HADES & EASAT-2
A VERSATILE PQ PLATFORM

A look inside AMSAT Spain pocketQube satellite platforms
PocketQube Workshop 2020

AMSAT-EA Radio-Amateur Satellite Association – Spain

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AMSAT EA President

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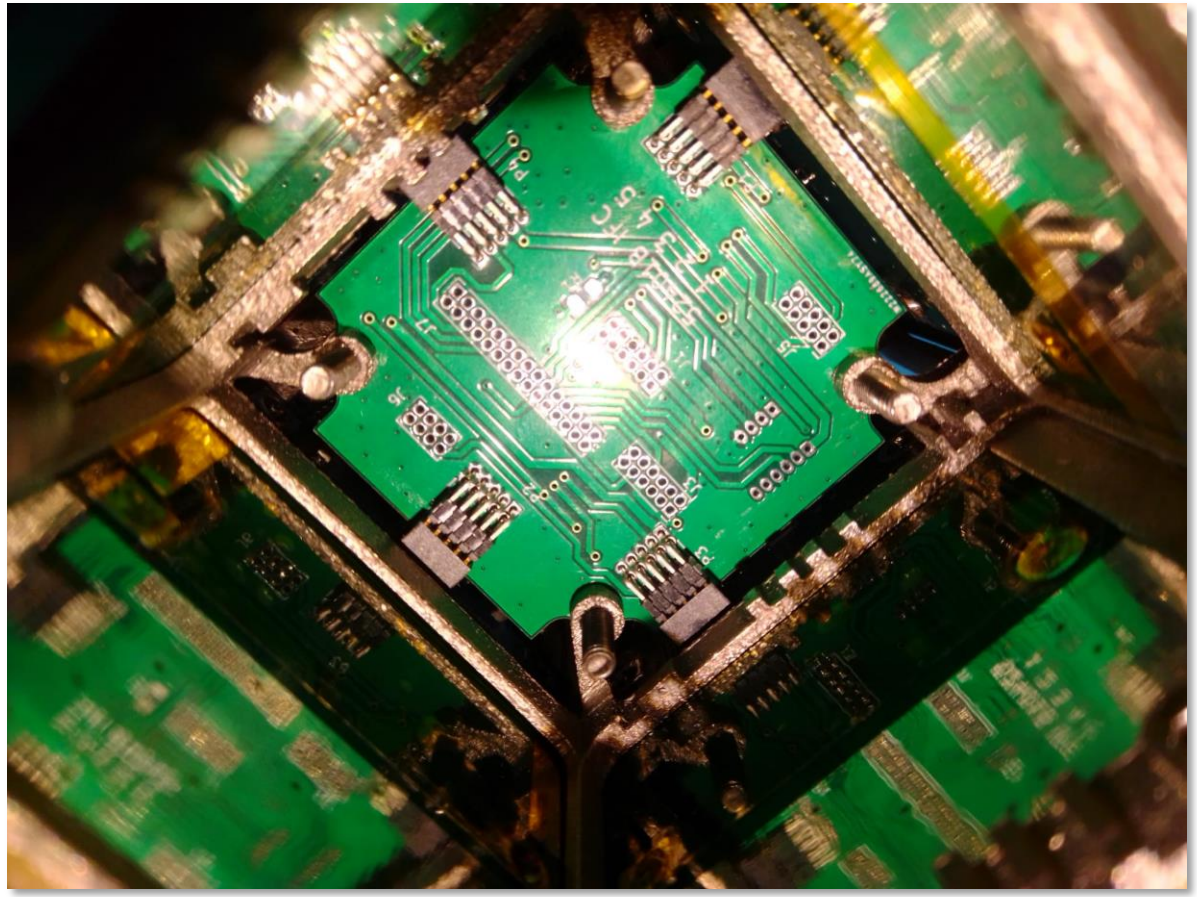


A look inside Hades satellite

ABOUT AMSAT EA

AMSAT EA is a Spanish non-profit cultural association dedicated to the study, information spreading, and the promotion and development of space satellites for the communication of the Radio Amateur Service, as well as the educational, scientific and experimental work associated with it.

AMSAT EA member Philippe EA4NF using Amateur Radio Satellites to communicate with other countries from Famara, Lanzarote Island, in August 2020

ABOUT AMSAT EA

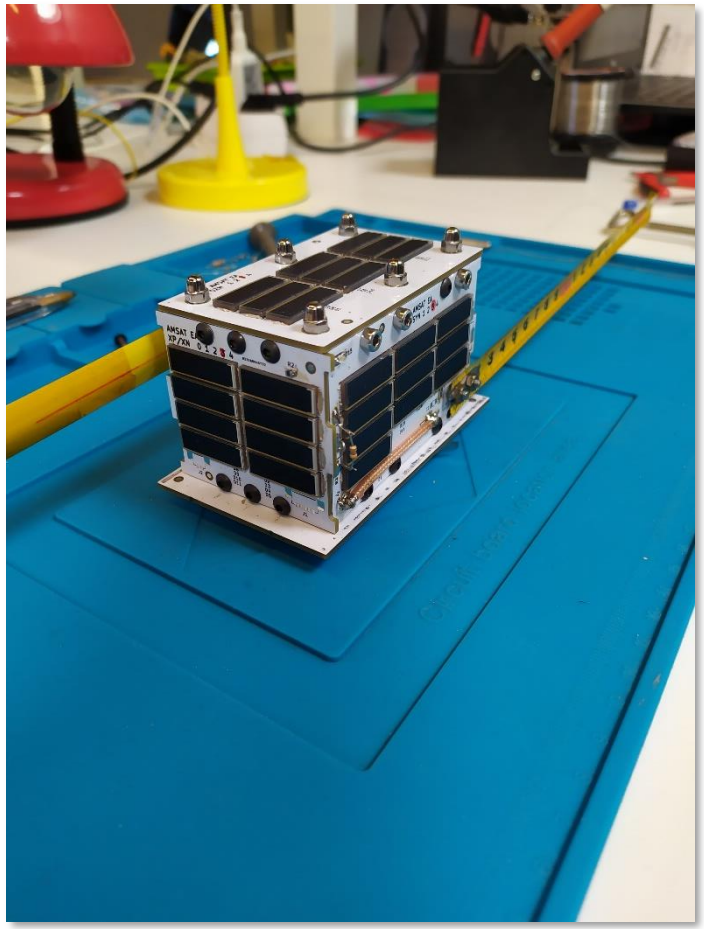
Our grattitude to partners and supporters in these missions

- EASAT-2 and Hades are satellites being made with students from Universidad Europea, being EASAT-2 fully financied by it.
- Comms systems made with help from Universidad Pontificia de Comillas - ICAI, and members of EA-QRP club.
- URE offers administrative support for the projects and acts as a finance support in case of need.

Thanks everybody that has supported these projects someway

The platform: EASAT-2 / GENESIS

- EASAT-2 platform based on GENESIS one due to time restrictions
  - 1.5P format
  - Made of Aluminum (CNC) and PCB (Fiber glass)
  - Small panel surface, but enough for most applications
- Structures allows:
  - Stack of subsystems PCBs
  - Battery
  - Payloads

