Performance of the H.E.S.S. cameras

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for the H.E.S.S. collaboration

LPNHE-Paris
 J-P.Denance, J.Guy, J-F.Huppert, P.Nayman, M.deNaurois, M.Rivoal, L.Rolland, J-P.Tavernet, F.Toussenel, P.Vincent
LLR
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PCC
 P.Espigat, M.Punch
MPIK-Heidelberg
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Fully embedded system

Requirements :

Low threshold ~ 120 GeV
Dynamic range up to few 10 TeV
Good collection efficiency
Energy resolution ~ 10-20%
Fast trigger.
Modularity : easy to repair

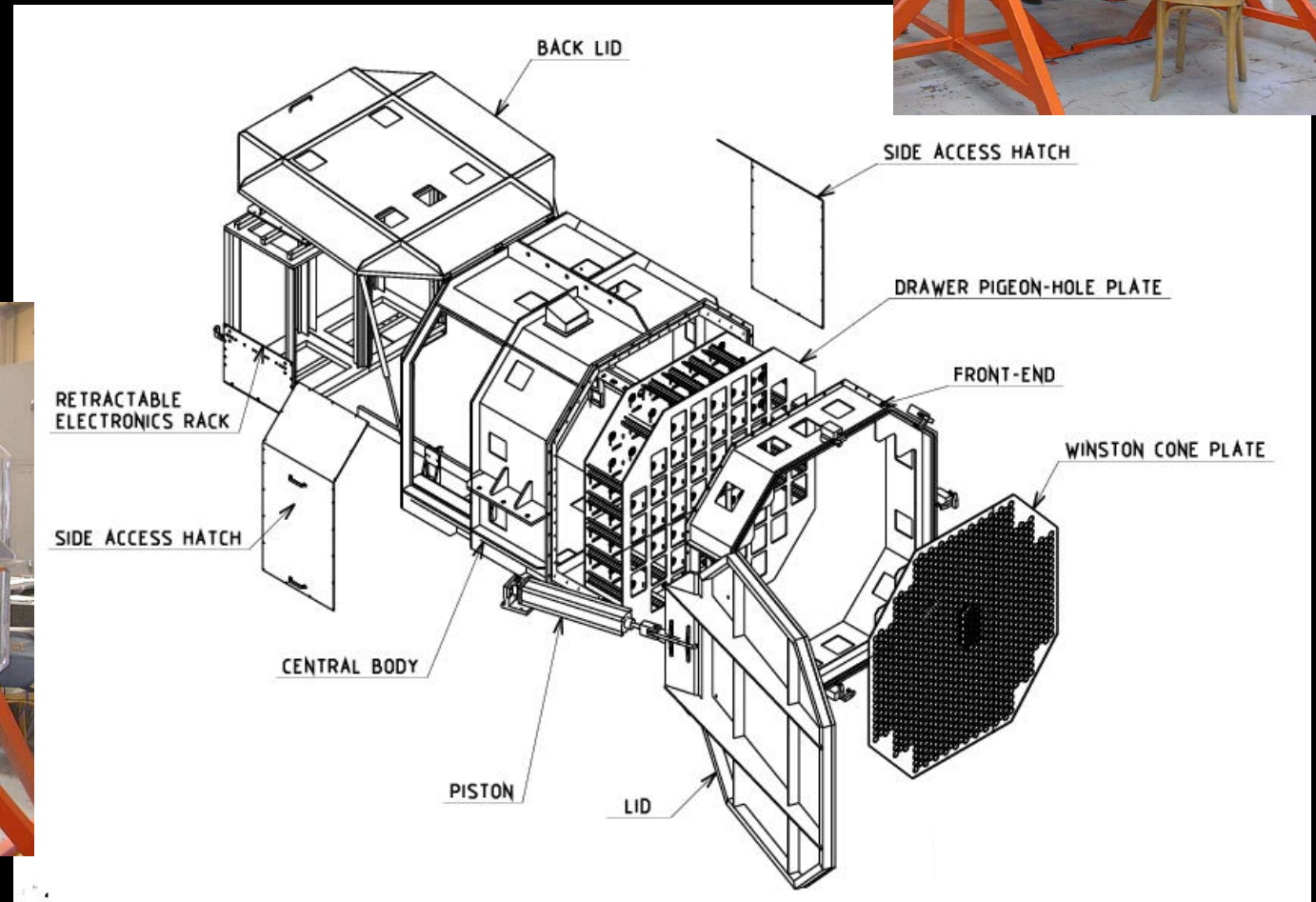*OG 2.5 Poster 2-P-112, A K Konopelko et al.*

Camera Mechanics

Modular system of 60 drawers of 16 phototubes each

Only 3 cables for power supply, central trigger and network.
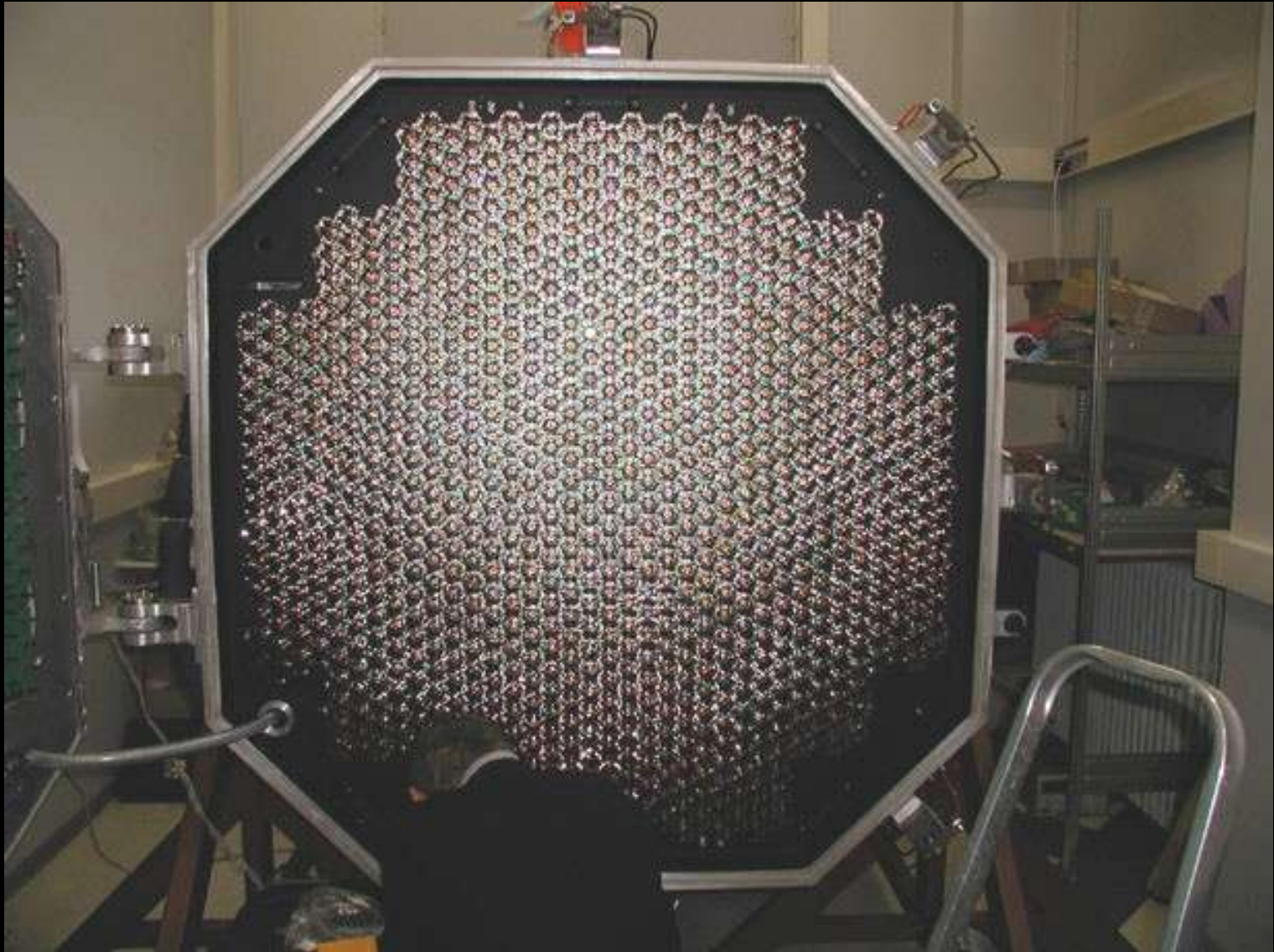
WaterProof (pneumatic front lid protection against sun & water)

