Virtual Observatory (VO)
An Introduction

Sudhanshu Barway

South African Astronomical Observatory (SAAO), Cape Town

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About this presentation

- What is a Virtual Observatory?
- How does it work?
- VO Tools and applications
- VO-enable research
- Introduction to VO tools
- VO at SAAO
- Summary

What's a Virtual Observatory?

What's a Virtual Observatory?

First, a real observatory-

- Telescope (optical, infrared, ultra-violet, radio, x-ray)
- Detectors, instruments (cameras, spectrographs, photometers)
- Site (ground, space)
- Computers (telescope control, instrument control, data acquisition, data processing, data storage [archive])
- Astronomers, technicians, engineers, support staff, …

What's a Virtual Observatory?

Virtual observatory -

- Telescope → digital data accessible on the Internet
- Detectors, instruments → computer programs
- Site → the user's desktop
- Computers (telescope control, instrument control, data acquisition, data processing, data storage)
- Astronomers, technicians, engineers, support staff, …

What's a Virtual Observatory?

- A suite of software applications on a set of computers that allows users to uniformly find, access, and use resources (data, software, document, and image products and services using these) from a collection of distributed product and service providers. (B. Weigel, GMU; ViRBO)
- A virtual observatory is a collection of interoperating data archives and software tools which utilize the internet to form a scientific research environment in which astronomical research programs can be conducted.

  -Wikipedia
- A collection of integrated astronomical data archives and software tool that utilize computer networks to create an environment in which research can be conducted. (answers.com)