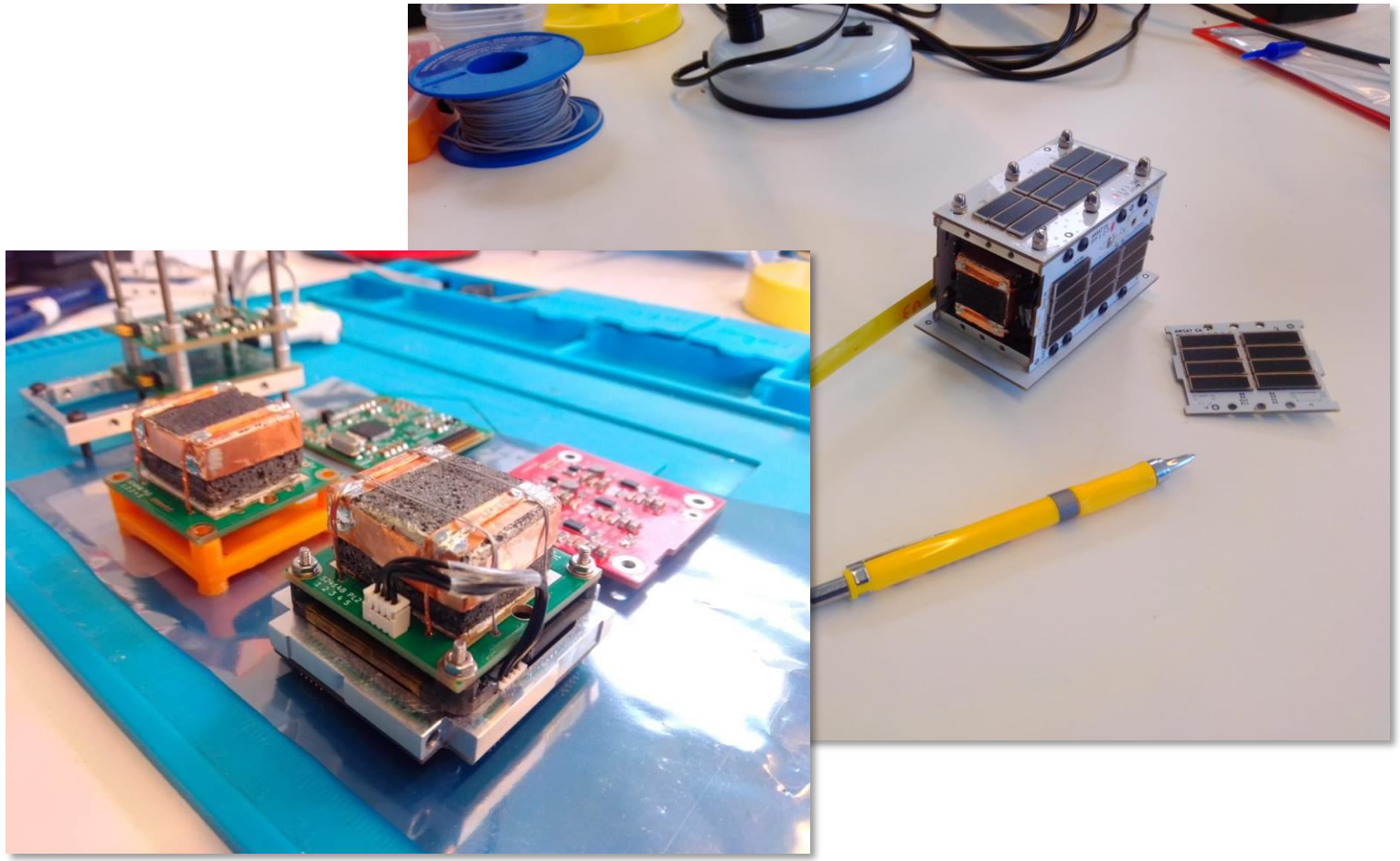


EASAT-2 Engineering model

The platform: EASAT-2 - mission

- VHF to UHF FM voice and FSK repeater
- Digitalized voice FM beacon: AM5SAT
- FSK telemetry
- Radio-meter
- Spin determination

- Payload:
  - Lunar Basalt experiment by research group on meteorites and planetary geosciences of the CSIC at the Institute of Geosciences, IGEO (CSIC-UCM) and that could be used as a construction material on the Moon

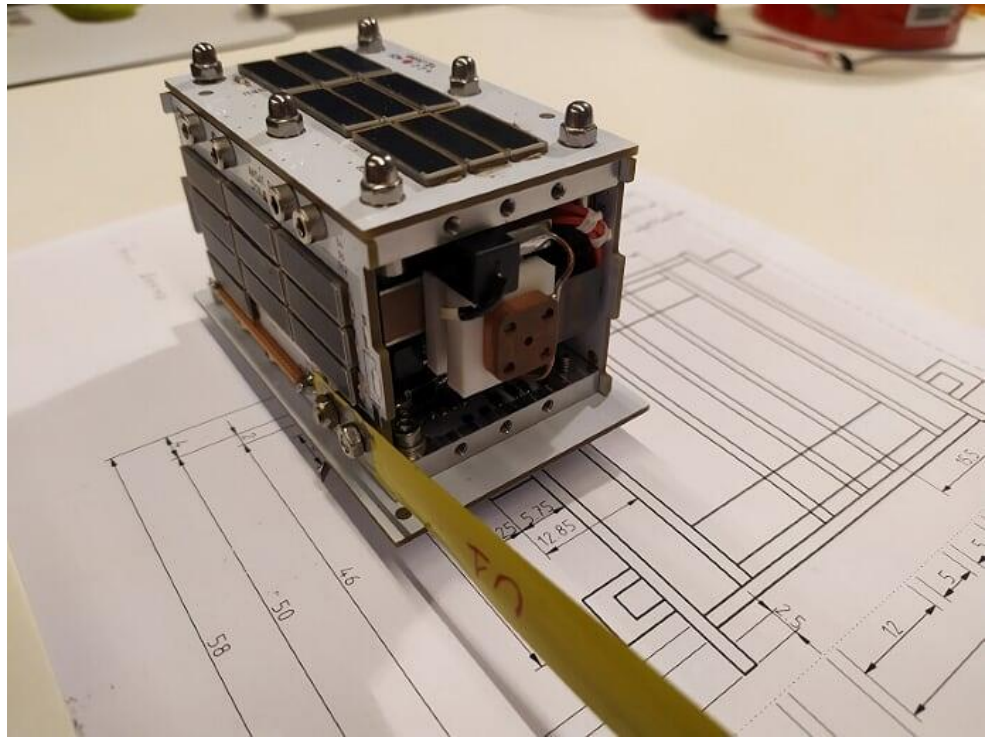


The platform: EASAT-2 – other payloads

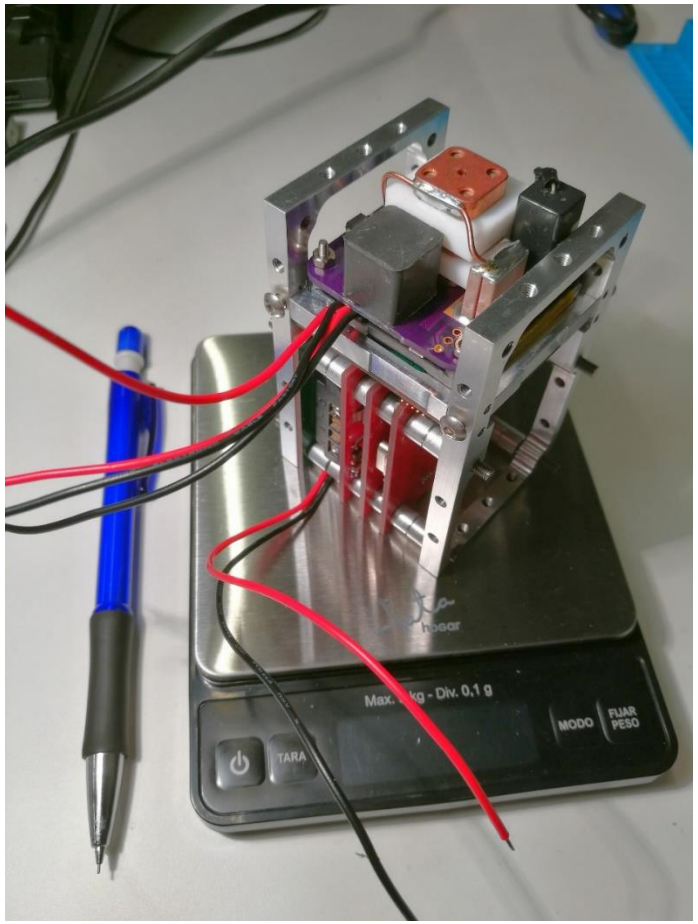
GENESIS-L and GENESIS-N mission flying with Firefly 2020 also used EASAT-2 type platform:

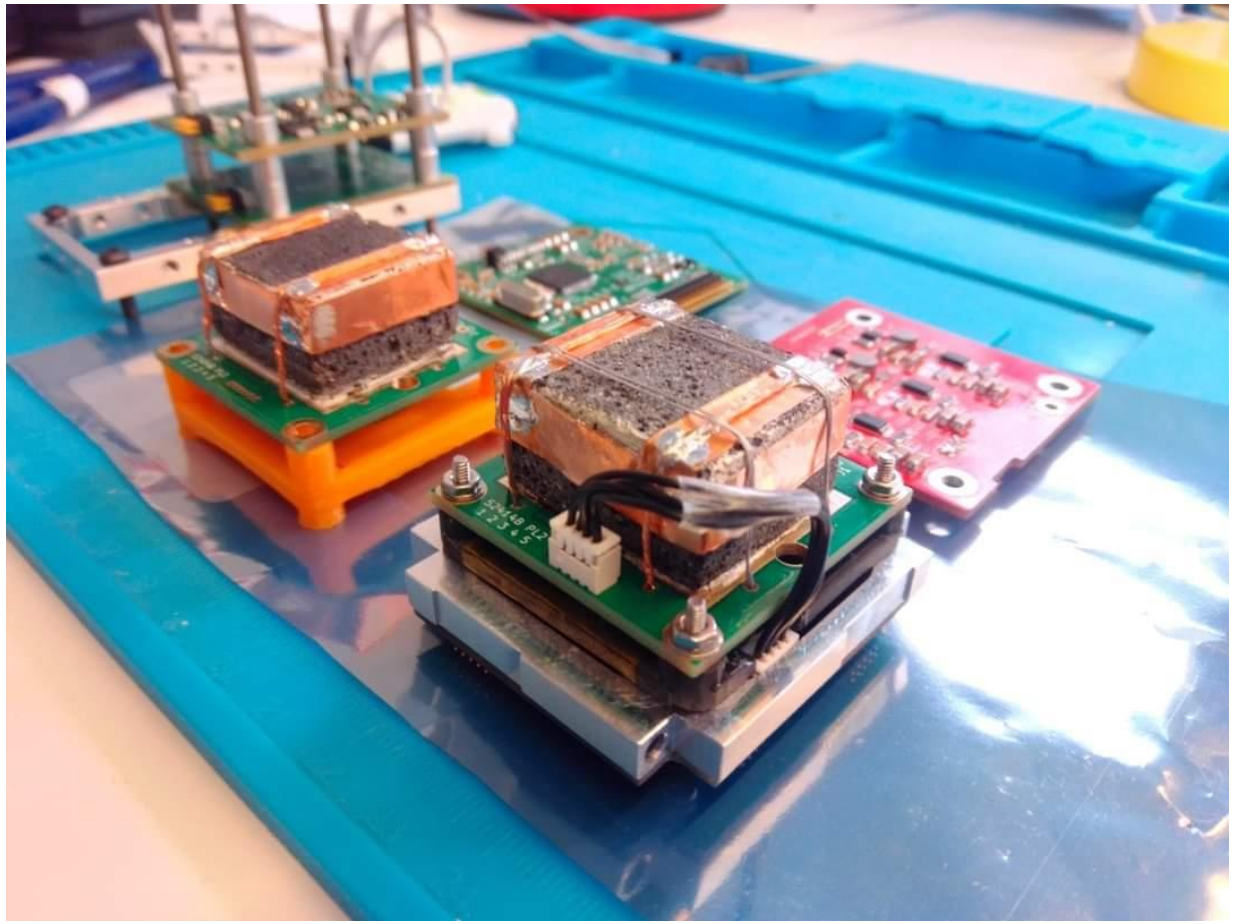
- VHF to UHF ASK/CW digital repeaters

- Payload:
- AIS-gPPT3-1C thruster by Applied Ion Systems



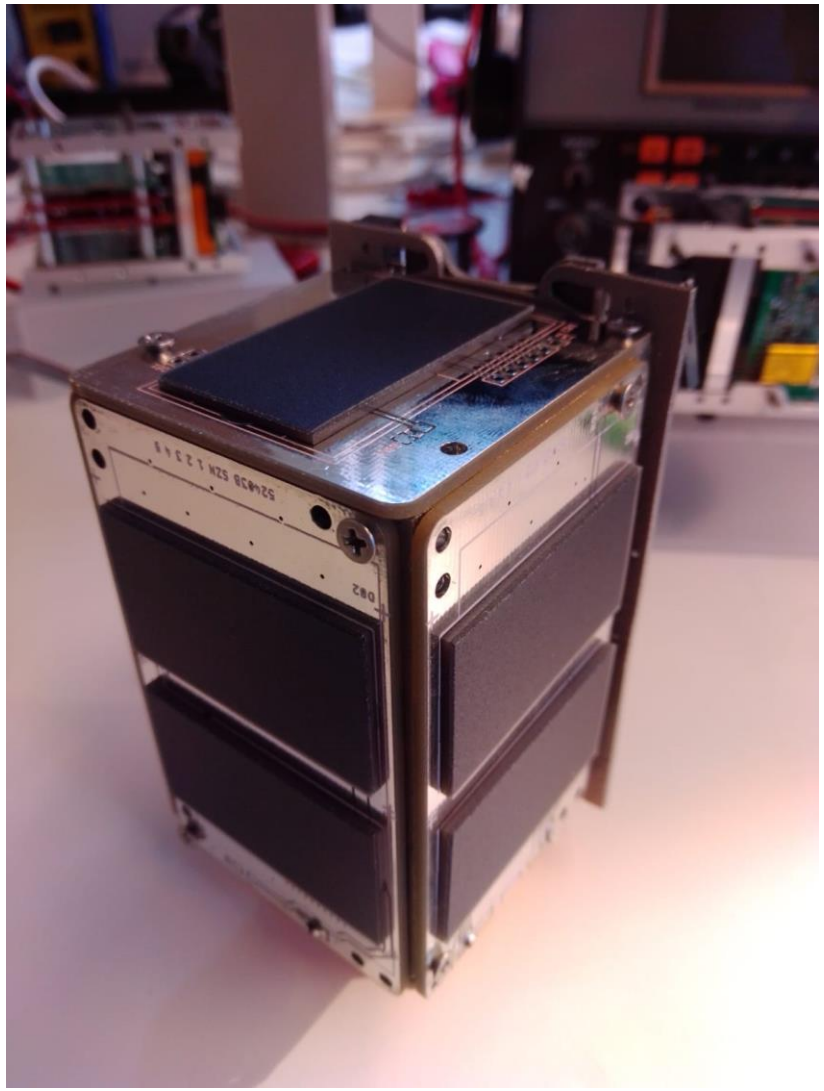
The platform: EASAT-2 / GENESIS - payloads





The platform: Hades

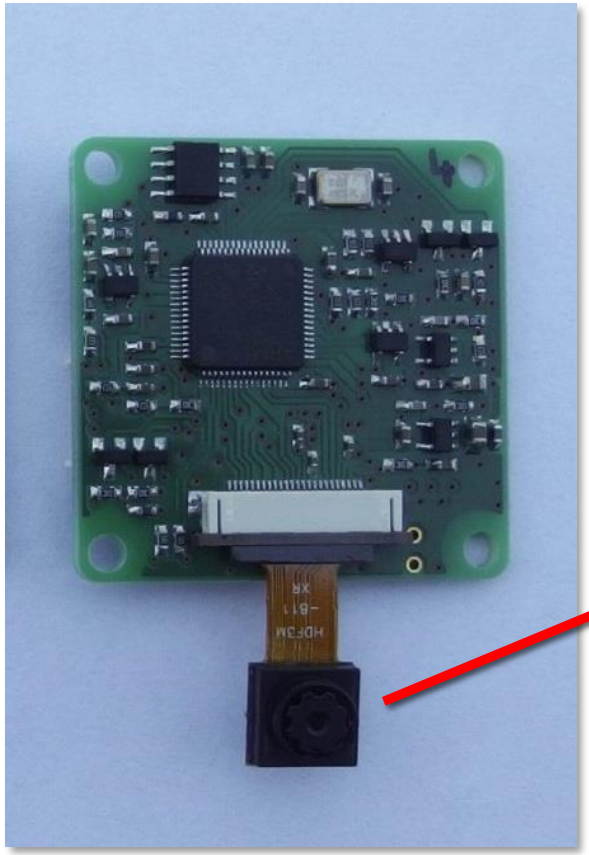
- Hades platform made from Steel
  - 1.5P format
  - 3D printed by laboratory
  - Almost all surface can be used for solar cells
    - Not best panels used by time restrictions
- Structures also allows for:
  - Stack of subsystems PCBs
  - Battery
  - Payloads

