SPICA SAFARI
ICU DPU OBS

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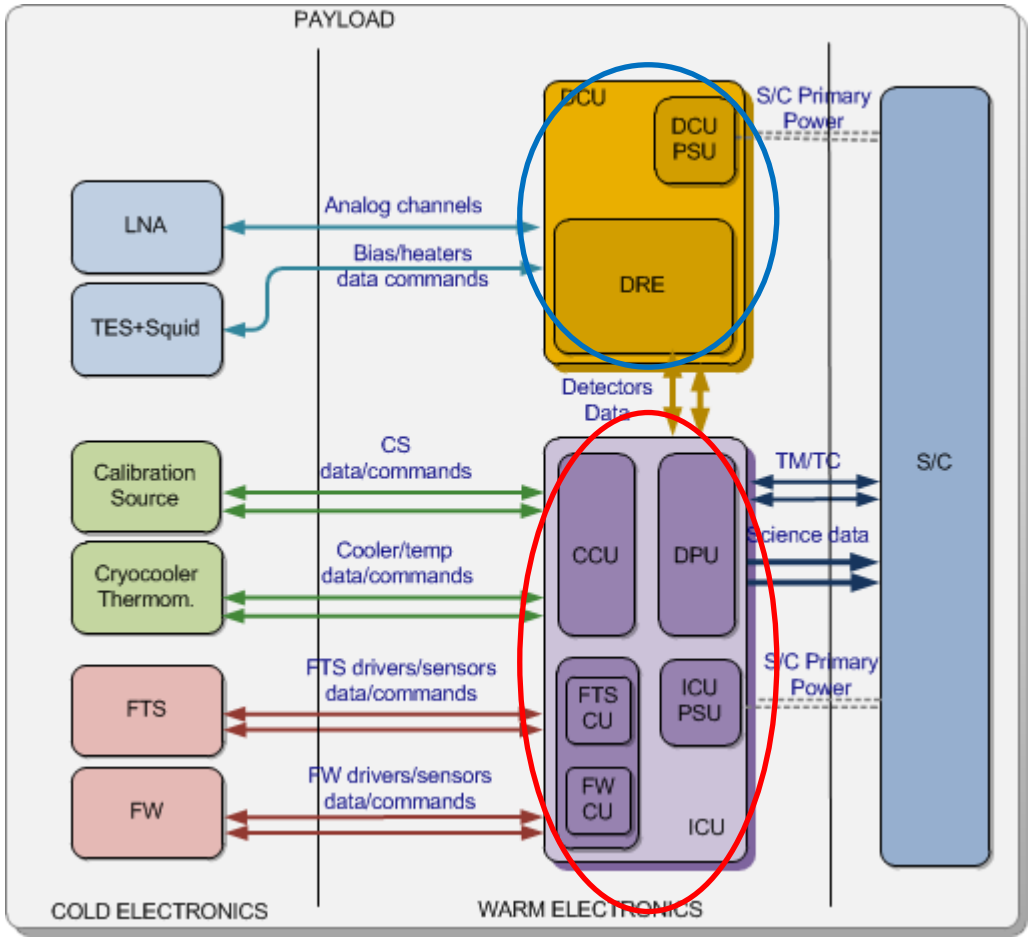
SAFARI Warm Electronics



DCU (Detectors Control Unit),
to drive the instrument TES detectors

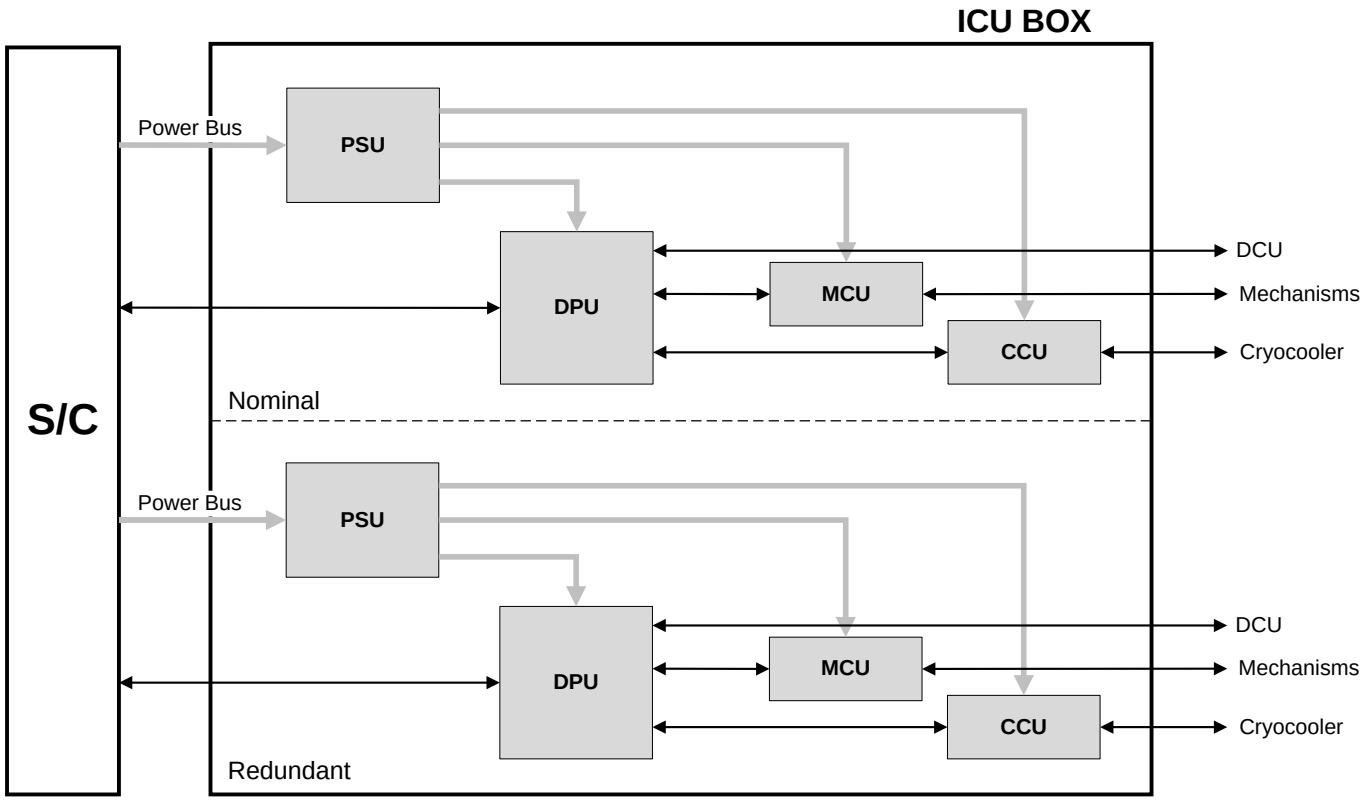
•DPU (Digital Processing Unit), to control the overall instrument and to implement the science data compression and packetisation.

•FTSCU (FTS mechanism Control Unit), to control the spectrometer scan mechanism

• FWCU (Filter Wheel Control Unit), to control the onboard filter wheel movements,

• CCU (Cooler Control Unit), to control the cooler and the instrument thermometry implementing an active thermal control and to monitor of the onboard calibration source;

