NA62 RICH mirrors alignment

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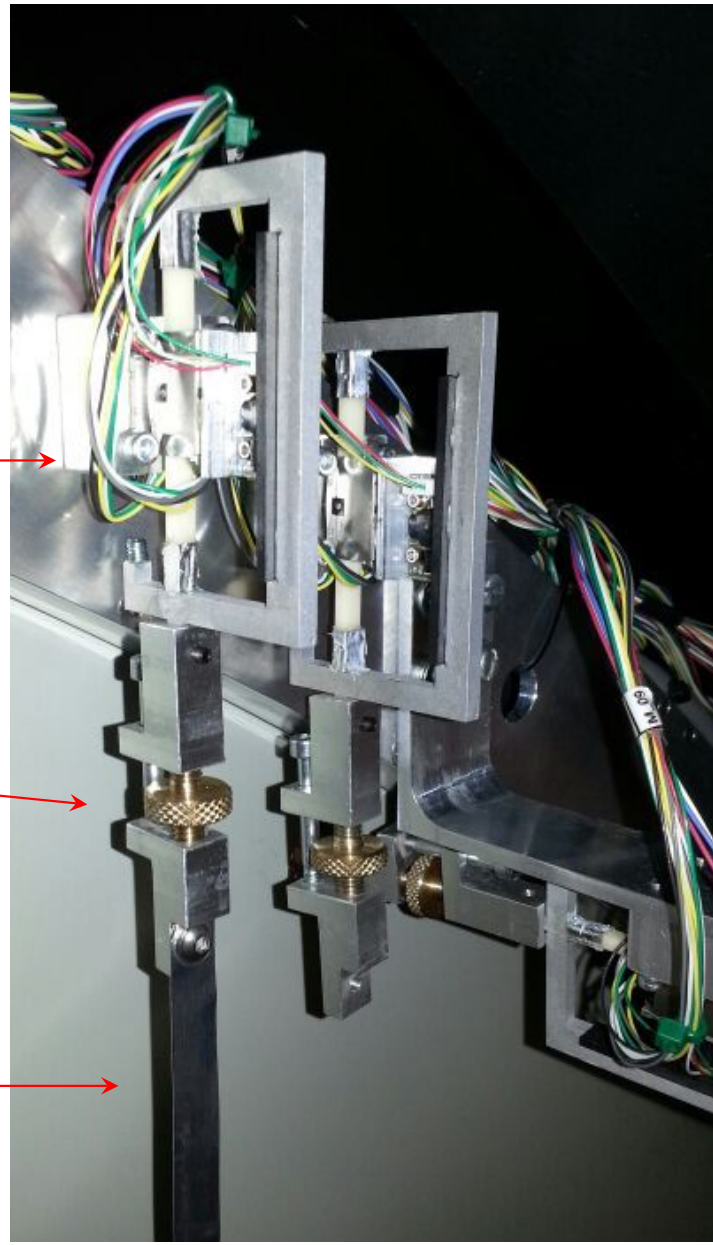
Mirrors actuating tools

Angular movement of each hexagonal mirror
is controlled by piezomotors
pulling two actuating ribbons

Piezomotor + encoder

Adjustment screw
for preliminary alignment

actuating ribbon



Mirror alignment operations

1. during the installation of each mirror,
   to set the correct length for actuating ribbons (± 1 mm)
2. just after the installation of each mirror, using adjustment screws
   with piezomotor positioned half-way between endpoints
3. after complete installation of all mirrors, using piezomotors:
   - test the movement of all piezomotors in both directions
   - final mirror alignment before the run
4. (possibly) during the run, using piezomotors
   after precise measurement with particles

Mirror alignment can be:

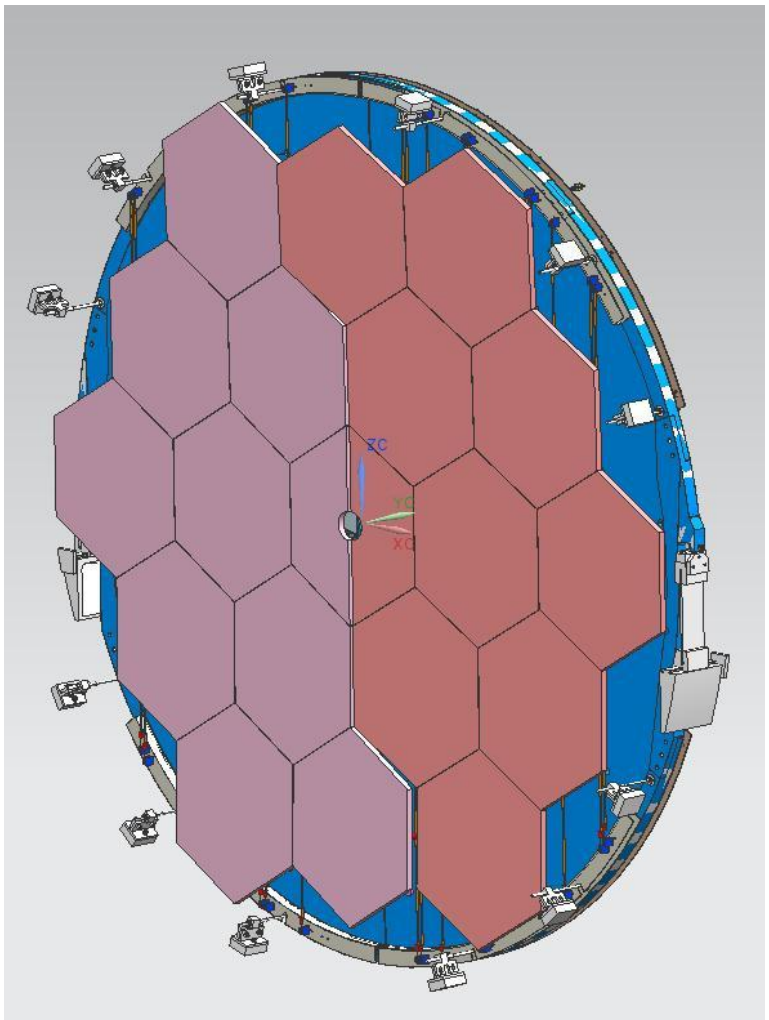
- absolute = w.r.t. nominal centre of curvature,
  need a laser beam and reference points far away
- relative = w.r.t. another mirror,
  does not need absolute positioning of reference points

