

Archiving data from a software telescope

An astronomer perspective

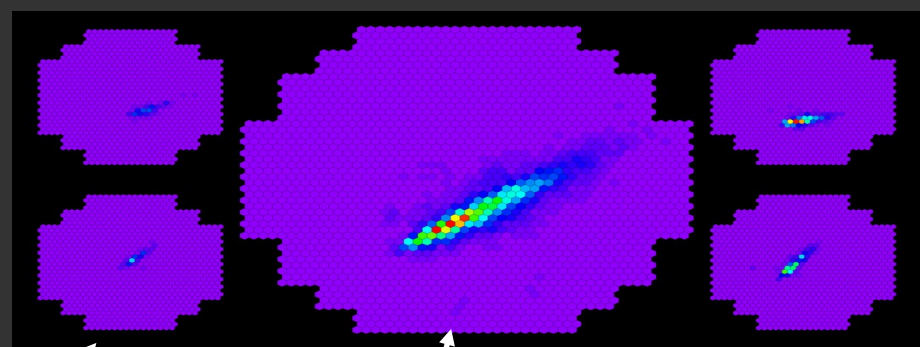
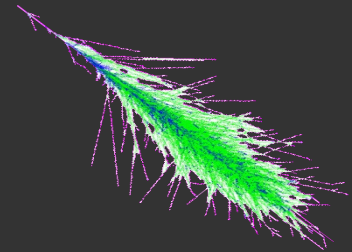
Catherine Boisson

ASTERICS OBELICS PyGamma19, Heidelberg 2019



the observatory for
ground-based
gamma-ray astronomy





Dark nights → small duty cycle

Event reconstruction :

photon, particle shower, Cherenkov light (faint, few nanoseconds)

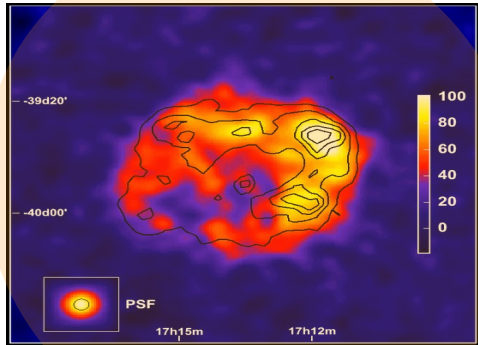
Atmosphere = calorimeter

Simulations, assumptions

Complex metadata : need to be structured

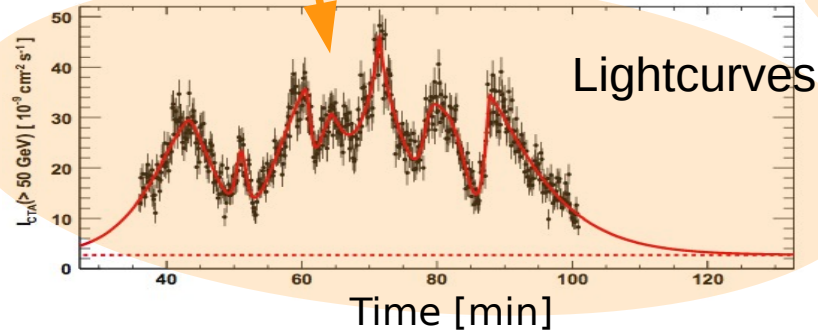


Multi-wavelength analysis

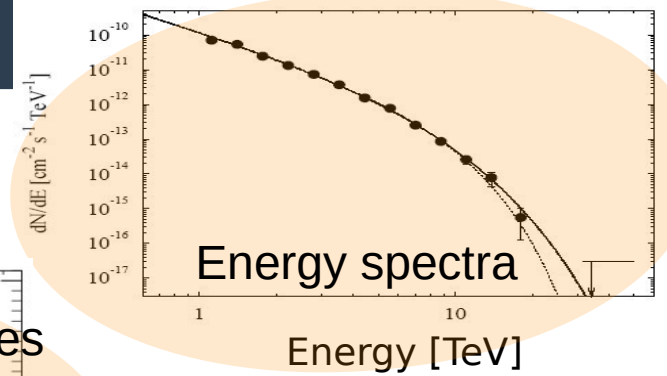


Images

Event lists
(coordinates, time, energy)

