ESA UNCLASSIFIED – Releasable to the Public

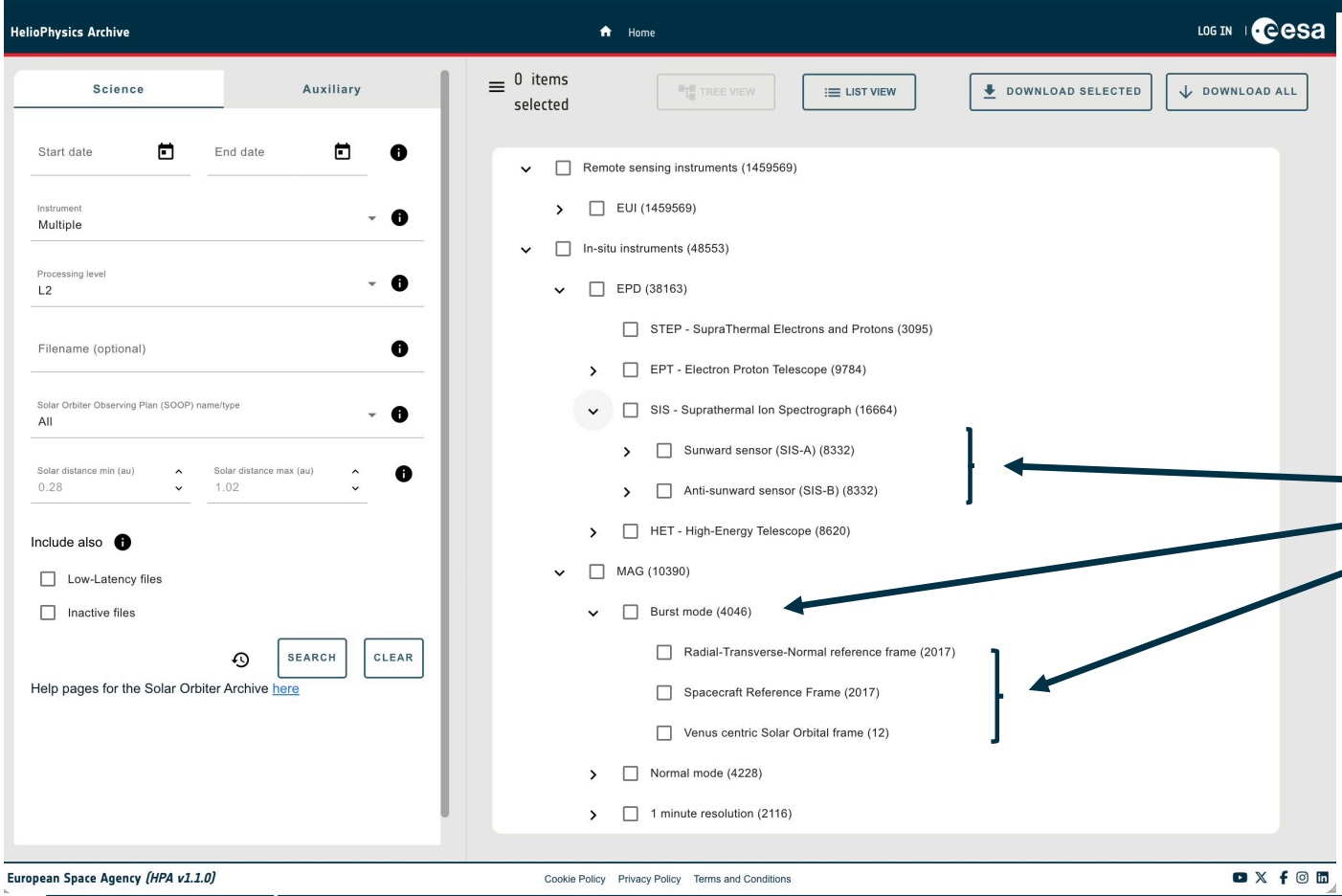
Heliophysics information architecture

A. Masson, Heliophysics archives science lead at ESAC (SCI-SAA)
and the ESDC Heliophysics archive team

ESLAB/3rd European Heliophysics Community conference
22/09/2026

EUROPEAN SPACE AGENCY

What I am NOT going to talk about…



Brand new Solar Orbiter archive released this summer

What science products are in the archive?

List by instruments/sensors/datasets with the Number of Files found

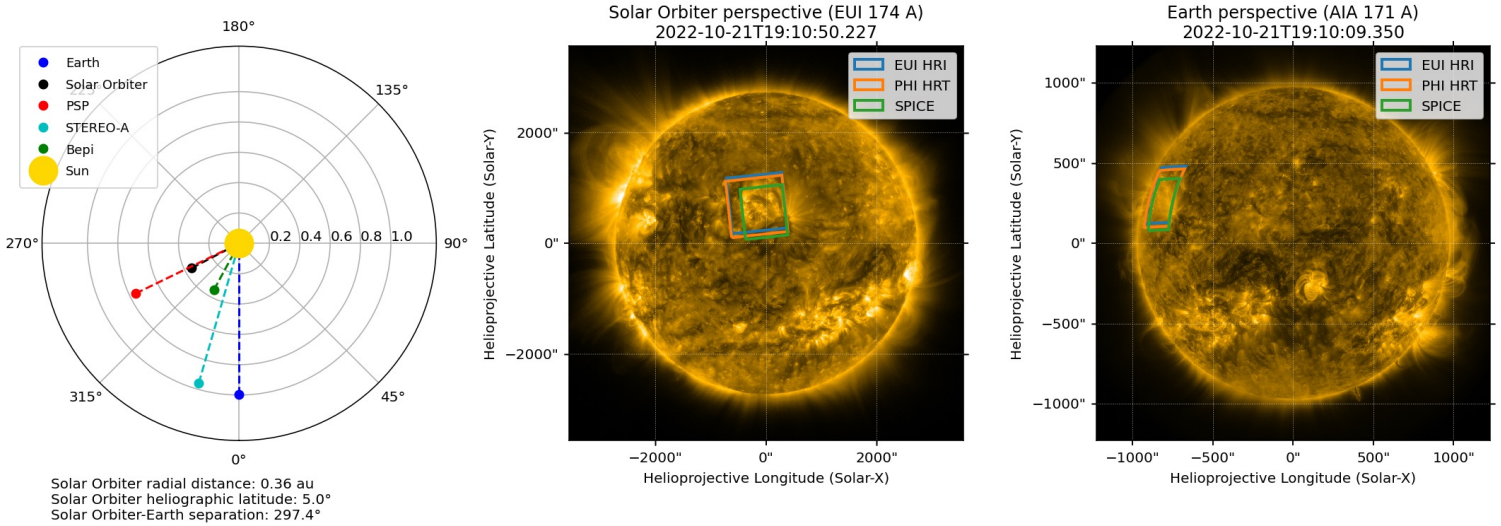
Allows to choose

- Wavelength (EUI, Metis)
- Main datasets (PHI, EUI, METIS)
- **Look direction (EPD)**
- **Cadence (EPD-EPT, EPD-SIS, MAG)**
- **Reference frames (MAG)**

