重慶大學
CHONGQING UNIVERSITY

上海交通大學
SHANGHAI JIAO TONG UNIVERSITY

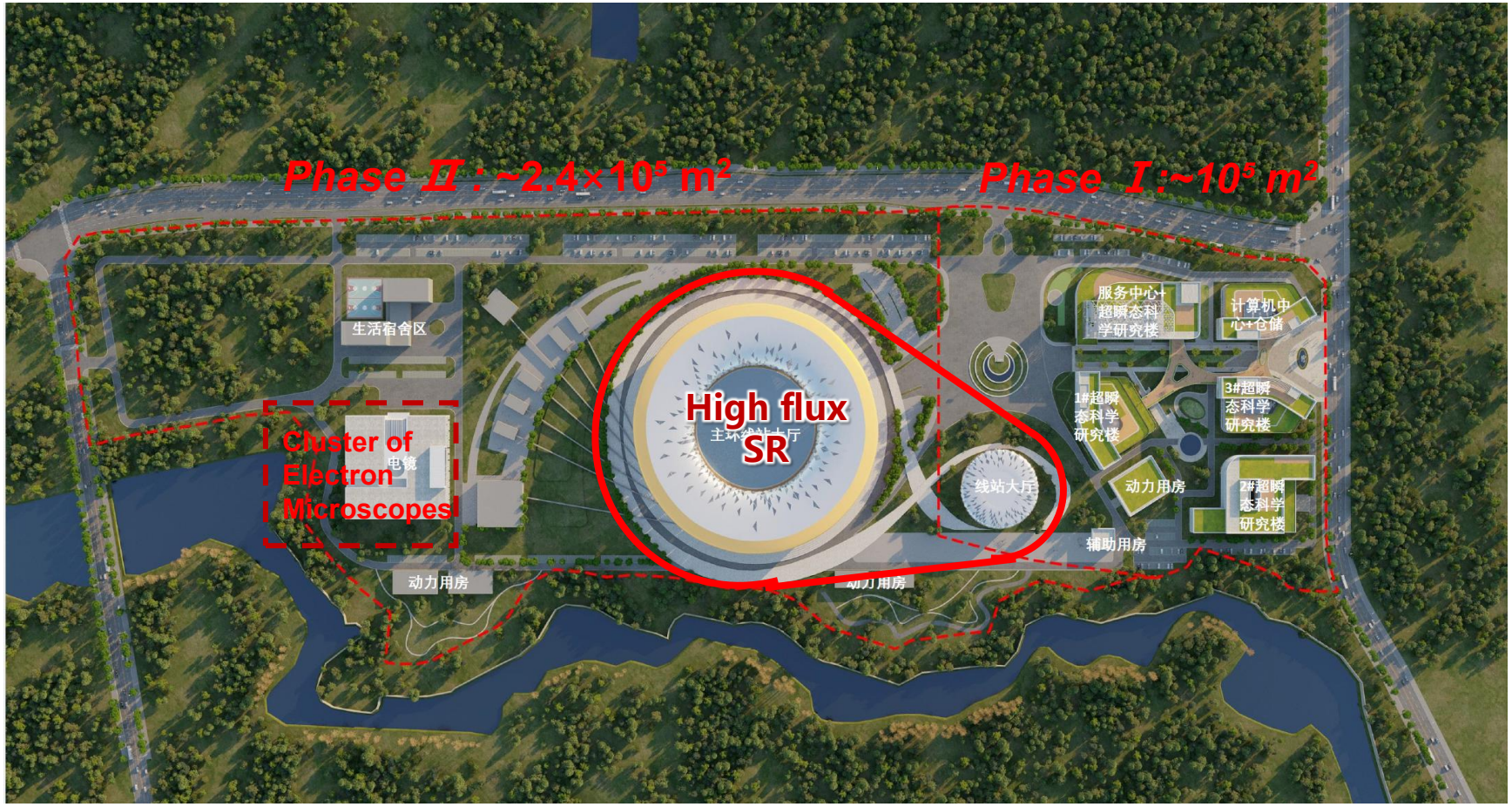
Progress of the UTEF Low Energy Light Source

Bocheng Jiang

Sep. 15, 2025, Chongqing

Ultrafast Transient Experimental Facility-UTEF

UTEF consists of a synchrotron radiation source and electron microscopes, integrating both photon and electron probes



Facilities

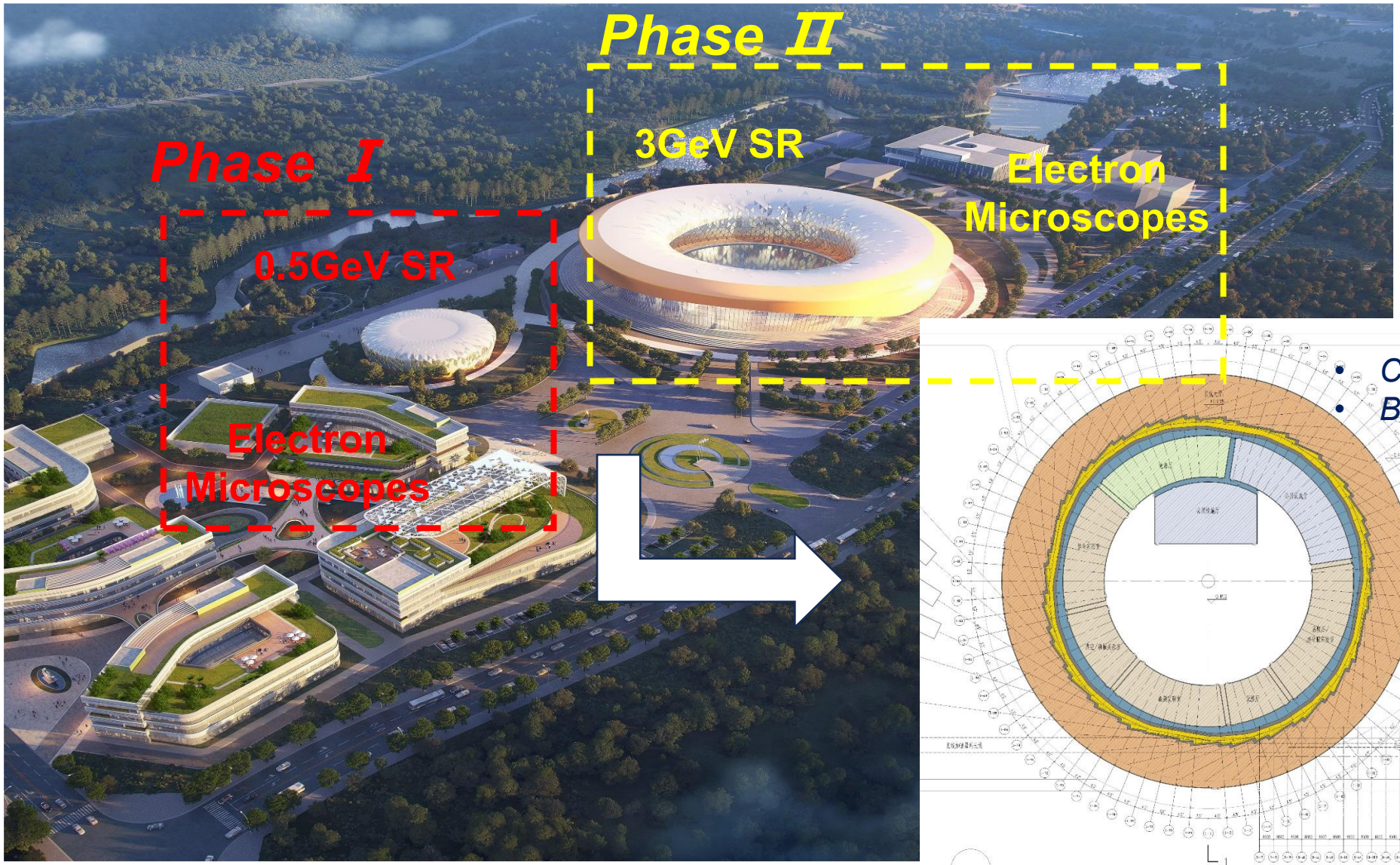
- 0.5GeV SR (UV-EUV)
- +3 Electron Microscopes

