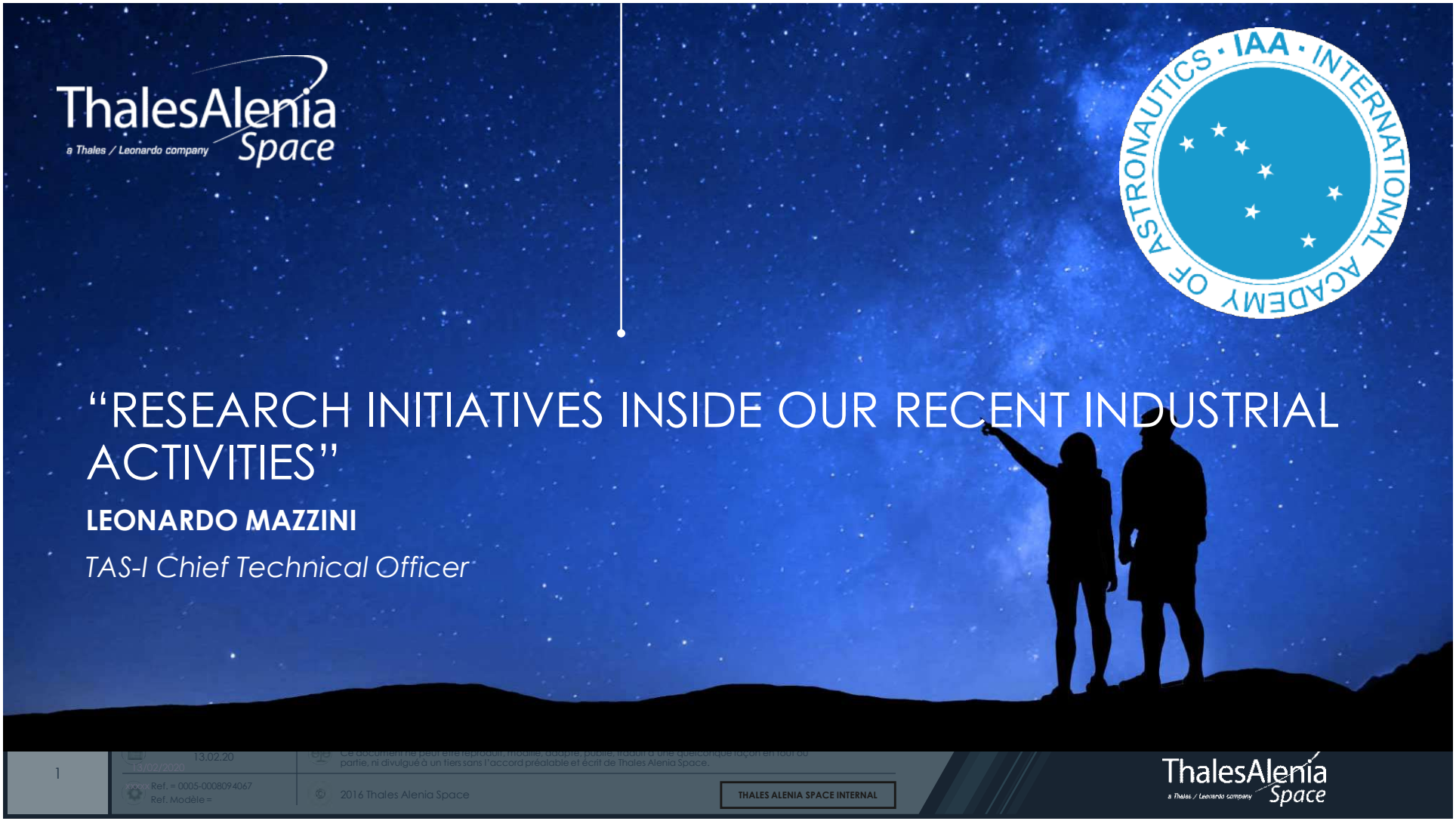
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IAA · INTERNATIONAL ACADEMY OF ASTRONAUTICS ·
"RESEARCH INITIATIVES INSIDE OUR RECENT INDUSTRIAL ACTIVITIES"
LEONARDO MAZZINI
TAS-I Chief Technical Officer
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13.02.20
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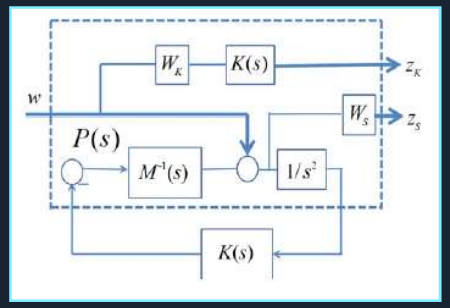
Research is a mission of TAS in the full Space Arena

RESEARCH ACTIVITIES – *AGILE AOCS*

- ***AOCS Attitude control for agile and flexible systems with specific focus on large flexible antennas***
  - Remote sensing satellites require agility to improve revisit performances theater imaging.
  - However radar satellites are equipped with large antennas requiring special AOCS design (for example H_∞ Design with Acceleration Sensitivity).

