

SANE

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

SANE Collaboration

U. Basel, Florida International U., Hampton U., Norfolk S. U., North Carolina A&T S. U.,
IHEP-Protvino, Kent S. U., U. of Regina, Rensselaer Polytechnic I., St. Norbert College,
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 7, 2006
Jefferson Lab

SANE Status - Organization

- Nine collaboration meetings: 11/03; 3/- 6/- 9/- 11/04; 1/- 4/- 9/- 12/05.
- Seven new collaborator groups since PAC:
 - Florida International U., Norfolk State U., U. of Regina, second U. of Virginia group, North Carolina A&T S.U., St. Norbert College, (WI) and Kent S. U.
- SANE poster for Hall C Open House prepared by
 - Brad Sawatzky and Florentin Butaru (Temple U.)
- Hall C schedule update:
 - 9/04: SANE tentatively to run in 2007
 - 12/05: SANE delayed to 2008 (27 PAC days)
- But:
 - Time lines still showing adequate lead time if run were in early 2007

SANE Physics

- Measure **proton** spin structure function $g_2(x, Q^2)$ and spin asymmetry $A_1(x, Q^2)$ at four-momentum transfer $2.5 < Q^2 < 6.5 \text{ GeV}^2$ and Bjorken x $0.3 < x < 0.8$

**REPORT TO THE
NUCLEAR SCIENCE ADVISORY
COMMITTEE**

**Submitted by the
SUBCOMMITTEE ON PERFORMANCE
MEASURES**

November 18, 2003

2011	<u>Measure the lowest moments of the unpolarized nucleon structure functions (both longitudinal and transverse) to 4 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.</u>
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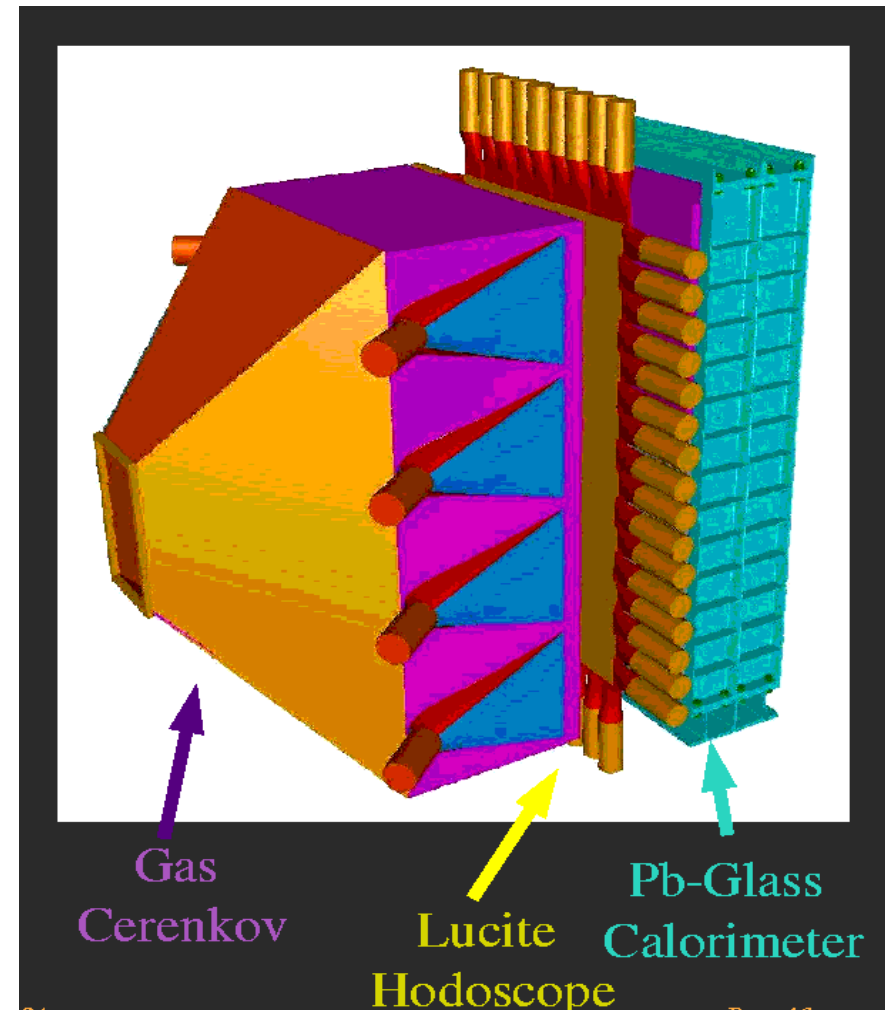
- Meets or Exceeds DOE 2011 Milestone for Proton Spin Structure, IF
 - **SANE takes data no later than 2008**

