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BeamCal Simulation

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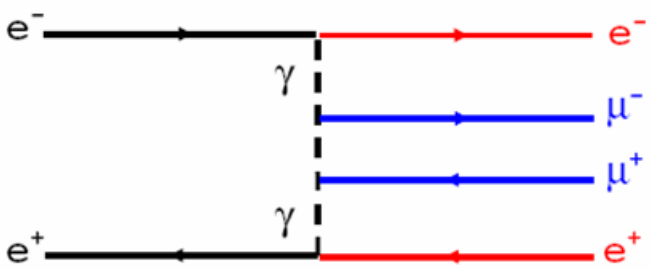
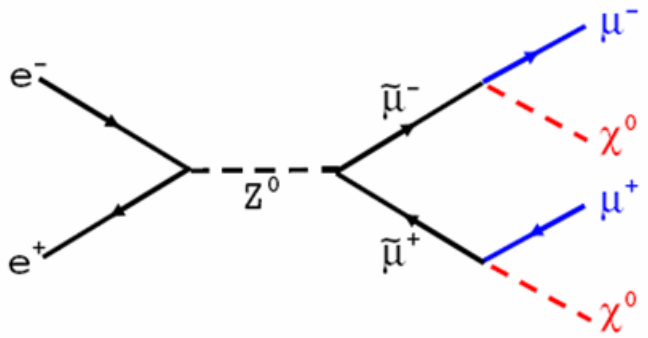
FCAL

Thanks to
Vladimir Drugakov
Andrey Elagin
Christian Grah
Wolfgang Lohmann
... ...

Beam Calorimeter

- ★ Beam diagnostics
- ★ Reduction of backscattering to inner subdetectors
- ★ Detection of high energy electrons and photons





Two photon background

$\mu^+ \mu^-$ + missing energy

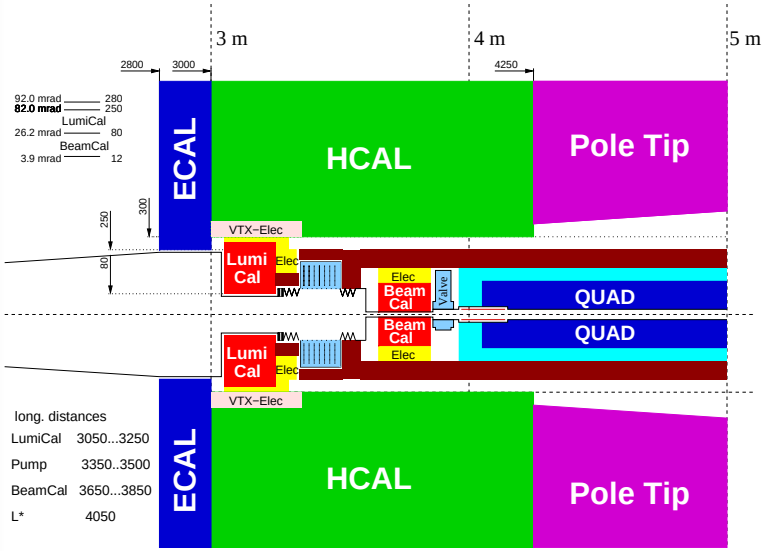
$\sigma \sim 10^6$ fb

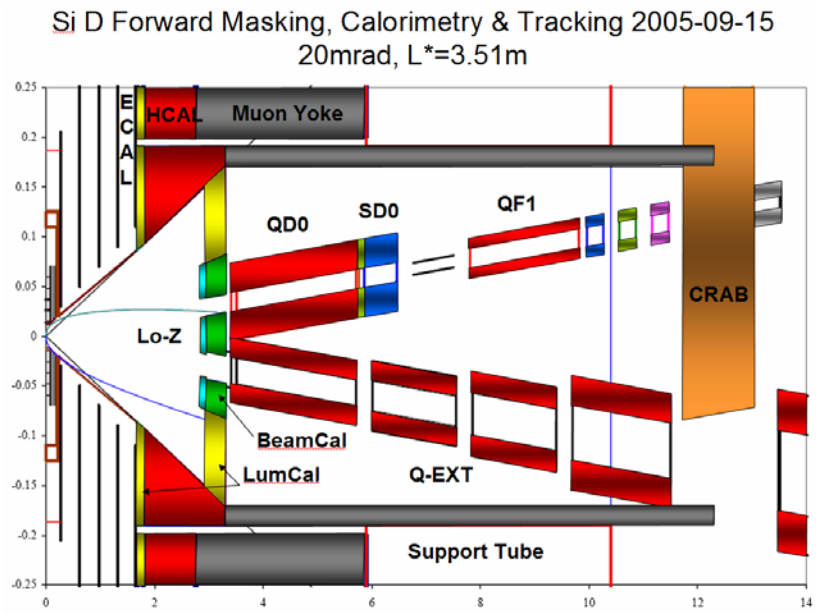
SUSY physics

$\mu^+ \mu^-$ + missing energy

$\sigma \sim 10^2$ fb

Very Forward Region





2mrad: 4 < θ < 28 mrad

20mrad: 5 < θ < 45 mrad

20mrad: 5 < θ < 25 mrad

Geometry Details

	Head-on	2mrad	20mrad
Absorber thickness (mm)	3.5	3.5	3.5
Sensor thickness (mm)	0.5	0.5	0.5
X/Y position (mm)	0/0	0/0	+36.5/0
Z position (mm)	±3650	± 3650	± 3650
Tilt angle (mrad)	0	0	10
R_{min} – R_{max} (mm)	15 – 100	20 – 100	20 – 165
θ_{in} – θ_{out} (mrad)	4– 28	5 – 28	5-45
Number of layers	30	30	30

