

An update on plasma accelerator facilities in China

Wei Lu

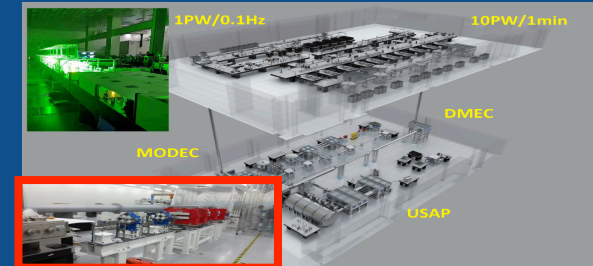
IHEP/Tsinghua University/BAQIS

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

Outline

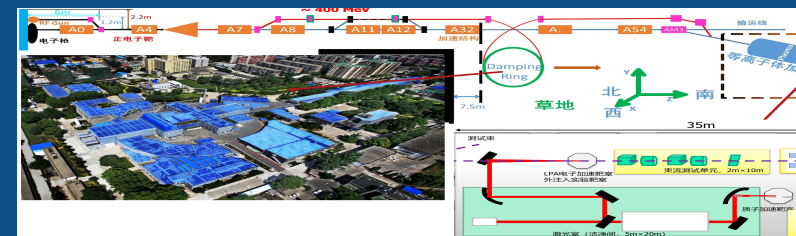
Major Laser Facilities: 6 PW+ systems in 1-3years

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



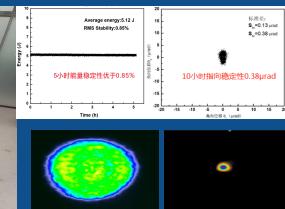
Laser development towards applications:

BAQIS + Qi-NLS + THU

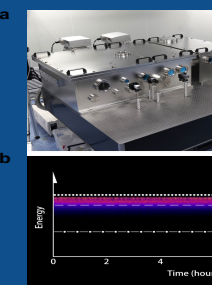
years effort on compact industry level TW-PW lasers

ers with much reduced size, enhanced long term performance

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



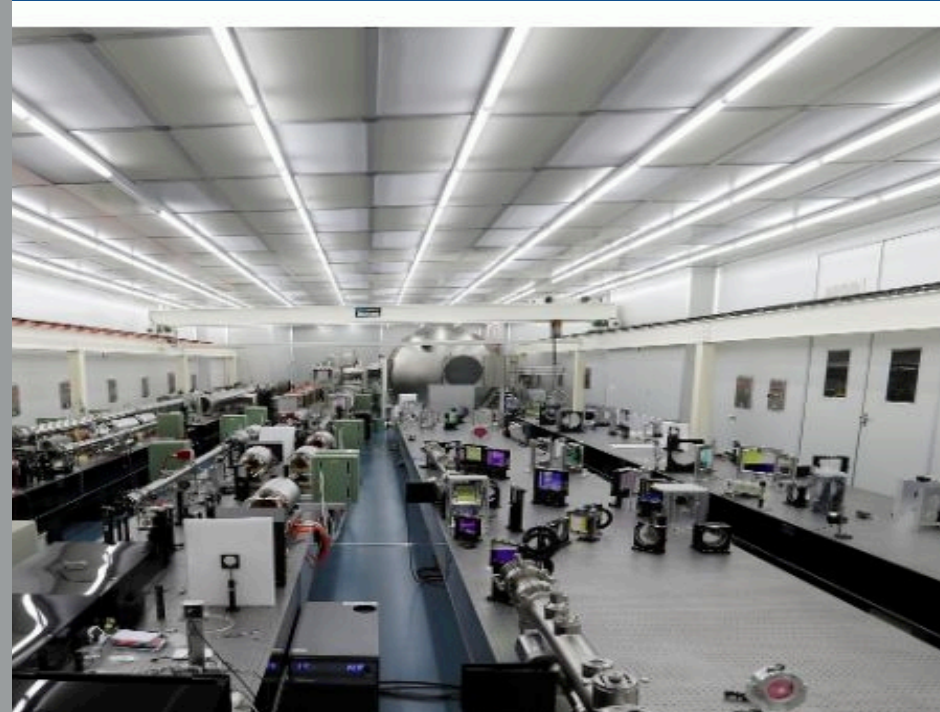
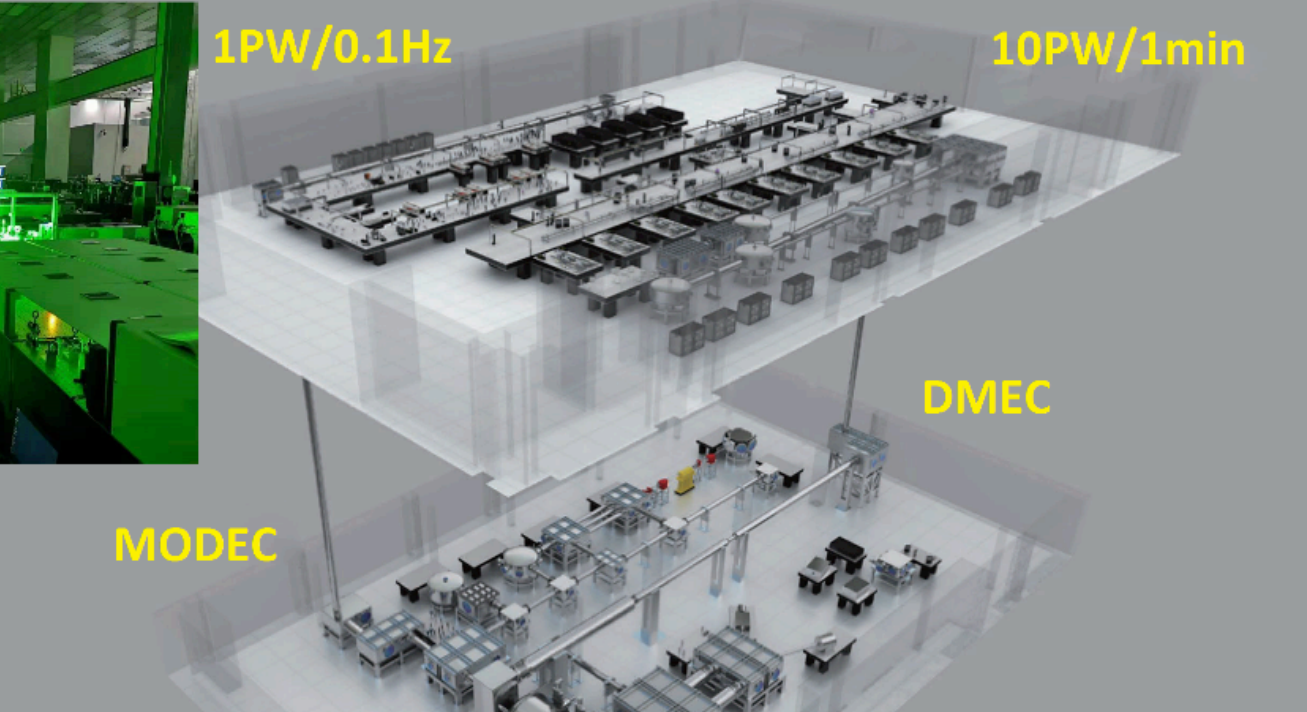
200TW compact system



