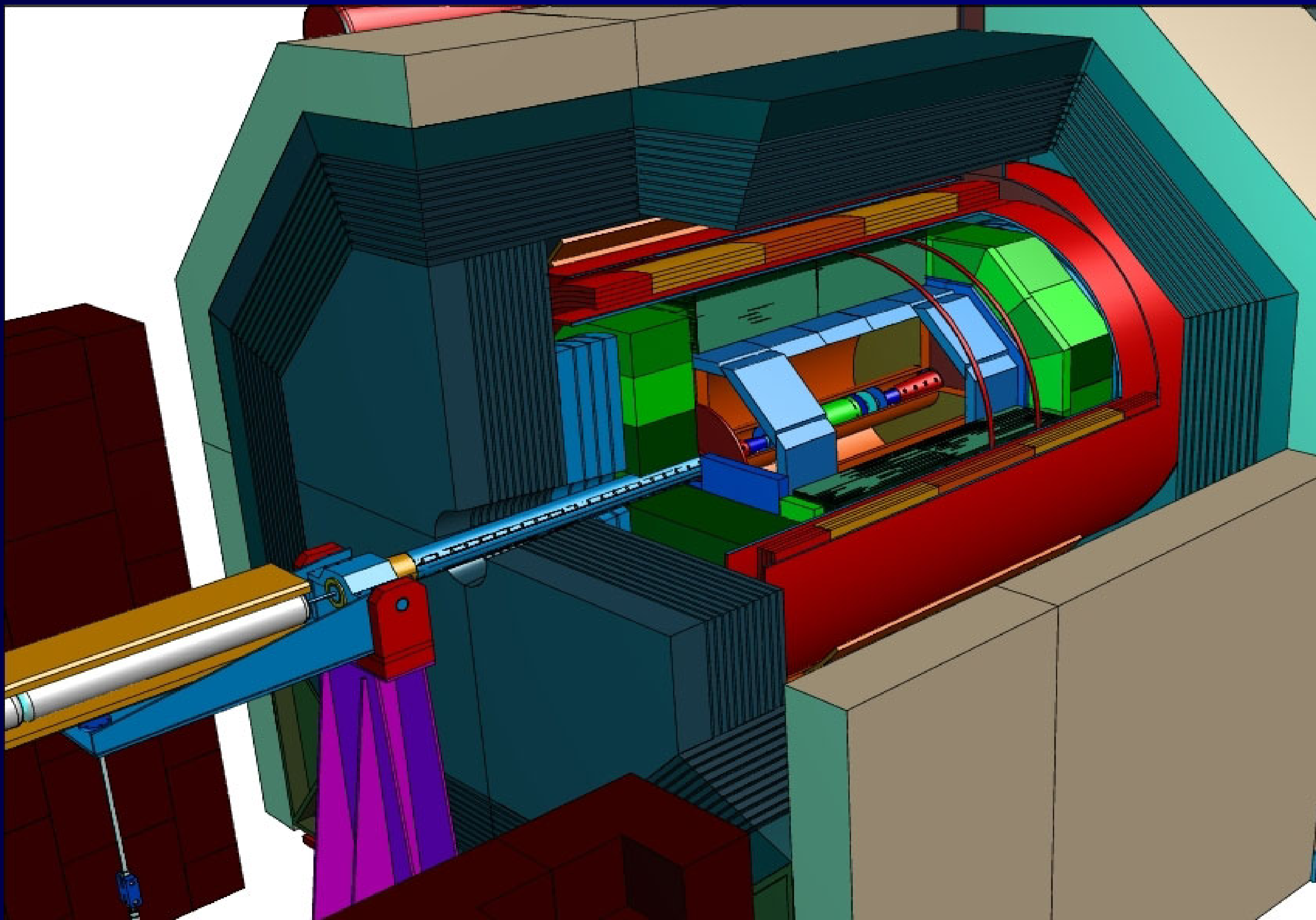
TESLA R&D: Forward Region



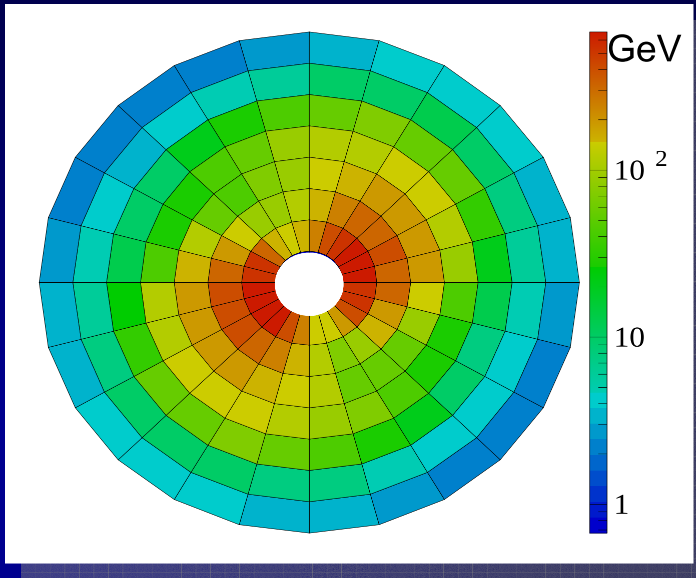
Cracow
Tel Aviv
Minsk
Prague
Colorado
Protvino
UC London
Dubna