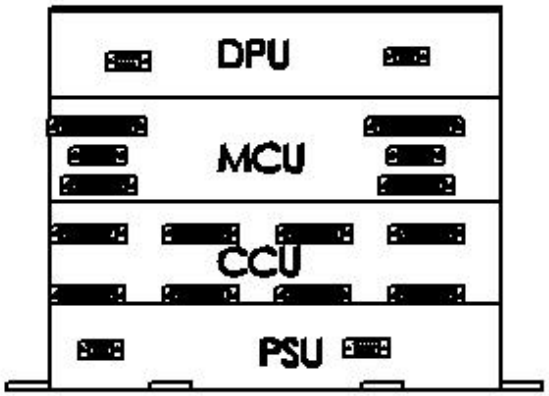
ICU Redundancy scheme

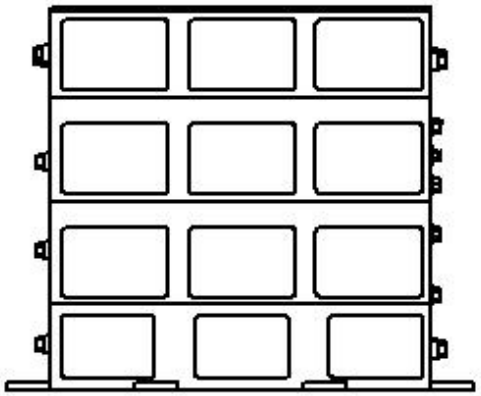


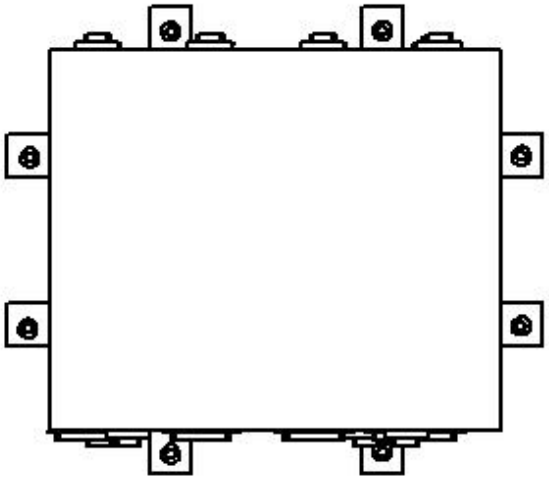
Cold redundancy.

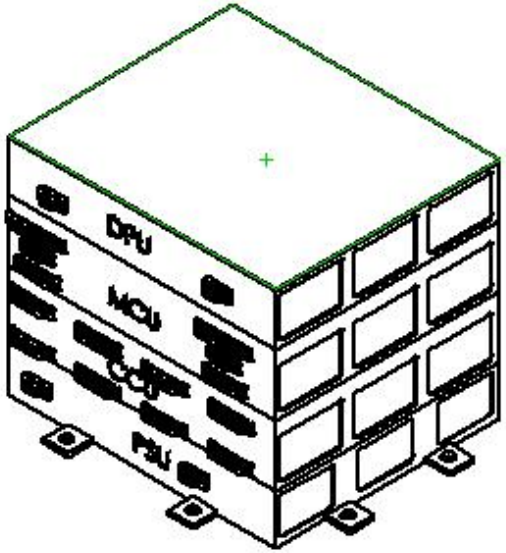
The two links towards DCU are cross-strapped inside DCU.

