New LumiCal mechanical structure and alignment in ILD

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Motivation

- Reduce heavy material (tungsten) in inactive zone (ring between radius from ~200 mm to ~250 mm) .
- Find more space for FE electronics and some 'symmetry' – same layout for all fan out and FE PCB.
- We have found some misunderstanding among many people concerning the LumiCal mechanical structure – clarify the design.

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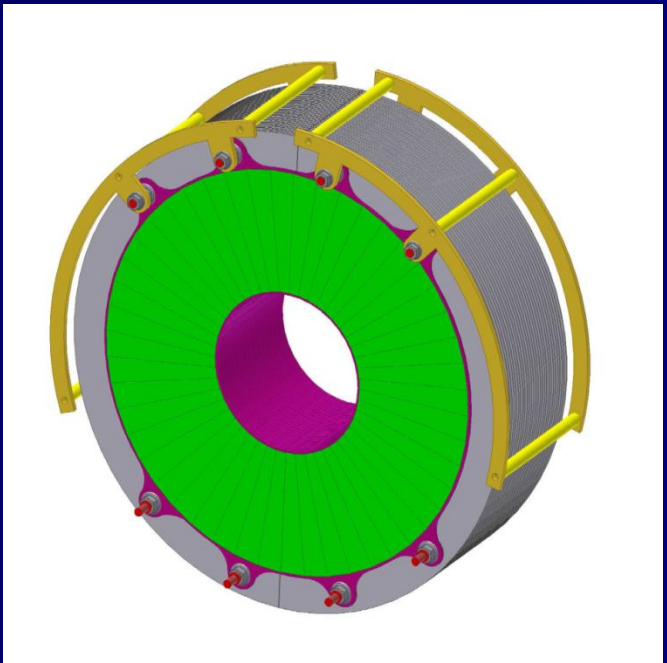
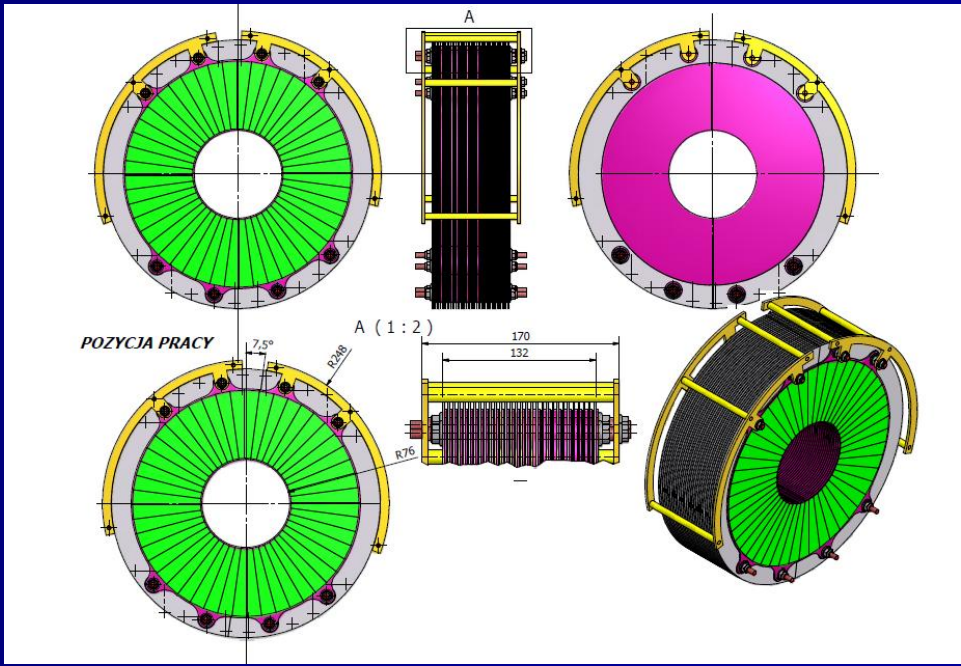
“Old” design of LumiCal



