Magnetospheric Multiscale (MMS) Mission Navigation Concept

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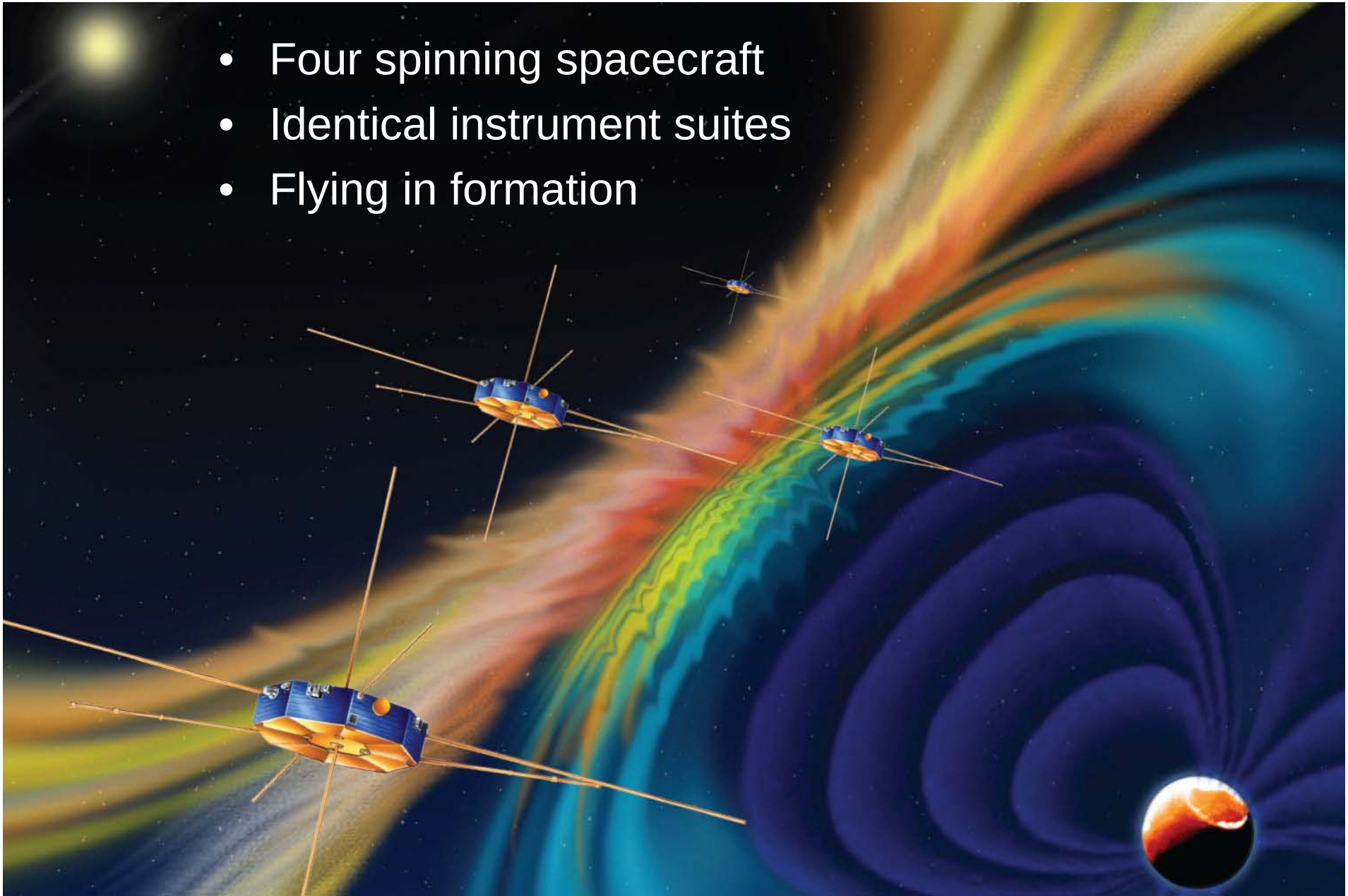
Mission Overview



MMS Science

Primary Objective: “Magnetic Reconnection”

