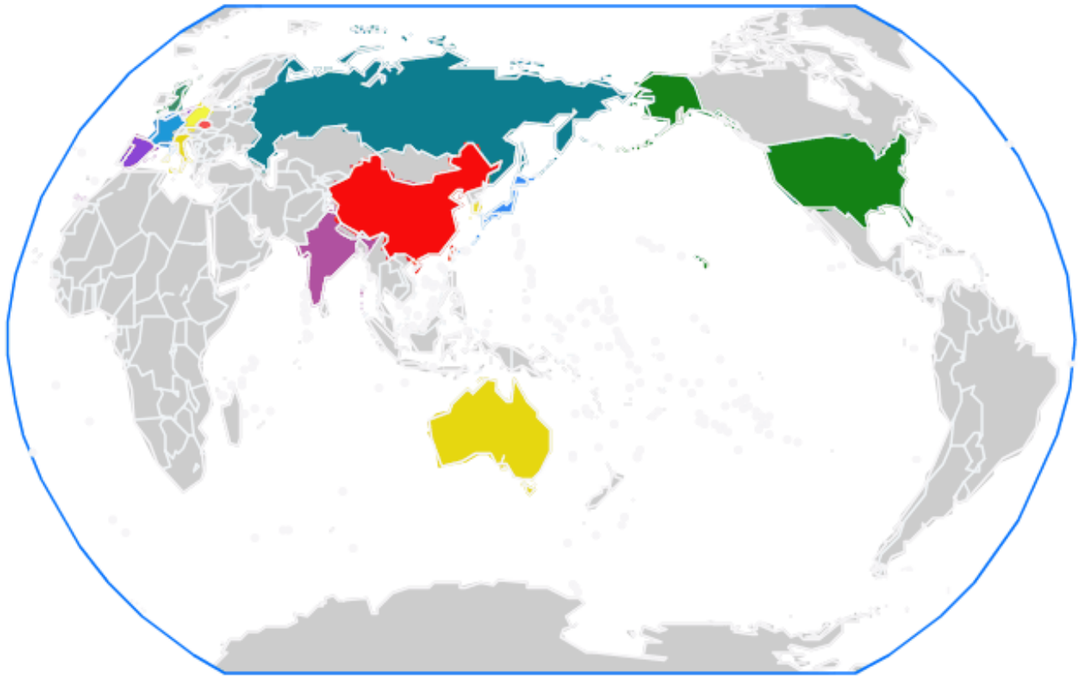
Torus mock-up



Construction site

Collaborative Growth: Moving Fusion Energy Forward with Our Partners

- Foster an open and inclusive global fusion R&D ecosystem.
- Engage with partners across academia, research institutions, industry, utilities and the private sector worldwide.
- Bring together complementary expertise and capabilities to advance fusion energy.



ENN is the first private company in China to join the International Tokamak Physics and Engineering Activity (ITPEA) physics activities.

Open Innovation and Shared Success



ENN launched the ***International Symposium on Proton-Boron Fusion Sciences and Applications (ISPBF)*** in 2023. This symposium serves as a platform to share the latest advancements and future plans in proton-boron fusion science and technology, while fostering a robust p-11B fusion research ecosystem both in China and worldwide.

ENN launched the ***Proton-Boron Fusion Research Fund*** to foster cross-disciplinary collaboration, supporting 43 projects since 2025. As we expand the scope of future calls, we look forward to welcoming researchers from around the world to join us in exploring new frontiers in proton-boron fusion.

