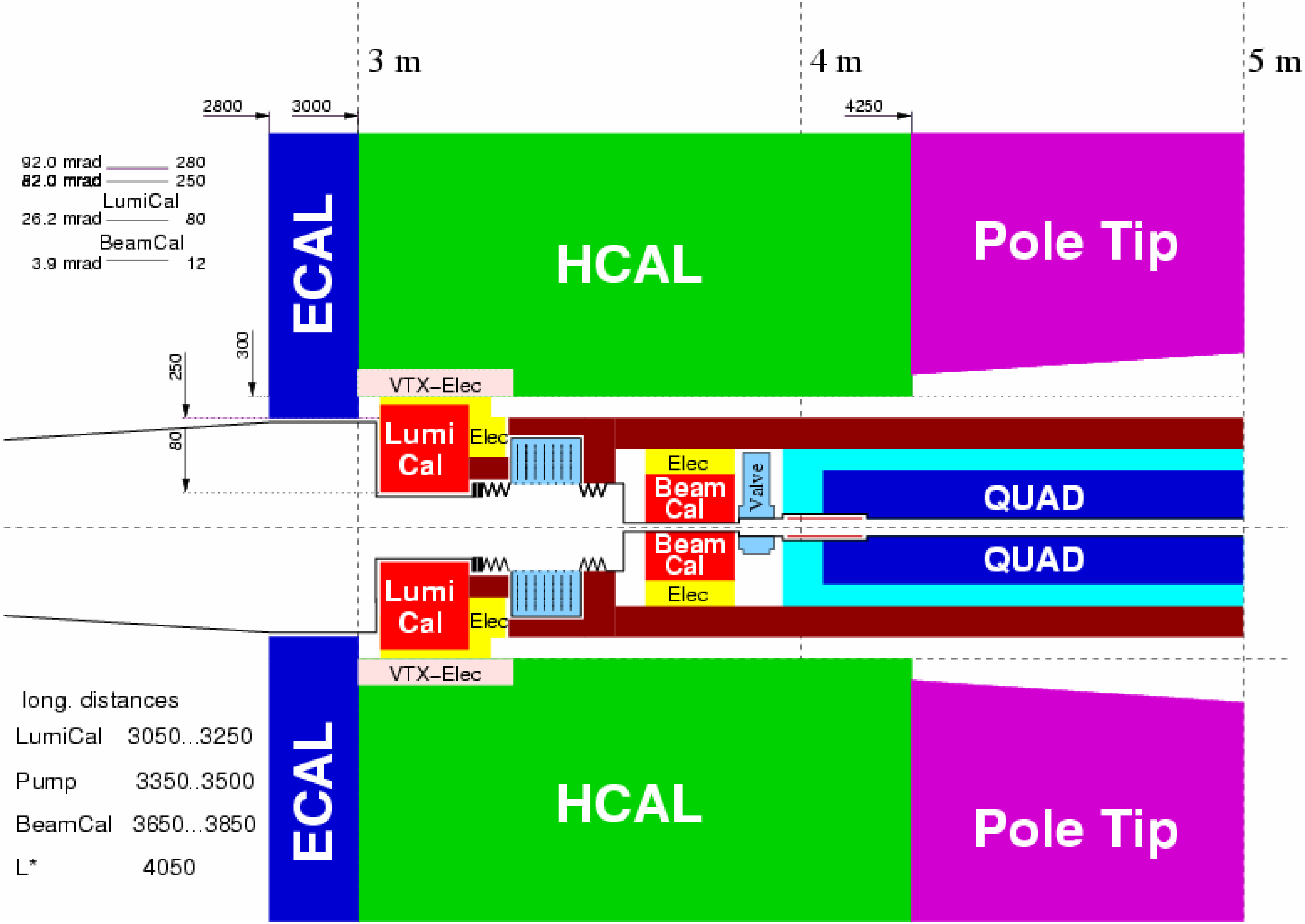
GamCal Issues

William Morse - BNL

FCAL R&D Collaboration

- W. Lohmann (DESY Zeuthen) spokesman
- W. Morse (BNL) beam diagnostics (BeamCal/GamCal) coordinator
- B. Pawlik (Cracow) simulations
- W. Lange (DESY) sensors
- TBD electronics
- W. Wierba (Cracow) LumCal laser alignment



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

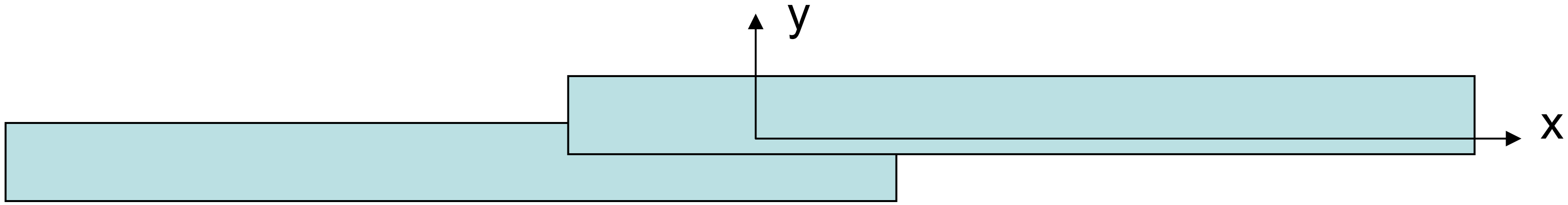
U.S. Forward

- G. Haller, A. Abusleme, M. Breidenbach, D. Freytag (SLAC): BeamCal readout design
- Z. Li (BNL): BeamCal radiation damage issues
- B. Parker (BNL): machine interface issues
- M. Zeller, G. Atoian, V. Issakov, A. Poblaguev (Yale): GamCal design issues
- Y. Nosochkov (SLAC): Extraction line issues
- U. Nauenberg (Colorado): SUSY studies

