Forward Tracking Hodoscope for SANE and Semi-SANE

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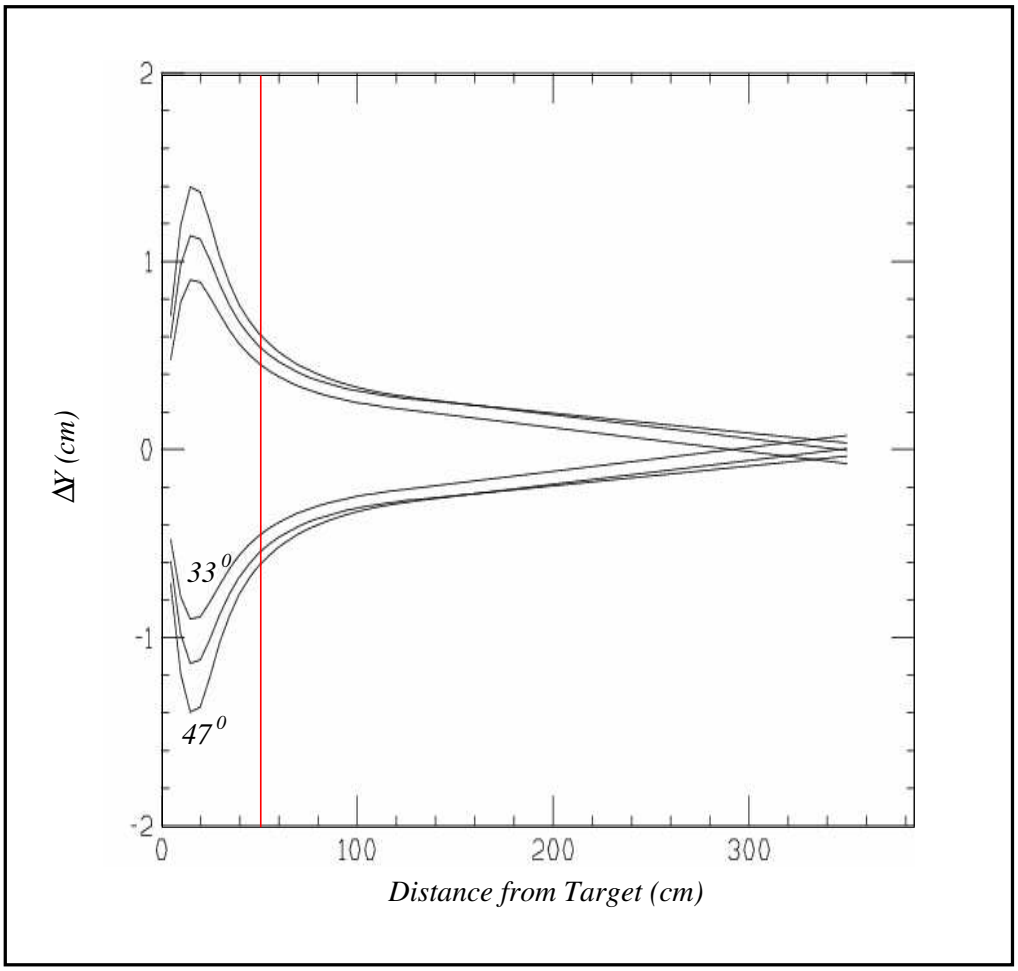
SANE Collaboration Meeting VII

April 21, 2005

Forward Tracking Hodoscope

- ***Purpose and Requirements:***
  - ☐ *Provide redundant and efficient electron detection with limited tracking resolution to suppress background.*
  - ☐ *Reject non-target related backgrounds.*
  - ☐ *Discriminate low momentum positrons from electrons.*
  - ☐ *Measure positron asymmetry for transverse field configuration.*
  - ☐ *Partially reduce positron contamination of electron sample.*
  - ☐ *Locate detector as close to target as possible to reduce knock-on electrons.*
  - ☐ *Detector as thin as possible.*
  - ☐ *Operate in high magnetic field ($\sim$5 kG) region.*

