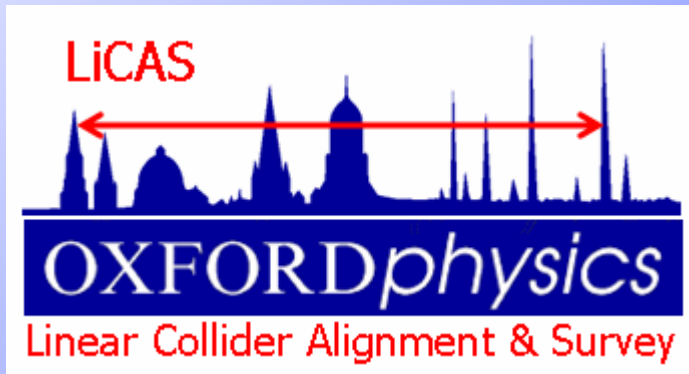


Initial Calibration and Stability Results from the LiCAS RTRS FSI System

John Dale for the LiCAS Collaboration
IWAA February 2008

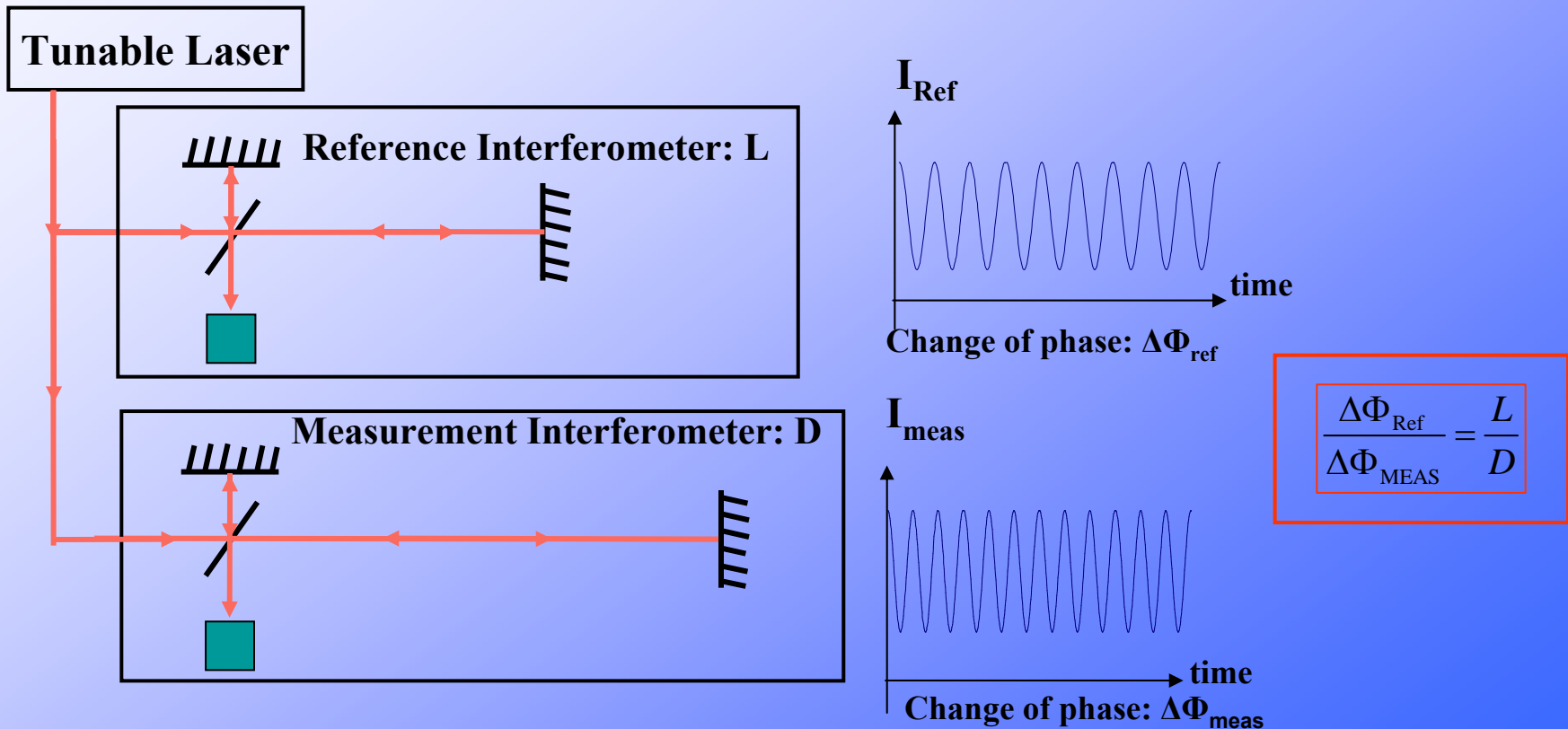


Introduction

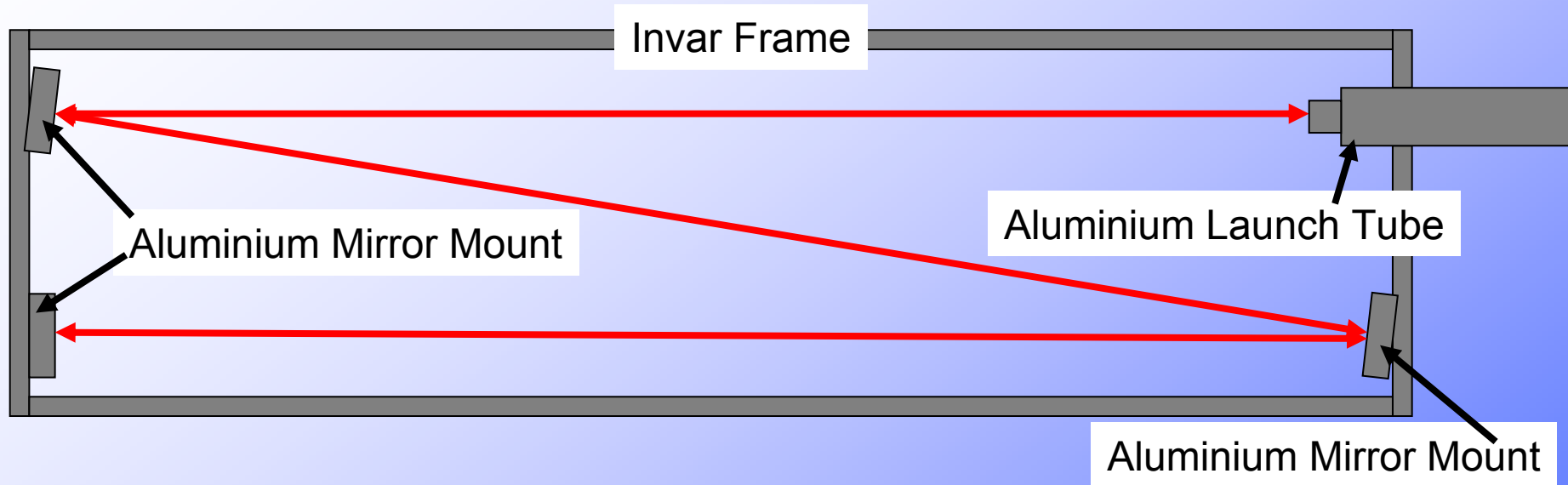
- Frequency Scanning Interferometry (FSI)
- Reference Interferometers
 - Design
 - Initial Length Calibration
 - Initial Thermal Calibration
- LiCAS Train FSI Measurement Sub-Systems
 - Initial Stability of the External FSI Sub-System
 - Initial Stability of the Internal FSI Sub-System

