The Camera of the H.E.S.S. II Experiment

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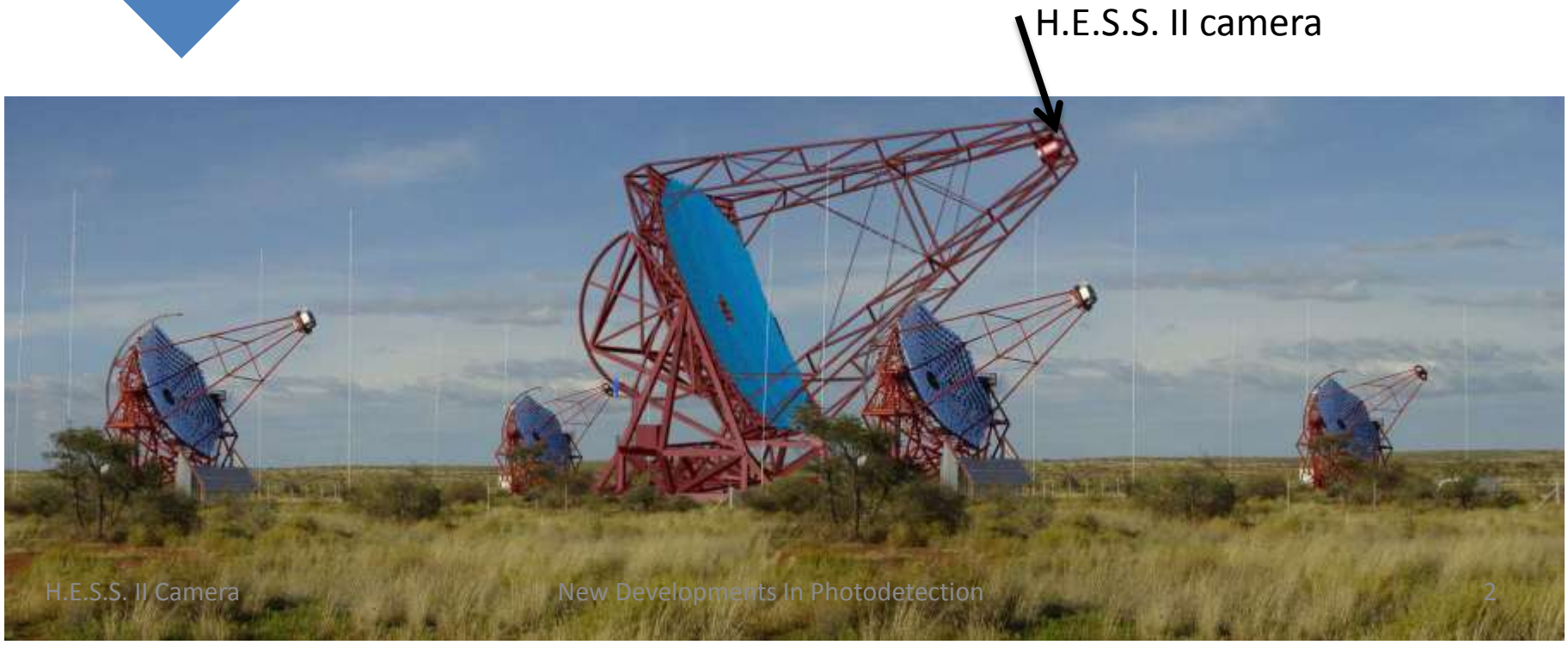
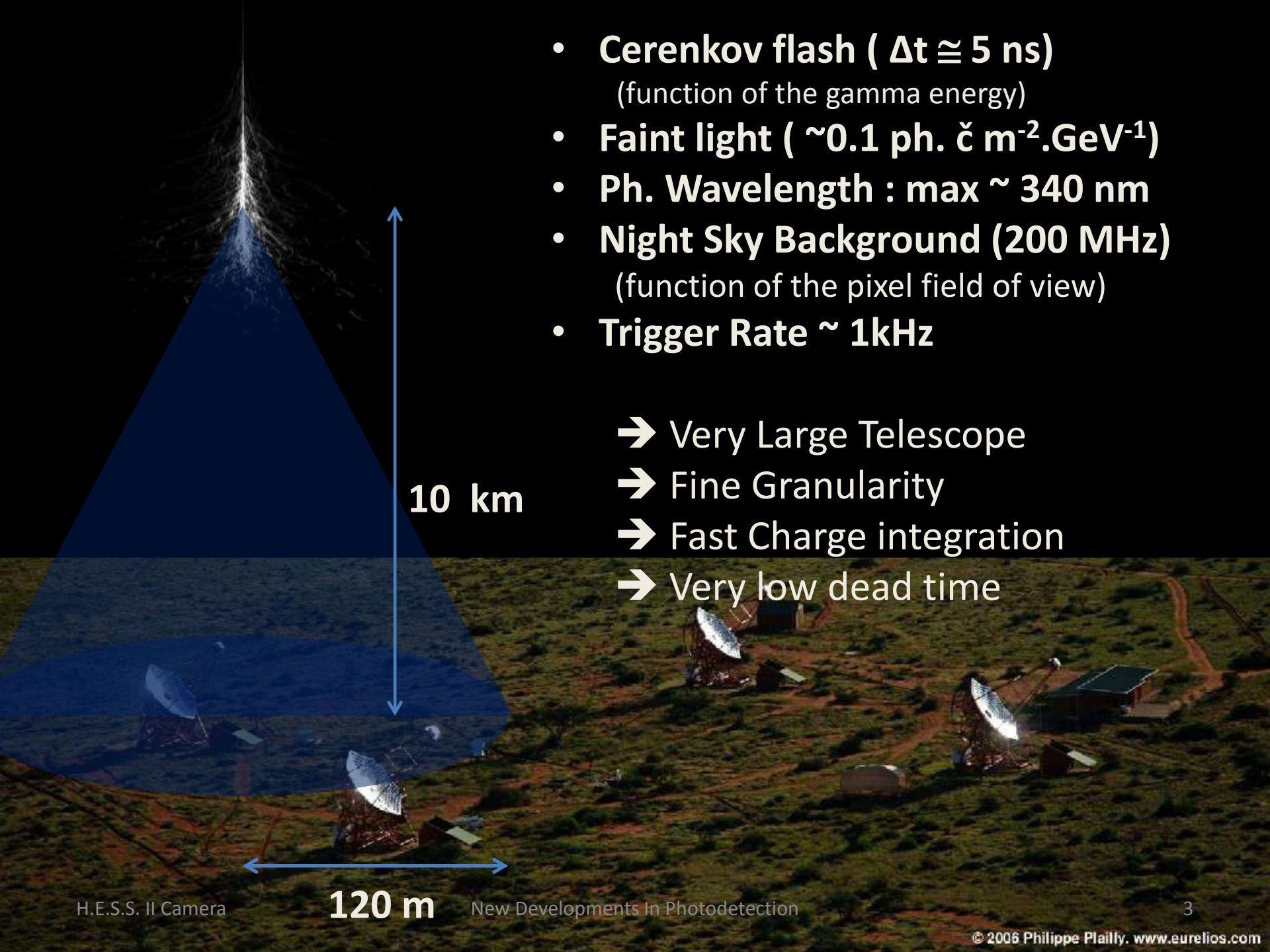
UPMC/LPNHE

OUTLINE

- Ground based Gamma Ray Astronomy
- Camera synoptic
- Camera description
- Some tests