ICU mechanical design

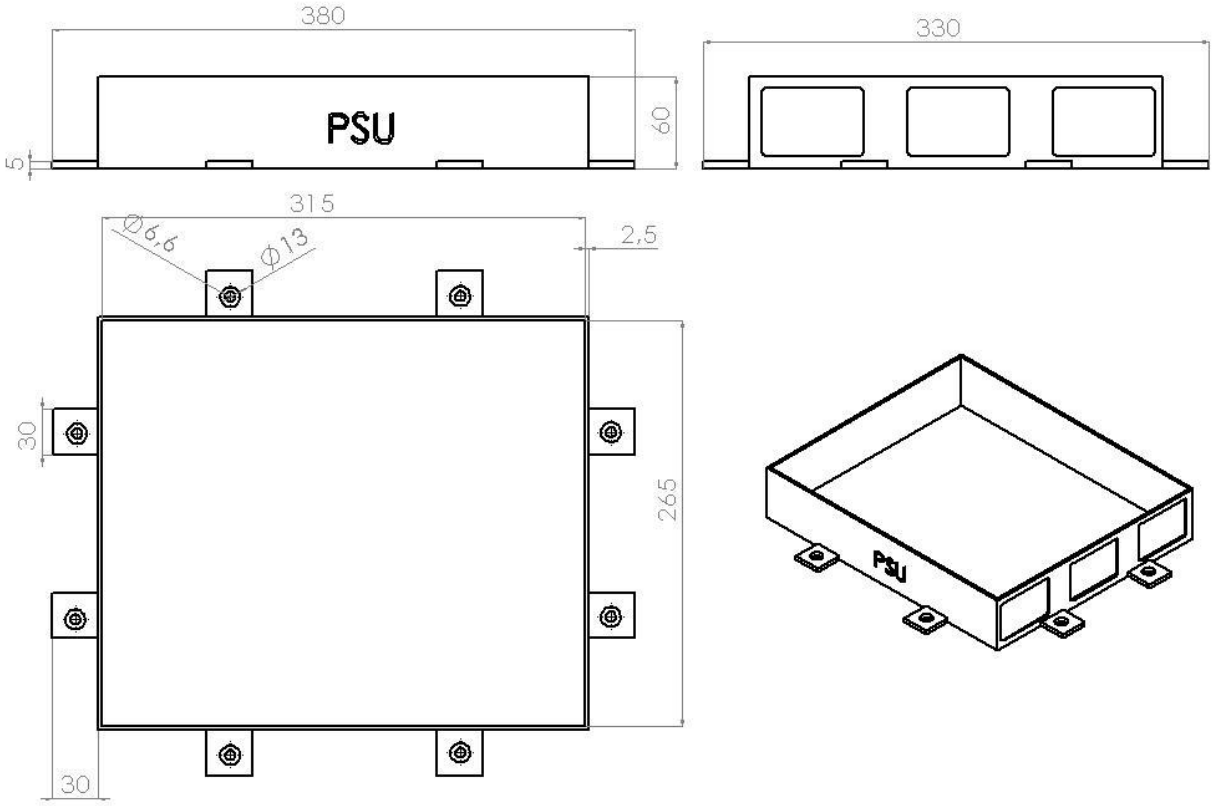






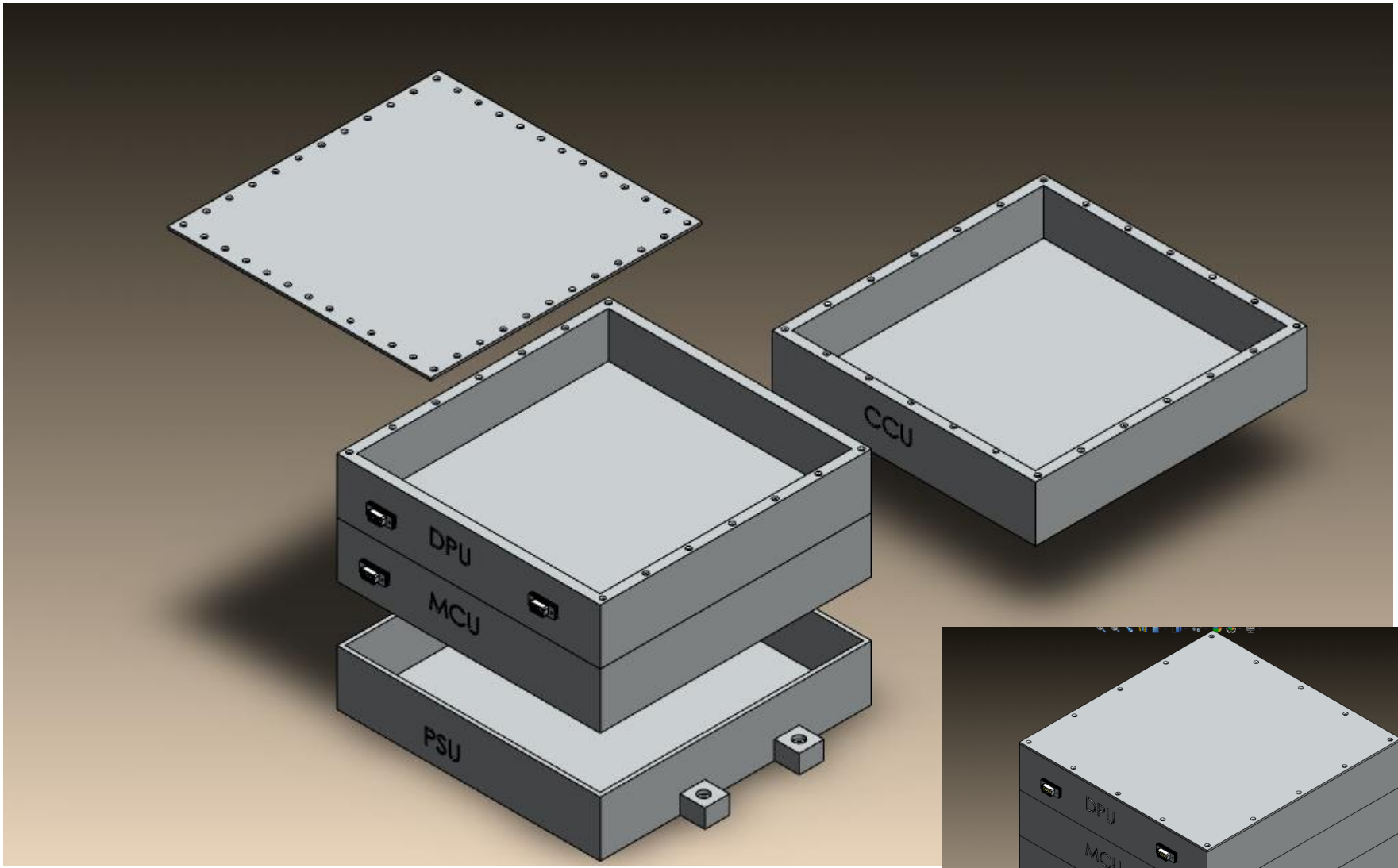


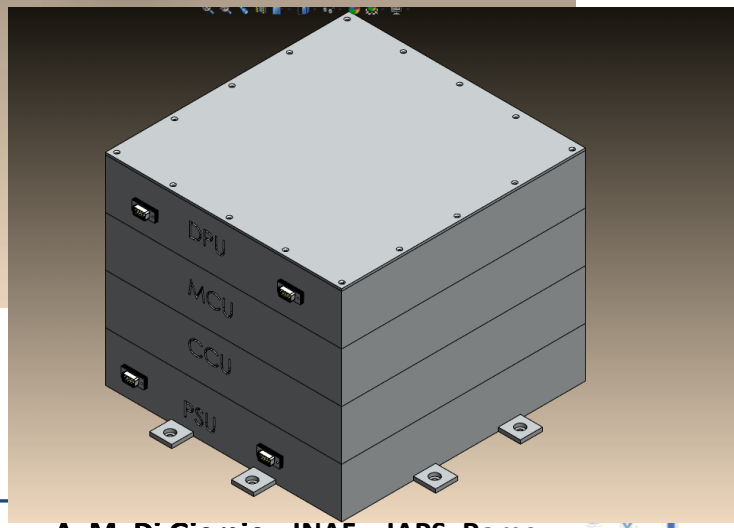
ICU mechanical design



Box material: aluminum Alloy,

A rough estimate of the box mass is about 5500g (cables, connectors, boards and electronic components not included)


CCU
DPU
MCU
PSU


DPU
MCU
CCU
PSU

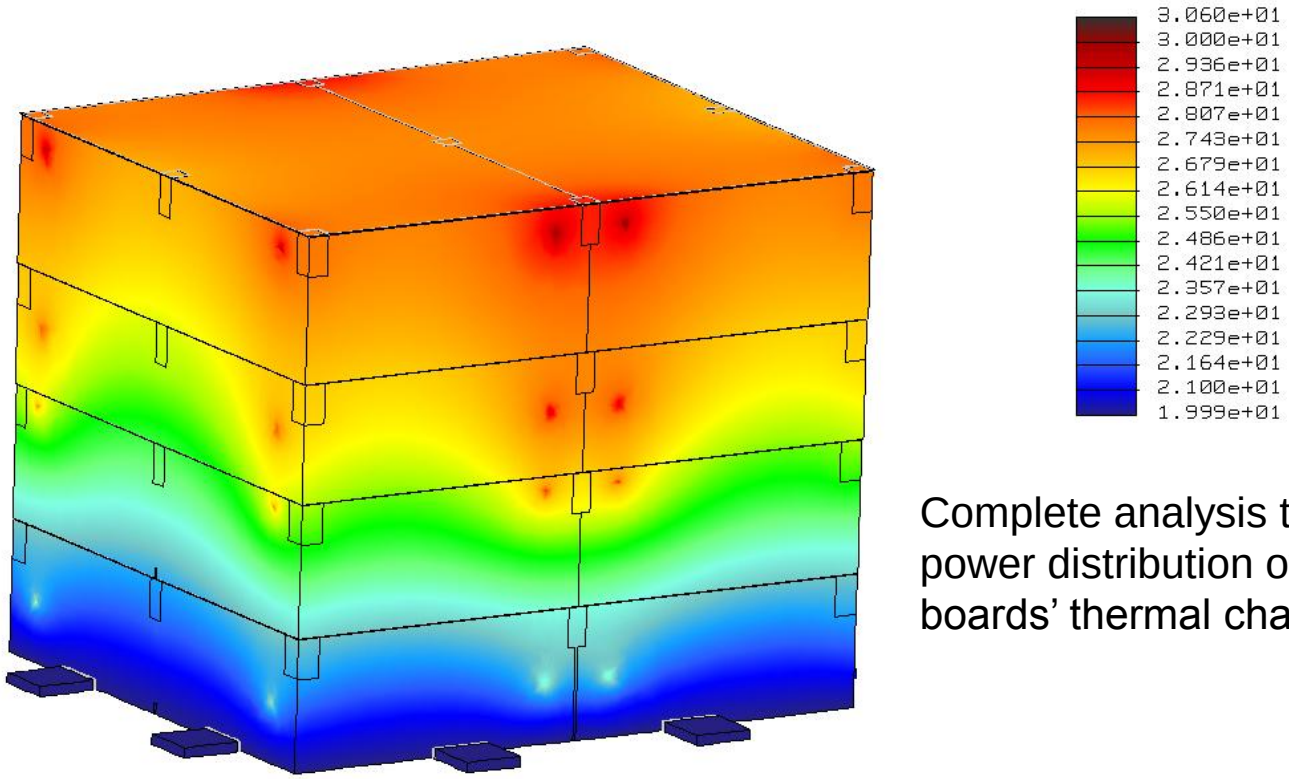
Mechanical characteristics

Warm Mass, total (with margin)	kg	**30.78**
DCU (Detector Control Unit)	kg	11.71
ICU (Instrument Control Unit: MCU, DPU, CCU, PSU)	kg	13.94
Margin	20%	5.13

ICU Dimensions	
Dimension	**Value(mm)**
Length	380
Width	330
Height	270

ICU thermal analysis

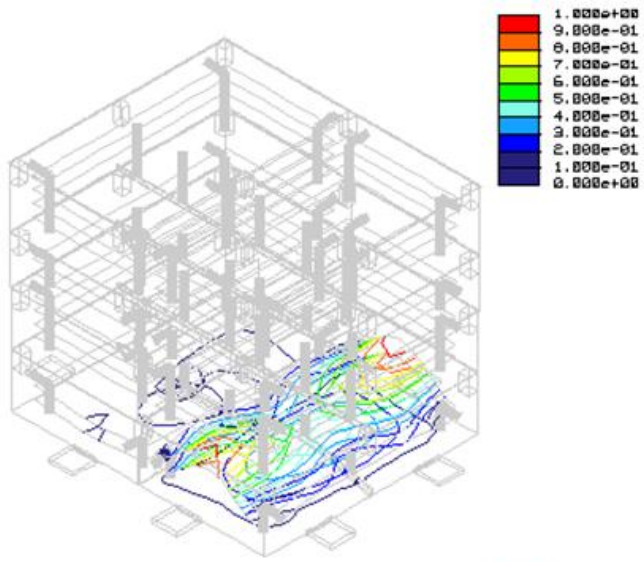
- Preliminary thermal analysis to predict the temperature distribution over the structure.
- The heat loads specified for each module have been applied at the mounting interfaces between boards and drawers.
- power dissipations increase from bottom to top. In the worst case the unit placed on top of the structure can be 10° warmer than the bottom one: the units with an higher power budget shall be placed on the bottom.

