中国科学院高能物理研究所

The operation status of neutron chopper system at CSNS

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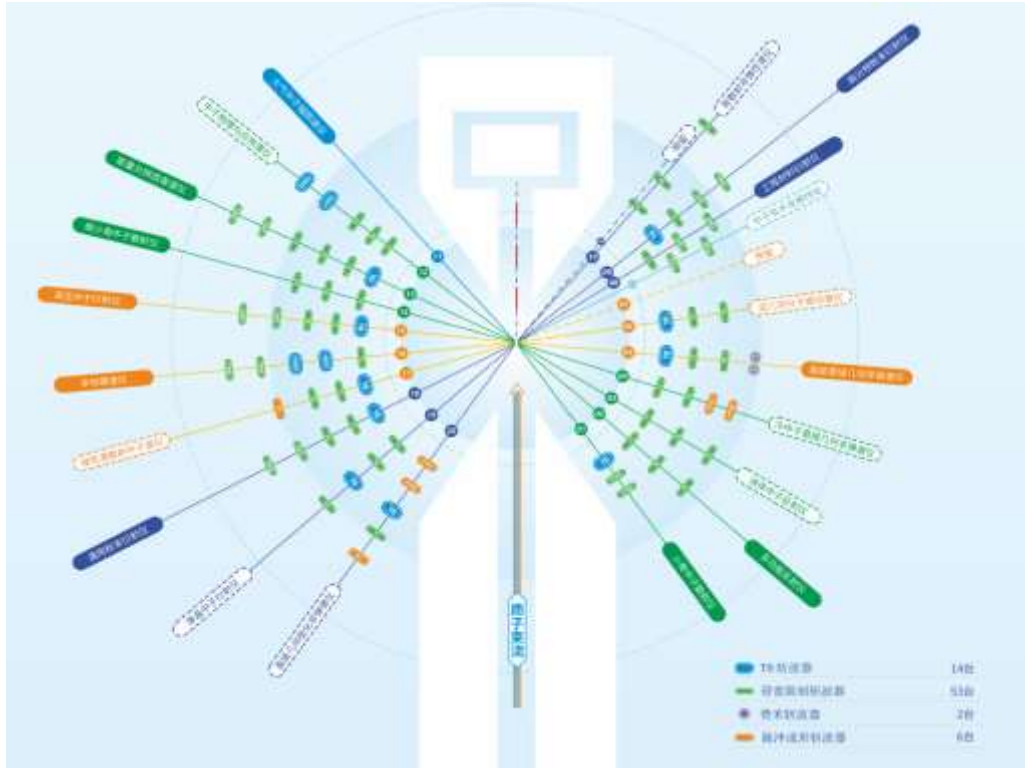
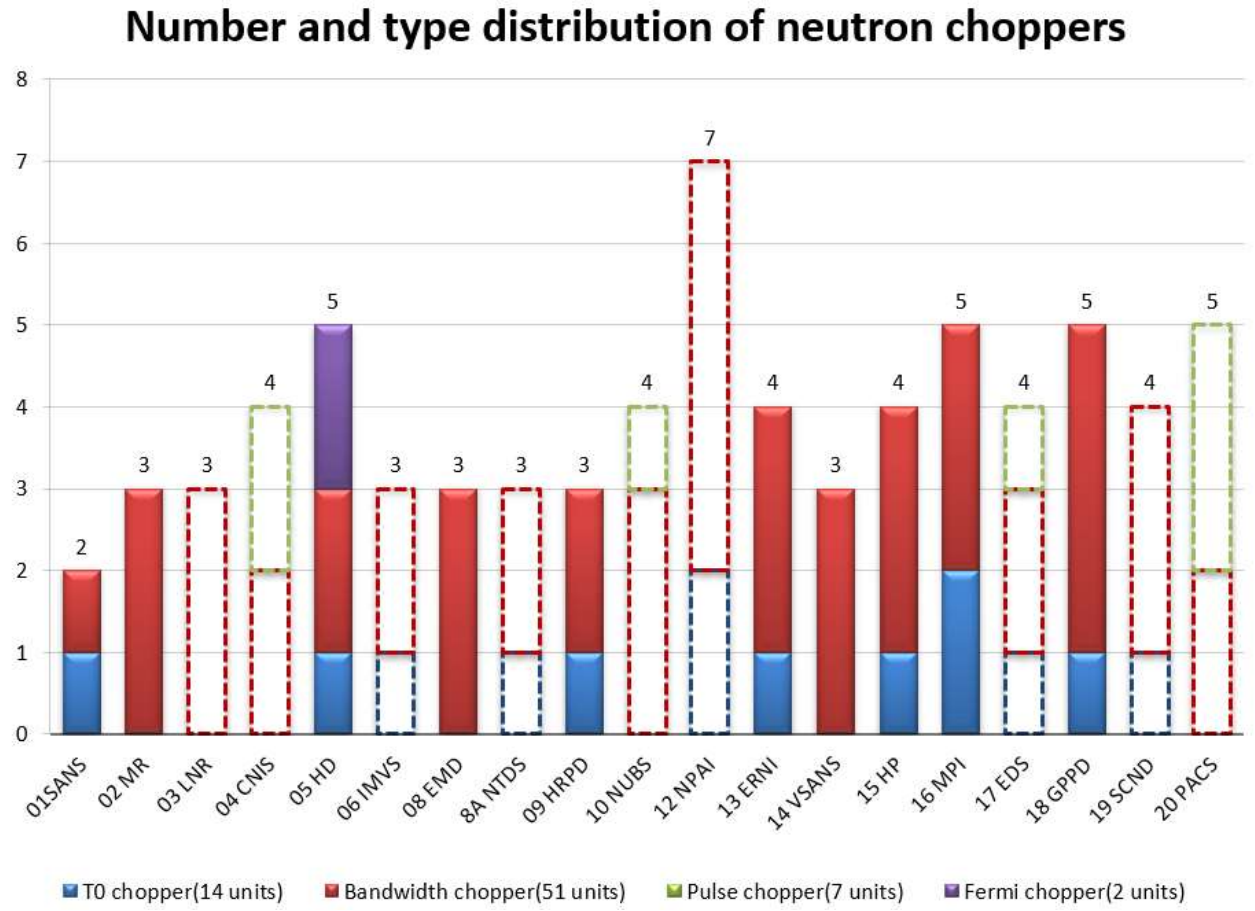
CSNS Neutron Chopper Group

