LumiCal Strip Design
and
Crossing Angle Background

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LumiCal description

- LumiCal consists of 30 tungsten disks, thickness 1X0 each (0.35 cm)
- Inner /outer radius of disk is respectively 8 cm/28cm
- Each disk has attached silicon strip detector (0.05 cm)
- Every second detector has either 120 radial strips to measure azimuthal angle φ or 64 concentric strips for measurement polar angle θ
- In total there is 15*(128+120)=3720 read-out channels (when bonding sectors will be possible) or 13320 otherwise

Advantages: 1. low number readout channels (?!)

2. fine granulation in θ, and φ angle

3. entire plane is active (no dead regions)

Data Sample

- Events generated with Bhlumi + BeamStrahlung at 250 GeV nominal beam energy
- Events were generated in the range

$$0.7*\theta_{min} < \theta < 2*\theta_{max}$$

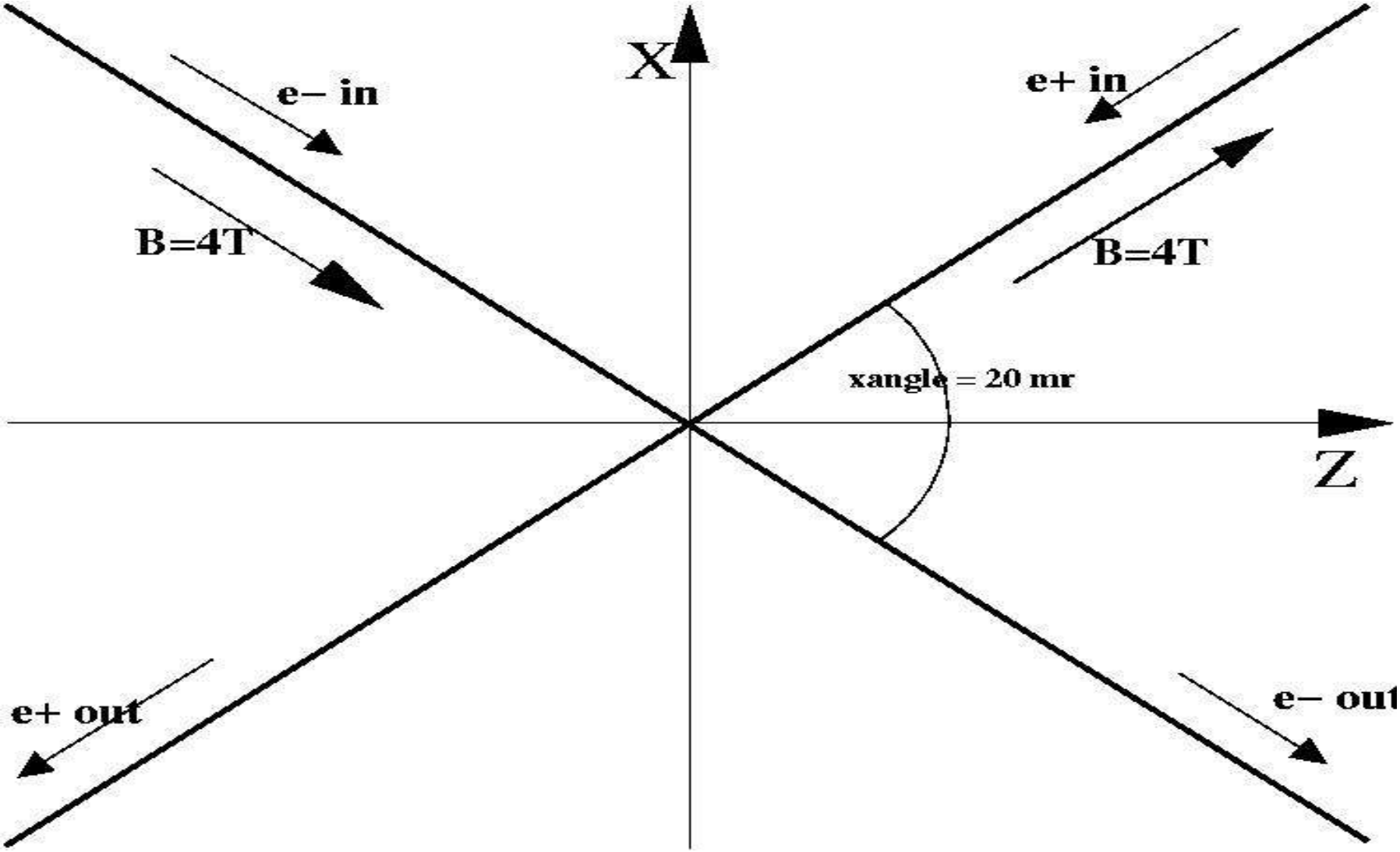
- Cuts applied

$$E_{cal} > 0.8 E_{beam}$$

$$0.028\ rad < \theta < 0.080\ rad$$

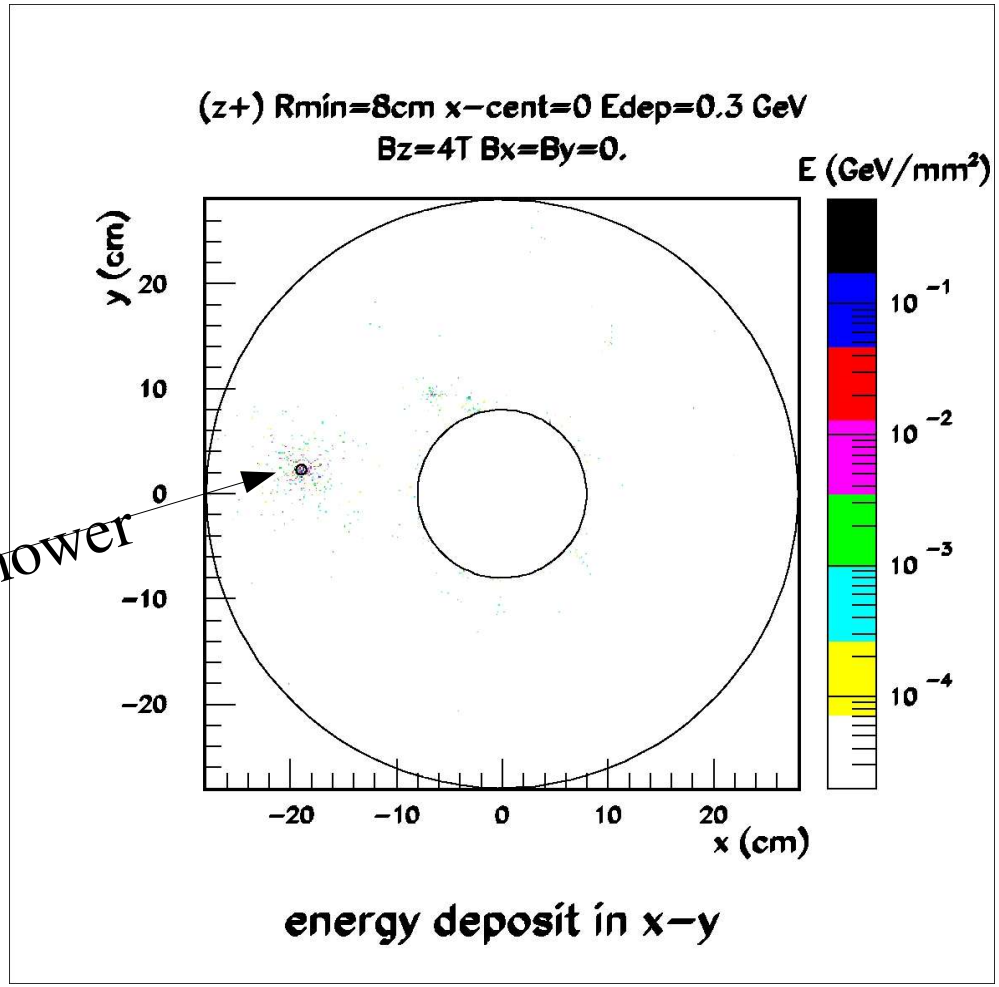
Bhabha electrons and photons generated outside of the LAT geometrical acceptance can be considered as a additional background.

