# **DOCKS**, an open-source software suite for space mission profiles

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CENSUS, space pole of *PSL Université*, hosted at Paris Observatory - PSL

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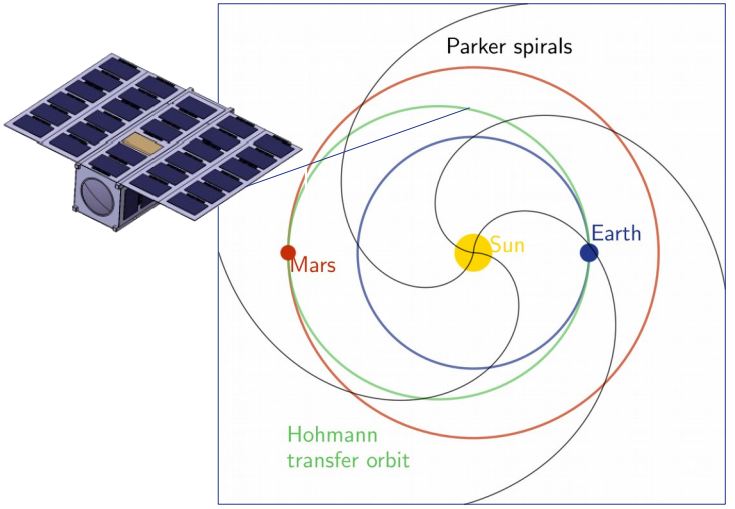
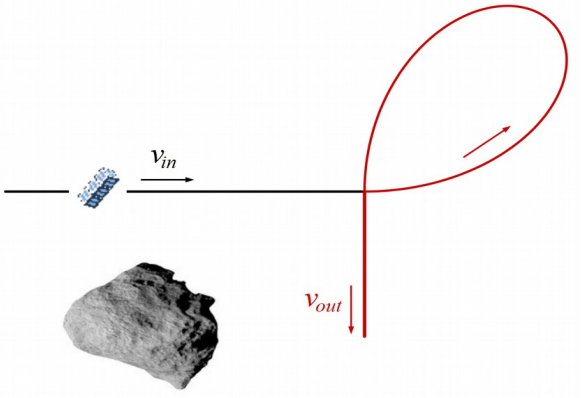
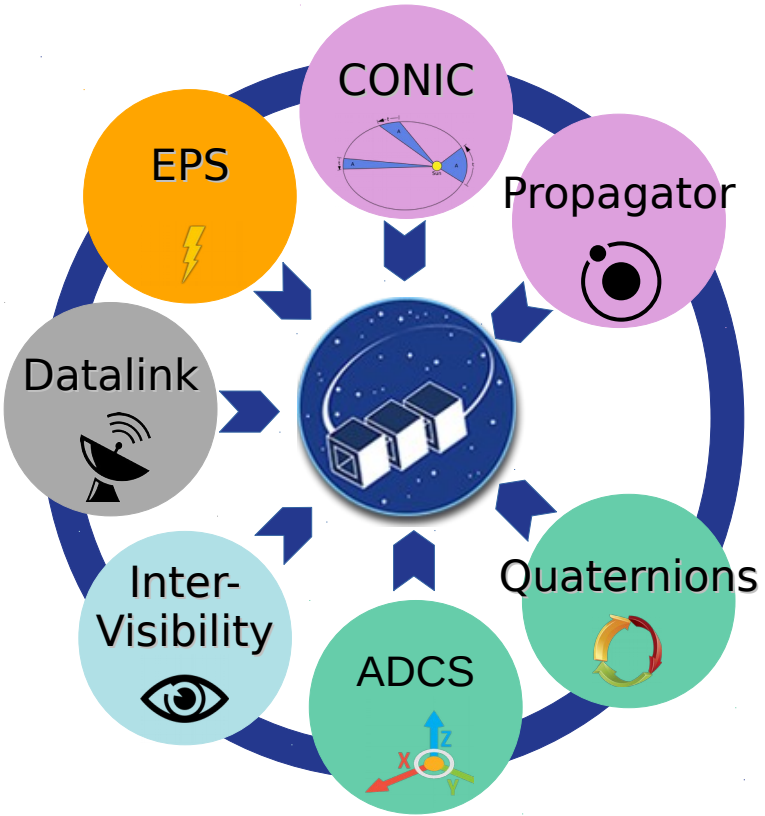
# CubeSats

