QD0 Alignment in ILD

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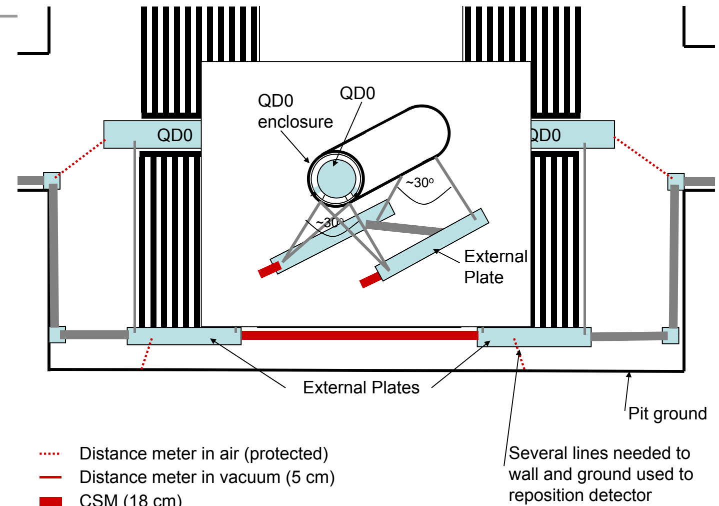
ILD Regional Integration Meeting

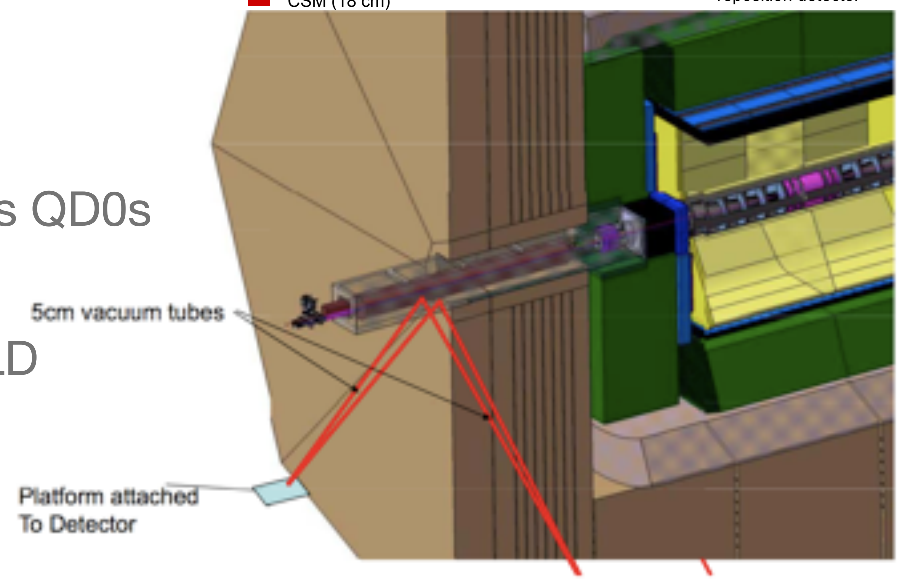
Alignment Requirements

- ILD detector axis:
  - ±1 mm, ±100 μrad
  - laser reference system on platform or hall, positive indexing system on platform
- QD0 magnets:
  - before low current beam is allowed in:
    - ±50 μm, ±20 mrad (roll) ± 1 mrad (pitch, yaw)
  - after beam-based alignment:
    - Stability over 200 ms: ±200 nm, 0.1 μrad
    - Vibration stability: less than 50 nm within 1ms bunch train
  - Alignment and positioning system on ILD
  - Cam movers on QD0s
- Reference line: defined by QF1 magnets in the beam line

QD0 Alignment in ILD LoI

- MONALISA (Oxford)
  - frequency scanning laser interferometer
  - could provide necessary precision for QD0s
  - could align ILD globally
  - could link left and right QF1
- Problems:
  - Lasers need to be in vacuum tubes
    -> No mechanical solution to access QD0s cold mass via yoke end caps
  - Oxford group stopped to work on ILD





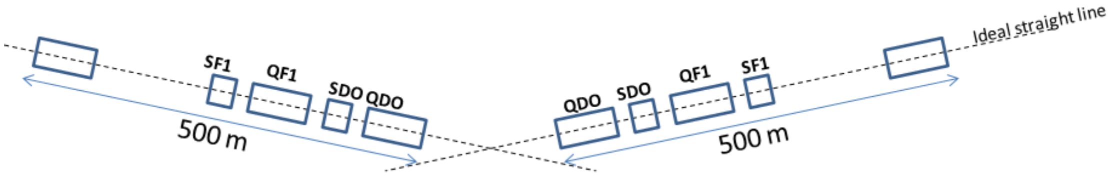
CLIC Approach

- CLIC requirements are much tighter for QD0 magnets:
  - alignment better than ±10 μm !

- CERN surveyor group is working on solutions for ILD@CLIC

- Klaus Sinram and myself met them at CERN during CFS BTR and disussed, if CLIC solution could be applied to ILD@ILC as well....

