



poliastro

Astrodynamics in Python

# Towards Better Space Situational Awareness

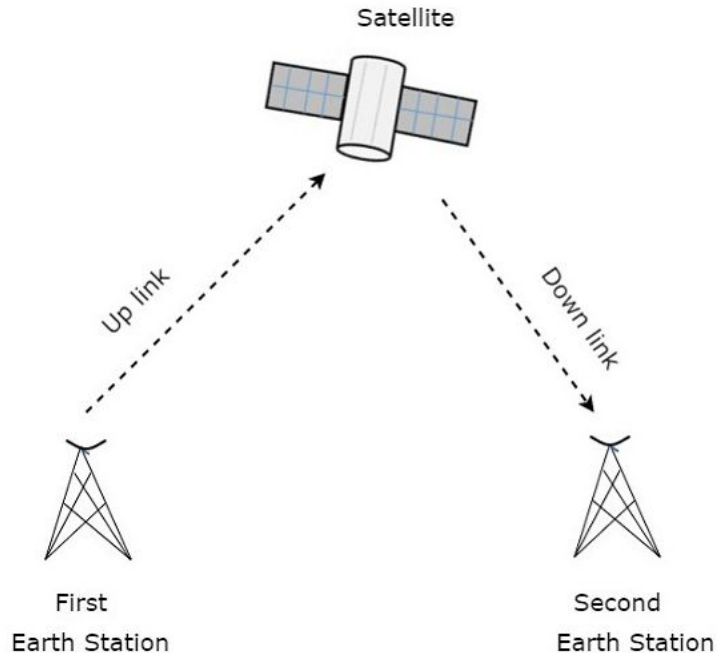
## Expanding Event Detection

Yash Gondhalekar

# Space Events are everywhere!

## Beneficial events:

E.g., Satellite communication



## Disastrous events:

E.g., Satellite collision, Debris collision, Satellite crashing onto attractor's surface, etc.



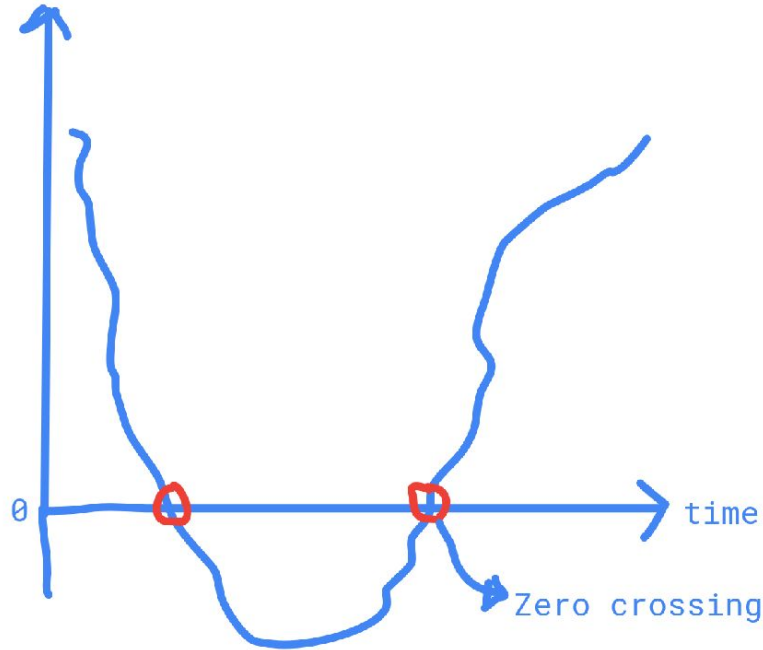
# Search for peculiar points based on classical orbital elements