NEUTRON CHOPPER

China spallation neutron source

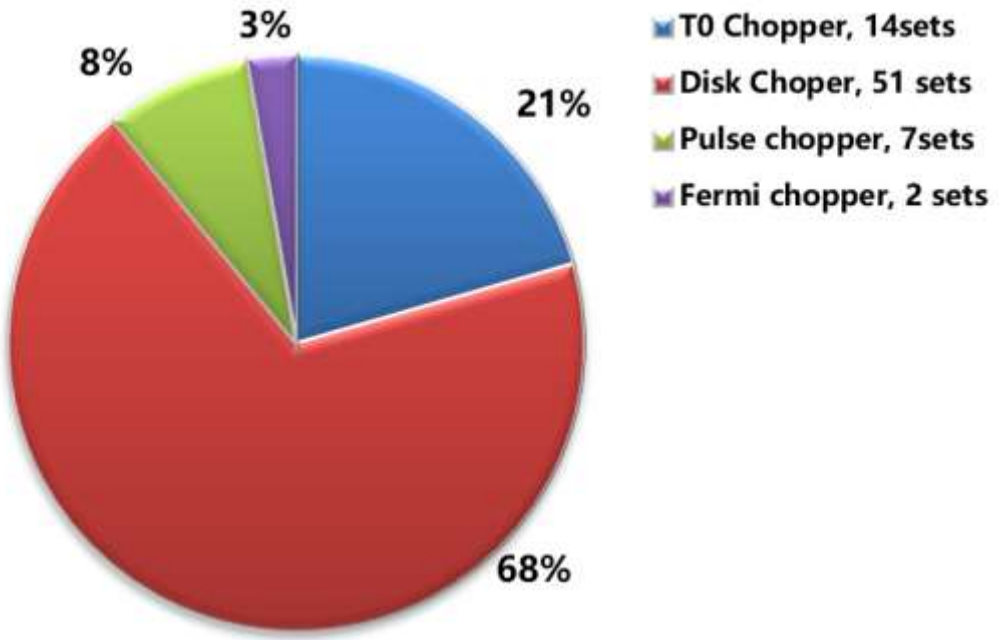




- 20 instruments, of which 10 are already running or about to run

Overview of neutron choppers systems at CSNS

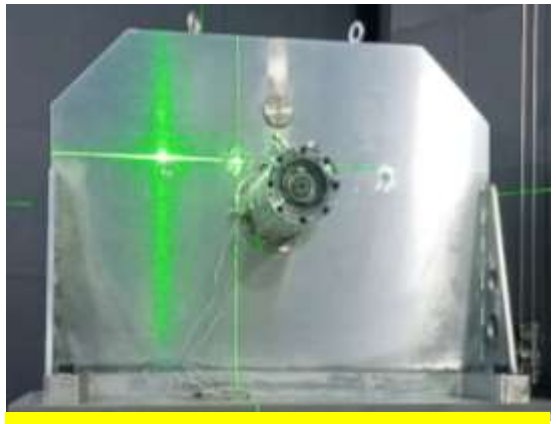
- 74 chopper systems total (with 36 done)
- 97% of all choppers at CSNS are self-developed
- 89% of all choppers at CSNS are low-speed type
  - ✓ 14 Horizontal Axis T-zero
  - ✓ 51 Low-speed Disks (35 single and 16 double)
  - ✓ 2 Fermi choppers (Mirrotron)
  - ✓ 7 High-speed Disks(3 single and 4 double)