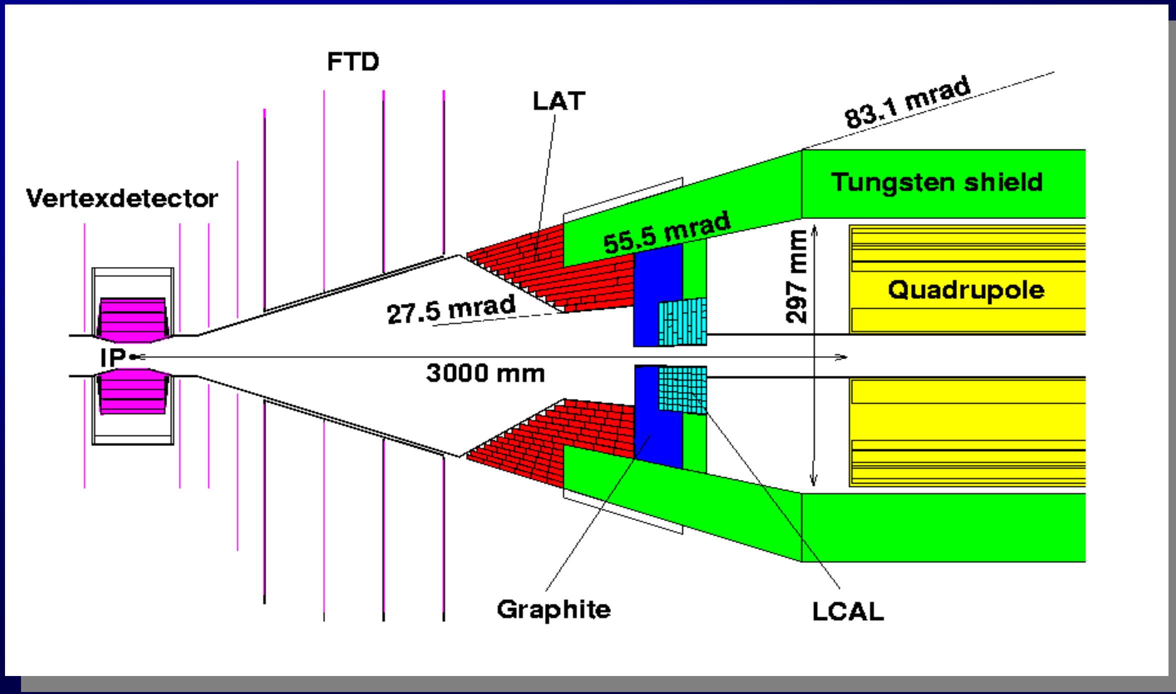
Achim Stahl

DESY Zeuthen

The Forward Region

- maximum hermiticity
- precision luminosity
- shield tracking volumne
- monitor beamstrahlung

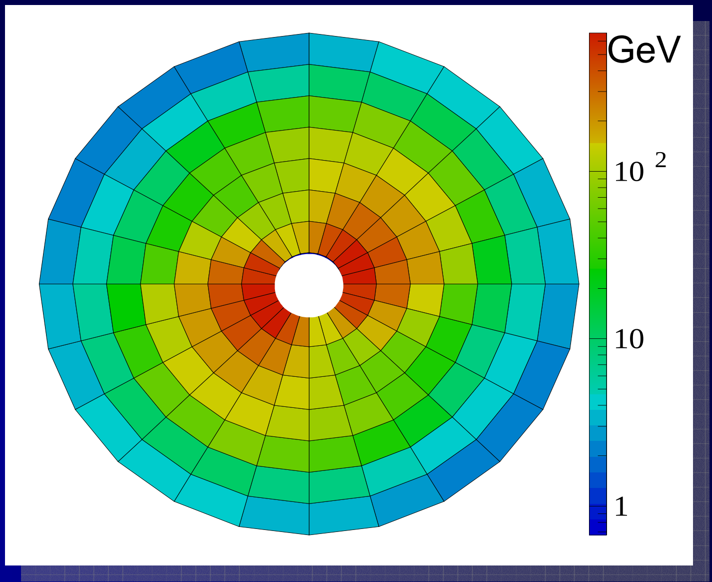




TDR design

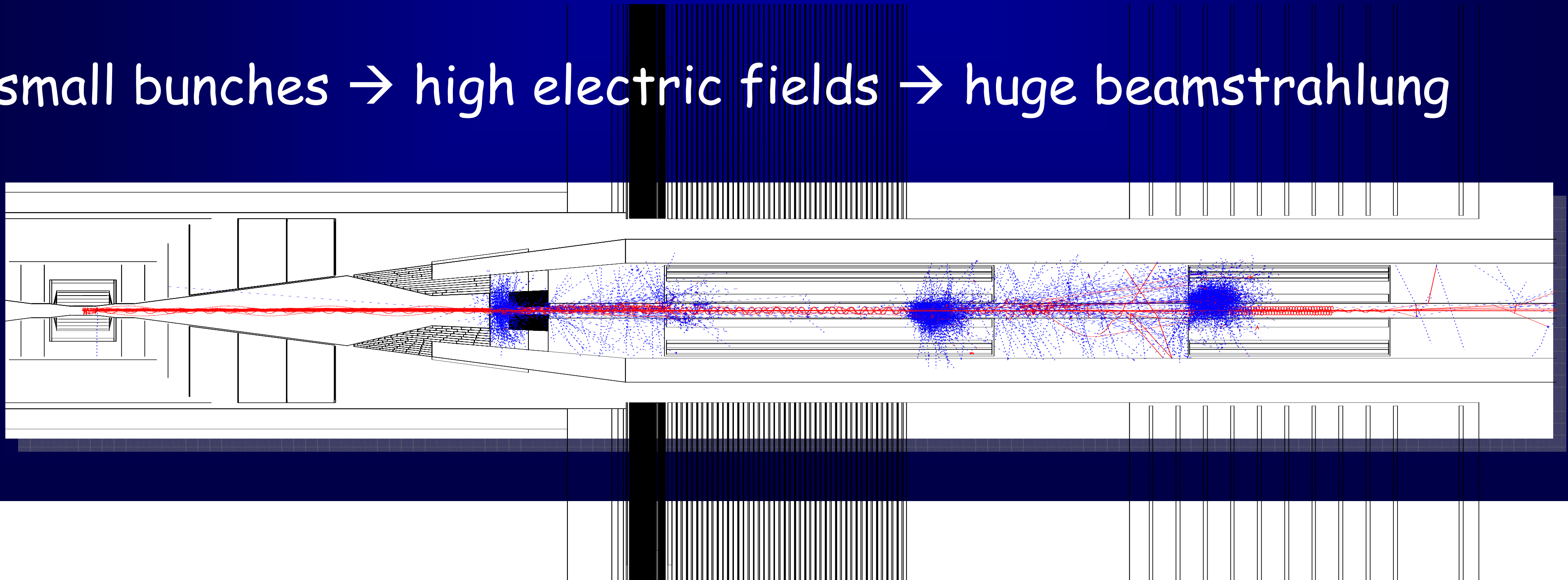
The Forward Region

- maximum hermiticity
- precision luminosity
- monitor beamstrahlung
- shield tracking volumne



≈ 20 TeV per side

small bunches → high electric fields → huge beamstrahlung



Proposal: 2-Year R&D Program

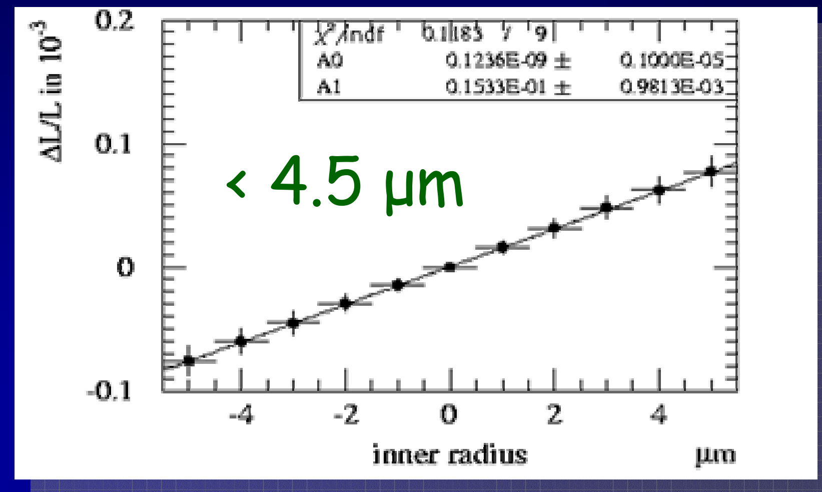
Instrumentation of the very forward region

