SANE
Spin Asymmetries on the Nucleon Experiment
(TJNAF E-03-109)

SANE Collaboration
U. Basel, Florida International U., Hampton U., Norfolk S. U., IHEP-Protvino, Rensselaer Polytechnic I., Temple U., TJNAF, U. of Virginia, College of William & Mary, Yerevan Physics I.

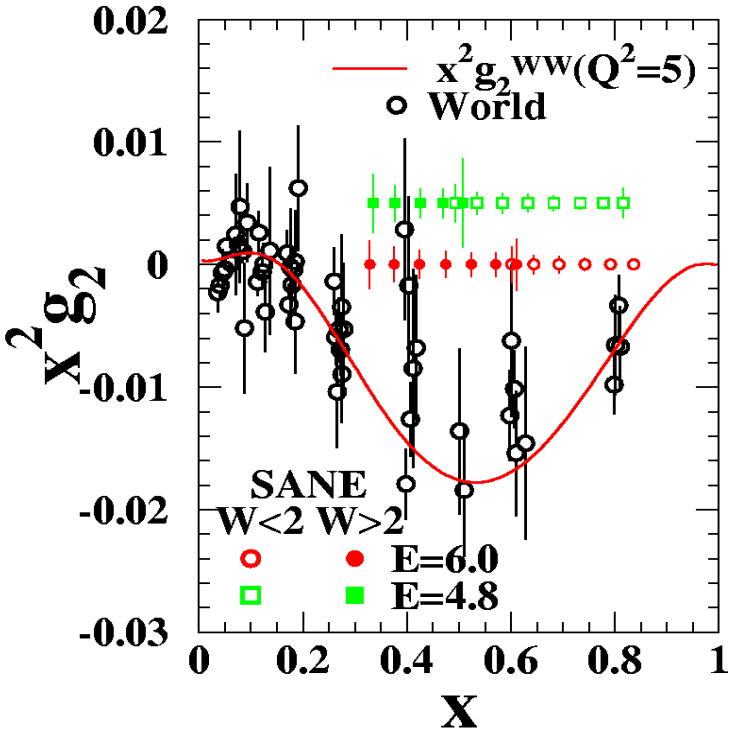
Spokespersons: S. Choi (Seoul), Z-E. Meziani (Temple), O. A. Rondon (U. of Virginia)

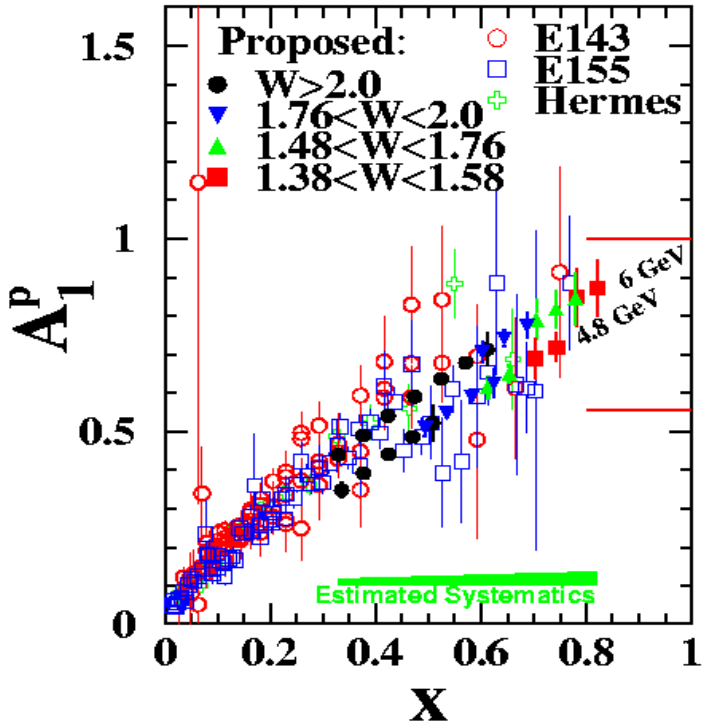
Hall C Users Meeting
January 8, 2005
Jefferson Lab

SANE Physics

- Measure proton spin structure function $g_2(x, Q^2)$ and spin asymmetry $A_1(x, Q^2)$ at four-momentum transfer $2.5 \leq Q^2 \leq 6.5$ GeV^2 and Bjorken x $0.3 \leq x \leq 0.8$
- Goals:
  - Study x and Q^2 dependence of SSF's in poorly measured region
  - Twist-3 effects from moments of g_2 and g_1
  - Comparison with Lattice QCD predictions of twist-3 matrix elements
  - Exploration of "high x" region: A_1 approach to $x = 1$
  - Test polarized local duality for final state mass $W > 1.4$ GeV
- Method:
  - Measure inclusive spin asymmetries for two orientations of target spin relative to beam helicity
  - Detect electrons with large solid angle electron telescope **BETA**

