

High energy data exploration with VO.

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What do we aim for?

We aim to explore high energy data (X-rays, GeV and TeV) with some of the VO tools as:

TOPCAT (explore, retrieve and cuts data)

ALADIN (visualize, crossmatch)

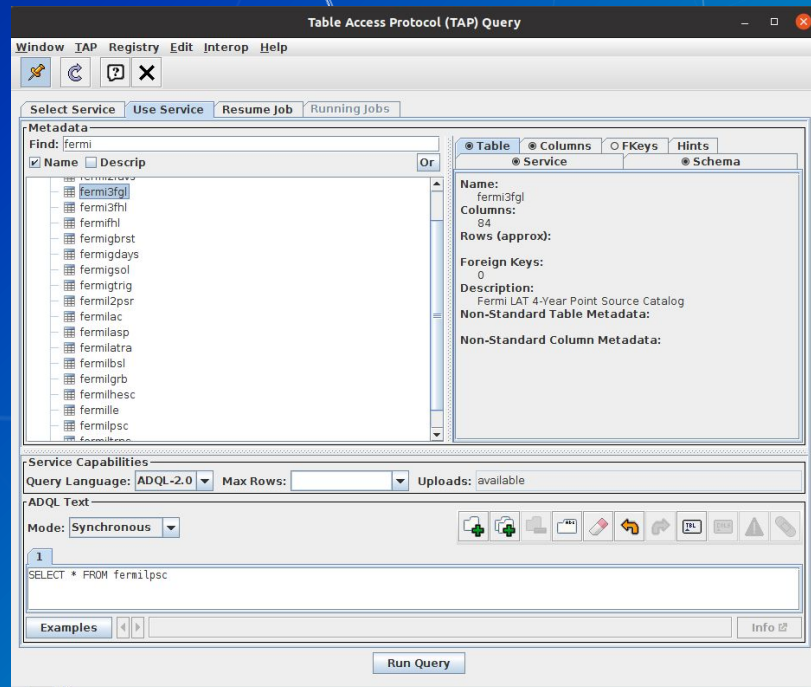
Paying special attention to **metadata, standard formats and access protocols.**

What we did?

- 1) We selected Fermi data with TOPCAT.
- 2) We explored and apply some cuts to the data.
- 3) We made a CROSS-MATCH between fermi and TeVCat.
- 4) We made a CROSS-MATCH with the result of step 3) with CHANDRA MOC.
- 5) We intent to analyse the result again with TOPCAT.

Select *Fermi* data with TOPCAT

- Different ways of querying the data with VO
- Use TOPCAT as a **Table Access Protocol** client
- I studied the different servers