https://hpa.esa.int/

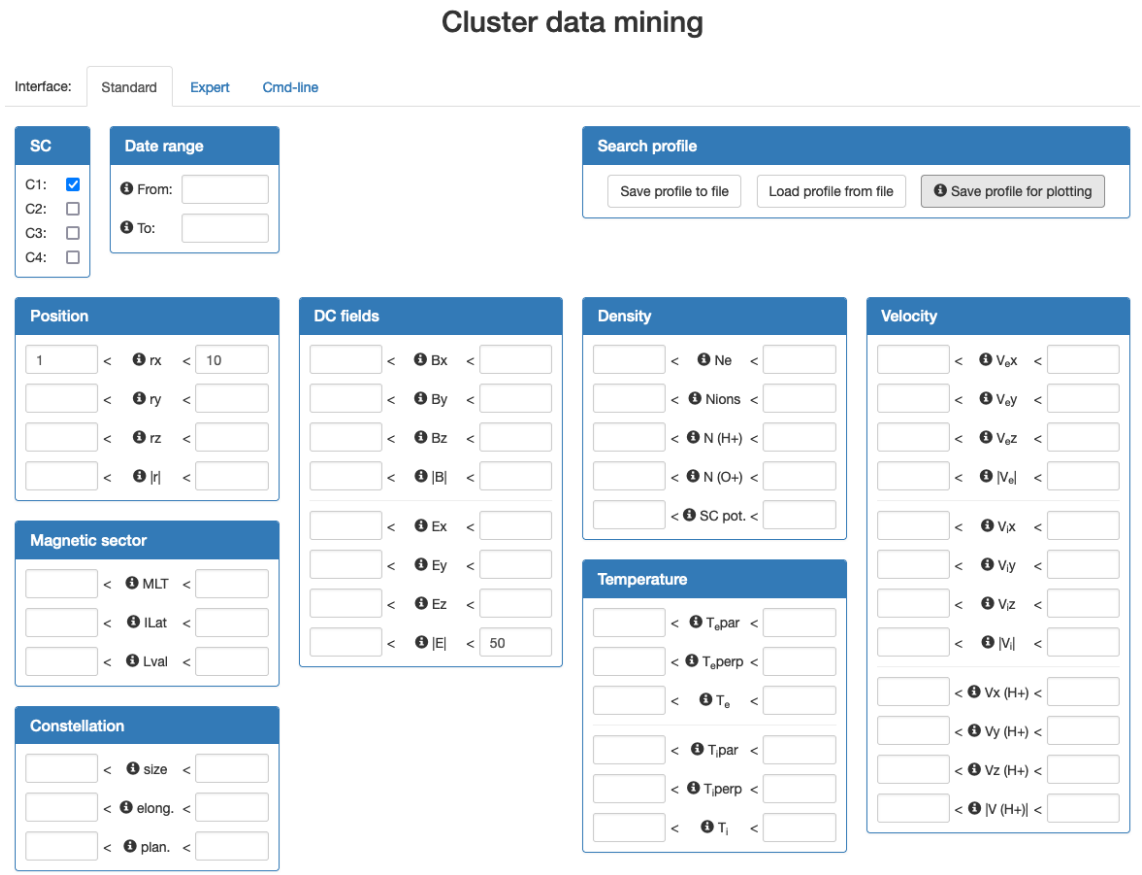
What I am NOT going to talk about…

Tool to visualize spatial coverage of high resolution telescopes
and imaging spectrometer field of view from Solo and Earth



Experiment	Sensor	Time	SOOP name	X/Y location from Solar Orbiter	from Earth
EUI	HRI_EUV	2022-10-21 19:10:50.221-19:10:51.871	R_SMALL_MRES_MCAD_AR-Long-Term	-166"/728"	-796"/301"
PHI	HRT	2022-10-21 19:15:03.019-19:16:28.577	R_SMALL_MRES_MCAD_AR-Long-Term	-170"/668"	-802"/280"
SPICE	SW	2022-10-21 19:13:03.168-19:24:21.564	R_SMALL_MRES_MCAD_AR-Long-Term	-42"/566"	-805"/241"

What I am NOT going to talk about…



ESAC Science Data Centre (ESDC)

