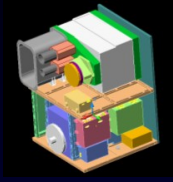


OVERVIEW OF THE INTAμSAT'S DATA ARCHITECTURE BASED ON SPACEWIRE

CONTENTS:

- Small satellites at INTA
- MicroSat programme objectives
- INTAμSAT-1 OBDH & SpaceWire overview
- Conclusions

D. Guzmán 1, M. Angulo 2, L. Seoane 2, S. Sánchez 1, M. Prieto 1, D. Meziat 1
1. Space Research Group. Dpto. Automática. Universidad de Alcalá
2. INTA

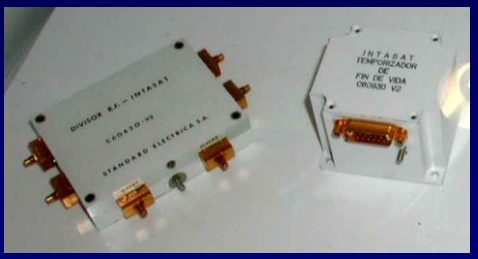
INTASAT 15 Nov. 1974 25 Kg First Spanish satellite

PAST MISSIONS

NiCd Battery

Encoder and pyro actuator

RF Units



RF divider and timer

Life : 2 years (end of life timer)

Orbit : 1.440 -1.475 Km, i= 101º sunsynchronous

Mass: 25 Kg

Power: 2,8 w

No TTC ¡¡
No OBDH ¡¡

Dimensions: 44,5 cm diameter x 45 cm height

Experiment : Ionospheric sounding in VHF

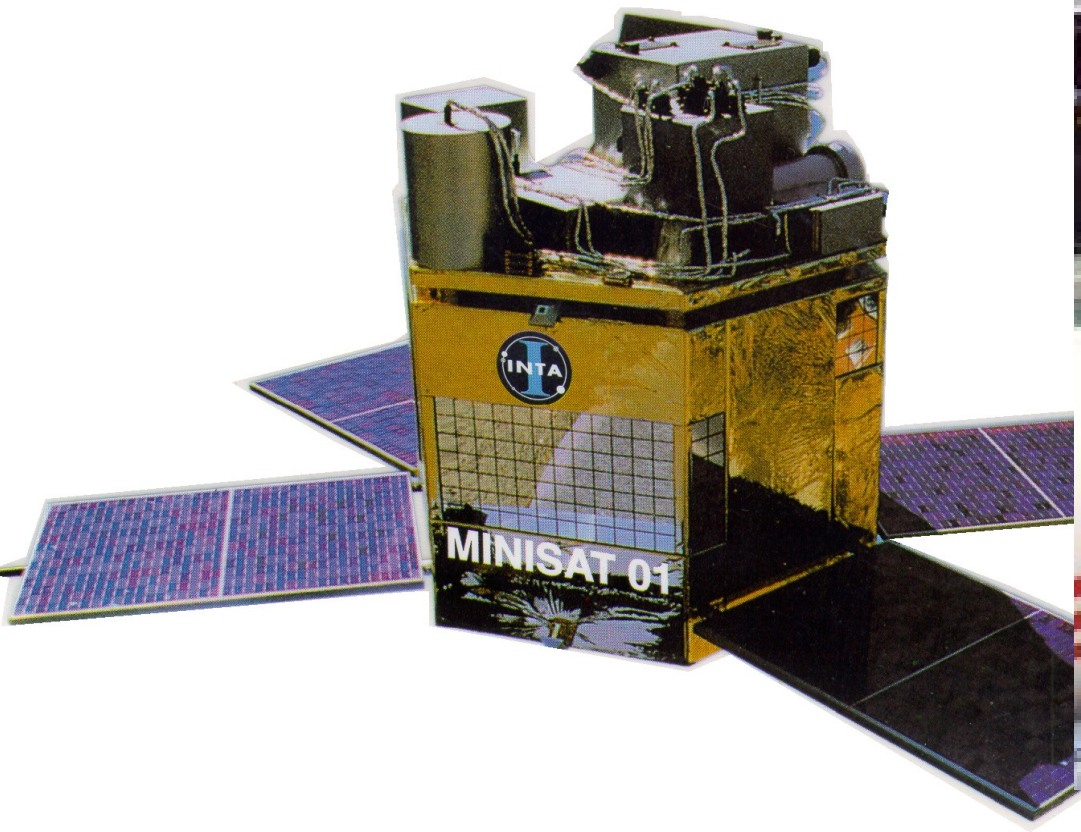
S/S : Developed at INTA and with Spanish industries

Launch : Delta rocket (Vandenberg-USA)

AIT: Integrated and tested at INTA facilities

1 Mbps TTC in S-Band
80386 OBDH – RS-232

PAST MISSIONS



MINISAT-01 Mar. 1997 - Feb. 2002 190 Kg.

- Launched in a Pegasus XL above the Canary islands. The integration campaign to the rocket was made at INTA facilities in Torrejón - MADRID.
- Three main instruments: LEGRI (INTA-UV-RAL), EURD (INTA-UCB) y CPLM (INTA-ETSIA)
- Minisat-01 reentered the atmosphere after 5 years working in orbit with remarkable scientific results

UPMSAT 1995-1997 40 Kg

Launched by Ariane-4 (Helios 1A)
qualified ant tested at INTA

NANOSAT-1 18 Dec. 2004 19 Kg

IN ORBIT MISSION

16 Kbps TTC in UHF-Band
68332 OBDH – SPI bus

Life: Designed for 3 years (possible 5-6)

Orbit: LEO 665 Km Sunsynchronous

Power: 19 w

Dimensions: 44 cm bw faces x 47 cm height

Sat. Mass : 19 Kg (Al alloy not optimised)

Unit Mass: 6 Kg with modular design (160x100x20 mm)

Misión: UHF Store-Forward Communications (400 MHz)