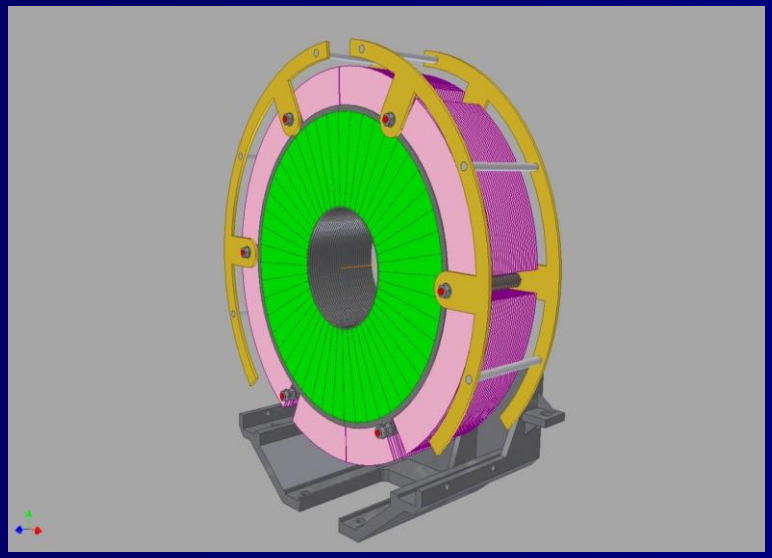


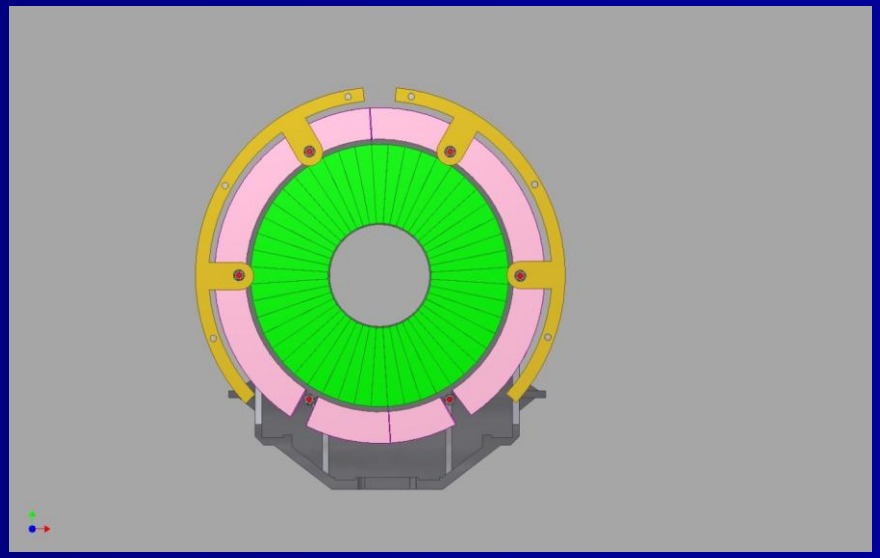
Too many fixing bolts, no ‘symmetry’, leak of space for fan out bonding.

Design overview

- Each calorimeter is in a form of a barrel which is divided into two parts along the vertical plane .
- The proposed LumiCal detector will consists of 30 layers of tungsten of 1 radiation length thickness and 320 μm silicon sensors layers.
- The sensitive region extends from 80 mm to 195.2 mm in radius.
- The outer radius of calorimeter is foreseen to be 280 mm to cover the space for front end electronics, readout cables, cooling and precision positioning sensors.
- The mechanical inner radius is 76 mm.