- Increasing use
  - LEO → Interplanetary + propulsion
  - new demand of mission profile analysis tools
- Mission profile analysis:
  - Optimal trajectory
  - + analysis of pointing/ power/ data volume
- Existing Tools
  - Do not perform complete mission profile
  - Not affordable for everyone



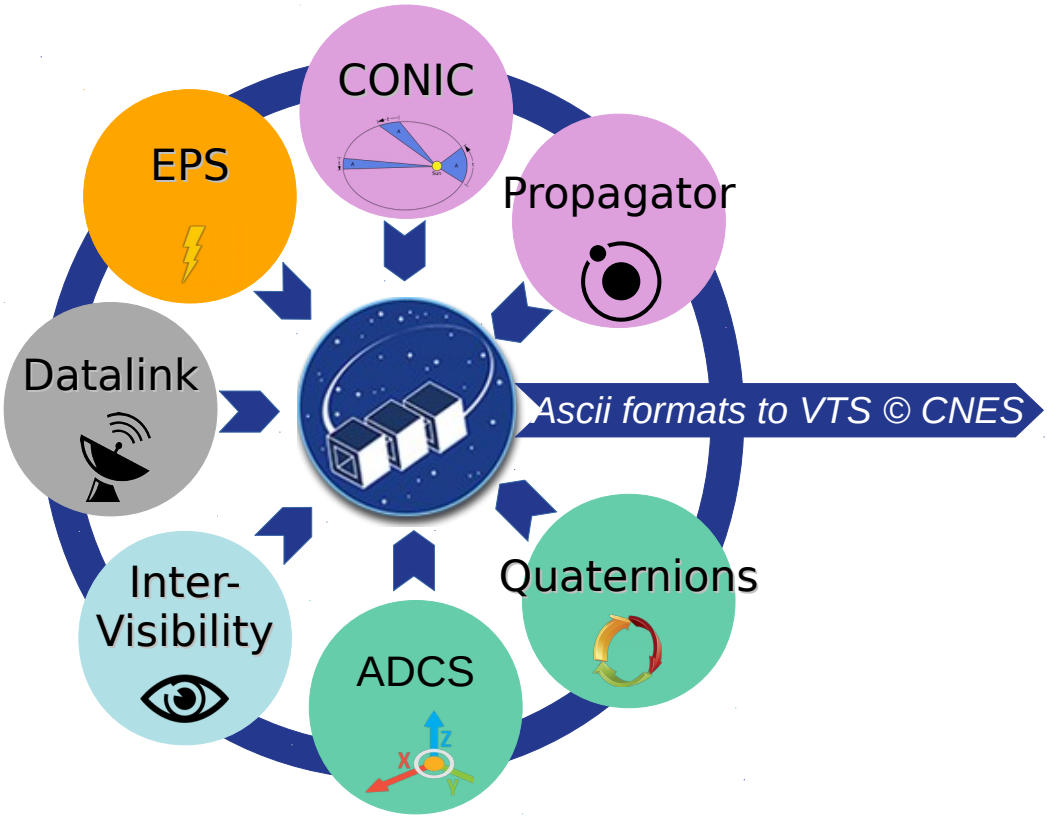
