exotrail
AGILE SPACE

# ExoMG™

## A flexible & high-thrust electric propulsion system for small satellites

| | |
|---|---|
| Document reference | EXO_DCM_PRE_200512_1CG |
| Version number (date) | V1 (12 may 2020) |
| Author | Clément Gimenez – Product Owner ExoMG |
| Verified | Jean-Luc Maria – CTO |
| Approved | David Henri – CEO |

# ExoMG™
# A FAMILY OF FLEXIBLE & HIGH-THRUST ELECTRIC PROPULSION SYSTEMS

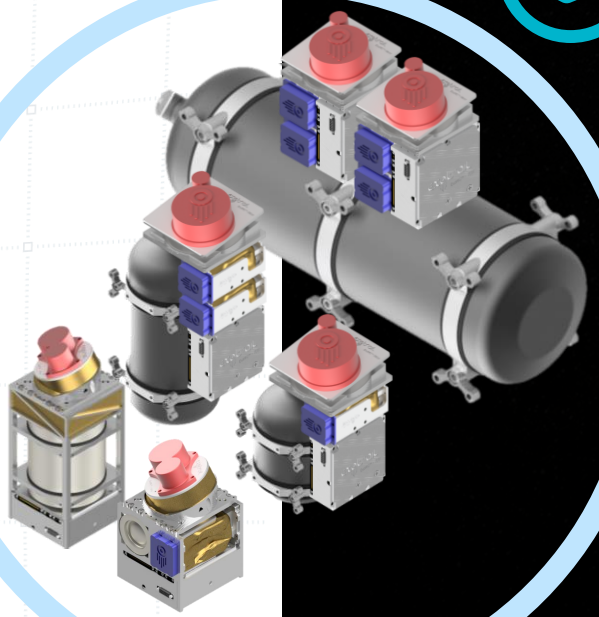
## ExoMG™-*nano*, ExoMG™-*micro*, ExoMG™-*cluster*

ExoMG™ is our turnkey solution for 10 to 250kg satellites.

Its modular approach based on pre-qualified building blocks allows our products to fit *your* requirements & adapt to *your* platform to make the design integration process an easy step.

| | ExoMG™-*nano* | ExoMG™-*micro* | ExoMG™-*cluster* |
|---|---|---|---|
| Thrust[1] | 1.8 mN | 7 mN | Up to 35 mN |
| Power [1] | 60 W | 150 W | Up to 800 W |
| $I_{sp}$[1] | 800 s | >1000 s | >1200s |
| Tot. Impulse | Up to 5 kNs | Up to 60kNs | Up to 240 kNs |
| Dry Mass [2] | 1.8 to 2.3 kg | 2.8 to 4.9 kg | 6.2 to 18.4 kg |

*[1]Range of operating points available. The table reports the overall system power.*
*[2]Depends on the total impulse & related tank selected*



### Higher thrust = Boost revenues

Smallsats have a limited lifetime. Sooner they get to the operational orbit, higher the effective time they can generate revenue

### High flexibility & scalability

The propulsion system adapts to *your* platform not the opposite, with limited non-recurring effort.

### From Cubesats to Smallsats

Whether you have a 6U Cubesat or a 200kg small satellite with 800W, we have a solution for you.

### Heritage & Maturity

We use a reliable space-proven technology– Hall Effect (HET). ExoMG™ has been qualified & first flight system has been delivered in 2019.