Absorber: tungsten

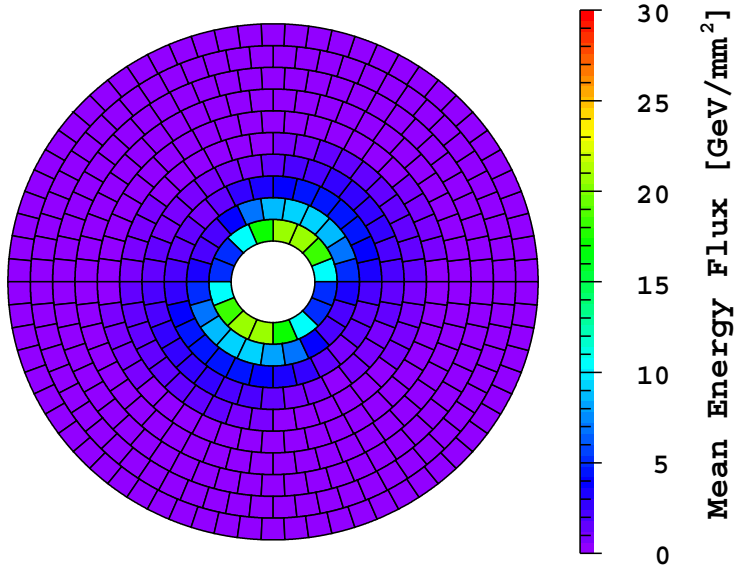
Sensor: diamond

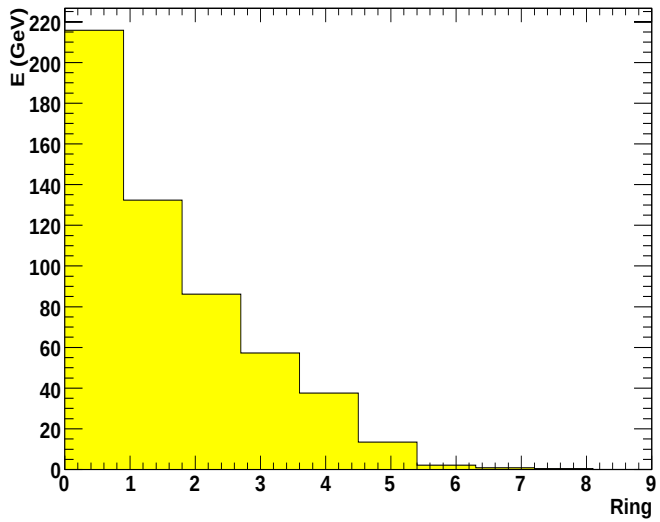
High Background

~20 TeV of energy deposited in beamcal

due to beamstrahlung per bunch crossing (500GeV)