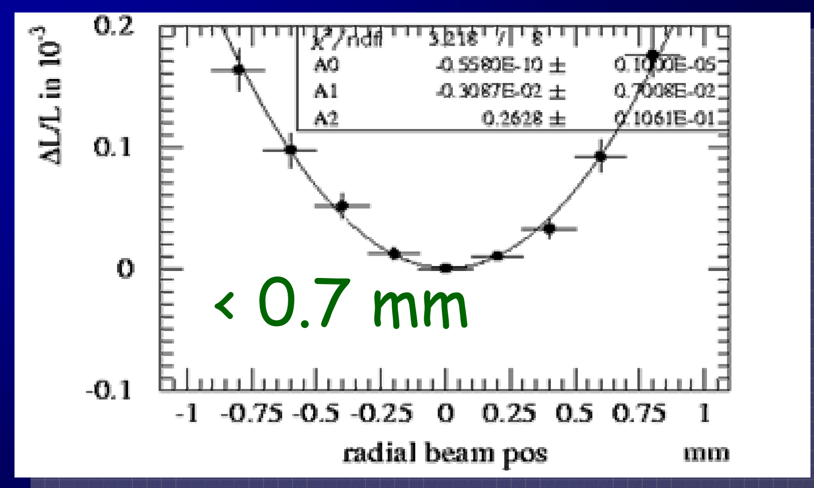
<u>LumCal</u>	<u>BeamCal</u>
Design & Simulation	Lab Tests & Simulation
Exp. Limitations Physics Needs	Identify most suitable technology

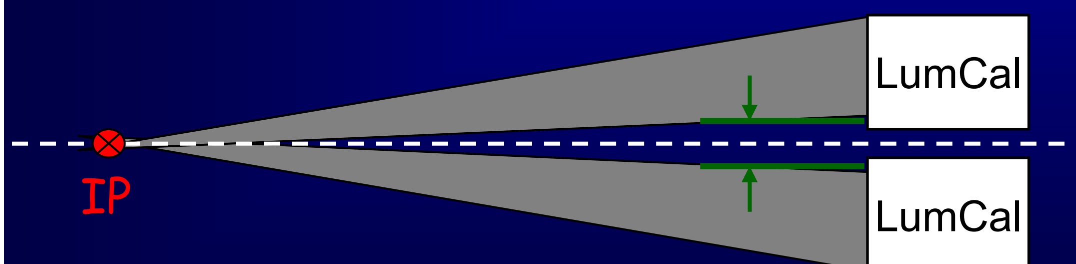
Lumi: Detector Requirements

Goal: ΔL/L: 10^{-4} (exp.)
ΔL/L: 10^{-4} (theo.)

Ref: OPAL (LEP)
ΔL/L: 3.4×10^{-4} (exp.)
ΔL/L: 5.4×10^{-4} (theo.)



