Shanghai Hard X-ray FEL Facility

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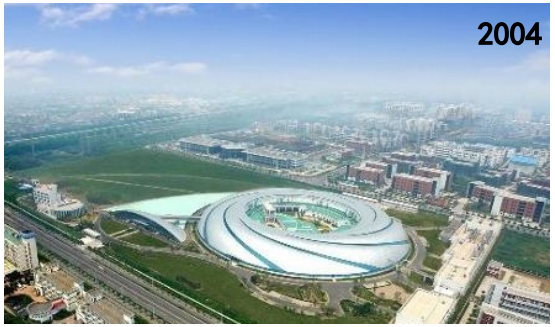
Feb.2 2018 @ ESS, Lund

The Status of Research Facility at Zhang-Jiang Science Park

Zhang-Jiang Science Park

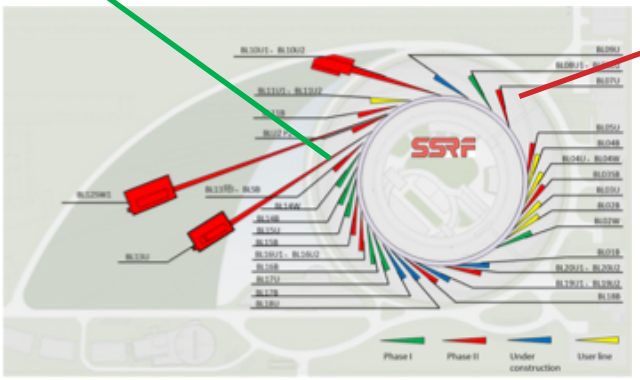
One of Most Important National Science Center in China



SSRF as major Research Facility plays a central role

- Phase I: *7* beamlines (Dec. 2004- Apr. 2009)
- In between: *8* Beamlines
- Phase II: *16* beamlines (Nov. 2016-Dec. 2020)
- SSRF operates to deliver the photon beam about 5,500hrs/year （4,500hrs/year for public users） in current years.
- Up to Dec. 2017: 2,297user groups/ 9,387 proposals/20,129users.

SSRF PHASE I



SSRF PHASE II

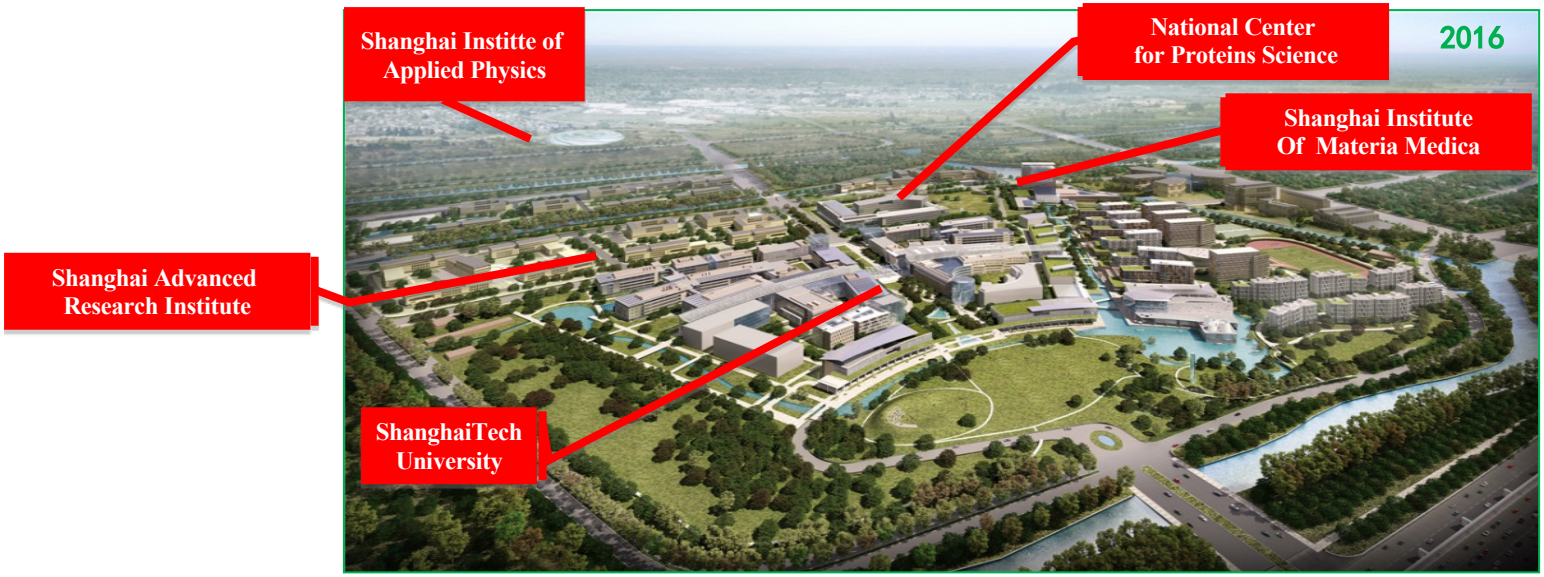
Zhang-Jiang Science Park

One of Most Important National Science Center in China

Shanghai Institute of Applied Physics CAS

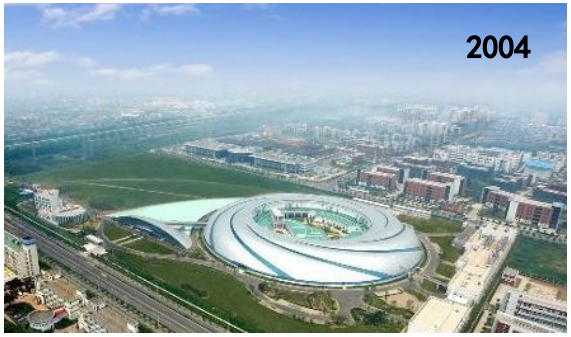
From SSRF to a Research and Education Complex

