Agenzia Spaziale Italiana

VO Activities @ Space Science Data Center:
possible application of VO protocols to SSDC archives

Francesco Verrecchia

(ASI-SSDC, INAF-OAR)

Vobs.it. 16 July 2021

SSDC
SPACE SCIENCE DATA CENTER

ASI - Italian Space Agency

The Space Science Data Center is a Research Infrastructure of the Italian Space Agency

MAIN GOAL

acquire, manage, process and distribute data from (mainly) space based mission adopting the FAIR (Findable, Accessible, Interoperable, Reusable) principles.

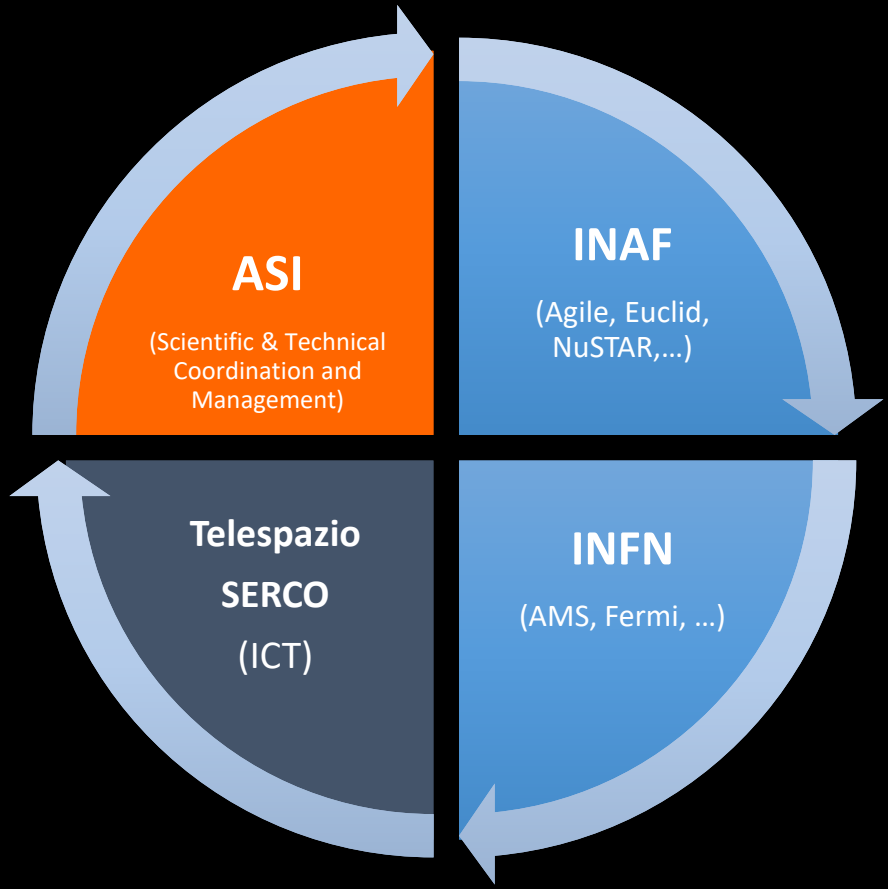
SSDC adopts international standards ensuring both the long term preservation of archives and the interoperability with other data centers.

SSDC – Universe Observation

SSDC – UO management and organization involves several Research Institutes:

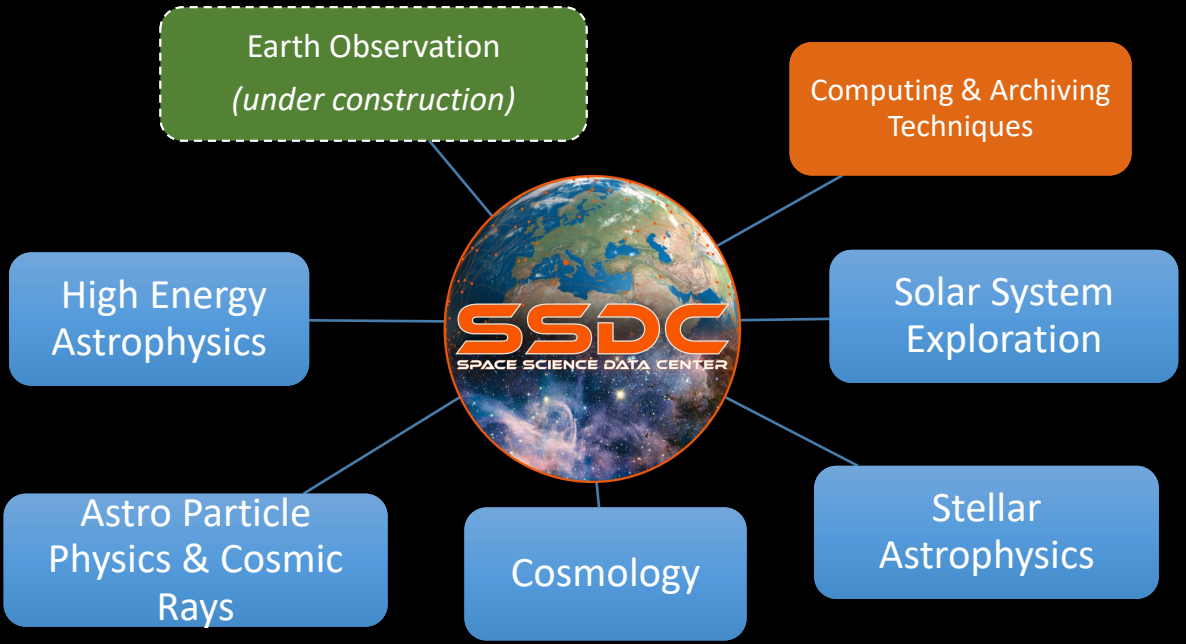
- **ASI** – Italian Space Agency
- **INAF** – National Institute for Astrophysics
- **INFN** – National Institute for Nuclear Physics

Industries are involved for Information and Communication Technology supports.



SSDC Scientific Expertise

At present, SSDC team involves around 40 people: scientists from ASI, INAF, INFN and SW engineers from Telespazio & SERCO, experts in different fields.



Effective approach: Developers and Users belong to the same communities.

SSDC VO activity (from interop presentation)

SSDC (ex-ASDC) has partecipated to the european data center census promoted by EuroVO Data Center Alliance (DCA) to identify public european data center following or which will follow the VO standards.

Current activities:

- Review of the VO access to the astronomical catalogs hosted within the SSDC services
- GAIA TAP service integration
- Update SSDC TAP service (new registration)
- Recover Catalog VO interoperability with SAMP protocol
- Activity to allow access to the Multi-Mission scientific data archives hosted at SSDC through the VO
  - Development of new services (SSAP, SIAP)
  - Development of MATISSE 2.0 and integration within VESPA for the planetary mission scientific archives
  - Implementation of IVOA standards in the on-line SSDC services and tools; SED, Data Explorer, Multi Catalog Search e Multi Mission Interative Archive

Future further developments

- Study of a Space Weather portal in SSDC (ASPIS): assessment of applicable VO protocols
- Earth Observation: assessment of applicable VO protocols

SSDC activity, prospects for VO

My contribution to SSDC (ex-ASDC): in some space missions in the past years on scientific standard data processing and QL monitoring, together with scientific results presentation to the community. Main involvement on High-Energy astrophysics but not only: mainly (chronologically) BeppoSAX, Swift and AGILE; a recent contribution in CHEOPS, then contributions to Multi-Wavelength/Multi-Mission services. In particular, for this presentation: BeppoSAX/WFC , Swift/UVOT archival DA and web services.

Then =>participation to the study and development of scientific on-line data analysis, mainly «Imaging tools».

In the last years a contribution to the Open Universe (OU) activities in SSDC, to some services on the ASI dedicated portal, mainly regarding Swift data.

Among all the possible application of VO protocols to SSDC tools and archives, I will show a few cases:

- Regarding development of new services (SSAP, SIAP)
  - Swift/UVOT (and XRT) imaging tools
  - BeppoSAX/WFC archives
  - OU services for Swift surveys: HiPS

SSDC Swift archive

I may suppose that is not needed to descrive the NASA Swift space mission ….

SSDC hosts one of the three official archives

Home About SSDC News and Communication Quick Look Missions Multimission Archive Catalogs Tools Links Bibliographic services
Helpdesk Privacy

Swift Home About Swift ASI HQ Swift Home Swift Data Archive Swift pointings Swift Catalogs Swift Quicklook Data Swift Data Analysis
Swift Helpdesk GCN ToO Request Form Malindi ground station Gallery

The Swift Gamma-Ray Burst Mission

ASI Swift Scientific Page (Italian)

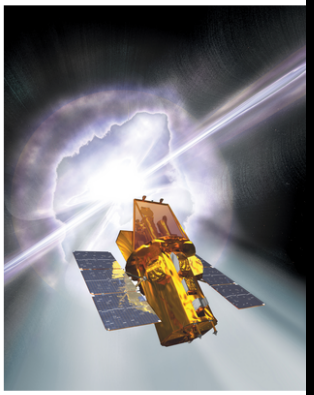
Swift is a MIDEX Gamma Ray Burst mission led by NASA with participation of Italy and the UK. The Swift data are available to the scientific community through data centers in the USA, Italy and the UK.

Italy contributes to the mission providing:

- **The XRT X-ray mirror**
- **The Malindi ground station**
- **XRT data reduction and analysis software**

The ASI Science Data Center (ASDC) contributes to the mission providing:

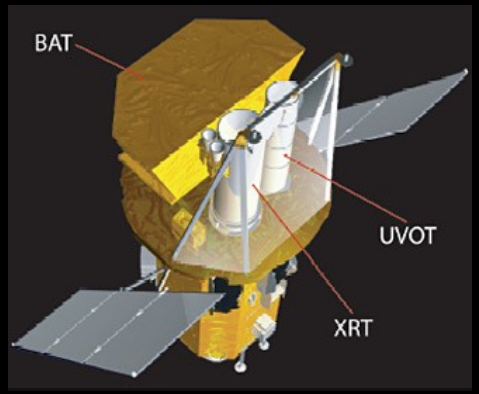
- **Swift Data Archive Mirror**
- **On-line XRT & UVOT data analysis**
- **Swift Quick Look Data (XRT & UVOT Interactive Quick Look)**
- **XRT Burst Support (XBS) and Burst Advocate (BA) activity**
- **XRT data simulator**
- **XRT Helpdesk**
- **XRT Data Analysis Software (XRTDAS)**
  Latest software release available here!



An artist rendering of the Swift satellite catching a Gamma-ray Burst

Latest Swift News

- **(Oct 28, 2015)** Swift catches its 1000th Gamma-ray Burst!



SSDC Science Gateway

http://www.ssdc.asi.it

The Multi-Mission Interactive Archive (MMIA) is the SSDC door to access all the hosted data archives.

=>TWO versions: 1) classic single archive query…

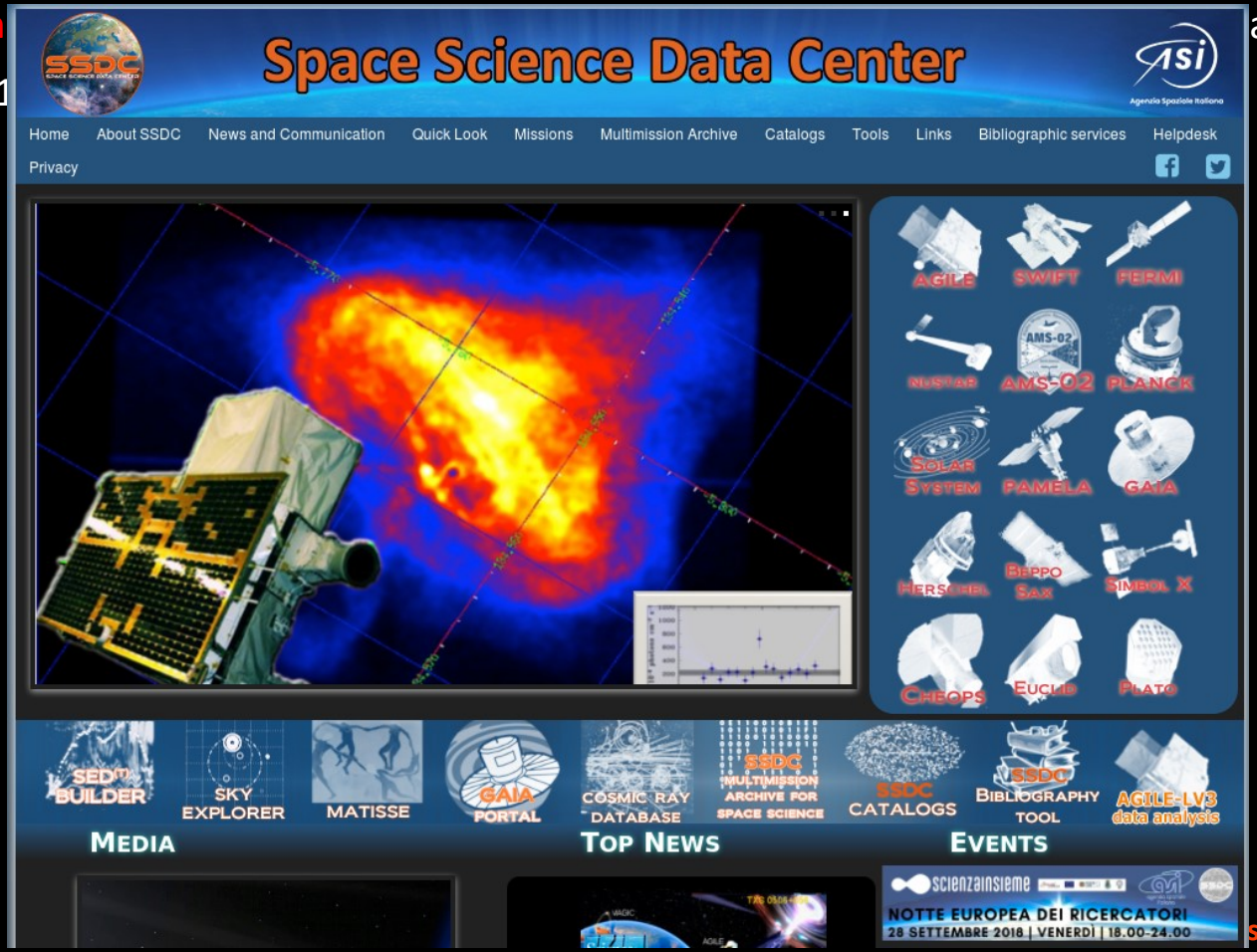
SSDC Science Gateway

http://www.ssdc.asi.it

The Multi-Mission [illegible] a archives.

=>TWO versions: 1

Science Tools allow the on-line access to data within a multifrequency environment



On-line Access to Space Missions Data Archives

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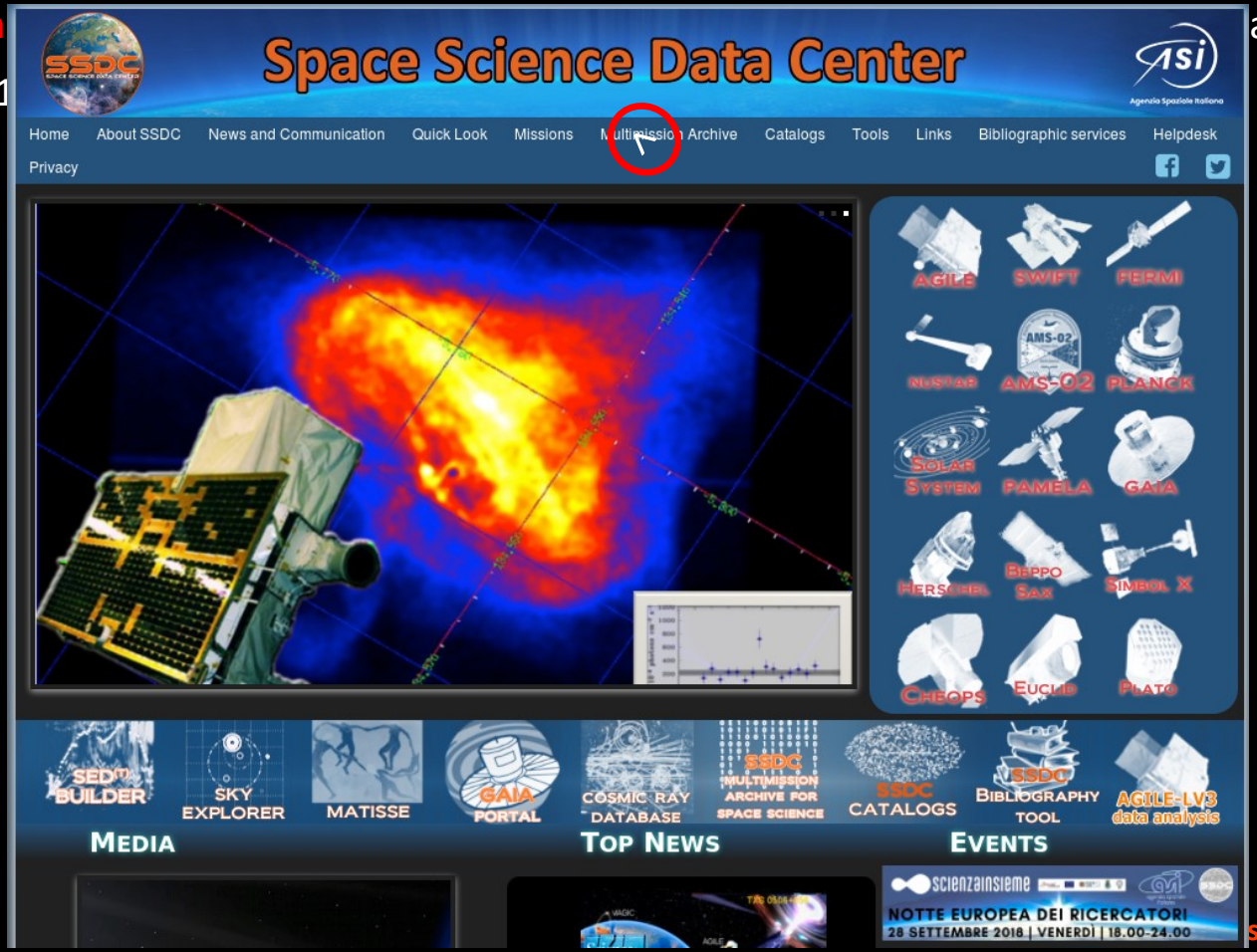

