

# DOCKS, a growing software suite for space mission profiles

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CCERES, space pole of *PSL Université*, hosted at Paris  
Observatory

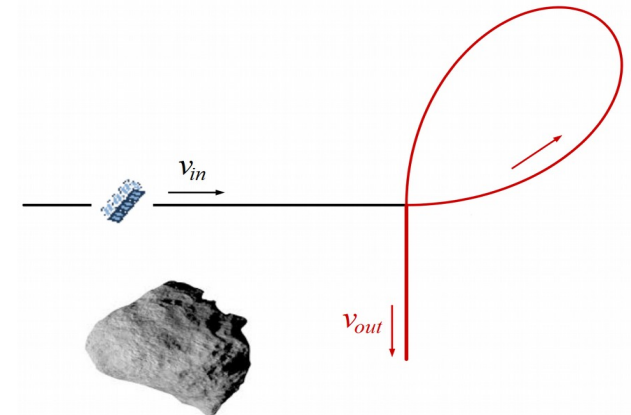
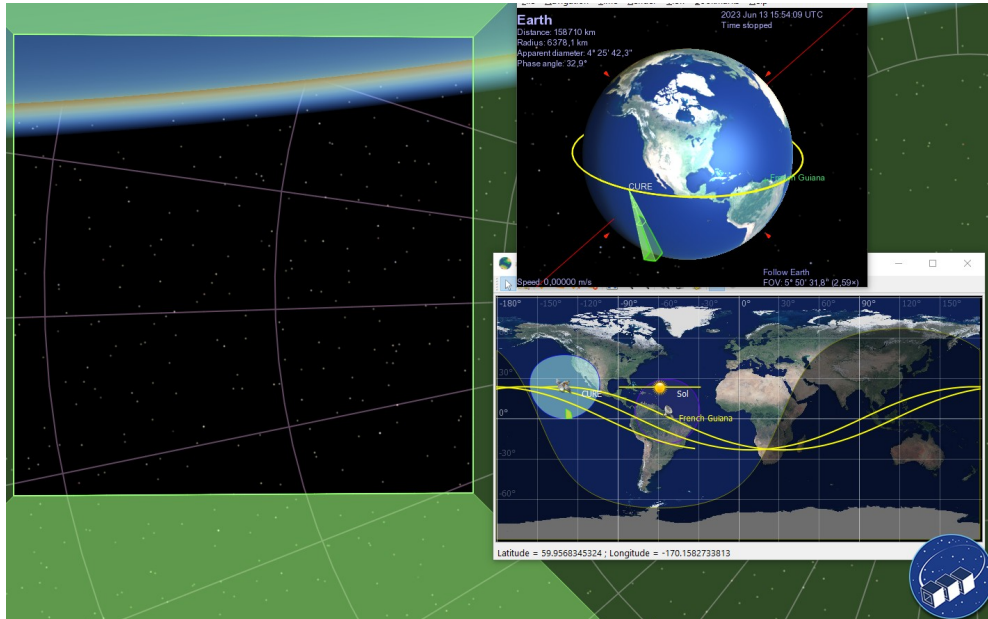
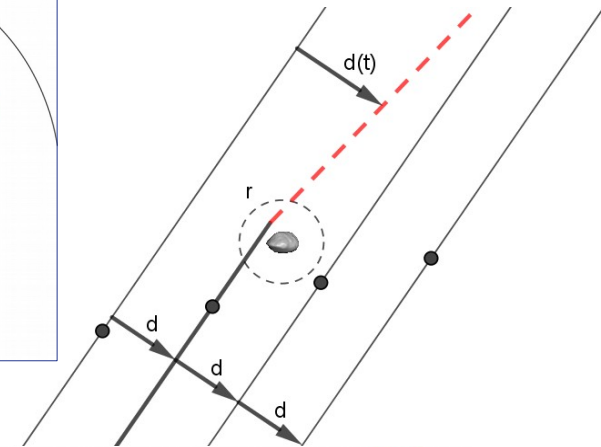
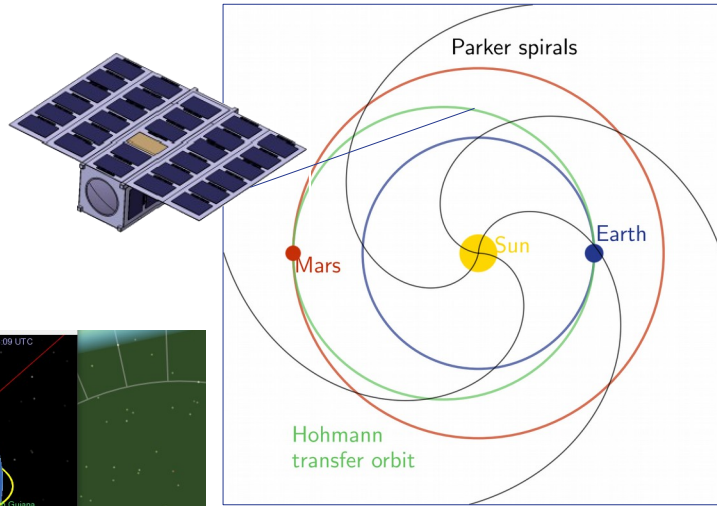
4<sup>th</sup> OSCW, 12-13 Dec. 2020