Magnetic Energy

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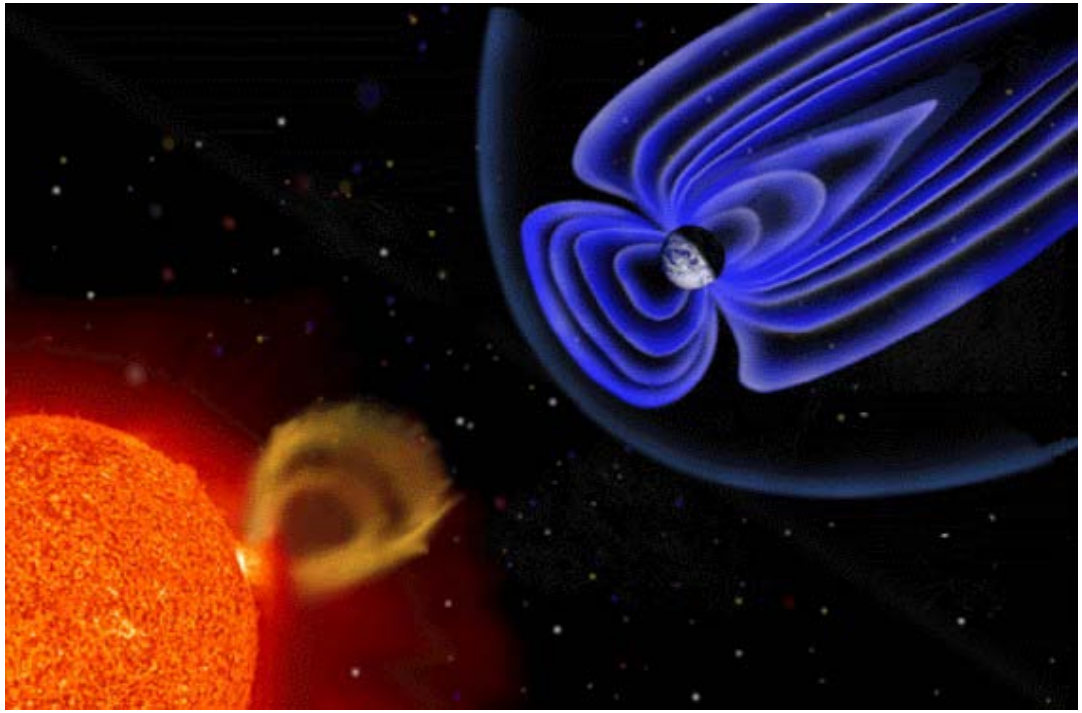
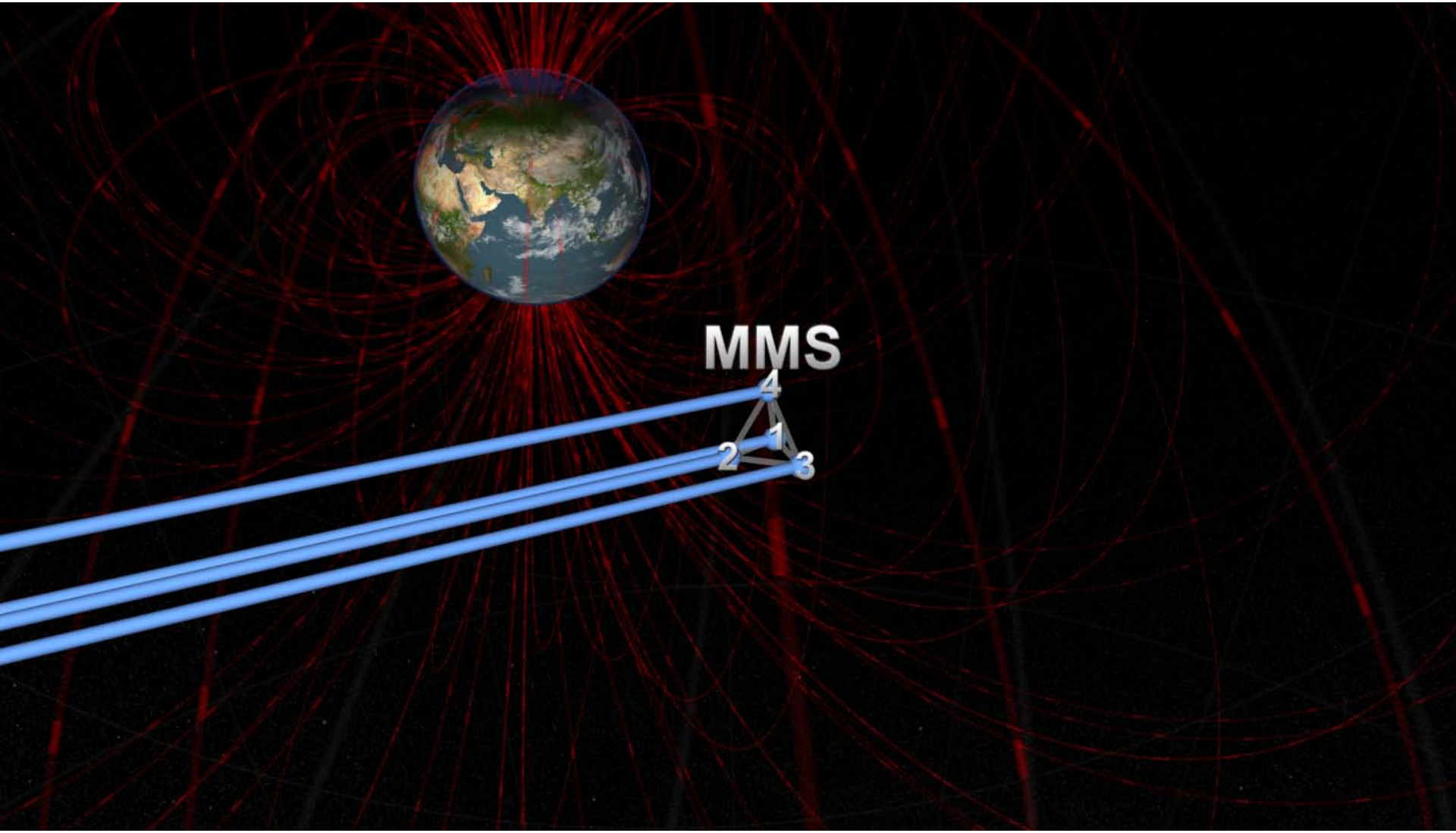
Heat, Kinetic Energy of Charged Particles

