The status of Insertion Devices magnetic field measurement at HEPS

ChenWan

IHEP

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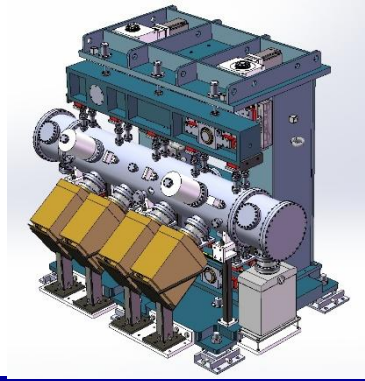
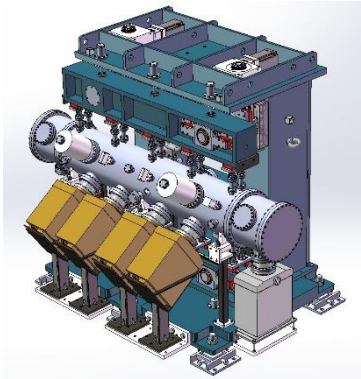


Outline

- Overview of HEPS and Insertion Devices
- Magnetic measurement laboratory for Insertion Devices
- Instruments of Insertion Devices magnetic measurement
- Summary



Overview of HEPS and ID System

HEPS introduction

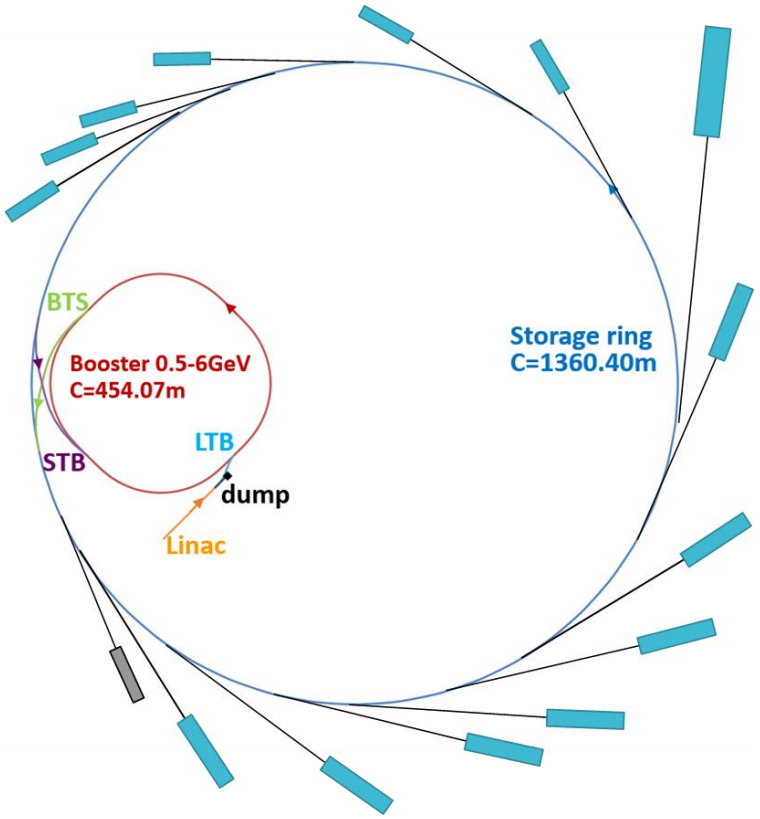
- HEPS will be the first high-energy synchrotron radiation light source in China.
- HEPS is a high-performance and high-energy synchrotron radiation light source with a beam energy of 6GeV and an ultra-low emittance of better than 60pm·rad.
- the project will be completed by the end of 2025.

Main parameters of HEPS	
Beam energy [GeV]	6
Circumference [m]	~1360
Emittance [nm.rad]	0.06
Beam current [mA]	200
Cell units	48
Injection	Top-up
Brightness [phs/s/mm^2/mrad^2/ 0.1%BW]	>10^{22}

Insertion Devices at first stage

- 14 beamlines for HEPS ,6 different types,totally 19 insertion devices

type	quantity
CPMU	6
IVU	5
IAU	4
IAW	2
AK	1
Mango	1



Main Parameters of HEPS ID Beamlines

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	ID41	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	