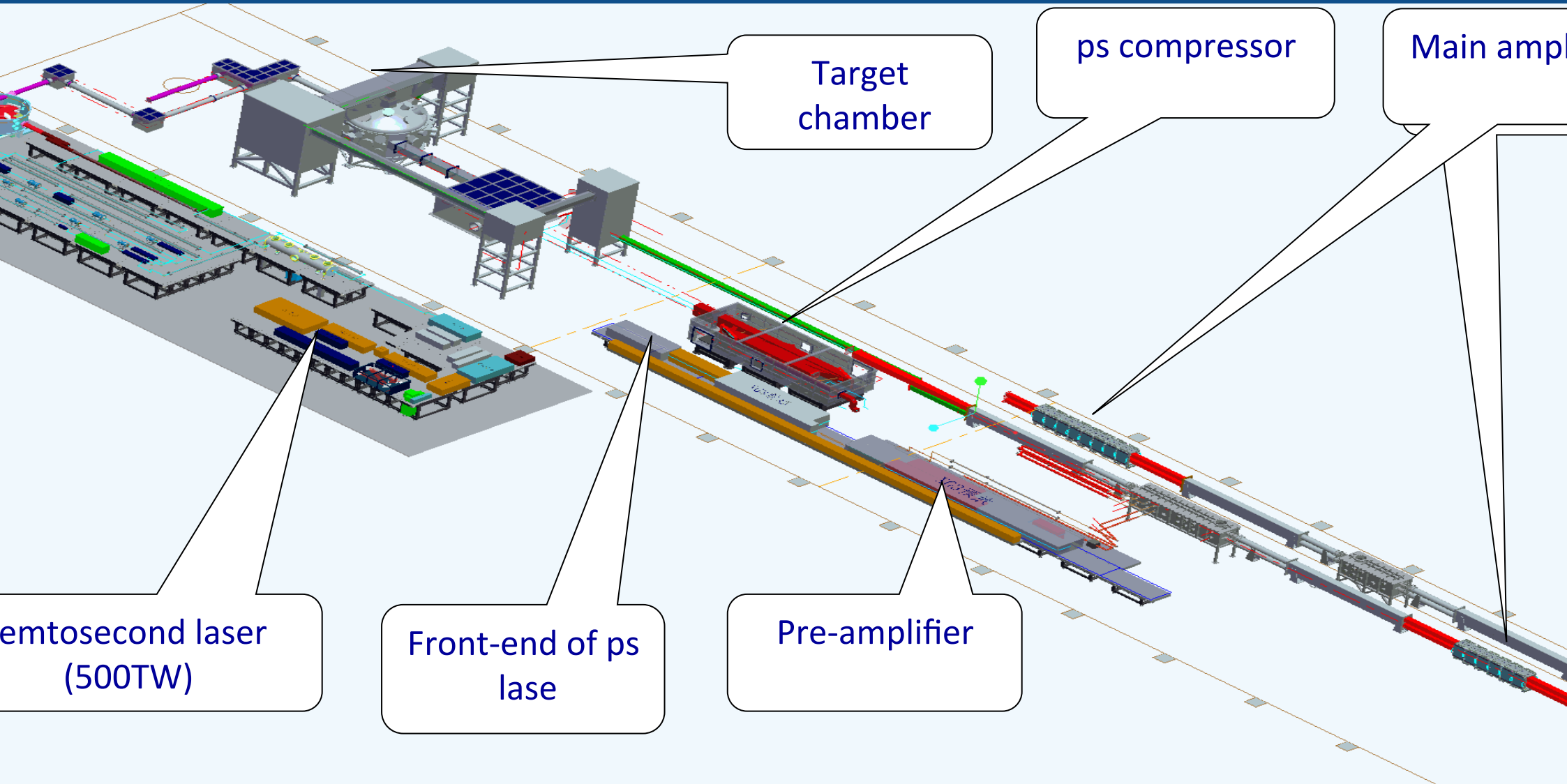
Major laser facilities involved in plasma acceleration in China

Institute	Peak Power	rep rate	main research	timeline
SIOM	10PW	1shot/min	extreme light physics	laser ready
LFRC	5PW	1shot/hour	extreme light physics	laser ready
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

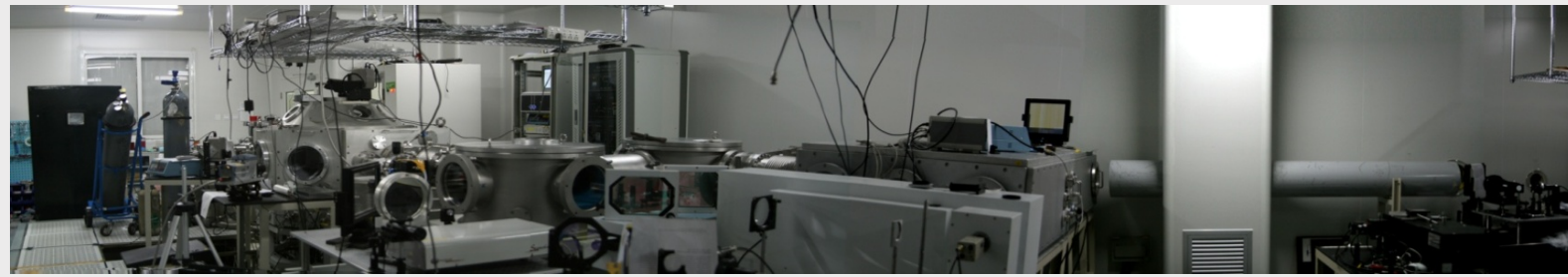
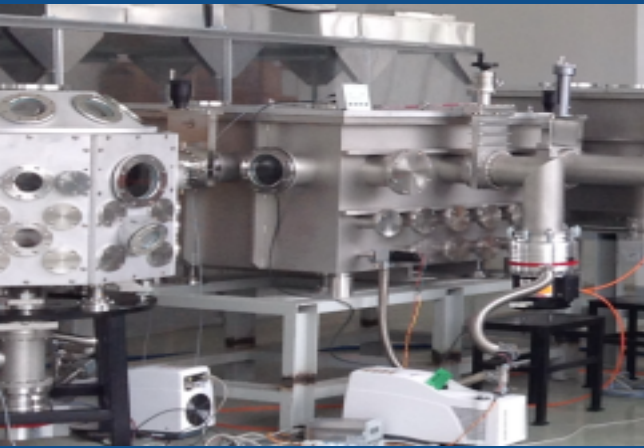


LFRC Xingguang III OPCPA 5PW (ns/ps/fs)



SJTU and IOP

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



CLAPA at PKU (laser ion source)

