MONALISA

Laser based alignment and stability monitoring

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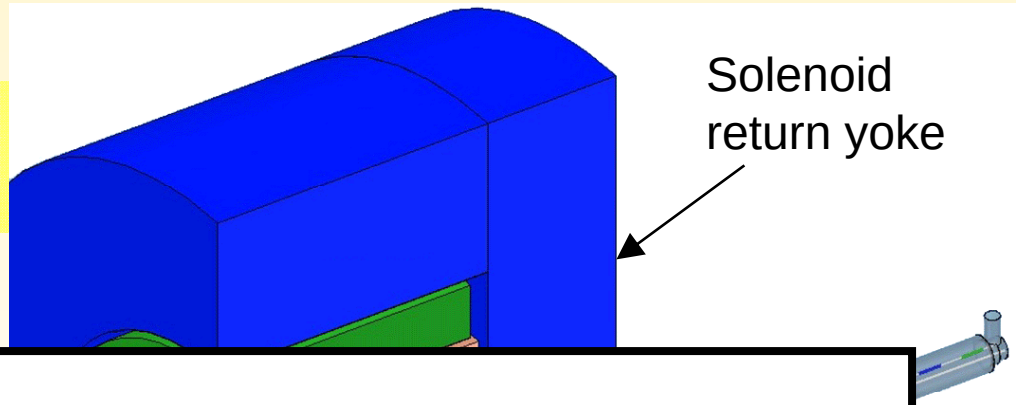
Overview

- Accelerator alignment challenge
- Example QD0 geometry
- Interferometer design
  - Prototype launch head
- Vacuum system at Oxford
- New ideas for straightness monitor
- ATF-2 plans

Component Alignment Challenge

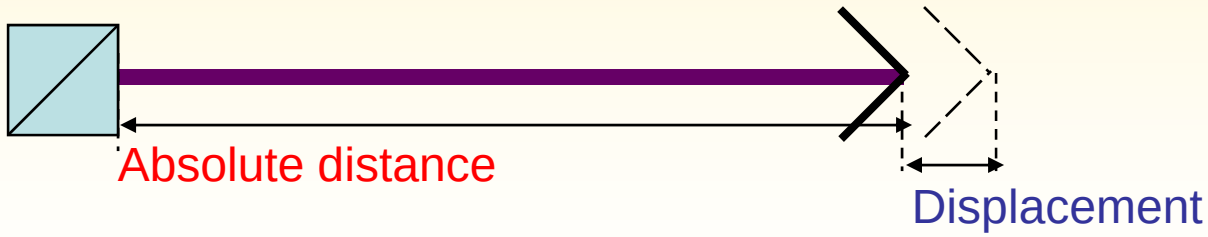
- relative mechanical DoF between many neighbouring components
  - choose important rotations / displacements
- in-situ
  - cramped spaces
- ILC, CLIC require large dynamic range
  - (sub) nm precision over range of metres
  - micron precision over many 10s of metres

