JEM-EUSO focal surface electronics

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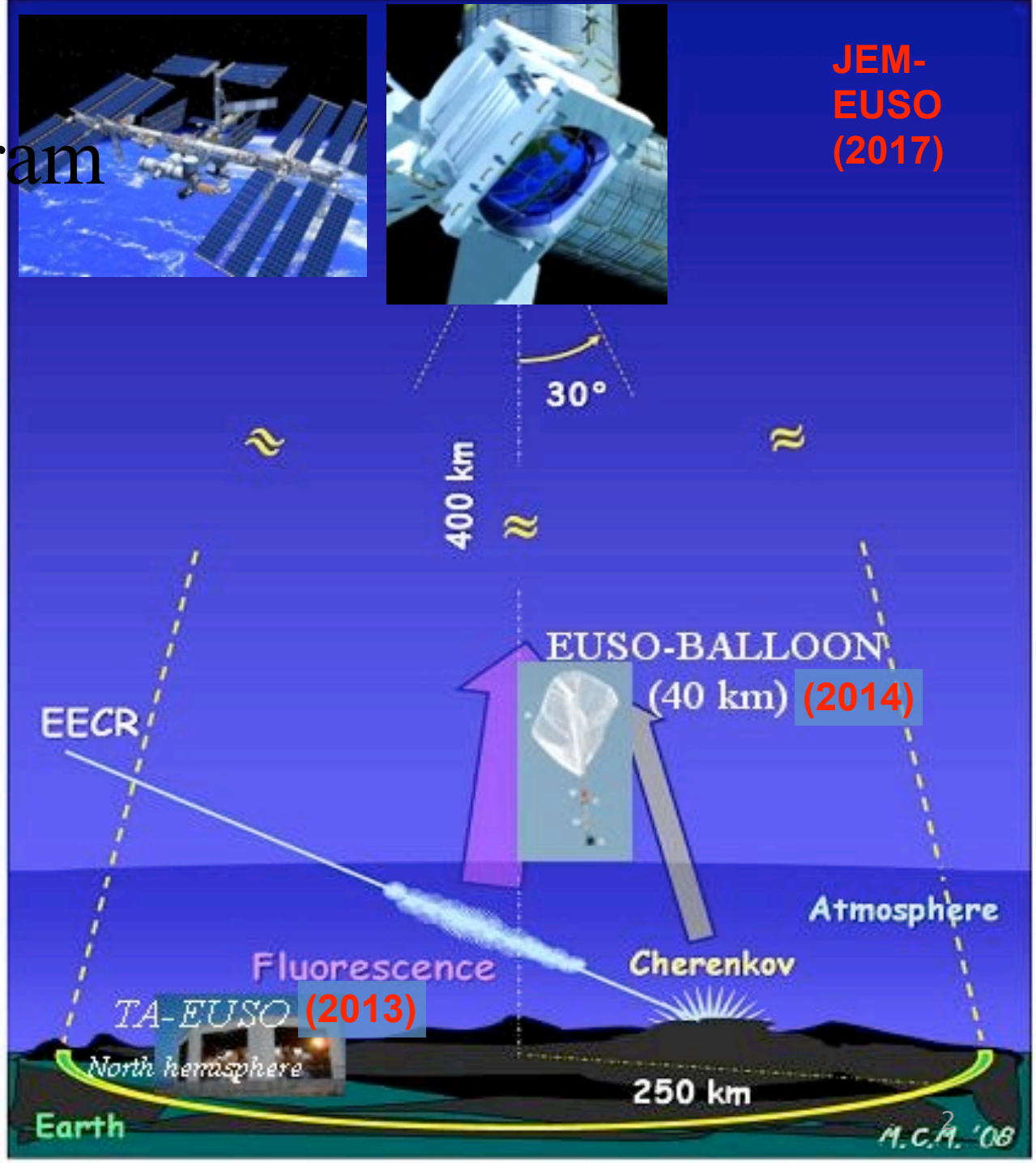
The EUSO program

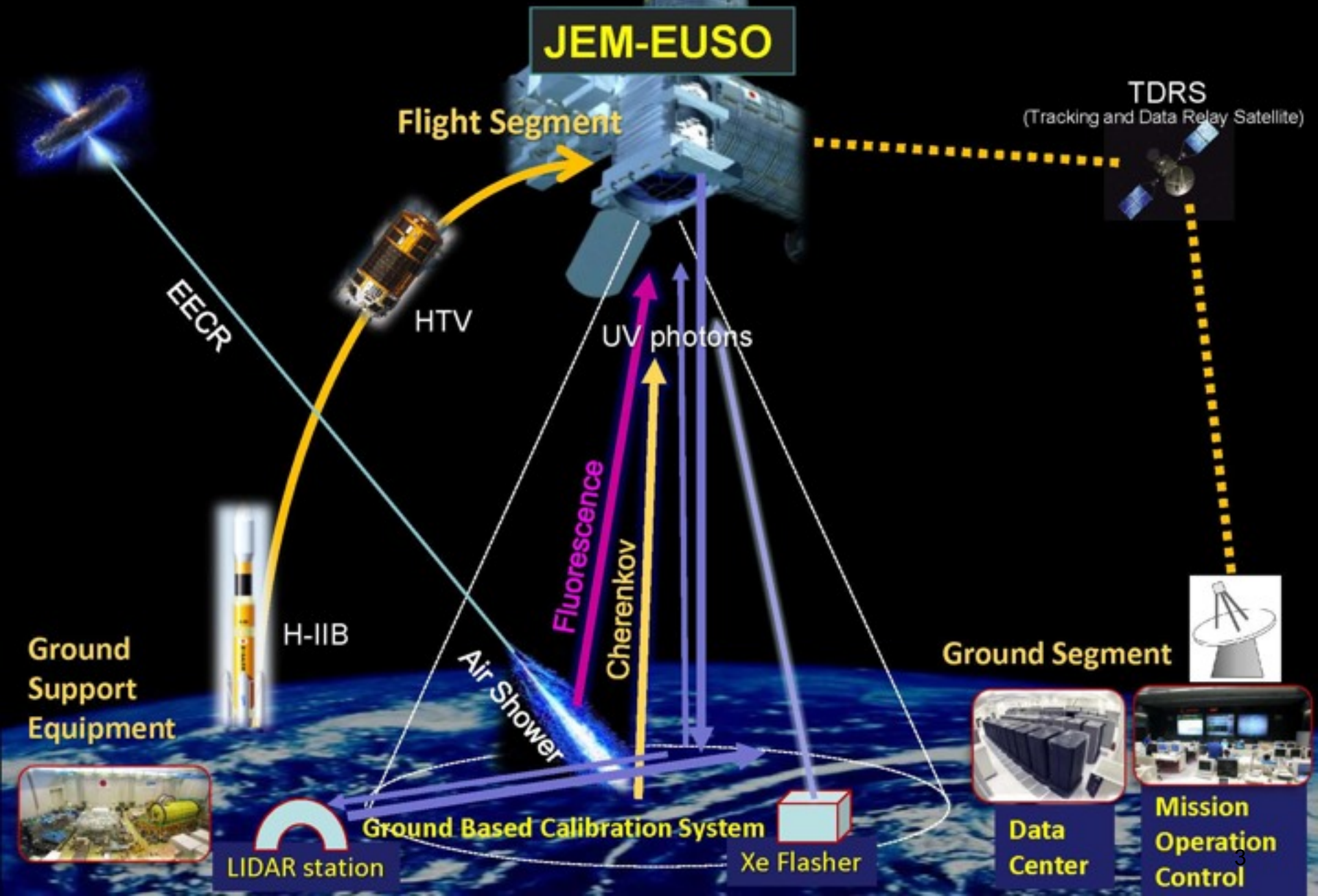
JEM-EUSO (2017)

1. Ground-EUSO: Test at Telescope Array site. (2013)

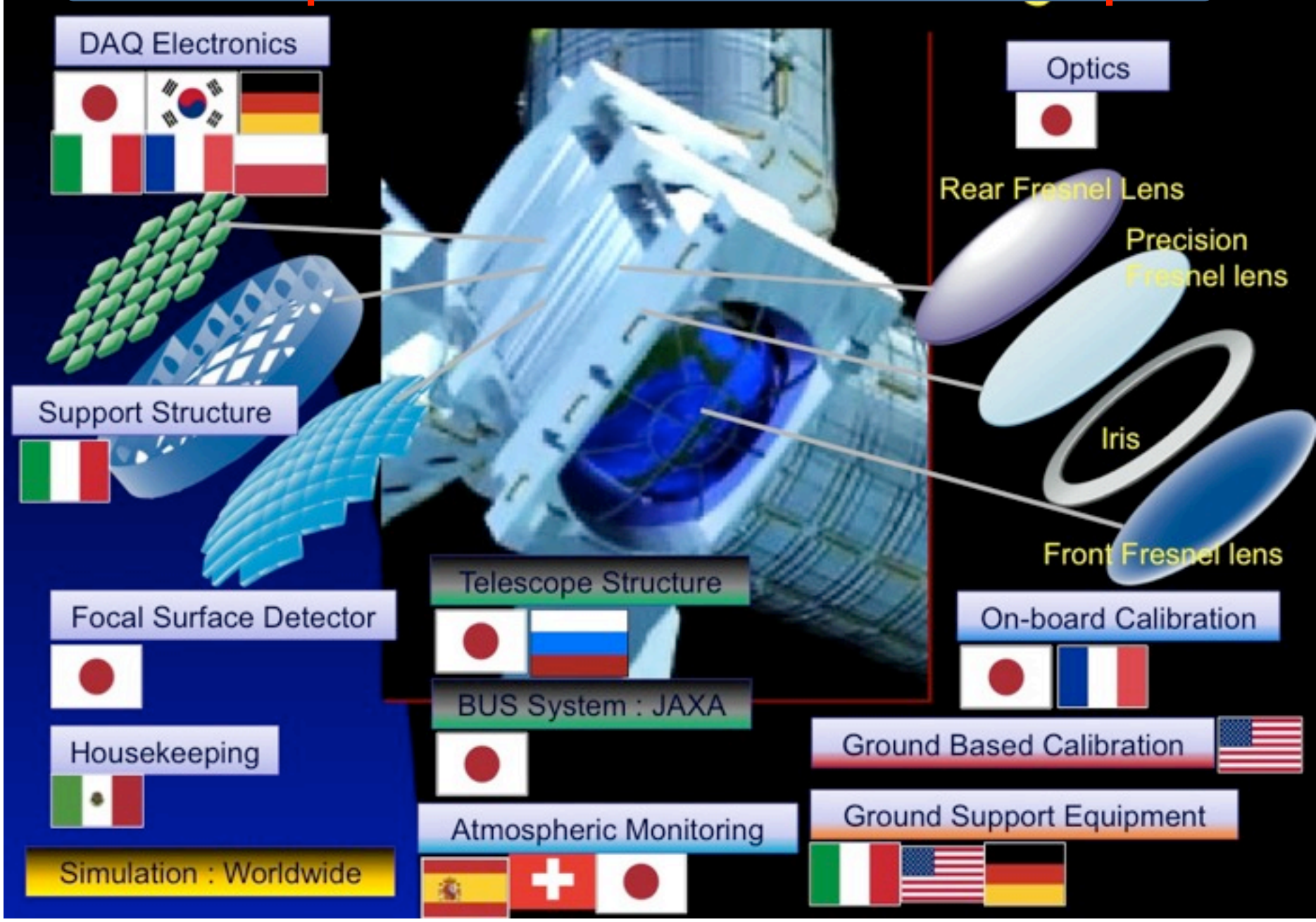
2. EUSO-BALLOON 3 Balloon flights from Canada (French Space Agency CNES) 2014-



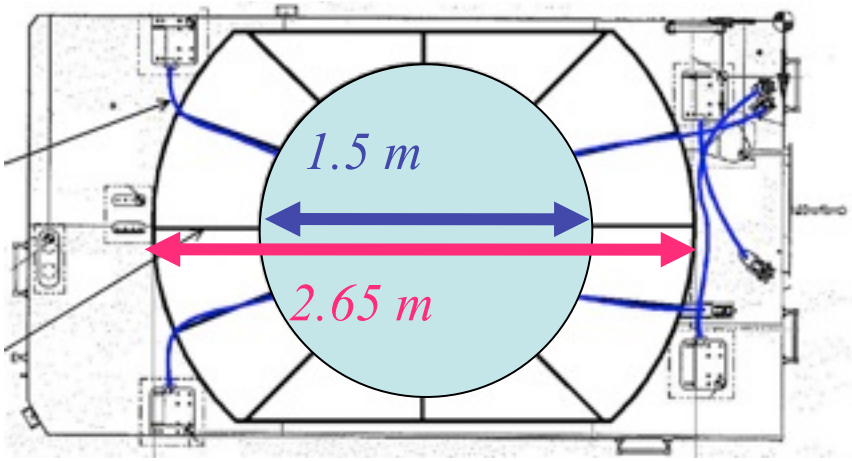
Conceptual view of the whole JEM-EUSO System



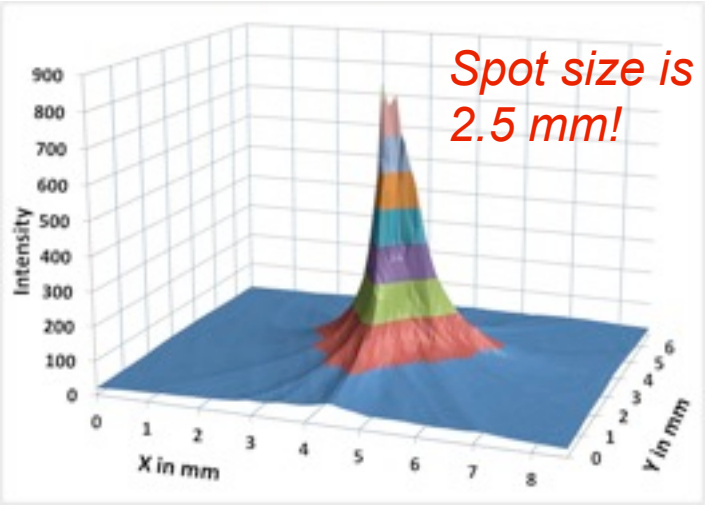
Conceptual view of the telescope



Optical system protoype

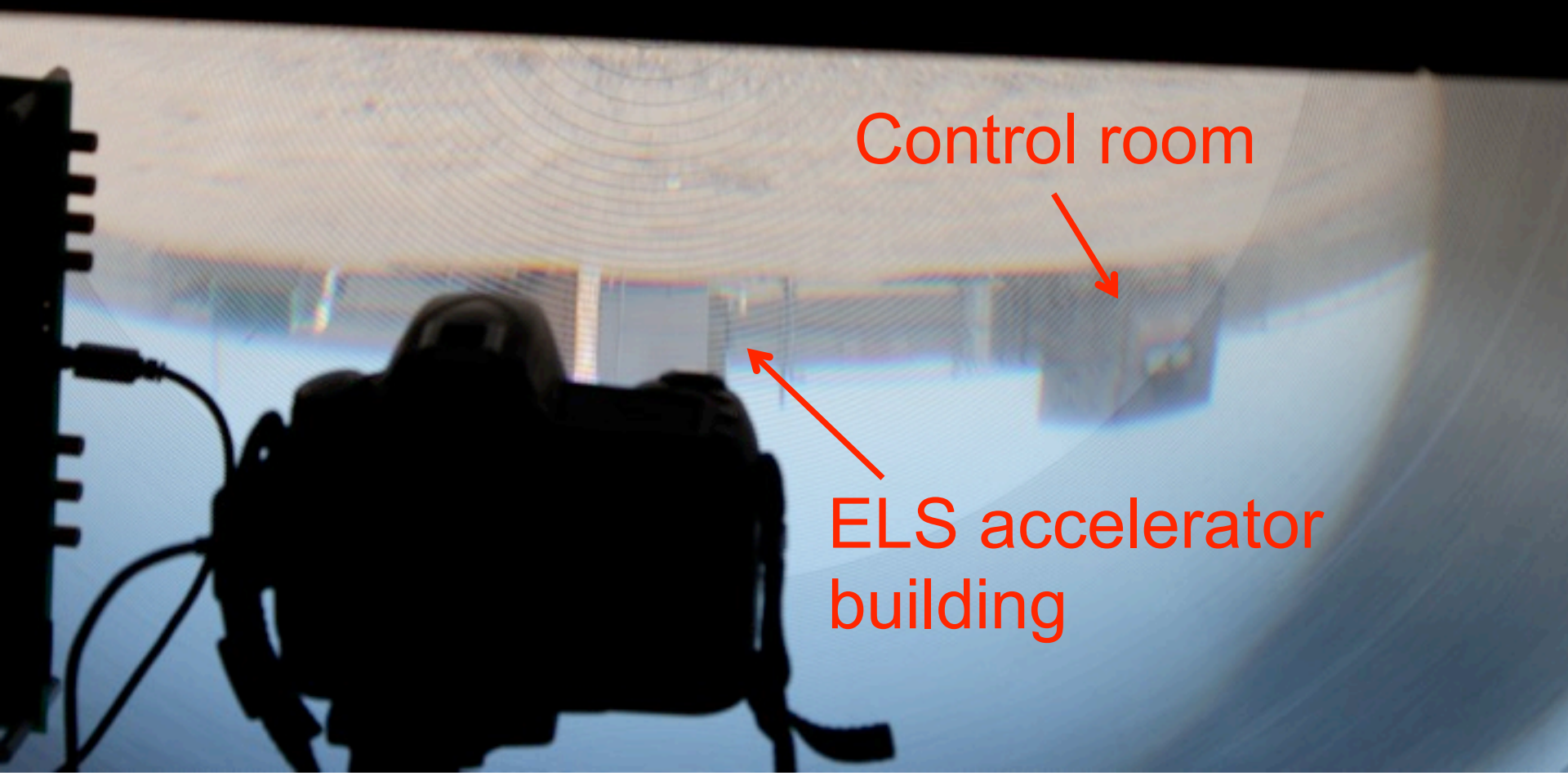


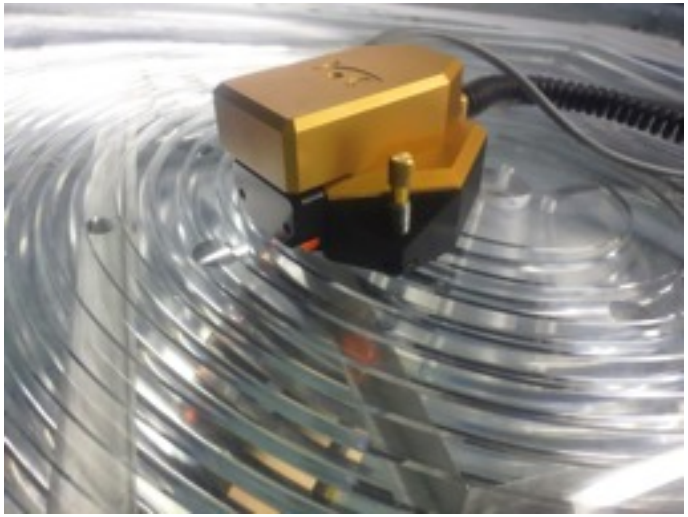
large diameter Fresnel lenses manufactured in Japan and tested in the US at the University of Alabama (Huntsville) and at MSFC (NASA)