European Space Astronomy Centre, ESAC, near Madrid, Spain

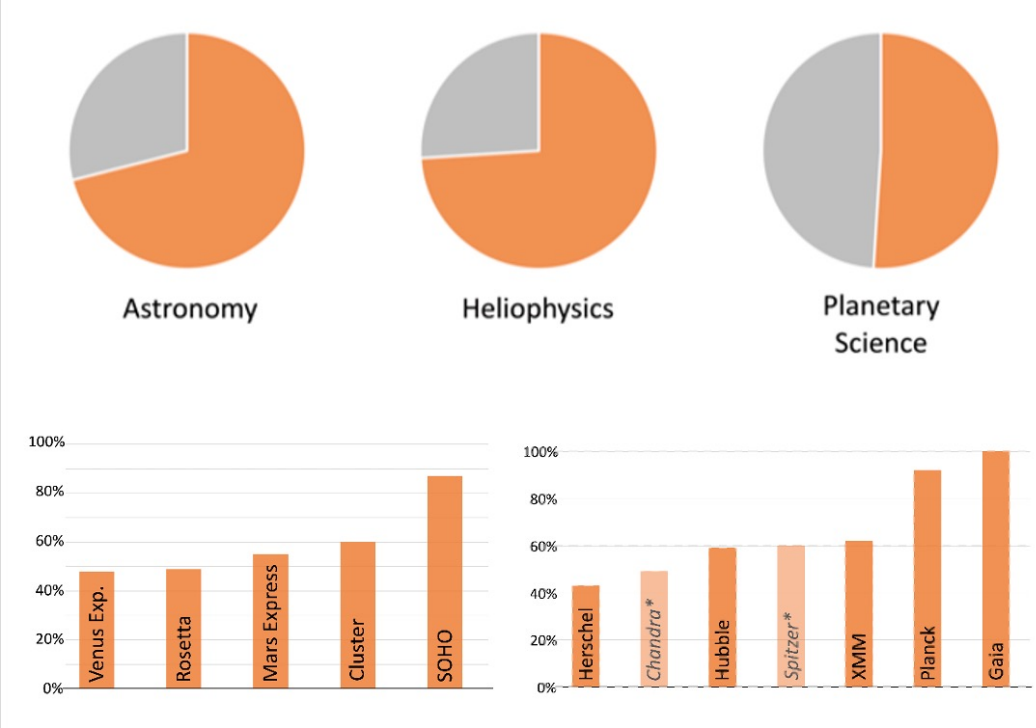




- Long term preservation of data collected by ESA missions is a mandate of the Agency
- ESAC Science Data Centre (ESDC) hosts the data from all ESA's science missions but not only!
- It includes archives from all space science domains, from Astronomy, Planetary Science, **Heliophysics** to Human and Robotic Exploration. First two goals: maximizing scientific return and efficient long term preservation

