Survey and Alignment Design for the Shenzhen Superconducting Soft-X-ray Free Electron Laser

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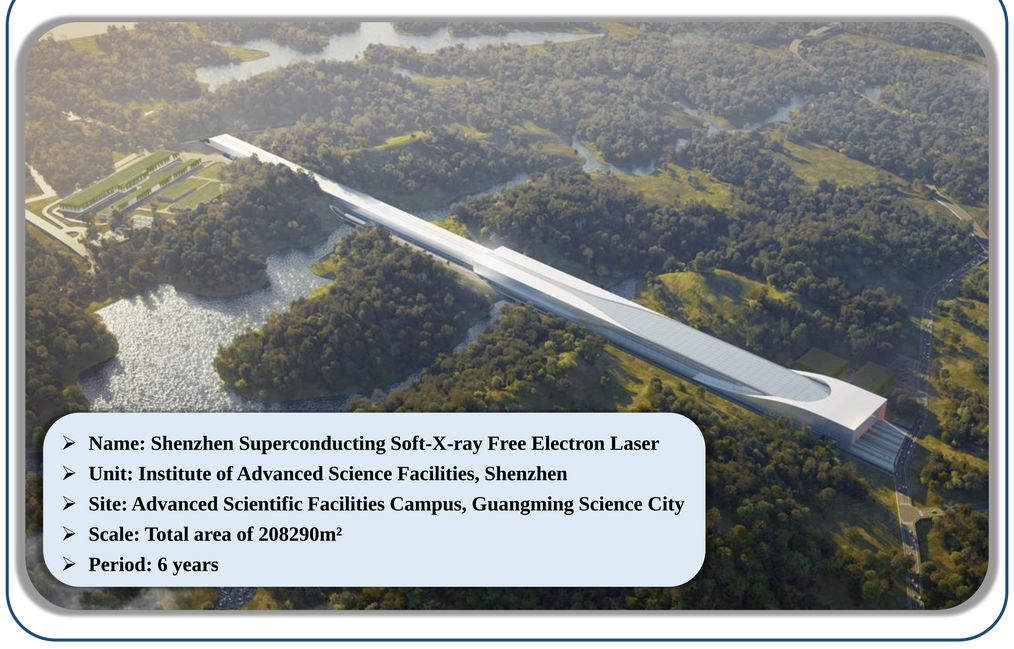
The objective of the Shenzhen Superconducting Soft-X-ray Free Electron Laser (S³FEL) is to develop a free electron laser source utilizing a superconducting linear accelerator operating at an electron energy of 2.5GeV. The facility has a length of approximately 1.8km and features a wavelength range of 1 to 30nm for its Free Electron Laser, aimed at advancing cutting-edge scientific research and development. High-precision control network data is essential as a reference benchmark for aligning the S³FEL components installed in four main areas: Linac, LTU, undulator, beamline and experimental station (BL & ES). This ensures smooth particle trajectories and the generation of high-quality beams. This poster focuses on the design indicators for alignment accuracy, control network types, measurement schemes, data processing methods, and accuracy evaluation of key components within S³FEL.

➢ Project Introduction

A: Overview

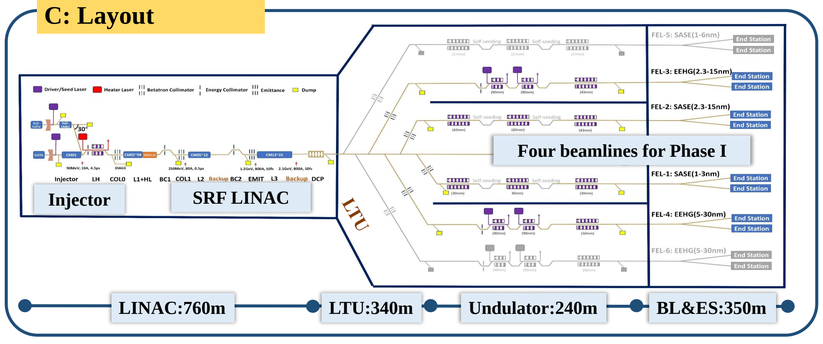


- Name: Shenzhen Superconducting Soft-X-ray Free Electron Laser
- Unit: Institute of Advanced Science Facilities, Shenzhen
- Site: Advanced Scientific Facilities Campus, Guangming Science City
- Scale: Total area of 208290m²
- Period: 6 years