Experiments: Micro-Nanotechnology

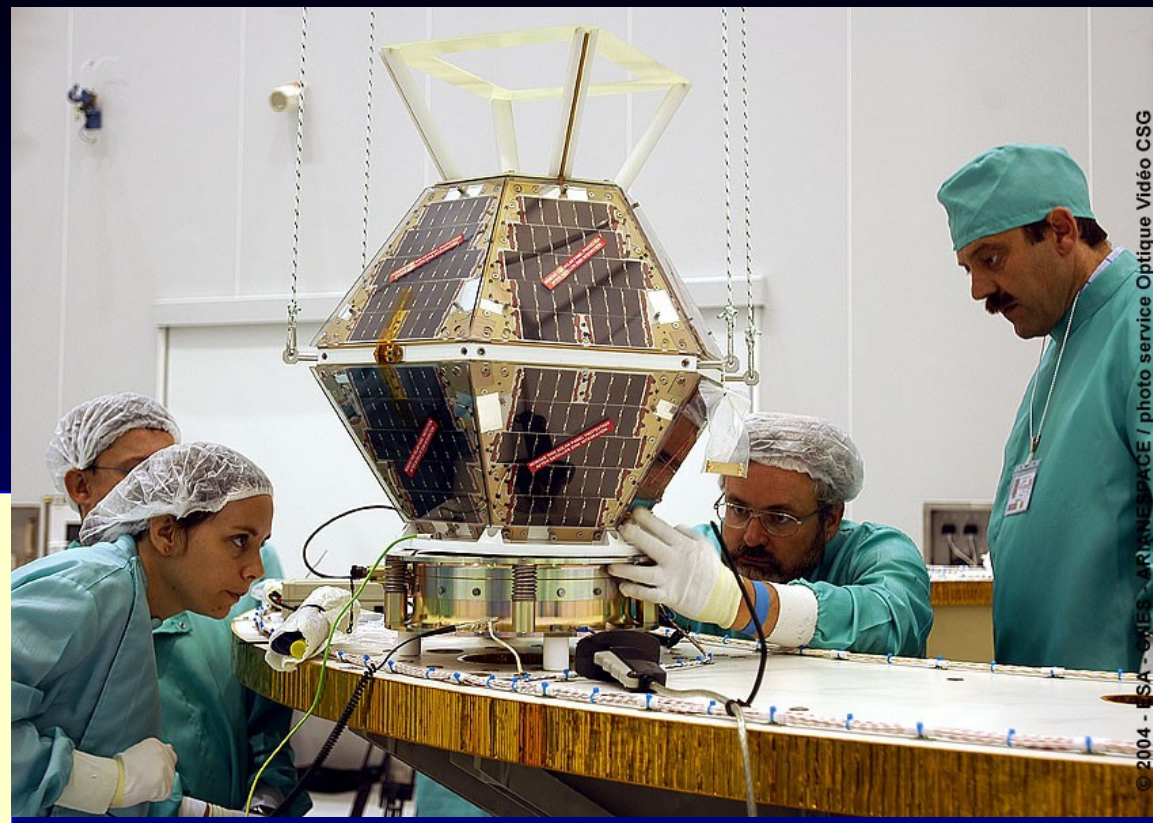
Development : INTA

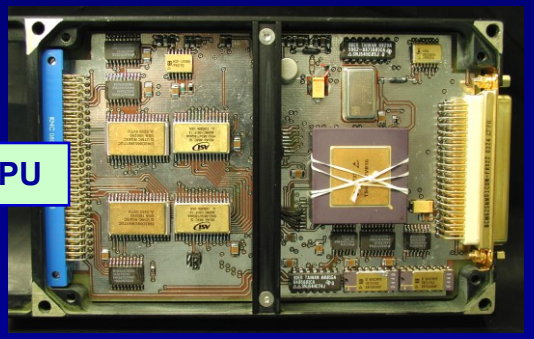
Batteries : Lithium Ion (AEA Technology - UK)

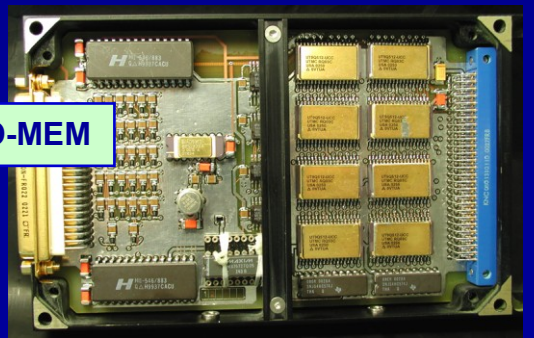
Solar Panels : GaAs/Ge (Galileo Avionica - Italy)