An example for segmentation of 8 mm cell size

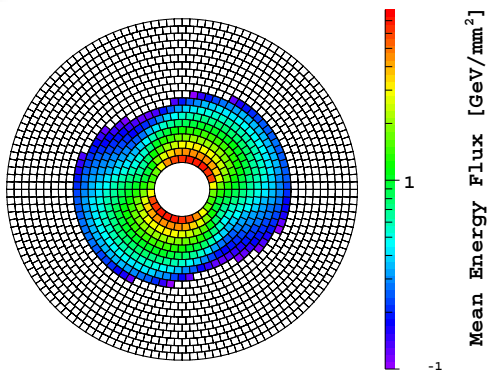




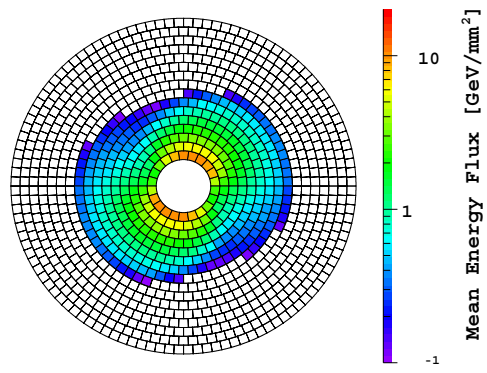
Energy distribution in X-Y plane

Energy vs. Ring number

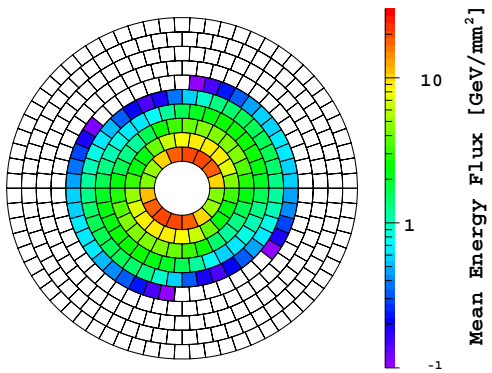
Segmentation



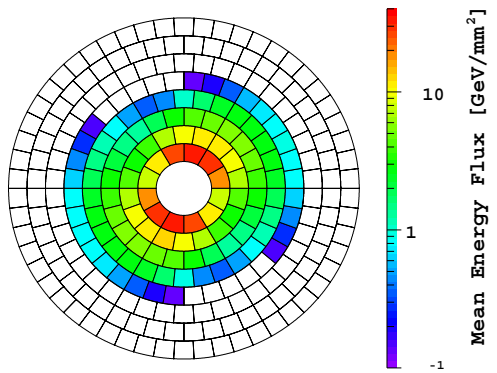
Optimization with fixed cell size



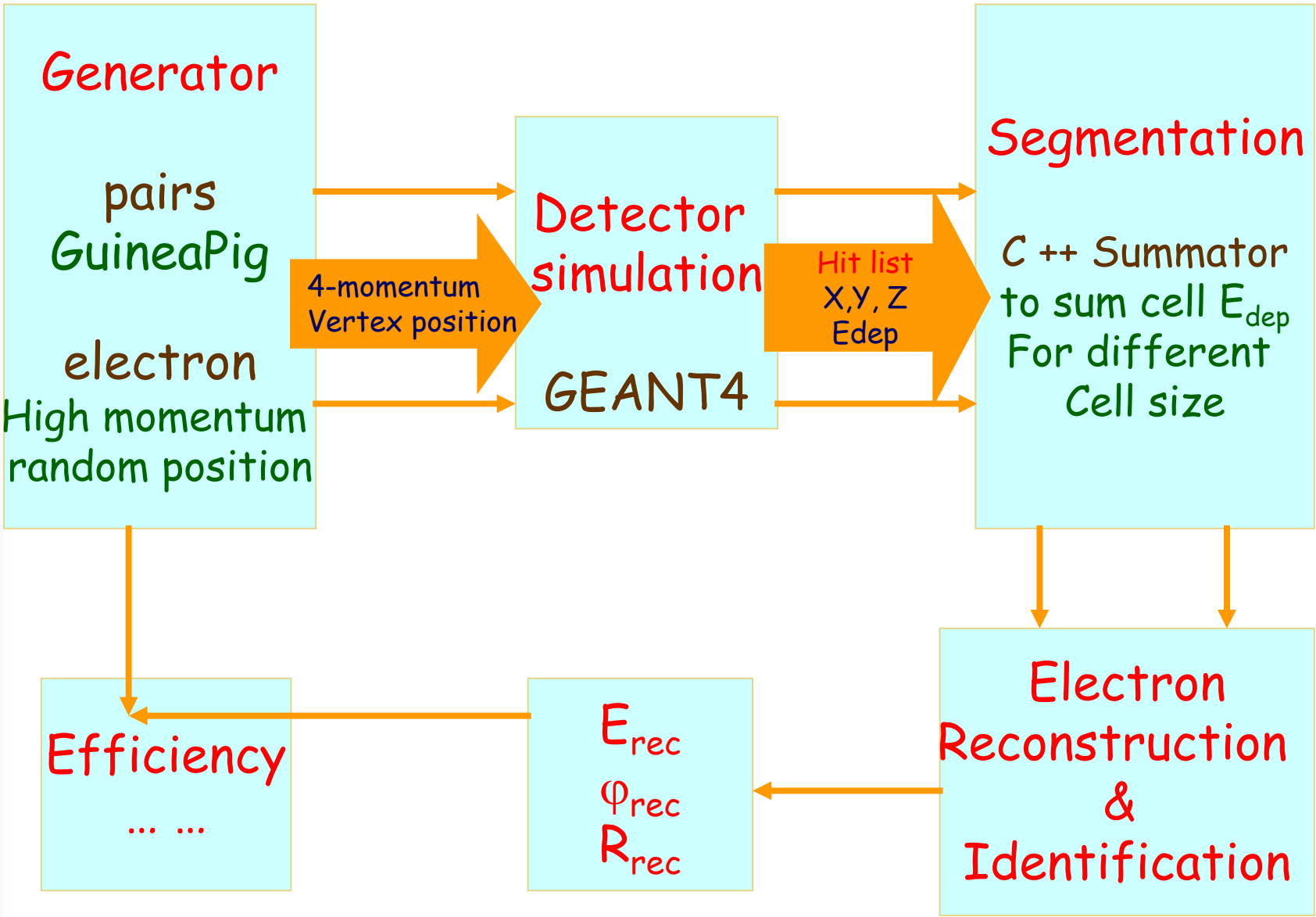
	4 mm	5 mm	8 mm	10 mm
Ring	20	16	10	8
Cell	1660	1072	430	264
Channel	49800	32160	12900	7920



Optimization for electron identification



Optimizing procedure



Event Reconstruction

