FETS Laserwire Emittance Scanner Update + BPM processing

on behalf of
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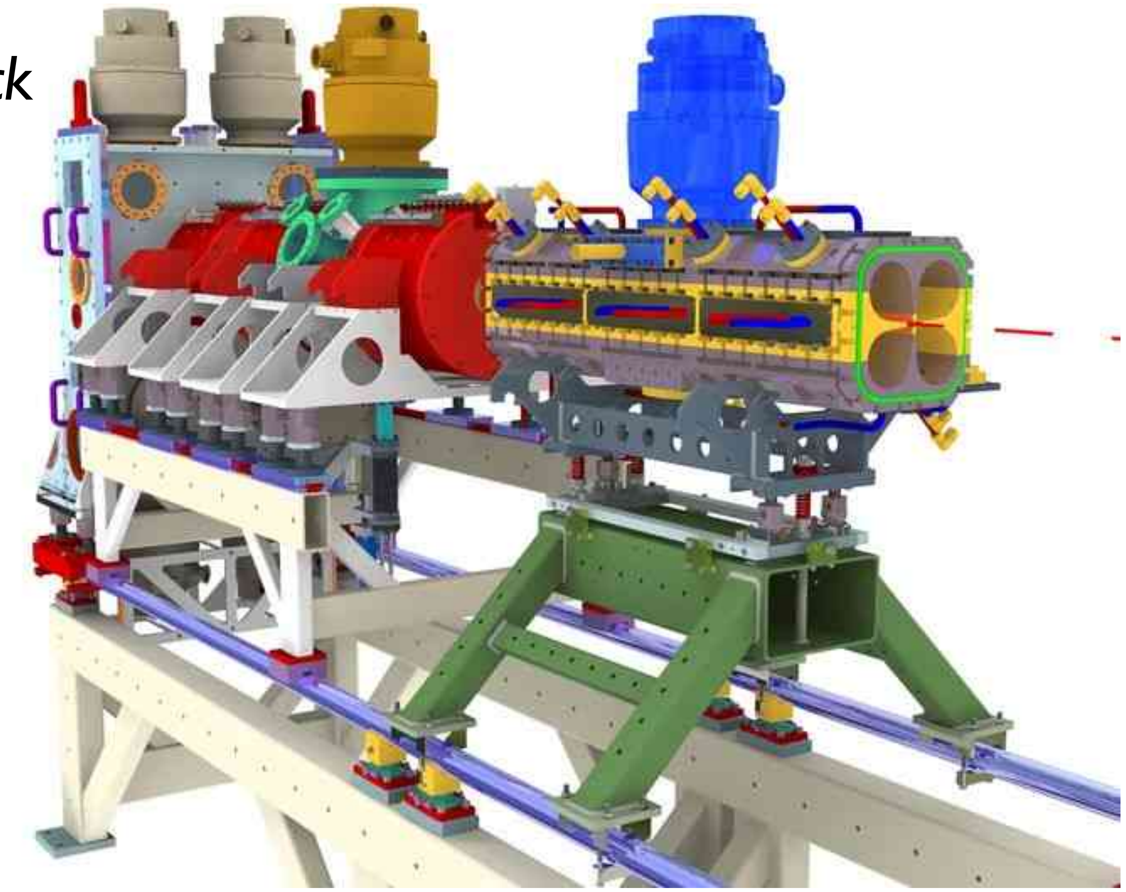
Thomas Hofmann - CERN

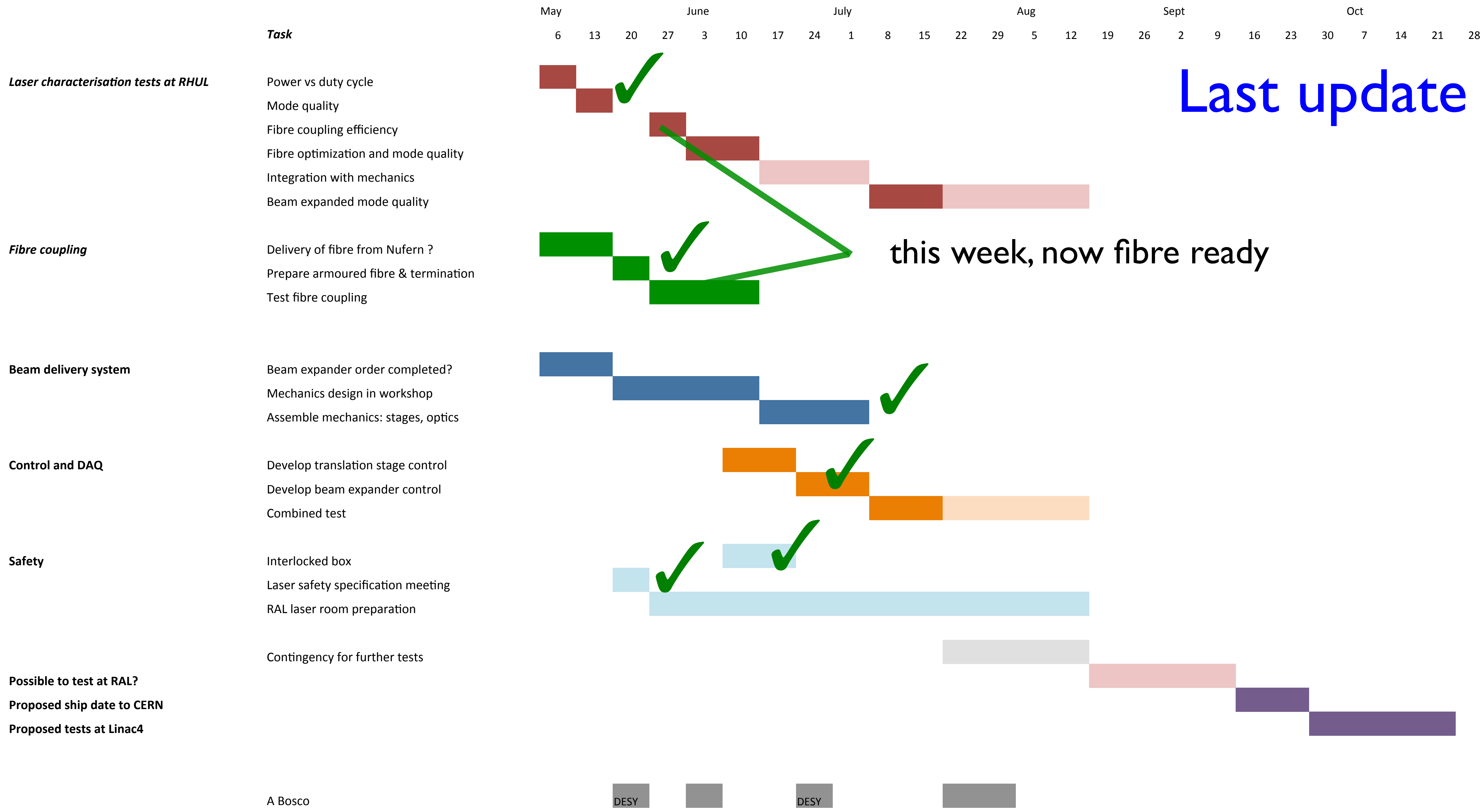
FETS Meeting, Warwick
31/07/2013

Outline

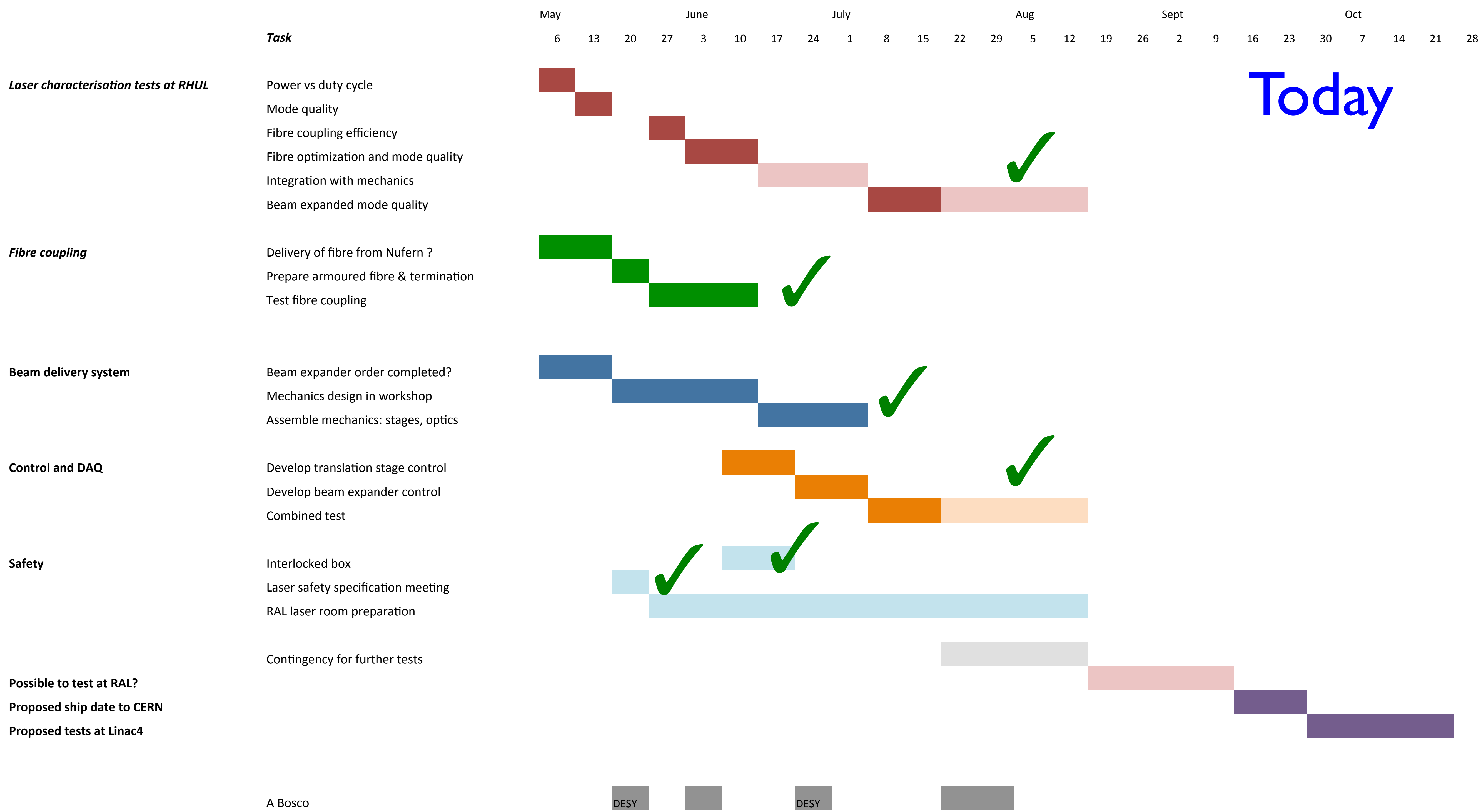
- Schedule & status
- Fibre coupling efficiency
- Laser beam M2 measurements
- Control and DAQ



