

SHARING SOLAR DATA WITH ESCAPE AND SOLARNET

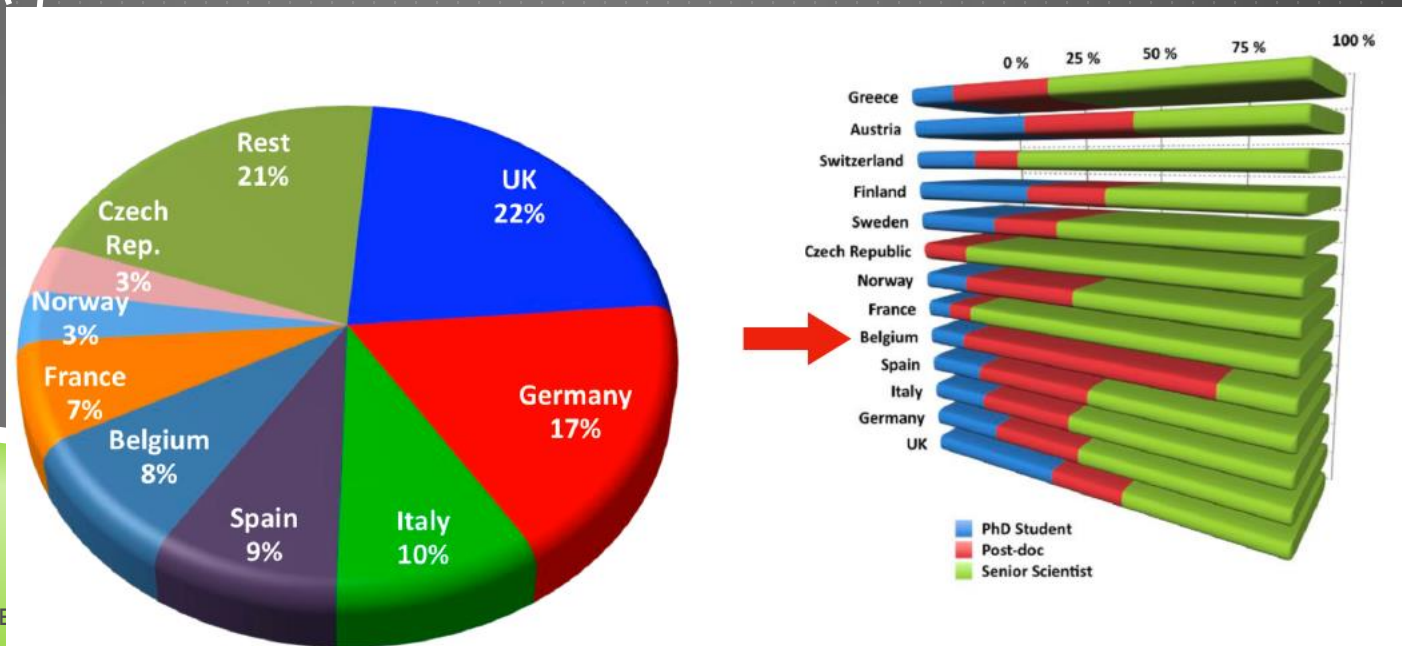
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SOLAR PHYSICS COMMUNITY: FACT SHEET

- ▶ ~615 European Solar physicists
- ▶ About the same in USA
- ▶ During 2005-2015, around 41% of refereed publications count with participation of Europeans

Much smaller
than Astronomy!

Source:
Results GRESt project (2016)



SOLAR PHYSICS COMMUNITY SPLIT IN GROUND-BASED VS SPACE-BASED

- ▶ European solar telescope (EST) is the next generation large aperture (4m) telescope for solar physics, to be built in Canary Island
- ▶ Since 2016, EST is part of the ESFRI roadmap
- ▶ EST takes part in ESCAPE
- ▶ Mostly driven by ESA/NASA/JAXA

PROCESSING SOLAR IMAGE

- ▶ FITS format almost a standard, but FITS keywords (metadata) far from being standardized, esp. for ground based data.
- ▶ Difference with astronomy: we catch the dynamics of the Sun in all its details
 - ▶ Image series (movies) and event databases are important
 - ▶ Besides a few exceptions, event databases are still far from being FAIR
- ▶ Since 2010, explosion in data volumes, dictating the need for automated processing, machine learning,...
 - ▶ Event databases populated by output of image processing algorithms running in real time on solar data

SOLARNET: ACHIEVEMENTS STANDARDISATION

FP7 SOLARNET (2013-2017)

- ▶ Recommendation for FITS metadata in case of space-based or ground-based observations (Stein Haugan)
- ▶ Development of a prototype of a Solar Virtual Observatory, as an entry point to access different data sets and catalogues

