

Beam-Gas Scattering Simulations at ILD

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Introduction

- Beam-Gas scattering in the ILD beam pipe was never really studied in the past
- Robert Karl (PhD student at DESY-FLC) has started a simulation effort to understand the vacuum requirements
- All what I will show here are his results and everything is still very preliminary!

Setup

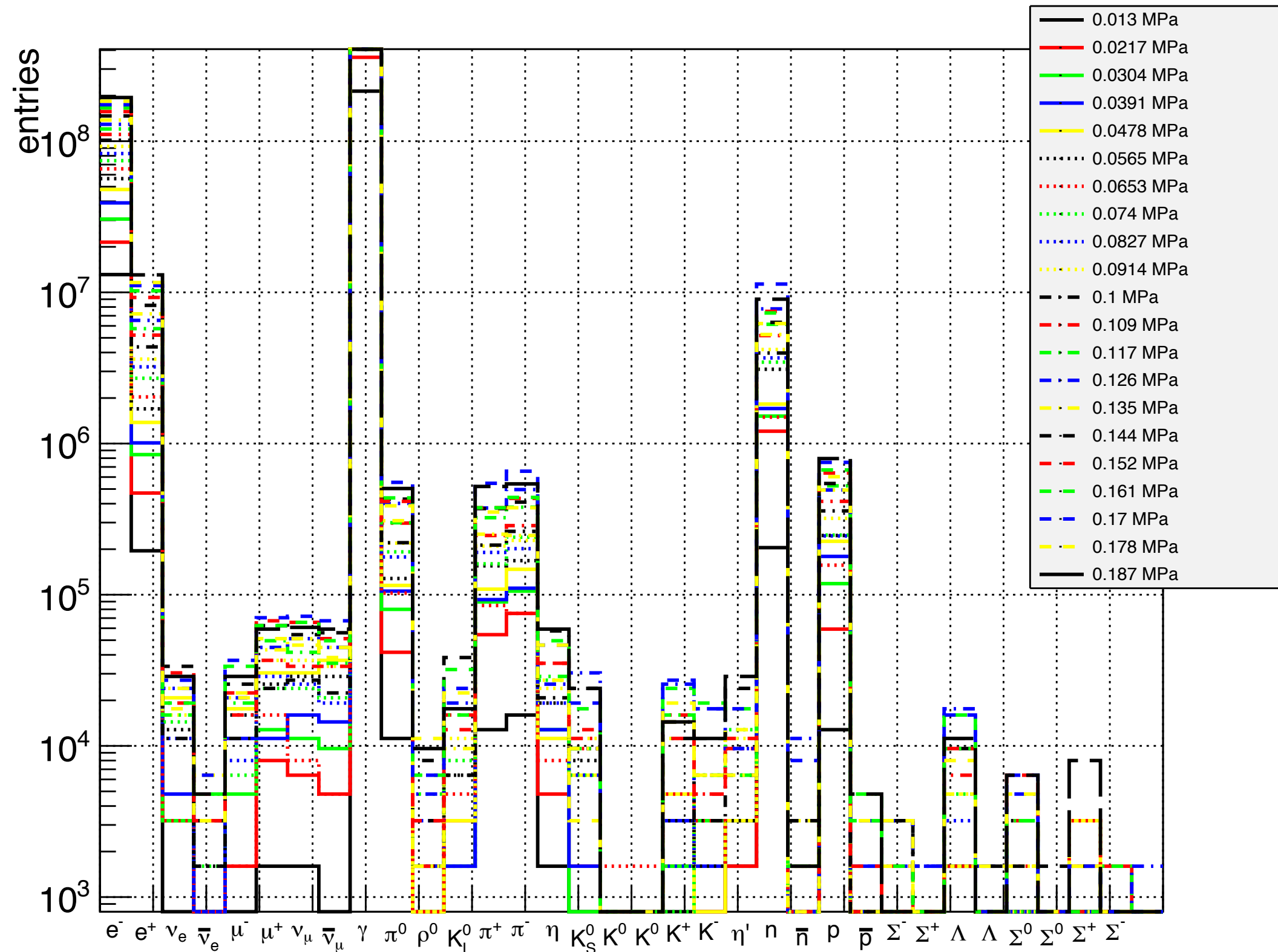


- Used full Geant-4 detector simulation MOKKA
- Standard LC physics lists (QGSP-BERT-HP)
 - should include e-N scattering, n transport, EM reactions
- Looked into area of $\pm 2.5\text{m}$ around the IP
 - ILD tracking system
- Assumed gas mixture of 62% H_2 , 22% CO , 16% CO_2
(as in ILC-Note-2007-16)
- to get some statistics: at highly increased pressures $\mathcal{O}(100\text{ kPa})$
- 500 GeV electron beam (1 TeV upgrade)
- 5×10^5 particles in each bunch, results scaled to 2×10^{10} particles/bunch

