MEETING ON PHYSICS WITH NEUTRAL PARTICLE SPECTROMETER

12 December 2012, JLab

GUIDANCE ON PAC RUN GROUPS

- If experiments can run together then they should be submitted together to the PAC
- Procedure allows for different scenarios, e.g.,
  - all experiments at same time to PAC
  - one experiment out of group to PAC and additional ones with SAME beam time requirements as request to Hall
  - few experiments with different beam time requests to PAC and any additional ones with same beam time requests to Hall
- It may be possible to get grades for the additional experiments in (2) and (3)
- Based on the new guidance the NPS requirements document is an important document

REQUIREMENTS DOCUMENT

- Can be submitted either with a proposal or a letter of intent to the PAC
- Good length to aim for is ~5 pages (max. length to aim for ~10 pages)
- Contents should include among other things:
  - photon angles and counting rates/luminosity to illustrate compatibility of measurements, for instance, DVCS and exclusive $\pi 0$ have similar photon angle requirements
  - idea for the instrumentation is to have a global facility with which one could measure all neutral particles at any angle
- Overall structure:
  - Executive summary
  - Introduction (once draft is written could ask theorists for review, e.g., P. Kroll, M. Vanderhaeghen or others...)
  - Individual measurements and requirements
  - Conceptual design considerations
  - Description of the device
- Individual structure:
  - Description of experiment
  - Instrumentation requirements: size and positioning of detector
    - Size of detector related to requirements on t-range
    - Detector positioning from target is a tradeoff between background (close), resolution (far), and acceptance (close). Optimal figure of merit seems to be at 4-5 m distance from target

        - Sweeping magnet field configuration, e.g., benefits of larger or smaller gap and benefits of transverse or horizontal magnetic fields for individual experiments. Or is the current proposed PbWO4 design sufficient?
            - Note that the magnetic field strength is determined from deflection needed to sweep away charged particles up to some energy until the remaining charged particles (electrons) background is no worse than the neutral particle background (photons). The calculation depends on the background energy spectrum. The current strength of 0.3 T-m was determined following this procedure and is a good value for the currently proposed PbWO4 (size: 64 cm x 74 cm) detector. Once agreed on the global size of the detector can revisit the sweeping magnet design
        - Acceptance is important for capturing $\pi 0$ exclusive and SIDIS
    - Special requirements

- Add exclusive eta production as topic/measurement
    - This measurement is important for determining overall detector acceptance requirement
- Practical considerations and timeline:
    - need to agree on global parameters of the detector. Need additional information on:
        - background at different current vs. angle normalized to 1 uA at 5 deg
        - maximum dose to put on crystal, e.g., 1 MHz rate (threshold=XYZ) on crystal for XYZ dose as function of angle
    - write individual sections (by end of January/February 2013?)
    - write introduction and summary
- Path forward:
    - Hamlet/Rolf will look into the background and maximum dose calculations
    - TH will update slides from meeting and send first draft for discussion

STATUS/PROGRESS ON QUESTIONS FROM ORSAY WS

DVCS UNPOLARIZED

- Possible solutions for the setting in kinematic table that exceeds HMS maximum momentum (7.3 GeV/c)
    - Use part of acceptance (+-8% nominal) - could allow for settings with 7.5 GeV/c rather than 7.3 GeV/c
    - Modify kinematics, preferably increase Q^2 slightly, but keep x the same, since it's a Q^2 scan

    - Note that HMS will be commissioned to 7.3 GeV/c by the time of the experiment. Thus far HMS has been commissioned up to 6 GeV/c.
- Maximum currents at larger angles?
- Background will be similar with exclusive pi0
- Add a setting at lower x, e.g., x=0.2, to further harmonize kinematics with exclusive and SIDIS pi0

DVCS POLARIZED

- Requires 3rd generation polarized target from UVa.
- Plan to submit this as different proposal from DVCS unpolarized since beam time different.
    - could be submitted relatively early too with the target as a technical requirement
- Note the 3rd generation polarized target will also be used by the already approved experiments A1N and GEN
- Projected luminosity on He3 target is ~10^35 (total) and sweeping magnet already included

WACS

- Can use global facility, but cannot run together with DVCS/exclusive mesons because of radiator requirement
- Need to determine maximum possible currents

EXCLUSIVE PI0

- Can one do this experiment with smaller PbF2 detector
- Maximum currents at larger angles?
- Background will be similar with DVCS unpolarized
- Justification to add lower energy 6.6 GeV (same as DVCS Hall A setting): consistency/reproducibility check for DVCS and epsilon range for exclusive pi0. In this scenario would run three energies: 6.6, 8.8, and 10.9 GeV/c.
- Benefits of adding setting at lower x, e.g., x=0.2, to further harmonize kinematics with DVCS unpolarized and SIDIS?

SIDIS PI0

- No strict requirements on exact Q^2 and x choices - will measure everything not exclusive
- Rates are higher, so statistics not a major problem
- Can DVCS benefit from small x point at x=0.2? This point would define the smallest angle for any of experiments.

REVIEW OF DETECTOR CHARACTERISTICS

- PbWO4 vs. PbF2:
  - Neutron background issues from LD2 drove in part decision for PbF2
  - Requirement to identify t in meson production drove in part decision for PbWO4
  - Exclusivity is better for PbWO4 and resolution higher (PbWO4=2.3%/sqrt(E) vs. PbF2=5.3%/sqrt(E)). For general detector good energy resolution would be beneficial
  - PbWO4 is scintillator, so long tails resulting in pile-up. However, have sweeping magnet so improves background for same angle
  - If beam was possible in ~2015 using exisisting PbF2 would make sense, if not, and if considering to build a new calorimeter perhaps PbWO4 better since better resolution even if background a little higher
  - For geometry 64x74 cm^2 would require 1116 PbWO4 crystals (available from Chinese manufacturer if not assuming that all available from PrimEx) and ~200 PbF2 crystals (in addition to 208 available crystals)

- Lifetime of calorimeter
  - Based on test during Qweak no problems are expected for PMTs (PMT with amplifier and without magnetic shield was placed in region 1 during Qweak and showed no radiation damage)
  - UV curing can be used to reverse accumulated dose in crystals (note that damage is worst at front - most sensitive to low energy background of ~10 MeV)

- Justification for: "Why not use the existing PbF2 calorimeter at shorter distance, e.g., 3m"
  - Cannot do entire DVCS program at 3m
  - Worse pi0 separation - this would need to be quantified for impact on pi0 separation with 208 crystals at 3m

NPS MAIN QUESTIONS

- Background rates and dose at different angles
  - background at different current vs. angle normalized to 1 uA at 5 deg
  - maximum dose to put on crystal, e.g., 1 MHz rate (threshold=XYZ) on crystal for XYZ dose as function of angle
- Eta --> additional information on size of detector
- For next PAC: create more realistic drawings of device, e.g., how it fits in Hall C and design support structure

DRAFT AGENDA FOR HALL C JANUARY 24 MEETING

- Total for NPS related talks: 2-3 hours

- Introduction to physics (4 x 25 minutes)
  - DVCS
  - Mesons (pi0 DES and SIDIS)
  - WACS
  - Eta (ask Peter Kroll for combined talk together with exclusive pi0?)

- Overview of NPS (30 minutes)

- Technical talks on instrumentation (2 x 25 minutes)
  - Properties of crystals and background tests (Hamlet?)
  - Simulations