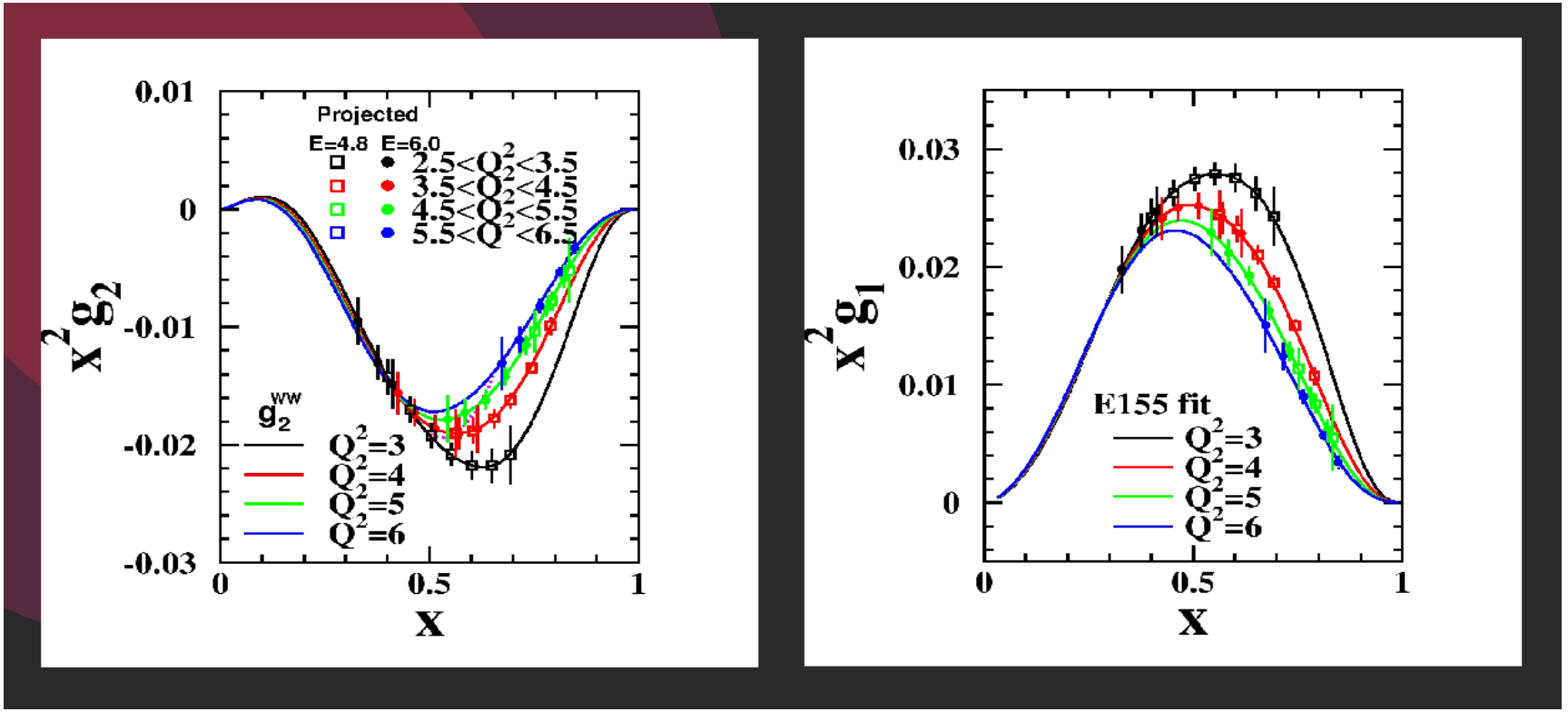
SANE Expected Results





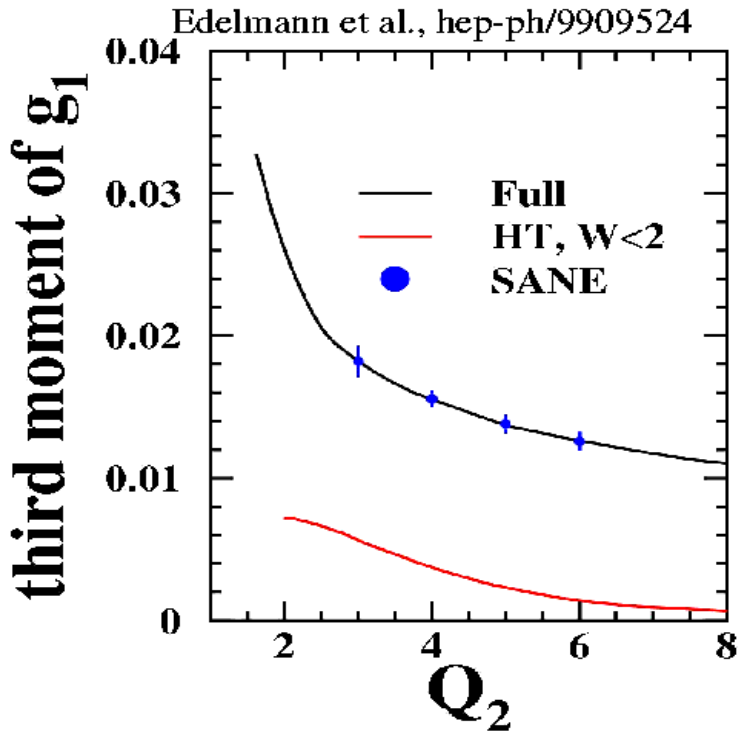
- DIS data for ***x*** up to 0.6 (with 6 GeV)
- Resonance data measured down to $W = 1.38$ GeV: test of spin duality

SANE Expected Results (II)



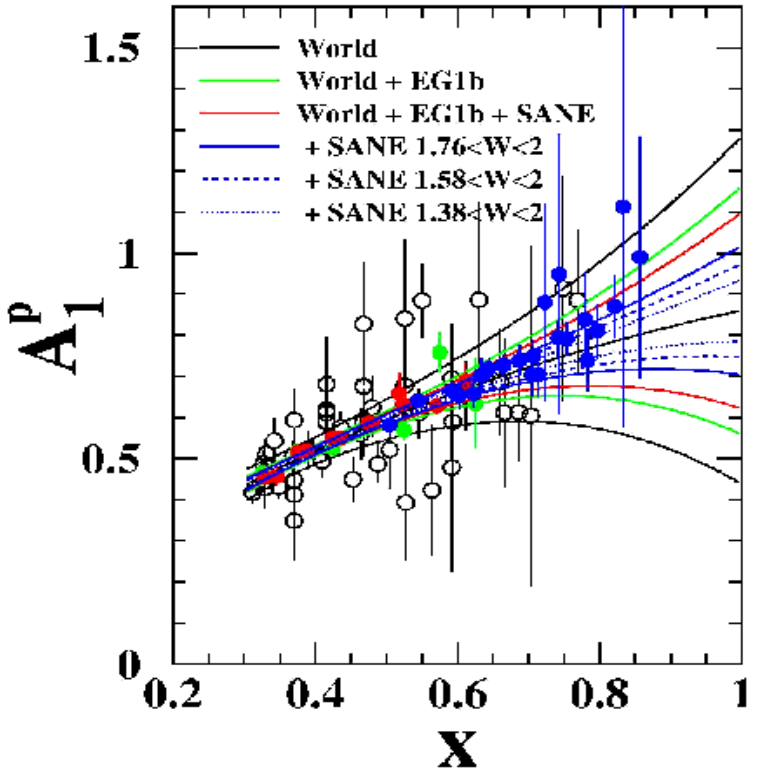
- x dependence at constant Q^2 and Q^2 dependence at fixed x