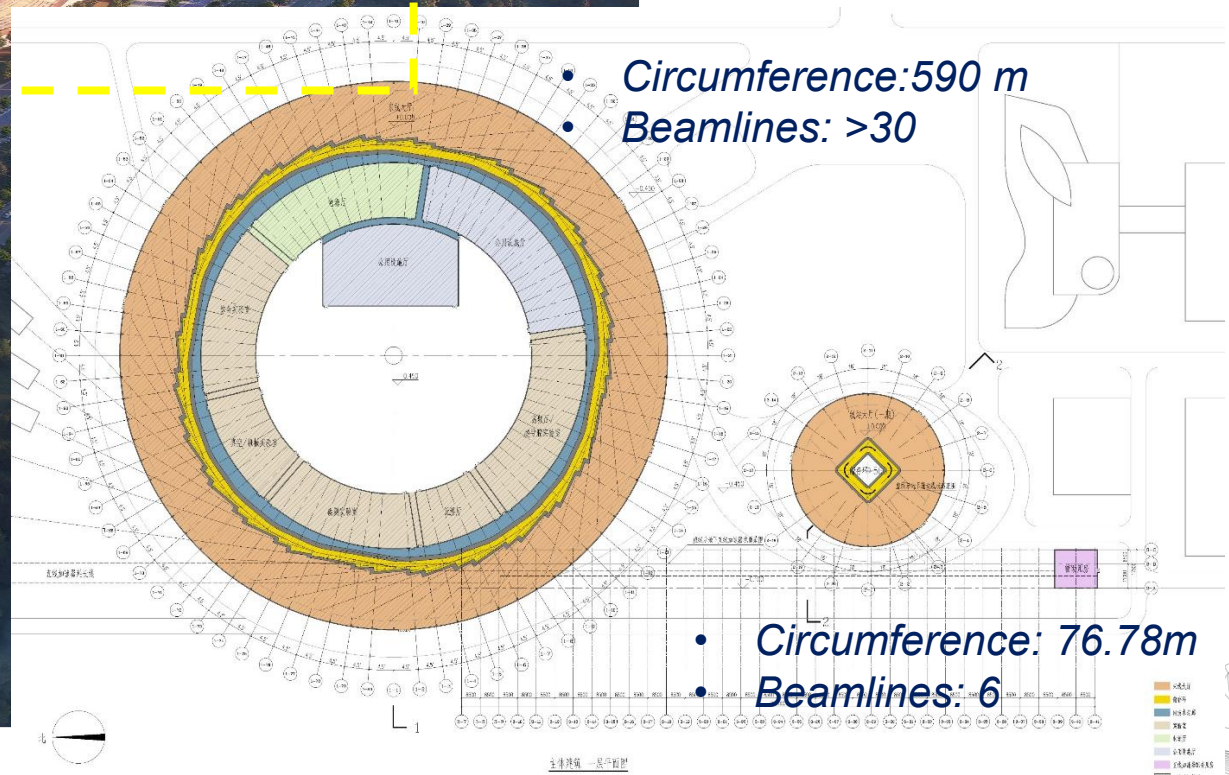
- 3.0GeV SR
- + Multiple Electron Microscopes

Advantages

- Wide spectral range
- High flux
- wide field of view

UTEF Complex





- *Circumference:590 m*
- *Beamlines: >30*

- *Circumference: 76.78m*
- *Beamlines: 6*

UTEF Complex

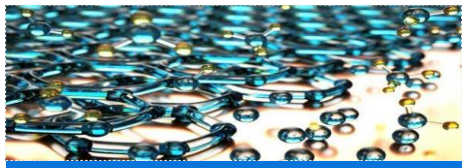
synchrotron radiation source

Electron Microscopes

- Comprising two core components: a synchrotron radiation facility delivering high-brilliance and high-flux photon sources, and an advanced cluster of electron microscopes.
- Enabling investigations of the dynamic evolution and regulation of matter across multiple dimensions and scales, with ultrahigh spatial resolution (10^{-10} m) and ultrafast temporal resolution (10^{-12}–10^{-15} s).
- Providing indispensable experimental conditions for addressing fundamental scientific questions

