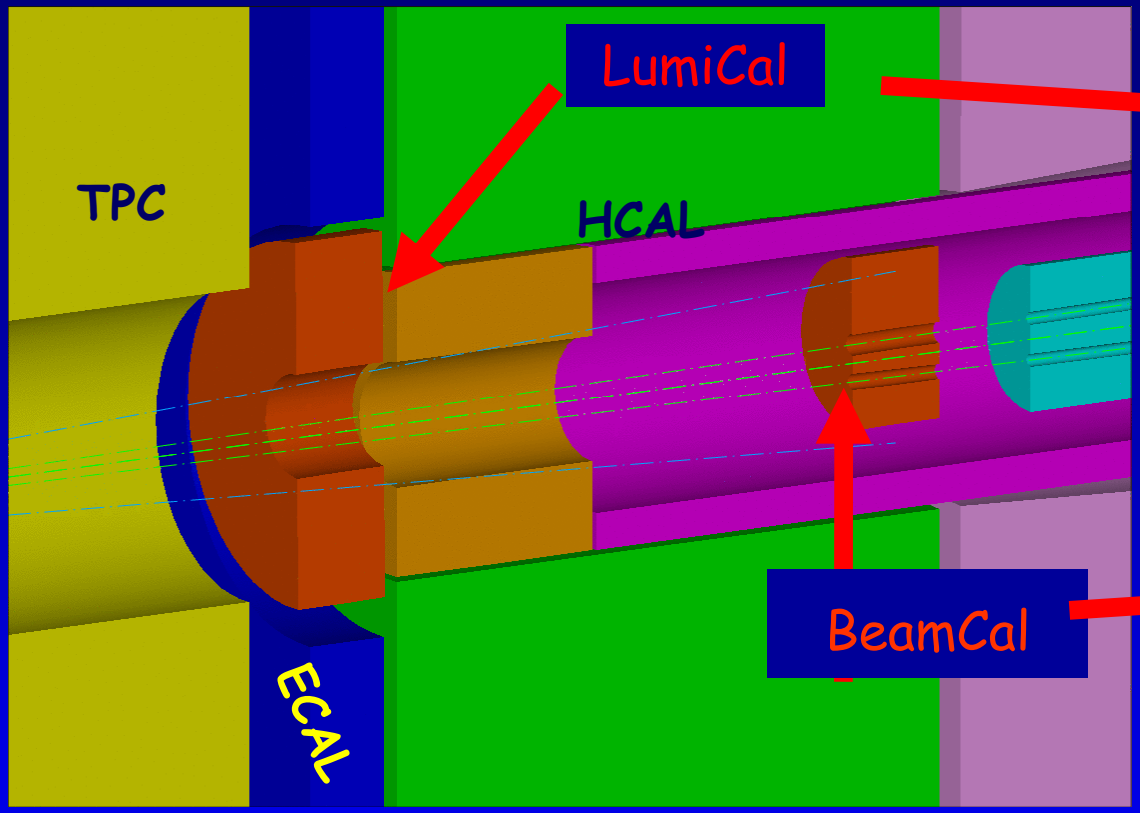
Very Forward Instrumentation of the ILC Detector

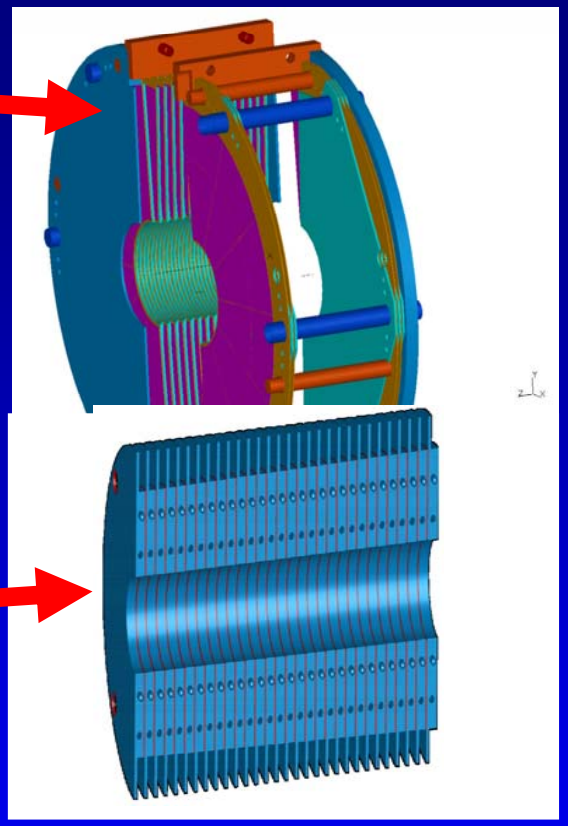
FCAL Collaboration
High precision design

Wolfgang Lohmann,
DESY

Talks by M. Morse, W. Wierba, myself

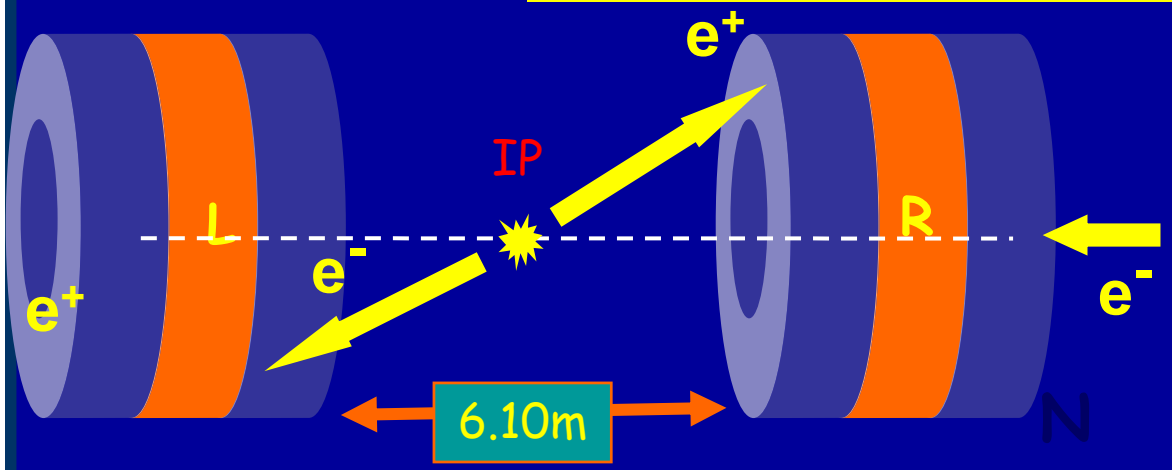
BeamCal and LumiCal (Example LDC, 14 mrad):





