Proposal Number:	PR12-14-005	**Hall: C**

Title: Wide Angle, Exclusive Photo-production of π^0 Mesons

Contact person: Dipangkar Dutta

Beam time request:

Days requested for approval:	20 (56 hours beyond PR12-14-003)
Tune up included in beam request:	No

Beam characteristics:

Energy:	11.0, 8.8, 6.6 GeV
Current:	6-60 uA
Polarization:	No

Targets:

Nuclei:	LH_2
Rastering:	Yes
Polarized:	No

Spectrometers:

SHMS:	No
HMS:	Yes
Other (BigBite, etc.):	Neutral Particle Spectrometer

Special requirements/requests:

Neutral Particle Spectrometer

Technical Comments:

Overview:

The proposal is to extend the *s* range of $\gamma+p\rightarrow\pi^0 + p$ cross-sections for angles near 90 degrees in the CM. Using scaling to extrapolate from the closest existing data, the measurements will extend the cross-section range downward by 2 orders of magnitude to ~10 pb/(GeV/c)^2. Challenges include the small cross-section, potential background from the radiator, the mixed beam of photons/electrons/hadrons on the LH_2 target, the modest energy resolution of the calorimeter, and the inability to over-determine the kinematics due to the unknown E_γ of the untagged bremsstrahlung photons. Radiator-out data will not routinely be taken, so $e+p \rightarrow e' + \pi^0 + p$ must be modelled and subtracted. Despite these challenges, it appears that the experiment's goals can be realized.

As far as cuts to reduce background are concerned, on the HMS side they include good proton ID, reconstructed Ztgt consistent with the LH_2 target, and a collimator aperture cut. (The latter two cuts help suppress protons that re-scatter.) These cuts were sufficient to isolate $d(\gamma,p)n$ early in the HMS 4 GeV program. Additional cuts will be available in this experiment, but one should keep in mind that the second arm is a relatively poor resolution calorimeter with no tracking and likely to be *very* busy with backgrounds from the radiator, target, and beamline. After forming a list of showers in the calorimeter which are in time coincidence with the proton, all pair-wise combinations of showers must be used to calculate the invariant mass $M\gamma\gamma$. If a π^0 signal candidate is found, it must then pass the co-planarity cut with the proton. Despite the limited energy resolution of the calorimeter, moderately inelastic backgrounds such as $\gamma+p \rightarrow 2\pi^0 + p$ are estimated to be small.

Suggestions for clarification:

- What *exactly* is the scheme for PID in the HMS? In that scheme, what is the efficiency for proton detection? What about contamination from π^+ and K^+?
- Can you provide a drawing that shows how the calorimeter would be shielded from the radiator without obscuring the upstream end of the LH_2 target?
- What is the nominal energy threshold used to search for calorimeter shower candidates, and what resulting rate per crystal can be expected?
- Can you make a new version of Table I where the last column has the acceptance for detecting both photons from $\pi^0 \rightarrow \gamma\gamma$ above threshold in the calorimeter located 11m from LH_2 target? The uncertainty on the NPS acceptance in Table VI is only 1.5% which suggests these corrections are small.

Several comments for information only:

- Because $PbWO_4$ is a scintillator, soft backgrounds are likely to shift the pedestal more than expected from the WACS collaboration's experience with Cerenkov radiators like lead glass. Happily, the new Flash ADC's will allow measurement of the pedestal on an event by event basis.
- The $PbWO_4$ crystals will become significantly and permanently activated due to neutrons from the radiator. This will increase the pedestal width and worsen the resolution more than collaboration anticipates. Most of this activity will be below 10 MeV and will not significantly deteriorate the energy resolution for GeV-scale photons. It might be problematic though for "backward" photons from $\pi^0 \rightarrow 2\gamma$ if the threshold extends down to 100 MeV.
- After all background subtractions, any non-zero yield above the bremsstrahlung endpoint in the reconstructed $E\gamma$ (after folding in the energy resolution) would indicate an unaccounted-for background.