Coordinate System



Energy deposit in Lumical xangle=0mr

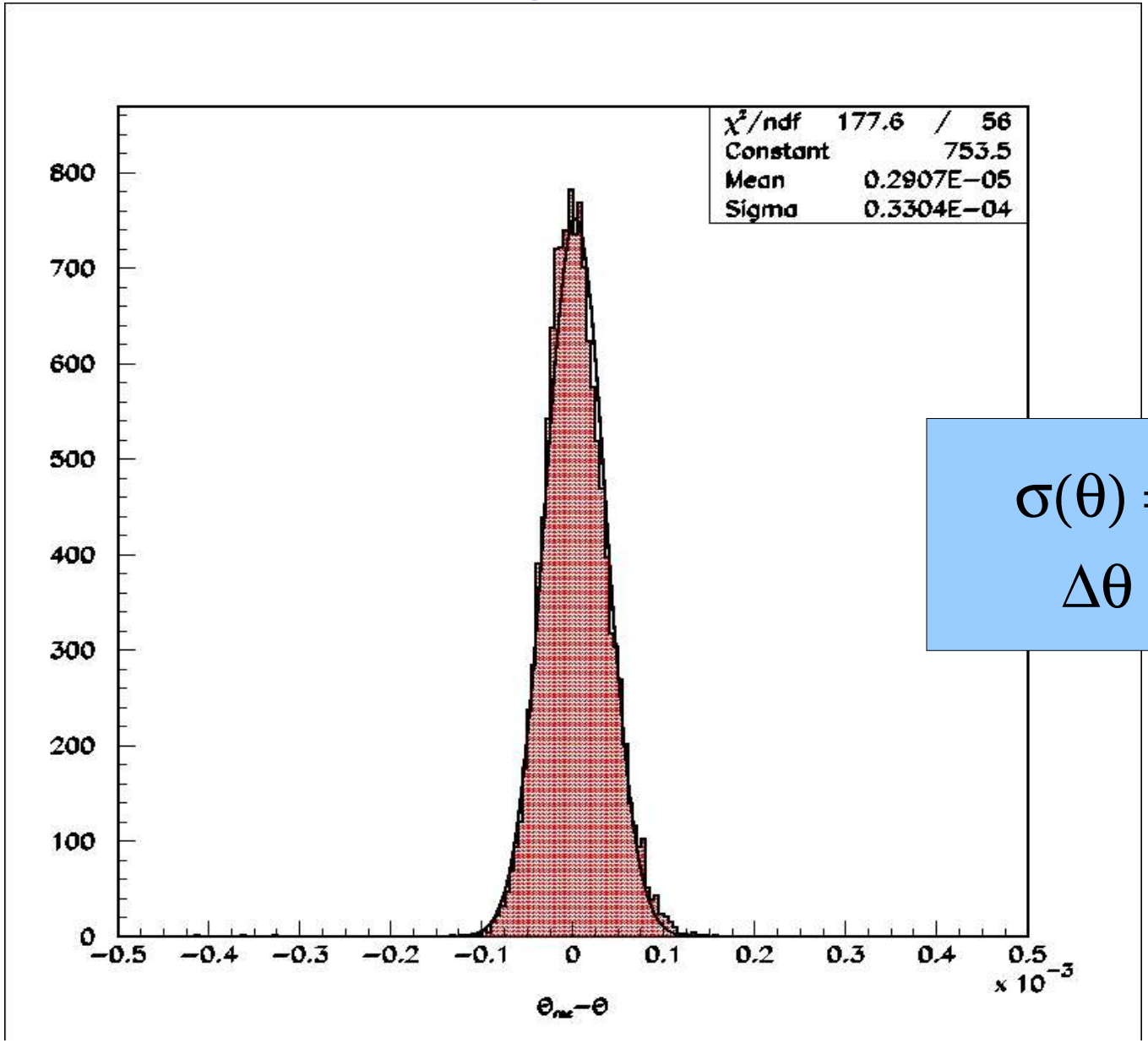
Rmin=8cm, DiD field, N=129 000



electron shower

σ = 5.8 nb (seen)

