

An update on plasma accelerator facilities in China

Wei Lu

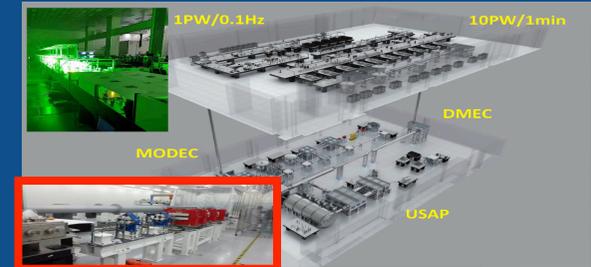
IHEP/Tsinghua University/BAQIS

The 2024 European Edition of the International Workshop on the Circular Electron-Positron Collider
Marseille, France, April 8th-11th.

Outline

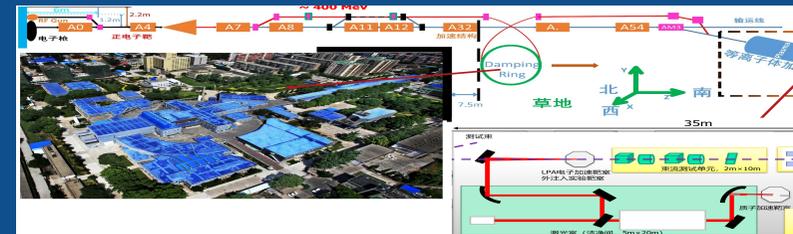
Major Laser Facilities: 6 PW+ systems in 1-3years

Facility	Peak Power	rep rate	main research	timeline
MOEC	10PW	1shot/min	extreme light physics	laser ready
USAP	5PW	1shot/hour	extreme light physics	laser ready
DMEC	1PW	1shot/min	X ray source (Betatron)	in 1 year
U+IHEP	1PW	1Hz	Electron accelerator	in 2 years
BAQIS	2PW	1Hz	Ion accelerator	in 2 years
THU	2.5PW	1shot/min	Lab Astronomy	in 3 years



Two major initiatives on PWFA

Facility	Energy	Research	timeline
BEPC	2.5GeV	e-/e+ for collider	In 3 years
SXFEL	1.5GeV	e- for FEL	ready



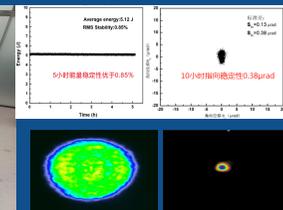
Laser development towards applications:

BAQIS + Qi-NLS + THU

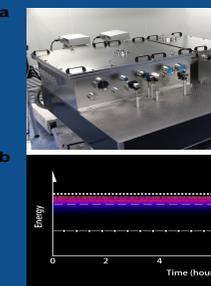
years effort on compact industry level TW-PW lasers

ers with much reduced size, enhanced long term performance

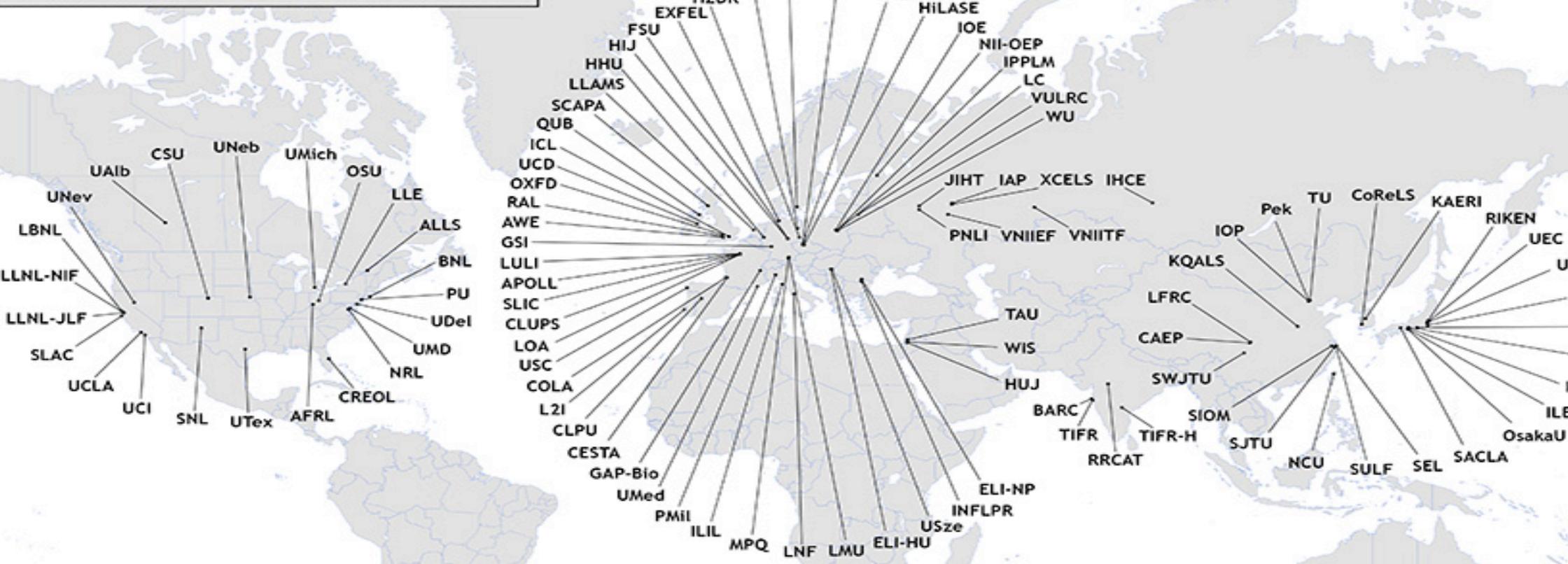
le top ultrafast synchrotron light sources demonstrated
very compact 20-40TW systems)



200TW compact system



ULTRAHIGH INTENSITY LASER FACILITIES



Committee on Ultrahigh Intensity Lasers www.cuil.org

Research Laboratory	Bayern
Extreme Light Source	Norwood
University of Paris Saclay	Paris
Research Center	Albuquerque
Research Center	Munich
National Lab, ATF	Upton
Center of Engineering Physics	Wuxi
Research Center	Bordeaux
Scientific Center of Techniques of Aquitaine	La Ferté
Research Center	Paris
Research Institute of Electric Power Industry	Yokohama
Research in Electro-Optics and Lasers	Orlando
University	Park Collins
Research Institute	Osaka
Research Institute	Darmstadt
Research Institute	Magyari
Research Institute	Schubert

