



The GCT's camera for the Cherenkov Telescope Array

Andrea De Franco

Supervisor : Dr. Garret Cotter



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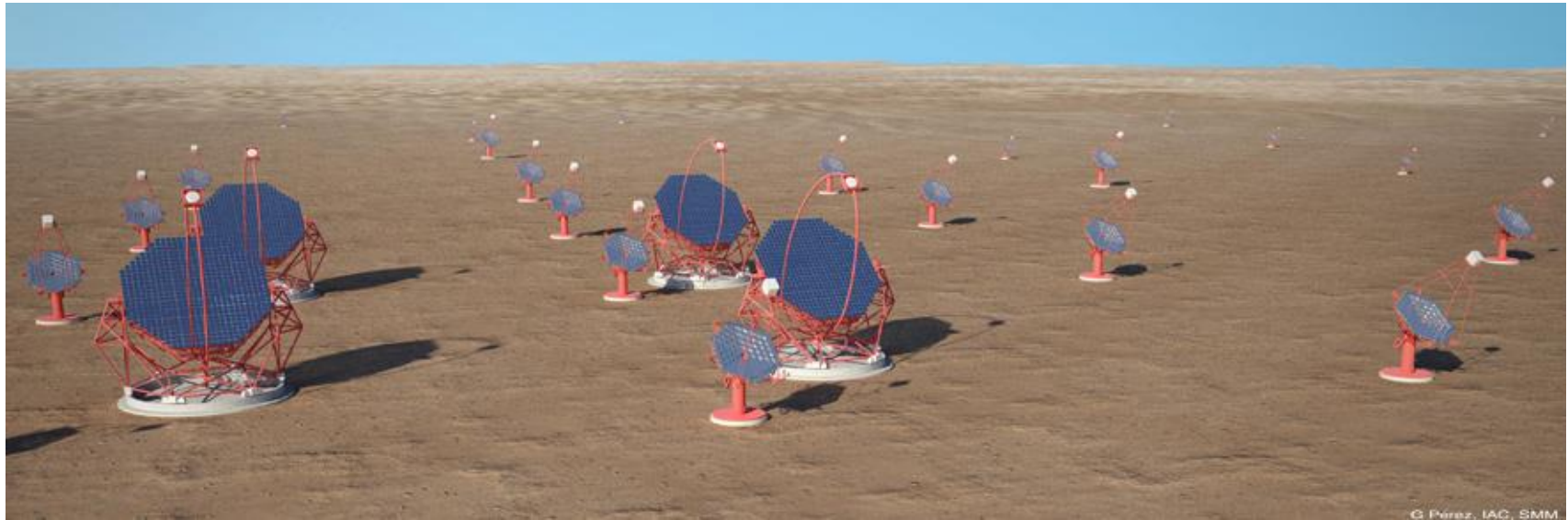
28 Countries

178 Institutions

1193 members (375 FTE)

Construction through in-kind contributions

Cherenkov Telescope Array (CTA)



CTA design goals:

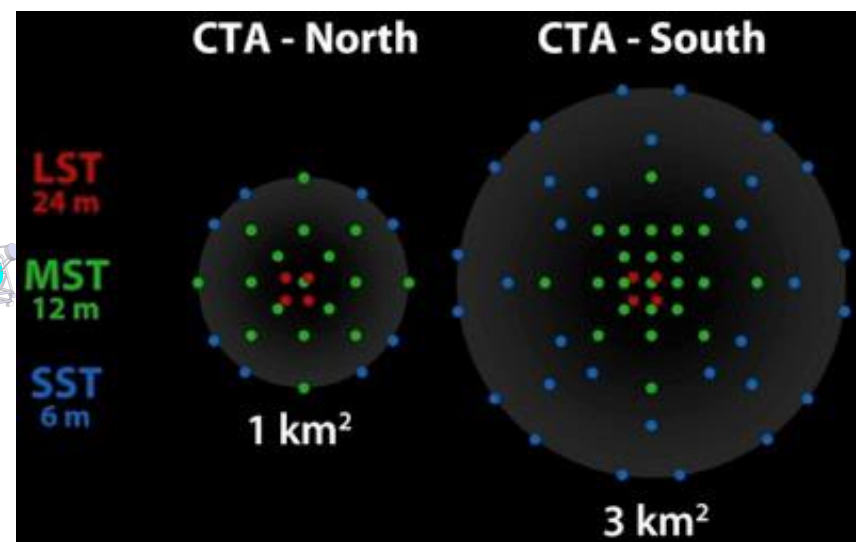
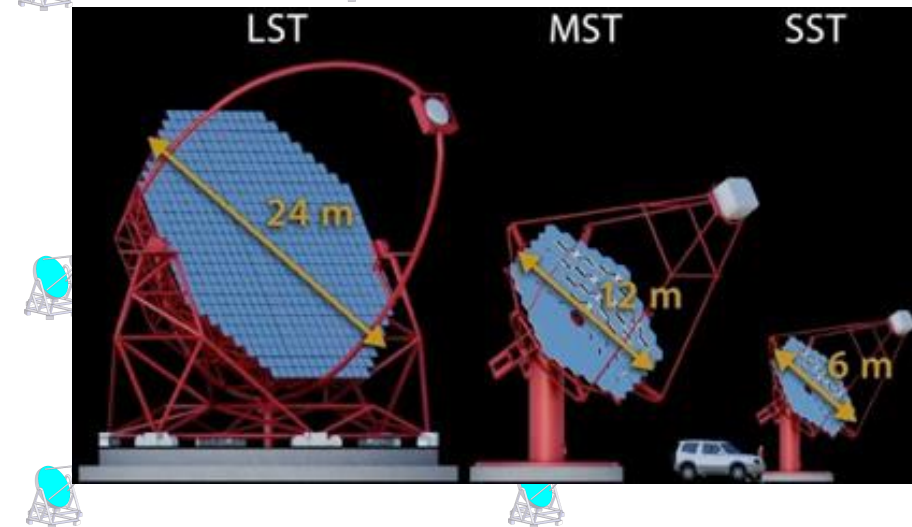
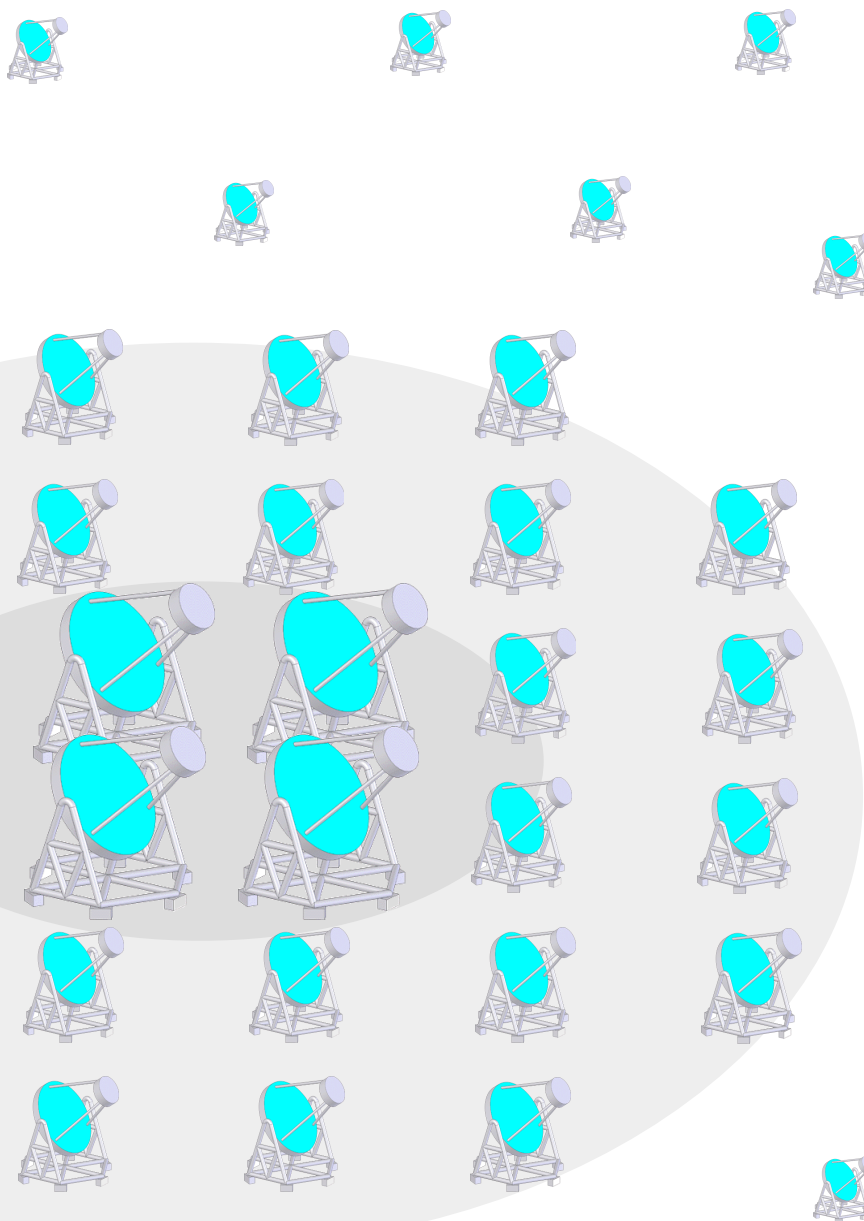
- sensitivity X10 actual IACT instr.
- energy range ~ 30 GeV - 300 TeV
- large ($\sim 8^\circ$) field of view for surveys
- improved angular and energy res.