Secondaries Production



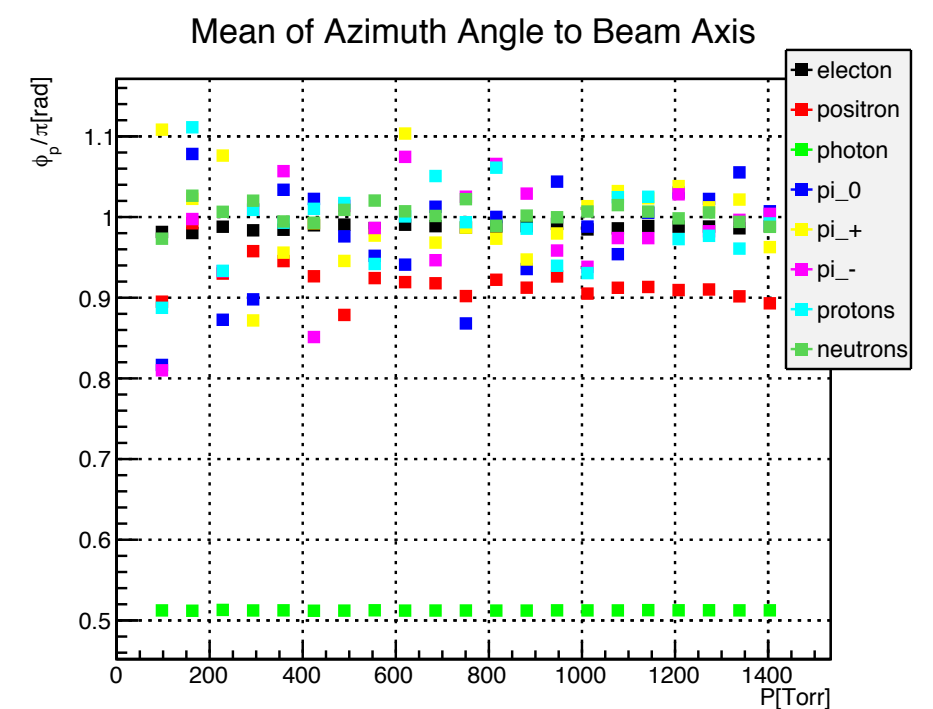
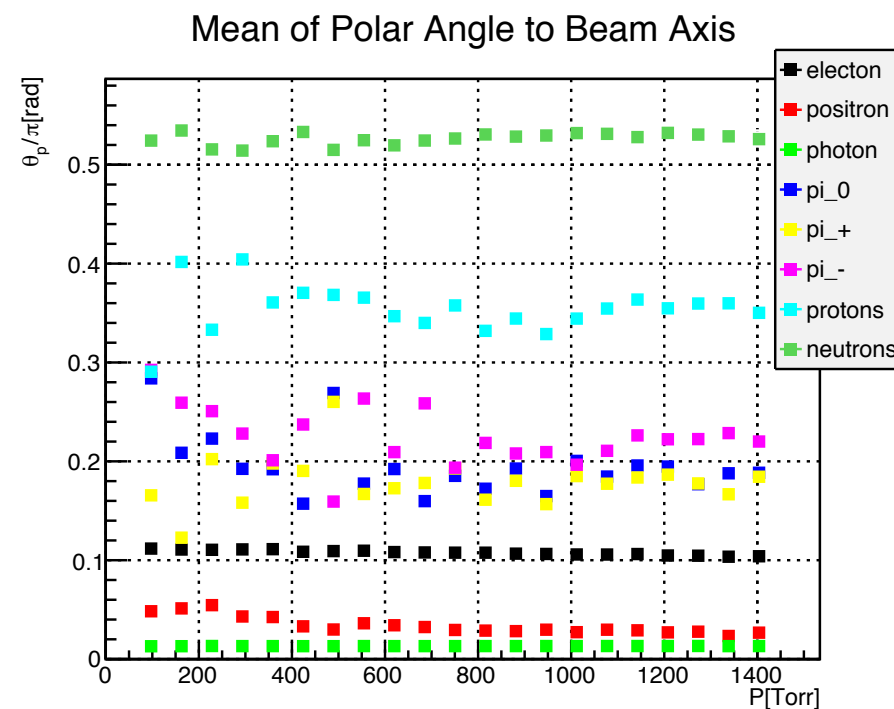