Achieving the Design Luminosity Will Be a Challenge

- Bunch P_- (t) {N, E, x, y, z, σ_x, σ_y, σ_z, σ_{xy}, ψ_x, ψ_y}
- Bunch P_+(t) {N, E, x, y, z, σ_x, σ_y, σ_z, σ_{xy}, ψ_x, ψ_y}
- Instantaneous Luminosity:

$$L(t) \propto \frac{N_+^o N_-^o}{\sigma_x^o \sigma_y^o}$$



Beam-strahlung

- $F = e(E + c\beta\times B)$. $B_{max} \approx 1KT$
- Instantaneous power radiated:
- $P_\gamma \approx 3\% \ P_e \qquad N_\gamma \approx 1.5 N_e$
- Bethe-Heitler: $\gamma e \rightarrow e\ e^+e^-$
- $\sigma_{BH} \approx 38$ mb
- <E> ≈ 1GeV
- Landau-Lifshitz: $ee \rightarrow ee\ e^+e^-$
- $\sigma_{LL} \approx 19$ mb
- <E> ≈ 0.15GeV
- Other processes much smaller
- C. Rimbault et al., Phys Rev ST AB 9,034402 (2006).

$$P = \frac{2 r_0 \gamma^2 F^2}{3mc}$$

Bethe-Heitler Pairs

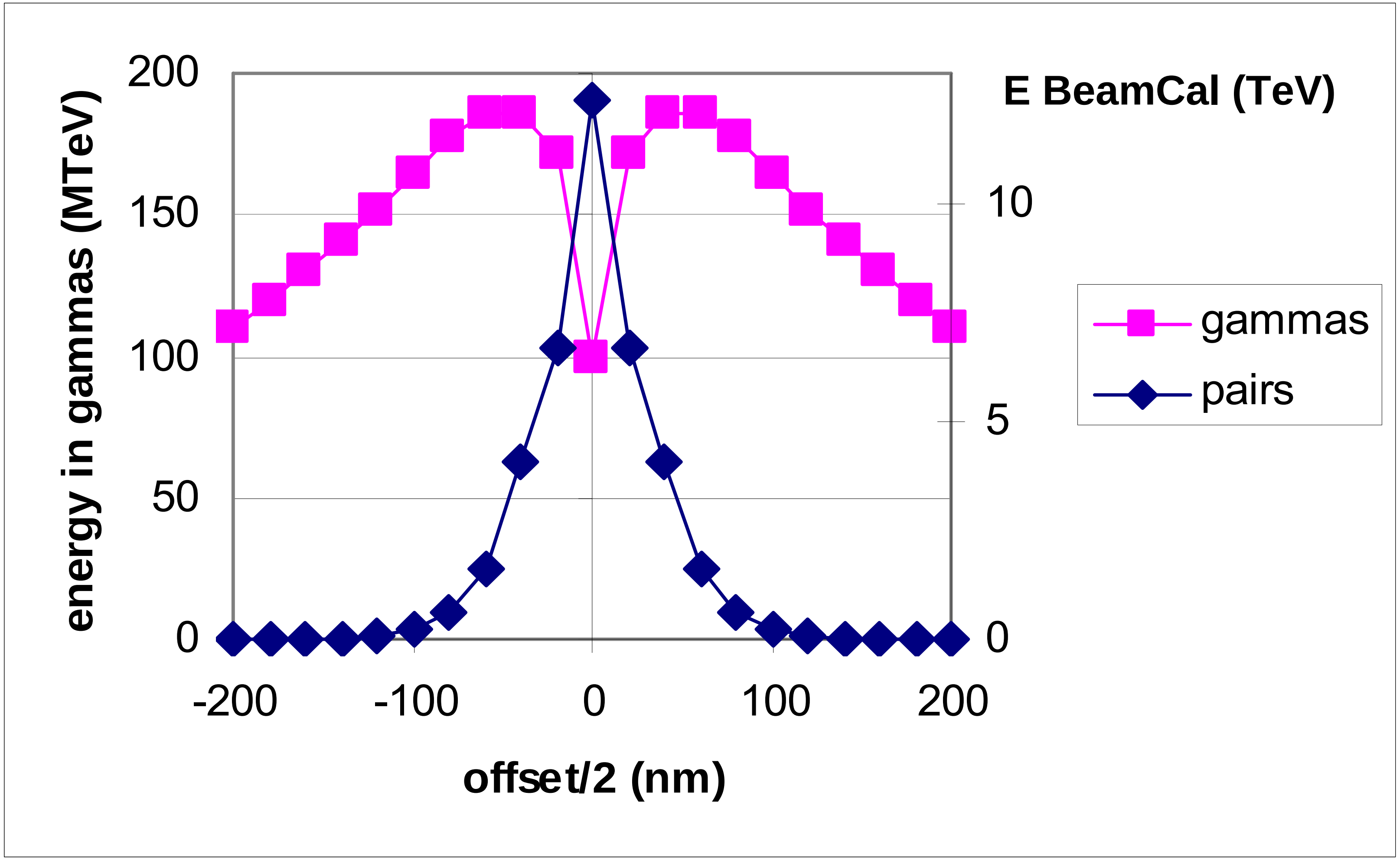
- $\gamma e \rightarrow e\ e^+e^-$

$$N_{ee} \propto \frac{\sigma_{BH} N_\gamma^o N_e^o}{\sigma_x^o \sigma_y^o} \qquad \frac{N_{ee}}{N_\gamma} \propto \frac{\sigma_{BH} N_e^o}{\sigma_x^o \sigma_y^o}$$

