CLAS12 Fast Monte Carlo

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CLAS MonteCarlo Review

	CLAS6 FastMC	**GEMC - CLAS12**
Process	Parameterization	Particle Swimming -- full detector response
Geometry	Static	User-defined
Time (single thread)	10^4 events/s	2 events/s (not including recon)

What we have for CLAS12

- GEMC
  - GEANT4 framework for JLab simulation
  - Contains all detector geometries
    - Very detailed detector response
  - Handles physics sub-processes
  - Extremely comprehensive

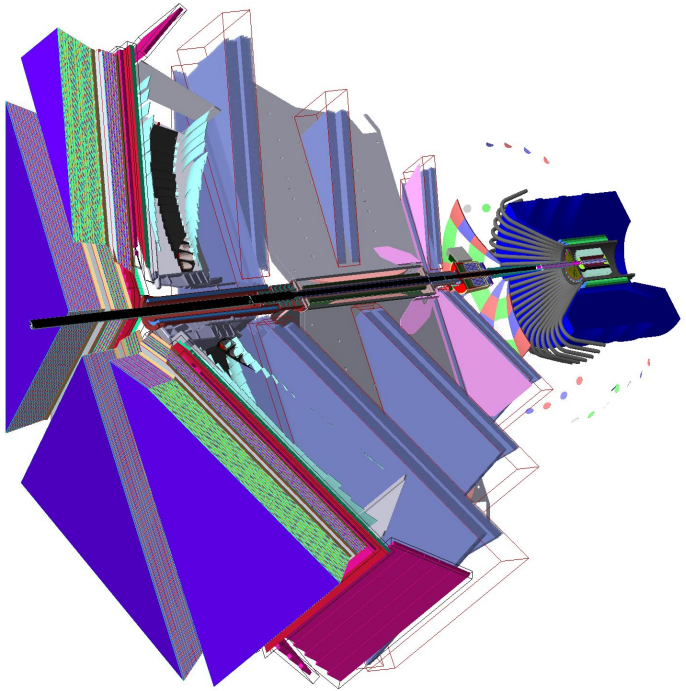


Image courtesy Nate Dzbenski

Clas12FastMC - Motivation

- GEMC is slow
  - 2 event/s
  - 1M events = 5.5 days computation time
  - This does not include reconstruction
- Ability to run large-event MC single-threaded/locally
- Full GEMC acceptances are not always needed

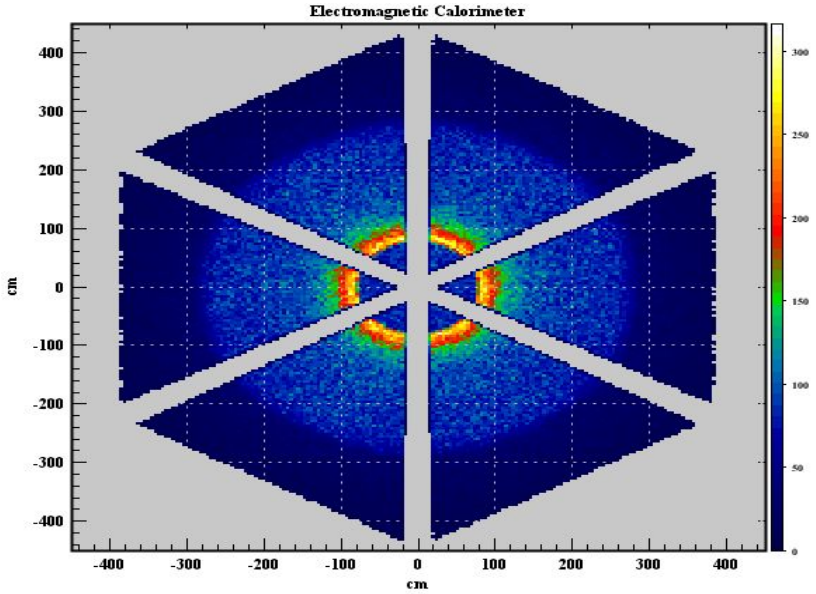
Clas12FastMC - How it works

- Part of the COATJAVA framework
- Detector geometry and detection parameters are user defined
  - What particles are detected in what detector and how
  - Default setting in the works - large amount of user control, if needed

```
Clas12FastMC clas12FastMC = new Clas12FastMC();
// Different ways you can detect proton
clas12FastMC.addConfiguration( pid: 2212, DetectorRegion.CENTRAL,   detector: "CVT",  hits: 3);
// This is proton in forward detector
clas12FastMC.addConfiguration( pid: 2212, DetectorRegion.FORWARD,    detector: "DC",  hits: 6);
clas12FastMC.addConfiguration( pid: 2212, DetectorRegion.FORWARD, detector: "FTOF",  hits: 1);
```

