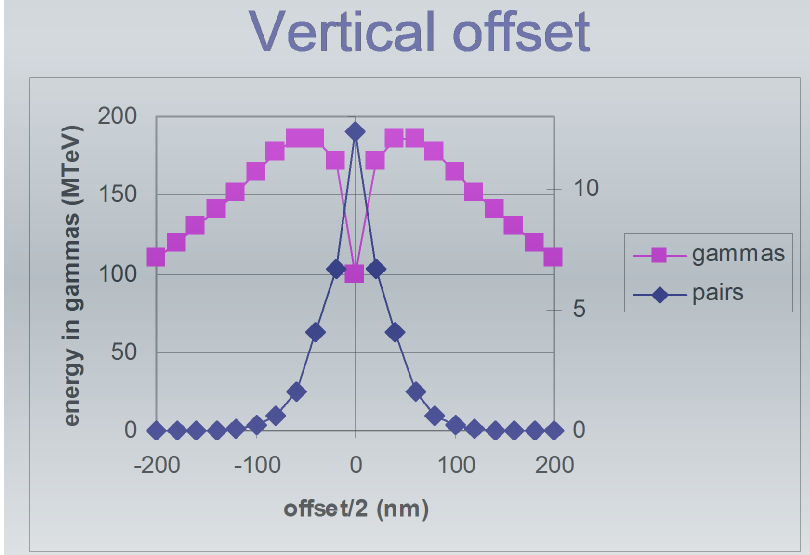
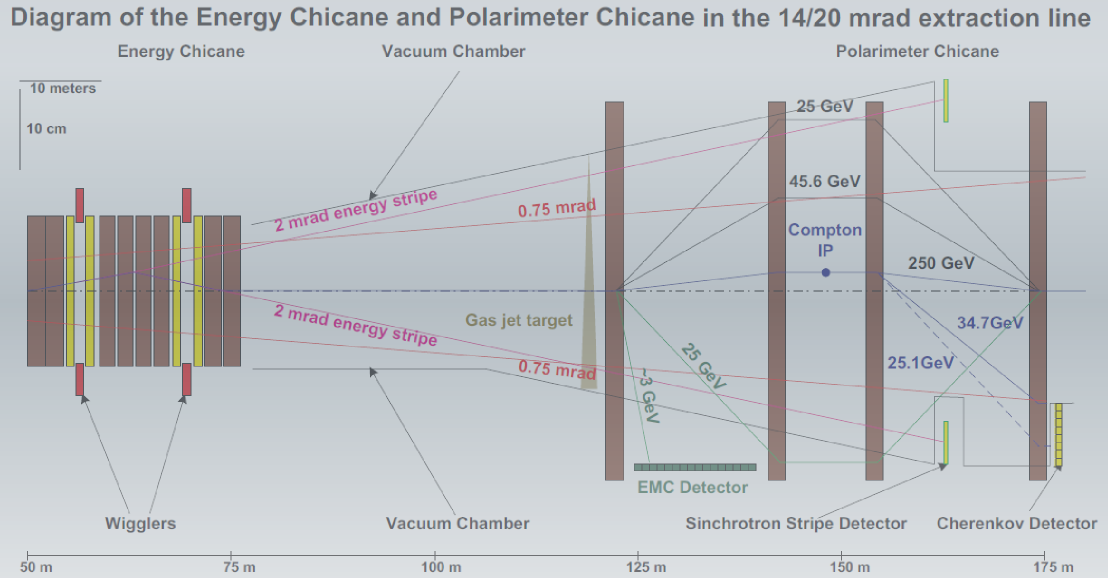
Report on a Proposal for GamCaL

...by Brett Parker/BNL, of the work of many people





The Nominal Cast of Characters

FCAL Meeting Oct. 17 MPI Munich

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

U.S. Forward

- BNL PI: W. Morse
- F. Lanni, D. Lissauer: BeamCal readout issues
- Z. Li: radiation damage issues
- B. Parker: machine interface issues
- Yale PI: M. Zeller
- G. Atoian, V. Issakov, A. Poblaguev: GamCal design issues
- Colorado PI: U. Nauenberg: SUSY studies