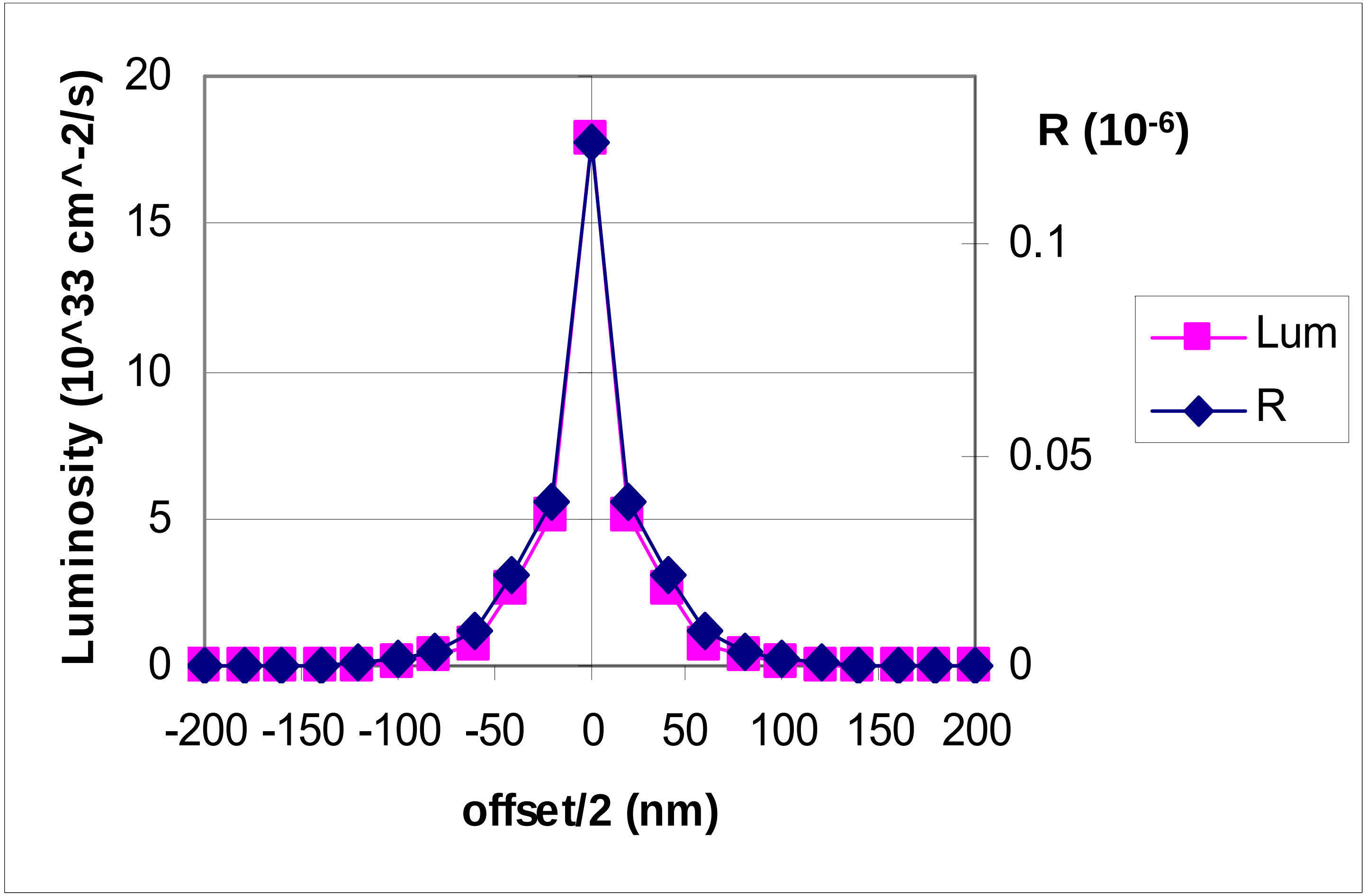
$$\frac{E_{ee}}{E_\gamma} \propto \frac{N_e^o}{\sigma_x^o \sigma_y^o}$$

For left and right detectors separately: $N^+/\sigma_x\sigma_y$ and $N^-/\sigma_x\sigma_y$.