Determination of the position of QD0 w.r.t other components of the BDS (1)

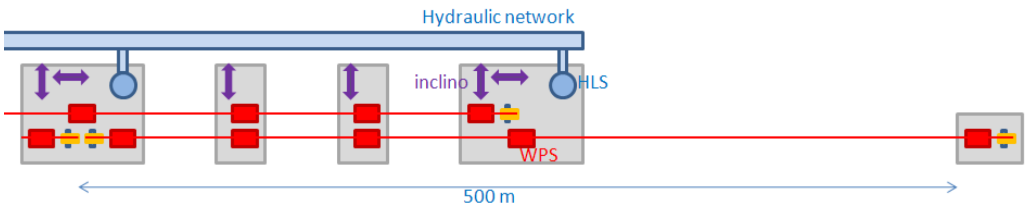


Requirements:

- ✓ Position of the zero of QD0 w.r.t ideal straight line of the 500 last meters of BDS: ± 10 µm rms (including fiducialisation)
- ✓ Longitudinal relative position between QD0 and QF1: ± 20 µm rms

Solutions:

- ✓ Main difference concerns the MRN network (due to lack of space):
  - ○ No overlapping of stretched wires in the last 250 m
  - ○ No HLS system needed for the modeling of the sag, which will be extrapolated on the last 250 m.



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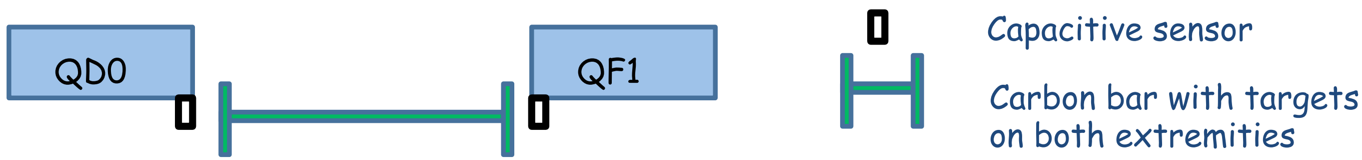
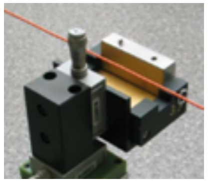
Determination of the position of QD0 w.r.t other components of the BDS (2)

✓ Longitudinal monitoring of QD0 w.r.t QF1: capacitive sensors coupled to each component measuring w.r.t targets of a common carbon bar



✓ Development of special mechanics and sensors to displace the stretching device when QD0 is removed.

- Development of « opened » WPS sensors



- Fixed part of stretched wire will have to displaced remotely, radially (get out the WPS installed on QD0) and longitudinally (get out the support tube of QD0). Can not be removed as it gives an alignment reference for all the BDS components over the last 500m.

Next steps

- Propose a design for these solutions and integrate them
- Validate prototypes on dedicated mock-ups

MDI area

Left side w.r.t right side

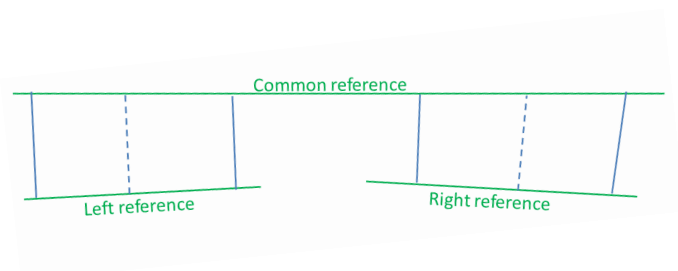
No survey galleries foreseen at ILC
Maybe not needed....

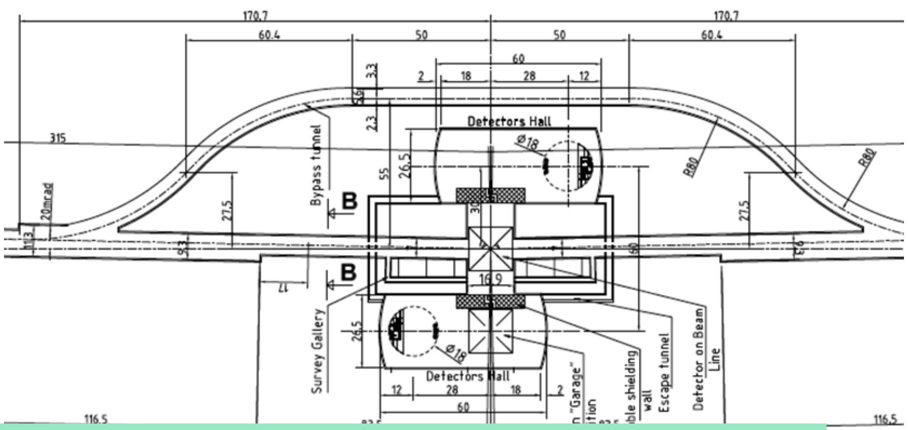
Requirements:

- ✓ Determination of left reference line w.r.t right reference line : within ± 0.1 mm rms
- ✓ Monitoring of left reference line w.r.t right reference line : within a few microns
- ✓ Monitoring of the position of left QD0 / right QD0 within ± 5 μm rms

Solutions:

- ✓ Determination of left reference line w.r.t right reference line &monitoring of one BDS w.r.t other: ➔link stretched wires on both side by a common reference (as in the LHC), using the survey galleries





