Hall B Status

Volker D. Burkert
Jefferson Lab

CLAS Collaboration Meeting
February 27, 2003

Run status
Publication status
PAC23
Schedule for 2003
New equipment initiatives
Energy upgrade
Hall B Status Overview

- Completed 5 years of physics data taking

- 19 major CLAS production runs completed
  - e1a/b, g1a/b, g6a, e1c, e2a, g6b, g2a, g1c, g3, e1d, e5, eg1b, g8a, g6c, e1-6, e6, e2b, g7, e1e (+ 2 non-CLAS experiments: g5, radphi)

- Data analysis using JLAB off-line farm
  - ‘cooking’ completed for e1a/b/c, g1a/b, g6a, eg1a, e2a, g2a, e1d, g1c, g2a, g6b, e5, e1-6, g6c, g3, e6
  - ‘cooking’ underway for eg1b, g8a, e2b,
  - calibration in progress for g7, e1e

- Publications
  - 15 technical papers published/accepted (14 in NIM)
  - 15 physics papers published/accepted in PRL, PRC, PRD
# Technical Publications

- **Torus Magnet**  
  IEEE Mag.25 (1989) 1902

- **Drift Chambers**
  - construction  Mac Mestayer  NIM A323 (1992) 191
  - update  Mac Mestayer  NIM A367 (1995) 316
  - Region I  Dan Carman  NIM A419 (1998) 315
  - Region II  L.M. Qin  NIM A411 (1998) 265
  - Summary  Dan Carman  NIM A449 (2000) 81

- **Cerenkov Counter**  Paul Stoler  NIM A465 (2001) 414

- **TOF Counters**  Elton Smith  NIM 432 (1999) 265

- **Start Counters**  Simon Taylor  NIM A462 (2001) 484

- **Forward Cal.**  Cole Smith  NIM A460 (2001) 239

- **Large Angle Cal.**  Mauro Taiuti  NIM A447 (2000) 431

- **Tagging System**

- **Polarized target**  Chris Keith  NIM A accepted

- **CLAS Overview**  Bernhard Mecking  NIM accepted
Physics Publications (ref. journals)

published before 10/17/02

- Photofission of Heavy Nuclei, PRL84 (2000) 5740
- $\phi$-Photoproduction at large t, PRL85 (2000) 4682
- $\eta$-Electroproduction, PRL86 (2001) 1702
- $\phi$-Electroproduction, PRC63 (2001) 065205-1
- $K^+\Lambda(1520)$ Electroproduction, PRC63 (2001) 044601
- $\rho^0$-Photoproduction, PRL87 (2001) 172002
- Beam Asymmetry in DVCS PRL87 (2001) 182002
- Double Spin Asymmetry in ep->e$\pi^+n$, PRL88 (2002) 082001
- N->$\Delta(1232)$ Multipoles from $\pi^0$ Electroproduction, PRL88 (2002) 122001
- Photofission of Heavy Nuclei, PRC65, 044622 (2002)

published/accepted since 10/18/02

- $\eta$-Photoproduction on the Proton, PRL89, (2002) 222002-1
- $\omega$-Photoproduction at large t, PRL90 (2003) 022002
- Polarisation transfer in ep->e$K^+\Lambda$, PRL accepted (2003)
- Single Quark Transition Analysis of N* Excitations in [70,1-], PRC67, 0352XX (2003) submitted
- Inclusive spin structure function in eD -> eX, PRC
- ep -> ep$\pi^+\pi^-$ and baryon resonance analysis, PRL
- Beam Spin Asymmetries in DIS ep->e$\pi^+X$ PRL
- Measurement of $\sigma_{LT}$ in the $\Delta(1232)$ region, PRL
- Nuclear Scaling in A(e,e') at x>1, PRC
- F2 and Moment analysis in ep-> eX, PRD
Physics Publications cont’d

Under Collaboration Review

- Polarization Asymmetries in ep -> epπ⁰ (A. Biselli)
- Inclusive double polarization asymmetries, g₁ and Γ₁⁰ (R. Fatemi)

Multi Hadron WG

- Correlations in ³He(e,e′pp)n (R. Niyazov)
- Femtoscopy (A. Stavinsky)