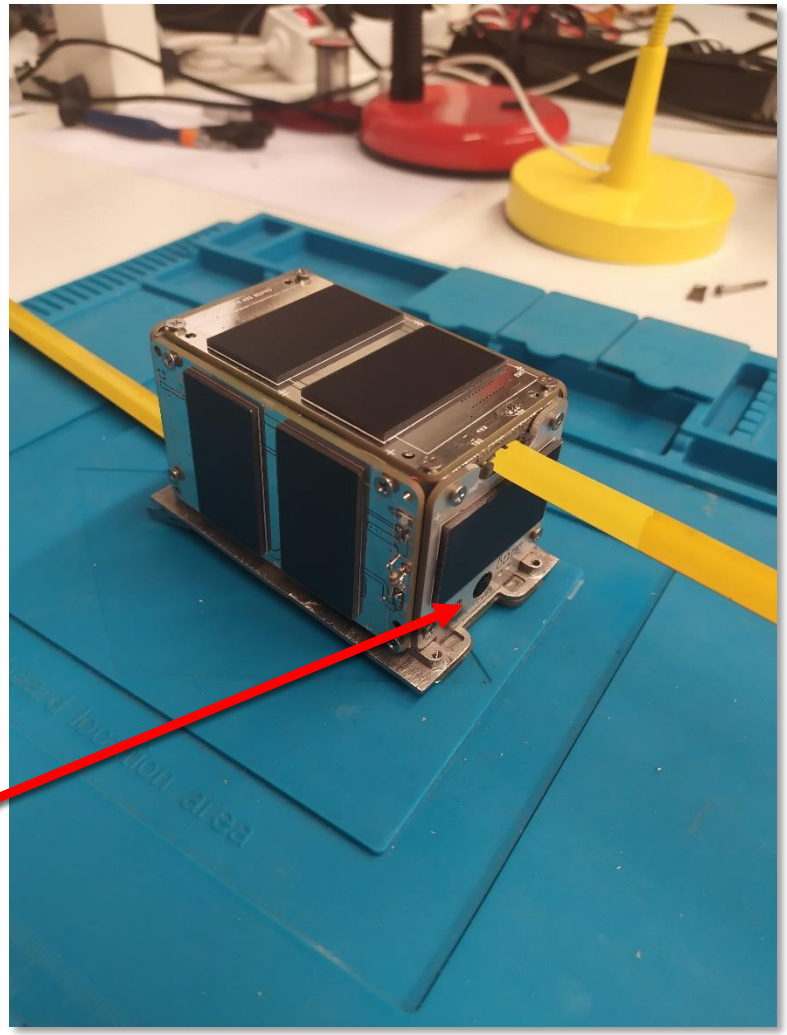


The platform: Hades - mission

- VHF to UHF FM voice and FSK repeater
- Digitalized voice FM beacon: AM6SAT
- FSK telemetry
- Radio-meter
- Spin determination

- Payload:
  - SSTV camera by Brno University
  - Robot36, Robot72, MP73 y MP115.
  - Design based on PSAT2 successful mission

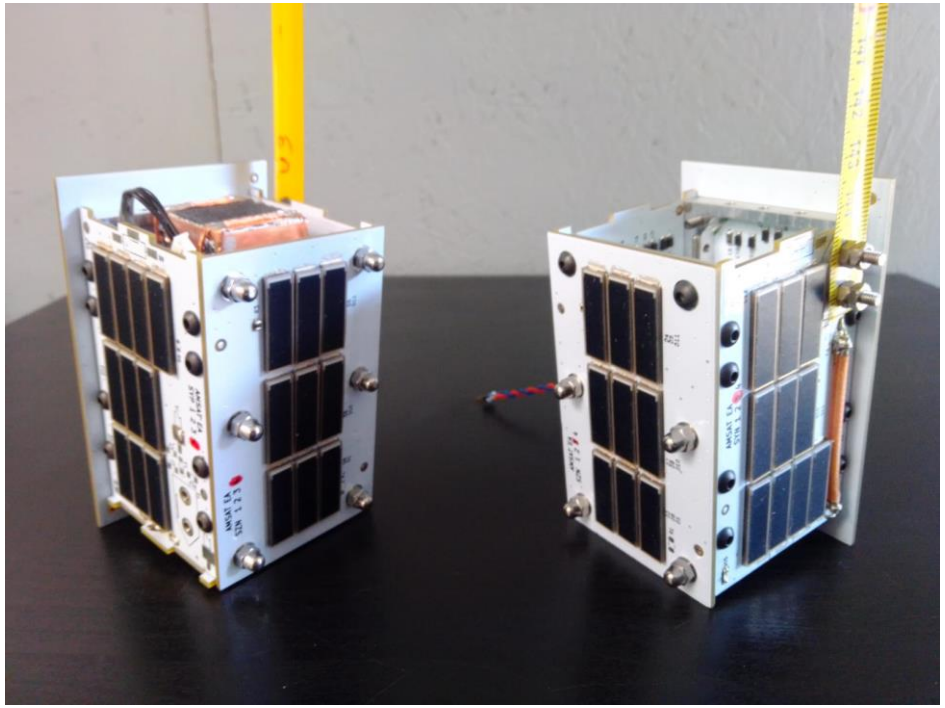




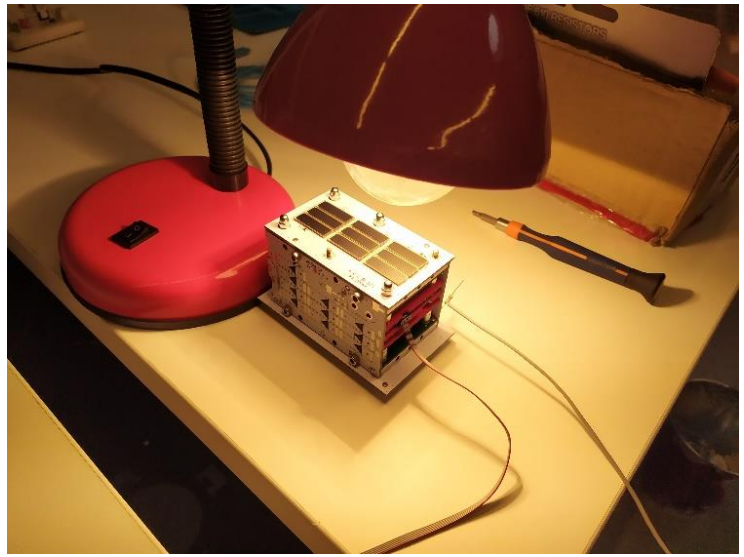
PLATFORM MILESTONES

- ✓Checking feasibility of the structures
  - ✓EASAT-2 / GENESIS one is easy to make
  - ✓Hades one requires Steel / Aluminium 3D printer
- ✓Checking lifetime of different types of solar cells
- ✓Validating EPS
- ✓Validating on-board computer
- ✓Validating custom made RX and TX subsystems
- ✓Integration of different payloads

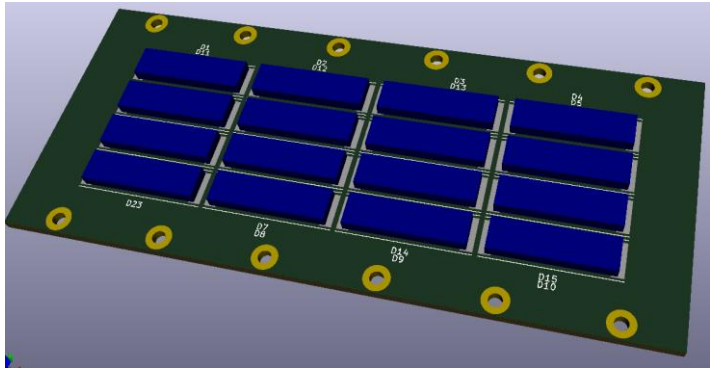
The subsystems around the platform



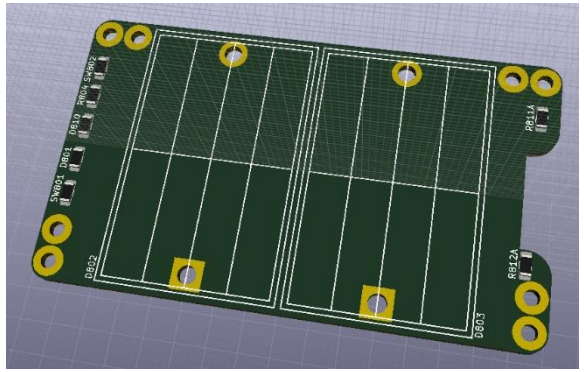
Energy Power System (EPS)