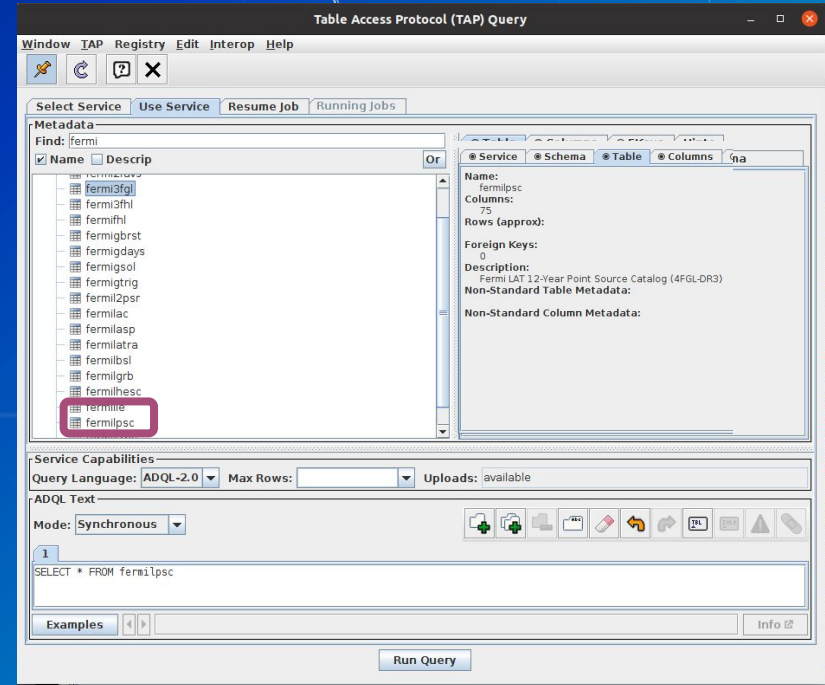


Select *Fermi* data with TOPCAT

- Different ways of querying the data with VO
- Use TOPCAT as a **Table Access Protocol** client
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- Not intuitive
- Importance of metadata
- Use Basic ADQL command



Select Fermi data with TOPCAT

Visualization
of the table,
metadata.

Table Access Protocol (TAP) Query

Window TAP Registry Edit Interop Help

Select Service Use Service Resume Job Running Jobs

Metadata

Find:

☒ Name ☐ Descrip Or

Service	Schema	Table	Columns	Keys	Hints
	Name	Type	Unit	Indexed	Description
	data_release	short			Data Release Version
	l	double	degree		Galactic Longitude
	plec_epeak_error	double			1-Sigma Uncertainty on Peak Energy Estimated From PL...
	pivot_energy	double	MeV		Energy at Which Error on Differential Flux Is Minimal
	pl_index	double			Photon Index for PowerLaw Fit
	flux_peak_error	double	photon/cm^2/s		1-Sigma Uncertainty in Peak Flux
	flux_1_100_gev	double	photon/cm^2/s		Integral Photon Flux 1 to 100 GeV
	assoc_error_radius	double	degree		Position Uncertainty at 68% Confidence Level for Assoc. ...
	plec_index_s	double			Best Fit Local Photon Index at Pivot_Energy for PLSuperE...
	ra	double	degree		Right Ascension
	tevcats_flag	char			Flag Indicates Possible Association with TeVcat
	flux_1_100_gev_error	double	photon/cm^2/s		1-Sigma Uncertainty in Photon Flux 1 to 100 GeV
	plec_flux_density	double	photon/cm^2/MeV/s		Differential Flux at Pivot Energy in PLSuperExpCutoff Fit
	lp_curve_significance	double			Significance in Sigma of the Fit Improvement Between P...
	semi_minor_axis_95	double	degree		Semi-Minor Axis of Error Ellipse at 95% Confidence (degr...
	frac_variability_error	double			1-Sigma Uncertainty on Fractional Variability
	flux_peak	double	photon/cm^2/s		Peak Integrated Flux from 100 MeV to 100 GeV
	plec_flux_density_error	double	photon/cm^2/MeV/s		1-Sigma Uncertainty on Differential Flux at Pivot Energy l...
	plec_index_s_error	double			1-Sigma Uncertainty on Local Photon Index for PLSuperE...
	assoc_name	char			Name of Identified or Likely Associated Source

Service Capabilities

Query Language: ADQL-2.0 Max Rows: Uploads: available

ADQL Text

Mode: Synchronous

1

SELECT * FROM fermilpsc

Examples

Run Query

Select Fermi data with TOPCAT

Visualization
of the table,
metadata.

Table Access Protocol (TAP) Query

Window TAP Registry Edit Interop Help

Select Service Use Service Resume Job Running Jobs

Unified Content Descriptors

Metadata

Find:

☒ Name ☐ Descrip Or

Service	Schema	Table	Columns	FKKeys	Hints		
		Name	Type	Unit	Indexed	Description	UCD
		data_release	short			Data Release Version	meta.version
		lra	double	degree		Galactic Longitude	pos.galactic.lon
		plec_epeak_error	double			1-Sigma Uncertainty on Peak Energy Estimated From PL	stat.error;em.energy
		pivot_energy	double	MeV		Energy at Which Error on Differential Flux Is Minimal	em.energy
		pl_index	double			Photon Index for PowerLaw Fit	spect.index
		flux_peak_error	double	photon/cm^2/s		1-Sigma Uncertainty in Peak Flux	stat.error;phot.flux;em.gamma
		flux_1_100_gev	double	photon/cm^2/s		Integral Photon Flux 1 to 100 GeV	phot.flux;em.gamma
		assoc_error_radius	double	degree		Position Uncertainty at 68% Confidence Level for Assoc	stat.error;pos
		plec_index_s	double			Best Fit Local Photon Index at Pivot_Energy for PLSuperB	spect.index
		ra	double	degree		Right Ascension	pos.eq.ra;meta.main
		tevcats_flag	char			Flag Indicates Possible Association with TeVcat	meta.code
		flux_1_100_gev_error	double	photon/cm^2/s		1-Sigma Uncertainty in Photon Flux 1 to 100 GeV	stat.error;phot.flux;em.gamma
		plec_flux_density	double	photon/cm^2/MeV/s		Differential Flux at Pivot Energy in PLSuperExpCutoff Fit	phot.flux.density
		lp_curve_significance	double			Significance in Sigma of the Fit Improvement Between P	stat.fit.goodness
		semi_minor_axis_95	double	degree		Semi-Minor Axis of Error Ellipse at 95% Confidence (deg	phys.angSize.sminAxis;pos.error
		frac_variability_error	double			1-Sigma Uncertainty on Fractional Variability	stat.error;src.var
		flux_peak	double	photon/cm^2/s		Peak Integrated Flux from 100 MeV to 100 GeV	phot.flux;em.gamma
		plec_flux_density_error	double	photon/cm^2/MeV/s		1-Sigma Uncertainty on Differential Flux at Pivot Energy	stat.error;phot.flux.density
		plec_index_s_error	double			1-Sigma Uncertainty on Local Photon Index for PLSuperB	stat.error;spect.index
		assoc_name	char			Name of Identified or Likely Associated Source	meta.id.assoc