Clas12FastMC - How it works

- Currently implemented detectors
  - DC
  - ECal
  - FToF
  - FT (Calorimeter only)
  - CVT (SVT only)
- All others: development in progress



Clas12FastMC - How it works

- Input/Output
  - PhysicsEvent -> PhysicsEvent - Class in COATJAVA Framework
- Swims particles in the event through detector geometry
  - Particle path determined from vertex and charge -> Check if path intersects detector geometry
    - Particle within detector geometry == hit
    - Allows for expansion/reduction of detector - unlike clas6 fastmc

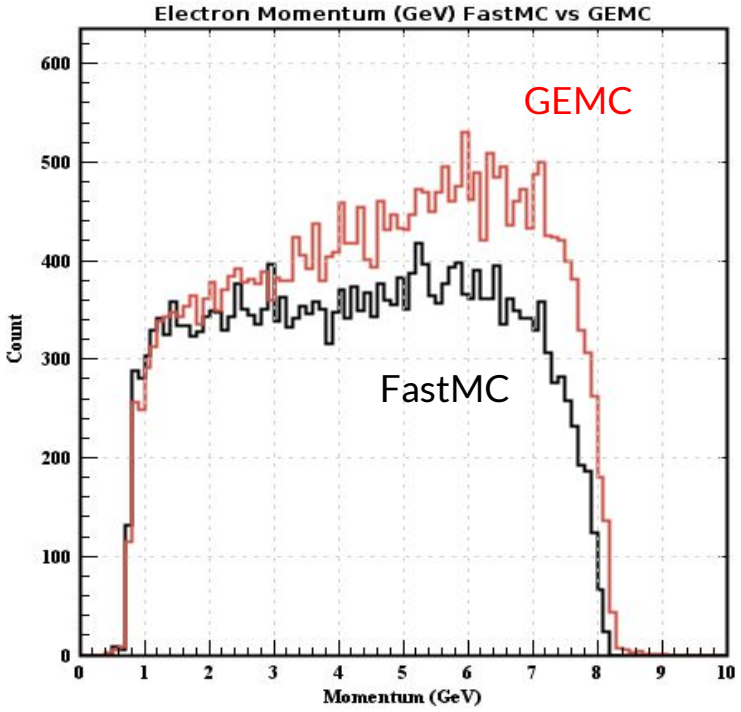
MC::Particle Bank

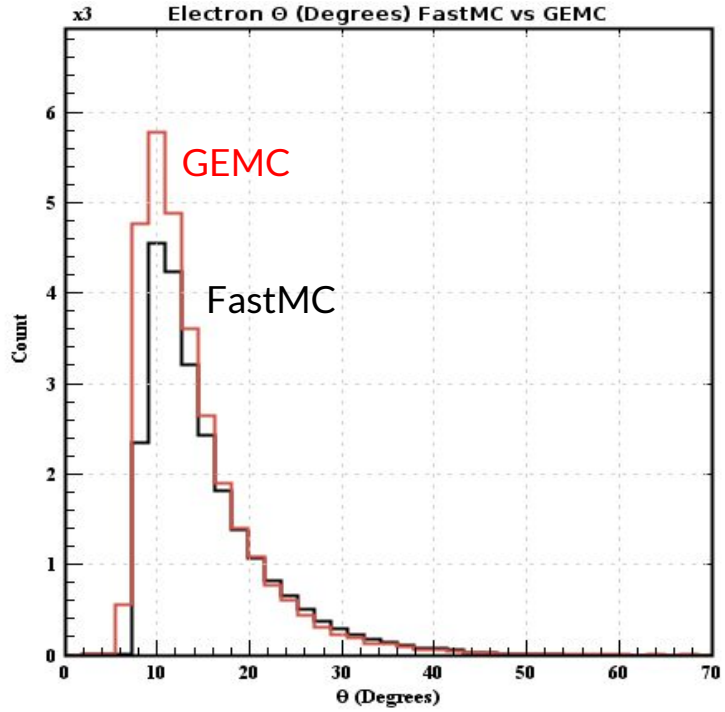
```
PhysicsEvent mcEvent = DataManager.getPhysicsEvent( beam: 10.6, mcParticle);
if (filter.isValid(mcEvent)) {
    PhysicsEvent fastMCEvent = clas12FastMC.processEvent(mcEvent);
    eventAcceptance.acceptanceFastmc(mcEvent, fastMCEvent);
```

Clas12FastMC - How good is it?

