Presentation of the Xatcobeo project

XAT-10000-PRE-012-UVIGO.INTA

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- Xatcobeo is a CubeSAT mission for deploying two payloads and a mechanism into space
- The system is to be designed, assembled and tested by students from the University of Vigo in Spain
- It is a joint effort between the University of Vigo and INTA (National Institute for Aerospace Technology)

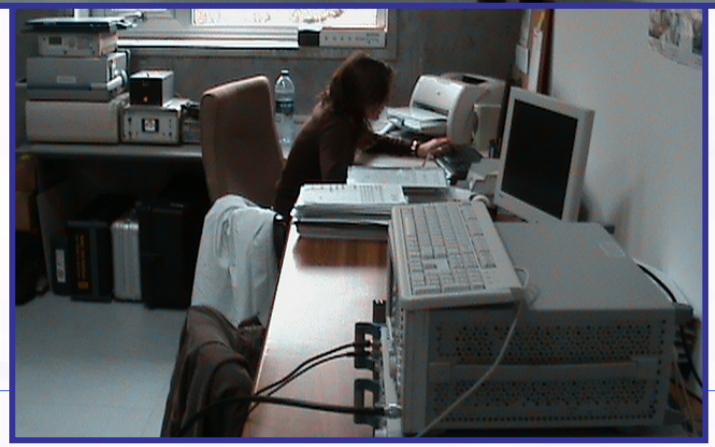
UNIVERSIDADE DE VIGO

- Several engineering schools
- Three campus, three cities:
  - Vigo, Ourense and Pontevedra
- Core of the Xatcobeo project:
  - multi-disciplinar team of students
- The schools involved in this project are:
  - Telecommunications engineering (Vigo Campus)
  - Industrial engineering (Vigo Campus)
  - Computer engineering (Ourense Campus)

- A large team composed of 39 students is working on the project
  - 29 students from telecom engineering
  - 2 students from industrial engineering
  - 5 students from computer science
- More than 15 teachers from Vigo and Ourense are also supervising the project
- More than 10 technicians from INTA are providing support

- Infrastructures
  - Anechoic chamber
  - Clean room

(1:10000)



- INTA is the Spanish Public Research Organization specialized in aerospace research and technology development
- INTA has its base in Madrid
  - So now it is three campus to coordinate!
- 9 people are working on support activities and payload development

- The project has been split in different phases, following the V-model for project development:
  - Phase 0 [KOM]: initial definition
  - Phase A [PRR]: project feasibility
  - Phase B [PDR]: preliminary design
  - **Phase C [CDR]**: design & implementation
  - Phase D [QR/FAR]: integration
  - Phase E: operation
  - Phase F: disposal

