



# DRCU Design and Interfaces

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# Overview

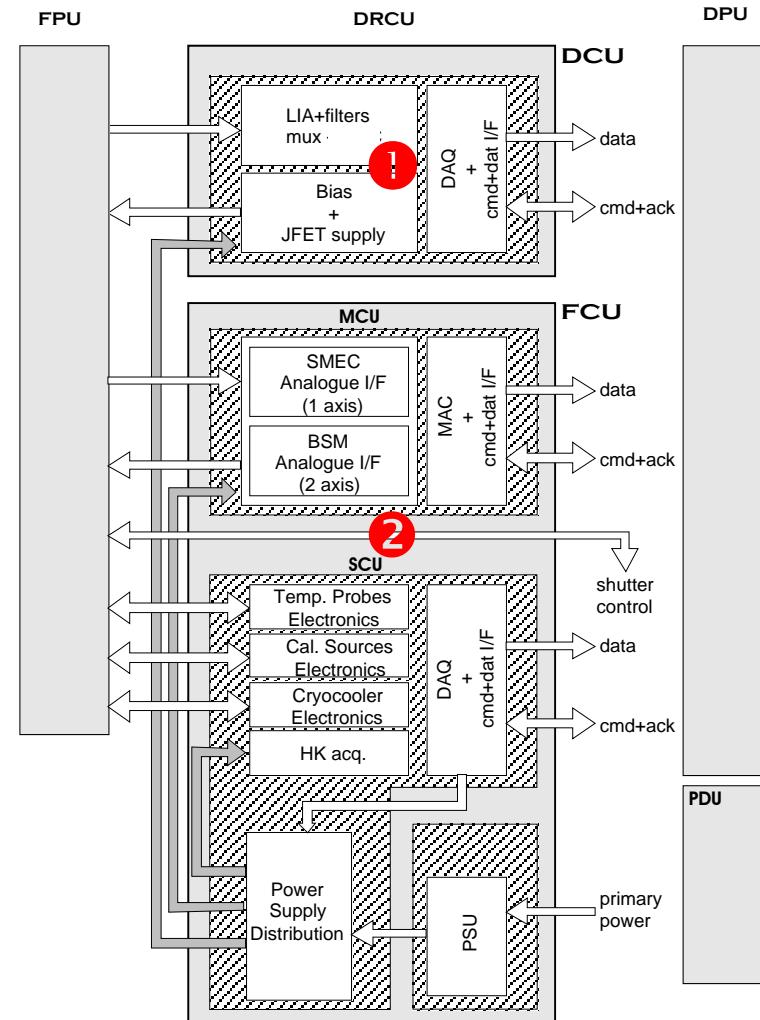
- The **DRCU** is a two box units:
  - The **FPU Control Unit** comprises
    - The FTS and BSM associated electronics which constitutes the Mechanisms Control Unit
    - The Calibrators, cooler and thermometer associated electronics along with the power control functions which constitutes the Subsystems Control Unit
    - The Power Supply
  - The **Detector Control Unit** comprises analog and digital electronics exclusively devoted to bolometers operation
- The **WIH** comprises all DPU to FCU and DCU harnesses and DRCU subsystem power distribution harnesses

# Block Diagram

① The Detector Control Unit

② The FPU Control Unit

- ◆ The Mechanisms Control Unit
- ◆ The Subsystem Control Unit
- ◆ The Power Supply Unit





# DCU Specifications (1)

- **Analog Processing channels**

- **Functions** : receive, amplify, demodulate & filter bolometer signals
- **336** total number : 288 for photometer & thermometer + 66 for spectrometer
- **Specifications:**
  - gains:
    - **Photometer : 375**
    - **Spectrometer : 265**
  - Input signal bandwidth:
    - **Photometer : 0.1 to 5 Hz**
    - **Spectrometer : 0.1 to 25 Hz**
  - Input noise  $\leq 7$  nV rms/rt(Hz)



## DCU Specifications (2)

- **Analog Processing channels ...**
  - Signal dynamic
    - **Photometer : 270 000**
    - **Spectrometer : 170 000**



## DCU Specifications (3)

- ***Bias generators***

- **Functions** : generate AC and DC biases for bolometers and JFETs
- 2 types are defined:
  - Adjustable AC biases:
    - Photometer: 1 sine generator / 4 channels with independent amplitudes
    - Spectrometer: 1 sine generator / 2 channels with independent amplitudes
  - Adjustable DC biases (with on/off command):
    - Photometer: 12 generators for JFET + 1 for heater
    - Spectrometer: 3 generators for JFET + 1 for heater