- Shanghai Institute of Applied Physics, CAS since 2004
- Shanghai Institute of Materia Medica, CAS (Phase II) since 2009
- Shanghai Advanced Research Institute, CAS since 2010
- National Center for Protein Science (Shanghai) since 2010
- ShanghaiTech University since 2013



Zhang-Jiang Science Park

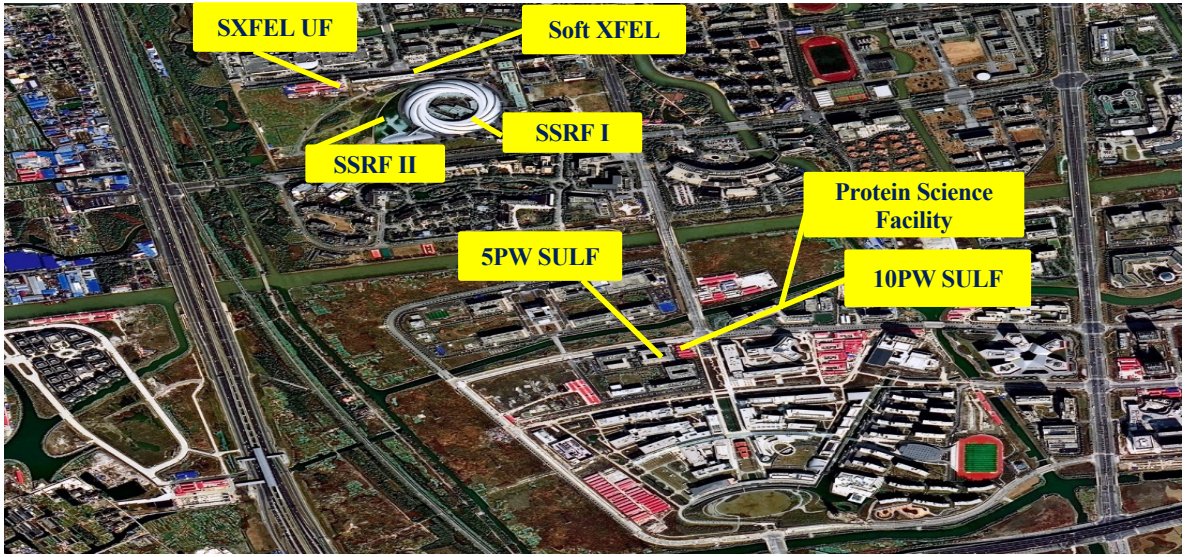
One of Most Important National Science Center in China



Shanghai Institute of Applied Physics CAS

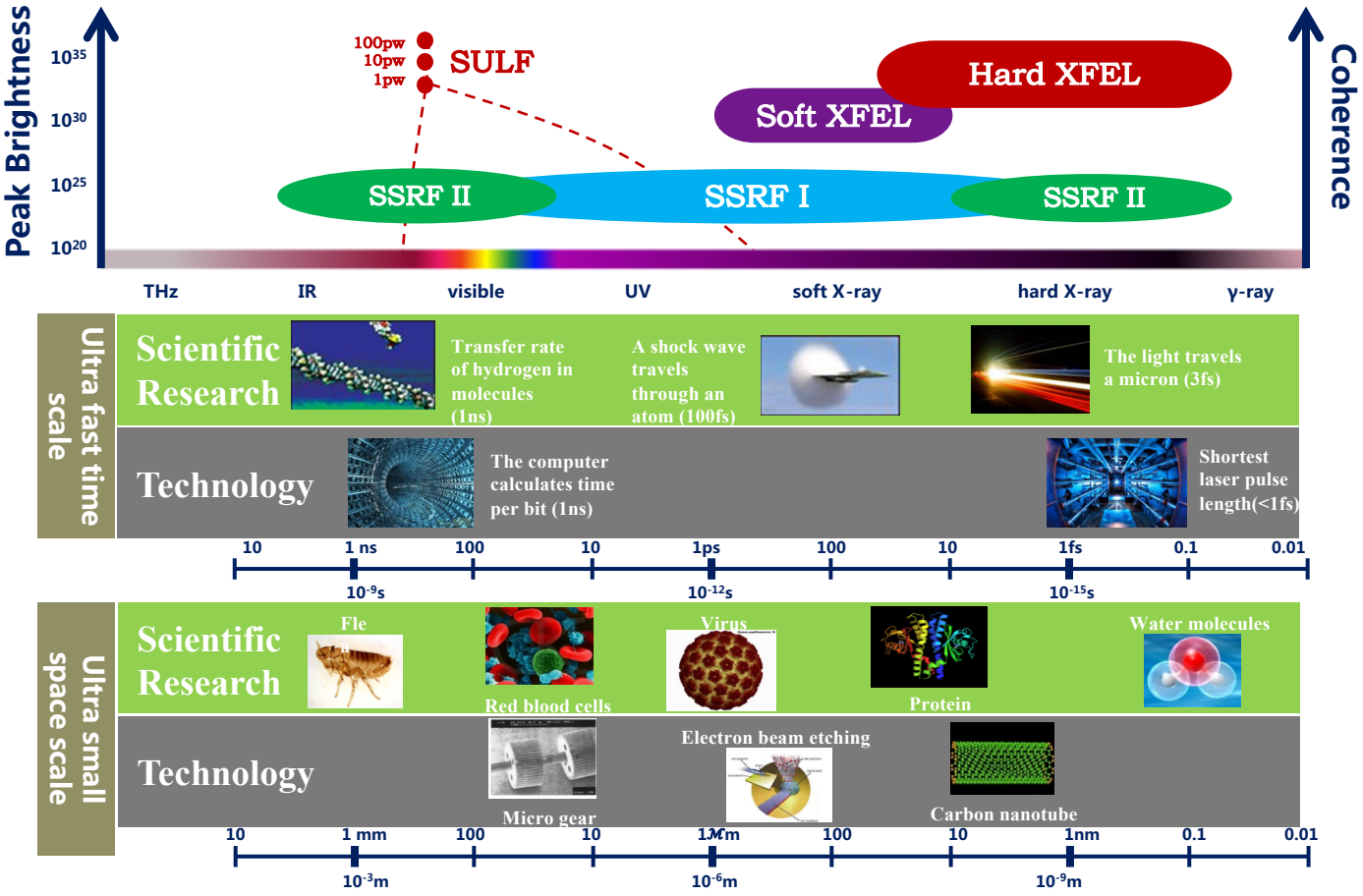
From SSRF to a Cluster of Advanced Research Facilities

