Concepts for Combining Different Sensors for CLIC Final Focus Stabilisation

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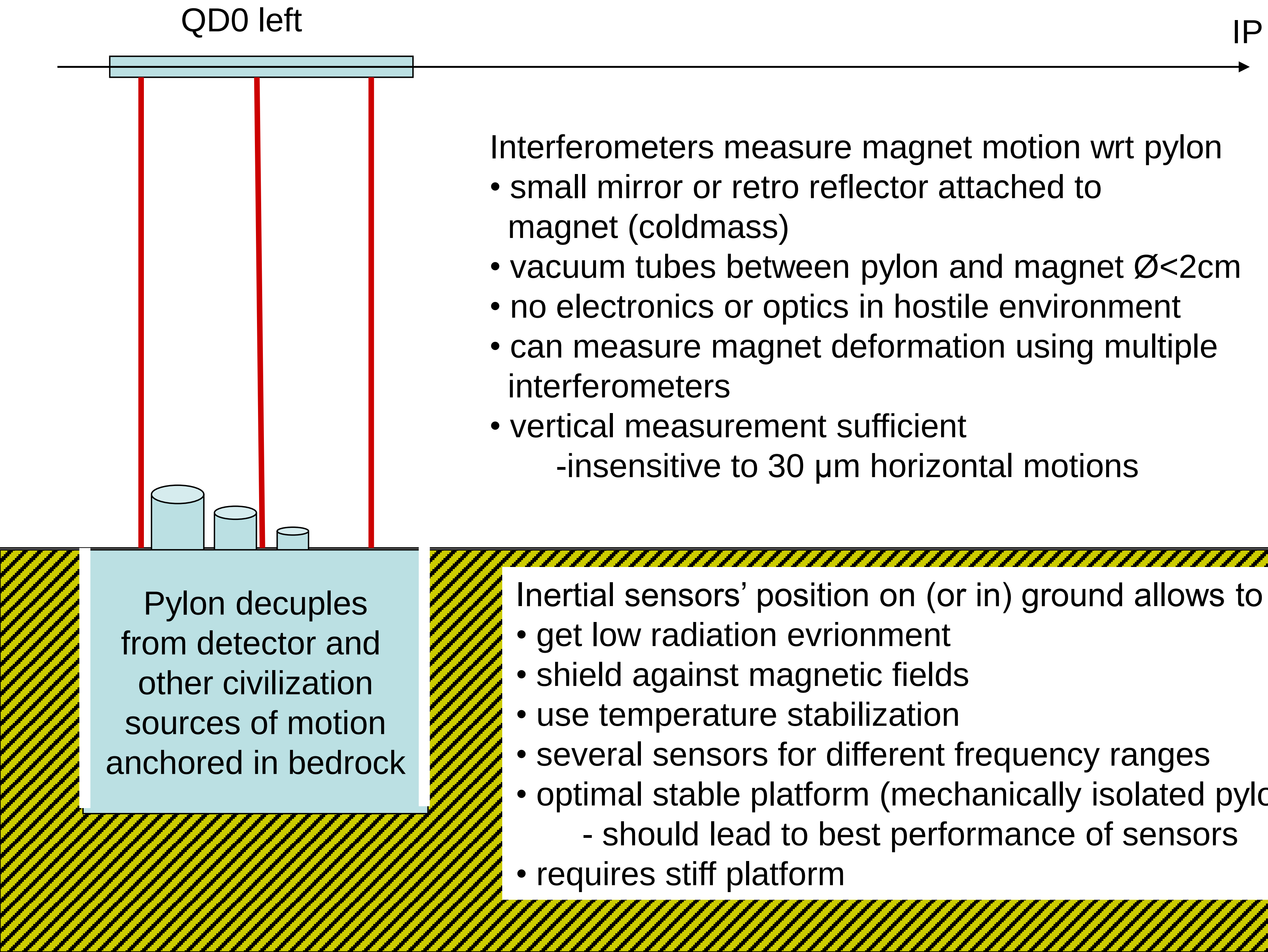
Outline

- Ideal sensor placement
- The role of optical sensors (interferometers)
- Sensor resolutions
- Beam dynamics simulations that include ground motion and sensor resolution for complex sensor setups

Ideal Sensor Placement

- Objective: observe coldmass motion of QD0
  - QD0: Difficult environment because of:
    - high radiation
    - high magnetic field
    - temperature (superconducting QD0)
    - restricted space
      - limits low frequency reach of inertial sensors
      - restricts use of multiple large sensors to
        - » hard to observe flex of QD0
  - Floor:
    - better (ideal) in all aspects!