Next steps

No further studies needed between 2012-2016

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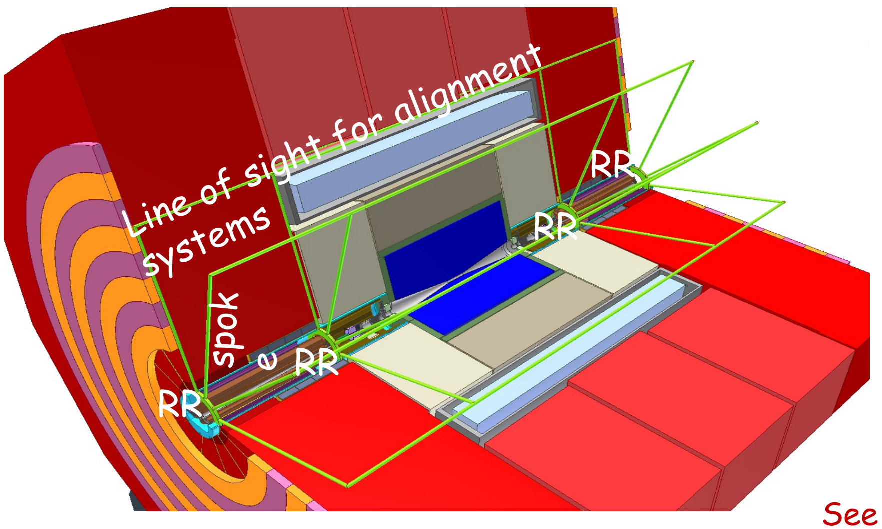
MDI area

Left side w.r.t right side

Monitoring of the position of left QD0 /right QD0: Concept

- ✓ 4 Reference Rings (RR) located at each extremity of QD0, supported from outer tube
- ✓ 6 radial spokes per RR



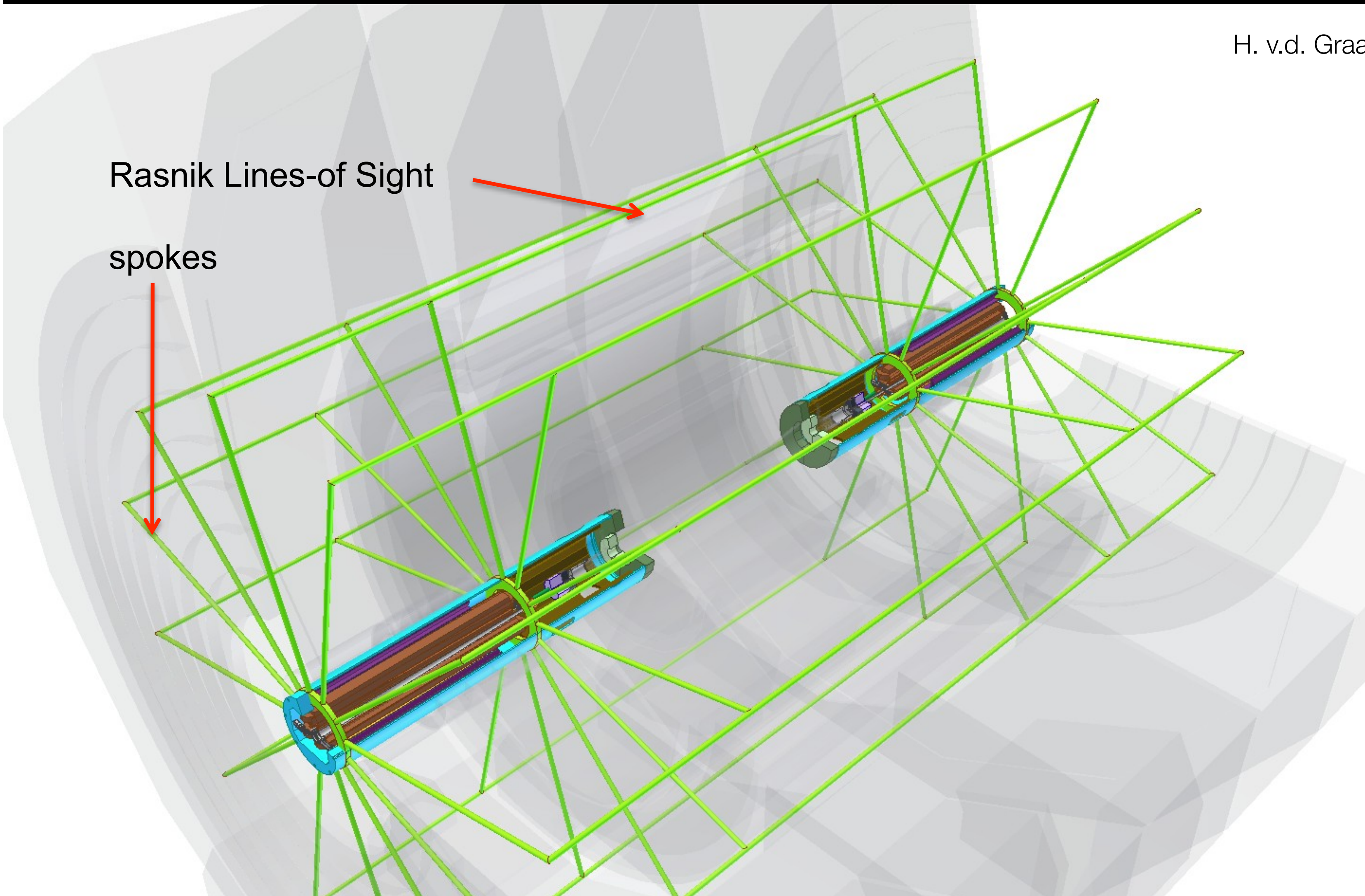
In two steps:

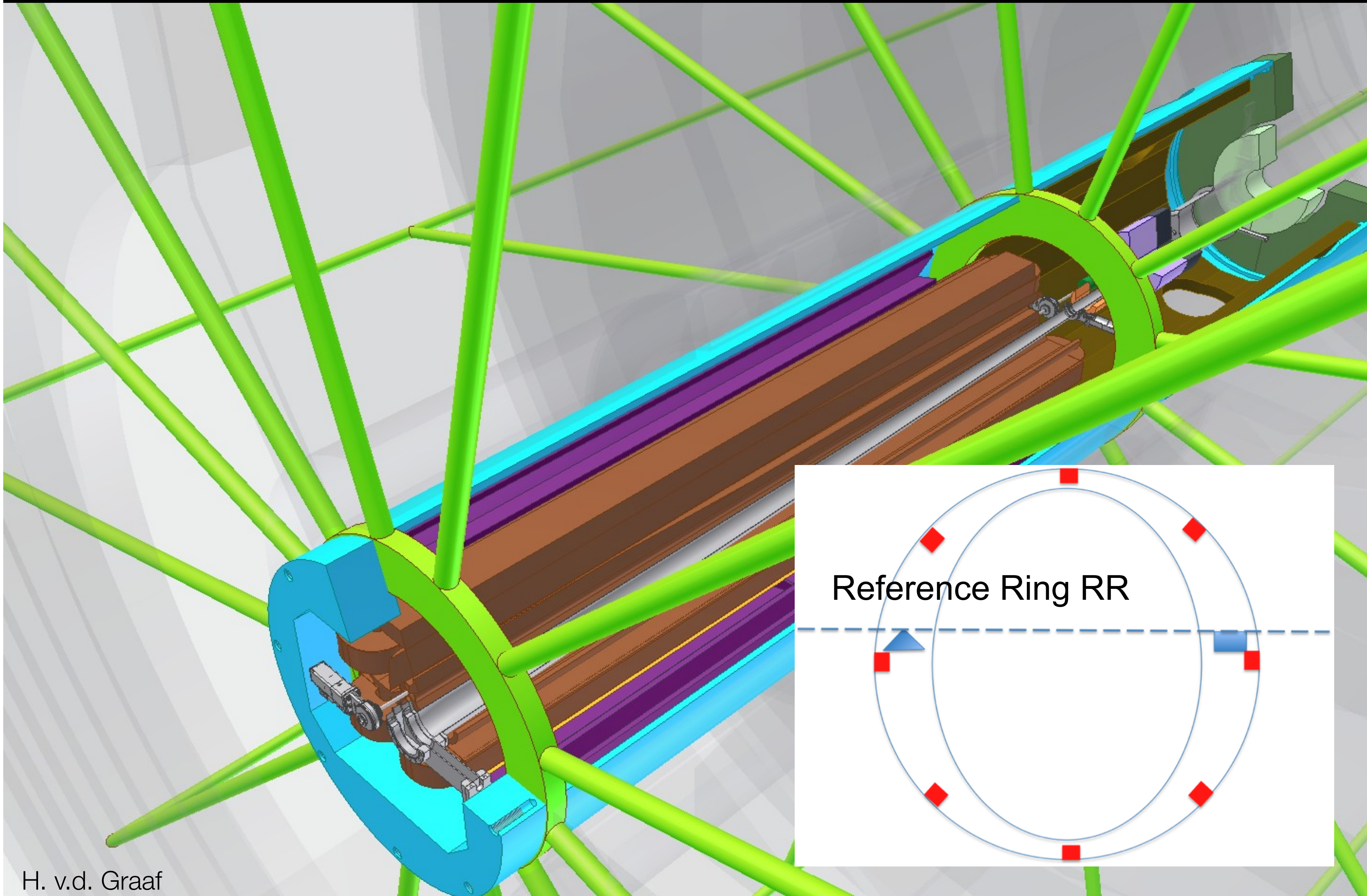
- ✓ A monitoring of the position of QD0 w.r.t RR thanks to proximity sensors. (initial calibration of their position performed on a CMM)
- ✓ A transfer of the position of RR thanks to 6 spokes to alignment systems. By combination of redundant information, the position of the center of 4 RR is computed.

