PSIDA 2022

EXPLORE

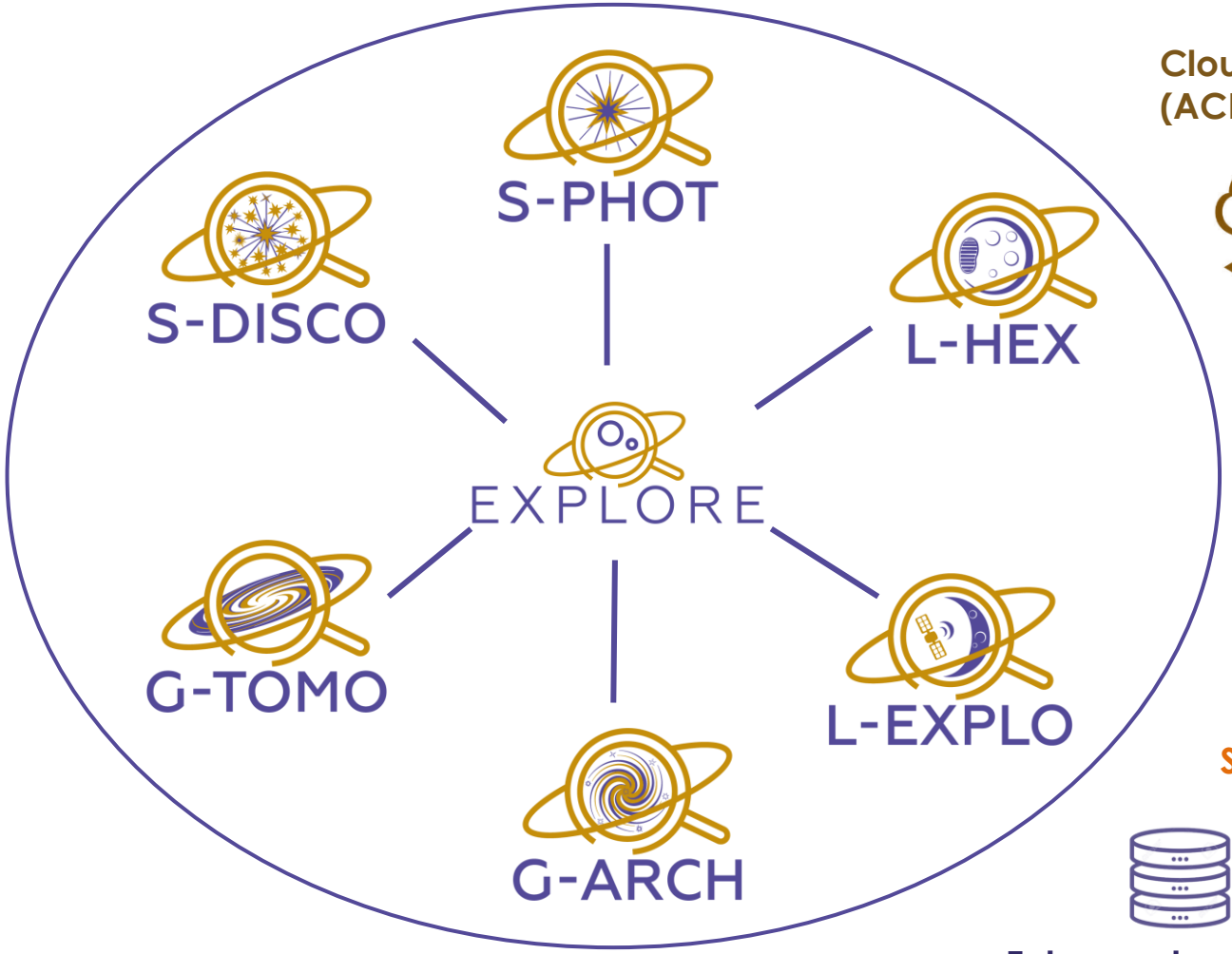
Innovative Scientific Data Exploration and Exploitation Applications for Space Sciences

Nick Cox & Louis Kleverman (ACRI-ST)
+ Angelo Pio Rossi & Giacomo Nodjoumi (Jacobs University)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement No 101004214

EXPLORE – Space Science in the Cloud

Lunar exploration and Gaia science applications powered with advanced visualization and machine learning features



Space and ground-based data

Cloud Platforms (ACRI-ST, ESA, EU)

Science Archives

Enhanced products

EXPLORE

EXPLORE – Space Science in the Cloud

Lunar exploration and Gaia science applications powered with advanced visualization and machine learning features

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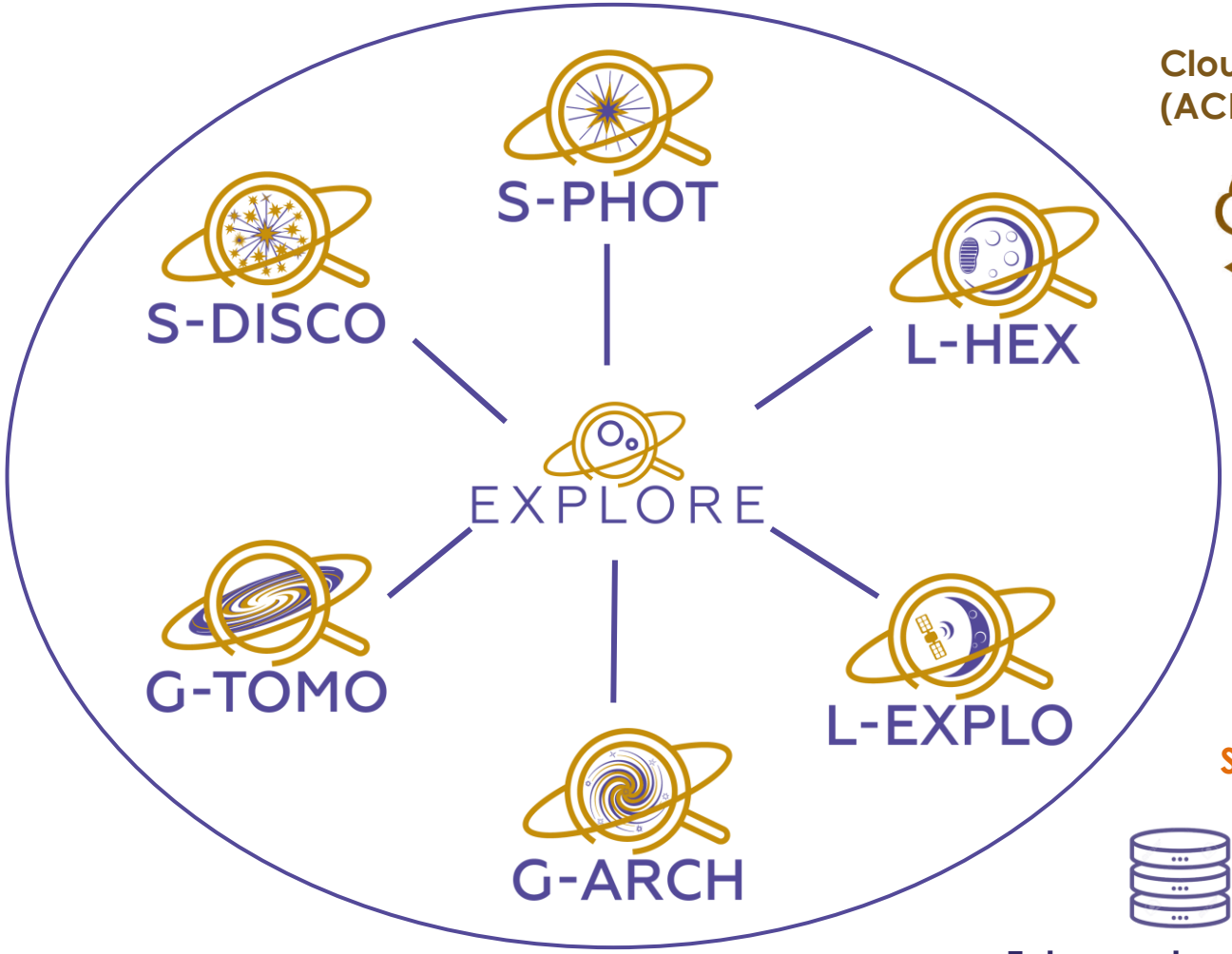


Cloud Platforms (ACRI-ST, ESA, EU)