Alignment method

presented at the 04-06-2014 NA62 RICH mirror mounting WG

Each half-mosaic has to be pre-aligned to its centre of curvature

Two centres of curvature,
positions determined by MC studies



Proposed method:

1) absolute alignment of all mirrors

2) relative alignment will be used as a cross-check

Absolute alignment - theory

A light beam coming from centre of curvature
is reflected back to the same path

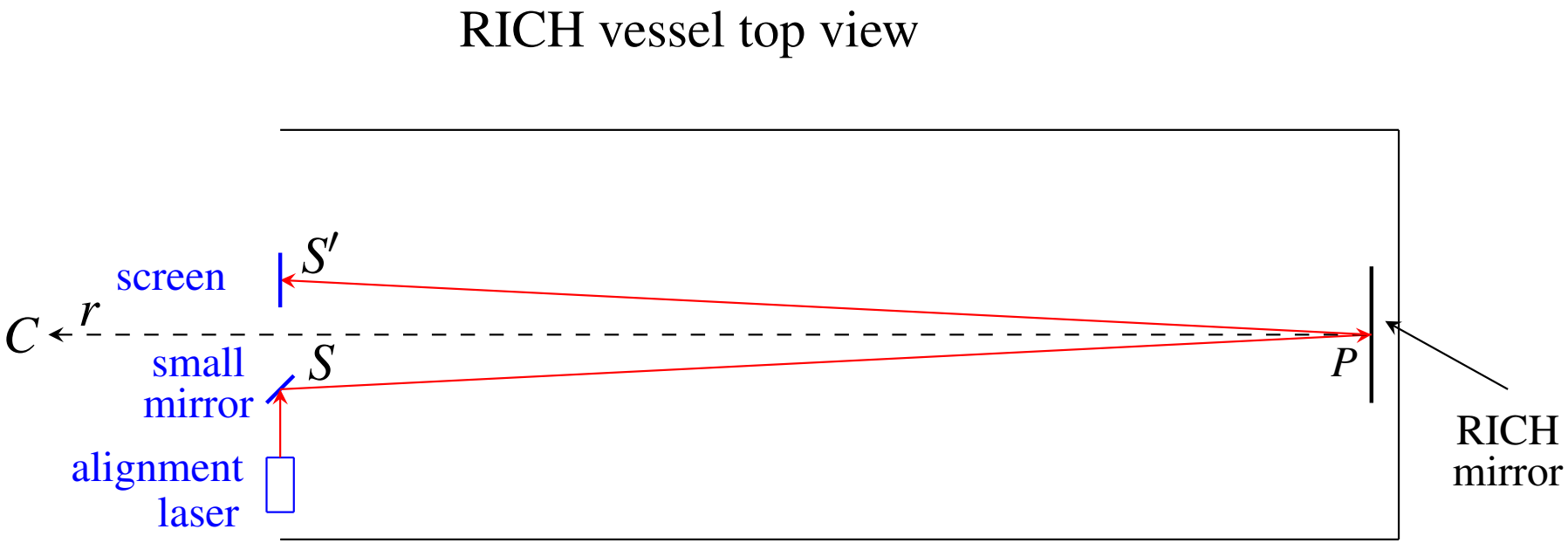
PROBLEM: nominal centre of curvature C not accessible

SOLUTION:

- choose a point P on the mirror
- choose a point S along the line r joining C and P
- send a light beam from the point S to the point P
- rotate the mirror until the light beam is reflected back to itself

NOTE:
For practical reasons the point S can be slightly displaced.
In this case the reflected beam has to be directed to a point S',
symmetric to S on the other side of r

