Forward Tracking Hodoscope for SANE and Semi-SANE

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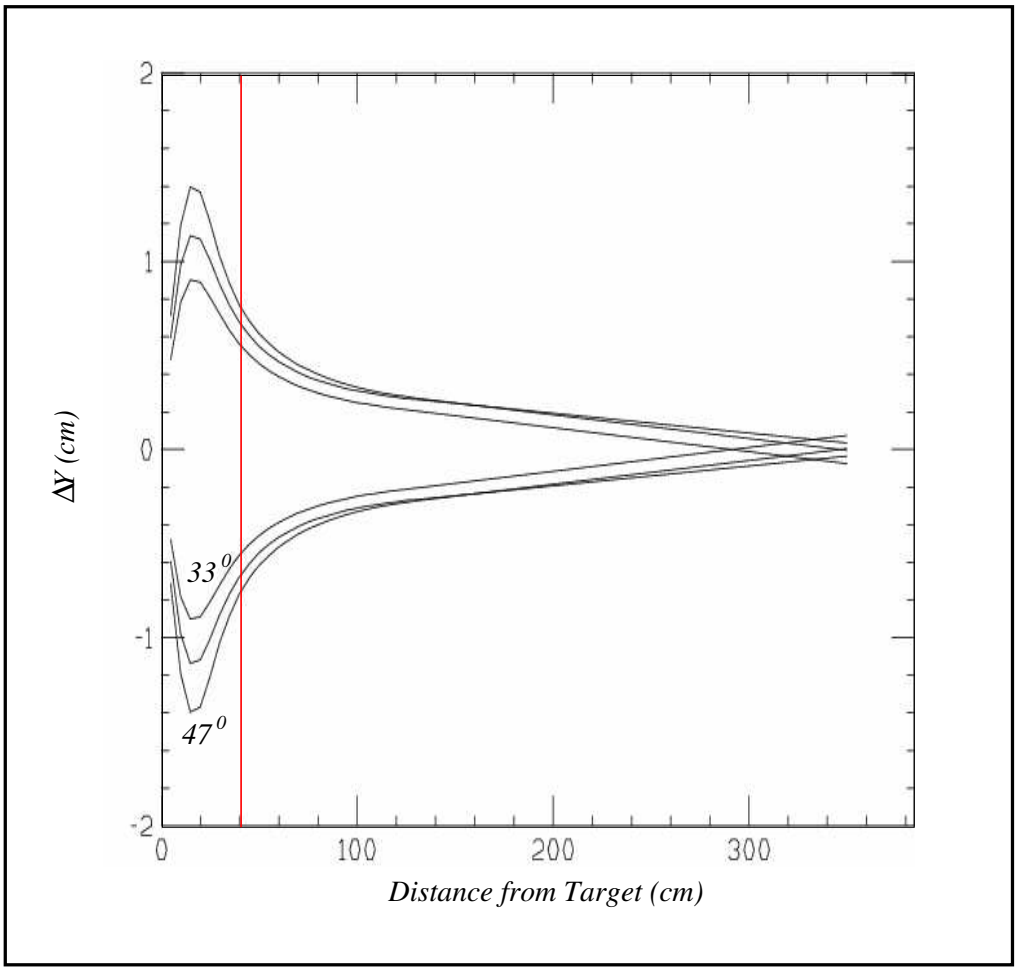
SANE Collaboration Meeting

January 14, 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$10 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.*