- data are concentrated in the region most sensitive to $x^2 g_{2,1}$

SANE Expected Results (III)



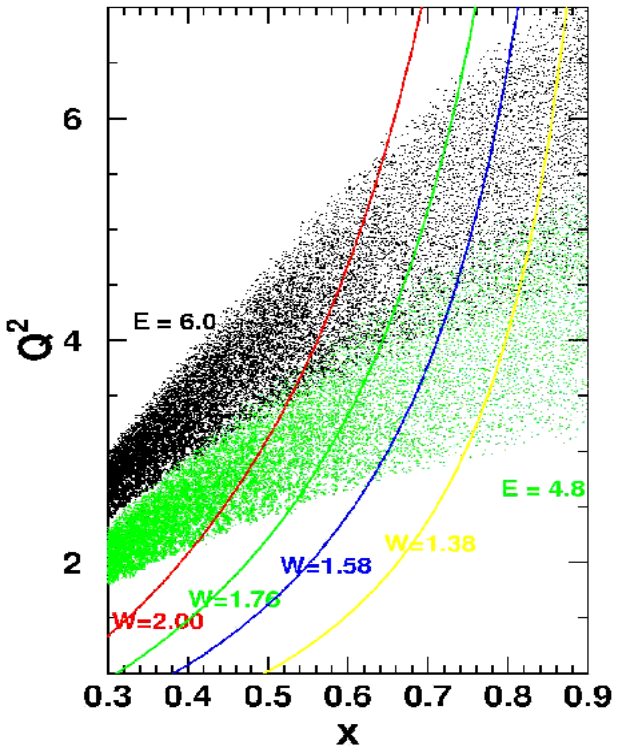
- Twist-3 matrix element $d_2 = \int_0^1 x^2 (2g_1 + 3g_2)\, dx$ calculable in Lattice QCD
- expected error on $d_2(Q^2 = 2.5 \text{ to } 6.5 \text{ GeV}^2) = 0.0009$ (½ the current world error)

