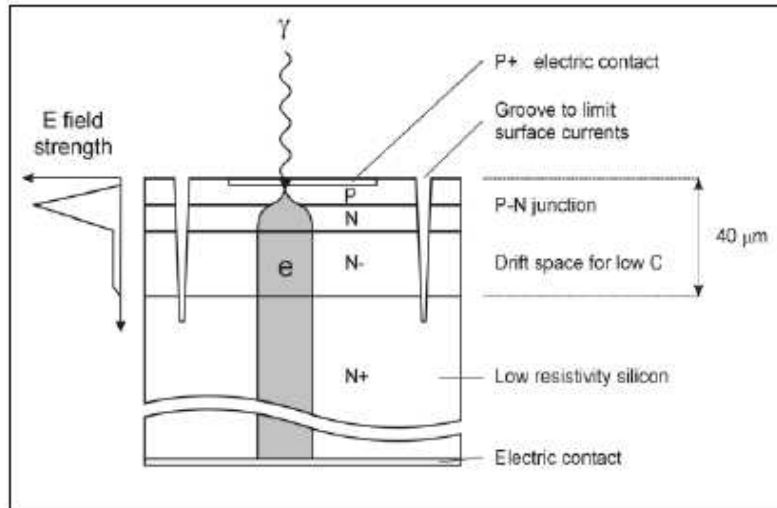


Report on Solid Čerenkov Detector

SiPM Option for Forward Quartz Detector

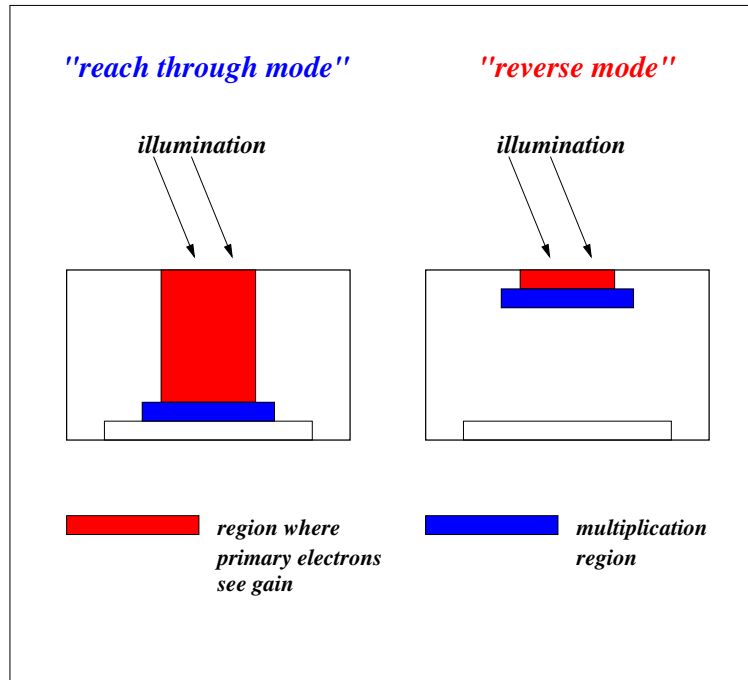
M. Khandaker
SANE Collaboration Meeting
November 12, 2004

Basic Structure of APD



- *Photo-conversion* electrons from thin p-layer induce *avalanche amplification* at p-n junction
- *Electrons* created by ionizing particles *traversing the bulk* are not amplified

Structure of "Reverse" APD



APD's "reverse" structure have improved characteristics:

- *high speed*
- *good response to blue and visible light*
- *small excess noise factor*
- *reduced temperature dependence*
- *radiation resistance*
- *small nuclear counter effect*

Geiger Mode APD or SiPM

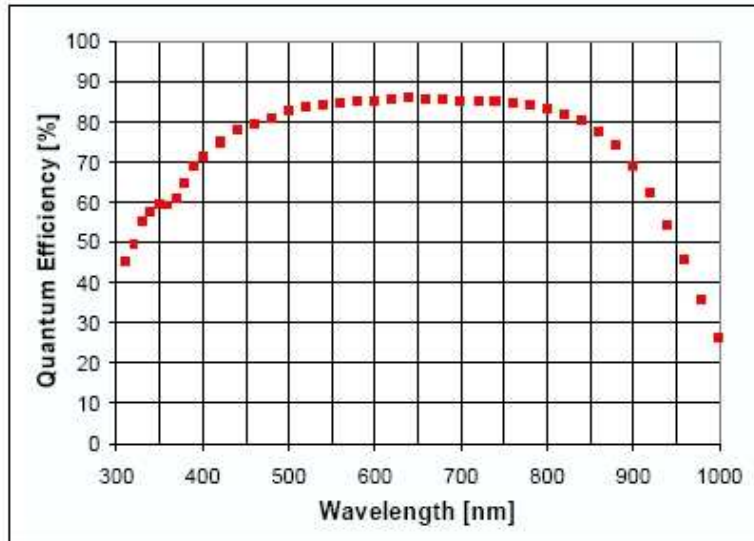
- APD's usually operated in *linear mode* – generated signal proportional to illumination
- APD's can be operated in *Geiger mode* when *bias voltage is few volts higher than breakdown voltage*
- Area of photodiode split into *large number of pixels* (*~1500 pixels/mm²*)
- Each pixel has its own connection to bias voltage via a resistivity of several 100 k Ω
- Diode is operated at a bias which can be up to 10 V higher than breakdown voltage
- *Single photon* hitting one pixel triggers a breakdown and an output signal of *~10⁶ electrons*
- Bias voltage of a pixel drops, breakdown is quenched and after *~100 ns, pixel is armed again*

