On-Line Mechanical measurement In NSRRC

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May 20,2005

Outline

1. Motivation.
2. Measurement system .
3. Improvement based on the measurement.
4. Conclusion.

Motivation

PAC 99 Kuo et al , NSRRC

2 ºC P-P Water temp
20um in Hor BPM
5um in Ver BPM

Measurement true?

Mechanism?
Physical consistence?

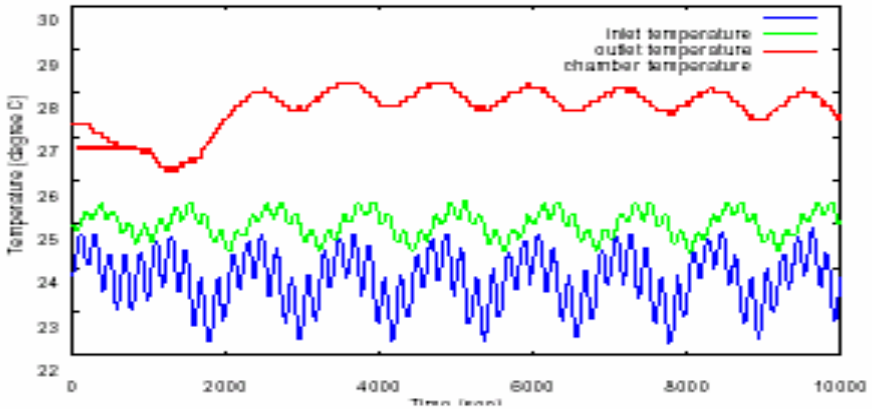


Figure 1: Water temperature (lower) and beam pipe temperature (top) in a test run.

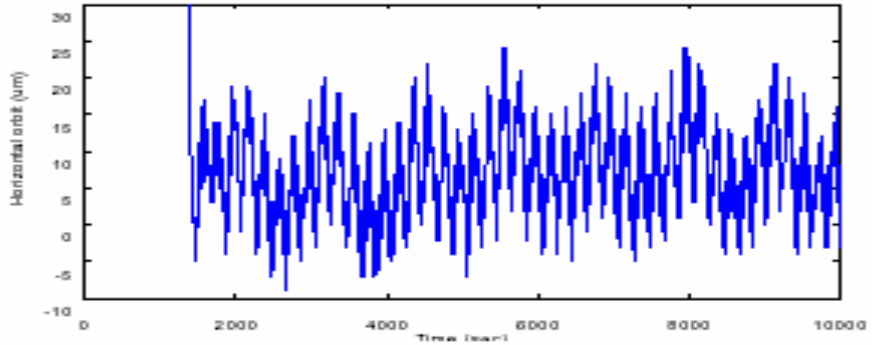


Figure 2(a): Horizontall orbit at one BPM with the

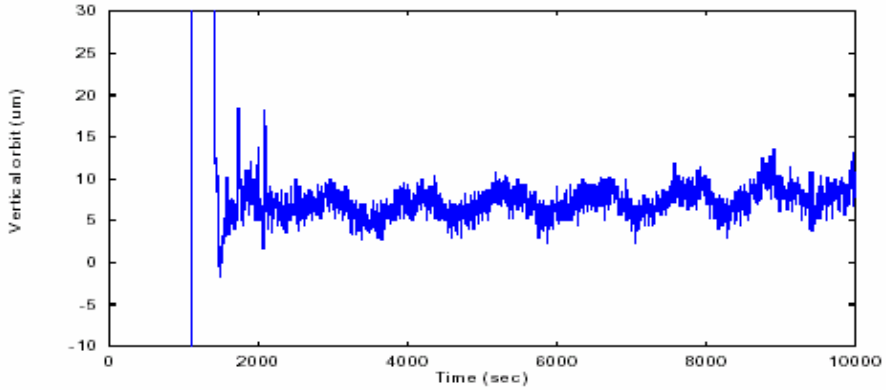
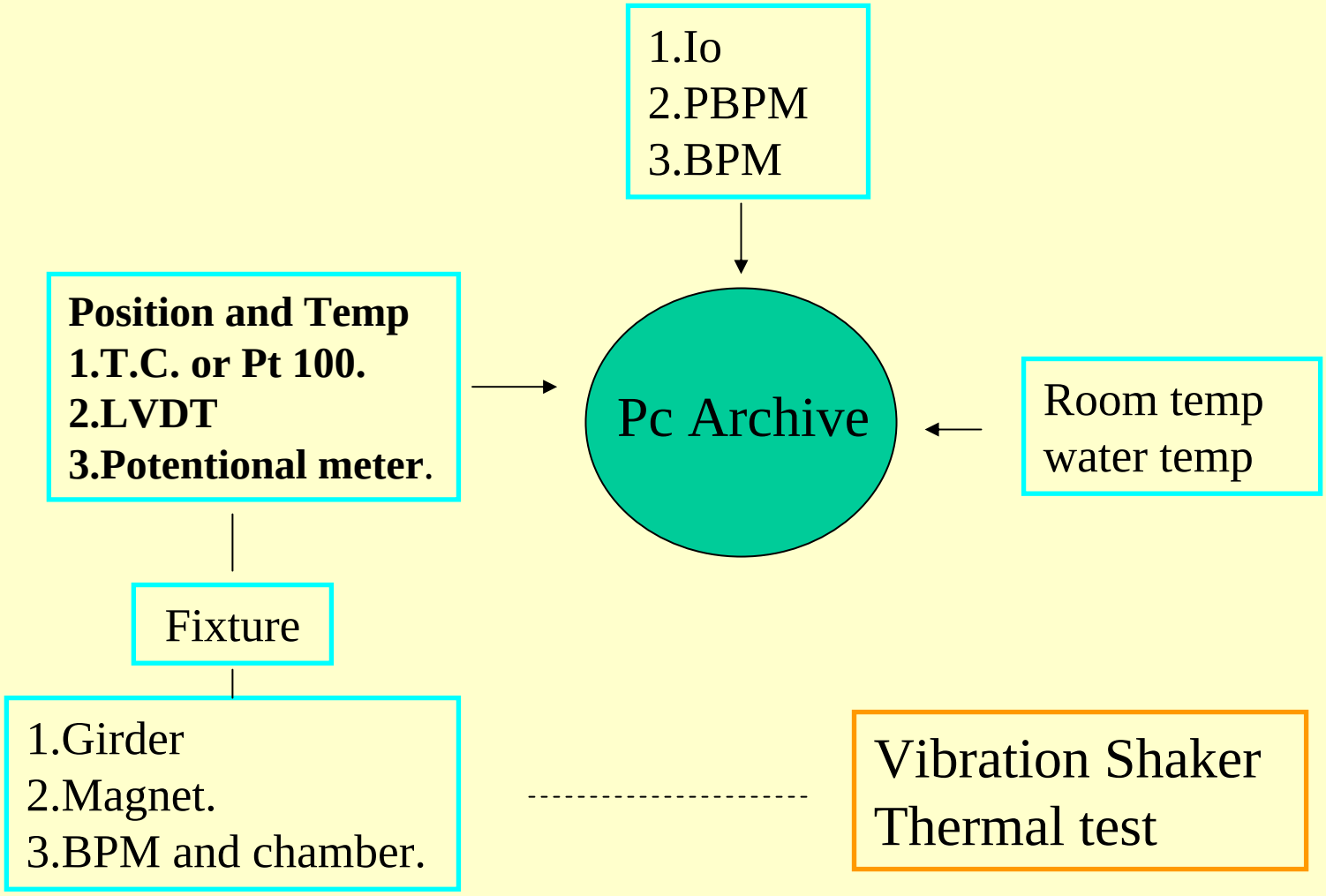


Figure 2(b): Vertical orbit at one BPM with the condition given in Figure 1.

***Measurement* system set up**



Potentional meter

stroke 10mm
linearity 0.1%
D : Vo = L : Vin

in our case Vin=10V
with 16 bit A/D module
set the input range ±1V
adjust the starting 0.5 V
The ideal resolution is
(1mm/V) *(2V/65536)=30nm

In reality 0.2um is no problem.

ADAM-4017

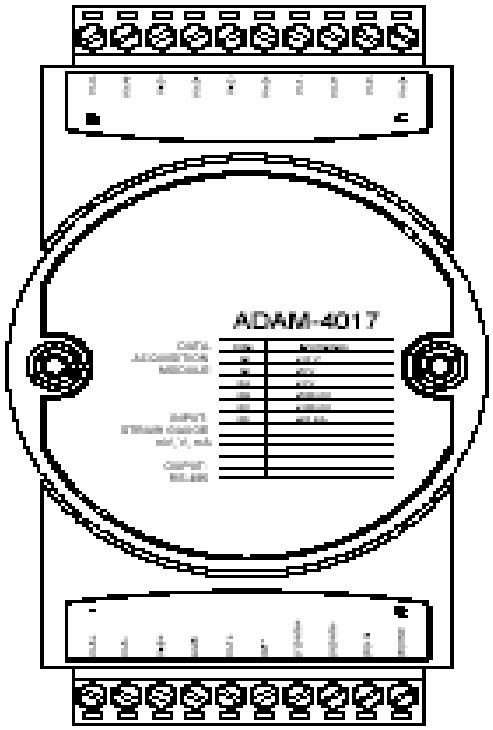


Figure 3-16 *ADAM-4017 8-channel Analog Input Module*

Channels:

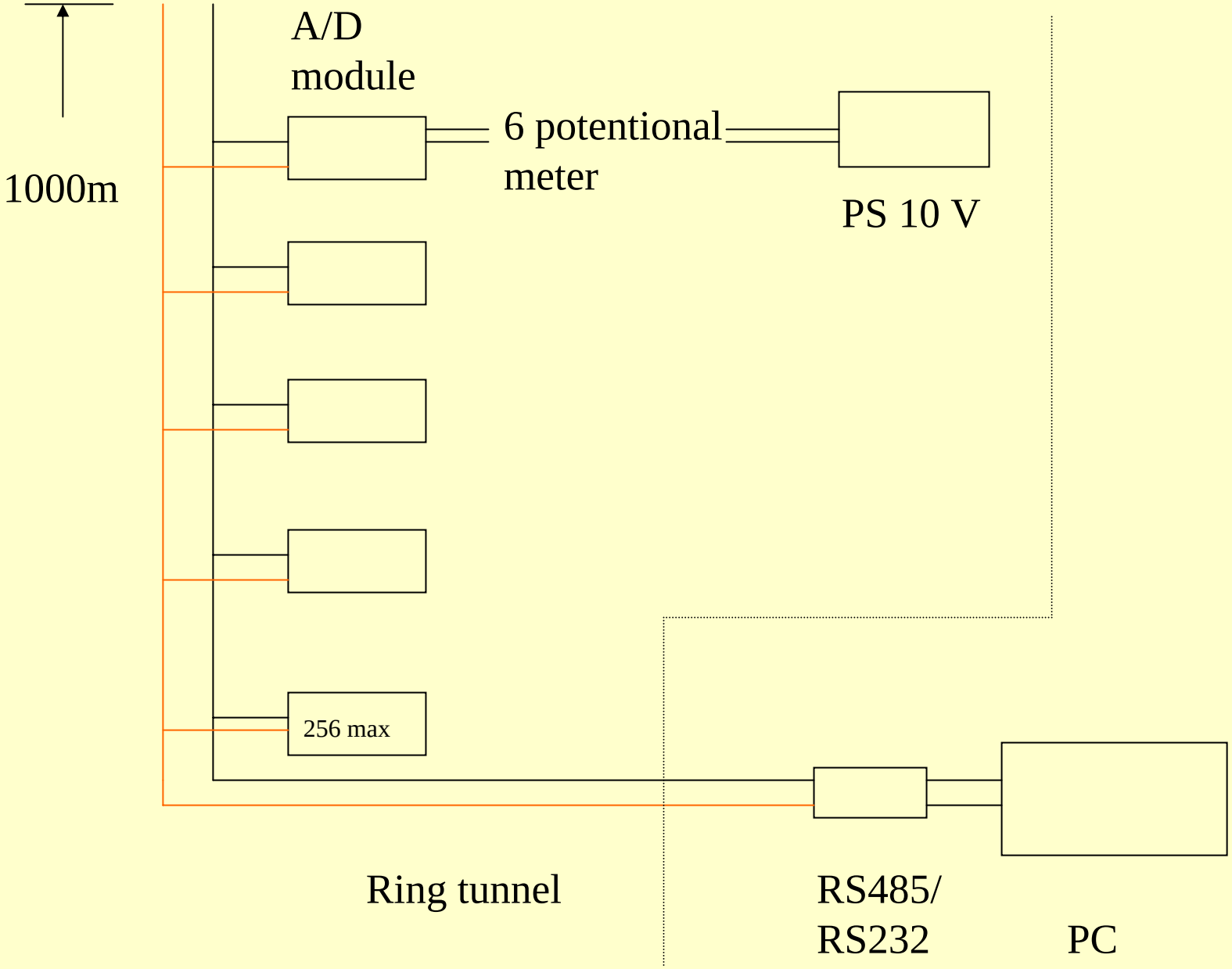
- six differential, two single-ended

Accepts:

- Millivolt inputs: ±150 mV and ±500 mV
- Volt inputs: ±1 V, ±5 V, and ±10 V
- Current input: ±20 mA (requires a 125 Ω resistor)

The module forwards the data to the host computer in engineering units (mV, V, or mA)

Connection layout



2-3-8
2005/ 4/11

LVDT (TESA, Switzerland)
linear variable differential transformer

repeatability (2 S) 0.01um
Hysteresis error (2S) 0.01um

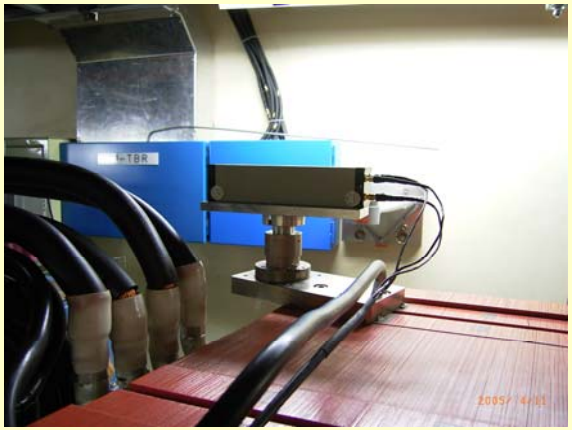
With RS 232 port to PC

Comparison

Potention meter	LVDT
100 USD /each	3000 USD/each
A/D+ PS, <100USD /each	
0.2um	<0.1um
No B field interference	B field interference
robust	fragile

Other measurement system

1.Laser interferometer (distance), RS232
2.Tilting sensor (A/D and RS485)
3.Temperature (A/D and RS485)
4. Vibration measurement (Entrx system)



Improvement based on the measurement

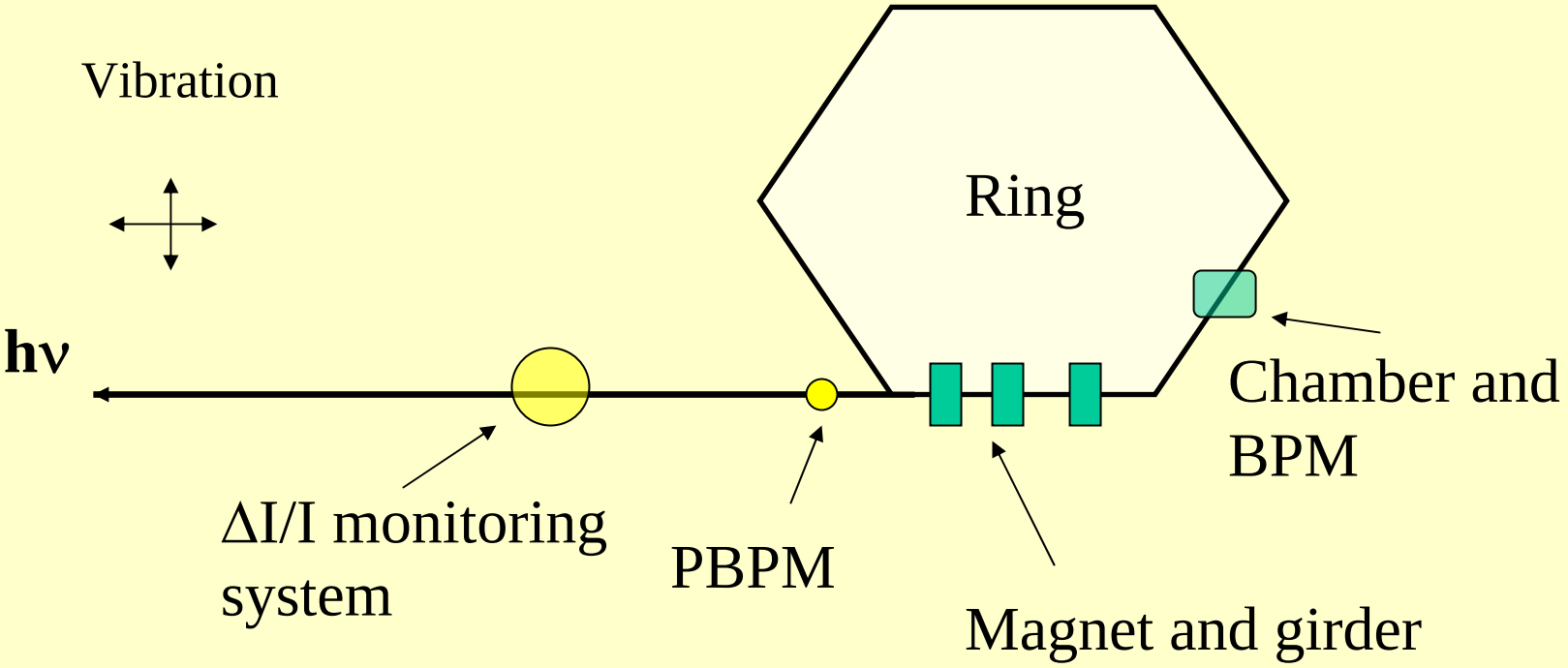
1. Requirement
2. $\Delta I/I$ monitoring system
3. Q magnet and Girder
4. Chamber and BPM
5. Vibration

Beam Stability Goal at NSRRC

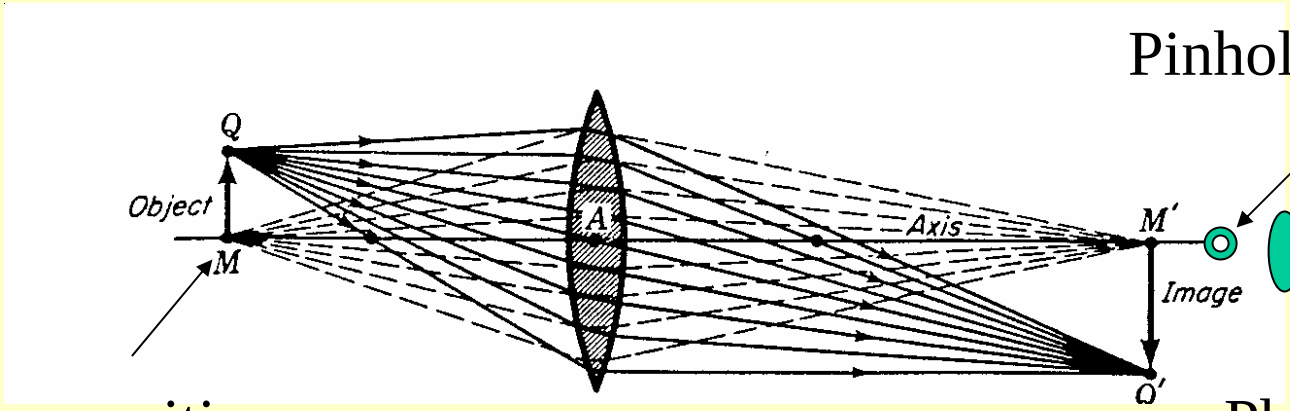
1. Intensity Monitor, $\Delta I/I < 0.1\%$ for about 5 min.
2. BPM $\leq 1\mu m$ rms.
3. PBPM $\leq 1\mu m$ rms.
4. Beam size monitor $\leq 1\mu m$ rms.

