

Interstellar Probe Baseline Science Traceability Matrix

Goal	Questions	Objectives	MAG	PLS	PUI	EPS	CRS	PWS	ENA	IDA	NMS	LYA	
1. Our Habitable Astrosphere in its Home in the Galaxy	1.1 Physical processes upholding the heliosphere from the Sun to the VLISM	PUI Evolution											
		S/W Transport											
		Interstellar Neutrals											
		Force Balance											
		Ribbon/Belt											
		ACRs											
		Termination Shock											
	Heliopause												
	1.2 Dynamics of the Heliosphere	Boundary Dynamics											
		VLISM Disturbances											
		GCR Modulation											
	1.3 VLISM properties and inhomogeneities	Bow Wave											
		Wall											
		VLISM Properties											

Inner Heliosphere <TS
 Heliosheath TS to HP
 Interstellar >HP
 Backup Measurement

Measurement Requirements	Spacecraft Requirements
MAG: 0.01 - 100 nT; 0.01 nT sensitivity, ≤60 s	10-m boom, spinning, cleanliness program
PLS: e, H ⁺ , He ⁺ , He ⁺⁺ , C ⁺ , N-O ⁺ , <3 eV/e-20 keV/e; ΔE/E≤10%, ≤60 s	Spinning for full sky coverage
PUI: 0.5-78 keV/e, ΔE/E≤10%, H, ² H, ³ He, ⁴ He, ⁷ Li, ¹² C, ¹⁴ N, ¹⁶ O, ²⁰ Ne, ²² Ne, Ar, Mg, Si, Fe, charge states	Spinning. Heliospheric PUIs and interstellar ram.
EPS: 20 keV - 20 MeV, H, ³ He, ⁴ He, Li, C, O, Ne, Ar, Mg, Si, Fe, ΔE/E≤30%, ≤60 s	Spinning for full sky coverage
CRS: 1 - 10 MeV e, 10 MeV/nuc - 1 GeV/nuc H-Sn, isotopes, m/Δm ≥ 10; ΔE/E ≤ 30%, weekly	Accommodation to cover anisotropies in the VLISM
PWS: 1 Hz - 5 MHz, ≤0.7 μV/m at 3 kHz, Δf/f≤4%, ≤60 s	4x50 m spin-plane deployed antennas
ENA: ~1-100 keV H, ΔE/E≤50%, ≤5°, ~weeks	Spinning. Accommodate sun exclusion zone.
IDA: 1e-19 to 1e-14 g, 1-500 amu, m/Δm≥200	Interstellar ram. Boresighted with NMS.
NMS: H, ³ He, ⁴ He, ¹⁴ N, ¹⁶ O, ²⁰ Ne, ²² Ne, ³⁶ Ar, ³⁸ Ar, m/Δm≥100, 1e-3 cm ⁻³ -3 sensitivity, weekly	Interstellar ram. Boresighted with IDA.
LYA: ±100 km/s doppler range, <10 km/s resolution, ≤5°, months	Spinning. Noseward and tailward directions.

Mission Requirements	Closure
Operations to TS	Current state of processes upholding the heliosphere
Operations through HP to ≥300 au ≥45° off nose longitude	
Operations to ≥350 au. Noseward hemisphere	Dynamical range of processes
Operations to ≥350 au Noseward hemisphere	Current VLISM processes and interactions

v7.1

- MAG** Magnetometer
- PUI** Pick-Up Ions
- CRS** Cosmic Ray System
- ENA** Energetic Neutral Atoms
- NMS** Neutral Mass Spectrometer
- PLS** Plasma System
- EPS** Energetic Particle System
- PWS** Plasma Wave System
- IDA** Interstellar Dust Analyzer
- LYA** Ly-Alpha Spectrograph

Interstellar Probe Augmented Science Traceability Matrix

Goal	Questions	Objectives	MAG	PLS	PUI	EPS	CRS	PWS	ENA	IDA	NMS	LYA	
1. Our Habitable Astrosphere in its Home in the Galaxy	1.1 Physical processes upholding the heliosphere from the Sun to the VLISM	PUI Evolution											
		S/W Transport					*						
		Interstellar Neutrals											X
		Force Balance						*					X
		Ribbon/Belt											
		ACRs						*					
		Termination Shock						*					
		Heliopause						*					
	1.2 Dynamics of the Heliosphere	Boundary Dynamics						*					
		VLISM Disturbances						*					
		GCR Modulation											
	1.3 VLISM properties and inhomogeneities	Bow Wave											
		Wall						*					X
		VLISM Properties						*					X

Inner Heliosphere <TS
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Augmentation
 Science Impact: PWS (low sensitivity) and LYA (removed)

