# SCIENTIFIC ANALYSIS WEB SERVICES FOR ASTRONOMY: THE SSDC SCIENTIFIC TOOLS

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*INAF - Astr. Obs. of Rome*

# OUTLINE

- An SSDC description
- The Multi-Mission & MWL environment of the ASI-SSDC and the SSDC online services
- A fast tutorial for SSDC web services (??)
- (The SSDC resident catalogues)
- Summary and outlook
- (VO services)

# SSDC OVERVIEW

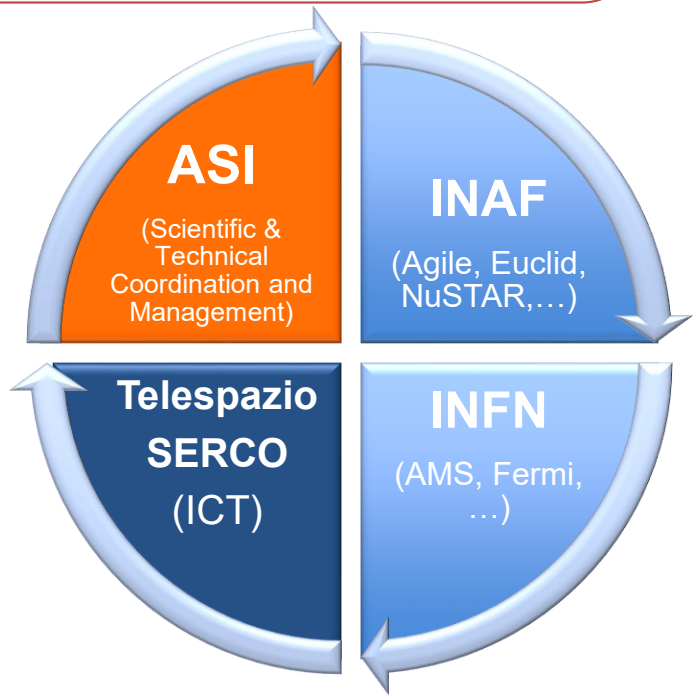
**The Space Science Data Center is a Research Infrastructure of the Italian Space Agency**

## MAIN GOAL

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

- SSDC 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 OVERVIEW

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

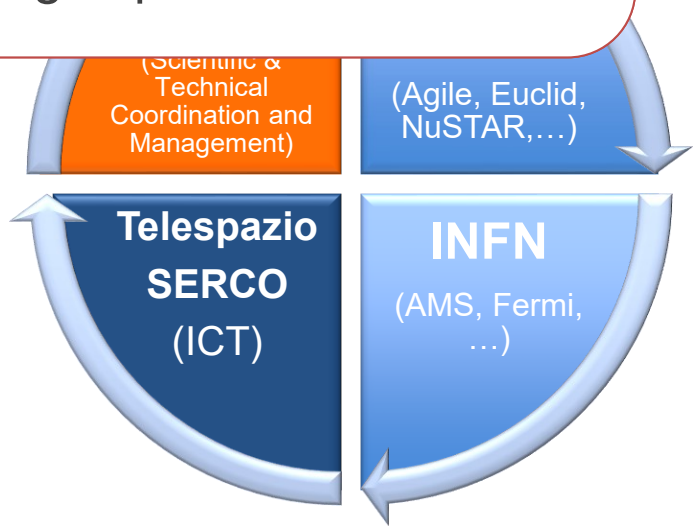
## MAIN GOAL

**so**

=>Multi-Mission, Multi-Instrument & Multi-frequency and apart from the hosting of all different archives, also interoperability of almost all data through specific tools

- 
so
  - **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 OVERVIEW

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

- SSDC infrastructure: HW (PCs, servers, network infrastructure), specific SW licenses

⇒ mainly **funded by ASI**

- SSDC scientific operations and research:

⇒ mainly **INAF & INFN responsibility** under ASI management and with contribution

- Infrastructure installation and maintenance, industr. SW development:

⇒ mainly **IT Industries responsibility** under ASI management and with contribution

Taking into account FAIR principles, **the SW environment and the specific SW development is mainly based on Open Source packages on Linux OSs, except for the single specific mission Data processing based on Teams official SW. =>DP pipeline developed in collaboration, IT & Scientists!**

# SSDC DUTIES

**The ASI-SSDC activities include various different cases, almost all interoperable through an HW and some SW infrastructures**

- SSDC data archives: general storage infrastructure, with clear specific exceptions
- Specific Mission Data processing (DP): each specific mission has its own duties specified in MoUs or other agreements. Different specific data processing are possible, from simple extraction and publication of delivered data results to a real complete DP from raw data with all data level production, as for case of the official unique **AGILE Data Center**
- SW Infrastructure: a DP SW repository including common multi-mission tools and mission official SWs; a web scientific services dedicated SW infrastructure
- **A specific NEW SW infrastructure for Advanced Scientific Tools:** born for the completely revised version (2005) of the historical SED Builder tool and applied to different and more recent tools such as Cosmic Ray DB & MATISSE but ALSO as portal to some data archive (Fermi Data Retrieval)
- **VO activities environment: currently mainly for catalogs!**