200TW 5Hz
2PW 1Hz

Gas-target Chamber

Cluster-
Chambe

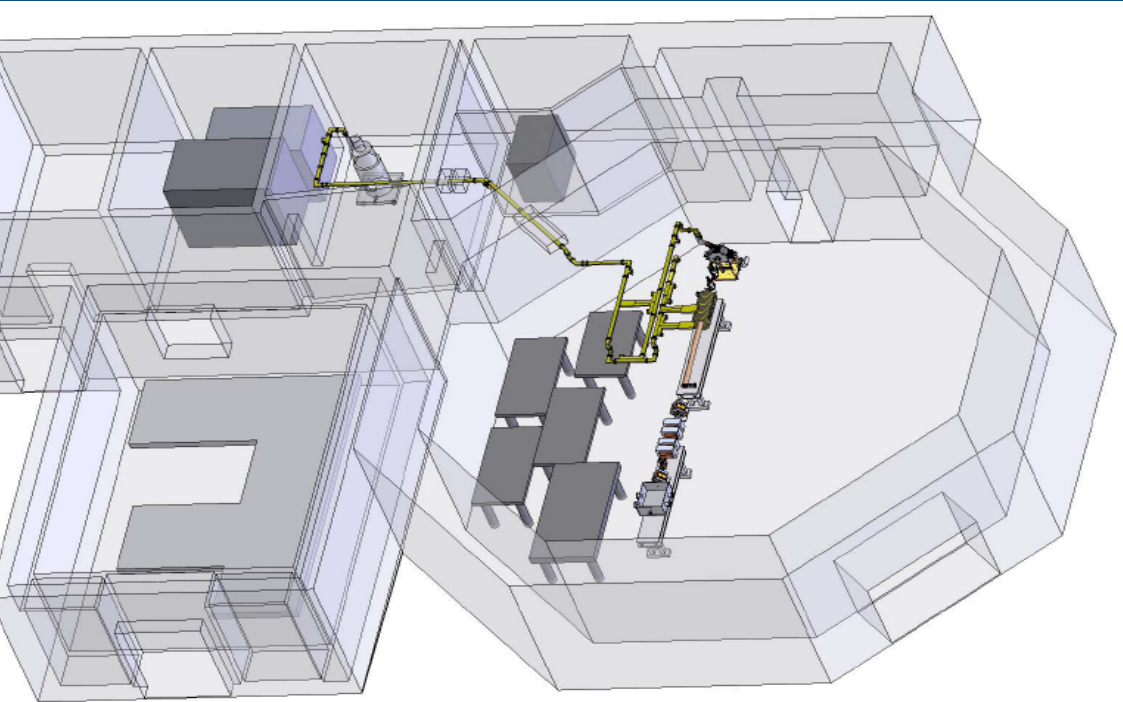
Proton Beam Line

Laser



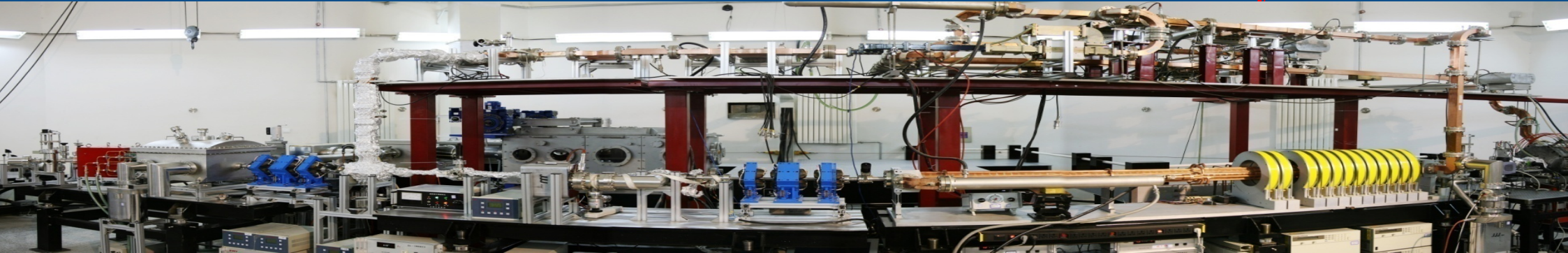
THU/BAQIS/Qi-NLS

40TW Laser + 45MeV Linac



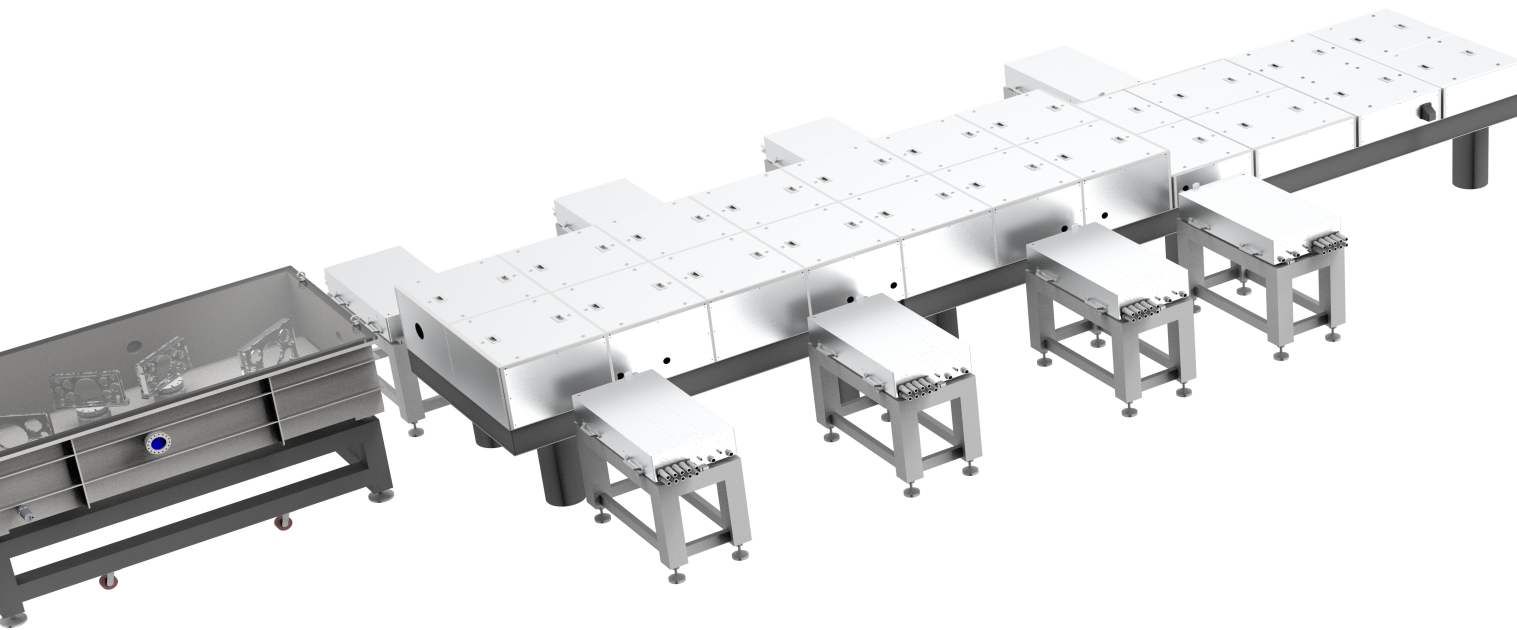
45MeV LINAC

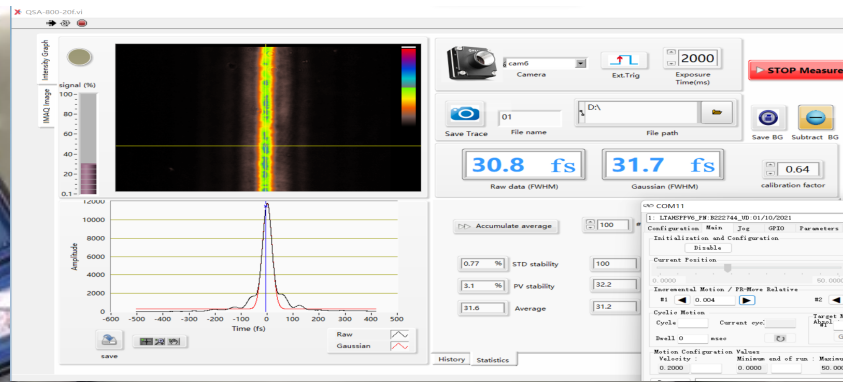
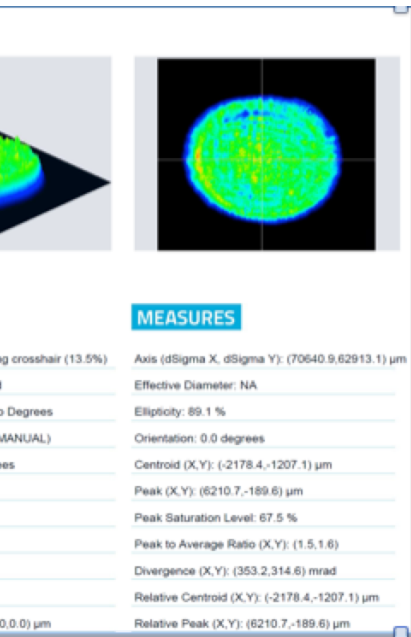
25fs 40TW Laser System



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

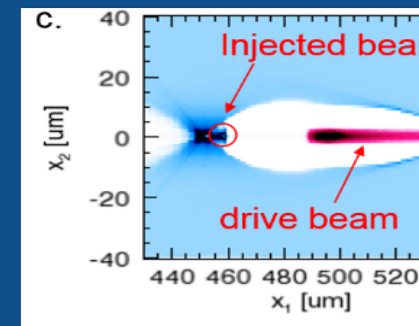
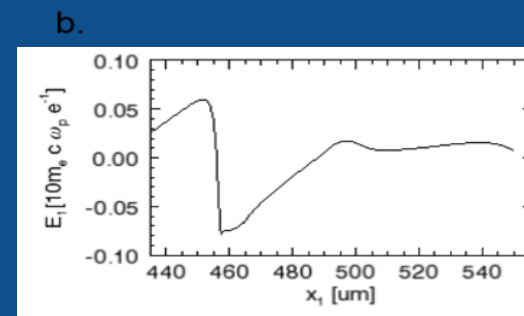
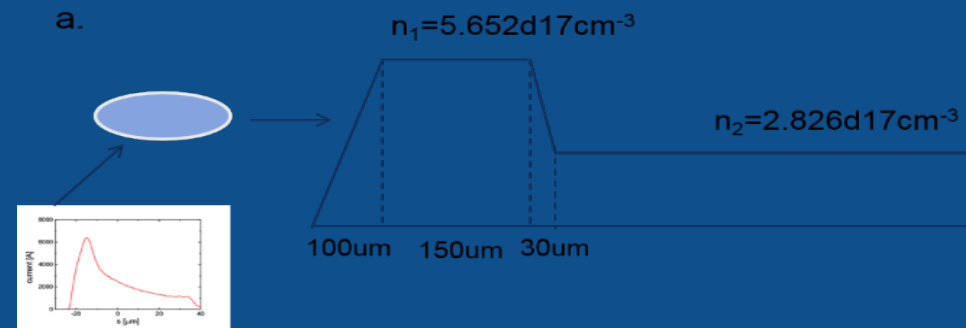
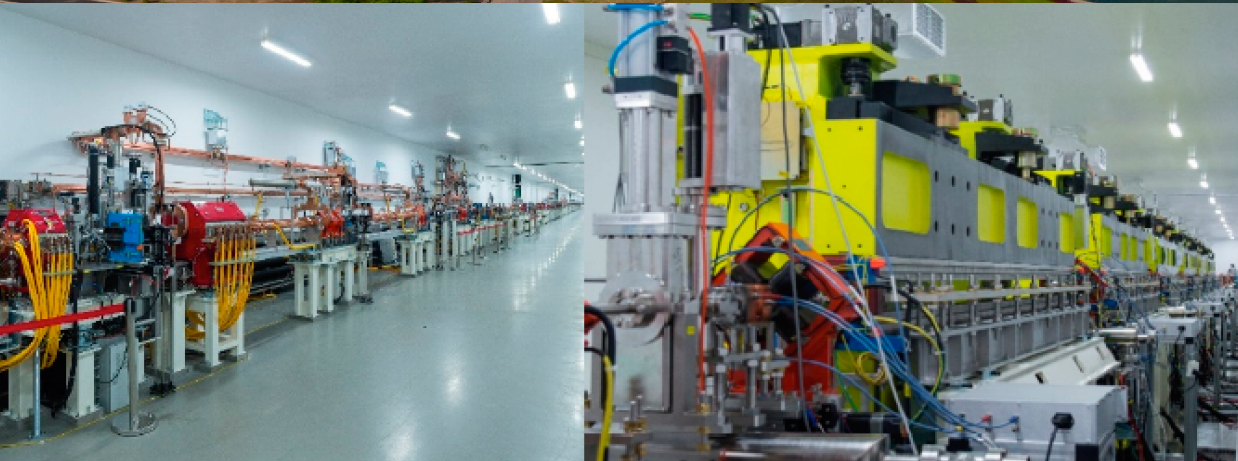
BAQIS Compact 1PW 1Hz