- National Protein Science Faciltiy (Shanghai) since 2010
- Shanghai Soft X-ray Free Electron Laser Facility (Test) since 2015
- Shanghai Soft X-ray Free Electron Laser Facility (User) under constr. 2016
- Shanghai Ultra-short and intense Laser Facility (SULF) 5PW since 2015
- Shanghai Ultra-short and intense Laser Facility 10PW under constr. 2016



The New Development of Research Facility at Zhang-Jiang Science Park

To Build Generic Research and Development Platforms for Photon Science at Zhang-Jiang Science Park

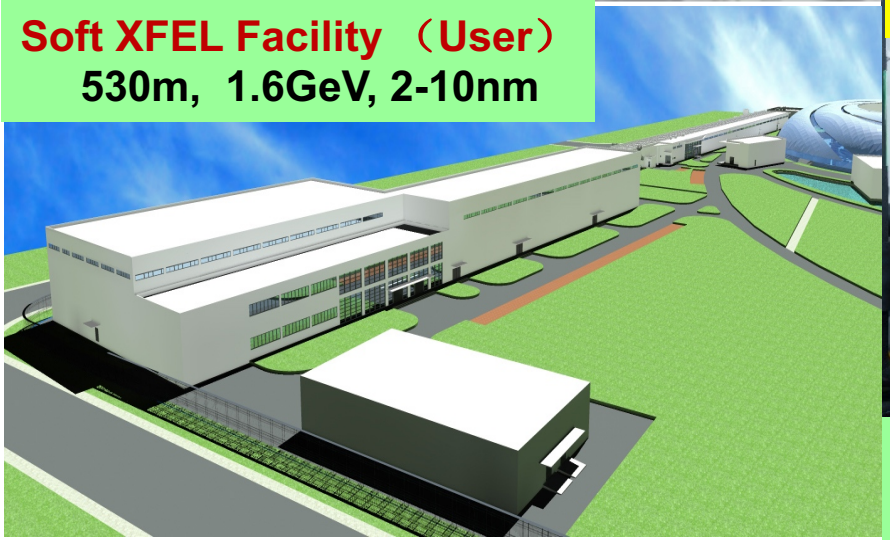


Existing High-Gain FELs in Shanghai

SDUV-FEL：
65m, 180MeV, 250-350nm

Under commissioning

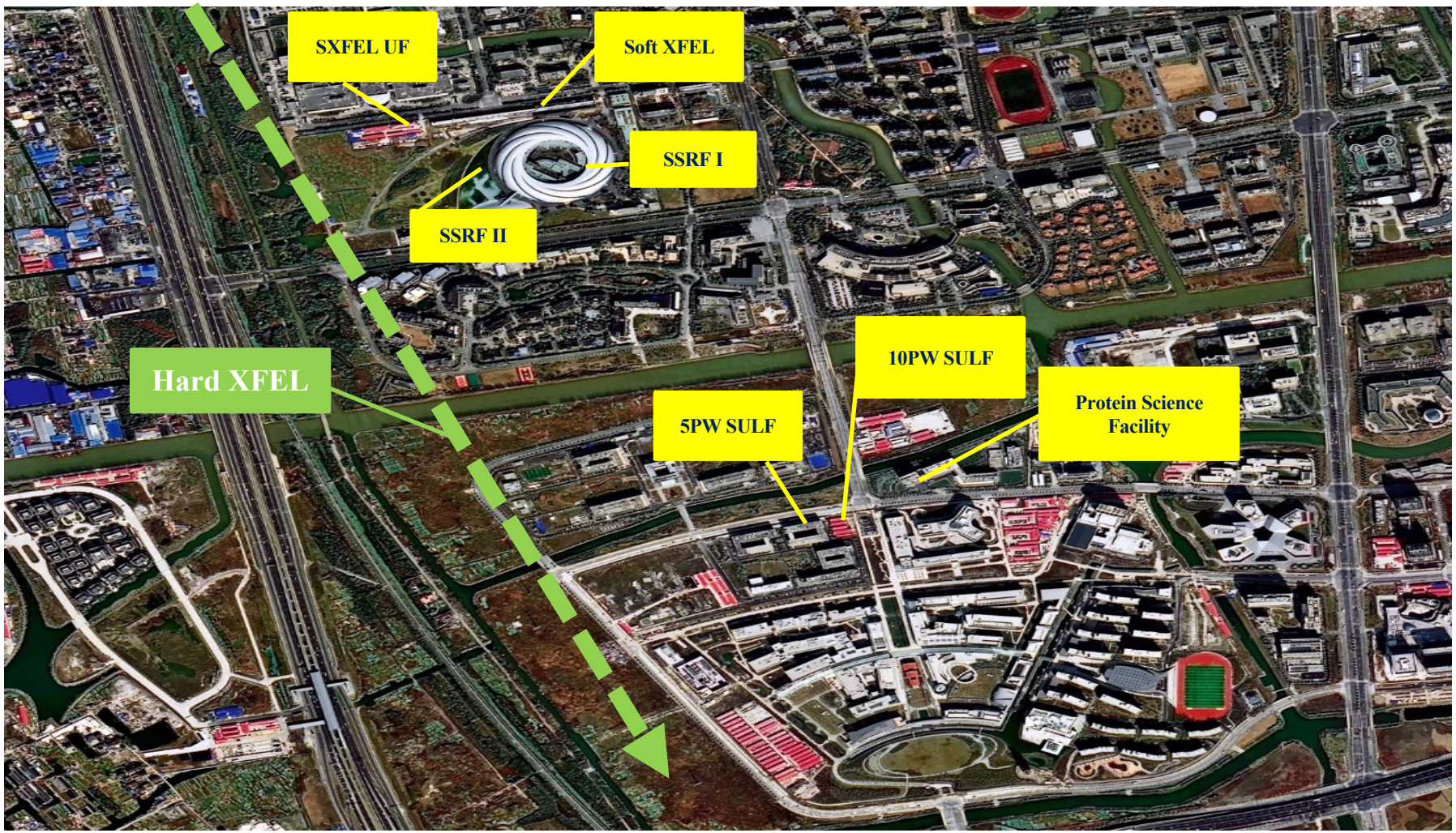
Soft XFEL Facility （User）
530m, 1.6GeV, 2-10nm



