NSW alignment ideas

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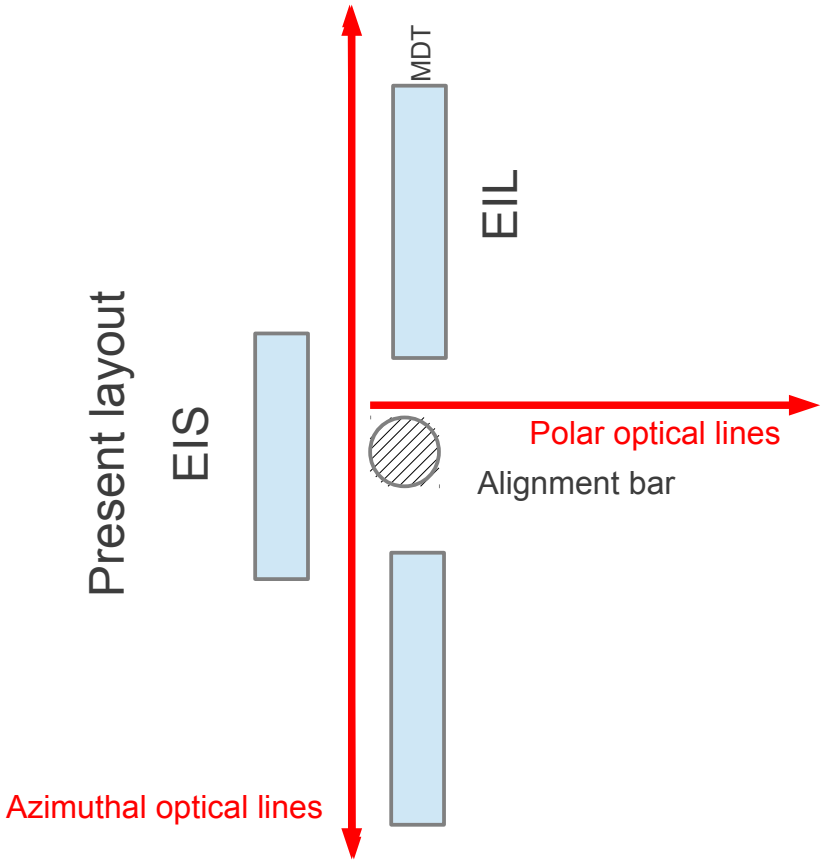
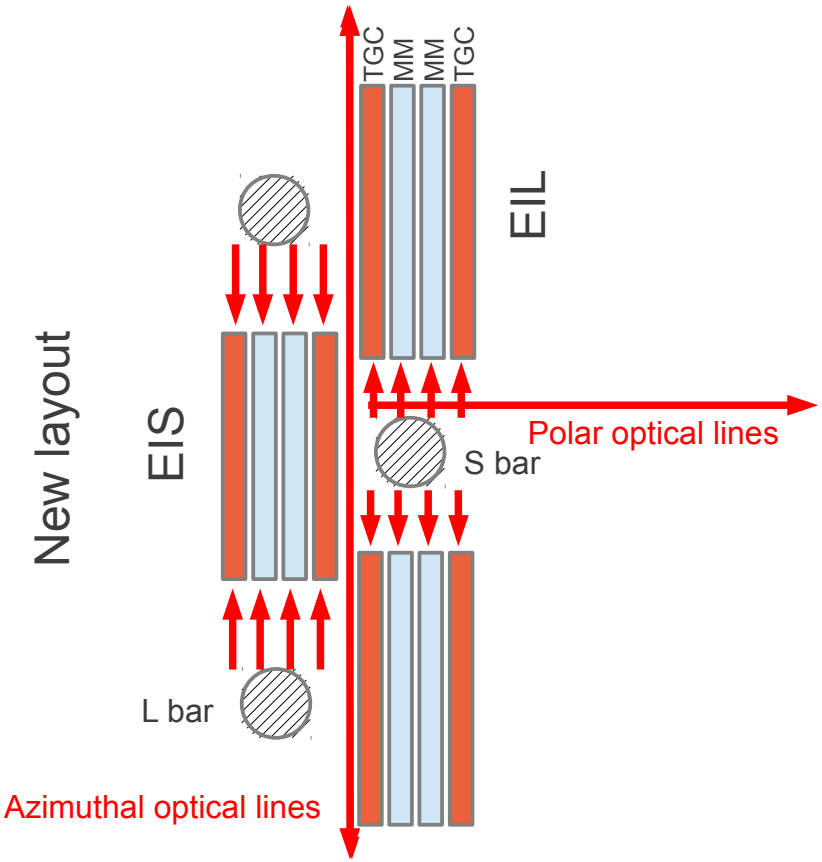
(Based mainly on discussions and information from C. Amelung)