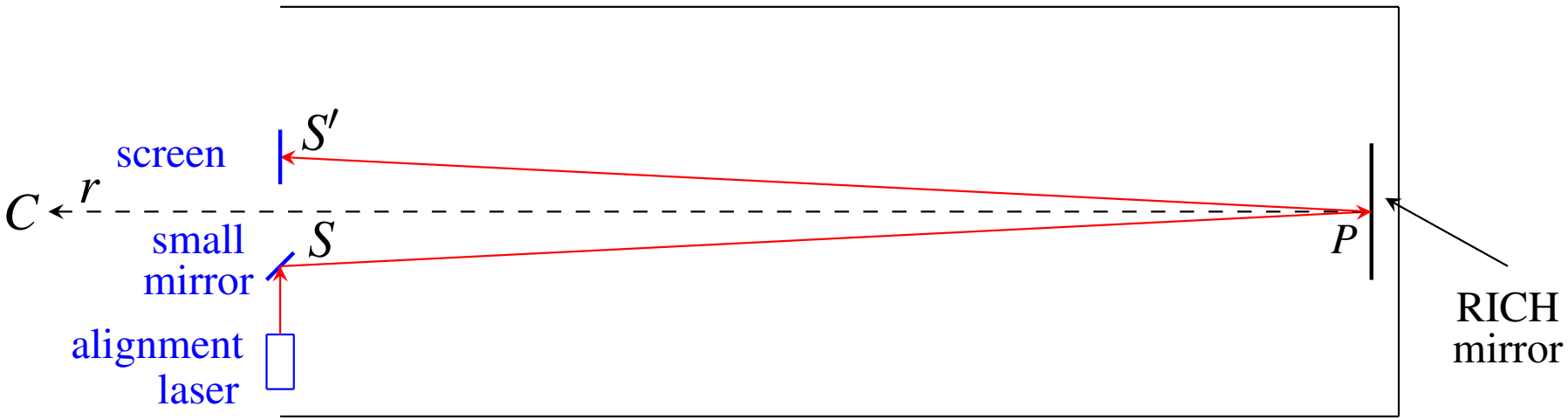
Absolute alignment - practice



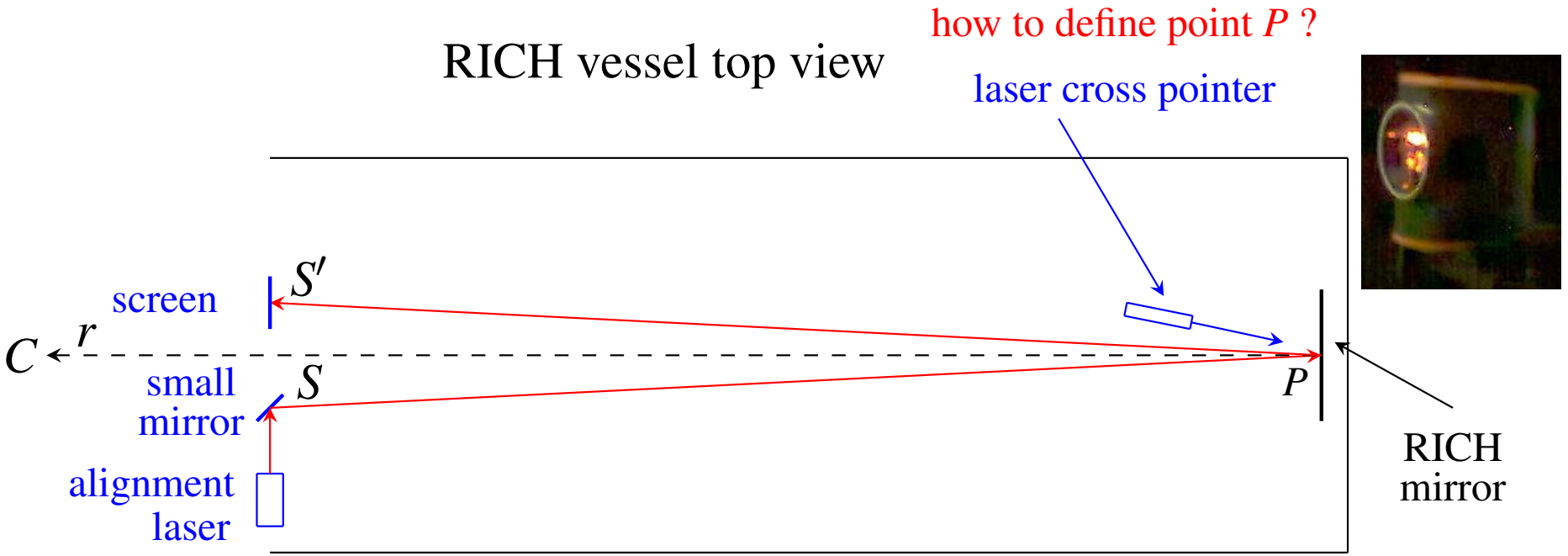
Absolute alignment - practice

how to define point P ?