Laser-diagnostics schedule



Laser-diagnostics schedule



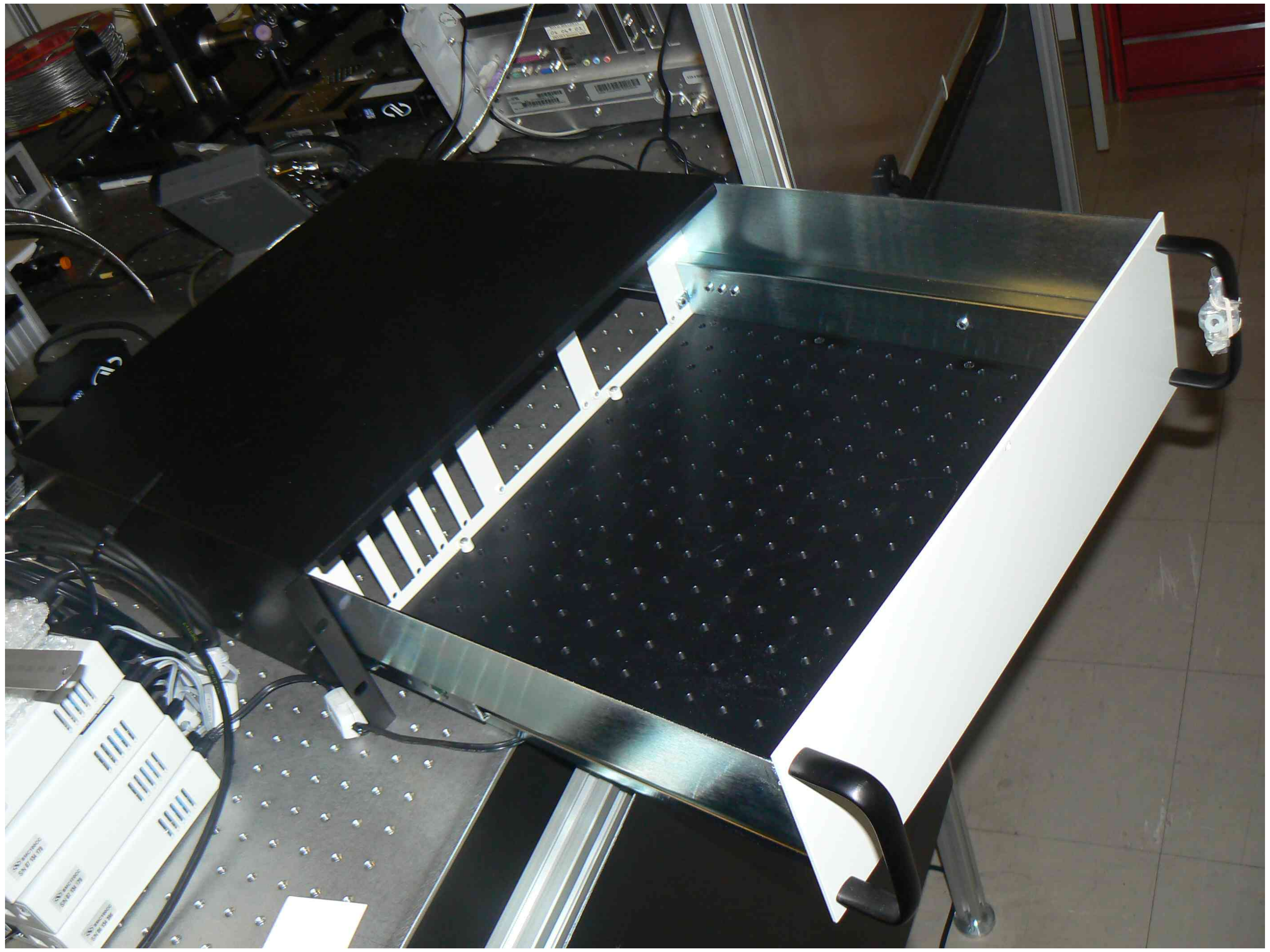
Summary of progress

- Since the last update in early July, the focus was on system tests at RHUL.

Main activities this month:

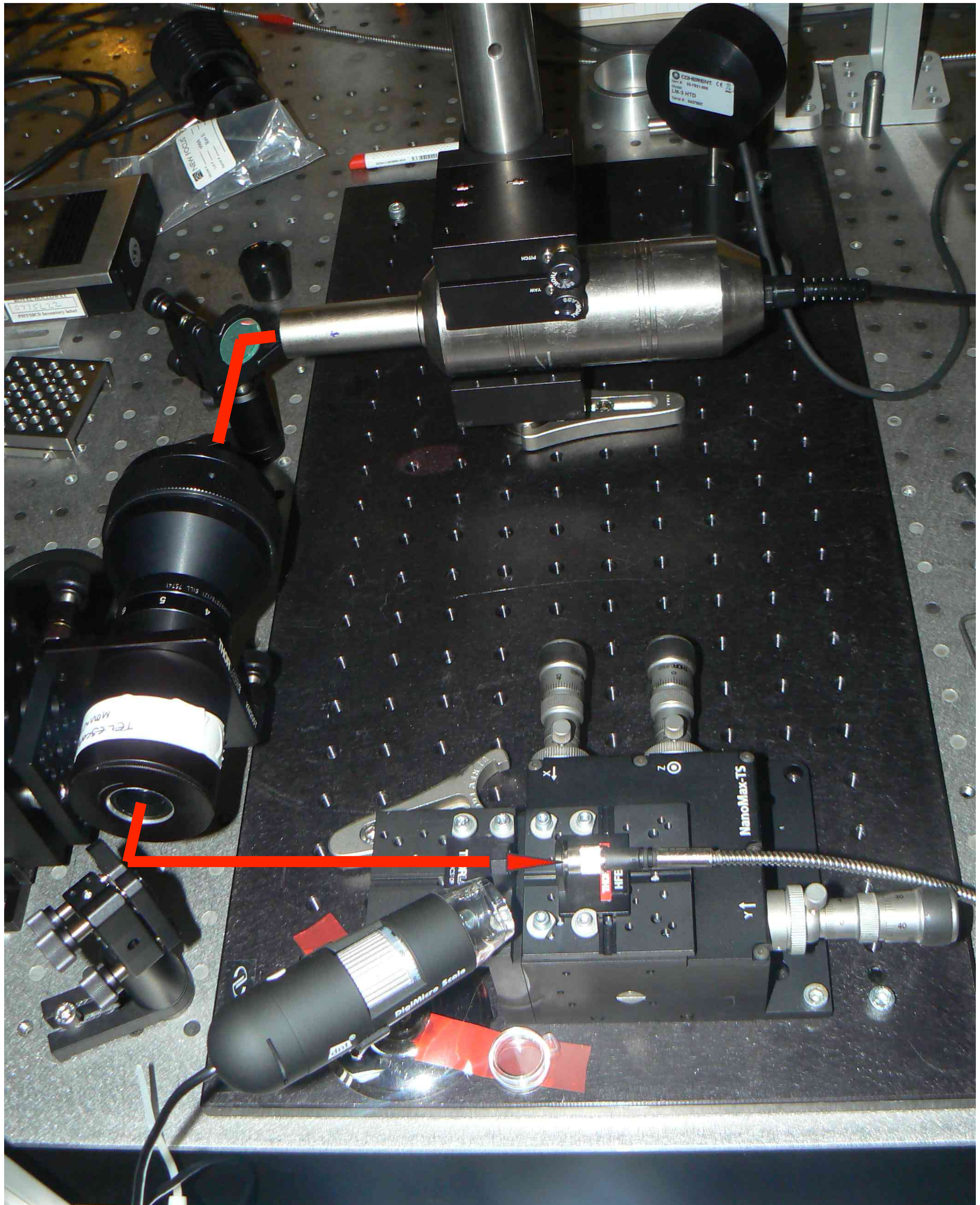
- MoU laserwire drafted together with CERN Linac4: Rhodri Jones, Uli Raich and Thomas Hofmann during visit to RAL and RHUL.
- Thomas stayed on for two weeks at RHUL for laserwire development.
- Laser fibre coupling and efficiency
  - Fibre launch system developed.
  - Light steered via aspheric lens to fibre and coupling efficiency measured.
  - Telescope test for improved efficiency.
- Laser beam delivery measurements
  - Alignment of fibre collimation lens, beam expander and focusing optics.
  - Test of beam expander control and stage movements.
  - Camera mounted on translation stage and M^2 measured.

Laser and coupling box

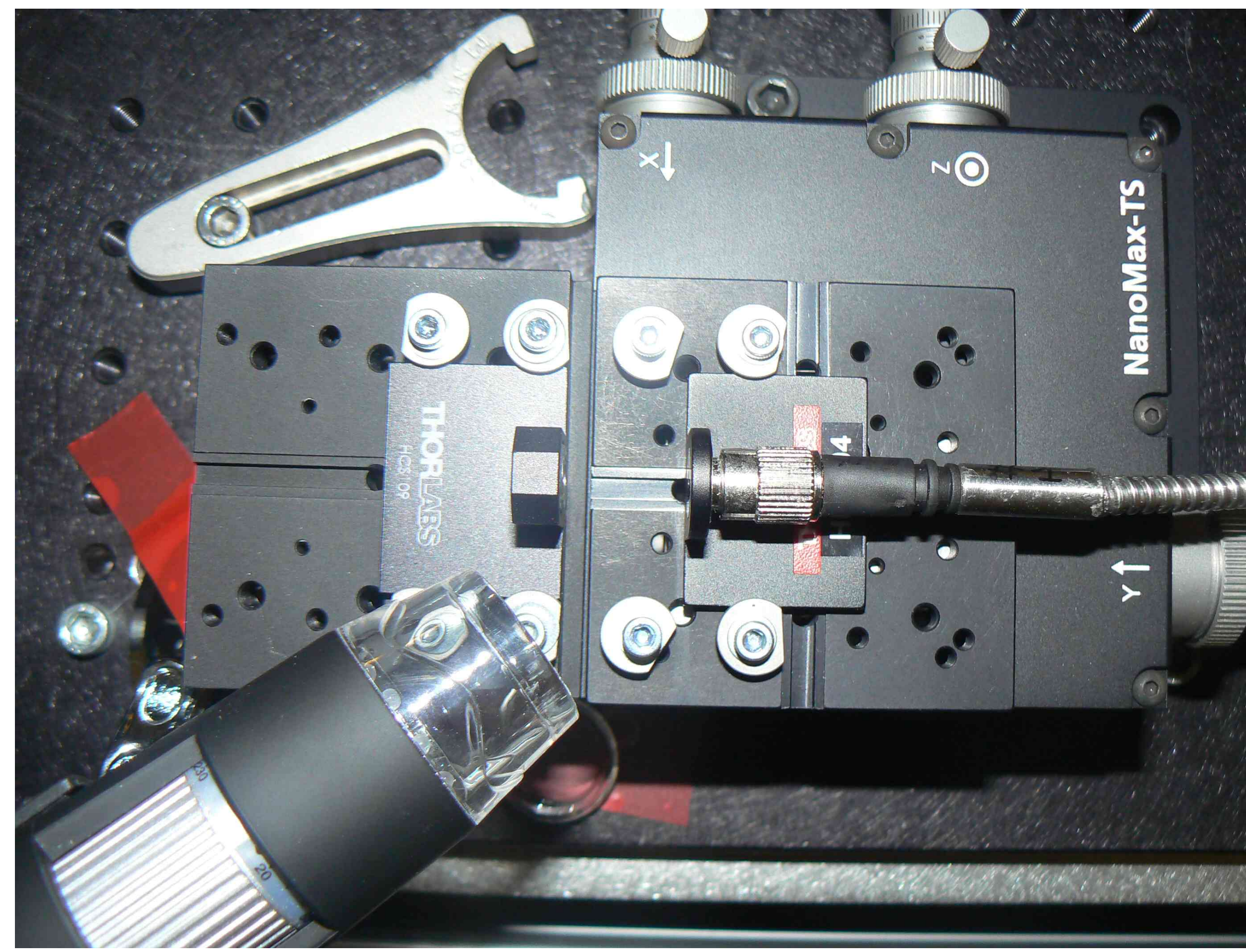


- Manlight Laser replacement:
  - Original (30 W) laser returned to France for "repair" - to improve performance at low duty cycles.
  - Meanwhile, have received equivalent model replacement laser (10 W) to continue development.
- Enclosure for fibre-coupling optics
  - Laser head and fibre-coupling optics will be installed in rack-mountable optical breadboard.
  - Ease of installation at Linac4 racks.