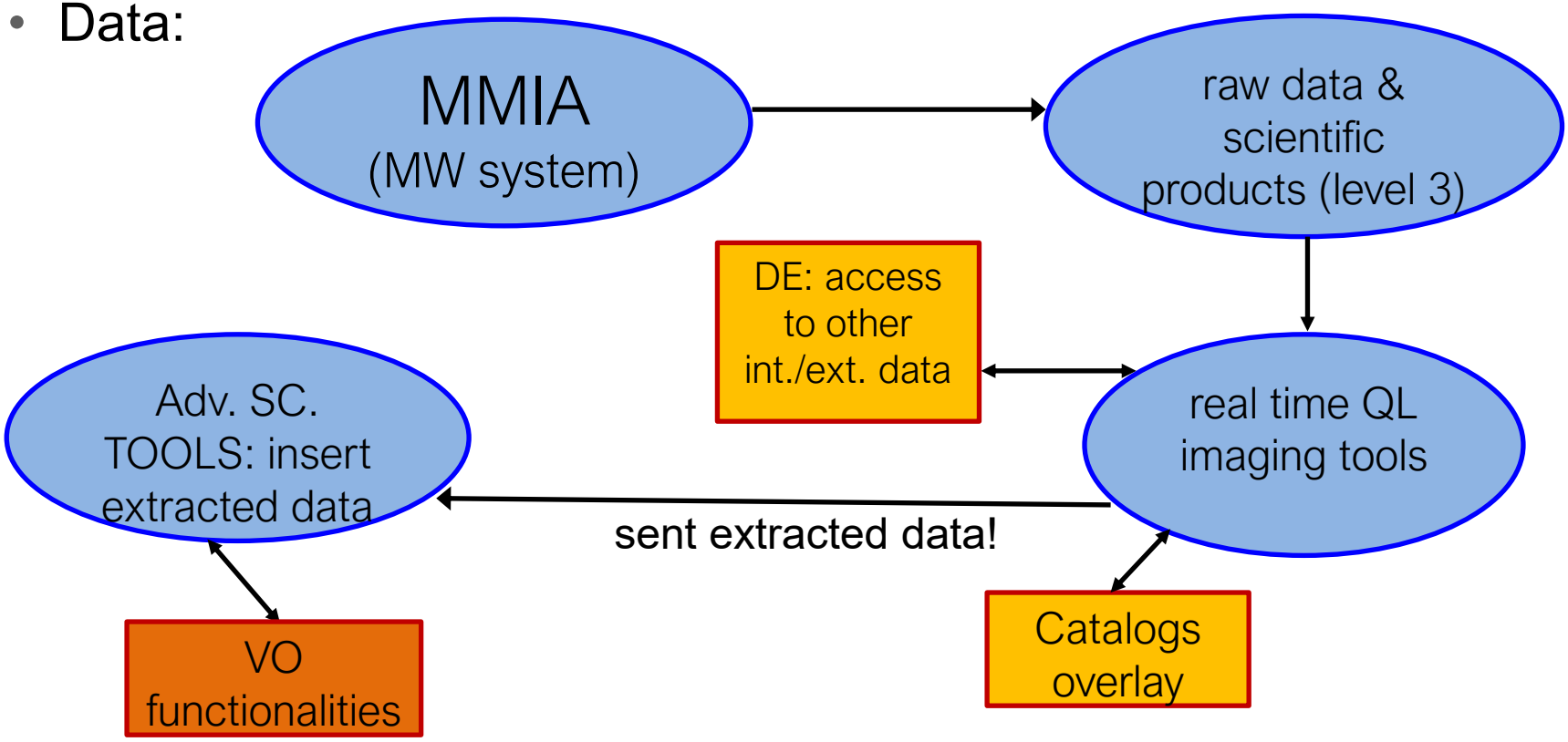
# THE ASI-SSDC MWL EXPERIENCE

- The ASI-SSDC (former ASDC) on MWL only!:

  - wide experience as MWL data center, both for low-level data products (AGILE data center, Fermi-LAT/SWIFT/… data mirror center) and high-level data, data products and catalogs (GAIA, AGILE, FERMI-LAT, ...).
  - Data and data products integrated in a fully MWL environment (MMIA: Multi-Mission Interactive Archive).
  - Possibility to perform cross-catalog searches between resident and external catalogs (DE: Data Explorer tool).
  - Powerful tools to extract SED of sources and modelization.

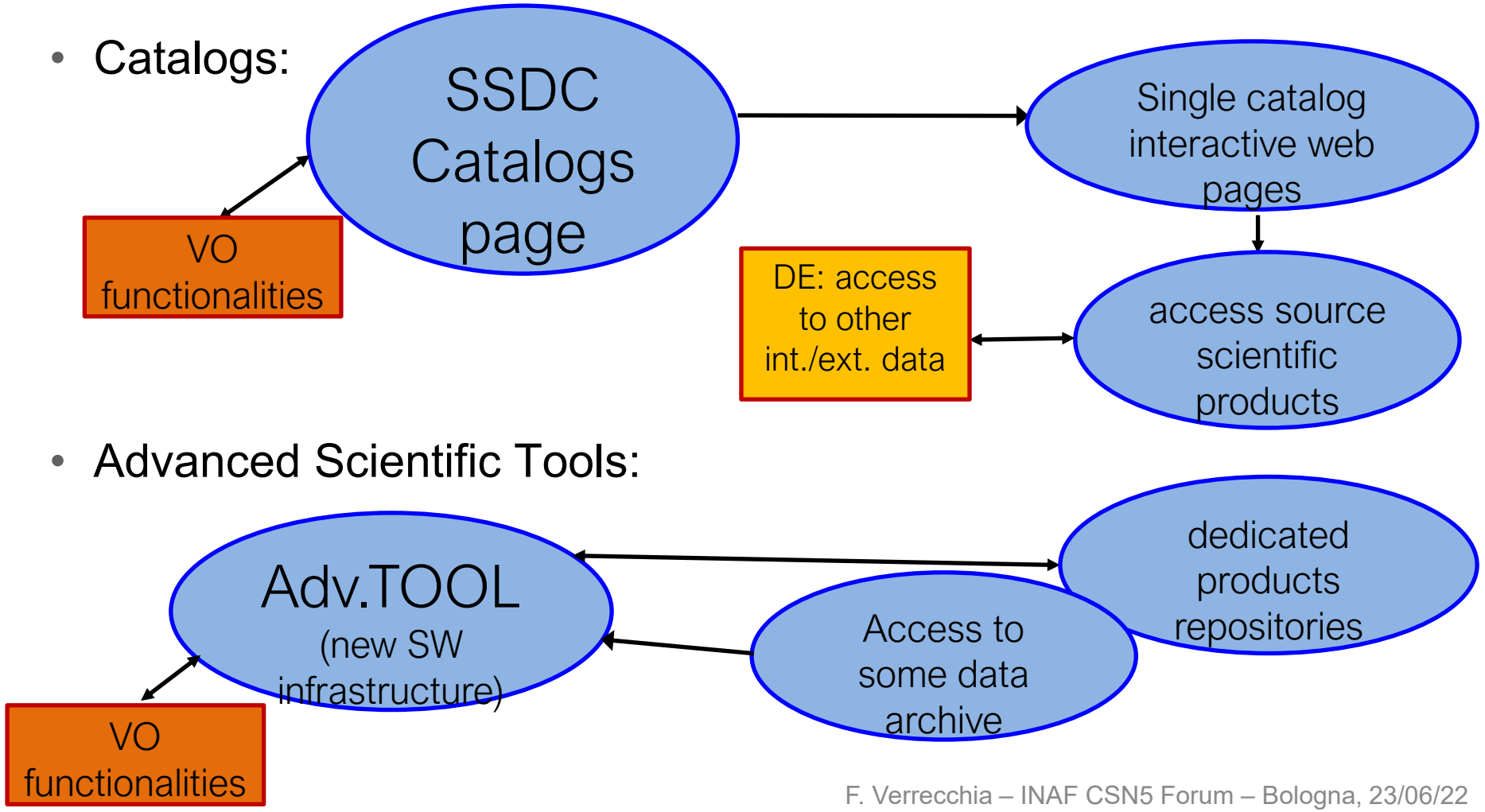
# THE ASI-SSDC MWL EXPERIENCE

- The ASI-SSDC (former ASDC) web services main scheme:
  - Data:



# THE ASI-SSDC MWL EXPERIENCE

- The ASI-SSDC (former ASDC) web services main scheme (II):



# THE ASI-SSDC MWL EXPERIENCE

- A web services main SIMPLIFIED scheme:
  - Data: =>single archives, with specific contraints=>inserted in unique infrastructure (MMIA)
  - Catalogs: =>published catalogs, with ADDED scientific value AND “per-source” products =>inserted in unique infrastructure
  - Advanced Scientific tools: different, dedicated SW environment (with specific refinements per mission/service)
  - VO-services: a new TAP service created, under population; other VO-service already present are under revision, further new ones under study

