MONALISA: Interferometric Position Monitor at the Nanometre Scale

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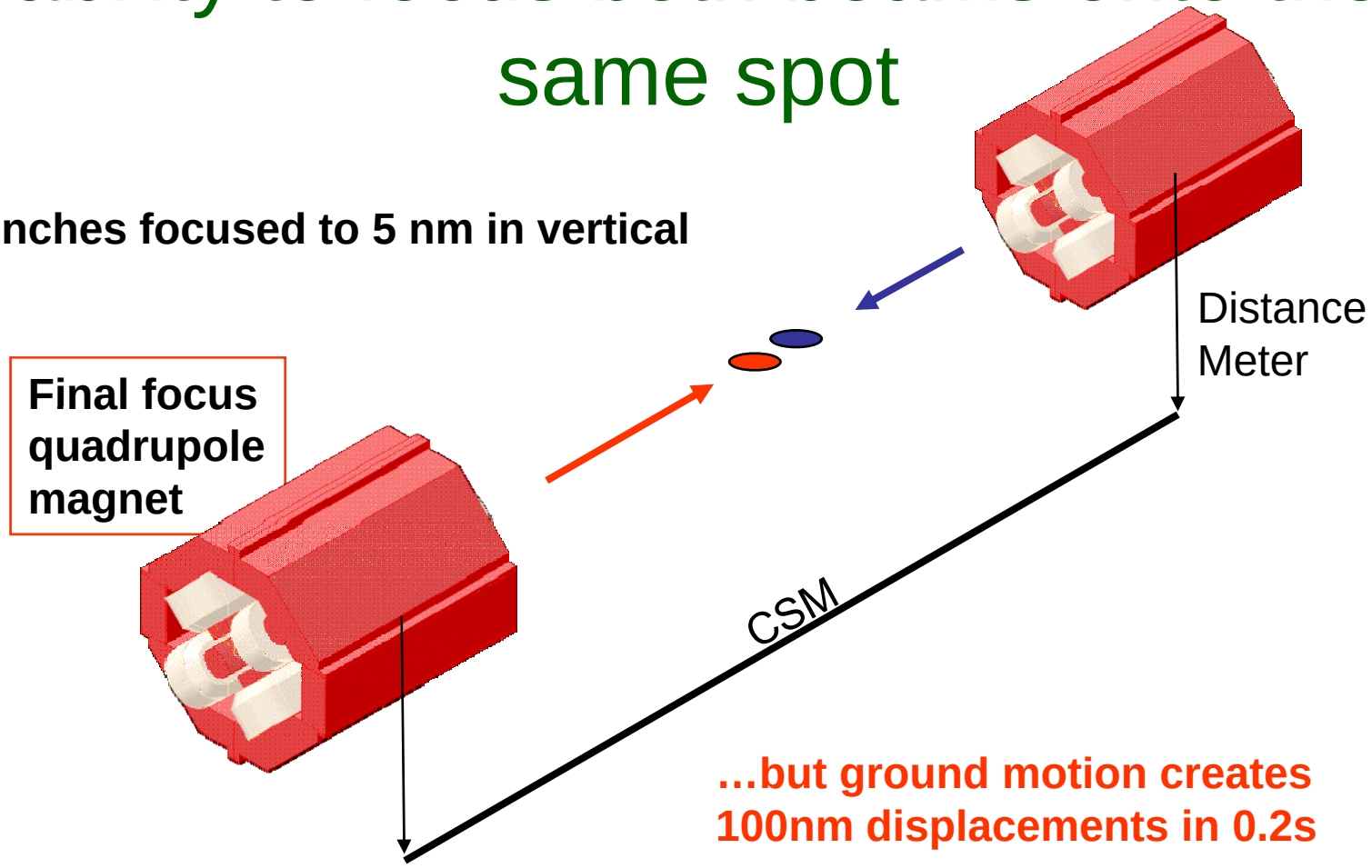
Why do we need nano-metre style position monitoring at ILC

- There are many places paricularly in the BDS where position monitors can be helpful.
- Technically the hardest problem is the final focus

