The Earth Affecting Solar Causes Observatory (EASCO)

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Earth Affecting Solar Causes

- CMEs (Geomagnetic Storms, Solar Energetic Particles)

- Source: active regions, filament regions

- CIRs and high speed stream

-source: coronal holes

- EASCO to measure and characterize CMEs and CIRs

Science Payload

Instrument	Measurement	FOV	SR	TR
Magnetic and Doppler Imager (MADI)	Photosph. B, V	Full disk	2”	90 min
White-light Coronagraph (WCOR), HI	Coronal images	2.5 – 215 Rs	1-2’	10, 60 min
Inner Coronal Imager at EUV (ICIE)	Coronal images	0 – 1.2 Rs	2”	1 min
Low-frequency Radio Telescope (LRT)	Dyn. spectrum	1 – 100 Rs	--	1 min
Solar Wind Plasma Instrument (SWPI)	Plasma param.	In situ	--	1 min
Solar Wind Magnetometer (MAG)	Magnetic field	In situ	--	1 min
Energetic Particle Detector (EPD)	SEP intensity	In situ	--	1 min
Hard X-ray Imager (HXI)	Flare Images	Full Disk	4-100”	0.1s
UV Off-limb Spectrograph	UV Spectra	2 coronal heights	20”	var

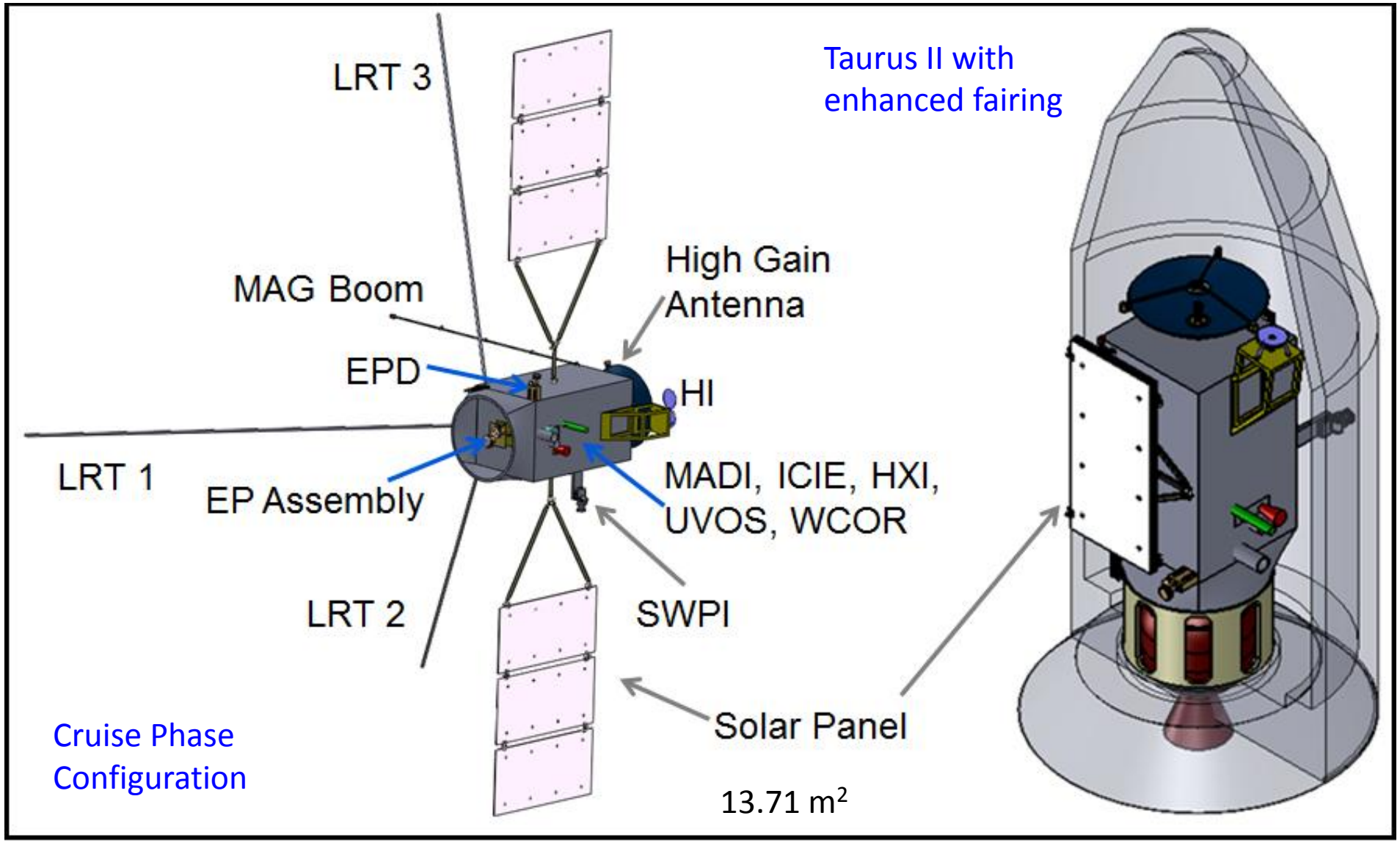
Instrument	Mass (kg)	Power (W)	Data Rate (kbps)
MADI	15	60	7
ICIE	10	8	30
WCOR	25	30	15
HI	10	15	5
HXI	6	5	2
UVOS	30	30	20
LRT	13	15	2
SWPI	10	5	3
MAG	3	3	3
EPD	16	23	3
Total	138	194	90