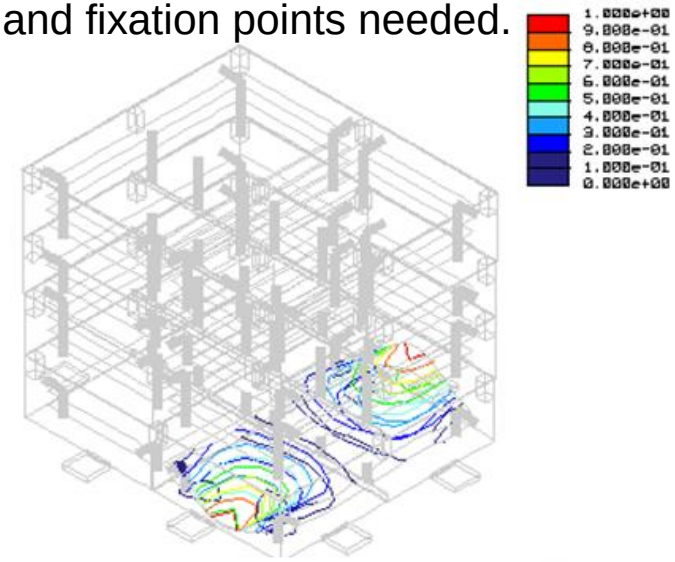


Complete analysis to be done with the actual power distribution over the boards and the boards' thermal characteristics.

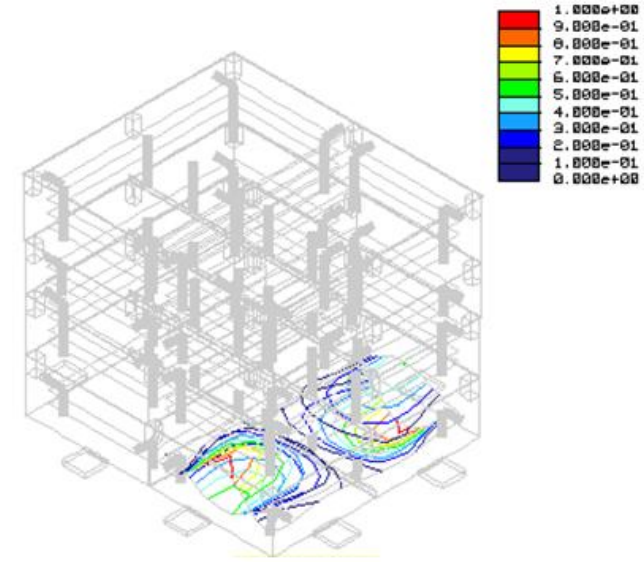
ICU Structural analysis

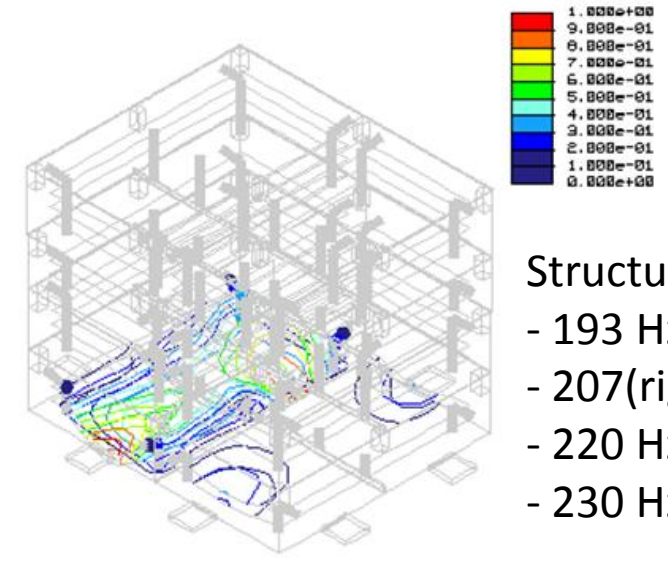
Preliminary structural analysis to verify the compatibility with the stiffness and strength requirements→ additional stiffening ribs and fixation points needed.





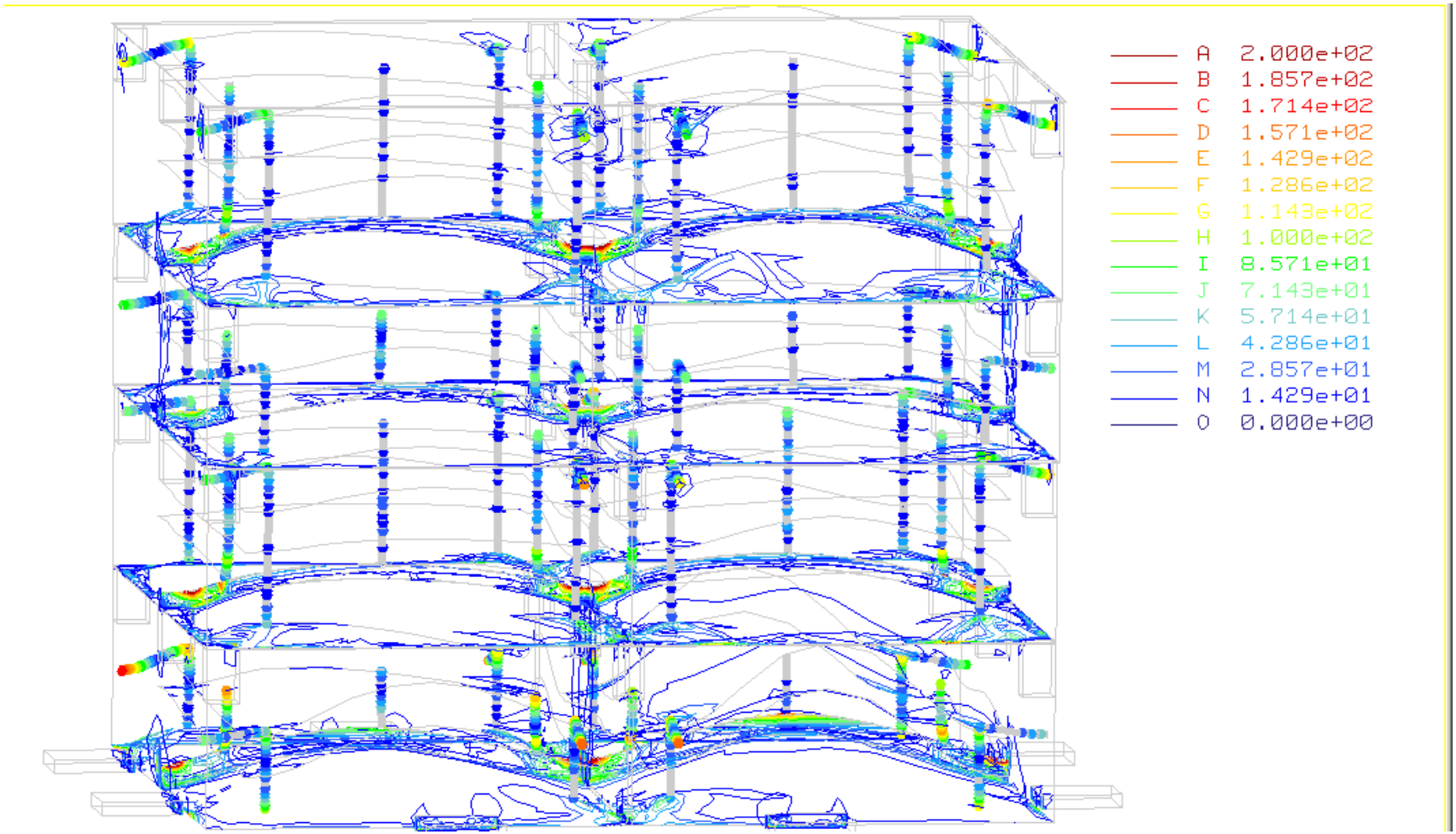
MODULE	MASS [kg]
PSU	3
CCU / MCU	2.4
DPU	1.3





Structure vibration modes: -
- 193 Hz (left, top),
- 207(right, top),
- 220 Hz (left, bottom),
- 230 Hz (right, bottom).

Von Mises stresses computed on the structure, Y loading direction



The maximum Von Mises stress of 200MPa was computed in the normal direction to the interface plane It is well within the yield stress of the Al 7075 that is assumed as reference for the structural components.

