Open Universe

Space science data for everyone

Paolo Giommi
Senior Scientist, International Relations Unit
Italian Space Agency,

Open Universe, an Italian initiative

"Open Universe" is an initiative proposed by Italy at the COPUOS session of June 2016 where it was agreed that it will be part of the activities in preparation of UNISPACE + 50

The main objective of Open Universe is to stimulate a dramatic increase of the utilization of space science data (e.g. astrophysics, planetary science, cosmic rays etc.), extending the potential of scientific discovery to new participants in all parts of the world.

A very wide range of communities will benefit from Open Universe: professional scientists, citizen scientists, teachers and students, potentially any citizen interested in space science.

Open Universe has been proposed by Italy as a contributing activity in preparation for UNISPACE+50, in line with the thematic priority "Capaciy Building", with focus on Science, Technology, Engineering and Mathematics (STEM)

Critical juncture in the history of human civilization:

- computing power, data storage and interconnectivity have become nearly limitless resources potentially available to billions of people in the world;
- **open data access** is a well-established principle of every scientific discipline that drives innovation and productivity;
- **however there is still a considerable degree of unevenness in the services** currently offered by scientific data providers.

Initiatives are necessary to expand availability and accessibility to open source space science data:

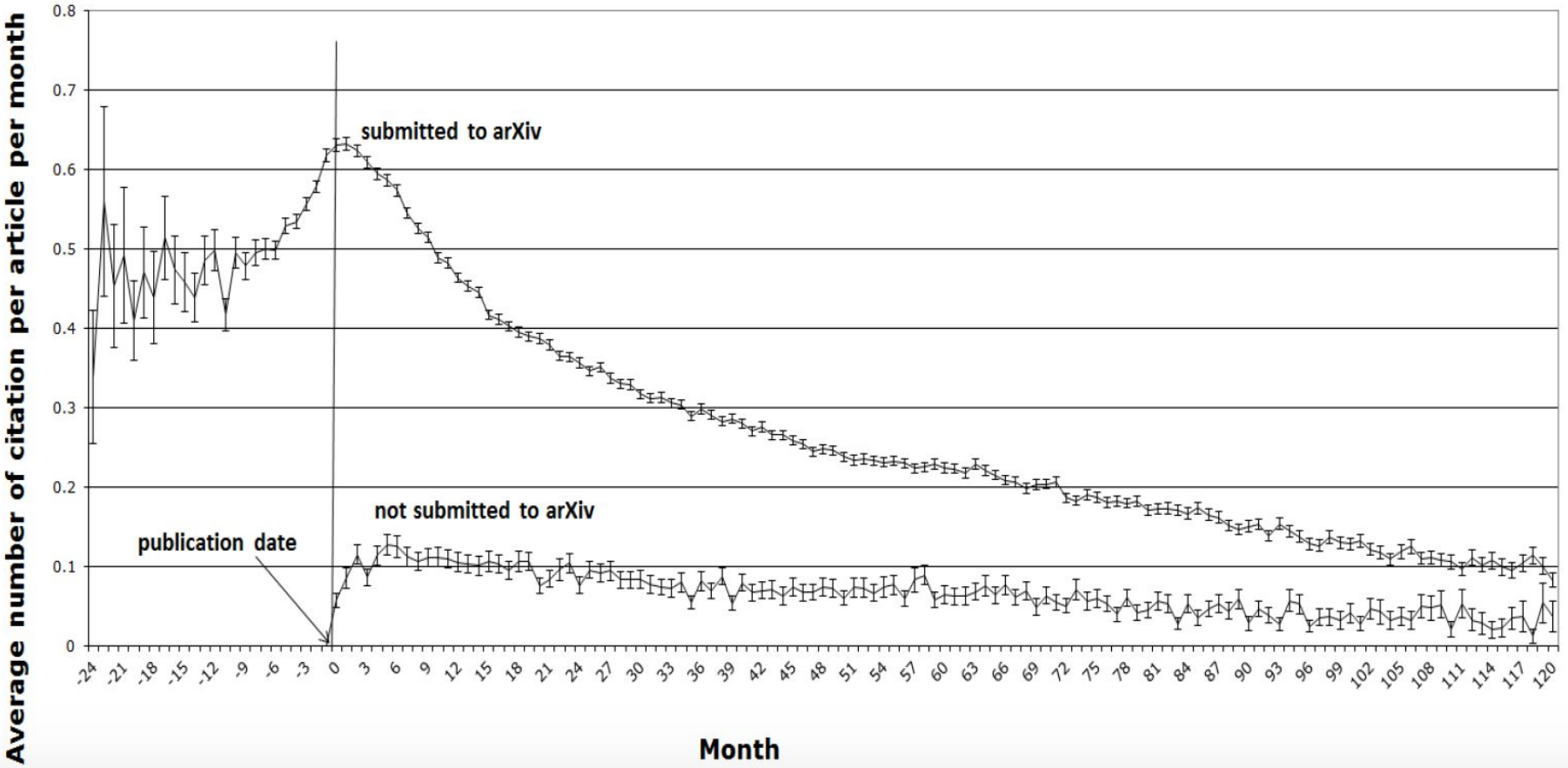
Open Universe

Space science data produced with public money is valuable.
It should be considered as a public good and preserved as such

Space science data policies should respond to the increasing demand for transparency of everything produced with public money

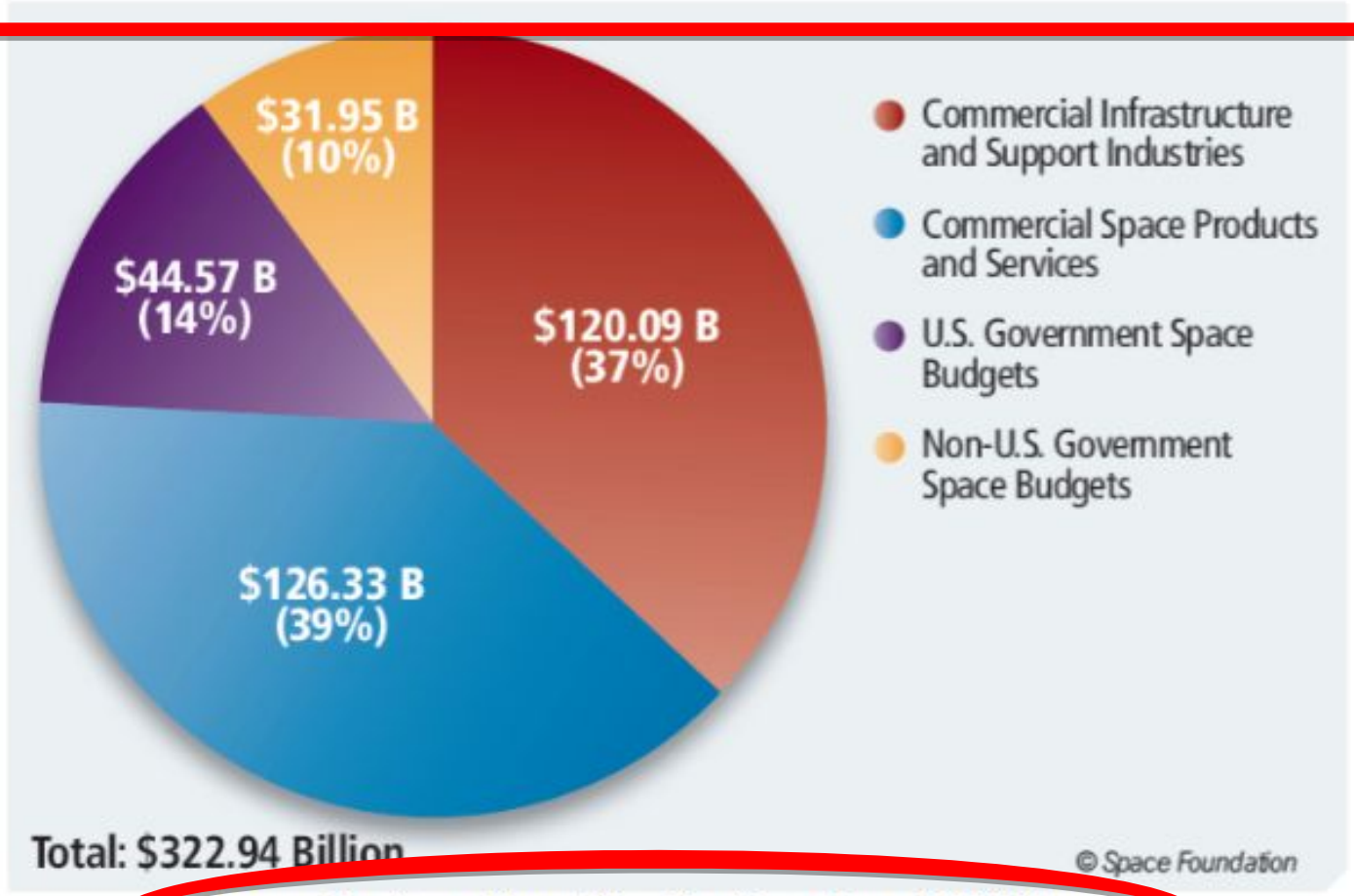
OECD (2015), "Making Open Science a Reality", *OECD Science, Technology and Industry Policy Papers*, No. 25, OECD Publishing, Paris.
http://dx.doi.org/10.1787/5jrs2f963zs1-en

Analysis based on articles published in the Journal of High energy Physics and Physical Review D



The economic value of space science data - I

Economic Value: in 2015 the global space economy represented $322.94 Billion of activity; apx. 76% of which represented private sector activity



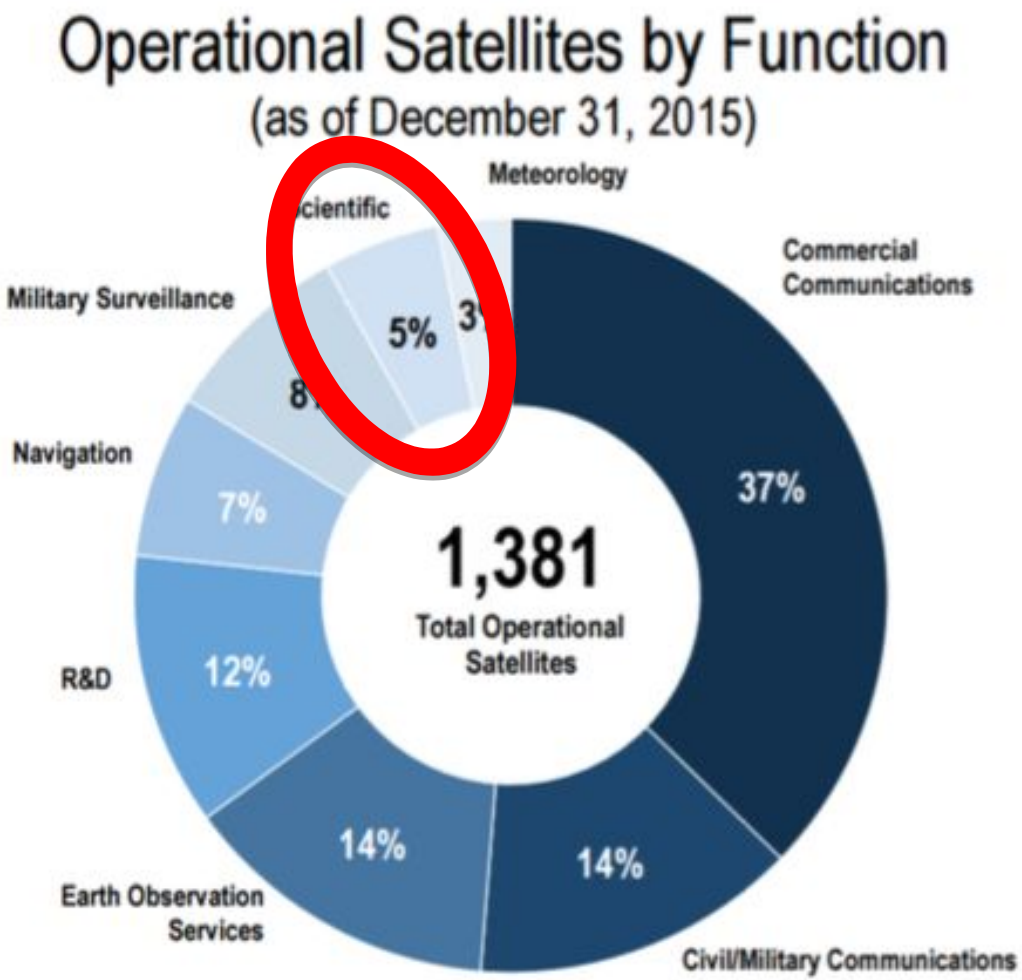
Source: The Space Foundation, *The Space Report 2016 Overview*