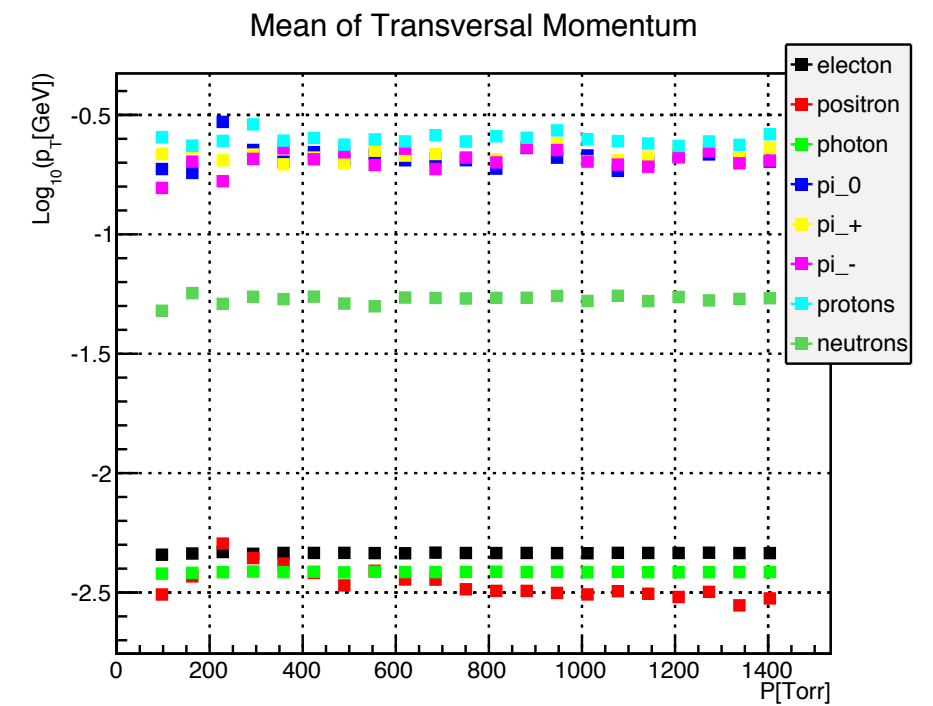
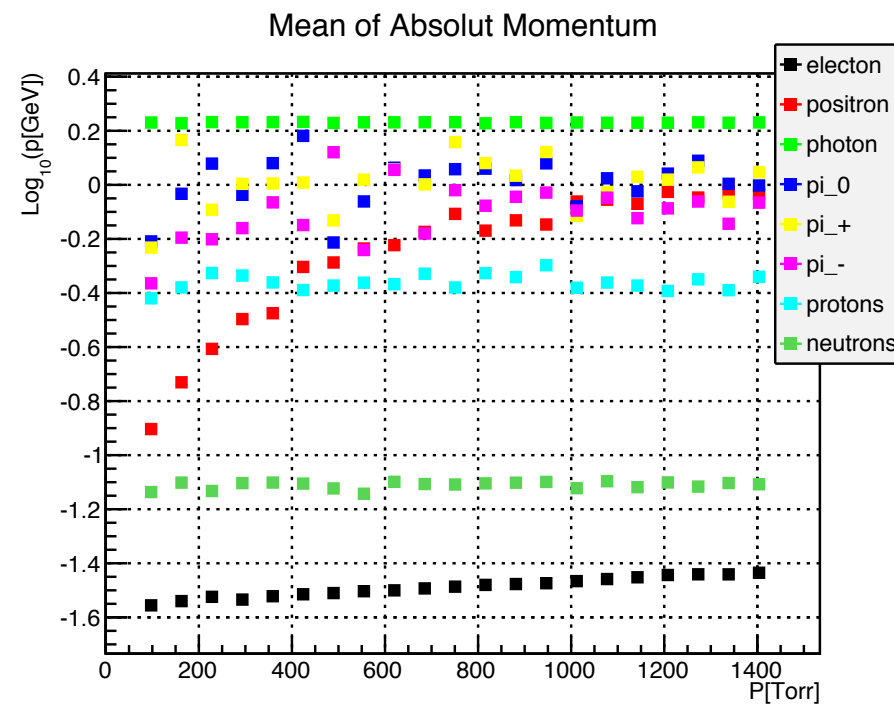
Number of Particles