Weight ~ 900 Kg

Winston cones

In the front of the camera 960 Winston cones collect ~70% of light

Front-end electronics

- **60 drawers of 16 PMs** (photonis PMT XP 2960) : QE ~ 25%

- **+ active bases**
  - DC-DC converter 0-1500 V
  - HV & current readout
  - Current limit

- **1 "Slow Control" card :**
  - High voltage control and monitoring
  - Temperature & Current monitoring
  - Counting scalers

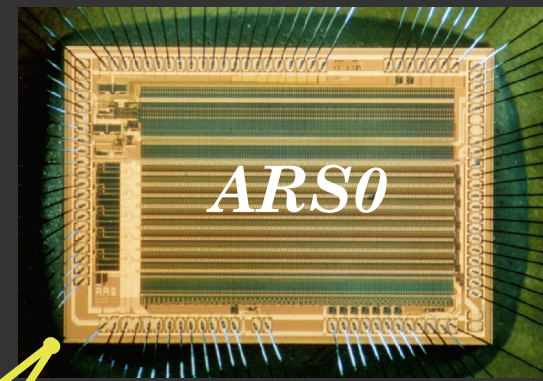- **2 cards with Analogue Memory ship (x8 PMTs).**

Analogue Memory ARS0
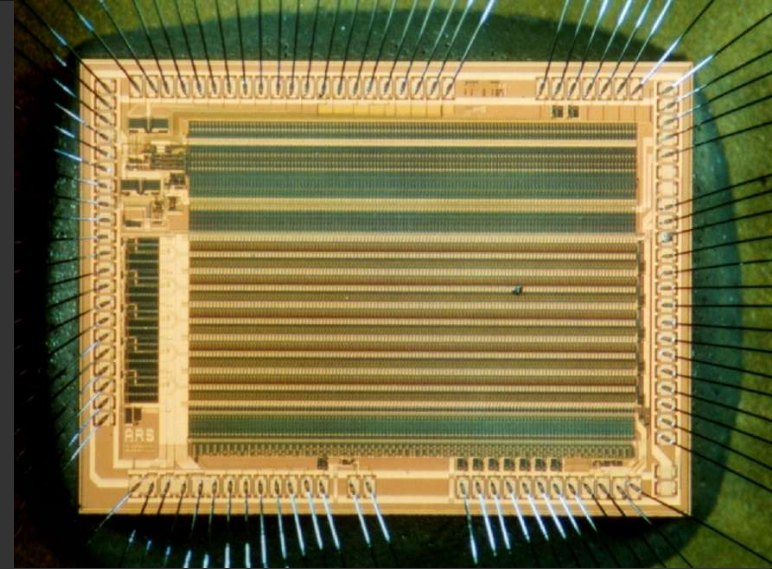
- **Analogue Memory ARS0 built for ANTARES experiment (SEI-Dapnia)**