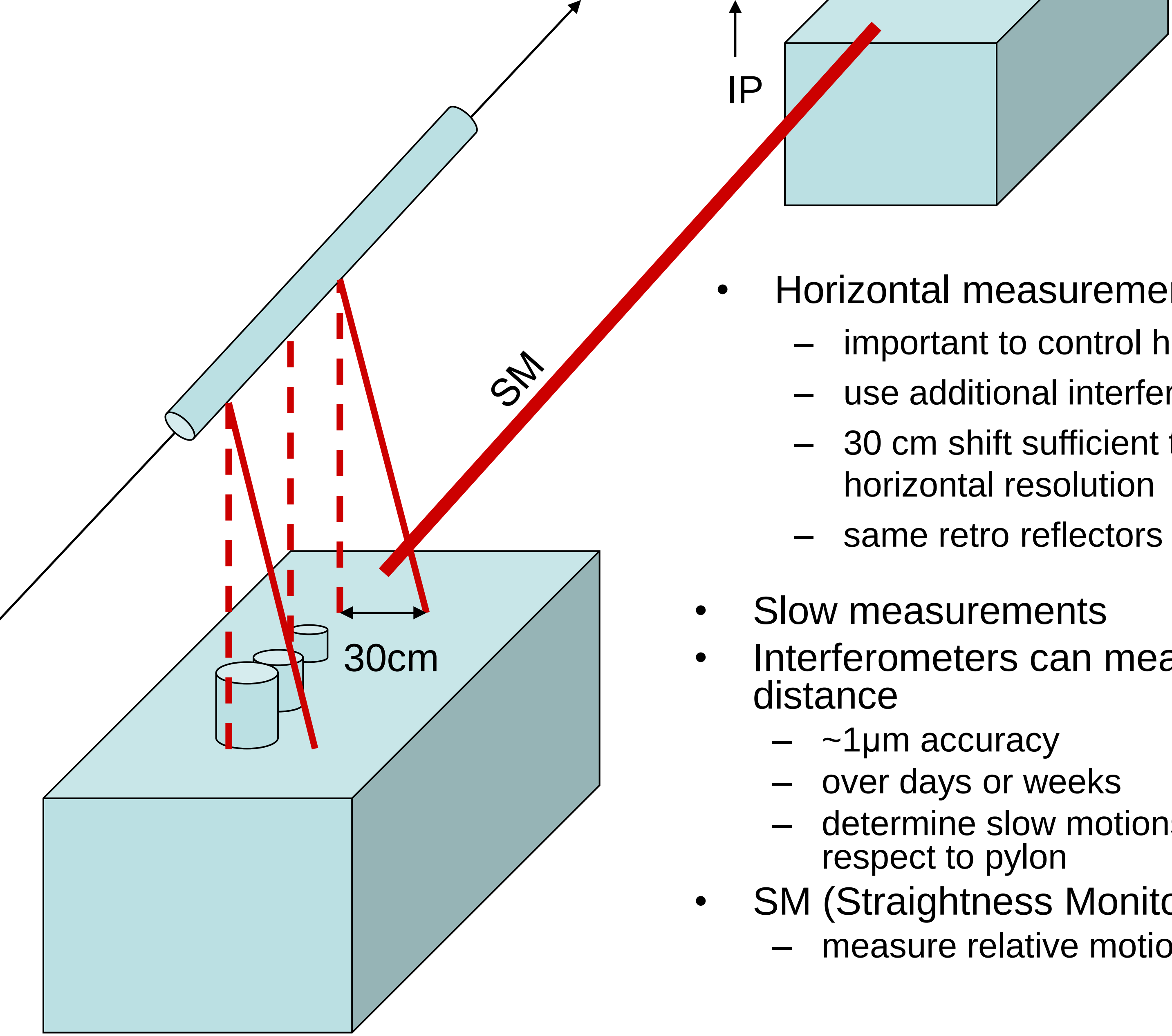


Interferometers measure magnet motion wrt pylon

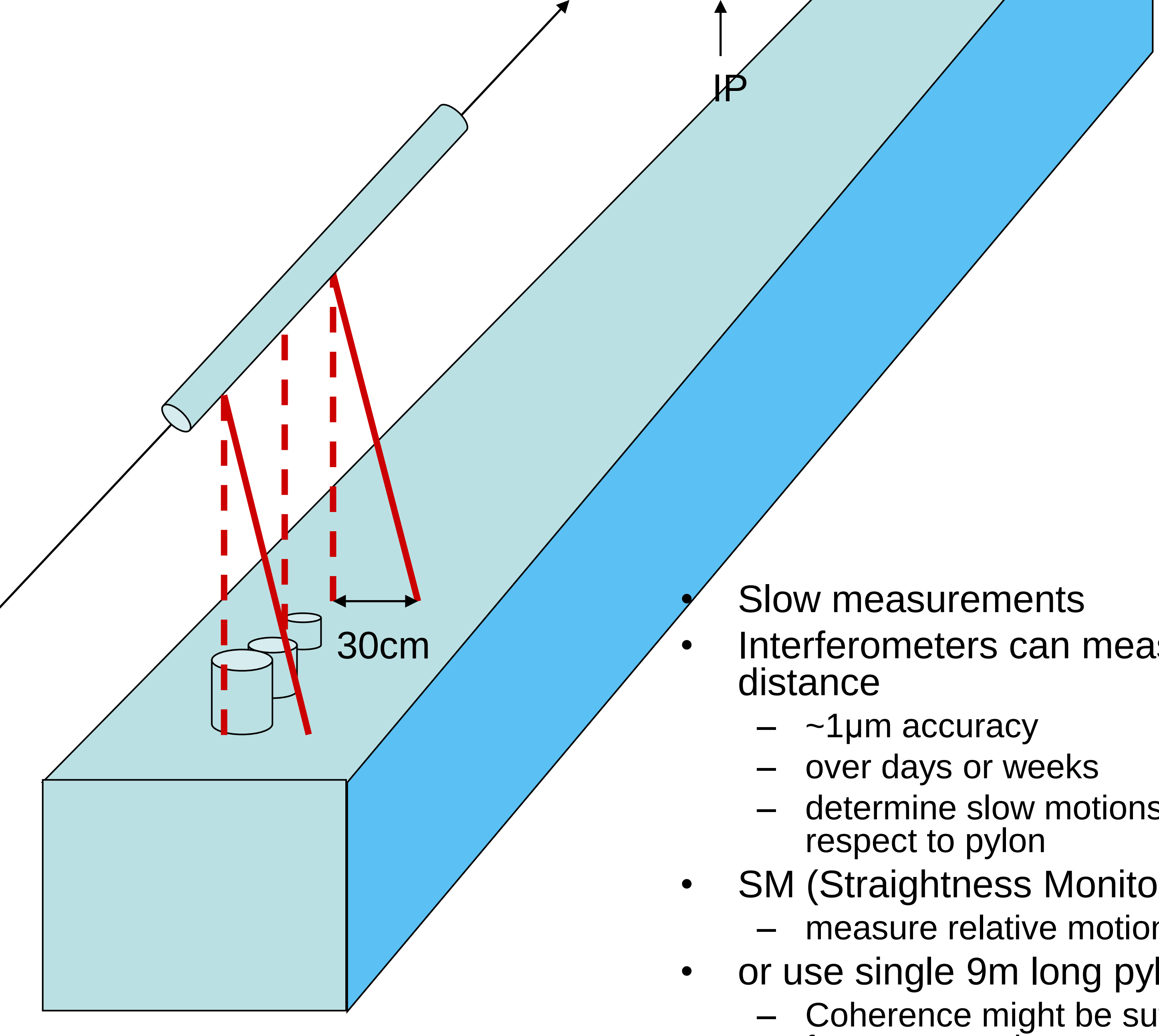
- small mirror or retro reflector attached to magnet (coldmass)
- vacuum tubes between pylon and magnet Ø<2cm
- no electronics or optics in hostile environment
- can measure magnet deformation using multiple interferometers
- vertical measurement sufficient
  - -insensitive to 30 μm horizontal motions