Overall layout

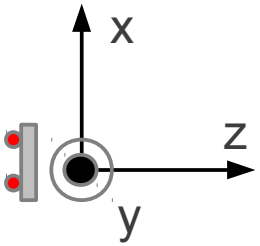
- Present small wheel layout
  - Smallest alignable unit: a complete MDT chamber
  - Optical system achieved with just 8 bars, lying in the small sectors
- New small wheel:
  - Smallest alignable unit: a MM or TGC wedge or multilayer
  - Present baseline: 8 additional bars are needed, to monitor all detector layers
  - Issue: the L bars will not be connected to the polar optical lines, they need to be aligned using the azimuthal optical system





BCAMs

BCAM



Light source

Displacement of light source along x and y measured precisely
Displacement of light source along z not measured
A BCAM may view several light sources at different positions in z

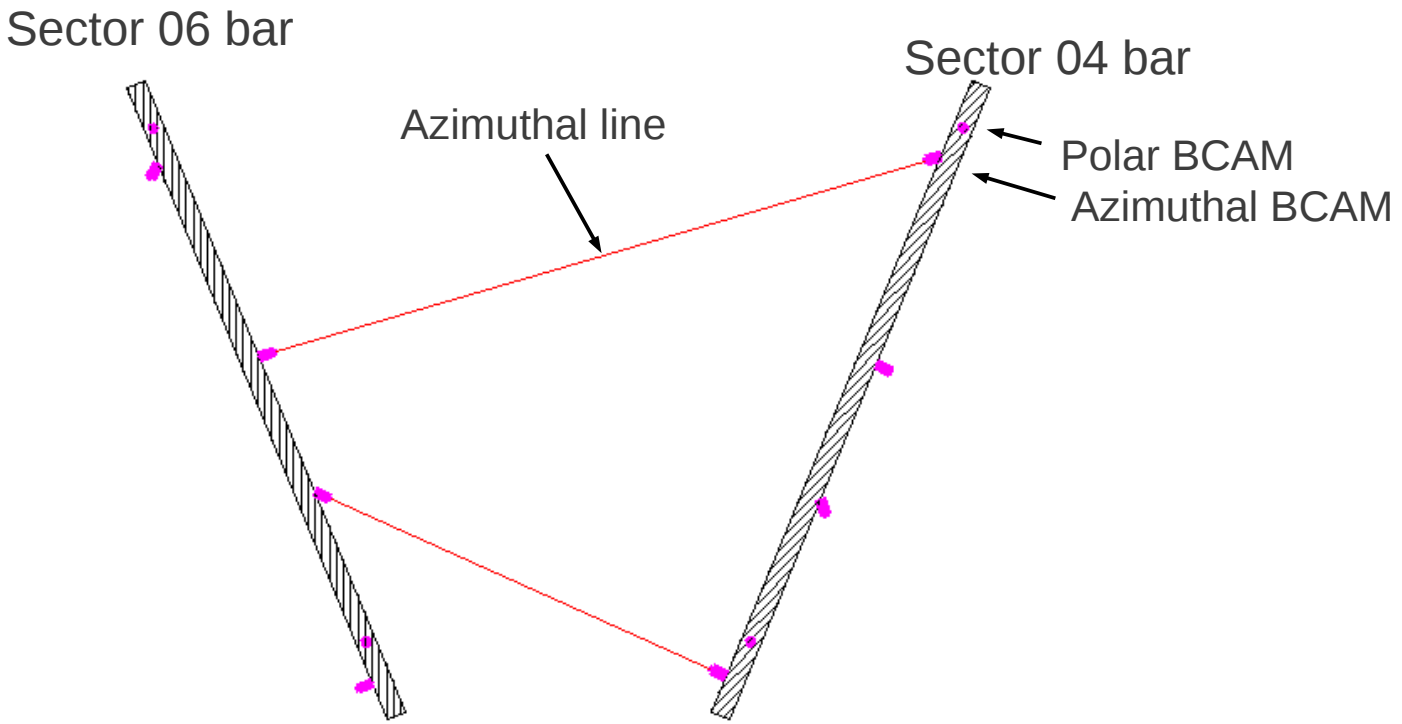
First example setup: pair of BCAMs

- Position of B measured by A with a precision of few 100 µm
- A small rotation of A around its mount has large lever arm when extrapolating to B

