Update on ALERT A Low Energy Recoil Tracker



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ALERT Collaboration

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Introduction

- Overview of ALERT Physics
- ALERT detector
- Subsystem progress
- Mechanical design progress
- Status and planned tests
- Summary





The ALERT Experiments

A comprehensive program to study nuclear effects

Coherent Processes on ${}^{4}\mathrm{He}$

- 4 He($e, e' {}^{4}$ He γ)
- 4 He($e, e' {}^{4}$ He ϕ)

Explores the partonic structure of ${}^{4}\mathrm{He}$



DIS on ${}^{4}\text{He}$ and ${}^{2}\text{H}$: Tagged EMC Effect

- ⁴He(*e*, *e*'+³H)X (proton DIS)
- 4 He(e, e'+ 3 He)X (neutron DIS)
- ${}^{2}H(e, e' + p)X$ (neutron DIS)

Test FSI and rescaling models



Incoherent processes on ${}^{4}\text{He}$ and ${}^{2}\text{H}$

- 4 He($e, e'\gamma p + {}^{3}$ H)
- 4 He $(e, e'\gamma + {}^{3}$ He)n
- ${}^{2}\mathsf{H}(e,e'\gamma+p)n$

Identify medium modified nucleons



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• Two goggles to view the nucleus

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- Two goggles to view the nucleus
- Coherent DVCS to probe the charge profile

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- Two goggles to view the nucleus
- Coherent DVCS to probe the charge profile

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• Coherent ϕ production to probe the gluon profile





- Two goggles to view the nucleus
- Coherent DVCS to probe the charge profile
- Coherent ϕ production to probe the gluon profile
- How does the gluonic form factor compare to the charge?

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${}^{4}\mbox{He}$ Transverse Quark and Gluon Densities

Coherent scattering on ⁴He





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Proposed Setup: CLAS12 + ALERT

- Use CLAS12 to detect scattered electron, $e^\prime,$ and forward scattered hadrons.
- A low energy recoil tracker (ALERT) will detect the spectator recoil or coherently scattered nucleus



ALERT requirements

- $\bullet\,$ Identify light ions: H, $^2\text{H},\,^3\text{H},\,^3\text{He},$ and ^4He
- Detect the **lowest momentum** possible (close to beamline)
- Handle high rates
- Survive high radiation environment
 → high luminosity



Why ALERT?

A new detector is needed

• Existing and proposed detectors (RTPCs) do not meet experimental needs





- Run group will operate at CLAS12 luminosity limit and Hall-B beam current limit
- ALERT will **provide full PID** of light ions, protons to ⁴He



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ALERT Design

Basic Design

- Detector will surround a \sim 3 atm gas target cell which is 6 mm in radius and constructed with 25 μ m kapton walls
- Hyperbolic drift chamber with 10° stereo angle.
- Outer scintillator hodoscope for PID





Hyperbolic Drift Chamber (HDC) Design

- 2 mm wire separation
- 10° stereo angle
- Minimize material (windows/walls)
- Detects $\theta\sim 30^\circ$ to 170°
- Acceptance minimum momenta: protons $\rightarrow 70~{\rm MeV/c}$ $^4{\rm He} \rightarrow 240~{\rm MeV/c}$





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ALERT Hyperbolic Drift Chamber (HDC)



HDC Status

- Simulations of stresses on endplates complete.
- MACOR selected for forward endplate (fabrication in progress).
- Designing wire assembly tools and jig.





Courtesy of Julien Bettane





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ALERT Time-of-flight (ATOF)





TOF separates light ions, except ⁴He and ${}^{2}H$ which have same m/g ratio



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ENERGY

ATOF Module



Note this is a slightly older design.

Module design status

- Conceptual design of rigid-flex PCBs and assembly complete.
- Design freeze of HDC's PCB radius needed to finalize ATOF module design .



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ATOF System Layout

- Readout electronics will mount on the upstream plate of ALERT
- All active components will be outside of the drift gas volume
- Developing modular readout electronics with engineering support from Nalu Scientific and JLab Fast electronics group

 \rightarrow JLab – Petiroc2A readout board (standard)

 \rightarrow Nalu – ASOC readout board (waveform digitizing)





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Mechanical design







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Mechanical design









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ALERT Status and Plans

- Prototype tests underway.
- Future tests include:
 - \rightarrow High field facility tests
 - \rightarrow In-beam prototype tests at ALTO
- Working closely with Hall B Task Force to prepare for experiment
- Followup to Nov. 2019 ERR expected late 2020/early 2021
- Some delays due to COVID19
- Detailed project schedule and plans. (not yet considered for beam time scheduling)
- Significant progress on hardware and software fronts





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Argonne High Field Test Facility



| Maximum Field | 4 T |
|---------------------|-----------|
| Bore diameter | |
| with gradient coils | 68 cm |
| w/o gradient coils | 90 cm |
| Homogeneity | 10^{-5} |
| Removable rails | |



In field tests:

- ATOF readout electronics test component magnetics.
- **2** HDC prototype wire forces
- **3** Full ALERT detector





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ALERT at ALTO Beam Test HDC Prototype:



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ALTO:



• HDC prototype test planned with ALTO ion beams.



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Summary

- Physics of ALERT is a comprehensive program to study nuclear effects
- ALERT design and construction is steadily progressing.











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Thank you!





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