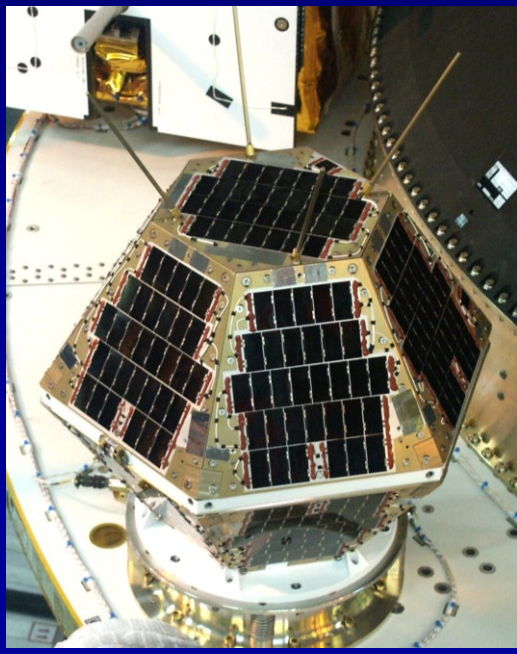
Launch: Ariane-5 ASAP 18 Dic. 04

AIT: Designed, manufactured, integrated, and qualified for flyght at INTA

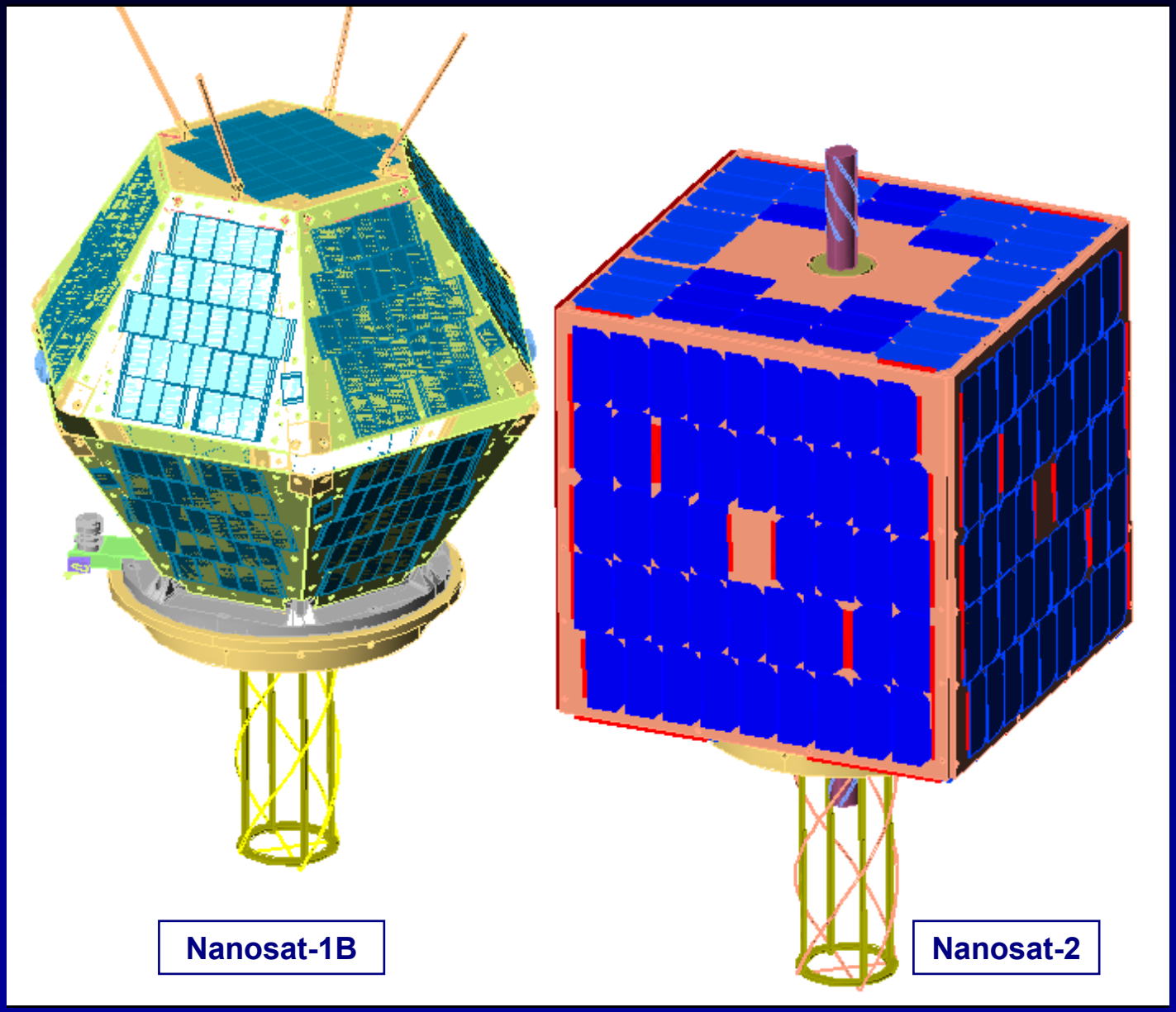



CPU


IO-MEM



2nd GENERATION COMPARISON



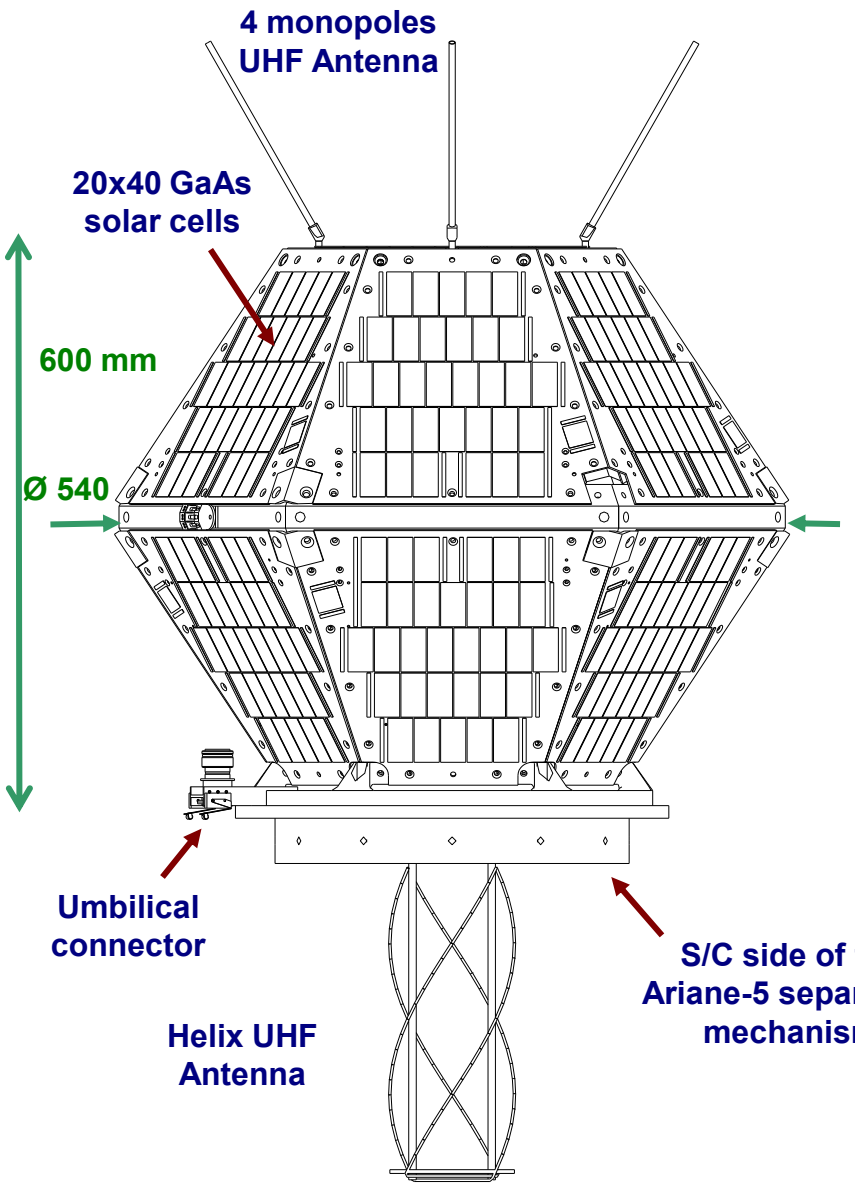
Nanosat-1B

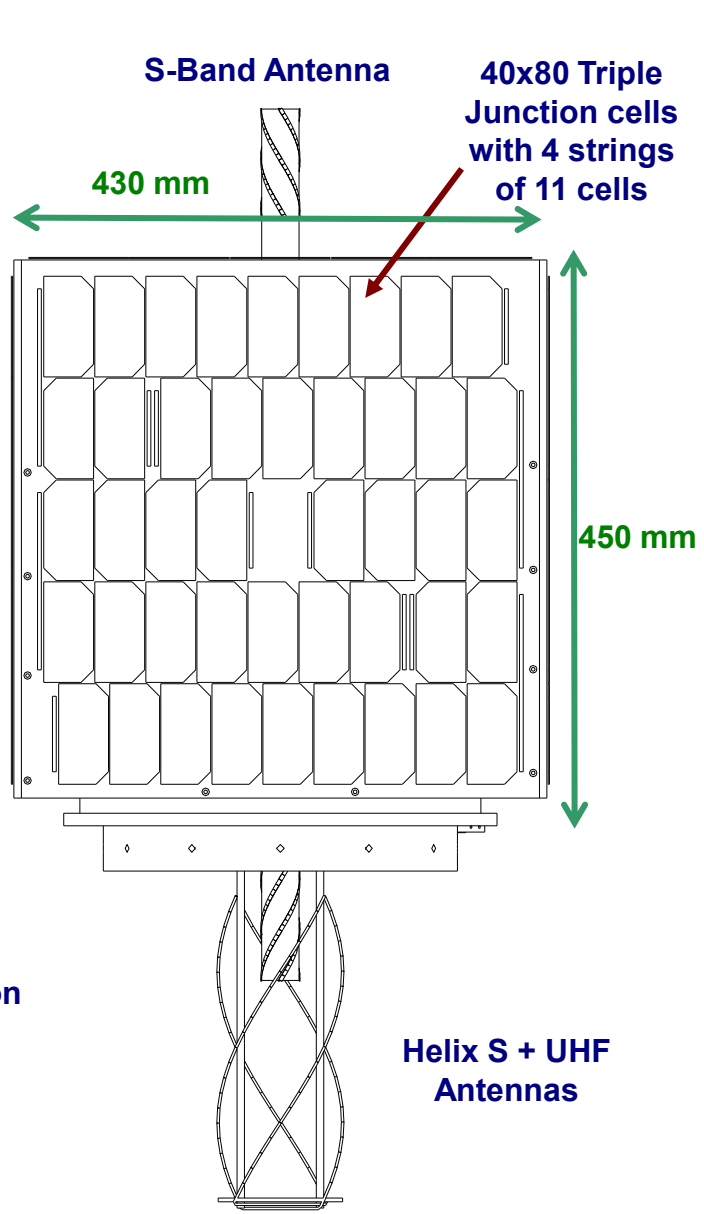
Nanosat-2

NANOSAT-2 Improvements:

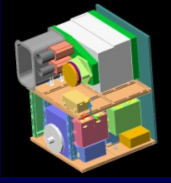
- More compact & better volume use
- Separated PLM & SVM
- Same μSat OBDH μProcessor
- Same TTC μSat Transceiver
- Use of CAN bus for TM & TC
- Spacewire use is TBC
- Some Nanosat-1 Units
- Enhanced ACS with 3-axes control using 3 RW and a Star Tracker

COMPARISON WITH NANOSAT-1





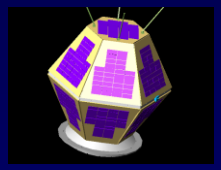
INTAμSat Programme 17 Sep 07



NanoSat-1 in orbit Phase-E

3 years life objective

18 Dec 07



NanoSat-1B planning

Phase C & D New Experiments - 15 mo.

Feb 07

Requir. review

System specification

Jan 06

FM Satellite

30 Oct 08

Nov 05

Phase C - 12 months

Phase D - 12 months

Launch

New modem development

Jun 07

Jun 08

Sep 08

Nov 08

Dec 06

Delta CDR

FRR

MicroSat planning

Presentation

INTAμSAT-1 Mission

PDR

PLM-QM

Oct 05

Oct 06

Phase B PLM 10 mo.

Phase C PLM - 12 mo.