Second example setup: triplet of BCAMs

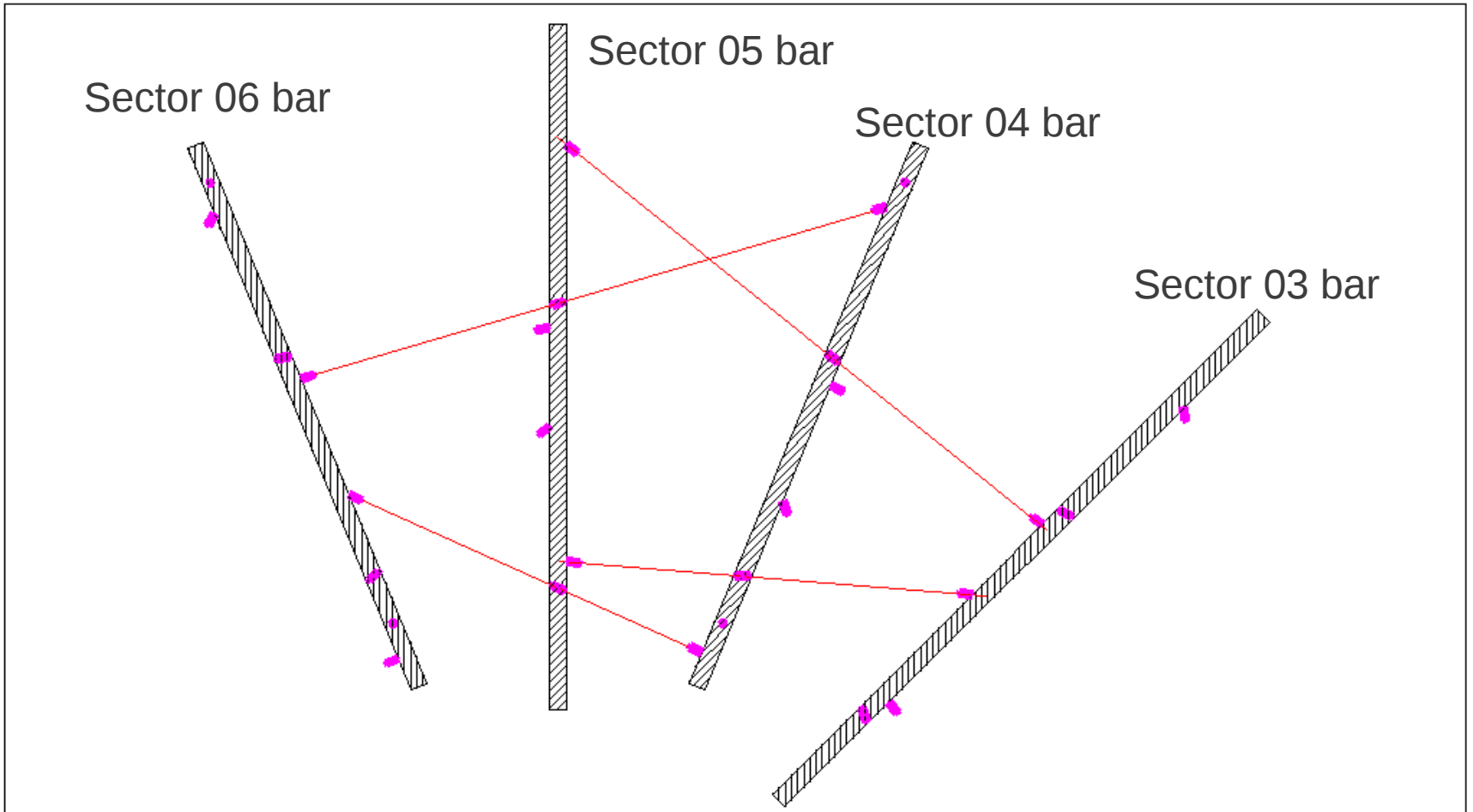
- Position of B with respect to a line connecting A and C is measured with a precision of ~ 5 µm / m
- Setups with triplets of BCAMs are much stronger than doublets