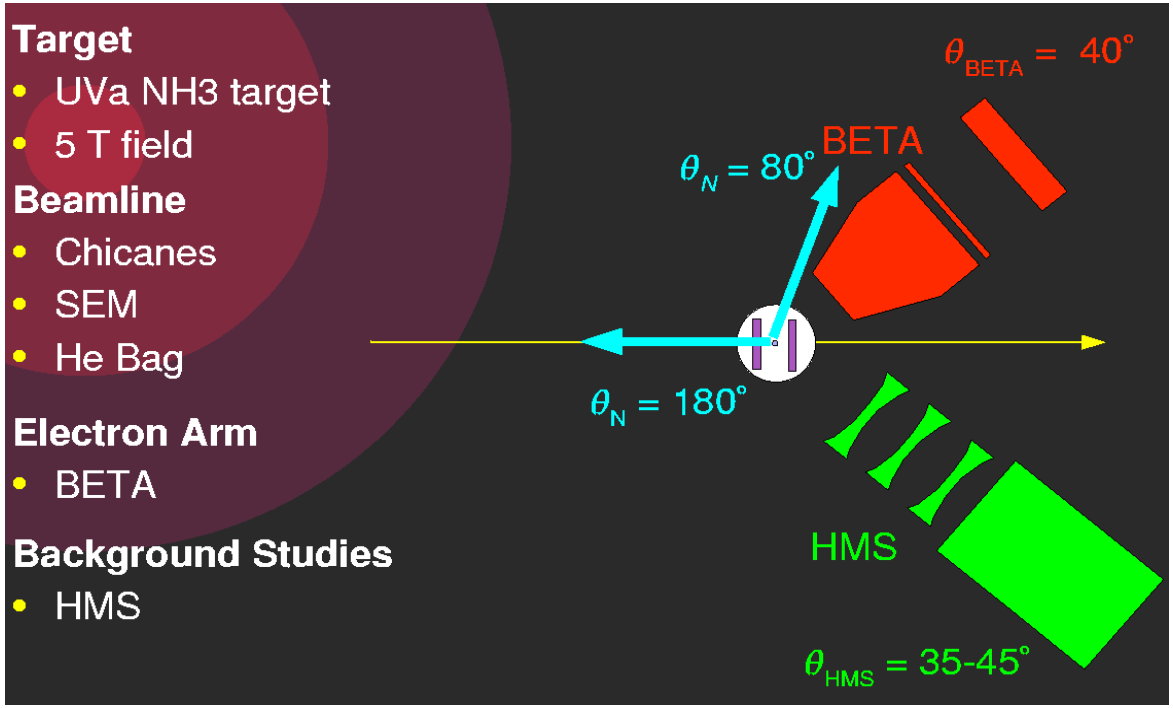
SANE Expected Results (IV)



- Using polarized local duality to explore $\mathbf{A_1^p}$ above $x \sim 0.6$
- Constrain extrapolations of $\mathbf{A_1^p}$ to $x = 1$ within +/- 0.1: distinguish between models