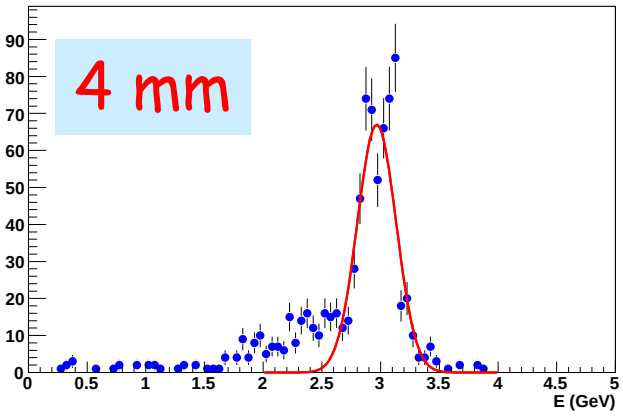
An event: one high energy electron embedded in the pair background of one bunch crossing

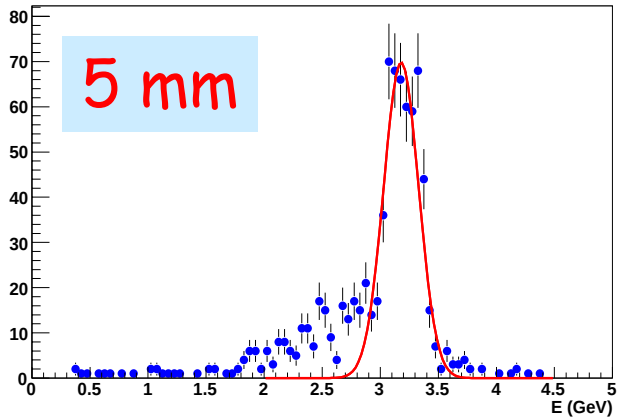
algorithm

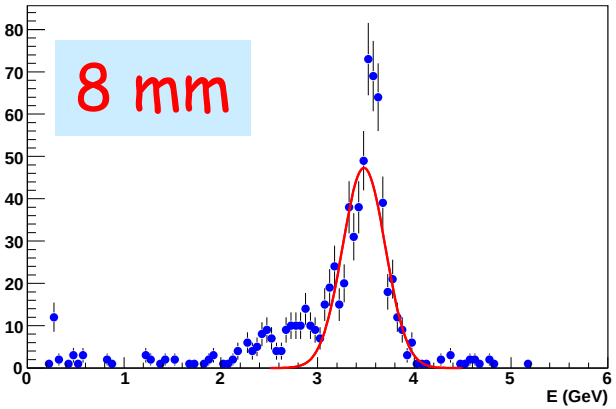
- ★ Use 10 bunches to define $\langle E_{bg} \rangle$ and RMS_{Ebg} for each pad;
- ★ Subtract $\langle E_{bg} \rangle$ from E_{dep} for each pad for a signal event;
- ★ Keep pads with remaining E_{dep} larger than $5 \cdot RMS_{Ebg}$;
- ★ Build clusters:
  more than **7** pads in the segment and
  more than **4** pads in at least one neighbor segment.