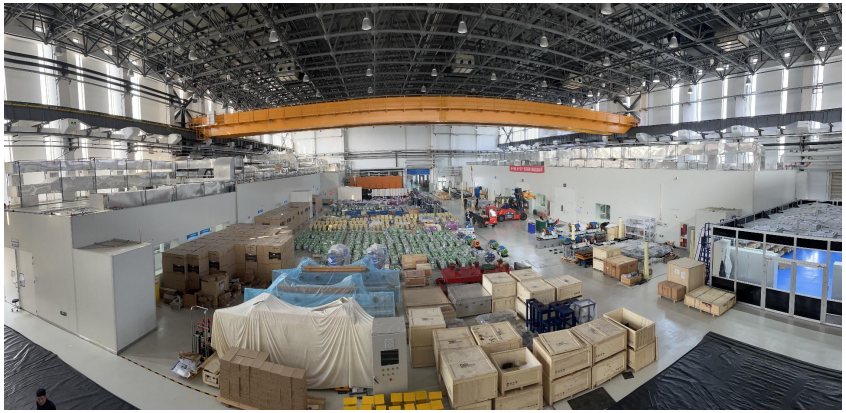
Magnetic measurement laboratory for Insertion Devices

New labs of insertion devices

- Totally 19 insertion devices,
- need to be completed in Apr.2024
- The existing lab is not big enough for accommodate the full HEPS insertion devices
- Construct new labs and new measurement systems

New labs of insertion devices

- new labs located in Magnet Technology Hall of PAPS
- PAPS(Platform of Advanced Photon Source Technology R&D) near HEPS

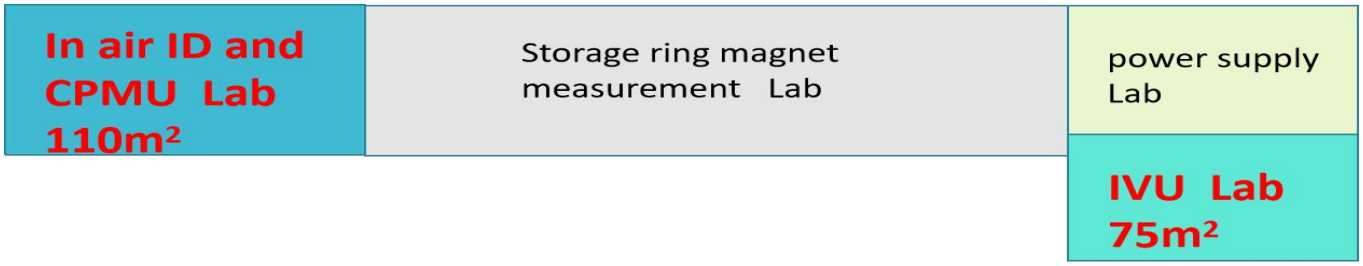


Magnet Technologgy Hall

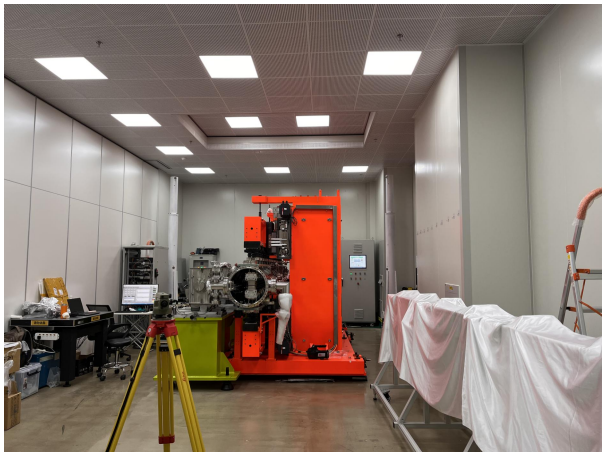
overlook of HEPS and PAPS

New labs of insertion devices

- Room with Temperature Regulation of 25C° ± 0.1C °
- the roof of the lab can be open or closed automatically



In air ID and CPMU lab



IVU lab

Magnetic measurement systems

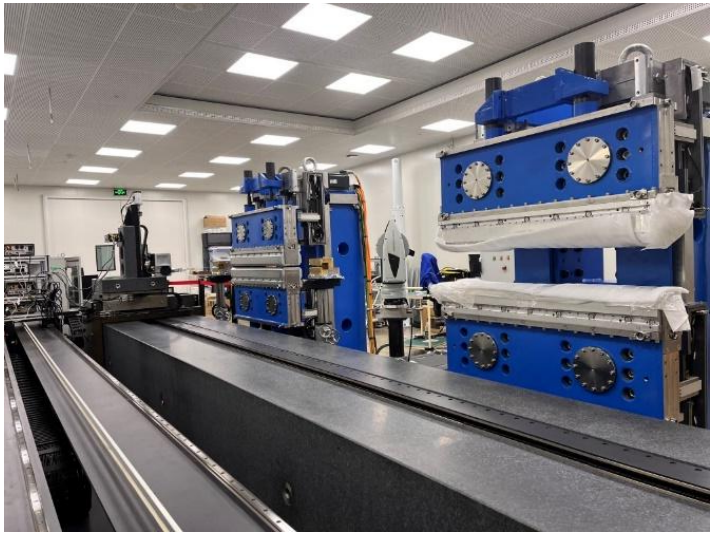
Magnetic measurement systems in used

	IAW	IAU	IVU	CPMU	AK	MANGO	system Status
1# Hall Probe bench		●		●			work
2#Hall probe bench	●	●	●	●	●		work
3m In-Situ Hall Probe measurement system				●			work
5m In vacuum Hall Probe measurement system			●				In commissioning
Lateral support Stretched Wire	●	●	●		●	●	work
Symmetrical support Stretched Wire			●	●			1 work 1Under development
Longitudinal probe Hall system						●	