Secondaries Angles and Momenta



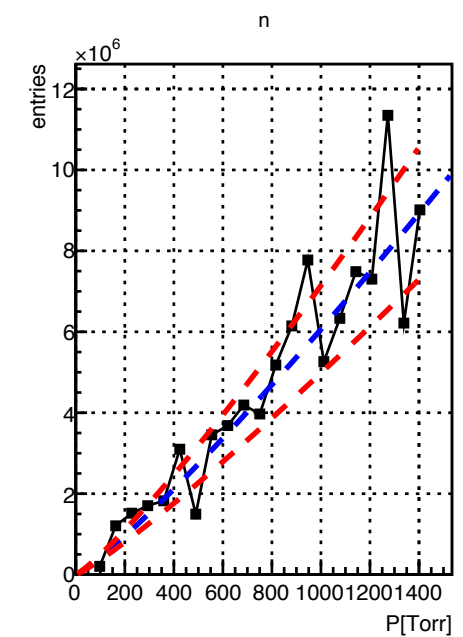
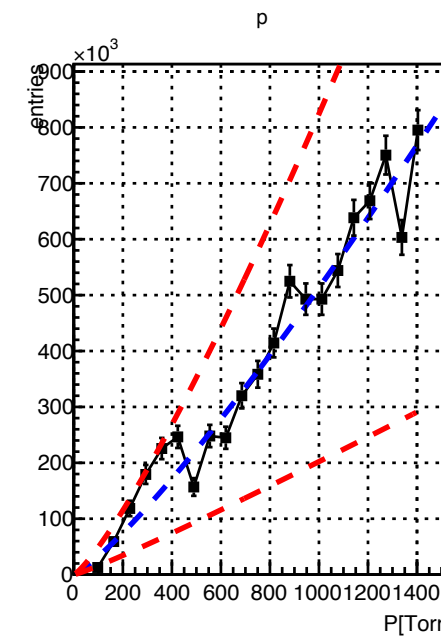
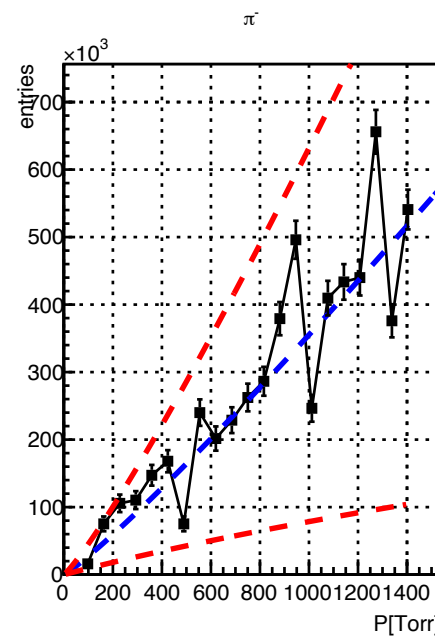
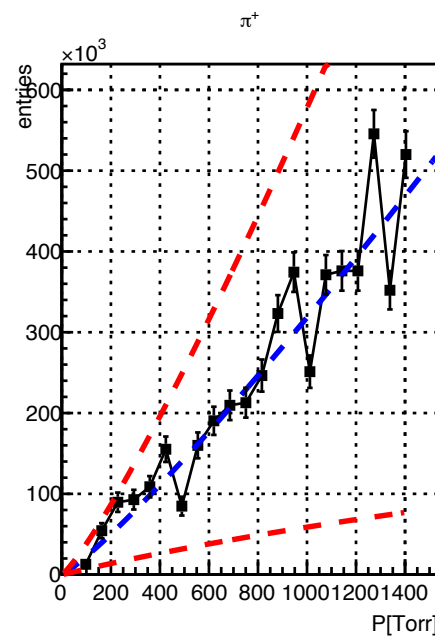
