



# Science Requirements and IVOA Standards

*Paolo Padovani*

on behalf of the Take-Up Committee



## Science Input at the IVOA

- Why this session? Because the final goal of the VO is to facilitate and foster astronomical research and astronomers are its ultimate users
- Therefore, scientific requirements should drive the IVOA process
- Our plan:
  - ✓ start from the most pressing scientific needs in the area of utilization of the VO for research purposes
  - ✓ describe briefly the science problem
  - ✓ discuss the requirements on the IVOA side
  - ✓ map these requirements to the relevant Working Group(s)



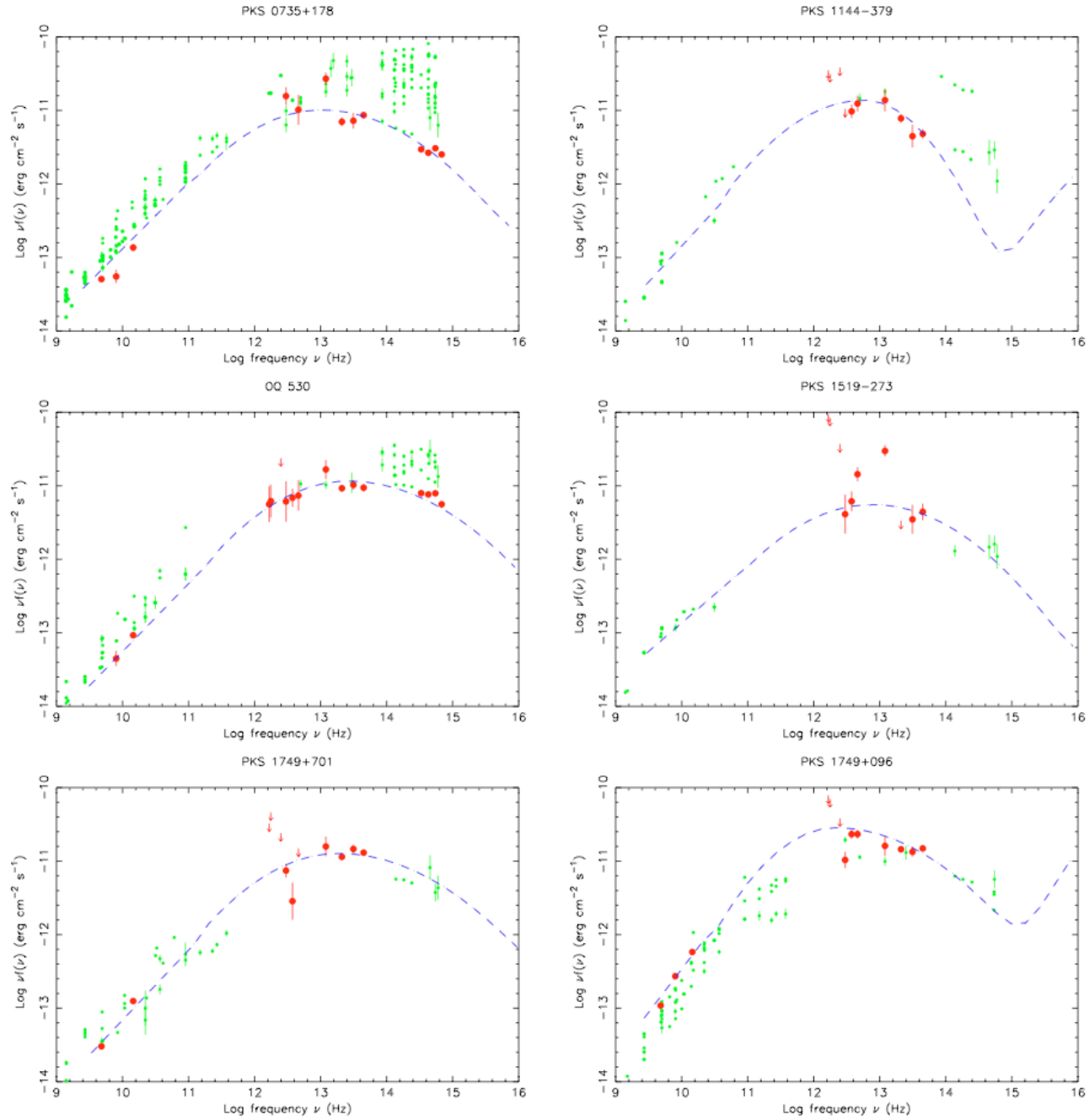
## The needs of the Astronomical Community

