Science & Technology Facilities Council

Royal Holloway University of London

JAI John Adams Institute for Accelerator Science

FETS Laserwire Emittance Scanner: Readiness for Linac4

on behalf of

C. Gabor, A. Letchford - STFC RAL

J. Pozimski, P Savage – Imperial College

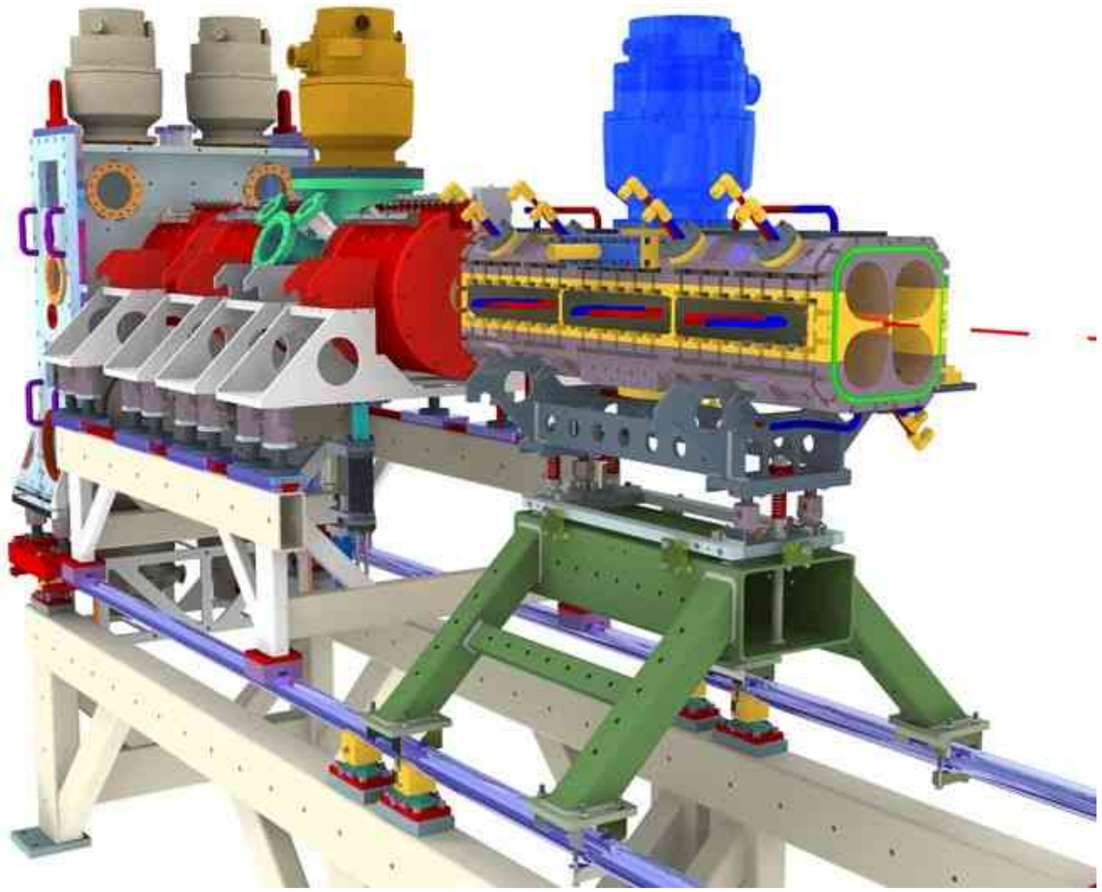
G. Boorman, A. Bosco, S. Gibson – RHUL

Thomas Hofmann - CERN

FETS Meeting, RHUL
23/10/2013

Outline

- Recent progress
- Fibre coupling efficiency
- Integration with Linac4
- Laser delivery enclosure