UNISPACE+50 - High Level Forum
November 20-22, 2016

2

swfound.org

The economic value of space science data - II



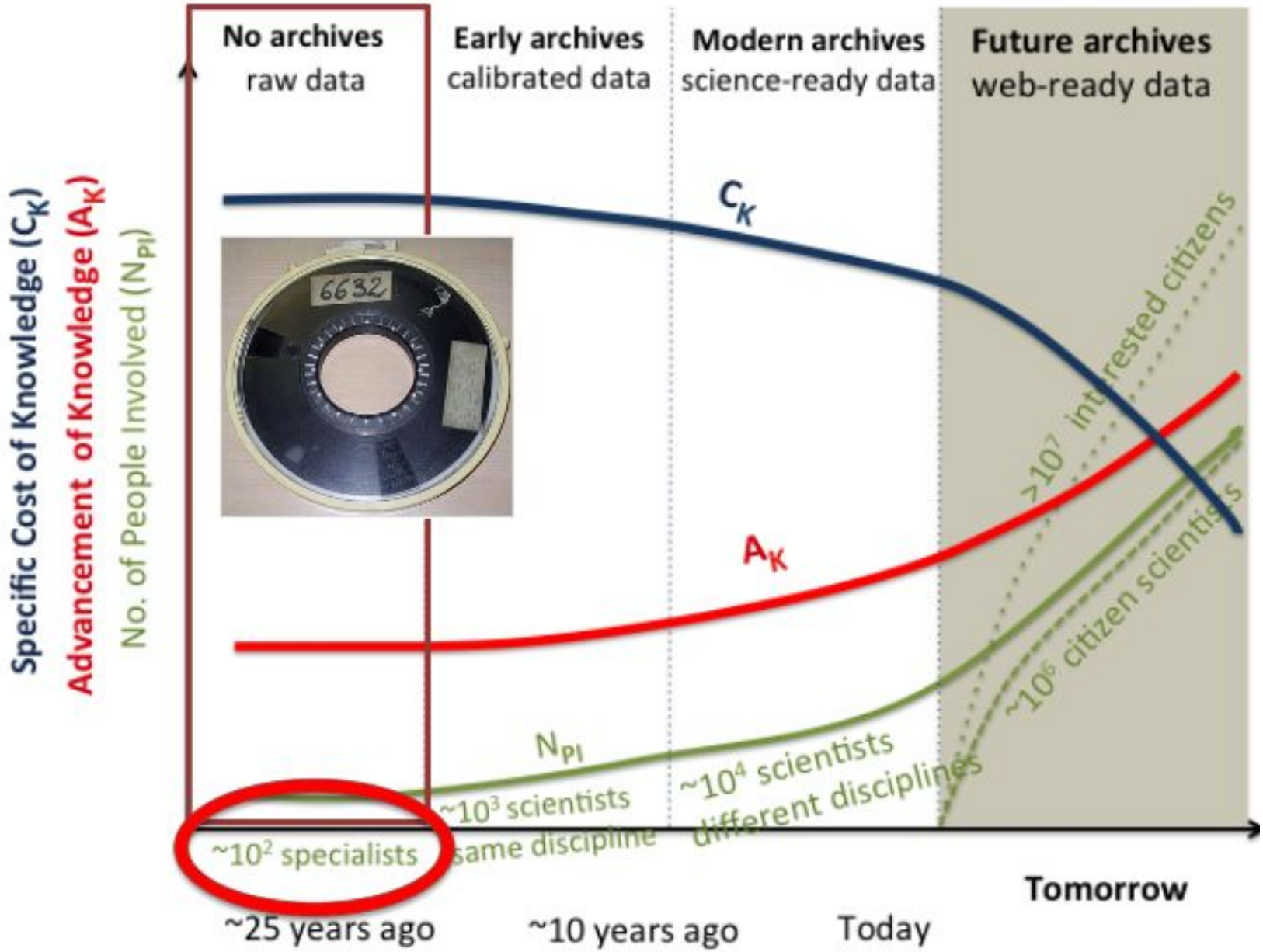
Source: Satellite Industry Association, *2016 State of the Satellite Industry Report*

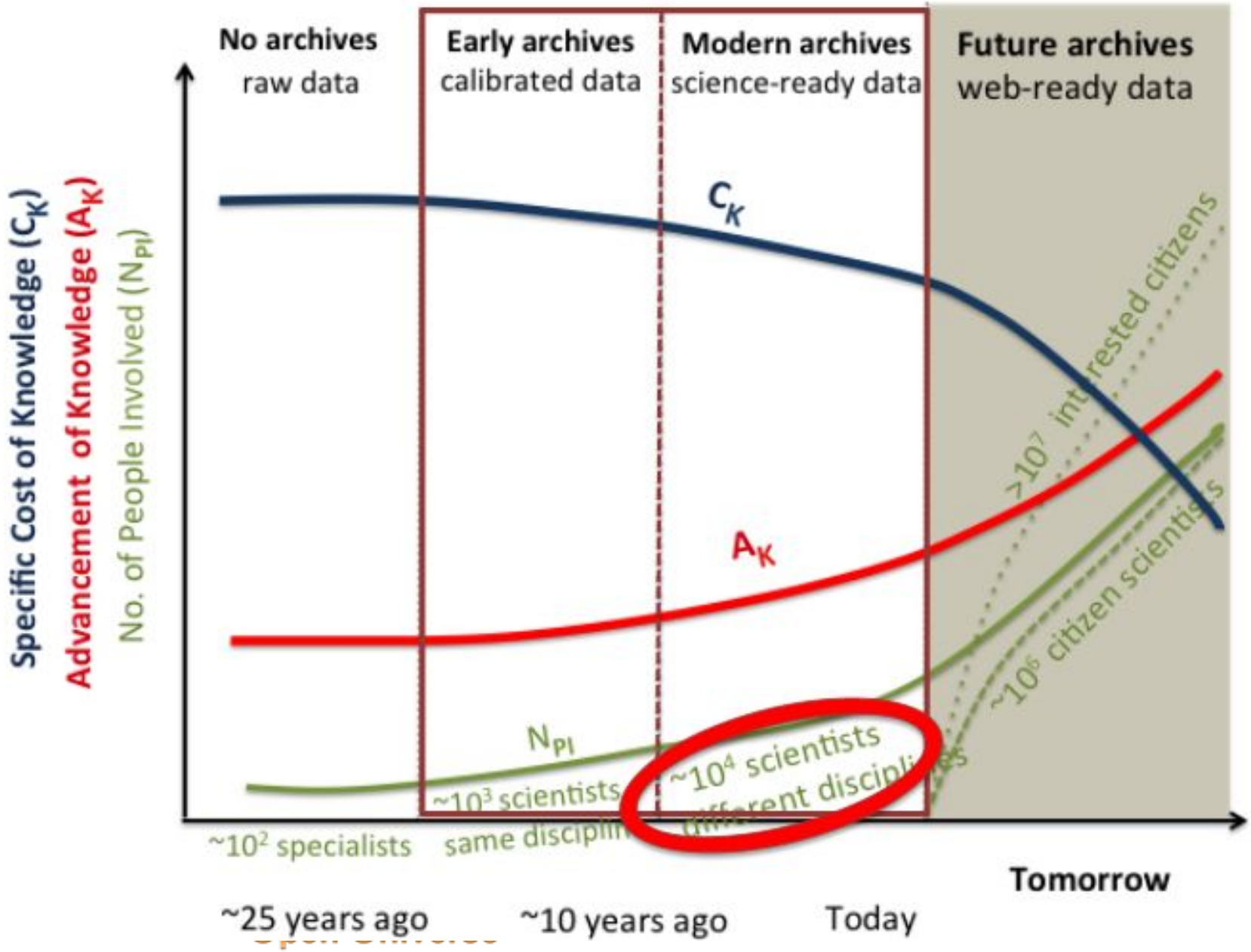
Satellite Communications Services:
2015 revenue of $127.4B (SIA)

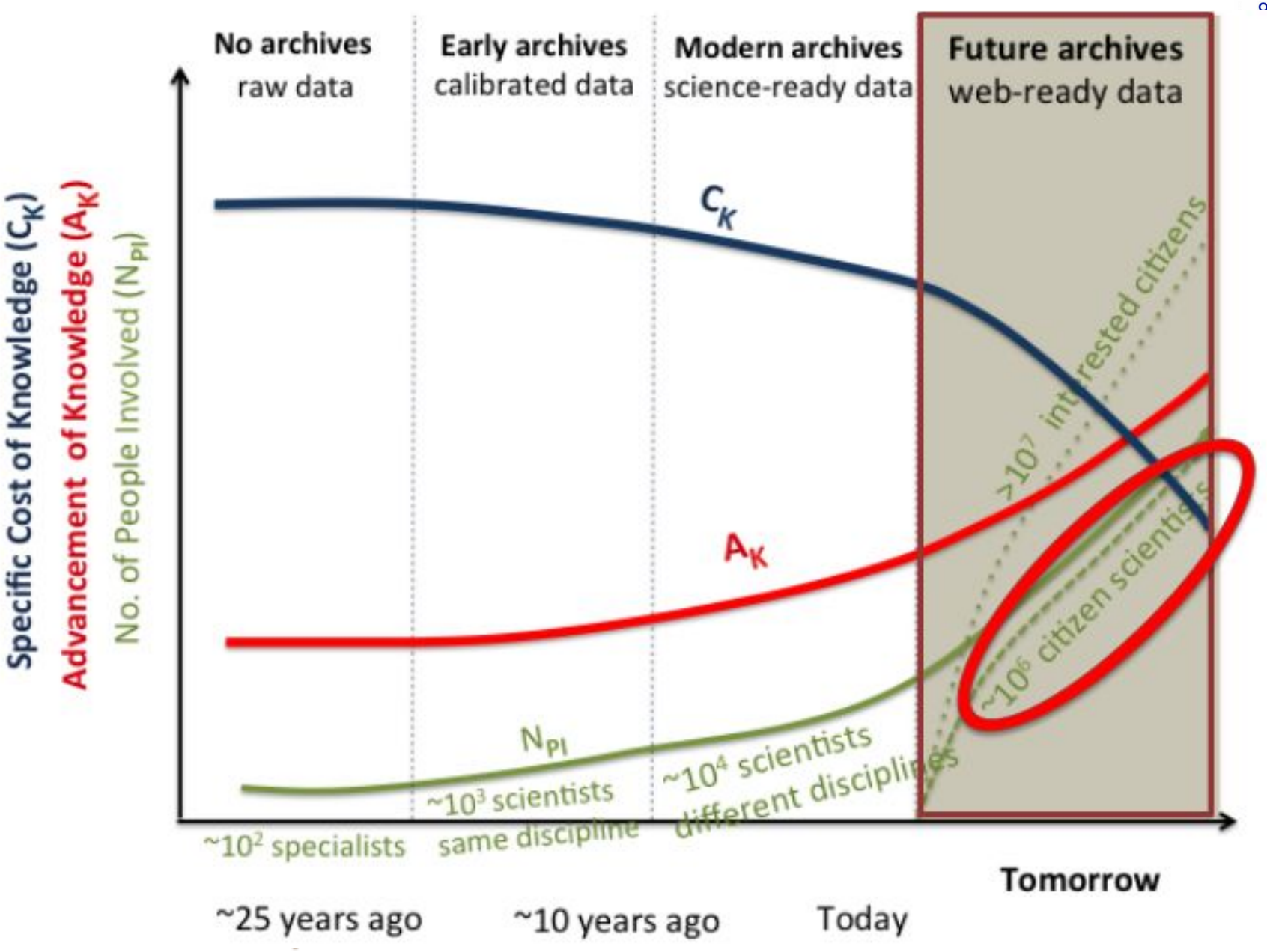
Earth Observation Services:
2015 revenue of $1.4B (SIA)

Navigation (GNSS) Equipment
2015 revenue of $1.4B (SIA)

Equivalent to ~15 billion Euros


No archives
raw data
Early archives
calibrated data
Modern archives
science-ready data
Future archives
web-ready data
Specific Cost of Knowledge (C_K)
Advancement of Knowledge (A_K)
No. of People Involved (N_{PI})
C_K
A_K
N_{PI}
6632
~10^2 specialists
~10^3 scientists same discipline
~10^4 scientists different disciplines
>10^7 interested citizens
~10^6 citizen scientists
~25 years ago
~10 years ago
Today
Tomorrow


No archives
raw data
Early archives
calibrated data
Modern archives
science-ready data
Future archives
web-ready data
Specific Cost of Knowledge (C_K)
Advancement of Knowledge (A_K)
No. of People Involved (N_{PI})
C_K
A_K
N_{PI}
~10^2 specialists
~10^3 scientists
~10^4 scientists
>10^7 interested citizens
~10^6 citizen scientists
~25 years ago
~10 years ago
Today
Tomorrow


No archives
raw data
Early archives
calibrated data
Modern archives
science-ready data
Future archives
web-ready data
Specific Cost of Knowledge (C_K)
Advancement of Knowledge (A_K)
No. of People Involved (N_{PI})
C_K
A_K
N_{PI}
~10^2 specialists
~10^3 scientists
same discipline
~10^4 scientists
different disciplines
>10^7 interested citizens
~10^6 citizen scientists
~25 years ago
~10 years ago
Today
Tomorrow

