AIDA

Advanced European Infrastructures for Detectors at Accelerators

Presentation

Laser alignment system – current status report, 22th FCAL Collaboration Workshop

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29 April 2013

The research leading to these results has received funding from the European Commission under the FP7 Research Infrastructures project AIDA, grant agreement no. 262025.

This work is part of AIDA Work Package **9: Advanced infrastructures for detector R&D**.

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Laser Alignment System

for LumiCal and BeamCal

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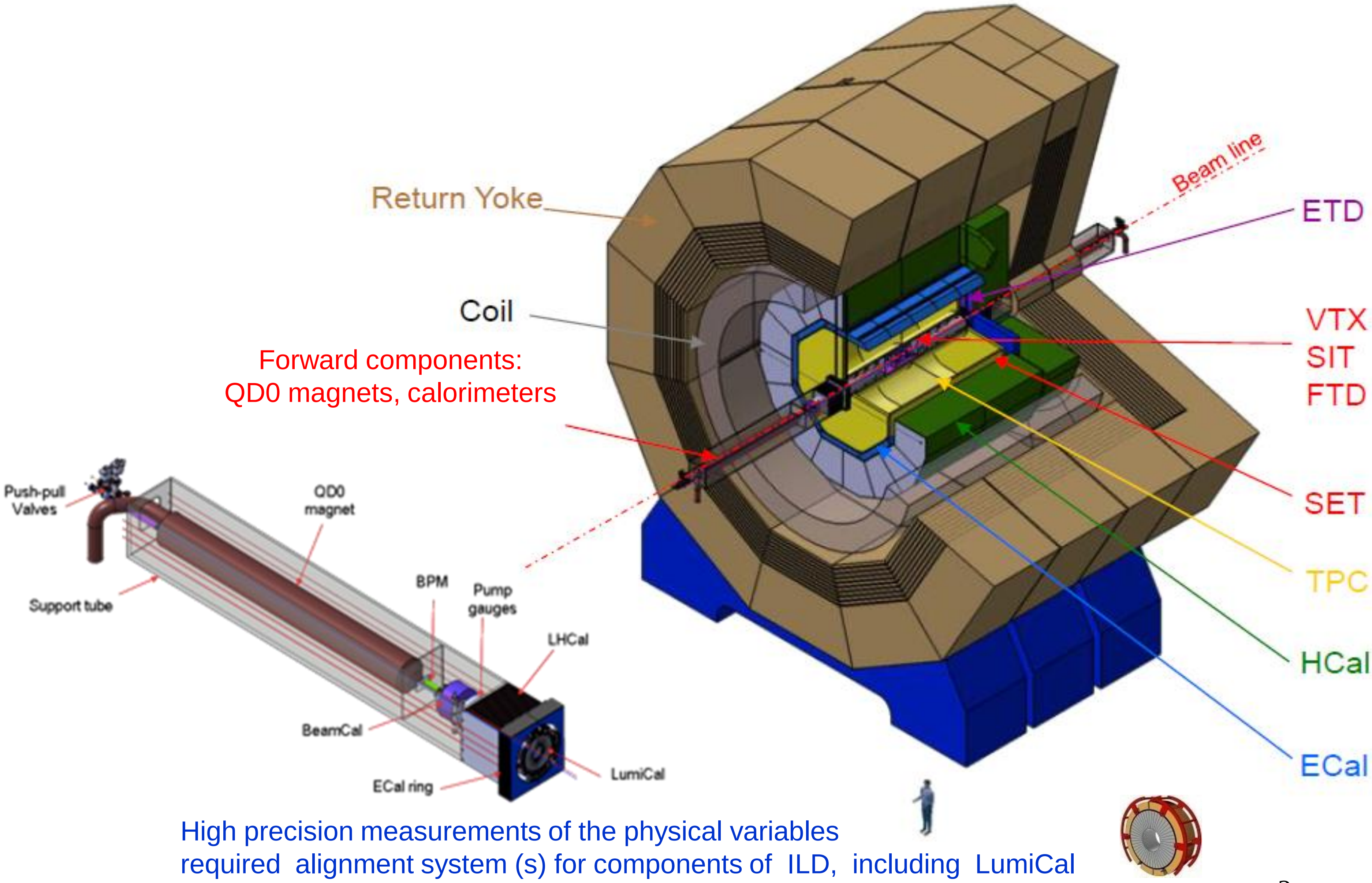
22nd FCAL Workshop, 29-30.04.2013, Cracow