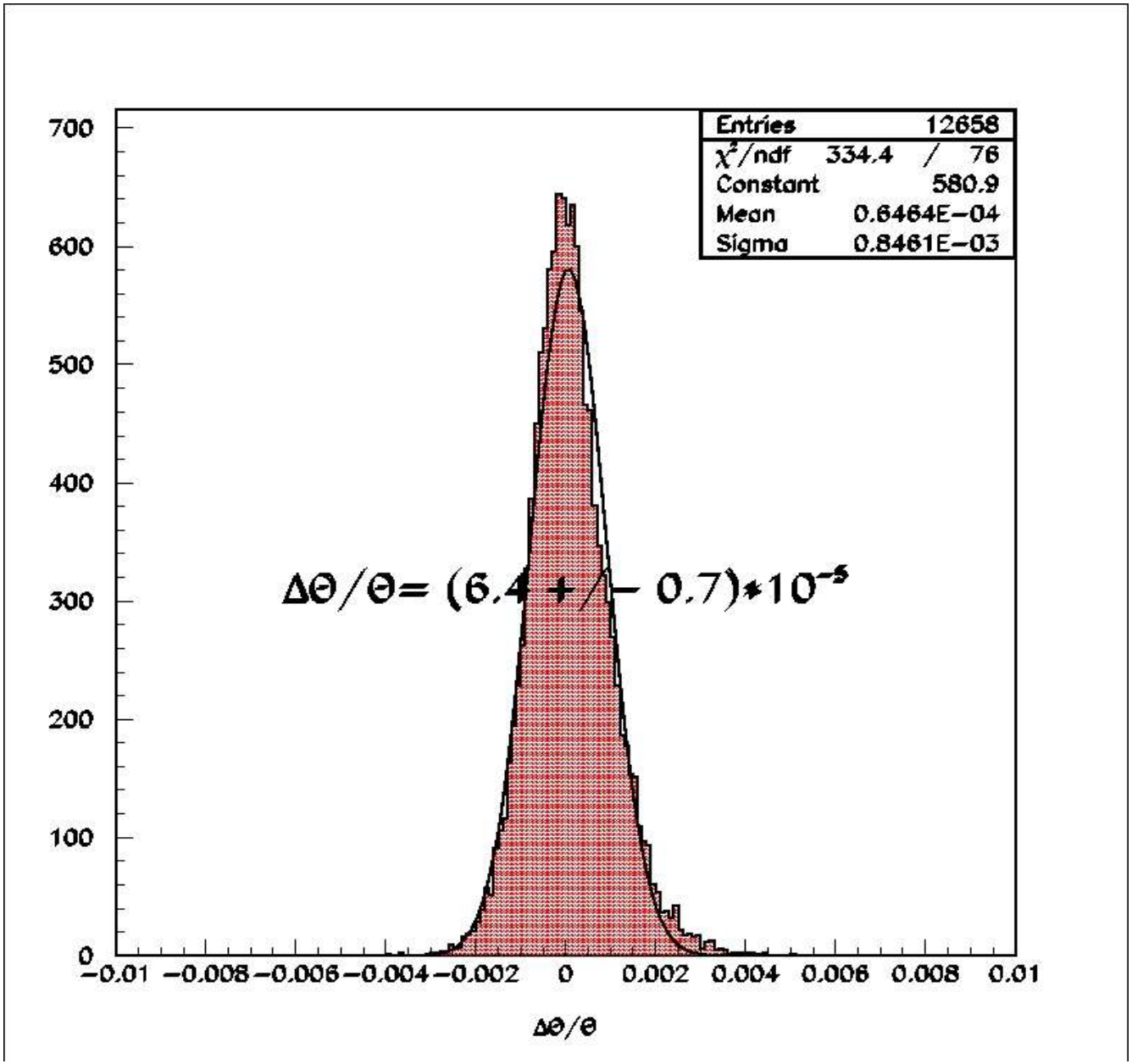
Θ angle resolution *(64 strips)*



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

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

Bias for polar angle Δθ



Average relative bias
for the simulated LumiCal

