

Status of IR-8 Vetoing Efficiency and Next Steps

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Status of IR-8 Vetoing Efficiency

- Draft of IR-8 vetoing efficiency on overleaf is **ready**
- Thinking of **PRD journal**
- <https://www.overleaf.com/2534154956nhddnyyvghgd#11fd4b>
- Outline
 - **Introduction** – EIC, EIC 1st & 2nd detectors, and Exclusive Diffractive VM measurements
 - **Proposed IR-8 layout** – Interaction region and secondary focus feature
 - **Far-Forward Detectors** – Detector general layout and acceptance
 - **Event Generator** – BeAGLE and incoherent sample
 - **Results** – Vetoing procedure , impact of secondary focus, and neutron exit window impact
 - **Summary & Outlook** – Possible physics cases (pion clouds/diffractive longitudinal structure function)
- Please let me know if you have any **comments** and **feedback**. I would **appreciate it**. If I may, it would be nice if I can make it in a good shape to submit a journal soon and have arXiv information before Diffraction and Low-x workshop in September (among Detector 2 diffractive physics program).

Next Steps

I wanted to investigate a capability on coherent tagging at IP-8 and evaluate how much impact at secondary focus can be made with tagging and reconstruction with various ions. (Thomas's and Kong's comments)

Good news!

Wan has already made a good progress on this topic with IP-8. **Stay tuned!**

Moving on,

What are topics/ideas for IP-8 (possibly IP-6) that would be interesting?

(Continued) Next Steps

Listing interesting topics with IP-8 (possibly IP-6 too) (for sure, there are more...)

- **Neutron spin structure from eHe3 scattering** Physics Letters B 823 (2021) 136726
 - Brought a discussion with Alex Jentsch: polarized He3 beam
 - Do we have eHe3 generator to start with? BeAGLE? CLASDIS? DJANGO?
- **Z-tagging at secondary focus** (Charles Hyde and Bill Li: EIC Generic R&D)
 - Brought a discussion with Bill Li (Stony Brook) when he gave a seminar at BNL (06/2024)
 - Feasibility is questionable to fit into space at secondary focus?
- **Transverse spatial structure of excited states in nuclei** (Pawel Nadel-Turonski)
 - Brought a discussion with Pawel (Stony Brook/JLab) at DIS 2024
 - See difference in structure functions measured with tagged final-state in excited/ground state (for structuring of excited target?)

Would be great if new topic would be beneficial and interesting for IP-8 and IP-6 both I can contribute.

Neutron Spin Structure from eHe3

- Goal using polarized ${}^3\text{He}$ beam
 - Origin of nucleon spin (one of physics objectives derived from NAS)
 - Extraction of neutron information
- Method: double tagging sample $e^3\text{He}$ (e, e', p_{1s}, p_{2s})
 - Requires two spectator protons to be detected in Far-Forward (active neutron)
 - Uses hit information from Roman Pot and total momentum reconstruction ($|\vec{p}_{1s} + \vec{p}_{2s}|$)
 - Calculate neutron asymmetry A_1^n as a function x_B and/or Q^2
- Impact
 - Provides valuable input for polarized parton distribution global fit and flavor separation
 - Tests nuclear correction by comparing to existing fixed target data

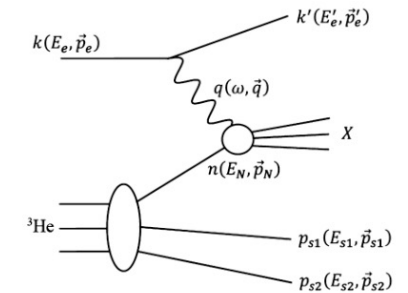


Fig. 2. A diagram of Deep Inelastic $e^+{}^3\text{He}$ scattering with double spectator tagging. The channel shown here is electron scattering off a neutron in ${}^3\text{He}$; the two spectator nucleons are the protons in the process ${}^3\text{He}(e, e' p_{s1} p_{s2})X$.

Reference
Physics Letters B 823 (2021) 136726

Z-tagging at Secondary Focus

- Goal (Mini Detector of Internally Reflected Cherenkov light (mini-DIRC))
 - Cherenkov detector identify charge of nuclear fragments from proton to uranium
 - In coincidence with detection of decay photons at B0 spectrometer and ZDC → rare isotope spectroscopy
- Method
 - Nuclear charge z of ion fragments at roman pot at the secondary focus
 - Thin quartz radiator coupled to a light collection volume and a high resolution photo-sensor
 - z -dependent signal is event-by-event absolute intensity of Cherenkov light pulse
- Impact
 - Excitation spectra of rare isotopes can be measured, particularly for short lived isotopes that are not accessible at FRIB and other facilities

Reference from EIC generic R&D

https://www.jlab.org/sites/default/files/eic_rd_prgm/files/2022_Proposals/Z_tagging_Mini_DIRC_EICGENRandD2022_09.pdf

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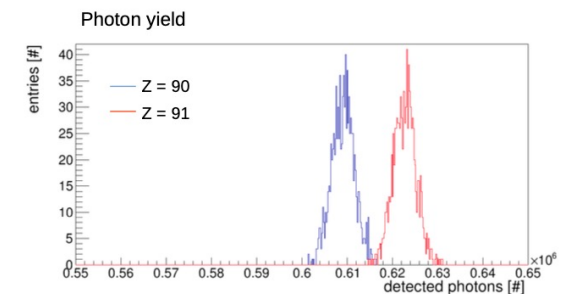


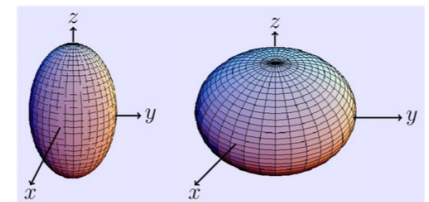
Figure 4: Comparison of the photon detection yield for $z = 90$ and $z = 91$ ions. The photo detection quantum efficiency is 30% for 280 nm to 400 nm. The statistical fluctuations correspond to only 10% of the Cherenkov yield, but the histogram is rescaled to the full yield.

Transverse Spatial Structure of Excited

- Goal
 - Probe structure of the excited target → new insights on structure of nuclei
- Discussion (in particular of U-238)
 - Q) excited state on time scale on production of photons or meson
 - Difference in the structure functions measured with tagged final state with ground state
 - Q) in event generator can we set to different deformed nuclei (rotational states)
 - Measuring photon-spectroscopy provides a precise determination of deformation
- Impact
 - On nucleon, transition GPDs describe process where initial state is ground state and final one is excited state
 - For nuclei, if final state is a rotational excitation, its transverse spatial distribution should be quite different. Final state can be determined by measuring associated γ -photons

Reference

<https://indico.bnl.gov/event/22023/contributions/92022/attachments/54814/93780/eA%20excited%20states.pdf> at ePIC eA study group meeting



Summary

- I would appreciate it if you can provide any feedback/comments on IP-8 vetoing efficiency draft. Thank you!
- Any suggestions for next steps? Within LDRD scope, what topics can be beneficial and interesting to be investigated?
- Will give a talk about “Diffractive Physics Program at EIC 2nd Detector” at Diffraction and Low-x 2024 workshop (<https://indico.cern.ch/event/1354173/>) for Sept 8 – 14, 2024. I am currently working on it and will share slides with you soon!