SANE Physics (II)

- Goal is to learn all we can about proton SSF's from inclusive measurement:
 - Study x and Q^2 dependence
 - Twist-3 effects from moments of g_2 and g_1 , comparison with Lattice QCD
 - Exploration of "high x " region: A_1 approach to $x = 1$
 - Test polarized local duality for $W > 1.4$ GeV
- Method:
 - Measure inclusive spin asymmetries for two orientations of target spin relative to beam helicity (anti-parallel and near-perpendicular)
 - Detect electrons with large solid angle electron telescope **BETA**

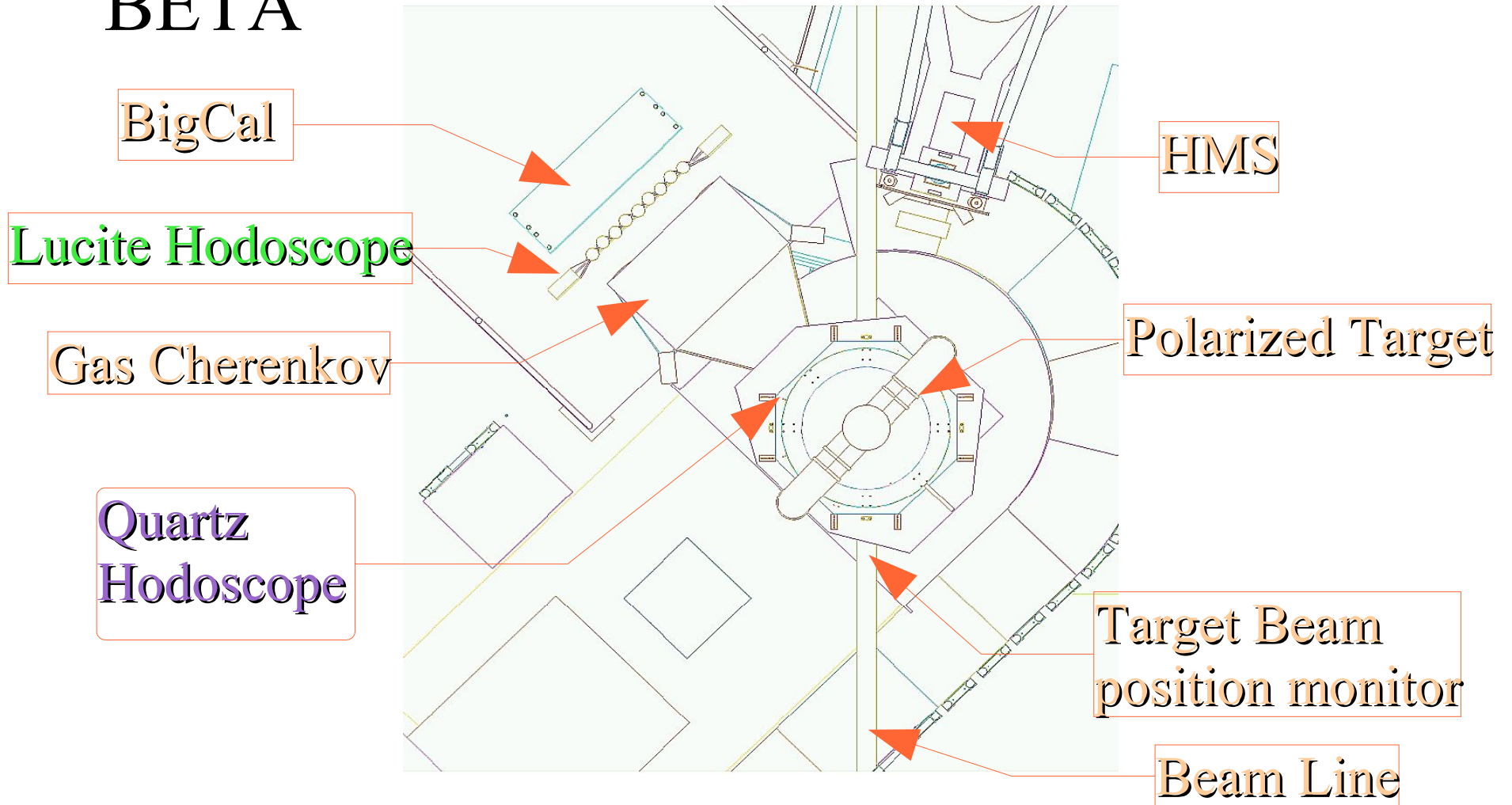
Big Electron Telescope Array - BETA

- BigCal lead glass calorimeter:
main detector, being built for *GEp-III*.
- Gas Cherenkov: additional pion rejection
- Tracking Lucite hodoscope (Cherenkov)
- Target field sweeps low E background
- BETA's characteristics
 - Effective solid angle = 0.194 sr
 - Energy resolution $5\%/\sqrt{E(\text{GeV})}$
 - angular resolution = 2 degrees
 - 1000:1 pion rejection
- Added: front quartz hodoscope (geometry only)
 - vertex resolution ~ 4 mm
 - angular resolution ~ 1 mr