Geometry



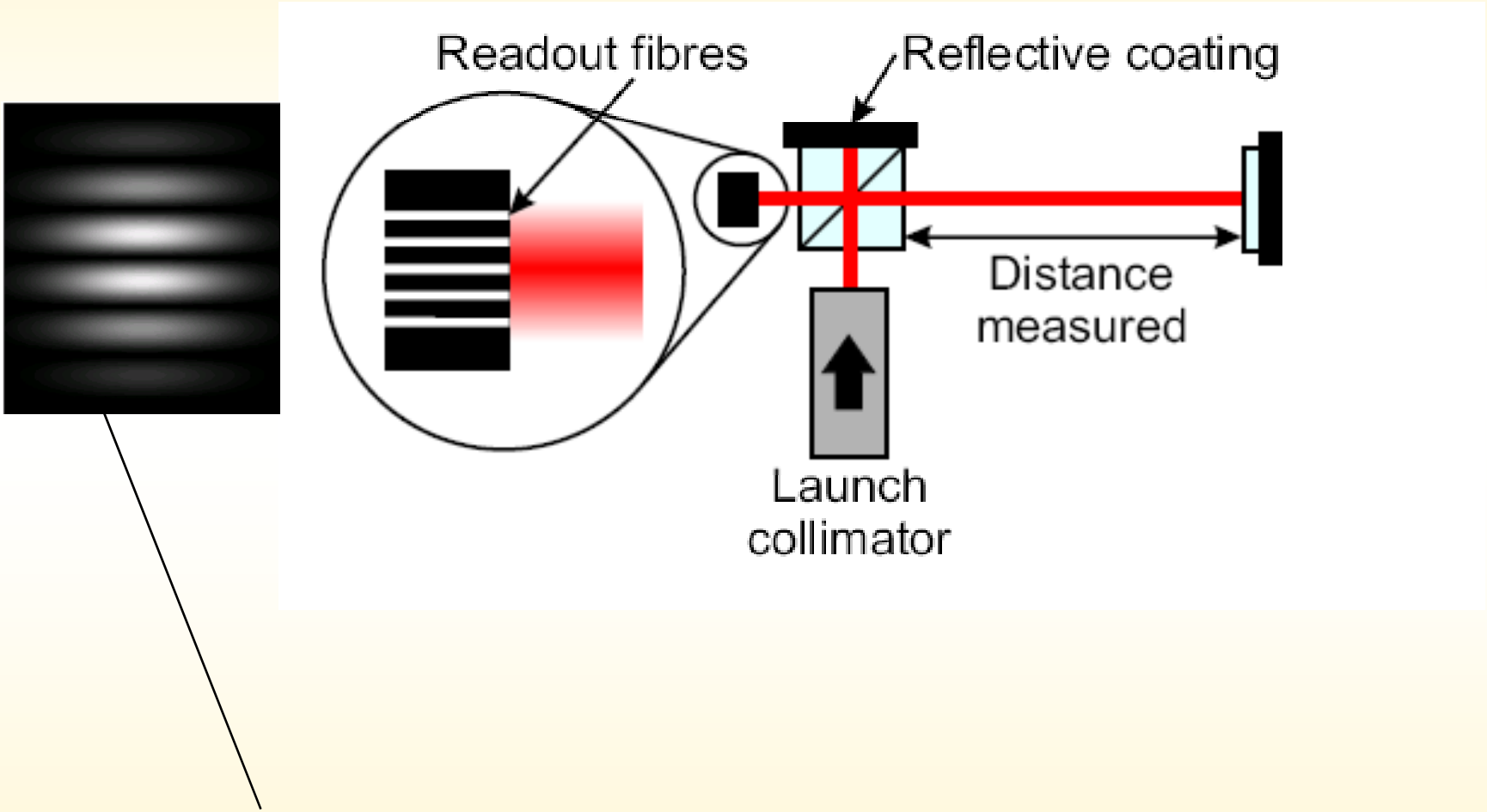
Straightness monitor concept

Measurement lines



- Distances measured along lines using:
  - Absolute distance interferometry
  - Displacement interferometry (like Michelson)
- Each line is the same
  - capable of performing both types of measurement