$\Delta\theta/\theta = (6.4 \pm 0.7) * 10^{-5}$

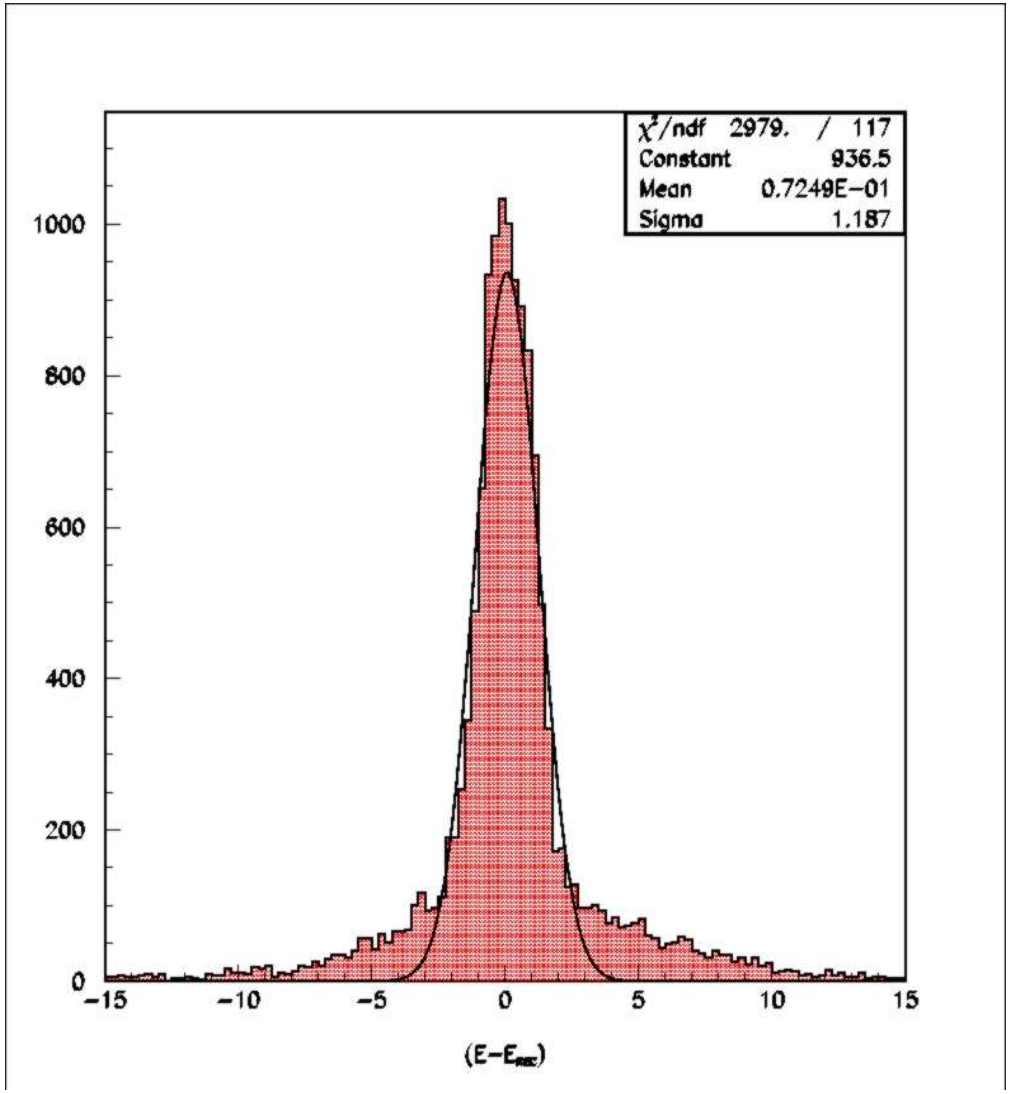
according to formula

$$\Delta L / L \approx 2 * \Delta\theta/\theta$$

one may expect

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

Calibrated Energy Resolution σ(E)