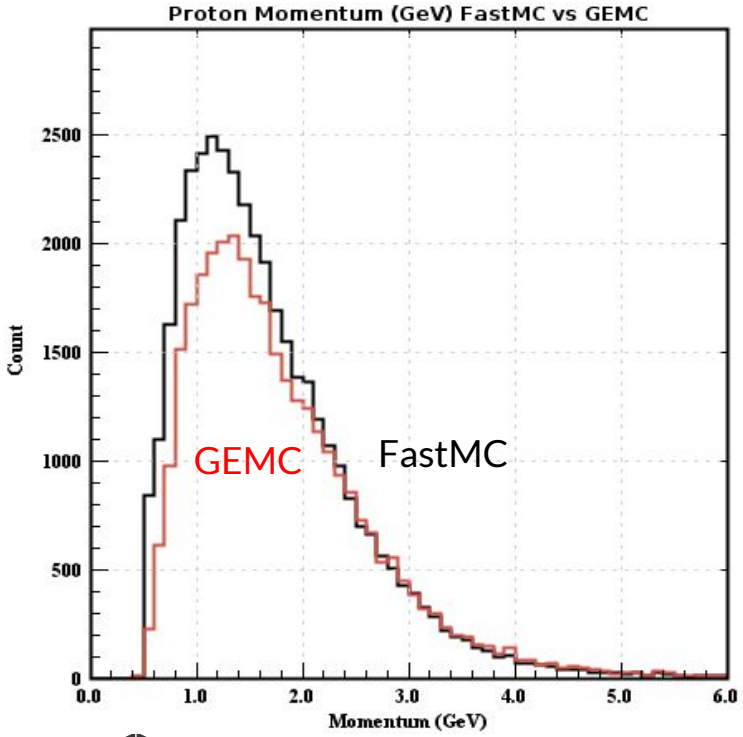
- Events generated with Pythia
- Reconstructed with GEMC and FastMC

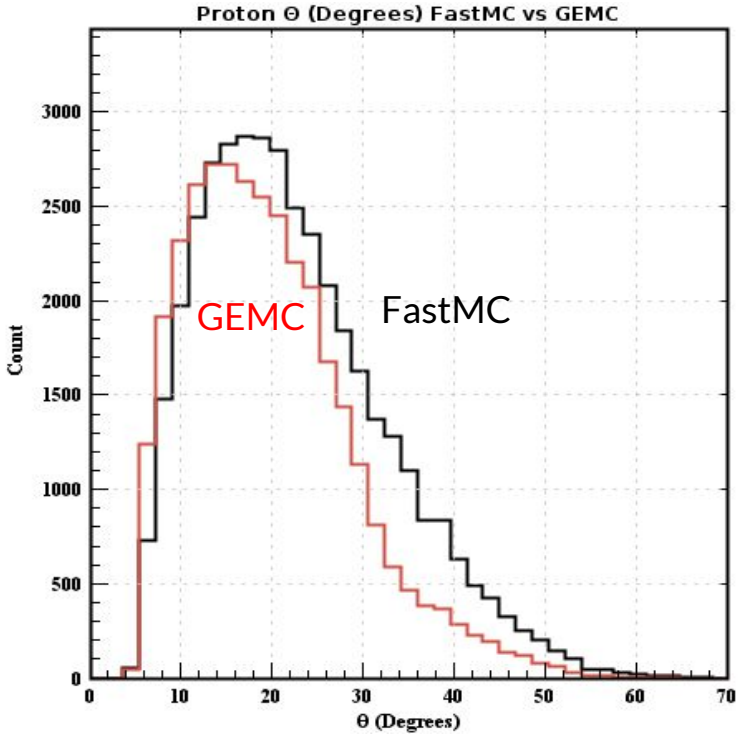
Clas12FastMC - Electron Reconstruction





Clas12FastMC - Proton Reconstruction





Clas12FastMC - How good is it?

