

# FARSuN

## Findability and Accessibility of historical (1610-1980) Raw Sunspot Numbers

**DURATION**  
 1/02/2023 - 1/05/2027

**BUDGET**  
 499 816 €

### PROJECT DESCRIPTION

The FARSuN project is centered on historical sunspot collections, a heritage of national and international origin, on which the World Data Center SILSO (<https://www.sidc.be/SILSO/home>) deploys its expertise within an international network of collaborators.

**Context:**

Visual sunspot observations go back to the beginning of the seventeenth century (1610) and are used to form the only indicator of solar activity on the long-term: the international sunspot number. The farther we go back in time, the more complex it is to find and understand sunspot data. Despite being at the center of a series of workshops (SSN workshops, ISSI team) over the last 10 years, which led to a recalibration of the series (cf. topical issue of Solar Physics), the corresponding historical data are still largely scattered: some have been digitized, some have been scanned but not digitized yet, some have been published in articles by various teams over time, and some are still in archives or personal collections. In order to be able to reconstruct this crucial long-term index we need to gather all these scattered data and make it easily findable and accessible for a larger scientific exploitation.

**Objectives:**

The goal of this project is to make the identified raw sunspot data Findable and Accessible through the determination of common criteria submitted to a validation by the scientific community and the inclusion into an existing Virtual Observatory (VO). This standardization process aims at filling a gap that does not allow experts in statistics to use this specific data (with a lot of gaps, few overlap between observers, sparse data, inhomogeneous quality, changes in observing techniques, etc...) without the intervention of a data expert. We will transform the solar data expertise dimension into a set of common criteria that will be used as metadata for the historical sunspot data.

**Methods:**

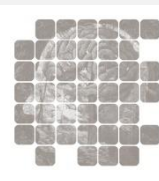
The project is organized around 4 axes: (1) gathering data sources, (2) processing the data support when necessary (3) validating data by adding homogeneous metadata and (4) disseminating the data.

**Dissemination:**

The data gathered and homogenized through this project will be made accessible via virtual observatory to everyone. In addition to that, a call for additional data will be extended to the public from Belgium and over the world through a citizen science project.

**Expected impact:**

Making these raw historical sunspot data collections findable and accessible will strengthen the activities led by the World Data Center SILSO at the Royal Observatory of Belgium, increase the visibility of this key dataset, and thereby improve the sustainability of the Belgian leadership in this area and its international recognition. It will also enhance social cohesion through awareness of the general public.



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## Expected Results:

Apart from the methods of reconstructions, a validation of all existing datasets in an homogeneous way is currently missing. Many archives are still unused precisely because they lacked this added value. The output of this project will enable the whole scientific community to readily find and use all raw sunspot data with an expert eye included. At the end of the project, we will be able to try and apply existing methods to the dataset, and achieve for example gap-filling, using for example singular value decomposition (Dudok de Wit, 2011) or combinations of data using tied ranking (Dudok de Wit: ISSI workshop), or matrix correlations (Usoskin et al., 2016).

The primary outcome of the project will be a verified catalog of sunspot data over a period of four centuries, with quality and uncertainty measures on the quantity of interest.

This compilation of historical sunspot numbers will be made available via standard VOTools defined by the IVOA. This will allow this catalog to be Findable (through EPN-TAP services registered in the IVOA Registry) and Accessible by query from a variety of TAP clients. In addition, other EPN-TAP services will be able to access the data, making them Interoperable while the rich catalog metadata will allow the data to be Reusable, i.e. it will be FAIR-compliant (<https://www.force11.org/group/fairgroup/fairprinciples>).

The SILSO team, and more largely the team in the department of solar physics and space weather of the Royal Observatory of Belgium, will gain in the process of making the data FAIR an expertise on international standards available for describing metadata and for accessing the data.

The project will create awareness on historical sunspot data, in particular within astronomical clubs, students in natural sciences, and interested citizens.

An important iteration is the reconstruction of the ISN aiming at a better understanding of the long-term evolution of the solar input on the Earth atmosphere (ERB) that will be invaluable for the study of the past and future evolution of the Earth climate.

The first complete consistent reconstruction of the historical HSN numbers. The importance of the HSN series was demonstrated in Veronig et al (2021), who confirmed that the solar cycle evolves independently in the two hemispheres. Empirical solar cycle prediction methods could therefore be improved by investigating the solar cycle dynamics in terms of the HSN evolution.

## CONTACT INFORMATION

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## LINKS

<https://www.sidc.be/FARSuN>