- How were these needs captured? From the many interactions some of us have had with the astronomical community, at various levels:
  - ✓ Workshops: Euro-VO Community Workshops
  - ✓ Dedicated schools: Euro-VO Schools, NVO Schools
  - ✓ Research Initiatives
  - ✓ VO Booths (e.g., AAS and JENAM)
  - ✓ VO lectures



## Building a Spectral Energy Distribution (SED)

- An SED is a plot of flux density versus frequency/wavelength/energy
- It can include any data which have been calibrated (in units of energy/area/time/frequency)
- A flux-calibrated spectrum is an SED, but usually an SED used for astronomical purposes will cover a frequency range  $>$  than that covered by a single spectrum
- Astronomers uses SEDs to, e.g.,:
  1. identify the physical process(es) responsible for the emission
  2. determine the source class and its distance



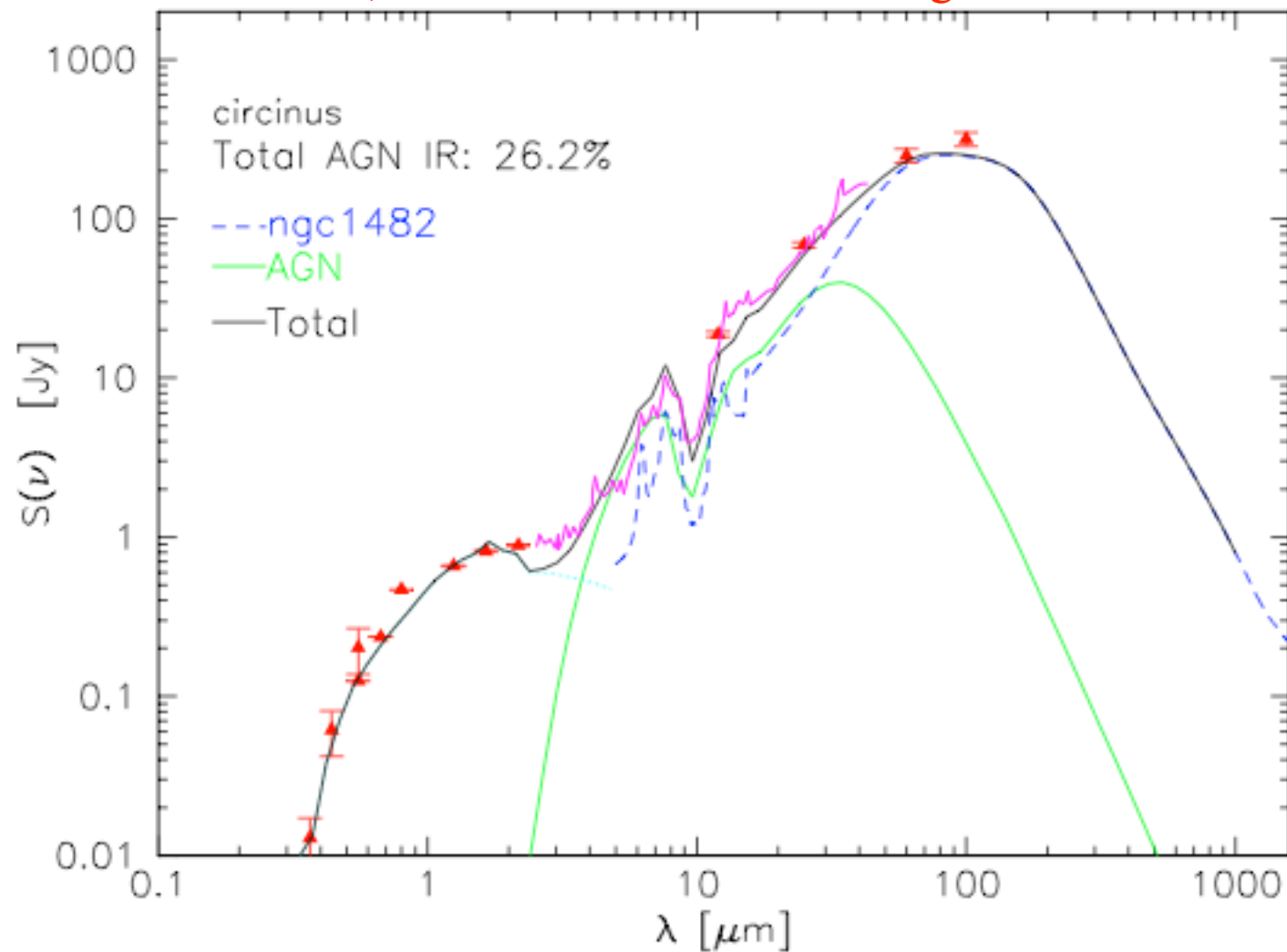
$\nu$  (SED)