Magnetic Field Lines

↓

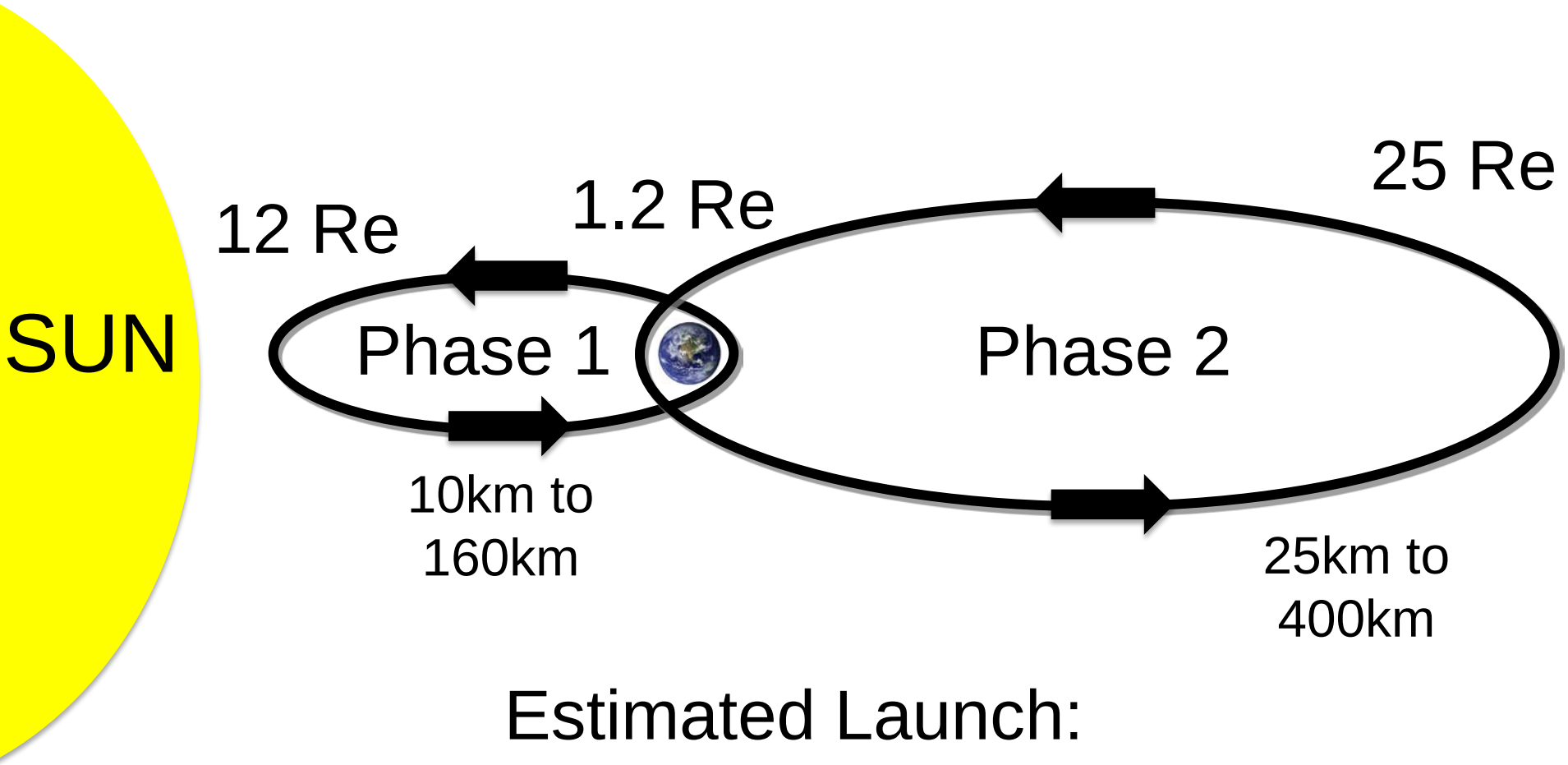


Tetrahedron Formation



Primary Science Phases

Re = Earth Radii = 6378 kilometers



Estimated Launch:
Late 2014

Sun Distance
Not to Scale

MMS Navigation

Navigation = Orbit and Time Determination

Primary Navigation Challenge: Relative Position and Time Accuracy Requirements

- 1% of separation for relative position
- 1 millisecond relative timing accuracy

MMS Navigation

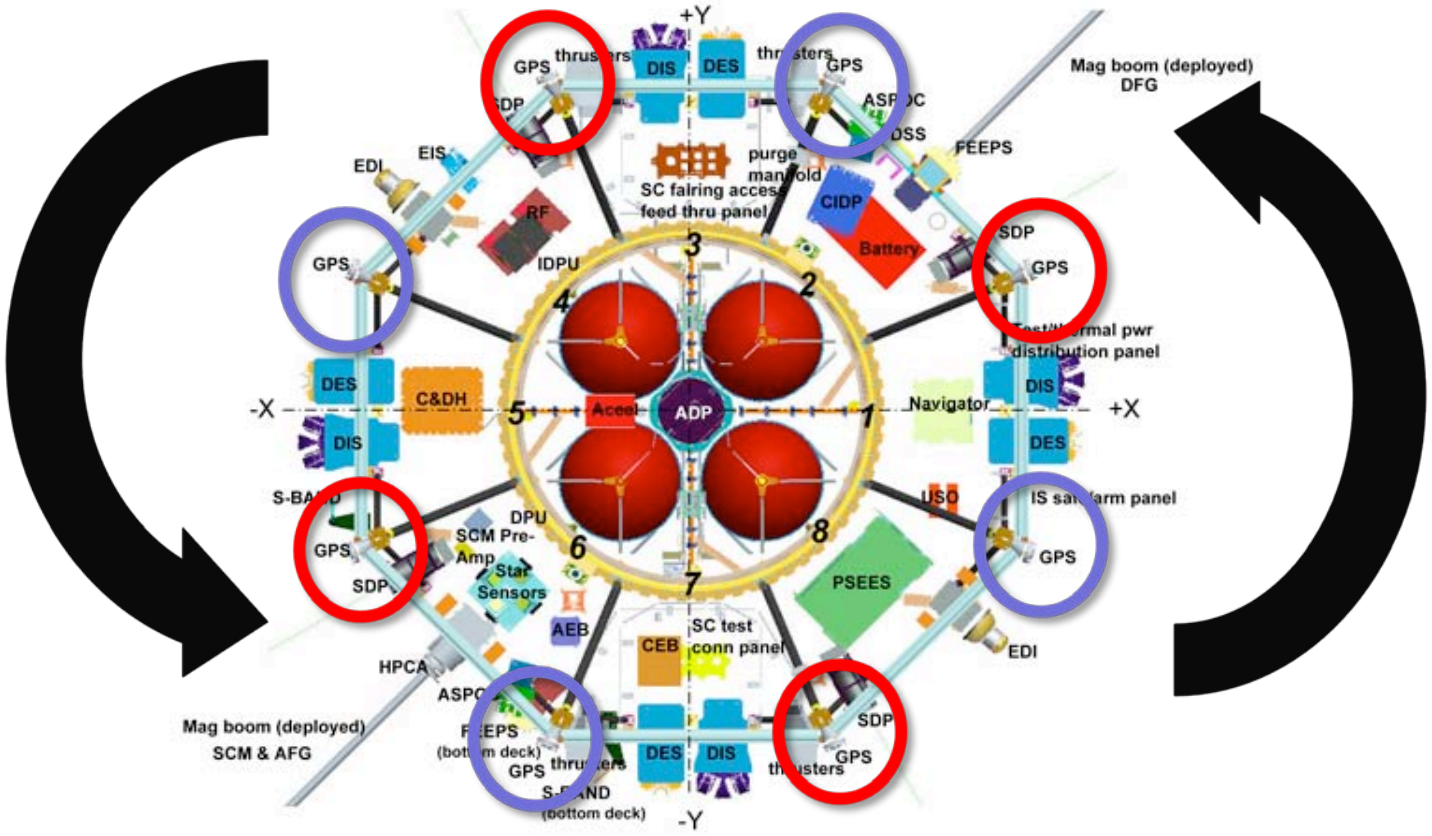
Only viable solution: onboard orbit and time determination using GPS