    - **5 buffers /chip, 128 cells per channel.**

    - **Sampling @ 1 GHz**

    - **Readout ~ 1 Mhz**

    - **Controlled by two parameters**

        - **Readout window (~16 ns)**
        - **Readout delay (50-70 ns)**

- **Readout : Sampling or integrated charge mode**
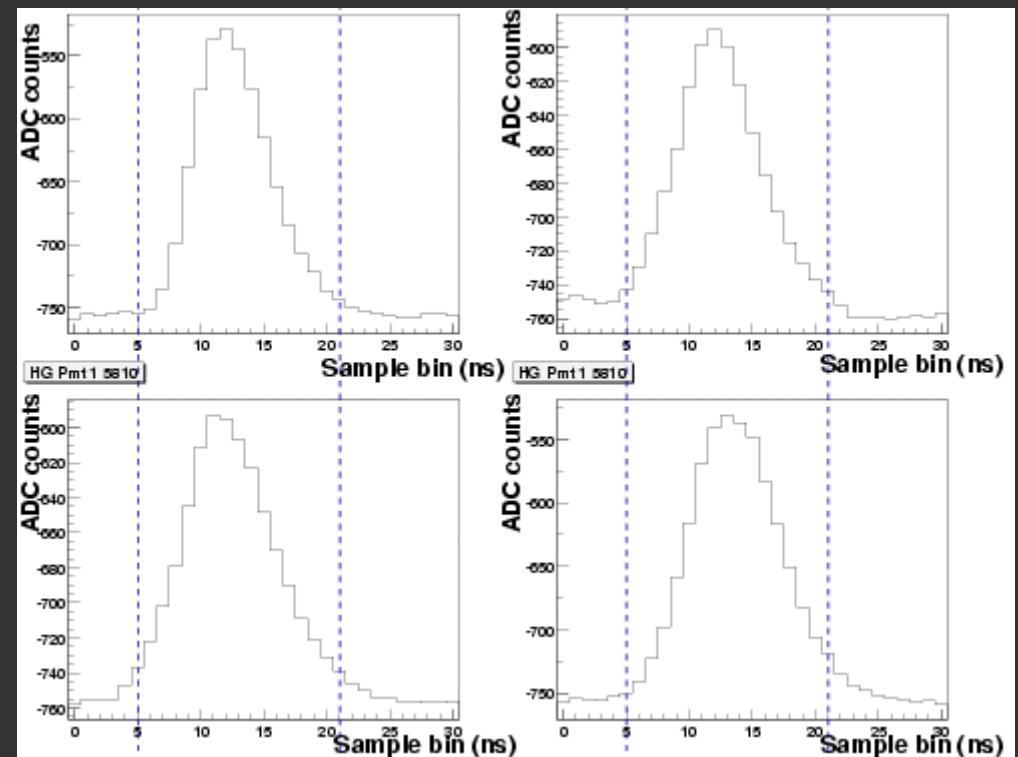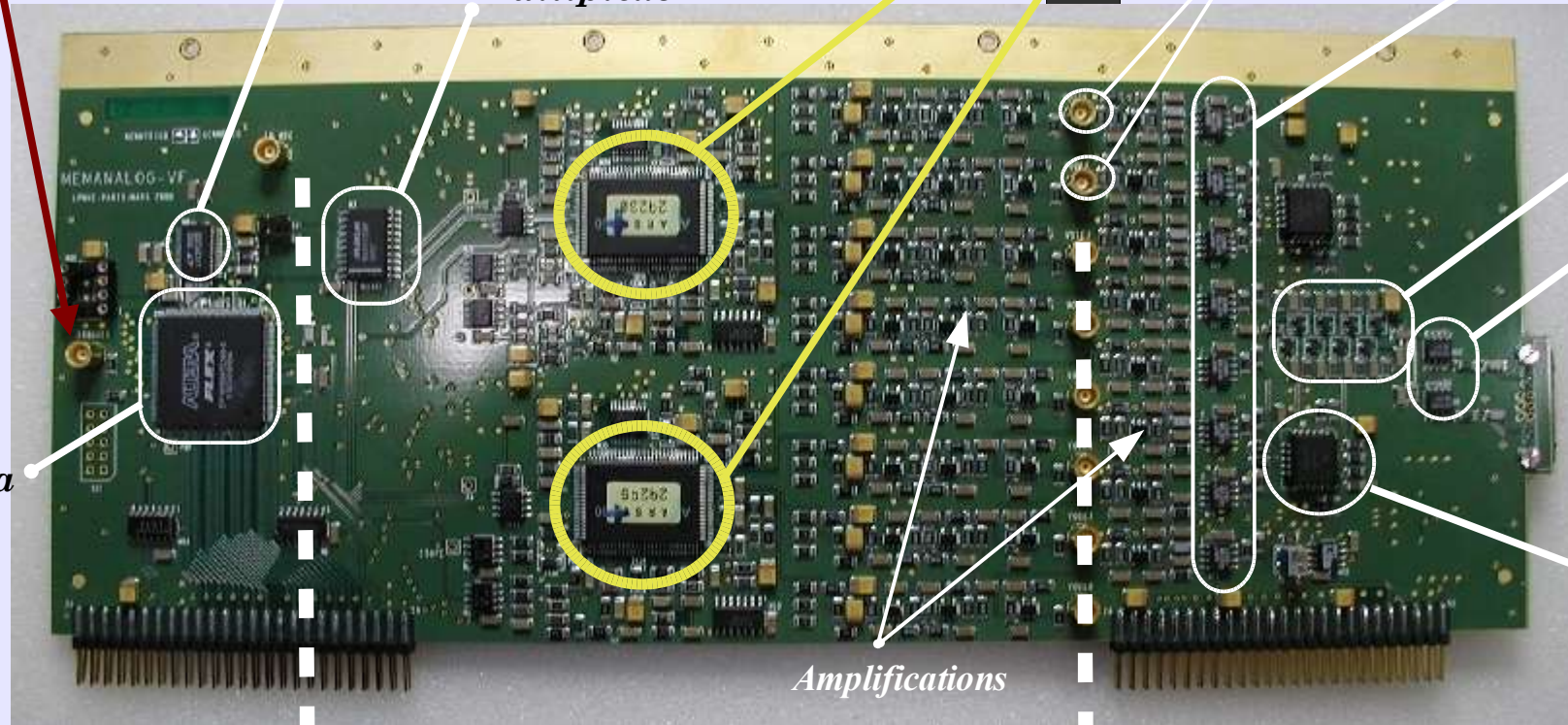
Readout & First level trigger

ARS0

Readout channels

Fanout signal entry

12 bits ADC

Multiplexor

Connection to photo-tubes

8 x comparators

Adder

Buffers

Fpga

output local trigger

Amplifications

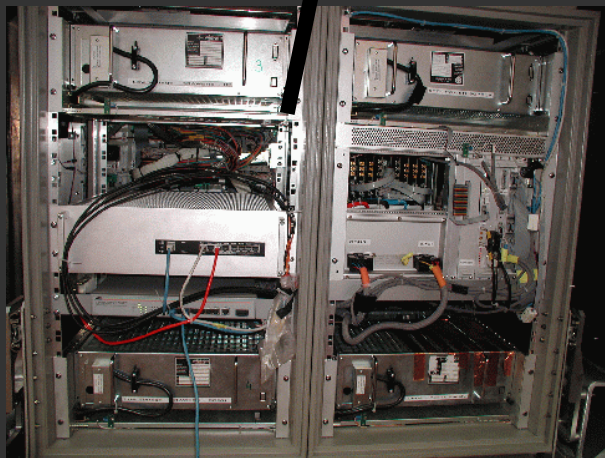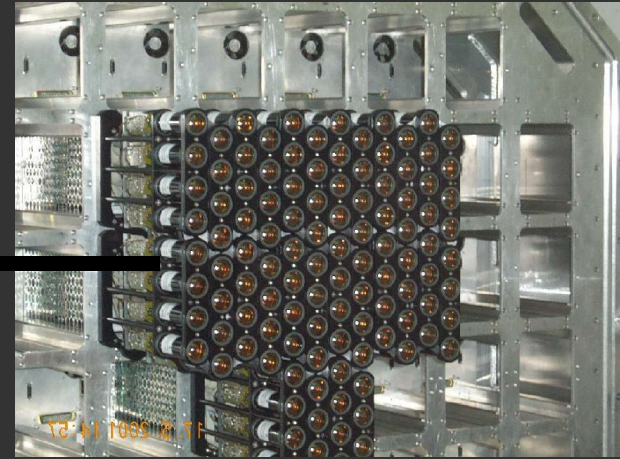*Enable/disable (4 channels)*
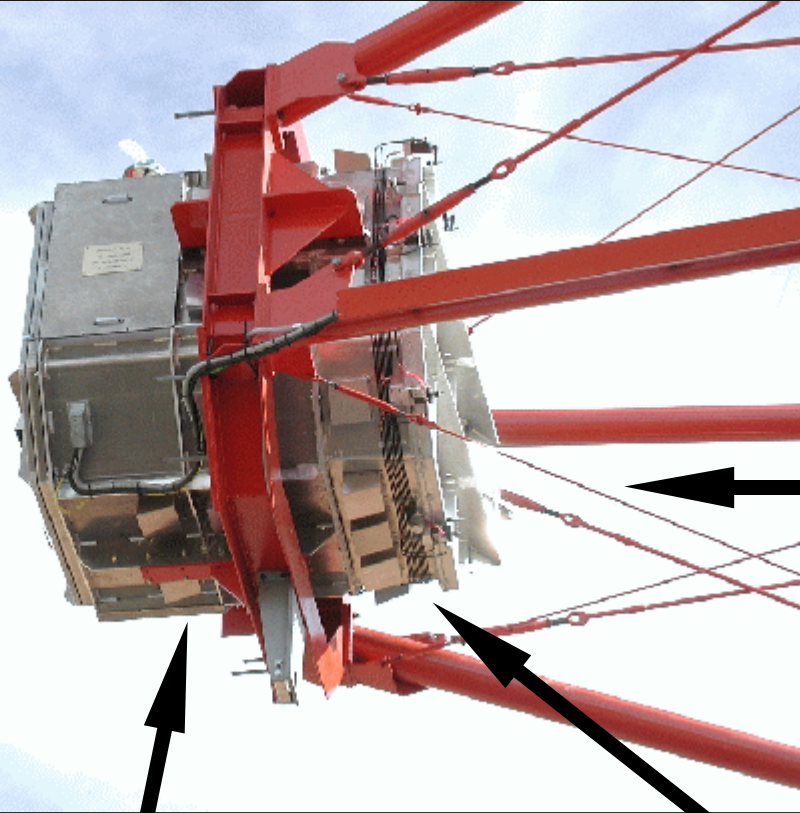
Digital