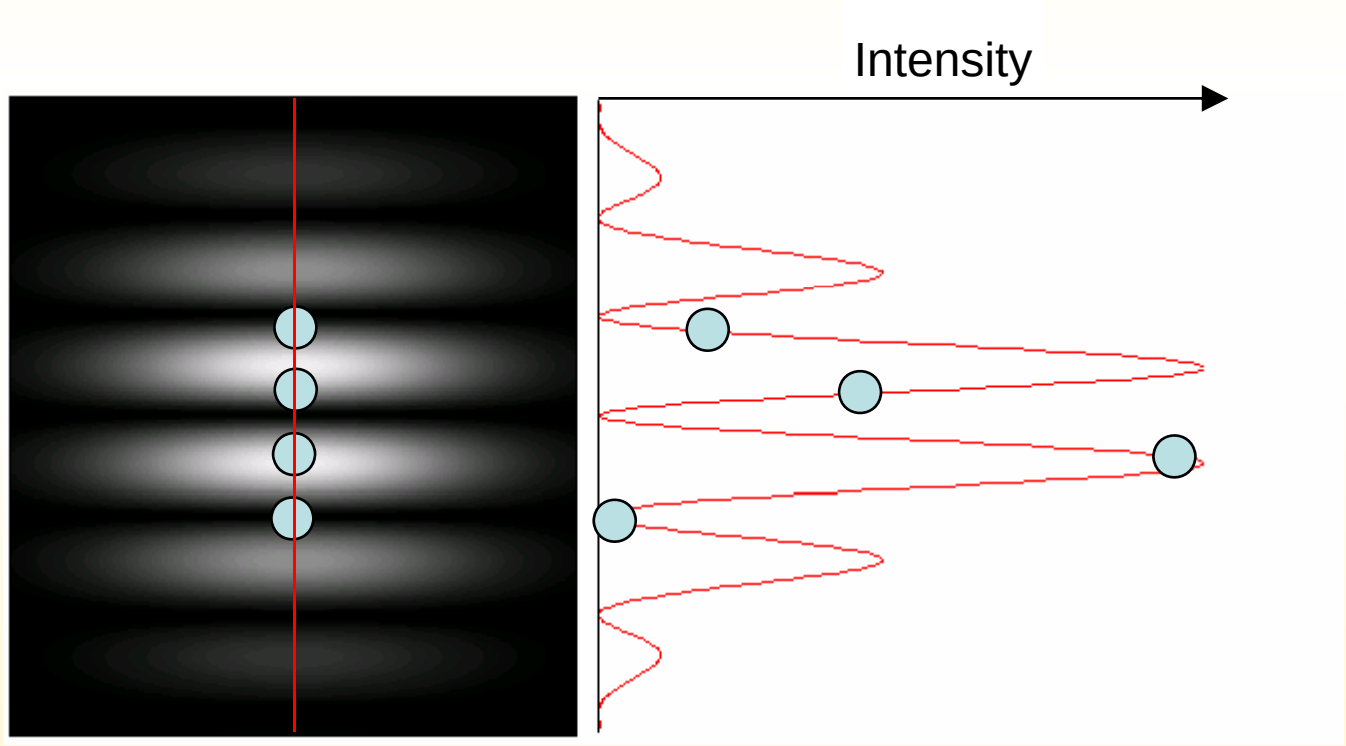
Distance Meter Interferometers



Simulated fringe pattern – as would be seen on a camera

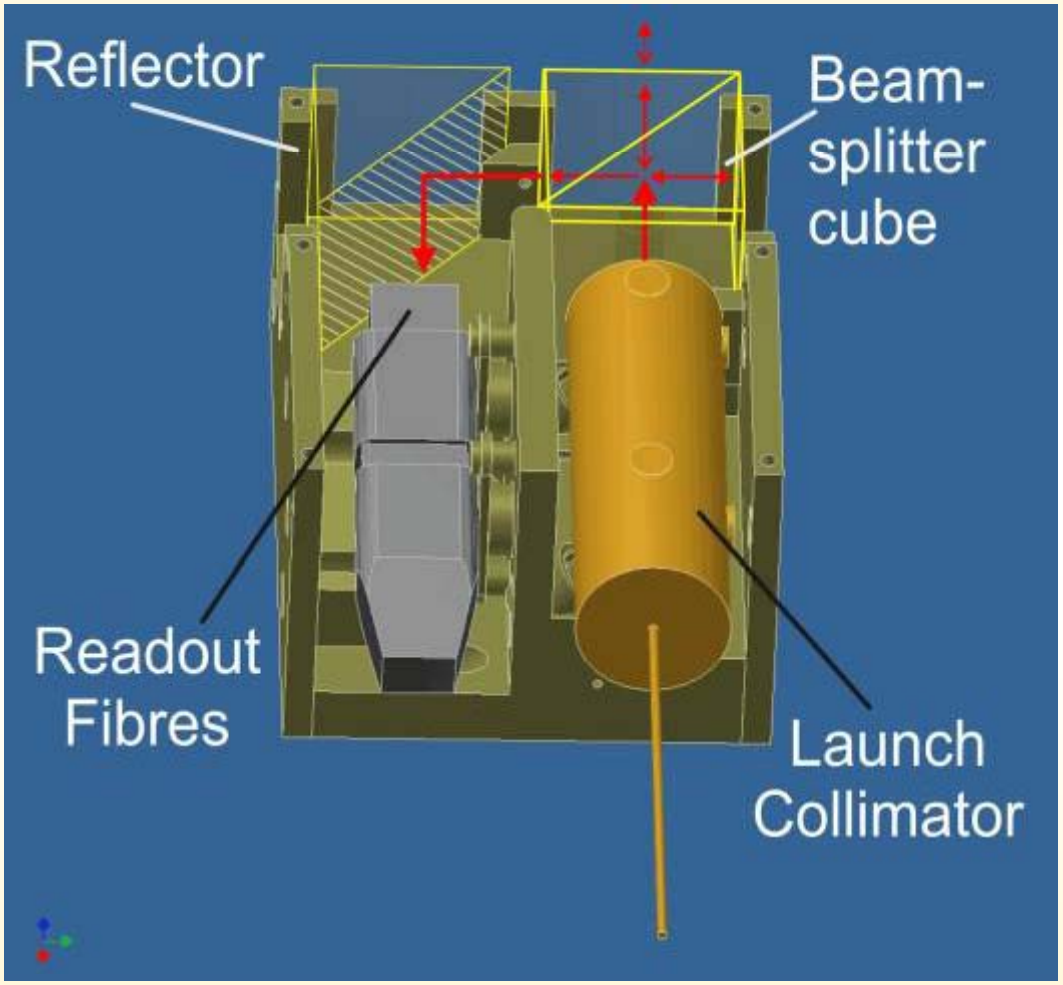
Distance meter phase readout

- Fringe intensity sampled
- Calculate interferometer phase



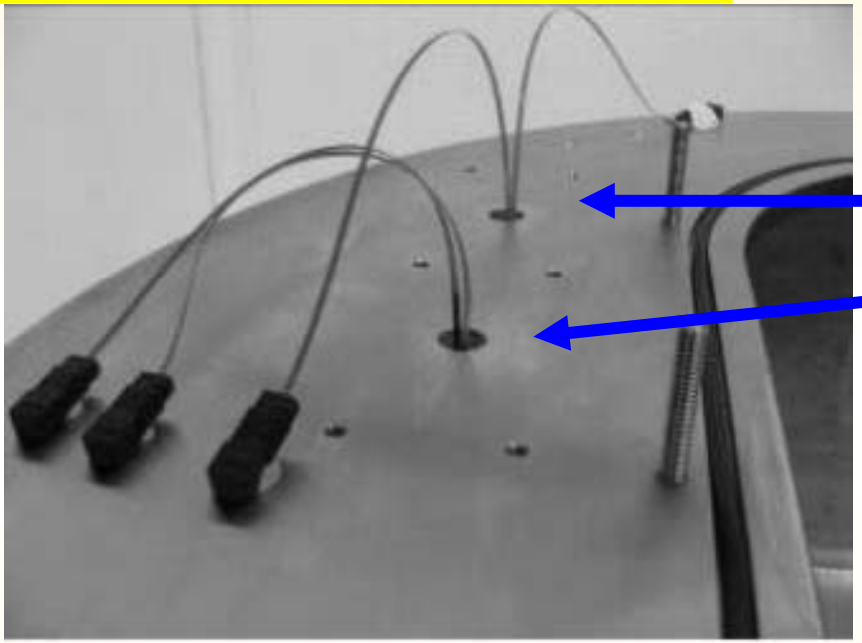
Distance meter launch / receive head

- One end of interferometer
  - Distance measured between head & reflector
- Components go inside vacuum
  - Compact to reduce vacuum tube size
  - Made from vacuum compatible parts
- Rugged and robust design
  - Does not need realignment
  - Thermally matched materials
- Titanium prototype being made