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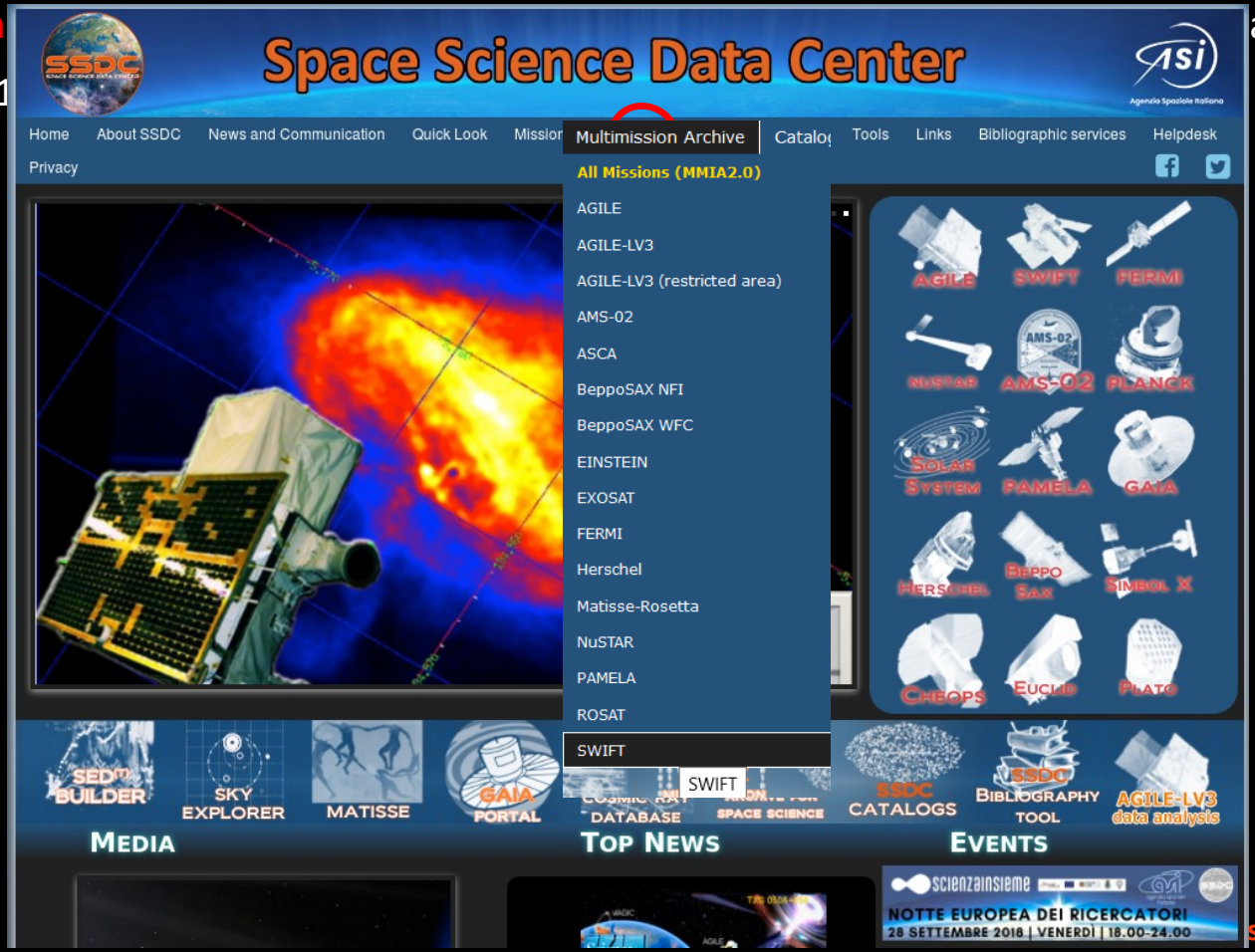

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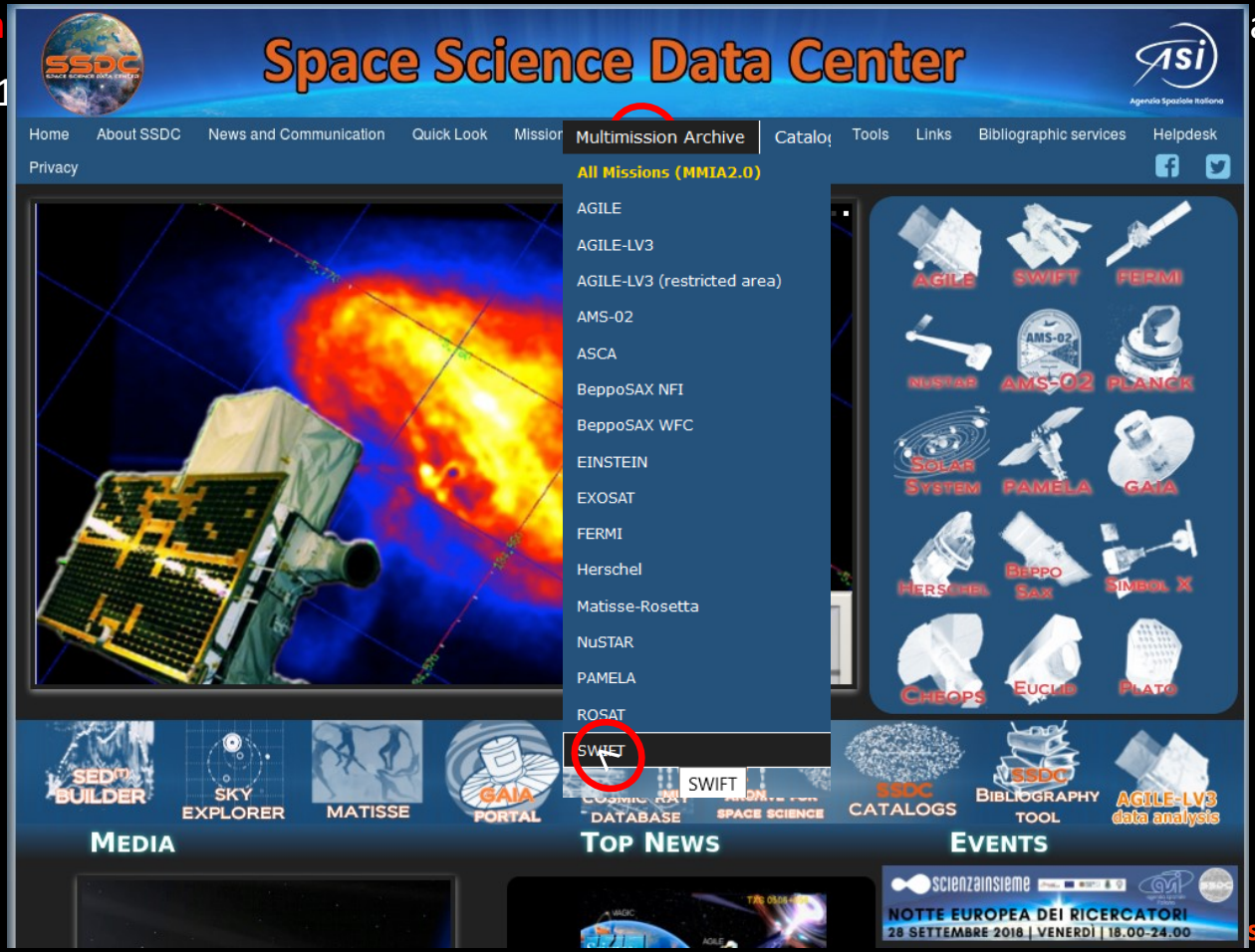

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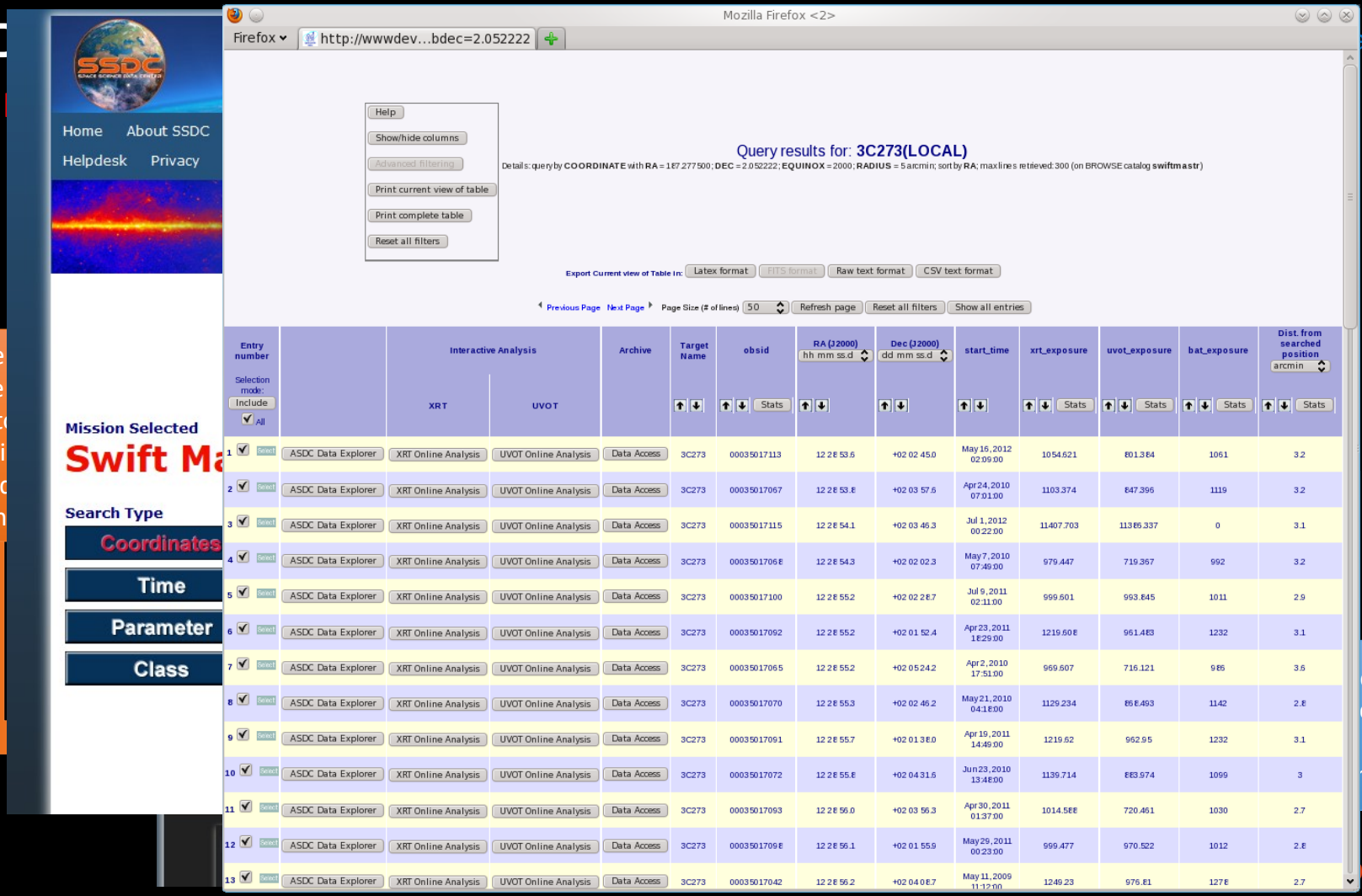
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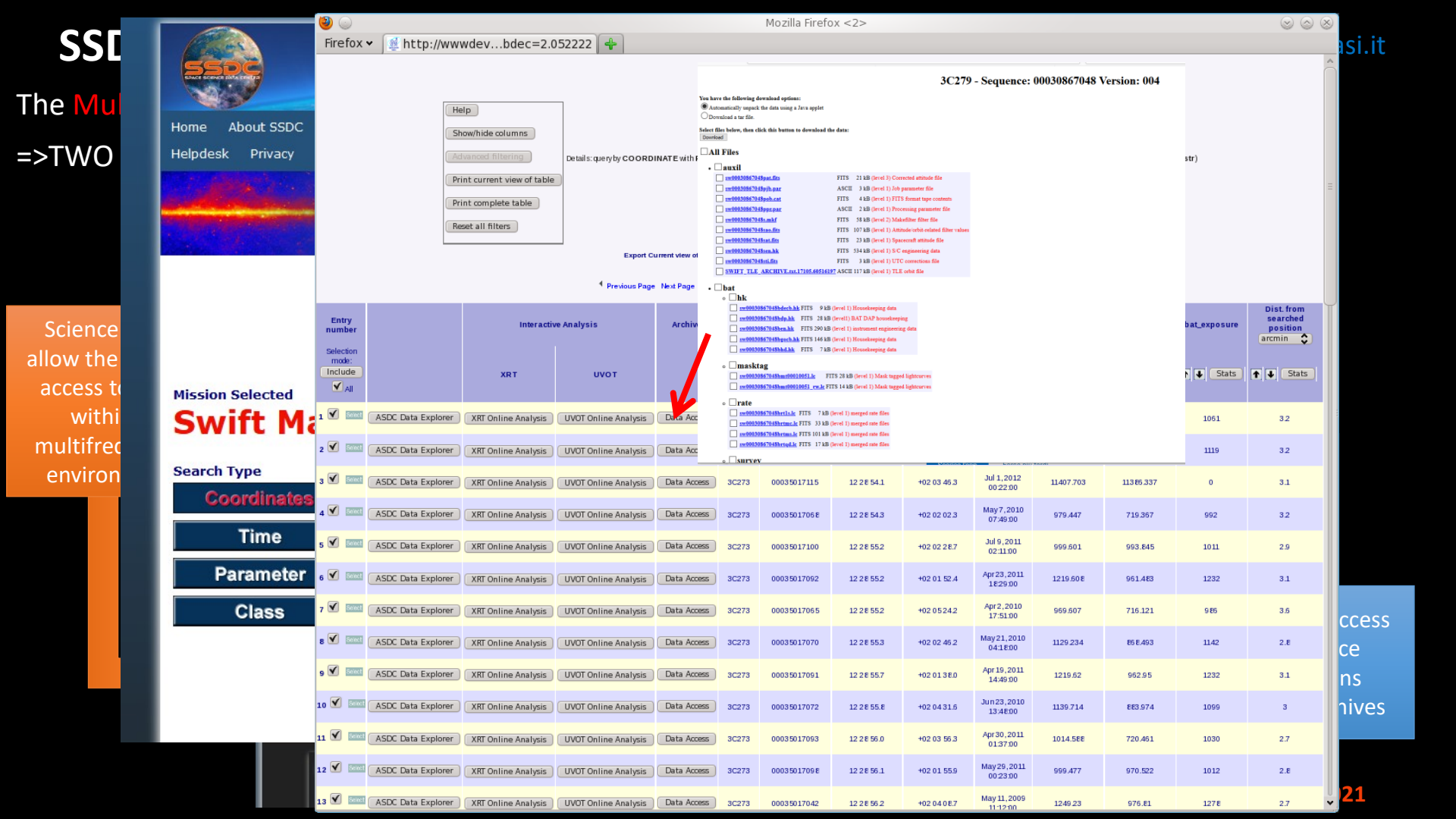
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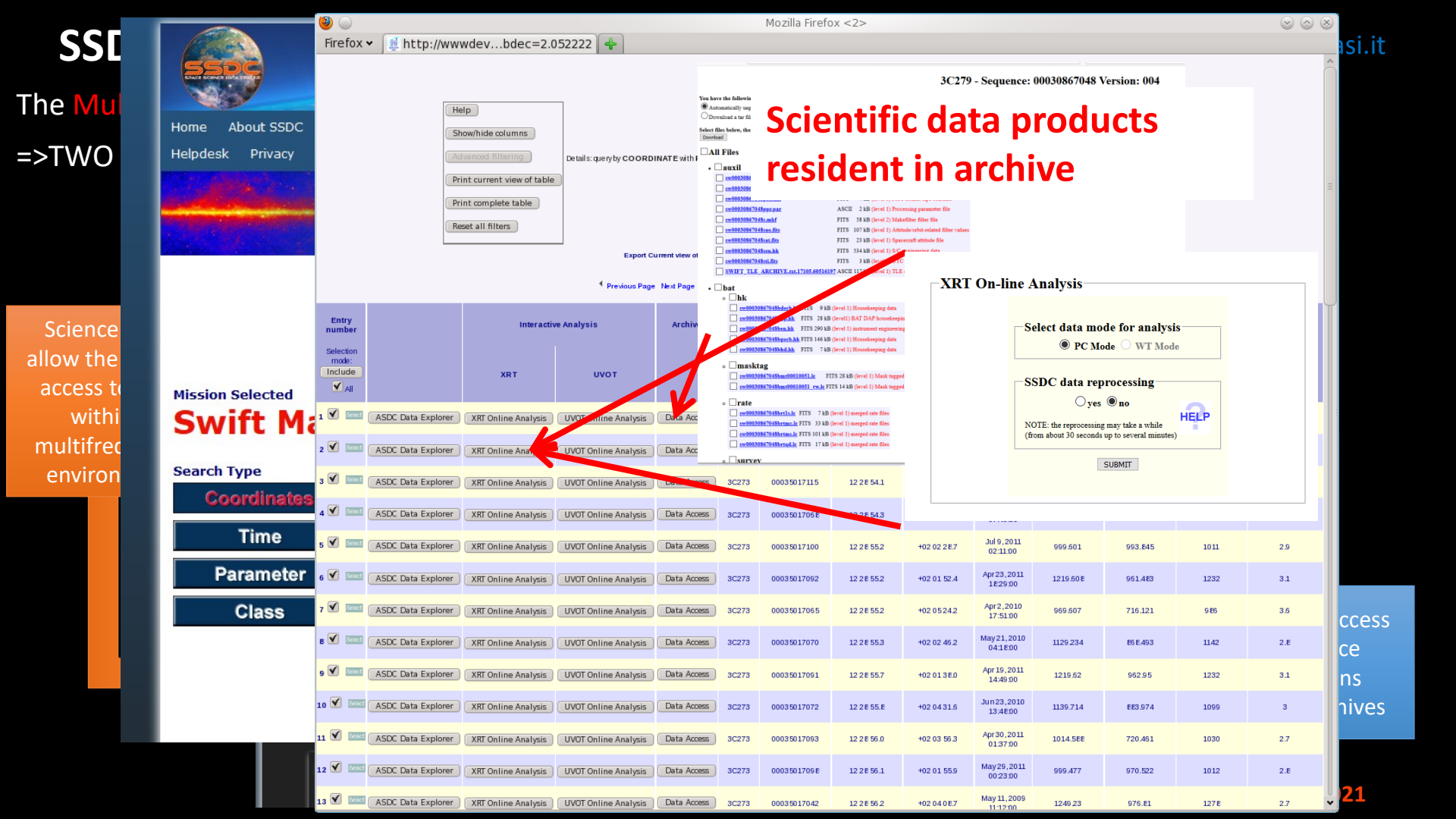
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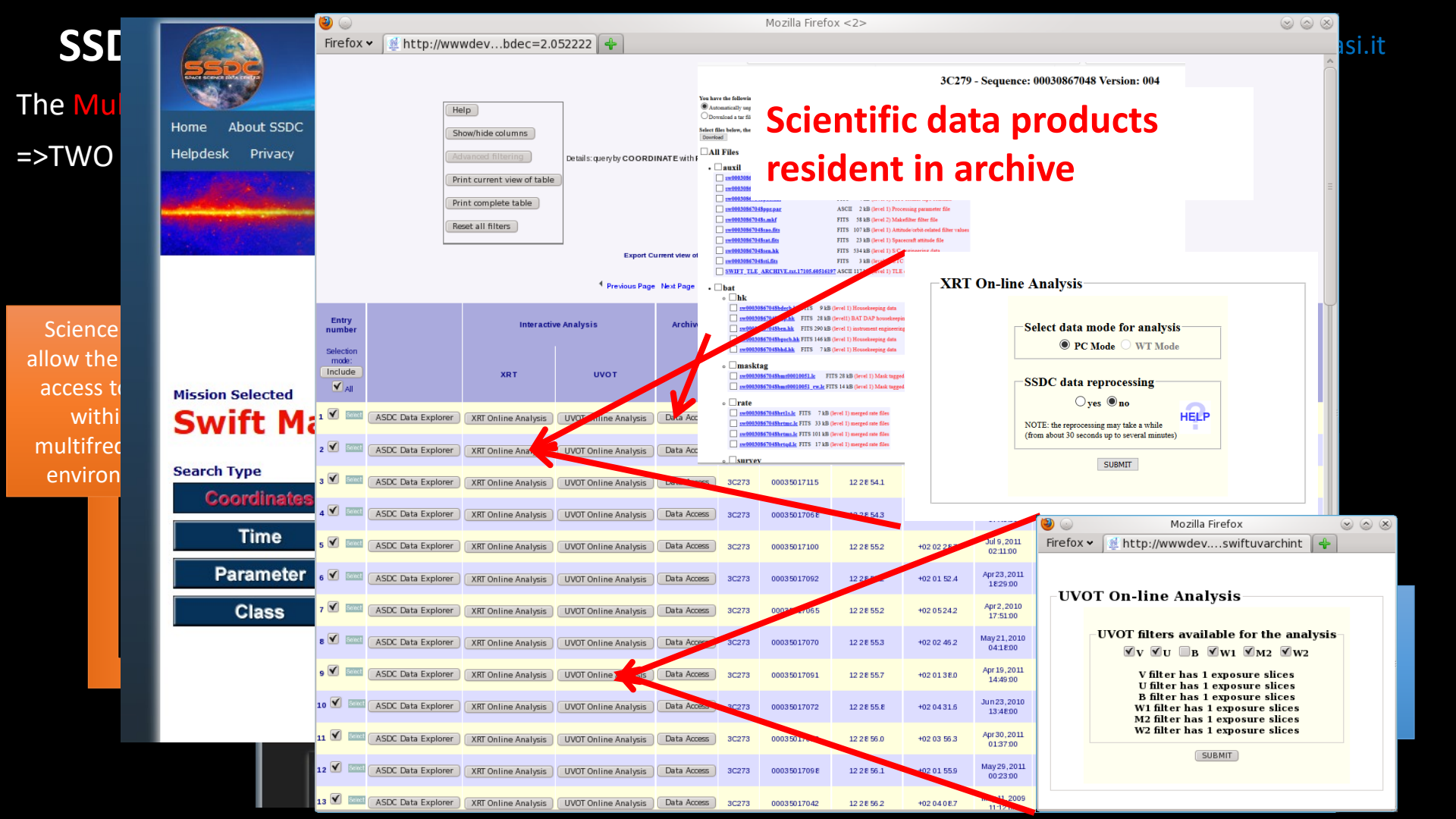
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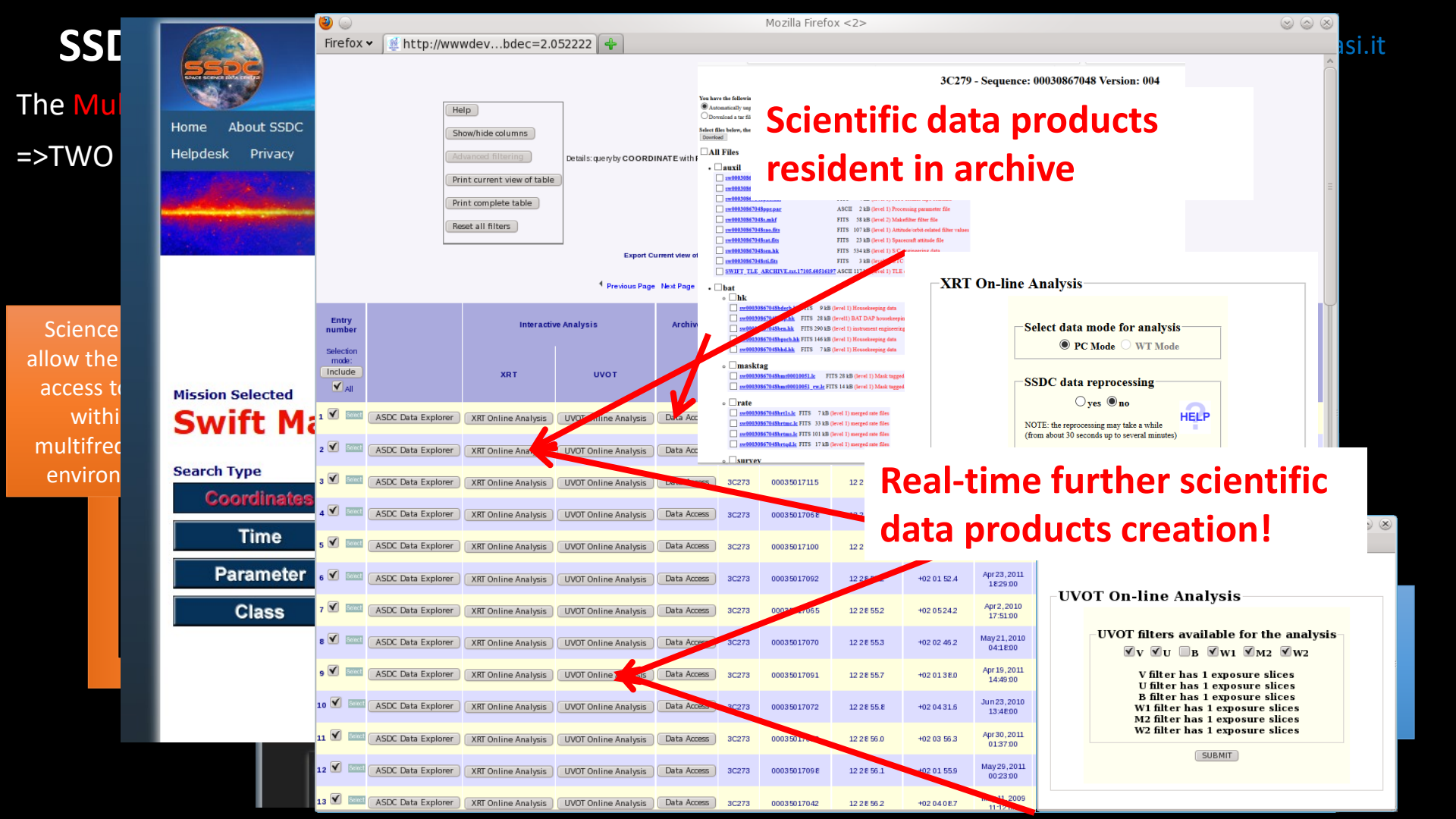
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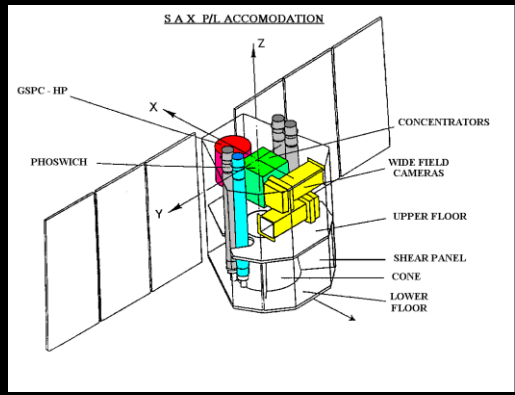
SSDC BeppoSAX-WFC archive