Tested performances meet already the requirements (or are close to it)

Image is inverted
(Seen from inside)

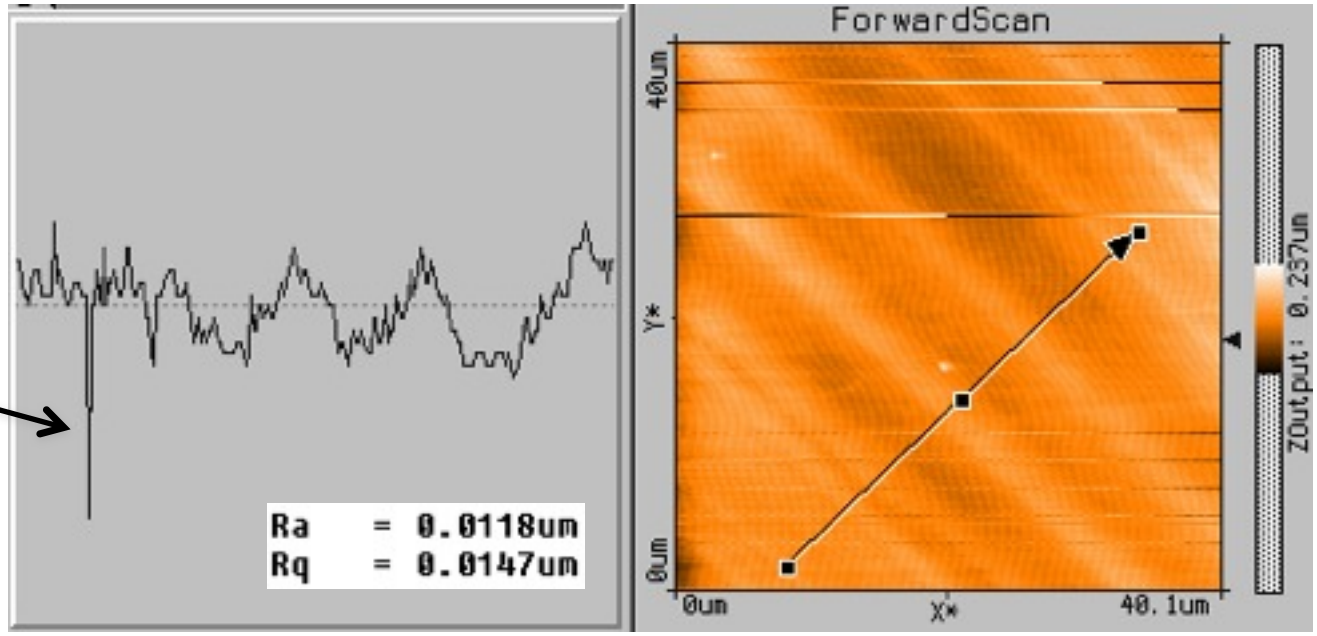




Lens precision: 20 nm

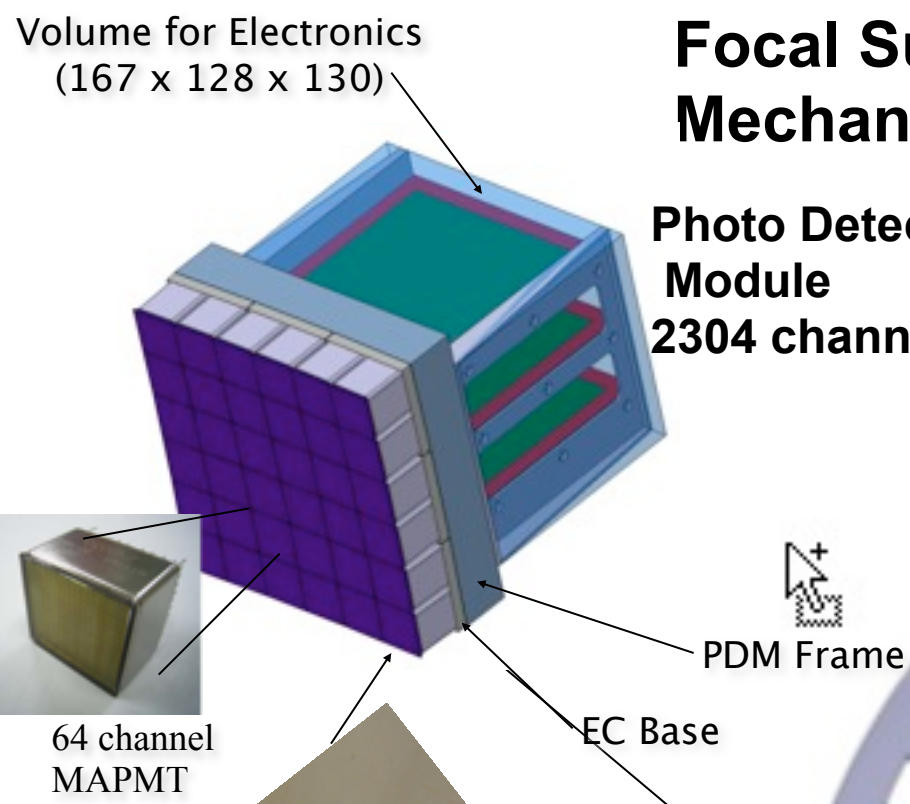
3rd groove surface roughness measurement

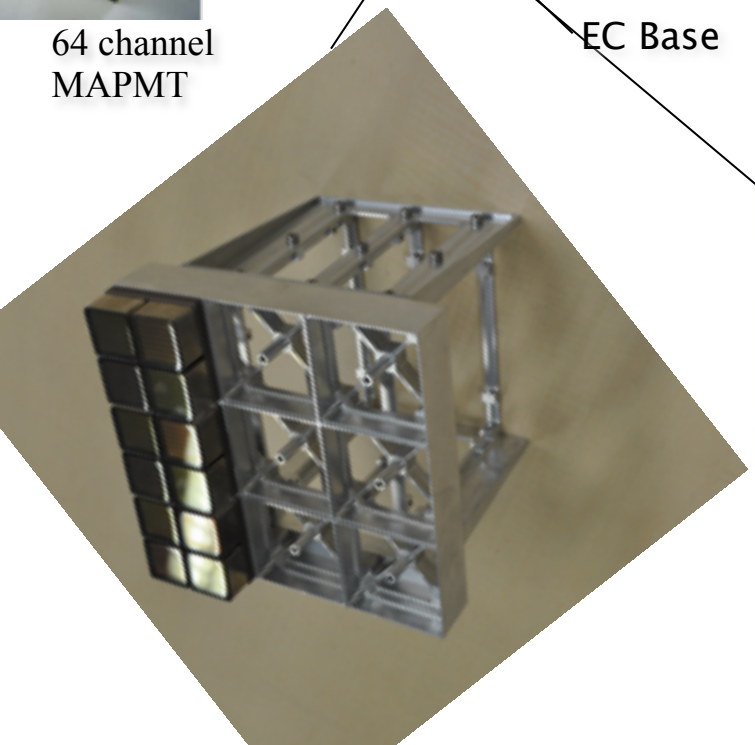
Electrical noise

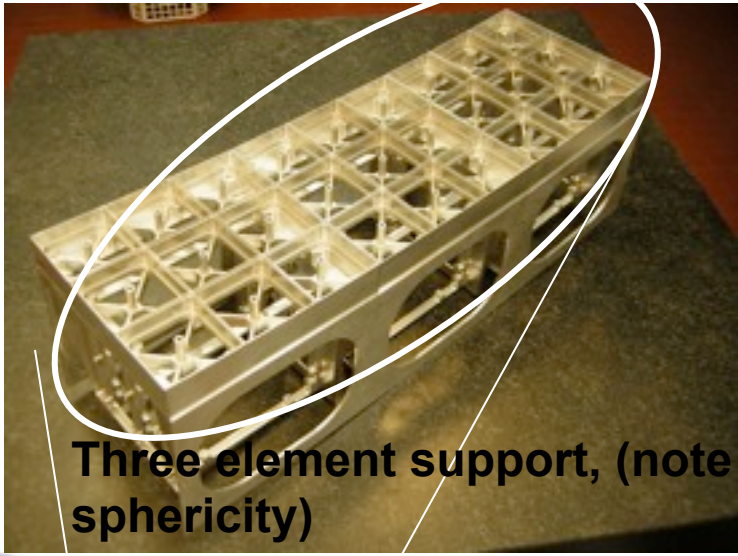


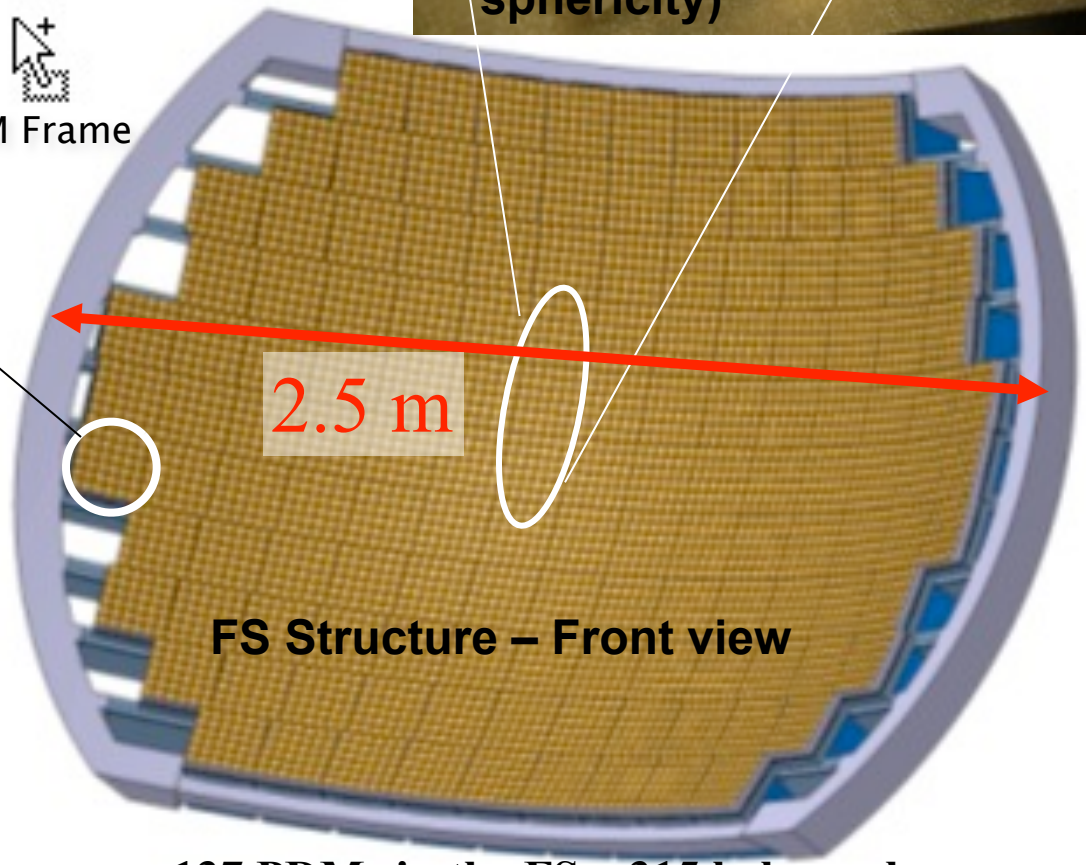
RMS surface roughness requirement : < 0.0200um (=20nm)