Analogue

Trigger channels

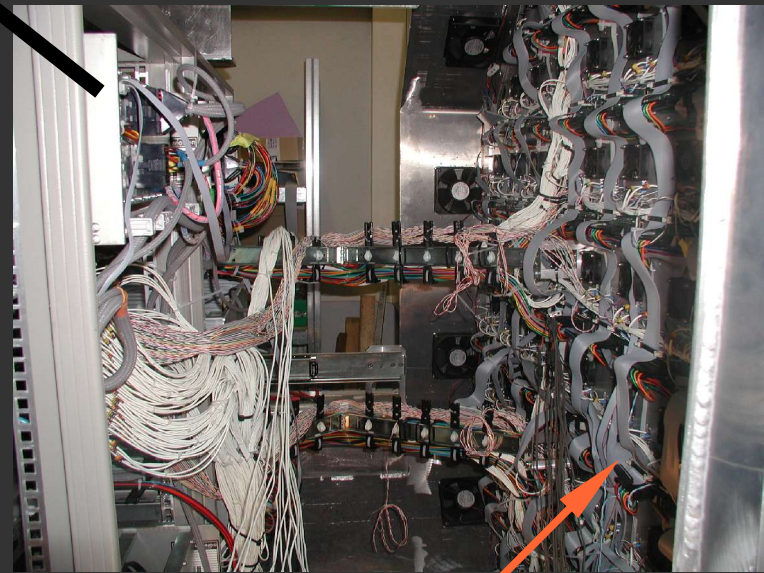# Camera trigger based on sectorisation (x64 pixels)
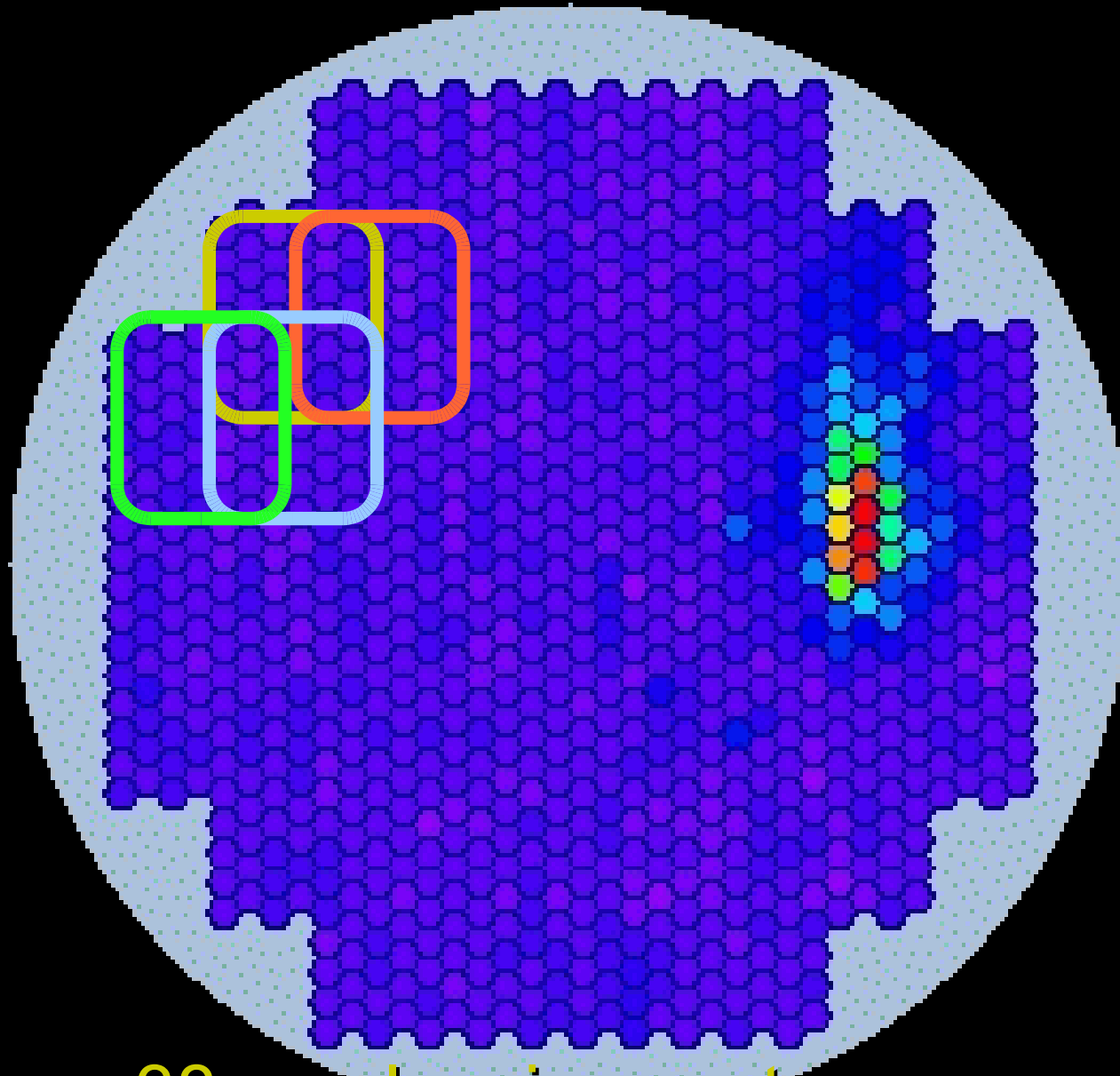
38 overlapping sectors

