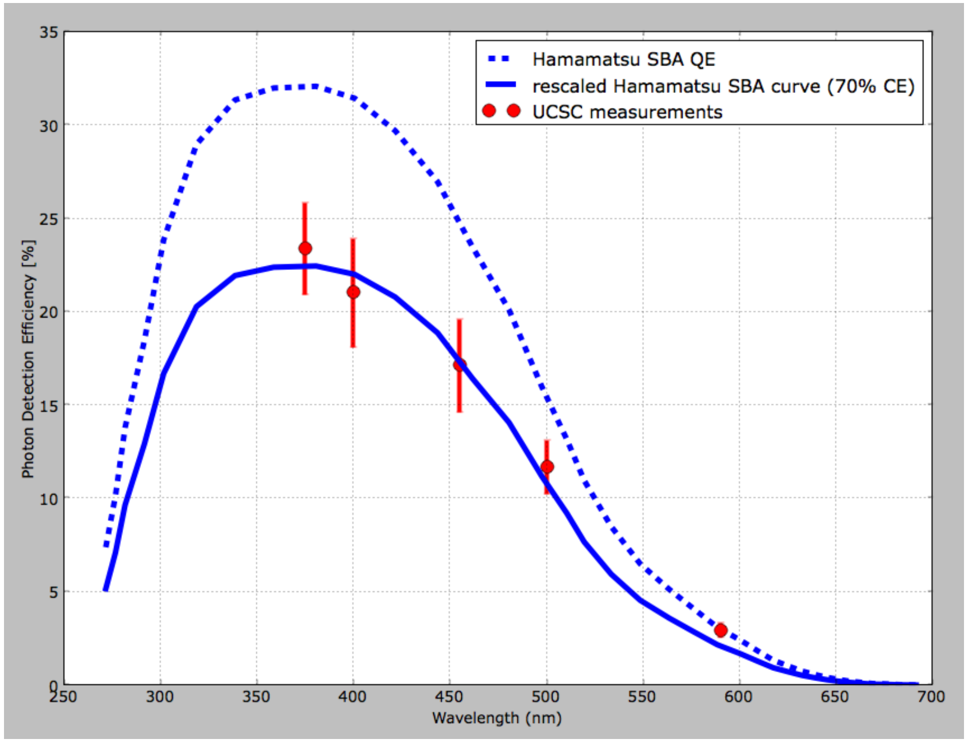
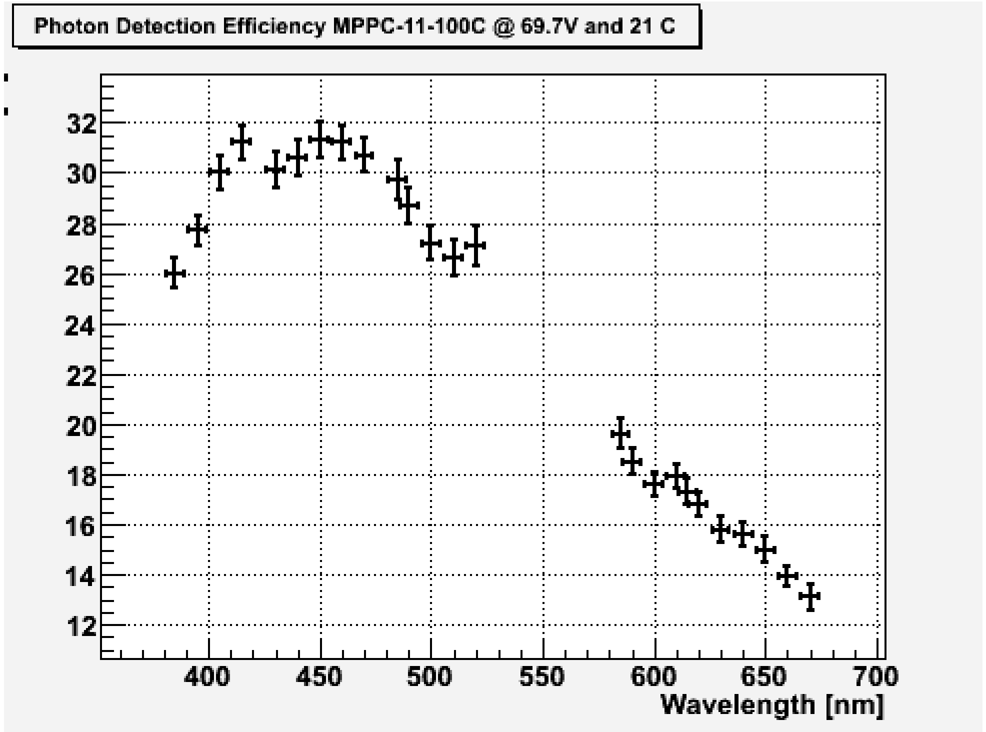
SiPM Camera