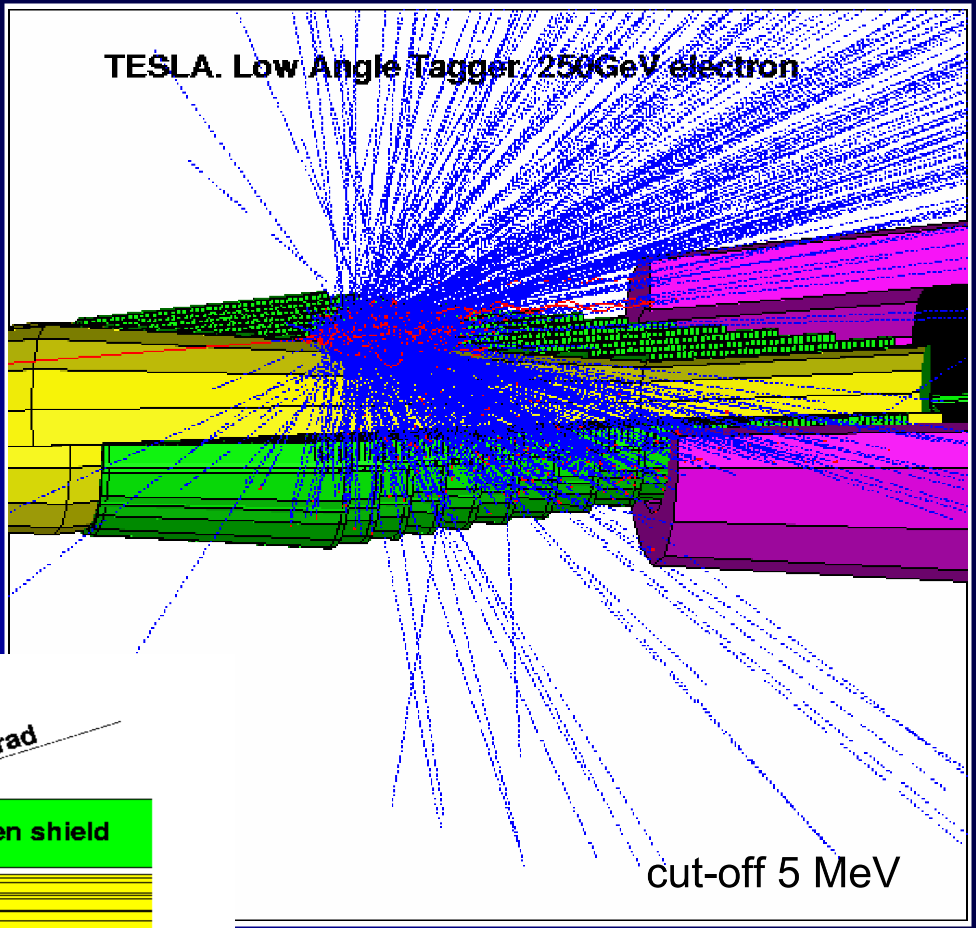


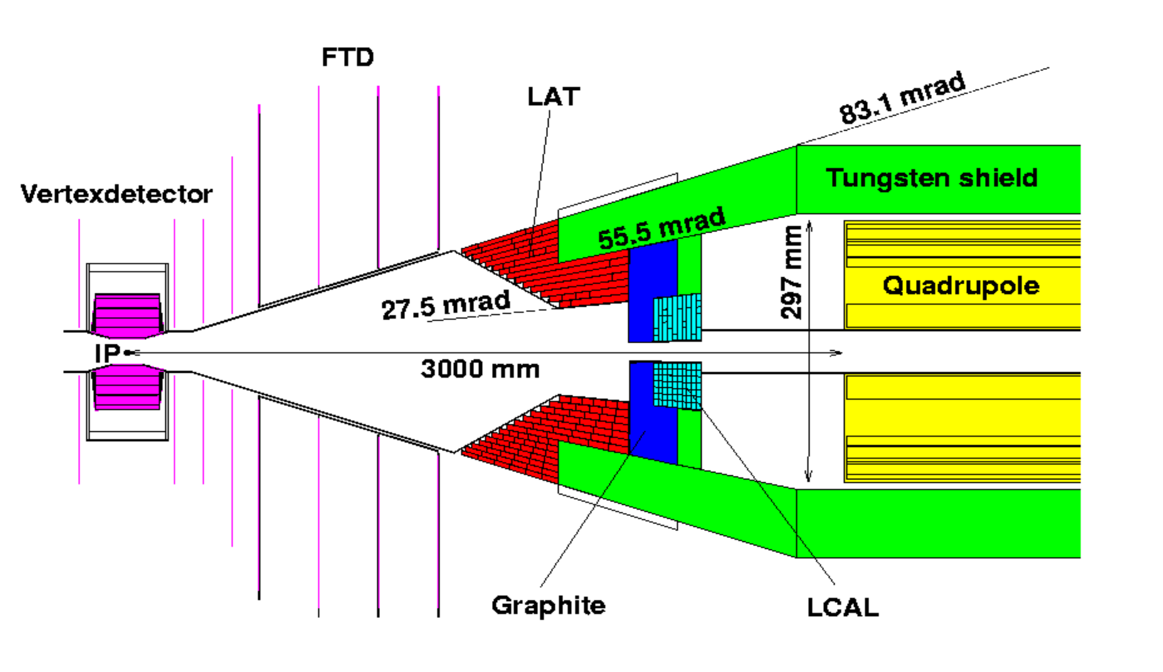


LumCal Design

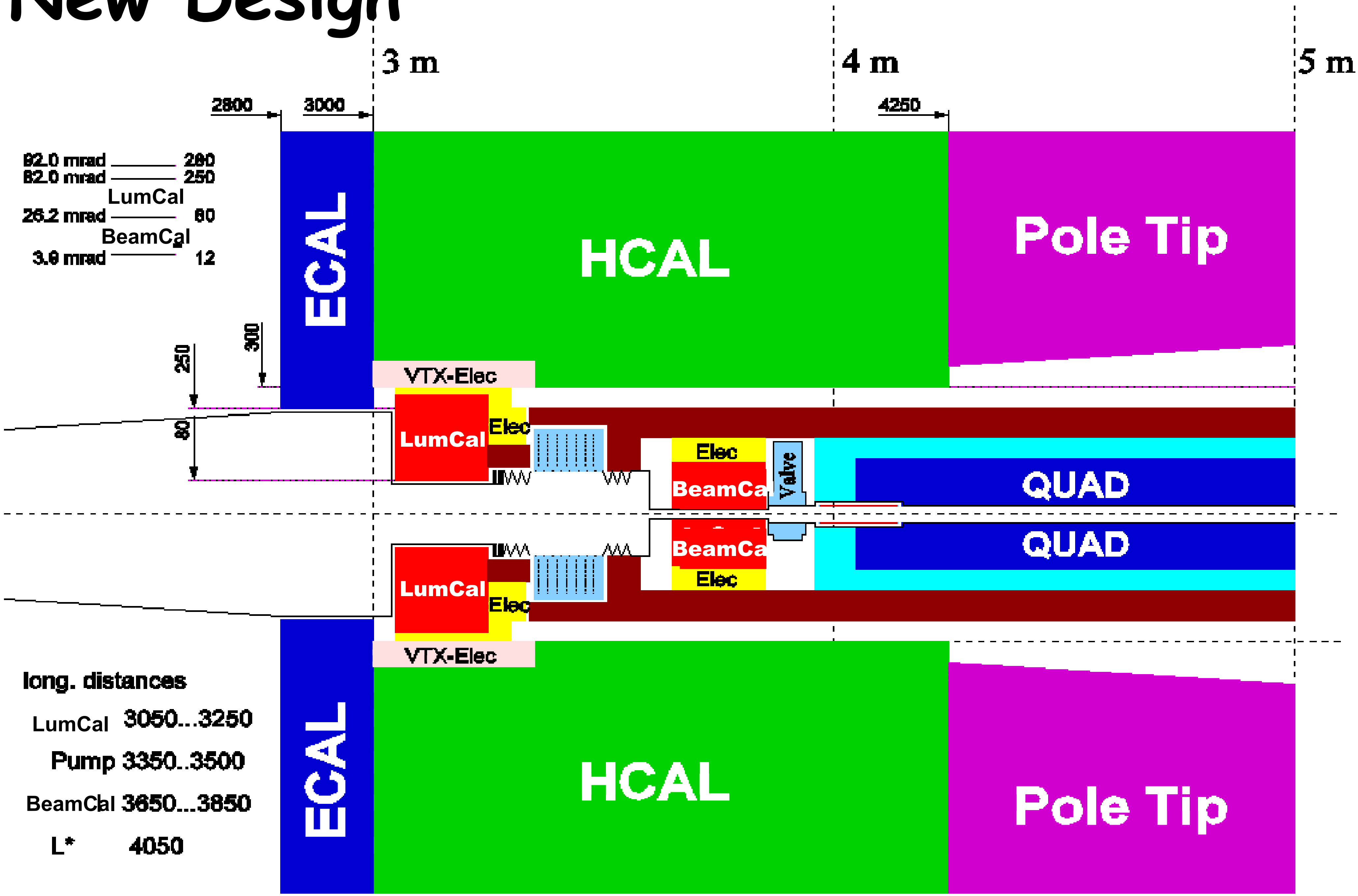
TDR design:

$\Delta L/L$ 10^{-4} impossible





New Design



3 m
4 m
5 m
2800
3000
4250
92.0 mrad 280
82.0 mrad 250
LumCal
26.2 mrad 80
BeamCal
3.8 mrad 12
250
300
80
ECAL
HCAL
Pole Tip
VTX-Elec
LumCal
Elec
Elec
BeamCal
Valve
QUAD
QUAD
BeamCal
Elec
LumCal
Elec
VTX-Elec
ECAL
HCAL
Pole Tip
long. distances
LumCal 3050...3250
Pump 3350..3500
BeamCal 3650...3850
L* 4050

