

LumiCal integration in ILD

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FCAL Meeting, DESY Zeuthen, 29-30.06.2009

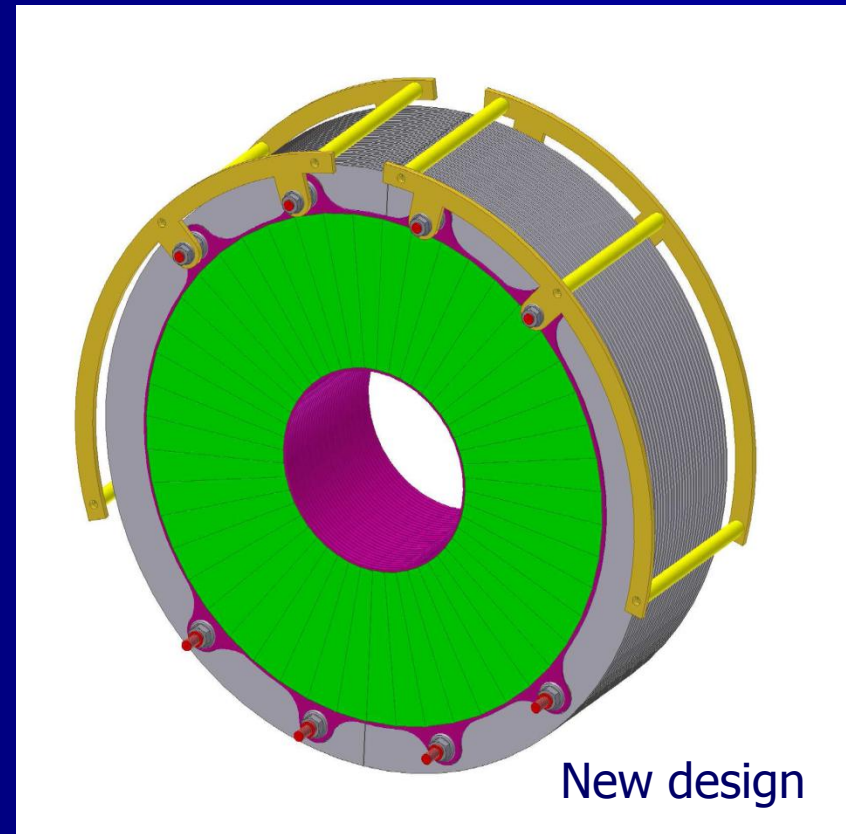
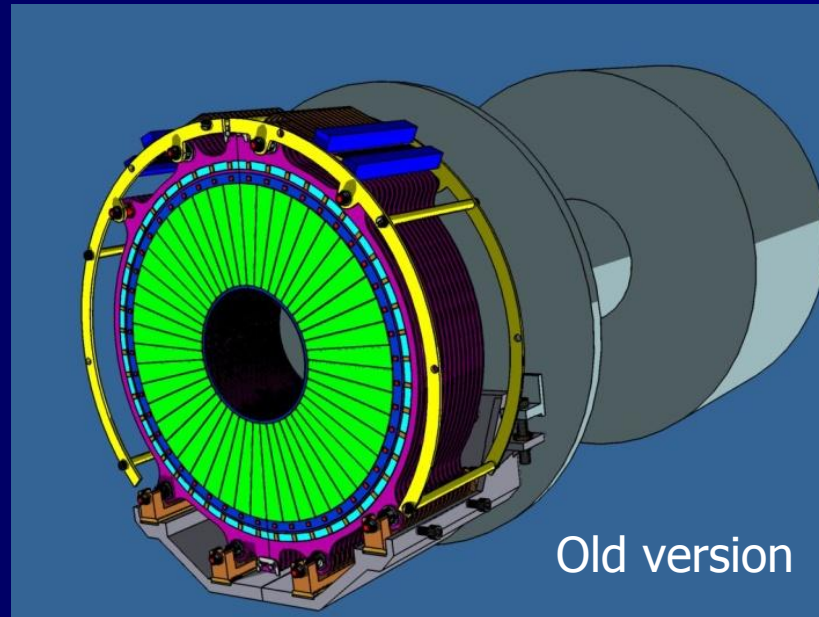
Topics

