### ALERT Run Group Update Run Group L



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# **ALERT Run Group**

- Run Group L measurements
- ALERT Detector
  - -AHDC construction
  - -ATOF construction
- Detector Transportation test
- Preparation of Magnetic tests
- Future plans





# The ALERT Experiments

### A comprehensive program to study the partonic nuclei and nuclear effects

### Coherent Processes on <sup>4</sup>He

- <sup>4</sup>He(e, e<sup>/</sup>
  <sup>4</sup>He γ)
- <sup>4</sup>He(*e*, *e*<sup>/</sup> <sup>4</sup>He φ)

# Explores the partonic structure of <sup>4</sup>He



### And many more channels for free



#### DIS on <sup>4</sup>He and <sup>2</sup>H : Tagged EMC Effect

- <sup>4</sup>He(e, e<sup>1+3</sup>H)X (proton DIS)
- <sup>4</sup>He(e, e<sup>1+3</sup>He)X (neutron DIS)
- ${}^{2}H(e, e^{l} + p)X$  (neutron DIS)

#### Test FSI and rescaling models



#### Incoherent processes on <sup>4</sup>He and <sup>2</sup>H

- 4He(e, e'γ p+3H)
- <sup>4</sup>He(*e*, *e*/γ +<sup>3</sup>He)*n*
- ${}^{2}H(e, e'\gamma + p)n$

#### Identify medium modified nucleons



A cartoon by W. Armstrong



· Two goggles to view the nucleus



A cartoon by W. Armstrong



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





- Two goggles to view the nucleus
- Coherent DVCS to probe the charge profile
- Coherent  $\varphi$  production to probe the gluon profile



A cartoon by W. Armstrong



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





# <sup>4</sup>He Transverse Quark and Gluon Densities

### **Coherent scattering on <sup>4</sup>He**





ENERGY Argome National Laboratory is a U.S. Department of Energy laboratory managed by UChicago Argome, LLC.

# A Low Energy Recoil Tracker (ALERT)

- Existing (eg6) and (BONUS) RTPC detectors do not meet our experimental needs
- · eg6 RTPC was slow and lacked full PID capabilities
- · BONUS12 RTPC will be similar and only detect protons



#### ALERT requirements

- Identify light ions: H, <sup>2</sup>H, <sup>3</sup>H, <sup>3</sup>He, and <sup>4</sup>He
- Detect the lowest momentum possible (close to beamline)
- Handle high rates
- Survive high radiation environment → high luminosity







# **Time-of-flight**

ENERGY U.S. Department of Energy laborator



# Design Parameters Need < 150 ps time resolution

Inner bar thickness : 3 mm. Outer wedge thickness : 2 cm.

TOF separates light ions, except He and <sup>2</sup>H which have same m/q ratio



# **ALERT Design and Construction**

### **Detector fully designed**

- Drift chamber (AHDC) by Orsay (IJCLab)
- Time-of-Flight (ATOF) by Argonne (ANL)
- Passed ERR in Summer 2021.

### The target and gas system

- · Very similar to BONUS
- Managed by Hall-B technical team







ALERT cart design and integration with detector gas enclosure from Tom O'Connor



### Construction



Downstream



AHDC inside wires



Upstream with electronics view





# Test of the Drift Chamber in ALTO

- Beam was proton and <sup>4</sup>He of energies comparable to what we want to detect in ALERT (6-18 MeV)
- Tested a drift chamber prototype with only a few wires, attached and supported identically to the final detector

Results finalized (Lucien Causse PhD thesis)

- HDC reconstructs tracks nicely
- Track resolution: 120 μm
- High detection efficiency →95% for protons →99% for alphas

AHDC design is fully validated





# **ATOF Module Construction and Performance Tests**



- Tested wedge time resolution with <sup>241</sup>Am source
- σ ~ 85-125 ps
- Observed tails in timing peak due to large source area  $\rightarrow$  future improvement.
- No data corrections or fine tuning of ASIC config  $\rightarrow$ Easily meeting 150 ps timing requirement of experiment!





# **ATOF Prototype Module**

Americium-241 source placed against the module's inner bar scintillator at various locations





**Figure :** the tdc difference for the module's bar sipms for different locations of the <sup>241</sup>Am source.



# **ATOF Construction**



Wedges put together and wrapped



Scintillation bars





# ALERT Simulation and Reconstruction Software

New Mexico State U., Mississipi State U., Temple & Jefferson Lab

- GEMC ALERT implementation is mostly complete
- ALERT drift chamber wire signal output has been improved according to external calculations/simulations of drift speed and associated uncertainties.
- We currently have a basic Kalman filter implemented for reconstruction.
- Work is being done to use AI to assist with track selection.
- Soon: Use AHDC and ATOF together to improve PID and explore how AI can help.



# **Calibration updates:**

### Soon: Need to connect with CALCOM

ATOF calibration is mostly done

Still need to implement cross-calibration of scintillators

Verification with GEMC output coming soon.

AHDC calibration routines are in progress

Currently working on verifying drift velocity calibration routine with GEMC output

T0 offset calibration was secently finished:



# TRANSPORTATION TO ARGONNE FOR MAGNETIC FIELD TESTS



Julien et Gabriel on an Air France flight with ALERT





# **Detector at Argonne**







# Magnetic test facility at Argonne

Laser head

DAQ



### Oscilloscope monitor



- · Will test ALERT in high magnetic fields up to 4T (depending on LHe availability)
- Will conduct long term tests using sealed sources







# **Summary and Future Plans**

- · ALERT construction is well underway
- · Design is completed with only minor hall installation issues pending
- · Major milestones completed
  - $\rightarrow$  ERR passed and beam schedule request submitted
- · Detector designs validated by simulations and prototype tests
- · The simulation and reconstruction software components are complete
- · First full sized HDC detector prototype made it to Argonne safely

### What are we doing now?

- · Prepare for the magnetic field tests that will be carried out before the summer
- · Working towards completing a full working detector

### We thank Patrick and Stepan for having us on the schedule





Thank you!





backup





# High Field Tests Preparation at Argonne









Simulation in GEMC

- Fully in place, with a basic digitization Reconstruction
  - · Basic helix fit and Kalman filters exist
  - The Kalman filter needs to be refined and pushed upstream
  - Work is ongoing to use AI to select tracks efficiently
  - The next significant step will be PID using both AHDC and ATOF information, with AI
  - Other improvements and fine tuning after data taking

Calibration

- · Systems are in place for ATOF
- Still working on drift chamber calibration code
- Will update with advanced detector test data





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