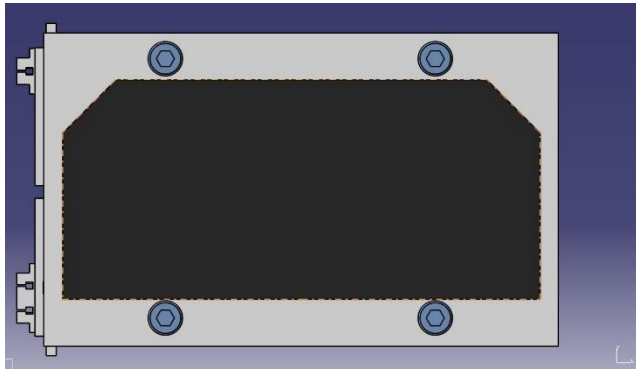
EPS: Solar panels



EASAT-2 configuration

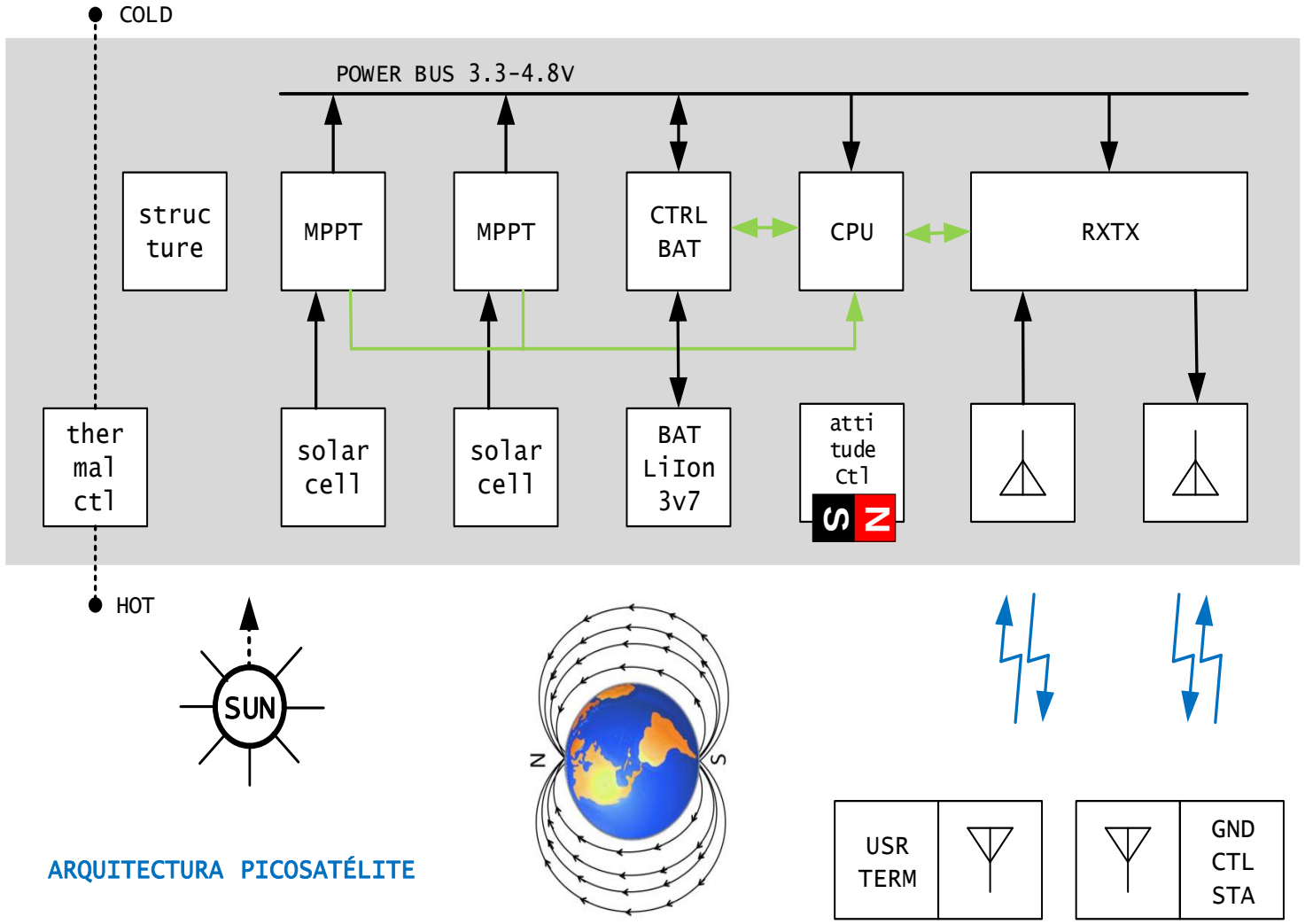


Hades configuration



Intended configuration (next mission!)

Energy Power System



ARQUITECTURA PICOSATÉLITE

Energy Power System (II)

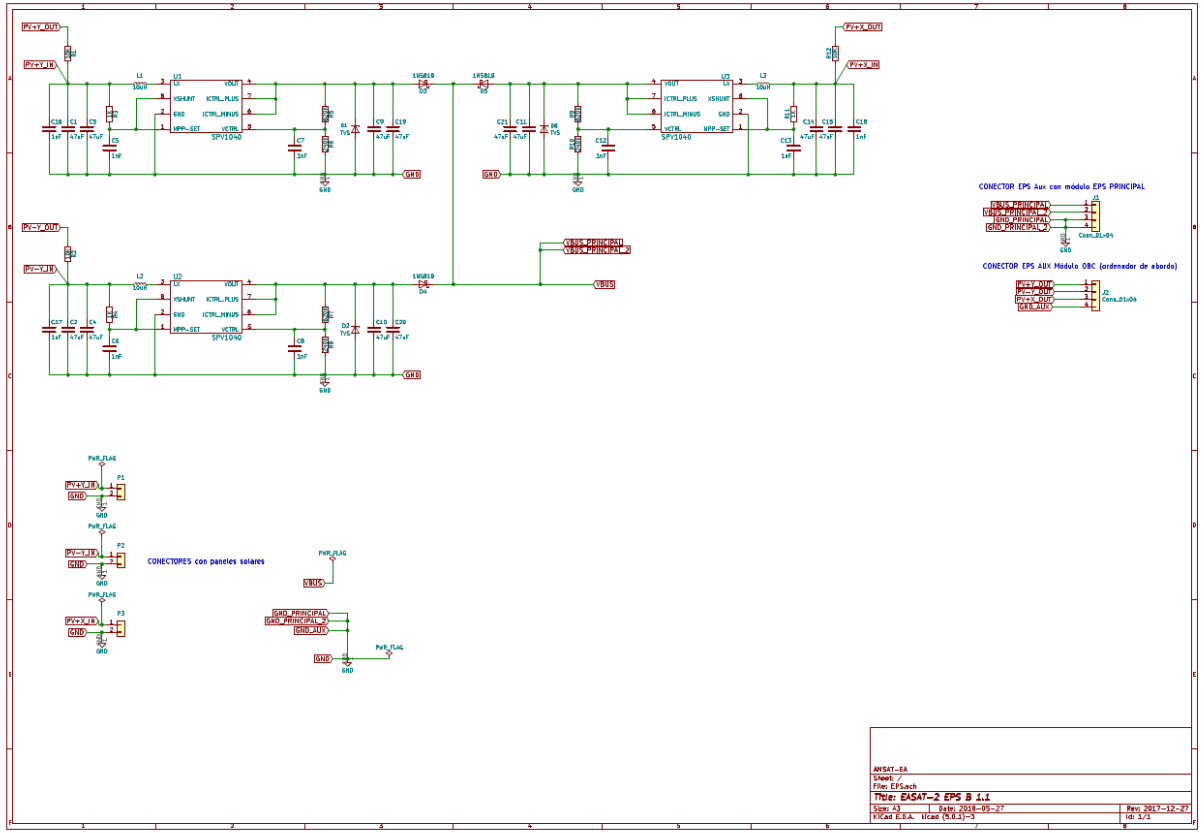
EPS Harvesting

- ❑ First version LTC 3129 based, discarded
- ❑ Second version SPV 1040 based

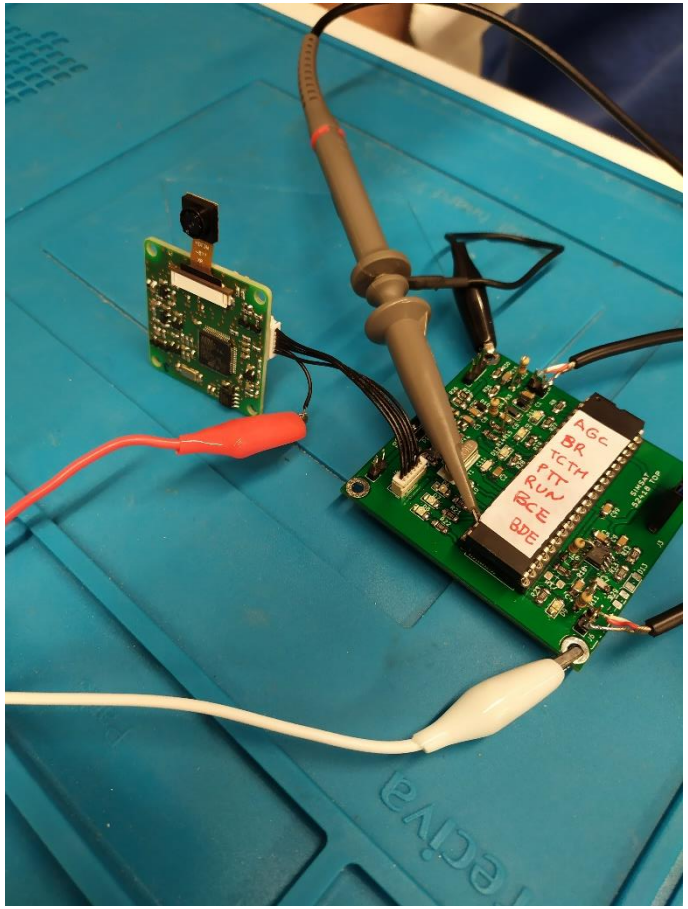
EPS Control

- ❑ Battery not connected directly to floating BUS
- ❑ CPU controls charge and discharge
  - ➢ Sats do not power on from battery
- ❑ CPU can take the battery out of circuit
- ❑ Latch up protection