cowell  
propagator

Scipy's  
solve\_ivp

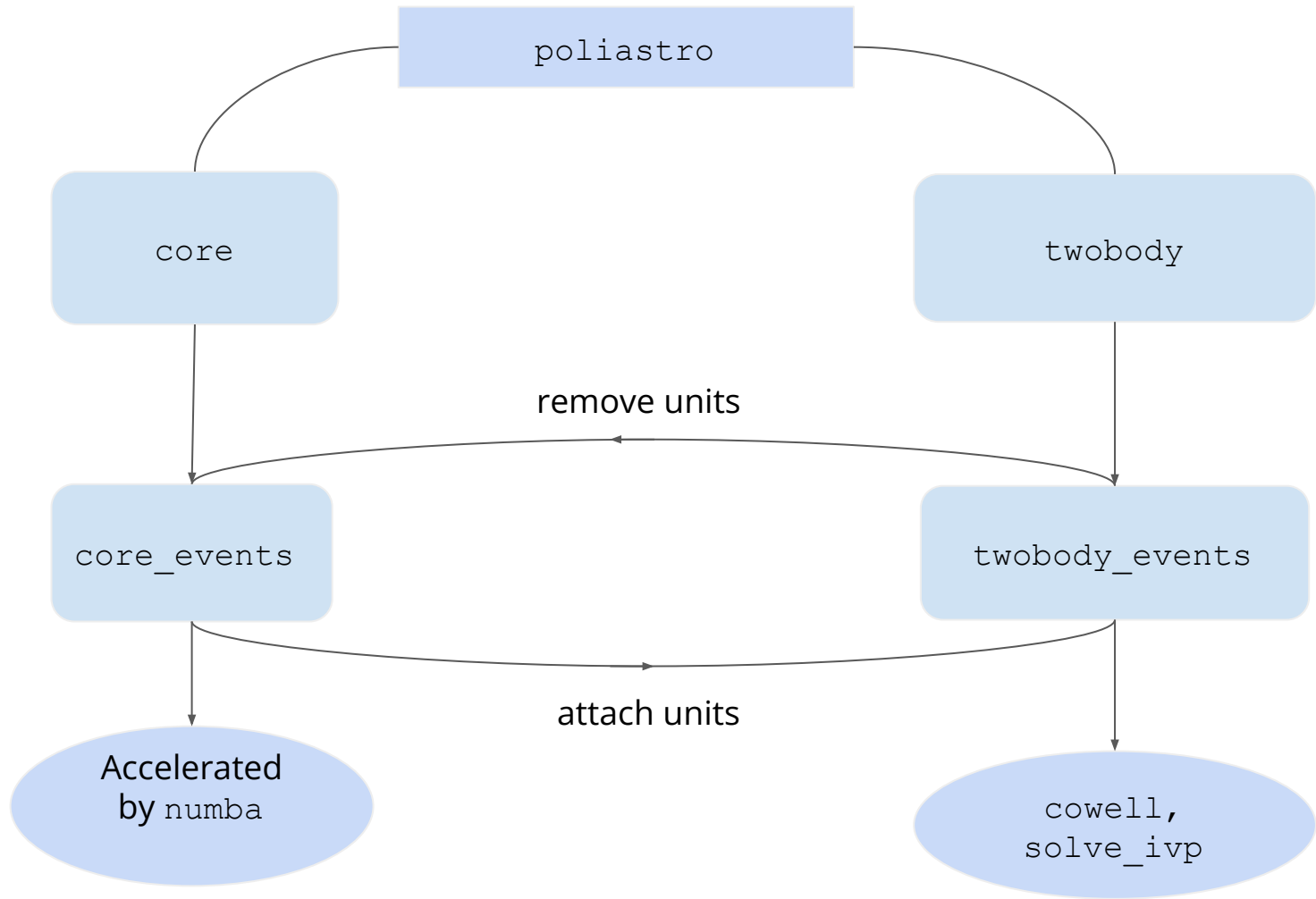
terminate  
and  
direction  
attributes

Event function



**point-by-point**  
check  
procedure

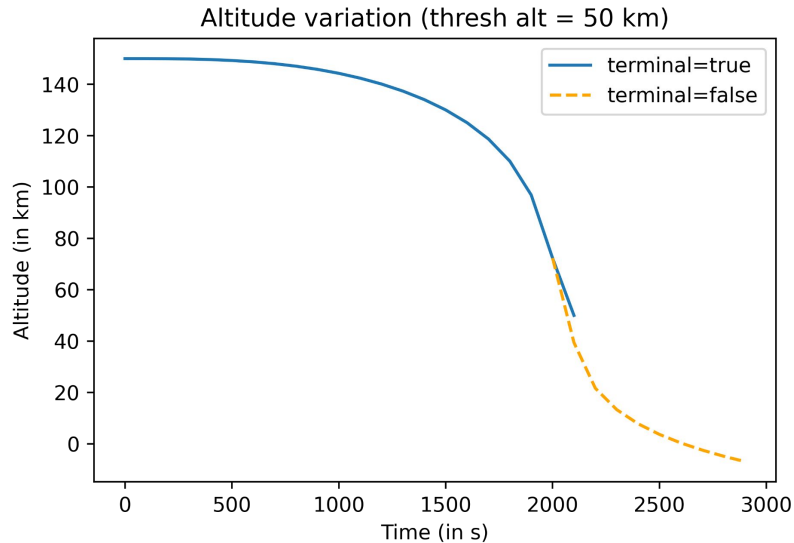
Works with any  
attractor!



