OLD DOMINION UNIVERSITY

Ion Polarimetry R&D Requirements for the EIC

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30 Nov 2018

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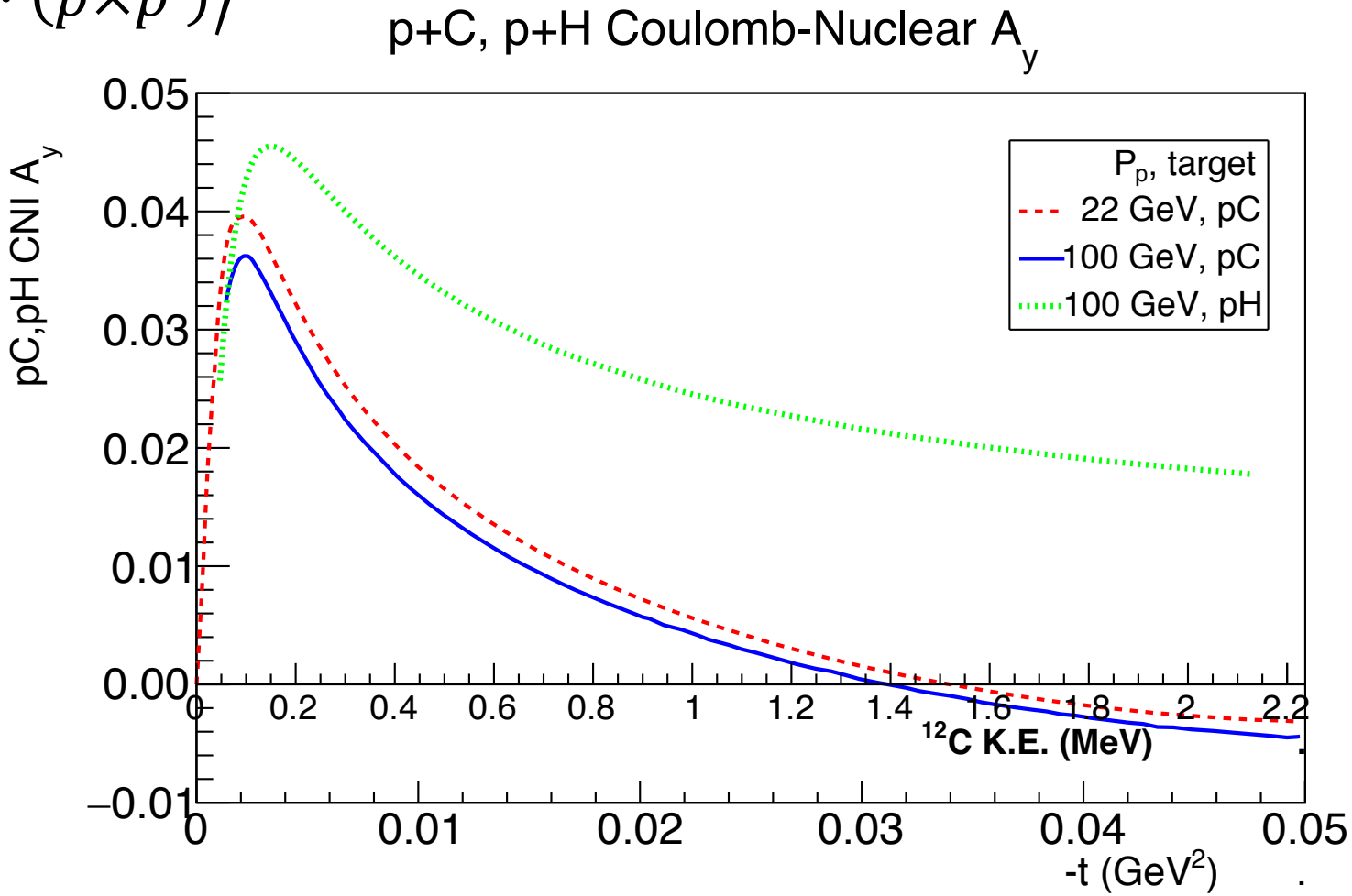
Topics / Challenges