Mechanical stability requires about 0.1 μm

1. ΔI/I Monitoring System

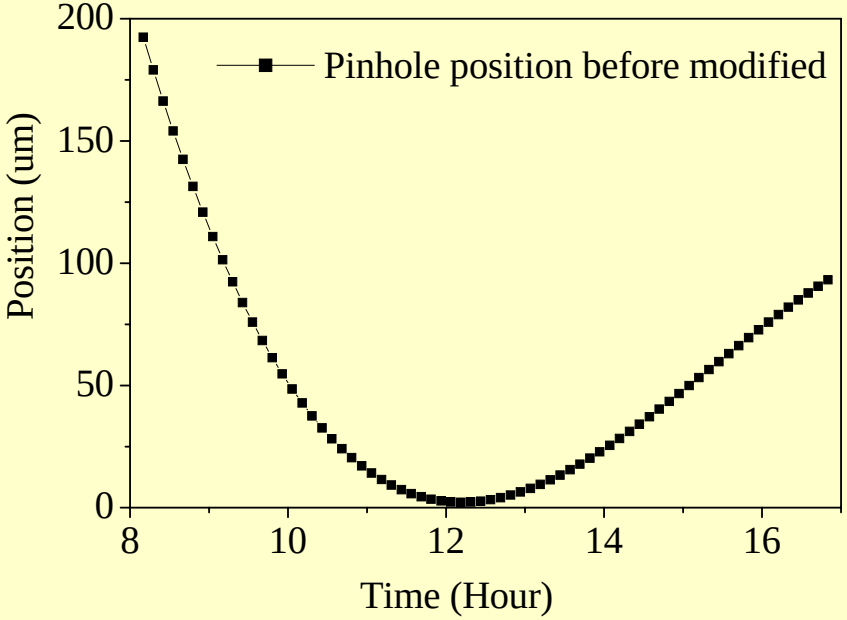


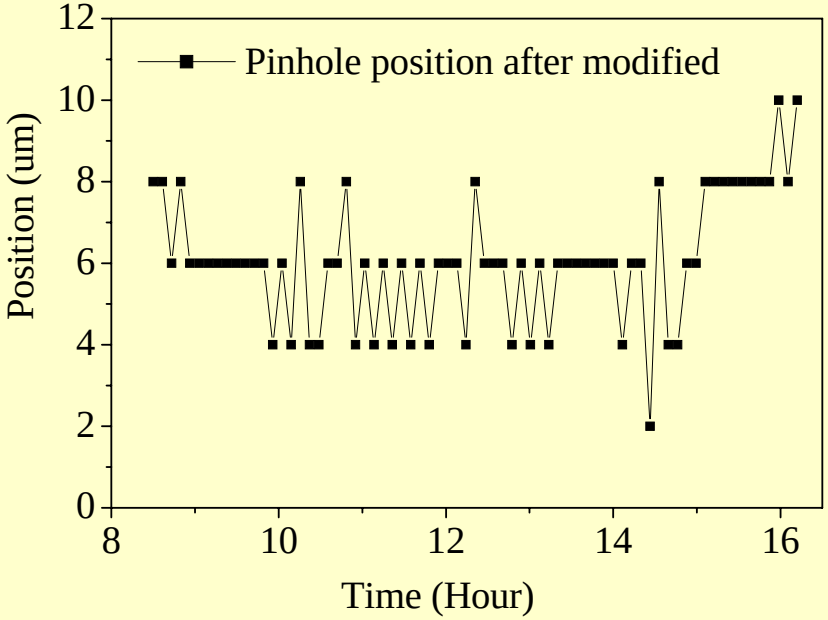
Io Monitor physical concept



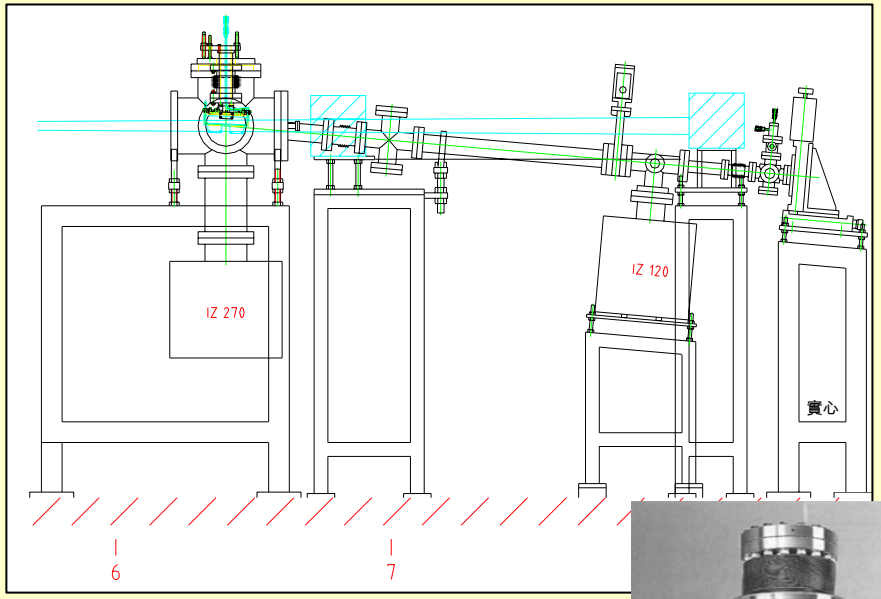
1. Source position change 3um, image position change 1um, ΔI/I change 0.1%.
2. The mechanical stability requirement is 0.1 um, for ΔI/I variation about 0.01%