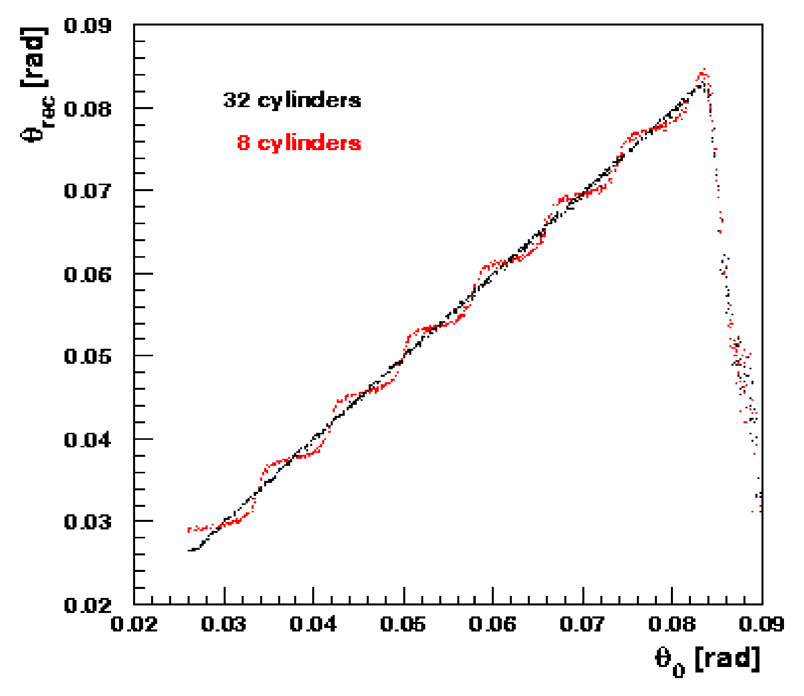
Lumi Simulations

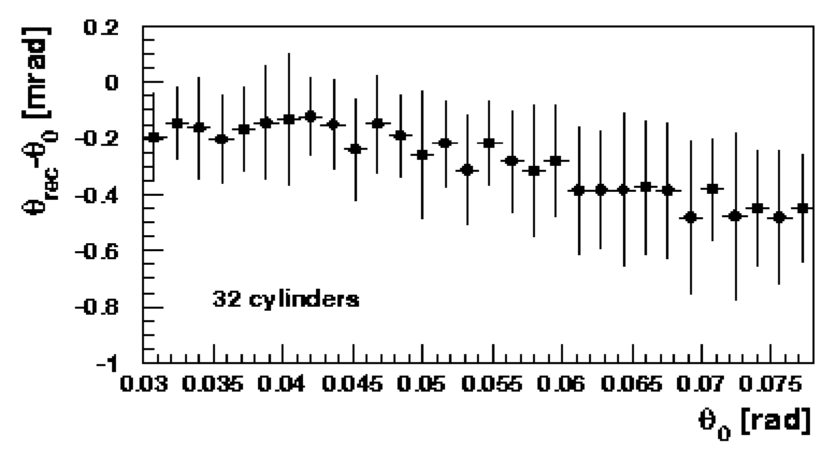
Full detector simulation
Event reconstruction

center-of-gravity algorithm

$$\bar{x} = \frac{\sum x_i e_i}{\sum e_i} \qquad \bar{y} = \frac{\sum y_i e_i}{\sum e_i} \qquad \bar{z} = \frac{\sum z_i e_i}{\sum e_i}$$

necessary segmentation:
- 32 rings in polar angle
- 48 sectors in azimuth
- 30 segments in depth

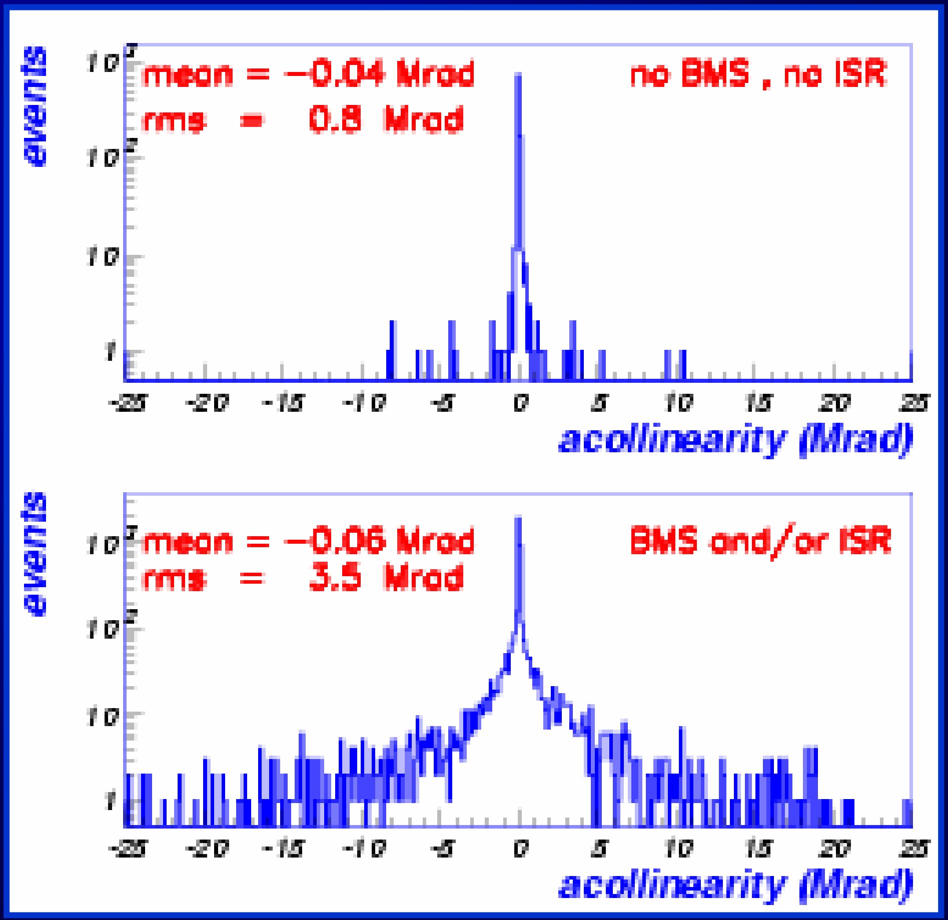




Lumi Simulations

Realistic Monte Carlo

- rad. corrections (BHWIDE)
- beamstrahlung (CIRCE)
- full detector simulation
- reconstruction of events