Simulations

- W. Morse (BNL)
- W. Lohman, E. von Oelson, and M. Ohlerich (DESY Zeuthen)
- To Be Submitted as an ILC Note
- Guinea Pig simulations varying some of the 500 GeV ILC bunch parameters around nominal values

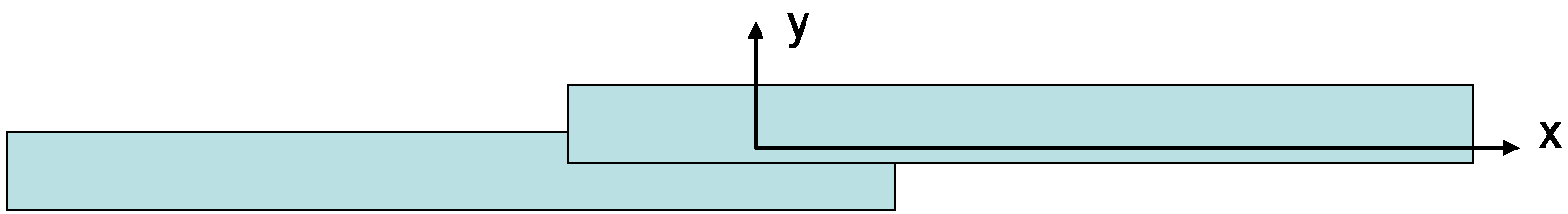
These slides are abstracted from SiD talk of W. M. Morse SLAC, 28-Oct-06.

Motivation....

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:

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



Motivation....

Run Time Measurements

- Beam-beam deflections (pickup electrodes)
- Beam-strahlung gammas (GamCal)
- Beam-strahlung pairs (BeamCal)