T0 Chopper

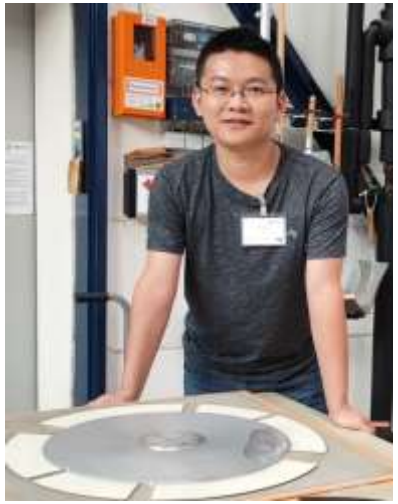

Disk Chopper


Fermi Chopper


Prototype of Pulse Chopper

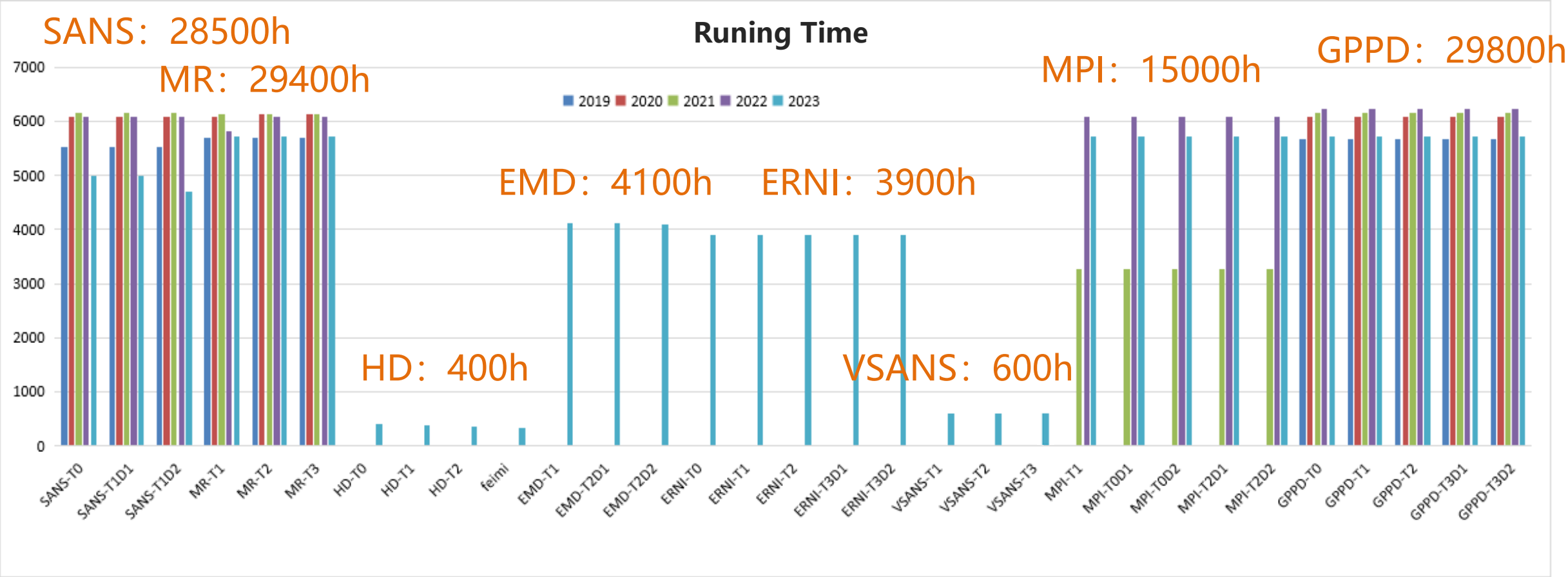
Chopper Team at CSNS

- 6 persons, 16 years（2007）
- Chopper Team responsibilities – design, installation, testing, maintenance, operations of all chopper systems.



