CTA instrumentation projects

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Current CTA instrumentation projects

Camera & Detector Development for CTA

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* *Also Leiden Observatory*
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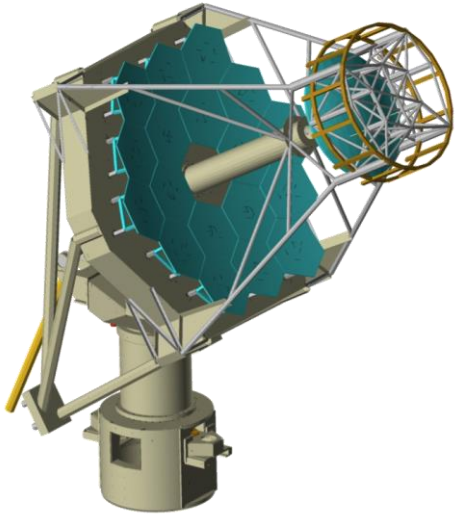
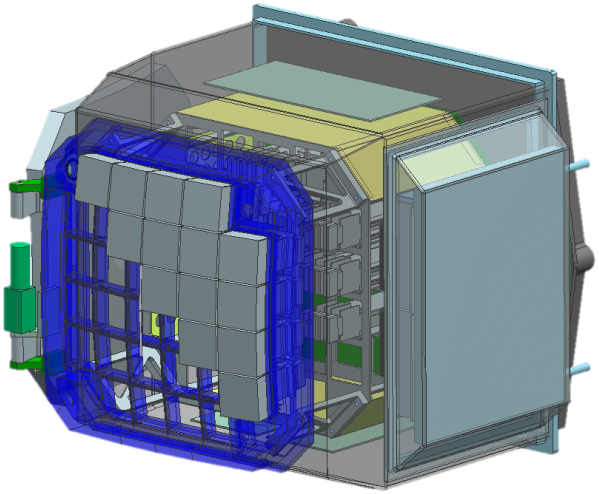
NOVA-4 instrumentation grant,
1.2 M€ (0.2 M€ contingency)

NOVA Work Packages

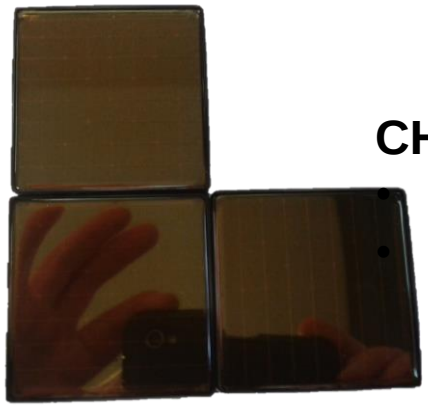
- WP1: contributions to the CHEC camera project for the dual-mirror SSTs (Amsterdam)
- WP2: development of new photo-sensors for CHEC (Nijmegen)
- WP3: SST pointing reconstruction system (Amsterdam & ASTRON)





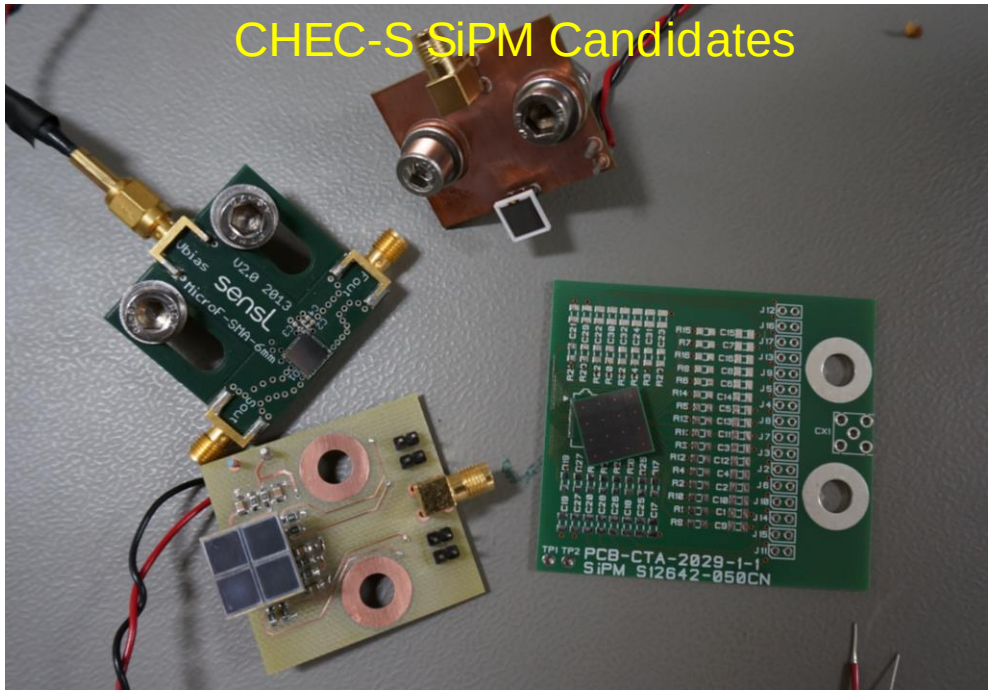
WP1 CHEC

- CHEC: A Compact High Energy Camera
- UK, US, Japan, Netherlands
- Camera for dual-mirror SSTs
- Funding in place for 2 prototypes
  - CHEC-M: photo-sensors MAPM, end 2014
  - CHEC-S: photo-sensors SiPM, mid 2015