# THE ASI-SSDC MWL EXPERIENCE

- An historical/functional SIMPLIFIED scheme: based on open source SW and programming languages

  - **Original web services CORE (from 90's)**: based on HEAsoft, IRAF packages, DS9; scientific Browse RDBMS for observations/catalogs repositories; Fortran 77, shell scripting, perl; web programming on HTML, PHP and CGI scripting (shell/perl) ->partly updated to use Python and RDBMS MySQL/PostgreSQL (e.a. AGILE/Fermi/ Herschel data archives); image visualization with JS9;

  - **Advanced TOOLS environment**: updated to use more recent COTS SW versions on more recent OSs, many Python env., Envi SW, vtp (3D), JS9, etc. (*SED Builder*, *Sky Explorer*, *MATISSE*, *Cosmic Ray DB*, *ExoPlanet*) also dedicated visualization with PHP/Java (SED Builder 3D plots)

# THE ASI-SSDC MWL EXPERIENCE

- An historical/functional SIMPLIFIED scheme: based on open source SW and programming languages

  - **Original web services CORE (from 90's)**: based on HEAsoft, IRAF packages, DS9; scientific Browse RDBMS for observations/catalogs perl; web programming on HTML,
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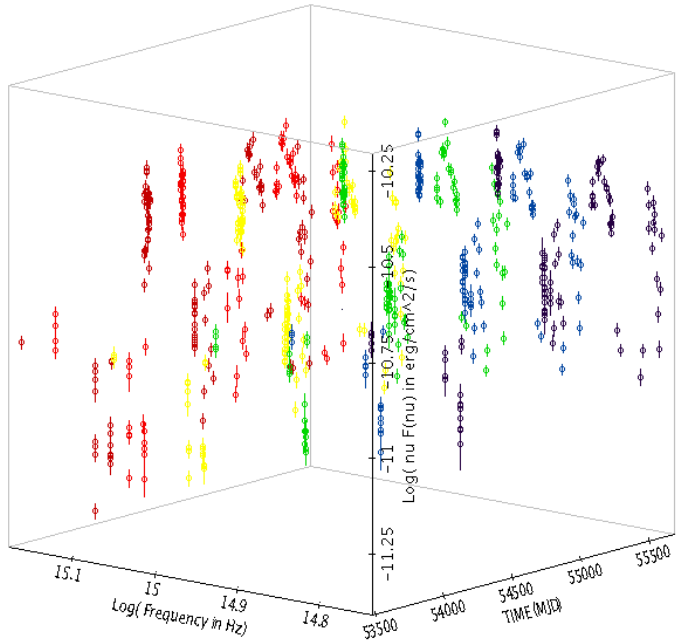
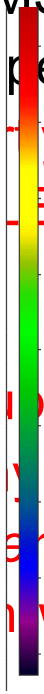
    E/Fermi/ Herschel data archives);

  - 
    
    
    odated to use more recent COTS
    Python env., Envi SW, vtp (3D),
    , *MATISSE*, *Cosmic Ray DB*,
    with PHP/Java (SED Builder 3D
    plots)

# THE ASI-SSDC MWL EXPERIENCE

- **Dedicated mission web servers**: AGILE Services; Fermi Data Retrieval; Gaia Portal! Solar System ; CHEOPS mirror

- Experience: problems & advices (obvious?)

  - =>**EASY** to develop NEW tools with NEW technologies!!
  - =>**VERY DIFFICULT** to MANAGE a COMPLETE UPGRADE of an operative Data Center with few decades life! Many interoperabilities between tools & archives
  - Better to DOUBLE the WEB services: a COMPLETE second independent DEVELOPMENT environment should be the best strategy
  - Currently strategy has been to proceed case-by-case
  - Collaboration among IT & Scientific personnel

# SUMMARY AND OUTLOOK

- We presented here a simple SSDC web services scheme and the expierience: from Original 90's to 2020's updates => new modern scientific topics (Solar Sys. Exploration, Cosmic Rays, Terrestrial physics, etc.) and advanced old&new tools (*SED Builder*, *Sky Explorer*, *MATISSE*, *Cosmic Ray DB*…).
- Transition in progress: convert old "Core" env. To new one
- The MWL SSDC environment provide several unique features that can support a large part of the astronomical community, from HE astrophysics to cosmology, planetology and cosmic ray physics.

# SUMMARY AND OUTLOOK

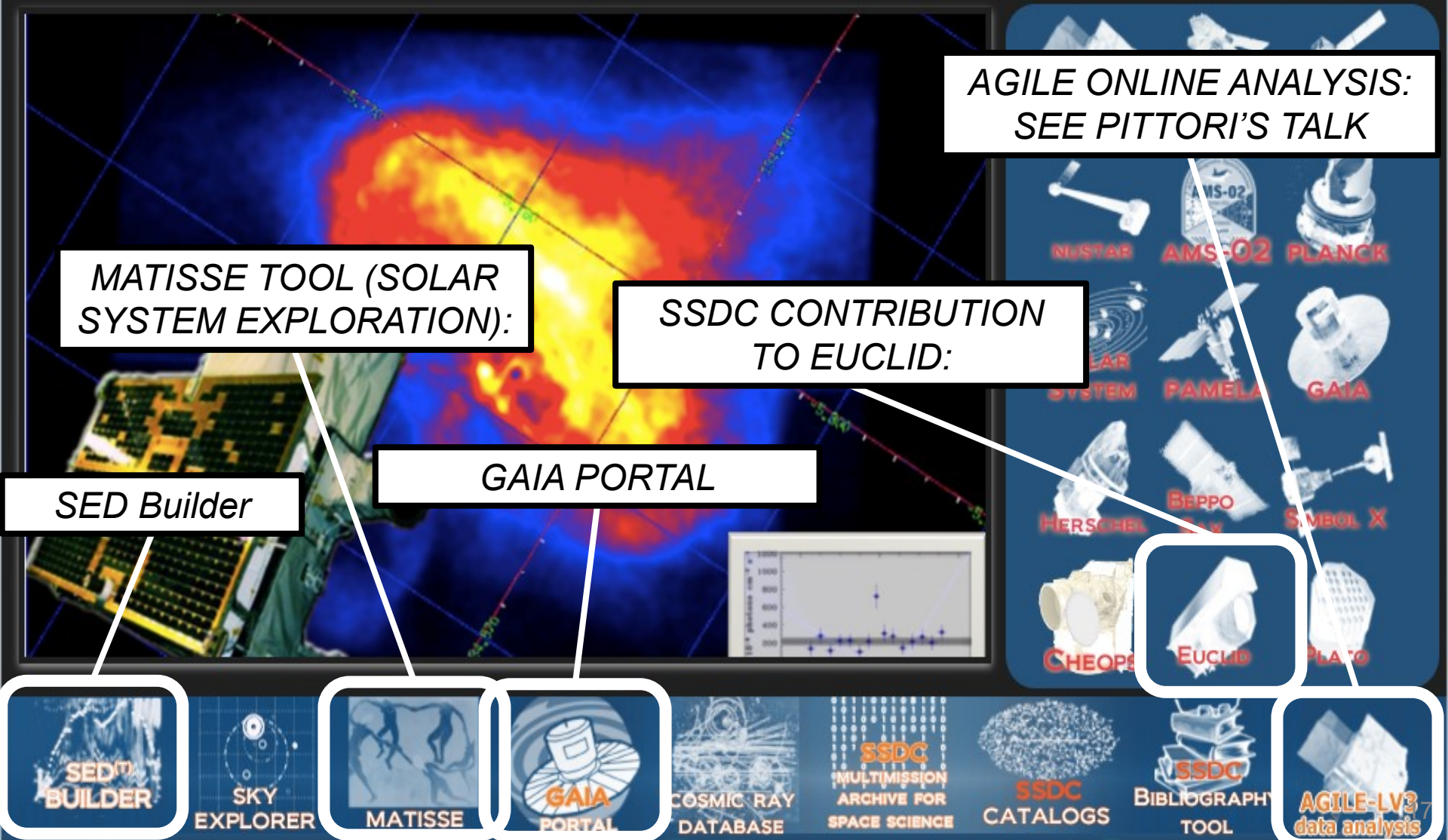
- All services and tools are updated/mantained (web server upgrade, improve graphical layout, add new features, bug-fixes …) in close synergy with the industrial support.
- Further Space Physics under study by ASI: solar physics, NEO obsrvations