# DOCKS



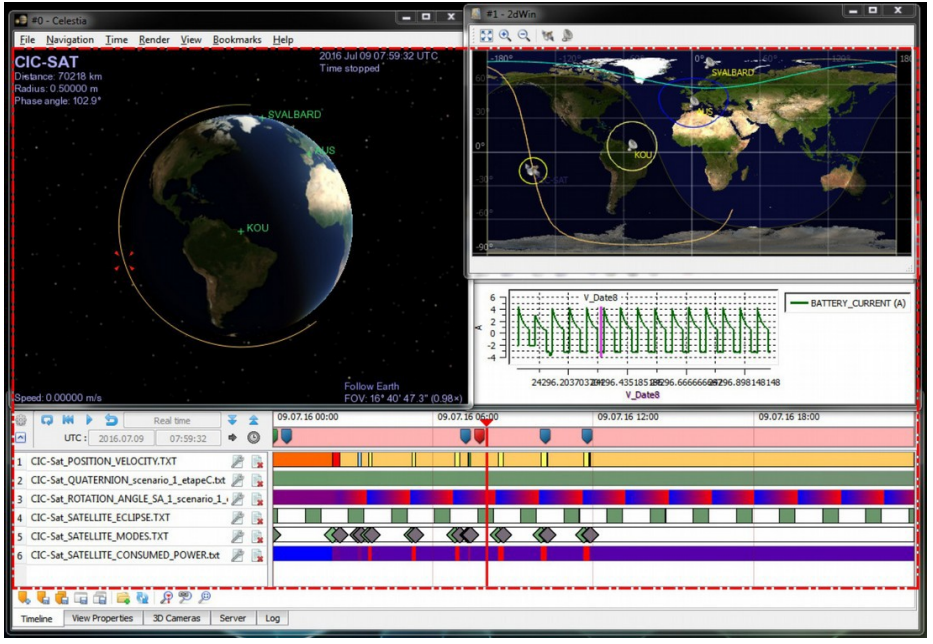

"Design and Operation Cross-checking Services"

- ✔ Open-source
- ✔ Scientific nanosatellite mission profiles
- ✔ Python based
- ✔ Ubuntu, Windows
- ✔ Remote service
- ✔ Free license: gitlab.com/cceres-docks

# DOCKS




VTS

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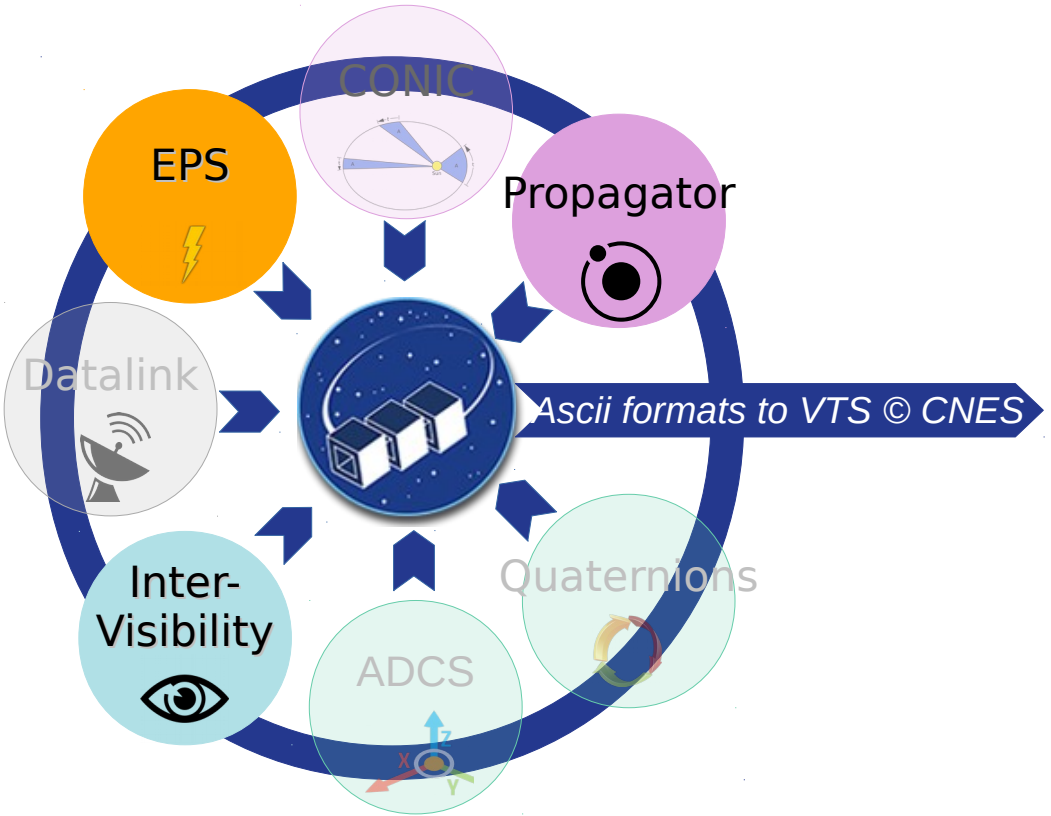
# DOCKS