Service Capabilities

Query Language: ADQL-2.0 Max Rows: Uploads: available

ADQL Text

Mode: Synchronous

1

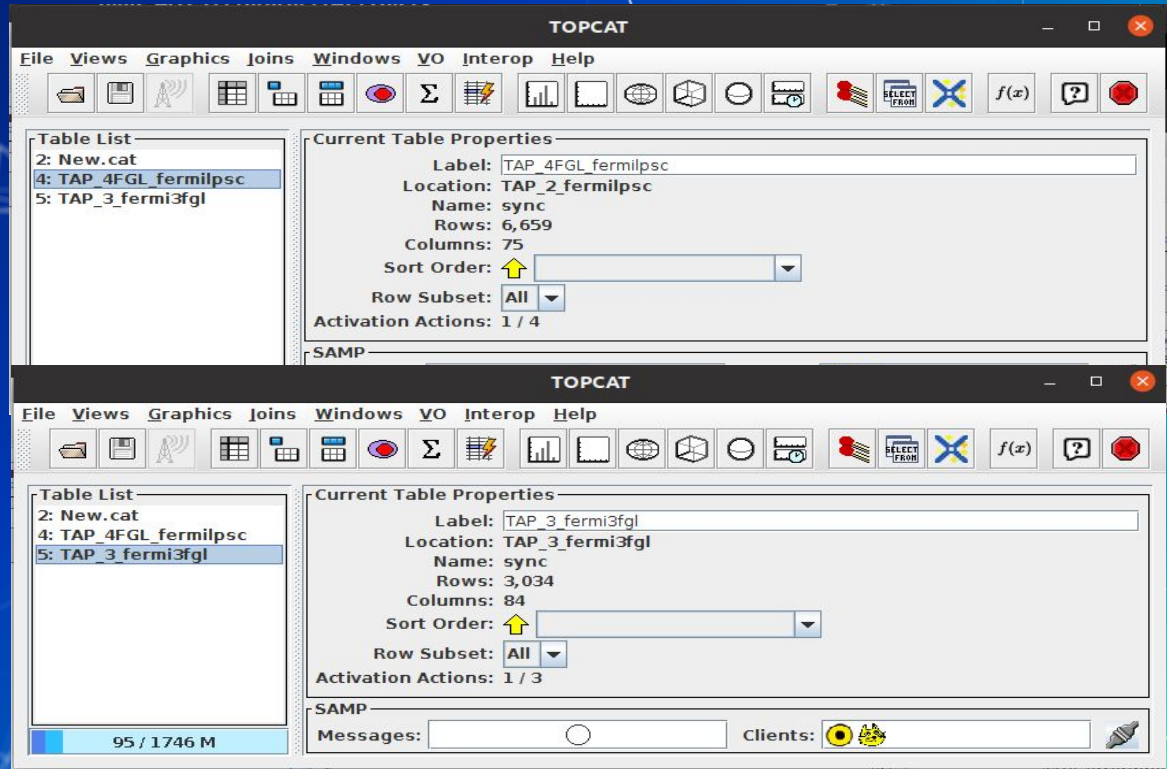
SELECT * FROM fermilpssc

Examples

Run Query

Select Fermi data with TOPCAT

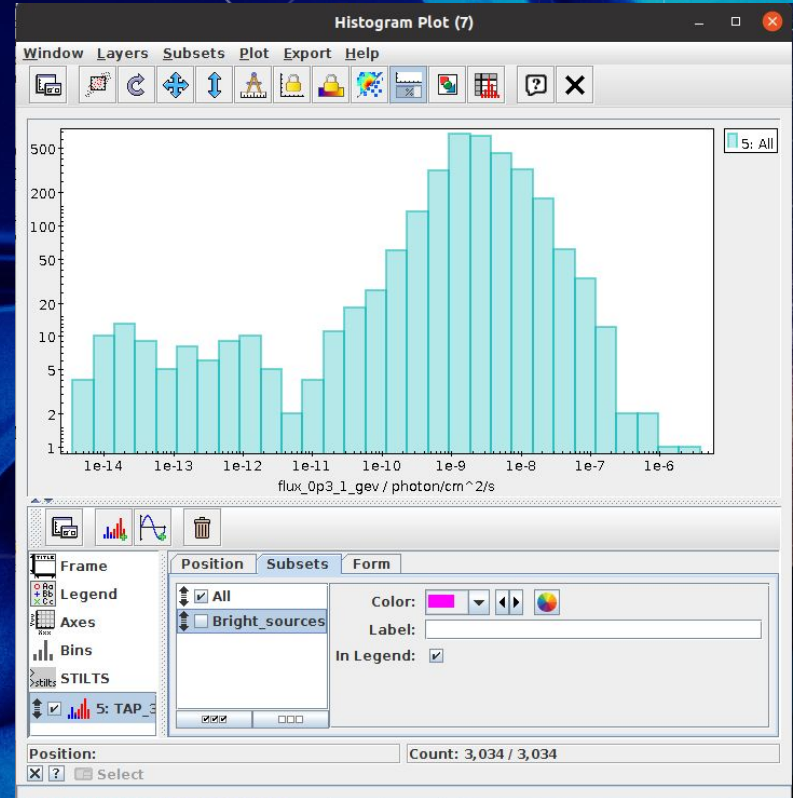
3FGL interested in a
particular E range
(300-1000 MeV)