- We need robust and complementary information

Beam-strahlung

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

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

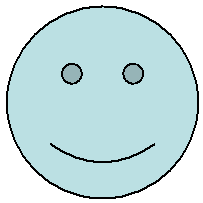
To skip some physics jump past the next two slides.

Bethe-Heitler Pairs

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

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

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



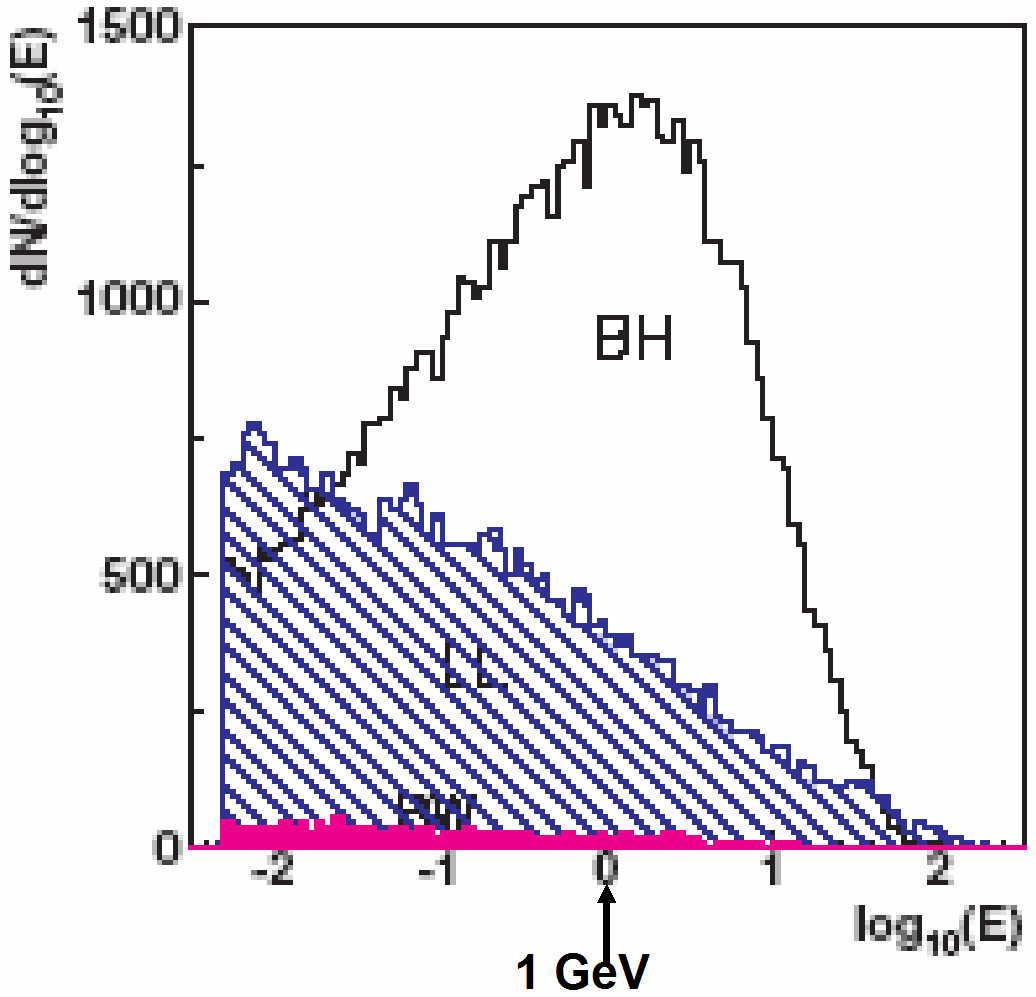
For left and right detectors separately: $N^+/\sigma_x\sigma_y$ and $N^-/\sigma_x\sigma_y$. Question: How well does this really work? Answer: Needs simulation.