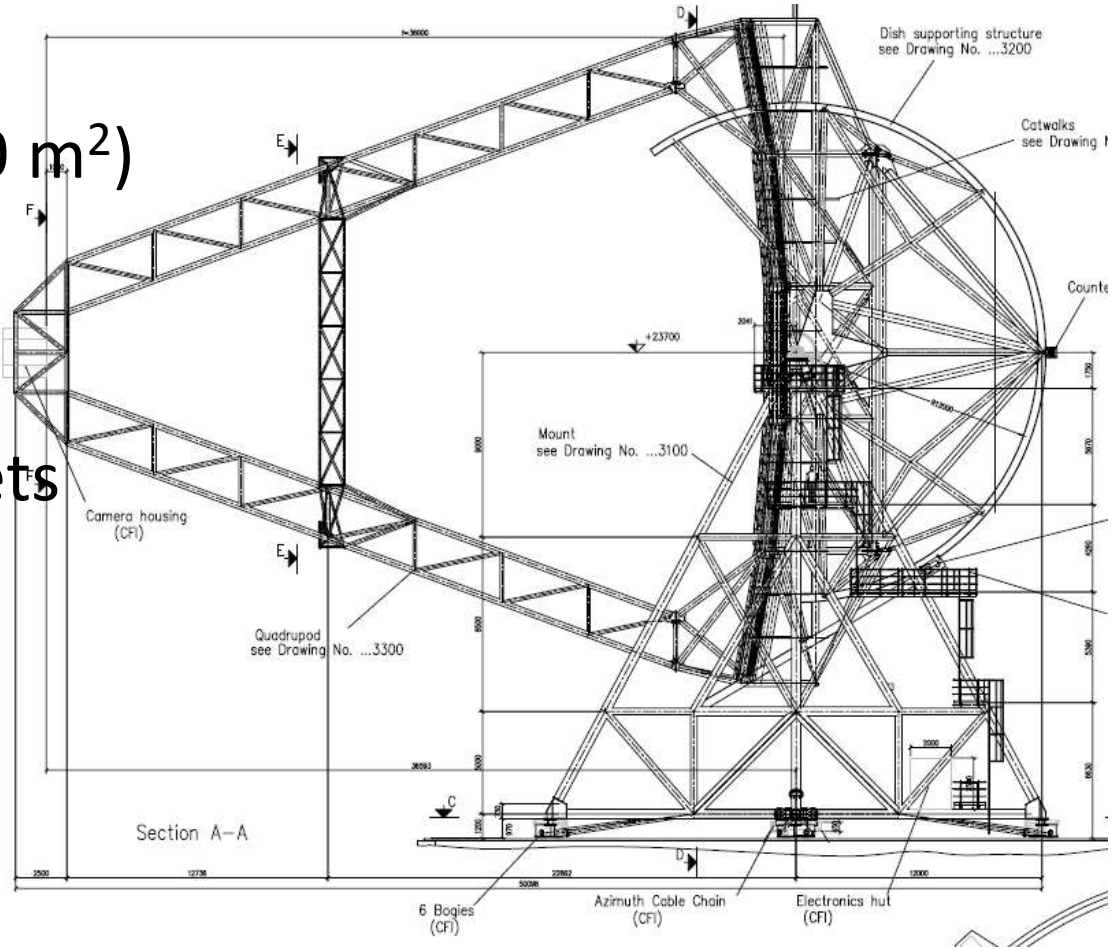


- **Cerenkov flash (Δt ≅ 5 ns)**
  (function of the gamma energy)
- **Faint light (~0.1 ph. č $m^{-2}.GeV^{-1}$)**
- **Ph. Wavelength : max ~ 340 nm**
- **Night Sky Background (200 MHz)**
  (function of the pixel field of view)
- **Trigger Rate ~ 1kHz**

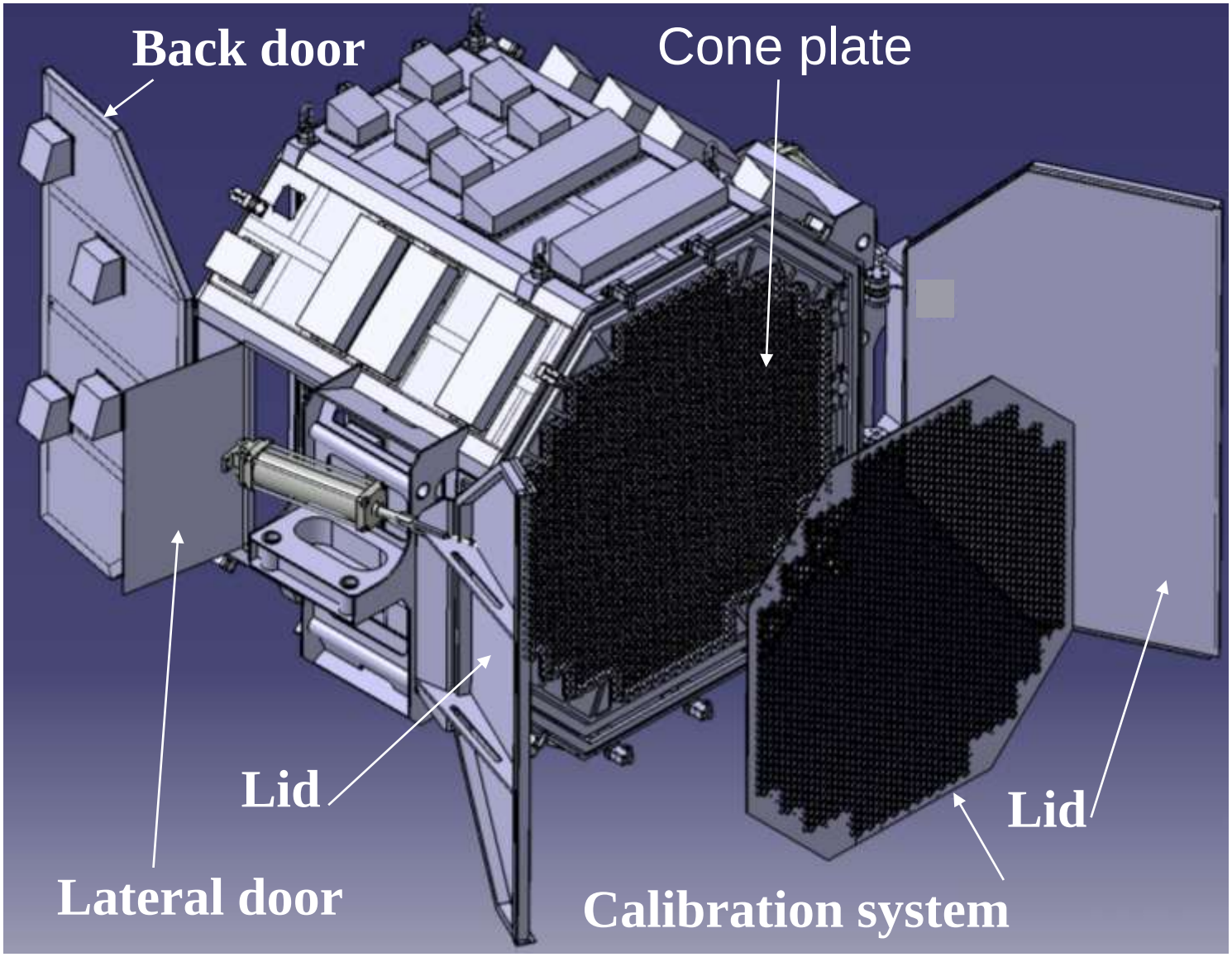
➔ Very Large Telescope
➔ Fine Granularity
➔ Fast Charge integration
➔ Very low dead time

The H.E.S.S. II telescope

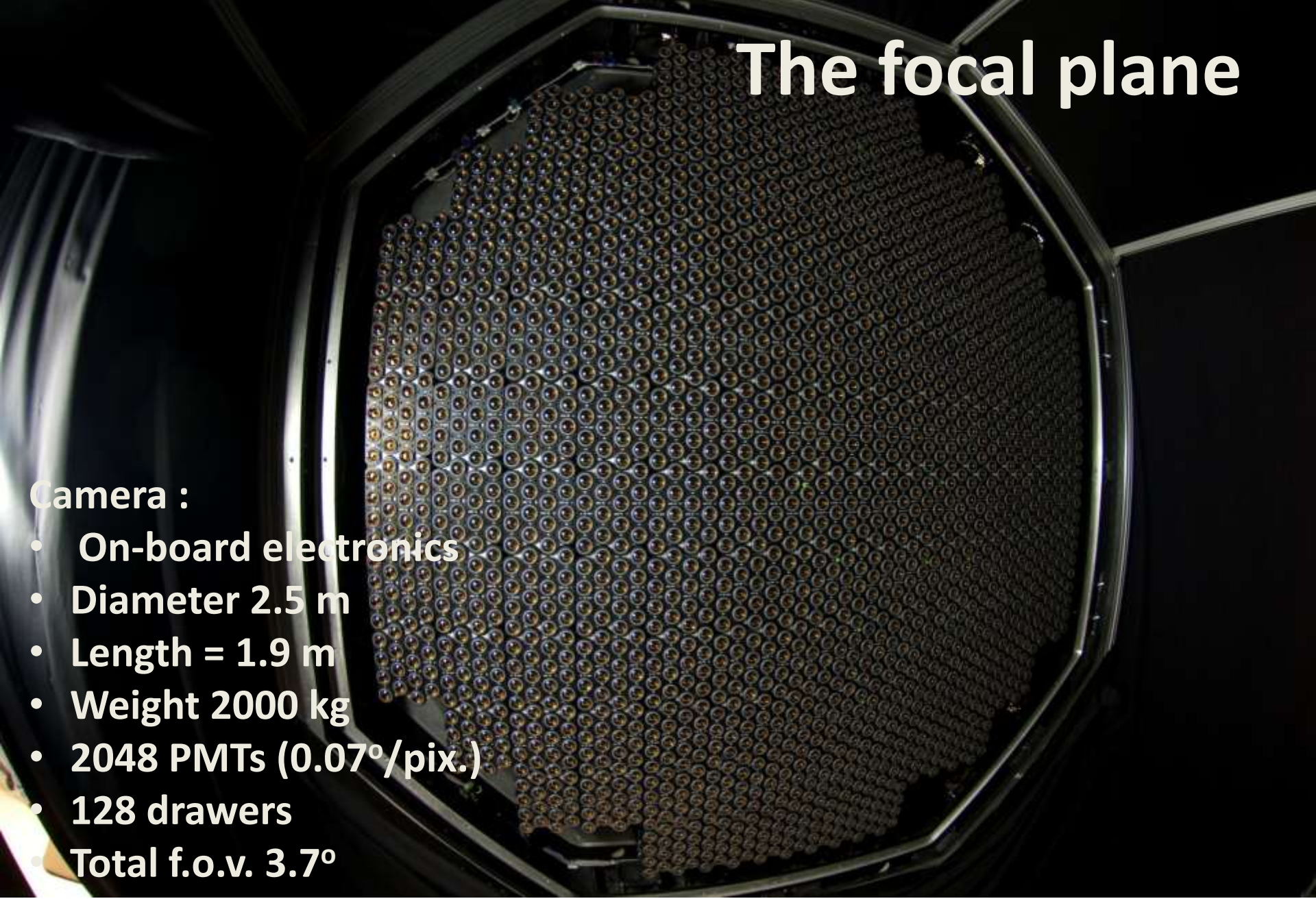
- Reflector : 28 m (~600 m^2)
- Focal distance ~36 m
- Parabolic dish
- Hexagonal mirror facets
- Steel mount 500 t
- Hauteur 40 m
- Autofocus system



