Space Science Data Handling at the ESAC Science Data Centre

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ESA_Lab “Space Data Management Workshop”, Venice, 8th of May of 2023

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Outline

- Space science data in ESA's Scientific missions
  - (science-driven) data management
  - International standardisation
- AI in space science data management
  - Citizen science projects
  - Virtual assisstants
- The future of space science

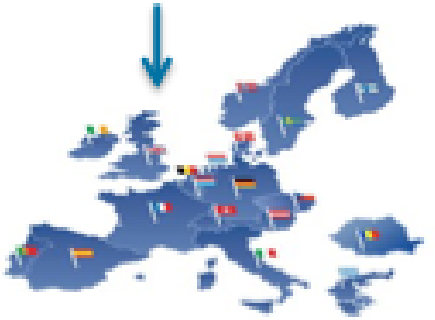
Space science data management in Europe today

ESA Coordination with Science Provider and User Communities

Science Operations Systems Studies, Design & Requirements	Science Operations Planning	Science Instrument Handling	Science Data Processing	Science Data Archiving

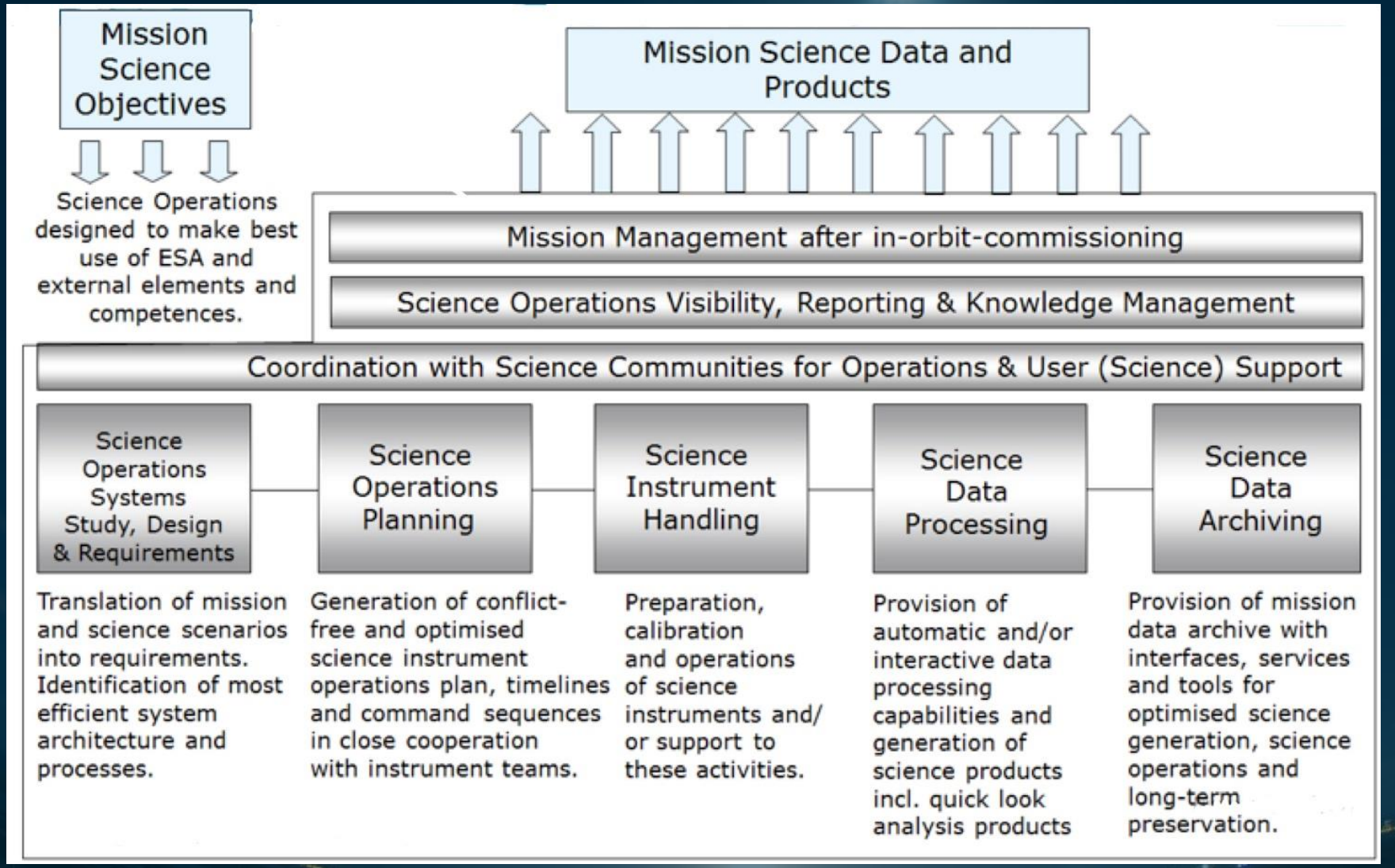
Usually more by ESA

Usually more by Member States

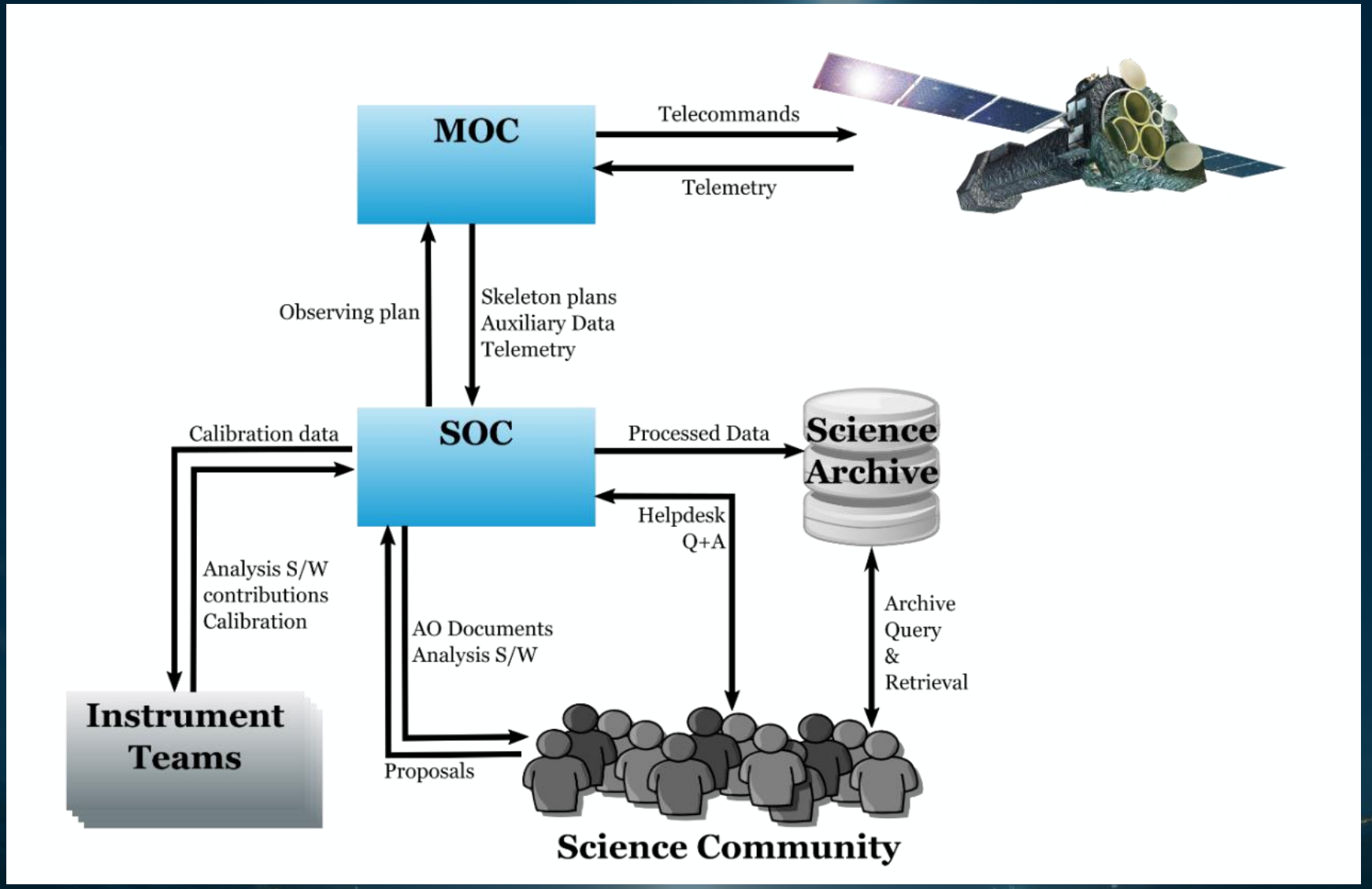


Usually more by ESA

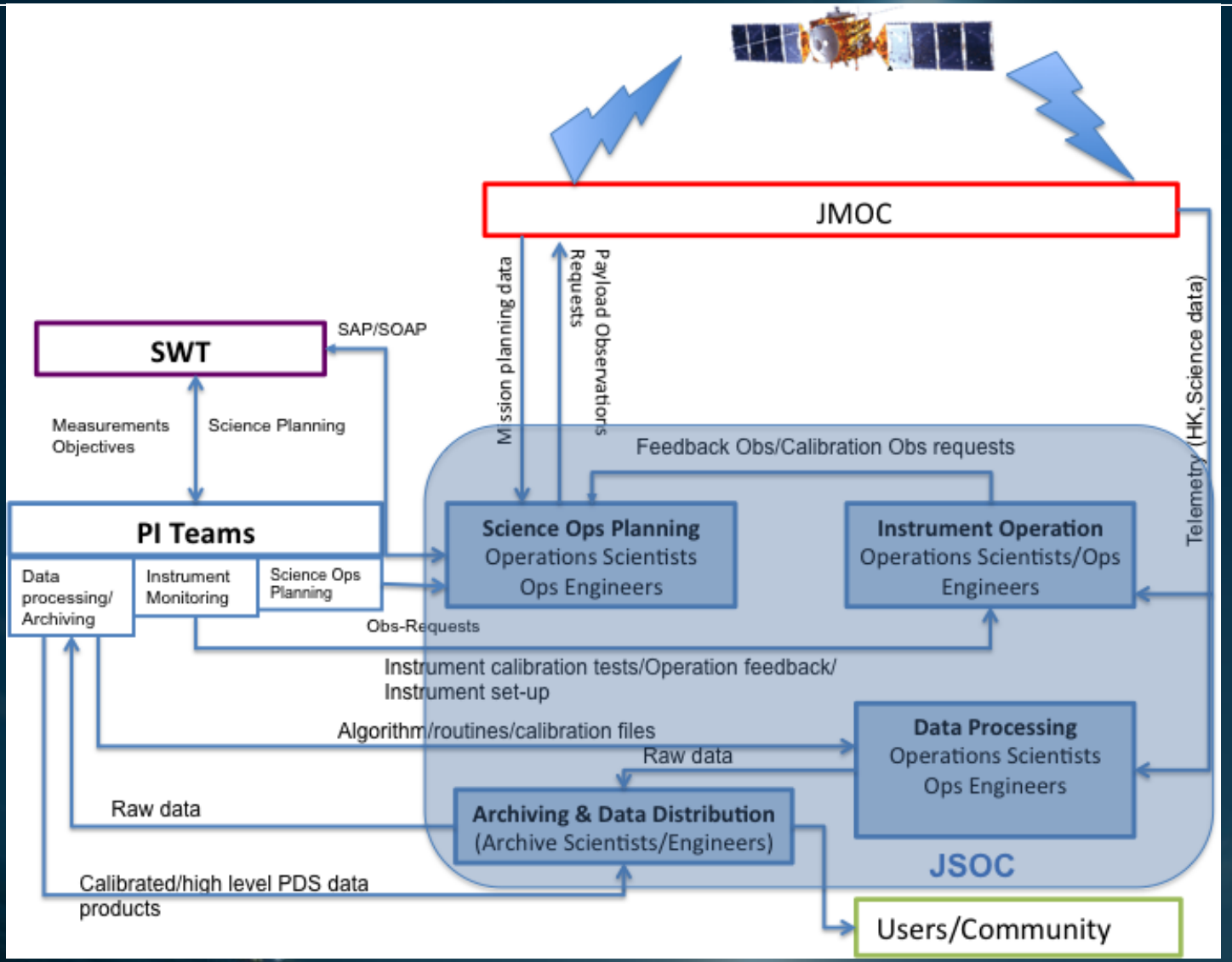
ESA Science Operations Scope



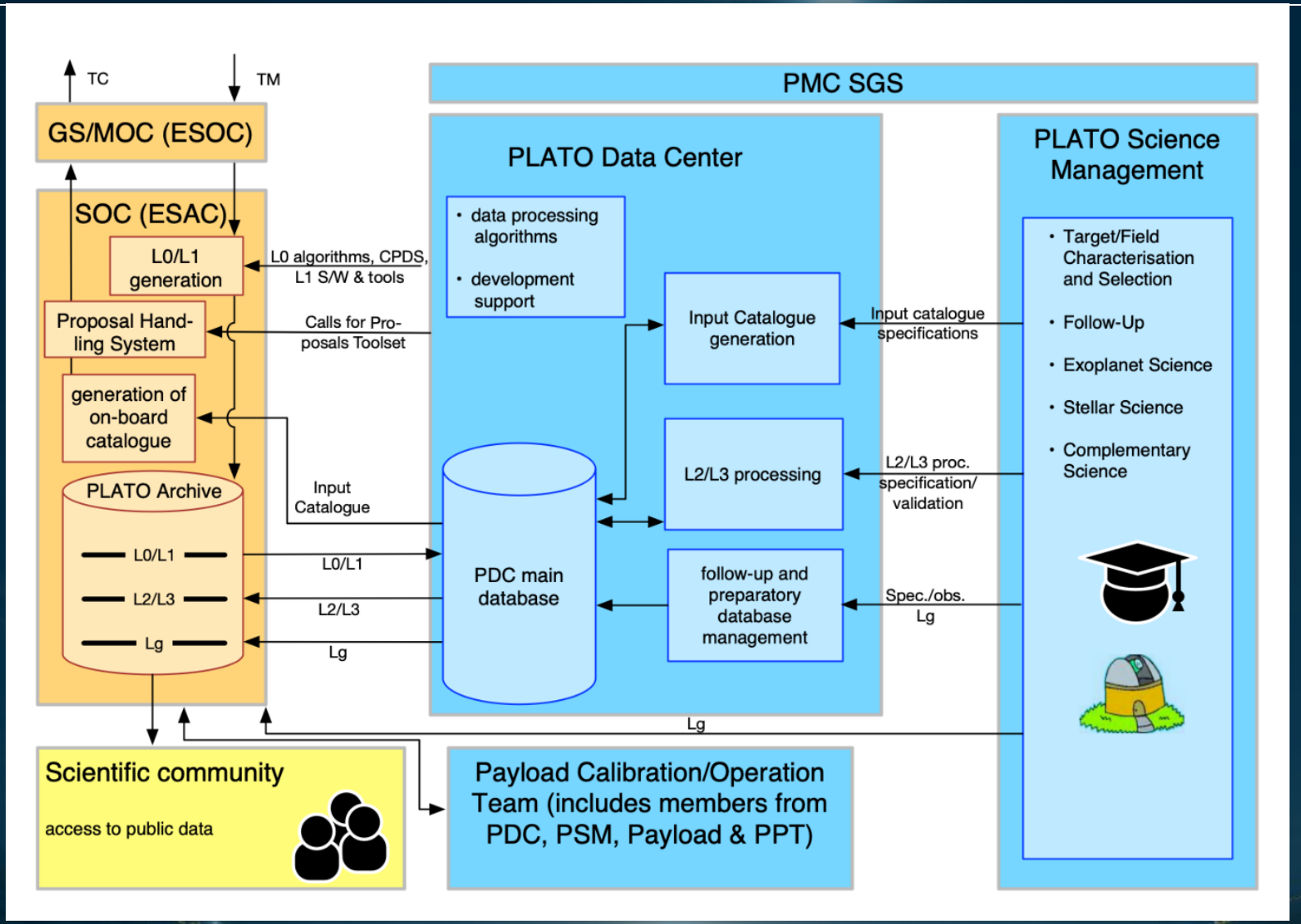
Example of data flow for a space science mission



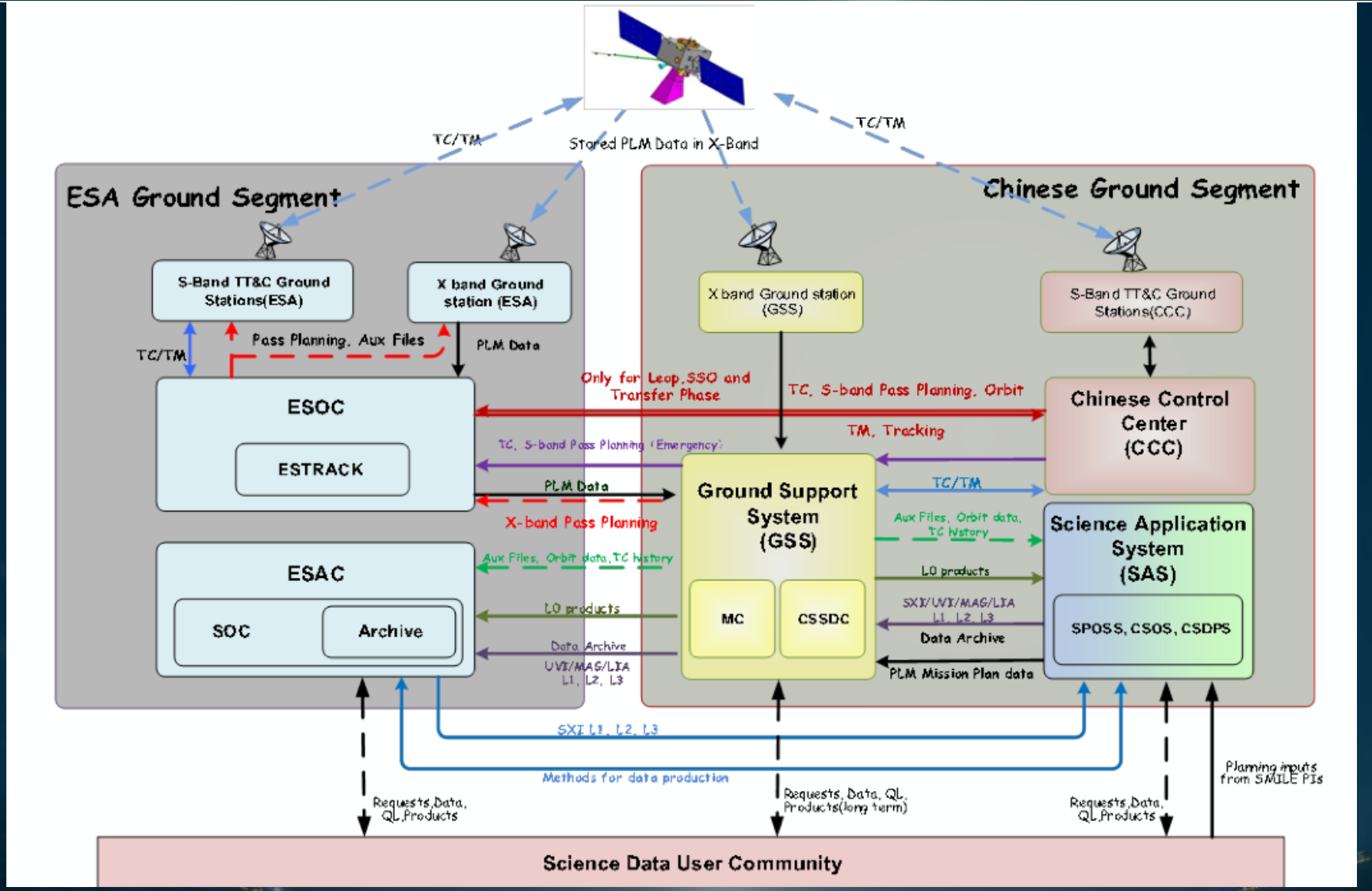
Example data flow for a Planetary mission : JUICE