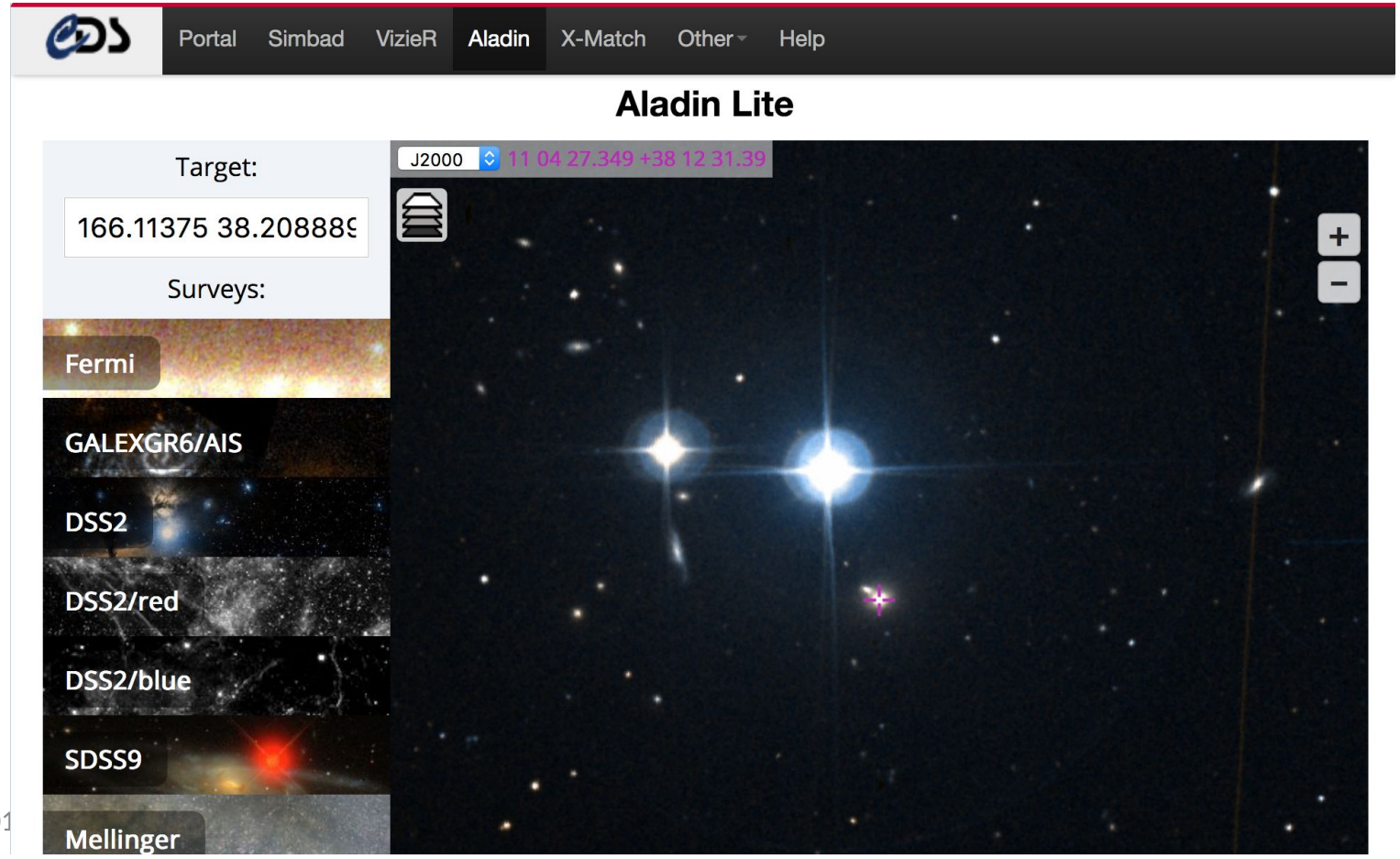
Space Science Data

(Astrophysics, cosmology, cosmic-ray, solar physics, planetary science, space weather etc.)

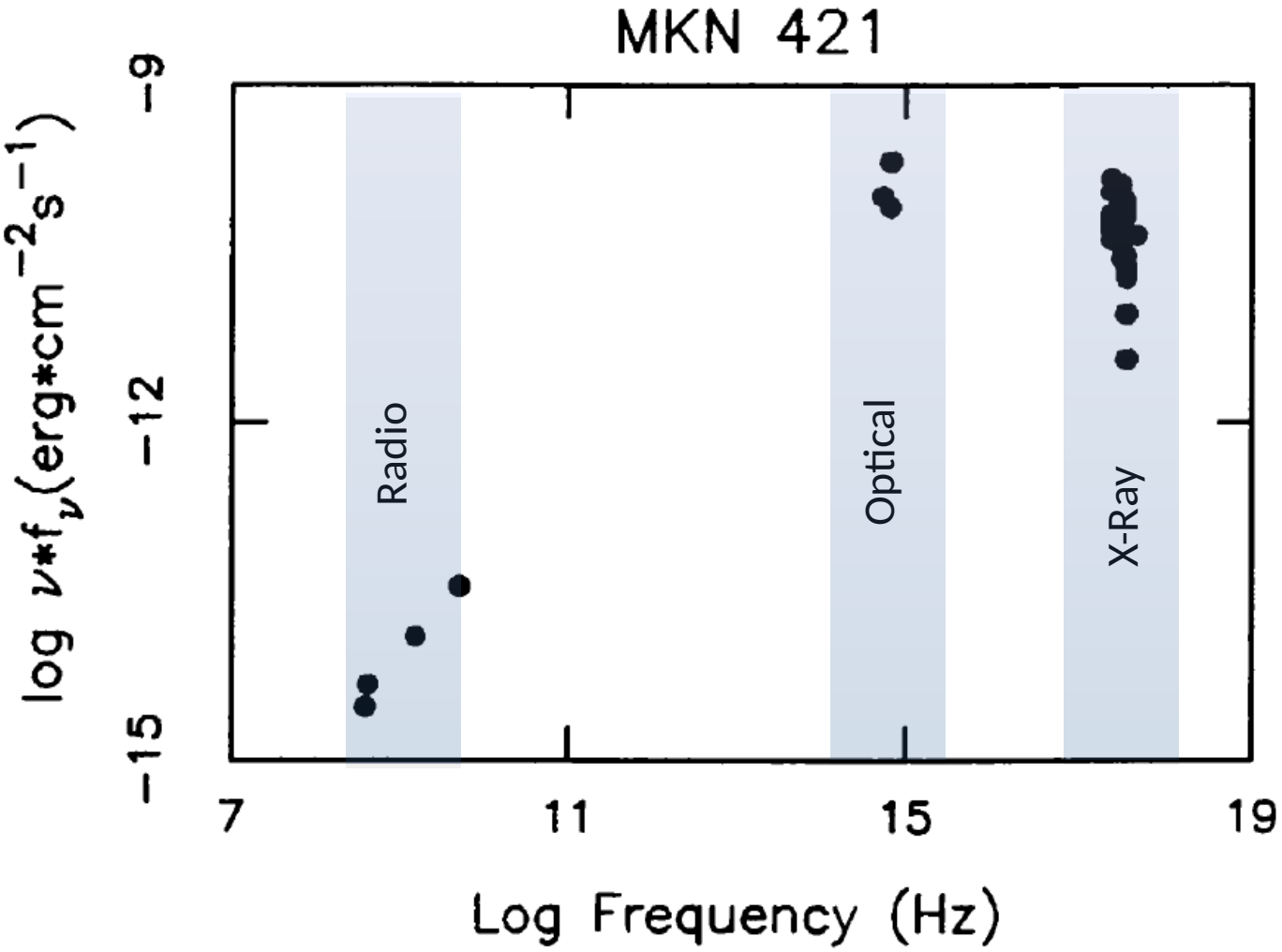
Proprietary	Open	Transparent
Only available to project team members. May be temporary (typically in astronomy and planetary science) or permanent (typically in cosmic rays, and VHE gamma-rays)	Available to anyone from on-line digital archives with no technical or legal restrictions. To fully use the data specialized knowledge may be necessary.	- User-ready science-ready for scientists, usable by anyone: specialized knowledge not necessary - Easily discoverable and free of bureaucratic barriers. Simple/quick learning curve - Web-ready User ready files downloadable with one-click. - Available in a timely fashion

Open vs Transparent : the case of MKN 421

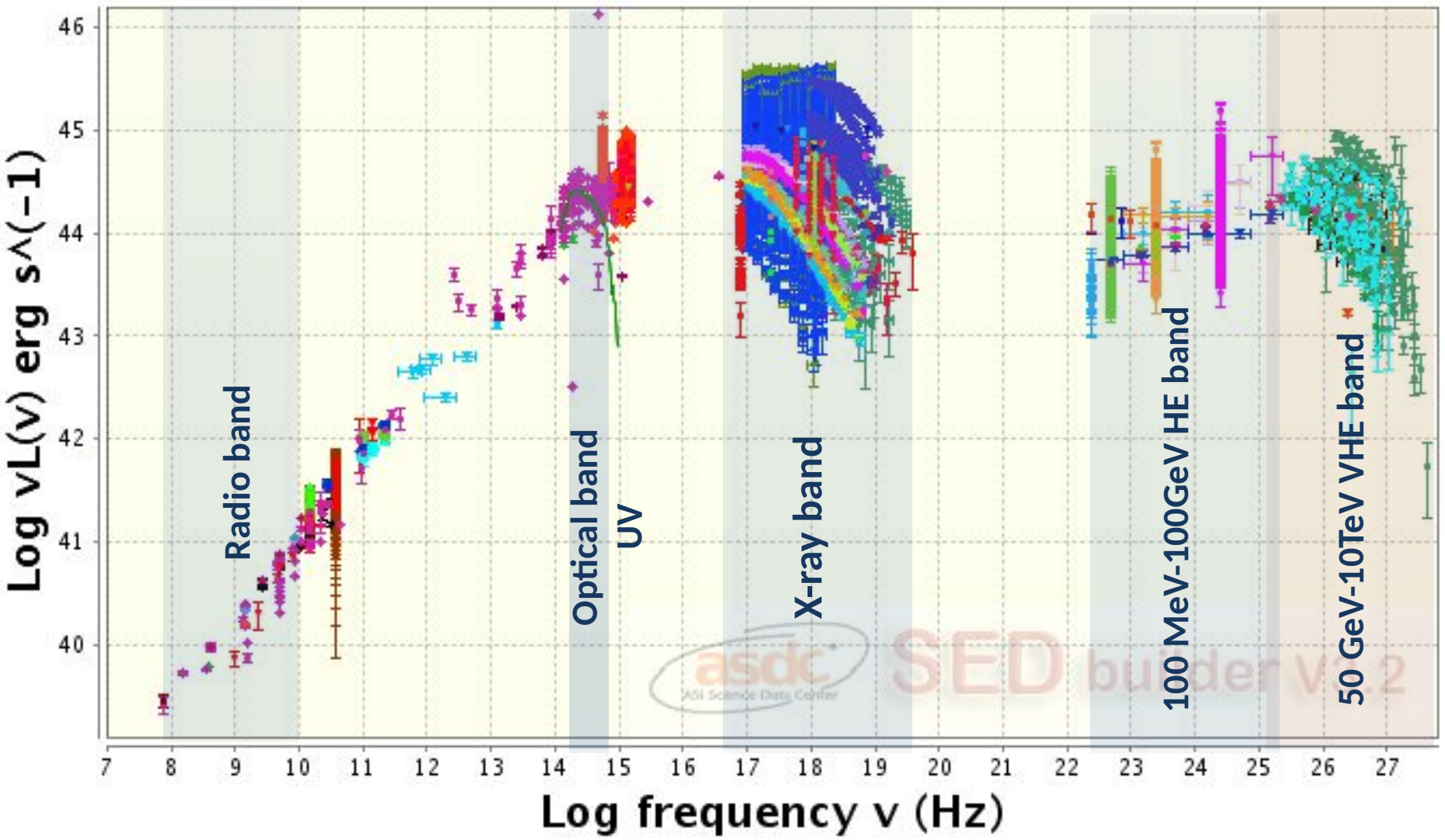
One of the best studied Active Galaxies (supermassive black hole) emitting at all energies and candidate multi-messenger (neutrino + UHECR) emitter