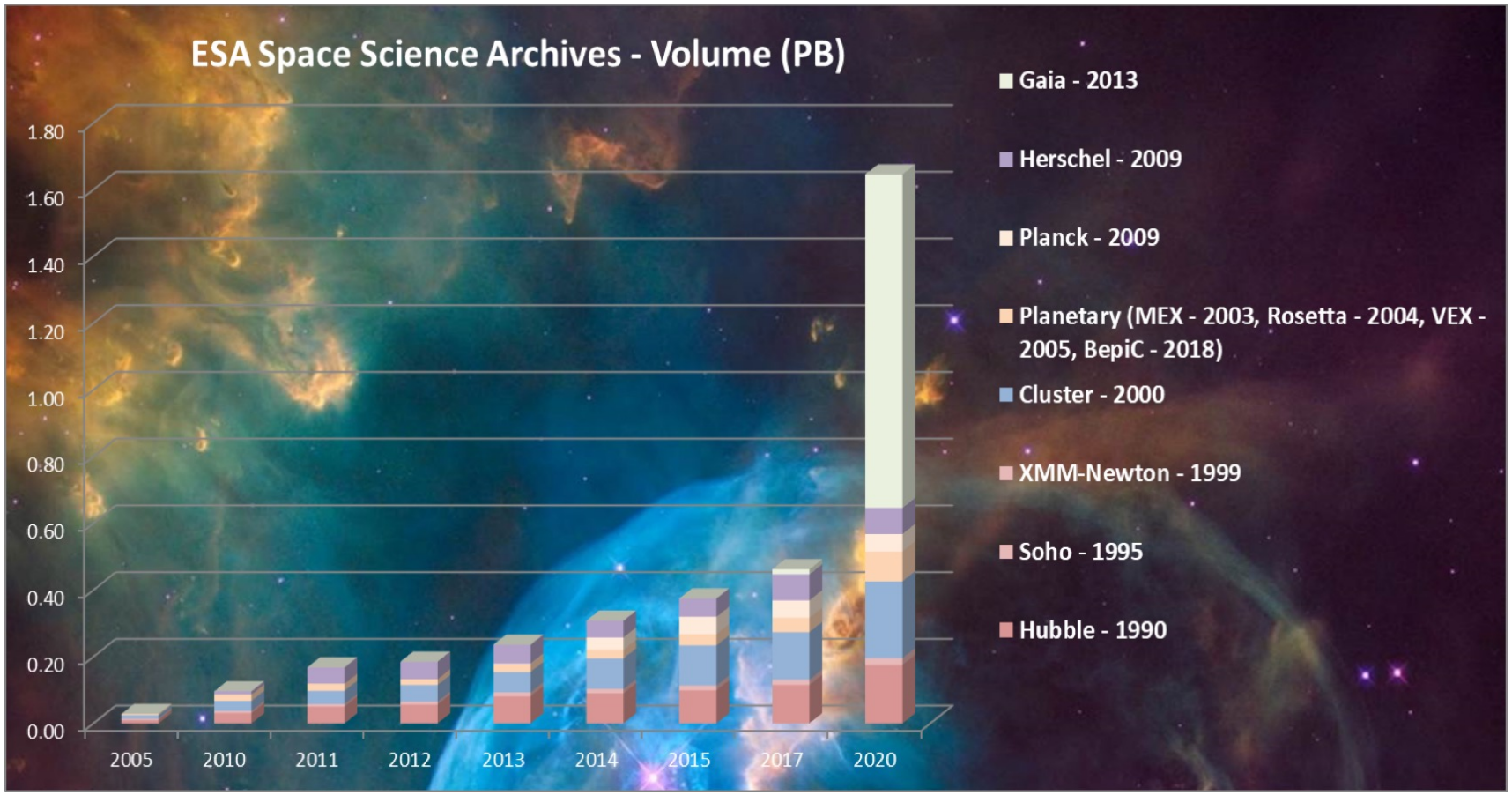
ESDC: key for scientific return

> 2/3 of the publications from ESA missions are archival

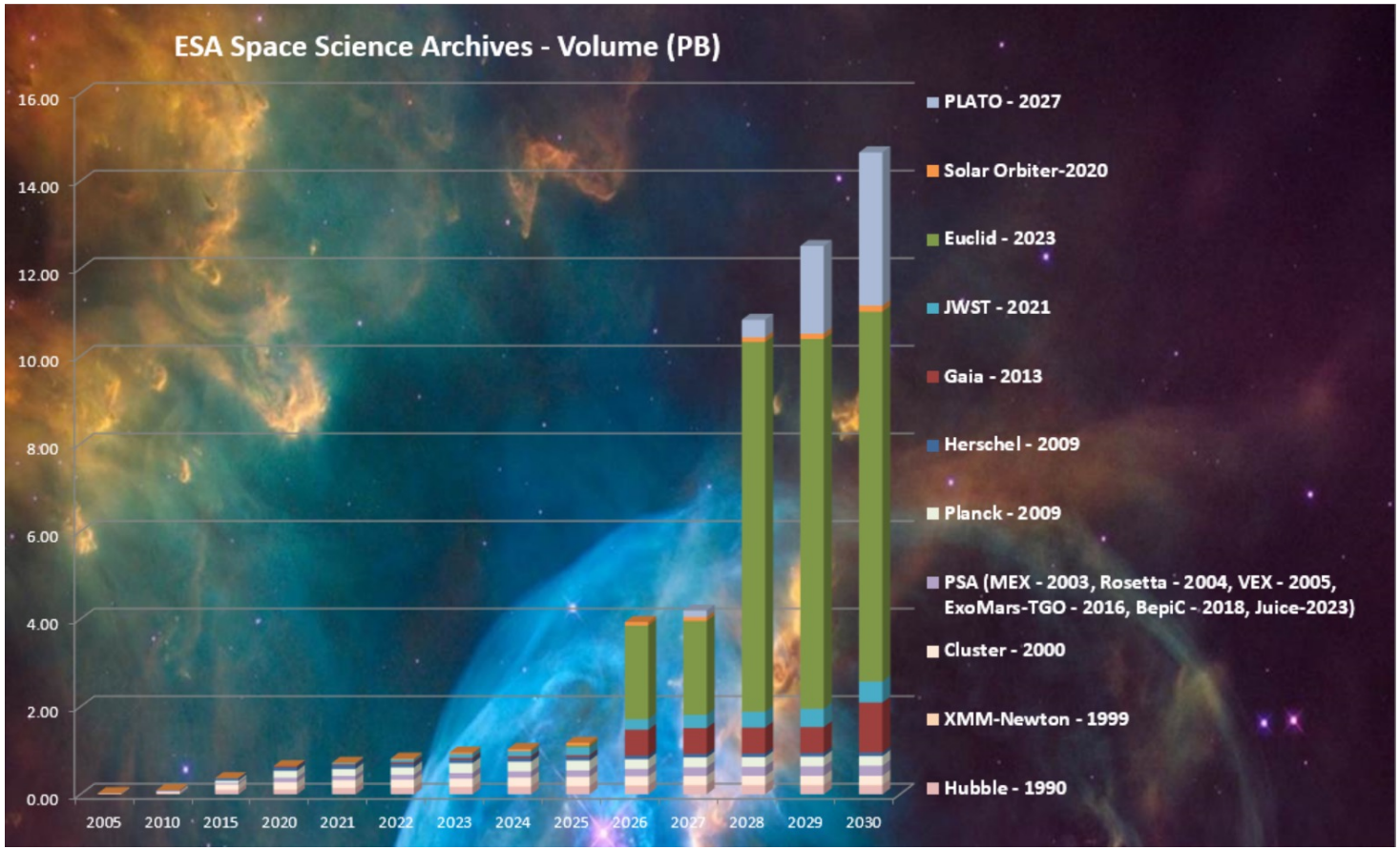


De Marchi and Parmar, 2025; https://doi.org/10.1007/978-3-031-69004-4_2

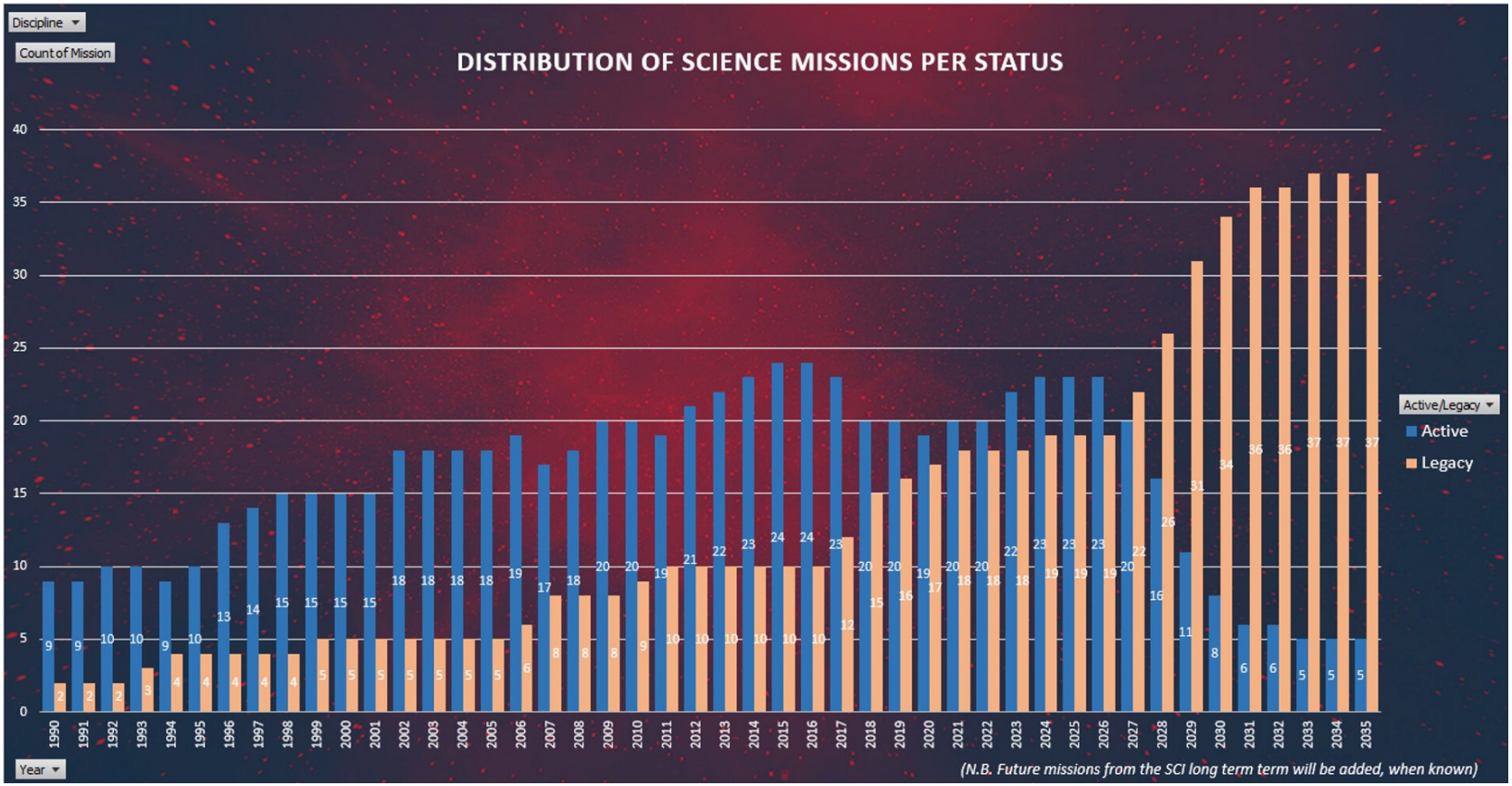
ESDC challenges: volume



Volume getting larger and larger (=> HW cost, possible move to cloud, data format)