Also the ASI BeppoSAX mission with participation of the Netherlands space should not need introduction…. SSDC is the official mission data center.

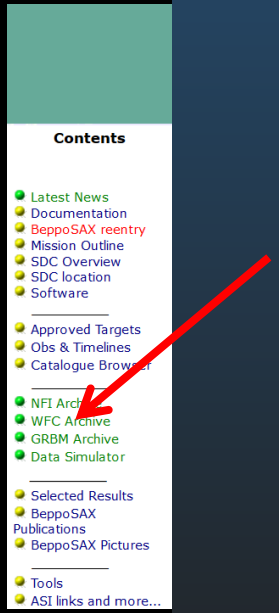
→Wide Field Camera

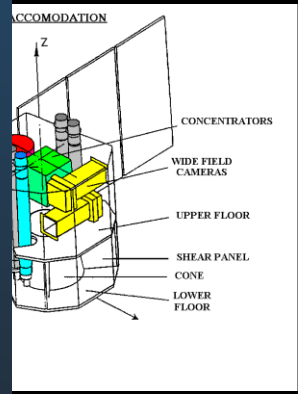


SSDC BeppoSAX-WFC archive

Also the ASI BeppoSAX mission with participation of the Netherlands space should not need introduction.

→Wide Field

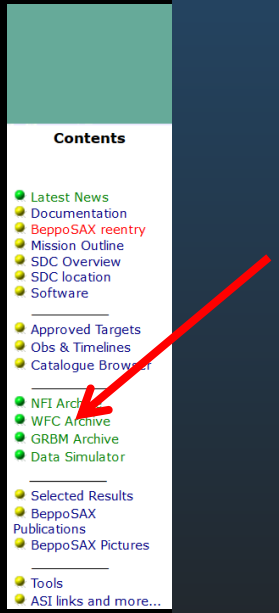


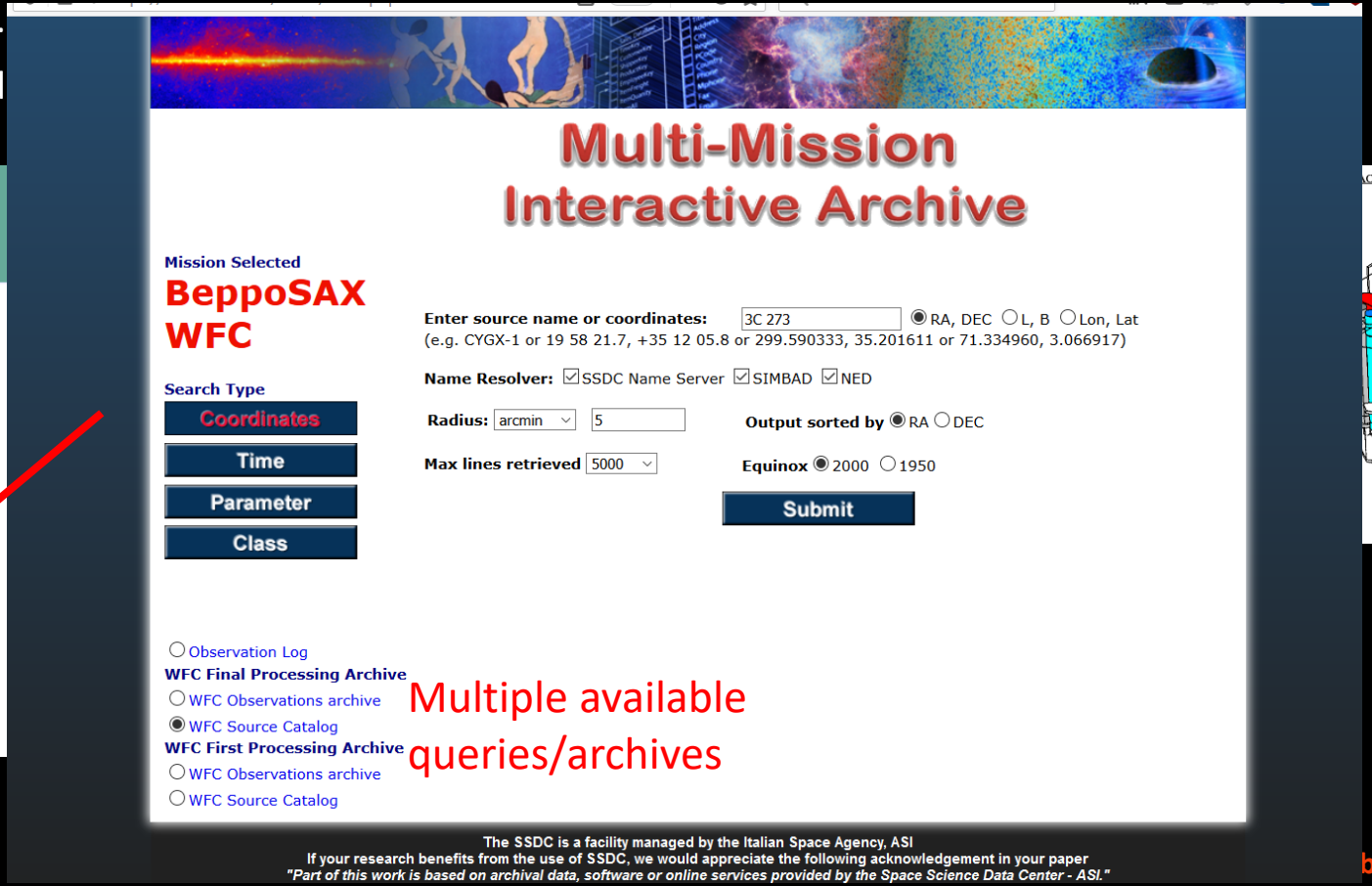


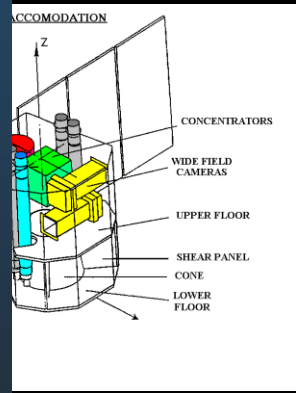
SSDC BeppoSAX-WFC archive

Also the ASI BeppoSAX mission with participation of the Netherlands space should not need introduction.

→Wide Field







SSDC BeppoSAX-WFC archive

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Reset all filters

Query results for: '3C273(SSDC)'

Details: query by **COORDINATE** with **RA** = 187.277875; **DEC** = 2.0523888888889; **EQUINOX** = 2000; **RADIUS** = 5 arcmin; sort by **RA**; max lines retrieved: 5000 (on BROWSE catalog **repwfcall**)

Export Current view of Table in: Latex format | FITS format | Raw text format | CSV text format | Browse table

Previous Page | Next Page | Page Size (# of lines) 200 | Reset all filters | Show all entries

This view includes 3 entries

Entry number Selection mode: Include / All		wfcname	RA (J2000) hh mm ss.d	Dec (J2000) dd mm ss.d	flux210	obs_code	dist_iroscat	off_axis_angle	Target Name	Dist. from searched position arcmin
					Stats	Stats	Stats	Stats		Stats
1 ☑ Select	SSDC Data Explorer	WFCJ1229.1+0201.9	12 29 02.99	+02 01 52.28	1.27e-10	1057200100	1.56	2.64	3C273	1.5
2 ☑ Select	SSDC Data Explorer	WFCJ1229.1+0203.5	12 29 03.4	+02 03 28.79	2.12e-10	9000044500	0.88	8.69	3C273	0.8
3 ☑ Select	SSDC Data Explorer	WFCJ1229.1+0202.3	12 29 05.4	+02 02 20.68	7.88e-11	5110900300	0.86	7.88	3C273	0.8

Previous Page | Next Page | Page Size (# of lines) 200 | Reset all filters | Show all entries

Export Current view of Table in: Latex format | FITS format | Raw text format | CSV text format | Browse table

hoice of column that can be displayed:

WFC Source Catalog

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SSDC BeppoSAX-WFC archive

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- GRBM Archive
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- Selected Result
- BeppoSAX Publications
- BeppoSAX Pict
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- ASI links and r

Query results for: '3C273(SSDC)'

Details: query by **COORDINATE** with **RA** = 187.277875; **DEC** = 2.0523888888889; **EQUINOX** = 2000; **RADIUS** = 5 arcmin; sort by **RA**; max lines retrieved: 5000 (on BROWSE catalog **repwfcall**)

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Previous Page | Next Page | Page Size (# of lines) 200 | Reset all filters | Show all entries

This view includes 3 entries

Entry number Selection mode: Include All		wfcname	RA (J2000) hh mm ss.d	Dec (J2000) dd mm ss.d	flux210	obs_code	dist_iroscat	off_axis_angle	Target Name	Dist. from searched position arcmin
					Stats	Stats	Stats	Stats		Stats
1 Select	SSDC Data Explorer	WFCJ1229.1+0201.9	12 29 02.99	+02 01 52.28	1.27e-10	1057200100	1.56	2.64	3C273	1.5
2 Select	SSDC Data Explorer	WFCJ1229.1+0203.5	12 29 03.4	+02 03 28.79	2.12e-10	9000041500	0.88	8.69	3C273	0.8
3 Select	SSDC Data Explorer	WFCJ1229.1+0202.3	12 29 05.4	+02 02 20.68	7.88e-11	5110900300	0.86	7.88	3C273	0.8

Previous Page | Next Page | Page Size (# of lines) 200 | Reset all filters | Show all entries

Export Current view of Table in: Latex format | FITS format | Raw text format | CSV text format | Browse table

hoice of column that can be displayed:

WFC Source Catalog

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- NFI Arch
- WFC Archiv
- GRBM Arch
- Data Simul

- Selected Re
- BeppoSAX Publications
- BeppoSAX

- Tools
- ASI links an

SSDC-BeppoSAX WFC Interactive Archive

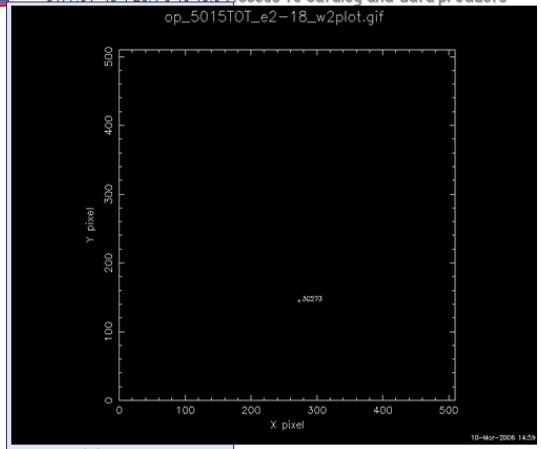
A Service of the ASI Space Science Data Center

Observation ID: 9000044500
Start Date: Sun Jul 26 1998
Target: 9000044500
PI: Public data

Available results and data products

Instrument	Duration	Ra Dec (J2000.0)	Results archive access
WFC1	8484.08	1 4 36.0 0 44 24.0	No Source Detected
WFC2	8477.01	13 4 26.4 0 40 48.0	Access to catalog and data products

op_5015TOT_e2-18_w2plot.gif



Reconstructed Sky 2-8 KeV.
Click to expand

ort by **RA**; max lines retrieved: 5000 (on BROWSE

ngle	Target Name	Dist. from searched position (arcmin)
	3C273	1.5
	3C273	0.8
	3C273	0.8

Stats

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- BeppoSAX
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- Catalogue I
- NFI Arch
- WFC Archiv
- GRBM Arch
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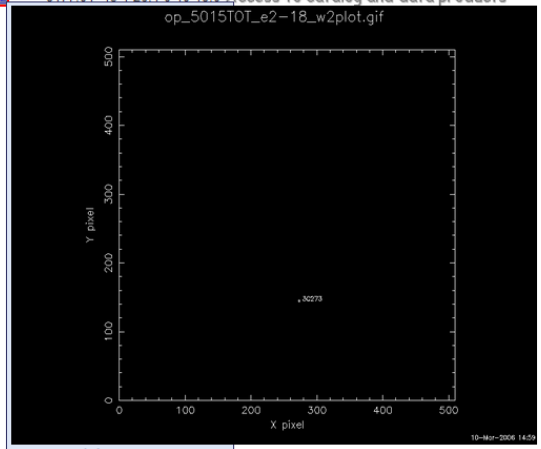
Instrument	Duration	Ra Dec (J2000.0)	Results archive access
WFC1	8484.08	1 4 36.0 0 44 24.0	No Source Detected
WFC2	8477.01	13 4 26.4 0 40 48.0	Access to catalog and data products

op_5015TOT_e2-18_w2plot.gif



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Click to expand

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ngle	Target Name	Dist. from searched position (arcmin)
	3C273	1.5
	3C273	0.8
	3C273	0.8