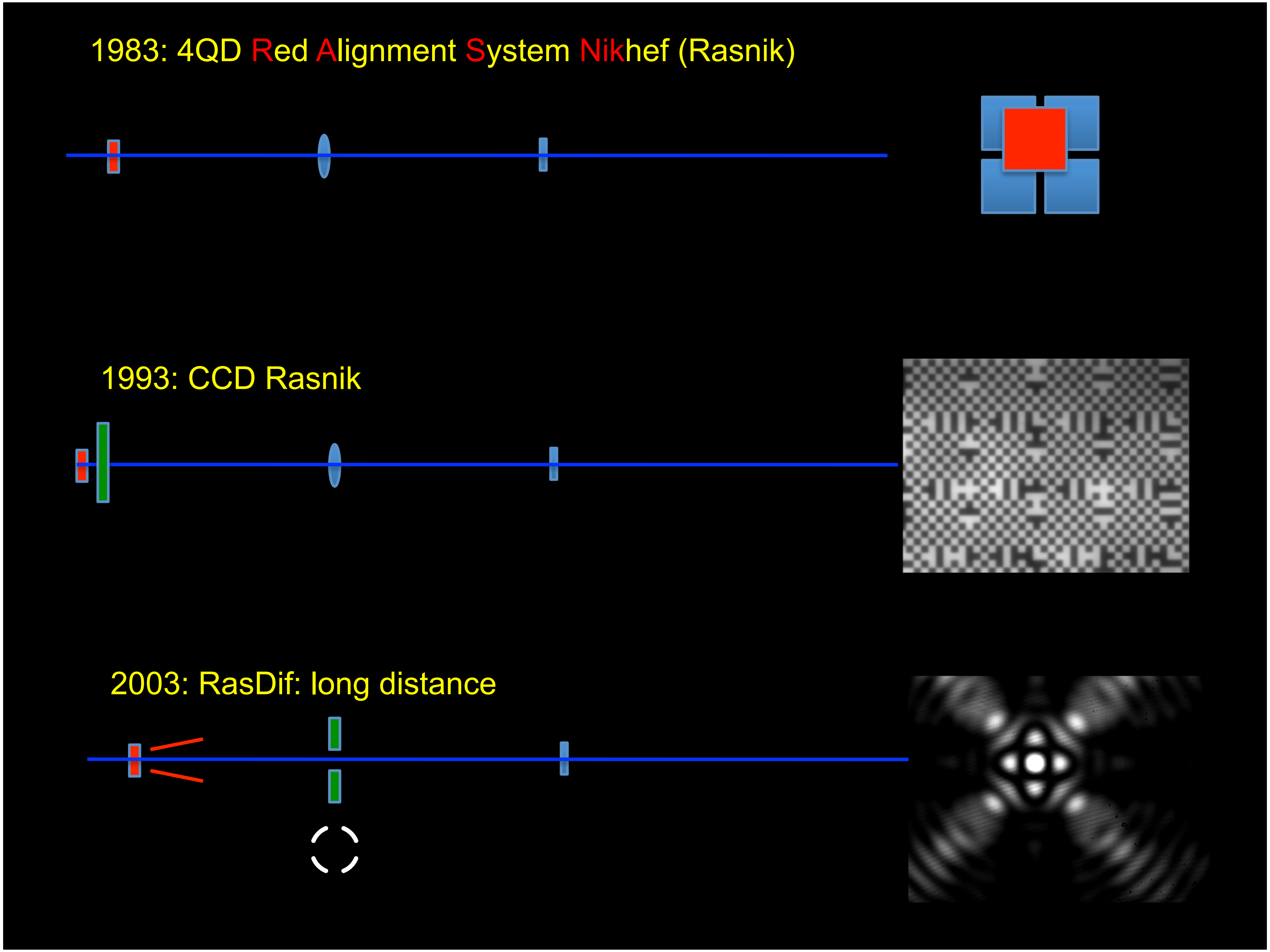
See next presentation by Harry van der Graaf

Next steps

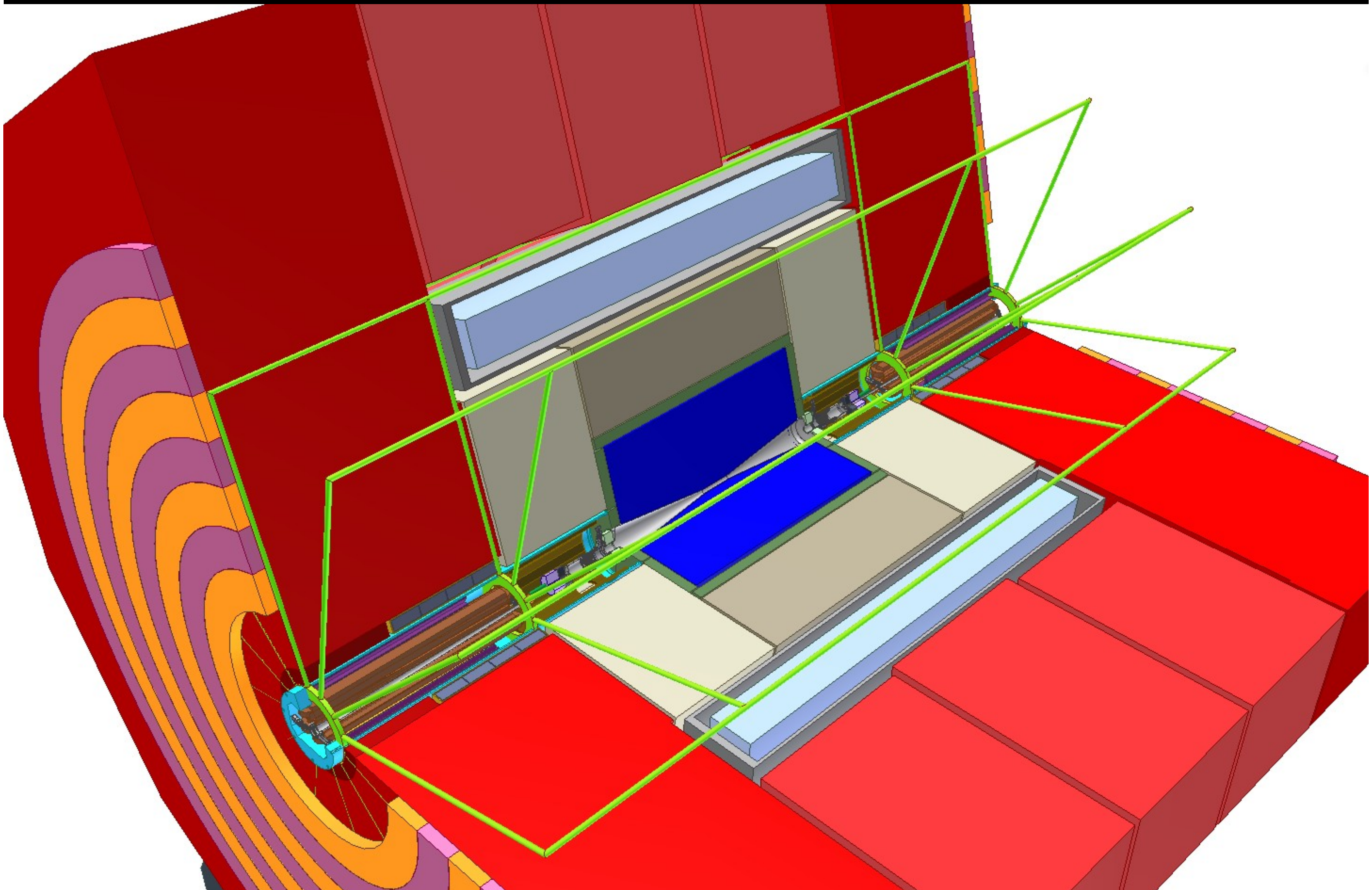
- Validation of spokes design and alignment systems at NIKHEF (2011-2012)
- Validation of the concept on a mock-up at CERN (2012-2013)