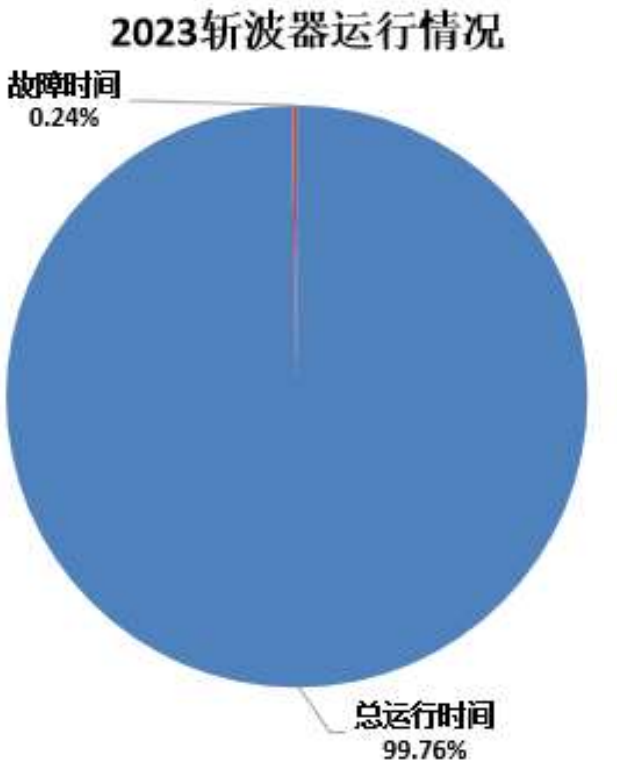
Operation status

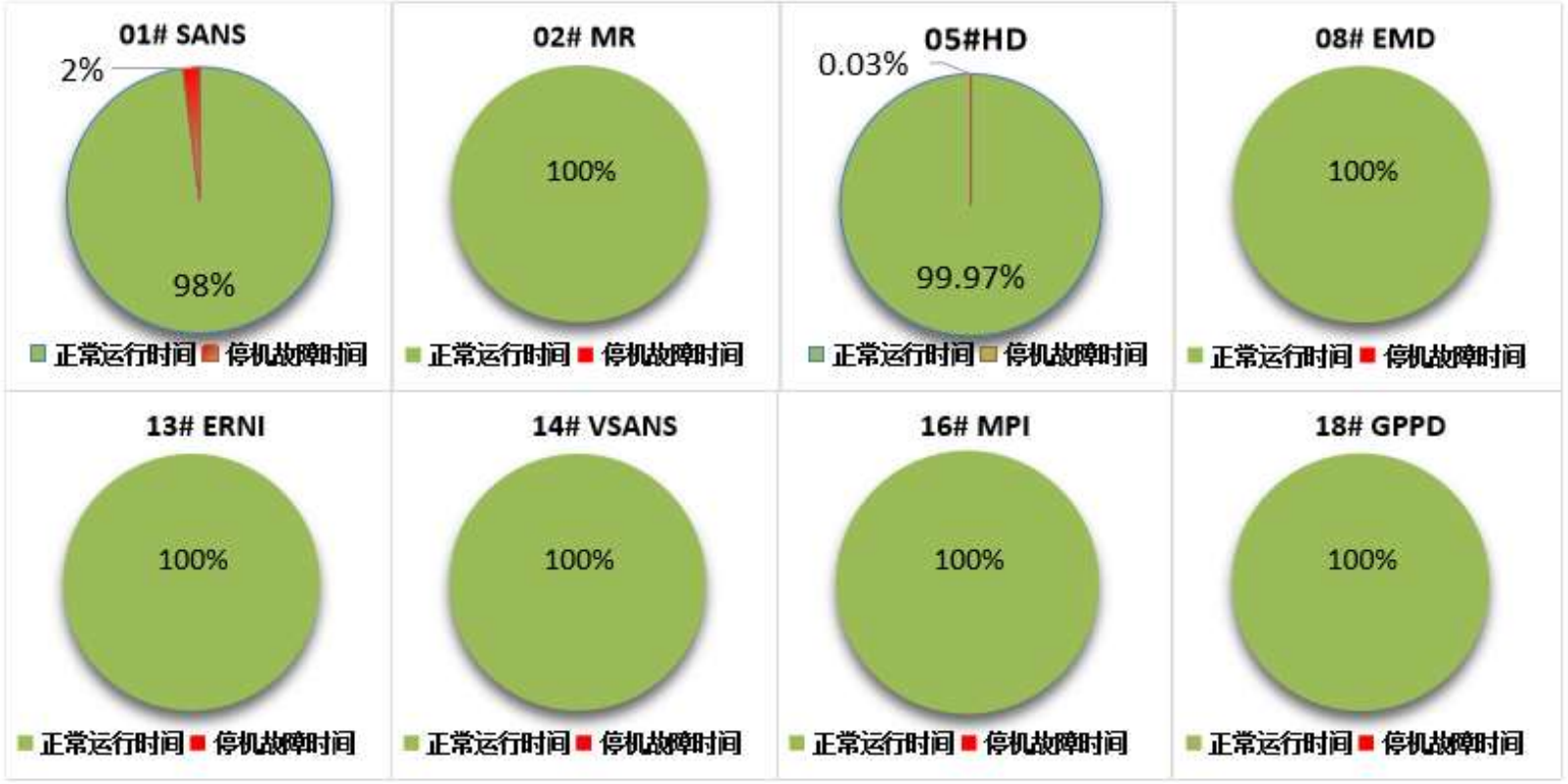
- Year 2019-2023：stable running state
- Accumulated running time exceeds 300,000 hours，Maximum single unit time>29000 hours



Operating efficiency

- In 2022-2023, the total fault downtime was 299.06 hours, and the total operating efficiency reached 99.76%.