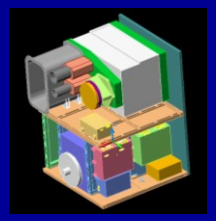
Phase A - 12 months

SVM-EM

PDR

SVM-QM

CDR



Phase B SVM -> 12 months

Phase C SVM- 12 months

Nov 05

Nov 06

Dec 07

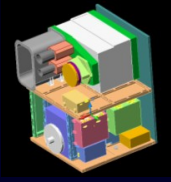
Jan 08

Dec 08

Technology Programme (Communic., OBDH, ACS)

Actual date

Sep 07



μSAT PROGRAMME OBJECTIVES

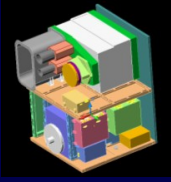
- R&D Programme in the field of Small Satellites

- The system and subsystems are developed at INTA, but with collaborations in the R&D work with several universities and other research centres in Spain

- Development of a multimission Service Module (SVM) compatible with Ariane-5 ASAP (also future VEGA): up to 150 Kg, 60 x 60 x 80 cm

- Offer specific tasks or satellite units to the small business Spanish industries, to encourage their entering into the space technology

- Give flight opportunities to the Spanish research community at an affordable budget target each 3-4 years, for new experiments and instruments for earth and space exploration



PLM attachments

Spacewire data bus from the P/L

From the star sensor heads

28 V to the PLM

SVM

AOCS S/S

CAN — Star sensor electronics

CAN — GPS Receiver

2 Magnetic sensors

CAN

2 Solar sensors

3 Coil torquers

CAN CAN CAN CAN

4 Reaction wheels

X-Band Transmitter

Communications S/S

HPA

Tx - Modem

CAN

S-band TTC Transceiver

Rx

Modem

Power control

Tx

CAN

X-Band antenna

TTC antennas

Spacewire connections

OBDH S/S

OBDH Unit

Mass Memory MMU

Mass Memory MMU

CPU

CAN

28 V

Power S/S

PDU - Power Distribution Unit

Telemetries

Power distrib.-2

Power distrib.-1

Power converters

CAN

3.3, 5 & 12 V

28 V

Li-ion Battery

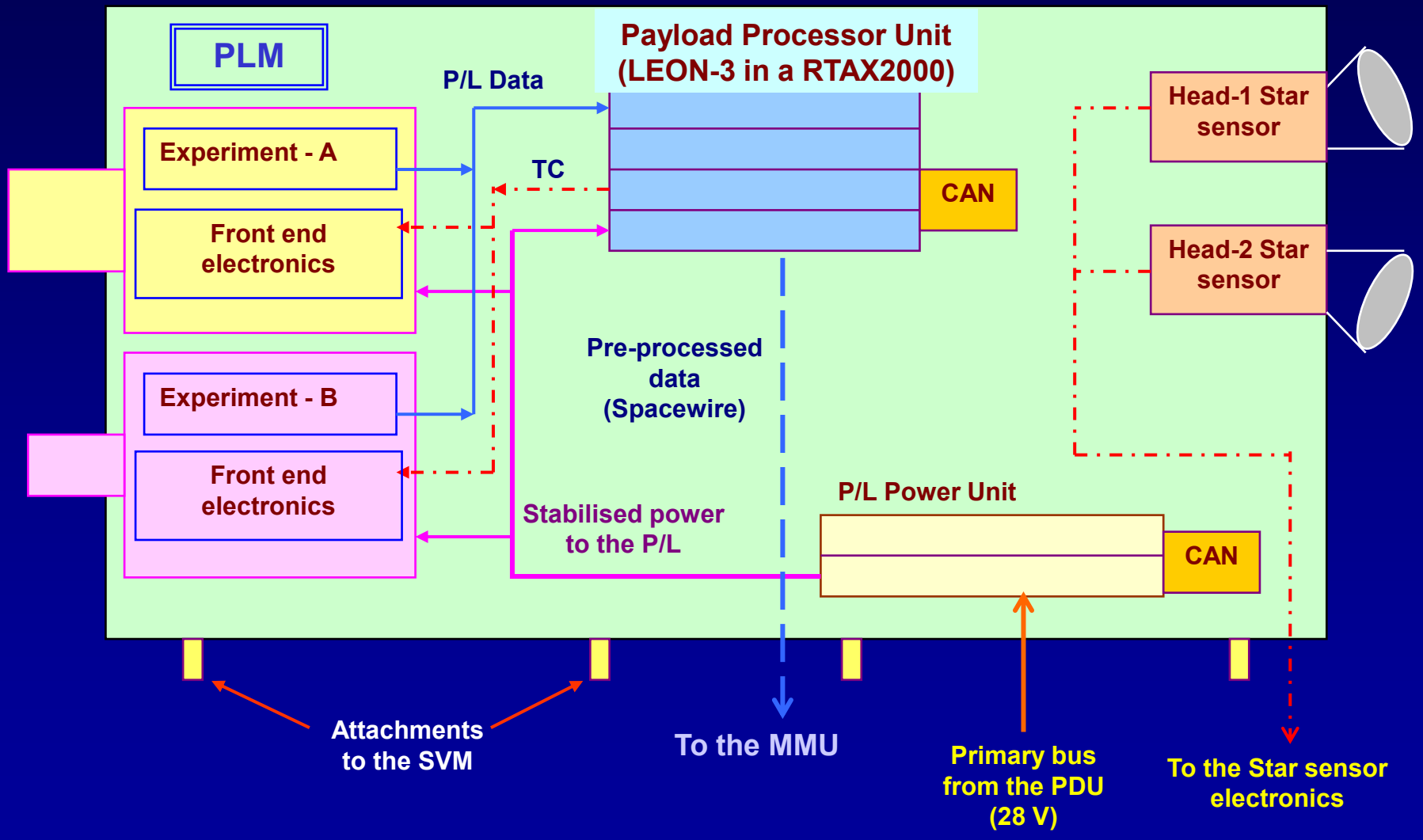
28 V

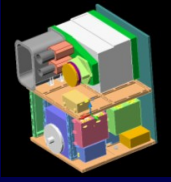
Solar panels

Launcher I/F

Service Module block diagram

Block diagram of the Payload





INTAμSAT-1 configuration (60 x 60 x 80 cm)