- Requests from ILD to change the LumiCal design after meeting in Ecole Polytechnique Palaseau.
- New mechanical design of LumiCal – step I
- Positioning of LumiCal in ILD (Frequency Scanning Interferometry, capacitance sensors)

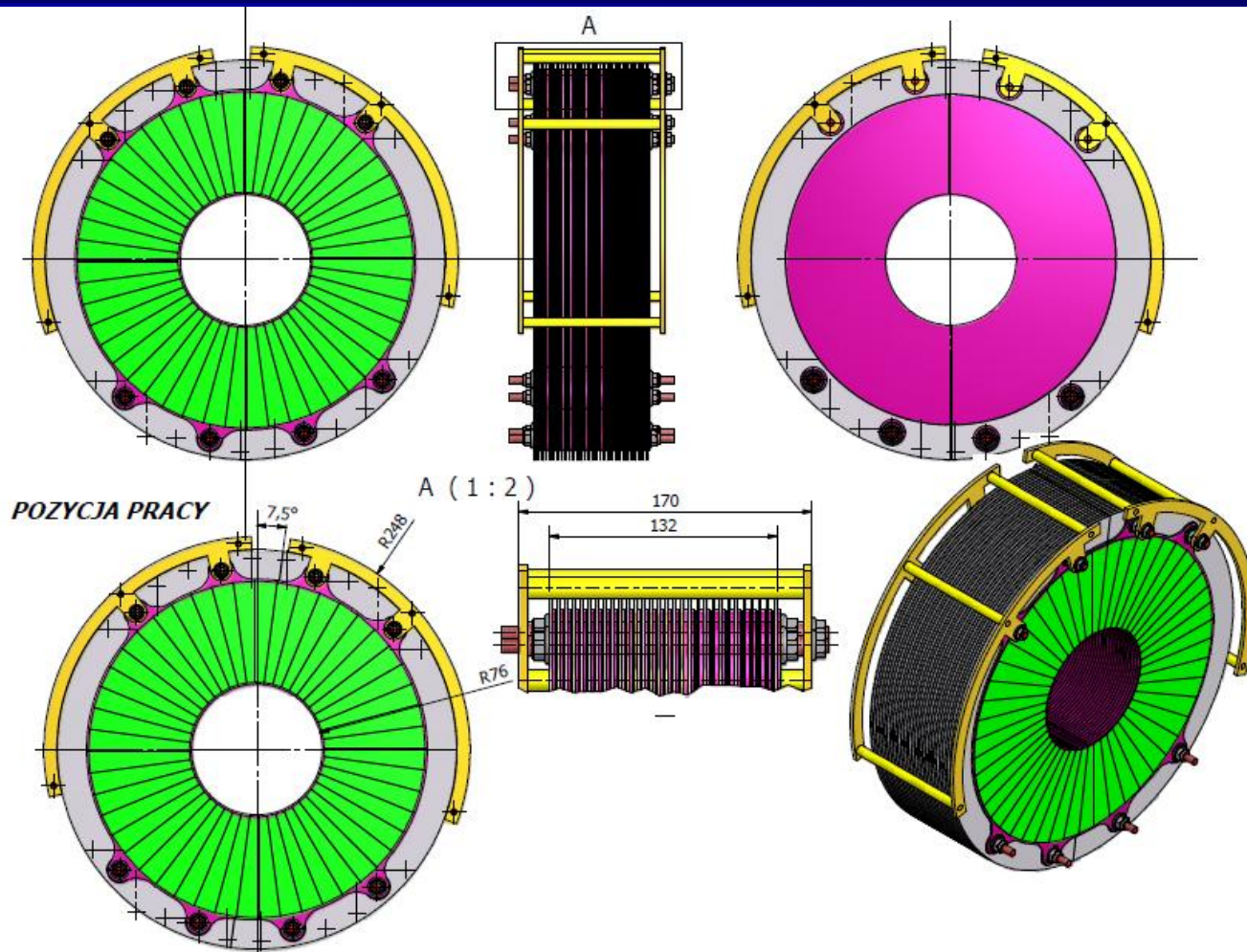
ILD requests to LumiCal

- Reduce heavy material (tungsten) in inactive zone (ring between radius from ~ 200 mm to ~ 250 mm) = step I
- Reduce the outer mechanical radius of LumiCal = step Ia
- Put the frontend electronics in the gap between absorbers = step II (?).
- Change of LumiCal fixing to the square supporting tube (in fact directly to the LHCAL).
- Initial alignment of LumiCal based on supporting tube position precision – no complicated adjustments.
- Readout cables feed out inside the supporting pipe.