Readout system

Acquisition system

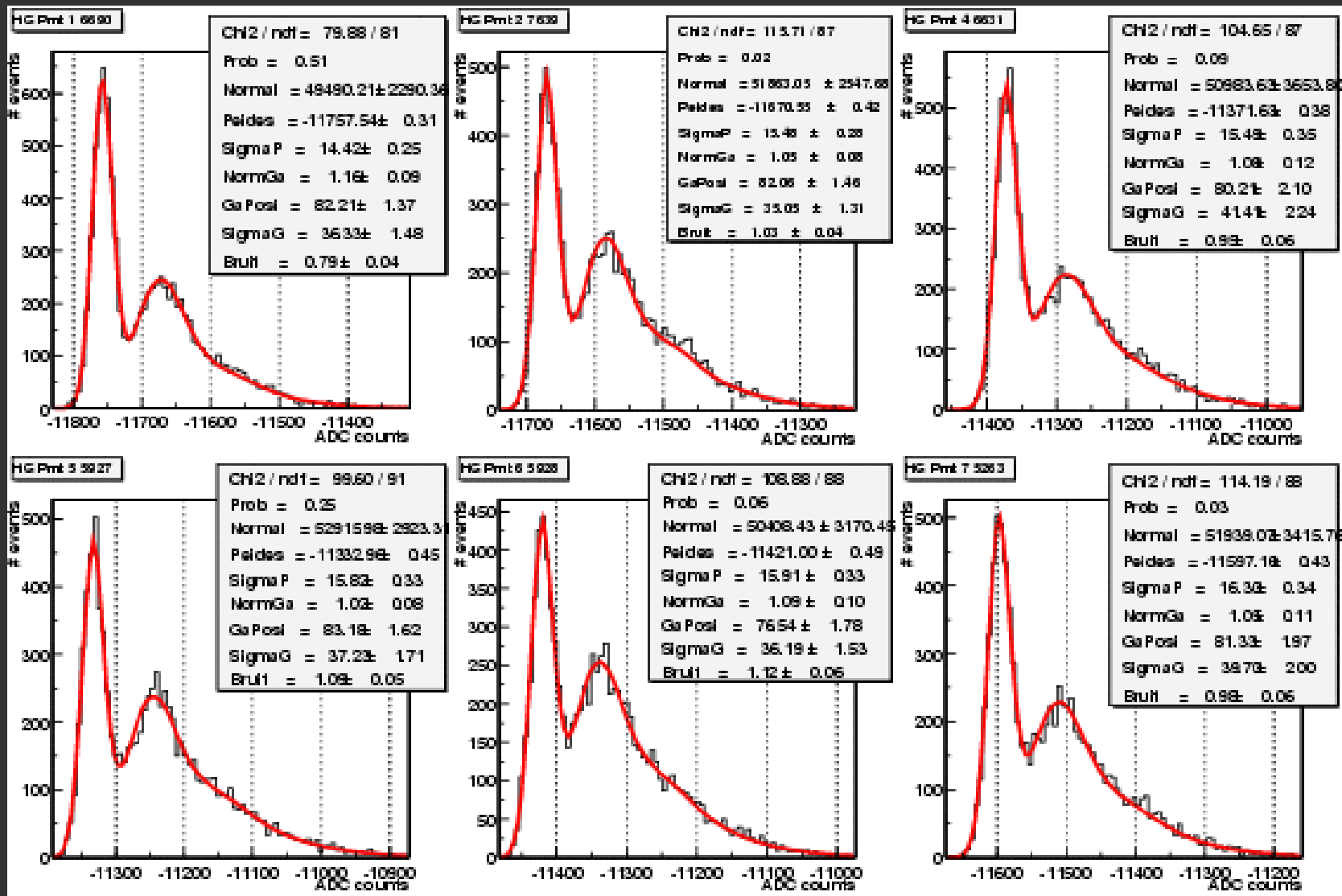Parallel transfer on 4(↗8) busses

Linearity

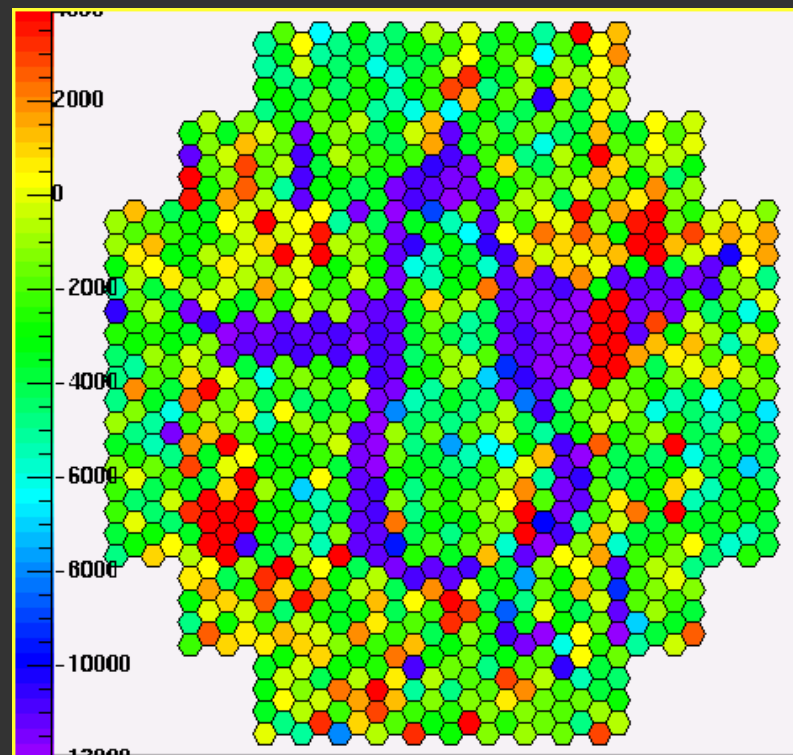| High gain	1	⇨	200 γe
Low gain	10	⇨	1 600 γe
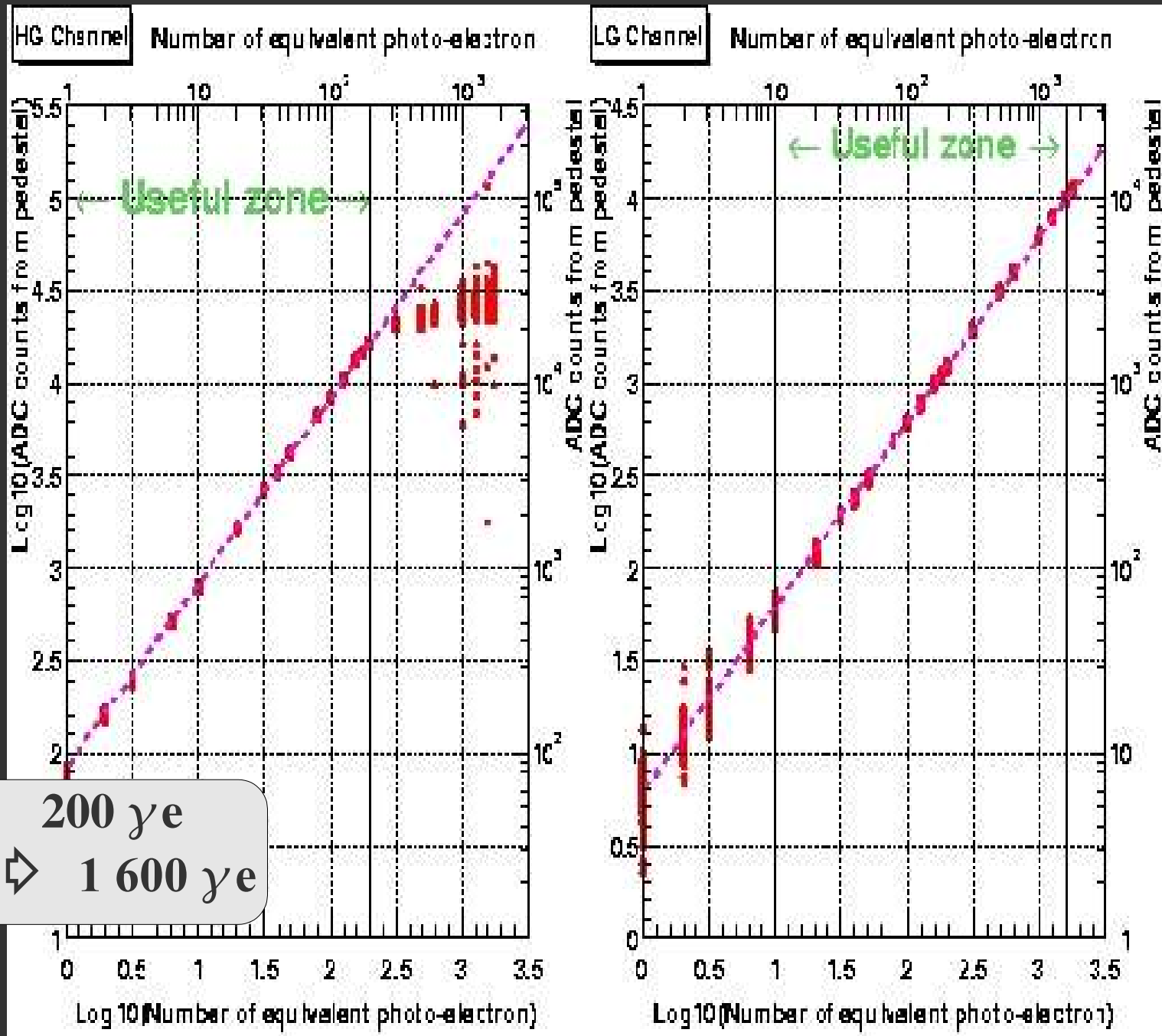
Single γe determination @ 2.10^5 of gain