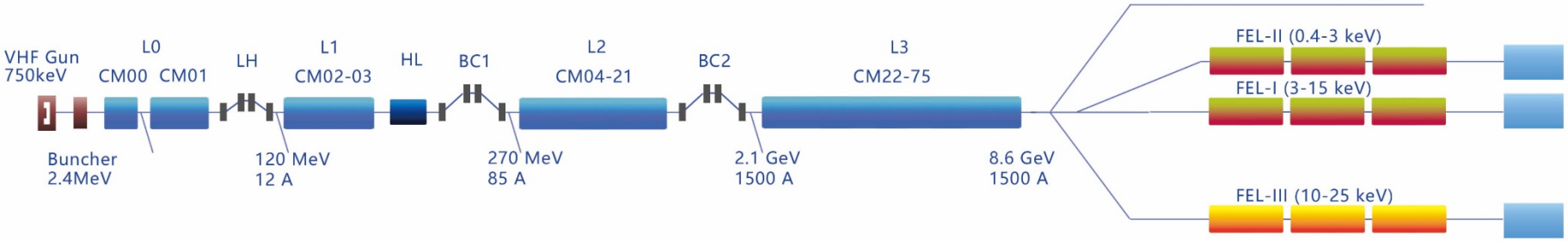
Soft XFEL Facility(Test)
300m, 840MeV, 9-40nm