Data exploration of the 3FGL

Keep the brightest sources

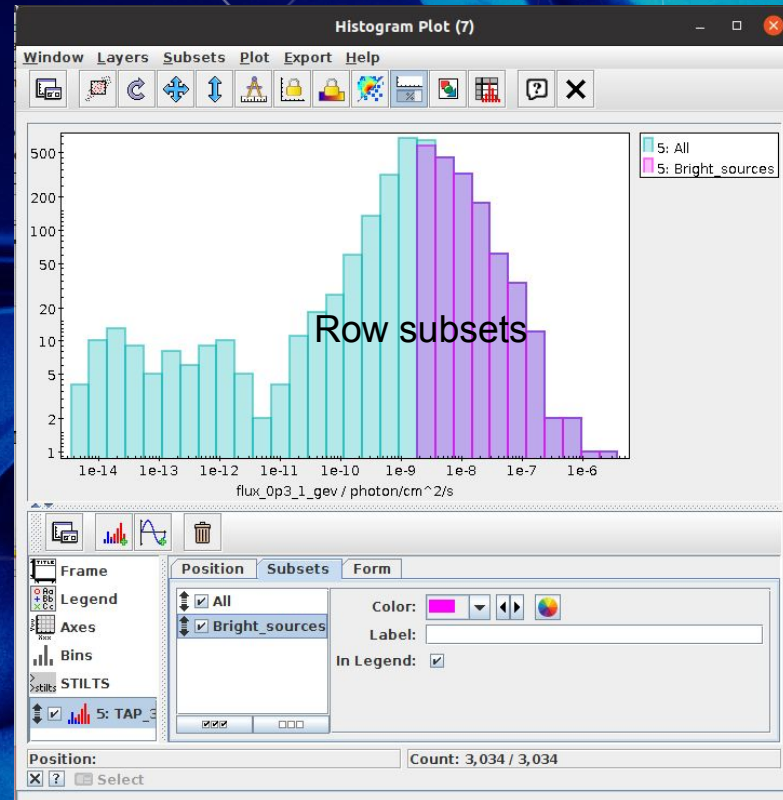
- Visualise the distribution in flux $F(0.3\text{GeV} < E < 1\text{GeV})$ of our Table.
- 2 populations.
- Now we want to select cut on the flux.



Data exploration of the 3FGL

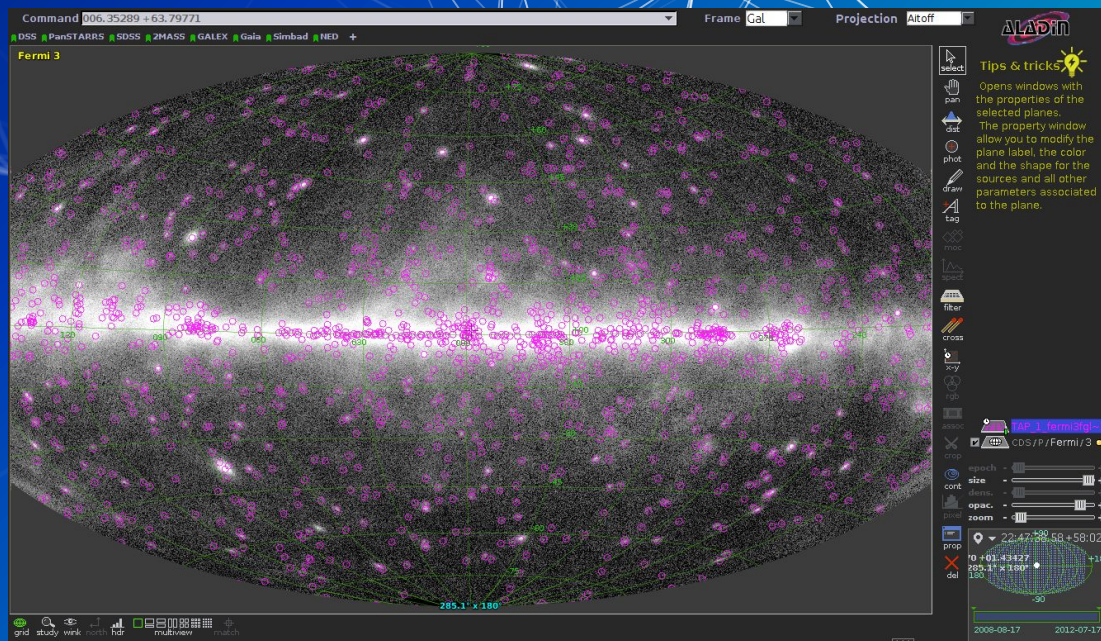
keep the brightest sources

- Visualise the distribution in flux $F(0.3\text{GeV} < E < 1\text{GeV})$ of our data
- 2 populations
- Now we want to select cut on the flux



