# Extreme Universe Space Observatory: Power Distribution, Data Link, and Control & Data Handling


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# Purpose and Contents

**This presentation is the beginning of a phase A study (under ASI funding) on some items of EUSO instrument.**

**A) It is based upon:**
- **EUSO IDD, issue 1 C, IFCAI/CNR, August 2001;**
- **Study Report on EUSO, INFN Genova, March 2001.**

**B) The overall approach is analyzed in terms of:**
- **Power distribution;**
- **Data link;**
- **Control & Data Handling (CDH) unit and processor selection.**

**C) An estimation is made for:**
- **Telemetry budget and CDH memory size.**

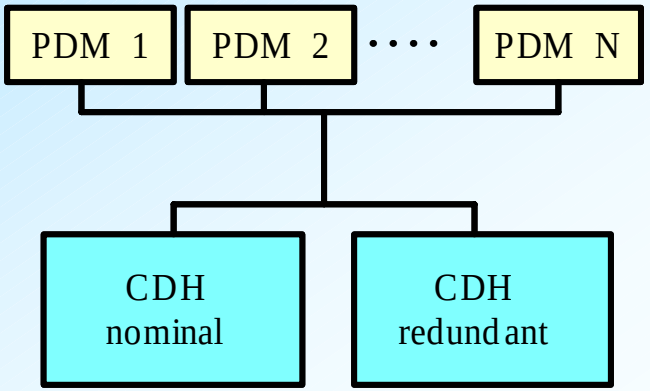
# Basic Assumptions

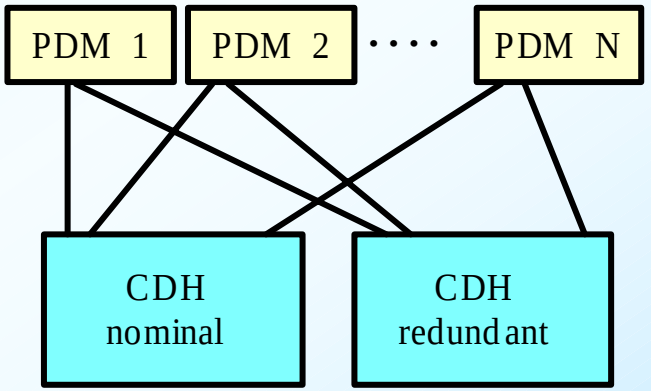
A) EUSO focal surface electronics is divided into N (~100) identical modules

