SoLID Simulation Update 2

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Outline

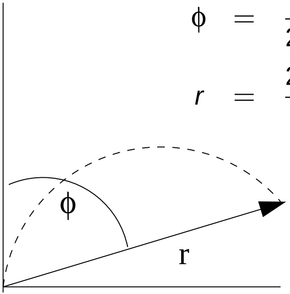
- Baffle Designs and Efficiency
- Figure of Merit
- Event Generation
- Roadmap

Solenoid Motion

For uniform magnetic field in z direction, particle motion for $v = c$, p [GeV], scattering angle θ as function of z is given by:

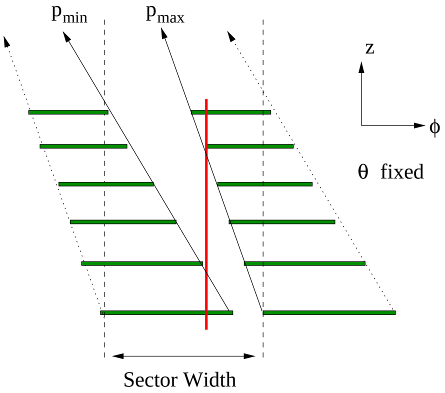
$$\phi = \frac{0.3 B_z z}{2p\cos\theta}$$

$$r = \frac{2p\sin\theta}{0.3 B_z}\sin\left(\frac{0.3 B_z z}{2p\cos\theta}\right)$$



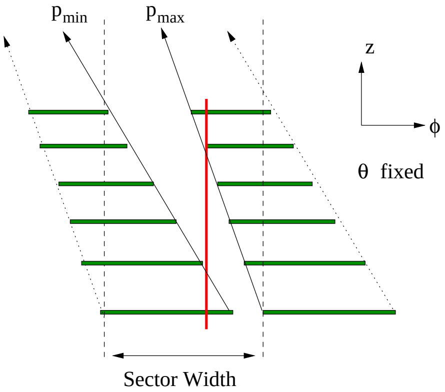
- ϕ is linear in z
- For 11 GeV beam, **worst** particles of interest deviate from linear r by few %

Baffle Design Considerations



- Range of x_{bj} at fixed θ defines cut
- Forbidding line of sight fixes width and spacing
- Too many baffles can have low momentum “jumping”
- Extended targets make the situation more complicated

More Baffle Design Considerations

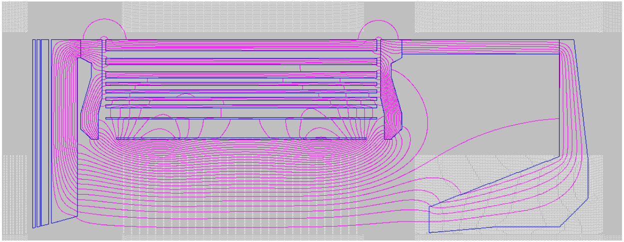


- Too many baffles can also produce backgrounds
- Too many baffles could thin structural integrity
- Raster effects need to be included (not currently present)
- Limiting to 30 slits (Eugene's design)
- Using 6 baffle planes (Eugene's design)

