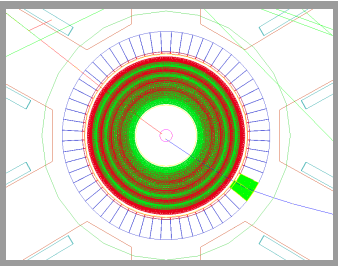
ALERT Run Group



Whitney R. Armstrong
Argonne National Laboratory

November 14, 2018

Argonne NATIONAL LABORATORY

Outline

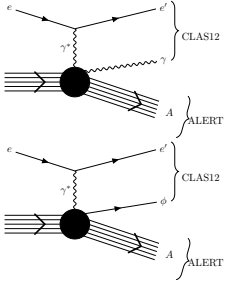
The ALERT Experiments

A comprehensive program to study nuclear effects

Coherent Processes on ^{4}He

- $^4\mathrm{He}(e, e'\ ^4\mathrm{He}\ \gamma)$
- $^4\mathrm{He}(e, e'\ ^4\mathrm{He}\ \phi)$

Explores the partonic structure of ^{4}He



The ALERT Experiments

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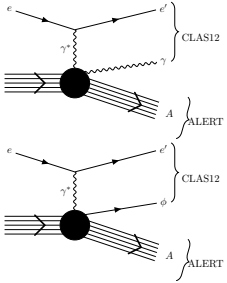
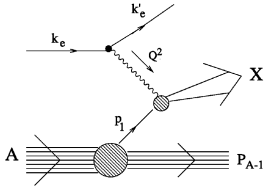


DIS on ^{4}He and ^{2}H : Tagged EMC Effect

- ^{4}He$(e, e' + ^3$H)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



The ALERT Experiments

A comprehensive program to study nuclear effects

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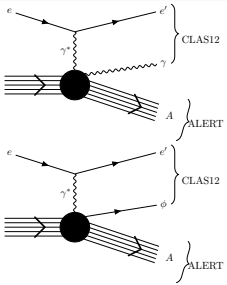

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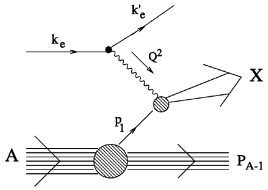
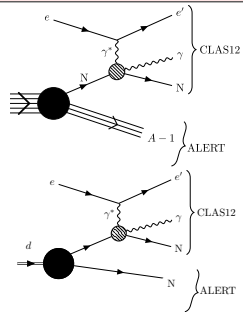


Incoherent processes on ^{4}He and ^{2}H

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

Identify medium modified nucleons

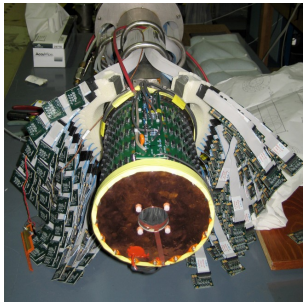


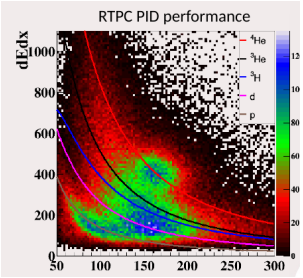
And many more channels for free

Why is the ALERT detector needed?

Existing and proposed detectors (RTPCs) do not meet experimental needs for ALERT run-group

- RTPC is rate limited; constantly being readout → no trigger capabilities
- BONuS cannot provide PID

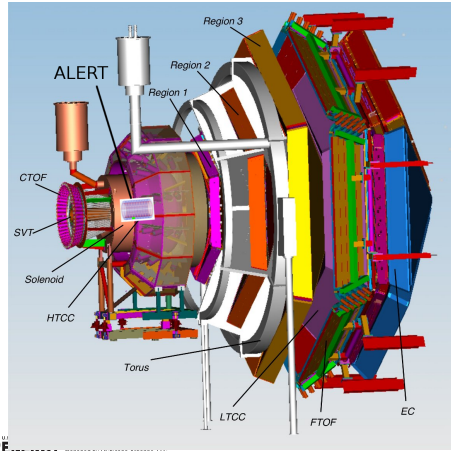




- Designed to operate in CLAS12 5 T field
- Runs at **CLAS12 luminosity limit** and **Hall-B beam current limit**
- PID of ions from protons to ^{4}He
- Independent trigger (can be adjusted to operate with higher luminosities).