Determination of Particle Sign



- *Plot shows typical vertical excursion Δy of P=1 GeV and infinite P for θ=33 to 47 degrees.*

- *Need position resolution of $\sigma_y \sim 1$–2 mm to determine particle charge sign.*

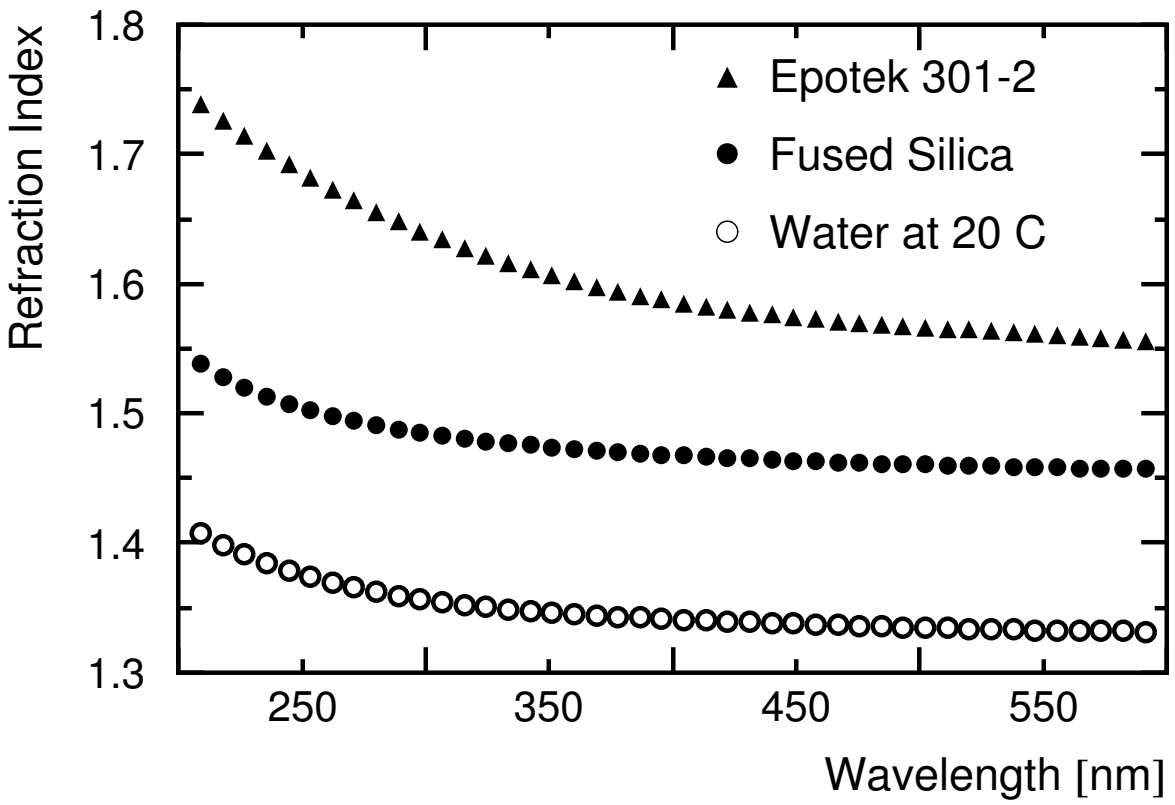
Tracking Hodoscope Proposal

- ***Solid Čerenkov Detector:***
- ***Located 50 cm downstream of target (just outside OVC).***
- ***Material: Synthetic Fused Silica (n=1.473).***
- ***Size: 32 cm (vertical) × 18 cm (horizontal).***
- ***Single bar dimensions:***
  320 mm × 5 mm × 3 mm (vertical)
  180 mm × 5 mm × 3 mm (horizontal).
- ***Position resolution, σ_y ∼1.44 mm. Resolution good enough for reliable sign determination up to ∼1.6 GeV.***
- ***64 bars along vertical and 36 along horizontal.***
- ***Two Y planes offset by 2.5 mm for redundancy and better noise rejection (128 bars).***
- ***One X plane (36 bars).***
- ***Total number of bars, 164.***
- ***Double-ended readout system with SiPM.***