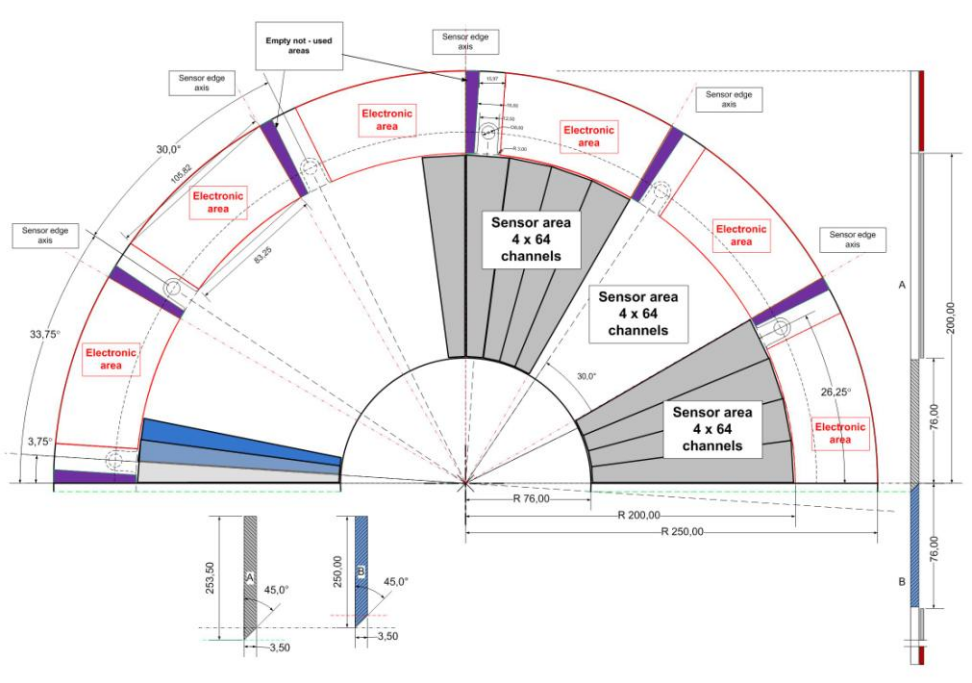
“New” design of LumiCal





Smaller in diameter fixing bolts, more space for FE electronics, ‘full symmetry’.
Fan out layout and FE PCB can have identical shape for all sensor tiles (4 sectors).

Detailed half plate design



- One LumiCal will have 92160 electronic readout channels. On one half plane it should be a place for 1536 electronic channels.
- The goal was to have all electronics for silicon tiles identical.

❑Due to rotation of odd and even sensor planes by 3.75° to overlap the gaps in Tungsten absorber, some space for electronics (with full symmetry) is lost, but our design minimize it.

❑We foresee 3 fixing bolts to mount one half plane, but it is possible to have 5 fixing bolts per half plane. More fixing bolts will increase the stiffness of LumiCal mechanical construction.

