Low momentum recoil detectors in CLAS12 at Jefferson Lab

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Recoil particle: a particle set in motion by a process or a collision involving another particle.

Why measure a low momentum recoil particle in nuclear physics?
- interaction occurred with the neutron with known momentum
- better event selection (match vertexes, momentum selection, angular selection)
- reduce model dependence
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Two experiments based on this method at CLAS12: **BONuS12** and **ALERT**
BONuS12 will measure low momentum spectator protons at high angles in coincidence with scattered electrons to study the neutron structure function.

A new detector is needed to detect recoil protons below 100 MeV/c. CLAS12 will detect the scattered electrons.

BONuS12 is currently scheduled for the beginning of 2019.

Readiness review in Spring 2017.
Which detector do we need?

Choice to use a Radial Time Projection Chamber (RTPC)

Advantages:
- Momentum threshold < 80 MeV/c
- Position resolution depends on pad size and time resolution
- Already used at Jlab: BONuS6, eg6

Improvements from previous detectors: different design, using different size GEM foils, and tape them at the top, larger radius, longer target and detector (400 mm long)
Improvements needed

Larger angular coverage

We want to reach 3 mm dead zone or 2° in azimuth
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Faster electronics (DREAM)

Use the electronics developed for the central tracker of CLAS12.
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\text{KF(red) vs GF(blue)}
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Gas properties and homogeneity stability

- Garfield++ simulations to choose the gas

- N. Dzbenski

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\text{Drift Time Plots}
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Initial Radius [cm]
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Gas properties and homogeneity stability

Gas flow studies to optimize the positions and number of inlets and outlets
ALERT and low momentum particles

ALERT: A Low Energy Recoil Tracker

Same requirements as BONuS12, same electronics will be used + part of the trigger + separate protons, deuterium, tritium, helium 3 and alphas.

=> a different detector is needed
ALERT and low momentum particles

ALERT: A Low Energy Recoil Tracker

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=> a different detector is needed
Carbon wires could be used instead of tungsten wires: less material, and lighter. R&D required to verify that it can be used for ALERT.

Soldering ability on a curved surface

Test in a low pressure chamber

Testing a carbon wire in a wire chamber

Amplitude comparison of a carbon and a gold tungsten wire (submitted to NIM A)
Conclusions

Low momentum recoil detectors in CLAS12 at Jefferson Lab

BONuS12 and ALERT are two experiments based on the detection of a low momentum recoil particle in CLAS12.

BONuS12 will run in 2019, the design is being finalized.

BONuS12 will use a RTPC.

ALERT conducts R&D to use a drift chamber+scintillators array.