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Accurate alignment of stretched-wire system in single magnet block and undulator of HEPS

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Outline

- Introduction
- Alignment of stretched-wire system in single magnet block and undulator of HEPS
- Magnetic field measurement activities in HEPS

Aerial view of HEPS

High Energy Photon Source(HEPS) is a new 6 GeV synchrotron radiation light source under construction(2019-2025).

View of HEPS under construction

The status of Insertion Devices

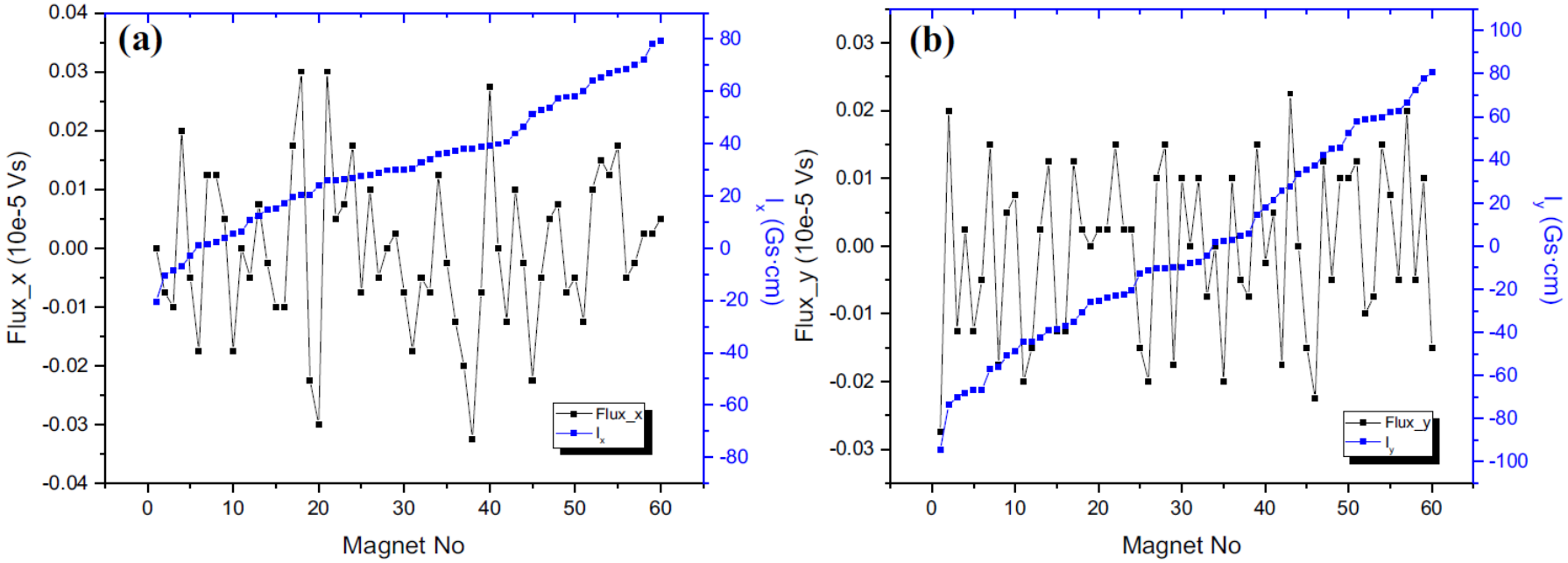
6 types of 19 Insertion Devices(ID) in total. (4 IAUs, 2 Wigglers，6 CPMUs, 5 IVUs ,1 AK and 1 Mango Wiggler).