Focal Surface Mechanics



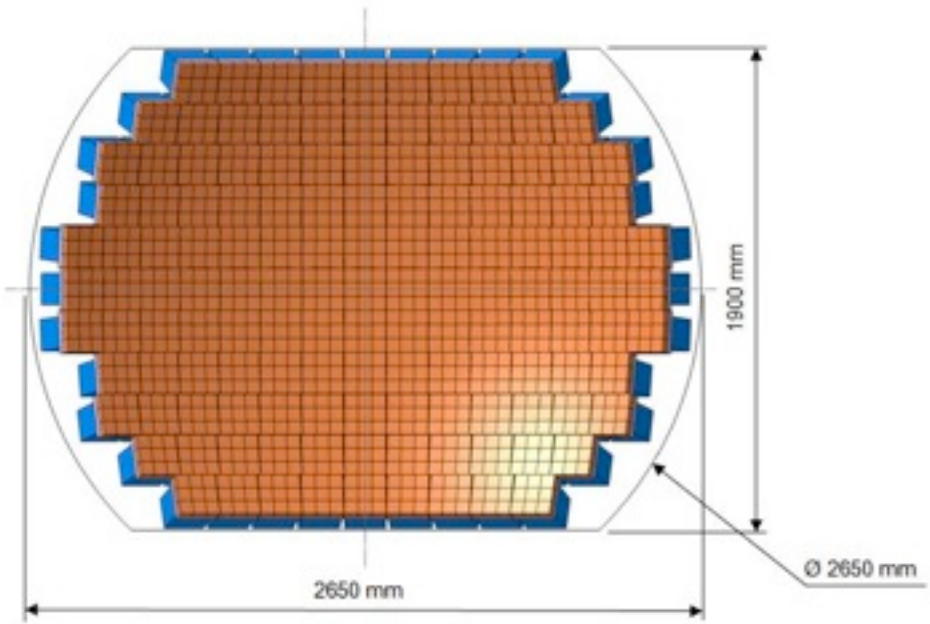


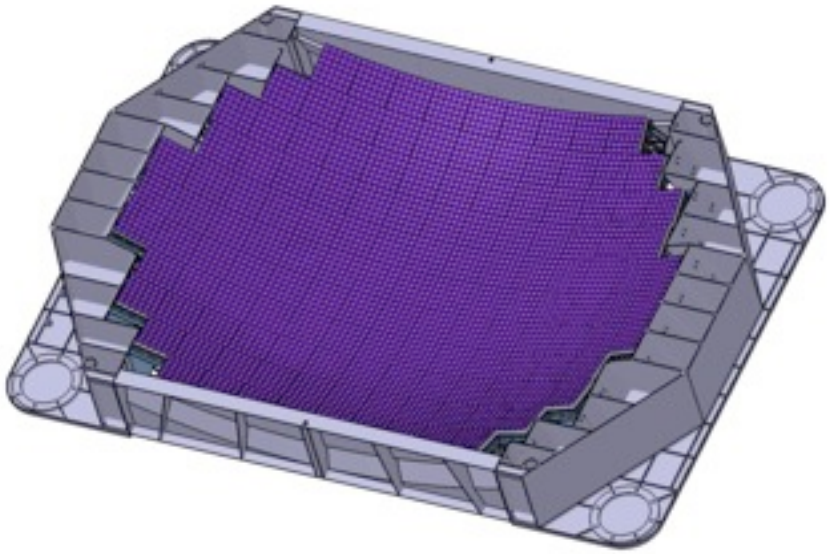




137 PDMs in the FS – 315 kchannels

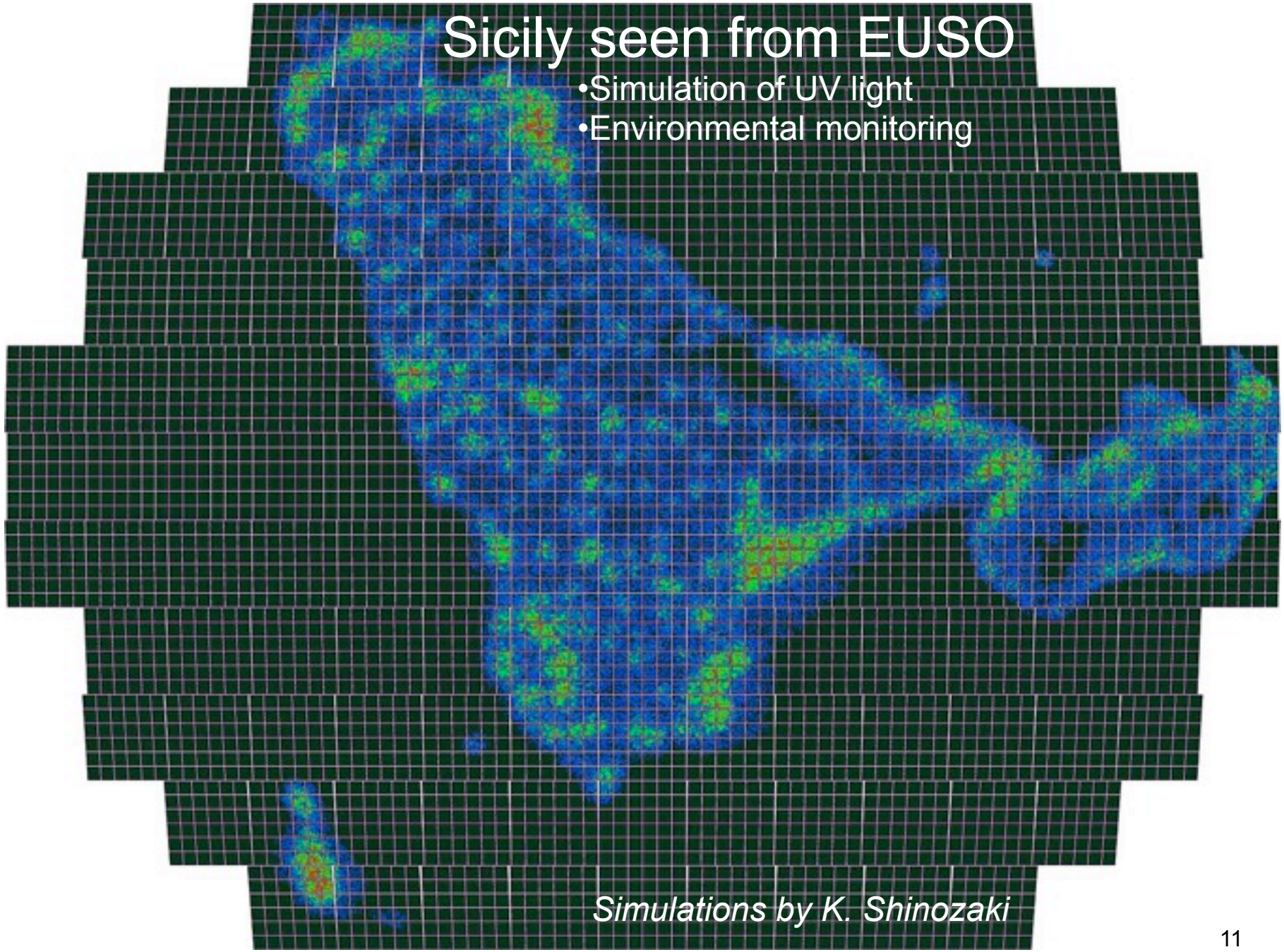
FS Shape





Sicily seen from EUSO

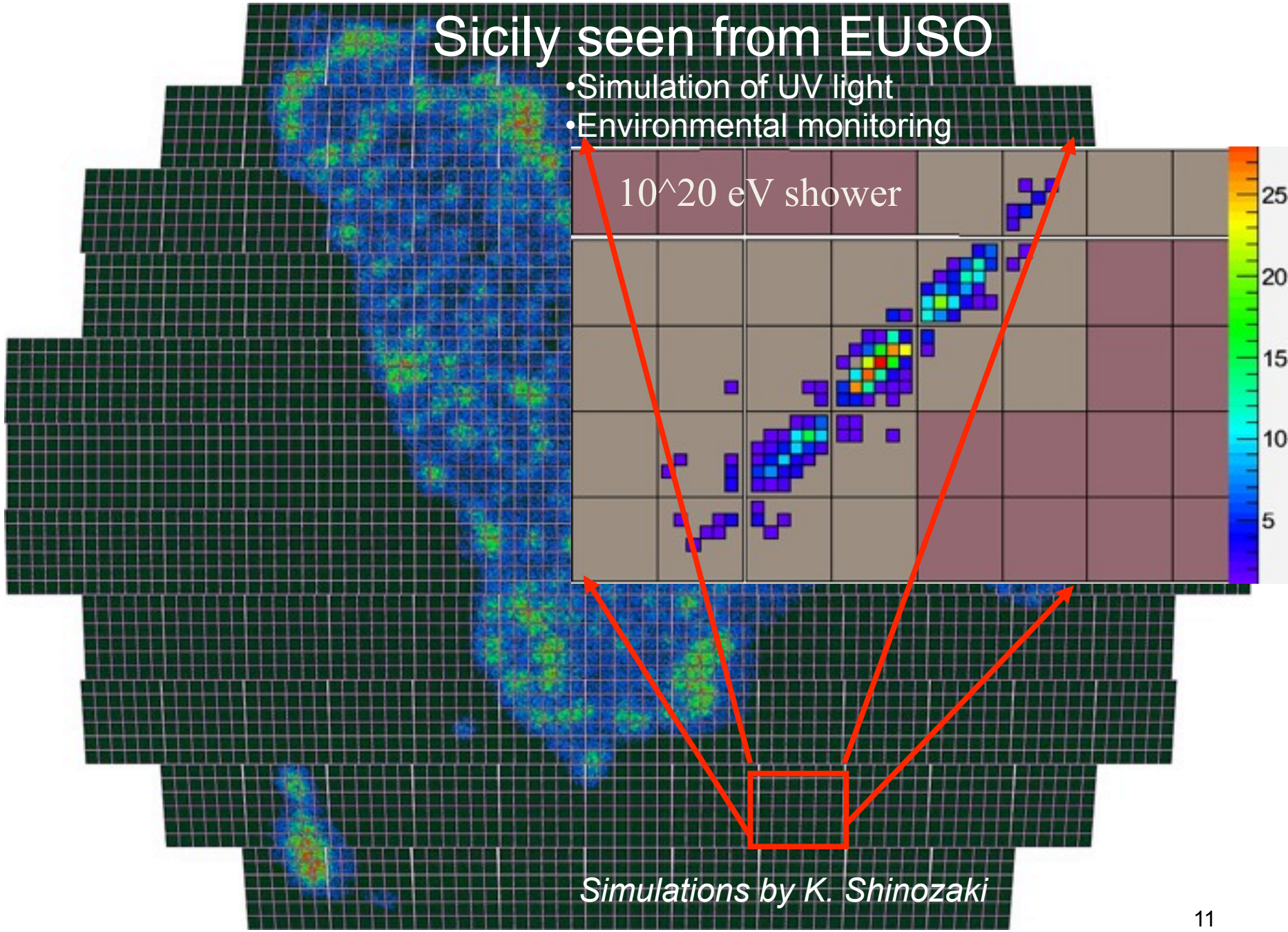
- Simulation of UV light
- Environmental monitoring



Simulations by K. Shinozaki

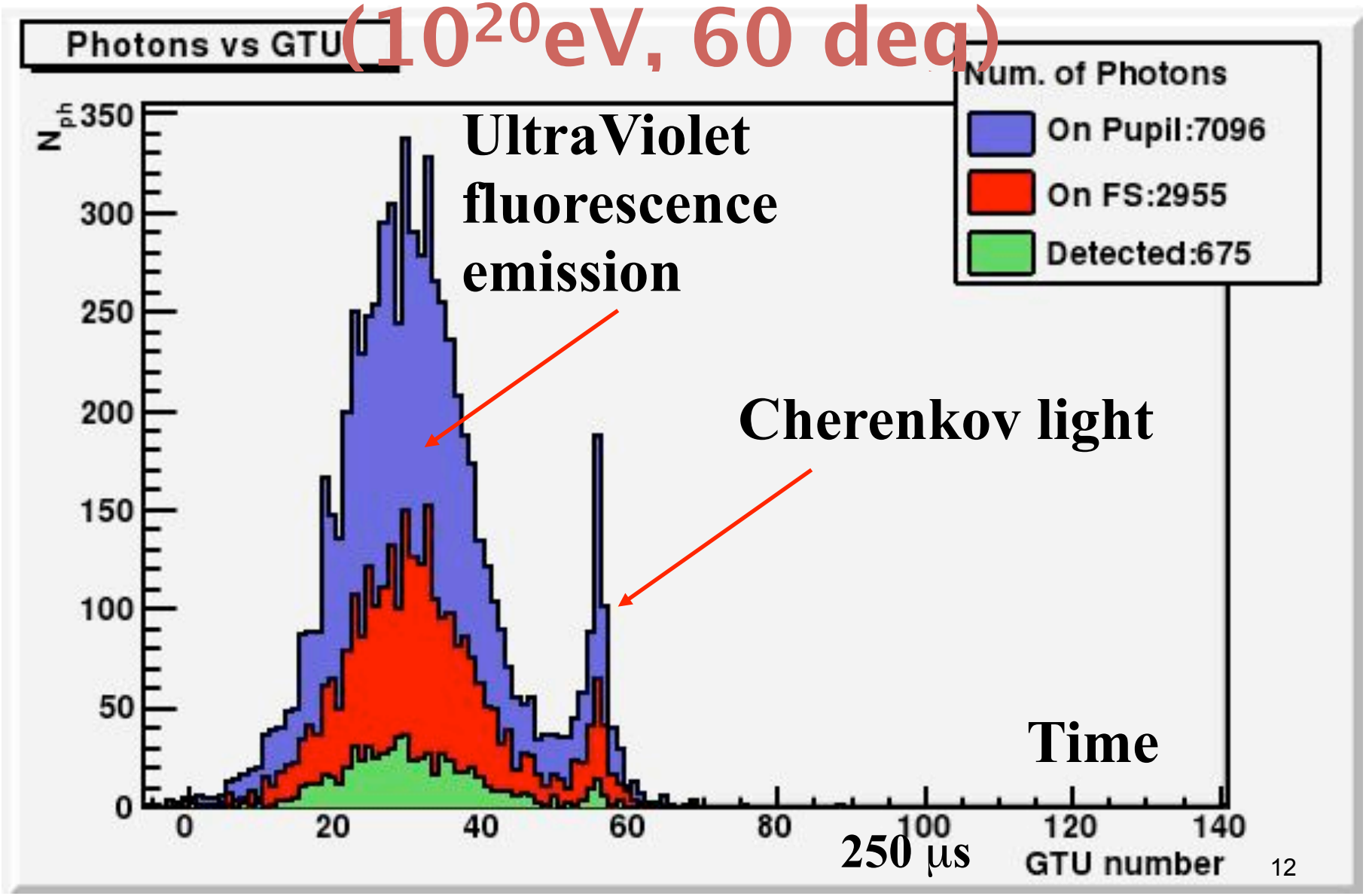
Sicily seen from EUSO

- Simulation of UV light
- Environmental monitoring

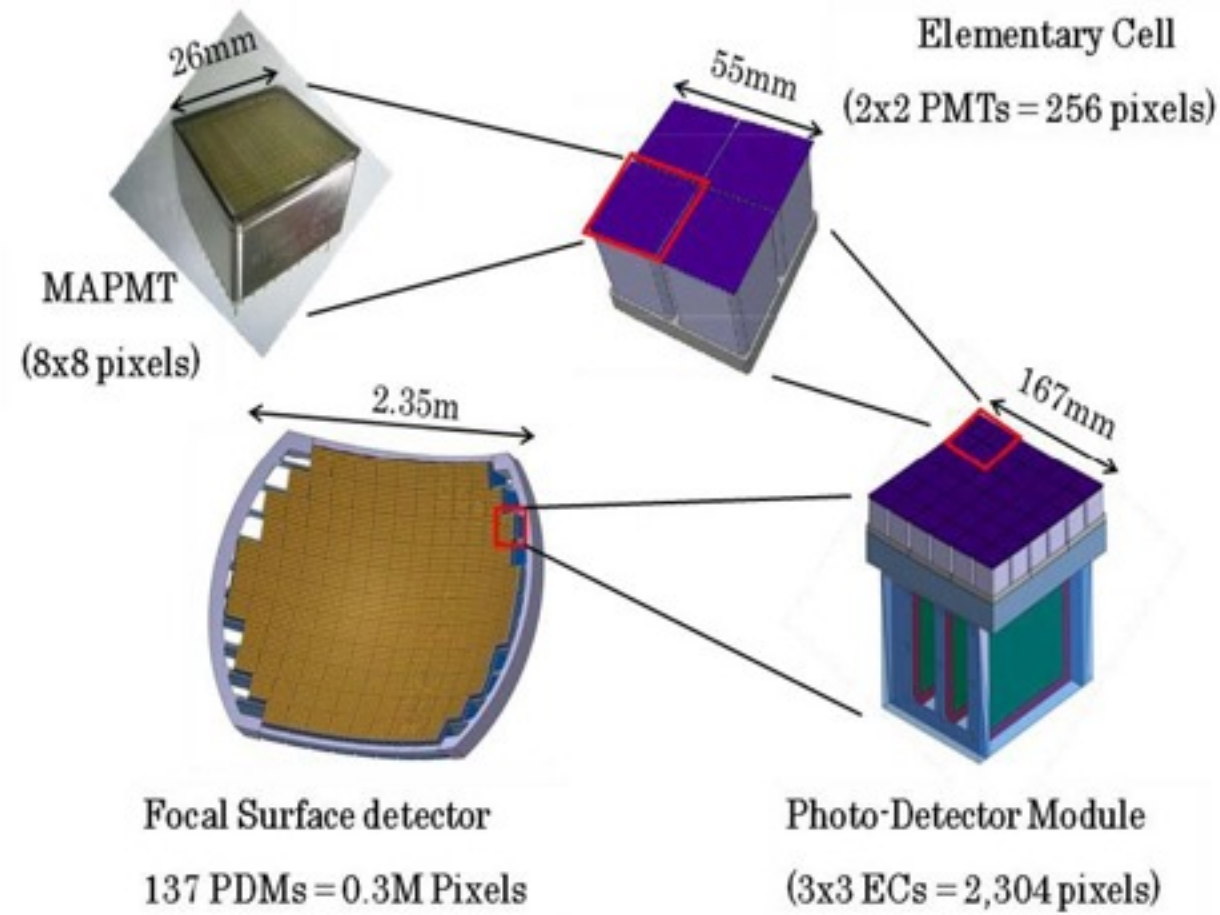


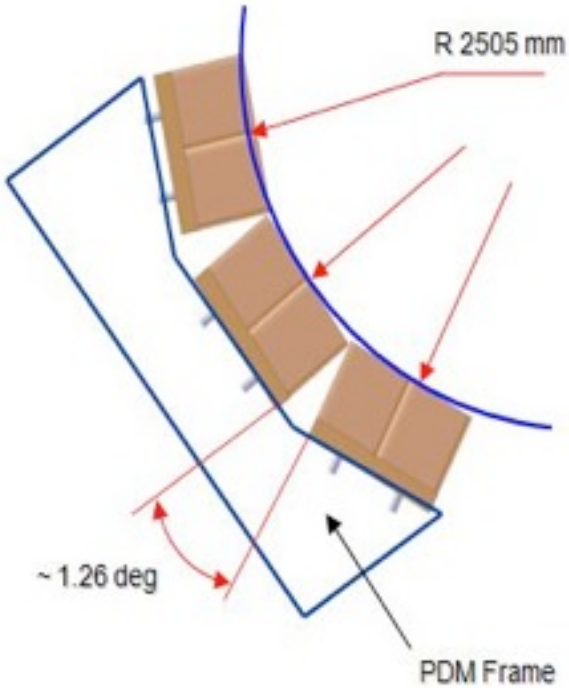
Simulations by K. Shinozaki

Signal of a proton shower (10^{20}eV, 60 deg)



Mechanical structure of the



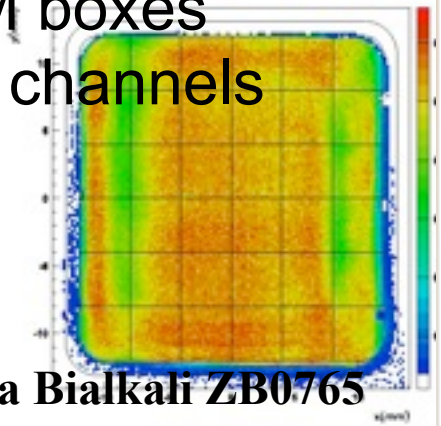


PMT development

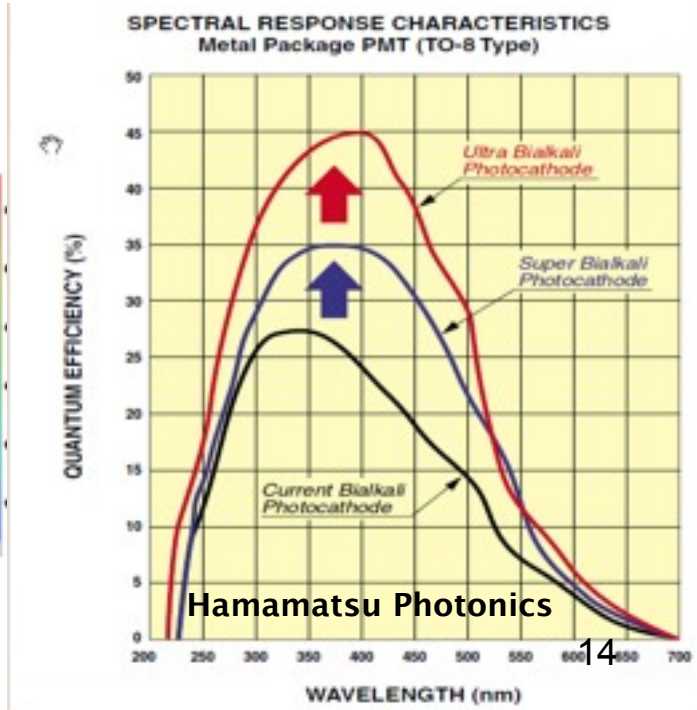
- Collaboration with Hamamatsu M64
- Reduction of size
- Improvement of Quantum efficiency
- Improvement of uniformity of response
- Each of the 137 PDM boxes PMTs, 64 channels

Miniaturization of dynodes

UV Filter

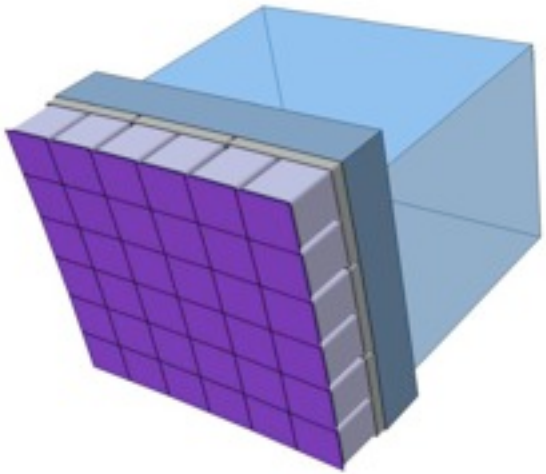


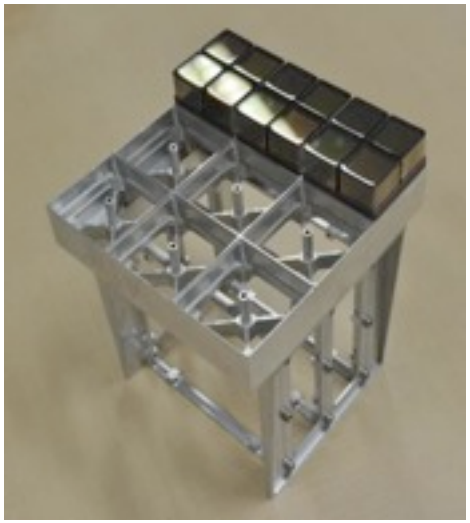
Ultra Bialkali ZB0765
Average: (24.4 ± 1.8)%