H2020 SOLARNET (2019-2022)

- ▶ Continue to provide SOLARNET recommendation for metadata
- ▶ Turn the prototype Solar VO into an operational tool

ESCAPE: MAKE THE DATA FAIR, CONNECT TO EUROPEAN OPEN SCIENCE CLOUD

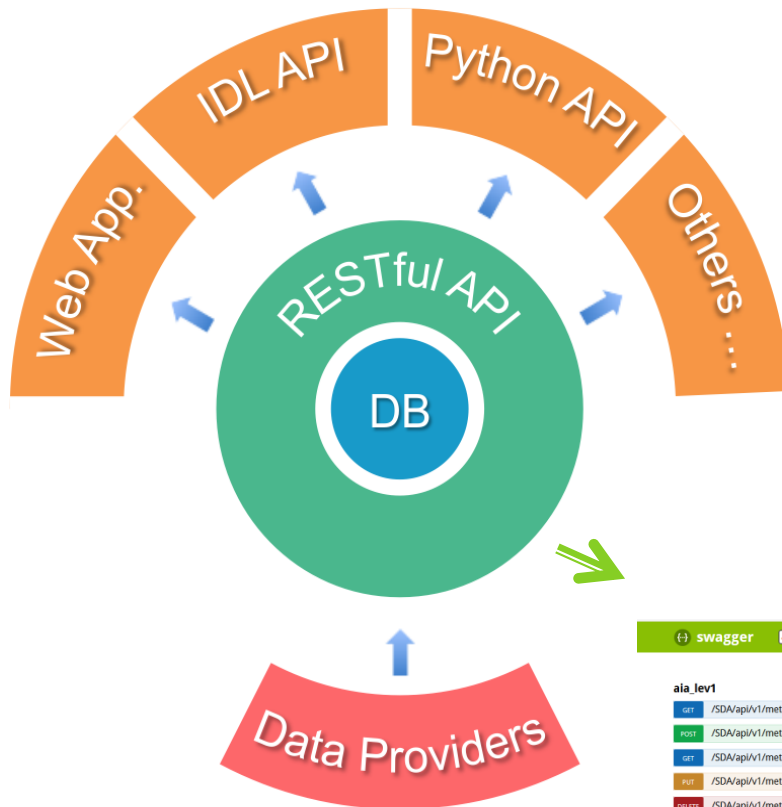
- ▶ Foreseen contributions from ROB
 - ▶ Data access and visualization tools : use (more) IVOA standards
 - ▶ Interoperability between data access (FITS files) and data visualization tool
 - ▶ Strengthen use of UCD, with the help a.o. of SOLARNET colleagues taking part in ESCAPE

SOLAR EVENT/FEATURE CATALOGS

- ▶ Many catalogs of solar features and events exist, each with its own output format:
 - ▶ VOEvent (standard v1.11) used in Heliophysical Event Knowledge base (HEK), LMSAL, US
 - ▶ VOTable used in Heliophysics Feature Catalog (ObsParis)
 - ▶ Custom-designed database (ROB/SIDC)
- ▶ A same algorithm sometimes runs on different platforms, essentially giving the same catalog but in different formats
- ▶ Objective: (more) harmonization of output format for solar event/feature catalogs

DATA ACCESS: SOLAR VIRTUAL OBSERVATORY

<http://solarnet.oma.be/>



- ▶ The data are hosted on the servers of the data providers.
- ▶ SVO collect the metadata into a central searchable database.
- ▶ To interface with the database we use the **RESTful API**
- ▶ User friendly web App
- ▶ IDL and Python API to make more complex searches and to be used in programs and scripts.

Method	Endpoint	Description
GET	/SDA/api/v1/metadata/aia_level/	Retrieve a list of aia levels
POST	/SDA/api/v1/metadata/aia_level/	Create a new aia level
GET	/SDA/api/v1/metadata/aia_level/{oid}/	Retrieve a single aia level by ID
PUT	/SDA/api/v1/metadata/aia_level/{oid}/	Update an existing aia level
DELETE	/SDA/api/v1/metadata/aia_level/{oid}/	Delete an existing aia level

Method	Endpoint	Description
GET	/SDA/api/v1/metadata/chrotel/	Retrieve a list of chrotels
POST	/SDA/api/v1/metadata/chrotel/	Create a new chrotel
GET	/SDA/api/v1/metadata/chrotel/{oid}/	Retrieve a single chrotel by ID
PUT	/SDA/api/v1/metadata/chrotel/{oid}/	Update an existing chrotel
DELETE	/SDA/api/v1/metadata/chrotel/{oid}/	Delete an existing chrotel