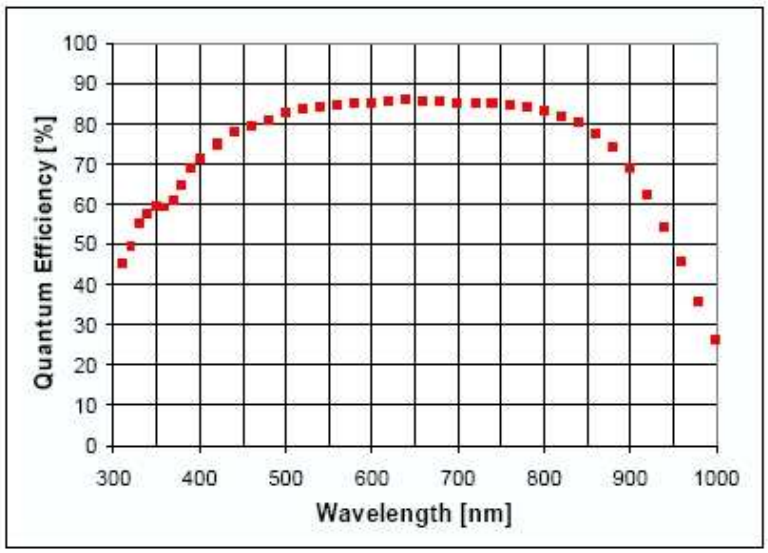
Tracking Hodoscope Proposal

- *Solid Čerenkov Detector:*
- *Located 40 cm downstream of target.*
- *Material: Quartz (n=1.47).*
- *Size: 26 cm (vertical) × 14 cm (horizontal).*
- *Quartz fingers: 5 mm × 3 mm bars.*
- *Position resolution, σ_y ∼1.5 mm.*
- *Expected number of P.E.'s ∼3–4.*
- *52 bars along vertical and 28 along horizontal.*
- *Two Y planes offset by 2.5 mm for redundancy (104 bars).*
- *One X plane (28 bars).*
- *Total number of bars, 132.*
- *Double-ended readout system.*

SiPM Characteristics

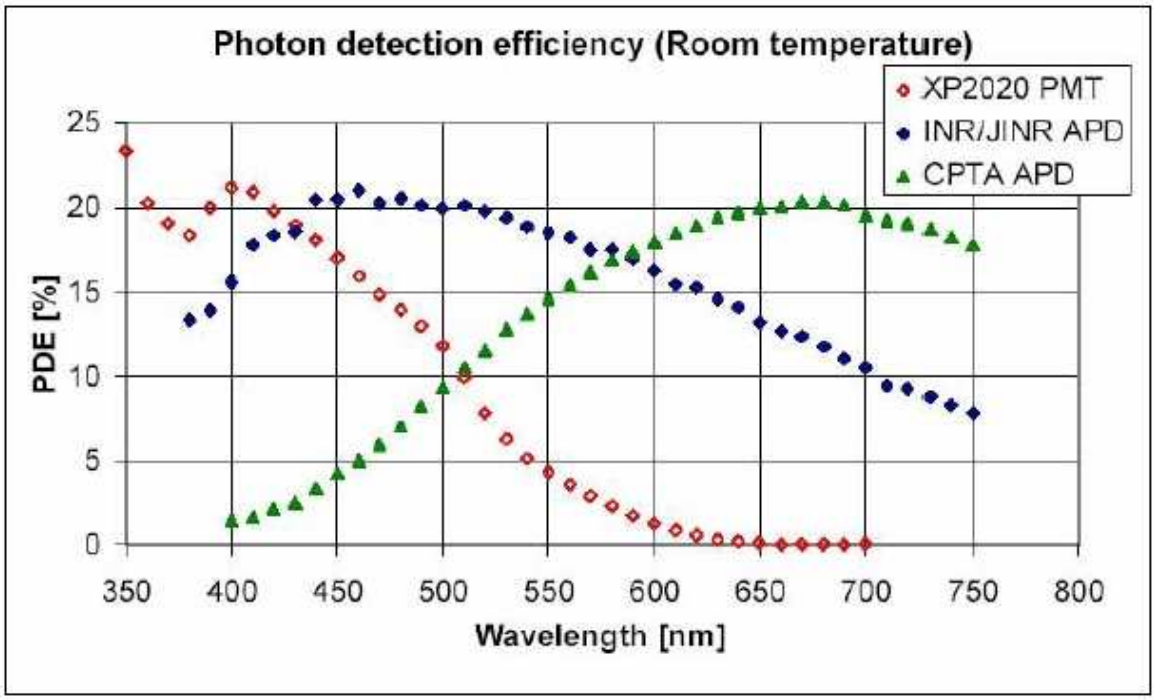
- *Silicon PMT:*
  - ☐ *novel type of APD.*
  - ☐ *insensitive to magnetic fields.*
  - ☐ *high gain* $\sim 10^6$.
  - ☐ *good quantum efficiency* $\sim 66\%$ *at* $\lambda = 550$ *nm.*
  - ☐ *excellent timing resolution* ~ 120 *ps for single photoelectron detection.*
  - ☐ *fast risetime* ~ 1 *ns.*
  - ☐ *achieves good dynamic range* $\sim 10^3/mm^2$.
  - ☐ *does not exhibit any serious radiation damage effects.*
  - ☐ *requires low bias voltage* ~ 50-60 *V.*
  - ☐ *low cost* $\sim \$55$ *per unit.*