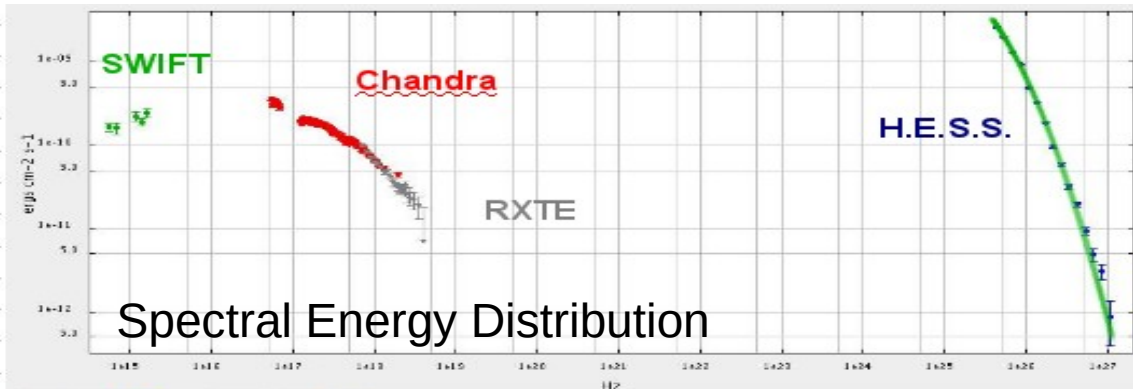


Lightcurves



Energy spectra

Energy [TeV]



Spectral Energy Distribution

Compatible data
at other wavelength?

Simultaneous
Calibrated
Specific Processing?
Context?

Only a few hours of useful data summed over a long time

HESS J0152+017


Close

Observation									Curation								
name	comments	pointing alpha	pointing alpha sys	pointing alpha stat	pointing delta	pointing delta sys	pointing delta stat	publisher	curation date	version	rights	contact name	contact email	title	creator	creation date	creation type
HESS J0152+017	October to November 2007 summed data; significance of 6.6 sigma	1:52:33.500	1.3	5.3	1:46:40.300	20	107	VO-Paris	02-08-2008	1.0	Public	C. Boisson	catherine.boisson@obspm.fr	Extragalactic	C. Boisson	28-07-2008	Archival

Not pixels but asymmetric energy bins

Time Axis			Spectral Axis	Spectral Data (E in TeV)	Flux Data (dN/dE in cm ⁻² s ⁻¹ TeV ⁻¹)	
bounds start	bounds stop	livetime	energy threshold	value	value	stat error
52412.075	53504.895	14.7	3	0.308457	2.03399e-11	6.67175e-12
				0.484509		1.63425e-12
				0.760992	1.20326e-12	5.01844e-13
				1.19525	3.12378e-13	2.16144e-13
				1.87731	1.18592e-13	8.50016e-14
				2.9486	4.0974e-14	3.51122e-14