MAG Magnetometer **PUI** Pick-Up Ions **CRS** Cosmic Ray Spectrometer **PWS** Plasma Wave System
PLS Plasma System **EPS** Energetic Particle System **ENA** Energetic Neutral Atoms **IDA** Interstellar Dust Analyzer **NMS** Neutral Mass Spectrometer
LYA Ly-Alpha Spectrograph

Measurement Requirements	Spacecraft Requirements
MAG: 0.01 - 100 nT; 0.01 nT sensitivity, ≤60 s	10-m boom, spinning, cleanliness program
PLS: e, H ⁺ ; He ⁺ , He ⁺⁺ , C ⁺ , N-O ⁺ , <3 eV/e-20 keV/e; ΔE/E≤10%, ≤60 s	Spinning for full sky coverage
PUI: 0.5-78 keV/e, ΔE/E≤10%, H, ² H, ³ He, ⁴ He, ⁷ Li, ¹² C, ¹⁴ N, ¹⁶ O, ²⁰ Ne, ²² Ne, Ar, Mg, Si, Fe, charge states	Spinning. Heliospheric PUIs and interstellar ram.
EPS: 20 keV - 20 MeV, H, ³ He, ⁴ He, Li, C, O, Ne, Ar, Mg, Si, Fe, ΔE/E≤30%, ≤60 s	Spinning for full sky coverage
CRS: 1 - 10 MeV e, 10 MeV/nuc - 1 GeV/nuc H-Sn, isotopes, m/Δm ≥ 10; ΔE/E ≤ 30%, weekly	Accommodation to cover anisotropies in the VLISM
PWS: 1 Hz - 5 MHz, sensitivity for Jovian science, VLISM density	4x2.5 m stacers (4x50 m post-flyby optional)
ENA: ~1-100 keV H, ΔE/E≤50%, ≤5°, ~weeks	Spinning. Accommodate sun exclusion zone.
IDA: 1e-19 to 1e-14 g, 1-500 amu, m/Δm≥200	Interstellar ram. Boresighted with NMS.
NMS: H, ³ He, ⁴ He, ¹⁴ N, ¹⁶ O, ²⁰ Ne, ²² Ne, ³⁶ Ar, ³⁸ Ar, m/Δm≥100, 1e-3 cm ⁻³ sensitivity, weekly	Interstellar ram. Boresighted with IDA.
VIR: ~0.4-3 μm; ≥5 ch., 2.3°-5.7° (cross track), 10 μrad iFOV	3-axis boresighted with IRM
IRM: 0.5 - 15 μm, R ~ 20 (spectral) I/ΔI=3 (broad band 30-200 μm)	3-axis boresighted with VIR

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Interstellar Probe Augmented Science Traceability Matrix

GOALS	Questions	Objectives	MAG	PLS	PUI	EPS	CRS	PWS	ENA	IDA	NMS	VIR	IRM
2. Origin and Evolution of Planetary Systems	2.1 Solar System Formation and Evolution	Dwarf planets, moons											
		Small bodies											
		ISM weathering											
		Jupiter m'sphere											
		Exoplan. analogue											
	2.2 Structure and Composition of Circumsolar dust disk	Dust properties											
		Dust distribution											
Disk structure													
3. Universe Beyond	3.1 Nearby and distant ISM	ISM dust											
		VLISM dust											
	3.2 Extragalactic Background Light	First-light galaxies											
		Energy release											
		Nucleosynthesis											

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MAG Magnetometer **PUI** Pick-Up Ions **CRS** **PLS** Plasma System **EPS** Energetic Particle System **PWS**

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EPS: 20 keV - 20 MeV, H, ³ He, ⁴ He, Li, C, O, Ne, Ar, Mg, Si, Fe, ΔE/E≤30%, ≤60 s	Spinning for full sky coverage
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PWS: 1 Hz - 5 MHz, sensitivity for Jovian science, VLISM density	4x2.5 m stacers + sounder (4x50 m post-flyby optional)
ENA: ~1-100 keV H, ΔE/E≤50%, ≤5°, ~weeks	Spinning. Accommodate sun exclusion zone.
IDA: 1e-19 to 1e-14 g, 1-500 amu, m/Δm≥200	Interstellar ram. Boresighted with NMS.
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VIR: ~0.4-3 μm; ≥5 ch., 2.3°-5.7° (cross track), 10 μrad iFOV	3-axis boresighted with IRM
IRM: 0.5 - 15 μm, R ~ 20 (spectral) I/ΔI=3 (broad band 30-200 μm)	3-axis boresighted with VIR

Mission Requirements	Closure
3-axis during flybys and lookback. Spinning otherwise.	See Foldout
Slow spin/3-axis In-situ 1-100 au Lookback 250 au	See Foldout
Slow spin/3-axis ≥150 au	See Foldout
Slow spin/3-axis ≥10 au	See Foldout

v7.1

NMS Neutral Mass Spectrometer
VIR Visible/Near IR Camera
IRM Infrared Mapper