Fig. 1. continued.



# Building a Spectral Energy Distribution (SED)

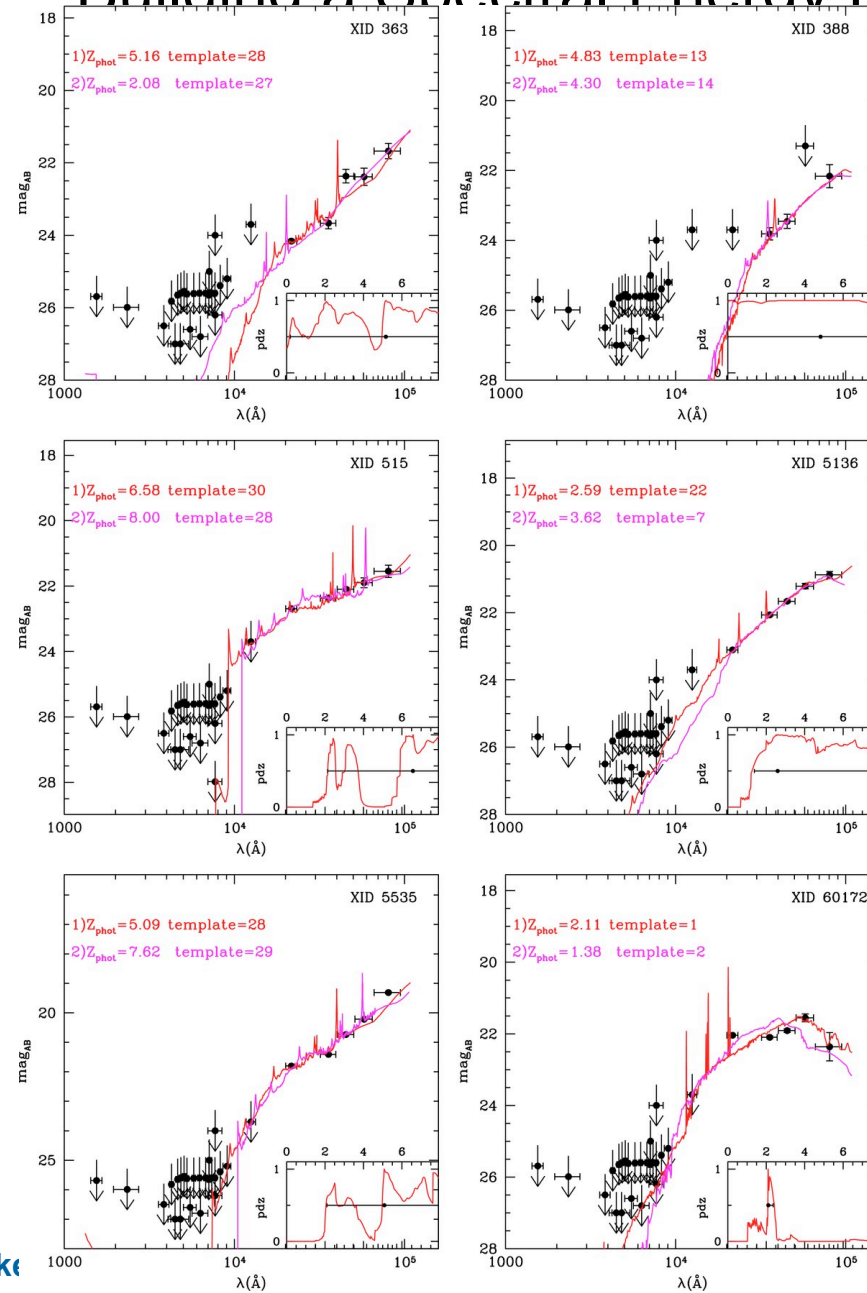
Fritz, Franceschini & Hatziminaoglou 2006