- Calibrated energy

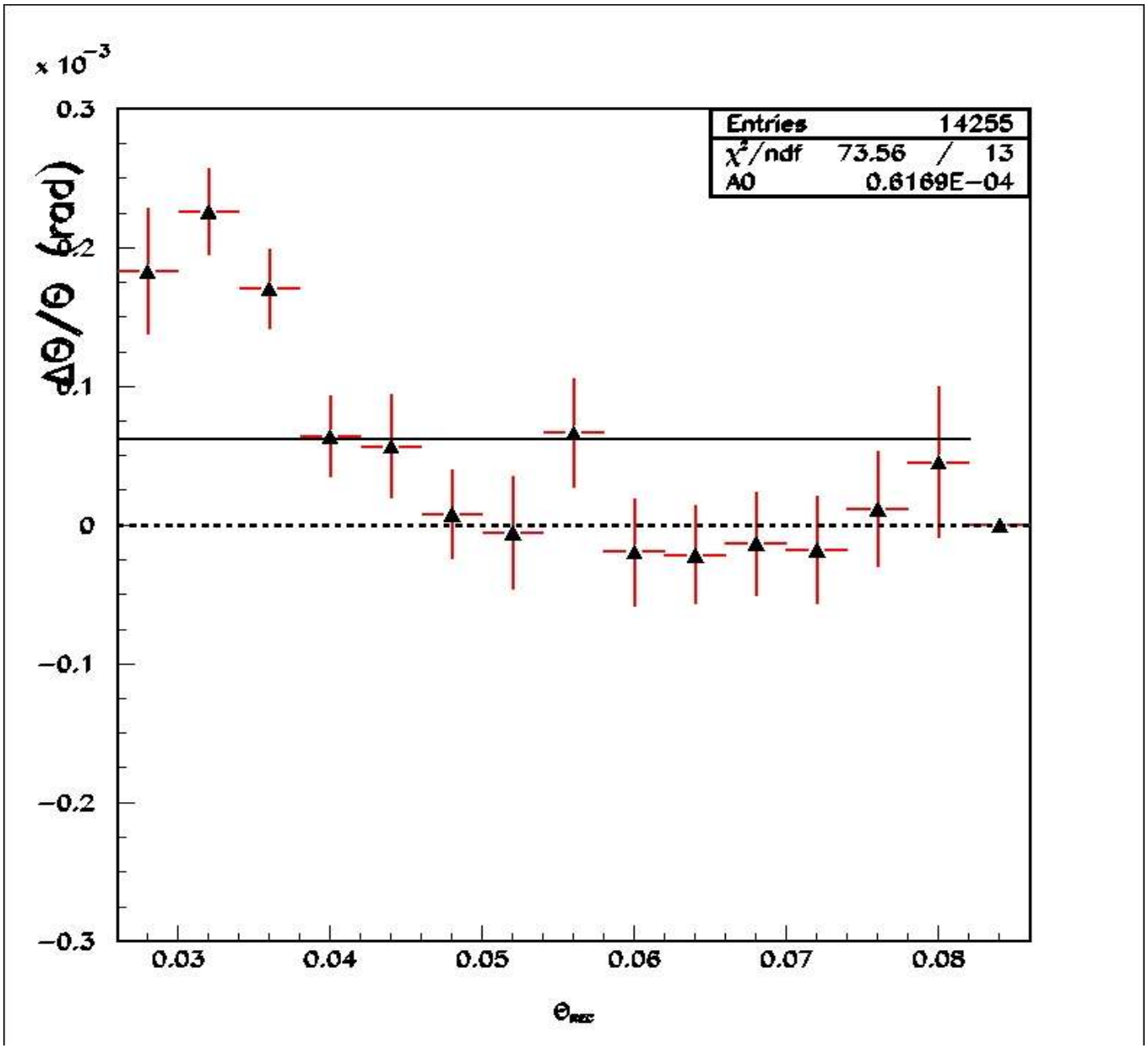
$$E_{CAL} = E_{DEP} * f_C$$

- Distribution is not Gaussian fitted σ= 1.2 GeV
- RMS however is 2.5
- This gives an estimate

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

at 250GeV

Bias for polar angle Δθ



for θ range 28 – 80 mrad

expected accuracy for luminosity measurement

$\Delta L/L \approx 4*10^{-4}$

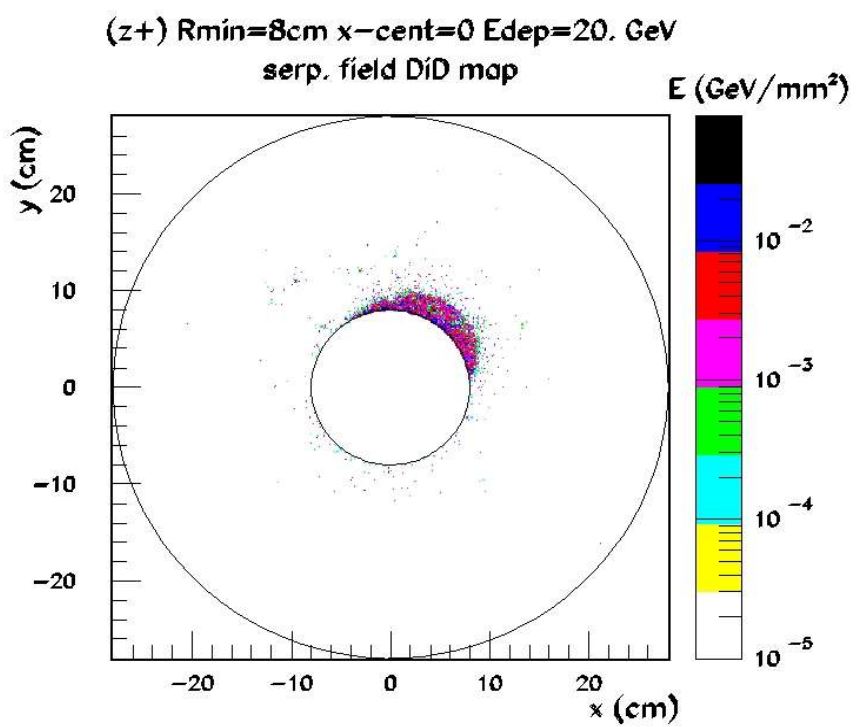
better result might be achieved for higher θ_{min}