Other options considered by NASA:

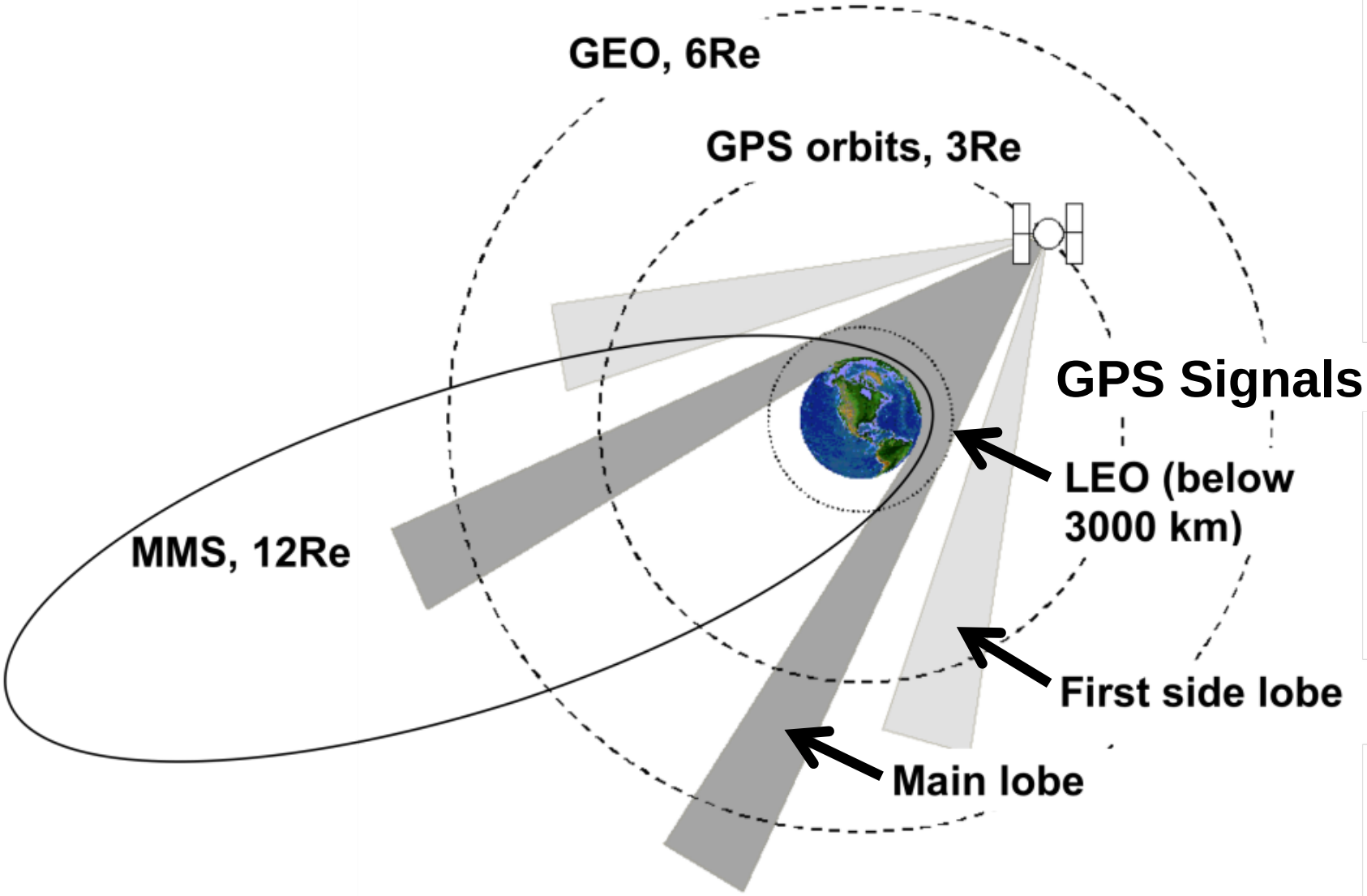
- Inter-spacecraft ranging
- Ground tracking

