

# Hall C Research Program



- Have been running experiments since November 1995
- 599 PAC Days run, or 28.5 experiments
- 309 (+50) PAC Days in queue, or 13.8 experiments

*(almost all large-scale installation experiments)*

*(Backlog: 4.4 Years, assuming 70 PAC days/year)*

- 70 Ph.D. Subjects (+ HKS : 75), 51 Ph.D.'s awarded
- 38 refereed publications to date (20 PRL), 5 submitted

*(not including NIM papers)*

- 8 Large Installations to date:  $t_{20}$ ,  $G_E^n$ -98, HNSS,

$G_E^n$ -00,  $G_E^n$ -01, G0 ( $\chi^2$ ), HKS

- ~400 Active users representing 19 different countries
- No collaboration, but steering committee (Beise, Hashimoto, Opper, Van Oers) to represent user community involved in **diverse** Hall C program **dominated by large-installation experiments.**

# Overview of Hall C Experiments

	Number Approved	Number Completed	Days Approved	Days Run	Days To Run
Nucleon and Meson Form Factors/Sum Rules	13+1	5.8 (1.2)	336+27	174 (19)	143+27
Few Body Nuclear Properties	6	4.5 (1.5)	143	99 (44)	0
Properties of Nuclei	11	8.2	178	143	35
N* and Meson Properties	11	8 (1)	132	92 (15)	25
Strange Quarks	4+1	2 (1)	177+(50)	91 (16)	70+(50)
Total	45+2	28.5 (4.7)	966+27+(50)	599 (94)	282+27+(50)

*Estimated HKS as 14/19 days done here*

- 14 (Conditionally) Approved experiments require polarized beam
- 4.6 Experiments removed by jeopardy process: indicated between ()
- Backlog ~ 4.4 years (not counting 50 G0-Backward-II days)
- HKS + Fission + G0-Backward + G0-Backward(II) = 82(+50) days →  
end of 2006 have projected 3.2 year backlog

# Hall C Approved Experiment Summary



## Base Equipment Experiments (1.6 experiments, 16 days):

E04-001	Measurements of $F_2$ and $\mathcal{R}$ on Nuclear Targets	5 days, 1/3 complete
E05-017	Measurement of Two-Photon Exchange in Unpolarized Elastic e-p Scattering	13 days

## Large Installation Experiments beyond HKS (11 experiments, 274 days):

E04-115	G0 Backward Angle Measurements	70 days	A
E04-101	Measurement of the PV Asymmetry for the $\mathcal{N}:\Delta$	0 days	B+
E05-108	G0 Backward Angle Measurements (II)	(50) days	A-
E04-108	Measurement of $G_E^p/G_M^p$ to $Q^2 = 9 \text{ GeV}^2$	40 days	A
E04-019	Measurement of the Two-Photon Exchange Contribution in e-p Elastic Scattering Using Recoil Polar.	18 days	A-
E03-109	Spin Asymmetries on the Nucleon Experiment	27 days	A-
E04-113	Semi-Inclusive Spin Asymmetries on the Nucleon	25 days	A-
E05-101	Helicity Correlations in Wide-Angle Compton Scattering	14 days	A-
E05-008	The Qweak Experiment: A Search for Physics at the TeV Scale via a Meas. of the Proton's Weak Charge	35 days	A
E04-110	The Neutron Electric Form Factor at $Q^2 = 4.3 \text{ GeV}^2$ from the $D(e, e' n)$ Reaction via Recoil Polarimetry	25 days	A-
E05-115	Spectroscopic Investigation of Hypernuclei in ... (II)	20 days	A-

# Hall C PAC-25/26/27/28 Summary



<i>PAC 25:</i>	<i>Days Requested</i>	<i>155 days ( 9 experiments)</i>
	<i>Jeopardy</i>	<i>0 days ( 0 experiments)</i>
	<i>Approved</i>	<i>23 days ( 2 experiments)</i>
<i>PAC 26:</i>	<i>Days Requested</i>	<i>257 days (11 experiments)</i>
	<i>Jeopardy</i>	<i>110 days ( 4 experiments)</i>
	<i>Approved</i>	<i>160 days ( 5 experiments)</i>
<i>PAC 27:</i>	<i>Days Requested</i>	<i>271 days ( 7 experiments)</i>
	<i>Jeopardy</i>	<i>23 days ( 1 experiment)</i>
	<i>Approved</i>	<i>48 days ( 2 experiments)</i>
<i>PAC28:</i>	<i>Days Requested</i>	<i>172 days (4 experiments)</i>
	<i>Jeopardy</i>	<i>9 days (1 experiment)</i>
	<i>Approved</i>	<i>34 days (3 experiments)</i>
		<i>+50 days not in books</i>
<i>Over last four PAC's:</i>	<i>25 + 135 + 23 + 9 days to approve</i>	
	<i>155 + 257 + 271 + 172 days requested</i>	
	<i>→ about 22% can be approved (31% was approved)</i>	

# Spin Asymmetries on the Nucleon Status

Now encompasses two experiments:

E03-109 "SANE" (Rondon, Choi, Mezziani):  $g_1$  &  $g_2$  at  $Q^2 = 4 \text{ GeV}^2$

E04-113 "Semi-SANE" (Bosted, Day, Jiang, Jones): Semi-Inclusive Spin Asymm.