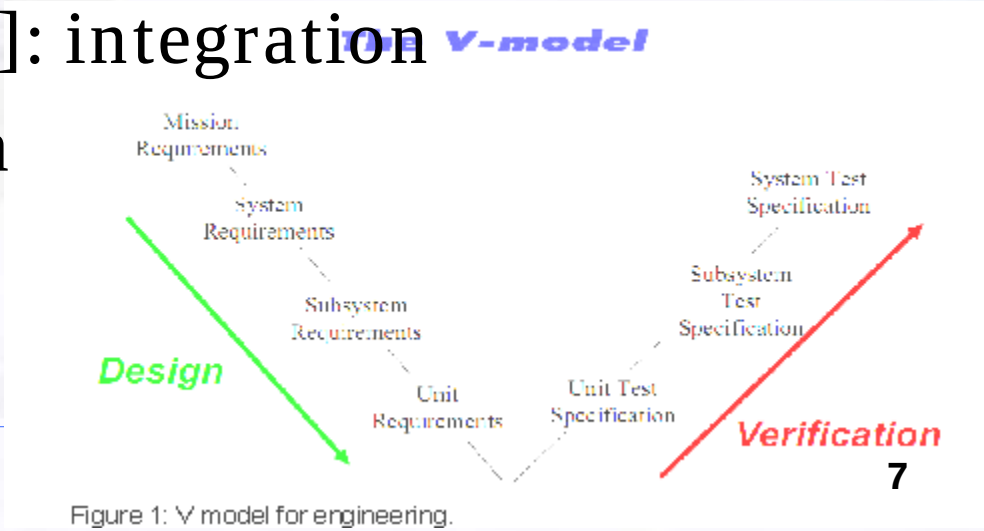
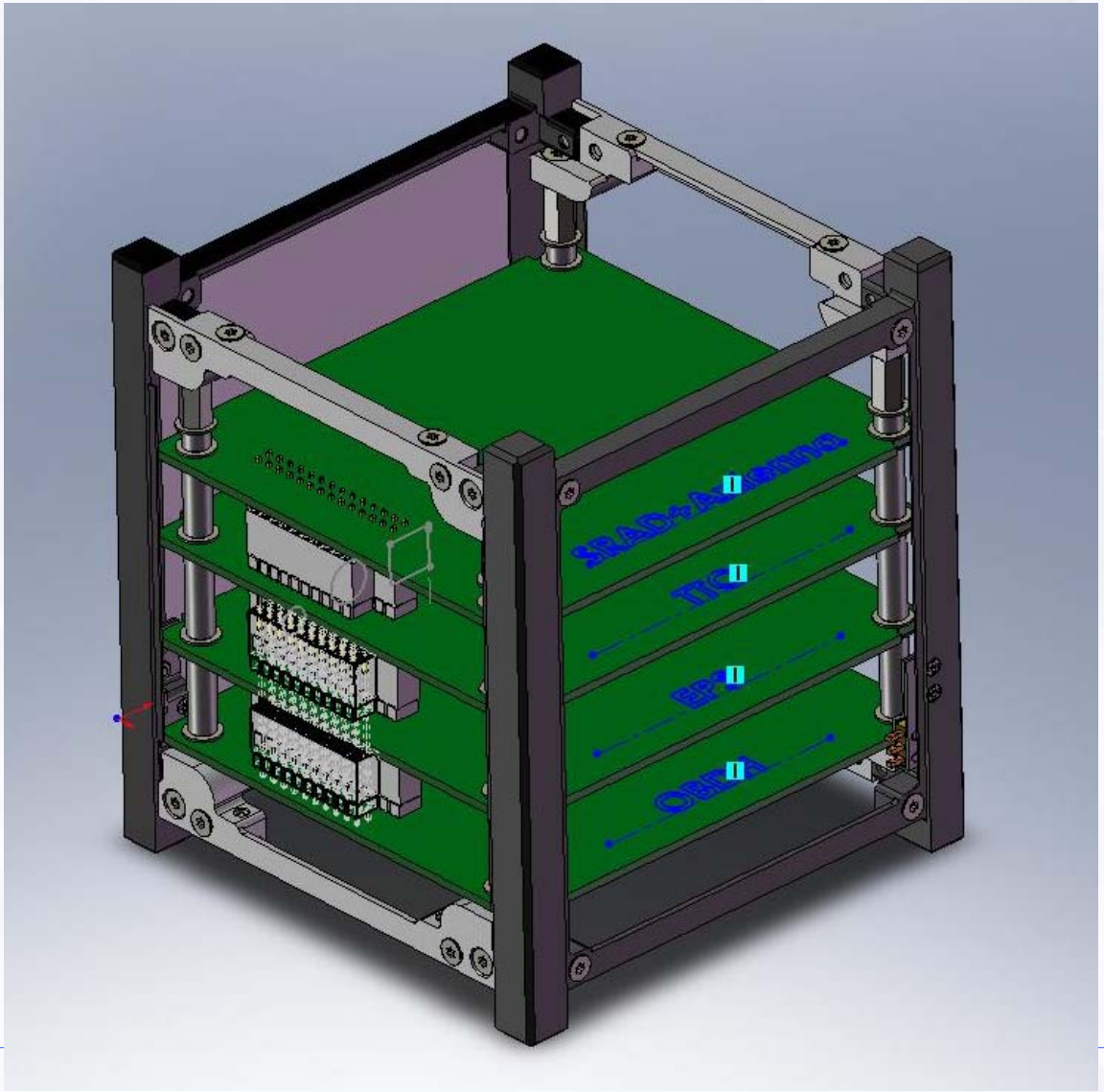


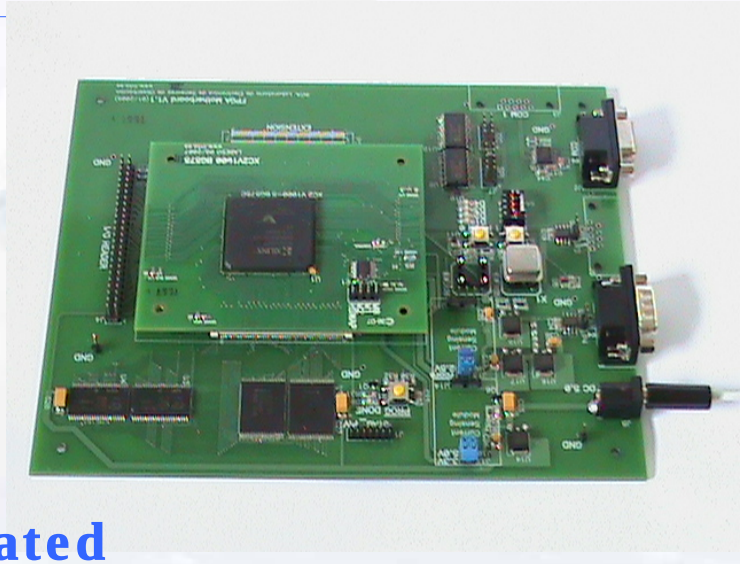
Figure 1: V model for engineering.

- VEGA is the new launcher from ESA for lightweight payloads
- Scheduled launch date is November 2009
- Xatcobeo was born as an answer to a Call for Proposals to include 9 CubeSATs in the Maiden Flight for VEGA
- VEGA will launch us into an elliptical LEO orbit

- Subsystems
  - OBDH: On Board Data Handler
  - TTC: Telemetry, Tracking and Command
  - EPS: Electrical Power Subsystem
  - Antennas
- Payloads
  - SRAD: Software RADio
  - RDS: Radiation Dose Sensor
- Qualification mechanism
  - PDM: Panel Deployment Mechanism

