

ESA heliophysics archives: a key asset for ISWI

Arnaud Masson

*ESA heliophysics science lead
Cluster deputy project scientist*

*UN-US workshop on ISWI
Boston College, 4 August 2017 08/02/2017*

ESA science archives



<http://archives.esac.esa.int>

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Astronomy Science Archives

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herschel	hubble space telescope	iso
lisa pathfinder	planck	xmm-newton

Heliophysics Science Archives

cluster	double star	ISS-SolACES*
proba-2	soho	ulysses

The Planetary Science Archive

cassini huygens	exomars	giotto
mars express	rosetta	smart-1
venus express		

LATEST NEWS

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ESA ESDC @ESAesdc
#ESASky is featured in this month's #INTEGRAL Picture of the Month!
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@ESA_Integral sky.esa.int

10h

ESA ESDC @ESAesdc
European Commission Horizon 2020 Proposers' Day 2017, 9-10 Nov 2017
Budapest, free admission
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28 Jul 2017

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Cuando ya no esté: Carlos Barrabès (Parte 1/2) | #0
buff.ly/2vdyhnE "Si yo tuviese 20 años hoy, me dedicaría al espacio"

ESA science archives



<http://archives.esac.esa.int>

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Future Archives

bepicolombo	euclid	juice
solar orbiter		

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The ESAC science data centre (ESDC)



1. Consolidation of all ESA Space Science Archives at ESAC, with strong re-use across projects, ensuring easier and cheaper long term data preservation
 - Hardware infrastructure
 - Software architecture and code, including technology migration
 - Human technical and scientific expertise
 - **Multi mission, multi instruments science exploitation**
2. Long term preservation of data processing capabilities (on-going)
 - Preserve software coming from various places
 - Provide data processing capabilities as a “service”
 - Bring the “user software to the data” instead of the “data to the user”
3. Sharing and preservation of knowledge, including international cooperation
 - IVOA, IPDA



Towards multi wavelengths Science data exploitation



- **Goal:** to facilitate data discovery and archival science for ALL users
 - Multi-wavelength
 - Project agnostic
 - Exploration
- Interface “on top of” all ESA astronomy archives



ESASky

Legacy: IUE, ..		XMM- Newton	HST	Planck		Integral	EXOSAT	Future: Gaia, JWST, Euclid, ..
--------------------	---	----------------	-----	--------	---	----------	--------	---

J2000 15 03 23.406 -42 05 21.11

Sky-XMM-Newton EPIC color All-sky maps for all ESA missions

Upload target list

Target list file: SNRs_list2.txt

SN 1006
SNR G315.0-02.3
08 52 00.0 -46 20 00
23 01 35.0 +58 53 00
05 26 30.0 +42 56 00
08 34 00.0 -45 50 00
15 53 00.0 -56 10 00
16 01 06.0 -51 34 00

Search...

- Web application
- Simple sky exploration interface

Screenshot Multi-target

Data Panel INTEGRAL#1 XMM-Newton#1 SUZAKU#1 XMM-OM(UV)#1 HST#1 Gaia DR1 TGAS#1

Imaging Observations

Instrument	Hard X-Ray	Soft X-Ray	UV	Visible	IR/Radio
INTEGRAL	~20	~20	~10	~10	~10
SUZAKU	~20	~20	~10	~10	~10
XMM-Newton	~20	~20	~10	~10	~10
XMM-OM(UV)	~20	~20	~10	~10	~10
XMM-OM(Optical)	~20	~20	~10	~10	~10
HST	~20	~20	~10	~10	~10
Herschel	~20	~20	~10	~10	~10

Source Catalogues

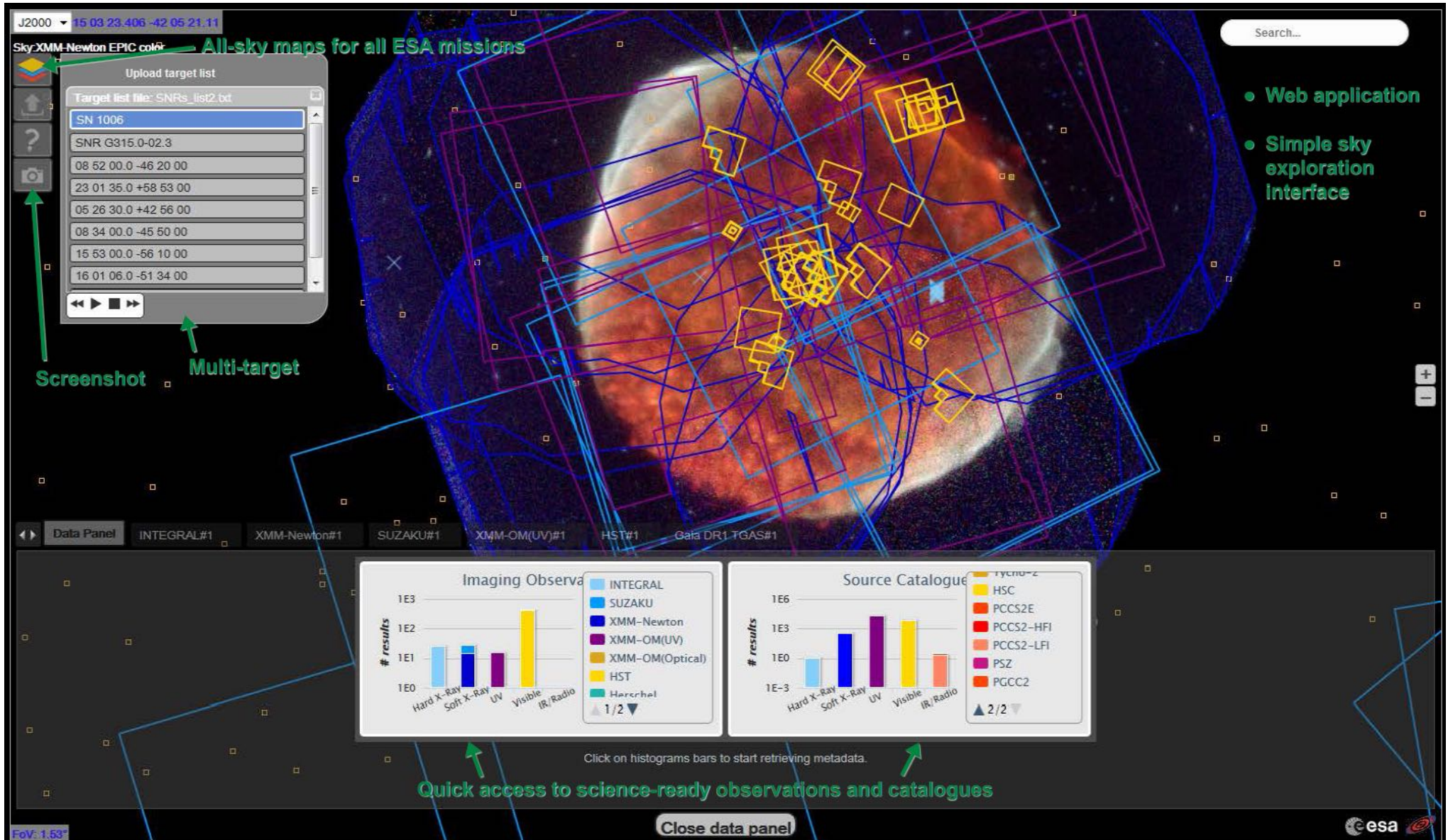
Catalogue	Hard X-Ray	Soft X-Ray	UV	Visible	IR/Radio
Tycho-2	~10	~10	~10	~10	~10
HSC	~10	~10	~10	~10	~10
PCCS2-E	~10	~10	~10	~10	~10
PCCS2-HFI	~10	~10	~10	~10	~10
PCCS2-LFI	~10	~10	~10	~10	~10
PSZ	~10	~10	~10	~10	~10
PGCC2	~10	~10	~10	~10	~10

Click on histograms bars to start retrieving metadata.