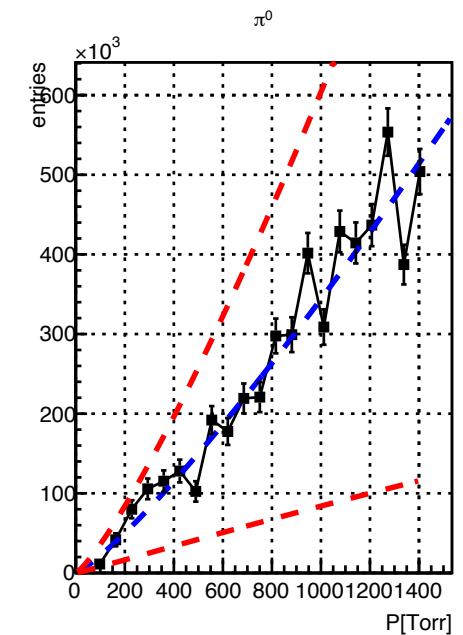
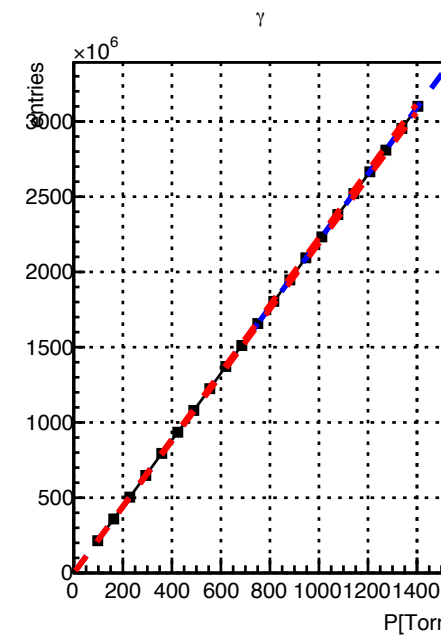
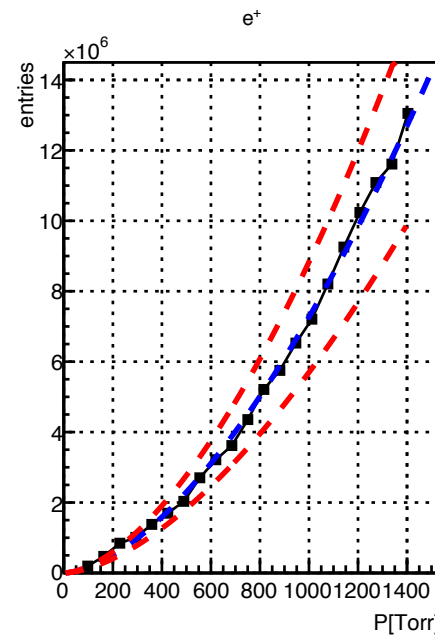
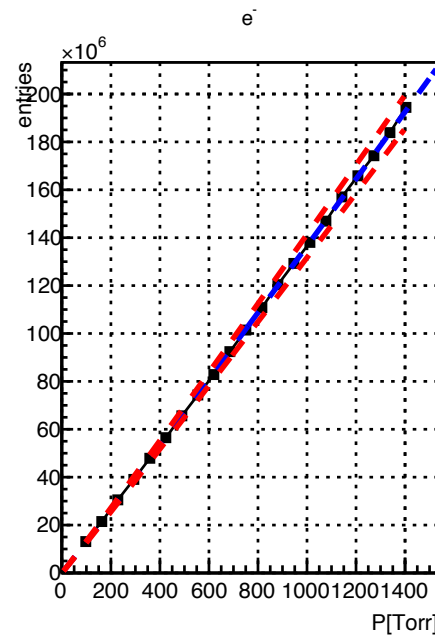
- forward peaked