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SSDC BeppoSAX-WFC archive

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SSDC-BeppoSAX WFC Interactive Archive

Available parameters

- name ra dec
- c/r 1.6-7.9 keV
- s/n 1.6-7.9 keV
- c/r 7.9-18.7 keV
- s/n 7.9-18.7 keV
- c/r 1.6-3.1 keV
- s/n 1.6-3.1 keV
- c/r 4.5-6.9 keV
- s/n 4.5-6.9 keV
- x_pix y_pix
- source_id classification
- exposure
- offset band ratios
- Gal NH

GO

Go to 9000044500 main page

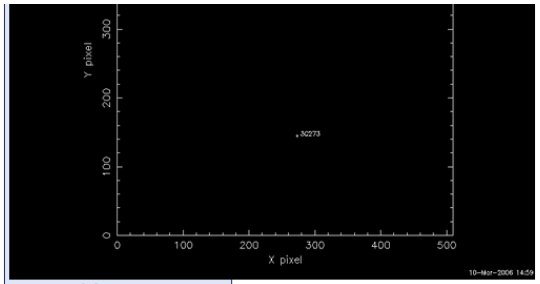
Catalog of detected sources produced at SSDC

Target : I-Pointi
Duration : 8477.01
Instrument : WFC2
Pointing (ra,dec) : 13 4 26.4 0 40 48.0
Start date : Sun Jul 26 1998 18:59:21 (UT)

Aitoff map Export to TXT

Energy band for detection selection 1.63-7.9 keV band Reset **Power law energy index for flux calculation** 1

Entry number			RA (J2000.0)	Dec (J2000.0)	Count rate 1.6-7.9 keV/ Flux 2-10 keV (Flux (erg/cm2/s))	Count rate 7.9-18.7 keV	Id from WFC reference catalog	Source class from cross-correlations	Offset from WFC center (degrees)	Counts ratios/ Spectral slope (from S/H) (Soft/Hard ratio)
Selection mode: inclusive			Stat	Stat		Stat	Stat	Stat	Stat	Stat
1 Select	ASDC Data Explorer	Data products	12 29 03.4	+02 03 28.7	2.025e-10	1.876	3C273	QSO radio loud flat r	8.68	0.471



Reconstructed Sky 2-8 KeV.
Click to expand

. from searched position
arcmin

Stats
3C273 1.5
3C273 0.8
3C273 0.8

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SSDC BeppoSAX-WFC archive

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SSDC-BeppoSAX WFC Interactive Archive

Available parameters
name ra dec
c/r 1.6-7.9 keV
s/n 1.6-7.9 keV
c/r 7.9-18.7 keV
s/n 7.9-18.7 keV
c/r 1.6-3.1 keV
s/n 1.6-3.1 keV
c/r 4.5-6.9 keV
s/n 4.5-6.9 keV
x_pix y_pix
source_id classification
exposure
offset band ratios
Gal NH
GO
Go to 9000044500 main page

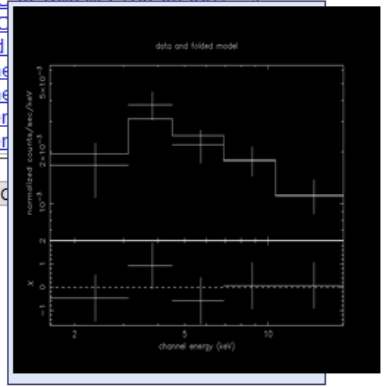
Source name: 3C273
Obs code: 9000044500

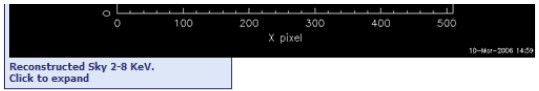
Available Products

Fits File
Retrieve Image FITS file (ch: 2-18)
Retrieve Image FITS file (ch: 2-27)
Retrieve Image FITS file (ch: 19-27)
Retrieve PHA file
Retrieve Light curve FITS file (ch: 2-18)

GIF and Text files
XSPEC fit wabspwlw2
SED from XSPEC fit PWLW2 (gif image)
SED from XSPEC
SED model used
SED from Hardne
SED from Hardne
Light curve in er
Light curve in er

Entry number		
Selection mode: inclusive		
1 Select	ASDC Data Explorer	Data products





Offset from WFC center (degrees)	Counts ratios/ Spectral slope (from S/H) (Soft/Hard ratio)
8.68	0.471

Stats	
3C273	1.5
3C273	0.8
3C273	0.8

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SSDC BeppoSAX-WFC archive

Also the
introdu
→Wide

SSDC-BeppoSAX WFC Interactive Archive

Available parameters
name ra dec
c/r 1.6-7.9 keV
s/n 1.6-7.9 keV
c/r 7.9-18.7 keV
s/n 7.9-18.7 keV
c/r 1.6-3.1 keV
s/n 1.6-3.1 keV
c/r 4.5-6.9 keV
s/n 4.5-6.9 keV
x_pix y_pix
source_id classification
exposure
offset band ratios
Gal NH
GO
Go to 9000044500 main page

Entry number		
Selection mode: inclusive		
1 Select	Data Explorer	Data products

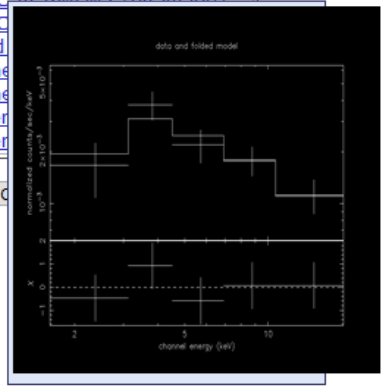
Source name: 3C273
Obs code: 9000044500

Available Products

Fits File
Retrieve Image FITS file (ch: 2-18)
Retrieve Image FITS file (ch: 2-27)
Retrieve Image FITS file (ch: 19-27)
Retrieve PHA file
Retrieve Light curve FITS file (ch: 2-

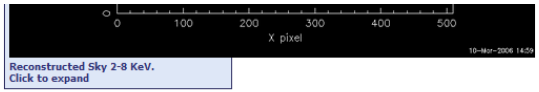
GIF and Text files
XSPEC fit wabspwlw2
SED from XSPEC fit PWLW2 (gif image)
SED from XSPEC
SED model used
SED from Hardne
SED from Hardne
Light curve in er
Light curve in er

Scientific data products resident in archive



Offset from WFC center (degrees)	Counts ratios/ Spectral slope (from S/H) (Soft/Hard ratio)
8.68	0.471

	Stats
3C273	1.5
3C273	0.8
3C273	0.8



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The Multi-Mission Interactive Archive is the SSDC door to access all the hosted data archives:

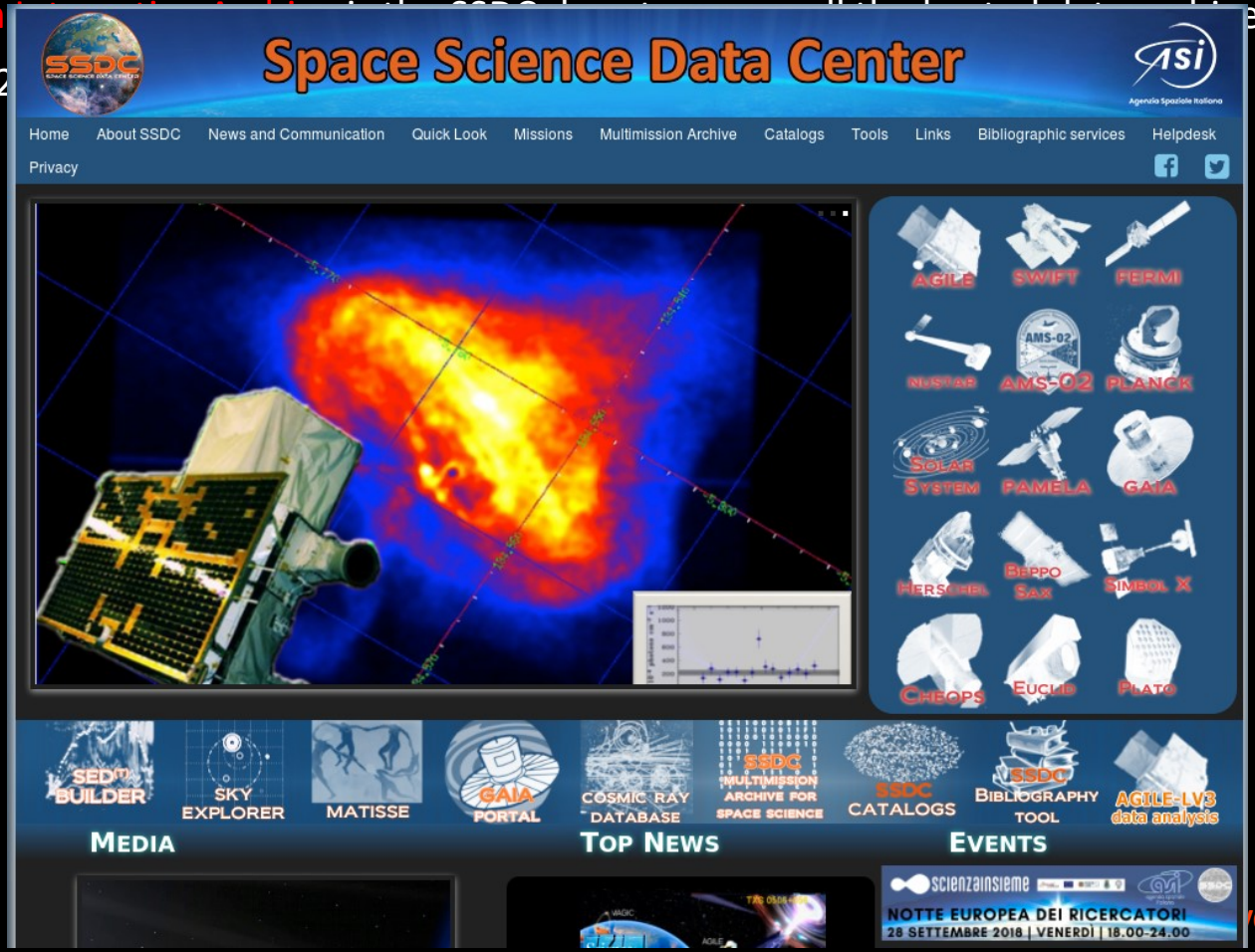
=>TWO versions: 2) parallel queries!

SSDC Science Gateway

http://www.ssdc.asi.it

The Multi-Mission [illegible] es:

=>TWO versions: 2



[illegible]OObs.it 16 July 2021

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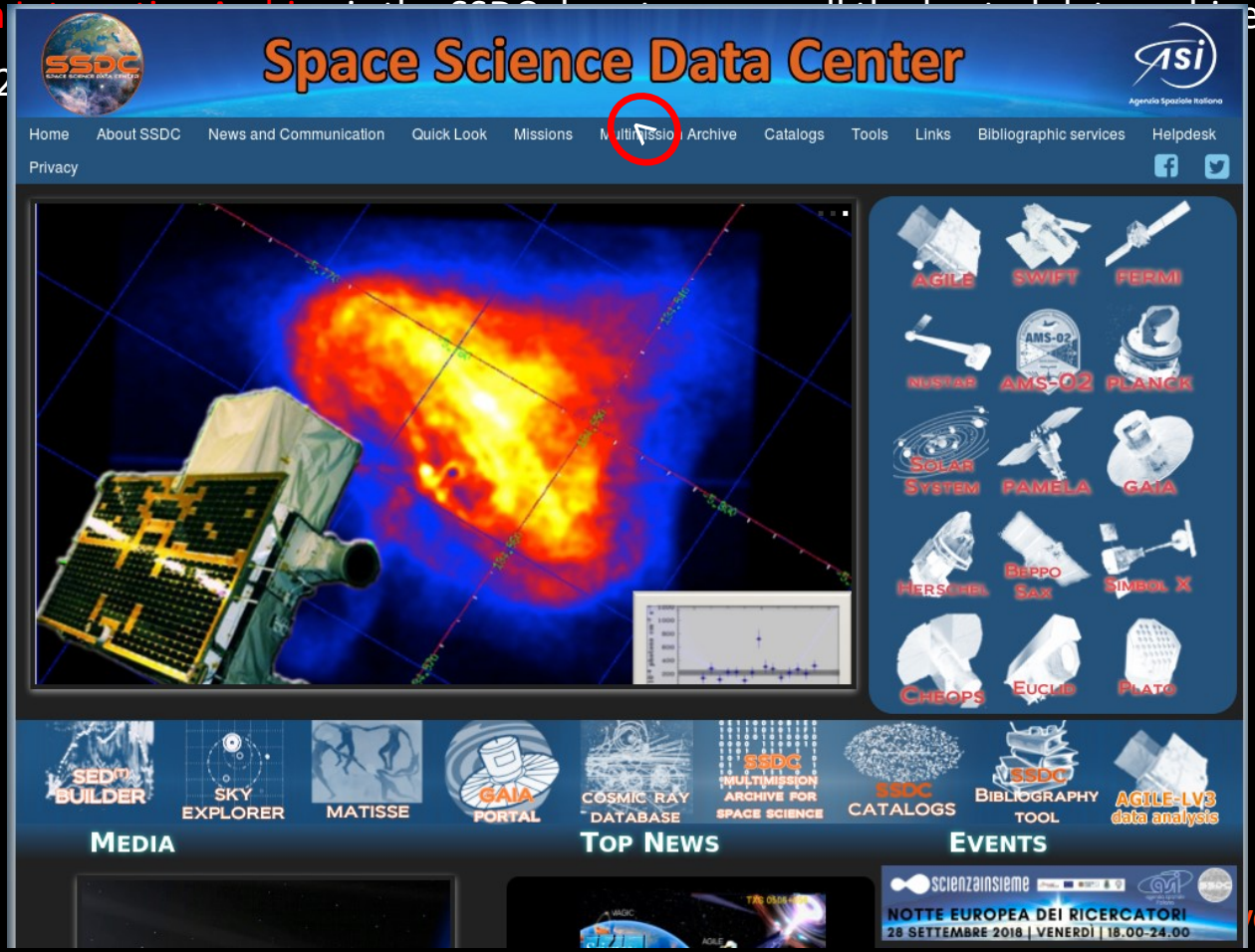
http://www.ssdc.asi.it

The Multi-Mission [illegible] es:

=>TWO versions: 2



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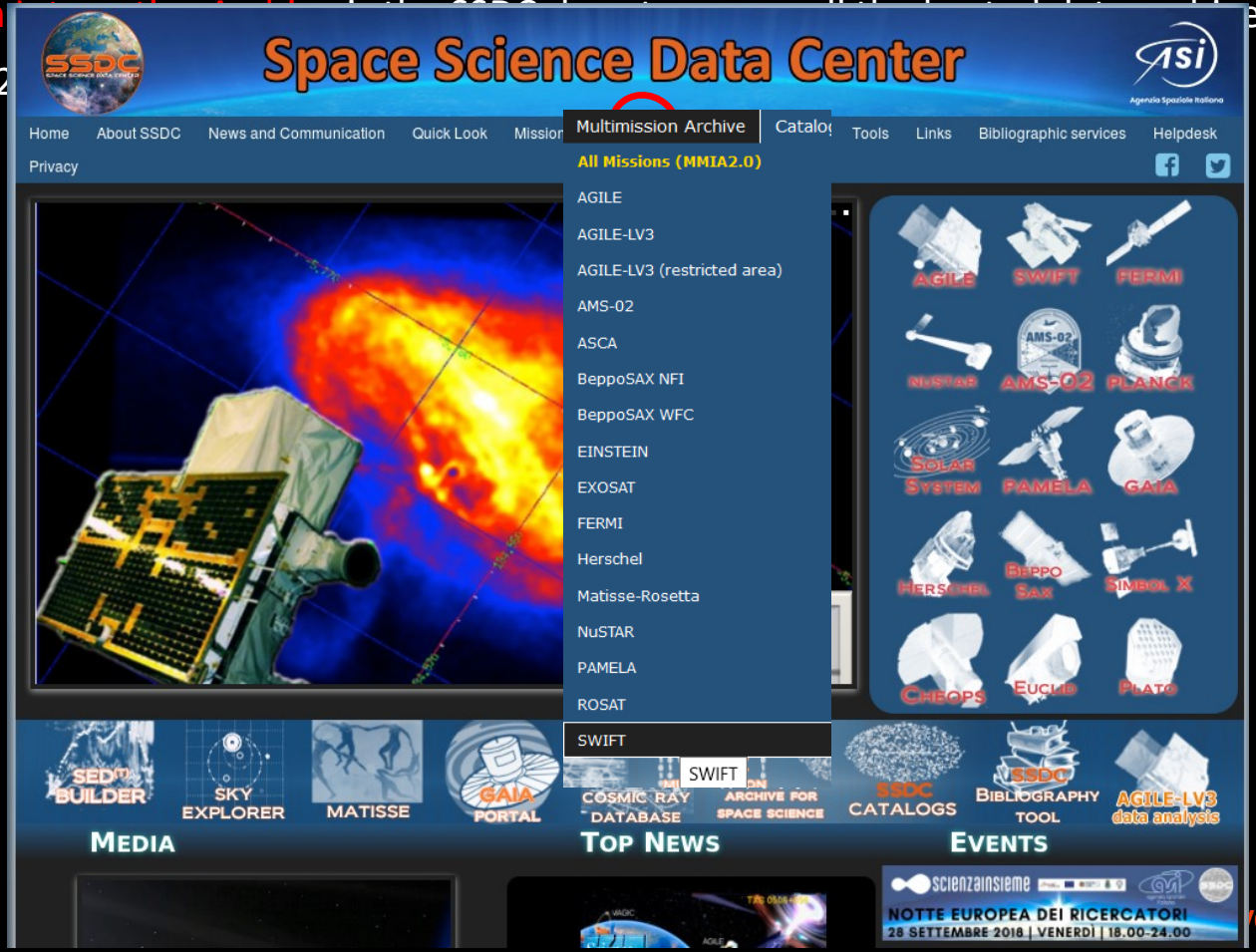
http://www.ssdc.asi.it

The Multi-Mission [illegible] es:

=>TWO versions: 2



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The Multi-Mission [illegible] es:

=>TWO versions: 2

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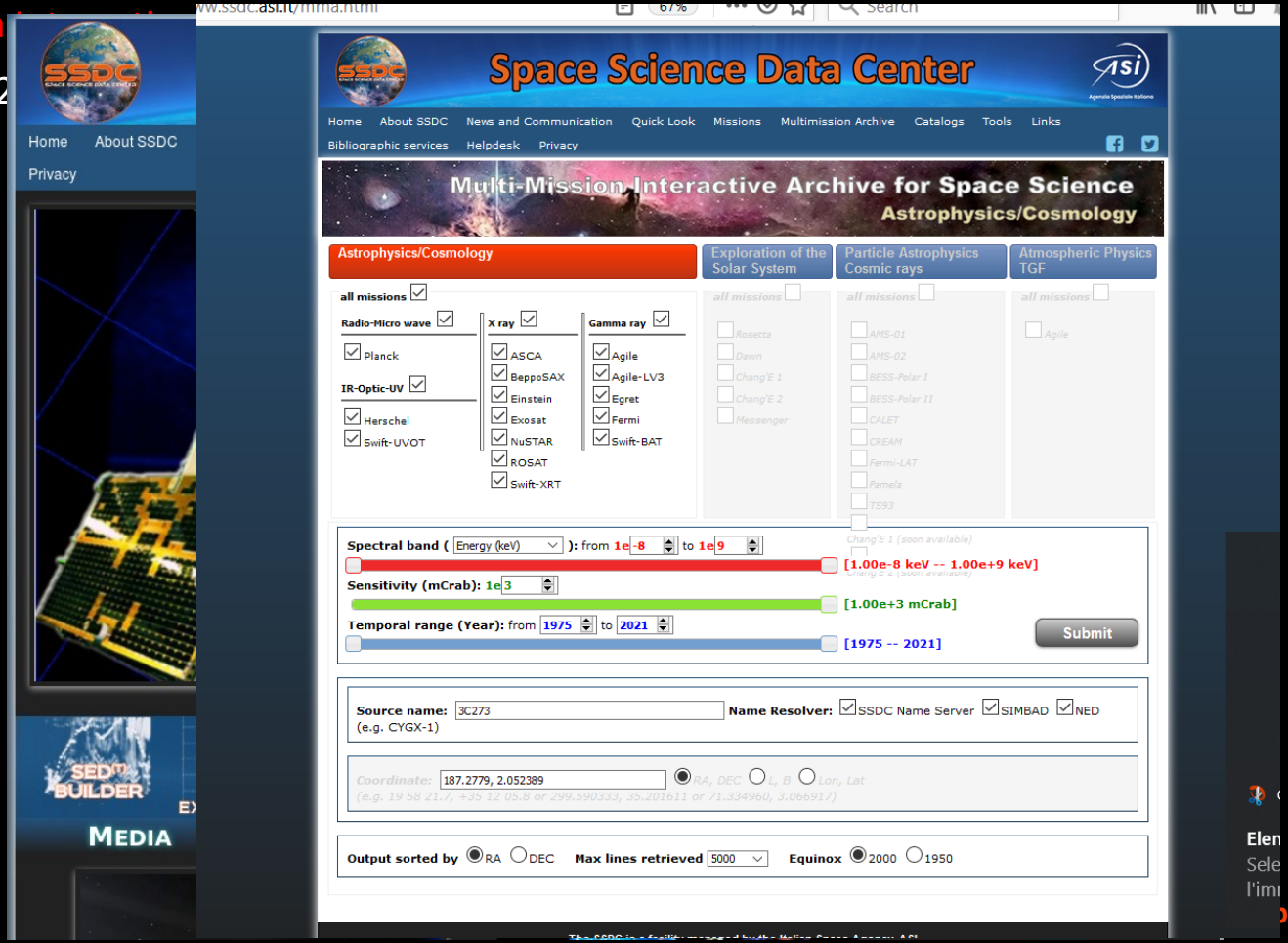
The Multi-Mission

=>TWO versions: 2



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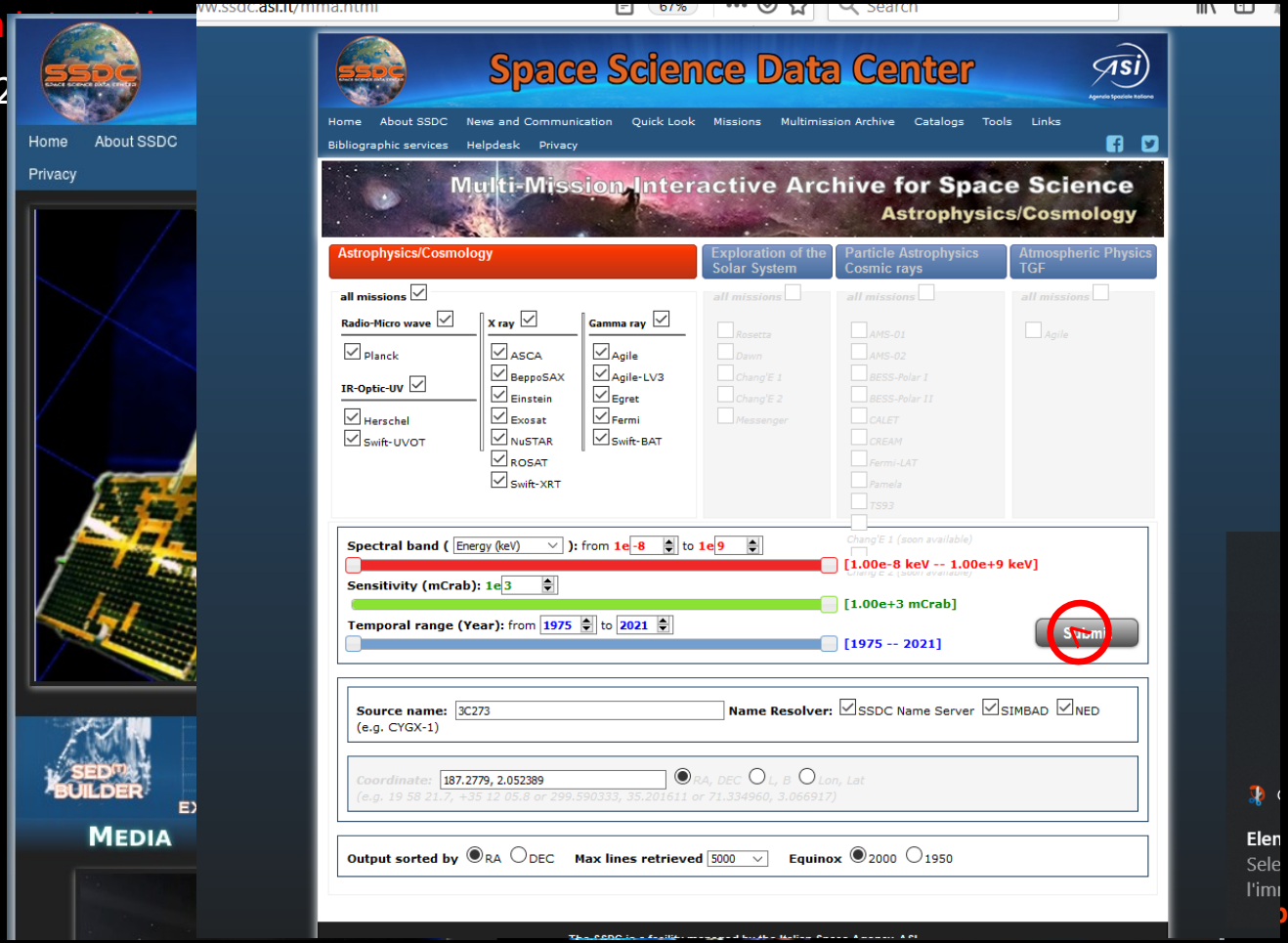
The Multi-Mission