Frequency Scanning Interferometry

- Idea is adapted from the Michelson interferometer
- Instead of moving the mirror we change the frequency of the laser

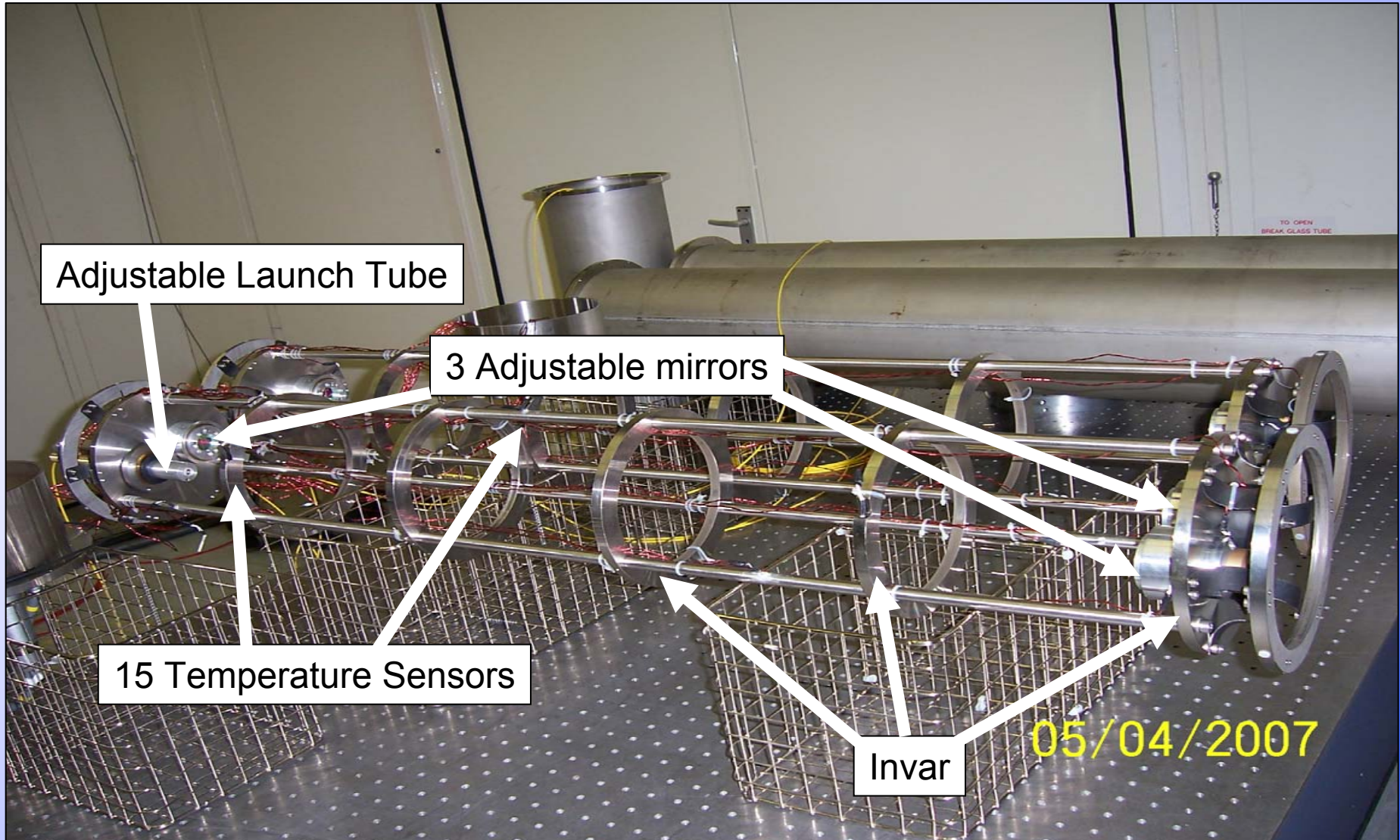


Reference Interferometer Design

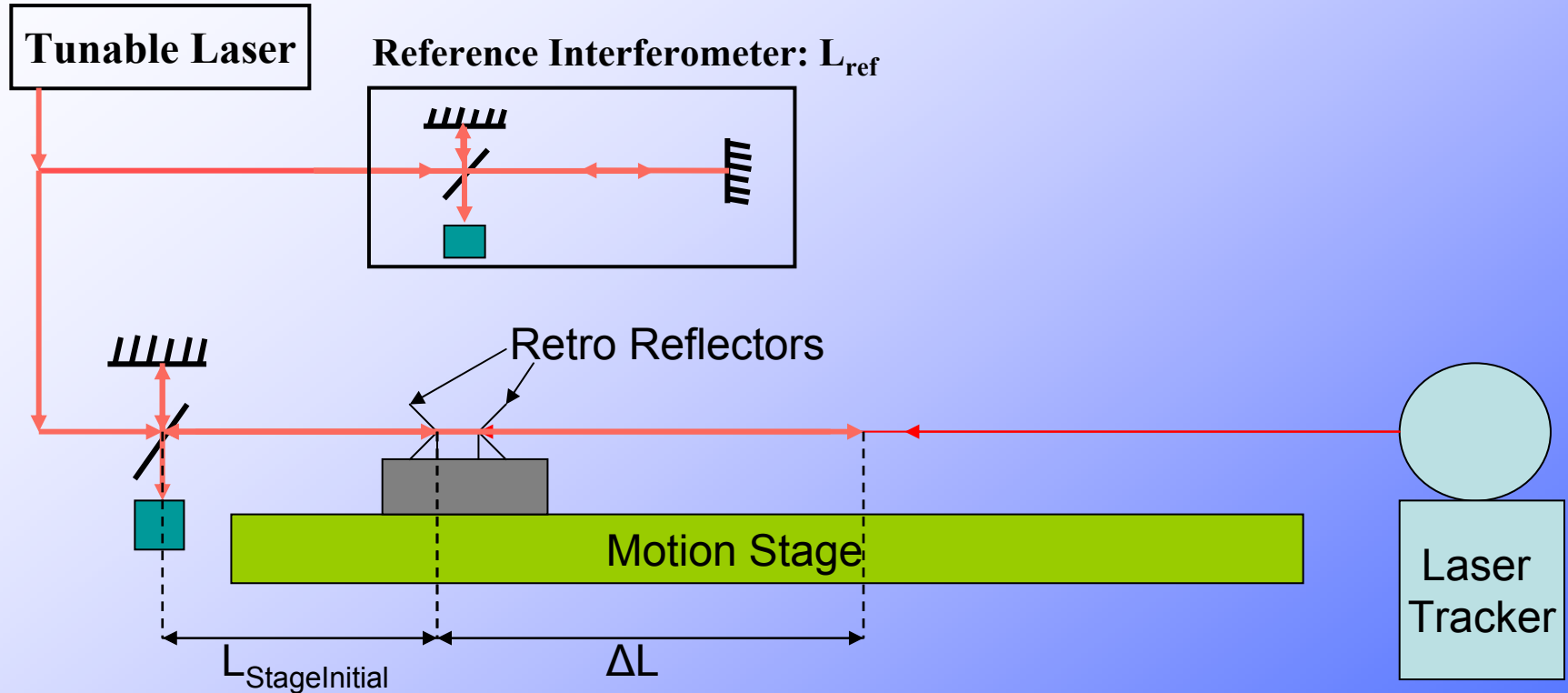


- Folded path interferometer with 6m Optical Path length Difference (OPD)
- Adjustable launch to compensate for thermal Expansion