Nepomuk Otte, GA Tech
Vladimir Vassiliev, UCLA
David Williams, UCSC

Why SiPMs?

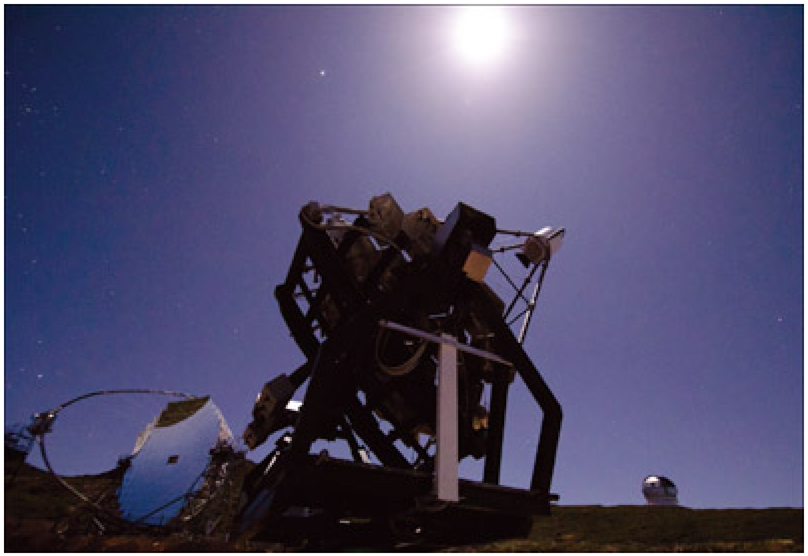
PDE of SiPMs is **higher** than that of MAPMTs