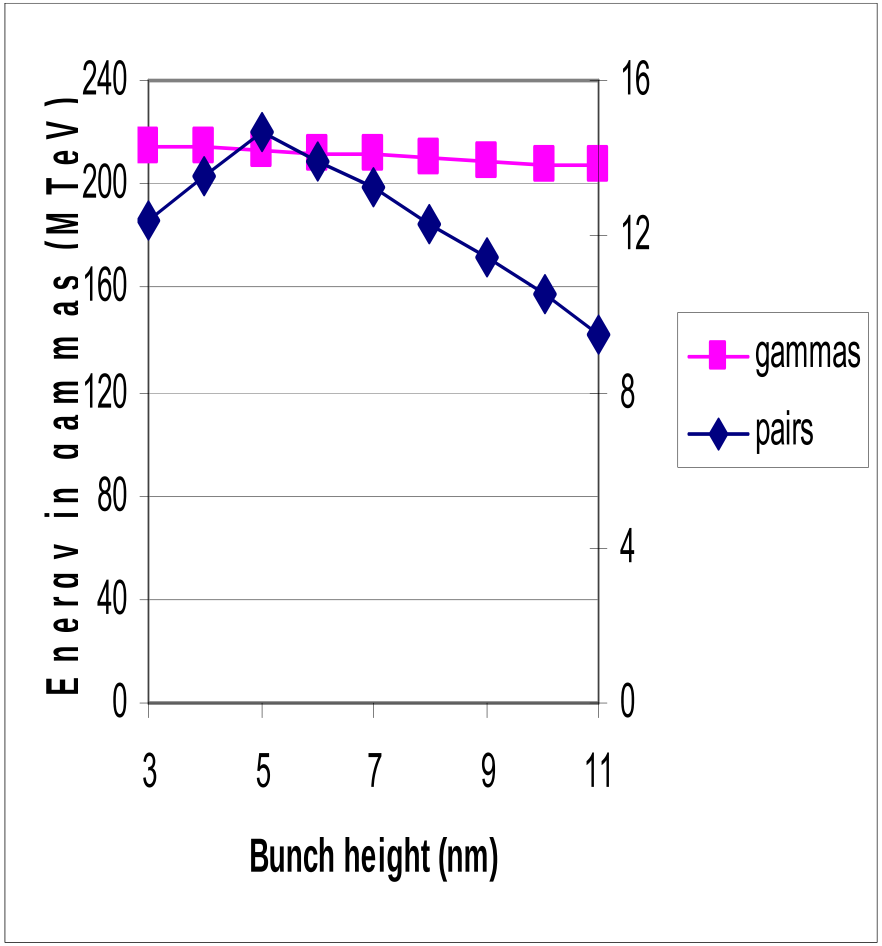
Vertical offset

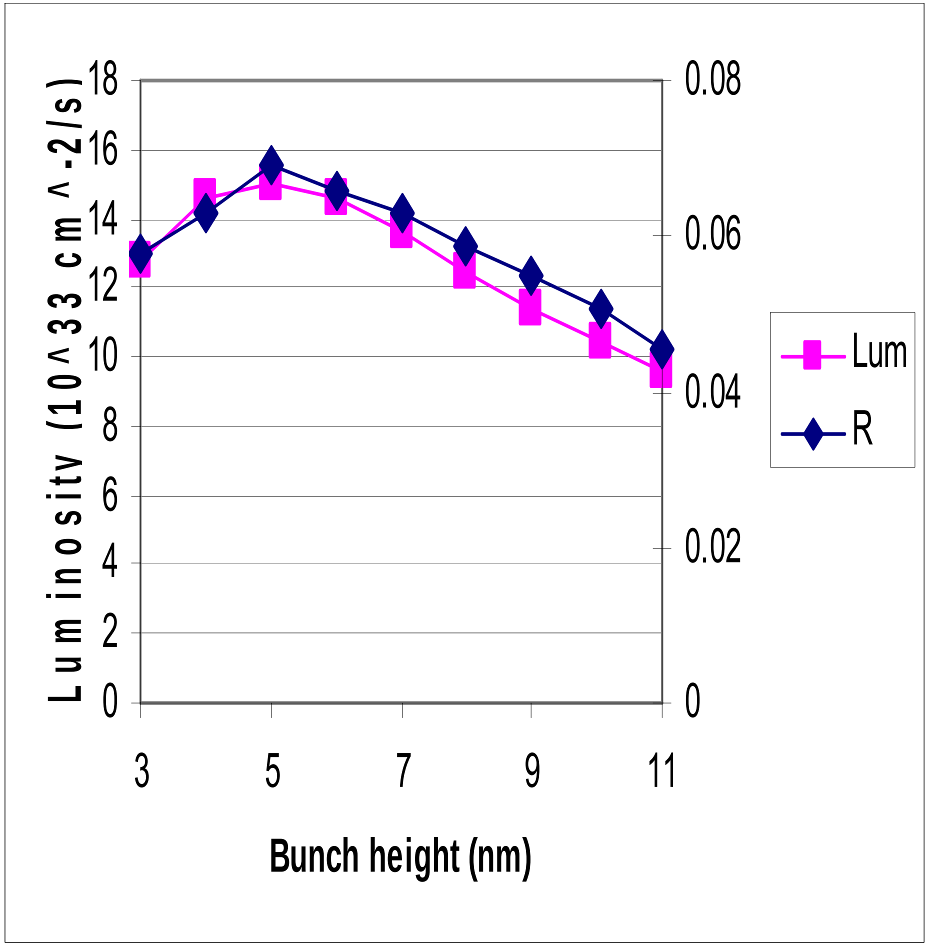


Vertical Offset

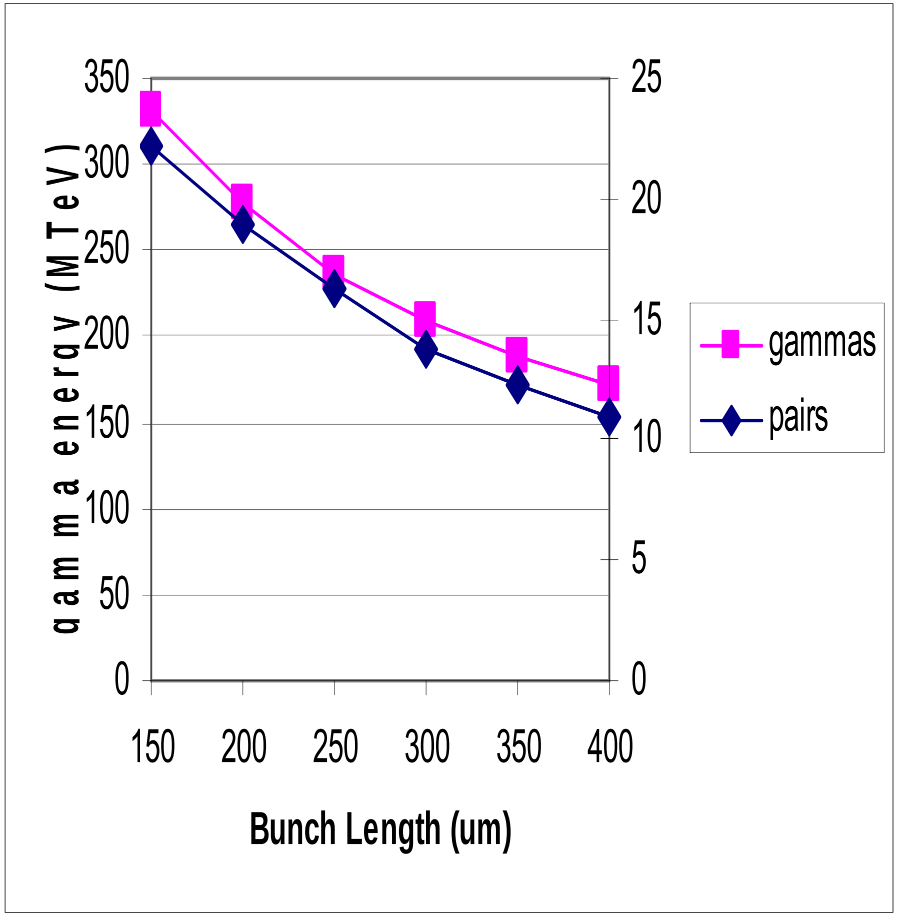


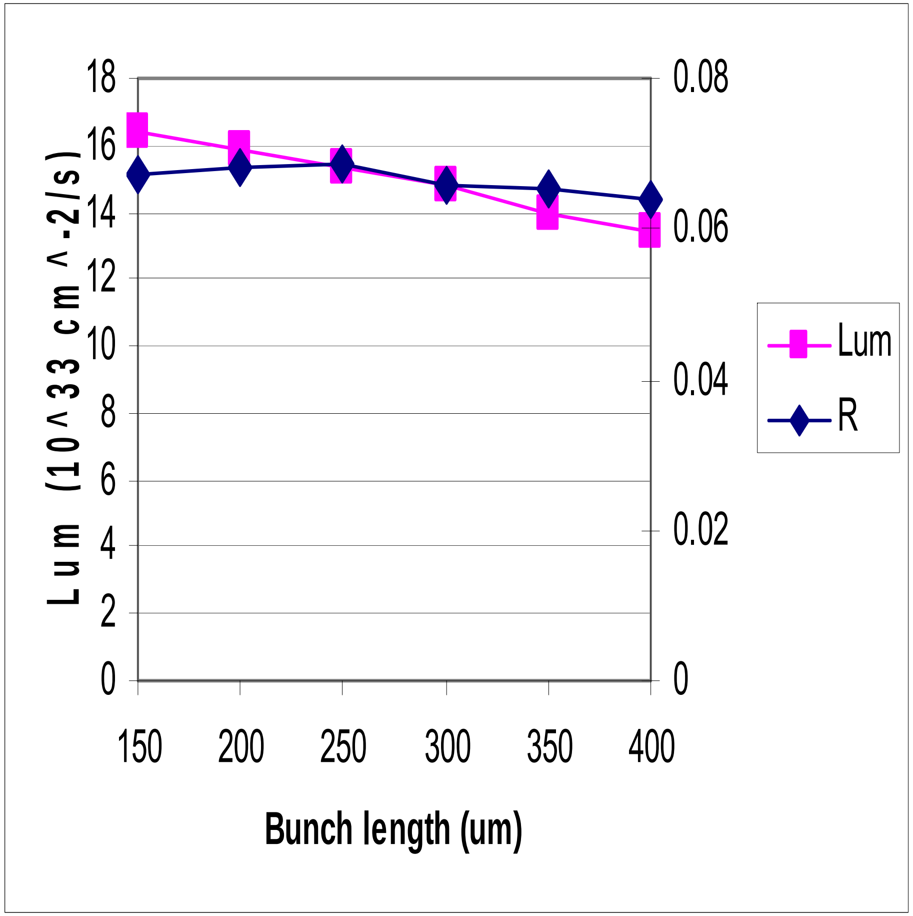