Reference Interferometer Design



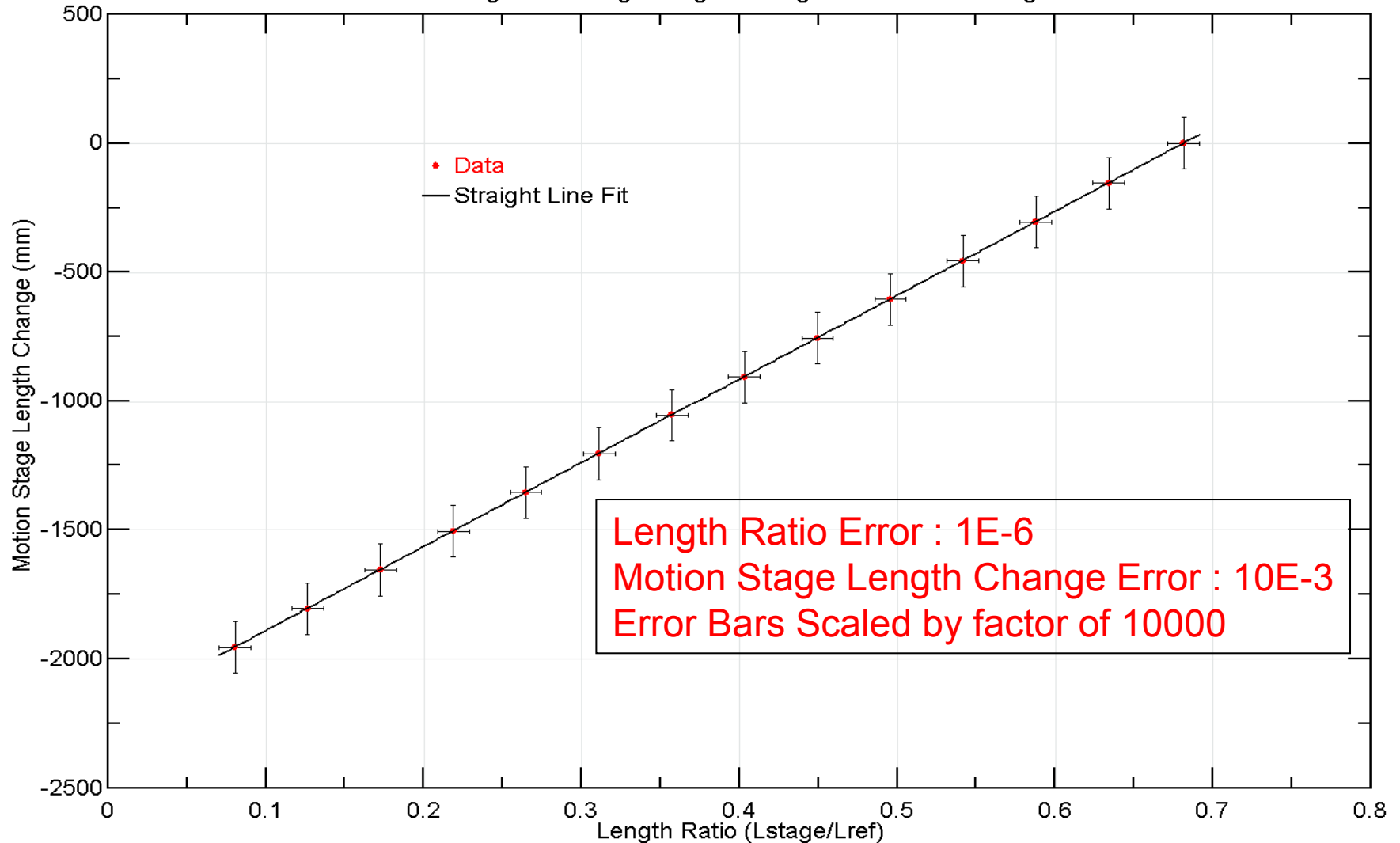
Length Calibration Method



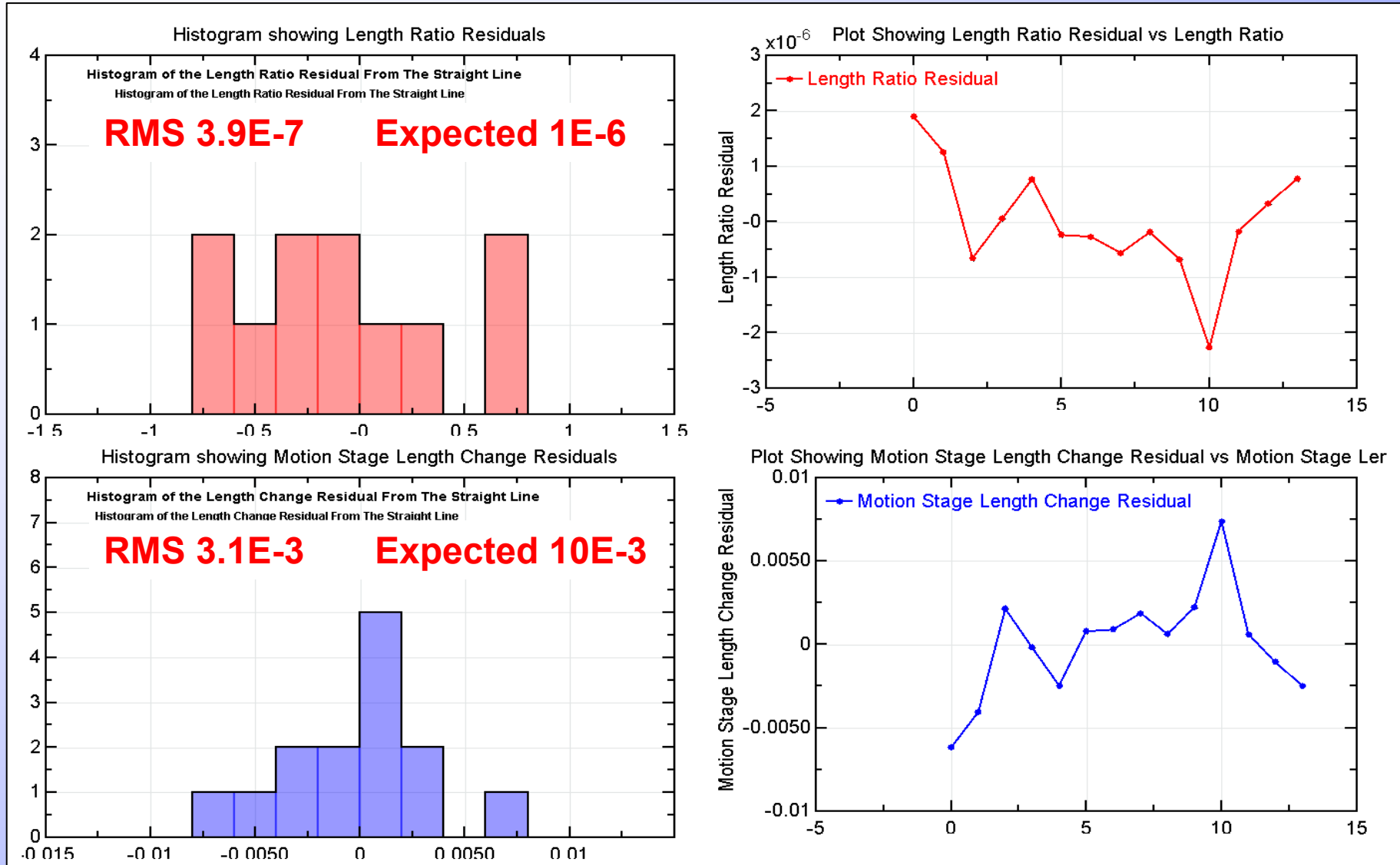
- FSI System Measures Length Ratio at each Position
- Laser Tracker Measure Length Change to each Position

