

## BETsMA: mitigating space debris with just one click

A friendly software aimed at the design of space debris mitigation missions using bare electrodynamic tethers

*BETsMA, a software developed under the FP7/Space project BETs funded by the European Commission, aim at preliminary mission analysis using bare electrodynamic tethers. It brings together in a friendly tool more than 20 years of research on bare tethers and the latest developments by the BETs Consortium. Using BETsMA, both experts and beginners on tethers will find the optimum tether system for a given space debris deorbiting mission, i.e. initial orbit altitude and inclination and mass of the host satellite. The software provides the main figures of merits, including deorbit time, mass of the subsystems, satellite trajectory and tether survival probability among others. Its friendly user interface and optimized algorithms validated against previous works on tethers are specially designed for quick parametric studies in a broad range of orbital and tether conditions..*

Technology solution supported by the Technical University of Madrid

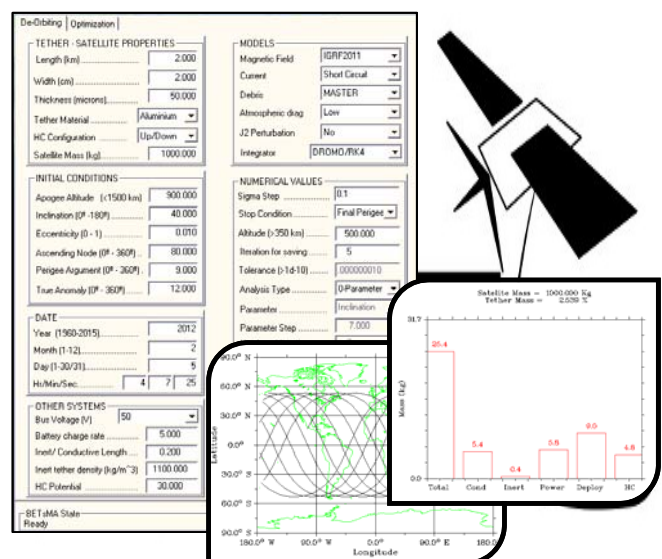
### Technology solution

BETsMA is a software dedicated to the preliminary mission analysis of deorbit missions with bare electrodynamic tethers, i.e. to bring back to the Earth the satellite at the end of its life. Its friendly-user interface makes BETsMA an ideal tool for non-expert engineers on tethers, who need a fast but accurate estimation of the parameters of the mission. It includes a tool to makes optimal tether design and a detailed flight simulator. Its intuitive interface, fast algorithms and thorough set of outputs, including evolution of the orbital parameters, deorbit time, tether electrical values along the deorbiting, and survival probability among others, make BETsMA a unique tool. The interface and the visualization tool is designed to carry out parametric studies in a broad range of conditions.

### Areas of application

- **Space:** preliminary design of deorbit missions with electrodynamic tethers.
- **Security:** parametric studies of space debris remediation scenarios in a broad range of conditions.

*"The user-friendly interface of BETsMA gives a fast and accurate response to the main issues related to deorbit satellite missions with bare electrodynamic tethers"*



PASSIVE ELECTRIC PROPULSION

## Market demands

- Space industry is threaten by 6000 tons of space debris, which now causes, in average, one collision each decade.
- Due to next launches, the Low-Earth-Orbit (LEO) satellite population will increase, thus making worse the space debris problem.
- ESA and NASA analyses suggest that, even without new launches, the number of objects will grow due to collisions.
- Recommendations and responsibilities has been approved to remediate the space debris problem. New ones will be soon implemented by governments and space agencies.
- A long term solution is to deorbit next launched satellites and final rocket stages. It requires a deorbit technology, which should be light, reliable and efficient at LEO.
- Space agencies look for disruptive technologies like tethers, which not only satisfy the above conditions but also are passive and do not need propellant neither batteries.
- Non-specialized engineers on tethers technology require a user-friendly software to carry out parametric analyses of deorbiting missions with tethers. These quantitative values can be used to make comparisons with other technologies and take decisions.

*“Space agencies, companies and research groups need a tool to design tether missions and calculate their costs”*

## Market potential

- More than one thousand satellites will be launched the next decade with a cost of manufacturing and launching about 150 billion €.
- A satellite failure due to a collision with space debris produces both operational and economical losses, which can reach values about hundreds of million €.
- Decreasing the mass of the deorbit technology is crucial due to the high costs (1kg of launched mass is about 10000 €).
- Currently, there are 6000 tons of space debris. BETs Consortium estimate that the deorbit cost using a tether could be about 50% smaller than a chemical rocket.
- Space agencies, companies and research groups are potential clients of BETsMA, because they all need fast but accurate estimation of the tether system performances.

## Competitive advantages

- BETsMA is the first simulator to be used by both expert and non-specialised engineers on tethers.
- Its optimization tool, aimed at finding the tether geometry, makes BETsMA an unique tool.
- Comprehensive software with a complete catalogue of outputs, including the evolution of the orbital elements, the tether electrical variables, mass of all the subsystems, and survival probability among others.
- User-friendly and intuitive interface and a visualization tool also integrated in the program. They are design to carry out parametric analysis of tether missions.
- It includes the latest developments on tether flight simulators like a detailed model for the current collection and an efficient orbit propagator.
- BETsMA manual gives a description of the implemented physical models and some mission examples to start with.

## References

BETsMA has been developed under the FP7/Space project “BETs” (No 262972) in the Departamento de Física Aplicada de la ETSI Aeronáuticos. The coordinator of the project, Prof. J. R. Sanmartín, introduced the bare tether concept in 1993 and the optimization scheme used by BETsMA.

## IPR

- Software in register process.

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

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