- Fast time structure
  - JLEIC 2 ns bunch to bunch
  - eRHIC 9 ns
  - Background rejection
- Multiple Species
  - $\vec{p}$, $\vec{d}$, $\overleftrightarrow{d}$, $^3\overrightarrow{He}$, Li?
- Improving precision to < 2%
- Test beam opportunities at JLab and RHIC

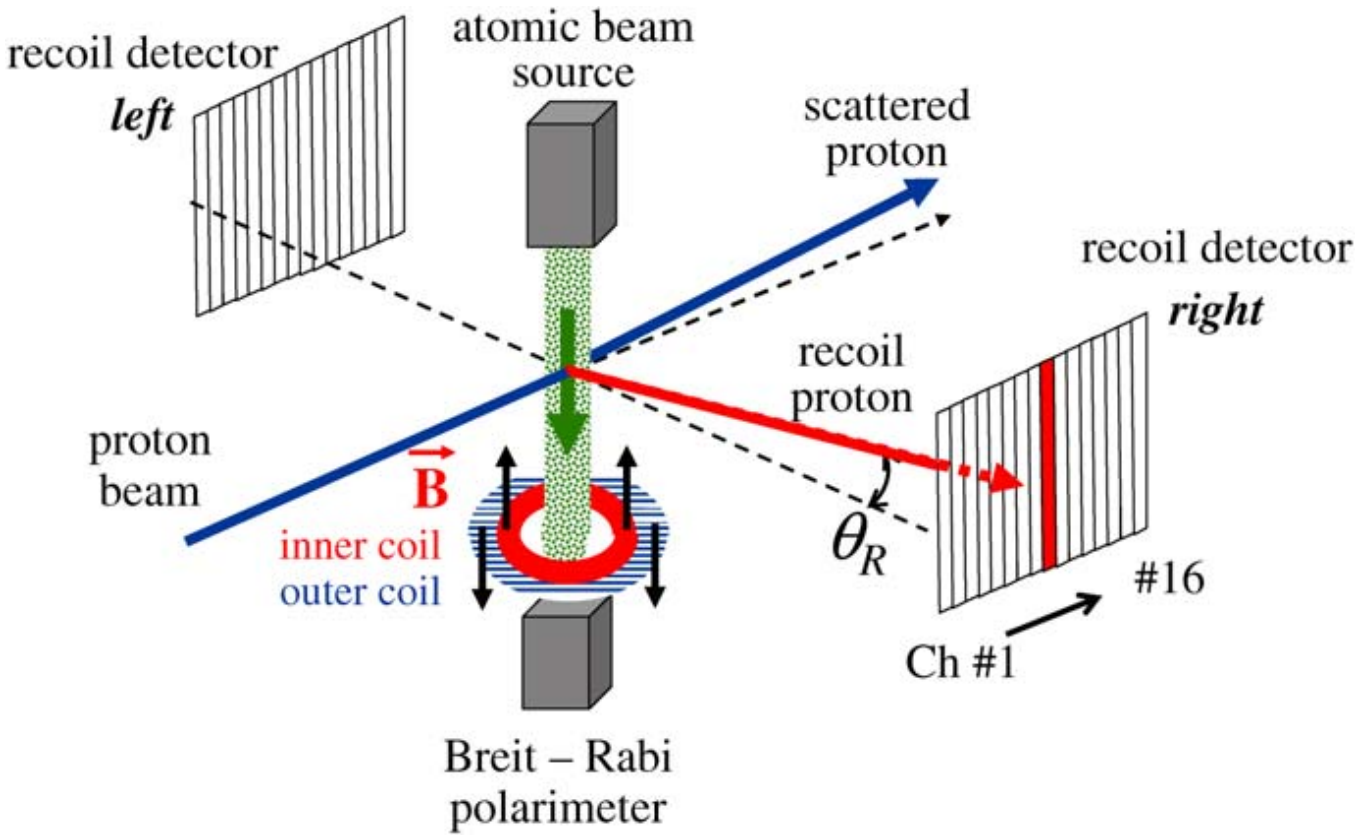
Coulomb-Nuclear Interference: pC and pH Scattering