Let's Explore **Events!**

# Altitude Cross Event and Lithobrake Event\*

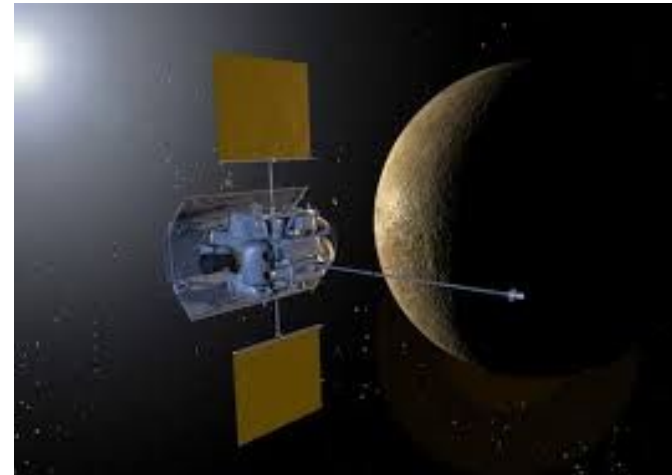
## Altitude



\*The Lithobrake event was already present. We modified its interface.

## Lithobrake

threshold altitude = 0

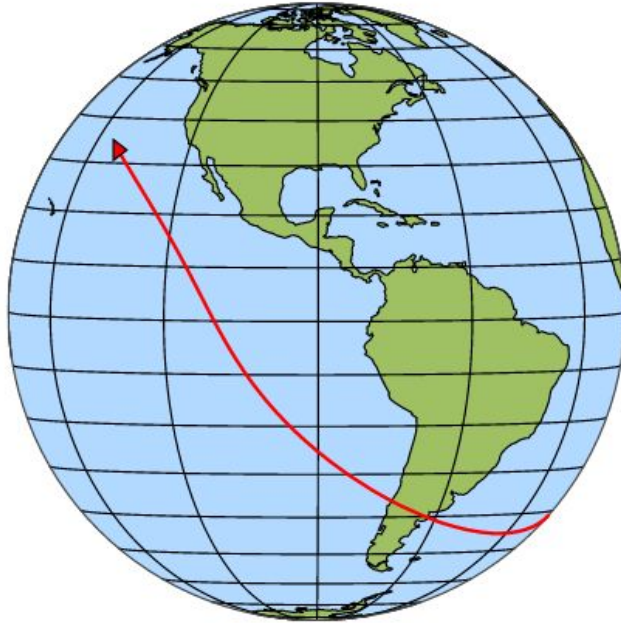


MESSENGER spacecraft

Other examples: defunct satellites

# Latitude Crossing Event\*

Detect when a satellite crosses a specific latitude on its attractor.

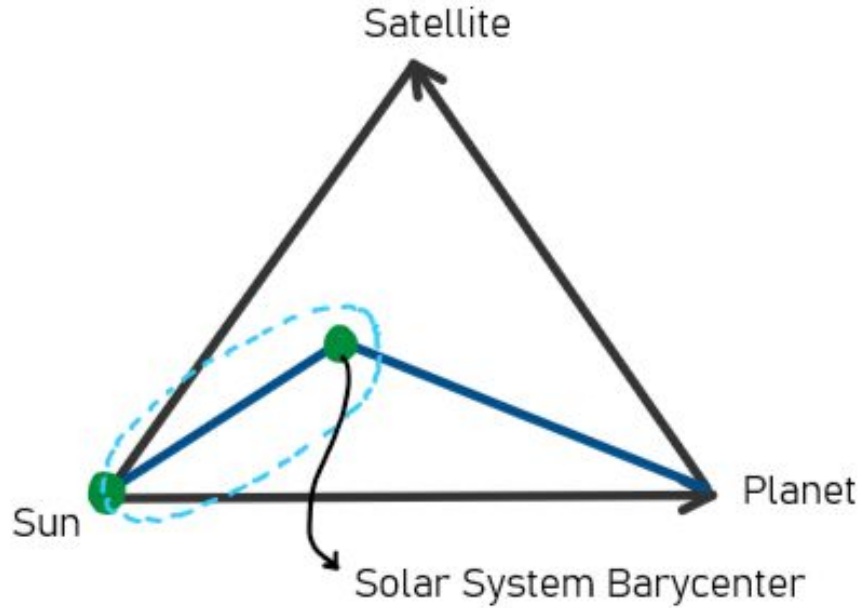


Flattening of attractor?

