Proposal name: C12-18-005

Title: Timelike Compton Scattering Off Transversely Polarized Proton

Contact Person: Marie Boer

Beam time request:

Days requested for approval:	49.5 PAC days
Time needed including energy changes:	none
Tune up included in beam time request:	5 PAC days

Beam characteristics:

Energy:	11 GeV
Current:	2.5 uA
Polarization:	Yes (85% or higher)
Radiator:	Yes (bremsstrahlung photon beam)

Targets:

Nuclei:	NH_3
Rastering:	Yes
Polarized:	Yes (proton)

Spectrometers:

HMS	No
SHMS	No
Other	Four NPS style calorimeters

Special requirements/requests:

- Four calorimeters
- Install a beam pipe with close to 6 degrees aperture to minimize background.
- Mount the so-called Top and Bottom calorimeters downstream of the target
- Mount the plastic scintillator hodoscope
- Mount the GEMs
- Install the Compact Photon Source
- Install the polarized proton target which will be oriented 100% transversely

Comments: The physics goals of the experiment are well-presented and will provide crucial insights to the 12 GeV GPD experimental program. The experiment will make use of a high rate real photon beam and transversely-polarized target and will utilize GEMs, scintillators, and calorimeters for triggering and particle ID. This measurement will be a very exciting test of the universality of GPDs and will access the GPD H, H˜ and E from TCS observables, and the poorly constrained GPD E.

Technical Considerations:

1. This experiment requires ~2100 PbWO4 calorimeter blocks, about 1000 more than the number planned for the NPS.
2. Is the attainable physics sensitive to the 11 GeV beam energy (e.g. if it is slightly less does this change anything)?
3. The text states "*The expected rates in the hodoscope are at least 15 MHz which is an order magnitude higher than the capability of this detector. In this case we require a signal in the three GEMs the hodoscope and the NPS. The identification of protons relies on measuring energy loss (dEdx) and the proton momentum which is measure with the position information from the GEMs and the timing information of the this five layered detector package.*"
   Does this mean that the GEMs will be integrated with the trigger? The overall trigger design is not clearly described.
4. *In order to achieve optimal rejection, separate particle momentum determination as well as cluster pattern recognition will be use. Advances in artificial neural networks have made significant progress with signal classification in this regard [72].*
   This is the plan to attain optimal rejection, but is it required? Will it be prepared at some level before the experiment and fine-tuned with data?
5. *It should be noted that resolution of electromagnetic calorimeters critically depends on the calibration procedure. With this respect, we count on taking separate calibration runs with tagged photon beam in Hall D. Alternatively, we can calibrate with electrons in elastic kinematics, by detecting recoil protons in a magnetic spectrometer. It can be done readily with HMS/SHMS spectrometers in Hall C.*
   Does this imply that the calorimeters will be placed in Hall D temporarily and then moved into Hall C? A calibration transferred between halls is probably only good to a few percent. What temperatures will the crystals be run at? Will there be any initial plans using cosmics, etc? If we are going to calibrate the calorimeters with the spectrometers, is this separate from the beam time request? The inclusion of an LED gain monitoring system could also be of help for this detector.
6. How will the gains be monitored for the PbWO4 crystals throughout running? There are known radiation effects that are observed in PbWO4. Is there a plan to monitor and restore the crystals during the run period?
7. Figure 25, page 38: How can the blue line for $\rho°$ be above the black (total) line at the right?
8. Target group comments:
   a. The UVa group has demonstrated that the sample rotation scheme works very well and does not interfere with either DNP or NMR.
   b. The magnet's transverse angular acceptance on page 17 is wrong. We believe it is +/- 15 degrees, not 17. (Measured it with a protractor from the original Oxford drawings). However, the lab is planning to procure a new magnet with a wider split, +/- 25 degrees.
   c. More discussion that compares the damage from real photons to an equivalent electron beam would be nice.
   d. The NMR coil is located outside the target sample. This will introduce an additional systematic uncertainty in the target polarization due to portions of the material that are not irradiated. Alternatively, one might prefer to irradiate fully to

the edge of the cup to ensure the beam dose is uniform over the entire target. The cups are usually Kel-F. Not sure how long they'll last though.

e. There are rotating vacuum seals that do not rely on a pair of elastomer o-rings (ferrofluidic, magnetic). Not sure what the UVA group has been using.
f. This proposal will use a high intensity bremsstrahlung beam on the UVa polarized target oriented for transverse polarization. The expected luminosity really high, about 2 x 10^{35} $cm^{-2}s^{-1}$. To distribute the resulting radiation across the full extent of the target, the sample will be continuously rotated about the beam access and moved up and down.
g. Technical concern on the target rotation, figure 10 page 22. Rotating vacuum seals need to have two elastomers with the gap differentially pumped. There's no detail about this, and I don't remember what the previous proposal using this target wrote. Radiation damage to the seal material could be an issue over the hundred days of the experiment. Given the statement about time to replace insert with completely new material at the bottom of page 45, it may be that one calendar day would suffice to replace the elastomer.
h. Contamination issues from vacuum grease on elastomers? Probably not, low Z.