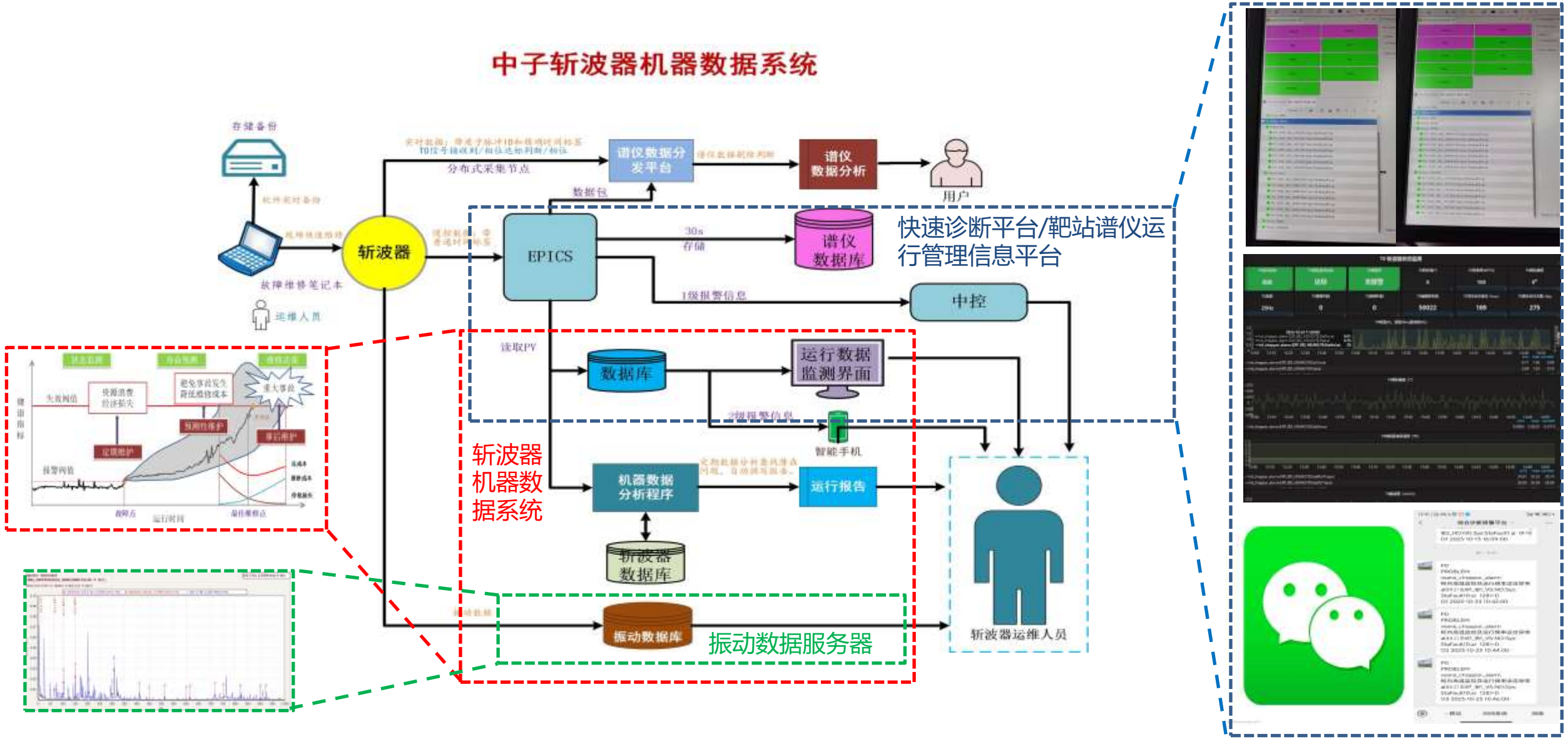


Maintenance strategy

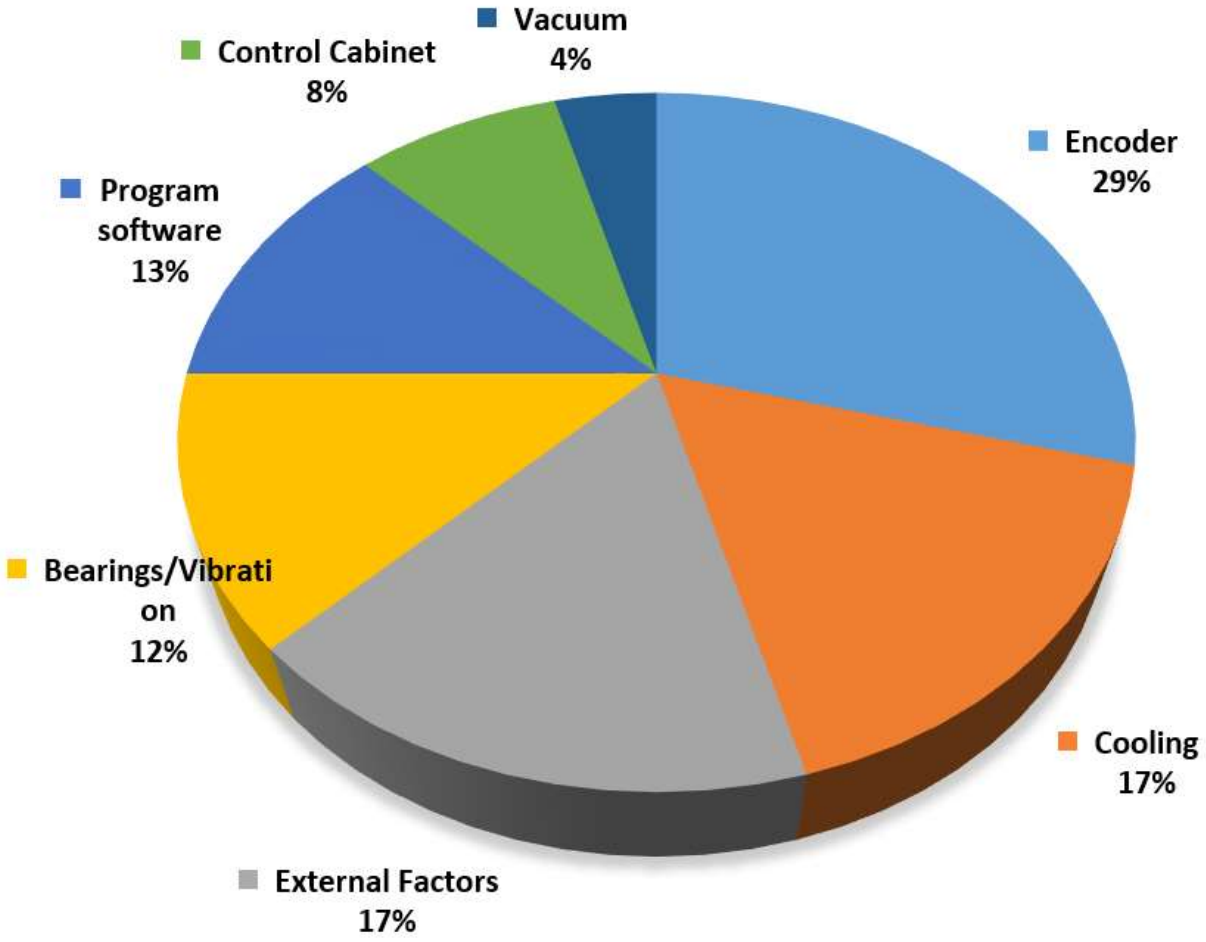
- Operation period
  - ✓ Routine inspection
  - ✓ Emergency maintenance (unexpected)
  - ✓ 24/7 standby
- Maintenance period
  - ✓ Planned & Annual maintenance