Hall probe measurement benchs for in air ID

- 2 Hall probe measurement benchs
  - 6.5m motion strock
  - 3-D Hall sensor
  - X,Y,Z,A,C 5 motion axes
  - A and C axes are useful for fine angular positioning of the Hall sensor

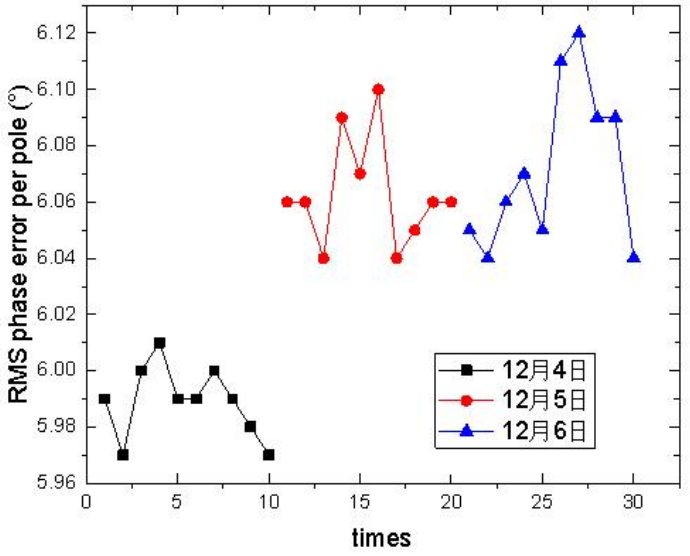
1#Hall Probe bench in YuQuanlu lab



2# Hall Probe bench in PAPS lab

Hall probe measurement benchs for in air ID

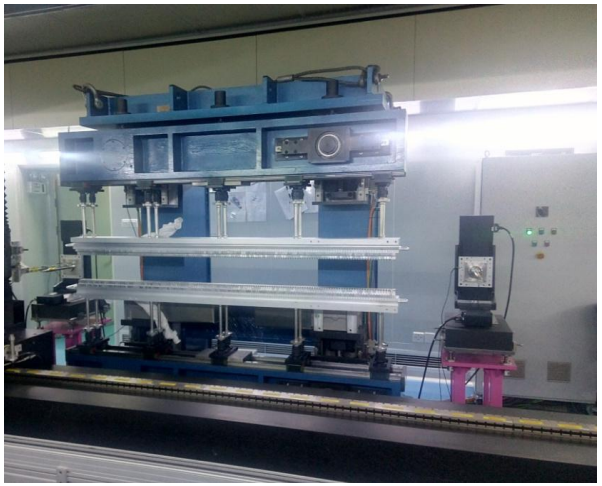
- Z axis Flatness deviation < ± 10 μm
- Z axis Positioning accuracy: <± 1.5μm
- RMS phase error :
  - 10 times RMS repeatability:<0.02º
  - 3 days reproducibility:<0.16 º

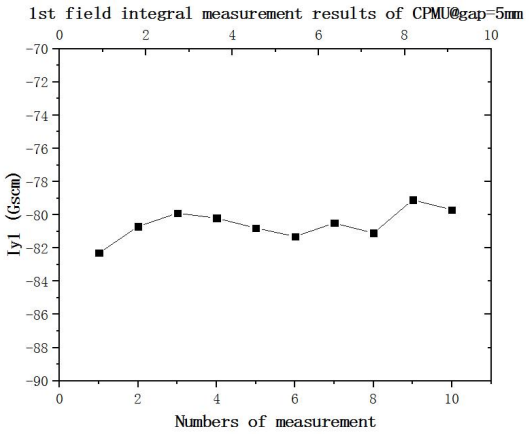


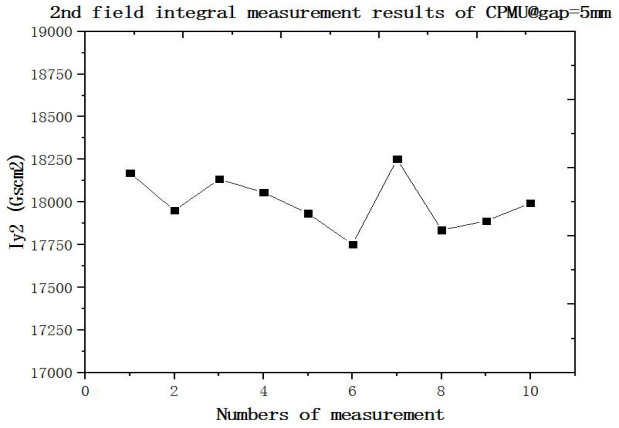
Stretched Wire for In air insertion devices