Real Photon WG

- Photoproduction of K⁺ΛΣ⁻ (J. McNabb)
- Photoproduction of pπ⁰π⁰ (B. Berman)
- Photoproduction of K⁺Σ⁻ on deuterium (I. Niculescu)
- Photoproduction of K⁺K⁺Ξ⁻ (J. Price)

Structure of the Nucleon WG

- Electroproduction of K⁺ΛΣ (R. Feuerbach, H. Niculescu)
- Electroproduction of ep -> enπ⁺ (H. Egiyan)
- Deeply virtual electroproduction of ρ⁰ (C. Hadjidakis)
- SSA in ep -> eπ⁺n (K. Joo)
- p(e, e′K*)X (K. Hicks)
- p(e, e′K⁺)Λ (Si McAleer)
# Physics Impact of CLAS Data?

<table>
<thead>
<tr>
<th>Paper</th>
<th>Physics</th>
<th>#citations &gt;10</th>
</tr>
</thead>
</table>
| PRL85 (2000) 4682 | $\phi$-Photoproduction at high $t$
Gluonic effects in production mechanism | 24              |
| PRL86 (2001) 86, 1702 | **Study of $S_{11}(1535)$ in $\eta$ electroproduction**
Hard transition form factor, quark models | 18              |
| PRL87 (2001) 172002 | $\rho^0$-Photoproduction at high $t$
Regge phenomenology, gluonic effects | 12              |
| PRL87 (2001) 182002 | **Deeply Virtual Compton Scattering**
GPD formalism, twist-2/twist-3 | 68              |
| PRL88 (2002) 182002 | **Multipoles from $\gamma^*N\Delta(1232)$ transition**
Lattice QCD, Nucleon/Delta deformation Test of hadronic models | 14              |
# PAC23 - Meeting, January 2003

## New Proposals:

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Physics</th>
<th>PAC days (45 days)</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-03-006</td>
<td>GDH Sum Rule at very small $Q^2$ (M. Ripani, et al.)</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>P-03-012</td>
<td>The Structure of the free Neutron (S. Kuhn, et al.)</td>
<td>25</td>
<td>A-</td>
</tr>
</tbody>
</table>

## Letters of Intent:

| LOI 03-1  | Pion Polarizabilities with low $Q^2$ tagger (K. Wang)     | - interesting physics, more work needed for proposal |
| LOI 03-2  | SSA with transversely polarized target (H. Avakian)       | - interesting physics, more work needed for proposal |
| LOI 03-3  | Spectroscopy on $^4$He with low $Q^2$ tagger (S. Stepanyan) | - invite proposal                                  |
| LOI 03-4  | Spectroscopy on $H_2$ with low $Q^2$ tagger (C. Salgado)  | - invite proposal                                  |
# Hall B Run Plan

<table>
<thead>
<tr>
<th>Run group</th>
<th>Run time (days)</th>
<th>PAC rating</th>
<th>Target</th>
<th>Energy (GeV)</th>
<th>Electron polar.</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>e1f/g</td>
<td>~40</td>
<td>A⁻</td>
<td>H₂</td>
<td>3 - 6</td>
<td>High</td>
<td>completes e1 runs</td>
</tr>
<tr>
<td>eg2</td>
<td>44</td>
<td>B⁺</td>
<td>nuclear</td>
<td>5 - 6</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>

unscheduled (alphabetical order):

