

UNIVERSITÀ
DEGLI STUDI
DI PADOVA

Development of Innovative Technologies for Miniaturized and Sustainable Propulsion Systems based on Electrodynamic Tethers

Marco Ghedin - 41° Cycle

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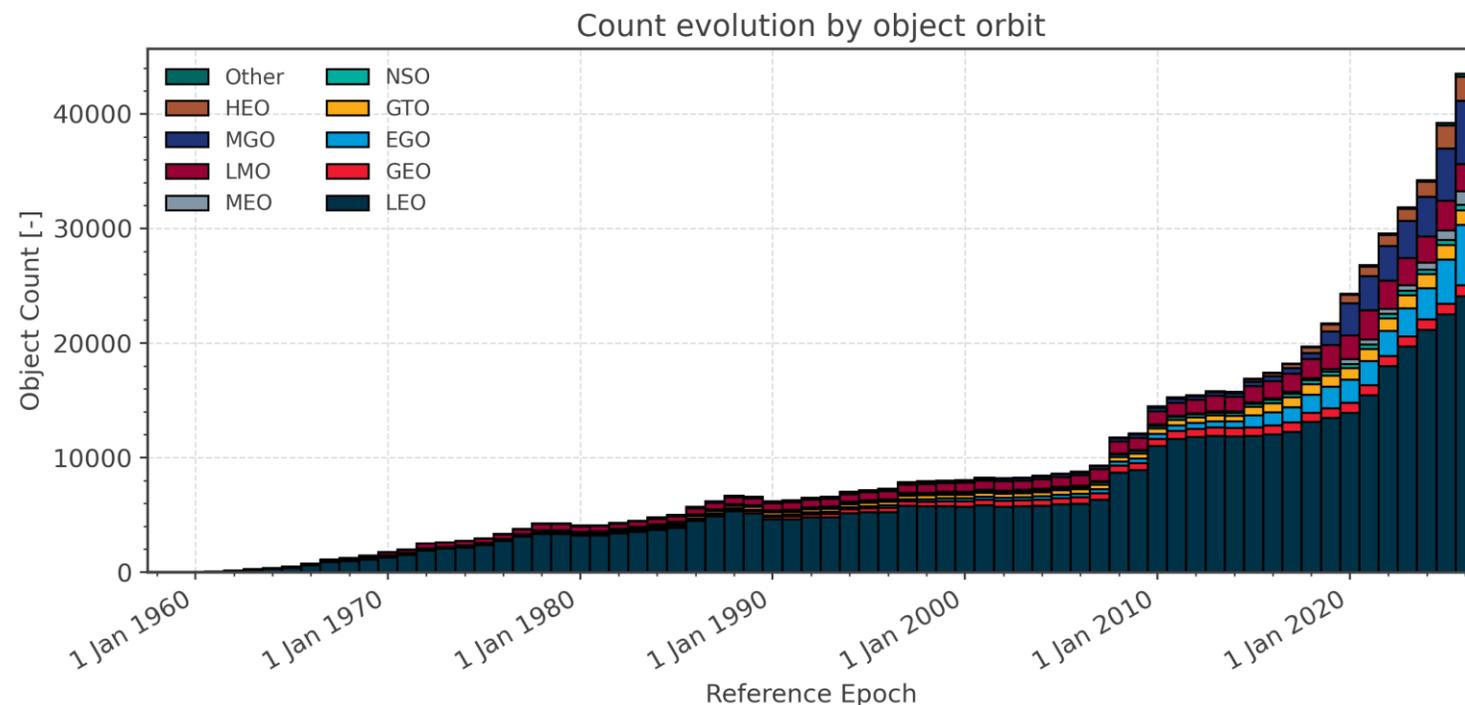
Meeting - 12/11/2025