Nav Challenge #2

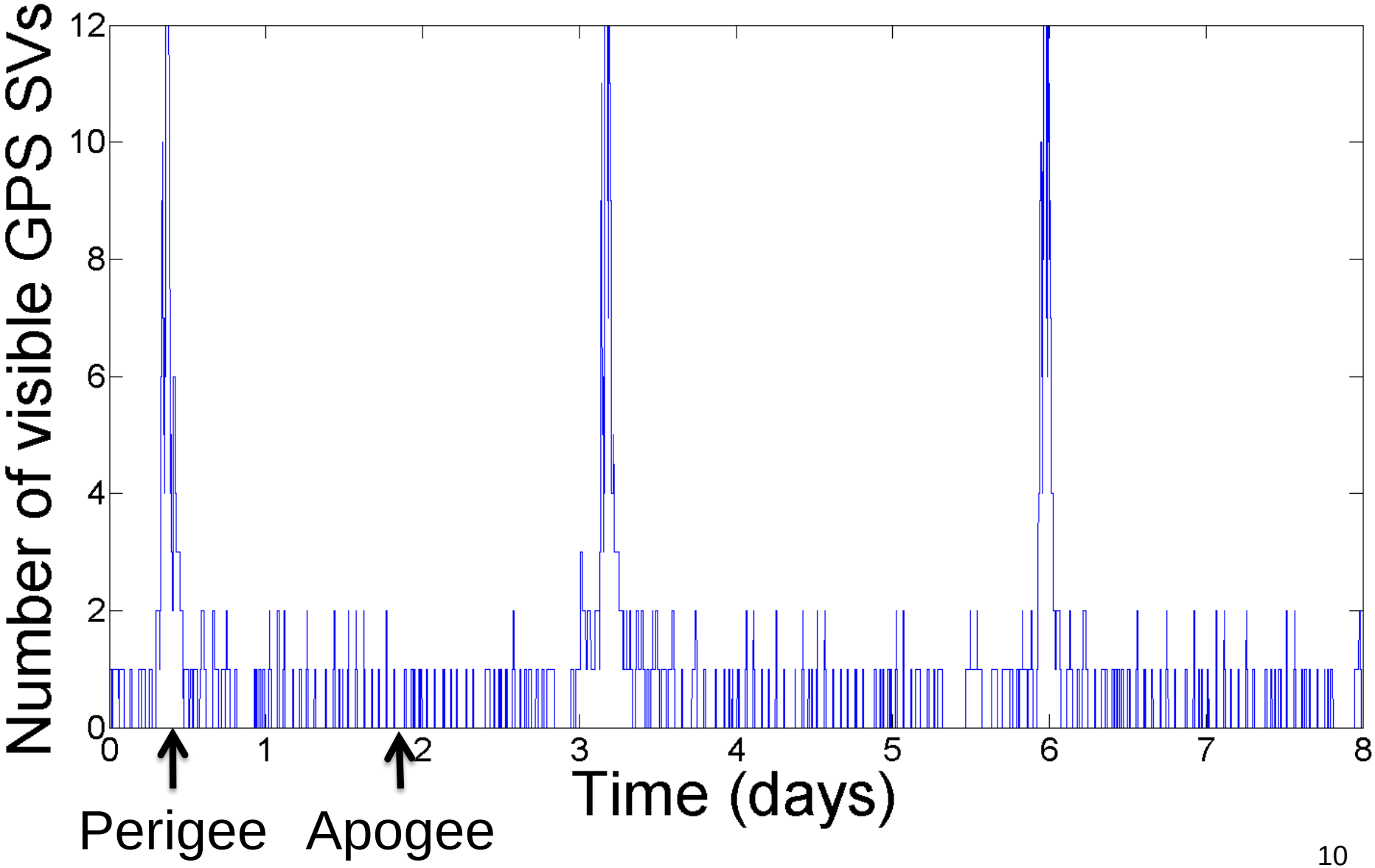
4 active GPS antennas on spinning spacecraft - handoffs required every 5 seconds



