Solar Orbiter Archive: New Features – Python/TAP/TOPCAT Access and Docs



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The ESAC Science Data Centre (ESDC) plays a crucial role in preserving and providing long-term access to data from all ESA space science missions.

Recent enhancements to the Solar Orbiter Archive (SOAR) aim to provide researchers with more intuitive and powerful tools for data access. These updates include the ability to search data by solar distance and utilize Field of View (FoV) tables. The contents of the Solar Orbiter mission orbit file have been ingested and is available via our standard TAP interface. This allows users to search a rich set of metadata based on Distance and Latitude. Integration with commonly used tools like Python, TOPCAT, and SunPy has further streamlined data access and interoperability. The redesigned help page demonstrates how to interact with these data and includes new tutorials and instrument



Orbit File

Metadata accessible via TAP:

CDF orbit file provides detailed information about the spacecraft's trajectory and position in space over time.



Solar distance refers to the distance between the spacecraft and the Sun expressed in Astronomical Units (au). Includes perihelion (0.28 au) and aphelion passes (1.02 au).

> Get the EPOCH and Heliocentric distance directly via TAP instead of downloading a CDF file, and easily plot and extract time intervals using a DataFrame for a given solar distance

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documentation.

Epoch and Heliocentric distance can be extracted as:

https://soar.esac.esa.int/soar-sltap/tap/sync?REQUEST=doQuery&LANG=ADQL&FORMAT=JSON&PHASE=RUN&QUER Y=SELECT+epoch,hcentric dist+FROM+time series.v solo anc socorbit 1

Data accessible via web interface:

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Orbite	r Archive		Ce e
	SEARCH		
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6	SOOP Name/Type	All	
	Solar distance	0.28 - 1.02	
	Include also:	Low Latency Inactive files	

2022-03-07 21:55:50 - 2022-04-14 01:55:50 2024-03-15 21:55:50 - 2024-04-23 05:55:50 024-09-11 15:55:50 - 2024-10-03 16:55:5



Use of sunpy-soar – A SunPy affiliated package that integrates with Fido to search for Solar Orbiter data using solar distance attributes from the Solar Orbiter Archive.

min dist = 0.28 $max_dist = 0.49$

df = pd.DataFrame(

"epoch": t,

"distance_km": d, "distance_au": d/AU

condl = df['distance_au'] <= max_dist</pre>

cond2 = df['distance_au'] >= min_dist

import astropy.units as u import sunpy.net.attrs as a from sunpy.net import Fido import sunpy_soar # NOQA: F401

instrument = a.Instrument("EUI") time = a.Time("2022-10-29 05:00:00", "2022-10-29 06:00:00") level = a.Level(2) detector = a.Detector ("HRI EUV") distance = a.soar.Distance(0.45 * u.AU, 0.46 * u.AU)

result = Fido.search(instrument & level & detector & distance) result

*	1442 Results from the SOARClient:									
	QueryRes	ponseTab	le len	gth=1442						
	Instrument	Data product	Level	Start time	End time	Filesize	SOOP Name	Detector	Wavelength	
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	EUI	eui- hrieuv174- image	L2	2022-10-29 05:00:00.231	2022-10-29 05:00:01.881	5.558	R_SMALL_HRES_HCAD_Atmospheric- Dynamics-Structure	HRI_EUV	174.0	
	EUI	eui- hrieuv174- image	L2	2022-10-29 05:00:05.221	2022-10-29 05:00:06.871	5.532	R_SMALL_HRES_HCAD_Atmospheric- Dynamics-Structure	HRI_EUV	174.0	

Field of View

Solar Orbiter has two telescopes and one instrument onboard that target a certain portion of the Sun in high resolution, i.e. within a Field of View (FoV)

FoV tables have been extracted from each HRI, HRT and SPICE file. These tables can be accessed via TAP and includes

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v soar (3/67)	crota	double			Rotation Angle						0
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	fov_earth_bot_left_arcsec_tx	double			FoV bottom left Tx in arcsec as seen from Earth in Helioprojective cartesian reference frame						0
	fov_earth_bot_left_arcsec_ty	double			FoV bottom left Ty in arcsec as seen from Earth in Helioprojective cartesian reference frame						0
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	fov_earth_top_right_arcsec_ty	double			FoV top right Ty in arcsec as seen from Earth in Helioprojective cartesian reference frame						0
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	mercury_pos_radius_au	double			Presenting local						0
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	solo pos radius au	double			Solar Orbiter position radius in Astronomical Unit (AU). Stonyhurst heliographic coordinate system						ä
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	stereoa pos radius au	double			Stereo-A position radius in Astronomical Unit (AU). Stonyhurst heliographic coordinate system						õ
	version	char			File version						0

- FoV in arcsec from a Solar Orbiter perspective.
- FoV in arcsec from an Earth perspective.

EUI HRI | PHI HRT | SPICE

- Position of Solar Orbiter, PSP, Bepi, STEREO-A.
- Positions of Earth and Mercury.

The following queries can be used to access the FoV tables and plot SOAR and Earth based views with help of sunpy.

vo.dal.TAPService("https://soar.esac.esa.int/soar-sl-tap/tap") fits_item_resulset = service.search("SELECT * FROM soar.v_eui_sc_fits WHERE filename='solo_L2_euifsi174-image_20221024T190050195_V01.fits'")

first_item = fits_item_resulset[0] fsi_obs_date = first_item["date_average"

fov_eui_resultset = service.search("SELECT * FROM soar.v_eui_hri_fov WHERE filename='solo L2 eui-

SELECT * FROM soar.v_spice_fov WHERE filename='solo_L2_spice-n-

Three different perspectives: Location of Solar Orbiter and related helio missions; Sun from a Solar Orbiter perspective; Sun from an Earth perspective at the same time (as observed by SDO).

Solar Orbiter perspective (EUI 174 Å) 2022-10-24T19:00:55.195

Earth perspective (AIA 171 Å) 2022-10-24T19:00:57.35

SunPy Access to SOAR Data and Metadata

Search by instrument, detector name, distance to the Sun and Solar Orbiter Observing Plan name using SunPy Fido:



Help Page

https://www.cosmos.esa.int/web/soar

Points in red have been redesigned:

- Each Solar Orbiter Instrument provides a Data Product Description Document (DPDD).
- The web interface user guide is up-to-date to include detailed navigation steps.
- Guidance on how to search by cadence for MAG, EPD, SWA 3D and PAD with units.
- Added data tutorials such as finding time intervals when searching by distance, examples with sunpy-soar and more.

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