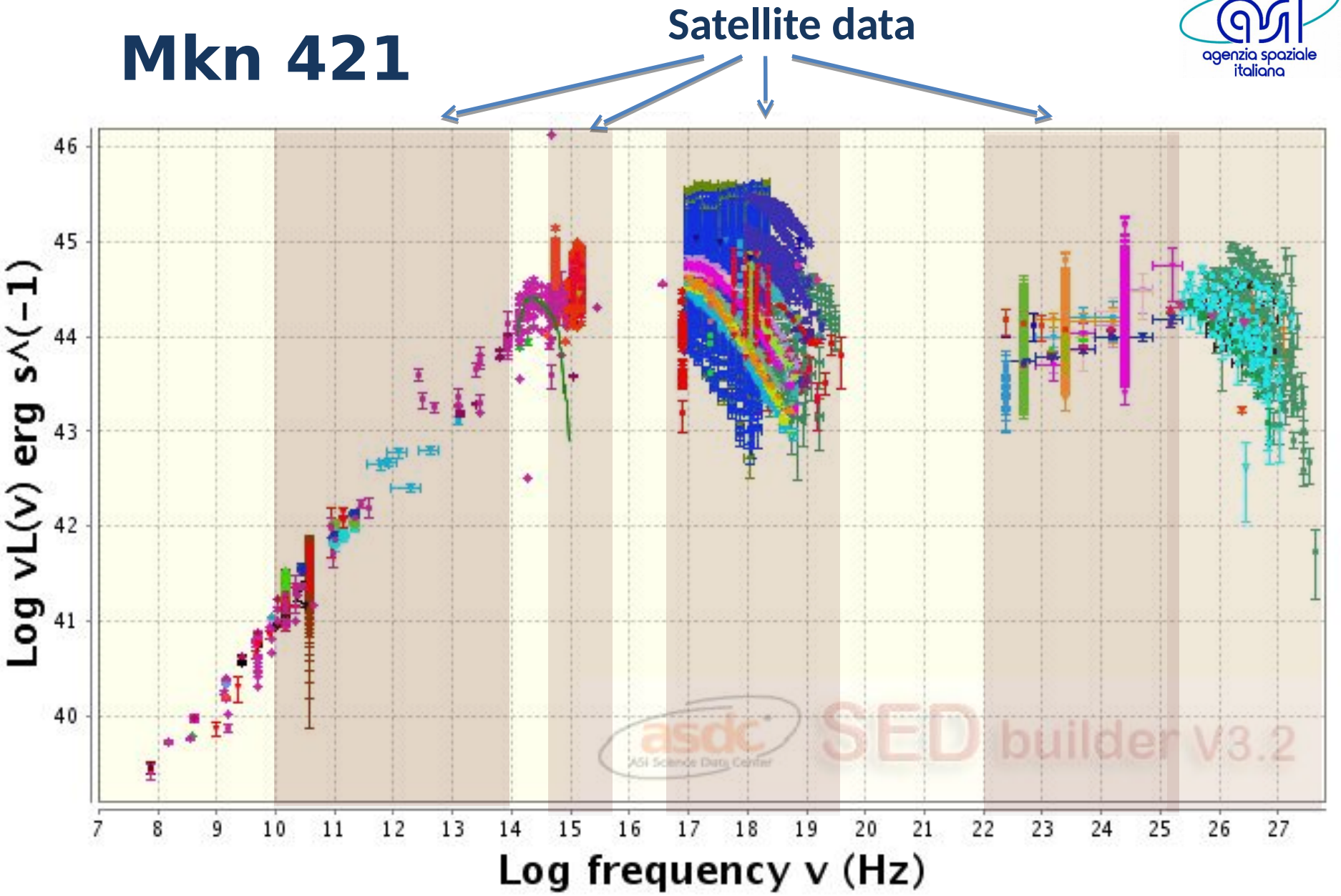
Giommi, Ansari & Micol, 1995, A&AS 109, 267



Mkn 421


Log vL(v) erg s^(-1)
Log frequency v (Hz)
Radio band
Optical band
UV
X-ray band
100 MeV-100GeV HE band
50 GeV-10TeV VHE band
asdc
ASI Science Data Center
SED builder v2

Mkn 421

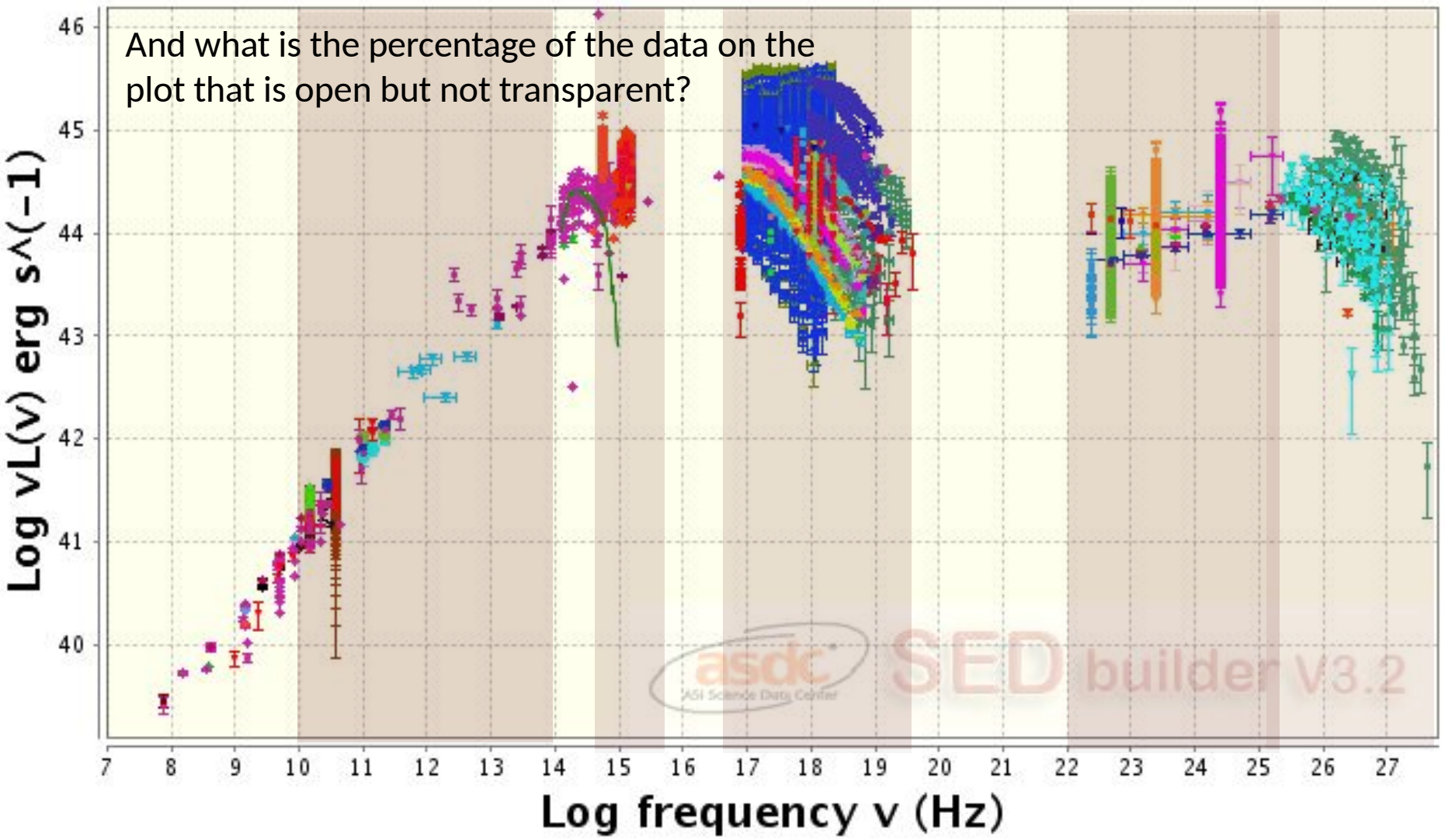

Satellite data
Log vL(v) erg s^(-1)
Log frequency v (Hz)
asdc
ASI Science Data Center
SED builder V3.2

Mkn 421

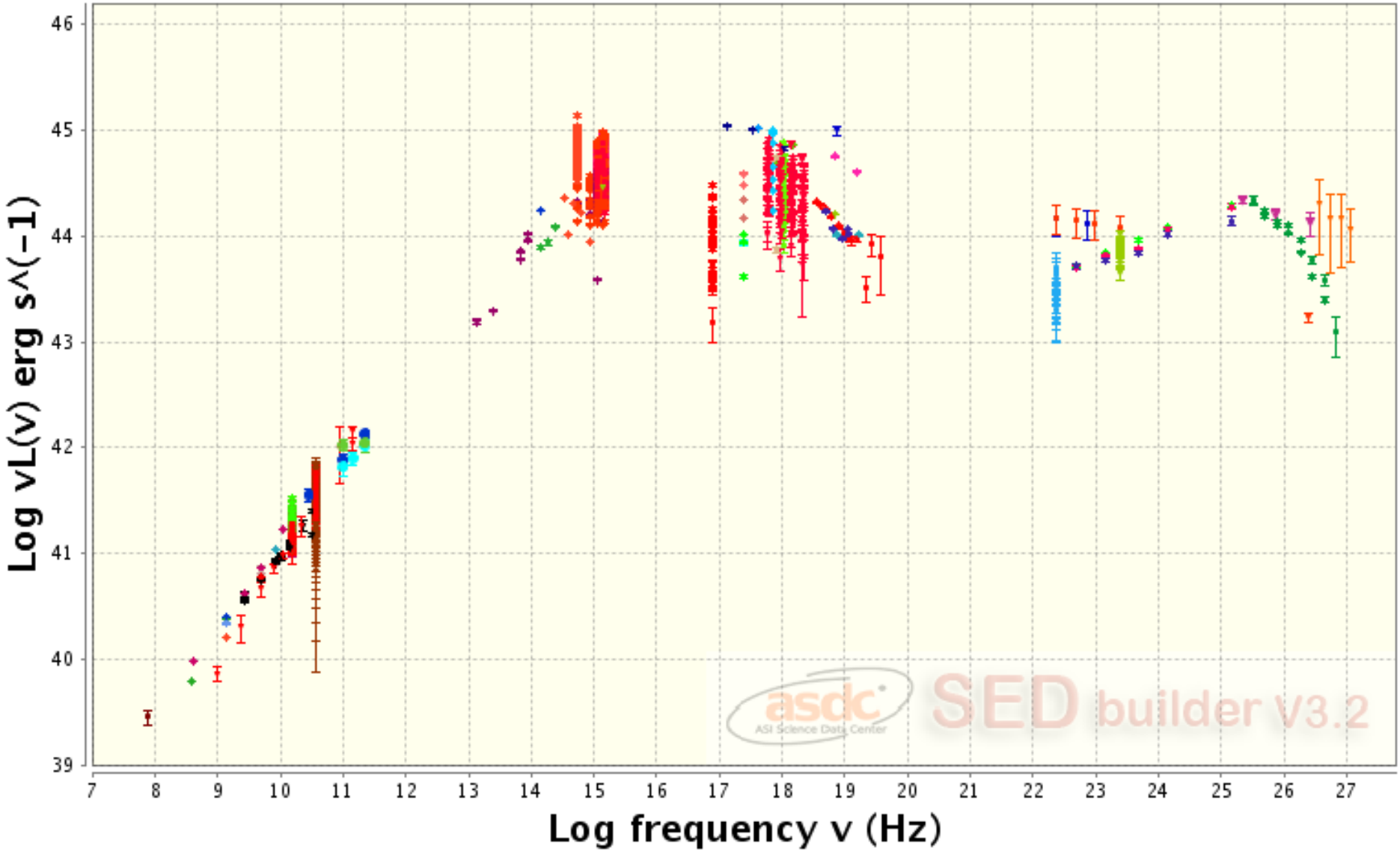
The amount of data points in this plot (~50,000) may be impressive

But the point is …

how many data measurements **exist** and **are not** on this plot



Mrk 421


Log vL(v) erg s^(-1)
Log frequency v (Hz)
asdc
ASI Science Data Center
SED builder V3.2

Space Science Data availability

(Astrophysics, cosmology, cosmic-ray, solar physics, planetary science, space weather etc.)

	Yesterday (1980's)	Today	Tomorrow (Open Universe)
Proprietary	100%	To be assessed > 50%?	Ideally 0%
Open	0%	To be assessed < 50%?	100%
Transparent	0%	To be assessed 10%?	Ideally 100%?

Space Science Data: from *Open* to *Transparent*

Data formats

- FITS for astronomy
- ROOT for cosmic-rays
- PDS for planetary science
- Other (fz)?

Software standards, protocols, data models,
Enable/facilitate data distribution
e.g. IVOA, XML,
other?

Data upgrade services/software tools
Value added, processing to upgrade open data to transparent level
Open software.
Requires skills to *ensure scientific quality*
Is preserved.

Recognition of existing space data
Estimation of the transparency level
Increase volume of open/transparent data by e.g. incentivizing open data policies

Data discovery services
Web portals, on-line services with easy/quick learning curve

Improve links with theoreticians
academy, museums, citizens
Developing and emerging Countries

Space Science Data Policies
Encourage decision makers to promote or enforce Open and Transparent policies for space science data
Open Universe – UNOOSA

UNITED NATIONS
Office for Outer Space Affairs

agenzia spaziale italiana

Expert Meeting in preparation of the

United Nations/Italy Workshop on the Open Universe Initiative

Programme

Hosted by

The Italian Space Agency

agenzia spaziale italiana

11-12 April 2017

ASI Tor Vergata
Via del Politecnico snc, 00133 Rome, Italy

Open Universe:Space Science data for everybody

The Italian initiative at the United Nations stems from the need to ensure that scientific data generated in space should be accessible as much as possible by anyone

by Redazione ASI Friday 14 April 2017

International experts gathered at the headquarters of the **Italian Space Agency** (ASI), in Rome for a two-day meeting (April 11-12, 2017) dedicated to **"Open Universe"**, an initiative proposed by Italy to the **United Nations Committee on the Peaceful Uses of Outer Space** (COPUOS).

The goal of **Open Universe** is to ensure that space science data become more and **more accessible and usable** to **all sectors of society** from the professional scientific community, through "citizen scientists", to universities, schools, museums, and ordinary citizens.