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GP	Graduate School for the Creation of New Photonics Industries
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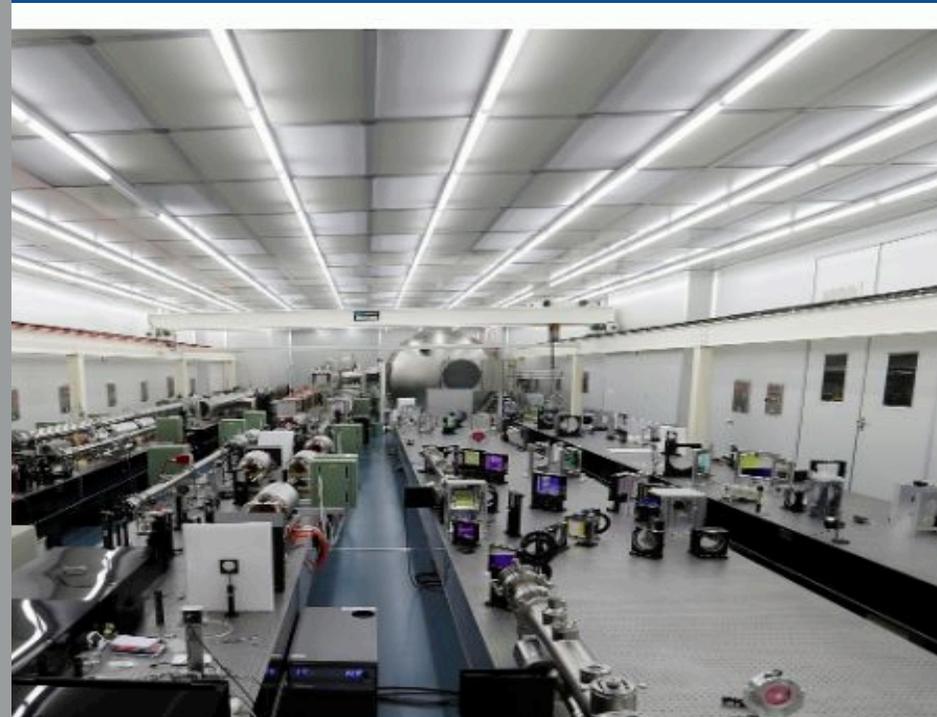
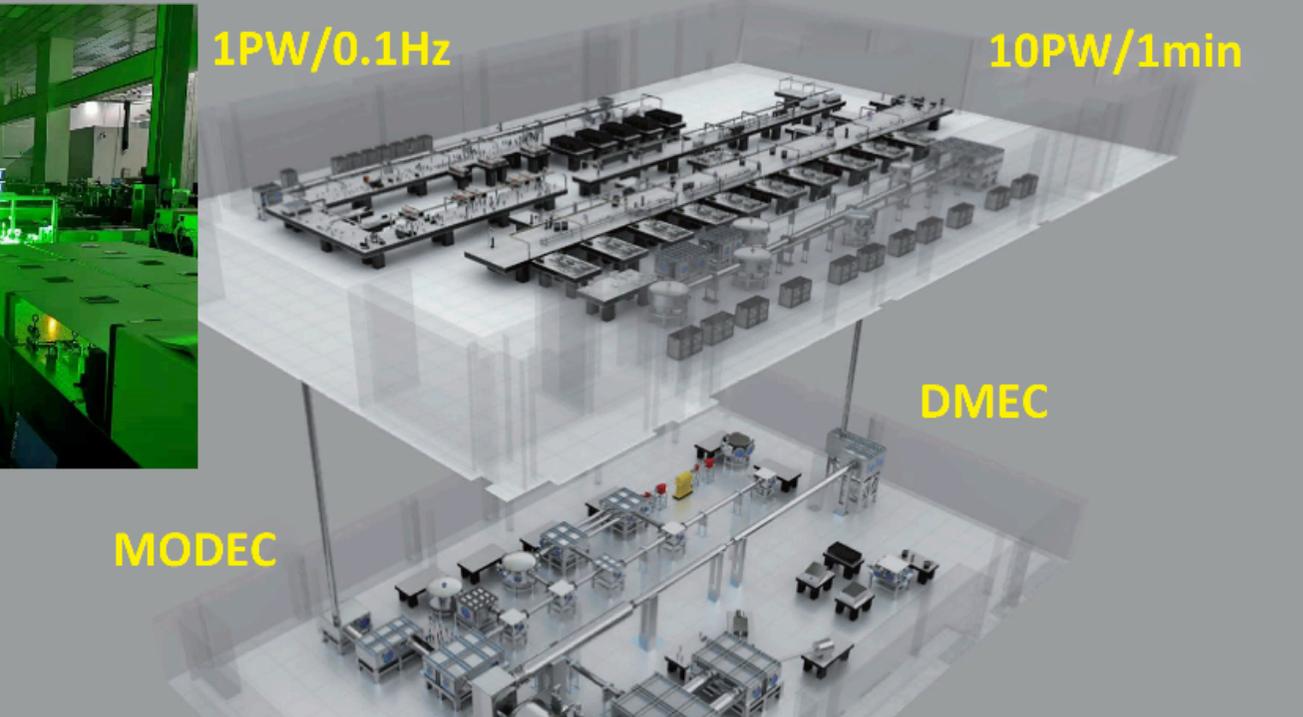
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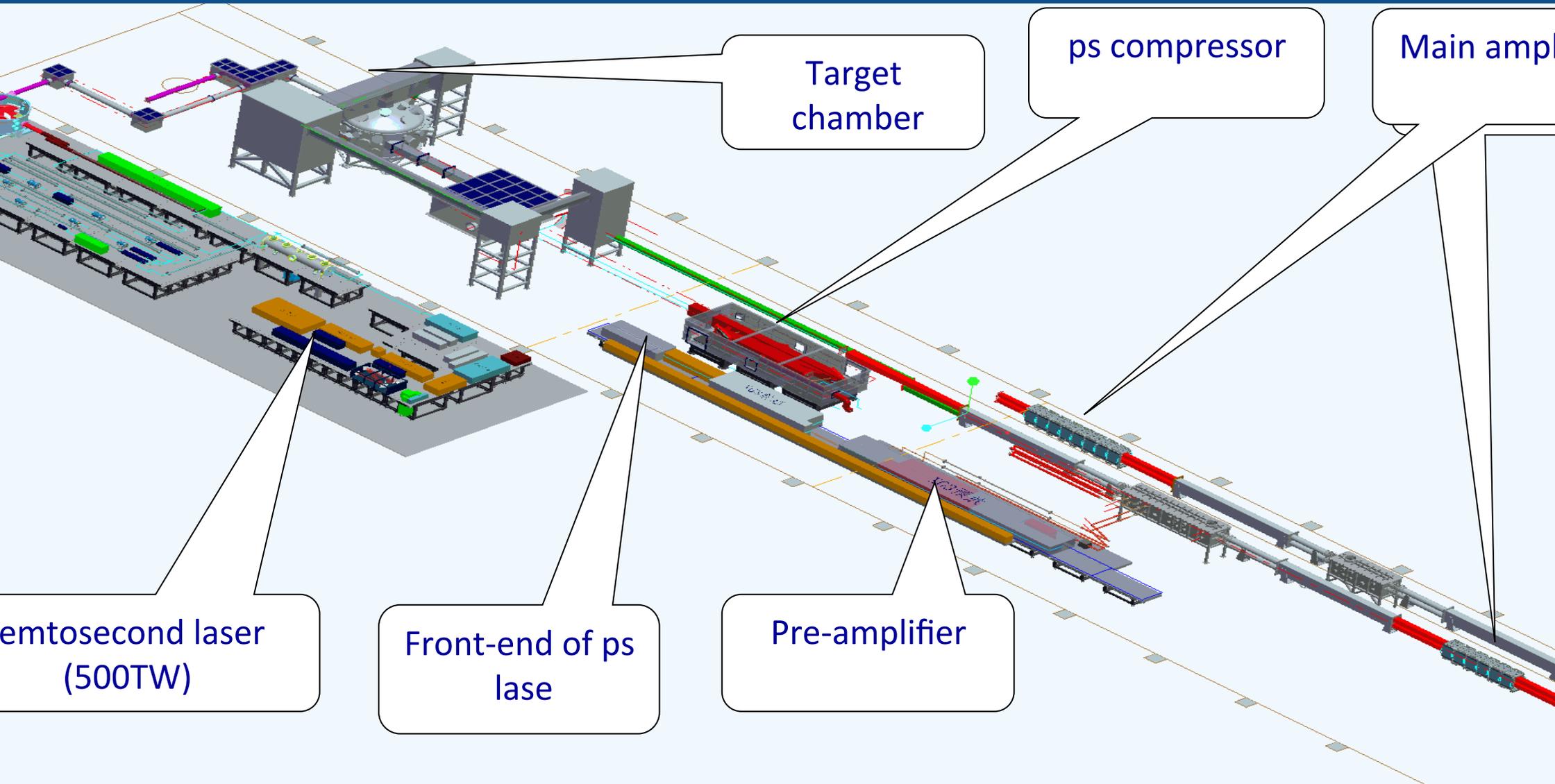
Major laser facilities involved in plasma acceleration in China

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IOP	1PW	1shot/min	X ray source (Betatron)	in 1 year
BAQIS+THU+IHEP	1PW	1Hz	Electron accelerator	In 1 years
PKU	2PW	1Hz	Ion accelerator	in 1 years
SJTU	2.5PW	1shot/min	Lab Astronomy	In 2 years

SULF at SIOM

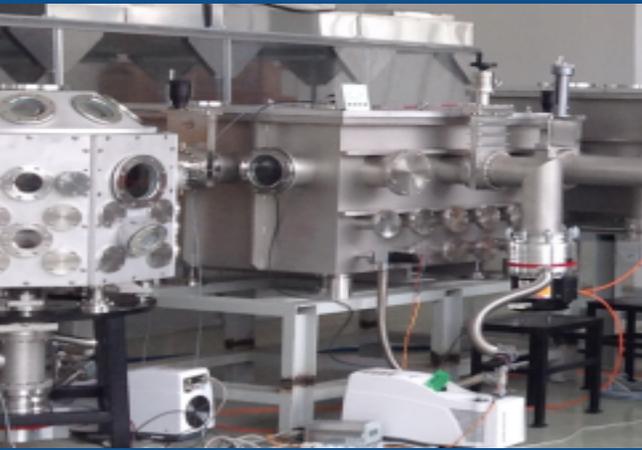


LFRC Xingguang III OPCPA 5PW (ns/ps/fs)



SJTU and IOP

20TW/200TW/**2.5PW/1PW**



CLAPA at PKU (laser ion source)