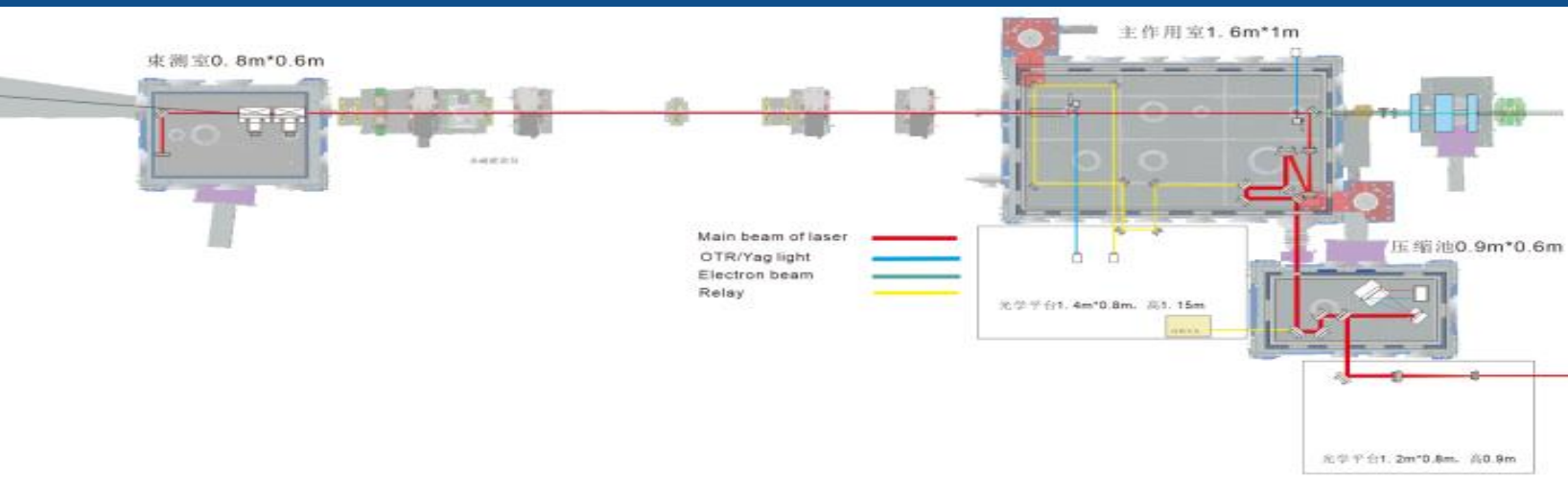
Long term energy stability better than 0.5% rms (10 hours)

