Cracow EUDET:

INP PAS , AGH-UST
(and UJ)

LumiCal - Status and Plans

- LumiCal Monte Carlo Simulation
- First test module
- Second test module and prototype
- Detector alignment

PEOPLE

Physicists, engineers and students
now participated in the project or which join it (temporary) in future

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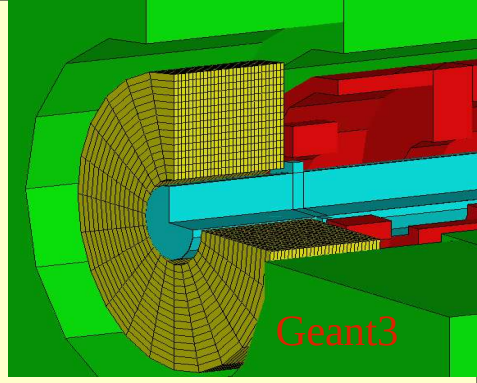
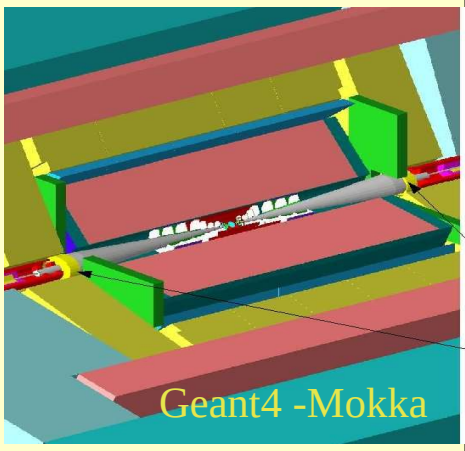
MC Simulation



Simulation of the W/Si LumiCal version with the strip sensors:

(Geant3/Geant4 - Barbi /Mokka)

- for required accuracy in luminosity calculation (Bhabha process - BHLUMI)
  - optimization of the calorimeter internal structure
  - with respect to the shape of the sensors,
  - number of layers and
  - number of electronics readout channels
  - uncertainties in theoretical calculations – help from Cracow theorists



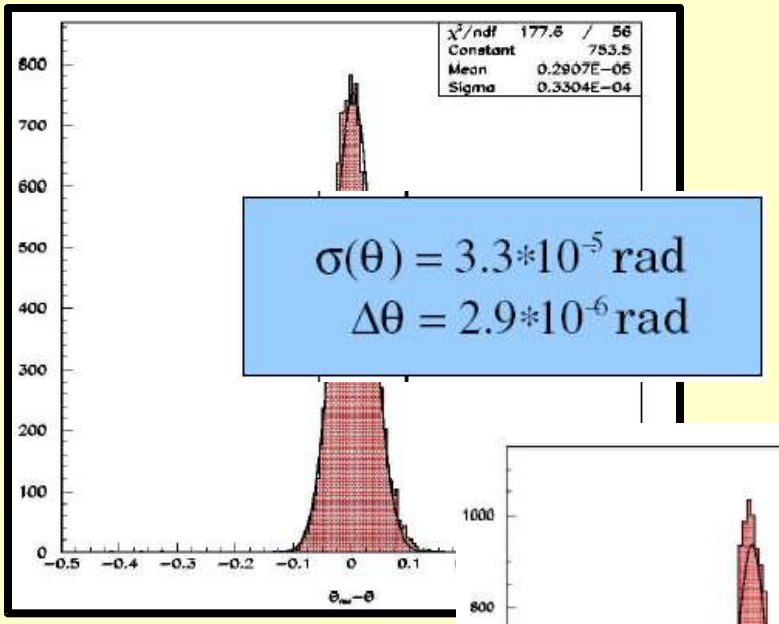
- give input for electronics FE design

- estimate the influence of the expected in LumiCal background
  - (beamstrahlung (Guinea-Pig), other than Bhabha processes like two-photon int.
  - (Vermasseren generator, KoralW)
  - on angles (energy) reconstruction

- estimate the systematic effects in luminosity calculation
  - coming from position uncertainties of the calorimeter, Si-sensors inside calorimeter and possible changes its internal structure according to temperature or/and gravitation.