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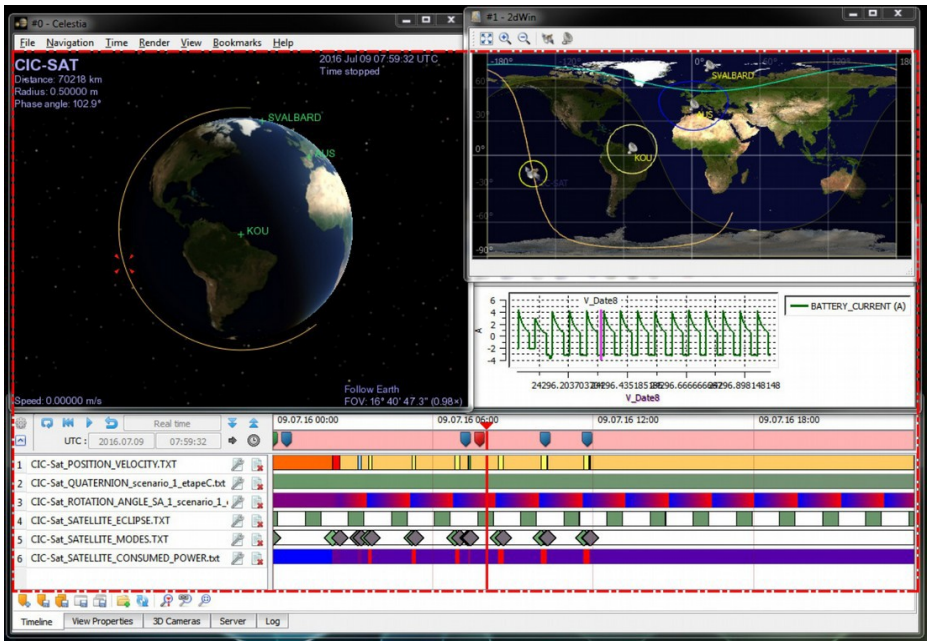


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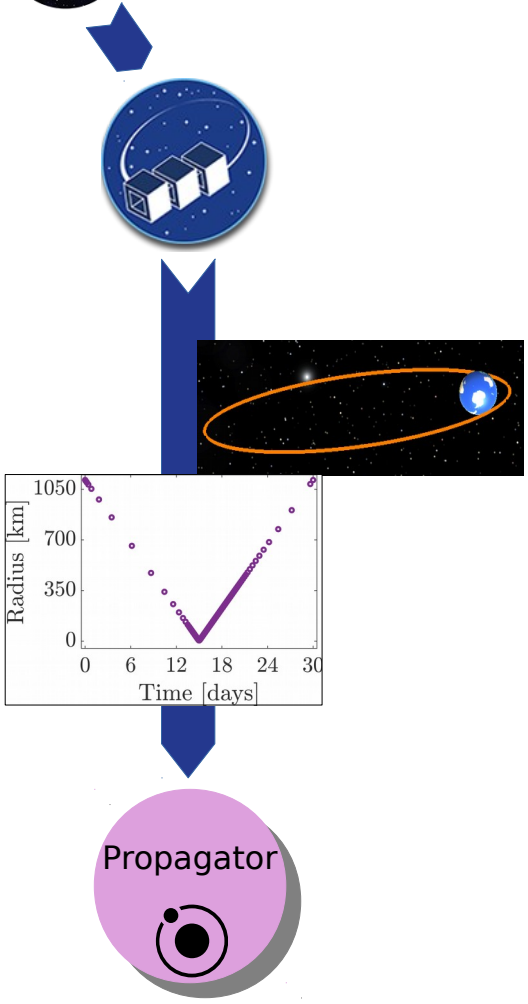
# DOCKS: Propagator

## Deep Space trajectories: Cruise/ Rdv/ Proximity Operations




Versatility

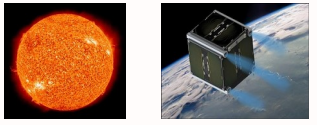
### Perturbations

**Gravitational**

- Simple
- Complex
  - Spherical Harmonics
  - **add custom models** (mass distribution)