Bunch Height





Bunch Length

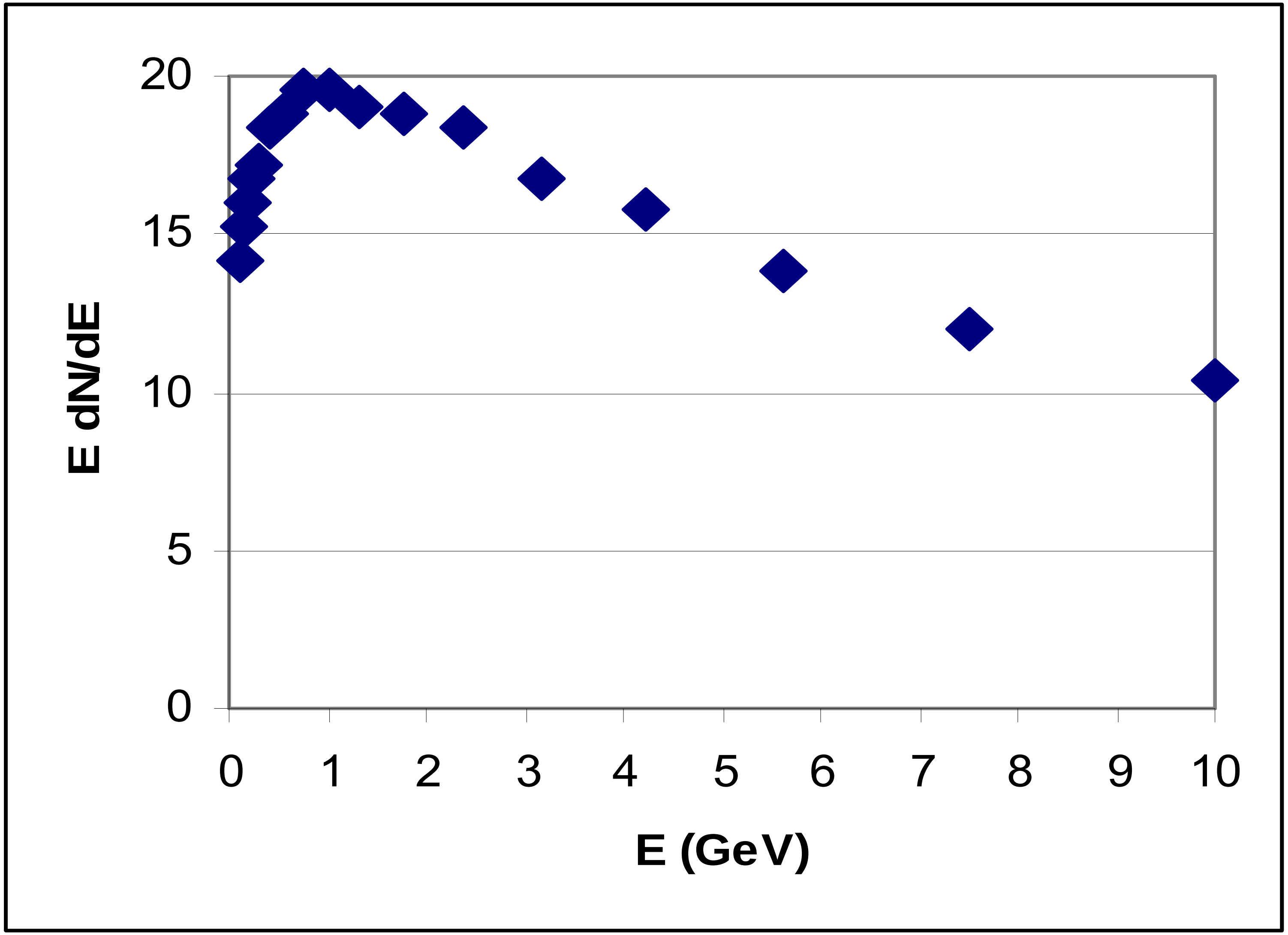




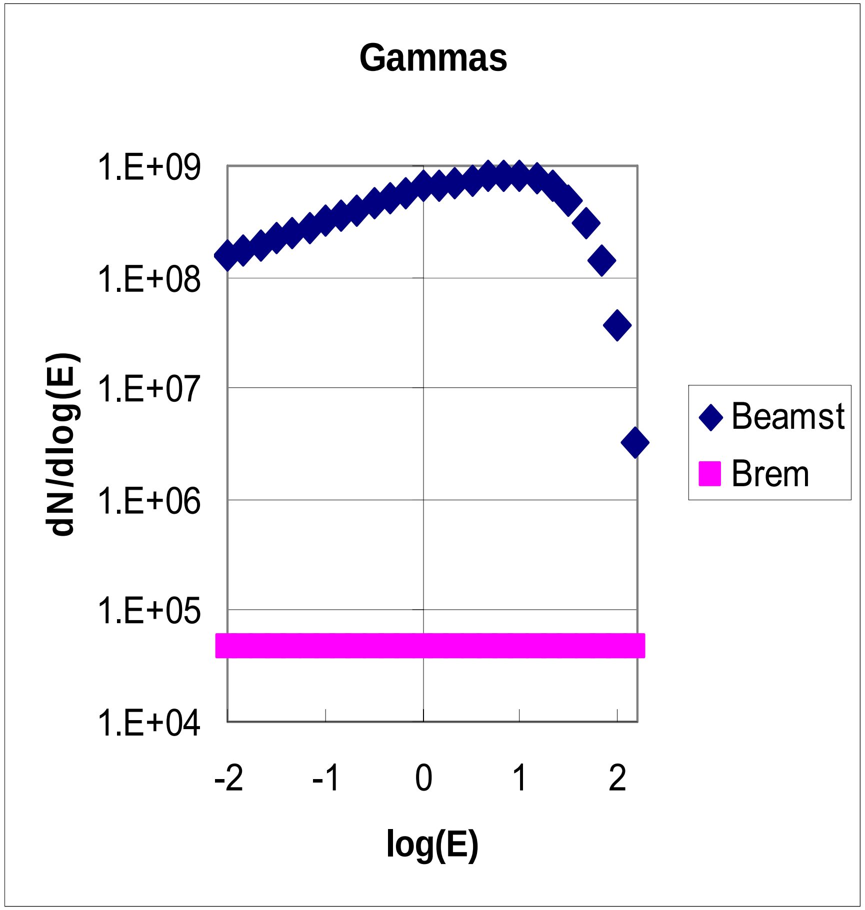
GamCal Detector Concepts

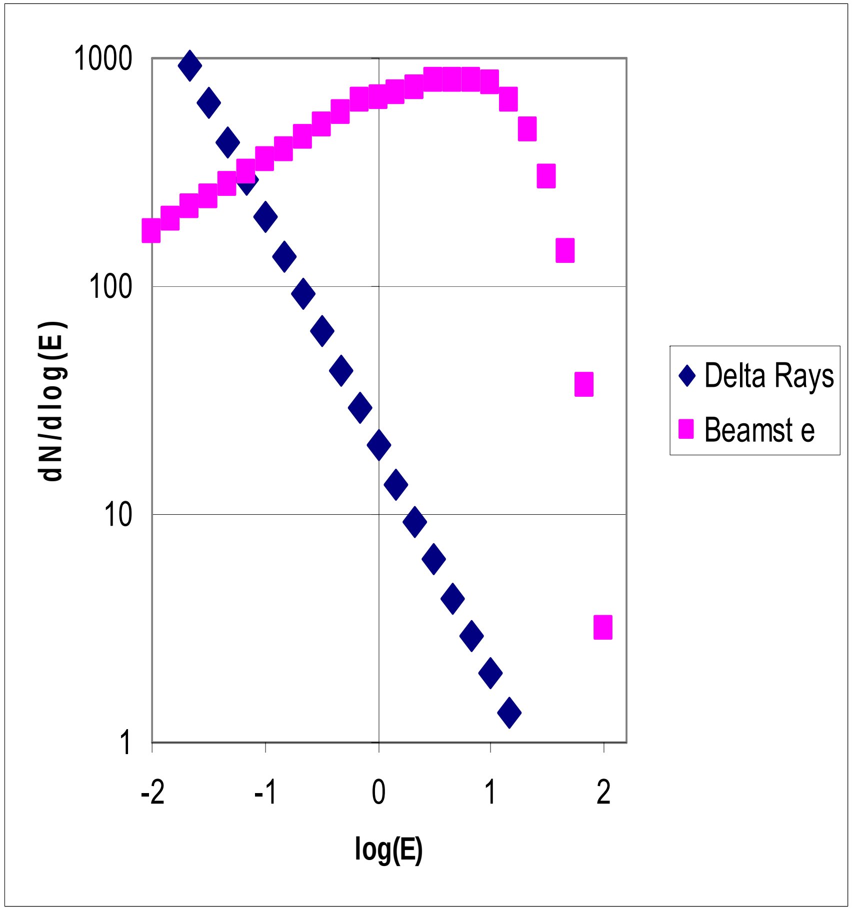
- 10^{-4} - 10^{-6} X_0 to convert beam-strahlung gammas into e^+e^- pairs
- Converter could be gas jet or a thin solid converter
- Magnet to separate pairs from beam electrons