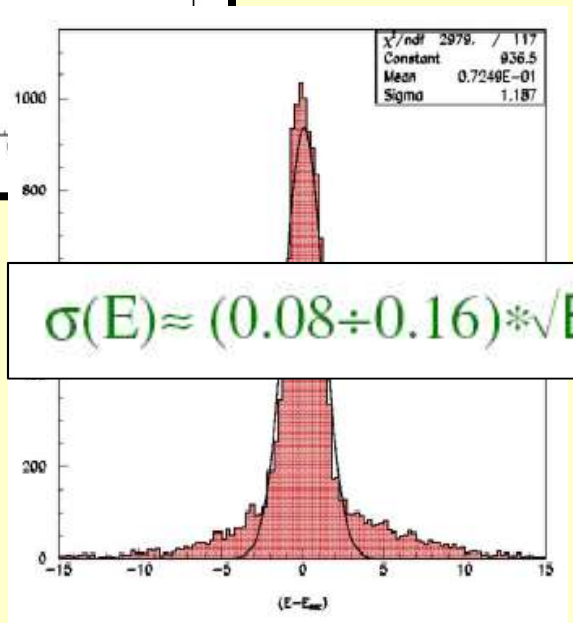
LumiCal - the strip version of sensors

each second layer



$\sigma(\theta) = 3.3*10^{-5}$ rad

$\Delta\theta = 2.9*10^{-6}$ rad

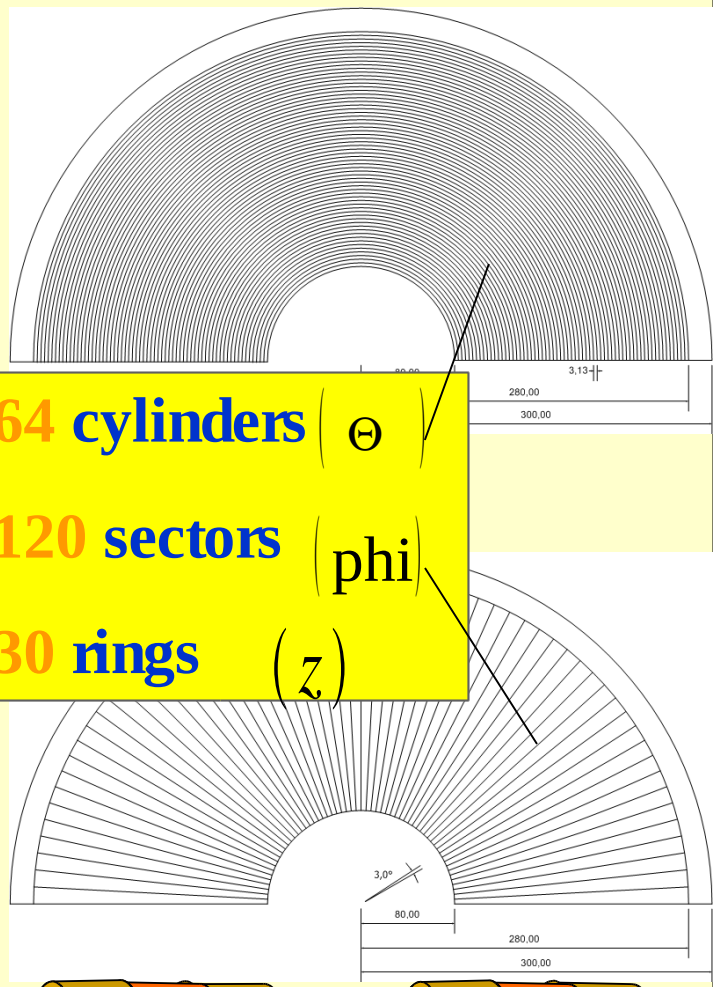


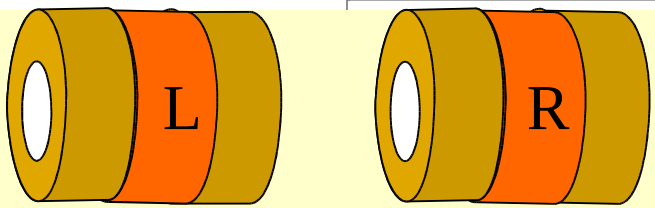
$\sigma(E) \approx (0.08 \div 0.16)*\sqrt{E}$