<table>
<thead>
<tr>
<th>Run group</th>
<th>Run time (days)</th>
<th>PAC rating</th>
<th>Target</th>
<th>Energy (GeV)</th>
<th>Electron polar.</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coherent ρ</td>
<td>50</td>
<td>A⁻</td>
<td>D₂</td>
<td>6.0</td>
<td>High</td>
<td>uses DVCS solenoid</td>
</tr>
<tr>
<td>DVCS</td>
<td>60</td>
<td>A</td>
<td>H₂</td>
<td>6.0</td>
<td>High</td>
<td>Solenoid, crystal EC</td>
</tr>
<tr>
<td>eg1(γ)</td>
<td>22</td>
<td>B⁺</td>
<td>p</td>
<td>1.6-4.0</td>
<td>High</td>
<td>Frozen spin target</td>
</tr>
<tr>
<td>g8</td>
<td>29</td>
<td>A⁻</td>
<td>H₂</td>
<td>4.2-4.5</td>
<td>No</td>
<td>Photon polarimeter</td>
</tr>
<tr>
<td>GDH (Low Q²)</td>
<td>20</td>
<td>A</td>
<td>p</td>
<td>1.2-4.0</td>
<td>High</td>
<td>New Cerenkov counter</td>
</tr>
<tr>
<td>Missing N*</td>
<td>20</td>
<td>A⁻</td>
<td>p</td>
<td></td>
<td>No</td>
<td>Frozen spin target</td>
</tr>
<tr>
<td>Neutron S.F.</td>
<td>25</td>
<td>A⁻</td>
<td>D₂ gas</td>
<td>4-6</td>
<td>?</td>
<td>Radial TPC</td>
</tr>
<tr>
<td>PrimEx</td>
<td>22</td>
<td>A</td>
<td>nuclear</td>
<td>6.0</td>
<td>No</td>
<td>ECALs, ..</td>
</tr>
</tbody>
</table>

248(unscheduled)
New Equipment Initiatives I

- **DVCS Experiment**
  - **PbWO$_4$ crystal calorimeter**
    - 220 (of 440) tapered crystals on site (ITEP, JLab)
    - Light readout by APDs (ITEP, obtain from CMS)
    - Mechanical structure in final design stage (Orsay)
    - Preamps - designs being evaluated (ITEP, Orsay)

Crystal array with 436 crystals
New Equipment Initiatives I

- DVCS Experiment cont’d
  - Superconducting solenoid (Saclay)
  - Sweep Möller electrons away from DVCS calorimeter
  - Final engineering design stage
  - Some delays occurred due to changes in engineering personnel

trapezoidal and rectangular coils
New Equipment Initiatives II

- Frozen Spin Target

Needed for Search for missing N* in hyperon photoproduction, Experiment E-02-112, F. Klein et al.

Work by Target group (Chris Keith, et al.)

- Conceptual design is completed, mechanical design in progress

- Design of saddle coil for transverse holding field is ongoing

- Construction of a 1K prototype nearly complete (final cryostat to operate at < 50mK)
New Equipment Initiatives III

- Radial Time Projection Chamber (RTPC)
  (needed for the BoNuS experiment, S. Kuhn, et al.)
  Goal: detect spectator protons with momenta as low as 70 MeV/c

- Concept of a prototype being developed (H. Fenker), expected to be ready this summer

- Would like to test prototype during the DVCS run (needs solenoid magnet for Moller shielding)
New Equipment Initiatives IV

- Gas Cerenkov Counter for outbending electrons (INFN, Genova)

  (Experiment E-03-006: GDH sum rule at very low $Q^2$, M. Ripani et al.)

- Simulations and conceptual design underway

![Diagram of Cerenkov counter with annotations](Image)
## Hall B 2003/2004 Schedule

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/06 - 01/23/03</td>
<td>e1e continued from 2002</td>
</tr>
<tr>
<td>01/26</td>
<td>Decision to begin DC repair period more than 3 weeks ahead of original schedule to allow for the repair of 4 drift chambers (low voltage shorts, corrosion on pre-amps boards, broken wire)</td>
</tr>
<tr>
<td>01/26 - 04/11/03</td>
<td>Hall maintenance, status: two chambers finished, repair of #3 underway</td>
</tr>
</tbody>
</table>

Schedule heavily constraint by two parity experiments in A/C, both need ~ 3 GeV

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>04/15 - 07/01/03</td>
<td>e1f/g continued (5.5 and 3.3 GeV)</td>
</tr>
<tr>
<td>07/12 - 09/14/03</td>
<td>eg2 A(e,e’X), A(γ,X)</td>
</tr>
<tr>
<td>09/15 - 10/19/03</td>
<td>Accelerator and Hall maintenance</td>
</tr>
<tr>
<td>10/20 - 10/27/03</td>
<td>DVCS Tests (with polarized target magnet in CLAS)</td>
</tr>
<tr>
<td>11/01 - 12/14/03</td>
<td>eg2 continued</td>
</tr>
<tr>
<td>12/15 - 12/24/03</td>
<td>PrimEx Installation</td>
</tr>
<tr>
<td>2004</td>
<td>no schedule yet</td>
</tr>
</tbody>
</table>
**PrimEx Preparations**