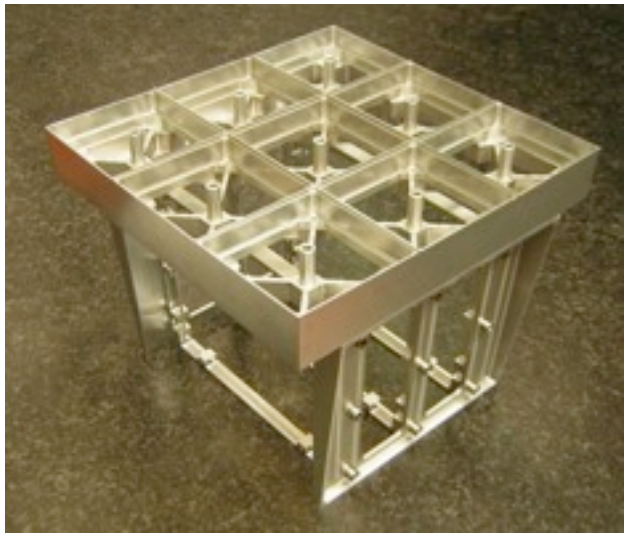


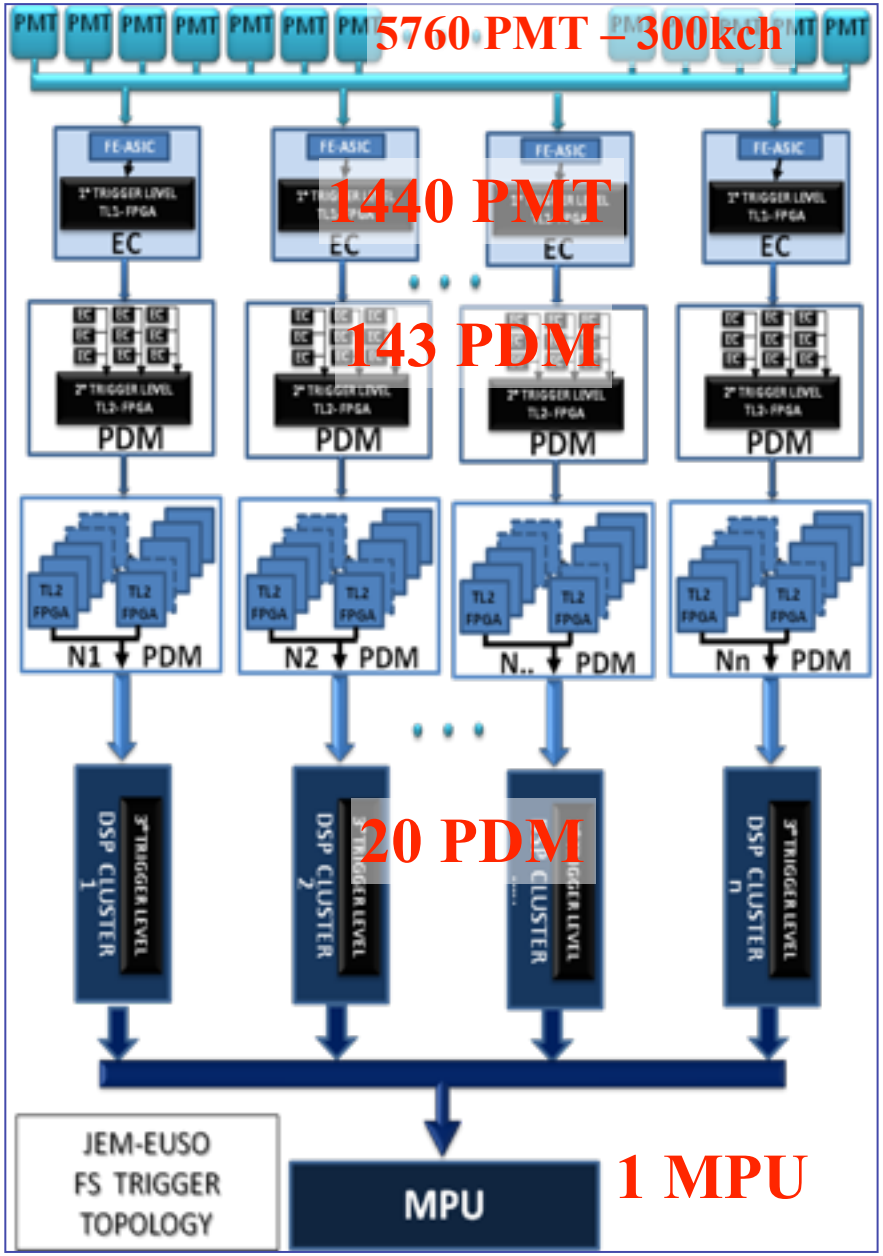
MAPMT

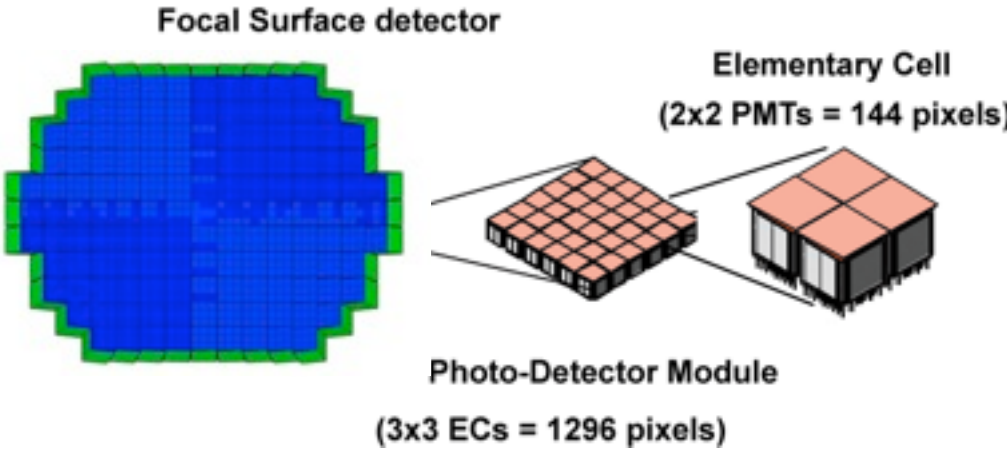
PDM



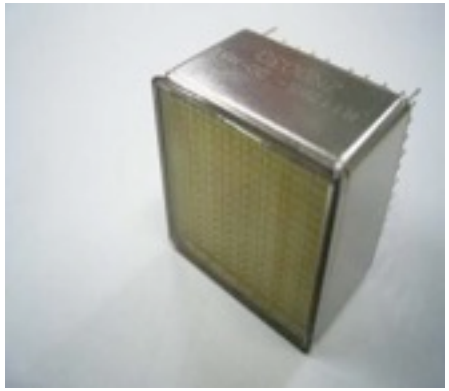








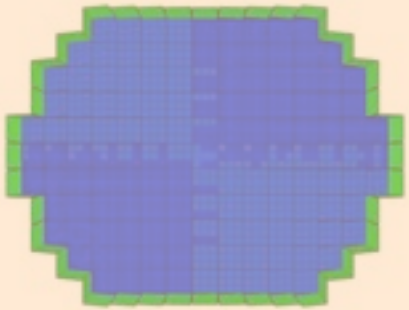
- 300 Kchannels
- Strongly parallel and hyerarchical structure
- Intrinsic redundancy



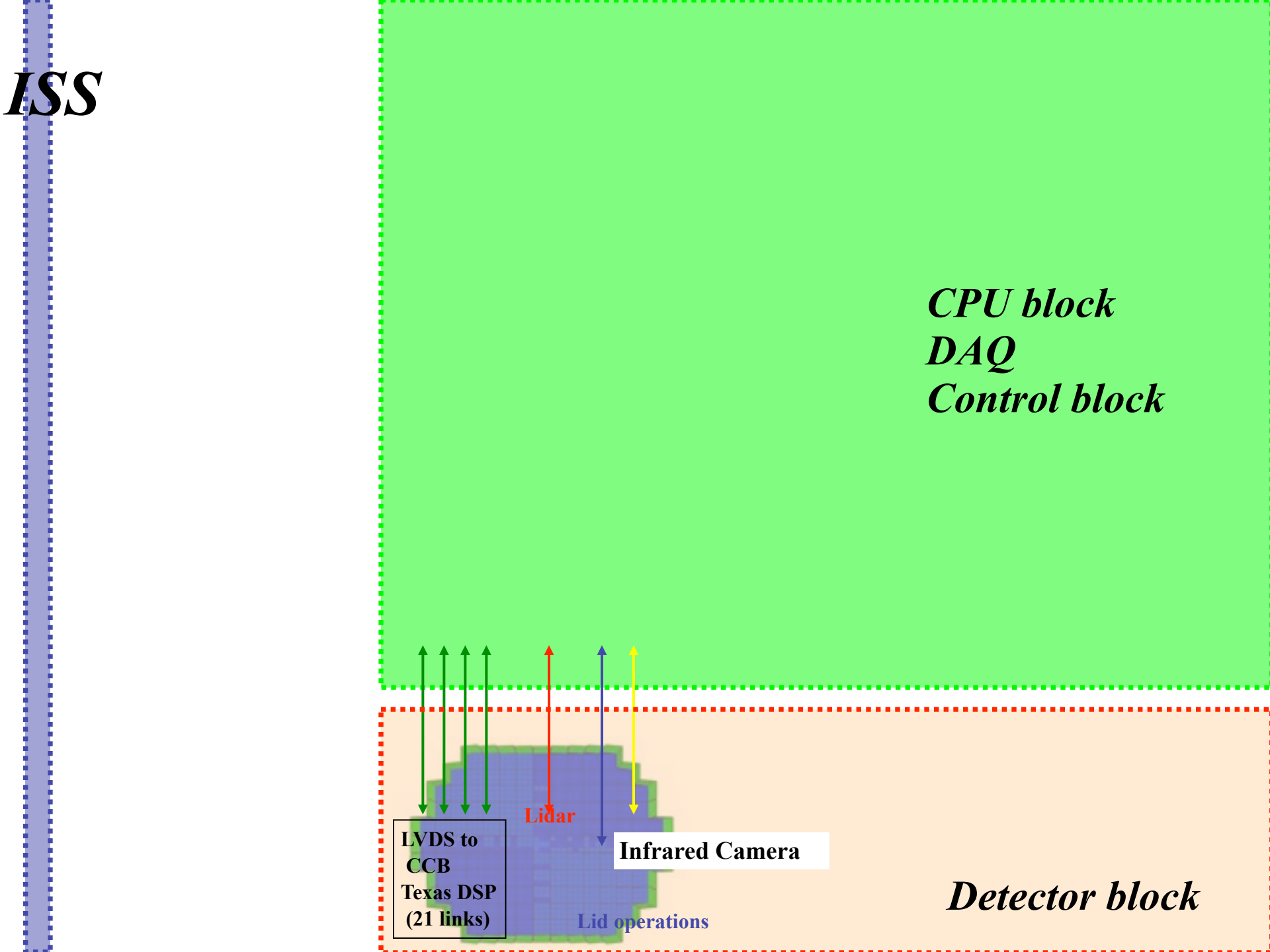
36 channel UBA PMT

ISS

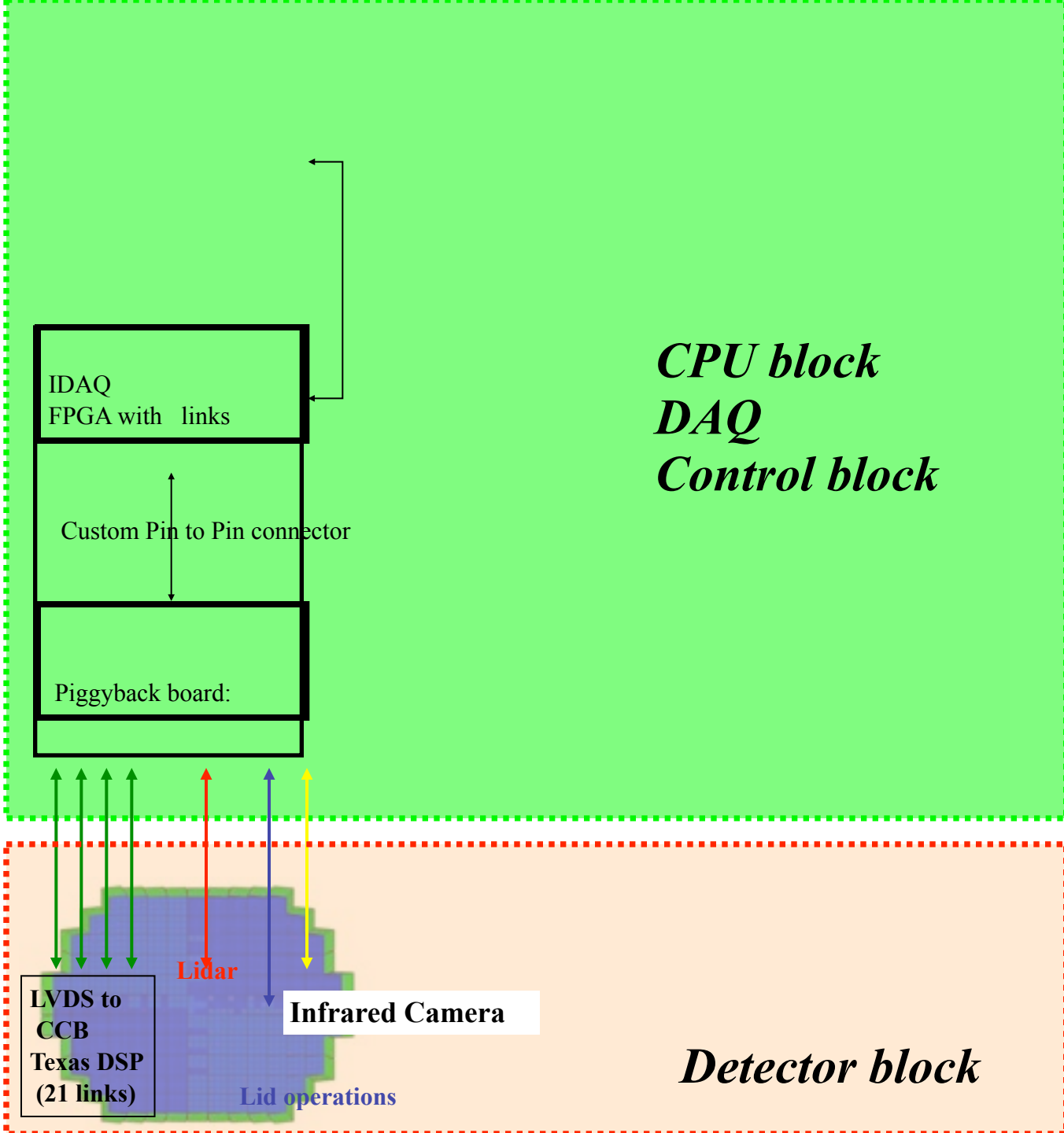
CPU block
DAQ
Control block



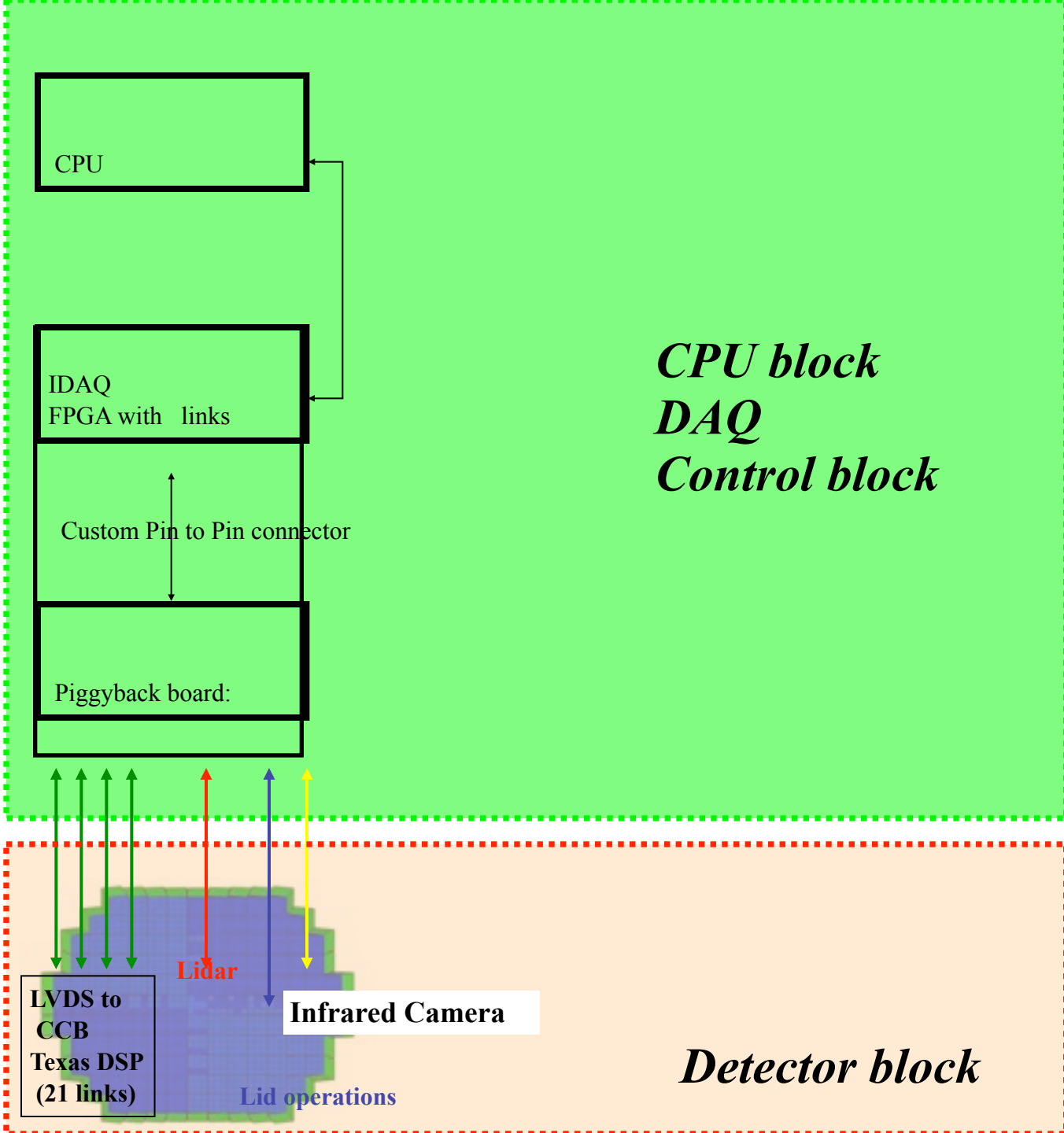
Detector block


ISS
CPU block
DAQ
Control block
LVDS to
CCB
Texas DSP
(21 links)
Lidar
Infrared Camera
Lid operations
Detector block