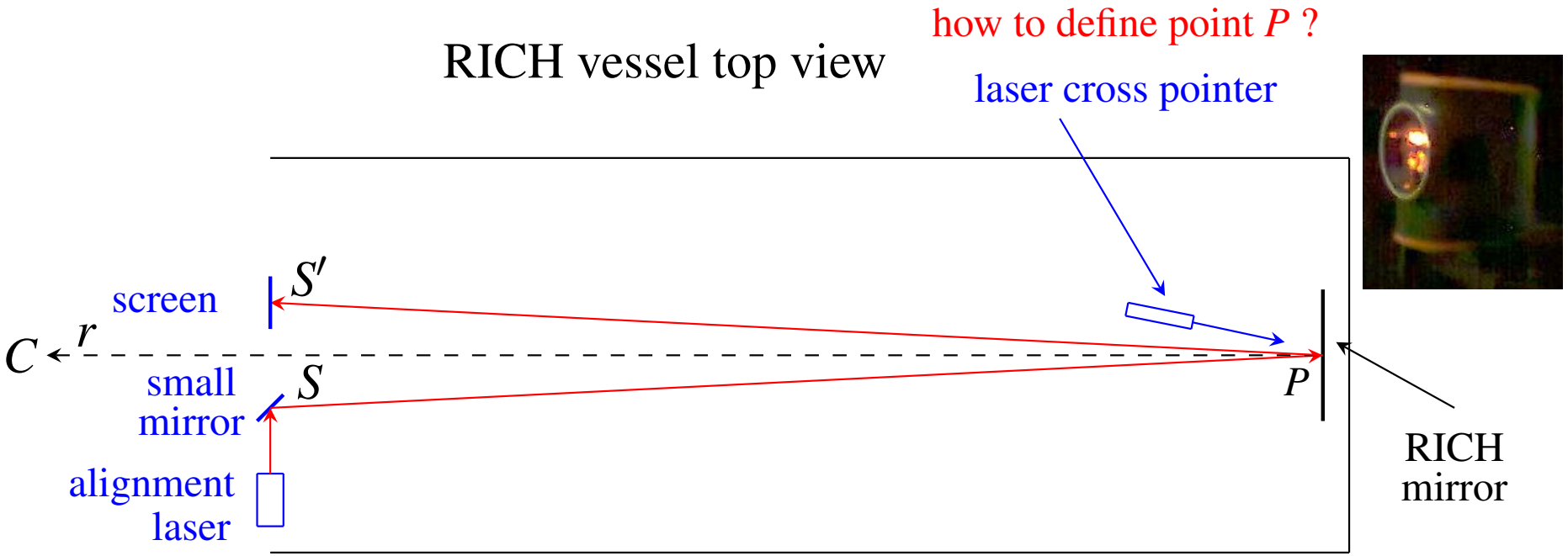
RICH vessel top view



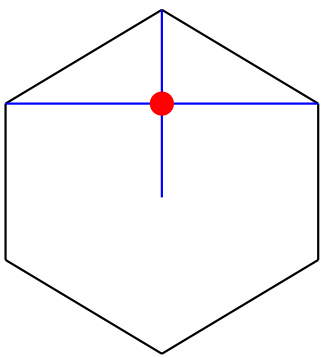
Absolute alignment - practice



Absolute alignment - practice



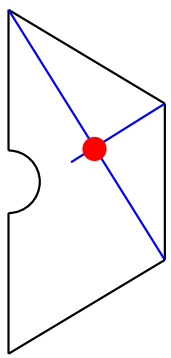
hexagonal mirror



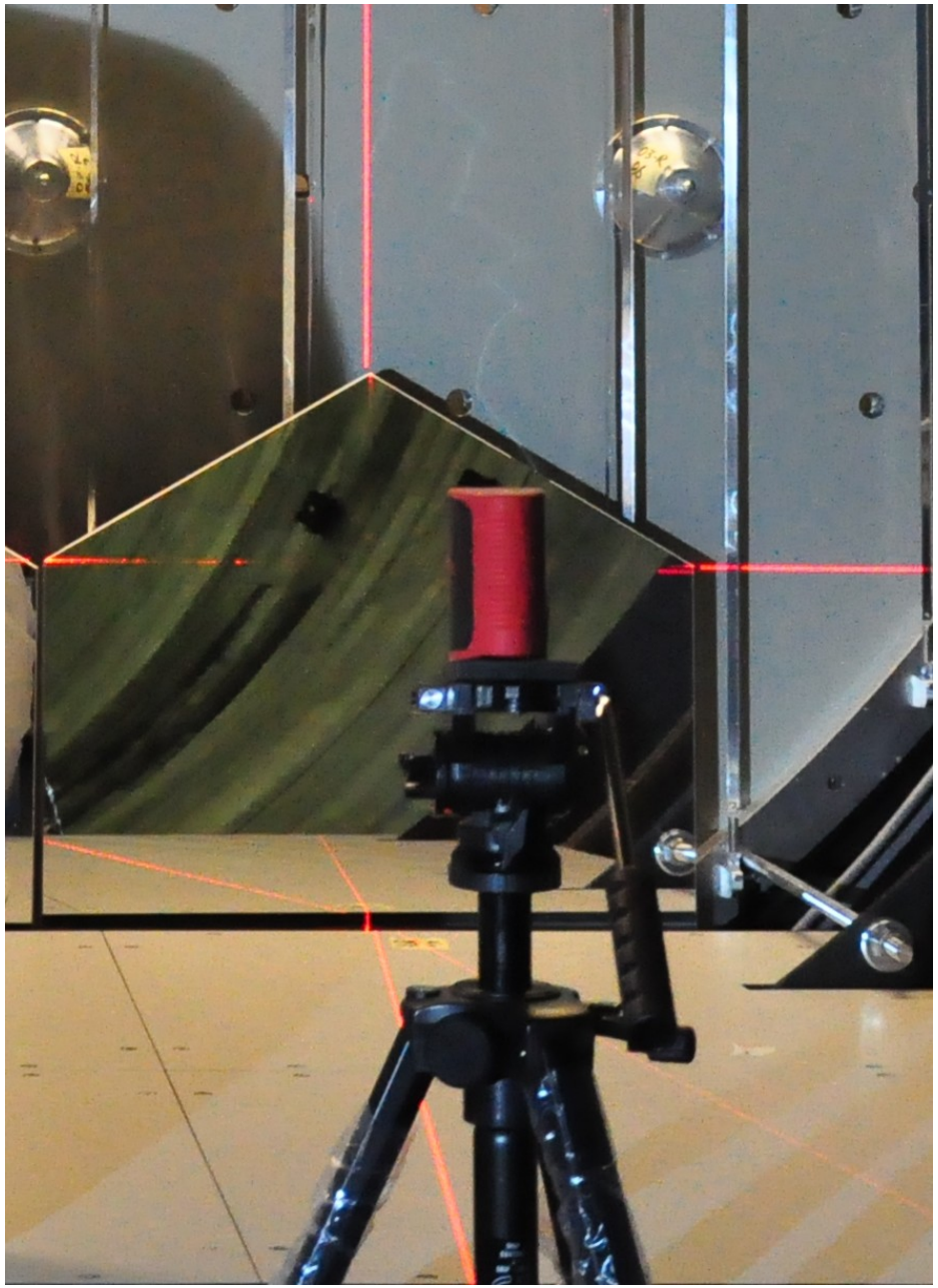
= cross on the mirror (from cross pointer)