# Building a Spectral Energy Distribution (SED)

Salvato et al. 2009



Tak

irements - 7/20



## Building a Spectral Energy Distribution (SED)

- If all data are already in flux units, then there is no problem, assuming VO spectral tools can deal with them
- If some of the data points are in magnitudes, then they need first to be converted to fluxes
- In the simplest, and most common, cases, since  $m = -2.5 * \log(\text{flux}) + K$ , conversion to flux requires only 2 numbers: the effective frequency and the “zero point”
- For more accurate results, one needs to do a calculation which involves the instrument transmission curve and the source spectrum
- The precision required is typically inversely proportional to the frequency span covered; but it all depends on the final science goal
- SEDs can also be needed for many (thousands) objects





## Building a Spectral Energy Distribution (SED) IVOA Requirements

- Photometric (magnitude) data need to be associated to:
  - ✓ effective frequency and “zero point” (mandatory)
  - ✓ instrument transmission curve (recommended)
- This information needs to be understood by VO spectral tools, which should also be capable of handling many sources and presenting the results in an efficient format
- Therefore, a **standard** needs to be generated
- Involved WGs: **DAL, DM, Applications**

*Astronomers are desperate for this!*

On-going Euro-VO efforts to be reported in a DAL session  
(Salgado + Rodrigo)



## Searching on classes of sources/lists of objects

- Astronomers need to search not only on a single source but on many at the same time; and, very often, many studies are done on *populations* of sources
- For example:
  - ✓ “tell me which of my sources have been detected in the radio band”
  - ✓ “find me all the quasars at redshift  $> 4$  with X-ray and optical images”
- This requires two things:
  1. the capability of searching on a list of targets
  2. access to source classification
- *We have been saying for quite a few years that the VO will allow exactly this kind of searches!*



Aladin v6.0

Location  ICRS Pixel  full

POSSILF-DSS2.301

ngc 1275

- select
- pan
- zoom
- dist
- draw
- tag
- text
- filter
- cross
- rgb
- assoc
- cont
- mqLSS
- pixel
- prop
- del

2MASS-PSC  
NVSS  
POSSILF-DSS2.301

Zoom 1x

12.9' x 12.9'

1' 11.62' x 10.73'

grid multiview match

Search

0 sel / 588 src 16Mb

jects

TIP: Compare several images side by side ["Multiview" icons]



## Searching on classes of sources/lists of objects

### Searching on a list of targets

- Very few VO tools can provide this and those that do need scripting or can access only one resource at a time

### Source classification

- Impossible task for data centres
- Done routinely at SIMBAD/NED



## Searching on classes of sources/lists of objects IVOA Requirements

- VO tools should all allow searches on list of sources to multiple resources in a simple way
- Information on source classification needs to be included
- Involved WGs: **Applications, Semantics, DAL**

Suggestion: Couldn't VO tools first query SIMBAD/NED and then send the request to the relevant resources?