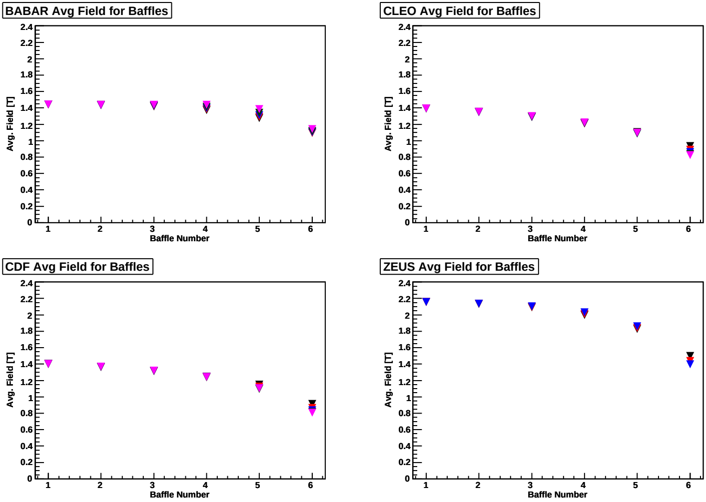
Available Magnets

	Inner Rad (cm)	Length (cm)	Field (T)
BaBar	150	345	1.5
CLEO	150	350	1.5
CDF	150	500	1.5
Zeus	86	245	1.8

- Fields produced in POISSON
- Imported into GEMC



Magnet Fields vs. z



- Fields tend to taper off at larger z
- Makes baffle design more difficult

Baffle Strategy

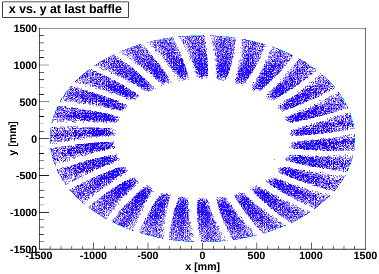
- Start with baffle design using constant field
  - Have Eugene's baffle design for BaBar as reference
- No physics to start - kill particles on baffle interaction
- Calculate propagation efficiency and FoM for different designs

To be done:

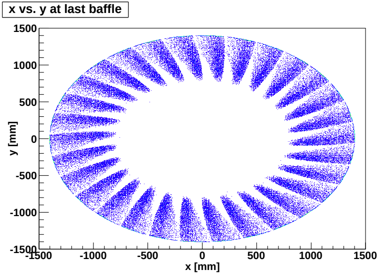
- Physics interactions
- Raster
- Optimize for field variations

BaBar Baffle Results - *x* vs. *y*

Eugene's baffles

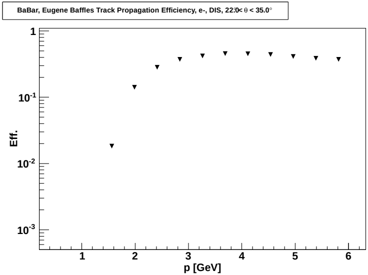


My baffles

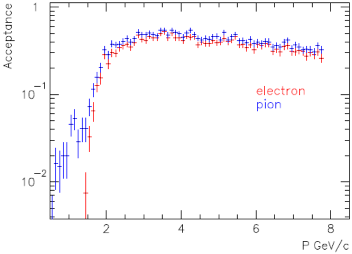


BaBar Baffle Results - Momentum efficiency

Eugene's baffles



Proposal



BaBar Baffle Results - Momentum efficiency

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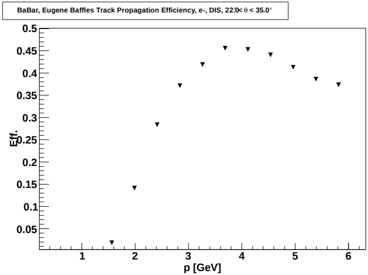

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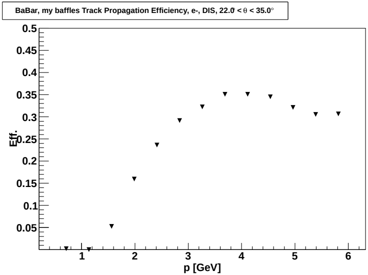
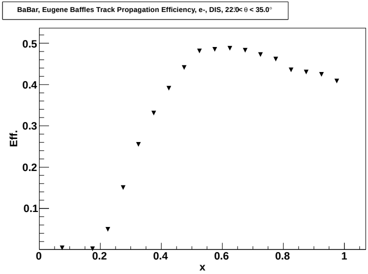
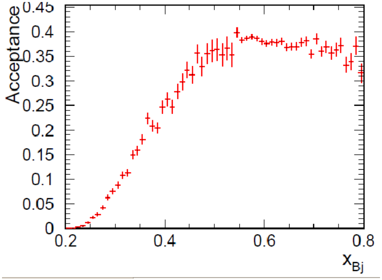