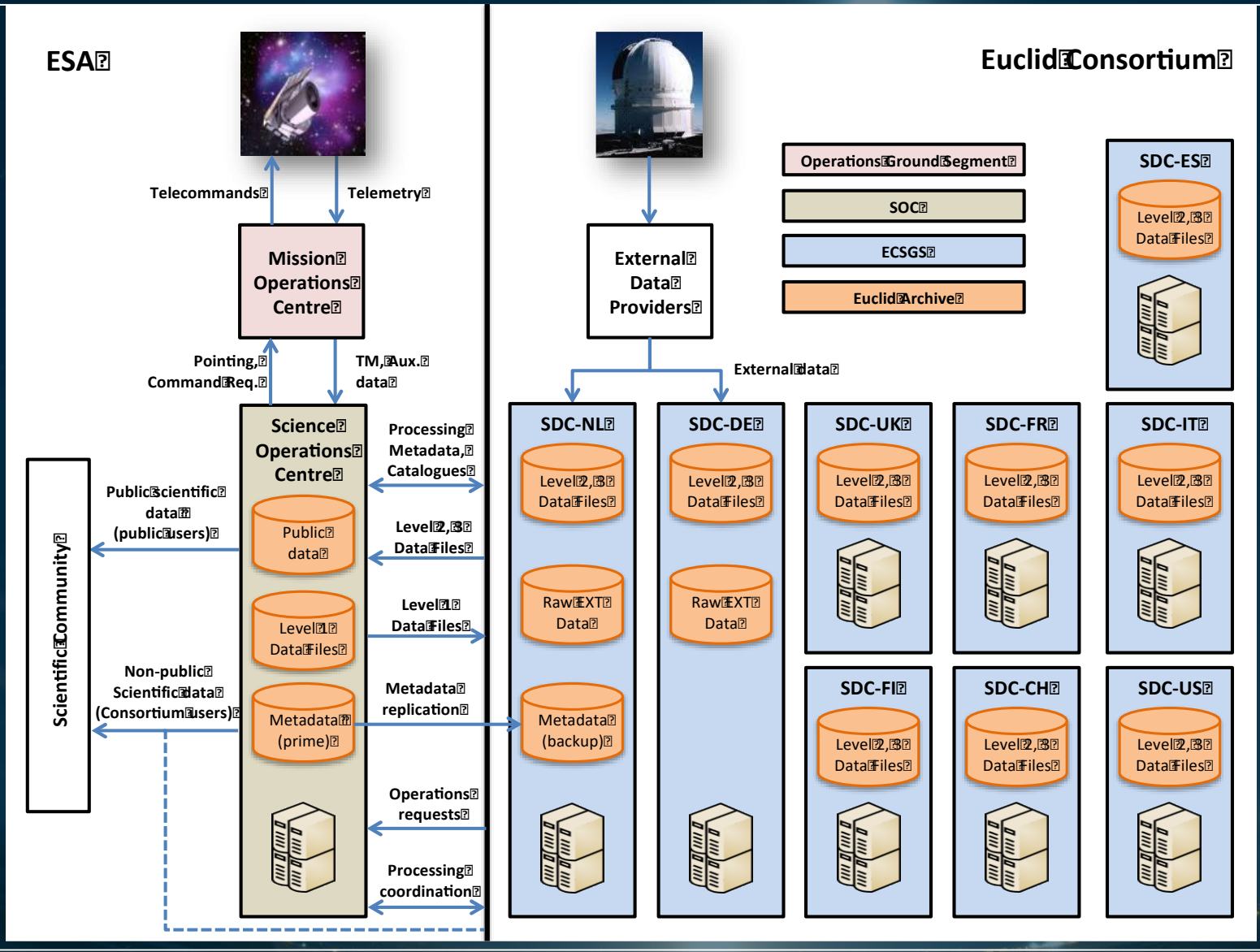
Example data flow for an Astronomy survey : PLATO