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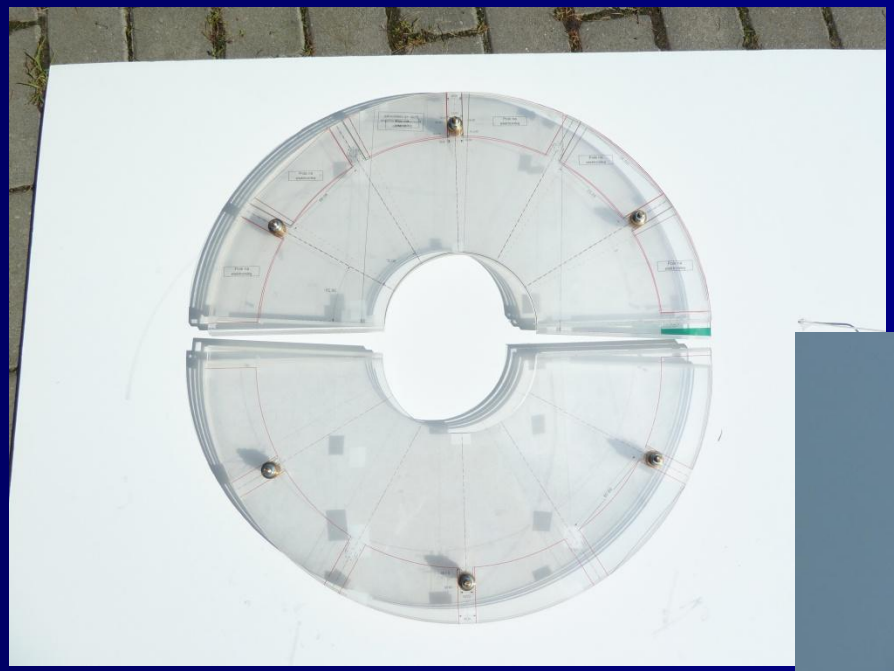
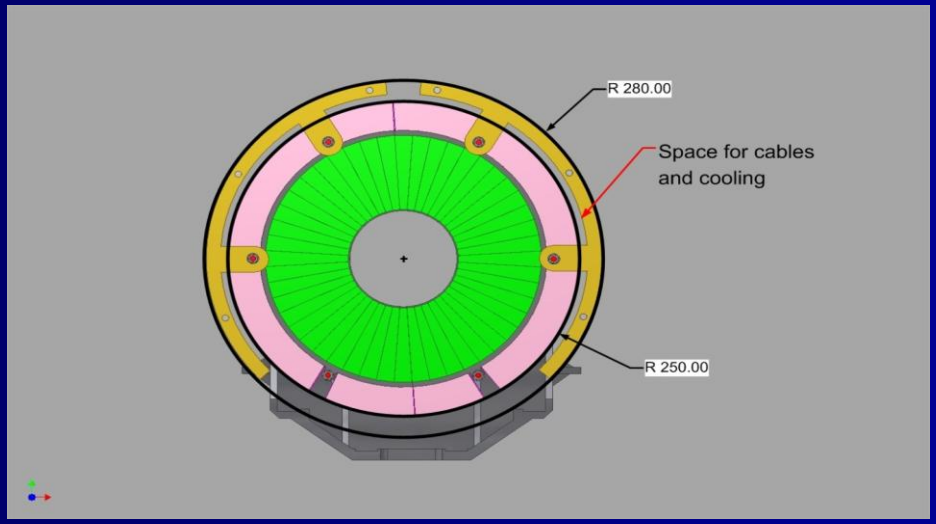
Model of a few layers



Space for cables and cooling



The electronic channels of LumiCal will be read in digital form to the DAQ placed ~10 m far from the detector outside the ILD. The cooper LVDS TP cables will go from each half plane of LumiCal around the barrel to the back side of each LumiCal where Data Concentrator will be placed. From Data Concentrator we foresee optical links to the DAQ. The fibre optics cables will go over LHCal and inside the square support tube (near QD_0 magnet) outside the ILD detector.

Conclusions I

•To find a space for FE electronics with some symmetry, we have to sacrifice the simplicity of LumiCal mechanical design – we will have 4 different shape tungsten half plates instead of 1 (2?).

• Design of new FE placement has started.

•Simple model in 1:1 scale of mechanical structure has been made from transparent plastics to clarify the design.

•Real model of LumiCal from steel will be made in second half of 2011.

