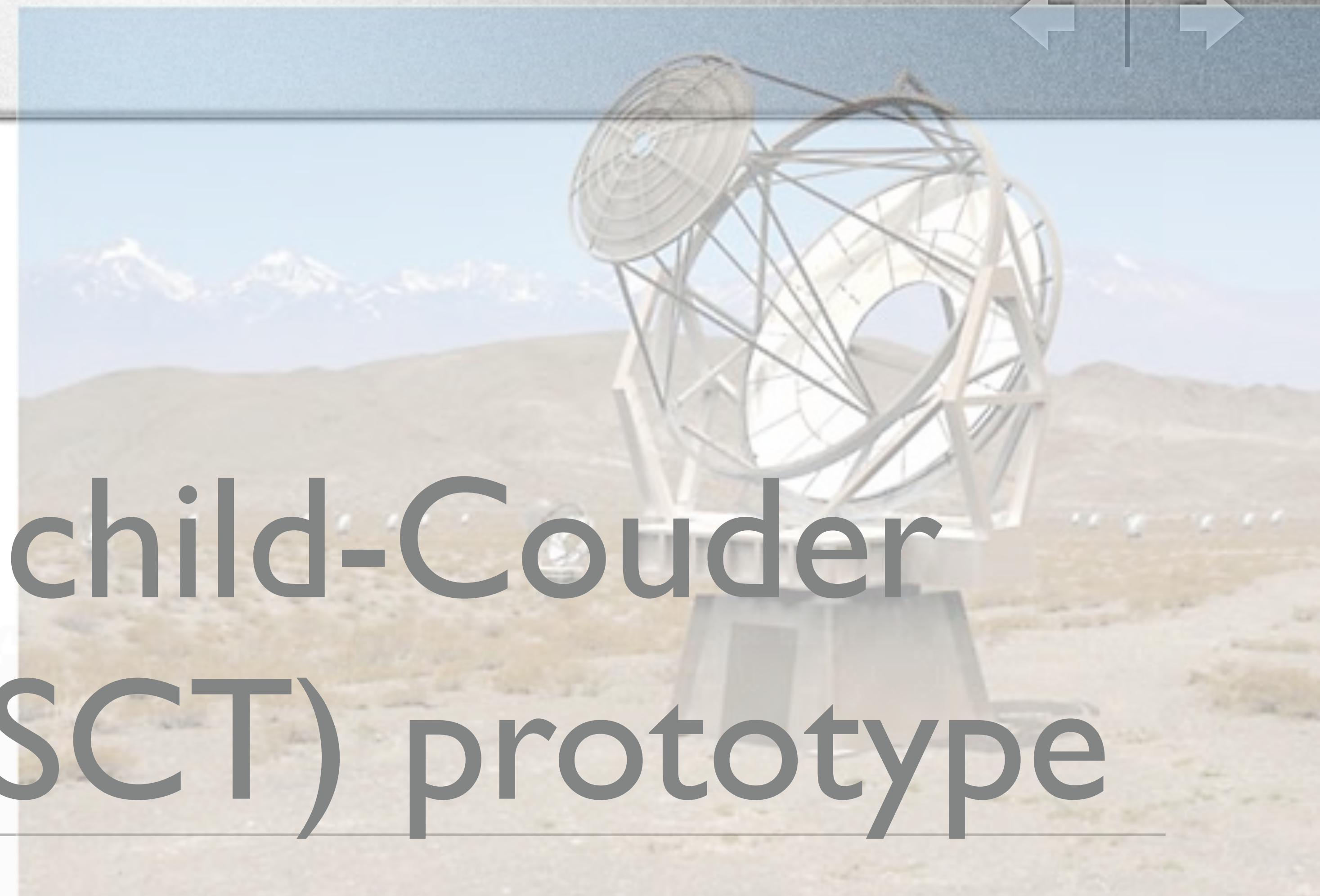
Schwarzschild-Couder Telescope (SCT) prototype



Project outline / Simulations

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Outline

- Novel imaging atmospheric Cherenkov telescope (IACT) for VHE gammas
- Stand-alone instrument
- Enhancement to VERITAS
- Pathfinder for CTA
- So far: only single-mirror (DC & parabolic) used as IACT
- Wide FOV with corrected aberrations
- Small time spread in the Focal Plane (FP)

