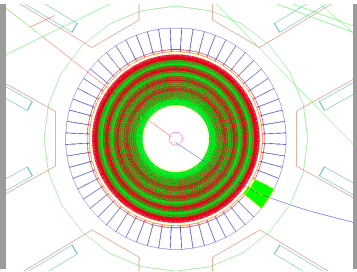
Update on the ALERT TOF detector

ATOF mechanical design and readout electronics



Whitney Armstrong Tom O'Connor
Argonne National Laboratory

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Argonne NATIONAL LABORATORY

Introduction

- Overview of ALERT Physics
- ALERT Detector and ATOF Requirements
- Mechanical design progress
- Readout electronics status

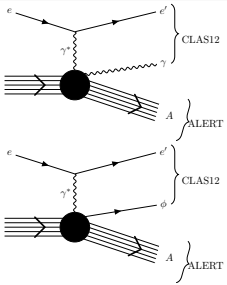
The ALERT Experiments

A comprehensive program to study nuclear effects

Coherent Processes on ^{4}He

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

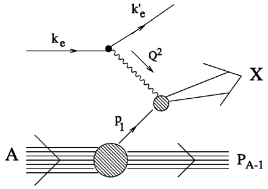
Explores the partonic structure of ^{4}He



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

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

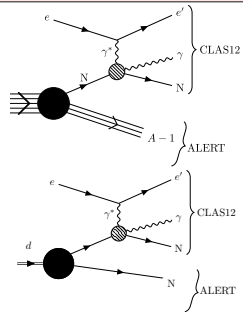