Year											
Q1			Q2			Q3			Q4		
1	2	3	4	5	6	7	8	9	10	11	12
Operation	Stop	Operation	Operation	Operation	Operation	Stop	Stop	Stop	Operation	Operation	Operation

Condition monitoring



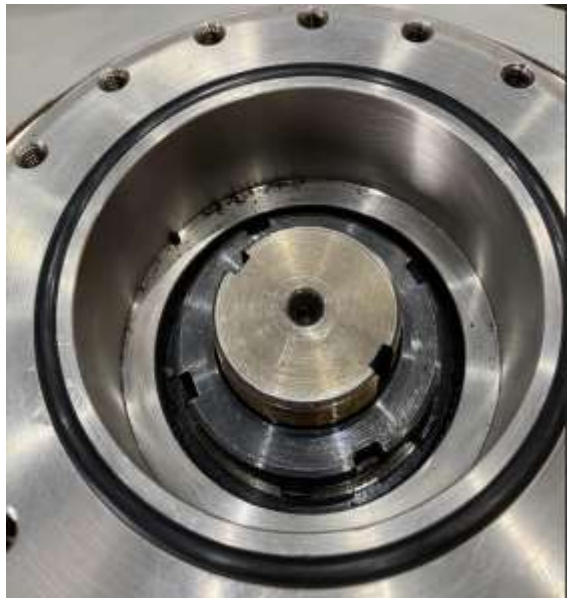
Statistics of Chopper Fault types

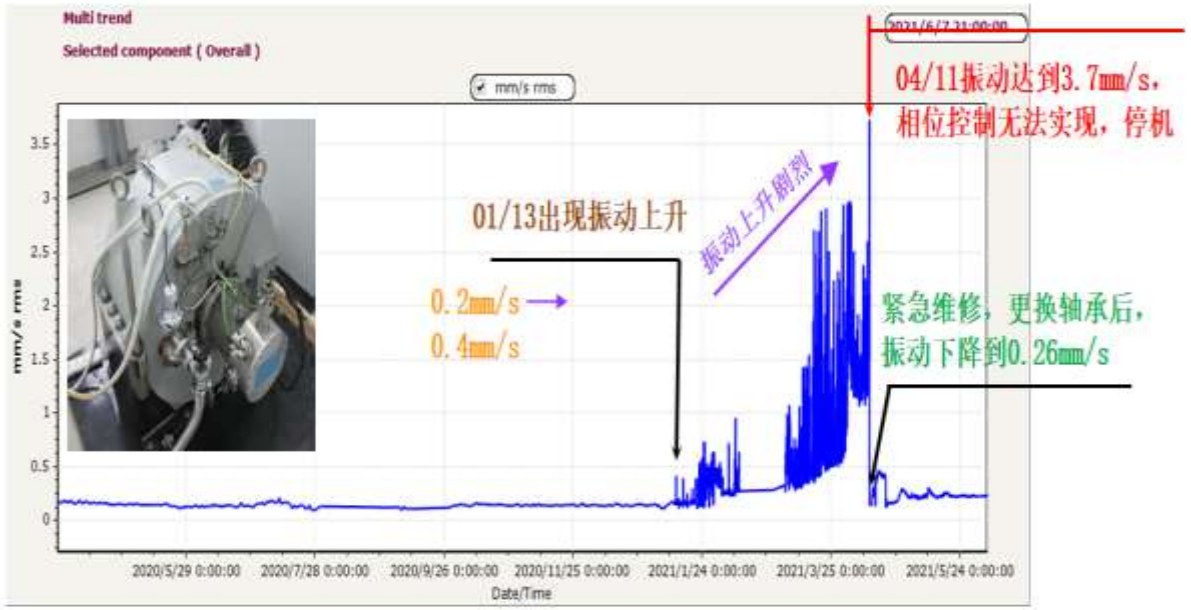


Chopper Faults						
	2019	2020	2021	2022	2023	Total
Encoder	2	3	1	0	1	7
Cooling	1	0	2	1	0	4
External Factors	3	0	0	0	1	4
Bearings/Vibration	1	0	2	0	0	3
Program software	1	0	1	1	0	3
Control Cabinet	0	1	0	0	1	2
Vacuum	0	0	0	1	0	1
Rotor	0	0	0	0	0	0
Motor	0	0	0	0	0	0
Cables/Connectors	0	0	0	0	0	0
Sensor	0	0	0	0	0	0
T0 signal	0	0	0	0	0	0
Others	0	0	0	0	0	0

Failure 1 - Bearings & Vibration

- T0 chopper - After 20000 hours running, T0 couldn’ t work caused by the bearing failure.
- Disk chopper - incorrect bearing selection(cylindrical roller bearings), resulting in shorter service life and a sharp increase in vibration
- 2 back to back ceramic ball angular contact bearings





Failure 2 - Cooling & Leakage

- Water-cooling pipe was plug by alumina particles which come from motor stator shell.
- Leakage of internal weld seam.