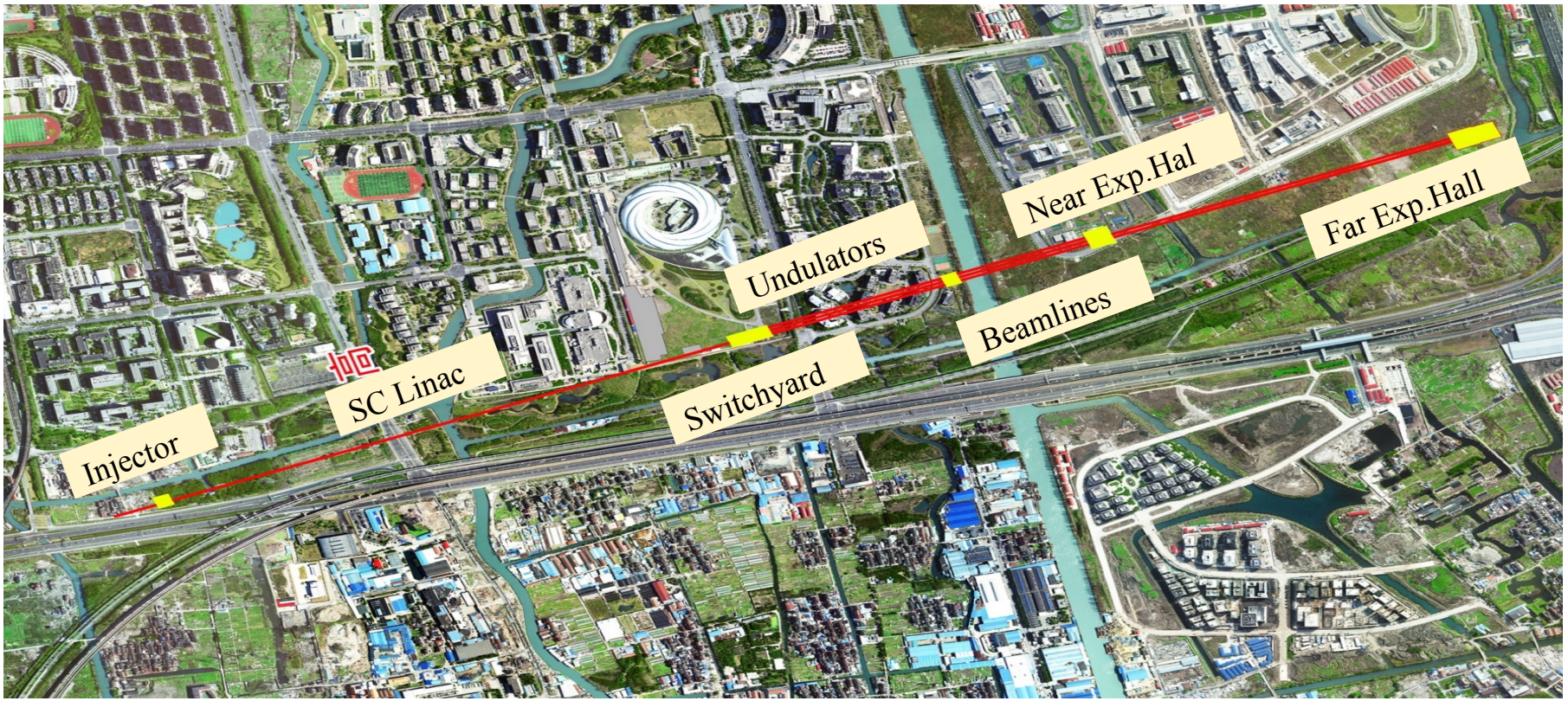
New Project

Shanghai Hard X-ray Free Electron Laser Facility

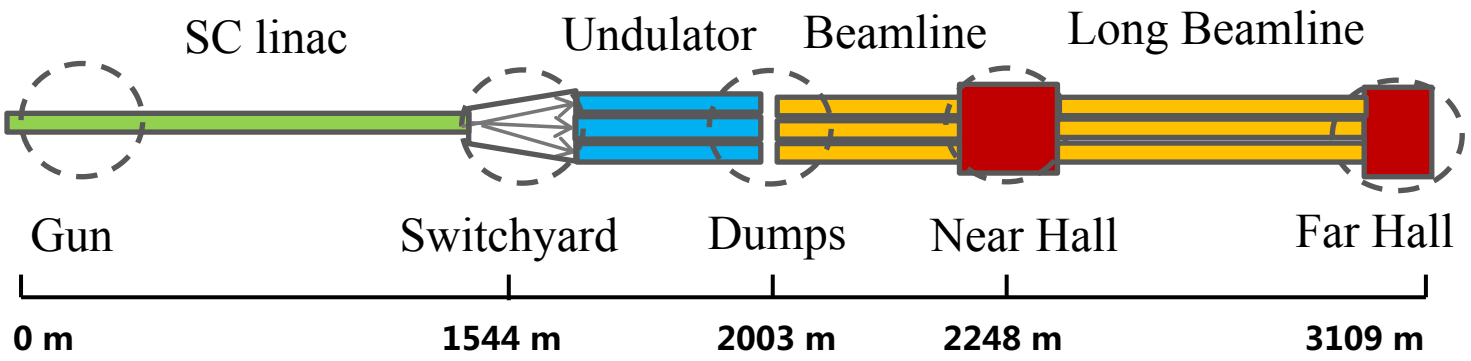


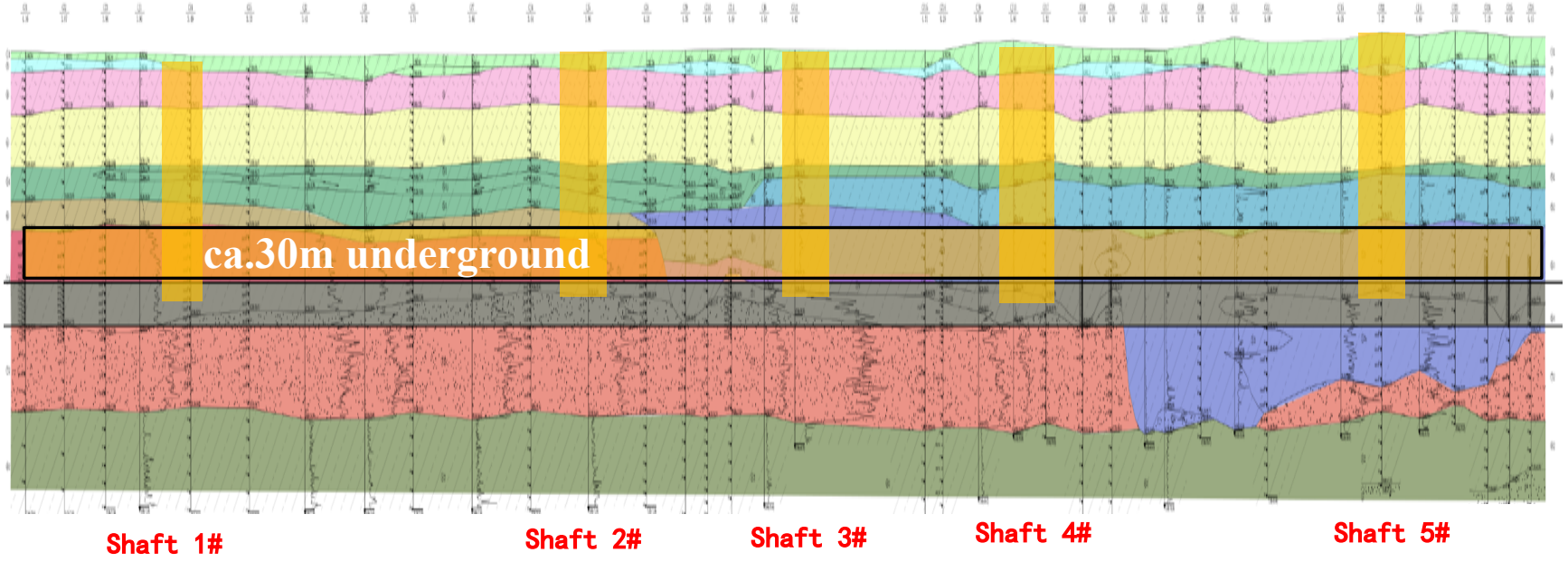
A high-rep rate XFEL based on SCRF



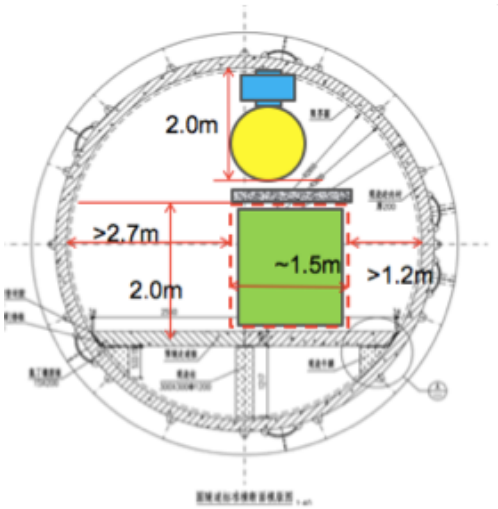


Shanghai Hard X-ray FEL Facility

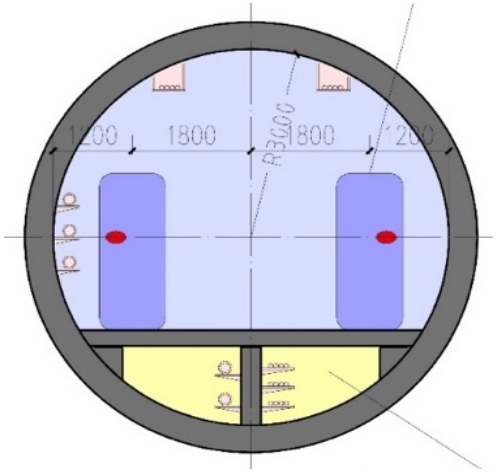




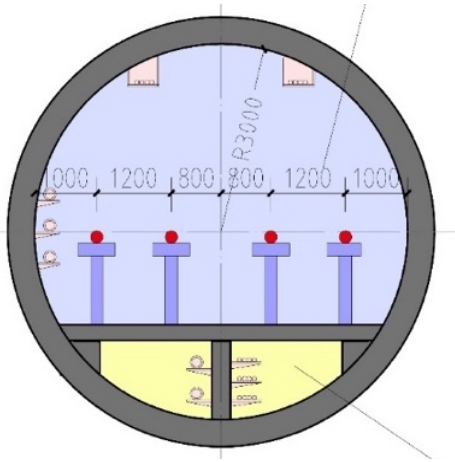
Layout of Cross Sections of the Tunnel @ Shanghai HXFEL



Linac Tunnel



Undulator Tunnels



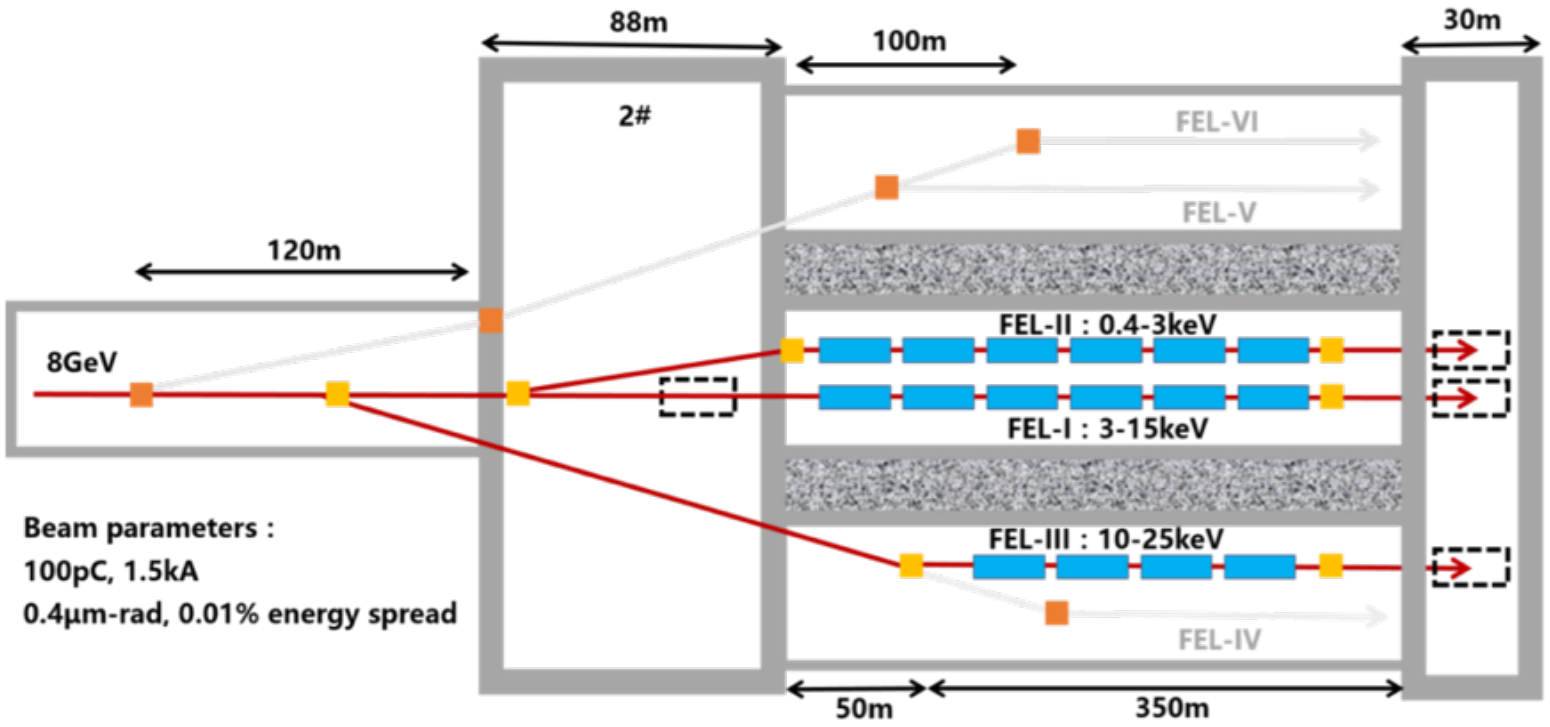
Beamline Tunnels

Layout of the Civil Constructions @ Shanghai HXFEL

Main Parameters of Shanghai HXFEL

	Nominal	Range	Unit
Beam energy	8	4-8.6	GeV
Bunch charge	100	10-300	pC
Max repetition rate	< 1	up to 1	MHz
Electron beam power	0.8	0 - 2.4	MW
Photon energy	0.4-25	0.4-25	keV
Pulse length	20-50	5-200	fs
Peak brightness	5×10^{32}	1×10^{31}-1×10^{33}	Photons/μm²/rad²/s/0.1%BW
Average brightness	5×10^{25}	1×10^{23}-1×10^{26}	Photons/μm²/rad²/s/0.1%BW
Total facility length	3.1	3.1	km
Total tunnel length	5.7	5.7	km
Tunnel diameter	5.9	5.9	m
2K Cryogenic power	12	12	kW
RF Power	2.28	3.6	MW

