



cherenkov
telescope
array



The GCT Camera for the Cherenkov Telescope Array

Jon Lapington



For the GCT Collaboration
and the CTA Consortium
<http://cta-observatory.org>



Components of CTA

Few large telescopes
for lowest energies

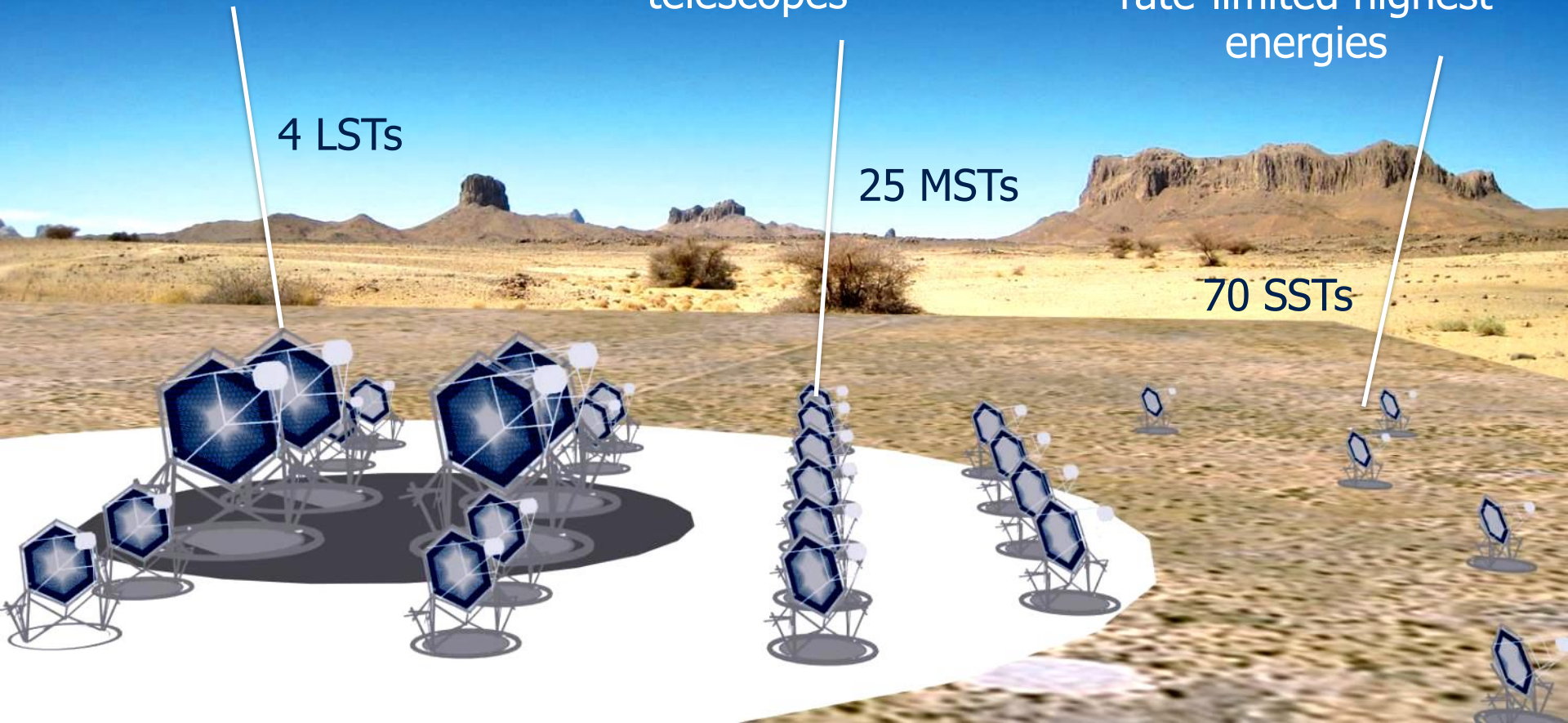
4 LSTs

\sim km² array of
medium-sized
telescopes

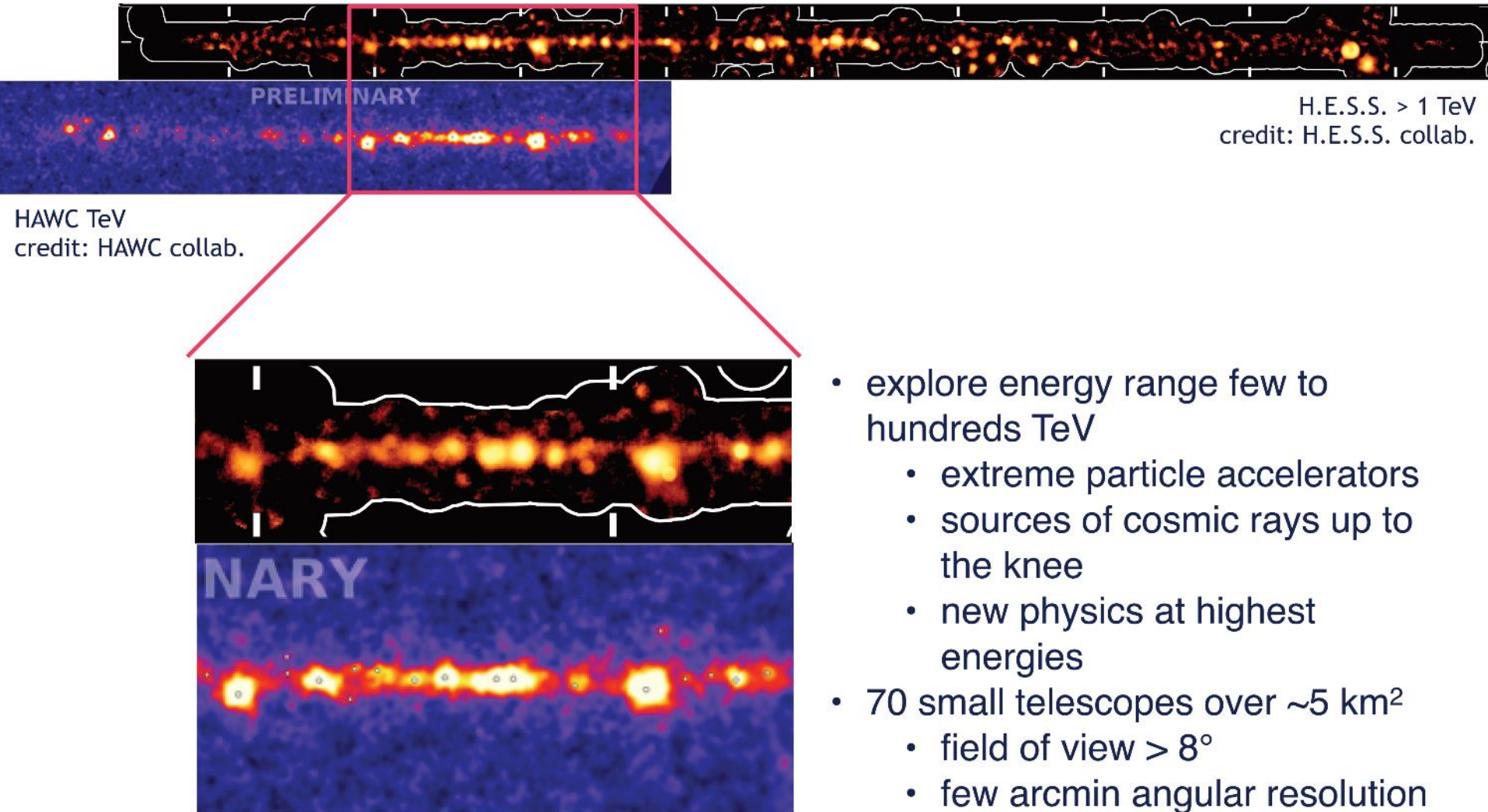
25 MSTs

large 5 km² array of
small telescopes, for
rate-limited highest
energies

70 SSTs



The Small-sized telescopes for CTA



H.E.S.S. > 1 TeV
credit: H.E.S.S. collab.