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Mission profile: Optimal trajectory

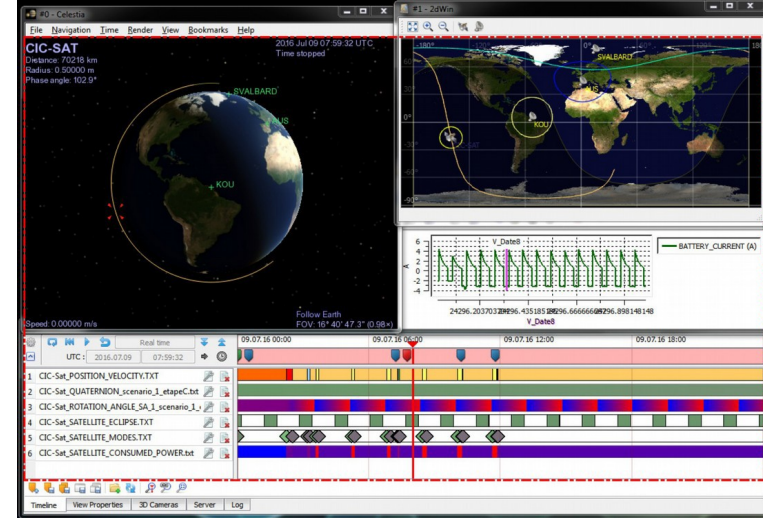
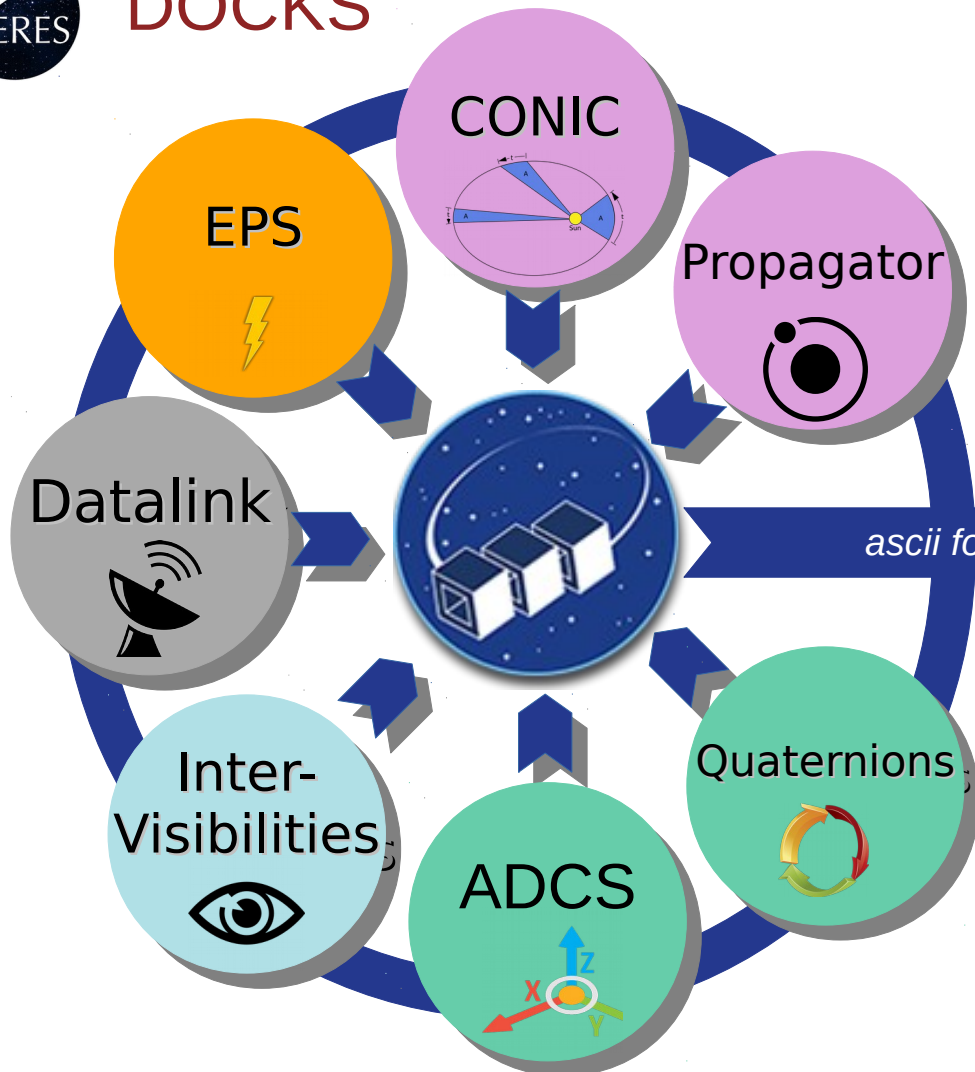
★ science/ power/ data volume

