Beam-gas Interactions in the Beam Delivery System

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Conclusions

160 bunches

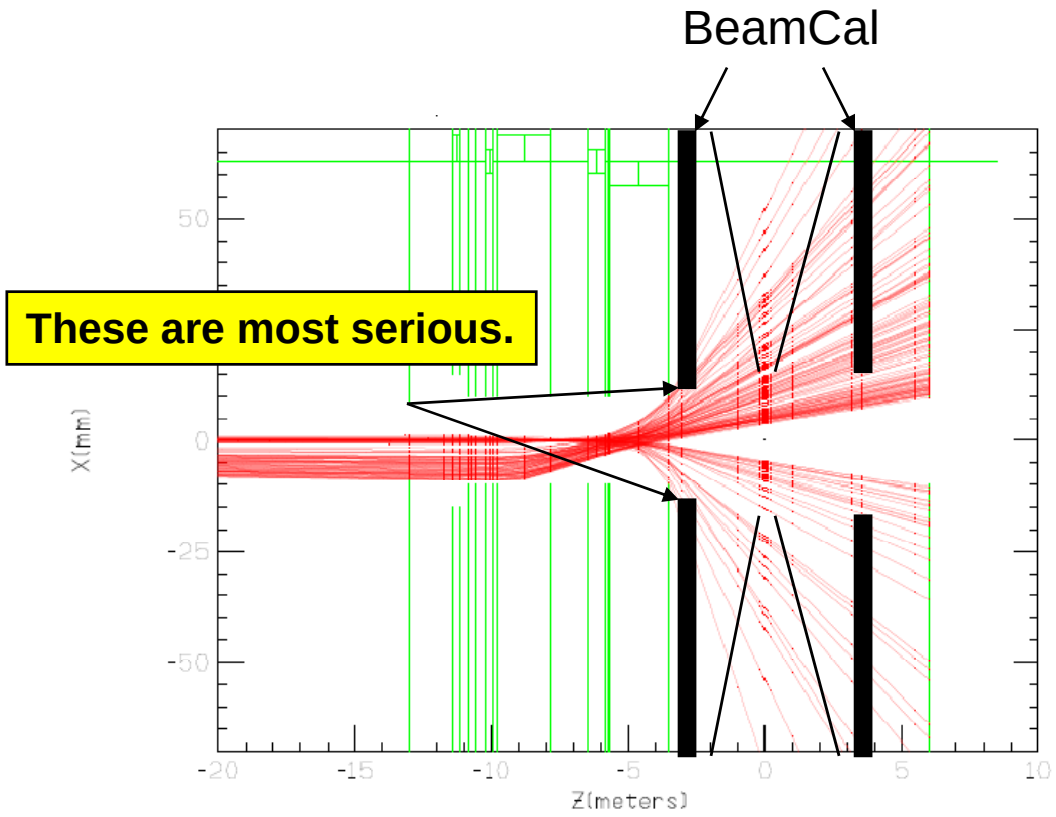
1. At 10 nTorr within the IP region there are 0.02–0.04 hits/bunch (3-6 hits TPC) at an average energy of about 100 GeV/hit originating inside 200 m from the IP. Some of these cause intolerable background in the vertex detector, so to reduce this background to less than 1% per bunch crossing, the pressure specification inside 200 m from the IP is 1 nTorr.

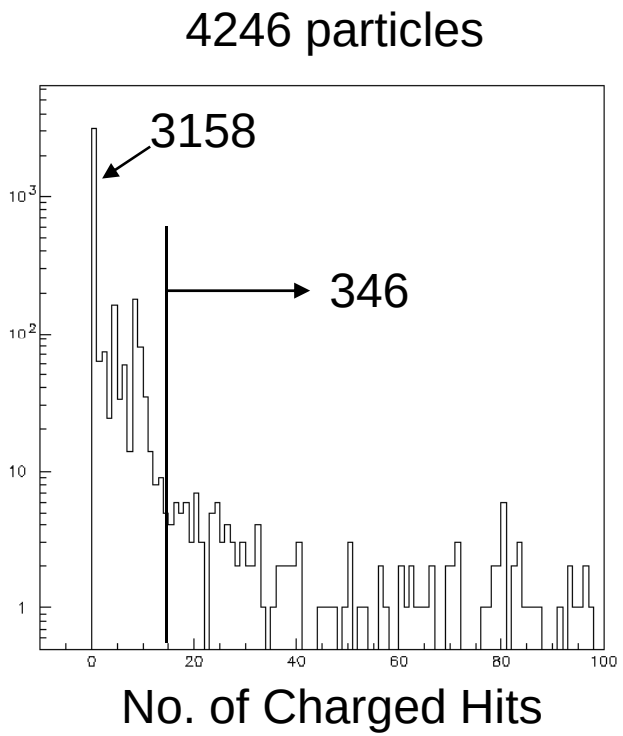
2. At 10 nTorr, on the FD protection collimator 13 m from the IP, there are 0.21 charged hits (33 hits TPC) at an average charged energy of about 240 GeV/hit and 0.06 photon hits/bunch (9 hits TPC) at an average photon energy of about 50 GeV/hit originating inside 800 m from the IP. This leads to a conservative pressure specification of 10 nTorr in the BDS from 200 to 800 m.

3. From a particle background standpoint, within the IP region between the QD0 quadrupoles, the pressure can be greater than 1 nTorr since luminosity backgrounds will be dominant in this region.

Update on Conclusion 1

Track those 0.02-0.04 particles/BX in the SiD detector.





- NH = 0: 3158/4246 = 74%
- NH ≤ 15: 742/4246 = 17%
- NH > 15: 346/4246 = 8%

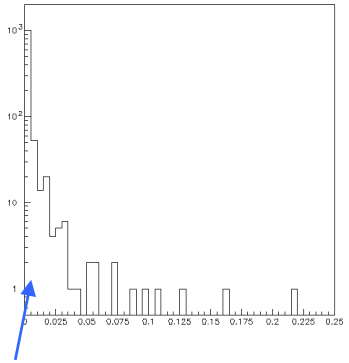
Only 10% of particles would generate significant number of hits.
→ 10 nT may be acceptable.

Update on Conclusion 3

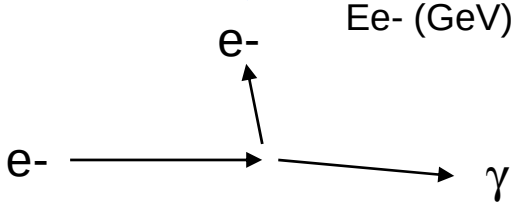
What is the beam-gas scattering rate in |Z| < 3.5 m at 1000 nT?

250 GeV e- ⟶ 2-cm ϕ 7-m long gas (H_2/CO/CO_2)

- Incoherent electronuclear process: e- $\rightarrow \gamma \rightarrow \gamma$N
  - Totally negligible, ~10^{-10}/BX@1000nT
- Coherent electronuclear process (deep inelastic scattering): e- $\rightarrow \gamma^* \rightarrow \gamma^*$N
  - FLUKA does not simulate this process.
    - Replace e- with γ : 1.9×10^{-3}/BX@1000nT
  - G4 simulates this process (GHAD package)
    - 3.3×10^{-3}/BX@1000nT
- 'Large angle' bremsstrahlung
  - 5.8 e-/BX@1000nT



Ee- (GeV)



Luminosity backgrounds (pairs, $\gamma\gamma\rightarrow$hadrons) are much higher.