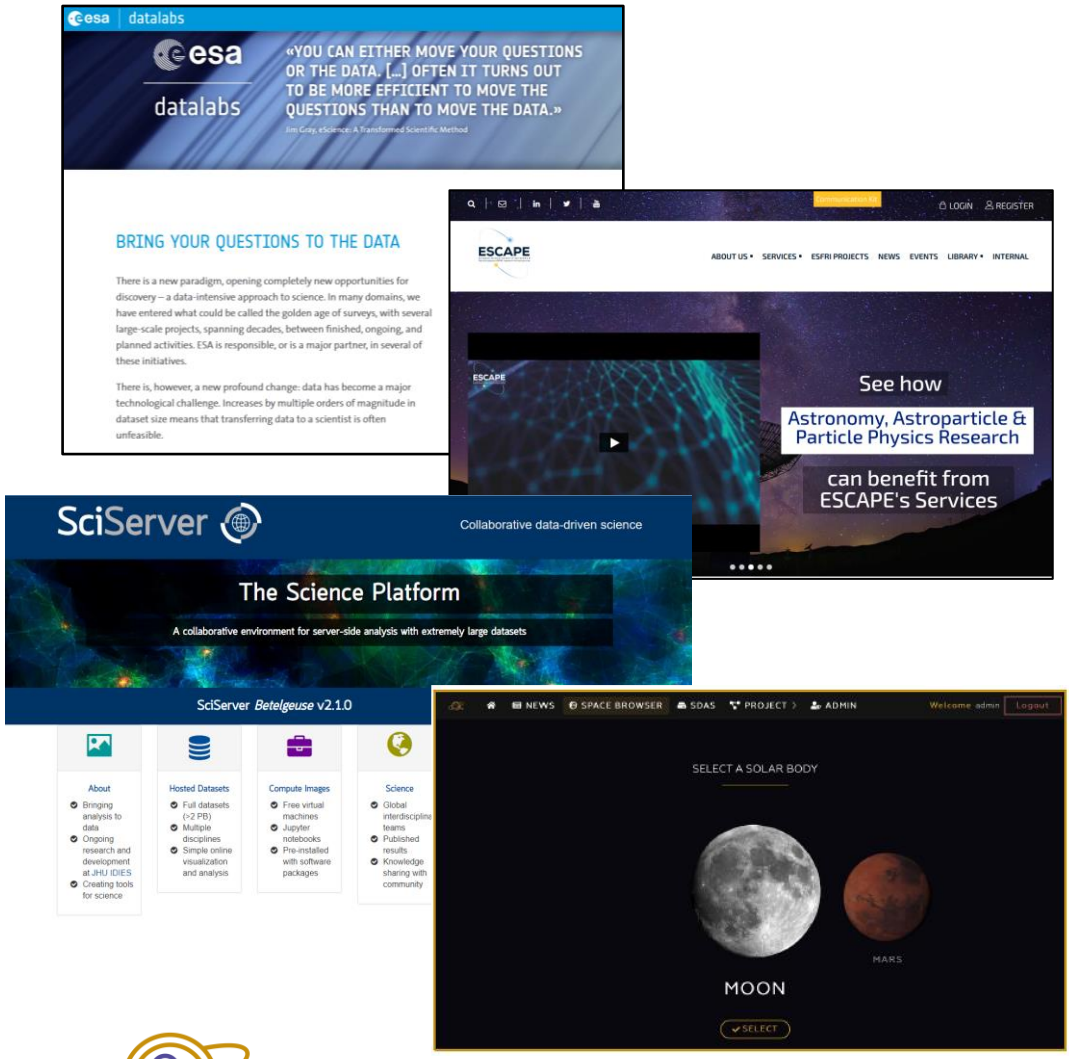
FAIR+open data, code, and science

Science Archives

Enhanced products

EXPLORE

Science Platforms & EXPLORE-platform



Science Platforms → scientific applications in the 'cloud' (close to the data)

For **space sciences**

- US: SciServer, CyVerse (generic)
- Europe: ESA Datalabs, ESCAPE SAP → EOSC ecosystem

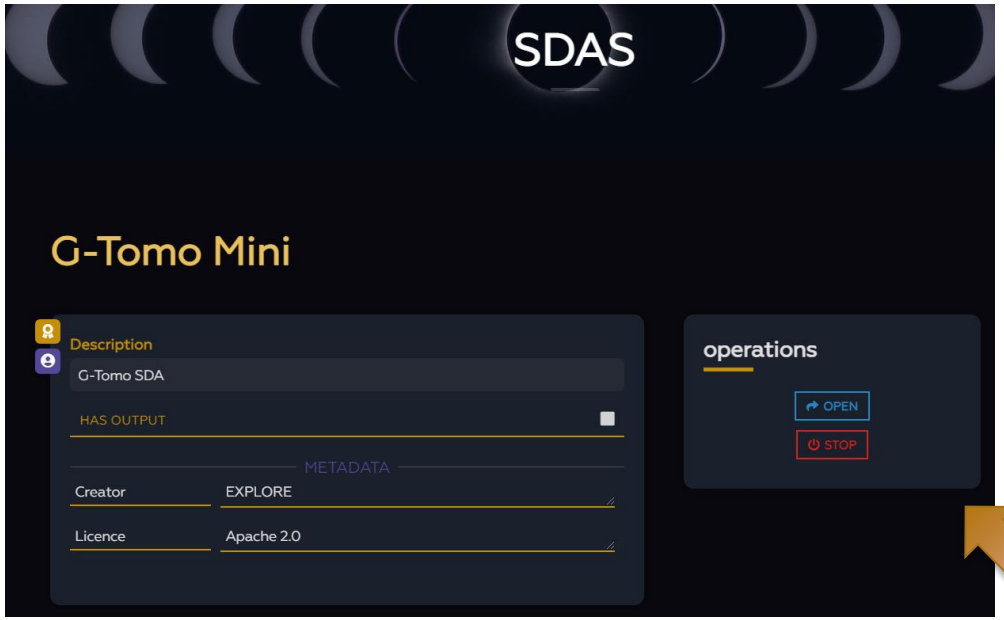
EXPLORE **dev/test** platform for SDA (with limited resources 👥&🖥)