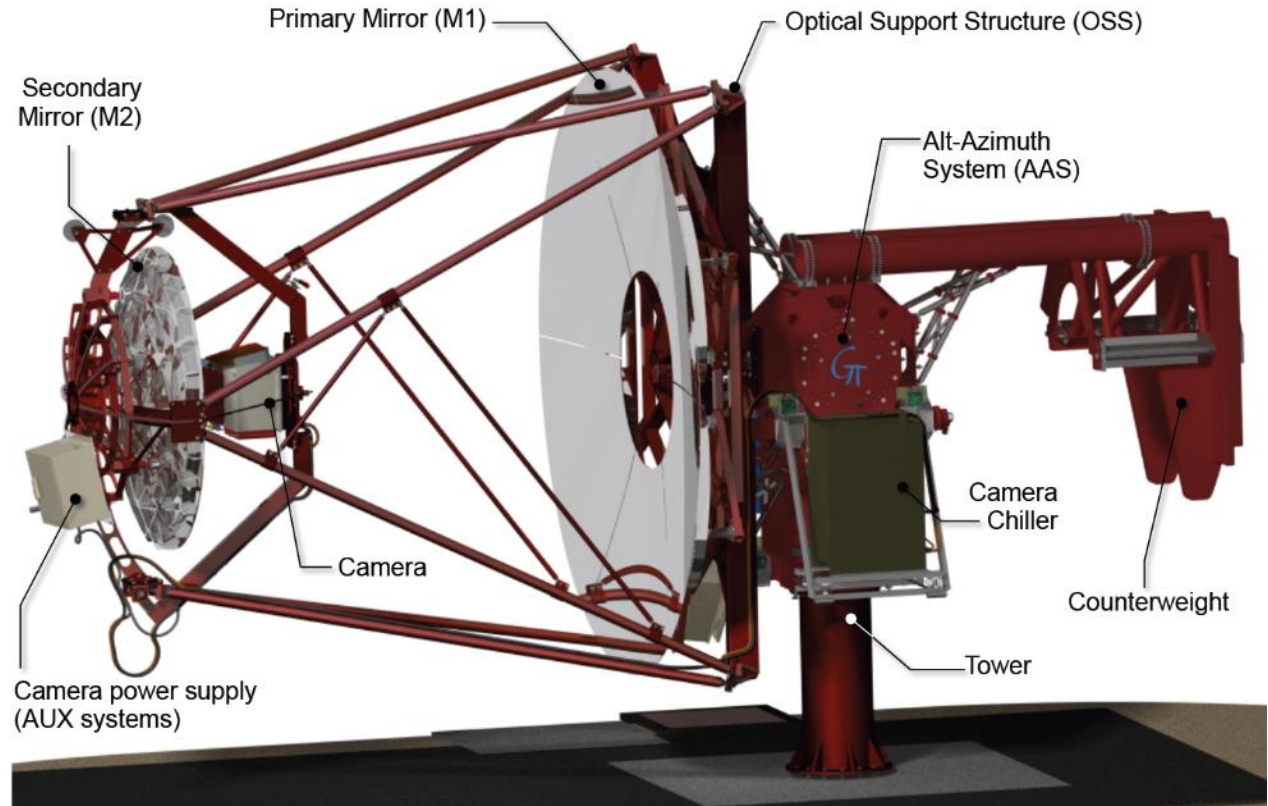
HAWC TeV
credit: HAWC collab.

- explore energy range few to hundreds TeV
 - extreme particle accelerators
 - sources of cosmic rays up to the knee
 - new physics at highest energies
- 70 small telescopes over $\sim 5 \text{ km}^2$
 - field of view $> 8^\circ$
 - few arcmin angular resolution

GCT mechanical design



- Paris 2015.
- Four masts to support secondary.
- Adjustable counterweight.
- Primary mirror rotation mechanism to facilitate mirror installation.
- Camera removal mechanism which allows camera installation or removal in 15 minutes.