Xatcobeo system





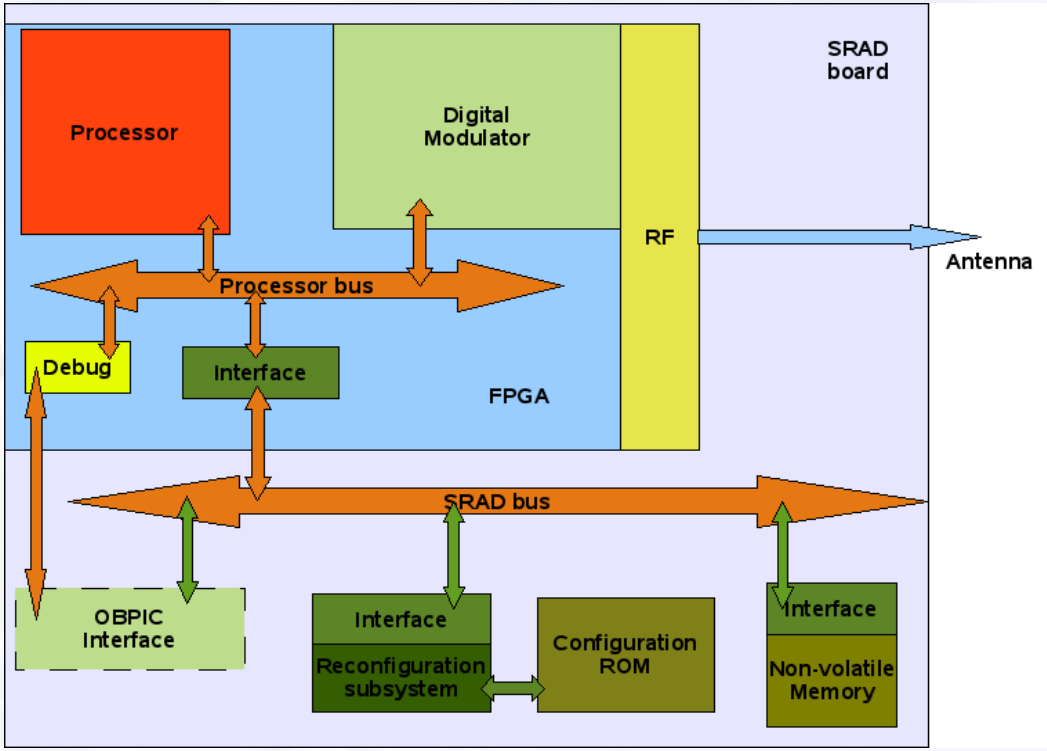
- OBDH
  - Based on a Virtex-II FPGA
  - Distributed system
    - OBC: On-Board Computer
      - **Contains the software**
      - **It is where the FPGA is located**
    - OBPIC: On-Board Programmable Interface Controller
      - **Controller for payloads power**
      - **Signal conditioners for system bus**
  - Average consumption of 0,55 W
    - Peak power of 2,7 W for less than 50 ms

- EPS
  - Provided by Clyde Space
  - Worst case ideal power generation of 3.27W
    - 2.41 W on system bus after degradations and performances
  - A battery of 1250 mAh is used for power storage
- TTC
  - Provided by GomSpace
  - Semi-duplex UHF, 437 MHz
  - Uses CCSDS for frame and channel coding

- Antennas
  - Turnstile UHF antenna
  - This antenna is complex in terms of deployment and integration
    - Total mass should be low
      - Our system weights **80 g** including cables, connectors, antennas, deployment system, fixation and electronics board
    - Deployment is attained in 3-6 seconds
  - Patent pending

- The SRAD Software Defined Radio will evaluate the possibility of reconfiguring a programmable logic device in flight.

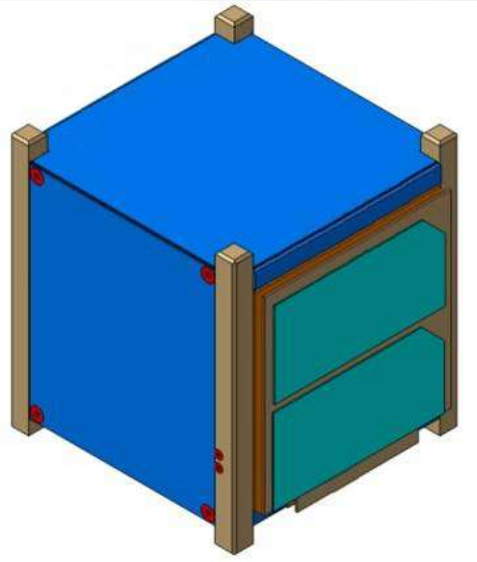
- PSK/DPSK gray coded
- FSK gray coded
- Binary ASK