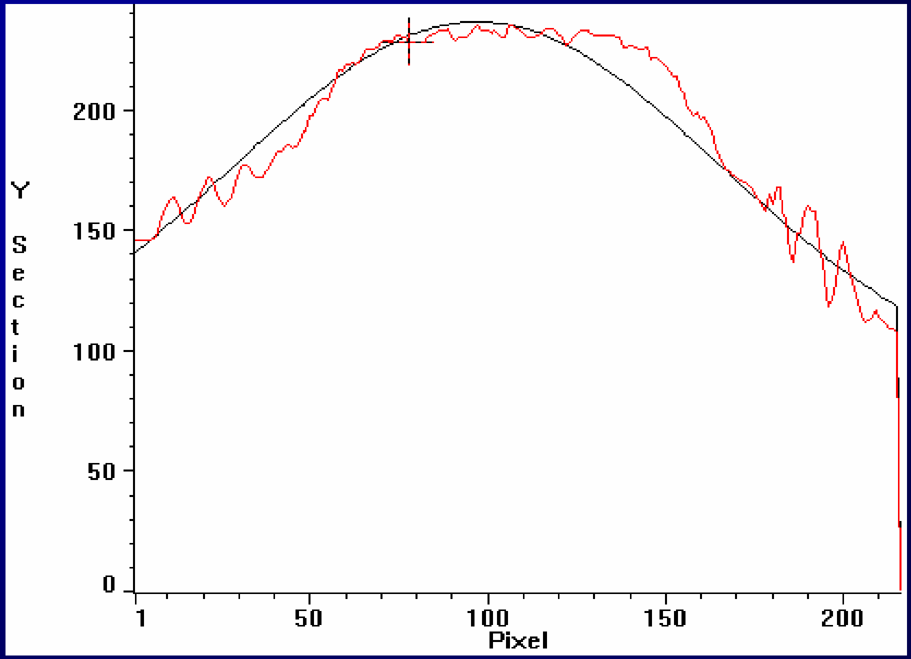


Laser Alignment System

New collaborator: Jagiellonian Univ. Cracow
Photonics Group

Work just started:

reconstruction of
Ne-Ne laser spot
on CCD camera



Bhabha Cross Section: Theory

Substantial effort to improve prediction
Goal: complete, massive 2-loop calculation

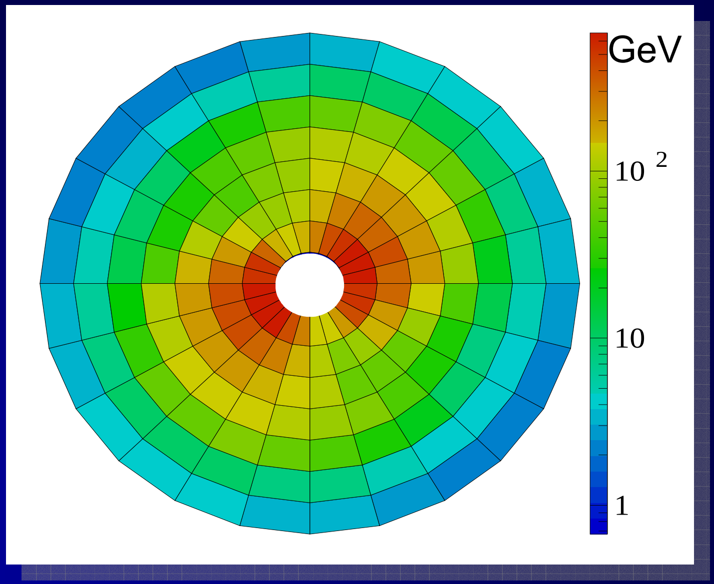
Collaboration:

Tord Riemann
with
Jochem Fleischer
Janusz Gluza
Alejandro Lorca
Oleg Tarasov
Anja Werthenbach

Good progress:

- 1-loop done (in SM)
  working FORTRAN code
- 2-loop: $|\text{1-loop}|^2$ + $|\text{Born x 2-loop}|^2$
  $|\text{1-loop}|^2$ near to finished numerically
  2-loop under study, some progress
- real corrections:
  interest from Jadach/Waş

Beam Monitoring



Beamstrahlung is sensitive to the machine parameters

- e^+e^- pairs in BeamCal
- photons downstream

Advantage of cold technology:

large bunch spacing
information can be used for feedback

First Results (over optimistic!)

detector: realistic segmentation, ideal resolution
single parameter analysis, bunch by bunch resolution

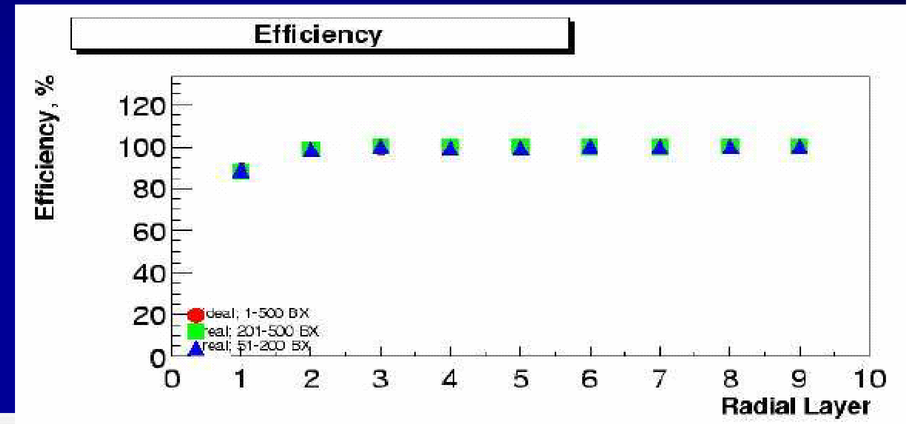
	nominal	our precision	Beam Diag.
Bunch width x Ave.	553 nm	1.2 nm	~ 10 %
Diff.		2.8 nm	~ 10 %
Bunch width y Ave.	5.0 nm	0.1 nm	Shintake
Diff.		0.1 nm	Monitor
Bunch length z Ave.	300 µm	4.3 µm	~ 10 %
Diff.		2.6 µm	~ 10 %
Emittance in x Ave.	10.0 mm mrad	1.0 mm mrad	?
Diff.		0.4 mm mrad	?
Emittance in y Ave.	0.03 mm mrad	0.001 mm mrad	?
Diff.		0.001 mm mrad	?
Beam offset in x	0	7 nm	5 nm
Beam offset in y	0	0.2 nm	0.1 nm
Horizontal waist shift	0 µm	80 µm	None
Vertical waist shift	360 µm	20 µm	None