DOCKS structures your CubeSat project





# DOCKS



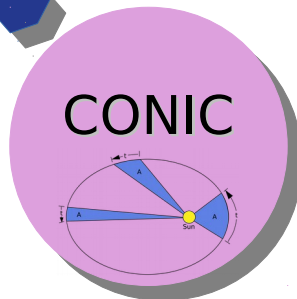
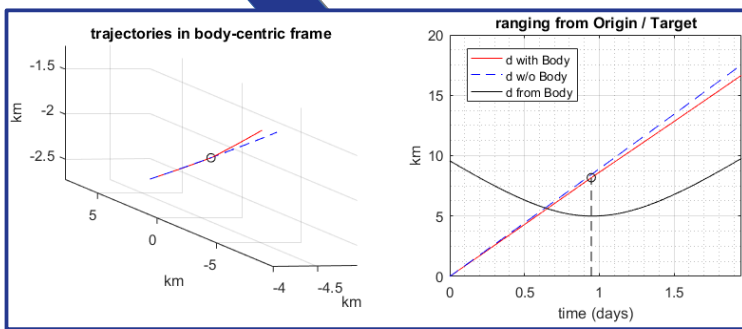
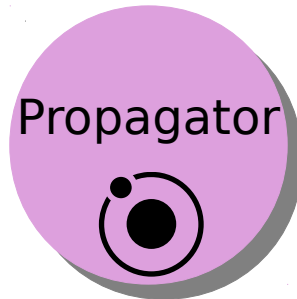
CNES

ascii formats to VTS © CNES



## “Design and Operation Cross-checking Services”

- ✓ open-source targeting scientific nanosatellite mission profiles.
- ✓ free license: <https://gitlab.com/cceres-docks>
- ✓ fully developed and validated in Python
- ✓ Ubuntu, Windows



Deep space trajectories: Cruise / RdV / ProxOps

★ Perturbations

- ▶ Gravitational:
  - simple + complex
  - spherical harmonics or other; **add custom models**
- ▶ Non-gravitational:
  - continuous propulsion, SRP, **atmospheric drag**

★ Engine

- ▶ Adaptive time-step
  - Runge-Kutta or Runge-Kutta-Fehlberg
  - **Accuracy-driven adaptive step**
- ▶ Forward / Backward propagation