CHEC-M MAPMs

- Hamamatsu H10966
- 32 devices now in house



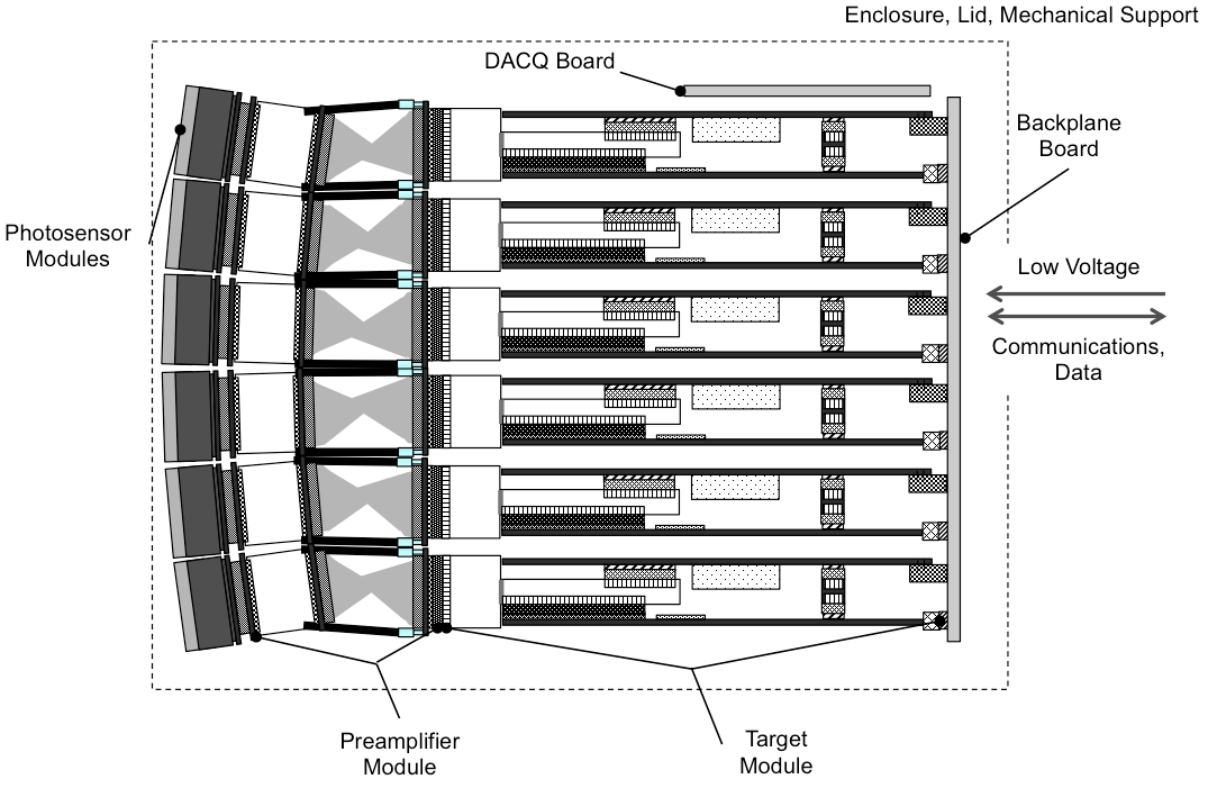
SST Camera

- For energy range 5 – 300 TeV
- Focal plane 40x40cm
- 2000 pixels

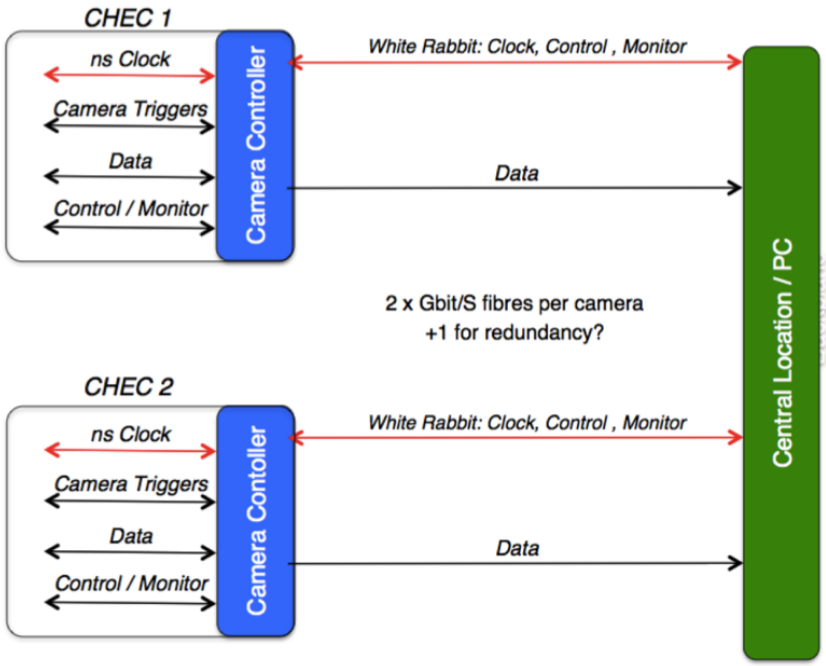
- For 400 Hz trigger rate, 100 ns traces, 12 bit at a 1 GS/s, O(1 Gb/s) output per camera