## DCU Specifications (4)

- ***Bias generators ...***

- Specifications:

AC bias

- Voltage range is 0 to 200 mV rms for bolometers and 0 to 500 mV for thermometers
- Accuracy: 1 mV ( equivalent to 8-bit DACs)
- Frequency range: 50 to 300 Hz

DC bias

- Voltage range (Vss): 0 to -5 V
- Output current: 5 mA max



## DCU Specifications (5)

- **Data acquisition & DPU interface**
  - **Functions:** digitize signals (from bolometers & H/K parameters), built / transmit data formats, receive / decode low-level commands.
  - **Specifications:**
    - Digitizing resolution: 19 bits (16-bit ADC + 4-bit offset)
    - Frame rate : 1 to 1/256 of AC bias frequency (max. 300 Hz)
    - Frame acquisition time  $\leq 3$  ms
    - Data formats and Command are defined in DRCU ICD
    - Electrical interface : RS422





# SCU Specifications (1)

- **Cooler Control Electronics**

- **Functions** : provide cryo-cooler heaters (gas switches + sorption pump) and FPU temperature stabilization heater with biases
- **Specifications** :
  - Heater bias :
    - 4 channels
      - » 1 high power : 0 to 500 mW (pump recycling)
      - » 3 low power : 0 to 200  $\mu$ W (gas switch+temperature stabilization)
    - Adjustable over 4000 steps

## SCU Specifications (2)

- ***Temperature probe electronics***
  - **Functions** : provide biases for temperature probes and digitize
  - **Specifications** :
    - Temperature probes :
      - 16 total channel number :
        - » 2 for "300 mK" range
        - » 14 for measurement above 1 K
      - 16-bit digitization
      - DC or AC (square) generators in the range 0.1  $\mu$ A to 10  $\mu$ A

## SCU Specifications (3)

- **Calibrators Control Electronics**

- **Functions** : provide biases for calibrator blackbodies, monitor voltage & current across the resistors
- **Specifications**:
  - Current bias:
    - 3 channels
      - » 2 point sources : 0 to 10 mW (into  $R_{bb}=200 \Omega$ )
      - » 1 flood source : 0 to 7 mW (into  $R_{bb}=200 \Omega$ )
      - » Time constant (PCAL) :  $\leq 6$  ms
      - » Stability/repeatability: max. of 5  $\mu$ A or 0.5%
    - Adjustable over 4000 steps



## SCU Specifications (4)

- **Power Distribution Electronics**

- **Functions** : provide sub-systems with power supply on/off switching and DCU main/redundant power switching
- **Specifications** :
  - 18 individual lines to be interrupted
  - 8 groups of power lines to be interrupted independently:
    - DCU\_LIA\_P
    - DCU\_LIA\_S
    - DCU\_DAQ
    - DCU\_BIAS\_P
    - DCU\_BIAS\_S
    - MCU\_MAC
    - MCU\_SMEC
    - MCU\_BSM



## SCU Specifications (5)

- ***Data acquisition & DPU interface***
  - **Functions:** collect digitized signals (from temperature probes & calibrators), digitize HK parameters (secondary supply voltages), built / transmit data formats, receive / decode low-level commands.
  - **Specifications:**
    - HK Digitizing resolution: **8 bits**
    - Data formats and Command are defined in DRCU ICD
    - Electrical interface: **RS422**



# PSU Specifications

- **Functions** : provide DRCU sub-systems with secondary power supplies from S/C power bus
- **Specifications** :
  - Secondary voltage normalized to +/- 9 V("analogue") and 5 V "digital") except for MCU
  - All power returns are isolated (DC/DC converter side)
  - Efficiency better than 70%
  - Power interface with S/C : compliant IID-A §
  - Running frequency : synchronized by space-craft CDMU synchronization signal
    - N x 131 kHz
    - Sync. electrical interface is tbd (likely diff. receiver)