Funded Projects in 2025

2025ENNHB01-001	氢硼聚变反应机制研究	庞丹阳	北京航空航天大学
2025ENNHB01-002	基于R-matrix理论的氢硼反应截面研究	茹龙辉	近代物理研究所
2025ENNHB01-003	固体硼靶中电子屏蔽对氢硼反应截面的影响	赵江涛	兰州大学
2025ENNHB01-004	极端非平衡等离子体中的氢硼核反应研究	魏文青	西安交通大学
2025ENNHB01-005	基于超强激光与含硼纳米结构靶的氢硼聚变研究	马文君	北京大学
2025ENNHB01-006	基于机器学习的激光驱动非热氢硼聚变能量增益优化研究	袁赟	南华大学
2025ENNHB01-007	相对论性氢硼等离子体及其核物理过程研究	李阳	中国科学技术大学
2025ENNHB01-008	高比压等离子体中磁流体力学不稳定性与磁场输运的关联机制探索	王昭	近代物理研究所
2025ENNHB01-009	和龙-2装置氢硼聚变运行模式设计与优化的集成模拟研究	魏来	大连理工大学
2025ENNHB01-010	面向氢硼聚变等离子体的ICRH全波模拟	张珈辉	西安电子科技大学
2025ENNHB01-011	螺旋波放电调控氢硼聚变等离子体边界密度的物理机制与实验验证研究	芸磊	重庆大学
2025ENNHB01-012	强流质子束在低密度等离子体中的能量损失与输运问题探索	张延师	先进能源科学与技术广东省实验室
2025ENNHB01-013	强流质子束在不同含硼密度物质中的能量沉积	马步博	西安交通大学
2025ENNHB01-014	氢硼聚变反应率研究的Geant4 程序开发	韩星池	山东大学
2025ENNHB01-015	α粒子撞击惰性气体电离与磁流体发电性能研究	黄护林	南京航空航天大学
2025ENNHB01-016	开放性磁力线位形中的质子-11B反应能量的直接转换研究	李景春	深圳大学
2025ENNHB01-017	质子硼捕获治疗在精准放射医疗领域的分子靶向作用机理和创新应用	初大可	西安交通大学
2025ENNHB01-018	基于纳剂量学的氢硼聚变反应生物学效应	关兴彩	兰州大学

Funded Projects in 2026

2026ENNHB01-001	人工智能驱动的氢硼聚变关键中间态及截面增强理论研究	吕梦蛟	南京航空航天大学
2026ENNHB01-002	面向p-^{11}B聚变工程的主-副反应全链条核数据计算	王小保	湖州师范大学
2026ENNHB01-003	氢硼聚变能区环境电荷对反应速率干扰研究	乔宇洁	兰州大学
2026ENNHB01-004	氢硼聚变反应机制的有效场论研究	任修磊	山东大学
2026ENNHB01-005	基于强流加速器的氢硼反应共振截面测量	田宁	中国科学院近代物理研究所
2026ENNHB01-006	基于 Tsallis 非广延统计的p-^{11}B聚变反应率研究	侯素青	中国科学院近代物理研究所
2026ENNHB01-007	面向氢硼聚变逆运动学小角区截面测量的AI智能体仿真平台开发与探测器布局优化研究	王守宇	山东大学
2026ENNHB01-008	激光氢硼聚变的理论模拟与点火方案设计	张国强	中国科学院上海高等研究院
2026ENNHB01-009	激光驱动对撞非平衡等离子体对氢硼聚变影响研究	谷渝秋	上海激光等离子体研究所
2026ENNHB01-010	基于靶内加速的新型氢硼聚变装置	符长波	复旦大学
2026ENNHB01-011	非平衡态下氢硼燃料的自加热条件及燃烧过程	王伟民	上海交通大学
2026ENNHB01-012	和龙2装置中氢硼燃烧等离子特性的第一性原理模拟研究	包健	北京瞬原科技有限公司
2026ENNHB01-013	磁约束氢硼等离子体中快质子—α粒子共振耦合与非线性输运机制研究	任海骏	中国科学技术大学
2026ENNHB01-014	EHL-2装置靶板侵蚀与杂质输运研究：ITCD与EMC3-EIRENE集成模拟	戴舒宇	大连理工大学
2026ENNHB01-015	基于SiC-LGAD的时间像素探测器系统研制	史欣	中国科学院高能物理研究所
2026ENNHB01-016	氢硼聚变等离子体温度的偏振汤姆逊散射诊断物理机理	吴坚	西安交通大学
2026ENNHB01-017	氢硼聚变中带电粒子与瞬发X双路联合诊断方案研究	曹喜光	中国科学院上海高等研究院
2026ENNHB01-018	氢硼聚变等离子体中杂质离子的高精度EUV光谱识别技术研究	周泽贤	先进能源科学与技术广东省实验室
2026ENNHB01-019	面向玄龙-50U聚变装置的高效偏滤器层析反演与光学边界识别算法研究	王逍	安徽大学
2026ENNHB01-020	面向H-B聚变的碳化硅alpha 粒子探测器	贾玉萍	中国科学院长春光学精密机械与物理研究所
2026ENNHB01-021	光瓦级太赫兹聚变回旋放大器	杜朝海	北京大学
2026ENNHB01-022	弧放电负氢离子源关键物理问题研究与实验验证	农竹杰	中国原子能科学研究院
2026ENNHB01-023	氢硼聚变DEC电极基体嵌入式微通道换热特性及优化设计研究	韩旭	哈尔滨工程大学
2026ENNHB01-024	氢硼等离子体高密度点火路径探索	刘家兴	聚核智算（武汉）科技有限公司
2026ENNHB01-025	锂于在氢硼聚变中的应用研究	崔著钫	南京大学

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