Camera Mechanic



The focal plane



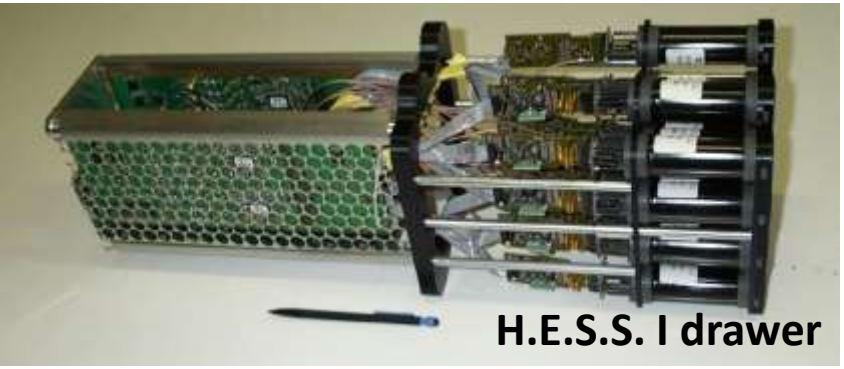
Camera :

- On-board electronics
- Diameter 2.5 m
- Length = 1.9 m
- Weight 2000 kg
- 2048 PMTs (0.07°/pix.)
- 128 drawers
- Total f.o.v. 3.7°

The Drawers

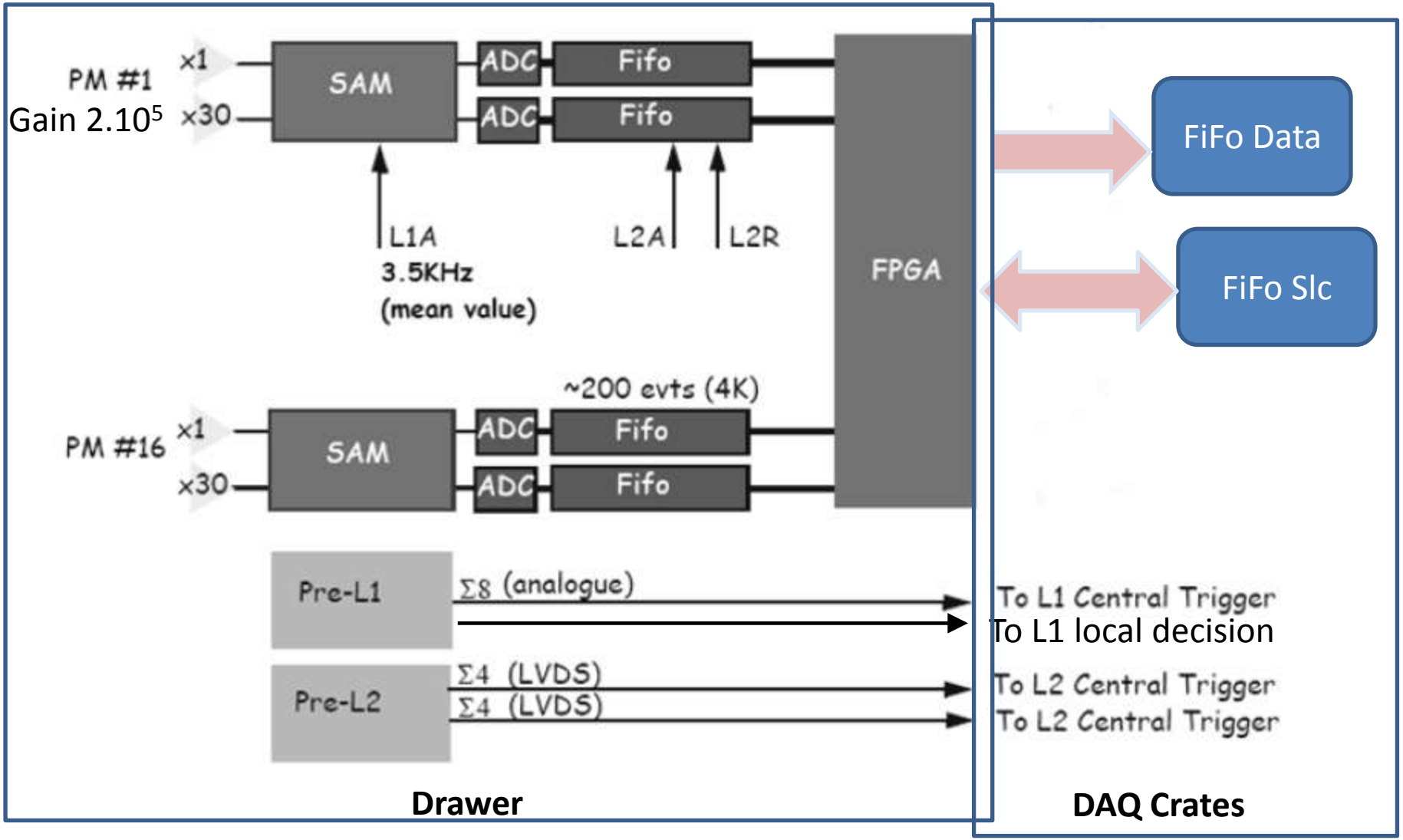
(Electronic masters)

Modular concept, all electronics inside camera



- Large dynamic range
- Good linearity (up to 6000 ph-e)
- Signal sampling in an analogue memory (SAM)
  - GHz sampling, storage during L1 trigger formation, fast memory readout
- Single photoelectron peak resolution
- Integrated charge over 16 samples
- Very low dead time
  - FIFO in drawer