Implications of 20mr crossing angle

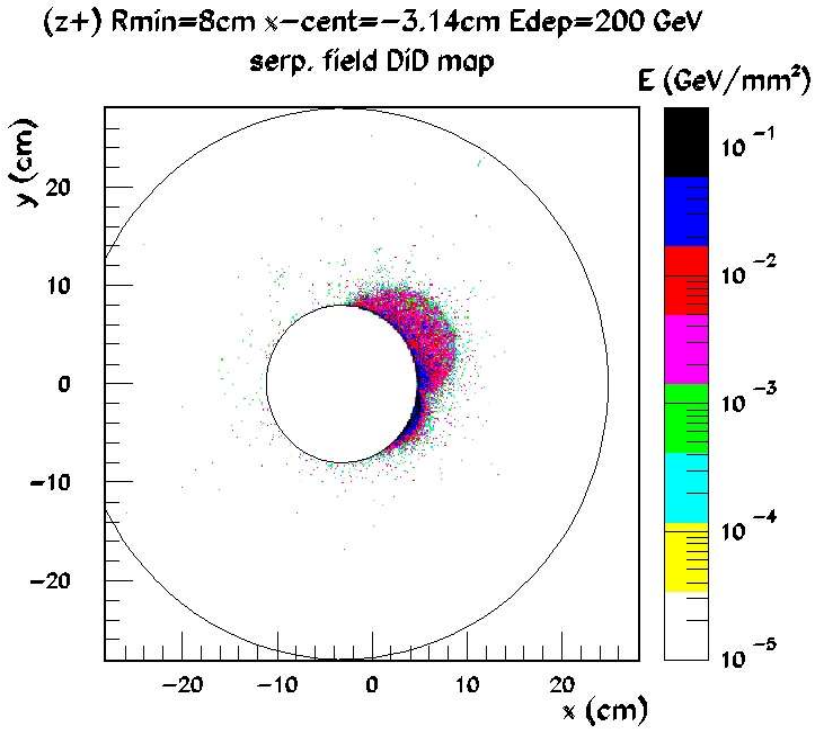
- need serpentine field and Lorentz boost
- Lab Frame is no longer CMS, no simple “back to back” Bhabha event tag
- products of beamstrahlung get into LumiCal acceptance
- θ and φ offsets become correlated due to serpentine field