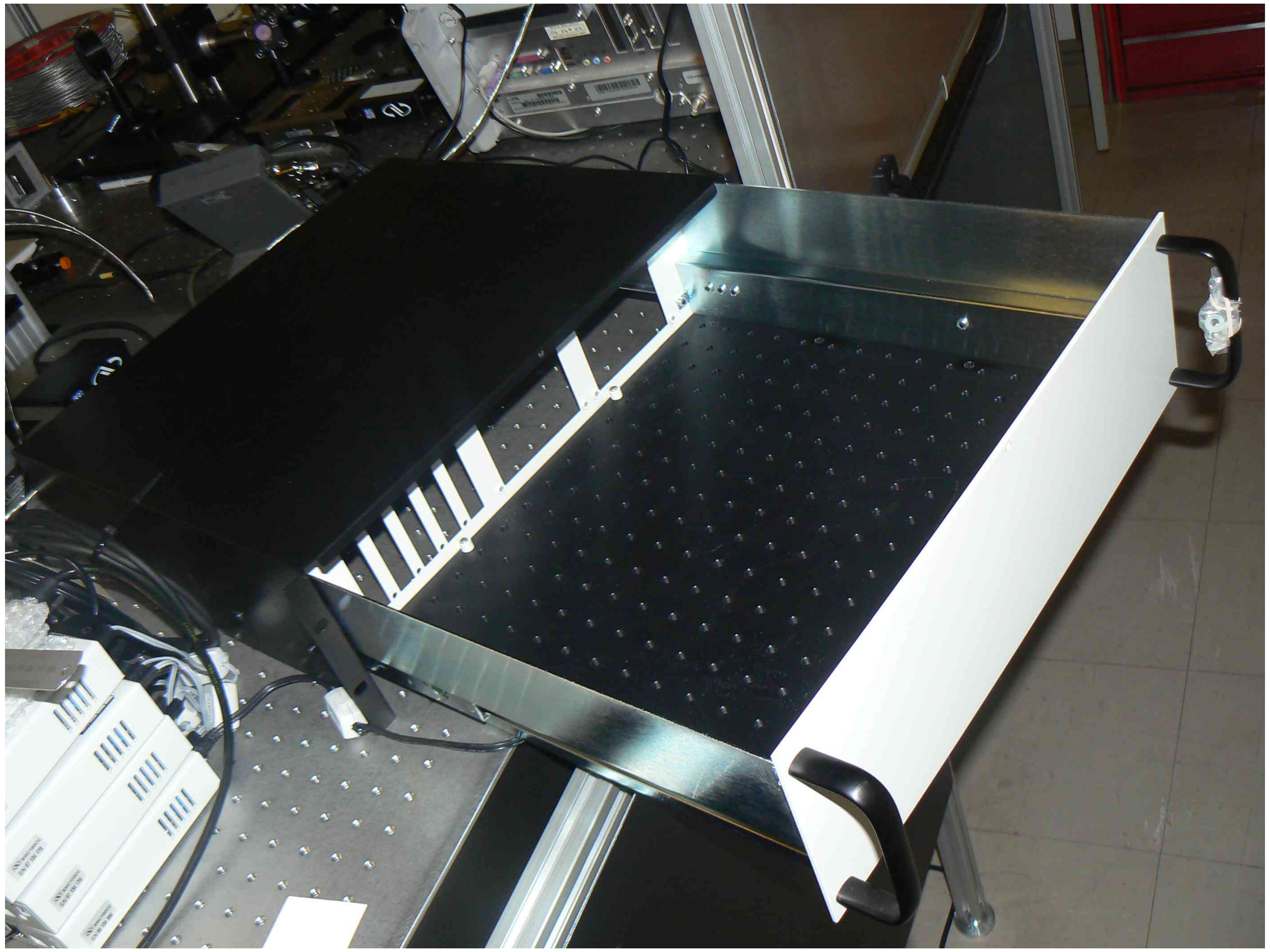
Summary of progress

- Since the last update, the focus has been on preparing hardware and software for Linac4 visit.

Main activities this month:

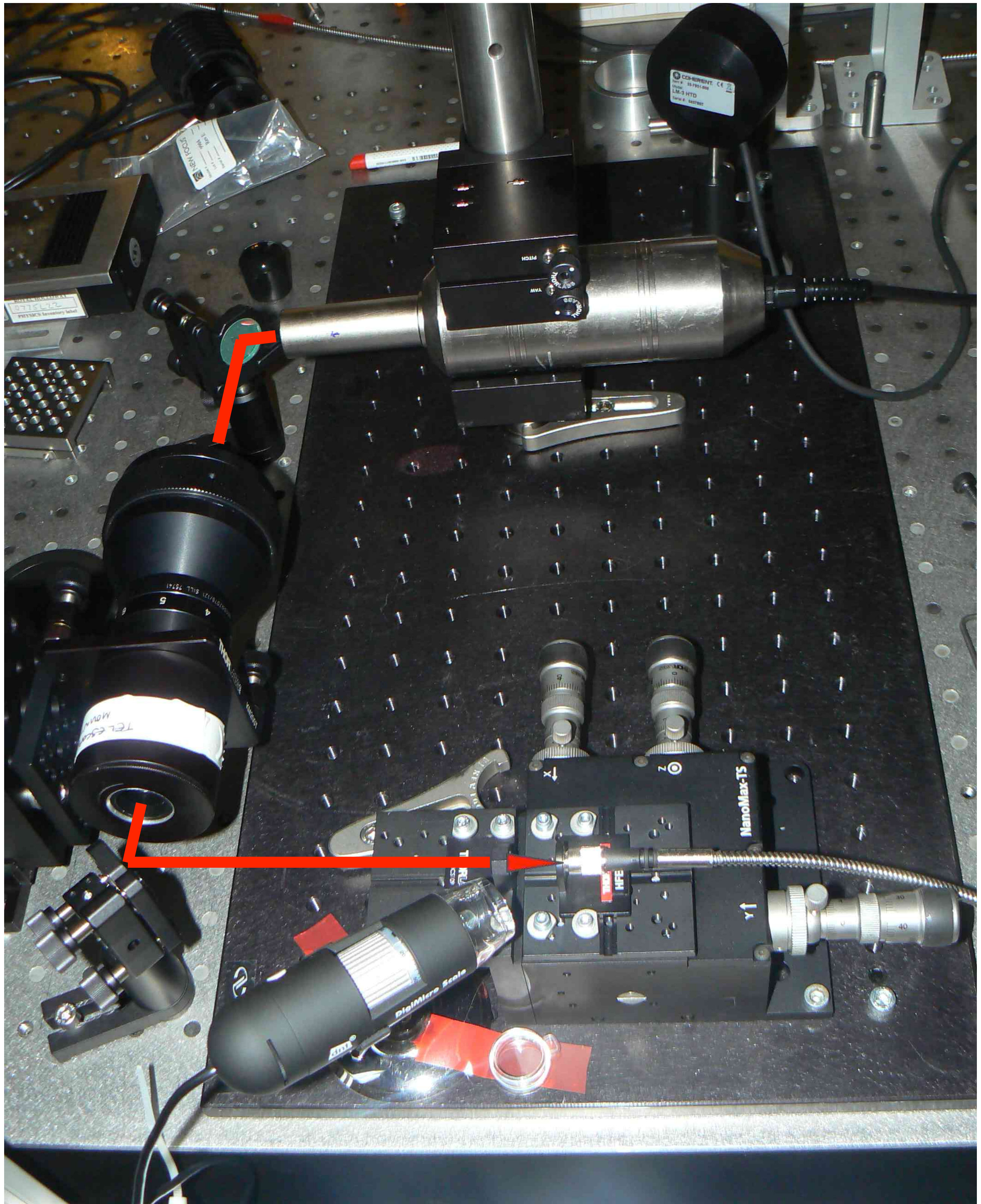
- Enclosure box finished and optics + cabling installed.
- Date now agreed with Linac4 for installation at CERN:
- Gary B. will visit CERN next week (from 28th Oct) with Richard D'Arcy for BPM tests. Gary will stay on to install PXI DAQ crate for strip detector and laserwire system and check LabView software.
- Alessio, Konstantin and Stephen have agreed with Thomas to visit CERN from Wed 6 – Wed 13 November for system installation:
  - Please let us know if you would like to join.
  - We will work evenings and the weekend when particle beam is not present.
  - Aim of this visit is initial hardware set up, optic alignment, safety, DAQ, etc..
  - Expect another trip to perform test programme with beam.

