Report of the CLAS12 Forward Tagger Design Review Committee

Review took place on December 11-12, 2012, Jefferson Lab

The CLAS12 Forward Tagger design review committee composed of G.V Margagliotti, INFN-TS, R. Miller, JLab, E. Pasyuk, JLab, P. Rosier, IPN-Orsay, S. Stepanyan, JLab (chair), and C. Zorn, JLab, heard presentations from and held discussions with members of the CLAS12 Forward Tagger (FT) collaboration on the simulations, design, presently completed R&D and prototyping, construction, installation, commissioning and operation of the Forward Tagger.

The Committee would like to thank the organizers for making the review materials available on time, and thank presenters for an interesting, informative, and relevant talks and useful conversation.

While the committee feels strongly that the design of the FT system is sound, and that the detector will be build and installed in Hall-B on time; there are several points that the collaboration should address before the construction and installation phases start.

Our report is subdivided as *Findings*, *Comments and Suggestions*, and formal *Recommendations*, followed by the requested point-by-point response to the *Charges*.

Findings:

The FT Collaboration made a strong case for having a detector system that can identify and trigger on electrons scattered from the CLAS12 target for a polar angular range from 2.5 to 4.5 degrees. This system, consist of a micromegas based tracker, a scintillation hodoscope, and a lead-tungstate calorimeter, will open new physics opportunities with CLAS12, in particular in the field of hadron spectroscopy. It was also demonstrated that the calorimeter of the FT could be effectively used for detection of high energy photons, important for the core physics program of CLAS12.

The FT collaboration performed systematic studies of the performance requirements for the detector in terms of energy and angular resolutions, trigger rates, and acceptance based on physics needs. Careful studies have been performed on possible impact of the FT on CLAS12 performance using state-of-the-art GEANT4-based simulations. Collaboration has demonstrated that the proposed detector system will meet physics requirements and will have negligible effect on the core physics program with CLAS12.

Design of the FT detector system is far along. The collaboration made excellent progress in the testing of components and prototypes for different systems. Funding for the construction is secured from European funding agencies. The collaboration was also awarded an NSF MRI grant for construction of the tracker and for procuring electronics components. Overall, FT is ready for the next stage: construction. Some of the

components are already ordered. The collaboration has a sound plan for calibration and commissioning of the system before and after the installation in Hall-B.

Comments and Suggestions:

1. While detailed simulations showed that the impact of FT on reconstruction of exclusive electroproduction reactions is negligible, studies are needed to see what the impact, if any, will be on semi-inclusive reactions where small asymmetries must be measured. Also efficiency and resolution effects close to the detector edges must be studied.
2. Simulations with rastered beams, needed for experiments with polarized targets, are necessary in order to study backgrounds and radiation on FT, and Moller shield configuration for CLAS12.
3. There is a large deficiency in geometrical details of the detector. There must be drawings with dimensions, tolerances, and keep-out zones, for internal to FT system, as well as relative to CLAS12.
4. The type of exhaust of the hot air from the tracker electronics box should be defined soon and coordinated with the Hall-B engineering group.
5. Mitigation of possible coolant leaks, internal and external, must be done in terms of how to protect electronics (FT calorimeter and CLAS12 DC) from coolant drips.
6. A nitrogen purge for the hodoscope should be considered to prevent aging and to slow down the process of radiation damage.
7. Cooling of SiPMs and amplifiers must be considered, or at least the effect of running without any cooling must be studied.
8. The choice of the gas sealed window for the tracker must be done soon. Gluing the window, which is a preferred method, may need some R&D for choosing radiation hard glue. The mechanical version may introduce additional material on the peripheral part that may affect background rates in CLAS12.
9. A study of possible radiation damage to the tracker front-end electronics should be performed.
10. Supports on readout corners of the calorimeter motherboard must be considered in order to lessen the cable load on the motherboard.
11. The temperature gradient inside the calorimeter is not fully studied, so measurements with the prototype must be done.
12. The radiation effects on the LED are unknown. The impact of the radiation and the mismatch of the LED and APD spectra on the calibration of the calorimeter should be studied.
13. Installing humidity sensors inside the calorimeter must be considered to make sure nitrogen flow is efficient.
14. The collaboration should consider and develop a plan for testing the FT system in Hall-B using the Hall-B tagged photon facility if that facility and beams will be available well before the installation starts.
15. Study the possibility of using the calorimeter as a neutron detector.

16. The feasibility of fabricating the designed tungsten parts and the impact of limitations of machining on the calorimeter design must be studied.

Recommendations

1. Perform engineering analysis of the central support part, PEEK ribs and polystyrene foam of the calorimeter, and also add earthquake loads of 0.1G in XYZ directions of the whole FT.
2. The calorimeter will need well-defined survey marks (connected to crystals). The location of markers is important since access will be very limited after the detector is installed. This should be done in contact with JLAB survey group.
3. Integration of the FT system in CLAS12 is not fully developed. Collaboration must work together with Hall-B engineering group to iron out all the details of the installation, providing the necessary utilities, and the plan for maintenance. Within the next few months all of the above, including work breakdown of engineering efforts between JLAB/Hall-B and FT collaboration must be performed.

Responses to the Charge

1. Are the detector specifications clearly defined and reflect the physics requirements?

   Yes

2. Does the detector design meet the required specifications?

   Yes

3. Are there remaining issues in the project that require additional R&D and/or design changes?

   Yes

4. Has the impact of the FT on the CLAS12 performance been thoroughly evaluated? Specifically, does the FT have any limiting effect on the angular coverage of CLAS12, the maximum luminosity that CLAS12 can be operated at, and the occupancies in Region 1 drift chambers?

   Yes, but some additional studies are necessary. From the presented material there are no limitations on CLAS12 performance due to FT.

5. Has the integration of the FT in CLAS12 been fully developed, in particular:

   No

   a. Possible interference with the Moller shield, the High Threshold Cherenkov Counter and the Drift Chambers?

   b. The location of utility lines (cooling and power) and signal readout cabling?

c. The access for repair and maintenance?

6. Is the schedule for construction and installation of FT in line with CLAS12 installation?

   Yes

7. Has a detailed plan for the commissioning and calibration been developed?

   Yes

8. Has a quality assurance plan be developed and put in place?

   Yes

9. Have safety issues been addressed?

   Yes

10. Other comments