BL No.	Beamline	SS No.	ID Type	Length [m]	ID No.	Period Length [mm]	B0[T]	Gap Range [mm]	Min. Phase Error RMS [Degree]	Photon Energy [keV]	β
B1(A)	Engineering Materials Beamline	ID07	CPMU	2	1	16.7	1.19	5.2-10	3	50-170	Low
B1(B)			CPMU	2	1	16.7	1.19	5.2-10	3		
B2	Hard X-ray Nanoprobe Multimodal Imaging Beamline	ID19	IVU(SmCo)	4	1	22.6	1.1	5.2-15.2	3	4.8-40	Low
B3(A)	Structural Dynamics Beamline	ID23	CPMU	2	1	12	0.81	5.2-7.0	4	20.9-24, 62.7-72	Low
B3(B)			CPMU	2	1	14.2	1.00	5.2-9.9	4	14.4-20.9, 43-62.7	
B4	Hard X-ray Coherent Scattering Beamline	ID09	IVU(SmCo)	4	1	19.9	0.97	5.2-14.0	3	7.33-13.34, 22-40	Low
B5	Hard X-Ray High Energy Resolution Spectroscopy Beamline	ID33	IVU(NdFeB)	4	1	18.6	1.04	5.2-13.0	4	7.1-16.88, 21.3-25	Low
B6	High Pressure Beamline	ID31	IVU(SmCo)	4	1	19.9	0.97	5.2-8.0	3	20-50	Low
B7(A)	Hard X-Ray Imaging Beamline	ID21	CPMU	2	1	18.8	1.35	5.2-13.1	3	10-90	Low
B7(B)			Wiggler	1	1	73	1.64	11	--	40-300	
B7-C			Mango Wiggler	1	1	50.7/50.0	1	11			
B8	X-ray Absorption Spectroscopy Beamline	ID46	IAU	5	1	35	0.88	11-24.5	4	4.8-45	High
B9	Low-Dimension Structure Probe Beamline	ID05	IVU(SmCo)	4	1	22.6	1.1	5.2-15.2	3	4.8-40	Low
BA	Microfocussing X-Ray Protein Crystallography Beamline	ID02	IAU	5	1	32.7	0.8	11-22.8	4	5-18	High
BB	Pink Beam SAXS Beamline	ID08	IAU	5	1	25	0.54	11.2-17.5	6	8-12, 24-33	High
BC	High Resolution Nanoscale Electronic Structure Spectroscopy Beamline	ID45	APPLE-KNOT	5	1	256.8		11	5	0.2-2	Low
BE	Transmission X-Ray Microscopy Beamline	ID30	IAU	5	1	32.7	0.8	11-21.2	4	5-15	High
BF(A)	Test Beamline	ID42	CPMU	2	1	22.8	1.18	7.2-16.0	3	10-90	High
BF(B)			Wiggler	1	1	73	1.64	11	--	40-300	

19 Insertion Devices of HEPS I

Magnet sorting study

The magnet sorting is a standard step in the undulator fabrication procedure. The idea is based on the superposition principle of the magnet field.

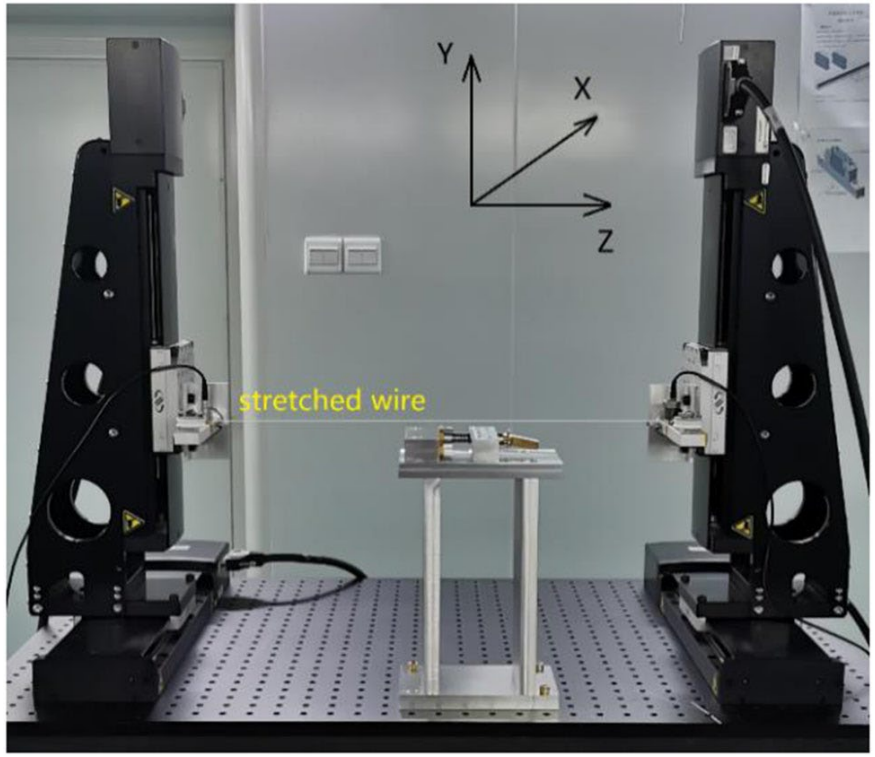


Comparison between the Helmholtz coil measurement for the magnetization and the first field integral measured by the stretched wire