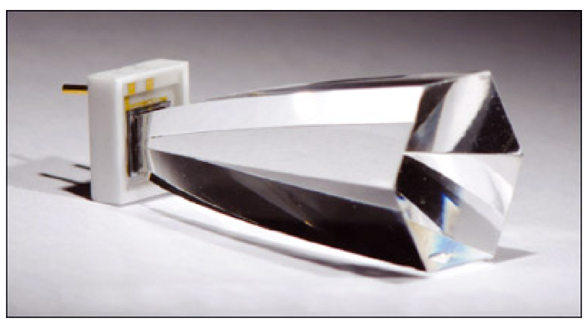


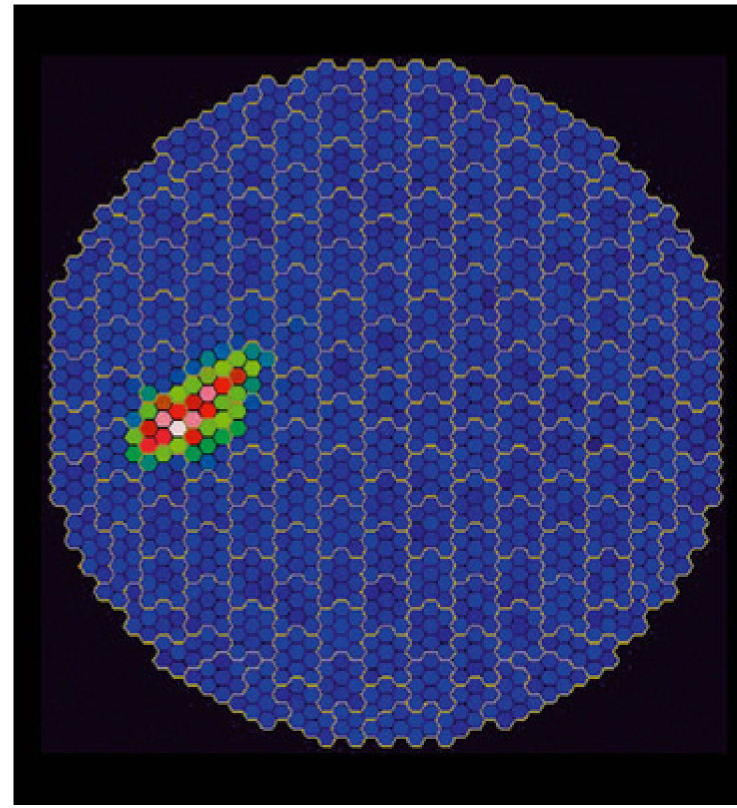


Costs per area became competitive with MAPMTs

First G-**A**PD **C**herenkov **T**elescope FACT



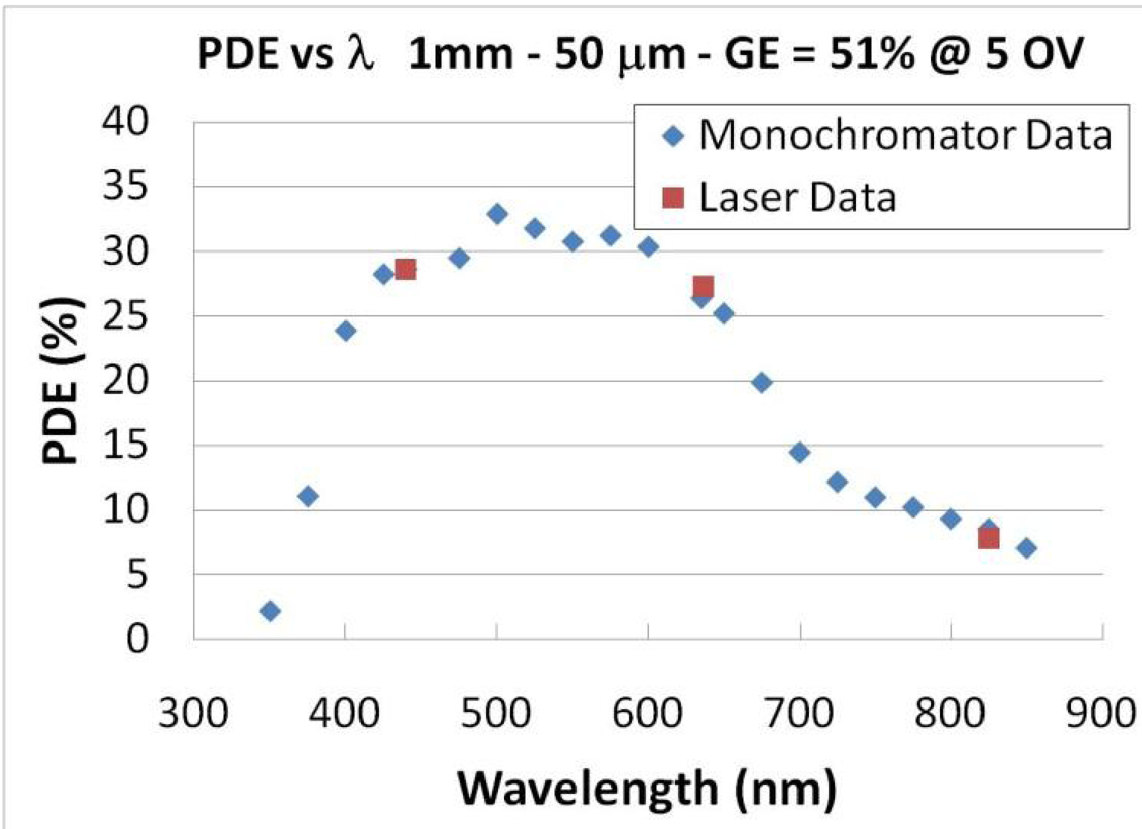


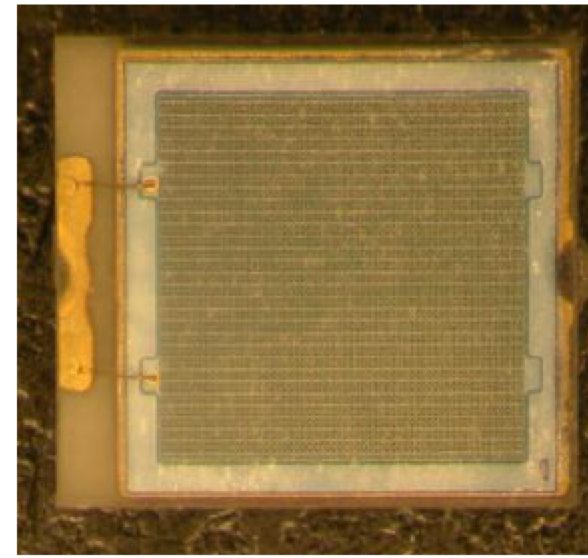


http://cerncourier.com/cws/article/cern/47816

SiPM from Excelitas

Content from talk by Arthur Barlow @ Ringberg 2011





$V_{bd} \sim 90 - 100$ V

$\delta V / \delta T \sim 70$ mV/°C

$\frac{1}{M}\frac{\delta M}{\delta V}(5V) \sim 1.5\%/50$ mV

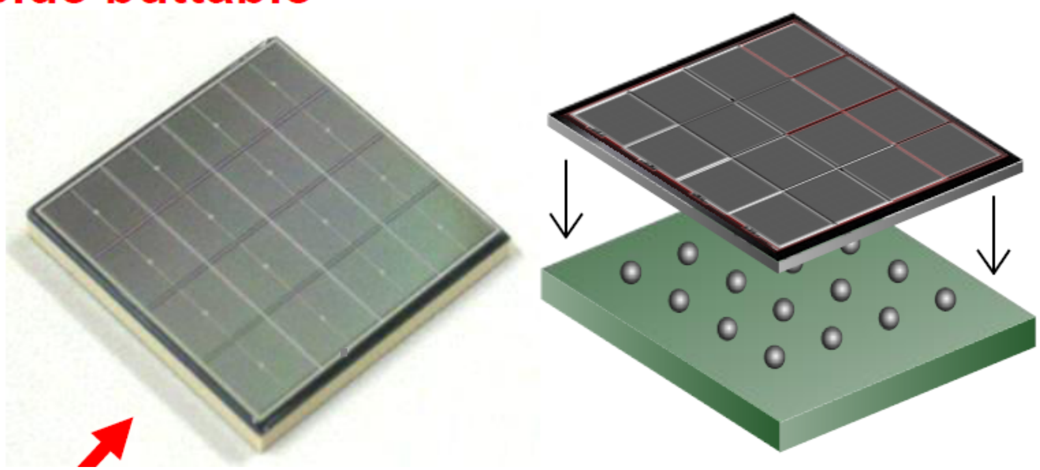