SANE Kinematics and Layout



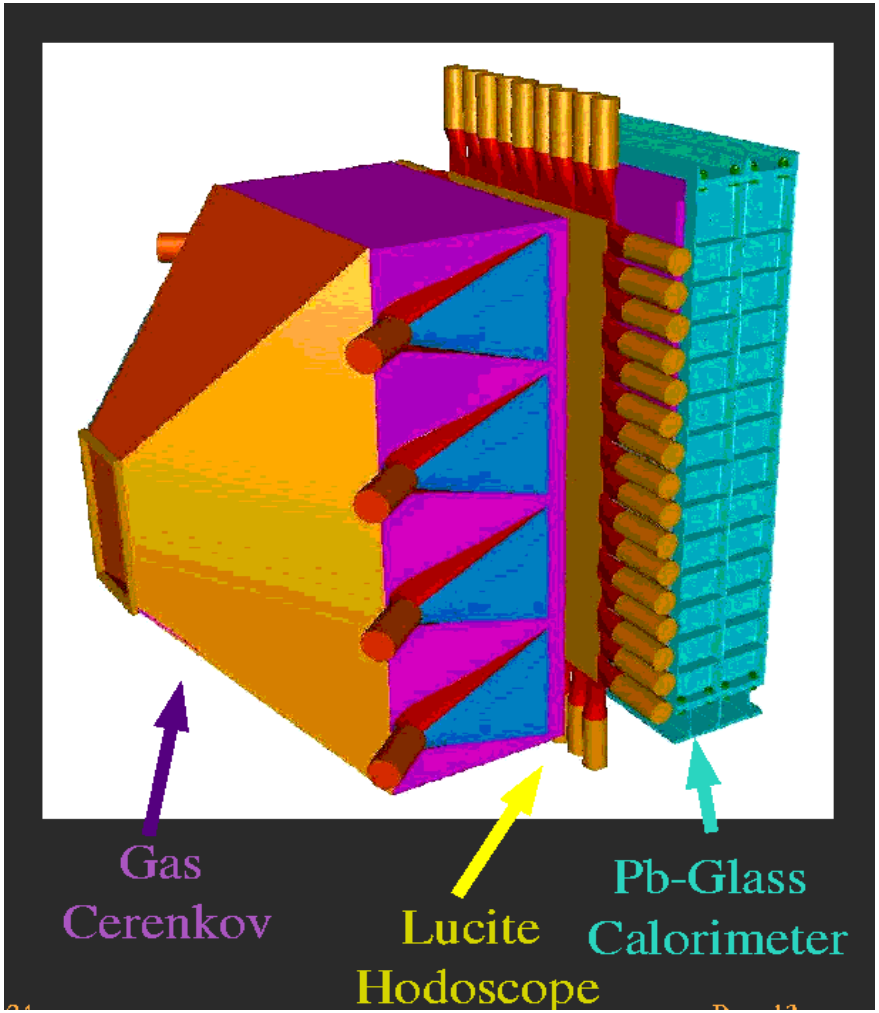


- Two beam energies:
  - **6 GeV**, **4.8 GeV**
- Very good high ***x*** coverage

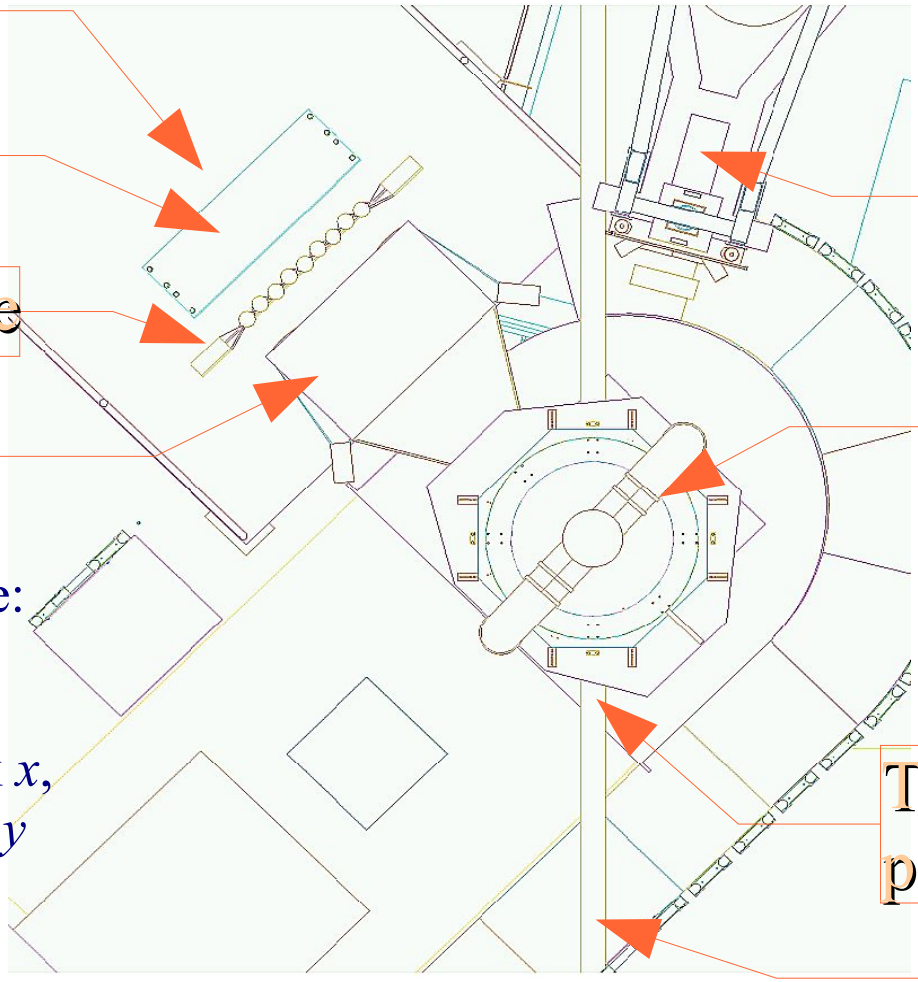
- Hall C facilities
- Target field aligned to measure Parallel and near-Perpendicular asymmetries