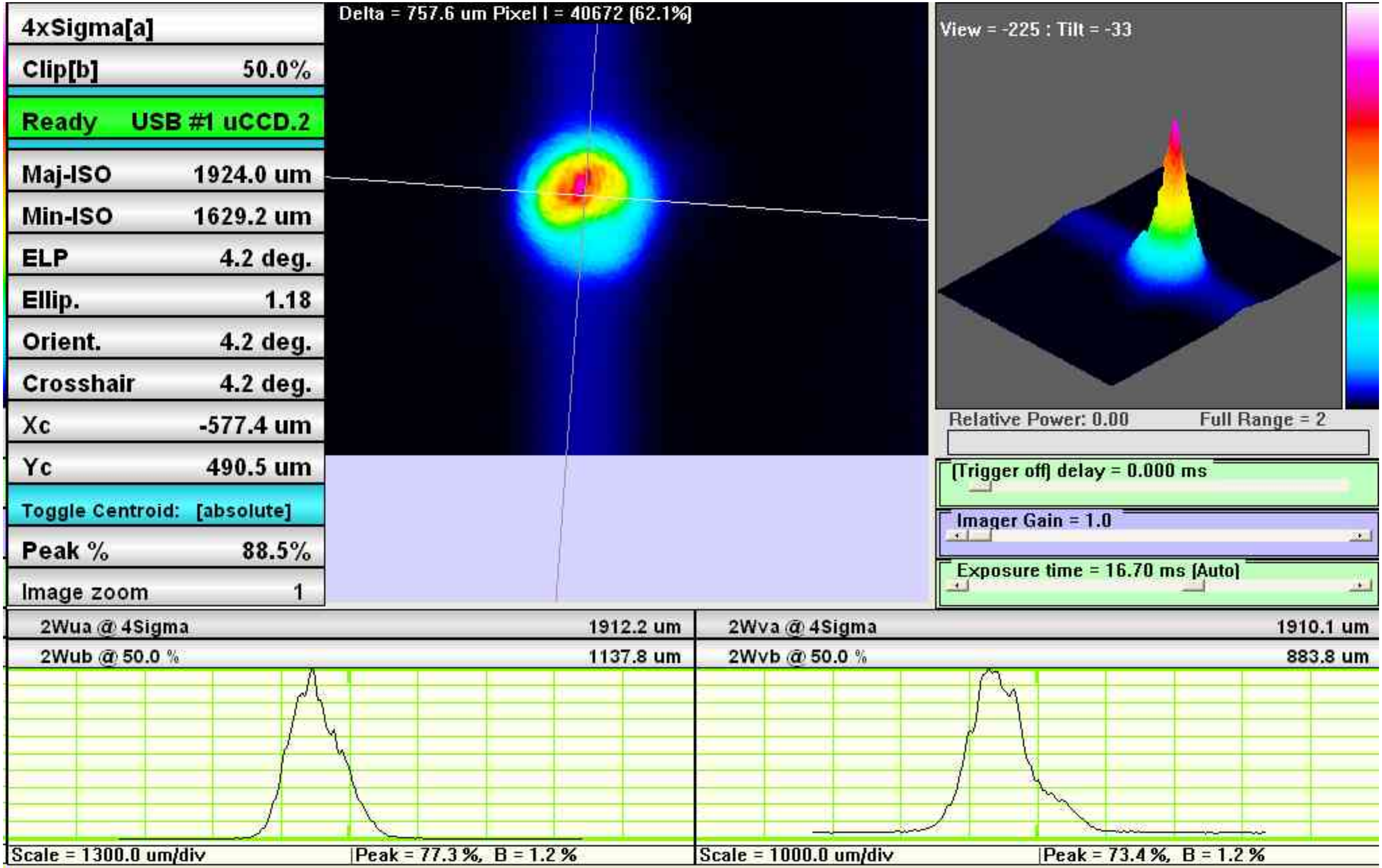
Optical fibre coupling



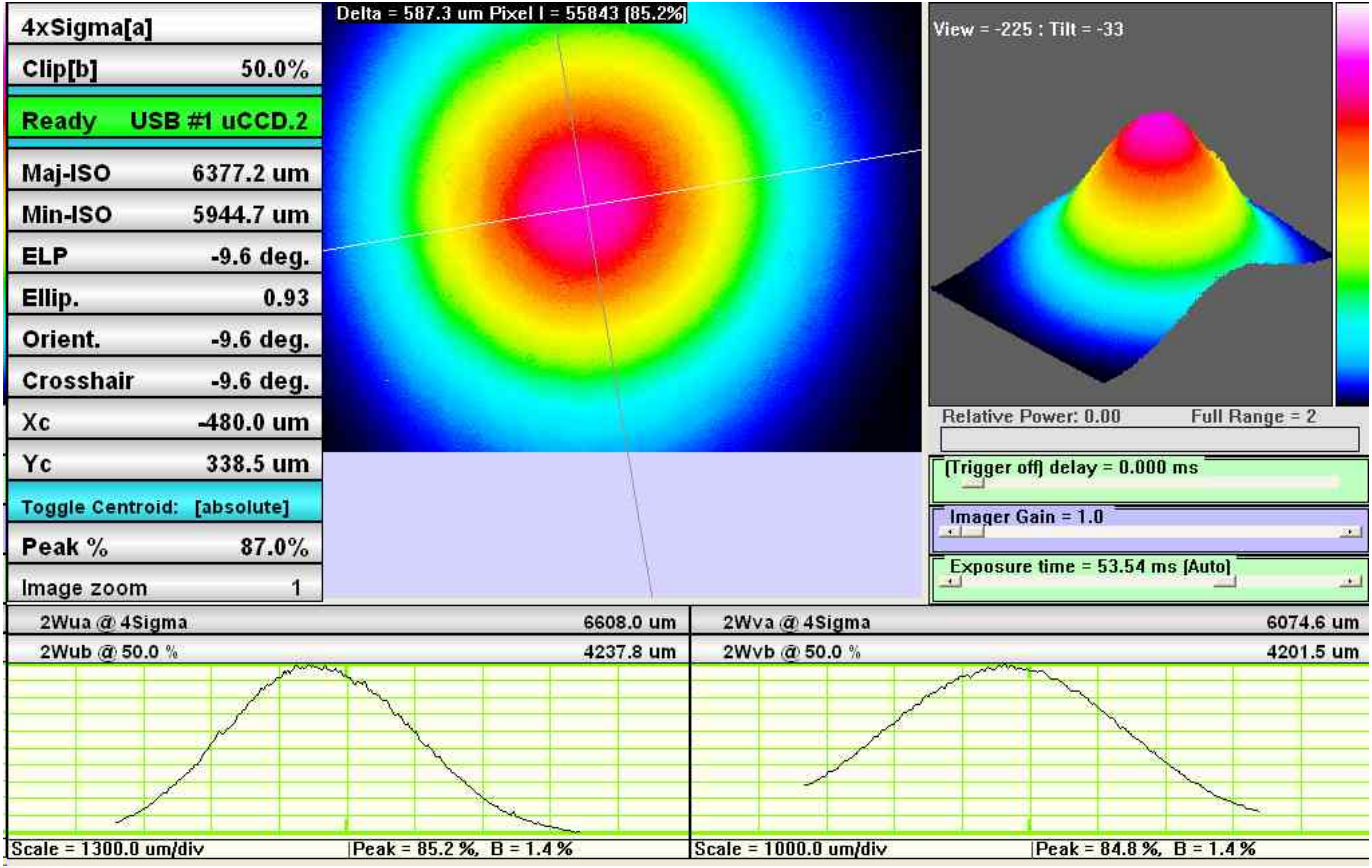
- Laser head and fibre-coupling mounted on optical table, within footprint of coupling box:
- 3-axis translation stage to align fibre to focus of aspheric lens.
- Initially <50% efficient due to divergent beam. With telescope > 60% coupling achieved so far…