200TW 5Hz

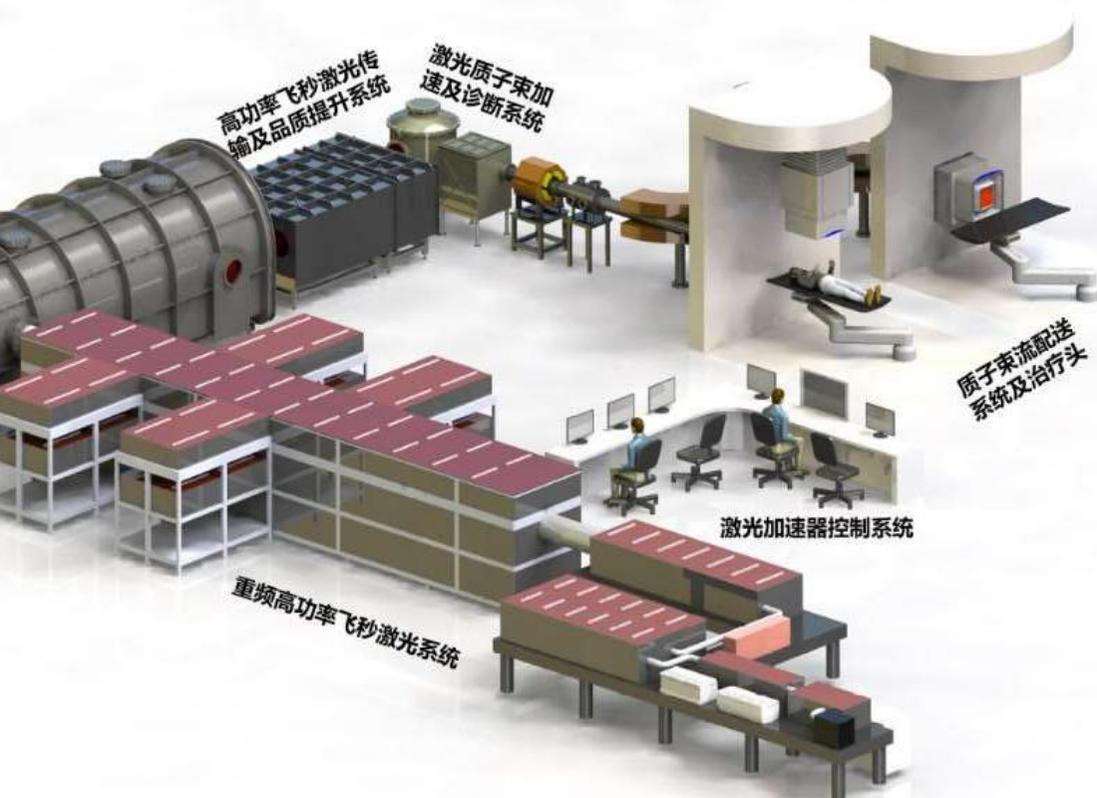
2PW 1Hz

Gas-target Chamber

Cluster-
Chambe

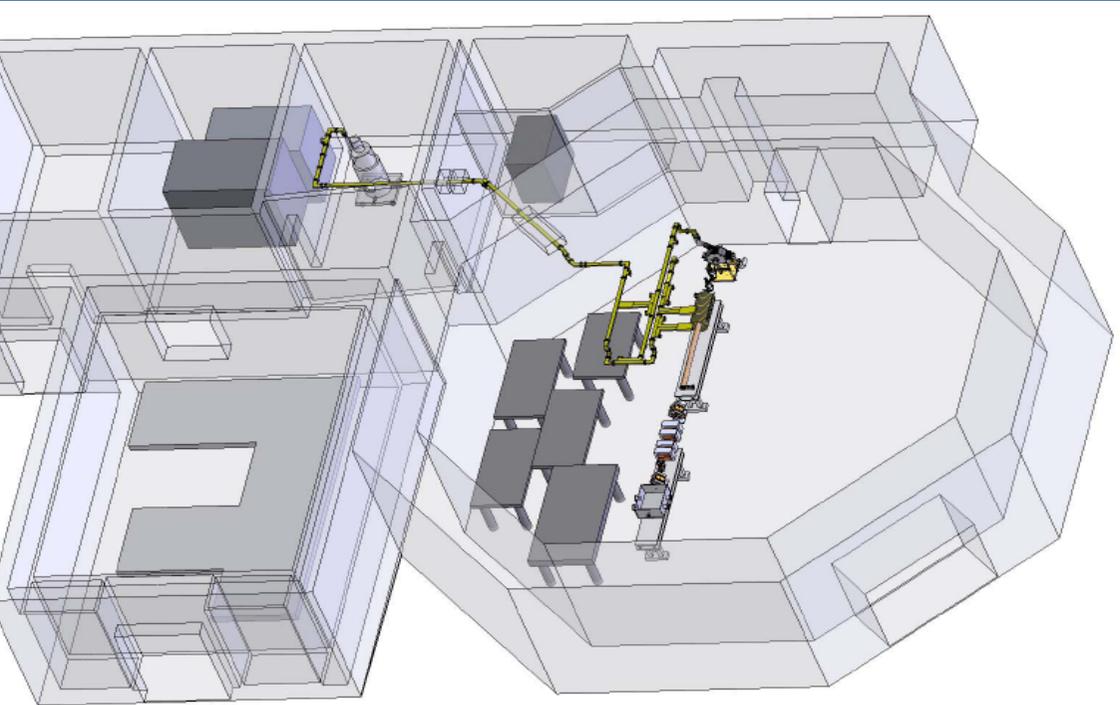
Proton Beam Line

Laser



THU/BAQIS/Qi-NLS

40TW Laser + 45MeV Linac



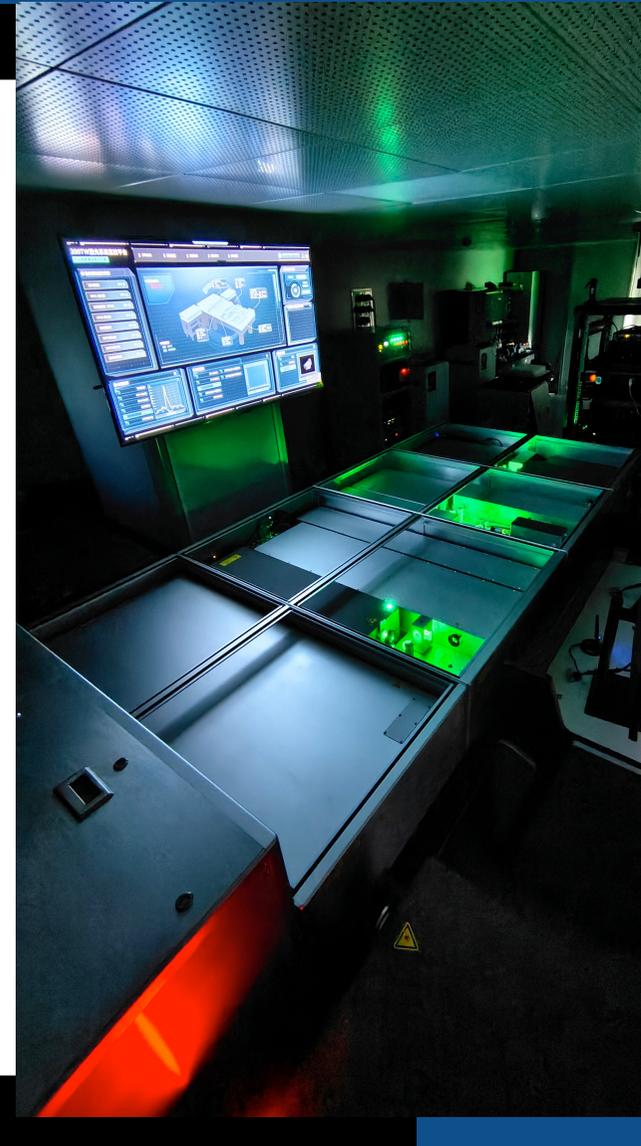
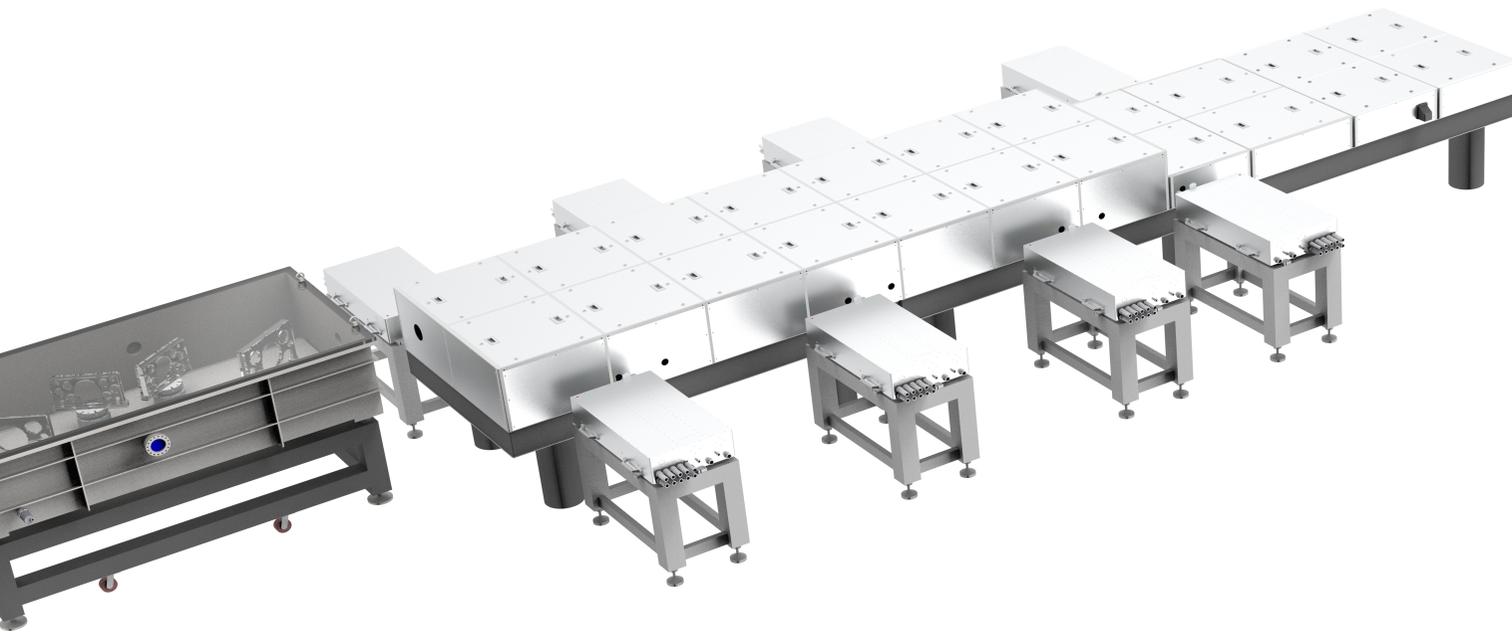
45MeV LINAC