Big Electron Telescope Array - BETA

- Three subsystems:
  - BigCal lead glass calorimeter: main detector, being built for ***GEp-III.***
  - Gas Cherenkov (N): additional pion rejection
  - Tracking hodoscope (Cherenkov)
- Target field sweeps low *E* background
- Characteristics of *BETA*
  - Effective solid angle (with cuts) = 0.194 sr
  - Energy resolution $5\%/\sqrt{E}(\mathrm{GeV})$
  - angular resolution = 2°
  - 1000:1 pion rejection

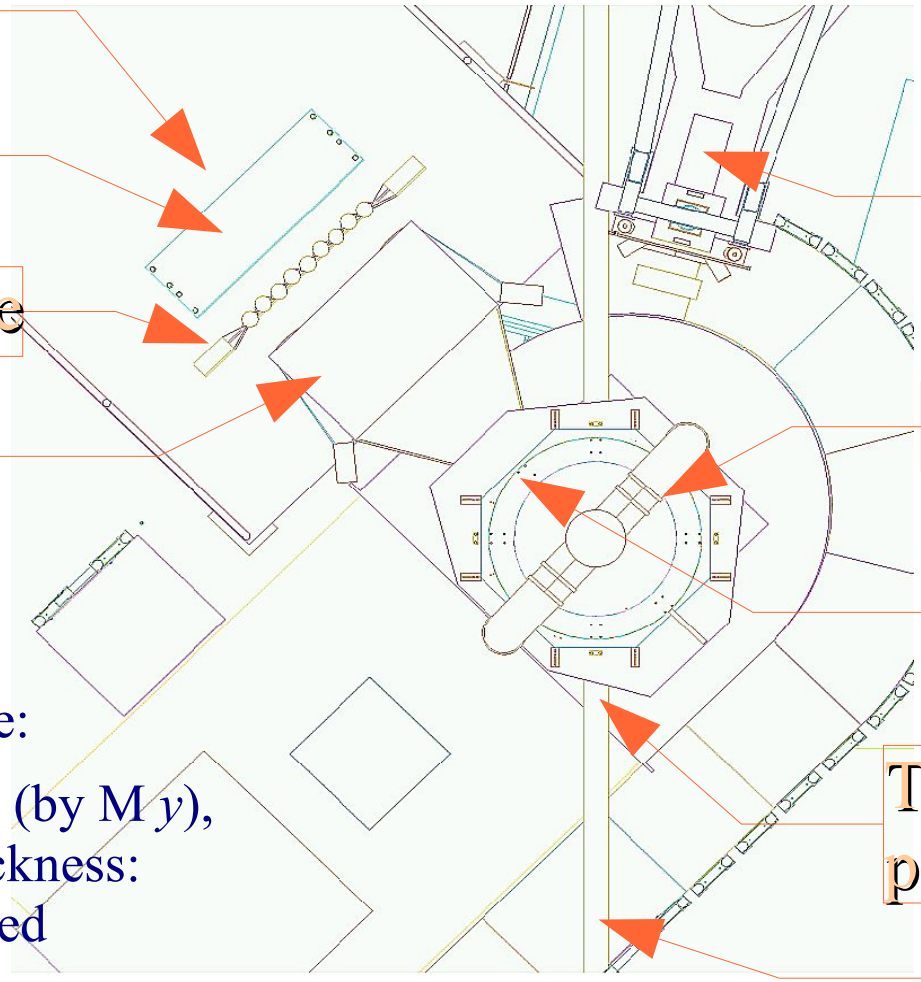


SANE Reference Design



- Lucite Hodoscope:
  - 16 *x* by 8 *y*
  - 1.25 cm thick *x*, 2.5 cm thick *y*
- PMT at each end
- reflective wrap: 10 p.e.'s