Quick access to science-ready observations and catalogues

Close data panel

FoV: 1.53°

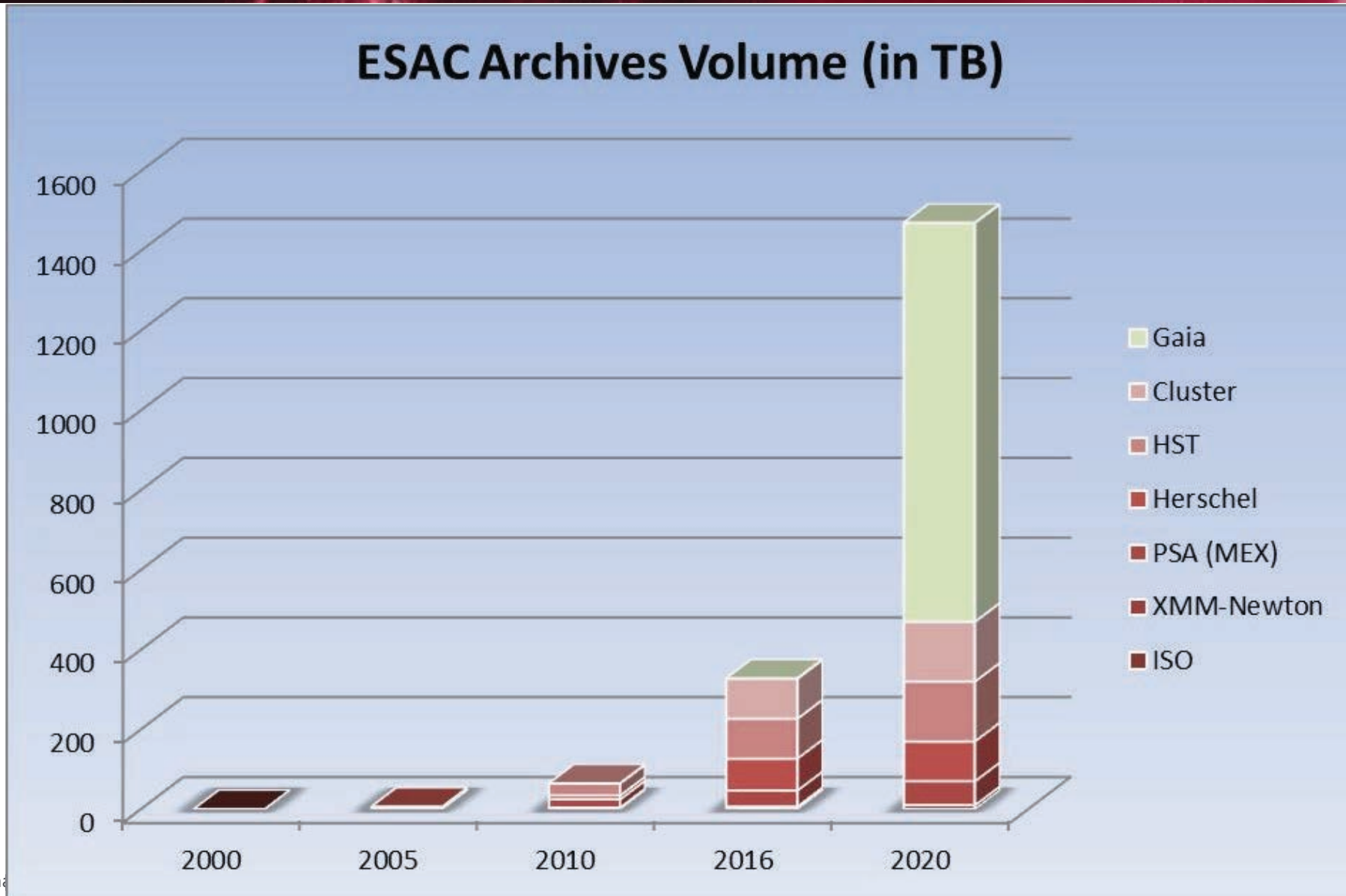


The ESAC science data centre (ESDC)



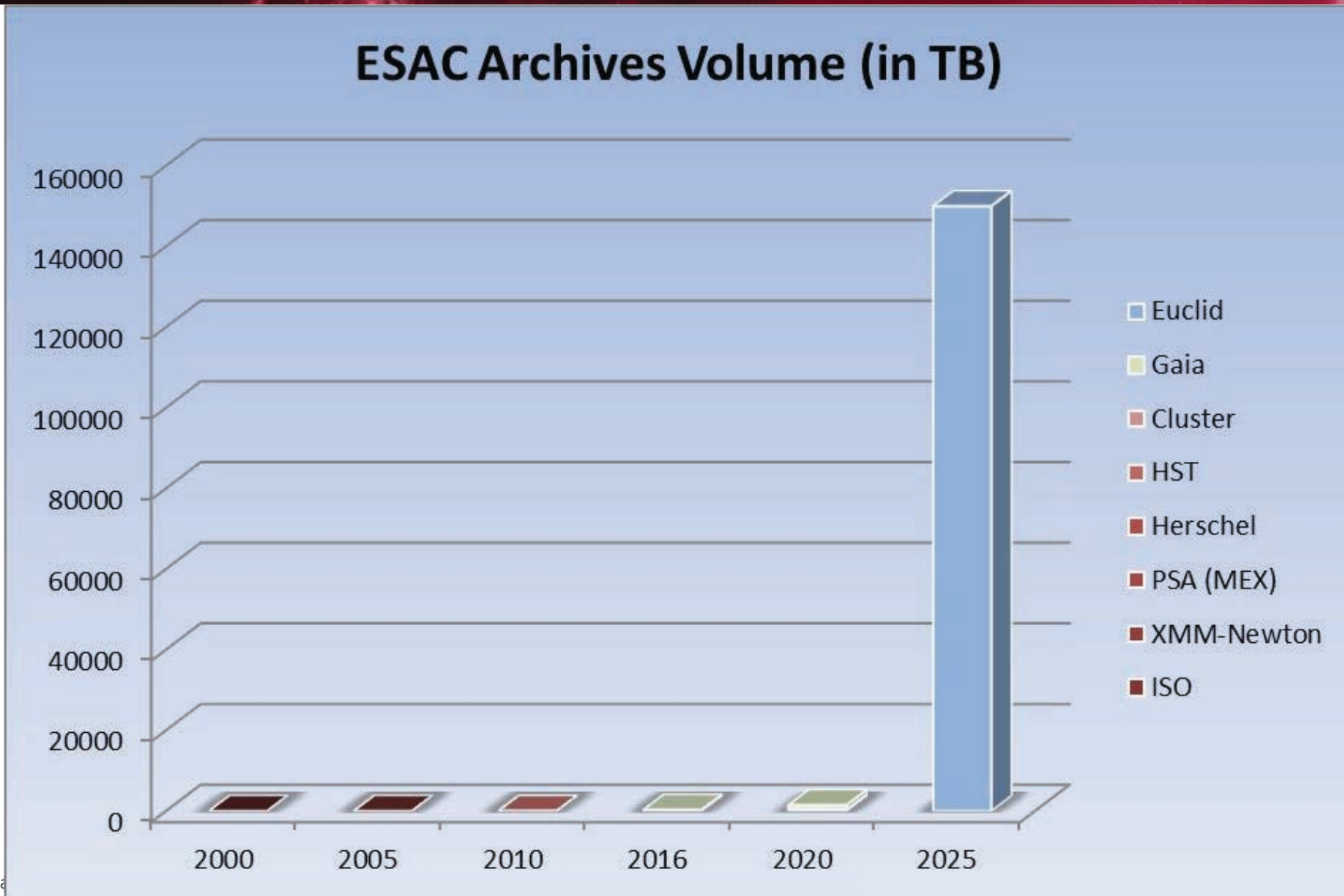
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Archives Volume evolution (2000-2020)



Arna

Archives Volume evolution (2000-2025)