ILD : International Large Detector

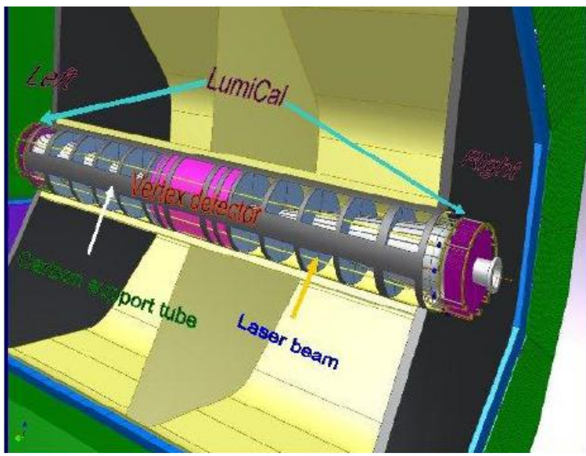


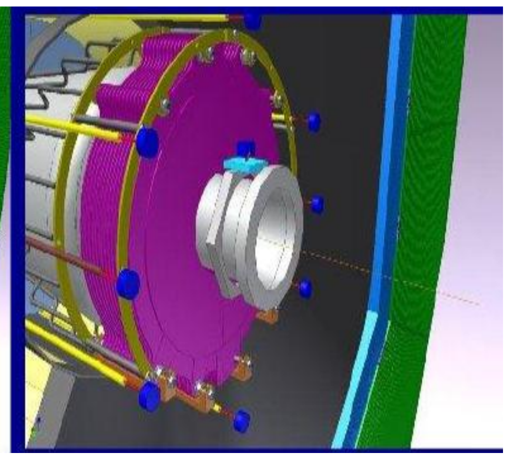
High precision measurements of the physical variables
required alignment system (s) for components of ILD, including LumiCal

LumiCal alignment

High accuracy in luminosity measurements at ILC/CLIC ($\Delta L/L \sim 10^{-3} / 10^{-2}$) require precisely measurement of the luminosity detector displacements:
less than 500 μm in X,Y directions , 100 μm in Z direction and
a few microns for internal silicon sensor layers

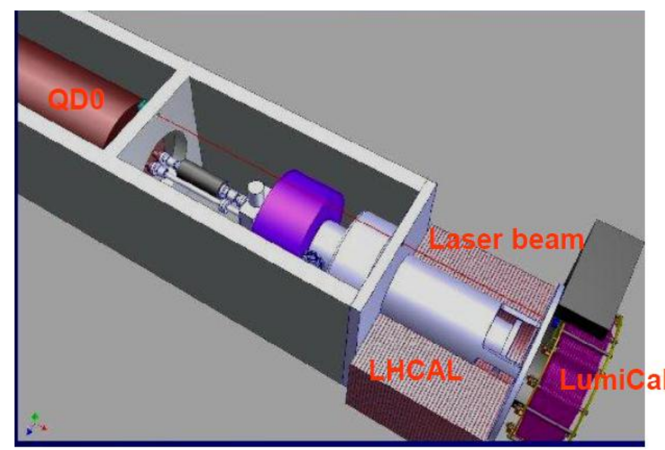
Mechanical aspect of LumiCal alignment





Good reference points for position measurement of LumiCal can be:

- QD0 magnet
- Beam Position Monitors
- also beam pipe

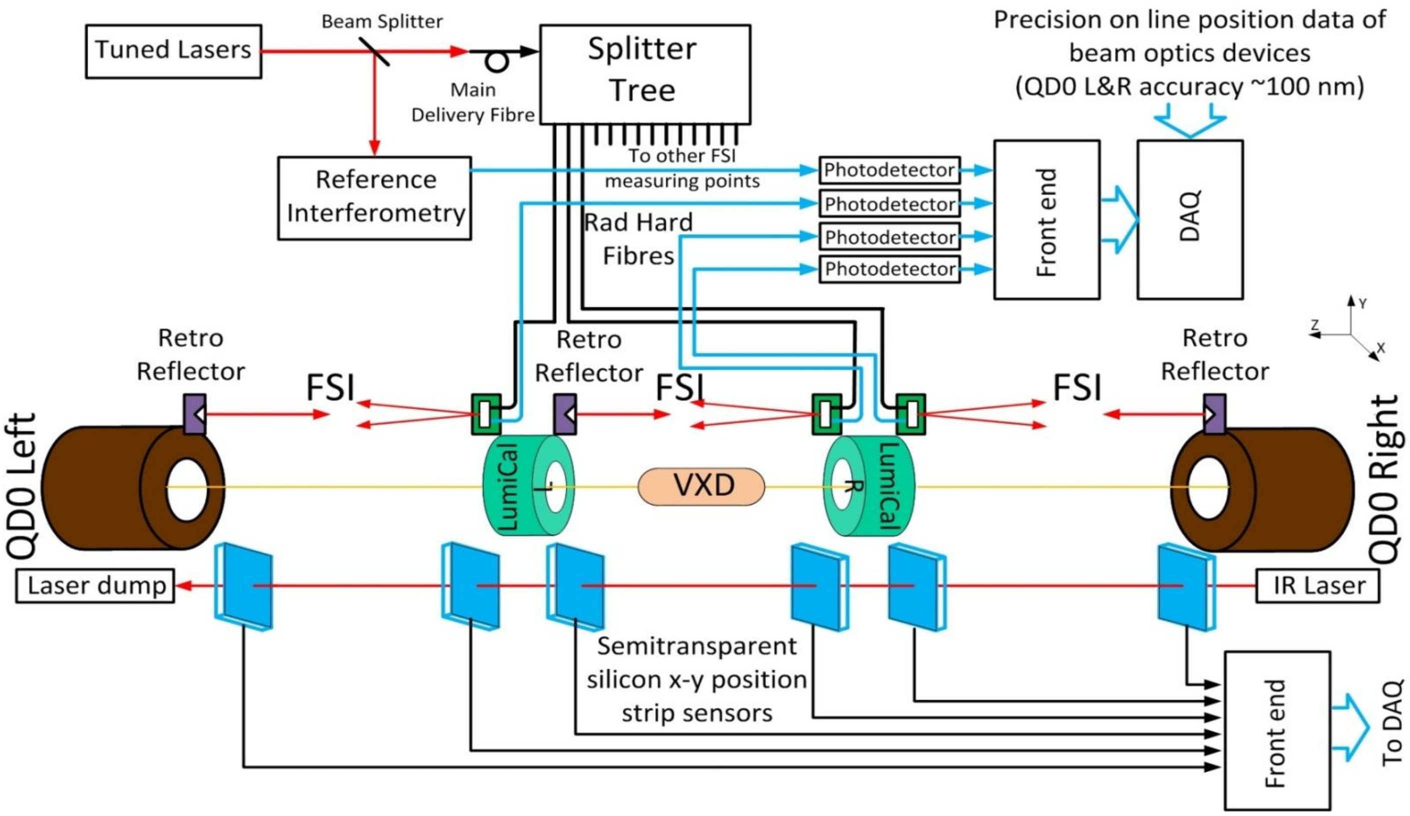


The measurements of absolute distance between Left and Right LumiCal calorimeters

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

The design of the LAS system

The laser alignmet system will contain the main components:
- infra-red laser beam and semi-transparent position sensitive detectors (PSDs)
- tunable laser(s) working within Frequency Scanning Interferometry (FSI) system

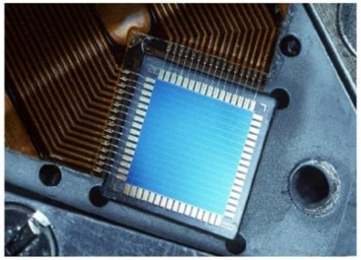


FSI – will be used for measurements of the absolute distance between LumiCal calorimeters by measurement of interferometer optical path differences using tunable lasers (by counting the frenges

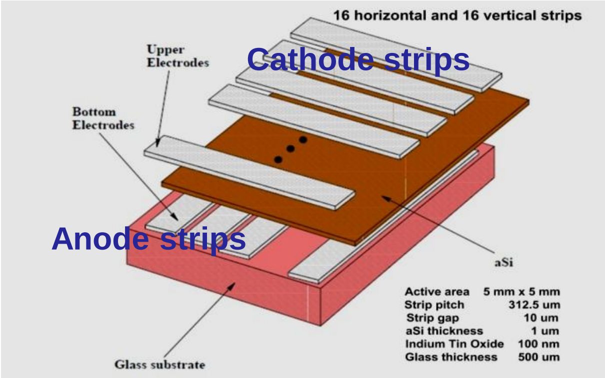
Semi-transparent sensors : LumiCal displacements of the internal Si layers and detectors relative positions