Secondaries Production



- Extrapolation of production rates vs gas pressure
 - still at high levels (unit is kPa)
- Need to extrapolate numbers to low pressure regime
- large uncertainties





Number of produced particles

- at 10 nTorr for 1 TeV upgrade
 - ~50 photons per bunch train
 - ~2 electrons per bunch train
- most particles would leave through the beam pipe
Number of produced particles:

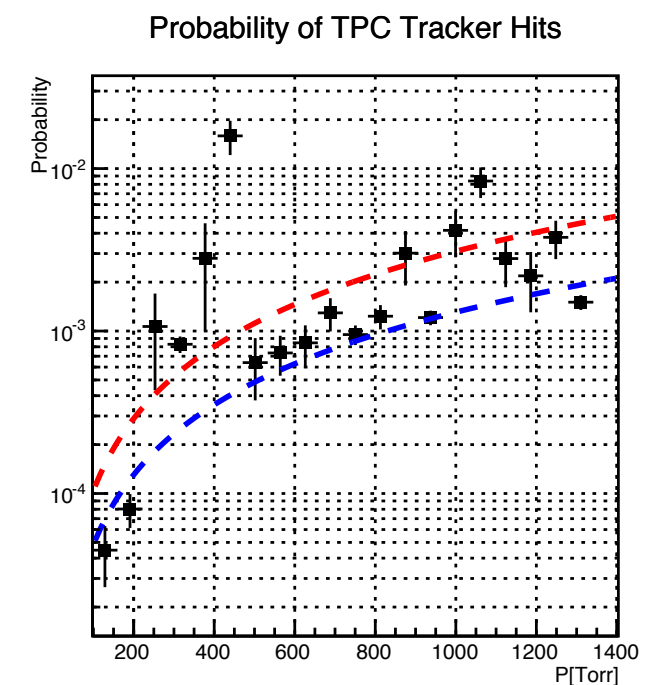
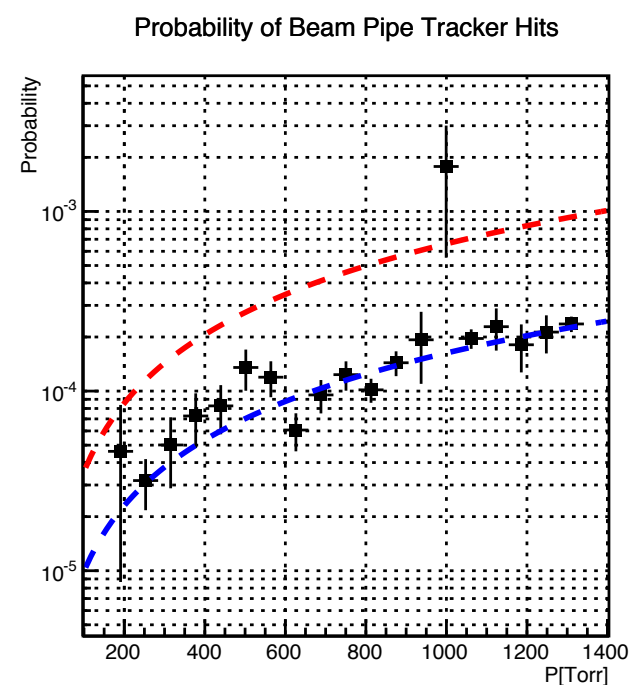
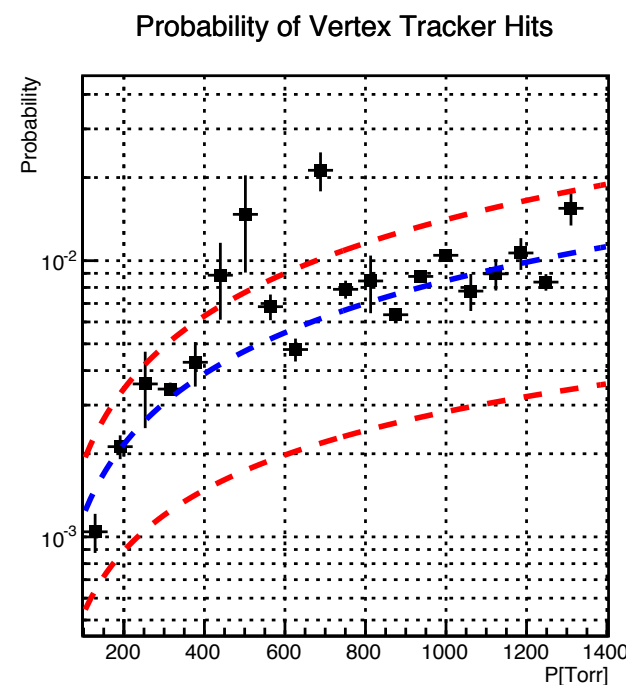
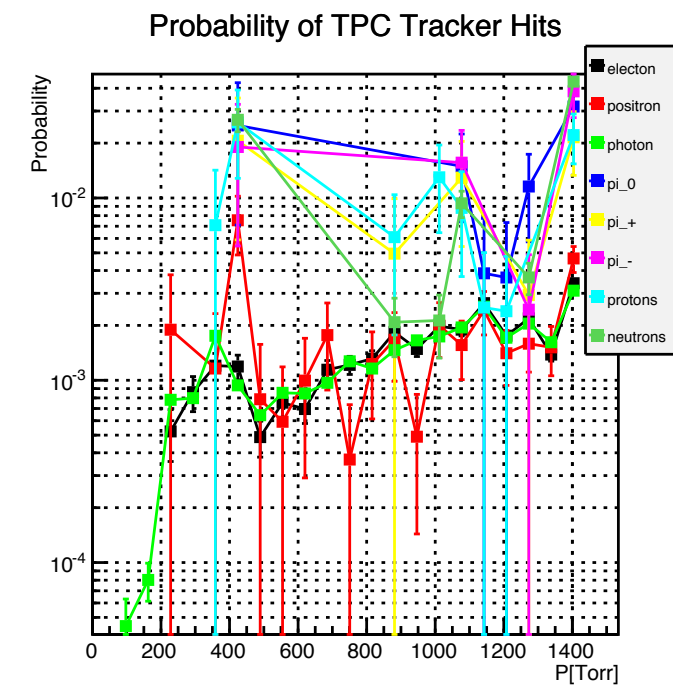
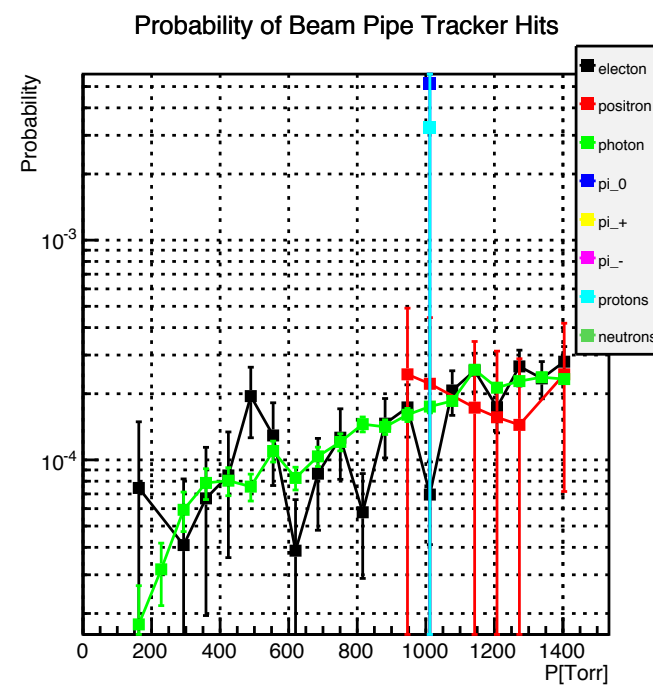
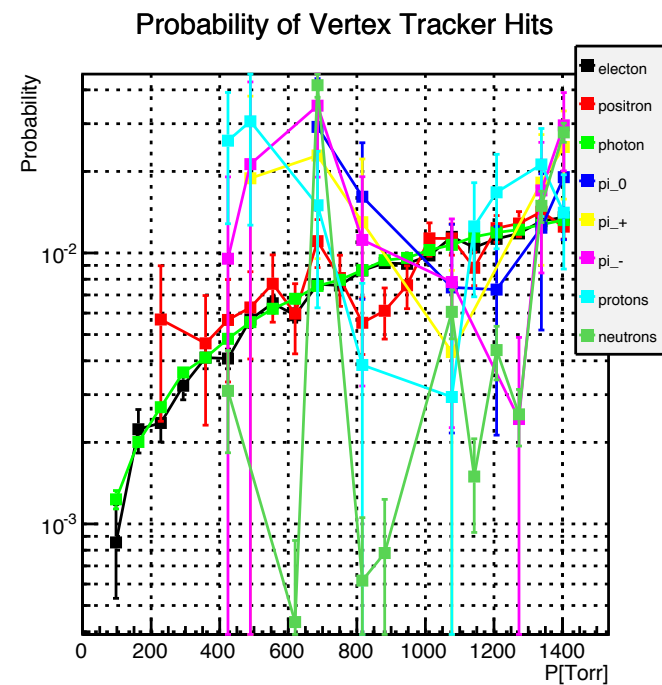
	0.1[nTorr]	1[nTorr]	10[nTorr]