Length Calibration

Plot Showing Motion Sage Length Change Vs Measured Length Ratio



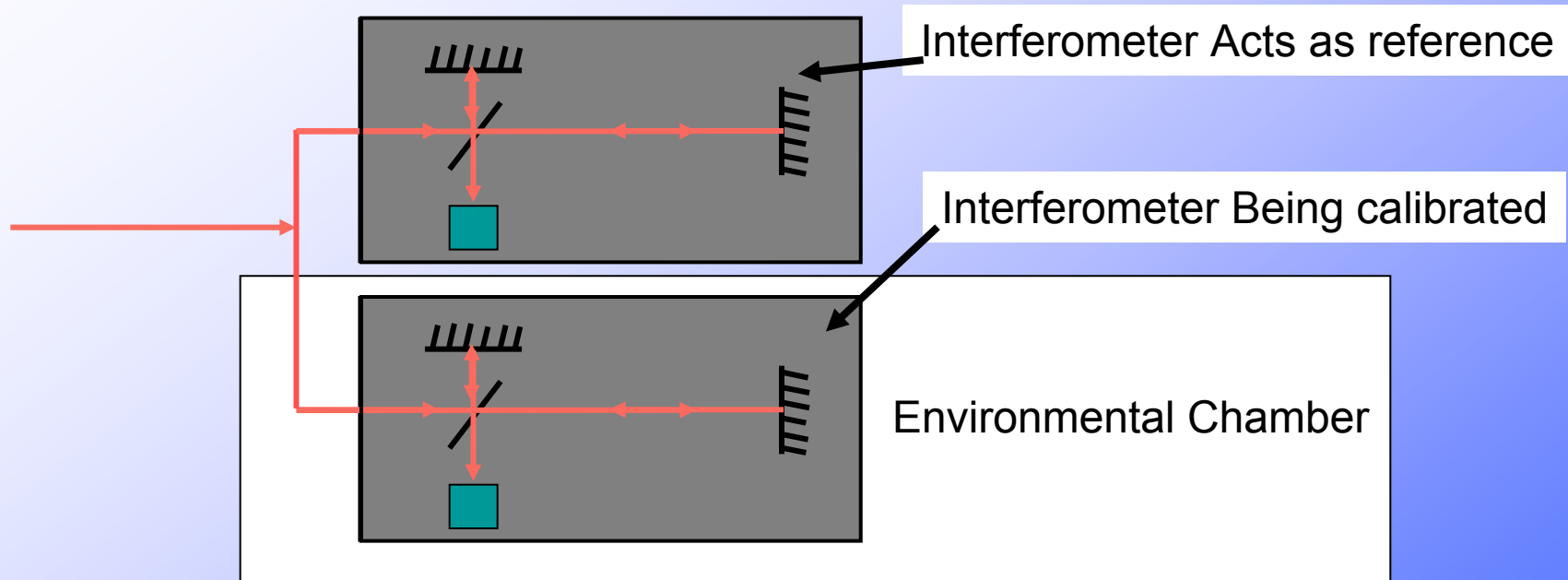
Length Calibration



Length Calibration Fit Results

- Fit give reference length of
 - 3.2521901 +/- 3E-6 m
- To improve value :
 - Take smaller steps
 - Use Laser tracker in optimum position and more accurate mode
 - Cover optical path to reduce air turbulence