## Top Level VO “Portal”

- Users get very confused when they try to “navigate” the VO
- It would make sense to have a centralized, unique “entry point”, managed by the IVOA
- Some resistance (loss of individuality, funding issues, etc.)
- Users do not care who made what tool: they just want to use them!
- Involved WGs: **Applications, Exec(!)**



Google

"Virtual Observatory"

Search

[Advanced Search](#)

Portal"

Web [+ Show options...](#)

Results 1 - 10 of about 89,700 for "[Virtual Observatory](#)". (0.21 seconds)

[National Virtual Observatory](#) [Research](#) [Astronomical Data](#) [Services](#) [Sky](#) [WOT Safe Search](#) [x]

### [Welcome to the US National Virtual Observatory](#)

Member of the International **Virtual Observatory Alliance** · [ivoa](#) · [Privacy Policy](#) | [Public Data Access Policy](#) | [Acknowledging NVO ...](#)

[The nvo book](#) - [News Archives](#) - [Faq](#) - [Behind the scenes](#)

[us-vo.org/](#) - [Cached](#) - [Similar](#) -

### [International Virtual Observatory Alliance](#)

IVOA logo. International **Virtual Observatory Alliance**. About IVOA · [Members](#) · [Contacts](#) · [IVOA Executive](#) · [Working Groups](#) · [Documents and Standards ...](#)

[www.ivoa.net/](#) - [Cached](#) - [Similar](#) -

### [Purpose & Goals - Astronomical Spectroscopy and Virtual ...](#)

... spectroscopy will be facing in the coming years, and to identify how the unique capabilities intrinsic to the **Virtual Observatory** concept can meet them. ...

[esavo.esa.int/SpectroscopyAndVOWorkshopMarch2007/](#) - [Cached](#) - [Similar](#) -

### [European Virtual Observatory](#)

19 May 2009 ... The EURO-VO project aims at deploying an operational **Virtual Observatory** (VO) in Europe. Its objectives are technology take-up and VO ...

[www.euro-vo.org/](#) - [Cached](#) - [Similar](#) -

### [SkyView Virtual Observatory](#)

A Virtual Telescope from NASA's High Energy Astrophysics Archive Research Center.

[Where Do I Find](#) - [Latest](#) - [Archive](#) - [SkyView Blog](#)

[skyview.gsfc.nasa.gov/](#) - [Cached](#) - [Similar](#) -

### [The National Virtual Observatory \(NVO\)](#)

21 Jun 2006 ... Welcome to the education site of the National **Virtual Observatory!**

Revolutionary: The NVO is a revolutionary new astronomy project. ...

[virtualobservatory.org/](#) - [Cached](#) - [Similar](#) -

### [Virtual Observatory - Wikipedia, the free encyclopedia](#)

14 Aug 2009 ... A **virtual observatory** (VO) is a collection of interoperating data archives and software tools which utilize the internet to form a ...

[en.wikipedia.org/wiki/Virtual\\_Observatory](#) - [Cached](#) - [Similar](#) -

### [Virtual Observatory India](#)

**Virtual Observatory** India.

[vo.iucaa.ernet.in/](#) - [Cached](#) - [Similar](#) -

### [Aus-VO - The Australian Virtual Observatory](#)

The Australian **Virtual Observatory** (Aus-VO) will be a facility that provides a distributed, uniform interface to the data archives of Australia's major ...

[aus-vo.org/](#) - [Cached](#) - [Similar](#) -

### [AstroGrid](#)

AstroGrid is the doorway to the **Virtual Observatory** (VO). We provide a suite of desktop ... STARTED, Read a little about the **Virtual Observatory** ...