Energy deposit in Lumical xangle=20mr

Rmin=8cm, DiD field, N=129 000



energy deposit in x−y

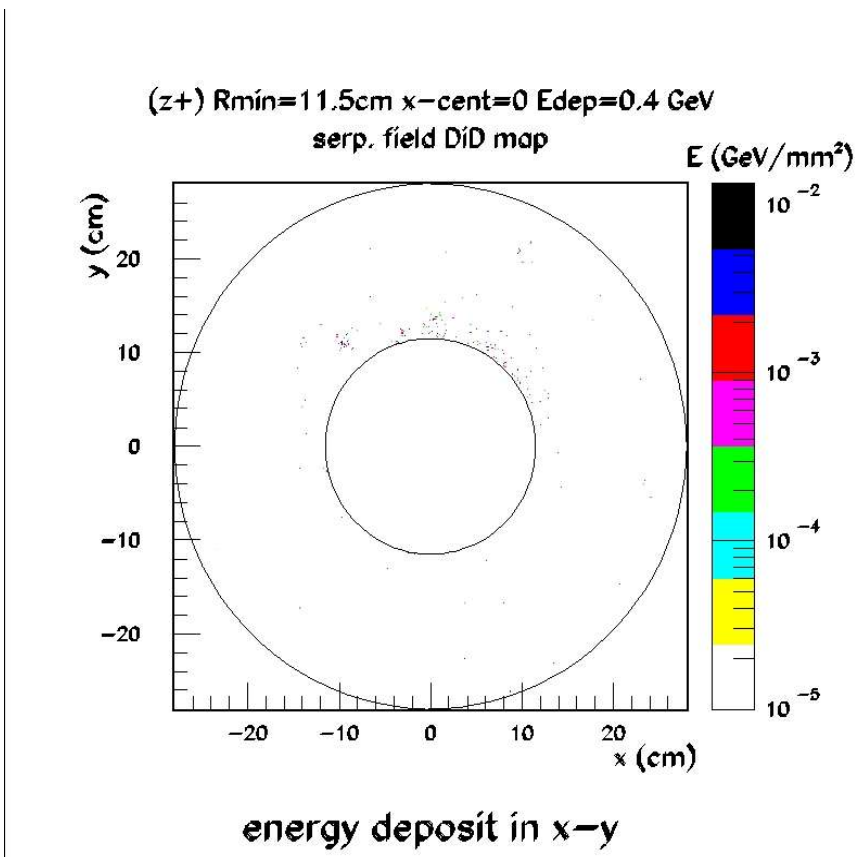


energy deposit in x−y

- keeping Lumical aligned with axis of the detector (xc=0) makes the measured distributions of Bhabha scattering asymmetric
- aligning Lumical with outgoing beam pipes (xc=-3.14 cm for 20mr crossing angle, increases background energy deposit by factor of 10.
- in order to reduce background energy seen in LumiCal, inner radius of sensors was increased from 8cm to 11.5cm and 13.5 cm for xc=0 and xc = -3.14 respectively.
- this procedure reduces background to harmless level of 0.3-0.4 GeV per bunch crossing as we had for 0mr crossing angle

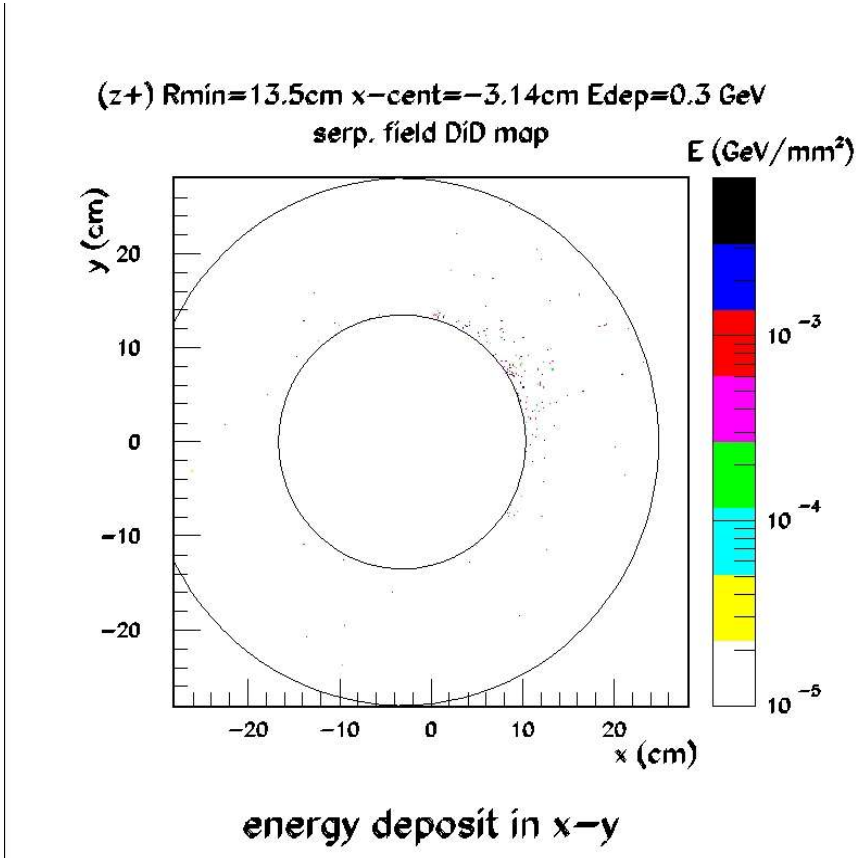
- reconstruction accuracy remains the same as for 0mr setup, but seen cross-section drops from 5.8 nb to 1.8/1.5 nb for xc = 0.
  and xc = -3.14 cm respectively.

Energy deposit in Lumical xangle=20mr reduced Rmin, DiD field, N=129 000



θ = 38-86 mr

σ = 1.8 nb



θ = 44-86 mr

σ = 1.5 nb

Summary

- Stripped LumiCal with enlarged inner radius to minimize influence of beamstrahlung background may achieve the same accuracy as for zero crossing angle. Resolution in polar angle θ order of $4x10^{-5}$ radian and offset $\Delta\theta/\theta \approx 6x10^{-5}$ which results in $\Delta L/L \approx 10^{-4}$
- Measured cross-section will drop however from 5.8 nb to 1.8/1.5 nb depending on position of LumiCal
- 20mr crossing angle and serpentine field introduces obstacles in reconstruction and tagging Bhabha events