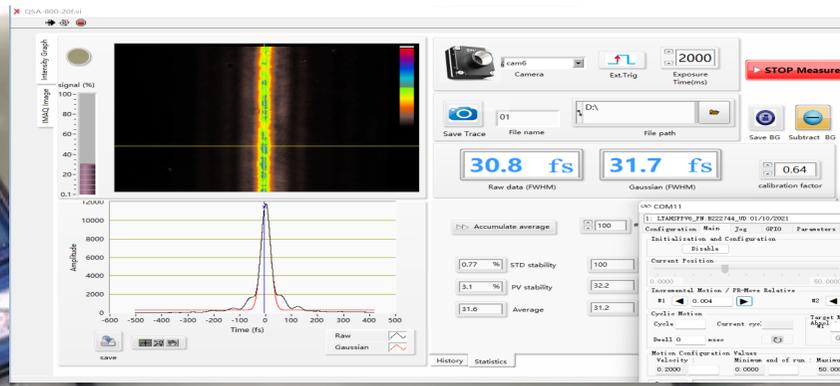
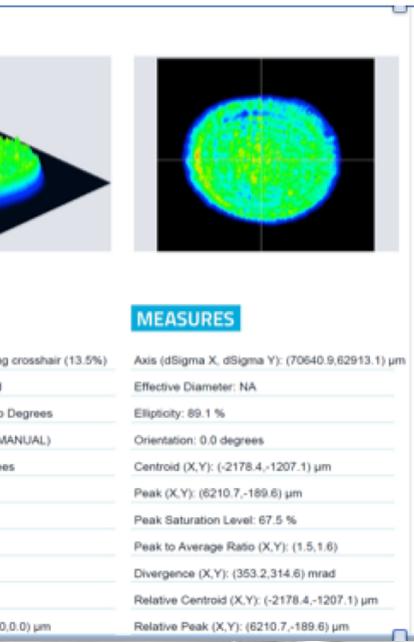
25fs 40TW Laser System



Sub 50fs high current (>5kA) electron beam obtained through hybrid compression

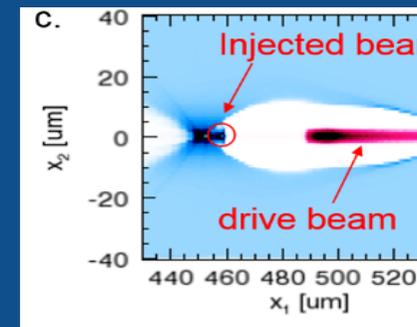
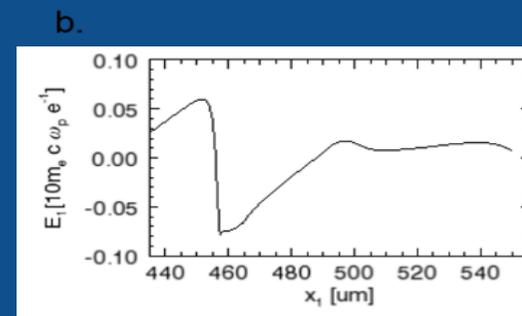
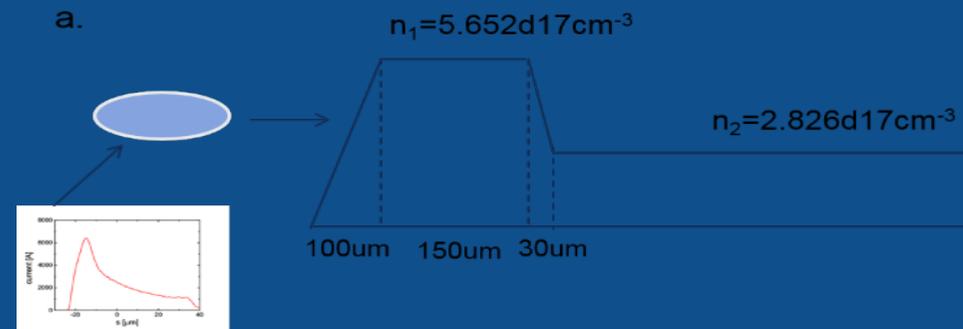
BAQIS Compact 1PW 1Hz





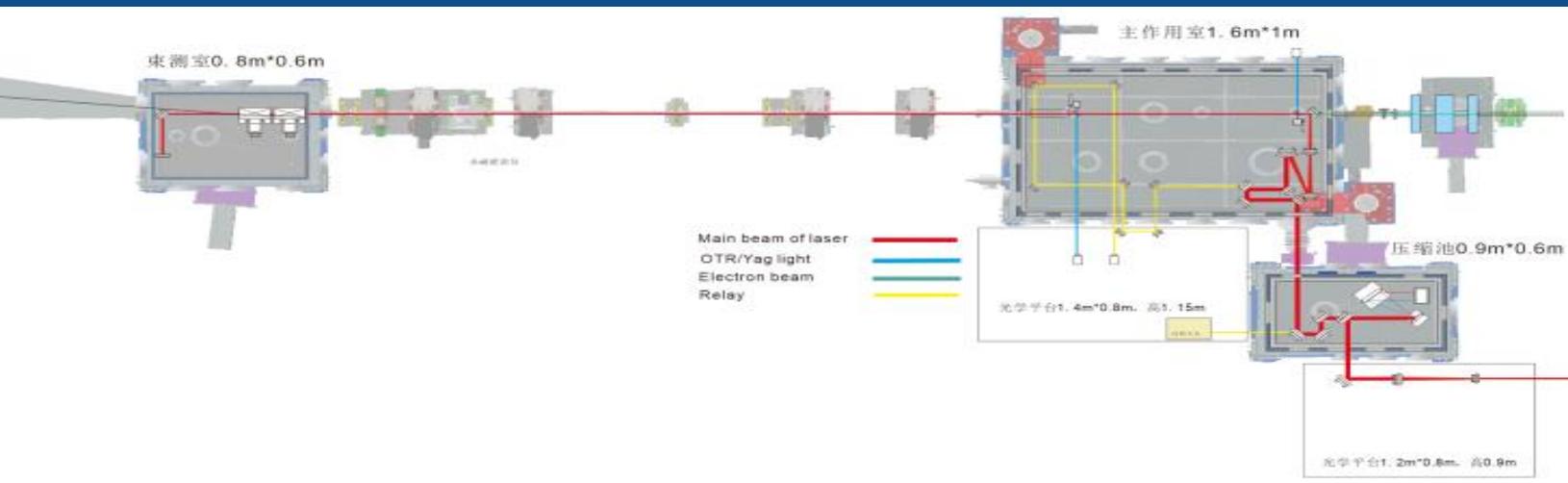
Long term energy stability better than 0.5% rms (10 hours)