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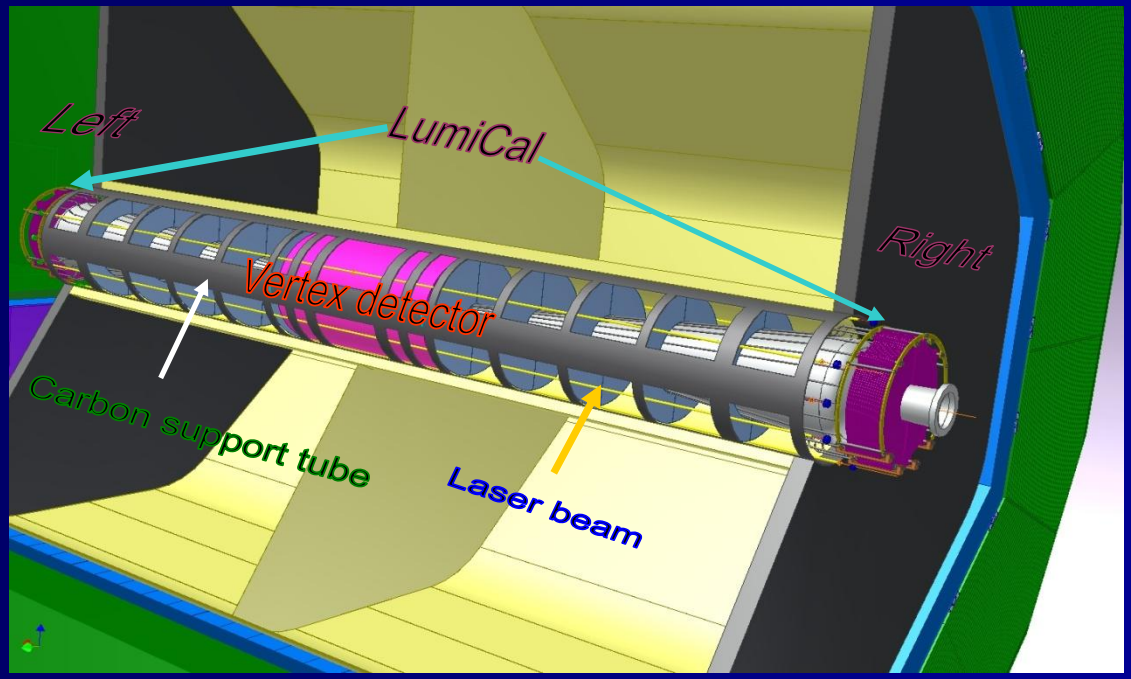
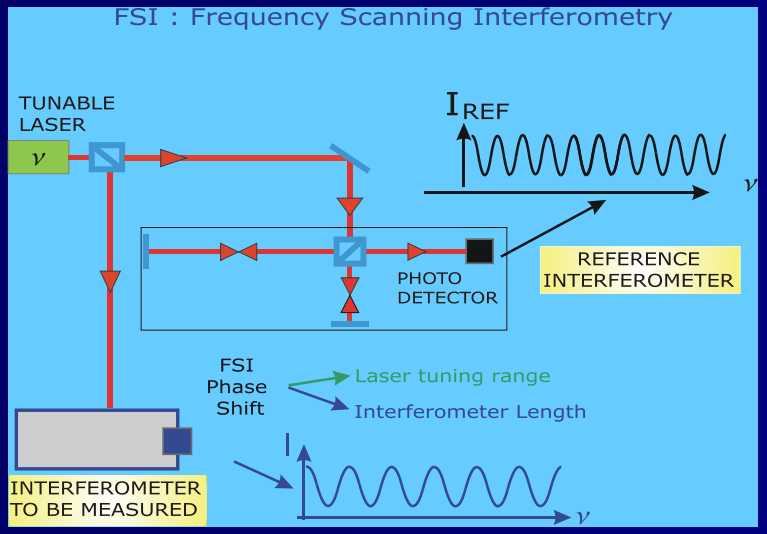
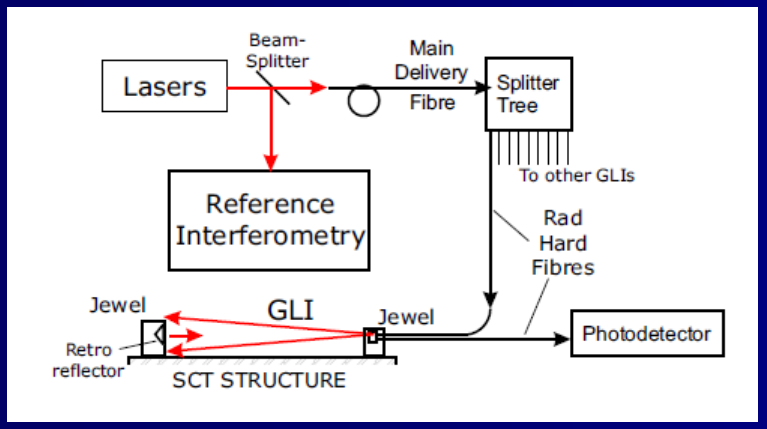
Precision LumiCal online position measurement