Azimuthal lines: present layout (schematic view)



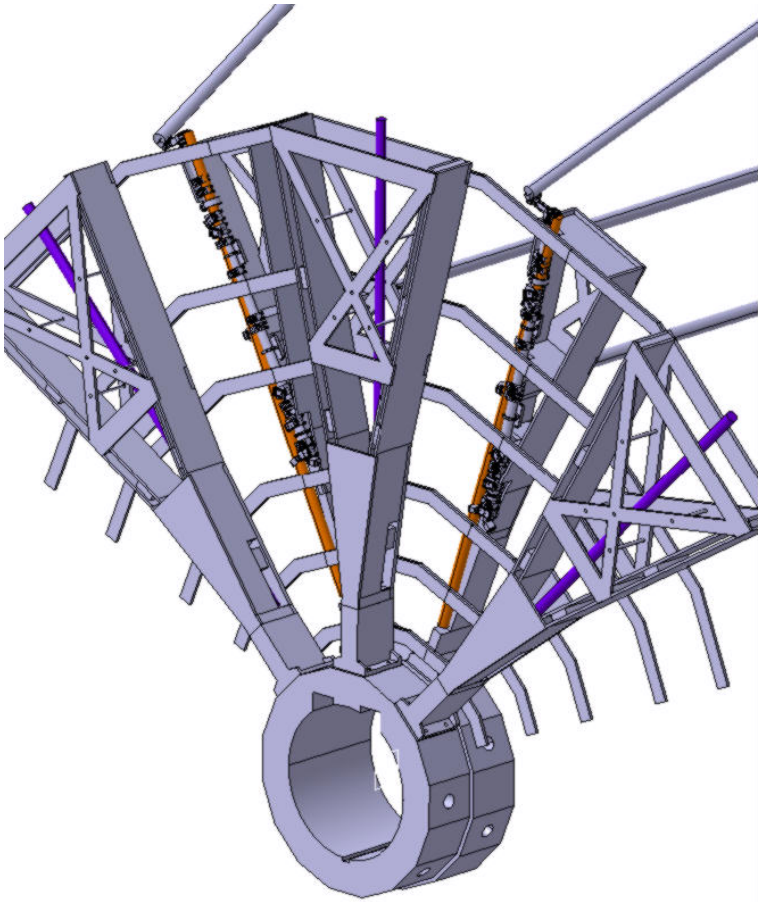
- In present layout, azimuthal lines are made of pairs of BCAMs
- The position of one bar with respect to the next is known at few 100 µm
- Each bar is connected to the polar system, which ensures the high sagitta precision

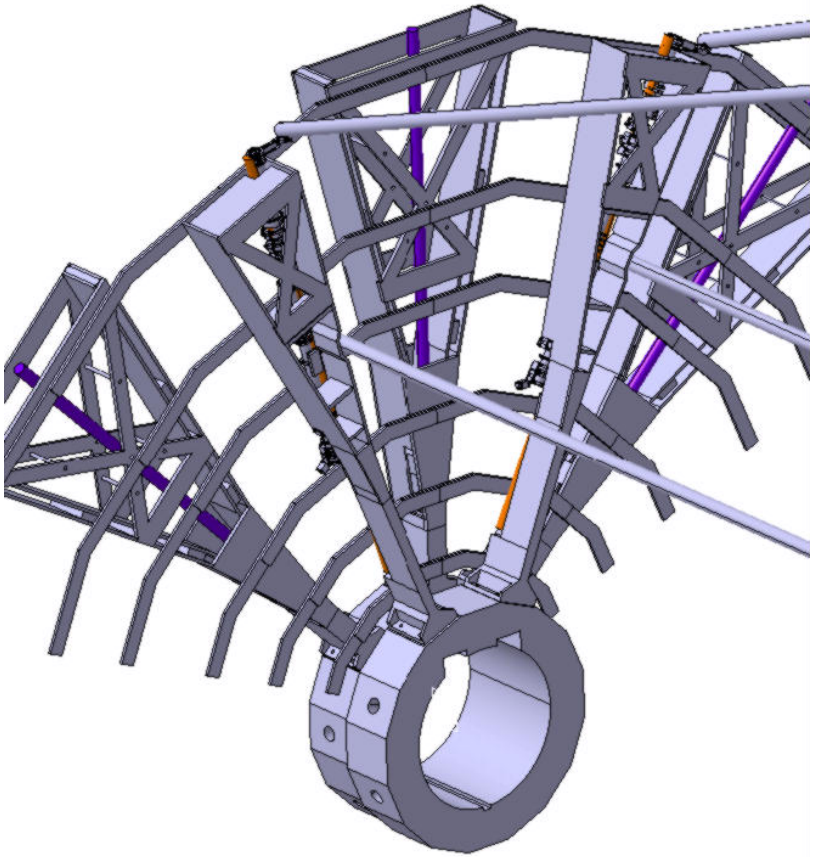
Azimuthal lines: new layout (schematic view)