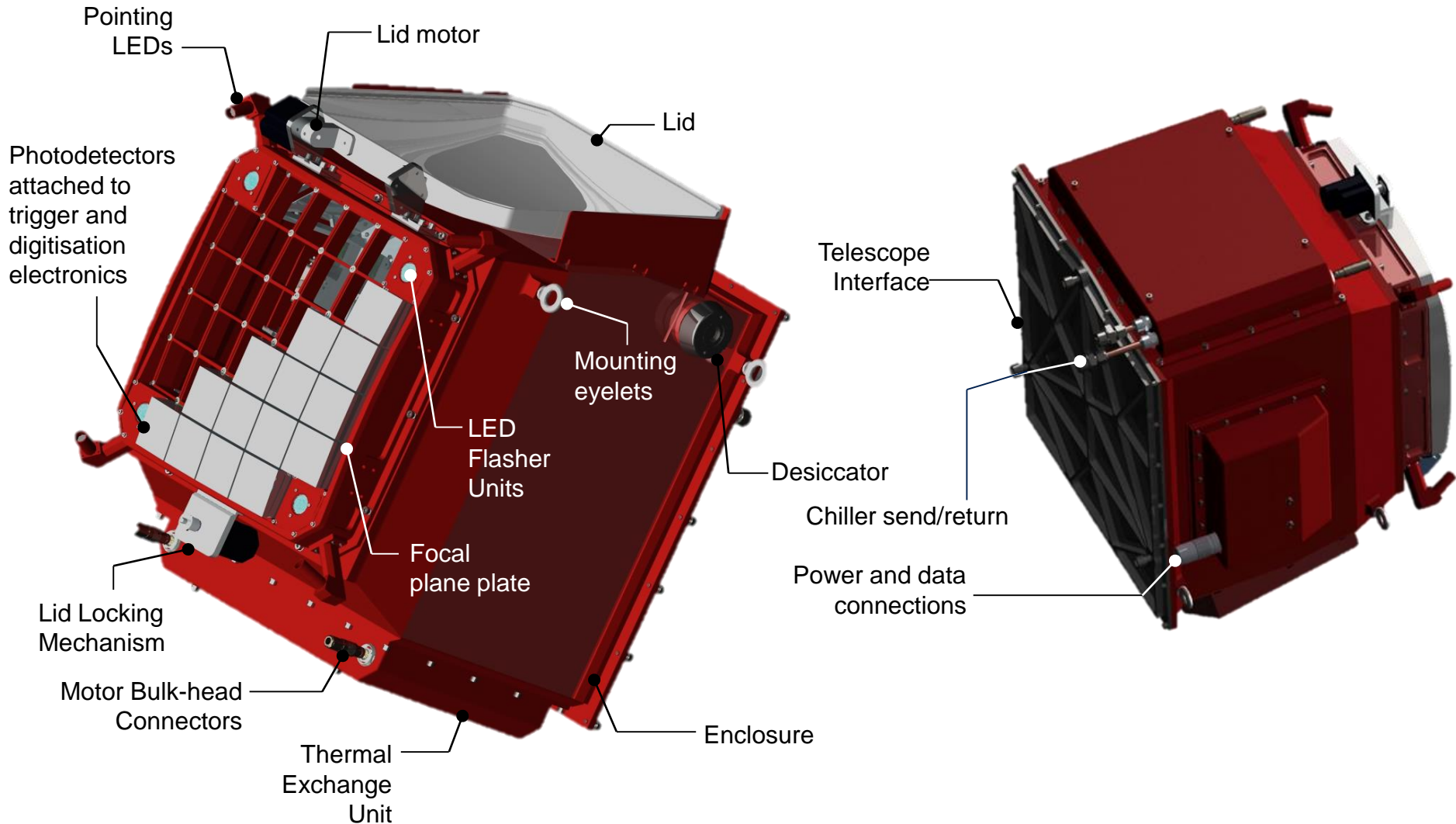


The GCT Camera

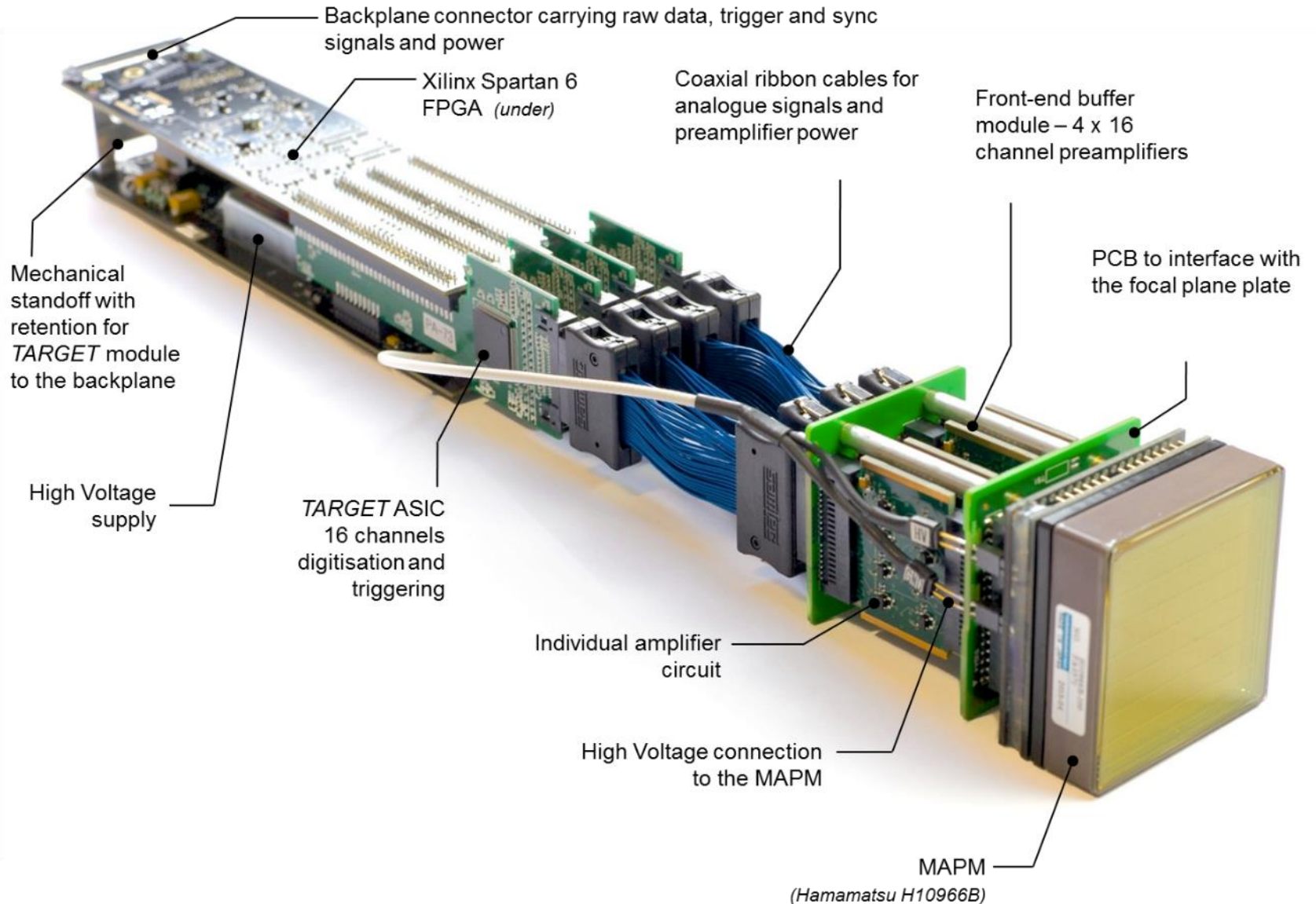


- International camera collaboration
 - UK, US, Germany, Japan, Netherlands, Australia
- Scope
 - 2 prototype cameras
 - CHEC-M based on MAPMs
 - CHEC-S based on SiPMs
 - At least 3 Pre-Production phase cameras
 - 35 Production phase cameras
- Philosophy
 - High performance at low cost
 - ~150 k€
 - Full waveform digitisation
 - Compatible with SST-GATE and ASTRI

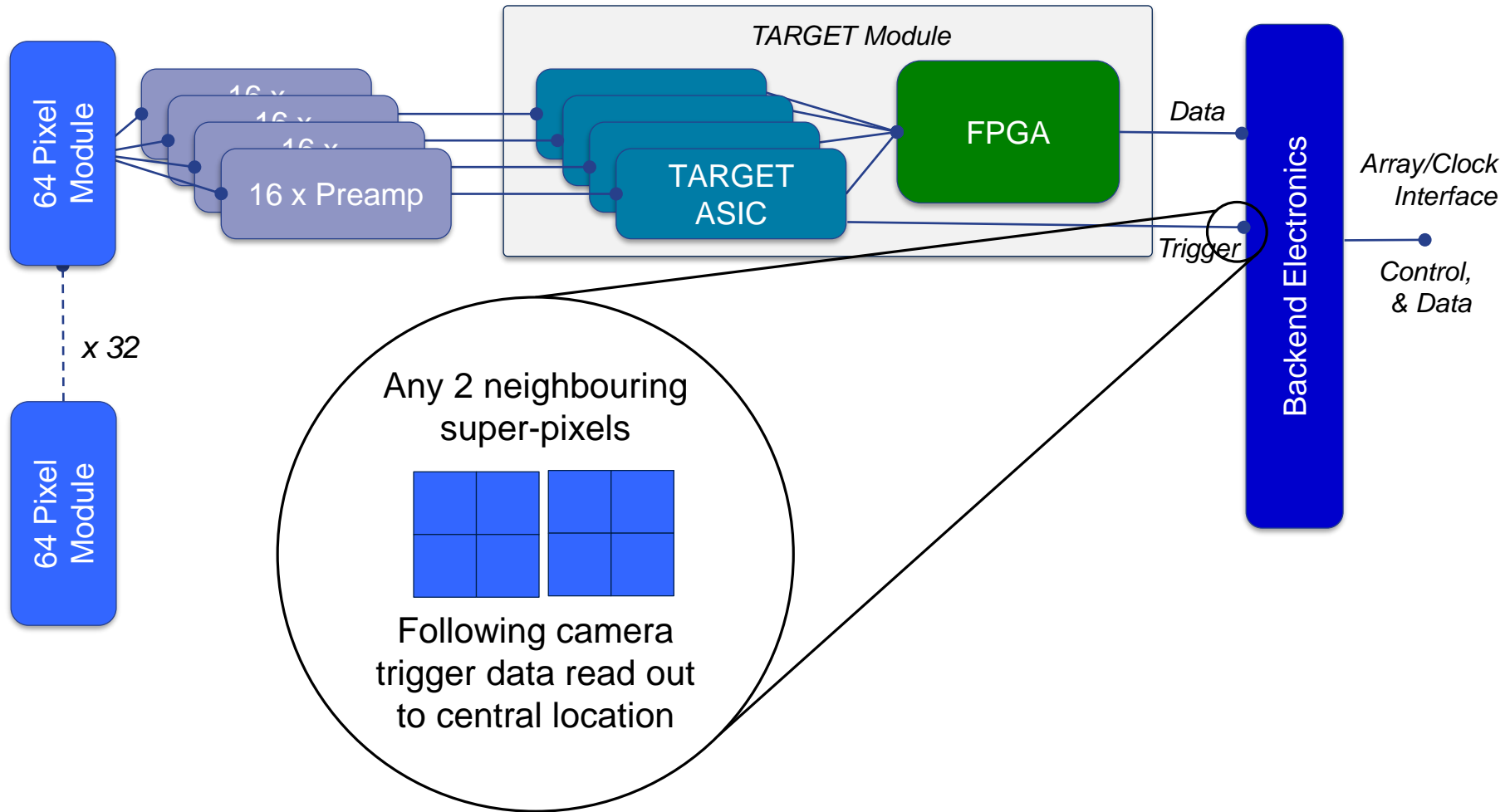
CHEC-M Overview



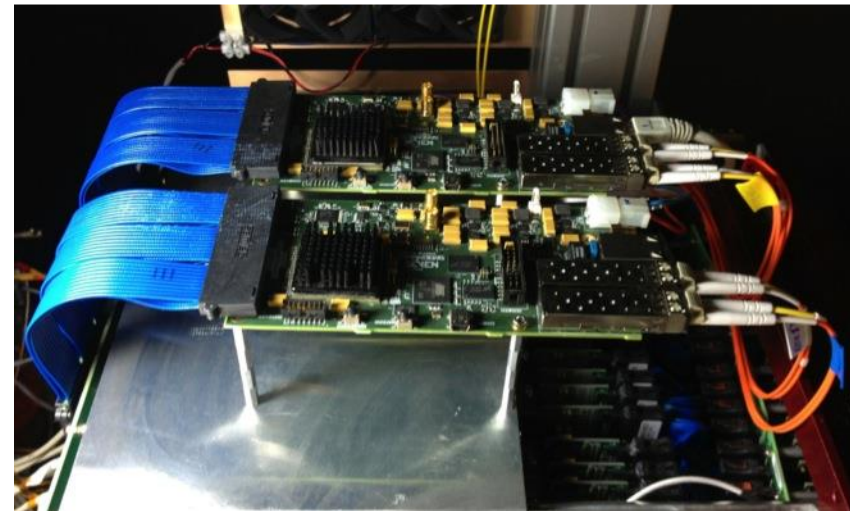
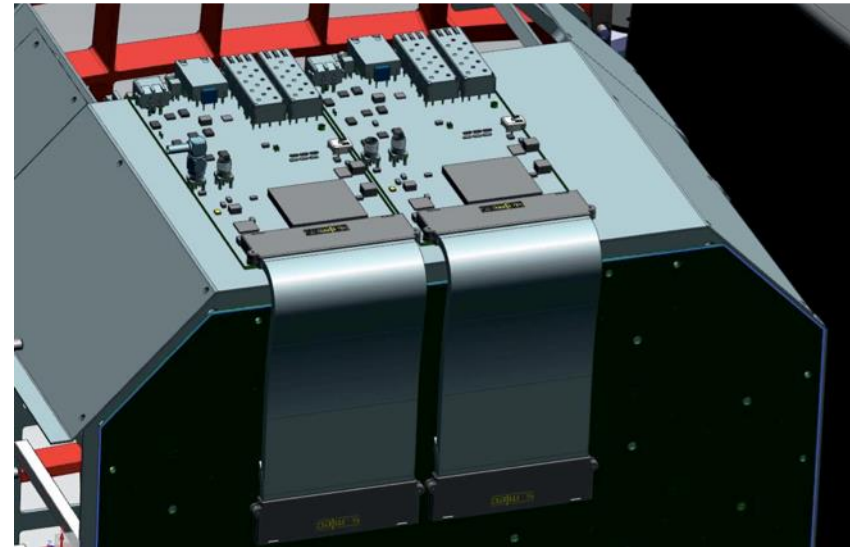
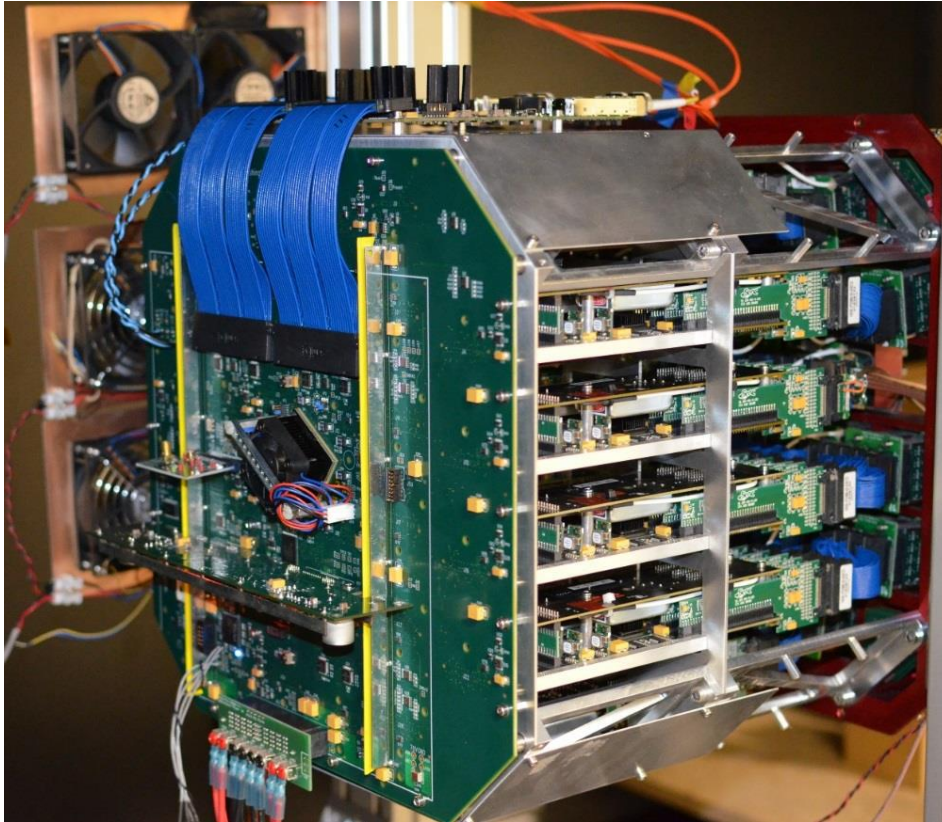
CHEC-M Camera Module