optimization

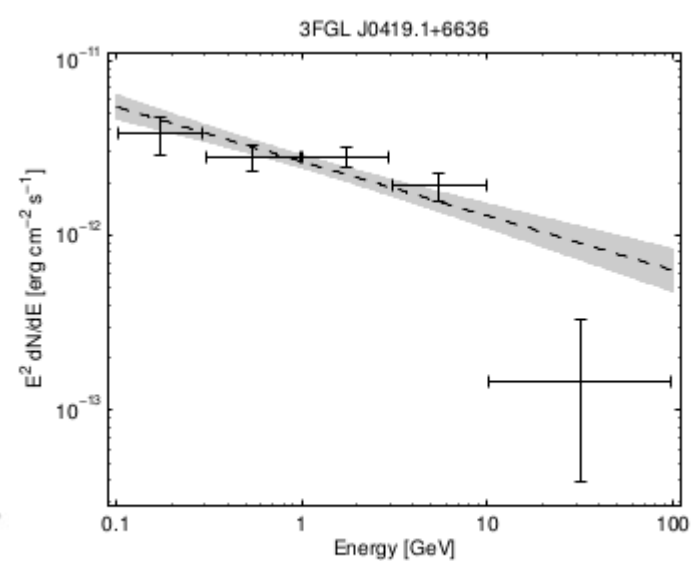
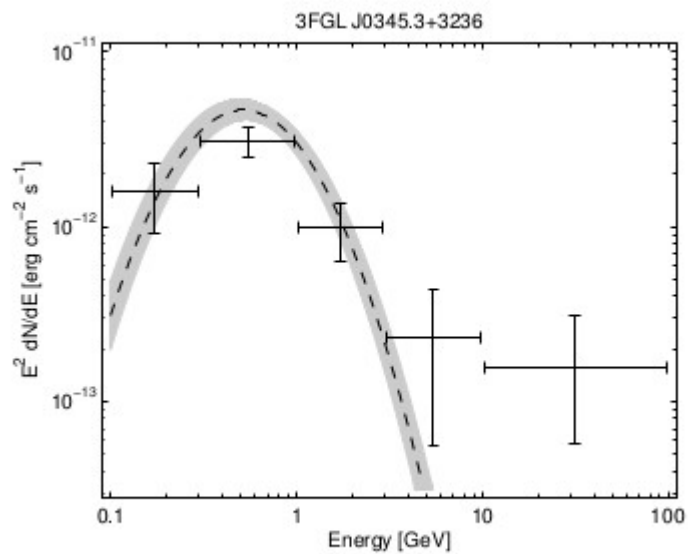
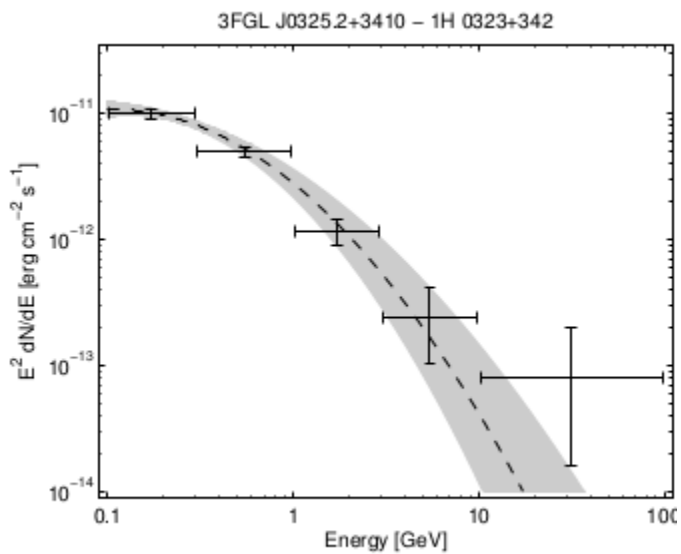
Segment											Quality	Cuts		Background	
length	data type	imgfile	comments	background	hypothesis power law	hypothesis gamma	hypothesis ngamma	hypothesis ch2	hypothesis dof	mean zenith angle	name	description	name	description	
6	Spectrum		Aharonian et al., A&A 481 (2008) L103	Reflected model	Single	2.95	173	2.16	4	26.9	Hillas soft cuts	Soft Cuts: as standard cuts but optimized for a 1% Crab flux (>100 GeV) source with a photon index of 5.0. * a 5/10 cleaning * a charge cut at 40 p.e. * a nominal distance cut at 2 degrees * a Mean Scaled Width between -2 and 0.9 * a Mean Scaled Length between -2 and 1.3 * a Theta^2 cut of 0.02	Reflected model	Technique used in standard wobble observation mode. See Aharonian et al. (H.E.S.S. Collaboration), A&A 457, 899 (2006)	