Full sky coverage :

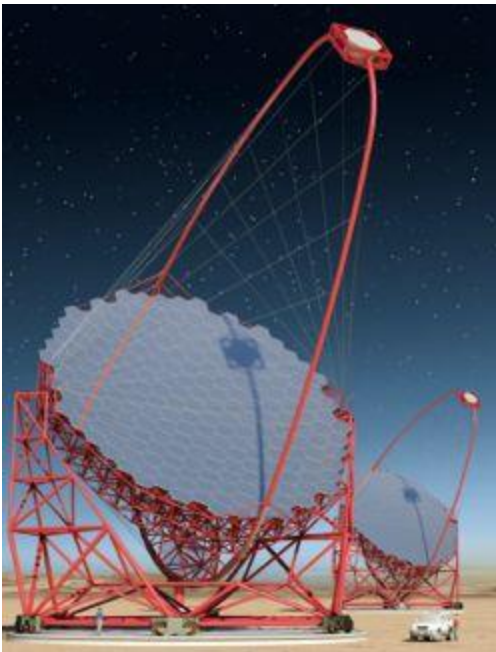
2 sites in Northern and Southern
emisphere

Operated as an Open Observatory

CTA Observatory

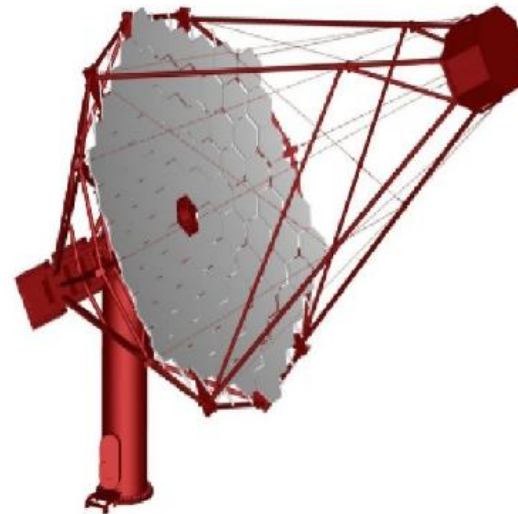


Large Size Telescope (LST)



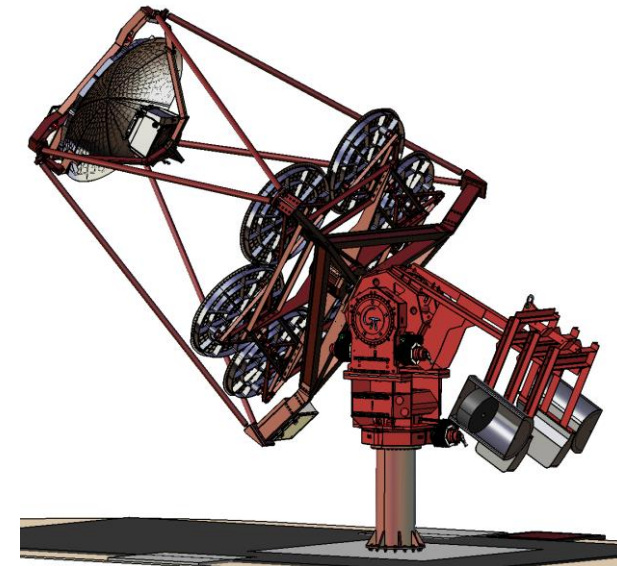
- 23m diameter
- 4.4° FoV
- 1700 Pixels

Medium Size Telescope (MST)



- 12m diameter
- 7-8° FoV
- 1500-2000 Pixels

Small Size Telescope (SST)