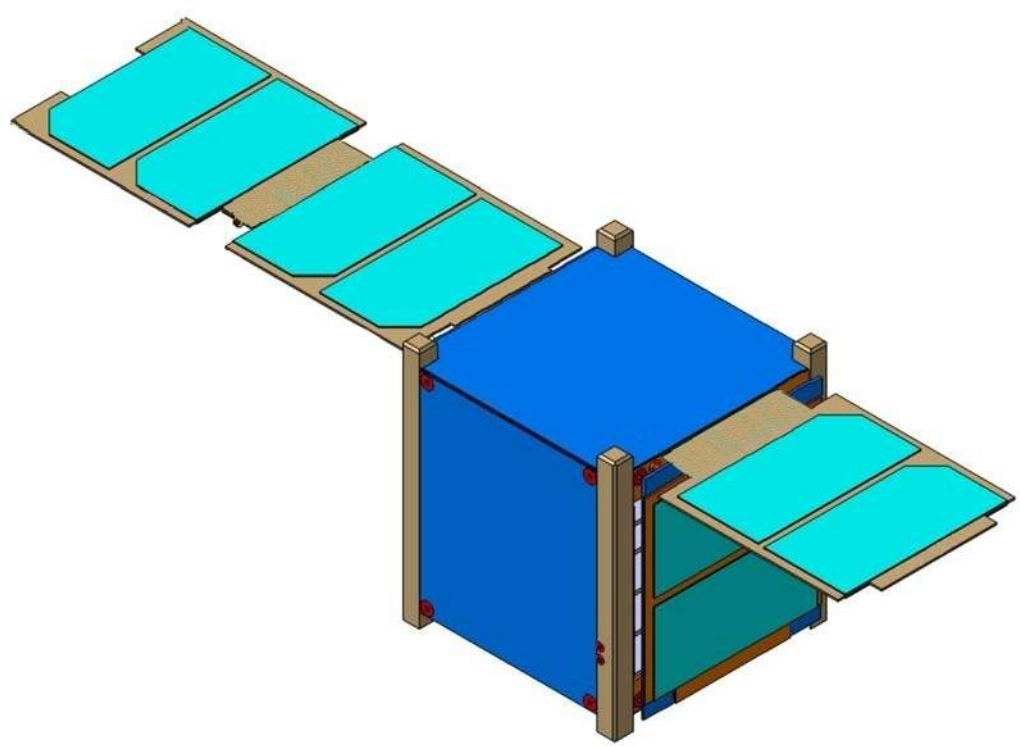


- The development of a panel deployment mechanism comes from:
  - Real CubeSATs present power limitations
  - CubeSat restrictions regarding pyrotechnics
  - Test in flight a reliable panel deployment mechanism
  - There aren't deployment systems for CubeSATs
- Improvement of power capacities and upgrade CubeSAT capabilities
- Xatcobeo will be a platform to qualify on–orbit deployment systems for CubeSATs

- PDM is a payload consisting of two sets of deployable solar panels.
  - Single panel deployment
  - Double panel unfolding.
- The first deployment mechanism is common for both sets
- In the double mechanism another mechanism is added to allow the unfolding of an extra panel.

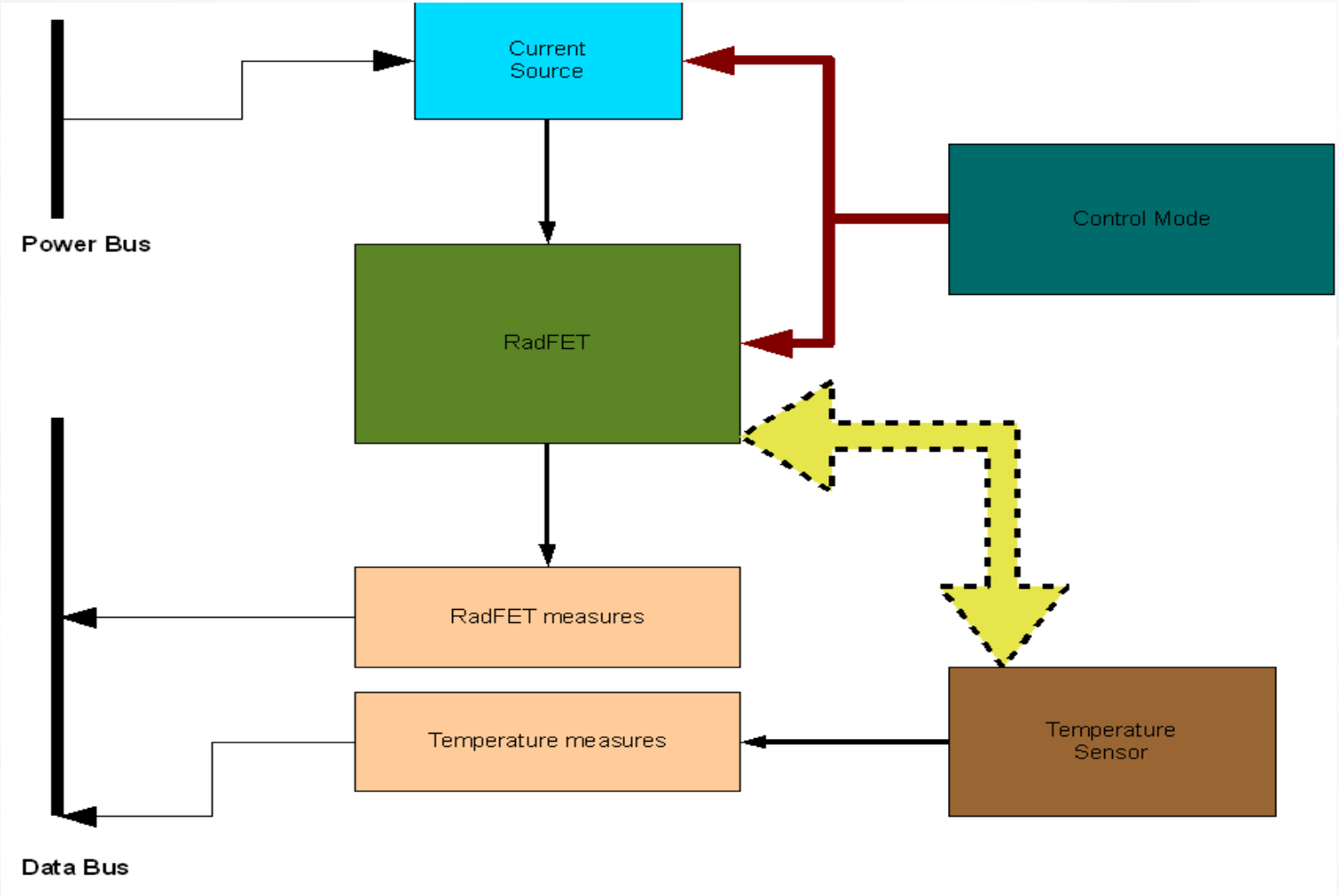
PDM Concept (II)