- Night-sky background (stray starlight, Zodiacal light) tens of MHz / pixel, need Cherenkov shower ‘blob’ trigger
- Analog trigger starts digitisation and readout out of frontend analog buffers

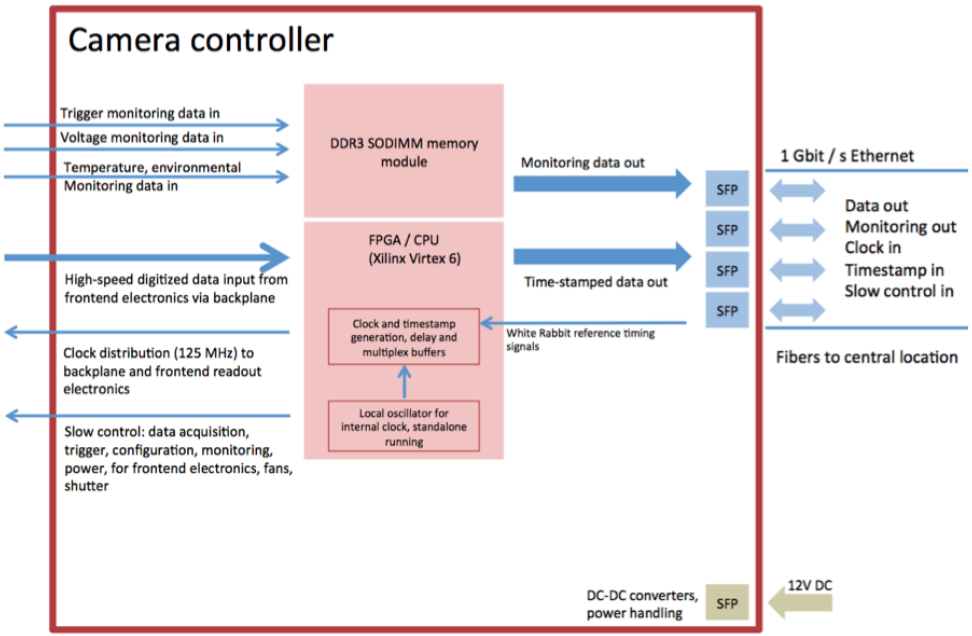
Amsterdam:

- SiPM procurement
- Camera interface card to central DAQ (data, clock, timestamp, housekeeping)