Focal plane 3 to 4 MS bands and 10-20 m GSD

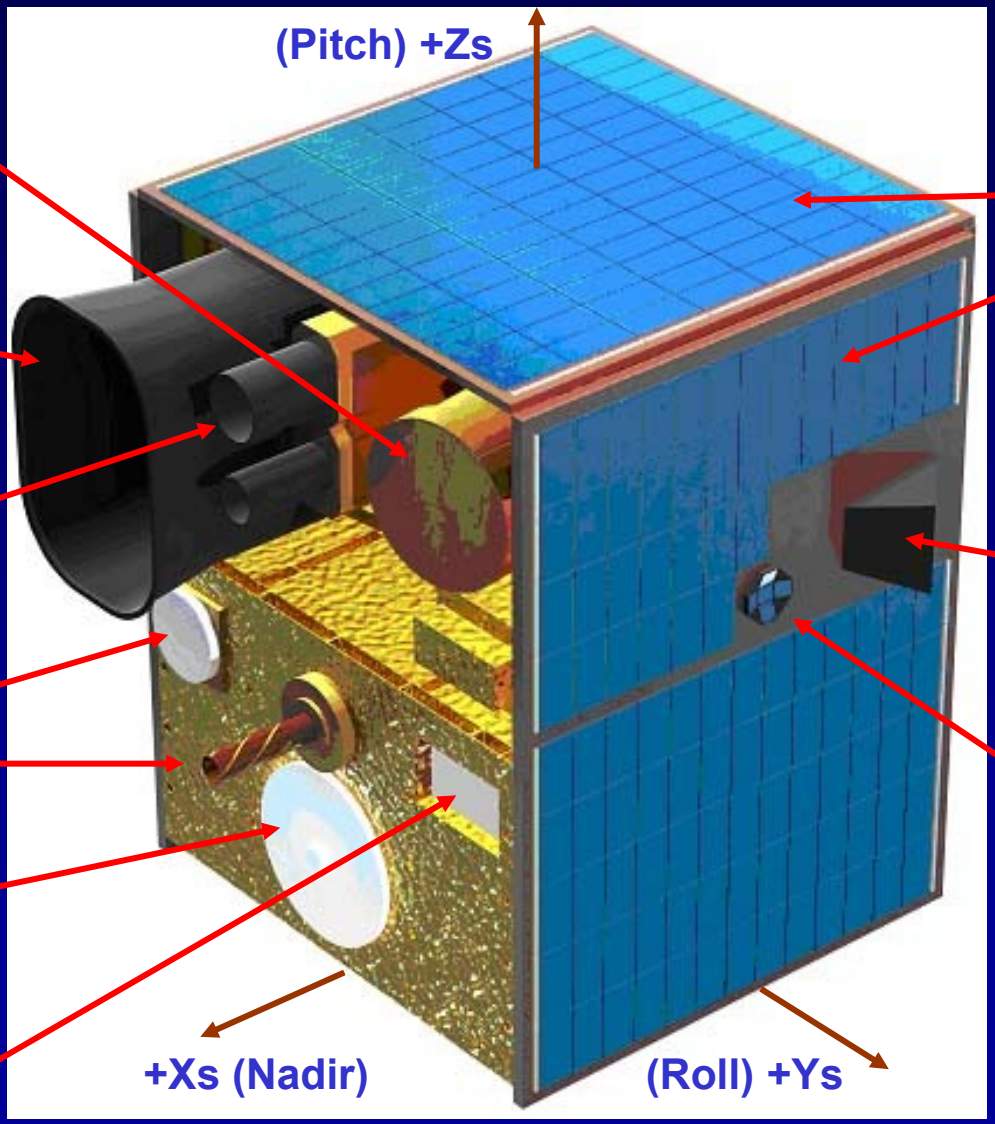
Baffle

MIR & TIR cameras (FUEGO)

S-Band antennas

X-band antenna

SVM & PLM connectors

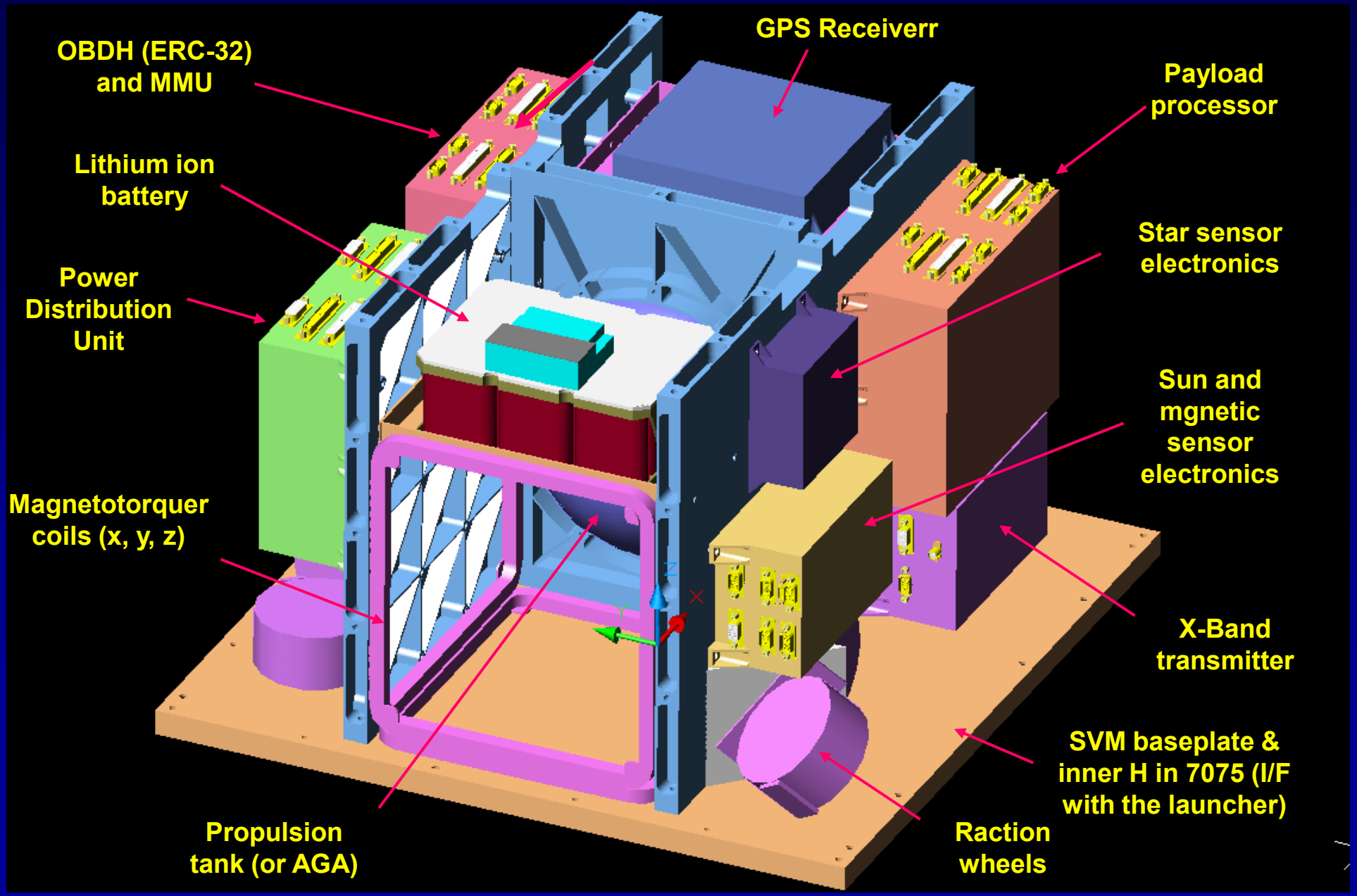


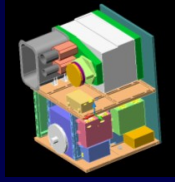
4 Fixed solar panels (-X, +Y, -Y, +Z)

Star sensor (external baffle)