SiPM Characteristics

- *Silicon PMT:*

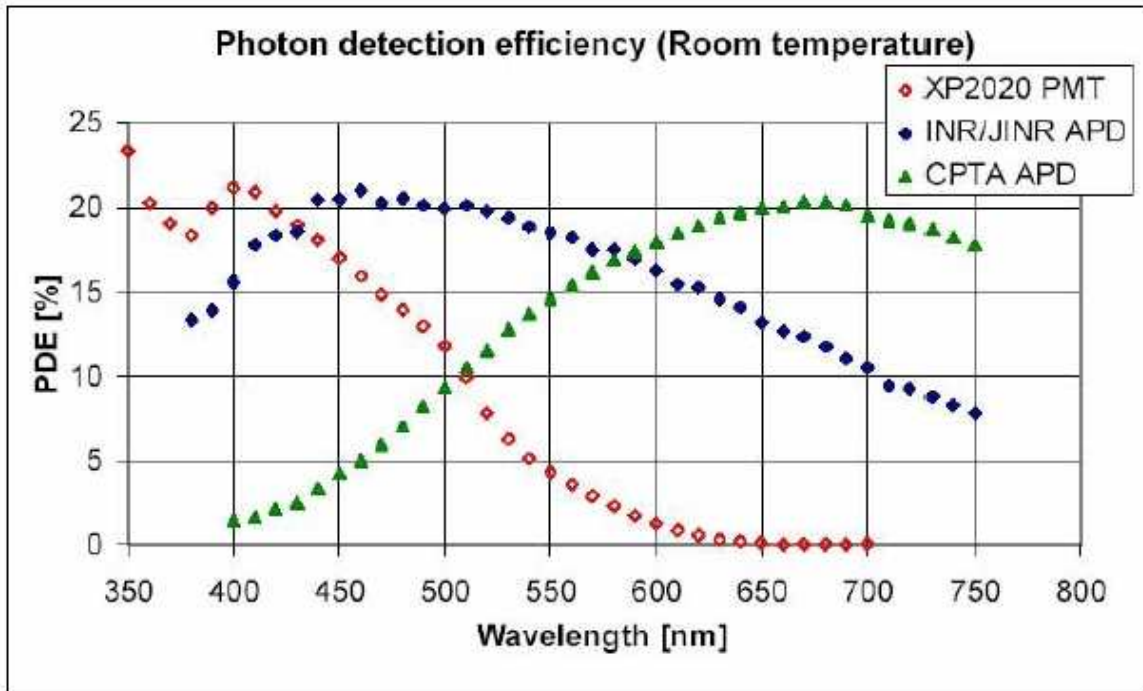
- *novel type of APD*
- *insensitive to magnetic fields*
- *high gain $\sim 10^6$*
- *good quantum efficiency $\sim 66\%$ at $\lambda = 550$ nm*
- *excellent timing resolution ~ 120 ps for single photoelectron detection*
- *fast risetime ~ 1 ns*
- *achieves good dynamic range $\sim 10^3/\text{mm}^2$*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