Example data flow for a collaborative mission : SMILE

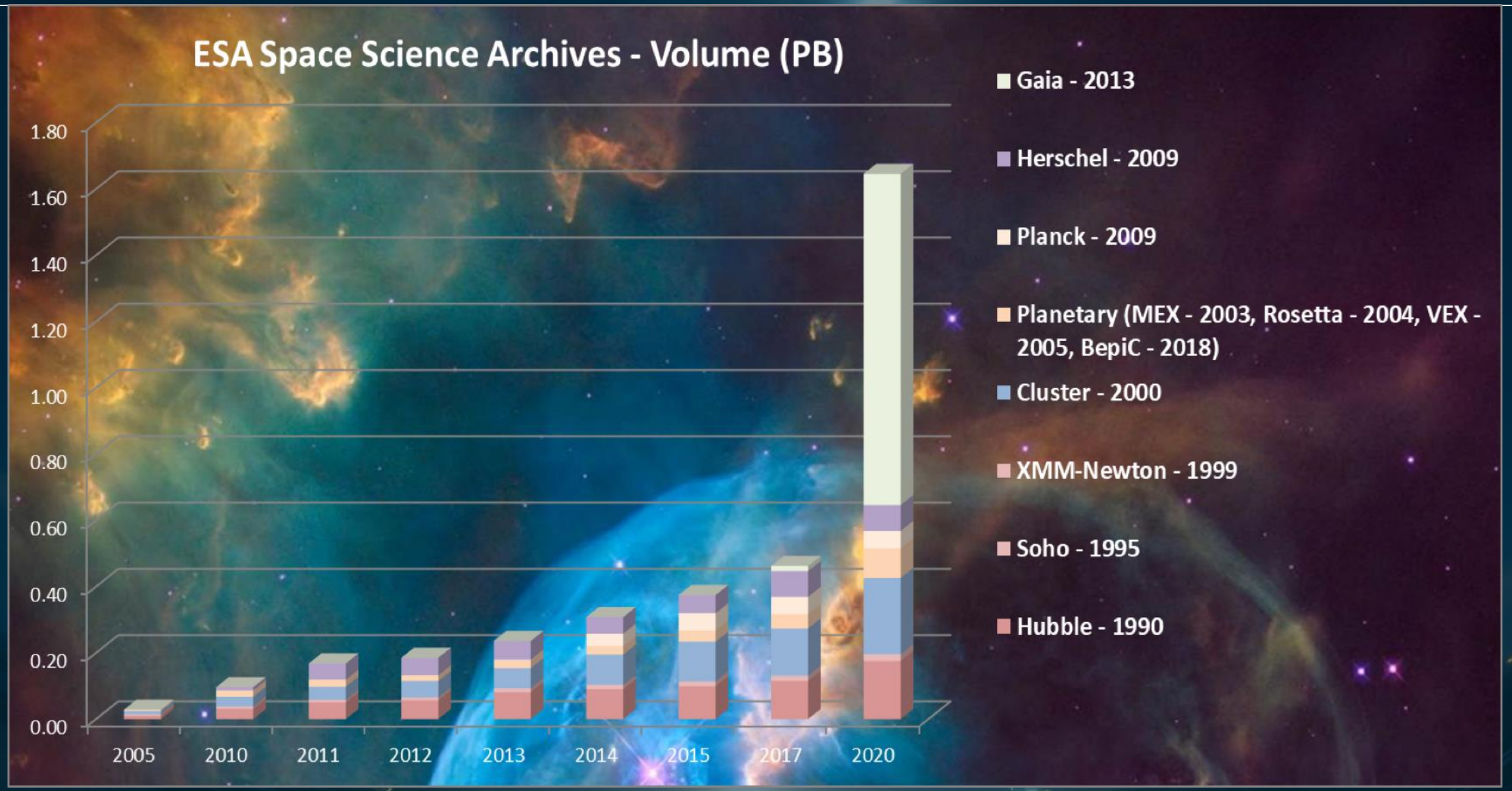


Example data flow for a Astronomy mission : Euclid

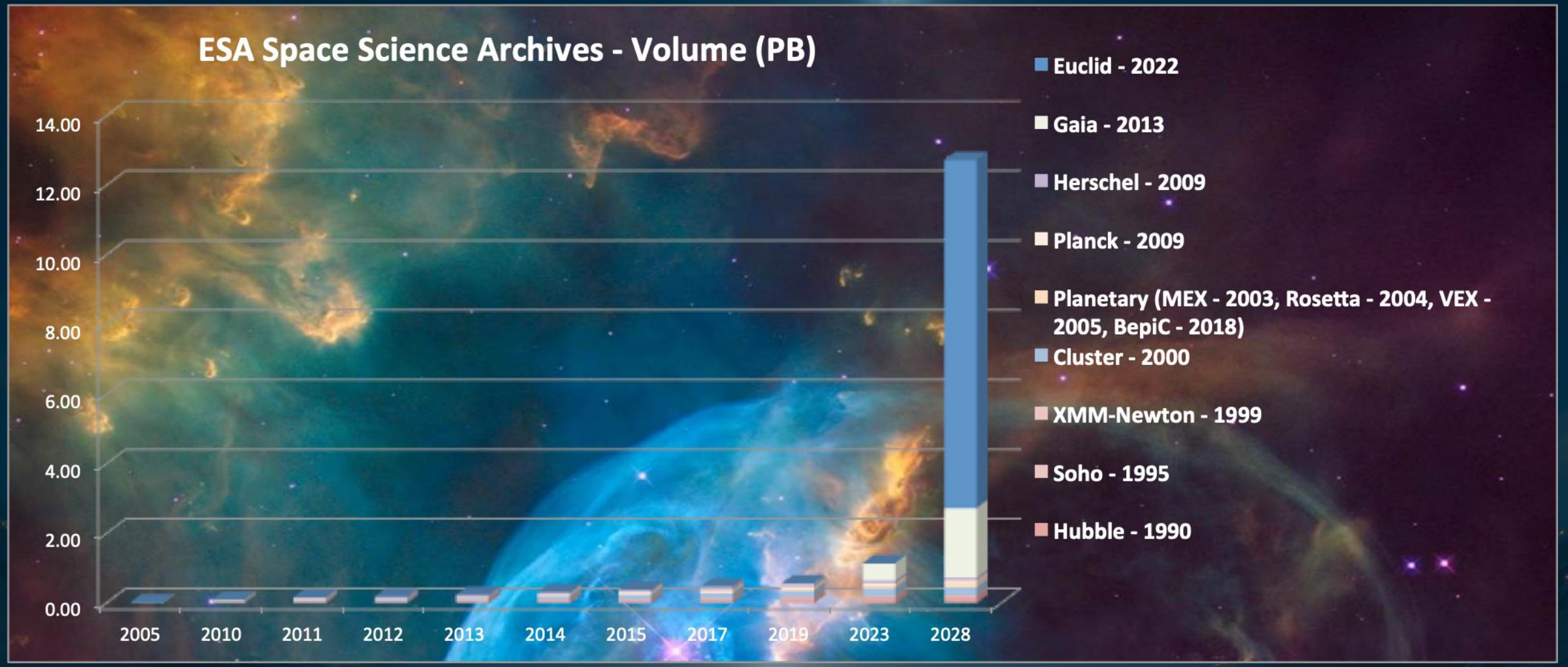



Science is about revisiting the data with new knowledge
re-search

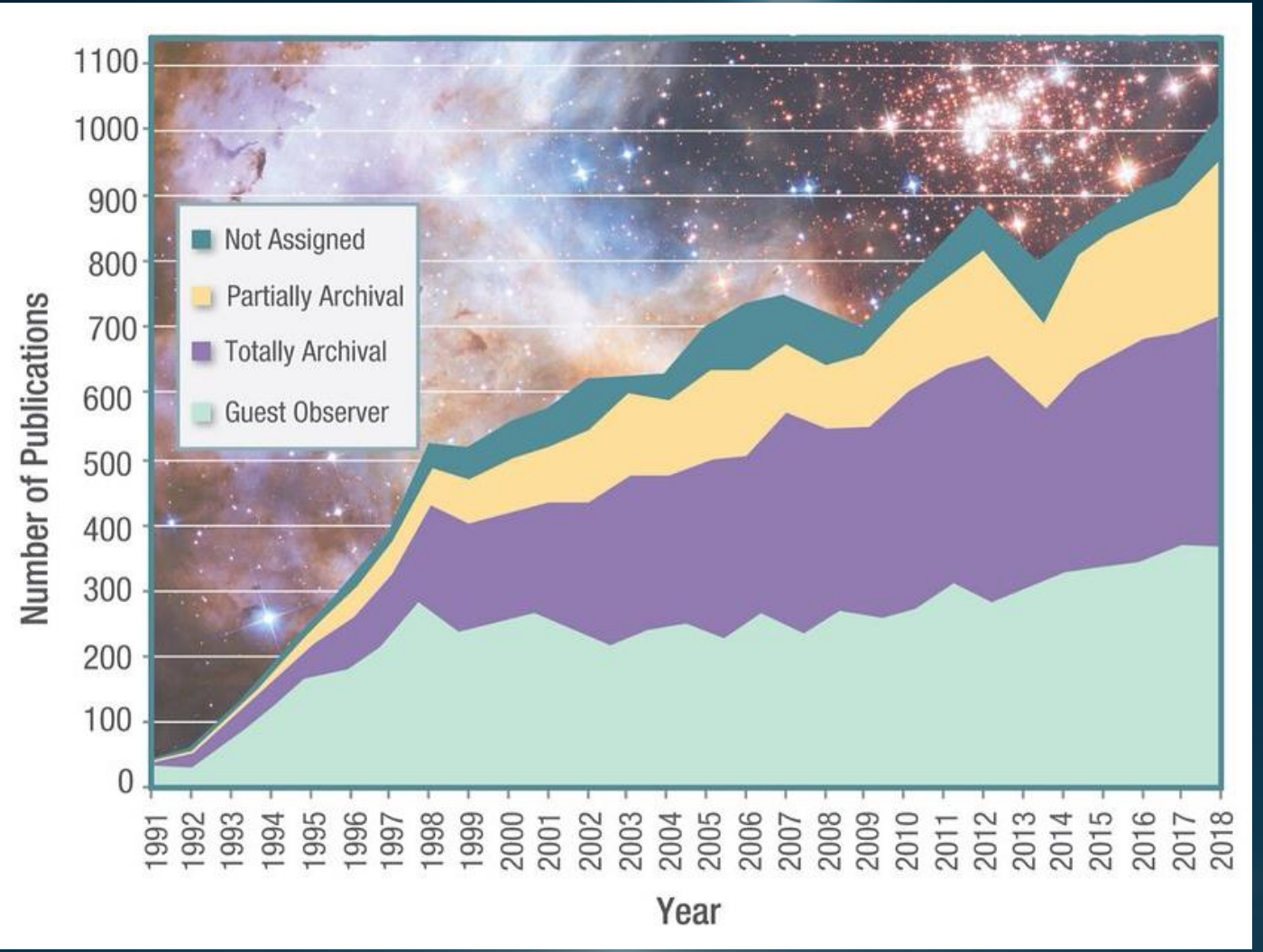
Complex data products grow in size and complexity



.. And they are getting very large very soon..

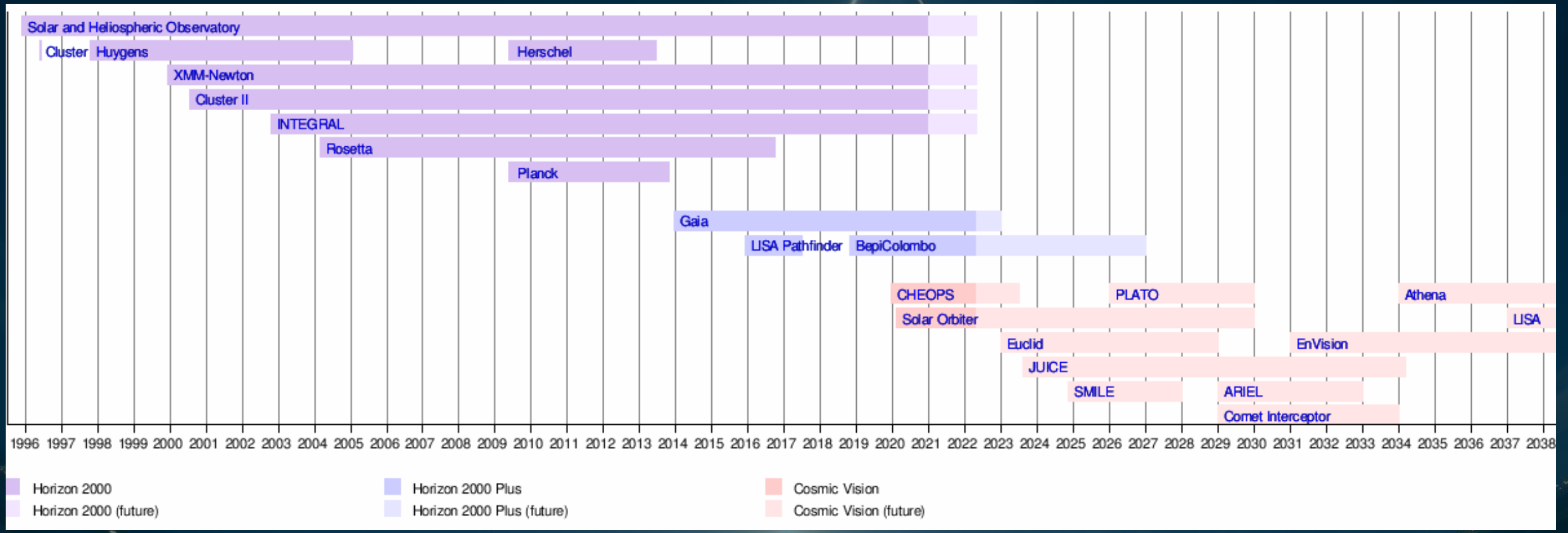


Astronomy is becoming a data-driven field



http://archive.stsci.edu/hst/bibliography/pubstat.html

Hosting science data for decades



24 missions developed, operated and curated for over four decades

International collaboration in standardisation

International Planetary Data Alliance

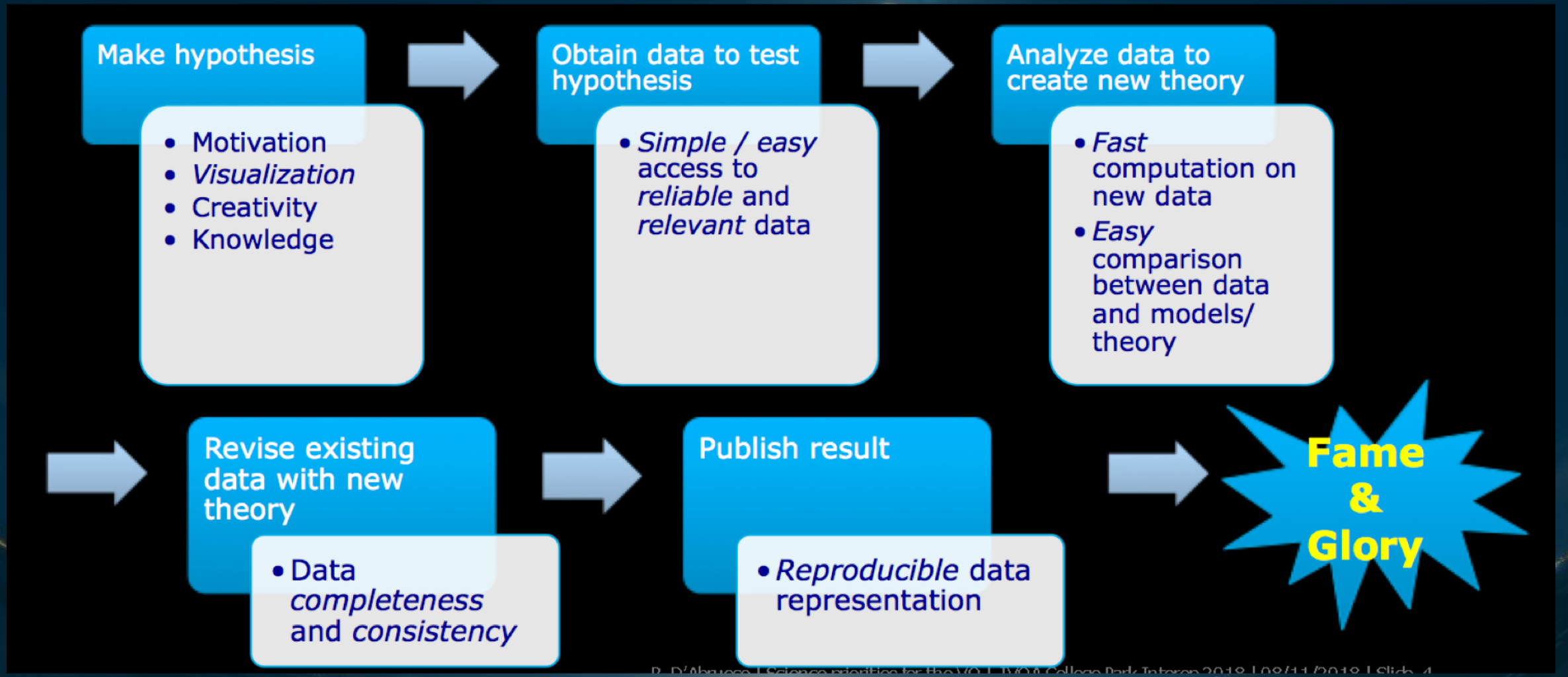
International Heliophysics Data Environment Alliance