Chamber deformation of Io monitor

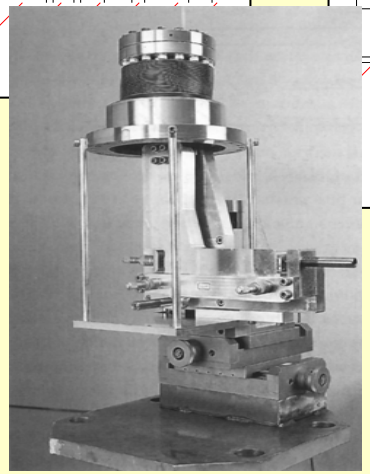


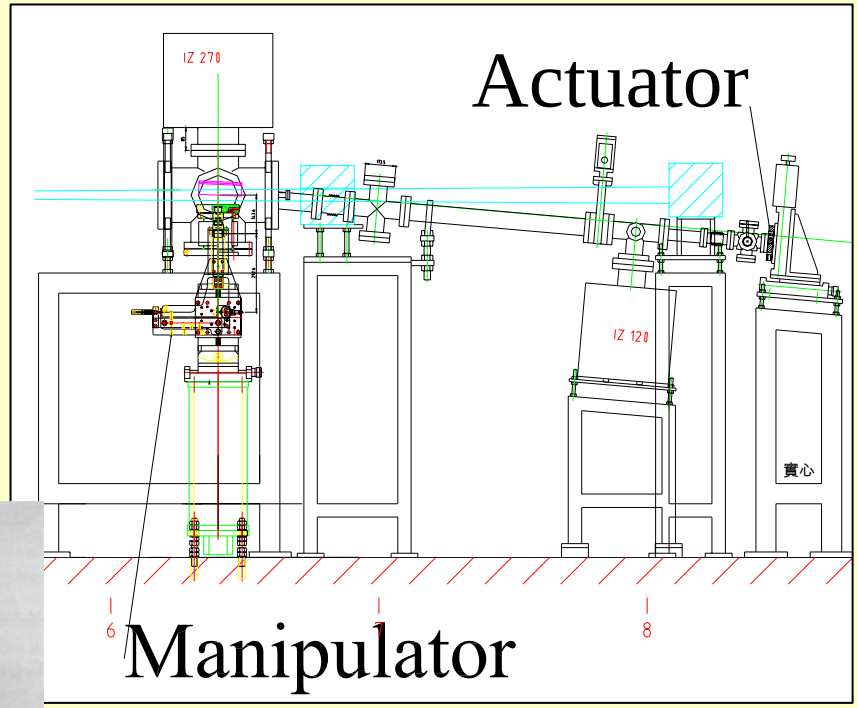


Chamber layout of Io Monitor



Before improvement



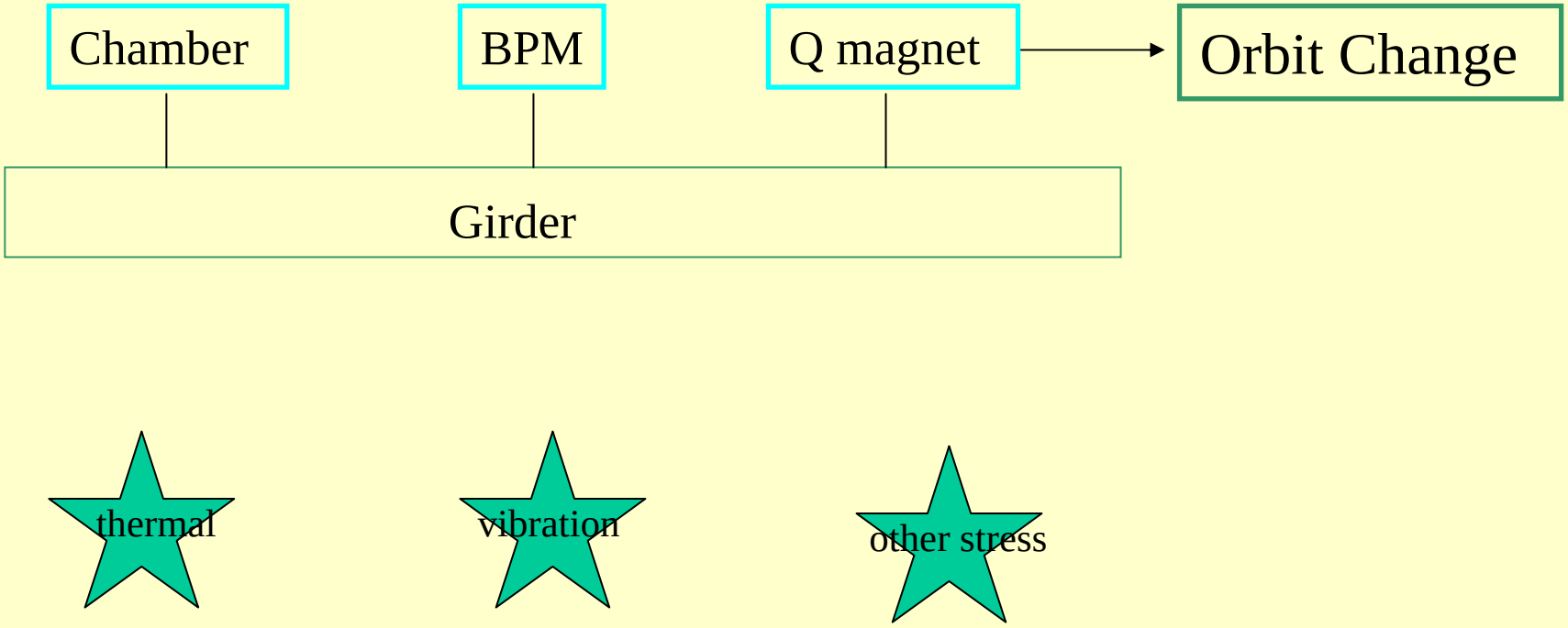


After improvement

2. Deformation of Magnet assembly

1.Magnet
2.Girder
3.Chamber and BPM

Mechanical interplay on Beam Stability



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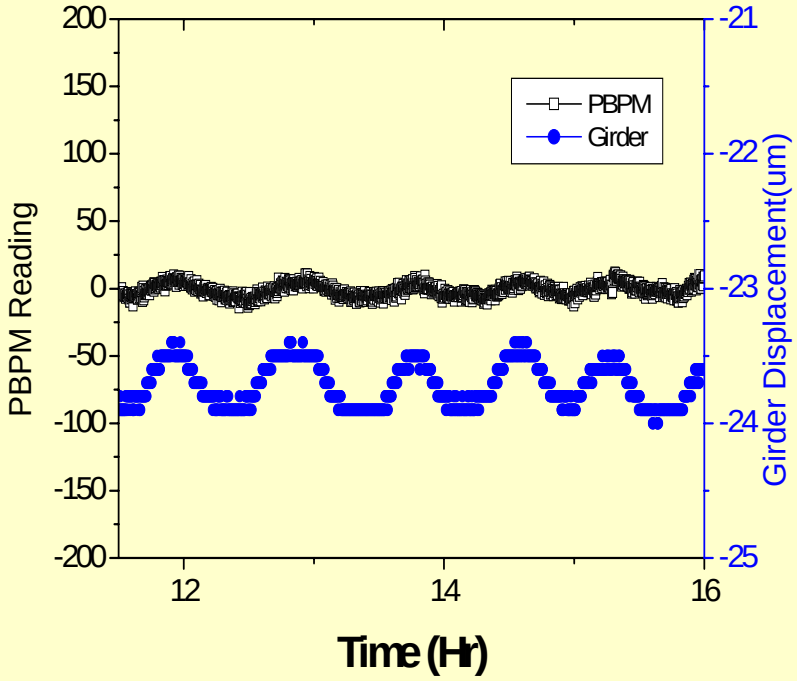
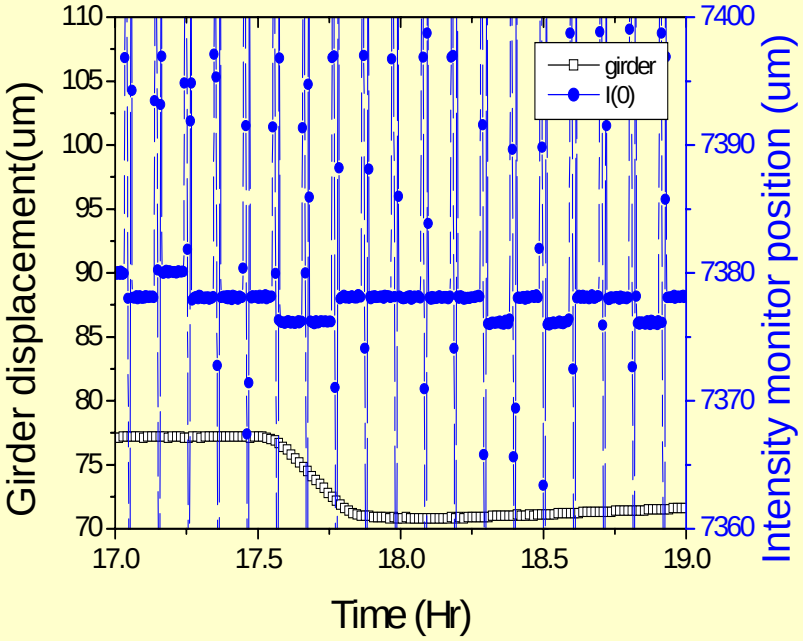
Machine Study

Girder height change versus beam position



1um girder, 20um PBPM



7um girder, 3um Io pinhole position