ISS


IDAQ
FPGA with links
Custom Pin to Pin connector
Piggyback board:
CPU block
DAQ
Control block
Lidar
LVDS to
CCB
Texas DSP
(21 links)
Infrared Camera
Lid operations
Detector block

ISS


CPU
IDAQ
FPGA with links
Custom Pin to Pin connector
Piggyback board:
CPU block
DAQ
Control block
Lidar
LVDS to
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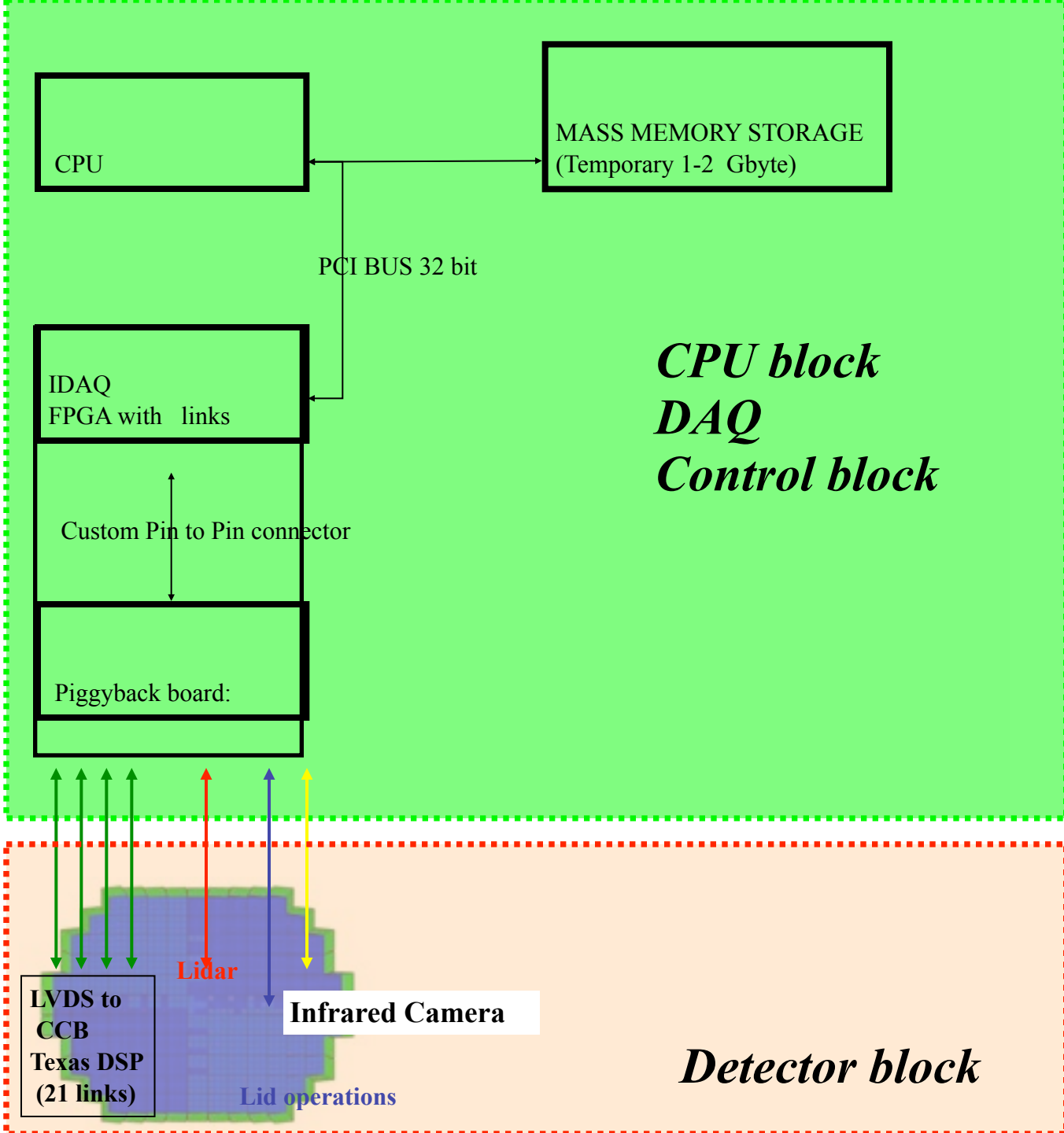
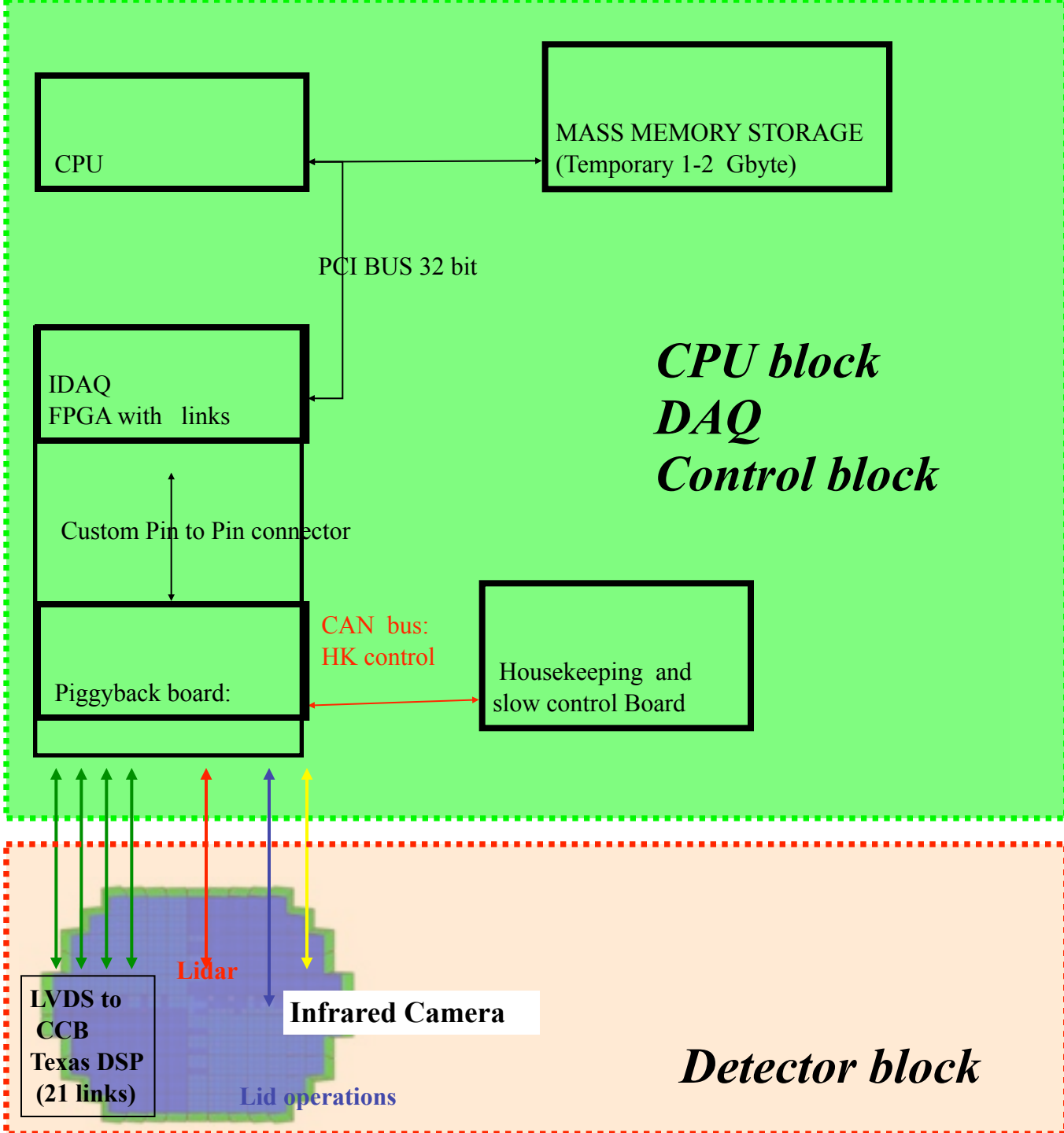
(21 links)
Infrared Camera
Lid operations
Detector block

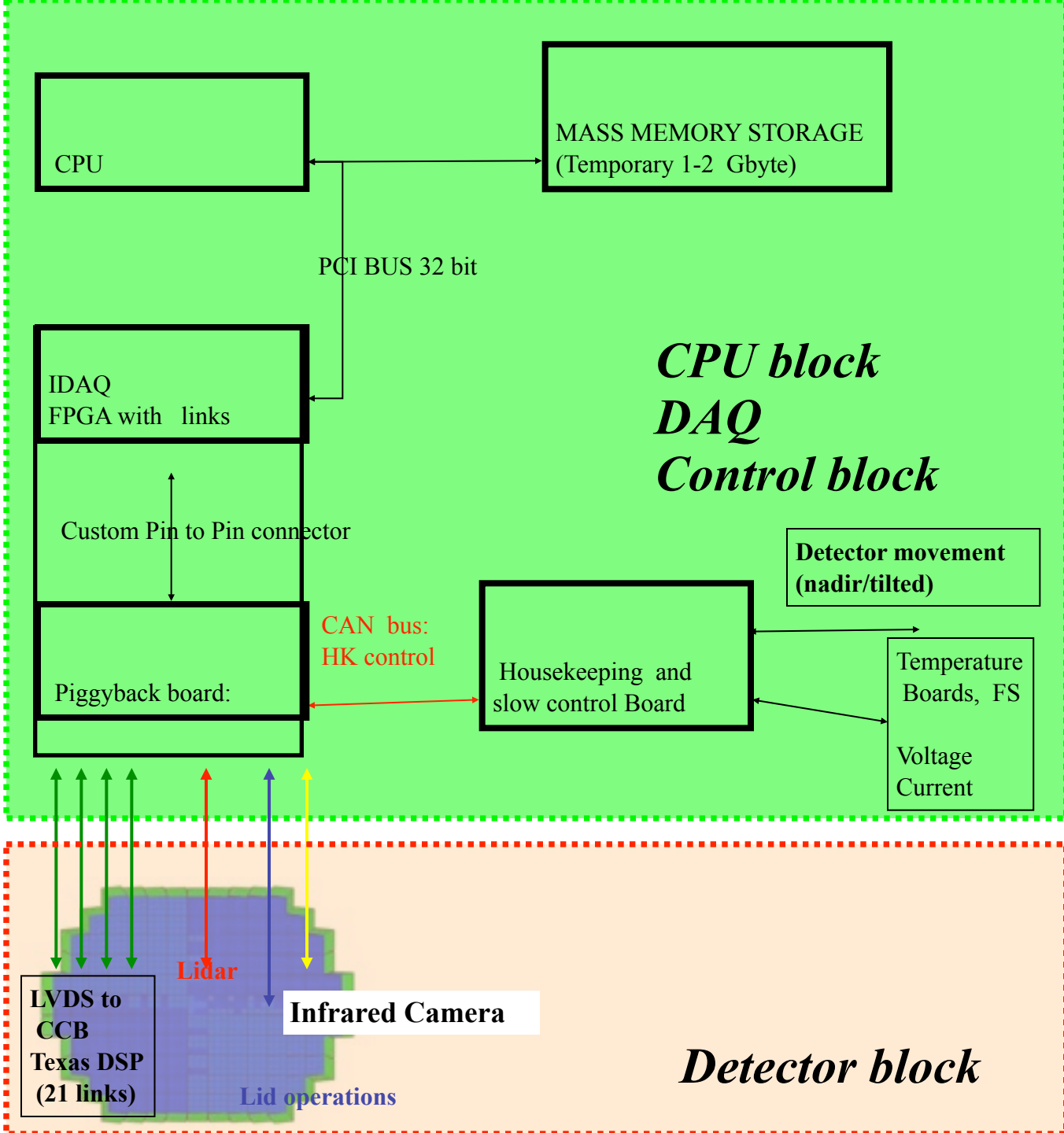
ISS


CPU
MASS MEMORY STORAGE
(Temporary 1-2 Gbyte)
PCI BUS 32 bit
IDAQ
FPGA with links
Custom Pin to Pin connector
Piggyback board:
CPU block
DAQ
Control block
Lidar
LVDS to
CCB
Texas DSP
(21 links)
Infrared Camera
Lid operations
Detector block

ISS


CPU
MASS MEMORY STORAGE
(Temporary 1-2 Gbyte)
PCI BUS 32 bit
IDAQ
FPGA with links
Custom Pin to Pin connector
Piggyback board:
CAN bus:
HK control
Housekeeping and
slow control Board
CPU block
DAQ
Control block
Lidar
LVDS to
CCB
Texas DSP
(21 links)
Infrared Camera
Lid operations
Detector block