Inertial sensors' position on (or in) ground allows to

- get low radiation evrionment
- shield against magnetic fields
- use temperature stabilization
- several sensors for different frequency ranges
- optimal stable platform (mechanically isolated pylon)
  - - should lead to best performance of sensors
- requires stiff platform



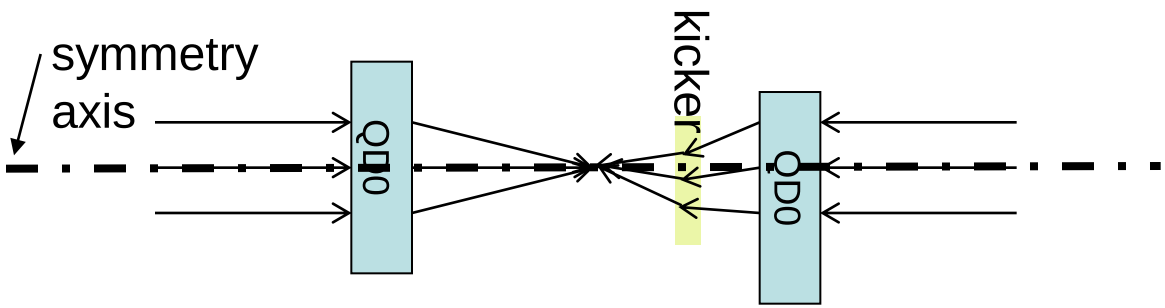
- Horizontal measurement
  - important to control horizontal motion too
  - use additional interferometer heads on pylon
  - 30 cm shift sufficient to get to 10nm horizontal resolution
  - same retro reflectors on magnet can be used
- Slow measurements
- Interferometers can measure absolute distance
  - ~1µm accuracy
  - over days or weeks
  - determine slow motions of magnet with respect to pylon
- SM (Straightness Monitor) between pylons
  - measure relative motion of pylons



- Slow measurements
- Interferometers can measure absolute distance
  - ~1μm accuracy
  - over days or weeks
  - determine slow motions of magnet with respect to pylon
- SM (Straightness Monitor) between pylons
  - measure relative motion of pylons
- or use single 9m long pylon
  - Coherence might be sufficient in low frequency region

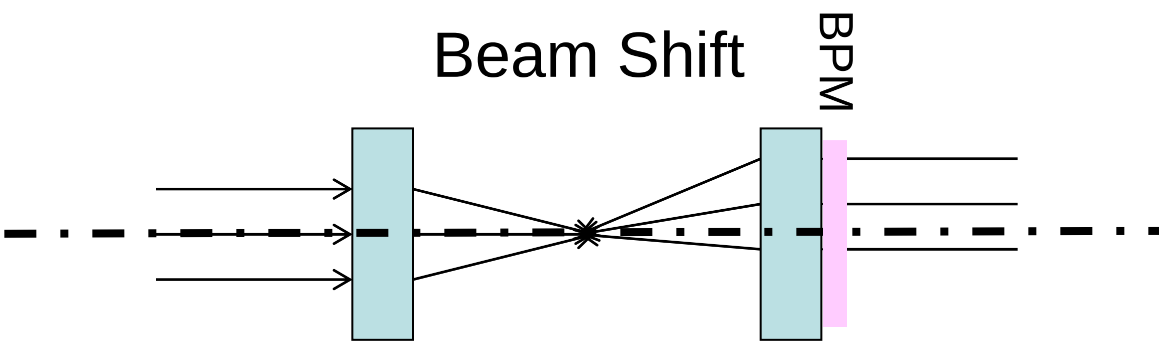
Advantage of Slow Monitor

Magnet Drift



FONT will recover lumi
Interferometer will allow feedback loop keeping magnet motions small at all times
- keep kicker strenght small at all times