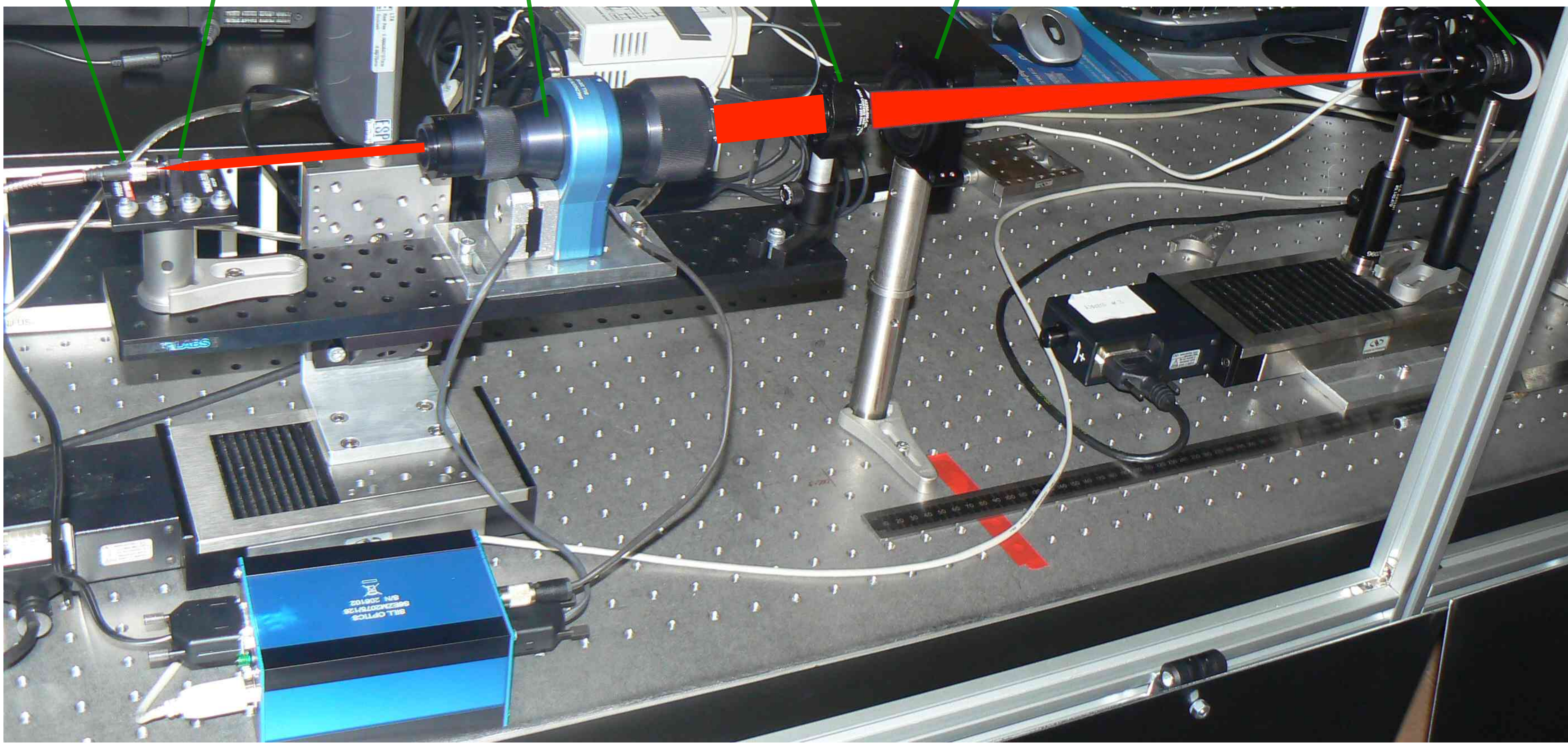
Beam direct from laserhead



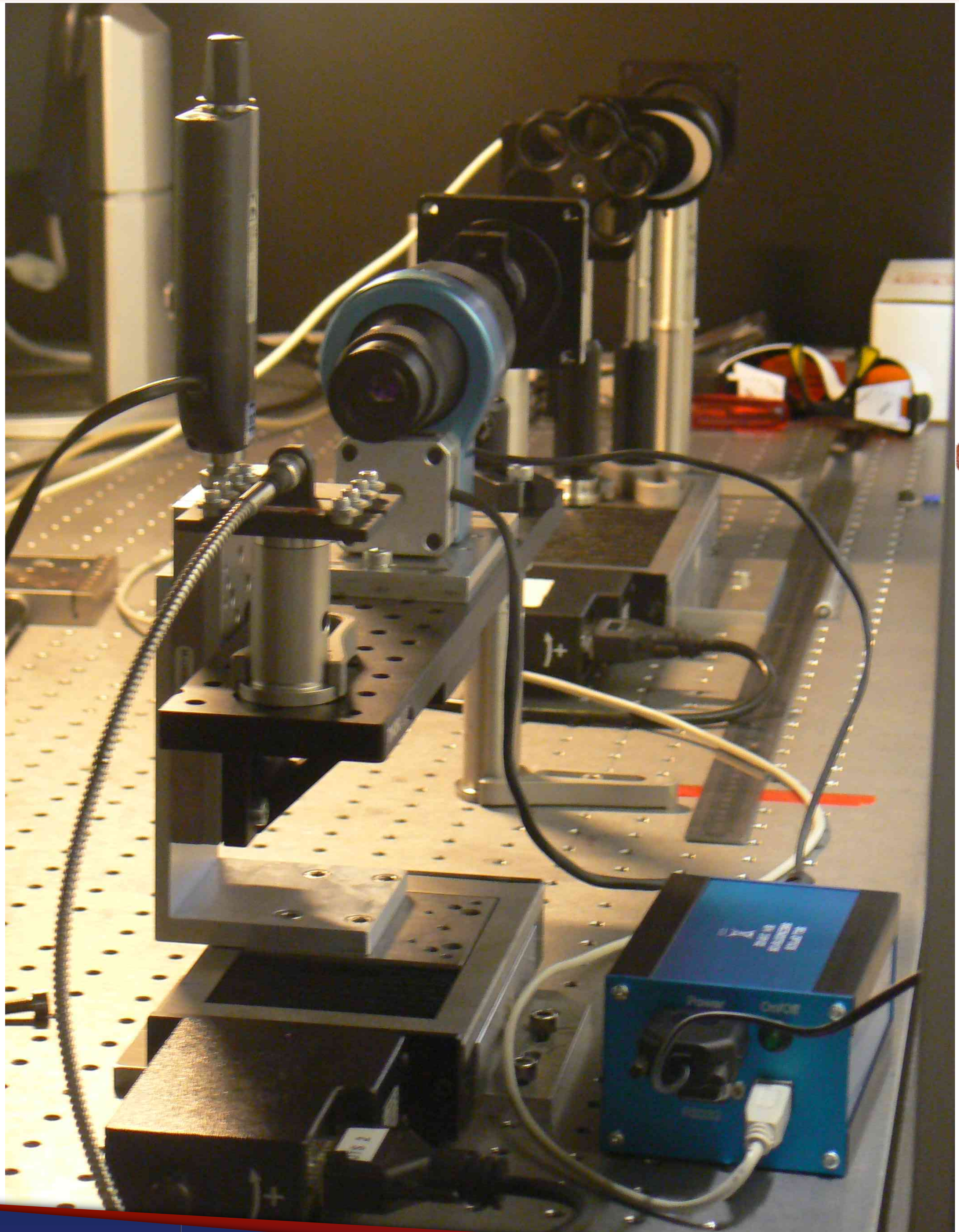
Beam after fibre (no collimation)

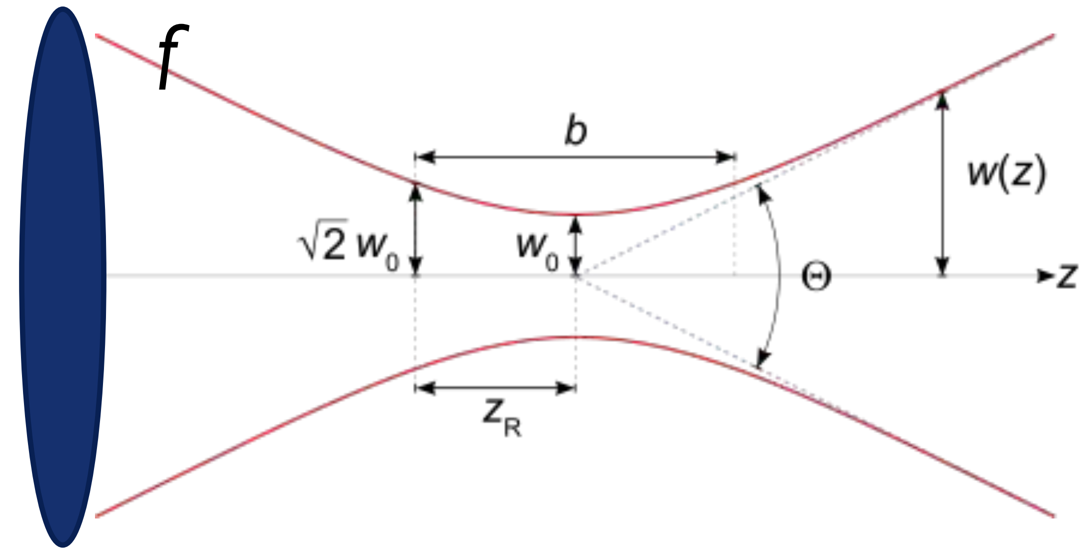


Beam delivery M2 measurement



Beam delivery M2 measurement





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

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

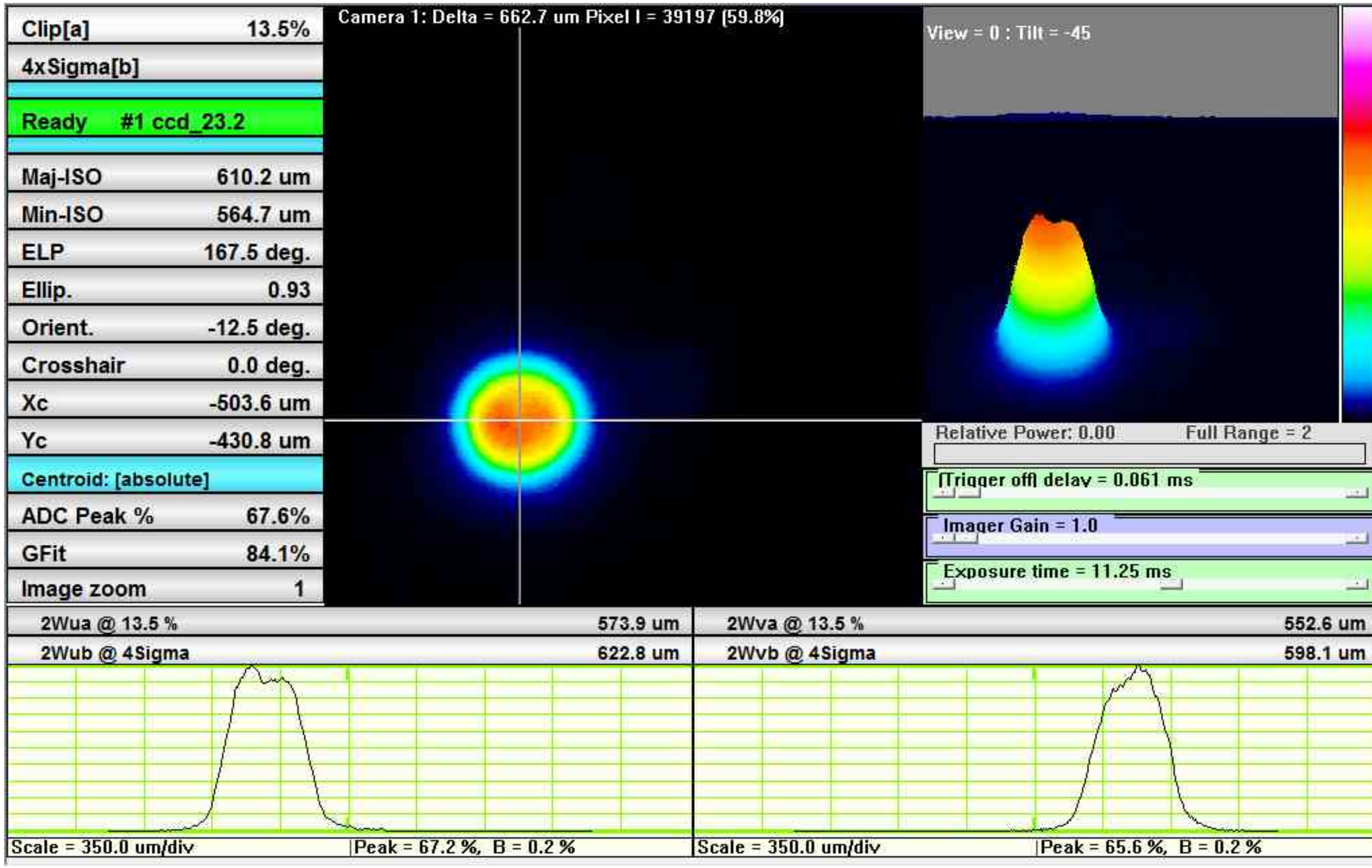
- Rayleigh length

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

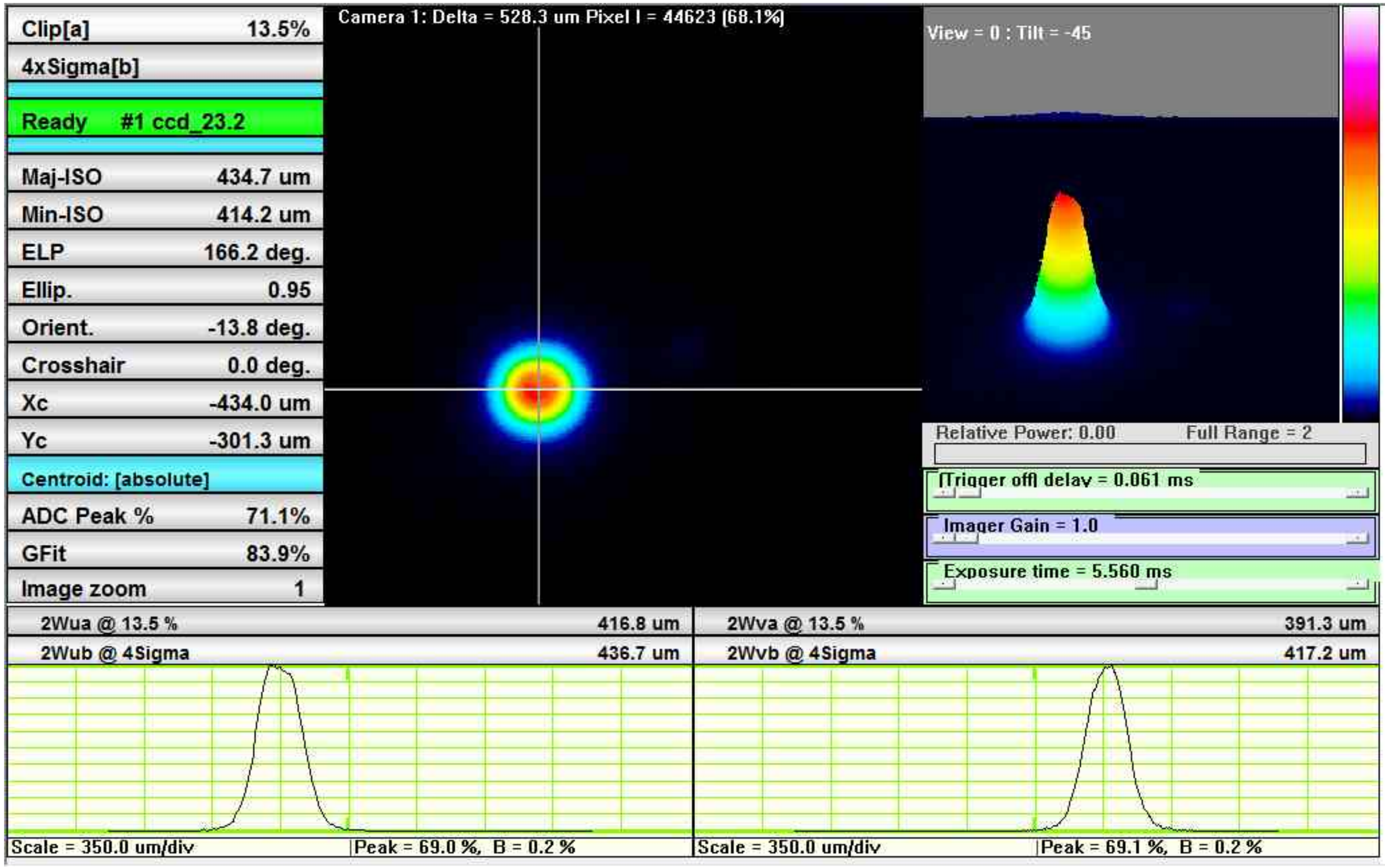
- Beam transverse size (1/e²):