★ Validations

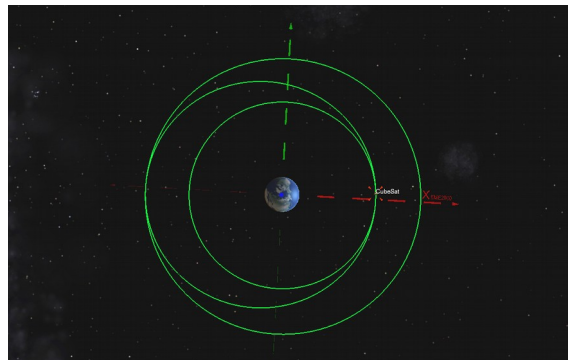
- ▶ Based on planets and asteroids
- ▶ **Still some issues** in special contexts
- ▶ **Cross-checking welcomed!**

Earth-vicinity: link to CNES' STELA

Keplerian engine: "CONIC"

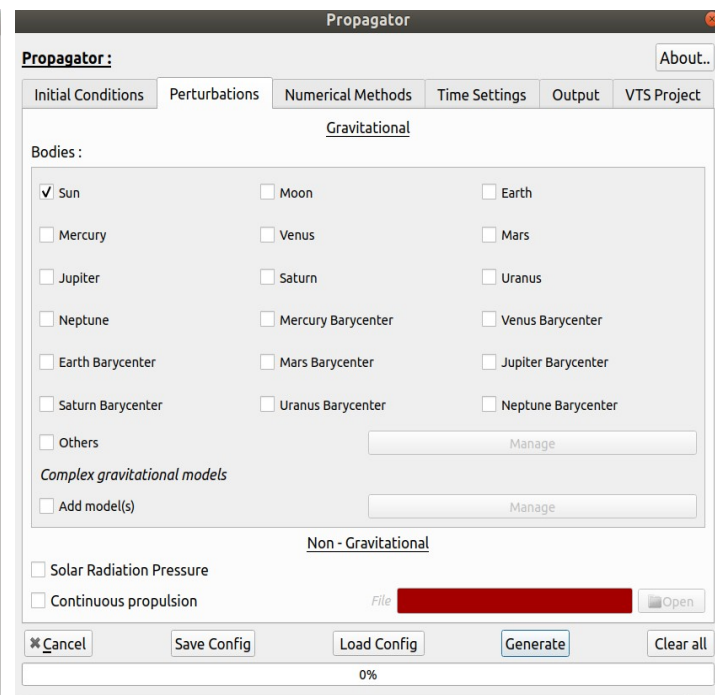
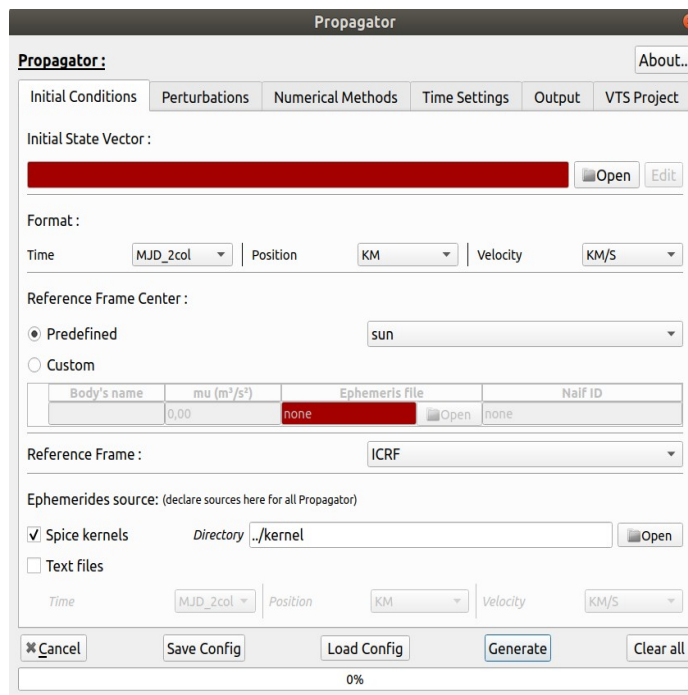
## Latest developments:

- ★ continuous propulsion
  - ▶ initial validation done
- ★ custom bodies
- ★ improved user interface