- RDS (*Radiation Dose Sensor*)
  - Developed by INTA
    - Electronics Design Laboratory.
    - Space Radiation and Effects Unit.
  - Updated design of the INTA ODM payload for OPTOS satellite.
  - Electronic sensors will be supplied by LAAS – CNRS France in order to:
    - Measure TID (total ionizing dose)
    - Improve Space Environment Models

RDS - Design


Current Source
Control Mode
Power Bus
RadFET
RadFET measures
Temperature measures
Temperature Sensor
Data Bus

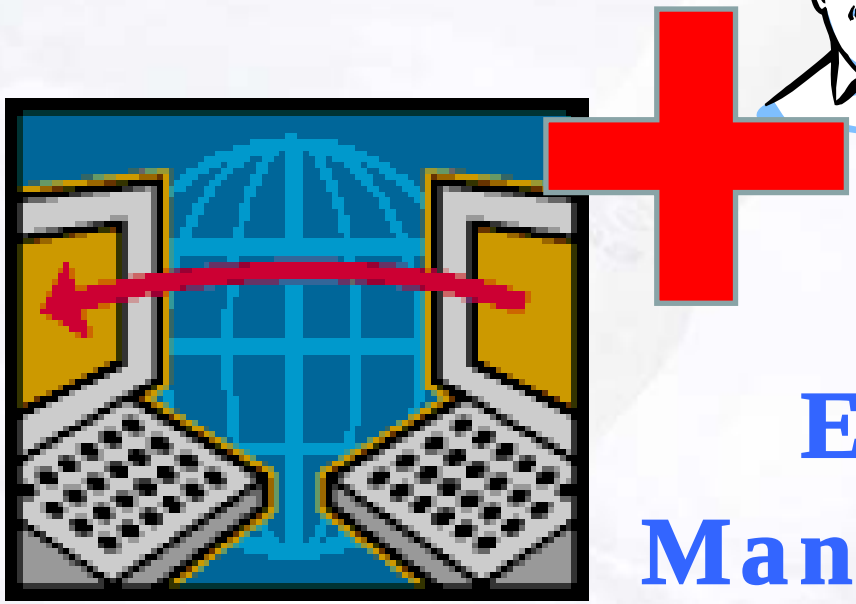
- Future steps
  - Evaluation of the replacement of one RadFET sensor by diode sensor.
    - Non-Ionizing Effects Data.
- Conclusions
  - In-Flight radiation data.
  - Improve radiation engineering processes.
  - Low power consumption sensor.

- ORGANIZATION PROBLEMS

- Dev. Teams located at different cities:
  - Madrid, Ourense and Vigo
- More than 40 people creating software, hardware and documents at the same time.