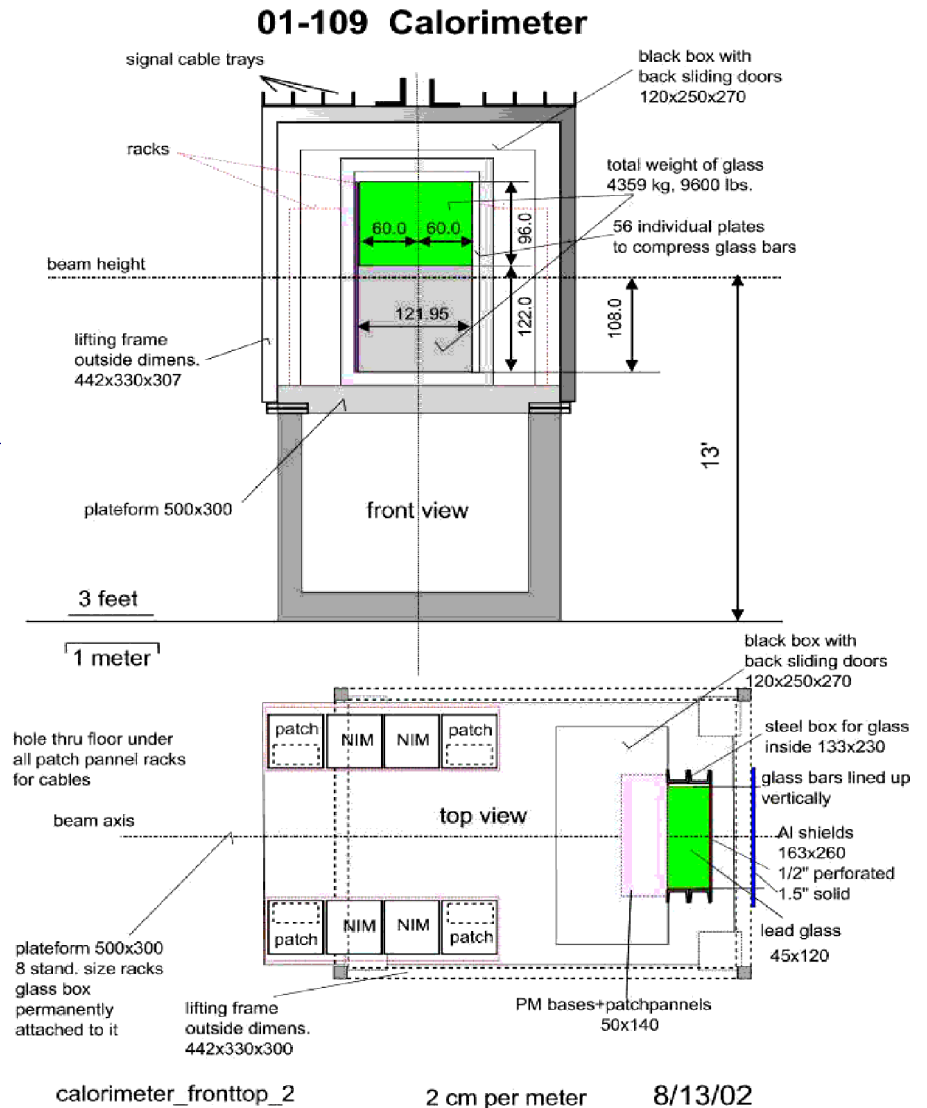
SANE Current Design (1/06)