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

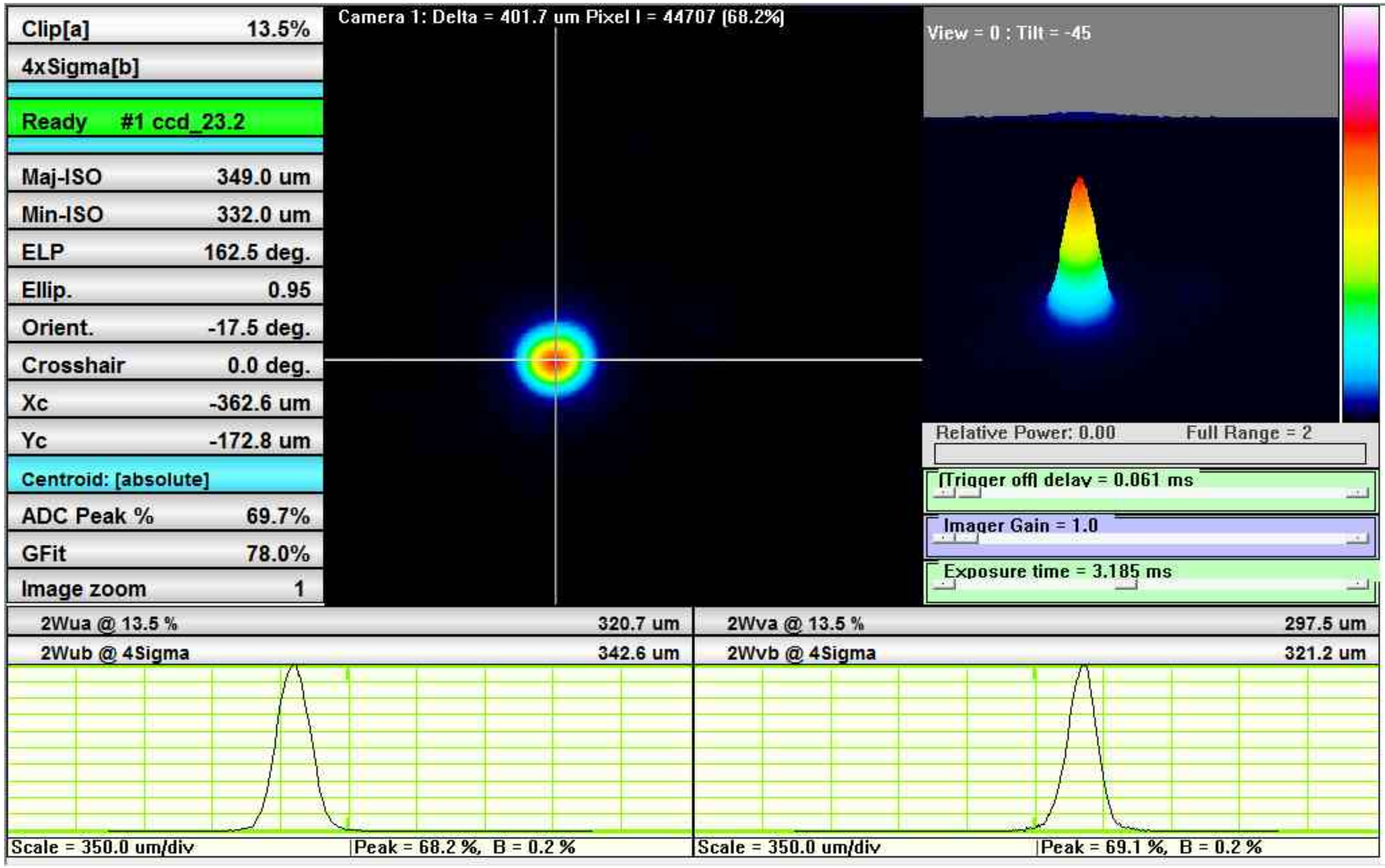
M2 measurement: -75mm



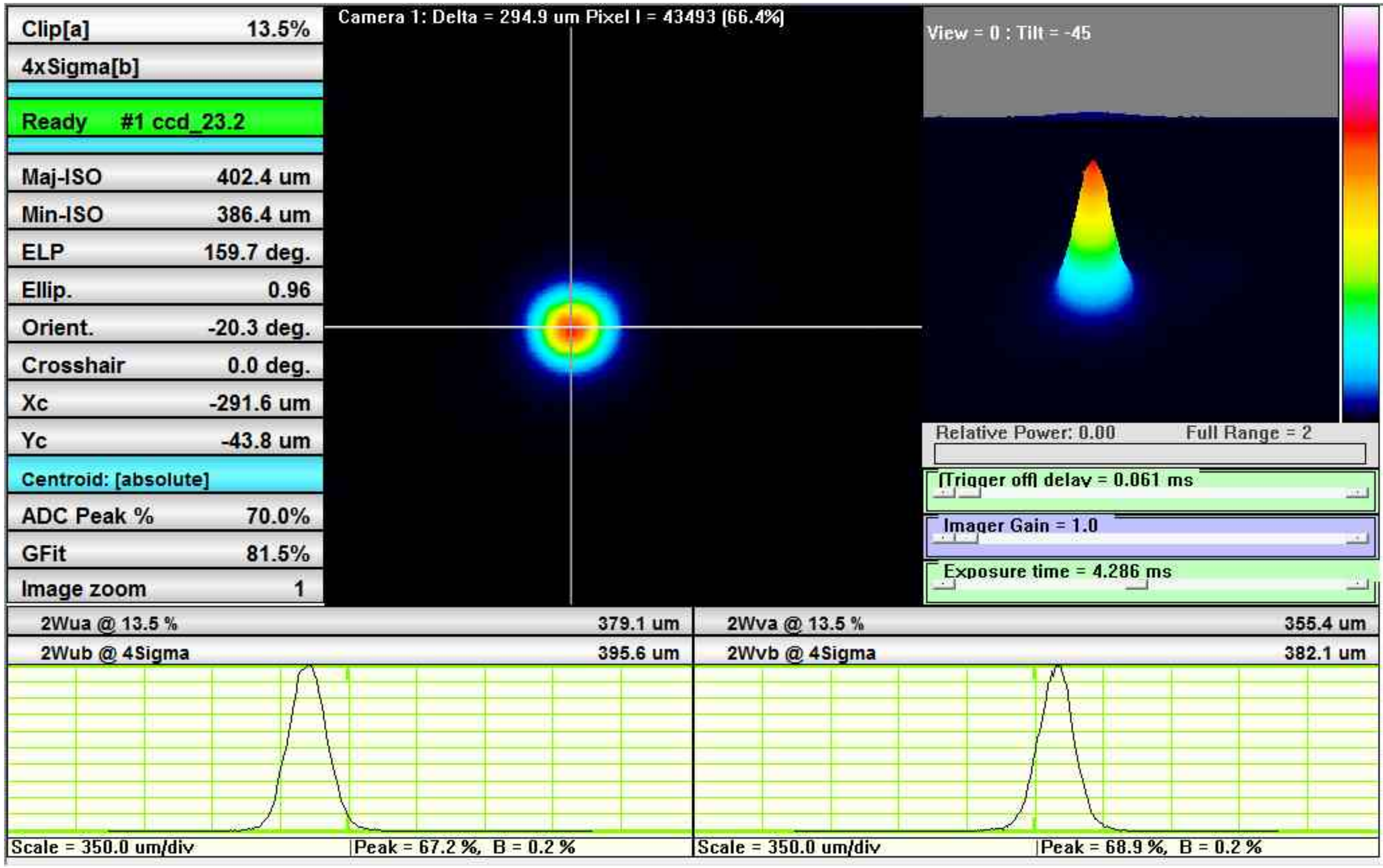
M2 measurement: -45mm



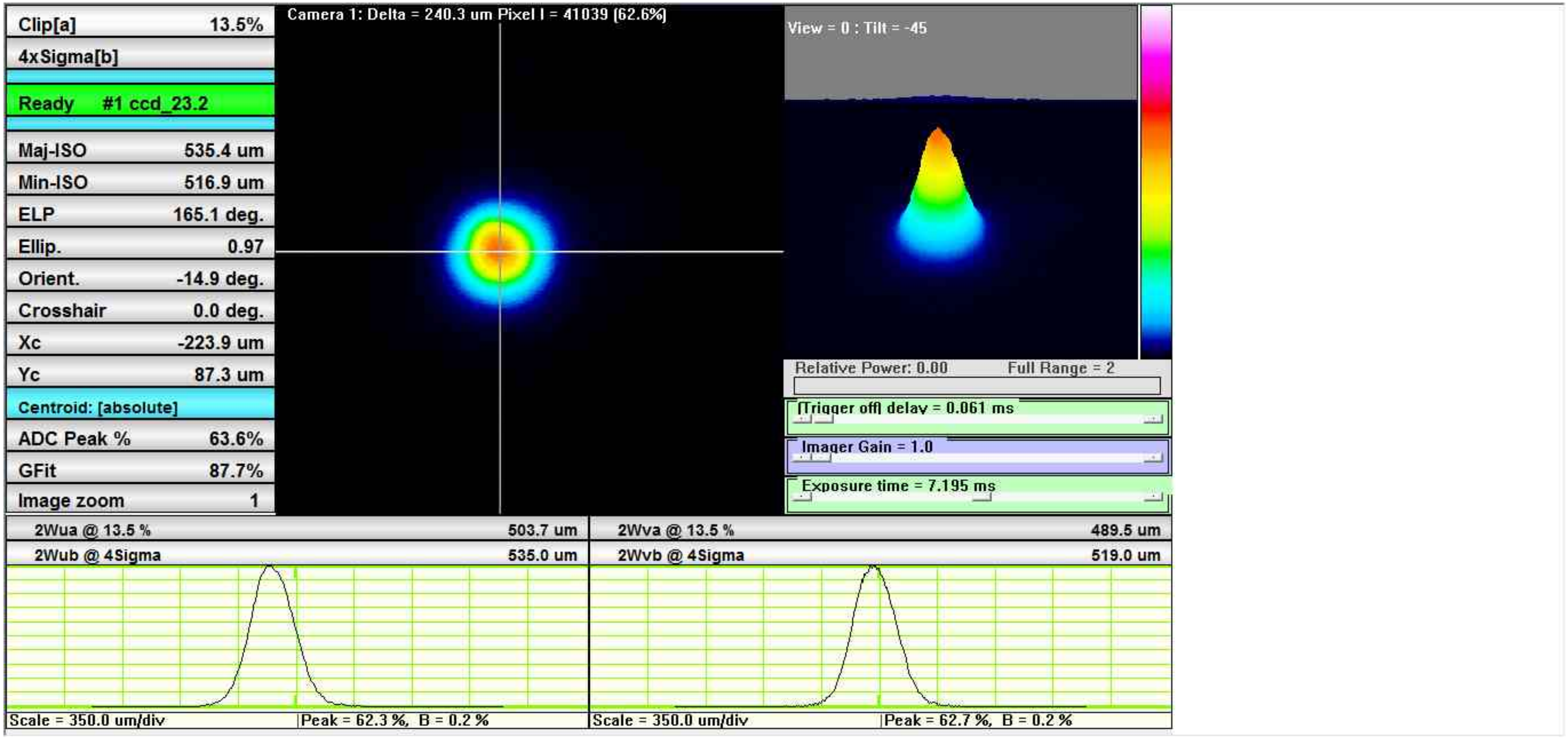
M2 measurement: -15mm



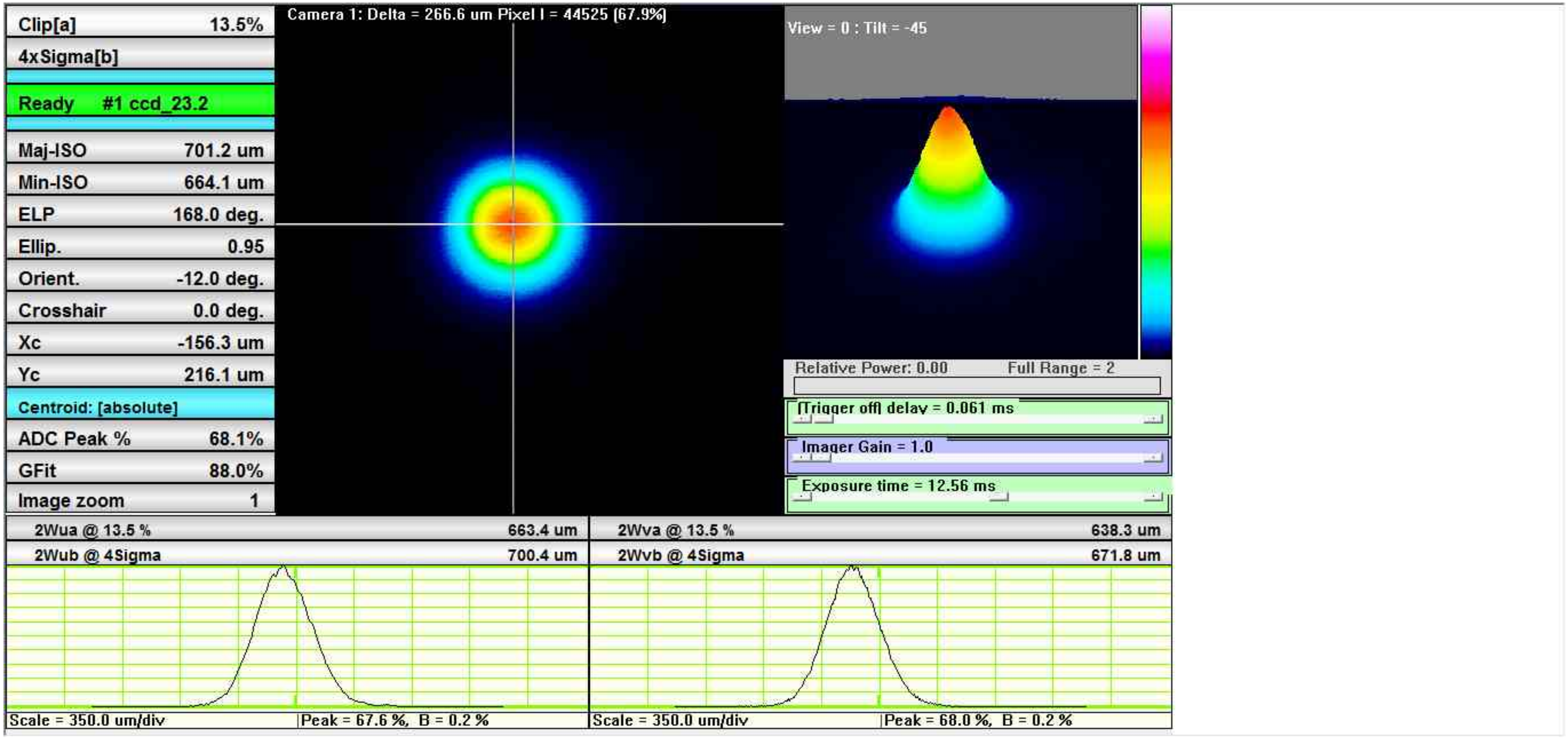
M2 measurement: +15mm



