Introduction to the EIC-YR Tracking WG Simulation

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Simulation and Integration

Main goal:

- integrate tracking detectors in the EIC simulation framework
- define detector layout and performance (tracking and vertexing capabilities):
  - ✓ momentum and pointing resolution vs momentum
  - ✓ tracking efficiency in a wide momentum and pseudorapidity range

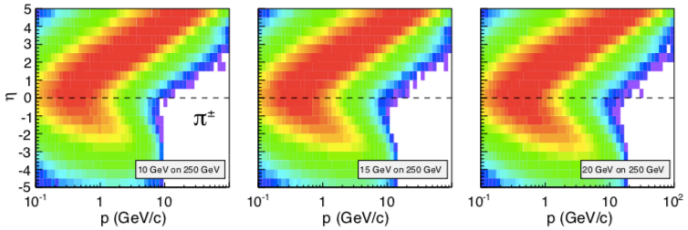
Connections:

- TECHNOLOGY → survey within the Tracking WG, current R&D status etc
- PHYSICS WG → input on the expected/required performance
- SOFTWARE WG → crucial help in approaching EIC simulation framework
- INTEGRATION WG → close link for integration issues

Tracking and vertexing for EIC

Central tracking system:

- main tracker
- silicon vertex tracker
- forward and backward trackers
- Roman Pots



η	Nomenclature			Tracking		
				Resolution	Allowed X/X_0	Si-Vertex
-6.9 — -5.8	↓ p/A	Auxiliary Detectors	low-Q^2 tagger	$\delta\theta/\theta < 1.5\%$; $10^{-6} < Q^2 < 10^{-2}$ GeV^2		
...						
-4.5 — -4.0			Instrumentation to separate charged particles from photons			
-4.0 — -3.5						
-3.5 — -3.0		Central Detector	Backwards Detectors	$\sigma_p/p \sim 0.1\% \times p + 2.0\%$		TBD
-3.0 — -2.5						
-2.5 — -2.0				$\sigma_p/p \sim 0.05\% \times p + 1.0\%$		
-2.0 — -1.5						
-1.5 — -1.0						
-1.0 — -0.5			Barrel	$\sigma_p/p \sim 0.05\% \times p + 0.5\%$	~5% or less	$\sigma_{xyz} \sim 20$ µm, $d_0(z) \sim d_0(r\phi) \sim 20/p_T$ GeV µm + 5 µm
-0.5 — 0.0						
0.0 — 0.5						
0.5 — 1.0						
1.0 — 1.5						
1.5 — 2.0			Forward Detectors	$\sigma_p/p \sim 0.05\% \times p + 1.0\%$		TBD
2.0 — 2.5						
2.5 — 3.0				$\sigma_p/p \sim 0.1\% \times p + 2.0\%$		
3.0 — 3.5						

Target:

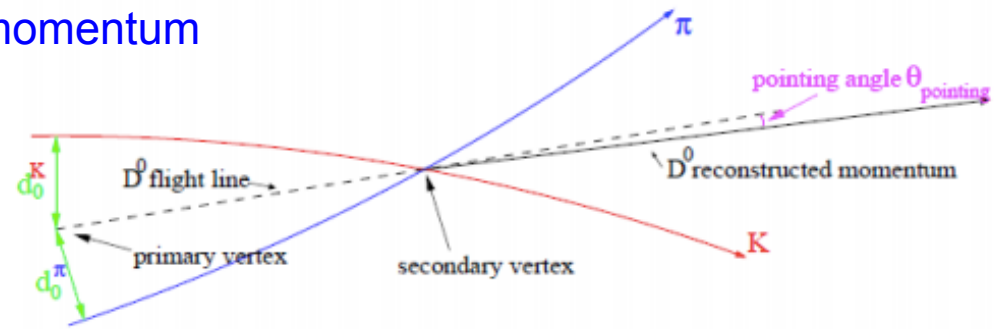
- hermetic coverage
- tracking resolution < few %
- low material budget ~ 3-5%

http://eicug.org/web/sites/default/files/EIC_HANDBOOK_v1.1.pdf

Tracking and vertexing performance

Tracking:

- efficiency in a wide momentum and pseudorapidity range
- relative momentum resolution
- to be studied as a function of momentum, for different combinations:
  - ✓ combined gaseous and silicon trackers
  - ✓ silicon tracking standalone for low momentum



Vertexing:

- primary vertex resolution
- impact parameter resolution:
  - ✓ to convolute with primary vertex resolution (→ pointing resolution)
- relevant for some measurements (eg reconstruction of HF decays)

Simulation software

Fast simulation:

- EIC common tool available (via docker): https://eic.gitlab.io/documents/quickstart/
- other tools also available in some groups, welcome at this initial stage
  - ✓ semi-analytical simulations, approximate geometry, average material etc
  - ✓ suitable for optimization of the layout, cross-check with first full simulation results

Full simulation:

- EIC framework simulations (centrally managed): Fun4All and G4E/eJANA
  - ✓ allow to implement detailed geometry, include full simulation and reconstruction
  - ✓ performance studies as in fast sim, but more reliable (and less optimistic)
- Full simulation tutorial by the Software WG (with slides and videos): https://indico.bnl.gov/event/7281/

Meetings and expressed interest

Tracking WG meetings:

- weekly held (on Thursday), started on 13/2
- collected interest from participating groups (next slide)
- recently dedicated to simulation issues

  27/2: https://indico.bnl.gov/event/7689/

  ✓ presentation on framework simulation tools (fast and full) by the SWG (Markus)

  ✓ detailed presentations on G4E/eJANA (Dmitry, Yulia, Nathan) and Fun4All (Chris)

  12/3: https://indico.bnl.gov/event/7885/

  ✓ question / answer session on Fun4All with Chris (and participating groups)
- plan to have next meeting with q/a session on G4E/eJANA
- follow up developments and steer direction

Meetings and expressed interest

Tracking WG meetings:

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Participating Institutes	Software oriented interest
eRD6: BNL, INFN Trieste, Florida Tech. Stony Brook U., Temple U., UVa, Yale U.	Central and forward tracking (gaseous)
eRD22: Jlab, Temple U., UVa	Central and forward tracking (gaseous)
CEA Saclay (France)	Central tracking
eRD18: University of Birmingham (UK)	Central tracking
LANL	Central and forward tracking
UC Berkeley / LBNL	Central and forward tracking
INFN Bari	Central tracking (silicon)

Concluding remarks

Basic workplan:

- optimize detector layout via fast simulation (eg silicon barrel layers)
- besides optimizations, proceed with integration in full simulation:
  - ✓ define baseline detector concept (BeAST? 1.5/3 T magnet? see Peter's suggestion)
  - ✓ keep working on both frameworks Fun4All and G4E
  - ✓ implement realistic material and services, connection to integration issues
- study track finding algorithms, connection to physics benchmarks

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→ more in the Barbara's talk

This session's agenda →

Introduction to YR-Tracking WG Simulation	*Domenico Elia*
Online	16:30 - 16:45
Overview of Tracking Simulation needs and Plans	*Barbara Jacak*
Online	16:45 - 17:15
Including detector services in simulations	*Leo Greiner*
Online	17:15 - 17:30
Open Discussion	*All*
Online	17:30 - 18:00