Good science with the SCT

- Detection, survey, monitoring of any source class:
  AGN, radio galaxies, starbursts, Galactic center, pulsars, X-ray binaries, supernova remnant, PWNs, nova, unidentified, you name it!
- Autonomous AGN monitoring, comparable to the Whipple 10m
- Enhanced sensitivity and angular resolution for VERITAS

Good science with the SCT: example

- High angular and temporal resolution: **direct-Chenrenkov cosmic-ray composition measurements**

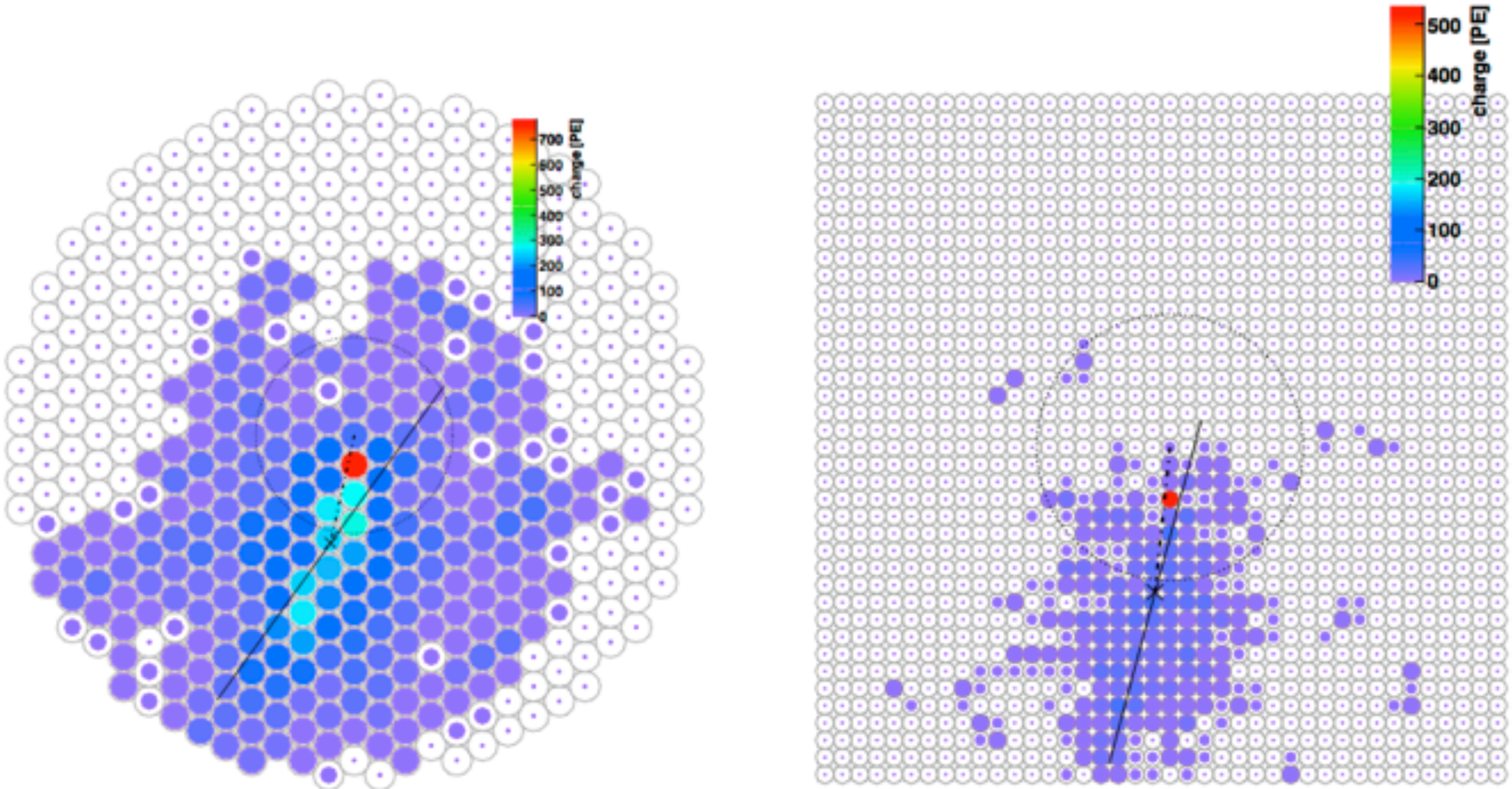


Figure 1: Simulated 30 TeV iron showers as recorded by the VERITAS (left) and the SCT (right) cameras. The direct Cherenkov light (the intense signals in red near the center of the camera) is more clearly distinguished from the rest of the shower in the SCT camera.

