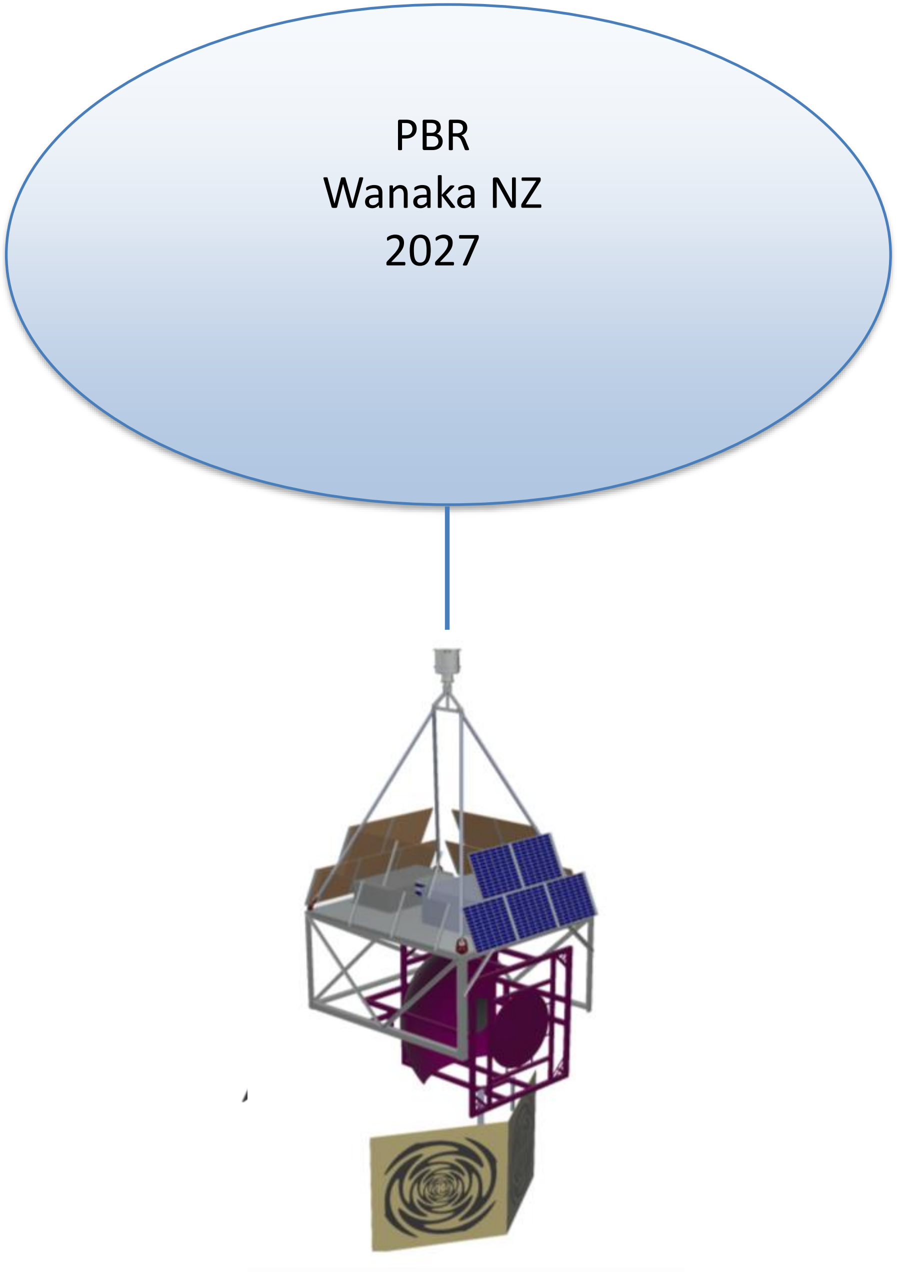
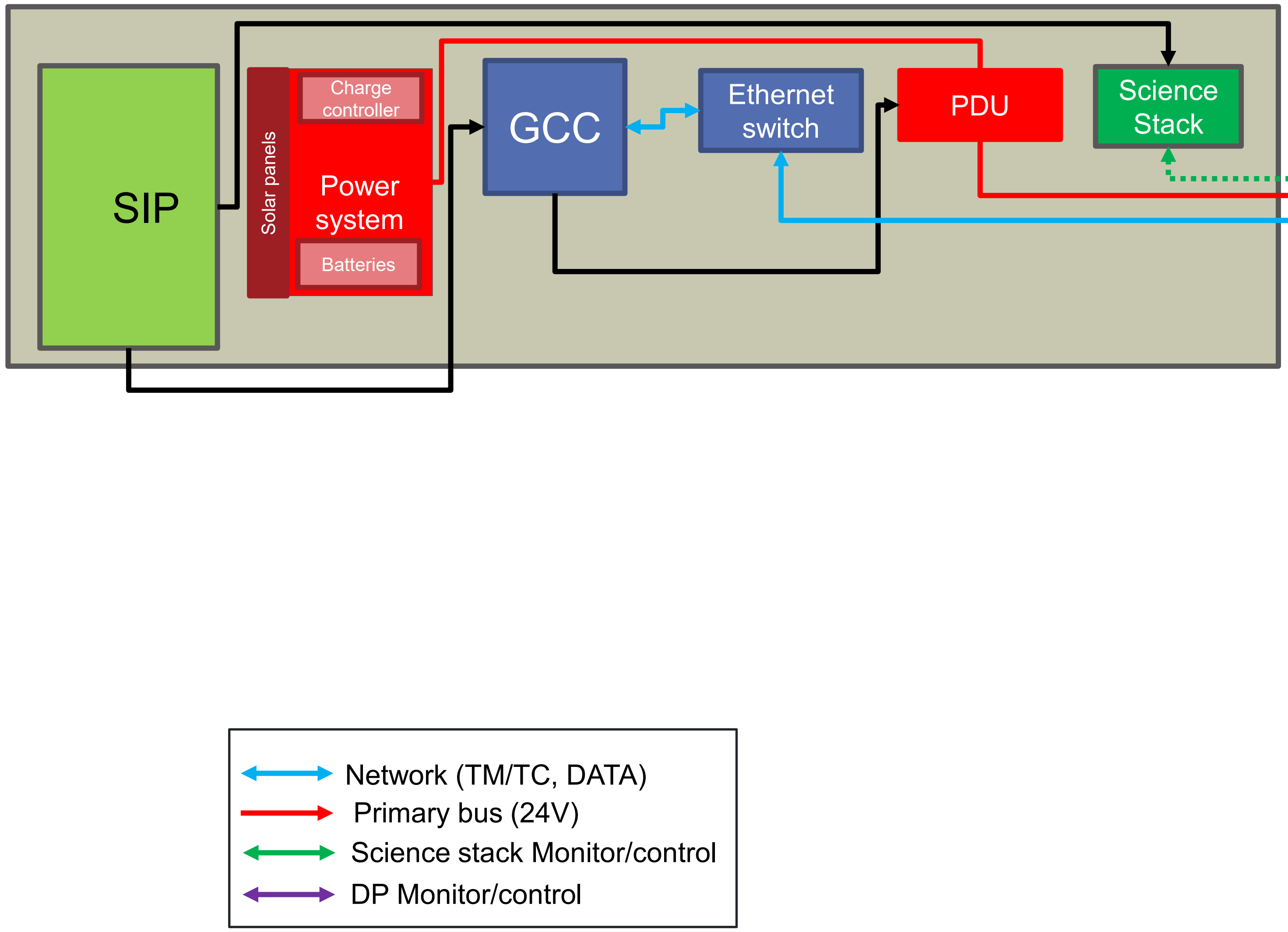
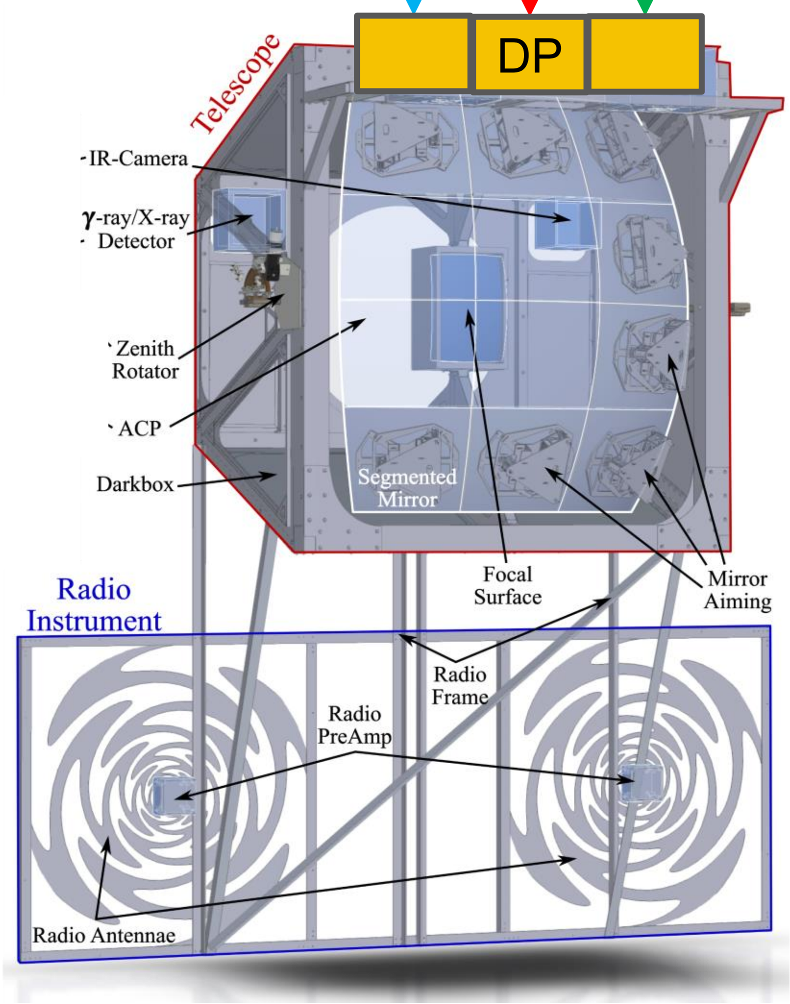
DP STATUS