PWFA platform at SXFEL in Shanghai

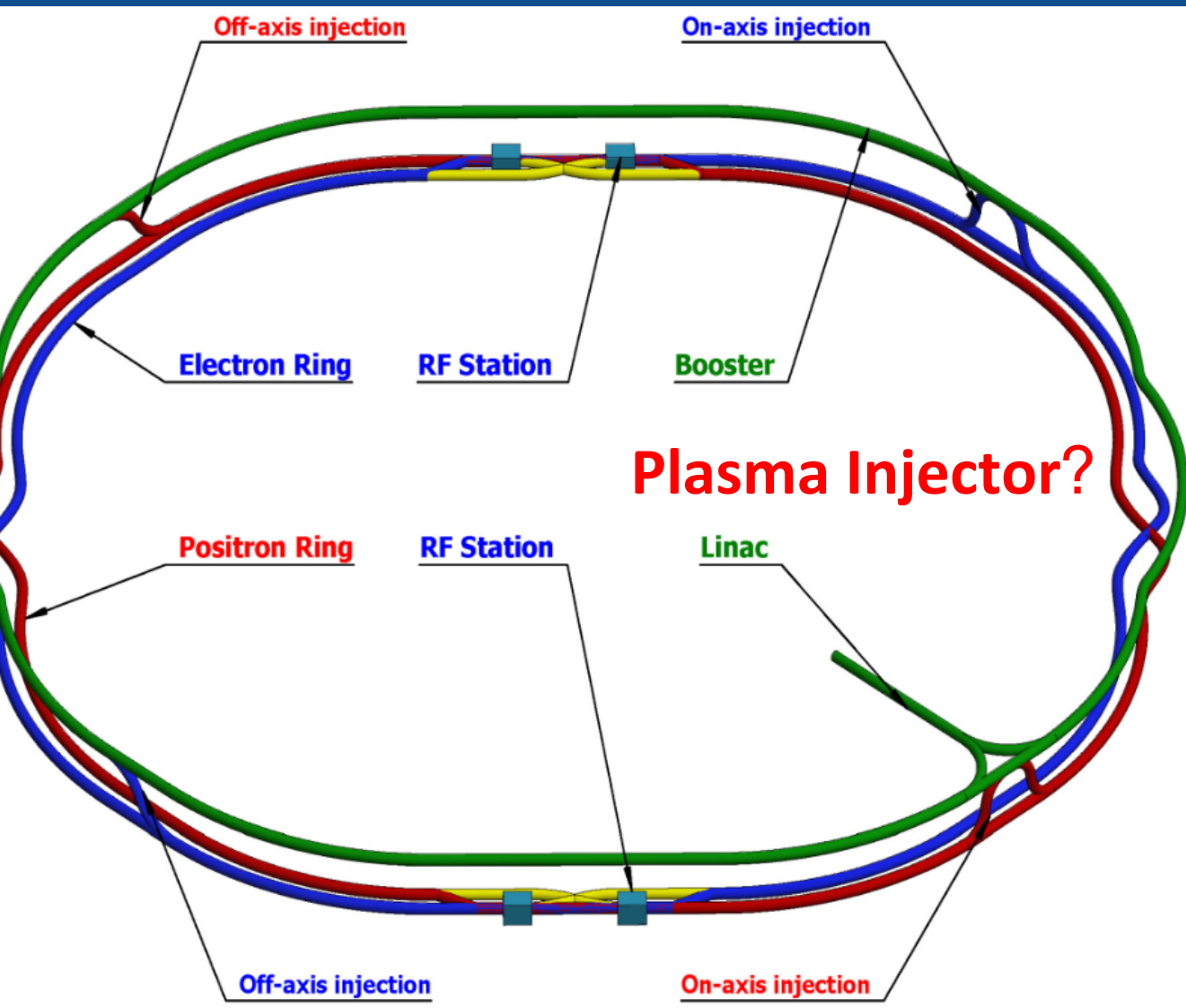


S. Huang et al., IPAC proceeding 2017

PWFA platform at SXFEL in Shanghai



CEPC plan in China



IHEP-CEPC-DR-2018-01

IHEP-AC-2018-01

CEPC

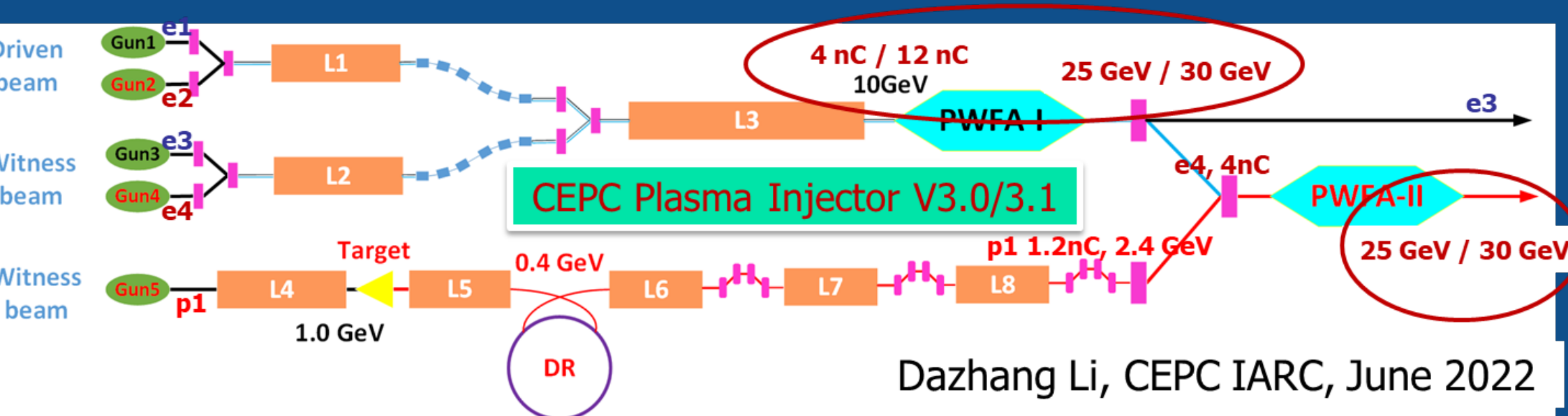
Conceptual Design Report

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

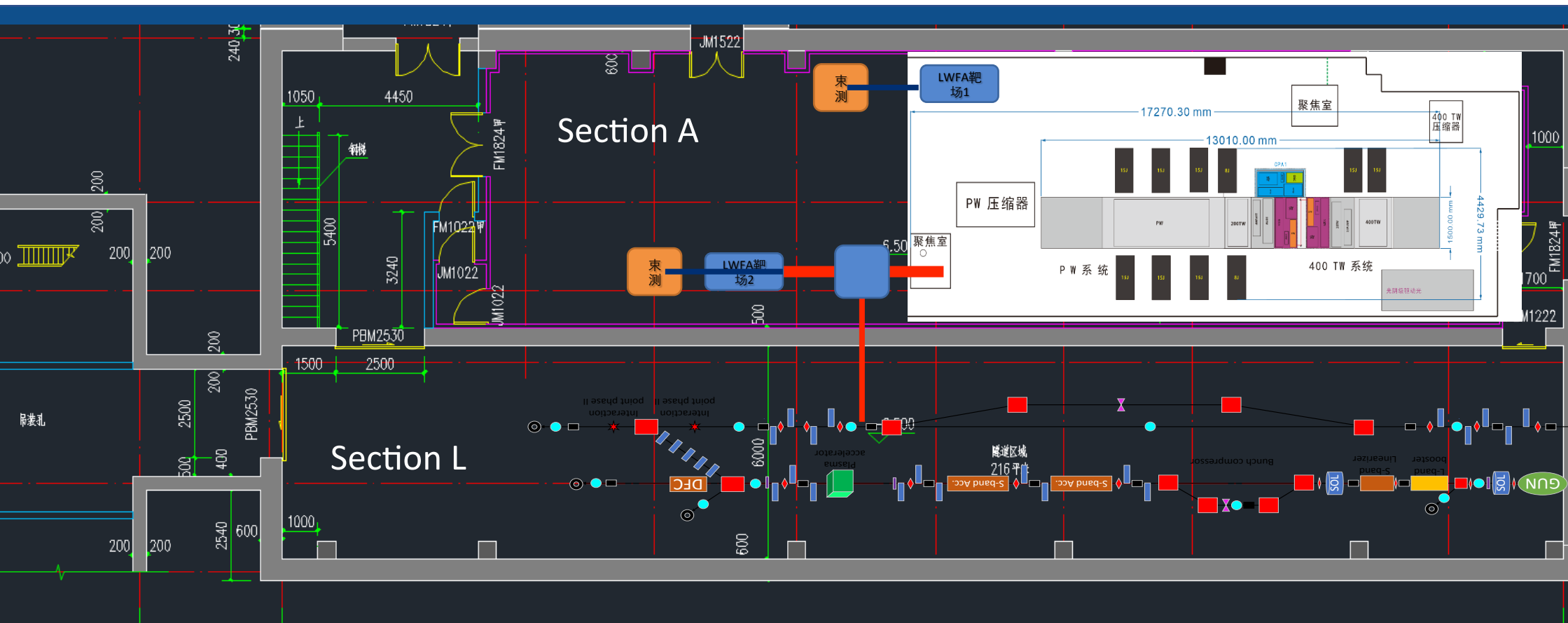
V3.1 TR≥1.5

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





- BEPC 2GeV e-/e+ beams with beam compression to 1ps
- A new beam line with 150MeV 1-5nC electron linac
- A 1PW 30fs 1Hz laser system
- All 3 systems are synchronized to work together

A joint effort on compact robust lasers



清華大學
Tsinghua University



BAQIS

北京量子信息科学研究院



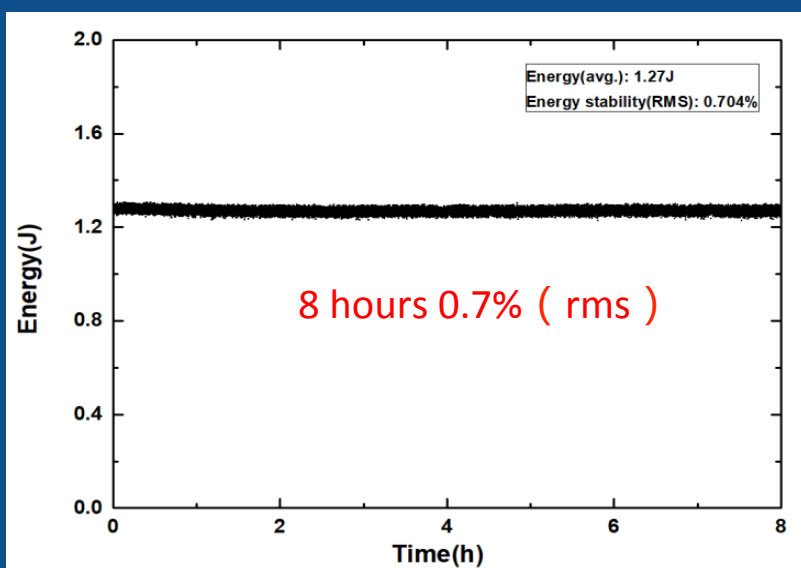
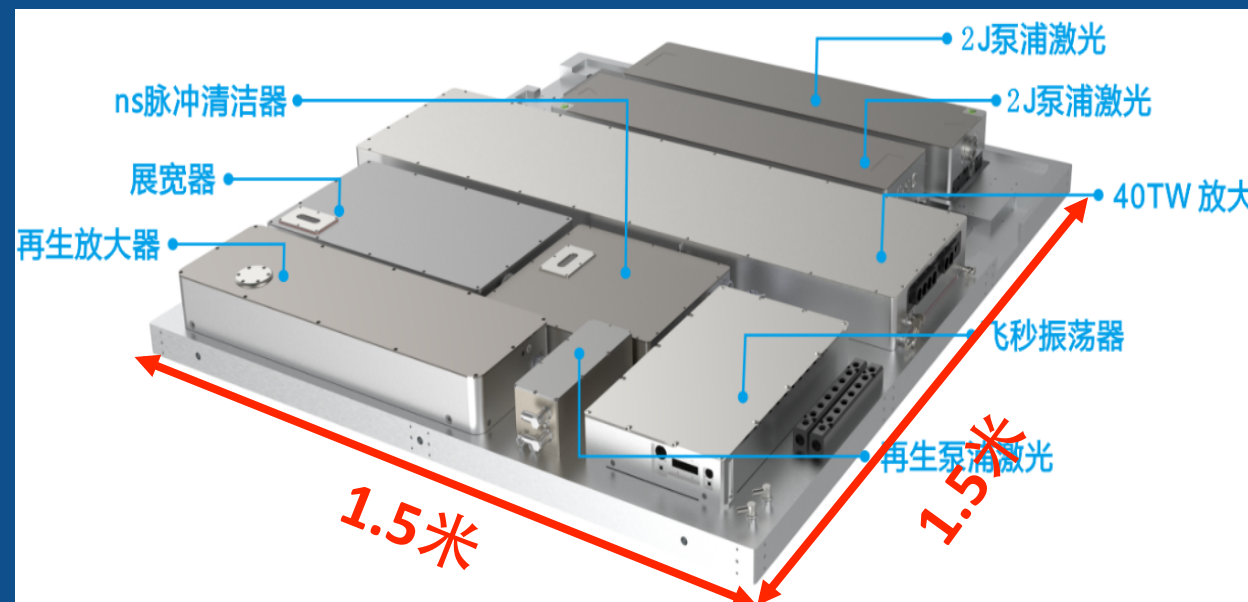
启源研究院