Instrument Description

- SiPM camera, highly integrated one (data processing starts at the camera level) with ASIC electronics
- SiPMs need high temperature stability
- Induces small focal length, ie small camera!
- This cost-effectiveness is balanced by a delicate mechanic alignment (ANL will lead this)

Camera

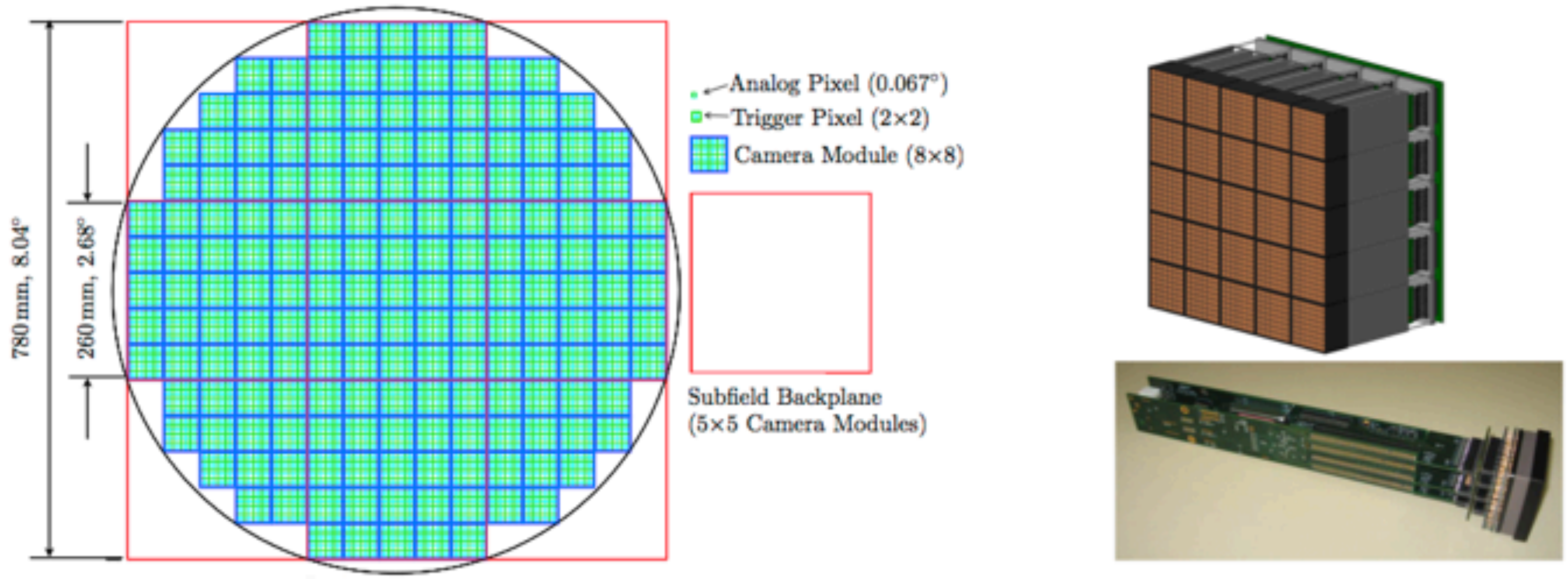


Figure 4: *Left:* Schematic of the complete 8° FoV camera, showing division into 9 subfield backplanes each with 25 modules having 64 readout ("analog") pixels grouped into 16 trigger pixels. *Upper right:* One camera subfield, the portion of the camera to be constructed for this proposal. *Lower right:* One camera module with front-end electronic boards and four TARGET ASICs. The module shown has a multianode PMT, rather than the SiPM that will be used.