Nav Challenge #3

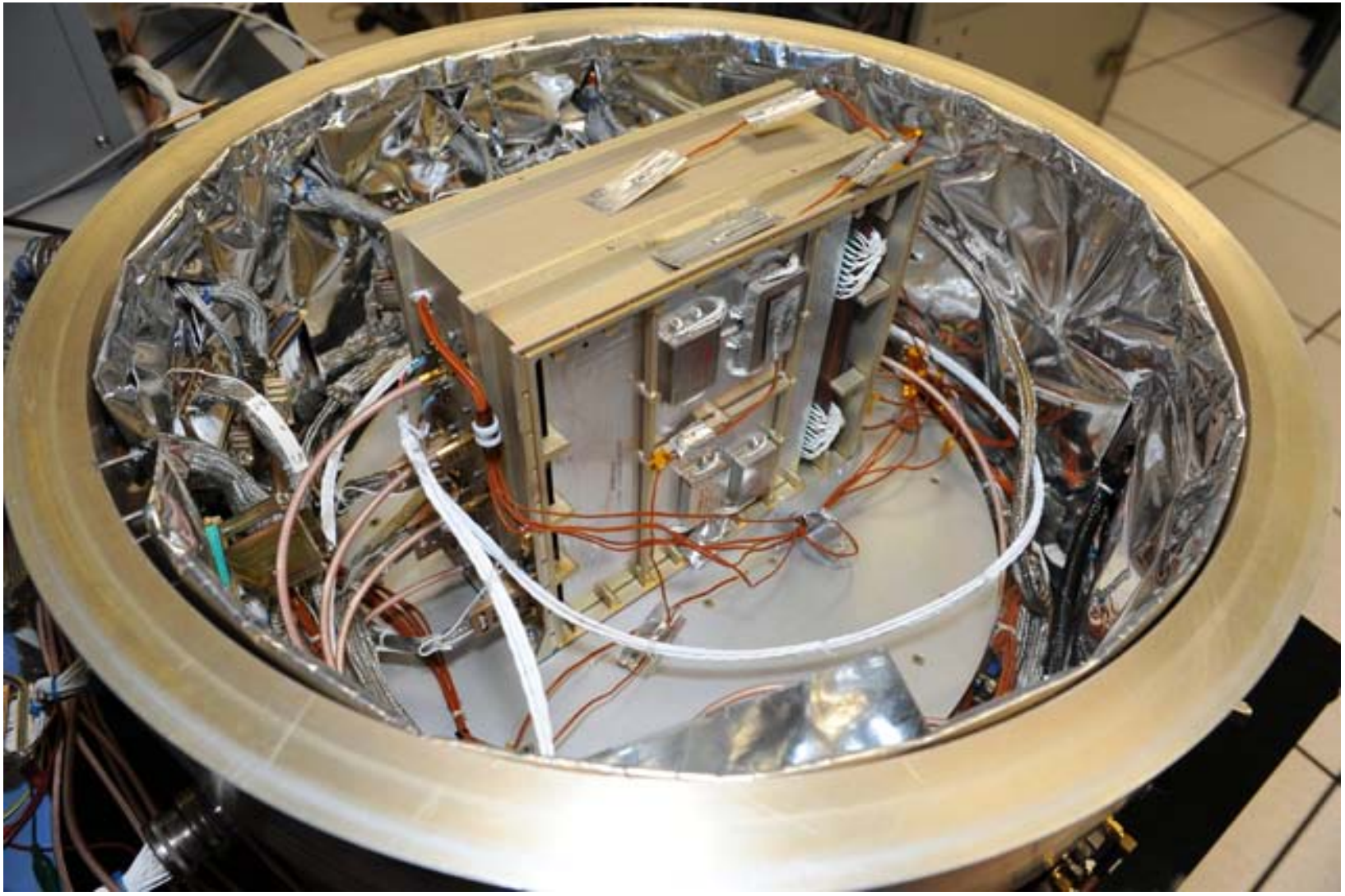


GPS Acquisition

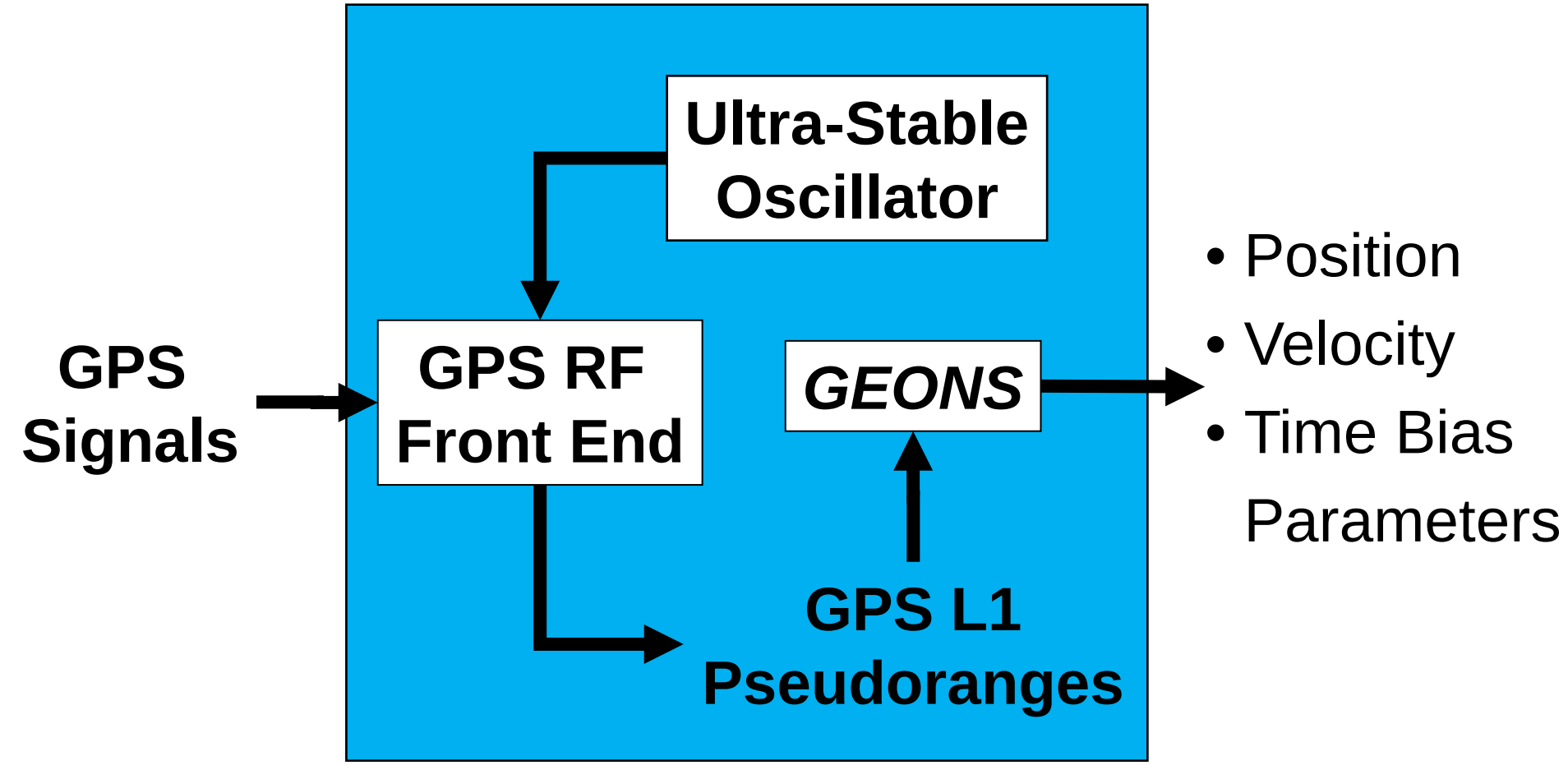


Navigator

Onboard GPS Receiver

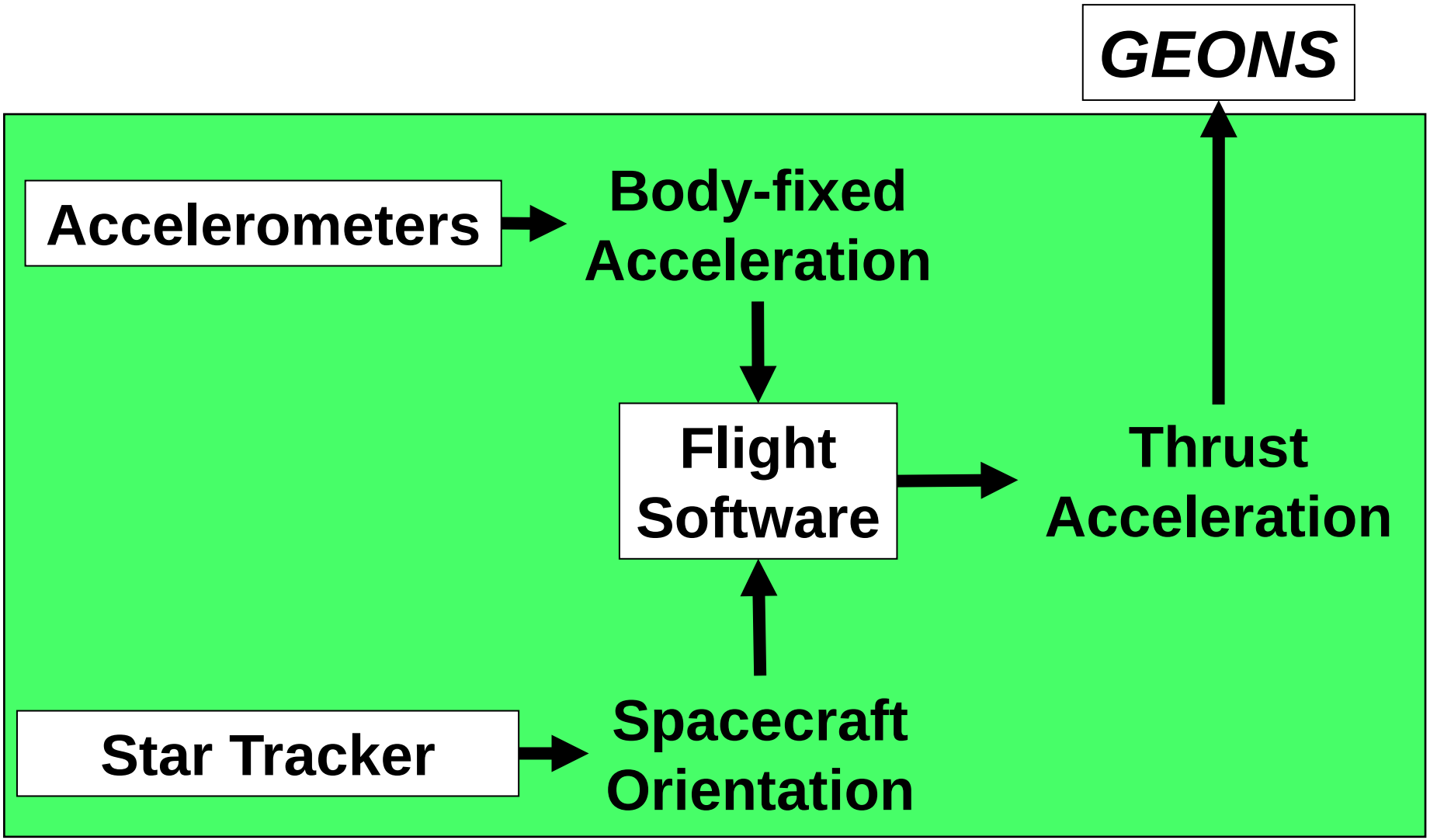


Navigator



$$\rho = c \times \Delta t$$

Other Sensors