Laser and coupling box

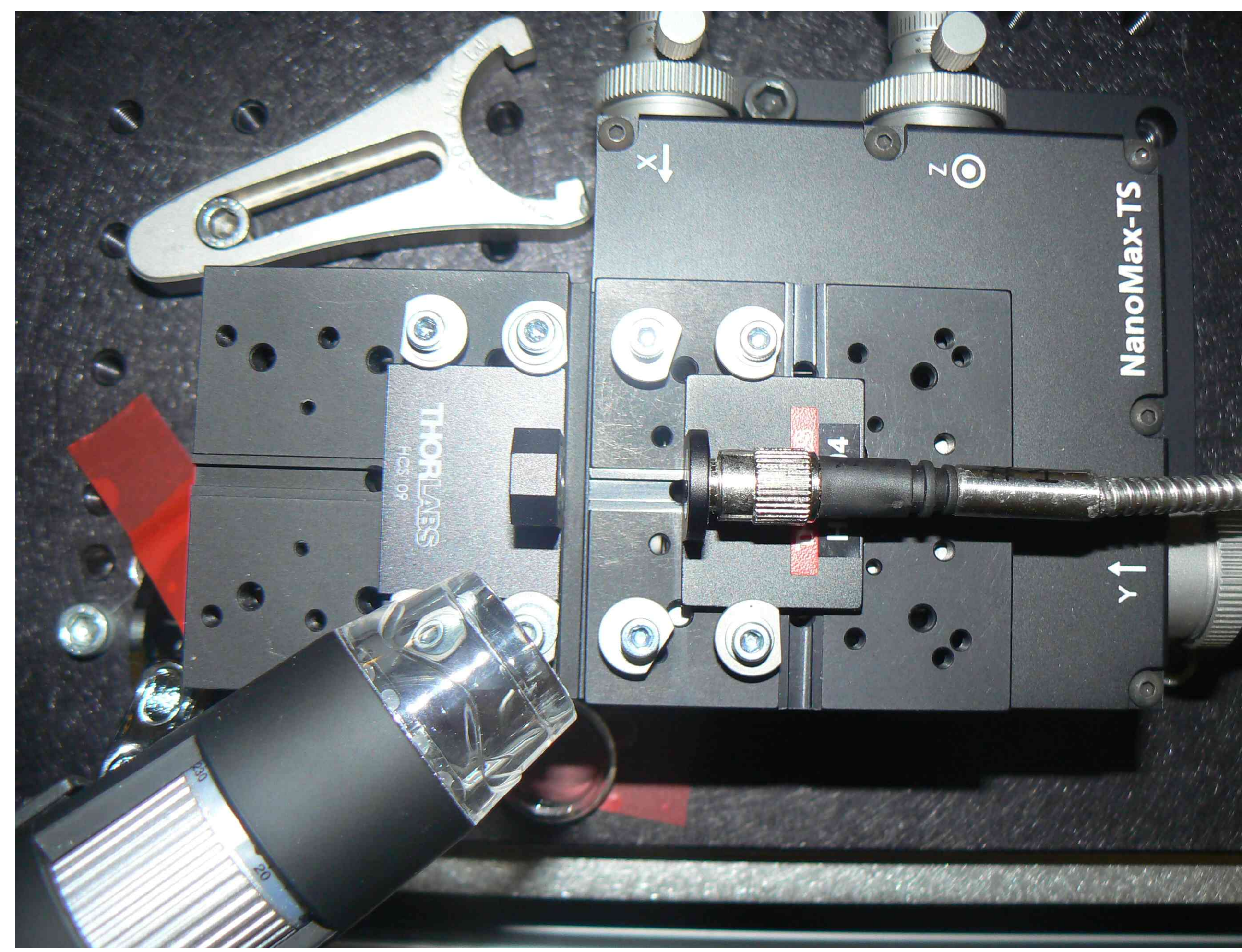


- Manlight Laser:
  - Original (30 W) laser returned from France following "repair" (no modification).
  - No sign of damage from transport.
  - Validation tests planned before shipping to CERN
- Enclosure for fibre-coupling optics
  - Laser head and fibre-coupling optics will be installed in rack-mountable optical breadboard.
  - Ease of installation at Linac4 racks.

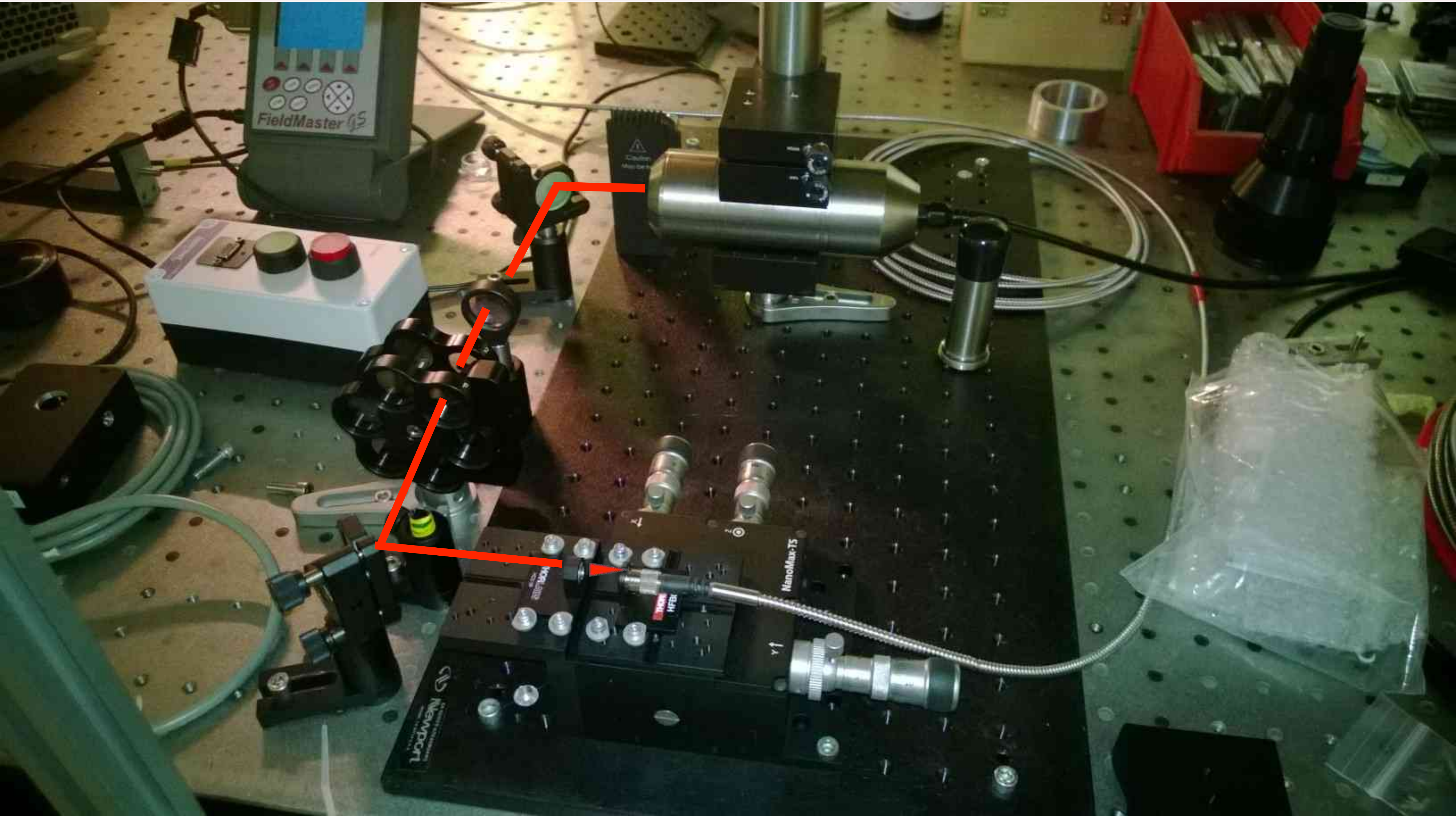
Optical fibre coupling – last time:



- Laser head and fibre-coupling mounted on optical table, within footprint of coupling box:
- 3-axis translation stage to align fibre to focus of aspheric lens.
- Initially <50% efficient due to divergent beam. With telescope > 60% coupling achieved previously….



Optical fibre coupling



- Coupling now improved to ~75-80%, with single lens and careful alignment.

Beam delivery outside box

Fibre

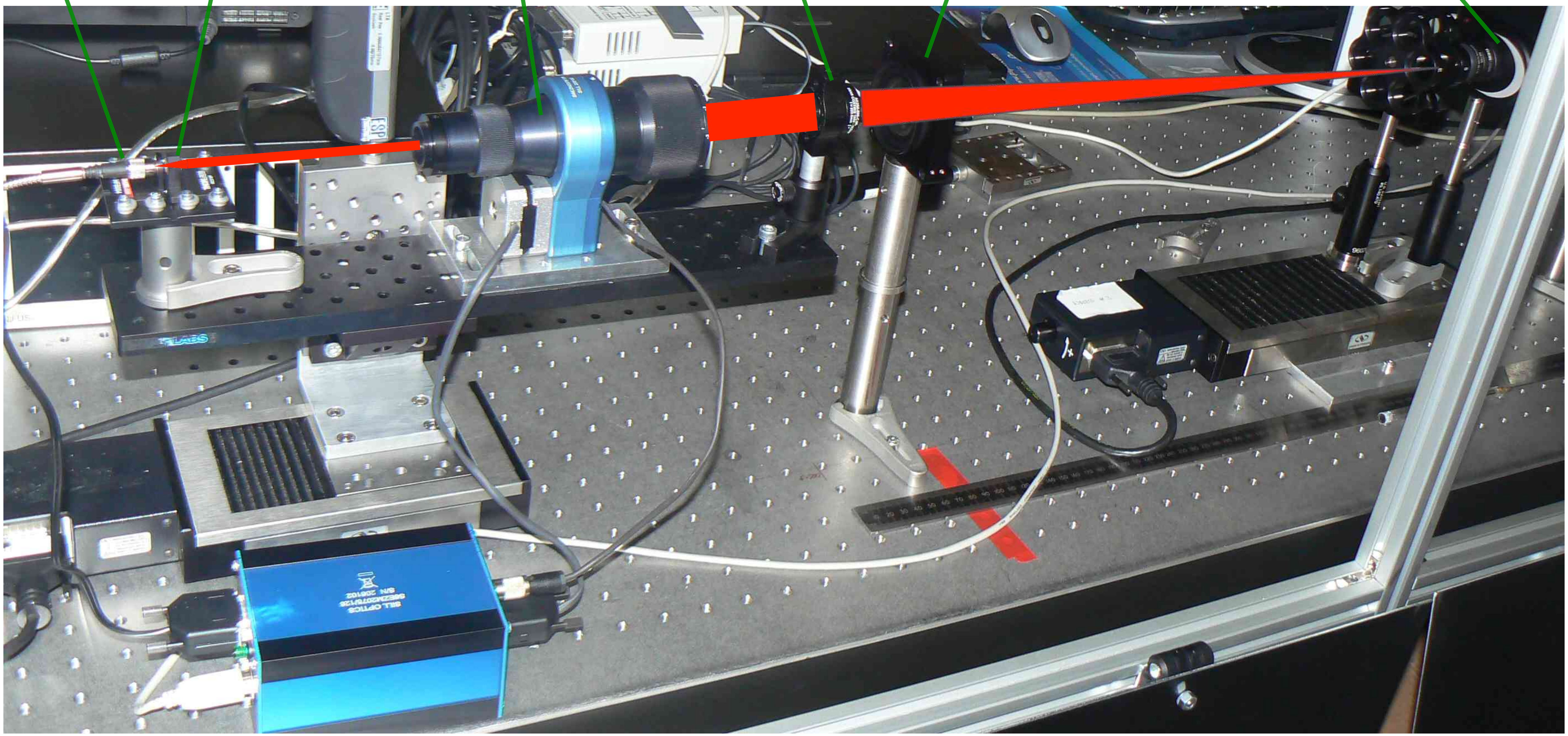
collimating Lens f=6.4mm

motorized beam expander

focusing lens f=500mm

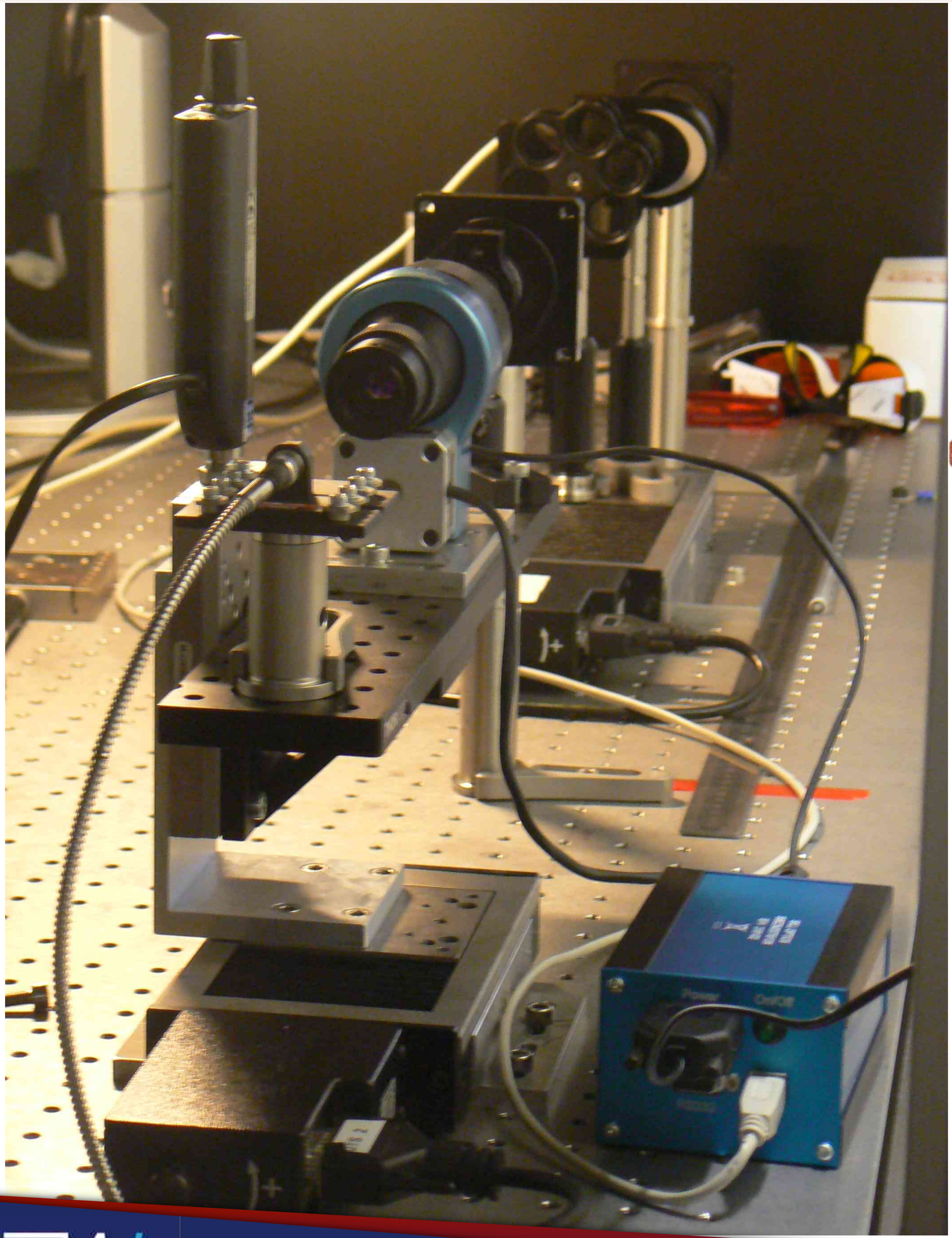
Iris for alignment

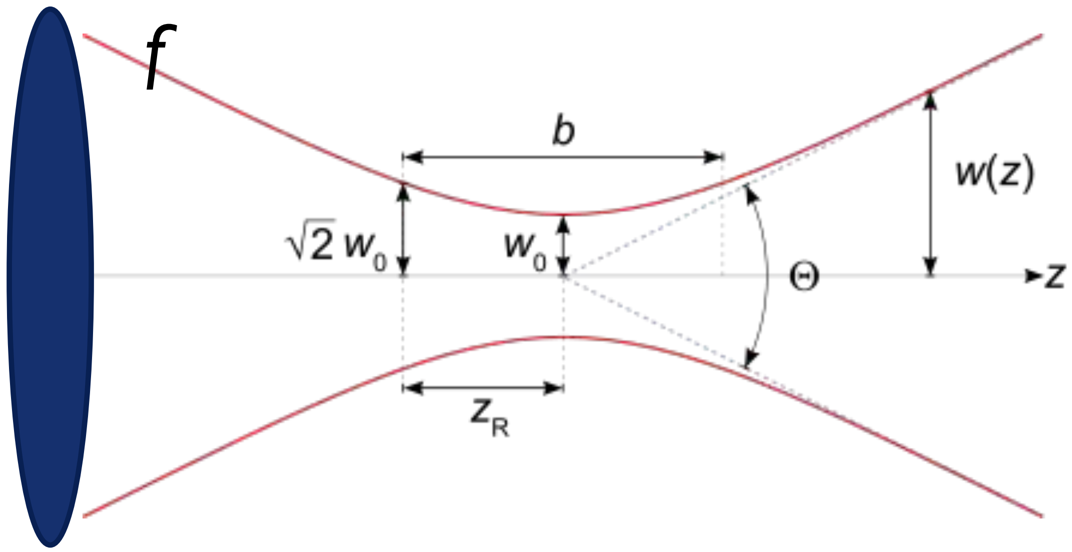
camera and filter wheel on translation stage around beam focus



BE control

Beam delivery M2 measurement





- Camera scanned through +/- 75 mm to measure beam variation around focus.
  - Beam waist