Close

Spectral Fit

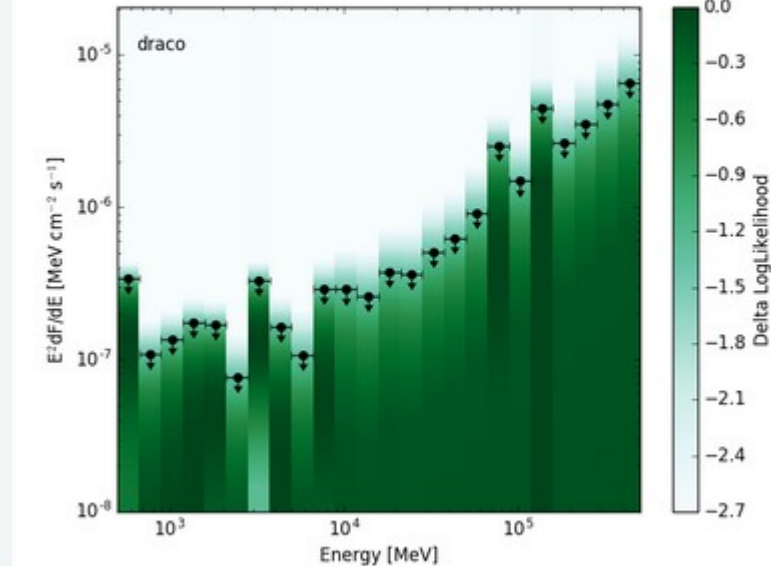
Bin-by-bin fluxes + broadband fit envelope

3FGL catalog

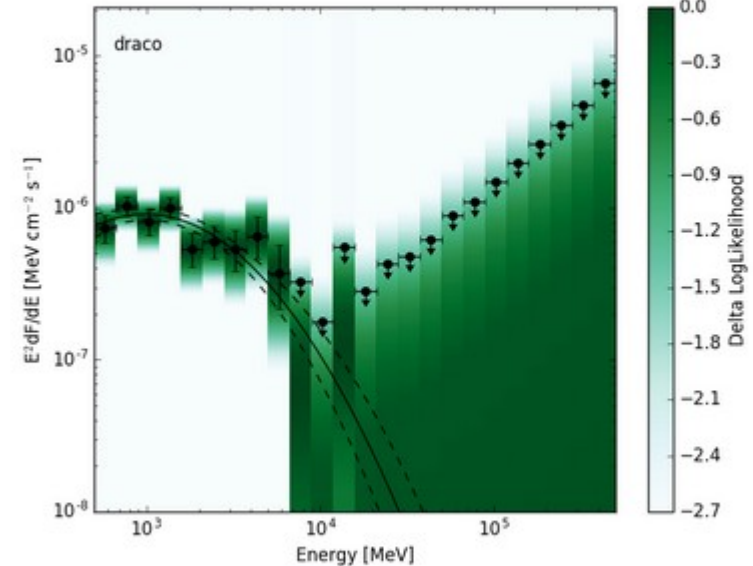


Format for complete likelihood curve

Low Significance Source



High Significance Source



https://gamma-astro-data-formats.readthedocs.io/en/latest/spectra/binned_likelihoods/index.html

see Eric Charles's presentation

Data from publications, catalogs...