[www.astrogrid.org/](#) - [Cached](#) - [Similar](#) -



## Links

### Applications (Please add new links by editing this page)

<a href="#">NVO Portal Services</a>	<a href="#">US National Virtual Observatory</a>
<a href="#">DataScope</a>	<a href="#">Broadcast query</a>
<a href="#">RVS</a>	<a href="#">Remote Visualization System</a>
<a href="#">VOPlot - VOIndia</a>	<a href="#">A tool for visualizing astronomical data</a>
<a href="#">TOPCAT</a>	<a href="#">Tool for OPerations on Catalogues And Tables</a>
<a href="#">STILTS</a>	<a href="#">Command-line tools for table/VOTable manipulation</a>
<a href="#">Treeview</a>	<a href="#">A viewer for hierarchical structures</a>
<a href="#">NOAO VOTool</a>	<a href="#">A VOTable Visualization and Editing Tool</a>
<a href="#">CDS Aladin</a>	<a href="#">Image and Catalogue tool</a>
<a href="#">Bell Labs Mirage</a>	<a href="#">Multi-dimensional visualization of data from VOTable</a>
<a href="#">ESA VOSpec</a>	<a href="#">A tool to handle VO compliant spectra through SSAP</a>
<a href="#">VOSED</a>	<a href="#">A tool for building Spectral Energy distributions</a>
<a href="#">VODesktop</a>	<a href="#">A resource-centered desktop client for VO: includes VOExplorer, Query and Task Runner, Astroscope, Myspace Browser</a>
<a href="#">VisIVO</a>	<a href="#">A Visualisation Interface to the Virtual Observatory</a>
<a href="#">A list of Visualization Tools</a>	<a href="#">VOTech Project DS6 survey</a>
<a href="#">A Study On Existing Tools</a>	<a href="#">VOTech Project</a>
<a href="#">China VO VOfliter</a>	<a href="#">VOTable Filter for OpenOffice Calc</a>
<a href="#">VOTable2XHTML</a>	<a href="#">XSLT Stylesheet for VOTable to HTML</a>
<a href="#">SPLAT</a>	<a href="#">Spectral Analysis Tool</a>
<a href="#">SAADA</a>	<a href="#">Auto-Configurable Database Generator</a>
<a href="#">Octet</a>	<a href="#">CVO Observation Catalog Exploration Tool</a>
<a href="#">NOAO NVO Portal</a>	<a href="#">NOAO Image Visualization Discovery Tool</a>
<a href="#">NOAO WCSFixer</a>	<a href="#">The NOAO Web-enabled IRAF Plate Solver</a>
<a href="#">VO-CLI</a>	<a href="#">Command-line Tools for the VO</a>
<a href="#">AR Commandline</a>	<a href="#">Python commandline VO tools</a>
<a href="#">VOStat - VOIndia</a>	<a href="#">A tool for statistical analysis of astronomical data</a>
<a href="#">VOCat - VOIndia</a>	<a href="#">A catalog data interface tool</a>

### Applications Infrastructure

<a href="#">Astro Runtime</a>	<a href="#">Middleware that makes it simple to call VO services from programs and science scripts</a>
<a href="#">Common Execution Architecture (CEA)</a>	<a href="#">A methodology and toolkit for VO enabling legacy applications by publishing them as web services</a>

### Libraries and Parsers



- Software
- Registries
- Tutorials
- IVOA Standards =>

- Data Centres
- Overview
- Partners
- Work Packages
- Tutorials

- Operations
- Overview
- Partners
- Work Packages

- About
- Introduction
- Presentations
- Structure
- Partners
- News
- Calendar
- Vacancies
- Glossary
- Q&A
- EC Support

- Press Room
- Media

- Links
- Search
- Euro-VO Internal =>
- AVO site(2002-2004) =>
- ASTROVIRTEL site (2000-2002) =>
- Contacts