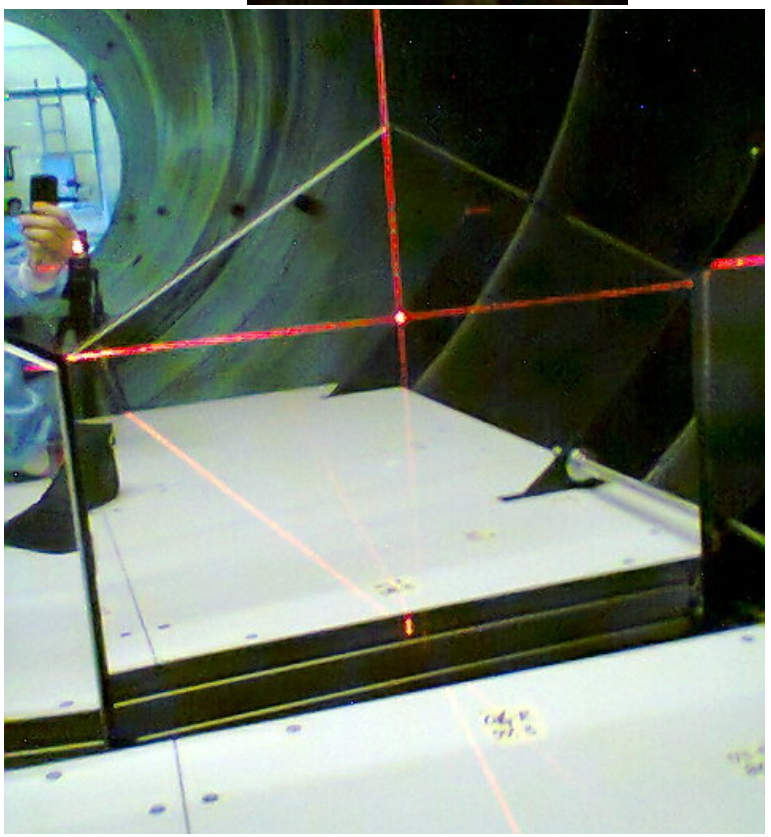
= reference point on the mirror

semi-hex. mirror

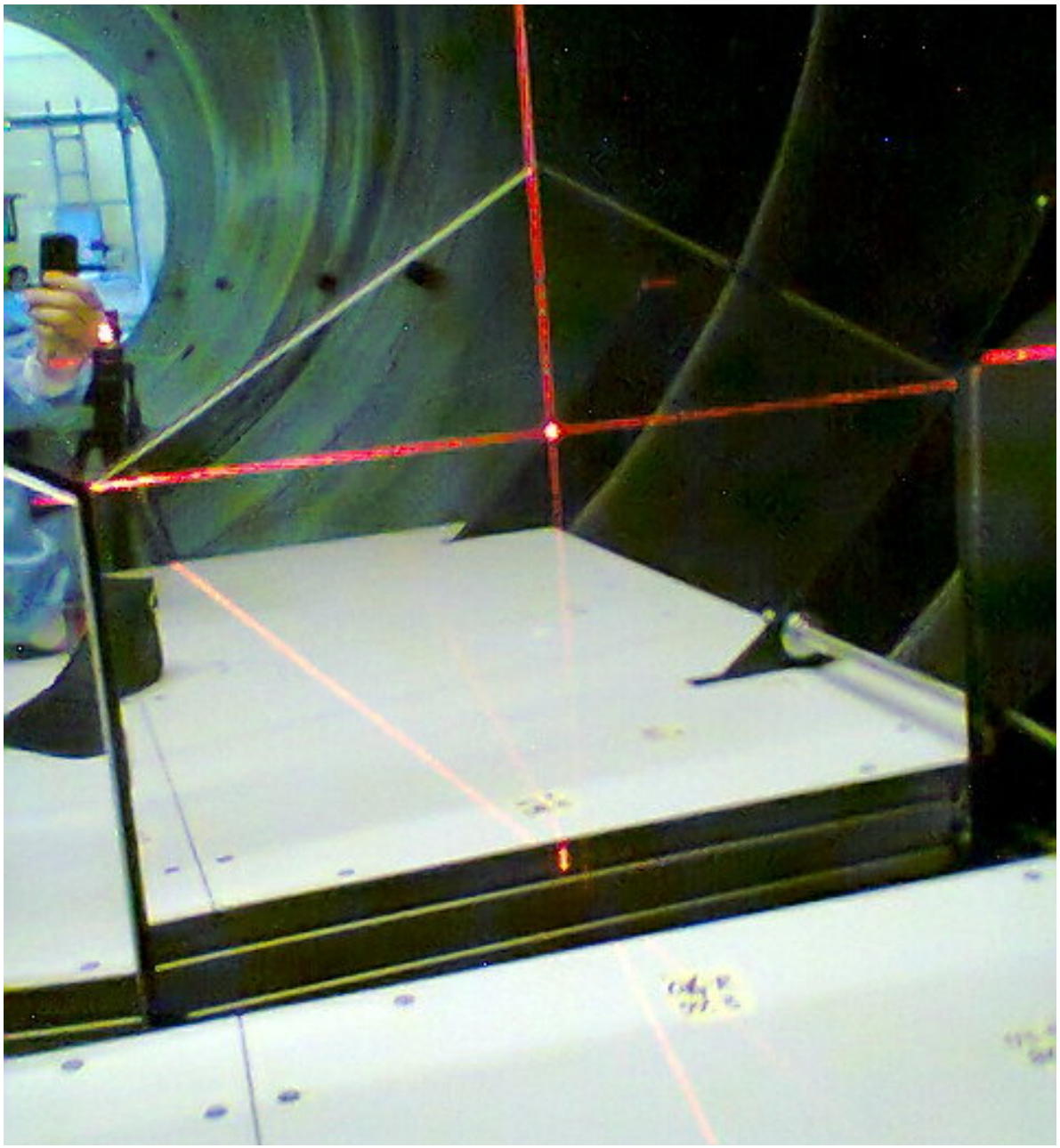


Point *P* on the mirror: defined by lines from cross pointer