Arna

ESA science archives



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- proba-2
- soho
- ulysses

The Planetary Science Archive

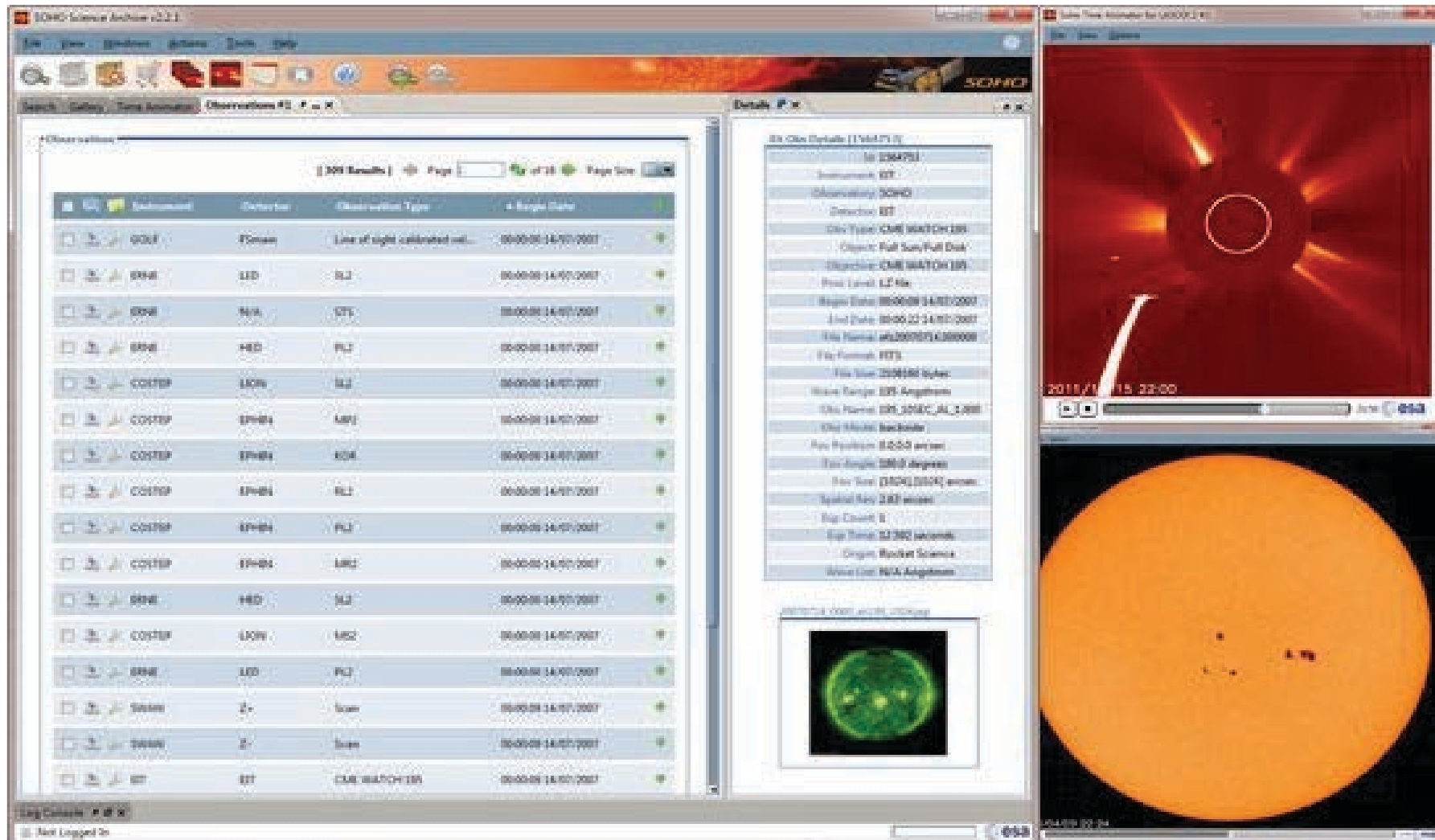
- cassini huygens
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- mars express
- rosetta
- smart-1
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The screenshot displays the Soho Science Archive web interface. On the left, a table lists observations with columns for Instrument, Center, Observation Type, and Acquire Date. The table contains 15 rows of data. In the center, a 'Details' panel provides information for a selected observation, including instrument type, observation name, observation ID, observation type, observation date, and observation time. On the right, two image thumbnails are shown: the top one is a coronagraph image of the Sun, and the bottom one is a full-disk image of the Sun.

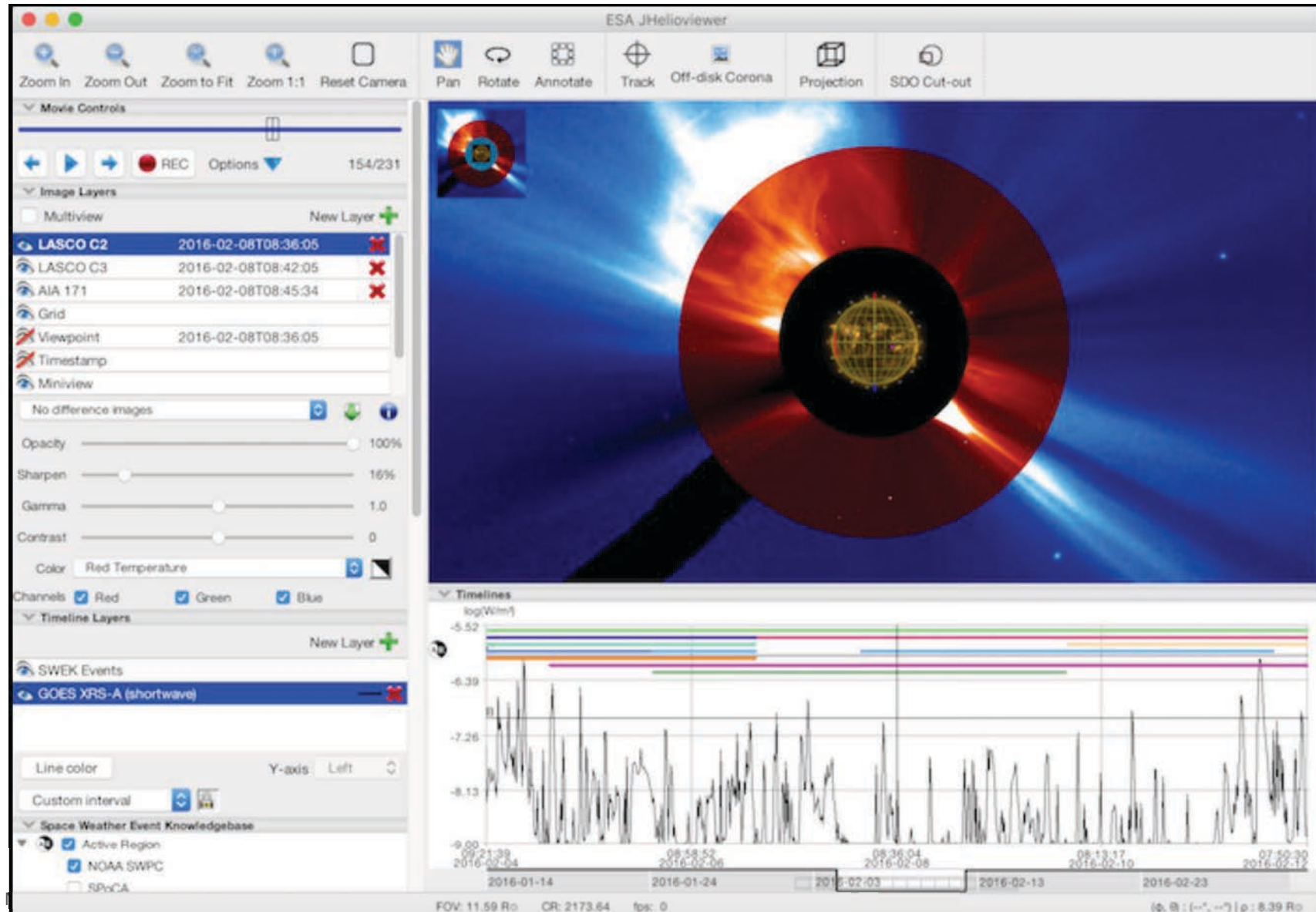
Instrument	Center	Observation Type	Acquire Date
SOUP	Focus	Line of sight calibrated vid.	00:00:00 14/07/2007
EPHE	LID	SL2	00:00:00 14/07/2007
EPHE	N/A	CT1	00:00:00 14/07/2007
EPHE	H4D	PL2	00:00:00 14/07/2007
COSTEP	LOW	SL2	00:00:00 14/07/2007
COSTEP	EPHE4	MR1	00:00:00 14/07/2007
COSTEP	EPHE4	K04	00:00:00 14/07/2007
COSTEP	EPHE4	SL1	00:00:00 14/07/2007
COSTEP	EPHE4	PL1	00:00:00 14/07/2007
COSTEP	EPHE4	MR2	00:00:00 14/07/2007
EPHE	H4D	SL2	00:00:00 14/07/2007
COSTEP	LOW	MR2	00:00:00 14/07/2007
EPHE	LID	PL1	00:00:00 14/07/2007
SWAN	Z-	Scan	00:00:00 14/07/2007
SWAN	Z-	Scan	00:00:00 14/07/2007
ST	ST	CAR WATCH 180	00:00:00 14/07/2007

**Soho Science Archive
Including Proba-2 data**

ESA science archives



<http://www.jhelioviewer.org>



Arnaud

<http://www.jhelioviewer.org>

JHelioviewer is an open-source application for visualization of solar images based on the JPEG 2000 standard.