B) All other functions will be located in the CDH units

C) Single Point Failure (SPF) failure tolerance is required at system level

# Power Distribution Trade-off




## Power Bus Connection

- FAILURE-FREE HARNESS
- ON/OFF SWITCHING AT PDM LEVEL
- N/R BUS OR-ING AT CDH LEVEL

## Star-Point Connection

- ON/OFF SWITCHING AT CDH LEVEL
- N/R BUS OR-ING AT PDM LEVEL

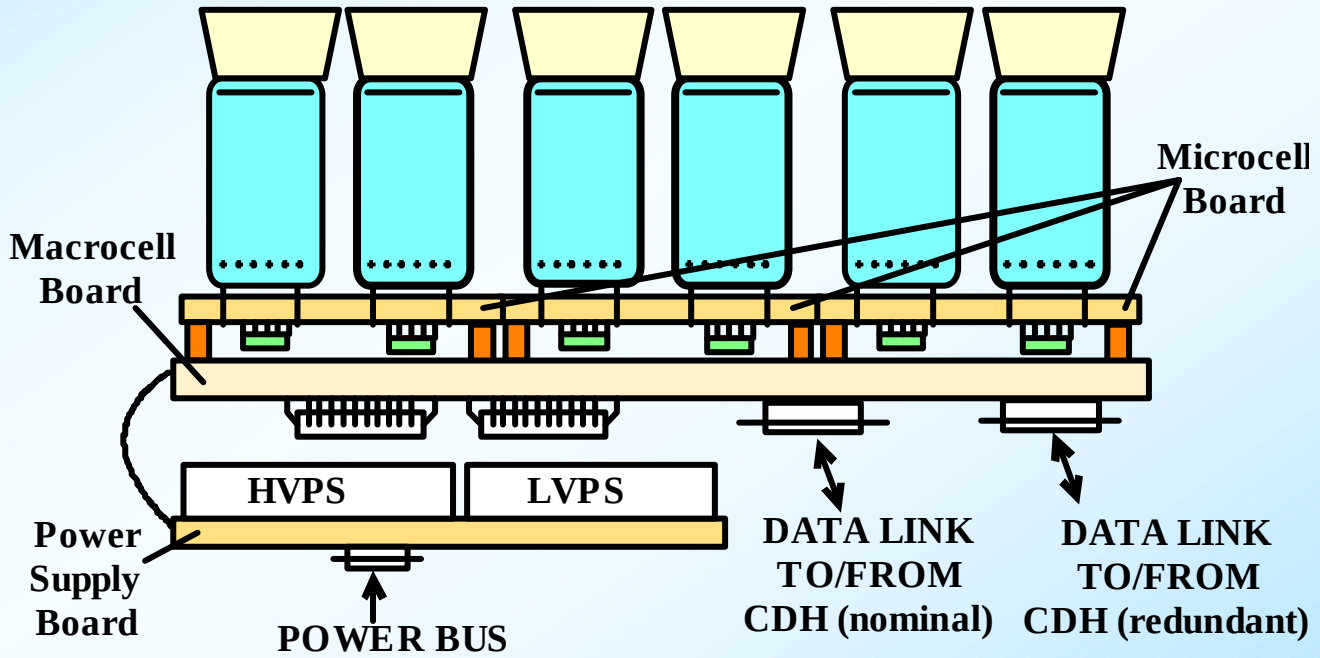
# Power Distribution Trade-off

**ASSUMPTIONS:**

- **Each macrocell has its own power supply board;**
- **The power supply received is the (unconditioned) 120 V from CEPF distributed by CDH;**
- **The power supply board generates both HV and LV;**
- **The operational requirements depend on the power distribution philosophy;**
- **A pictorial view is given in the following figure.**

# Power Distribution Trade-off

**Pictorial view of the location of the power supply board:**



# Power Budget of the EUSO instrument

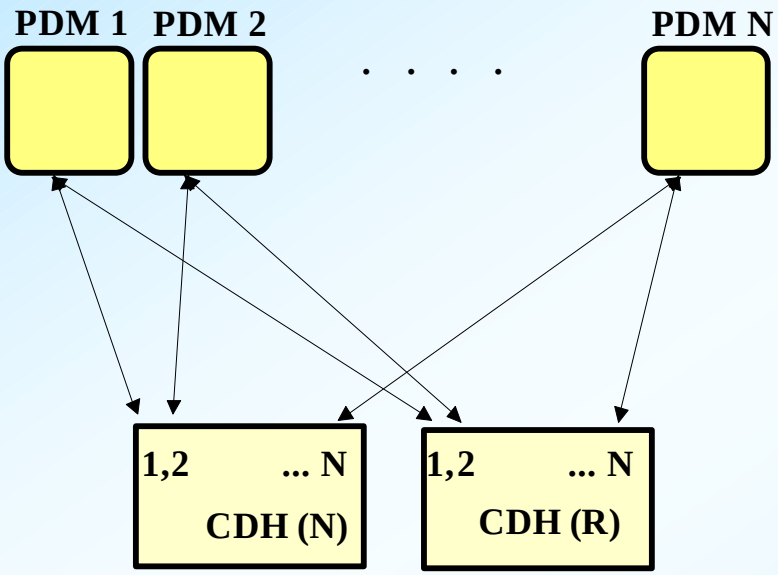
## Photodetector Module

| Item Name | Item Power (W) | Nr.of items | Total Power (W) |
|---|---|---|---|
| HV -MAPMT | 0.025 | x 36 | 0.9 |
| HV - Converter (efficiency: 50%) | 0.900 | x 1 | 0.9 |
| LV - ASIC | 0.064 | x 36 | 2.3 |
| LV - Read-out and Control Electronics | 2.100 | x 1 | 2.1 |
| LV - Converter (efficiency: 75%) | 1.101 | x 1 | 1.1 |
| Total without margin | | | 7.3 |
| Total with margin (15%) | | | 8.4 |