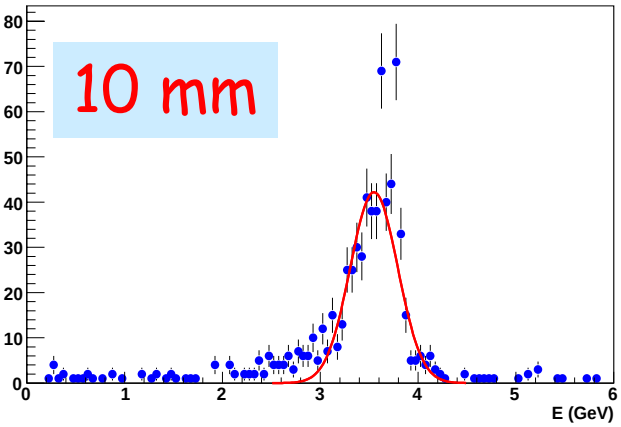
Energy Reconstruction

200 GeV e^- in high background region ($\phi \sim 90°$)



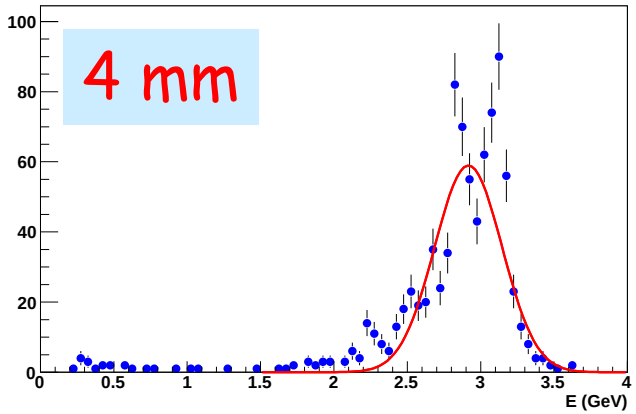


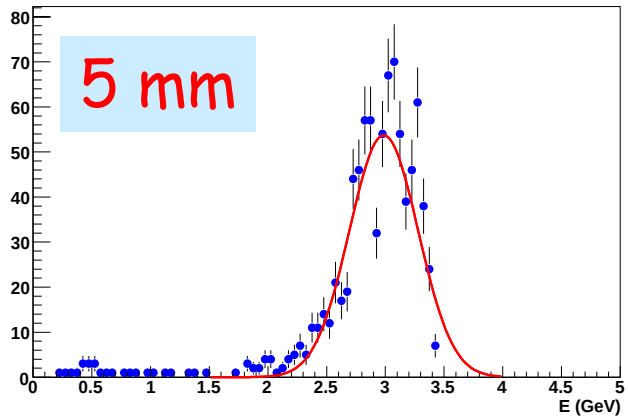


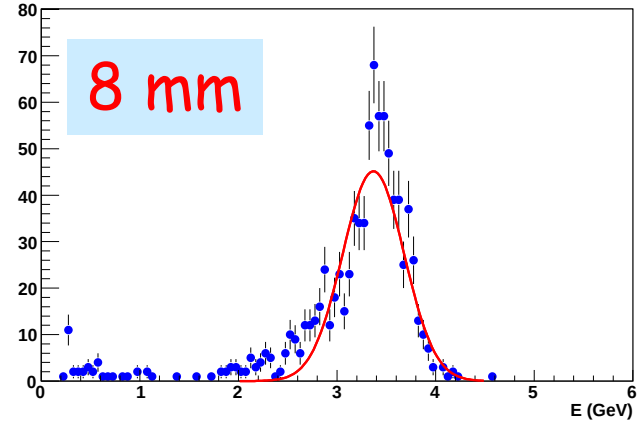


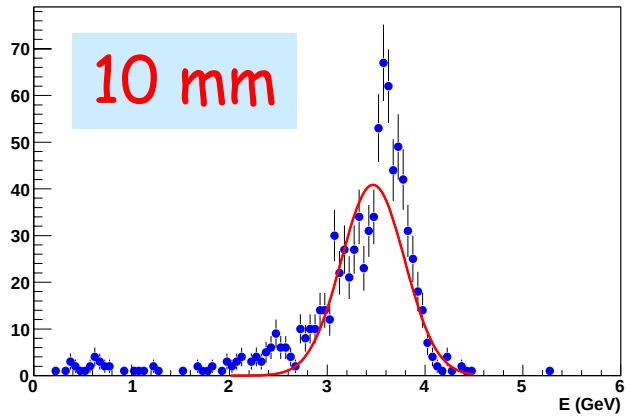
Energy Reconstruction

200 GeV e^- in low background region ($\phi \sim 0°$)





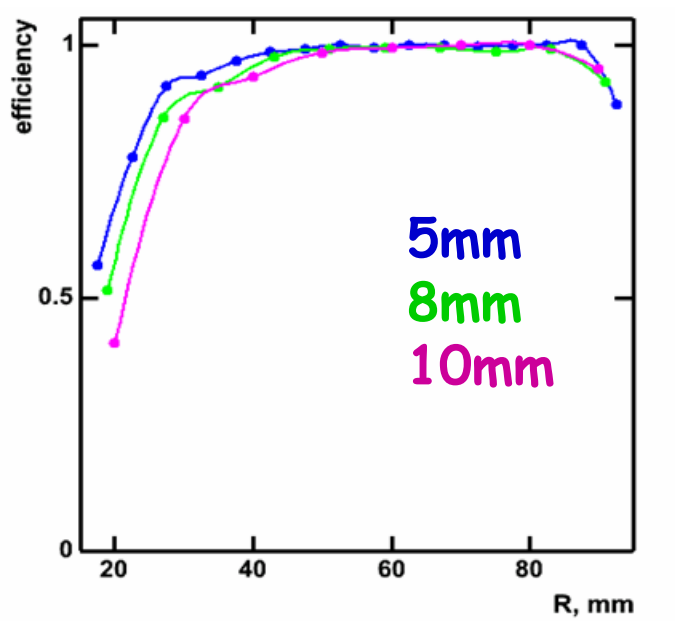




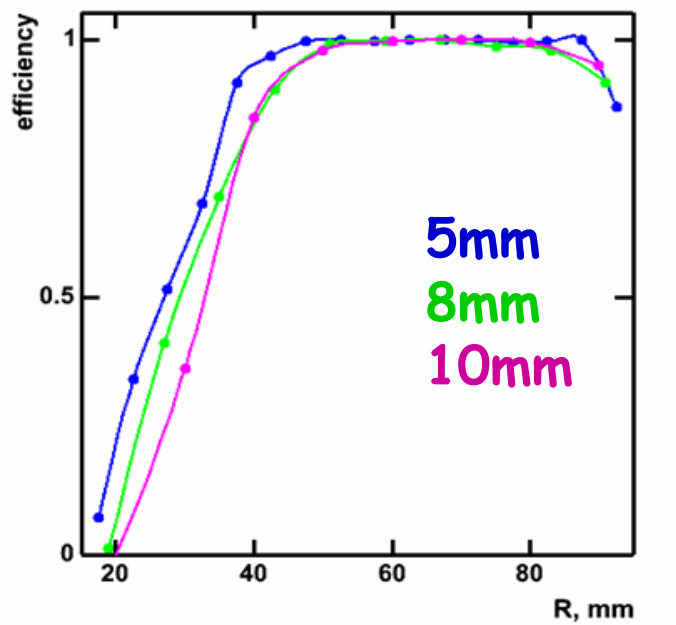
Electron Identification

200 GeV e^-

- ★ $|E_{rec} - E_{fit}| < 3\sigma_{fit}$
- ★ $|R_{rec} - R_{sim}| <$ CellSize/2
- ★ $|\varphi_{rec} \cdot R_{rec} - \varphi_{sim} \cdot R_{sim}| <$ CellSize/2