BETA



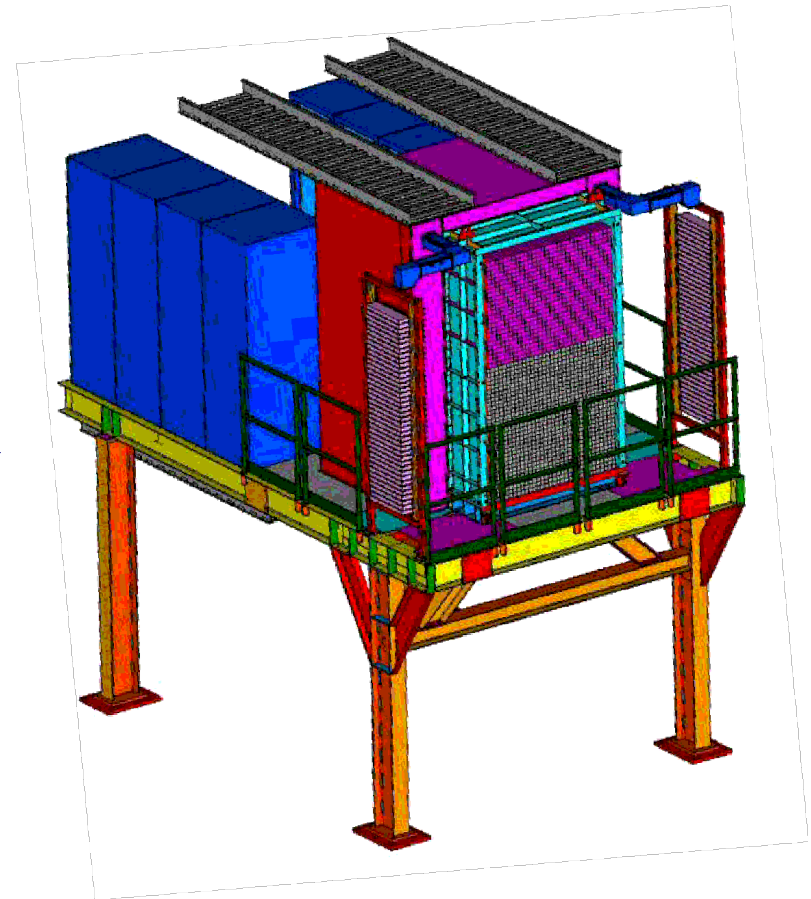
SANE Status – Subsystems(I)

- BigCal Calorimeter for *GEp-III*
- 1744 lead crystals, all PMT's and bases installed
- 3 platforms: Glass and mutilplexers, cables and floor electronics
- Replaced optical grease couplings between PMT and glass with silicone cookies.
- Added permanent perforated Al front plate with 1744 5mm holes
- Completed 2nd. round of cosmic ray tests on Protvino glass, RCS glass in progress
- Three IHEP physicists worked 6 mos. in 2005; two others coming in 2006.