- 4m diameter
- 7-10° FoV
- 1300-2000 Pixels

CTA Observatory Site Selection



North:
-Arizona
-Mexico
-Canary Island

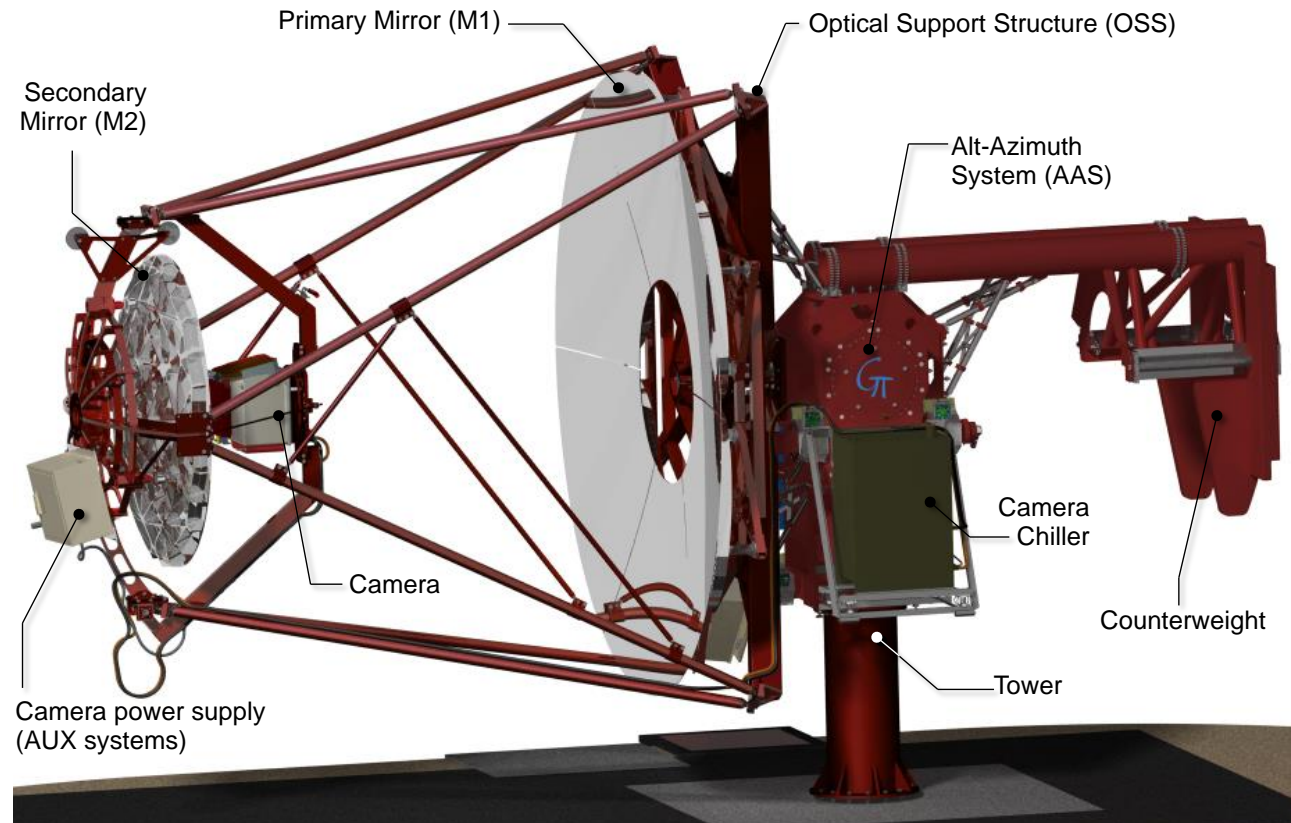
South:
-Namibia(HESS)
-Chile (ESO)

CTA Timeline



- Now: Prototypes under commissioning
- 2015: Site selection finalised
- 2016: Start construction
- 2016: First Science with array of Small Telescope (~7-9)
- 2020: CTA complete

GCT for CTA (Dual Mirror Telescope)



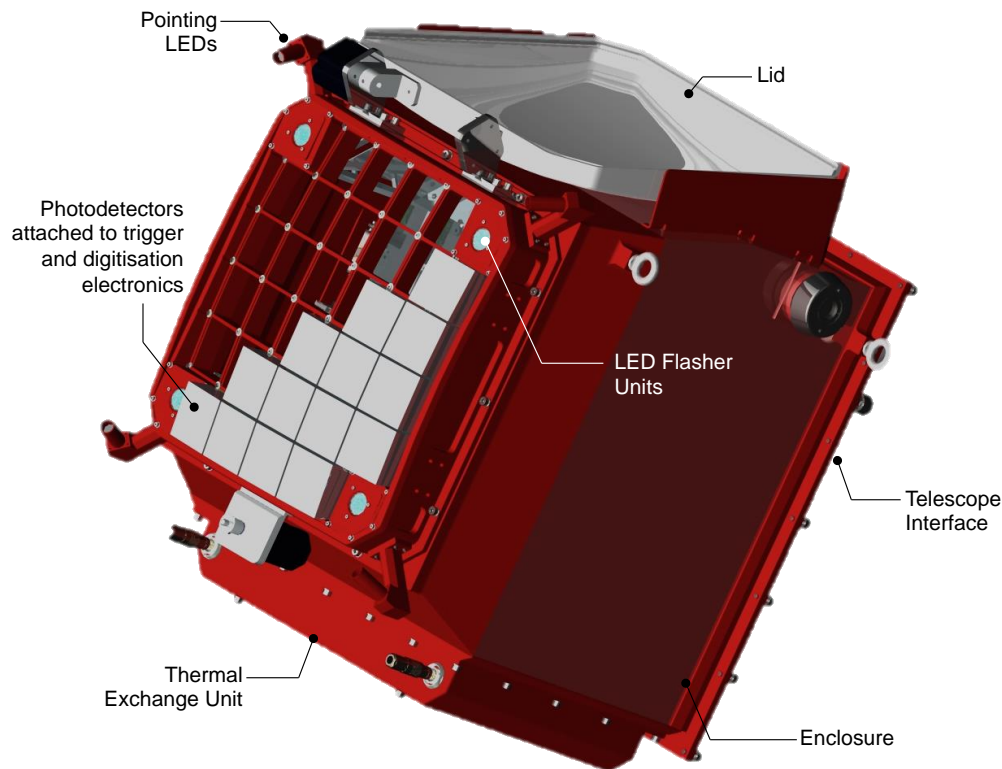
Reduce Camera Size (Power Consumption – Cost)

Compact photosensor.

Smaller pixel angular size

More uniform Point Spread Function across the Field of View

GCT Camera



International Project:
UK, US, Japan,
Germany,
Netherlands, Australia

2048 pixels
32 x 64 pixel modules

Funding in place for 2 prototype cameras

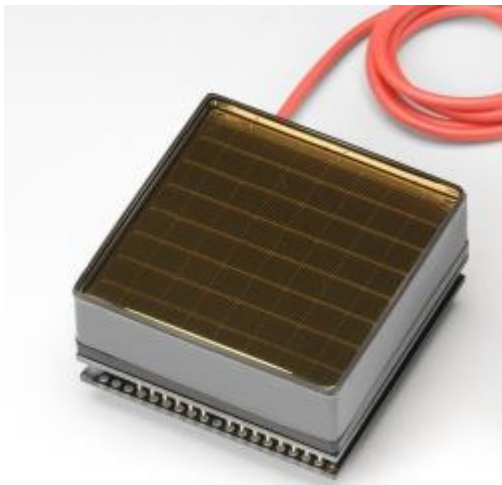
- GCT-M: Multi Anode Photo Multipliers
- GCT-S: Silicon Photo Multipliers

MAPM Vs. SiPM



MAPM

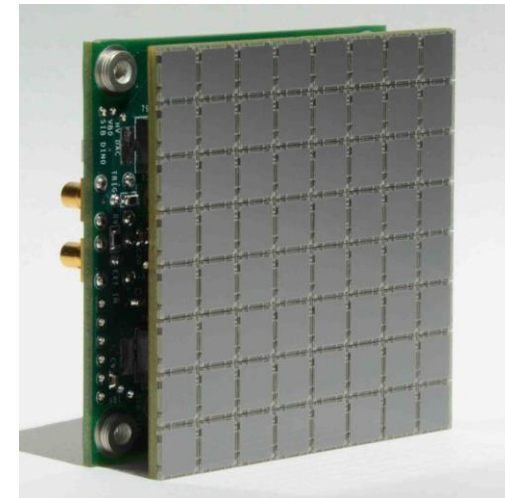
Multi Anode PhotoMultiplier



PMT technology with common photocathode and a matrix of dynode chain.