- By adding L bars, the azimuthal lines become triplets of BCAMs
- Azimuthal alignment is thus reinforced, should provide accurate alignment of the L bars even though they are not connected to the polar system
- ***This is a critical point to be checked by simulation!***
- Simulation will also answer the question of how many azimuthal lines are needed

Feasibility of a layout with 16 alignment bars





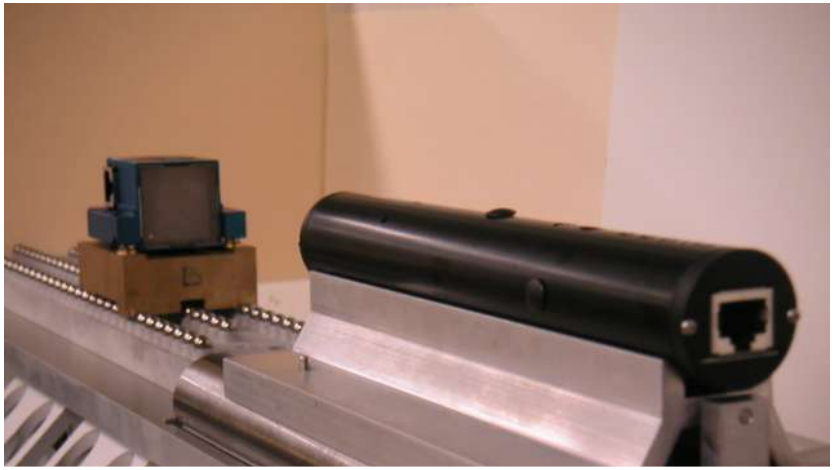
Feasibility of a layout with 16 alignment bars per small wheel has been investigated by Patrick Ponsot, Marco Ciapetti:

- 16 alignment bars is possible
- It is excluded that they extend to the inner radius (η=2.7)

On-chamber sensors

- Requirements:
  - Should monitor position of the chamber with respect to the bars
  - Should monitor the internal deformation of the chamber
  - Should fit in the small space available between layers of MM and TGC
- Available hardware: BCAMs, Rasniks