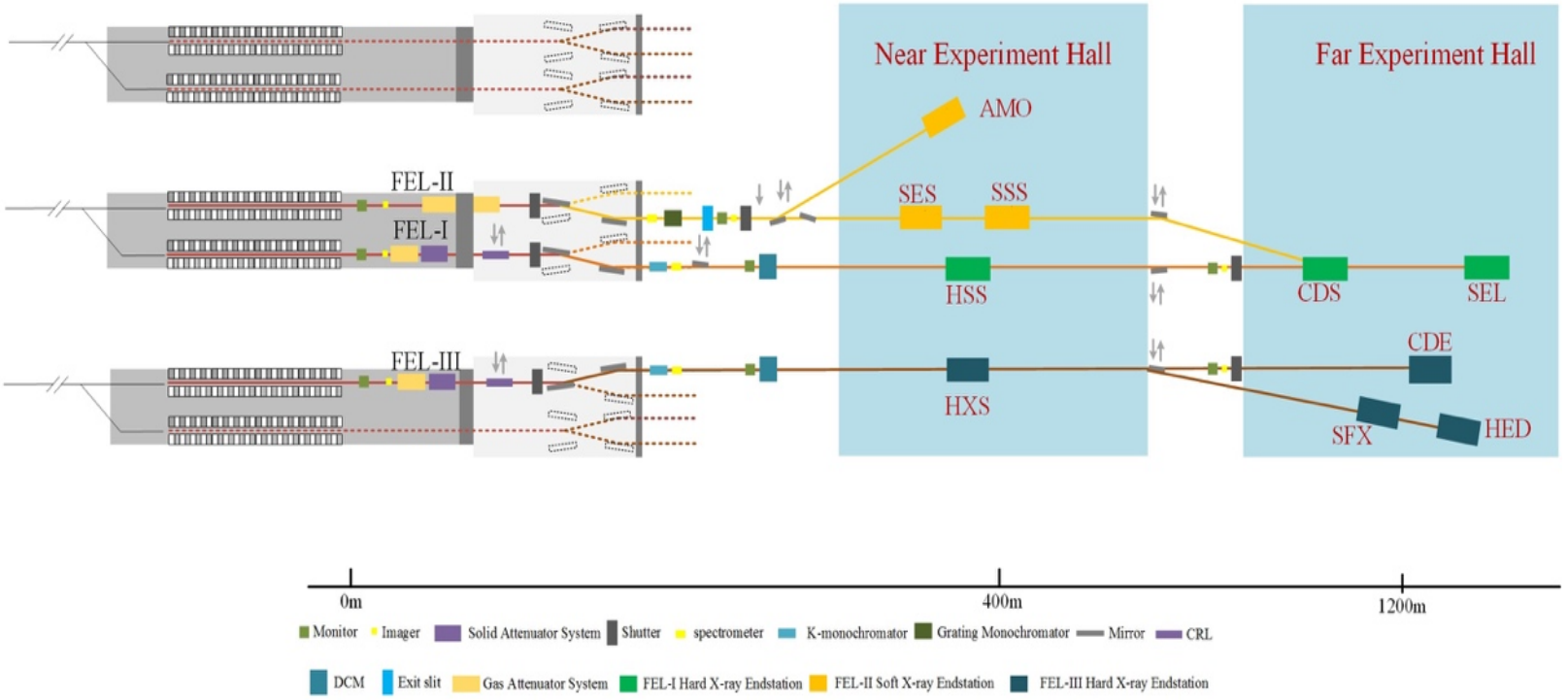
Layout of Beam Distribution and FEL Systems of Shanghai HXFEL



Main FEL Parameters of Shanghai HXFEL

	Nominal	Objective	Unit
FEL-I			
Photon energy	3-15	3-15	keV
Photon number per pulse @12.4keV	$>10^{10}$	$>10^{11}$	
Max pulse repetition rate	0.66	1	MHz
FEL-II			
Photon energy	0.4-3	0.4-3	keV
Photon number per pulse @1.24keV	$>10^{12}$	$>10^{13}$	
Max pulse repetition rate	0.66	1	MHz
FEL-III			
Photon energy	10-25	10-25	keV
Photon number per pulse @15keV	$>10^{9}$	$>10^{10}$	
Max pulse repetition rate	0.66	1	MHz

Layout of Beamlines @ Shanghai HXFEL



10 End-Stations @ Shanghai HXFEL

FEL-I Hard X-ray Endstation

- **HSS:** Hard X-ray Scattering Spectrometer
- **CDS:** Coherent diffraction end-station for single particle and biomolecules
- **SEL:** Station of Extreme Light
  - **XFEL Facility +100 PW Laser Facility**

FEL-II Soft X-ray Endstation

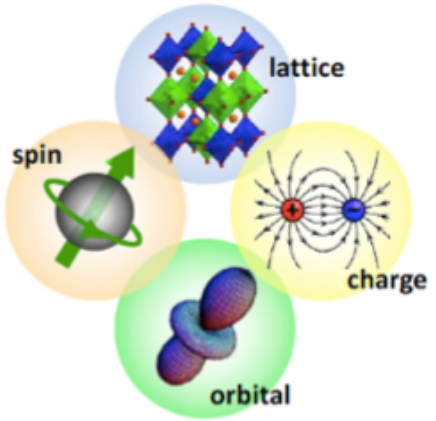
- **AMO:** atomic, molecular, and optical physics
- **SES:** Spectrometer for Electronic Structure
- **SSS:** Soft X-ray Scattering Spectrometer

FEL-III Hard X-ray Endstation

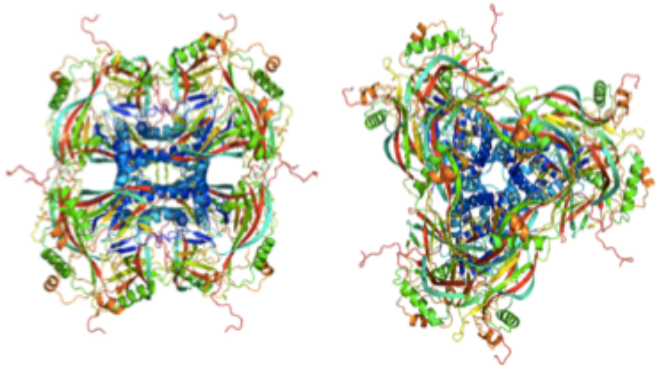
- **HXS:** Hard X-ray Spectroscopy
- **SFX:** Serial Femtosecond Crystallography Endstation
- **CDE:** Coherent Diffraction End-station
- **HED:** High Energy Density Science