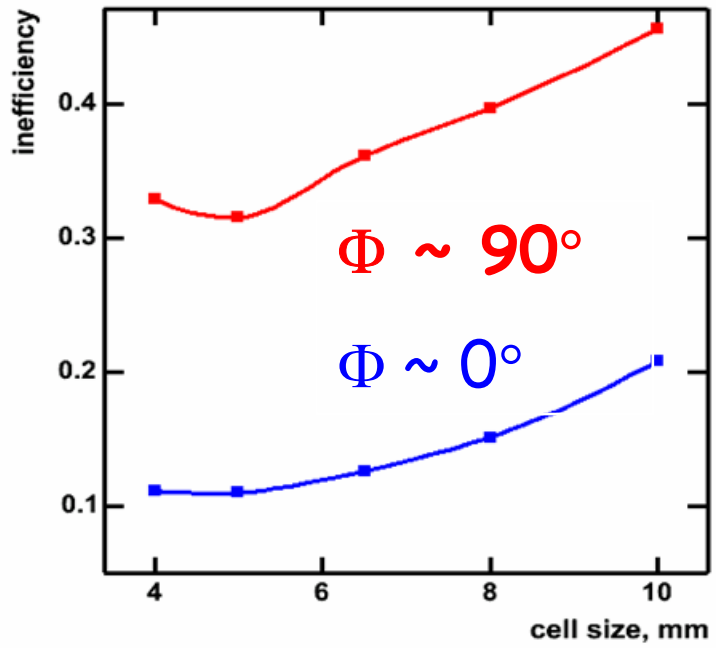
$\varphi \sim 0°$



$\varphi \sim 90°$

Electron Identification

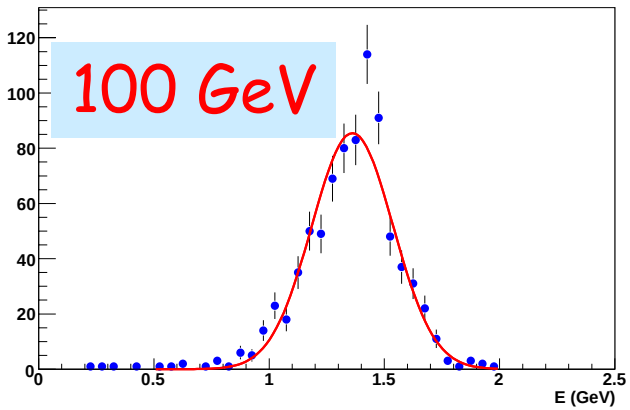
200 GeV e^-

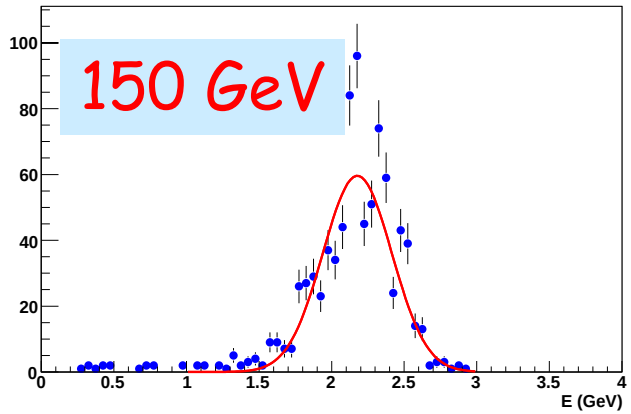


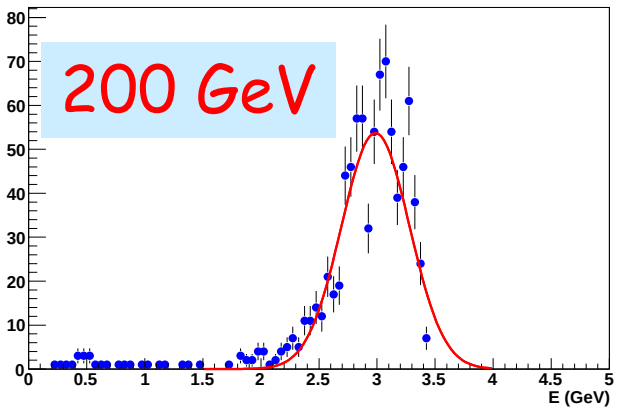
Lose particles when R <55 mm

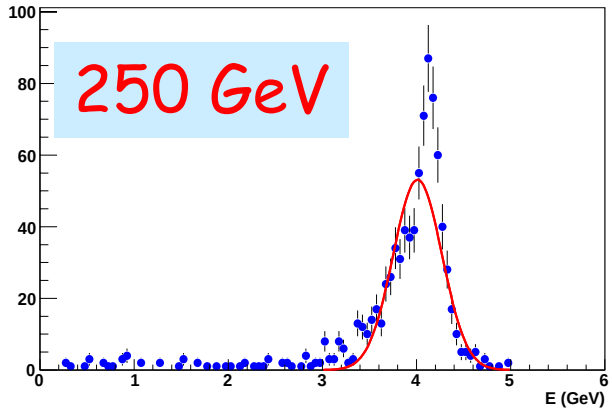
Energy Reconstruction

5 mm segmentation





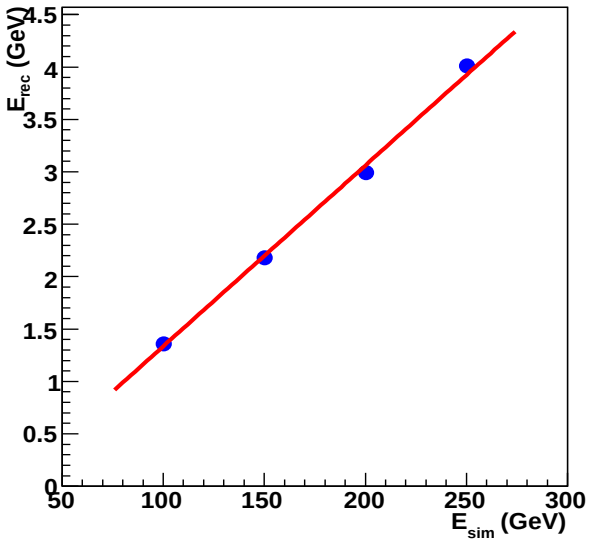


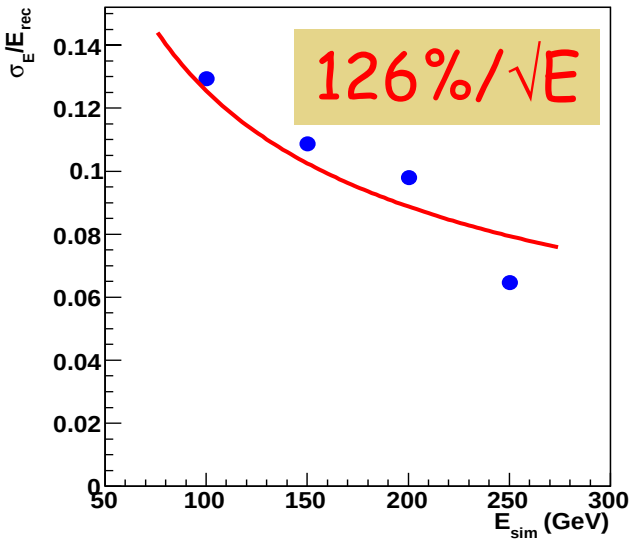


Energy Reconstruction

calibration

resolution





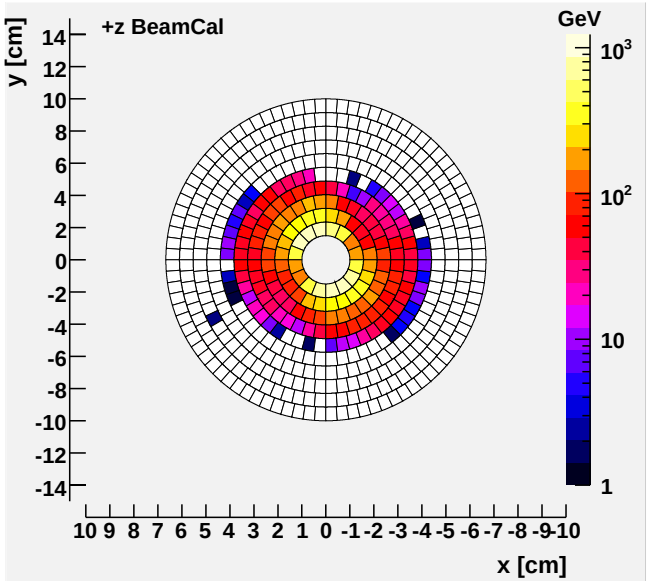
Segmentation with less channels

	Head-on	2mrad	20mrad
Rings	10	10	18
ΔR (mm)	8.5	8.0	8.06
N_{seg} in 1st ring	16	16	16
ΔN_{seg} per ring	8	8	8
N_{seg} per layer	520	520	1512
Blind area	0	0	±15°