Optics simulation

- Two-mirror design, FP is curved to minimize astigmatism
- 5.5m focal length, 2.7° FOV (this project, 8° final design),
- secondary mirror is so much curved ==> expensive (electroforming) ==> only an annulus ==> inside diameter is 3.16 m, outside diameter is 4.11 m
- avge reflectivity 90%

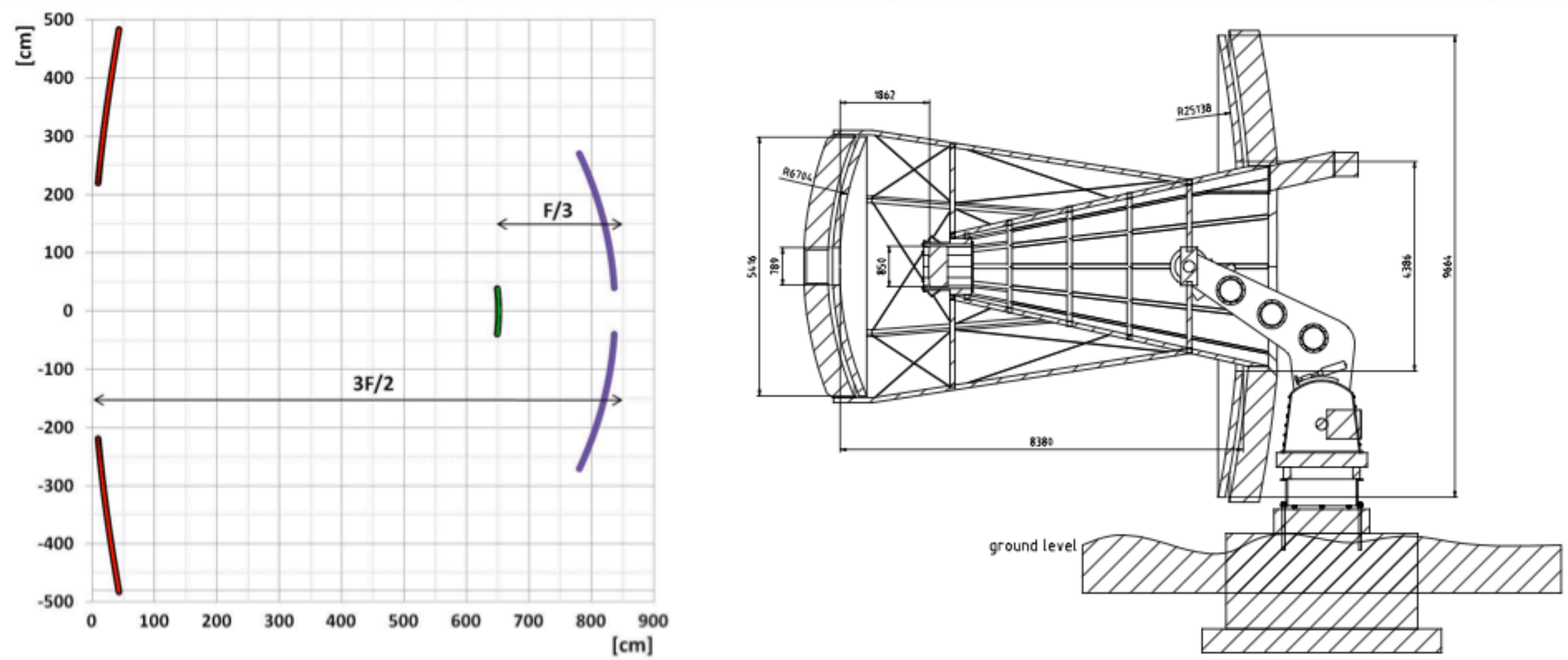
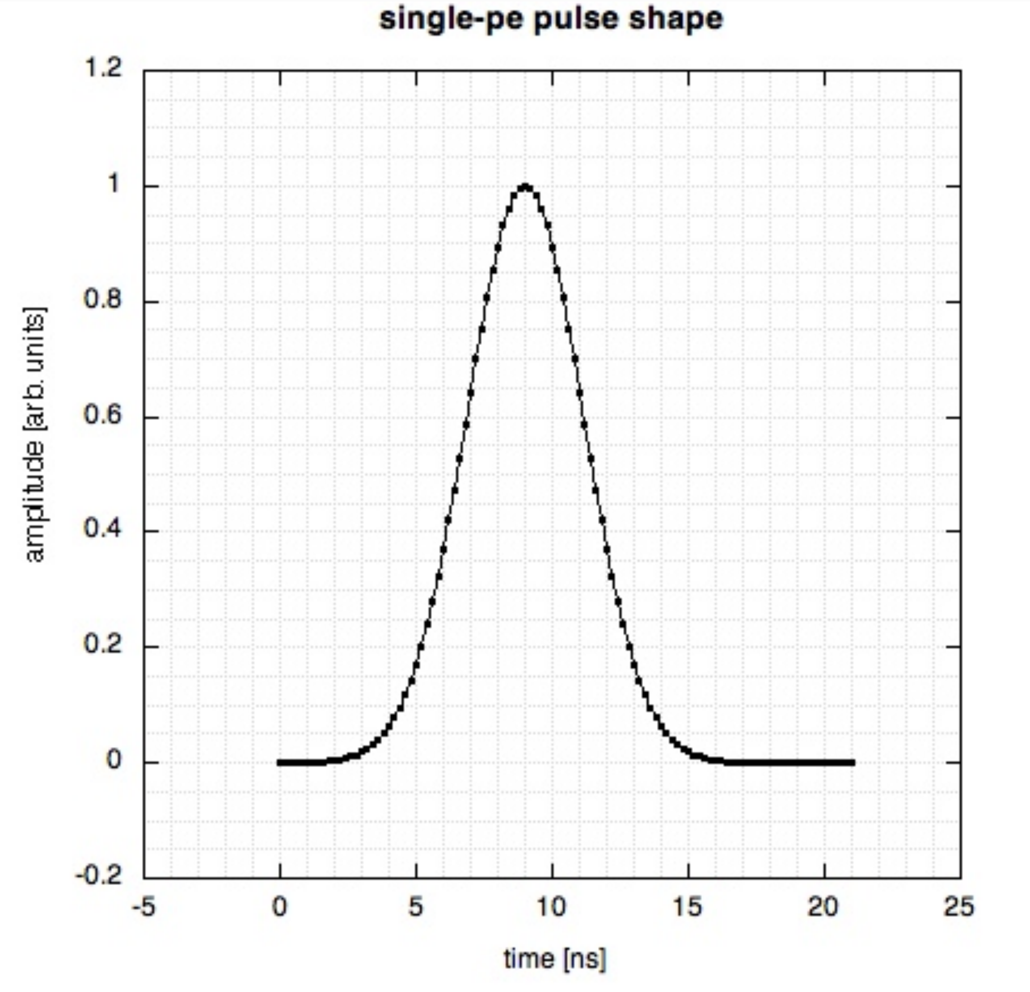
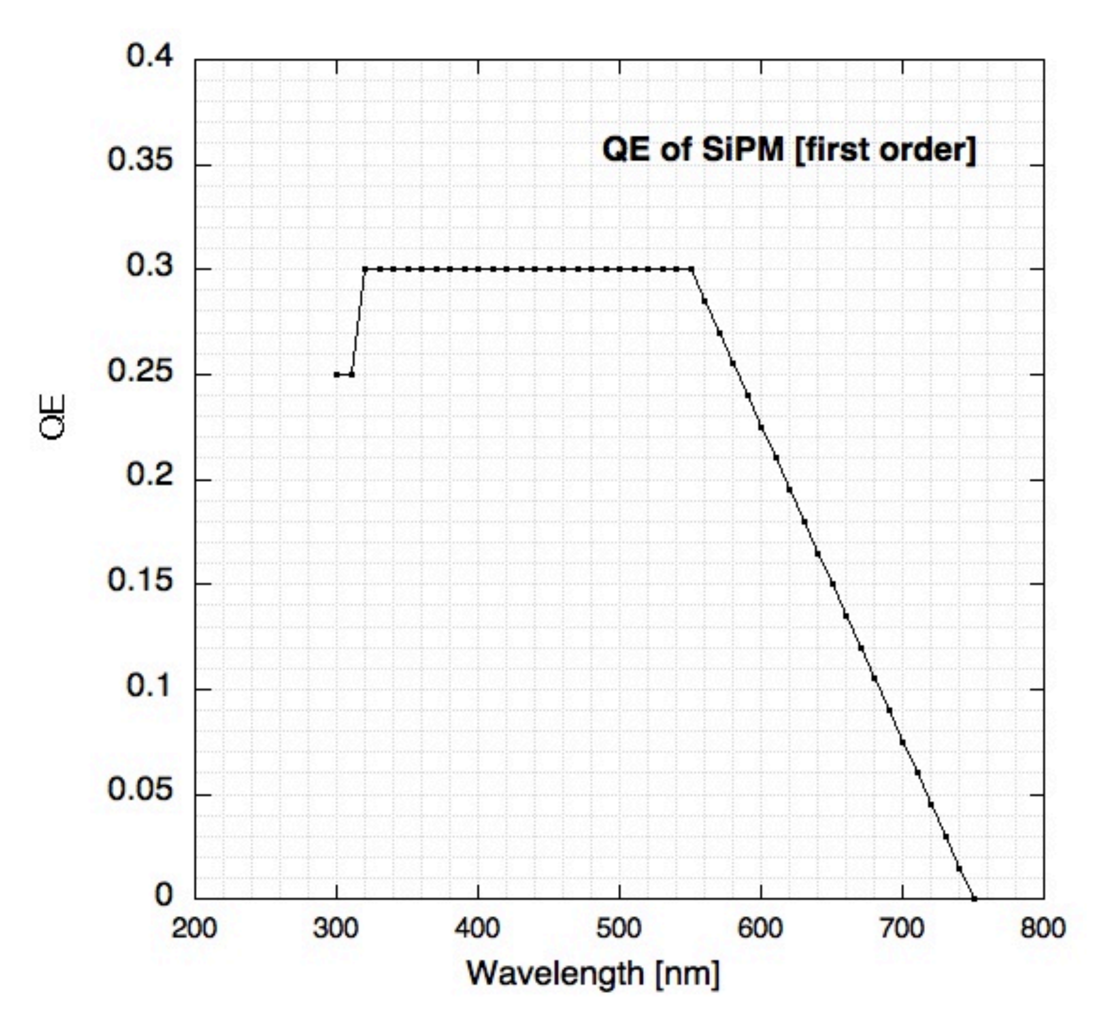