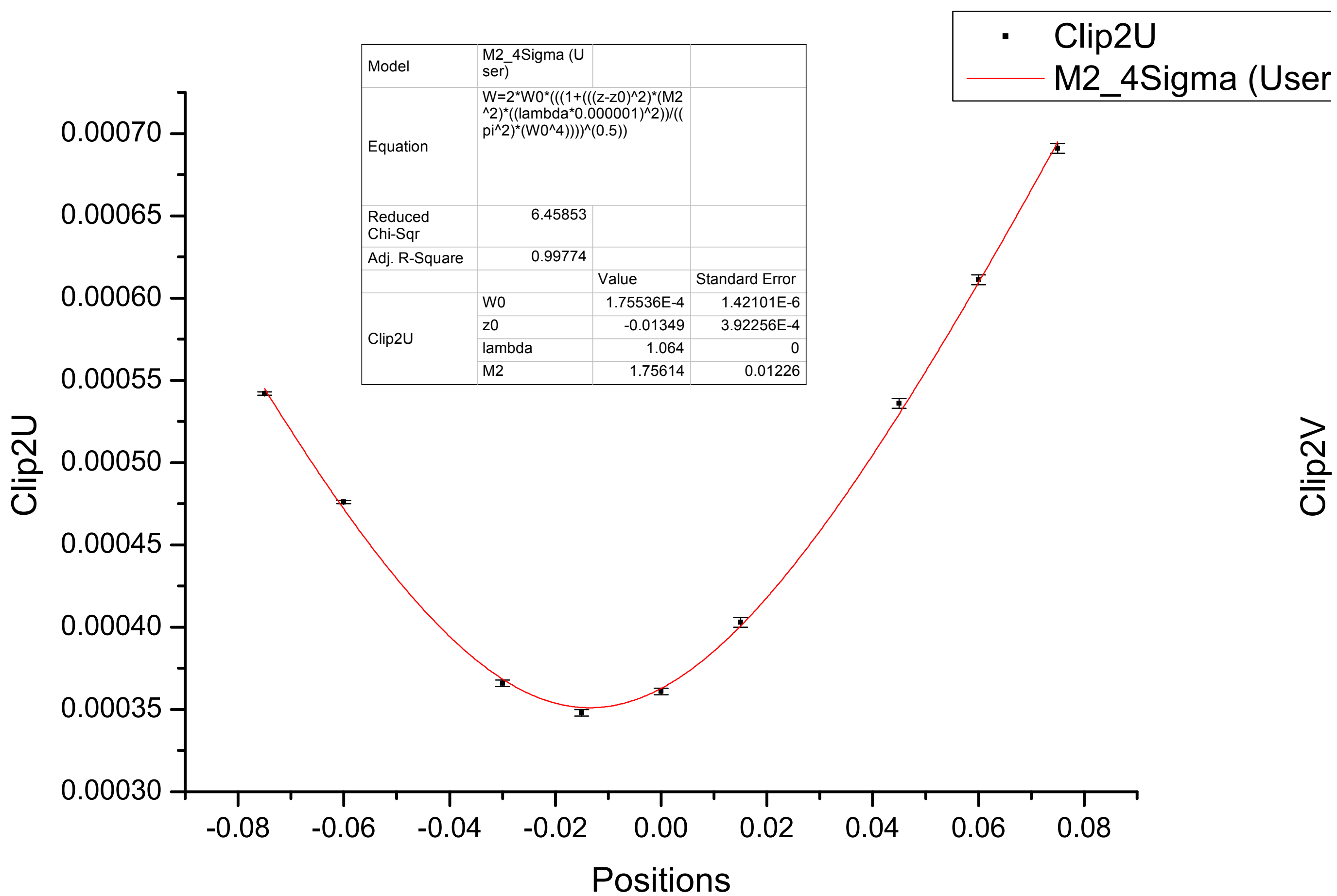
M2 measurement: +45mm

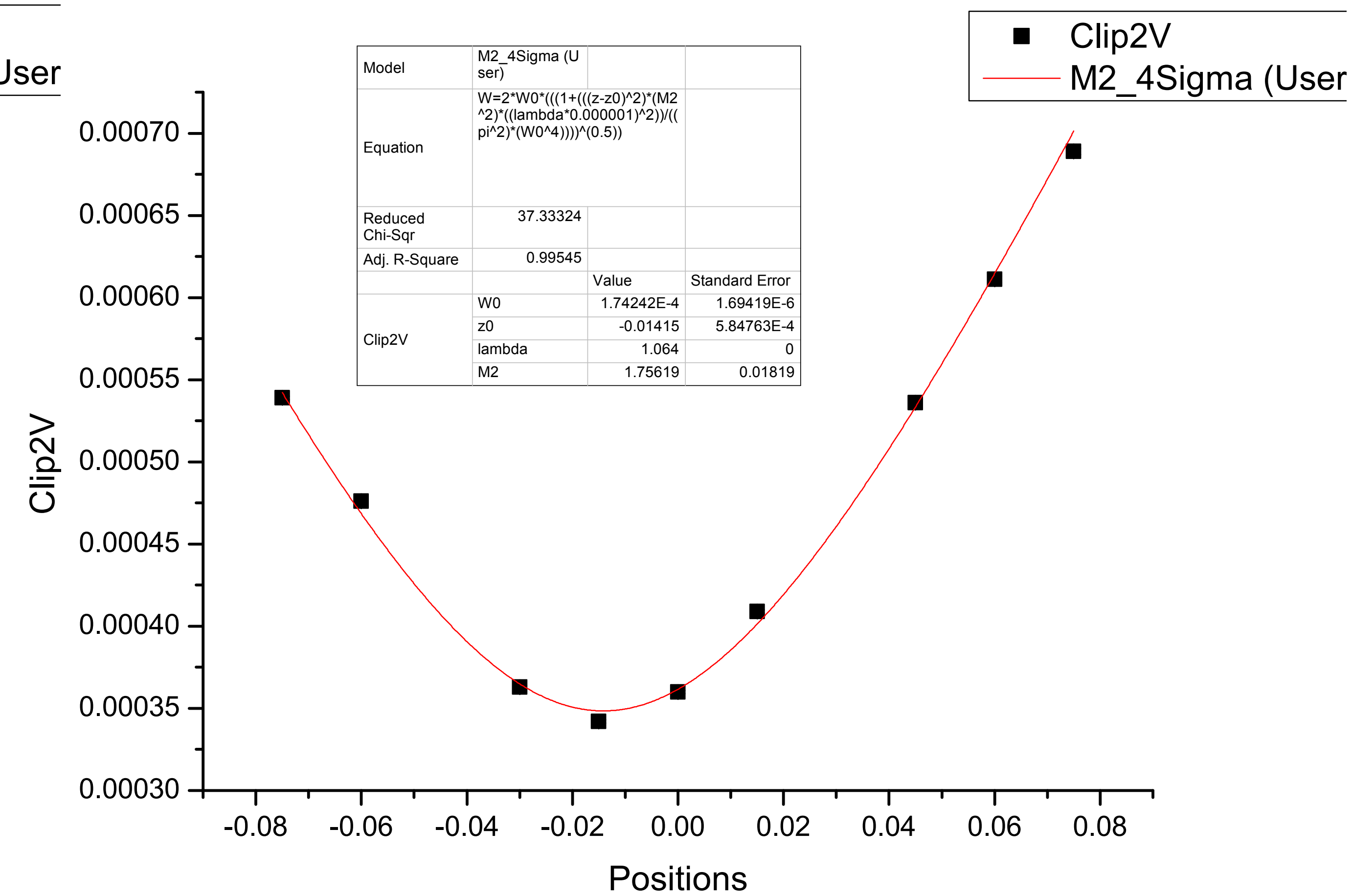


M2 measurement: +75mm



M2 measurement results





Horizontal M^2 *= 1.756 +/- 0.012*

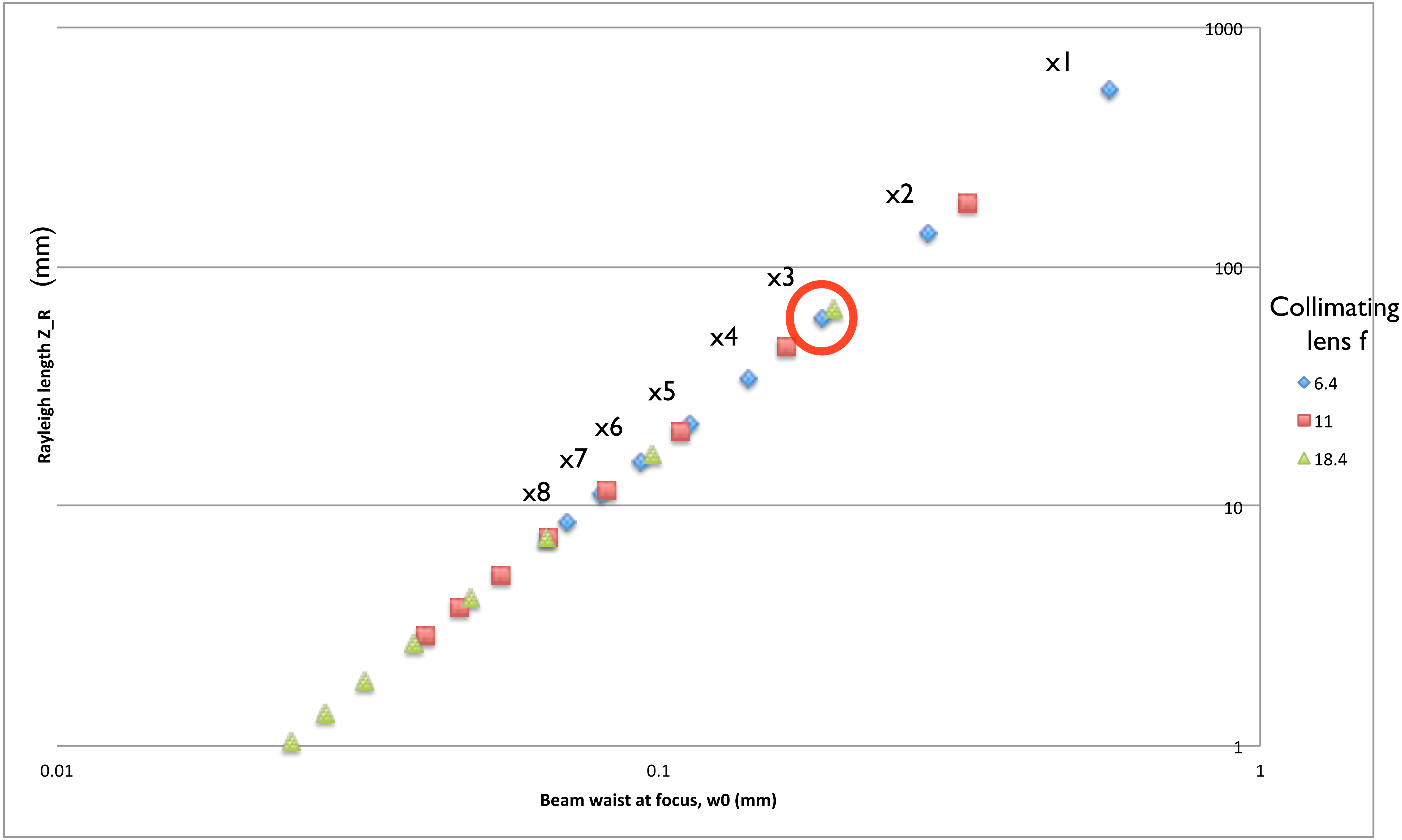
Horizontal w_0 (2σ) *= 176 +/- 1.4* μm

Vertical M^2 *= 1.756 +/- 0.018*