International Virtual Observatory Alliance

ESAC SCIENCE DATA CENTRE

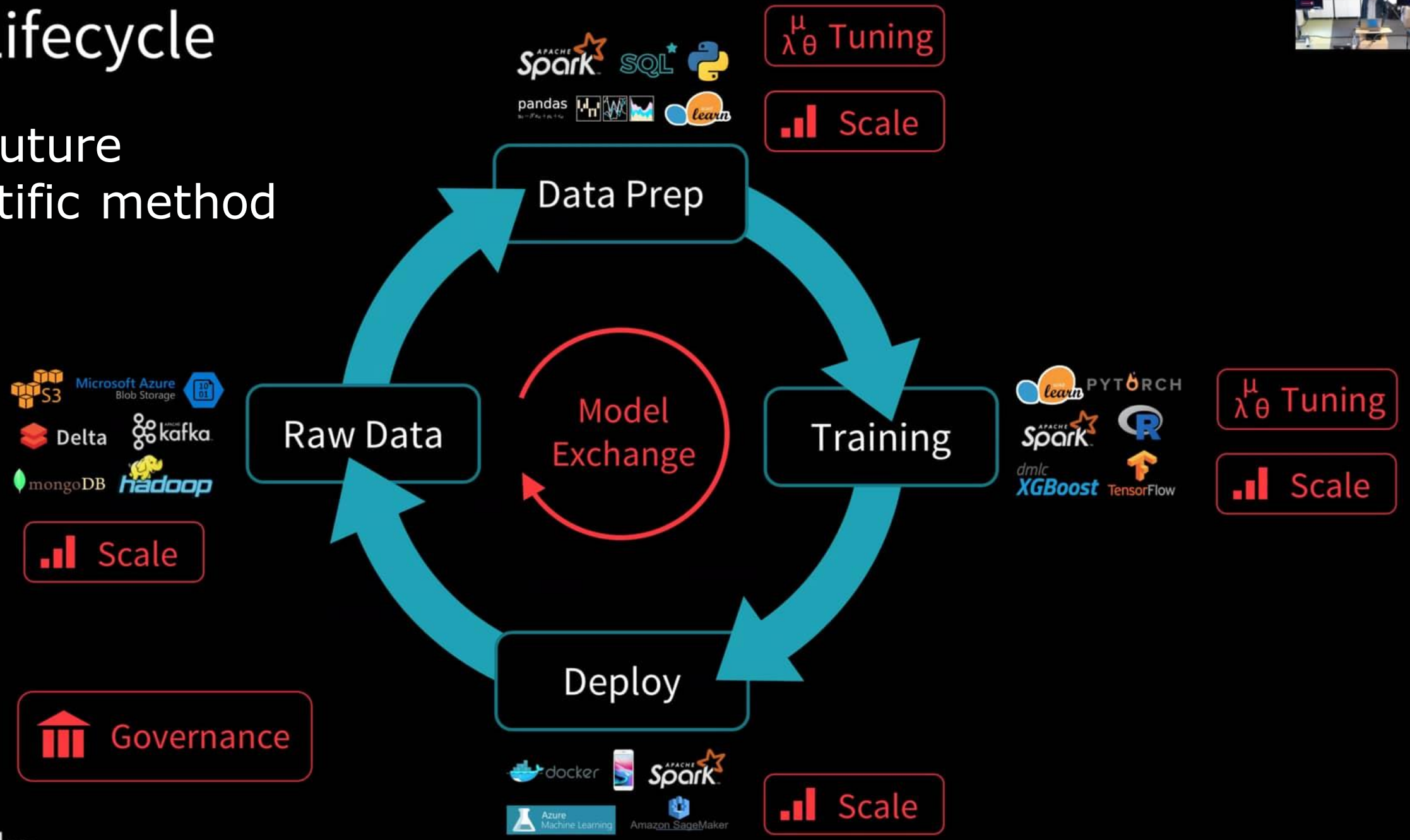
Astronomy, Heliophysics and Planetary Archive Users Groups

The traditional scientific method



ML Lifecycle

The future scientific method

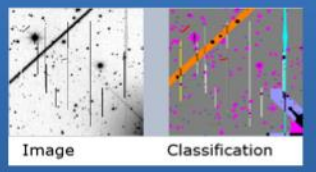


databricks

How [illegible] fit in our da[illegible]

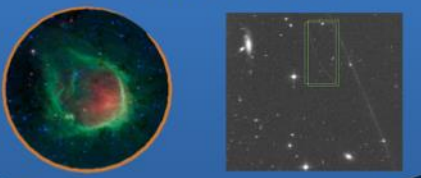
esa

Deep learning classifiers of image contents for data-driven searches or quality control: images with asteroid trails or cosmic rays



NLP to automate linking of data to scientific papers. Automatic generation of statistics on Papers on our missions

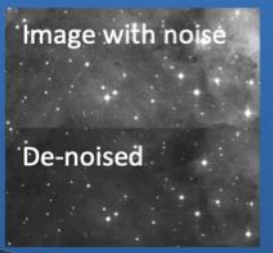
Deep learning classifiers of image contents for data-driven searches: e.g. search images with Interstellar medium bubbles



Data production → Curation → Archiving → Valorisation → Dissemination → Support to users in their exploitation

ESAC Science Data Centre Value Chain

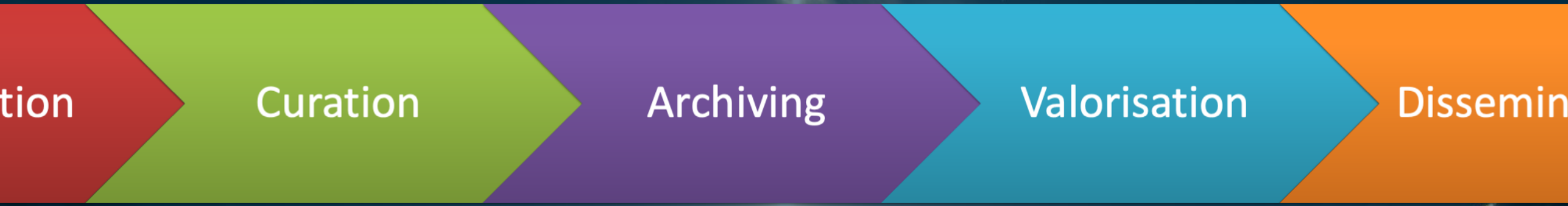
Noise reduction in astronomical images with neural networks, gaining a 50 % in S/N



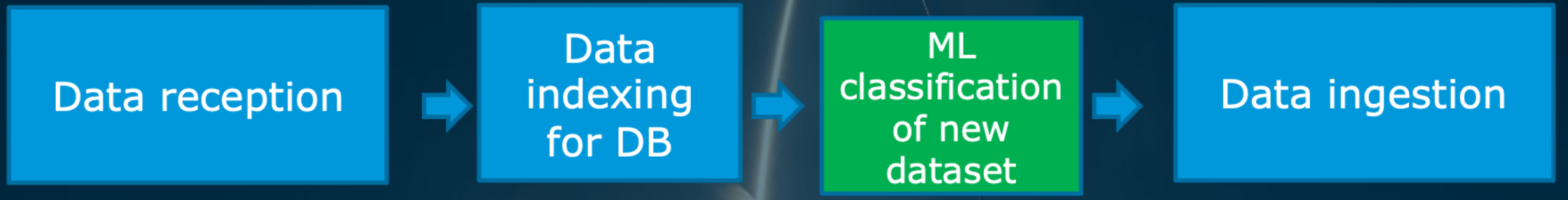
Virtual Assistants to support users on our Web Portals (e.g. Cosmos, ESASky)