- Latgeral support Stretched Wire system
  - 2182A nanometer
  - 2-D newport motion stages

	Δ I1(Gscm)	Δ I2(Gscm²)
short term	<1	<300
long term(5days)	<4	<500



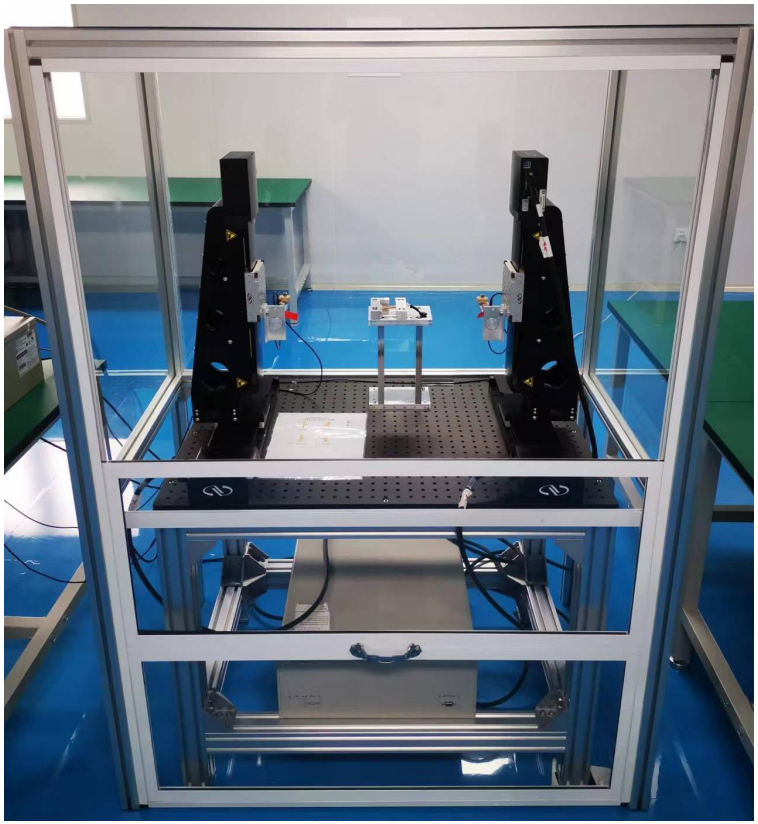




5 days long term error of I1 and I2

Stretched Wire for In air insertion devices

magnet girder measurment

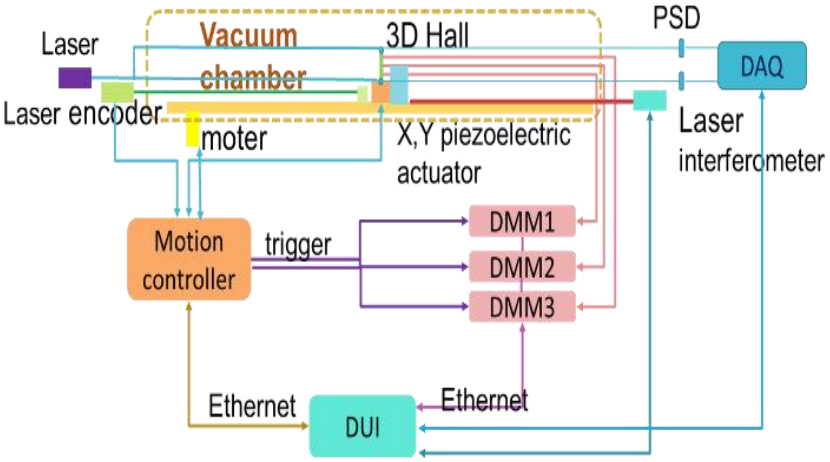


single magnet block measurement

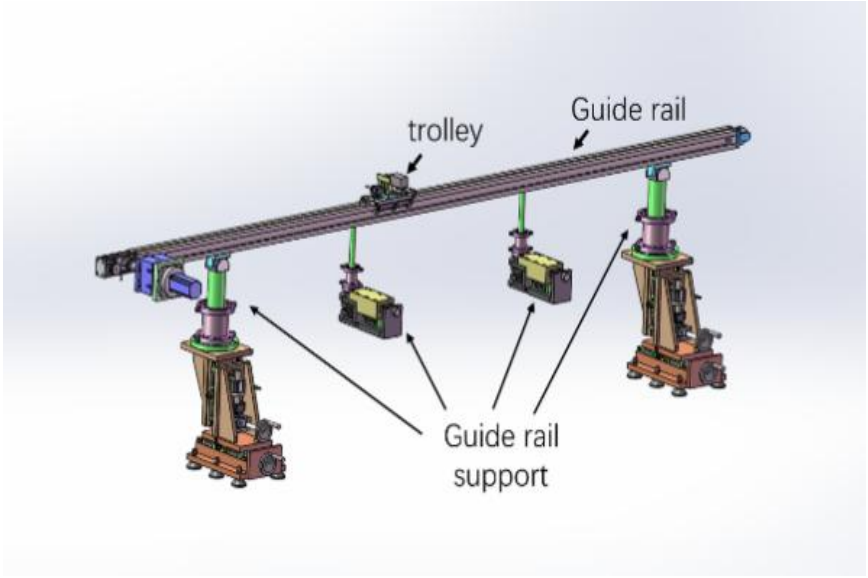
CPMU measurement system

- 3m In-Situ Hall probe system
- Symmetrical support SW

3m In-Situ Hall probe system



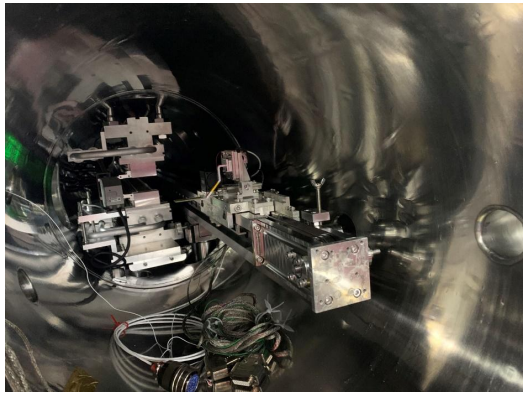