Beyond project EXPLORE platform could offer **bespoke niche services**

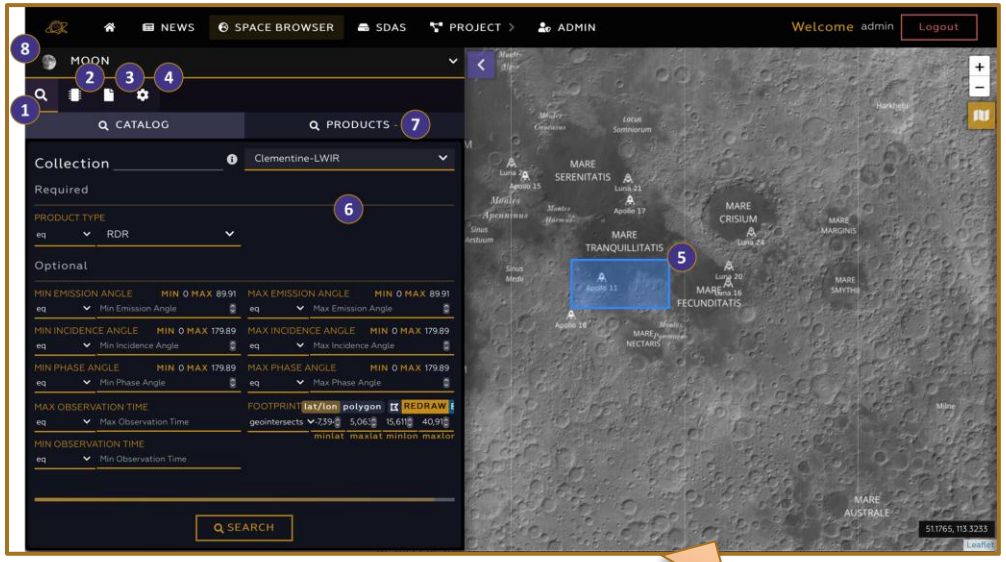
EXPLORE

EXPLORE dev platform

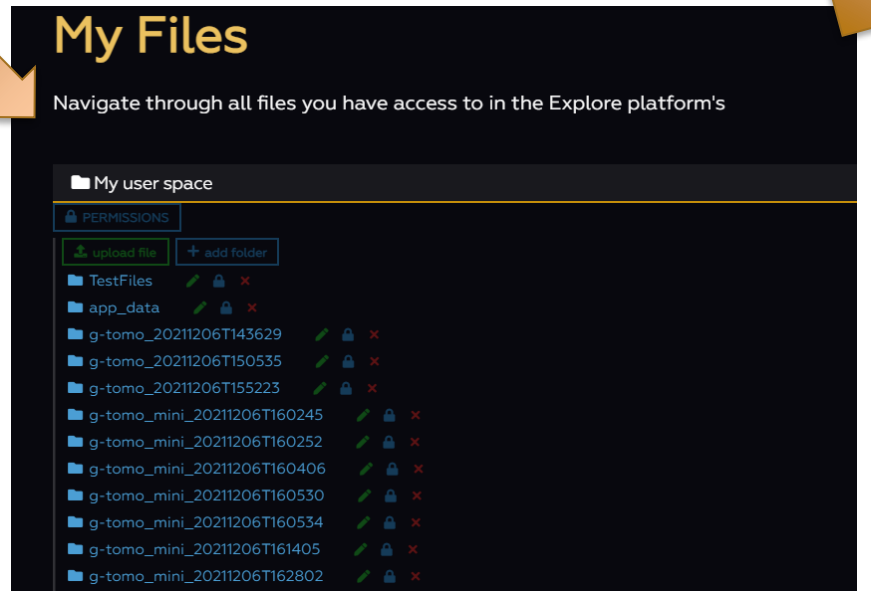
Applications

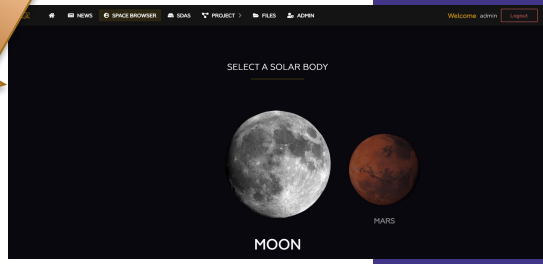


Space browser



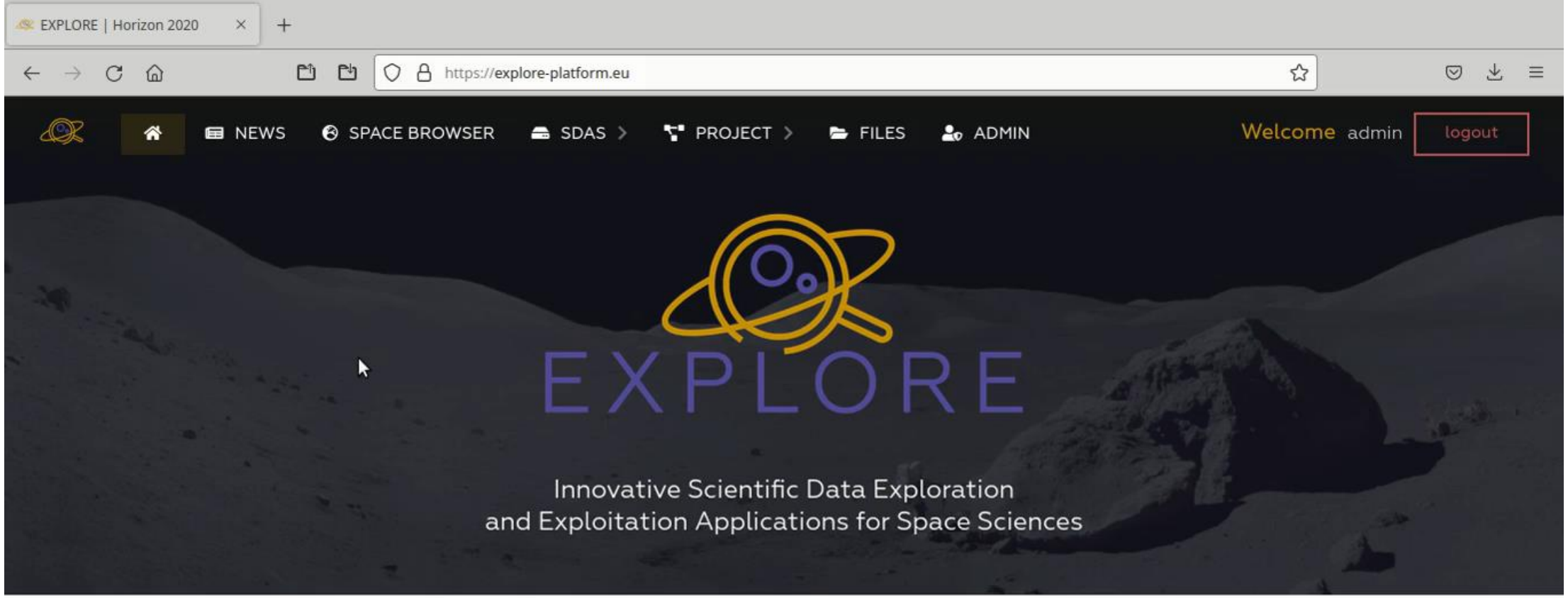
User workspace





https://explore-platform.eu

EXPLORE



GOAL

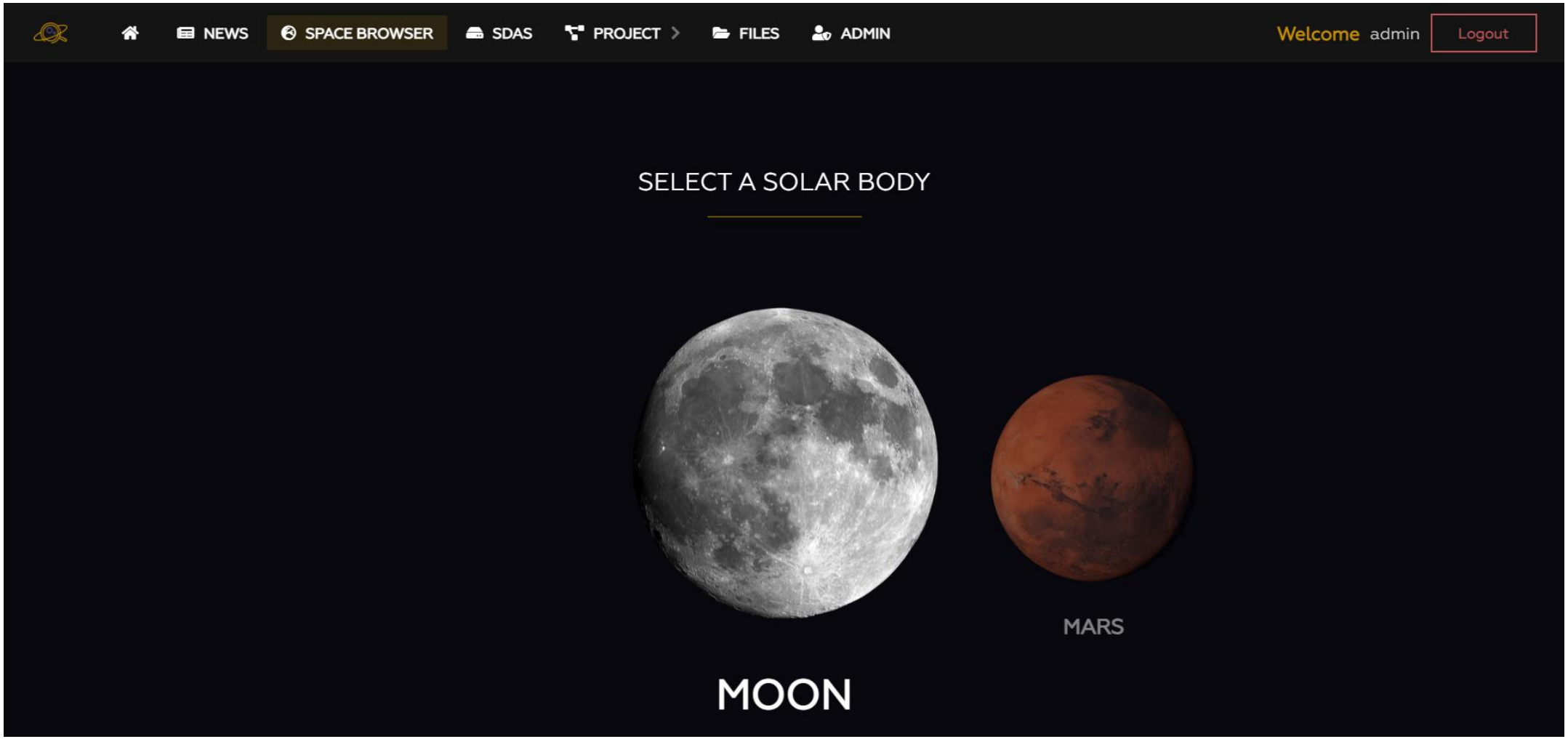
Advance the exploration and exploitation of European space science data

TEAM

8 international partners, including SMEs, academic institutions and research & outreach centres

OUTCOME

6 Scientific Data Applications for space sciences powered with state-of-the art AI and Visual Analytics deployed on cloud platforms


