CHEAPS: CHaracterizing Earth Albedo and Planetary Systems (Walking on the cheap side of life)

A. Moya, H. Deeg, P. Amado, E. Palle, E. Martin, C. Martínez and the INTA team

General context (science)

PLANETARY SYSTEMS

1) Searching for life on other planets.
2) We need to find and study planets orbiting other stars
3) Roadmap already designed: Exoplanet search, accurate characterization of these exoplanets, searching for biomarkers on their atmospheres.

ESA Exoplanet Roadmap Advisory Team (EPR-AT) October 2010

General context (science)

EARTH ALBEDO

Objective: Absolute calibration of the Earth's albedo related with the Sun emission

Justification: The Earth's climate depends directly on the net sunlight incident on the Earth and the amount of sunlight reflected back into space

Present problem: All the space missions characterizing Earth's albedo rely on absolute measurements and they are prone to calibration errors

Scientific cases

The project has two main objectives:

1) Accurate characterization of known exoplanets. The discovery of new exoplanets is possible.
2) Monitoring of Earth's albedo.

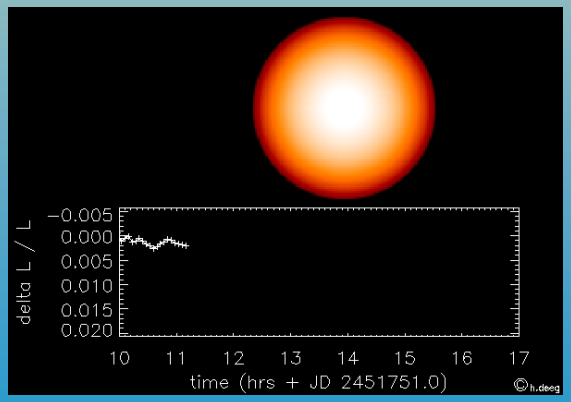
Observational technique: Time series of high-precision photometry. The photometric band to be determined.

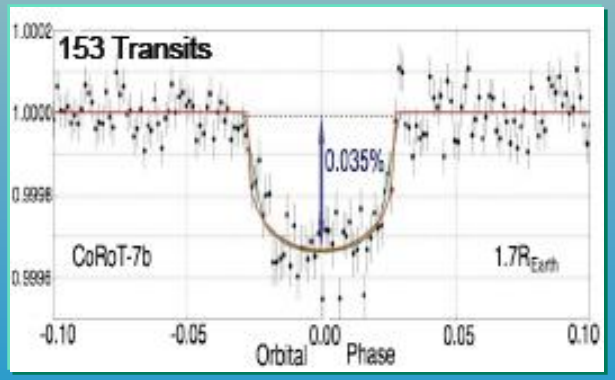
Sub-Scientific case 1

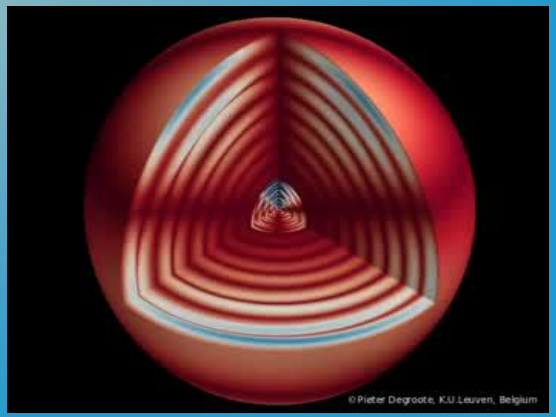
Techniques:

1) Monitor of transiting planets
2) Accurate determination of the stellar properties using asteroseismology
3) Monitor of transits on planets discovered using radial velocity. There are around 20 planets with high transiting possibilities.

If possible, we are going to monitor the spectral regions dominated by vapor water and stars with debris disks