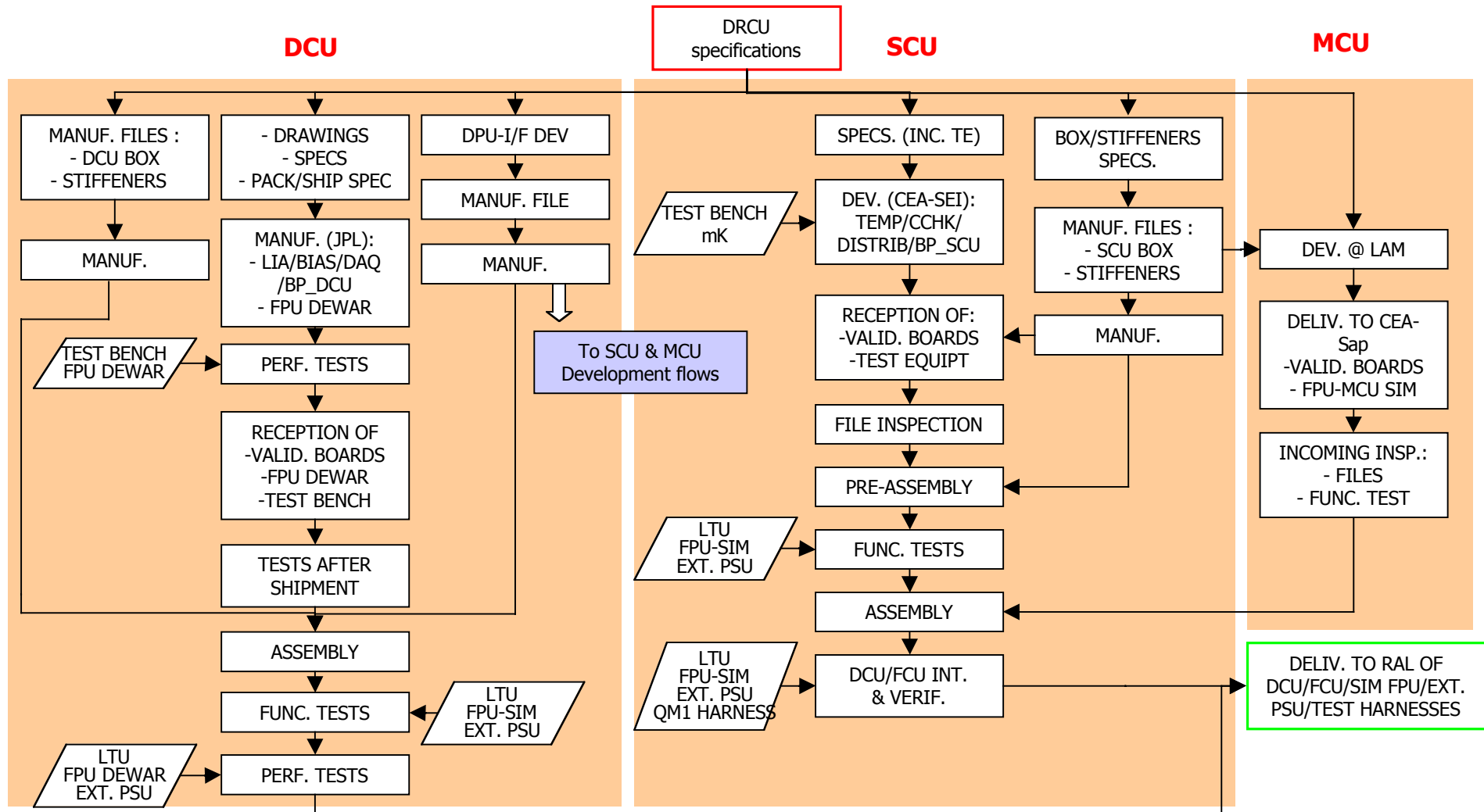


# MCU Specifications

- ***See dedicated presentation ...