64 cylinders (Θ)

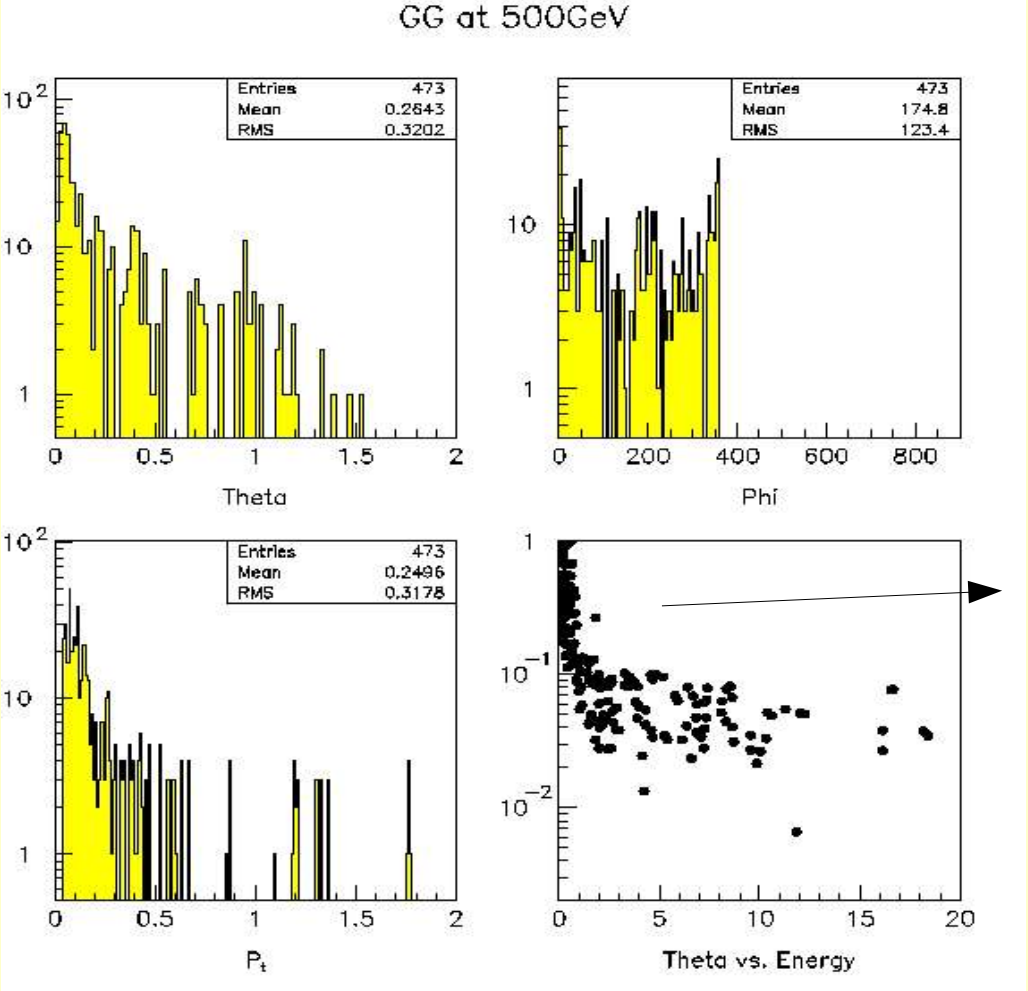
120 sectors (phi)

30 rings (z)





MC example : gamma – gamma -> e+e-



gamma-gamma -> e+e-

Total rate = $2.8*10^{-3}$/b.cr.

Mean energy E_{inc} = 0.9 GeV

Rate(E_{inc}>150GeV) =~$6*10^{-5}$/b.cr.

(MC statistics is small – only ~10 particles >150GeV)

Comparable (?) to Bhabha rate = ~$6* 10^{-5}$/b.cr.