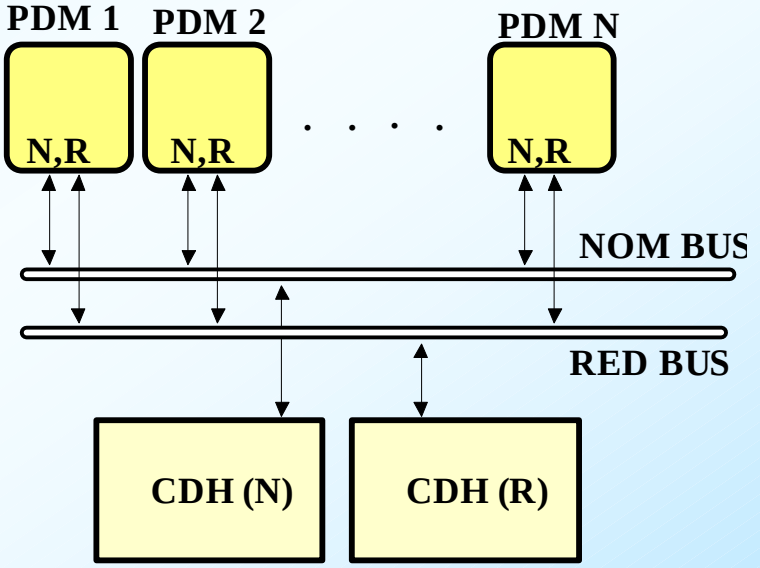
## Instrument

| Item Name | Item Power (W) | Nr.of items | Total Power (W) |
|---|---|---|---|
| Photodetector Module | 7.3 | x 100 | 730 |
| Control & Data Handling Unit | 14 | x 1 | 14 |
| Total without margin | | | 744 |
| Total with margin (15%) | | | 856 |

# Data Link between PDM's and CDH




**BIDIRECTIONAL SERIAL POINT TO POINT CONNECTION**




**BIDIRECTIONAL SERIAL BUS**

# Data Link between PDM's and CDH

**BIDIRECTIONAL SERIAL POINT-TO-POINT CONNECTION**

**Seven differential (balanced) lines are proposed (Standard: EIA RS 422A), namely:**

- **Clock** **from CDH;** **(dedicated line)**
- **Clock Echo** **to CDH;** **(dedicated line)**
- **TC Data** **from CDH;** **(dedicated line)**
- **TM Data** **to CDH;** **(dedicated line)**
- **Load** **from CDH;** **(dedicated line)**
- **Save Frame** **from CDH;** **(dedicated line)**
- **PDM Trigger** **to CDH;** **(dedicated line)**

# Data Link between PDM's and CDH

**BIDIRECTIONAL SERIAL BUS**

**The PDM's are grouped in groups of ten-fifteen (max 31).**

**For each group, a differential (balanced) bus is proposed (Standard: EIA RS 485), namely:**

| | | |
|---|---|---|
| • Clock | From CDH; | (broadcast to 10-15 PDMs) |
| • TC data | From CDH; | (broadcast to 10-15 PDMs) |
| • TM data | To CDH; | (bus-ed from 10-15 PDMs) |
| • Frame | From CDH; | (broadcast to 10-15 PDMs) |
| • Load | from CDH; | (broadcast to 10-15 PDMs) |
| • Save Frame | from CDH; | (dedicated line) |
| • PDM Trigger | to CDH; | (dedicated line) |