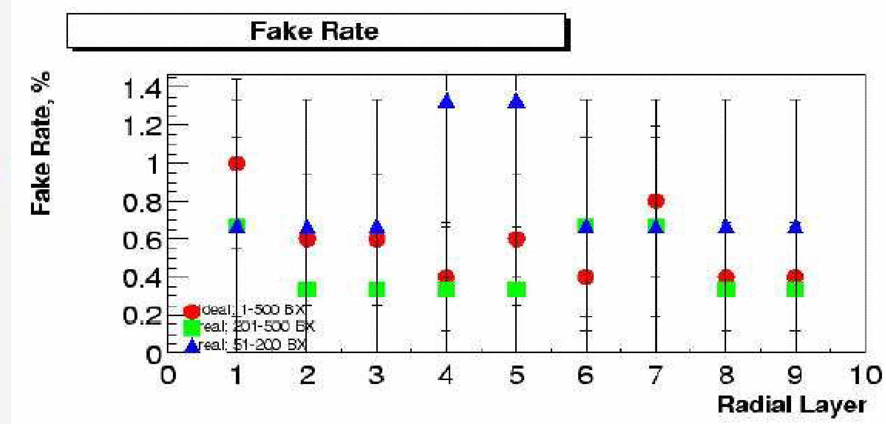
Hermeticity: 2-photon-veto

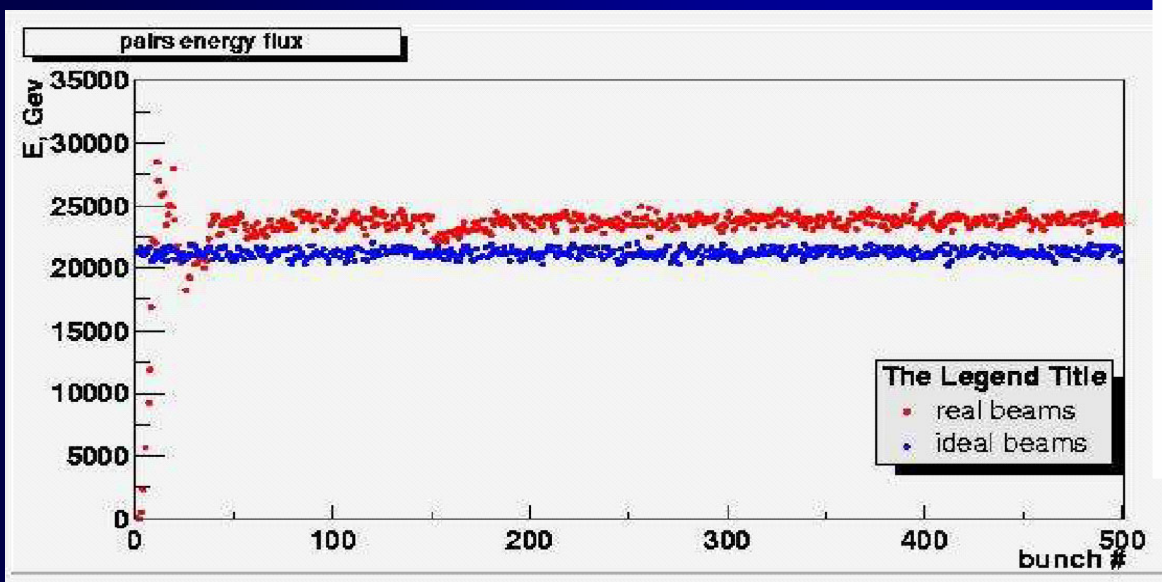
Simulation: identify electrons close to the beam
in the presence of large beamstrahlung

min. detectable energy: 100 GeV
for 250 GeV beam

analysis with realistic beam background
including ground motion & feed back







Technologies for BeamCal

- **Sandwich: W / Si**

  radiation hardness ?

- **Sandwich: W / diamond**

  → next slides

- **Sandwich: W / gas ionisation chambers**

  good progress, better suited for γ-detection?

- **Xtals with ultrathin phototriodes**

  waiting for funding (UK)

- **Xtals with fiber readout**

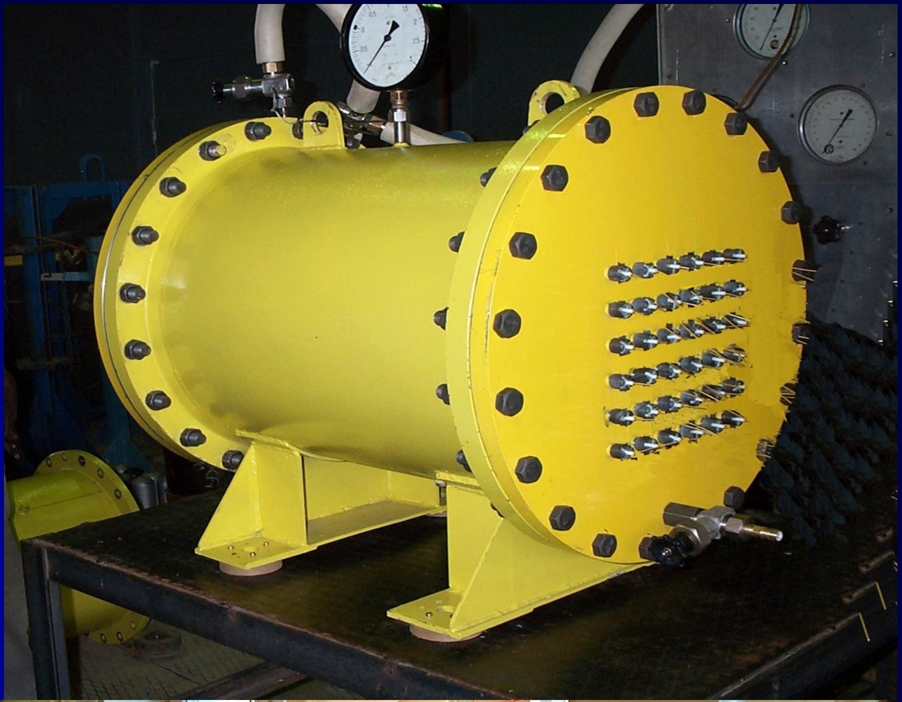
  no funding @ DESY, looking for new collaborator

