Applications of MPGD at BNL/Jlab and the future EIC.

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In recent years, we have seen a growing and impactful community participating in MPGD established in the US.

-- S. Dalla Torre, MPGD 2017
BoNuS (Barely Off-shell Nucleon Structure)
CLAS12 Barrel $\mu$MEGAS

Dream

Reality

Jefferson Lab
PREX/CREX

Lead ($^{208}\text{Pb}$) Radius Experiment: PREX
Lead ($^{48}\text{Ca}$) Radius Experiment: CREX

\[ \sigma \approx \left| e^{-} \gamma + e^{-} Z^0 \right|^2 \]

\[ A_{PV} = \frac{\sigma_R - \sigma_L}{\sigma_R + \sigma_L} \sim 10^{-4} \times Q^2 \sim 10^{-6} \]

Electroweak Asymmetry in Elastic Electron-Nucleus Scattering: A measure of the neutron distribution

Neutron Skin

\[ R_n - R_P = \sqrt{\langle r_n^2 \rangle} - \sqrt{\langle r_P^2 \rangle} \]
Super BigBite Spectrometer
Moller
DarkLight

Detecting A Resonance Kinematically with target

Older

Newer

Photograph of the prototype constructed by the GEM-TPC collaboration. (C) JLab
LEGs

Fig. 1. A schematic illustration of the LEGS TPC.

Fig. 5. The completed full size TPC with its readout electronics.
PHENIX HBD

- Windowless Cherenkov detector
- Triple GEM
- CSI photo-cathode
- Pure CF4: N0 = 322 cm\(^{-1}\)
- 2.4% total radiation length.

\(\pi^0\) rejected, 45 photons instead of 22!
STAR FGT

FGT installed inside STAR
sPHENIX

1.6 m

2.11 m

72 modules
2(z), 12(ϕ), 3(r)

Quad-GEM Gain Stage
Operated @ low IBF

μMEGA Lower IBF
The Long Range Plan!

What is the spatial mapping of quark and gluon fields in the nucleon AND nucleus.

Is the missing spin to be found via quark orbital momentum?

Are new phases of matter (Color-Glass Condensate) accessible at low x in nuclei?

RECOMMENDATION III
Gluons, the carriers of the strong force, bind the quarks together inside nucleons and nuclei and generate nearly all of the visible mass in the universe. Despite their importance, fundamental questions remain about the role of gluons in nucleons and nuclei. These questions can only be answered with a powerful new electron ion collider (EIC), providing unprecedented precision and versatility. The realization of this instrument is enabled by recent advances in accelerator technology.

We recommend a high-energy high-luminosity polarized EIC as the highest priority for new facility construction following the completion of FRIB.
HBD-like RICH (Generic R&D)
TPC-Cherenkov (Generic R&D)

- Primary electron nearly absent
- How to extend eID as far as possible?
- HBD
  - Primary Electron dominates
  - TPC Tracker
  - TPCC
- Top HV Plate
- Field Cage Wire Plane
- 3 Sided Field Cage Foil
- Moveable CsI GEM
- TPC Field Cage
- Beam Drift

Cherenkov

30 pe @ full size

Good Fit

Detected Electrons vs Radiator Length

Ionization (Transfer gap & less gain)
3-Coordinate Readout & ZigZags (Generic)

- Hit matching: GEOMETRY & CHARGE

σ ~ 110-120 µm in each coordinate

New 3-coordinate Readout

Theory leading R&D
Minidrift (Generic)

- Planar GEMs lose position resolution dramatically if/for includes tracks.
- Significant improvement possible with short drift section.
Large Area GEM Detectors (Generic)

- Single pattern to drive R&D at 3 institutions:
  - FIT, UVA, TEMPLE
- Initial pattern from beam pipe to 1 meter.
  - Larger than most current EIC designs.
Era of directed R&D.

Meeting prior to MPGDL to establish R&D path forward into directed R&D.
Directed R&D Key Elements for MPGD app.

- **TPC with Continuous Readout & IBF Suppression**
  - Optimized for $dE/dx$ rather than momentum resolution (unlike sPHENIX).
  - R&D into gain stages including proper minimization of IBF for:
    - High luminosity.
    - Possible high backgrounds (esp. Day 1).
  - Maximize $dE/dx$ resolution:
    - High ionization density gas.
    - Instead look toward cluster-counter???

- **Barrel Tagger**
  - Fast (single crossing) device to verify tracks from slower trackers.

- **TRD in hadron direction** to study leptonic decays (e.g., $J/\gamma$).

- **Chromium GEM at forward angles** to complement MAPS pixel sensors.

- **Gas RICH** as a technology follow-up to the COMPASS RICH UPGRADE.
Vision of directed R&D featuring MPGD @ EIC:

- Large Planar Trackers
- Single Crossing Devices
- Chromium GEM
- Continuous Readout TPC
- GAS RICH
- TRD
Summary

- Significant MPGD work has been done by the US community anticipating EIC.
- Much more work awaits in our future as MPDG find vast applications at EIC.
- One can only expect that the efforts will grow to meet the needs.
- I believe that the reception assertion is proved.

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