Thermal Calibration Method

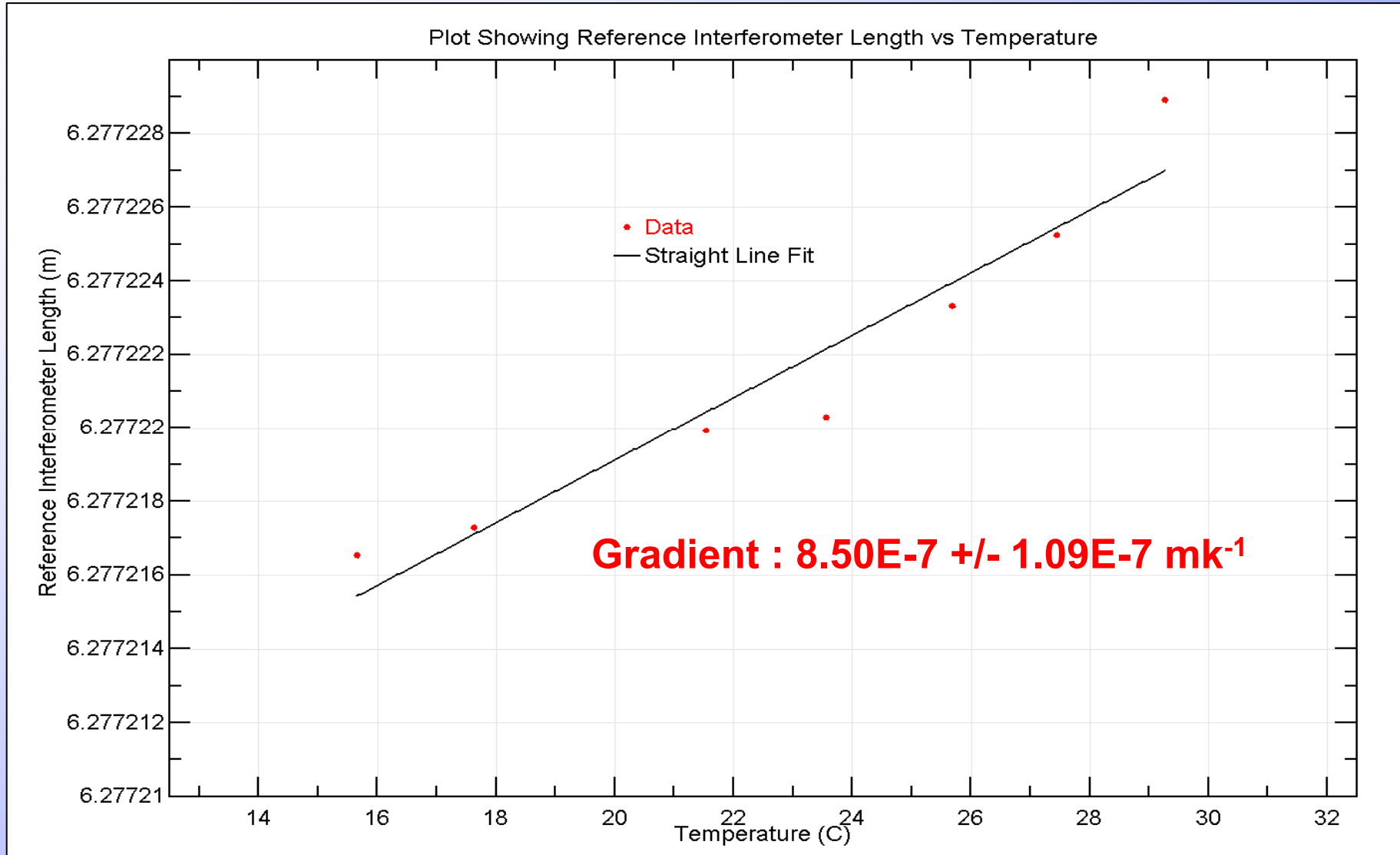


- One Interferometer remains at constant temperature and acts as the reference
- Second interferometer in environmental chamber and is the interferometer under calibration
- Environmental chamber has its temperature changed and the length ratio measured at each temperature

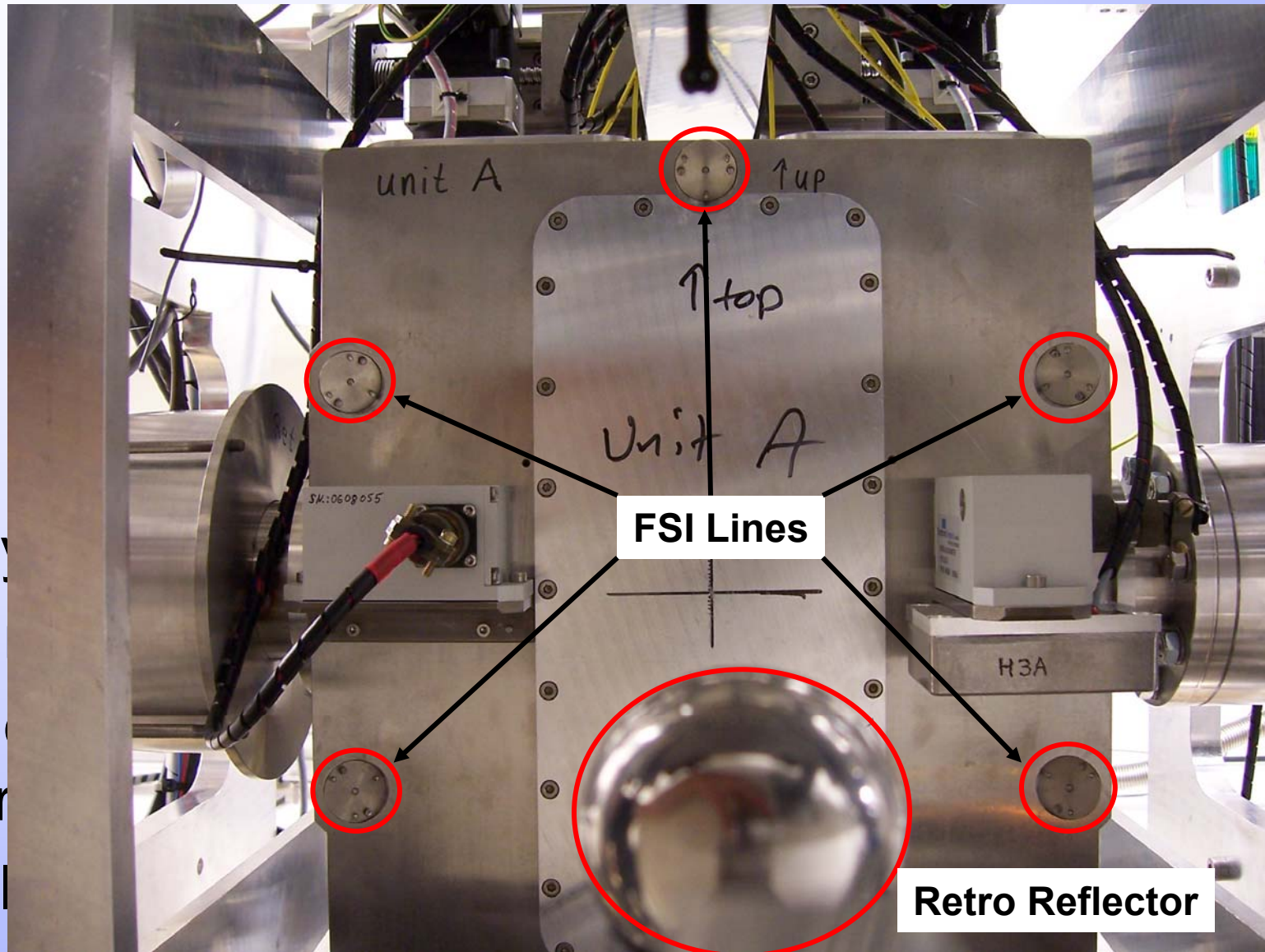
Thermal Calibration Method

- 2 Stages to thermal calibration
 - Stage 1
 - Conduct experiment to determine thermal expansion coefficient
 - adjust the launch tube to minimise thermal expansion coefficient
 - repeat.
 - Stage 2
 - When launch adjustment required is small, repeat experiment
 - Use thermal expansion coefficient for off line corrections