# Data Link between PDM's and CDH

## BIDIRECTIONAL SERIAL POINT TO POINT CONNECTION:

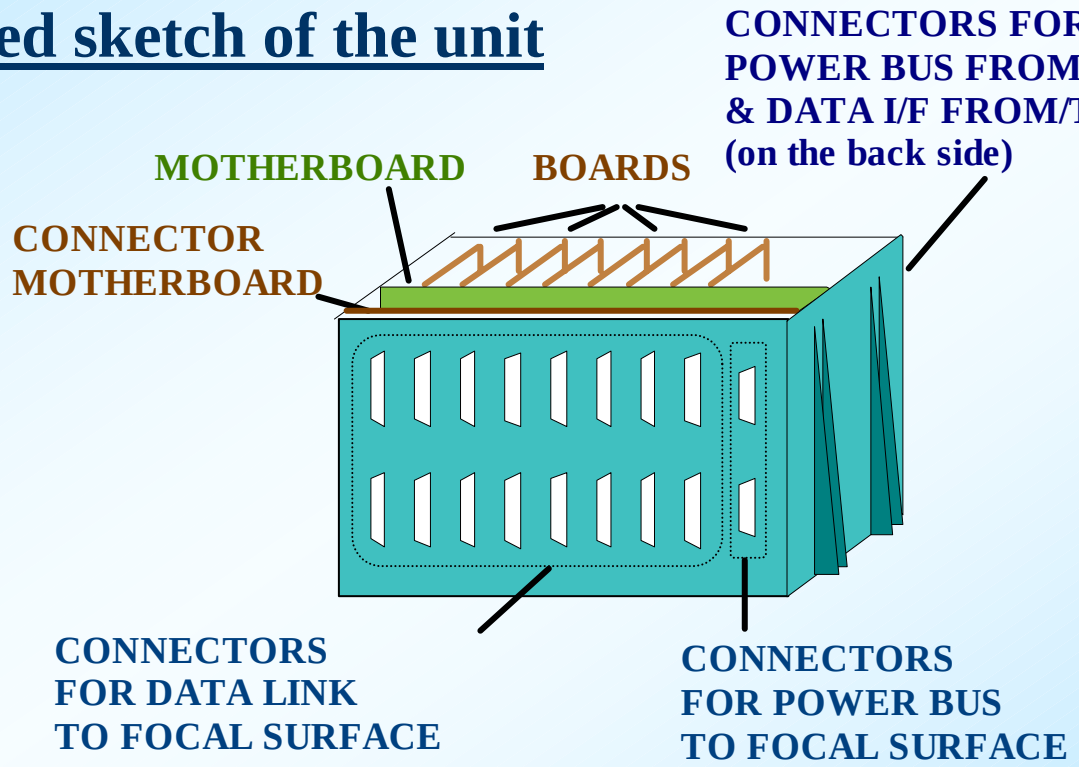
- TESTING AT SUBSYSTEM LEVEL IS LESS COMPLEX;
- THE DATA EXCHANGE PROTOCOL IS SIMPLER.
- EASIER FAULT ISOLATION

## BIDIRECTIONAL SERIAL BUS:

- THE NUMBER OF WIRES IS REDUCED;
- A DEDICATED BUS PROTOCOL IS REQUIRED;
- THE MANAGEMENT OF THE PDM's I/F's IS MORE COMPLEX.