The meeting was attended by about **50 experts** representing major space agencies, **NASA**, **ESA**, **JAXA**, **ASI**; international organizations, **COSPAR** - Committee On Space Research, **ESO** - European Southern Observatory, **IAU** - International Astronomical Union, **ICRANet** - International Relativistic Astrophysics Network, **GEO** - Group of Earth Observations, **OECD** - Organization for Economic Co-operation and Development; and research institutes and universities from different countries.

In the presence of Mr. **Enrico Padula** of the Italian Ministry of Foreign Affairs and International Cooperation, the meeting was introduced by the president of **ASI**, **Roberto Battiston**, and **Simonetta Di Pippo**, director of the **United Nations Office for Outer Space Affairs** (UNOOSA). Participants discussed in detail how to fulfil the initiative's objectives.

The next step will be a joint **UN-Italy workshop**, open to the international community, to be held at the UN headquarters in Vienna from 20 to 22 November 2017.

Open Universe is one of several activities in preparation for **UNISPACE+50**, a major event to be held in June 2018 at the United Nations in Vienna on the occasion of the **50th anniversary** of the **first UN conference** on the exploration and peaceful uses of outer space. At **UNISPACE+50** the international community will meet to define the contributions of space activities to the achievement of the UN's Sustainable Development Goals.

UNITED NATIONS
Office for Outer Space Affairs

Open Universe initiative

agenzia spaziale italiana

Open Universe Expert Meeting

11-12 April 2017
ASI-HQ, Rome, Italy

Expert Meeting Programme PDF

video1 video2 reset

Meeting presentations

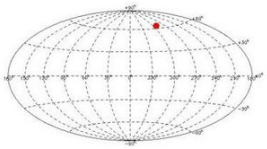
The Open Universe Initiative	P. Giommi - ASI	PDF
Inexorable Logic of the Open Universe	A. Pollock - University of Sheffield	PDF
Open Science at NASA Implementation and lessons learned	G. Allen - NASA	PDF
Space Science Data at ESA	C. Arviset - ESA	PDF
Space Science Data at JAXA	K. Masuda - JAXA/ISAS	PDF
Space Science Data at ASI	E. Russo - ASI	PDF
Challenges of open data provision	J. Osborne - University of Leicester	PDF
ESO's activities in open science data	A. Williams - ESO	PDF
Space and ground-based data management at the CADC	D. Schade - CADC	PDF
The CDS experience	M. Allen - CDS	PDF
The IVOA and space data	G. Fabbiano - IVOA/Harvard	PDF
ASTRONET	D. Mourard - CNRS	PDF
Big observatories - big data: the approach to astrophysical data and open science in the CTA, E-ELT and SKA era	F. Zerbi - INAF	PDF
Legacy power in high-energy astrophysics	R. Walter - ISDC, Geneva	PDF

UNITED NATIONS
Office for Outer Space Affairs

Open Universe initiative

agenzia spaziale italiana

Open Universe @ ASI | Space Astronomy » | Ground-Based Astronomy » | Planetary Science » | International Space Station » | VO and General services » | Bibliographic services » | Cosmic Rays » | Other Initiatives »



Source Name(s) : 3C273
R.A.(J2000) = 12 29 06.66 (187.277772 deg)
Dec.(J2000) = +02 03 08.42 (2.05234 deg)

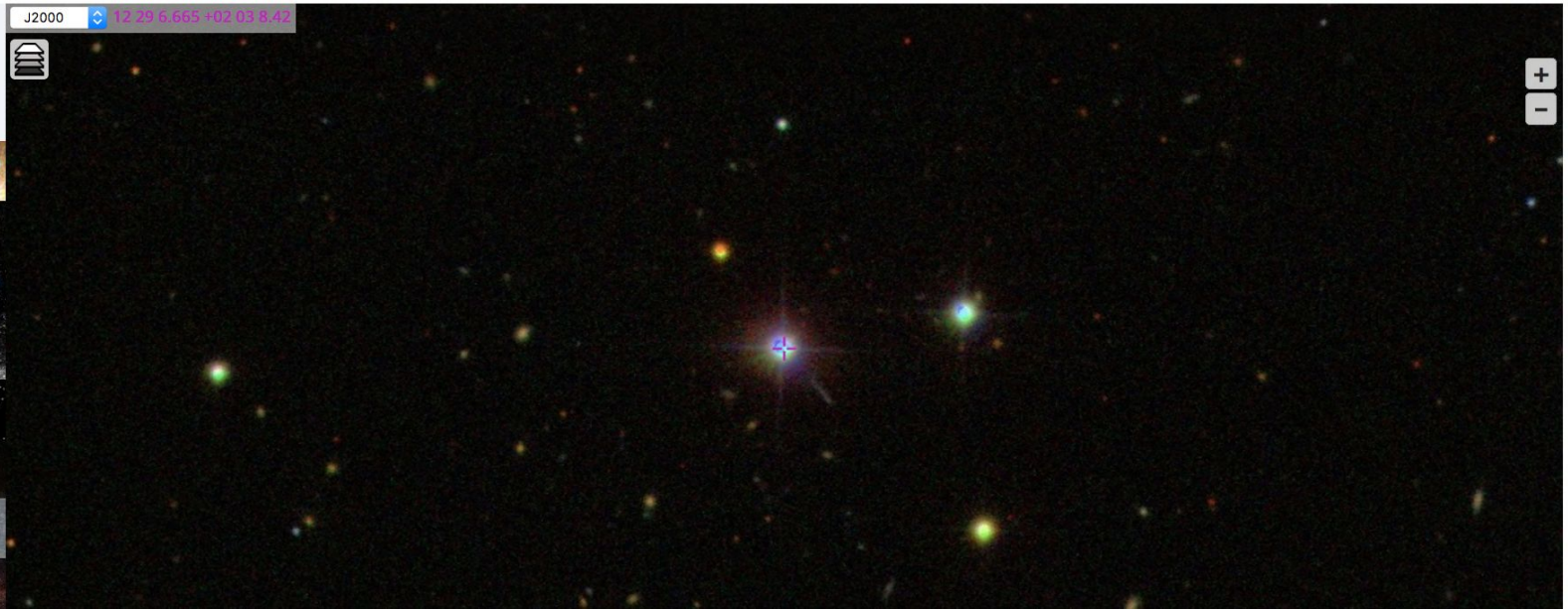
Prototype v.0.8.5
User: giommi (Logout)
Object name or coordinates: 3C273 (ASDC)
3C273
Reset

ESASky | SKY-MAP.ORG | Google Sky | SDSS SkyServer | Aladin Lite | SuperCOSMOS | Radio Surveys | Error Circle | Astronomical Catalogs | Groups of Catalogs
CADC | ESO Archive | NRAO Archive | ALMA Archive | ISDC - HEAVENS | Data archive | SED builder | SED movie | Bibliographic Search

CDS Portal | Simbad | VizieR | Aladin | X-Match | Other | Help

Aladin Lite

Target:
187.277772 2.05234
Surveys:
Fermi
GALEXGR6/AIS
DSS2
DSS2/red
DSS2/blue
SDSS9
Mellinger
2MASS

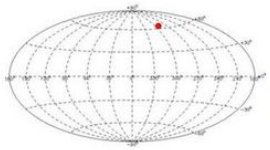


UNITED NATIONS
Office for Outer Space Affairs

Open Universe initiative

agenzia spaziale italiana

Open Universe @ ASI | Space Astronomy » | Ground-Based Astronomy » | Planetary Science » | International Space Station » | VO and General services » | Bibliographic services » | Cosmic Rays » | Other Initiatives »



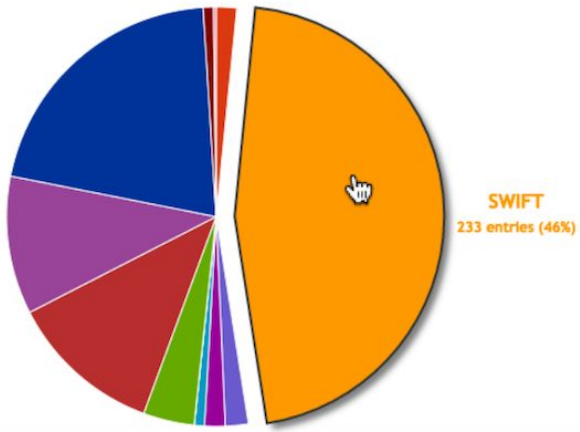
Source Name(s) : 3C273
R.A.(J2000) = 12 29 06.66 (187.277772 deg)
Dec.(J2000) = +02 03 08.42 (2.05234 deg)

Prototype v.0.8.5
User: giommi (Logout)
Object name or coordinates: 3C273 (ASDC)
3C273
Reset

ESASky | SKY-MAP.ORG | Google Sky | SDSS SkyServer | Aladin Lite | SuperCOSMOS | Radio Surveys | Error Circle | Astronomical Catalogs | Groups of Catalogs
CADC | ESO Archive | NRAO Archive | ALMA Archive | ISDC - HEAVENS | Data archive | SED builder | SED movie | Bibliographic Search

asdc
ASI Science Data Center

ASDC Multi-Mission Interactive Archive



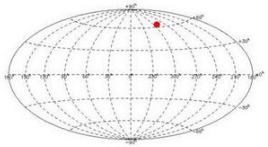
MISSION	ENTRIES
PLANCK	0
HERSCHEL	8
SWIFT	233
ASCA	0
BeppoSax NFI	9
BeppoSax WFC	8
EINSTEIN	4
EXOSAT	0
NUSTAR	20
ROSAT	60
AGILE	54
AGILE-LV3	106
EGRET	4
FERMI	1

UNITED NATIONS
Office for Outer Space Affairs

Open Universe initiative

agenzia spaziale italiana

Open Universe @ ASI | Space Astronomy » | Ground-Based Astronomy » | Planetary Science » | International Space Station » | VO and General services » | Bibliographic services » | Cosmic Rays » | Other Initiatives »



Source Name(s) : **3C273**
R.A.(J2000) = **12 29 06.66 (187.277772 deg)**
Dec.(J2000) = **+02 03 08.42 (2.05234 deg)**

Prototype v.0.8.5 — User: giommi (Logout)
Object name or coordinates: 3C273 (ASDC)
3C273 — Reset

ESASky | SKY-MAP.ORG | Google Sky | SDSS SkyServer | Aladin Lite | SuperCOSMOS | Radio Surveys | Error Circle | Astronomical Catalogs | Groups of Catalogs
CADC | ESO Archive | NRAO Archive | ALMA Archive | ISDC - HEAVENS | Data archive | SED builder | SED movie | Bibliographic Search

Government of Canada / Gouvernement du Canada — Canada.gc.ca | Services | Departments | Français

Canadian Astronomy Data Centre

Canada

Telescope Data Products | Advanced Data Products | Services | Documentation | Advanced Search | Login

CADC Home » Advanced Search

Advanced Search

Search | Results | Error | ADQL | Help

Download complete query results: VOTable CSV TSV — Bookmark URL

Download — Showing 4195 rows (4195 before filtering). — Change Columns — View in sky

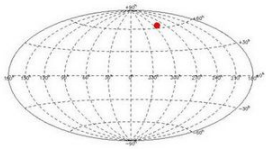
Mark	Preview	Collection	Obs. ID	RA (J2000.0)	Dec. (J2000.0)	*Start Date*	Instrument	Int. Time
Filter:				H:M:S	D:M:S	Calendar		Seconds
		JCMT	scuba2_00014_20170513T053119	12:29:08.70	+02:03:29.6	2017-05-13 05:32:20	SCUBA-2	134.000
		JCMT	scuba2_00014_20170513T053119	12:29:08.70	+02:03:29.6	2017-05-13 05:32:20	SCUBA-2	134.000
		JCMT	scuba2_00020_20170512T062023	12:29:08.63	+02:03:37.1	2017-05-12 06:21:45	SCUBA-2	133.000
		JCMT	scuba2_00020_20170512T062023	12:29:08.63	+02:03:37.1	2017-05-12 06:21:45	SCUBA-2	133.000
		JCMT	scuba2_00014_20170512T051716	12:29:08.70	+02:03:28.1	2017-05-12 05:22:21	SCUBA-2	132.000
		JCMT	scuba2_00014_20170512T051716	12:29:08.70	+02:03:28.1	2017-05-12 05:22:21	SCUBA-2	132.000
		JCMT	scuba2_00014_20170504T055106	12:29:08.37	+02:03:27.1	2017-05-04 05:56:11	SCUBA-2	136.000
		JCMT	scuba2_00014_20170504T055106	12:29:08.37	+02:03:27.1	2017-05-04 05:56:11	SCUBA-2	136.000
		JCMT	scuba2_00014_20170429T060648	12:29:08.73	+02:03:27.1	2017-04-29 06:07:49	SCUBA-2	137.000
		JCMT	scuba2_00014_20170429T060648	12:29:08.73	+02:03:27.1	2017-04-29 06:07:49	SCUBA-2	137.000

UNITED NATIONS
Office for Outer Space Affairs

Open Universe initiative

agenzia spaziale italiana

Open Universe @ ASI | Space Astronomy » | Ground-Based Astronomy » | Planetary Science » | International Space Station » | VO and General services » | Bibliographic services » | Cosmic Rays » | Other Initiatives »



