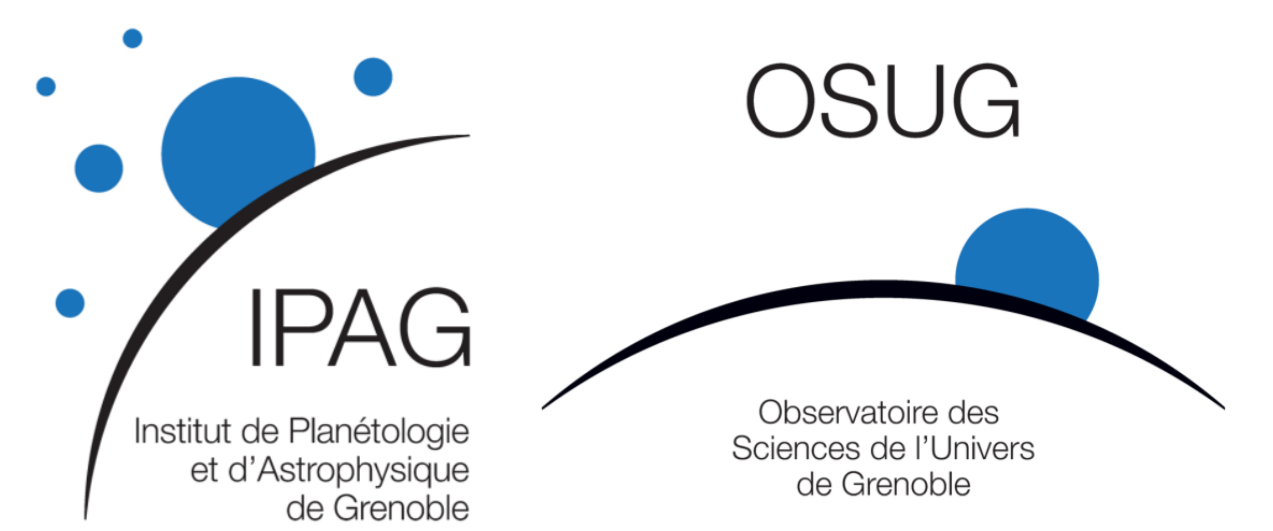# SSHADE: THE EUROPEAN SOLID SPECTROSCOPY DATABASE INFRASTRUCTURE

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Introduction

Spectroscopy and spectro-imagery are increasingly used in space missions towards planets and small bodies, **including the Moon** (NIR/Clementine, SIR/Smart-1, MI/Selene-Kaguya, SIR-2 and M3/Chandrayaan-1, IIRS/Chandrayaan-2, …), to study the solid phases at their surface (ices, minerals or organic materials).

- **Infrared, Raman, fluorescence and X-rays micro-spectroscopies** are also used to study **planetary materials,** such as Lunar samples, meteorites and cometary dust, in the laboratory and onboard some space missions (landers, rovers).
- A major contribution to the analysis of these observations is the **measurement in the laboratory of UV, Visible, IR, sub-mm, Raman and XANES spectra of a variety of or synthetic materials** expected to be present at the surface of the bodies of the solar system or in their ejected grains (e.g. comets, asteroids, Pluto, Mars, the Moon, …).

Solid spectroscopy data in Europe

A large number of laboratories in Europe have developed experiments to measure and study the spectroscopic properties of a variety of solid materials of astrophysical interest, either natural (terrestrial or extra-terrestrial) or synthetics.

- **The amount of data collected is huge** and many of these **laboratories boast leading-edge expertise in some solid spectroscopy fields**. However most of the published data are very difficult to access in a usable form (i.e. electronic) to compare with observations or to use in radiative transfer codes.

➢ We thus decided to extend our datamodel of solid spectroscopy (SSDM) and expand the GhoSST database (http://ghosst.osug.fr) to **build a database infrastructure able to gather and distribute the spectroscopic data of most of the European laboratories** working on solids with astrophysical and terrestrial applications.

## What is SSHADE?   *https://www.sshade.eu*

SSHADE ("Solid Spectroscopy Hosting Architecture of Databases and Expertise") is a project of a **set of databases on solid spectroscopy** that started its development in September 2015 and is now **open to the community since 5th February 2018**.