Different mechanism of magnet motion

1. Pedestal expansion, α = 11ppm for steel.
2. Girder bending by temperature gradient.

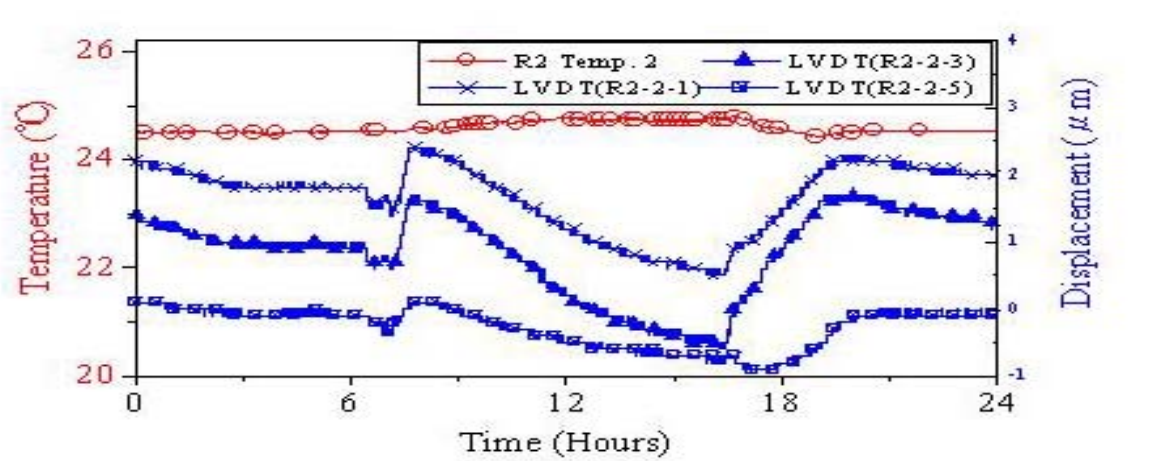
   (2m long, 30cm thick, 0.1C. $\rightarrow$ 1.6um sag.)

3. Chamber expansion out of control.

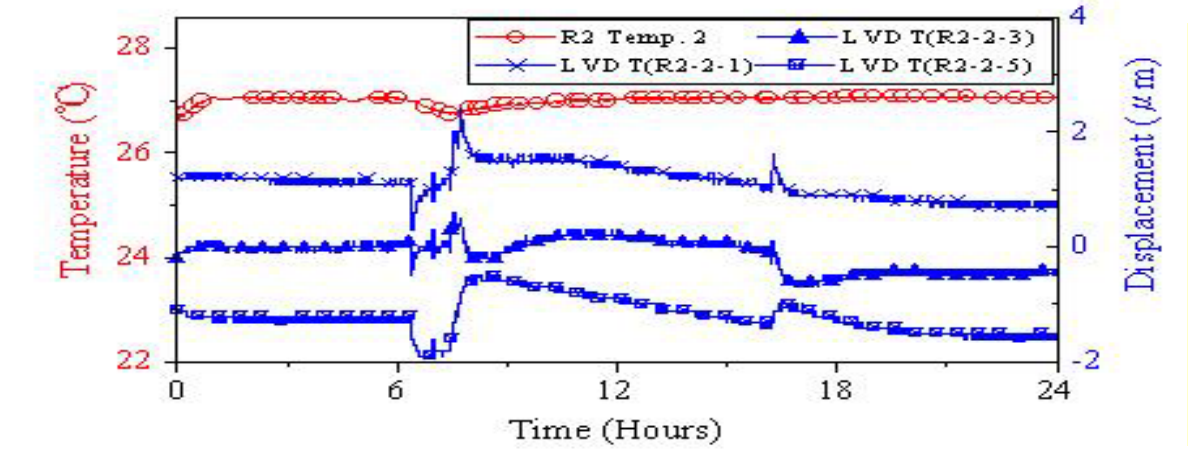
Verify the mechanism then take actions

Girder height change by air temperature

Before insulation, 0.2C, 2um

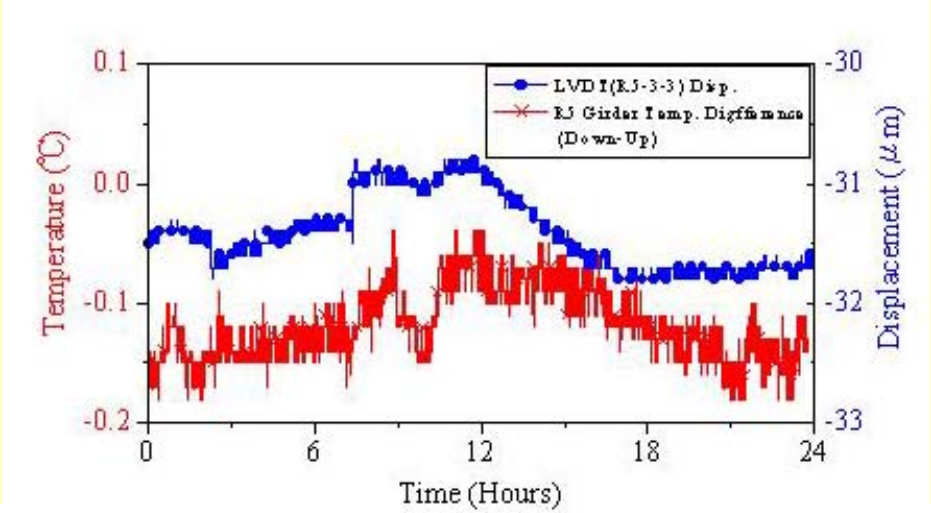


After insulation, 0.2C, 0.5 um

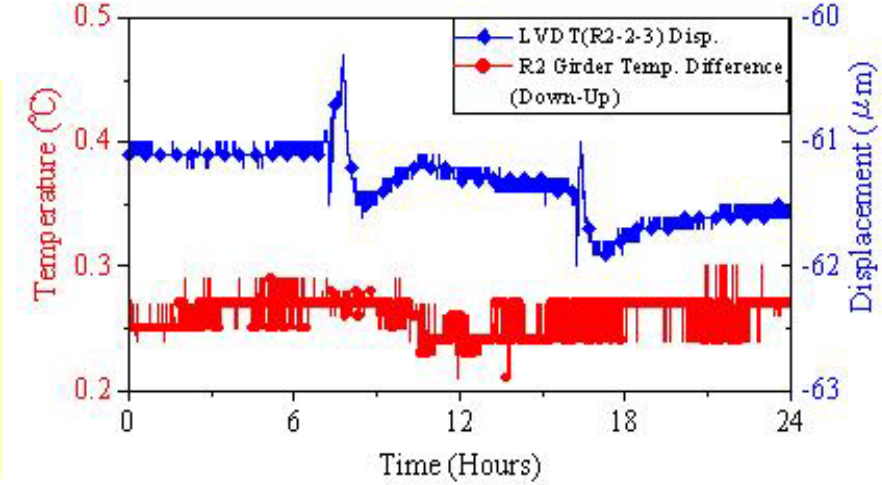


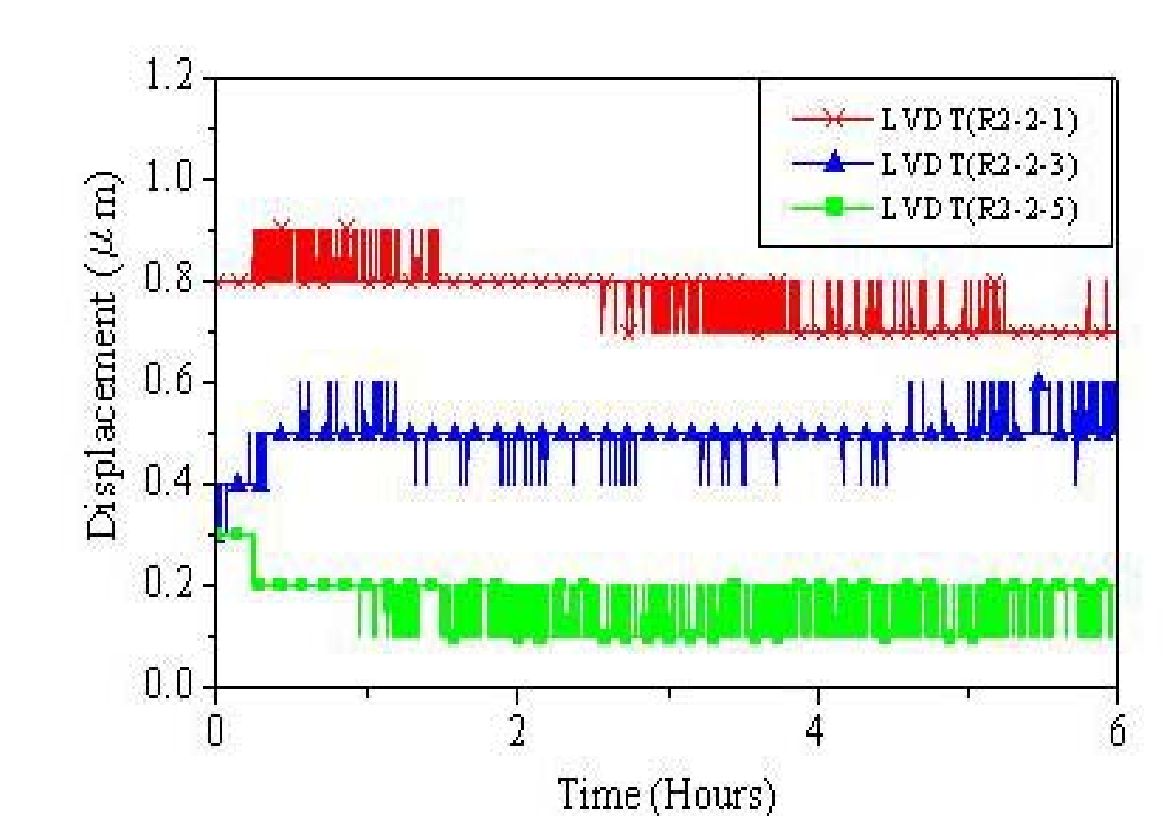
Girder bent by temperature gradient of girder