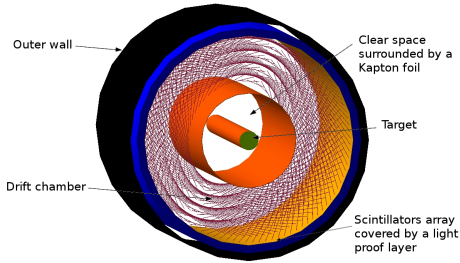
Hall-B Setup: CLAS12 + ALERT

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



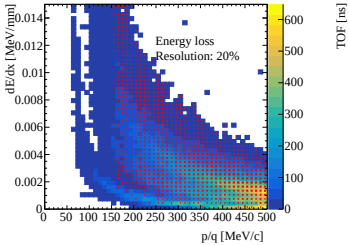
ALERT requirements

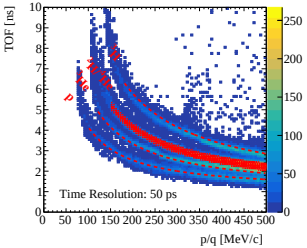
- Identify light ions: H, ^{2}H, ^{3}H, ^{3}He, and ^{4}He
- Detect the **lowest momentum** possible (close to beamline)
- Handle **high rates**
- Provide **independent trigger**
- Survive high radiation environment $\rightarrow$ **high luminosity**

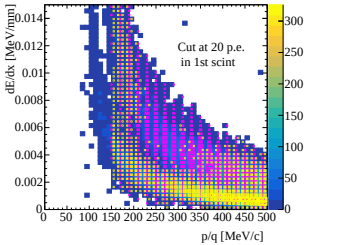


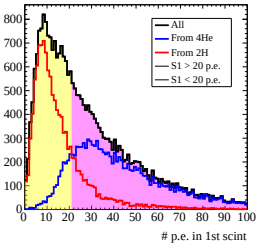
ALERT Design and Simulations

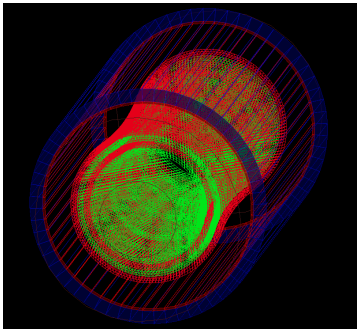
Particle Identification







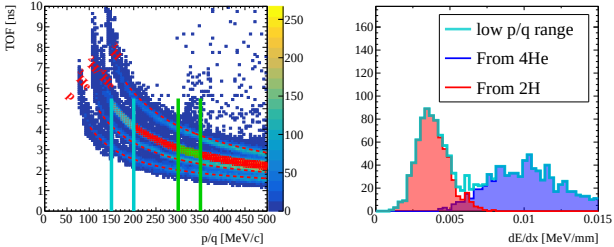


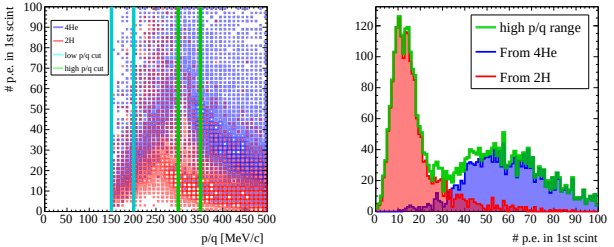


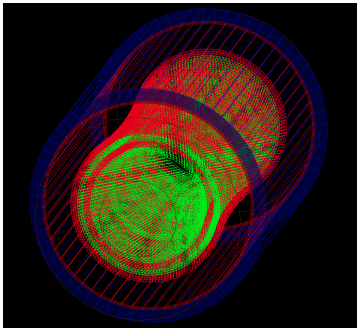
- dE/dx cannot be improved (it fixed by nature)
- TOF separation can always be improved!
- Scintillator topology (thin inner layer vs. thick outer layer) also helps

ALERT Design and Simulations

Particle Identification







- TOF provides most PID
- ^{2}H and ^{4}He degenerate in TOF.
- Separated by dE/dx at low p/q
- Scintillator topology at high $p/q \rightarrow \alpha$s don't make it through first layer.