ESA mandate: long term preservation



ESDC Heliophysics archives





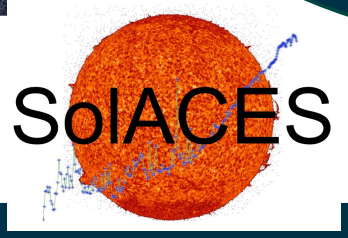




ESAC Science Data Center
(ESDC)
Heliophysics archives

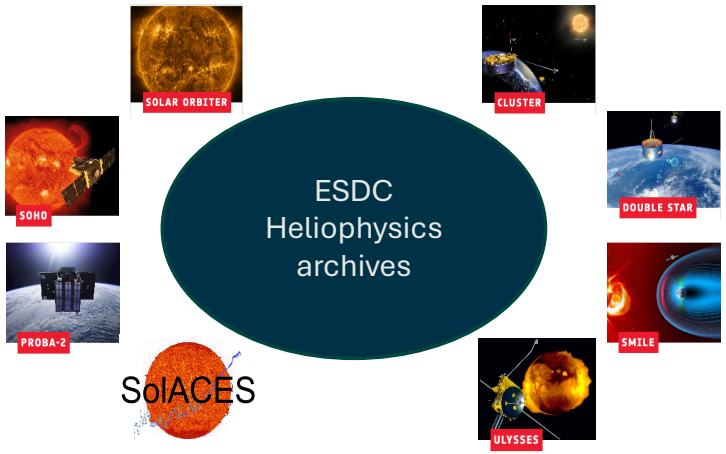




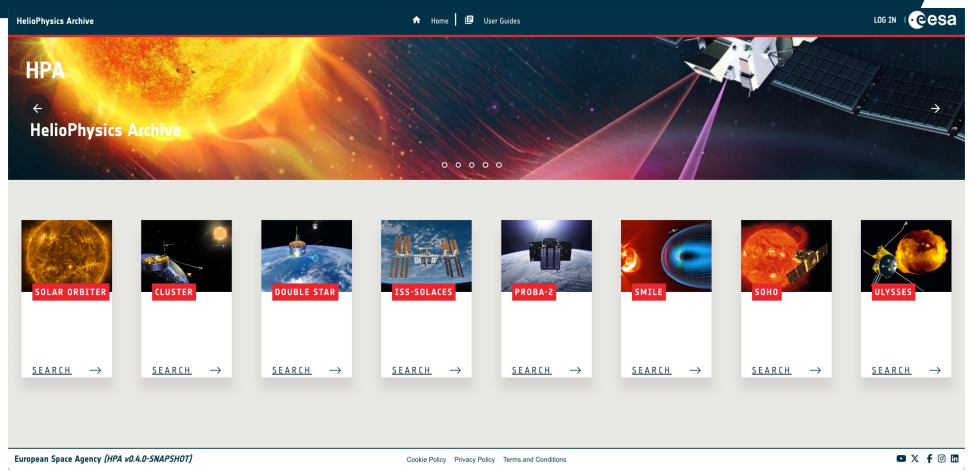




Towards a multi-missions software architecture: GUI

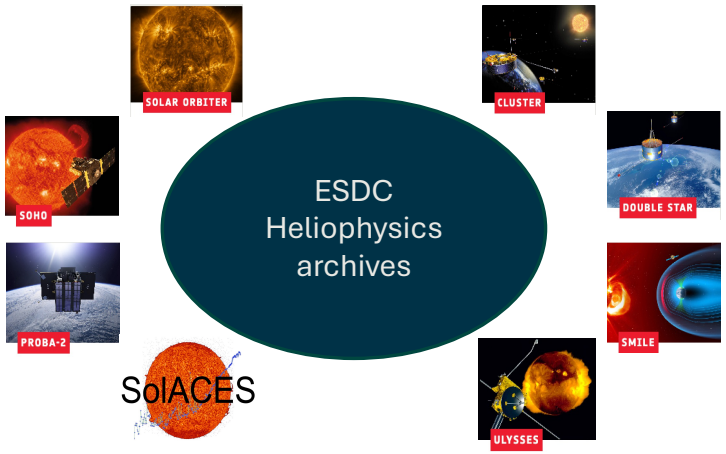


in progress

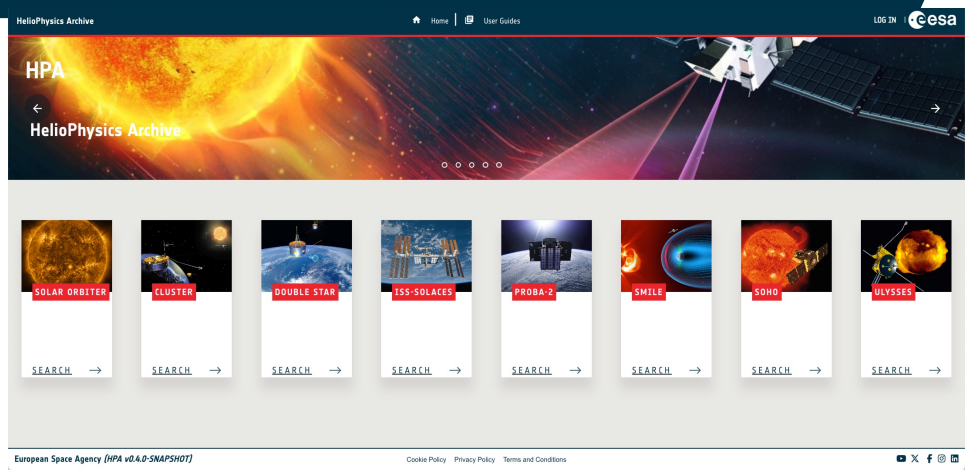


- The HelioPhysics Archive (HPA) is being developed at ESDC to provide a single point of access
- HPA 1.0 released in summer 2026 - https://hpa.esa.int/ - with Solar Orbiter, SMILE +2 legacy
- HPA in December 2026: release of Proba-3 and Proba-2 archives