Figure 3: *Left:* Cross section of the SC optics showing the primary mirror (red), secondary mirror (violet) and focal plane (green). *Right:* The IFJ PAN-Krakow design of the SCT using a rigid central cone.

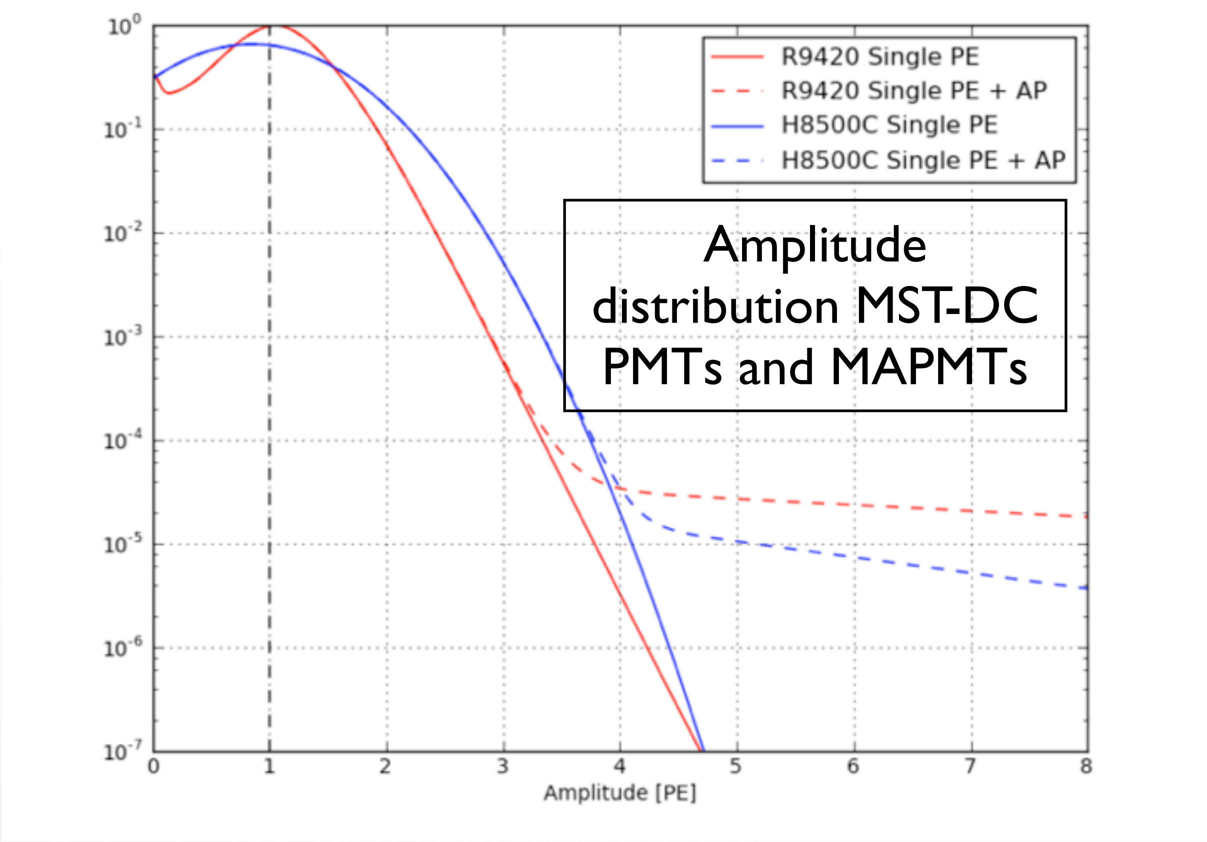