$\frac{1}{M}\frac{\delta M}{\delta T}(5V) \sim 2.1\%/°C$

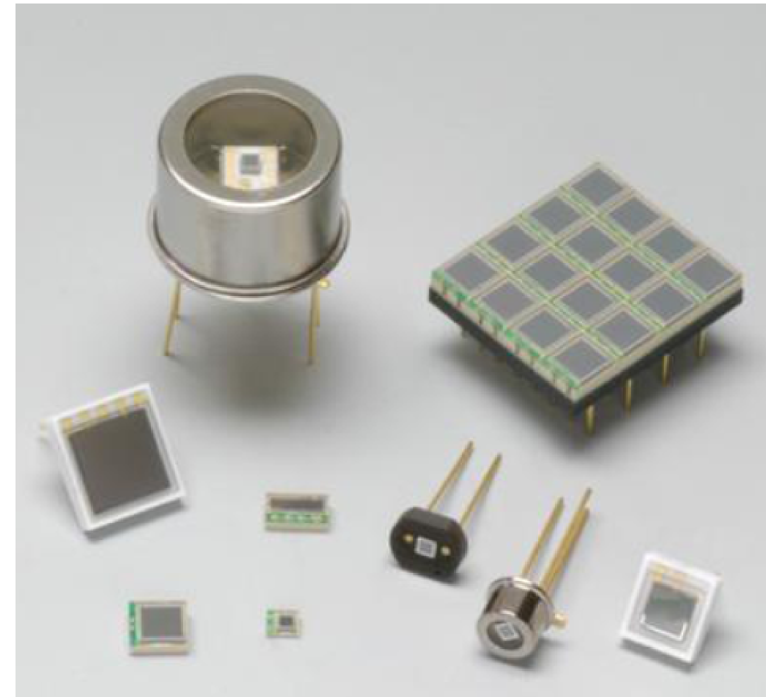
Dark count rates ~200kHz per mm^2

MPPCs from Hamamatsu

Interesting new developments

4-side buttable





Light concentrators not feasible ->
we need maximum possible fill factor

Hamamatsu also works on more blue sensitive devices

SiPM require extra TLC

Varying ambient temperature

Changes breakdown voltage

→ Changes gain
Changes photon detection efficiency

Optical Crosstalk

→ Impacts trigger threshold

Is <10% is what we need to aim at?
Needs simulation studies (sumtrigger and clipping)