Towards a multi-missions archive: back-end



in progress



- In parallel, set up of the ESAC Multi-Missions Data Services (EMDS) scalable back-end infrastructure across domains (Heliophysics, Astronomy, Planetary) offering in particular
  - Programmatic access from a common TAP server (TAP: Table Access Protocol)
    - Now: SMILE, Ulysses
    - By end of 2026: Proba-3, SOHO, Proba-2
    - 2027-2028: Cluster/Double Star

International collaboration in standardisation



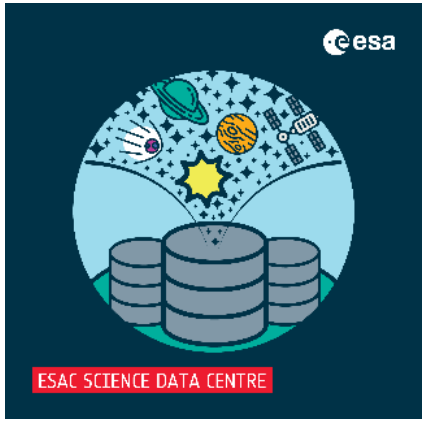
International Planetary Data Alliance



IHDEA International Heliophysics Data Environment Alliance



International Virtual Observatory Alliance



International Heliophysics Data Environment Alliance (IHDEA)

United States

Europe

Japan

Korea

India

China



International Heliophysics
Data Environment Alliance

https://ihdea.net

International Heliophysics Data Environment Alliance (IHDEA)



International Heliophysics Data Environment Alliance

https://ihdea.net

International Heliophysics Data Environment Alliance (IHDEA)

IHDEA

Home | Data Environment | Working Groups | Events | Contact | About

Working Group	Lead(s)	Description	Join
Coordinate Systems Standardisation	Bob Weigel (George Mason University)	Goal is to describe coordinate systems in unambiguous terms, especially where reference models differ over time [e.g. GSM (IGRF-12 vs IGRF-13)]. This working group meets every month. More information here.	Join
Data Access Layer	Jon VandeGriff (JHU/APL), Jon Cook (Starion for ESA), Jack Ireland (NASA)	Goal is to improve the Heliophysics API (HAPI), International Virtual Observatory Alliance (IVOA) data access protocols (e.g. Table Access Protocol or TAP) and Virtual Solar Observatory (VSO) services and to expand adoption of supporting servers at more data centers.	Join
Heliophysics Semantics and Capabilities	Ryan McGranaghan (NASA JPL), Baptiste Cecconi (Observatoire de Paris)	The purpose of this working group is to align, converge, and accelerate ongoing efforts to represent Heliophysics knowledge in ways that strengthen both our data ecosystem and our community. Goals include creation of a glossary/dictionary for Heliophysics, establishment of processes for harmonization across vocabularies including crosswalks from Heliophysics data and information models to other community semantic resources, to foster the creation of semantic tools for Heliophysics, and to serve as a forum for more sustained and cross-group and -domain exchange. It will be a venue for bringing scholarship around knowledge commons	Join



International Heliophysics Data Environment Alliance

https://ihdea.net

International Heliophysics Data Environment Alliance (IHDEA)

Identifying spacecraft relative location in heliospheric environments	Benjamin Grison (IAP/Czech Academy of Sciences), Charlotte Goetz (U. of Northumbria, UK), Bayane Michotte de Welle (NASA)	Due to the variability in time and space of plasma regions, coordinate systems do not suffice to locate plasma region or boundary layer (magnetopause, plasmapause, ...) crossed by a spacecraft at any given time. The main output of this WG is the definition of a standard for region identification in the heliosphere utilising several decades of experience and data from in-situ measurements.	Join
Persistent IDentifiers (PIDs) for Science	Joana Oliveira (TpZ for ESA), Rebecca Ringuette (UMBC for NASA)	Nearly ten years after the beginning of the findability, accessibility, interoperability, and reusability (FAIR) movement, funders and journals increasingly require or recommend persistent identifiers (PID) for a growing variety of object types, ranging from data and observing platforms hosting the instruments collecting those data to the researchers themselves. Heliophysicists aim to comply, but are now faced with a much richer and bewildering landscape of persistent identifiers and their supporting infrastructure services than before. Without recommendations or best practices to follow, Heliophysicists are left to guess their way forward. However, the full benefits of assigning persistent identifiers to these objects is only realized when similar types of objects have the same type of persistent identifiers, particularly in the same science area (e.g.,	Join



International Heliophysics Data Environment Alliance

https://ihdea.net

International Heliophysics Data Environment Alliance (IHDEA)

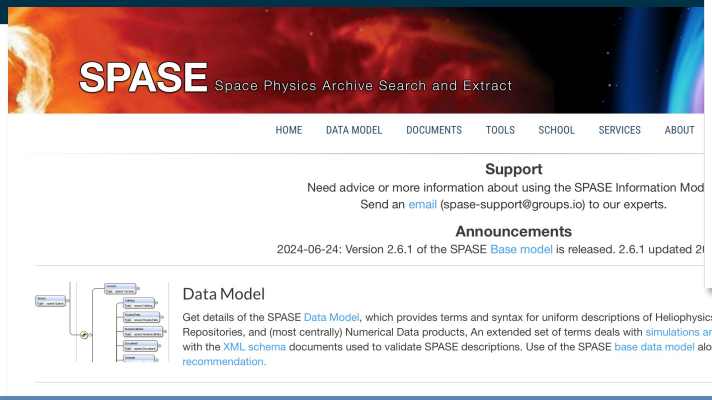
Python in Heliophysics Community (PyHC)	Julie Barnum (LASP)	Goal is to survey the use of Python in the Heliophysics domain and report on tools, services and web sites, especially through the Python in Heliophysics Community (PyHC) initiative, see PyHC website. PyHC's meetings/telecons are all recorded and posted to the PyHC's YouTube channel (link), important documents are displayed on the PyHC website (Documents tab), bi-annual meeting planning materials and notes are on Google drive (each meeting's folder can be located by going to the meeting's web page from the PyHC website Meetings tab), and finally, DOIs related to PyHC can be found on Zenodo Communities (link). PyHC has bi-weekly telecons, and bi-annual meetings.	Join
Science Platforms Coordination	Shawn Polson (LASP), Jan Reerink (ESA)	Goal is to develop international standard software computing environments for Heliophysics. Further information and source files are kept in GitHub	Join
SPASE Information Model	Brian Thomas (NASA), Arnaud Masson (ESA)	Goal is the improvement of the SPASE Information Model for describing observational and derived data, and for describing simulation models, simulations runs, and simulation output (inc. NASA Community Coordinated Modeling Center or CCMC, ESA Virtual Space Weather Modelling Centre, VSWMC and European Union supported Integrated Medium for Planetary Exploration or IMPEx). In particular, defining metadata for simulation models and	Join

