CLAS12 Event Reconstruction Overview

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Outline:

1. Summary of internal tracking review, February 2007.
2. Summary of external tracking review, March, 2007.
3. CLAS12 Track Reconstruction Working Group Projects.
4. Future Plans and Priorities.

CLAS12 Internal Tracking Review, Feb, 2007

- Committee of CLAS member (L.B. Weinstein, G.P. Gilfoyle, F.J. Klein) evaluated the design of the CLAS12 tracking system in conjunction with the Hall B 12-GeV Upgrade Workshop held Feb 2-3, 2007.
- Charged with setting priorities for an external drift chamber review in March, 2007 and for the CD2 review in June, 2007.
- Considerable progress has already been made on design, simulation, and prototyping different components of CLAS12.
- The committee was pleased to see detector maintenance issues addressed in the design phase.

CLAS12 Internal Tracking Review, Questions/Issues

- Physics requirements: minimum polar angle? resolution requirements?
- VT: super-layer separation in forward part? stereo angle?
- DC configuration changes: large-stereo-angle chamber? additional super-layers or chambers?
- Other tracking issues: procedures for surveying, measuring the magnetic field?
- Reconstruction: effect of occupancies, different backgrounds, use of tracklets/stubs?

CLAS12 Internal Tracking Review, Plans

- For March DC review.
  1. Check θ, ϕ, and p resolutions with the latest geometry for effects on physics goals (MOMRES and FASTMC), increase resolution by 50%.
  2. Compare GSIM12/RECSIS12 with FASTMC.
- For CD2
  1. Get vertex tracker geometry in GEANT4.
  2. Update estimates of occupancies and backgrounds in DCs.
  3. Study resolution and luminosity effects of alternate designs (micromegas versus silicon, large-stereo-angle chamber, ...).
- Beyond CD2
  1. Get CLAS12 geometry in GEANT4.
  2. Full study of alternate detector configurations.

CLAS12 External Drift Chamber Review, March 2007

- Committee of external reviewers (David Christian, Michael Kelsey, Douglas Hasell, Bernhard Mecking) evaluated the construction plans CLAS12 drift chambers, March 2007.
- Charged with evaluating the CLAS12 drift chambers design in terms of meeting physics requirements, safety and environmental constraints, and adequacy for establishing a cost and schedule baseline.
- Findings.
  - 'The design is 'well motivated by the group's summary of deep inelastic electron scattering physics.'
  - 'The performance requirements for the drift chambers are derived from these physics requirements.'
  - 'The design is a 'simplification' of the successful CLAS drift chamber system.

CLAS12 External Drift Chamber Review, March 2007

- Comments
  - ‘Strongly support’ the construction of the region 1 prototype to test hardware designs and to to explore cost saving construction procedures.
  - Explore design modifications to region 2 to ‘maximize the active area near the CLAS beamline.’
  - Need for detailed simulations in the ‘near-future’ to study the addition of the vertex tracker to the reconstruction and investigate the impact of chamber misalignments and wire positioning errors on the CLAS12 resolution.
  - Study the effect of helium bags between the drift chambers.

Validates the CLAS12 design for achieving the required resolution and luminosity goals.

CLAS12 Reconstruction Group, Membership and Projects

- Jerry Gilfoyle:
  - 12-GeV event generators
  - implement plugins in GEANT4 simulation.
- Henry Juengst:
  - revision of original SDA code for CLAS12.
  - include energy loss, multiple scattering.
- Franz Klein: GSIM12/RECSIS12, see talk.
- Dave Lawrence:
  - track reconstruction framework JANA.
  - liaison with GlueX software effort.
- Sebastien Procureur: central detector reconstruction, see talk this session.

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CLAS12 Reconstruction Algorithms - Henry Juengst

- Revision of GSIM, uses calibration constants from database, all ADCs and TDCs 100% comparable with run-specific experimental data, good role model for CLAS12
- Revision of original SDA code for CLAS12
  - All information organized in structures, no side-effects, most important steps done for transition to C++ implementation
  - Everything in cooking based on definitions in GEANT/GSIM, such as detectors, materials, calibration constants
  - Changing experimental setup or adding new detectors piece-of-cake
  - Lots of revised code, like pattern recognition (finding 30% more tracks), momentum fit, track extrapolation

- Inclusion of energy loss in reconstruction
  - systematic error of reconstructed momentum at vertex is less than 1 MeV/c (checked with simulated data), for 0.25-2 GeV/c protons, results unbiased and only statistical errors important
  - Change of trajectories due to magnetic field in target region fully included in calculations
  - Change of momentum from vertex to end of track well known, better track length calculation (particle identification)
- Methods for handling multiple scattering, error propagation through covariance matrix, not perfect, but better than what we use so far
- No need for empirical momentum corrections
- Report coming soon!