**Application / Version (in alphabetical order)**

- [Aladin](#)  
v6.011 (September 2009)
- [Datscope](#)  
v2.1 (March 2007)
- [Montage](#)
- [Octet](#)
- [Open SkyQuery](#)
- [SkyView](#)
- [SPLAT](#)  
3.9.0 (May 2009)
- [Specview](#)  
2.14.4 (August 2009)
- [TOPCAT/STILTS](#)  
3.4-3/2.0-5 (July 2009/October 2009)
- [VisIVO](#)  
1.5.7.1 (May 2009)
- [VOConvert](#)  
1.0 (June 2006)
- [VODesktop](#)  
1.3 (June 2009)
- [VOEventNet](#)
- [VOPlot](#)  
1.5 (May 2009)
- [VOStat](#)  
1.1 (November 2008)
- [VOSA](#)  
1.0.2 (March 2009)
- [VOSED](#)  
1.3 (July 2009)
- [VOServices \(Footprint, Spectrum, Filters, ...\)](#)  
2.1.0.0
- [VOSpec](#)  
V5.5 (September 2009)
- [WCSFixer](#)

[Link to the old software page](#)

**IVOA Applications Working Group**

**Functionality**

- Search for Images:**  
[Aladin](#), [Datscope](#), [SkyView](#), [VODesktop](#)
- Search for Spectra:**  
[Aladin](#), [Datscope](#), [SPLAT](#), [Specview](#), [VOServices](#), [VOSpec](#)
- Search for Catalogues:**  
[Aladin](#), [Datscope](#), [TOPCAT](#), [VODesktop](#)
- Image visualisation:**  
[Aladin](#), [SkyView](#)
- Spectra visualisation:**  
[SPLAT](#), [Specview](#), [VOServices](#), [VOSpec](#)
- Catalogues visualisation:**  
[Aladin](#), [TOPCAT](#), [VOPlot](#)
- Cross-correlation:**  
[Aladin](#), [Open SkyQuery](#), [STILTS](#), [TOPCAT](#)
- Scatter, 3D plots and histograms:**  
[TOPCAT](#), [VOPlot](#)
- Statistics:**  
[VOStat](#)
- Footprint Service:**  
[Aladin](#), [VOServices](#)
- Table format conversion:**  
[TOPCAT](#), [VOConvert](#)
- Filter curves:**  
[VOServices](#)
- SED building:**  
[VOSA](#), [VOSED](#), [VOSpec](#)
- Fixing WCS:**  
[Aladin](#), [WCSFixer](#)

**Other VO-compliant tools**

- [DS9](#): Image visualisation
  - [GOSSIP](#): SED fitting
  - [Mirage](#): Table visualisation
  - [VirGO](#): Search for Images and Spectra
- Browse the Registries**
- [EURO-VO Registry](#)
  - [AstroGrid Registry](#)
  - [NVO Registry](#)
- Manuals, Tutorials, How-tos**
- [Aladin User manual](#)
  - [Datscope how to](#)
  - [Montage help](#)
  - [Open SkyQuery help](#)
  - [SkyView documentation](#)
  - [Specview examples](#)
  - [SPLAT documentation](#)
  - [STILTS documentation](#)
  - [TOPCAT documentation](#)
  - [VisIVO how to](#)
  - [VODesktop how to](#)
  - [VOSpec User manual](#)



## More issues

- “All-VO” queries should be more complex and allow users to search on parameters like exposure time, observing date, position angle, etc. In other words, available metadata should be exposed to searches; if more are needed they should be made mandatory

Involved WGs: **DAL, Applications, DM, VOQL**

- Positional cross-matches are too simplistic; more sophisticated methods exist and should be included in VO tools. Related to SED building for large number of sources

Involved WGs: **Applications, DAL, DM**



## More issues

- VO tools should be made more robust. This is especially true now that many VO projects are holding Workshops, Schools, and “VO days” to “educate” the astronomical community on using the VO to do research  
Involved WG: **Applications**



## Science Input in the IVOA

- This is a first start; but this type of session will become a standard feature of IVOA Interops
- There will also be a “Science Input Assessment” session at the end, where the Take-Up Committee will take a look at what happened from the point of view of the science requirements
- A more formal, more permanent process needs to be set-up. This is under discussion within the Exec