- under study

Low energy particles

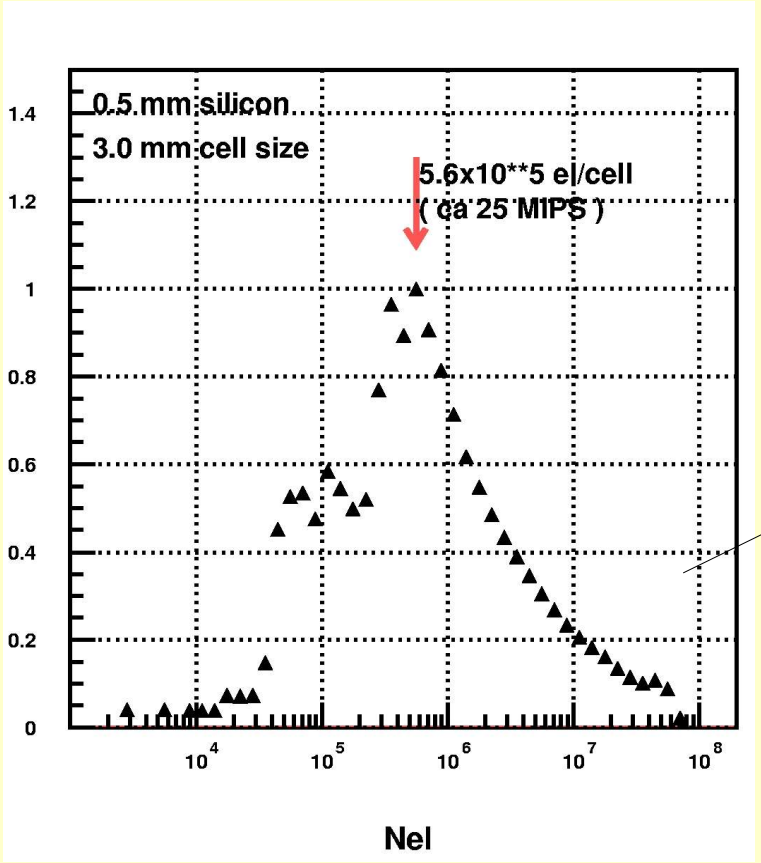
emitted at large angles

hit LumiCal

MC example : shower in calorimeter

number of electrons in shower

250 GeV electrons



How much mips on ADC channel ?

noise from electronics ~ 1000-2000 electrons

signal/noise > 500

> 400 mips

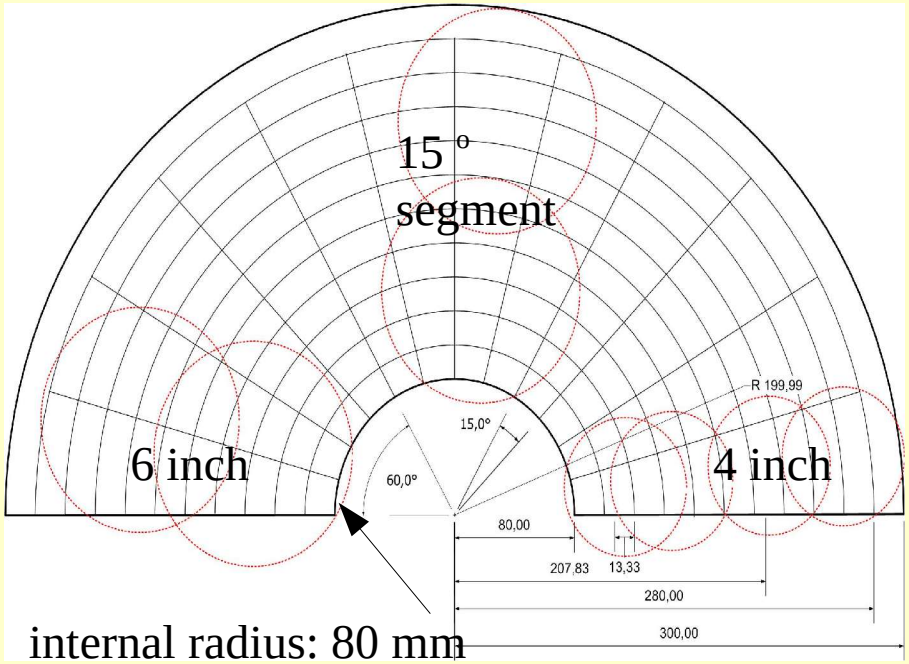
with 10 bits ADC > 0.4 mip/ADC (resolution)