SiPM

Silicon PhotoMultiplier



Very fine pixelated Geiger Mode avalanche photodiodes. (Reverse biased PN junction operating above breakdown voltage)



MAPM

Multi Anode PhotoMultiplier

- Fragility (sealed vacuum tube)
 - Operation under high voltage
 - Aging
 - Limited photon detection efficiency
 - Sensitivity to Earth magnetic fields
 - Limited pulse height resolution
-
- + Time FWHM (1 ns)
 - + Low dark noise

SiPM

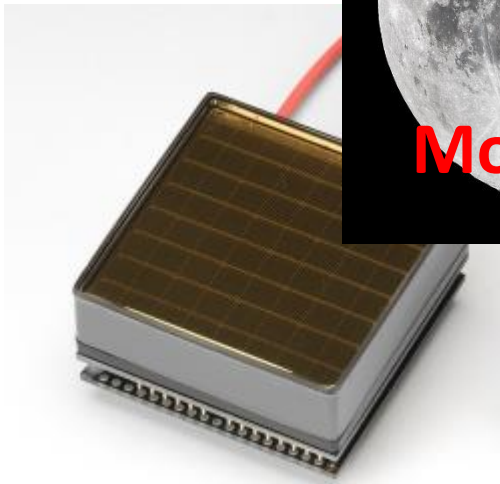
Silicon PhotoMultiplier

- + Ruggedness
 - + Low voltage operation (~ 20-100 V)
 - + Resistance to high light levels
 - + High photon detection efficiency in principle achievable
 - + Insensitivity to magnetic fields
 - + Excellent pulse height resolution
 - + Rapidly decreasing cost
-
- Time FWHM (>20 ns)
 - Dark Noise
 - Strong Temperature dependence
 - Cross talk

MAPM Vs. SiPM

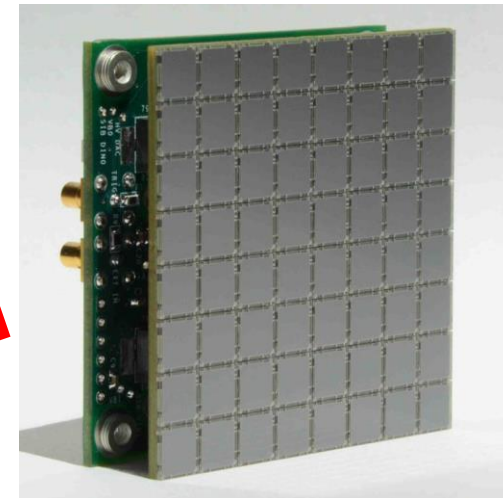


MAPM
Multi Anode Ph



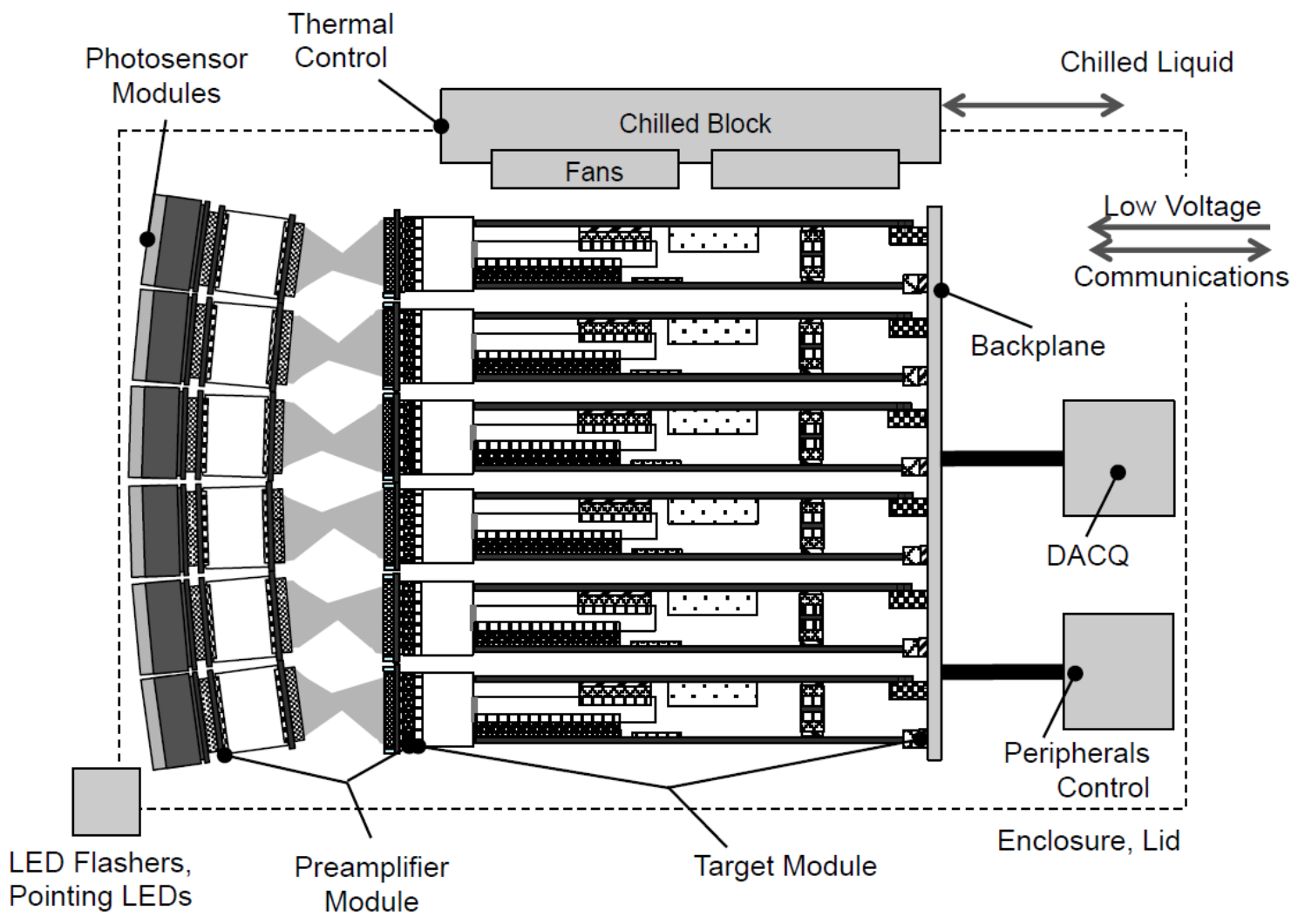
PMT technology with common photocathode and a matrix of dynode chain.