***



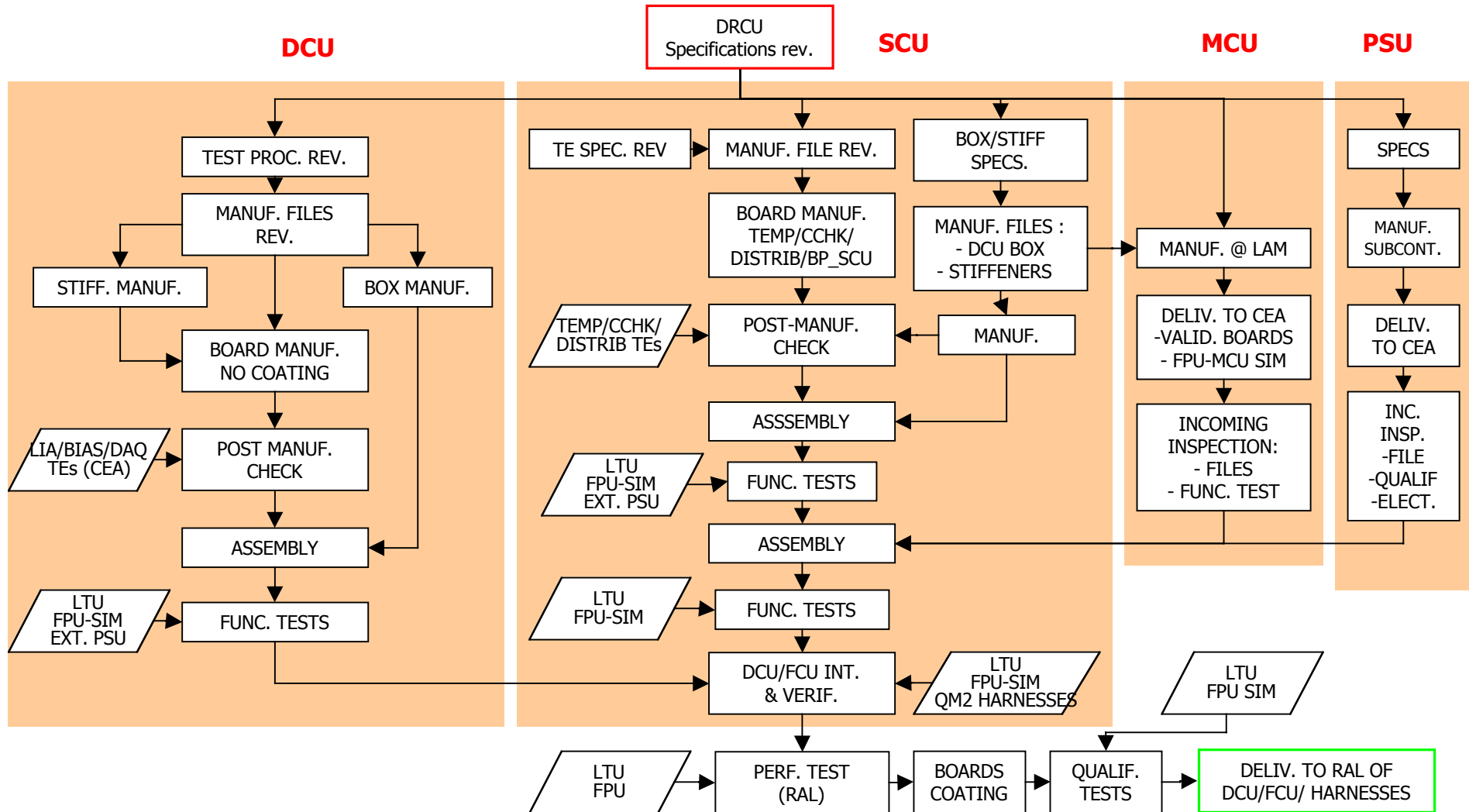
# Development Plan (QM1)