# Control & Data Handling (CDH) Unit

## Simplified sketch of the unit



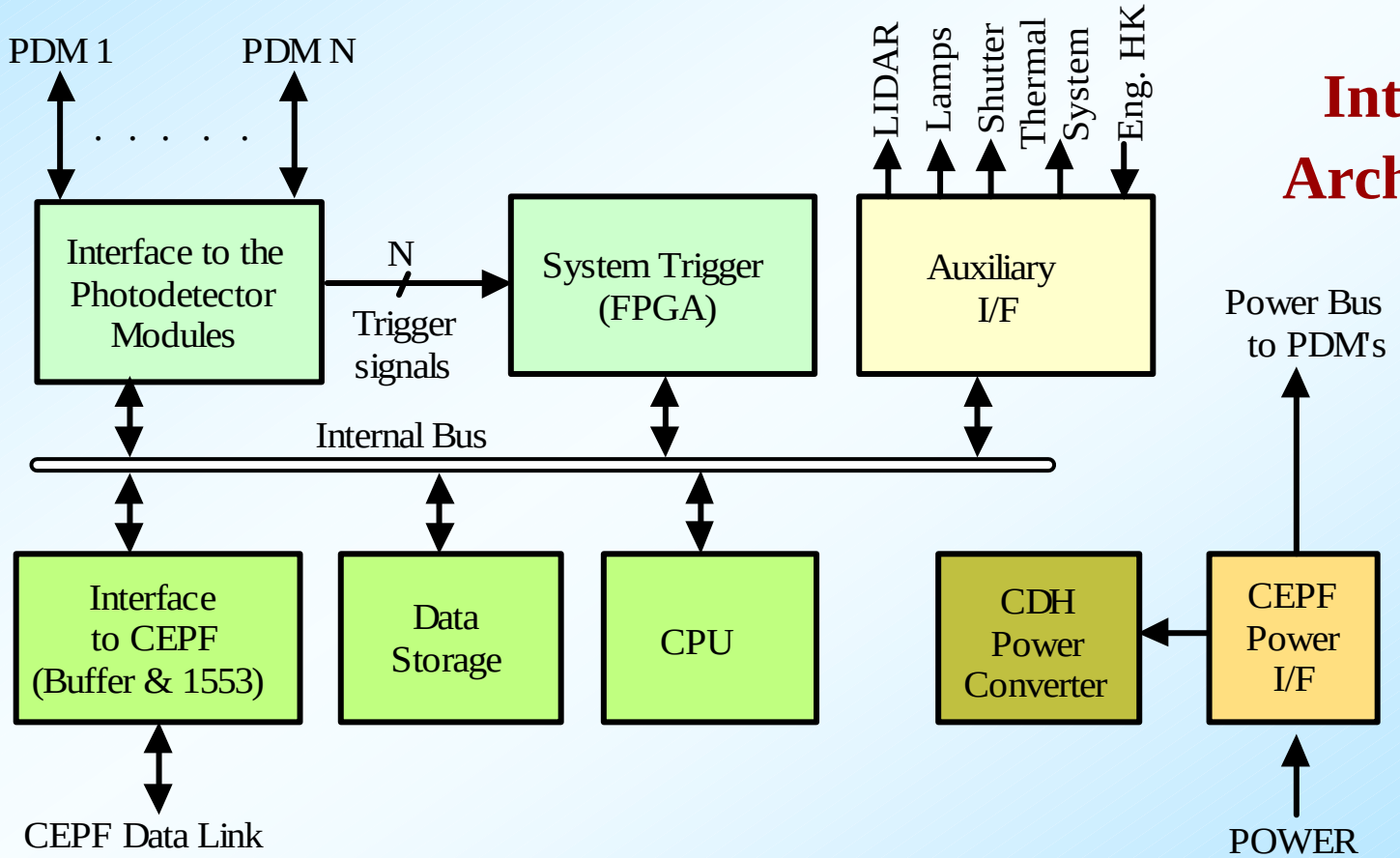

**Two identical units are planned in cold redundancy**

# Control & Data Handling (CDH) Unit

## List of the Main Functions

- Reception, validation, and execution of the TC's;
- Collection and evaluation of the scientific data, triggering at system level (dedicated application/scientific SW);
- Preparation of the scientific TM packets;
- Collection of the HK monitors and preparation of the HK TM packets;
- Storage of the TM packets;
- Management of the power distribution to the PDM's;
- Management of the settings (configuration) of the PDM's;
- Distribution of a programmable clock to the PDM's;
- Management of the shutter (actuators);
- Management of emergency situations;
- Management of the Thermal Control System (TBC).