=>TWO versions: 2

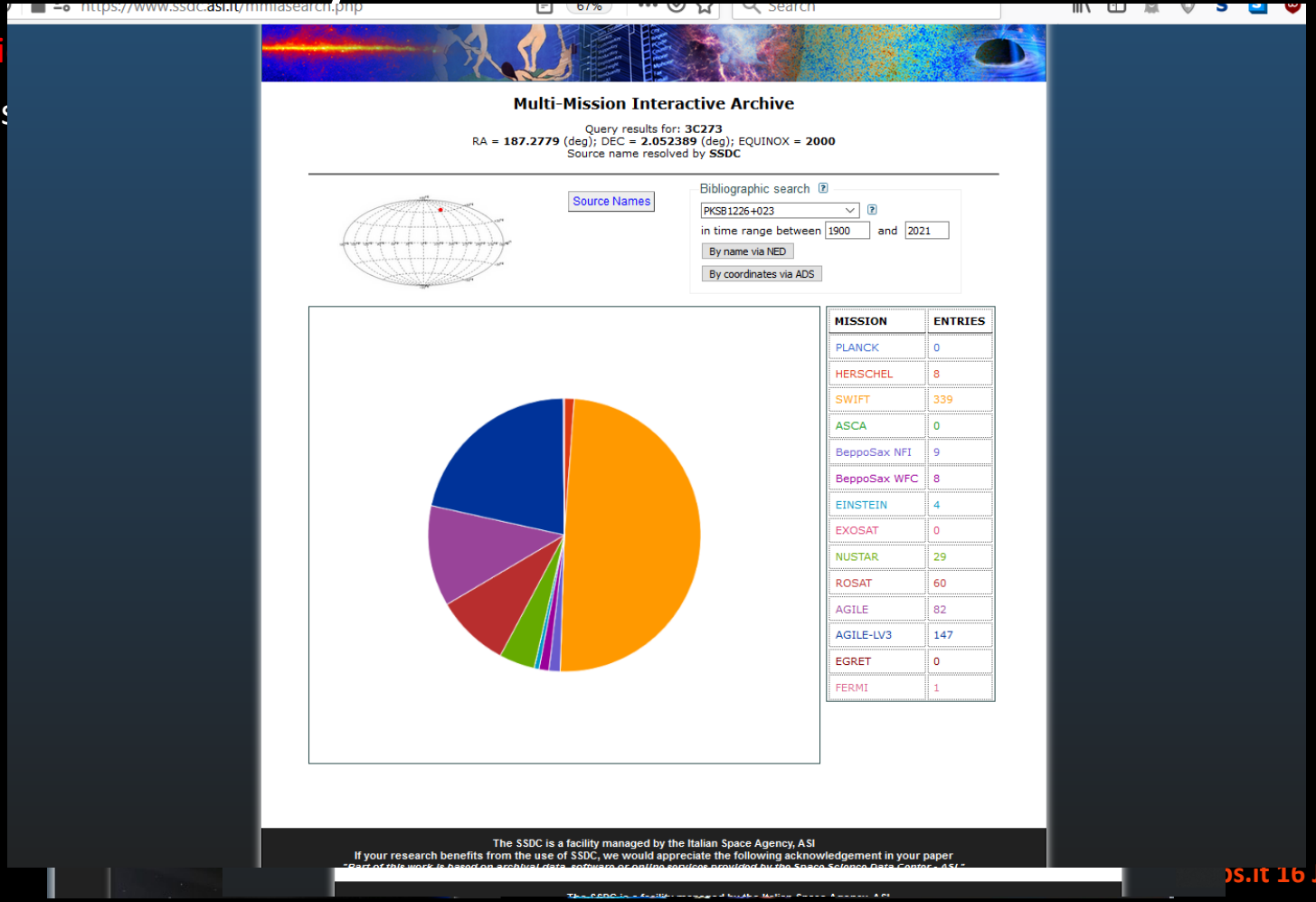


SSDC Science Gateway

http://www.ssdc.asi.it

The Multi-Missi

=>TWO versions

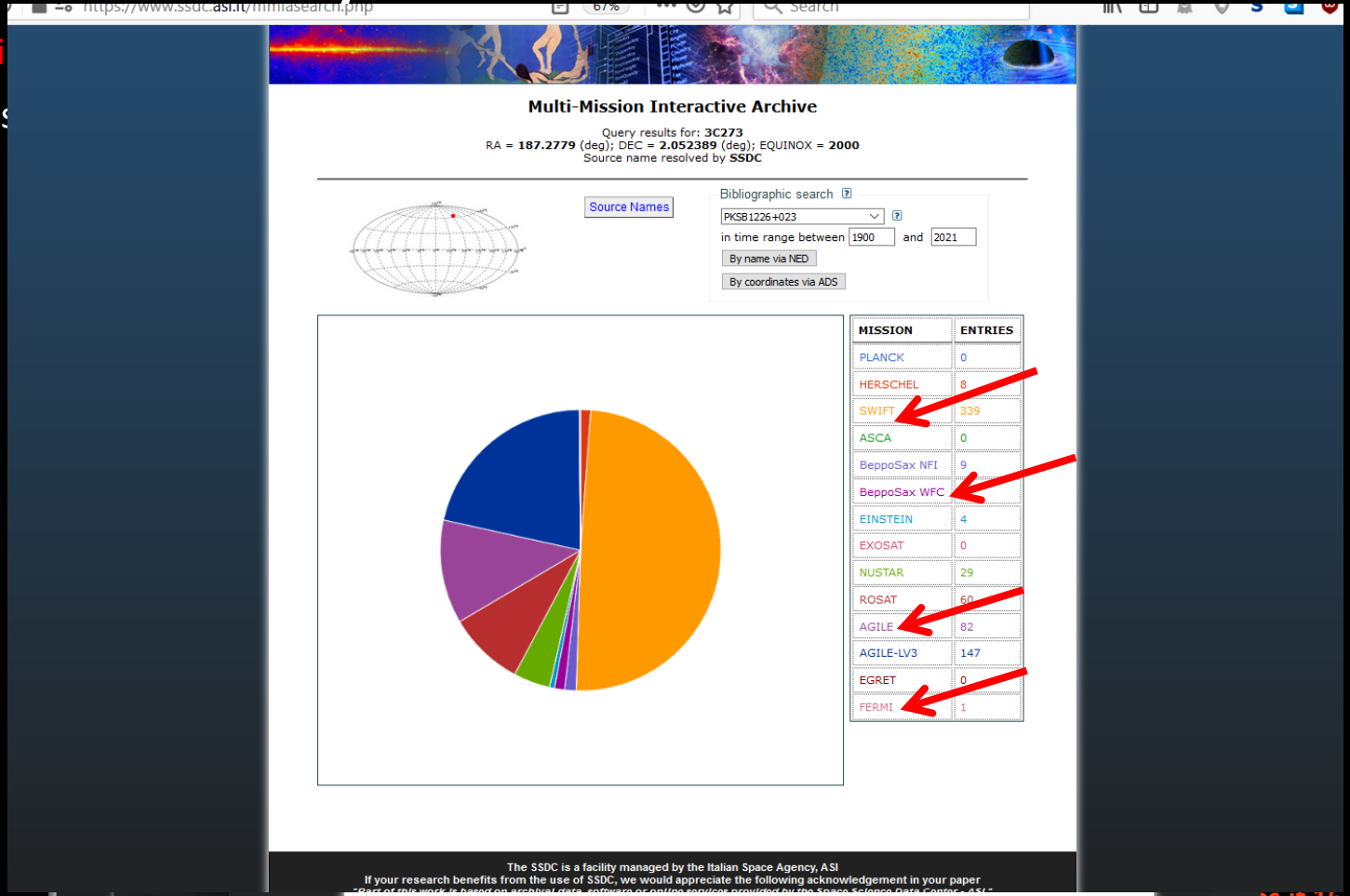


SSDC Science Gateway

http://www.ssdc.asi.it

The Multi-Missi

=>TWO versions

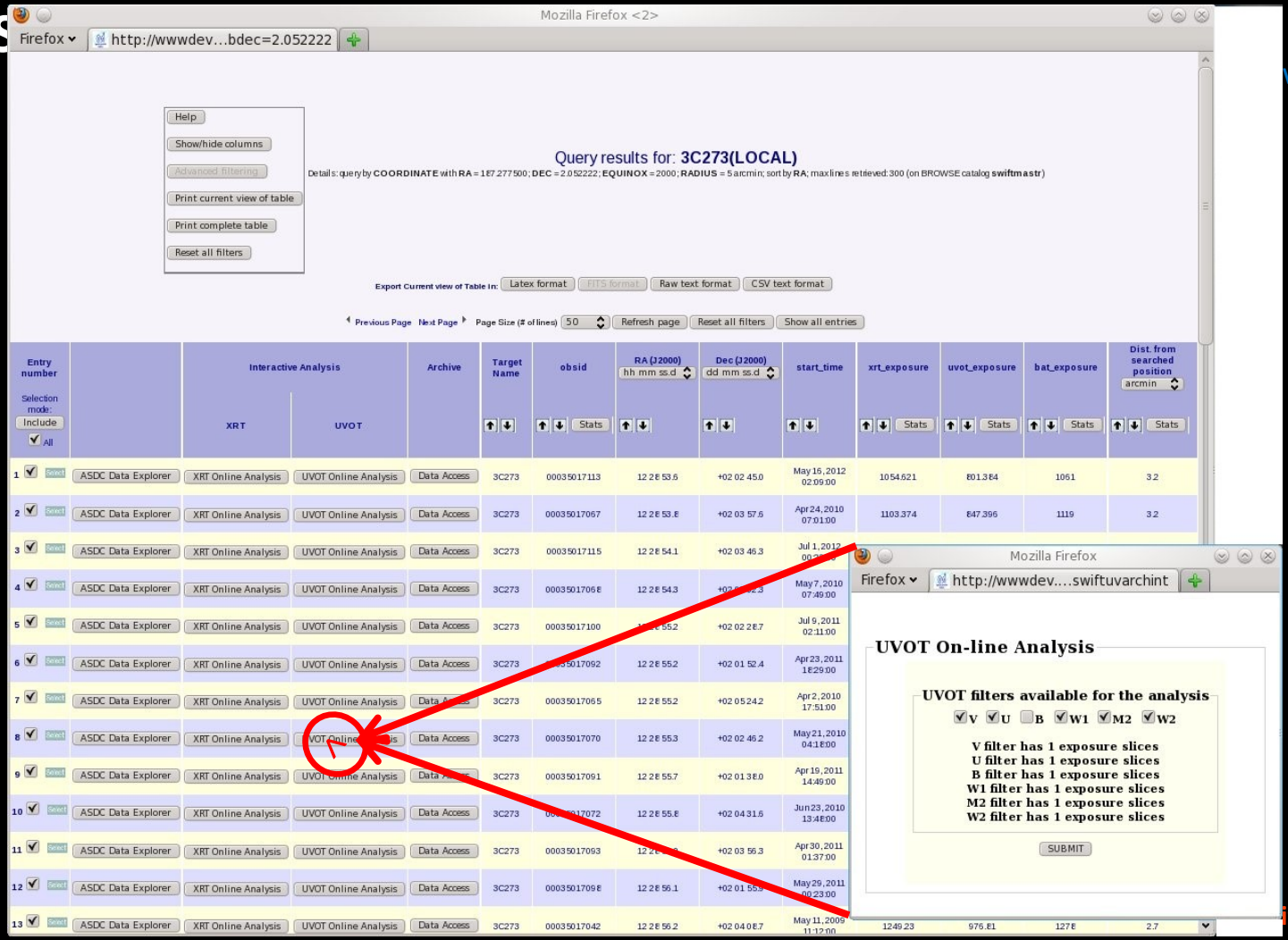


SSDC Science Gateway: UVOT imaging tool

http://www.ssdc.asi.it

SSDC S

w.ssdc.asi.it



SSDC S

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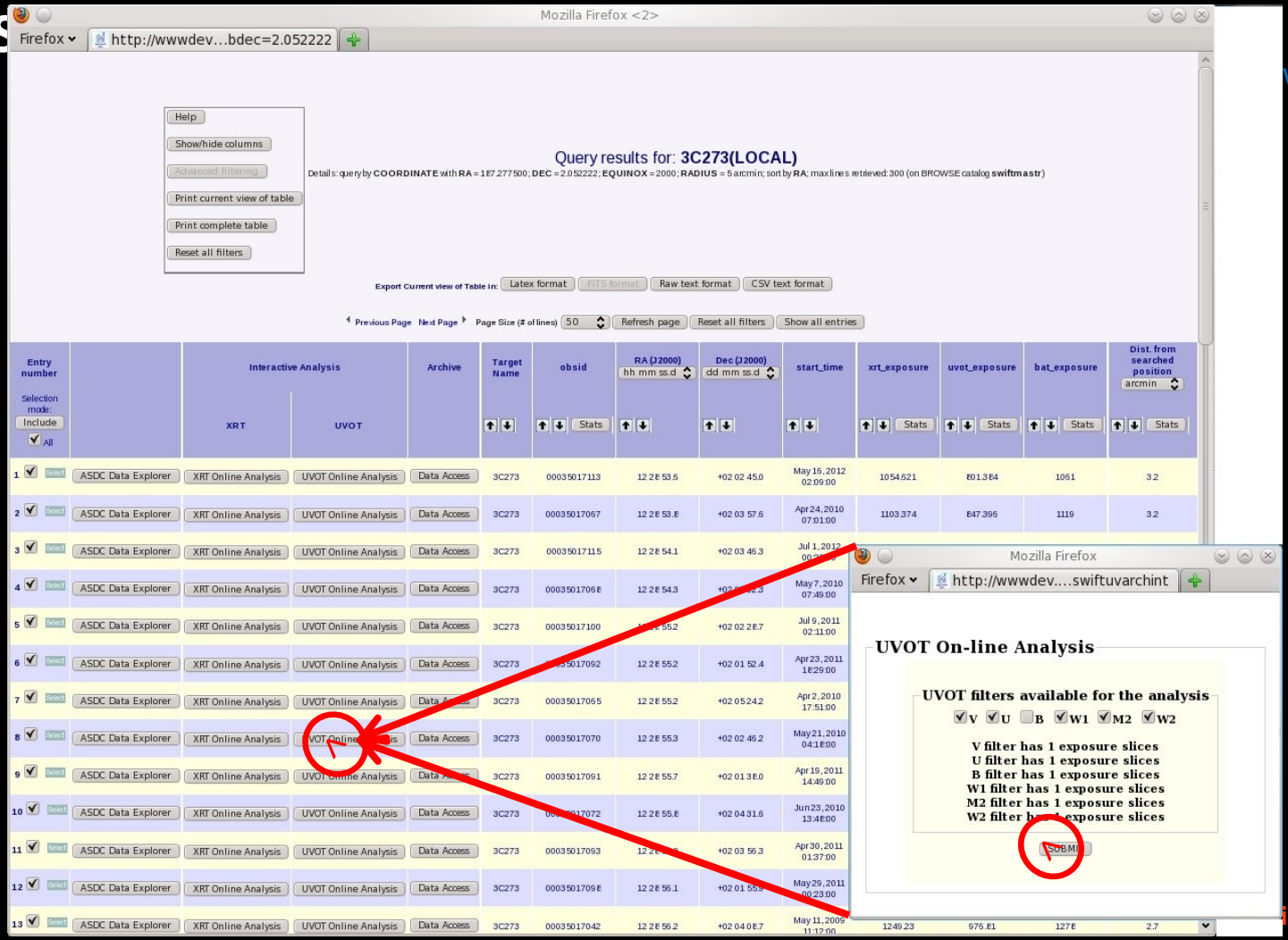

SSDC S

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Firefox | ASDC INTERACTIVE ARCHIVE

Show sources list sorted by :
--

Size (archmin)
10

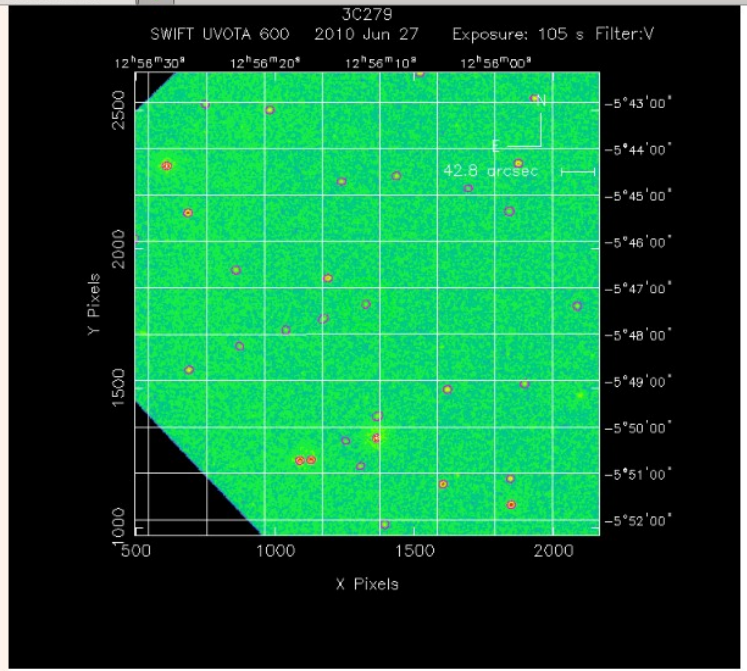
Color table
Default

Image scaling
Default

Error radius (arcsec)
0

Overlay catalogue entries

A2LED
A2PIC
ABELL
AGLGRD1CAT
Submit



OBS Code : **00035019037**
Selected Filter : **V**

Filters available
V
U
B
W1
M2
W2

Download image file

About this tool

Details for source/cursor position (j2000.0)
Source: **Ra**=12 56 11.2 **Dec**=-05 47 21.4 **Vmag**=18.49+/-0.15 **Umag**=18.16+/-0.1 **Bmag**=18.87+/-0.11 **W1mag**=17.86+/-0.09 **W2mag**=18.08+/-0.07

Derived quantities: **V: f(5402Å)**=0.15878+/-0.021814 **mJy**; **nuF(5.5463e+14 Hz)**=8.8105e-13+/-1.2166e-13 **erg/cm2/s**; **U: f(3501Å)**=0.088813+/-0.0080493 **mJy**; **nuF(8.5704e+14 Hz)**=7.6033e-13+/-6.8353e-14 **erg/cm2/s**; **B: f(4329Å)**=0.12751+/-0.012365 **mJy**; **nuF(6.9183e+14 Hz)**=8.8308e-13+/-8.5312e-14 **erg/cm2/s**; **W1: f(2634Å)**=0.078353+/-0.0064097 **mJy**; **nuF(1.1376e+15 Hz)**=8.9125e-13+/-7.3888e-14 **erg/cm2/s**; **W2: f(2030Å)**=0.054097+/-0.0035098 **mJy**; **nuF(1.4757e+15 Hz)**=7.9799e-13+/-5.1469e-14 **erg/cm2/s**;

javascript:void(0)

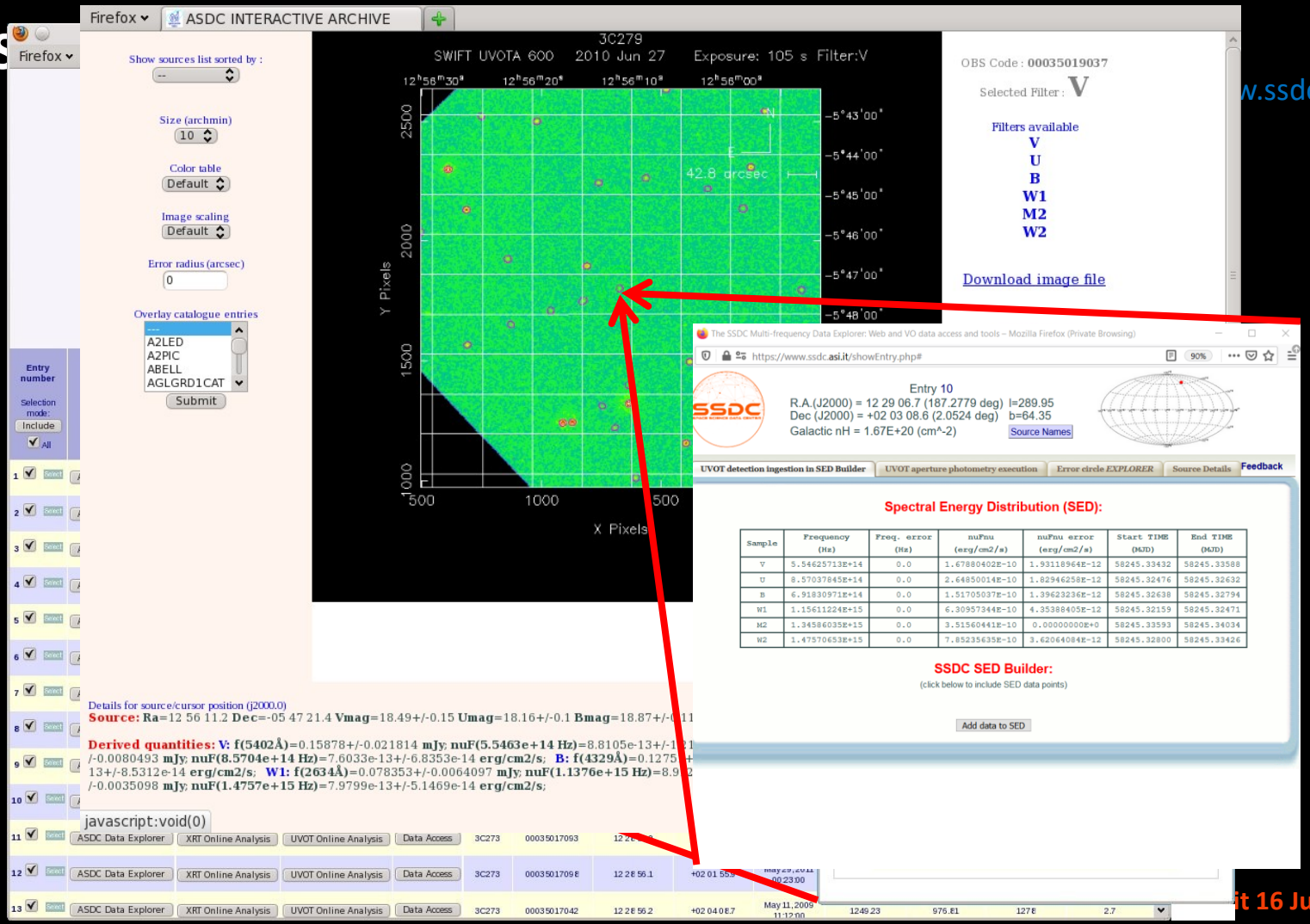
Entry number | Selection mode: Include | All

11	ASDC Data Explorer	XRT Online Analysis	UVOT Online Analysis	Data Access	3C273	00035017093		+02 03 56.3		
12	ASDC Data Explorer	XRT Online Analysis	UVOT Online Analysis	Data Access	3C273	00035017098	12 28 56.1	+02 01 55.9	May 29, 2011 00:23:00	
13	ASDC Data Explorer	XRT Online Analysis	UVOT Online Analysis	Data Access	3C273	00035017042	12 28 56.2	+02 04 08.7	May 11, 2009 11:12:00	1249.23 976.81 127.8 2.7

it 16 July 2021

SSDC S

w.ssdc.asi.it



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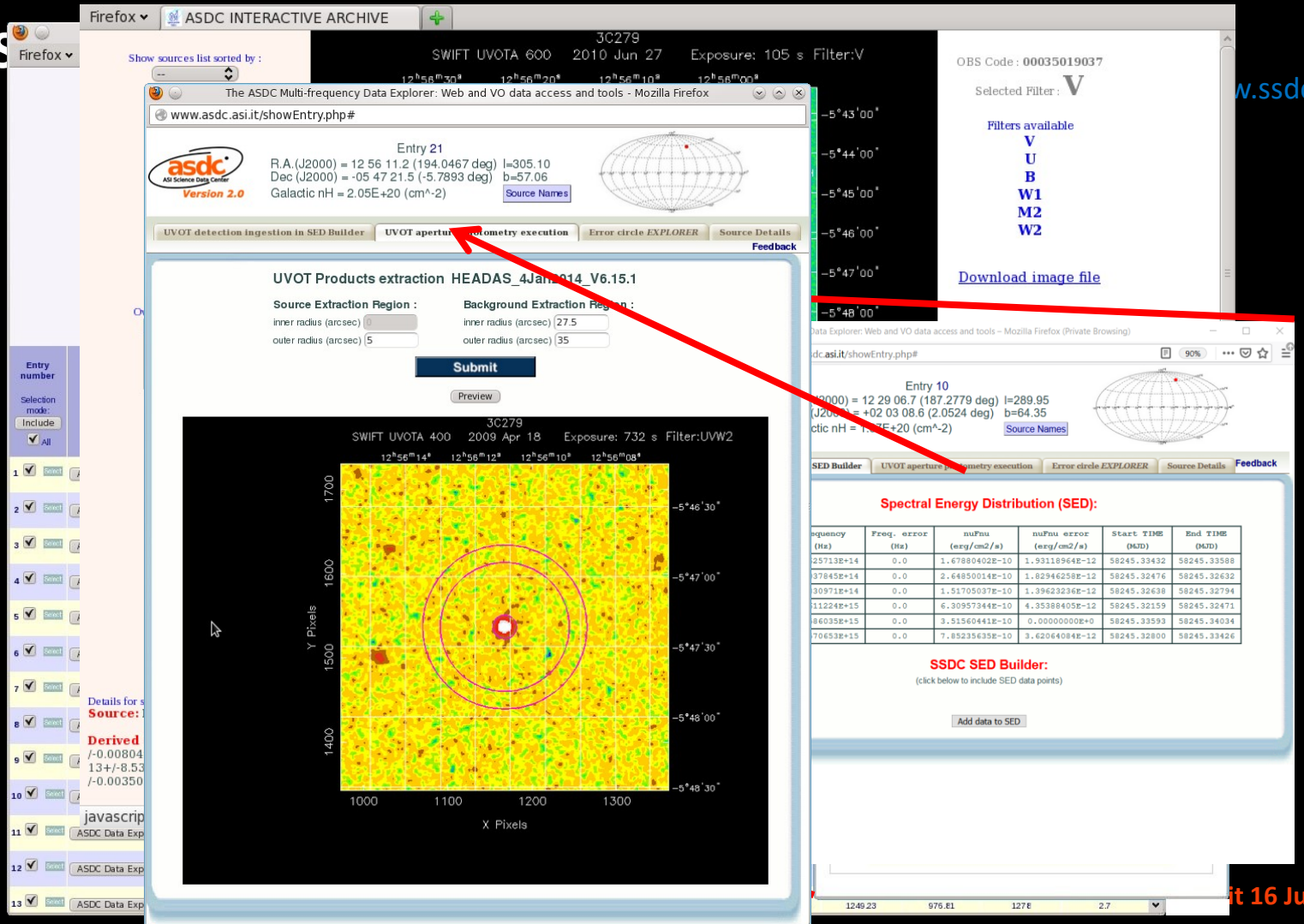
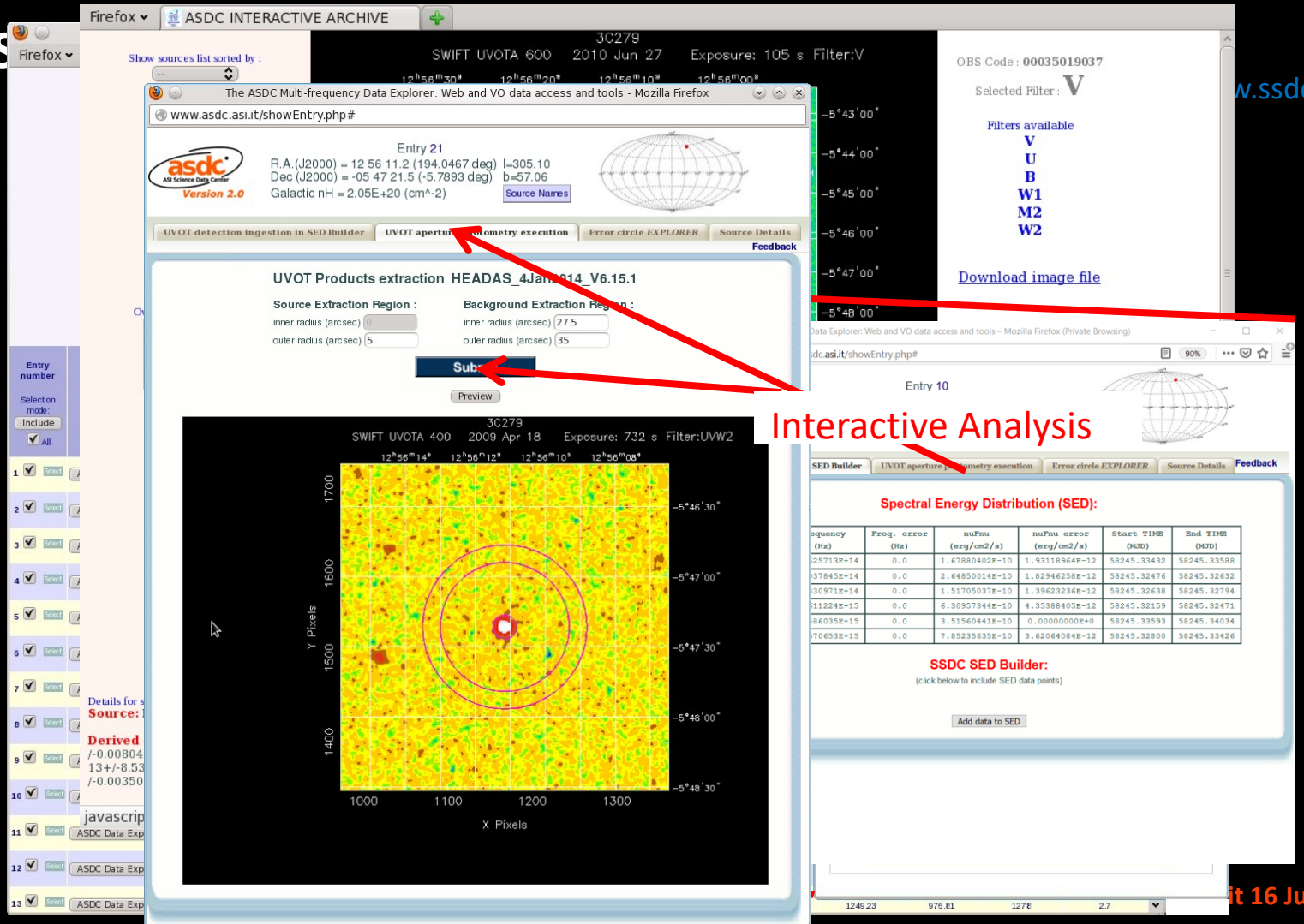
SSDC S

w.ssdc.asi.it



SSDC S

w.ssdc.asi.it



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Swift UVOT Products - Mozilla Firefox

