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TELESCOPIC NAZIONALE GALILEO

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Abstract

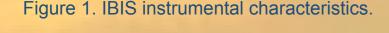
We review the efforts undertaken to set up an archive of ground-based solar spectro-polarimetric observations into the VO framework according to the SOLARNET standards as well as its web interface, by using IBIS data, SOAP/XML and RESTful Web Services and a Usage-Centered Design approach.

The **IBIS** (Interferometric Bldimensional Spectropolarimeter, Cavallini 2006, Solar Physics 236, 415) is a high cadence imaging spectro-polarimeter based on a dual Fabry-Perot interferometric system. Fig.1 summarises the instrumentl characteristics of the IBIS. The IBIS, which has been constructed by a consortium of Italian institutes, is installed at the Dunn Solar Telescope at NSO/Sacramento Peak, USA. The instrument allows for **spectro-polarimetric observations of the solar photosphere and chromosphere at high spatial, spectral, and temporal resolution.**

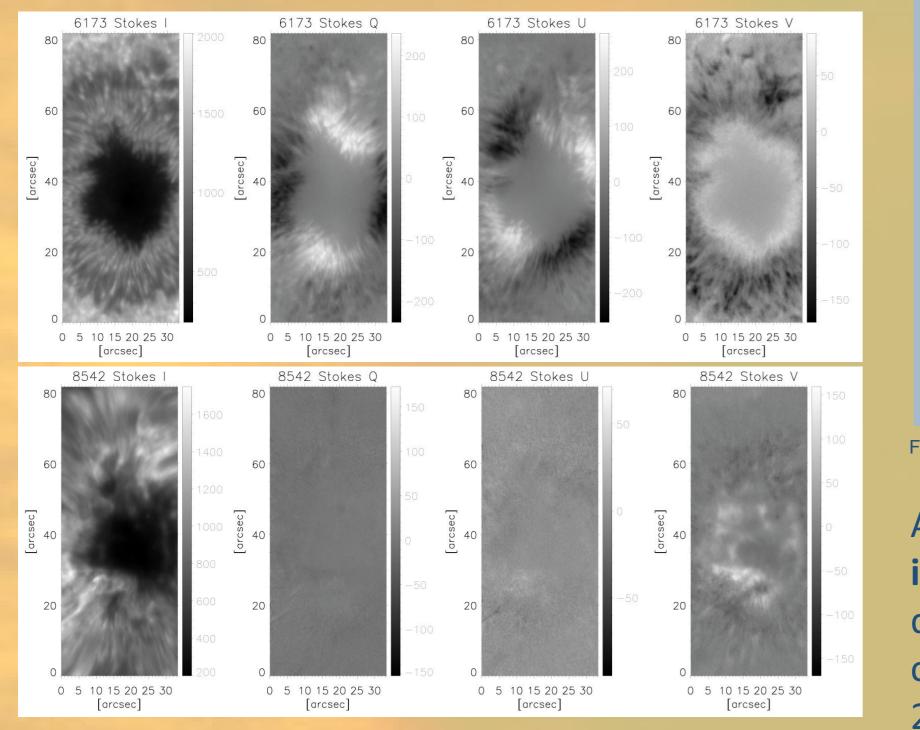
IBIS data

Spatial Resolution	\leq 0.18 arcsec
Spectral Resolution	212 000 - 274 000
Temporal Resolution	3 images s ⁻¹
Field of View	45 x 85 arcsec
Operating Range (λ)	2800 Å (5800 - 8600 Å)
Available Wavelengths	5896 Å Na D1 6302 Å Fe I 7090 Å Fe I 7224 Å Fe II 8542 Å Ca II
Range Width	2.0 Å (5800 Å - 7500 Å) 3.5 Å (7500 Å - 8600 Å)
Exposure Time	7 - 18 ms

A **typical IBIS data set** consists of measurements taken in sequence over 3 spectral lines (e.g. 6302 Å, 6173 Å, and 8542 Å); each line is sampled at several spectral points (e.g. 30, 24, and 25), each point at six polarimetric states (I+Q, I-Q, I+V, I-V, I+U and I-U), for a total of **many data** (e.g. 349 images, 1000 x 1000 pixel each, in 67 sec).



BSA



Fe I 6302 Å 30 spectral points (photosphere)Fe I 6173 Å 24 spectral points (photosphere)Ca II 8542 Å 25 spectral points (chromosphere)Each point acquired in 6 polarimetric states:Each point acquired in 6 polarimetric states:Image: Ca II 8542 Å 25 spectral points (chromosphere)1000 × 1000 pixel 0.095 arcsec/pixel FOV of (45x85)"Image: Ca II 8542 Å 25 spectral points (chromosphere)		Scan over 3 spectral lines:							
(photosphere) (photosphere) (chromosphere) Each point acquired in 6 polarimetric states: I+Q, I+V, I-Q, I-V, I-U, I+U 1000 × 1000 pixel 0.095 arcsec/pixel 180 total frames 144 total frames 25 total frames		Fe I 6302 Å	Fe I 6173 Å	Ca II 8542 Å					
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	FOV of (45x85)"	180 total frames	144 total frames	25 total frames					

IBIS-A is a new MySQL archive to access IBIS data. It is powered by **Django 1.9.1**, which is a free and open-source web framework written in Python. Django allows to create dynamic high-security web applications; its high-level Python Web framework encourages rapid development and clean, pragmatic design. We used its object-relational mapper to model the layout of the IBIS-A DB, as shown in Fig. 4.