SST camera electronics work

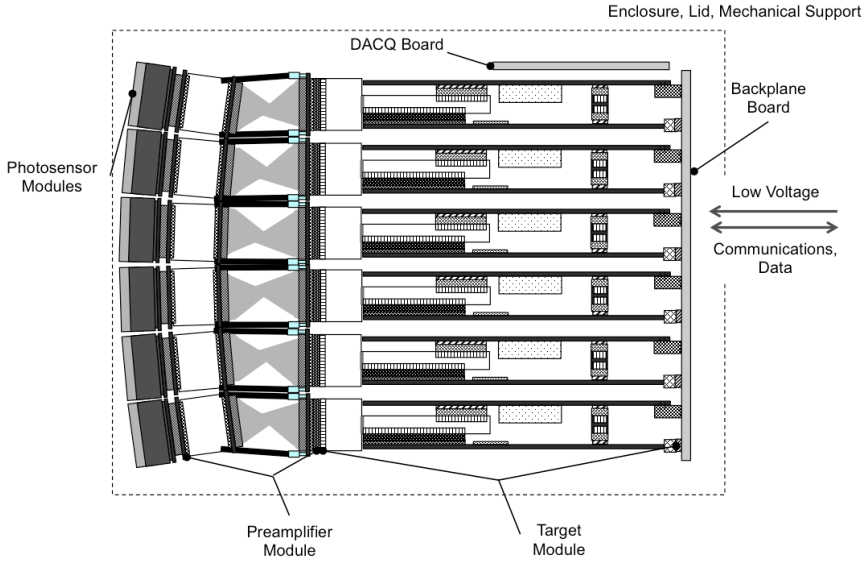


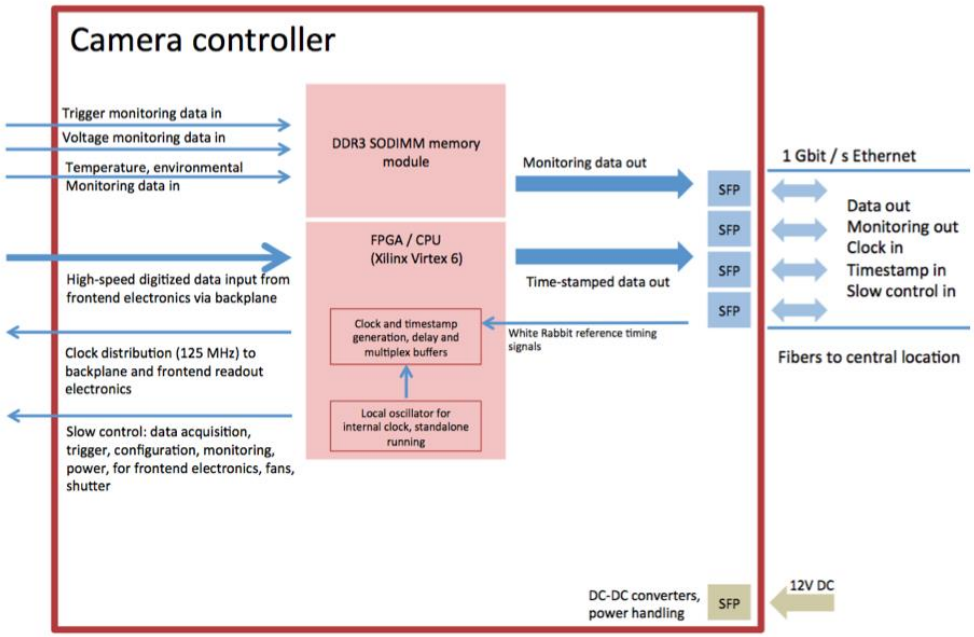


White Rabbit: need <1ns clock sync between cameras, spaced up to 7km apart

SST camera electronics work

Amsterdam, hopefully help from Groningen soon





Delivery of first board by April ‘14, second board end of ’14

Conceptual design, fabrication, firmware programming, eventually camera commissioning, software, etc

WP2: photo-sensors

- To start January 2014 with postdoc hire in Nijmegen
- Develop SiPMs with Philips, eventually for CHEC
  - Philips units spit out digital photon counts, rates and sensitivities for blue Cherenkov light challenging
  - Fitting into the CTA schedule is clearly also a challenge, given the advanced state of SiPM studies
- At the same time, lab contribution to CTA common camera testing