Electronic Information

New Energy Vehicle



New Material

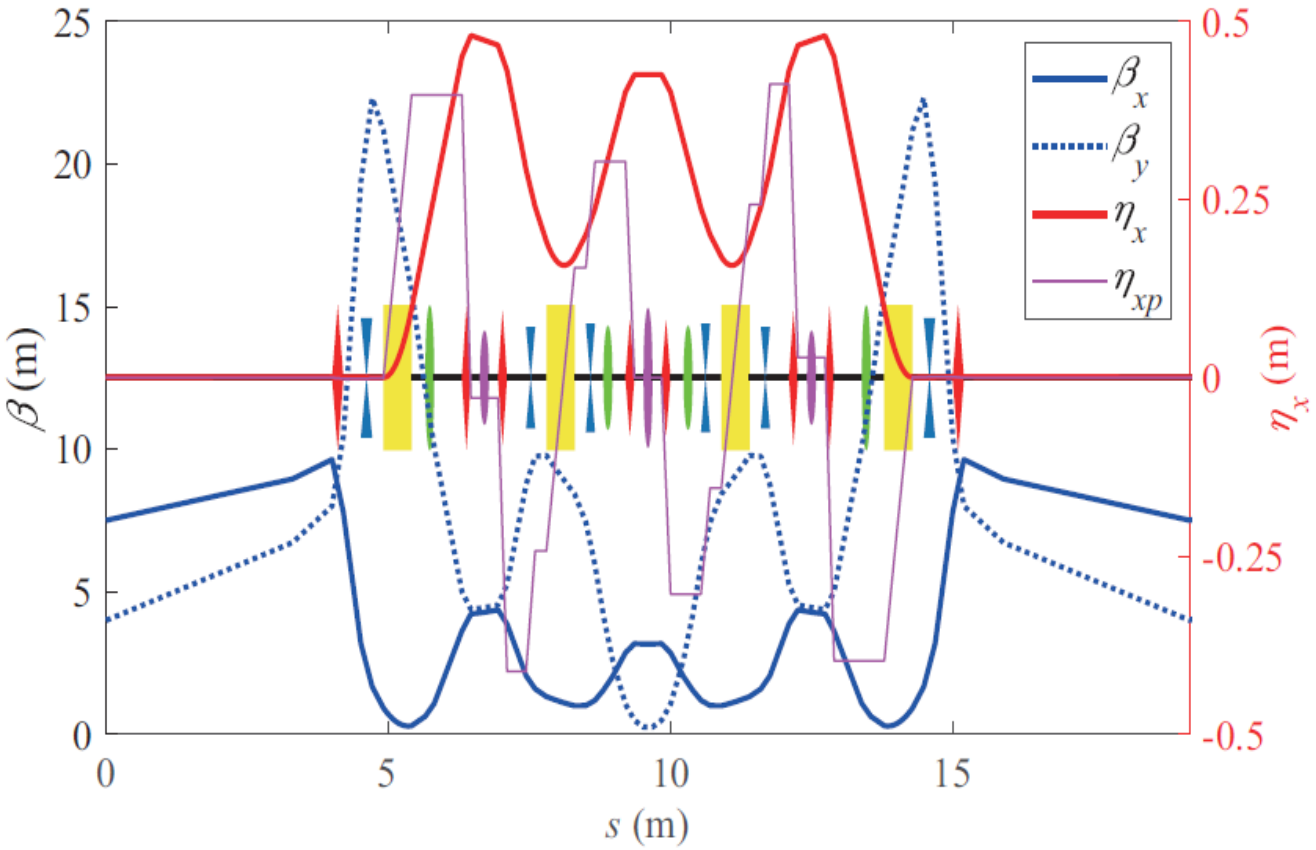
Life Science and Medicine

Advanced Manufacturing

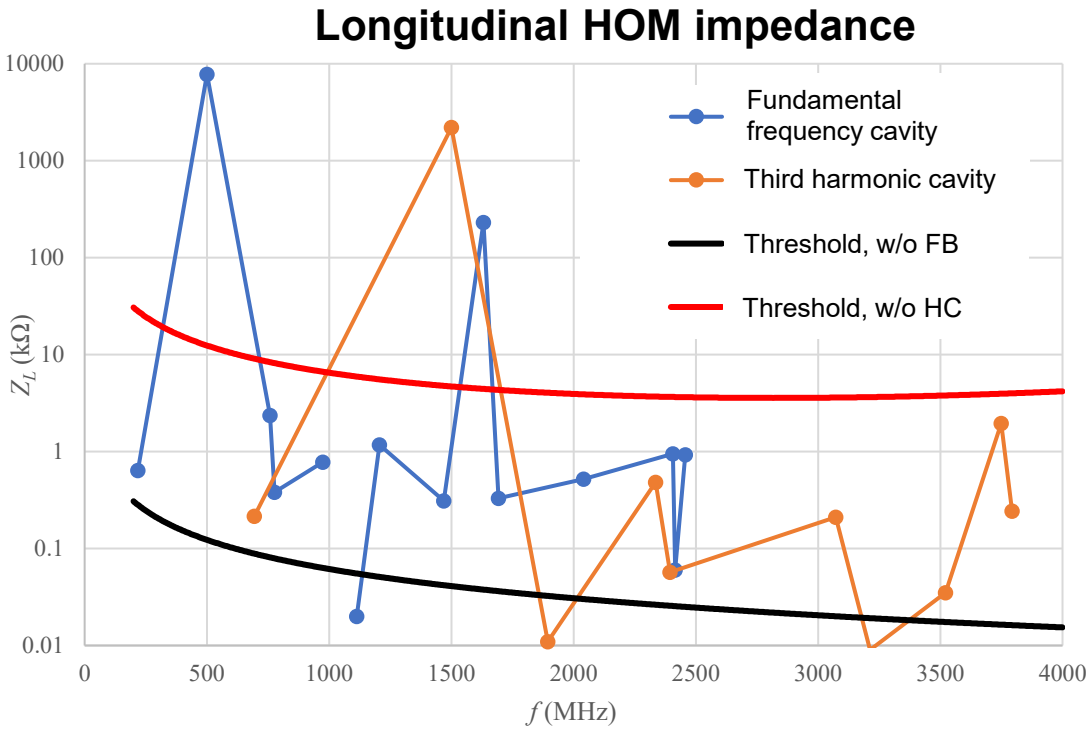
0.5GeV Light Source

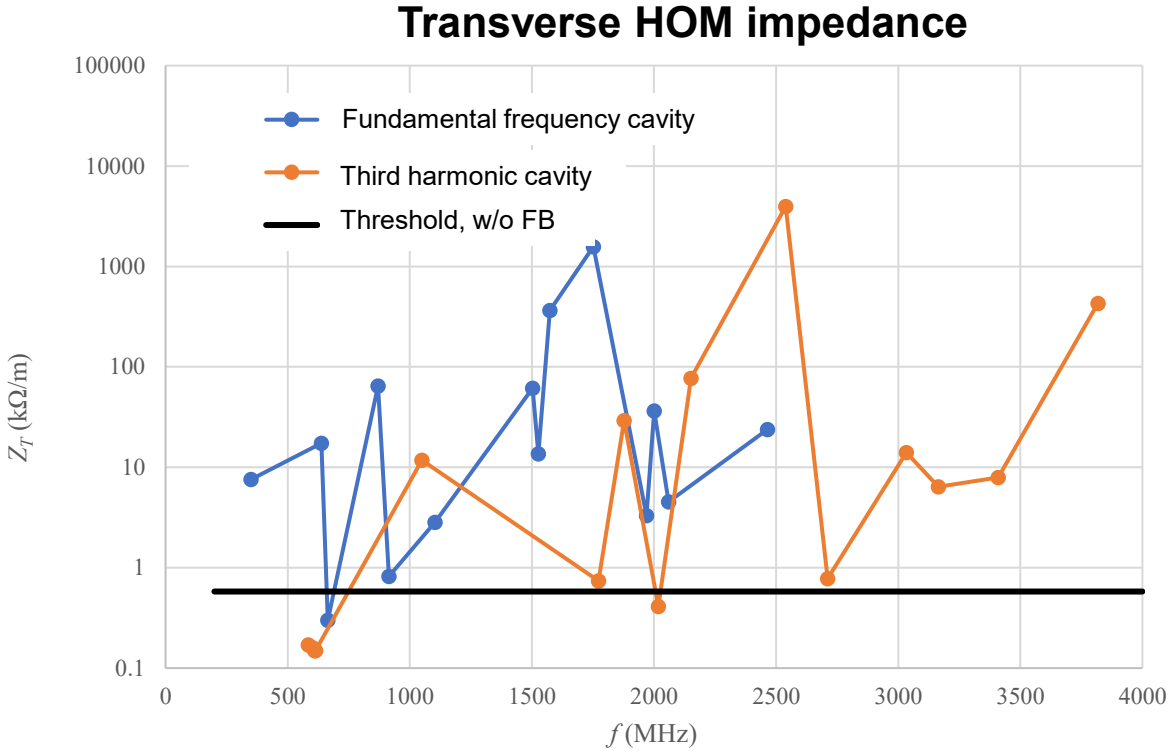
Main parameters of storage ring

Parameter	Value	Unit
Energy	0.5	GeV
Circumference	76.78	m
Natural emittance	8.59	nm rad
Period	4	-
RF frequency	499.784	MHz
Current	500-1000	mA
Bunch length	2.7-12.2	mm
Damping time	59/59/29.5 (H/V/Z)	ms
Straight section length	8	m



RF Cavity Impedance





- Achieving high beam intensity while suppressing beam instability has become a key technical challenge.