DPU requirements

Data rates:
SPICA will have a DTCP of at least 8 hours, with a telemetry budget 30 GB/day.
20 (TBC) observ. hours, available rate: 30/20/3600*8 = **5.2 Mbit/s.**
- Science data
- housekeeping data (status values sent independent of the science data)
- metrology data (timing and positional parameters needed to interpret the detector data)

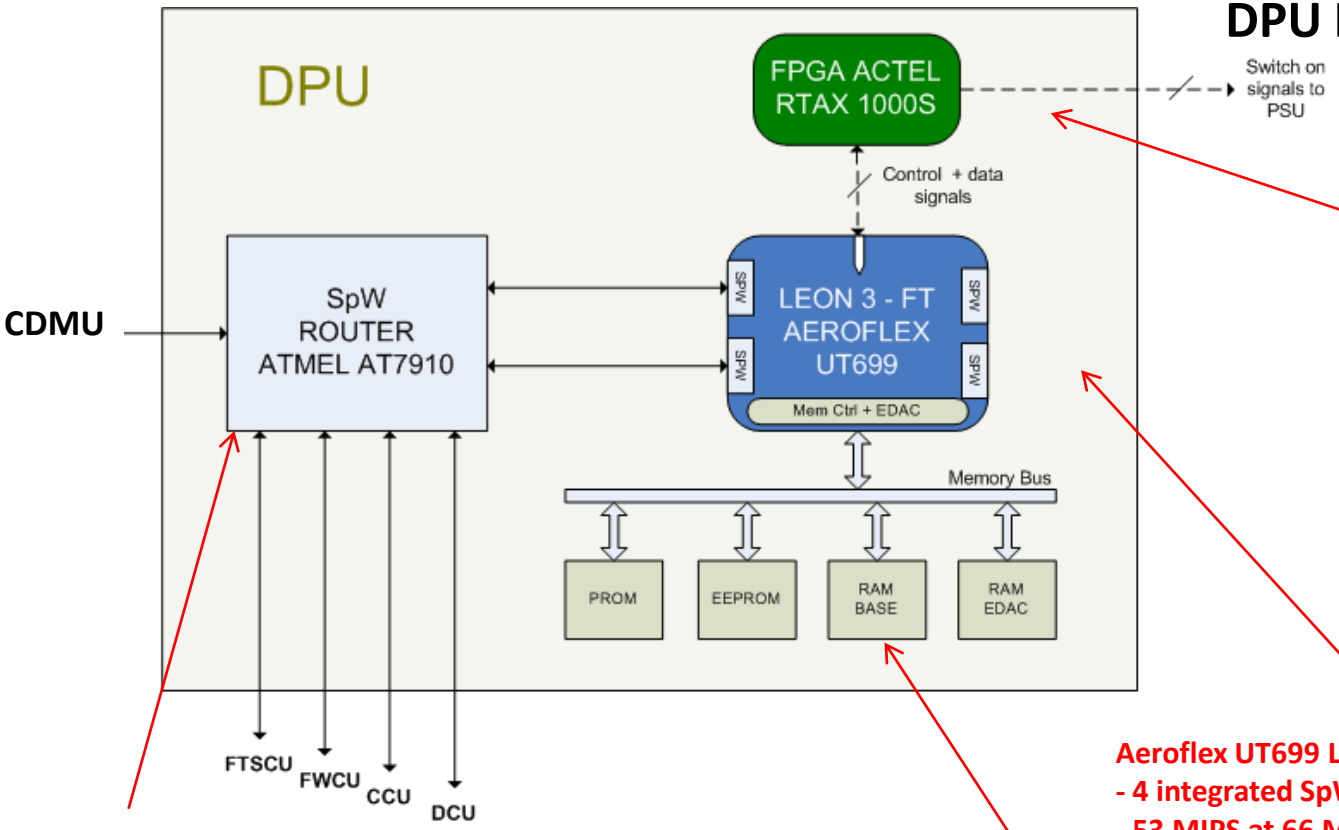
Expected detectors (DCU) data rate: 6-12Mbps (TBC)
HK data rate: - max rate 1kHz data from MCU

Science Data Compression on board is necessary.
→ Lossless Compression - Collaboration with University of Wien

Buffering: compression algorithm dependent.
Processing: compression algorithm dependent.

Preliminary compression tests started in the past month on the first set of simulated interferograms.

DPU High level architecture



Small capacity Actel FPGA to implement additional logic:
- control signals for subsystems switch ON/OFF
- DPU board HW monitoring functions
- DPU board reset (TBC)

Aeroflex UT699 Leon3-FT processor:
- 4 integrated SpW ports, two of which supporting RMAP
- 53 MIPS at 66 MHz clock frequency:
WARNING: can be insufficient if science data rates from DCU highly exceed 4 Mbits/s (=> compression algorithm with a CPU load greater than 20-30 MIPS)

Atmel AT7910 SpW Router connected to the external SpW links and to Leon processor
-Time Codes from SPICA network automatically propagated to all the Safari units, as required by the internal synchronization scheme
- non-blocking crossbar switch connecting any input port to any output port
- the 8th SpW port of the Router can provide a second connection to CDMU (if crossed strapping required) or a third connection to the Leon (to improve bandwidth)

Estimated memory requirements:
- PROM: 256 kB
- EEPROM: 3 MB
- SRAM: 40 MB (32 + 8 for EDAC redundancy)

DPU On Board Software

•Telemetry and Telecommand exchange with the S/C

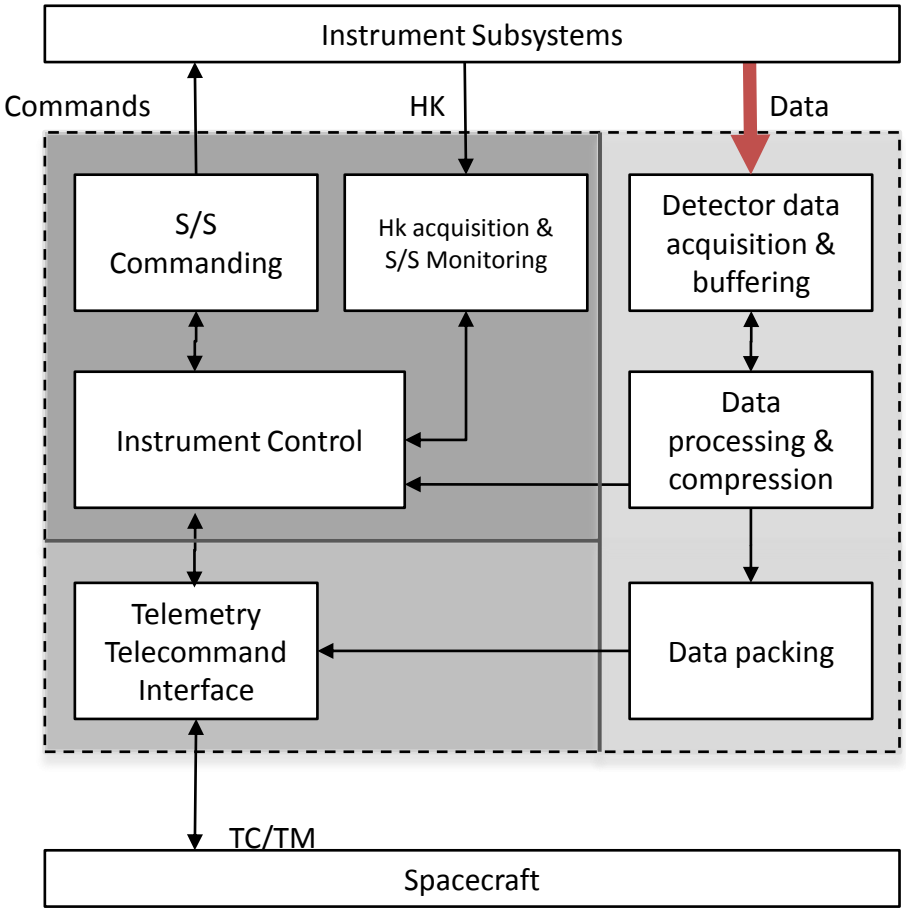
•Instrument Commanding, based on the received and interpreted TCs, in agreement with the current instrument operating mode (implementation of detectors calibration procedures based on DCU data TBC)

•Instrument monitoring and control, based on the Housekeeping data (HK) acquired from the other instrument units

•Detectors readout data acquisition, pre-processing and formatting according to the selected Telemetry protocol

• On board time management and synchronization of all the instrument activities

•On board Memories management



SAFARI On Board Software

1. **DPU OBS (Instrument Control and data processing/compression)**
2. **MCU OBS (FTS/FW control)**
3. **Common Layer SW (Boot SW, FDIR, OBSM, On board time handling)**