- SOLUTION

Hierarchical organization



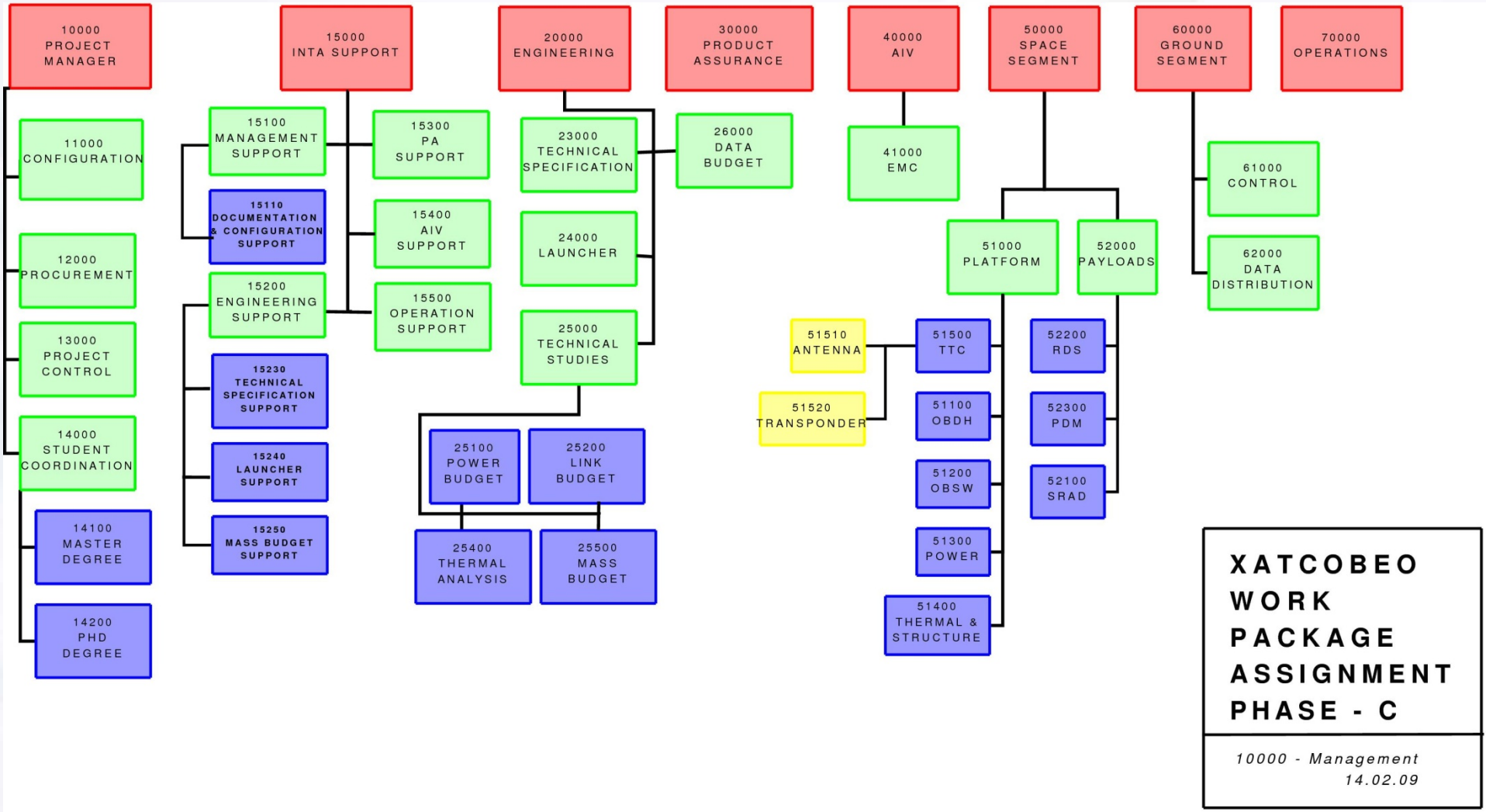
Electronic Management

• HIERARCHY

1. Tasks are split into WorkPackages (WP).
2. Each WP is assigned to a different team.
3. Each team is formed by:

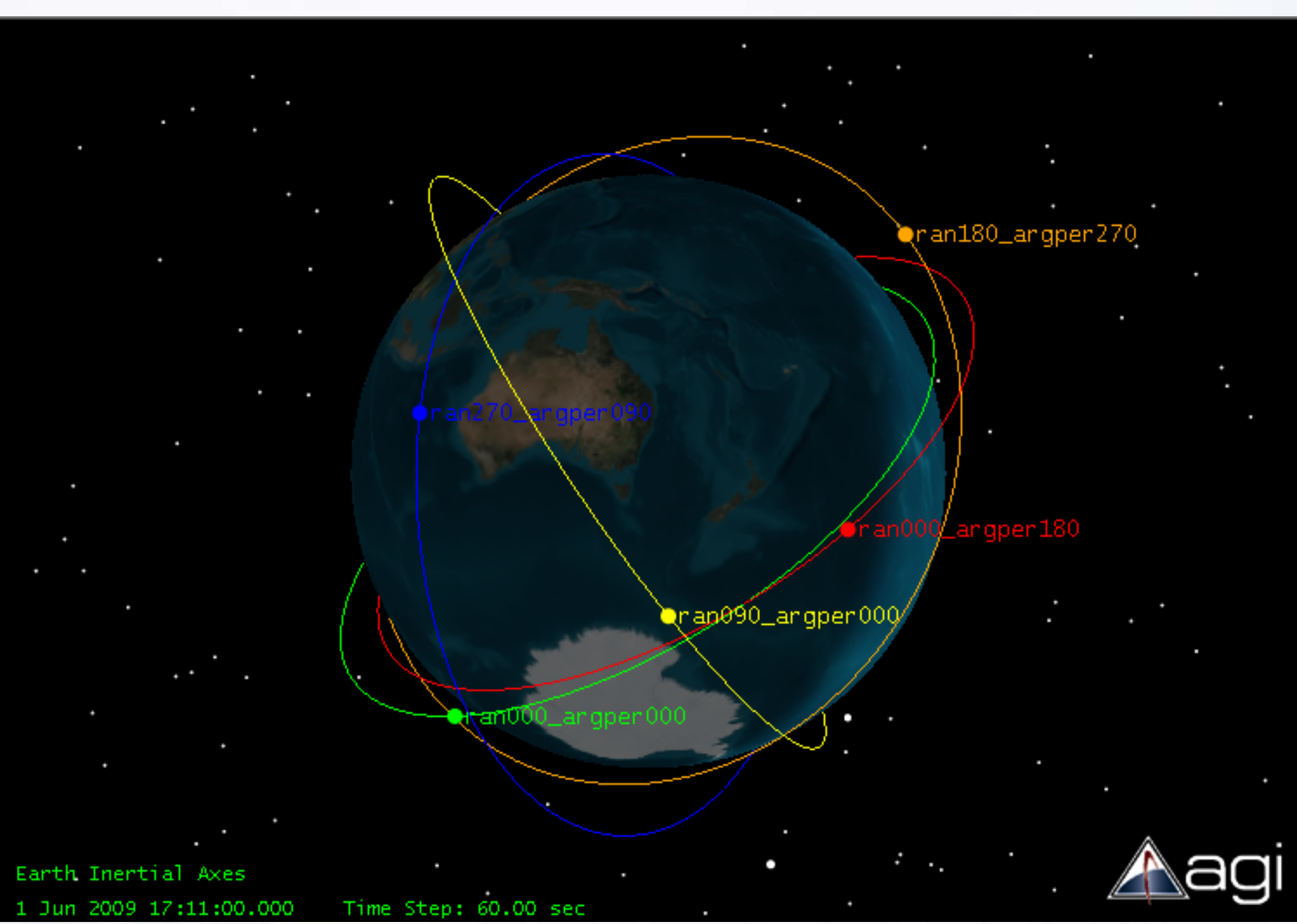
- 1 teacher as supervisor
- 1 member of INTA for providing support
- 1 PhD student responsible
- N MsC/BsC thesis students as members
- X students as cooperators