# THE SSDC WEB GATEWAY

## AND A SIMPLE EXAMPLE (IF THERE'S TIME)

# Space Science Data Center

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



# THE SSDC RESIDENT CATALOGS

# ALL SSDC SOURCE CATALOGS

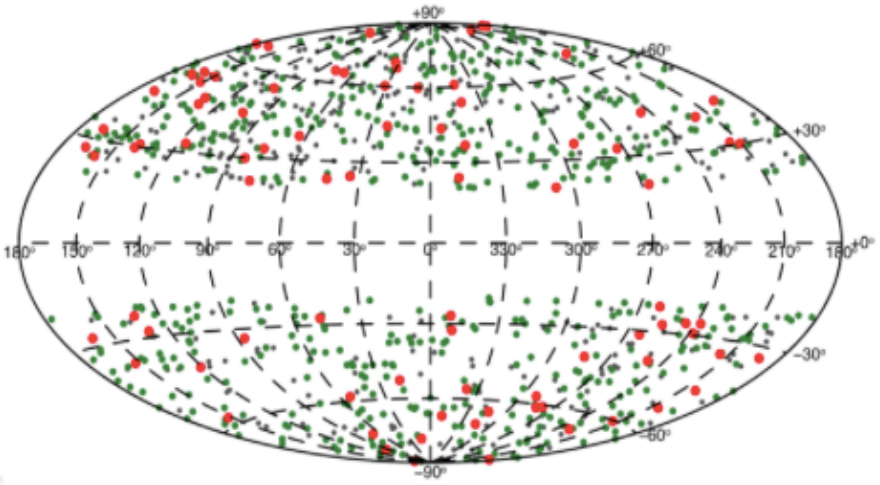
# MULTI-BAND AND MULTI-FREQUENCY CAT.

## SSDC catalogs

*On-line interactive version of catalogs produced at SSDC or with the contribution of SSDC staff*

Cross-search SSDC catalogs

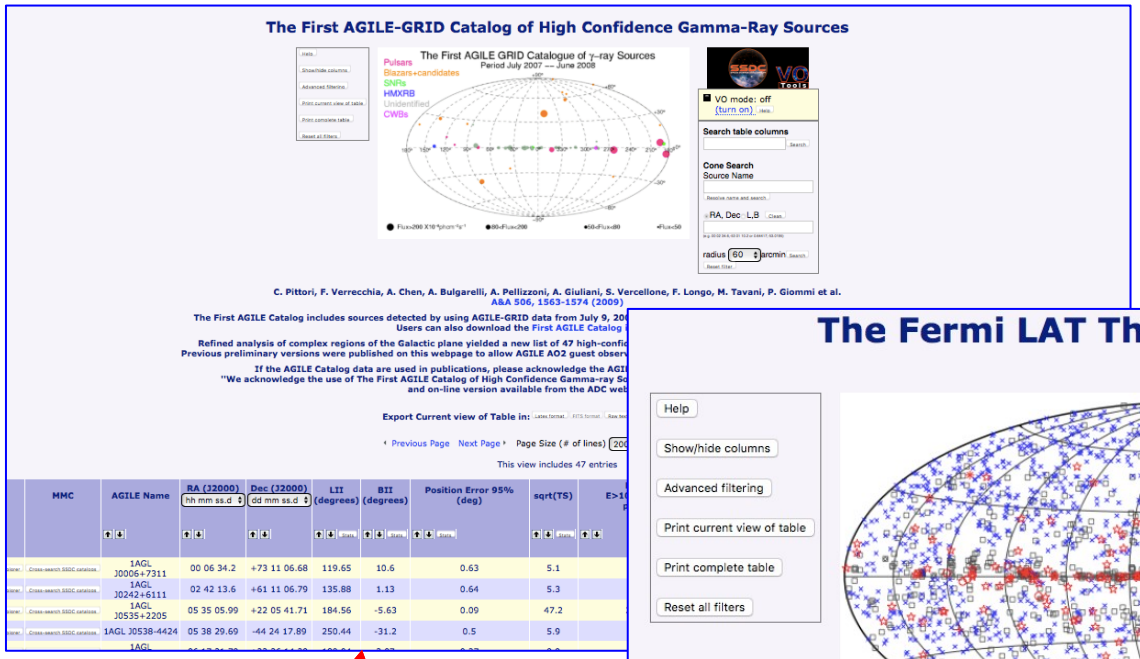
VHE | Gamma-Ray | X-Ray | UV-optical-NIR | Radio-Microwave | Multi-frequency | Non Astronomical | All SSDC catalogs