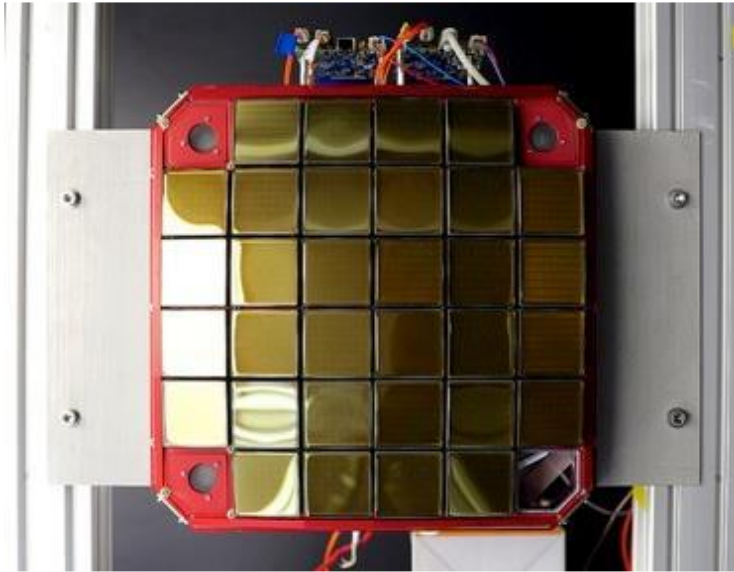
Electronics and Readout



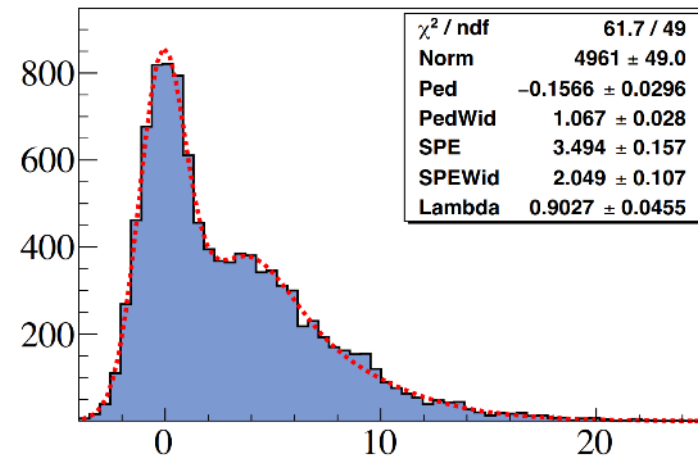
CHEC-M Backplane and DACQ boards



CHEC-M Commissioning Lab Setup



Single PE spectrum (1 pixel) 1100 V



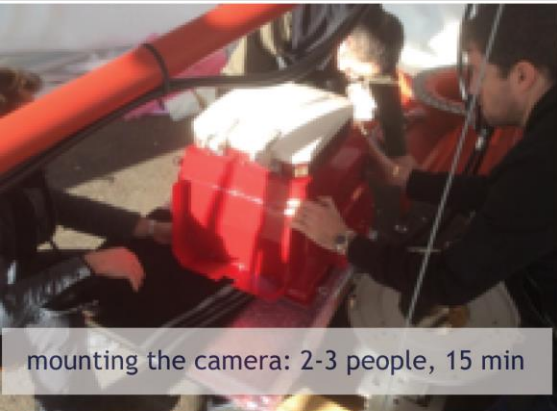
Inauguration of the telescope



- CHEC-M on-telescope campaign
- 2.5 weeks November 2015, Observatoire de Paris, Meudon
- Telescope prototype – 2 out of 6 M1 mirrors installed
- Inauguration – early December 2015



Commissioning and first light



mounting the camera: 2-3 people, 15 min



night-sky background in Meudon (Nov 26 2015): 20-100 times brighter than at CTA site