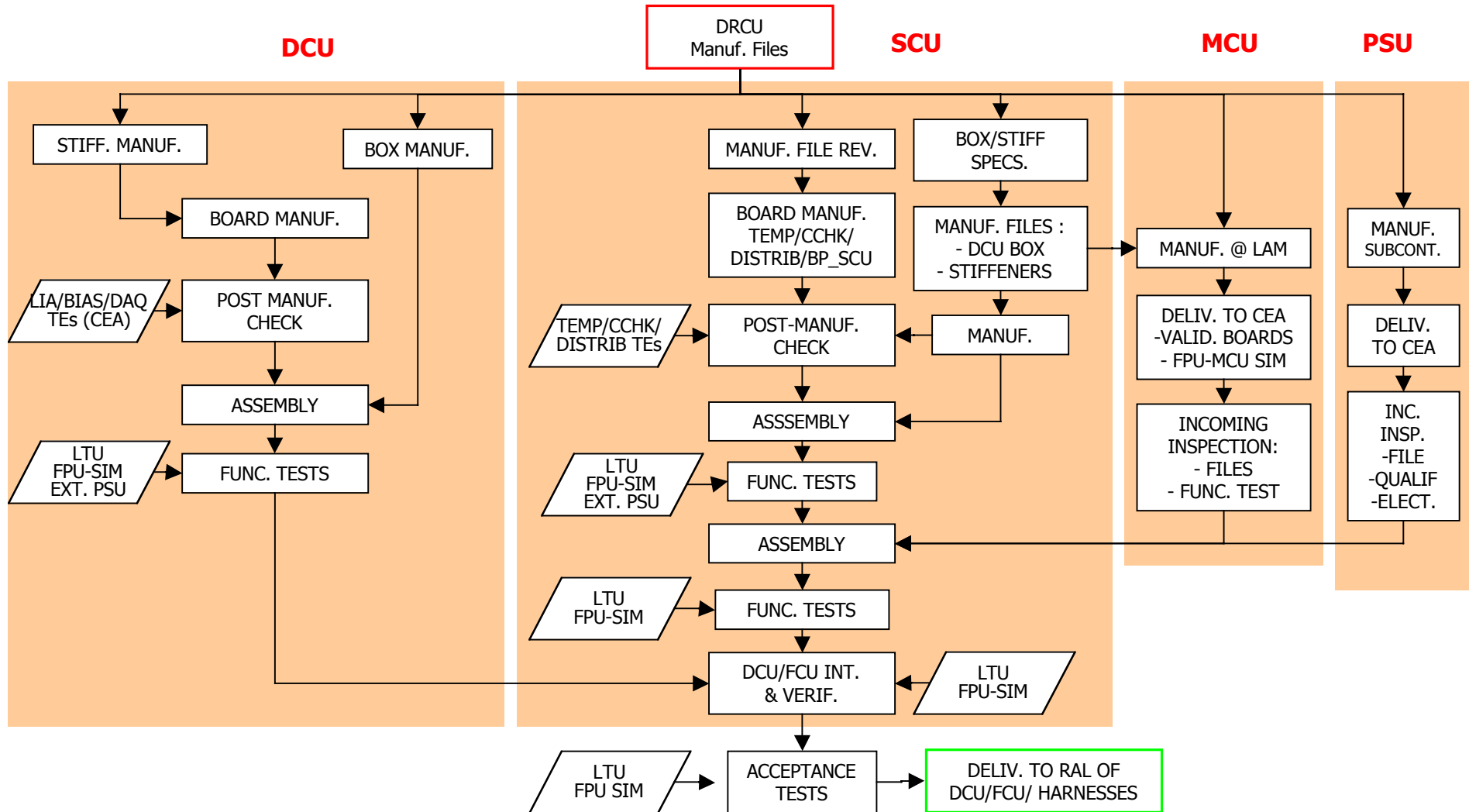


# Development Plan (QM2)





# Development Plan (FM)





# Design Status (1)

- **Detector Control Unit**

- QM1 development is divided into:

- **Phase 1:** July 2000 to December 2000

- Breadboard design & testing including 2 analog channels, 1 bias channel and 1 data acquisition channel.

- Goal: elementary functions & internal interfaces optimization

- **Phase 2:** January 2001 to July 2001

- QM1 design including 5 complete analog boards (2 for photometer & 3 for spectrometer), 1 bias board and 1 data acquisition board.

- Electrical schematics are ready - verification in under progress

- QM1/QM2/FM Part lists released

- Ends with DDR foreseen in August

- **Phase 3: Realization and Test at JPL**

- **Phase 4: integration and test at SACLAY**



## Design Status (2)

- Mechanisms Control Unit: see dedicated presentation



## Design Status (3)

- **Sub-systems Control Unit**
  - QM1 development is divided into:
    - **Phase 1:** January 2001 to July 2001
      - Breadboard design & testing for critical functions:
        - 0.3 Kelvin thermometry channel
        - “high power” bias for cooler recycling.
    - **Phase 2:** September 2001 to end 2001
      - QM1 design