- LumiCal x, y position with respect to the beam (incoming) should be known with accuracy better than ~700 μm (LumiCal's will be centered on outgoing beam)
- Distance between two LumiCal's should be known with accuracy better than ~60-100 μm

Frequency Scanning Interferometry





- Freq. scan ~12 nm@670nm (8 THz)
- Accuracy ~1μm@4m (sophisticated methods ~50nm, simple methods ~20μm)
- Up to ~1000 measuring points for 1 laser (laser price ~20000€)
- Single fiber (delivery&return)
- No optics at the end of the fiber
- Retro reflector made as corner cubic pressed in to polished aluminum

Courtesy Paul Coe

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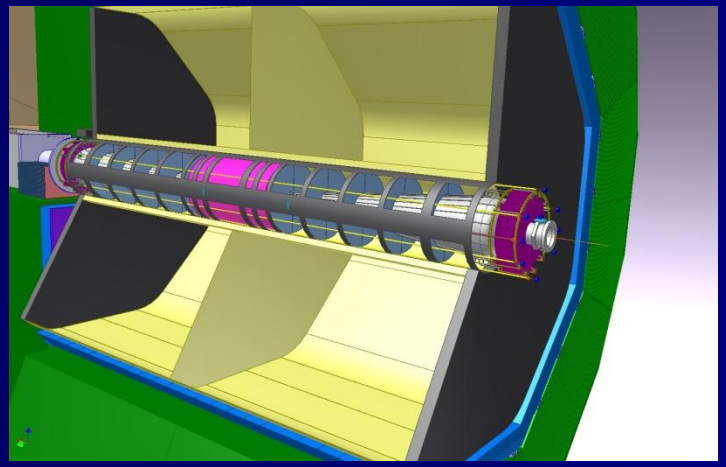
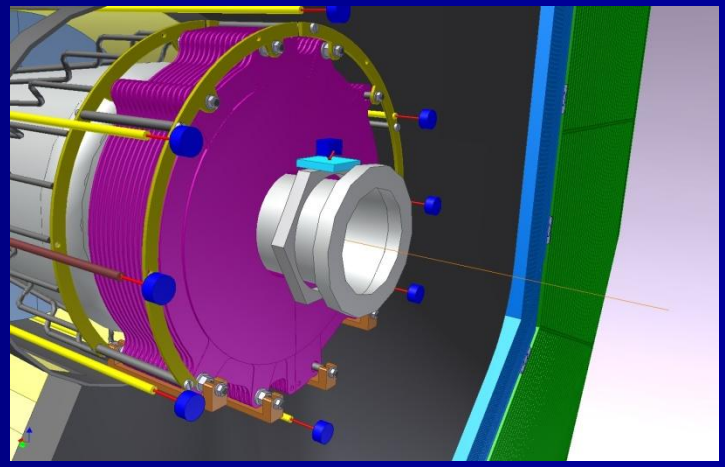
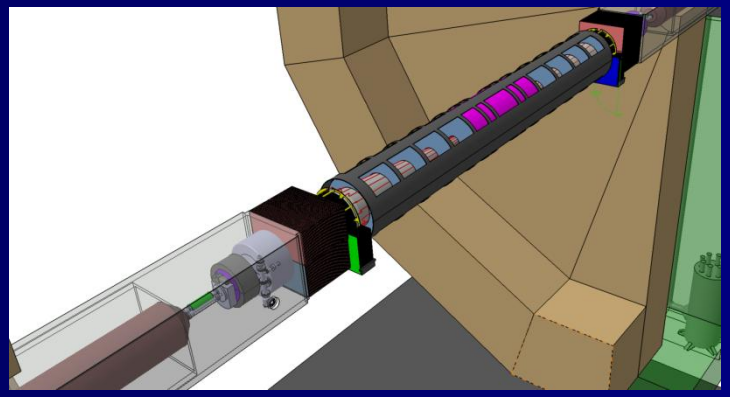
Two LumiCal's alignment Space for laser beams