Hybrid Calorimeter (HyCal)

- 3 m travel
- 0.6 m travel

**Status:**

- Engineering design completed
- All PbW0₄ crystals and Pb-glass blocks at JLab, are being assembled
- Plan for cosmic ray testing in July
- Installation in Hall B in 12/2003
12 GeV Upgrade

12/2002 - Preliminary Design Report - Hall B/CLAS++
01/2003 - PAC23 Upgrade Meeting

CLAS collaboration members in working groups:
Meeting at Jlab: pCDR Working groups
Generalized Parton Distributions* - V. Burkert, C. Hyde-Wright
PDF - High-x Physics - S. Kuhn
Formfactors and GPDs* - P. Stoler
Limits of S.M. of Nuclear Physics - L. Weinstein
Hadronization* - W. Brooks, J.M. Laget
Semi-Inclusive Processes* - H. Avakian, L. Elouadrhiri

Meeting at the Outer Banks:
Detector Upgrade & Physics* - V. Burkert, B. Mecking

*) slides available: http://www.jlab.org/Hall-B/xxxxx
Very positive reaction of the extended PAC23 to the Hall B Physics plans and equipment upgrade.

Preliminary PAC23 comments on Hall B Upgrade:

- A major new initiative for Jlab is the study of Generalized Parton Distributions to add a new dimension to our understanding of nuclear structure. Such measurements are ideally carried out with a full acceptance detector designed to identify specific exclusive channels. This can be accomplished by an upgrade to the existing CEBAF Large Acceptance Spectrometer (CLAS).

- The upgrade plan is well matched to the high priority physics goals that are best addressed in a large acceptance apparatus: measurements of GPD’s through DVCS and DVMP, and measurements of spin/flavor PDF’s through inclusive and semi-inclusive electron scattering. The ability to measure neutron structure functions through spectator proton tagging is unique to CLAS++ and essential to the PDF program. The important study of spacetime characterization of hadronization requires the new capabilities of CLAS++.

- Several experimental programs would benefit from a transversely polarized target in CLAS++ and from a tagged real photon facility in one of the existing Halls. We recommend exploring the feasibility of developing these capabilities.
12 GeV Upgrade - cont’d

- Preliminary Conceptual Design Report (pCDR) March ‘03
- NSAC subcommittee on future projects, meeting Feb 15
  - full support for the 12 GeV Upgrade
    - physics program ‘absolutely central’ for the field
    - ready for construction
- NSAC chairman Rick Carstens to visit Jlab in April
- JLab beyond 12 GeV (ELIC and 25 GeV fixed target) => talk by Rolf Ent.
12 GeV Upgrade - cont’d

CLAS++ Central Detector - Prototyping Effort
12 GeV Upgrade - cont’d

CLAS\textsuperscript{++} - Prototyping Effort I

Central Detector:
Tungsten-powder-SciFi calorimeter (Jlab & Norfolk State University, NASA)

Prototype with axial readout of 5,500 fibers under construction

PMTs
Axial fibers
Polar angle fibers
Fiber readout
Tungsten-SciFi
12 GeV Upgrade - cont’d

CLAS$^{++}$ - Prototyping Effort II

Central Detector:
Silicon Strip Vertex Detector

- **Goal**: Build a complete sector, single layer prototype within one year, with help from the BNL instrumentation group
- **Status**: Specifying read-out chip (F. Barbosa)
Central Detector:
Time-of-flight Counters

Kyungpook University

- Setup for tests of timing resolution of short scintillators and fast PMTs.
- Goal: $\delta T \sim 50\text{ psec}$
Conclusions

CLAS is doing well:
- Physics output is accelerating
- Physics scope is broadening
- Proposals receive high ratings
- Interesting instrumentation developments provide basis for future experiments
- Compelling Physics for the 12 GeV Upgrade
- CLAS++ - a good start for detector upgrade

But:
- Need wider distribution of results
- Involve theorists in solving specific problems
- More presence at conferences/workshop

Lurking problem:
- Drift chamber electronics board corrosion
Bernhard,
Thank you for your leadership, inspiration, and foresight!
Bernhard,
Electromagnetic Nuclear Physics would not be what it is today, without your vision!