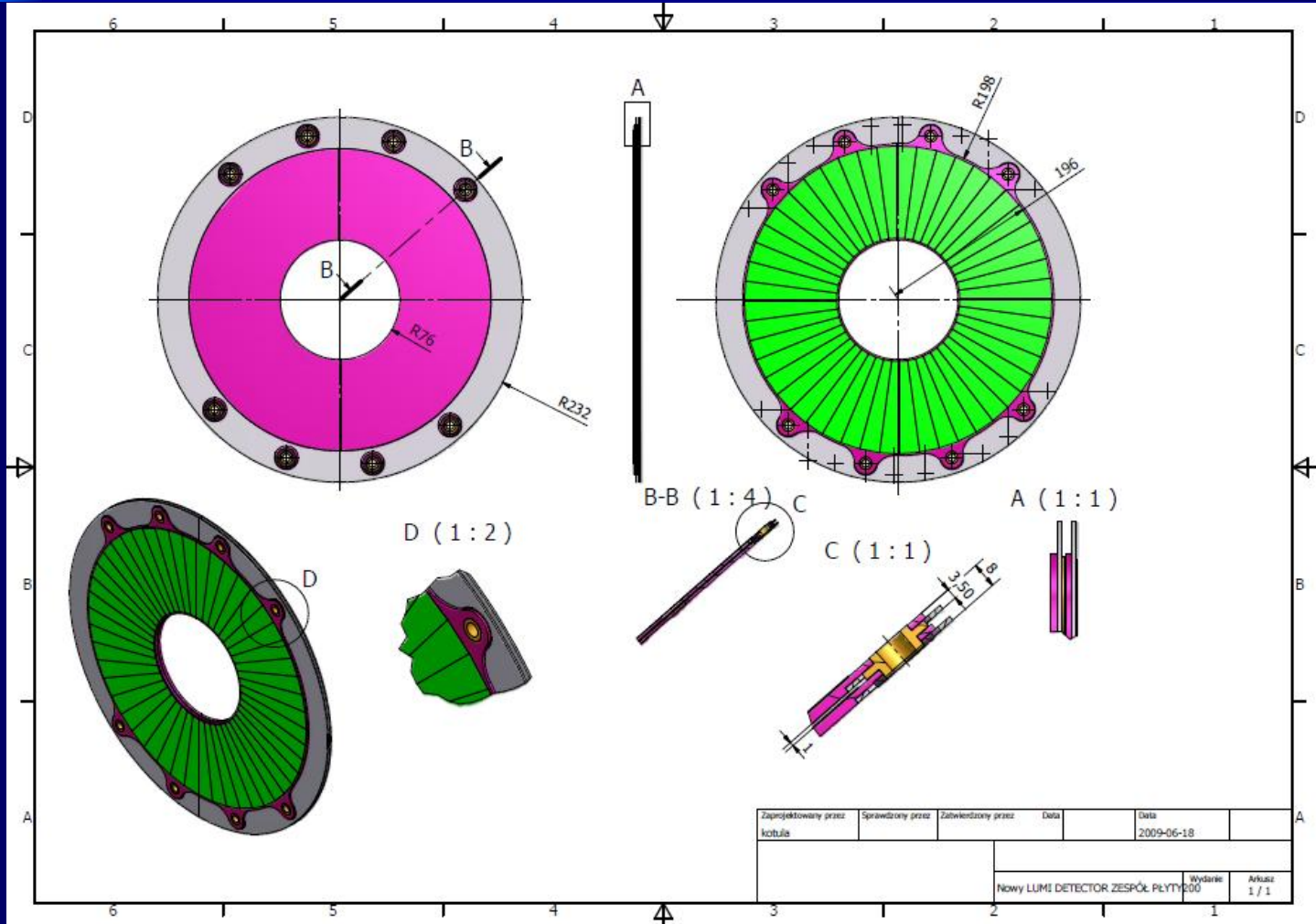
New design of LumiCal step I



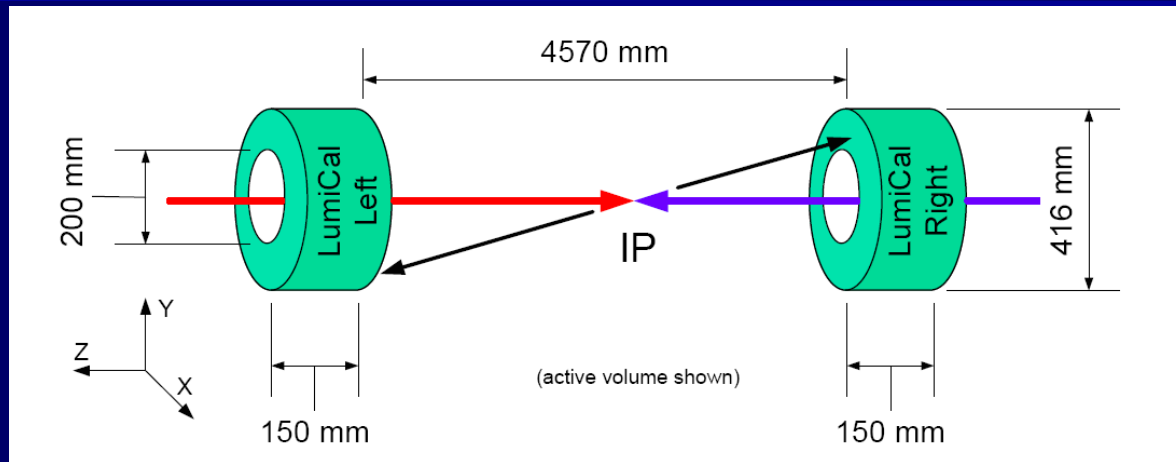