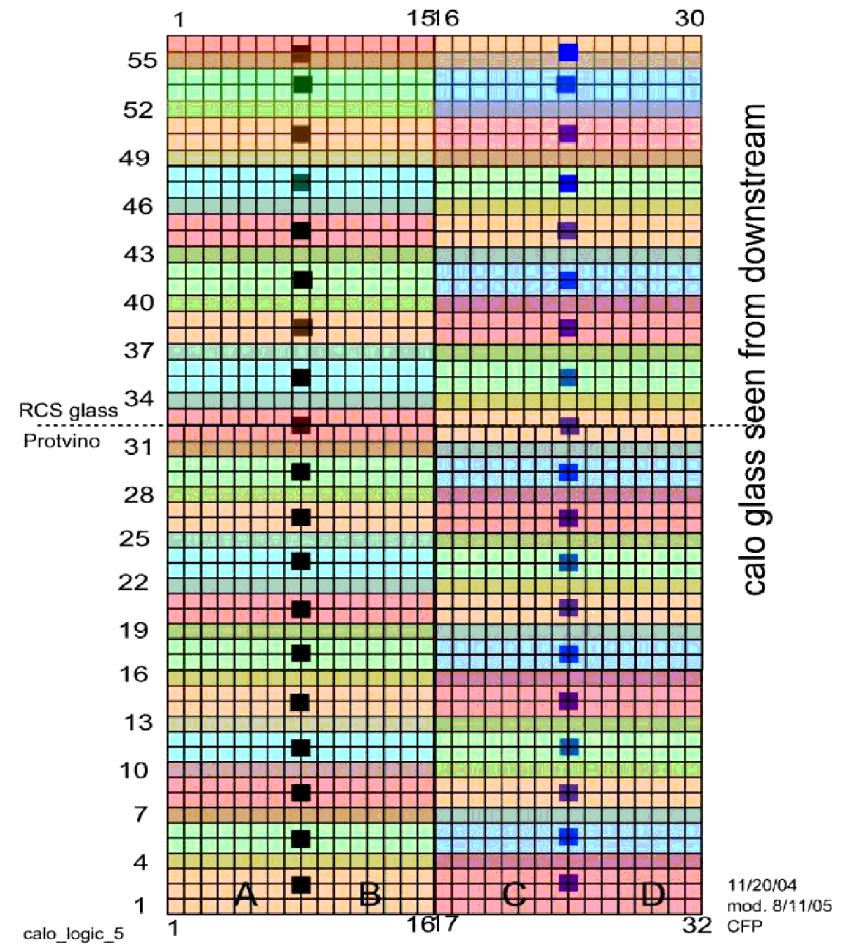
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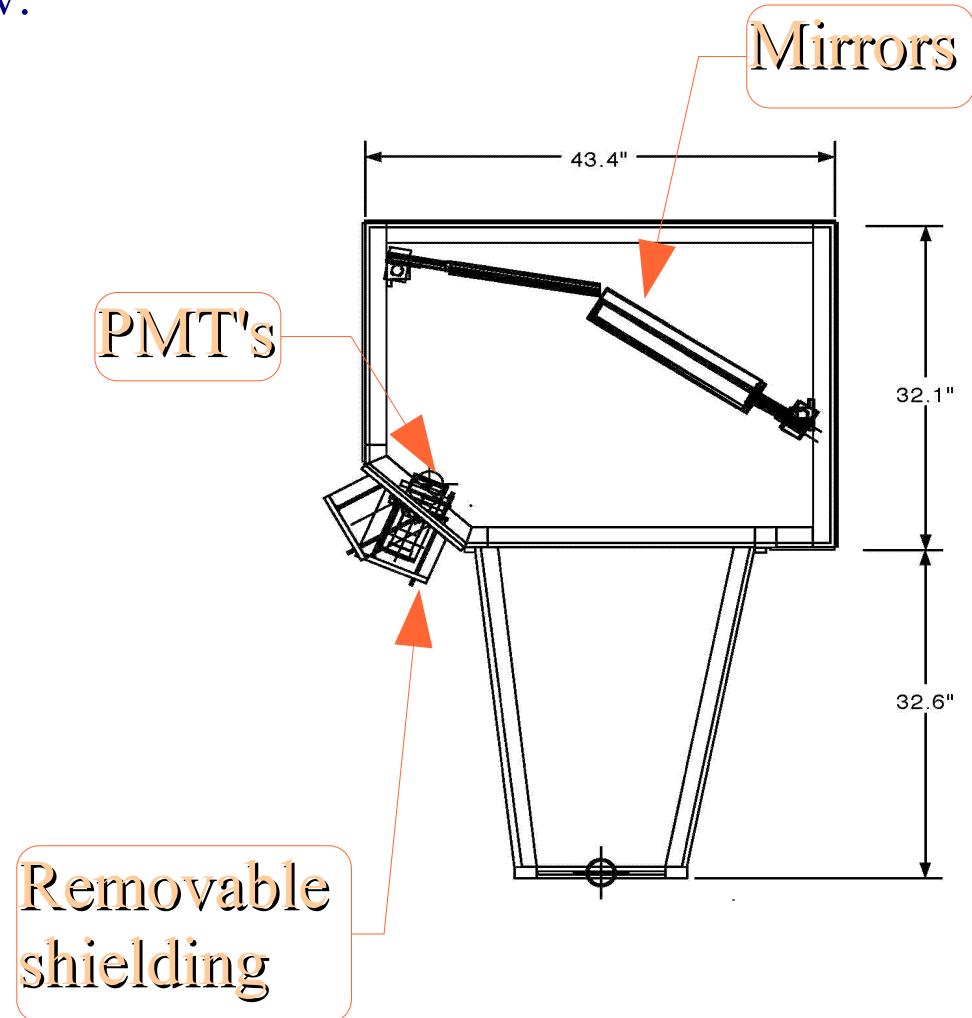
SANE Status – Subsystems(III)

- BigCal Trigger for *GEp-III*:
 - signals from every 8 crystals summed by 244 first summing modules
 - 5x signals to ADC's
 - 1x signals to second level
 - every 8 first modules added in 38 second summing modules.
 - every fourth row duplicated in second summing modules
 - all modules in hand at JLab
- MC trigger simulations (V. Kravtsov) show good efficiency with overlapping groups
- For SANE: integrate P. Degtiarenko particle generator for BETA with IHEP A. Puckett code