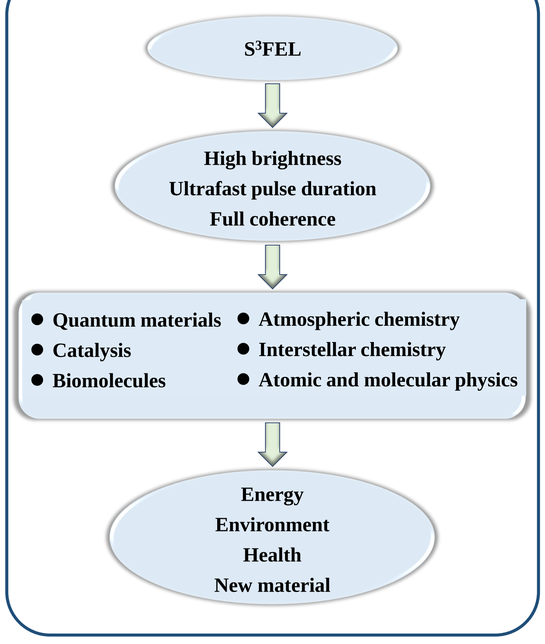
B: Parameters

Parameter	Design	Range	Unit
Energy	2.5	1.0-2.5	GeV
Charge	100	10-300	pC
Emittance	0.5	0.2-1.0	mm·mrad
Wavelength	1-30	1-180	nm
Rep. Rate	1	0-1	MHz

C: Layout



D: Significance

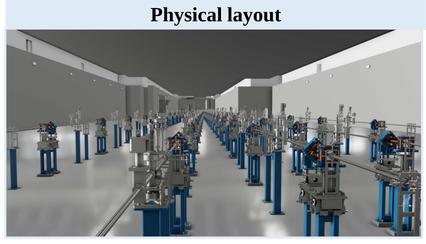


➢ Control Network Design

Influencing Factors

Terrain conditions

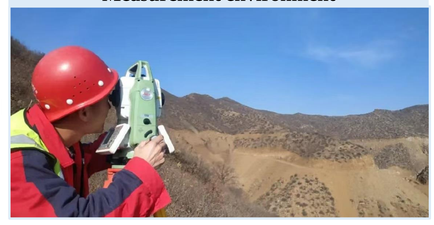
Physical layout



Accuracy requirements

Area	Component	Relative position accuracy/mm			Absolut position accuracy/mm		Angle/mrad		
		△X	△Y	△Z	△X	△Z	Roll	Pitch	Yaw
Linac	Cryomodule	0.5	2	0.5	2	2	2	0.05	0.05
	Quadrupole magnet	0.1	0.5	0.1	2	2	1	5	5
	Dipole magnet	0.1	0.1	0.1	2	2	1	5	5
	Kicker	0.1	0.1	0.1	1	1	1	1	1
	Analysis magnet	0.1	0.5	0.1	1	1	5	5	5
Undulator	Undulator	0.1	0.5	0.1	0.25	0.25	1	0.1	0.1
	Phase shifter	0.1	0.5	0.1	0.25	0.25	1	1	1
	Quadrupole magnet	0.1	0.5	0.1	0.25	0.25	1	5	5
BL & ES	All beamline stations	0.1	0.5	0.1	0.5	0.5	1	0.1	0.1

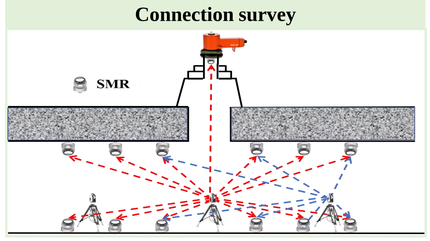
Measurement environment



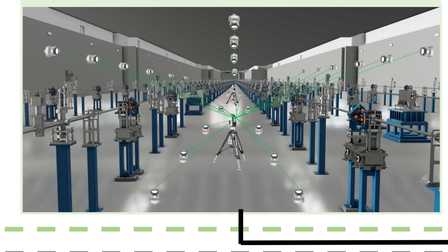
Control Network Types

Surface control network

Connection survey



Tunnel control network



Measurement Scheme

A: On-site Measurement

GNSS: Static Observation

Contrast

Total station: Multiple Rounds Measurement

Levels: Elevation Measurement

B: Measurement Adjustment

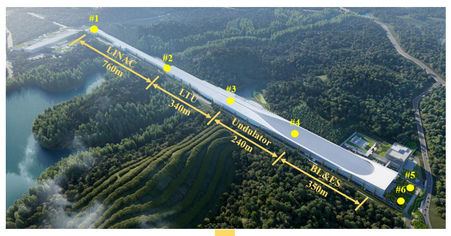
- Leica Infinity
- COSA_GPS
- VECTOR
- COSA_CODAPS
- COSA_LEVEL

C: Connection Survey

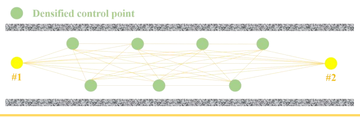
Transit Square/Optical Plummet: Forced Centering

Coordinate Transfer

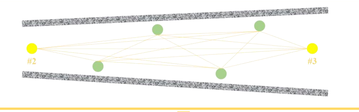
D: Densified Control Network



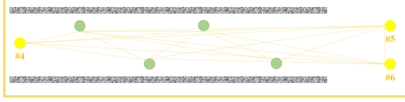
LINAC



LTU



BL&ES



Constrained Adjustment

E: USMN