Landau-Lifshitz Pairs

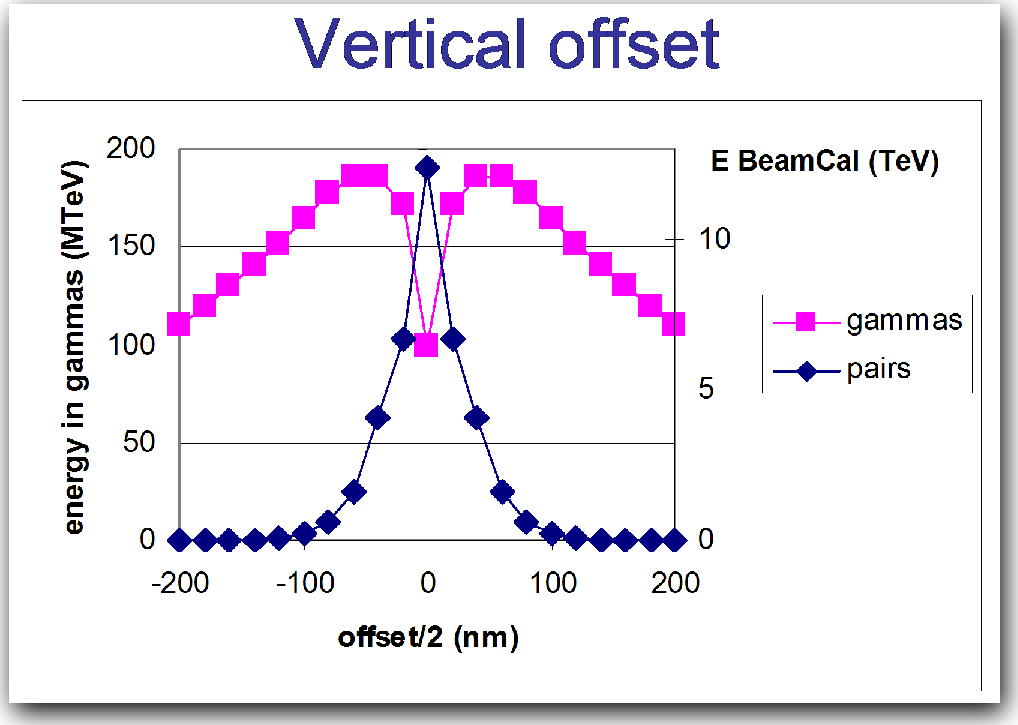
- $ee \rightarrow eee^+e^-$

$$N_{ee}^{LL} \propto \frac{\sigma_{LL} N_-^o N_+^o}{\sigma_x^o \sigma_y^o}$$

For left and right detector equally

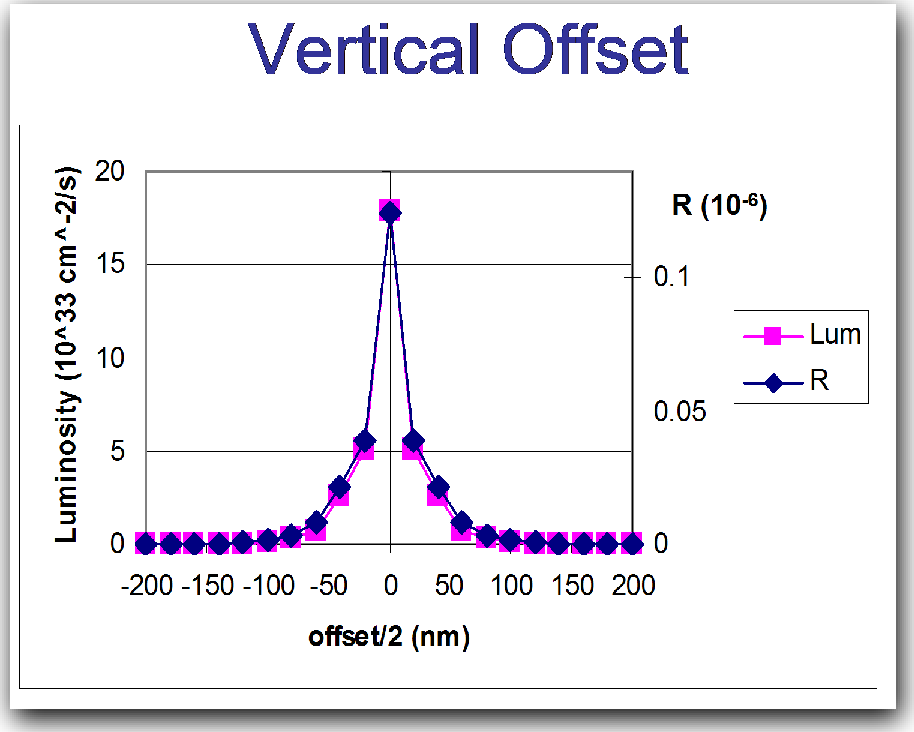


R = Pairs/Gammas for Luminosity Signal.



- Max pairs when beams aligned.
- Min γs when beams are aligned.

Ratio gives a good luminosity signal.