GIUSEPPE OSTERIA (INFN NAPOLI)

TELESCOPE - DP MAIN INTERFACES





TELESCOPE MAIN SUB-SYSTEMS

Focal surface

- <u>Fluorescence Camera</u>
  - **Optics**
    - 4 x FC PDMs → 36 Elementary Cells (EC) with 4 MAPMTs each → 144 MAPMTs
    - Field Flatners and BG-3
  - **Electronics**
    - ASIC board (144 units), Cockcroft-Walton board (144 units)
    - Zynq boards (4 units)
    - Cross boards (12 units)
    - HV generator (4 units) + switches (4 units)
    - DC-DC converters (4 units)
  - **Trigger**
    - (Firmware on the Zynq board)
  - **Mechanics**
    - PDM mechanical structure, Cooling system, EMC shielding
- <u>Cherenkov Camera</u>
  - **Optics**
    - 4 x CC PDMs → 32 Elementary Cell (EC) with 1 SiPM array each
  - **Electronics**
    - ASIC boards (4 units?)
    - FPGA boards (4 units)
    - Synchronization system (1 unit)
    - Bias voltages generators (? units)
    - DC-DC converters (? Units)
  - **Trigger**
    - (Firmware on the FPGA board)
  - **Mechanics**
    - CC mechanical structure, Cooling/heating system, EMC shielding

TELESCOPE MAIN SUB-SYSTEMS

Data Processor

- **Electronics**
  - CPU (2 units, Hot and Cold)
  - Trg&Sync Boards (2 units)
  - GPS receivers (2 units, four antennas)
  - HK board
  - Ethernet switches (4 units)
  - Solid State Power Controller (2 units)
- **Mechanics**
  - DP box1 (Eurocard chassis)
  - DP box2 (Power & Ethernet box) (Eurocard chassis)
  - DP box3 (Power & Ethernet box) (Eurocard chassis)

Ancillary devices

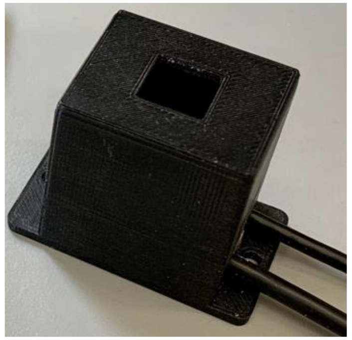
- Health LED (2 units)
- EMON (2 units)
- LID Controller ?
- Tilt system?

External Detectors

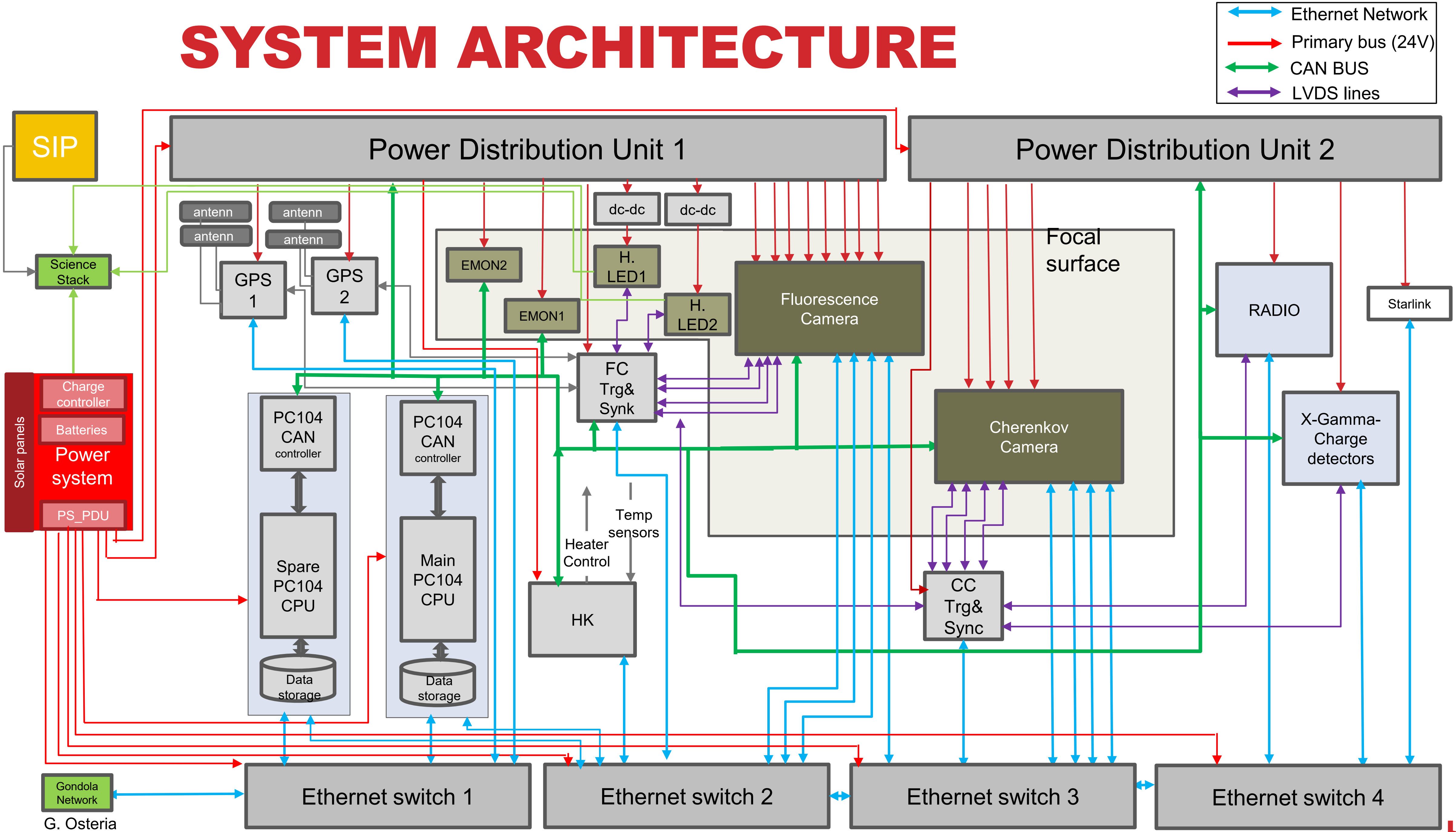
- RADIO
- X-Gamma detectors

Harness (Cables, connectors, hatch panels) (a lot of…)