SiPM
Silicon PhotoMultiplier

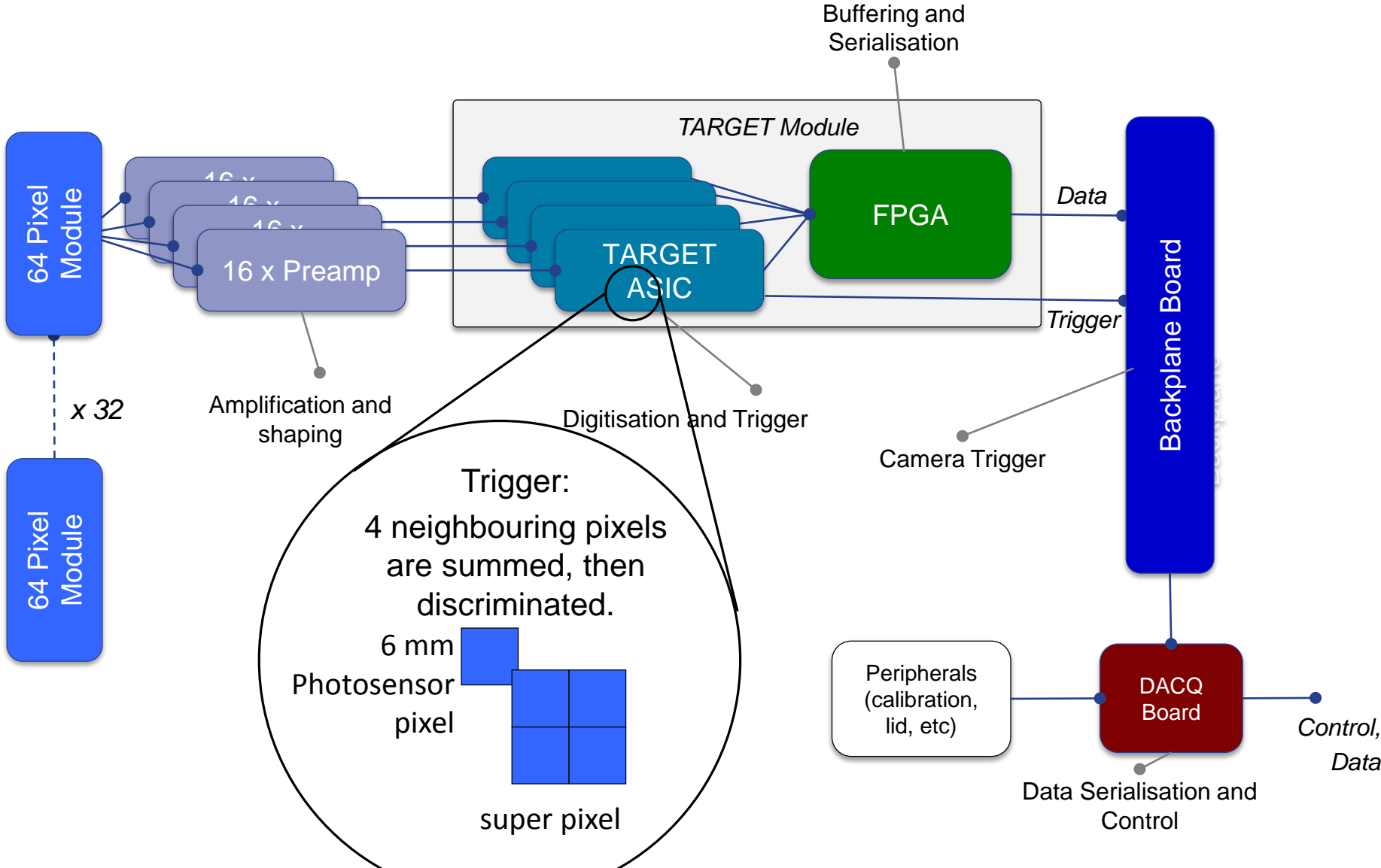


Very fine pixelated Geiger Mode avalanche photodiodes. (Reverse biased PN junction operating above breakdown voltage)

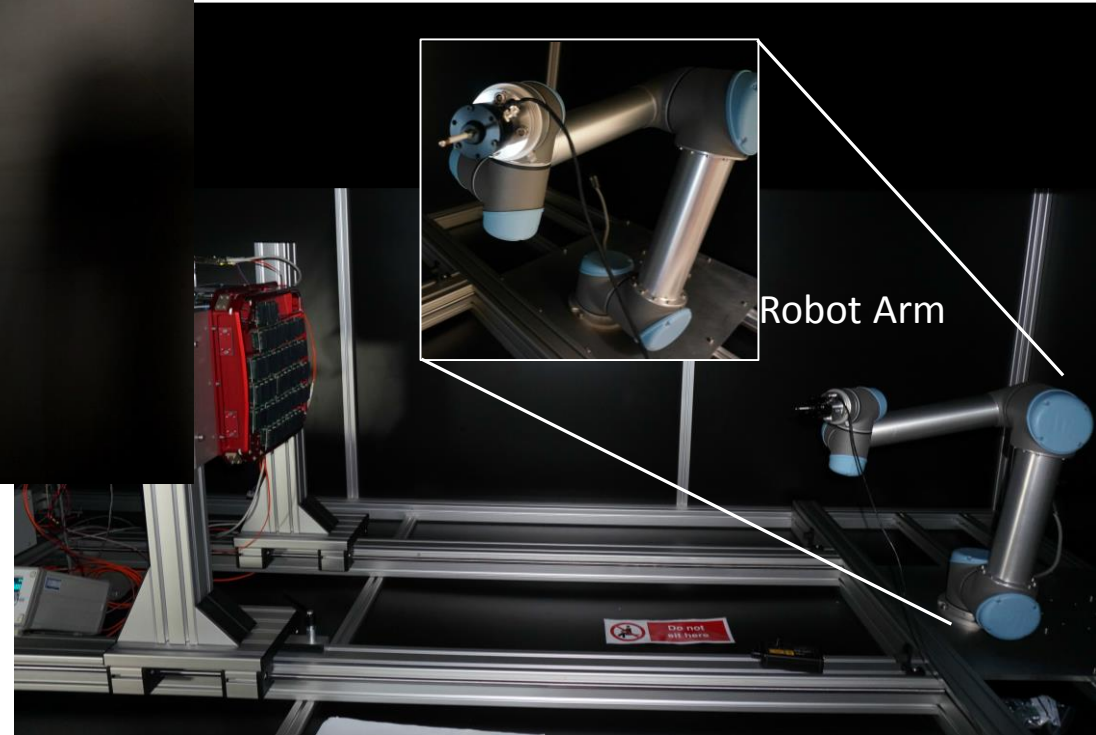
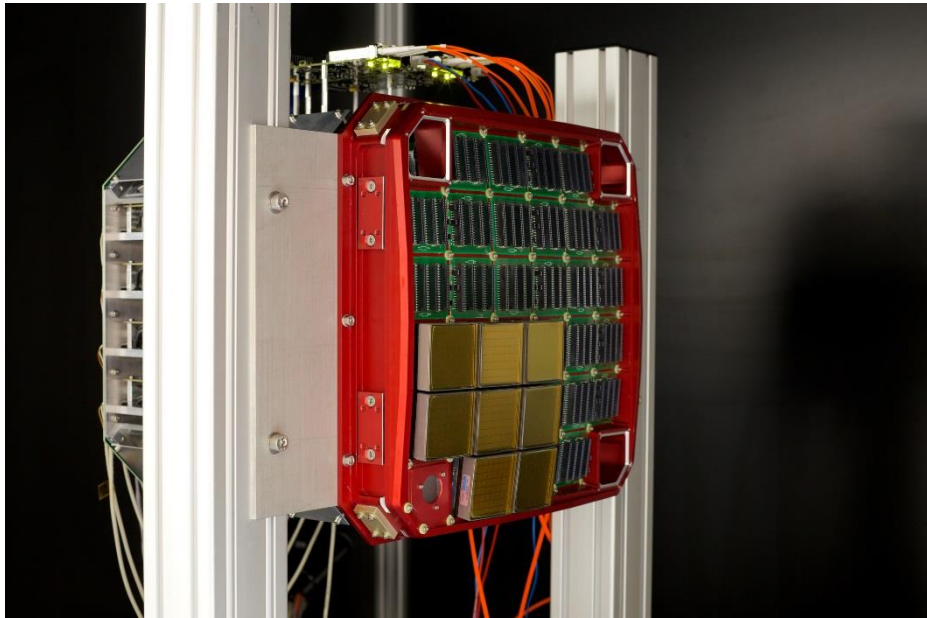
GCT Camera