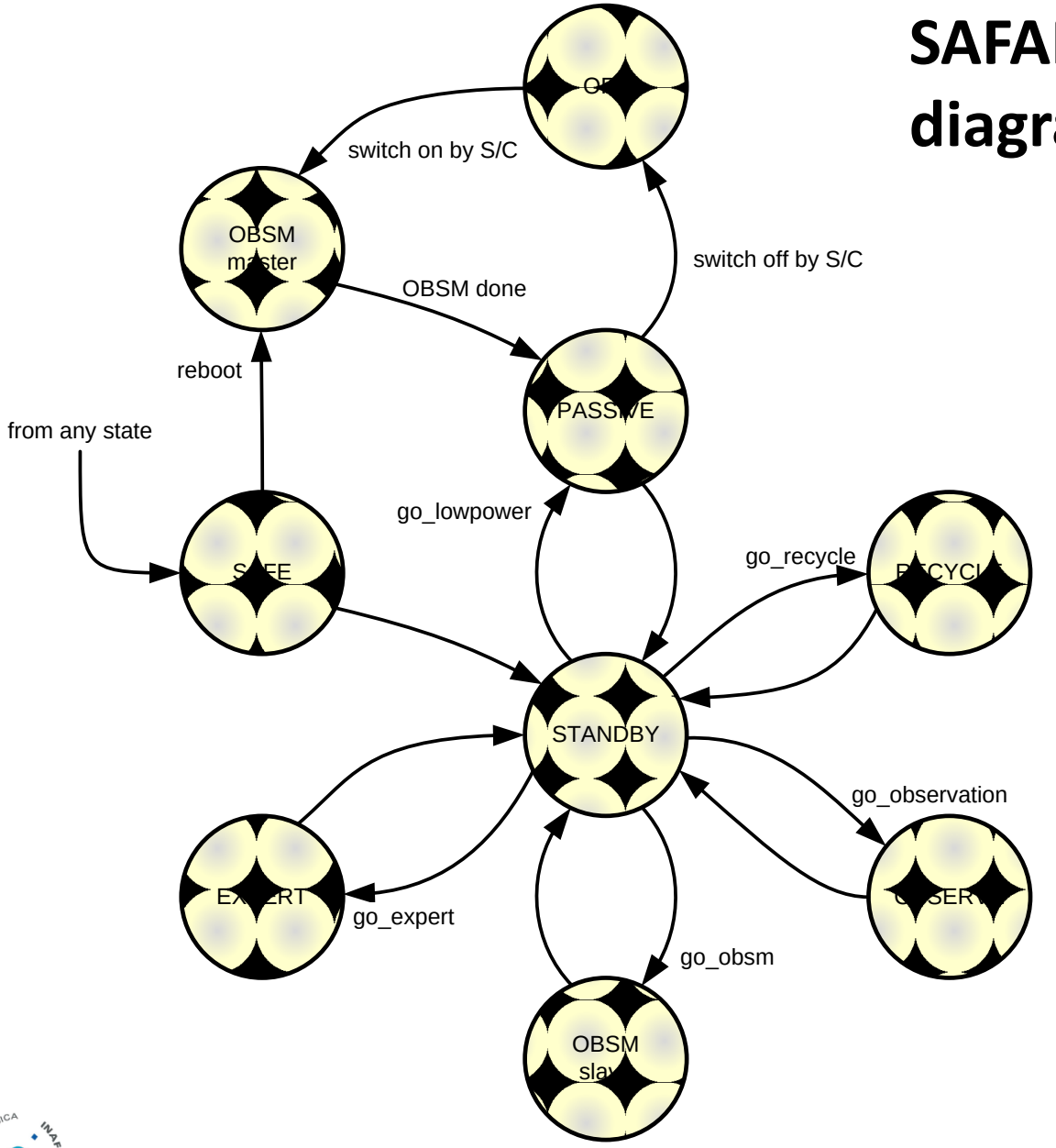
•RTEMS operating system (RTEMS, Real-Time Executive for Multiprocessor Systems, real-time operating system designed for deeply embedded systems, free open source, supports multi-processor systems, Multitasking capabilities, dynamic memory allocation)

•C++ language for application software

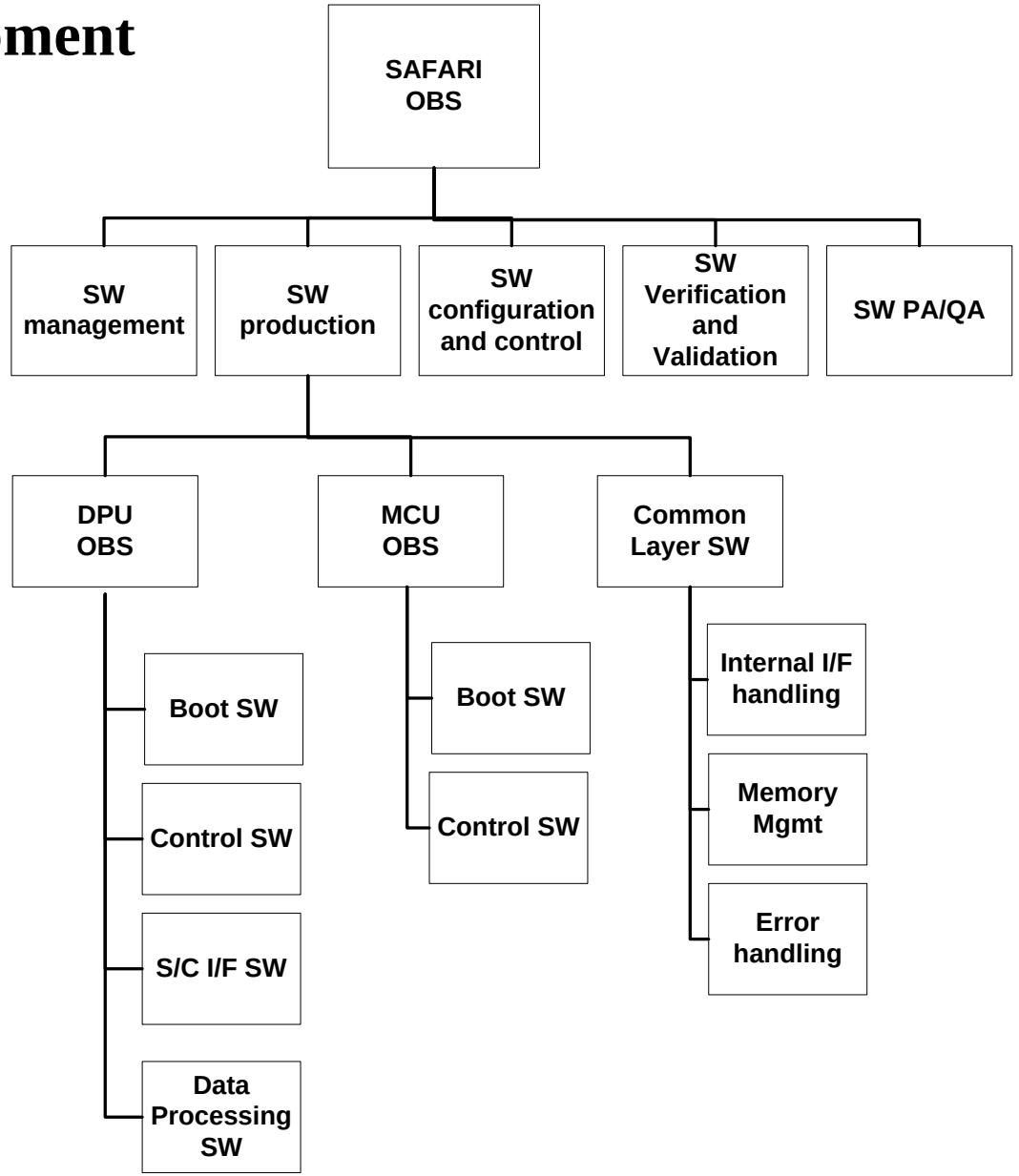
•All SWs to be compliant with a common PA/QA Plan: in particular the adoption of a common configuration control tool, a common naming convention and a common software problems tracking system is foreseen.

•A common format to exchange software images will be adopted (e.g. ICD14 standard, TBC).