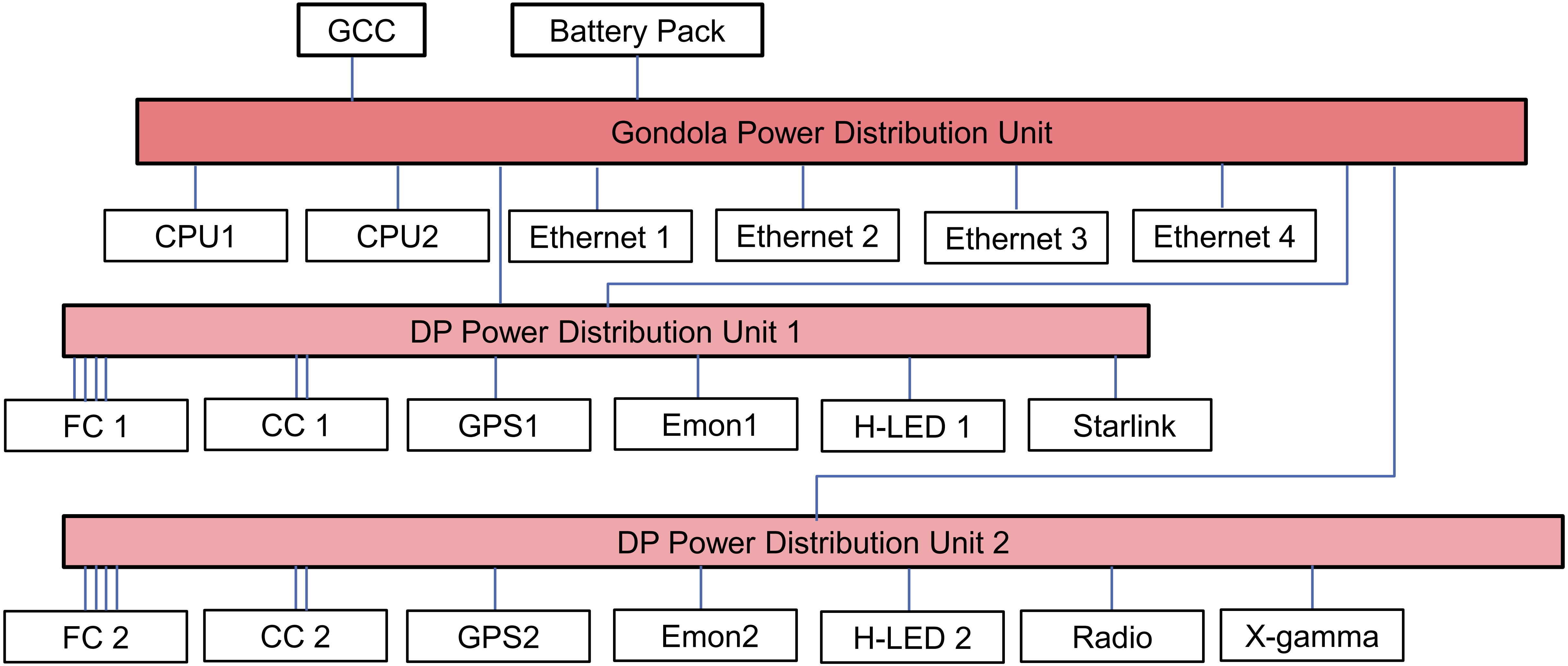
Starlink systems



SYSTEM ARCHITECTURE

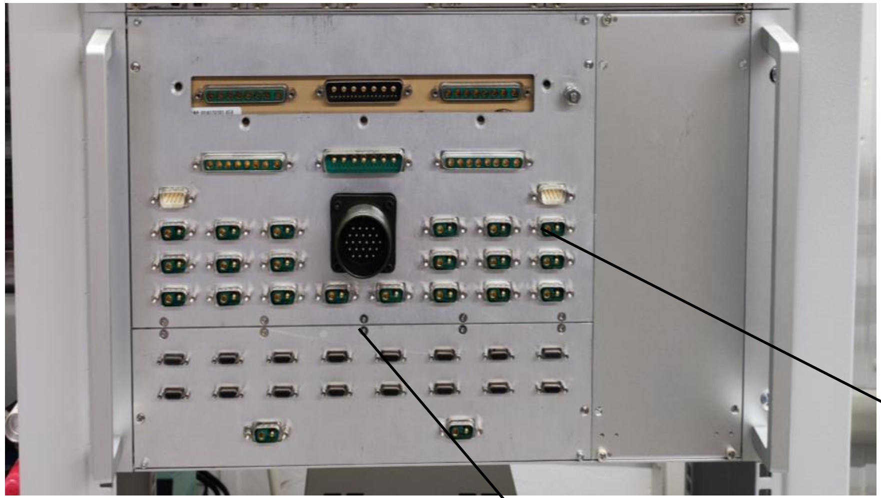


POWER DISTRIBUTION



POWER CONNECTORS

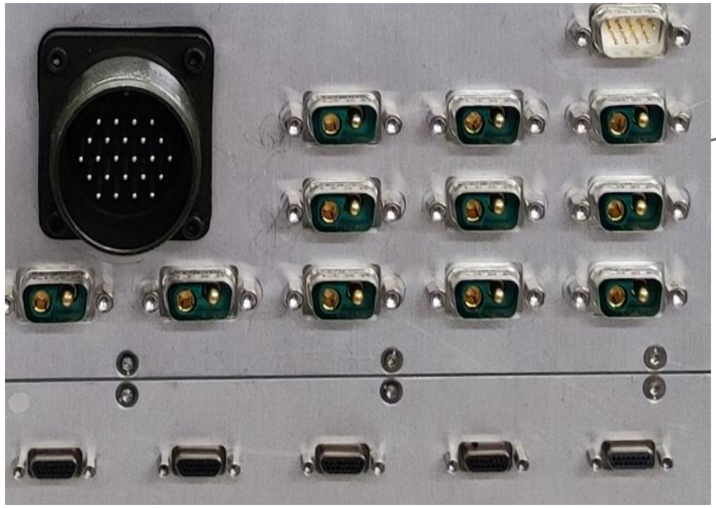
Waiting for a better EMI solution



Suggested power connector for:

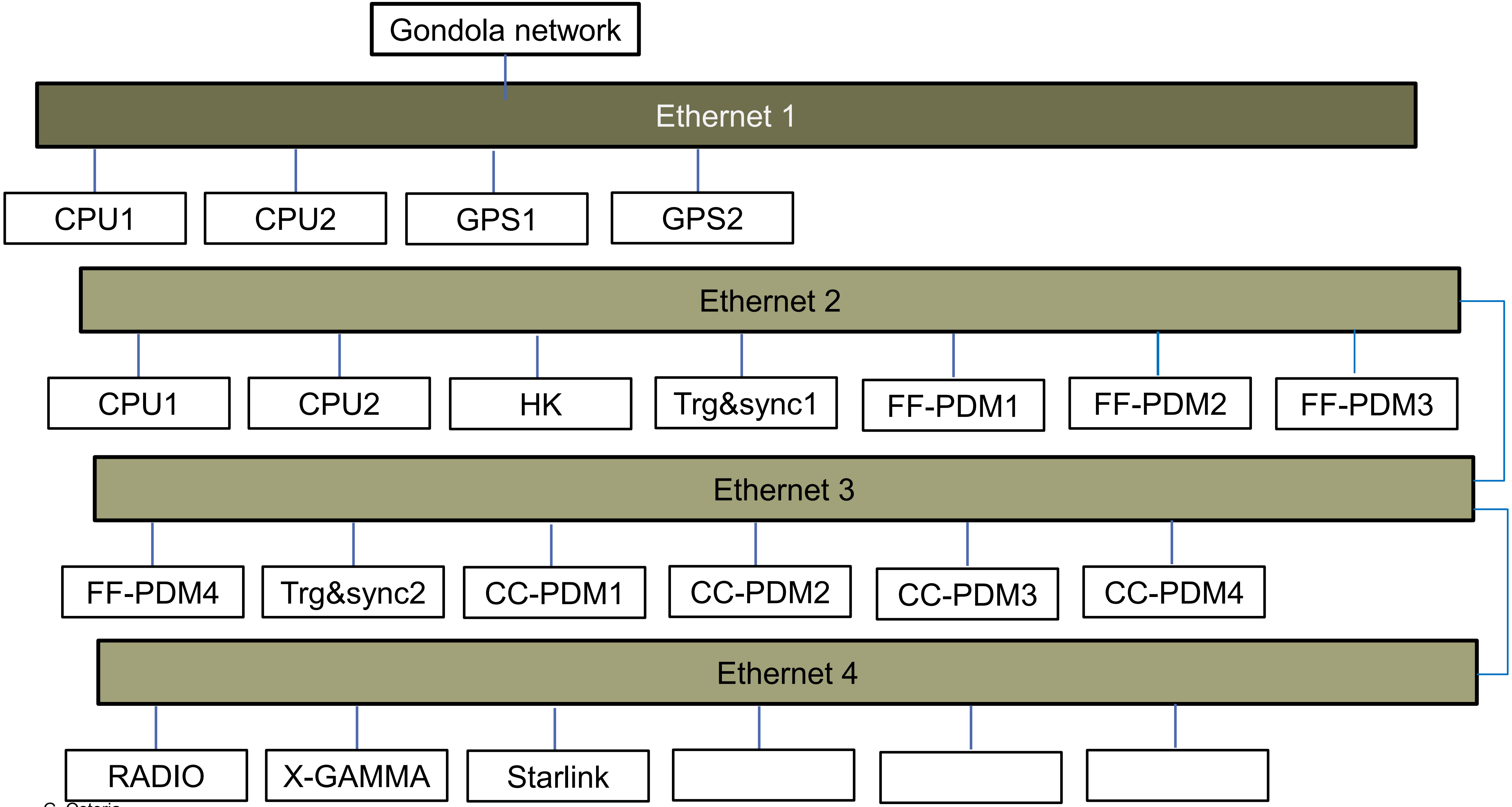
- FC-PDM
- CC-PDM
- RADIO
- GPX

From gondola PDU



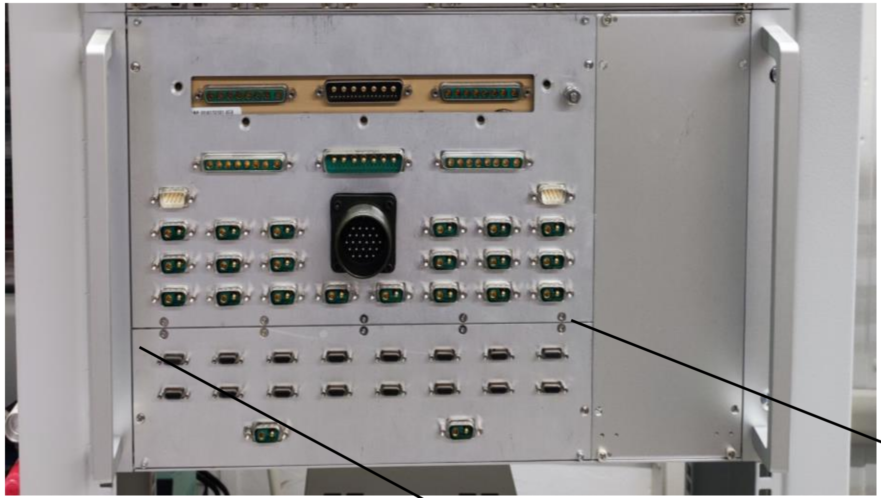
D-Sub power connector, 2 pins

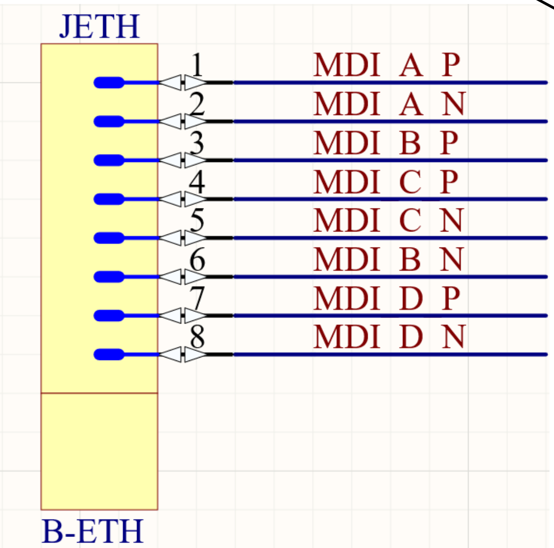
NETWORK CONNECTIONS



ETHERNET CONNECTOR

Waiting for a better EMI solution





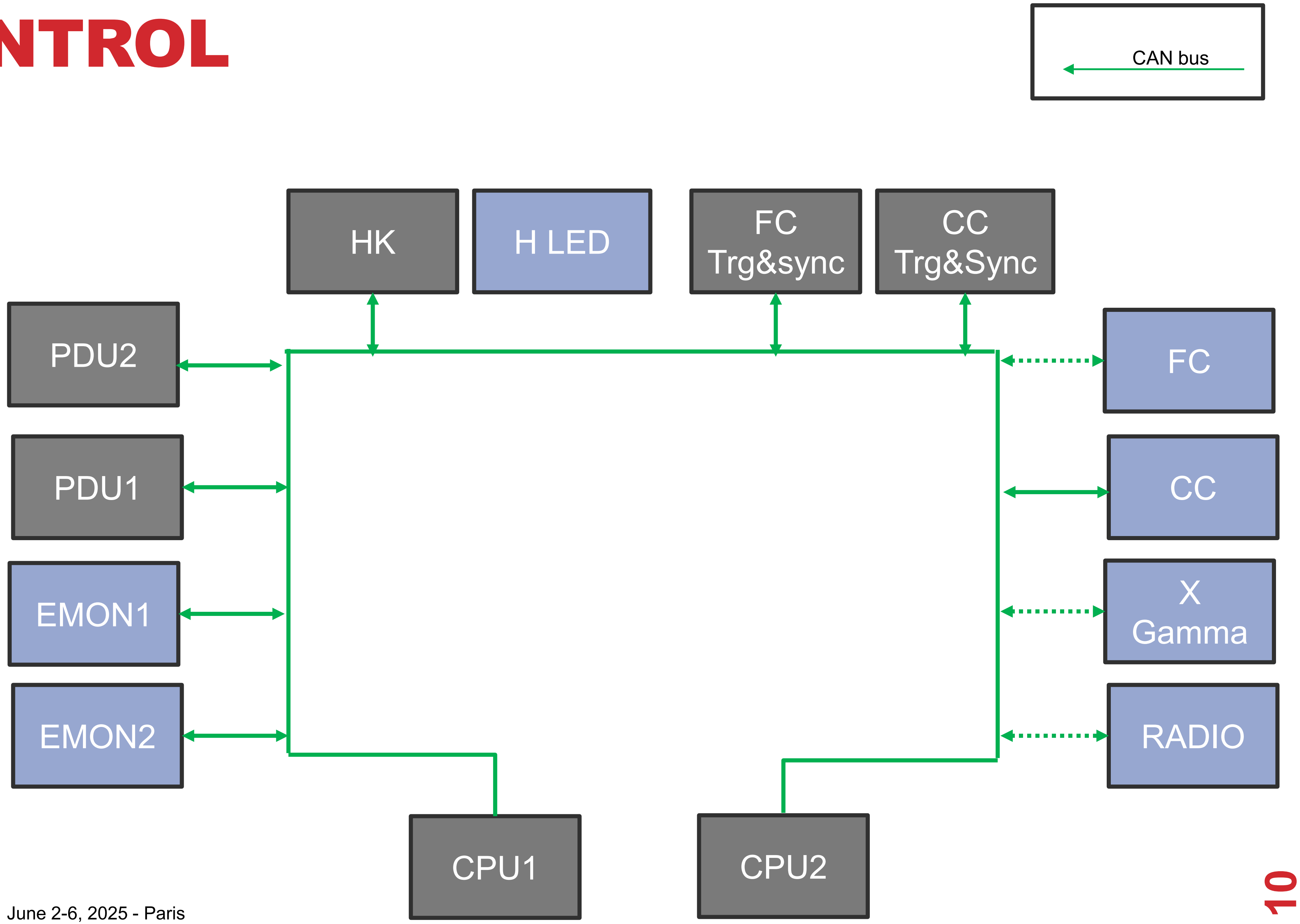
Suggested Ethernet connector for:

- FC-PDM
- CC-PDM
- RADIO
- GPX

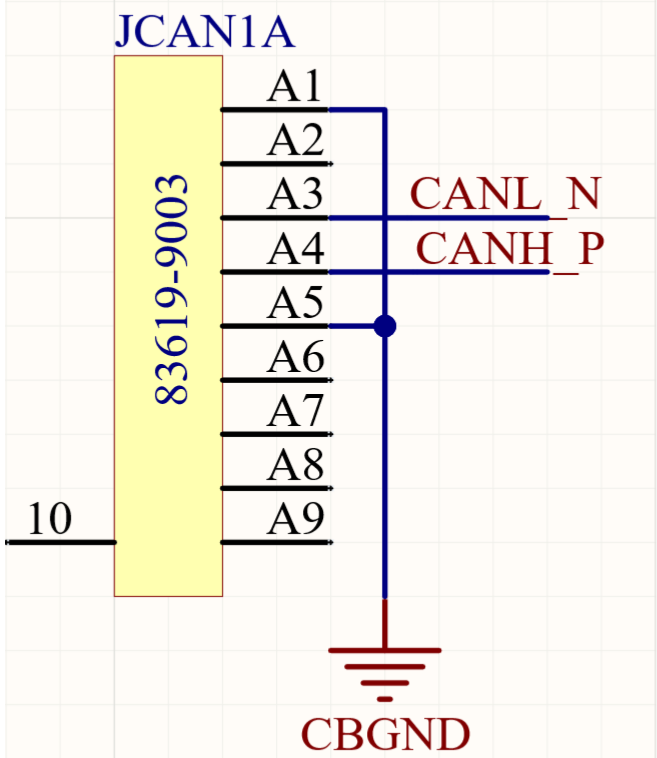
Micro-D High-Density Connector 15 pins

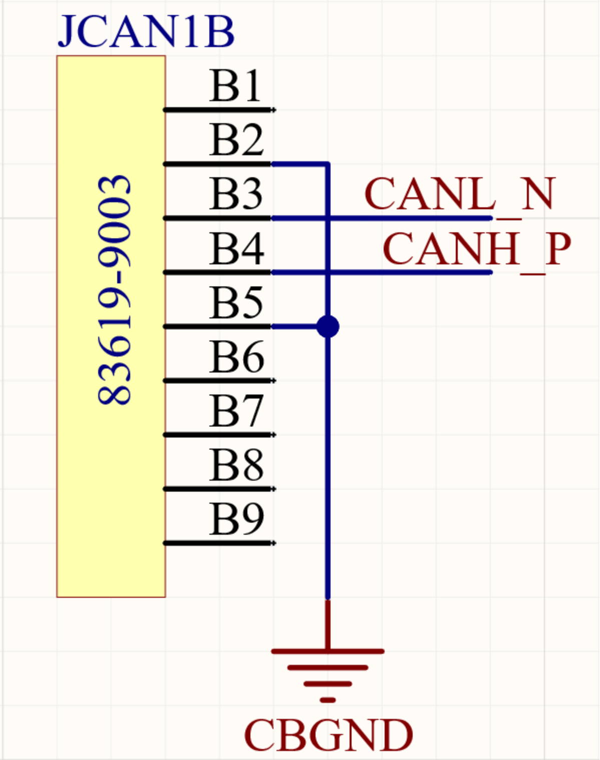
SLOW CONTROL

Slow control (on the CAN bus) is used to control and acquire HK data from sub-systems
PDUs, EMONs, and HK board are controlled and acquired only through a CAN bus connection.