Camera simulation: essential parameters

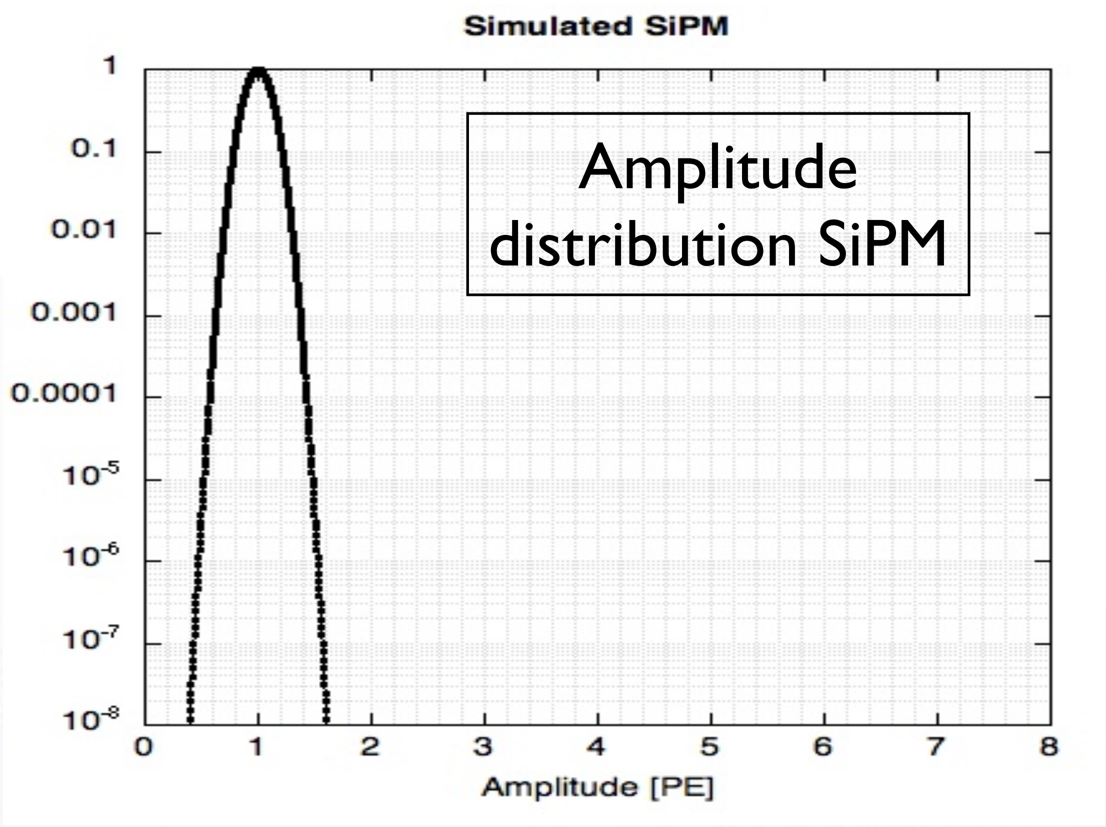
- 40 x 40 pixels, no light-guides
- SiPM (Hamamatsu MPPC-11-100C)
- no after-pulsing, high QE
- single-pe pulse shape is ~Gaussian
- 1 GHz
- 32 samples recorded if camera trigger is fired