- 333 events/s
  - Many more optimizations to be made

Clas12FastMC - Recap

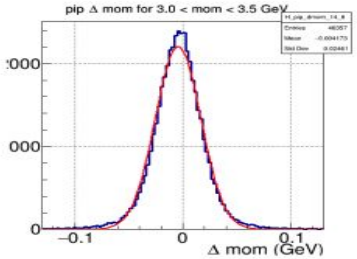
	CLAS6 FastMC	GEMC	CLAS12 FastMC
Process	Parameterization	Particle Swimming -- full detector response	Particle Swimming -- shape-path intersection
Geometry	Static	User-defined	User-defined (shape-path intersection)
Time (single thread)	10^4 events/s	2 events/s	333 events/s

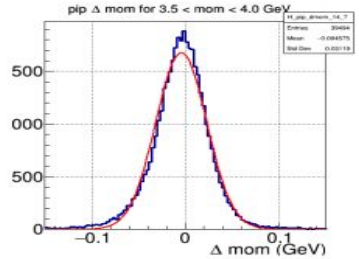
To-do

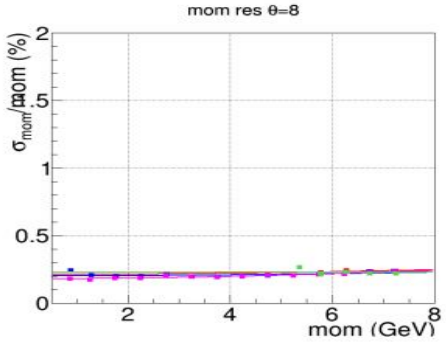
- Add remaining geometry services
- Implement resolutions (FX - next slide)
- Develop automated LUND2HIPO tool w/ topology filter -> pass through FastMC
- Implement detector response requirements from GEMC

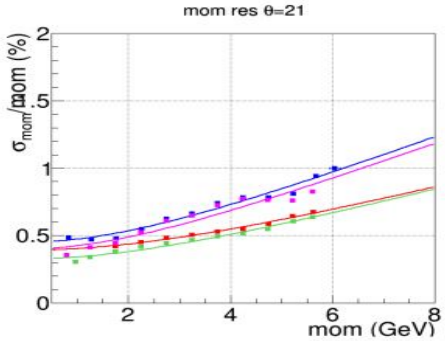
GEMC Resolutions for e, p, π^+, and π^-

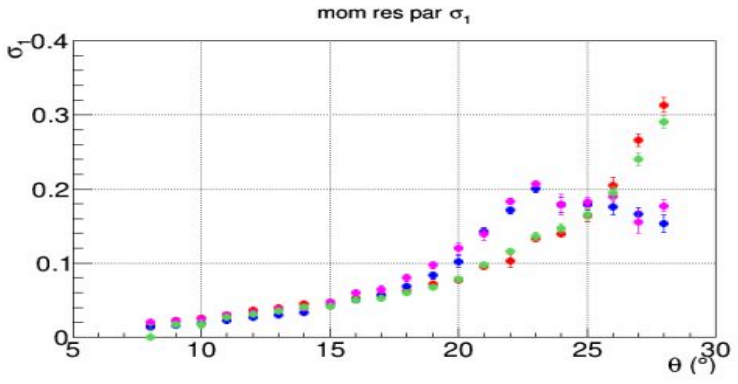
- Step 1: fit $\sigma_p = p_{\text{rec}} - p_{\text{gen}}$, σ_θ, and σ_ϕ in bins of θ and p
- Step 2: fit the gaussian width parameter vs p for each θ bin
- Step 3: obtain resolution parameterization vs p and θ











Parameterizations: $\frac{\sigma_p}{p} = \sqrt{\sigma_1^2 p^2 + \left(\frac{\sigma_2}{\beta}\right)^2}$, $\sigma_{\theta,\phi} = \sqrt{\sigma_1^2 + \left(\frac{\sigma_2}{p\beta}\right)^2}$

Questions

Clas12FastMC - Analysis Viability

$\rho^0 \rightarrow \pi^+\pi^-\gamma$

Reaction: $ep \rightarrow e'p'\pi^+\pi^-\gamma$