PWFA platform at SXFEL in Shanghai

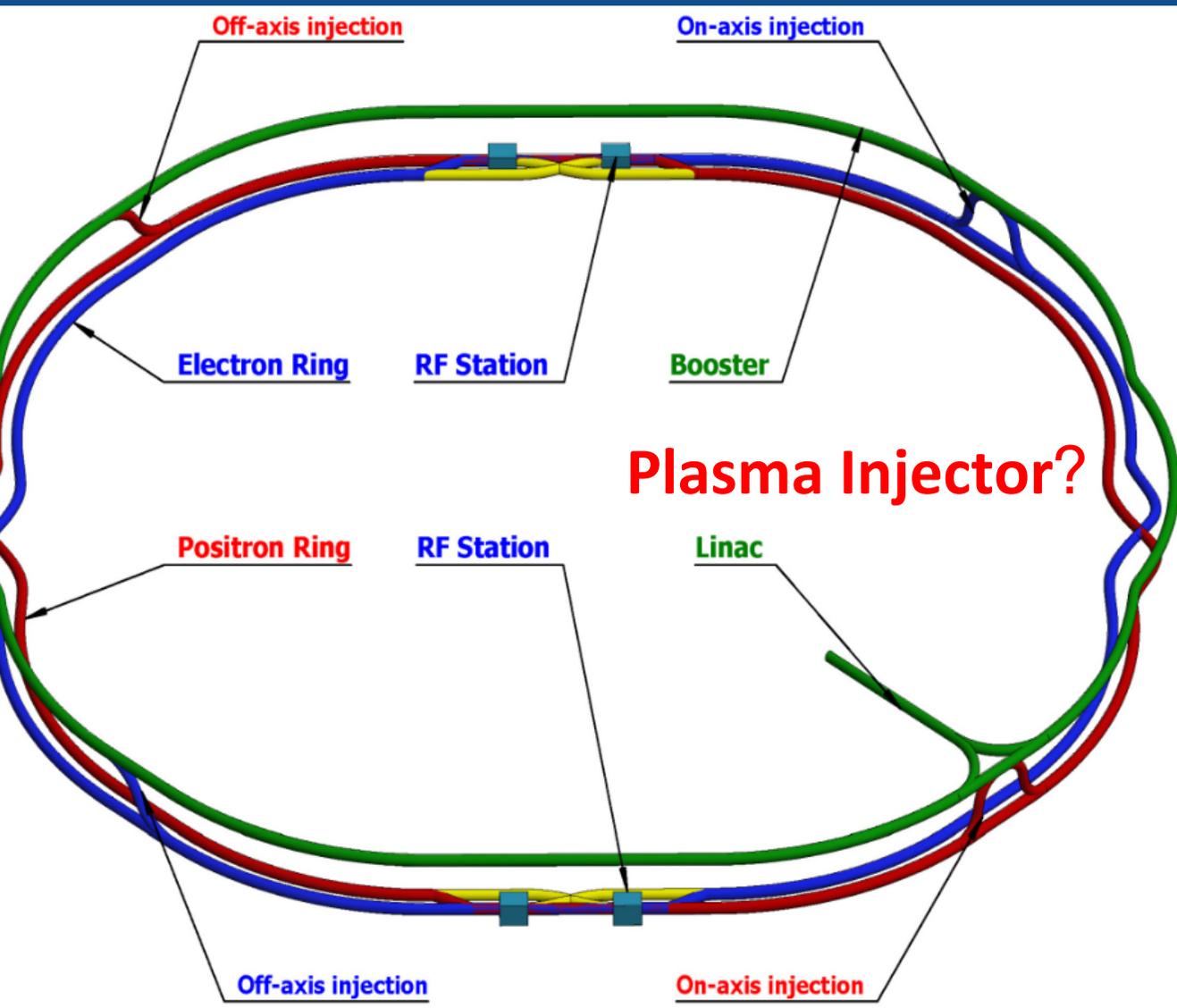


S. Huang et al., IPAC proceeding 2017

PWFA platform at SXFEL in Shanghai



CEPC plan in China



IHEP-CEPC-DR-2018-01

IHEP-AC-2018-01

CEPC

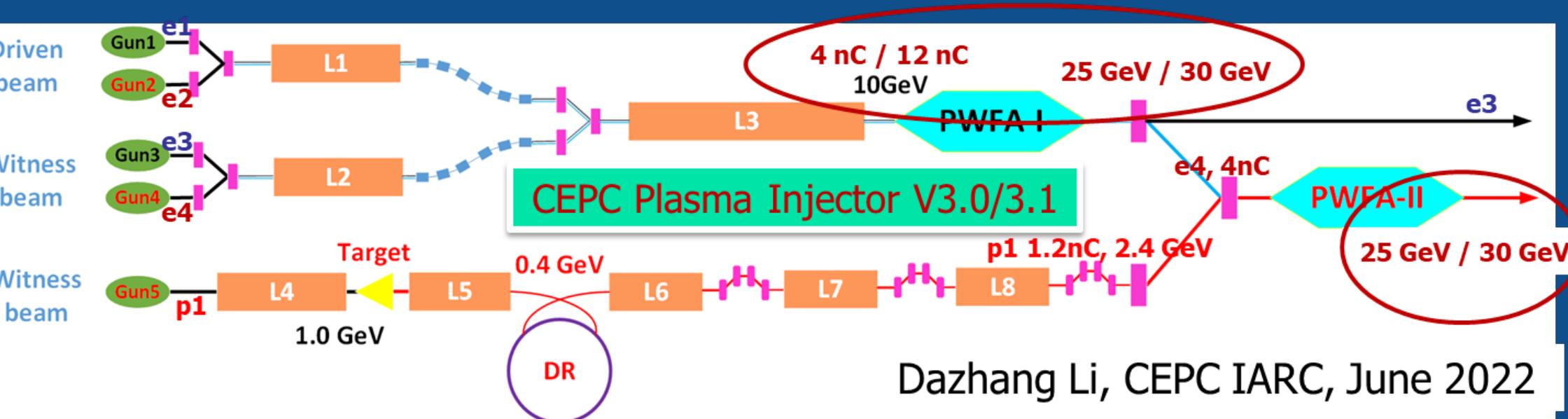
Conceptual Design Report

Volume I - Accelerator

The CEPC Study Group
August 2018

CDR (Acc.) International Review @ 2018.6.28-6.30 & Final Released @ 2018.9.2

CEPC Plasma Injector V.3



Dazhang Li, CEPC IARC, June 2022

V3.0 TR≥2

beam	Driver	Trailer
plasma density $n_p (\times 10^{16} cm^{-3})$	0.50334	
Driver energy $E (GeV)$	10	10
Normalized emittance $\epsilon_n (mm mrad)$	20	10
Length (μm)	350	90
(matched) Spot size (μm)	3.89	2.75
Charge (nC)	4.0	1.2
Beam distance (μm)	180	

Accelerating distance (m)	6.3
Trailer energy $E (GeV)$	30
Normalized emittance $\epsilon_n (mm mrad)$	10
Charge (nC)	1.2
Energy spread $\delta_E (%)$	0.32
Efficiency (%) (driver → trailer)	66.0

V3.1 TR≥1.5

beam	Driver	Trailer
plasma density $n_p (\times 10^{16} cm^{-3})$	0.50334	
Driver energy $E (GeV)$	10	10
Normalized emittance $\epsilon_n (mm mrad)$	20	10
Length (μm)	305	80
(matched) Spot size (μm)	3.89	2.75
Charge (nC)	4.63	1.5
Beam distance (μm)	184	

Accelerating distance (m)	4.8
Trailer energy $E (GeV)$	25
Normalized emittance $\epsilon_n (mm mrad)$	10
Charge (nC)	1.5
Energy spread $\delta_E (%)$	0.37
Efficiency (%) (driver → trailer)	52

A PWFA facility under construction at BEPC of IHE



A joint effort on compact robust lasers



清华大学
Tsinghua University



BAQIS

北京量子信息科学研究院



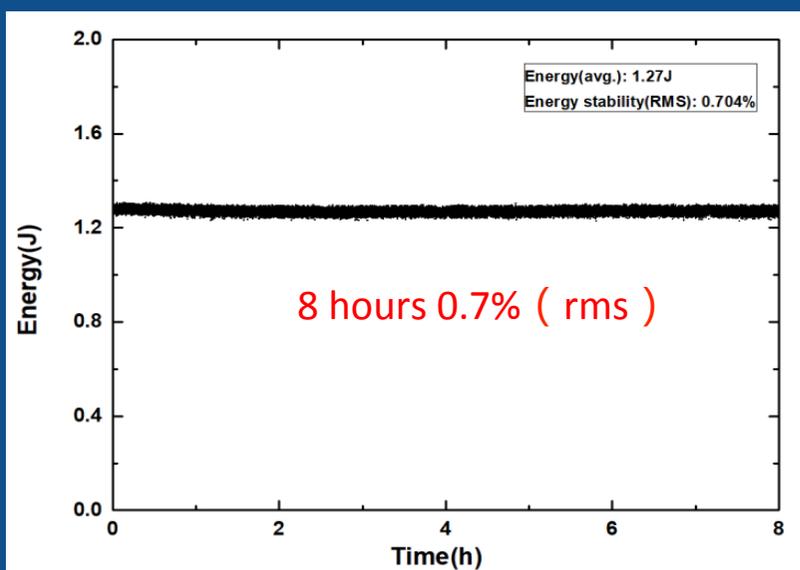
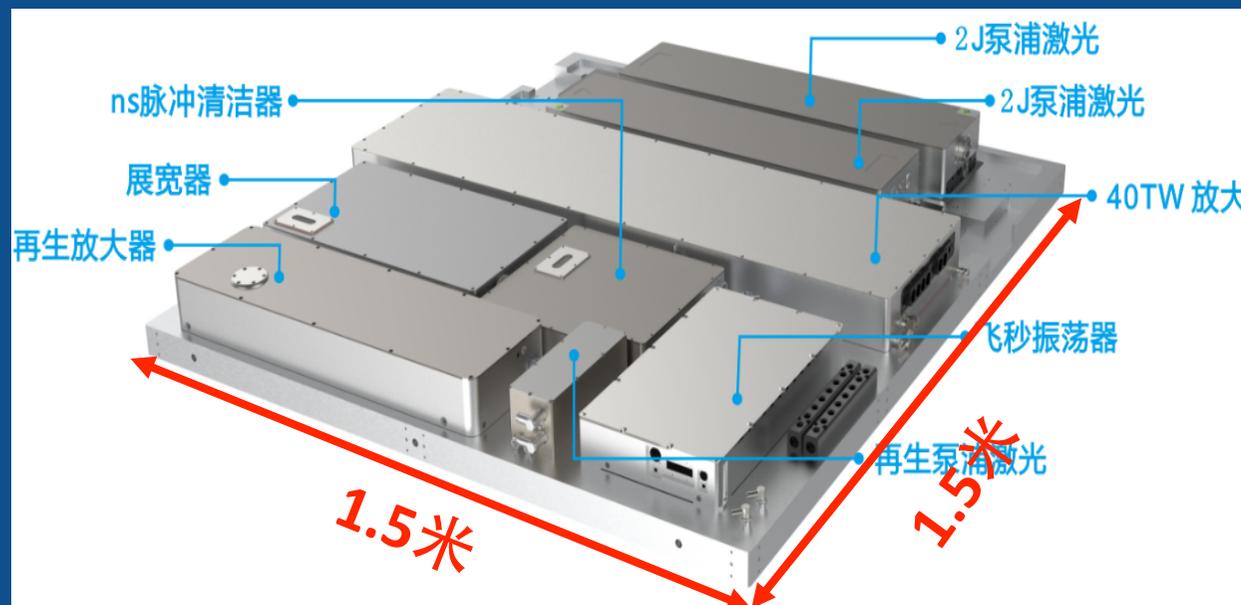
启源研究院



