SHINE

IWAA2024

Recent progress of alignment for the SHINE project

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Introduction

- The Shanghai HIgh repetition rate XFEL aNd Extreme light facility (SHINE) is a new continuous-wave (CW) hard X-ray free electron laser (FEL) currently under construction in China
- The Tasks and Objectives of alignment include control network measuring 、components alignment and Monitoring deformation
- Primary control network 、 Expanded control network and Sencond control network was measured to ensure the accuracy of the SHINE components
- Hydrostatic Leveling System(HLS): Monitoring the deformation in elevation direction of Linac and undulator tunnels
- Vacuum Laser Alignment System(VLAS): Monitoring the deformation in the lateral and elevation directions of the undulator tunnel
- Wire Postion Monitor(WPM): Monitoring the deformation of superconducting cavities and quadrupole in cryogenic environments

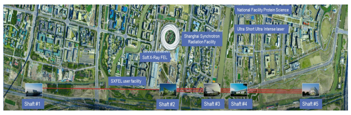
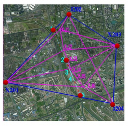


FIG. The layout of the SHINE

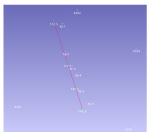
TABLE1. The accuracy of the SHINE accelerator components

	Component	Relative accuracy/mm(rms)			Absolute accuracy/mm		Angle error/mrad		
		ΔX	ΔY	ΔZ	ΔX	ΔZ	Roll	Pitch	Yaw
Linac 1400m	Cryomodule	0.3	2	0.3	2	2	2	0.05	0.05
	Quadrupole	0.1	0.5	0.1	2	2	1	5	5
	Dipole	0.1	0.1	0.1	2	2	1	5	5
	Kicker	0.1	0.1	0.1	1	1	1	1	1
Undulator 400m	Undulator	0.1	0.5	0.1	0.25	0.25	1	0.1	0.1
	SC 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	0.1	0.5	0.1	0.25	0.25	1	5	5
The whole facility <3mm/3km									



Shanghai urban coordinate system

	North/mm	East/mm
XJ-1	-3817726	10420165
XJ-2	-4702497	10578462
XJ-3	-5160705	10811064
XJ-4	-5359020	11005645
XJ-5	-5868395	11136993
XJ-6	-6253378	11461375
X201	-6485638	9130025
X202	-3345621	10869832
X203	-4485851	12835801
X204	-7017341	12706506
T12_S	-3749661	10127612
T12_E	-5083157	10644030
T45_S	-5803991	10923185
T45_E	-6512702	11197645



Civil engineering primary control network :XJ1-XJ6 、X201-X204
The coordinates were provided by Shanghai surveying and mapping institute
Tunnel central axis:T12_S、T12_E、T45_S、T45_E
The coordinates were provided by architectural design institute

FIG. Civil engineering primary control network of the SHINE

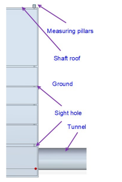
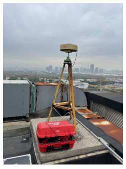
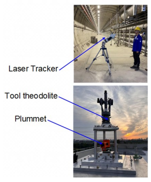
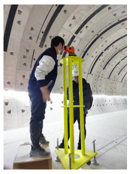


FIG. Visibility requirement of the shaft

Control network measurement







平差坐标及其精度

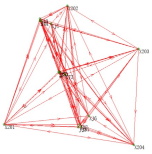
Name	X(m)	Y(m)	MX(cm)	MY(cm)	MP(cm)	E(cm)	F(cm)	T(dms)
S1	0.0000	0.0000						
S8	1402.5228	0.0000						
S4	603.2640	-0.7977	0.035	0.038	0.052	0.038	0.035	90.1222
S5	801.5880	0.7712	0.035	0.038	0.052	0.038	0.035	90.1312
S2	200.7053	-1.2533	0.036	0.031	0.048	0.036	0.031	179.2336
S3	398.9952	0.3477	0.036	0.036	0.050	0.036	0.036	89.0607
S6	999.8811	-0.3907	0.035	0.036	0.050	0.036	0.035	89.5147
S7	1198.1312	1.1595	0.035	0.030	0.047	0.035	0.030	179.4533
S9	1426.5655	1.3812	0.063	0.009	0.063	0.063	0.008	3.3520