Electronic drawer synoptic

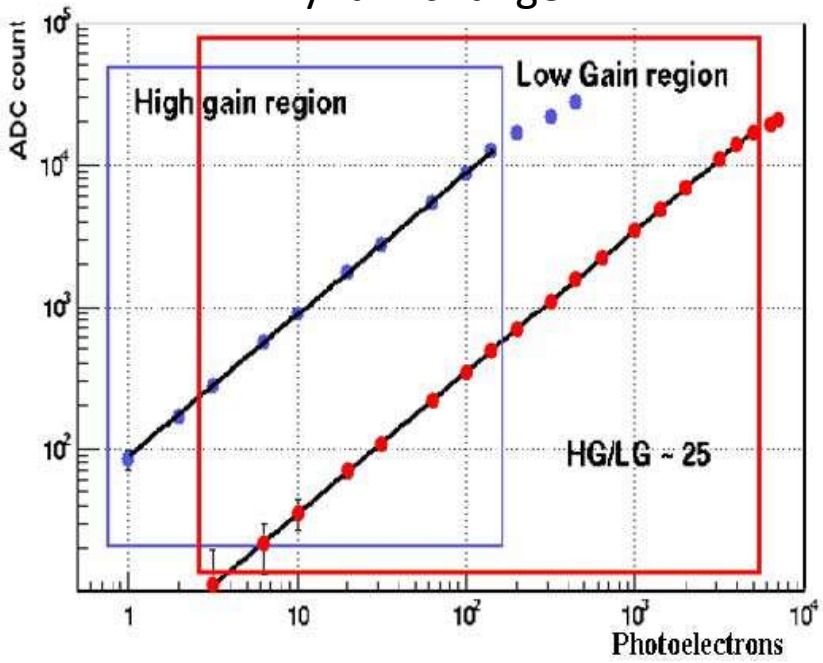


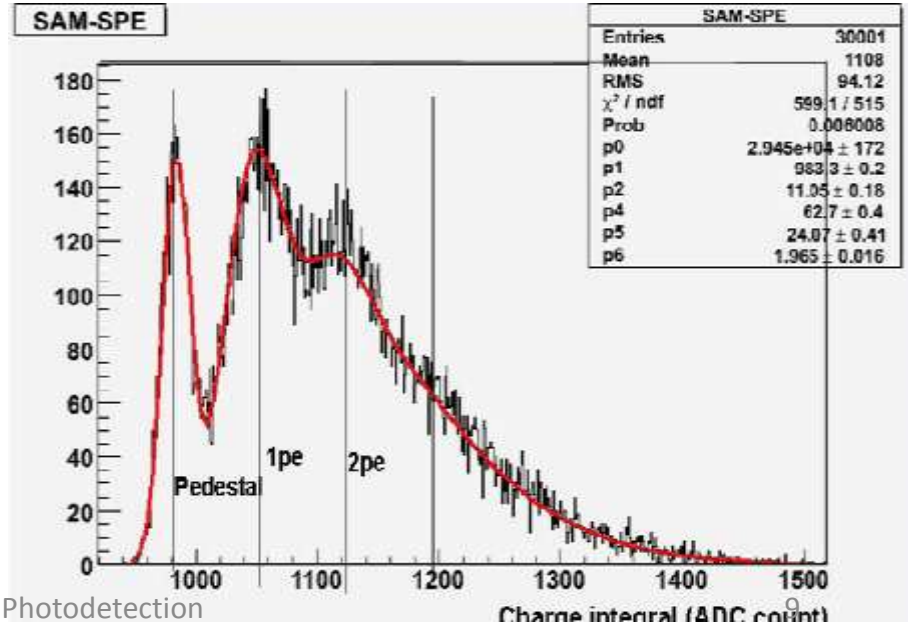
Some Drawer performances

MAIN SAM MEASURED PERFORMANCES

NAME	Value	Unit
Power Consumption	300	mW
Sampling Freq. Range	<1to 2.5	GS/s
Analog Bandwidth	~250	MHz
Maximum event readout Frequency	>800	kHz
Read-out speed for Ncell cells to read	90+ 90*cell	ns
Fixed Pattern noise	0.4	mV rms
Total noise	0.65	mV rms
Maximum signal (limited by ADC range)	2	V
Dynamic Range	>11.6	bits
Crosstalk	<3	per mil
Integral non linearity	< 1	%
Sampling Jitter	<40	ps rms

Dynamic range



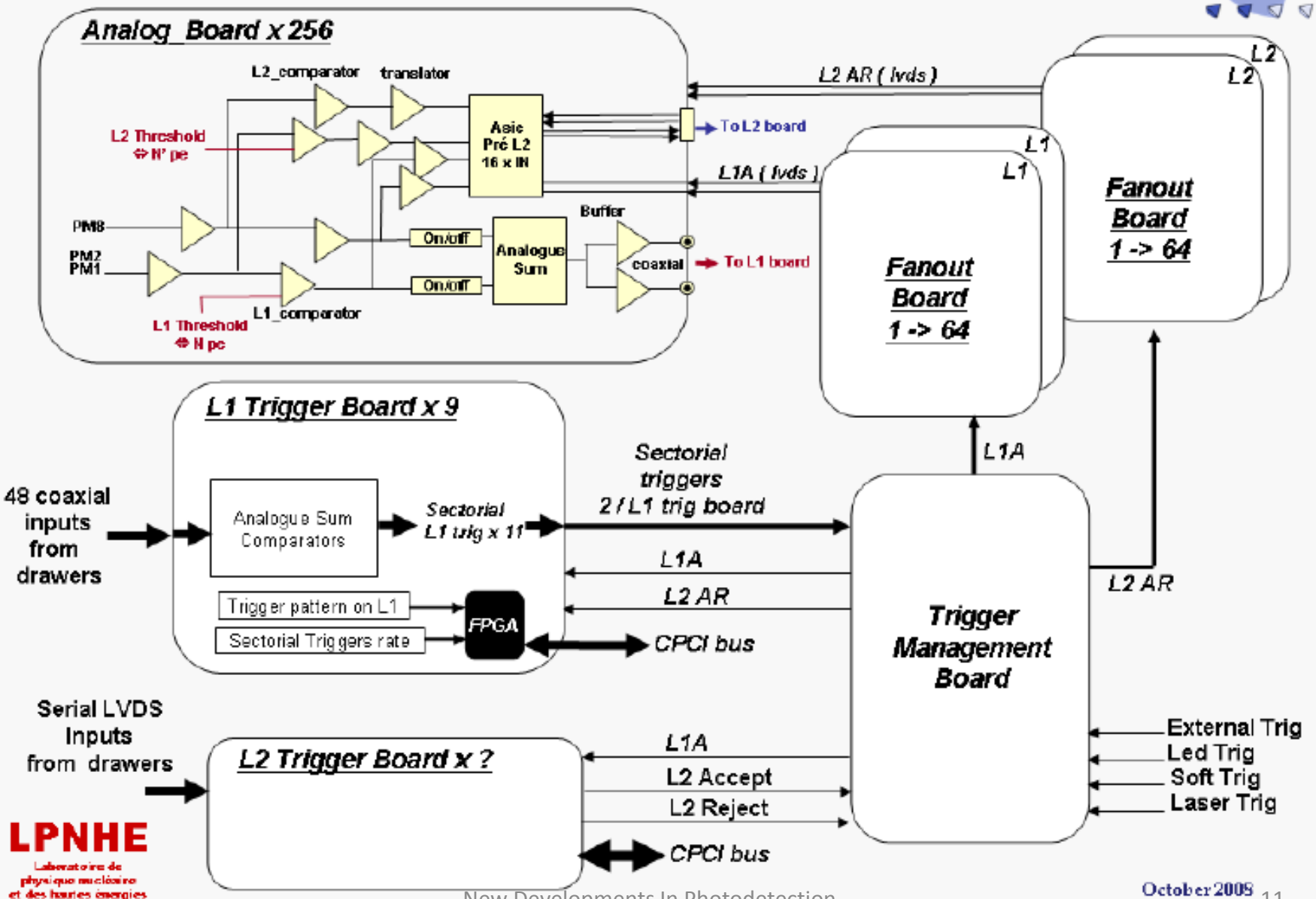


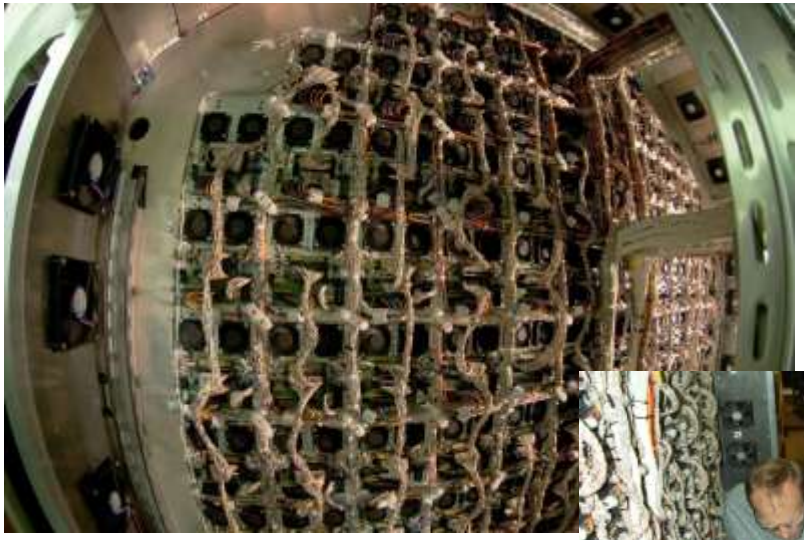
Trigger System

- **Level 1 trigger (L1)**
  - Same principle as for HESS-I, all electronics in camera, formation time ~70ns
  - Overlapping sectors (99) of 64 pixels
  - Analogue sum
    - trigger condition: *n* pixels in sector above threshold (*m* phe)
    - Front-end DAQ can handle 50 kHz rate with <10% dead-time
- **Level 2 trigger (L2)**
  - New system, to select L1 events within 20µs
  - Based on two binary images of the camera PMTs given by 2 thresholds
  - Allows rejection of NSB, hadrons, …
  - so reduce the rate of data which needs to be sent out of the camera

- **Central trigger:** as H.E.S.S. I (if energy enough)