- $A_y = \langle \sigma_p \cdot (p \times p') \rangle$

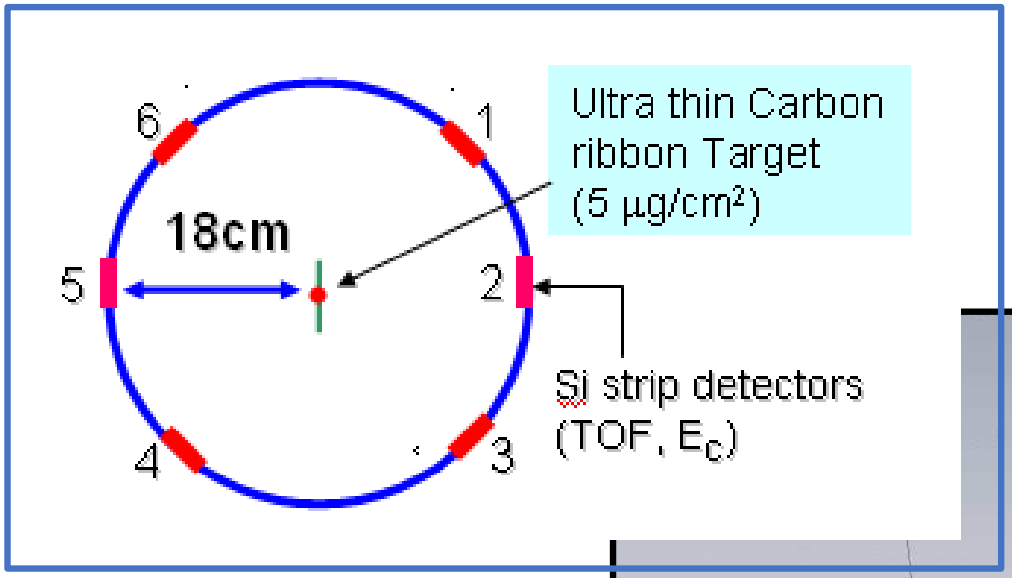


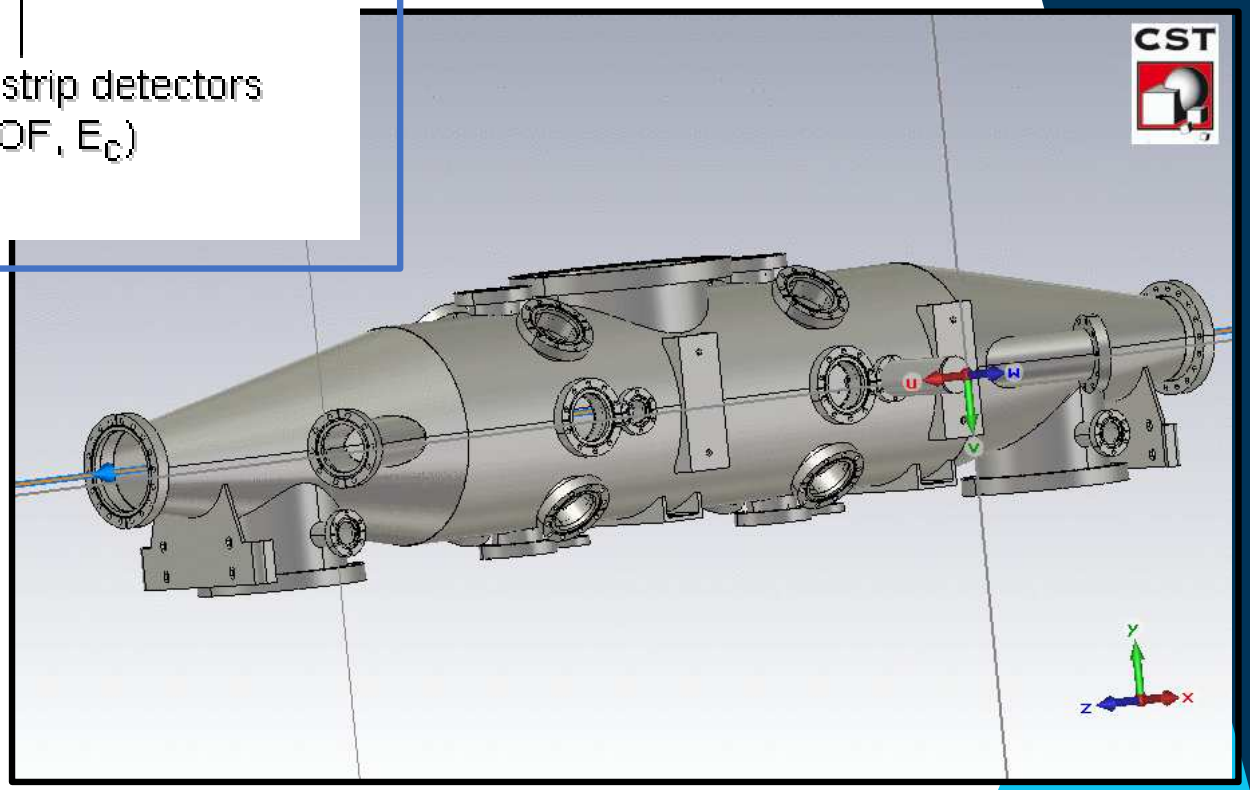
RHIC pH Polarimeter