Method	Endpoint	Description
GET	/SDA/api/v1/data_location/	Retrieve a list of data locations
POST	/SDA/api/v1/data_location/	Create a new data location
GET	/SDA/api/v1/data_location/{tid}/	Retrieve a single data location by ID

DATASETS

- ▶ Only a few datasets at the moment (prototype) but possibility to do search based on **characteristics** (ground-based, Full Sun, partial sun, EUV, ...) and **tags** (moon transit, planet transit, test data, etc,...)

solarnet.oma.be/SVO/#/dataset

SOLARNET Datasets Data selections Events

Telescopes
select or search telescopes

Characteristics
select or search characteristics

Tags
select or search tags

Observation date
start end
[calendar icon] [calendar icon]

Observation wavelength
min max
[dropdown] nm [dropdown] nm

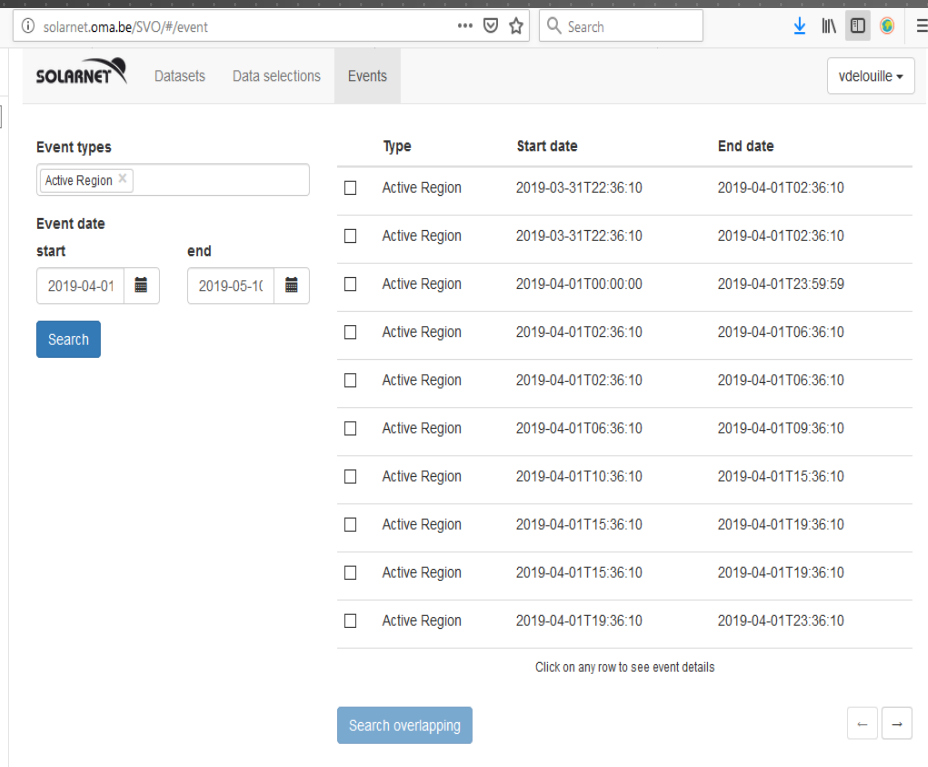
Search

Dataset	# Items	Instrument	Telescope	Characteristics
<input type="checkbox"/> AIA level 1	501672	AIA	SDO	space based, full sun, E.U.V.
<input type="checkbox"/> ChroTel	70199	ChroTel	ChroTel	ground based, full sun, E.U.V.
<input type="checkbox"/> EIT level 0	36470	EIT	SOHO	space based, E.U.V.
<input type="checkbox"/> GRIS level 1	1637	GRIS	GREGOR	spectograph, ground based
<input type="checkbox"/> HMI magnetogram	50181	HMI	SDO	space based, full sun
<input type="checkbox"/> IBIS	1396	IBIS	DST	ground based, spectropolarimetric data, partial sun
<input type="checkbox"/> ROSA	12639	ROSA	DST	ground based
<input type="checkbox"/> SWAP level 1	1231849	SWAP	PROBA2	space based, full sun, E.U.V.
<input type="checkbox"/> Themis	15	Themis	Themis	test, ground based
<input type="checkbox"/> XRT	891952	XRT	Hinode	space based, full sun