General architecture of the trigger

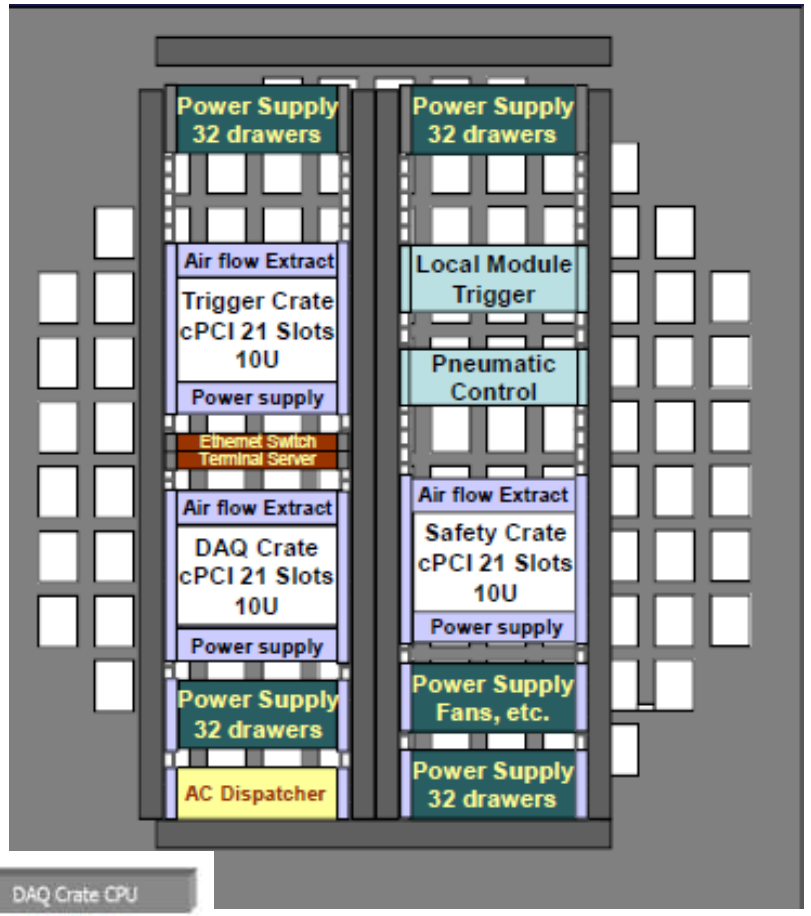


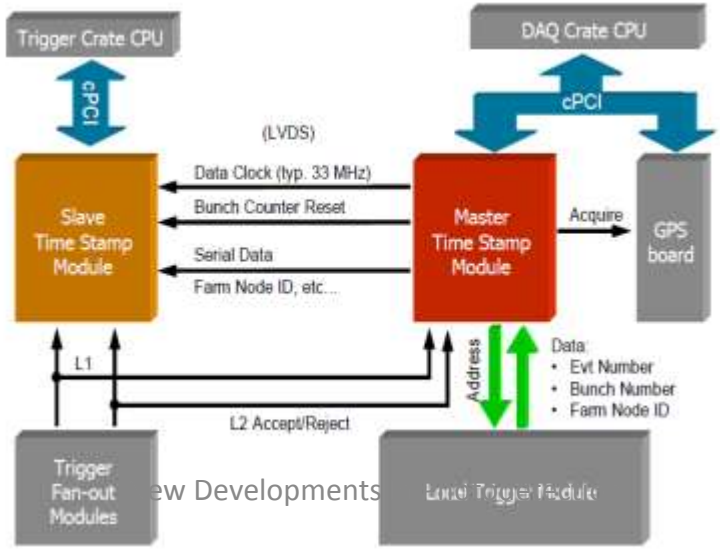


DAQ crates synoptic

- Connections to ground limited :
  - 5 Ethernet cables

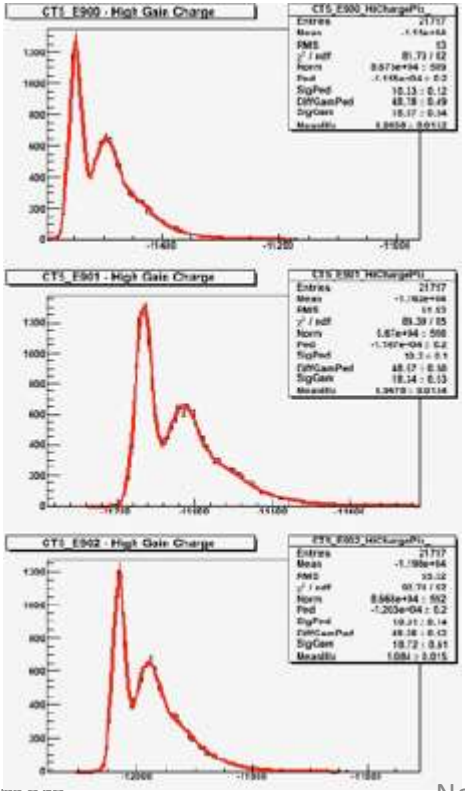
    (data, trigger, slc, security, central trigger)
  - 1 Power cable (220 V AC)
- Cooling system : fans
- Time tagging and synchronization of trigger and data events