- Absolute
  - Main systematic is un-polarized residual H
  - Slow



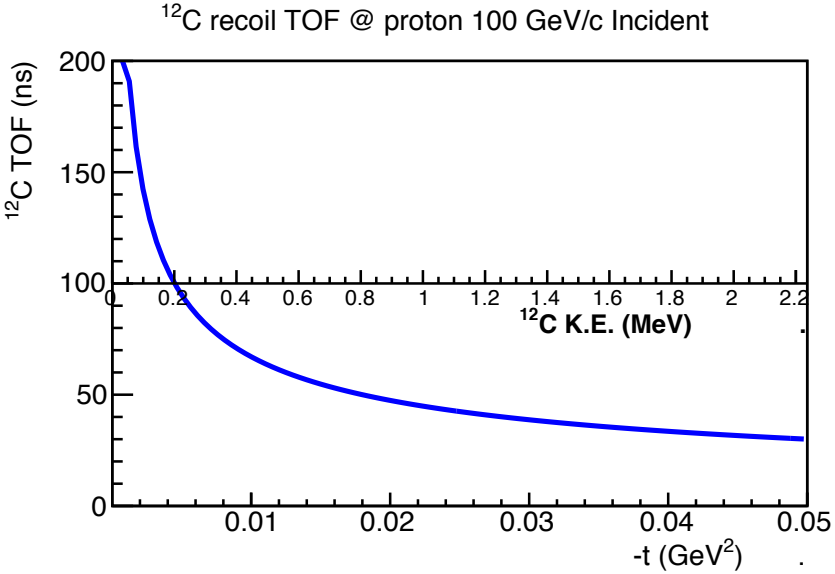
RHIC pC Polarimeter