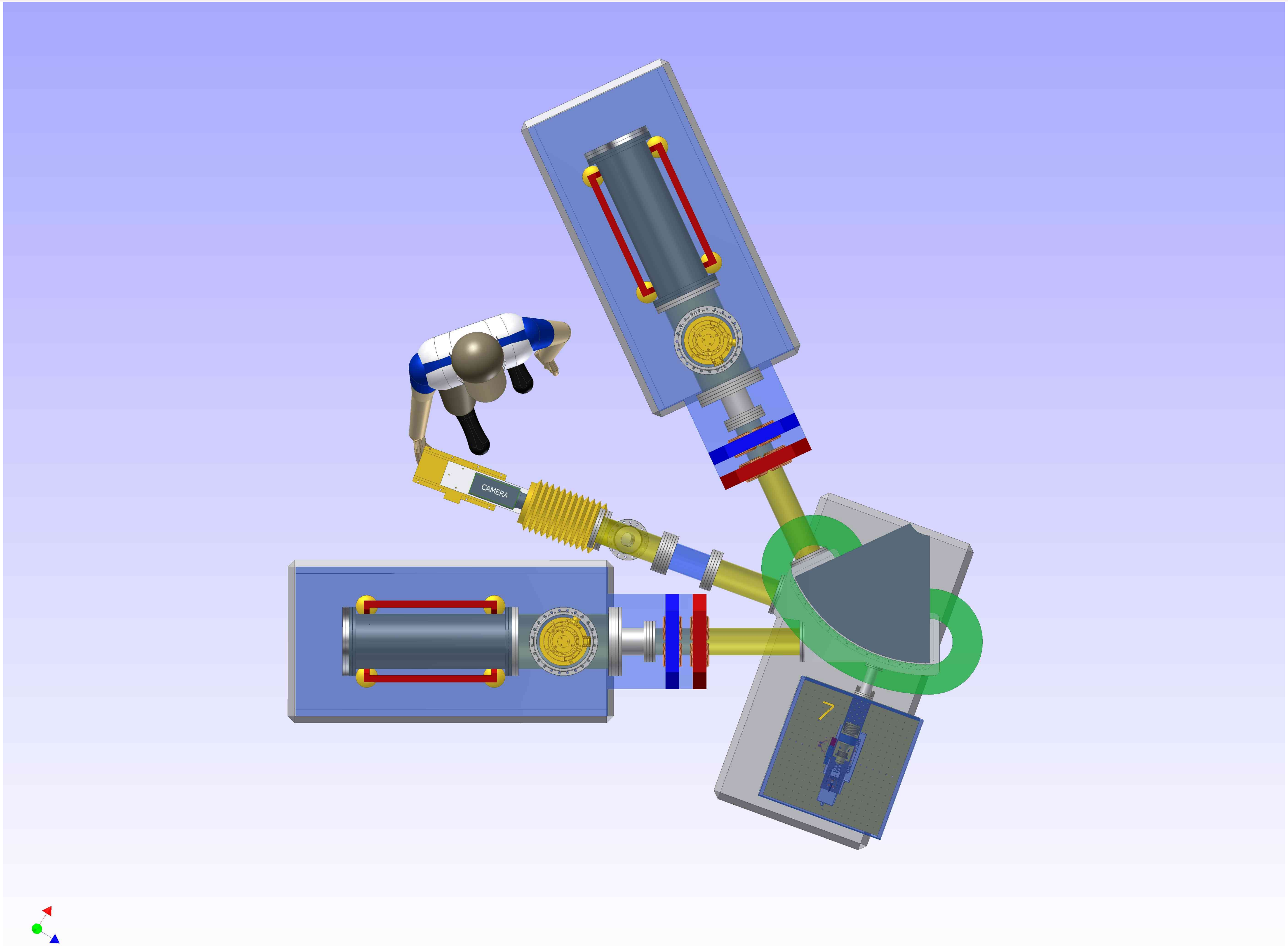
Horizontal w_0 (2σ) *= 174 +/- 1.7* μm

- Reasonable M^2 for first measurement after beam expander. Negligible astigmatism.
  - Expect further improvement from: better coupling, improved alignment of beam expander etc…
  - Beam spot mode quality looks most Gaussian at centre of focus.