Beam Shift



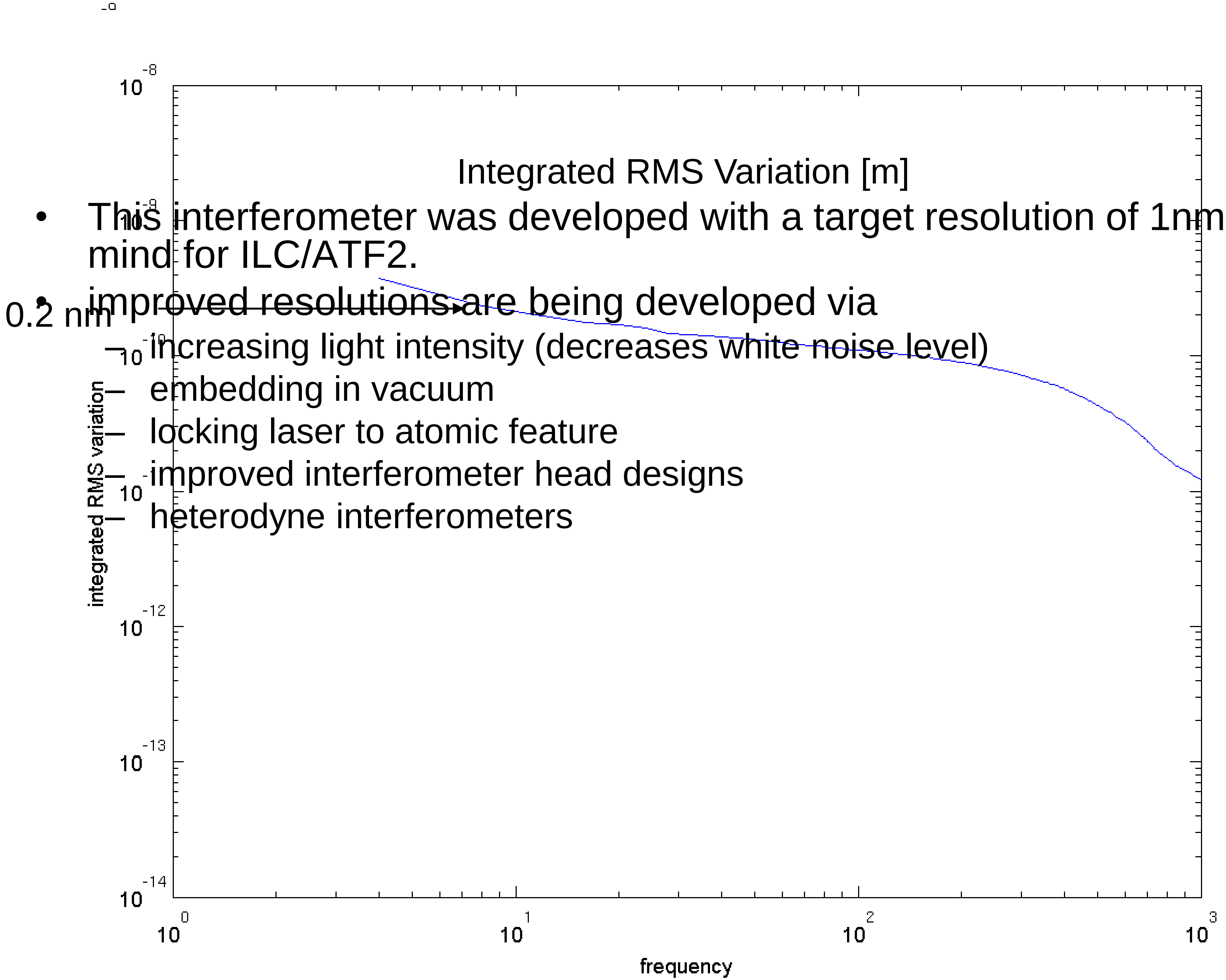
BPM will spot move and feed info back to BDS slow feed back system

In principle BPM and kicker can resolve difference between beam shift and magnet drift, but requires complex feedback system

Interferometer Resolution

- 100 cm long interferometer
  - in open air
  - on passive optical table
  - laser not locked to absorption line (yet)
  - Compact interferometer launch head
  - measurement over 1s.
  - Bandwidth of electronics 0-1MHz
  - Acquisition rate 2MHz
  - Offline low pass filter: 1kHz

- This interferometer was developed with a target resolution of 1nm in mind for ILC/ATF2.
- improved resolutions are being developed via
  - increasing light intensity (decreases white noise level)
  - embedding in vacuum
  - locking laser to atomic feature
  - improved interferometer head designs
  - heterodyne interferometers