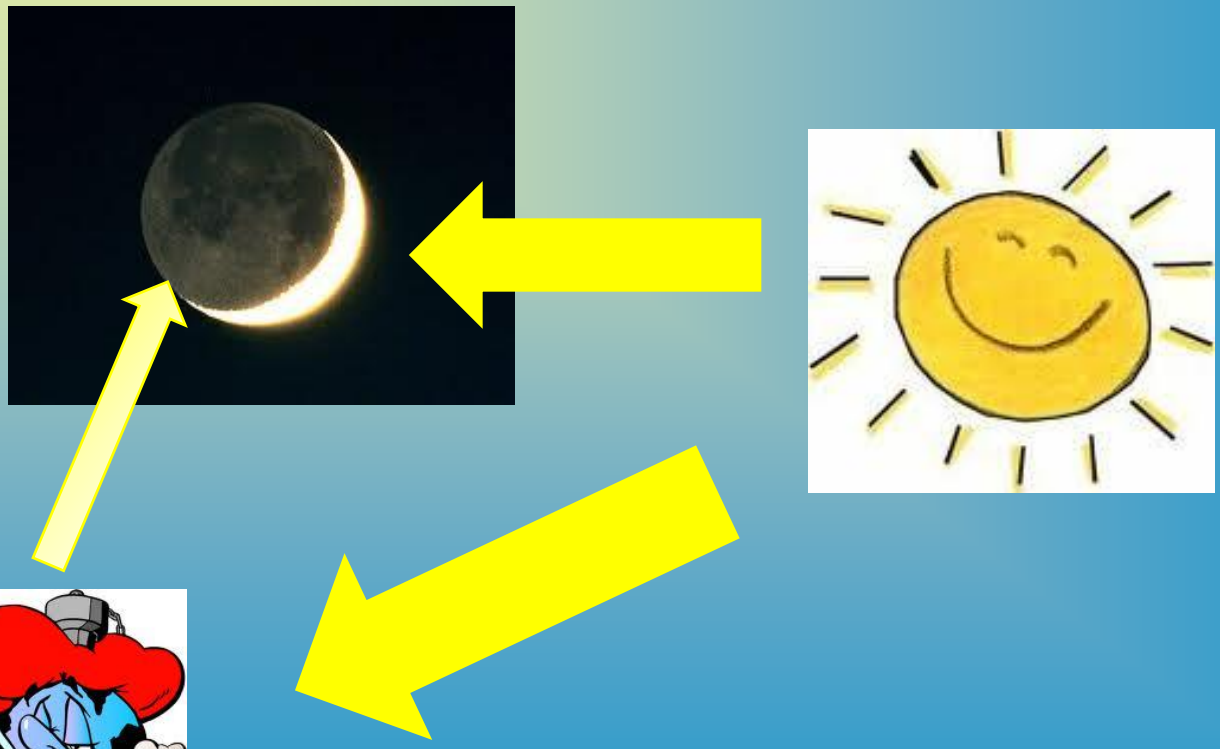




Sub-Scientific case 2

Technique: Observation of the day and night areas of the Moon

The FOV of the satellite allows the achievement of this objective



General context (technical)

INTA

Spanish National Institute for Aerospace Technology. In space since 1974: INTASAT (1974), MINISAT (1997), NANOSAT 1A (2004), NANOSAT 1B (2009)

OPTOS

New line in CubeSats:

- A reliable platform to provide “easy” access to space
  - High quality and standards / short development time
- First in the line: OPTOS (to be launched 2012)
- Actual status: FM integration and testing

FIRST GOAL: CubeSat pointing at will ☑

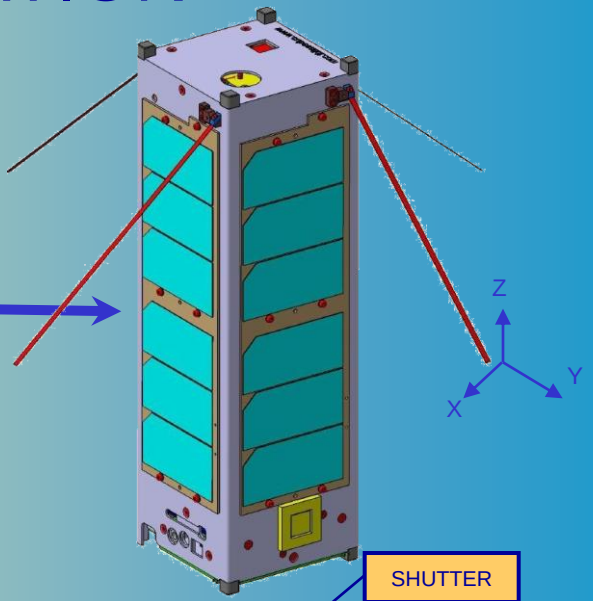
NEXT GOAL: Accurate pointing (OPTOS 2G), Scientific payload

