VO implementation at Observatorio Astrofísico de Javalambre

Tamara Civera & Javier Hernández
CEFCA

CEFCA and the OAJ

The Observatorio Astrofısico de Javalambre (OAJ, Teruel, Spain)

CEFCA is an institution of the Government of Aragón for research in *Astrophysics and Cosmology*, whose activities focus on the technological development and operation of the Observatorio Astrofísico de Javalambre (OAJ, Teruel, Spain) and on its scientific exploitation.

Telescopes and instrumentation at OAJ

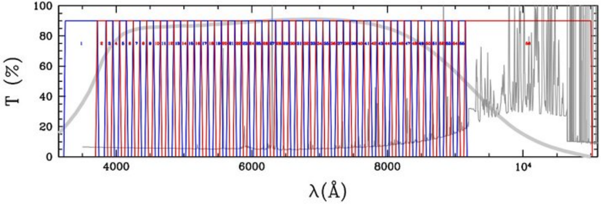
Two main telescopes with large fields of view (FoV) and image quality all over their entire FoVs:

- The 80cm Javalambre Auxiliary Survey Telescope, JAST/T80, with a FoV of **2 deg**.
- The 2.5m Javalambre Survey Telescope, JST/T250, a large-etendue telescope with a FoV of **3 deg** diameter.

The scientific instruments for the telescopes are:

- For the JAST/T80 a wide-field camera equipped with a **9.2k-by-9.2k** high efficiency CCD.
- JPCam is a wide field **14 CCD-mosaic** camera that for the JST/T250.

J-PLUS and J-PAS Surveys

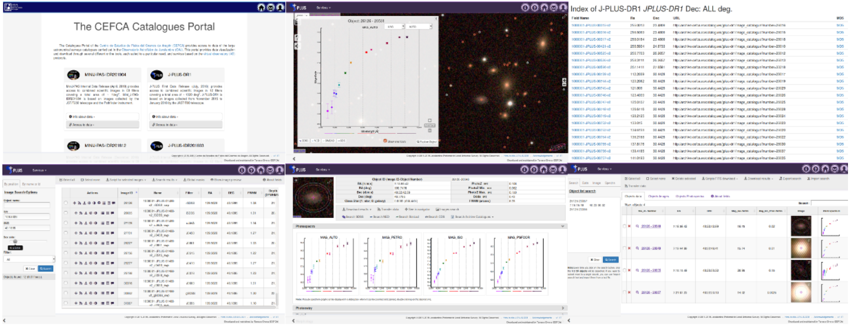


JPCam filter system

- Javalambre-Photometric Local Universe Survey, J-PLUS, is a photometric sky survey of 8500 deg^2, using a set of **12** broad, intermediate and narrow band filters. Designed to carry out the photometric calibration of J-PAS.
- Javalambre Physics of the Accelerating Universe Astrophysical Survey, J-PAS, is an unprecedented photometric sky survey of 8500 deg^2 in **59 colors**, using 54 narrow plus 5 broad bands.

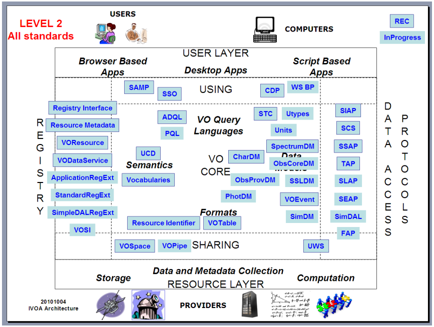
Data Publication

Web Portal: Sky Navigator, Image Search, Cone Search, Object Visualization, Object List Search, MOC Download.



archive.cefca.es

Choosing VO Services



LEVEL 2
All standards

USERS

COMPUTERS

REC

InProgress

USER LAYER

Browser Based Apps

Desktop Apps

Script Based Apps

USING

SAMP

SSO

CDP

WS BP

REGISTRY

Registry Interface

Resource Metadata

VOResource

VODataService

ApplicationRegExt

StandardRegExt

SimpleDALRegExt

VOSI

ADQL

PQL

VO Query Languages

STC

Utypes

Units

UCD

Semantics

Vocabularies

VO CORE

CharDM

SpectrumDM

Data Models

ObsCoreDM

ObsProvDM

SSLDM

PhotDM

VOEvent

SimDM

Formats

Resource Identifier

VOTable

DATA ACCESS PROTOCOLS

SIAP

SCS

SSAP

TAP

SLAP

SEAP

SimDAL

FAP

VOSpace

VOPipe

SHARING

UWS

Storage

Data and Metadata Collection

Computation

RESOURCE LAYER

20101004
IVOA Architecture

PROVIDERS

- Simple Image Access: image search and download (full and *cutouts*).
- Simple Cone Search: catalogue object search.
- TAP: search images, catalogue objects, derived data (*photo-redshifts*, stellarity, ...). Describe data.
- SAMP: push data from our web portal.