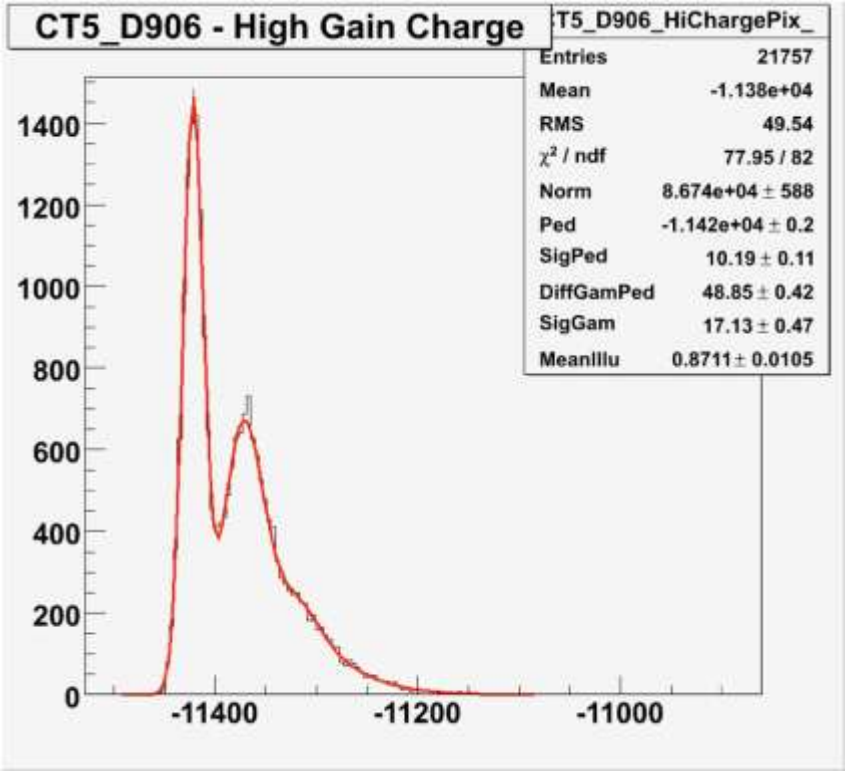




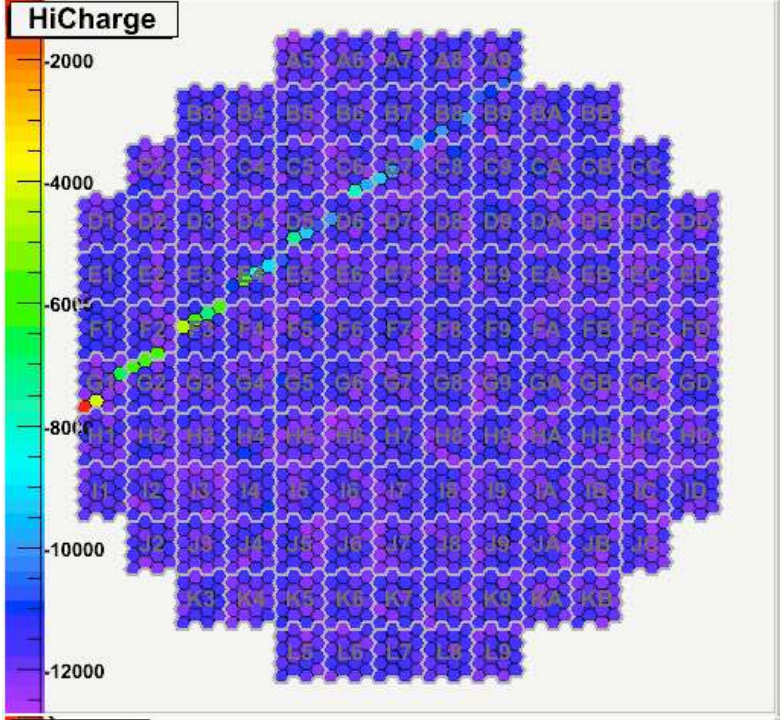
Test : single photoelectron response

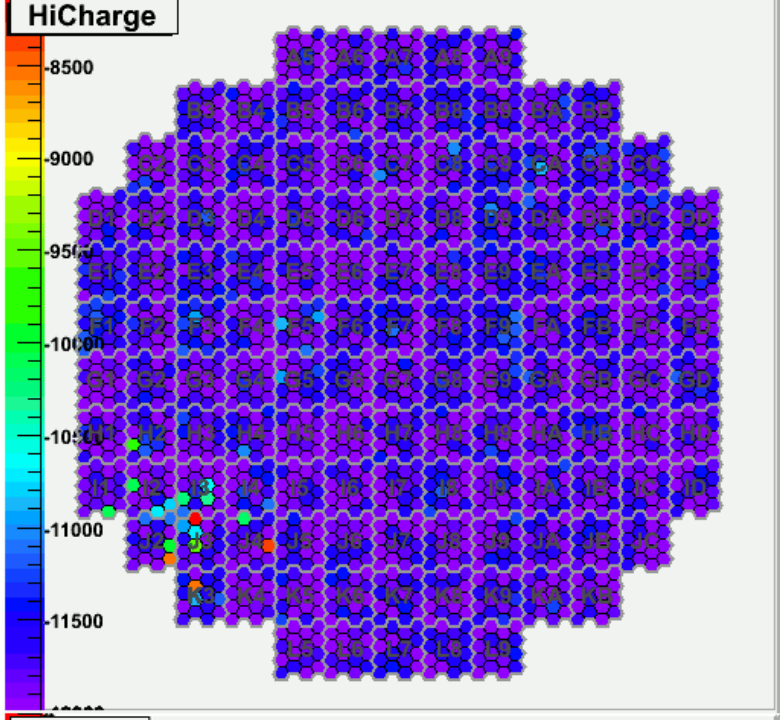
- Pulsed UV LED
- External trigger

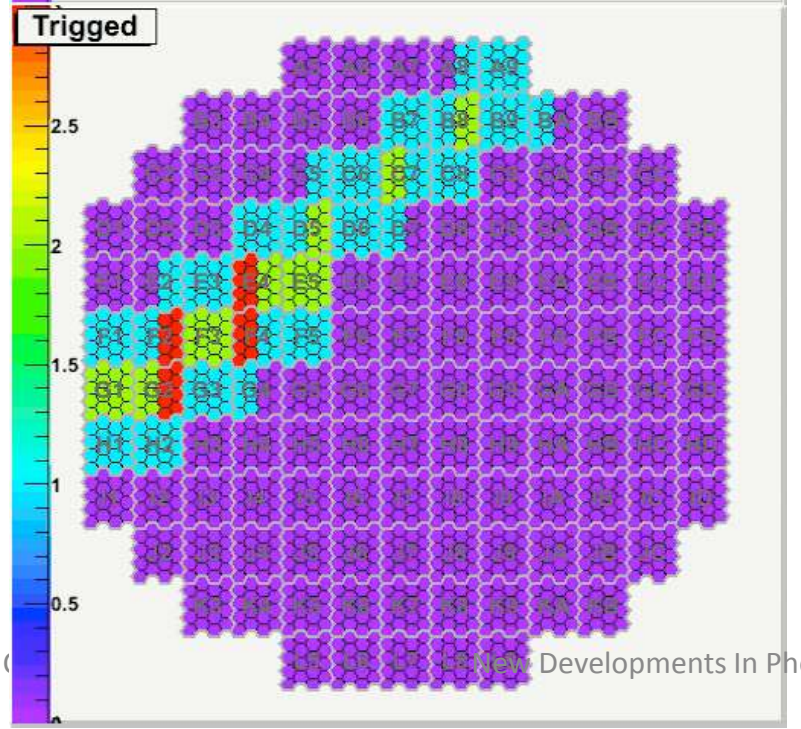


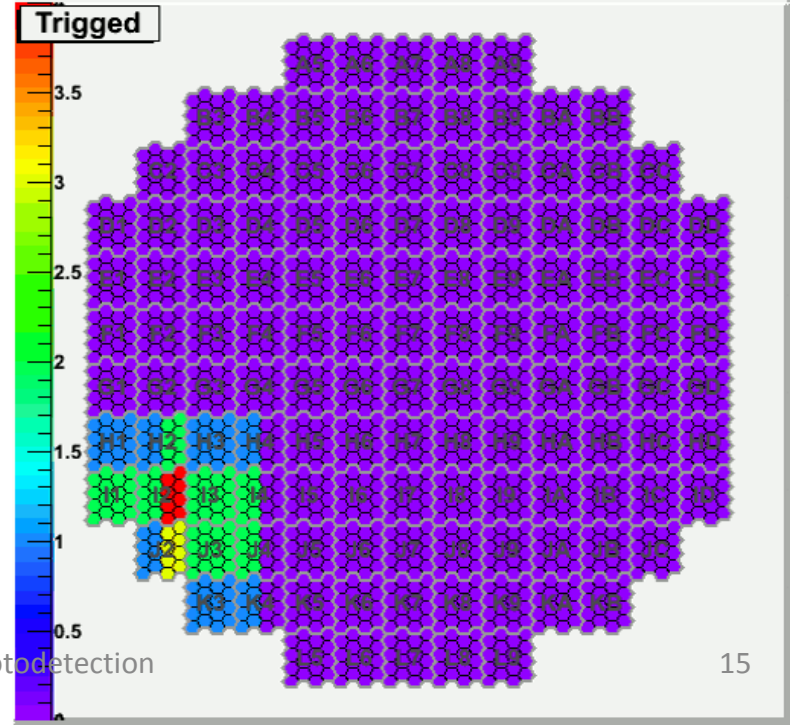


Muons through PM tube



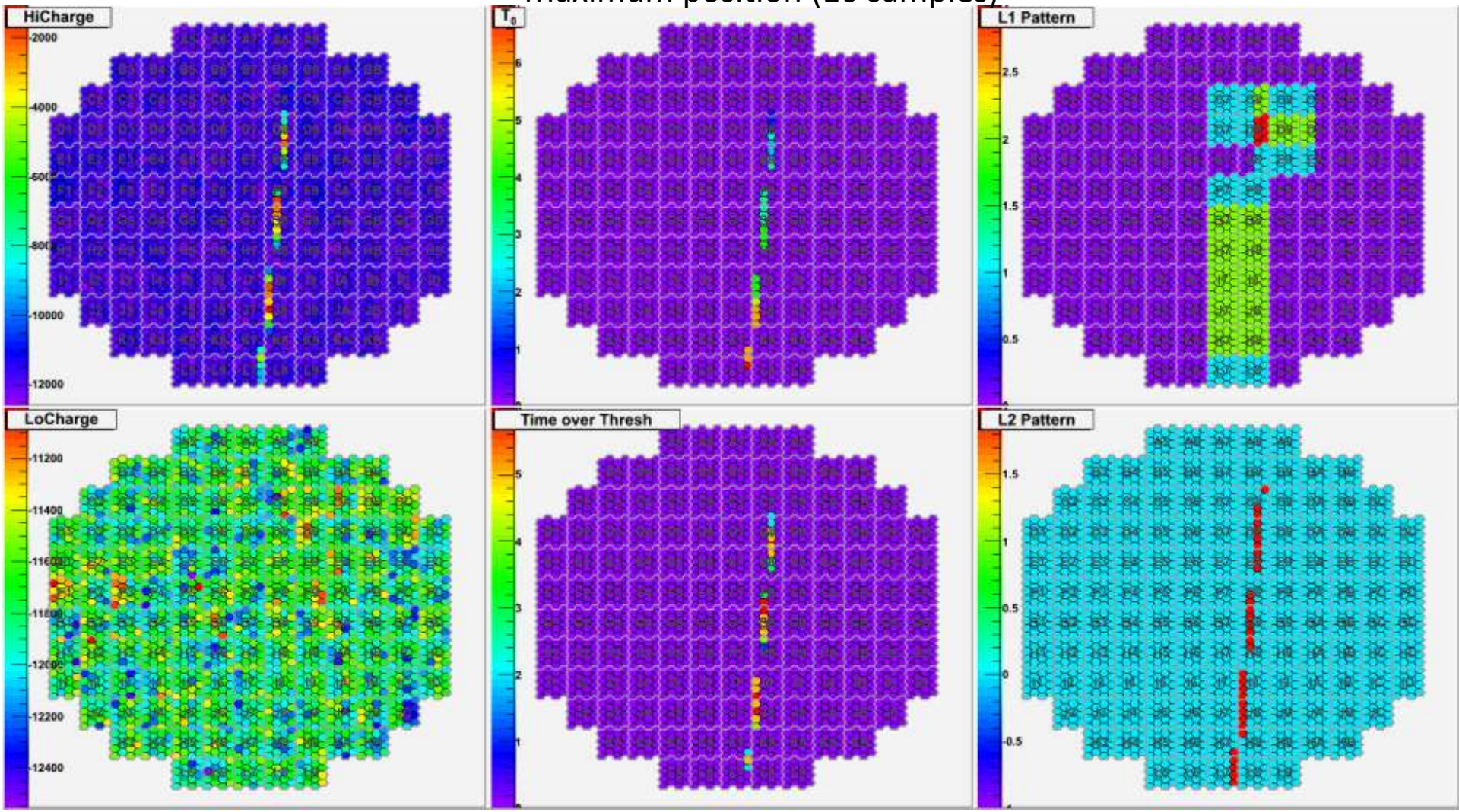






Information per pixel

Maximum position (16 samples)