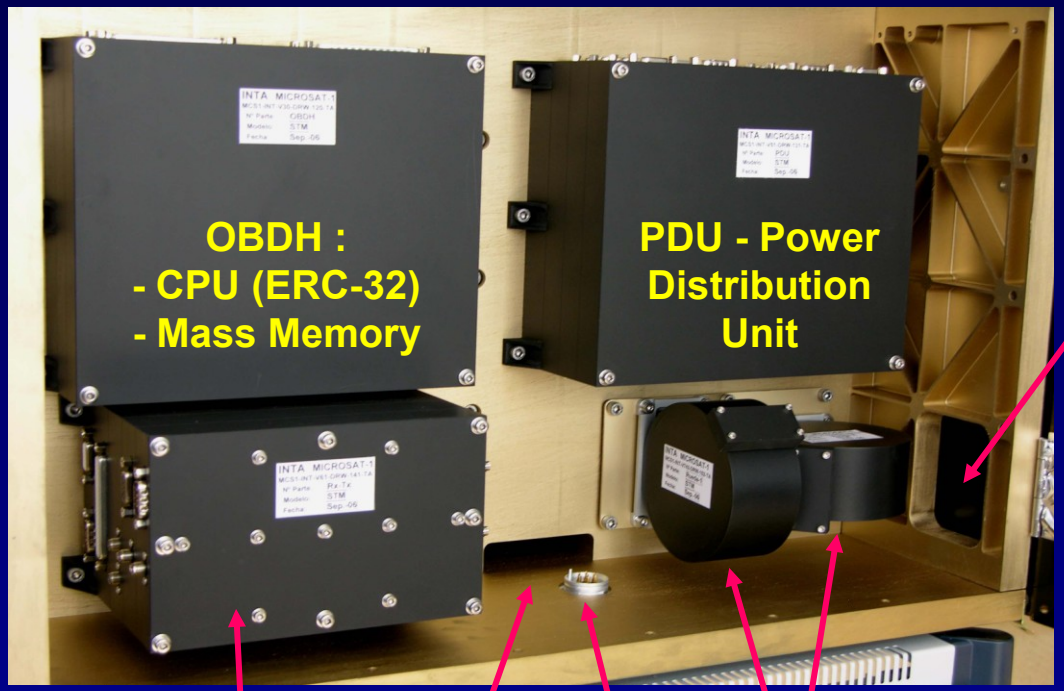
Solar sensor

SERVICE MODULE - SVM





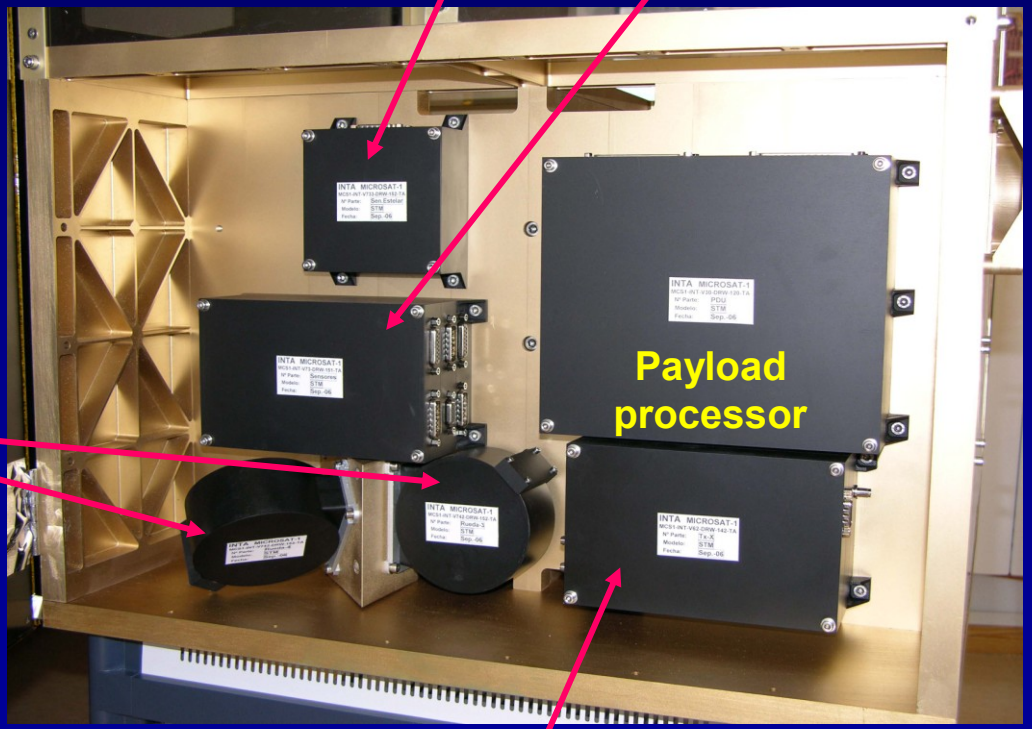
DISTRIBUTION OF THE SVM UNITS



Acces open for the solar panel connec.

Star sensor electronics

Sun and magnetic sensor electronics



S-Band Transceiver

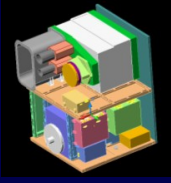
Harness accesses

Umbilical Connector

Reaction wheels

X-Band Transceiver

OBDH S/S



LVDS Space Wire

MMU

External Connectors

LVDS Space Wire

Payload Processor

External Connectors

Payload Instrum.

CAN BUS

CPU

2 KNC-80 Connectors to the Backplane

CLK & RESET

Test port

TSC-695 Micro (ERC-32)

EEPROM closed

EEPROM open

RAM

Power

FPGA RTAX-250

CONTROL

D/IO

UART X 4

CAN

1 Sub-D 44 External connector for I/F and power

CAN BUS

FPGA S-Band Modem

FPGA X-Band Modem

RTU solar & magnetic sensors

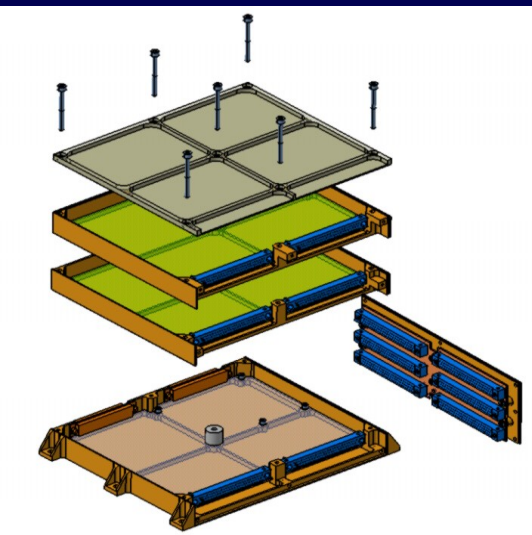
RTU for the PDU

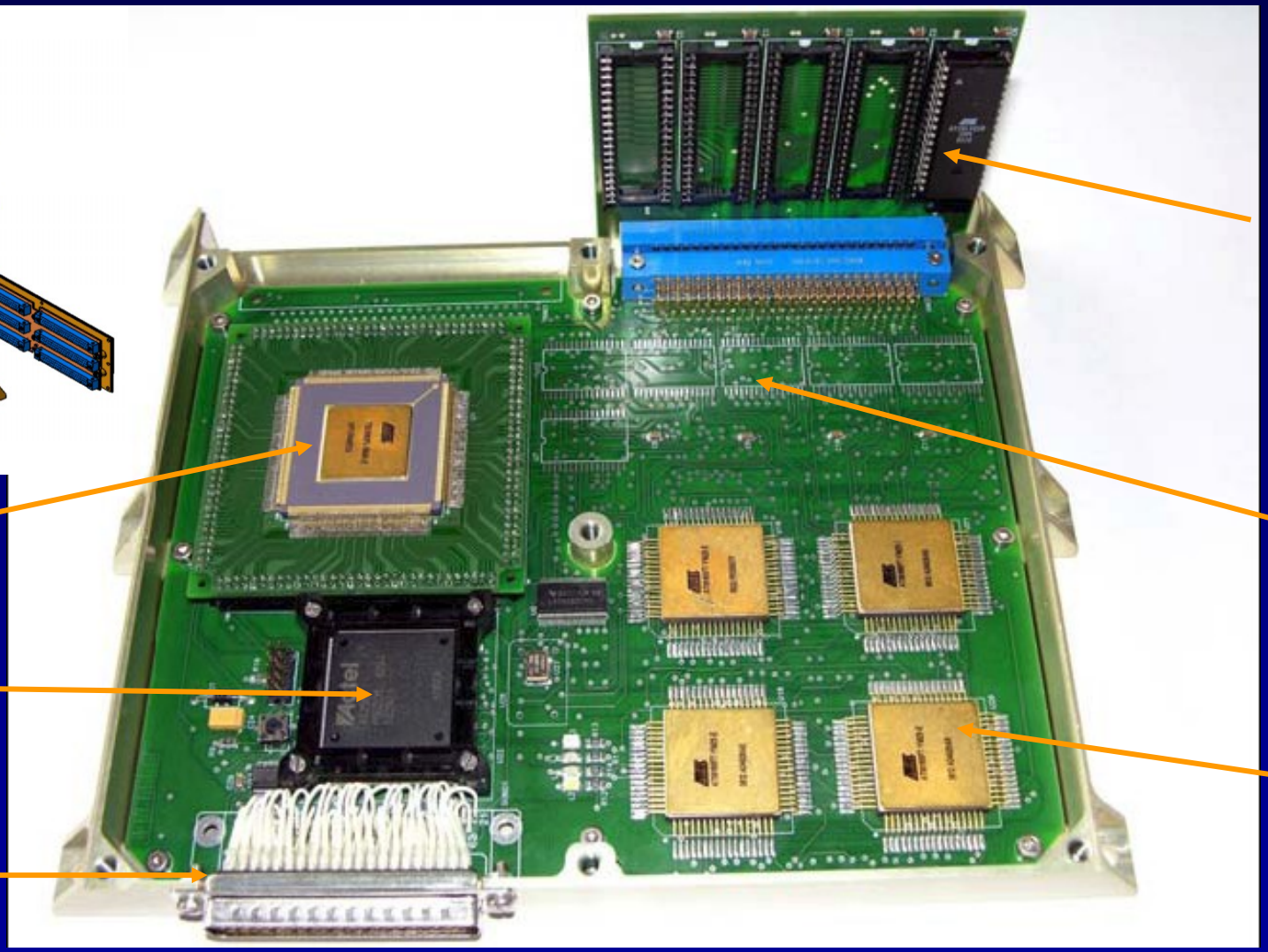
Star Sensor

GPS Receiver

4 Reaccion wheels

EM - CPU (May 07)