Portal Simbad Vizier Aladin X-Match Other Help

pk2155-304

J2000 position for pks2155-304 (QSO B2155-304):
21 58 52.065 -30 13 32.12

239 HiPS images

499 Vizier tables

1498 bibliographical references

Object (Simbad)

Main ID
QSO B2155-304

Object type
BL Lac - type object

Z
0.116

More info in Simbad

Magnitudes

- B : 13.36
- V : 13.09
- R : 12.62
- J : 11.398
- H : 10.46
- K : 10.134

Object (NED)

No data in NED.

http://cdsportal

Images

239 HiPS images available 0.20° around 21 58 52.065 -30 13 32.12 :

Wavelength : Gamma-ray X-ray UV Optical Infrared Radio Gas-line

Resolution : Low Medium High

Show : All HiPS CDS featured My favorites

Filter: 16 entries (filtered from 239 total records)

continuous update

	title	wavelength	Sky fraction	
★	Fermi Color HEALPix survey	Gamma-ray	100 %	i
★	Swift-BAT 70-month all-sray hard X-ray survey image	X-ray	100 %	i
★	False color X-ray images (Red=0.5-1 Green=1-2 Blue=2-4.5 Kev)	X-ray	8.29 %	i
★	GALEX GR6 AIS (until March 2014)- Color composition	UV	79.79 %	i