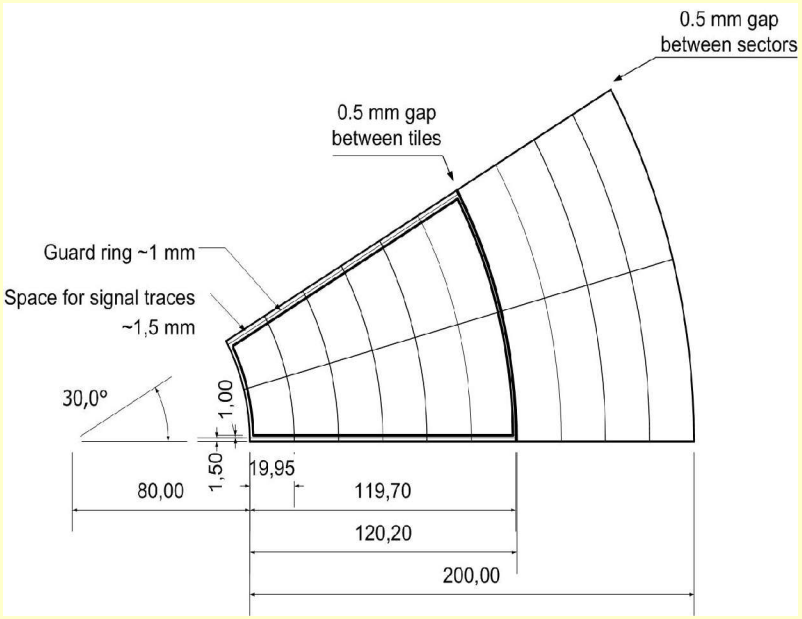
Two LumiCal versions : pads and strips

Parameter	Pad Performance	Strip Performance
Energy resolution	25% $(\sqrt{GeV})$	8:16% $(\sqrt{GeV})$
resolution	$3.5 * 10^{-5}$ rad	$3.3 * 10^{-5}$ rad
phi resolution	10^{-2} rad	10^{-3} rad
bias (gen-rec) $\Delta\Theta$	~ $1.5 * 10^{-6}$ rad	~$2.9* 10^{-6}$ rad
Electronics channels	25,200	3720 (with bonding sectors) 13,320 (without bonding)

