RESEARCH ON MECHANICAL & ALIGNMENT SYSTEM FOR HEPS-TF

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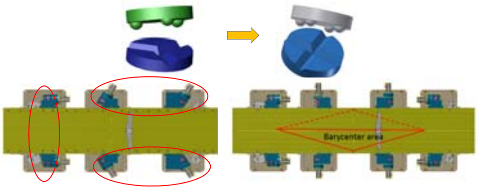
HEPS is a new generation synchrotron facility with a challenging requirement of very low emittance, and the key technology difficulties are supposed to be overcome during the stage of HEPS-TF. For the mechanical & alignment system, the requirements are very stringent. The alignment error of magnets on a girder should be less than 30μm. Besides, the girder should be capable of doing beam-based alignment remotely to minimize the magnets position error during the runtime. To meet these requirements, studies on vibrating-wire alignment technique and auto-tuning magnet girder were carried out in HEPS-TF. This paper will describe the design and progress of those work.

Auto-tuning girder

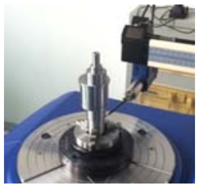
- Design Features:
  - ✓ Adjustability: Cam mover + Ball transfer unit
  - ✓ Stability: Multi-support +Locking system
- Two prototypes developed:
  - ✓ Girder I: 3.3m, 6 support points
  - ✓ Girder II: 4.3m, 8 support points

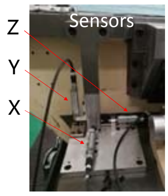


Supporting scheme of girders

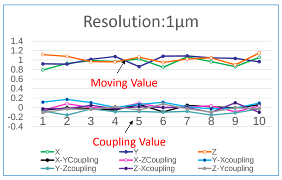
- With the kinematic design, Girder I is a fully constrained structure. Stepping motors are used to perform movement.
- Although Girder II is over-constraint, elastic property can make the 8 points loaded simultaneously. Servo motors are used to make sure the force balanced.
- Both girders are fully tested and show similar performance.

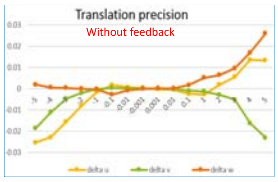
Check & Fiducialization



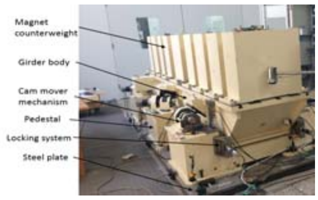


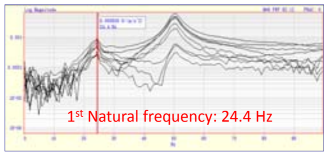
- ◆ Good adjustability:
  - ➢ Resolution: 1μm
  - ➢ Precision :
    - ✓ Feedback: 1μm, ±0.1mm
    - ✓ No feedback: 1μm, full moving range(X/Z: ±5mm; Y: ±10)





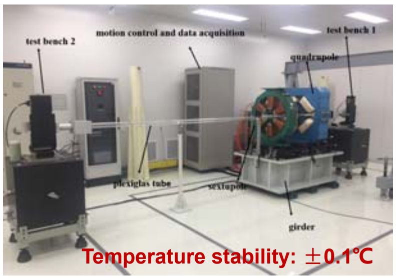
- ◆ Stability: f_1=24Hz
- ● Locked by mechanism;
- ● Not grouted on the floor.

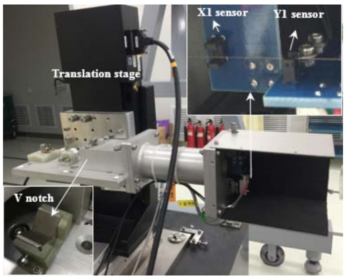




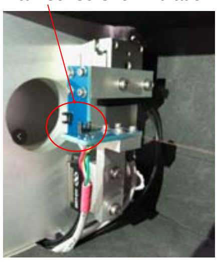
Vibrating-wire alignment

- Align the magnets on a girder based on the magnetic center measurement, using a wire carrying AC current.

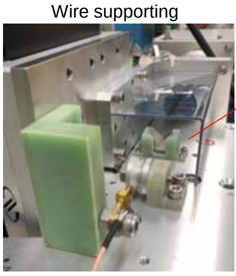




X&Y sensors for Vibration



Wire supporting



∅0.125 Be-Copper wire

➢ Repeatability: <±3μm

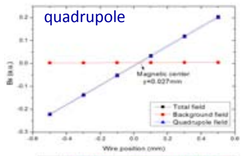
Precision (μm)	Quadrupole		Sextupole	
	10 times	5 days	10 times	5 days
X	± 0.3	± 0.7	± 2.4	± 2.3
Y	± 1.0	± 1.6	± 1.8	± 2.8

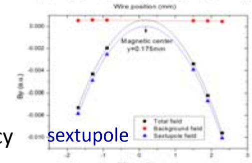
*Ground vibration may be an issue, vibration isolated foundation is essential to avoid unexpected resonance of the wire.

➢ Background field correction

- Experiment was conducted to verify the main source of background.
- Main source: Remnant field of nearby magnets

		Magnetic center position		
		No shield	shield	Δ
Before correction	X	0.245	-0.019	0.264
	Y	-0.173	-0.184	0.011
After correction	X	-0.031	-0.032	0.001
	Y	-0.183	-0.180	0.003





➢ Sag correction

- Based on the measurement of 1st natural frequency of wire.

$$sag = \frac{g}{32 f_1^2}$$

$$s = -\frac{4sag}{l^2} z_{mag}^2 + \frac{4sag}{l} z_{mag}$$

Weights /kg	f1 /Hz	s /mm	Magnetic center/mm	
			Before correction	After correction
1kg	28.95	0.247	0.031	-0.216
1.1kg	29.3	0.241	0.026	-0.215
1.15kg	30.1	0.228	0.013	-0.215

➢ Magnet adjusting

- Reading of DVRT is much more stable than Laser Tracker. It is very helpful to decrease magnet position errors.
- Magnetic center deviation can be less than 6μm after adjustment of magnet.

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