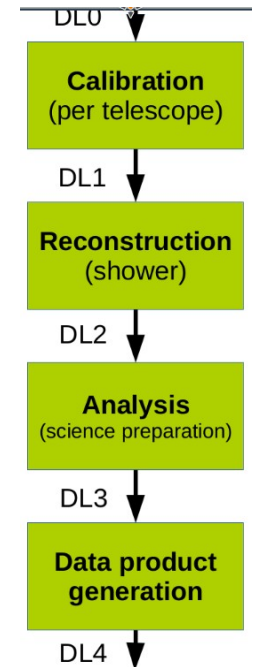
Aladin Lite

DSS colored

J2000 21 58 52.065 -30 13 32.12

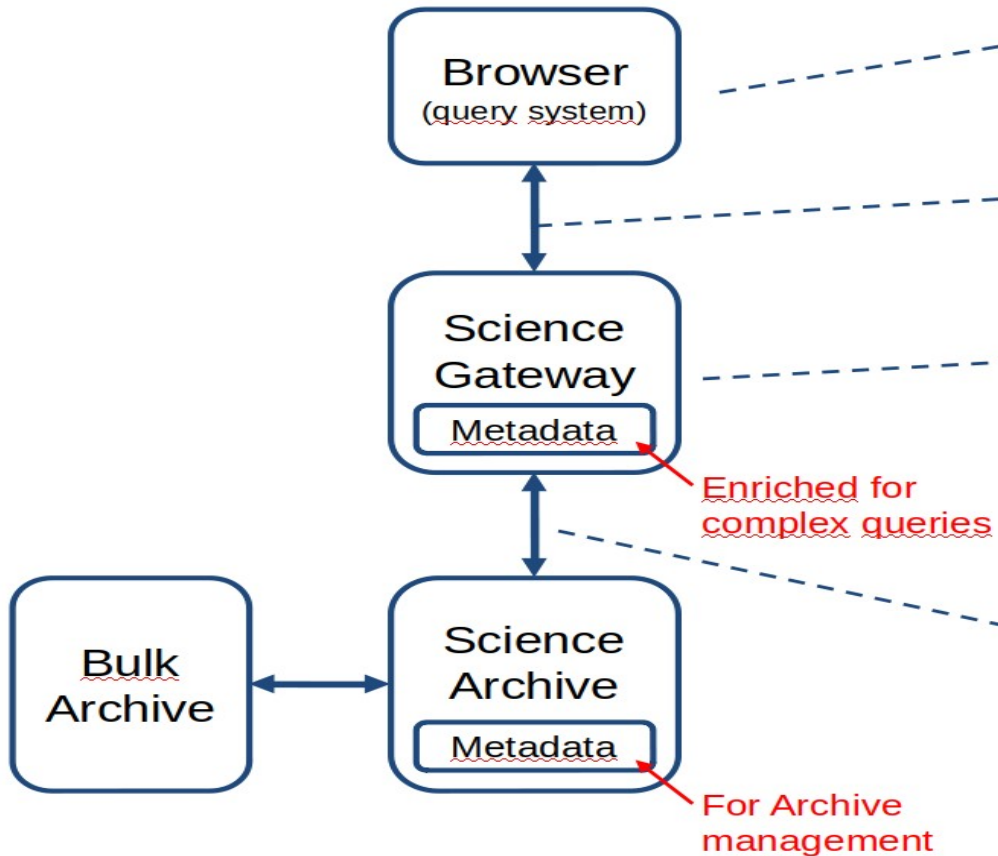
CTA & Virtual Observatory

- Virtual Observatory (VO) standards and framework explored for several CTA use cases
 - Identify how a data was produced → Provenance
 - Identify what detailed options were used → Configuration
- IVOA Provenance data model
 - See Mathieu Servillat's presentation
- Link Master Configuration Data Model / Provenance Data Model
- Extension of tools (e.g. ctapipe, gammapy) to include access to provenance information



Science Archive in the VO framework

CTA Data Access



In the VO Framework

Client: submits a query

- VO tools (Topcat, Aladin, scripts...)
- Dedicated Web Client

Protocol: standard for query exchange

- ADQL (Astronomical Data Query Language)
- TAP (Table Access Protocol)

Server: computes query results

- TAP Service
- VO Data Models (ObsCore, DataSet, ...)
 - RA → s_ra
 - Dec → s_dec
 - obs_id, t_min, t_max, access_url, ...
- ⇒ ObsTAP Service

Retrieval System:

- VO ObsCore access_url + DataLink
- Any service at the access_url
 - FTP, HTTP server
 - VO Space
- e.g. <https://archive.cta.org/retrieve?id=###>

CTA Data Distiller

<https://voparis-cta-test.obspm.fr>



CTA Data Distiller

🔍 Search Form

✔ Results

👤 Sign in

Cone Search

Target Name

Used to query Simbad with Sesame and set RA/Dec.

Source RA (deg)

Right Ascension.

Source Dec (deg)

Declination.

Search radius (deg)

- ◆ Django, jQuery, Bootstrap3
- ◆ Name resolver
(Simbad through Sesame)
- ◆ Builds and Sends the ADQL query

▼ ObsCore Search

proposal_id

Proposal ID

dataprodect_type


Data product (file content) primary type

dataprodect_level

DL0-5

CTA Data Distiller

<https://voparis-cta-test.obspm.fr>



CTA Data Distiller Search Form Results Job List Selected Job Authentication: Sign out user

Search Analyse

PAADC Paris Astronomical Data Centre

cta cherenkov telescope array

Results [show/hide query](#)

```
SELECT * FROM cta.vo_obscore as o WHERE 1 = intersects(o.s_region, circle('ICRS', 329.717000, -30.226000, 0.001000))
```

ADQL query

Send

ObsCore fields

	dataprodukt_type	obs_collection	obs_id	target_name	s_ra (deg)	s_dec (deg)
<input type="checkbox"/>	eventlist	HESS-DR	47802	PKS 2155-304	330.295	-30.2256
<input type="checkbox"/>	eventlist	HESS-DR	47803	PKS 2155-304	329.138	-30.2256
<input type="checkbox"/>	eventlist	HESS-DR	47804	PKS 2155-304	329.717	-29.7256
<input type="checkbox"/>	eventlist	HESS-DR	47827	PKS 2155-304	330.295	-30.2256
<input type="checkbox"/>	eventlist	2	47828	PKS 2155-304	329.138	-30.2256

Showing 1 to 5 of 6 rows 5 records per page

<< < 1 2 > >>

IVOA Standards

SAMP

Interop (SAMP)

Send Result Table

Send Selected Data

Analysis tools

Count Map(s)