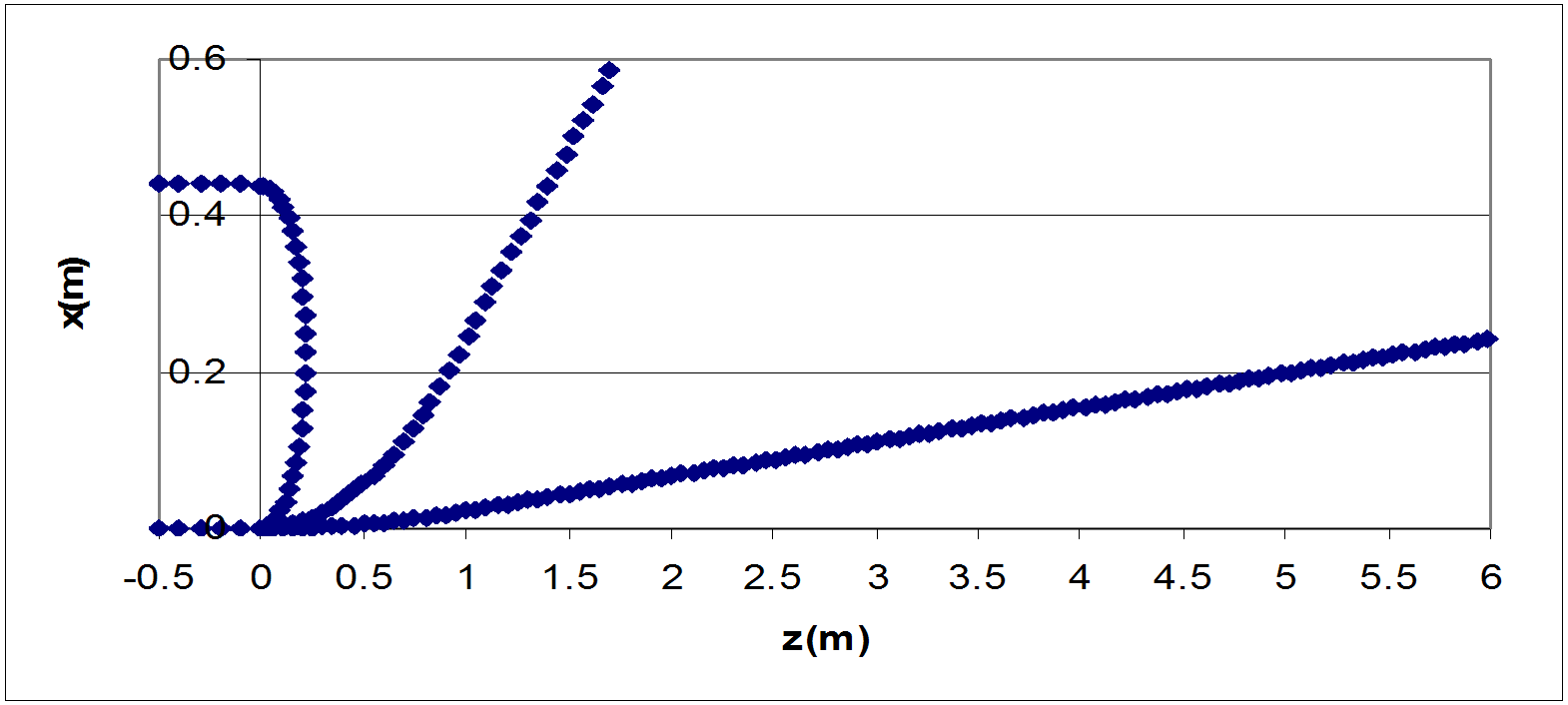
Here is what we want to do.

GamCal Detector Concepts

- 14mrad crossing angle (Expensive to separate gammas from main beam)
- $\approx 10^{-6}$ X_0 gas jet to convert beam-strahlung gammas into e^+e^- pairs (Rate for main beam $\approx 10^{-12}$ X_0^2)
- Magnet to separate electrons from positrons
- Detect "wrong sign" particles
- Probably need to be after E/P detectors at z=175m (Yale group asks why?)
- GamCal z = 185m? Or maybe even 120m?

Spectrometer for the wrong sign particles.

