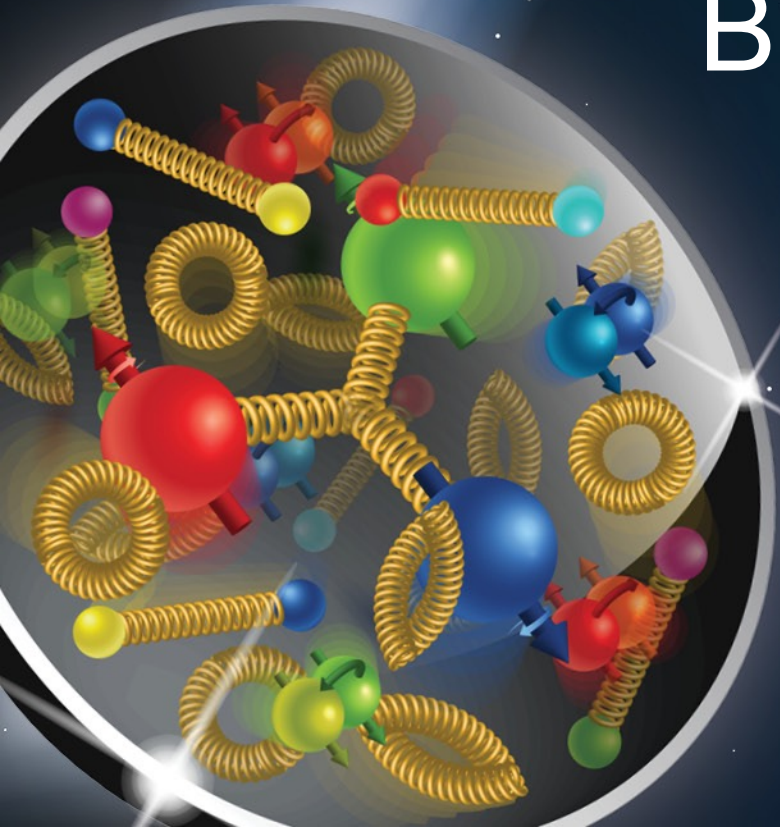


Hadron Beam Gas Background @ the RP

Cross-Collaboration FF Meeting

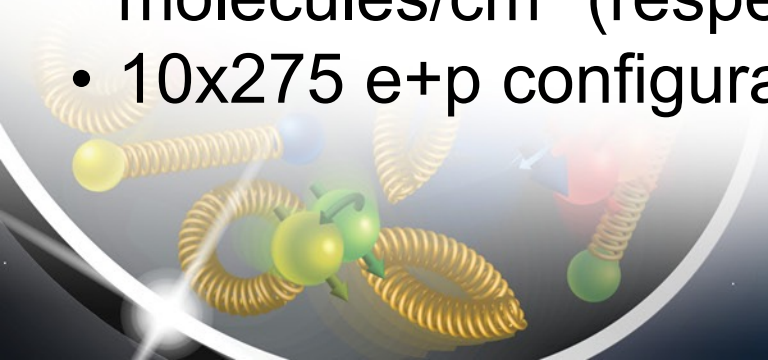
Alex Jentsch (BNL)



Electron Ion Collider

Basic Assumptions

- 25cm x 10cm active area with 0.05cm x 0.05cm pixels
 - 100k pixels per plane.
- Bunch crossing rate $\sim 100\text{MHz}$.
- Collision Rate $\sim 500\text{kHz}$.
- e+p cross section @ 18x275GeV $\sim 50\text{ub}$.
- Lumi $\sim 10^{34}\text{cm}^{-2}\text{sec}^{-1}$
- p+H₂ cross section $\sim 60\text{mb}$
 - Simulated using PYTHIA p+p events with randomized z-vertex position along beamline.
- Gas @ 10^{-9} to 0.27×10^{-10} (current RHIC vacuum @ 20m from IP) mbar $\rightarrow 2.4 \times 10^7$ to 6.6×10^5 molecules/cm³ (respectively)
- 10x275 e+p configuration (maximum proton current)