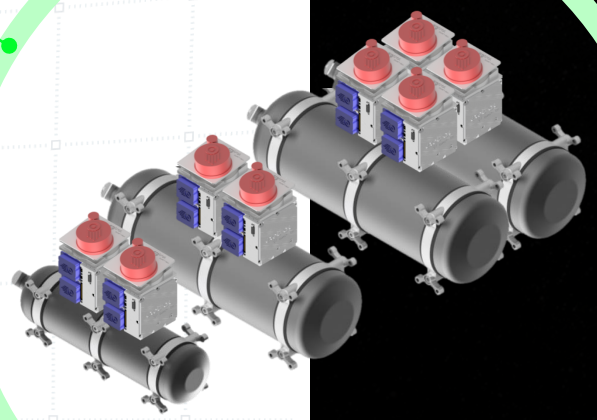
# ExoMG™
# FOCUS ON THE CLUSTER

## Multiply Performances

Operate up to 4 ExoMG™ – *micro* thrusters in a bundle, for bigger platforms and longer missions.

| | ExoMG™-*cluster x2* | ExoMG™-*cluster x4* |
|---|---|---|
| Nominal Power[1] | 300 W | 800 W |
| Nom. Thrust[1] | 14 mN | 35 mN |
| $I_{sp}$[1] | >1000 s | >1200 s |
| Total impulse | Up to 120 kNs | Up to 240 kNs |
| Dry mass[2] | 6.2 to 8.5 kg | 13.3 to 18.4 kg |

*[1]Range of operating points available*
*[2]Depends on the total impulse & related tank selected*



## Scalable Thrust at highest performance

Each thruster will operate at its most efficient operating point, the thrust level can be varied just selecting the number of firing thrusters

## AOCS Capabilites

Use the relative position of thrusters to perform attitude maneuvers

## Cumulative Heritage

The electronics and the fluidics flying on *your* x4 cluster will be the same than on our small nano S. Cumulative heritage reduces risks.