Electronics

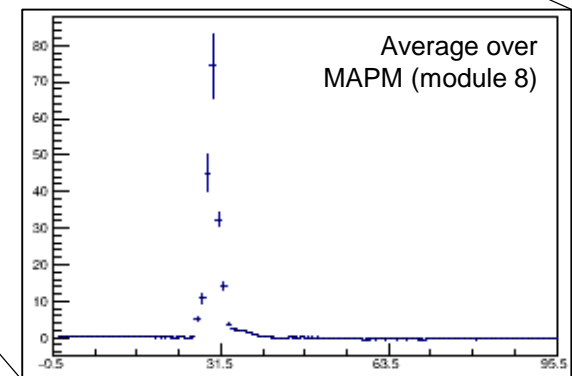
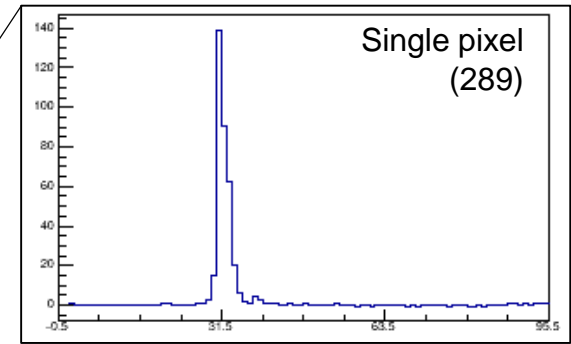
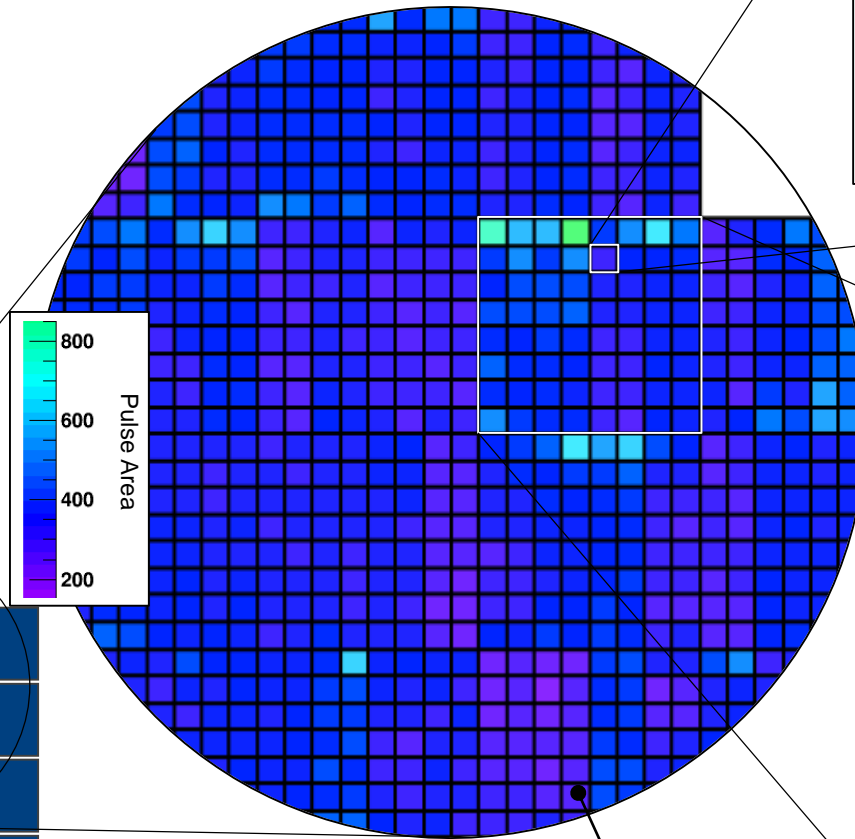


GCT Camera - Commissioning



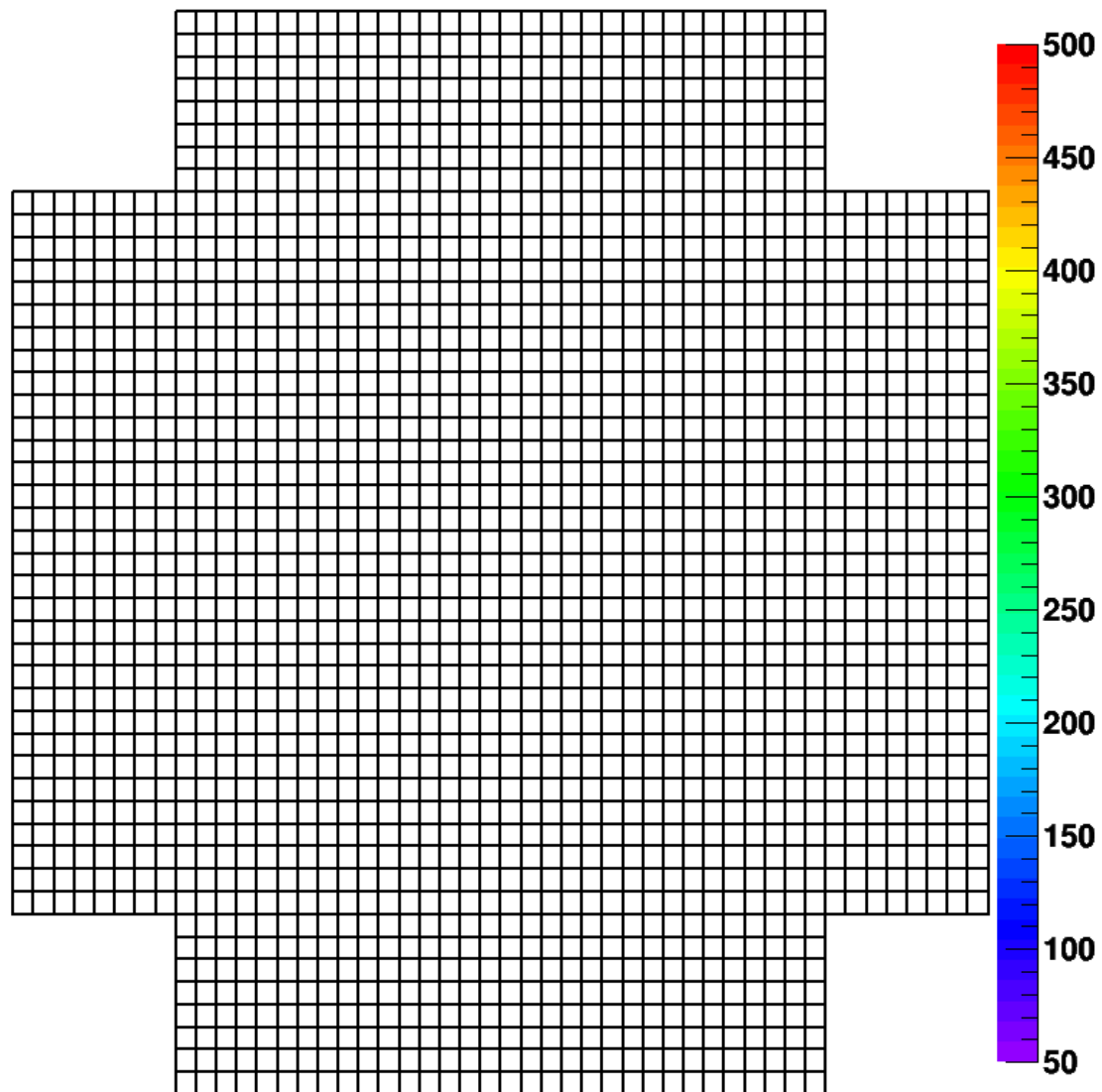
First results on lab test intended to be presented at ICRC 2015
(The first GCT camera for the Cherenkov Telescope Array.
A. De Franco, R. White et. al. for the CTA consortium)