WP3 SST (CTA) pointing system

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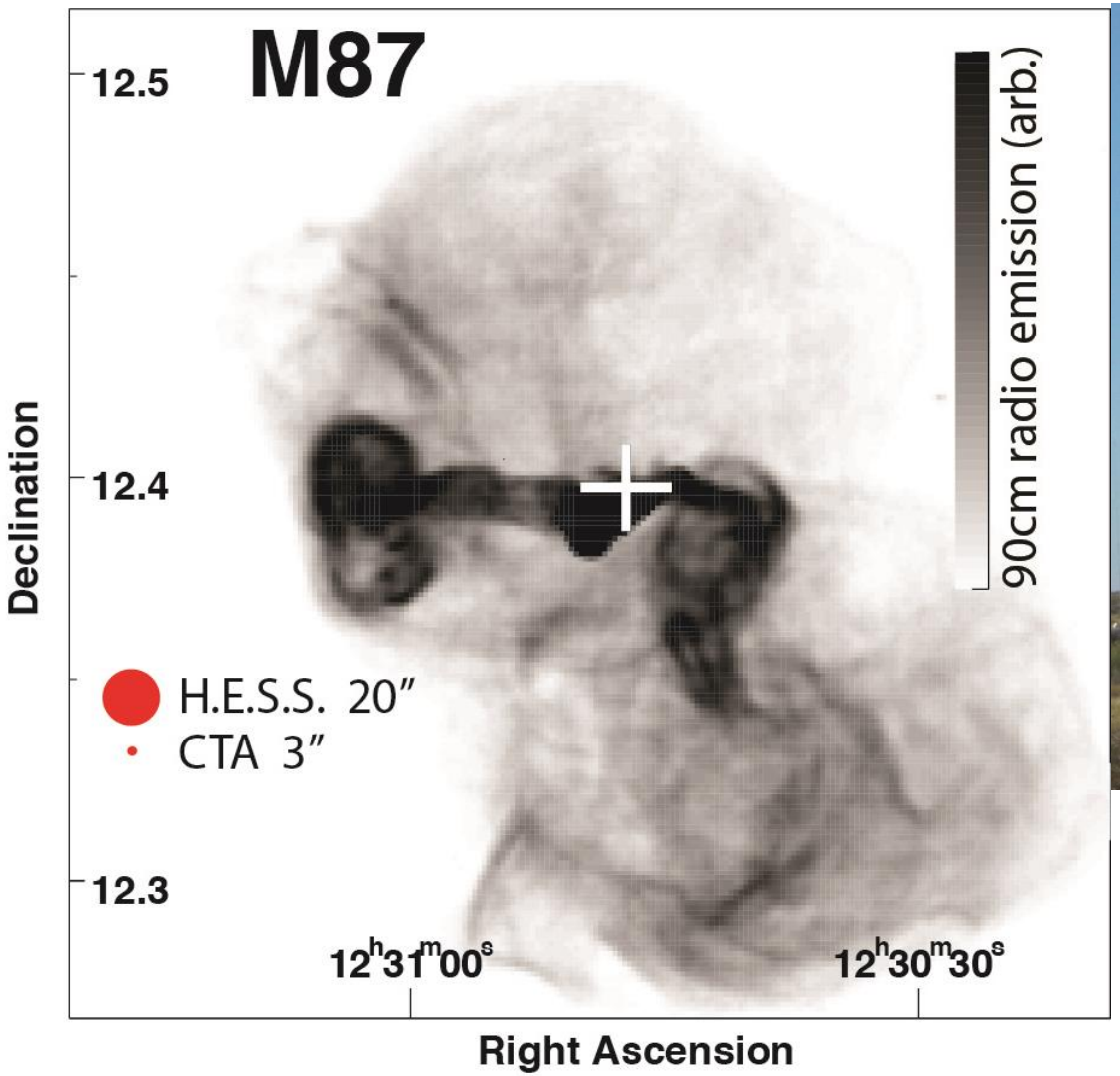
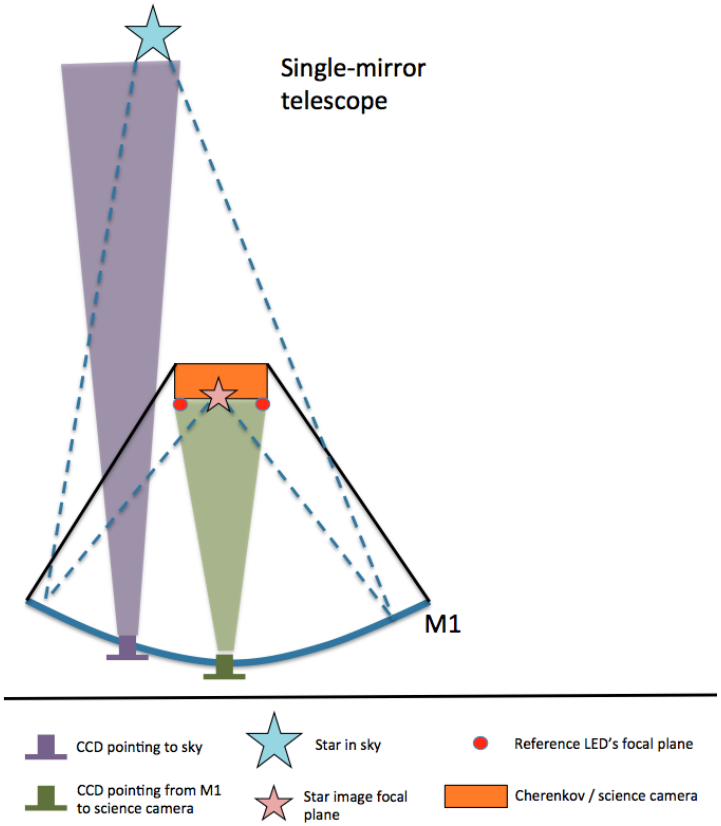