SAFARI Mode transition diagrams



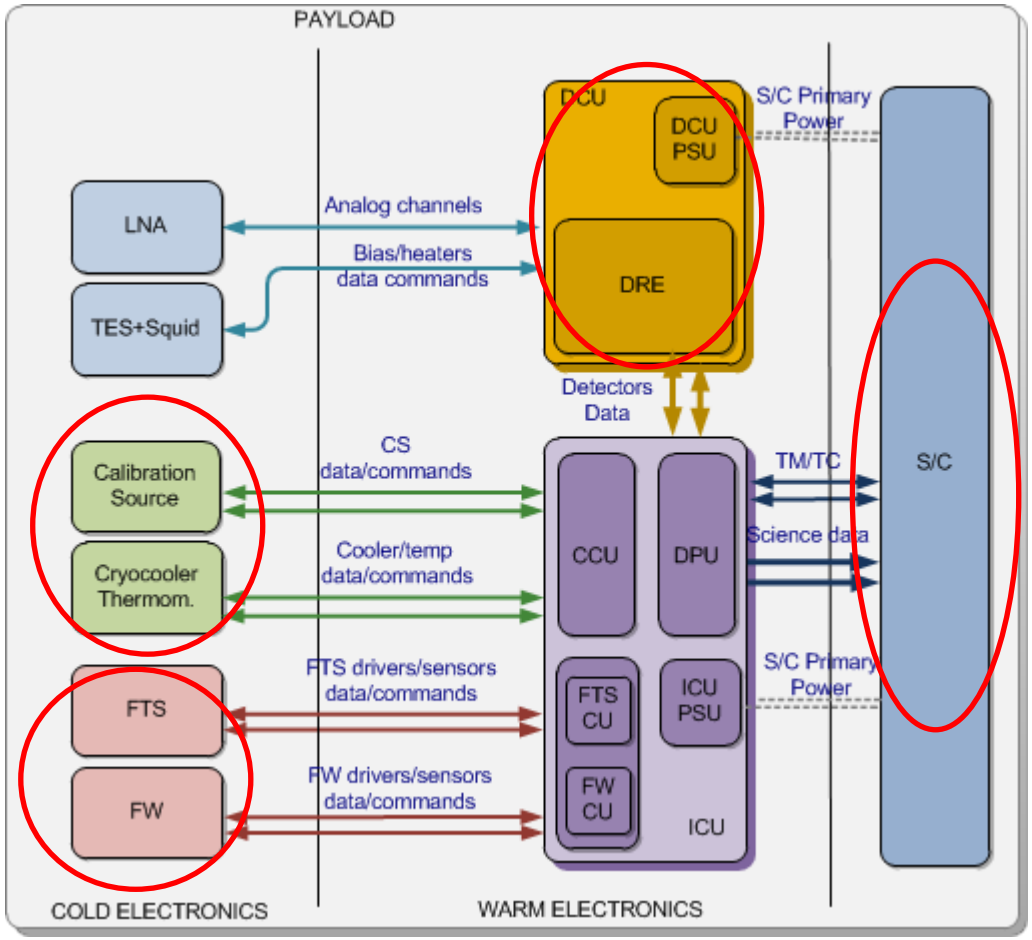
OBS development

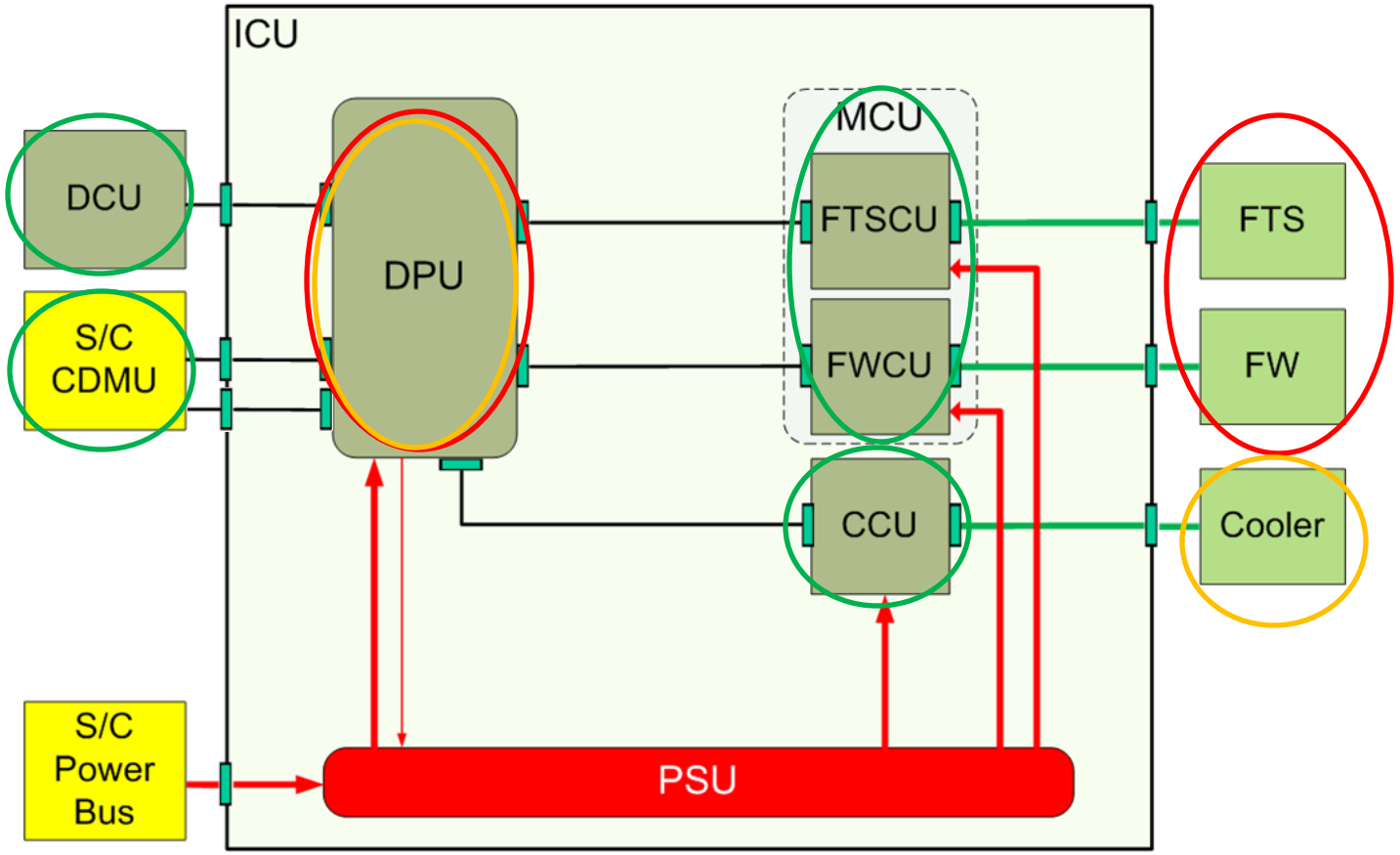


ICU Testing

S/C CDMU simulator
Mech. Simulators

DCU Simulator
Calib source/therm simulators





DPUtesting:

S/C CDMU simulator
DCU Simulator
MCU simulator(s)
CCUsimulator

MCUtesting:

DPU Simulator
Mech. simulator(s)

CCUtesting:

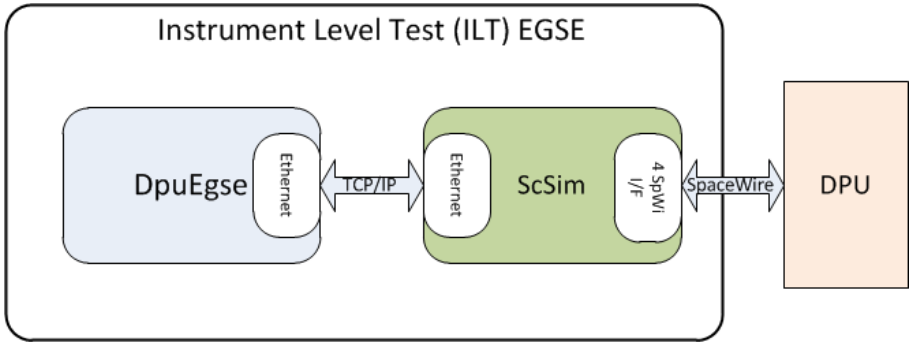
DPU Simulator
Cooler/Temp simulator(s)