## Higher reliability

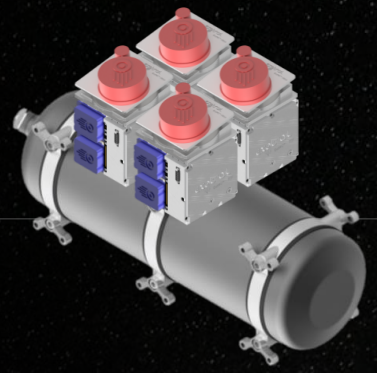
An intrinsically redundant architecture

# ExoMG™
# TYPICAL CONFIGURATIONS

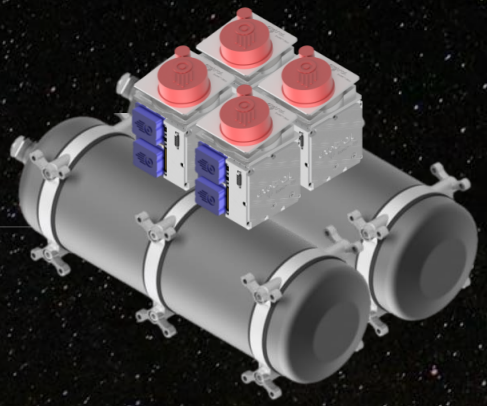
INDICATIVE SPACECRAFT MASS
THRUST

Total impulse range

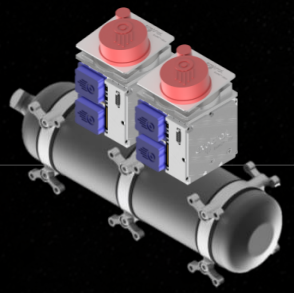
150-250 KG
28 MN



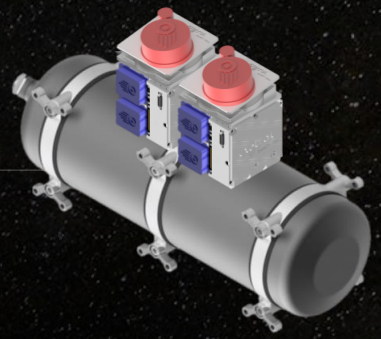
ExoMG™ - *cluster* x4
Up to 240 kNs



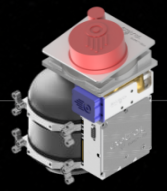
50-200 KG
14 MN



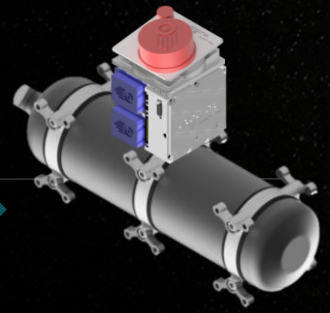
ExoMG™ - *cluster* x2
Up to 120 kNs



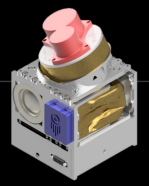
30-100 KG
7 MN



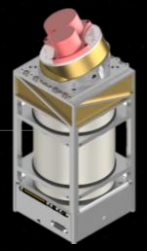
ExoMG™ - *micro*
Up to 60 kNs



10-30 KG
1,8 MN



ExoMG™ - *nano*
Up to 5 kNs



## Chose *your* Thruster

The configurations presented here cover the typical needs for platforms between 10 and 250kg and represent a discussion baseline.

The form factors, as well as the total thrust are designed to be adapted to *your* needs. Ask our business development engineering team for more information in order to tailor the solution that suits *your* mission and *your* platform.

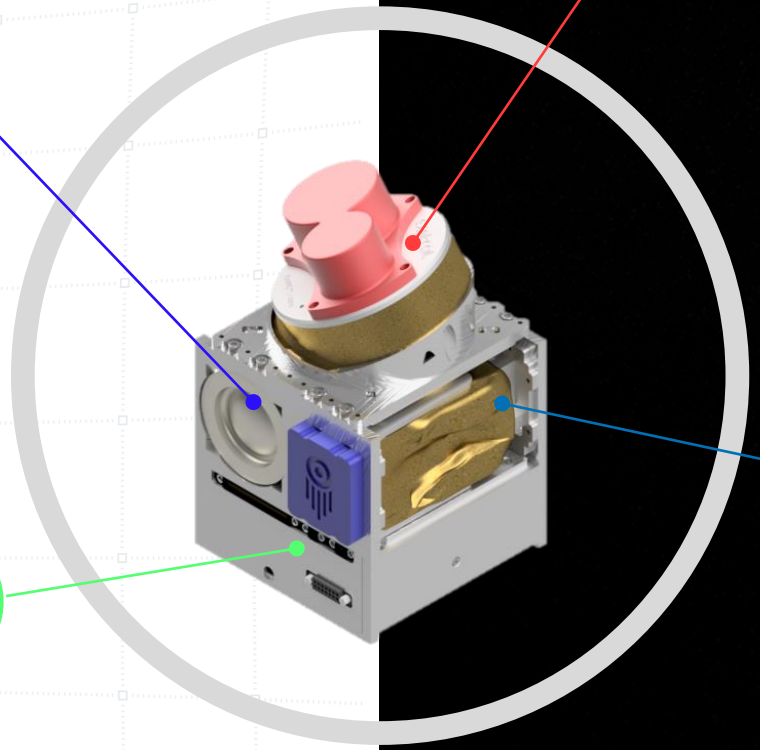
# ExoMG™
# SYSTEM OVERVIEW

## Tanks

A Tank Assembly for gas storage.
Multiple tank assemblies are available to meet a wide range of delta-V requirements.

## Thruster Control Unit

The control and command Subsystem.
It hosts the power management and the communication with the satellite.
Compatible with both the nano and the micro thruster head.



## Thruster Head

The thruster head generates the thrust. It hosts the anode and cathode assemblies. Two thruster heads are available:

- the 60W-class ExoMG™ - *nano*
- the 150W-class ExoMG™ - *micro*

Do you need higher thrust or redundancy?
ExoMG™ – *cluster* features multiple thruster heads to meet the requirements of larger platforms.

## Xenon Management System

Subsystem for gas distribution towards the anode assembly and the cathode. Compatible with both the nano and the micro thruster heads.