New design of LumiCal step I



New design of LumiCal step I

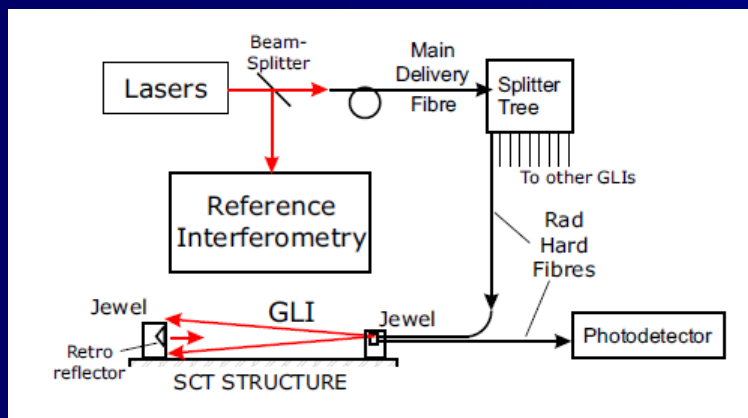
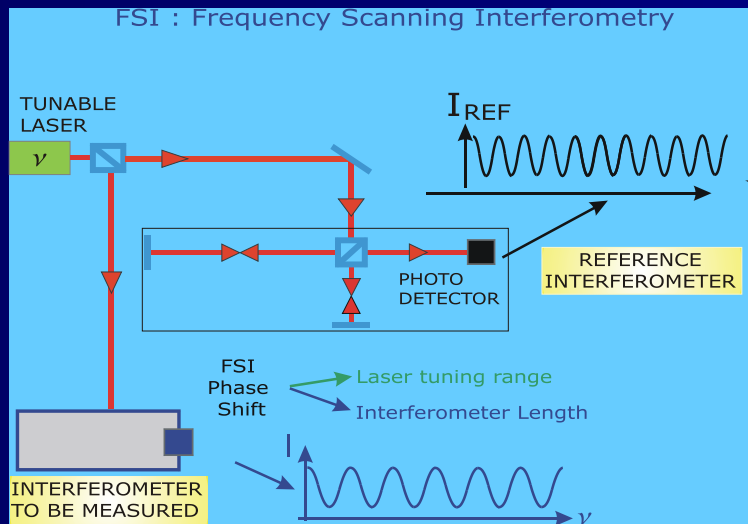