ISS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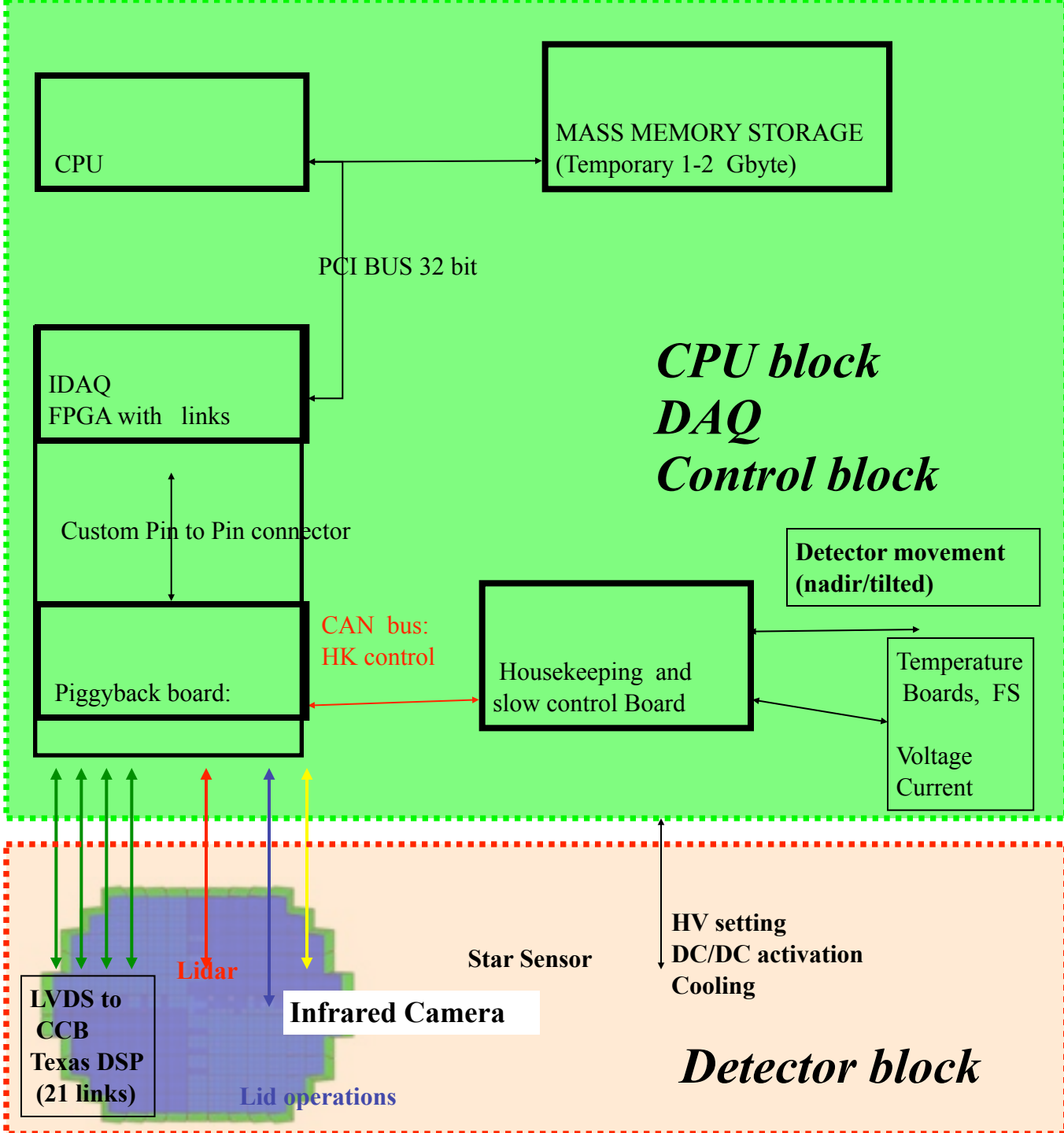
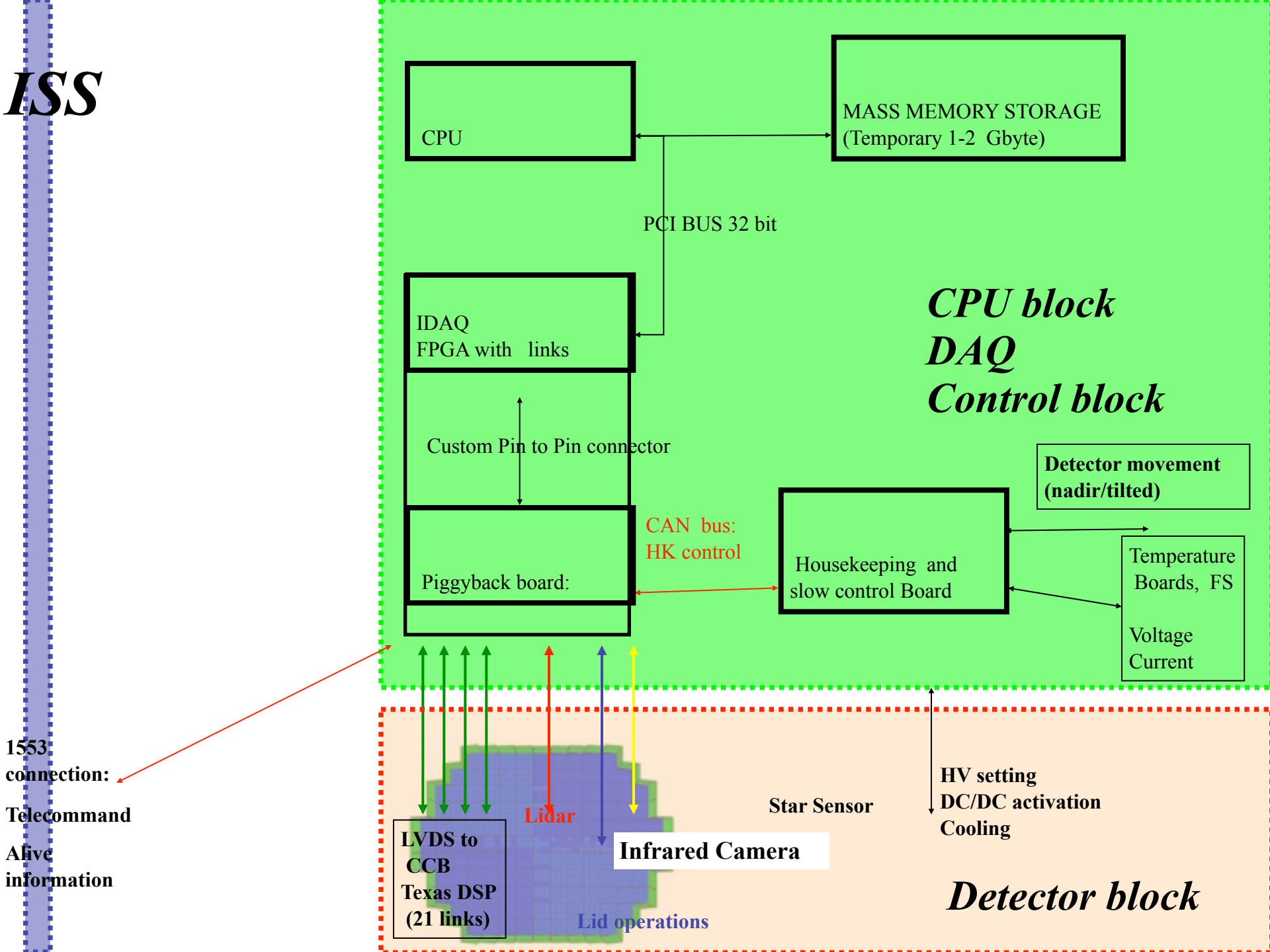
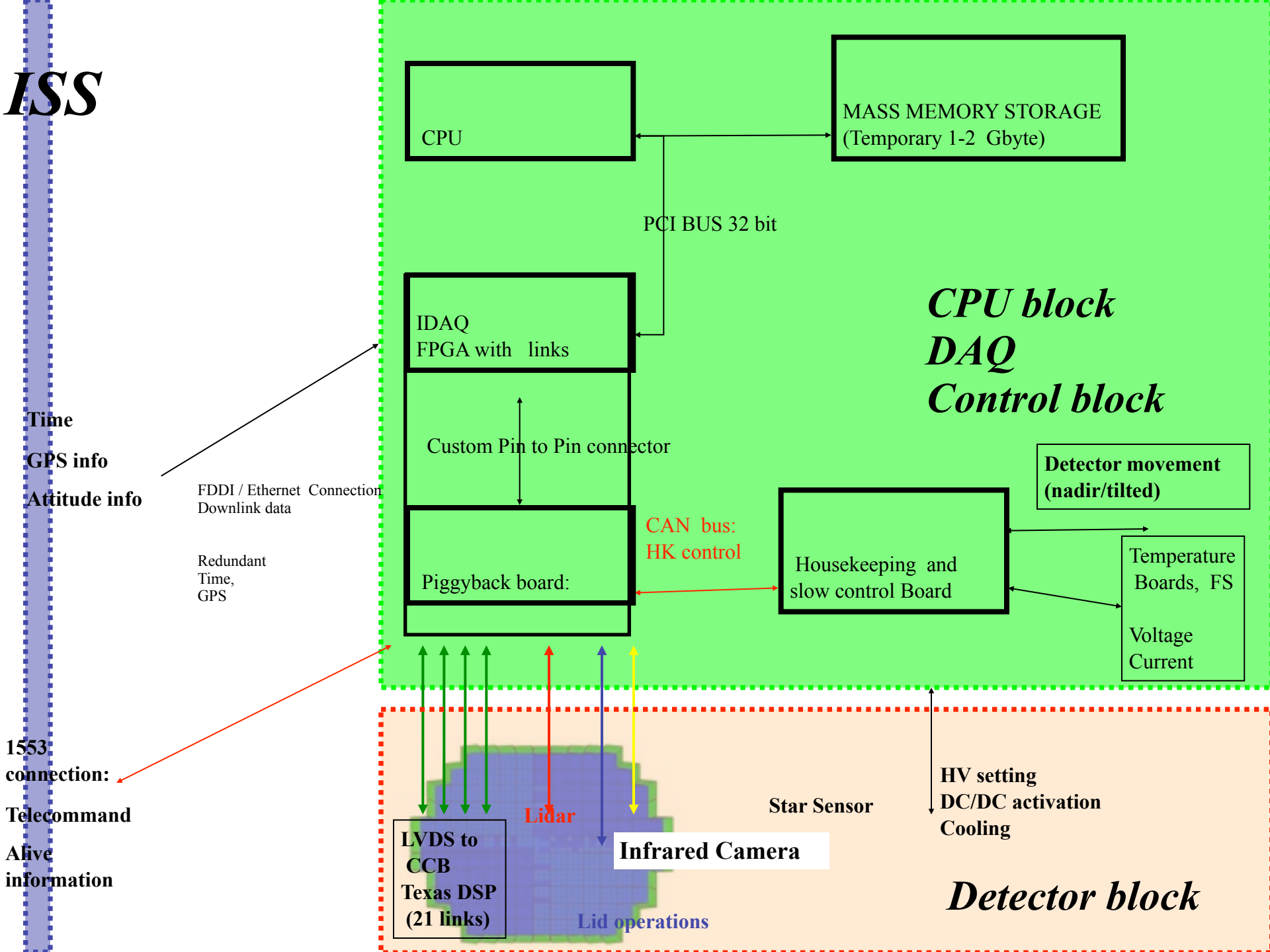
MASS MEMORY STORAGE
(Temporary 1-2 Gbyte)
PCI BUS 32 bit
IDAQ
FPGA with links
Custom Pin to Pin connector
Piggyback board:
CPU block
DAQ
Control block
Detector movement
(nadir/tilted)
CAN bus:
HK control
Housekeeping and
slow control Board
Temperature
Boards, FS
Voltage
Current
LVDS to
CCB
Texas DSP
(21 links)
Lidar
Infrared Camera
Lid operations
Detector block

ISS


CPU
MASS MEMORY STORAGE
(Temporary 1-2 Gbyte)
PCI BUS 32 bit
IDAQ
FPGA with links
CPU block
DAQ
Control block
Custom Pin to Pin connector
Detector movement
(nadir/tilted)
CAN bus:
HK control
Housekeeping and
slow control Board
Temperature
Boards, FS
Voltage
Current
Piggyback board:
HV setting
DC/DC activation
Cooling
Star Sensor
Lidar
LVDS to
CCB
Texas DSP
(21 links)
Infrared Camera
Lid operations
Detector block


ISS
CPU
MASS MEMORY STORAGE
(Temporary 1-2 Gbyte)
PCI BUS 32 bit
IDAQ
FPGA with links
Custom Pin to Pin connector
Piggyback board:
CPU block
DAQ
Control block
Detector movement
(nadir/tilted)
CAN bus:
HK control
Housekeeping and
slow control Board
Temperature
Boards, FS
Voltage
Current
1553
connection:
Telecommand
Alive
information
LVDS to
CCB
Texas DSP
(21 links)
Lidar
Infrared Camera
Lid operations
Star Sensor
HV setting
DC/DC activation
Cooling
Detector block


ISS
CPU
MASS MEMORY STORAGE
(Temporary 1-2 Gbyte)
PCI BUS 32 bit
IDAQ
FPGA with links
Custom Pin to Pin connector
Piggyback board:
CPU block
DAQ
Control block
Time
GPS info
Attitude info
FDDI / Ethernet Connection
Downlink data
Redundant
Time,
GPS
CAN bus:
HK control
Housekeeping and
slow control Board
Detector movement
(nadir/tilted)
Temperature
Boards, FS
Voltage
Current
1553
connection:
Telecommand
Alive
information
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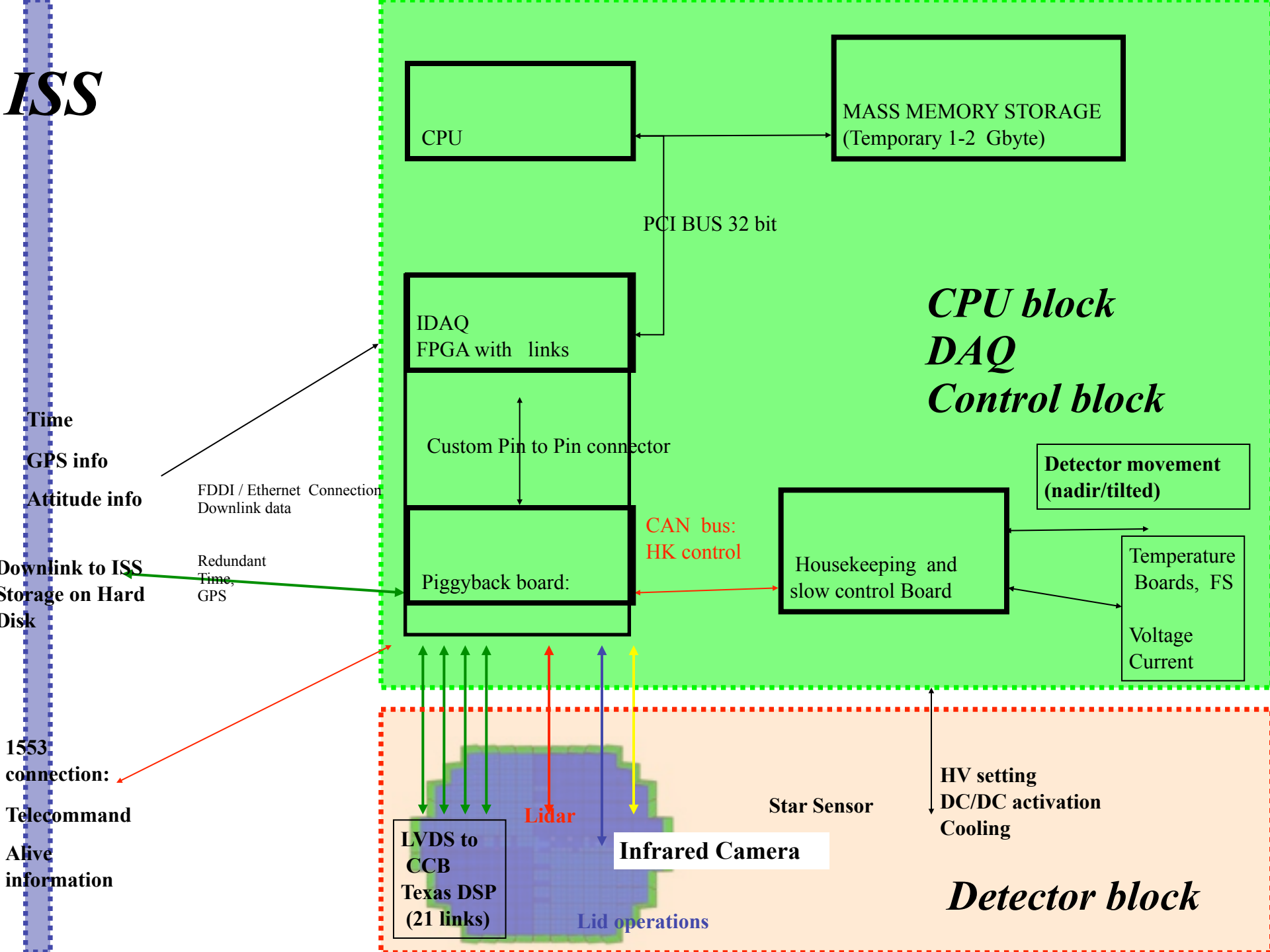
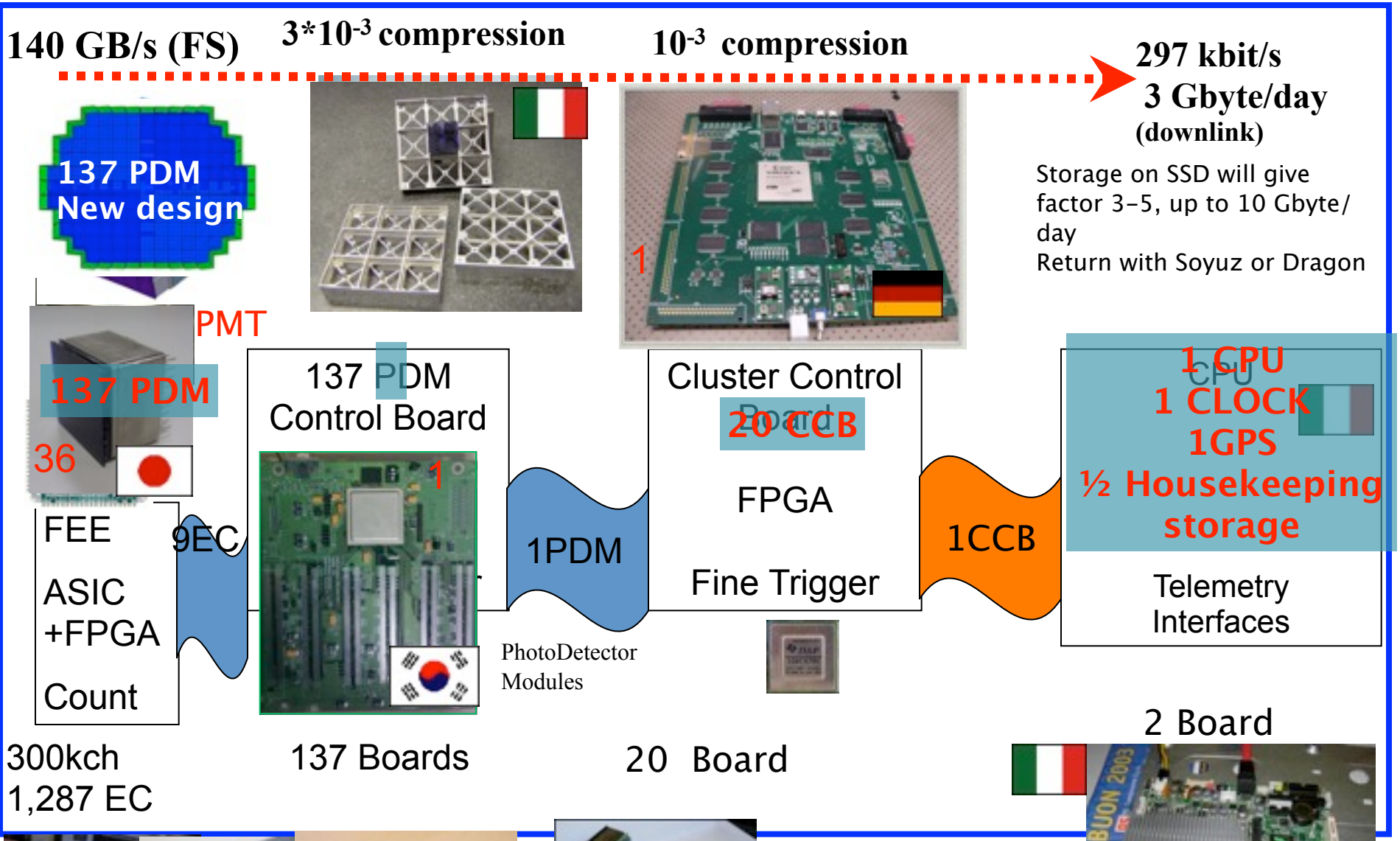
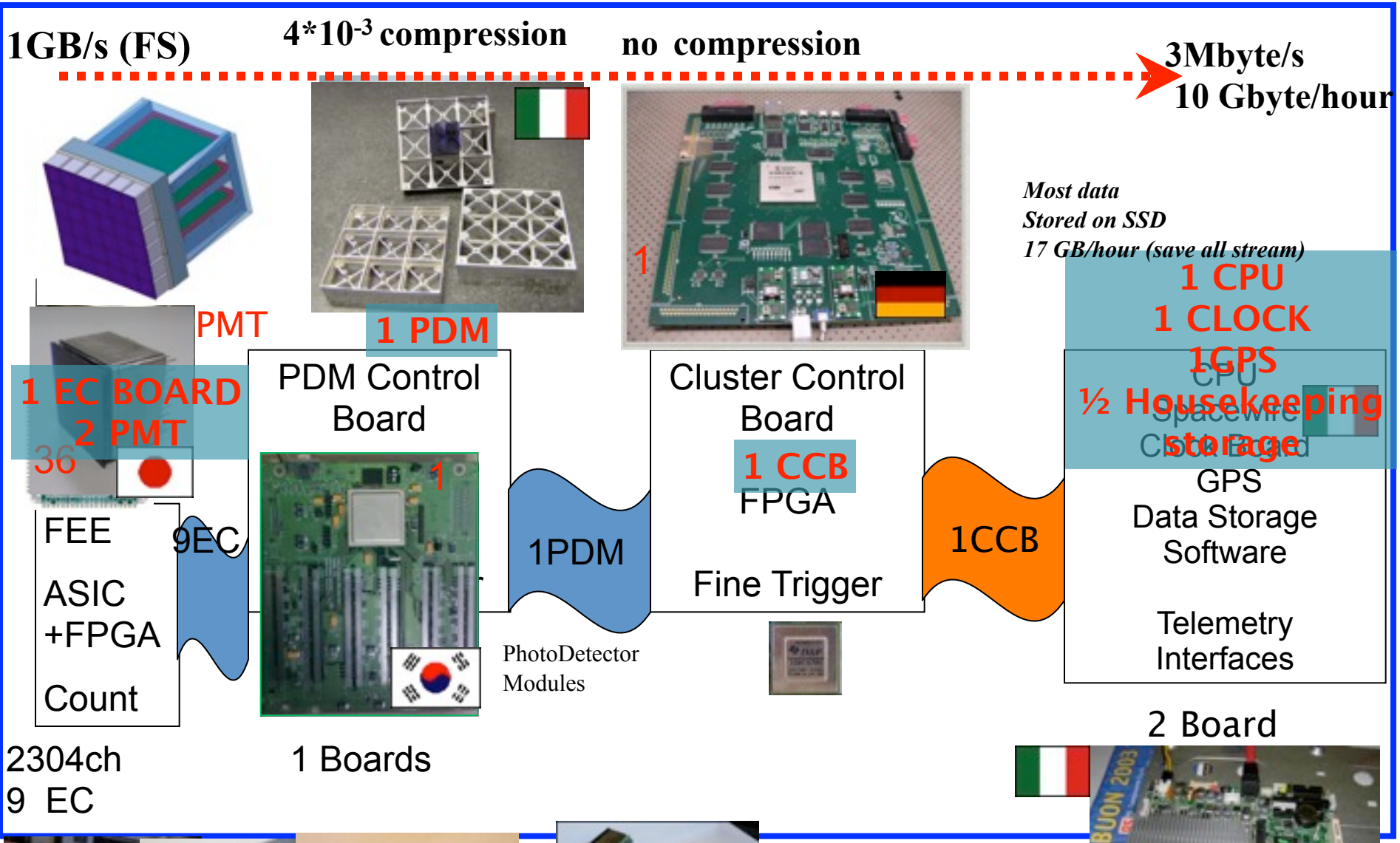
(21 links)
Lidar
Infrared Camera
Lid operations
Star Sensor
HV setting
DC/DC activation
Cooling
Detector block