CAN CONNECTORS





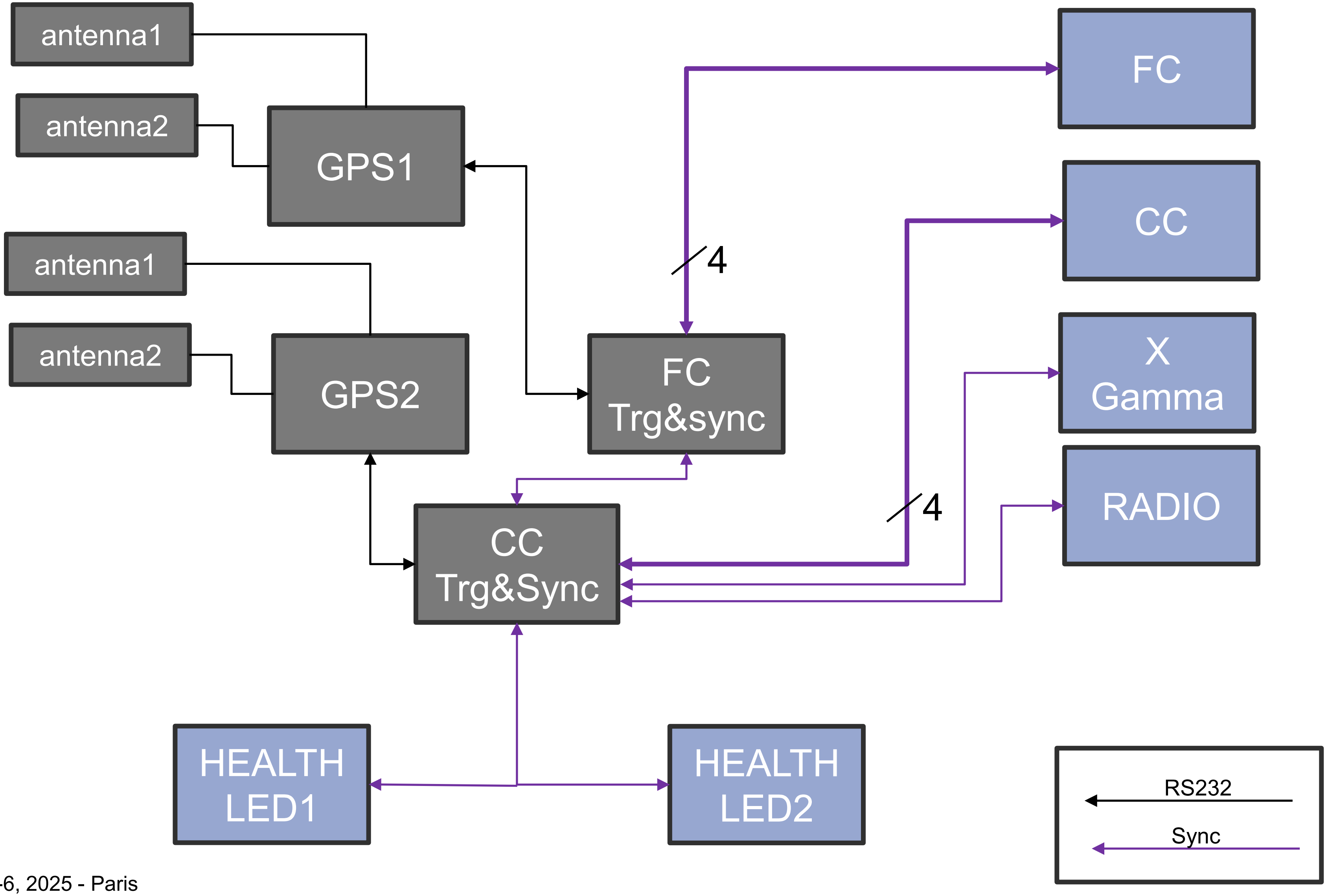
MOLEX 83619-9003

Suggested connectors:
2 Micro-D High-Density Connector 9 pins

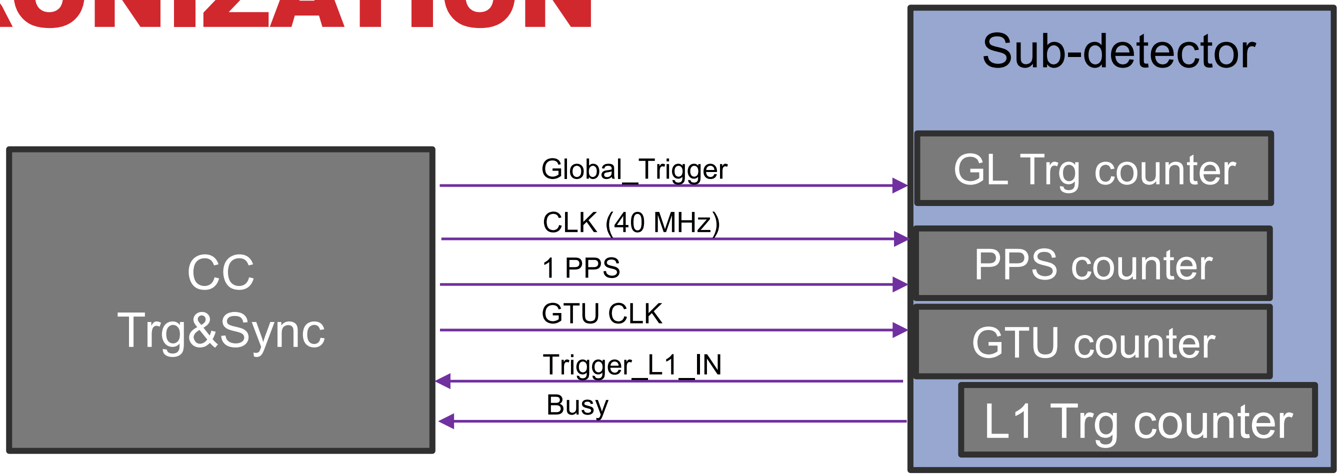
TIME SYNCHRONIZATION

The four PBR sub-detectors need to be synchronized by a master board (CC Trg&Sync). The CC Trg&Sync board manages and distributes:

- Local and global trigger signals
- 1 PPS signal from GPS
- GTU Clock
- Busy signals from sub-detectors



TIME SYNCHRONIZATION



We define the «**time of the run**» as the sum of the **1 PPS** value and the **GTU clk**.

- At the start of the run, when all the sub-detectors are ready to start (no busy signals asserted), the 1PPs and the GTU clk signals are sent to all the sub-detectors, which begin to count the time relative to that run.
- If properly managed, the time of the run should be **the same for each sub-detector** within one microsecond.
- Synchronization among sub-detectors is obtained through the following counters:
    - 1 PPS counter
    - GTU counter

The values of the two counters shall be stored at each Global trigger received and added to the event data, together with the values of the L1 and Global trigger counters.

Sub-detector Data packet

DEAD AND LIVE TIME

Each sub-detector measures its own dead and live times.
Dead and live times units = GTU clk (1 microsec)
Dead time ≡ time elapsed with the sub-detector «Busy» signal ON
Live time ≡ time elapsed between the «Busy» signal OFF and the arrival of the Global Trigger signal

For each event, the sub-detector adds to the data packet:

- the dead time conter (which measures the dead time reletive to the previous event)
- The live time counter (measuring the elapsed time between the previous and the actual event

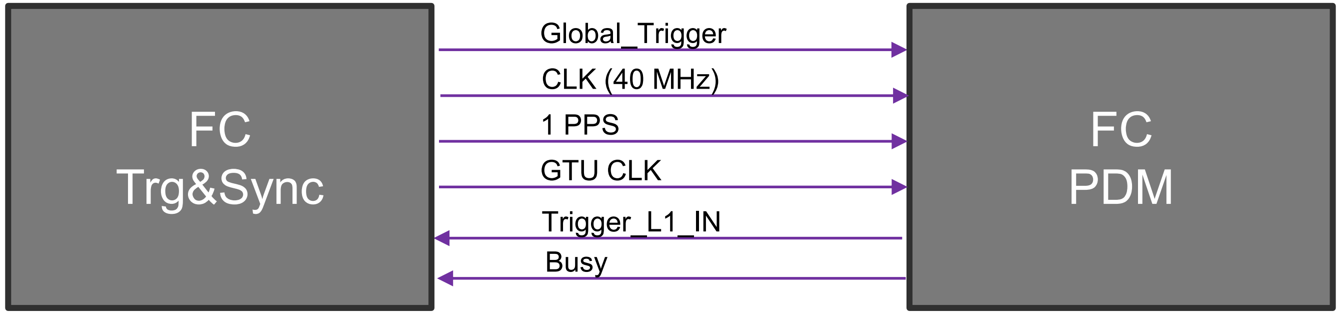
At the end of the run, the sum of the dead and live time should be equal to the run duration.