$$w_0 = \frac{\lambda}{\pi} M^2 \frac{2f}{d}$$

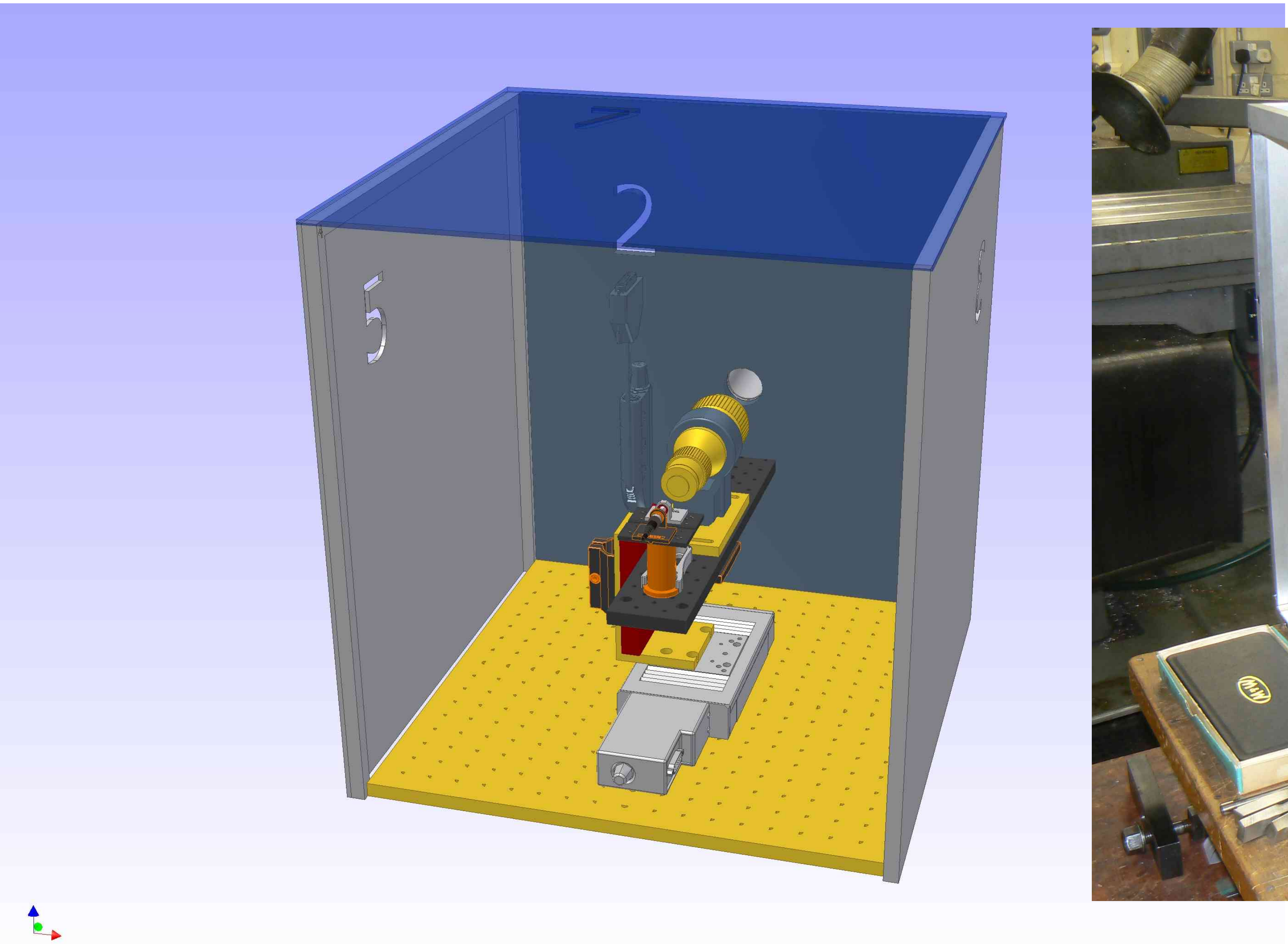
  - Rayleigh length

$$z_R = \frac{\pi {w_0}^2}{\lambda M^2}$$

  - Beam transverse size (1/e^2):