- precise (LumiCal) and fast (BeamCal) luminosity measurement
- hermeticity (electron detection at low polar angles)
- mask for the inner detectors
- GamCal ~150 m downstream for fast luminosity

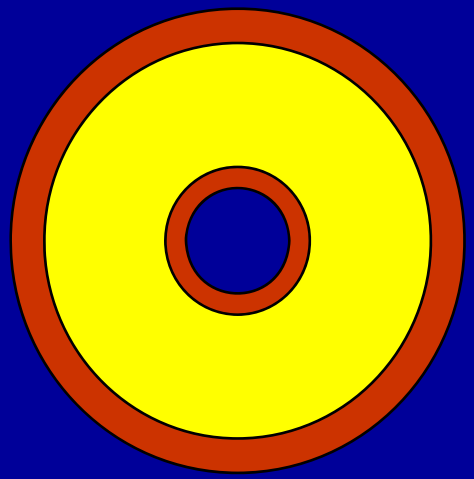
Measurement of $\mathcal{L}$

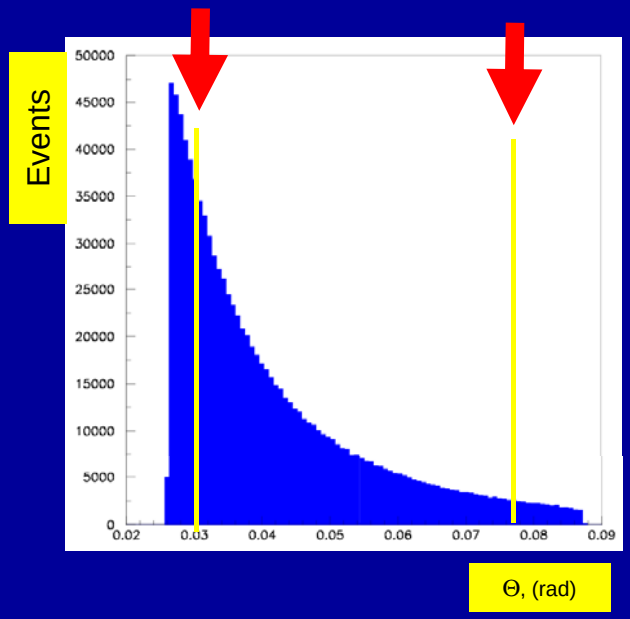


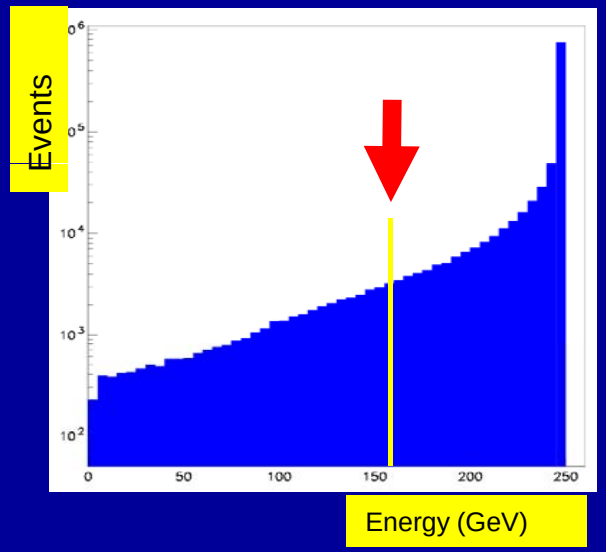
$$\mathcal{L} = N / \sigma$$

Count Bhabha events

From theory



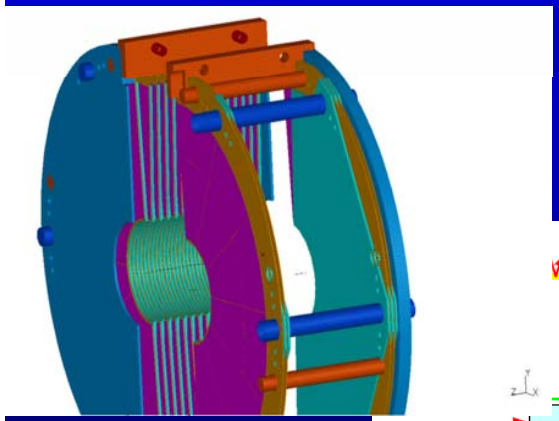


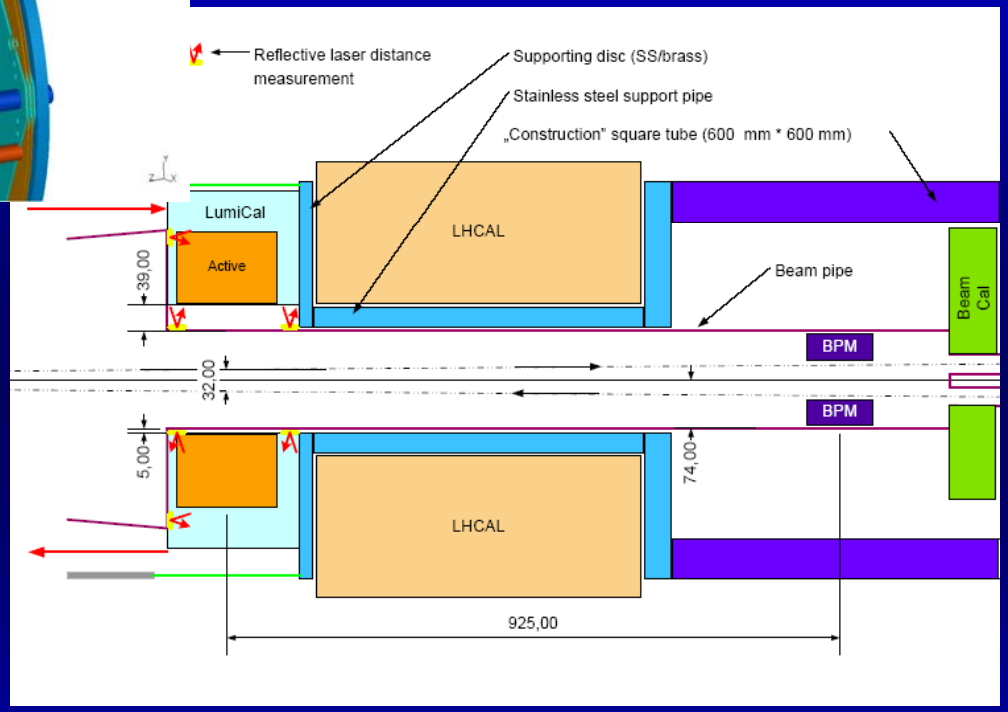


Goal: Precision $< 10^{-3}$

Inner Radius of Cal.:	**< 10 μm**
Distance between Cals.:	**< 600 μm**
Radial beam position:	**< 1000 μm**

LumiCal mechnics and positioning





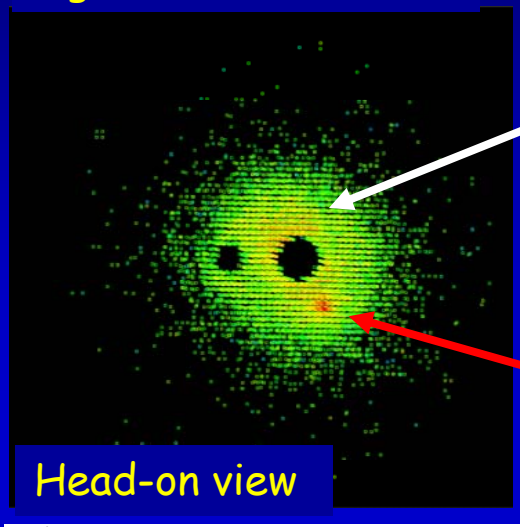
- Reflective laser distance measurement – accuracy ~1-5 μm, resolution ~0.1-0.5 μm
- Mirrors glued to beam pipe
- Calibration of sensors procedure – detector push-pull solution (?)

- Beam pipe (well measured in lab before installing, temperature and tension sensors for corrections) with installed BPM (BPM's also on outgoing beam?)
- Laser beams inside 'carbon' pipe (need holes, but possible)

Simulations to optimise the Design

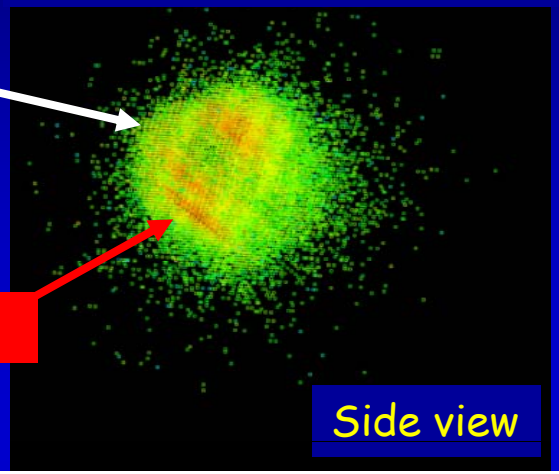
Efficient detection of high energy electrons is essential for search experiments