Two form factors are available, in order to fit at its best the propulsion system on the platform volume constrains

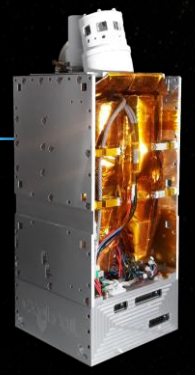
# ExoMG™ HERITAGE

*Your* tailored configuration will benefit from heritage deriving from all our previous missions

Even if *your* mission or platform requires dramatic changes in the form factor or total impulse of the thruster, the heritage of its building blocks remains.

We rely on extensive ground tests and In Orbit Demonstrators to validate all new technologies.

nano avionics

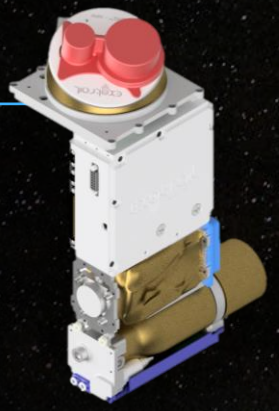


Sept 2019 : on time delivery of our first In Orbit Demonstrator, carrying the first version of our modules

2020 : Launch

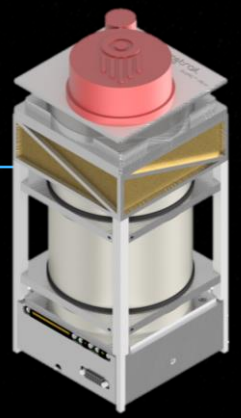
eutelsat

AAC CLYDE SPACE



2020 : our first commercial mission, with the delivery of 2 flight models to Clyde Space for the Eutelsat ELO 3 and 4 satellites.

2021: launch



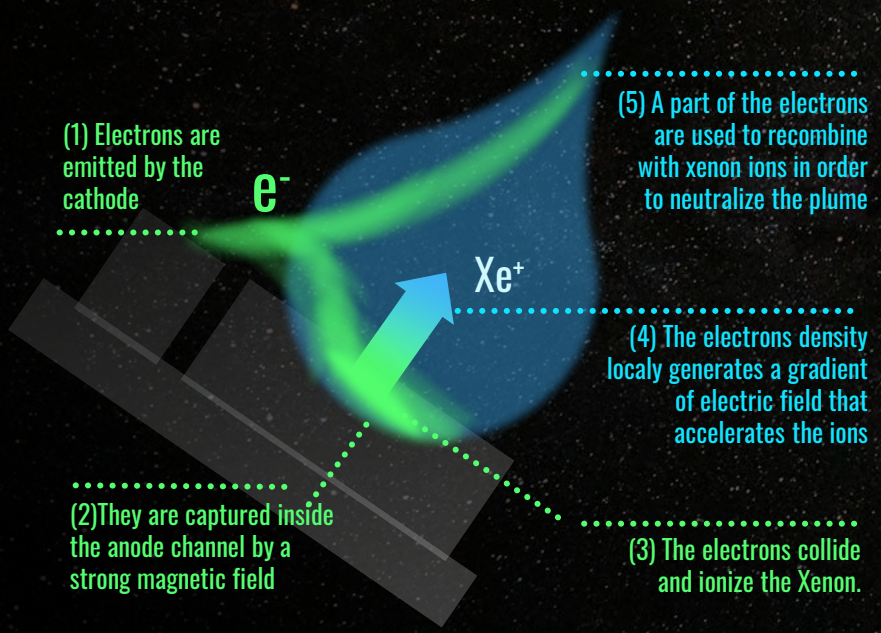
2021-22 : other demonstration missions.
Let's make new blocks fly !