Larger devices -> slower pulses (not a general rule)

How slow before it cuts into telescope performance?
Optimization of FE?
Needs simulation studies

Temperature Stabilization

Advantages:

- Significant reduction in calibration effort (PDE, gain, ...)
- Reduction of systematic uncertainties
- Possibility to control SiPM intrinsic dark rate

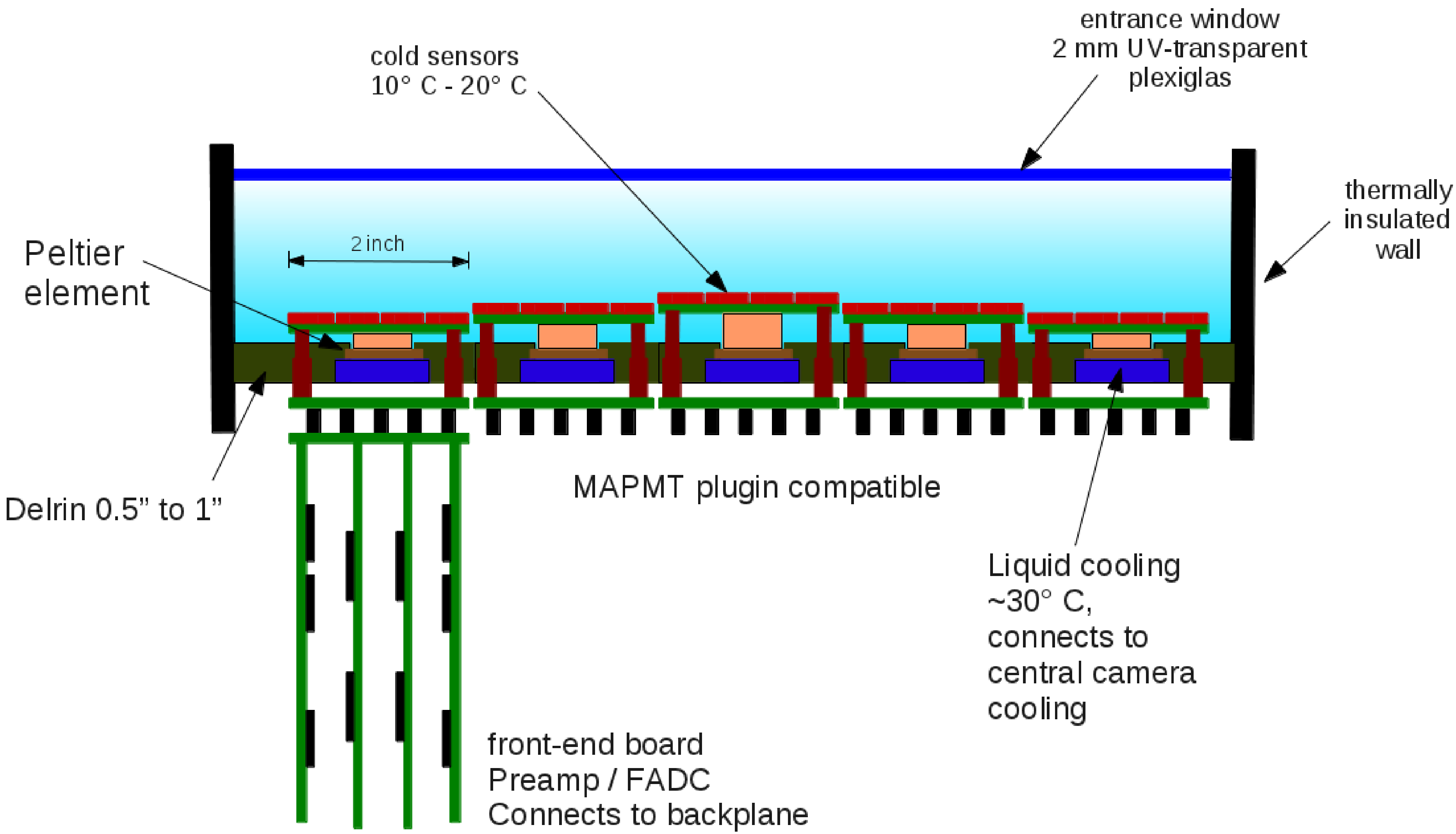
more stable system

How stable is stable?