GCT Camera - Commissioning



Pedestal subtracted,
un-calibrated data

GCT Camera - Commissioning





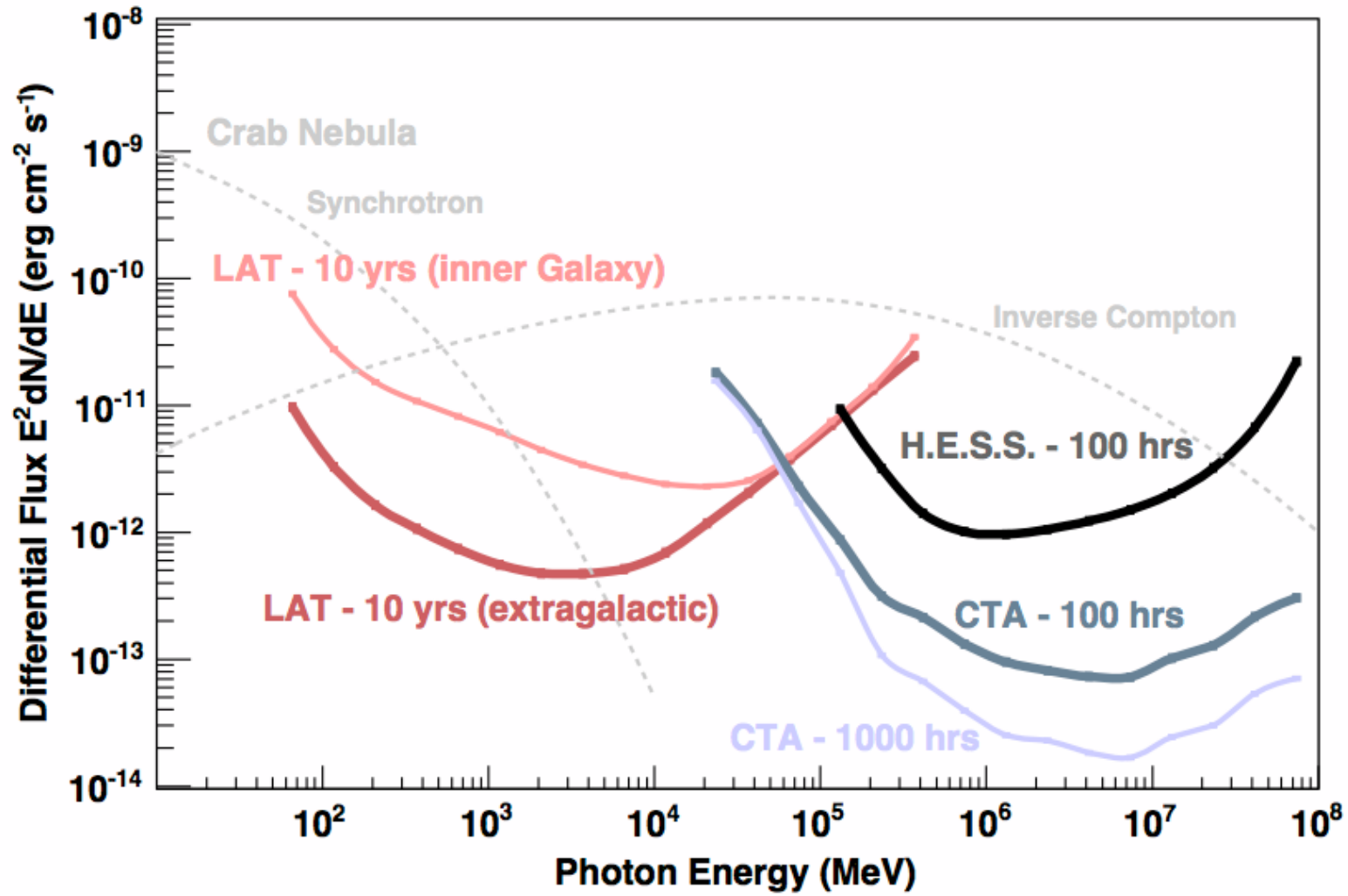
The GCT's camera for the Cherenkov Telescope Array

Thank you!!!