It is part of the ESA/NASA Heliviewer Project and another client to the Heliviewer web services alongside the Heliviewer.org web application.

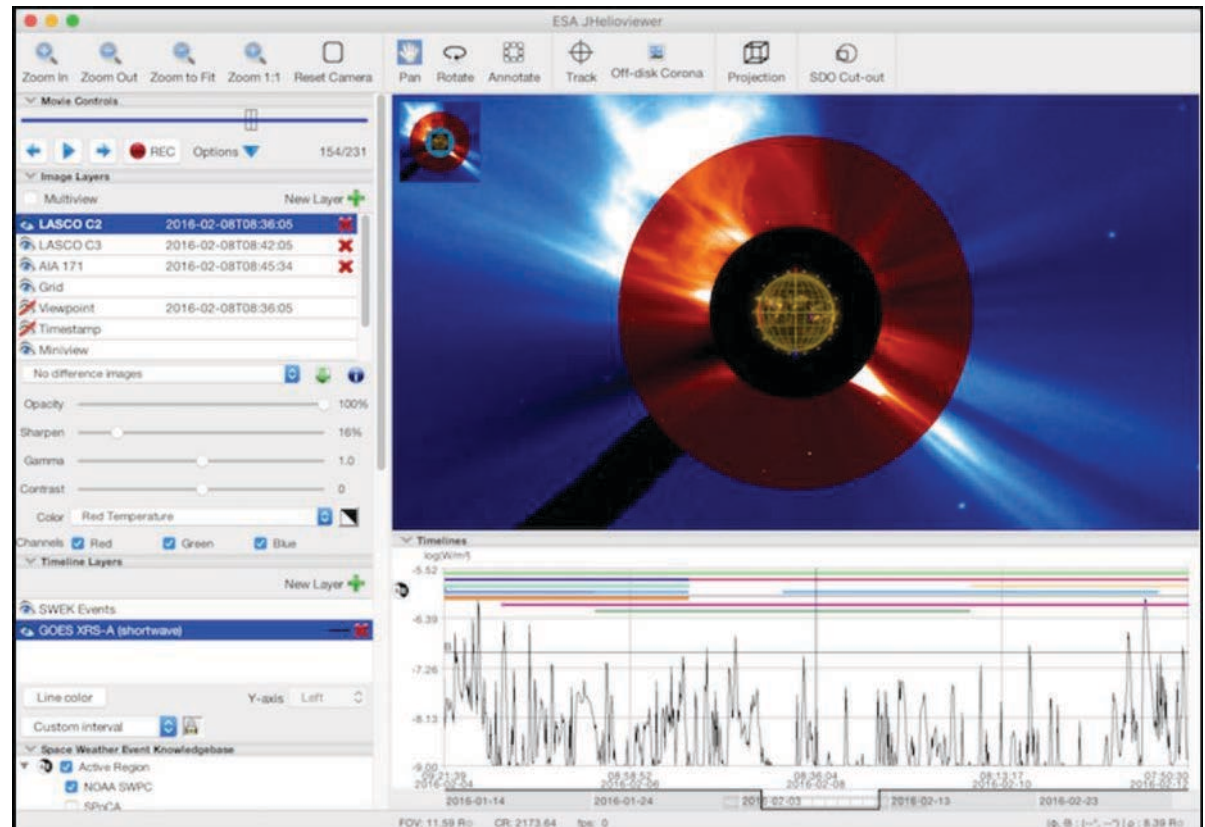
Commonly referred to as "Space Weather HeliViewer". Many of the new additions will be of particular interest to the Space Weather community.

JHelioviewer "2.10" released in March 2016 offers new features, including:
Combined view from different vantage points (e.g. [STEREO](#) and [SDO](#)) for full sphere mapping

Timeline datasets viewing, synchronized with the time of the current image

Integration of features and events from the [Space Weather Events Knowledgebase \(SWEK\)](#), and alerts from the COMESEP system.

Magnetic field line extrapolations



ESA science archives



<http://archives.esac.esa.int>

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The Cluster Science Archive


<https://cosmos.esa.int/csa>



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cluster science archive

Cluster Science Archive » Access to the Archive



cluster

- Access to the Archive
- Registration
- Frequently Asked Questions (FAQ)
- Multi-Spacecraft Analysis Techniques
- Cluster quicklook plots
- Double Star quicklook plots
- Documentation
- Software links
- Other useful links
- Workshops
- CSA Helpdesk
- Data Mining
- People Editor
- Self Registration Moderation
- Find CSA Members

THE CLUSTER AND DOUBLE STAR SCIENCE ARCHIVE

VERSION 1.4.4, RELEASED 31 JULY 2017

→ **START THE CSA GRAPHICAL USER INTERFACE (1.4.4)**

To access the archive through its Java graphical user interface, please use the above link. This interface includes the following data services:

- Direct data download up to 1 GB or Schedule data download up to 40 GB
- Visualize key datasets (on-demand & pregenerated plots)
- Visualize particle distributions (on-demand only)
- Browse inventory information
- Store data profiles

[Automatic login](#)

→ **COMMAND-LINE WEBSITE**

Since August 1, 2017, command line users must renew their CSACOOKIE, due to the installation of a new server on July 31. Use the above link to learn how to access the Cluster science archive data products via several ways including: wget, MATLAB, IDL and data streaming.

Check the [FAQ section](#) if any problem occurs, or [contact us](#).

KEY NEW FEATURES

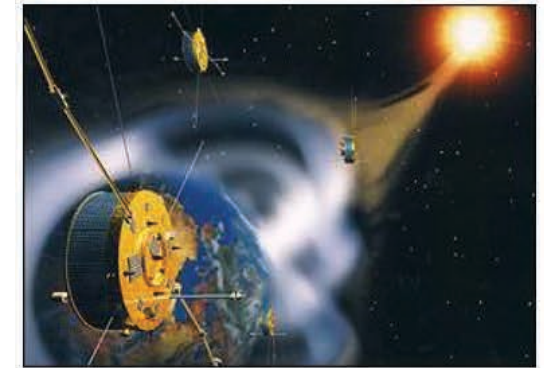
V1.4.4 Faster CSA server installed, minor update of inventory plots; for command line users, it **requires** their **CSACOOKIE to be regenerated**



cluster science archive



- First 4-spacecraft magnetospheric constellation
- Polar orbit, probing most regions of the magnetosphere: solar wind, bow shock, Magnetosheath, MP, cusp, PSBL, plasmashet, AAR, outer plasmasphere, lobes...
- Various inter-spacecraft distances: from 3 km at the bow shock to 20,000 km along the magnetopause... over 17 years, under 2 very different solar cycles!
- Provide ground truth to test MHD-EPIC code for instance thanks to its magnetosphere coverage
- > 2500 publications and 120 PhD
- Still active with on-going coordinated observations campaign with MMS and THEMIS up to 2020
- > 100 TB of data