Temp gradient 0.2 C, 1um, before insulation



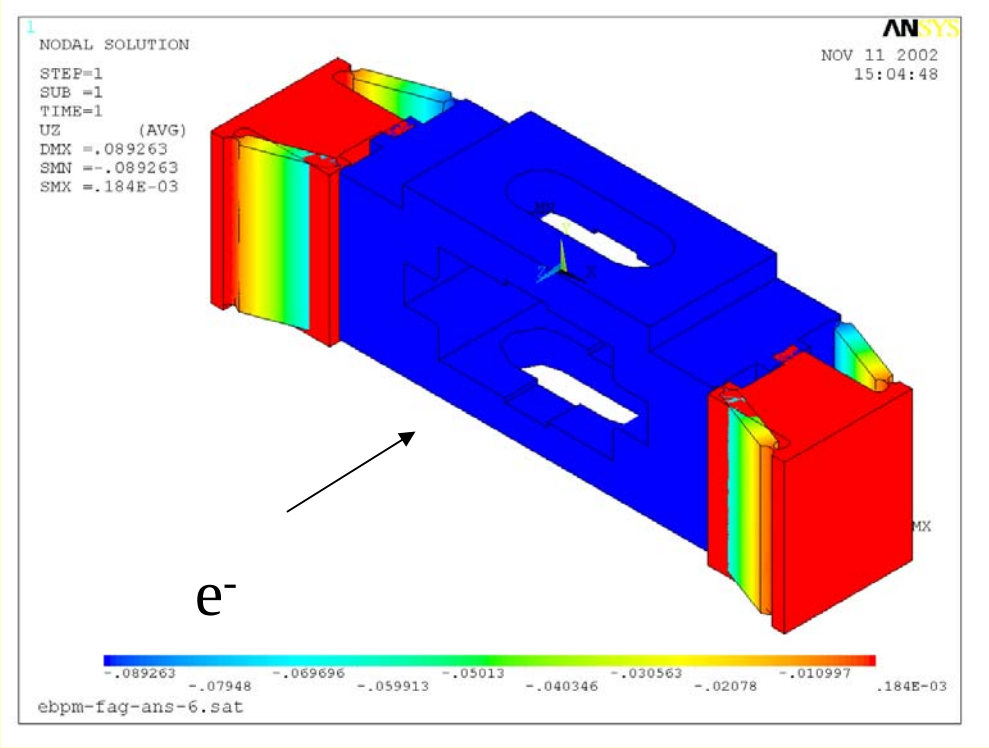
Temp gradient 0.05 C, 0.2um, after insulation



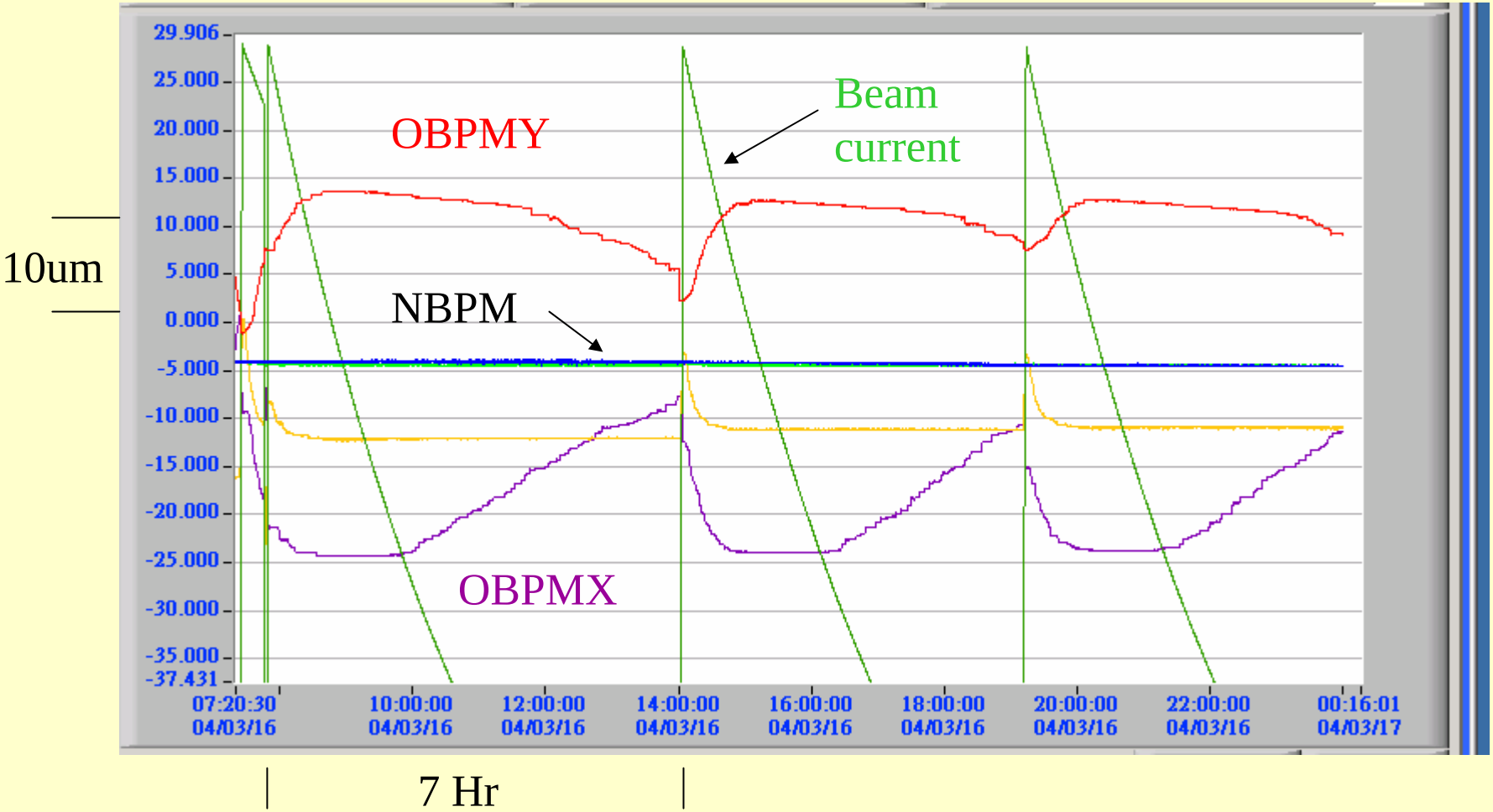


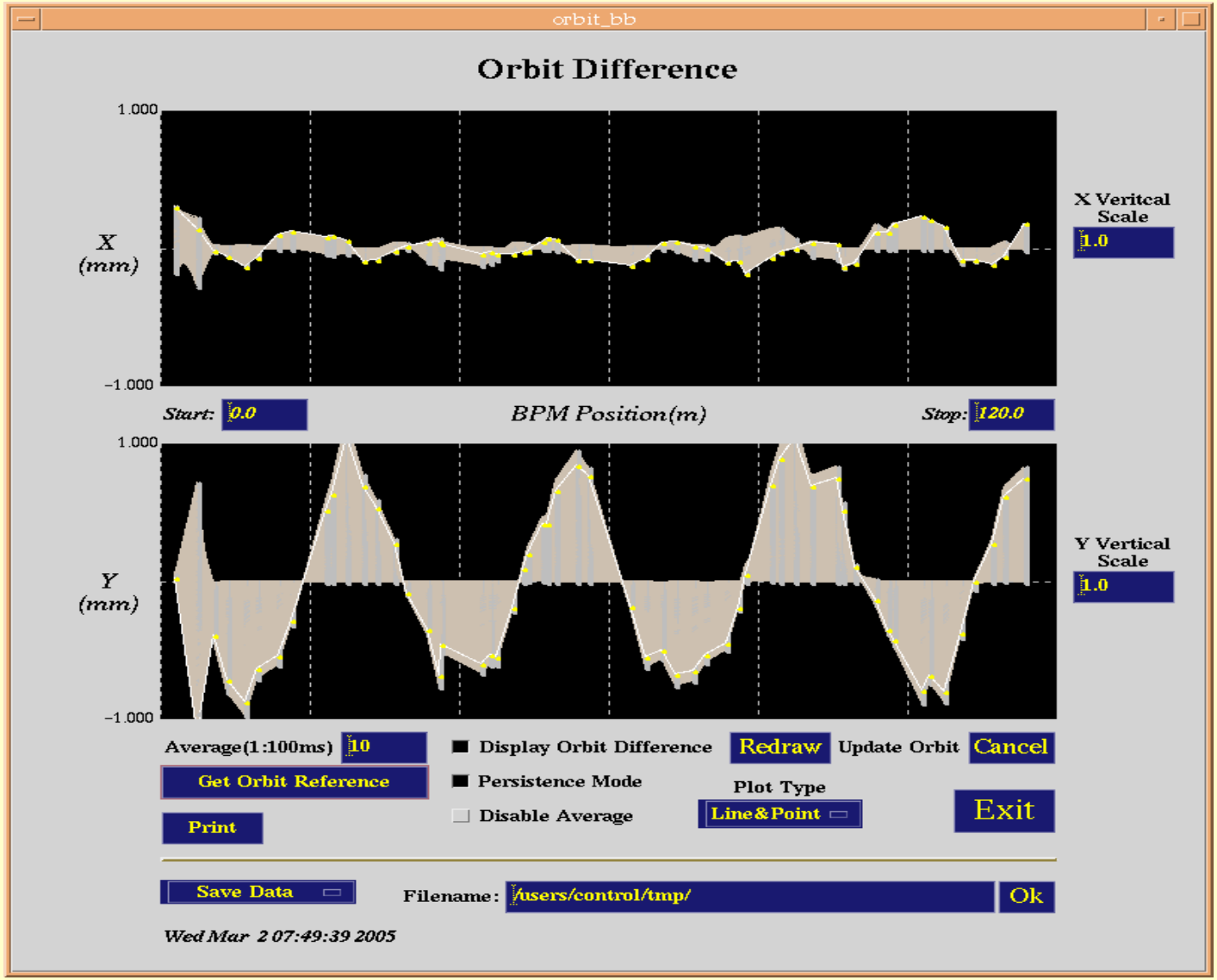
1. **Do the thermal insulation**
2. **Reducing the chamber expansion effect.**

