MEIC tracking and reconstruction

2010 user workshop (PNT, C. Hyde)

- Initially proposed configuration IP1
  - Si-pixel vertex tracker
  - Small TPC with micromegas (MM) barrels inside and outside of the TPC
    MMs provide good z-position and aid reconstruction in high-rate environments
  - Multi-layer GEMs at endcap ends for track segment reconstruction
    Track segments suppress ghost tracks
- Challenges with TPC-based trackers
  - Can only be used in a flat field region
    Cannot fully benefit from magnet radius ($dp/p \sim 1/R^2$ at central rapidities)
    Cannot shape field for RICH requirements
  - Large mass (multiple scattering) in endcap readouts
    Degrades resolution, in particular for low-momentum electrons
  - High-rates problematic?
- Similar layouts were later adopted for BNL detectors (BeAST, ePHENIX)
  - The TPC based tracking option was then shifted to MEIC IP2
    Not efficient to duplicate effort
  - Focus for IP1 shifted to non-TPC options

Endcap trackers

- Strategy: vertex tracker + 3 regions for track segments
  - Reconstruction of track segments suppresses ghost tracks (from combinatorics)
    Additional single points can be provided by layers closing the central "barrels" if needed
  - Resolution requirement for each region is lower as the lever arm increases
  - Low mass requirement is also reduced towards the end of the tracker
  - Large crossing angle (50 mrad) eliminates need for high-res small-angle trackers

- Technology choices
  - Si-pixel vertex detector (20 μm pixels)
    MAPS-based ALICE or DEPFET-based Belle-II vertex trackers can be a starting point
  - Si-strip Region 1 segment detector (50 μm strips)
  - MM-based Region 2 segment detector (80 μm resolution at normal incidence)
    Low-mass advantageous
  - GEM-based Region 3 segment detector (80 μm resolution at normal incidence)
    Higher mass not an issue. Simpler readout configuration advantageous

Central tracker options

- Basic choice: MM-GEM barrel only or a MM-DC-GEM hybrid?
- Simple MM option has been explored by F. Sabatie et al (EIC detector R&D)
  - Needs lots of optimization (*e.g.*, track segments needed?)
  - Since DIRC is polygonal, outermost layer can be GEMs
  - Integration with MEIC encap trackers would be needed
- Ultra-low mass, cluster-counting DC an interesting alternative
  - Proposed for ILC 4th concept detector, the μ2e experiment, etc
  - Based on low-mass KLOE chambers
  - All-stereo, low-mass wires (wire maps available from designers)
  - He-gas provides low mass and slow drift
    Makes possible to use cluster-counting for PID with reasonably fast readout
  - Would need outer MM/GEM layer for improved z-resolution
  - Gap to beamline needed to reduce rate on first wire layers
  - Open question: possible to integrate with an inner Si/MM tracker layer?
    Would improve z-definition, but also introduce additional mass
    Can the vertex tracker provide all necessary information?

Road map for reconstruction software

- Validate the resolution of single tracks in the central detector
  - Include multiple scattering from major sources of dead material
- Study the impact of secondaries and random backgrounds
  - Use more realistic layout of support structures, cooling, and other dead material
- Implement full track reconstruction in the central detector using all subsystems
  - This will add additional constraints on the tracking

    Example: electrons at small angle have better momentum resolution in PWO EMcal
  - Tracking will also aid in reconstruction for other systems (ring centers for RICH)

    *Good **extrapolation** needed!*
- Extend reconstruction to near- and far forward regions
  - Or integrate with parallel code that could be developed independently
- Develop a full reconstruction code for analysis of actual EIC data
  - Should be blind to source (MC or actual data)