# Control & Data Handling (CDH) Unit




## Internal Architecture

# Control & Data Handling (CDH) Unit

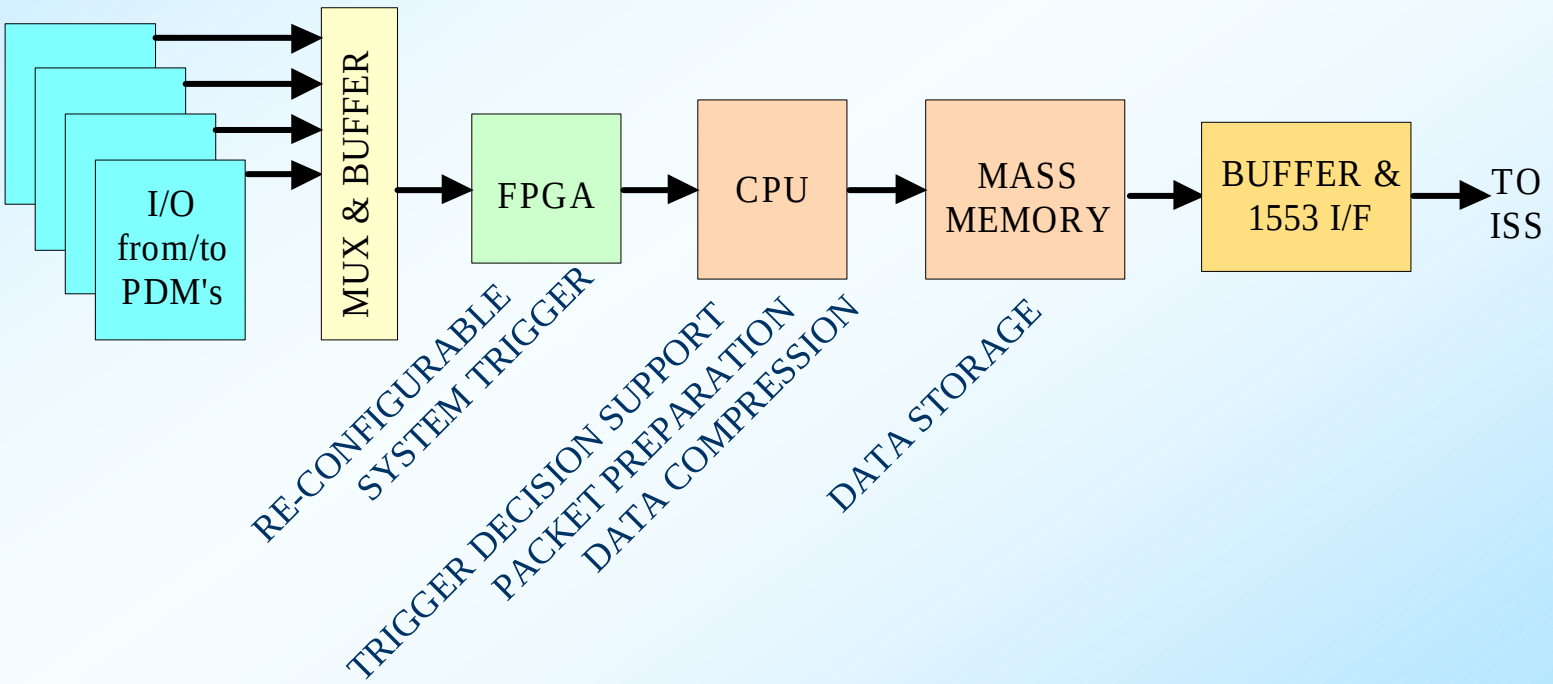
## List of the Main Features

- CPU suggested: ESA space-qualified **DSP TSC21020**
  - rad- tolerant;
  - 20 MIPS nominal;
  - 40 MFLOPS sustained;
  - 60 MFLOPS peak;

- Possibility of data compression;
- Mil-Std-1553 B interface to CEPF;
- SW reconfigurable trigger (FPGA);
- Quality level of EEE components: ESA SCC;
- Rad-tolerant components.

# Control & Data Handling (CDH) Unit

## Data Flow Diagram



# Telemetry Budget of the EUSO Instrument

## Assumption on main telemetry parameters

| Parameter | Value | Units | Notes |
|---|---|---|---|
| Downlink rate (minimum) | 300 | kbit/sec | ISS resource |
| Downlink duration | 600 | sec/orbit | orbit = 5400 sec |
| Downlink capability (minimum) | 180 | Mbit/orbit | |
| Allocated storage memory in CDH | 180 | Mbit | one orbit worth of data |
| EECR track duration (max) | 300 | GTU | GTU ≈ 1 uS |
| EECR storage requirements | 256 | bit/GTU·macrocell | X,Y, E & auxiliary info |
| Max memory needed per EECR event | 700 | kbit | 9 macrocells |
| Expected EECR (E > 3 10^19 eV) rate | ~ 10 | events/day | |

- The allocated telemetry storage resources largely exceed the euso needs for eecr observations;
- Additional needs can be fulfilled by dedicated strategies like on board pre-processing or data compression.