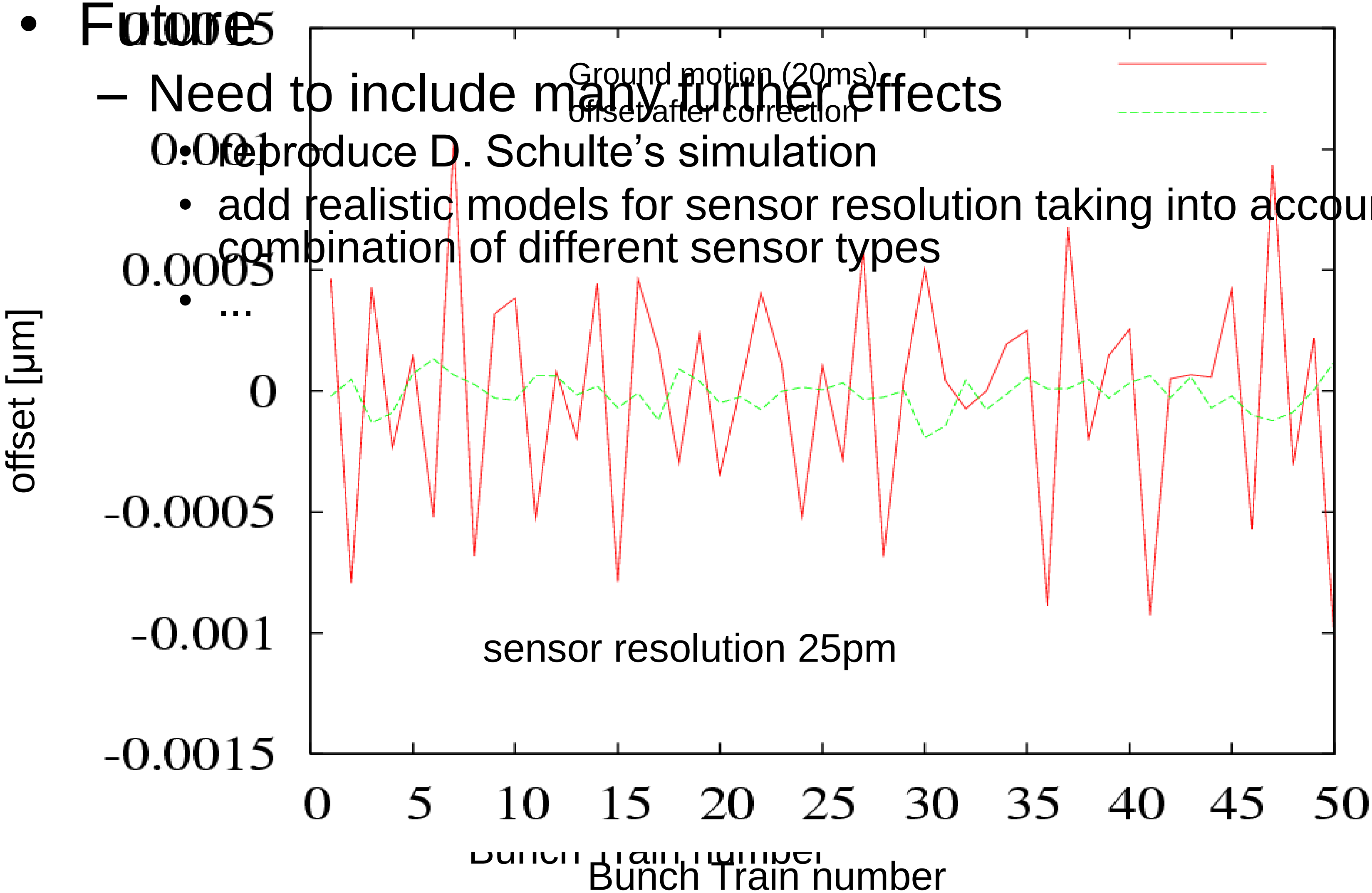


Beam Dynamics Simulations First Baby Steps

- We received funding for graduate student
  - Supervision by Armin Reichold
  - half a year of work on CLIC beam-dynamics with emphasis on stabilisation issues
- With help of J. Resta-Lopez:
  - developed first very simple simulation using PLACET
    - starting at end of linac
    - Include ground motion for electron QD0
    - Include resolution of QD0 sensor
    - calculate beam offset

Beam Dynamics Simulations
First Baby Steps

- Future
  - Need to include many further effects
    - reproduce D. Schulte's simulation
    - add realistic models for sensor resolution taking into account combination of different sensor types
    - ...



End

Interferometer Resolution