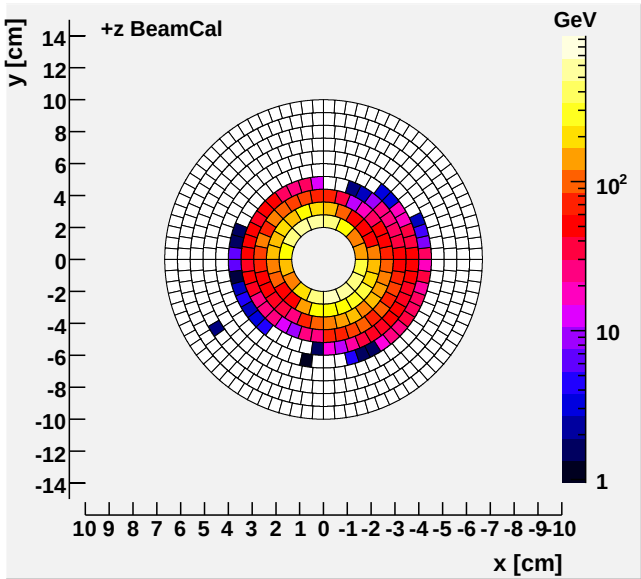
Fast Simulation

One bunch crossing (500GeV)

Head on

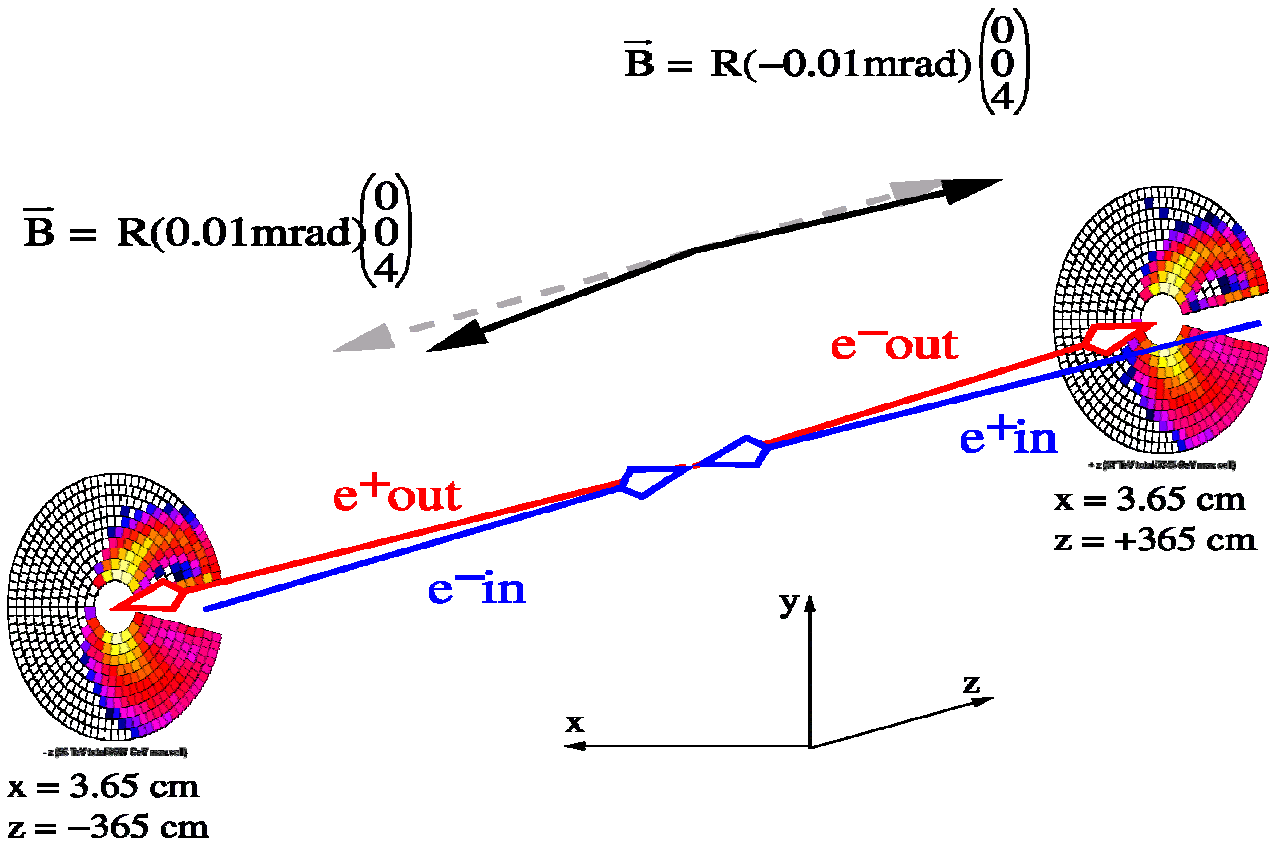


2 mrad



20mrad crossing angle & DID

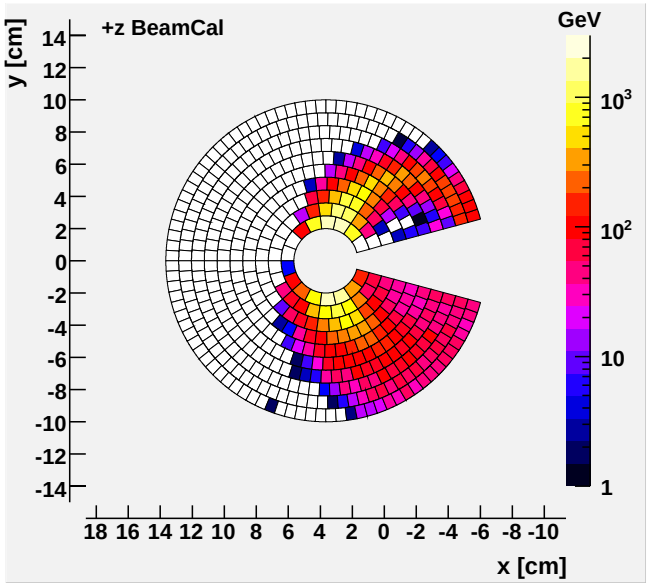
- ★ Detector mounted on the outgoing beam
- ★ Blind area for the incoming beam
- ★ Simplified implementation of DID