SR: Spatial Resolution; TR: temporal Resolution

EASCO Mission Requirements

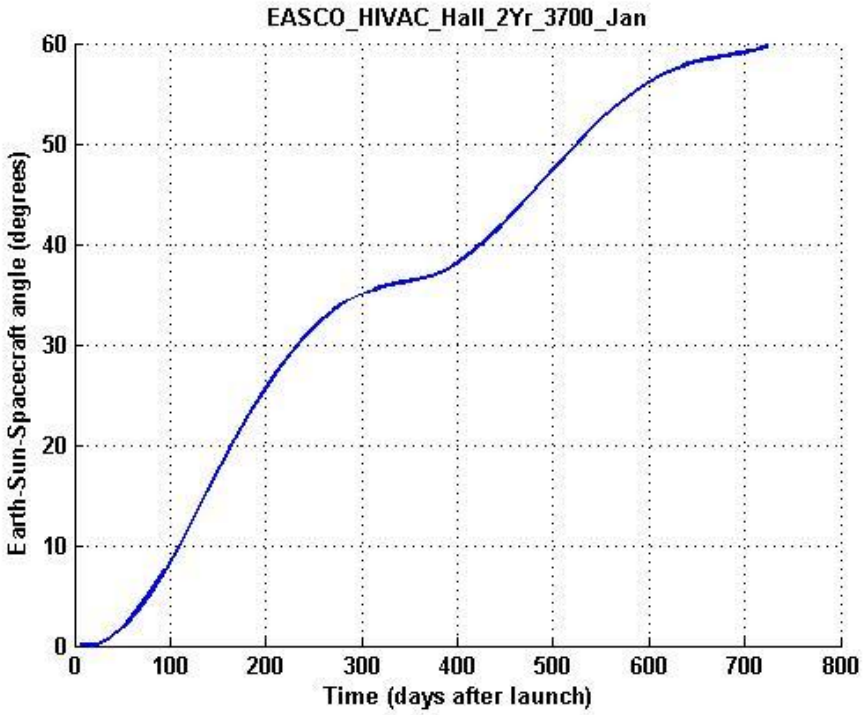
- 10 science instruments with various fields of regard and exclusion zones
- 2 year cruise to Sun-Earth L5
- 4 year primary science mission (2024 – 2027)
- Consumables sized both for primary and potential extended mission (12 years total)
- Class B redundancy approach
- Space Weather Beacon
- Optional Cruise Phase Science