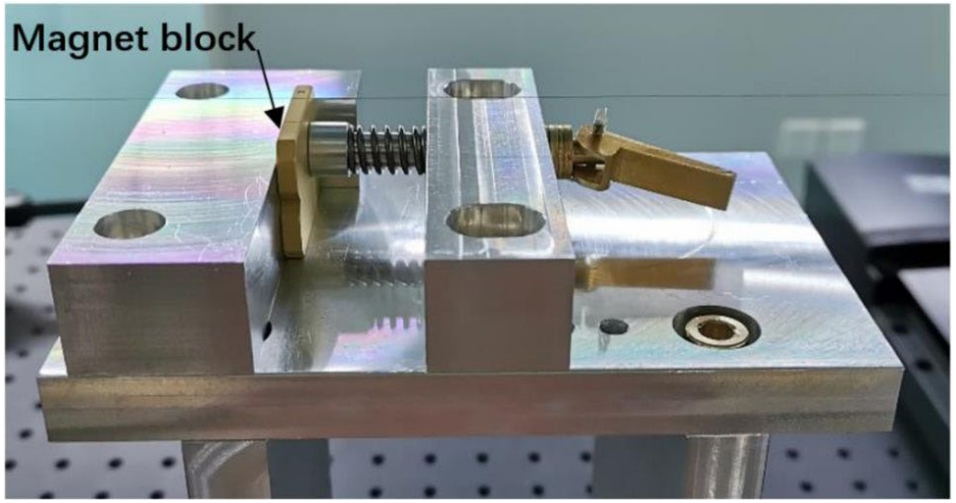
Stretched-wire is a better choice for the magnet sorting.

Magnet block measured by Stretched-wire system

- The magnet block must be put in the middle of the wire
- The wire and loop must be long enough to contain all divergent magnetic field



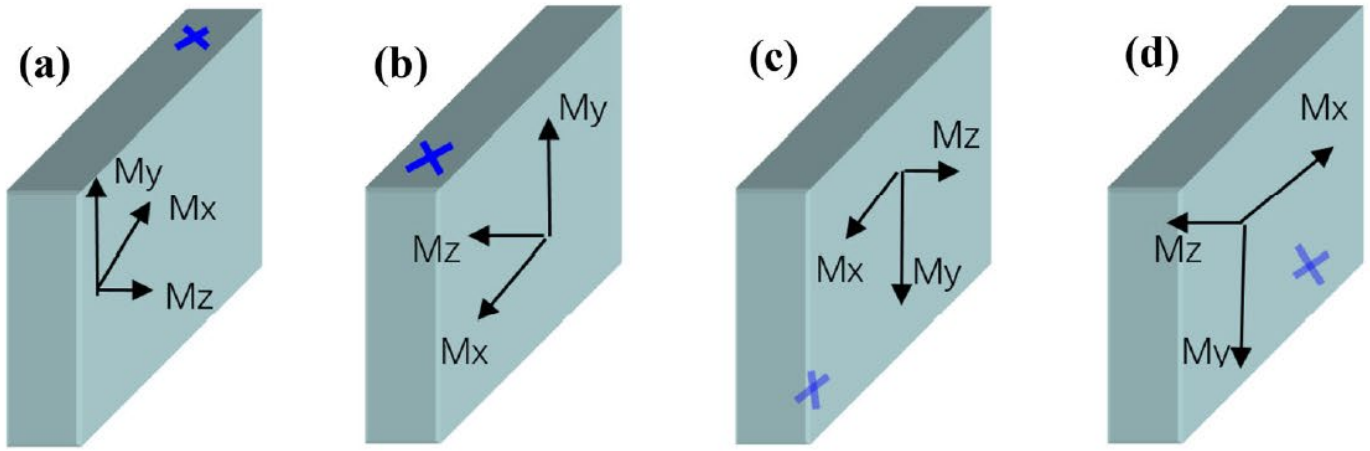
Stretched-wire system

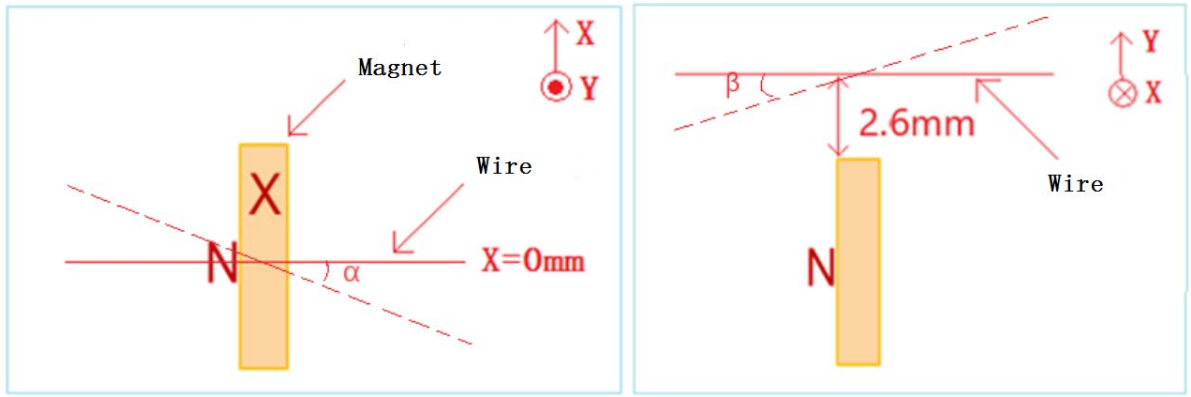


Magnet block platform

Alignment of Stretched-wire system in single magnet block

Different rotation statuses of a single magnet block. **a** the "normal" status; **b** the "reverse" status; **c** the "flip" status; and **d** the "flip" + "reverse" status