Possible to get accuracy in luminosity: $\Delta L / L \sim 10^{-4}$

Calorimeter structure : Si-sensor wafers



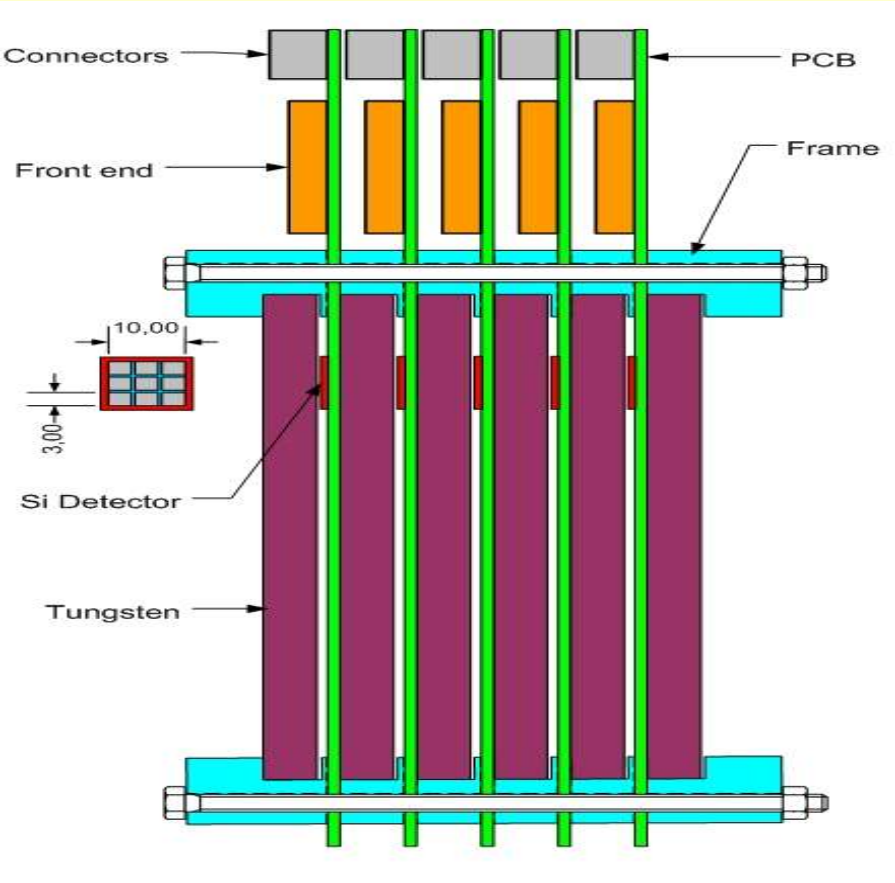


possible structure for
different silicon wafers

reduction of the active area of Si-sensors - guardring

First test module

- small prototype using sensors from Prague
  (3 x 3 mm^2) and tungsten 2 X_0 : (5 – 6) layers
- bonding Cracow (Zeuthen?)
- mechanical design – steel / aluminium frame
- readout - one channel preamplifier (Minsk) :
  about (50 – 60) readout channels
- test beam – DESY: electrons (1-5) GeV



Possible cost : ~ (2-3) k EU (preamplifiers)

The second test module

Design for sensor mask :

intensive MC studies : preparation of the specifications for sensors.
Where : Prague, Minsk, Dubna ... others.
How many versions?

Purchase of the tungsten : (for the dedicated shape)

The sensor quality measurements :

Cracow - purchase of the equipment for LAB complete - probe card, switching matrix

FE electronics design : chip - two iteractions to get the final version ?

DAQ design

water cooling option

plan for temporary employment : electronics, engineers, technicians, students

Possible cost: (10-12) k EU, (mask)
(4 – 6) k EU ? tungsten
(5 -8) k EU , probe card + switching matrix
> 10 k EU , chip
> 10 k EU , temporary employment
and more if other design for mask, chip

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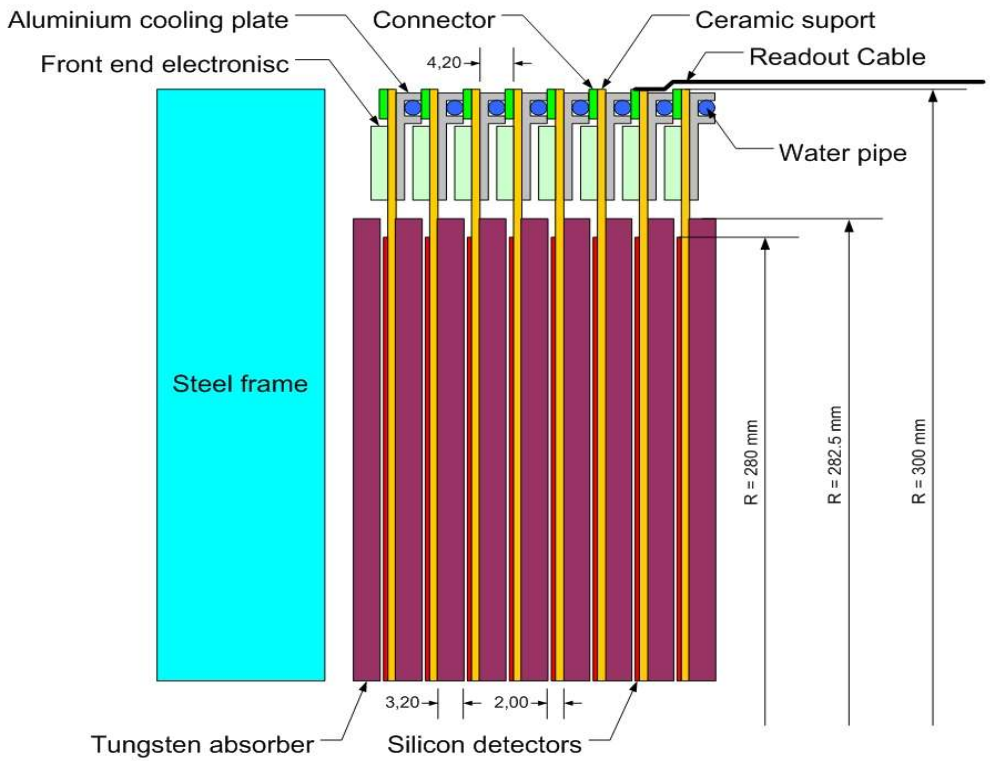
collaboration with