The System schematic layout of Hall probe measurement system

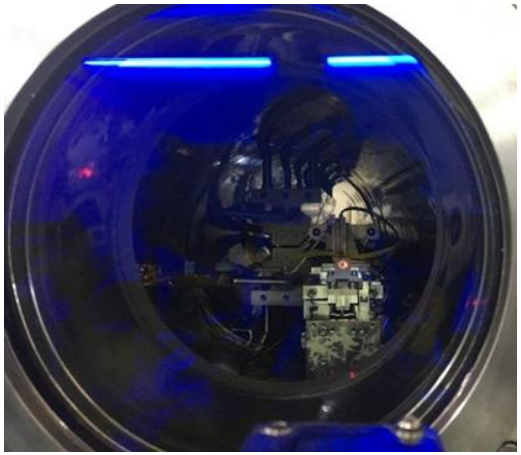


The three-dimensional diagram of four-point support guide rail structure

In-Situ Hall probe system

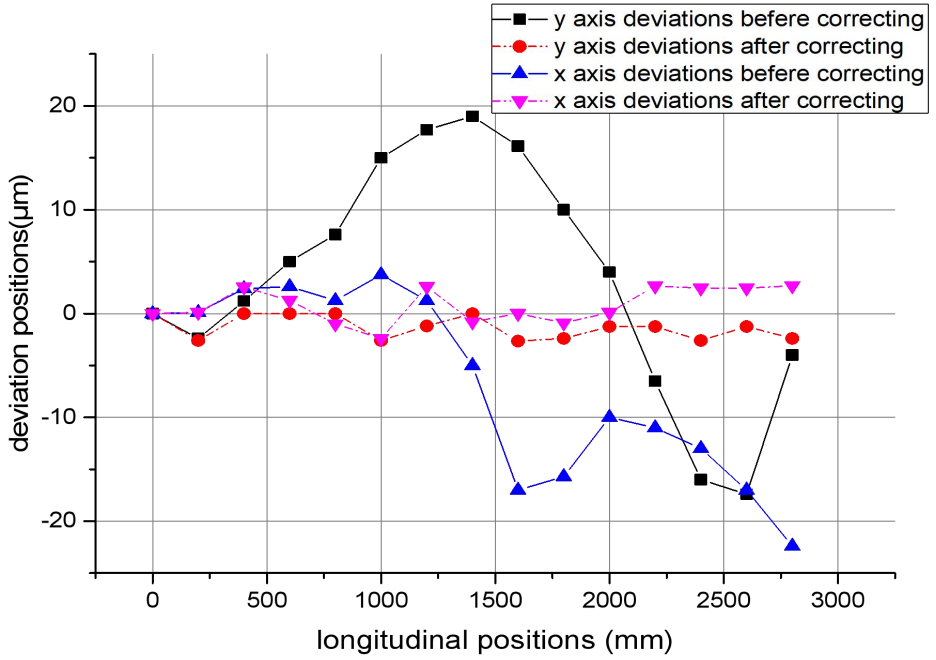
- Two dimensional piezoelectric stages, Hall probe, optical mirror, pinhole, etc. are placed on the trolley
- The strokes of piezoelectric stages in X and Y directions are 26mm and 12mm respectively, which are used for CPMU magnetic center scanning and guide rail straightness error dynamic compensation.