Swift UVOT Products

www.asdc.asi.it/cgi-bin/swiftuvot_products_preview

Cerca

Swift UVOT Data Products

Standard Products

- Show Image
- Show Exposure Map

Download Data

- Sky Image File
- Exposure Map File
- Output FITS File

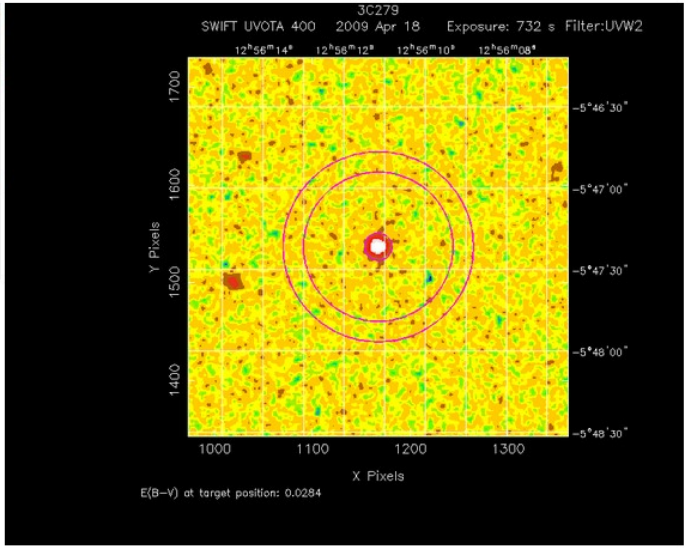

Image center (R.A.,Dec.): 194.0465 , -5.7893

Aperture photometry results

Estimated Galactic E(B-V) at object position: 0.02845

Filter	Observed Magnitude	Mag. error	Dereddened FluxDensity (mJy)	FluxDensity error (mJy)
V	16.880	0.07	6.9837e-01	4.5425e-02

Spectral Energy Distribution (SED):

Frequency (Hz)	Freq. error (Hz)	nuFnu (erg/cm2/s)	nuFnu error (erg/cm2/s)	Start TIME (MJD)	End TIME (MJD)	U.L. Flag
5.5497E+14	0.0	3.8757E-12	2.521E-13	54939.8591698	54939.9932169	

ASDC SED Builder: (click below to include SED data points)

Add data to SED

re: 105 s Filter:V

-5°43'00"
-5°44'00"
-5°45'00"
-5°46'00"
-5°47'00"
-5°48'00"

OBS Code : 00035019037

Selected Filter : V

Filters available
V
U
B
W1
M2
W2

Download image file

Feedback

w.ssdc.asi.it

Interactive Analysis

Data Explorer: Web and VO data access and tools – Mozilla Firefox (Private Browsing)

dc.asi.it/showEntry.php#

90%

Entry 10

SED Builder | UVOT aperture photometry execution | Error circle EXPLORER | Source Details | Feedback

Spectral Energy Distribution (SED):

sequency (Hz)	Freq. error (Hz)	nuFnu (erg/cm2/s)	nuFnu error (erg/cm2/s)	Start TIME (MJD)	End TIME (MJD)
25713E+14	0.0	1.67880402E-10	1.93118964E-12	58245.33432	58245.33588
37845E+14	0.0	2.64850014E-10	1.82946258E-12	58245.32476	58245.32632
30971E+14	0.0	1.51705037E-10	1.39623236E-12	58245.32638	58245.32794
11224E+15	0.0	6.30957344E-10	4.35388405E-12	58245.32159	58245.32471
86035E+15	0.0	3.51560441E-10	0.00000000E+0	58245.33593	58245.34034
70653E+15	0.0	7.85235635E-10	3.62064084E-12	58245.32800	58245.33426

SSDC SED Builder:

(click below to include SED data points)

Add data to SED

1249.23 976.81 127E 2.7

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SSDC Science Gateway: XRT imaging tool

http://www.ssdc.asi.it

Skipped!

SSDC Swift archive

Interactive session???

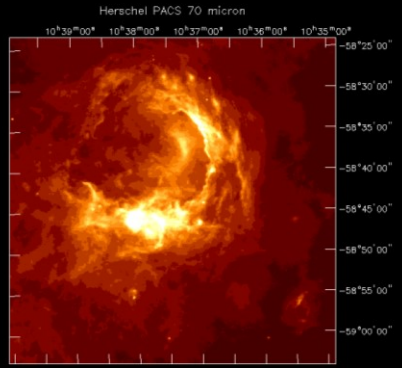
SSDC Science Gateway: many other tools…

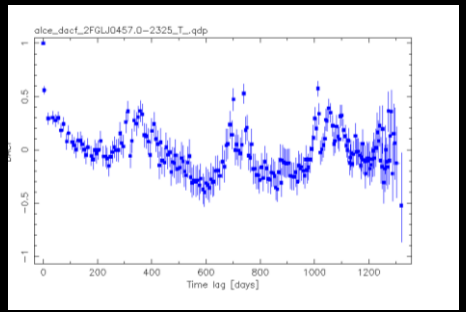
http://www.ssdc.asi.it

Skipping many other tools, in particular other imaging ones…

- On data from various older (BeppoSAX/NFI, Einstein..) or newer (NuSTAR) X-ray telescopes;
- On Herschel data;
- On AGILE & Fermi gamma-ray data: various tools, also on time domain;

….

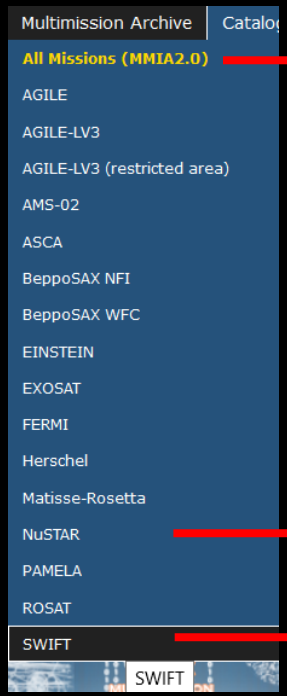


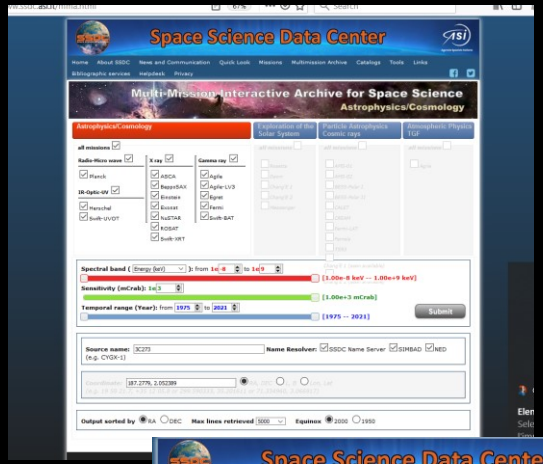


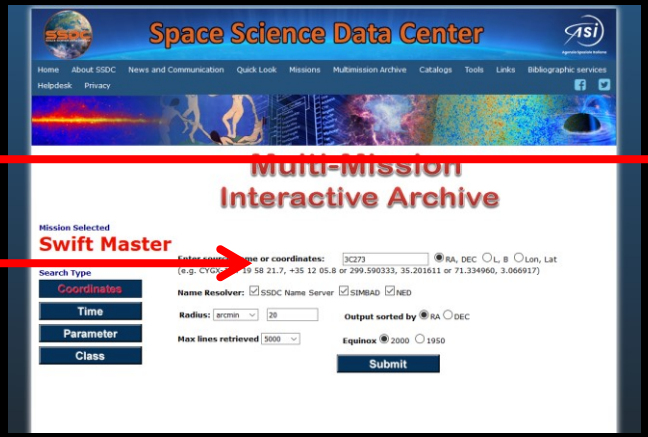
Summary on SSDC MMIA

The Multi-Mission Interactive Archive is the SSDC door to access all the hosted data archives.

=>TWO versions: single or multiple parallel archive queries…







SSDC MMIA data publication in VO

MMIA update to allow data access through the VO:

- easily access main resident products through the VO?
- and what about real-time DA tools producing further data products?
- different approach: integrate VO tools in our web DA tools??

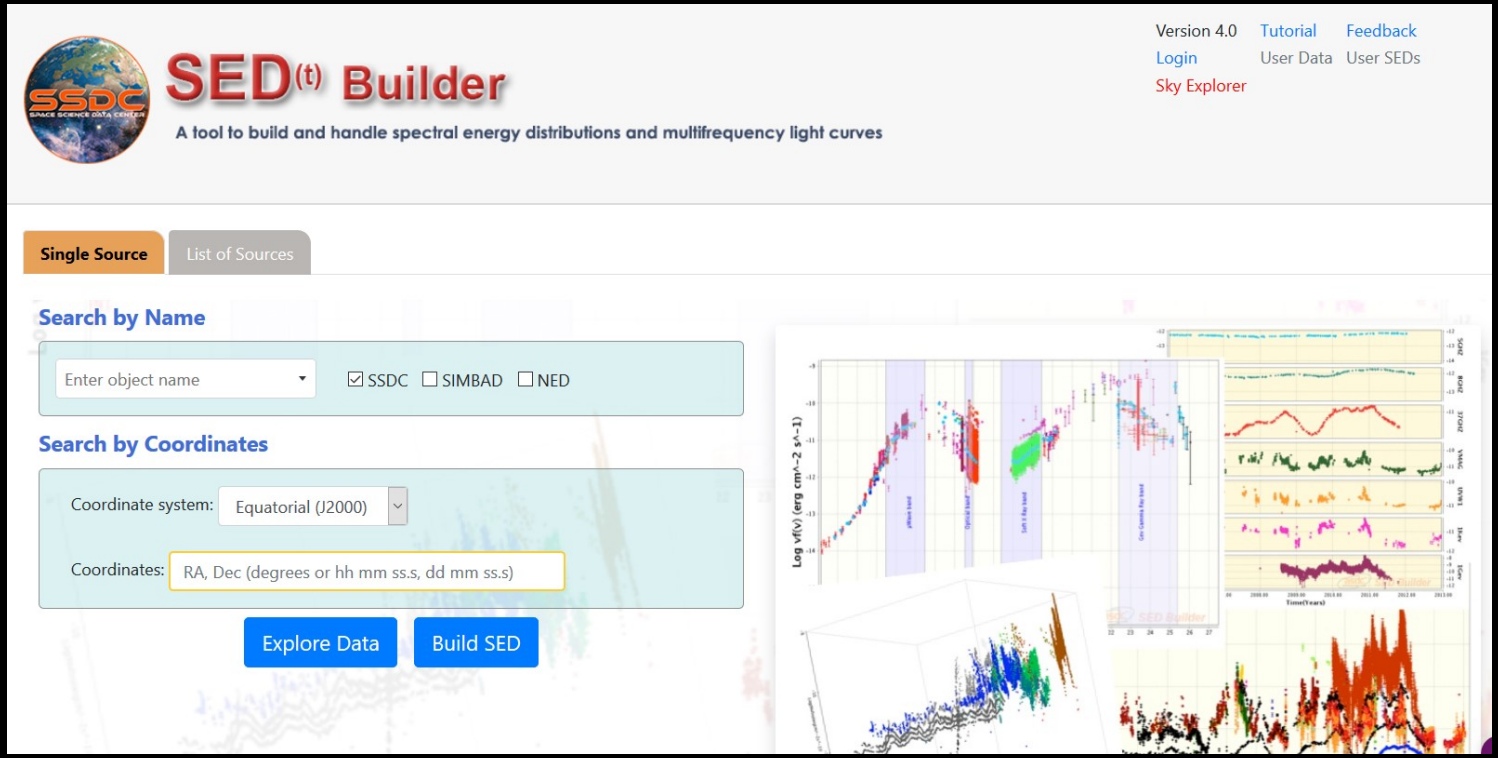
Further possible developments

- Upgrade of other SSDC main tools, for instance the SED-Builder tool (a link within Imaging tools has been shown: an independent application using data in a unique SEDs DB server)

An example of advanced application: the SED-Builder

SED (t)

Login is needed to see VO-tools



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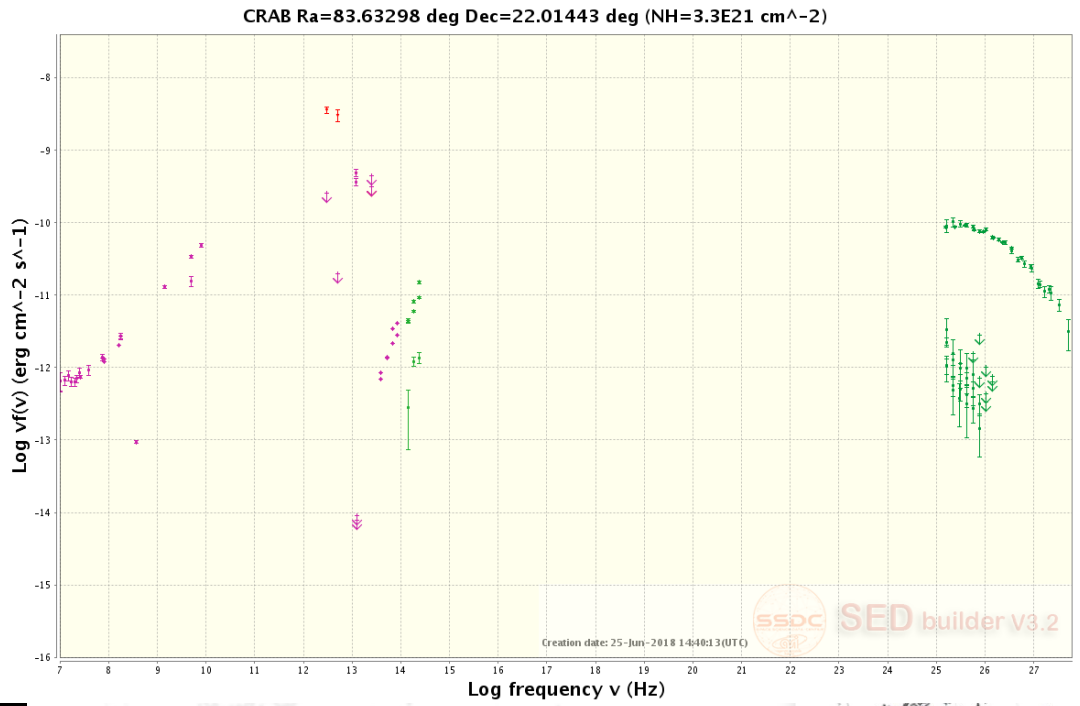
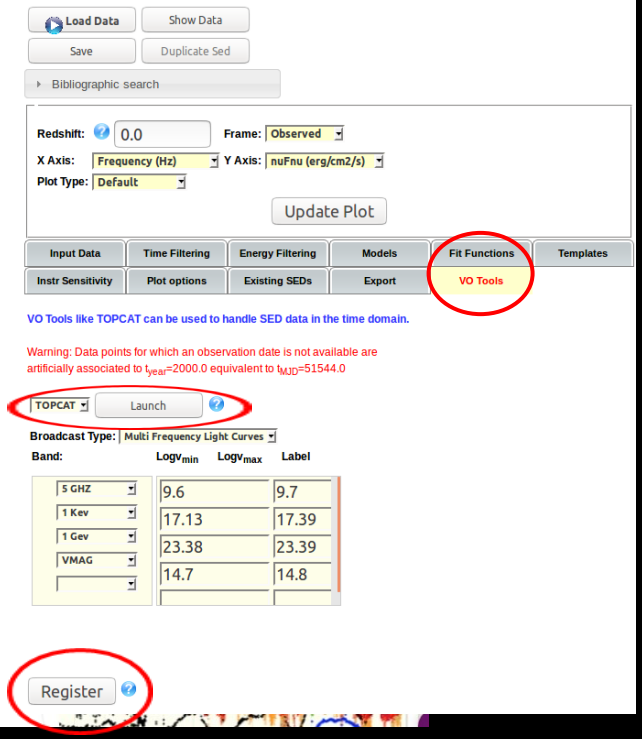
Login is needed to see VO-tools





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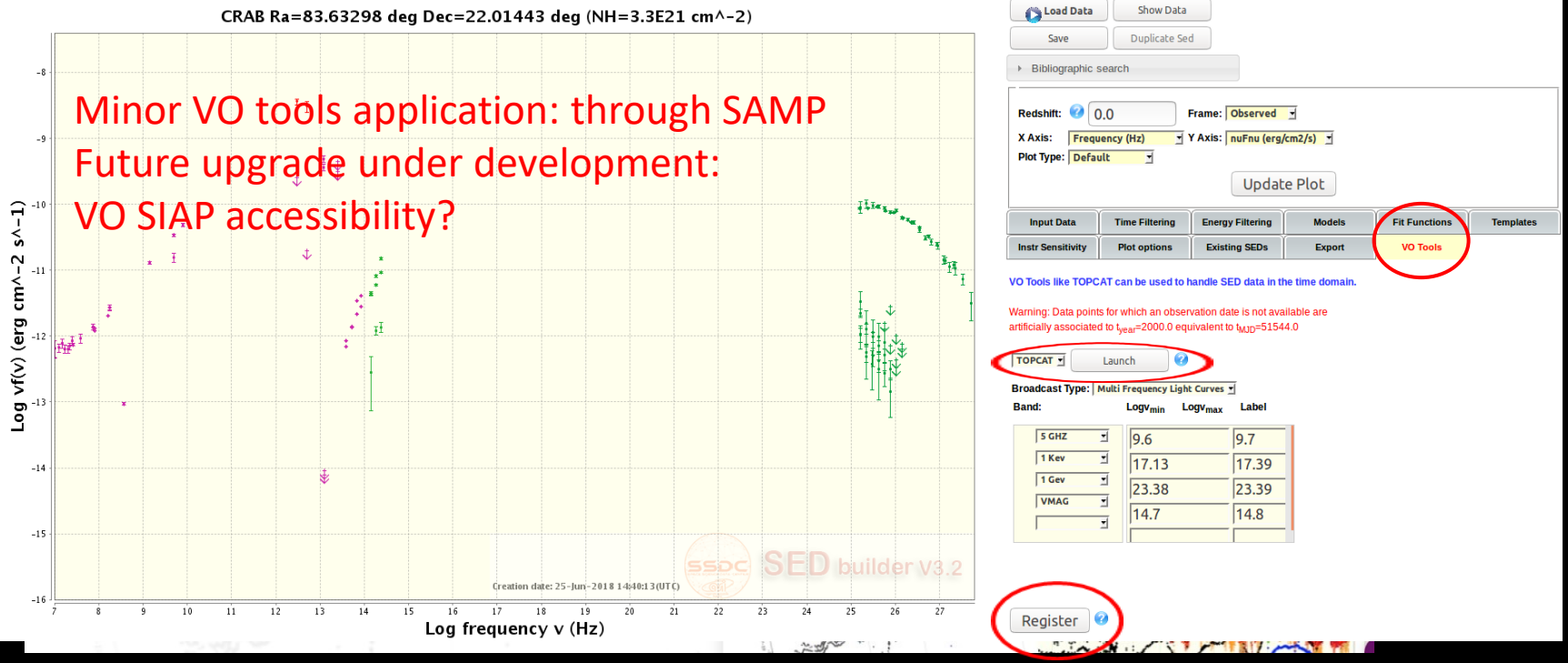

The Open Universe ASI portal

The mission of the Open Universe initiative is to make astronomy and space science data much more openly available, easily discoverable, free of bureaucratic, administrative or technical barriers, and therefore usable by the widest possible community, from professional researchers to all people interested in space science, in all parts of the world.