Initial Thermal Calibration Results



External FSI Sub-System

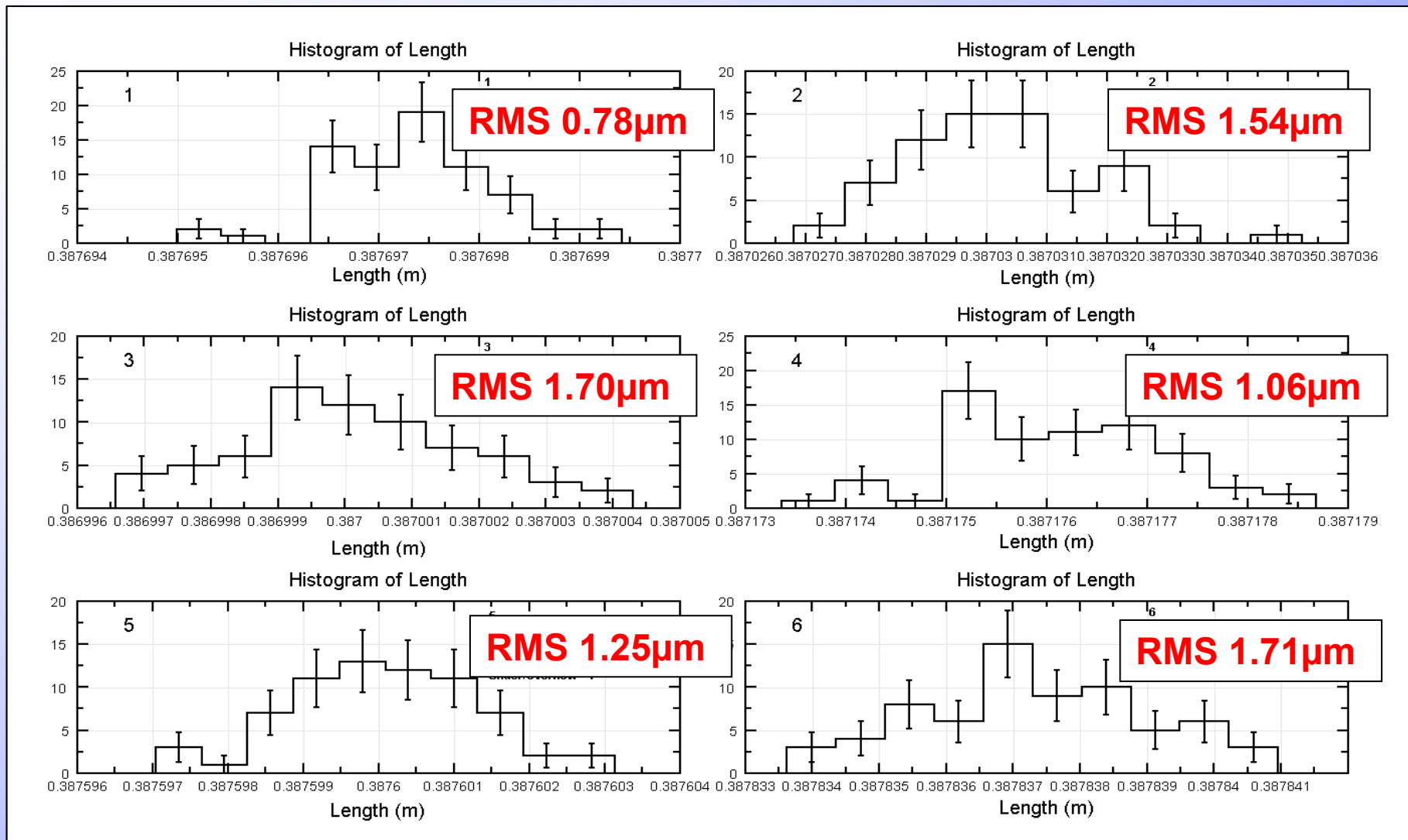


- SY
- U
- N
- or
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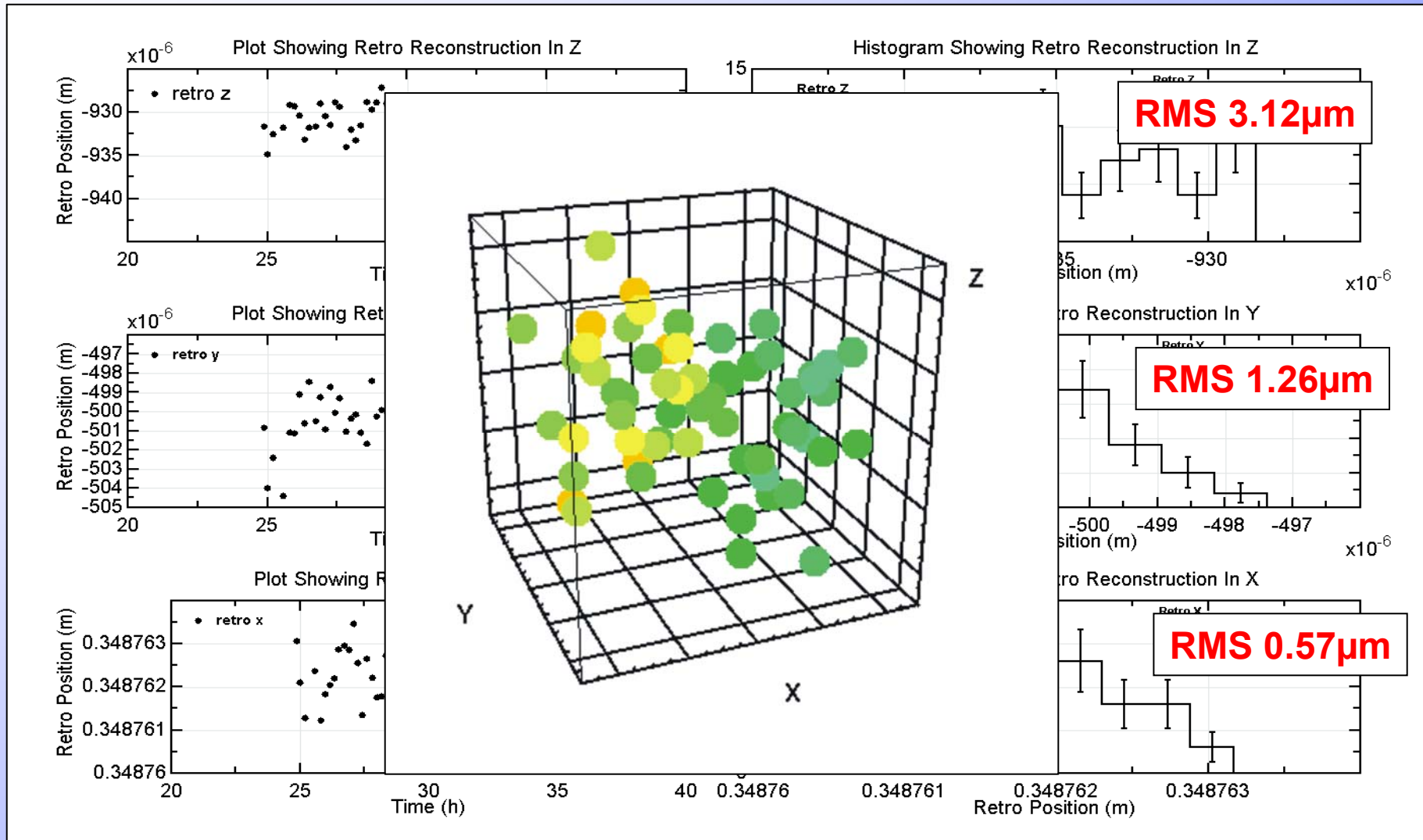
Retro Reflector