$$w(z) = w_0 \sqrt{1 + \left({}^{z}/_{z_R}\right)^2}$$

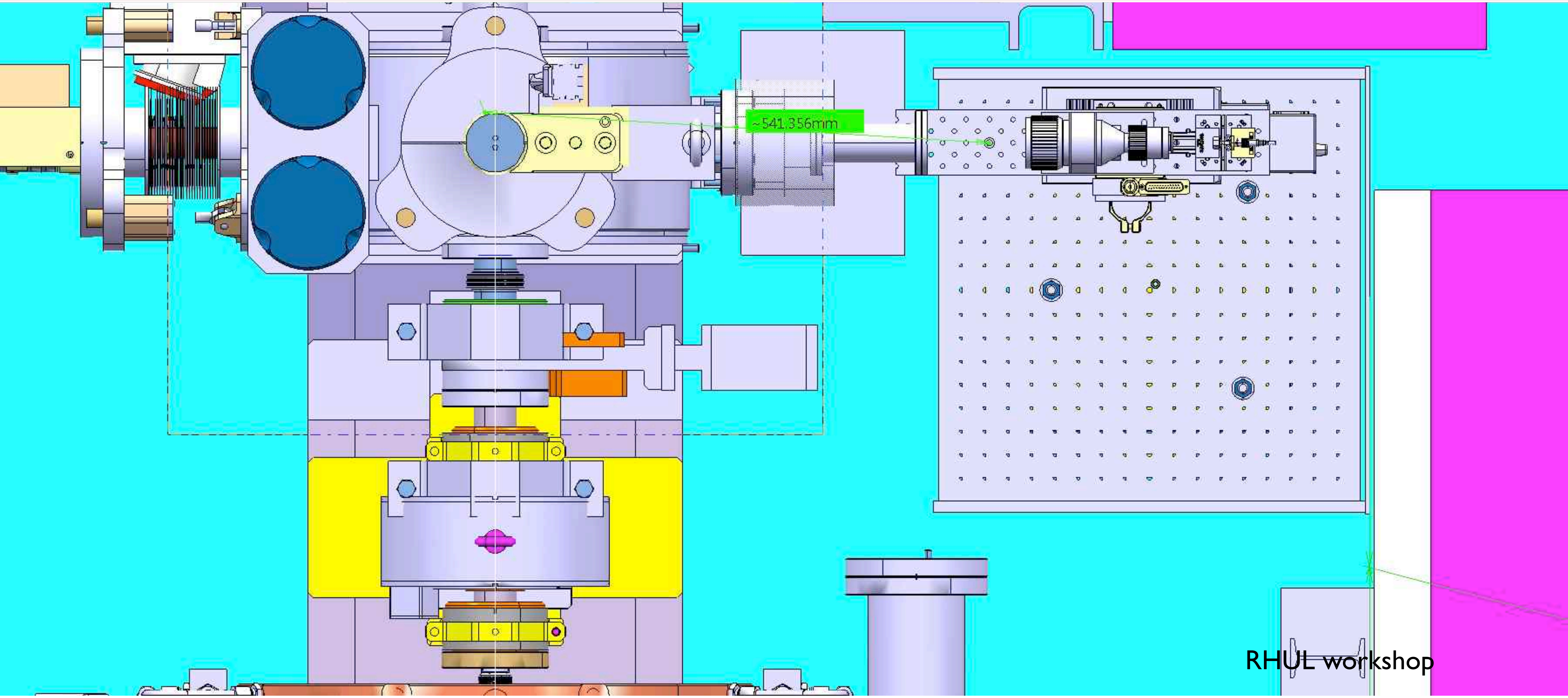
Interlocked enclosure



RHUL workshop

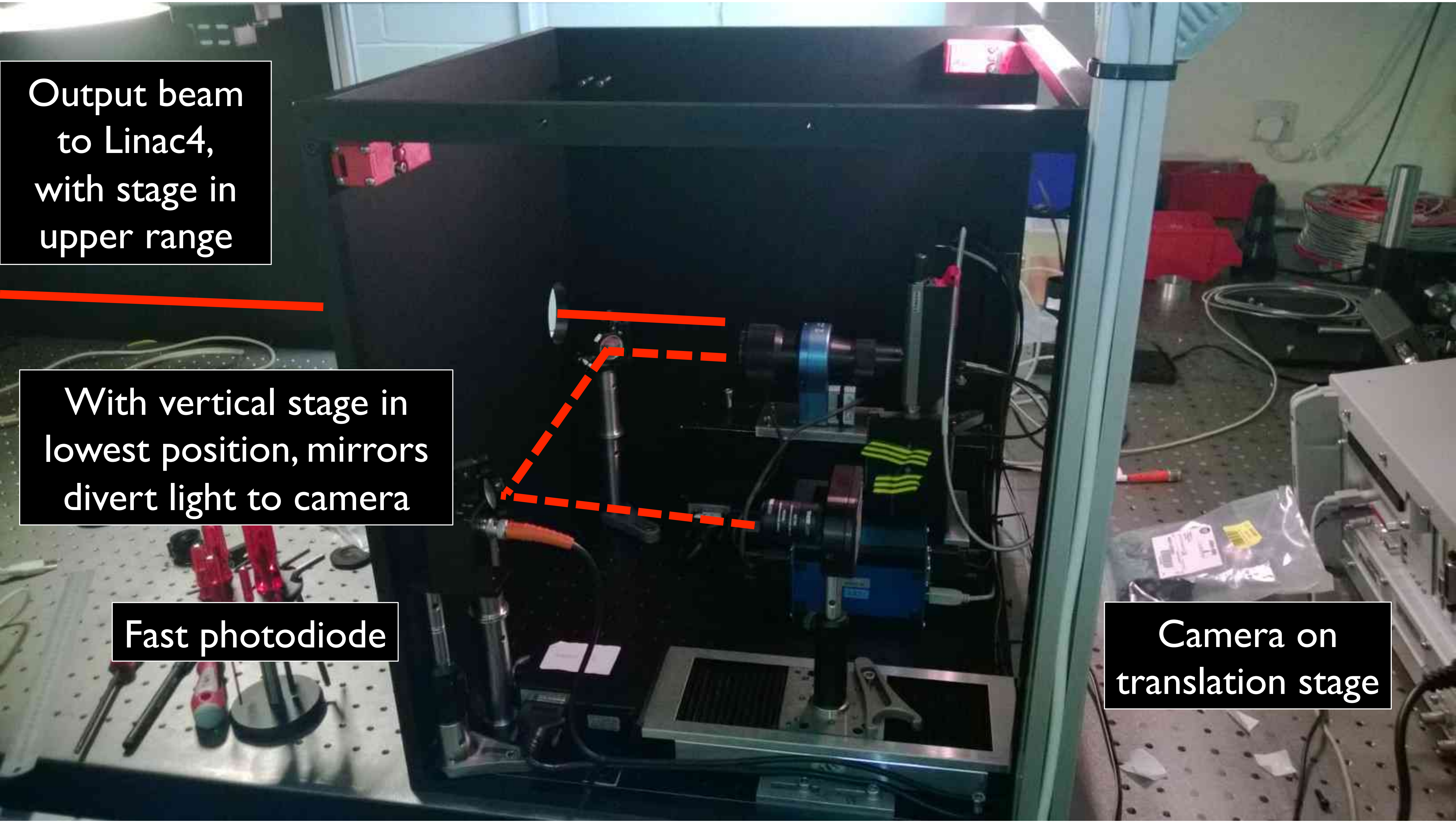
- Beam delivery system enclosed in aluminum box, on 450x450mm breadboard.
- The top and two side panels are removable for access.
- Opening the box breaks the interlock and dumps the laser beam.
- Key to override interlock for exceptional access / alignment.