ALERT status

ALERT Run Group Planning Meeting held on November 12, 2018

- Engineering from Argonne, Orsay, and JLab present
- ALERT Conceptual design is complete.
- Identified a number of new items to be addressed (ALERT cart assembly)
- Final designs choices are being worked out

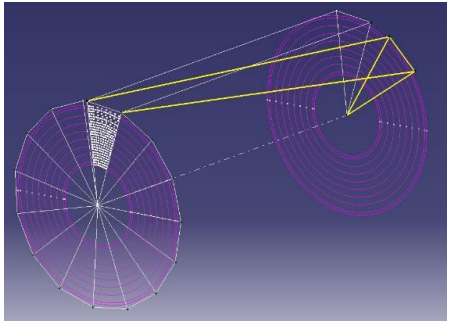
ALERT Drift Chamber Design

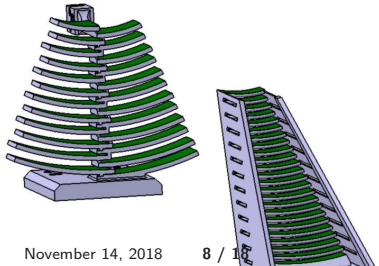
Basic Design

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

Drift Chamber Design

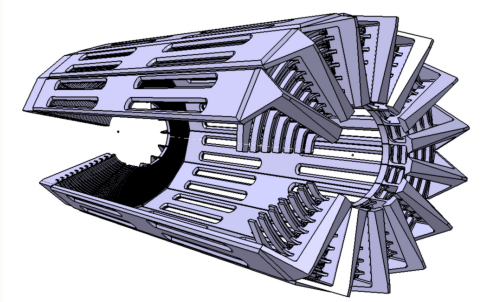
- 2 mm wire separation
- 10° stereo angle
- Minimize material (windows/walls)
- Detects $\theta \sim 30^\circ$ to 170°

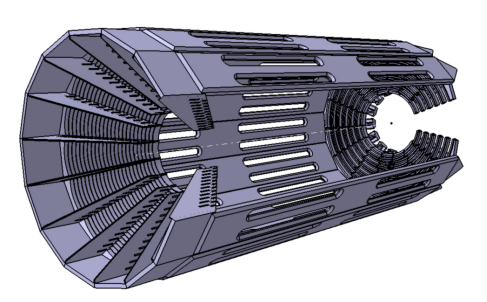




ALERT Design

Ongoing work led by IPN Orsay





Modular design has a flexing problem and becomes less modular in order to be more rigid.

ALERT Design

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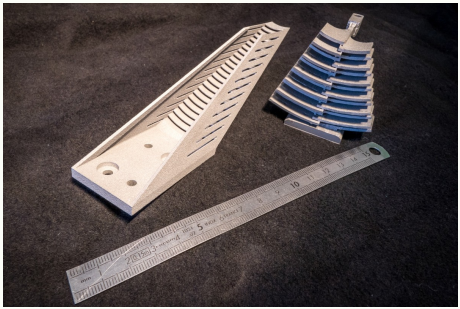

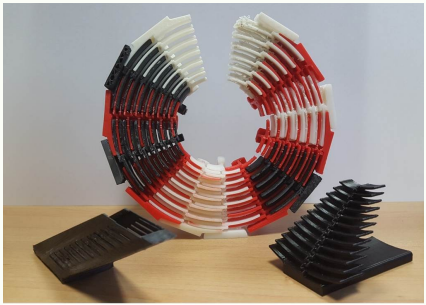

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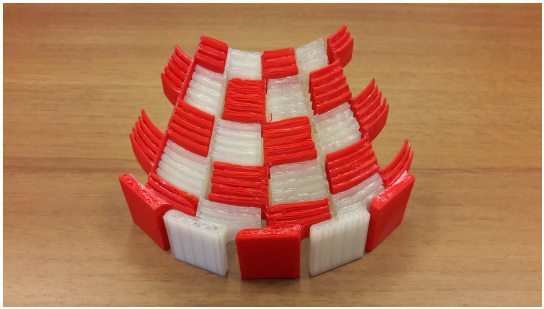

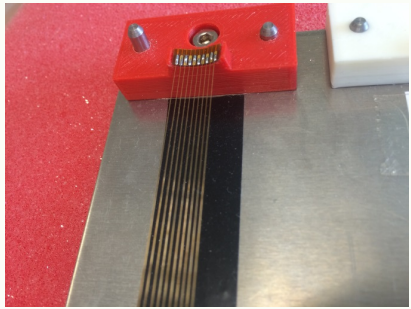

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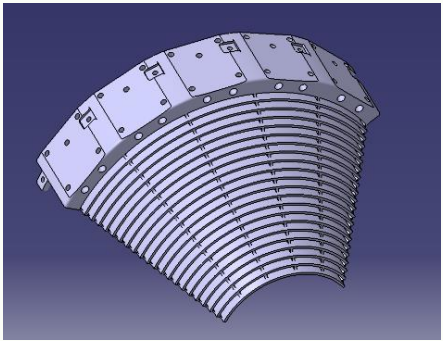