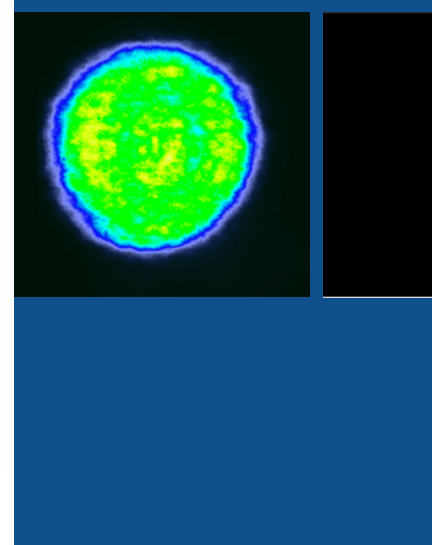
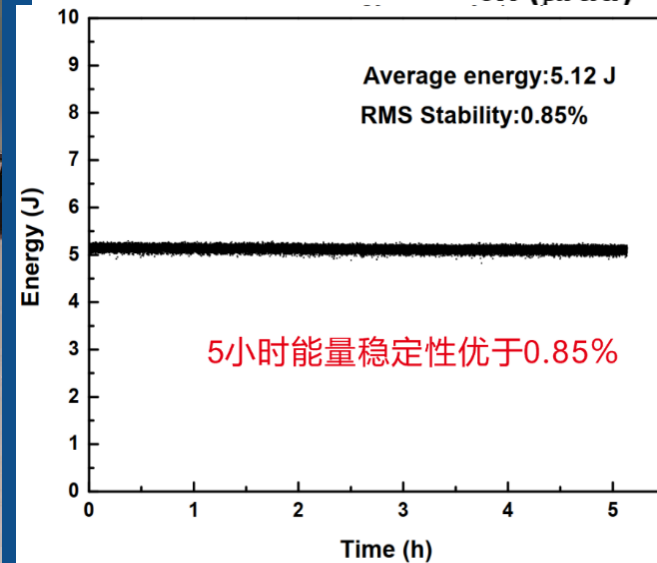
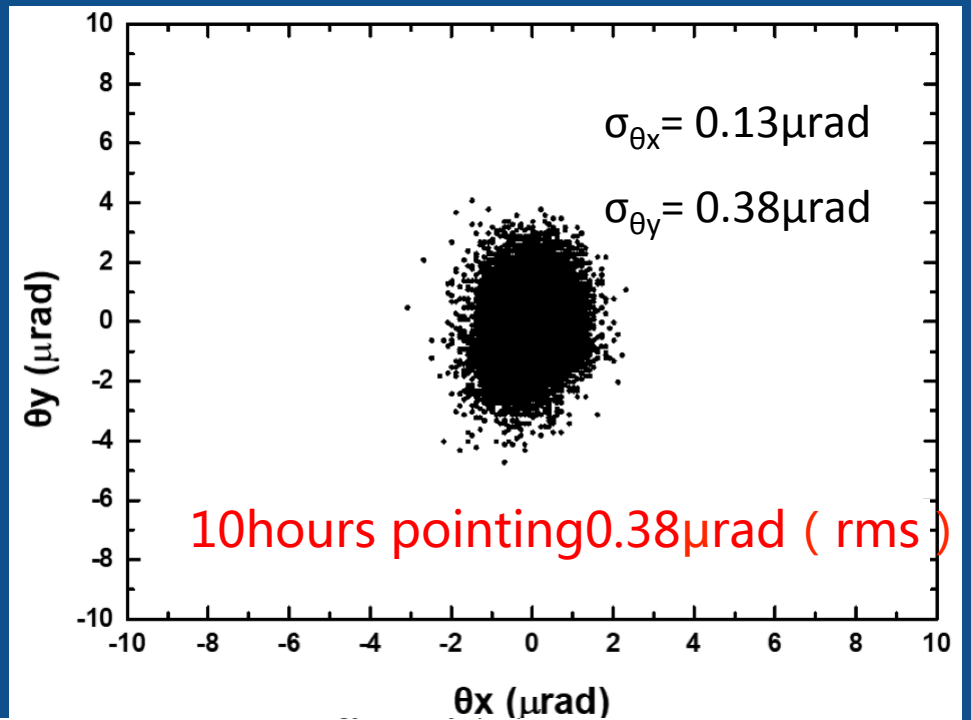
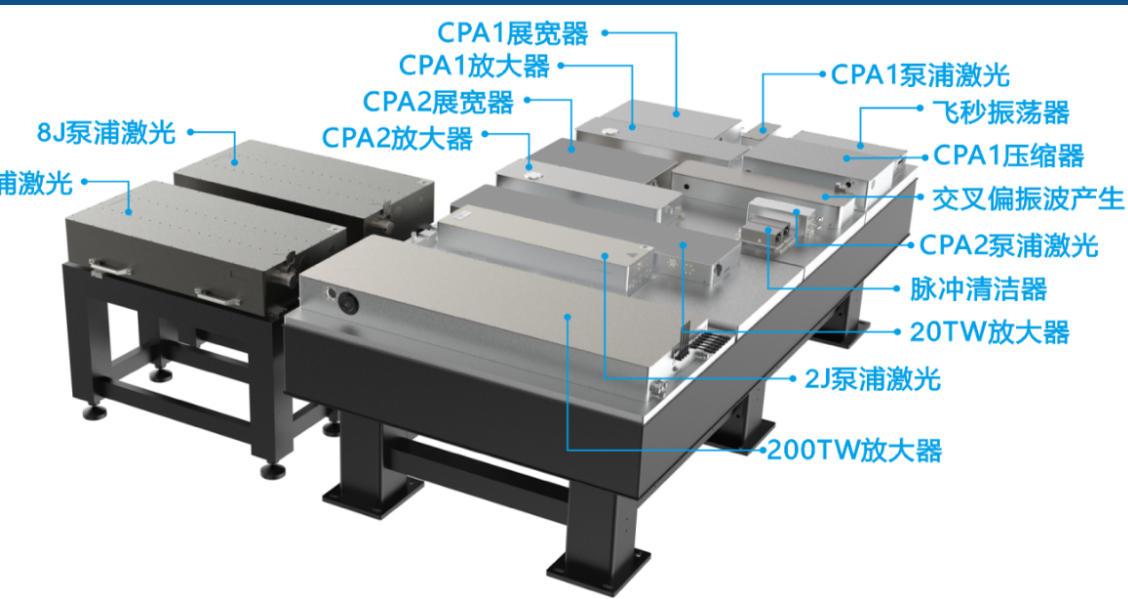
Newlight Source
QiFeng Technology