The **SSHADE databases** cover laboratory, field and simulated spectral data including **various levels of products** (transmission, reflectance, optical constants, band list, …)
- ✓ **for many different types of synthetic, natural and extraterrestrial solids**: ices, snows and molecular solids, minerals, rocks, inorganic solids, natural and synthetics organic and carbonaceous matters, meteorites, IDPs and other cosmo-materials,…
- ✓ They come **from a wide range of measurement technics**: transmission, bidirectional reflection, Raman, fluorescence, microscopy…
- ✓ **over a wide range of wavelengths**: X-rays, UV, visible, infrared, mm to radio

Solid planetary materials in SSHADE

- ✓ **Ices**, hydrates, clathrates, … + irradiation
- ✓ **Organic solids**: simple, macromolecular materials, polymers, …
- ✓ Rocks, **minerals**, salts, hydrated materials, adsorption, …
- ✓ Other compounds (sulphur compounds, …) + irradiation
- ✓ Extraterrestrial samples (meteorites, IDP's, Stardust grains, **Lunar soils/rocks**…)

Ices (UV)   Organic solids (MIR)   Hydrated minerals (NIR)   Meteorites (MIR)

The SSHADE Projet and Consortium
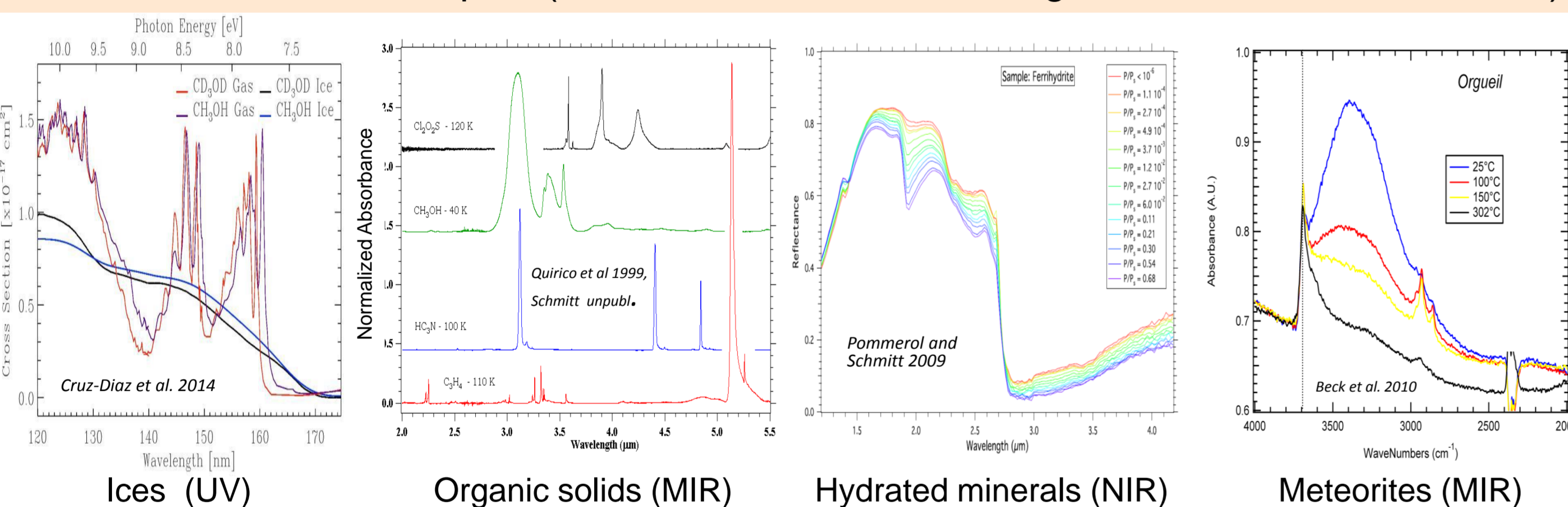
The SSHADE project, based on the GhoSST database developments (Europlanet-RI + VAMDC 2009-2012) is **part of the VESPA activity within the European e-infrastructure Europlanet 2020-RI** of the Horizon 2020 program (2015-2019).
- ✓ The SSHADE infrastructure is hosted at OSUG Data Center (Univ. Grenoble Alpes).