Test FSI and rescaling models



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

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

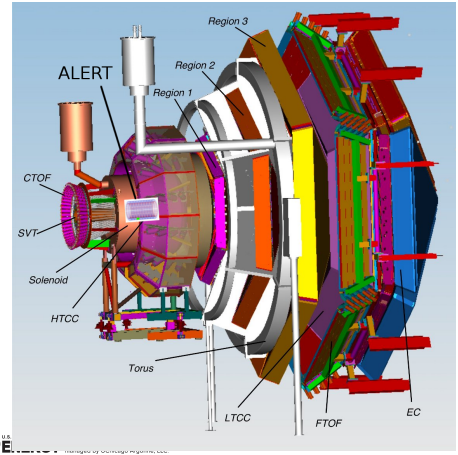
Identify medium modified nucleons



And many more channels for free

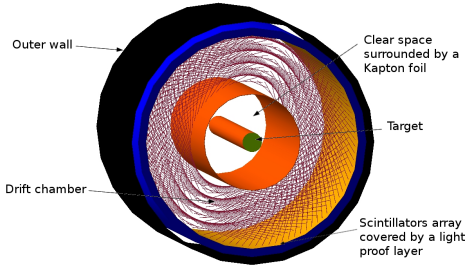
Proposed Setup: CLAS12 + ALERT

- 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

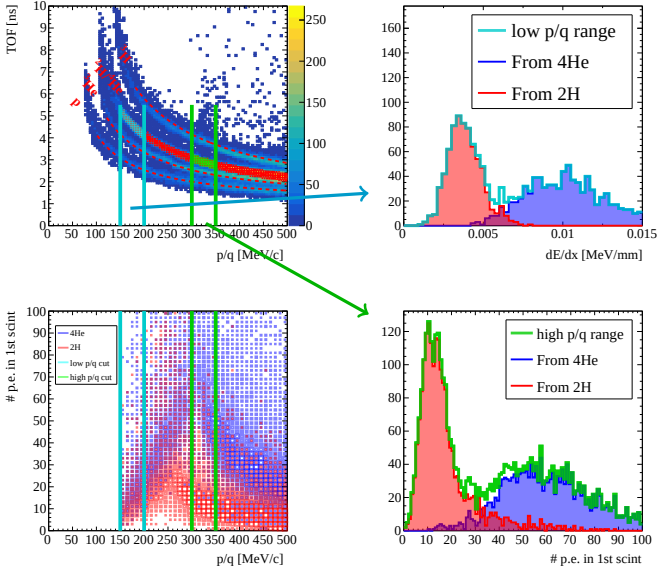


ALERT requirements

- 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**



Time-of-flight



Design Parameters

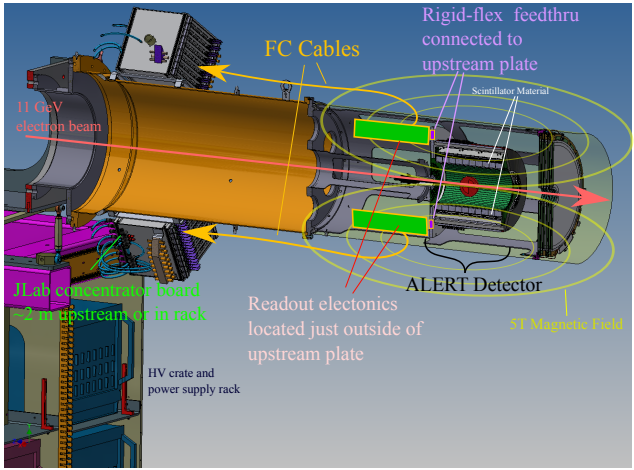
Need < 150 ps time resolution shooting for 50 ps

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

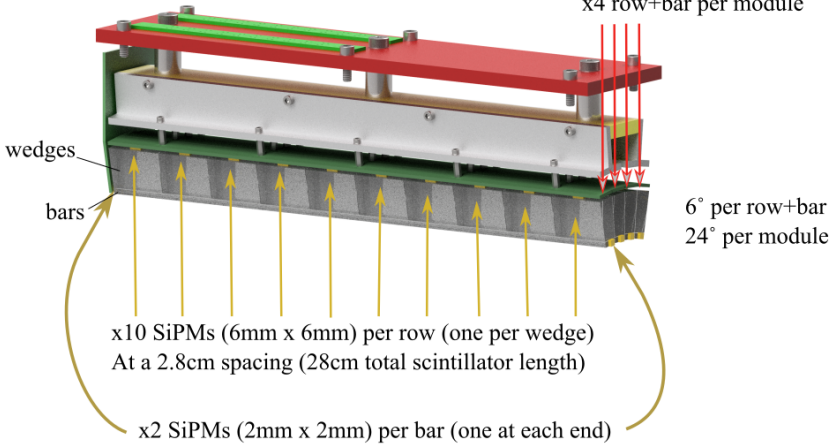
TOF separates light ions, except ^{4}He and ^{2}H which have same m/q ratio