EPS Energy harvesting

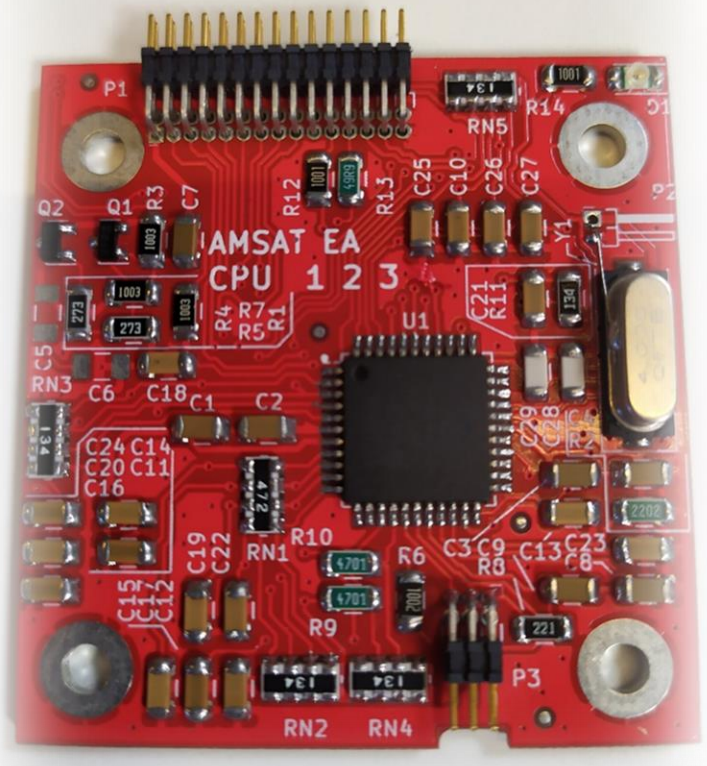


Onboard Computer (OBC)



OBC DEV board connected to SSTV module

Onboard computer (OBC)



HADES / EASAT-2

- PIC 18F46K22
- 64KB Program Flash
- 4KB RAM
- 1KB EEPROM
- 64 MHz, needed for Digitalized voice and DSP (FSK processing)

Used as IHU and DSP (SDR!)

Onboard computer Tasks

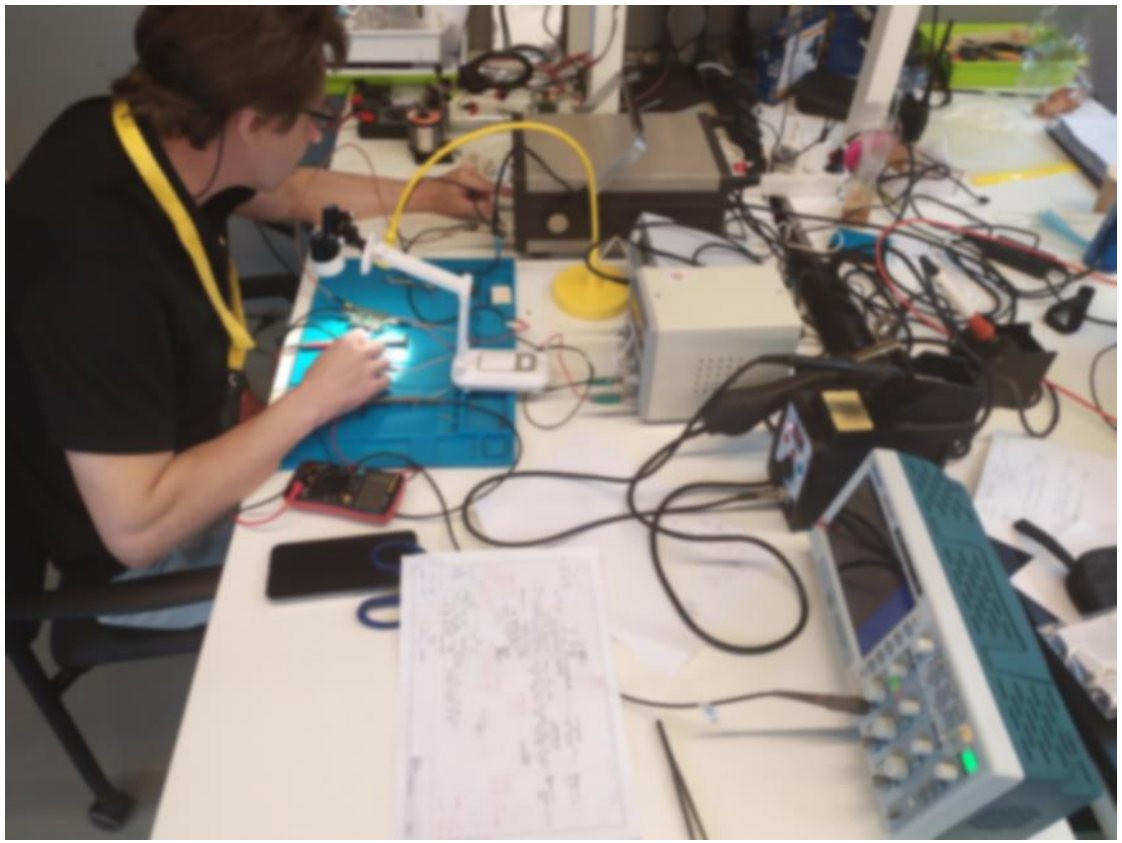
CPU is used as OBC and DSP:

- Reads sensor data including payloads
- Controls EPS (battery levels, incoming currents, invalid conditions)
- Controls RX and TX conditions
- Generates Morse beacon and FSK telemetry
- Generates Digitalized Voice (stored in Flash, about 30Kb)
- Controls SSTV transmissions
- Performs timed RX sampling to decodify FSK datagrams
- Determines RX noise level, the squelch level and the difference level between 0 and 1 for FSK
- Activates the transmitter when a strong signal is detected, which exceeds the squelch level for some time.
- Decodes and processes the remote commands
- Calculates CRCs for both RX and TX
- Generates statistics
- Persists relevant data into EEPROM each 5 minutes

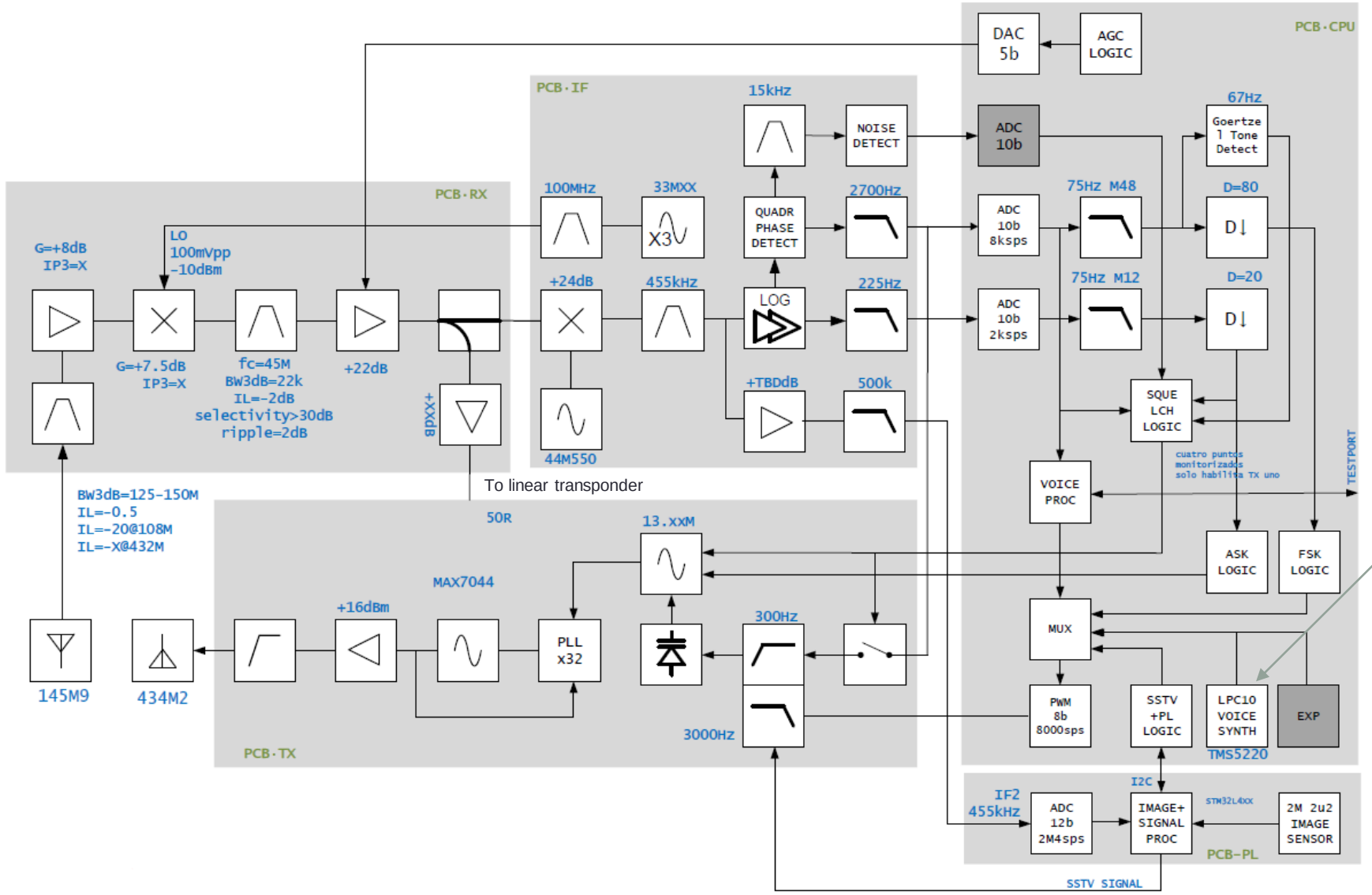
- Custom ad hoc operating system
  - Hardware control
  - Core tasks
  - Scheduled conditional tasks