Charge = sum over 16 samples

Time over a threshold

Conclusions

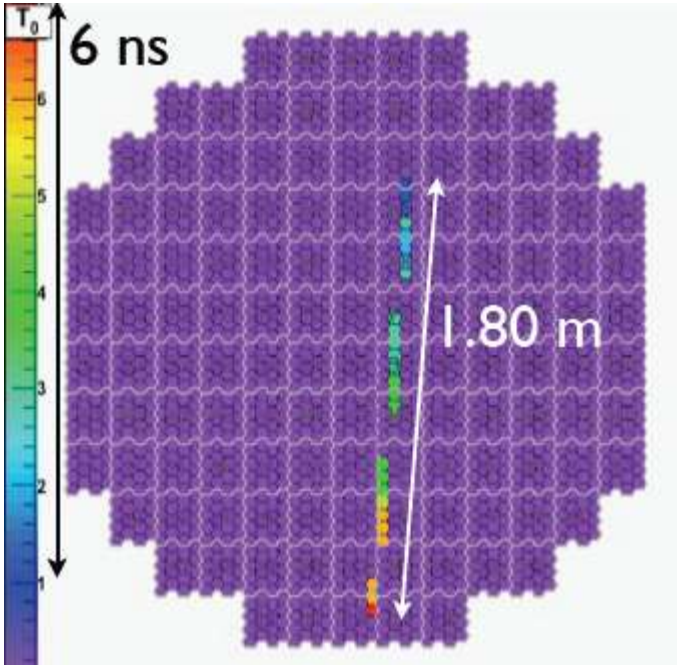
- The camera works perfectly fine
- It is calibrated
- Final tests in progress

- Telescope construction in progress

- **First lights in June 2012**

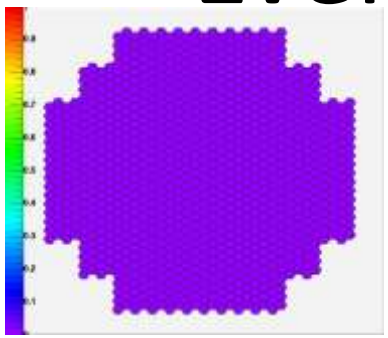
Just for fun : a physical result

- ΔT = 7 – 1 ns = 6 ns
- Δ L = 1.80 m

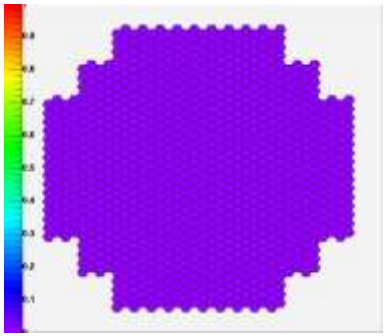


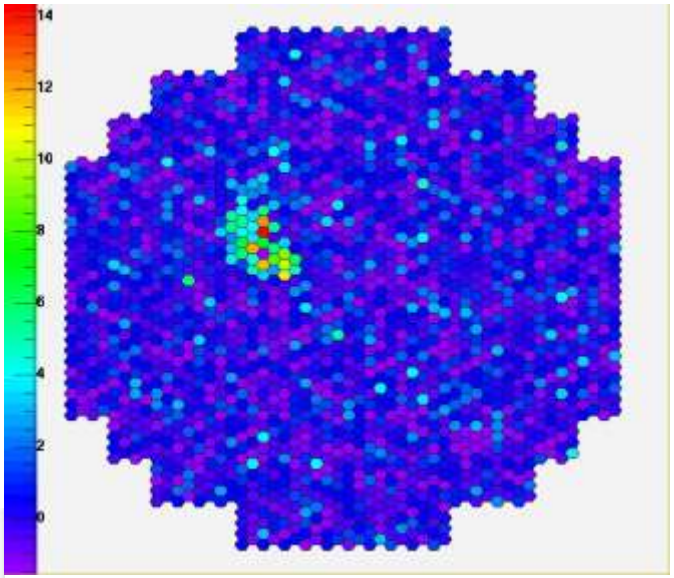
$$\mathbf{c = 3 \times 10^{8} \pm 27\%(sys) \pm 100\ \%\ (stat)}$$

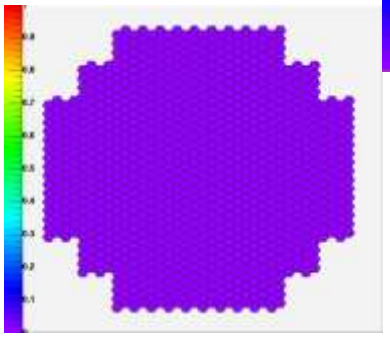
Event Display - Simulation



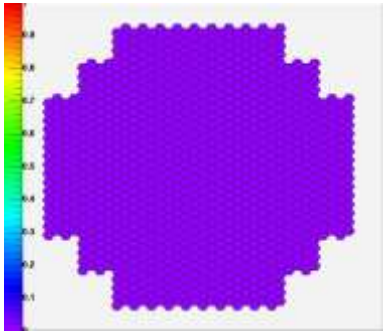
10 GeV γ-ray shower



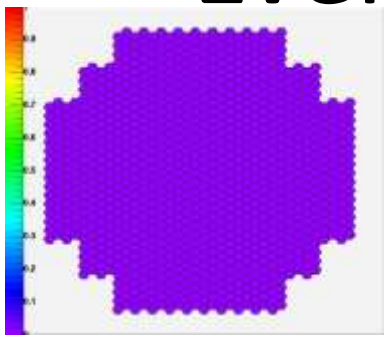




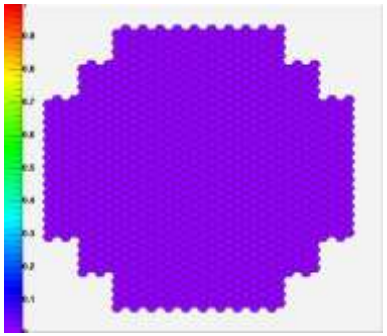
Monoscopic event class
10GeV<E<50GeV

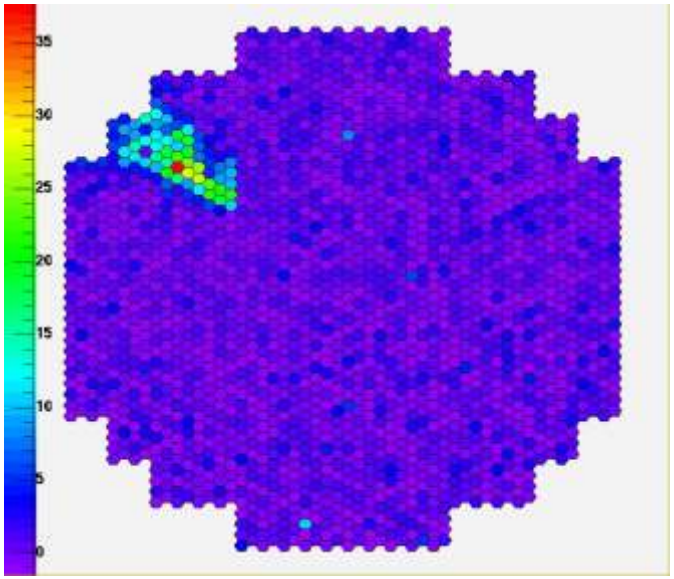


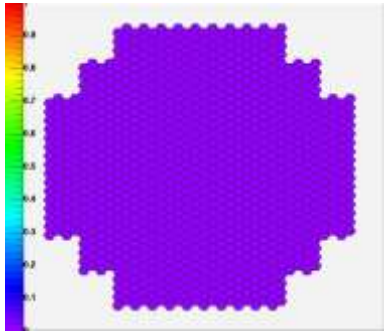
Event Display - Simulation



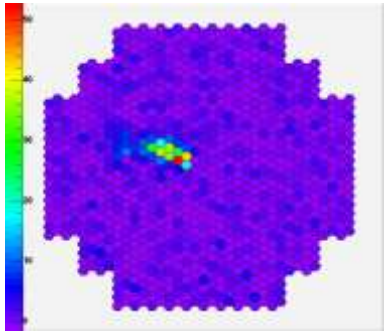
70 GeV γ-ray shower



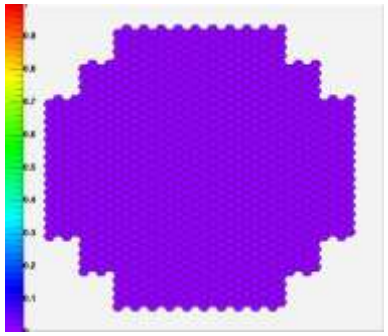




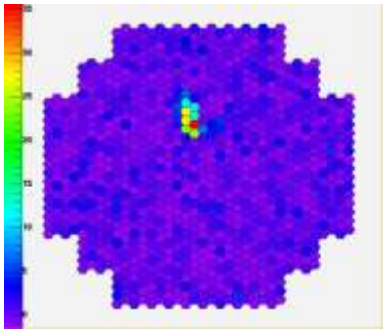
New stereoscopic event class 50 GeV<E<100GeV