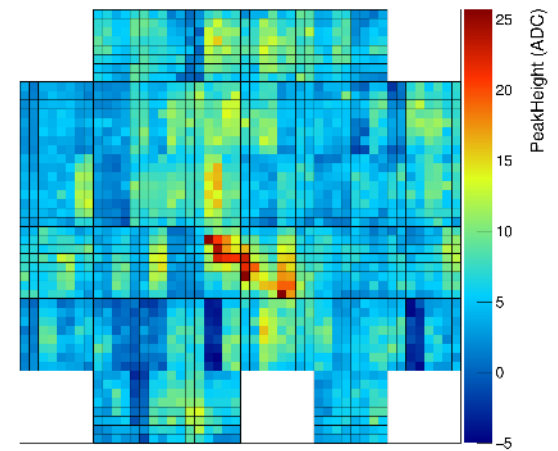
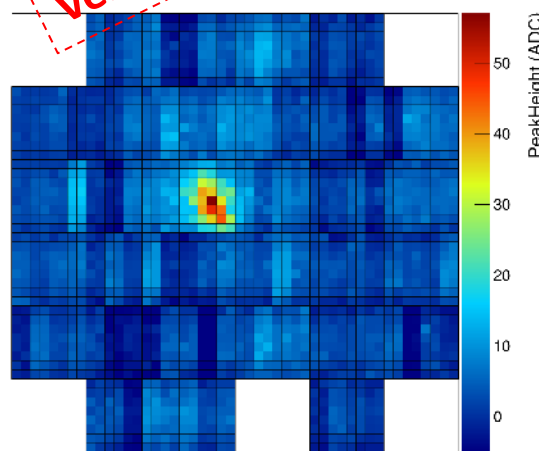
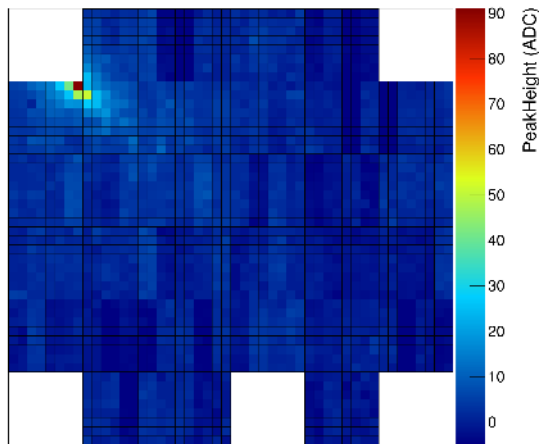
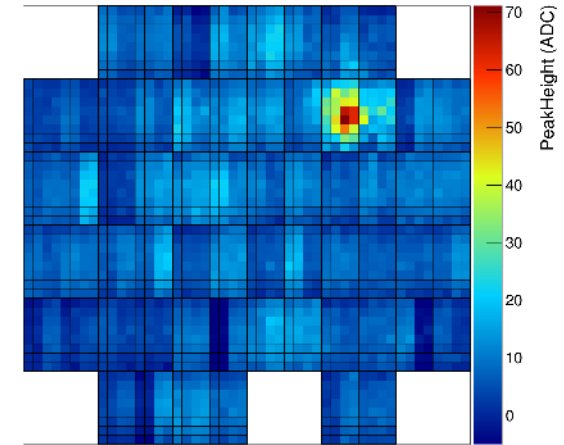
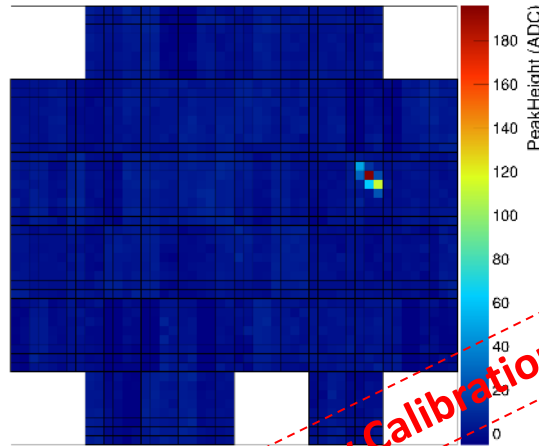
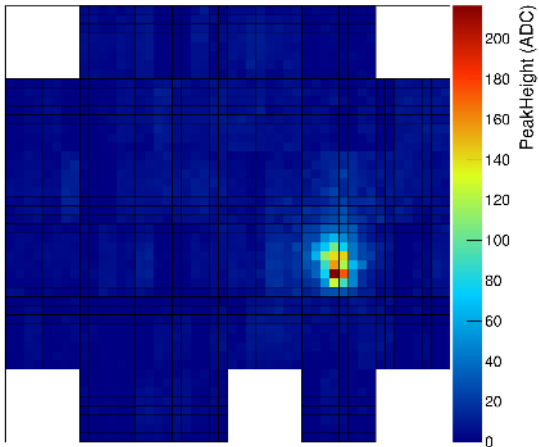
Paris – Observing Conditions



- NSB
 - At least 500 MHz
 - Nominal operating condition in Chile: 12 MHz NSB
- Gain
 - Lab measurements done gain-matched to 950 V max
 - Onsite: 750 V max, estimated gain-matching only (1/3 nominal gain)
- Collection area
 - 1/3 mirror area on primary
 - No mirror alignment