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

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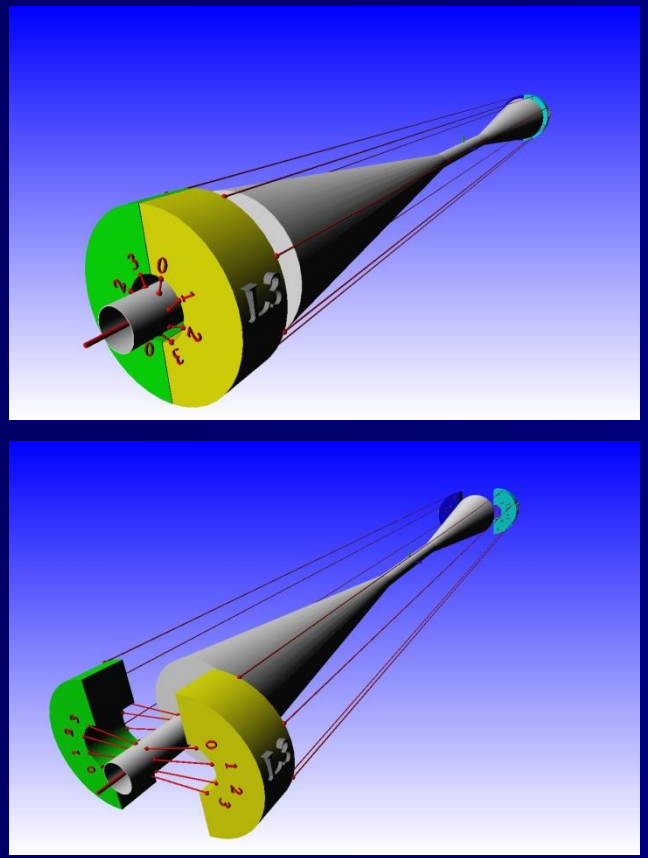
Simulation of simple FSI



- 6 laser beams between two LumiCal's
- 8 laser beams from each LumiCal to the beam pipe for x, y measurement
- Laser beams for x, y not perpendicular to the beam pipe axis – sensitive for rotation of LumiCal
- Half barrels of LumiCal's numbered from L0 to L3

Can we trust to the x, y position of the beam pipe?

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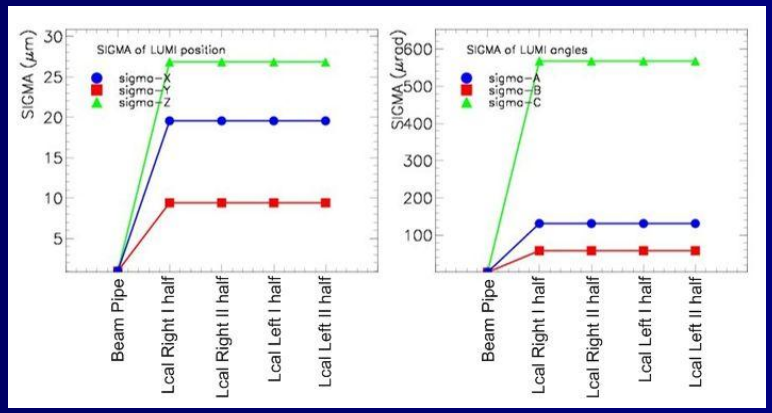
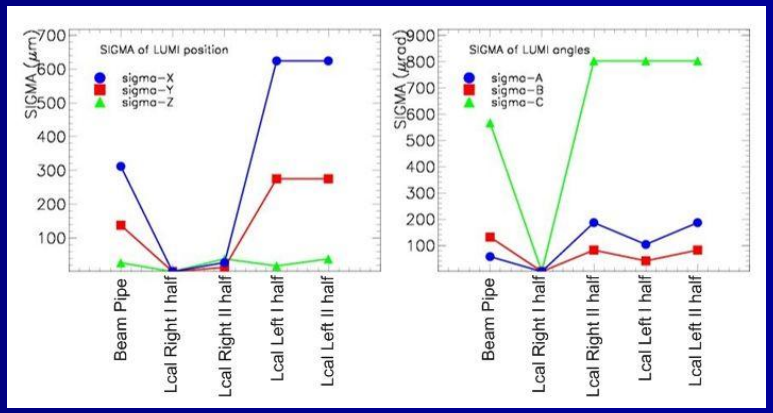
Results of simulation