GL Trg counter	PPS counter	GTU counter	L1 Trg counter	Dead time counter	Live time counter	Data

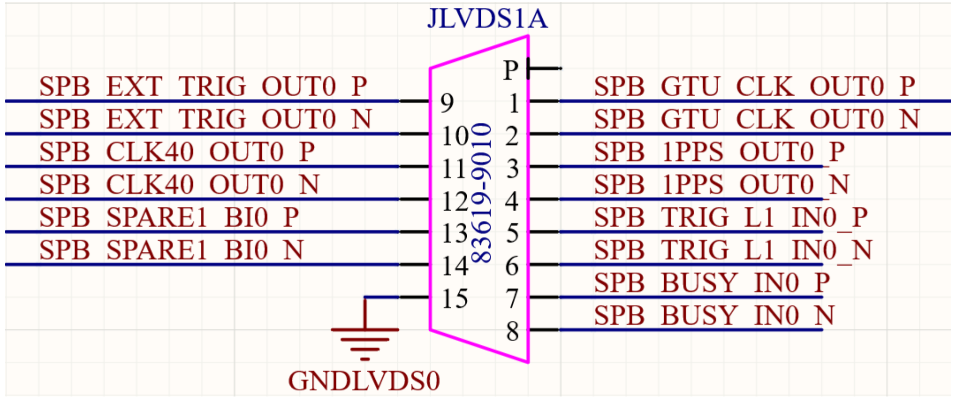
Data packet

SYNCHRONIZATION SIGNALS: FC

LVDS opto isolated (on the CC_Trg&Sync side)



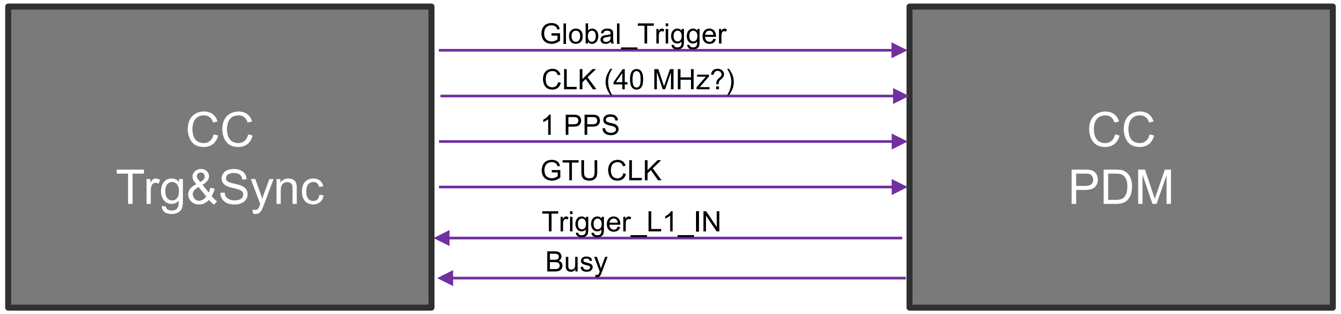
MOLEX 83619-9010



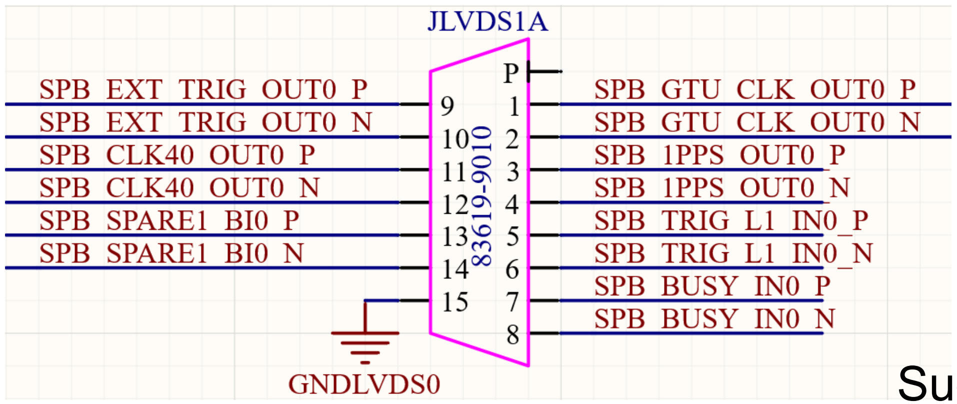
MOLEX 83619-9010

SYNCRHONIZATION SIGNALS: CC

LVDS opto isolated (on the CC_Trg&Sync side)



MOLEX 83619-9010

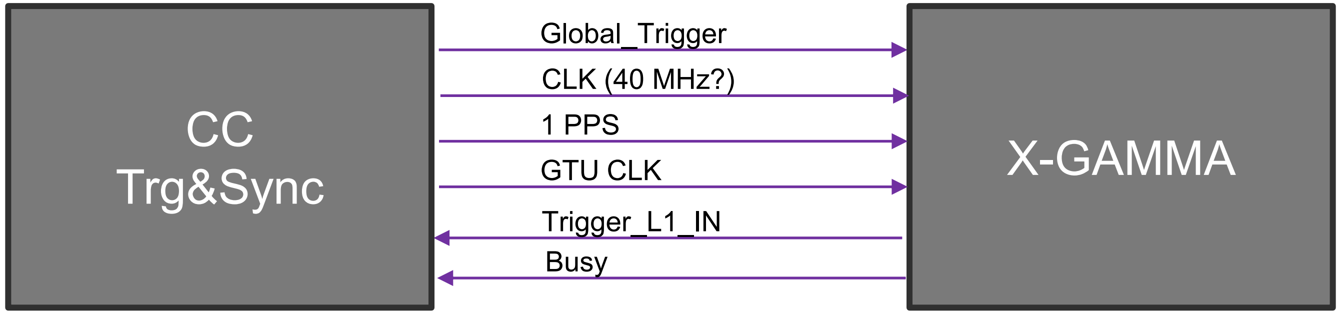


Suggested connector:
Micro-D High-Density Connector 15 pins

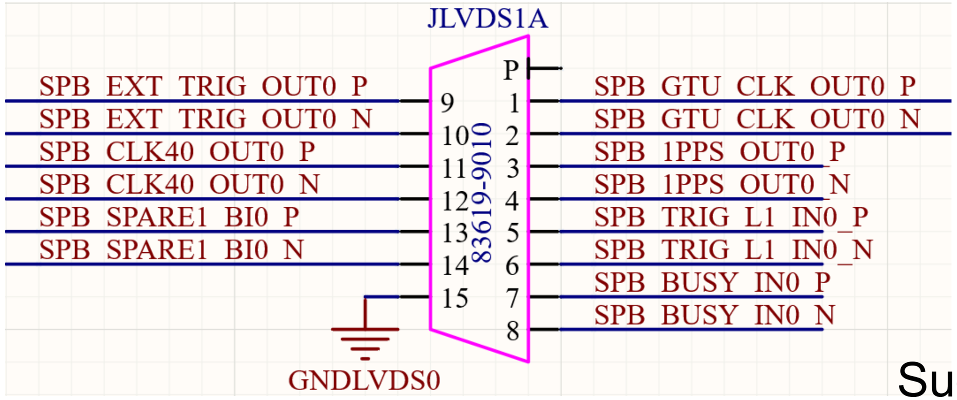
G. Osteria
37th JEM-EUSO Collaboration meeting, June 2-6, 2025 - Paris

SYNCRHONIZATION SIGNALS: X-GAMMA

LVDS opto isolated (on the CC_Trg&Sync side)