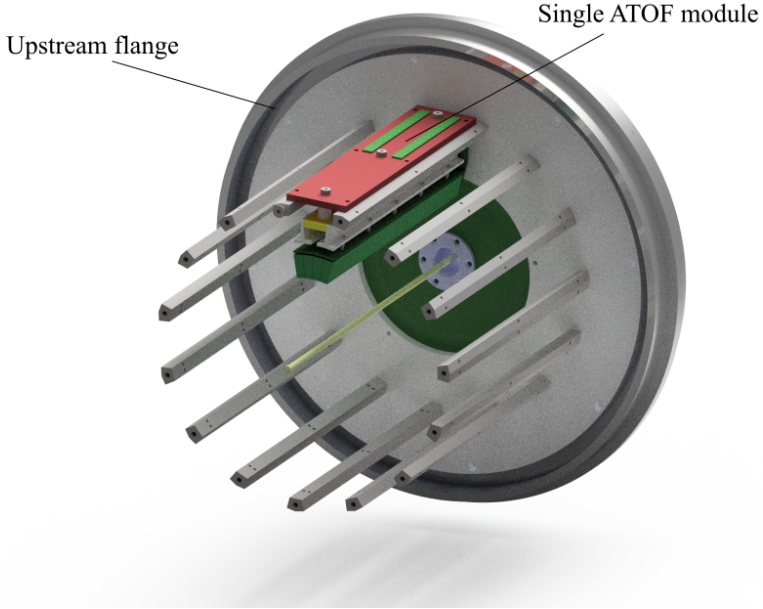
ATOF System Layout

- 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

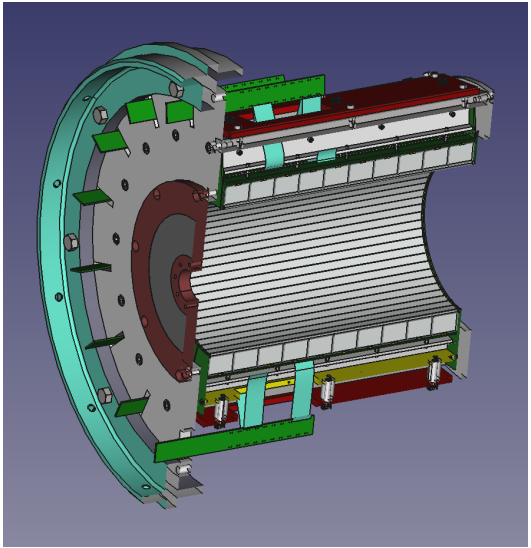


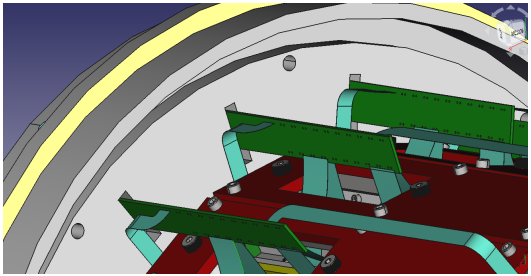
ATOF Module


x10 scintillator wedges per row
x1 scintillator bar per row of wedges
x4 row+bar per module
wedges
bars
6˚ per row+bar
24˚ per module
x10 SiPMs (6mm x 6mm) per row (one per wedge)
At a 2.8cm spacing (28cm total scintillator length)
x2 SiPMs (2mm x 2mm) per bar (one at each end)


Upstream flange
Single ATOF module

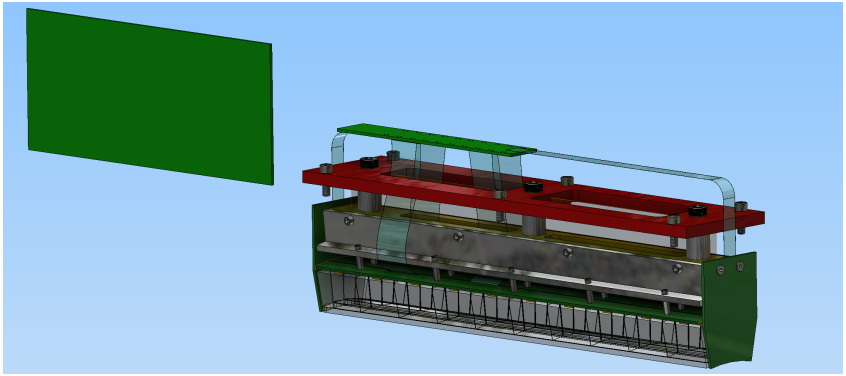
Mechanical design





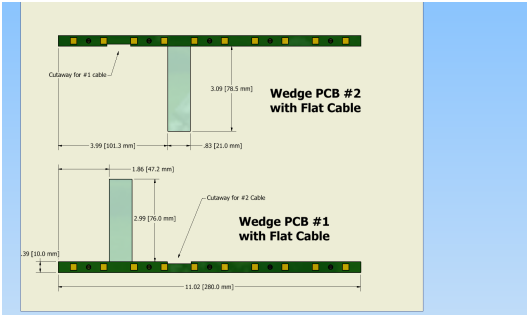
Note this is a slightly older design.