Depends on SiPM characteristics

Assuming dM/M ~ 2% /°C -> requires dT < 0.5C

Condensation on entrance window?



Heat produced by Thermoelectric Element (TE)

A conservative estimate of TE waste heat:

Main contributor to heat flow into cold volume
Camera electronics

Assuming 40 °C on electronics side, 0 °C on cold side, and 0.5 inch thick Delrin in between

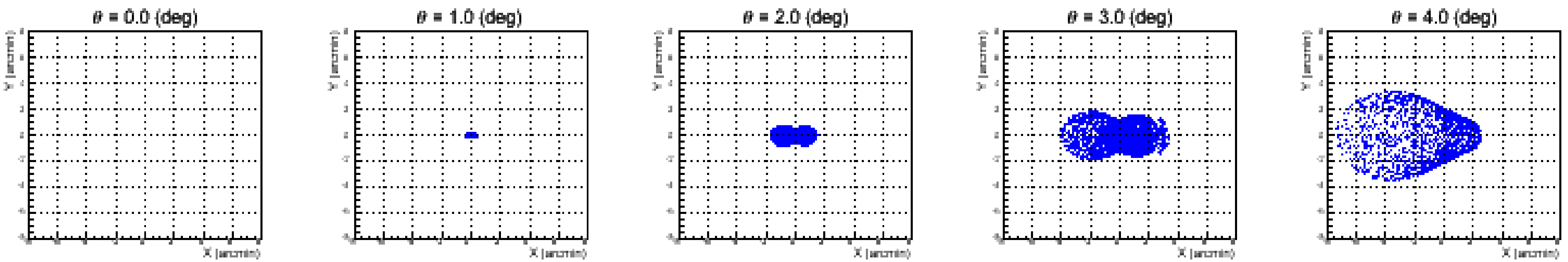
-> Heat flow into cold volume: **4 W per 2 inch^2**

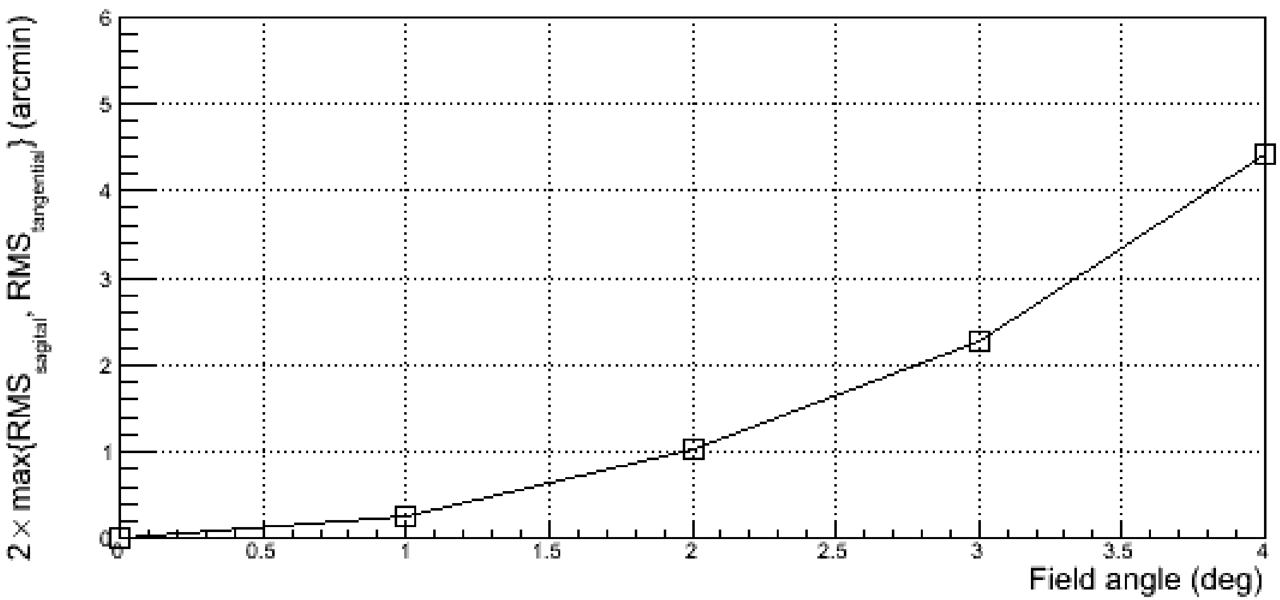
Cooled away be TE with 40 °C on hot side of TE coupled to heat exchanger
-> **Waste heat 15 W** per 2 inch^2 (for TE-127-1.0-2.5 @ 9V operating at max COP, element size 30x30 mm^2)