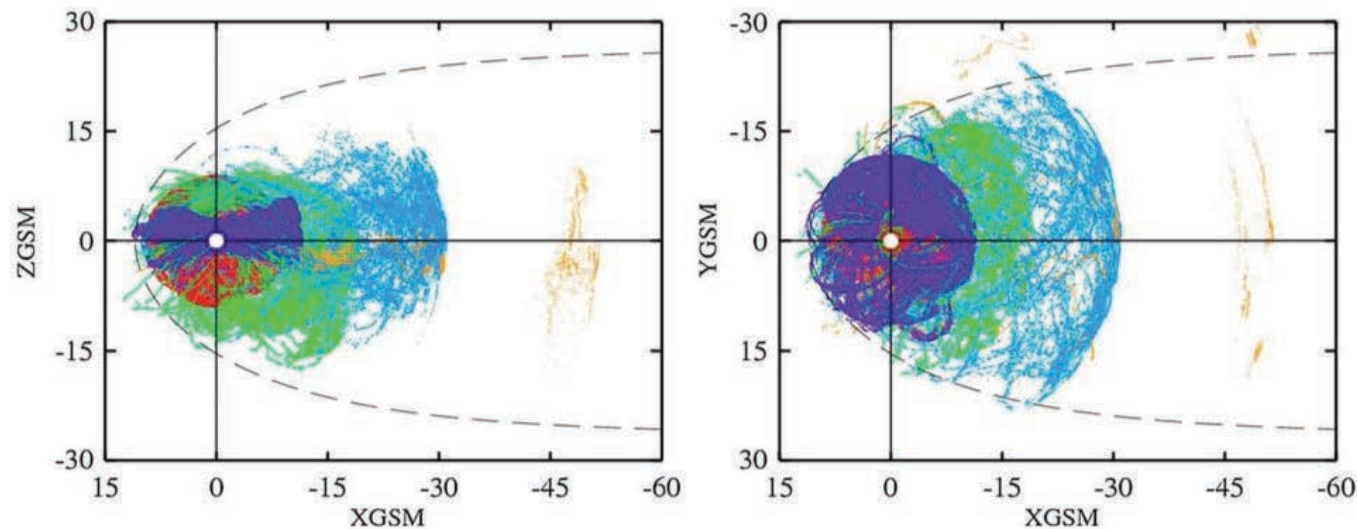


Figure 10. Spatial distribution of the data records in the modeling “grand” set, in projection on (left) XZ and (right) XY planes. Color coding: red = Polar, green = Cluster, light blue = Geotail, dark blue = THEMIS-A, -D, and -E, and light brown = THEMIS-B and -C. Average magnetopause location is shown by dashed lines.

Tsyganenko, 2014

The Cluster Science Archive

<https://cosmos.esa.int/csa>



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cluster science archive

Cluster Science Archive » Cluster quicklook plots

cluster

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PLOT TYPE: Quicklook - Per-Orbit Overview # Plots 1 Size 1.00

Submit |< < 2017 Jul 24 18:00-24:00 > >| ^ Reset [MSP, ?](#)

Cluster Quicklook Per-Orbit: Overview

2017-07-24 Orbit 2684

The plot displays several data series over time (20:00 on 2017-07-24 to 22:00 on 2017-07-26):

- FBM Magnetic Field Strength, nT:** Logarithmic scale from 1 to 1000 nT.
- EFW $-(S/C \text{ Pot})$ Volts:** Linear scale from -50 to 0 Volts.
- CIS Ion Speed km/s:** Logarithmic scale from 10 to 1000 km/s.
- Ion Energy keV:** Logarithmic scale from 0.1 to 10.0 keV.
- Electron Energy keV:** Logarithmic scale from 0.001 to 10.000 keV.
- B Wave Freq kHz:** Logarithmic scale from 0.01 to 1.00 kHz.
- E Wave Freq kHz:** Linear scale from 20 to 80 kHz.

Color bars on the right indicate scales for CIS Ion E-Flux, REACE Electron Units, STAFF SA Bx Field, and WHISPER E Field.

Small diagrams on the right show the Cluster spacecraft configuration in X, Y, and Z coordinates.

Last Updated: Sun Jul 30 01:08:27 2017 <http://www.cluster.lac.uk/csdweb/>

Solar Images: [Solar Monitor](#) | [ACE SW](#) | [GOES X-ray](#) & [SatEnv](#) | [DST from WDC-C2](#)

The Cluster Science Archive



cluster science archive



Cluster Science Archive » Documentation



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DOCUMENTATION

Cluster Instrumentation

- User guides, calibration reports, ICDs
- Other Documents

Double Star Instrumentation

- User guides, calibration reports, ICDs
- Other documentation

CAA Documentation

- General
- CEF format and Metadata Information
- Raw data media
- Technical Notes

Other Documentation

- ESOC Documentation
- ECLAT Documentation





Cluster Science Archive » Documentation



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INSTRUMENT USER GUIDES, CALIBRATION REPORTS AND ICDS

Each instrument has produced the User Guide (UG) and the Calibration Report (CR) to help the CAA users in their CAA data exploitation activities. The Instrument Control Document (ICD) is a technical document between the instrument team and the CAA core team and is given here for the completeness. The purpose of these documents are:

- UG describes the key science datasets and their caveats and quality flags.
- CR describes the key results of the instrument calibration and cross-calibration activities
- ICD describes the detail syntax of the instrument datasets

User Guide	Calibration Report	ICD
ASPOC,v1.0	ASPOC,v1.0	ASPOC,v1.3
CIS,v3.7	CIS,v1.7	CIS,v3.4.3
DWP,v1.11	DWP,v1.3	DWP,v11.0
EDI,v3.5	EDI,v1.6	EDI,v2.7
EFW,v3.8	EFW,v2.4	EFW,v4.10
FGM,v6.2	FGM,v6.2	FGM,v6.2
PEACE,v2.6	PEACE,v1.7	PEACE,v6.4
RAPID,v5.1	RAPID,v5.0	RAPID,v5.4
STAFF,v3.5	STAFF,v4.2	STAFF,v5.5
WBD,v3.1	WBD,v3.0	WBD,v3.3
WHISPER,v1.6	WHISPER,v1.7	WHISPER,v1.12
AUX,v1.0		



Project

7.1 Comparison of STAFF-SC Spin plane DC field with FGM

7.1.1 Case studies

The STAFF/FGM comparison plots below have been presented at the *1st Cross-Calibration Workshop, 2006, ESTEC*, and at the *8th Cross-Calibration Workshop, Kinsale, Ireland, 28-30 October 2008*.

A first problem was identified after launch: the perpendicular DC-field measured by the spinning spacecraft at the spin frequency was not the same from S/C #1 than from the other S/C: The difference was of ~ 8 to 20% with respect to FGM. S/C# 1 gave always lower values than other S/C by $\sim 10\%$, and the difference was confirmed by FGM.

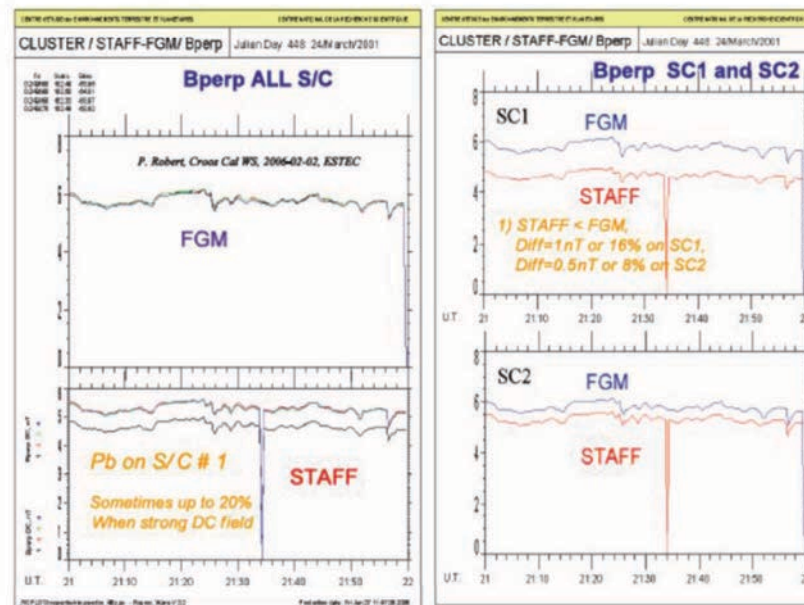


Figure 6: Comparisons of the modulus of the DC field in the plane perpendicular to the spin axis.

Left: comparison of the perpendicular components between the four spacecraft. Top panel is for FGM and bottom for STAFF-SC. Right: comparison of FGM and STAFF-SC for C1 and 2.