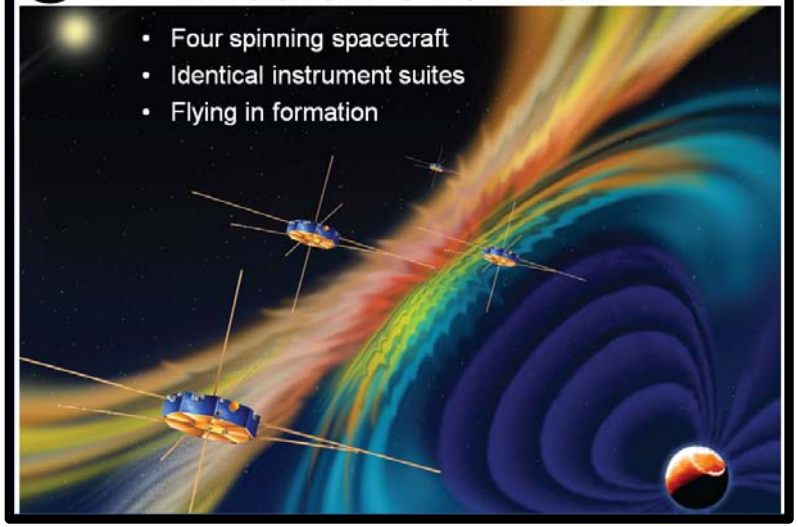
Navigation Products

Ground Uses of GEONS Information

- Definitive position & velocity for science
- Using definitive, generate predictive
  - Science planning
  - Mission management & scheduling
  - Maneuver planning