Implementation: The Data Layer

- We wanted a open source SQL database (*ADQL friendly*).
- J-PLUS and J-PAS Catalogue final data is expected to occupy several terabytes.
- With flux and error measures for about 16 apertures in 59 filters, just for photometry, we have 1888 columns of data in the object table.
- **PostgreSQL** has known support of big databases, support for custom functions, and *array types* (which simplify storing all filter flux data in one column).
- Spatial index in the database is very important, we opted to use **Healpix**.

Implementation: The Web Layer

- The **Python** programming language was in use in the house for the reduction pipelines, so we evaluated it for creating web applications.
- The Python WSGI specification, with a lot of implementations (Apache mod_wsgi, Unicorn, uWSGI, ...), supports web applications.
- A lot of frameworks (Pyramid, Flask, Django, ...) simplify development, easily map a Python function to a web URL, and access to web parameters.
- Large amount of libraries for astronomy, database access, and Healpix are available.

And some results ...

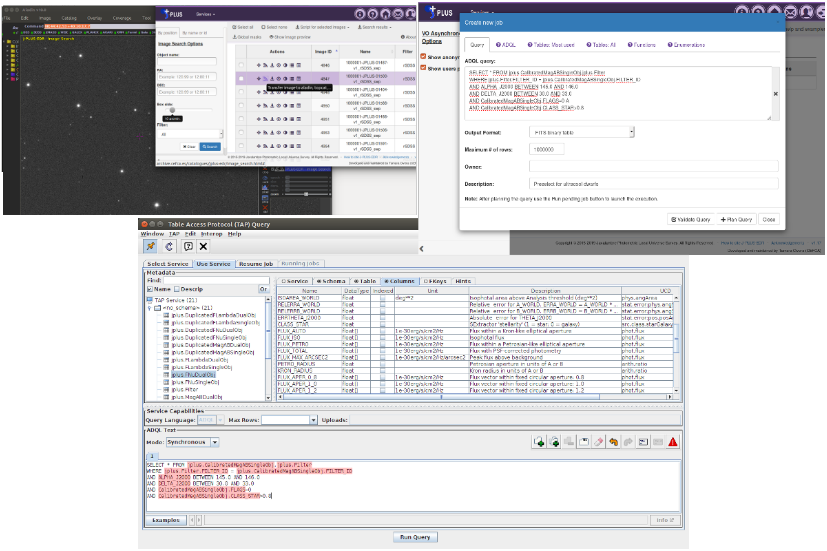


Image Search Options

Object name:

RA: Example: 120.99 or 12:80:11

DEC: Example: 120.99 or 12:80:11

Box side: 10 arcmin.

Filter: All

	Actions	Image ID	Name	Filter
□		4946	1000001-JPLUS-01487-v1_rSDSS_swp	rSDSS
□		4947	1000001-JPLUS-01500-v1_rSDSS_swp	rSDSS
□		4948	1000001-JPLUS-01404-v1_rSDSS_swp	rSDSS
□		4950	1000001-JPLUS-01588-v1_rSDSS_swp	rSDSS
□		4951	1000001-JPLUS-01488-v1_rSDSS_swp	rSDSS
□		4953	1000001-JPLUS-01506-v1_rSDSS_swp	rSDSS
□		4954	1000001-JPLUS-01591-v1_rSDSS_swp	rSDSS

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Developed and maintained by Tamara Civera (CEFCA)

archive.cefca.es/catalogues/jplus-edr/image_search.html#

ADQL query:

```
SELECT * FROM jplus.CalibratedMagABSingleObj,jplus.Filter
WHERE jplus.Filter.FILTER_ID = jplus.CalibratedMagABSingleObj.FILTER_ID
AND ALPHA_J2000 BETWEEN 145.0 AND 146.0
AND DELTA_J2000 BETWEEN 30.0 AND 33.0
AND CalibratedMagABSingleObj.FLAGS=0 A
AND CalibratedMagABSingleObj.CLASS_STAR>0.8
```

Output Format: FITS binary table

Maximum # of rows: 1000000

Owner:

Description: Preselect for ultracool dwarfs

Note: After planning the query use the Run pending job button to launch the execution.