**Non-gravitational**

- Solar radiation pressure
- **Continuous propulsion**



User should not be asked for the time-step

### Engine

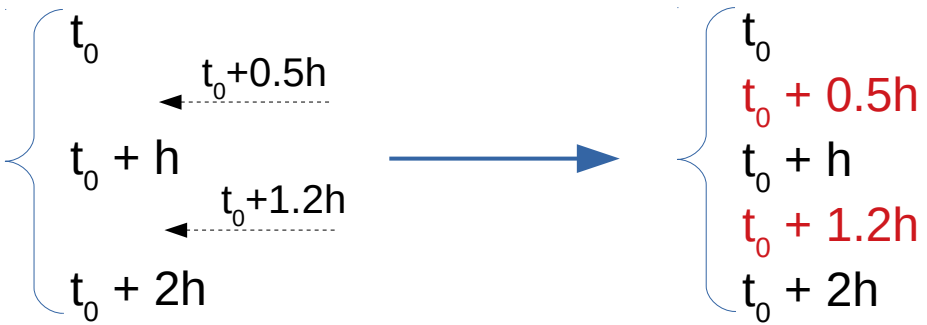
**Accuracy-driven adaptive time-step**

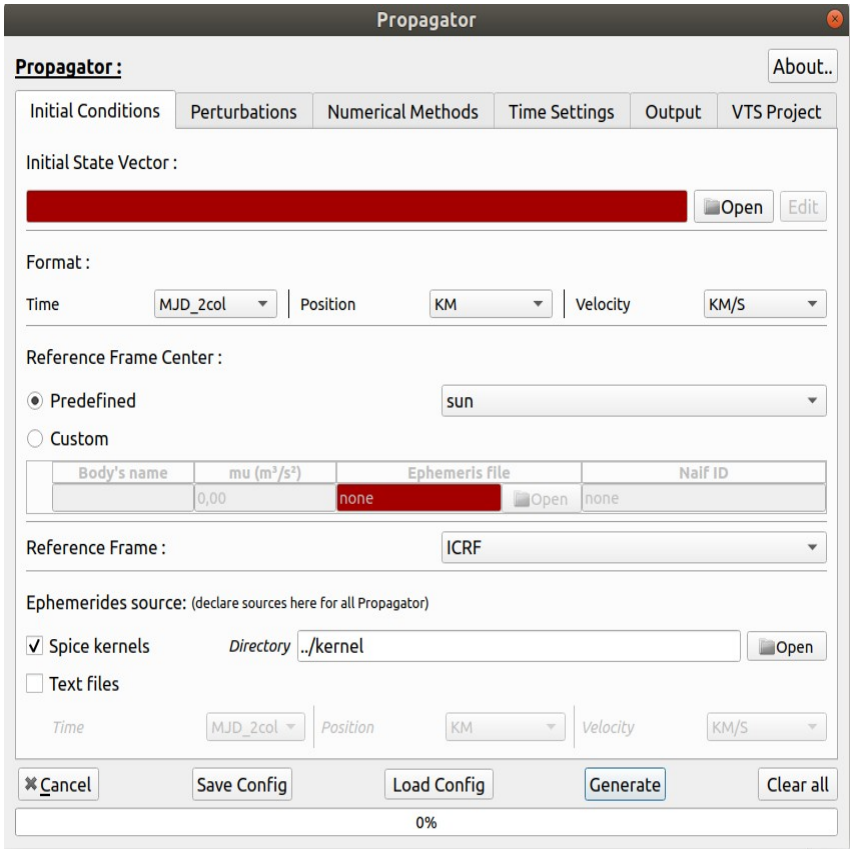
- Runge-Kutta 4
- Runge-Kutta-Felhberg
- **IAS15**
- Forward/ backward propagation

# DOCKS: Propagator

## Time Step Manager:

- continuous propulsion




*Graphical User Interface*

# DOCKS: EVTF and Intervisibilities

## EVTF

- Event Files
- Structures your mission

## Intervisibilities with….

- Sun, Ground station(s)
- Output = “Event File” (**EVTF)**
- Parallelization
- Tunable accuracy