First Cherenkov Light

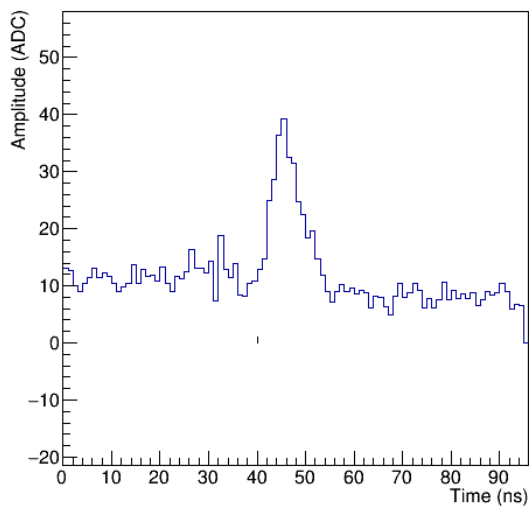


Very Preliminary Calibration

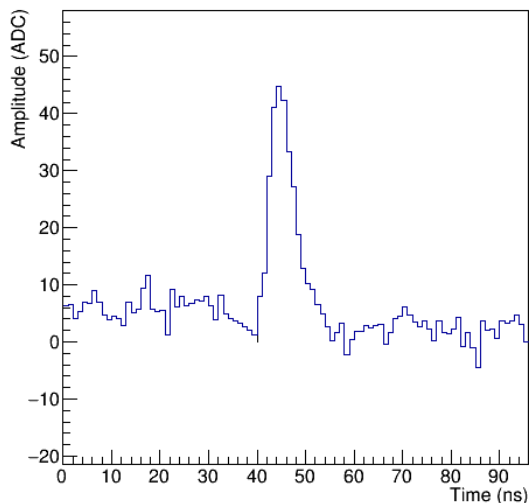
First Cherenkov Light



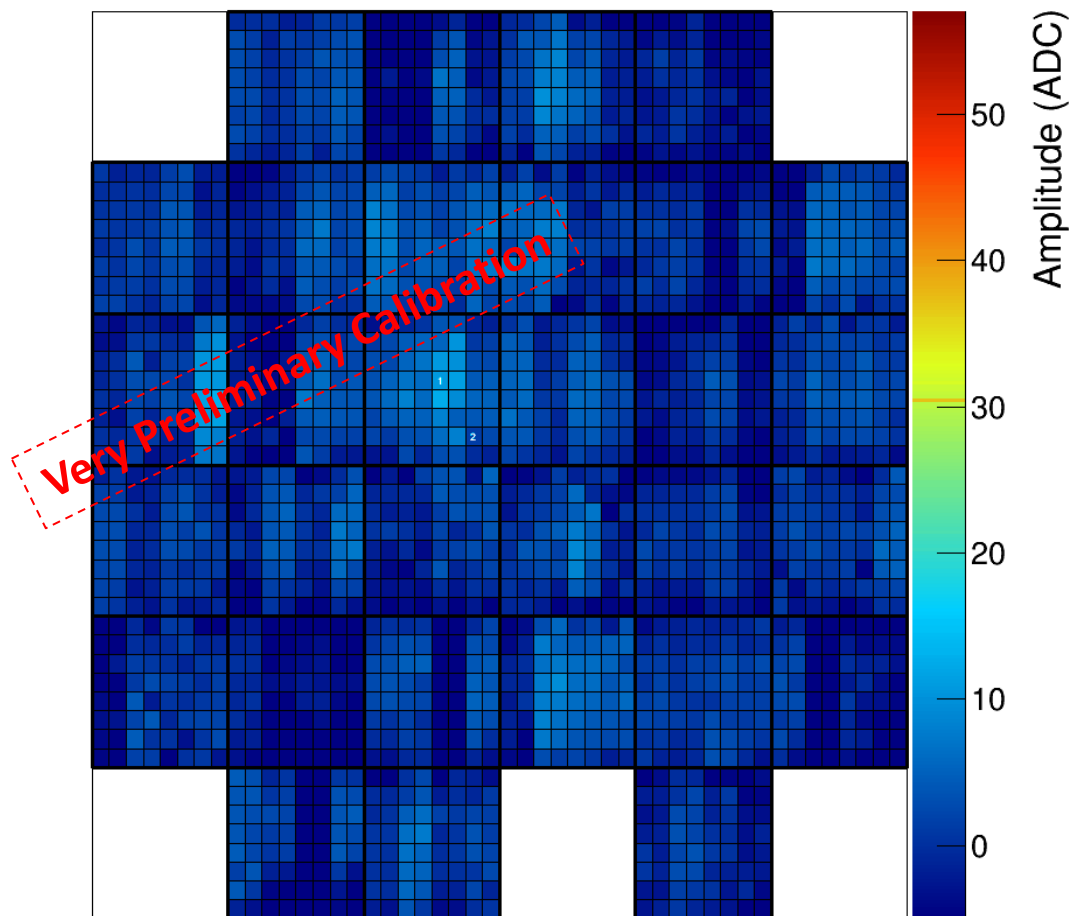
r1594_e2_t40-60_EventMoviePixel804



r1594_e2_t40-60_EventMoviePixel950



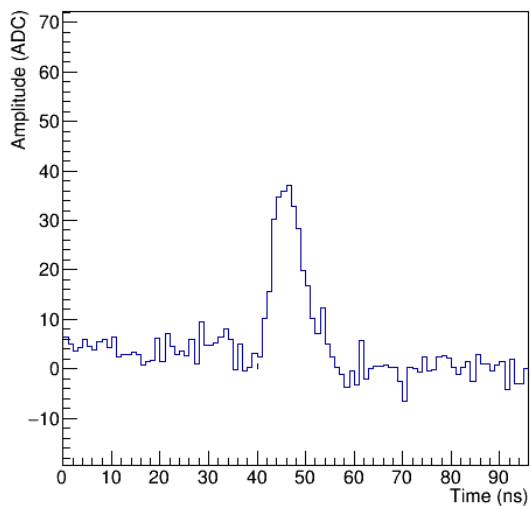
r1594_e2_t40-60_EventMovie



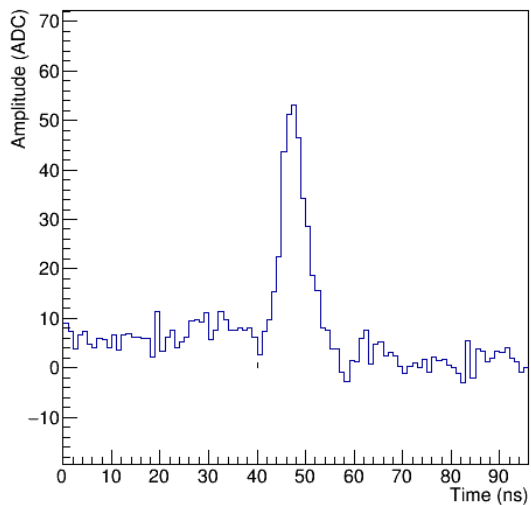
First Cherenkov Light



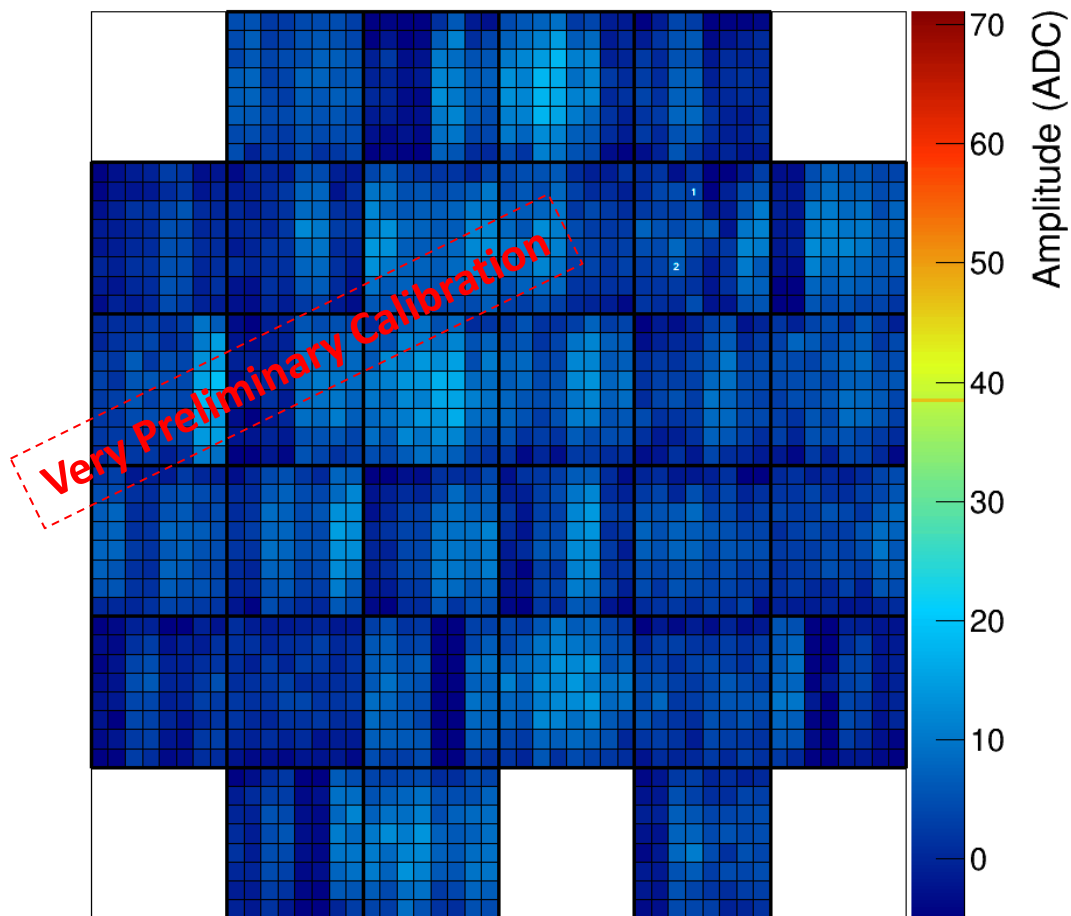
r1594_e7_t40-60_EventMoviePixel339



r1594_e7_t40-60_EventMoviePixel530



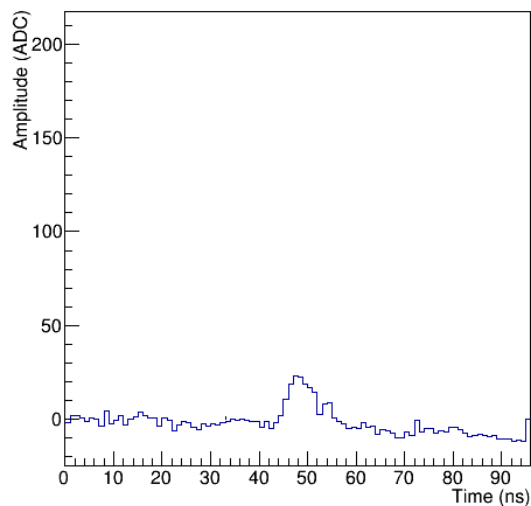
r1594_e7_t40-60_EventMovie