Angle deviation between wire and magnet

$$\Delta Iz_x = \frac{I_{x,normal} + I_{x,flip}}{2} = -\frac{I_{x,reverse} + I_{x,reverse+flip}}{2}$$

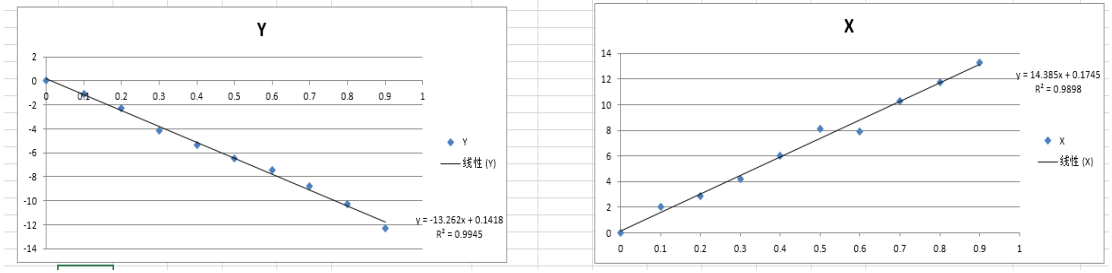
$$\Delta Iz_y = \frac{I_{y,normal} - I_{y,reverse}}{2} = \frac{I_{y,flip} - I_{x,reverse+flip}}{2}$$

adjustment principle by 1st integral of X and Y

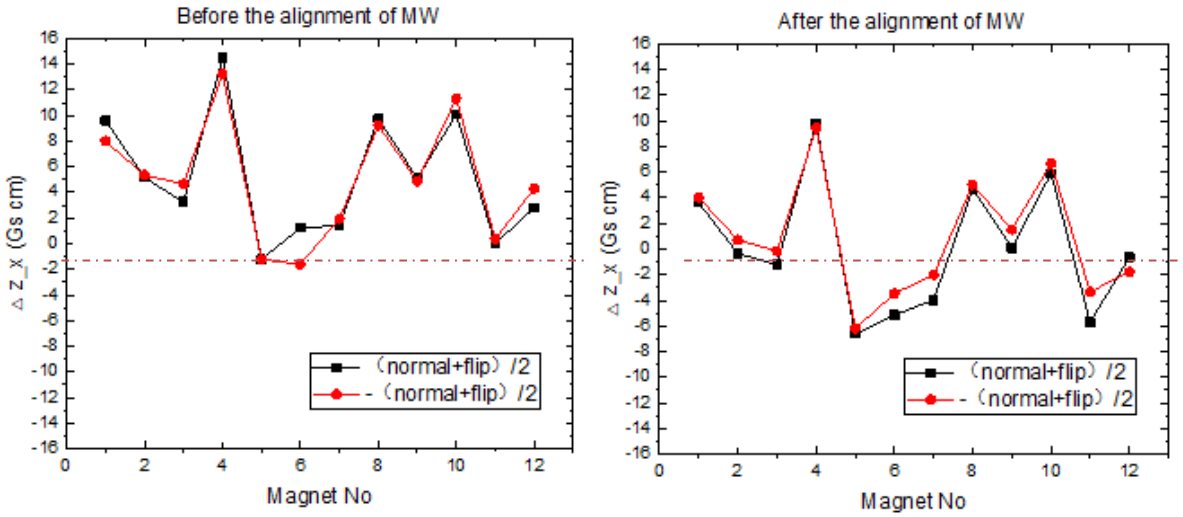
Alignment of Stretched-wire system in single magnet block

- The 1st integral of each 0.1mm change of the two stages must be measured
- Calculate the stage movement by principle
- adjust the average value to 0Gscm