BaBar Baffle Results - x efficiency

Eugene's baffles

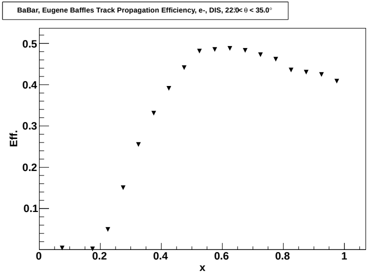


Proposal

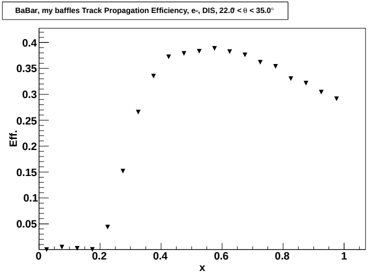


BaBar Baffle Results - x efficiency

Eugene's baffles



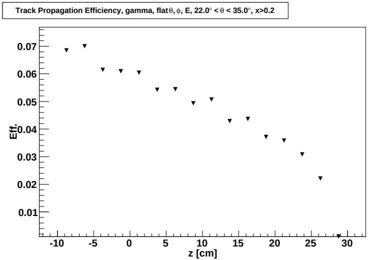
My baffles



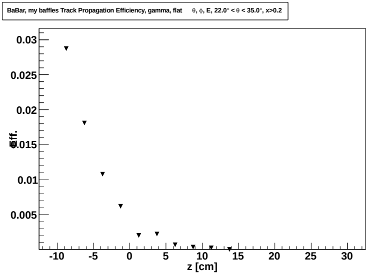
BaBar Baffle Results - Photon Blocking

- Some amount of photons still get through

Eugene's baffles

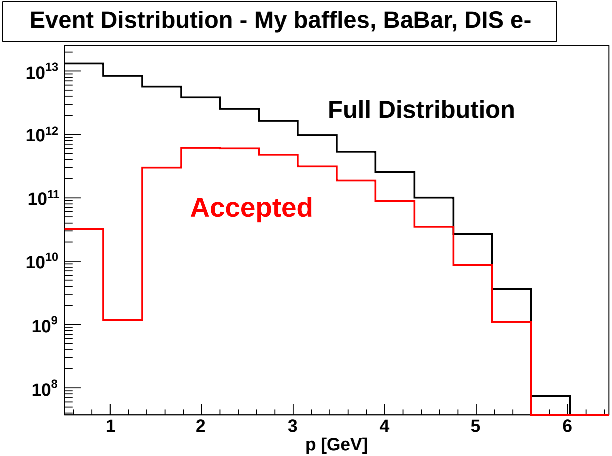


My baffles

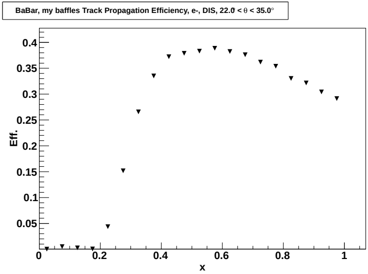


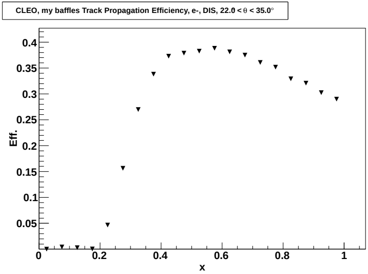
BaBar Baffle Results - Low Momentum Blocking

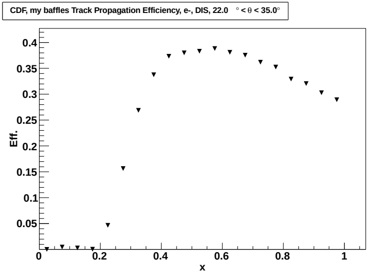
- Some very low energy particles “jump” between slits
- Not a serious concern at this level?
- Vary number of slits to optimize?