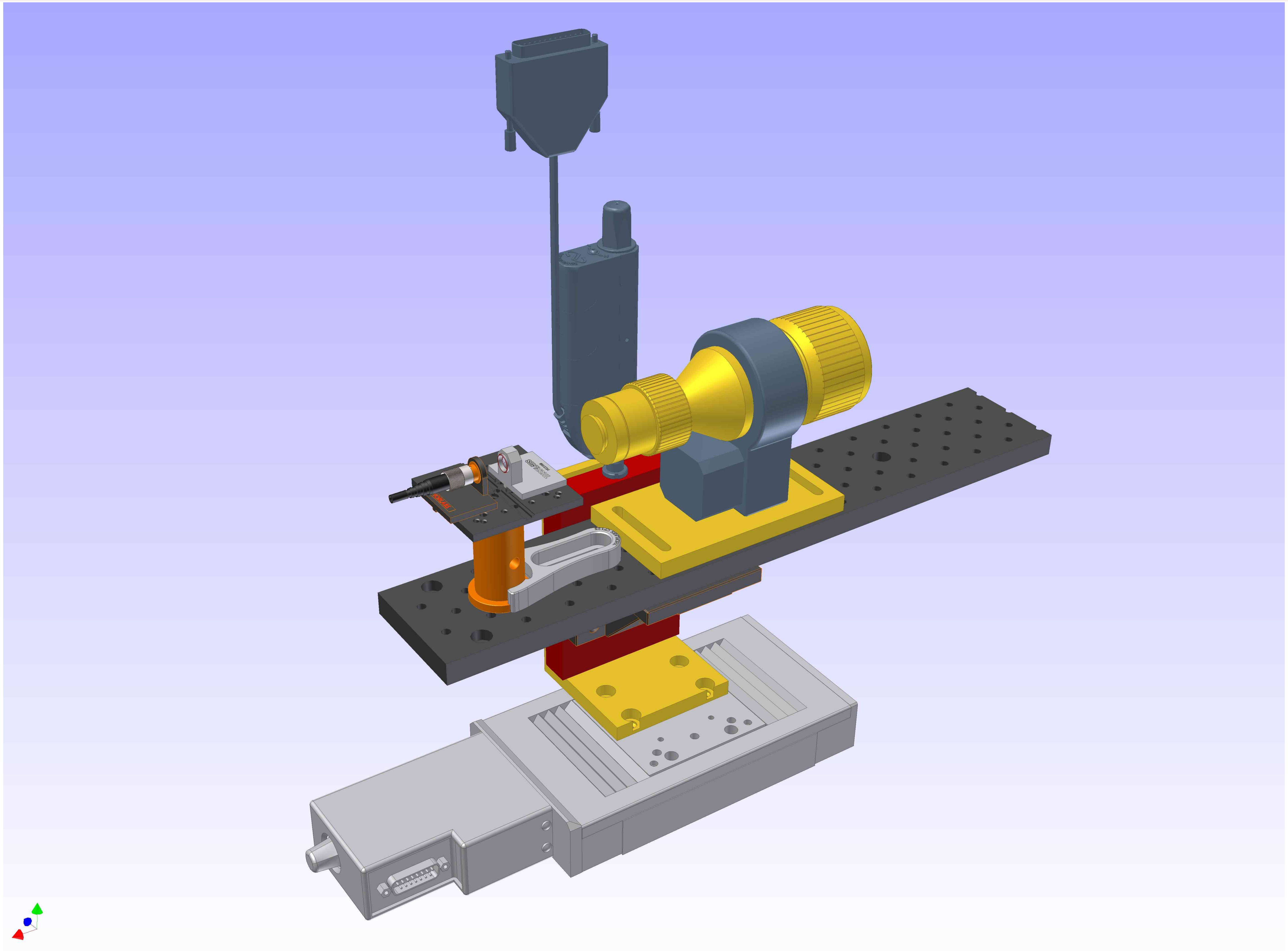
Effect of lens f and BE magnification



Plan view of FETS diagnostic

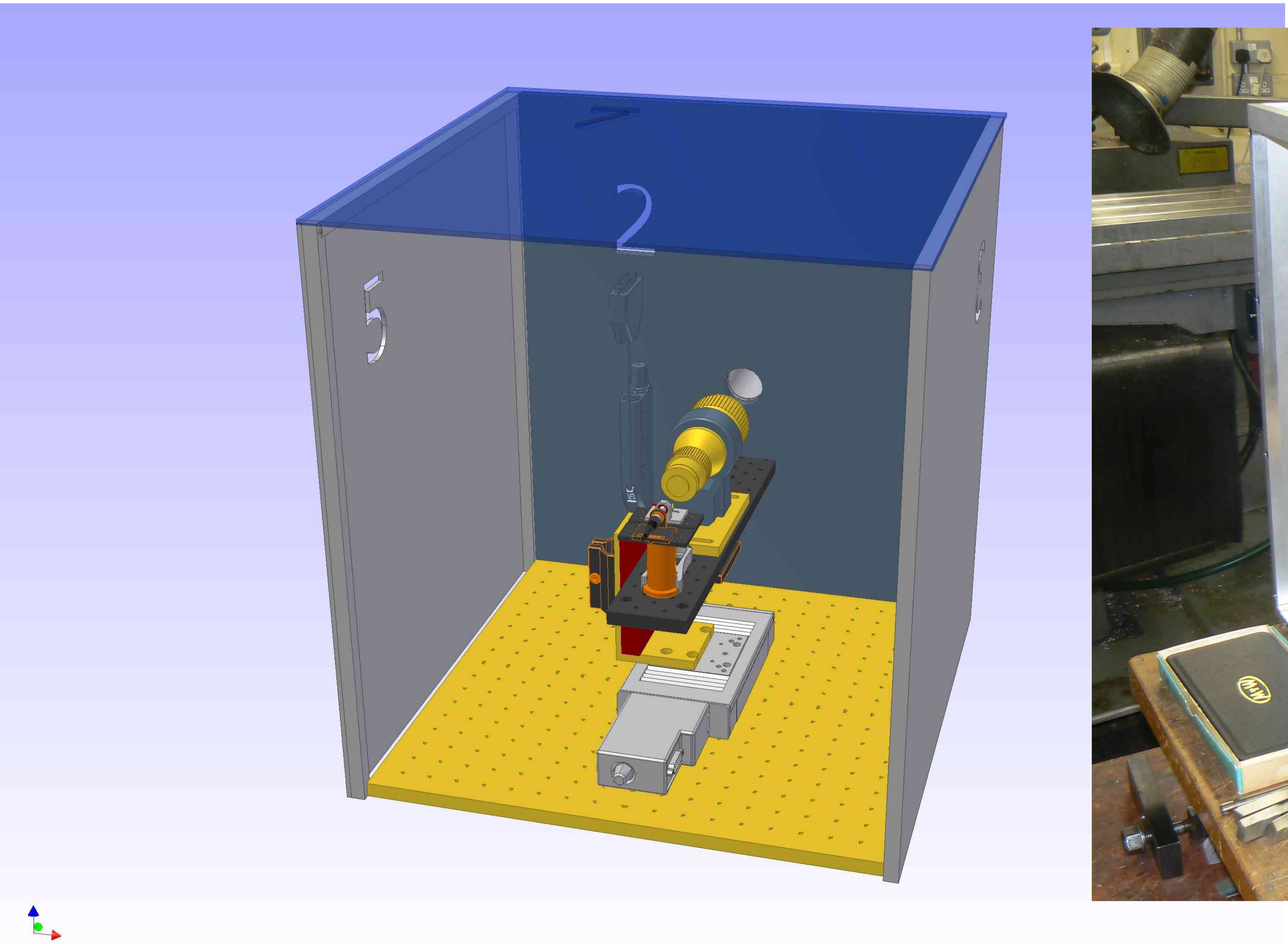


Beam Delivery System CAD



Beam Delivery System

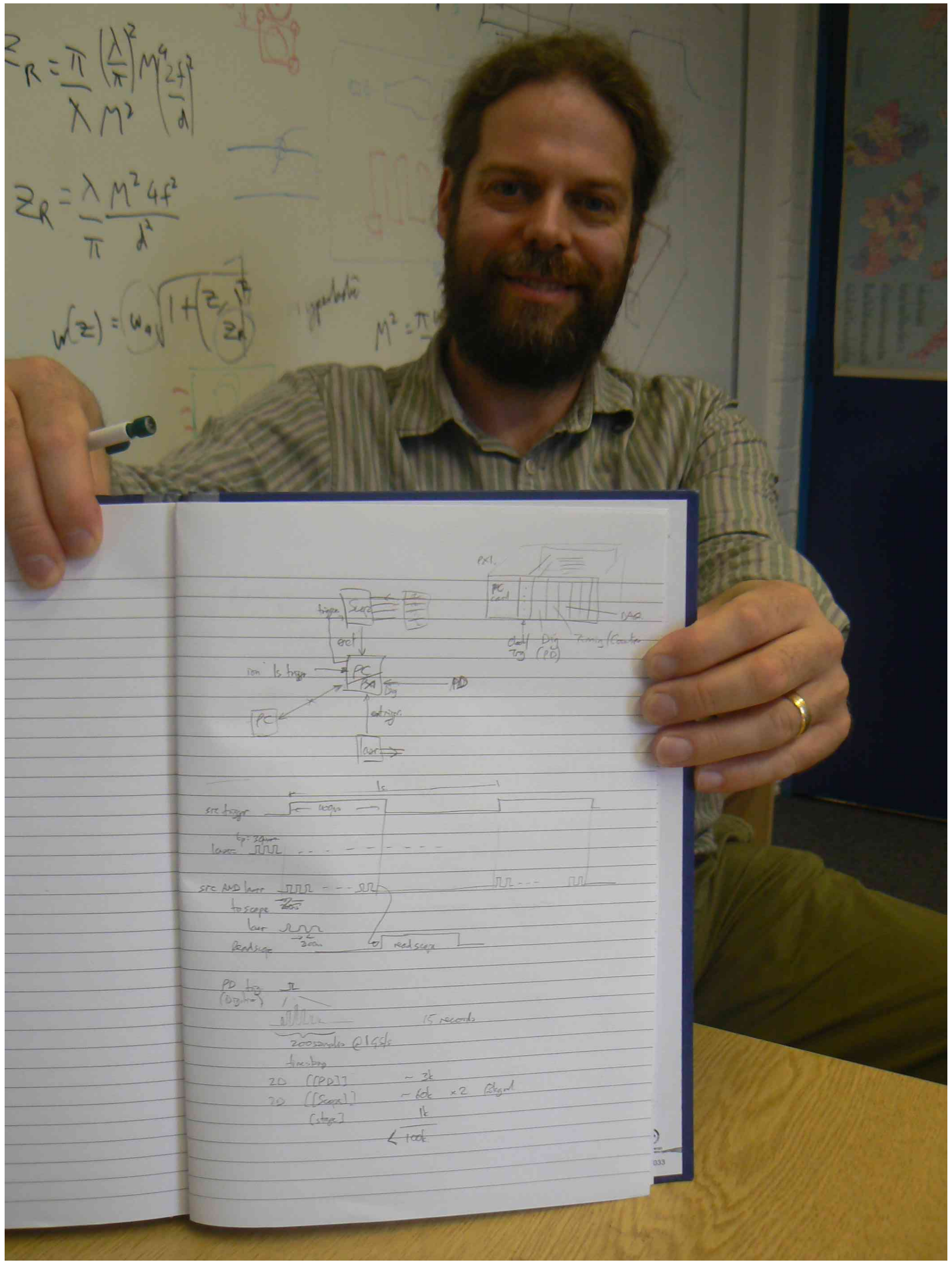
Interlocked enclosure



RHUL workshop

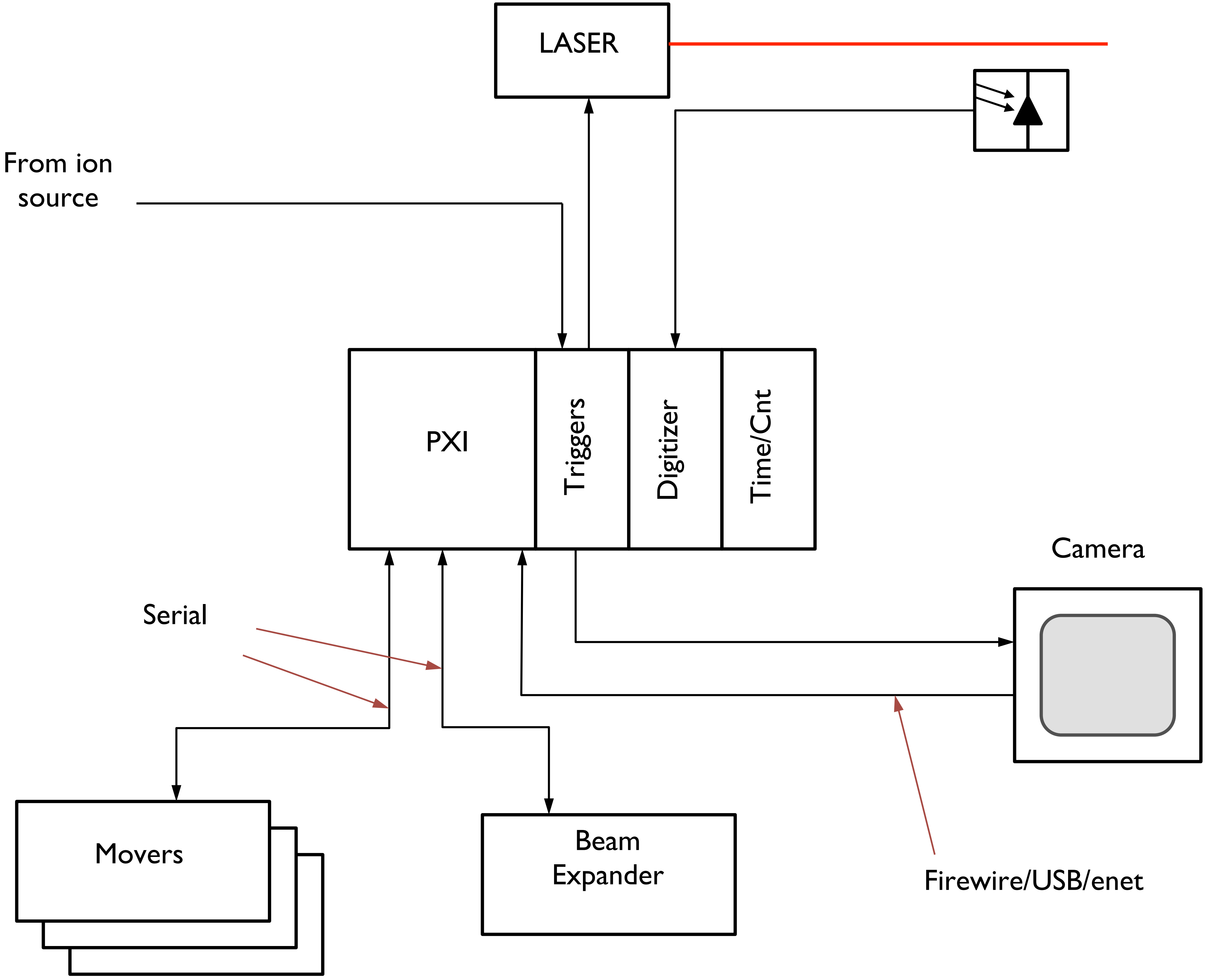
- Beam delivery system enclosed in aluminum box, on 450x450mm breadboard.
- The top and two side panels are removable for access.
- Opening the box breaks the interlock and dumps the laser beam.
- Key to override interlock for exceptional access / alignment.

Control and DAQ



- Detailed discussions with Gary and Thomas this week at RHUL.
- Outline of data acquisition for FETS and LINAC4 Laser Scanning completed.
- Thomas Hofmann agreed to draft a DAQ document for Gary / FETS to check.
- Based on:
  - PXI crate with cards for trigger, digitization and timing/counter.
  - LabView control of motion stages, beam expander and camera.
  - Data archived and published via EPICS server for easy online monitoring.

Control and DAQ



BPM processing

Summary from Gary Boorman:

BPM Processing

The FPGA and Digitizer have been delivered to RHUL, but awaiting the breakout box.

The FPGA code has been developed for the BPM processing, and tested using simulated signals on a PC. Once the breakout box has arrived testing of the code using emulated signals can start (hopefully the week after next).

CERN are happy to loan us both a button and stripline BPM for testing – there is a test jig at CERN (contact Jocelyn Tan) we could use. CERN will soon be manufacturing the final version of the front-end electronics PCB – Rhodri says a few extra PCBs could be made for FETS, although we would have to populate them ourselves.

Back up

Project Safety Procedure

Safety discussed and essential plan agreed with Steve Warner and Duncan Francis on Monday. Brief summary below, being written up in Project Safety Procedure:

- Swipe card access to outer door, with competent person list maintained by LRO.
- Keypad on inner door, code only given by LRO after explaining local procedures and checking safety training.
- Breaking the door interlock either stops laser via interlock (to be checked) or IEC lead to cut mains. Gravity fed safety shutter on output beam.
- Red/green laser signage on outer door and inner door.
- Interlock wire in armoured fibre to interlocked laser box within the radiation shielding. Cutting the fibre or opening laser box breaks the interlock and drops the shutter in laser room.
- For exceptional maintenance / alignment with laser box open within the radiation shielding, a castell double key on outer door us used for an override key on the interlocked laser box, so that particle beam is off while personnel are working in the radiation shielded area.
- Three level signage on outer shielding door.