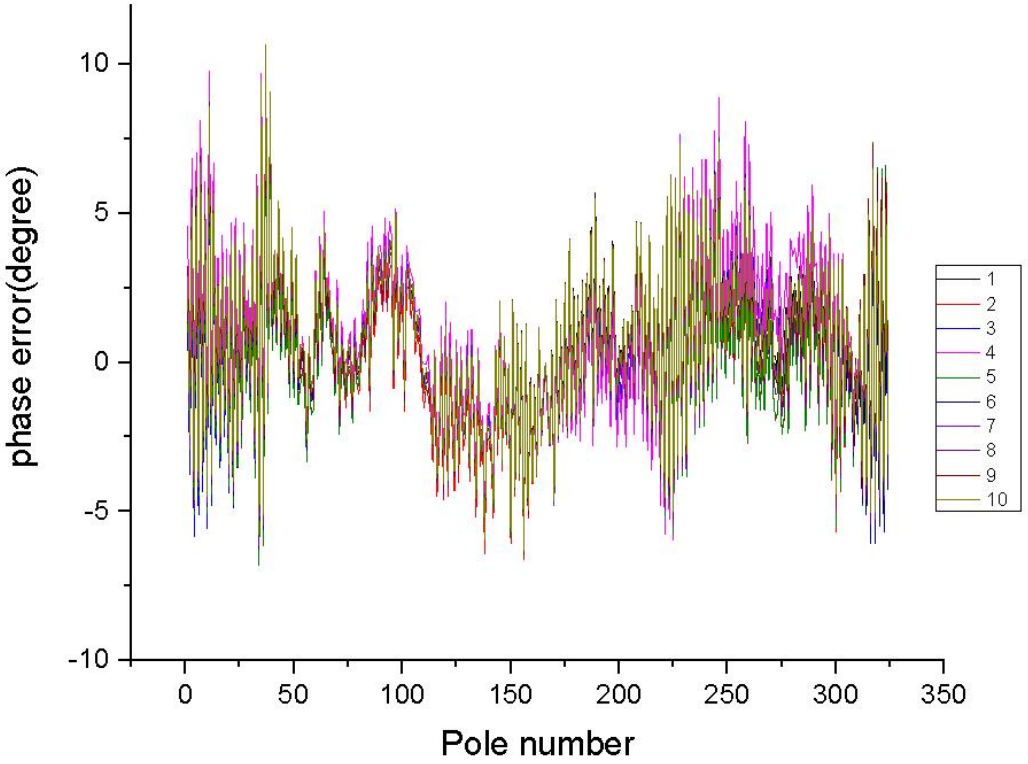
In-Situ Hall probe system

- The max error of x direction before and after compen-sation are 30 μm and 6μm; the max error of y direction before and after compensation are 40 μm and 5μm.