Luminosity depends crucial on our ability to focus both beams onto the same spot

Bunches focused to 5 nm in vertical



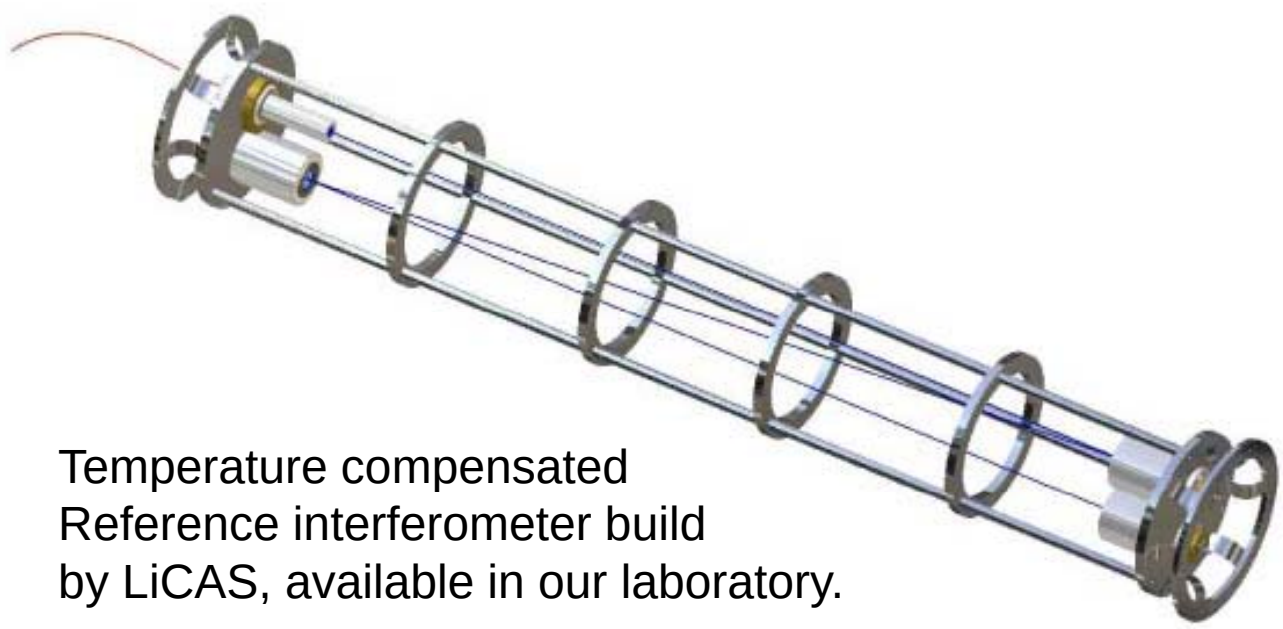
Want relative motion information … but there's no direct line of sight!

Interferometers

- Need 2 tools, both with nm type resolutions over order 10m.
  - Straightness Monitor measuring motion perpendicular to line of sight. Main tool to measure the relative motion of objects (magnets)

  - Distance metre:
    - Easier to build
    - Required to solve fundamental questions regarding laser quality.
    - Can also provide perpendicular measurements if several measurements are combined to do triangulation. Hence we also need order 1μm absolute distance measurements to understand the geometry.
    - Combine both measurements into one system!