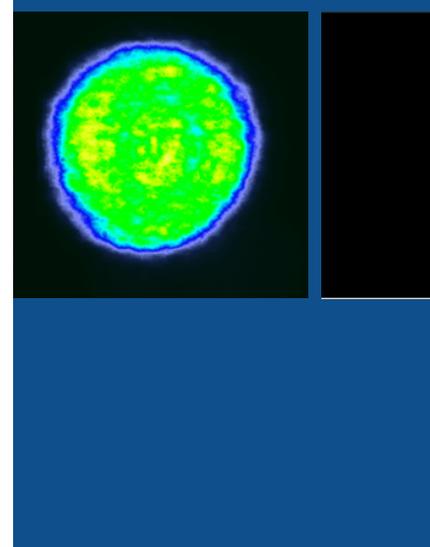
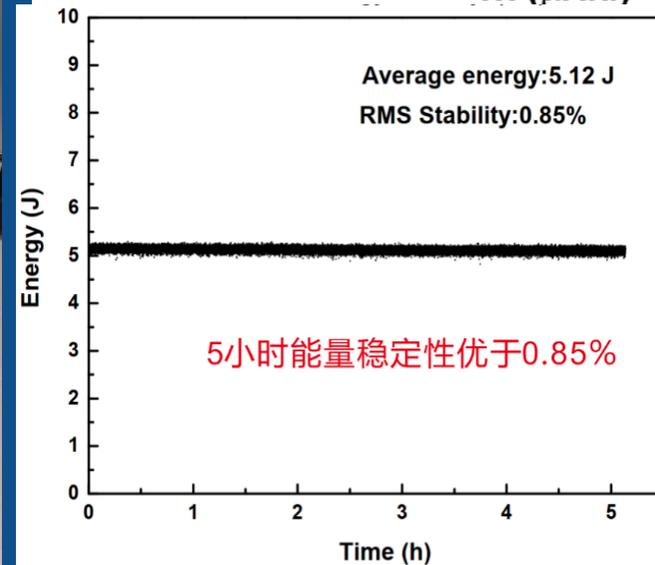
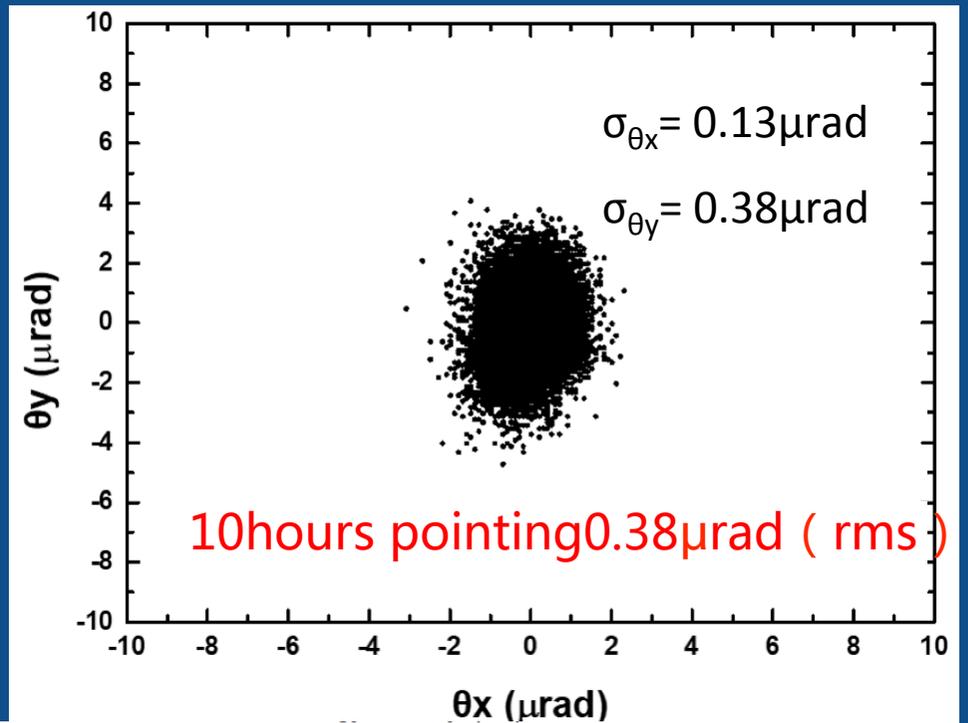
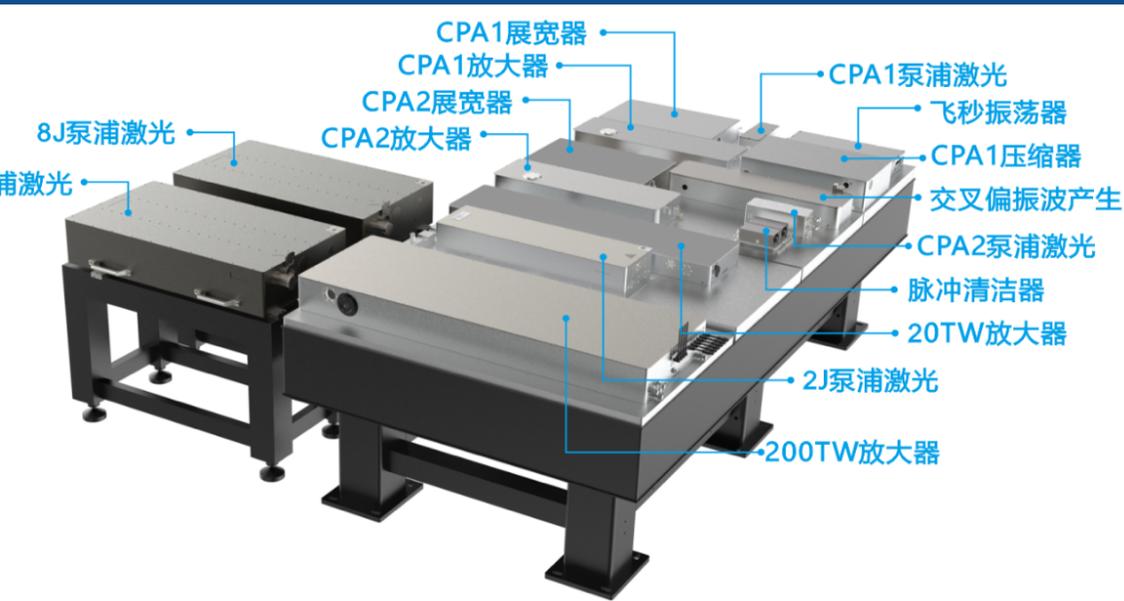
Newlight Source
QiFeng Technology