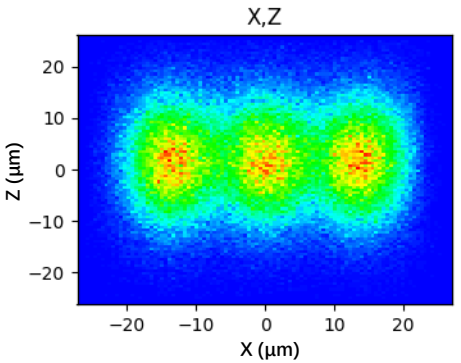
1. Optimize impedance and increase the radius of the vacuum chamber to suppress the impedance, optimize HOM of the RF cavity.
2. Use the third harmonic cavity to stretch the bunch, reduce charge density, and provide Landau damping.
3. Implement a transverse feedback system to suppress transverse instability.
4. Adopt a higher RF cavity voltage to increase the longitudinal oscillation frequency and suppress instability.

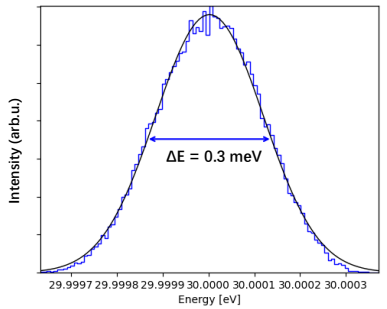
ARPES Beamline (Under construction)

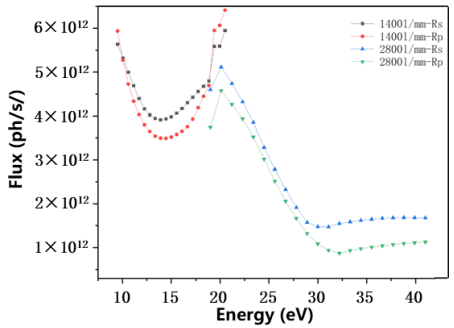
- Photon energy: 10-40eV
- Energy resolution: < 0.4meV
- Photon flux at the sample: > 1×10^{14} ph/s@0.1%B.W
- Photon polarization can be tuned
- Sample temperature: Main station-1K, Sub-station-5K
- Beam size@sample: 20 μm × 20 μm
- Two analytical chamber: ultra-low temperature high energy resolution, large angle high flux spin resolution
- Configuration: Equipped with PLD, MBE thin film growth sample chamber, ozone system for oxide growth, vacuum interconnected glove box, and offline vacuum transfer sample chamber.

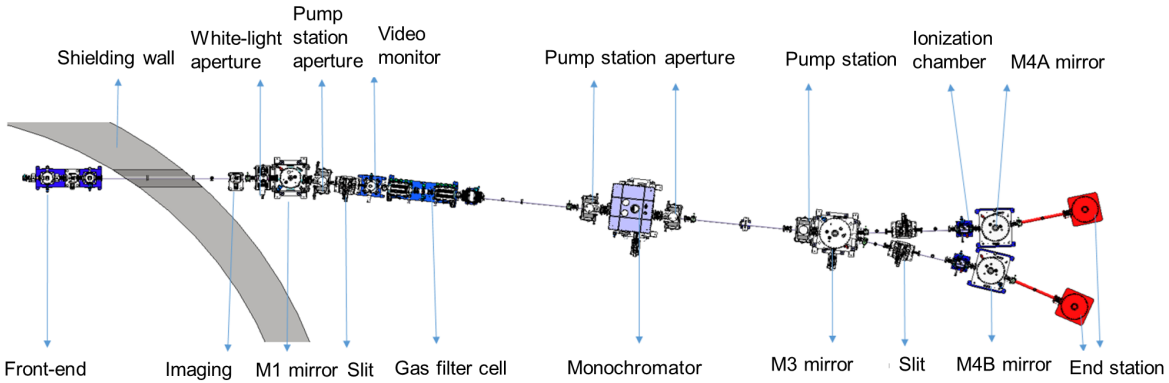
Undulator parameters

Parameter	EPU
Period length	62mm
Period number	78
Total length	4836mm
Peak magnetic field (circular polarization)	0.37T
Peak magnetic field (vertical polarization)	0.45T
Peak magnetic field (horizontally polarized)	0.7T
Minimum gap	20mm







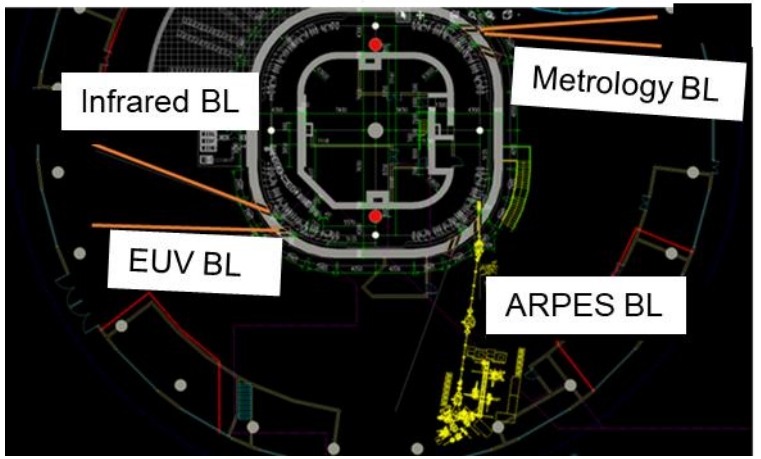


UV-EUV photon flux 10 times higher than existing facilities!

EUV Metrology Beamline (Planned)

	General Test	Angular divergence
Wavelength range	5-70nm (17eV-250eV)	5-20nm (62eV-250eV)
Wavelength resolution	≤0.005nm (12meV-250meV)	≤0.01nm (31meV-500meV)
Divergence angle	≤5mrad@13.5nm	≤0.5mrad
Wavelength stability (RMS)	<0.1%	<0.1%

Combustion and Flame BL



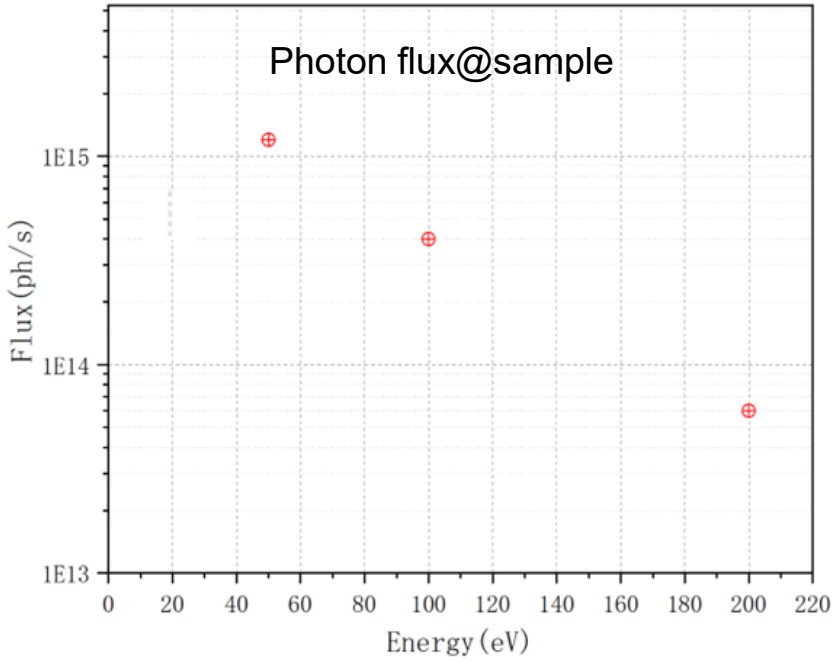
Future Expansion

Irradiation & Contamination Test

- **Max power density:** ≥3.5 W/cm² @13.5nm
- **Background vacuum:** <1×10⁻⁵ Pa
- **In-situ characterization:** Reflectometry, XPS, SEM, TEM, EDS
- **Operation time:** >100 hours