The SSHADE consortium has currently **23 partner groups** in **21 laboratories** from **10 different countries** (F, UK, I, D, E, HU, PL, CH, IN, TW). Information about this project can be found in the SSHADE wiki: *http://wiki.sshade.eu*

SSHADE Infrastructure

The SSHADE infrastructure has:
- A common data model: SSDM
- A common 'solid spectroscopy' interface
- A common **Import / Search / Visualization / Export engine**
- A common fundamental database (species, phases, publications, objects, …)
- A set of spectral databases: one per group/laboratory (GhoSST is one of them)

SSHADE Databases implementation

We are progressively implementing in the SSHADE infrastructure the databases of each of the 23 partners of the SSHADE consortium.
- ✓ **12 databases are already active** in SSHADE, and **over 1400 spectra are already online** (from 200 experiments on over 1100 samples).
- ✓ A **'band list'** database of molecular solids will soon complement the spectral data..

SSHADE interface : search tool

A user can search **either spectral data or publications** through two distinct forms:
- ✓ a simple 'Google-style' search tool
- ✓ a number of specialized filters to refine the search.

For the spectral data he can filter his search according to a series of topics:
- ✓ by experiment, by instrument parameters, by environment, by extraterrestrial object, by sample, by composition and/or by publication.

https://www.sshade.eu
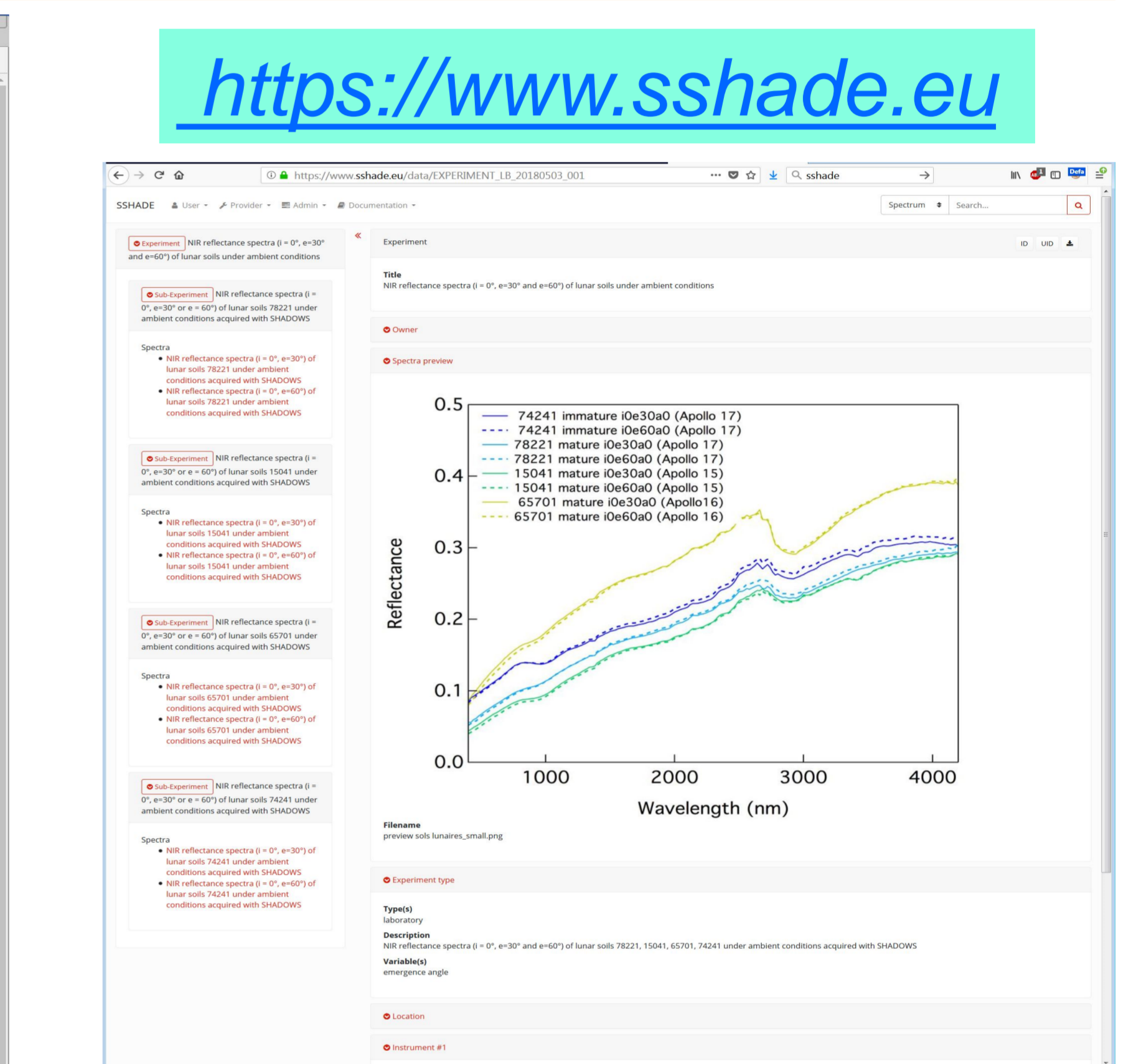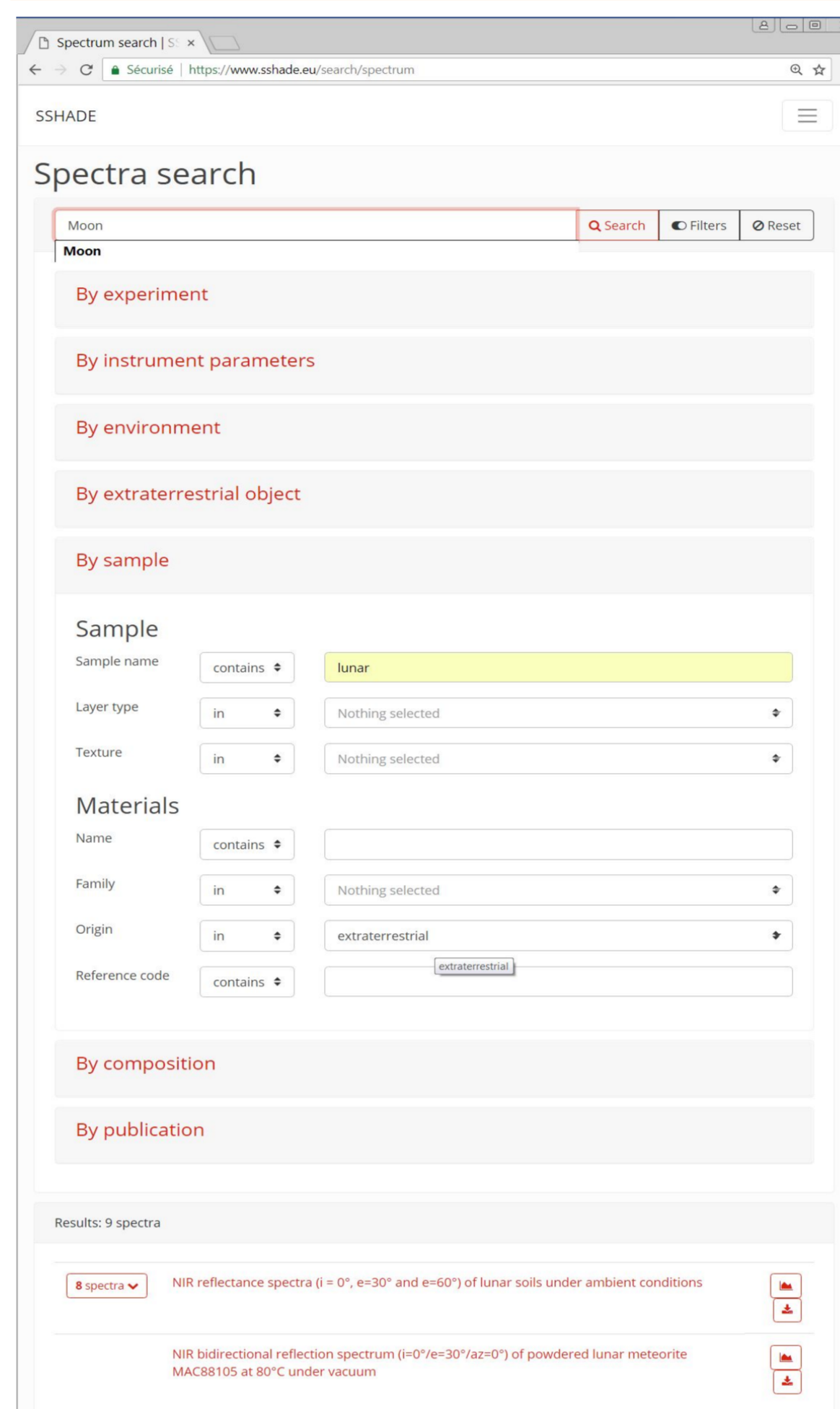
SSHADE search tool for spectra