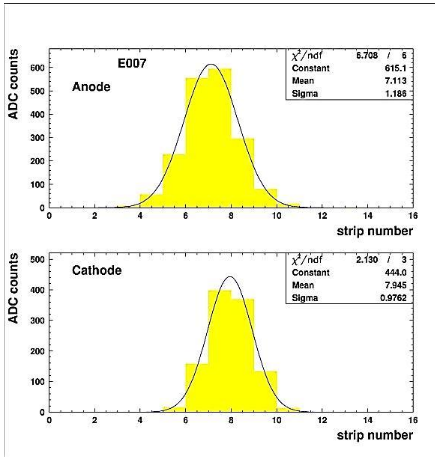
A roughly estimation of the size of LAS output data is on the level of hundred kB/s and they will be included into LumiCal DAQ system

Semi-transparent sensors (PSD)

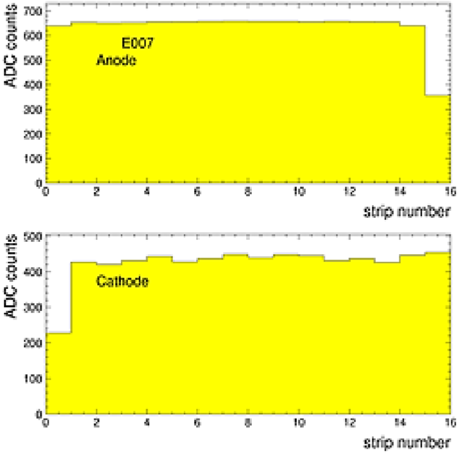


Semi - transparent amorphous silicon strip sensors , DPSD-516 - using laser with wavelength above ~ 780 nm, received from Oxford University,
High precision (ZEUS MVD)
position measurements in two coordinates X / Y : ~10 μm

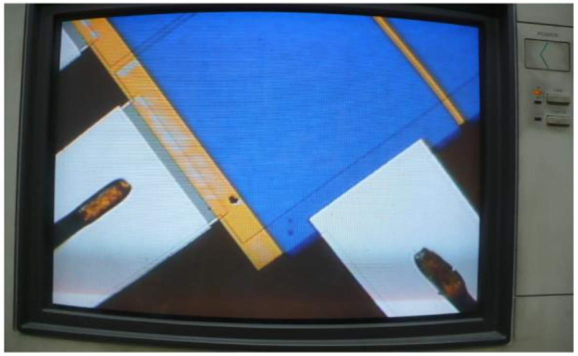




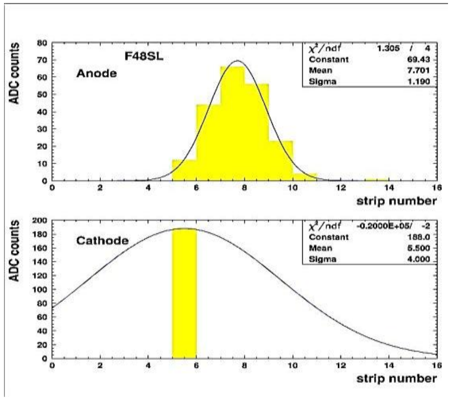
Proper shape of signals distributions from cathode and anode strips



Quality testing of the sensors: microscope, probe station, and laser beam



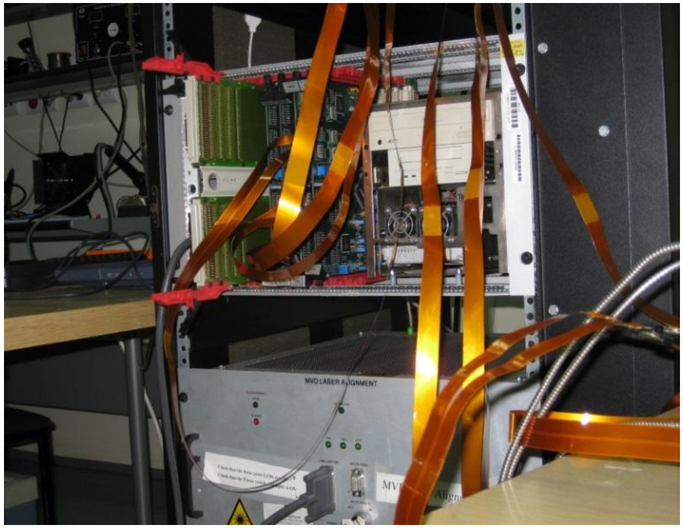
Problem with some of the sensors: no signals from X or Y strips