NEWS
SPACE BROWSER
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SELECT A SOLAR BODY
MARS
MOON

EXPLORE

MOON

CATALOG | PRODUCTS -

Collection

Clementine-LWIR

Required

PRODUCT TYPE

eq | RDR

Optional

MIN EMISSION ANGLE MIN 0 MAX 89.91

eq | Min Emission Angle

MAX EMISSION ANGLE MIN 0 MAX 89.91

eq | Max Emission Angle

MIN INCIDENCE ANGLE MIN 0 MAX 179.89

eq | Min Incidence Angle

MAX INCIDENCE ANGLE MIN 0 MAX 179.89

eq | Max Incidence Angle

MIN PHASE ANGLE MIN 0 MAX 179.89

eq | Min Phase Angle

MAX PHASE ANGLE MIN 0 MAX 179.89

eq | Max Phase Angle

MAX OBSERVATION TIME

eq | Max Observation Time

FOOTPRINT lat/lon polygon REDRAW

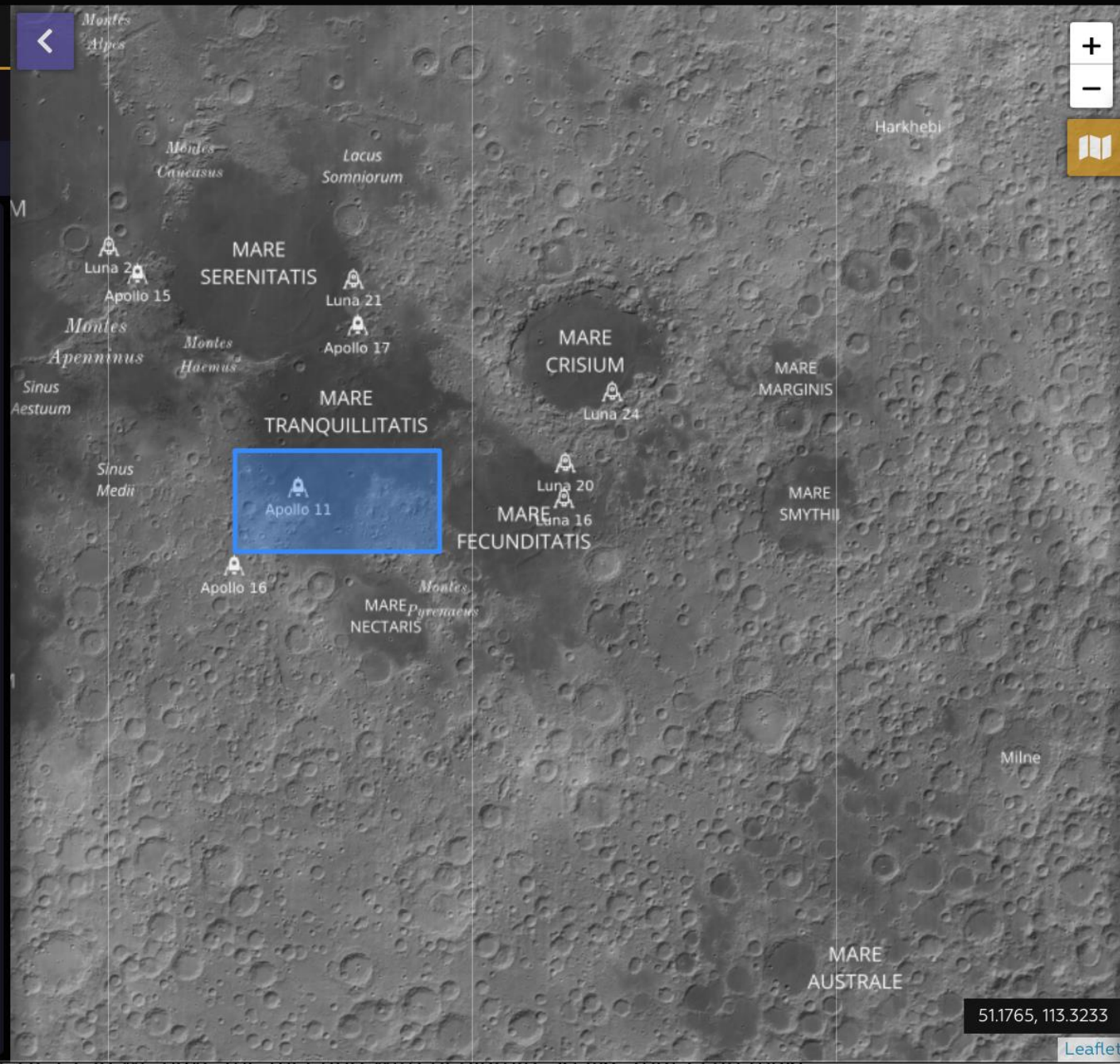
geointersects -7,39 5,06 15,611 40,91

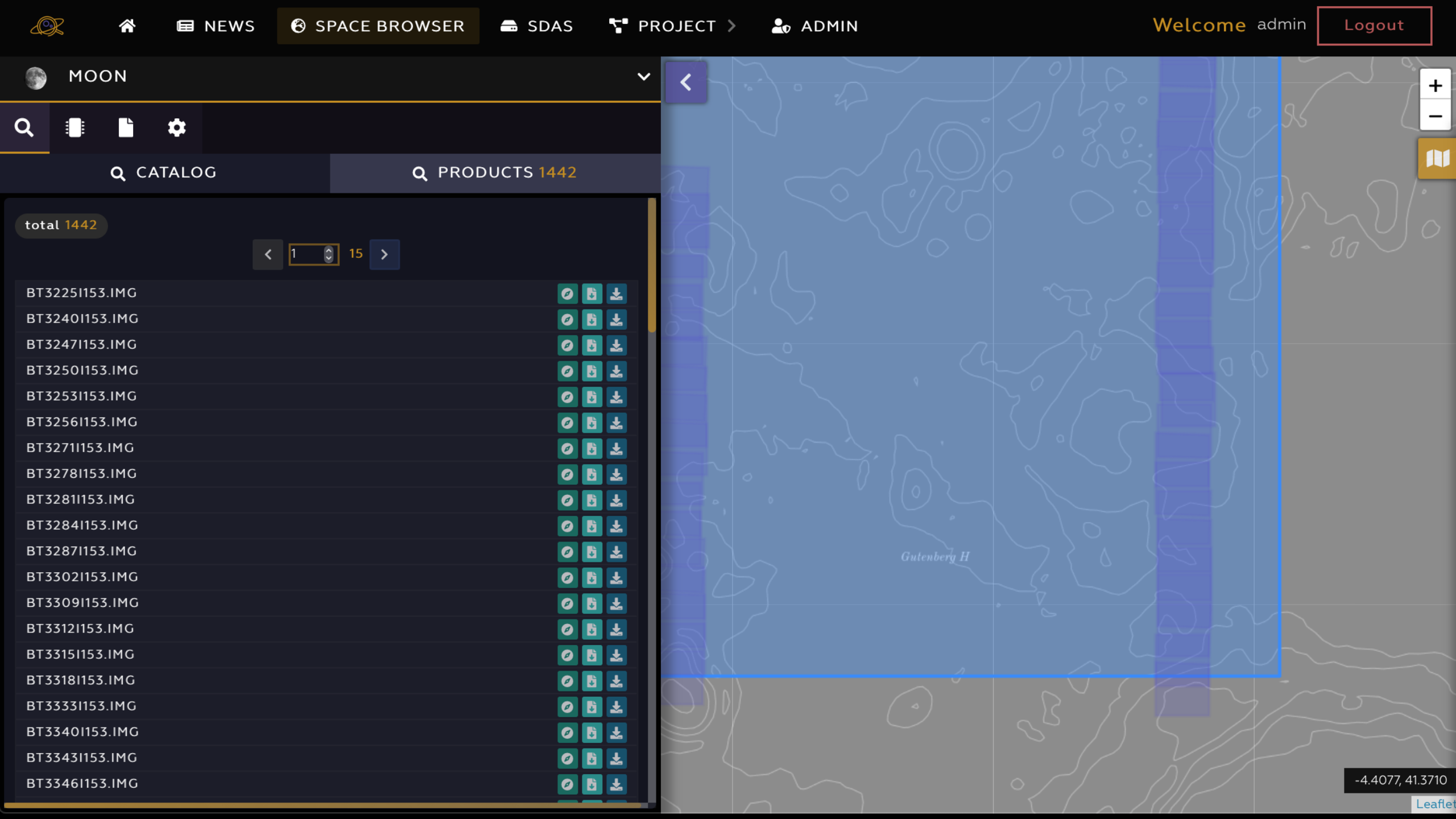
minlat maxlat minlon maxlon

MIN OBSERVATION TIME

eq | Min Observation Time

SEARCH

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Leaflet

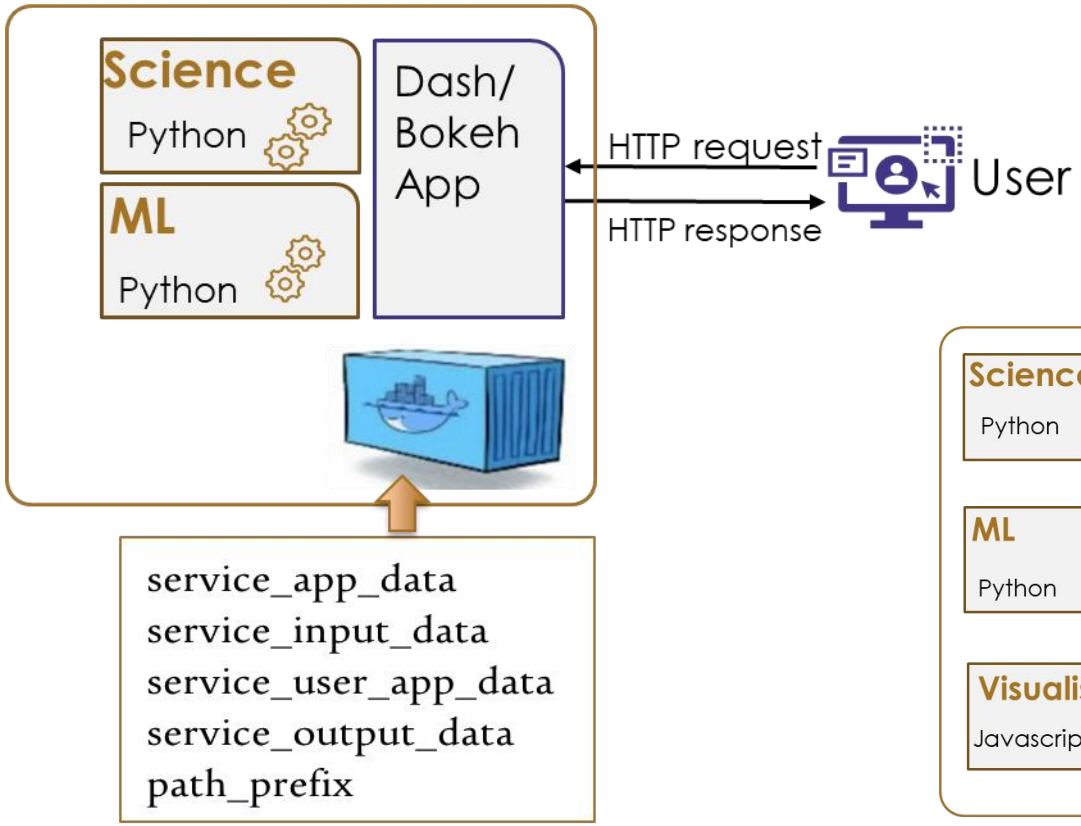
Scientific Data Applications (SDAs)?

- Applications / tools for scientific data exploration, visualisation, analysis
- Deployed on science 'cloud' platforms and accessed through a web frontend interface (UI) or API.
- Let users interact remotely with data (bringing the users to the tools and data rather than bringing the tools/data to the user)
- Container approach to create, deploy, and share open-source, interoperable SDAs
- SDAs to demonstrate and promote, leading by example, space science exploitation and uptake of science platforms.