Calibration System for the first camera
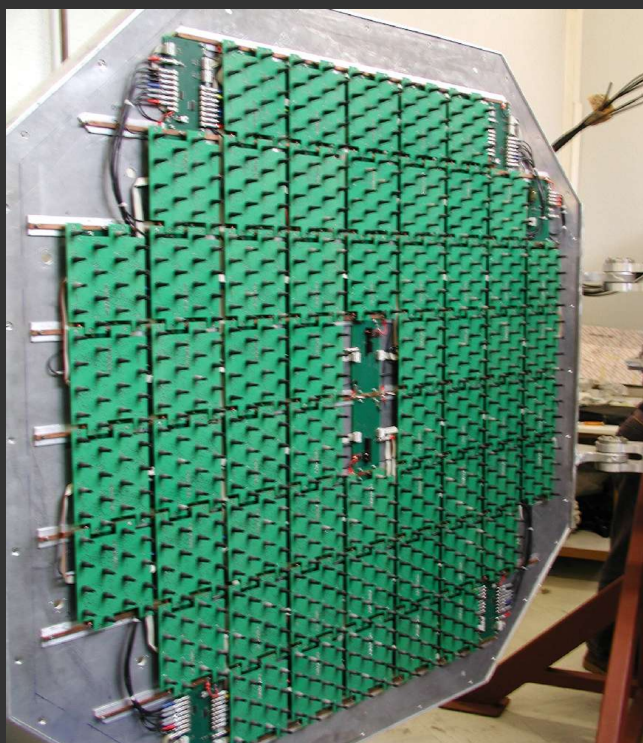
LED system

Camera response

960 LEDs with programmable intensity from **0.6** to more than **10.000** γe
Pulse width of ~ 2 ns
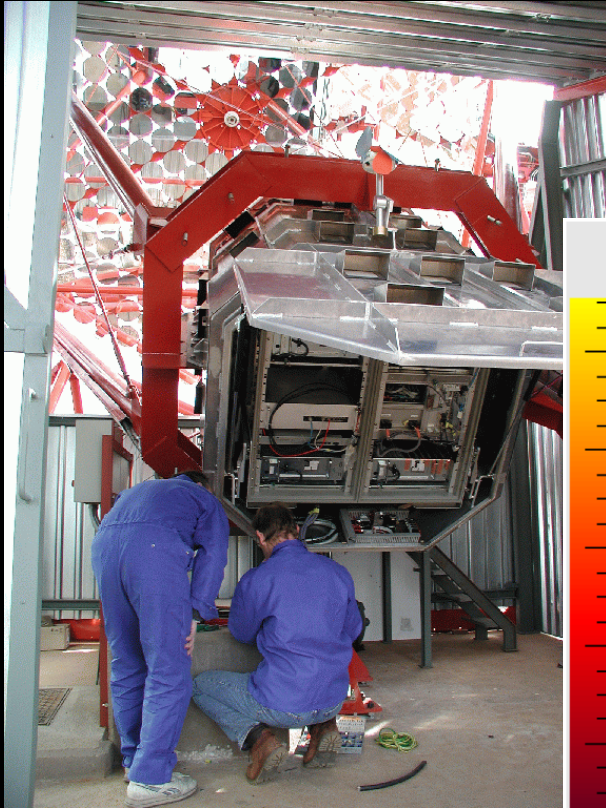Synchronisation < 1ns
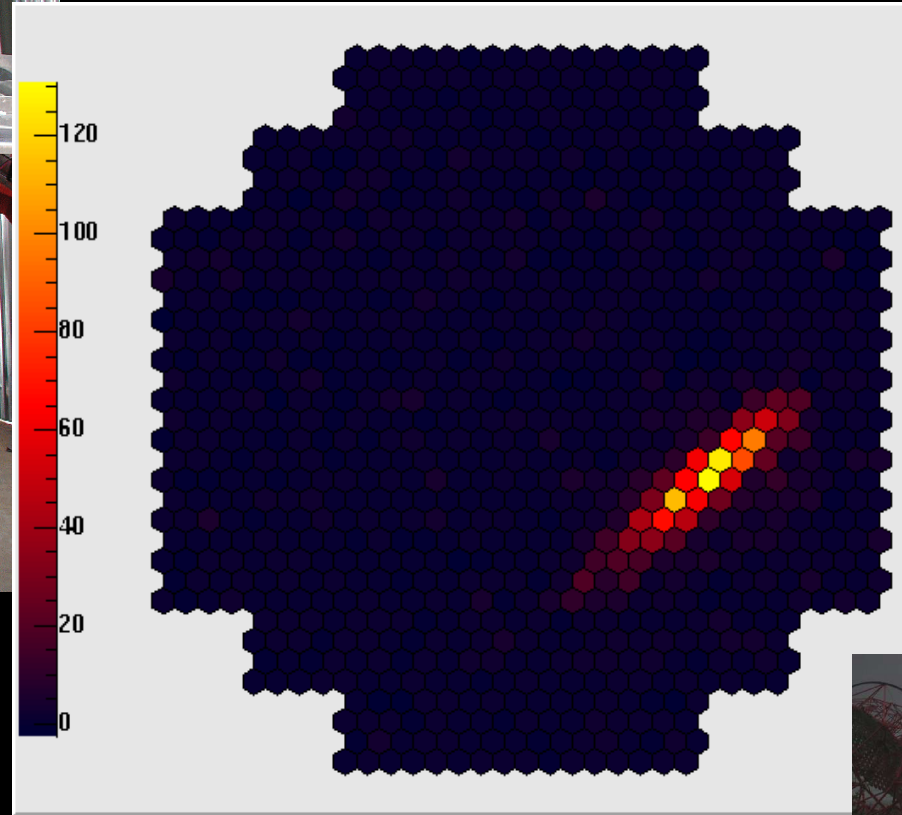Controlled by camera CPU