H. v.d. Graaf
Rasnik Lines-of Sight
spokes

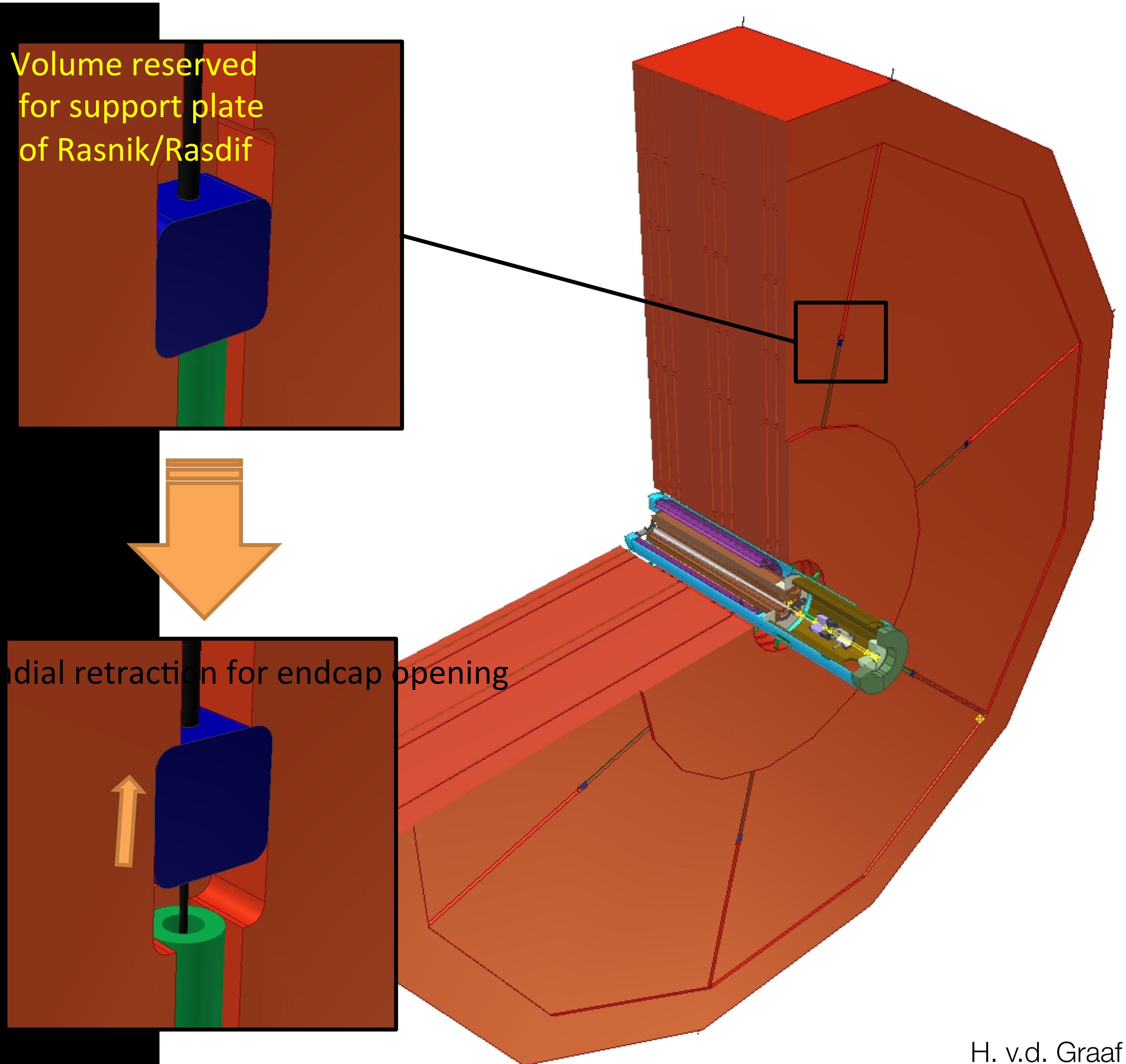

Reference Ring RR
H. v.d. Graaf


1983: 4QD Red Alignment System Nikhef (Rasnik)
1993: CCD Rasnik
2003: RasDif: long distance