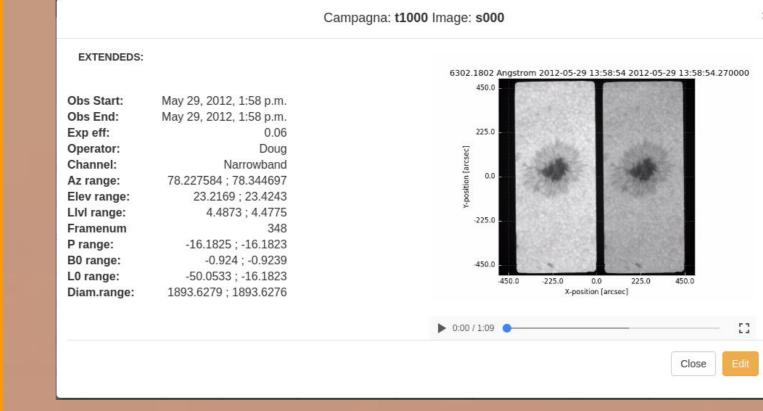


Figure 5. Modal window showing extended information and video.

The **DB** query allows to search data depending on e.g. solar target, disc position, observational mode, date range. Fig. 6 shows an example of the results from a DB query.



Figure 4. Entity-Relationship Model of the IBIS-A database.

A **Python script** allows to ingest the data into the DB, and to create h.264/mp4 **movies for all the managed data** (see e.g. Fig. 5). The movies are created for quick look purposes by using the 2D plotting library Matplotlib version 1.5.2.

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IBIS-A using Django-Python Framework

Figure 3. Example of the photospheric (top) and chromospheric (bottom) data acquired on 20 May 2016 on a large sunspot in active region NOAA 12546.

349 total frames+ 349 Whitelight and G-Band
simultaneous imagesFigure 2. Example of typical data set acquired with the IBIS.At present, the IBIS archive
includes 5.15 Tb of data taken
during 5 observing campaigns
carried out from 2012 to 2016 on
22 days. Find in Fig. 3 some
examples of IBIS data.

Figure 6. Example of the results from a database query. The log file of the observations is available for download as PDF

IBIS-A integration into the SOLARNET Archive

The IBIS-A is realised in the framework of the **FP7 SOLARNET High-resolution Solar Physics Network** that aims at integrating the major European infrastructures in the field of high-resolution solar physics, as **a step towards** the realisation of the **4m EST European Solar Telescope**. SOLARNET WP50.3 is centered on the setup of a the SOLARNET Virtual Observatory Prototype (SVO) archive of high resolution solar data acquired with the current most advanced instrumentation. The integration of the IBIS-A into the SOLARNET-SVO is work in progress.

SOLARNET Virtual Observatory Prototype

SOLARNET

This web server is a prototype for the SOLARNET Virtual Observatory, and is hosted currently at the Royal Observatory of Belgi

Access data via a web application - Wizard

The wizard is a simple web application to search and download solar data. Search and create selection of the data you want. The selection will be available for download through FTP. It's purpose is to give a very simple access to data. For more complex ways of selecting data, please see the IDL and python API below

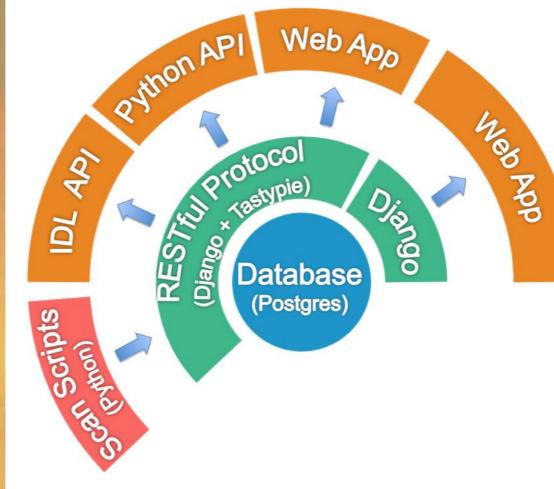
Access data via IDL

To search and download solar data from IDL, you will need IDL version 8.0 or higher and to download the following library on your computer SOLARNET.pre You can then compile it and use it as in the examples in the README

Access data via Python

To search and download data from python, install the SOLARNET python library. If you have pip install, it is as simple as doing

The **SVO archive** was designed as a searchable database of all the meta-data available from the observations, allowing for cross database searches (Fig. 7). The data will be made available through the Representational state transfer (REST) protocol making it accessible through the SVO web app, IDL, Python based technology stack (Fig. 8). Efforts are spent to make the **meta-data produced** by the different telescopes **as uniform as possible** by using the most generally accepted standards available (e.g. FITS standards such as the World Coordinate System).



pip install solarnet



Figure 7. http://solarnet.oma.be/ SOLARNET VSO Web page.

Figure 8. SOLARNET Data access structure.



Coming soon also the integration of IBIS-A into the US-VSO Virtual Solar Observatory that allows users to search data in several archives of solar ground- and space-based observations. The US-VSO user can search data across multiple instruments and events. We are ready with all SOAP web services required for the IBIS-A integration into the US-VSO. Future work will also include refinement of current IBIS-A web interfaces by using an Usage Centered Design approach.

This work is carried out as a step towards the realisation of the data archive of the 4m EST European Solar Telescope (www.est-east.eu).

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