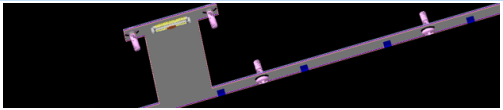
ATOF Module boards

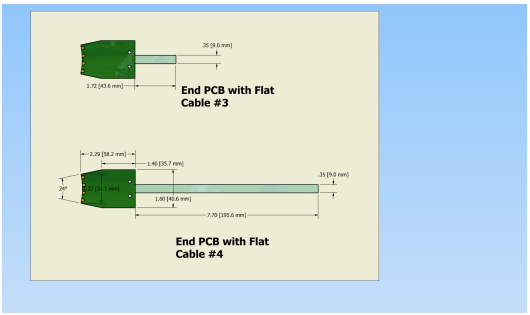


- Rigid-flex PCB will connect SiPMs to upstream readout electronics
- Upstream plate feed-through (from inside drift gas volume to air) being designed

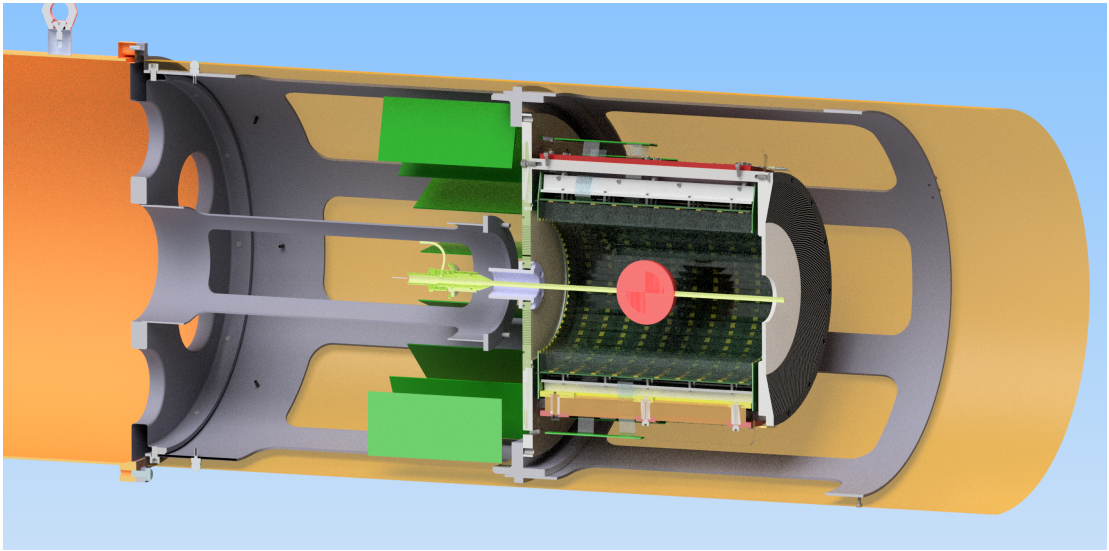
ATOF Rigid-Flex PCB



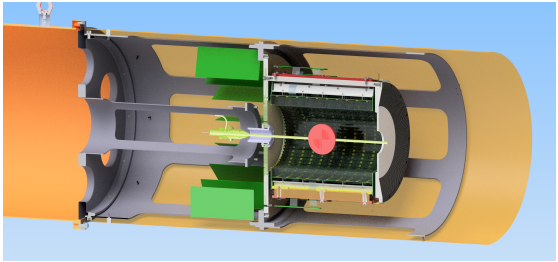


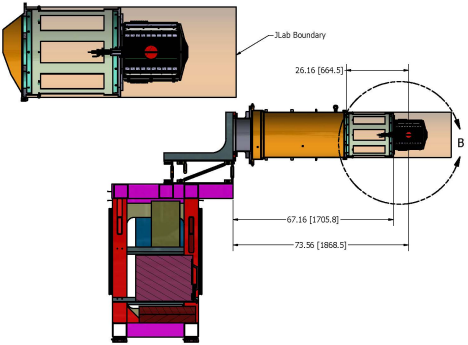


Mechanical design



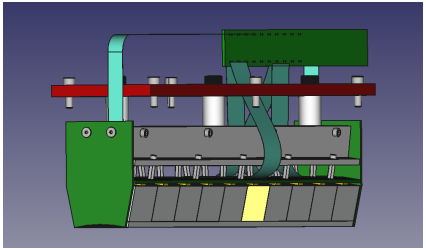
Mechanical design





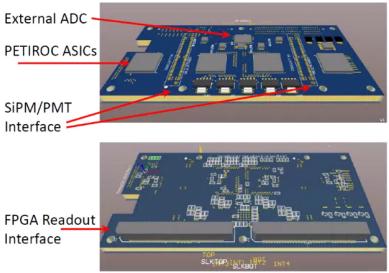
Electronics

- Prototype Petiroc2A fabrication soon (Cuevas,Raydo)
- Working with Nalu Scientific for engineering of readout electronics
- Developing prototype zero dead-time, waveform readout with Nalu
- Collaborating with JLab to make modular system which interfaces with JLab FPGA
- Readout is mostly Petiroc2A boards with swappable waveform digitizing boards for systematic checks.
- JLab SSP concentrator board will be used.

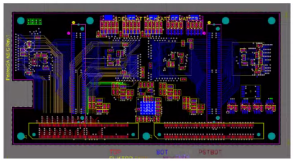


Prototype Electronics

PETIROC ASIC PCB Status



- Placement was redone to optimize SiPM -> ASIC traces