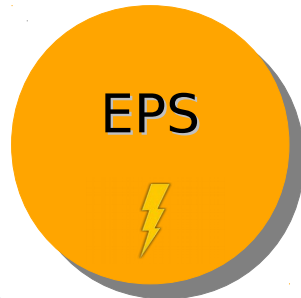


## Future developments:

- ★ change of integration method to adaptive time step => fast
- ★ time step manager
- ★ atmospheric drag







```

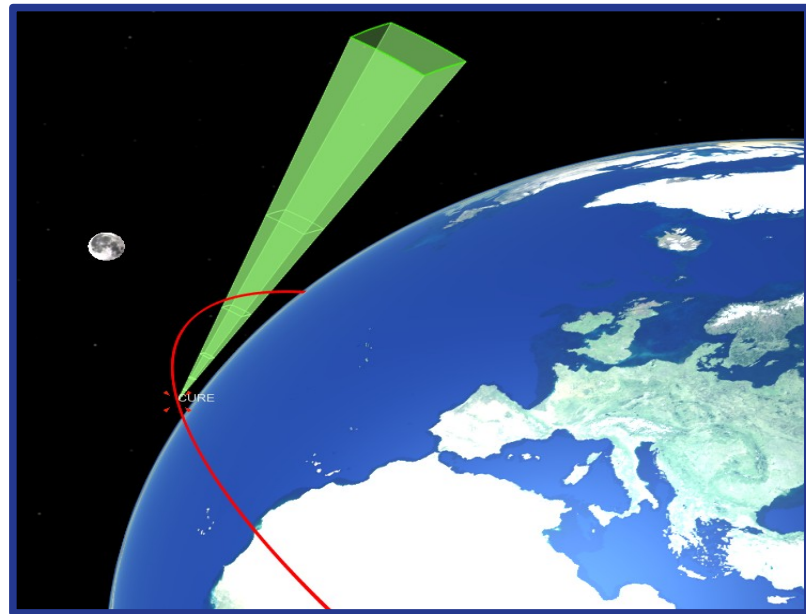
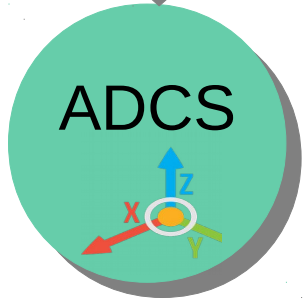
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1  CIC_MEM_VERS = 1.0
2  CREATION_DATE = 2020-12-07T16:50:12.014
3  ORIGINATOR = DOCKS / CCERES / LabEx ESEP -
  Paris Observatory - PSL University Paris
4
5  META_START
6
7  COMMENT = Intervisibility for config :
  EVTF_VISI_CASSTOR.yam1
8
9  USER_DEFINED_PROTOCOL = NONE
10 USER_DEFINED_CONTENT = OEF
11 USER_DEFINED_SIZE = 2
12 USER_DEFINED_TYPE = STRING
13 USER_DEFINED_UNIT = [n/a]
14 TIME_SYSTEM = UTC
15
16 META_STOP
17
18 60676 0.0 ECL/IN 00001
19 60676 1140.0 COM/IN 00003
20 60676 1260.0 COM/IN 00004
21 60676 1320.0 COM/EG 00003
22 60676 1380.0 ECL/EG 00001
23 60676 1920.0 COM/EG 00004
24 60676 5160.0 ECL/IN 00002
25 60676 5580.0 COM/IN 00002
26 60676 6300.0 COM/EG 00002
  
```

## Intervisibilities with...

- ★ Sun, Ground station(s)
- ★ Output = “Event File” (**EVTF**)
- ★ **Adaptive time accuracy**

## Energy Power Simulator

- ★ Solar arrays mounting, cells & battery techno
- ★ Mode strategy
- ★ Quaternions & Intervisibilities
- ★ **GUI**



## Datalink

- ★ Primitive modeling with intervisibilities
- ★ Mode strategy
- ★ Output = "Data volume on board"