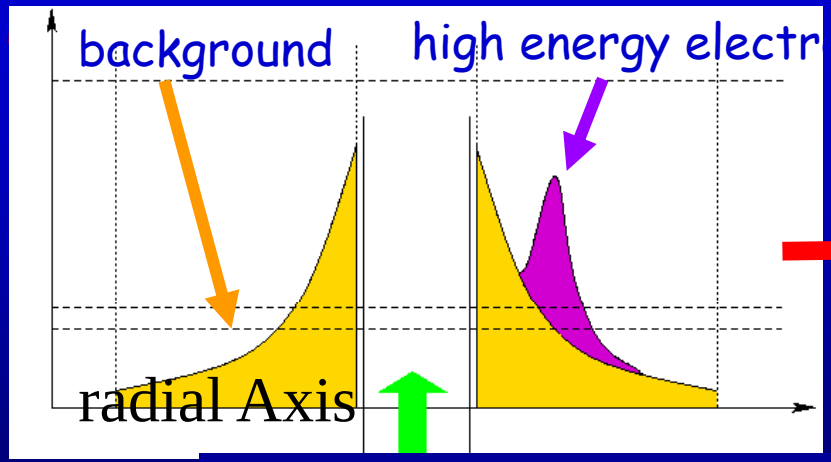
E.g. from UC Boulder

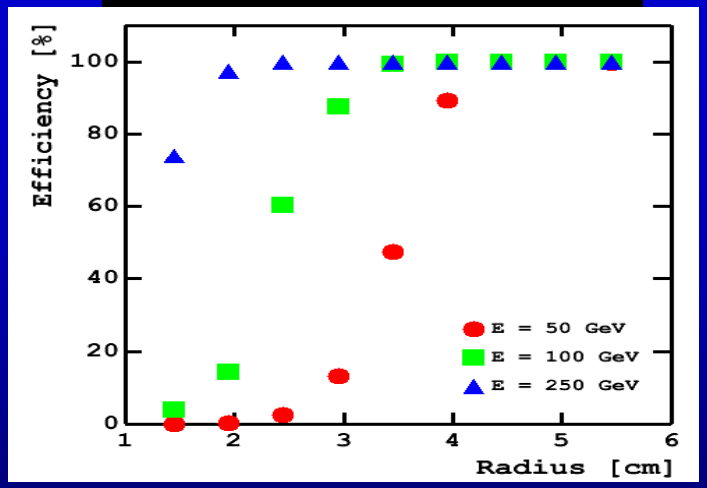


Beamstrahlung
TeV per BX

electron from 2γ process



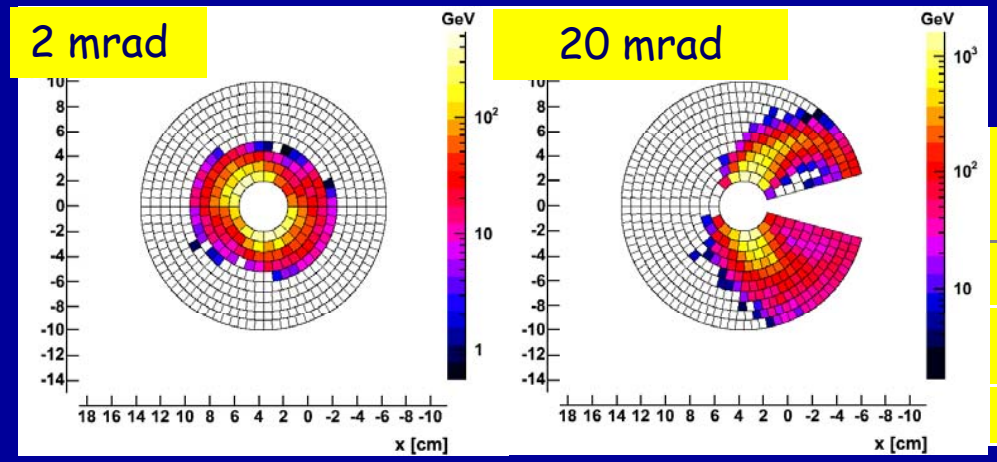




Finely segmented, compact calorimeter with fast readout

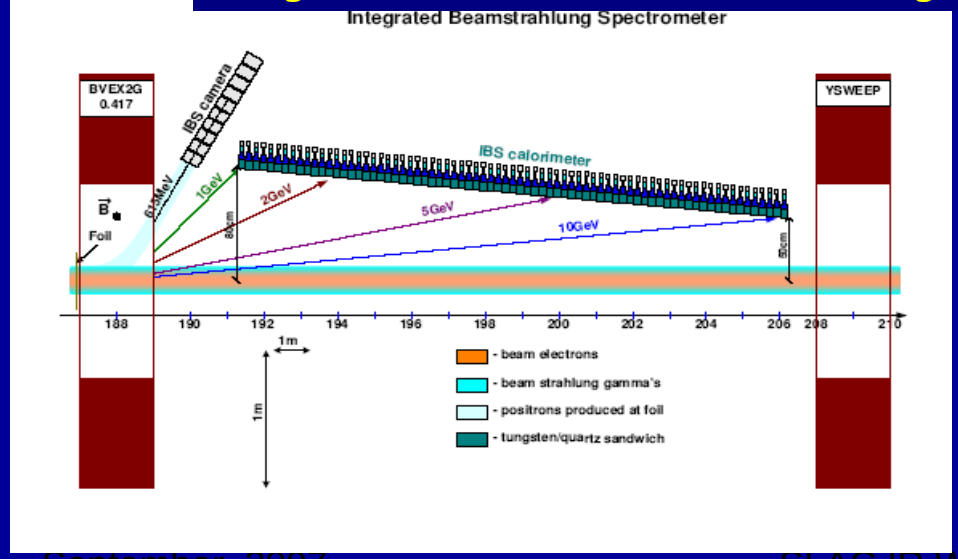
BeamCal & GamCal

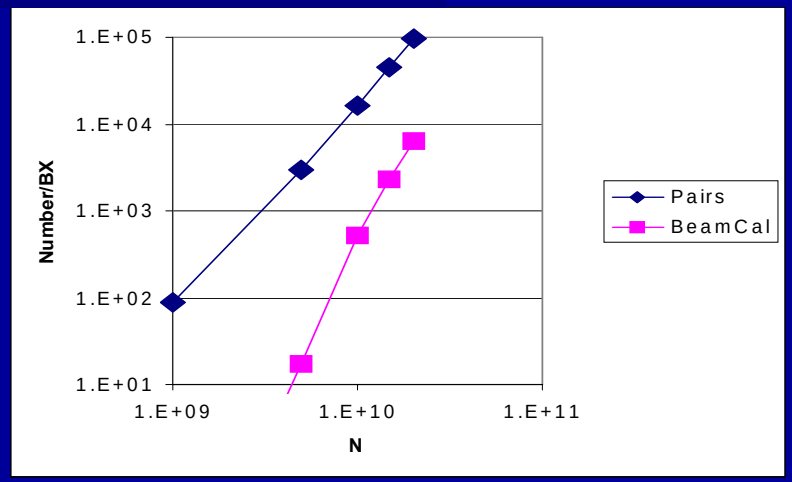
Determination of beam parameters from beamstrahlung depositions on BeamCal:



Quantity	Nominal Value	Precision
σx	553 nm	2.9
σy	5.0 nm	0.2
σz	300 µm	8.5

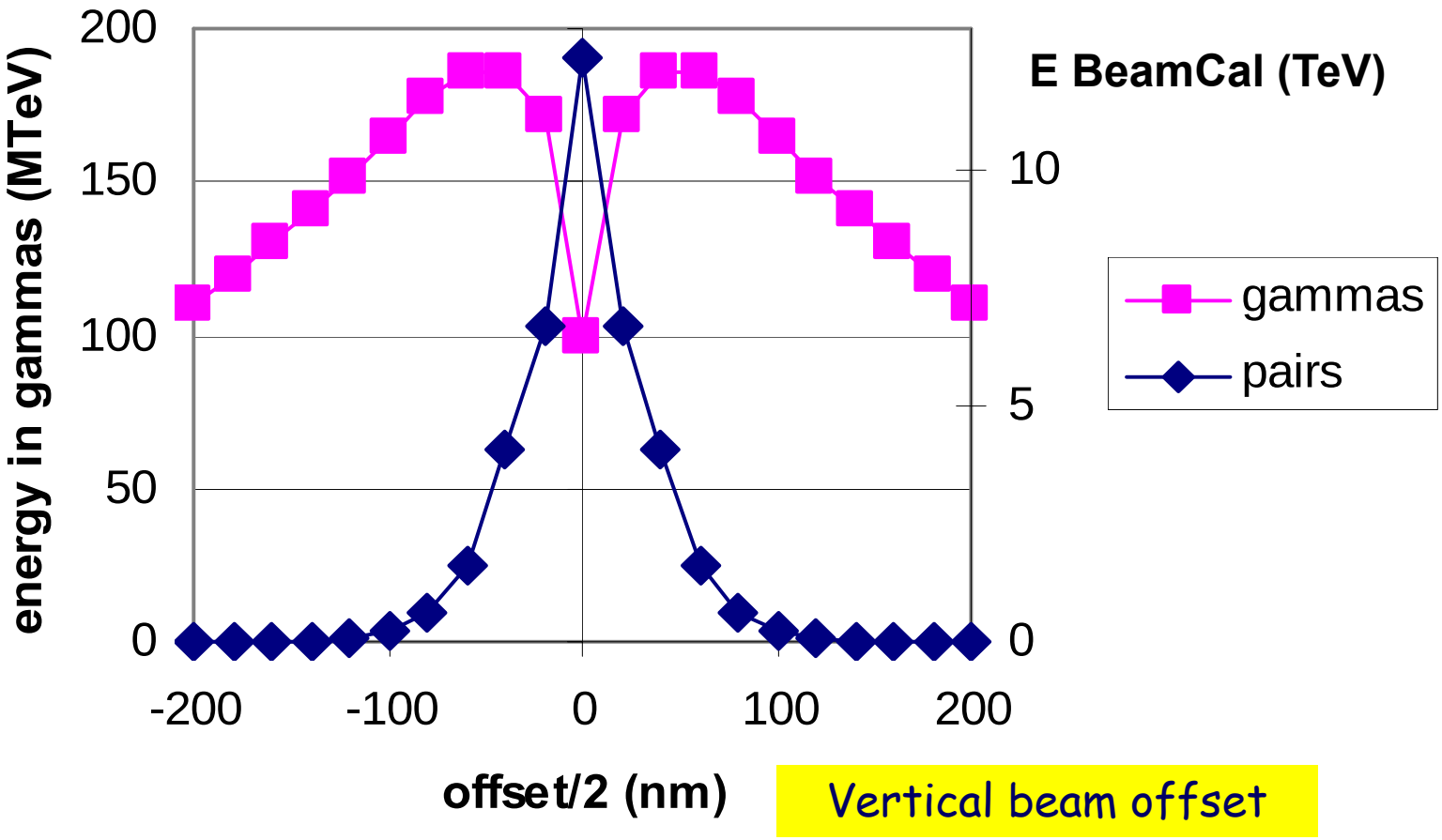
Rough information on bunch crossing at low bunch charges





BeamCal & GamCal

Combine informations from pairs and photons (B. Morse)