OS8: Schwarzschild-Couder Telescope

See memo"Optical Systems of Schwartzchild Telescope for CTA, Vladimir V. Vassiliev, Oct. 25, 2010

No camera: focal surface only

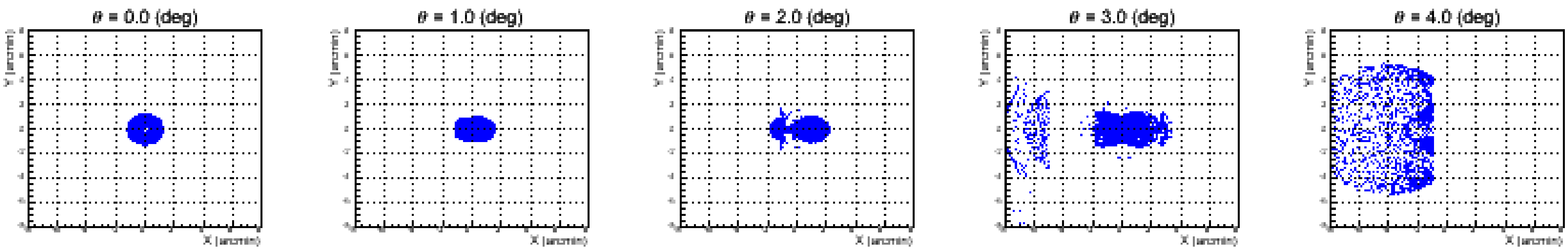


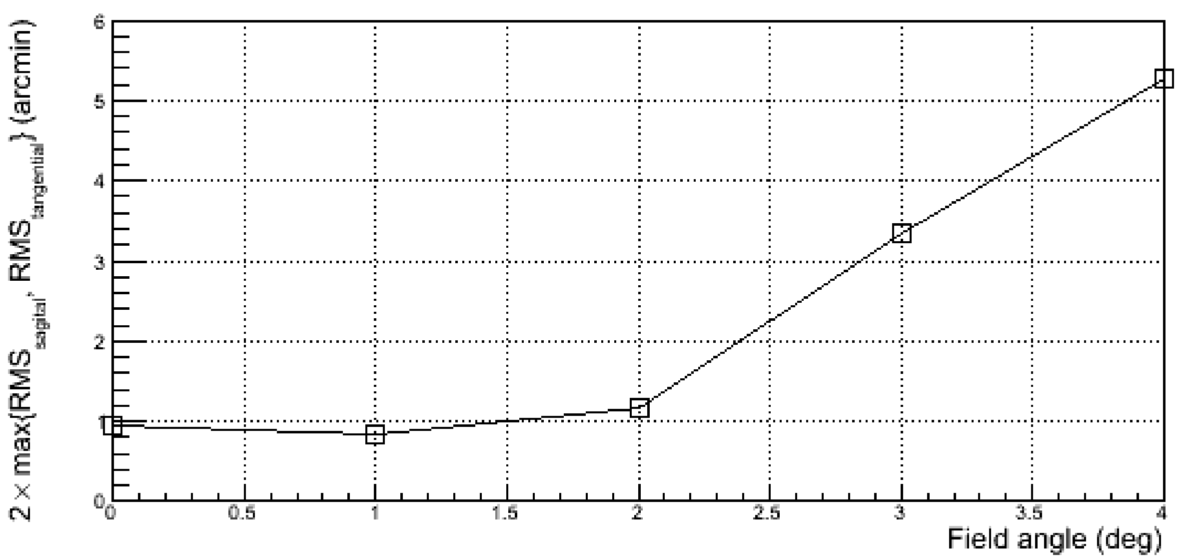


Slide from Charlie Duke

OS8: Schwarzschild-Couder Telescope: MAPMT camera

Center of photosensitive plane at focal surface
Input window thickness: 2 mm
refractive index: 1.5
Gap between window and photosensitive surface: 10.0 mm