e^-	$(7.12e \pm 0.31) \cdot 10^{-6}$	$(7.48 \pm 0.30) \cdot 10^{-5}$	$(7.87 \pm 0.28) \cdot 10^{-4}$
γ	$(21.9 \pm 0.24) \cdot 10^{-5}$	$(21.9 \pm 0.21) \cdot 10^{-4}$	$(22 \pm 0.19) \cdot 10^{-3}$
π^0	$(9.75 \pm 9.1) \cdot 10^{-11}$	$(1.53 \pm 1.3) \cdot 10^{-9}$	$(2.4 \pm 1.8) \cdot 10^{-8}$
n	$(6.98 \pm 1.5) \cdot 10^{-9}$	$(9.84 \pm 1.97) \cdot 10^{-8}$	$(1.39 \pm 0.25) \cdot 10^{-6}$

- Save to assume: beam-gas backgrounds are not a big issue at the discussed vacuum levels

Impact on Tracking System



- First estimates on tracker hits (by geometry only)





Open Points and Problems

- General problem: try to extrapolate results from high pressures by many orders of magnitude down
- Hits in the detector need to be simulated properly
- Comment received recently: gas in the beam pipe should be ionised
 - need to understand impact on simulations
- Try to find benchmarks (experiments, other simulations) to cross-check

- It is reasonable to assume that beam-gas scattering backgrounds are small compared to e.g. pair background...



Conclusion

- ILD can save 40 cm in the forward region:
 - either: $L^*=4.1$ m plus additional 10 cm for a BPM on the incoming beamline
 - or: $L^*=4.0$ m without additional BPM
- NB: changing L^* of QF1 might have other implications for ILD, but not part of this change request