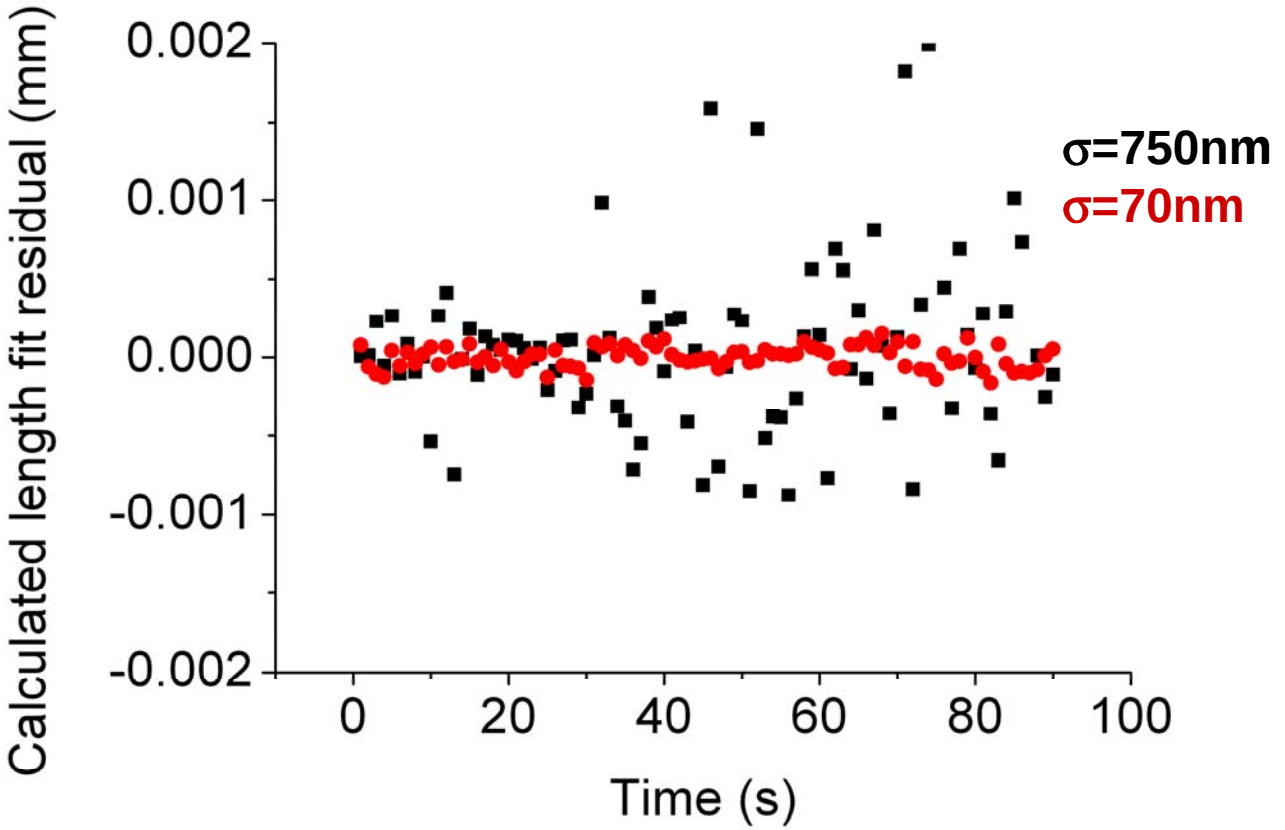
FSI (Frequency Scanning Interferometry)



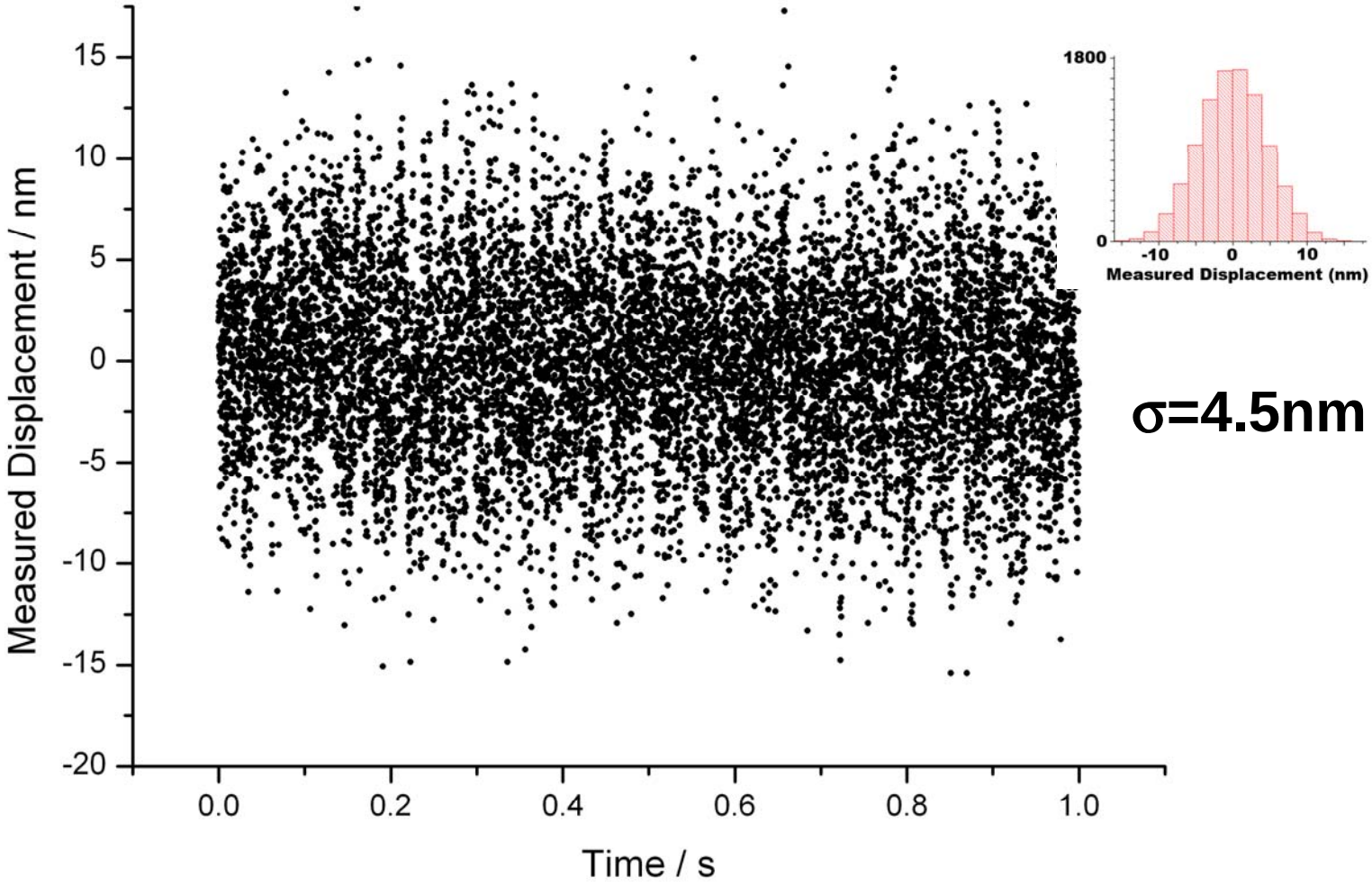
Temperature compensated
Reference interferometer build
by LiCAS, available in our laboratory.