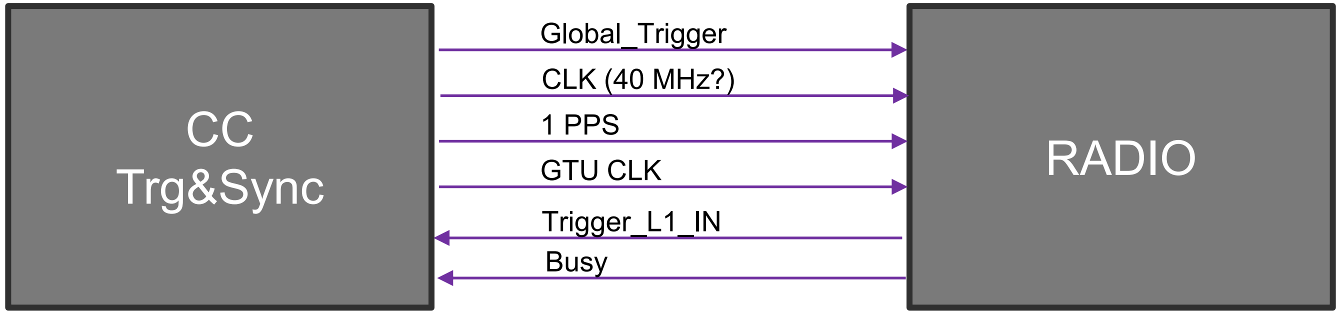
MOLEX 83619-9010



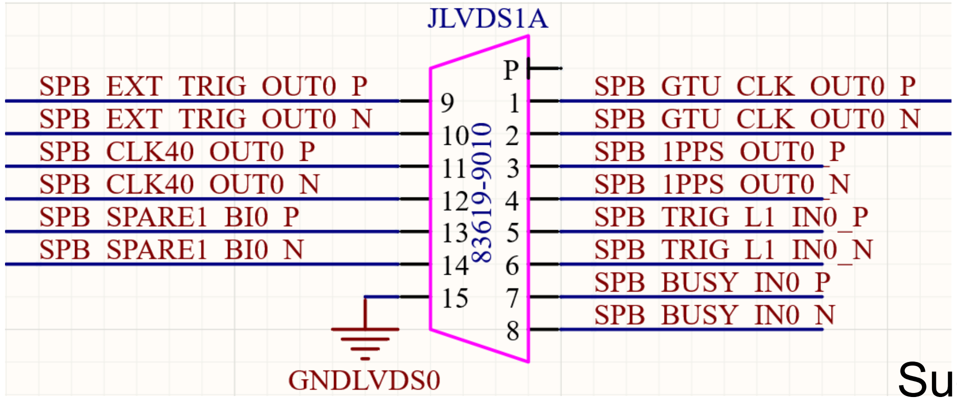
Suggested connector:
Micro-D High-Density Connector 15 pins

SYNCRHONIZATION SIGNALS: RADIO

LVDS opto isolated (on the CC_Trg&Sync side)



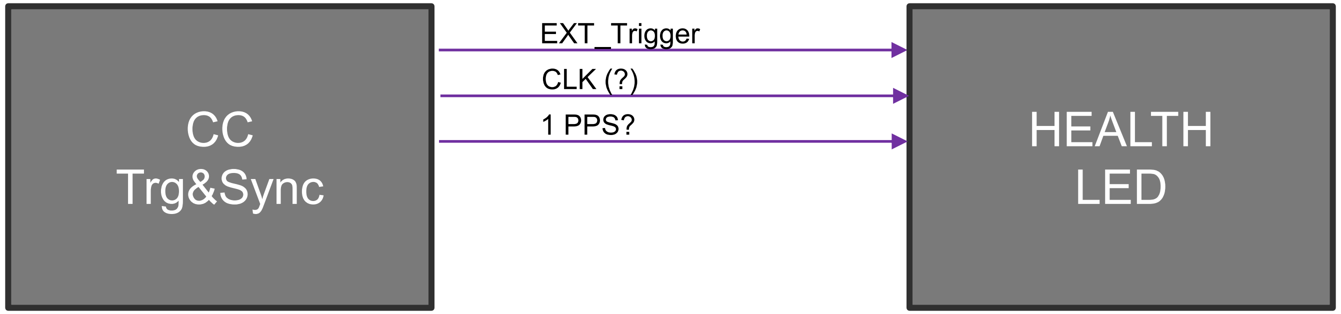
MOLEX 83619-9010



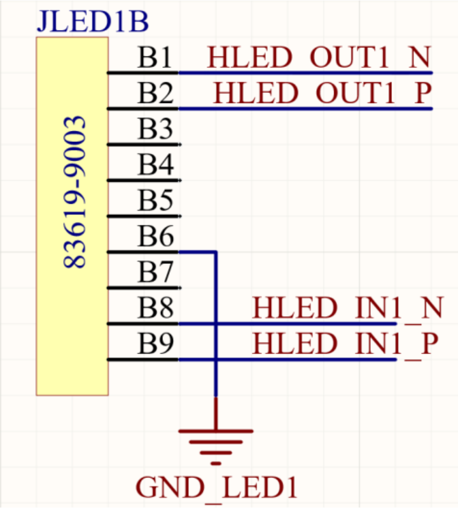
Suggested connector:
Micro-D High-Density Connector 15 pins

SYNCRHONIZATION SIGNALS: HEALTH LED

LVDS opto isolated (on the CC_Trg&Sync side)



To Be Discussed



[MOLEX 83619-9003]

Suggested connector:
Micro-D High-Density Connector 9 pins

TELESCOPE OPERATING MODES:

- **Day modes**
  1. Data transmission to Ground
  2. Data acquisition of the RADIO (auto-trigger mode), X-Gamma?
  3. Data acquisition with shutter closed
  4. …
- **Night modes**
  1. Data acquisition of:
     - CC-PDM (auto-trigger)
       - CC-PMDs
       - RADIO (ext-trigger)
       - X-Gamma (ext-trigger)
     - FC-PDM (auto-trigger)
       - FC-PDM

The CC and FC systems work in parallel;

DAQ TIMING

Power ON :

- **Internal integrity check**
- **Reset all the internal counters**
- **Busy signal is asserted**
- **Acquires and transmits on CAN BUS slow control parameters**
- **Wait for a Configure System commands sequence from CPU**
    - Configure parameters
- **Wait for a Start ACQ command from CPU**

DAQ TIMING

Start Acquisition:

- **Busy signal is deasserted**
- **Start to count the time of the run**
- **Start to count the live time**
- **Wait for a trigger**

DAQ TIMING

<u>When a trigger occurs:</u>

- **Busy signal is asserted**
- **Stop to count the live time, begin to count the dead time**
- **Scientific data are produced (ADC conversion, data transfer, etc)**
- **Scientific data are packed and stored in a FIFO memory**
  - FIFO depth > n events
  - (FIFO control lines move the Busy status)
- **As soon as the system is ready to receive a new trigger, Busy is deasserted**
- **Stop to count the dead time, begin to count the live time**
- **Wait for a new trigger**
- **A Finite State Machine starts to unpack and transfer data to the CPU**
  - Data ready to be transferred to the CPU («push» logic?)

DAQ TIMING

Stop Acquisition:

- **Busy signal is asserted**
- **Complete the unpack and transfer data to the CPU procedure**
- **Wait for a new command from the CPU**