Large Crossing Angle GamCal

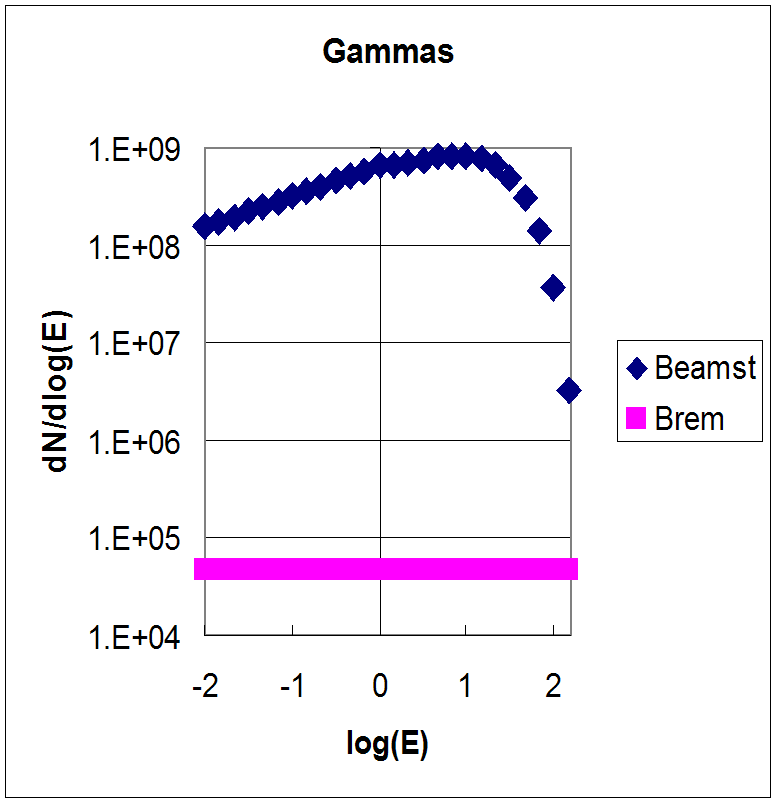


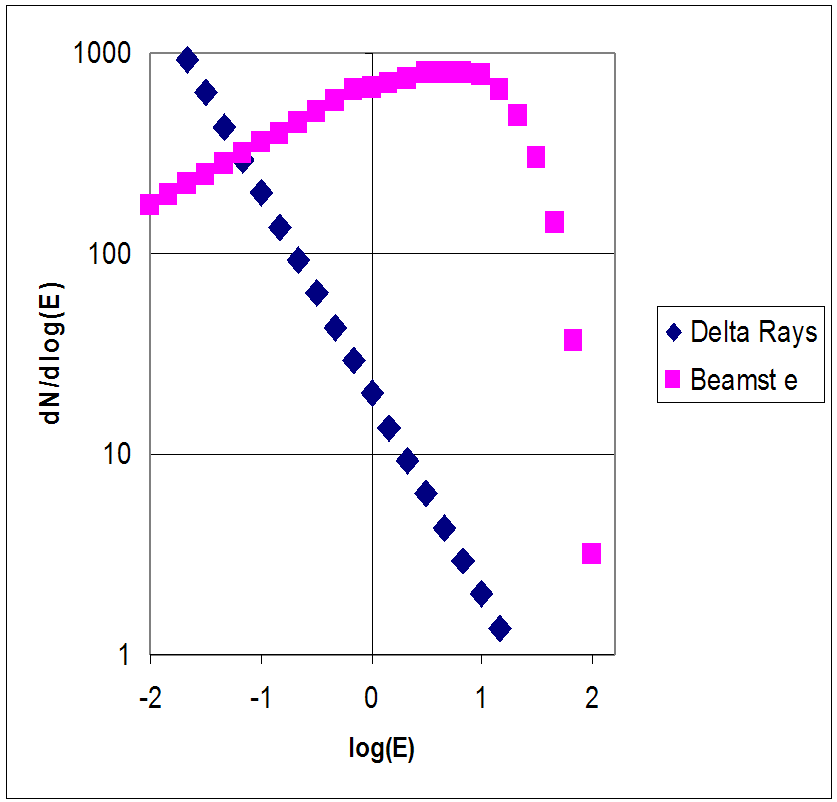
Gas jet followed by a 1m long 1.5T dipole magnetic field. Trajectories of positrons of momentum 0.1, 1, and 10 GeV/c are shown.

Ed. Comment: 1.5 T seems a bit too high to me. B.P.

What about the expected backgrounds?