## Orientations:

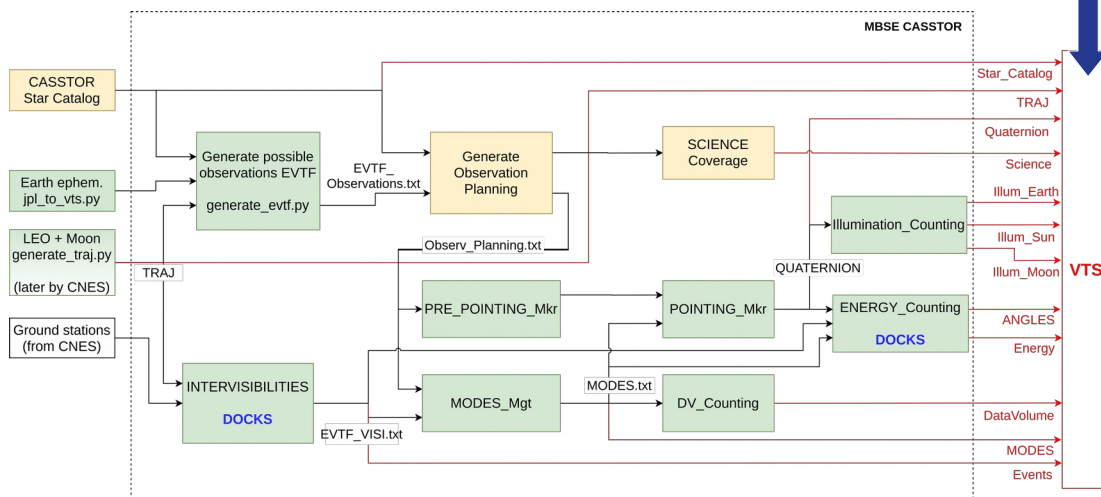
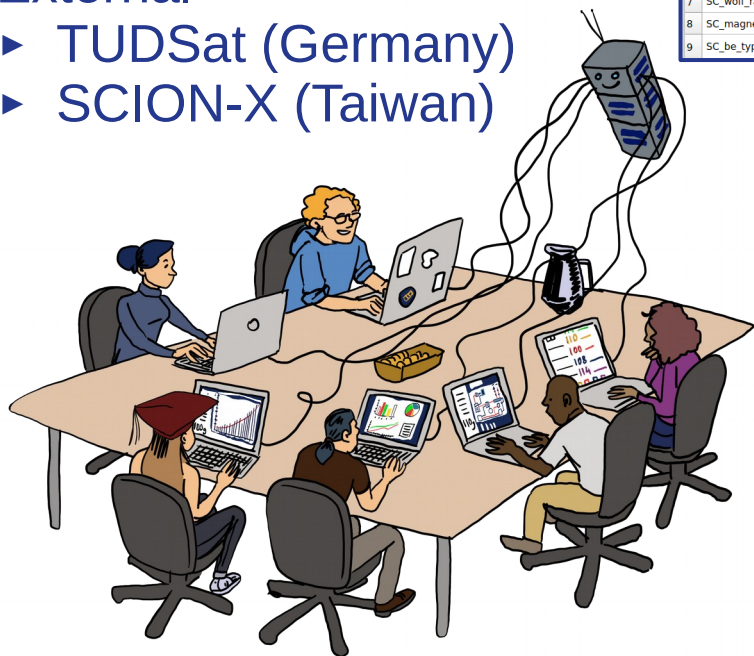
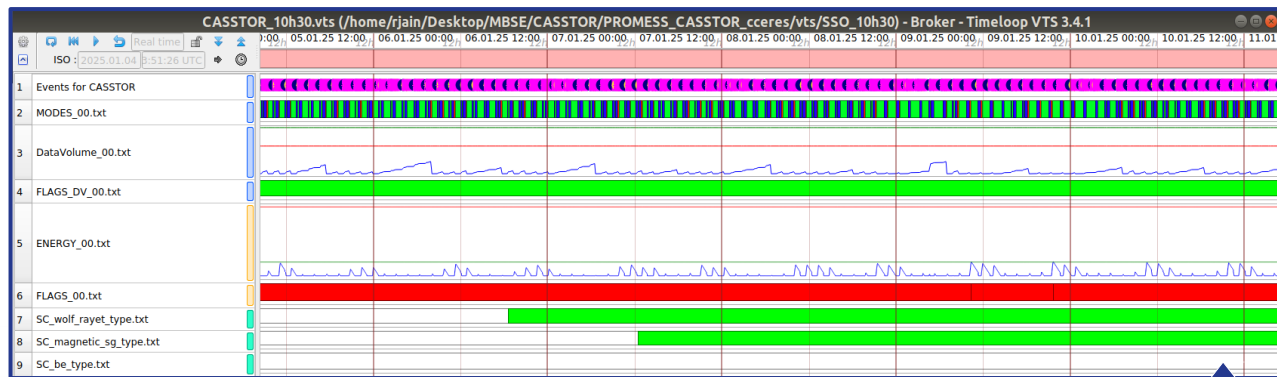
- ★ Coupling with continuous propulsion
- ★ Standard control laws
- ★ Output = Quaternions, slew rates