Wave Aberration Measurement

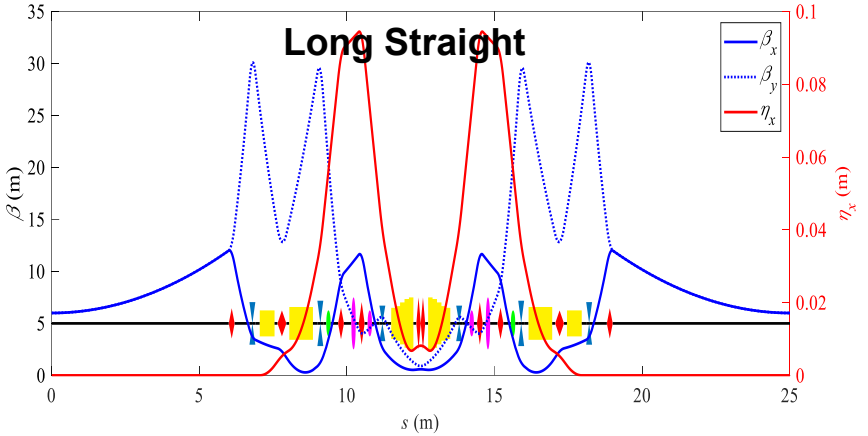
- **Photon flux:** ≥2×10¹⁴ ph/s @13.5nm
- **Stability:** within ±15%
- **Beam diameter:** 10mm
- **Brightness:** ≥1×10¹⁷ ph/s/mm²/mrad²/@13.5nm±0.1% BW
- **RMS accuracy:** <0.1 nm

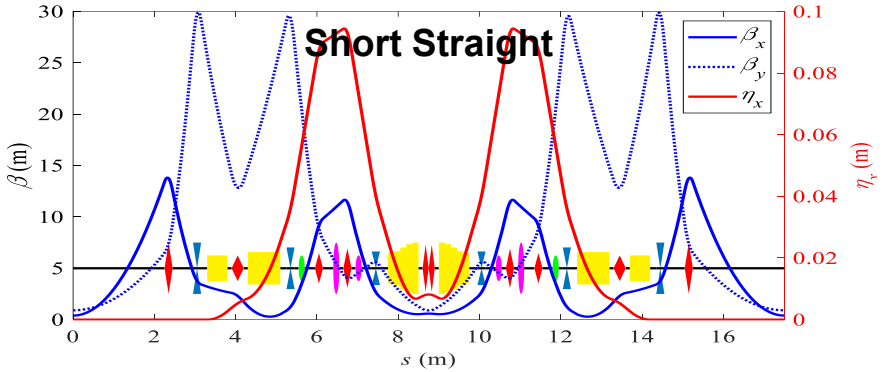


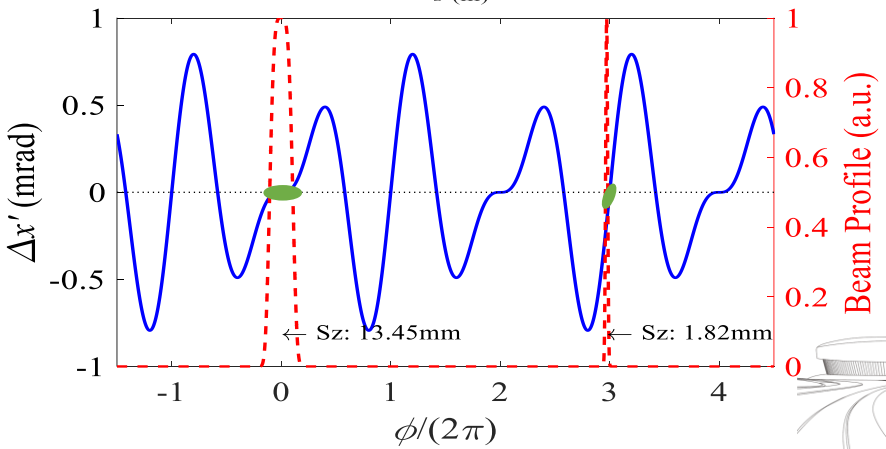
3GeV Light Source

Main parameters of the storage ring

Parameter	Sym.	Value	Unit
Energy	E_0	3	GeV
Circumference	C	590	m
Average Current	I_t	600	mA
Natural Emittance	ϵ_{x0}	349	pm
Coupling	-	100%	-
Momentum comp. factor	α_c	1.2×10^{-4}	-
Energy loss per turn	U_0	447	keV
RMS energy spread	σ_δ	7.0×10^{-4}	-
Beam size@Short Str. Sec.	$\sigma_{xb,yb}$	8.2/12.5	μm
Beam size@Long Str. Sec.	$\sigma_{xc,yc}$	32.3/32.3	μm
Horizontal/Vertical tune	ν_x/ν_y	61.371/23.154	-
Natural chromaticity	ξ_{x0}/ξ_{y0}	-141.4/-167.9	-
Natural damping time (x/y/z)	$\tau_x/\tau_y/\tau_s$	26.4/26.4/13.2	ms
RF frequency	f_{RF}	499.993	MHz
Max. Bend field	B	1.05	Tesla



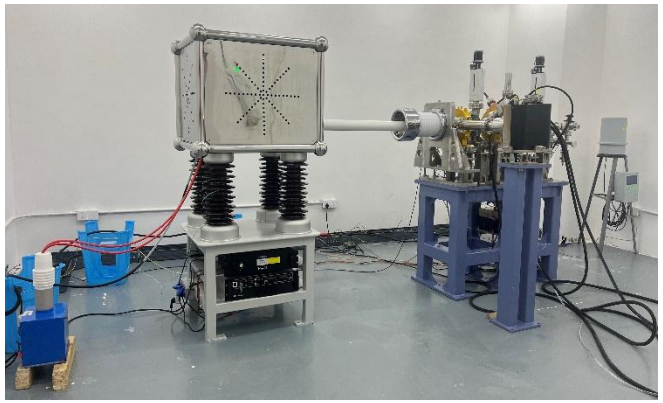




Progress of 0.5GeV Light Source

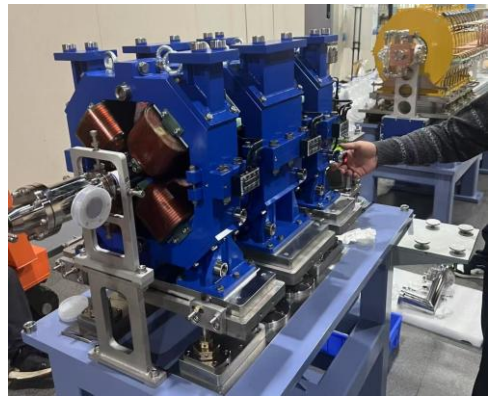
- ✓ **For linac, all equipment has been delivered; core systems finished acceptance tests**
- ☐ **Klystron:** high-power microwave generation, (Canon, Japan)
- ☐ **Modulator:** high-voltage pulsed power supply, (Wuhu Micovey, China)
- ☐ **Low-Level Radio Frequency (LLRF) system:** phase & amplitude control, in-house developed
- ✓ **Electron gun unit, A1 accelerating structure and triplet magnets fully assembled and commissioned**