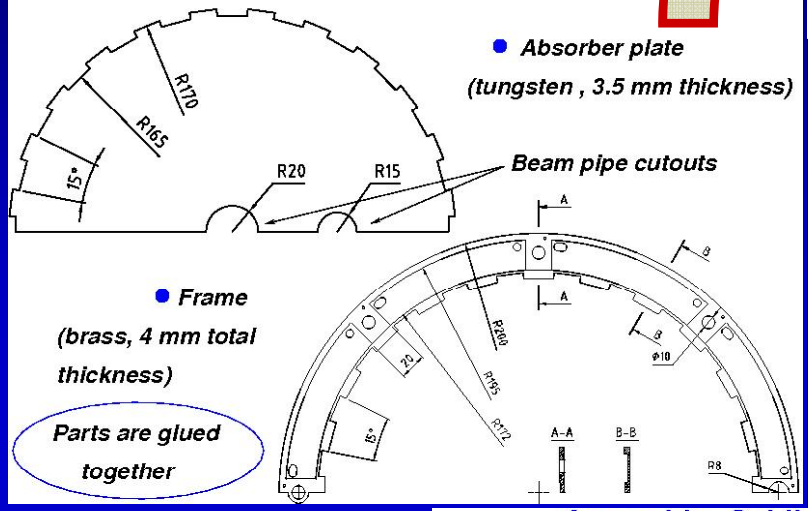


Vertical beam offset

The ratio of the two quantities is proportional to the actual luminosity

BeamCal Mechanics

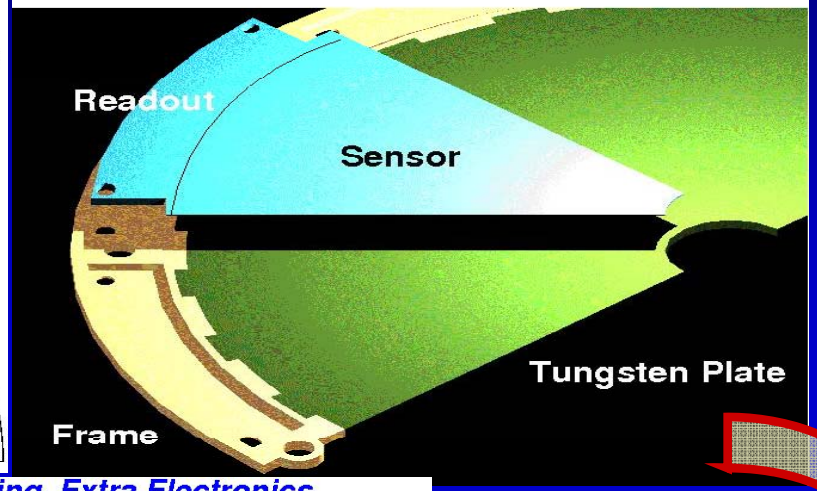
Half-Layer Mechanics



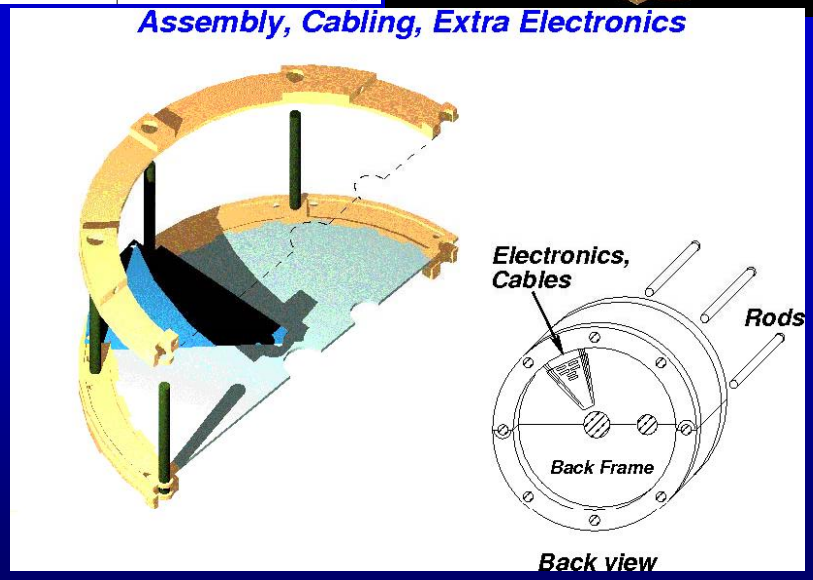
- Absorber plate (tungsten , 3.5 mm thickness)
- Beam pipe cutouts
- Frame (brass, 4 mm total thickness)