Prototype Interferometre: 400mm OPD: FSI – Mode

Add box to reduce air turbulence



Prototype Interferometre: 400mm OPD: Fixed Freq. Mode



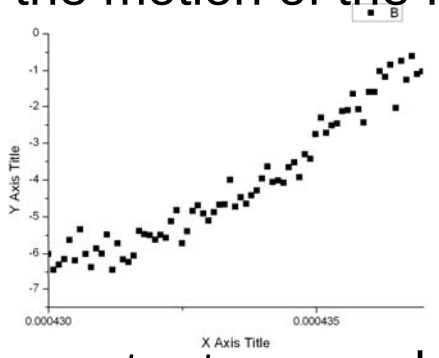
σ=4.5nm

5Hz Feed-Forward

- Final Focus Quadrupoles:
  - How to best use motion information between the two FF magnets?
  - Feedback/stabilization is difficult
    - Little room to move large magnet
    - Another feedback system that can interfere with existing feedback systems
  - Feed-Forward information to FONT
    - Elegant
    - Can help that FONT converges faster, particularly during commissioning, when beams are less well defined
    - However need detailed simulation to study how much such a system can help.
    - Study must include scenarios where things are not nice e.g:
      - Position monitor signal noisy
      - Bunch deformed
      - Large incoherent fluctuations between bunches.

Fast Feed-Forward

- Final Focus quadrupole cold mass is a fairly large object that is supported at only few places
  - Unclear how high we can push resonance frequencies.
  - Unclear how much ground motion is amplified at these resonance frequencies.
- Altough the frequencies are very slow compart with the train length, they can cause a substantionl motion of a FF-quad
  - MONALISA can, given the necessary effort, sample at very high rates and predict the motion of the FF-quads.



  - A vertical distance metre to ground is sufficient, since ground will not move at these short times
  - Simulation how much help this information can give to FONT are required.

Push-Pull

- If FF quadrupoles are monitored this information can also be usefull during Push-Pull operations
  - Relative measurement can monitor frequency behaviour of QD0s
  - Absolute measurement can measure if Quadrupole returned to same position (relative to detector and ground) to order 1μm
  - Y. Nosochkov: Large y-offsets at IP should be efficiently detected and prevented (keep below 200nm)

Critical magnets in BDS

- Quite a large number of magnets in BDS with position tolerances of order 100nm.
- Slow drifts will move them fairly quickly away from their position
  - Plan: regular beam based alignment to move them back to ideal position
- However there are several 5Hz based feedback systems that will influence this process
  - It is rather easy to imagine that the whole system can drift away
- A position measurement of some critical magnets would have clear benefits:
  - Produce independent check.
  - Less time required for beam based alignment.
    - Would be nice if we could estimate how much beam time can be won.
  - Large potential time savings particular at commissioning.
  - After longish shutdowns (hours to weeks) MONALISA system can move monitored magnets immediately into optimal position. (FSI measures absolute distances!)
  - Simulation needed to understand if and how much MONALISA information can help 5Hz feedback systems in BDS

Conclusion

- Nice new results for MONALISA interferometer
- Studies needed to understand improvement if MONALISA data is included in feed-back systems
- Push-Pull might be a strong rational to find the energy to study the implications of a postion monitoring system for QD0s.