Second Calibration System
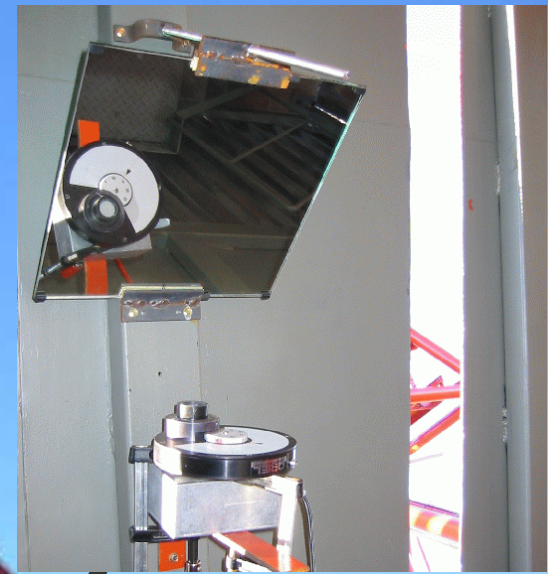
LED system for gain estimation @ single γe

Installation of the first camera, by the end of may 2002

First light june 11, 2002

© W.Hofmann

New busses & CPU

Installation of the second camera, february 2003
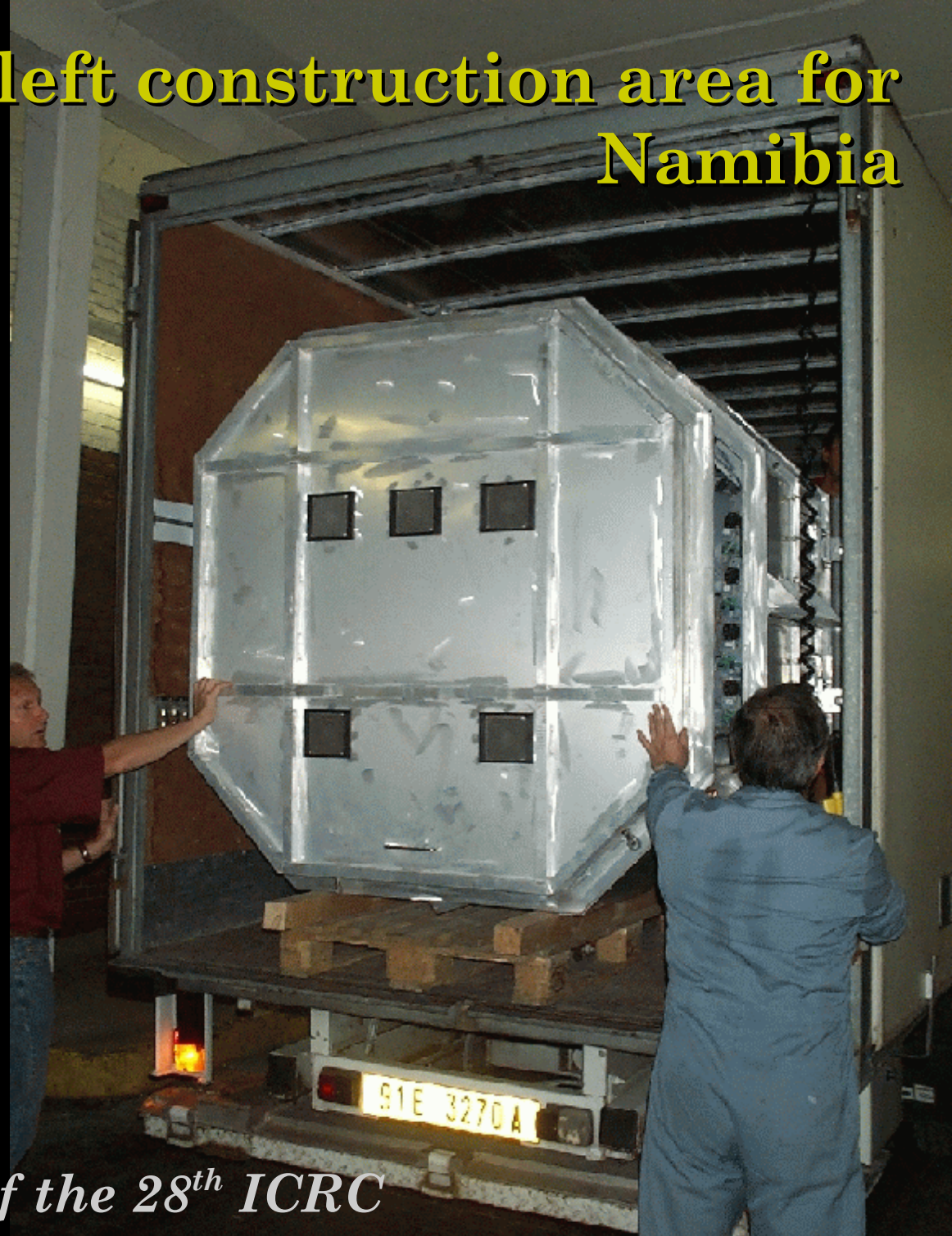
Camera 3 & 4 under construction