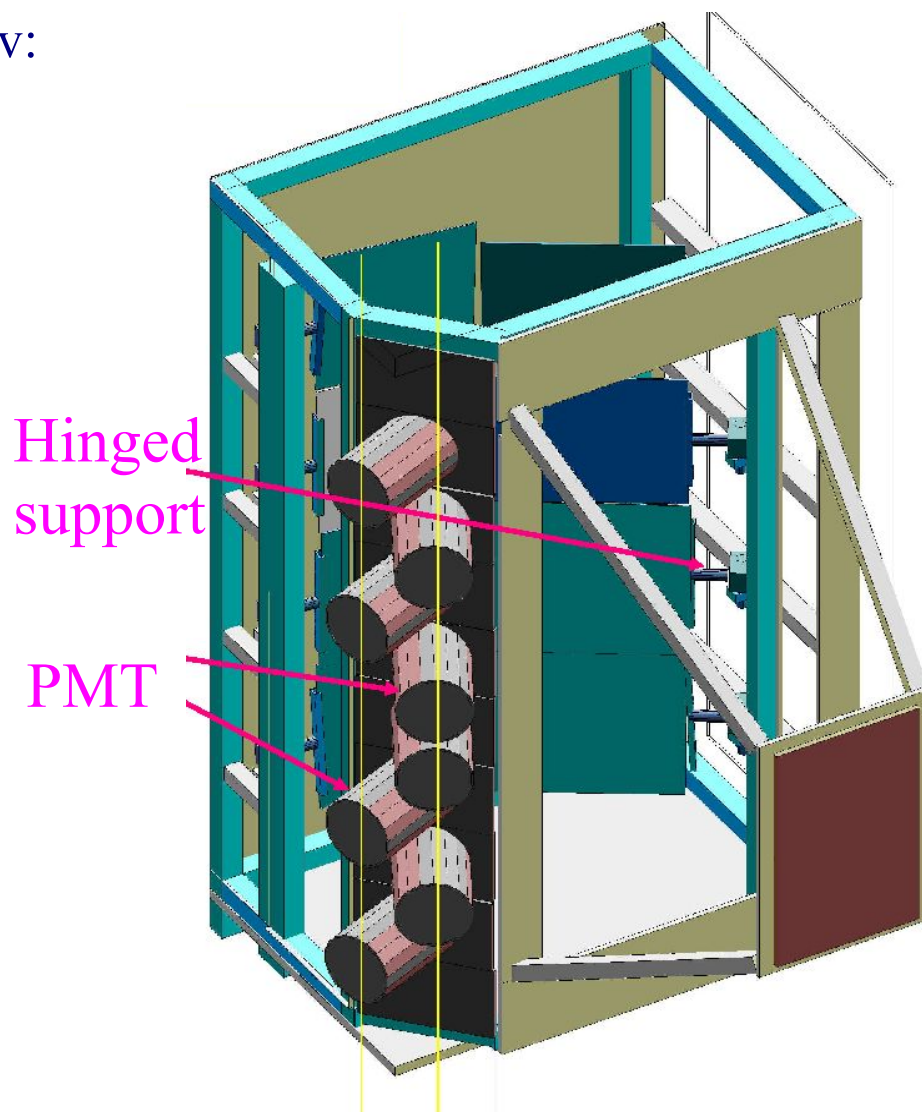
SANE Status - Subsystems (IV)

- Temple U.'s modular design of gas Cherenkov:
 - 4 spherical mirrors
 - 4 elliptical mirrors
 - 8 3" PMT's on side far from beam
 - Mirror section decouples from upstream drift section
 - PMT positions can be adjusted in multiple ways
- Frame being built by Alpha Tool (NJ)



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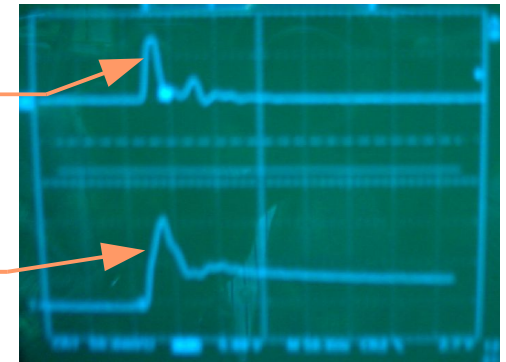


SANE Status – Subsystems (VI)

- Forward tracking hodoscope
 - Next to target OVC, much improved tracking resolution vs. reference design
 - Quartz as Cherenkov material:
 - 36 35x5x3 mm³ vertical bars x 2x64 20x5x3 mm³ horizontal bars
 - SaintGobain Spectrasil 2000 test bars 35x5x3 mm³
 - Attenuation tests using GEp-III setup in EEL
 - SiPM 3x3 mm² light detectors purchased by Hall C for tests, operate at 2 T
 - UVA purchased Channel PM with response in UV, quartz window
- M. Khandaker (NSU) leads project
- P. Bosted proposed device