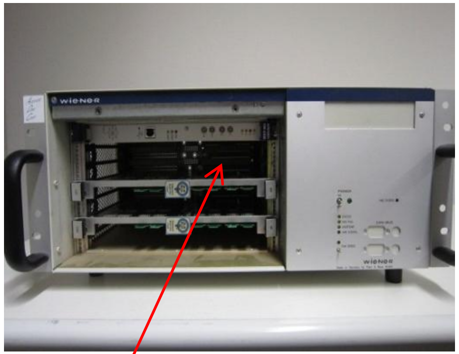
9 high-quality sensors were selected and they will be used to construct a prototype of the positioning system in laboratory

Towards the laboratory prototype

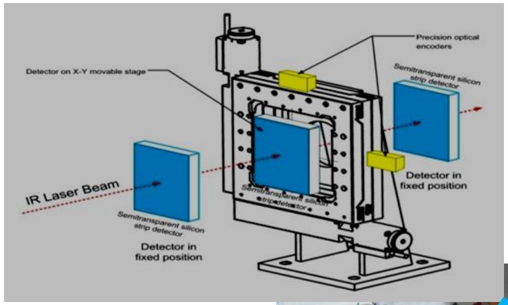
VME : launch of the system LynxOS
to read data from sensors



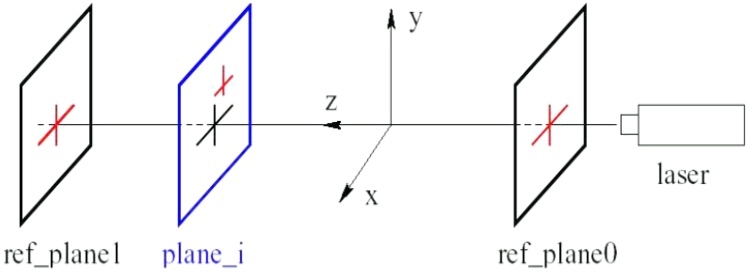
or use a Wiener crate



VM-USB VME controller
with USB2 interface:
To read directly data
from cards and for
integration with DAQ system



LAB - system prototype with optical movable table 2D
Studies on the behaviour of the sensors, laser beam and calculation of the prototype displacements in ref. frame - actual accuracy.