Precision LumiCal online position measurement



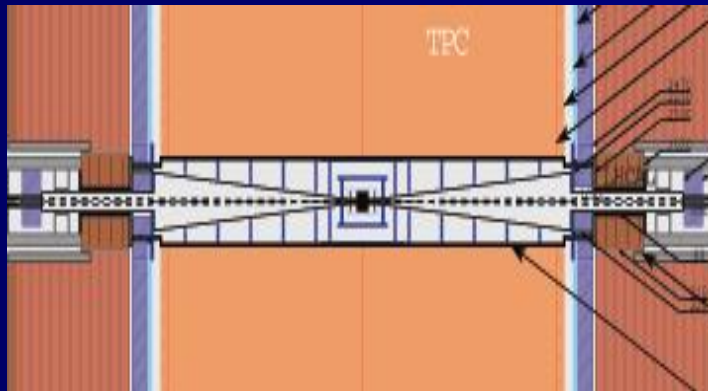
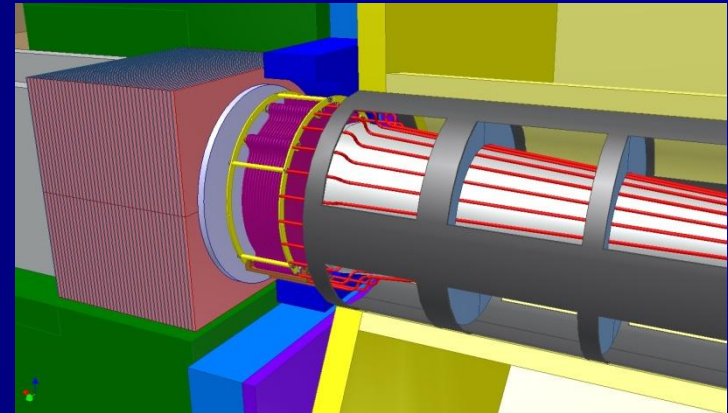
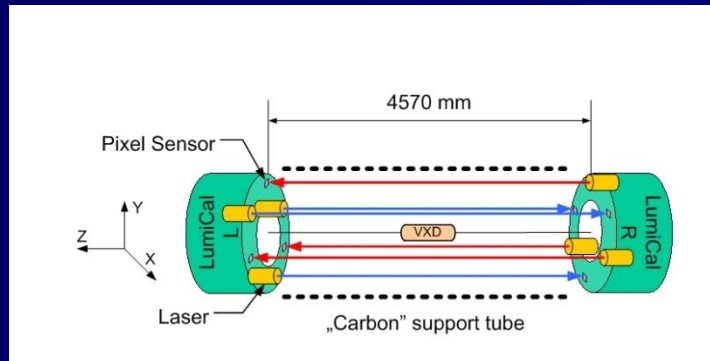
- LumiCal x , y position with respect to the beam (incoming) should be known with accuracy better than $\sim 700 \mu\text{m}$ (better $\sim 100\text{-}200 \mu\text{m}$) (LumiCal's will be centered on outgoing beam)
- Distance between two LumiCal's should be known with accuracy better than $\sim 60\text{-}100 \mu\text{m}$