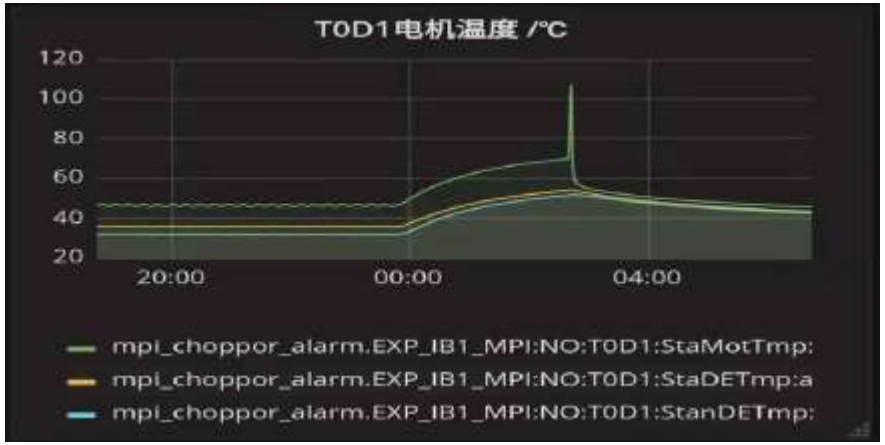
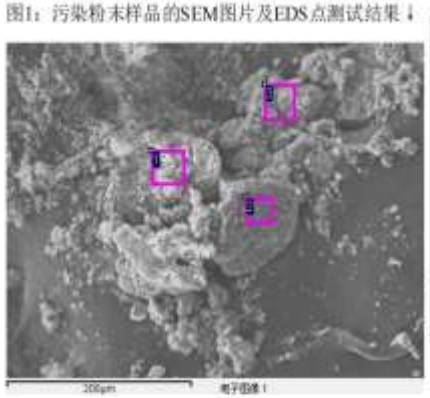
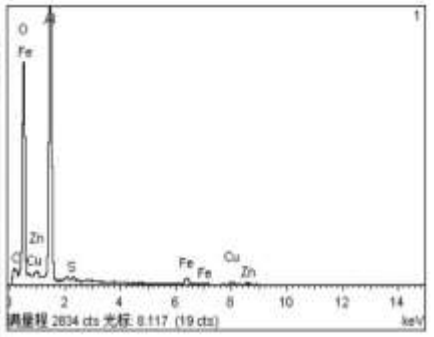