Mx均值: 0.04　My均值: 0.03　Mp均值: 0.05

最弱点及其精度

Name	X(m)	Y(m)	MX(cm)	MY(cm)	MP(cm)	E(cm)	F(cm)	T(dms)
S9	1426.5655	1.3812	0.063	0.009	0.063	0.063	0.008	3.3520

FIG. Totla station measurement and calculation of the expanded control network



平差坐标(X,Y)

No.	Name	X(m)	Y(m)	Mx(cm)	My(cm)	Mp(cm)
1	X202	-3345.6210	10869.8320			
2	J1W	-3748.5059	10127.7919	0.10	0.09	0.13
3	J21	-5087.7863	10663.4769	0.13	0.12	0.17
4	J22	-5169.9611	10664.9724	0.15	0.14	0.21
5	J23	-5091.6080	10629.5525	0.17	0.15	0.23
6	J51	-6503.6531	11219.1081	0.11	0.10	0.15
7	J52	-6581.1115	11238.4341	0.11	0.10	0.15
8	J53	-6570.5916	11191.1721	0.13	0.12	0.18
9	X201	-6485.6215	9130.0367	0.10	0.10	0.14
10	X203	-4485.8302	12835.7831	0.10	0.10	0.14
11	X204	-7017.3133	12706.4922	0.11	0.10	0.15
12	XJ3	-5160.6848	10811.0674	0.10	0.09	0.14

最弱点

No.	Name	MX(cm)	MY(cm)	MP(cm)
5	J23	0.17	0.15	0.23

FIG. GNSS measurement and calculation of the primary control network

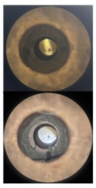
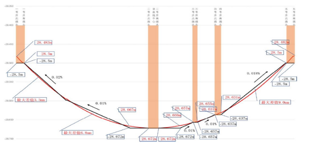


FIG. Projection of the primary control network



Point	Distance/m	Theoretical/mm	Measured/mm	Deviation/mm
S1	0	159.41	158.7	0.71
S2	200	117.83	125.1	-7.27
S3	399	82.68	90	-7.32
S4	603	53.10	55.5	-2.40
S5	801	30.62	34.2	-3.58
S6	1000	14.23	12.2	2.03
S7	1198	4.08	0.3	3.78
S8	1402	0.05	-8.7	8.75
S9	1426	0.00	0	0.00

FIG. Civil construction and elevation measurement results of the linac tunnel

Monitoring deformation

Hydrostatic Leveling System

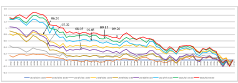


FIG. HLS results of the linac tunnel

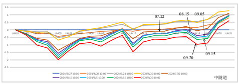


FIG. HLS results of the undulator tunnel

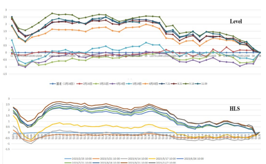


FIG. The Comparison of HLS and Level Results in the linac tunnel

Vacuum Laser Alignment System

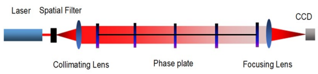


FIG. The principle of vacuum laser alignment system

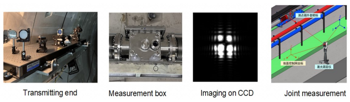


FIG. The on-site photos of vacuum laser alignment system

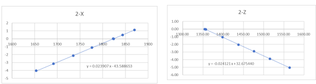


FIG. Calibration results of 2# measuring point box

Wire Postion Monitor

FIG. The WPM on-site installation

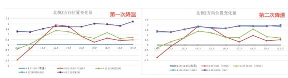


FIG. WPM results of twice cooling

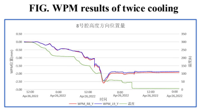


FIG.The Cavity deformation during cooling process

Installation

FIG. Injector tunnel

FIG. Linac tunnel

CONCLUSIONS AND OUTLOOKS

- The facility coordinate system of the SHINE has been established, and the three-dimensional coordinates of five primary control network points have been obtained.
- The installation of components is fully underway, including linac and undulators, and the injector has been installed.
- Three sets of online deformation monitoring systems have been developed.
- SHINE is aiming at the first lasing in 2025.