- AOCS for flexible structures -

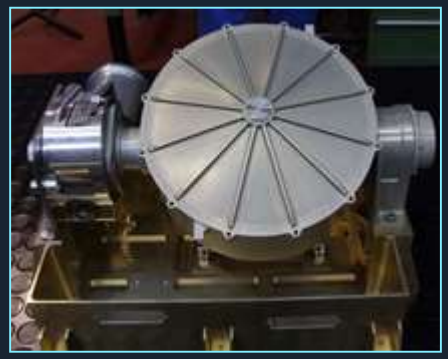


- Mixed acceleration sensitivity set up -
(image taken from "Flexible Spacecraft Dynamics, Control and Guidance" by L.Mazzini)

- EOS 20 Radar (Korea) -

RESEARCH ACTIVITIES - *AGILE AOCS*

- ***Agility requires the development of new control actuators and specific AOCS structures***
  - ***Control Moment Gyro*** (CMG), an actuator able to strongly enhance satellites attitude agility.
  - ***Miniaturized Control Moment Gyro*** (MCMG) where electronics and mechanics have been optimized for the use on microsatellites.
  - ***Gyro-CMG internal loop control*** Large bandwidth Gyro-CMG loop to realize high fidelity target acquisition profiles with minimal effect from flexible modes



- Control Moment Gyro -

- Mini Control Moment Gyro -

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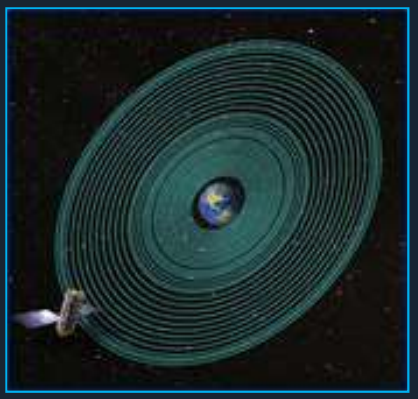
RESEARCH ACTIVITIES – *ORBITAL TRANSFERS OPTIMIZATION*

❑ ***Orbital transfers optimization***

- The use of ***plasmic propulsion*** allows telecom satellite transfer from ***LEO to GEO*** orbit, we are developing an electrical platform (***ItalGovSatCom*** with ASI) compatible with ***VEGA*** injection in LEO.
- The Optimal Steering of the thrust direction requires the use ***Optimal Control Theory*** applied to very long low thrust orbital transfers
  - ✓ Hamilton-Jacobi-Bellman equation with averaging
  - ✓ Sufficient and necessary conditions for non-regular Hamiltonian
  - ✓ Systems of autonomous navigation based on characteristics method



- Very long orbital transfer -

- Autonomous station keeping for IOS -

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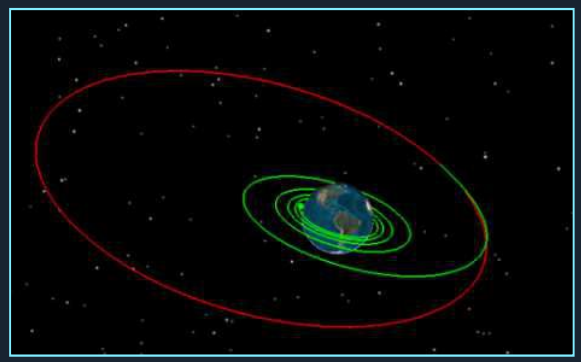
RESEARCH ACTIVITIES – *ORBITAL TRANSFERS OPTIMIZATION*

Hamiltonian technics for Orbital Transfers Optimization of electrical satellites are used to:

- ***Calculate on board the LEOP transfer steering laws,***
- ***Calculate on board orbit keeping maneuvers using GPS receivers in GEO which allow also precise satellite collocation.***

❑ Electric propulsion system implies very low thrust thus the orbital transfers may take many months and hundreds of orbits requiring specific averaged optimization.

❑ To reduce the operational cost of the LEOP ***AUTONAV function*** allows to compute on board the optimal trajectory in real time, avoiding several ground segment contacts.



- Electric satellite orbital transfer -

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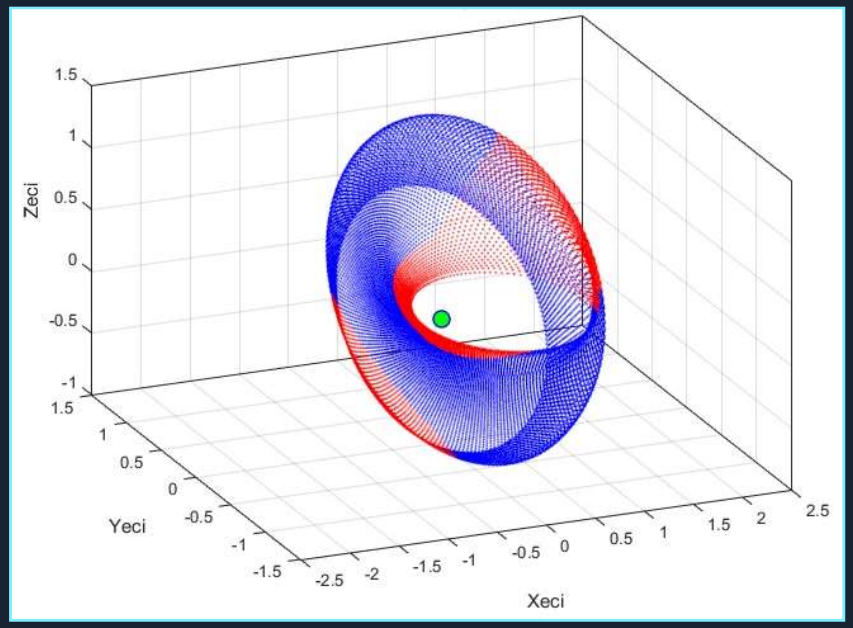
RESEARCH ACTIVITIES – *ORBITAL TRANSFERS OPTIMIZATION*