Summary

Mission Overview



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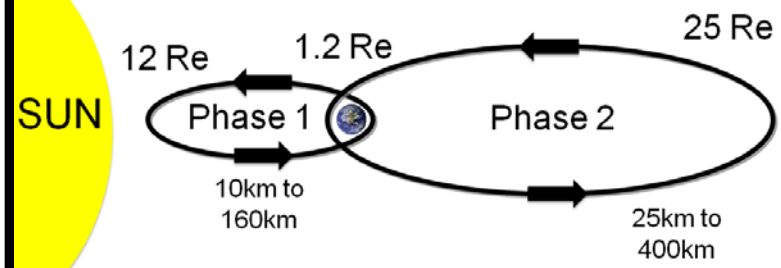

Estimated Launch: Late 2014

Sun Distance Not to Scale

5

Nav Challenge #2

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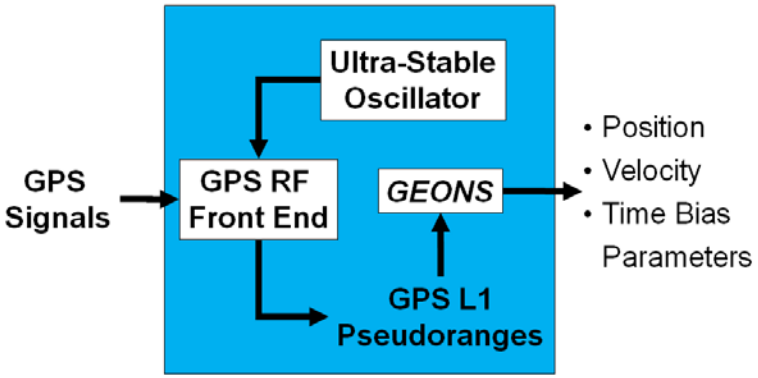
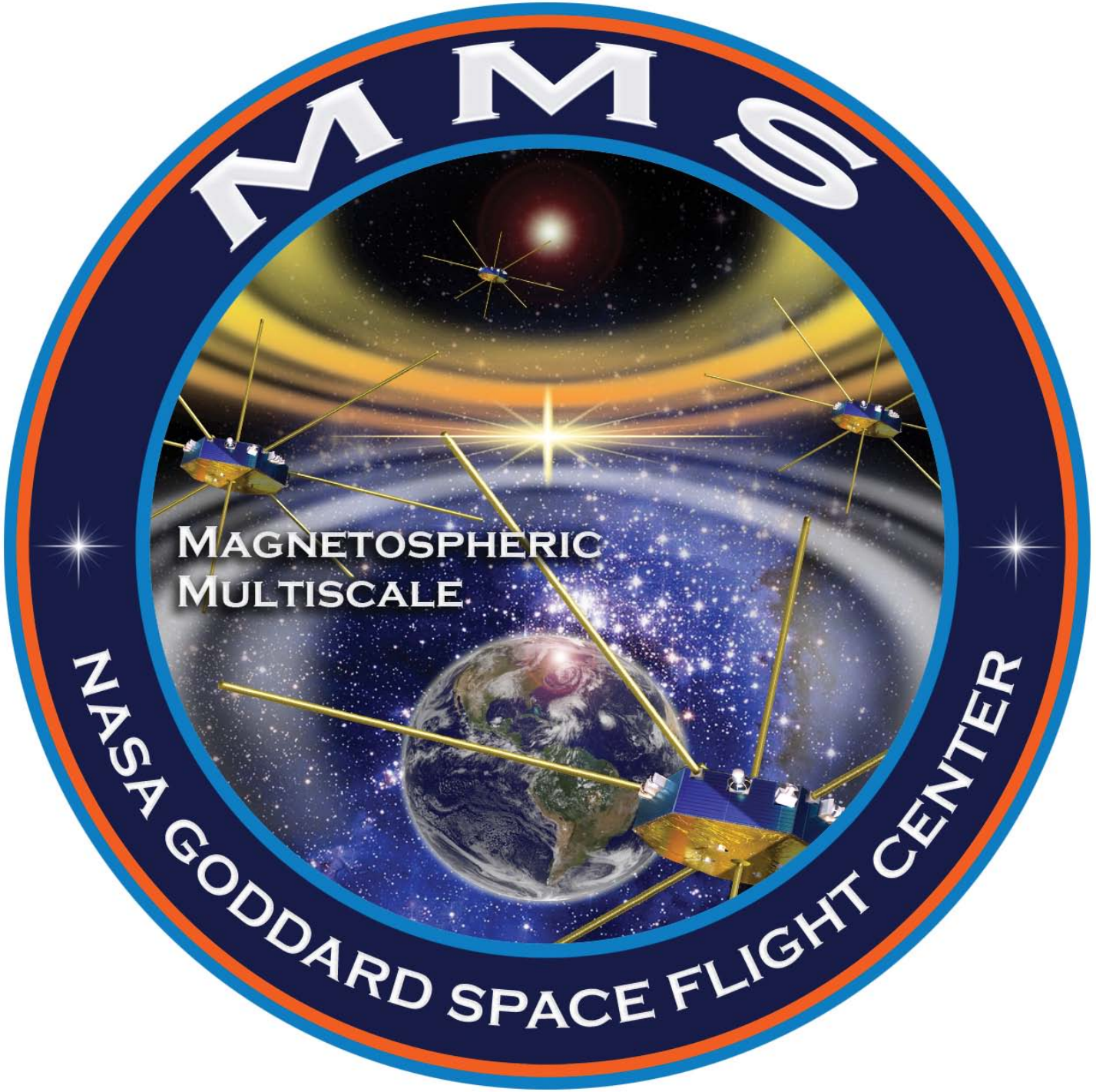
8

Navigator



$\rho = c \times \Delta t$

12


MMS
MAGNETOSPHERIC
MULTISCALE
NASA GODDARD SPACE FLIGHT CENTER