3. New BPM Fixture for Relieving Chamber Expansion



Effect of BPM Fixture

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Stop: 120.0
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Y
(mm)
-1.000
Y Vertical Scale
1.0
Average(1:100ms) 10
Display Orbit Difference
Redraw
Update Orbit
Cancel
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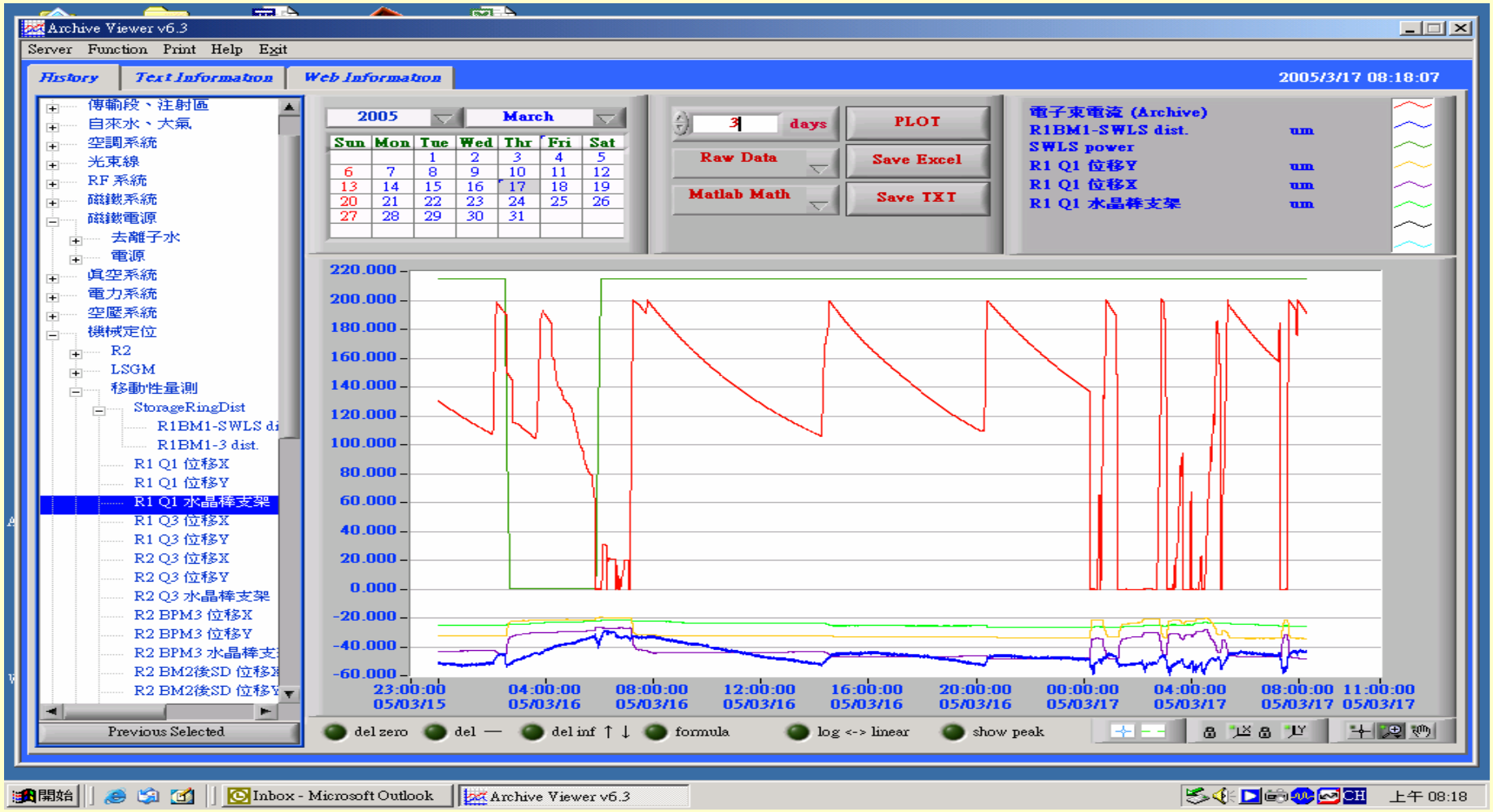
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磁鐵電源
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電源
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電力系統
空壓系統
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R2
LSGM
移動性量測
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R1BM1-SWLS di
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R1 Q1 位移X
R1 Q1 位移Y
R1 Q1 水晶棒支架
R1 Q3 位移X
R1 Q3 位移Y
R2 Q3 位移X
R2 Q3 位移Y
R2 Q3 水晶棒支架
R2 BPM3 位移X
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R2 BPM3 水晶棒支
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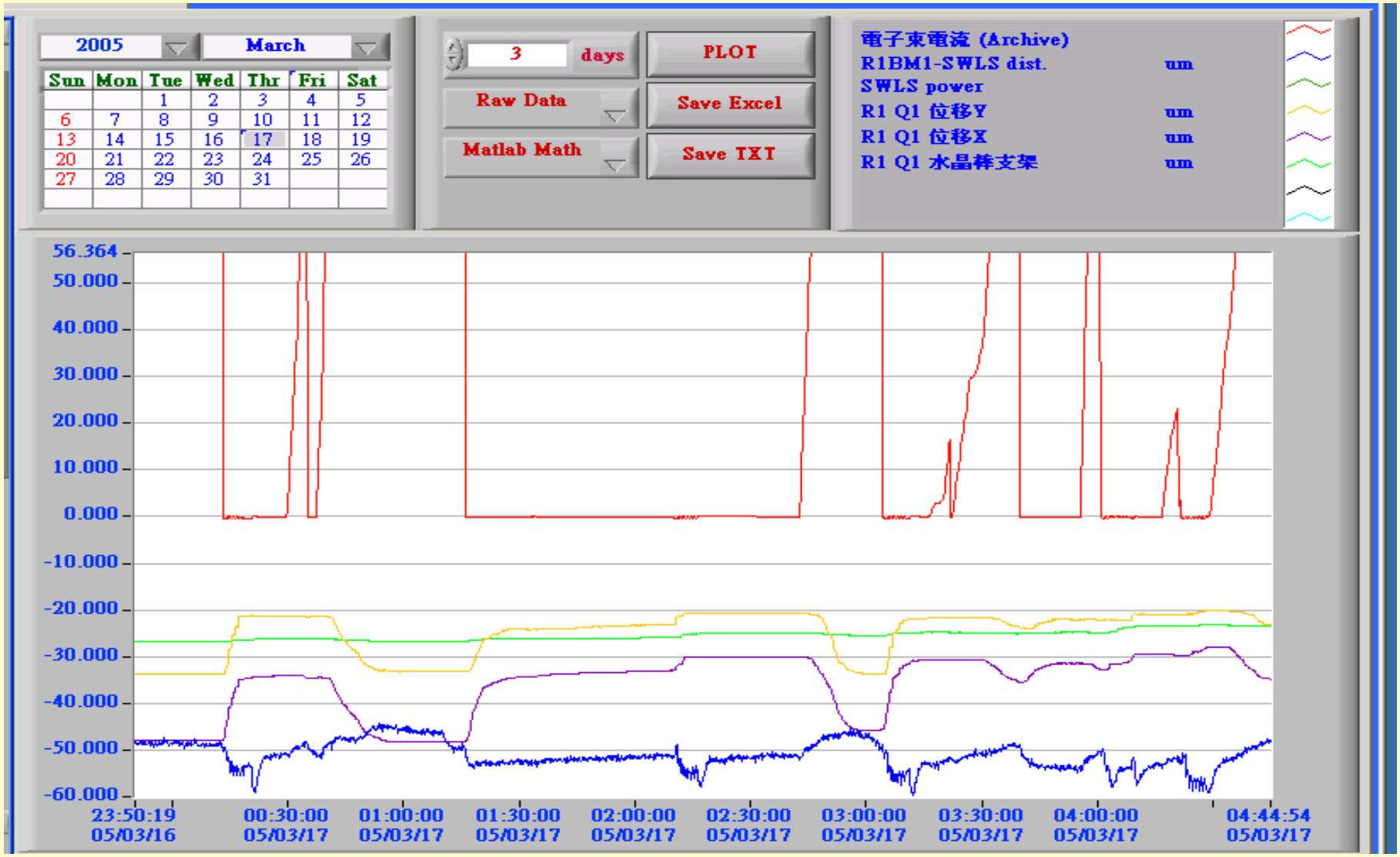
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3 days
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Matlab Math
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電子束電流 (Archive)
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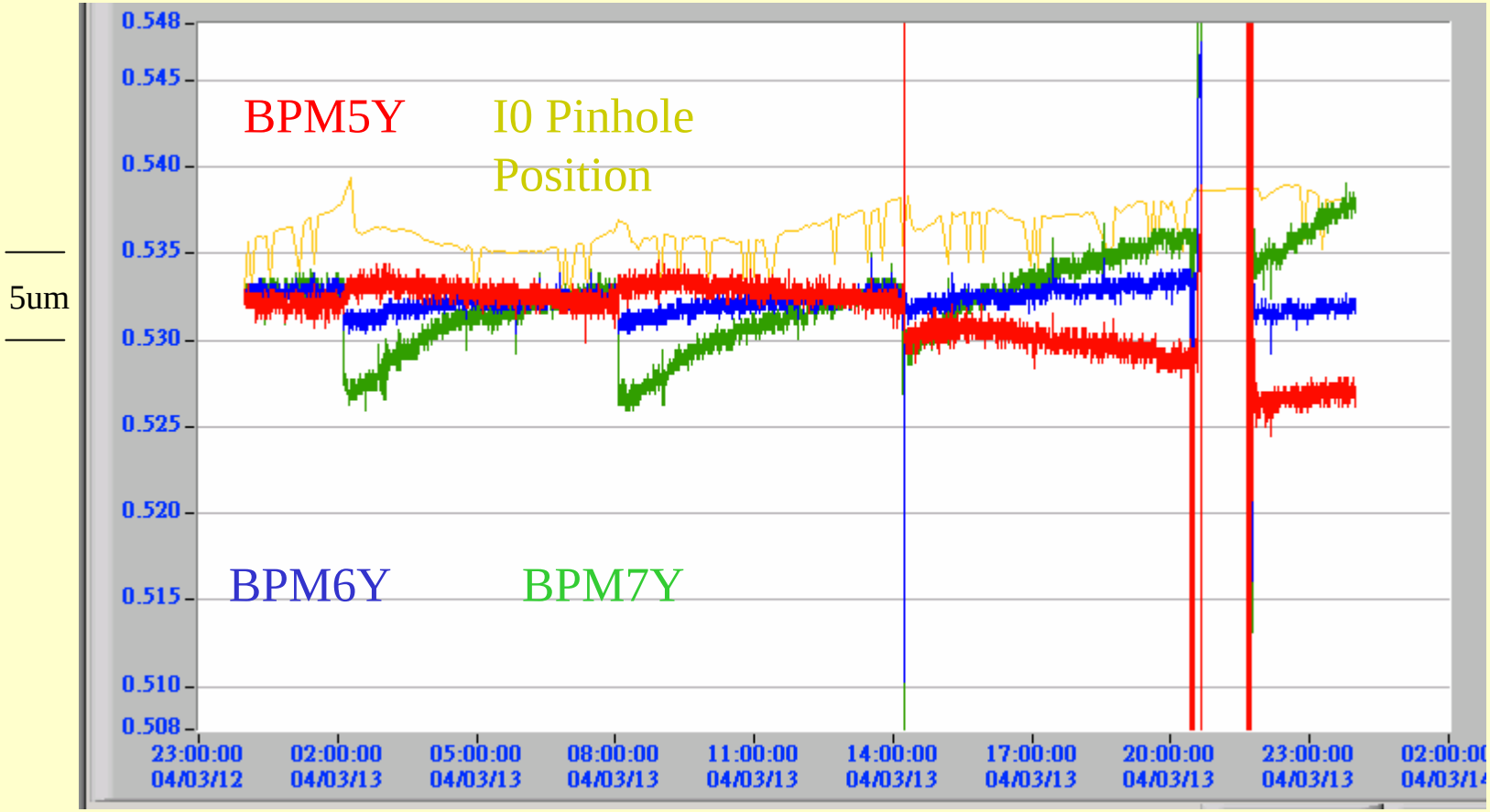
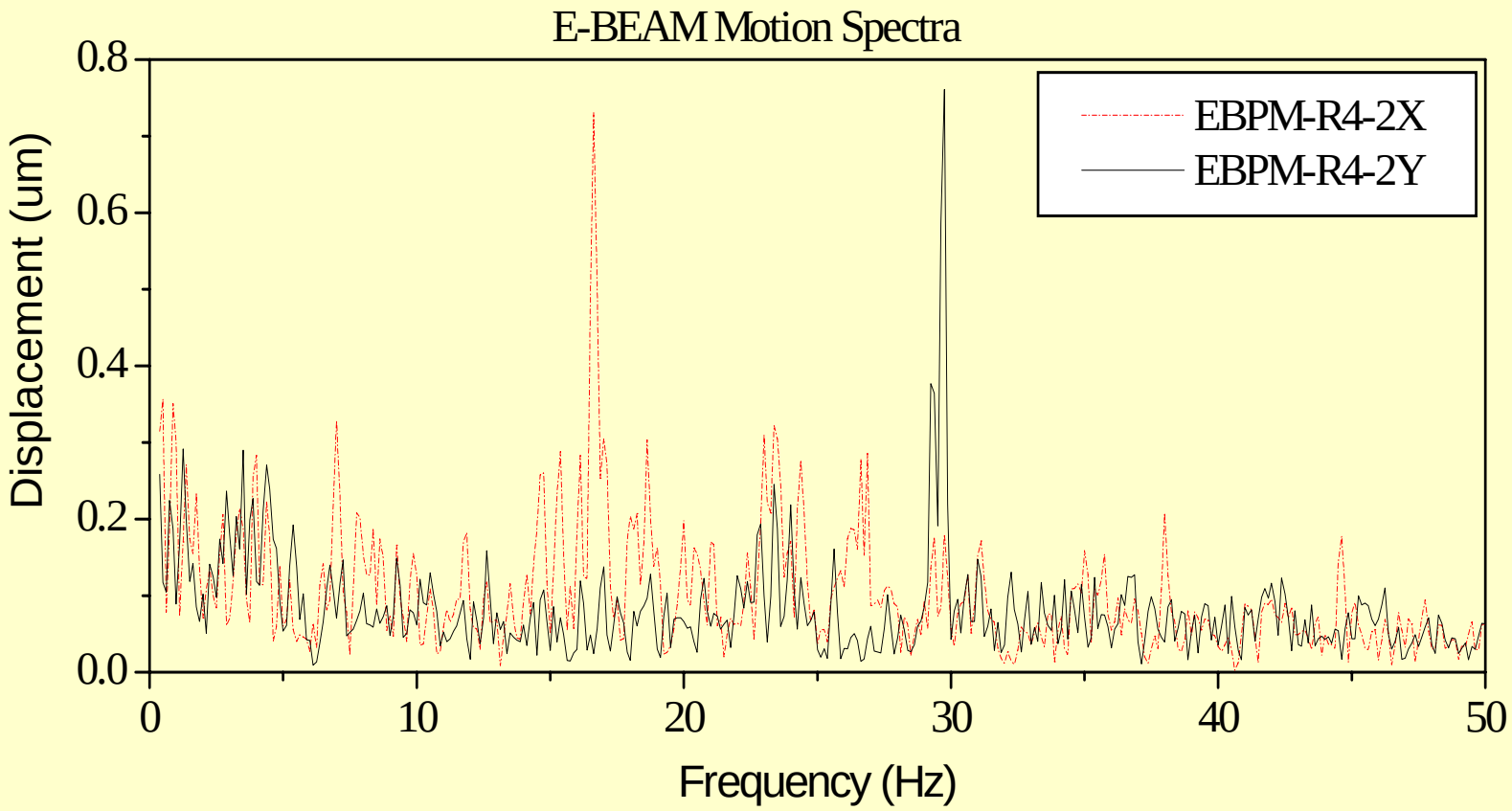
Stability Status of Ring By EBPM