Beam-strahlung $\gamma Z \rightarrow eeZ$



GamCal Backgrounds



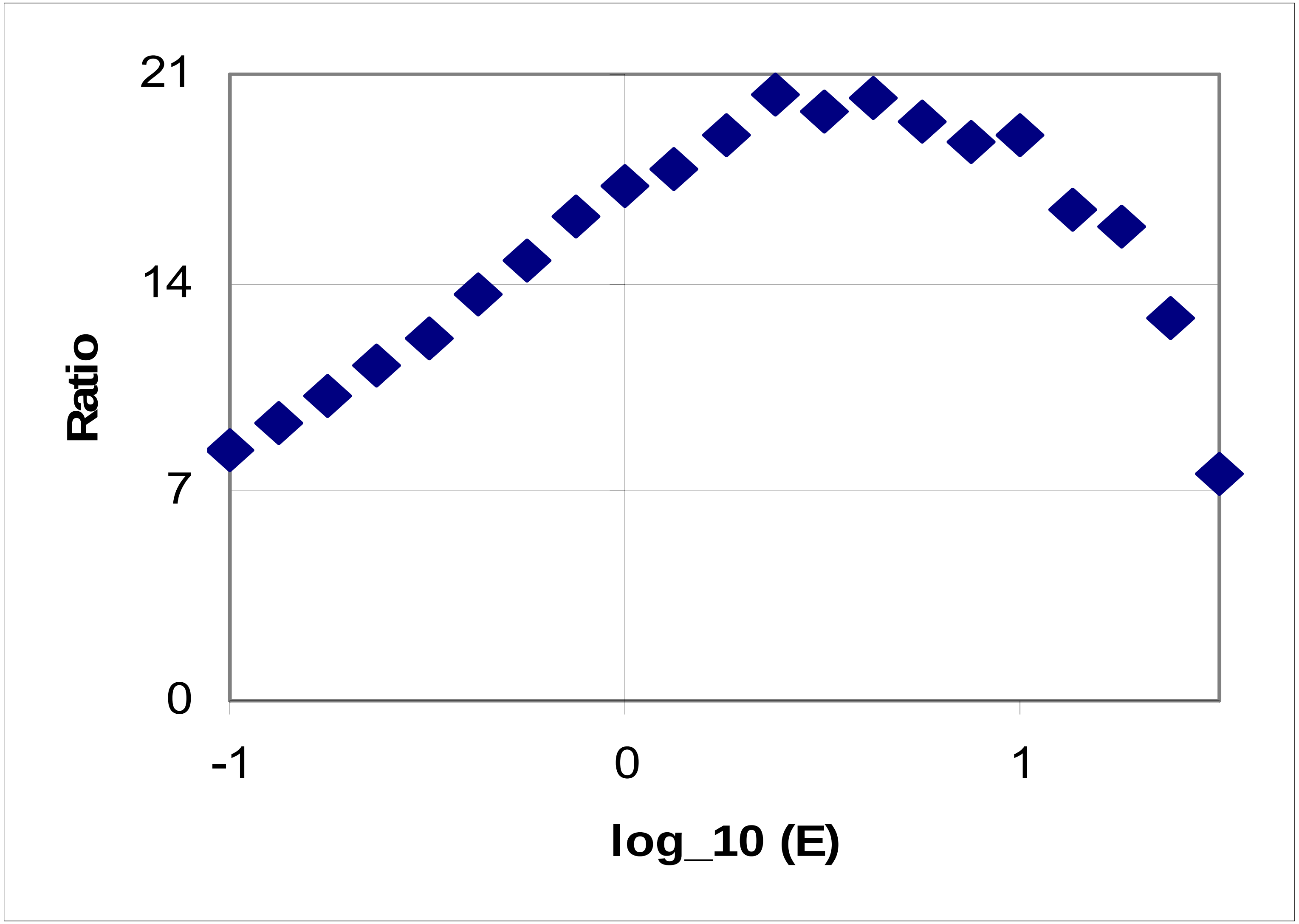


$\gamma Z \to eeZ$ vs. $eZ \to eZee$

- Electron carries virtual gammas
- Landau-Lifshitz conversion of virtual gammas

$$\frac{dN}{d\omega} = \frac{2\alpha}{\pi} \frac{1}{\omega} \left[\ln \frac{1.1\gamma c}{\omega b_{\min}} - \frac{1}{2} \right]$$

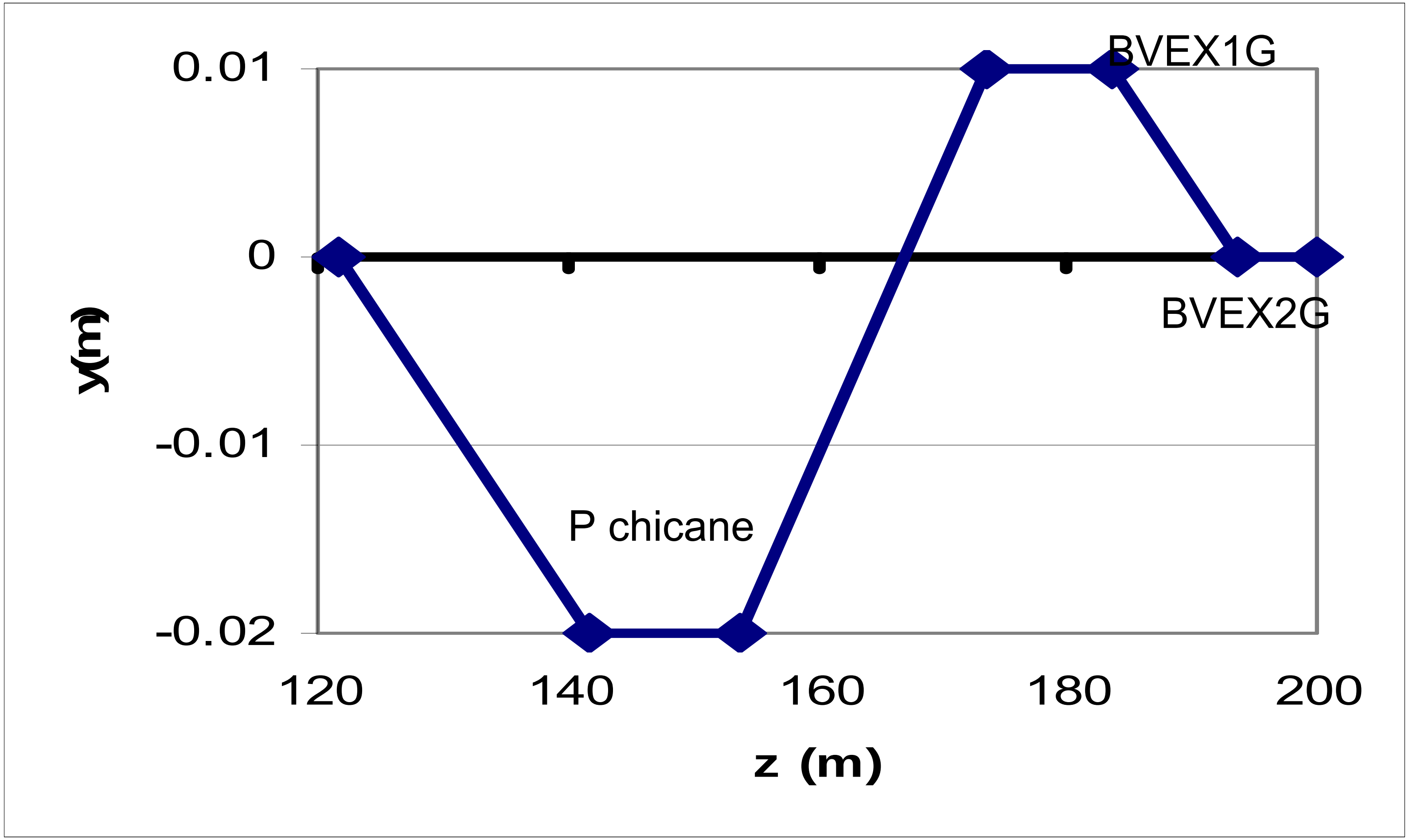
Ratio of $\gamma Z \rightarrow eeZ$ vs. $eZ \rightarrow eZee$