Klystron test platform



Electron gun unit

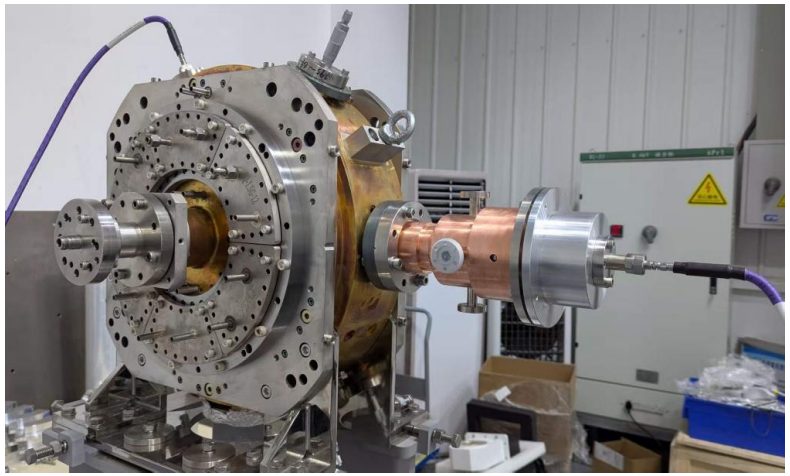
A1 accelerating structure



Triplet magnets

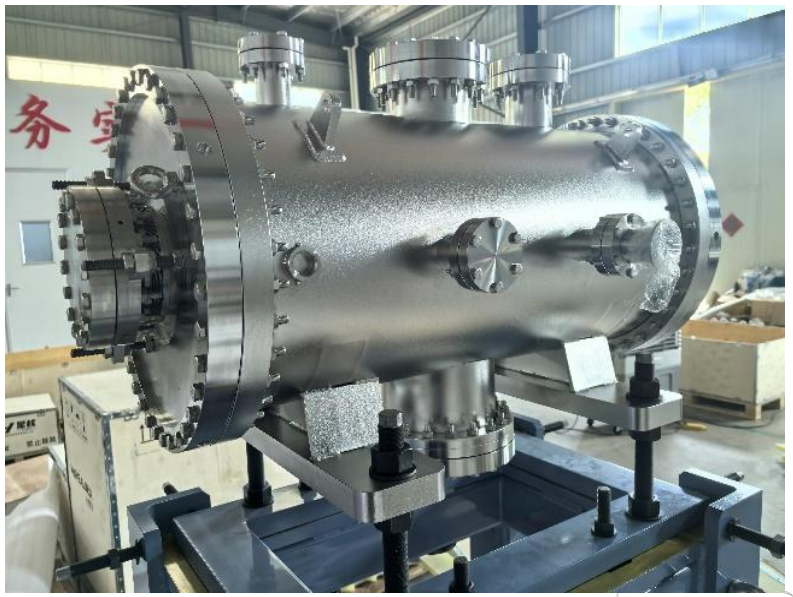
RF system of storage ring

- **Third Harmonic Cavity (1.5 GHz TM020)**
  - ✓ Manufacturing completed
  - ✓ Cold test results meet all specifications
- **High-Frequency Solid-state Power Source**
  - ✓ Assembly completed
  - ➢ Performance commission in progress
- **Nonlinear Kicker Magnet**
  - ✓ Component processing completed
  - ➢ Assembly in progress



Third harmonic cavity

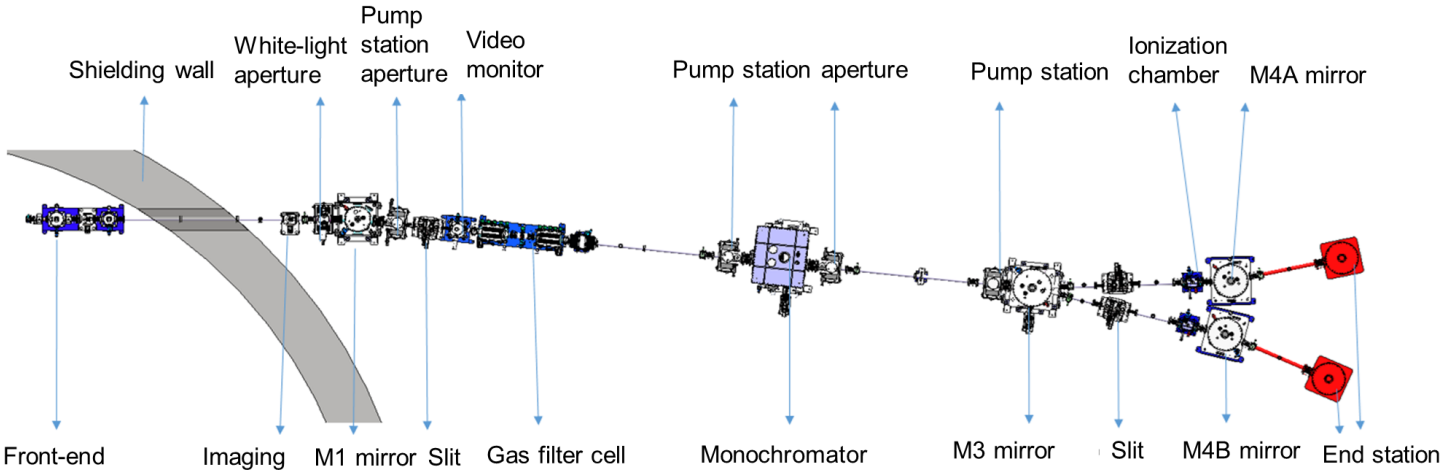
Solid-state power source

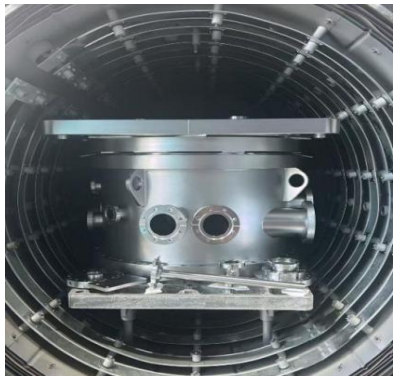


Nonlinear Kicker Magnet

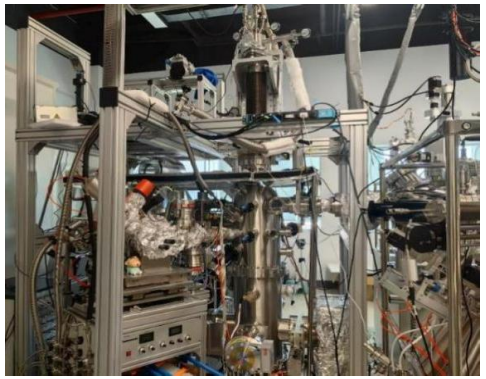
ARPES beamline

- ✓ Optical & engineering design completed, and **energy resolution< 0.4 meV, world-leading performance**
- ☐ The detailed design and engineering drawings of key components have been completed and in production
- ☐ Key Components: Detailed designs and engineering drawings finalized; currently in production
- ✓ 1.5K ultra-low temperature sample holder
- ✓ Cryogenic high magnetic field sample transfer chamber