exotrail AGILE SPACE

# ExoMG™
# THE HALL EFFECT TECHNOLOGY

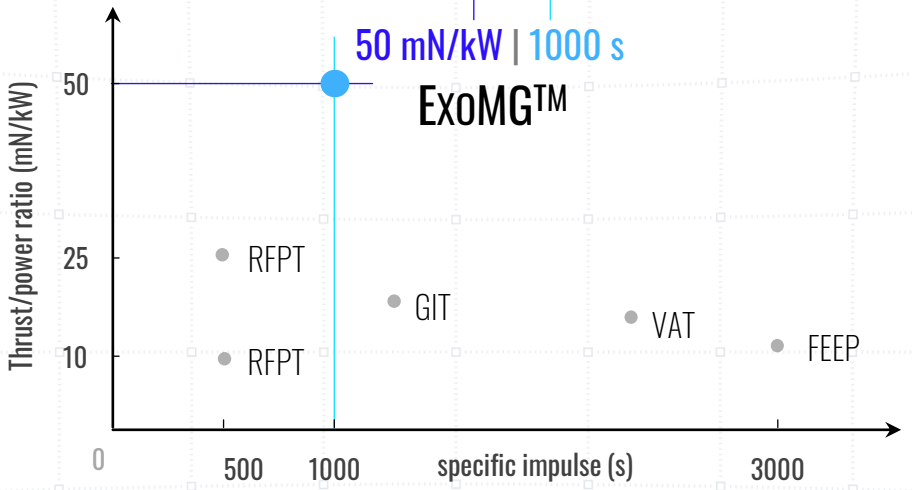
A reliable technology, as old as the spacial era.
Exotrail has miniaturized it for cube and small satellites.




# ITS BENEFITS FOR YOUR MISSION

**Highest Thrust**
Reach *your* optimal orbit, faster than with other electric technologies

**Good Efficiency**
Embark less propellant, spare weight and volume




RFPT : Radio Frequency Plasma Thruster
GIT : Grid Ion Thruster
VAT : Vaccuum Arc Thruster
FEEP : Field Emission Electric Propulsion

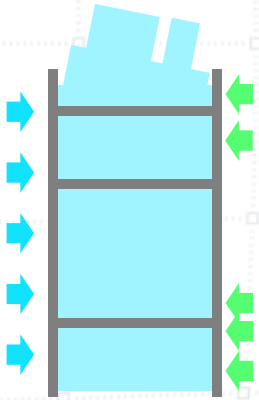
ExoMG™

# INTERFACES

## Mechanical

The ExoMG™ building blocks are assembled together by a mean of an exoskeleton.

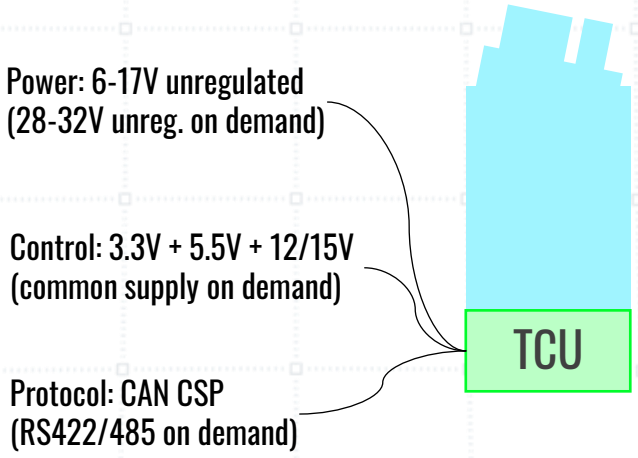
This exoskeleton can be adjusted for every project in order to comply with the customers mounting interfaces at fairly low extra costs.



Predesigned bolting interfaces can be easily adjusted

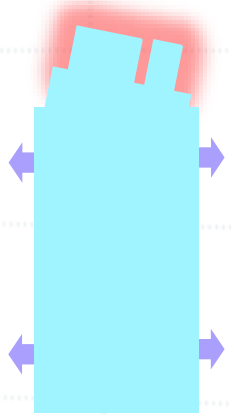
## Electrical

All electrical interfaces with the platform are concentrated on the Thruster control unit : Power and Control supplies as well as communication Protocol.




## Thermal

The thruster head is thermally decoupled from the rest of the thruster, and thus from the platform.
More than 90% efficient Power Processing Unit grants minimal conductive coupling.
Thermal coupling with the platform is then minimal.