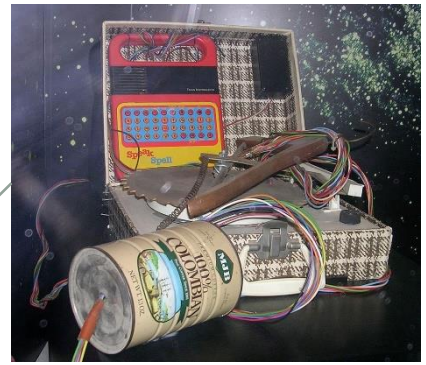
Comms:

VHF uplink
UHF downlink



Comms: Hades / EASAT-2





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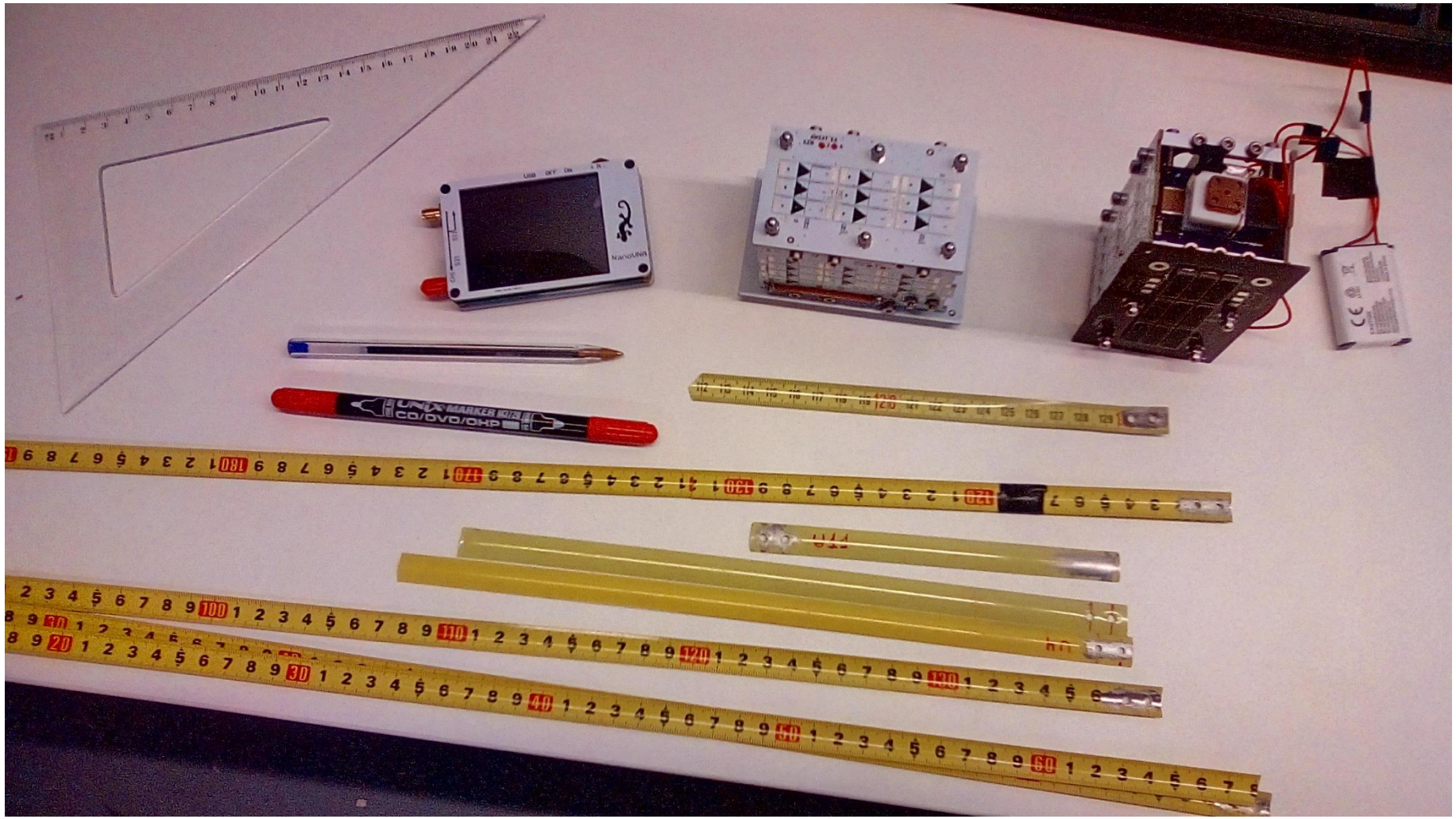
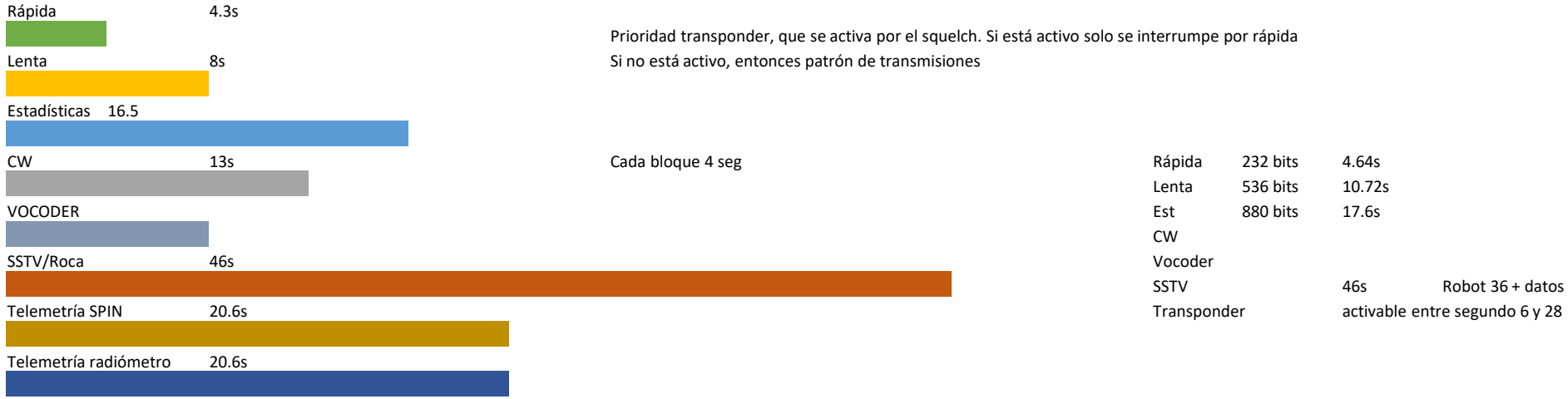
Comms: Antennas



Comms: Testing antennas

Comms: Transmissions pattern



Prioridad transponder, que se activa por el squelch. Si está activo solo se interrumpe por rápida
Si no está activo, entonces patrón de transmisiones

Cada bloque 4 seg

Rápida	232 bits	4.64s
Lenta	536 bits	10.72s
Est	880 bits	17.6s
CW		
Vocoder		
SSTV		46s Robot 36 + datos
Transponder		activable entre segundo 6 y 28