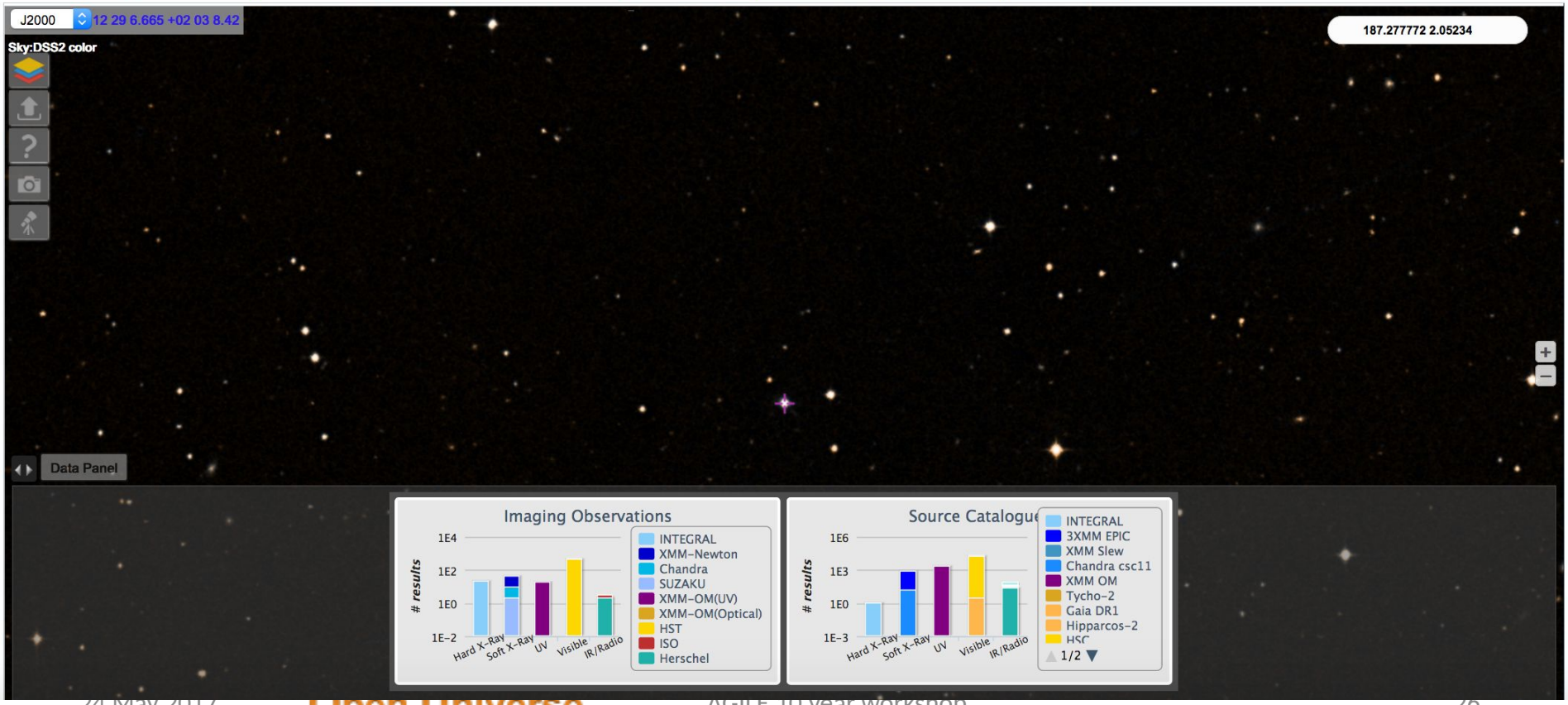
Source Name(s) : 3C273
R.A.(J2000) = **12 29 06.66 (187.277772 deg)**
Dec.(J2000) = **+02 03 08.42 (2.05234 deg)**

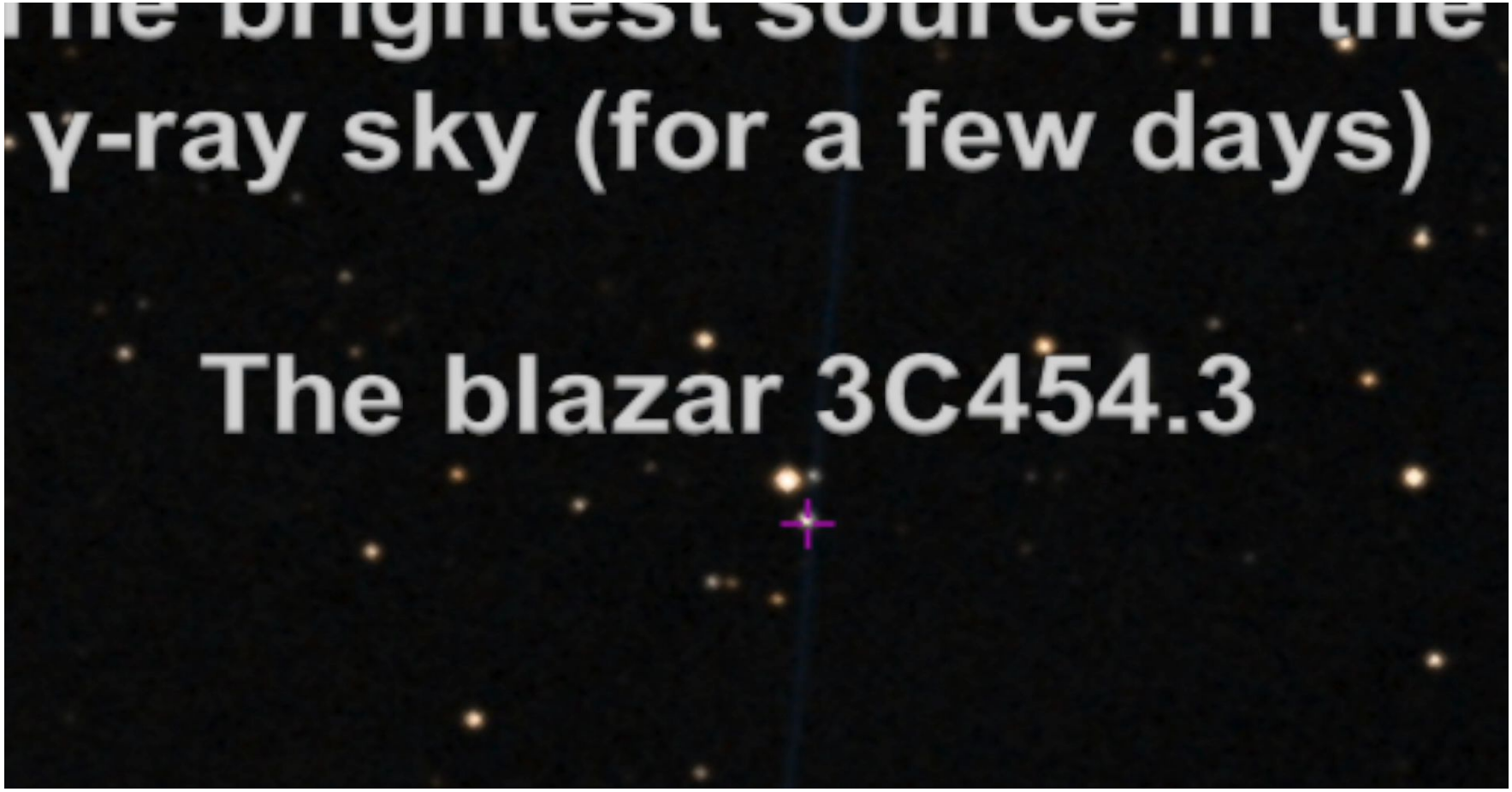
Prototype v.0.8.5 — User: giommi (Logout)

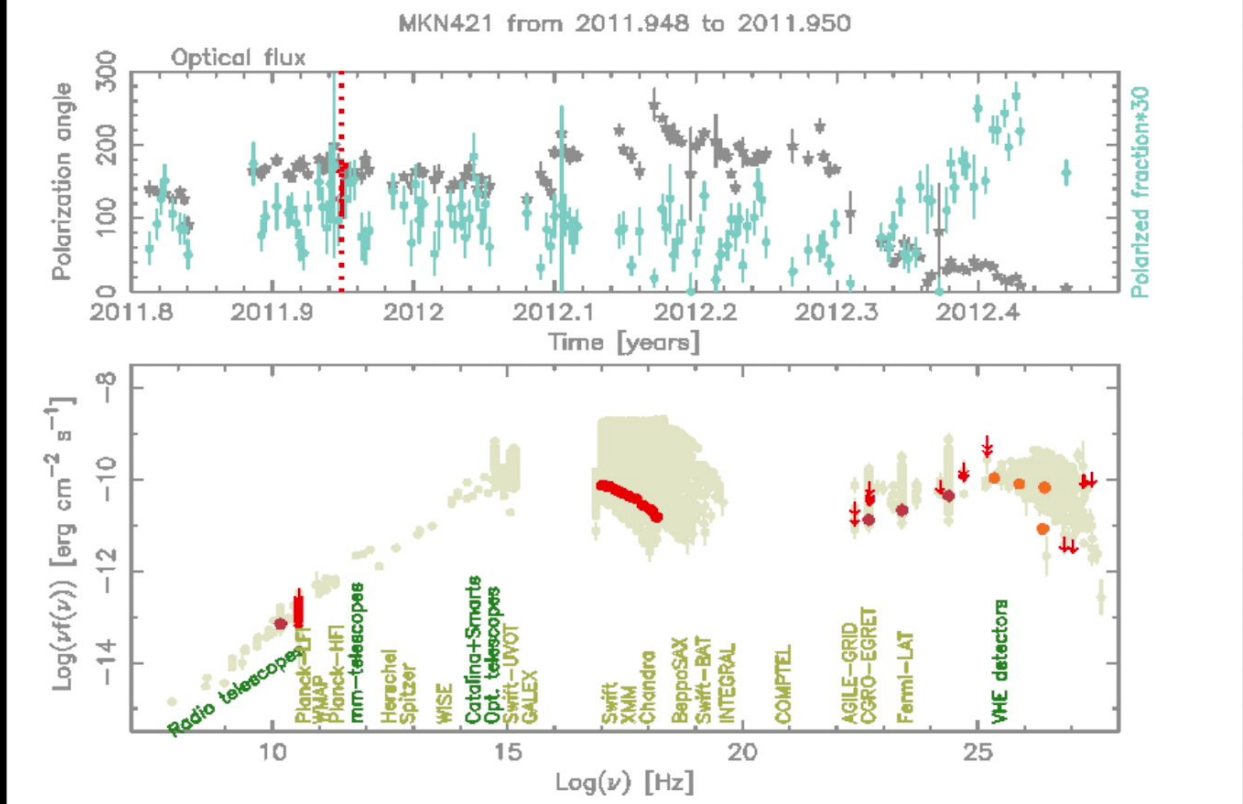
Object name or coordinates: 3C273 (ASDC)

3C273 — Reset

ESASky | SKY-MAP.ORG | Google Sky | SDSS SkyServer | Aladin Lite | SuperCOSMOS | Radio Surveys | Error Circle | Astronomical Catalogs | Groups of Catalogs
CADC | ESO Archive | NRAO Archive | ALMA Archive | ISDC - HEAVENS | Data archive | SED builder | SED movie | Bibliographic Search



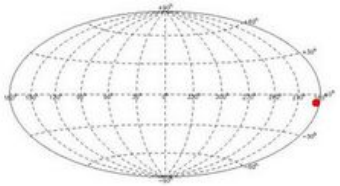

γ-ray sky (for a few days)
The blazar 3C454.3


MKN421 from 2011.948 to 2011.950
Optical flux
Polarization angle
Polarized fraction*30
Time [years]
Log(νf(ν)) [erg cm⁻² s⁻¹]
Log(ν) [Hz]
Radio telescopes
Planck-LFI
WMAP
Planck-HFI
mm-telescopes
Herschel
Spitzer
WISE
Catalina+Smarts
Opt. telescopes
Swift-UVOT
GALEX
Swift
XMM
Chandra
BeppoSAX
Swift-BAT
INTEGRAL
COMPTEL
AGILE-GRID
CGRO-EGRET
Fermi-LAT
VHE detectors