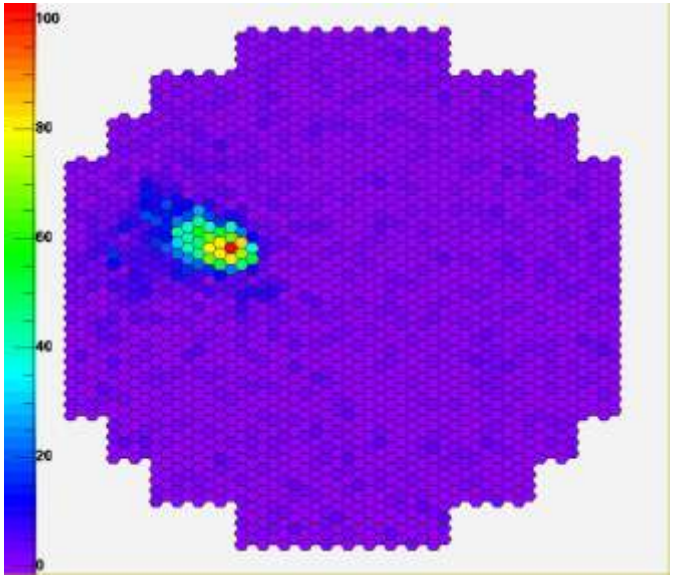


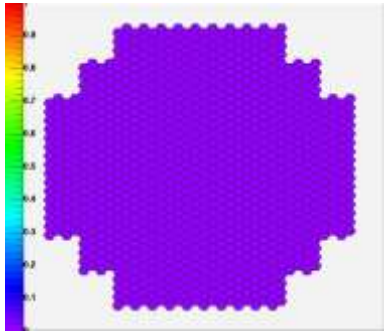
Event Display - Simulation



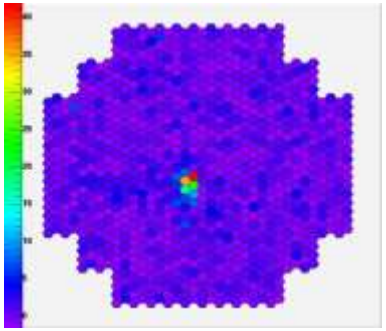
100 GeV γ-ray shower



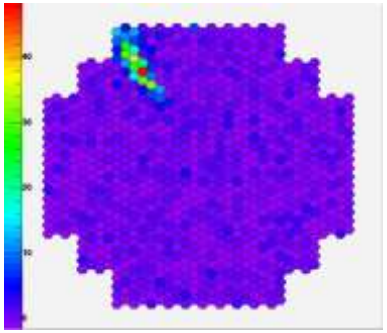




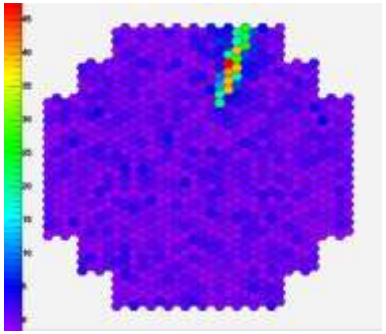
Stereoscopic event class
E>100GeV

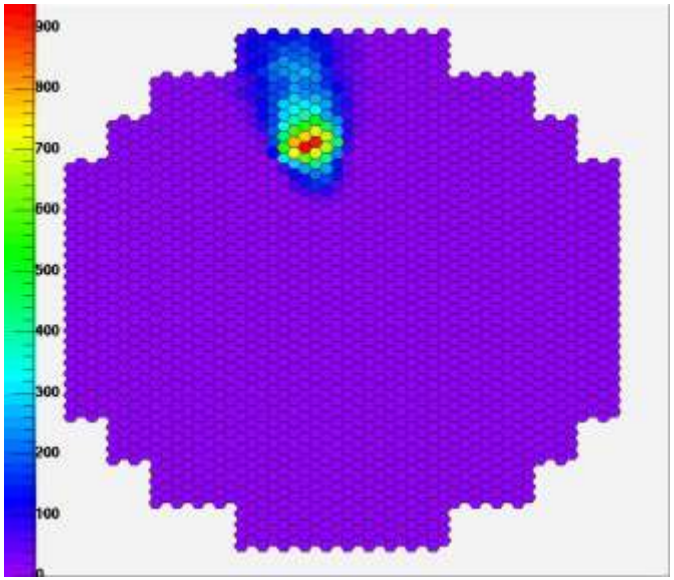


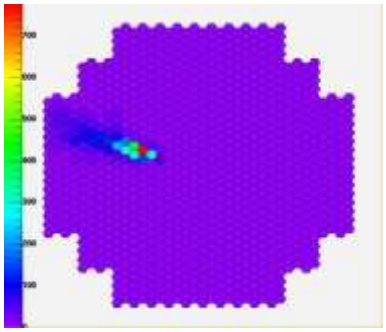
Event Display - Simulation



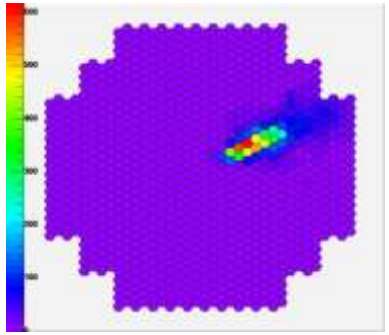
1 TeV γ-ray shower

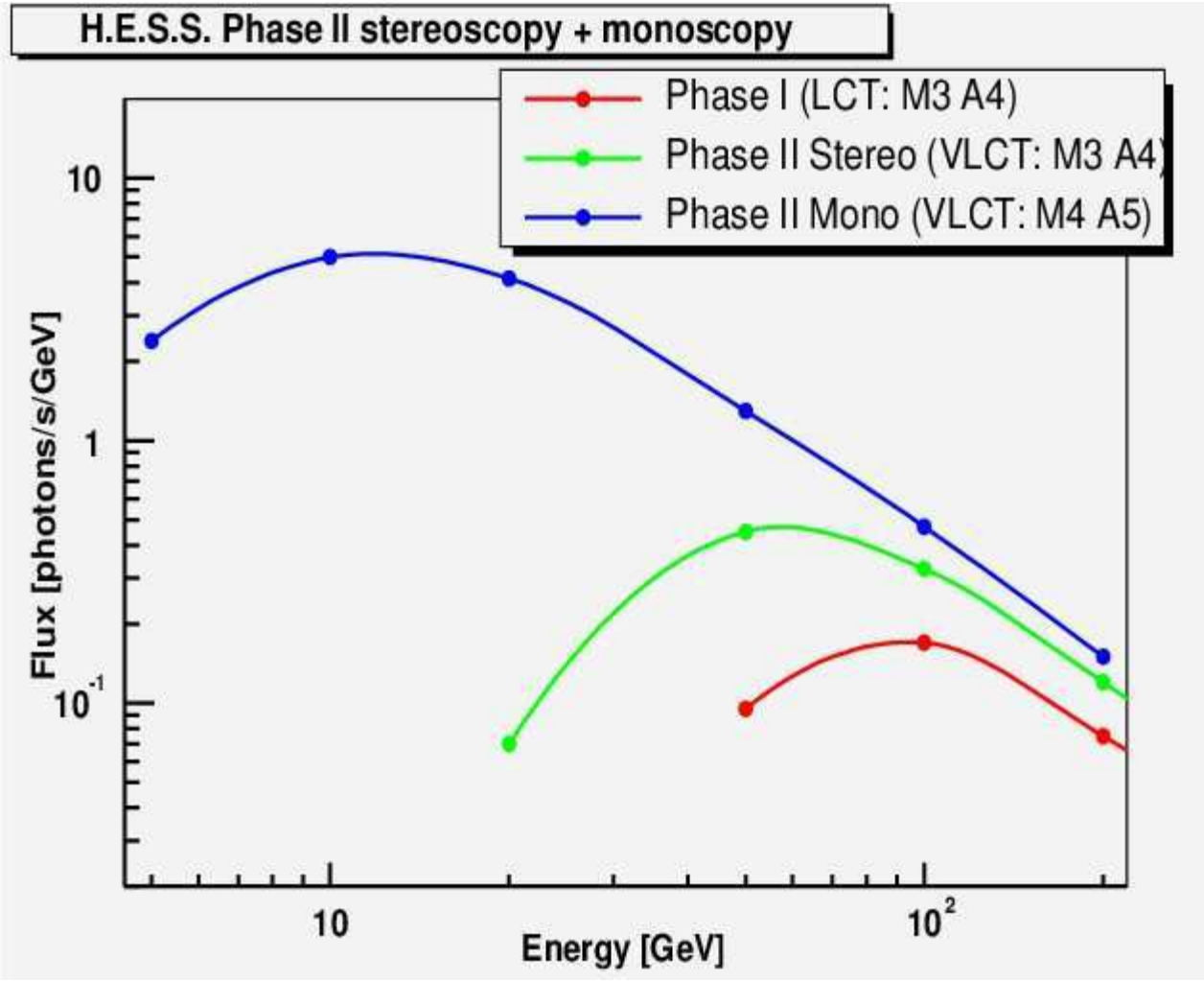






Stereoscopic event class
E>100GeV




H.E.S.S. Phase II stereoscopy + monoscopy
Phase I (LCT: M3 A4)
Phase II Stereo (VLCT: M3 A4)
Phase II Mono (VLCT: M4 A5)
Flux [photons/s/GeV]
10
1
10^-1
10
10^2
Energy [GeV]