Camera 4

Camera 3

Busses x 4(↗8) busses

Camera 3 has left construction area for Namibia
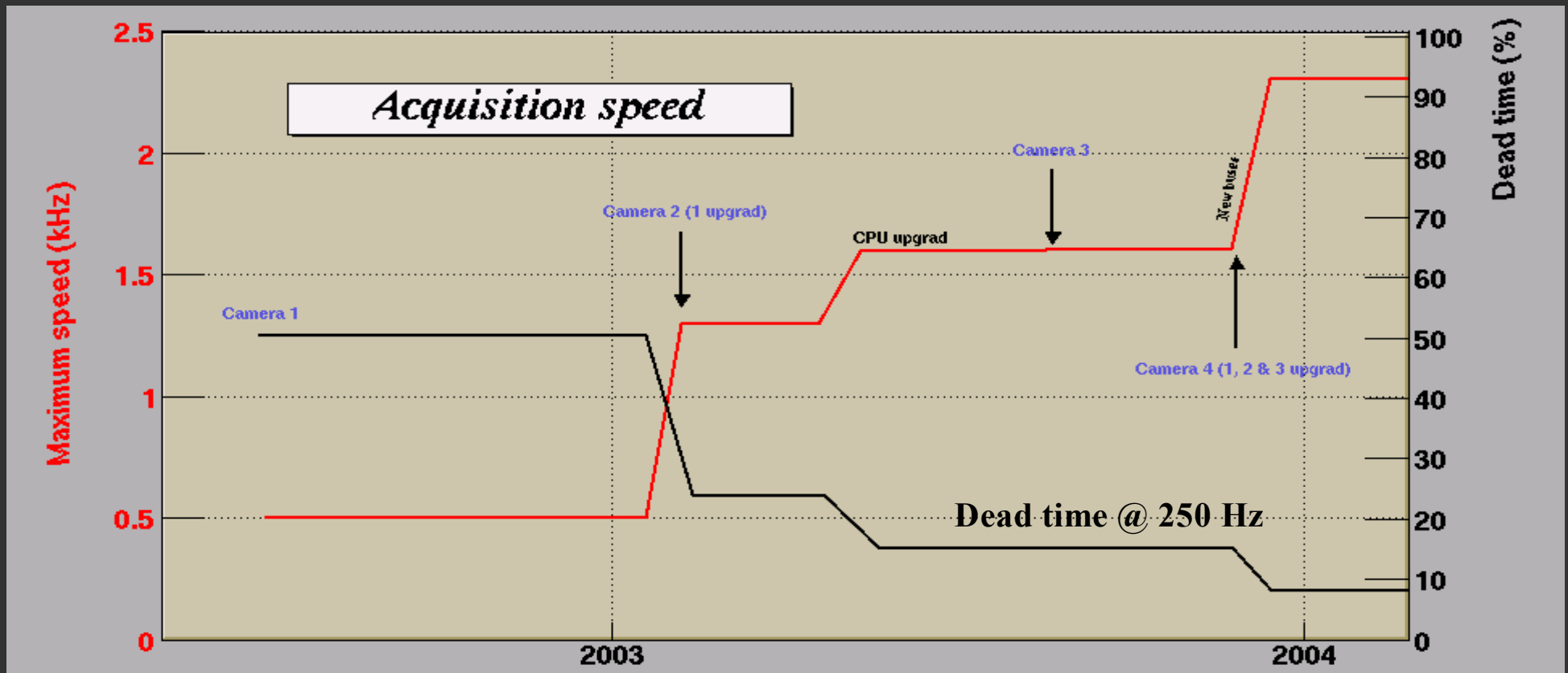
August 31, 2003
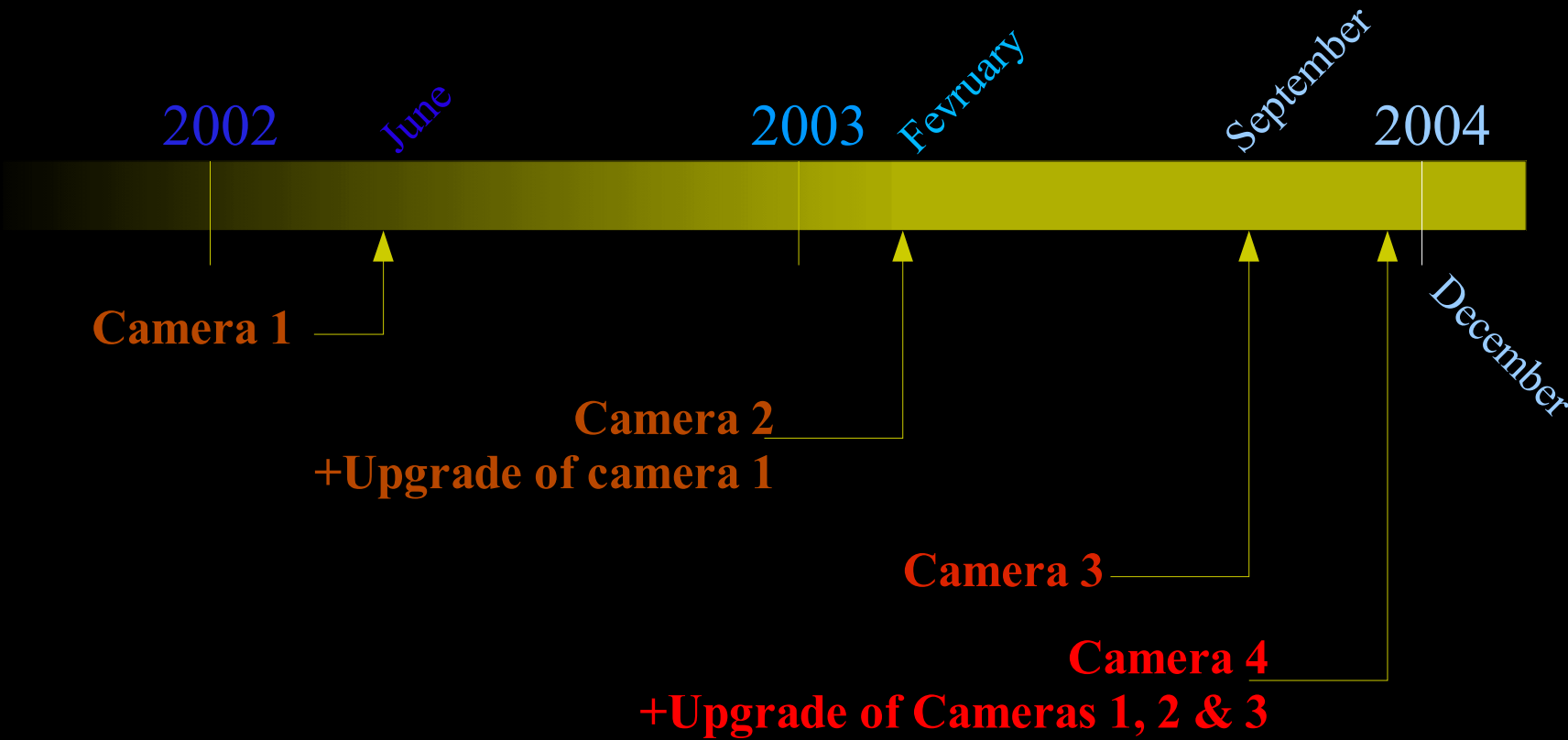*for the opening ceremony of the 28th ICRC*

Acquisition speed

Limited by :

readout of the analogue memories.
data transfer on the drawer's busses.
readout by the CPU.

Camera installation schedule

2002   *June*   2003   *Fevruary*   *September*   2004   *December*

Camera 1

Camera 2
+Upgrade of camera 1

Camera 3

Camera 4
+Upgrade of Cameras 1, 2 & 3

That's all folks!