μP TSC-895

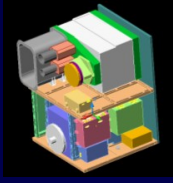
FPGA (Actel RTAX 250 for FM)

RS-422, CAN, & power connector

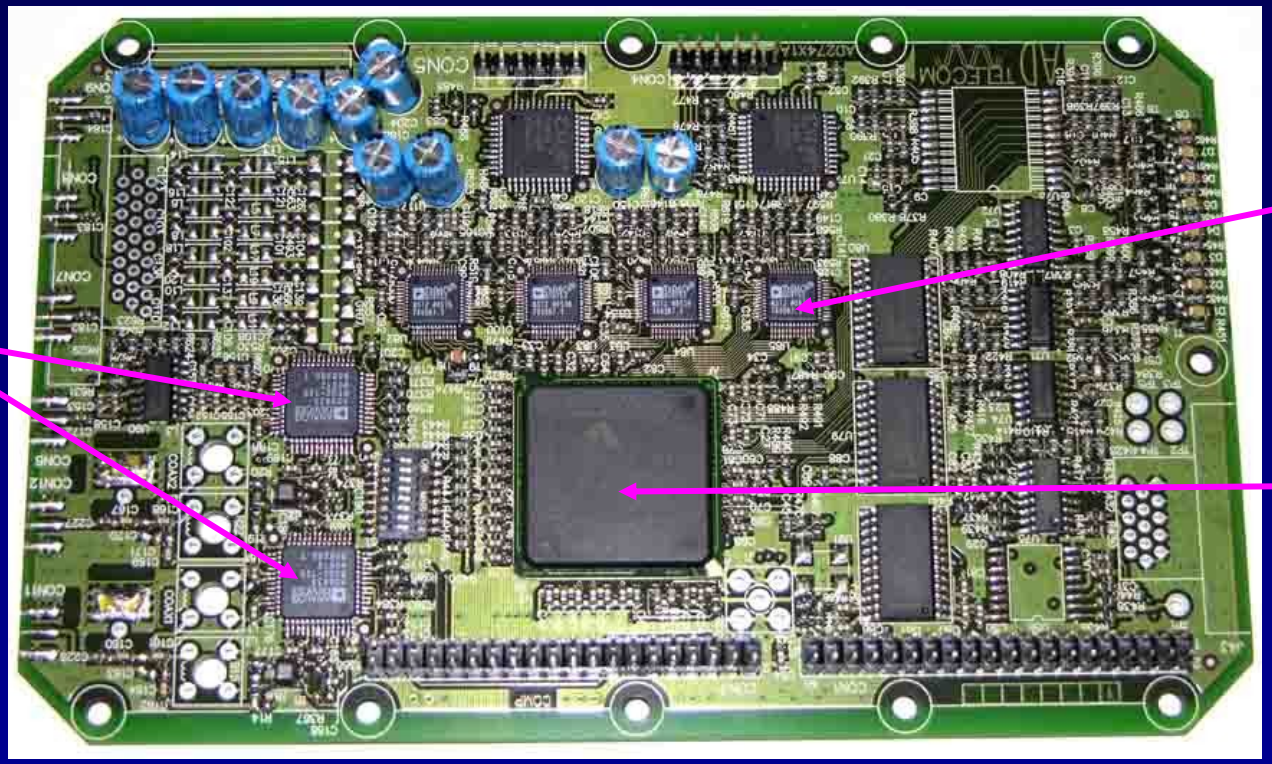
EM – EEPROM memories (in plastic only for development)

FM – EEPROM memories with EDAC (not mounted)

ATMEL SRAM memories with EDAC

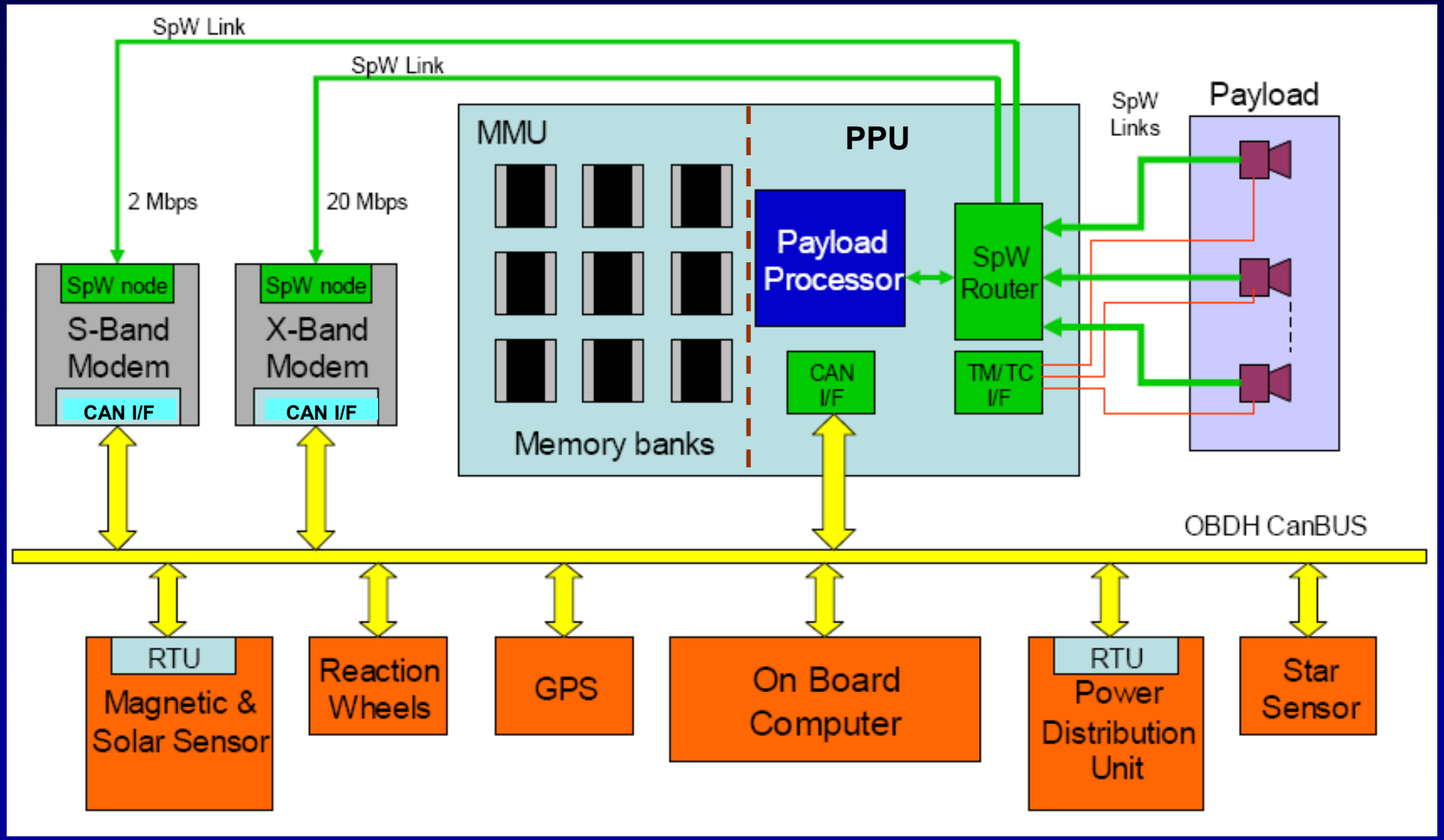


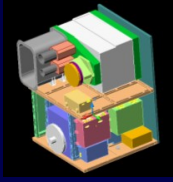
EM - Modem (Dec. 06)