Open Universe

agenzia spaziale italiana

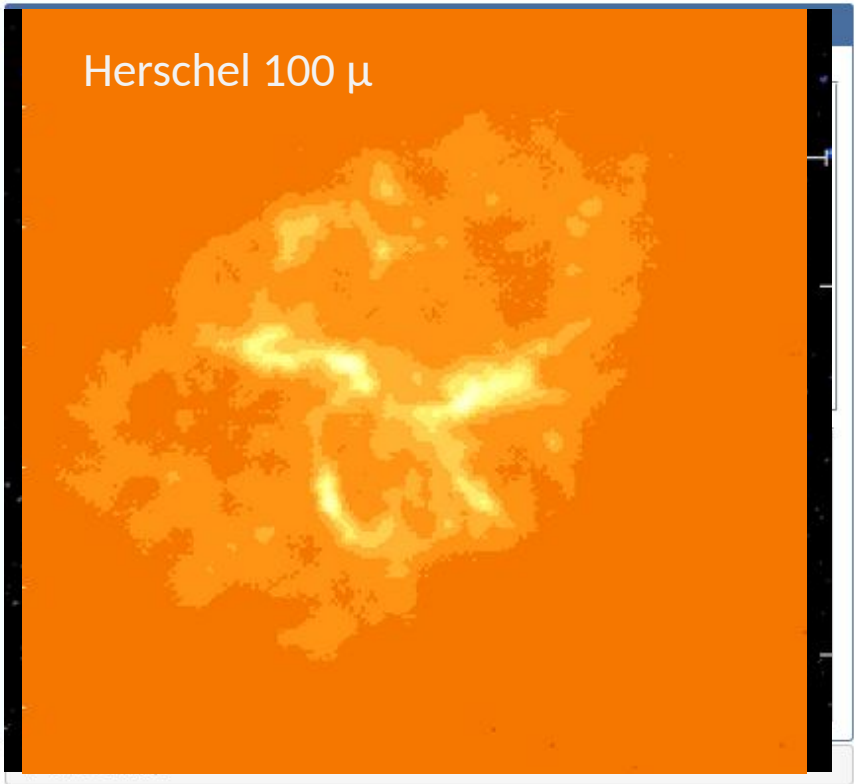
Open Universe @ ASI | ASDC | ESA Sky | Open Planetary | CDS | NED | IPAC | Heasarc | Google Sky | BSDC | MAST | Others sites



Current Source Names = **m1**
R.A.(J2000) = **05 34 31.97 (83.633212 deg)**
Dec.(J2000) = **+22 00 52.05 (22.01446 deg)**
Source name resolved by: **NED**

Astronomy
Planetary
Cosmic Rays
Atmosphere-TGF

Google Sky



ASDC SED Builder

Bibliographic Search

ESASky | Google Sky | SDSS SkyServer

Object name or coordinates: 83.633212, 22.01446 (NED) [1]
m1

Open Universe

agenzia spaziale italiana

Open Universe @ ASI | ASDC | ESA Sky | Open Planetary | CDS | NED | IPAC | Heasarc | Google Sky | BSDC | MAST | Others sites

Multi-Mission Interactive Archive for Space Science

Exploration of the Solar System

Astronomy | Planetary | Cosmic Rays | Atmosphere-TGF

Google | Search | Link this view

Apollo | Visible | Elevation | Charts

Copyright NASA / USGS / LPI / ASU ©2016 Google - Terms of Use

Apollo Series

These six missions of the Apollo Program, which lasted from 1963 to 1972, were the first and last times that Mankind has set foot on another world.

Google Sky

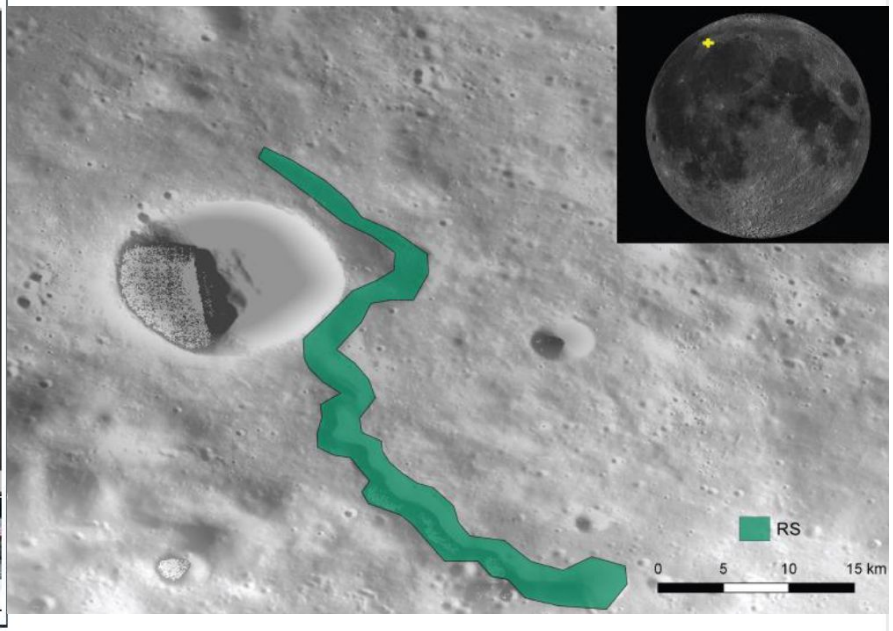
Google Moon

Object name or coordinates: 0.0, 0.0 (ASDC) [2]

Moon

Solar System - MATISSE

Moon-mapping Chang'e2 data



TERRESTRIAL LAVA TUBES

Open Universe

agenzia spaziale italiana

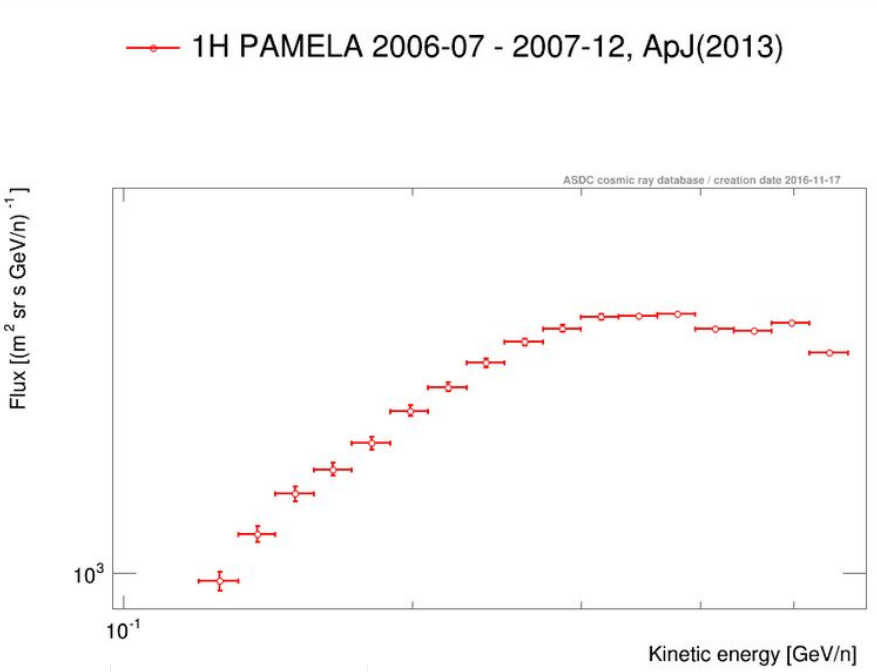
Open Universe @ ASI | ASDC | ESA Sky | Open Planetary | CDS | NED | IPAC | Heasarc | Google Sky | BSDC | MAST | Others sites

Multi-Mission Interactive Archive for Space Science

Particle Astrophysics/Cosmic rays

Astronomy
Planetary
Cosmic Rays
Atmosphere-TGF

Open Universe

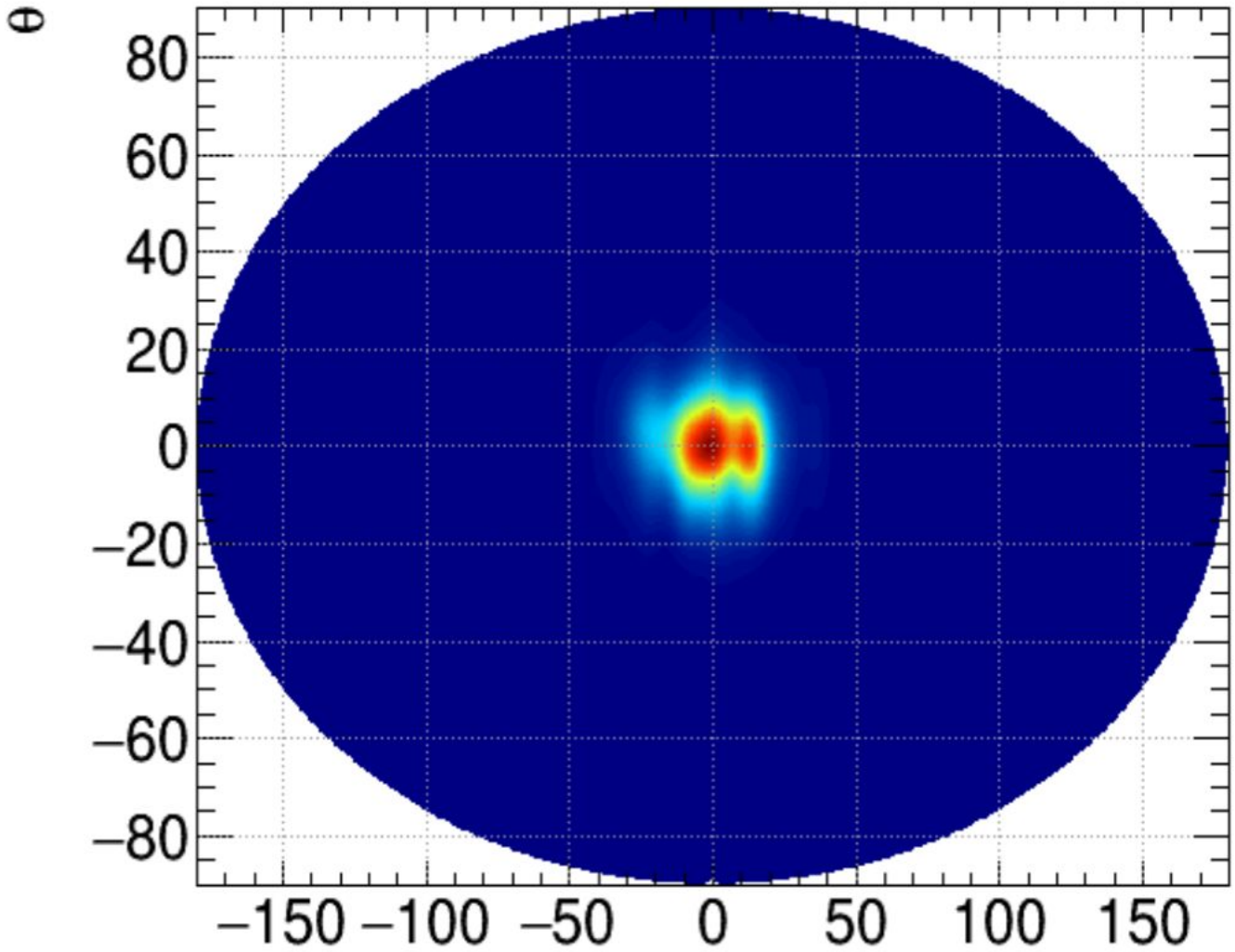


Object name or coordinates: 0.0, 0.0 (ASDC) [3]

Protons

Reset

Links to Open Universe documents



Picture courtesy of F. Nozzoli,

Sun centered map of the sky using Ions (not photons

Open Universe

agenzia spaziale italiana

Open Universe @ ASI | ASDC | ESA Sky | Open Planetary | CDS | NED | IPAC | Heasarc | Google Sky | BSDC | MAST | Others sites

Multi-Mission Interactive Archive for Space Science

Earth's Atmosphere/Terrestrial Gamma-Ray Flashes

Astronomy
Planetary
Cosmic Rays
Atmosphere-TGF

Open Universe

Object name or coordinates: 0.0, 0.0 (ASDC) [4]