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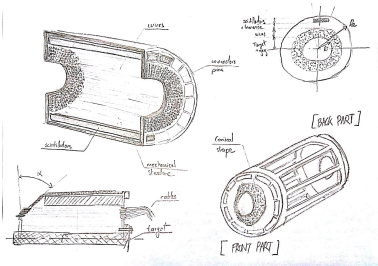
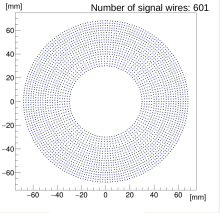
ALERT Drift Chamber 2.0

G. Charles and J. Bettane



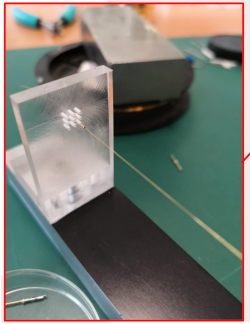
Drift chamber layout (new version)

Number of field wires: 2404
Number of signal wires: 601



With usual gold plated tungstate wires, to ensure a 20 microns sag, the total weight on the end plate due to the tension is about 600 kg.
Tests will be performed with carbon and aluminum wires.
Aluminum wires are already used in many drift chambers.

- New design consisting of one set of wires
- No dead region due to mechanical constraints.
- Wire pin testing looks promising (and familiar).

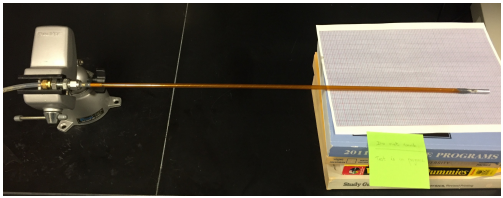


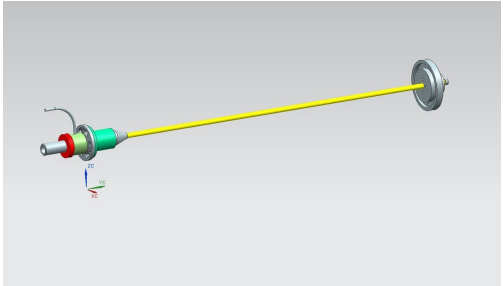
Tests with pins, setting method

- **Machining of a special tool to test the setting method**
- **Tests with the same pins used on the BELLE detector (KEK)**

ALERT Target

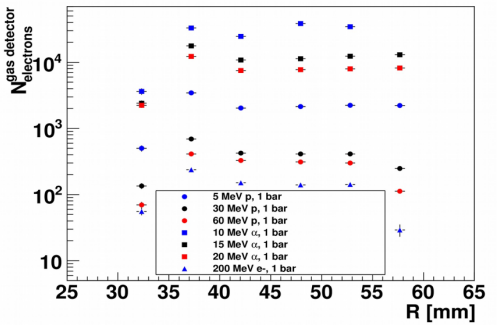
M. Hattawy





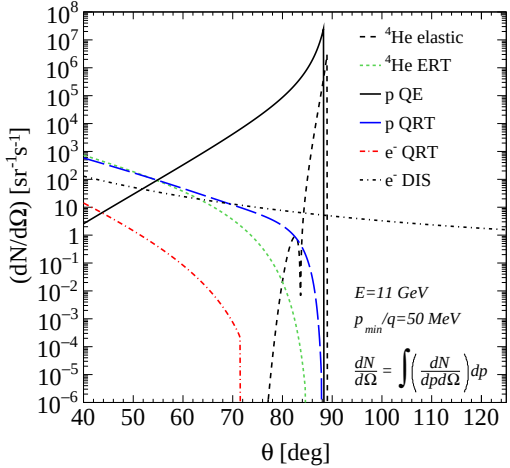
- Target will be similar to BONuS12 target
- Need to simulate beamline (more on this later)
- Will investigate new designs for better flushing of residual gasses when changing targets

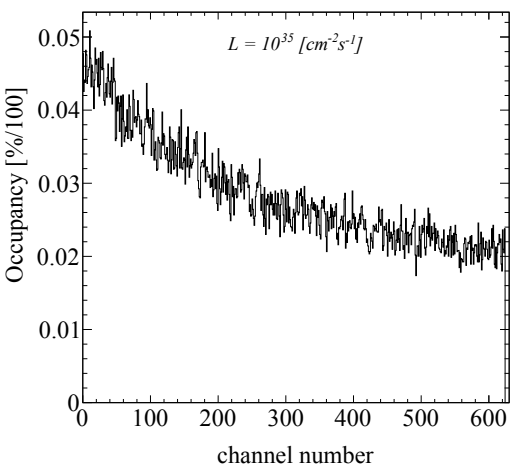
ALERT Trigger and DAQ integration



- "CLAS12 Trigger Integration" – Benjamin Raydo (JLab)
- Calculations of minimum ionizing particle signals (G. Charles)
- For Nuclear GPD proposal and running at few $> 10^{35}$ will require increasing the threshold to only trigger on alphas.