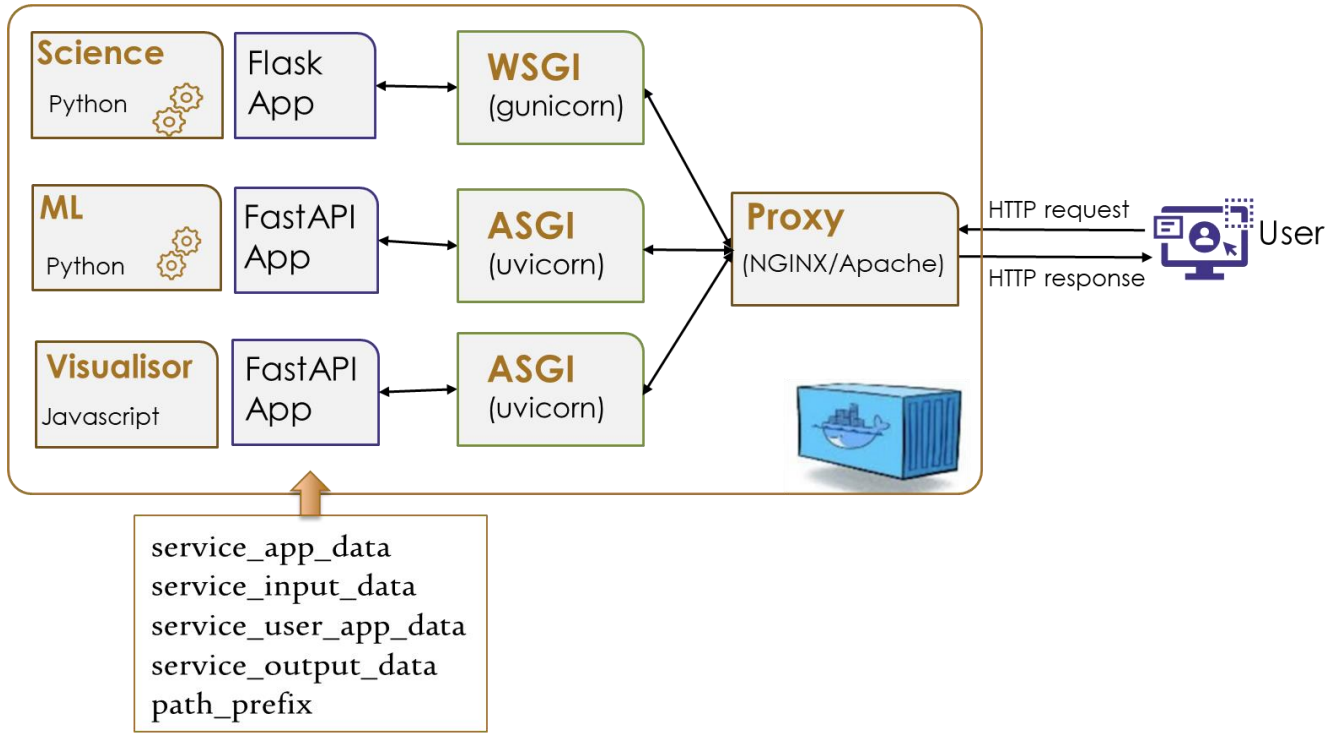
EXPLORE

Scientific Data Applications

Single-service SDA

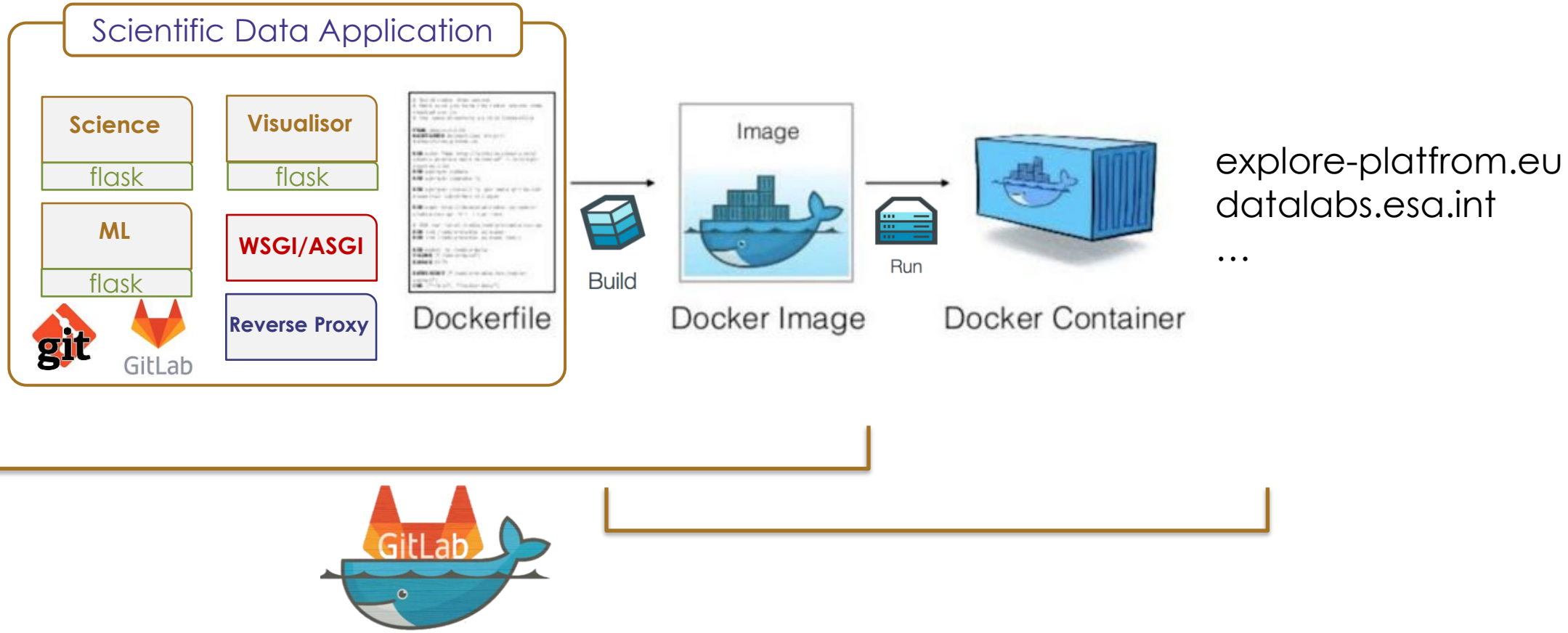


Multi-service SDA



EXPLORE

SDA ‘dev-build-deploy’ process

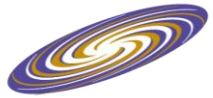


EXPLORE

Scientific Data Applications

Led by Science Experts

G-Arch: *Galactic Archaeology* OBSERVATOIRE DE LA CÔTE D'AZUR UNIVERSITÉ CÔTE D'AZUR



G-Tomo: *Galactic Interstellar Tomography* ACRI ST

S-Phot: *Stars and their Blue/Red Excess* MANCHESTER 1824 The University of Manchester

S-Disco: *Spectral Discovery for Stars* TEL AVIV UNIVERSITY Pursuing the Unknown

L-Explo: *Exploring the Moon with multi-scale data* JACOBS UNIVERSITY

L-Hex: *Lunar Human Exploration tools* JACOBS UNIVERSITY

EXPLORE

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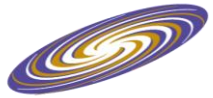

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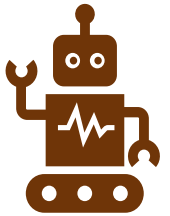

A.I. methods

TEL AVIV UNIVERSITY אוניברסיטת תל אביב

H.I. methods

KNOW Center

EXPLORE

Scientific Data Applications

Led by Science Experts

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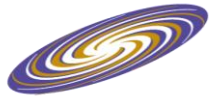

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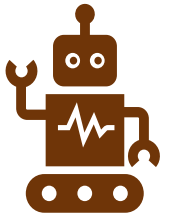

A.I. methods

TEL AVIV UNIVERSITY אוניברסיטת תל אביב

H.I. methods

KNOW Center

EXPLORE

Science Archives

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Cloud Deployment

Scientific Data Applications

Led by Science Experts

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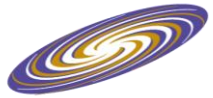

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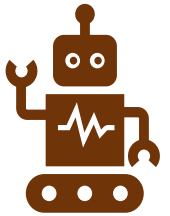