40TW compact laser

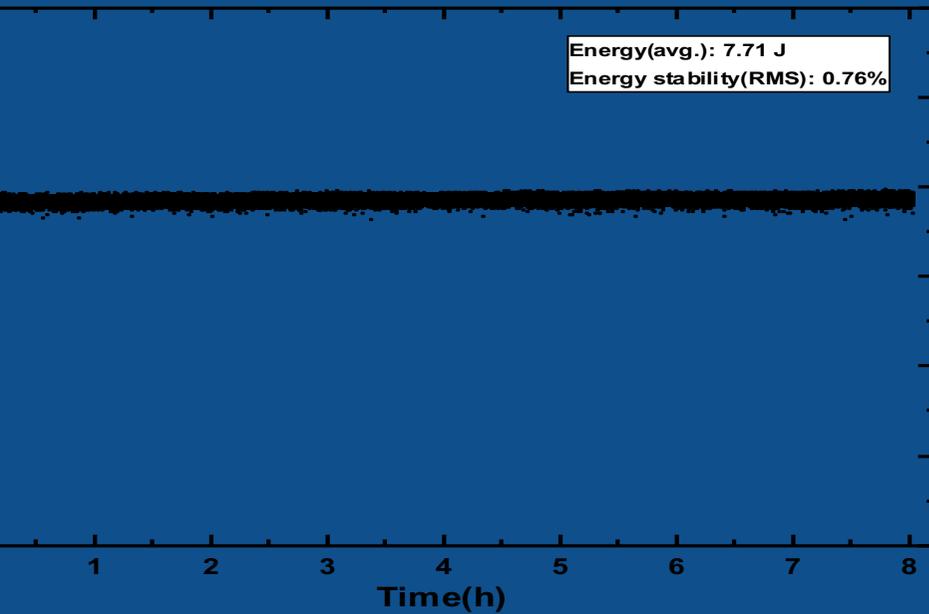


200TW compact laser



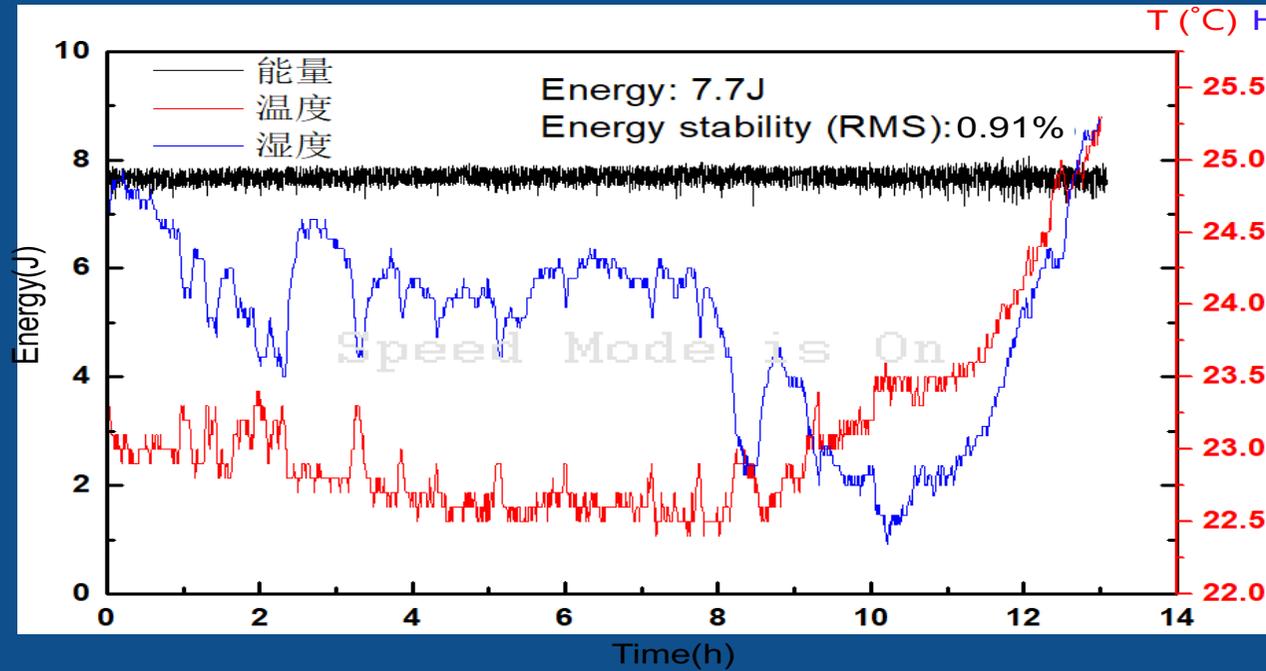
Stability for varied temperature

长期能量稳定性 ($\pm 0.5^{\circ}\text{C}$)



8 h 0.76% (rms)

◆ 长期能量稳定性 ($\pm 1.5^{\circ}\text{C}$)



14h 0.91% (rms)

Compact high energy pump 16J

16J泵源激光器

激光波长	532nm
重频	1~5Hz
光斑调制度	<1.3 PTA
能量稳定度rms	<0.4% @ 24hrs
尺寸	1200*530*300mm

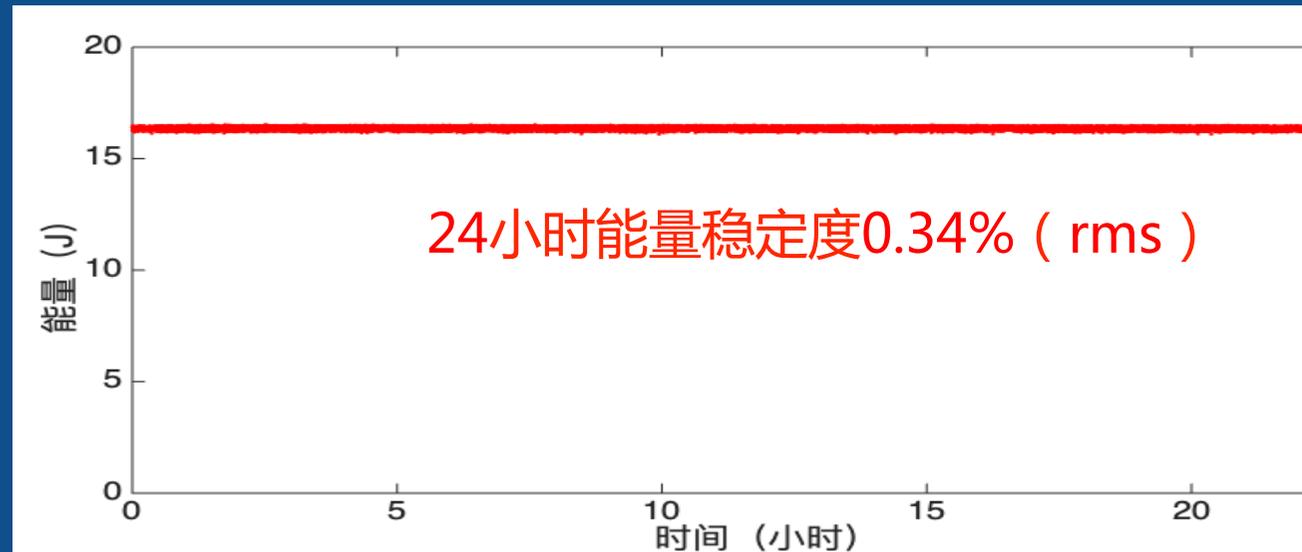
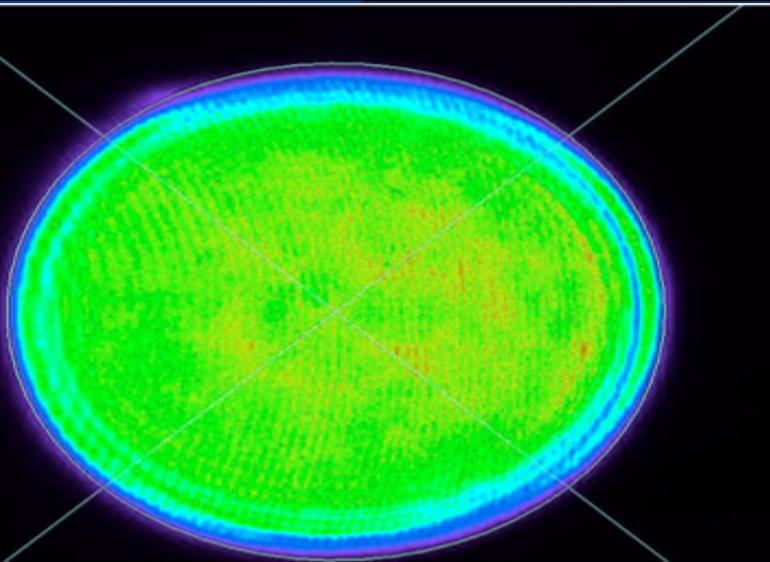
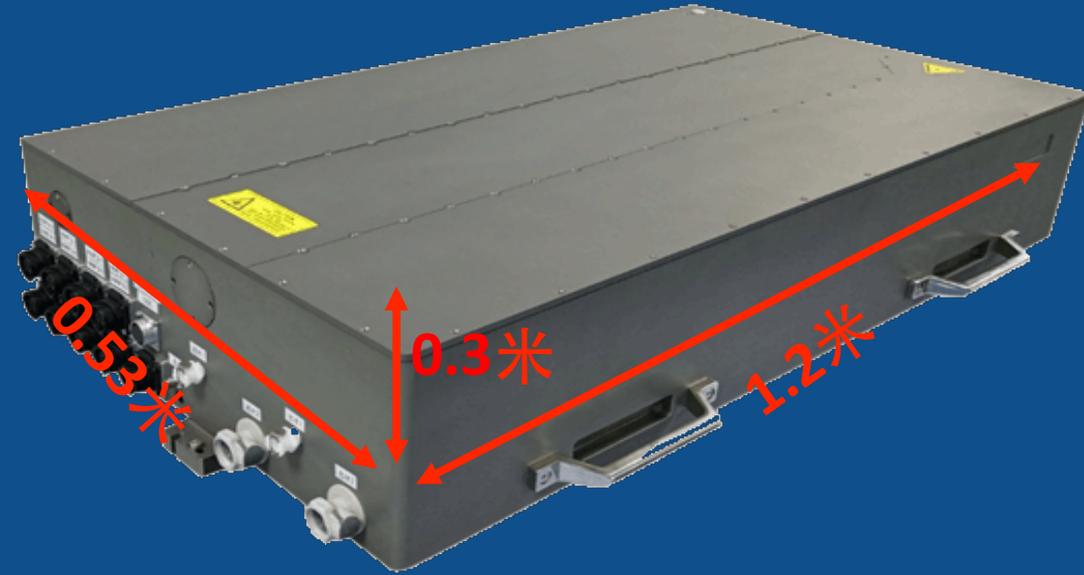