In doing so, Open Universe aims to support an increase in productivity of space research, facilitate the emerging field of data-driven science, and stimulate a significant acceleration towards the democratisation of space science and the benefits therefrom.

Initially proposed in 2016 to the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), Open Universe is now actively developed by a number of countries (Italy, Brazil, Armenia, and Argentina) and international scientific institutions, in coordination with the United Nations Office for Outer Space Affairs (UNOOSA).

In this phase **Open Universe** gives access to a number of **services**, is engaged in the generation of several **user-ready** space science **data sets**, and in **scientific activities**, including:

The Open Universe web portal @ ASI

The Open Universe for Blazars program

The Open Universe for GRBs program

This is the front page of the Open Universe web portal developed at the Italian Space Agency, ASI. Click on the picture to visit the site.

The Open Universe ASI portal

- Contribution to SSDC activities for OU: name server, catalog web pages, and support to Swift surveys

=>Swift/XRT survey HiPS

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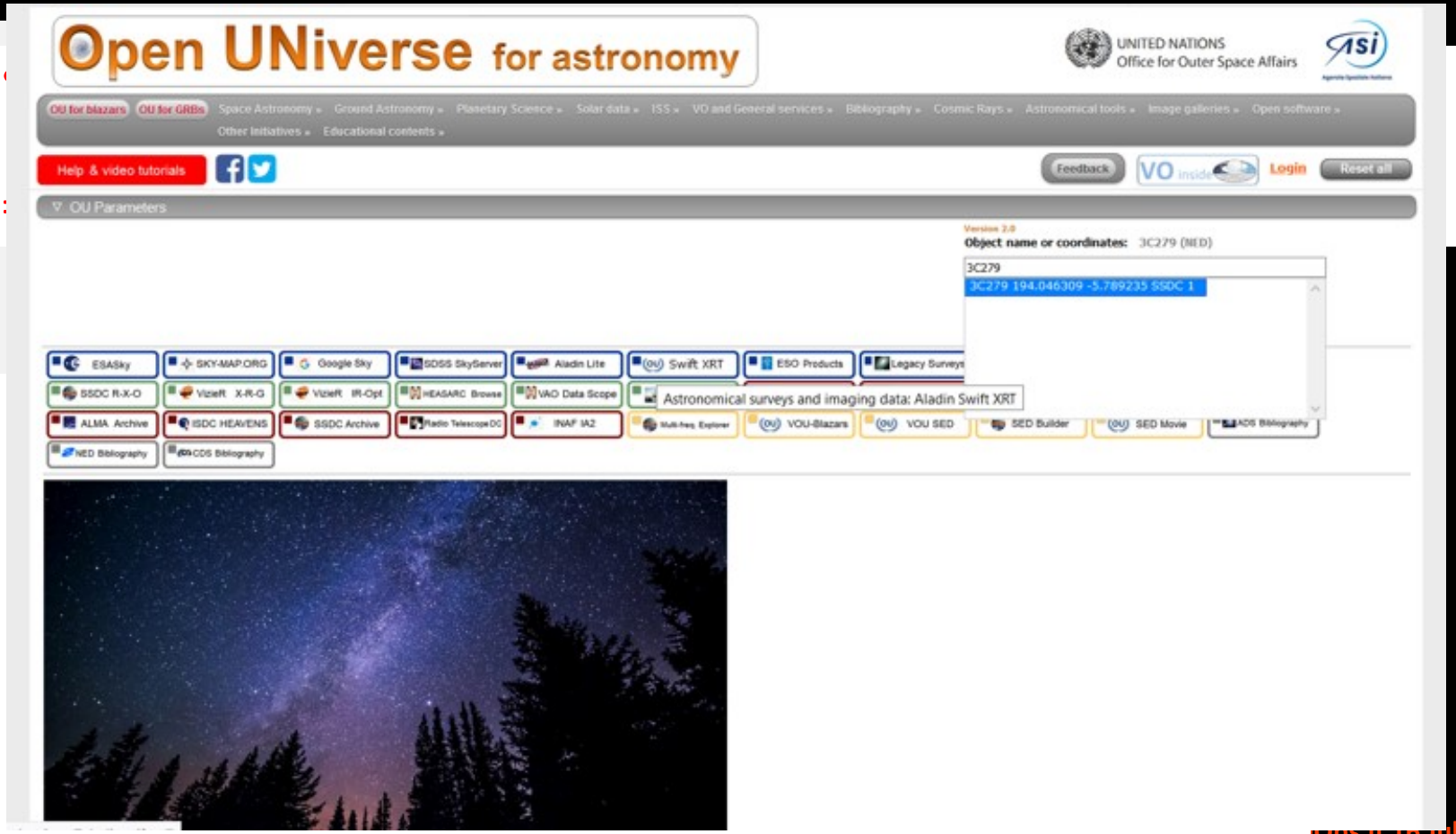
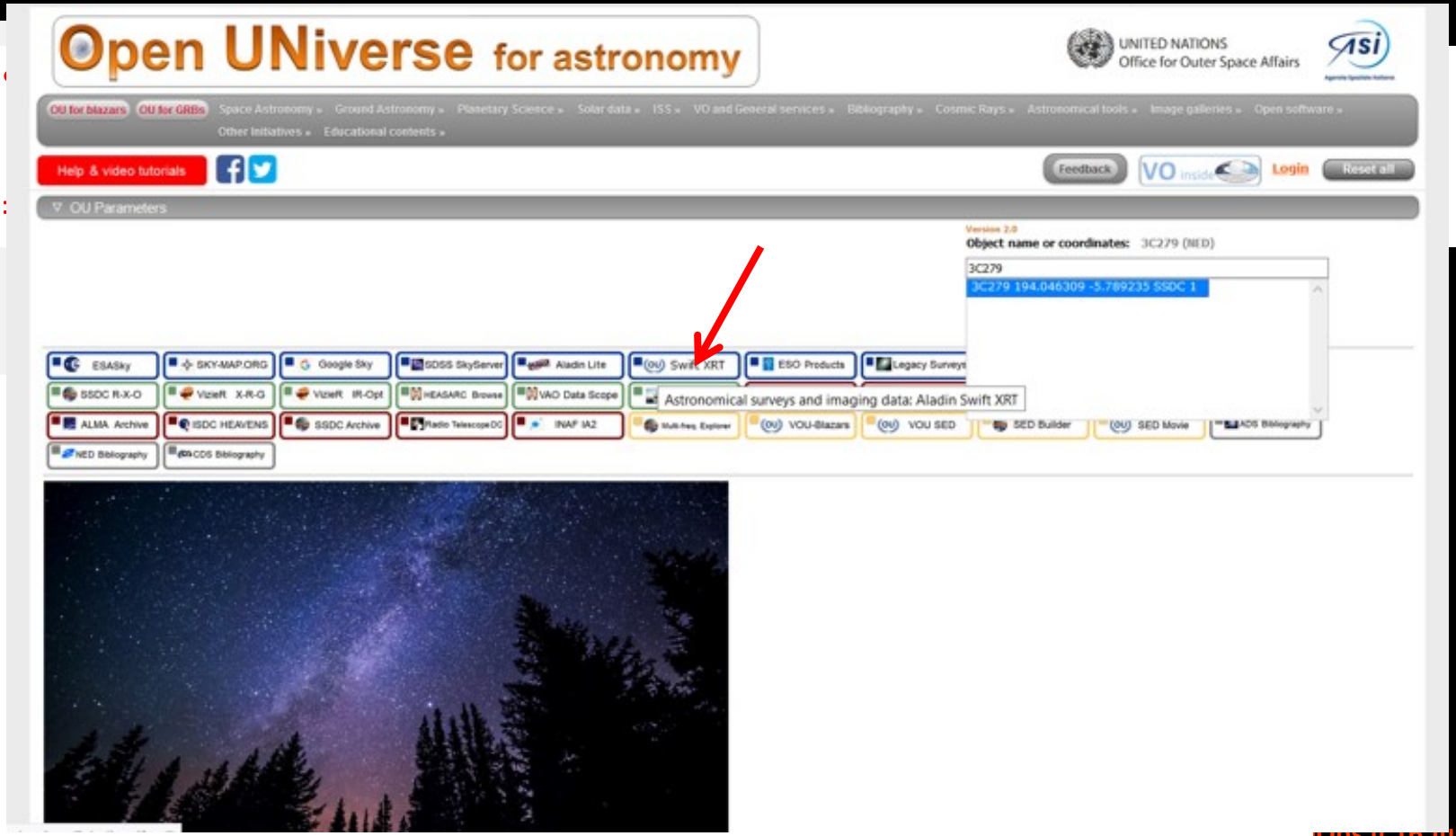
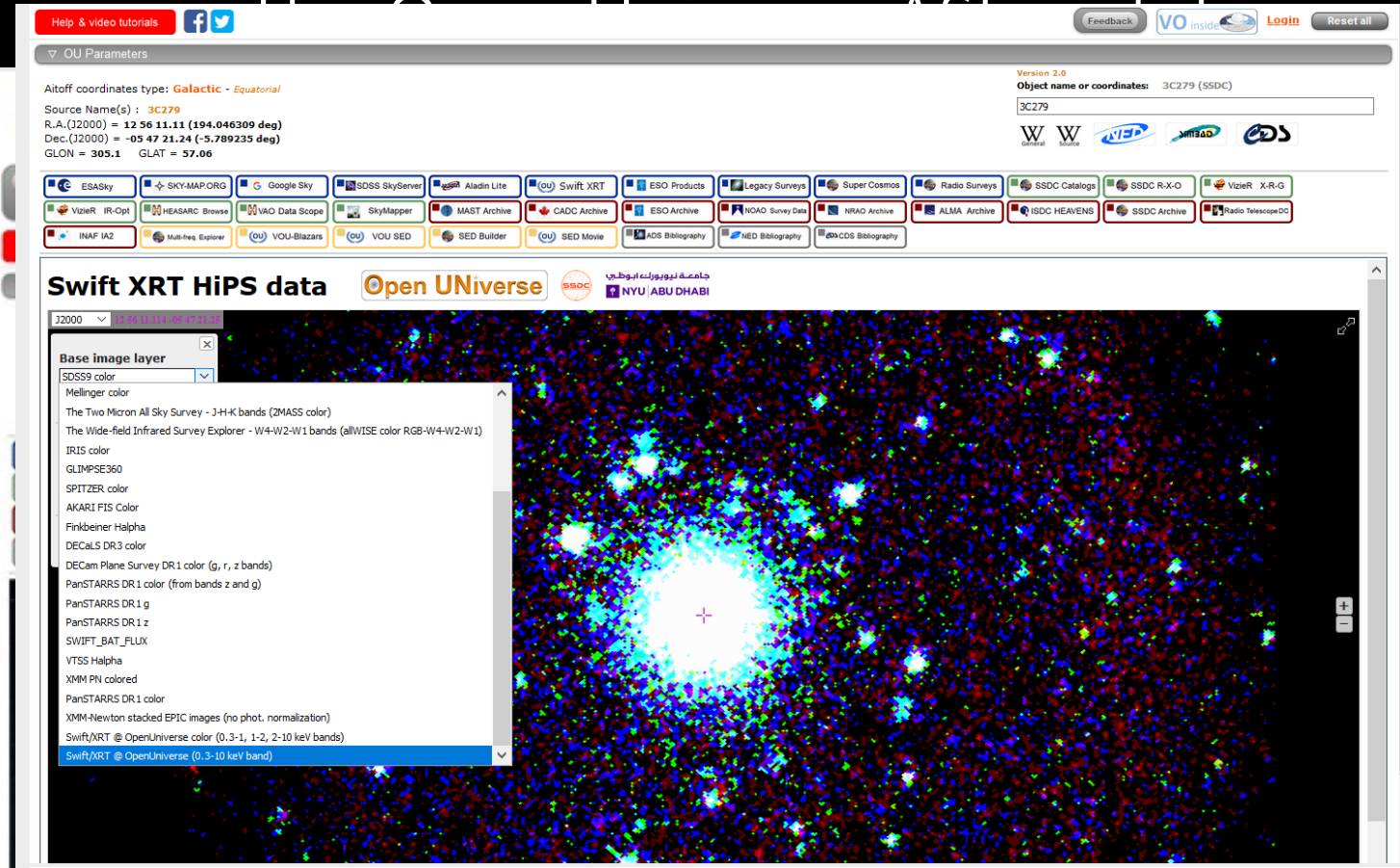


The Open Universe ASI portal





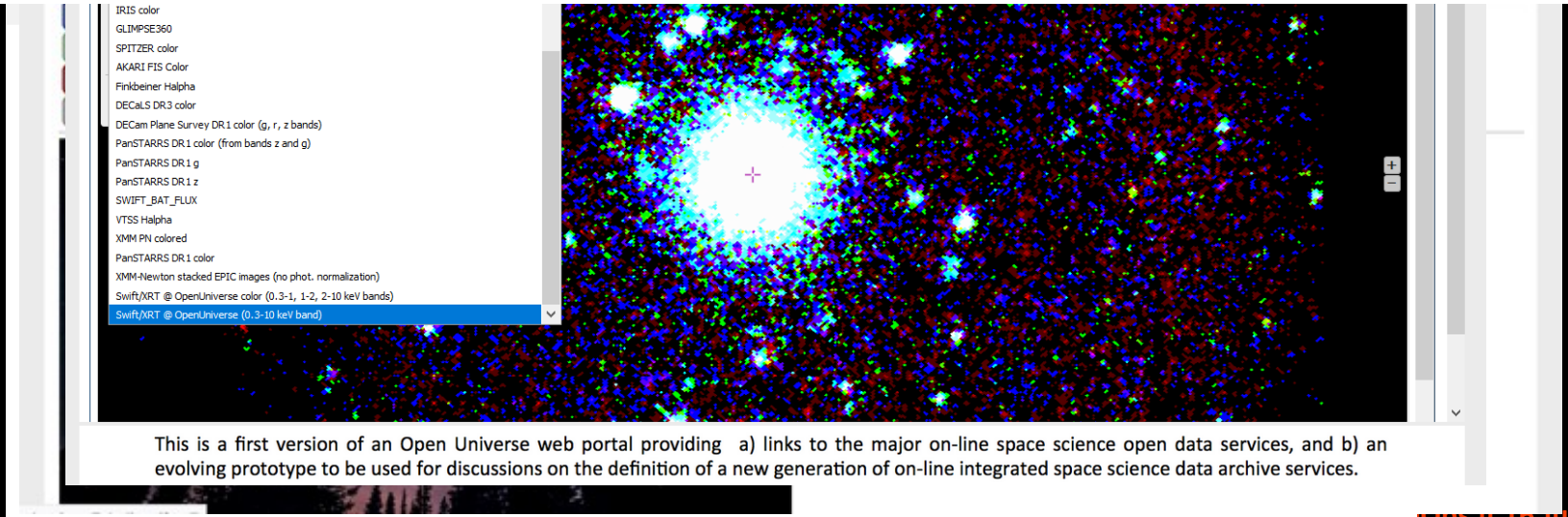
This is a first version of an Open Universe web portal providing a) links to the major on-line space science open data services, and b) an evolving prototype to be used for discussions on the definition of a new generation of on-line integrated space science data archive services.

- Contribution to SSDC activities for OU:

=>Swift/XRT survey HiPS

Developed also in preparation of future application of HiPS to other SSDC archives

Question: is it possible to link single specific data products to HiPS? And/or they should be available independently



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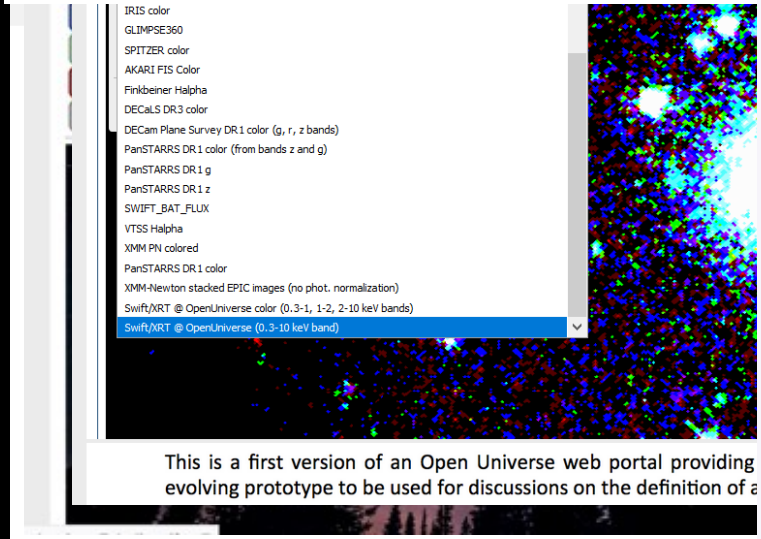

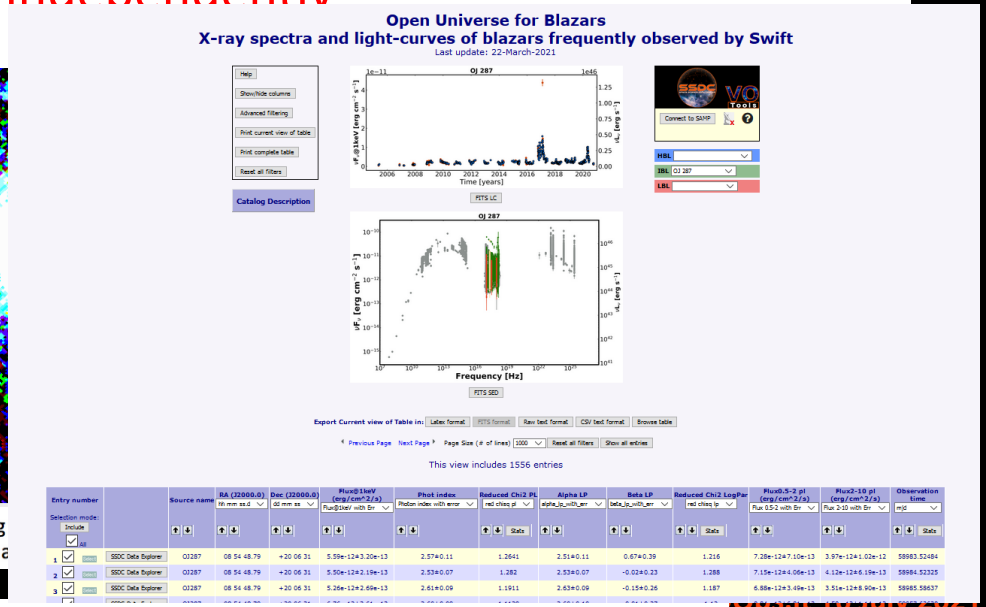

Summary and next steps

- Current access to SSDC data archives: MMIA & MMIA 2.0
- Allow access to various data types using SIAP/SSAP?
- For some specific SSDC tool generated products
- VOSSIA possible application
- Access to specific spectral products from within an application
- First application of HiPS for OU
- Access to archival data through HiPS or viceversa
- Future development on other archives
- …….

VOObs.it 16 July 2021

Thank you!