Frequency Scanning Interferometry



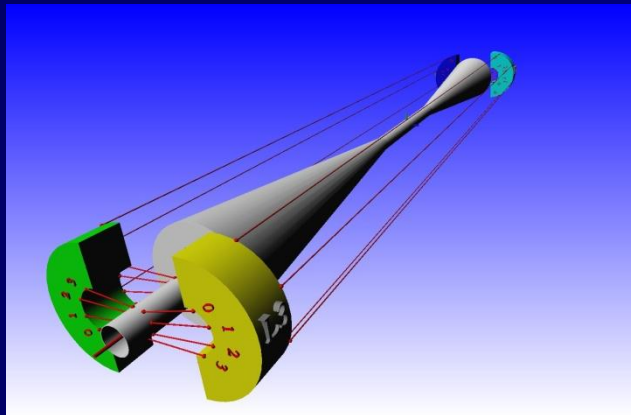
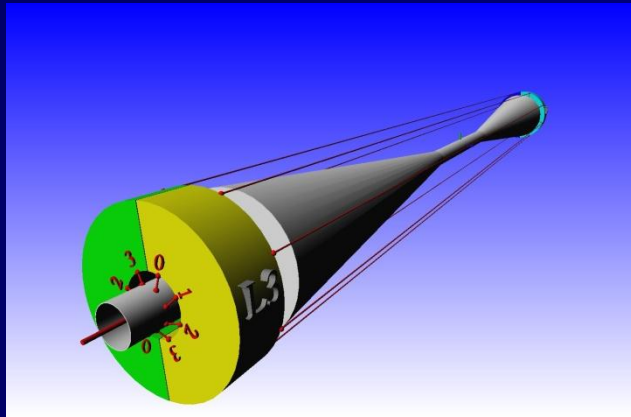
- Freq. scan ~ 12 nm@670nm (8 THz)
- Accuracy $\sim 1\mu\text{m}$ @4m (sophisticated methods $\sim 50\text{nm}$, simple methods $\sim 20\mu\text{m}$)
- Up to ~ 1000 measuring points for 1 laser (laser price $\sim 10000\text{€}$)
- Single fiber (delivery&return)
- No optics at the end of the fiber
- Retro reflector made as corner cubic pressed in to polished aluminum