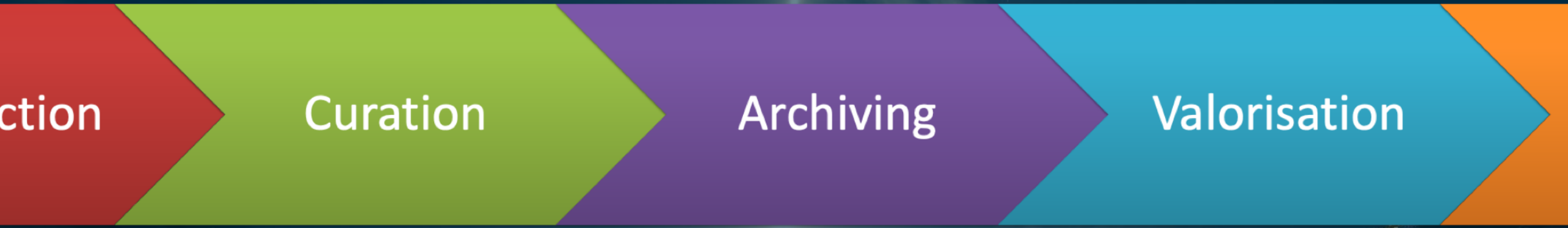
AI / ML to enhance science data

Data reception → Data indexing for DB → Data ingestion

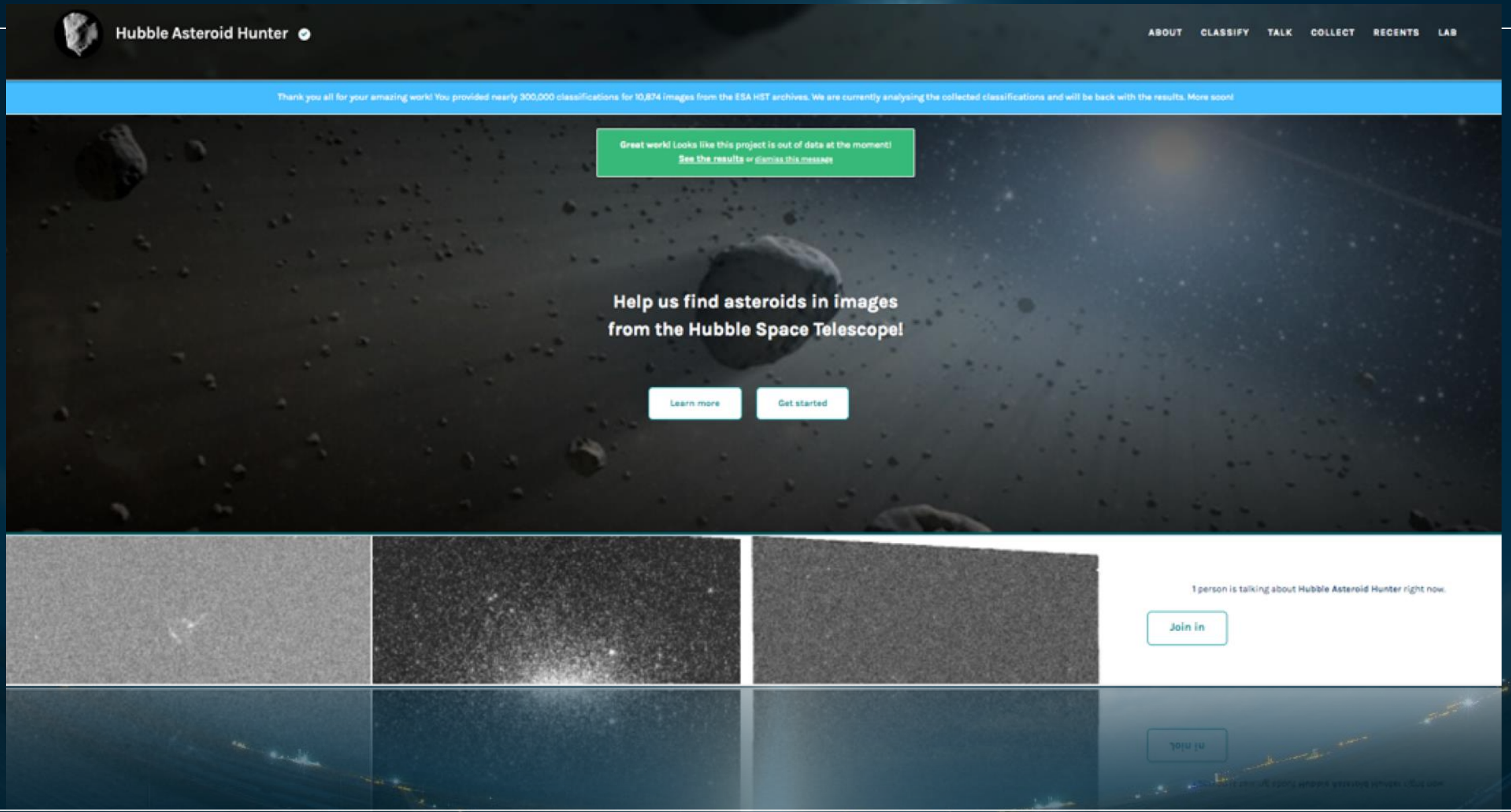


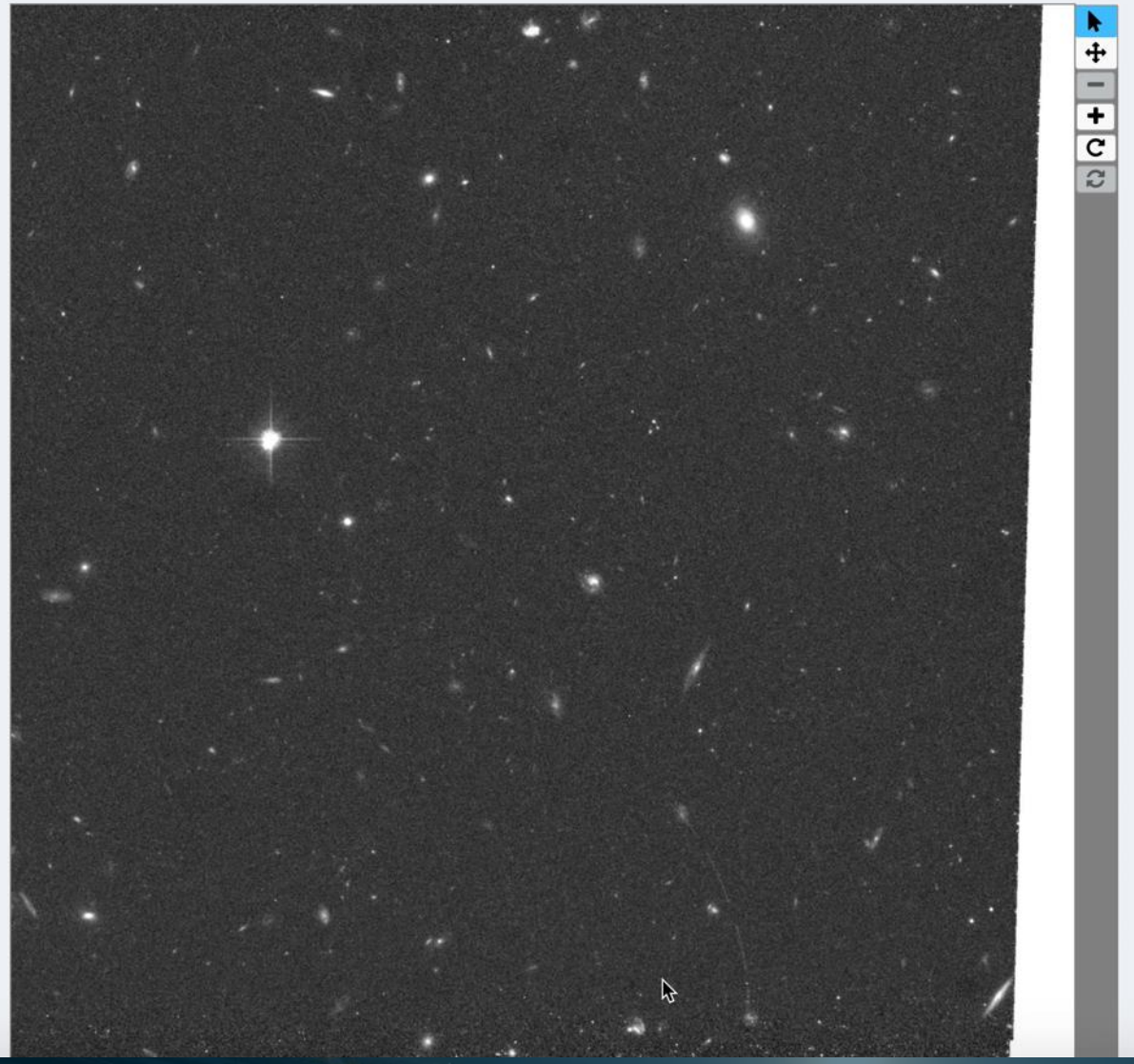
AI / ML to enhance science data





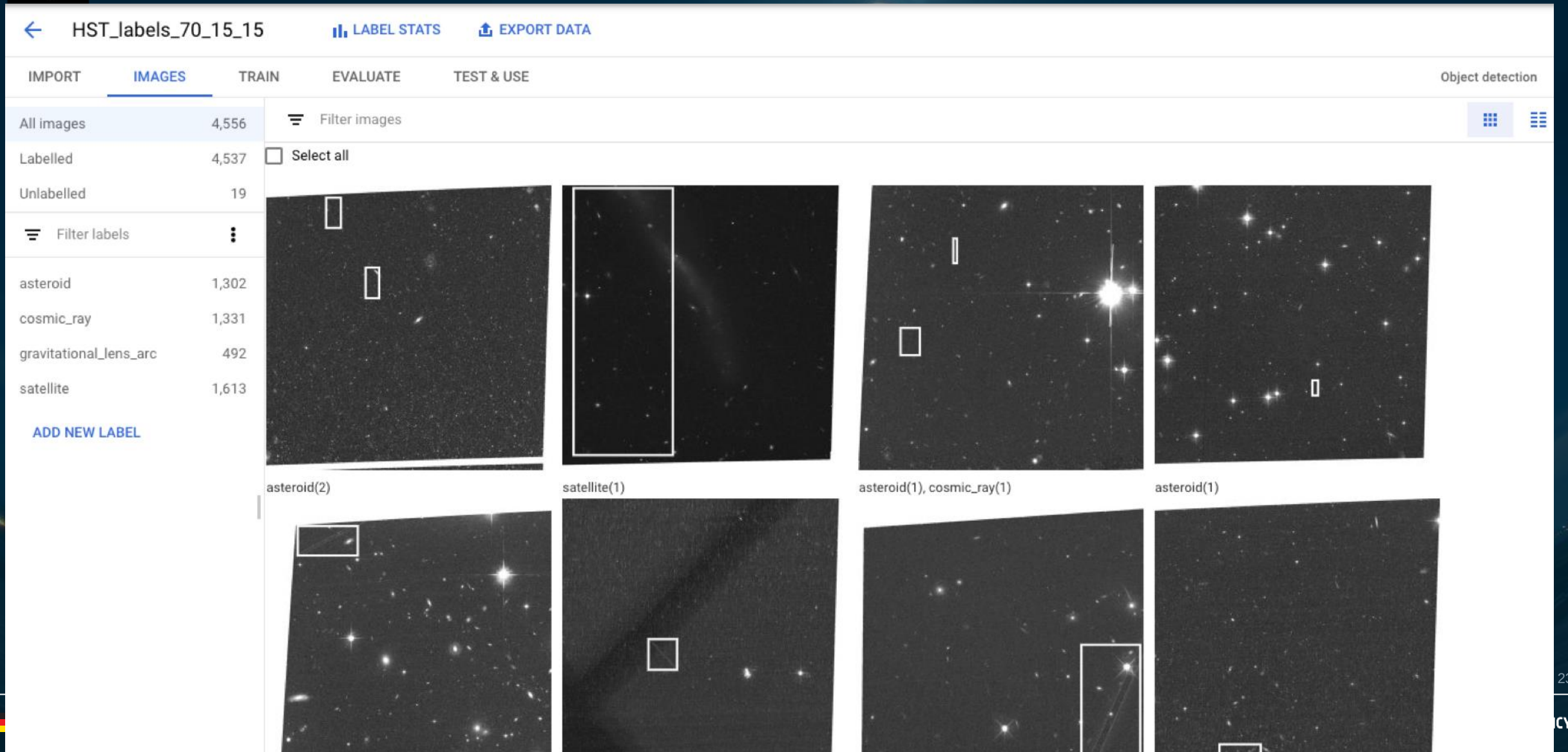
We use citizen science to generate labels