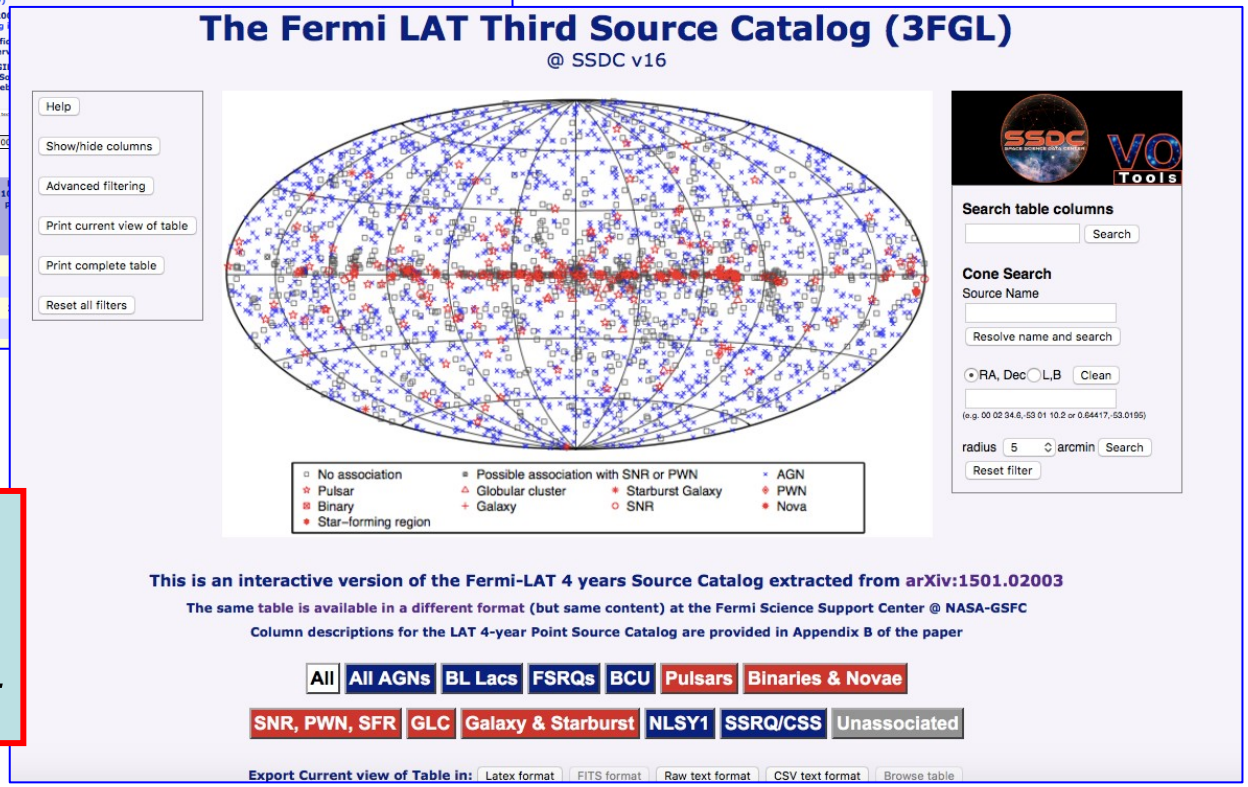



**1WHSP**

- **TeGeV** - The TeGeV Catalogue @ SSDC is a catalogue of VHE sources observed by ground-based Cherenkov telescopes.
- **1WHSP** - 1WHSP: an IR-based sample of ~1000 VHE gamma-ray blazars candidates (Arsioli, Fraga et al. 2015 A&A 579, 34)
- **2WHSP** - The 2WHSP catalog of HSP blazars (Chang, Arsioli et al. 2016. A&A, in press, ArXiv:1609.05808)

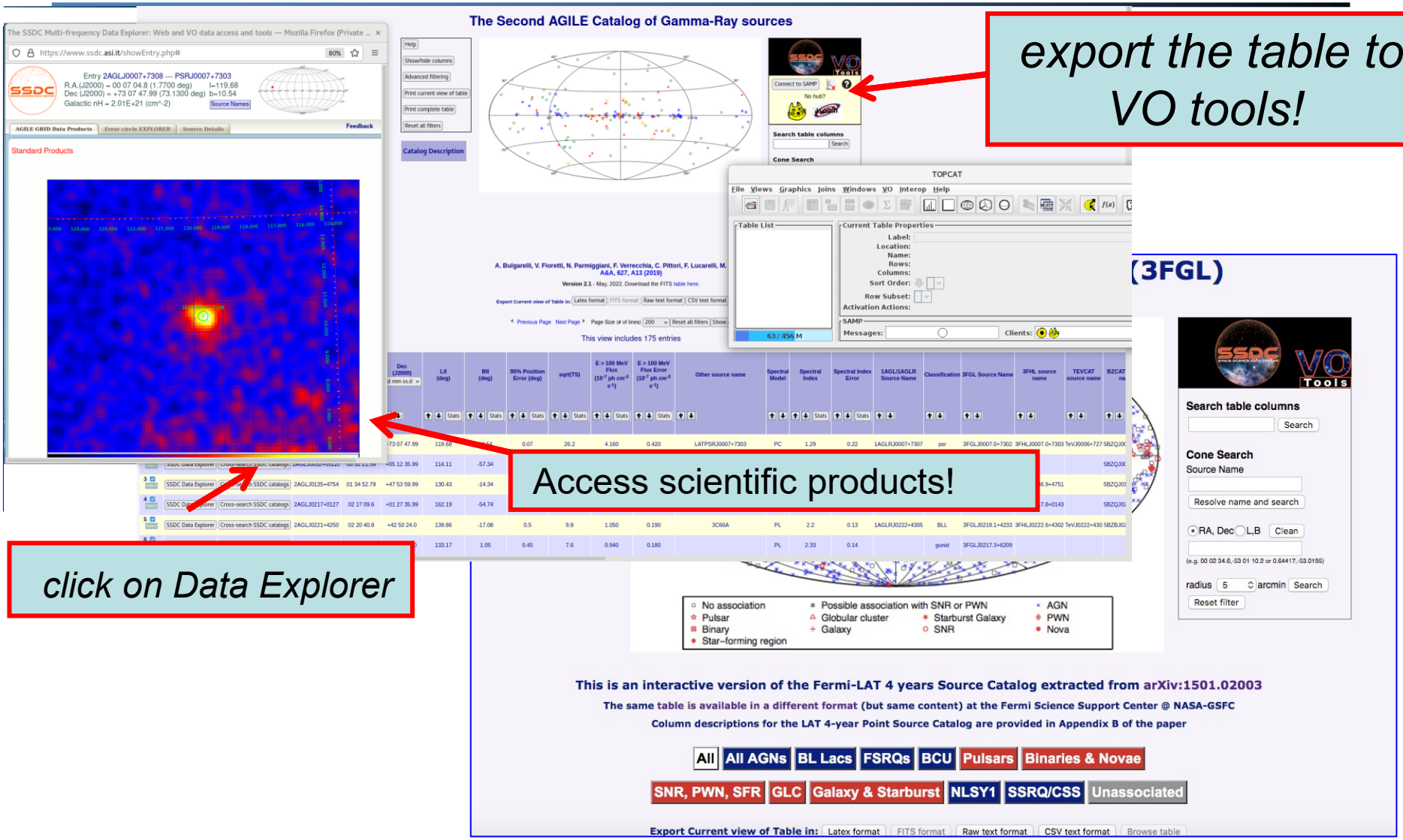
# ACCESS TO SSDC MISSION CATALOGS




*Possibility to export the table in CSV, LaTex, ASCII format*

# ACCESS TO SSDC MISSION CATALOGS

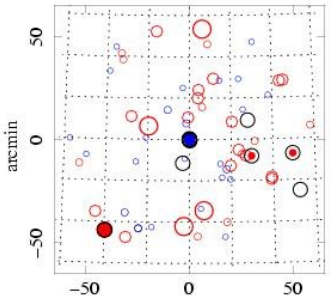


# THE SSDC

Entry TeV J1959+6508
R.A.(J2000) = 19 59 59.9 (299.9996 deg) l=98.00
Dec (J2000) = +65 08 54.7 (65.1485 deg) b=17.67
Galactic nH = 1.00E+21 (cm^-2) Source Names