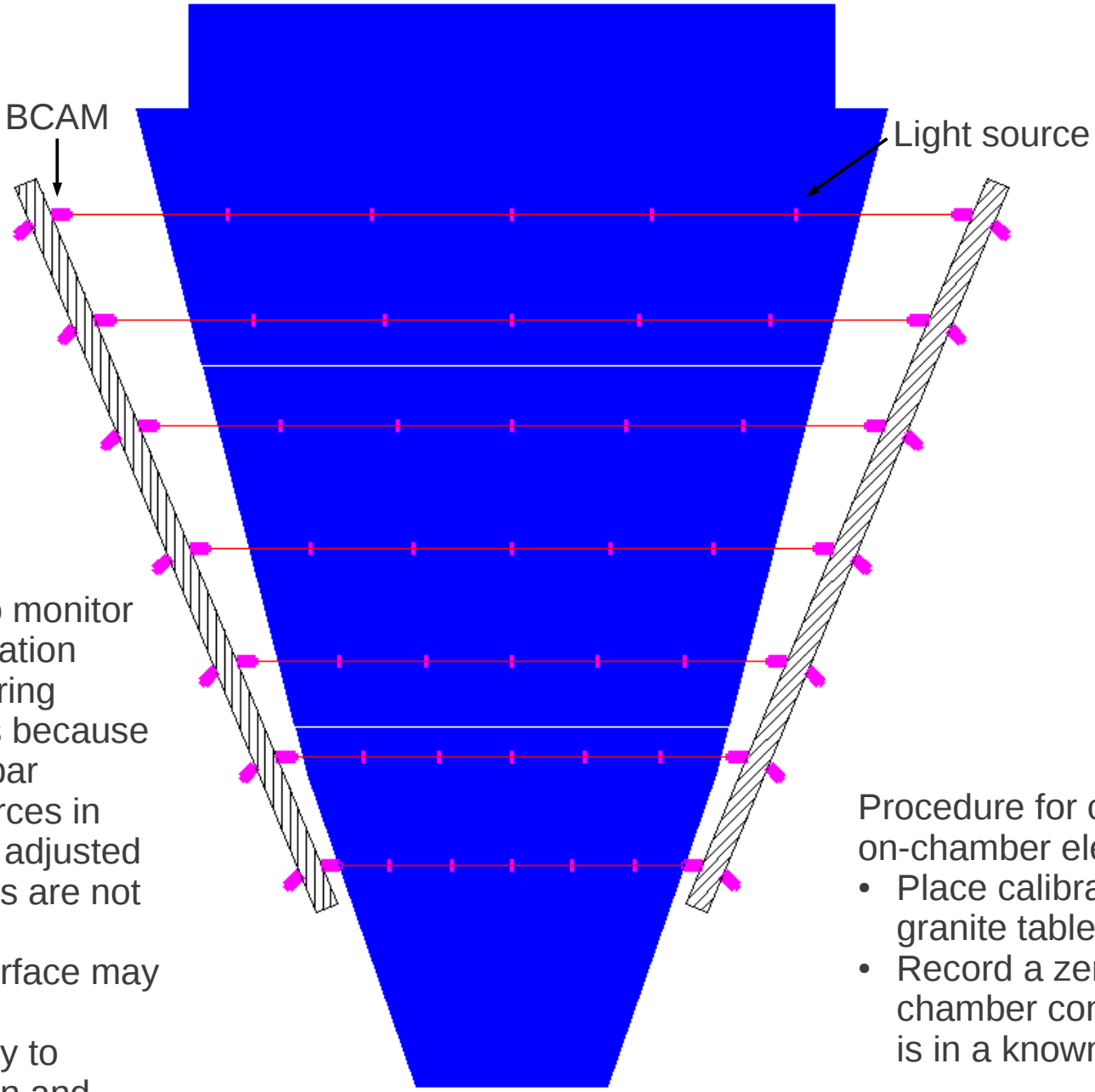
BCAM light source using fibers
The space needed for the fiber is <10mm
The laser diode and electronics board may be placed in a remote location where more space is available



A Rasnik mask and a camera
The Rasnik mask may be made of 10 mm size
The CCD board itself is less than 10 mm. CCD control electronics board is larger, but may be placed flat next to the CCD

- Custom alignment hardware will need to be designed, as available hardware is taking too much space
- To save space, alignment sensors may need to be glued directly on the chambers
  - Instead of having individual mounts for the sensors as in the present layout