4 Lunar soils (Apollo 15, 16, 17) *Experiment with Near-IR reflectance spectra at 2 angles*

SSHADE Interface : Display tool

- ✓ The user can select and visualize a spectrum. A page displays the **experiment/spectra** and the **sample/layer/material/constituent(s) structures**.
- ✓ The page also display a **preview of the spectrum** together with the main information on the spectrum and on the measured sample.
- ✓ The user can **visualize the spectrum interactively** or have a look at the detailed information on the experiment or on any element of the sample structure.
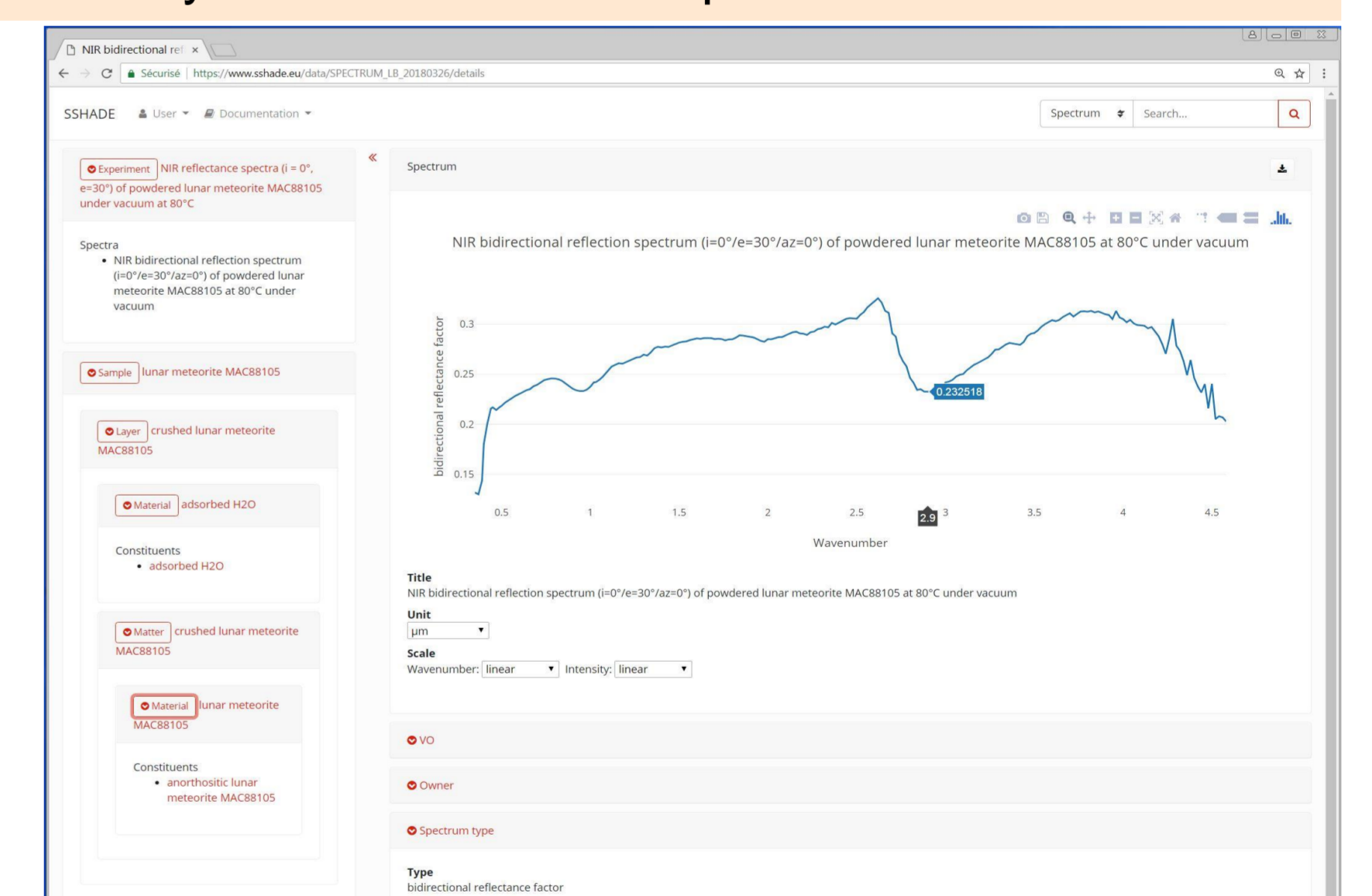

Lunar meteorite (MAC88105)

*Experiment structure
+
Sample structure
+
Interactive spectrum
+
Spectrum information*