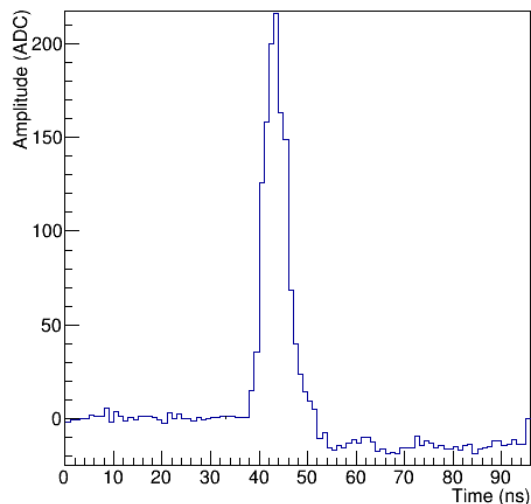
First Cherenkov Light



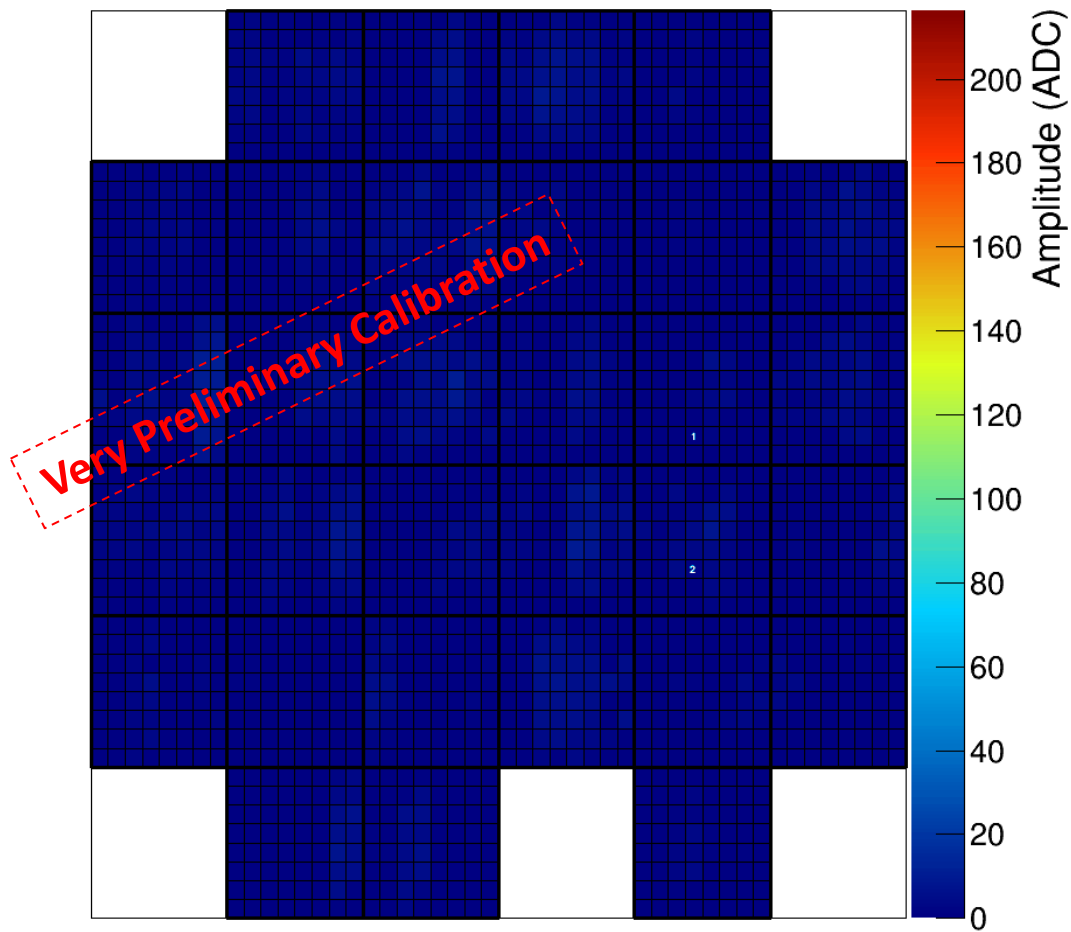
r1594_e9_t33-54_EventMoviePixel963



r1594_e9_t33-54_EventMoviePixel1299



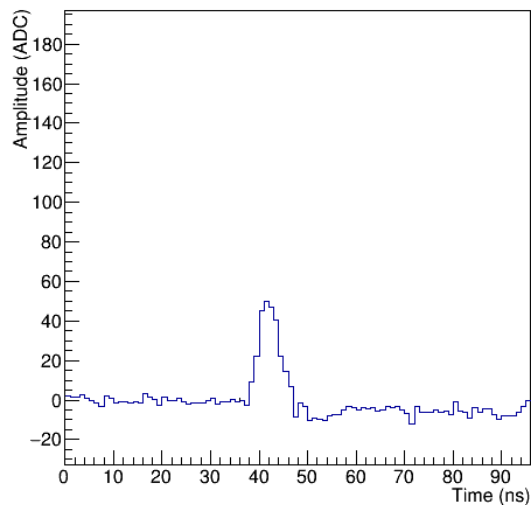
r1594_e9_t33-54_EventMovie



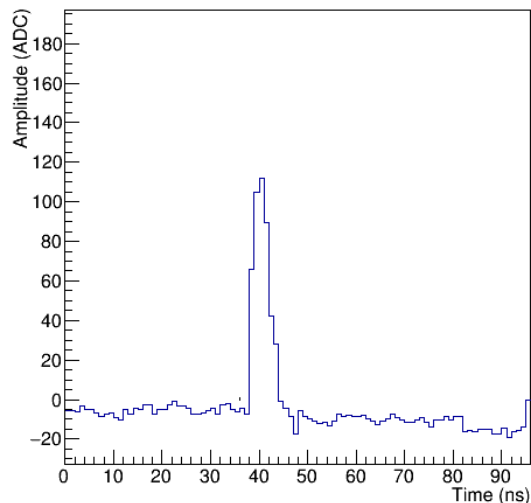
First Cherenkov Light



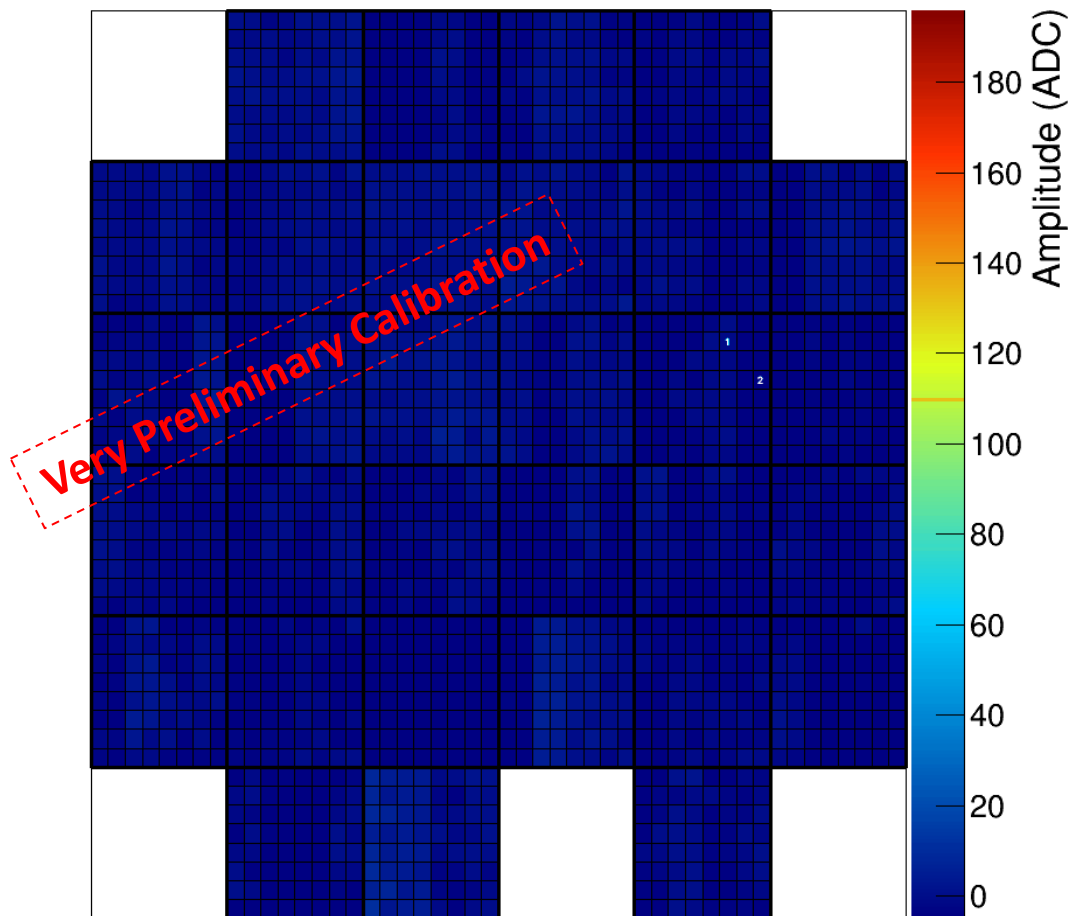
r1594_e11_t36-48_EventMoviePixel725



r1594_e11_t36-48_EventMoviePixel823



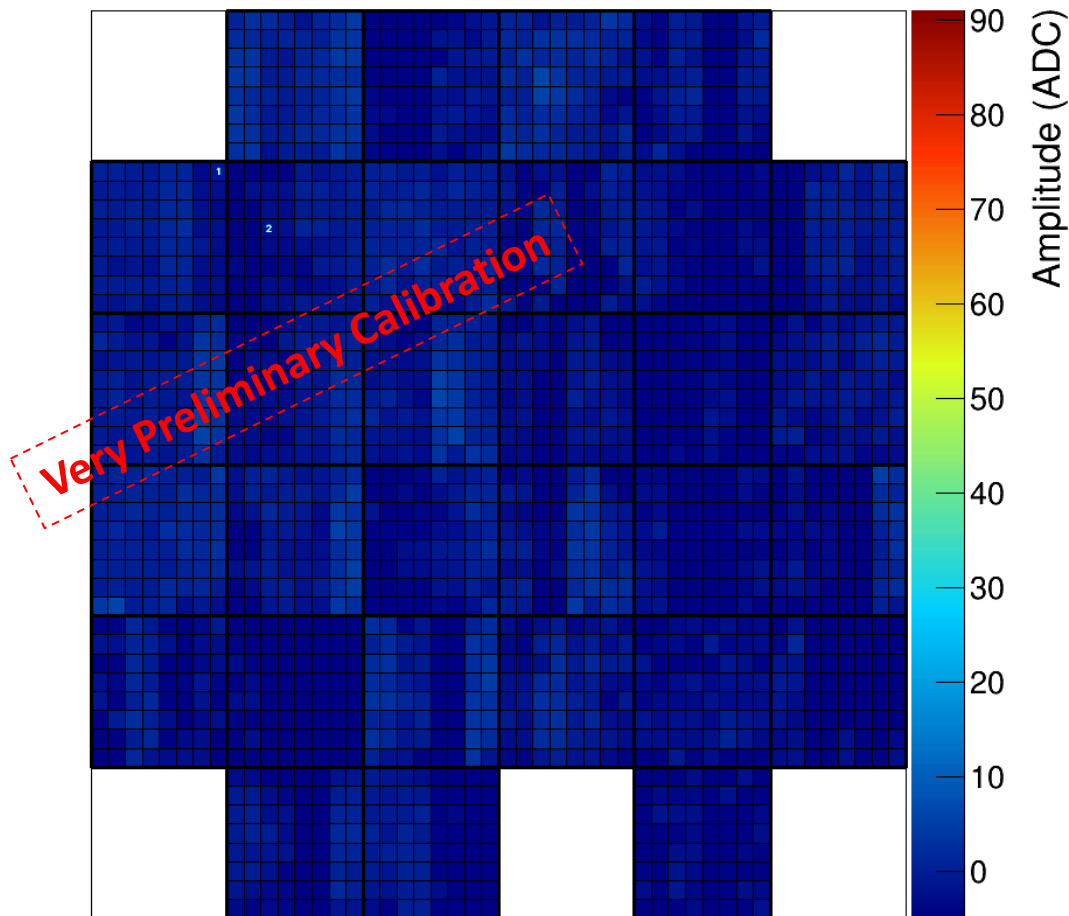
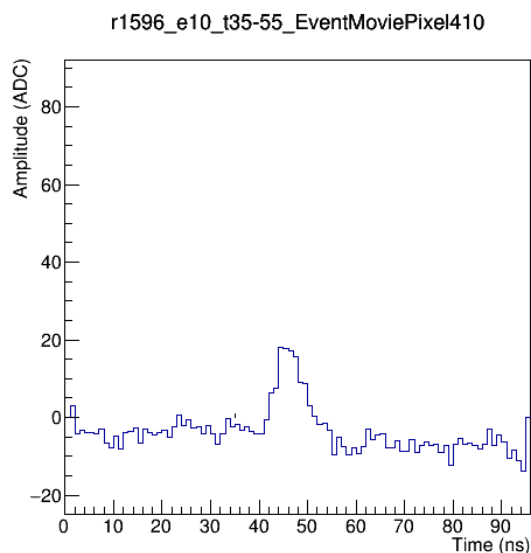
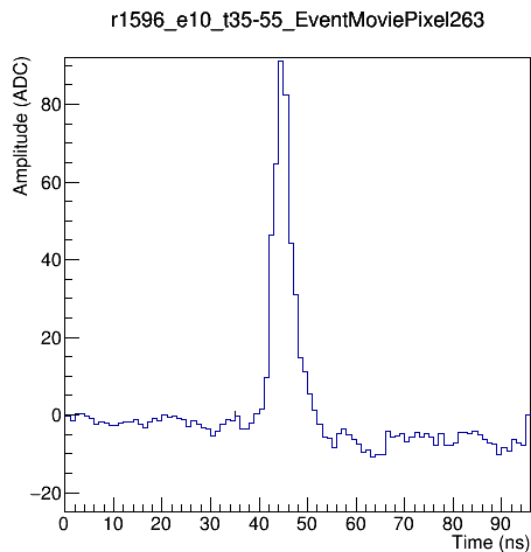
r1594_e11_t36-48_EventMovie