The platform

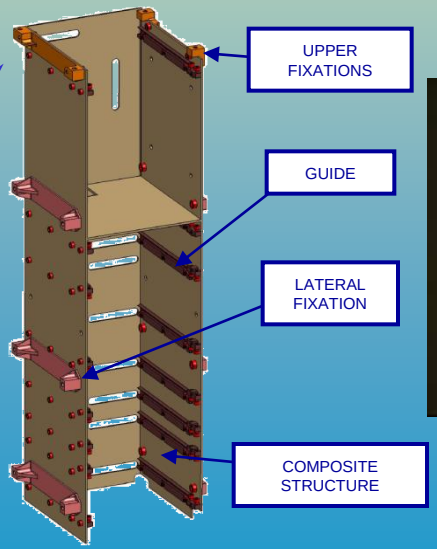
SYSTEM CONFIGURATION

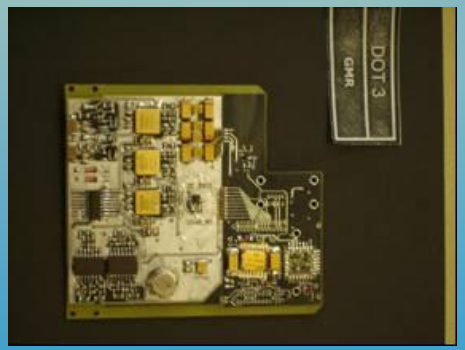
External Structure:
CUBESAT KIT 3U

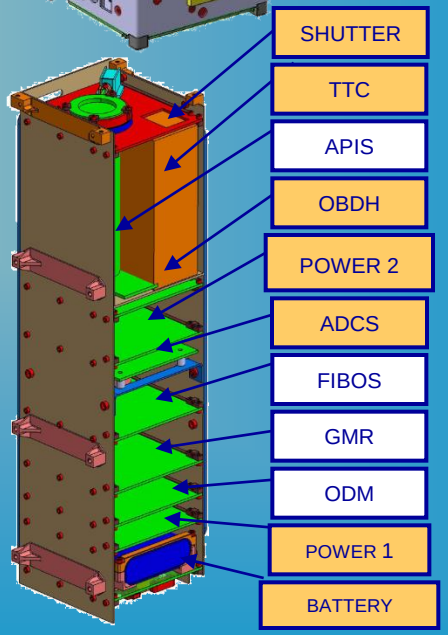
External Configuration



Internal Configuration







CHEAPS

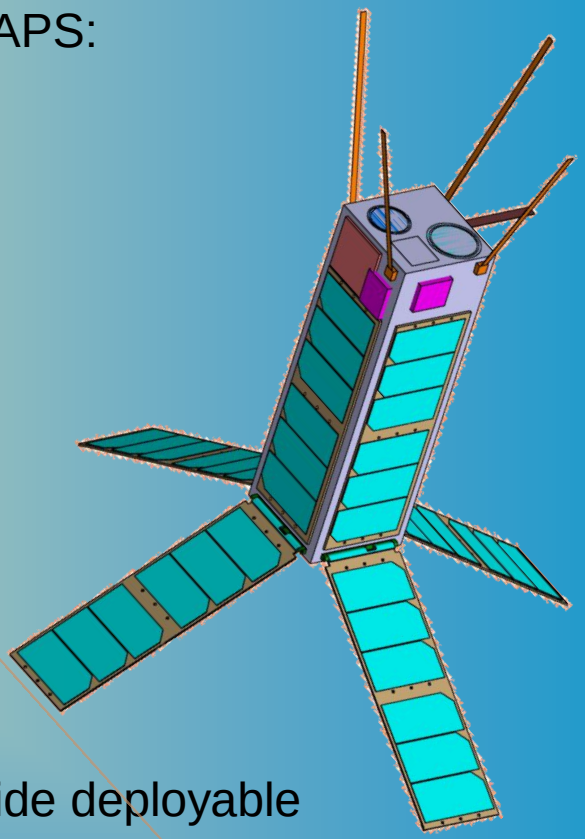
INTA: OPTOS 3U CubeSat line

- Why is OPTOS different from other CubeSats
  - OPTOS is a PROFESSIONAL, not an EDUCATIONAL satellite
  - ECSS standards / MIL-STD-883B qualification
  - Structure: Composite internal / standard CubeSat external
  - OBDH: Distributed architecture (cards in rack) based on CPLDs and FPGAs
  - Internal communications: Wireless from card to card (infrared)
  - TTC: Half-duplex, UHF, 4 monopoles, 5kbps (down) / 4kbps (up)
  - EPS: 4 PCB solar panels with 6 Triple Junction cells each (7.2W EOL)
  - ADCS: 1 RW, 1 MGM, 2 SS, 1 SPD (sensors) / 1 RW, 5 MGT (actuators) → 5 deg (knowledge), 15 deg (control), 20 arcsec (stability)

OPTOS 2G: improvements

- OPTOS 2G to carry an specialized mission as CHEAPS:

  improvements needed:
  - Specialized and “professional” payload
  - Strong room requirements
  - Strong power requirements
  - Strong pointing requirements
  - Strong data budget requirements



- OPTOS 2G improvements predesigned:
  - ➢ An specialized telescope
  - ➢ Space optimized due to subsystems relocation: up to 150 x 100 x 100 mm available for payload
  - ➢ Power: same than OPTOS + four 6-cell double-side deployable panels in “tetrahedron” configuration: up to 18W
  - ➢ ADCS: same than OPTOS but: 5 SS + 4 wheels + 1 star tracker → 10 arcsec (knowing), 1 deg (control), 20 arcsec (stability)
  - ➢ TTC: OPTOS (UHF) + S-band transmitter: full-duplex, 4-256 kbps configurable (down) / 4 kbps (up)