H. v.d. Graaf

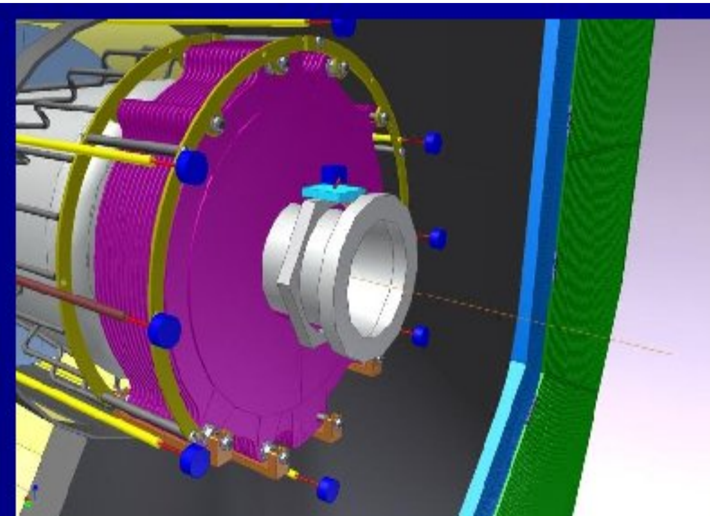


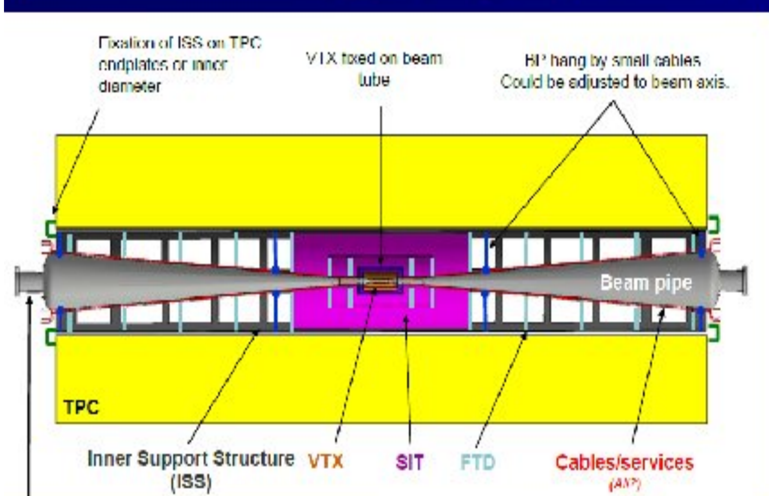
H. v.d. Graaf


Volume reserved
for support plate
of Rasnik/Rasdif
[redacted]dial retraction for endcap opening
H. v.d. Graaf

Mechanical aspect of alignment LumiCal calorimeters

What about FCAL?
slides from Leszek Zawiejski

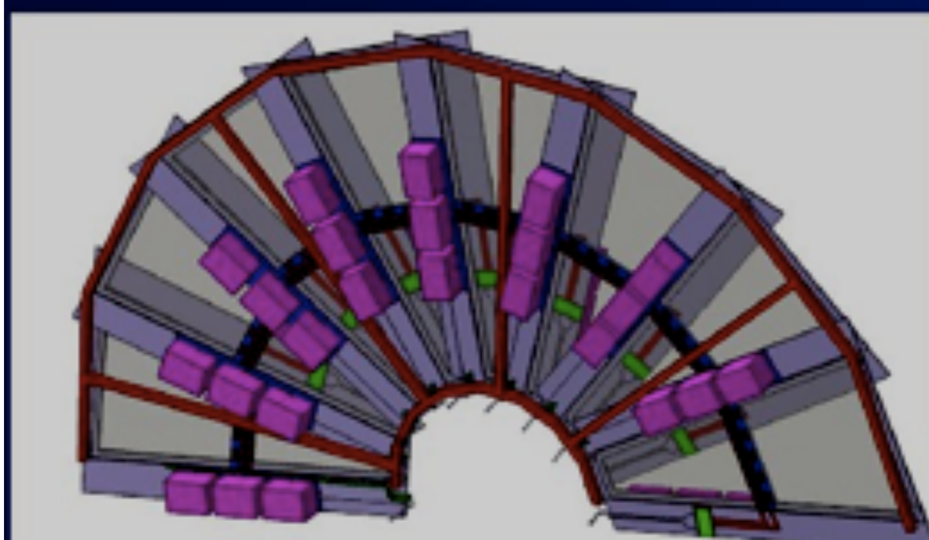


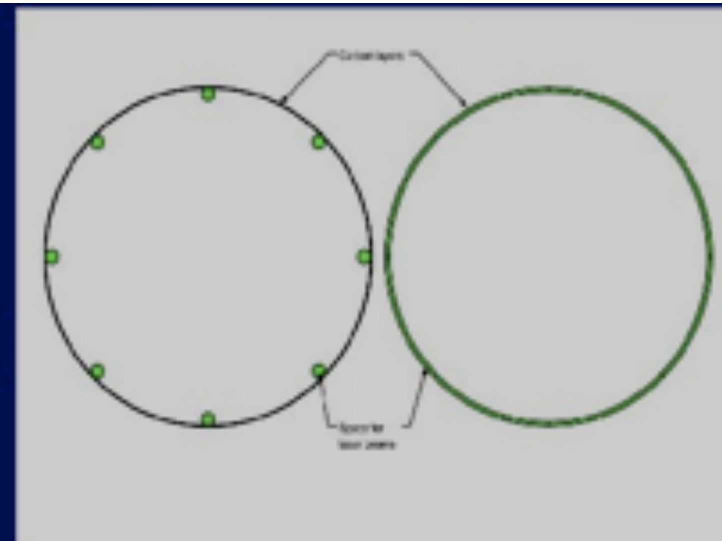


Carbon tube made with pipes for laser beams (higher stiffness)
Possible (?) windows in beam pipe for laser beams