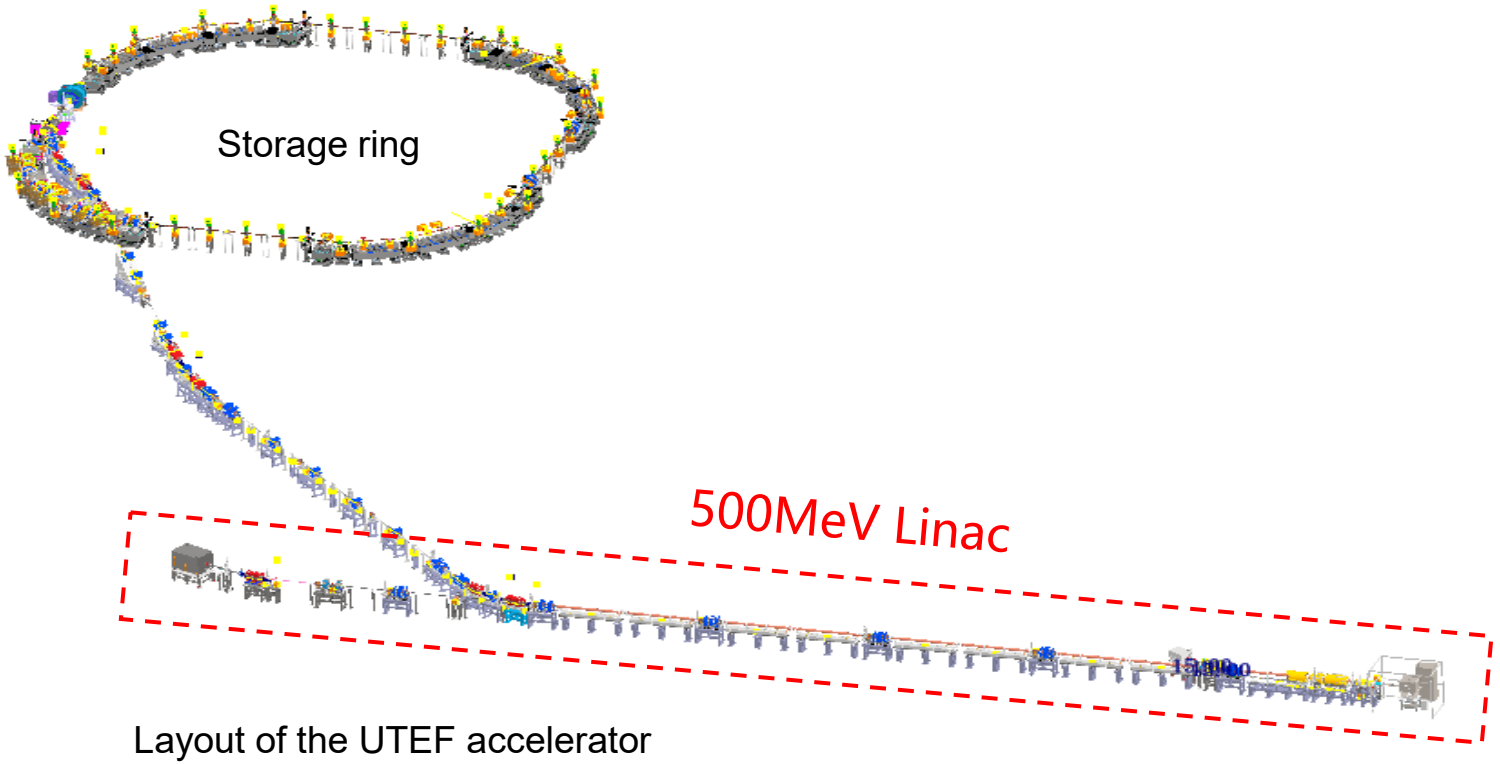
M4 mirror



End station

LINAC

- Installation start: June 2025
- Pre-installation milestones Achieved:
- ✓ Installation positions confirmed through alignment survey.
- ✓ Primary and secondary control networks established.
- ✓ Majority of Linac support girders installed.



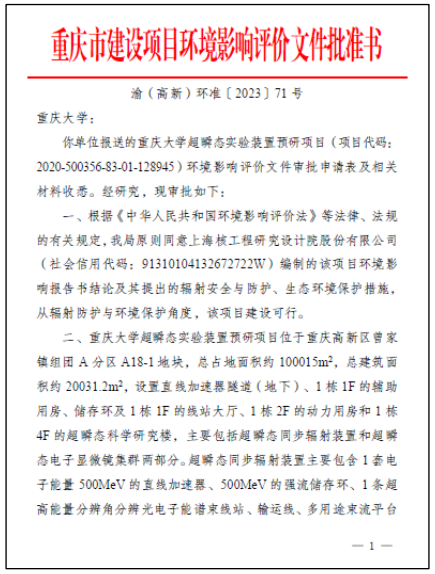
Layout of the UTEF accelerator

Linac tunnel(Sep. 2025)

Radiation Safety

- ✓ Environmental & Occupational Health Approvals Obtained (Oct 2023)
- ☐ Radiation Safety License Application in Progress
- ☐ Key Safety Equipment Ready:
- ✓ Radiation monitoring and personnel protection system (PPS) system: fabrication and testing complete.
- ✓ Shielding doors installation completed
- ✓ Radiation safety regulations established

Personnel access control (with EPD)



重庆市建设项目环境影响评价文件批准书

渝（高新）环准〔2023〕71号

重庆大学：

你单位报送的重庆大学超瞬态实验装置预研项目（项目代码：2020-500356-83-01-128945）环境影响评价文件审批申请表及相关材料收悉。经研究，现审批如下：

一、根据《中华人民共和国环境影响评价法》等法律、法规的有关规定，我局原则同意上海核工程研究设计院股份有限公司（社会信用代码：91310104132672722W）编制的该项目环境影响报告书结论及其提出的辐射安全与防护、生态环境保护措施，从辐射防护与环境保护角度，该项目建设可行。

二、重庆大学超瞬态实验装置预研项目位于重庆高新区曹家镇组团A分区A18-1地块，总占地面积约100015m²，总建筑面积约20031.2m²，设置直线加速器隧道（地下）、1栋1F的辅助用房、储存环及1栋1F的线站大厅、1栋2F的动力用房和1栋4F的超瞬态科学研究楼，主要包括超瞬态同步辐射装置和超瞬态电子显微镜集群两部分。超瞬态同步辐射装置主要包含1套电子能量500MeV的直线加速器、500MeV的强流储存环、1条超高能量分辨角分辨光电子能谱束线站、输运线、多用途束流平台