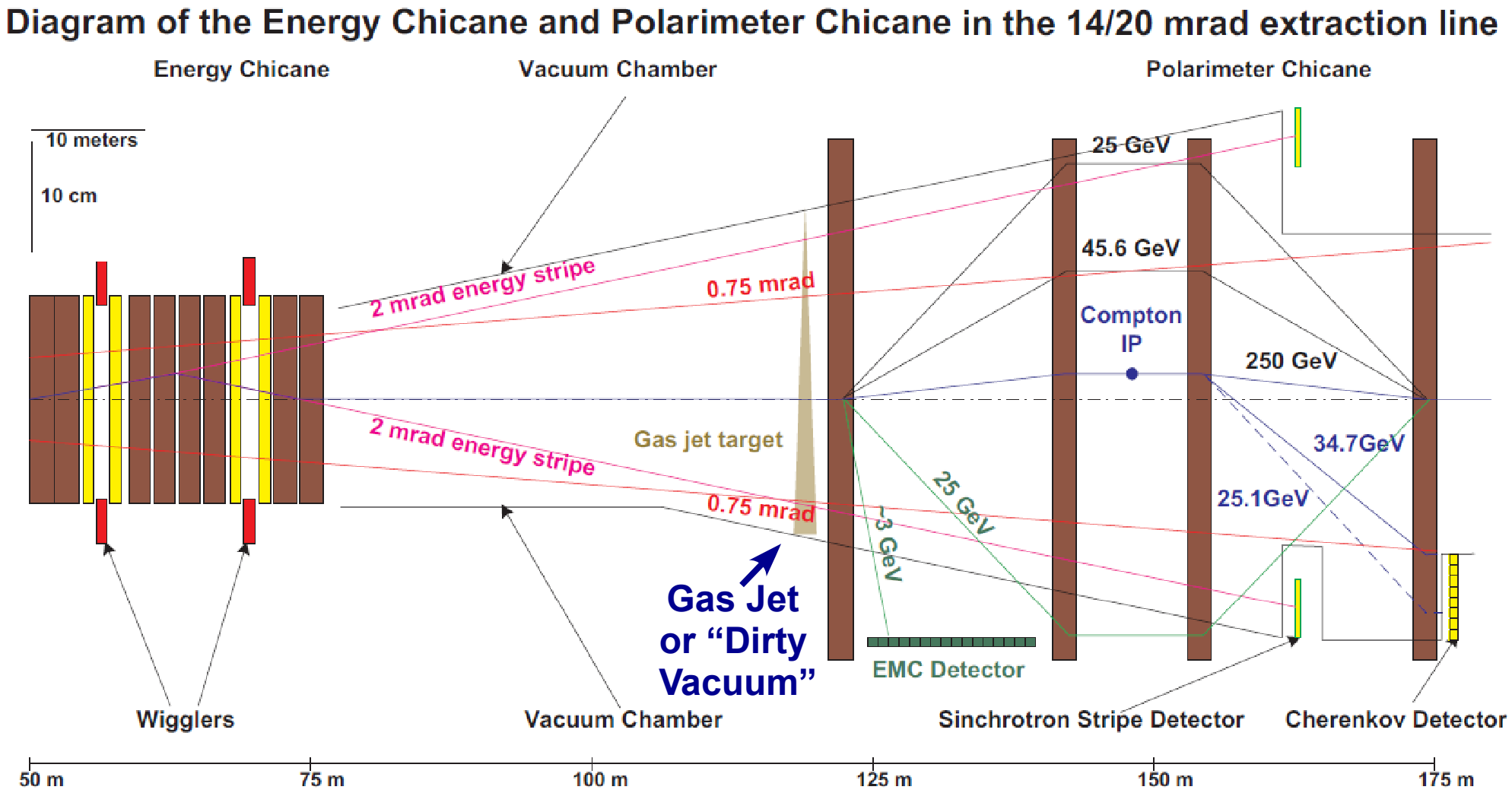
GamCal Backgrounds





Just stay away from very low energies.

Yale Proposal: Use Polarimeter Chicane



Check if magnets sweep out particles before they can hit other detectors!

Conclusions

- We need robust, redundant information:
- Beam-beam deflections
- Beam-strahlung gammas
- Beam-strahlung pairs
- E(pairs)/E(gammas) particularly valuable
- Largely proportional to instantaneous luminosity

Brett's Summary.

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Maybe it is possible to place this thin target upstream of the polarimeter chicane and use the first chicane magnet as our spectrometer without having to add any new beamline magnets? Such a GamCal proposal merits careful study.