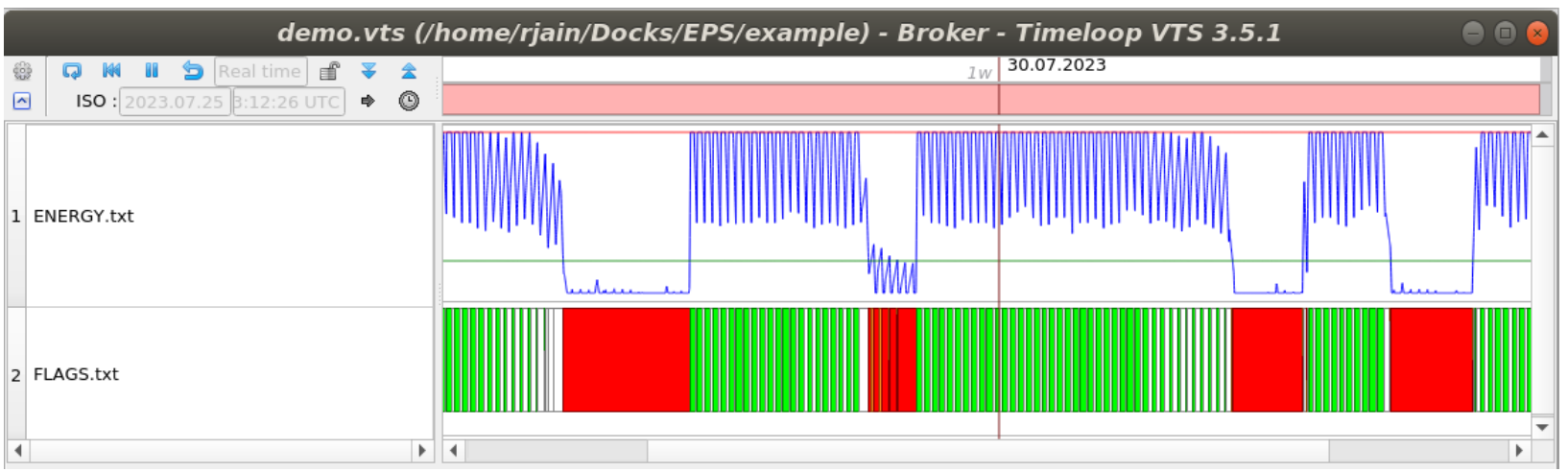

```
1  CIC_MEM_VERS = 1.0
2  CREATION_DATE = 2021-11-03T14:25:48.925
3  ORIGINATOR = DOCKS / CENSUS / LabEx ESEP - Paris
   Observatory - PSL University Paris
4
5  META_START
6
7  COMMENT = Intervisibility for config : CONFIG_VISI.yaml
8  COMMENT = Columns: DATE MJDday + MJDseconds + EVENT +
   EventIndex
9
10 USER_DEFINED_PROTOCOL = NONE
11 USER_DEFINED_CONTENT = OEF
12 USER_DEFINED_SIZE = 2
13 USER_DEFINED_TYPE = STRING
14 USER_DEFINED_UNIT = [n/a]
15 TIME_SYSTEM = UTC
16
17 META_STOP
18
19 60798      60840.000000    COM/IN   00004
20 60798      61620.000000    COM/EG   00004
21 60798      63840.000000    ECL/IN   00001
22 60798      63900.000000    ECL/EG   00001
23 60798      66120.000000    COM/IN   00003
24 60798      66600.000000    COM/IN   00004
25 60798      66720.000000    COM/EG   00003
26 60798      67320.000000    COM/EG   00004
```

**EVTF**

# DOCKS: Energy Power Simulator

## Energy Power Simulator

- Solar arrays mounting, cells & battery techno
- Mode strategy
- Quaternions & Intervisibilities
- Output = on-board power, warning for low power