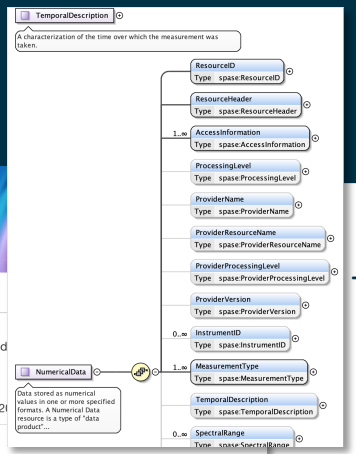


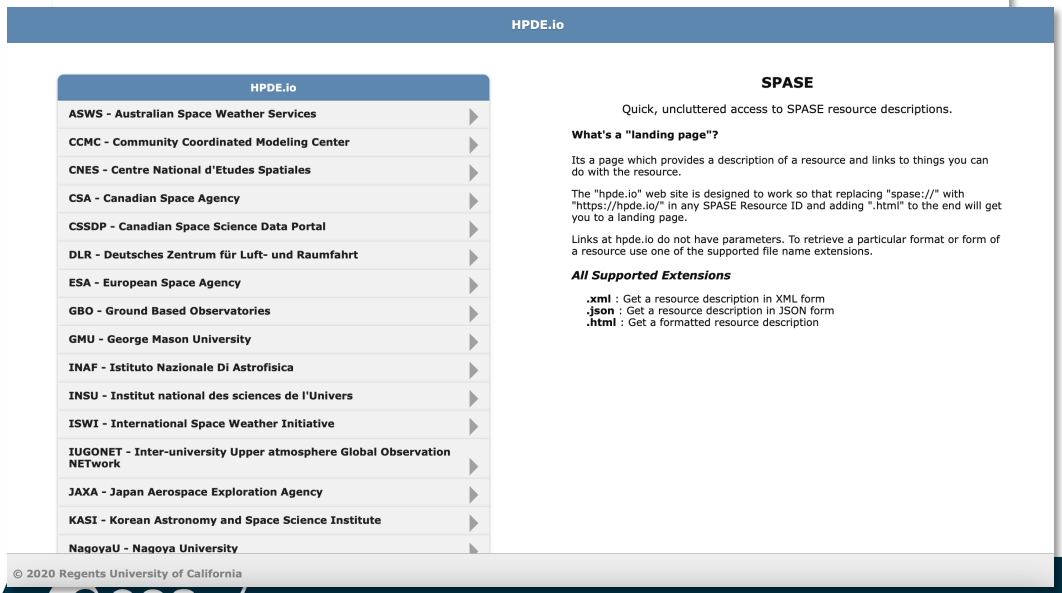
International Heliophysics Data Environment Alliance

https://ihdea.net

SPASE







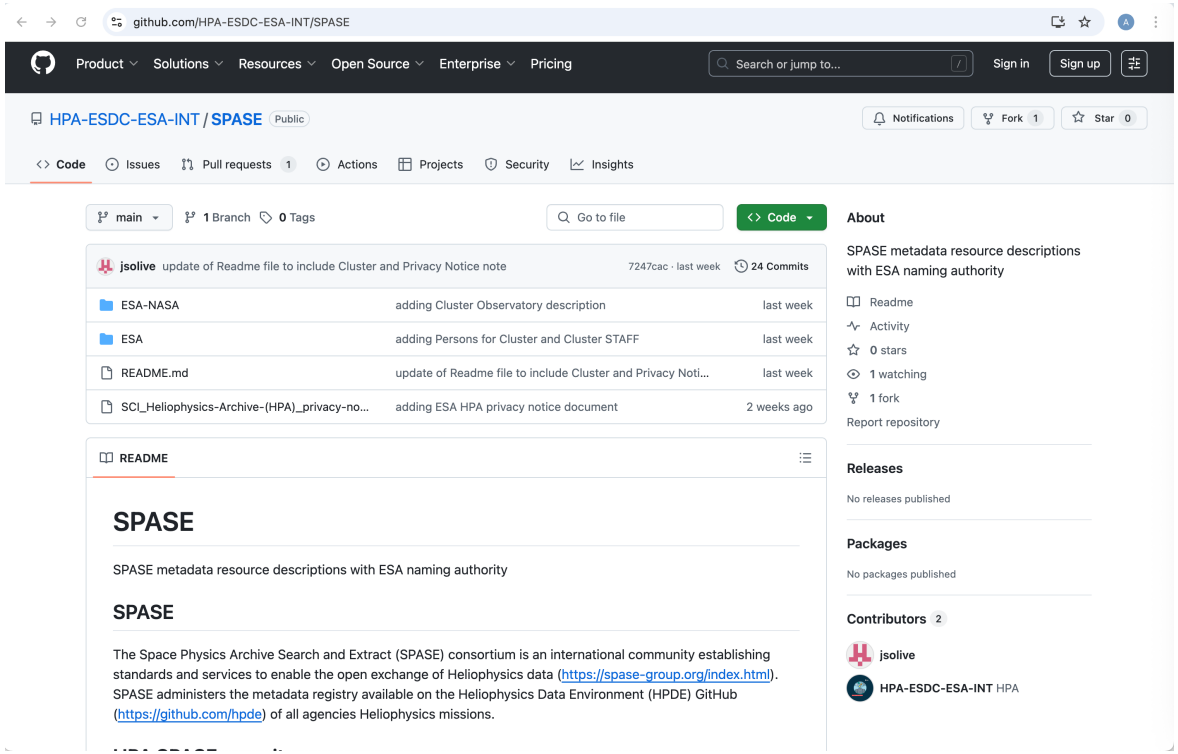
- The Space Physics Archive Search and Extract (SPASE) is a metadata model discussed every month within the IHDEA (International Heliophysics data alliance) SPASE working group.
  - Metadata model https://spase-group.org