SiPM Quantum Efficiency

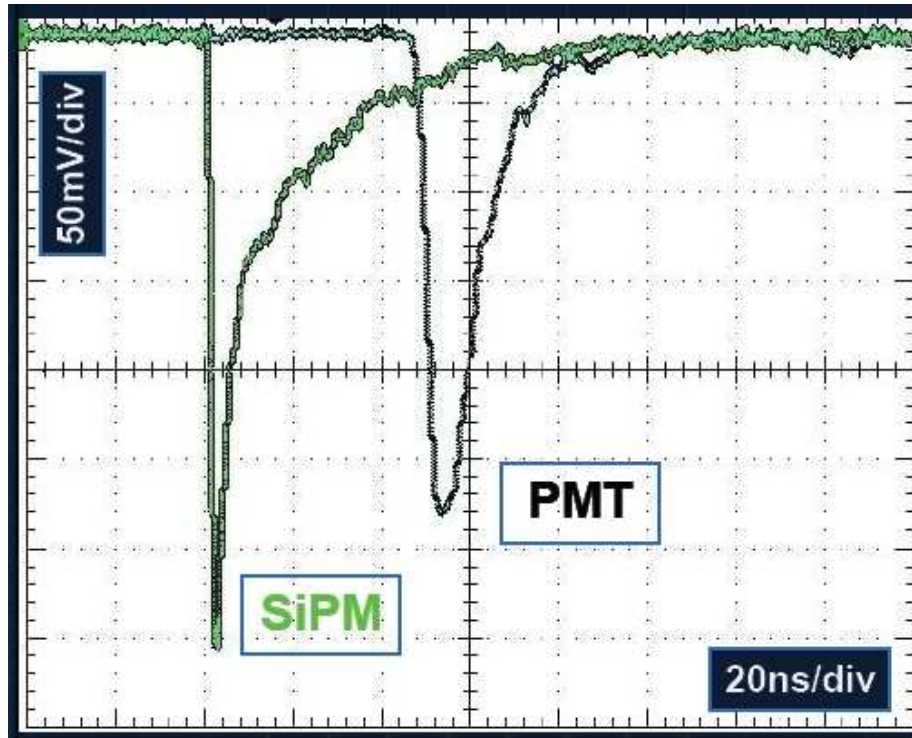


- *QE* in *UV* region below 300 nm is still *20-30%*
- *Doping* can increase *QE* to more than *50%*

SiPM Photon Detection Efficiency

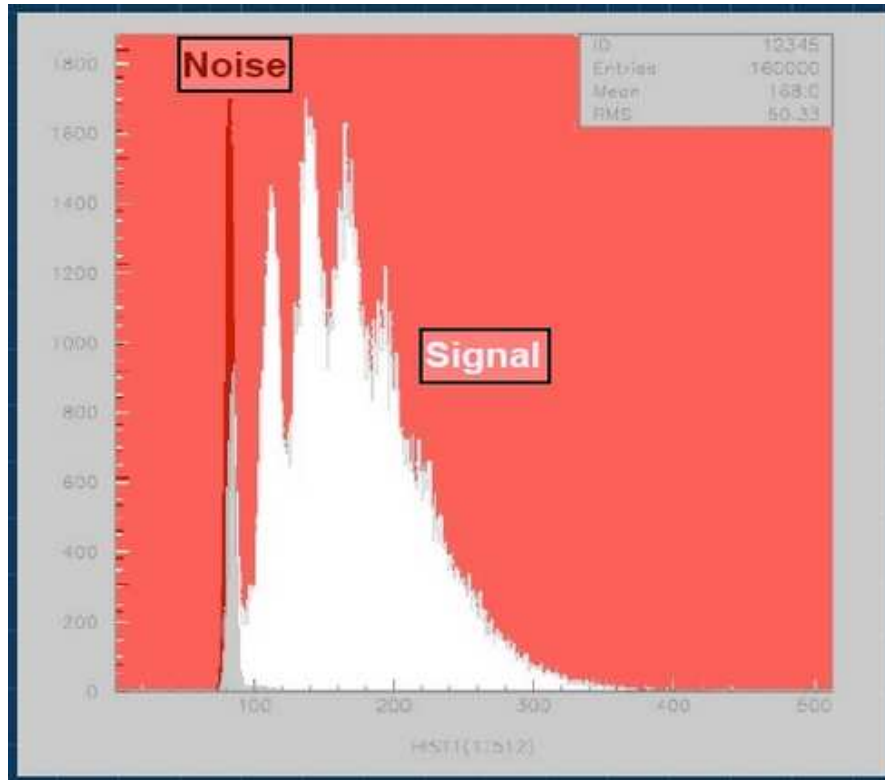


SiPM vs. Burle 8575



- *SiPM* flashed with *Optitron NR-1A*
- *Burle 8575* under identical conditions, at 2 kV

SiPM Signal vs. Noise



- *CPTA SiPM with SciFi and LED triggered at 100 kHz*
- *“Noise” rate negligible compared to real events*
- *Noise amplitude below one P.E. level*

Summary

- *SiPM's are a viable alternative to Fine Mesh PMT's*
- *High magnetic field operation*
- *Radiation hard device*
- *Reliability better than 99% can be expected even in very hostile environment*
- *Low cost and can be tailored to specific needs*
- *Coupling to Quartz or SciFi needs more study*