Crossmatch the subset of the Fermi-LAT and TeVCat \Rightarrow **Aladin** Interoperable

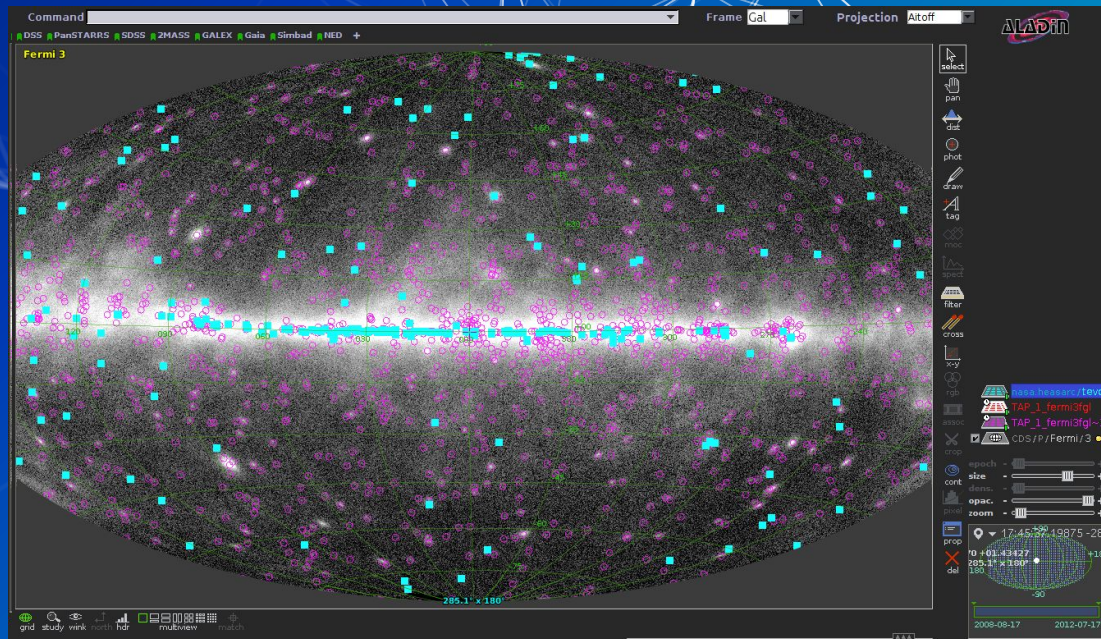
- Load Bright
- Load TeVCat in *Aladin*
- CDS 300-1000MeV HEALPix map



Crossmatch the subset of the Fermi-LAT and TeVCat \Rightarrow **ALADiN** Interoperable