TGF

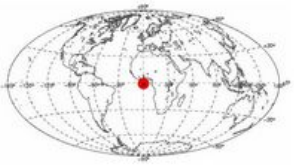
Reset

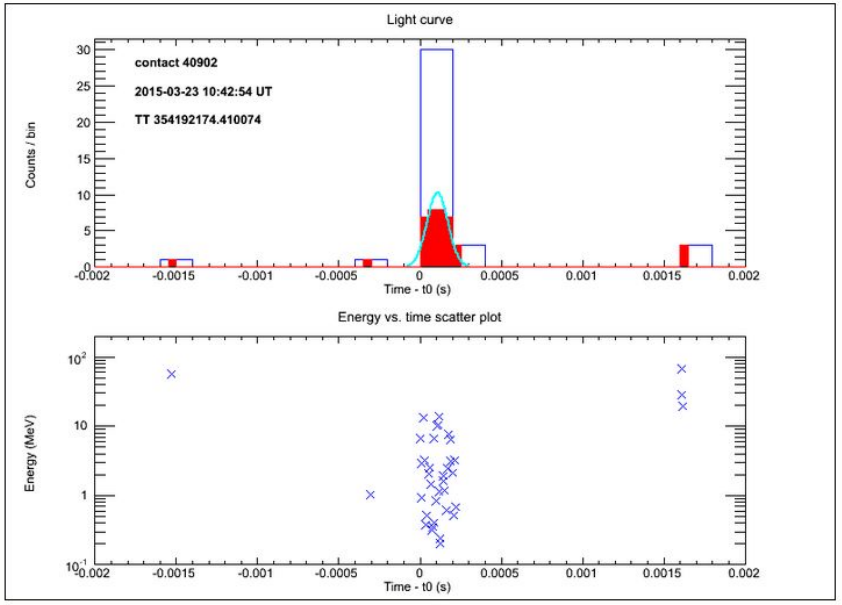
Links to Open Universe documents

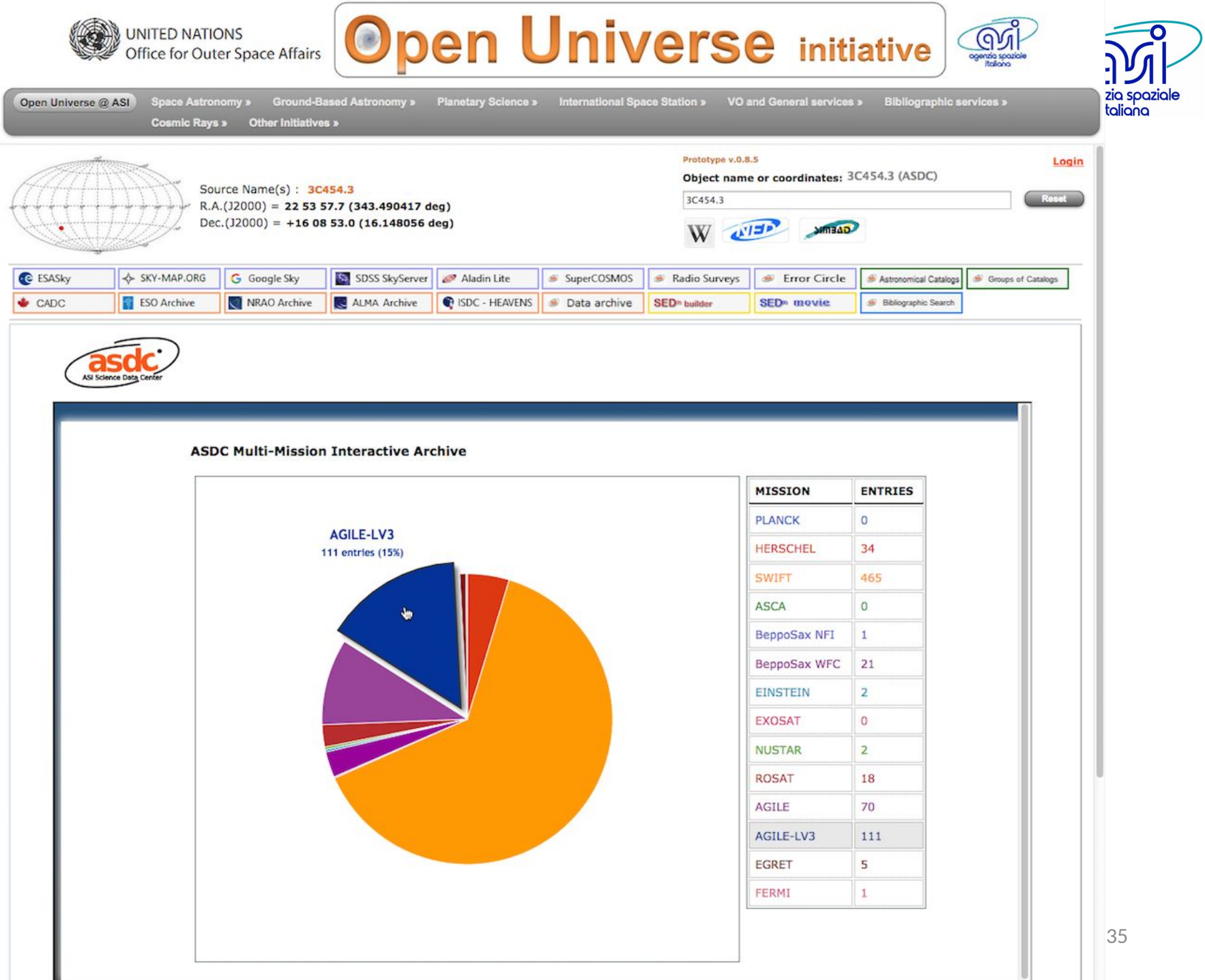
Standard Products

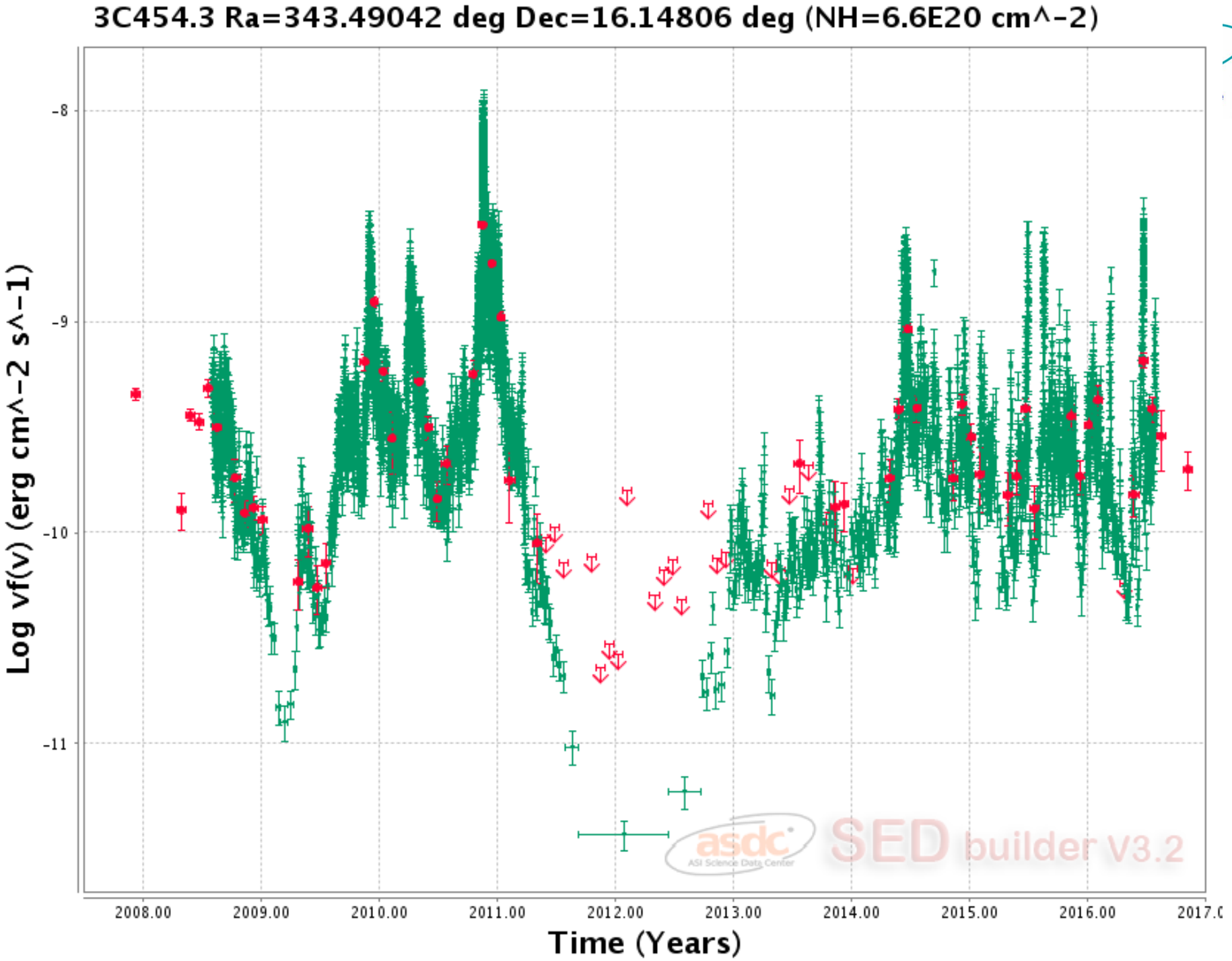
Light Curve Legend:

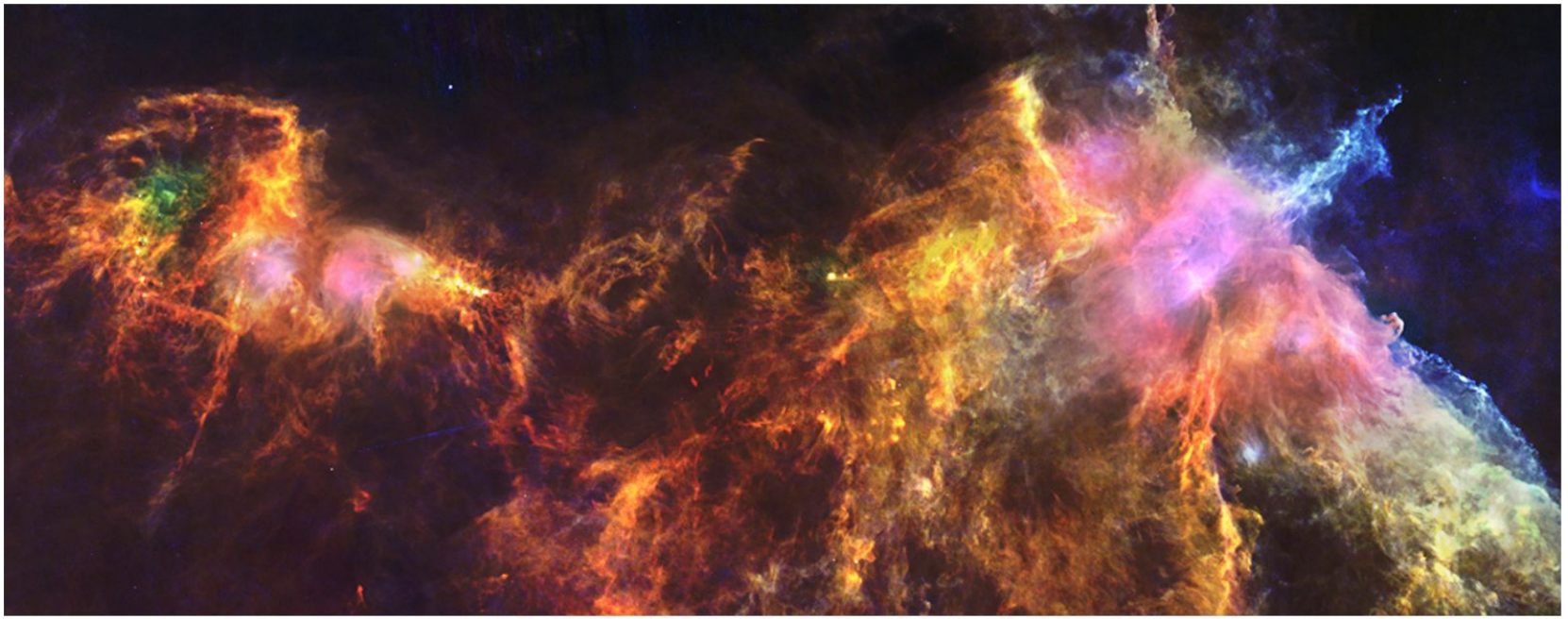
Blue histogram: 200 microsec time bin
Red filled histogram: finer binning 50 microsec
Cyan curve: maximum likelihood Gaussian fit






UNITED NATIONS
Office for Outer Space Affairs
Open Universe initiative
Open Universe @ ASI
Space Astronomy »
Ground-Based Astronomy »
Planetary Science »
International Space Station »
VO and General services »
Bibliographic services »
Cosmic Rays »
Other Initiatives »
Source Name(s) : 3C454.3
R.A.(J2000) = 22 53 57.7 (343.490417 deg)
Dec.(J2000) = +16 08 53.0 (16.148056 deg)
Prototype v.0.8.5
Login
Object name or coordinates: 3C454.3 (ASDC)
3C454.3
Reset
ESASky
SKY-MAP.ORG
Google Sky
SDSS SkyServer
Aladin Lite
SuperCOSMOS
Radio Surveys
Error Circle
Astronomical Catalogs
Groups of Catalogs
CADC
ESO Archive
NRAO Archive
ALMA Archive
ISDC - HEAVENS
Data archive
SED builder
SED movie
Bibliographic Search
asdc
ASI Science Data Center
ASDC Multi-Mission Interactive Archive
AGILE-LV3
111 entries (15%)
MISSION
ENTRIES
PLANCK 0
HERSCHEL 34
SWIFT 465
ASCA 0
BeppoSax NFI 1
BeppoSax WFC 21
EINSTEIN 2
EXOSAT 0
NUSTAR 2
ROSAT 18
AGILE 70
AGILE-LV3 111
EGRET 5
FERMI 1


3C454.3 Ra=343.49042 deg Dec=16.14806 deg (NH=6.6E20 cm^-2)
Log vf(v) (erg cm^-2 s^-1)
-8
-9
-10
-11
2008.00
2009.00
2010.00
2011.00
2012.00
2013.00
2014.00
2015.00
2016.00
2017.0
Time (Years)
asdc
ASI Science Data Center
SED builder V3.2



United Nations / Italy Workshop on the Open Universe Initiative

VIENNA, AUSTRIA, 20-22 NOVEMBER 2017

Organized by the United Nations Office for Outer Space Affairs and
The Italian Space Agency, on behalf of the Government of Italy
Hosted by the United Nations Office for Outer Space Affairs and