- Routing in progress - probably another week or two before ready for assembly



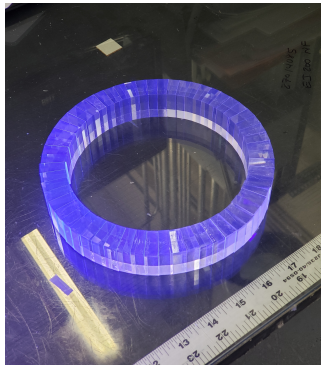
Features:

- 128 channels (PMT or SiPM inputs)
- Few to few thousand photoelectron charge measurement sensitivity
- <50ps hit timing resolution
- Expected >50kHz trigger rate capable
- Optical readout with Jlab FPGA readout board. Jlab CODA integration with SSP backend optical concentrator.

Courtesy Ben Raydo

Summary

- ATOF mechanical design is very far along
- Prototype Petiroc2A readout board ready for fabrication
- ATOF module rigid-flex PCB design well underway
- Trade study for readout system underway with expected report in July .

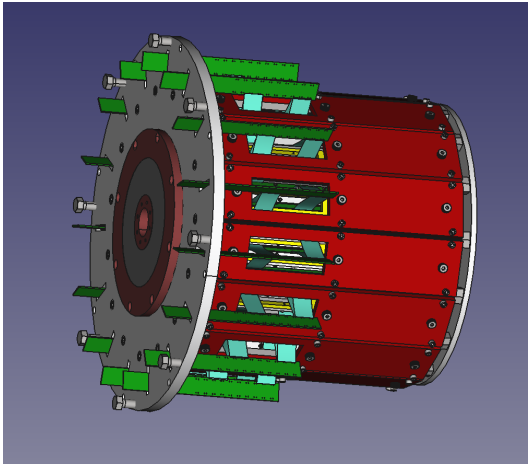


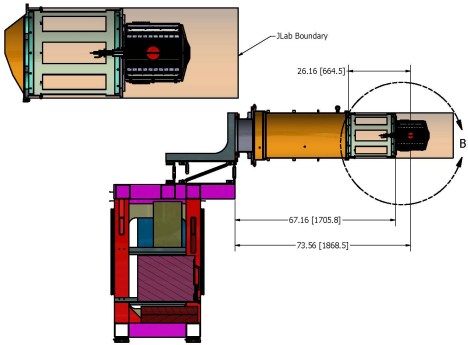
Many thanks to the ATOF team

Tom O'Connor, Todd Hayden (Argonne),
Ben Raydo, Chris Cuevas (JLab Fast Electronics),
the team at Nalu Scientific,
and the ALERT Collaboration

backup

Mechanical design





Petiroc2A

- Readout electronics
- 32 Channels per chip
- 37 ps time resolution
- Time and charge mode readout takes 12 us per event