Fit Spectrum

Plotting tools

TOPCAT

Aladin

VOSpec

SPLAT

HESS DL3 data release exposed using VO protocols

Computing and workflow management

- **OPUS** (Observatoire de Paris UWS Server)
 - a light **job controller** for the Paris Observatory **work cluster** developed in Python
<https://uws-server.readthedocs.io/en/latest/>

The screenshot displays the OPUS web interface. At the top, there is a navigation bar with 'OPUS', 'Job Definition', 'Job Manager', and 'Sign out admin'. Below this is a 'Job Description' section with a 'Back to job list' button. A table shows job details for 'anactools_v1.1', which is in the 'COMPLETED' phase. The table has columns for Type, Start Time, Destruction Time, Phase, Details, and Control. Below the table is a sidebar menu with options: Job Properties, Job Parameters, Job Results, and Job Details. A callout box on the right lists features of the system.

Type	Start Time	Destruction Time	Phase	Details	Control
anactools_v1.1	2017-03-15 01:09:12	2017-04-14 01:09:08	COMPLETED		

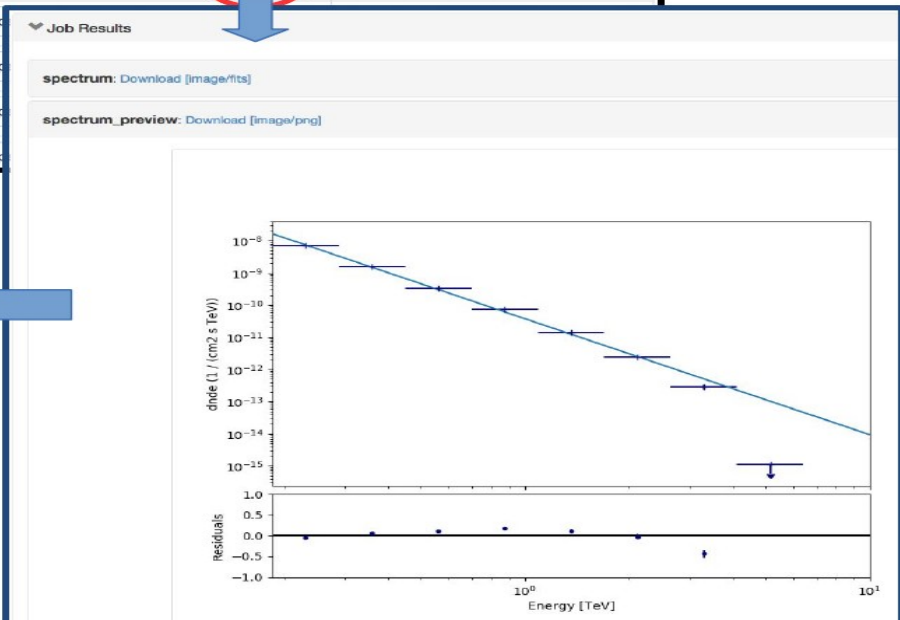
- Follows the **IVOA UWS pattern**
- REST web service
- Job definition editor
- Job manager
 - Stores job **properties** (start, stop time...)
 - **Parameter** also kept
 - Access to **results**
 - **Visualization of logs and Provenance information**

Web client working prototype - DL3+

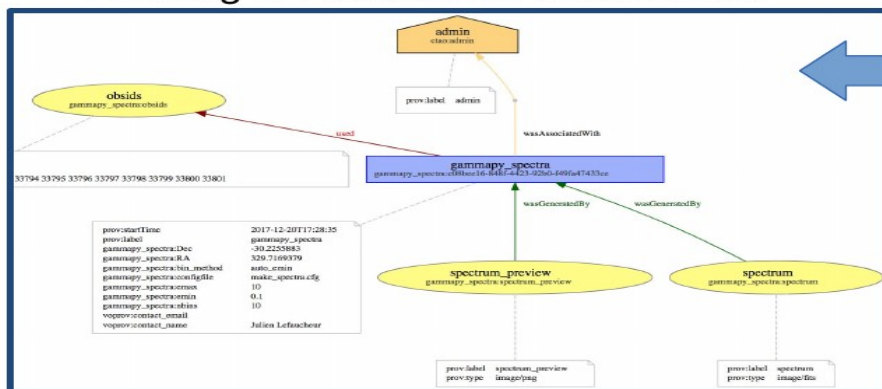
OPUS [Job Definition](#) [Job List](#) Signed in as user