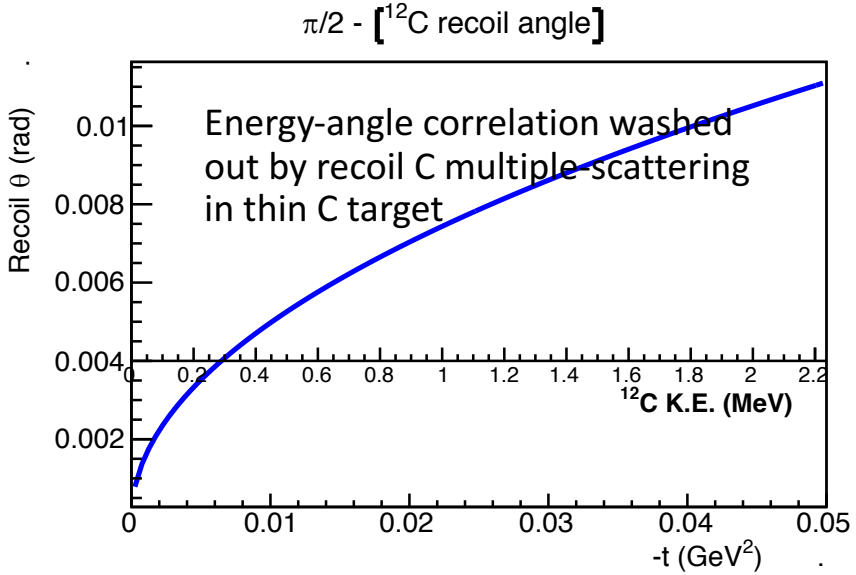


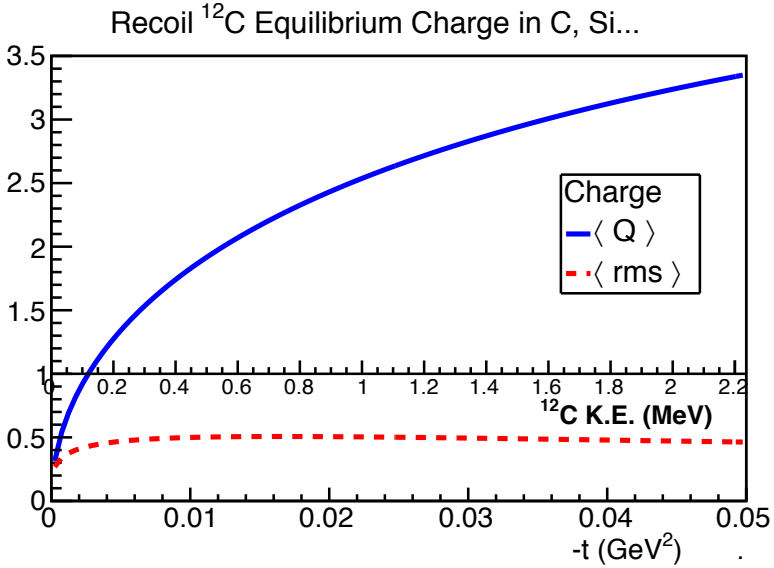


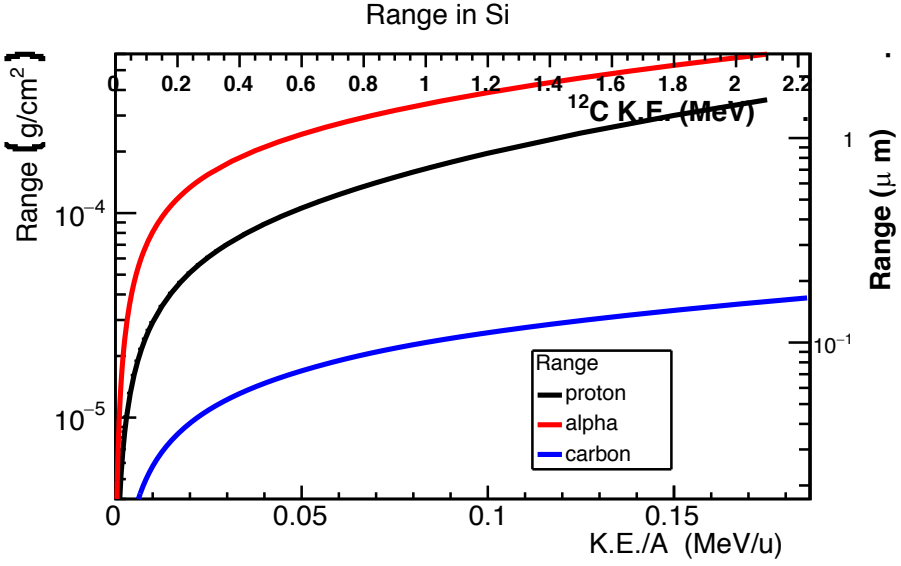
- Dual targets
- 15 inch diameter
- 1:5 taper