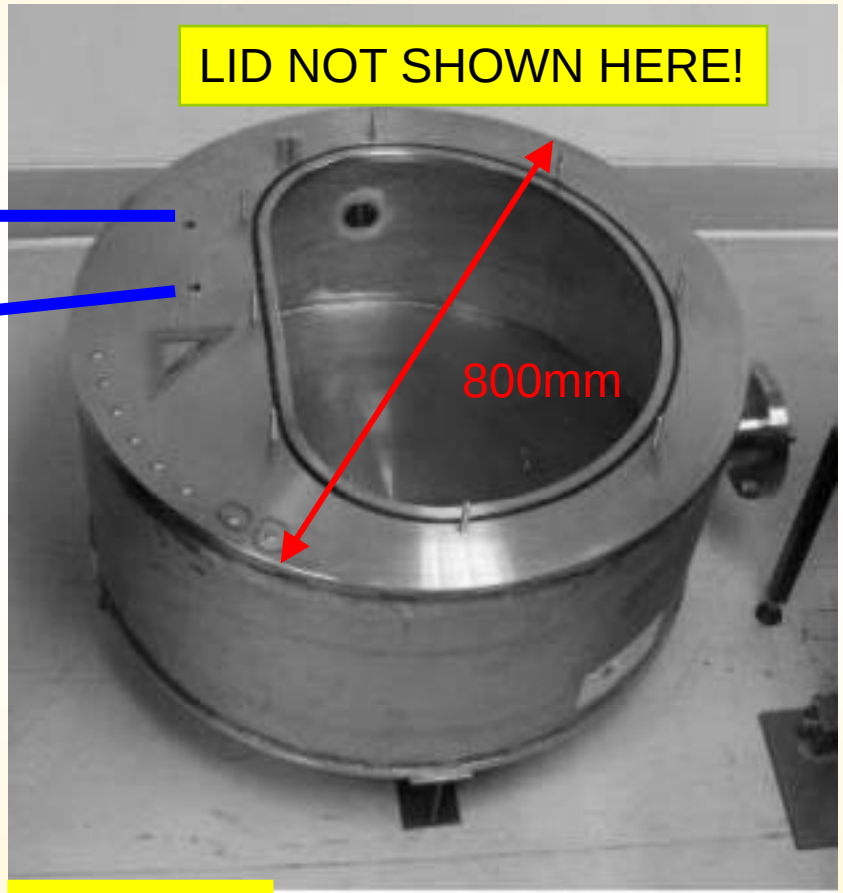


Vacuum Vessel (Jan 2008)

Equipped with 4 x 8 way fibre



AFTER



BEFORE

Testing vacuum vessel (Apr 2008)

- Scroll pump reached 0.05 mbar
- Want to test turbo pump
- Want to see how long vacuum holds

Laser Straightness Monitor: Ideas

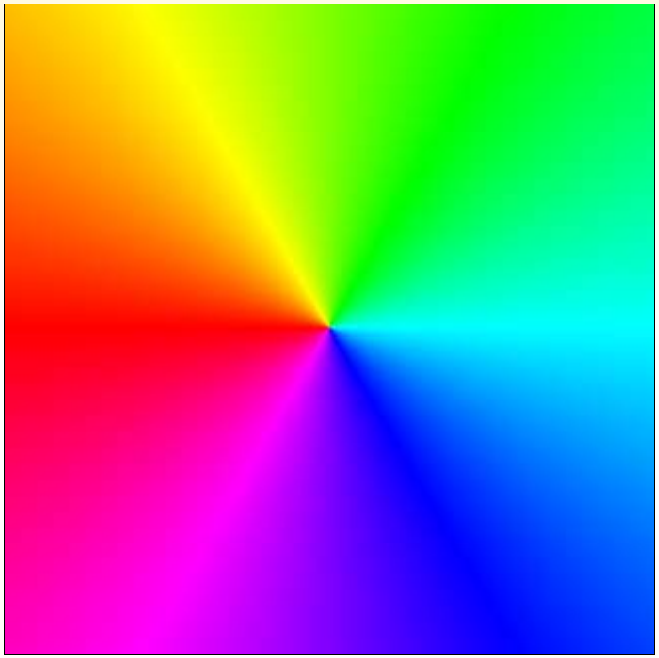
- Phase measurement concept
  - Camera pixel wrt laser beam phase profile

Enhanced sensitivity

Rapid gradient of **phase** (across beam)