40TW compact laser

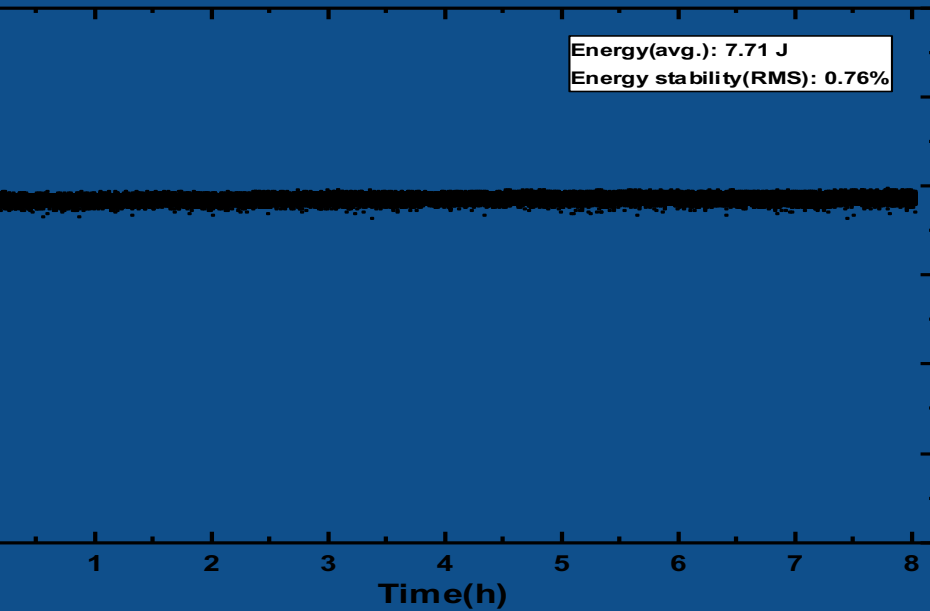


200TW compact laser



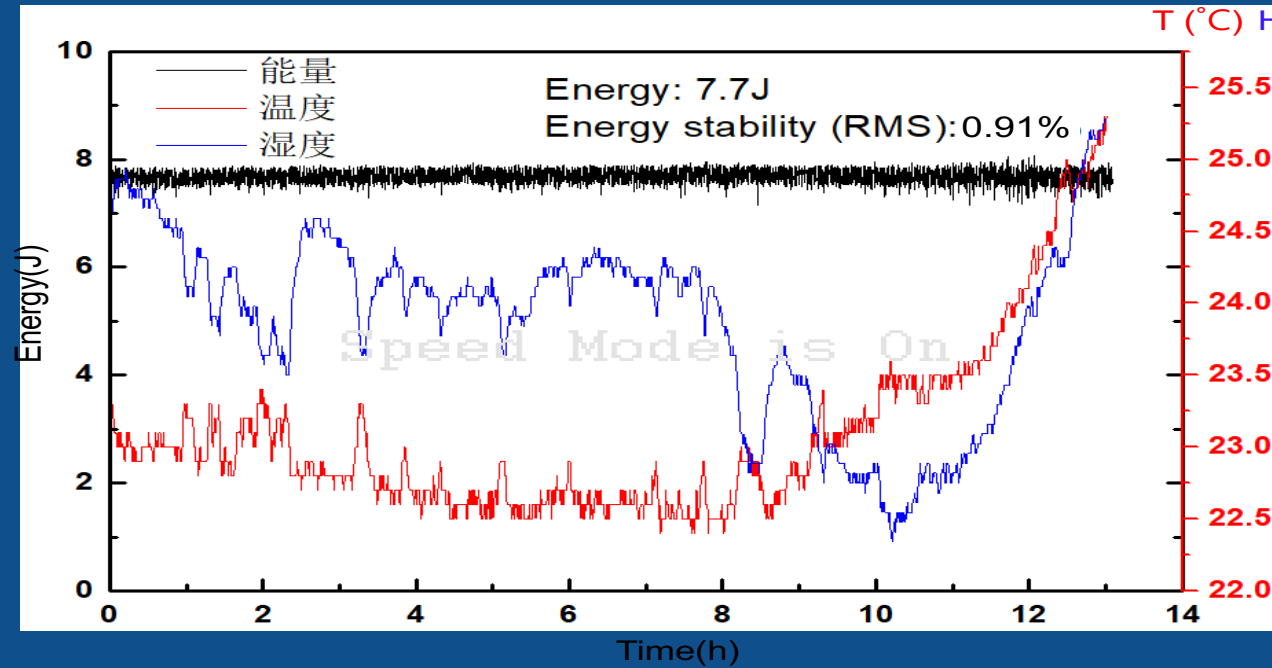
Stability for varied temperature

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

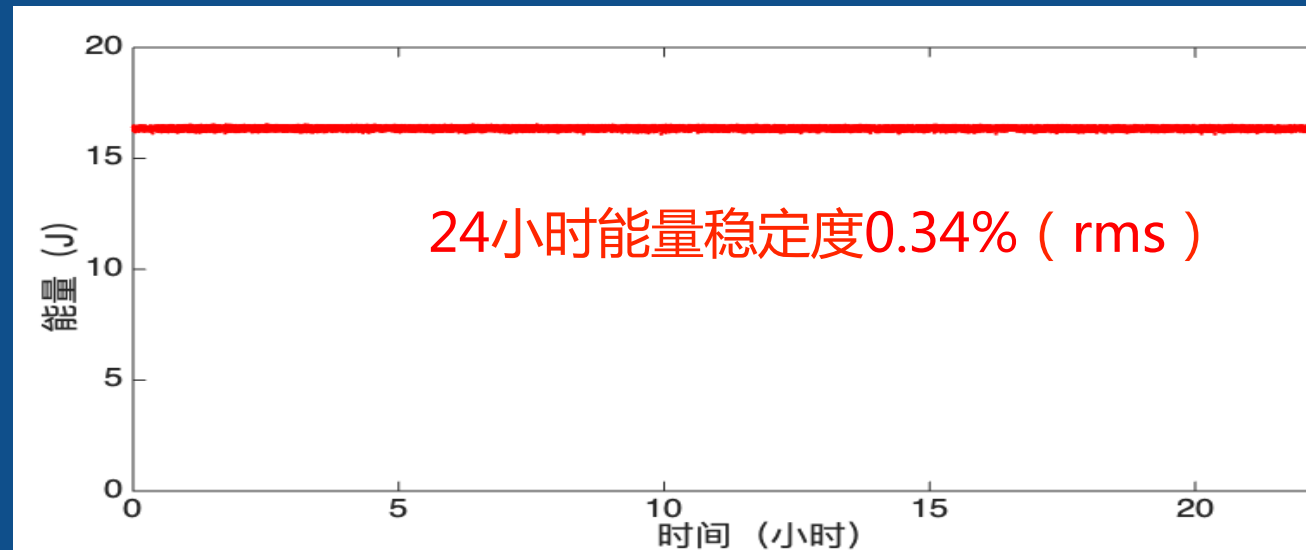
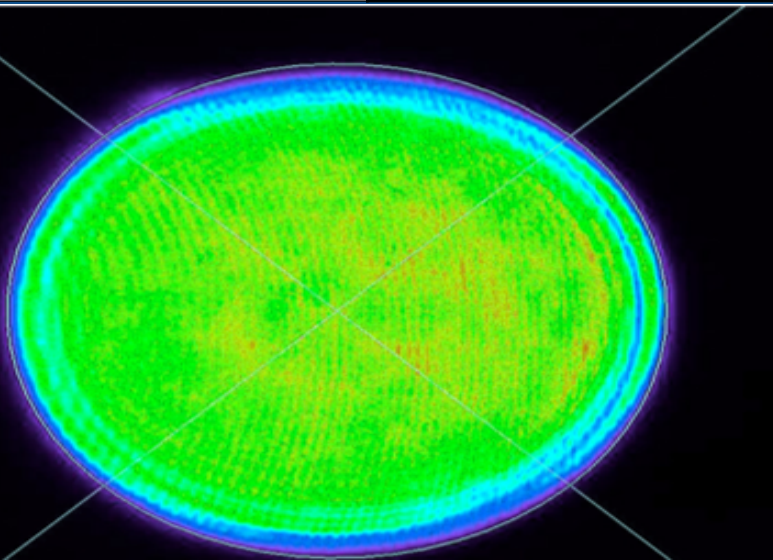
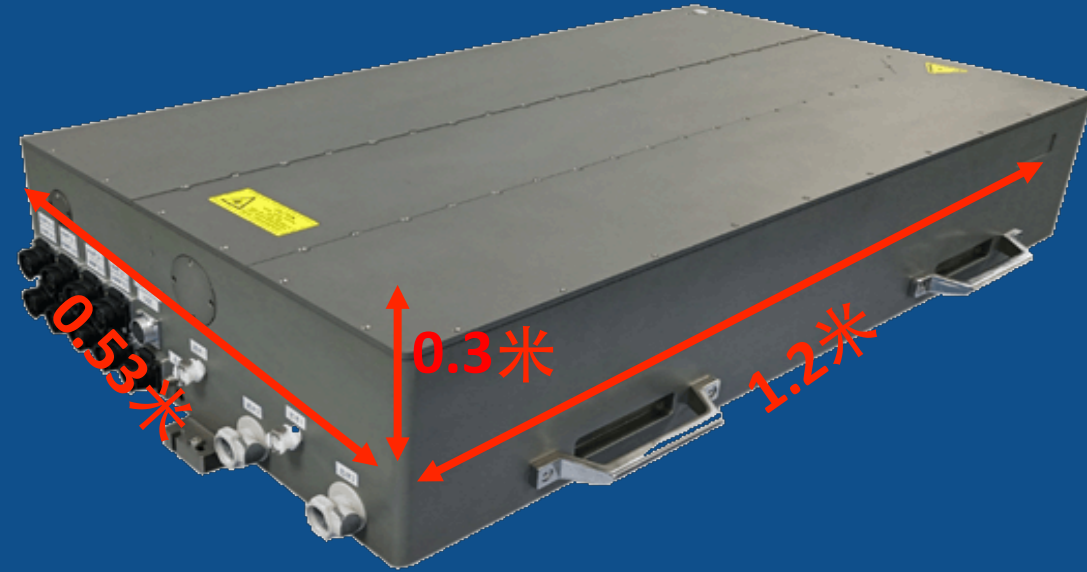