R-002
4.2
04-27
of 62

II.5. Visualization tools

- Key graphical products (PI interaction)
- Pre-generated plots (1h, 6h, 24h)
- On-demand key graphical products visualization
- QL plots inc. cross-calibration plots
- Inventory plots



CLUSTER

Search View Key Graphical Products Distribution Functions Profiles List Data Request #1

Plots

Distribution Function Plots

Date Range
 yyyy-MM-dd HH:mm:ss
 Begin 2009-12-30 06:30:00
 End 2009-12-30 06:31:30
 Duration
 Hours 0
 Minutes 1

Plotting Options

#channels (Sauvaud plots):
 Varying scale (pa/nrj or angle/angle plots):
 Velocity plot (wheel plots):

Plot Panel(s)

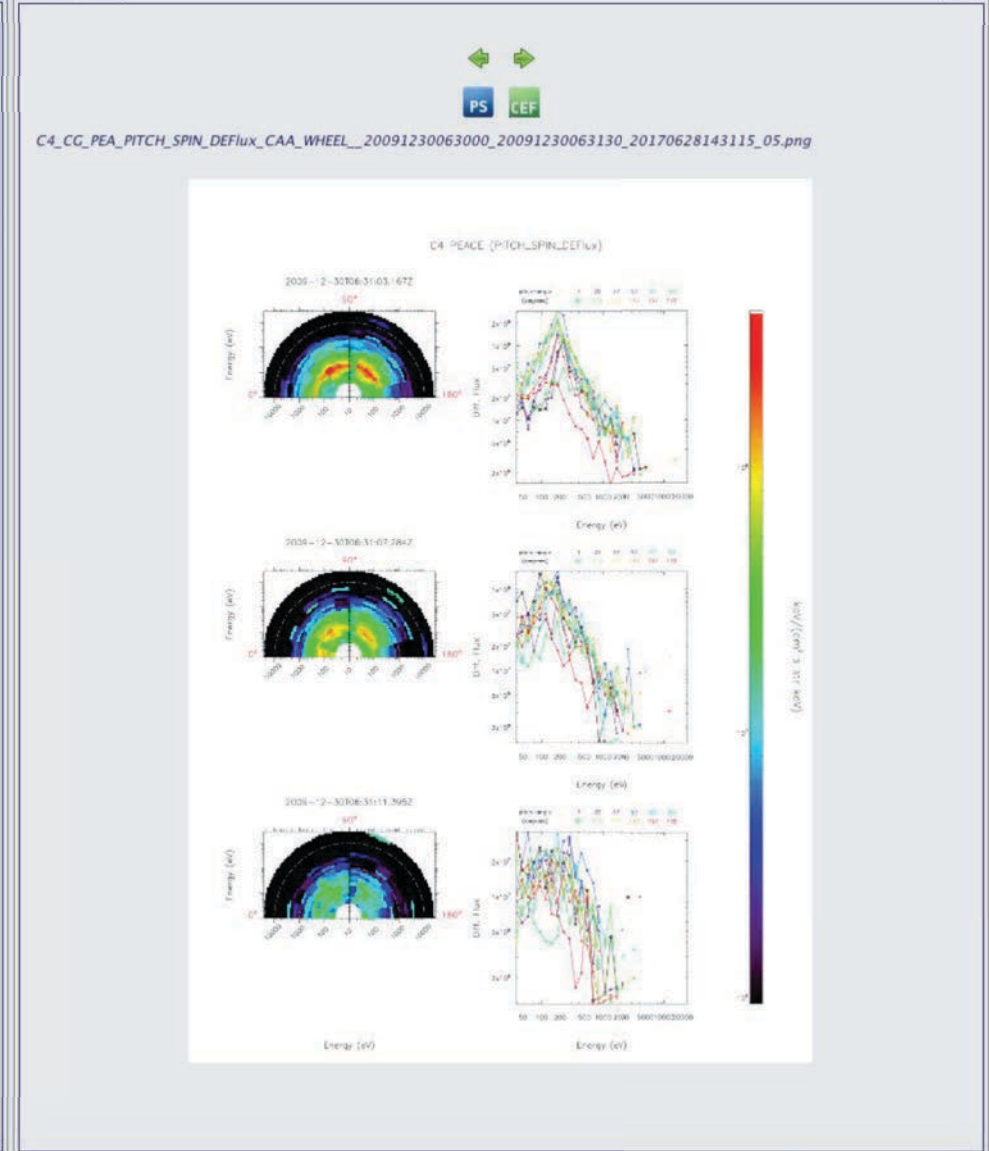
C1 C2 C3 C4

CIS

PEACE

ANGLE-ANGLE DISTRIBUTION (HEEA)
 ANGLE-ANGLE DISTRIBUTION (LEEA)
 PITCH_ANGLE/ENERGY PLOT
 SAUVAUD PLOT
 WHEEL PLOT
 WHEEL PLOT (FULL)

RAPID



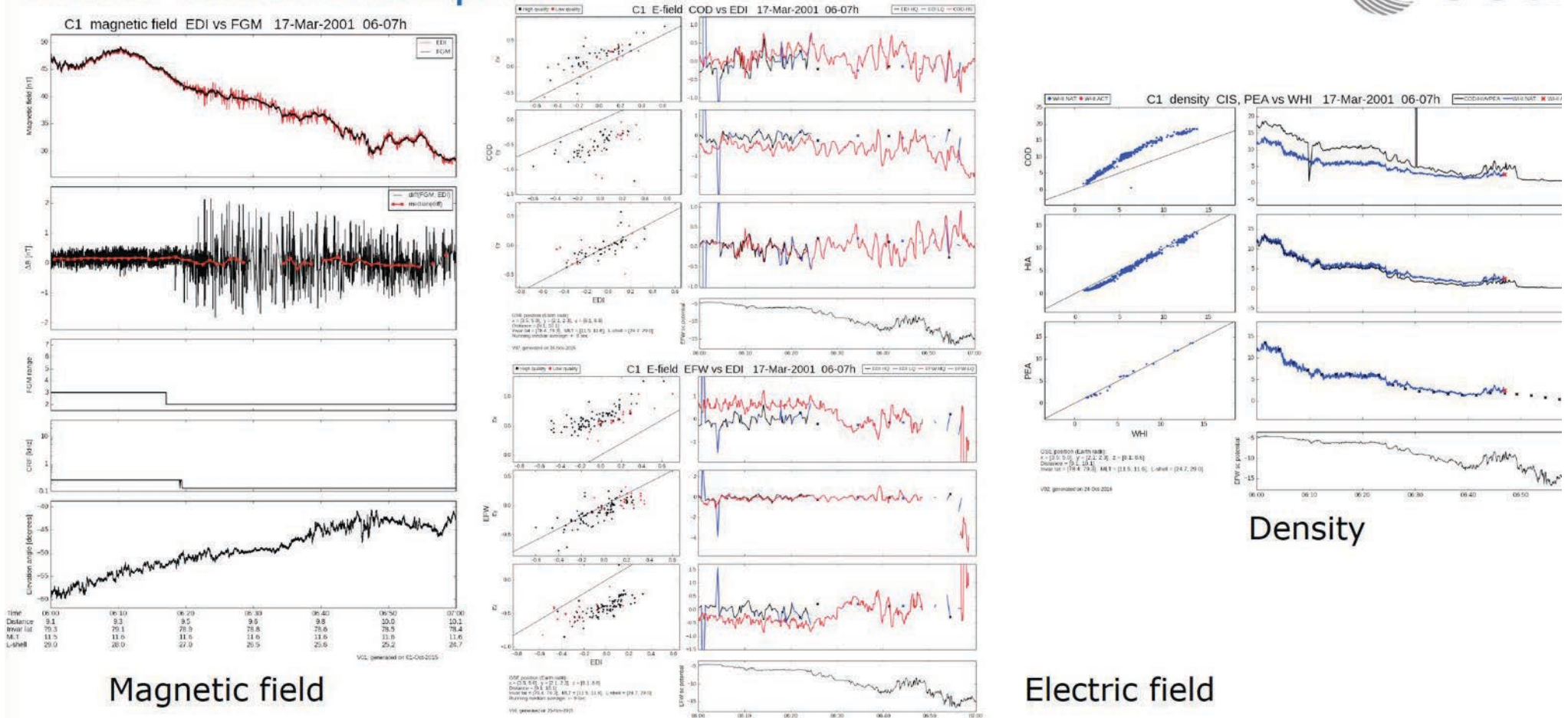
amasson has logged in at 8:17:40 AM



The Cluster Science Archive



Cross-calibration plots



Magnetic field

Electric field

Density

Systematic 1h plots comparing key parameters like DC magnetic, electric field and density from independent experiments

3. The

The screenshot shows the Cluster Science Archive v1.4.3 web interface. The browser window title is "Cluster Science Archive v1.4.3". The navigation bar includes "Login", "Go To", "Tools", "Preferences", and "Help". The user "amasson" is logged in. The interface has tabs for "Search View", "Quicklook Plots", "Inventory Plots", and "Data Request #1". The "Data Request #1" tab is active, displaying a list of 20 data request items, each with a radio button and a green plus icon. The items are categorized by mission and instrument type.