SANE Current Design (1/05)



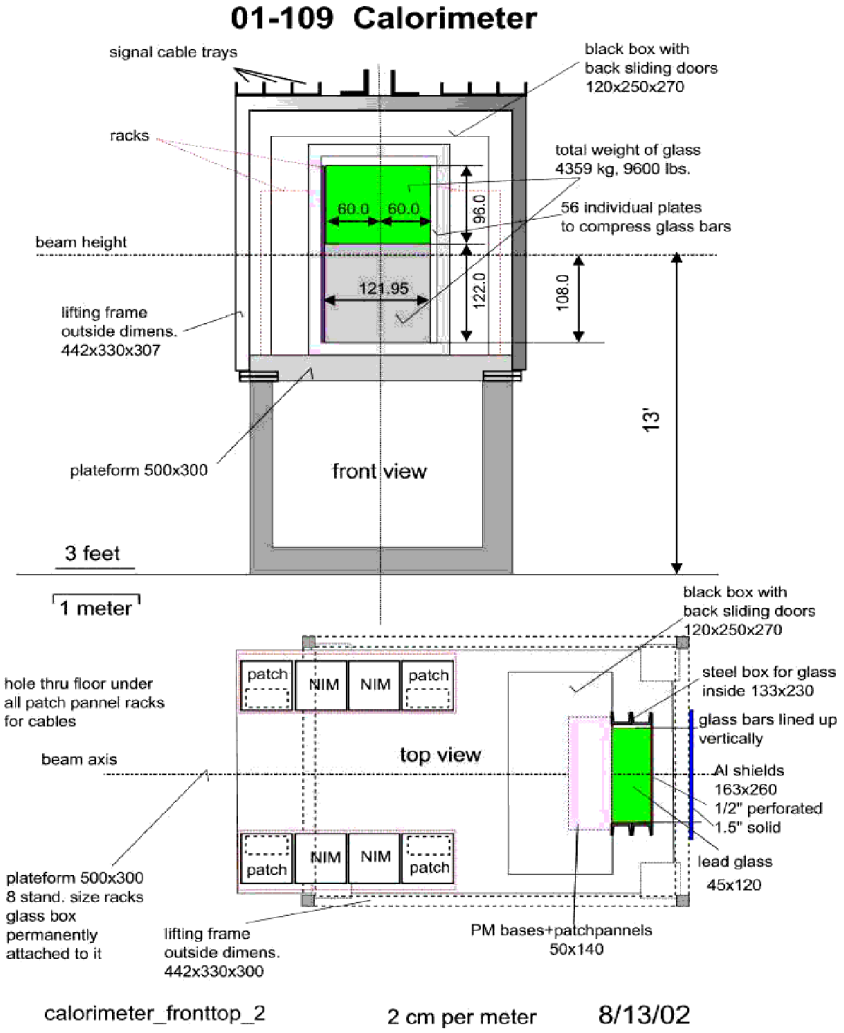
- Lucite Hodoscope:
  - Numbers N *x* (by M *y*), elements' thickness: to be optimized
- PMT at each end

SANE Status - Organization

- Conditional approval by PAC24 for 27 days in Hall C with A- rating
  - experimental verification of energy resolution, pion rejection, tracking
  - tools to check expected rates and backgrounds during commissioning
- Five previous collaboration meetings (11/2003, 3/, 6/, 9/ and 11/2004)
  - Next meeting Friday Jan. 14, 2005.
- Three new collaborator groups since PAC: Florida International U., Norfolk State U., and second U. of Virginia group
- IHEP-Protvino collaborator to work on BigCal 6 mos. starting 3/05
- Hall C schedule (R. Ent):
  - SANE tentatively to run in 1st. half 2007, followed by Semi-SANE
- Time lines show adequate lead time for installation in Fall 2006.
- SANE Web site: http://www.jlab.org/~rondon/sane/

