Tagger system
September 1, 2004

Purpose, Resolution Requirements, Description, Mass, Channel count

The purpose of the Tagger system is to provide a flux of $\sim 10^8$ Hz of linearly polarized photons from coherent bremsstrahlung in a thin, orientated diamond crystal. This is achieved by measuring the energies of the energy degraded bremsstrahlung electrons in the spectrometer. The photon energy resolution is required to be less than 0.1% r.m.s. of E_0 for E_γ between 70 % and 75 % of E_0, which corresponds to 12 MeV r.m.s. energy resolution for a 12 GeV electron beam. The Tagger system consists of a quadrupole and 2 dipole magnets, a vacuum chamber and the associated focal plane detectors. The dipoles are two identical magnets that will be run at 1.5 T and at present the pole shoe surfaces will be part of the vacuum chamber. The focal plane detector array is located just outside the vacuum chamber. It consists of a set of 128 fixed scintillation counters spanning the full energy range from 25 % to 92% of E_0 and is required for the alignment of the diamond. A movable "microscope" of 64 narrow counters is required to measure accurately the photon energies in the energy range of 70 to 75% of E_0. The total mass of the tagger system will be $\sim$ 90 tons.

Raw Signals, Stages of Amplification, Final readout

Since individual detectors in the focal plane array will have to count at rates in excess of 5×10^6 Hz, a *plastic scintillator/photomultiplier* combination is appropriate. A detailed design which specifies the precise geometry of the scintillators and their support frame still has to be finalized. The signal readout from the focal plane detectors will be standard.

R&D Issues, Simulations and Other Considerations

The Glasgow and Catholic Universities groups have calculated the tagger optics separately, the results of which can be found in Hall D note 70[1] and the GlueX/Hall D Design Report (Nov 2002). The Design Report tagger is different from the design described above. It has a single long, narrow dipole which is 6.1 m in length and weighs $\sim$ 100 tons. Due to concerns about the mechanical stiffness, the availability of sufficiently large pieces of iron of the necessary quality and the availability of suitable manufacturers, Glasgow and Jlab investigated the possibility of a tagger consisting of two identical magnets in series[2]. By careful positioning of the two magnets it is possible to obtain a design that is equivalent, and in some respects superior, to a single magnet configuration. The two magnet design concept was accepted by the collaboration at the Indiana meeting in May 2004. Glasgow has studied the design in more detail and has produced drawings of the two magnet assembly, including a possible vacuum system, which should contain sufficient details for budget prices to be obtained from potential manufacturers. It is also relevant to mention that prior to version 4 of the Design Report, Glasgow and Jlab investigated the feasibility of a tagger with superconducting coils[3] with a magnetic field of 5T and main beam bend angles of 15, 30 and 45 degrees, for both curved and straight output edges - the room temperature tagger bend is 13.4 degrees. After careful consideration, the superconducting option was rejected since there are several distinct disadvantages and no clear advantages.

Manpower, R&D and Production Schedules

The Tagger system has been the responsibility of groups from Glasgow University, JLab and Catholic and Connecticut Universities. More work is required to investigate alternative vacuum system designs - we have already considered a vacuum chamber which, (i) is external to the tagger dipole magnets, or (ii) uses the pole shoe surfaces as an integral part of the chamber. Vacuum systems which are either completely welded or use a combination of O-ring seals and welds have also been examined. It should be realistic to obtain cost estimates for the magnets and vacuum system in the near future. The Moscow group using ISTC financing could provide the necessary manufacturing skill and manpower to produce the magnets and the vacuum chamber. Basic R&D is required for the focal plane assembly, and a decision on which group or groups should take on this responsibility should be made in the near future, bearing in mind manpower requirements.

[1] Optics calculation for the Hall D tagging spectrometer for a 12 GeV electron beam. G. Yang, January 2004.
[2] Optics calculation for a two magnet tagged photon spectrometer for GlueX. G. Yang, July 2004.
[3] Possible designs for a 12 GeV superconducting Tagger. J. Kellie, November 2001.