Click on any row to see dataset content or refine search

Save selection

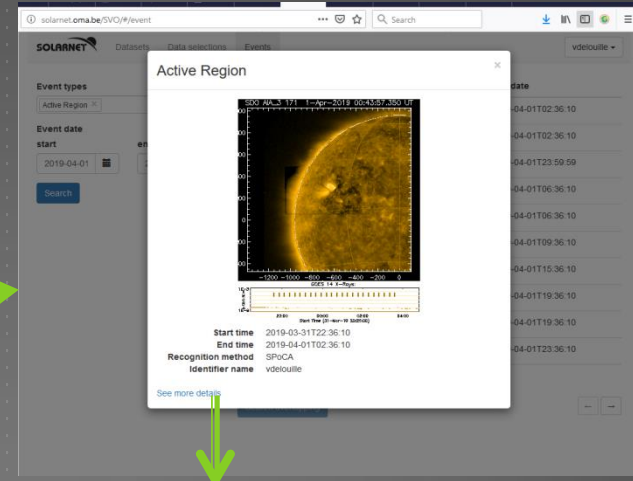
EVENTS: API TO LINK TO THE HEK



The screenshot shows the SOLARNET web interface. At the top, there are navigation tabs for 'Datasets', 'Data selections', and 'Events'. The 'Events' tab is active, and a dropdown menu shows 'vdelouille'. Below this, there are filters for 'Event types' (set to 'Active Region') and 'Event date' (start: 2019-04-01, end: 2019-05-11). A search button is present. The main content is a table of events:

Type	Start date	End date
<input type="checkbox"/> Active Region	2019-03-31T22:36:10	2019-04-01T02:36:10
<input type="checkbox"/> Active Region	2019-03-31T22:36:10	2019-04-01T02:36:10
<input type="checkbox"/> Active Region	2019-04-01T00:00:00	2019-04-01T23:59:59
<input type="checkbox"/> Active Region	2019-04-01T02:36:10	2019-04-01T06:36:10
<input type="checkbox"/> Active Region	2019-04-01T02:36:10	2019-04-01T06:36:10
<input type="checkbox"/> Active Region	2019-04-01T06:36:10	2019-04-01T09:36:10
<input type="checkbox"/> Active Region	2019-04-01T10:36:10	2019-04-01T15:36:10
<input type="checkbox"/> Active Region	2019-04-01T15:36:10	2019-04-01T19:36:10
<input type="checkbox"/> Active Region	2019-04-01T15:36:10	2019-04-01T19:36:10
<input type="checkbox"/> Active Region	2019-04-01T19:36:10	2019-04-01T23:36:10

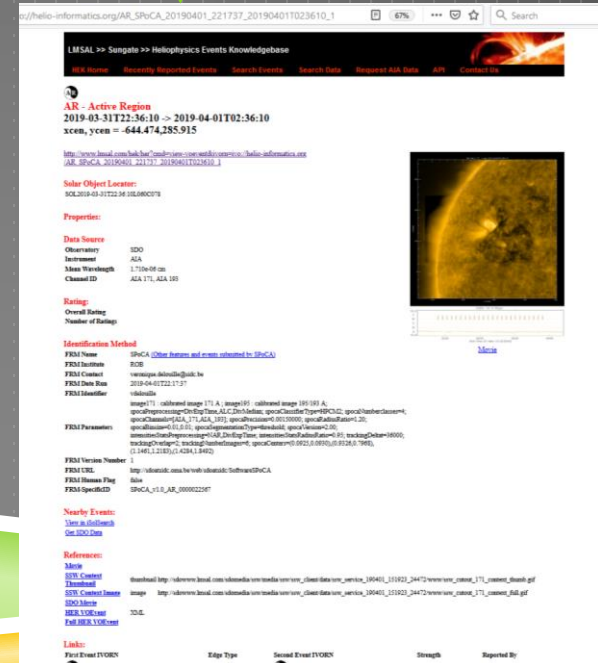
At the bottom of the table, there is a 'Search overlapping' button and a note: 'Click on any row to see event details'.



This screenshot shows the 'Active Region' detail view in the SOLARNET interface. It features a central image of the Sun with a yellow box highlighting an active region. Below the image, the following information is displayed:

- Start time: 2019-03-31T22:36:10
- End time: 2019-04-01T02:36:10
- Recognition method: SPVCA
- Identifier name: vdelouille