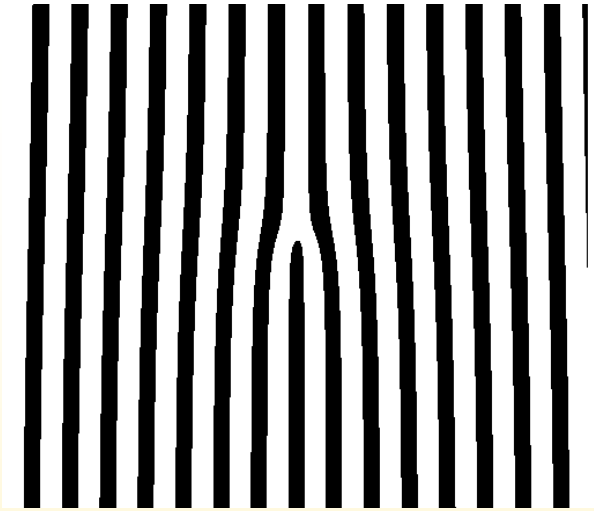
Vortex Beam Advantages

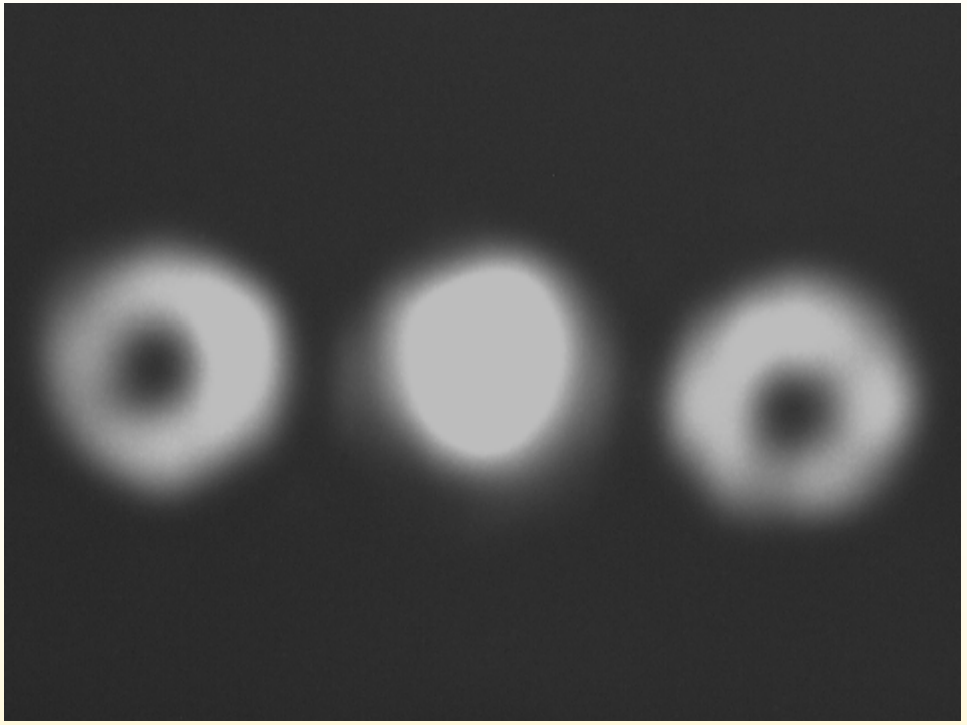
- Large phase gradient
- Gradient unaffected by diffraction
- Phase measurement noise insensitive