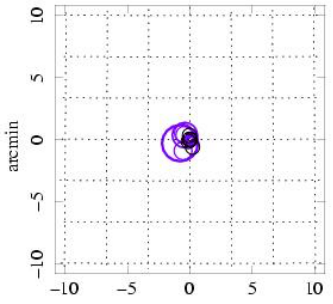
Error circle *EXPLORER* | Source Details | Feedback

TUTORIAL HELP




show sources list
download image in ps format

Default catalogs (always selected)
Selectable catalogs:
Default selection [i]
Radio [select]
Infrared [select]
Optical [select]
X-Ray [select]
Gamma [select]
Source Catalogs [select]
[Selected catalog List >> ]
size (arcmin) 60
Create new image




show sources list
download image in ps format

Position selected for the analysis: R.A.=19 59 59.9 (299.9996 deg) l=98.00 b=17.67 SED Builder Source Names
Reset Position Galactic nH= 1.00E+21 (cm^-2)

Additional Services -

SSDC-resident astronomical catalogs
Group of Catalogs Selected Catalogs
Radio IR Optical QORG AGN BZCAT
X-ray Gamma ZCAT NGC ZWICKY
Search radius 0.2 arcmin

Search Other Services
VIZIER(X-R-G) VIZIER(O-IR) NED
SIMBAD HEASARC(X-R-G)
GSC2 STSCI MAST 2MASS
SDSS USNO-B1.0 NVO
Search radius 0.2 arcmin

Bibliography search
BZBJ1959+6508
in time range between
1900 and 2018
By name via NED
By coordinates via ADS

Access to Public Data Archives -

Gamma Ra
AGILE Fermi EGRET
Search radius 50 degrees

Radio-Micro wave
IR-Optic-UV
X ray
Gamma ray

| | | |
|---|---|---|
| 134 Select | SSDC Data Explorer | Cross-search SSDC |
| 135 Select | SSDC Data Explorer | Cross-search SSDC |
| 136 Select | SSDC Data Explorer | Cross-search SSDC |
| 137 Select | SSDC Data Explorer | Cross-search SSDC |
| 138 Select | SSDC Data Explorer | Cross-search SSDC |
| 139 Select | SSDC Data Explorer | Cross-search SSDC |
| 140 Select | SSDC Data Explorer | Cross-search SSDC |
| 141 Select | SSDC Data Explorer | Cross-search SSDC |
| 142 Select | SSDC Data Explorer | Cross-search SSDC |

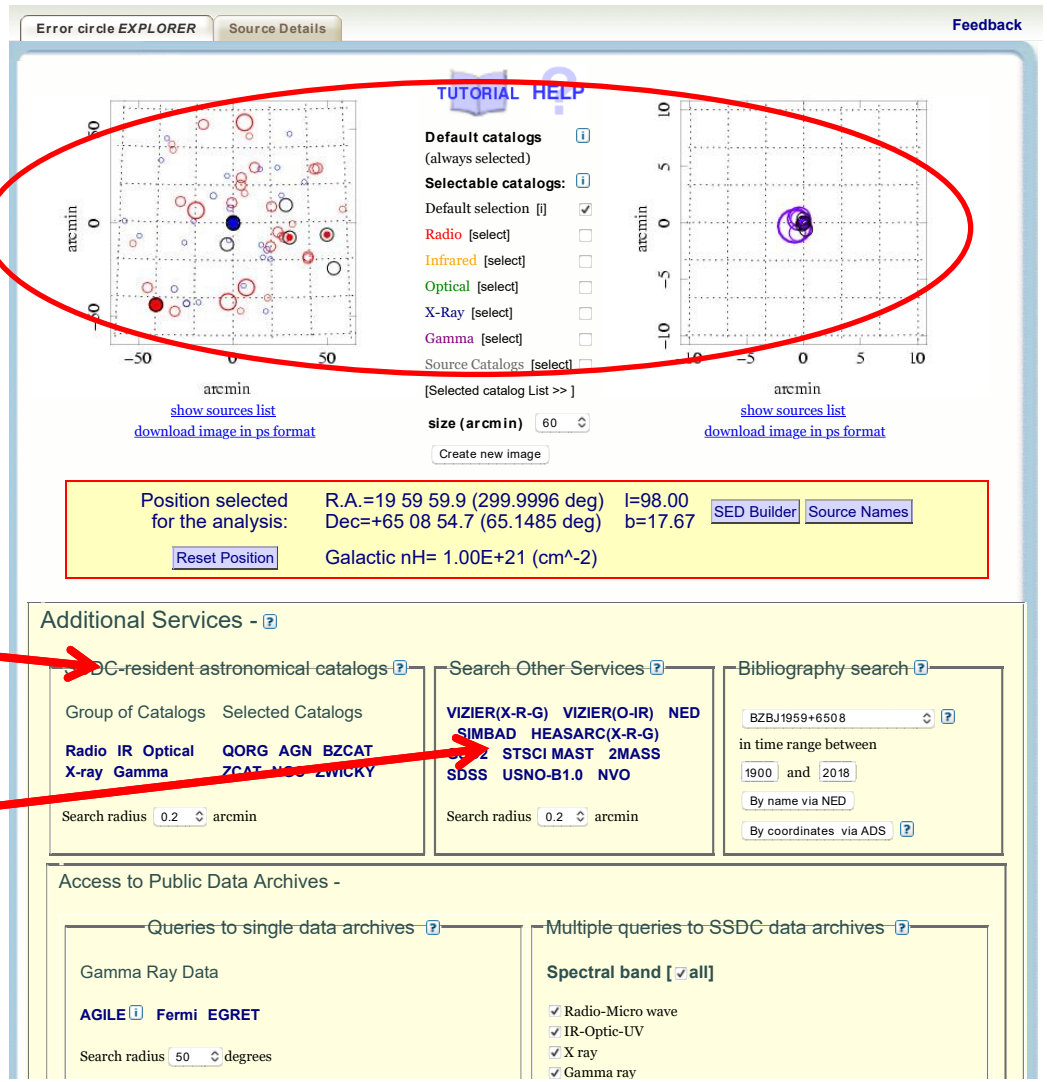
*Data Explorer*

# ACCESS TO SSDC MWL TOOLS

THE ERROR CIRCLE EXPLORER (ECE)

Catalog queries:

- **Internal**: for each energy band
- **External**: to external catalogs DB or data archives