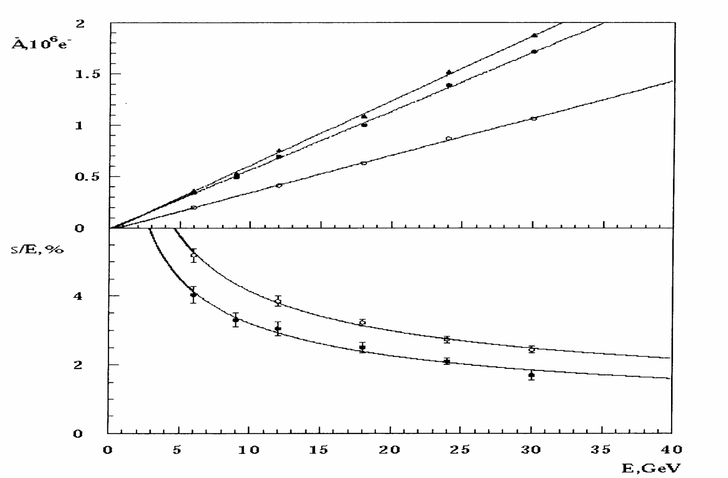
Gas Calo: Beamtests

sampling calorimeter

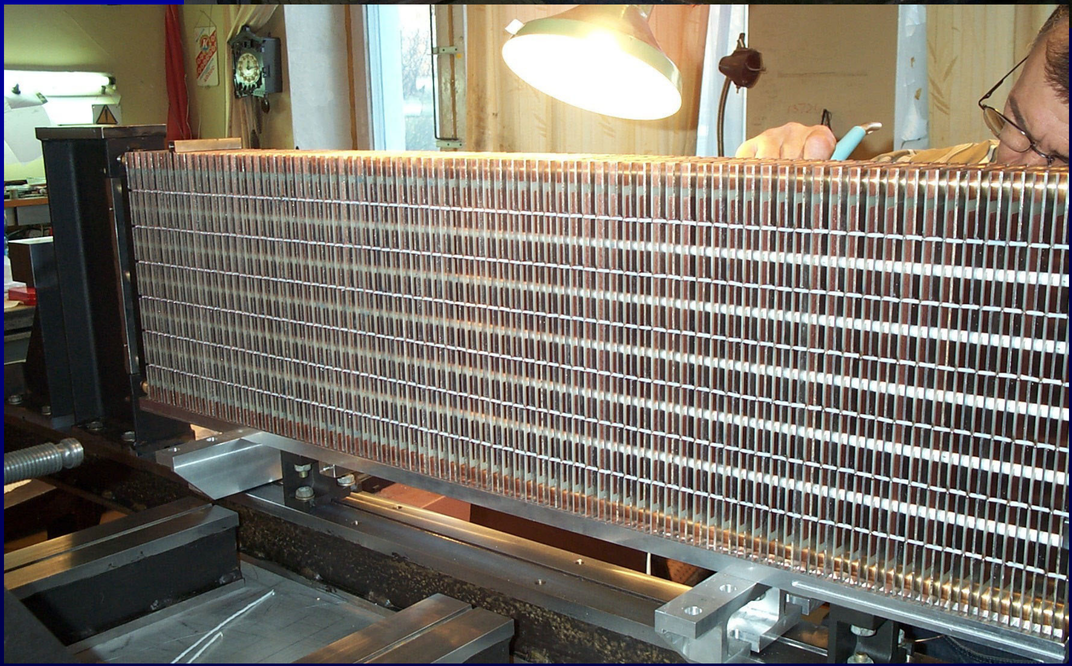
- ❑ tungsten absorbers
- ❑ gas ionisation chambers

- ➢ extreme radiation hardness
- ➢ detect beamstrahlung on downstream collimator

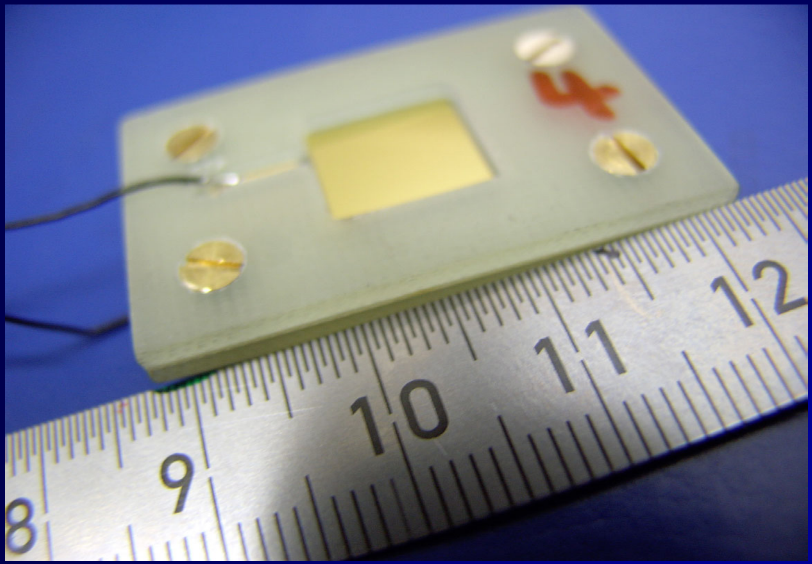


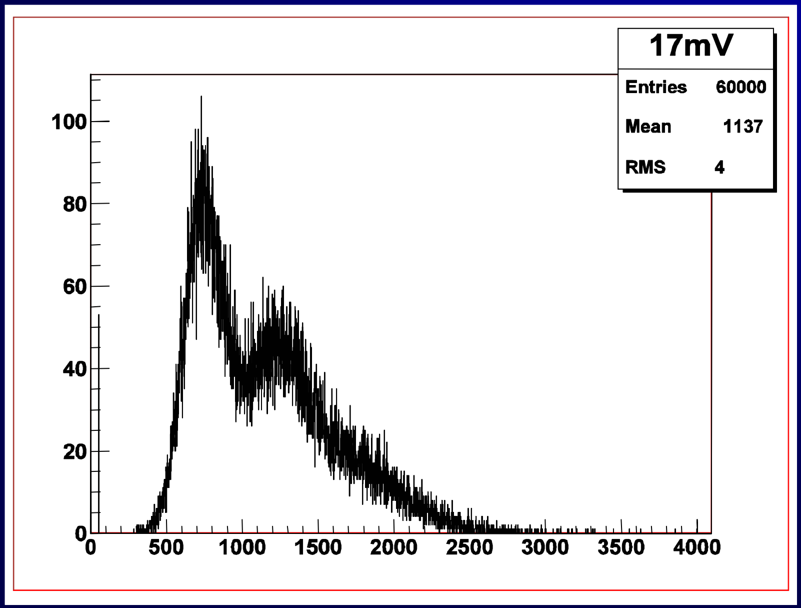


Pulse height and energy resolution vs energy:
●,▲ – 1.5mm Pb, ○ – 3mm Pb,
●, ○ – 9 towers are used, ▲ – 21 towers are used.
Enegry resolutions are corrected for the electronics noise and the beam momentum spread. The energy dependence of σ/E is fitted by the following expressions:
1.5mm Pb: $\sigma/E=(10.1\pm0.5)/\sqrt{E} \oplus (0.0\pm1.5)$,
3mm Pb: $\sigma/E=(12.9\pm0.6)/\sqrt{E} \oplus (0.8\pm0.5)$.



Diamond Sensors





12 samples (12 x 12 mm)
Frauenhofer Inst. Freiburg

measured:
- I-V characteristics
- charge collection distance

to be done:
- homogeniety

1st mono-crystal (2 x 3 mm)
Almazot / Minsk

under investigation

expect diamonds from
Dubna soon

Charge Collection Distance

Sensor	R(Average)	ccd Up 500V	ccd Up 800V	ccd Down 500V	ccd Down 800V
11	4.60E+13	37		35	
12	3.20E+14	27	30	35	43
13	8.88E+11	21		25	33
21	5.92E+14	17		24	
22	7.39E+14	9	10 (700V)	9	11
23	3.93E+14	10	13	9	12
31	1.04E+11	33 (400V)		28	
32	5.12E+13	50		50	57
33	4.63E+13	52	58	49	54
41	5.12E+11	48		45 (400 V)	
42	4.35E+14				
43	5.24E+13	60	65	54	

Conclusions

Good progress in most areas