Calculations

$$\text{DIS Collision rate} = L * \sigma_{ep} = 50\mu b \times 10^{34} \text{cm}^{-2} \text{s}^{-1} = 50 \times 10^{34} \times 10^{-6} \times 10^{-24} \text{cm}^2 \text{cm}^{-2} \text{s}^{-1}$$

DIS Collision rate ~ 500 kHz

*Background Luminosity = (current) * (gas density) * (length)*

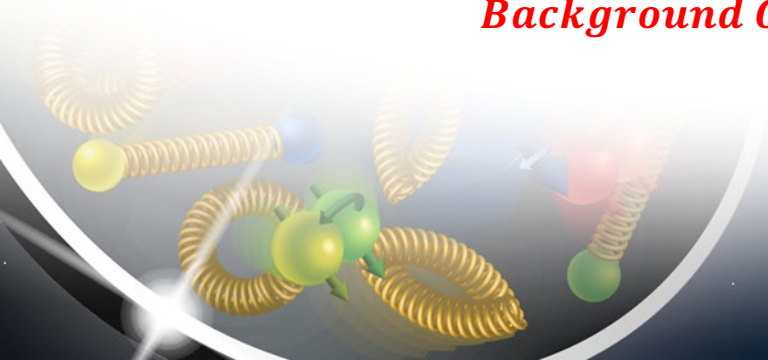
$$\text{current} = \left(1.0 \frac{\text{C}}{\text{s}}\right) * \left(\frac{\text{protons}}{1.6 \times 10^{-19} \text{C}}\right) = 0.63 \times 10^{19} \frac{\text{protons}}{\text{s}}$$

length = 5m (rough length between B1apf and RP)

$$\text{Background Luminosity} = \left(0.63 \times 10^{19} \frac{\text{protons}}{\text{s}}\right) * \left(2.4 \times 10^7 \frac{\text{H}^2 \text{ molecules}}{\text{cm}^3}\right) * (500 \text{cm}) = 8.5 \times 10^{28} \text{cm}^{-2} \text{s}^{-1}$$

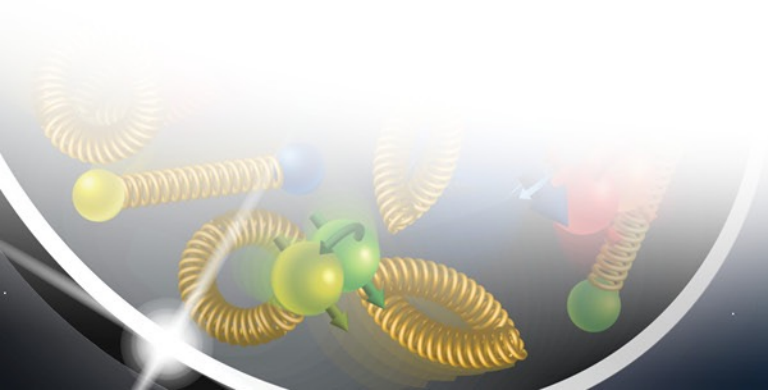
$$\text{Background Collision rate} = L_{bg} * \sigma_{pH_2} = (8.5 \times 10^{28} \text{cm}^{-2} \text{s}^{-1}) \times 60 \text{mb} = 510 \times 10^{28} \times 10^{-3} \times 10^{-24} \text{cm}^2 \text{cm}^{-2} \text{s}^{-1}$$