Minimal thermal dissipation from the thruster head towards the platform

# ExoOPS™

*Our mission design and operations software,*
*for an end to end propulsion solution*

ExoOPS™

# INTRODUCTION

We provide an end-to-end propulsion solution. Our ExoOPS™ family of software allows you to optimize the design & operation of *your* mission – for propulsion, and more.

## Mission Optimization & Insights

- Compare the impact of different propulsion solutions on *your* system, *your* mission, *your* business case
- Generate reports with ΔV, duration, power consumption, duty cycle, propellant use, thrust & attitude
- Compute *your* manoeuvres with optimized thrust strategies & analyse the precise impact of propulsion on AOCS, power system, etc.

## Optimized Launch Strategies

- Analyse the impact of different missions such as RAAN Phasing or altitude transfers on *your* operation
- Compute thousands of different scenarios in seconds
- Analyse orbital deployment timings and costs
- Perform trade-off analysis between rideshare + propulsion and dedicated launch scenarios

## Access Anywhere & Easy to use

- Intuitive software and user-friendly interface make the platform easy to use, even for non experts
- Cloud based software, with local data storage options
- Time-based licenses, frequent updates automatically included

## Available missions


ORBITAL TRANSFER


STATION KEEPING


RAAN PHASING


DEORBITATION

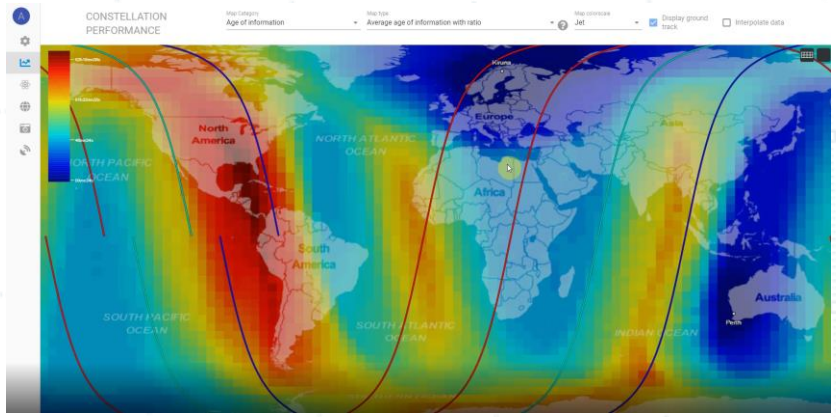

ORBIT PHASING


ORBIT EXTRAPOLATION

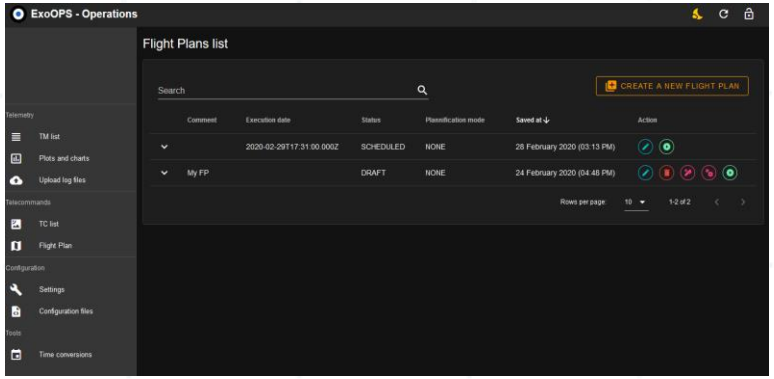

SPACECRAFT DESIGN ANALYSIS

ExoOPS™

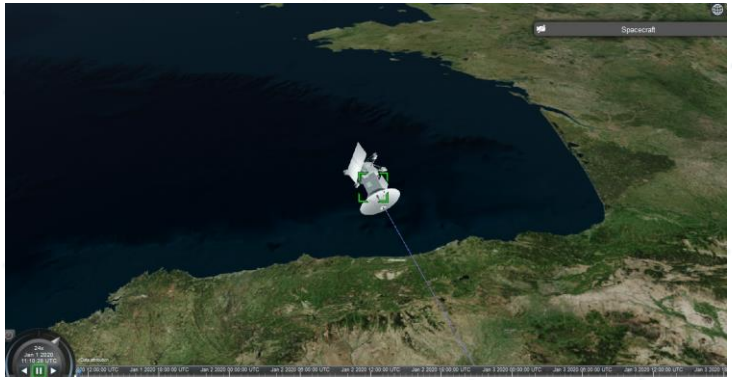
# RESULTS EXAMPLE'S



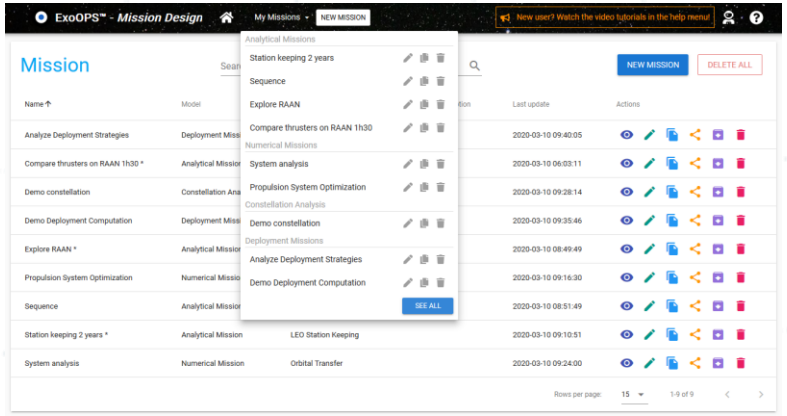

*Age of information statistics, ground stations and ground tracks*



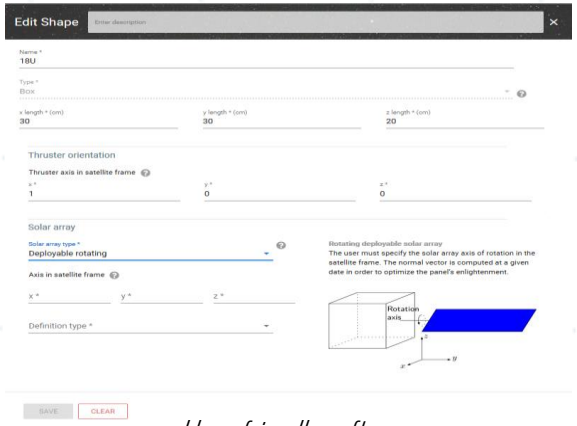

ExoOPS™ - *Operations, our propulsion operation software*



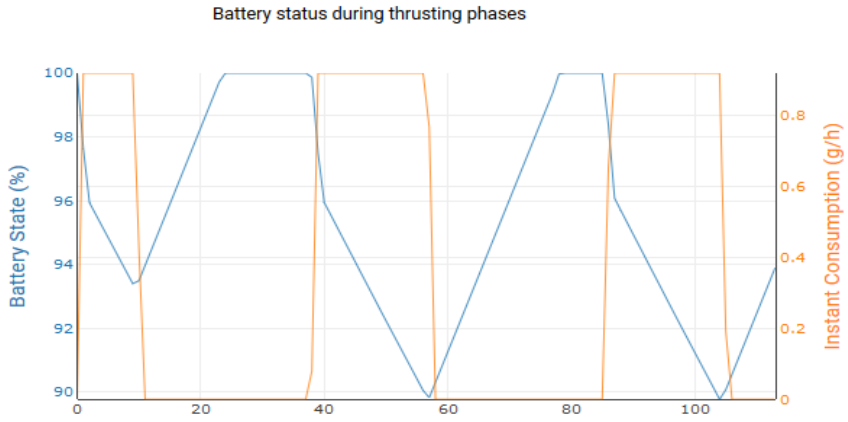

*3D Visualisation tool*




*Visual of the software*




*User-friendly software*




*Time history for battery state and consumption*