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TAP Service (21)
- <no_schema> (21)
  - jplus.DuplicatedFLambdaDualObj
  - jplus.DuplicatedFLambdaSingleObj
  - jplus.DuplicatedFNuDualObj
  - jplus.DuplicatedFNuSingleObj
  - jplus.DuplicatedMagABDualObj
  - jplus.DuplicatedMagABSingleObj
  - jplus.FLambdaDualObj
  - jplus.FLambdaSingleObj
  - jplus.FNuDualObj
  - jplus.FNuSingleObj
  - jplus.Filter
  - jplus.MagABDualObj

Name	DataType	Indexed	Unit	Description	UCD
ISOAREA_WORLD	float	□	deg**2	Isophotal area above Analysis threshold (deg**2)	phys.angArea
RELERRA_WORLD	float	□		Relative error for A_WORLD. ERRA_WORLD = A_WORLD * ...	stat.error;phys.ang
RELERRB_WORLD	float	□		Relative error for B_WORLD. ERRB_WORLD = B_WORLD * ...	stat.error;phys.ang
ERRTHETA_J2000	float	□		Absolute error for THETA_J2000	stat.error;pos.posA
CLASS_STAR	float	□		SExtractor 'stellarity' (1 = star; 0 = galaxy)	src.class.starGalaxy
FLUX_AUTO	float[]	□	1e-30erg/s/cm2/Hz	Flux within a Kron-like elliptical aperture	phot.flux
FLUX_ISO	float[]	□	1e-30erg/s/cm2/Hz	Isophotal flux	phot.flux
FLUX_PETRO	float[]	□	1e-30erg/s/cm2/Hz	Flux within a Petrosian-like elliptical aperture	phot.flux
FLUX_TOTAL	float[]	□	1e-30erg/s/cm2/Hz	Flux with PSF-corrected photometry	phot.flux
FLUX_MAX_ARCSEC2	float[]	□	1e-30erg/s/cm2/Hz/arcsec2	Peak flux above background	phot.flux
PETRO_RADIUS	float	□		Petrosian aperture in units of A or B	arith.ratio
KRON_RADIUS	float	□		Kron radius in units of A or B	arith.ratio
FLUX_APER_0_8	float[]	□	1e-30erg/s/cm2/Hz	Flux vector within fixed circular aperture: 0.8	phot.flux
FLUX_APER_1_0	float[]	□	1e-30erg/s/cm2/Hz	Flux vector within fixed circular aperture: 1.0	phot.flux
FLUX_APER_1_2	float[]	□	1e-30erg/s/cm2/Hz	Flux vector within fixed circular aperture: 1.2	phot.flux

```
SELECT * FROM jplus.CalibratedMagABSingleObj,jplus.Filter
WHERE jplus.Filter.FILTER_ID = jplus.CalibratedMagABSingleObj.FILTER_ID
AND ALPHA_J2000 BETWEEN 145.0 AND 146.0
AND DELTA_J2000 BETWEEN 30.0 AND 33.0
AND CalibratedMagABSingleObj.FLAGS=0
AND CalibratedMagABSingleObj.CLASS_STAR>0.8
```

SAMP with Aladin. TAP web interface. TAP Topcat.

A few lessons learned

- TAP more difficult that we thought. The idea to pass directly queries to the database was not feasible, needed a SQL dialect translation. But good for security, limiting result size or add our extensions (*enumerations* to assign names to filter positions *'jplus::rSDSS'*).
- Also in TAP we found that implementing the geometric functions is very complex due to the rich functionality defined, so at the moment only partial support for that functions exists.
- IVOA centres on public data so access control is not standardised. We finally achieved to support authentication for some tools like Topcat using *Basic HTTP* authentication.

A few lessons learned (II)

- Performance is always something that at some point you have to improve.
- We initially implemented in Python the needed database functions for ADQL but later we moved to a C implementation because it is *ten* times faster.
- TAP queries can take some minutes to execute, so executing concurrently them is mandatory. Python *threads* have some blocking issues, fortunately Python *multiprocessing* package has a similar API.

Thank you!

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