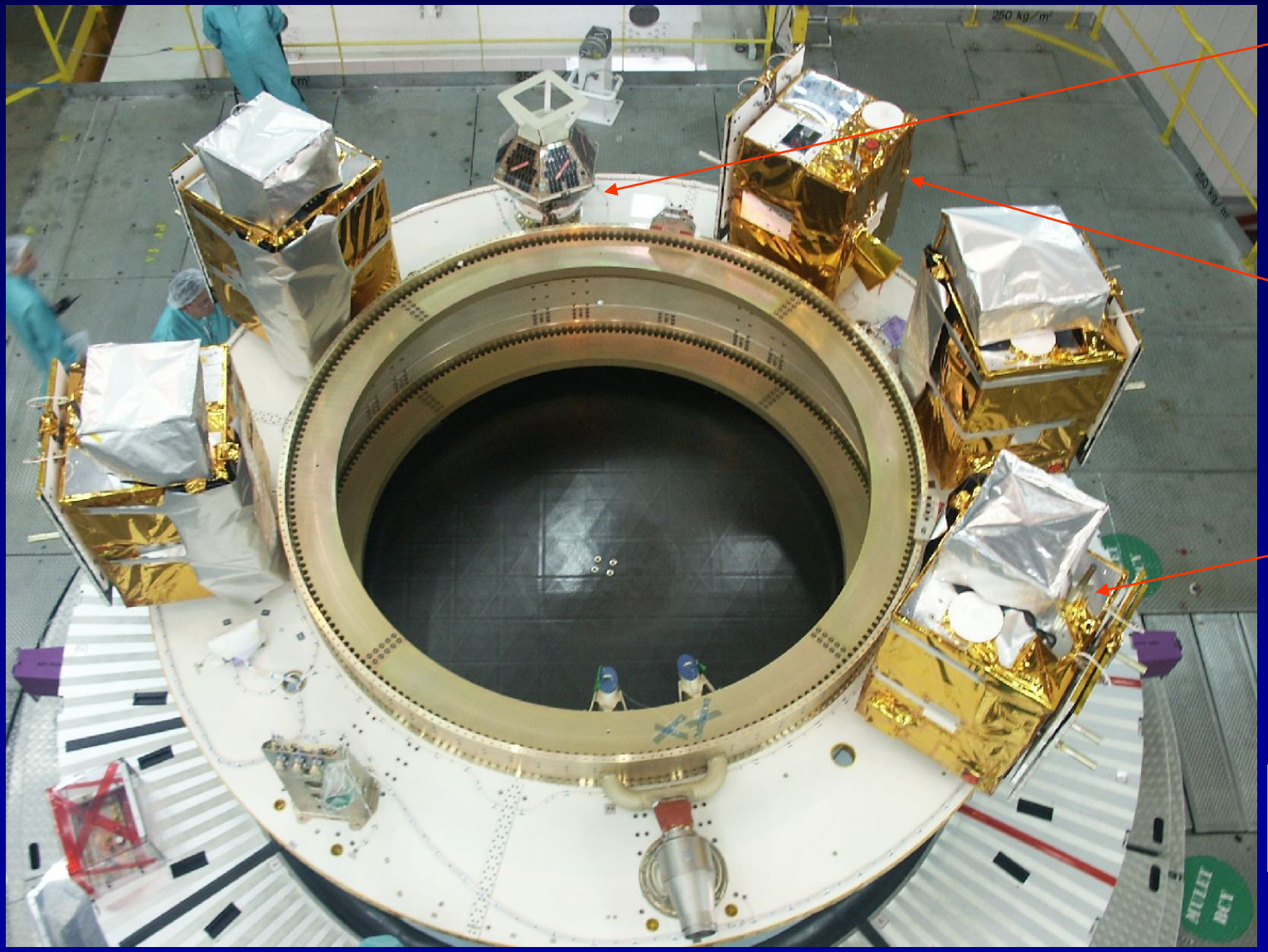
Engineering Model for Nanosat-1B mission (40-80 Kbps), that will be reused for the S-Band TTC transceiver at 2 Mbps and at 20-40 Mbps for P/L TM in MicroSat

SpaceWire LINK DETAILS





LAUNCH WITH ARIANE-5 OR VEGA

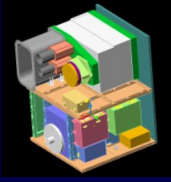


NANOSAT-1 (INTA)

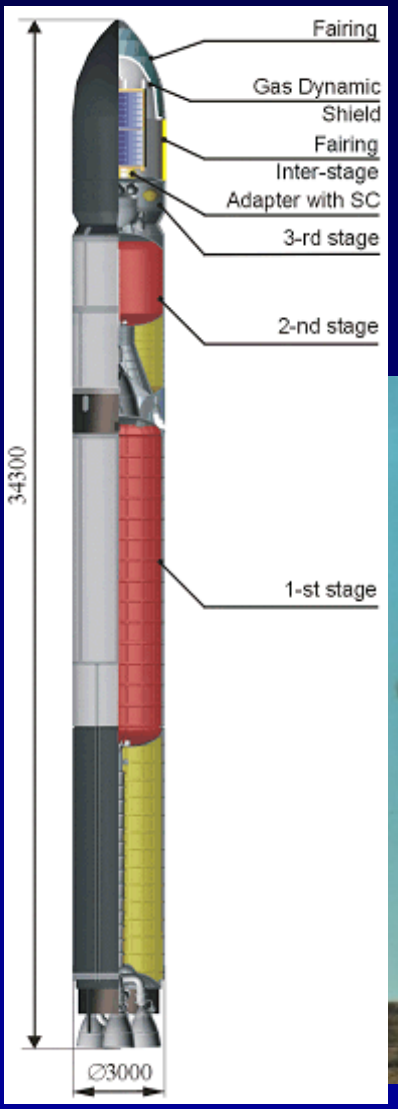
PARASOL (CNES)

4 ESSAIM (DGA- EADS Astrium)

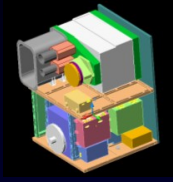
ASAP Passengers in V-165 (18 Dec. 04)



LAUNCH WITH DNEPR

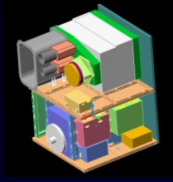


DEMETER (CNES) and several small satellites (June 2004)



CONCLUSIONS (1 of 2)

- Nanosat is a well established programme at INTA since 1998. Very interesting micro & nano-technology and diffuse IR OWLS experiments are running OK in Nanosat-1, in orbit since 18 Dec. 04.
- We have developed with success all the units, subsystems and space & ground segment at INTA, with the help of other national research centres (experiments), some Spanish Universities (SW), and a small RF company in Barcelona (Rx-Tx).
- Nanosat-1B is a sister satellite, that will be launched in 2008 to complement the store and forward communication mission.
- Nanosat-2 is an improved new generation with increased capabilities, but with the same philosophy.
- Since Oct. 05 we have started the MicroSat programme, a 100 – 150 Kg microsatellite as a further step. This again will follow the same principles and development rules of Nanosat, together with the acquired know-how and lessons learned up to now.



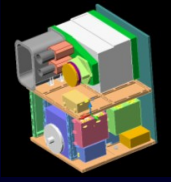
CONCLUSIONS (2 of 2)

- **MicroSat development planning:** The target since the programme presentation in Oct. 05 was to have ready the first mission in 4 years. At this stage near the end of Phase-B and thanks to the R+D Technology effort dedicated to new developments, this objective seems realistic and reachable in 2010.

- **Mid Resolution MS Camera:** We are starting the work and setting the requirements for a new camera that will be develop at INTA, as the Payload for the first Mission INTAμSAT-1.

- **Payload Processor Unit and Spacewire:** After the full testing of the OBDH EM-CPU and CAN bus terminals (EM-RTUs) planned for the end of this year, we plan to develop the PPU and SpW links engineering models along the next year 2008.

We need SPACEWIRE for advanced small satellites missions and we NEED IT NOW ¡



THANK YOU FOR YOUR ATTENTION