- ESA has recently developed its own GitHub to store the description of its heliophysics datasets, starting with in-situ L2+ datasets; its content will be mirrored in the NASA metadata registry

- These SPASE descriptions will be used to mint DOI (DataCite) for every dataset, L2/L3 to start with

SPASE metadata model: increasing findability across missions

https://github.com/HPA-ESDC-ESA-INT

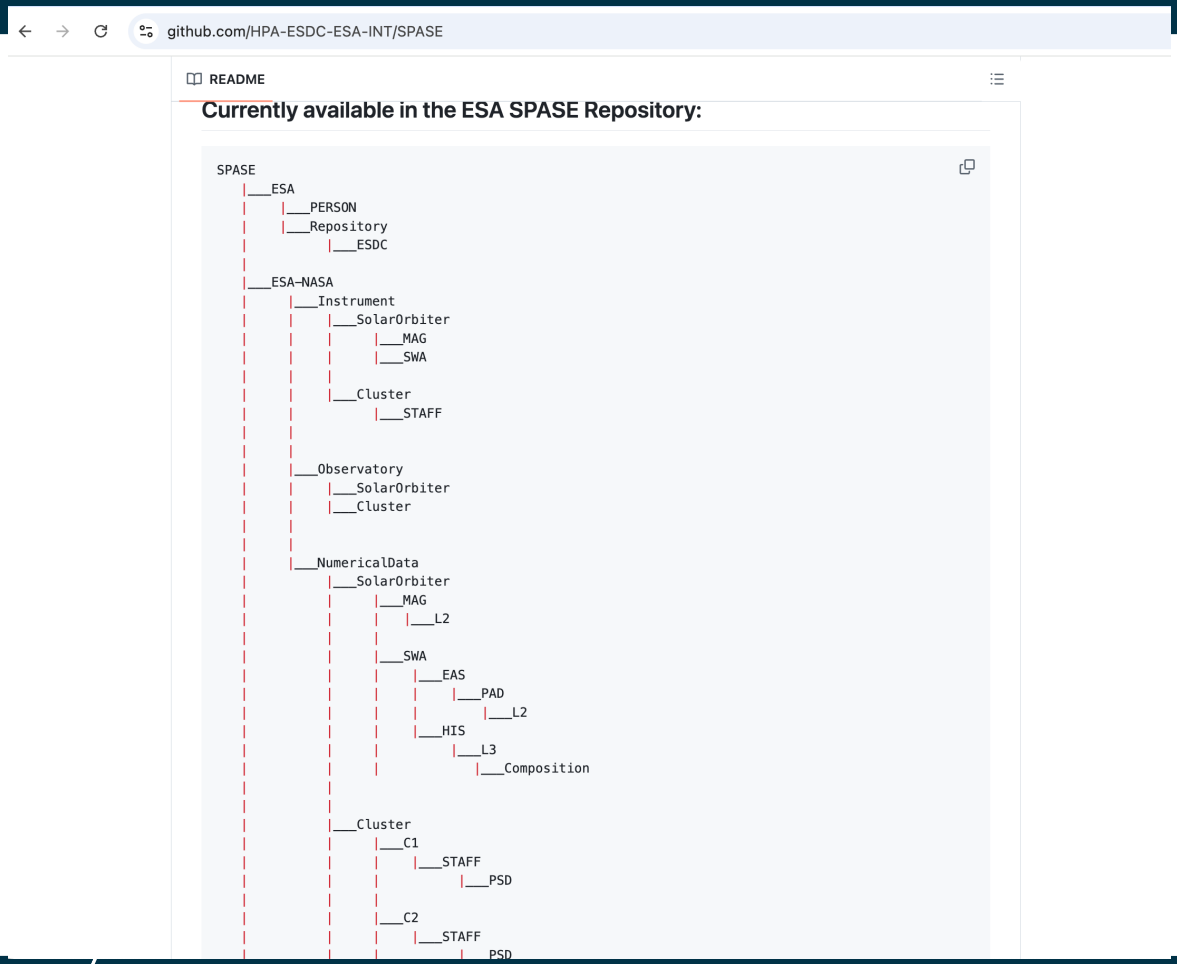


Dataset metadata description (XML)

Validated by PI teams

ESA independent metadata repo, part of the resilient aspect of the archives

SPASE metadata model: increasing findability across missions



Dataset metadata description (XML)

Done for Cluster, in progress for Solar Orbiter

Applicable to in-situ and modelling datasets, to be further developed for describing remote sensing datasets

Key for improving internal GUI search across missions but also Google dataset search [Masson et al., 2022]

International Heliophysics Data Environment Alliance (IHDEA)

DASH/IHDEA 2026

Oct 4 – 9, 2026
Europe/Dublin timezone

Enter your search term

Last count
95 in person + 35 online

- Overview
- Timetable
- Session Descriptions
- Registration
- Travel Support
- Visas
- Poster information
- Venue
  - Getting Around
  - Local Information
  - Accommodation
  - Welcome Reception
  - Conference Dinner
- Organisation
- Data Protection Notice
- Code of Conduct



The 2026 DASH / IHDEA Meeting will take place at the Royal Irish Academy of Music in Dublin, Ireland

International Heliophysics
Data Environment Alliance

htpps://ihdea.net

Information architecture for the space weather decadal roadmap

Heliophysics and space weather information architecture and innovative solutions: current status and ways forward
Masson, A., S. Fung, E. Camporeale, M. Kuznetsova et al., ASR, 2024; https://doi.org/10.1016/j.asr.2024.05.052

Outline

1. Information architecture key buidling blocks
    - metadata registry (SPASE)
    - data formats and data access protocols
    - DOI

2. Open science tools and infrastructures (collaborative science platforms, simulations services)
    - Tools (Python in Heliophysics, Kamodo, executable papers, possible ways forward)
    - Infrastructures
        - Collaborative science platforms (DataLabs at ESA and HelioCloud at NASA)
        - Simulations services (CCMC at NASA, VSWMC at ESA)

3. Innovative solutions
    - Machine Learning techniques succesful applied to improve the speed of space weather forecasting
    - ML ready datasets
    - GPU to boost computation

4. Recommendations

Progress reported at COSPAR GA Panel on Space Weather information architecture session

EUROPEAN SPACE AGENCY

THANK YOU!

Arnaud.Masson@esa.int