

Baseline: Goal 1

Goal	Science Objectives	Specific Questions	Measurement Objectives	Measurements	Mission Requirements
1. Understand Our Habitable Astrosphere and its Home in the Galaxy	Physical Processes and Global Manifestation	Global Structure; Force Balance	In-situ spectra, composition, flows, densities, temps and fields across HS and into LISM, flows; Remote wave, Ly-a and ENA imaging.	MAG, PLS, PUI, EPS, CRS, ENA, PWS, LYA	Spinning; ENA imaging from ~250 AU
		Ribbon/Belt	ENA imaging; In-situ within ribbon.	ENA, PLS, PUI, EPS, MAG	Spinning; through ribbon to ~300 AU
		ACRs, shocks, reconnection, TS, HP	Fields, e/ion composition plasma to ACRs across TS, HS; Fields, waves, particle spectra, composition for HP instabilities	MAG, PLS, PUI, EPS, CRS, PWS	Spinning; through HP ~130 AU; spend sufficient time in HS
		Neutrals in the Heliosphere	LOS velocity, temperature, density of H	LYA, NMS	Through HP ~130 AU
	Dynamics and Evolution	Solar Wind Effects on the Boundary	In-situ variations in HS; ENA variations remotely	MAG, PLS, PUI, EPS, ENA	Spinning; spend sufficient time in HS
		Shock Propagation and Turbulence	Fields, e/ion plasma to GCR anisotropies; fields turbulent spectra Earth to LISM	MAG, PLS, PUI, EPS, CRS, PWS	Spinning; sufficient time beyond HP out to ~400 AU
		GCR Modulation/Shielding	GCR e/ion composition, fields out to LISM	MAG, CRS	Spinning; sufficient time beyond HP out to ~400 AU
	Properties of the Unexplored VLISM	Nature of Bow Shock/Wave	In-situ fields, plasma	MAG, PLS	Spinning; ≤300 AU
		Hydrogen Wall	LOS H; In-situ H and composition	LYA, NMS	≥300 AU
		Neutrals/Dust Filtration	In-situ elemental and isotopic out to LISM	PLS, PUI, PWS, NMS, IDA	~400 AU
		LISM gas and plasma	Density, temp., composition, ionization	MAG, PLS, PWS, NMS	Spinning; ~400 AU
		LISM Inhomogeneities	Variability of properties on 100's AU	PLS, PWS, NMS, IDA	Spinning; ~400 AU
	Origin of GCRs	Elemental/isotopic abundances, spectra	CRS	Spinning; sufficient time beyond HP	

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Augmented Option: Goal 1 Trades

~~LYA~~ Removed

Trades: PWS 4x2.5 m rigid antennas

* Partial impact

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1. Understand Our Habitable Astropshere and its Home in the Galaxy	Physical Processes and Global Manifestation	Global Structure; Force Balance	In-situ spectra, composition, flows, densities, temps and fields across HS and into LISM, flows; Remote wave, Ly-α and ENA imaging.	MAG, PLS, PUI, EPS, CRS, ENA, LYA , PWS	Spinning; imaging from ~250 AU
		Ribbon/Belt	ENA imaging; In-situ within ribbon.	ENA, PLS, PUI, EPS, MAG	Spinning; through ribbon to ~300 AU
		ACRs, shocks, reconnection, TS, HP	Fields, e/ion composition plasma to ACRs across TS, HS; Fields, waves *, particle spectra, composition for HP instabilities	MAG, PLS, PUI, EPS, CRS, PWS	Spinning; through HP ~130 AU; spend sufficient time in HS
		Neutrals in the Heliosphere	LOS velocity , temperature *, density of H	LYA , NMS	Through HP ~130 AU
	Dynamics and Evolution	Solar Wind Effects on the Boundary	In-situ variations in HS; ENA variations remotely	MAG, PLS, PUI, EPS, ENA	Spinning; spend sufficient time in HS
		Shock Propagation and Turbulence	Fields, e/ion plasma to GCR anisotropies; fields turbulent spectra * Earth to LISM	MAG, PLS, PUI, EPS, CRS, PWS	Spinning; sufficient time beyond HP out to ~400 AU
		GCR Modulation/Shielding	GCR e/ion composition, fields out to LISM	MAG, CRS	Spinning; sufficient time beyond HP out to ~400 AU
	Properties of the Unexplored VLISM	Nature of Bow Shock/Wave	In-situ fields, plasma	MAG, PLS	Spinning; ≤ 300 AU
		Hydrogen Wall	LOS H ; In-situ H and composition	LYA , NMS	≥ 300 AU
		Neutrals/Dust Filtration	In-situ elemental and isotopic out to LISM	PLS, PUI, PWS, NMS, IDA	~400 AU
		LISM gas and plasma	Density, temp *, composition, ionization	MAG, PLS, PWS , NMS	Spinning; ~400 AU
		LISM Inhomogeneities	Variability of properties on 100's AU	PLS, PWS, NMS, IDA	Spinning; ~400 AU
	Origin of GCRs	Elemental/isotopic abundances, spectra	CRS	Spinning; sufficient time beyond HP	