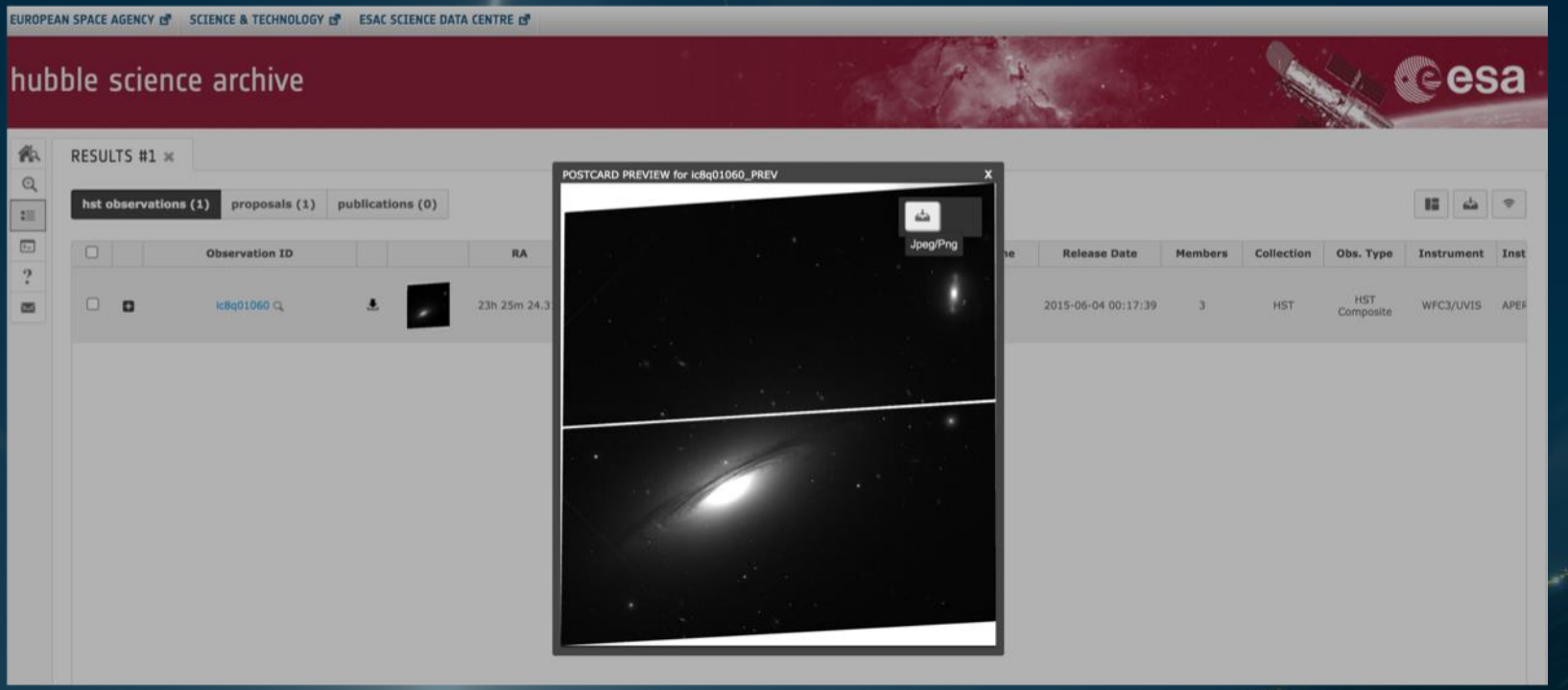
More than 11,000 volunteers classified 19 years of HST images finding a few thousand new trails of asteroids in just a few months!

Trained Google Auto-ML with the labels from volunteers

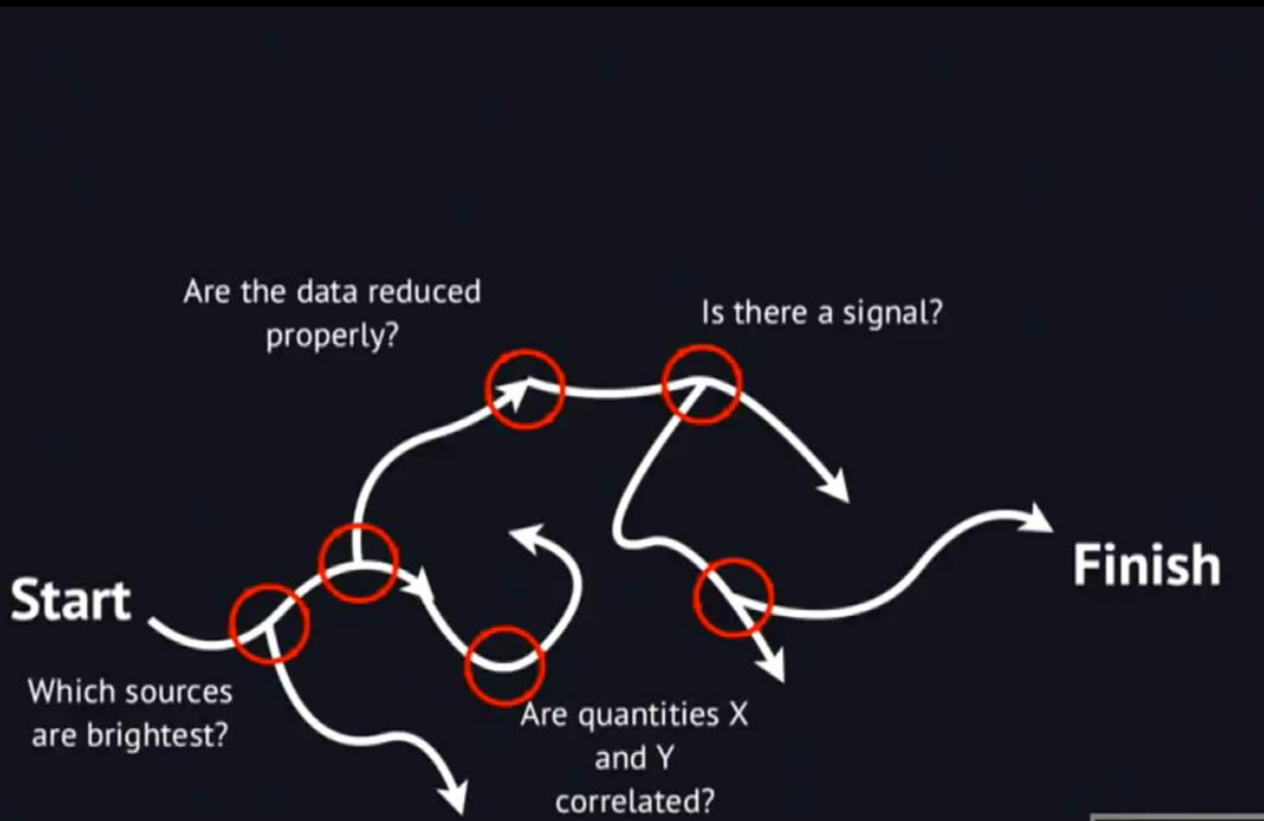


Classifying the eHST archive

- 40,151 “composite” HST ACS/WFC and WFC3/UVIS images (x4 cutouts = 160k cutouts)
- 122 computer Node Hours (~ €350)
- Run on multiple nodes for ~3 hours
- Batch classification on Google Cloud: ~7 hours (38 Node Hours, €60)

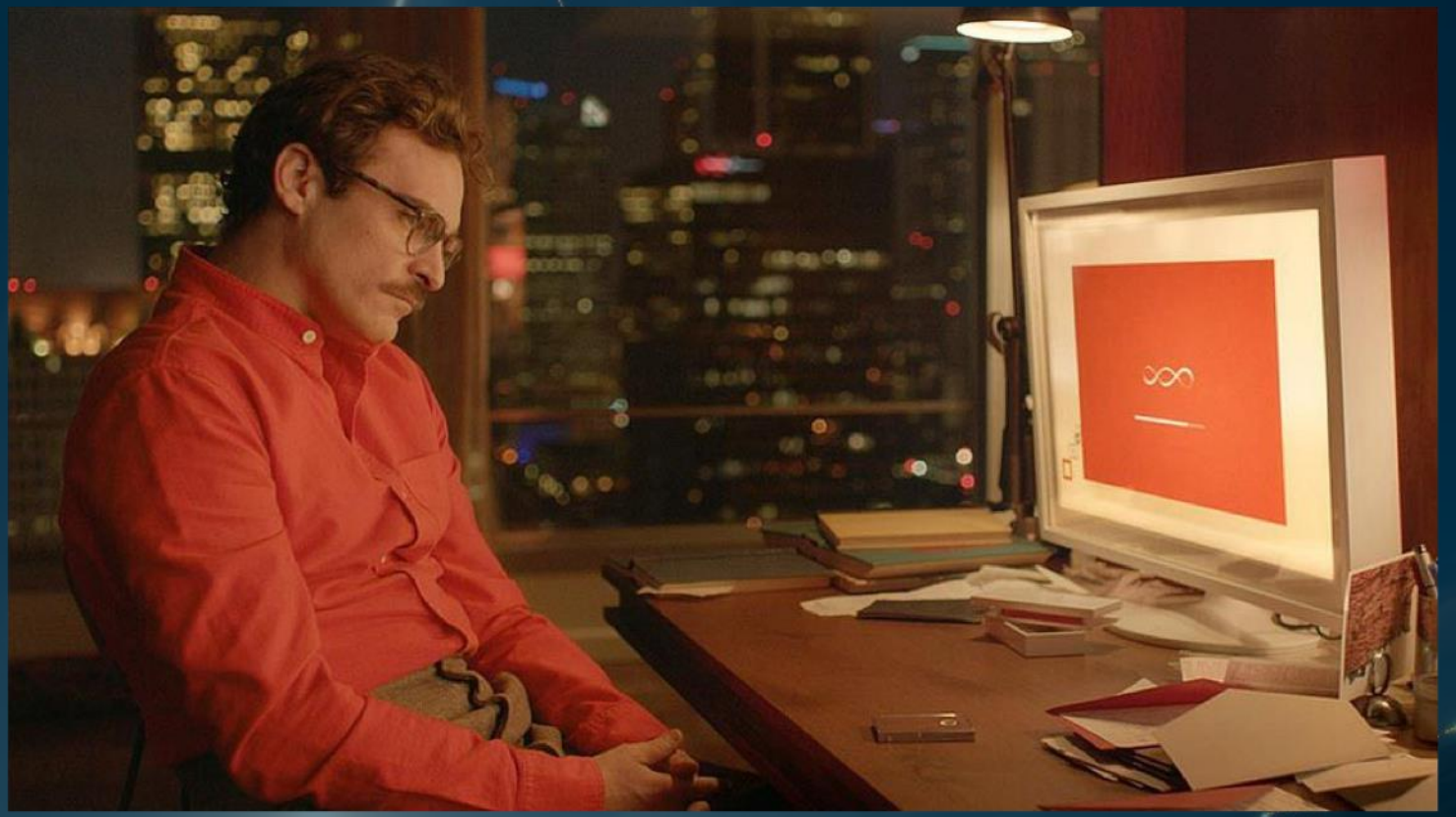


How will the future look like?