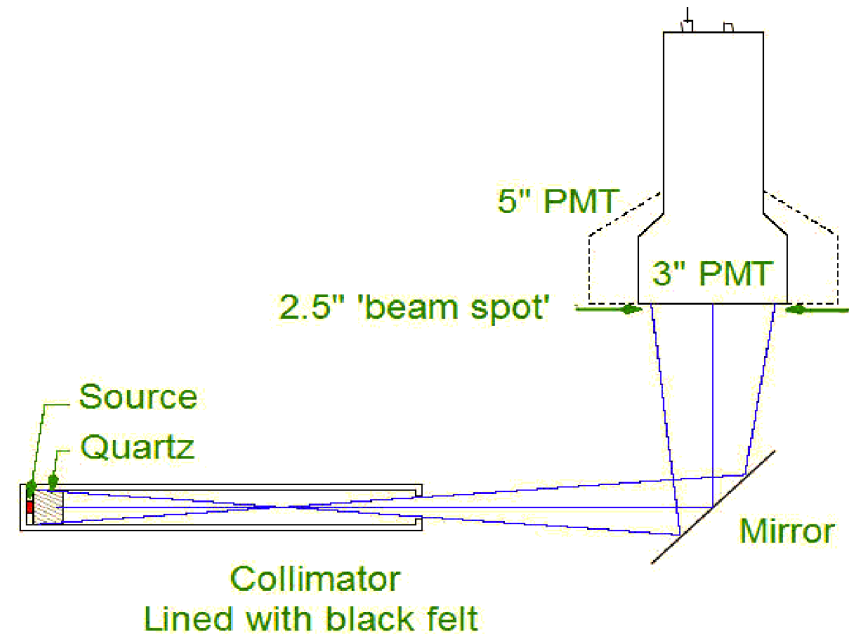
Blue LED pulse

SiPM response



SANE Status - Subsystems (V)

- Tested sample mirror for three gases, N_2 , CO_2 and air, and two PMT types:
 - Burle: ~82% reflectivity (expected)
 - Photonis: ~97% (under review)
- Readout may use flash ADC's (S. Wood report, 6/04)
- Dedicated tests of the Cherenkov are planned during GEp-III

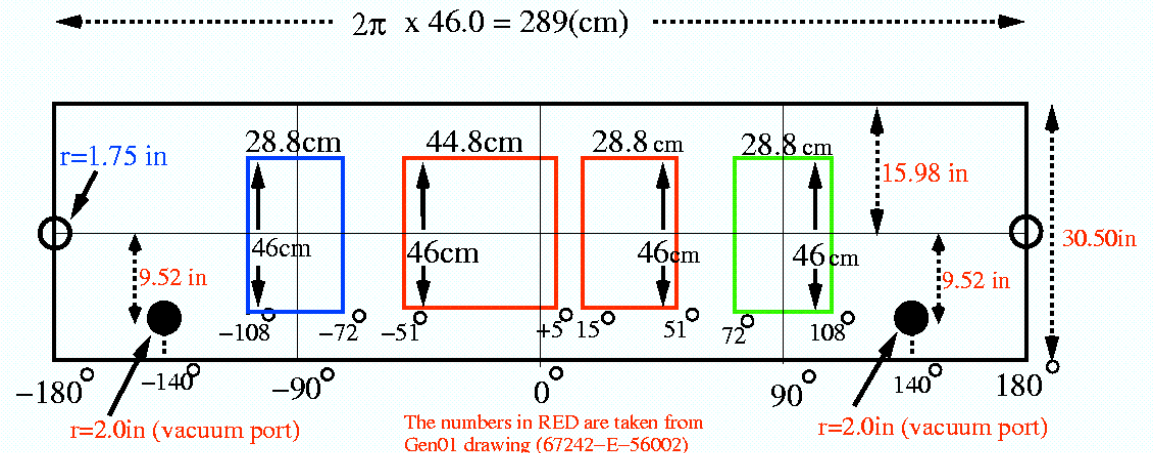
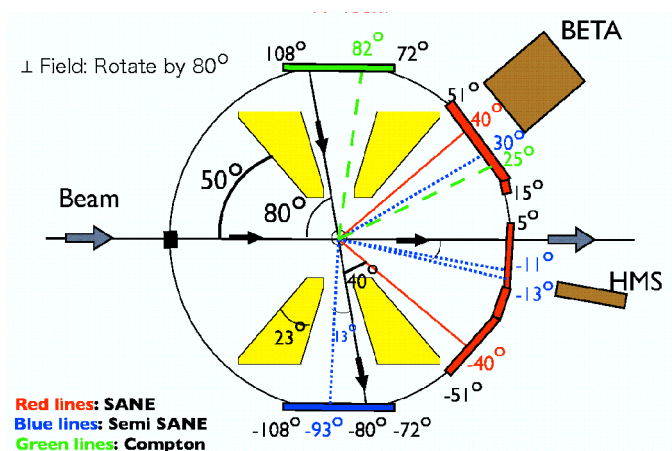


SANE Status - Subsystems (VII)