ISS
CPU
MASS MEMORY STORAGE
(Temporary 1-2 Gbyte)
PCI BUS 32 bit
IDAQ
FPGA with links
Custom Pin to Pin connector
Piggyback board:
CPU block
DAQ
Control block
Time
GPS info
Attitude info
FDDI / Ethernet Connection
Downlink data
Downlink to ISS
Storage on Hard
Disk
Redundant
Time,
GPS
CAN bus:
HK control
Housekeeping and
slow control Board
Detector movement
(nadir/tilted)
Temperature
Boards, FS
Voltage
Current
1553
connection:
Telecommand
Alive
information
LVDS to
CCB
Texas DSP
(21 links)
Lidar
Infrared Camera
Lid operations
Star Sensor
HV setting
DC/DC activation
Cooling
Detector block

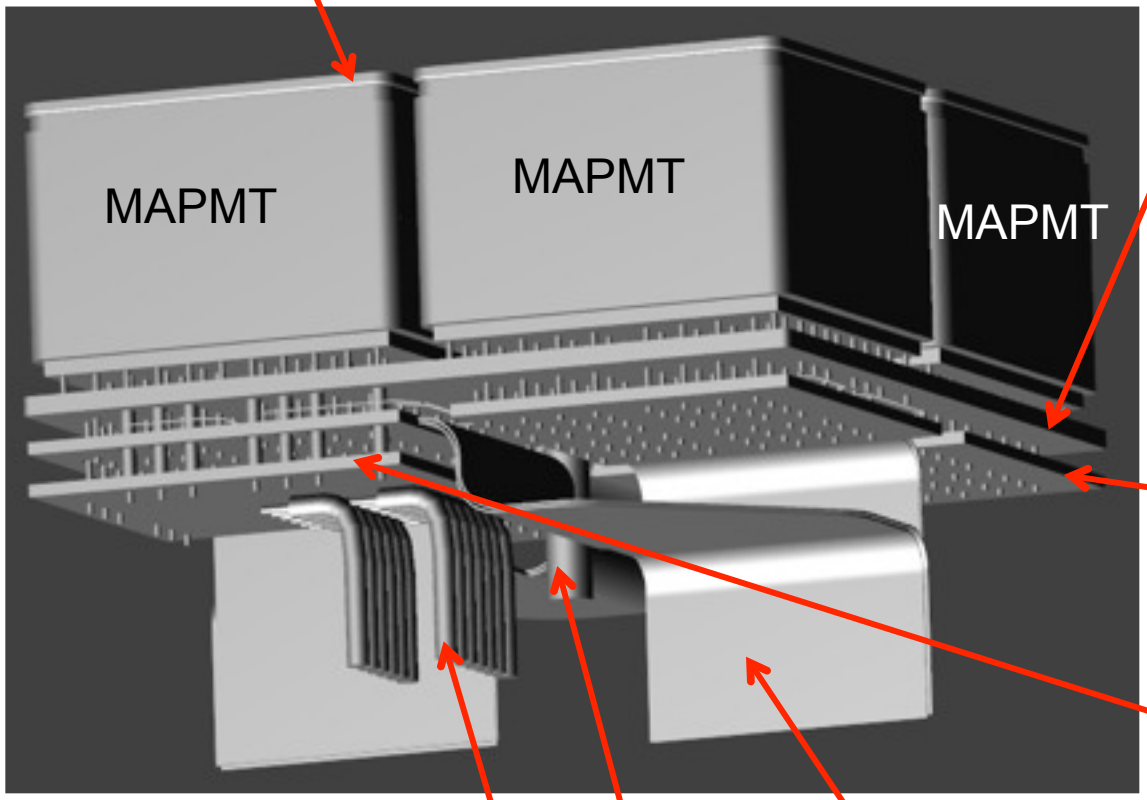
JEM-EUSO DAQ – CURRENT Electronic System scheme



TA EUSO DAQ – CURRENT Electronic System scheme



UV filter



- **<u>3 different PCBs</u>:**

- First one (*EC DYNODE board*) allows to reroute half of the dynodes of 1 MAPMT so that they are aligned perpendicularly to the others. It covers the 4 MAPMTs.

- Second one (*EC ANODE board*) covers one MAPMT but has dimensions reduced allowing a flex pcb to get out. It is used to collect signal from the anodes and send them to the ASICs.

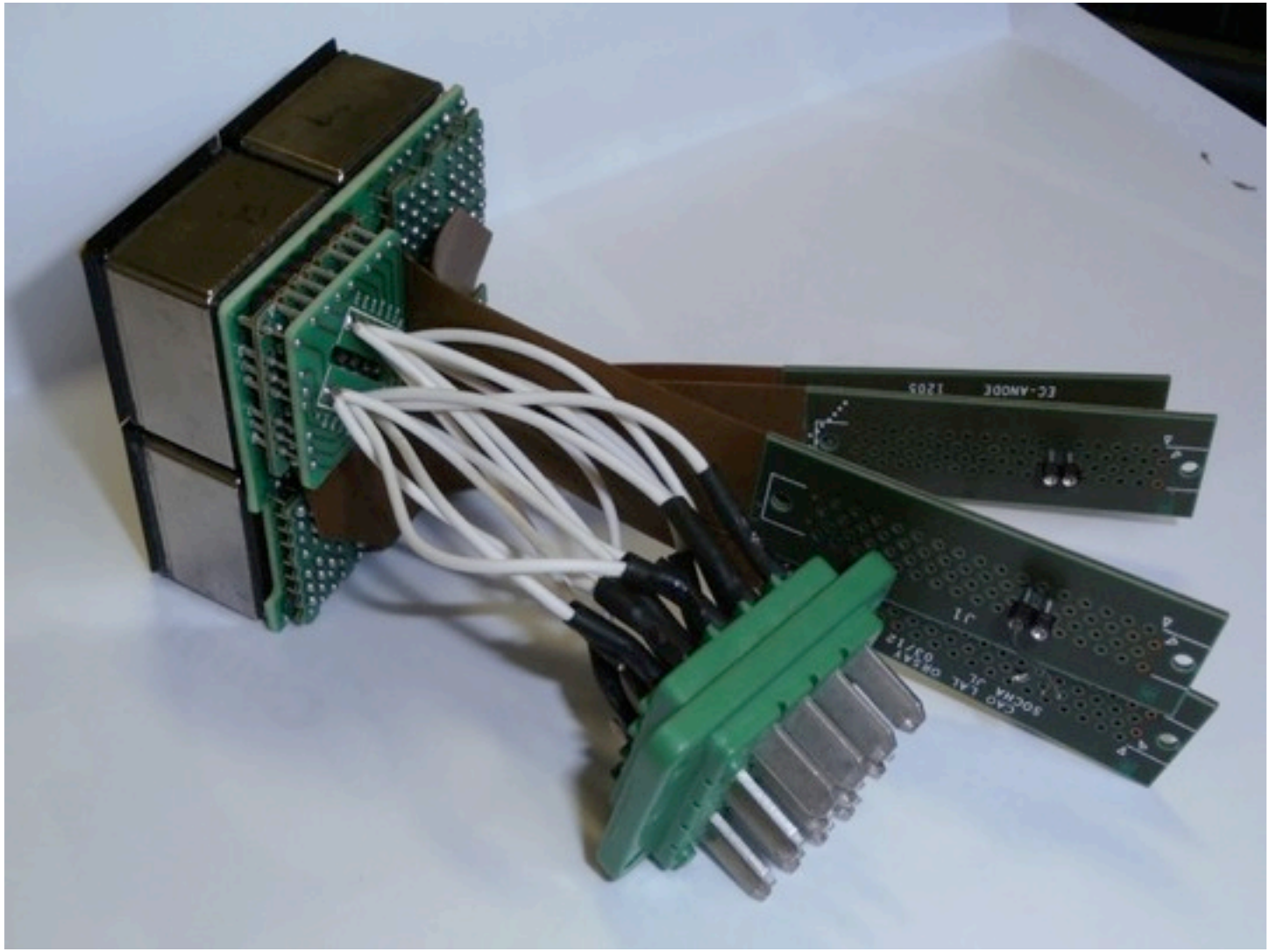
- Third one (*EC HV board*) covers one MAPMT. It welcomes the dynodes and supplies the HV (up to 1000 V) to the EC-dynode board which transmits it to the 4 MAPMTs.

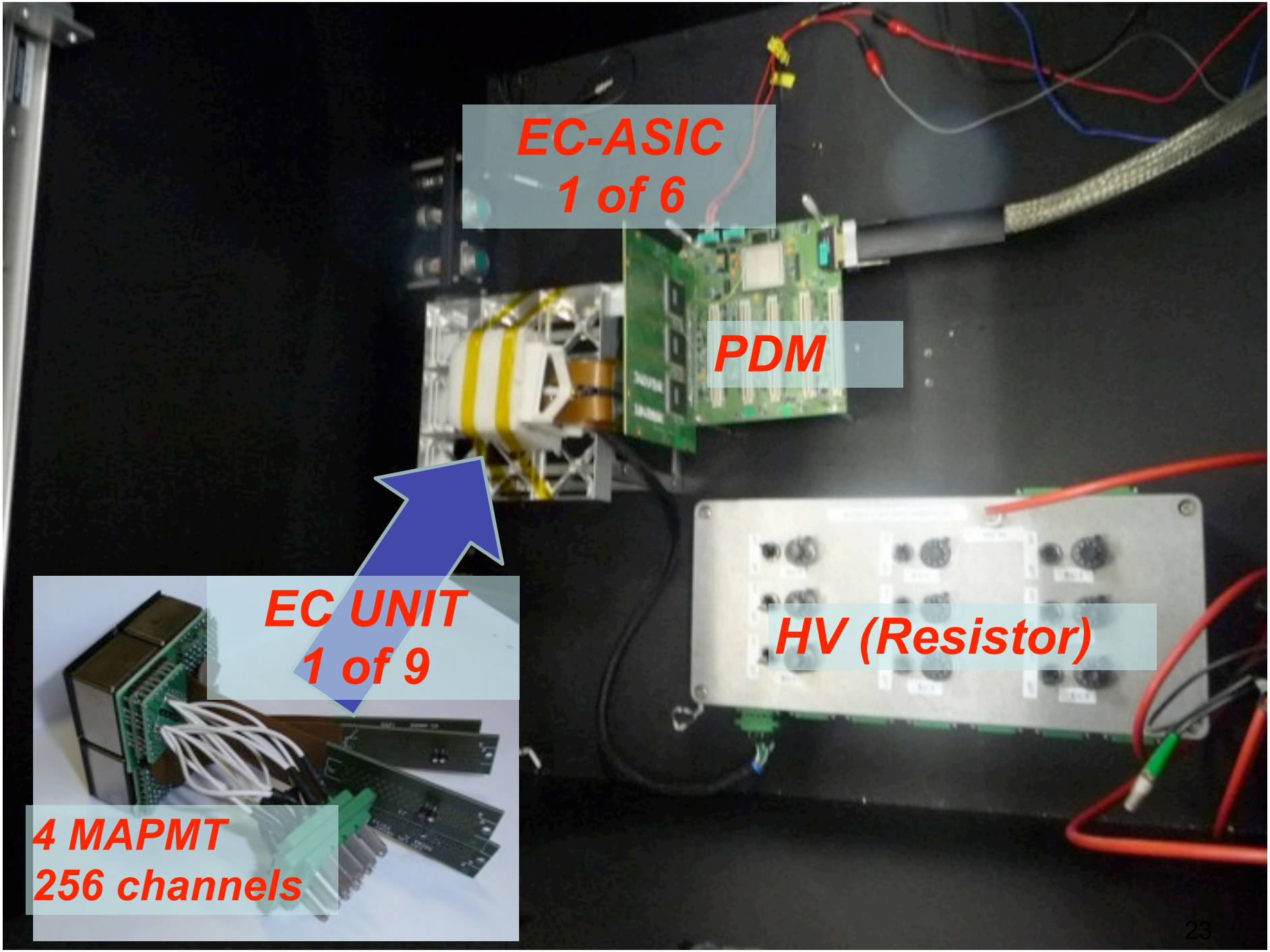
Per EC unit:
- **1 EC-DYNODE board**
- **4 EC-ANODE boards**
- **1 EC-HV boards**