Point *P* on the mirror: defined by lines from cross pointer

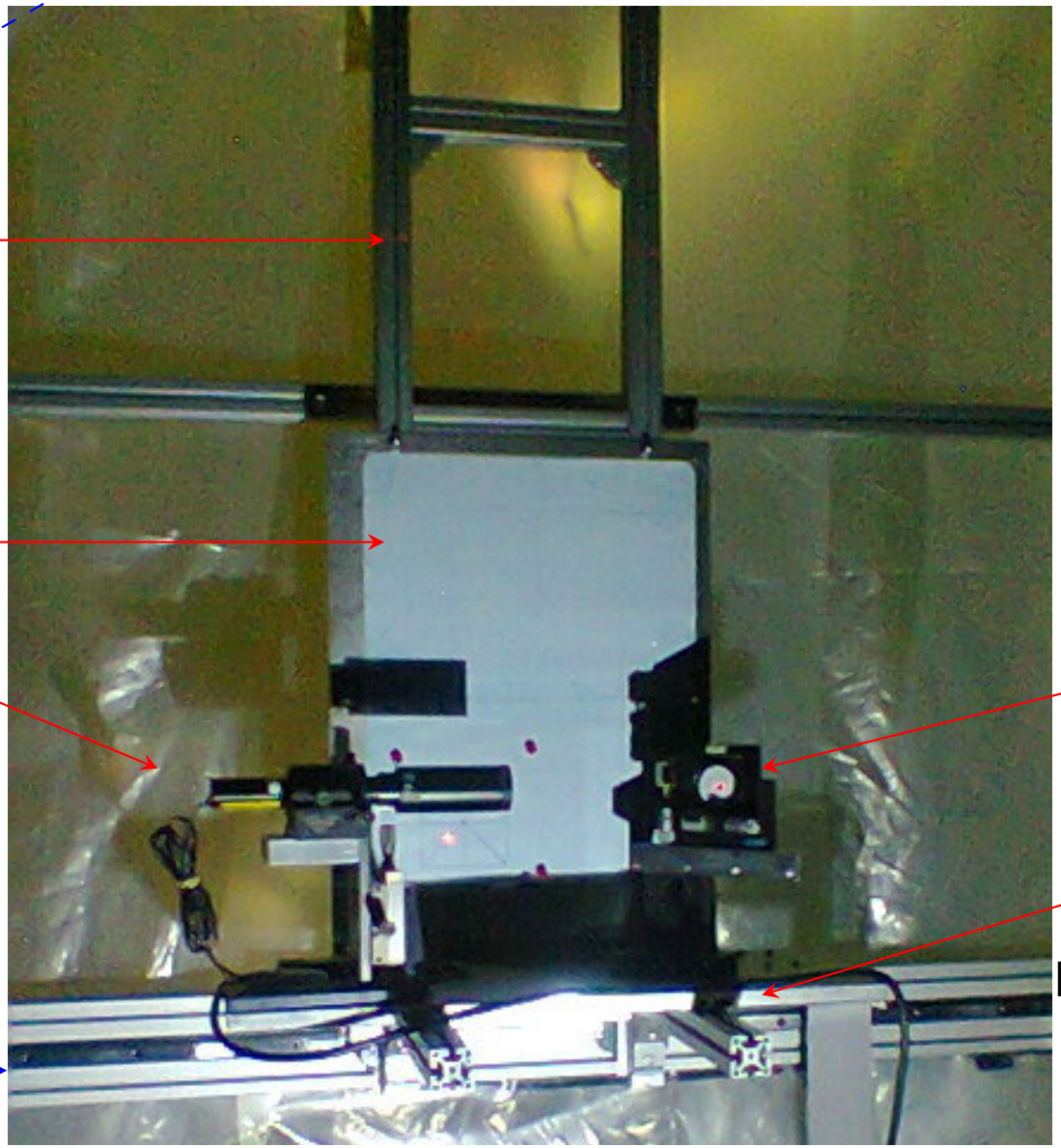


Alignment tools: mechanical support structure (aluminum)