— 1 —

EIA report approved (Oct. 2023)

PLC control in PPS

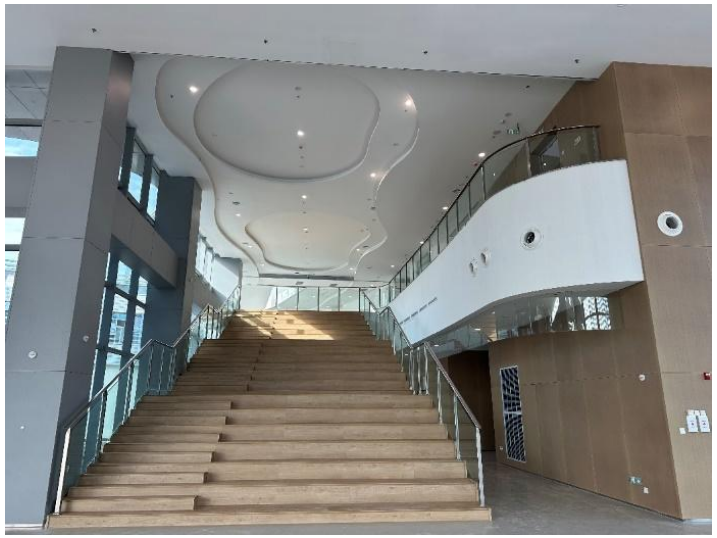
Shielding door in linac

Calibration test of neutron dosimeter

Construction Progress-*Science and Research Building*

- ✓ **Oct. 2024:** Completion of individual building works; passed energy-saving (green building) acceptance.
- ✓ **Dec. 26, 2024:** Passed final construction quality acceptance by the High-tech Zone Construction Bureau.
- ✓ Electron Microscopy Laboratory Area (#1-15 room) environmental renovation completed.

Science and research building



Interior photos of the building

Electron microscopy laboratory

Construction Progress-*Linac*

- ✓ **April 8, 2024:** Construction permits approved for the light source, utility building, and guardhouse; project officially launched.
- ✓ **Dec. 2024:** Main structure of the linear accelerator topped out.
- ✓ **May 18, 2025:** Civil construction of the linear tunnel completed, enabling installation of support systems.


中华人民共和国

建筑工程施工许可证

编号 500115202404080301

根据《中华人民共和国建筑法》第八条规定，经审查，本建筑工程符合施工条件，准予施工。

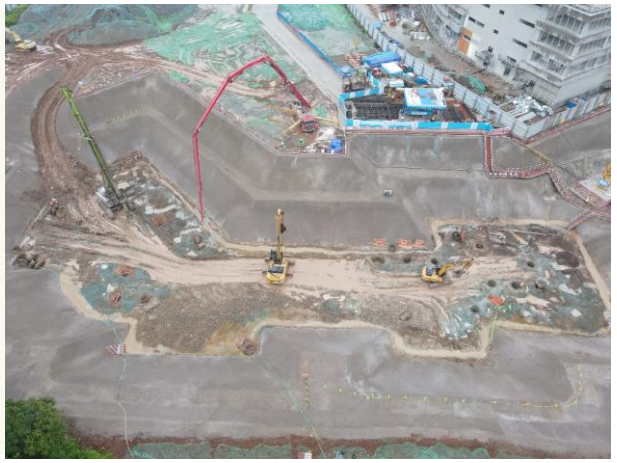
特发此证

发证机关

发证日期

Construction Permit

April 2024



Excavation & Foundation Work of Linac

May 2024

Main Structure of Linac Topped Out

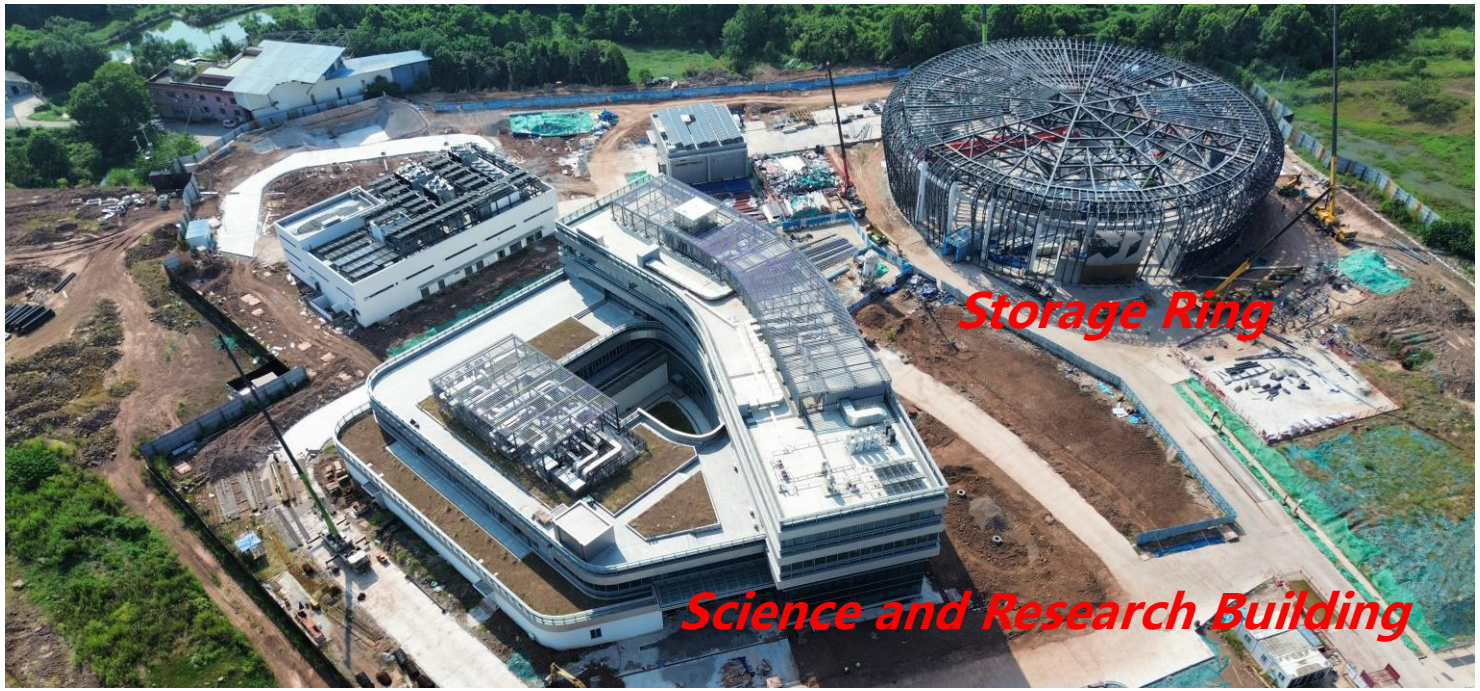
Dec. 2024

Linac Tunnel

May. 2025

Construction Progress-*Storage Ring*

- **Light Source Beamline Hall:** Base slab and main structure completed; roof steel structure installed; 15t overhead crane installed, Installation of exterior curtain wall trusses and curtain wall mock-ups in progress
- **Outdoor Works:** Site grading, perimeter walls, stormwater/sewage pipelines, and road construction



Bird's-eye view of storage ring

Curtain wall mock-up


Thanks for your attention!
Welcome to Chongqing!