测量序号	Y(mm)	Yr(mm)	X(mm)	Xr(mm)	IY(Gscm)	△Y（mm）（L+0.1R-0.1）	△IY(Gscm)	测量序号	Y(mm)	Yr(mm)	X(mm)	Xr(mm)	IX(Gscm)	△X（mm）（L+0.1R-0.1）	△IX(Gscm)
1	70.509	67.631	-11.99	-14.31	24.33	0	0	11	70.509	67.631	-11.99	-14.31	63.22	0	0
2	70.609	67.531	-11.99	-14.31	23.24	0.1	-1.09	12	70.509	67.631	-11.89	-14.41	65.25	0.1	2.03
3	70.709	67.431	-11.99	-14.31	22.03	0.2	-2.3	13	70.509	67.631	-11.79	-14.51	66.12	0.2	2.9
4	70.809	67.331	-11.99	-14.31	20.15	0.3	-4.18	14	70.509	67.631	-11.69	-14.61	67.44	0.3	4.22
5	70.909	67.231	-11.99	-14.31	19.01	0.4	-5.32	15	70.509	67.631	-11.59	-14.71	69.26	0.4	6.04
6	71.009	67.131	-11.99	-14.31	17.82	0.5	-6.51	16	70.509	67.631	-11.49	-14.81	71.35	0.5	8.13
7	71.109	67.031	-11.99	-14.31	16.88	0.6	-7.45	17	70.509	67.631	-11.39	-14.91	71.11	0.6	7.89
8	71.209	66.931	-11.99	-14.31	15.53	0.7	-8.8	18	70.509	67.631	-11.29	-15.01	73.48	0.7	10.26
9	71.309	66.831	-11.99	-14.31	14.06	0.8	-10.27	19	70.509	67.631	-11.19	-15.11	74.93	0.8	11.71
10	71.409	66.731	-11.99	-14.31	11.99	0.9	-12.34	20	70.509	67.631	-11.09	-15.21	76.52	0.9	13.3
调整坐标	70.417	67.723	-16.334	-9.966											



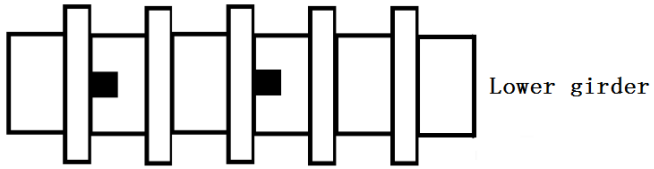
the 1st integral of each 0.1mm change of the stage



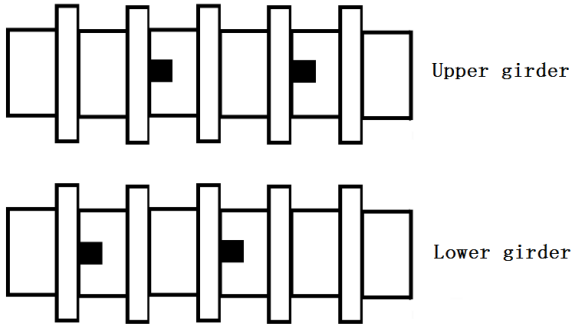
before and after adjusting angle of stretched-wire

Alignment of Stretched-wire system in undulator

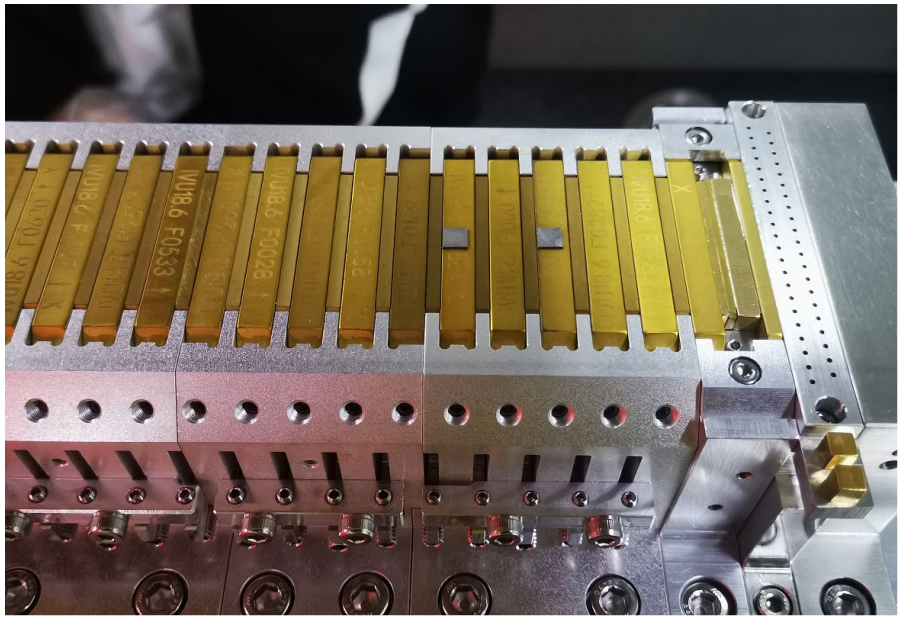
According to the magnetic center found by the Hall system, place iron sheets at the entrance and exit of the undulator respectively, compare the 1st integral changes of the Hall and Stretched-wire system before and after placing the iron sheets, and adjust the position of the entrance and exit of Stretched-wire. The consistency between the alignment of the two systems and the final measurement results is ensured.