FSI Lines

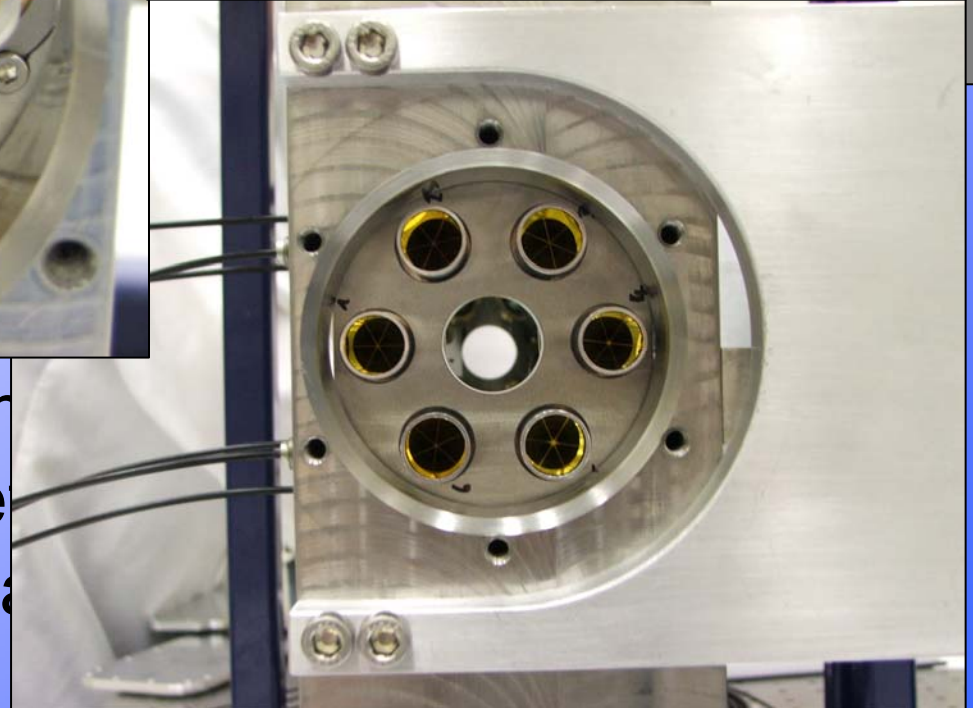
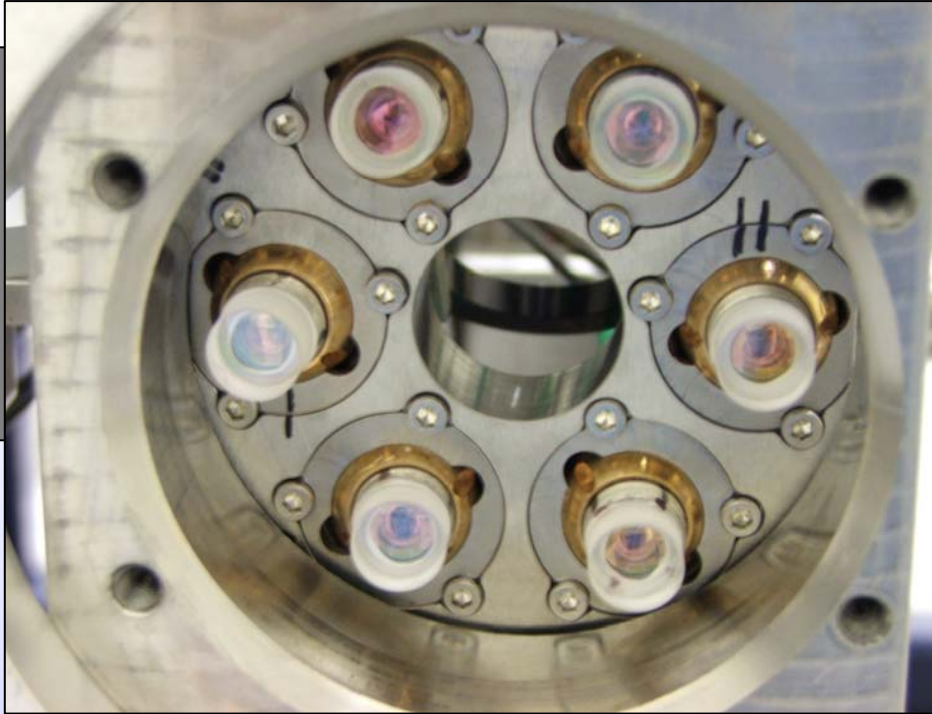
Initial Stability of External FSI Sub-System



External Marker Reconstruction Using External FSI Lines

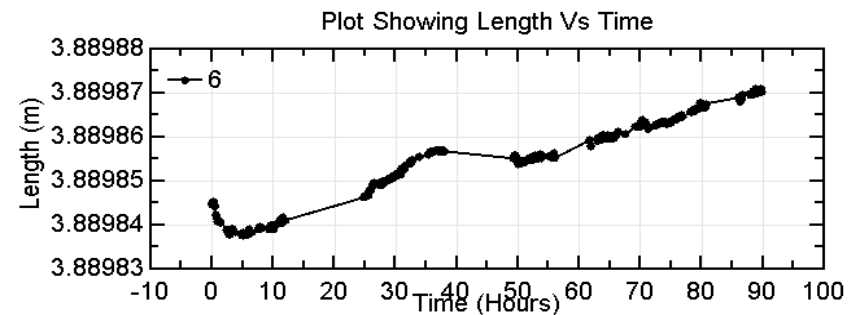
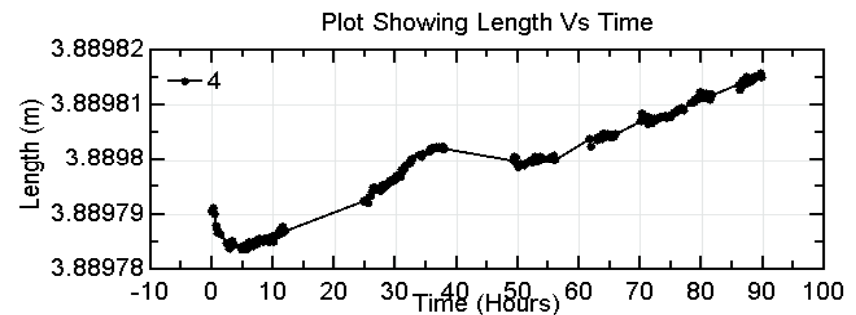
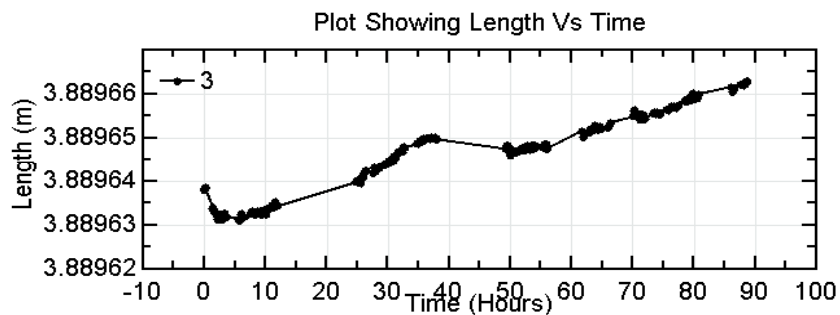
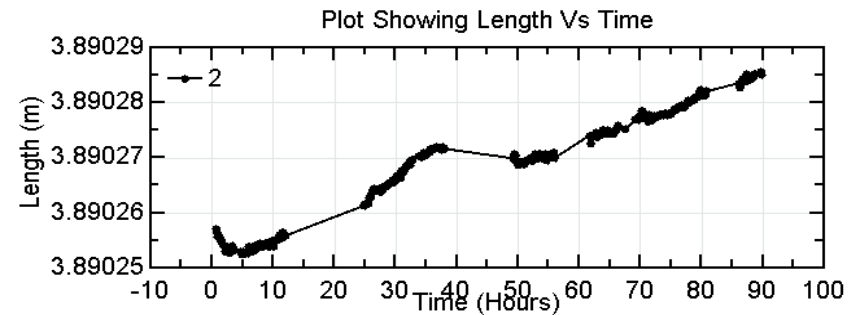
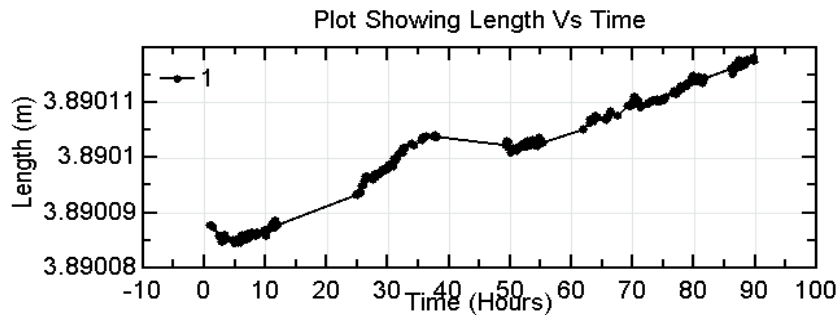