SSHADE Interface : Display tool & Export

- ✓ At each level of the experiment or sample structure a page contains **all the relevant parameters** values with **various links**:
  - ▪ to another level of the structure,
  - ▪ to other information stored in SSHADE (such as publications)
  - ▪ to external web pages (Wikipedia, WebMineral…)
- ✓ The users can **download a spectrum or an experiment** from the export page.
- ✓ The users may also add a spectrum or experiment in his 'dashboard' for future export.
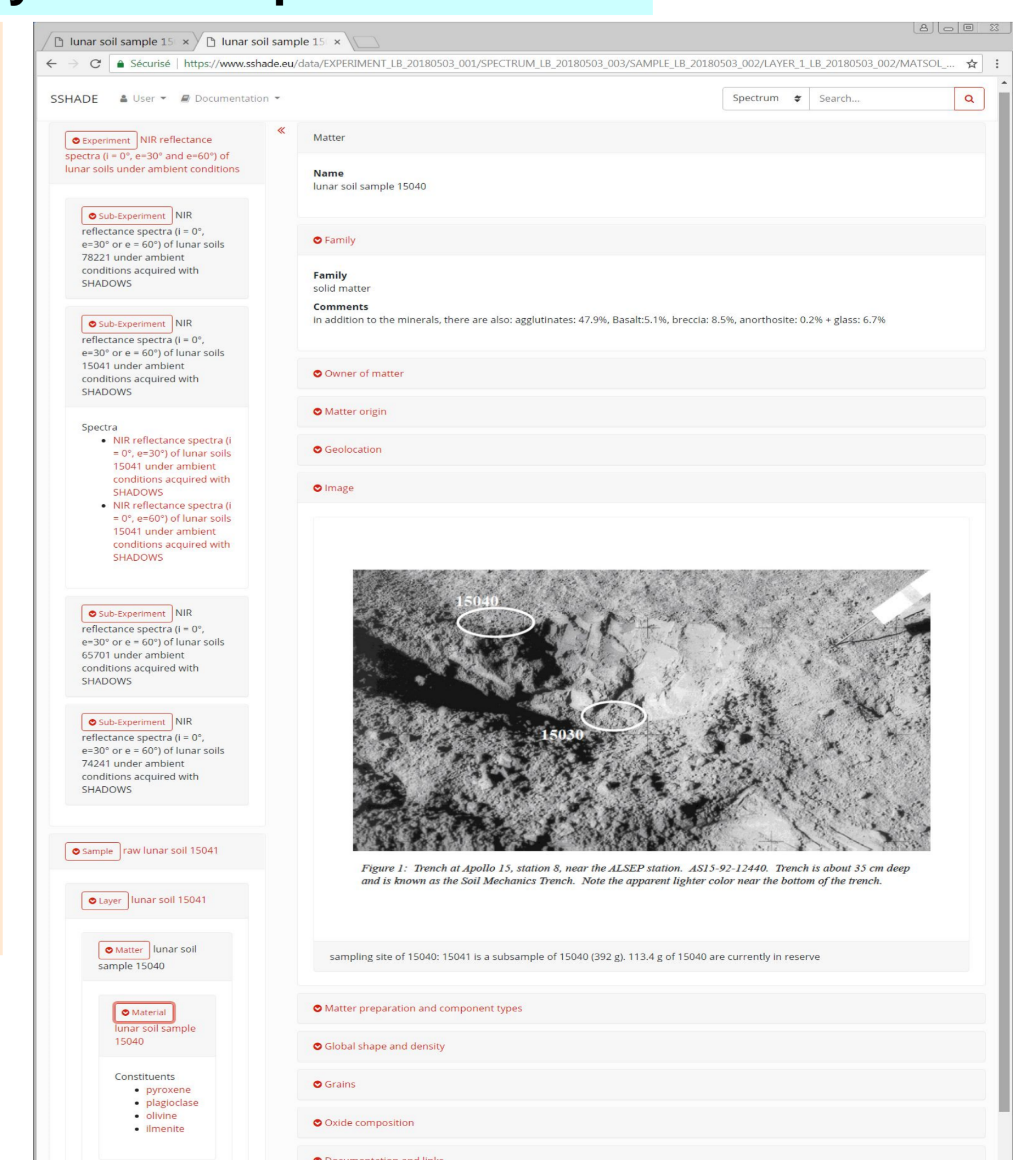
Lunar soil 15041 (Apollo 15) *Experiment structure + Sample structure + Detailed information*