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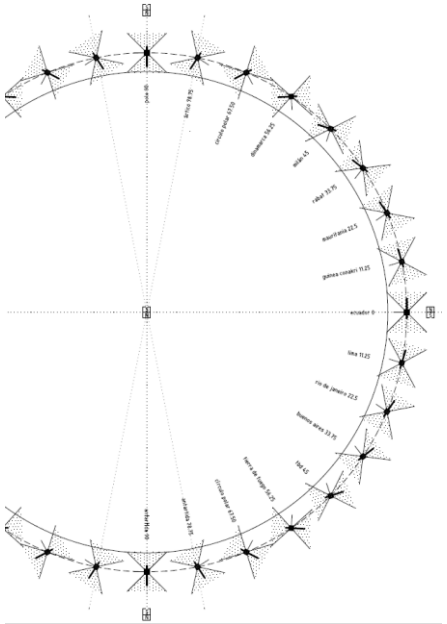
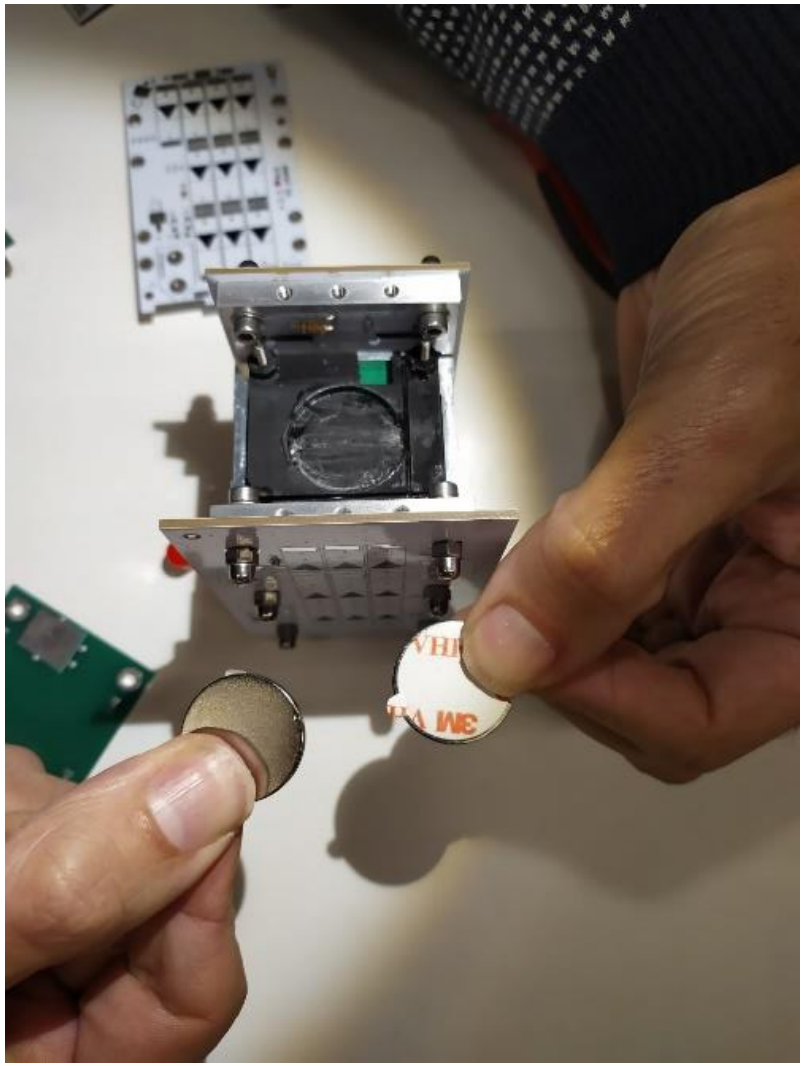
Attitude Control

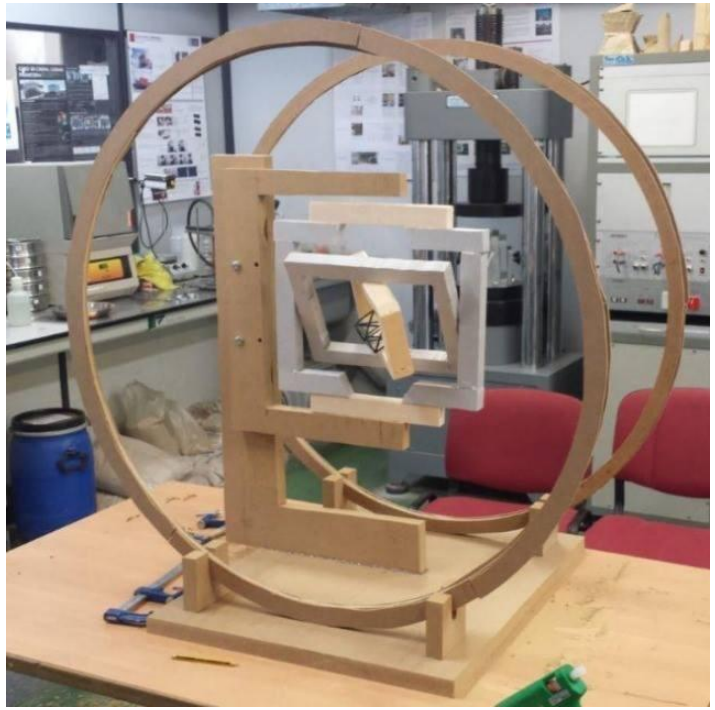
Usual passive system on small sats based on a magnet and hysteresis rods

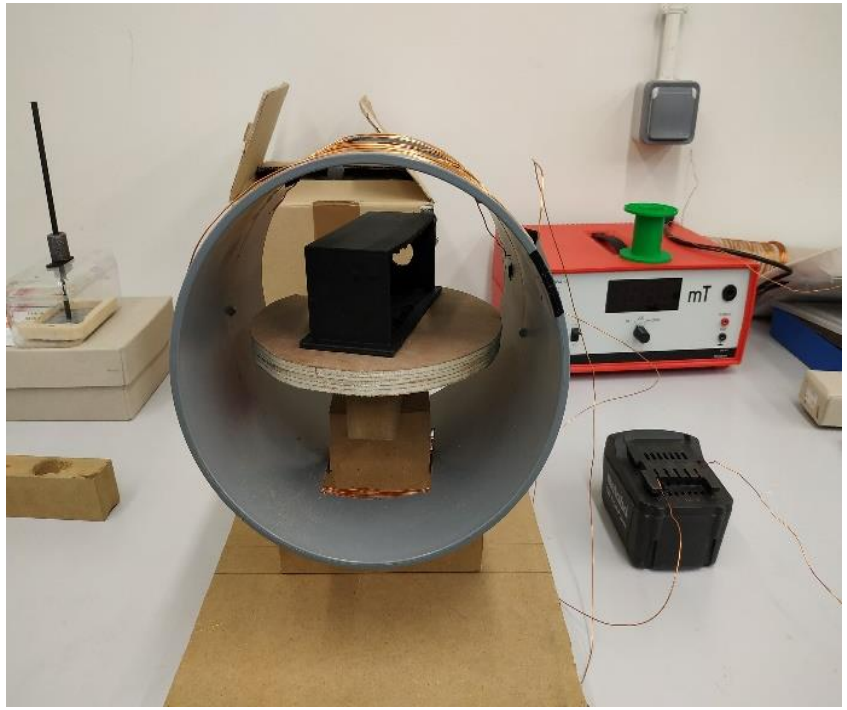
- Should align satellite with Earth magnetic field
- No space for active systems
- Enough for the application

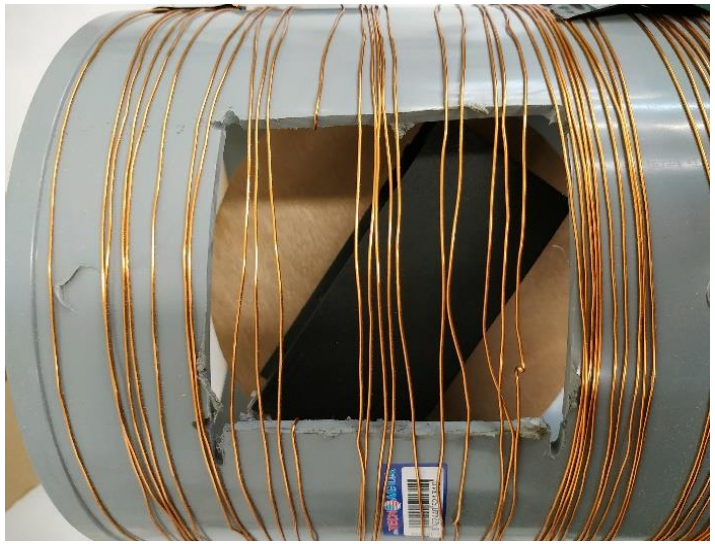




Attitude Control: Testing







Thanks a lot for watching

Write us to contacto@amsat-ea.org

More information on https://www.amsat-ea.org/proyectos/

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