CLAS12 Reconstruction Validation Studies

The ultimate purpose of the studies that will be performed with the first release of the CLAS12 reconstruction software are:

1. Understanding the tracking efficiency and resolution: are we reconstructing all the tracks that we are suppose to reconstruct? Is the resolution consistent with expectations?
2. Understanding tracking efficiency and resolution as function of luminosity: how does the background affect the reconstruction in terms of resolution and efficiency?
3. Understanding CLAS12 operating luminosity (simulation): do we have the appropriate shielding design?
4. Understanding the magnetic field and impact on acceptances, efficiencies, and resolutions: effect of the solenoid on forward tracking, what are the acceptable magnetic fields, what is the optimal magnetic field configurations for the first run group.
5. Understanding the PID for both charged particles (TOF) and neutrals (calorimeters)
6. Understanding the reconstruction speed and software performance in view of data challenges
7. etc.

Since the tracking is the most advanced component of the present reconstruction release, the main focus of the studies should be on points 1-4. Nevertheless studies on other software components, such as the ones related to PID, will be performed to debug the first release and provide feedback to the developers. For an effective organization, the work will be focused on point 1 first and then extended to the following ones.

The reconstruction studies will be performed simulating and reconstructing the following final states (with beta testers listed for each study):

a. Understanding the operating luminosity of CLAS12 – Latifa Elouadrhiri, Maurizio Ungaro, Raffaella De Vita and Dan Carman
b. Individual tracks (electrons, charged hadrons) – Veronique Ziegler, Mac Mestayer
c. DVCS – Harut Avakian, Daria Sokhan (TBD), Angela Biselli
d. Exclusive e p→ p pi0 events – Andrey Kim
e. Exclusive e p→ p pi+ pi- events – Andrey Kim
f. Vertex reconstruction – Tony Forest
g. Multiparticle final states – Veronique Ziegler, Raffaella De Vita

Generated files in LUND format for the reactions listed above as well as others are available in /group/clas12/mcdata/generated/lund in the following subdirectories:

- dvcs
- pi0
- ppippim
- klambda
- multitrack
- elastic
- sidis

Individual files contain 20000 events each.

For each of these final states, simulations will be first performed with GEMC, data will then be reconstructed and analyzed. Simulations will be done by experts and made available to collaborators for reconstruction studies. Alternatively, collaborators will be running simulations themselves, using scripts and gcards provided by experts. Once reconstructed data are available, the analysis will be performed for each of the simulated data sets comparing generated and reconstructed distributions. In order to collect the information necessary to answer point 1 and the following points, collaborators doing the analysis should provide at least the following plots:

- final states a-f:
  - p vs. θ (lab) and theta vs. ϕ (lab) for :
    - all hadrons,
    - positive and negative,
    - individual hadron types to check PID;
  - p_{REC} -p_{GEN} for electrons and hadrons as a function of p_{GEN}, θ_{GEN}, ϕ_{GEN};
  - θ_{REC} -θ_{GEN} for electrons and hadrons as a function of p_{GEN}, θ_{GEN}, ϕ_{GEN};
  - ϕ_{REC} -ϕ_{GEN} for electrons and hadrons as a function of p_{GEN}, θ_{GEN}, ϕ_{GEN};
  - β vs. p_h and p_h vs. M (to judge π/K/p separation and momentum reconstructions);
- final states b-f:
  - cos θ_e (CM) vs. ϕ (CM) (angle between electron and hadron planes);
  - MM_X (missing mass for various exclusive 2-body channels);
  - IM_X (invariant mass for various hadronic decays);
  - IM(2γ) (two photon invariant mass for pi0 reconstruction);
  - Q^2 vs. W.

These plots should be made for the full CLAS12 spectrometer, as well as for the forward and central detectors, separately.

Initially, simulations will be done with nominal field (100%) for both torus and solenoid and no background, to address point 1. In a second iteration, simulations will also be done with different magnetic fields, target (polarized target, nuclear targets, …) and background, to address points 2-4.

Detailed documentation and instructions can be found at:
https://clasweb.jlab.org/wiki/index.php/CLAS12_Calibration_and_Commissioning#CLAS12_Reconstruction_and_Calibration