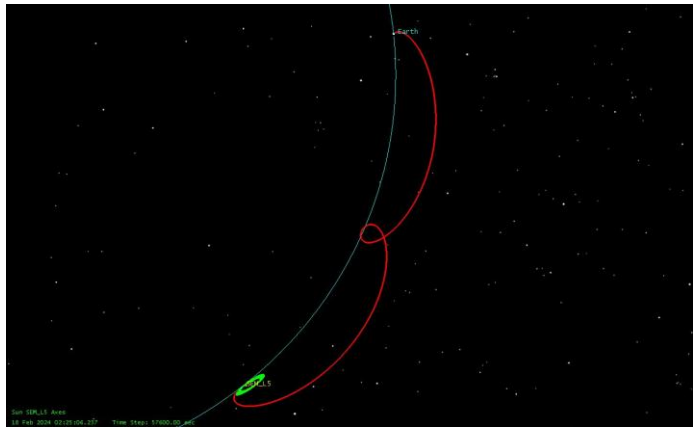
EASCO Payload Accommodation

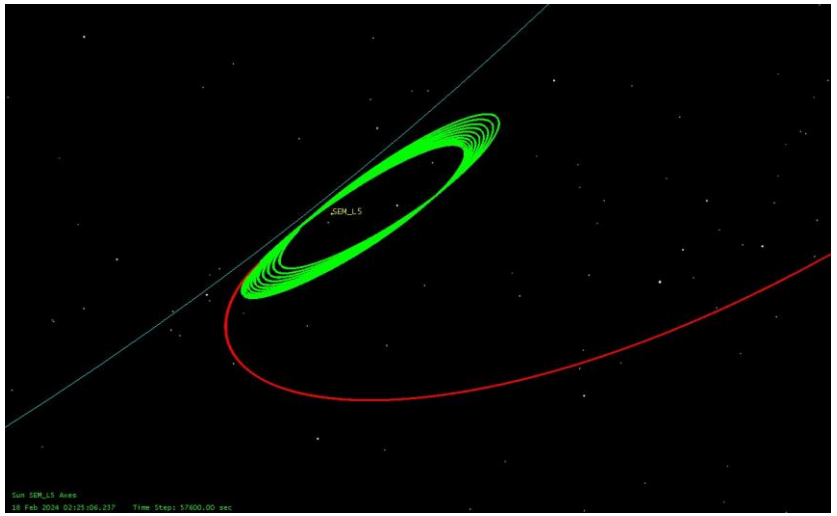


Flight Dynamics Summary

- **Baseline Low-Thrust Trajectory to Sun-Earth L5 using Solar-Electric Propulsion**
  - Transfer time: ~2 years
  - Launch C3: ~2.2 km^2/s^2
  - ΔV: ~1.5 km/s
  - Propellant (xenon) required: ~55 kg
- **Optional High-Thrust Trajectories using Chemical Propulsion**
  - Transfer time: ~2 years
  - Launch C3: ~1.0 km^2/s^2
  - ΔV: ~950 m/s
  - Propellant (hydrazine) required: ~300 kg