pC Kinematics ~90°



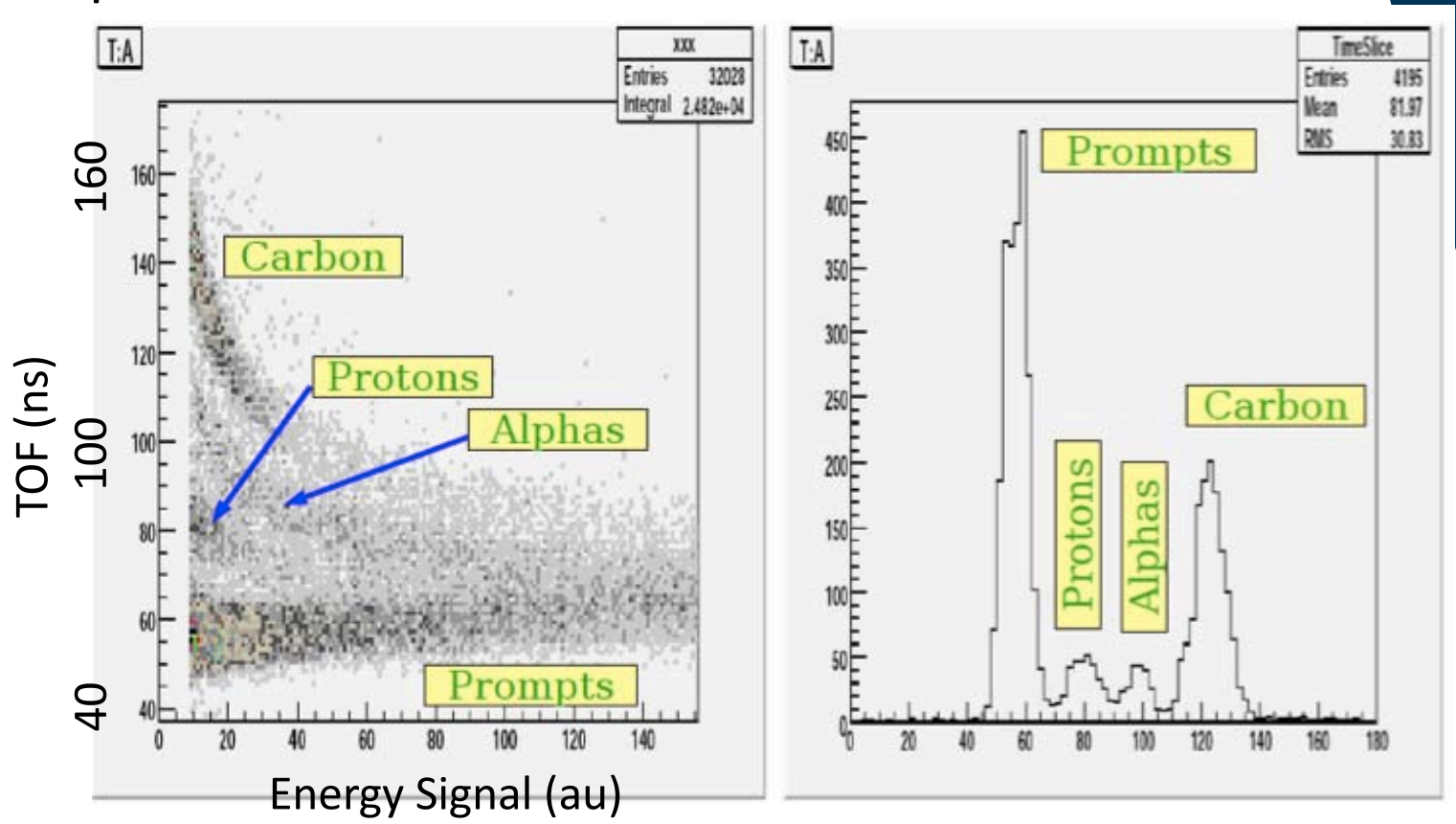






Energy-Time Correlation

RHIC pC



- Impossible to resolve C signal from p, α, π background with EIC bunch rep rate of 2 – 10 ns