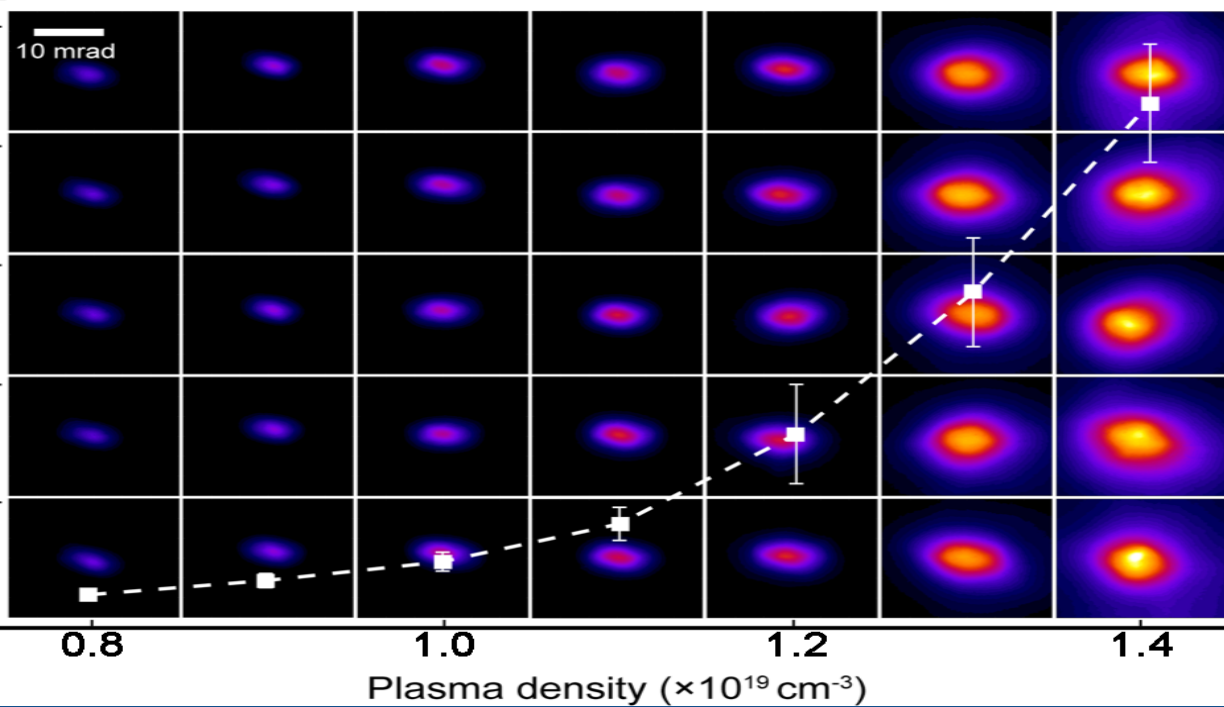
Table top ultrafast synchrotron source



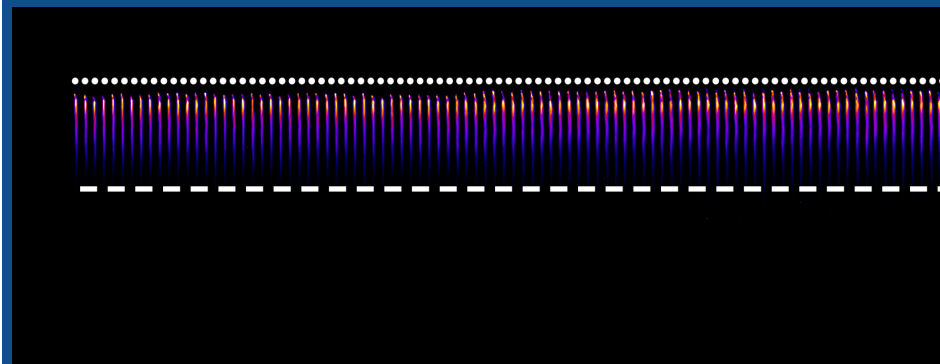
A movable system in a container



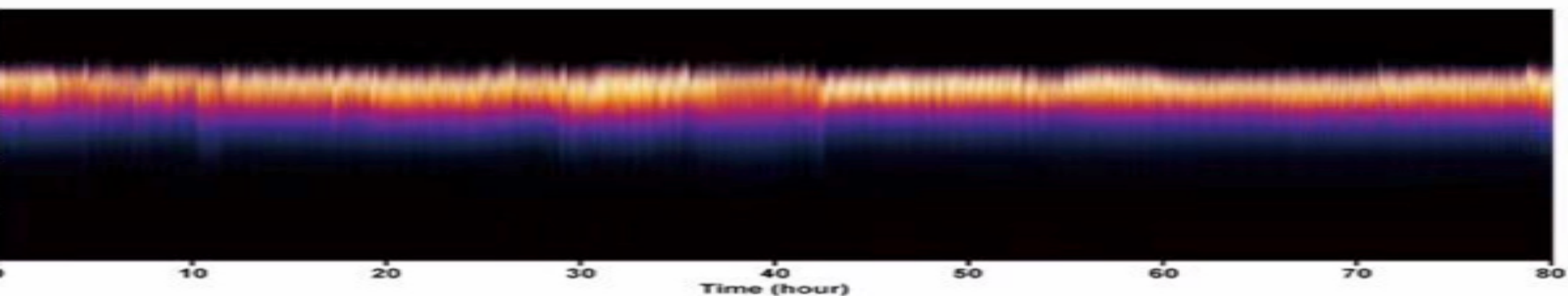
Stable high charge beams for applications



10Hz 100shots

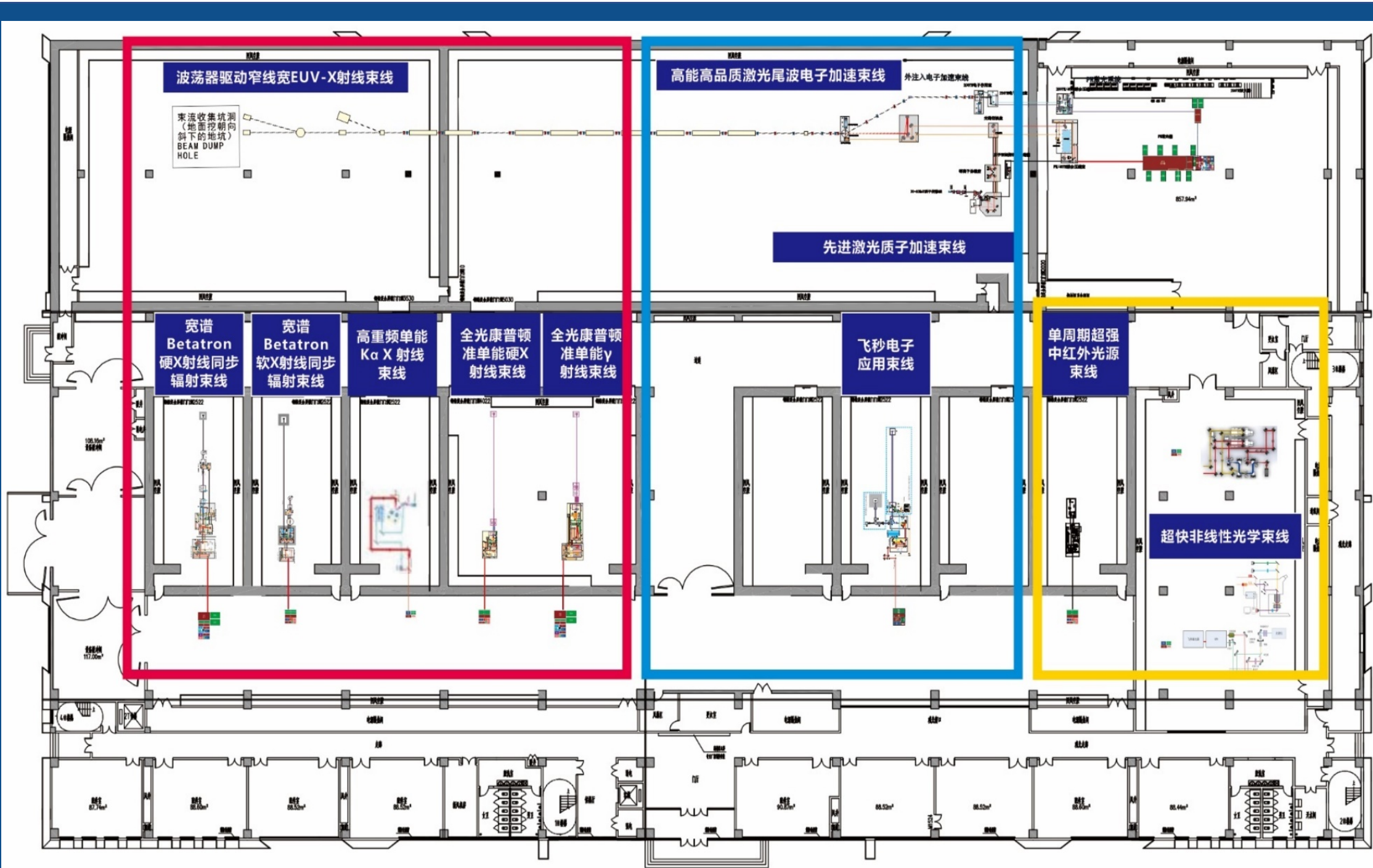


80 hours operation



Laser Plasma Accelerator Application Facility





Thank you!