Local EGSE

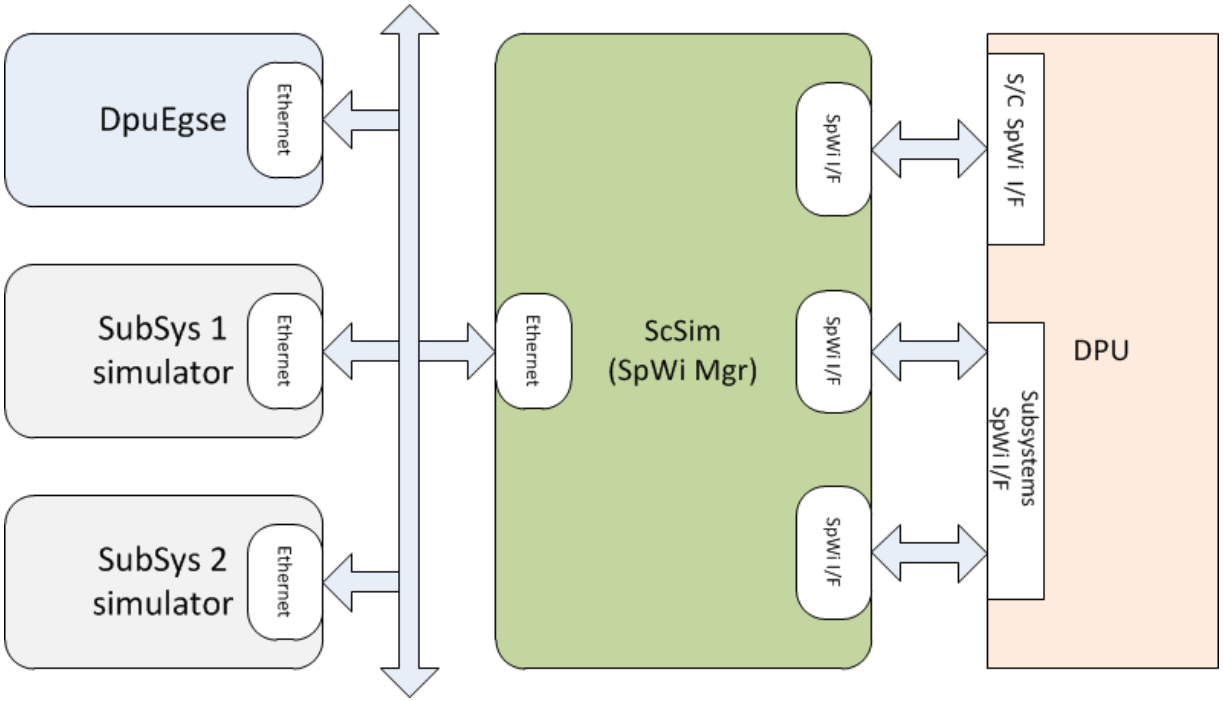
Client/Server configuration

The local EGSE consists of two programs modules linked via standard TCP/IP socket in a server-client configuration:

- The **Spacecraft simulator** program ScSim (server) which communicate with the DPU via a Space-Wire I/F and with the Dpu Egse via a TCP/IP socket. This program manage the Space-Wire communication protocol by means of a *PCI SpaceWire board from SkyLab*.
- The **DPU EGSE** DpuEgse (client) sends telecommands and receives telemetry to/from the DPU via ScSim. The program sends predefined telecommands sets and receives (display and store) the DPU telemetry by means of a script-like interpreted sequence of commands.



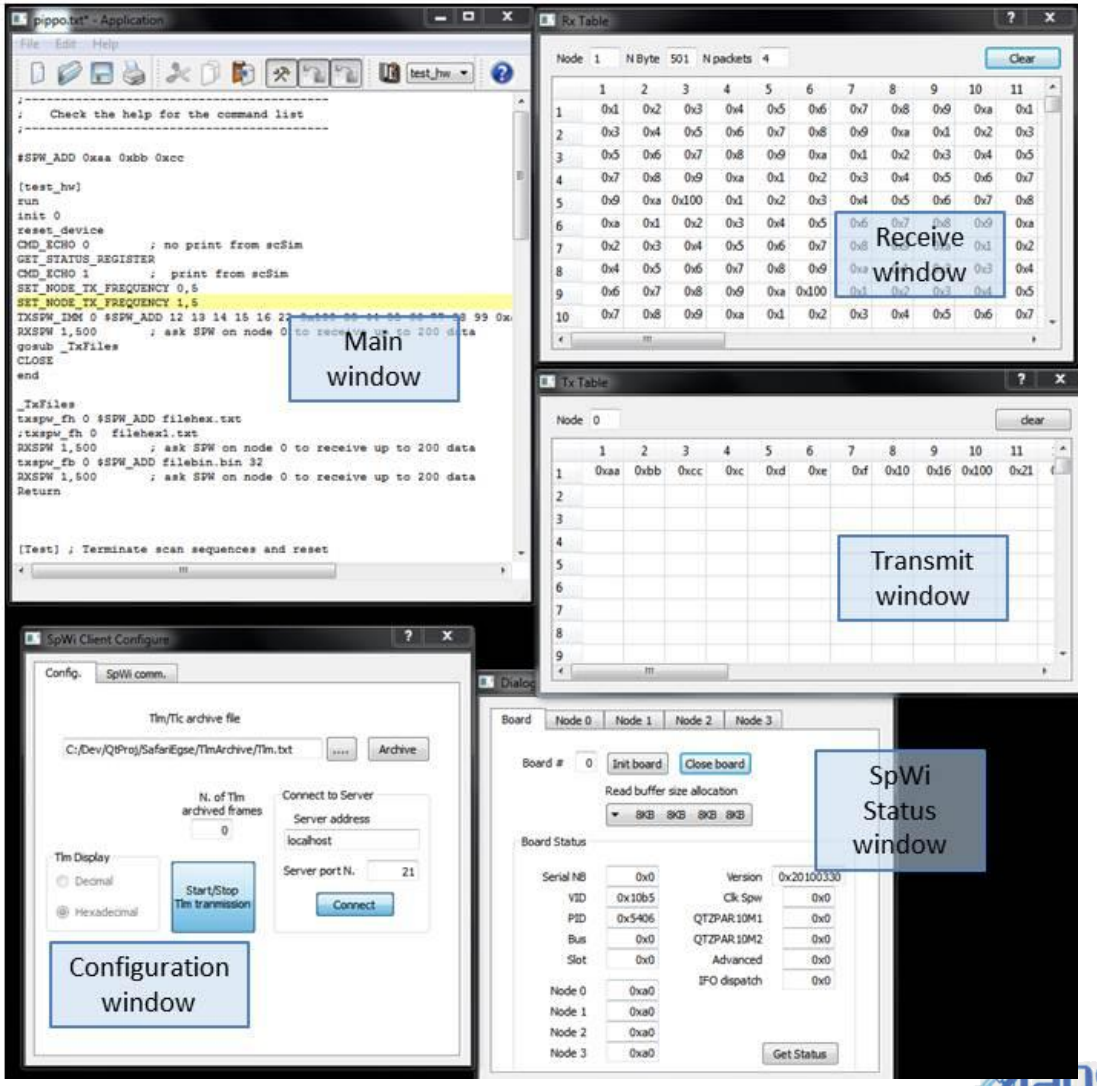
- Due to the TCP/IP socket, the two programs may run on different network connected computer.
- Another advantage of the server-client architecture is that other clients can connect to the ScSim (which acts as a Space Wire manager) using one of the **four** SpW nodes of the SkyLab board, so that it is possible to simulate also the other DPU SpW connected subsystems in SAFARI.



http://pptt4.ifsi-roma.inaf.it/~cerulli/safariEgse/index.html

DpuEgse(client)

The main window shows several “procedures” in a script-like language used to control the DPU.
The other four windows display auxiliary information on SpWi status and Tlc/Tlm contents



ScSim (server)

Here is the server GUI with the main window, the SpaceWire configuration window and a monitor window for the data flow with the SpW board.