A.I. methods

TEL AVIV UNIVERSITY אוניברסיטת תל אביב

H.I. methods

KNOW Center

EXPLORE

Science Archives

adwäisEO

Cloud Deployment

Objectives L-Hex and L-Explo

- **Provide access to relevant higher-level data** from Lunar orbital missions

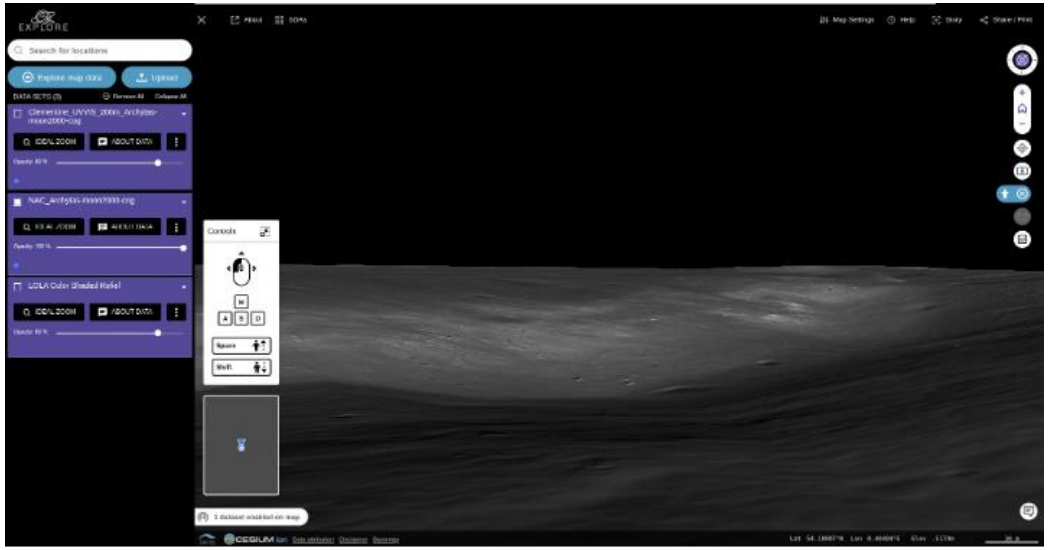
- **Allow analytical operations** (e.g. i**mage visualisation, colour-composites**, hyperspectral summary products, spectral indexes visualisation or generation

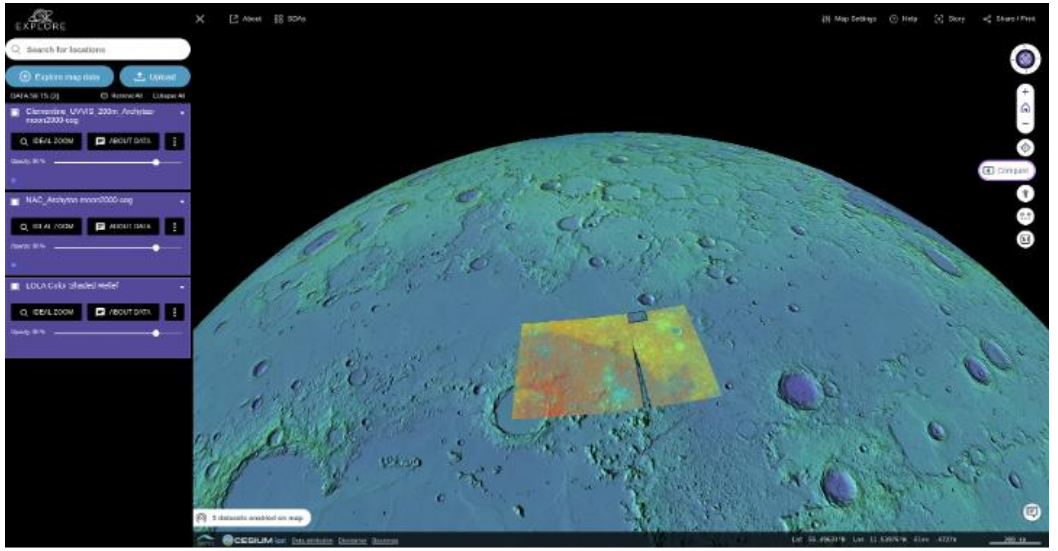
- **Provide functionality for building workflows** (e.g. from data selection, gathering, visualisation, analysis, export e.g. to GIS systems)

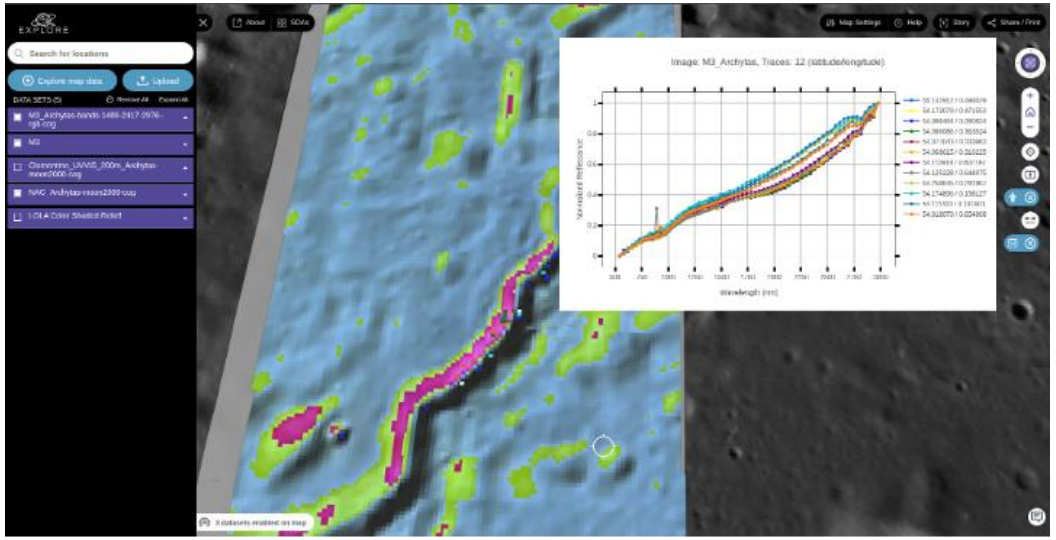
- **Support surface mapping tasks**, including geologic mapping (e.g. via data export and embed in external mapping workflows)

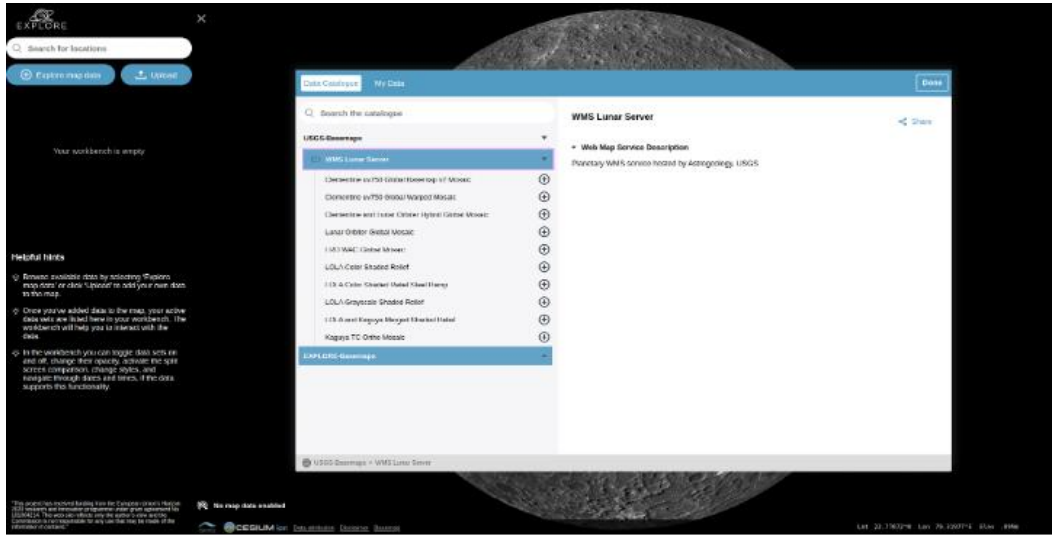
EXPLORE

Lunar SDAs (L-Explo & L-HEX)









Frontend based on TerriaJS and Cesium

SDA – L-Hex and L-Explo

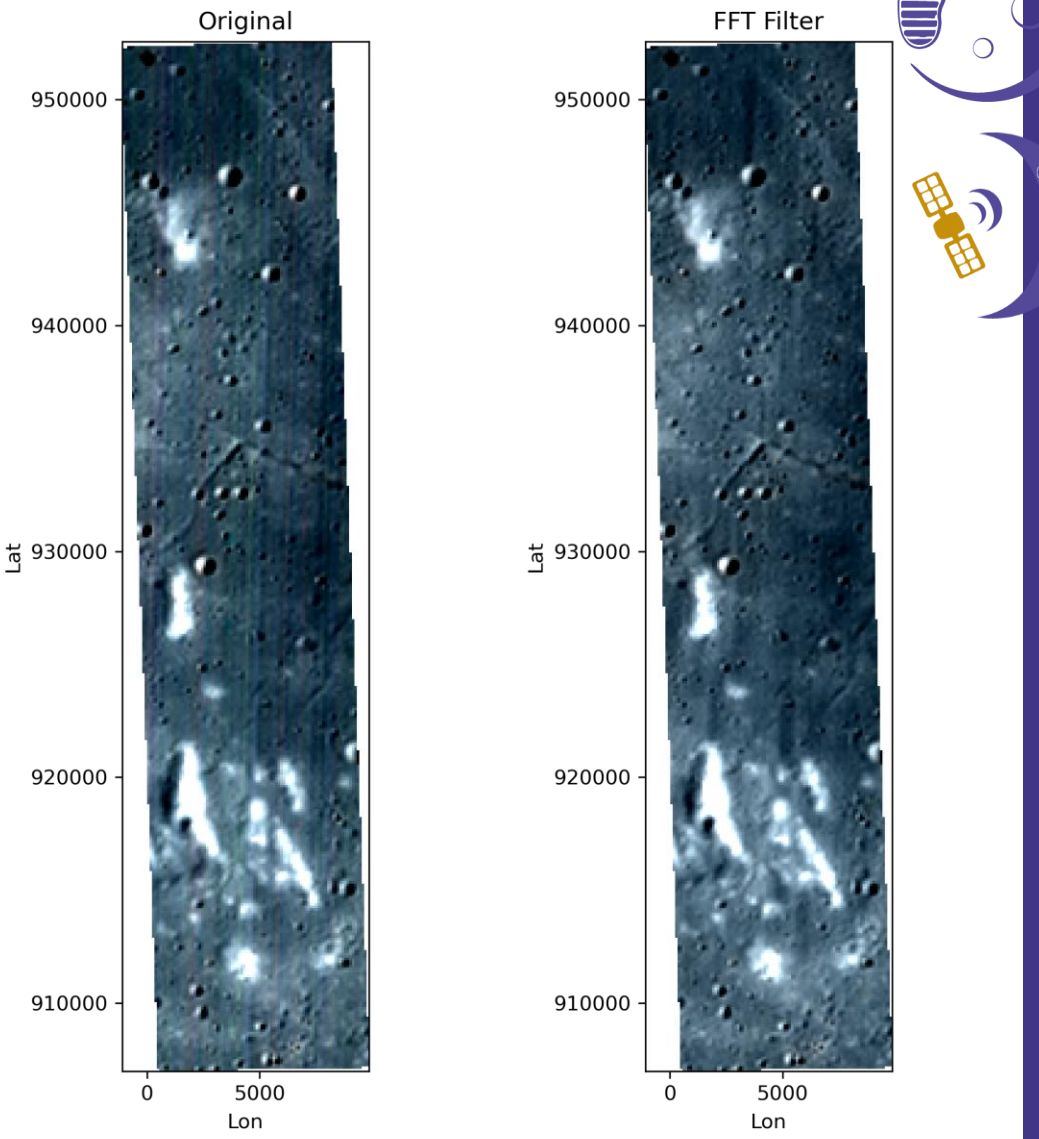
Integrated processing tools:

- **Spectral Profile tool** → API →
  retreive spectral profile of M3 data at user's clicked coordinates (UI under implementation)

- **Spectral Band Compositions** → API →
  create RGB type images from user's selected wavelenghts (UI under implementation)

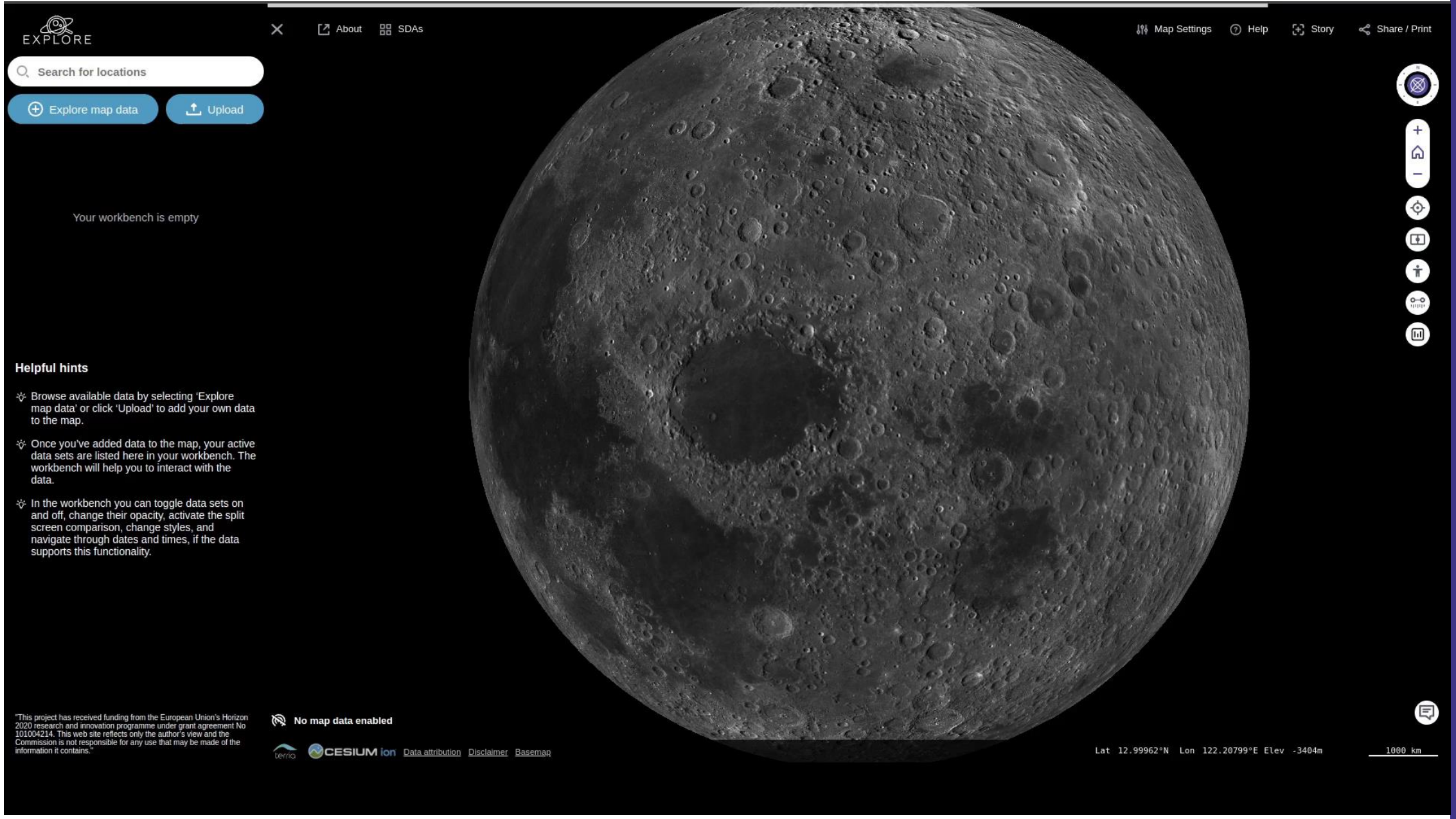
- **Spectral Index** → API →
  create specific spectral indexes from a predefined list or custom user's input (Under Development)

- **Spectral Advanced filtering** → API →
  process M3 data and perform advanced filtering such continuum removal



Before and after inverse FFT transform to remove vertical stripes clearly visible in the left image. See Shkuratov et al, 2019

EXPLORE


EXPLORE
About
SDAs
Map Settings
Help
Story
Share / Print
Search for locations
Explore map data
Upload
Your workbench is empty
Helpful hints
Browse available data by selecting 'Explore map data' or click 'Upload' to add your own data to the map.
Once you've added data to the map, your active data sets are listed here in your workbench. The workbench will help you to interact with the data.
In the workbench you can toggle data sets on and off, change their opacity, activate the split screen comparison, change styles, and navigate through dates and times, if the data supports this functionality.
"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004214. This web site reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains."
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Disclaimer
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EXPLORE

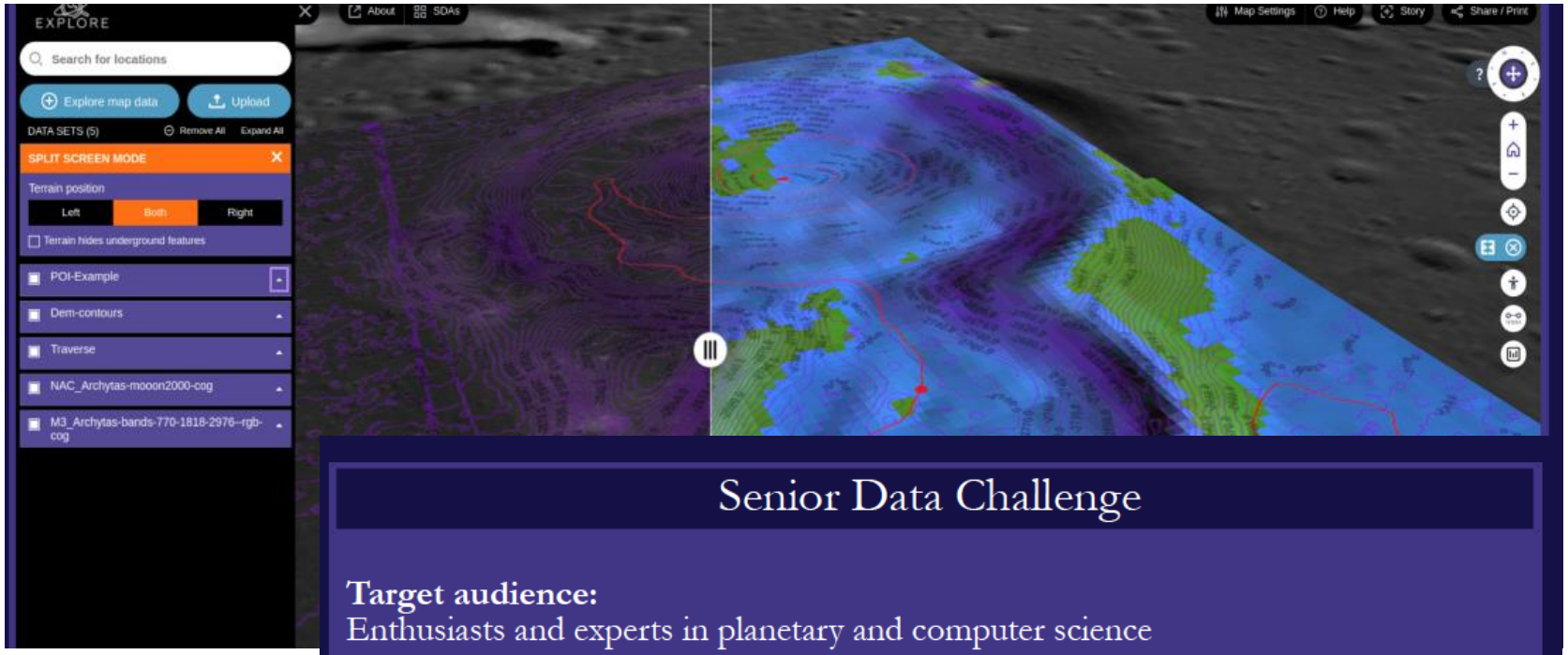
EXPLORE DATA CHALLENGES

Advancing the exploration and exploitation of European space science data.