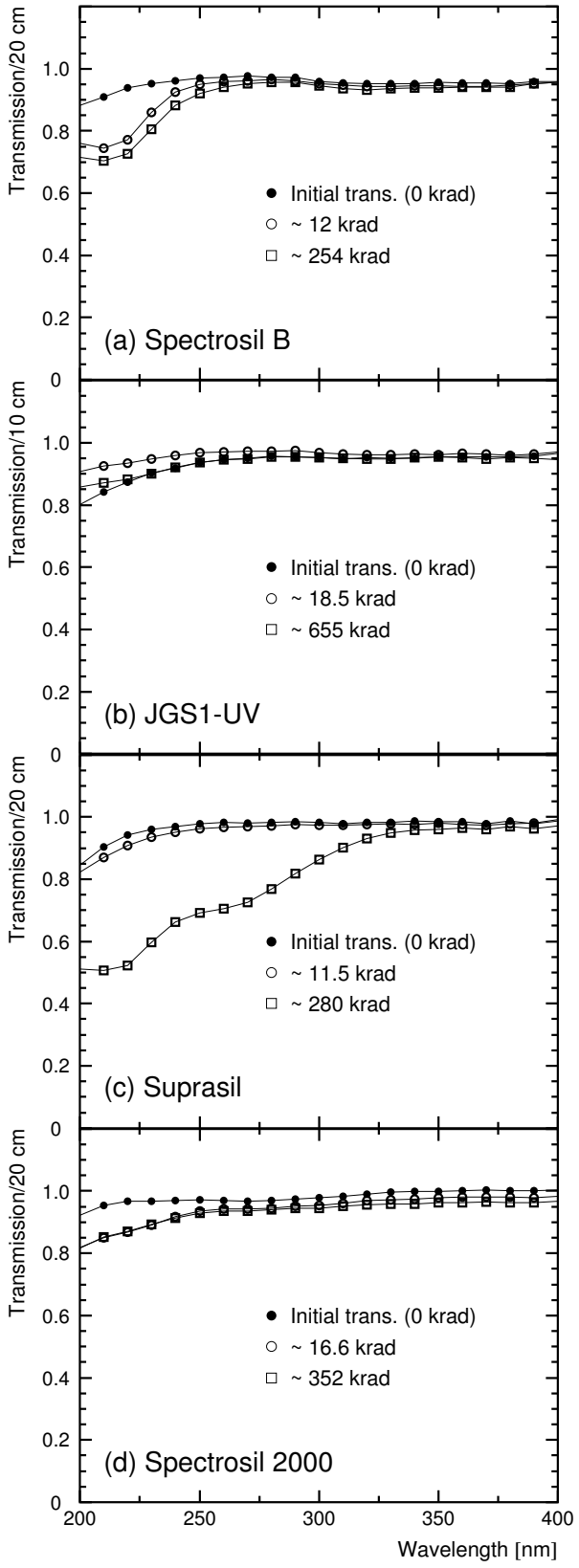
Synthetic Fused Silica Quartz

- *Saint-Gobain Quartz - Spectrosil 2000:*
  - *ultra pure (>99.9999%) synthetic transparent fused silica.*
  - *excellent optical transmission over a wide range of wavelengths, 180 nm (UV) to 3500 nm (IR).*
  - *almost no dependence of refractive index on wavelengths, 300 nm to 600 nm.*
  - *very radiation hard material.*
  - *reasonable cost for material fabrication.*
  - *used in DIRC detector for BaBar at SLAC and proposed for Qweak at JLab.*