Andrea De Franco

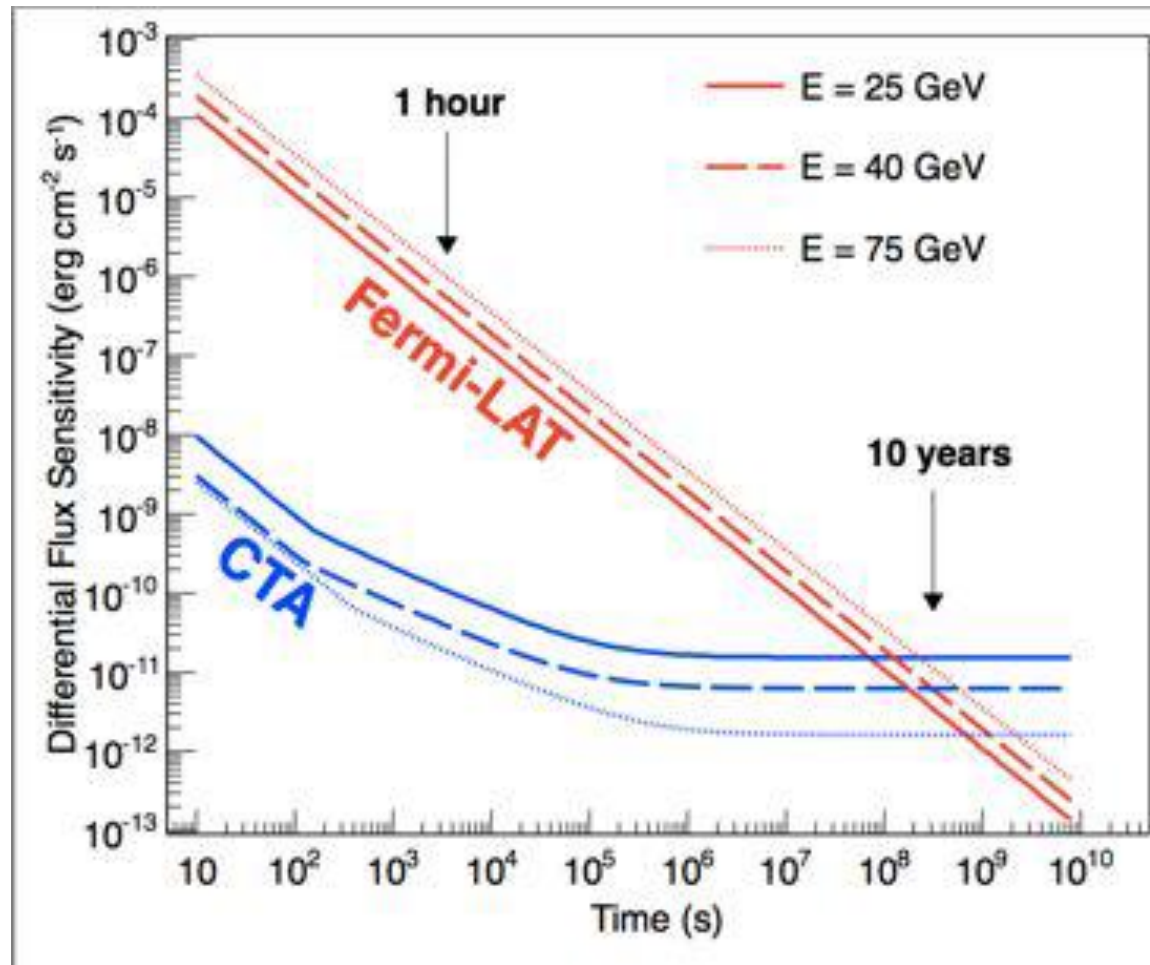
Supervisor : Dr. Garret Cotter

CTA expected Sensitivity



(Hinton & Funk
arXiv:1205.0832)

CTA expected Sensitivity - Transients



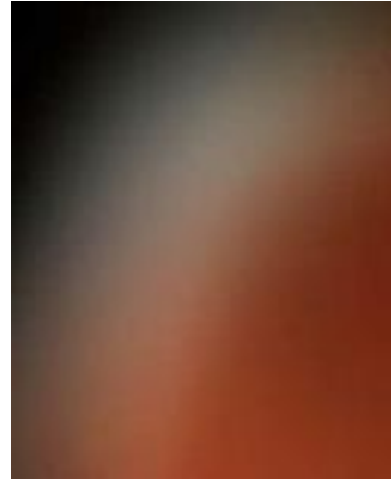
(Hinton & Funk
arXiv:1205.0832)

Could investigate short time scale phenomena
(GRBs, microquasar flares, ...)

CTA expected Angular Resolution



***0.004°
XMM 10 keV***



***0.1°
Simulation
with current
IACT***



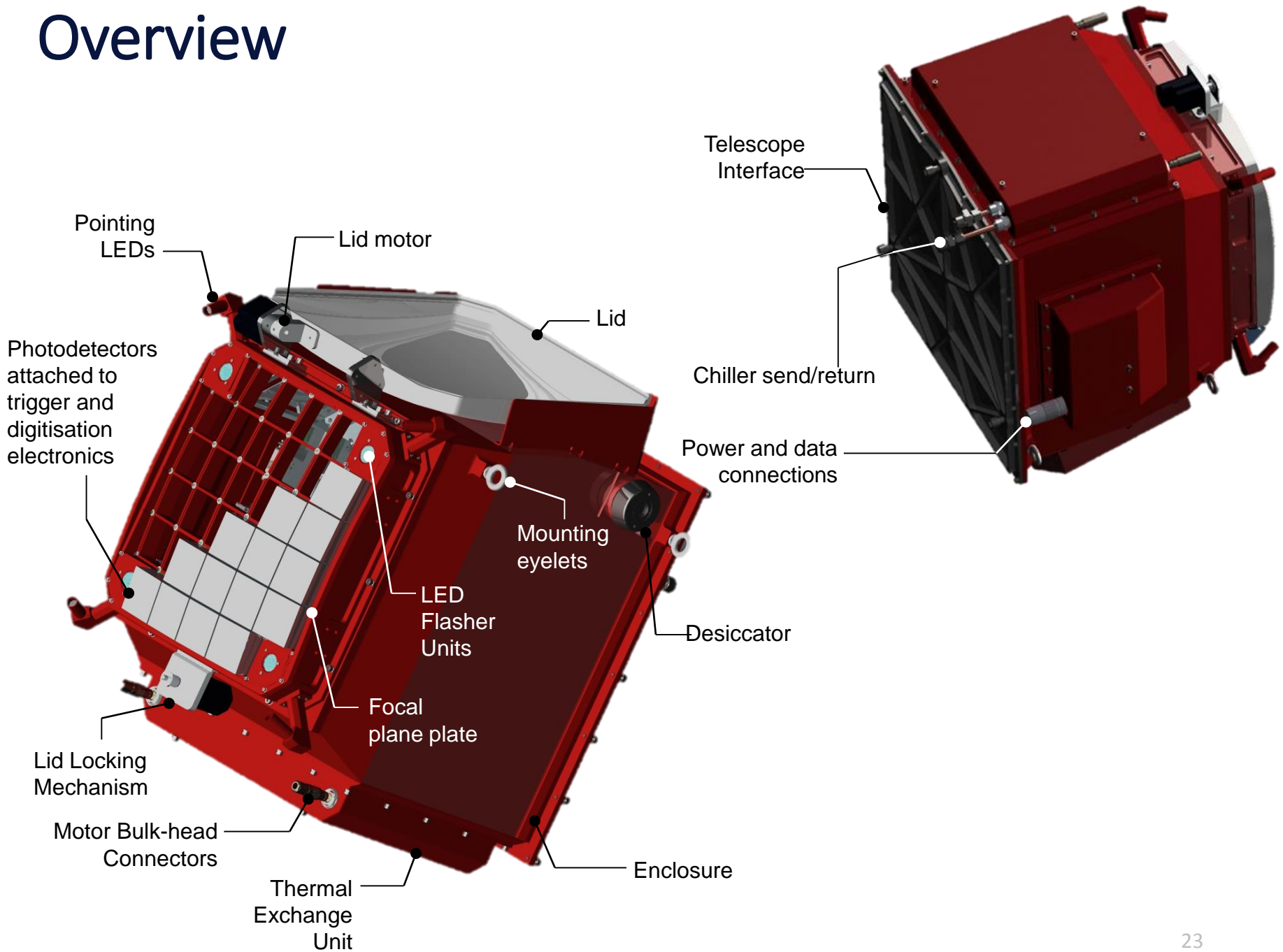
***0.02°
CTA at few
TeV***

Probing sub structure of SNR shock front

GCT Main Parameters

Optical Parameters		Camera Parameters	
FoV ^(a)	8.5° - 9.2° ^(b)	Number of pixels	2048
Focal length	2283 mm	Physical pixel size	6 x 6 mm ² - 7 x 7 mm ² ^(f)
F-number	0.58	Angular pixel size	0.15° - 0.2° ^(f)
Effective Plate Scale ^(c)	38.9 mm/°	Camera size	~ 0.35 m x 0.35 m x 0.5 m ^(g)
Throughput ^(d)	> 60%	Camera Mass	45 kg
PSF size on axis	0.05° @ 80% ^(e)	Camera power consumption	~ 450 W ^(h)
Focal plane radius	1.0 m	Pixels per electronics module	64
		Number of electronics modules	32
		Sampling rate	1 GSa/s ⁽ⁱ⁾
		Readout window size	96 ns ^(j)
		Transmitted data	12-bits per sample, all samples
		Data rate (at 600~Hz)	~3 Gbps ^(k)

Overview



Overview