Introduction and Motivations

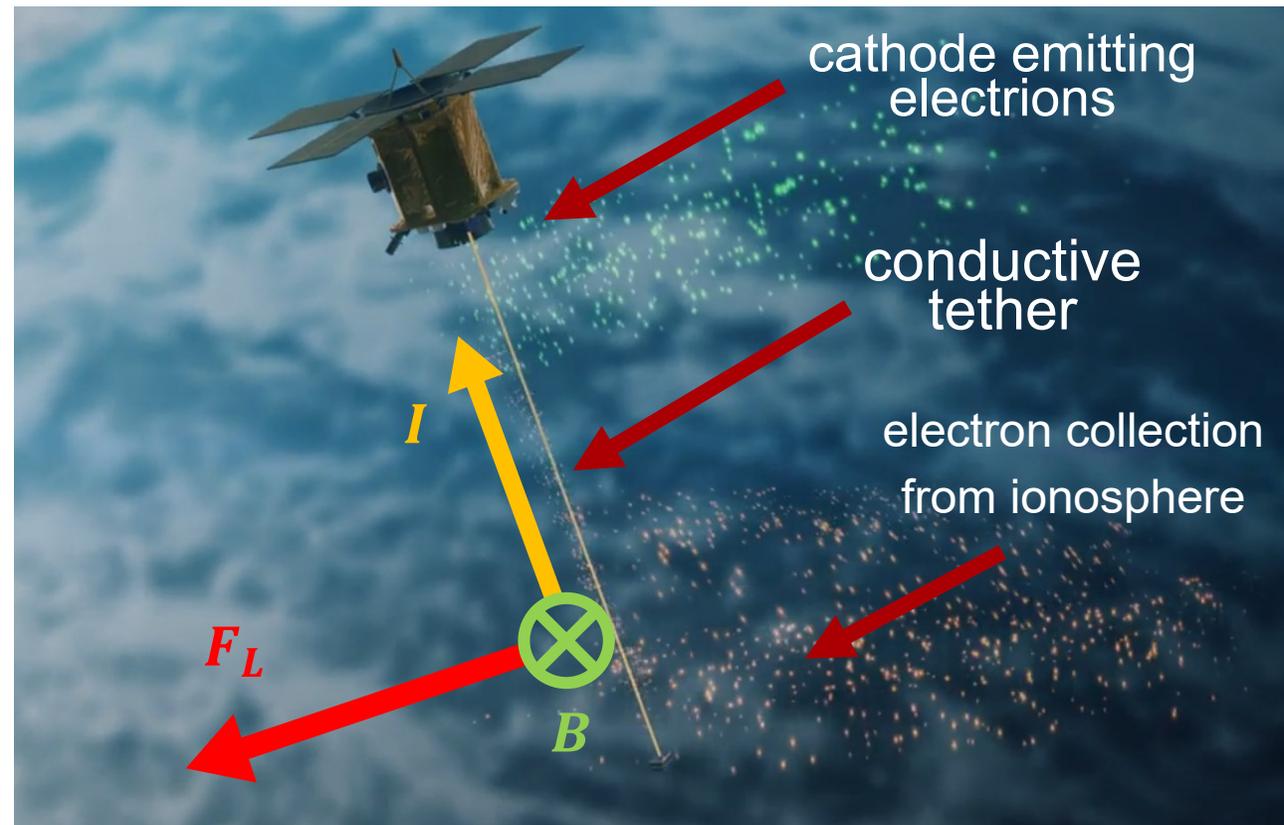


- Proliferation of LEO satellites constellations (e.g., Starlink, Project Kuiper)
- Accumulation of orbital debris and increasing collisions risk (e.g., Iridium 33)
- International regulations on post-mission disposal (FCC & ESA)



Need for compact, low cost, low power deorbiting/reboosting technologies for small satellites

- **EDTs:** long conductive tether that generate thrust/drag by interacting with the Earth's geomagnetic field



$$F_L = I \times B$$

F_L Lorentz Force

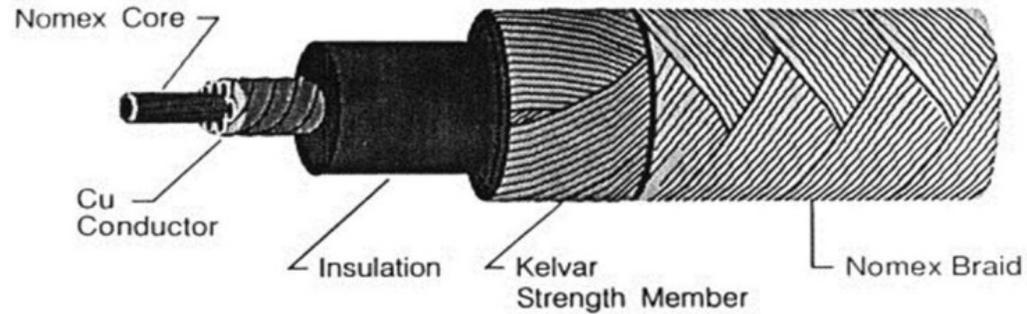
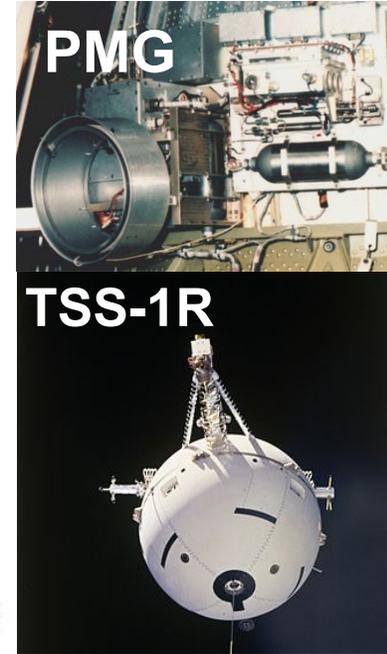
I Current