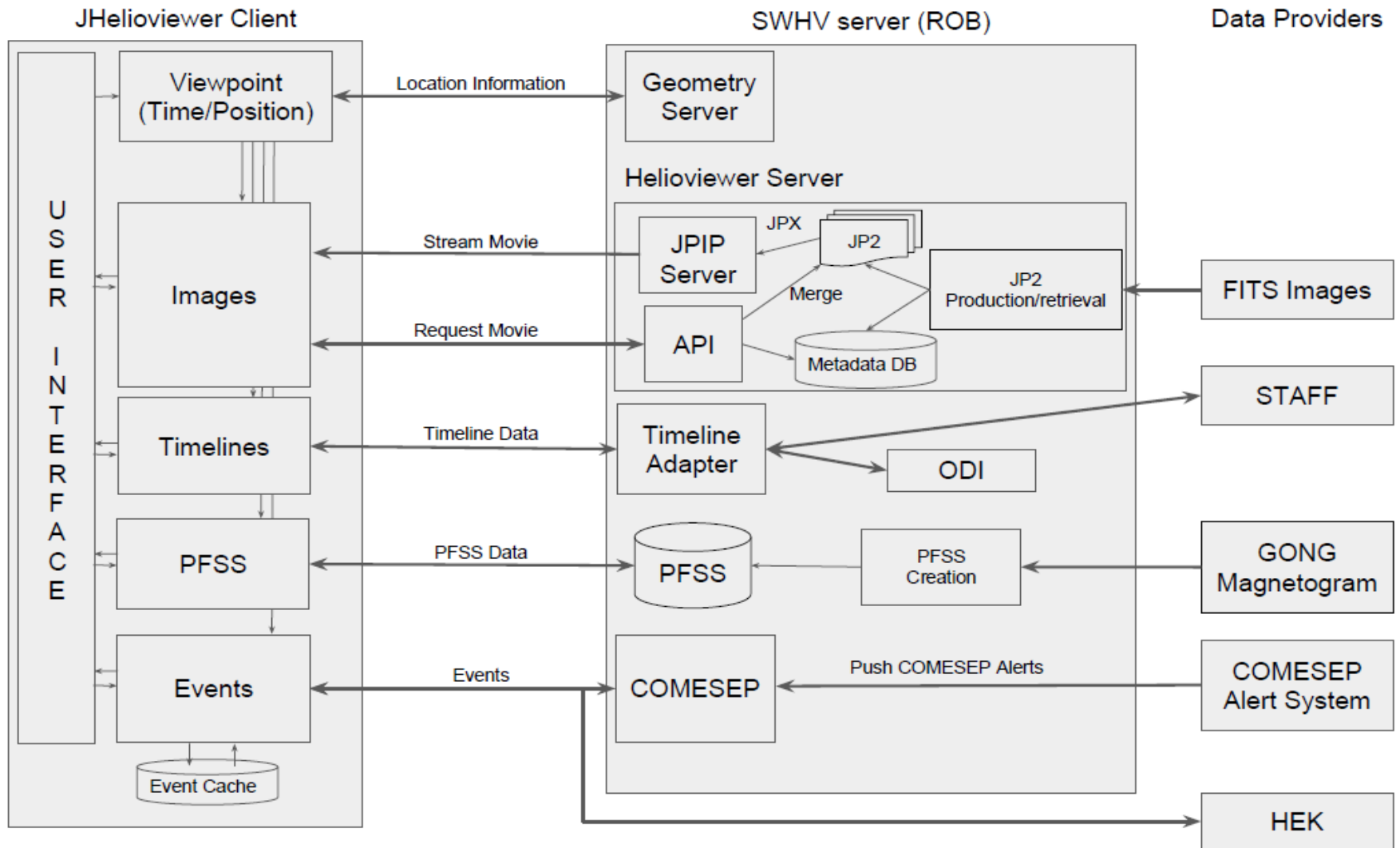
A 'See more details' link is visible below the information.