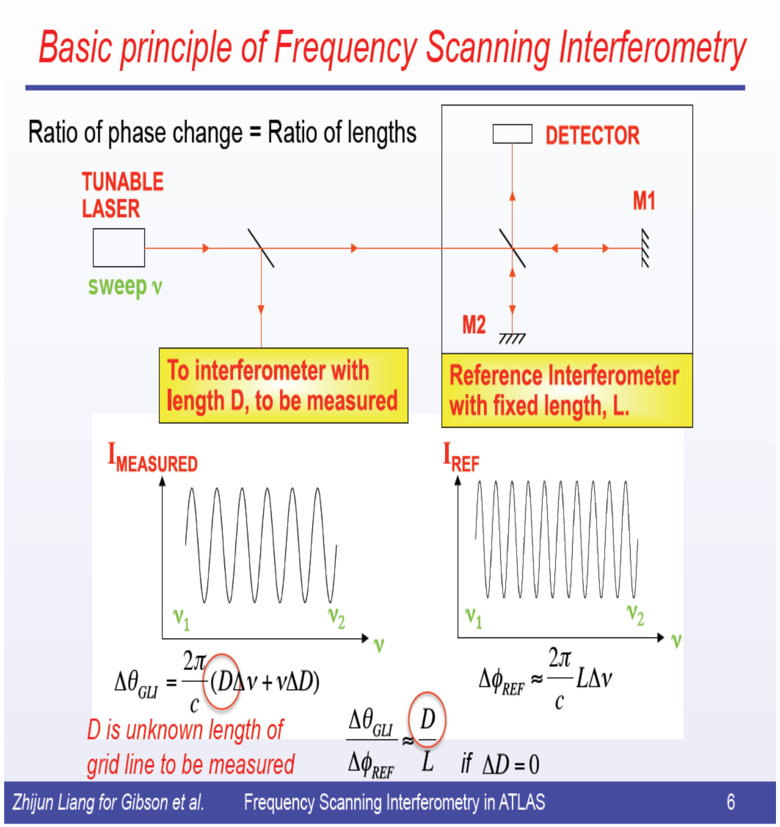


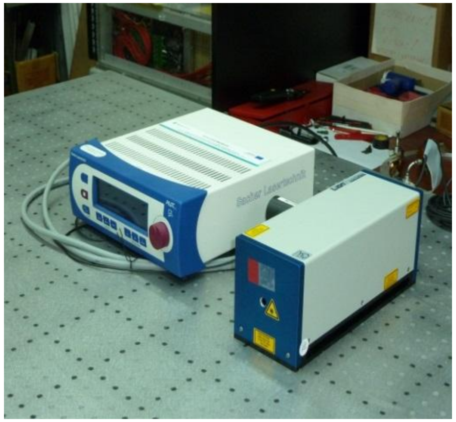
Roughly position calculations – mean values: mx, my

$mx = \Sigma_i \; x_i w_i$, $my = \Sigma_i \, y_i w_i$
with $w_i = I_i / \Sigma \, I_i$ $i = 1 \ldots N$
x_i, y_i - strip positions,
I_i - strip signals

Alignment system based on Frequency Scanning Interferometry

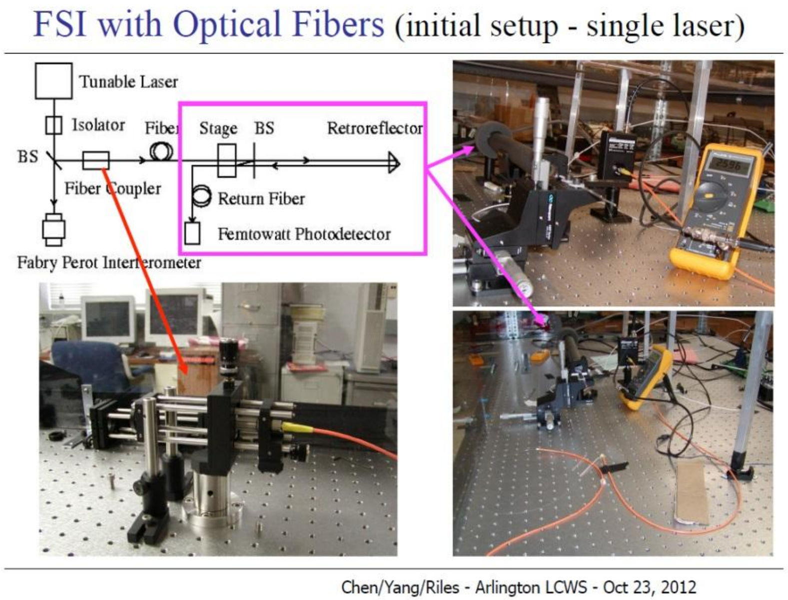
FSI technique enables remote, multiple, simultaneous and precide distance measurements.
It uses tunable lasers for measurement of interferometer optical path differences and provides an absolute distance measurements





The first step :
the tunable laser was purchased to laboratory
power 10mW
wavelength range:
663 – 678 nm

Next step : build in laboratory FSI system prototype (similar to that used for SiD (ATLAS concept)



Summary

- Accuracy of X, Y position measurement using semi-transparent strip sensors can reach ~10 µm
- The readout electronics can be placed outside ILD, but log cables decreases accuracy and consume space
- FSI looks very promising – used in many HEP experiments
- Accuracy of very simple FSI absolute distance measurement in air can reach ~10-20 µm in X, Y and ~30 µm for Z
- More sophisticated FSI methods can give ~100 nm (or better) accuracy
- FSI equipment (Tunable Laser - ~10k€, Controller ~5k€, Optics/FO etc. – ~100€/measuring point) is expensive for low amount of measuring points.
- The FSI laser beam can be splitted up to ~1000 measuring points.