X magnetic center patch method



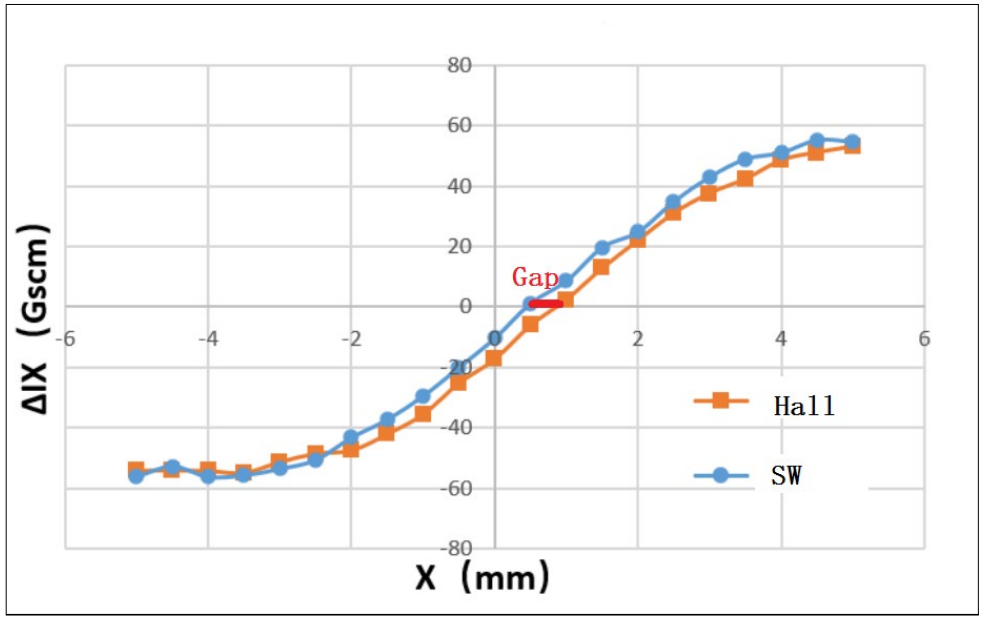
Y magnetic center patch method



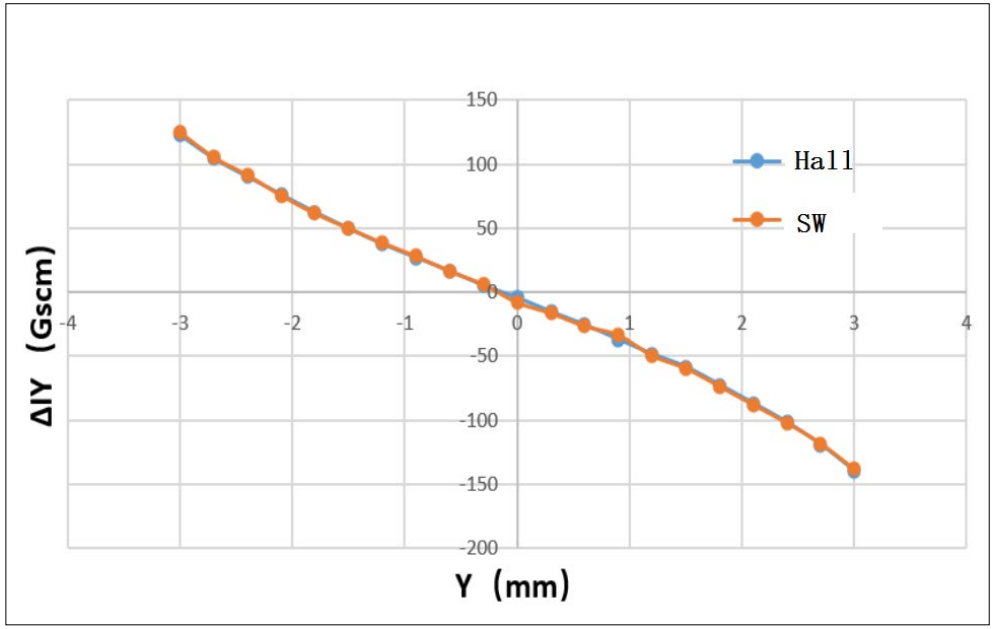
IVU18.6 alignment in-air

Alignment of Stretched-wire system in undulator

- Adjust the two XY stage positions of the entrance and exit according to the gap of the intercept on the X axis of the curve