B Earth magnetic field

- Change of orbital parameters
 - Inclination
 - Semimajor axis (deorbiting/reboost)

- Early Missions (TSS-1R, PMG):

- Demonstrated feasibility of power generation and propulsion capabilities
- massive, insulated tethers (required end masses for electron collection)



- Modern Shift:

- bare tethers (ultra-thin, non-insulated) significantly reduced mass and volume, making the technology viable for small satellites (e.g., STARS, KITE),
- tape-shaped for better survivability to M/ODs and electron collection (e.g., T-REX, E.T.PACK)





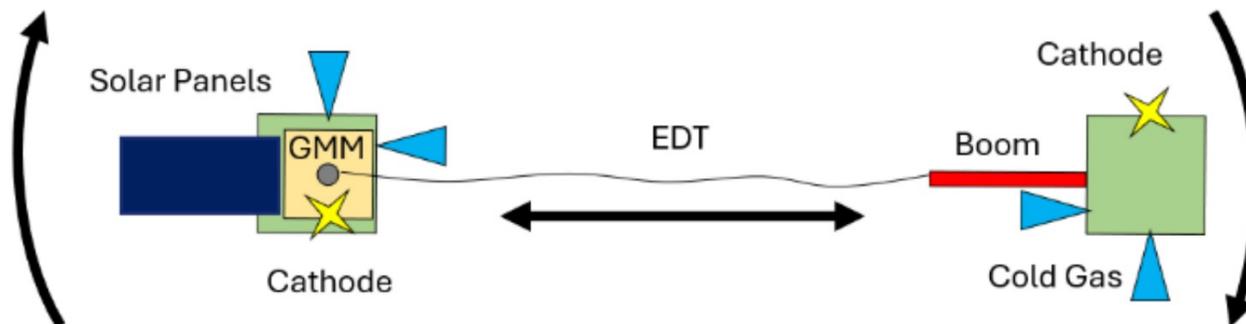
E.T.COMPACT Framework



E.T.COMPACT

Horizon EIC Pathfinder project for development of a **Green Mobility Module (GMM)** with key EDT technologies:

- **Bare Photovoltaic Tether (BPT)** based on CIGS/Perovskite flexible solar cells
- **Printable Structure** with integrated sensors and equipment
- **Spinning EDT system** for high inclination orbits
- **Retrievable Deployment Mechanism (DM)** for tape tethers
- **Field Emission Cathode (FEC)** for expellantless propulsion





Research Objectives



- Design a compact, motorized tether deployment and retrieval mechanism for the GMM
- Develop a DM digital twin for predictive performance assessment
- Reach TRL 4 for the GMM
(further TRL increase for future In-orbit Demonstration)
- Exploring applications of the GMM In-Orbit Servicing mission scenarios



Year 1 (Oct 2025 – Sep 2026):

- Design and structural analysis (CAD & FEM)
- Modelling of the system (MATLAB/Simulink)
- Mock-ups (PLA/breadboards)
- Prototype manufacturing (E.T.COMPACT DM)

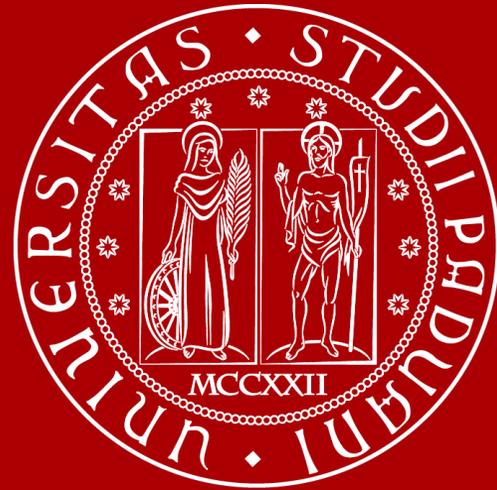
Year 2 (Oct 2026 – Sep 2027):

- Integration in E.T.COMPACT Green Mobility Module (INDRA DEIMOS)
- Experimental validation (TRL 4, SPARTANS facility)

Year 3 (Oct 2027 – Sep 2028):

- System-level and mission analysis, IOD preparation

Thanks for the attention



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