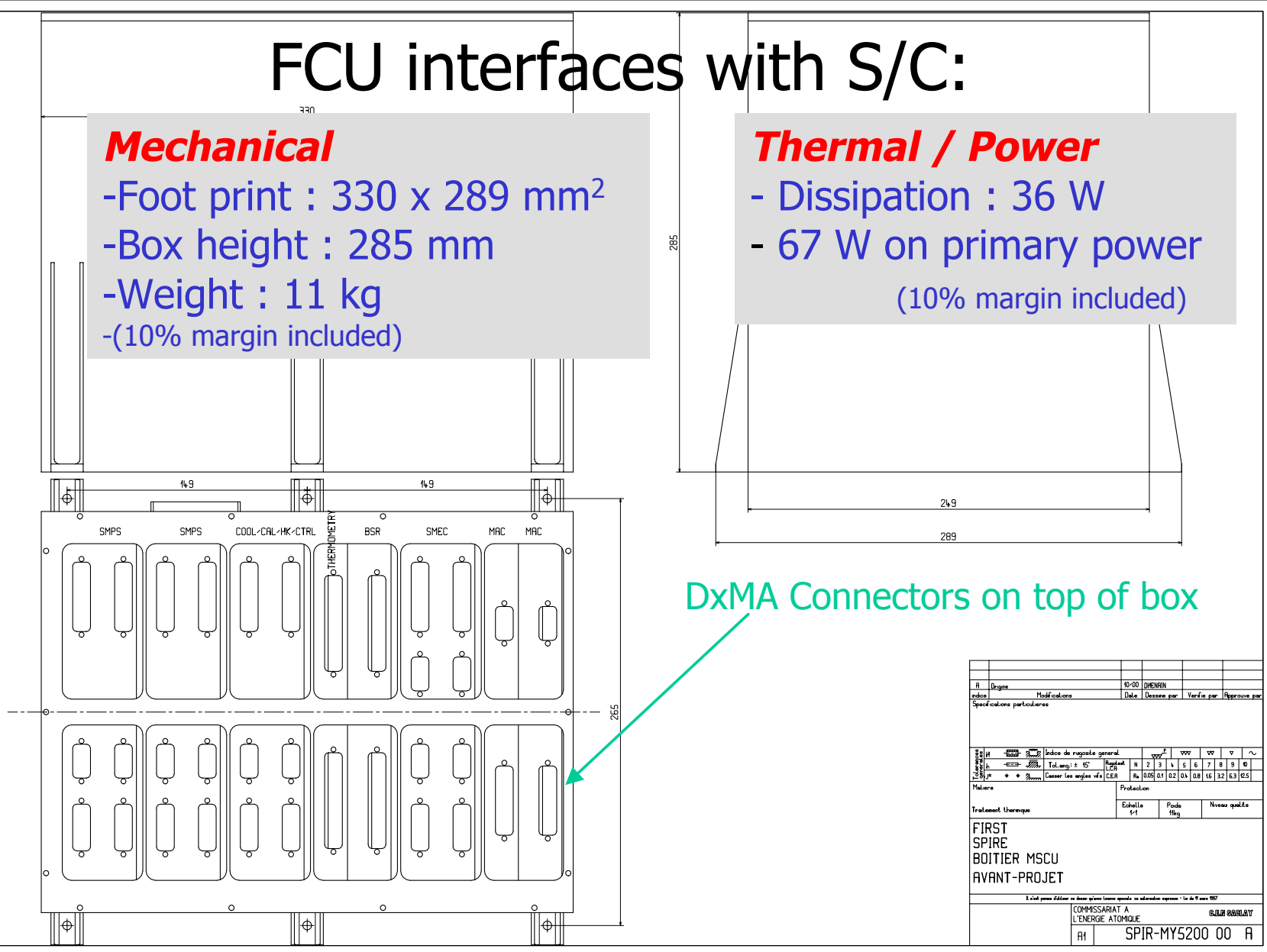
# FCU interfaces with S/C:

## Mechanical

- Foot print : 330 x 289 mm<sup>2</sup>
- Box height : 285 mm
- Weight : 11 kg
- (10% margin included)

## Thermal / Power

- Dissipation : 36 W
- 67 W on primary power  
(10% margin included)