Flexible pcb toward EC-back

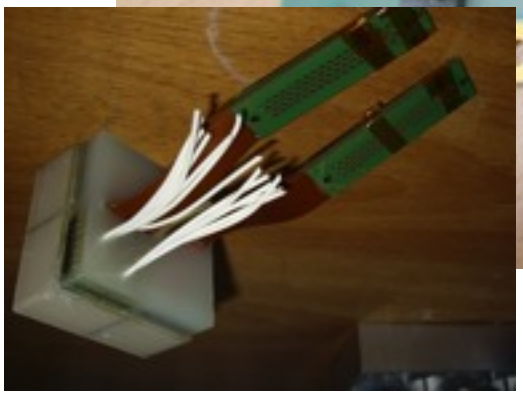
Central column

HV cables toward HV box

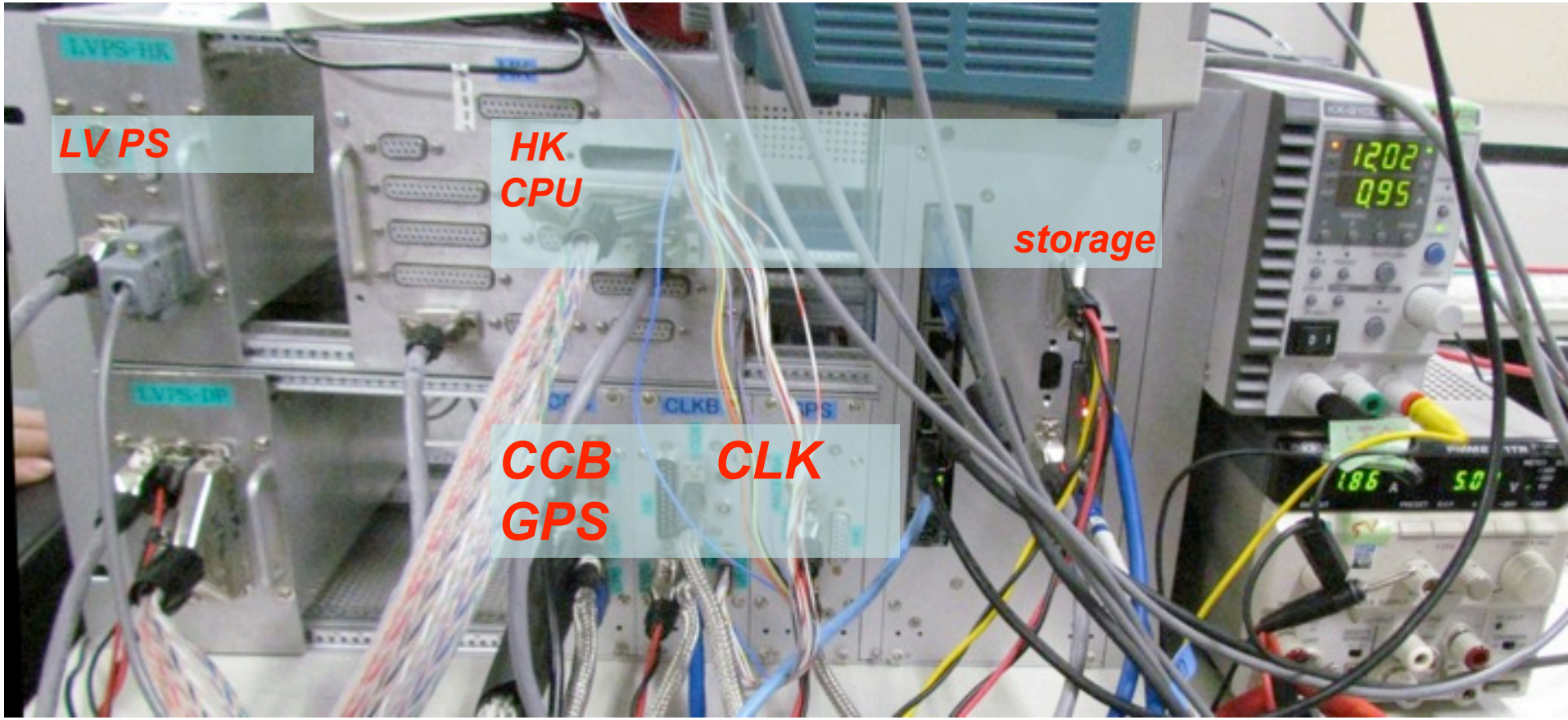

EC-ANODE 1205
J1
SOCKET J2
CAD LAL OBSAY 03/12


EC-ASIC
1 of 6
PDM
EC UNIT
1 of 9
HV (Resistor)
4 MAPMT
256 channels

6 EC-ASICS, each with 3+3 Asics



PDM EC-ASIC EC-UNIT

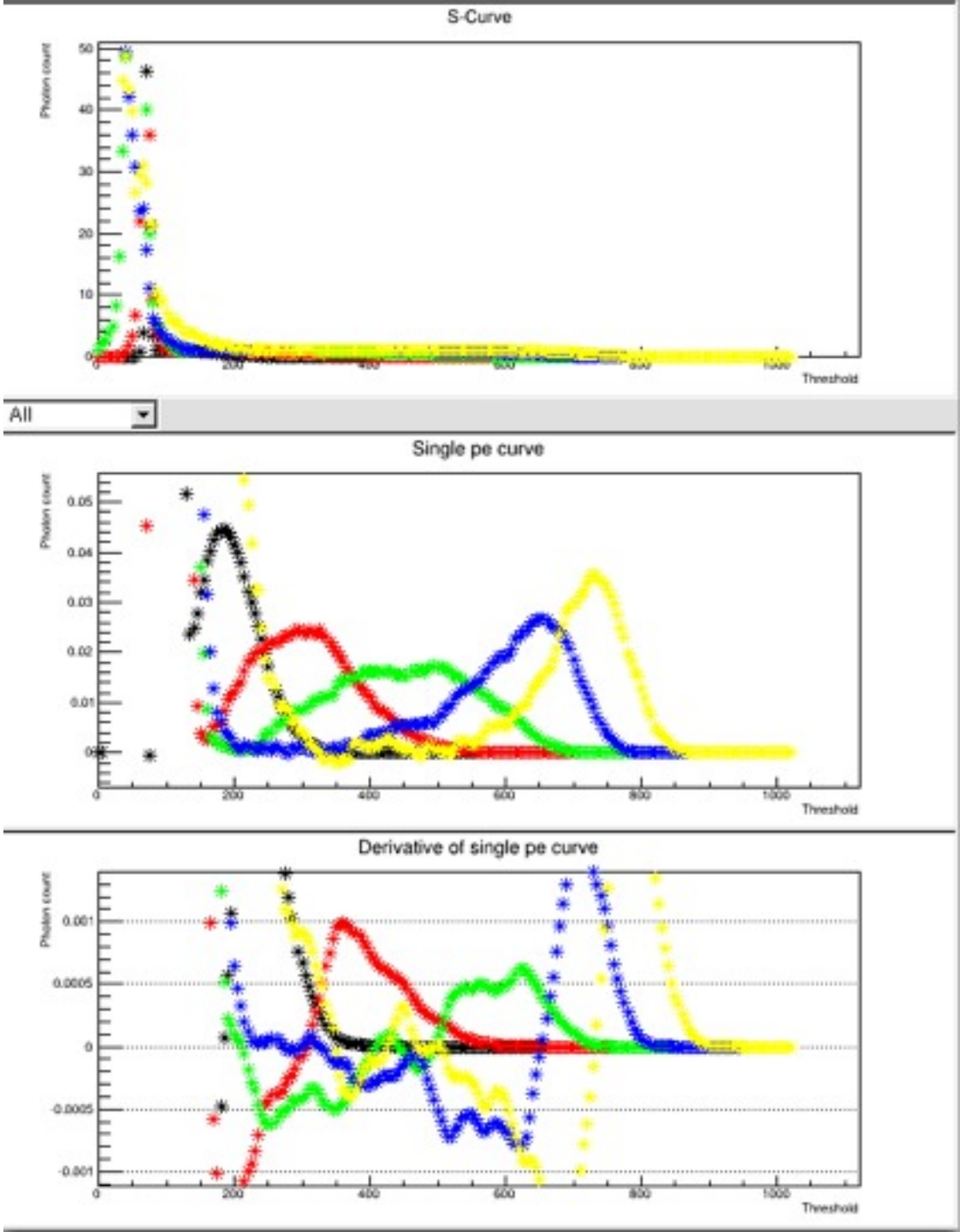


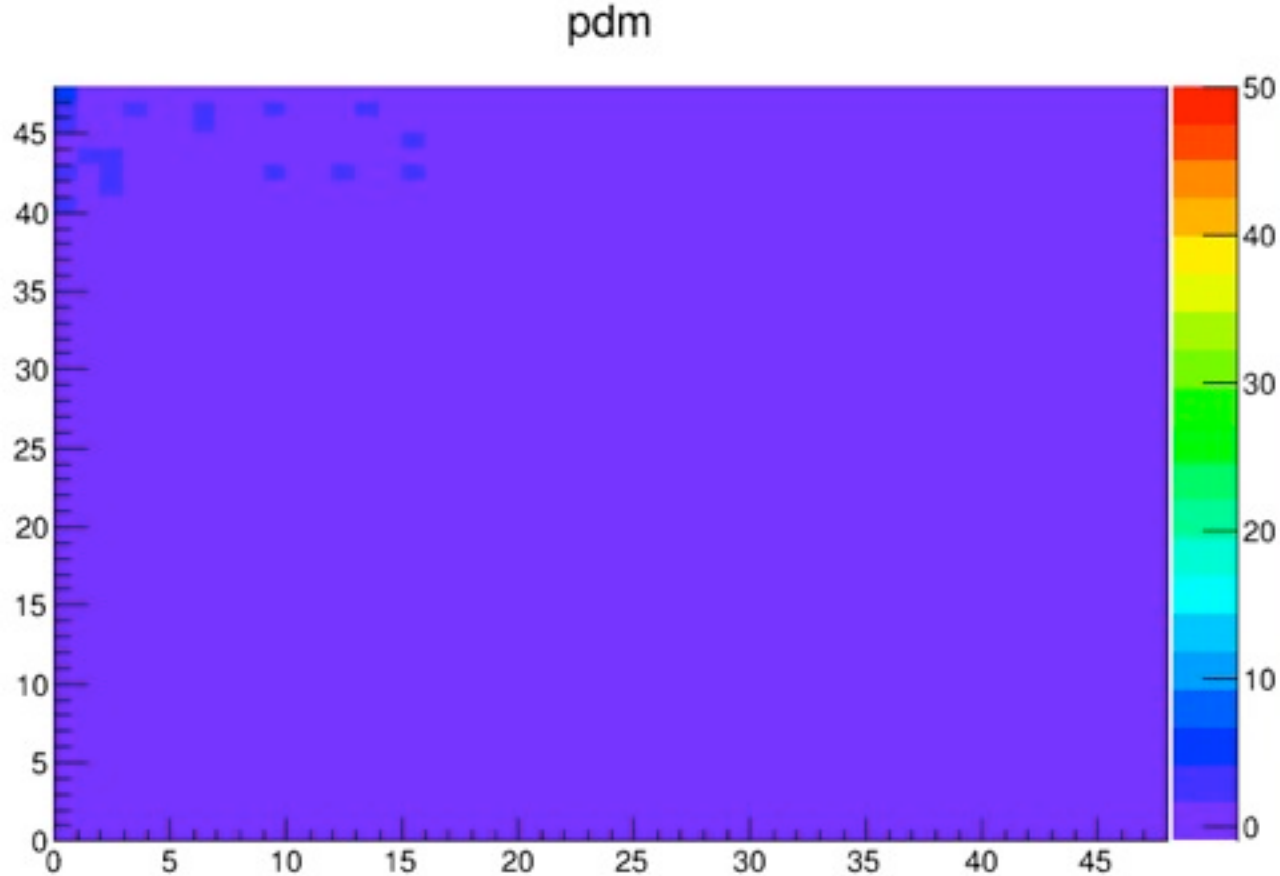
Laser Light

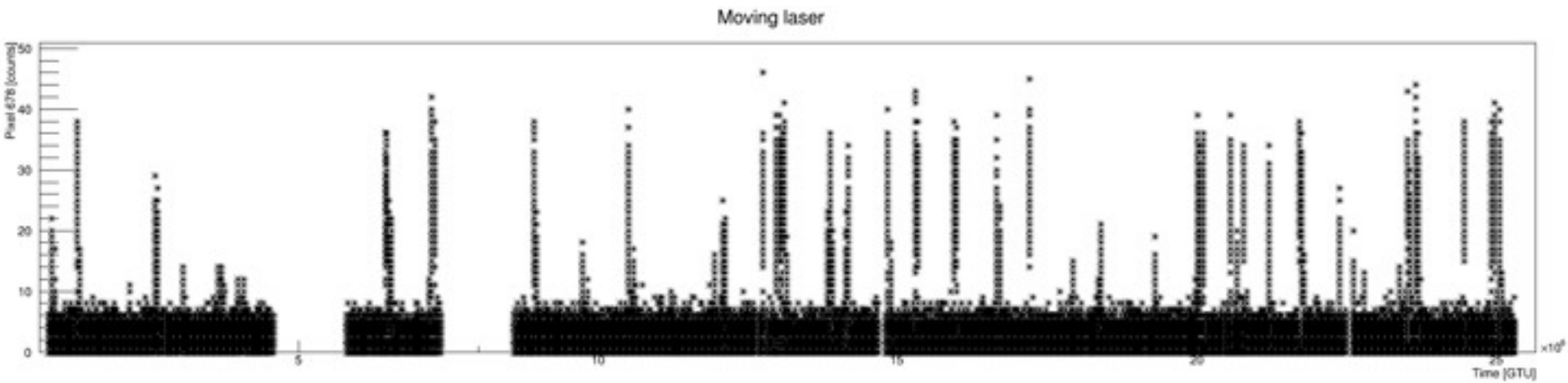
Spot seen in the focal point

Real-time
On board calibration

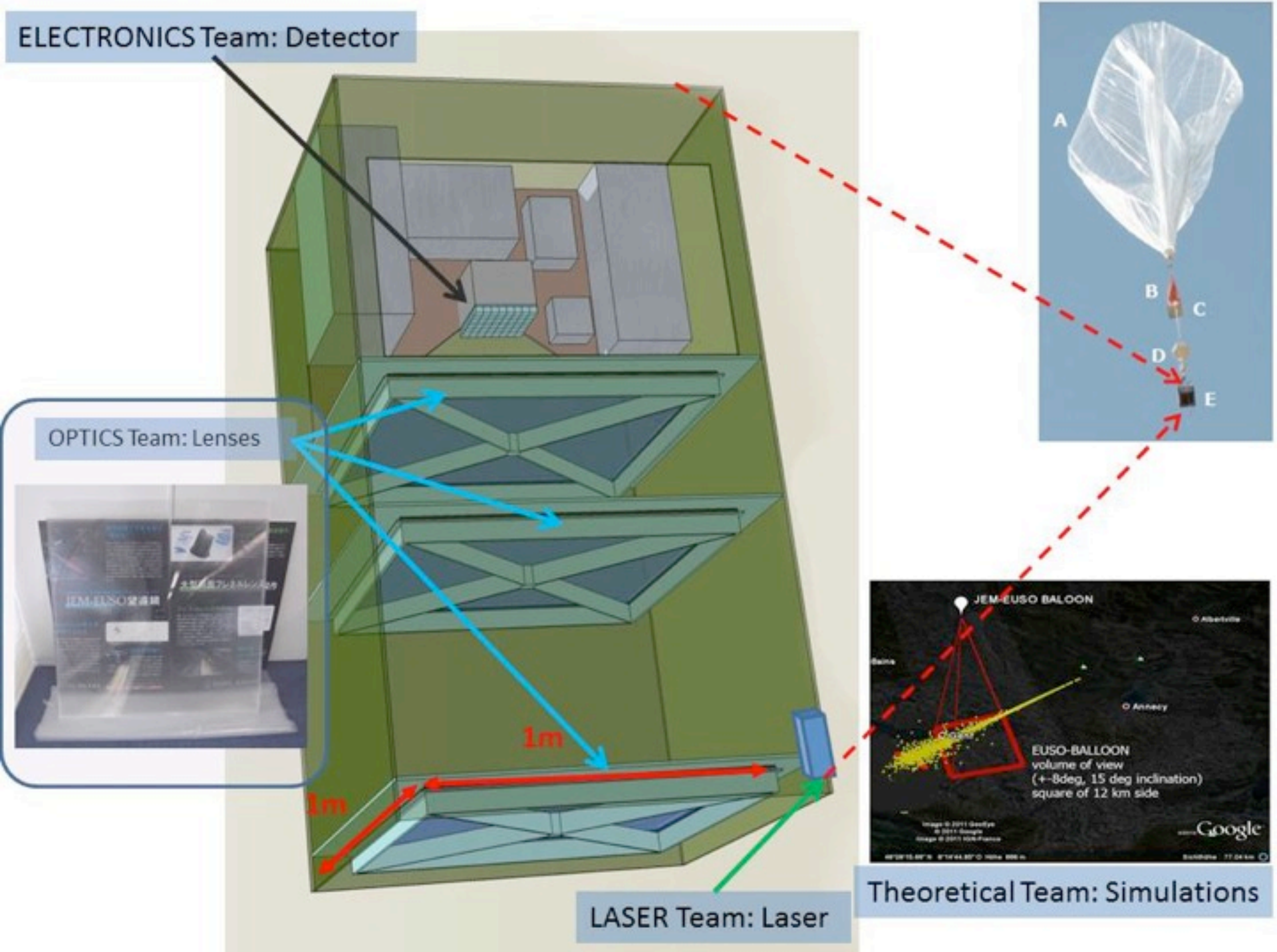
Individual channel




pdm
0
5
10
15
20
25
30
35
40
45
50

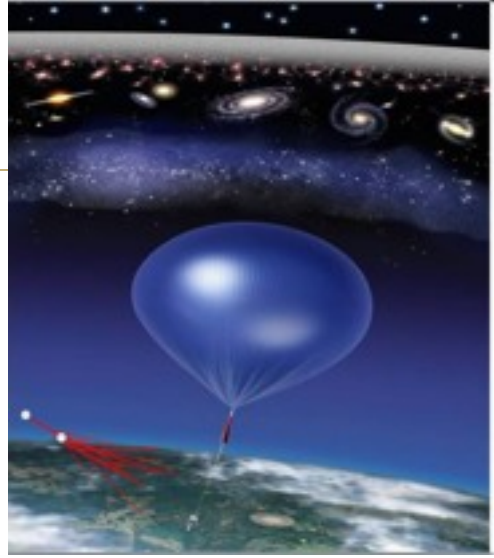

Moving laser
Pixel 678 [counts]
Time [GTU]

CNES approved balloon mission
First flight 2014

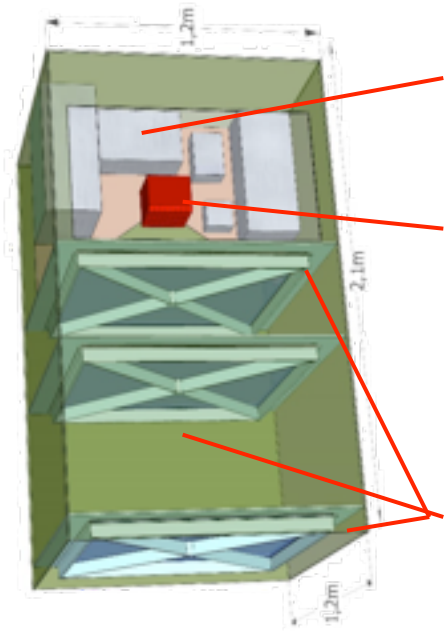

ELECTRONICS Team: Detector
OPTICS Team: Lenses
JEM-EUSO
1m
1m
LASER Team: Laser
A
B
C
D
E
JEM-EUSO BALOON
Annecy
EUSO-BALLOON
volume of view
(+-8deg, 15 deg inclination)
square of 12 km side
Google
Theoretical Team: Simulations

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

Balloon-EUSO



The EUSO-Balloon is a Pathfinder-mission to perform a complete end-to-end test of JEM-EUSO' s key technologies and instrumentation



data processing
photo detection

optical system

Multiple launches planned in 2014 at altitude ~ 40 km