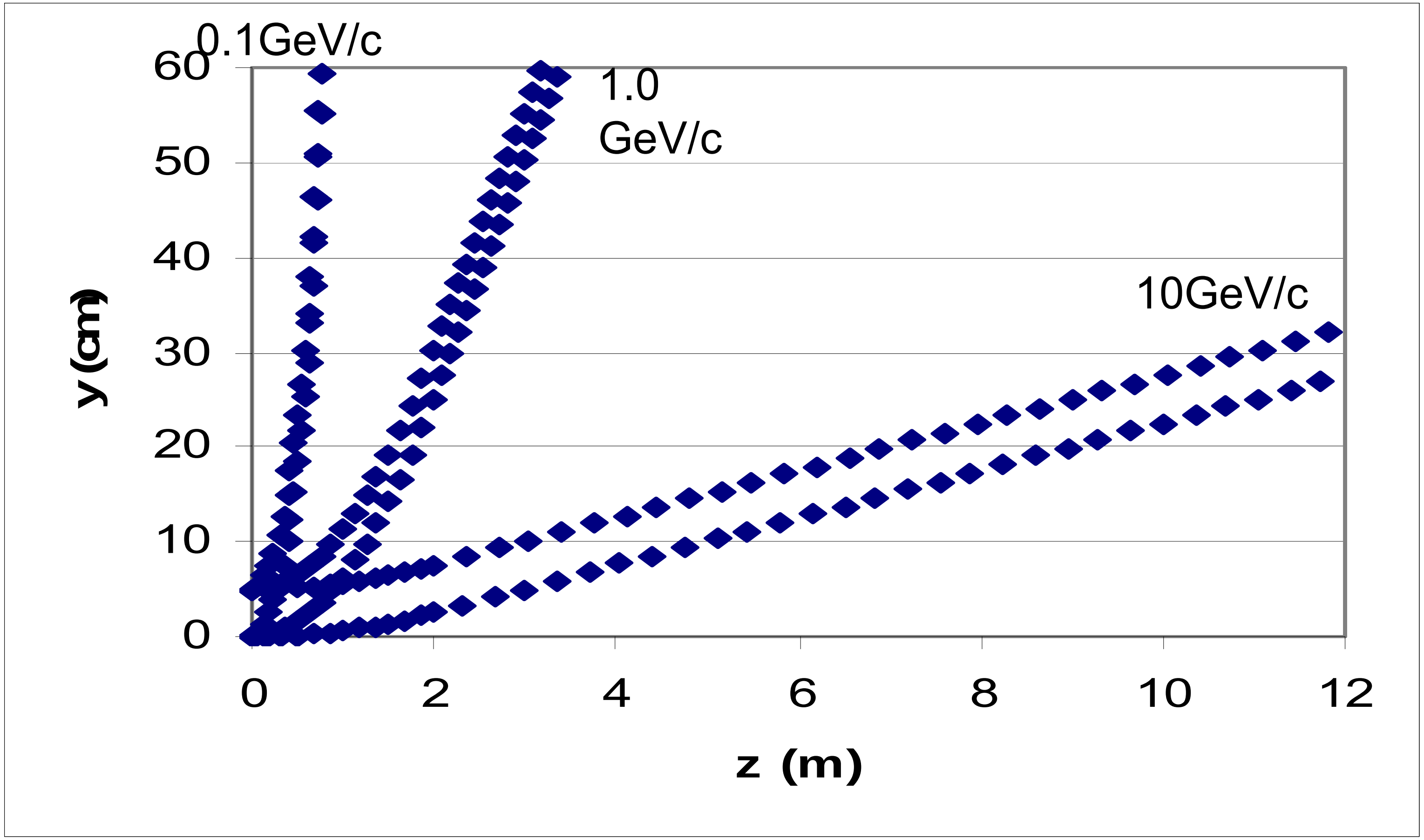
π Production Compared to ee

- $\gamma p \to eep \quad \sigma \approx 10$ mb
- $\gamma p \to \pi N \quad \sigma \approx 0.5$ mb in resonance region
- $\gamma p \to \pi N \quad \sigma \approx 0.1$ mb $\quad E > 4$GeV
- $ep \to e \pi N \quad \sigma \approx 10^{-3}$ mb
- Thus $ep \to e \pi N$ is a negligible background

New Polarimeter/Gamma Chicane



BVEX2G Magnet Works Well

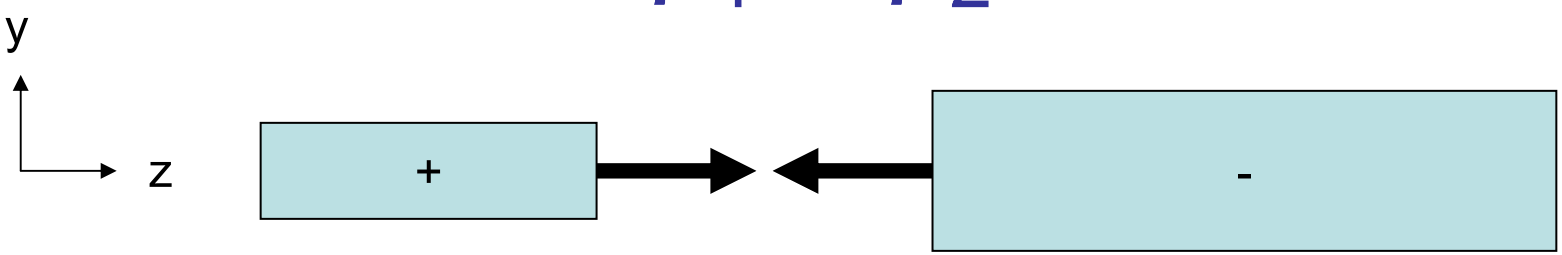


Conclusions

- BVEXG1/BVEXG2 area looks good for GamCal.
- GamCal needs ≈10m after BVEXG2
- Backgrounds to E and P detectors small.
- Backgrounds out of time by ≈50ns.
- E and P detectors shielded by BVEXG1 magnet.
- Working on design, simulations, etc.

Extra Slides

$\rho_1 \neq \rho_2$



$$F_1 = \frac{ey}{\varepsilon_0}\left(\rho_2 - \rho_1 + \beta^2\left(\rho_1 + \rho_2\right)\right) \approx \frac{2\rho_2 ey}{\varepsilon_0}$$

$$E = \frac{\left(\rho_1 - \rho_2\right)y}{\varepsilon_0} \qquad B = \frac{\beta\left(\rho_1 + \rho_2\right)y}{\varepsilon_0}$$

Perfect Collisions

$$E_\gamma \propto \frac{N^2}{\sigma_x^2 \sigma_z}$$

$$E_{ee} \propto \frac{N^3}{\sigma_x^3 \sigma_y \sigma_z}$$