Integration with Linac4



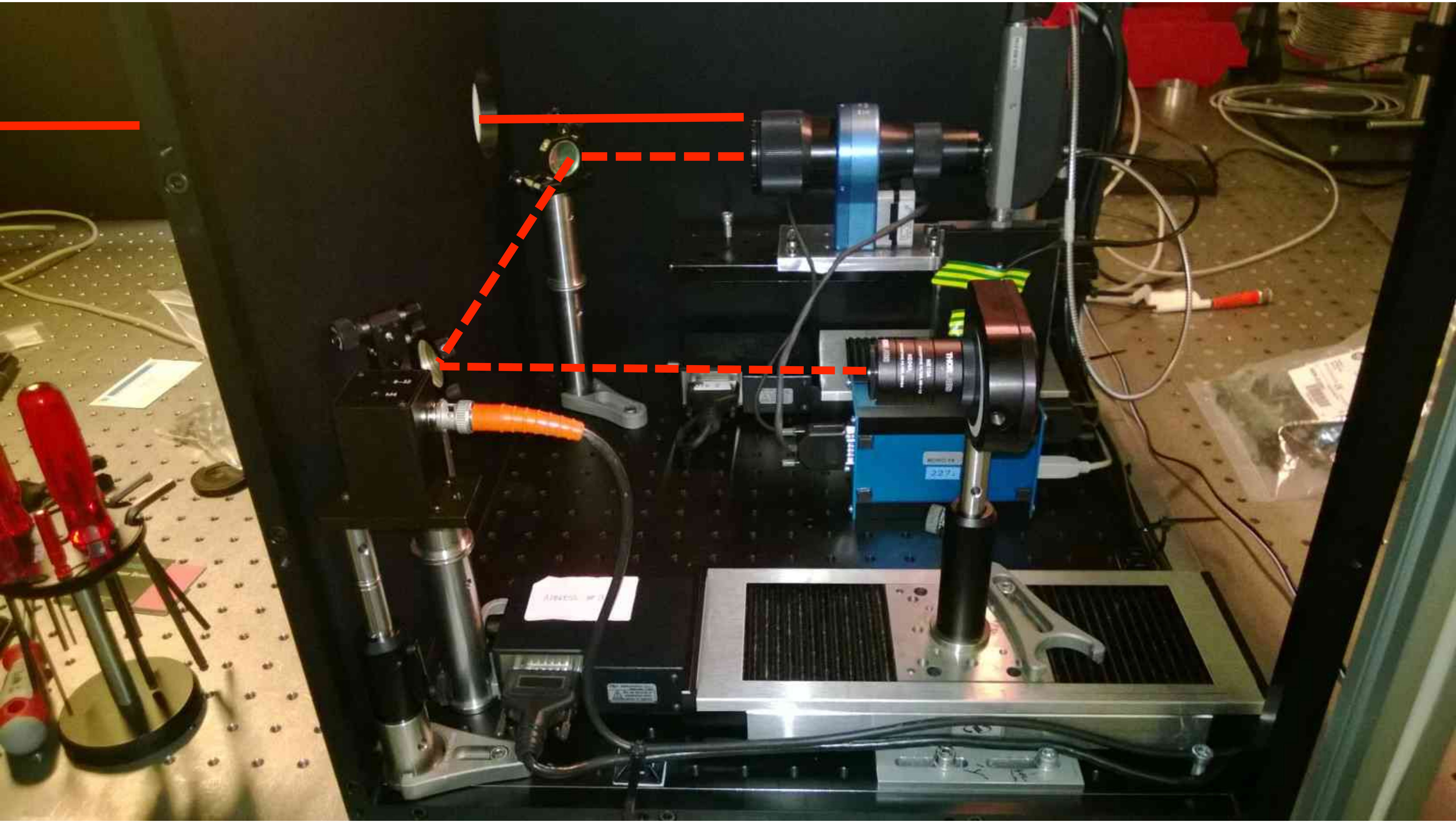
- Position of lens defined with Linac4 CAD team. (had to increase to f=600mm)
- Beam expander and translation stage assembly moved to side of the box, to avoid the box clashing with an existing pillar at Linac4.
- Cylindrical shield from box to the Linac4 vacuum vessel.

Beam delivery system in enclosure



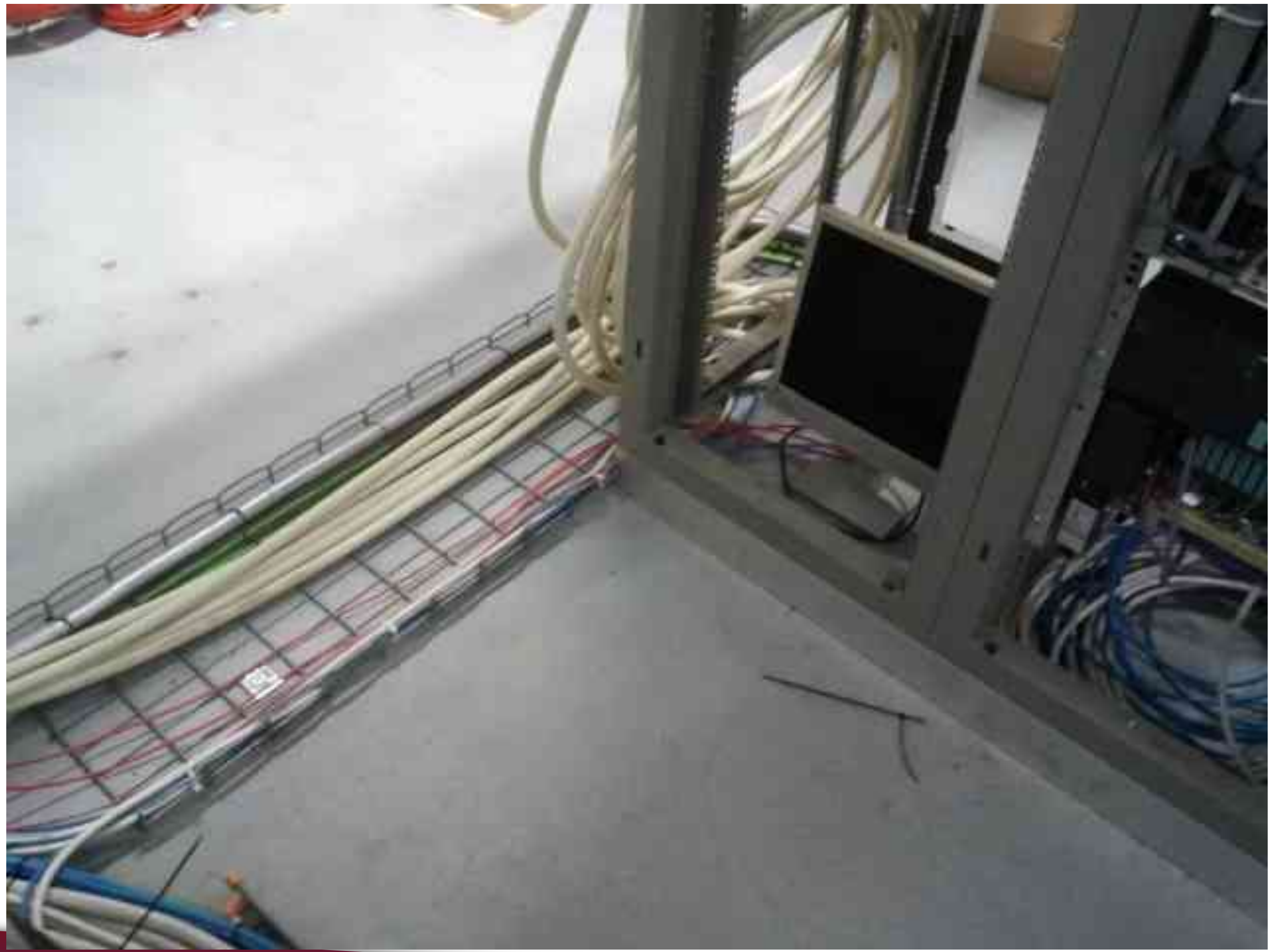
Beam delivery system in enclosure

Beam delivery system in enclosure



Rack in Linac4 tunnel

- Laser and optical coupling box to be rack mounted in Linac4 tunnel, adjacent to diagnostics test bench.
- Fibre route planned: 5m length is possible.



Linac4 tunnel, laser port visible

Back up

Plan view of FETS diagnostic