Project organization



- Mission analysis consists in a series of studies about the environment for whom the system will be designed
- This environment adds constraints to the functioning of the system
- Stakeholders shall be identified previously
- Main studies for the mission analysis:
  - Link budget
  - Thermal budget
  - Space environment specification

- Vega mission's orbit
  - Keplerian elements:
    - Inclination = 71º
    - Altitude of perigee = 354 km
    - Altitude of apogee = 1447 km
    - Semimajor axis (a) = 7058.137 km
    - Eccentricity (e) = 0.075
    - Arg. of perigee [0º, 360º)
    - RAAN [0º, 360º)
    - Launch date, November 2009 (TBC)

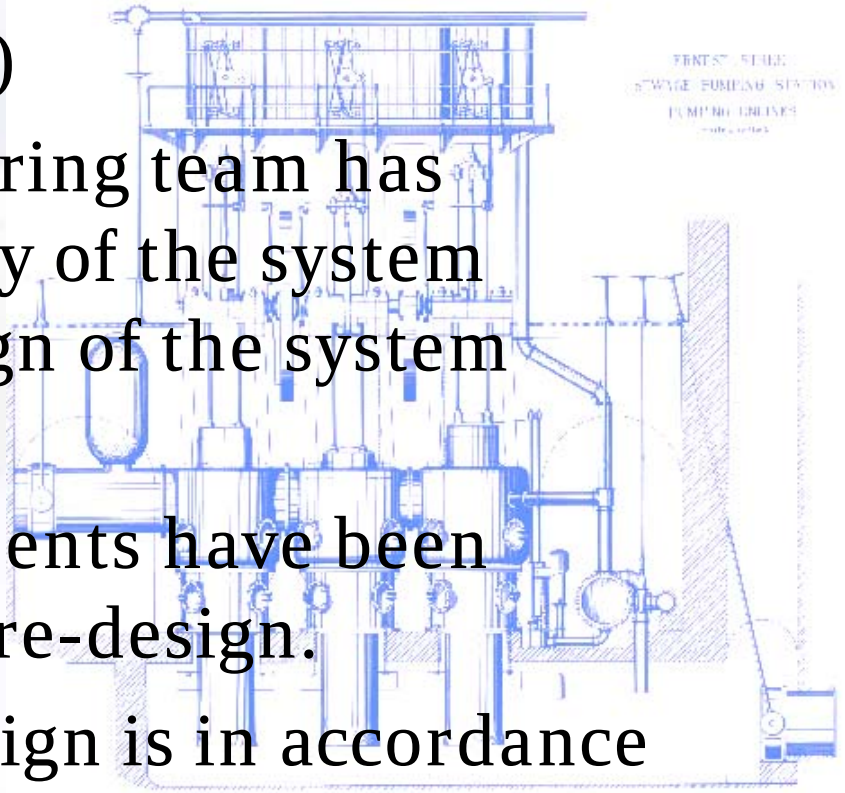

ran180_argper270
ran270_argper090
ran000_argper180
ran090_argper000
ran000_argper000
Earth Inertial Axes
1 Jun 2009 17:11:00.000
Time Step: 60.00 sec
agi