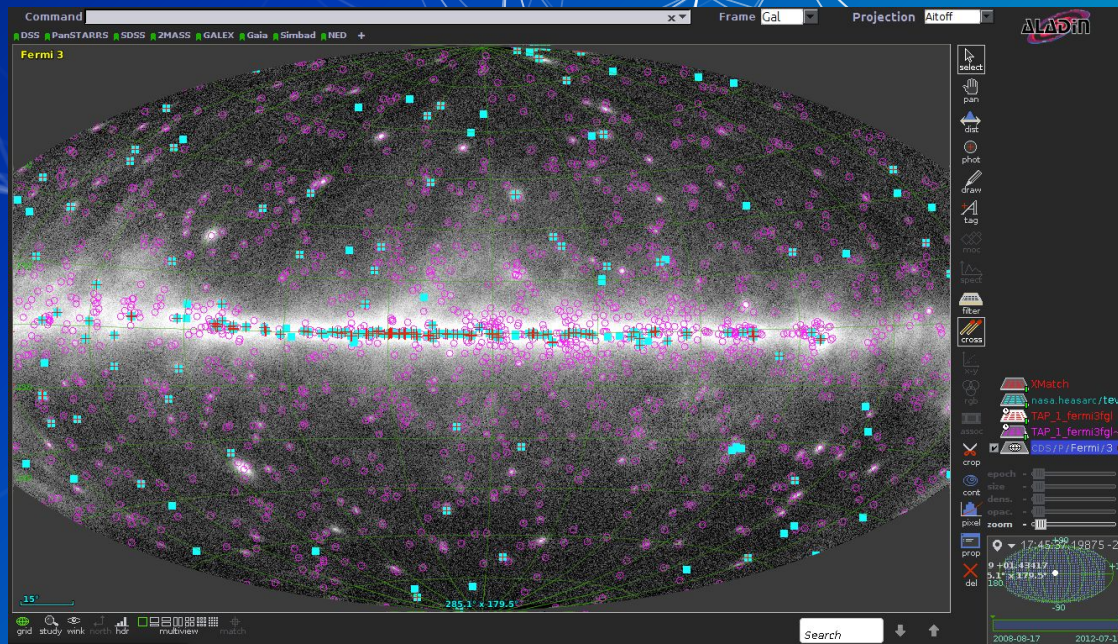
TeVCat

Catalog|Cross match
objects (Best matches)



Crossmatch the subset of the Fermi-LAT and TeVCat \Rightarrow **ALADiN** Interoperable

Catalog|Cross match
objects (Best matches)
195!



Filter the PSC/TeVCat cross-match with the CHANDRA MOC



Catalog

CSC - CSC - The Chandra Source Catalog, Release 1.1 (Evans... [...](#)

Provenance: [CDS](#) [...](#)
Coverage: 57.34°² Reference pub. year: [2010](#) Nb rows: 106,586






Access mode ☐ in view ☐ by region & MOC ☐ by CDS Xmatch ☐ by criteria

derived prod. ☒ space


Only load the sources inside the selected region or MOC for the selected collections supporting

[CDS/IX/45/csc11](#)