Vortex beam demonstrated

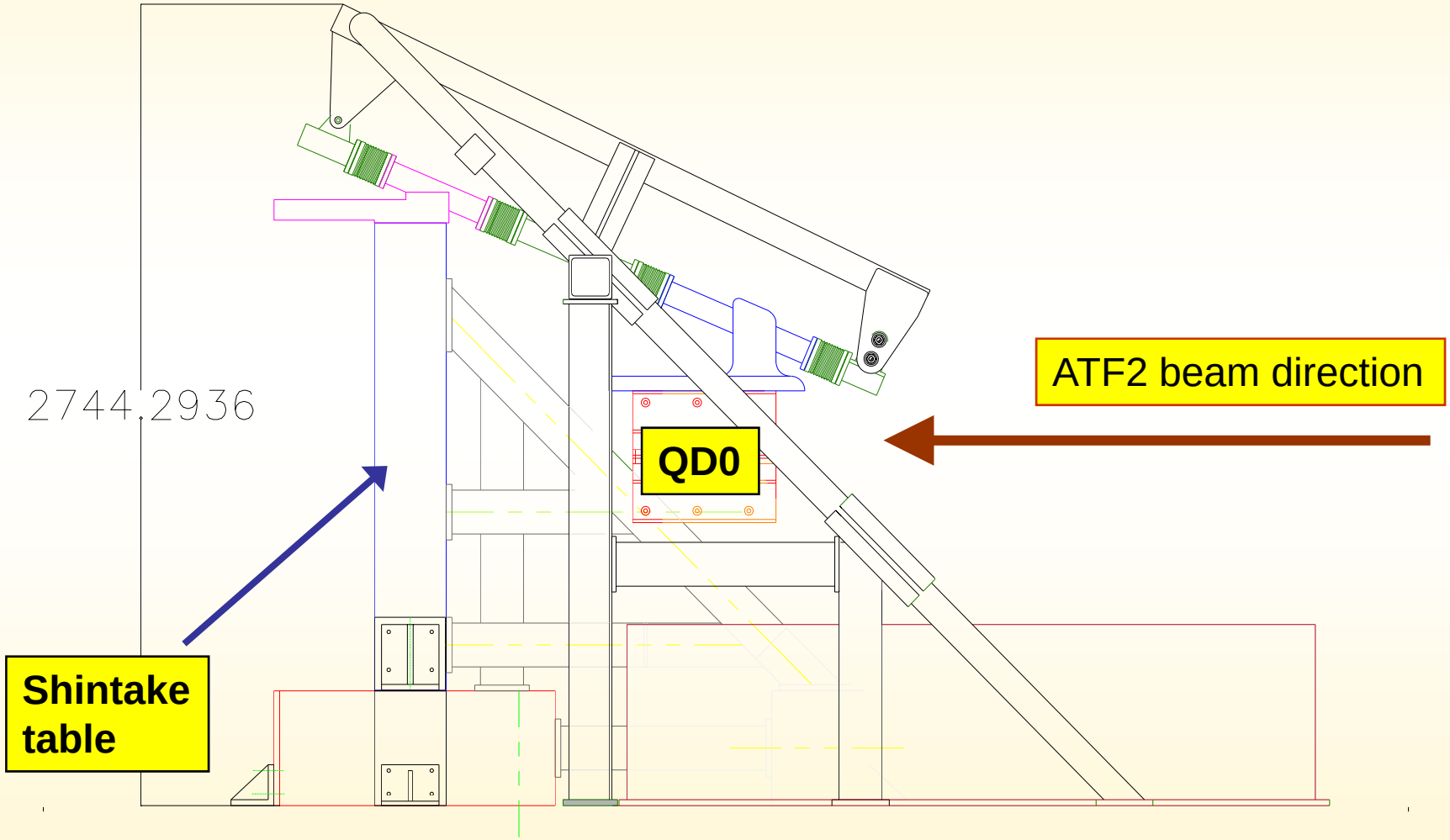
- Pass Gaussian laser beam through grating
- +1,0,-1 orders observed