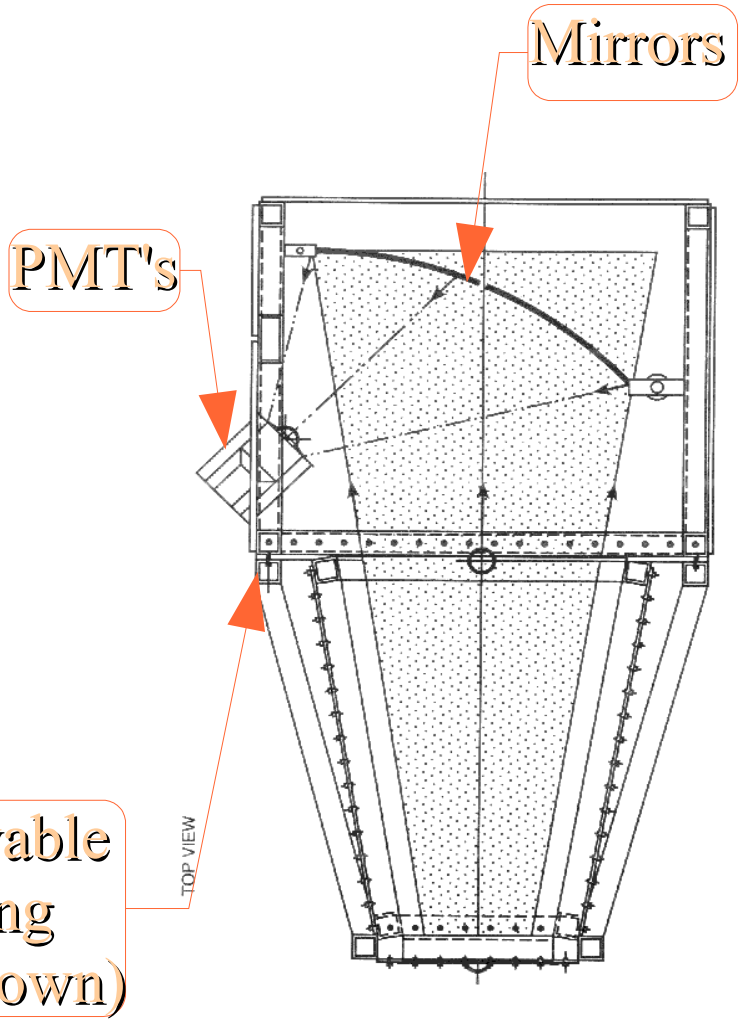
SANE Status - Subsystems(I)

- BigCal Calorimeter for ***GEp-III***
- 1744 lead crystals, all PMT's and bases installed
- 3 platforms: Glass and multiplexers, cables and floor electronics
- Cosmic rays tests partly completed
- Coincidence tests with HMS done
- Work in progress
  - Software readout
  - Calibration
  - Gain monitor
- BigCal collaboration – L. Pentchev, project leader



SANE Status - Subsystems (II)

- Temple U.'s new modular design of gas Cherenkov:
  - 3" PMT's only on side far from beam
  - Mirror section decouples from upstream drift section
- Tests of prototype gas Cherenkov in Hall C
  - Fall 2004 thru Jan. 2005
- Mechanical design nearly complete
- Readout may use flash ADC's (S. Wood report, 6/04)



SANE Status - Subsystems (III)

- Alternative design for tracking hodoscope
  - Located next to target chamber
  - Quartz as Cherenkov material is feasible because of reduced size
  - Much improved tracking resolution vs. reference design
  - SiPM light detectors operate in 1 T fields, but response is above 400nm
  - proposed by Peter Bosted
  - Mahbub Khandaker (NSU) leads project, proposal to Hampton U. F. of P. Center
- Lucite hodoscope not discarded
  - needs redesign, group in charge
  - great opportunity

SANE Status - Subsystems (IV)

- Gain Monitor: Lucite Plate excited by laser light
  - UVA (D. Pocanic's group) built similar for Hall B's RadPhi
  - bench tests of glass response to Lucite light at UVA
  - integration with BigCal in 2005
- Polarized target outer vacuum can (OVC) design under way (UVA polarized target group)
  - windows number, locations and sizes
  - can dimensions
- Integrate OVC with requirements of
  - quartz forward hodoscope
  - *e-p* elastic calibrations and asymmetries measured with HMS
  - Semi-SANE kinematics

SANE Status - Open Issues (= Opportunities)

- Backgrounds and their reduction:
  - from beam line: detailed simulation and shielding design
  - from target: pion and positron rejection/identification
    - improved tracking
    - Pion scintillator wall behind BigCal - group in charge welcome
  - V. Dharmawardane (Hall C) report 1/14/05 on pair symmetric background
- BigCal absolute energy calibration
  - *e-p* elastic scattering with *p* in HMS: kinematics and running time optimization
  - π° mass reconstruction: simulation and on-line code
- Target material: $^{14}NH_3$ or ^{7}LiH?
- Optimization of pair-symmetric asymmetry measurement with HMS