DxMA Connectors on top of box

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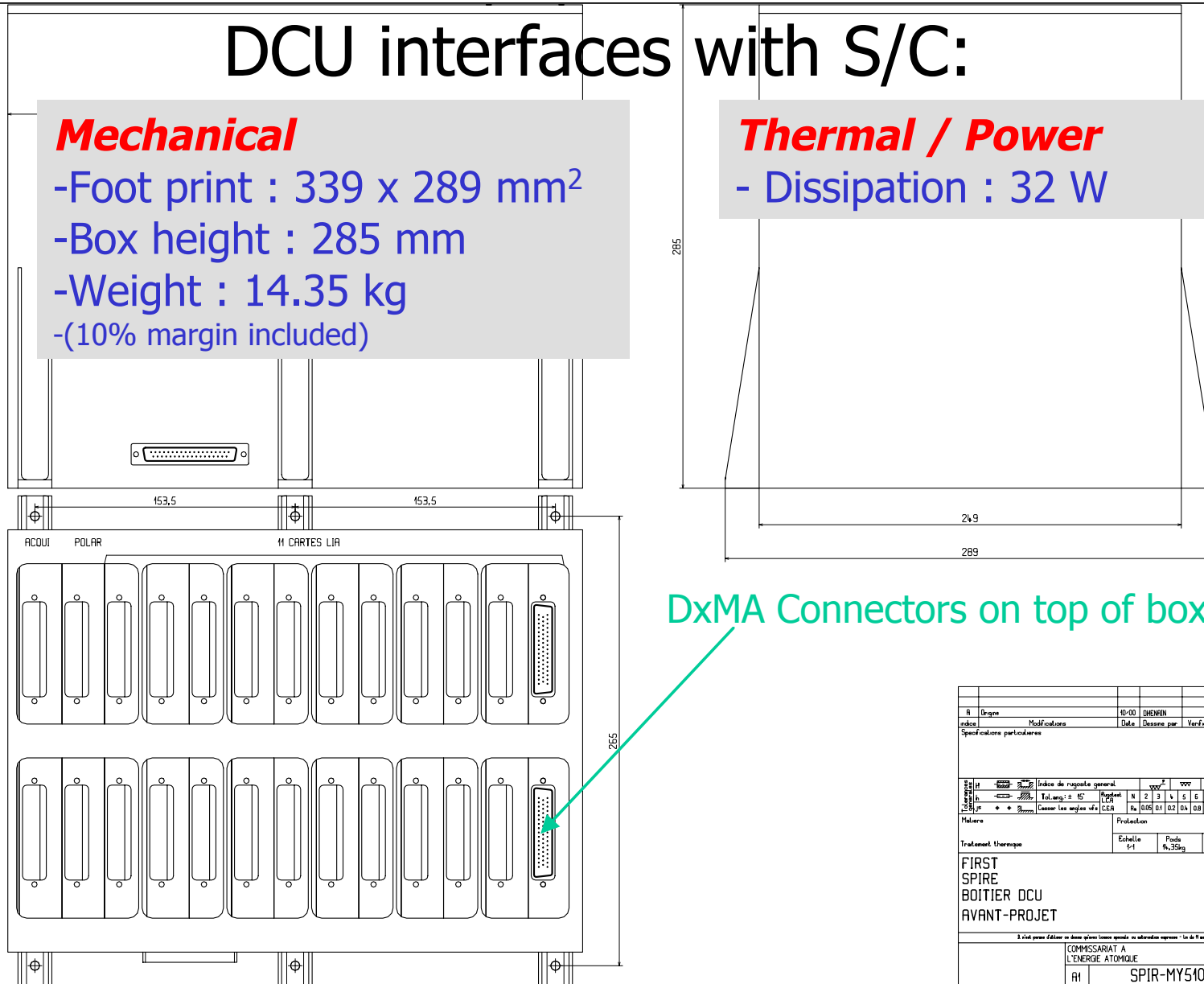
# DCU interfaces with S/C:

## Mechanical

- Foot print : 339 x 289 mm<sup>2</sup>
- Box height : 285 mm
- Weight : 14.35 kg
- (10% margin included)

## Thermal / Power

- Dissipation : 32 W



DxMA Connectors on top of box

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indice		Modifications		Date	Dessiné par	Verifié par	Approuvé par		
Spécifications particulières									
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Traitement thermique		Echelle	1-1	Poids	4,35kg	Niveau qualité			
FIRST SPIRE BOITIER DCU AVANT-PROJET									
Il est permis d'utiliser ce dessin qu'une licence expresse ou autorisation expresse - loi de 19 mai 1957									
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# Critical Areas

- **Part Procurement :**
  - Design status does not allow to finalize part list
  
- **PSU :**
  - Development is on critical path for QM2 delivery
  - ➔ Specifications to be frozen as soon as possible
  - ➔ Contacts with potential sub-contractors started
  
- **DRCU specifications :**
  - Internal grounding scheme remains difficult to define due to isolation requirement between photometer and spectrometer instrument





## Future ...

- *Finalize internal grounding scheme*
- *PSU specification completion for submission to subcontractor*
- *Finalize design of cooler/temperature sensor electronics (elementary "bricks" exist)*
- *Perform an FMECA on DCU and FCU designs*