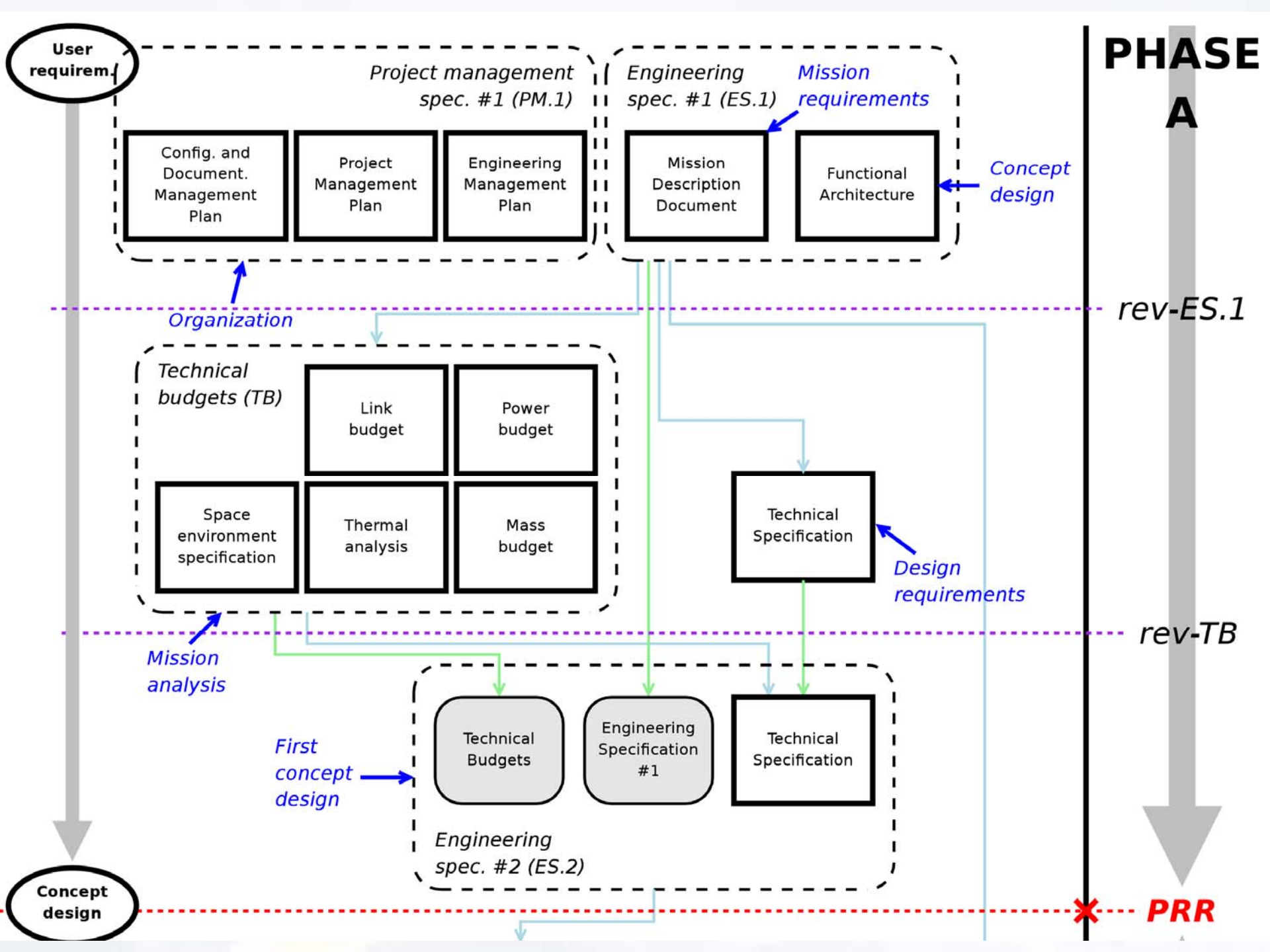
- Link budget:
  - Study of the link between ground and space segments
  - Constraints: RF design and antennas
    - Antenna: 4-monopole UHF turnstile
    - PEP: 27 dBm (500 mW)
- Thermal budget:
  - Heat balance
  - Cold case: almost 40% of one orbit's time in eclipse

- Space environment:
  - Stimated using SPENVIS
  - Radiation environment:
    - South Pacific anomaly (~300 km)
    - Van Allen radiation belts (~1500 km)
  - Constraint (comercial components):
    - 5 krad in 3 months -> 190 grams of shielding

20 % of the CubeSAT is shielding!!!!

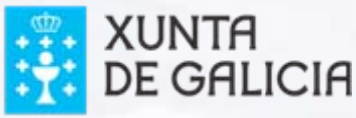
- Design of the overall system until a certain level of detail (system level)
- Currently, systems engineering team has finished the feasibility study of the system (phase A) and the pre-design of the system (phase B):
  - Initial mission requirements have been evolved into a feasible pre-design.
  - System's overall pre-design is in accordance with the pre-design for each subsystem




User requirem.
Project management spec. #1 (PM.1)
Config. and Document. Management Plan
Project Management Plan
Engineering Management Plan
Engineering spec. #1 (ES.1)
Mission requirements
Mission Description Document
Functional Architecture
Concept design
PHASE A
Organization
rev-ES.1
Technical budgets (TB)
Link budget
Power budget
Space environment specification
Thermal analysis
Mass budget
Technical Specification
Design requirements
rev-TB
Mission analysis
First concept design
Technical Budgets
Engineering Specification #1
Technical Specification
Engineering spec. #2 (ES.2)
Concept design
PRR

- Conclussions:
  - Not a common CubeSAT: requirements imposed by Vega's orbit
    - Power
    - Link
    - Thermal
    - Radiation
  - Current state of the project: phase C, detailed design
  - 2 payloads/1 mechanism:
    - Deployable solar panels
    - Software RADio
    - Radiation Dose Sensor

Sponsors


XUNTA
DE GALICIA


retegal


GOBIERNO
DE ESPAÑA
MINISTERIO
DE CIENCIA
E INNOVACIÓN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