Internal FSI Sub-System

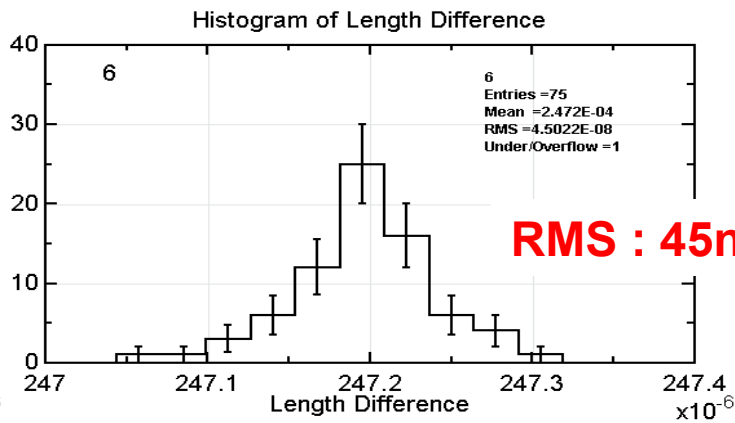
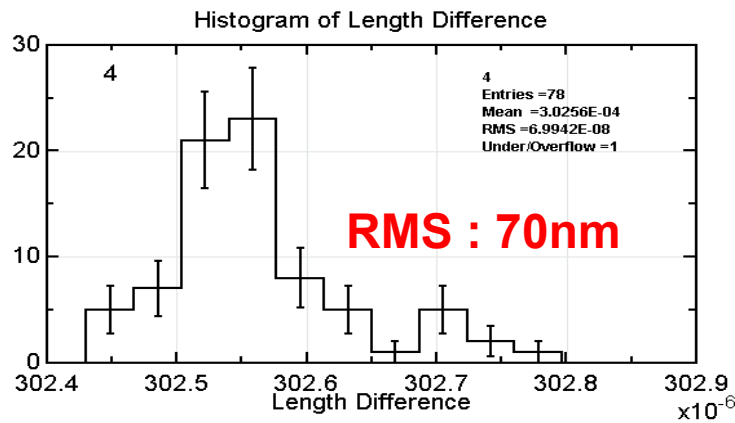
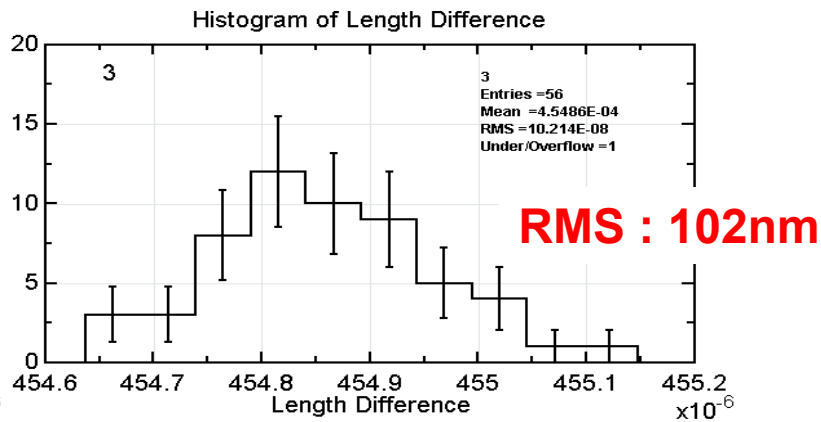
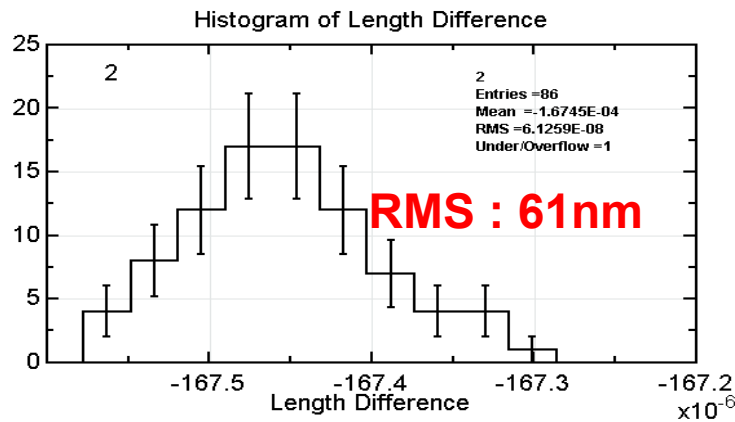


- First Unit has 6 collim
- Second Unit has 6 re
- Each Fibre Monitors a

Initial Stability of Internal FSI Sub-System



Initial Stability of Internal FSI Sub-System



Summary

- Reference Interferometers are under calibration
- External FSI System giving precision of 1-1.5 μm
- We have the ability to reconstruct wall marker positions to a precision of order 1.3 μm
- Internal FSI System giving precision of 45 -100 nm