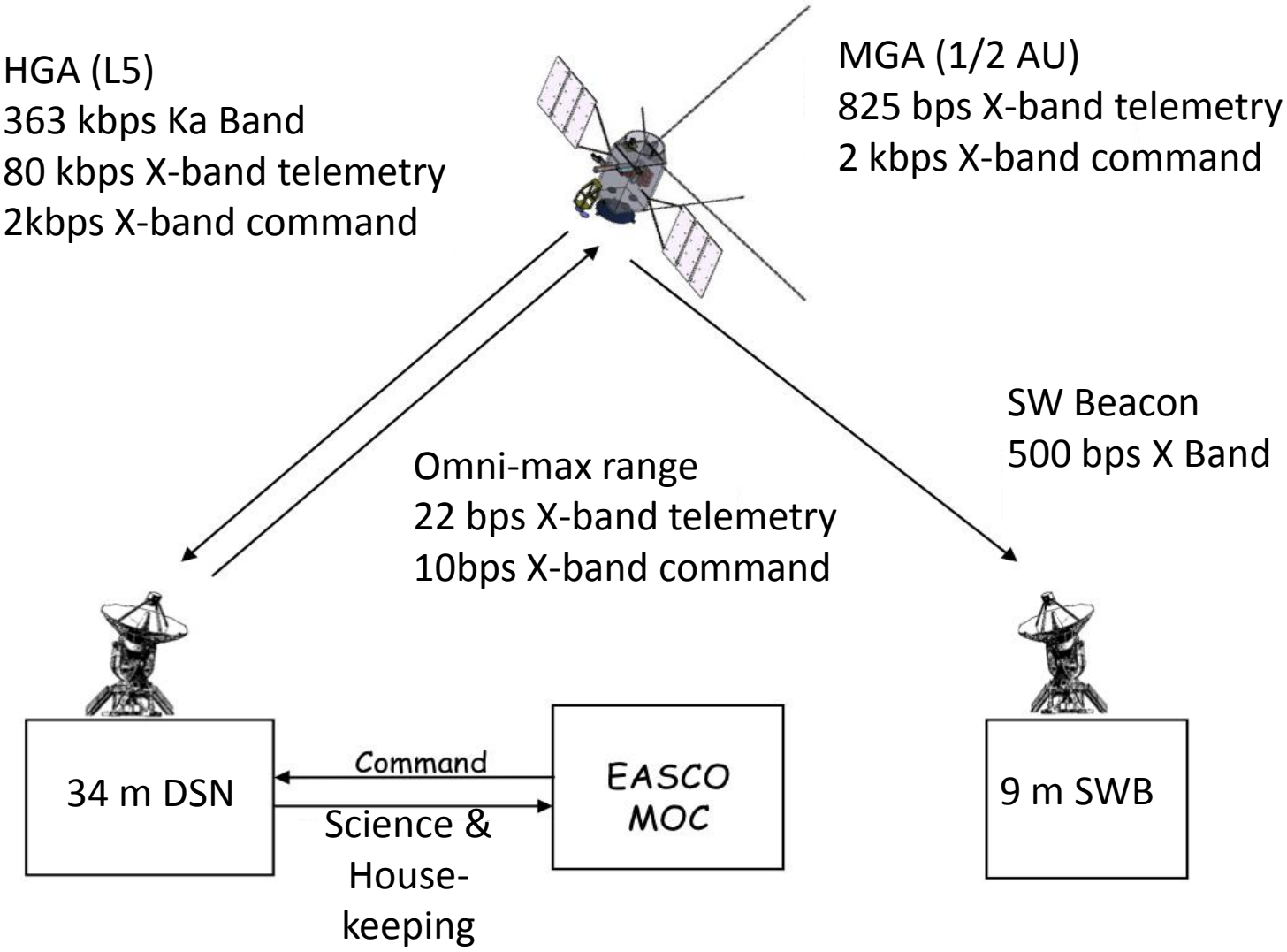
EASCO Systems Engineering Summary

- The spacecraft meets all mission requirements:
  - 10 science instruments with various fields of regard and exclusion zones
  - 2 year cruise to near Sun-Earth L5
  - 4 year primary science mission
  - Consumables sized both for primary and potential extended mission (12 years total)
  - Class B redundancy approach
- System level margins are sufficient:
  - Mass >37% using Taurus II Launch Vehicle
  - Power >100% on-station, ~10% during cruise with high TRL electric propulsion
  - Data Rate 30%; more if data compression is implemented

Mass Summary			
	Current Best Estimate	**Contingency**	**Allocation**
Instrument Total	138 kg	29%	178 kg
S/C Bus Total	559 kg	18%	657 kg
S/C Dry Mass	**698 kg**	**20%**	**835 kg**
Xenon	55 kg	0%	55 kg
Hydrazine	10 kg	0%	10 kg
S/C Wet Mass			**900 kg**
Sep Sys (LV portion)	3.3 kg	10%	3.6 kg
Launch Mass			**904 kg**

LAUNCH VEHICLE EVALUATION	
Taurus II Enhanced Capability for C3 = 2	1240 kg
Throw Mass Margin	336 kg
Throw Mass Margin (%)	37.2%

Ground System



Mission Cost Estimate Summary (4/2011)

WBS ELEMENT	Total Phase A-F	Contingency	Total w/Contingency
1. Project Management	26.64	30%	34.64
2. Systems Engineering	26.64	30%	34.64
3. Safety and Misison Assurance	16.65	30%	21.65
4. Science and Technology	21.65	15%	24.89
5. Payload	185.00	30%	240.50
6. Flight System	148.04	30%	192.45
7. Mission Operations	21.60	30%	28.08
8. Launch Vehicle	100.00	0%	100.00
9. Ground System	2.46	30%	3.20
10. Systems I&T	4.05	30%	5.26
11. Education and Public Outreach	3.33	15%	3.83
		TOTAL:	**689.13**

Cost estimate has the level of fidelity in accordance with a five day study
15-30% cost contingencies assumed. Maybe up to 50% for lower TRL

EASCO MDL Study Summary

- The EASCO Mission is considered very achievable with no new technology required
- A medium launch vehicle is adequate for this mission concept study (Taurus II with enhanced fairing)
- The key to the simple yet very flexible concept is the use of existing, flight proven, electric propulsion system hardware
  - Many variations are possible from the baseline developed during the study
  - Other mission concepts using chemical propulsion are possible but adequate launch mass margin requires a larger launch vehicle
  - The system design using electric propulsion is an efficient, elegant solution to meeting the mission requirements
- All other subsystems are well within standard capabilities and borrow directly from the successful STEREO mission
- The EASCO mission can benefit from further study and refinement to simplify and reduce costs.