ALERT Drift Chamber Rates





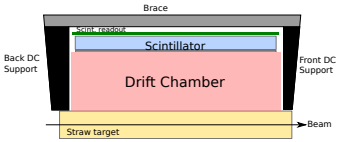
- Need to keep occupancies low (few percent) for efficient reconstruction.
- Rough $p-^4$He (trigger level) separation via DC signal threshold $\rightarrow$ raise thresh to lower p trigger rate
- Occupancy is conservative upper limit (more on this in a moment)

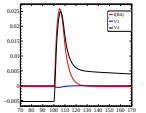
ALERT TOF System

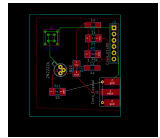
Scintillator detector

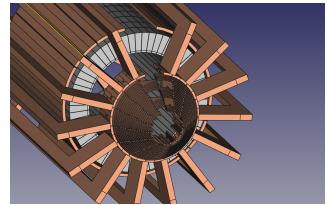
Scintillator Detectors

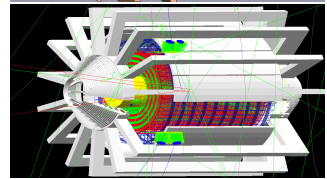
- > 700 SiPMs to readout
- **Current mode** pre-amps $\rightarrow$ **best time resolution** (shooting for 50 ps, simulating 150 ps)
- Two options
  1. Petiroc2 ASIC - 32 channel charge and time readout ASIC for SiPMs.
  2. External digitizers.
- The ASIC solution looks most promising but needs to be tested.
- Prototype with Petiroc demo board being developed at Argonne
- Mechanical structure and assembly engineering in progress.

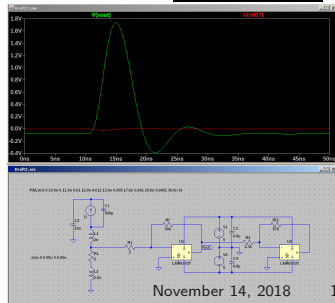












ALERT and CLAS12 Computing

Laboratory Computing Resource Center

Bebop (2017)

- 1024 public nodes
- 128GB DDR4 (Intel Broadwell) / 96GB DDR4,16GB MCDRAM (Intel Knights Landing) of memory on each node
- 36 cores (Intel Broadwell) / 64 cores (Intel Knights Landing) per compute node
- Omni-Path Fabric Interconnect

LCRC project approved for FY19

- 4 TB storage and 15000 core hours in first quarter – now.
- Nodes purchased for one-time cost (then maintained and integrated by LCRC ☺)
- Storage and compute nodes will be exclusive to project (Tape storage also available)
- Bebop has same architecture as ALCF's Theta (and likely Aurora)
- ALERT Run Group will do initial testing by running ALERT beamline simulations.

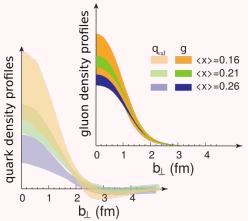
Lay the computing ground work for CLAS collaboration to use exascale computing in near future

See Sylvester Joosten's Talk : Opportunities for tier-2 computing at Argonne

ALERT Run Group

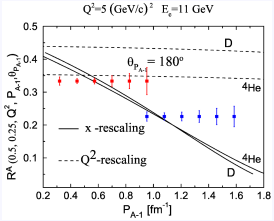
A Comprehensive Program to Study Nuclear Effects

Nuclear GPDs



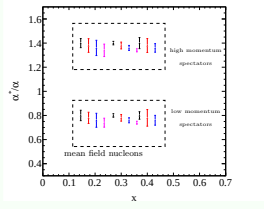
Directly compare quark and gluon radii

Tagged EMC



Address key questions about the EMC effect

Tagged DVCS



Connect partonic and nucleonic modification

ALERT is a bridge from JLab 12 GeV physics to the Electron Ion Collider

Run-Group L Future Plans

- Near term goals include finalizing design parameters.
- Optimize final target parameters: window thicknesses, pressures, downstream beamline
- Begin engineering on ALERT cart and support tube.
- ERR by May 2019.

Thank You!

Backup