Relevant for galactic center, M87, Cen A…

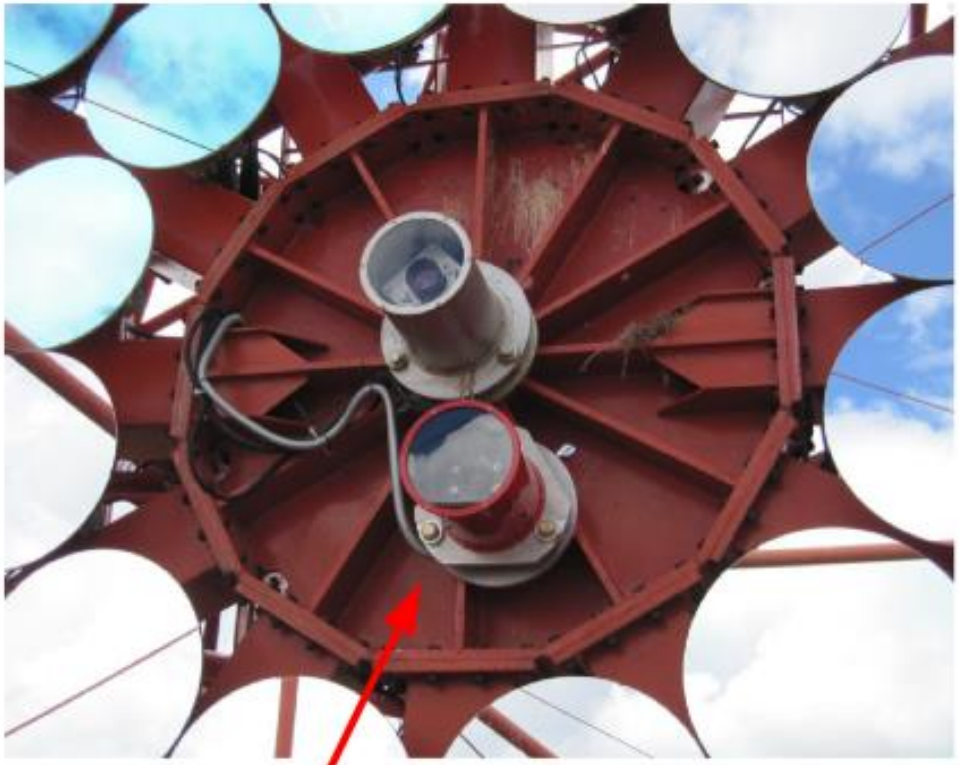
WP3 SST (CTA) pointing system

$$p \approx 150\,\mu m \times \frac{f}{6m} \times \frac{\Delta}{5''}$$

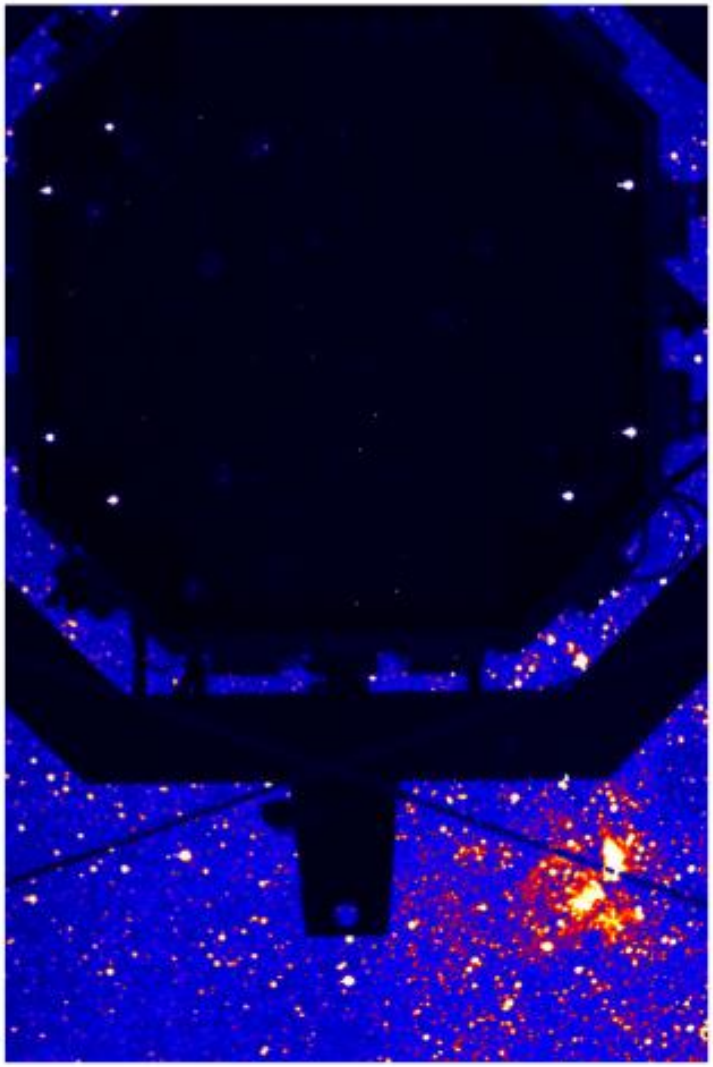
WP3 SST (CTA) pointing system



WP3 SST (CTA) pointing system



Apogee Alta U2, 85mm lens
FoV (total): 59 sq deg
FoV (unshadowed): 13 sq deg

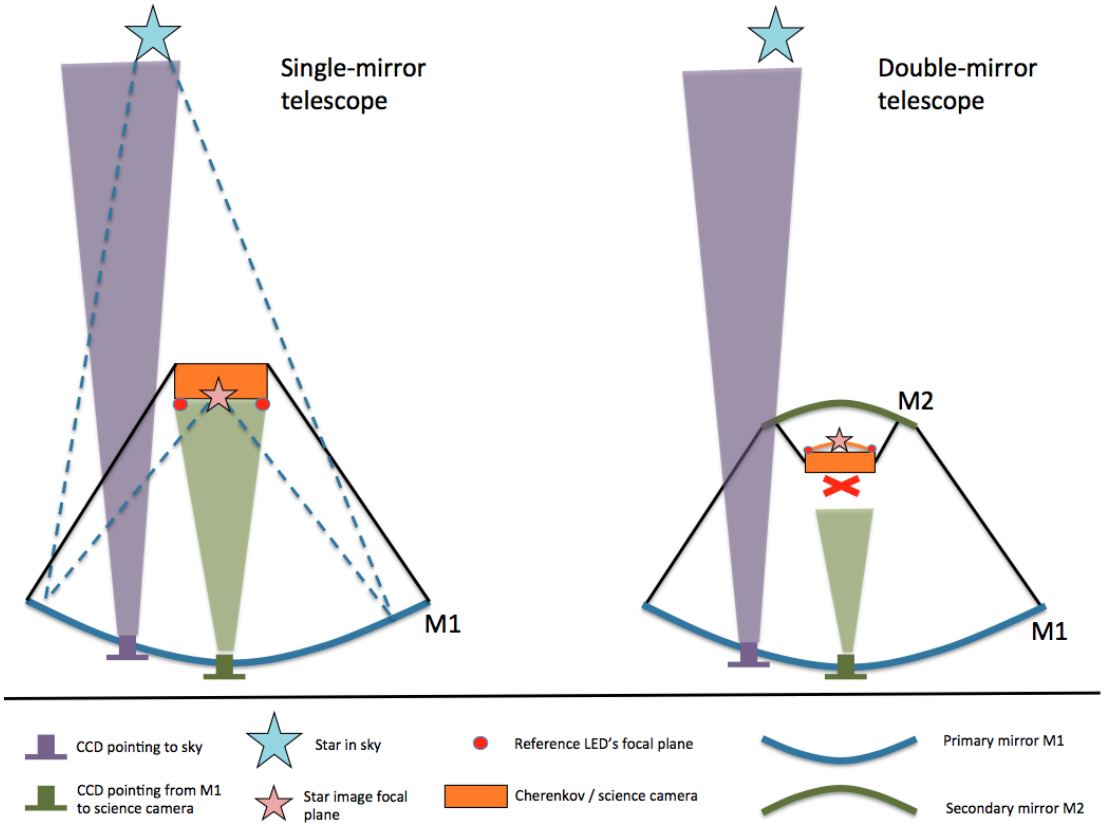


WP3 SST (CTA) pointing system

HESS approach with CCDs doesn't work for 2M SSTs

Our approach: measure starlight directly with Cherenkov pixels