To Explore Science Opportunities

- ***Fundamental Dynamics of Energy & Charge in Atoms & Molecules***
- ***Catalysis, Photo-catalysis, Environmental Chemistry***
- ***Quantum Materials***
- ***Nanoscale Heterogeneity***
- ***Materials Dynamics, Energy Transport, and Phase Transitions at the Nanoscale***
- ***Matter in Extreme Environments***
- ***Dynamics of Biological Complexes &Molecular Machines***
- ***Dynamics, Structure & Function of Biological Assemblies in near-native environments***
- ***Vacuum birefringence in strong-field QED***
- ***…***



Strongly coupled spin, orbital, lattice, and charge degrees of freedom in quantum materials.

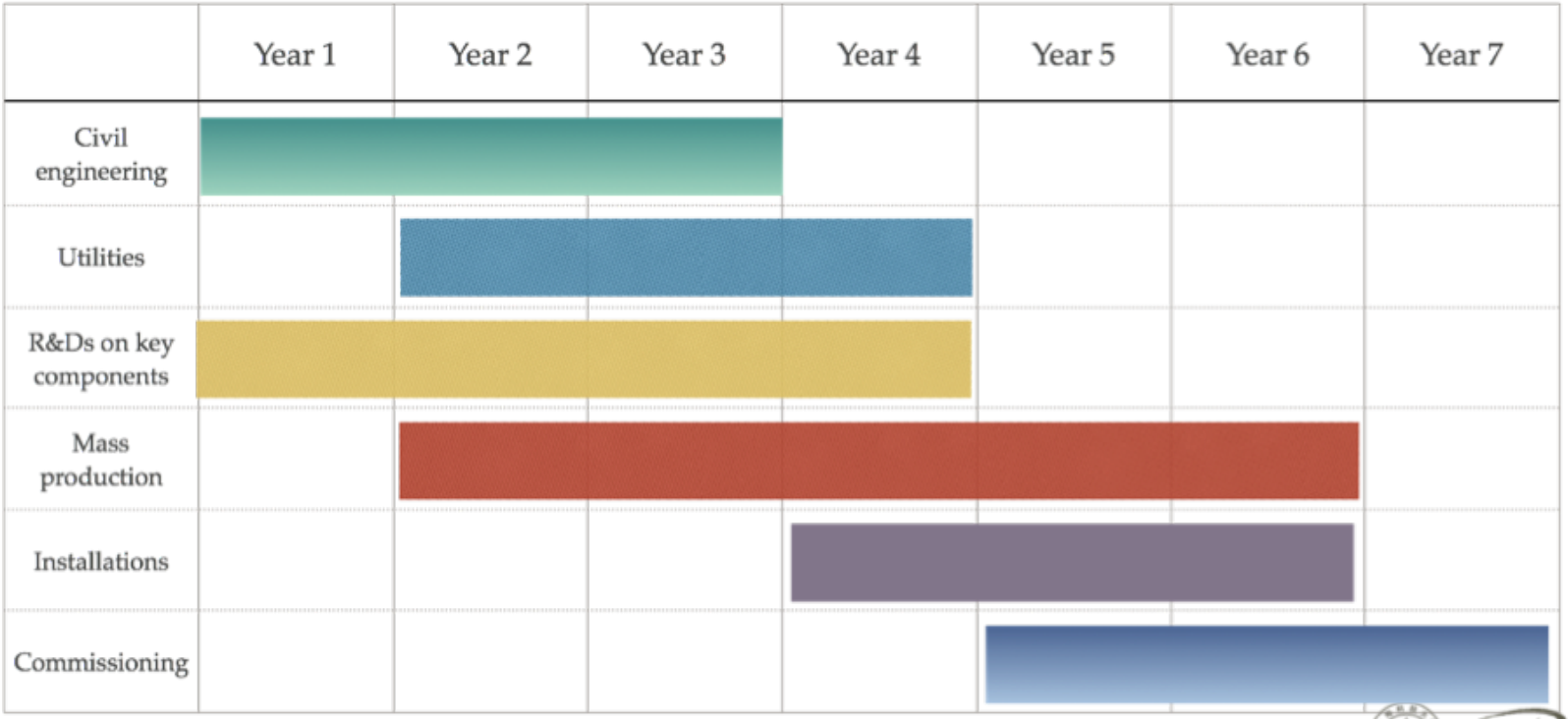


"Watch" the dynamic structure of protein

Estimated Cost of Shanghai HXFEL Facility

Item	Cost (US$)
Total Cost	~1.3B

Preliminary Schedules for Construction



Summary

- Shanghai Hard X-ray FEL Facility is based on an 8 GeV CW SCRF linac, its repetition-rate could be up to 1MHz.. It contains 3 FEL undulator lines with energy 0.4-25keV and 3 beamlines as well as 10 end-stations. It will be located at the ZhangJiang Science Park. The major facility will be installed in the tunnels at the depth of ~30m underground and with a total length of 3.1 km.
- This project is an important core content of Zhang-Jiang Science Park. It gets fully support from the center government in Beijing and the city Shanghai as well as the Chinese Academy of Sciences.
- This project has been approved by Chinese Center Government at the end of November, 2017.
- The construction of Shanghai Hard X-ray FEL Facility has been entrusted to ShanghaiTech Univerisity, Shanghai Institute of Applied Physics, CAS and Shanghai Institute of Optics and Fine Mechanics, CAS.

Thank you for your attention

谢谢！