Explore Data Challenges

The EXPLORE Data Challenges aim to raise awareness of Scientific Data Applications (Apps) produced by the EXPLORE project, and to improve the accuracy of the Apps by harnessing expertise from other data analysis fields.

Senior Data Challenges



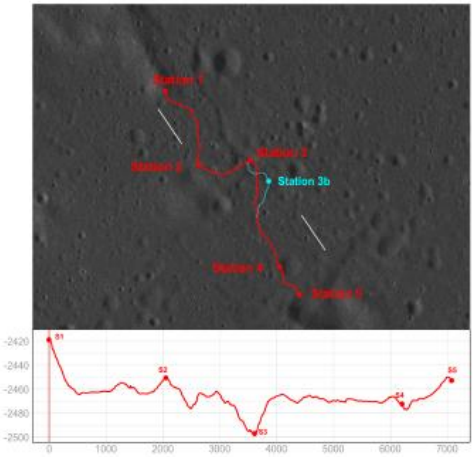
Senior Data Challenge

Target audience:
Enthusiasts and experts in planetary and computer science

Objectives:
- Train Machine Learning models and use them to detect and map relevant features (e.g., Craters, Rilles, Mounds)
- Design an optimal traverse for a manned or unmanned exploration rover, possibly using Machine Learning (e.g., Reinforcement Learning) [2-3]

Materials

Basemaps, Digital Elevation Models, Hyperspectral data, targets of interest, example traverse, processign scripts.



Station	Objectives
1	Collect samples of the Kipuka rocks.
2	Collect samples of the possible cinder cone.
3	Test the ability of the rover to cross steep terrains. Recover samples at the bottom of the rille.
3b	Alternative sampling path and station in case the rover cannot cross the terrain.
4	Collect impact breccia at the edge of the crater.
5	Take samples at the rim of the round feature.

Figure 3. Example of traverse, including alternative route and a descriptions of the tasks performed in the points of interest.

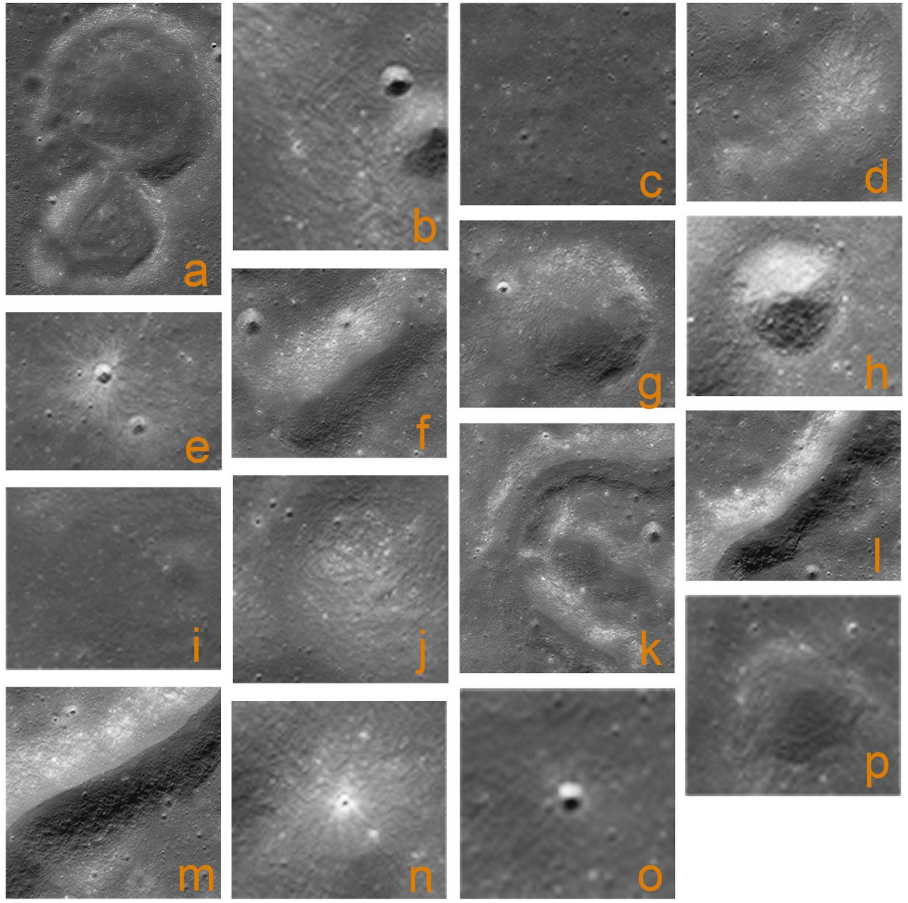
EXPLORE

Junior Data Challenges

EXPLORE-ing the Surface of the Moon

Activity 1: Pattern Recognition

- Can you sort these images into groups based on which look similar?
- Once you've done this, what do you think the images in each group are showing?



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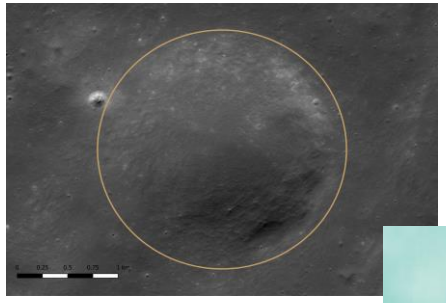
Junior Data Challenges

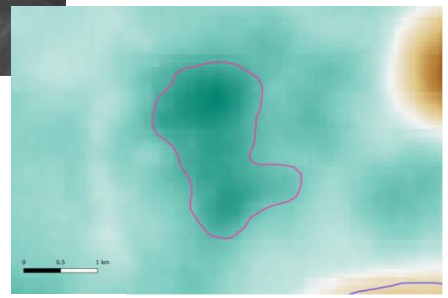
EXPLORE-ing the Surface of the Moon

Activity 2: Identifying Features on the Moon

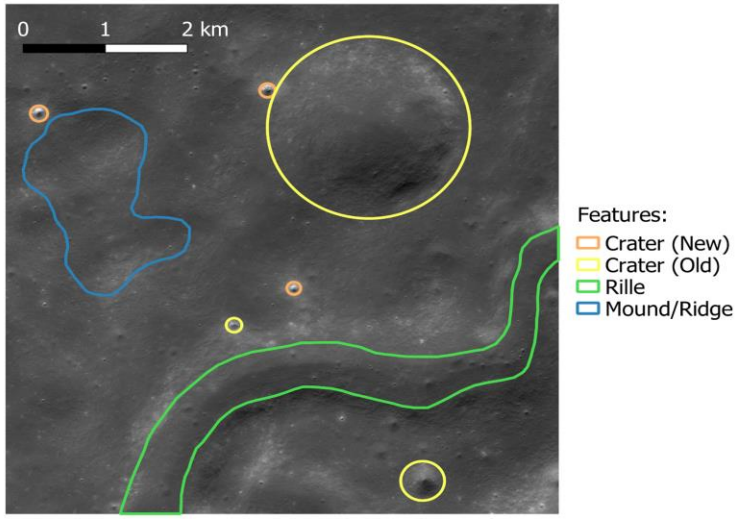
- In this activity, you are tasked with identifying features on the surface which could be a hazard for a future rover mission!
- You will be shown some real images taken by a satellite in orbit around the Moon called the Lunar Reconnaissance Orbiter



Old/Eroded Craters



Mounds / Ridges



EXPLORE

EXPLORE

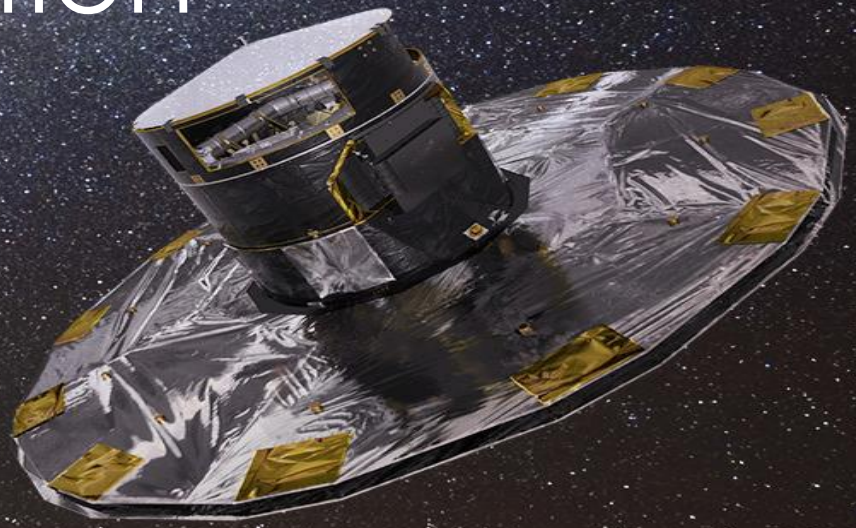
Thank you for your attention

More info on:

explore-platform.eu

Get in touch:

contact@explore-platform.eu



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