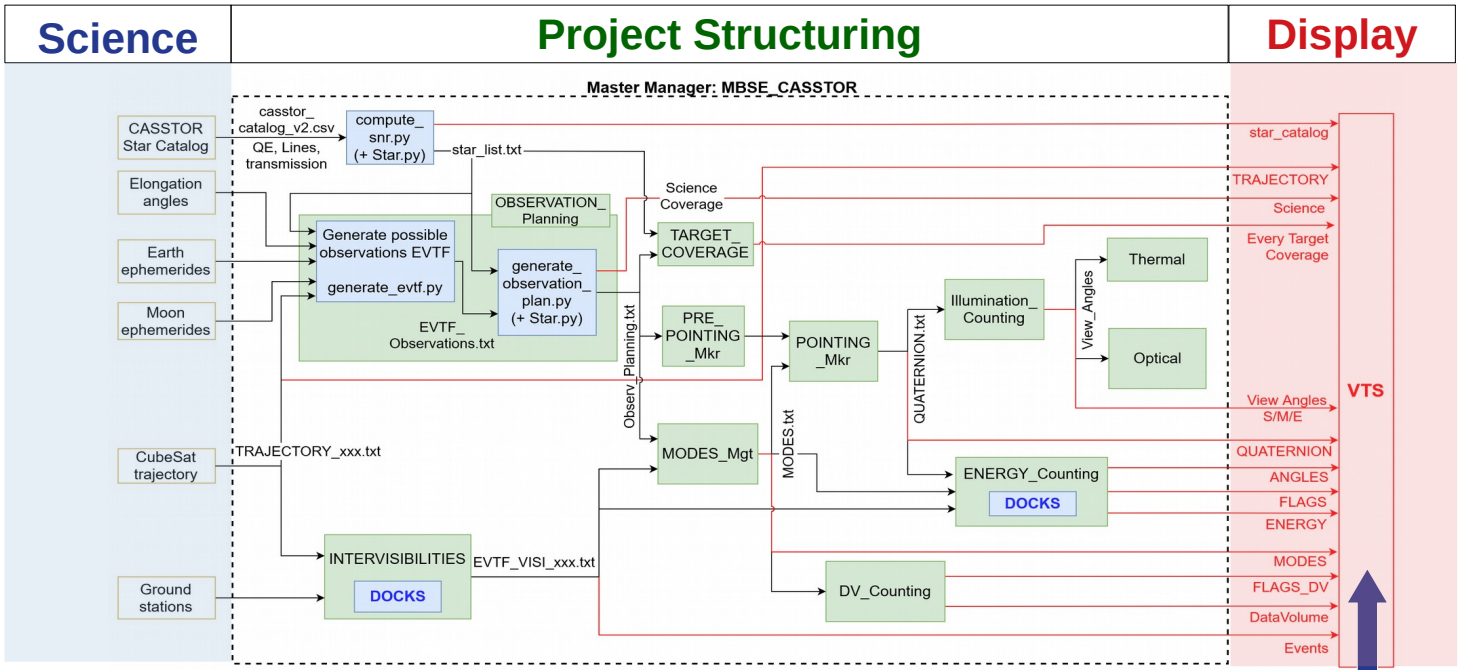


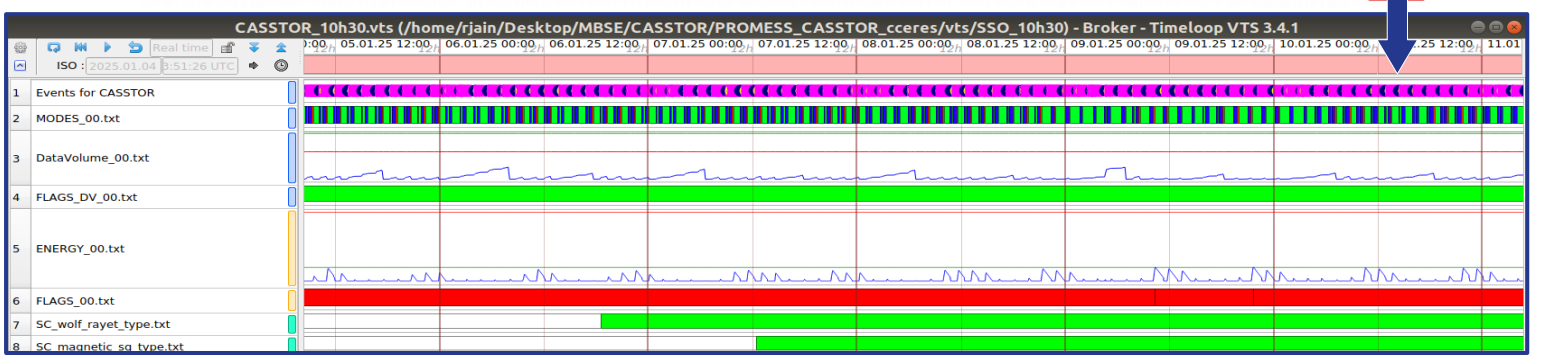
# DOCKS Remote Service

- Compute mission profiles using our server
- No installation required
- Faster computations

# DOCKS: Example in MBSE

- Internal
  - BIRDY
  - CIRCUS
  - CASSTOR
- External
  - TUDSat (Germany)
  - SCION-X (Taiwan)



# Conclusions

- DOCKS helps structure your CubeSat project
- Computes complete mission profile
  - Propagator: smart numerical integrator
    - Accepted paper for IEEE Aerospace Conference 2022, to be published in March 2022

      *R. Jain, H. Sharma, B. Segret, "DOCKS Propagator: An Open-source Adaptive Time-step Trajectory Propagator for CubeSat Missions", IEEE Aerospace Conference 2022*
  - EVTF/ Intervisibility, EPS……more to come
- Free and accessible to everyone
- Remote service

## On-going development

- Speed
- User-friendly
- GUI

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