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

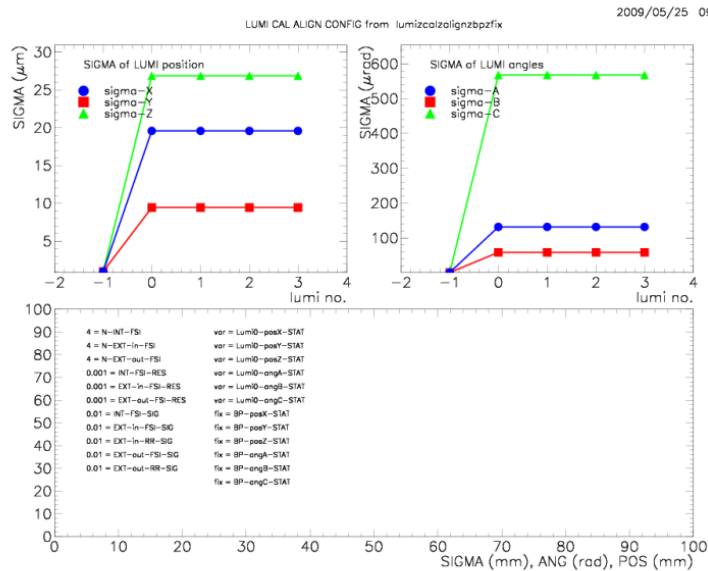
Simulation of simple FSI



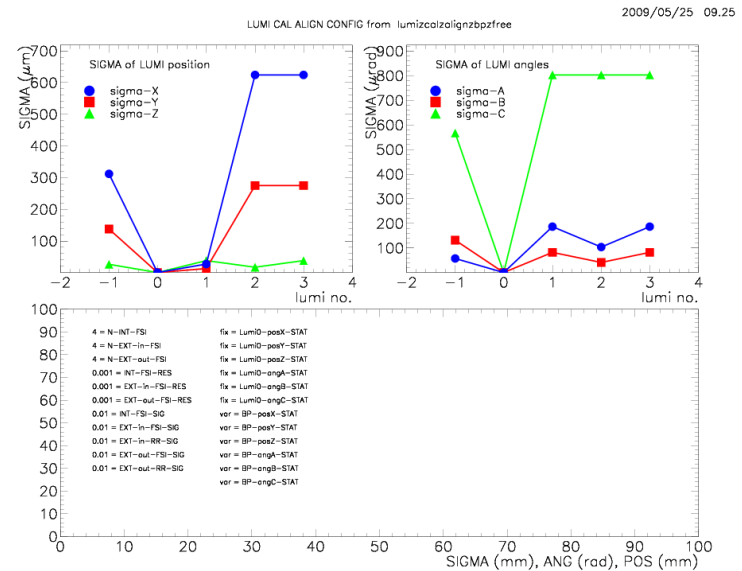
- 6 laser beams between two LumiCal's
- 8 laser beams from each LumiCal to the beam pipe for x, y measurement
- Laser beams for x, y not perpendicular to the beam pipe axis – sensitive for rotation of LumiCal
- Half barrels of LumiCal's numbered from L0 to L3

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

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

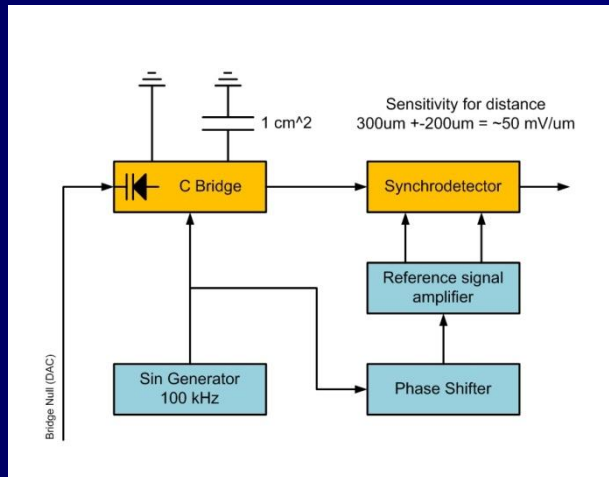
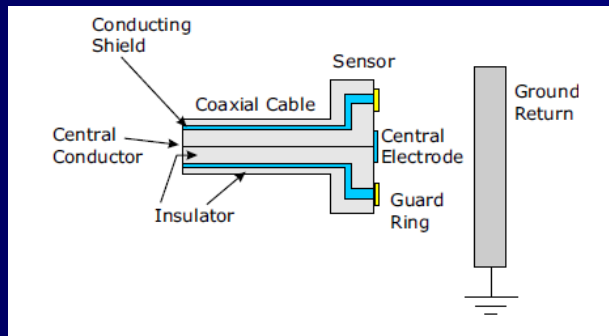
Reference points

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?

Capacitance measurement



- With test setup we can easily see distance changes smaller than 0.5 μm (thermal expansion of aluminum support).
- The long term drifts with constant setup temperature and separated sensor and electronics limited accuracy to ~2 μm.
- The results are very promising, the method is simple, sensitive, cheap and easy implemented inside LumiCal.
- We are working on miniaturization and integration of C bridge & synchrodetector directly with sensor. This will probably increase sensitivity and stability of measurement

Conclusions

- We have started with new design of LumiCal. Now we are concentrated on the version I (reduced radius of tungsten). Next step will be try to reduce the outer radius (version Ia). The idea to put front end electronics in to the gap between tungsten absorbers has to be investigated carefully. Major problems seems to be cooling and increasing the gap between layers.
- 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).
- 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 and increasing generator frequency (= higher sensitivity) are next steps.