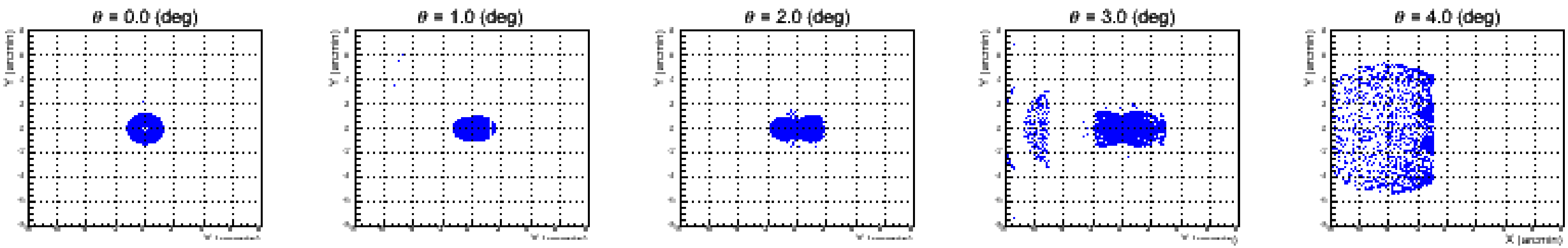


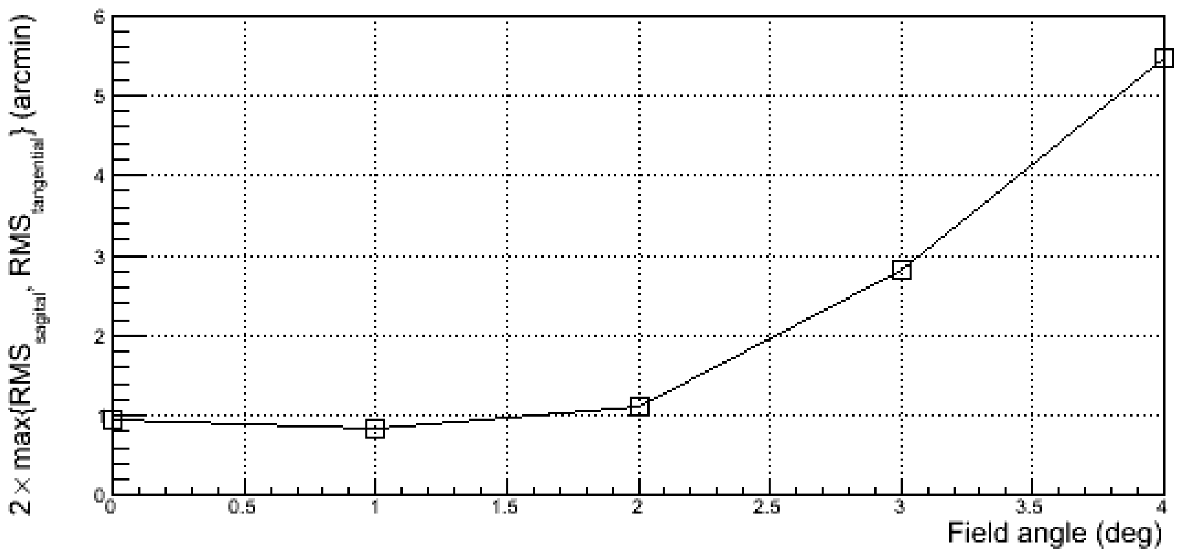


Slide from Charlie Duke

OS8: Schwarzschild-Couder Telescope: MAPMT camera

Center of photosensitive plane at focal surface
Input window thickness: 2 mm
refractive index: 1.5
Gap between window and photosensitive surface: 20.0 mm





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