Designed to be insensitive to backgrounds and have good Particle Id. Target field screens much of low-energy background.

Gas Cherenkov (Temple)

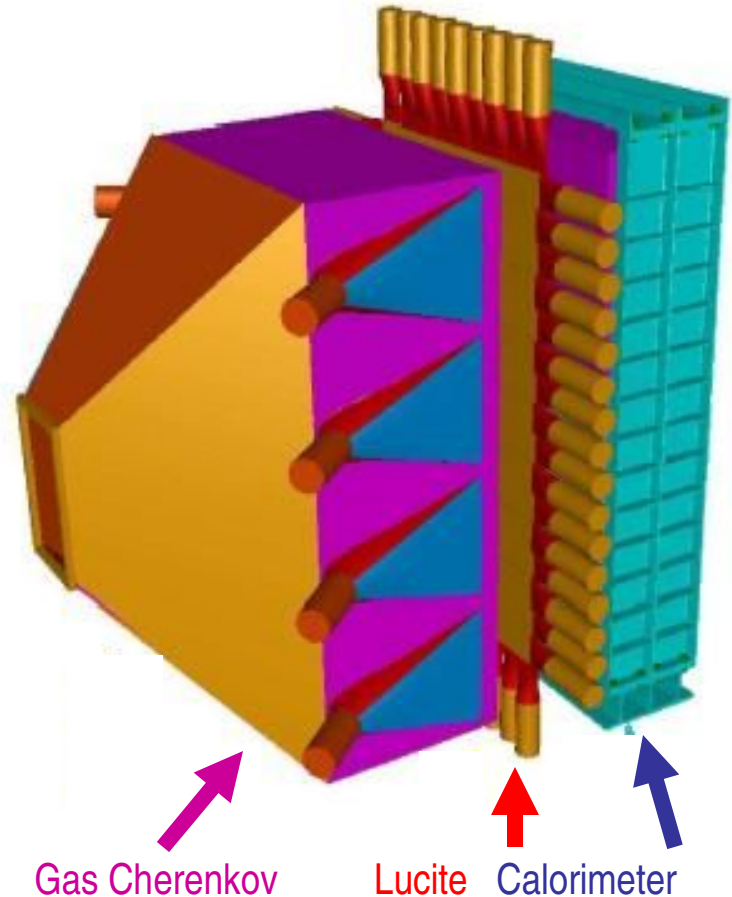
- Particle identifications ( $e/\pi$ )
- Minimal knock-on
- Prototype tested in Hall C
- Design & Construction Now

Lucite Cherenkov (Norfolk State)

- Redundant P.Id. + coarse tracking
- Quartz detector as a Hodoscope before gas Cherenkov under consideration for  $e^+ / e^-$  separation

Pb-Glass Calorimeter from GEp-III

- Add gain monitoring system (UVa)



**Scattering Chamber under design, close to final**

**Uniform polarized target raster R&D completed, construction ongoing**

*In September 2003, the Department of Energy and the National Science Foundation charged the Nuclear Science Advisory Committee (NSAC) to provide an assessment and recommendations to the Office of Science regarding performance measures for the Nuclear Physics Program. The performance measures are intended to focus on outcomes and meaningfully reflect the purpose of the program, to guide program management and budgeting, and to promote results and accountability.*

### *From DOE Performance Measures:*

*Measure the lowest moments of the unpolarized nucleon structure functions (both longitudinal and transverse) to  $4\text{GeV}^2$  for the proton, and the neutron, and the deep inelastic scattering polarized structure functions  $g_1(x, Q^2)$  and  $g_2(x, Q^2)$  for  $x=0.2-0.6$ , and  $1 < Q^2 < 5 \text{ GeV}^2$  for both protons and neutrons.*

*[2011, Hadronic Physics]*

*also related to:*

*Perform lattice calculations in full QCD of nucleon form factors, low moments of nucleon structure functions and low moments of generalized parton distributions including flavor and spin dependence.*

*[2014, Hadronic Physics]*



# “Old” Long-Term Experiment Schedule

(assuming continuation of FY05 budgets – shown last SANE meeting)

- 2005
  - Hypernuclear Physics
    - HKS Experiment (Hashimoto, Nakamura, Reinhold, Tang) (1.8-2.0 GeV)
    - Hypernuclear Life Time Experiment (Hu, Margaryan, Tang)
  - Transition to E04-115 Experiment (Beck, G0 Backward)
- 2006
  - G0 Backward Run (0.8 GeV)
  - Transition to E04-108 Experiment
  - GEp-III Run (Perdrisat, Brash, Jones, Punjabi)
    - 2- $\gamma$  Exchange Run intermixed?
- 2007
  - HMS/SOS L/T Runs? (Bodek, Christy, Keppel)
  - Polarized Target Runs
    - SANE ( $g_2$  at high  $Q^2$ ) Run (Rondon, Mezziani, Choi)
    - Semi-SANE (flavor decompositions) Run (Jiang, Bosted, Day, Jones)
- 2008
  - Qweak (Bowman, Carlini, Finn, Kowalski, Page) Phase I
  - GEn Run (Madey, Anderson, Kowalski, Semenov)
  - Qweak (Bowman, Carlini, Finn, Kowalski, Page) Phase II?
- 2009
- 2012? Start 12-GeV Program?