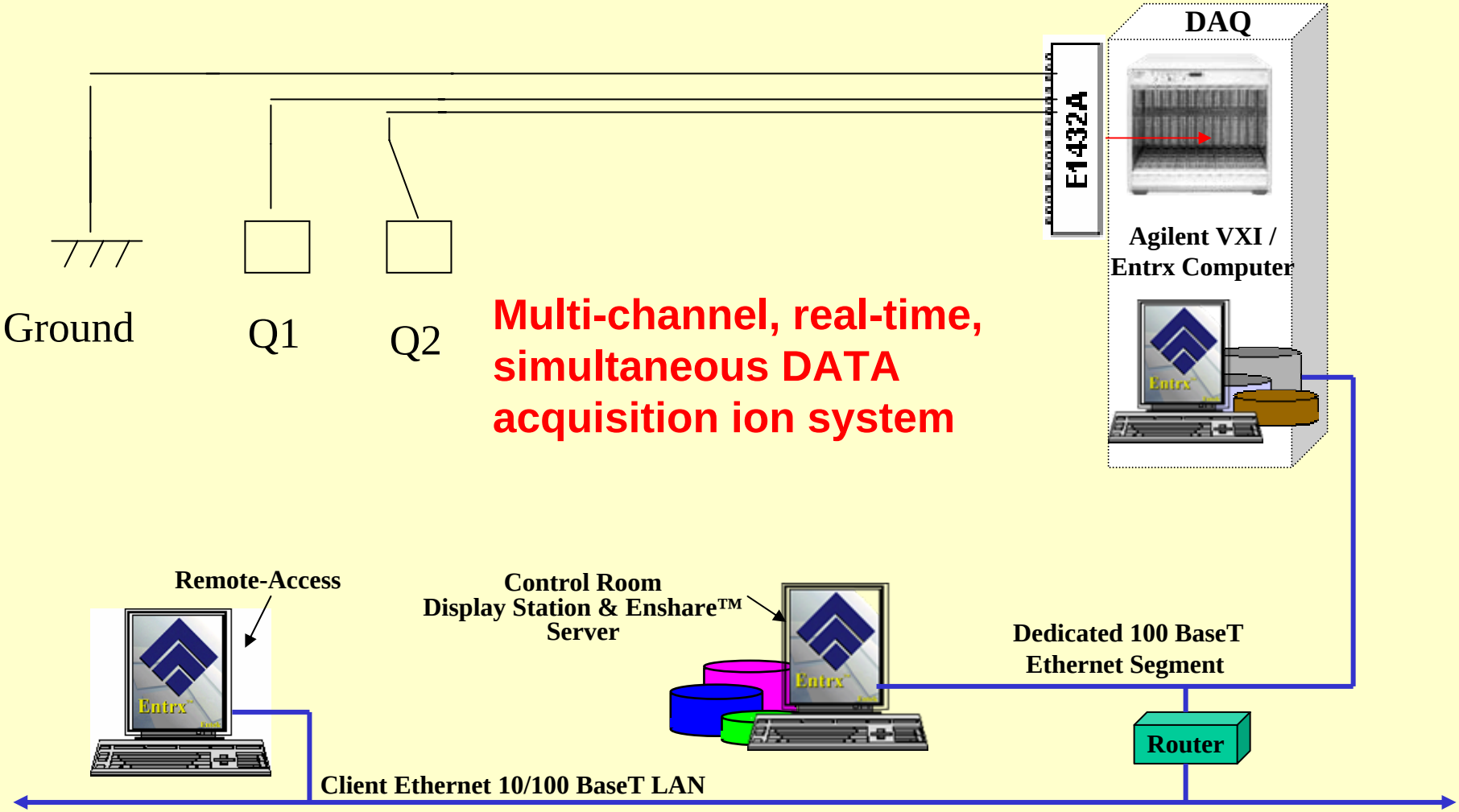


1 day

Vibration Spectrum of EBPM

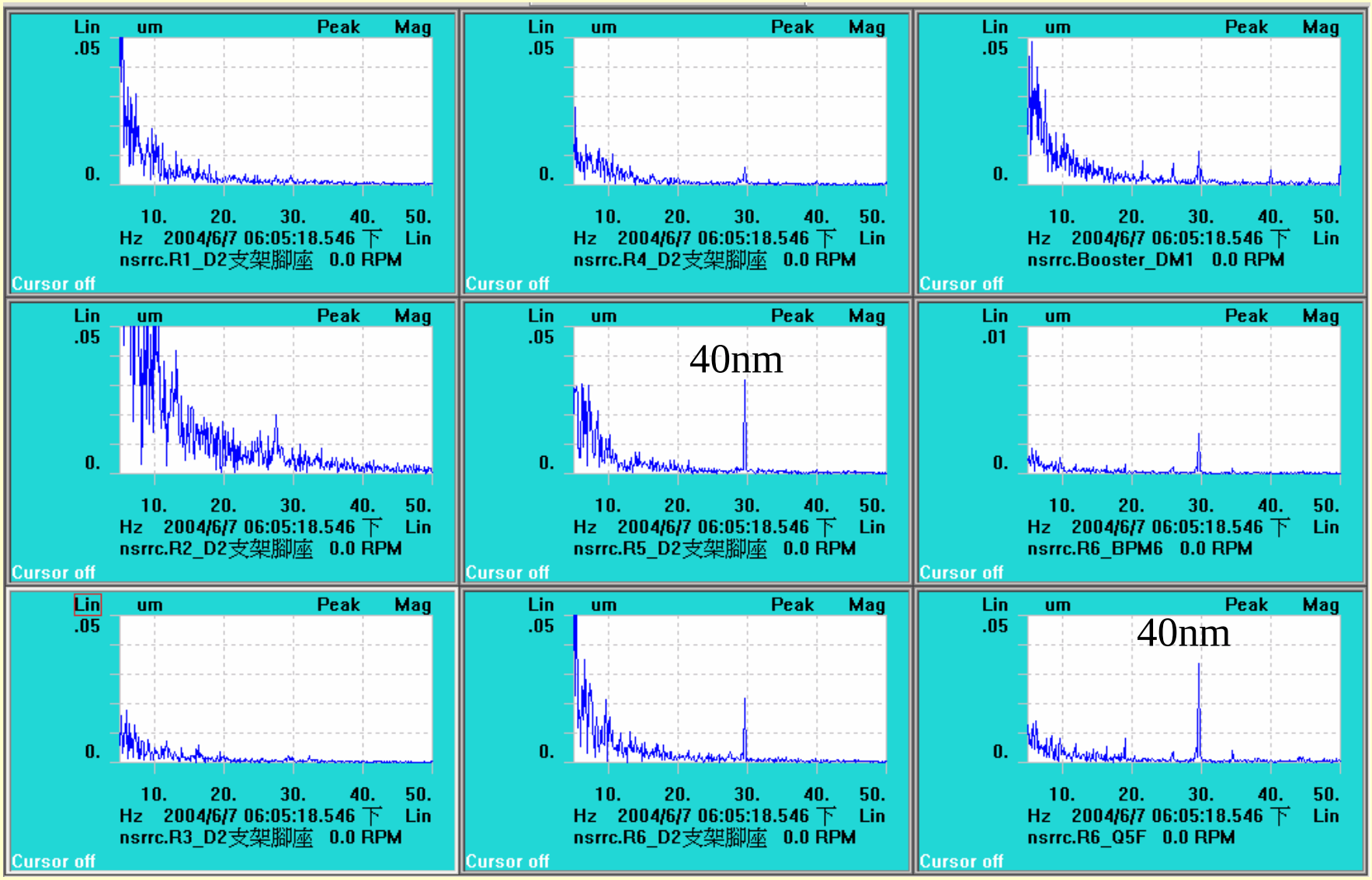


Agilent VXI/ Entrx system

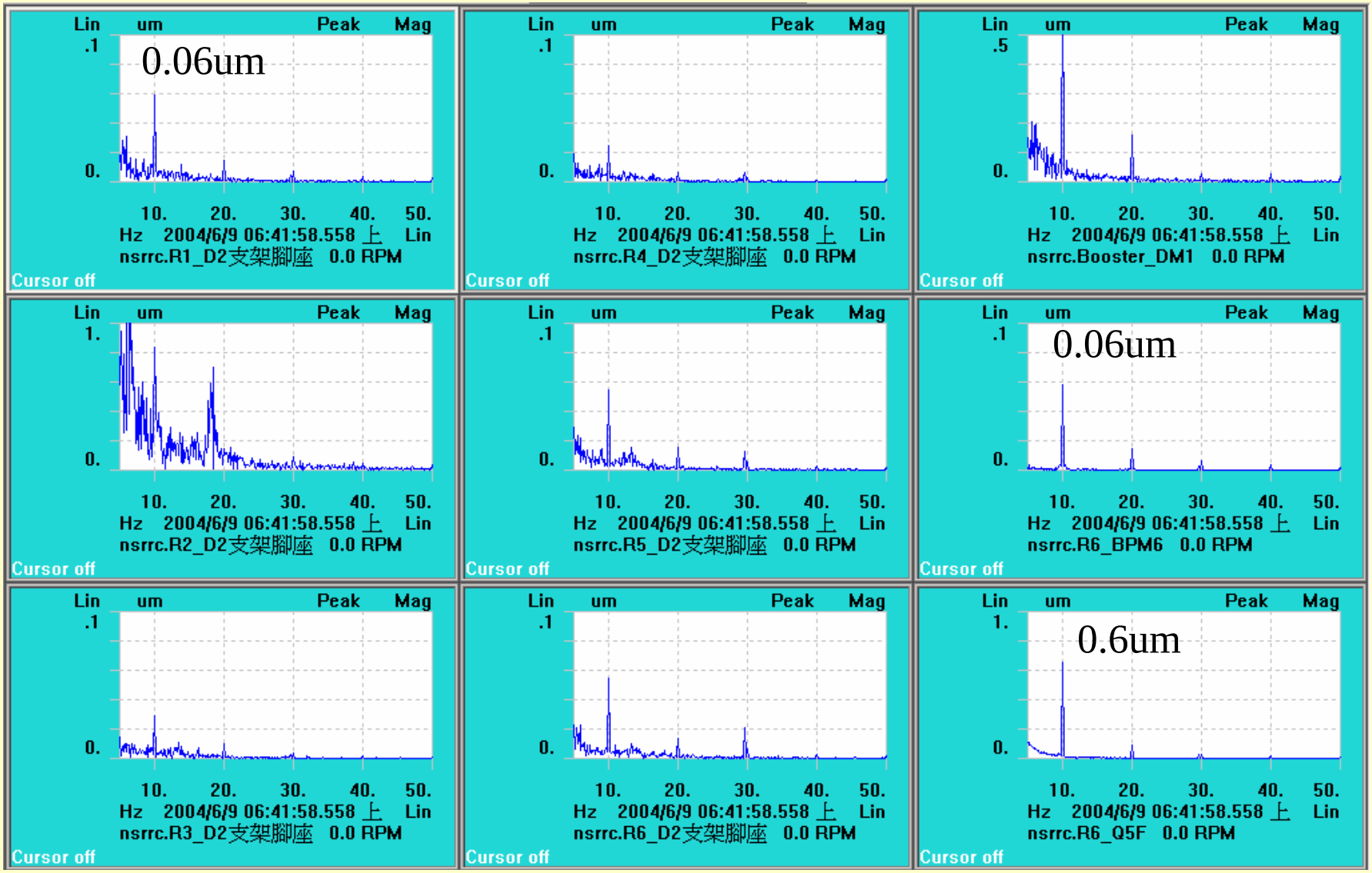


SENSOR SIGNAL CONDITIONER
MODEL SERIES 481
PCB PIEZOTRONICS
RESET
INPUT FAULT
OVERLOAD
OUTPUTS
Agilent
2005/ 4/11

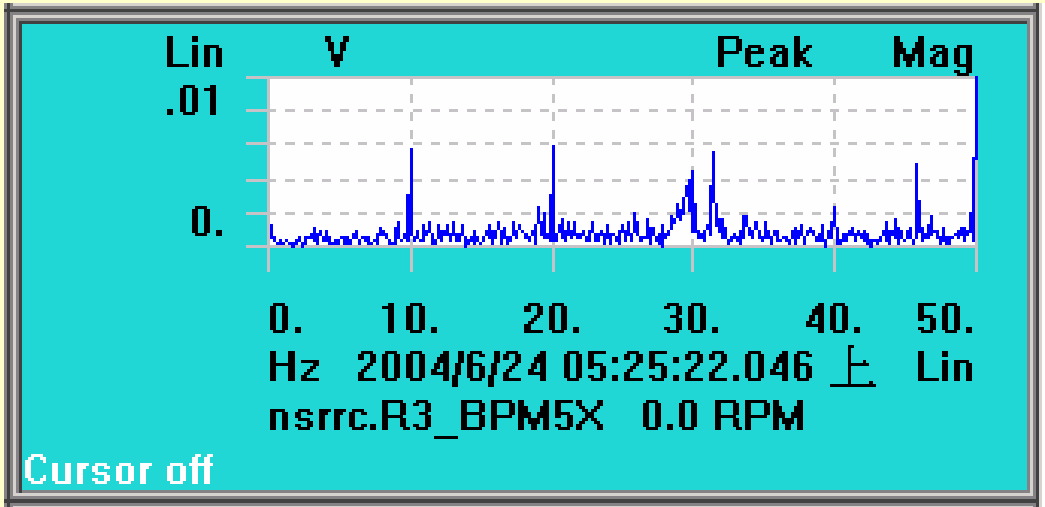
Vertical Vibration Spectrum



Vertical Vibration Spectrum in Top-Up

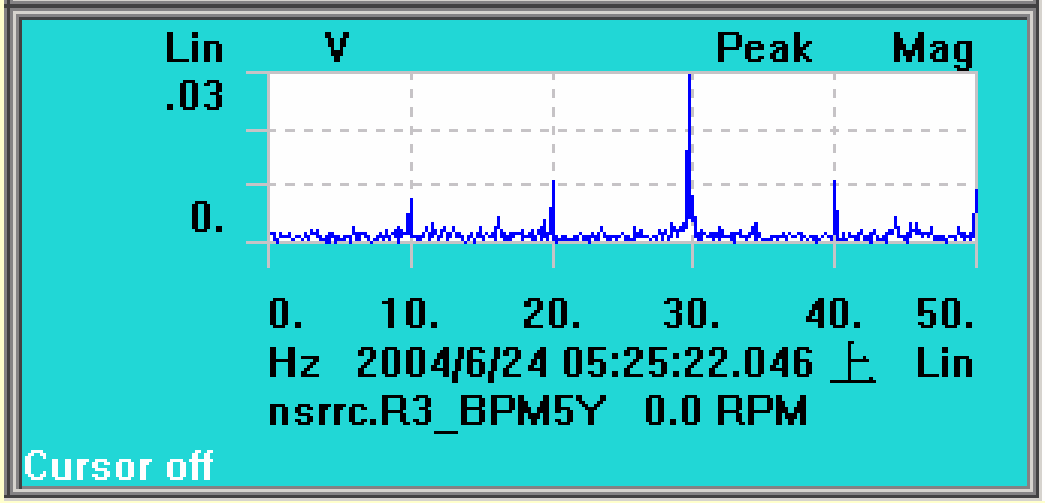


Response of EBPM in Top Up



R3 BPM5X

1V=1.7mm
10 um @10 Hz



R3 BPM5Y

1V=1.5mm
15um @10Hz

Summary of Improvement

1. Monitoring system	Independent mirror manipulator
2. Girder height change	Insulation, A/C improvement
3. Girder temperature gradient	Insulation
4. Chamber deformation	New BPM Fixture
5. Vibration Suppression	Composite material Double stage spring

Conclusion

- On-line measurement shows us the direction to do improvements.
- Explore deformation mechanism and take right actions .