Low thrust orbital transfer minimizing the mass propellant consumption



- 3D trajectory for a GTO to inclined MEO (56°) in Vmin mission analysis where the thrusters are switched off (blue) and switched on (red)-

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PLATFORM DEVELOPMENT - *MICROSAT PLATINO*

- ***PLATiNO*** is a Micro multi-application platform capable to respond to the international and Institutional market opportunities (P/L mass up to 80 kg) it is a project in collaboration with Sitael

- The platform electronics is based on an highly integrated design and the use of ***COTS*** in order to get low masses and costs
- Only three electronics
  - The ***IPAC*** for all Avionic and Power functions
  - The ***ICU*** for the transmission to ground
  - The ***mCMG*** for the actuation control

- PLATiNO -

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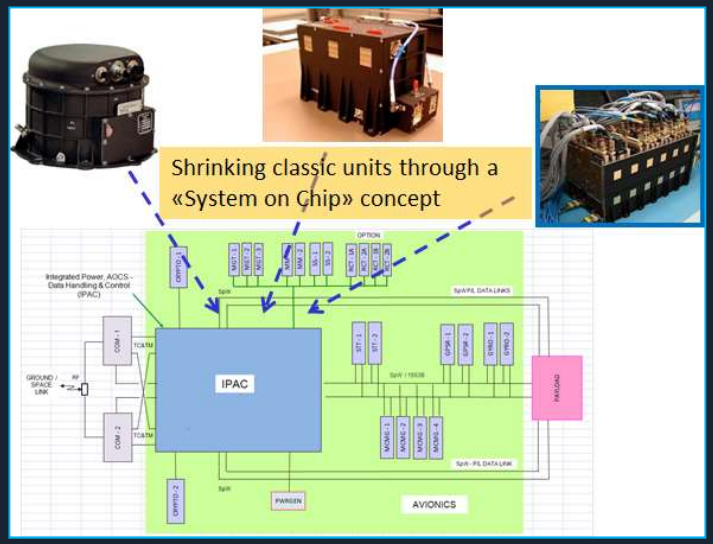
PLATFORM DEVELOPMENT - *PLATINO KEY TECHNOLOGIES*

Integrated Avionics with ***IPAC*** (Integrated Power, Attitude Control And Data Handling Control Unit):

- The IPAC contains the following functional and fully redundant modules:
  - Multi Core Processor Module (MCPM) including Star Trackers and GPS processing
  - Telemetry, Telecommand, Mass Memory
  - Reconfiguration Module (T2MR)
  - Input & Output Module (IOM)
  - Power Module (PWM)



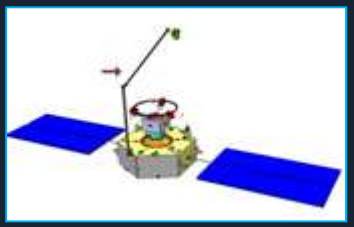
OTHER NEW RESEARCH ACTIVITIES

- ***Large Deployable Reflector*** (LDR) for Radar & NAVCOM & TLC solutions Improving P/L size with mass optimization
- ***Insert new digital technologies in space-borne radars and Communication*** evolving space-borne radar capabilities thanks to Digital Beam Forming and introducing Post 28nm Deep Sub Micron ASIC Technologies in Radar and TLC
- ***Quantum Communications*** Architecture & Critical elements (QKD) defining the architecture of satellite Quantum Communication system
- ***Innovative solution for Exploration & Space Commercialization***, habitative pressurized modules for human operations in space (***SpaceHOME***), platform for In-Orbit Services (***SpaceSTART***), landers and re-entry vehicles, robotics, rovers for planet exploration, etc.)

- Large Deployable Reflector -

- Opticla feederlinks for VHTS -

- SpaceHOME -



- In Orbit Services -

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OTHER NEW RESEARCH ACTIVITIES

- ***Evolution of Digital technologies and porting to Space Missions***
  - ***Big Data, AI and Internet of Things***
    - ✓ AI algorithms for Image Processing and Image Analytics
    - ✓ AI on Exploration Rovers autonomous navigation
  - ***Cybersecurity in four domains***
    - ✓ Processes of production,
    - ✓ On Board S/W
    - ✓ Ground Segment
    - ✓ Satellite Ground segment link

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