Request Item	Status
<input type="radio"/> MAARBLE: IMAGE OIJ ground-based Pc3-5 power	+
<input type="radio"/> MAARBLE: CARISMA PINA ground-based Pc3-5 power	+
<input type="radio"/> MAARBLE: CARISMA RANK ground-based Pc3-5 power	+
<input type="radio"/> MAARBLE: IMAGE RVK ground-based Pc3-5 power	+
<input type="radio"/> MAARBLE: IMAGE SOD ground-based Pc3-5 power	+
<input type="radio"/> MAARBLE: Themis-A Pc 1-2 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-A Pc 3-5 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-A VLF Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-B Pc 1-2 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-B Pc 3-5 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-B VLF Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-C Pc 1-2 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-C Pc 3-5 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-C VLF Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-D Pc 1-2 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-D Pc 3-5 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-D VLF Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-E Pc 1-2 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-E Pc 3-5 Wave Spectra and PP Parameters	+
<input type="radio"/> MAARBLE: Themis-E VLF Wave Spectra and PP Parameters	+

FP7/H2020 datasets included in the archive

Now, in front of our request, we put `--content-disposition`. This is a `wget` command which *should* (see [Specifying the wget output filename](#)) give the output filename a suitable name.

```
--content-disposition "https://csa.esac.esa.int/csa/aio/product-action?
DATASET_ID=C1_CP_FGM_SPIN&START_DATE=2003-03-03T00:00:00Z&END_DATE=2003-03-
05T00:00:00Z&NON_BROWSER&CSACOOKIE=<cookie>"
```

And finally, put `wget` on the front and it's ready to run.

```
wget --content-disposition "https://csa.esac.esa.int/csa/aio/product-action?
DATASET_ID=C1_CP_FGM_SPIN&START_DATE=2003-03-03T00:00:00Z&END_DATE=2003-03-
05T00:00:00Z&NON_BROWSER&CSACOOKIE=<cookie>"
```

If everything works correctly, you will receive a `.tar.gz` file with your username and a number, e.g., `hmidlet1784379.tar.gz`.

SPECIFYING THE FILENAME

You can specify the filename returned by replacing `--content-disposition` with `-O <filename>`, where `-O` is uppercase O for Oscar. The example above would become:

```
wget -O <filename>.tar.gz "https://csa.esac.esa.int/csa/aio/product-action?
DATASET_ID=C1_CP_FGM_SPIN&START_DATE=2003-03-03T00:00:00Z&END_DATE=2003-03-
05T00:00:00Z&NON_BROWSER&CSACOOKIE=<cookie>"
```

USING THE DIFFERENT TYPES OF REQUEST

The other data requests are used with `wget` in exactly the same way as above, using the `https` requests and parameters detailed on their respective tabs, but their outputs will be different. If you are supplying the filename, as detailed above, it makes working with the data easier if the correct file type is given:

DATA REQUEST

A data request, if successful, will supply a file package in **.tar.gz format**, as in the example above.

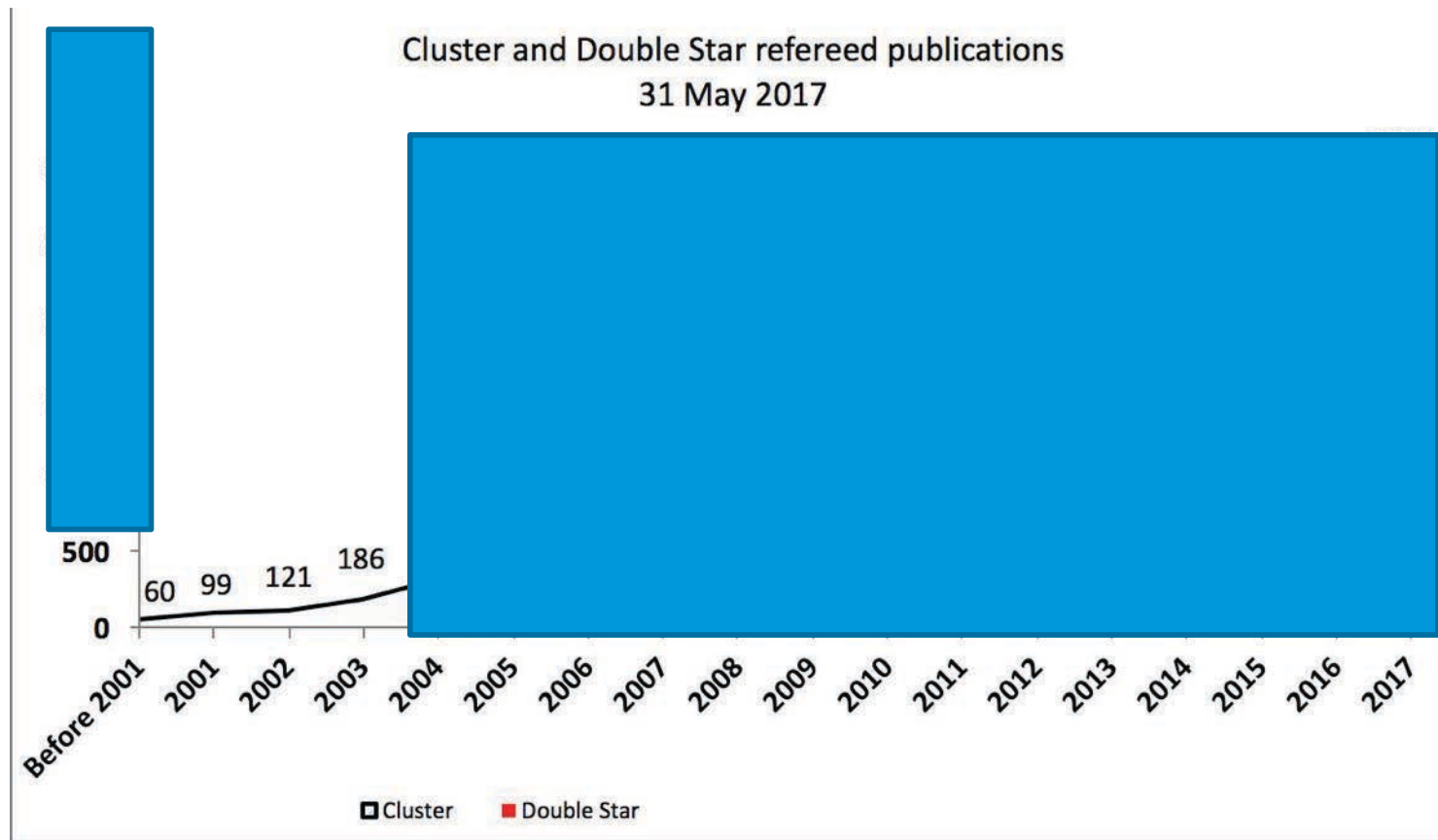
ASYNCHRONOUS DATA REQUEST

When you submit a successful asynchronous data request, the returned file will be a **text file** that should contain text similar to this:

The Cluster Science Archive



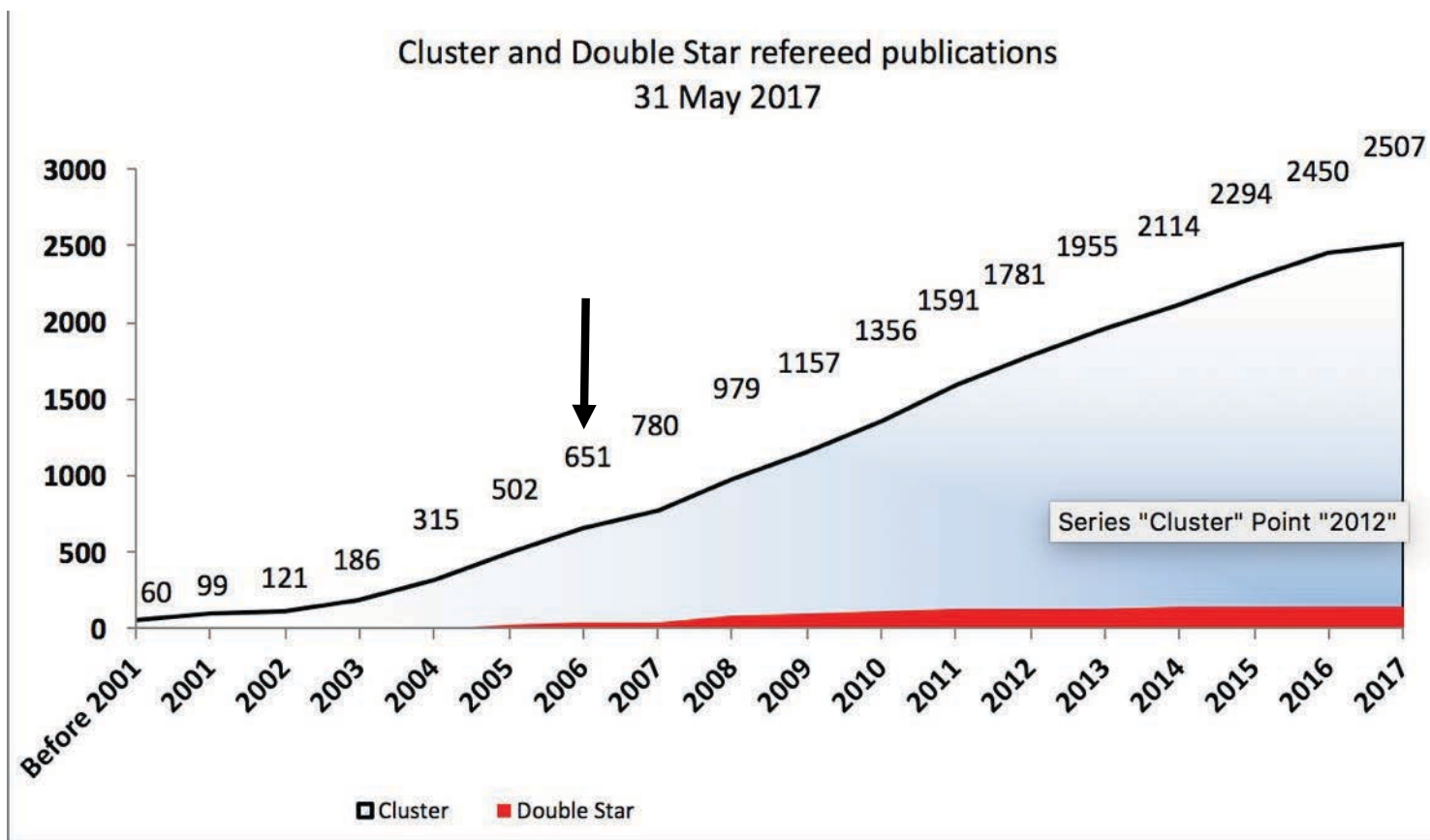
II.10. Wrap-up



The Cluster Science Archive

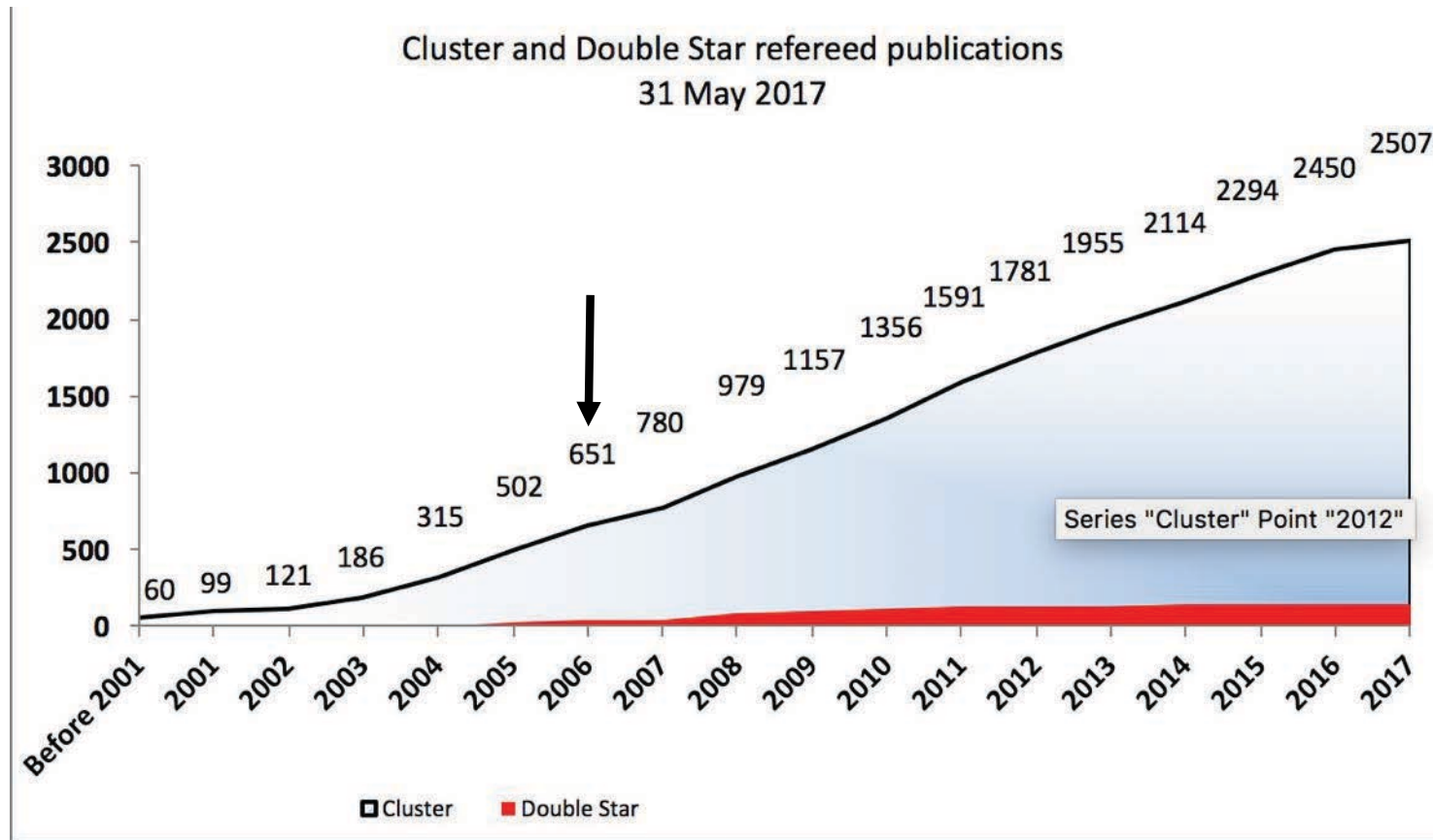


II.10. Wrap-up



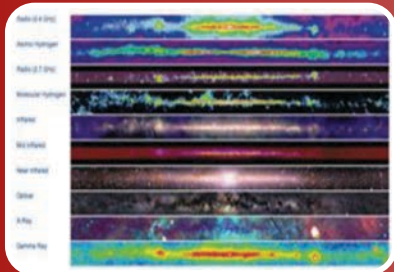
The Cluster Science Archive

II.10. Wrap-up



Rank	Country
1	USA
2	China
3	UK
4	France
5	Sweden
6	Germany
7	Russia
8	Austria
9	Japan
10	Czech Rep.
11	Finland
12	Belgium
13	Italy
14	Netherlands
15	India
16	Canada
17	Norway
18	Hungary
19	Poland
20	Greece
21	Romania
22	Brazil
23	Australia
24	Mexico
25	Korea
26	Serbia
27	Israel
28	Switzerland
29	Palestinian T
30	Pakistan
31	Argentina
32	Armenia
33	South Africa
34	Thailand
35	Turkey
36	Chile
37	New Zealand
38	Spain
39	Ireland
40	Croatia
41	Iran

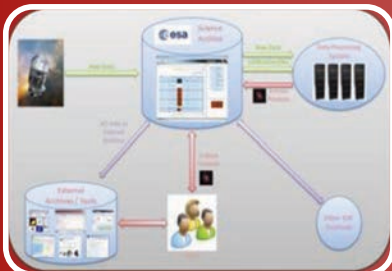
ESAC Science Archives Strategy



Enable maximum **scientific exploitation** of data sets



Enable efficient **long-term preservation** of data, software and knowledge, using modern technology



Enable cost-effective archive production by **integration in, and across, projects**