Job List for gammapy_spectra Refresh Job List Create Test Job Create New Job

Type	Start Time	Destruction Time	Phase	Details	Control
gammapy_spectra	2017-10-02 10:47:07	2017-11-01 10:47:05	COMPLETED	Properties Parameters Results	Start Abort Delete
gammapy_spectra		2017-11-01 10:47:03	PENDING	Prop	
gammapy_spectra	2017-09-29 15:07:52	2017-10-29 15:07:51	COMPLETED	Prop	
gammapy_spectra	2017-09-29 14:55:10	2017-10-29 14:55:09	ABORTED	Prop	
gammapy_spectra	2017-09-29 14:21:20	2017-10-29 14:21:19	COMPLETED	Prop	

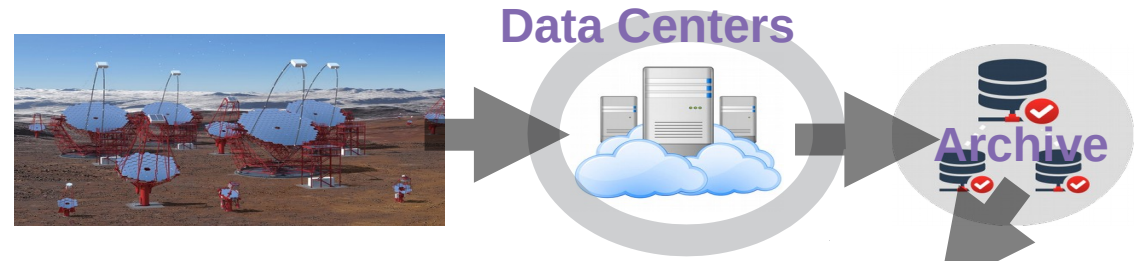


Tracking of Provenance informations



Science Archive & Science Gateway

- Conception of a CTA Master **Configuration Data Model**
- Containing detailed **Provenance** metadata stored in the **Archive**
- Compatibility with **Virtual Observatory** standards
- **Science Gateway** = collection of **interconnected** web services with common **Authentication/Authorization** system



The screenshot shows the "CTA Data Distiller" web interface. The URL is <https://voparis-cta-test.obspm.fr>. The interface includes a search bar, a navigation menu with "Search", "Analyse", and "Visualisation", and a "Results" section. The "Results" section displays an ADQL query and a table of data. The table has columns for "dataprodukt_type", "obs_collection", "obs_id", "target_name", "s_ra (deg)", and "s_dec (deg)". The "ObsCore fields" are highlighted in the table. On the right side, there are several tool buttons: "Interop (SAMP)", "Analysis tools", and "Plotting tools".

dataprodukt_type	obs_collection	obs_id	target_name	s_ra (deg)	s_dec (deg)	
<input type="checkbox"/>	eventlist	1	23592	Crab Nebula	82.01333618164062	22.01444435119629
<input type="checkbox"/>	eventlist	1	23559	Crab Nebula	85.25333404541016	22.01444435119629
<input type="checkbox"/>	eventlist	1	23526	Crab Nebula	83.63333129882812	22.51444435119629
<input type="checkbox"/>	eventlist	1	23523	Crab Nebula	83.63333129882812	21.51444435119629
<input type="checkbox"/>	eventlist	3	5003499	CrabNebula	83.28087615966797	21.784133911132812