Refractive Index vs. Wavelength



Optical Transmission vs. Wavelength



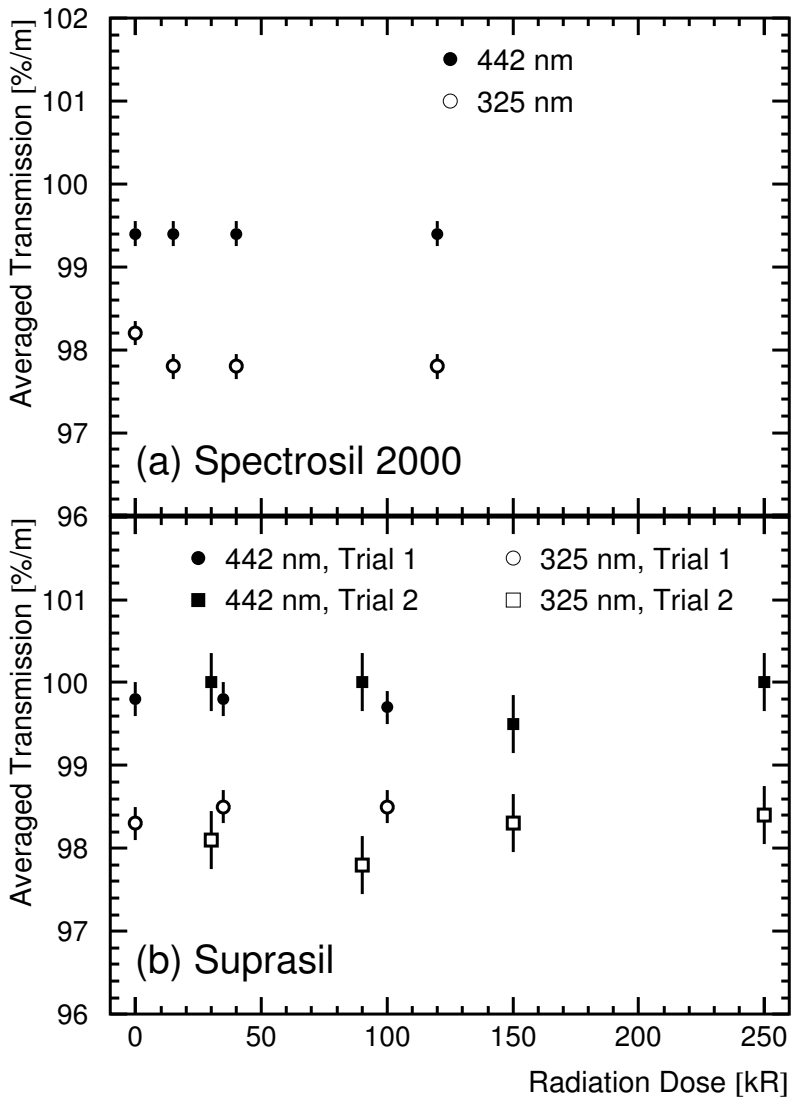
Transmission vs. Radiation Dose

- ***Radiation dose estimate for electrons:***

$$\textbf{Dose } (MeV/g) = \frac{N_e \times dE/dx}{Area}$$

  - ☐ ***assume a rate of*** $\sim 5 \times 10^6$ ***Hz at 50 cm from target:***

$$\textbf{Dose} = 7.5 \times 10^{10}\ MeV/g = 1.2\ krad.$$



Quartz Bars Fabrication Cost

- *Saint-Gobain Quartz - Spectrosil 2000:*
  - $350 \pm 0.25\ mm \times 5 \pm 0.10\ mm \times 3 \pm 0.10\ mm$ *@ \$109/bar = \$14 k.*
  - $200 \pm 0.25\ mm \times 5 \pm 0.10\ mm \times 3 \pm 0.10\ mm$ *@ \$ 98/bar = \$3.5 k.*
  - *Total cost for fabrication ∼\$18 k.*
- *Specialty Glass Products, Inc. of PA ∼\$27 k.*

Budget Estimate

- *Quartz bars ∼$18 k.*
- *SiPM and electronics ∼$27 k.*
- *Total cost ∼$45 k.*