- Lucite Hodoscope reference design
 - 8 $160 \times 10 \times 1.2 \text{ cm}^3$ vertical bars x 16 $80 \times 10 \times 2.5 \text{ cm}^3$ horizontal bars
- Sam Danagoulian and Abdellah Ahmidouch of N.C. A&T State joined SANE with plan to build hodoscope
- N.C. A&T preliminary design uses 32 5-cm wide, 3.8 cm thick horizontal bars
 - Horizontal position determined from mean timing with 1" PMT's at both ends
 - Improves reference design vertex and angular resolution by better than factor of 2 to 4cm x by 8 cm y RMS vertex and 1° angular resolutions
 - Michael Olson, St. Norbert College (WI) interested in contributing with expertise
 - Kent S. U. graduate students (M. Petratos) will help

SANE Status - Subsystems (VIII)

- Polarized target outer vacuum can (OVC) design completed
 - S. Tajima (UVA) submitted apertures design to Hall C engineering staff
 - Hall C has completed FE analysis of can
 - minimum working thickness is $\frac{1}{4}$ ", recommended $\geq \frac{1}{2}$ ".
 - window thickness under design
- Nitrogen shield apertures design completed, support design in progress
- OVC expected ready for bids by March 2006. **Hall C funds available.**



SANE Status - Subsystems (IX)

- Gain Monitor: Lucite Plate excited by laser light
 - UVA (D. Pocanic'd group) built similar for Hall B's RadPhi.
 - bench tests of glass response to Lucite light at UVA
 - integration with BigCal planned for 2005, postponed for 2006 due to BigCal light coupling and glass shifting
 - E. Frlez (UVA) and IHEP-Protvino will work on gain monitor
- Target Beam Position Monitor (Secondary Emission Monitor):
 - needed to determine beam raster position
 - sent to U. Basel for refurbishing and modification of electronics
 - electronics box will be moved away from above beam line

SANE Status - Progress on Open Issues as of 1/05

- Backgrounds and their reduction:
 - from target: pion and positron rejection/identification
 - V. Dharmawardane reviewed reference estimates, >20% rate for $E' < 1.1$ GeV, reduce background with software cut
 - I pointed out that in given bin of $x-Q^2$ rate is dominated by small angle, high momentum events, so low E' cuts have small impact on statistics
 - P. Bosted: precision $\square\square$ asymmetry possible with 0.7 GeV threshold; can be used to make pair symmetric asymmetry systematics negligible
- BigCal absolute energy calibration
 - $e-p$ elastic scattering with HMS: kinematics and running time optimization
 - G. Huber analysis: 2-3 days of field on (2 polarities) / field off runs, detailed simulations to follow

SANE Status - Open Issues

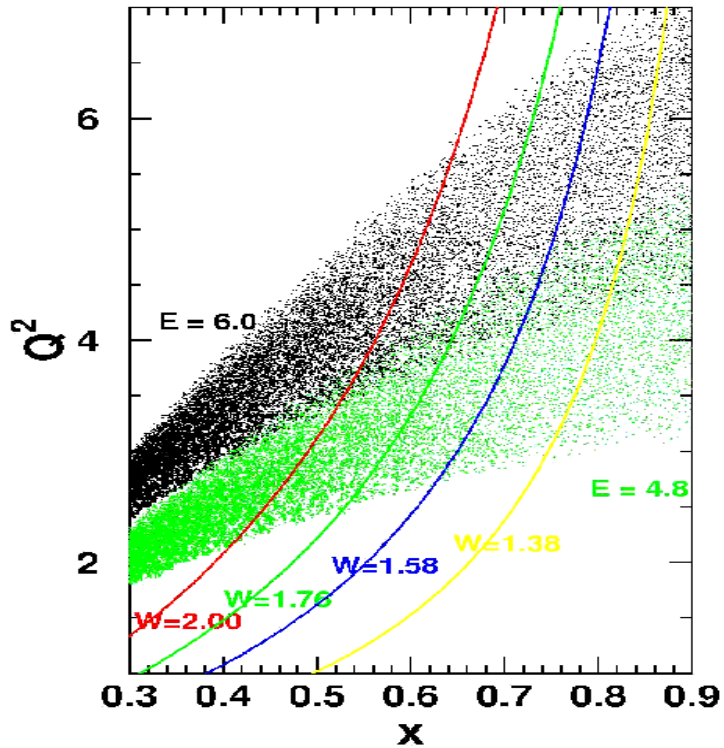
- Backgrounds and their reduction:
 - from beam line: detailed simulation and shielding design:
 - Seonho Choi will direct student at Seoul U.
- BigCal absolute energy calibration
 - □□ mass reconstruction: simulation and on-line code
- Target material: $^{14}\text{NH}_3$ or ^7LiH ?
 - ^7LiH has superior radiation resistance, but in-beam polarization uncertain.
- Target platform design, integration with BETA stands

SUMMARY

Steady progress over 2 years

Could install by year's end if beam schedule allowed

SANE Kinematics



- Two beam energies:
 - 6 GeV, 4.8 GeV
- Very good high x coverage with detector at 40°