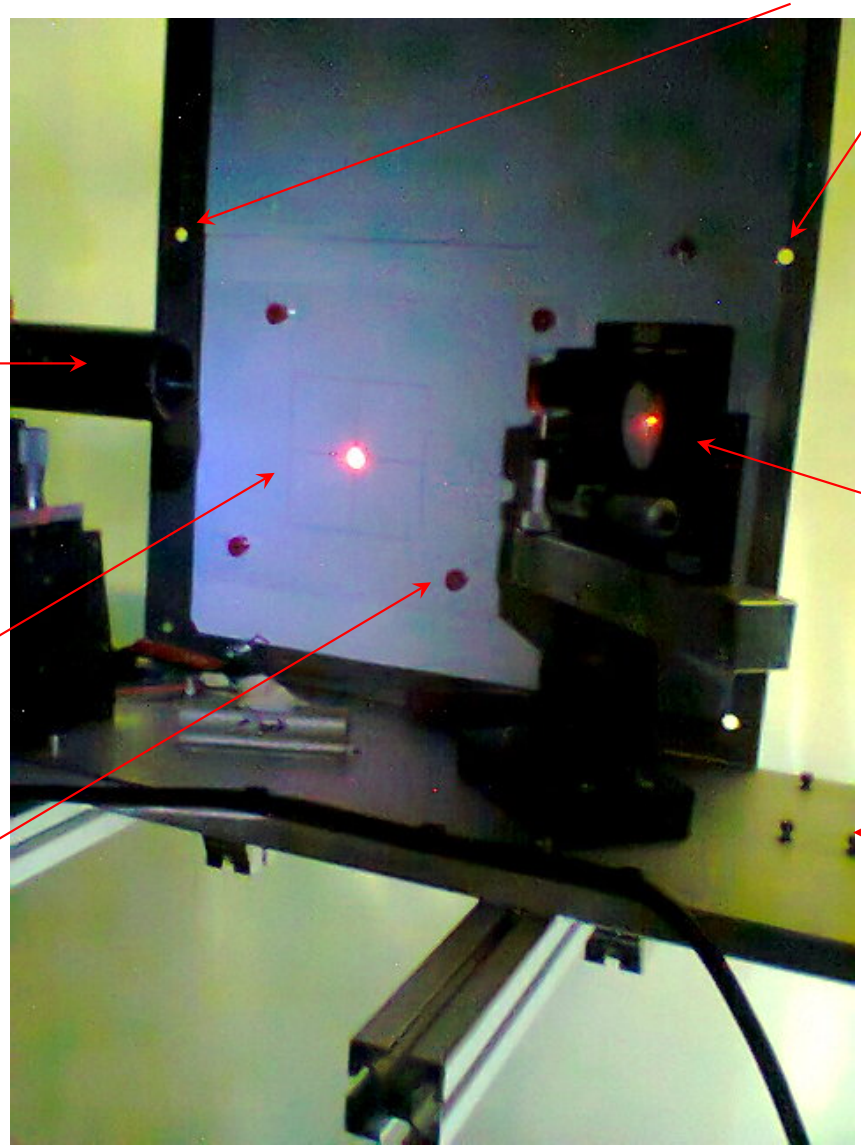
- 2 vertical beams fixed to the upstream flange of Drum 1
- 2 horizontal beams, with rail on the inner side, fixed to the vertical ones
- platform with alignment tools, movable along the rails (next slide)

Alignment tools: laser and screen support "ladder"

(seen from inside the RICH vessel)



Alignment tools: laser and screen

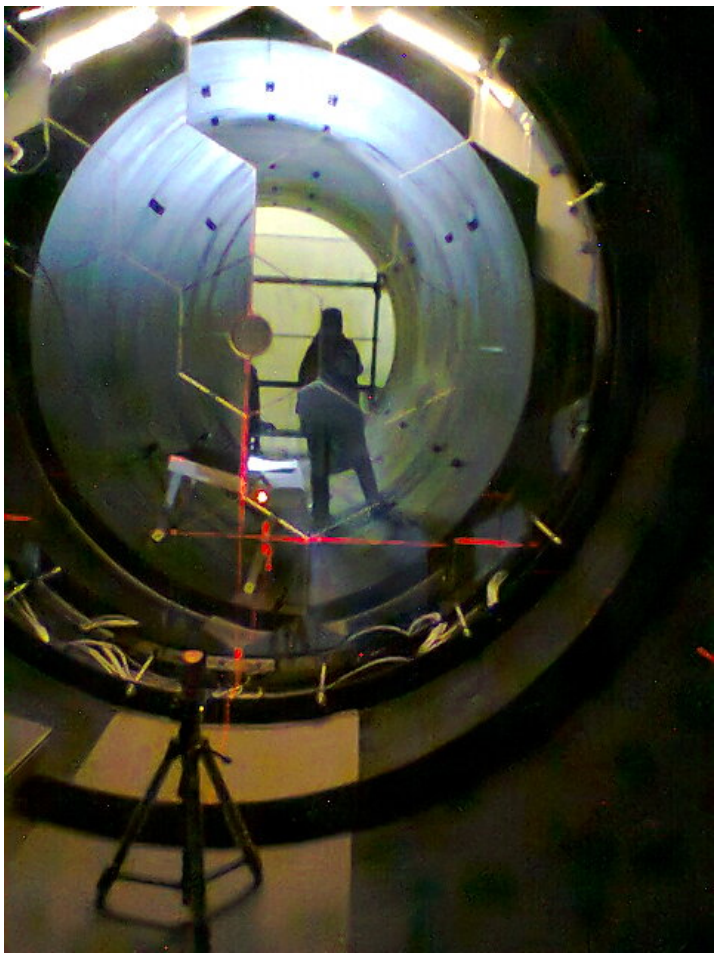


Alignment precision: few mm / 32 m $\approx$ 0.1 – 0.2 mrad

Relative alignment (used as a cross-check)

Consider two adjacent mirrors. If relatively aligned:

- they are optically equivalent to one (larger) mirror
- the image of a far (≈ 17 m) object is continuos across the border



Jura, Salève half-mosaics $\Rightarrow$ 2 images

Mirror alignment operations

1. during the installation of each mirror,
   to set the correct length for actuating ribbons (± 1 mm): OK

2. just after the installation of each mirror, using dedicated screws and keeping the piezomotor half-way between endpoints
   $\Rightarrow$ Need to do it twice because screws loosening with time due to ribbon oscillations, then screws have been fixed with glue. OK

3. after complete installation of all mirrors, using piezomotors:
   - test the movement of all piezomotors in both directions
   - fine tuning of mirror alignment