Camera simulation: essential parameters



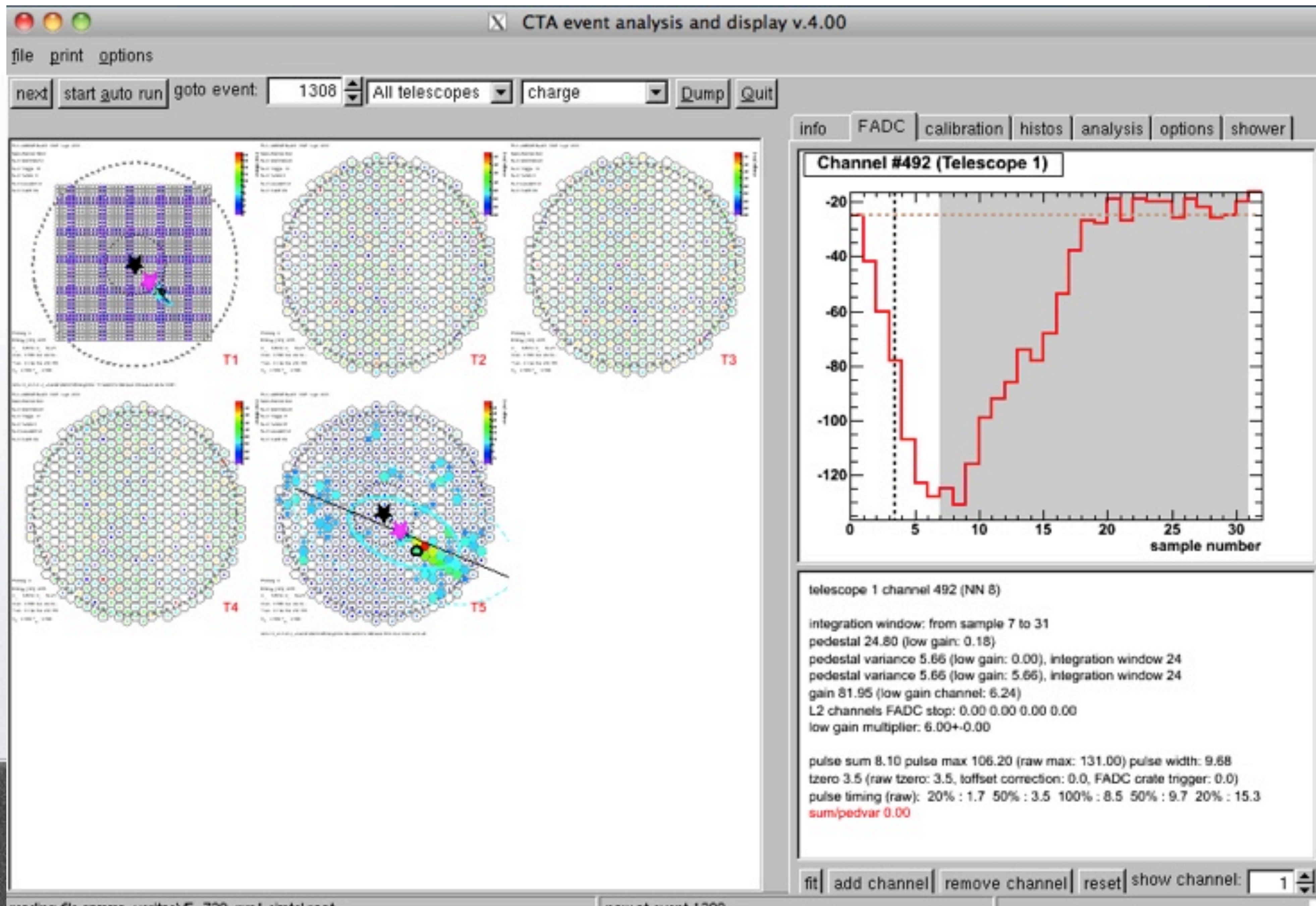


Camera simulation: essential parameters

- 20 photo-electrons minimum
- NSB ~20 MHz / pixel
- multiplicity trigger of 3 connected "trigger pixels"
- 1 "trigger pixel" = (analog sum of 2x2 pixels)
- 3 trigger pixels above 3.5 PE within 6 ns ==> Camera trigger

DAQ simulation

- 32 samples recorded if L2 trigger fired
- due to a lack of time, loose cuts for image cleaning
- images converted/stored in a root file ===> input for Jon Dumm



What we gain with the SCT

- 15% more triggered events
- 2.5x more events with 3 reconstructable images
- Increased footprint of VERITAS and provides high-resolution images
- resulting in larger effective area, improved angular resolution and better background rejection
- Follow Jon's talk to learn more!

SCT Location

- Current plan: the old T1 location at VERITAS base camp
- Cheapest way, might not be the best choice performance-wise
- Very important question!
- Jamie made a few suggestion (see picture)