Load

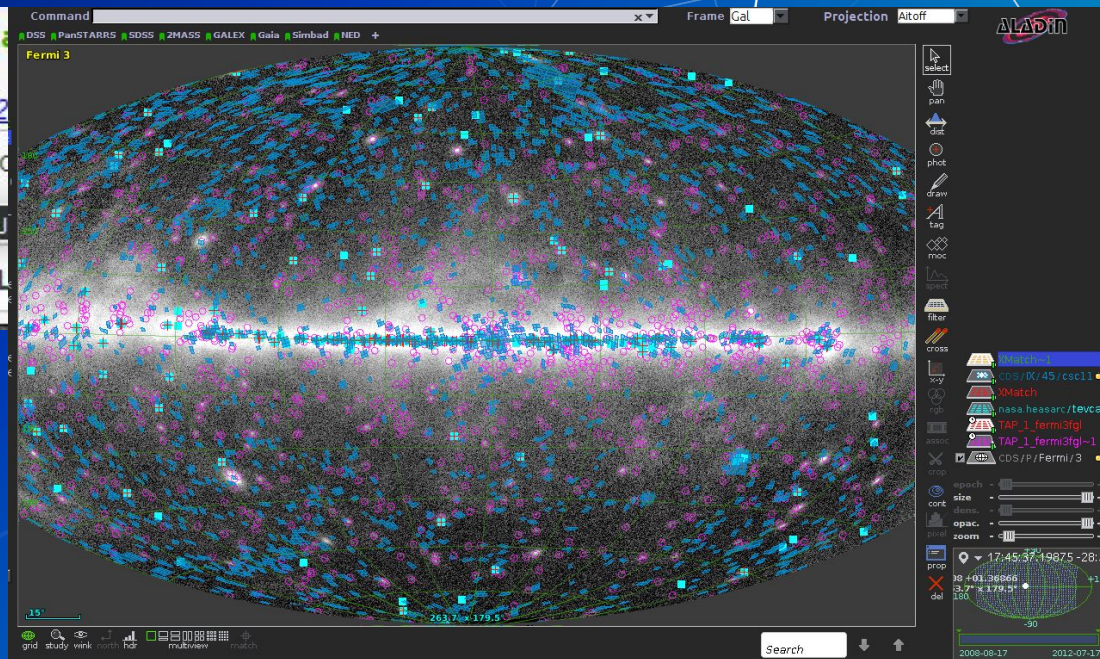


Filter the PSC/TeVCat cross-match with the CHANDRA MOC



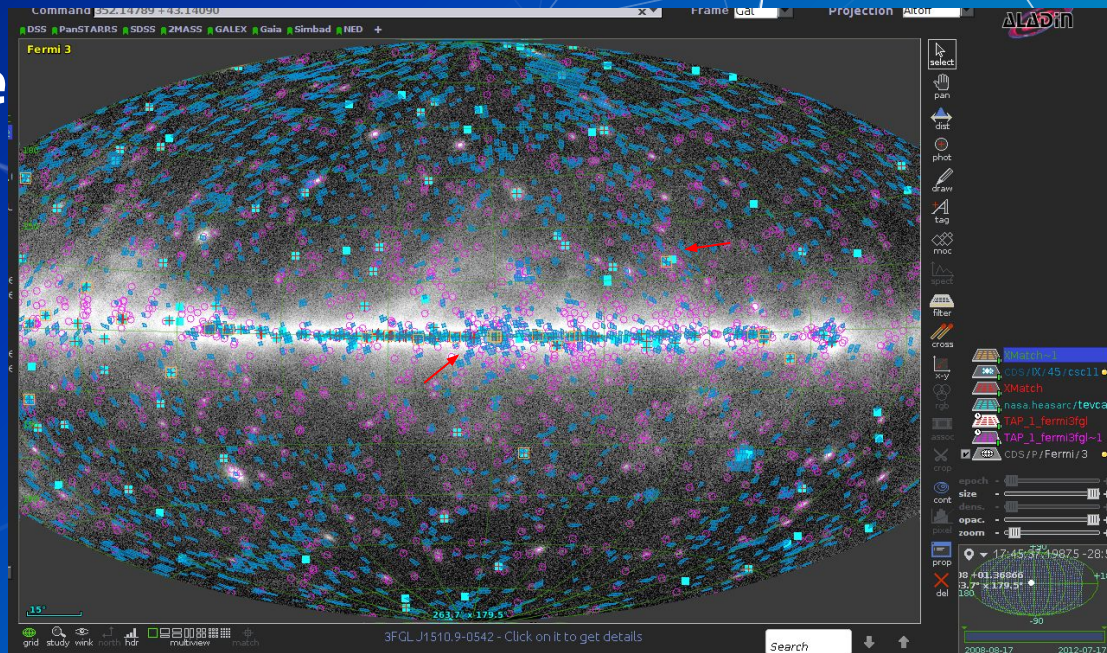
CSC - CSC - The Chandra Source Catalog
Provenance: CDS
Coverage: 57.34° Reference pub. year: 2000
Access mode ☐ in view ☐ by region
derived prod. ☒ space Only load the sources
CDS/IX/45/csc11

Identify the different kinds of data: **catalogues, MOCs and images**



Filter the PSC/TeVCat cross-match with the CHANDRA MOC

by Coverage|Filter a table
by a MOC ⇒
30 sources!



//

Export the final cross-matched table to TOPCAT by **Interop** ❤️

- 1) New Chandra detections.
- 2) Think about any useful colour-colour diagrams.
- 3) Finding the distance of each source in order to build a L_x-L_{HE} correlation.

An astronaut in a white spacesuit is floating in the center of the frame against a black background. The astronaut is holding a small object in their right hand. The background is decorated with a complex, white wireframe mesh that resembles a molecular structure or a network of interconnected points and lines. At the bottom of the image, a thin, horizontal band of blue and white represents the Earth's horizon.

Thanks!