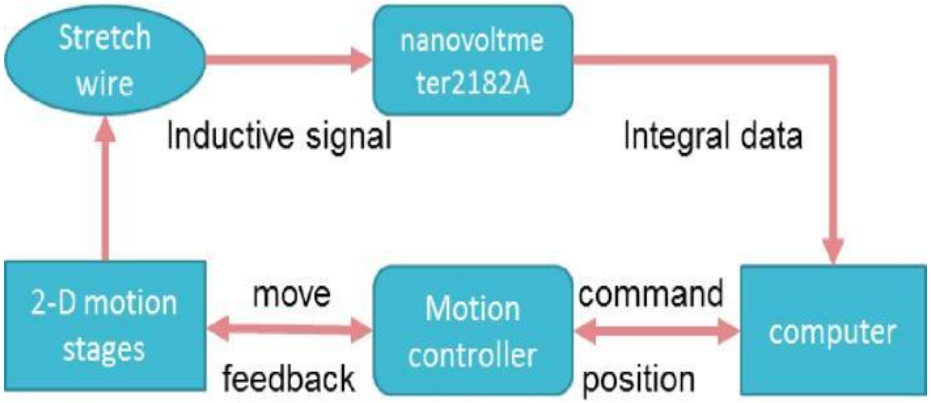
In-Situ Hall probe system

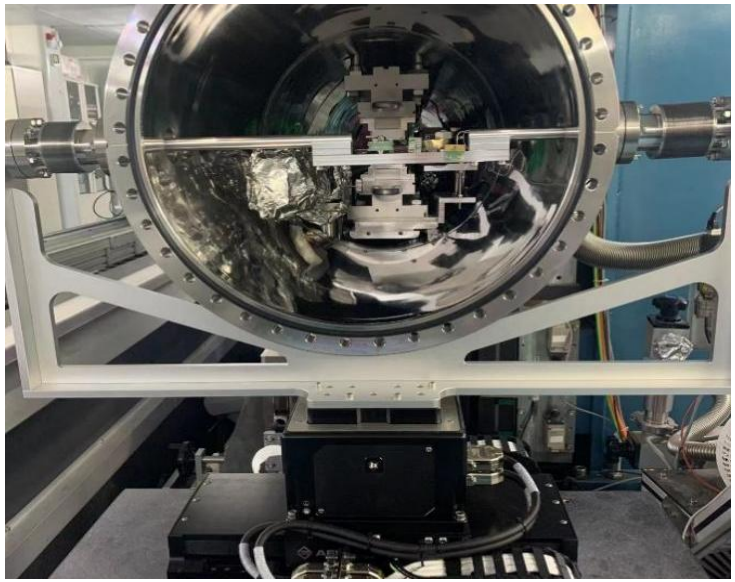
- 2m CPMU12@Gap5.2
- 10 times in-situ RMS phase error measurement repeatability is 0.034°



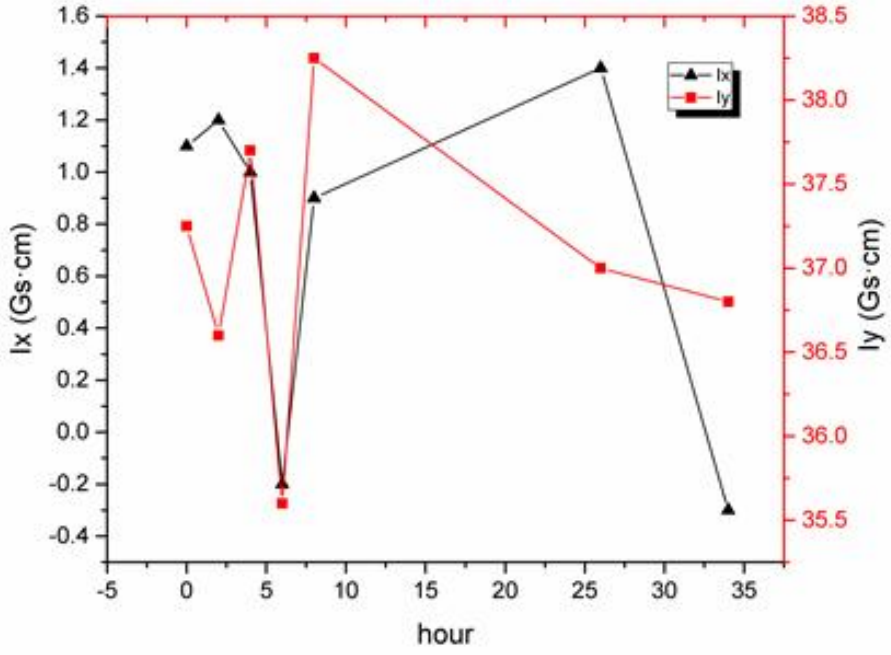
Stretched wire system

- symmetrical support structure Counteracts the effects of vacuum suction.