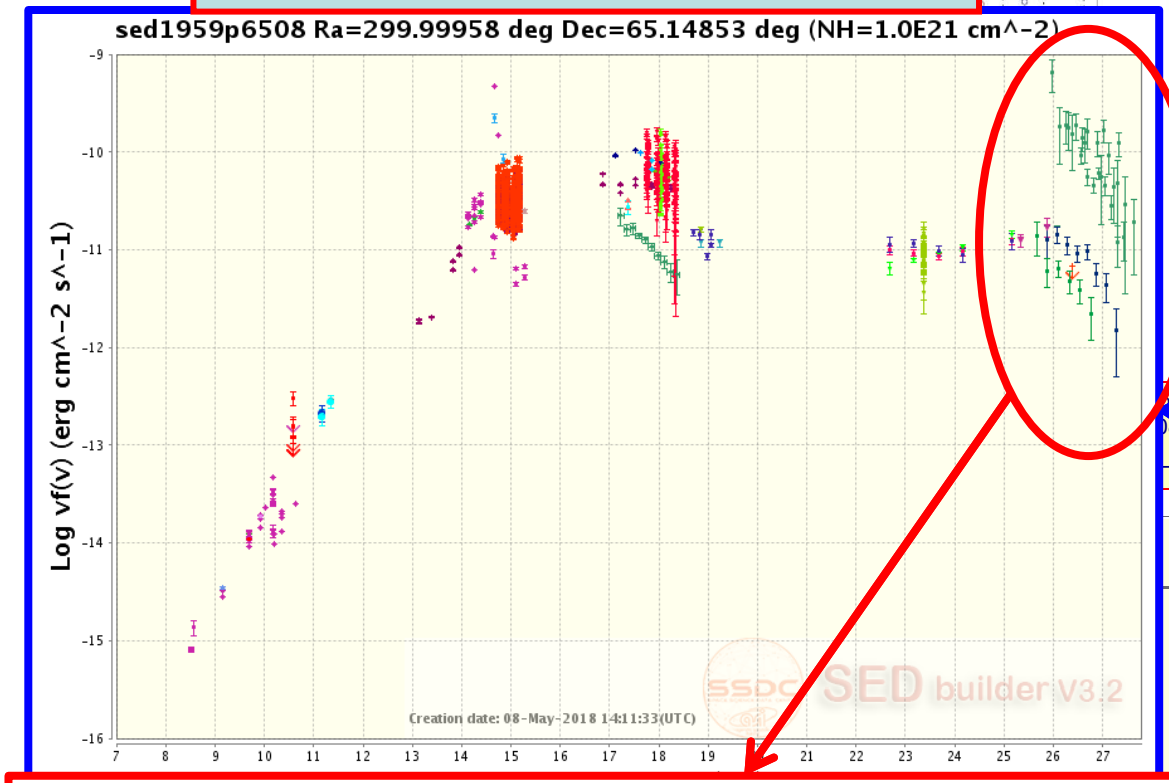


# LINK TC

Entry TeV J1959+6508
R.A.(J2000) = 19 59 59.9 (299.9996 deg) l=98.00
Dec (J2000) = +65 08 54.7 (65.1485 deg) b=17.67
Galactic nH = 1.00E+21 (cm^-2) Source Names

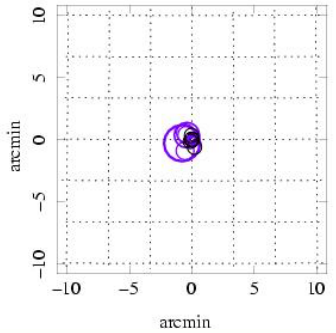
Error circle *EXPLORER* | Source Details | Feedback

## *SEDBuilder*




TUTORIAL HELP

Default catalogs (always selected)
Selectable catalogs:
Default selection [i]
Radio [select]
Infrared [select]
Optical [select]
X-Ray [select]
Gamma [select]
Source Catalogs [select]
[Selected catalog List >>]
size (arcmin) 60
Create new image




show sources list
download image in ps format

9.9 (299.9996 deg) l=98.00
08 54.7 (65.1485 deg) b=17.67
H= 1.00E+21 (cm^-2)
SED Builder Source Names

Search Other Services
VIZIER(X-R-G) VIZIER(O-IR) NED
SIMBAD HEASARC(X-R-G)
GSC2 STSCI MAST 2MASS
SDSS USNO-B1.0 NVO
Search radius 0.2 arcmin

Bibliography search
BZBJ1959+6508
in time range between
1900 and 2018
By name via NED
By coordinates via ADS

Archival data from WHIPPLE, HEGRA, MAGIC, VERITAS

142 Select
SSDC Data Explorer
Cross-search

Queries to single data archives
Gamma Ray Data
AGILE Fermi EGRET
Search radius 50 degrees

Multiple queries to SSDC data archives
Spectral band [all]
Radio-Micro wave
IR-Optic-UV
X ray
Gamma ray

# SSDC STAFF

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

| SSDC Management | |
|---|---|
| Gianluca Polenta (ASI) | Director |
| Valerio D'Elia (ASI) | Universe Observation Manager |
| Marco Giardino (ASI) | ICT Manager |
| Matteo Perri (INAF) | INAF Project Scientist |
| Bruna Bertucci (INFN) | INFN Project Scientist |

| Secretary and Data Assistant |
|---|
| Cristina Leto (ASI) |
| Gianluca Perini (INAF) - part time |

| ICT |
|---|
| Giuseppe Di Persio (INAF) - part time |

| AGILE Team | |
|---|---|
| Carlotta Pittori (INAF) | Coordinato |
| Fabrizio Lucarelli (INAF) | |
| Francesco Verrecchia (INAF) | |

| AMS | |
|---|---|
| Valeria Di Felice (INFN) | Coordinato |
| Federico Donnini (INFN) | |
| Behrouz Khiali (INFN) | |

| CHEOPS Team | |
|---|---|
| Francesco Verrecchia (INAF) | Coordinator |
| Giuseppe Di Persio (INAF) - part time | |

| CTA Team | |
|---|---|
| Fabrizio Lucarelli (INAF) | Coordinator |
| Ciro Bigongiari (INAF) | |
| Saverio Lombardi (INAF) | |

| Euclid Team | |
|---|---|
| Fabiana Faustini (INAF) | Coordinator |
| Andrea Bonchi (INAF) | |
| Ronaldo Oliveira da Silva (INAF) | |

| Fermi Team | |
|---|---|
| Stefano Ciprini (INFN) | Coordinator |
| Federica Giacchino (INFN) | |
| Dario Gasparrini (INFN) | |

| GAIA Team | |
|---|---|
| Paola Maria Marrese (INAF) | Coordinator |
| Giuseppe Altavilla (INAF) | |
| Vittorio Francesco Braga (INAF) | |
| Michele Fabrizio (INAF) | |
| Silvia Marinoni (INAF) | |

| Herschel Team | |
|---|---|
| Fabiana Faustini (INAF) | Coordinator |
| Ronaldo Oliveira da Silva (INAF) | |