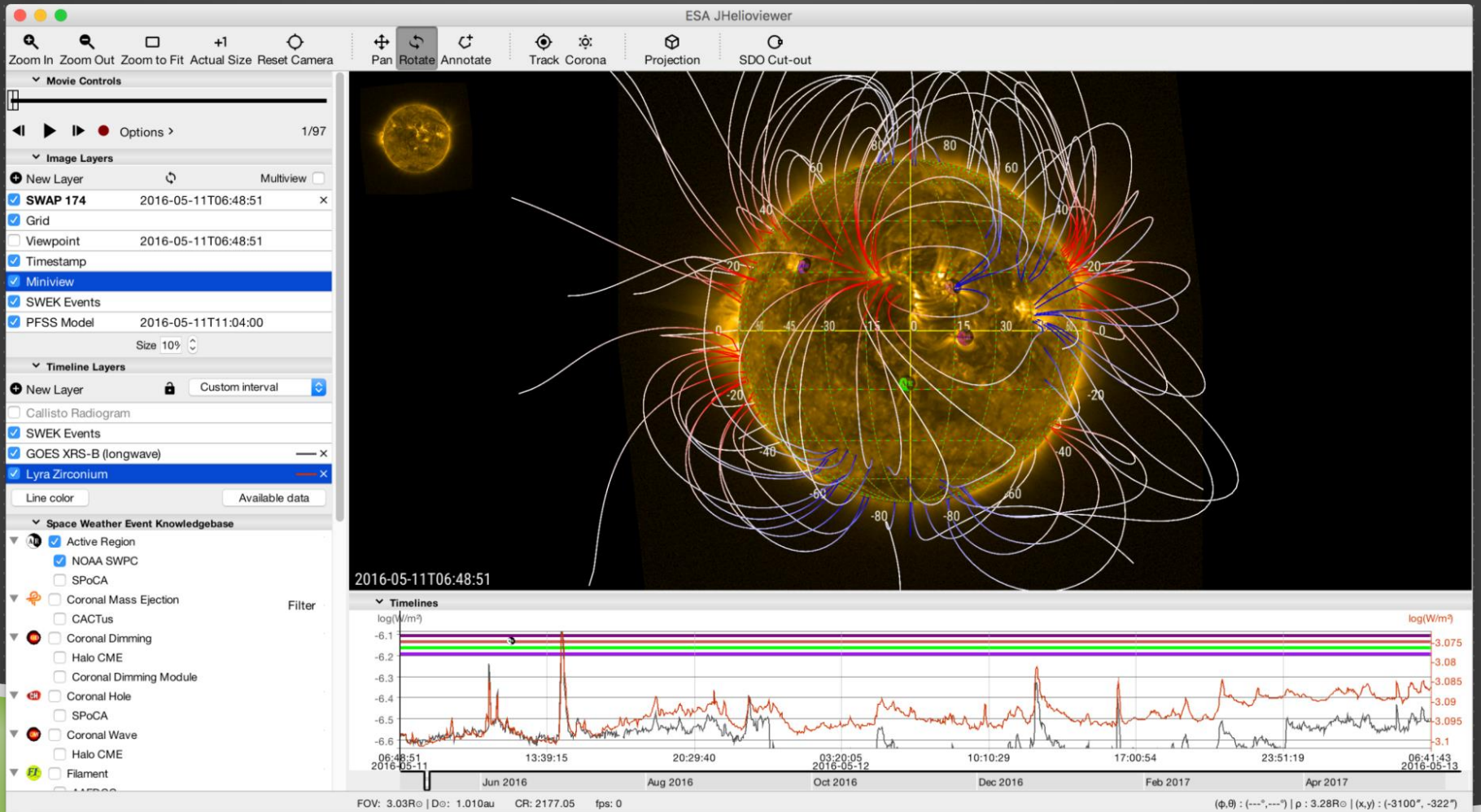
This screenshot shows the HelioPhysics Events Knowledgebase (HEK) detail view for an Active Region. The page title is 'AR - Active Region' and the event ID is '2019-03-31T22:36:10 -> 2019-04-01T02:36:10'. The coordinates are given as 'xcen, ycen = -644.474,285.915'. The page includes a 'Solar Object Locator' map, a 'Properties' section, a 'Data Source' section (listing SDO, AIA, and AIA 191), a 'Rating' section (Overall Rating: 1), an 'Identification Method' section (listing SPVCA and various parameters), a 'Nearby Events' section, and a 'References' section. A 'Links' section at the bottom lists 'Event TYOEN', 'Event Type', 'Send Event TYOEN', 'Strength', and 'Report By'.