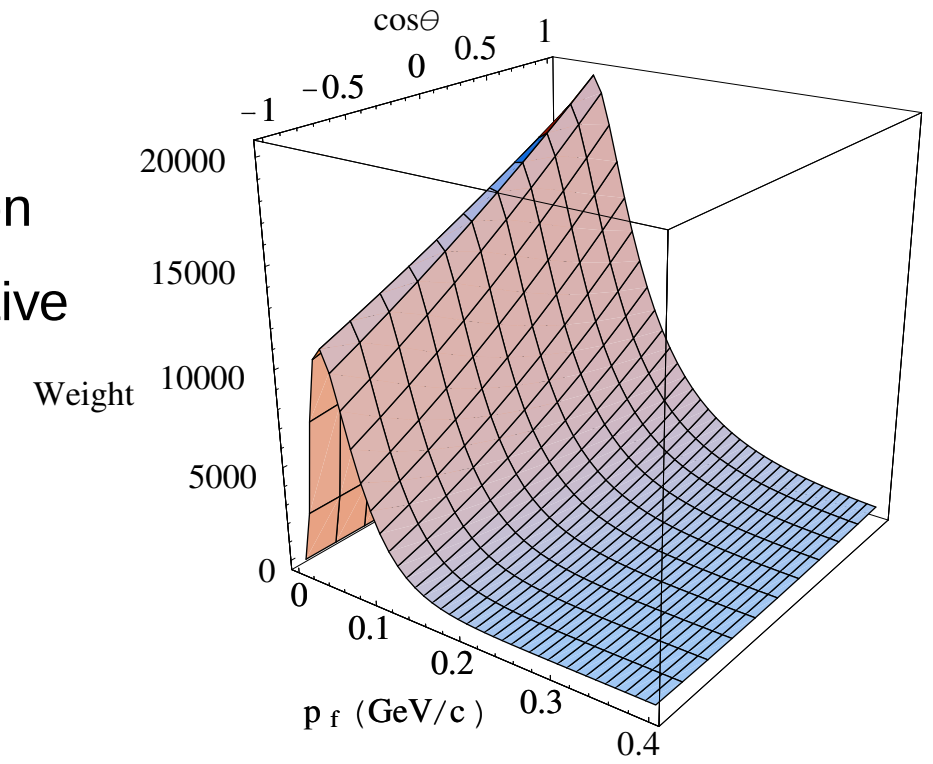
CLAS12 Event Generator for $D(e, e'p)n$ - Jerry Gilfoyle

1. Physics motivation: preparation for G_M^n measurement.

2. Simulate quasi-elastic and inelastic scattering (to understand backgrounds) with Fermi motion added.

3. Incorporating the Fermi motion.

   (a) Pick the nucleon's $\cos\theta$ and p_f weighted by the Hulthen distribution and the cross section for the effective beam energy integrated over the CLAS12 acceptance. Choose ϕ randomly.



(b) Boost to the rest frame of the about-to-be-struck nucleon, calculate a new beam momentum, and rotate coordinates so the beam momentum lies along a new z axis.

(c) Let the simulation proceed as ‘normal’.

(d) At the end, reverse the rotation of the coordinates and boost back to the laboratory frame.

4. Use the Galster parameterization for the quasielastic cross section.

5. For the inelastic part use the GENOVA event generator modified to include the Fermi motion and calculate the entrance-channel cross section effect using existing data parameterizations.

Plans and Priorities

1. Continue projects listed above.
2. Study of correlated backgrounds in CLAS12.*
3. Compare 8-layer and 6-layer designs of the central detector.*
4. Investigate different stereo angle configurations in the VT, impact of micromegas.*
5. Compare GSIM12/RECSIS12 results with FASTMC and update physics simulations.*
6. Include vertex tracker in reconstruction and study of effect of misalignments on resolution.*
7. Vertex tracker geometry in GEANT4.
8. Full CLAS12 geometry in GEANT4.
9. Procedure for CLAS12 timing and calibration.
10. Event display in GEANT4.
11. ‘Use it and abuse it’, realistic physics studies to test GEANT4 simulation.
12. Event generator plugins for GEANT4.
13. **Others???**

* - Time critical, needed for CD2.

Updated Plans and Priorities

1. Include vertex tracker in reconstruction and study of effect of misalignments on resolution.*
2. Study of correlated backgrounds in CLAS12 and compare 8-layer and 6-layer designs of the central detector.*
3. Optimize forward VT spacing.*
4. Investigate alternate detector configurations like large stereo angle DC, micromegas.*
5. Clear physics justification for current ϕ resolution.*
6. Comparison of GEANT4 and latest GSIM12 with VT reconstruction.*
7. Each group should have a geometry manager.
8. Vertex tracker geometry in GEANT4.
9. Full CLAS12 geometry in GEANT4.
10. Procedure for CLAS12 timing and calibration.
11. Event display in GEANT4.
12. Level 2 trigger development.
13. Realistic physics studies to test GEANT4 simulation.
14. Event generator plugins for GEANT4.
15. Continue existing projects.

*** - Needed for CD2.**