Other Magnets - x eff







- 1.5 T magnets yield similar results with same baffles

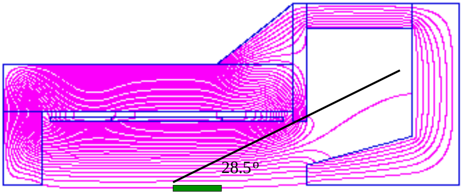
Zeus Baffles

Zeus requires special considerations due to difference size and field

- Can move forward for same angular coverage at expense of field integral
- Can move back for same field integral at expense of angular coverage

Taking the second approach:

- Maximum angle at back of target $\sim 28^\circ$
- Baffle spacing 30 cm $\rightarrow$ 20cm

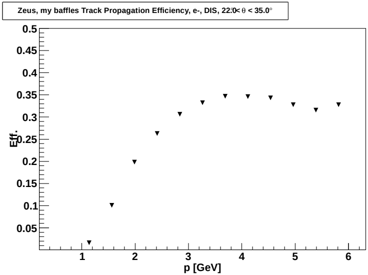


(not to scale)

Zeus Baffle Results - Propagation Efficiency

- Results somewhat comparable to previous designs
- Angular coverage suffers

BaBar Baffles



Zeus Baffles

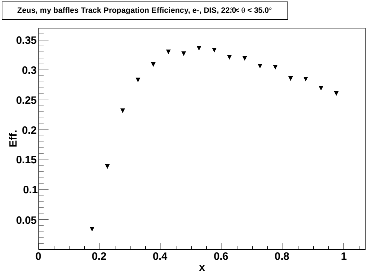


Figure of Merit

Figure of merit for a given magnet defined by:

- PV asymmetry
- Higher twist measurements
- Charge symmetry violation sensitivity
- d/u on $\mathrm{LH_2}$

$$A_{LD_2} = A_{PV}\left[1+\beta_{HT}\frac{1}{(1-x)^3Q^2}+\beta_{CSV}x^2\right]$$

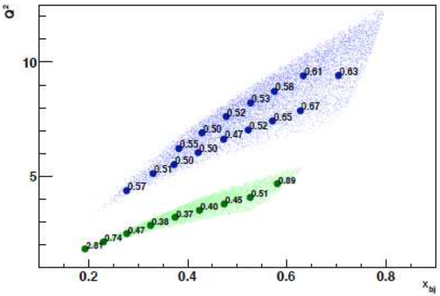
$$A_{LH_2} = \eta_{\gamma Z}\left[\frac{12C_{1u}-6C_{1d}d/u}{4+d/u}+f(y)\frac{12C_{2u}-6C_{2d}d/u}{4+d/u}\right]$$

$$d/u = b+m(x-1)$$

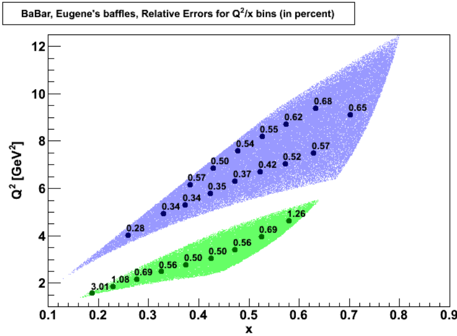
- Calculations done assuming proposal values:

Target	Beam [GeV]	I [μA]	Time [days]
LD_2	11.0	50.0	120
LD_2	6.6	50.0	60
LH_2	11.0	50.0	90