DESY Zeuthen
Tel Aviv
Prague
Minsk
Dubna

LumiCal prototype - one possibility

Very preliminary design



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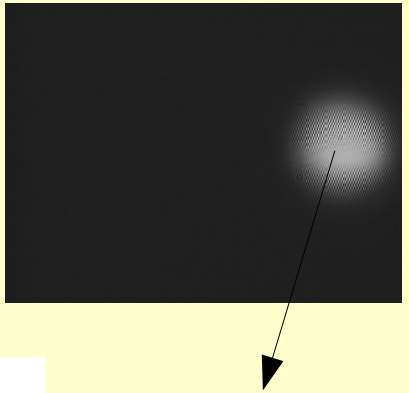
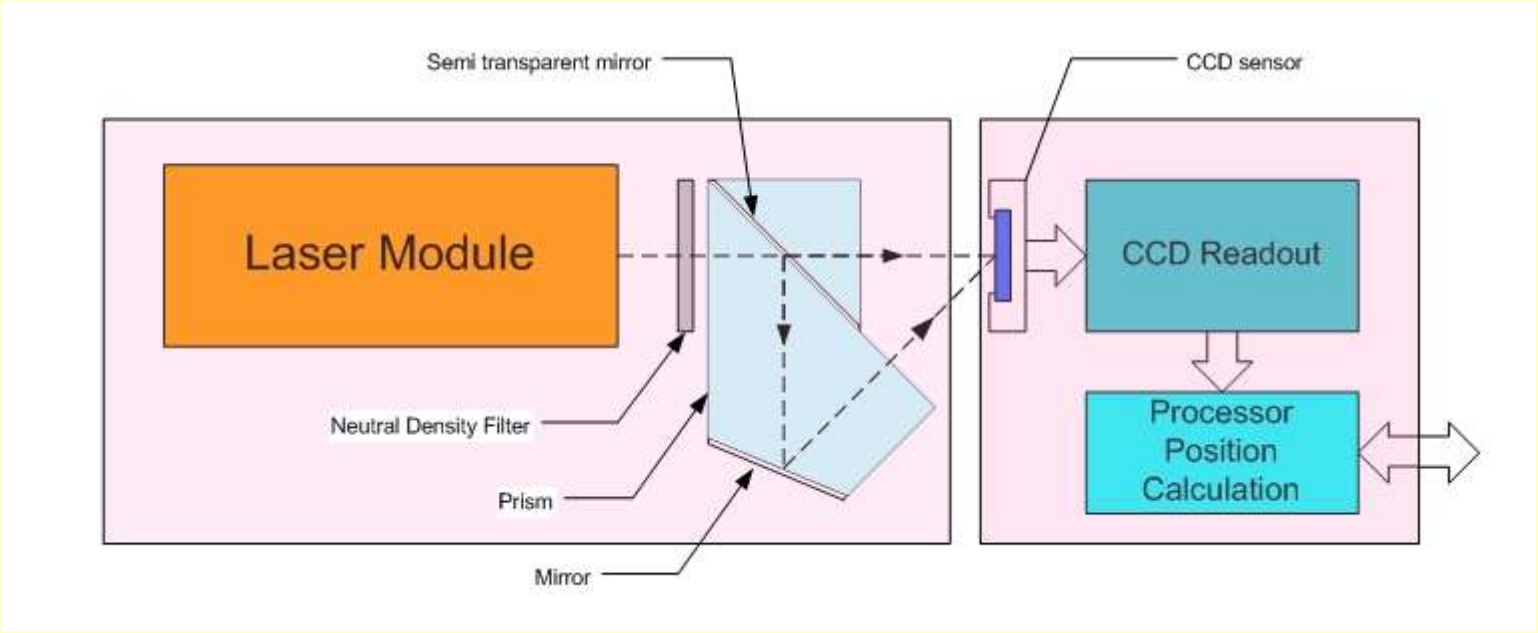
Alignment – position measurements