| LIMADOU | |
|---|---|
| Matteo Mergé (INFN) | Coordinator |

| Multi-frequency and VO Team | |
|---|---|
| Carlotta Pittori (INAF) | Coordinator |
| Valerio D'Elia (ASI) | |
| Alessio Giunta (ASI) | |
| Alessandra Lamastra (INAF) - part time | |
| Cristina Leto (ASI) | |
| Alessandro Maselli (INAF) | |
| Francesco Verrecchia (INAF) | |

| NuSTAR Team | |
|---|---|
| Matteo Perri (INAF) | Coordinator |
| Simonetta Puccetti (ASI) | |

| PAMELA |
|---|
| Valeria Di Felice (INFN) |

| Planck Team | |
|---|---|
| Gianluca Polenta (ASI) | Coordinator |
| Gemma Luzzi (ASI) | |
| Beatriz Ruiz-Granados (INFN) | |

| Solar System Exploration | |
|---|---|
| Angelo Zinzi (ASI) | Coordinator |
| Veronica Camplone (INAF) | |
| Edoardo Rognini (INAF) | |

| Swift Team | |
|---|---|
| Matteo Perri (INAF) | Coordinator |
| Valerio D'Elia (ASI) | |
| Riccardo Middei (INAF) | |

| Science Communication |
|---|
| Elisa Nichelli (INAF) |

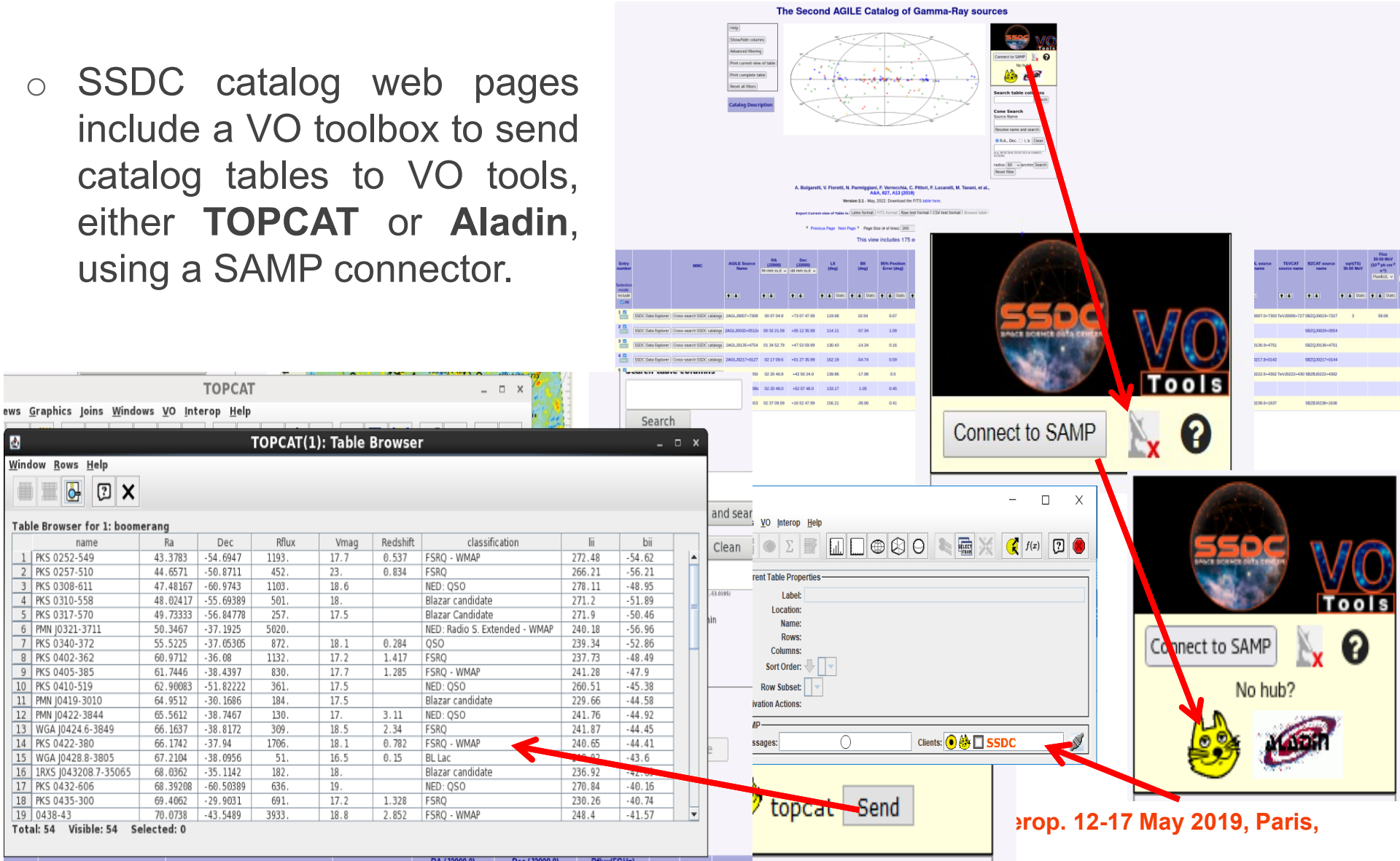
| Engineering Team | |
|---|---|
| Paolo D'Angeli (TELESPAZIO) | system manager |
| Fabrizio Fabri (SERCO) | software developer |
| Giorgio Fanari (SERCO) | software developer |
| Antonio Guerra (TELESPAZIO) | team leader |
| Daniele Navarra (SERCO) | web developer |
| Roberto Primavera (TELESPAZIO) | technical manager |
| Pier Vincenzo Severo (TELESPAZIO) | team specialist |

| Senior Scientists | |
|---|---|
| Lucio Angelo Antonelli (INAF-Osservatorio Astronomico di Roma e ASI) | SSDC |
| Roberto Buonanno (INAF-OA Teramo e Univ. Roma Tor Vergata) | GAIA |
| Maria Teresa Capria (INAF-IAPS Roma) | ESS (Solar System Explor |
| Elisabetta Cavazzuti (ASI) | Fermi |
| Domenico D'Urso (Univ. Sassari ed INFN-LNS) | AMS/DAMPE |
| Paolo Giommi (ASI) | Open Universe |
| Paolo Natoli (INAF-IASF Bologna e Univ. Ferrara) | Planck, Fermi |
| Ernesto Palomba (INAF-IAPS Roma) | ESS (Solar System Explor |
| Elena Pancino (INAF-Osservatorio Astrofisico Arcetri) | GAIA |
| Piergiorgio Picozza (INFN Roma2) | PAMELA |
| Antonio Stamerra (INAF-OA Torino) | MWL, CTA, Fermi |
| Simona Zoffoli (ASI) | LIMADOU |

ssdc.asi.it

# BACKUP SLIDES

# SSDC VO SERVICES

# VO ACTIVITIES: CATALOG SAMP CONNECTOR

- SSDC catalog web pages include a VO toolbox to send catalog tables to VO tools, either **TOPCAT** or **Aladin**, using a SAMP connector.