Parts are glued together

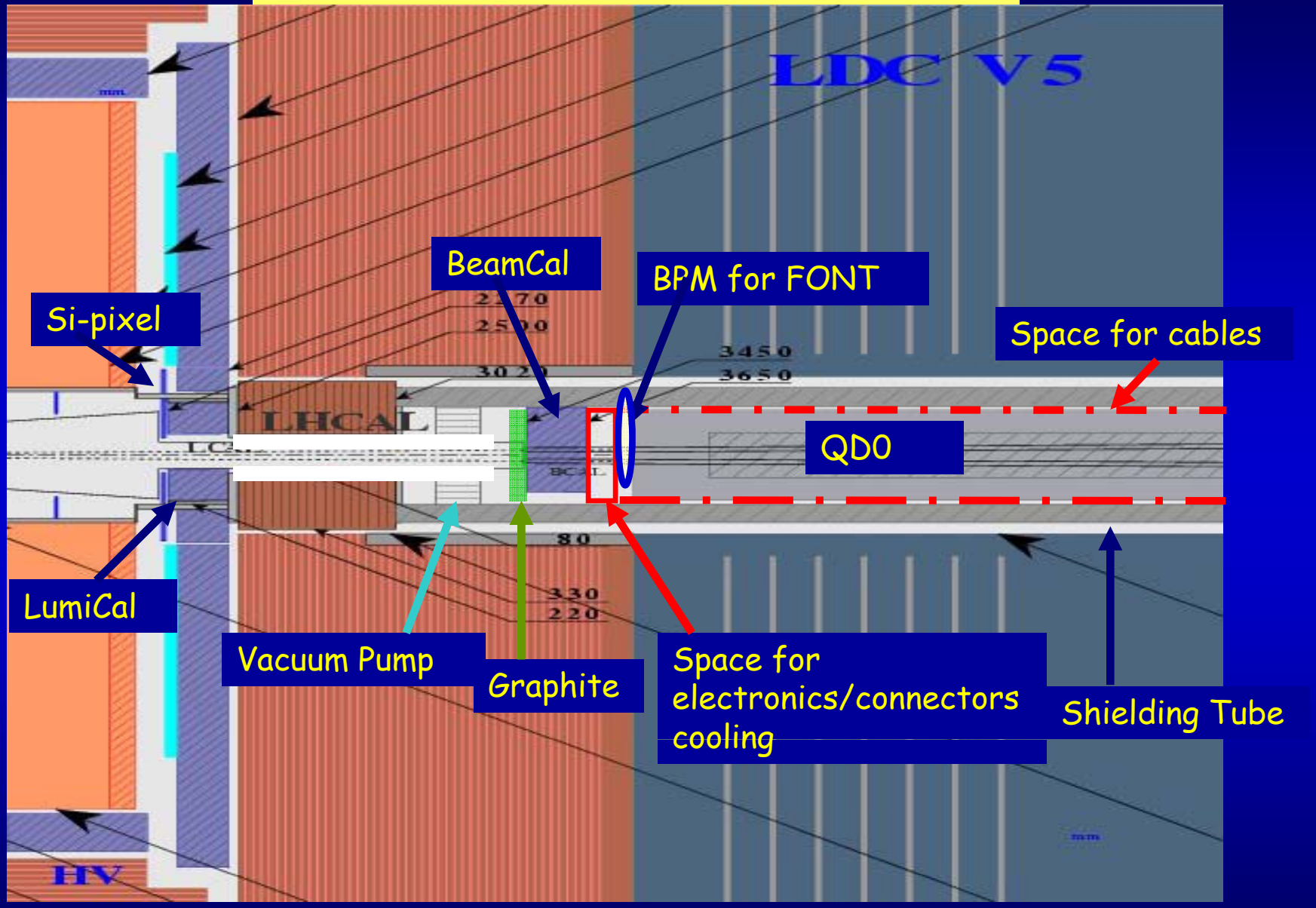
Sensor and R/O Hybrid



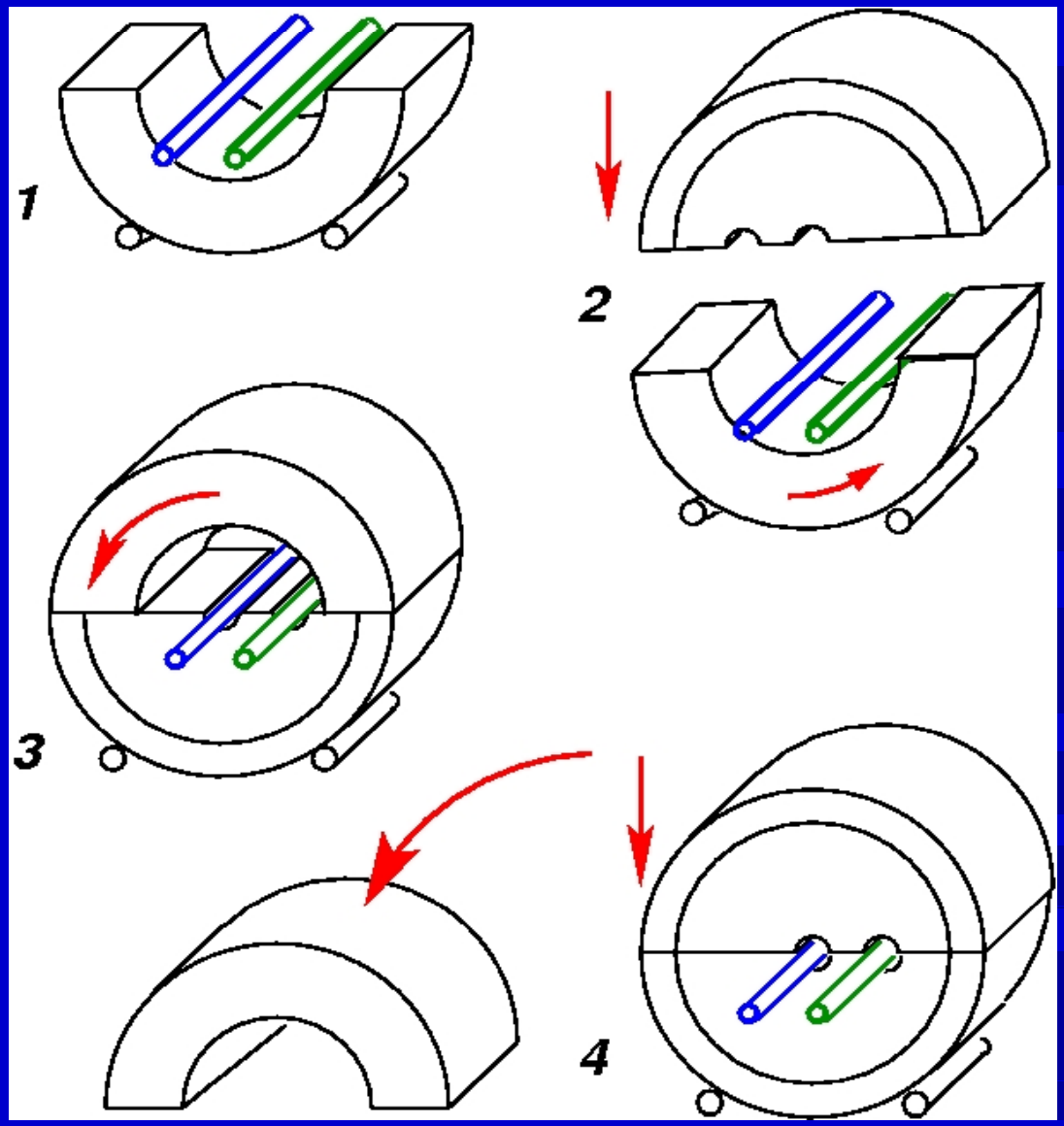
Assembly, Cabling, Extra Electronics



Forward Region, example LDC



The Mounting Procedure for BeamCal



Installation and disassembly must be possible without opening the vacuum!

1 montage of an auxiliary structure

2 montage of the first half barrel

3 Turn the barrel and bring the first calorimeter half barrel in final position

4 remove the auxiliary structure

5 montage of the second half barrel

To perform this procedure the upper half of the shielding tube has to be removed