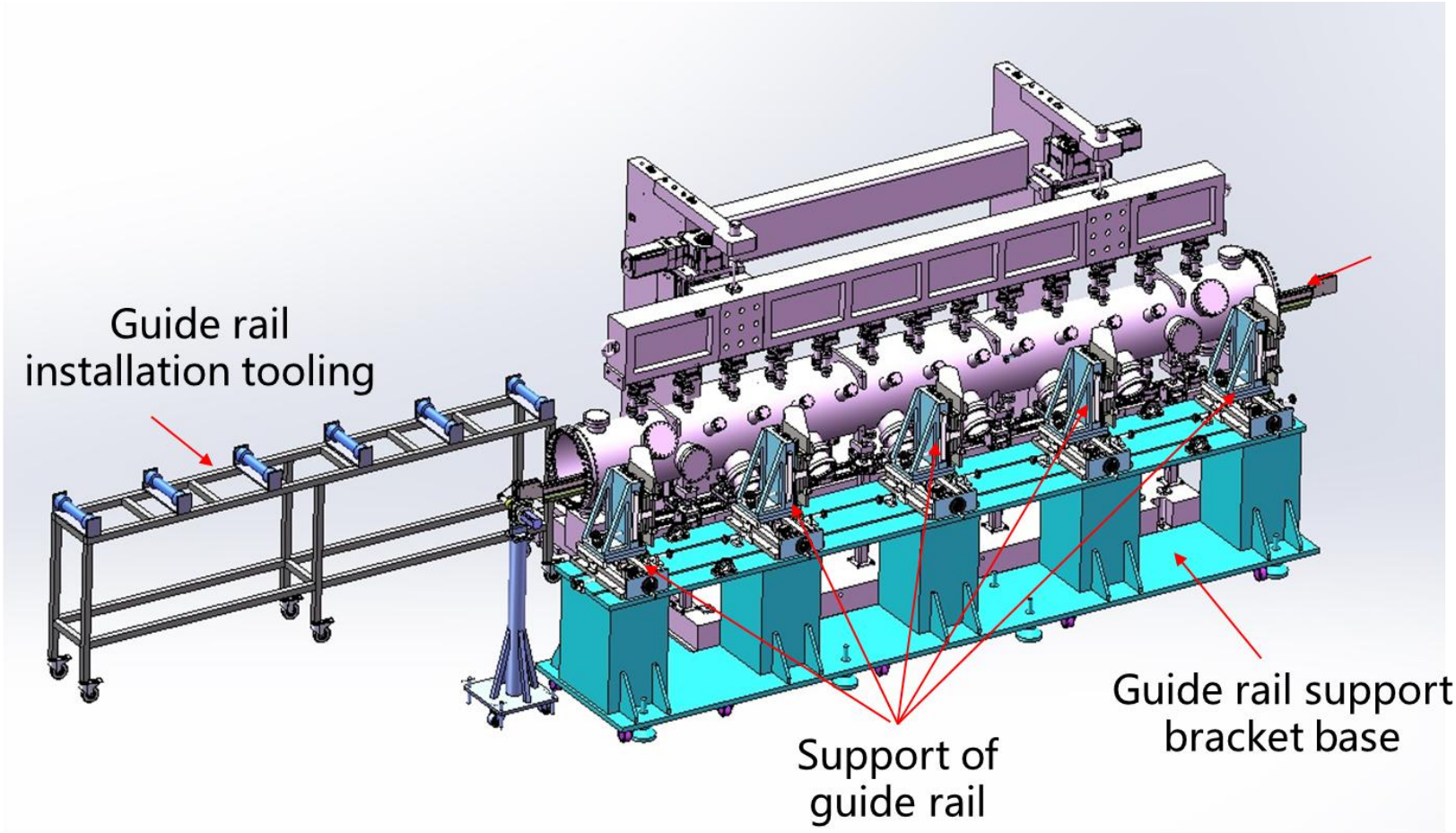
- horizontal and vertical first field integral measured by stretched wire system in 2 days. The maximum error of horizontal and vertical first field integral is 1.71and 2.68 Gs cm respectively.



IVU measurement sytem

- 4.8m in-Situ Hall probe measurement system
- symmetrical support SW,same as the SW of CPMU

4.8m in-Situ Hall probe easurement system



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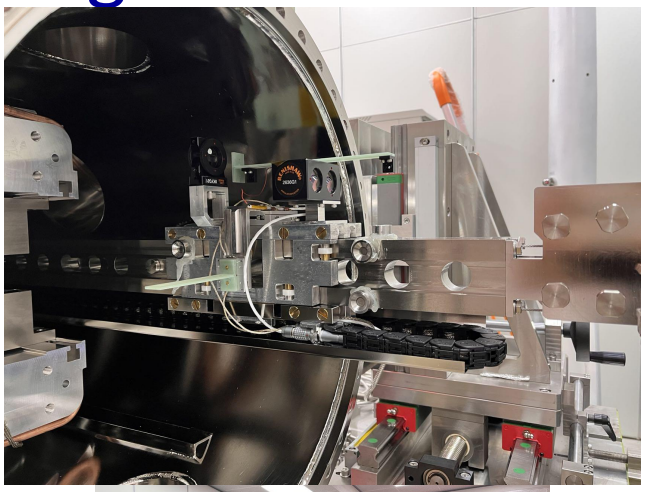
4.8m in-Situ Hall probe easurement system

- the system is in commissioning



Summary

- 2 new magnet measurement laboratories are built to handle the insertion devices magnetic measurements.
- All measurements of IDs must be completed in April 2024.
- There are still many challenges of magnetic field measurement for IVU ,CPMU and AK.

Thank You

for

Your Attention!