LumiCal calorimeters - space for laser beams

What about FCAL?
slides from Leszek Zawiejski

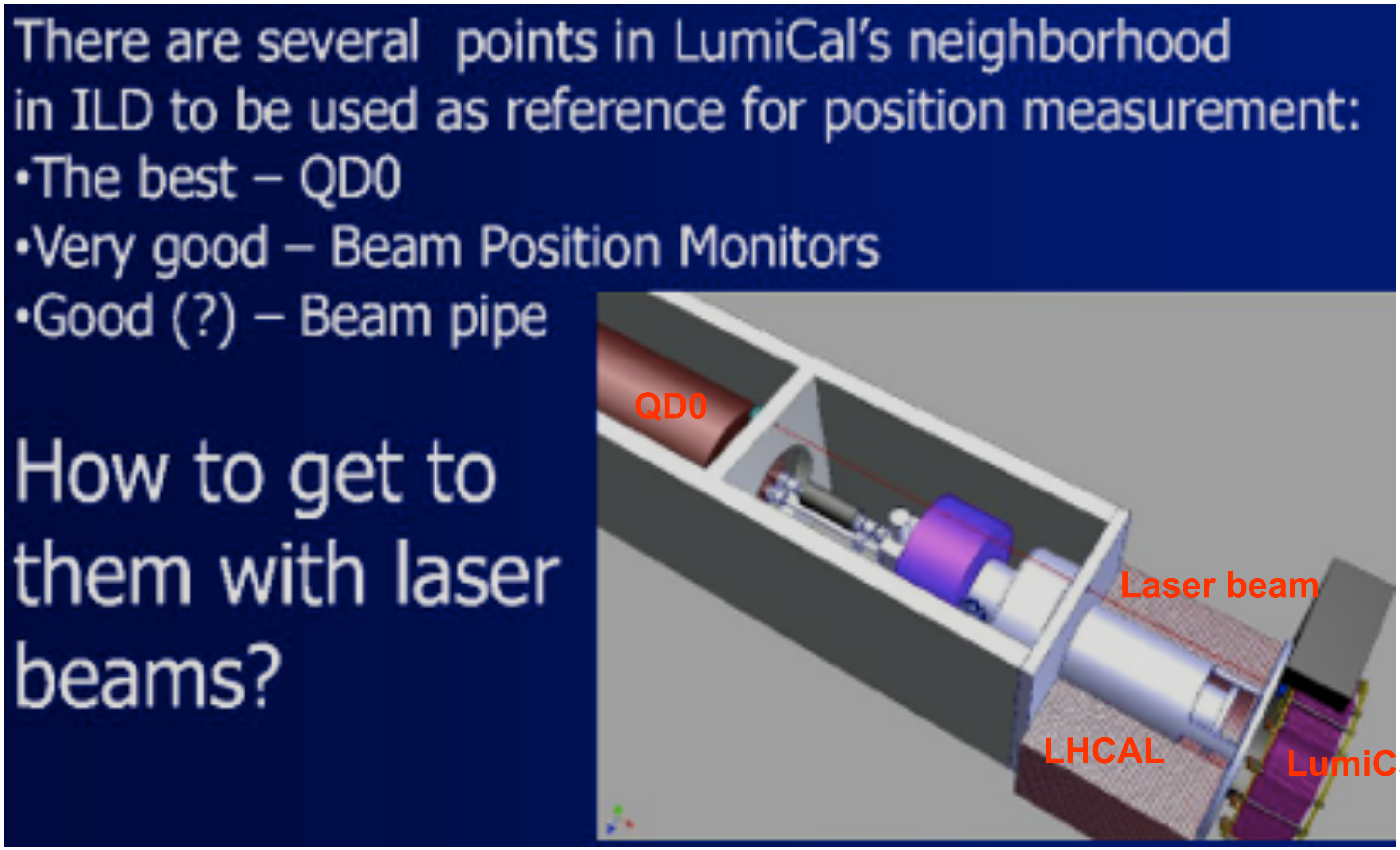




Carbon tube with glued carbon pipes (left) – less material, more stiffness, limited number of laser beams
Double layer carbon tube (right) – less material, more stiffness, lot of space for many laser beams

Reference points

What about FCAL?
slides from Leszek Zawiejski



Possible measurements of the relative distances to QD0 in X,Y and Z directions

Comments

- We need to write something about the QD0 alignment in the DBD
- The LoI system was MONALISA: open technical questions; no-one is working on it anymore for ILD
- CLIC has much more stringent requirements and the CLIC group is working on an alignment system for ILD@CLIC
- Should we copy it?
- If yes, what do we still need to do:
    - continue discussions with CLIC experts
    - assign space in the detector for spokes and lines of sight for RASNIKs
    - understand differences
        - definition of magnetic axis at s/c quadrupoles different than at permanent quadrupoles (CLIC)
- Look for synergies (e.g. combine systems for QD0 alignment and LumiCal)