# Now Installed in Hall C: HKS



*Delay in startup of HKS experiment, due to multiple of reasons:*

- Mechanical installation “finalized” last day before lockup.
- *Lack of technical manpower shows*, but \*did\* get a lot of help from Accelerator Division groups.
- No time for full checkout of many parts, like magnets at full current, beam diagnostics, ion chambers, etc.
- Some beam diagnostics parts not in until week later. Some didn't work.
- *Complexity of beam line chicane* with many magnets and fringe fields grossly *underestimated*. Beam diagnostics is marginal.
- Part of problems due to three different groups working on various (large) systems with not sufficient manpower full-time dedicated for oversight.
- *New F1-TDC's* came with additional commissioning time, and should have been in more hermetically sealed electronics huts with good cooling.





# *Upcoming Program in Hall C*

<b>DATE</b>	<b>EXP</b>	<b>PROGRAM</b>	<b>SPOKESPERSON</b>
June-September, 2005	E01-011	Spectroscopy Study of Medium to Medium-Heavy Mass $\Lambda$ Hypernuclei	O. Hashimoto, S. Nakamura, J. Reinhold, L. Tang
September-October, 2005	E02-017	Hypernuclear Life Time Experiment	B. Hu, A. Margaryan, L. Tang
October 2005-March, 2006		G0 Backward Experiment Installation	
March-December	E04-115, E05-108	G0 Backward Angle Measurement	D. Beck
March-December (parasitic with E04-115)	E04-101	Parity-Violating Asymmetry in the N- $\Delta$ Region	N. Simicevic, S. Wells

*Schedule has shifted by ~3 months compared to previous version, due to:*

- 2) More running time for HKS to compensate for difficult startup.*
- 3) G0 backward installation now 5 instead of 3 months:*
  - a) Installation schedule untenable with only 5 techs.*
  - b) G0 shielding more complicated, and could not be prepared with the limited manpower.*



# Long-Term Experiment Schedule

(taking into account a ~3-month delay in the HKS/G0 schedules, this is the version pre-PAC-28)

- 2005
  - Hypernuclear Physics
    - HKS Experiment (Hashimoto, Nakamura, Reinhold, Tang)
    - Hypernuclear Life Time Experiment (Hu, Margaryan, Tang)
- 2006
  - Transition to E04-115 Experiment (Beck, G0 Backward)
  - G0 Backward Run (0.8 GeV & ~0.4 GeV)
- 2007
  - Transition to E04-108 Experiment
  - GEp-III Run (Perdrisat, Brash, Jones, Punjabi)
    - 2- $\gamma$  Exchange Run intermixed?
  - HMS L/T Runs? (Arrington, Bodek, Keppel)
- 2008
  - Polarized Target Runs
    - SANE ( $g_2$  at high  $Q^2$ ) Run (Rondon, Mezziani, Choi)
    - Semi-SANE (flavor decomposition) Run (Jiang, Bosted, Day, Jones)
    - Helicity in WACS Run? (Day, Wojtsekhowski)
- 2009
  - Qweak (Bowman, Carlini, Finn, Kowalski, Page) Phase I
  - GEn Run (Madey, Anderson, Kelly, Kowalski, Semenov)?
- 2010
  - Qweak (Bowman, Carlini, Finn, Kowalski, Page) Phase II?
  - HKS(II) Run?
- 2012?
  - Start 12 GeV program?



## *Summary:*

- *Reduction of technical crew by almost two has caught up with large installations:  
HKS installation barely in time → no quality checkout before start HKS.  
Can't do professional job of preparing well for next experiments, e.g. G0.  
Direct impact: (far) longer installation times, and delay of 2005/2006  
schedule by about 3 months.*
- *Hall C physics program is now essentially **only** large-installation experiments.*
- *Worry about capital funds and beam time needed to finalize large installations in  
reasonable time frame.*
- *Can only finalize experimental program in reasonable time scale if*
  - 1) *Sufficient Capital funds to keep large installations moving.*
  - 2) *Sufficient technical manpower to prepare installations well, saving  
largely on actual installation times.*
  - 3) *Schedule large-installation experiments as large blocks of time.*
  - 4) *Need to run at least 70 PAC days per year.*
- *SANE specific: will purchase new scattering chamber early in FY06, construction  
of polarized target raster systems ongoing, anticipated scheduling date 2008?*
- *SANE experiment essential to fulfill DOE Performance Measure milestone by 2011.*