Bar to chamber sensors: option 1, all BCAMs

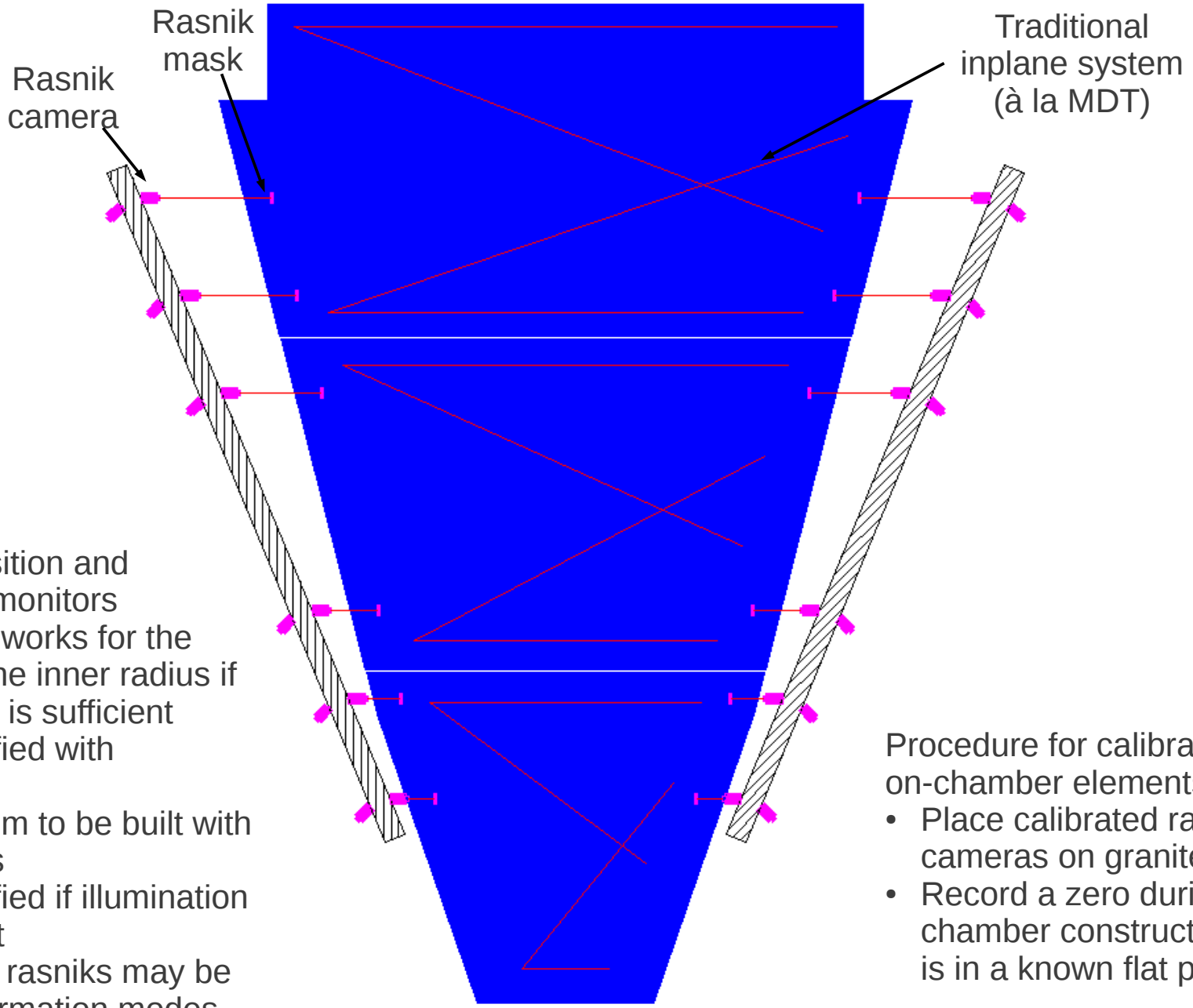


- Single optical line to monitor position and deformation
- Deformation monitoring without large angles because camera sits on the bar
- Number of light sources in optical path may be adjusted if deformation modes are not simple
- Caveat: not all of surface may be covered
- Caveat: may be risky to entangle deformation and position monitoring

Procedure for calibration of the on-chamber elements:

- Place calibrated BCAMs on granite table
- Record a zero during chamber construction when it is in a known flat position

Bar to chamber sensors: option 2, all Rasniks



- Separate position and deformation monitors
- This solution works for the chamber at the inner radius if the lever arm is sufficient
  - To be clarified with simulation
- Inplane system to be built with a 10 mm lens
  - To be clarified if illumination is sufficient
- More inplane rasniks may be added if deformation modes are not simple

Procedure for calibration of the on-chamber elements:

- Place calibrated rasnik cameras on granite table
- Record a zero during chamber construction when it is in a known flat position

Conclusion

- Simulation of the 16 bar layout to be carried out shortly
  - Does this layout work?
  - How many azimuthal lines are needed?
- Layout and length of the bars to be clarified
  - Longest possible bars are desired
  - Should integrate in mechanical structure
  - Space needed for bar installation and adjustment (final adjustment in the pit)
- On chamber alignment system needs to be looked at carefully
  - Optical lines need to pass in regions with many services
  - Alignment corridors should be arranged
- To design the inplane system, the deformation modes of the chamber have to be clarified
  - From first simulations of Patrick Ponsot, the deformation modes look simple
  - Would be good that this is answered with the mechanical prototypes