What about the Longitude detector?

\*Latitude refers to *geodetic*, or in general, *planetodetic* latitude.

# Penumbra and Umbra



## Assumptions/Considerations:

Flattening of attractor? ❌

Movement of bodies? ✅



# Eclipse Geometry

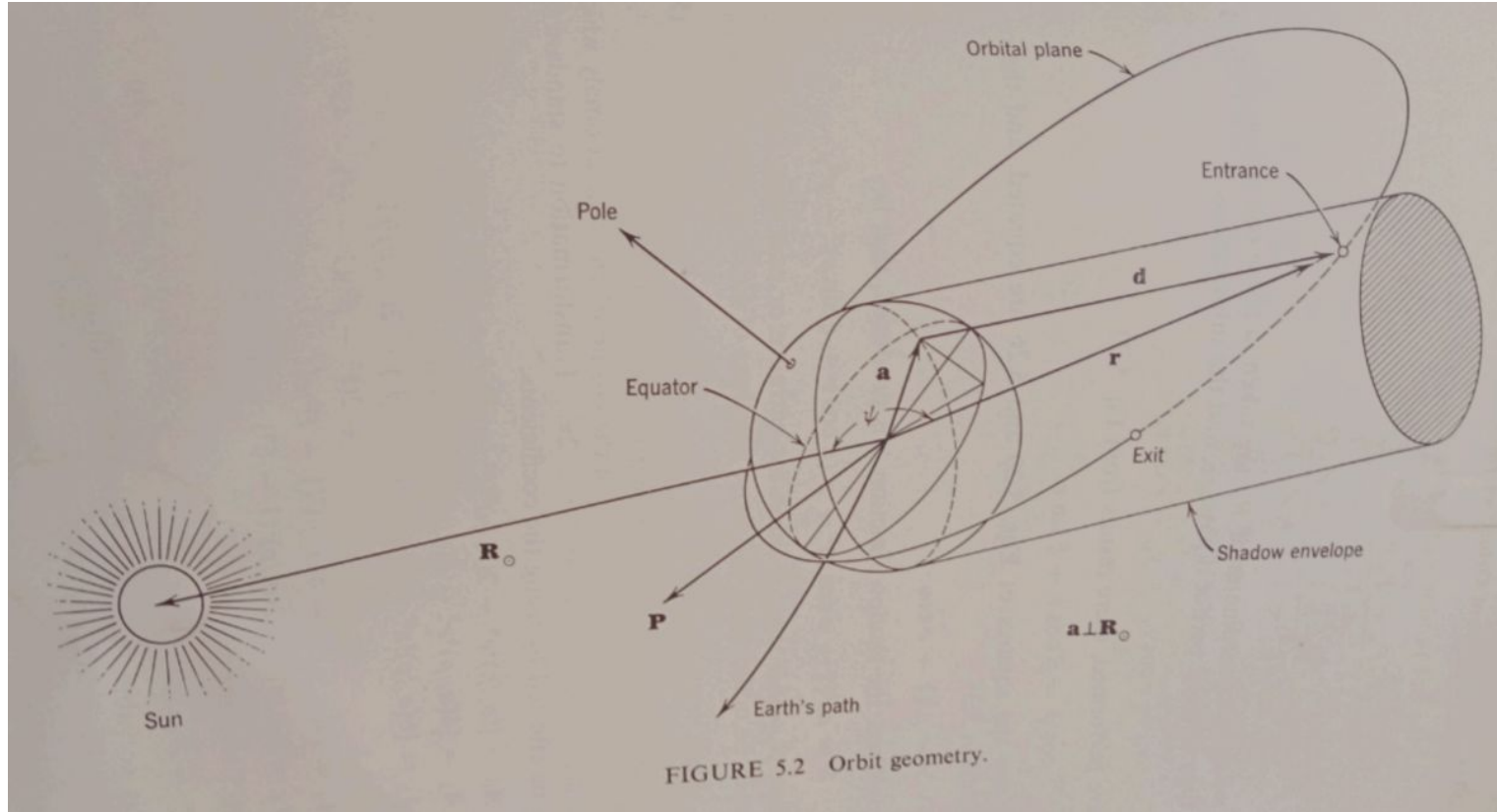
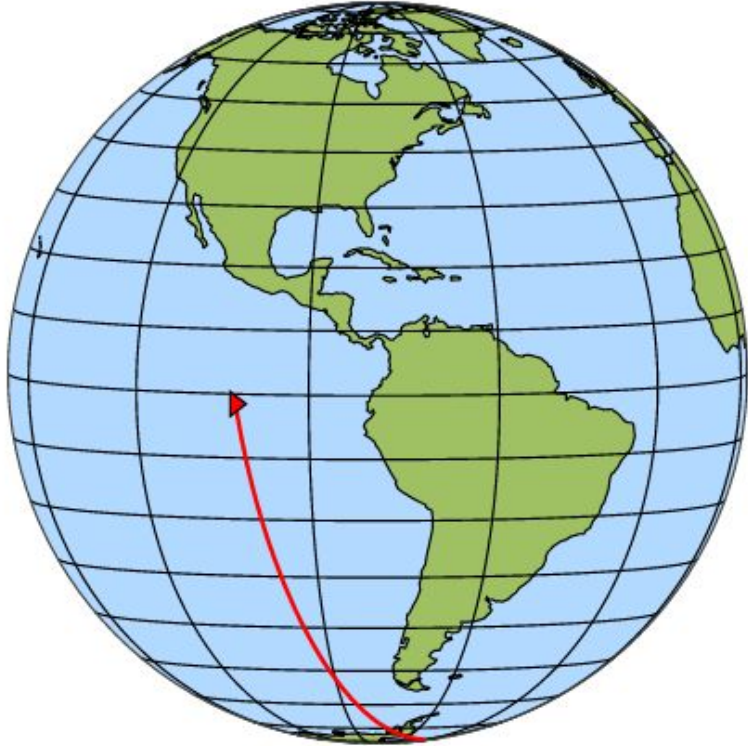