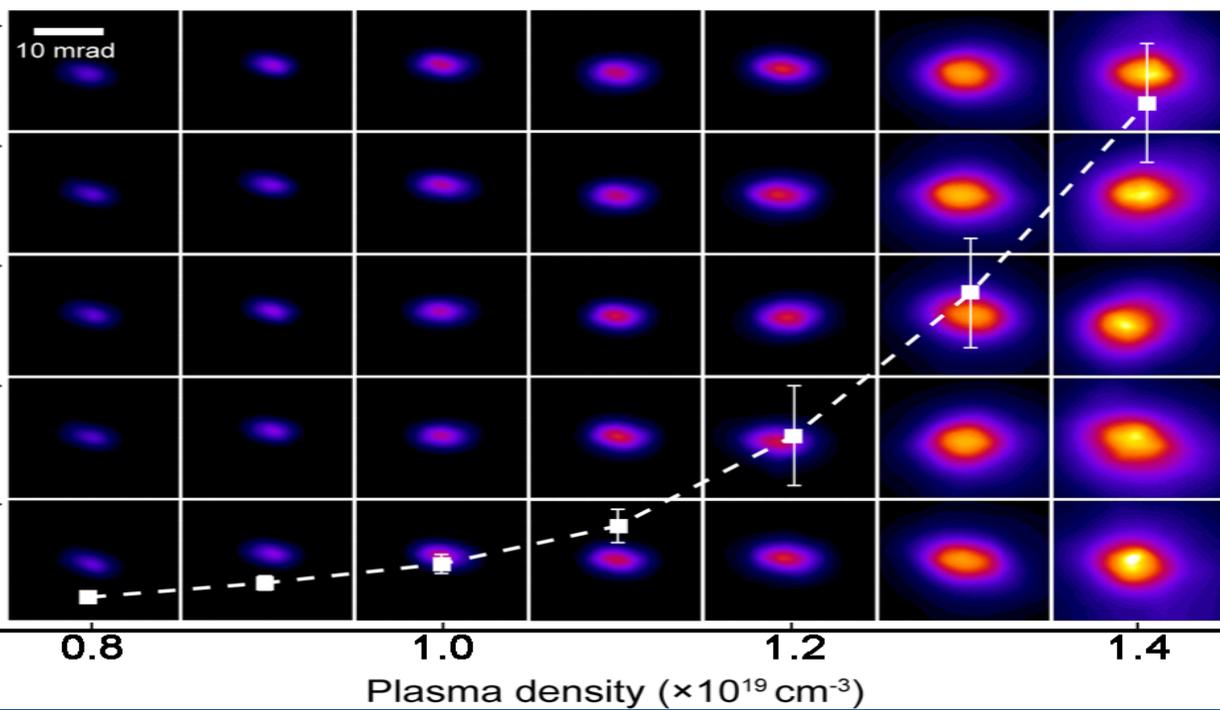
Table top ultrafast synchrotron source



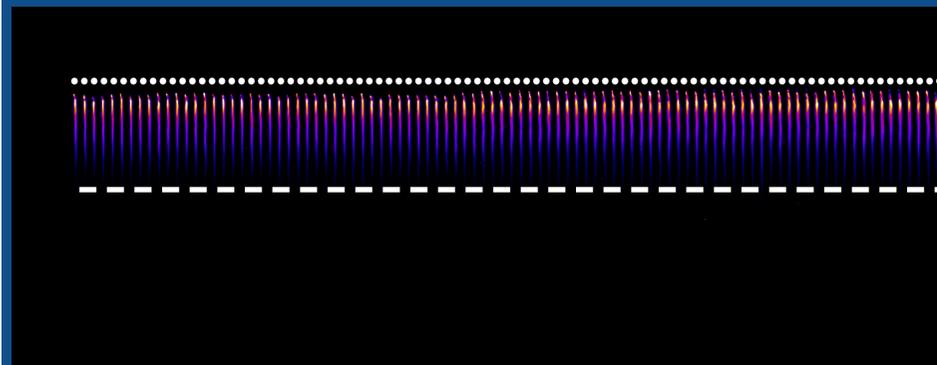
A movable system in a container



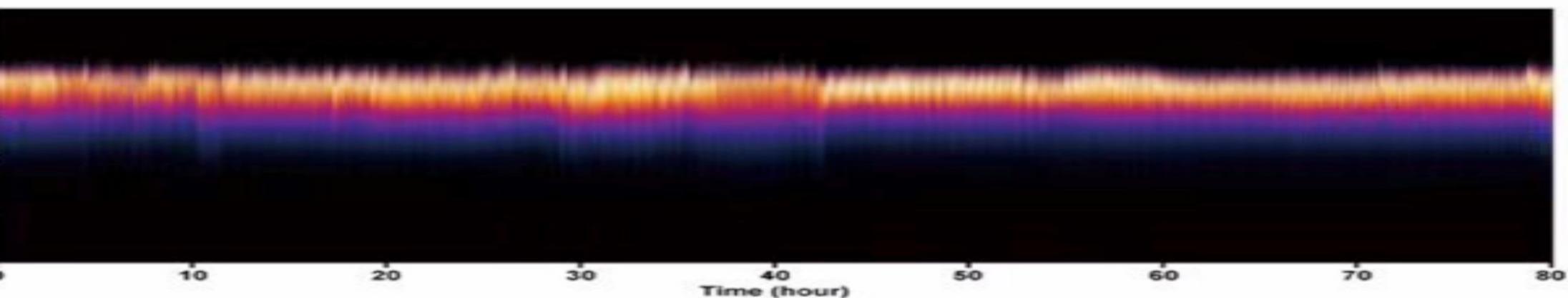
Stable high charge beams for applications



10Hz 100shots

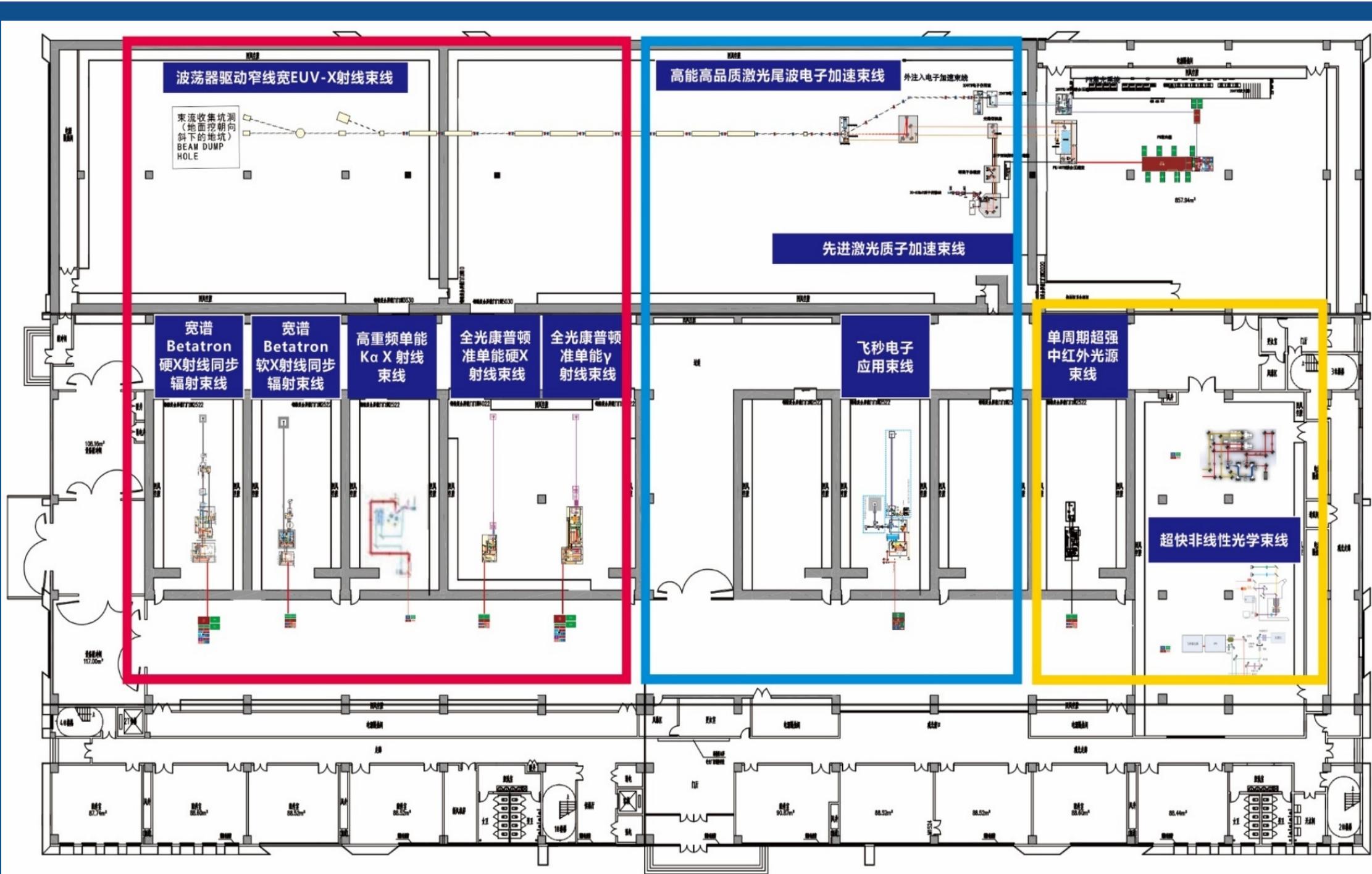


80 hours operation



Laser Plasma Accelerator Application Facility





Thank you!