Summary

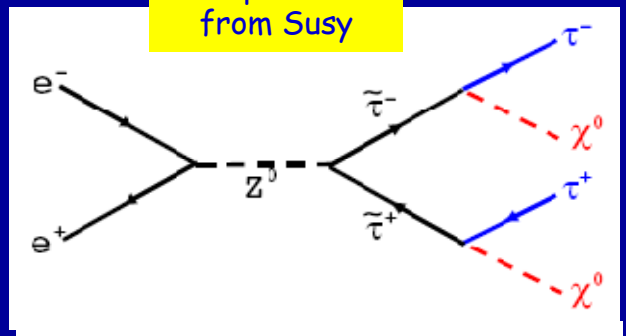
- Forward calorimeters interfere with QD0, vacuum pumps, BPM's, ballows, other beam diagnostics devices …….
- We have to avoid matter in front of the calorimeters
- LumiCal has challenging position accuracy requirements

Lets Stay in Touch

BeamCal

Efficient low angle electron veto
Why:
Background suppression in search channels, e.g.

Signal expected from Susy

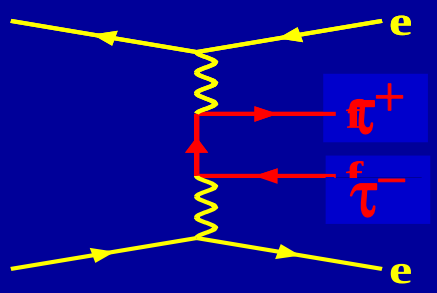


L = 500fb^{-1}

Number of SUSY events ~ 20

Similar signatures, Two photon cross section much larger

Background (two photon)