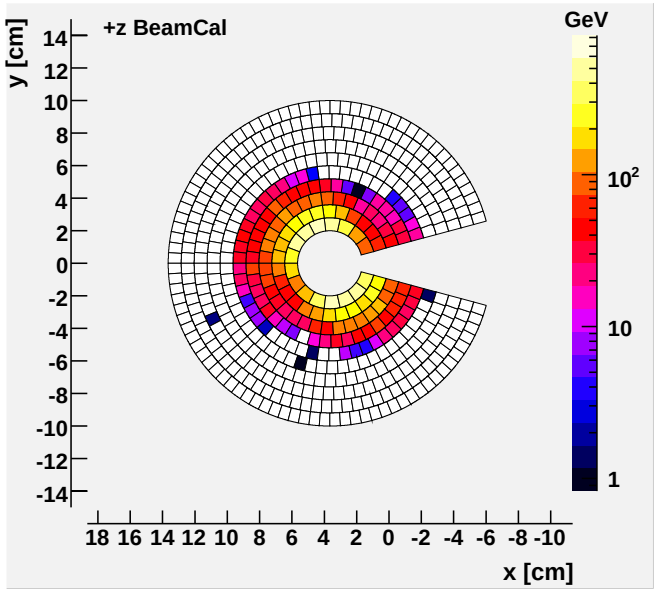
Fast Simulation

One bunch crossing (500GeV)

20 mrad old DID

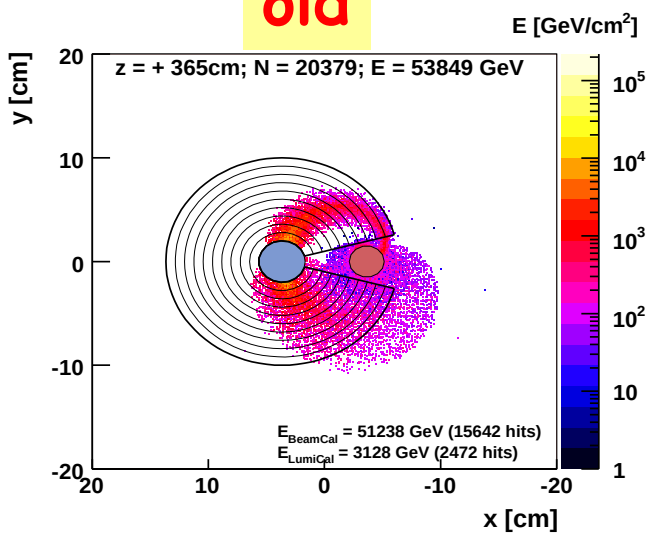


20 mrad old antiDID

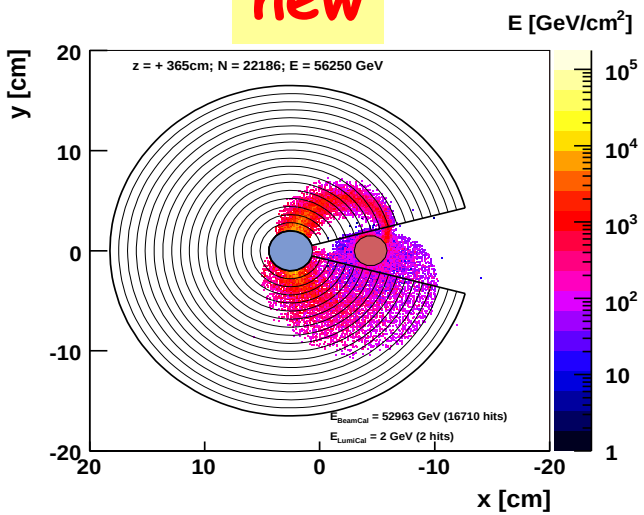


Problem & Possible Solution

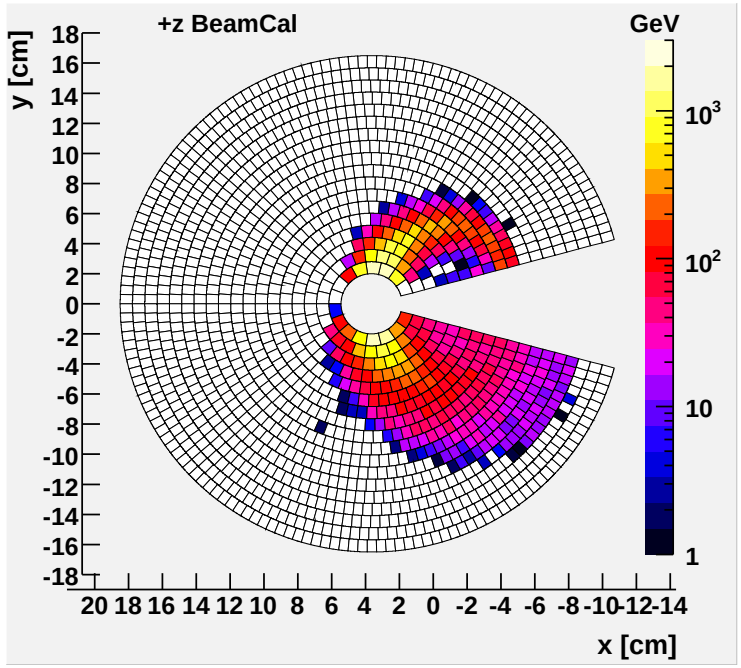
old



new



20 mrad new DID



To-do list

- ★Full simulation of the new 20mrad geometry (diamond-tungsten);
- ★Electron identification study based on the new 20mrad geometry;
- ★Simulation of the silicon –tungsten configuration.