   $\Rightarrow$ Some problems with cabling and piezomotors
   Alignment nearly OK
   (mirror 8-L alinged less precisely due to M5 broken piezomotor)

Problems with cabling

- connectors compatibility between cable and piezoMux
  $\rightarrow$ piezoMux connectors replaced by Roberto Ciaranfi
- pin order inversion between inner and outer cables at the flanges
  $\rightarrow$ add inverting adapters between flanges and external cables:
  - eight 37-pin adapters built and installed
  - one 50-pin adapter built and tested (three more are needed)
- the functionality of all piezomotors after the addition of inverting adapters has been tested

Cabling is now OK

Problems with piezomotors and encoders

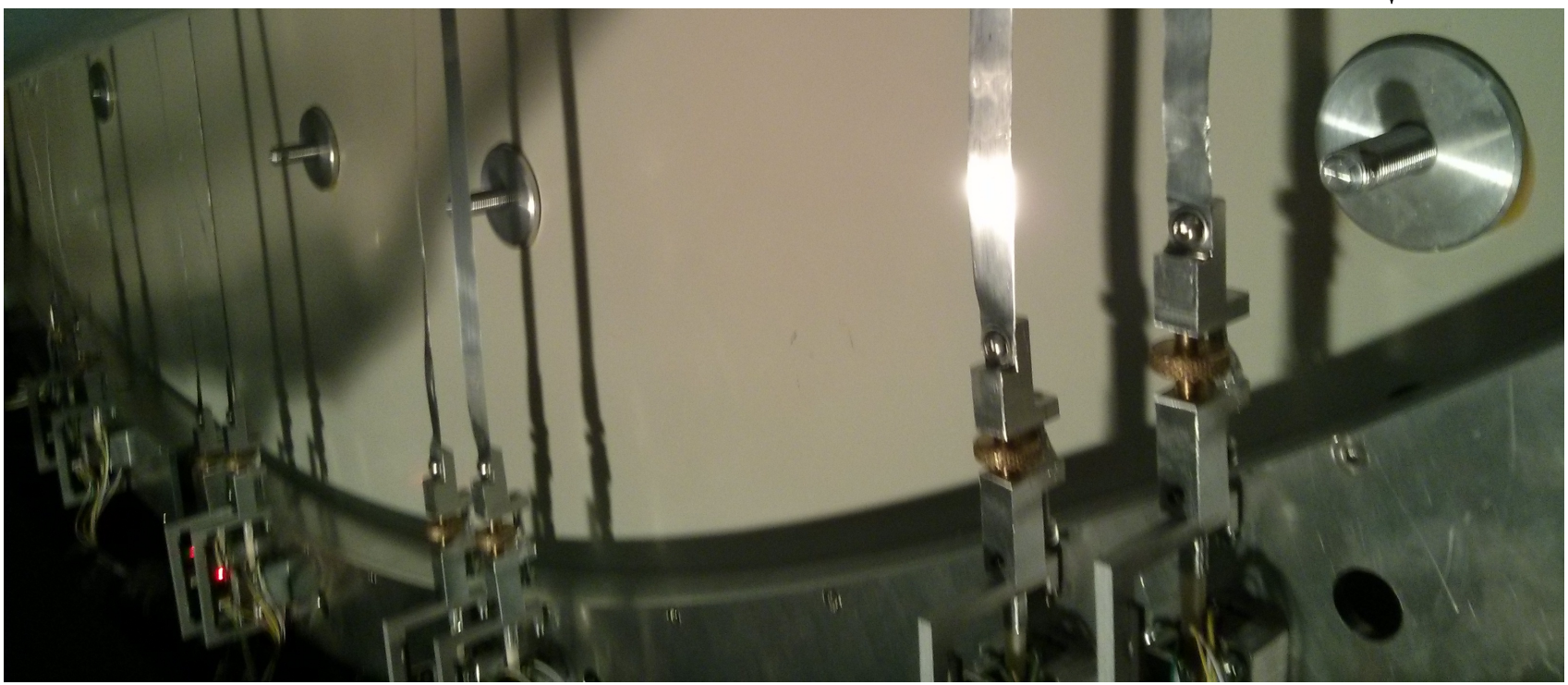
- piezomotor M5 (mirror 8-L) dead
- piezomotor M7 works only in "open loop" mode,
  i.e. not using the encoder feedback.
  If operated in "closed loop" it starts moving and never stops!
- Several piezomotors seem to have broken/defective encoder:
  they move but provide no encoder feedback
- Mirror movements are not easily predictable
  - in some cases, pull/release piezomotos movements of the same size produce very different mirror movements ($\approx \times 10$)
  - even when moving in the same direction, the same piezomotor movement may produce quite different mirror movement

Mirror alignment with pins

Threaded pins have been installed outside of detectors acceptance as alternative tools to set the angular position of two mirrors with bad encoders (10-L, 4-L on Jura side, lowest row).

pin support (disc with threaded hole), glued to the panel

↓



Summary

- RICH mirrors have been aligned during and after installation, both with piezomotors and with pins, to 0.1-0.2 mrad precision
- relative alignment has been used as a cross-check
- piezomotor cabling problems fixed, all piezomotors tested in place
- mirror movements using piezomotors still show some problem:
  - several encoders seem not to work properly
  - non trivial relation between piezomotor and mirror movement, may be not reproducible
  - alignment with piezomotors during the run may give incorrect results: it will need many iterations and require a fast feedback from data (minutes, not days)
  - software-based methods can be used to measure possible mirror mis-alignment and apply the best correction for this