Image Source: [Escobal, 1985](#)

# Node Crossing Event

Equatorial crossing

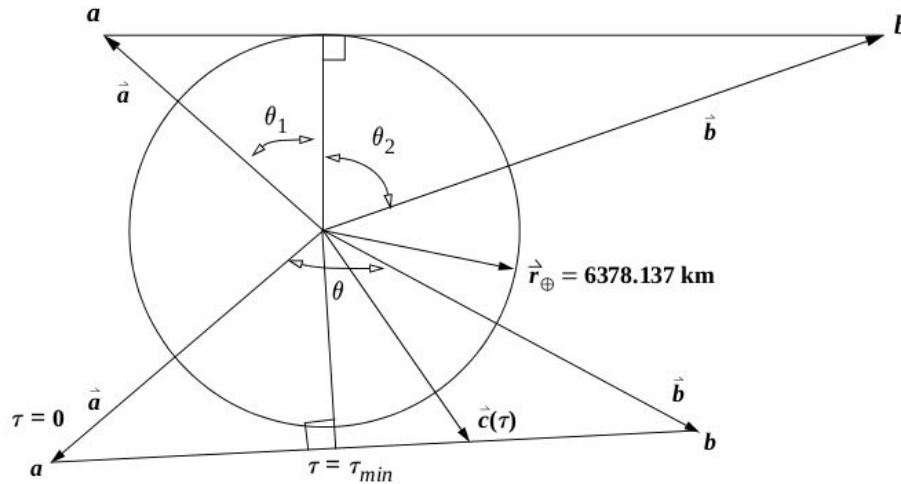


— Orbit

Check for the inclination,  $i$ ,  
of the orbit!

# Line-of-Sight (LOS) Event

LOS between two satellites orbiting the same attractor



LOS geometry: From [Vallado & McClain, 2013](#)

LOS

$$\theta_1 + \theta_2 \leq \theta$$



$$\theta_1 + \theta_2 > \theta$$



Eg: Importance in inter-satellite communication.