图1：污染粉末样品的SEM图片及EDS点测试结果↓



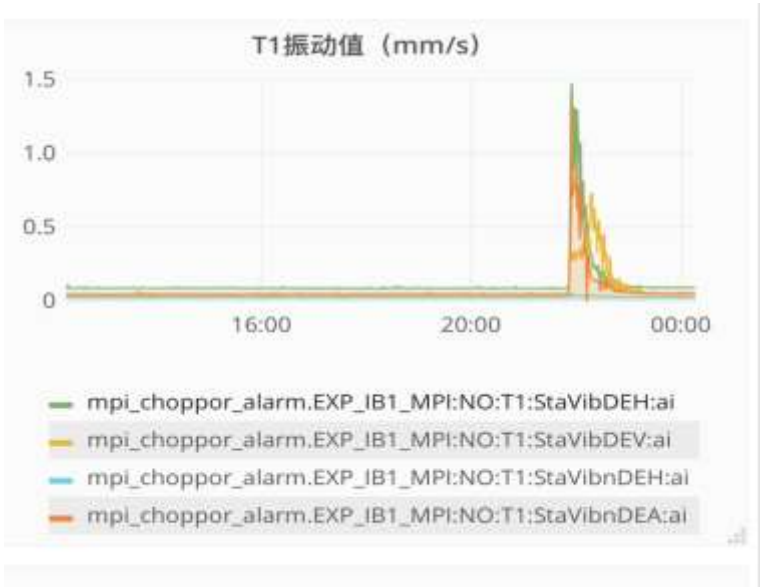


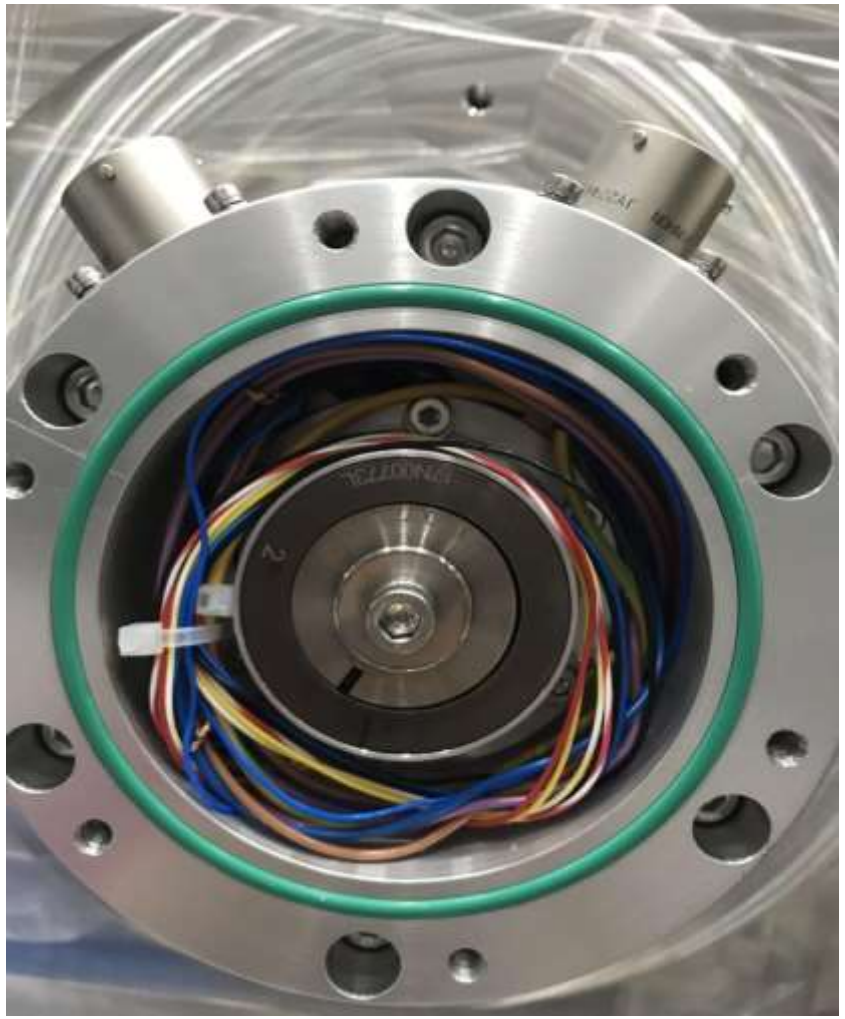
谱图	C	O	Al	S	Fe	Cu	Zn	总的
1	0.24	53.29	35.52	0.71	5.80	2.13	2.31	100.00
2	4.34	46.73	41.58	0.59	3.44	1.59	1.74	100.00
3	3.71	56.19	33.90	0.45	2.31	1.68	1.77	100.00

备注：1. 按重量百分比显示的所有结果；2. EDS为半定量分析，结果仅供参考。

Failure 3 - Electromagnetic Interference

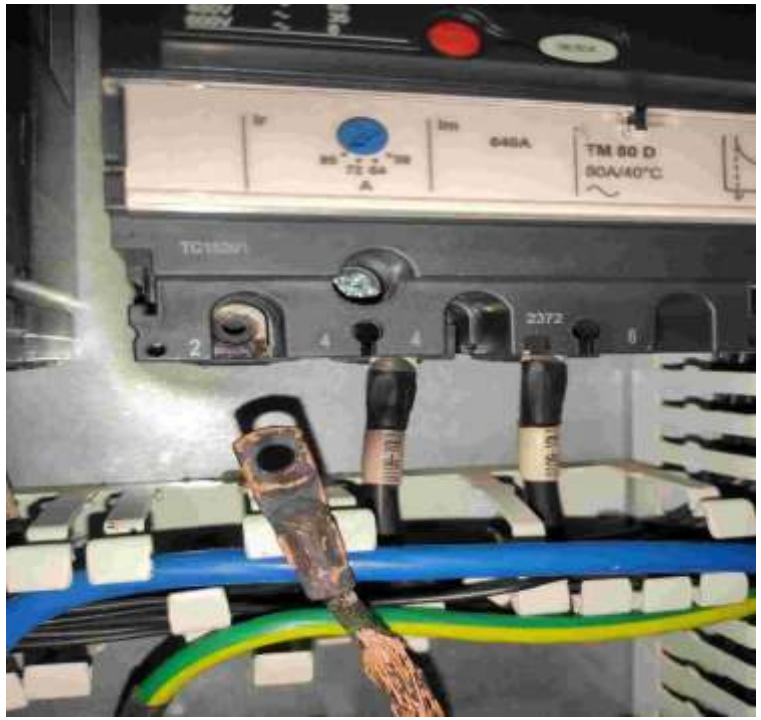
- Unexplained interference
- Encoders, vibration sensors, and other electronic devices
- Trial solution: Add additional shielding

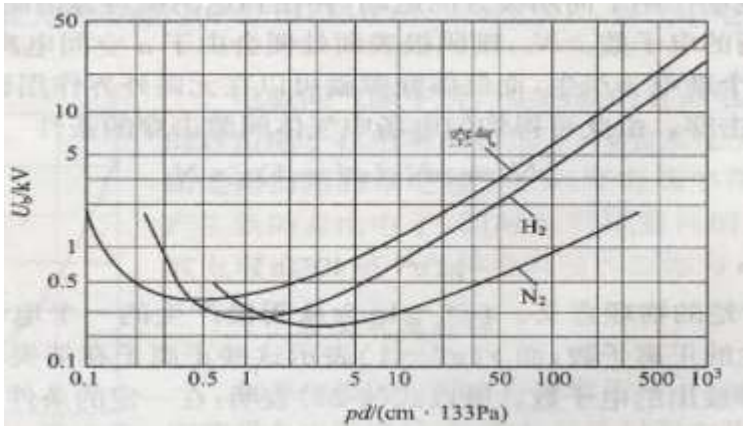




Failure 4 - Connecting & Safety

- Loose connections, dust accumulation, vacuum discharge, etc
- Solution: Regular maintenance, cleaning, and tightening, epoxy enhances insulation





Summany

- 16 years，6 persons
- 36 choppers（30 are operating）
- 5 year and 11 months，over 300,000 hours
- high operating efficiency（99.7%）

Low failure rate
Efficient operation
Professional maintenance

Thank you for your listening！ ！ ！