Beam pipe x, y position fixed
(we can trust on beam pipe position)

Beam pipe x, y position free
Half barrel "0" fixed

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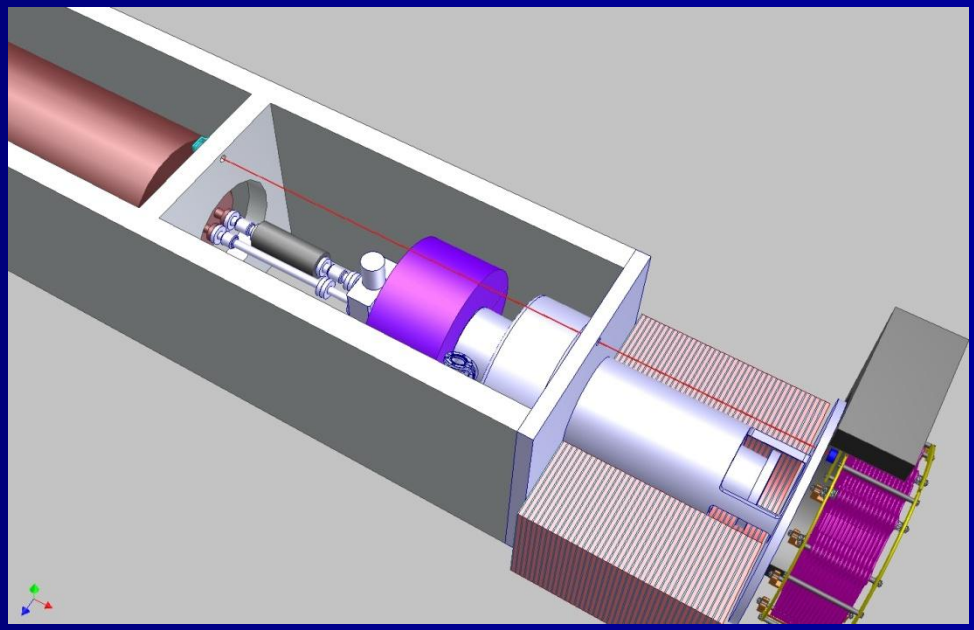
Reference points

There are several points in LumiCal's neighborhood in ILD to be used as reference for position measurement:

- The best – QD0
- Very good – Beam Position Monitors
- Good (?) – Beam pipe

How to get to them with laser beams?



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Conclusions II

•First attempt to simulate the FSI LumiCal's laser position measurement has been done and even with simple devices we can achieve satisfied results. We have to investigate the possibility to use good reference points (i.e. QD0) to increase accuracy (independent measurements from different reference points).

• Transparent position sensors can be used for x, y position measurement.

• Capacitive position sensors seems to be a good alternative for x, y measurement, even as a second position monitoring system. We want to test them in the foreseen model of LumiCal. Miniaturization of sensors are next step.

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