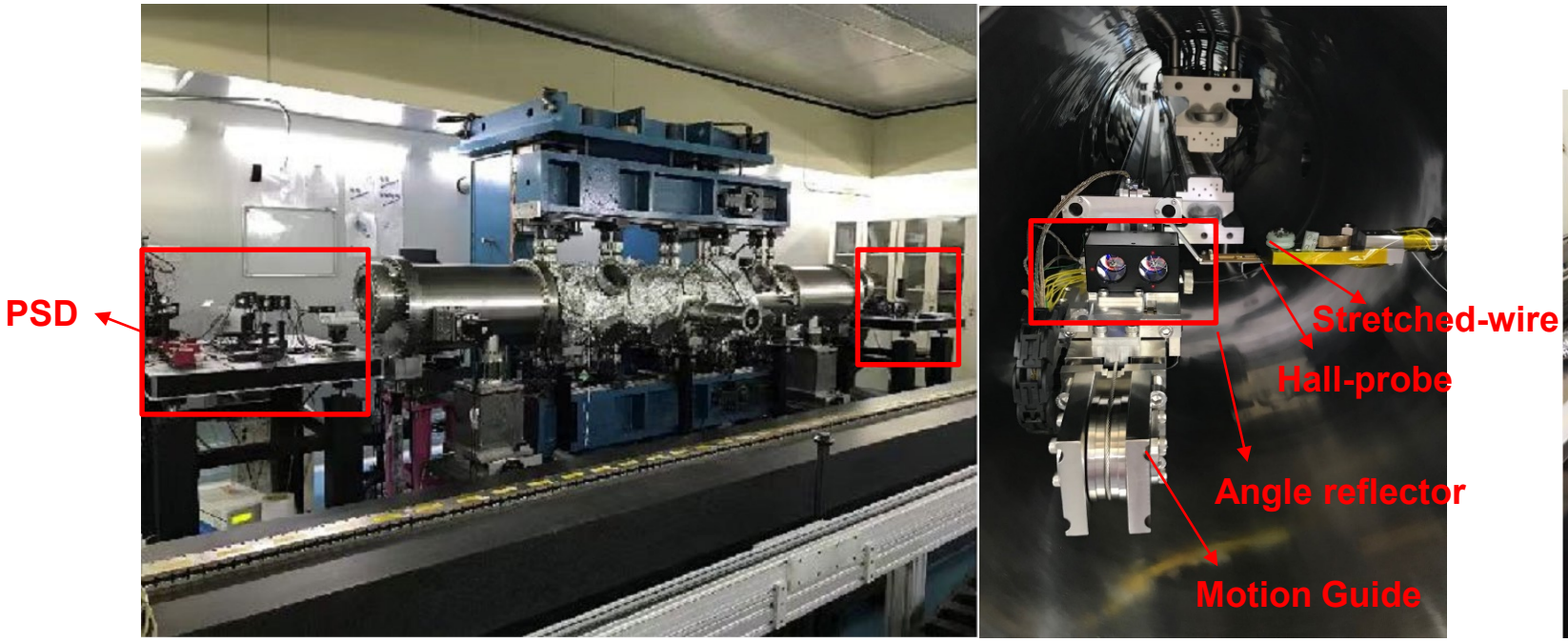
△IX Comparison of 1st integral change



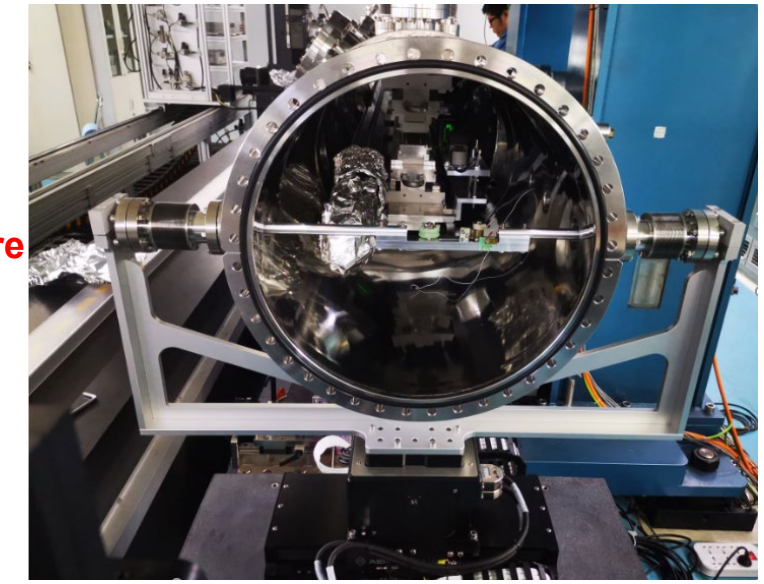
△ IY Comparison of 1st integral change

Magnetic field measurement activities in HEPS

First CPMU12 has been completed, the performances of magnetic field achieve the goal.