Background Collision rate = 0.12kHz to 4.5kHz



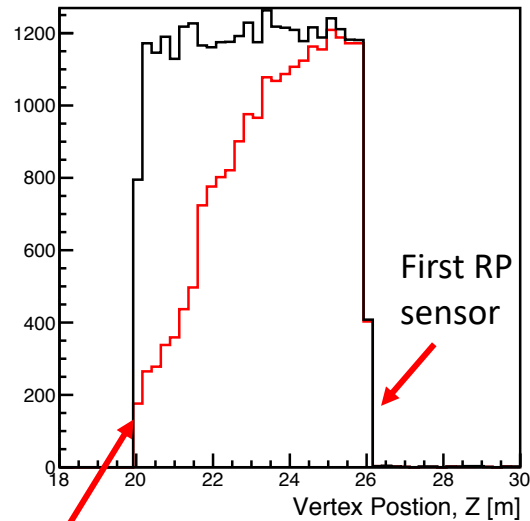
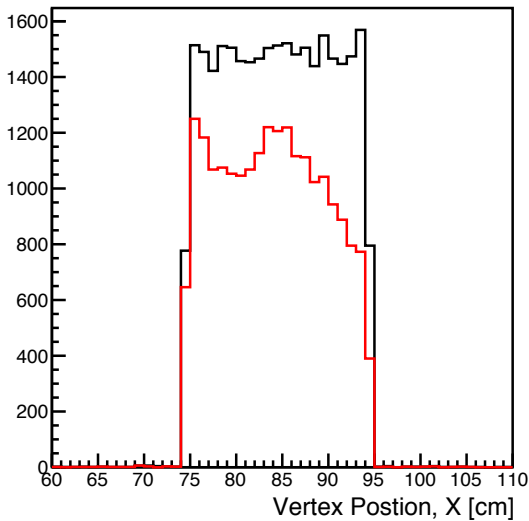
Effect on Roman Pots

- 505 kHz DIS and beam+gas background combined rate.
 - Current worst-case.
- 100k pixels on single layer.
- If we assume roughly equal probability of single pixel being hit by particle.
 - 505 kHz (\sim one potential particle per collision) / 100k pixels \sim 5 hits/pixel/sec
- Overall occupancies much lower than what is observed at the LHC for the RP.

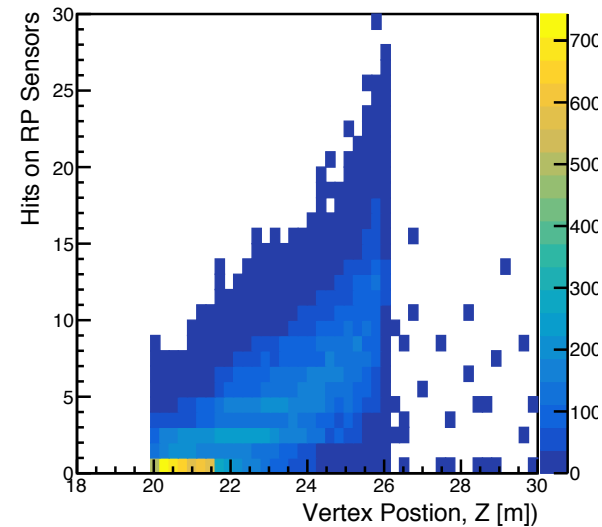


Backgrounds from beam+gas

- Collisions of beam hadrons with gas molecules in the beam pipe are a source of background for the Roman Pots.
 - Vacuum will be $\sim 10^{-9}$ mbar (conservatively) in the drift region near the Roman Pots.
 - With the beam parameters in the CDR, collision rate will be ~ 500 kHz, while the beam gas rate (assuming H_2 is dominant gas) is ~ 5 kHz.



Rough position
of b1apf



Only appreciable beam+gas events come from the drift area *after* the last dipole before the Roman Pots.

Summary

- Overall beam+gas rates in the RP are going to be **very low**.
 - Only beam+gas collisions happening roughly between B1apf and the RP can contribute (earlier collision products will be swept away by dipoles).
 - Collision rate + background rate ~ 505 kHz.
- Beam+machine (i.e. showers from collisions with vacuum system) will be more appreciable, but detailed study will need to be carried out once a preliminary vacuum design is ready.