SiPM Quantum Efficiency



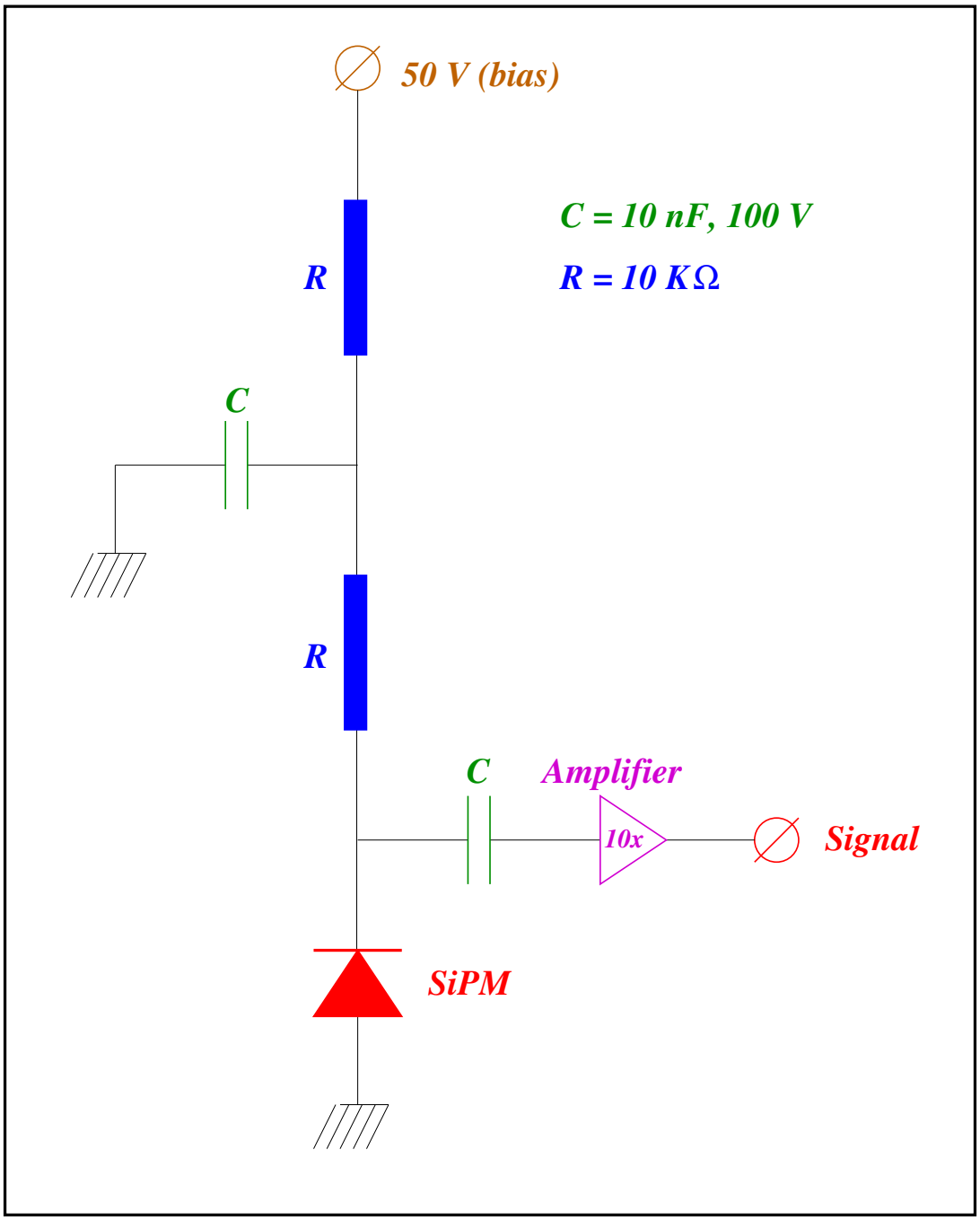
- *QE in UV region below 300 nm is still 20-30%.*
- *Doping can increase QE to more than 50%.*

SiPM Photon Detection Efficiency



- ***Will need Yellow-Green wavelength shifter for optimum detection efficiency.***

SiPM Electronics Schematic



Alternative to SiPM

- ***Channel photomultiplier from Perkin-Elmer.***
- ***Operates in UV.***
- ***More expensive ($500 per unit).***
- ***Needs HV supply and magnetic shielding.***

Budget Estimate and Funding

- *Quartz bars ($500 per unit × 132) ∼ $66 k.*
- *SiPM and electronics ∼ $27 k.*
- *Total ∼ $100 k.*
- *Possible funding source - Physics Frontiers Center at Hampton University.*
- *Proposal to be submitted to External Advisory Committee on January 27, 2005.*