laser beam spot on CCD camera

Status: measurements of the XYZ "detector" displacement



Measurements of the laser beam spot on CCD sensor (camera – 640x480 pixels), precisely translations with micrometers using movable table,
accuracy ~ 1 micrometer for center of the beam spot measurements with accuracy 0.1 pixel

Alignment

Next step towards the prototype : more additional studies

- include some additional equipment,
- new version of the reconstruction algorithm

Possible cost : (0.3 -0.5) k EU , red laser with laser beam collimation,
~ 1.5 k EU, system for independent position measurement (RENISHAW), 20 micrometer RGH24 readheads with optical linear and PC card,
~ 2 k EU, temporary employment

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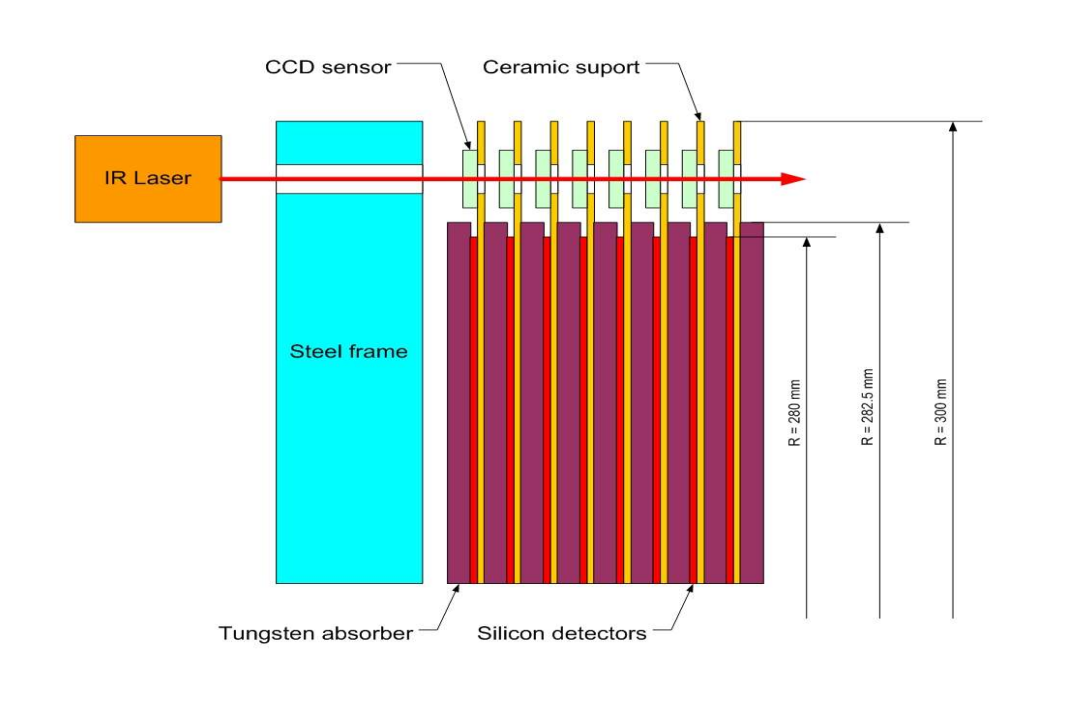
Sensors alignment

measurements of the laser beam spot on the following CCD sensors



Posible cost: ~ 2 k EU , CCD sensors (like in CCD camera) and readout electronics
- test for transparency of the sensors for laser light (red or IR) ,
~ 3 k EU , temporary employment