SBS RICH DETECTOR STATUS

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Outline

• HERMES RICH Detector
• Technical Details
• SBS RICH
• Current Status at UConn
• Future Work
Old photo of $\frac{1}{2}$ of the RICH where the aerogel has been removed in order to see the spherical mirror array.
HERMES Design Requirements

- Need to separate pions, kaons, & protons in momentum range 2 - 15 GeV
- Low end determines index of refraction needed for aerogel
  - $n = 1.03$ ($\lambda = 633$ nm) leads to kaon threshold of 2 GeV
- High end is determined by maximum separation momentum for $\pi/K$ in gas
- Well suited for SBS needs
Design Aspects

• Thin 1 mm thick Al entrance window
• Aerogel wall: Tiles stacked in 5 planes, each plane has 17 columns and 5 rows
• UVT-lucite window behind aerogel, dual purpose:
  1. Protect aerogel from $C_4F_{10}$
  2. Absorb UV photons $\lambda < 290$ nm, reduce Rayleigh scattering background noise
• Mirrors: Constructed from 2 rows of 4 Carbon-fiber composite ($R = 2.2$ m), aluminized surface provides reflectivity $> 85\%$ for 300 – 600 nm
• PMT Matrix: 1934 Philips XP1911/UV with a diameter of 0.75”
Philips XP1911/UV PMT Specs

- Radiant sensitivity & converted QE plot, max. sensitivity \( \approx 420 \text{ nm} \)
- Hexagonally packed into a focal plane of dimensions 147.4 x 62.8 cm\(^2\), pixel size 23.3 mm\(^2\)
- Photocathodes alone cover \(~38\%\) of focal plane, add aluminized funnels increases coverage to \(~91\%\)
SBS RICH

- Charged particle identification \((p, \pi^\pm, K^\pm)\) in SIDIS (E12-09-018) in the momentum range \(2 - 10\) GeV with an approximate angular acceptance of \(10 \leq \theta \leq 22\) and \(-60 \leq \phi \leq 60\) degrees
- Located at a central angle of \(14^\circ\), utilizing SBS trackers and HCAL for PID reconstruction (Inverse Ray Tracing)
- Differences between reconstruction using IRT and true emissions angles yield a resolution of \(~8\) mrad, a result dominated by pixel size (photocathode + funnel)
- Will use CDet NINO, 61 HV channels (32 PMT/channel) operating \(~1.35\) kV, and Fastbus 1877s TDCs for readout
RICH at UConn (before)
RICH at Uconn (after) – animation
PMT Array & HV Interface

- 73 columns, rows alternate between 26 & 27 PMTs
- SN #, row, column, and HV group were recorded for each PMT
- Colors above represent a HV group of 32 (sometimes 16 or less) PMTs of presumably similar gain values (testing in progress now)
PMT testing is approximately 60% complete
RICH Status, Challenges and Near-Term Plans, I

- PMT testing at UConn will (mostly) conclude by the end of summer 2016; however:
  - More detailed characterization of a small subset of PMTs will continue as needed
  - Still need to determine expected timing resolution with NINO discriminator output and optimize operating gain for NINO threshold/signal dynamic range
- Need to check/determine status of aerogel as soon as possible, so that if any corrective action is needed, it can happen on a timeline compatible with readiness for SIDIS run (2020? 2021?)
  - It is risky at UConn to open/handle even spare aerogel (much less RICH tank itself), given relatively dirty/dusty and poorly climate-controlled environment, and limited-to-nonexistent technical support. Safer to do at JLab with better infrastructure, technical support.
- **Our opinion**—It will soon become more productive to locate the RICH at JLab—we aim for the move to occur by first-half of 2017 (big renovation and move of entire UConn physics department will start ~fall 2018! RICH = gone well before then).
  - Need to arrange space at JLab for testing and begin planning move
  - UConn group will have local manpower at JLab (1 grad st. (Obrecht) and 1 postdoc starting Fall 2016) → **RICH work can proceed more efficiently at JLab**
RICH Status, Challenges and Near-Term Plans, II

- Detector checkout items:
  - Check aerogel optical properties; refractive index, transparency
  - Alignment of spherical mirror array

- Gas system:
  - Need heavy gas, plan to use C4F10, C4F8O or similar, based on what is available when SIDIS is about to run.
  - Planning for gas system not started; basic idea is to essentially copy GRINCH solution, which is needed sooner

- Front-end electronics:
  - PMT signal cables end in two-pin connectors compatible with CDet version NINO card inputs “out of the box”; BUT:
    - Signal cable is only ~5 feet long (this was a space-saving design to connect to old PCOS4 front-end electronics mounted directly on RICH)
    - NINO card form factor and power consumption probably prohibit mounting directly on RICH—estimate ~760 W power consumption by 121 NINO cards required to fully instrument RICH → we will need new patch panel on RICH, and NINO card mounting close to the RICH

- HV power supply:
  - PMT HV divider draws 40-50 µA, depending on HV ⇐ typical HV supply can power 32 PMTs—need 61 channels of HV power supplies and associated cabling
  - HV distribution boards already exist, with standard SHV connectors to interface to external power supply. These can be reused as-is.
RICH Status, Challenges and Near-Term Plans, III

- DAQ/cabling—Basically copy CDET plans, using NINO front-end cards and Fastbus 1877S TDC readout, potentially with 2 or 3-fold parallel DAQ; i.e., “crate flipping” (no current plan to do ADC readout, since most signals are single-ph.e.). This presents some issues, including:
  - NINO cards (probably) need to be located reasonably close to RICH, due to short PMT cable length
  - Where will FastBus electronics be located (presumably in bunker, far away)?
  - Can the readout electronics for RICH be located close to SBS?
  - If not, do we need to patch NINO discriminator output signals to coaxial cable and back to ribbon cable at the bunker, at significant cost? Can we re-use some existing patch panels/cables for this (i.e., ECAL, which won’t be used in SIDIS)?

- Support structure/installation:
  - SIDIS requires vertically centered, vertically symmetric orientation of detectors.
  - RICH support structure/installation design basically not started. When does it make sense to start?