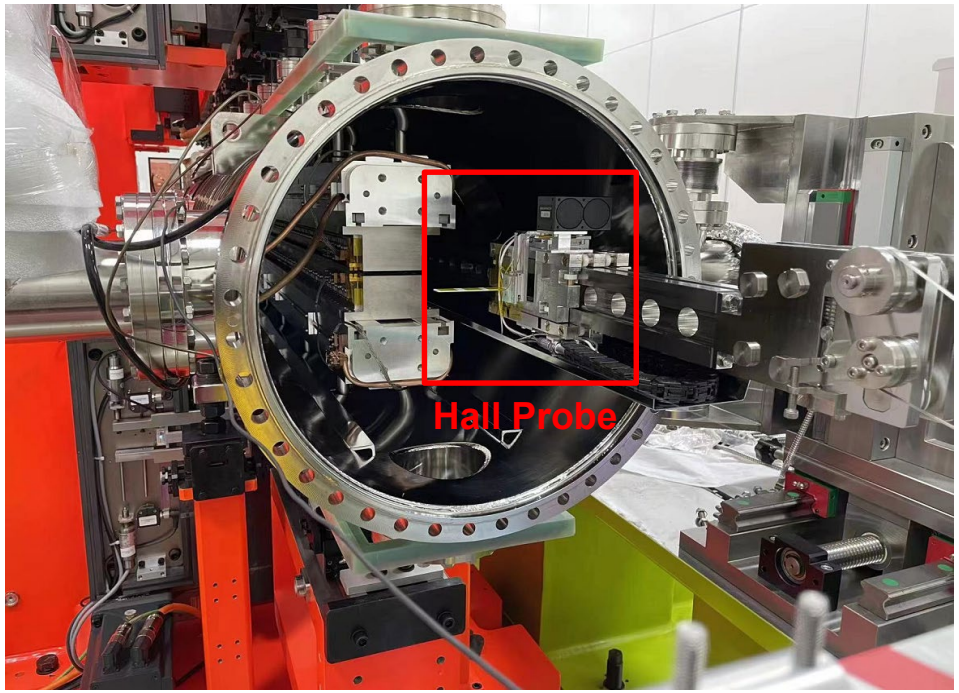
2m CPMU12 measured by 3m Hall and Stretched-wire in-vaccum

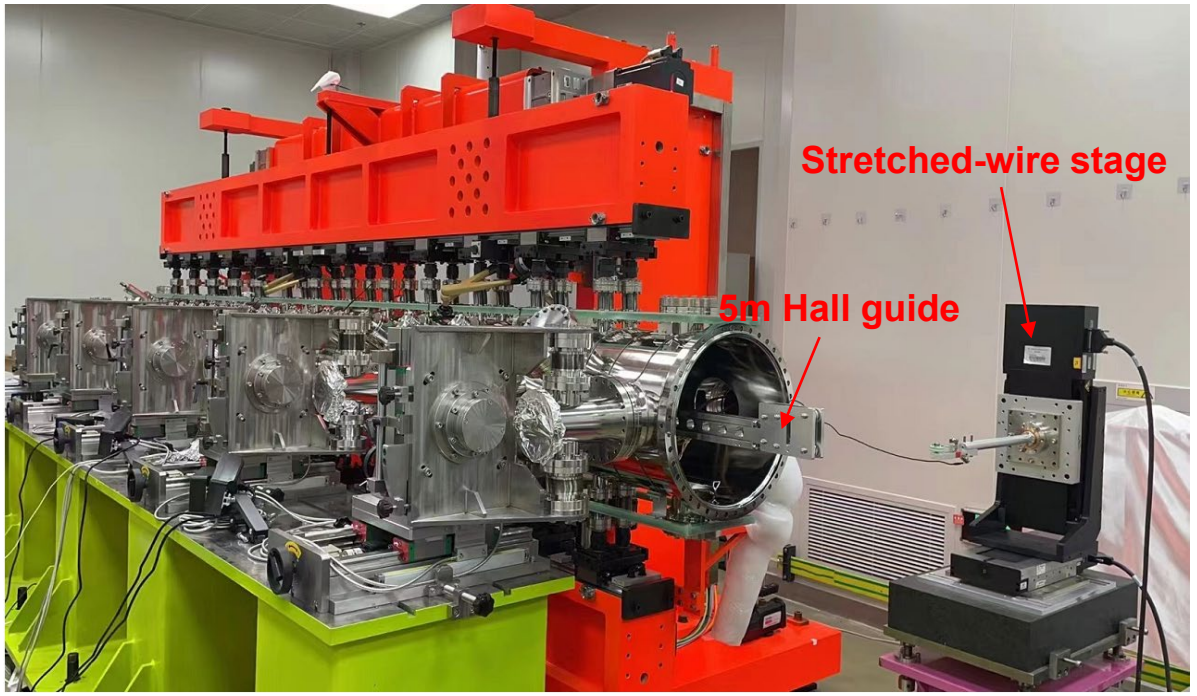


Symmetrical structure of SW

Magnetic field measurement activities in HEPS

4m IVU18.6 with vaccum chamber is in progress





Magnetic field measurement activities in HEPS

3 of 4 IAU have been finished，Only IAU25 is in progress.

5m IAU32.7 measured by 6m Hall-Bench and 6m Stretched-wire

Thanks for your attention!