Task: measure DC light with AC coupled electronics…



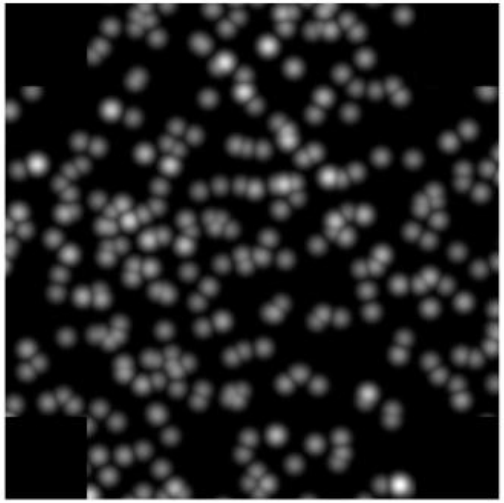
WP3 SST (CTA) pointing system

Use the Science Camera

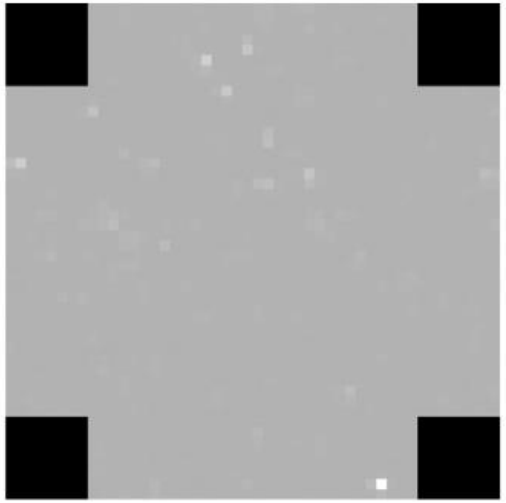
- No additional optics
  - Only electronics + control
- Continuous monitoring
  - On-line system & pointing stamping, but might save all data
- Tracks the actual sky rather than the telescope
  - “Crappy” image quality
  - Dual Mirror Design
  - Segmented design
- Calibration
  - Known gamma-ray sources
  - Drift scans