ATF2 extraction line: 08 Feb 2008

ATF2: Monitor relative vertical motion



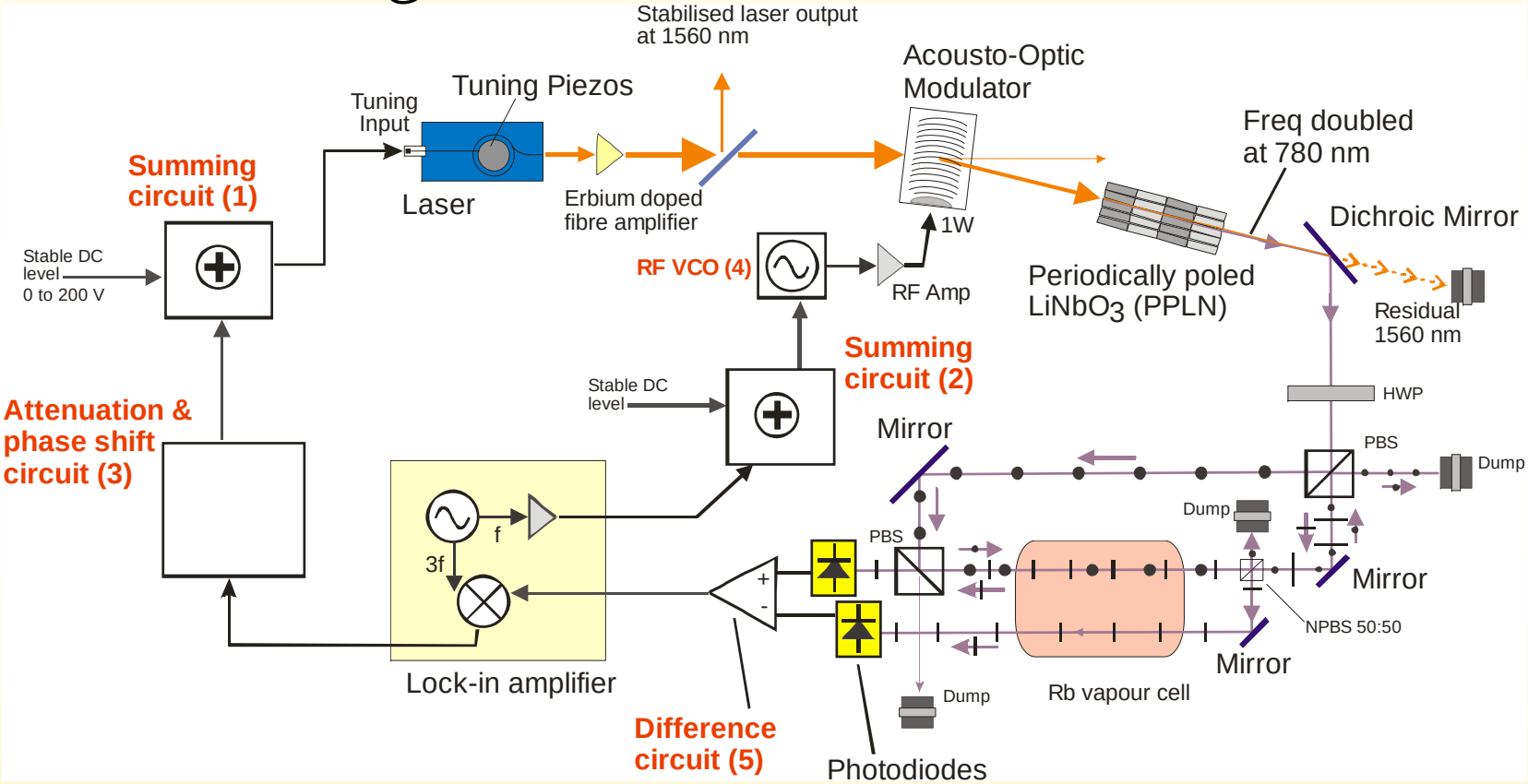
Summary

- MONALISA will be a boon to future colliders
  - QDzero nanometre vertical alignment
  - Repositioning after push-pull at ILC to microns
- Performance demonstrations on going
  - Oxford: Vacuum and frequency reference systems
  - ATF2: Final focus monitoring system to be installed
- New ideas under constant review

Back up slides

Rb-87 frequency reference (FFI)

- **Target ~3 khz linewidth**
- **Need 19 kHz for 1nm @ 10m**



Almost all equipment has been ordered or purchased : setting up from March on

MONALISA: Benefits 1

Monitoring fiducial locations on key components

- after interruption of beam
  - independently follows changes in alignment
- during commissioning / start up
  - improves understanding of machine behaviour
- before accelerator operation
  - speeds up initial convergence of machine

MONALISA: Benefits 2

Return detector / QDzero position after push-pull

- expect to get micron repeatability
  - for return of magnet positions
- get machine within beam based capture range
  - improves switchover time
- more reliable accelerator operation
  - lower chance of damage
  - luminosity can only win

The aims of MONALISA

- To monitor relative stability of vital components down to the nm scale
- To use interferometers in a grid around the vital components
- To use established interferometric techniques with novel design interferometers
- To measure positions at least at 100 Hz