## ★ Internal

- ▶ BIRDY
- ▶ CIRCUS
- ▶ CASSTOR

## ★ External

- ▶ TUDSat (Germany)
- ▶ SCION-X (Taiwan)

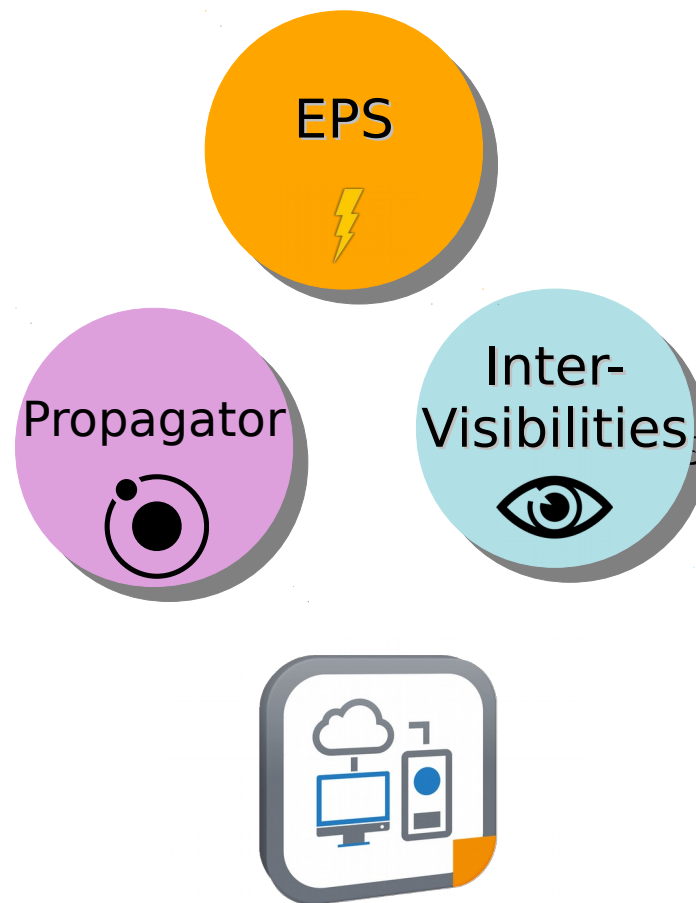






## What we are currently working on..

- ★ Acceleration of DOCKS modules
  - ▶ Parallelization
  - ▶ Vectorizing
  - ▶ Intervisibility (10 times faster)
- ★ Configuration files more user friendly
- ★ Installation of DOCKS easier
- ★ Remote service with CCERES server
  - ▶ Drop config files -> server computes
  - ▶ No installation required



Skills	A - Top Priority	B - High Priority	C - Interesting!
USER	<i>Report bugs</i>	<i>Report boring use</i>	<i>Request features</i>
Scientist / Engineer	<i>Challenge performances</i>	<i>Add a complex model (Propagator)</i>	<i>Module for Thermal analysis</i>
IT enthusiast	<i>User-friendly GUI</i>	<i>Reading from GMAT/STK</i>	<i>Wizards</i>
Open Source enthusiast	<i>Tutorials &amp; Citations</i>	<i>"Modules' datasheet"</i>	<i>Templates</i>

# Thank you for your attention!



- ★ Check-out DOCKS: <https://gitlab.com/cceres-docks>
- ★ Contact / Support (Gitlab): [\*\*docks.contact@obspm.fr\*\*](mailto:docks.contact@obspm.fr)
- ★ Partnering: [cceres.psl@obspm.fr](mailto:cceres.psl@obspm.fr)
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