First Cherenkov Light



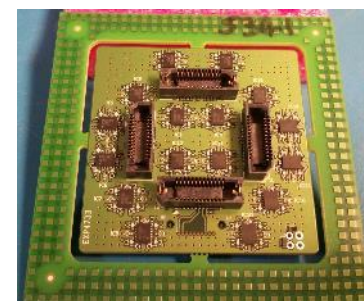
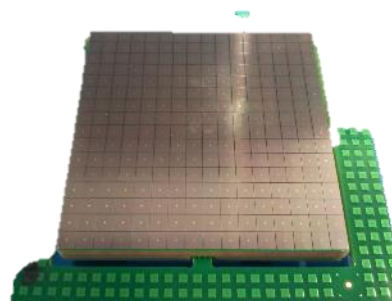
r1596_e10_t35-55_EventMovie



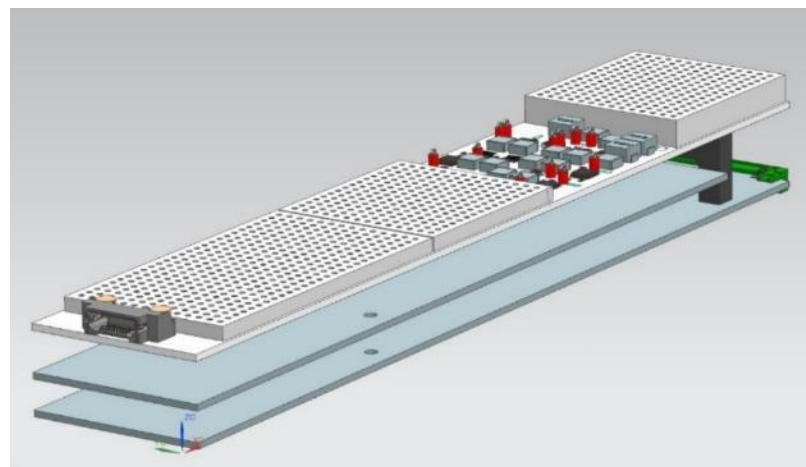
CHEC-S Second Camera Prototype



- SiPM sensors replace MAPMs
 - Hamamatsu S12646-1616PA-50
- Mechanical design improvements inc. cooled focal plane
- Redesigned TARGET module with latest generation ASICs
 - Separated digitiser and trigger functionality – TARGET-C & T5TEA
 - TARGET-C: 1.9 V dynamic range, improved charge resolution
 - T5TEA: triggering with $< 1/4$ p.e. noise
- Reworked safety/control system
- DACQ boards upgraded to 10Gb/s
- CHEC-S assembly test and 2017

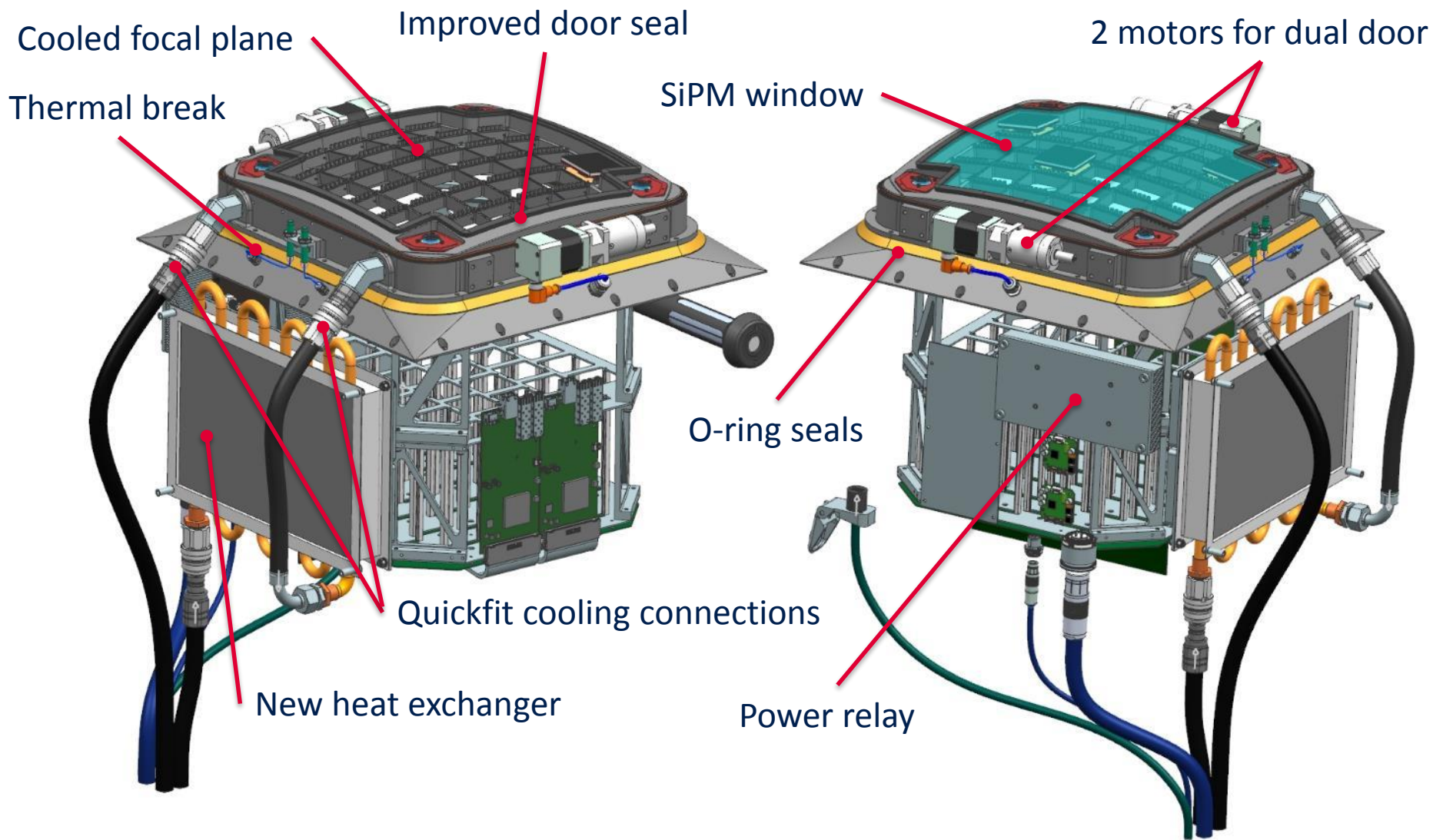


SiPM sensor and 64 channel preamplifier



Redesigned 3 board TARGET module

CHEC-S Camera Mechanics



Summary



- Characterisation of CHEC-M on prototype in Meudon has proven the GCT concept.
- CHEC-S design nearing completion: CHEC-S will be late, but is close to the GCT pre-production camera.
- CHEC-S will be built, tested in the lab and on the telescope prototype at Observatoire Paris-Meudon during 2017.
- Ambitious schedule sees 3 GCT telescopes completed for installation on CTA Southern site in 2018
- Overall we propose to contribute 35 GCTs with installation complete on CTA Southern site by late 2021.