DATA VISUALIZATION: JHELIOVIEWER

<https://www.jhelioviewer.org/>



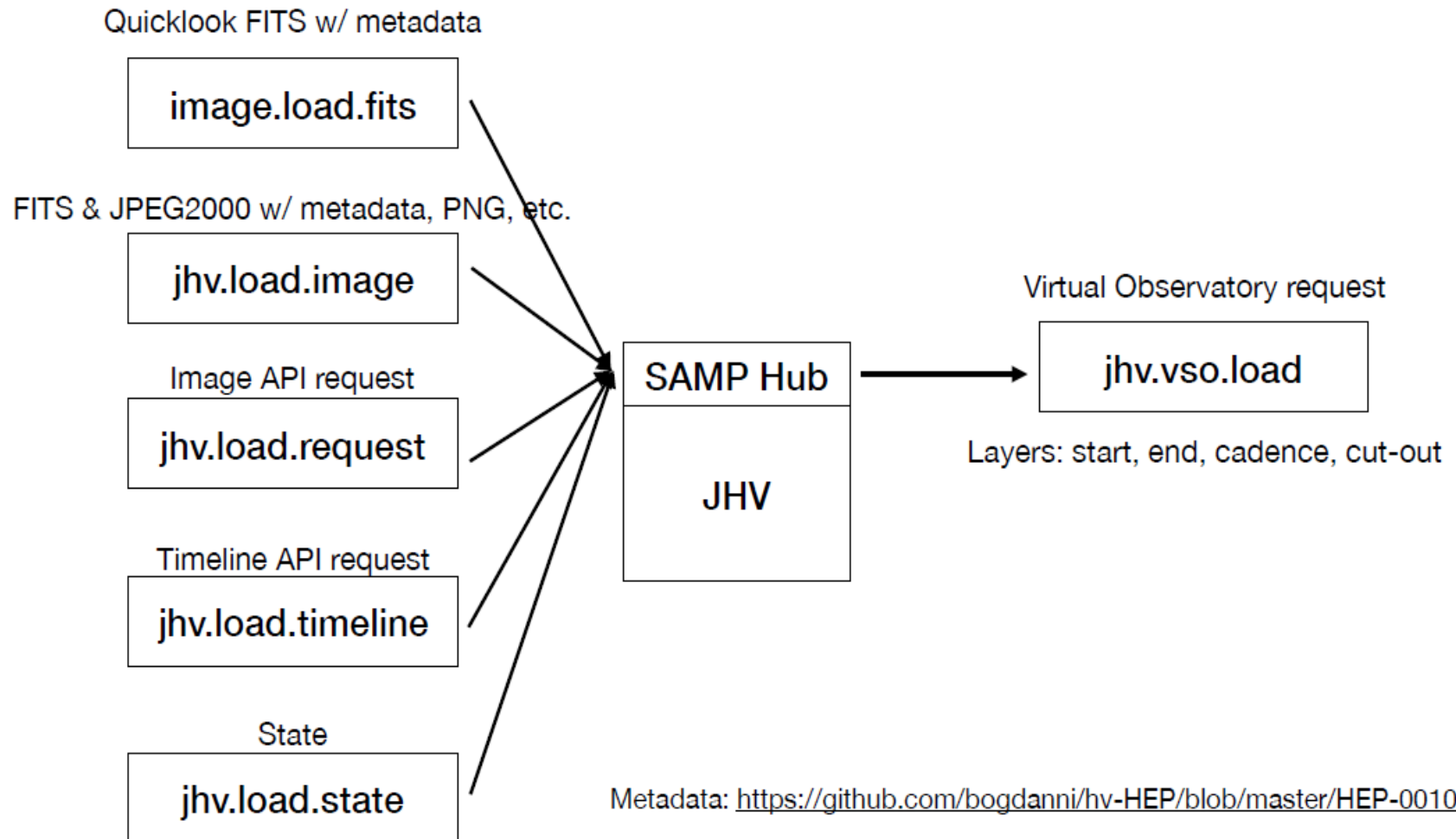
OVERVIEW CAPABILITIES FROM JHELIOVIEWER



JHELIOVIEWER & SAMP

Sources: SAOImage DS9, ESA SSA, web, Helioviewer API, etc.

Implementations: SunPy, SolarSoft IDL



IN THE FUTURE:

JHelioviewer

- ▶ Modify JHelioviewer to support TAP in order to search and retrieve data
- ▶ Primary Targets:
 - ▶ Solar Orbiter data archive
 - ▶ Event Database from ROB

Solar VO

- ▶ Build a TAP service layer around the RESTful API (possibly using DaCHS)
- ▶ Versioning: if a field in table A is pointing to a key in the other table B: what if A or B are updated independently?
- ▶ concept of "ownership" of the link: this is the Element that owns the link which decides on its update

RECOMMENDATION FOR FITS KEYWORD & UCD

SOLARNET FITS keyword (Haugan, 2017): origin, acquisition,...

- ▶ PROJECT: Name(s) of the project(s) affiliated with the data
- ▶ MISSION: Typically used only in space-based settings
- ▶ OBSRVTRY: Name of the observatory
- ▶ TELESCOP: Name of the telescope.
- ▶ TELCONFIG: Telescope configuration.
- ▶ INSTRUME: Name of the instrument.
- ▶ CAMERA: Name of the camera.
- ▶ FILTER: Name(s) of the filter(s) used during the observation.
- ▶ DETECTOR: Name of the detector.
- ▶ OBS_MODE: A string identifying operation mode
- ▶ SETTINGS: Other settings – “parameter|n, ...
- ▶ OBSERVER: Who acquired the data.
- ▶ PLANNER: Observation planner(s).
- ▶ REQUESTR: Who requested this particular observation.