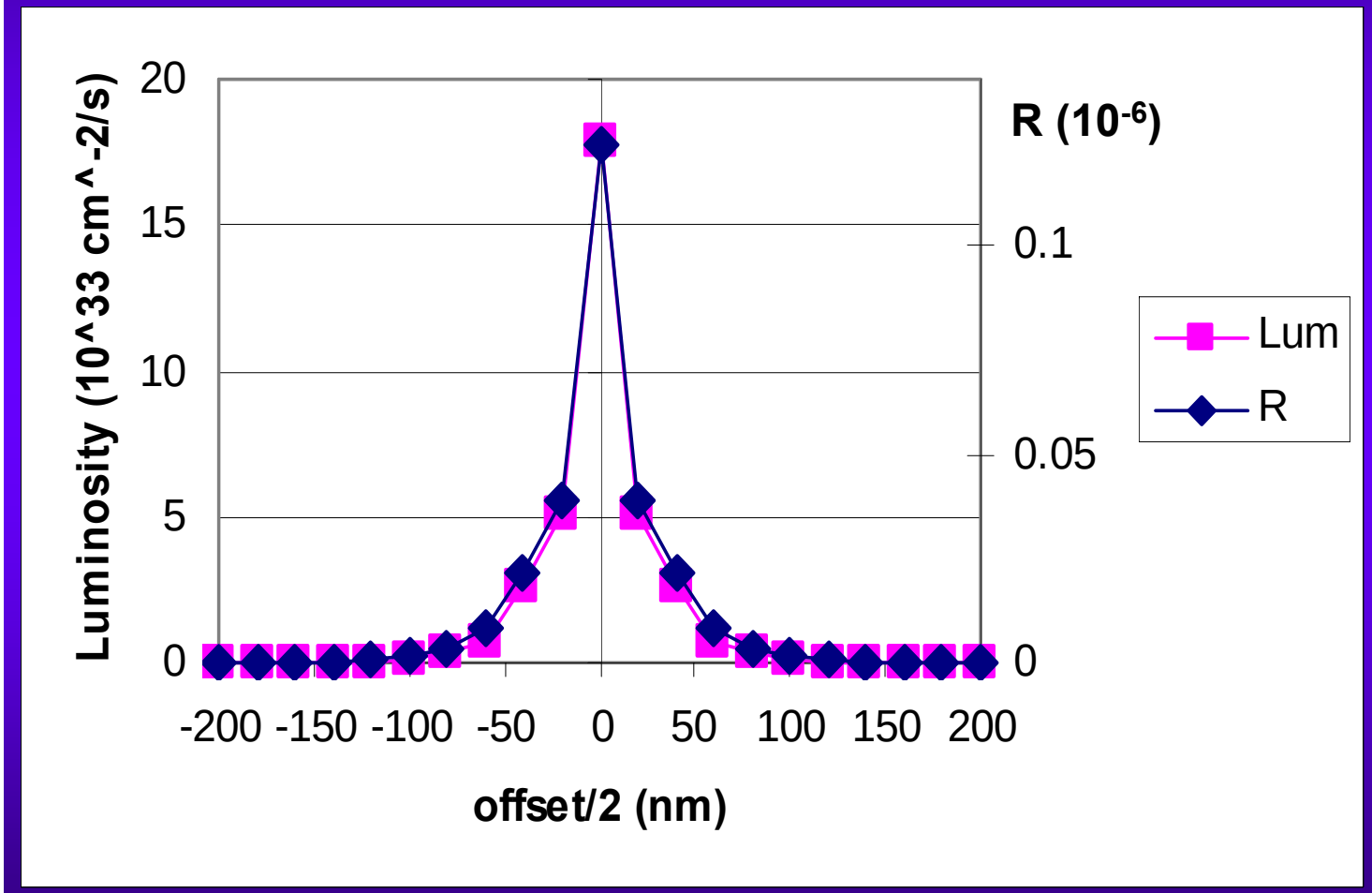


Number of unvetoed 2-photon events:

Veto Energy Cut, GeV	75	50
Nominal	45	5
Low Q	40	0.1
Large Y	50	9
Low P	364	321
Nominal, 20mrad	396	349

GamCal &LumiCal

Ratio of energy depositions in BeamCal and GamCal:

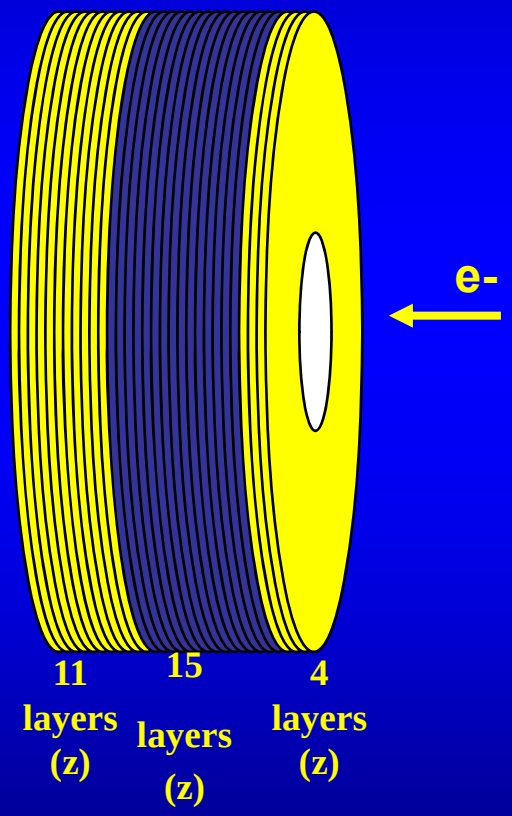


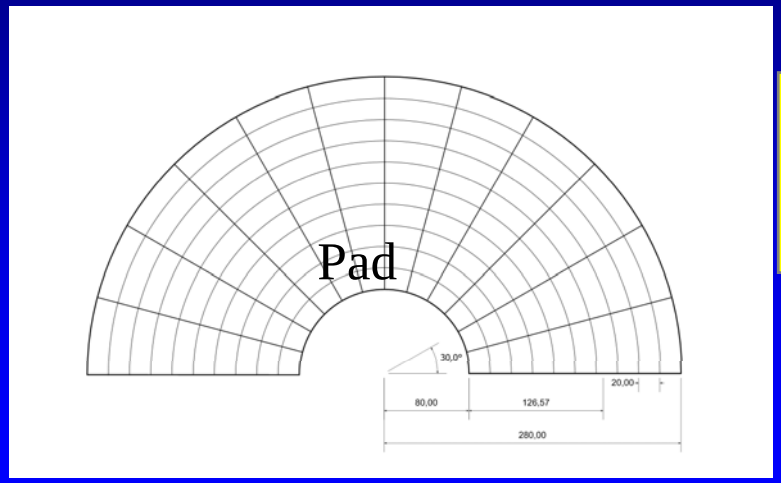
Almost proportional to the Luminosity !!!

LumiCal, present understanding

Maximum peak shower

- 10 cylinders (θ)
- 60 cylinders (θ)





64 cylinders

120 sectors

30 rings

Parameter	Pad Performance
Energy resolution	25% ($\sqrt{GeV}$)
θ resolution	$3.5 * 10^{-5}$ rad
ϕ resolution	10^{-2} rad
Δ θ	~ $1.5 * 10^{-6}$ rad
Electronics channels	25,200