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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

Augmented Option: Goals 2 and 3 Only

Goal	Science Objectives	Questions	Measurement Objectives	Measurements	Mission Requirements
2. Origin and Evolution of Planetary Systems	Planets, dwarf planets and KBOs	State and evolution of dwarf planets, KBOs	Landforms, composition, thermal; Magnetic field strength and direction; atmospheres and rings	VIR, IRM, MAG, NMS	3-axis, $\leq 10^4$ km flyby
		Collisional, orbital, geological history	Rotation and phase curves of distant bodies Atmospheres, rings, nightside temperatures	VIR, IRM	3-axis, 10^6 km
		Compositional state of Kuiper Belt	PUI distribution and composition Dust composition and distribution	PUI, MAG, IDA, NMS, VIR, IRM	≤ 100 AU
		Interstellar Space Weathering	Panchromatic distant observations	VIR, EPS, CRS	3-axis, 10^6 km
		Solar System as Exoplanetary Analogues	Planetary rotation and phase curves	VIR	3-axis, look back @10's AU
	Circum-solar Dust Cloud	Dust disk total mass	In-situ/Visible-FIR observations of dust	IDA, NMS, IRM (PWS)	≤ 0.1 RPM, ≤ 100 AU
		Interplanetary dust grain production	In-situ dust mass distribution	IDA, IDC, NMS	≤ 100 AU
		Solar nebula chemical processing	In-situ dust composition; spectral features	IDA, NMS, IRM	≤ 0.1 RPM, ≤ 100 AU
		Large-scale processes due to solid bodies and solar activity; comparables to exodisks	In-situ/remote correlation with bodies; IR dust extinction during CME passages; In-toto IR	IDA, NMS, IRM	≤ 0.1 RPM, ≤ 250 AU
	3. Galactic and Stellar Evolution	Nearby and Distant ISM	Properties of distant ISM dust	NIR diffuse and FIR galactic emissions	IRM
Properties of VLISM dust			In-situ ISD	IDA, NMS	≤ 0.1 RPM, ≥ 120 AU
EBL		Nucleosynthesis and star formation	Diffuse spectrum in optical/NIR/FIR	IRM	≤ 0.1 RPM, ≥ 10 AU
		Emissivity budget of galaxy formation	Decompose NIR/FIR spectra	IRM	≤ 0.1 RPM, ≥ 10 AU
Nucleosynthesis		Evidence for recent nucleosynthesis	Isotopic gas and dust ratios in the VLISM	NMS, IDA, PLS	Spinning, ≤ 400 AU

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MAG Magnetometer

PUI Pick-Up Ions

CRS Cosmic Ray System

IDA Interstellar Dust Analyzer

VIR Visible/Near-IR

PLS Plasma System

EPS Energetic Particle System

PWS Plasma Wave System

NMS Neutral Mass Spectrometer

IRM IR Mapper

Baseline by Phase and Measurement

Goal	Objective	Questions	MAG	PLS	PUI	EPS	CRS	PWS	ENA	IDA	NMS	LYA
1. Our Habitable Atmosphere in its Home in the Galaxy	1.1 Physical Processes and their Global Manifestation	1.1.1 Global Structure										
		1.1.2 Force Balance										
		1.1.3 Ribbon/Belt										
		1.1.4 ACR acceleration										
		1.1.5 Termination Shock and Shock Acceleration										
		1.1.6 Role of Reconnection										
		1.1.7 Nature of Heliopause										
		1.1.8 Interstellar Neutrals within the Heliosphere										
	1.2 Dynamics and Evolution of the Heliosphere	1.2.1 Solar Wind Effects on the Boundary										
		1.2.2 Shock Propagation, Extent, Turbulence										
		1.2.3 GCR Shielding and Modulation										
	1.3 Properties of the Unexplored VLISM	1.3.1 Nature of Bow Shock/Wave										
		1.3.2 Hydrogen Wall										
		1.3.3 Composition and Filtration Processes										
		1.3.4 Field, Density, Temperature, Ionization										
		1.3.5 LISM Inhomogeneities on 100's AU scales										
		1.3.6 Origin of GCRs										

Phases

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

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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