Corresponding UCD (Version 1.3)

- ▶ PROJECT:
- ▶ MISSION: *instr.obsty*
- ▶ OBSRVTRY: *instr.obsty*
- ▶ TELESCOP: *instr.tel*
- ▶ TELCONFIG:
- ▶ INSTRUME: *instr*
- ▶ CAMERA:
- ▶ FILTER: *instr.filter*
- ▶ DETECTOR: *instr.det*
- ▶ OBS_MODE: *phys.? Instr.setup?*
- ▶ SETTINGS:;
- ▶ OBSERVER:
- ▶ PLANNER:
- ▶ REQUESTR:

UCD may provide ideas for new FITS keywords recommendation



Q instr	Instrument
E instr.background	Instrumental background
Q instr.bandpass	Bandpass (e.g.: band name) of instrument
Q instr.bandwidth	Bandwidth of the instrument
Q instr.baseline	Baseline for interferometry
S instr.beam	Beam
Q instr.calib	Calibration parameter
S instr.det	Detector
Q instr.det.noise	Instrument noise
Q instr.det.psf	Point Spread Function
Q instr.det.qe	Quantum efficiency
Q instr.dispersion	Dispersion of a spectrograph
Q instr.experiment	Experiment or group of instruments
S instr.filter	Filter
S instr.fov	Field of view
S instr.obsty	Observatory, satellite, mission
Q instr.obsty.seeing	Seeing
Q instr.offset	Offset angle respect to main direction of observation
Q instr.order	Spectral order in a spectrograph
Q instr.param	Various instrumental parameters
S instr.pixel	Pixel (default size: angular)
S instr.plate	Photographic plate
Q instr.plate.emulsion	Plate emulsion
Q instr.precision	Instrument precision
Q instr.rmsf	Rotation Measure Spread Function
Q instr.saturation	Instrument saturation threshold
Q instr.scale	Instrument scale (for CCD, plate, image)
Q instr.sensitivity	Instrument sensitivity, detection threshold
Q instr.setup	Instrument configuration or setup

RECOMMENDATION FOR FITS KEYWORD & UCD-I+

SOLARNET FITS keywords: data statistics

- ▶ DATAMIN : the minimum data value
- ▶ DATAMAX : the maximum data value
- ▶ DATAMEAN : the average data value
- ▶ DATAMEDN : the median data value.
- ▶ DATARMS : the RMS deviation from the mean
- ▶ DATAKURT : the kurtosis
- ▶ DATASKEW : the skewness

UCD-I+

- ▶ DATAMIN : stat.min
- ▶ DATAMAX : stat.max
- ▶ DATAMEAN : stat.mean
- ▶ DATAMEDN : stat.median
- ▶ DATARMS : stat.rms
- ▶ DATAKURT : stat.kurt ?
- ▶ DATASKEW : stat.skew?



SOLARNET keywords may provide ideas for new UCD-I+ names

EVENT/FEATURE CATALOGS: METADATA STANDARD?

Active Region catalog in HEK (part)

- ▶ Event_Probability Event_Importance
- ▶ Event_Type KB_ArchivDate KB_ArchivID
- ▶ KB_Archivist KB_ArchivURL
- ▶ Event_CoordSys Event_CoordUnit Event_EndTime
- ▶ Event_StartTime Event_Expires Event_Coord1
- ▶ Event_Coord2 Event_Coord3
- ▶ Event_MapURL Event_MaskURL
- ▶ Event_PeakTime Event_CIError
- ▶ Event_C2Error Event_ClippedSpatial
- ▶ Event_ClippedTemporal Event_TestFlag
- ▶ Event_Description FRM_Contact
- ▶ FRM_DateRun FRM_HumanFlag
- ▶ FRM_Identifier FRM_Institute
- ▶ FRM_Name FRM_ParamSet
- ▶ FRM_VersionNumber FRM_URL
- ▶ FRM_SpecificID OBS_Observatory
- ▶ OBS_ChannelID OBS_Instrument
- ▶ OBS_MeanWavel OBS_WavelInit
- ▶ Bound_CCStartC1
- ▶ Bound_CCStartC2
- ▶ Bound_ChainCode BoundBox_C1LL
- ▶ BoundBox_C2LL BoundBox_C1UR
- ▶ BoundBox_C2UR ChainCodeType

Active Region catalog in HFC (part)

- ▶ FRC_INFO_ID OBSERVATIONS_ID
- ▶ OBSERVATIONS_ID_T FEAT_DATE
- ▶ FEAT_DATE_PREV FEAT_X_ARCSEC
- ▶ FEAT_Y_ARCSEC FEAT_X_PIX
- ▶ FEAT_Y_PIX FEAT_HG_LONG_DEG
- ▶ FEAT_HG_LAT_DEG
- ▶ FEAT_CARR_LONG_DEG
- ▶ FEAT_CARR_LAT_DEG FEAT_AREA_PIX
- ▶ FEAT_AREA_MM2 FEAT_AREA_DEG2
- ▶ BR_X0_ARCSEC BR_Y0_ARCSEC
- ▶ BR_X1_ARCSEC BR_Y1_ARCSEC
- ▶ BR_X2_ARCSEC BR_Y2_ARCSEC
- ▶ BR_X3_ARCSEC

Not a single name in common!

Difficult to change the names themselves (history etc...), but whenever possible should associate the corresponding Unified content descriptor Need for UCD in VOEvent