DP STATUS

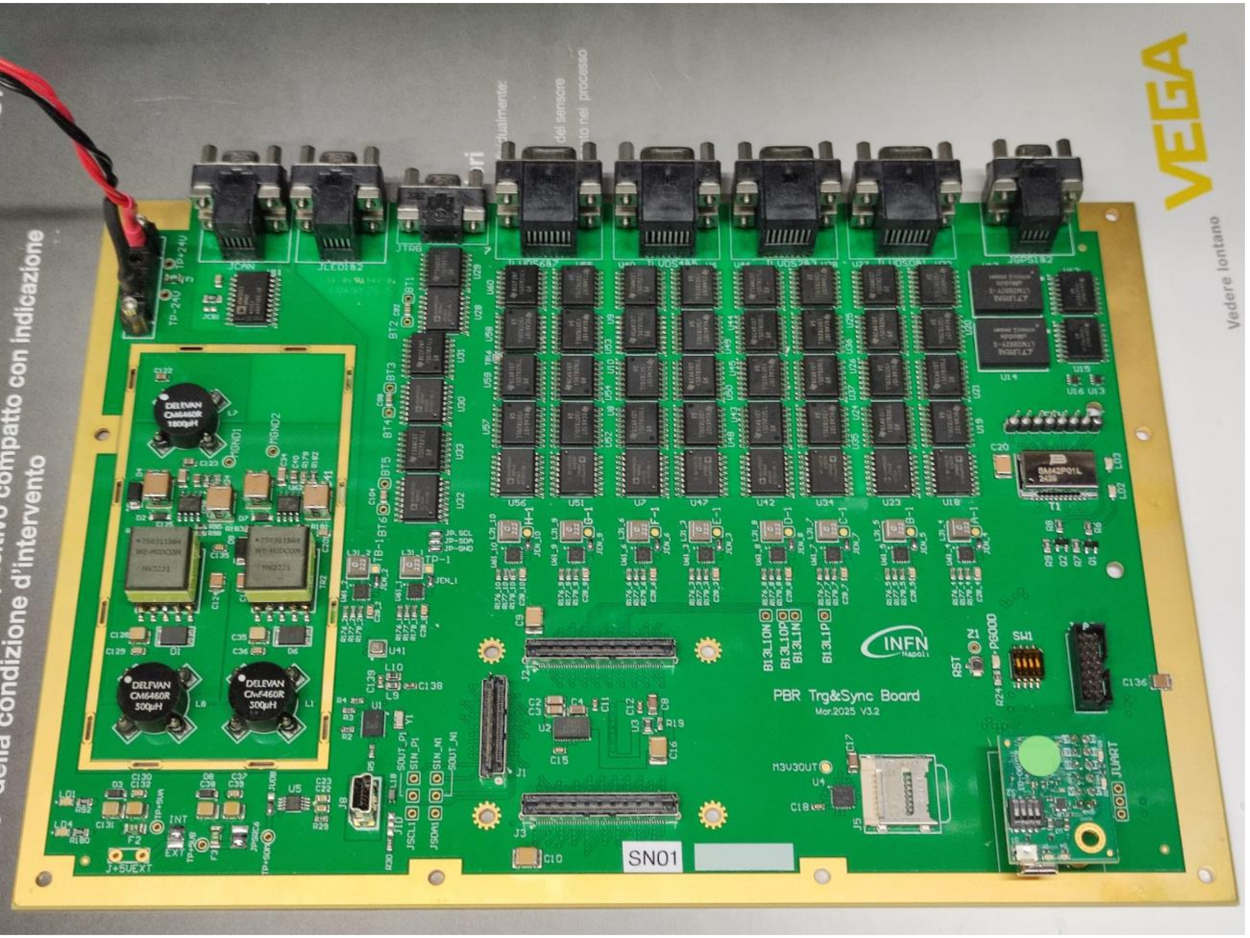
- **What we have**

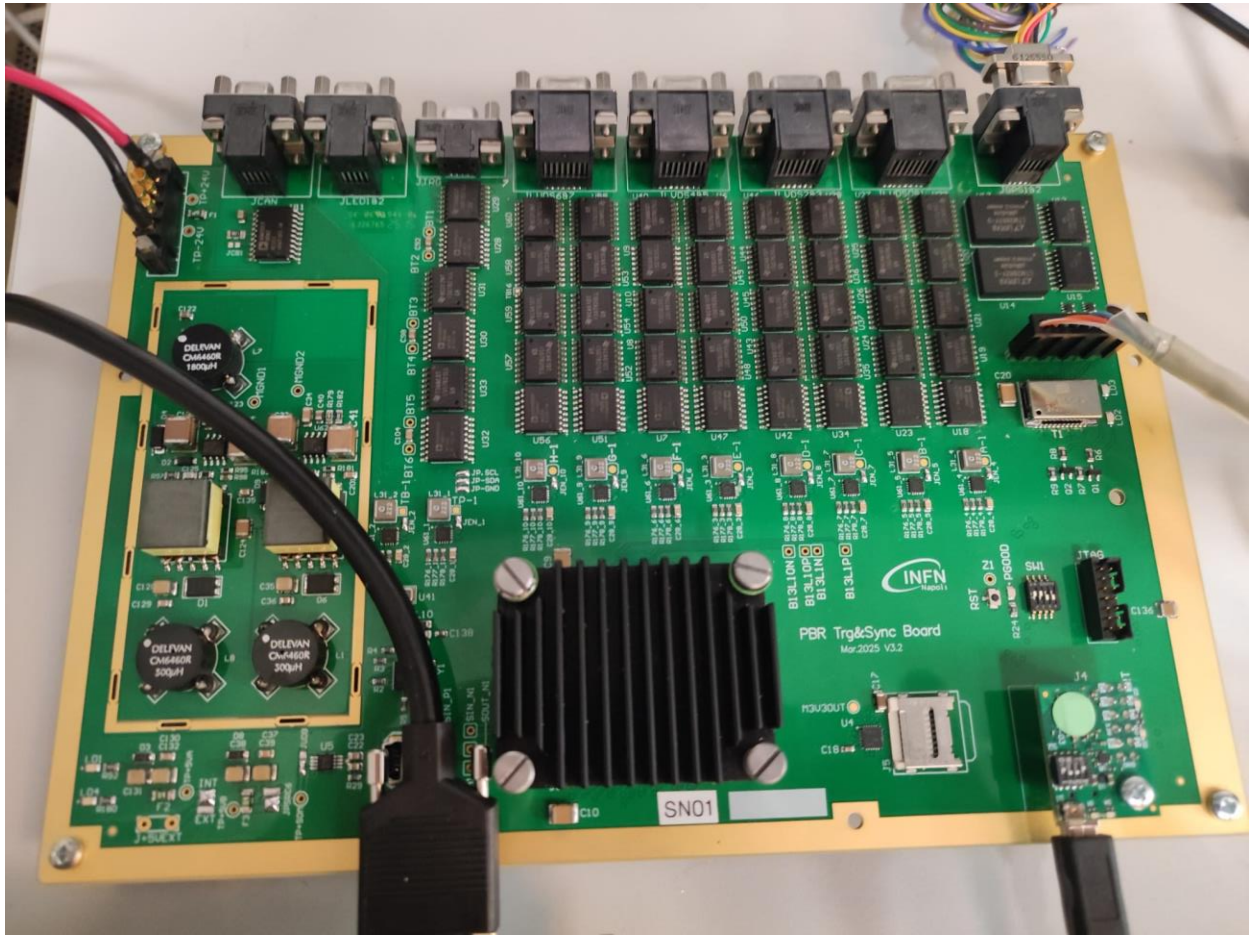
SPB2 DP Spare Model

SPB2 DP Prototype

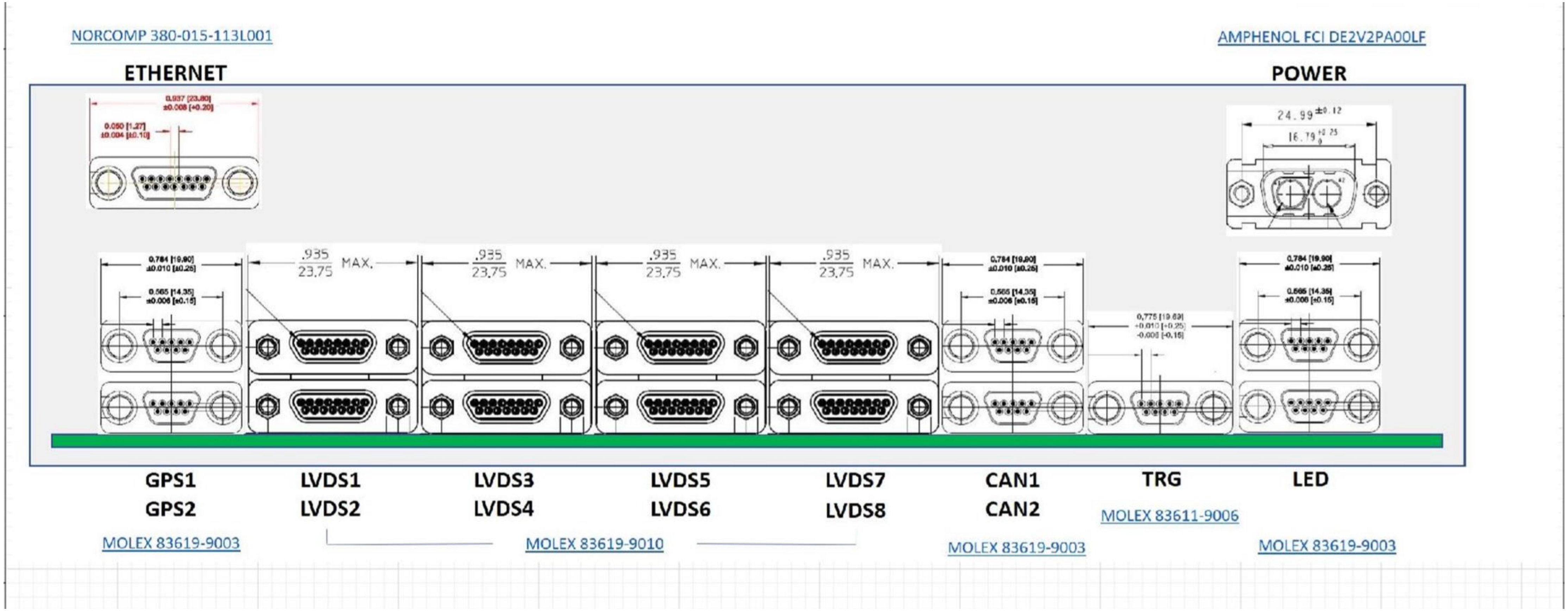
- **what we need:**
  - New and bigger disks for both CPUs (4 8TB hard disks already purchased)
  - New antennas (4) for GPS receivers (AV39)
  - New TRG&CLK boards (2 x 8-channel boards)
  - New power and network distribution sub-rack
  - Updated version of the HK board
  - Spare units (PDU, Ethernet switches, mechanics)
  - New mechanics (TRG&CLK front panel, new coolink plates,etc)
  - Cables and connectors (a lot of)

TRG&CLK BOARD STATUS:
TWO BOARDS DELIVERED AND SUCCESSFULLY TESTED





TRG&CLK BOARD STATUS: FRONT PANEL DRAWING



Thank you