First optical study

Done for the worst case, that is:

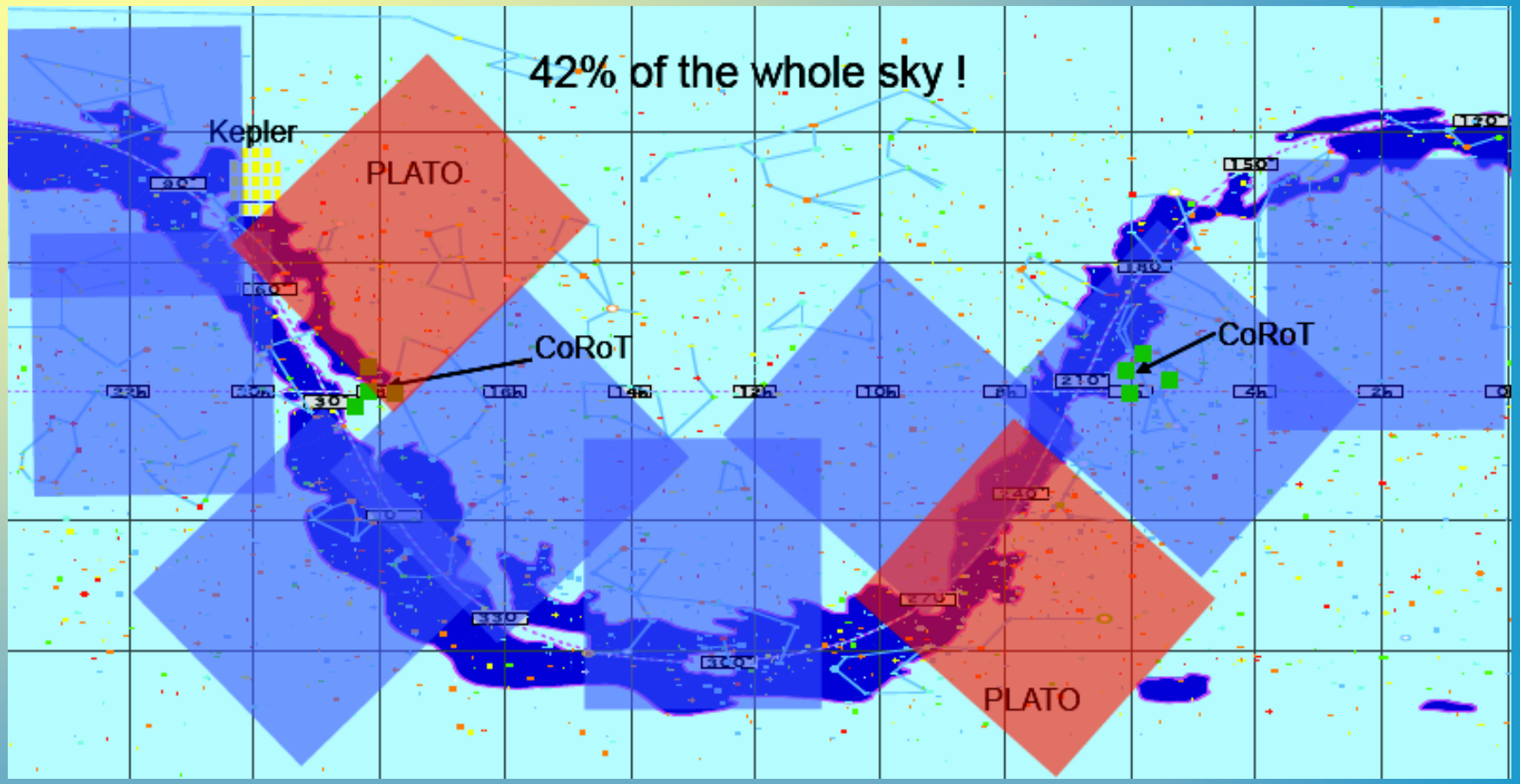
1) Star of Mv=8
2) Aperture = 4cm

The worst and limiting case is 1mmag for and sampling of 15min

CHEAPS in context

1) The project covers a large group of targets not covered by the rest of the space missions (Kepler, CoRoT)
2) It will by launched, if everything is OK, before Plato and ECHO
3) It is compatible and complementary with the ground-based projects (CARMENES, EXPRESSO, etc.)
4) It is a interdisciplinary project, (exoplanets and Earth climate)

One of its main characteristics is that CHEAPS will point wherever we want, whenever we want, and the time we want.


42% of the whole sky !
Kepler
PLATO
CoRoT
CoRoT
PLATO

This mission is also a very good school for more ambitious space projects

Thank you!