# Validation

Against the **Orekit** library

Thanks to the [Orekit Python Wrapper](#)!

**Methodology:** Propagate both Orekit and poliastro orbits and match the time of event occurrence.

**Outcome:** Time difference  $< 2-3$  s.

# Other approaches to event detection

Eg:

## 1) Anomaly detection approach (Li & Chen, 2019)

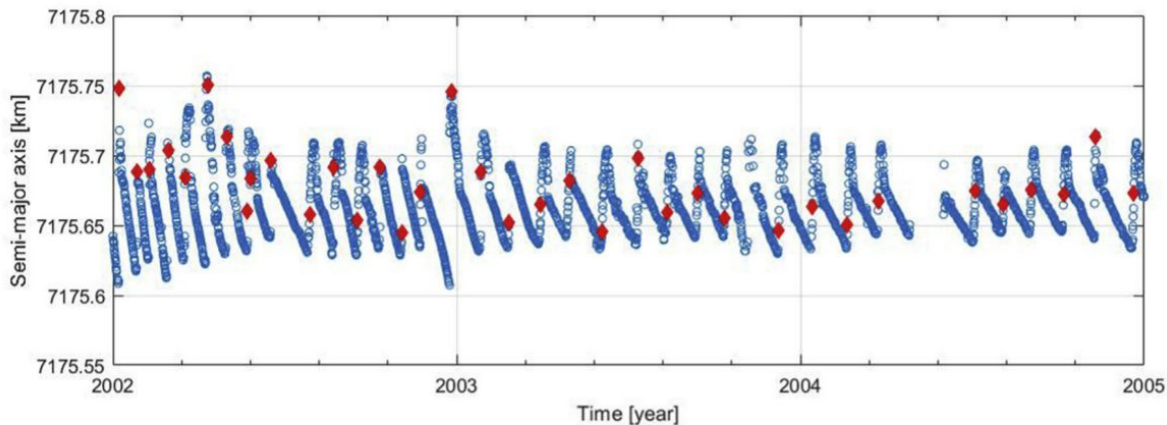


Fig. 2. Orbital anomaly detection results of RADARSAT from 2002 to 2004.

2) **Weather satellites** - measure **sea surface temperature (SST)** and its spatial and temporal variation. Eg: Tracking progression of the **El Niño–Southern Oscillation (ENSO)**.

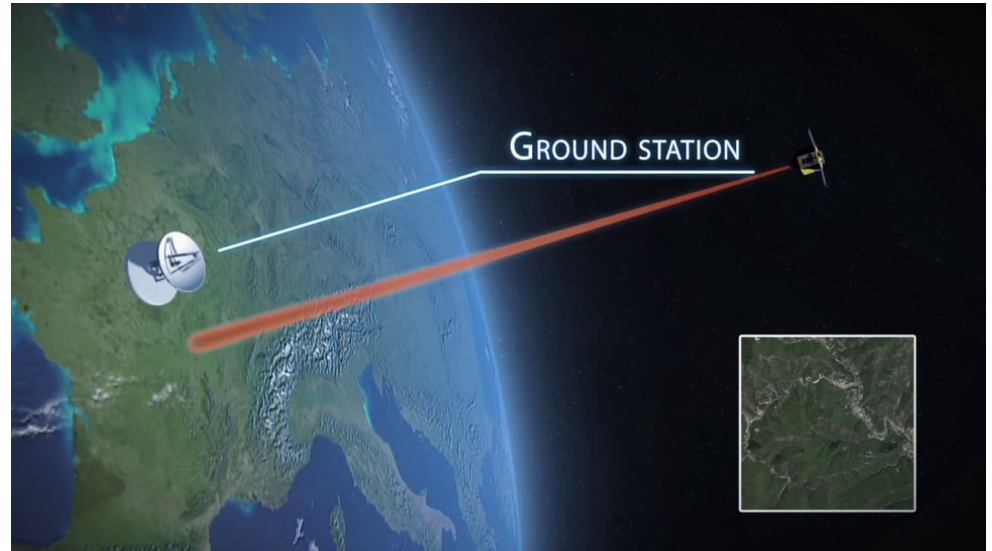
# Future prospects...

In progress ...

- Satellite visibility
- Attractor surface visibility

In future ...

- Satellite collision
- ...



# Thank you!

We are looking for suggestions, ideas, and bugs! (the software ones...)