Proposal



Eugene's Baffles



FoM Results

Magnet	A	β_{HT}	β_{CSV}	$b_{d/u}$	LH_2 high x
BaBar, Proposal	0.3%	0.0026	0.017		
BaBar, Eugene's baffles	0.18%	0.0018	0.013	2.7%	0.96%
BaBar, my baffles	0.23%	0.0022	0.018	3.4%	1.11%
CLEO, my baffles	0.23%	0.0022	0.018	3.4%	1.11%
CDF, my baffles	0.22%	0.0021	0.018	3.4%	1.11%
Zeus, my baffles	0.21%	0.0022	0.016	3.5%	1.25%

- Clearly optimization to be done
- All 4 magnets with 1st order baffle designs give similar uncertainties
- Where do differences show up?

Need more optimization!

Baffle Work - To Do List

- Better optimization on baffle design
- Turn on physics - look at backgrounds produced
- Turn on raster
- Should we see more of a difference between magnets?
    - Quantitatively explore field integrals

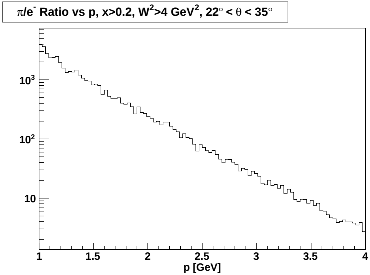
Event Generation

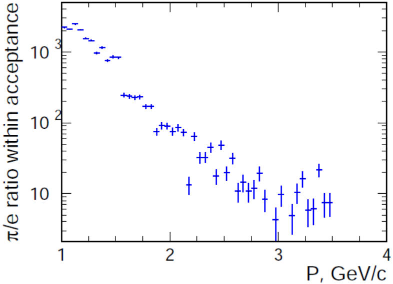
Work in event generation

- Weights can now be propagated in GEMC
- Added in Wiser code parameterization for $\pi^{\pm}$ cross sections
- $\pi^0 = \pi^- + \pi^+$
- π^0 decay is done and two photons produced
- Additional EM background can be done by Geant4 EM packages

π^- / e^- Ratio vs. p

π^- / e^- ratio evaluated for $\mathrm{LD_2}$, 11 GeV beam

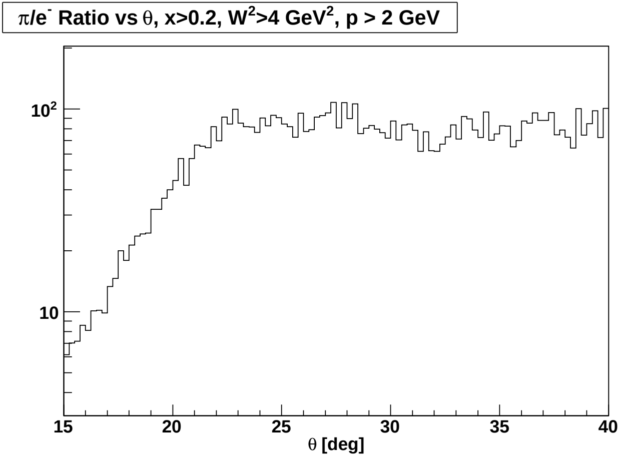




Results somewhat close to proposal

π^-/e^- Ratio vs. θ

π^-/e^- ratio evaluated for $\mathrm{LD_2}$, 11 GeV beam



- Ratio somewhat flat cross θ

Summary and Roadmap

Work Completed:

- Software framework specified
- DIS, π, EM, and neutron backgrounds generators in hand
- Field maps for magnets in hand
- First order baffle designs
- Quantitative method for evaluation of design
- Comparison to proposal numbers underway

Summary and Roadmap

Work To Be Done:

- More refined baffles, baffles with physics
- More final FoM numbers for all designs
  - Numbers for SIDIS are crucial as well
  - Need to integrate in SIDIS event generator
- Full detector inclusion/digitization
  - SBB GEM responses
  - Cherenkov
  - Calorimeter
- Tracking
  - Need wish/concern/question list