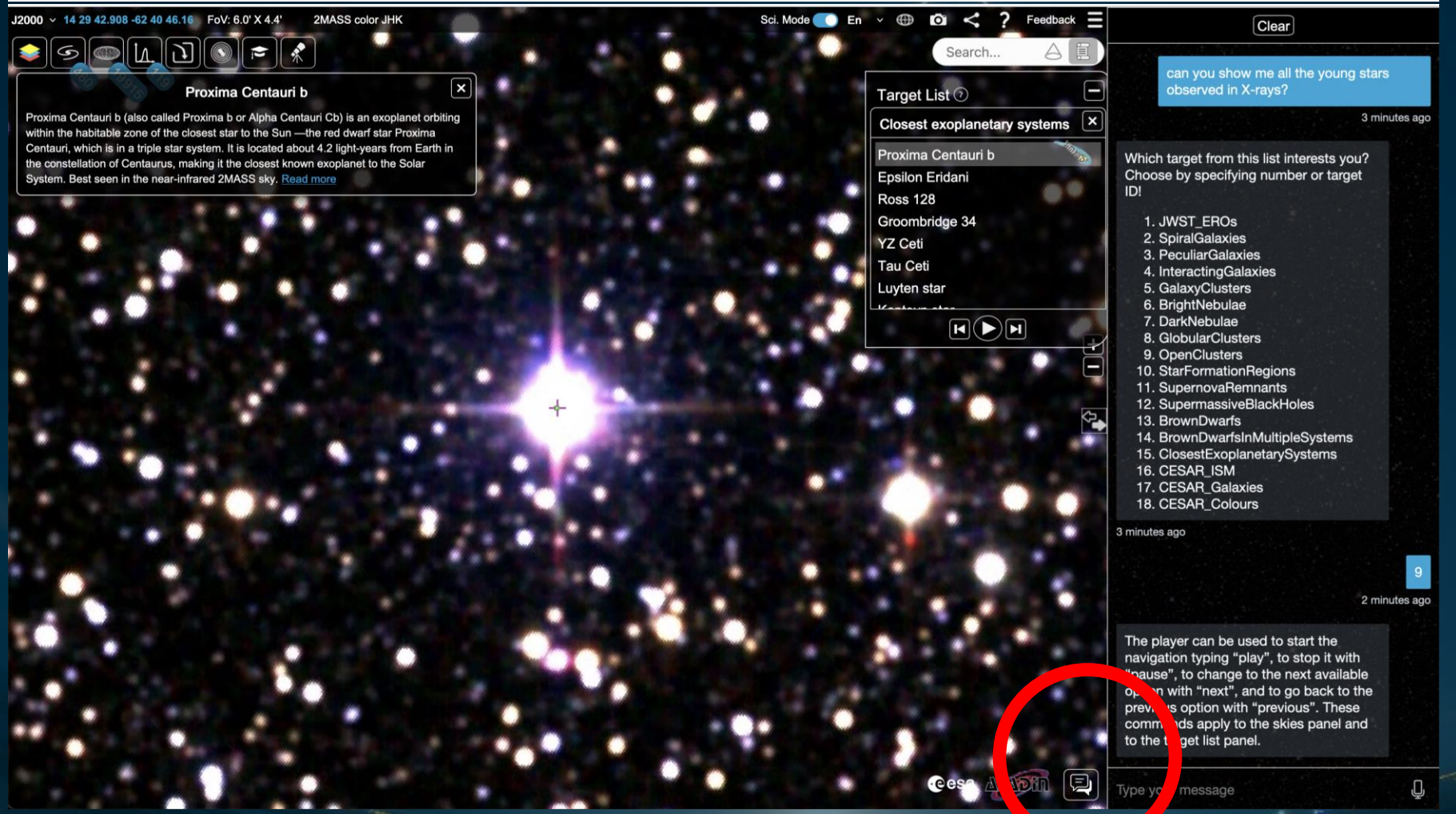
Chris Beaumont - Hackable User Interfaces and The Future of Data Analysis in Astronomy https://www.youtube.com/watch?v=SES7DMwq9Lc

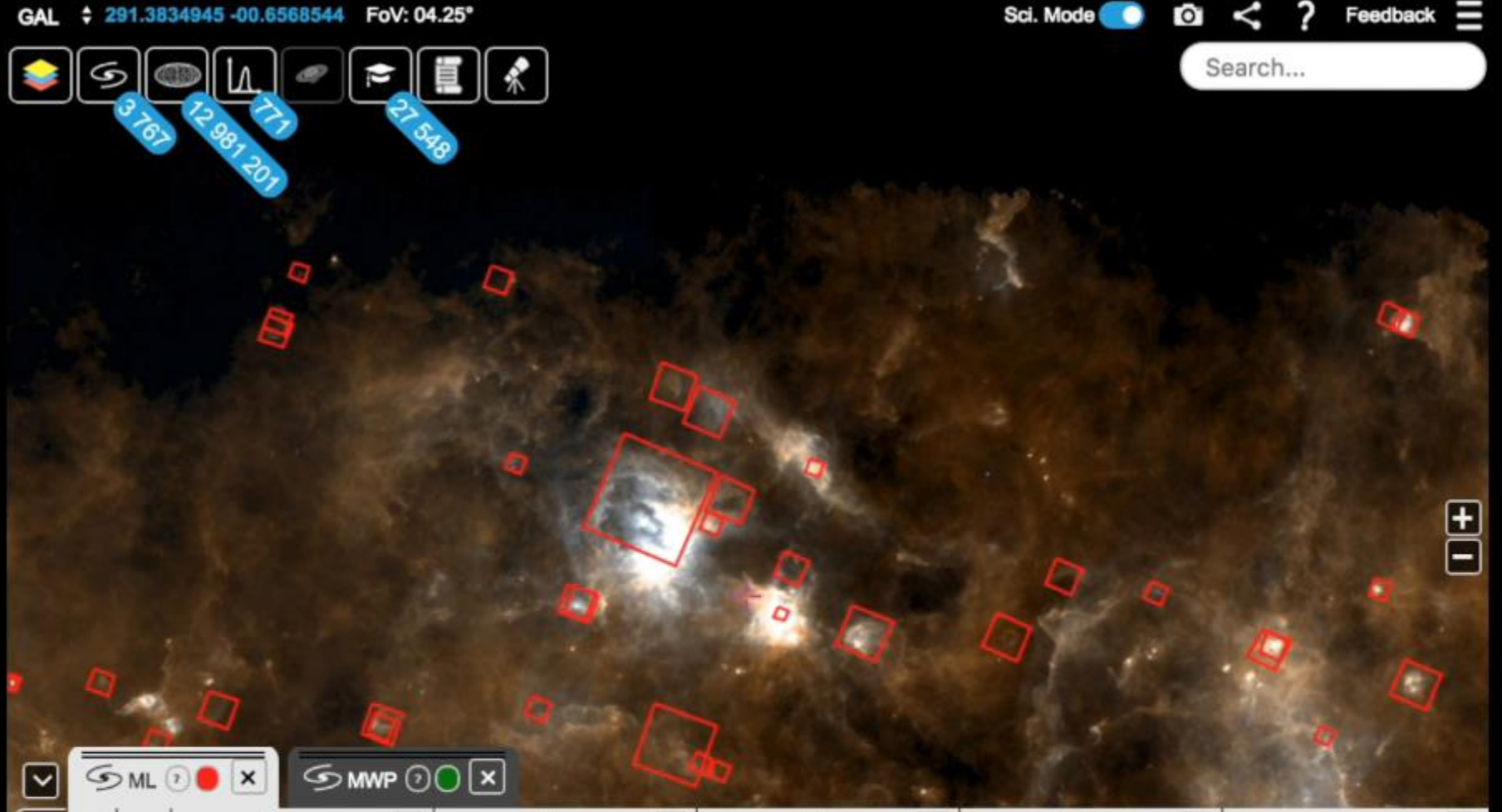
The most advanced ultimate data query system should enable a dialogue with the user, like in the movie “her” (2013)



ESASky already features a virtual assistant !

http://sky.esa.int





		Name	id	wid	hei	score
☐		2965	2965	0.0469026696833339	0.0452581568469874	0.562308788299561
☐		2966	2966	0.0295482488183723	0.0285908031789202	0.999996662139893
☐		2967	2967	0.0176068844646977	0.0170042056114692	0.996415853500366
☐		2968	2968	0.0248743126943793	0.0237259600980728	0.932490587234497
☐		2969	2969	0.0234461656885685	0.0225580393023321	0.911825120449066
☐		2970	2970	0.0554963909035564	0.053729375506177	0.999999761581421
☐		2971	2971	0.038421063194		3569488525

3574 Observation(s) in the chosen area

Our powerhorse enabling all this: ESA Datalabs

→ THE EUROPEAN SPACE AGENCY

ESA Datalabs [0.3.0/BETA]

ESA Datalabs is available as a private beta release, public access is planned for Q3 2022.
If you wish to join our private beta programme, please submit your request here.

«YOU CAN EITHER MOVE YOUR QUESTIONS OR THE DATA. [...] OFTEN IT TURNS OUT TO BE MORE EFFICIENT TO MOVE THE QUESTIONS THAN TO MOVE THE DATA.»

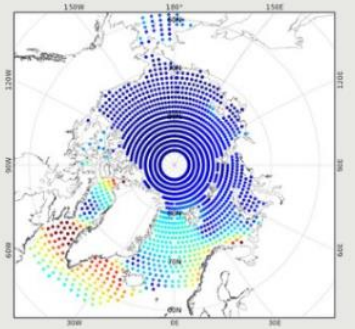
Jim Gray, eScience: A Transformed Scientific Method

BRING YOUR QUESTIONS TO THE DATA

There is a new paradigm, opening completely new opportunities for discovery – a data-intensive approach to science. In many domains, we have entered what could be called the golden age of surveys, with several large-scale projects, spanning decades, between finished, ongoing, and planned activities. ESA is responsible, or is a major partner, in several of these initiatives.

There is, however, a new profound change: data has become a major technological challenge. Increases by multiple orders of magnitude in dataset size means that transferring data to a scientist is often unfeasible.

ESA datalabs gives you a privileged position; bring your code directly to ESA's infrastructure – there is a great set of tools and programming languages are flexible – and execute it with direct access to ESA's archives.



Thanks for your attention !

http://archives.esac.esa.int

http://sky.esa.int

http://datalabs.esa.int

bruno.merin@esa.int