WP3 SST (CTA) pointing system

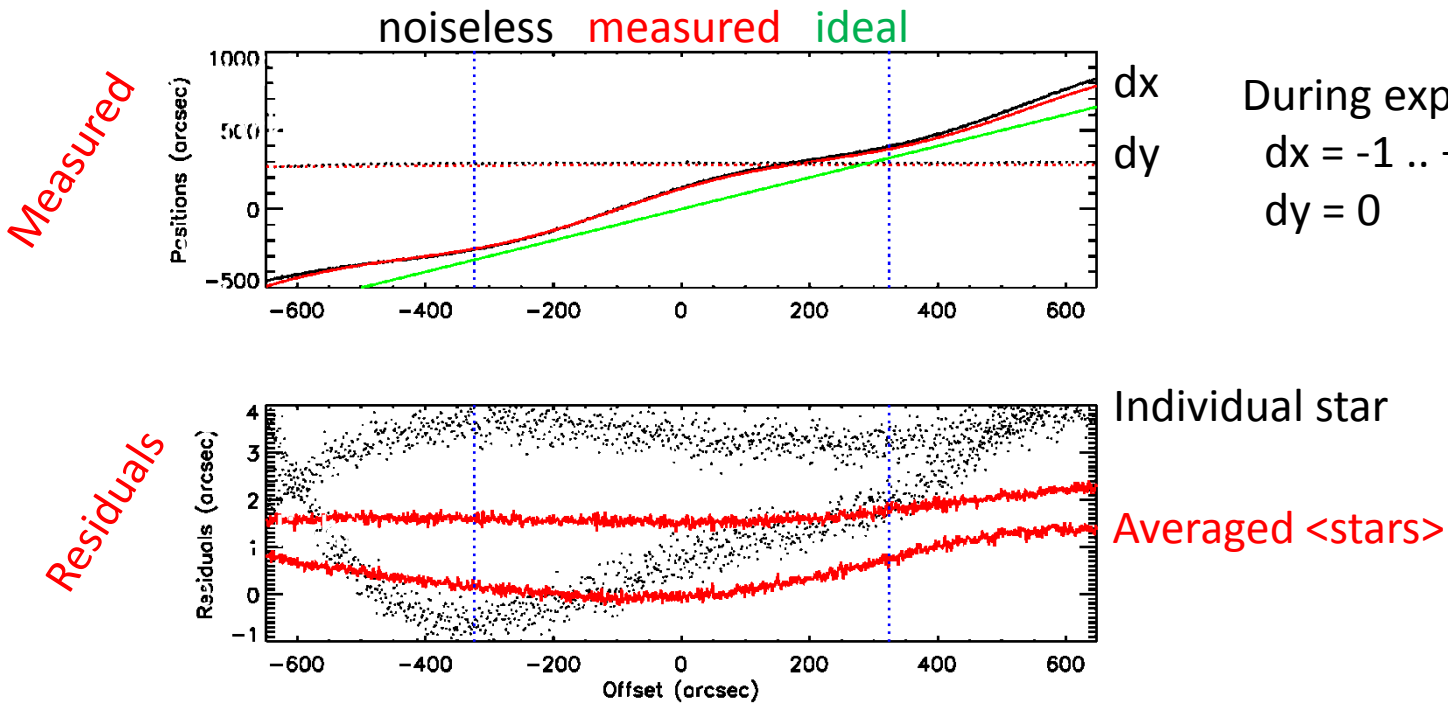
Simulated sky image (no bg)



~What CHEC sees

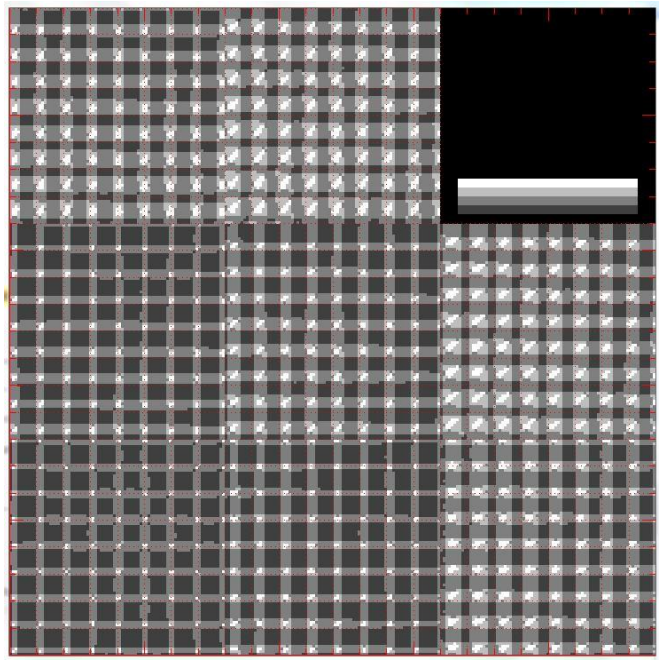


WP3 SST (CTA) pointing system



During experiment:
dx = -1 .. +1 pix
dy = 0

WP3 SST (CTA) pointing system



 # pixels containing >10% energy
White = 4, Darkest gray = 1

Sensitivity: extremely sensitive at pixel edges, not so sensitive at pixel centres

Cooperate with Leicester to split slow starlight from fast Cherenkov signal, separate readout path

CTA pointing: recent development

- NWO-M grant application
  - 1 more postdoc, equipment money (electronics modifications)
  - Extend to MSTs
  - Decision February 2014
- CTA pointing coordination by one of us
  - Our work and ideas is being recognised within CTA

Further opportunities?