R&D Project 1

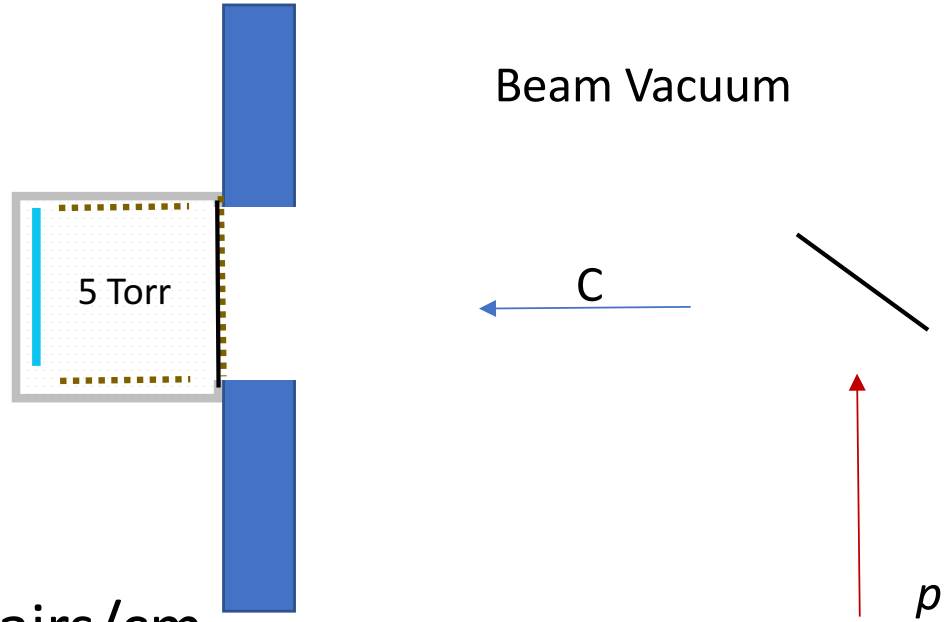
- Understand the background
  - RHIC experience says it is beam-target
  - p, α particles semi-isotropic
    - Fermi-momentum larger than momentum transfer at 90 deg
    - p, α, C stop in < 1 micron of Si-strip detector
  - Prompt signal is likely minimum ionizing
    - Punches through Si detector
- Install a second layer to tag prompts
  - Decrease primary detector thickness to ~50 μm
  - Tests do not require polarized beam
    - Polarized proton beam in RHIC 2021
      - AGS also possible
    - Are ion beams usefull?

R&D Project 2

- Improve the energy and TOF precision
  - Optimize Si sensor for low-energy heavy-ionizing C recoil
  - Range is 50 – 100 nm in Si
    - Dead areas are OK, dead-layers are not
  - Present energy resolution is ~ 4%
    - Poisson statistics limit $\sqrt{\frac{4eV}{0.4MeV}} = 0.1\%$
  - Low Gain Avalanche Diode (LGAD) detectors are striving for 10 psec time resolution
    - C Signal is large

R&D Project 3

- *p, α, C* PID from ΔE/E measurement
- Borrow concepts from low energy nuclear physics
- 5 Torr gas detector ~ 1 cm in front of Si-strip detector
  - Vacuum window must be as thin as target foil (5 μg/cm^2). Support window with micro-mesh.



- C energy loss ≤ 0.1 MeV/cm in 5 Torr CO_2
- ≤ 3000 e^-ion pairs/cm

Ions: d, ^{3}He, …

- p+p and p+C kinematics, asymmetries similar
- Expect d+C, ^{3}He+C… to have comparable asymmetries
  - Tagging beam breakup channels might even enhance S:N
- Absolute polarization measurements possible with Polarized Atomic Beams
  - $\vec{d} + \vec{D}$, $\quad {}^3\overrightarrow{He}^{++} + {}^3\overrightarrow{He}$
- What are the dD and dC tensor asymmetries?

Conclusions

- R&D needed
  - Feasible with existing beams at RHIC, Jlab
- References

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