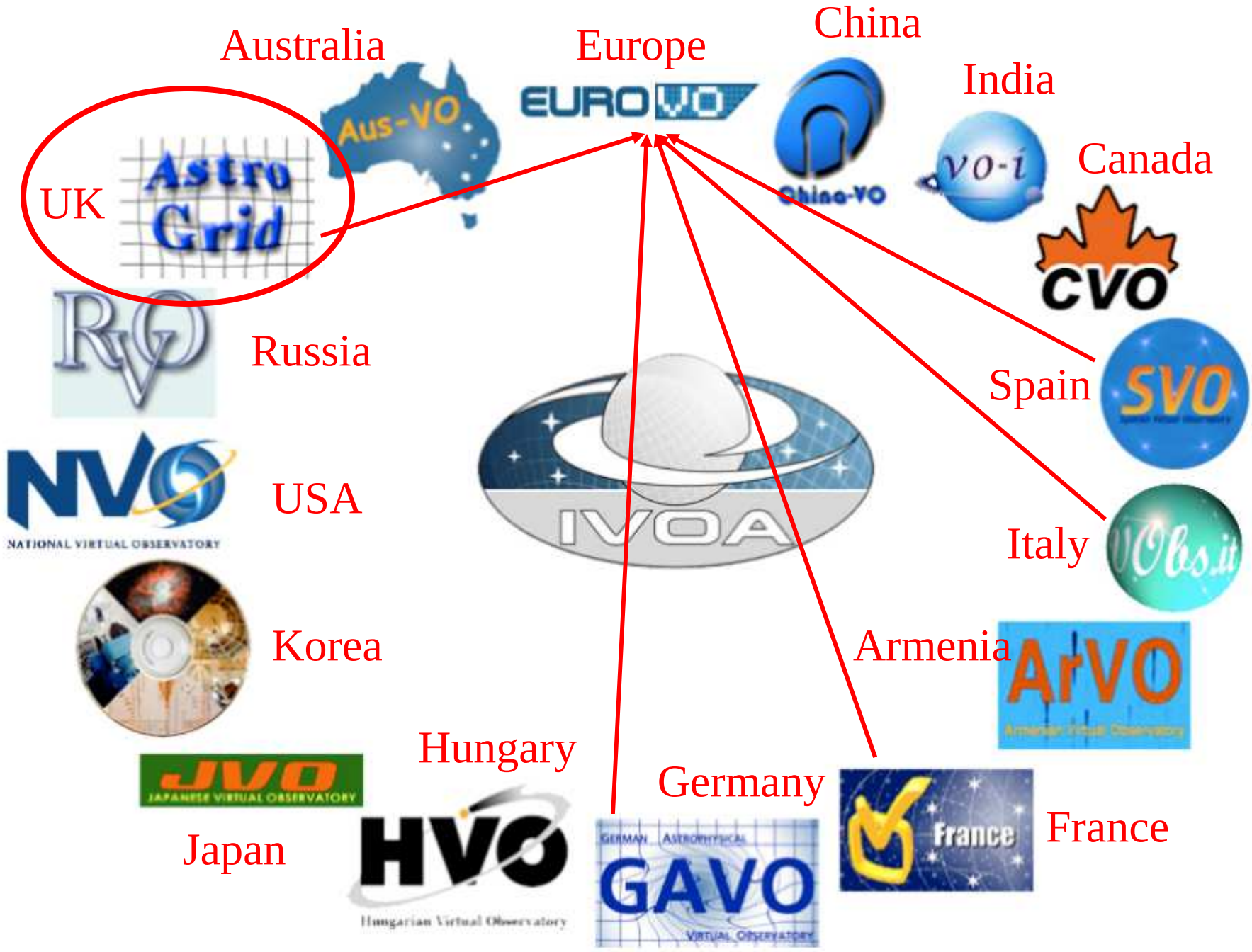
The Virtual Observatory…

- Provides observers/astronomers with access to all archived astronomical data as if it were stored on the local computer
- Provides tools to locate and retrieve data of interest, regardless of where it is stored
- Provides tools to compare data from different real telescopes and instruments
- Provides computational services and data management services on a supercomputer scale

All of the above requires the various VO players to speak the same language
Need to define VO standards and protocols

International Virtual Observatory Alliance (IVOA)

16 Member Organizations



Without VO

n services,
n interfaces

archive 1

archive 2

archive 3

survey 1

survey 2

survey 3

service 3

service 2

service 1

With VO

n services,
“1” interface

archive 1

archive 2

archive 3

survey 1

survey 2

survey 3

VO

service 3

service 2

service 1

Images cutouts in many wavelengths

National Virtual Observatory

VIM: Visual Integration and Mining

*Restart Vim | NVO Portal Home | Help | Contact Us

Hosted By

Position list is from: **Arp peculiar galaxies that are also members of the Revised Shapley-Ames Catalog of Bright Galaxies. Correlations by Al Kelly from tables assembled by Dennis Webb, originally to support the Johnson Space Center Astronomical Society Texas Star Party 1997 Supernova Campaign.**

Bench has 90 sources: below is from 1 to 90

sources | View All Files | at='CSV')

sources					optical		skyview				
RightAscension	Declination	VIM_SOURCE_ID	Type	Mag	SDSSr	DSS2B	RASS	FIRST	SUMSS	2MASSJ	IRIS60
190.52500 12h 42m 6.00s	32.53333 +32d 31m 60.0s	Arp281	SB(s)d	9.8							
190.92500 12h 43m 42.00s	11.55000 +11d 33m 0.0s	Arp116	E2	9.8							
190.92500 12h 43m 42.00s	16.40000 +16d 23m 60.0s	Arp189	SA(rs)c	11.4							
191.32500 12h 45m 18.00s	27.13333 +27d 07m 60.0s	Arp163	SB(s)0/ap	13.1							
192.95000 12h 51m 48.00s	25.78333 +25d 46m 60.0s	Arp159	SBcd?p sp	13.0							
194.75000 12h 59m 0.00s	34.86666 +34d 51m 60.0s	Arp266	SB(s)m:	12.8							
195.97500 13h 03m 54.00s	-11.48333 -11d 29m 0.0s	Arp176	S0 pec	13.2							
201.37500 13h 25m 30.00s	-43.01667 -43d 00m 60.0s	Arp153	S0 pec	7.9							
202.47500 13h 29m 54.00s	47.20000 +47d 12m 0.0s	Arp085	SA(s)bc p	9.0							

hover mouse to enlarge

This page is http://envoy5.cacr.caltech.edu:8888/?benchID=keep/abell

Find Catalog Objects Near My Sky Positions

Search radius, arcseconds: 20

Catalog: The NASA/IPAC Extragalactic Database

Verbosity: minimal

Threads: multi(10)

New Table Name:

Start Proximity Search

```
# read in URL for abell table
sourcesURL.run(bench, sourcesURL='http://envoy

# some dss cutouts, 400 pixels across
skyview.run(bench, isize=400, surveylist=['DSS2B',

# rosat broadband intensity cutout images
skyview.run(bench, isize=60, surveylist=['RASS'],

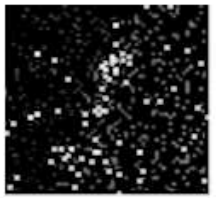
# try the rosat faint sources
proxsearch.run(bench, survey='ROSAT/FSC', sr=

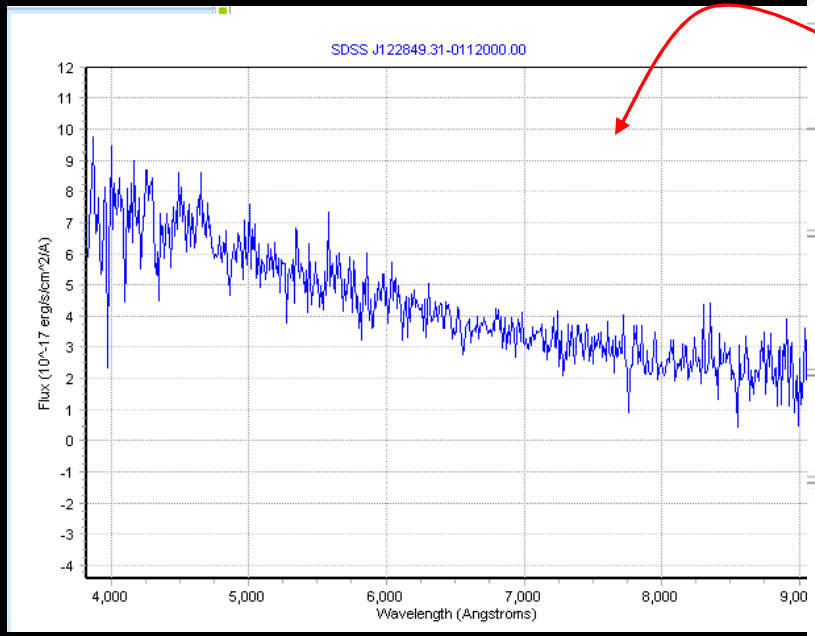
# some more cutouts in the xray
```

47

	dss2		more_xray	rassfsc			rosat
RCE_ID	DSS2IR	DSS2B	Count	hardness_ratio_1	name	count_rate	RASS
			1	1.00	1RXS J003940.0+211519	7.401e-02	
			1	0.97	1RXS J004039.4+180916	4.281e-02	
				0.68	1RXS J004036.1+181638	4.600e-02	
					1RXS J004147.5+211832	3.656e-02	
					1RXS J004133.3+212844	3.490e-02	
					1RXS J004444.6+202243	3.426e-02	
					1RXS J004330.7+203734	1.641e-02	
					1RXS J004736.9+202526	1.860e-02	
					1RXS J004635.0+201554	3.737e-02	
					1RXS J004625.8+201305	2.450e-02	
					1RXS J004635.5+202726	4.046e-02	
					1RXS J004444.6+202243	3.426e-02	
					1RXS J004949.3+242707	1.686e-01	
					1RXS J005158.1+215918	1.851e-02	
					1RXS J005353.1+221750	2.406e-02	

X-ray

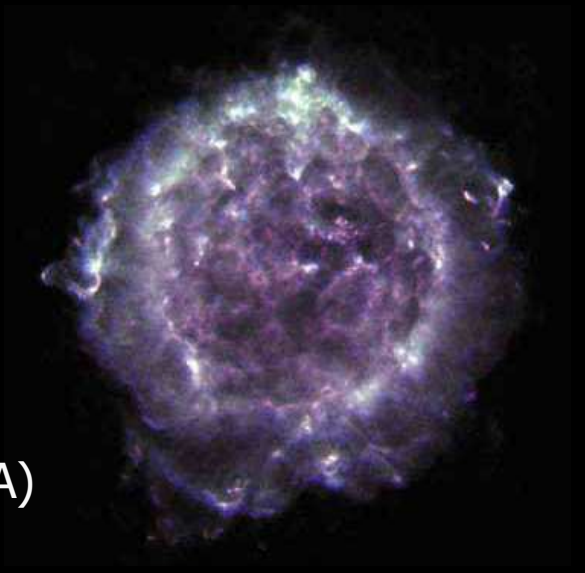




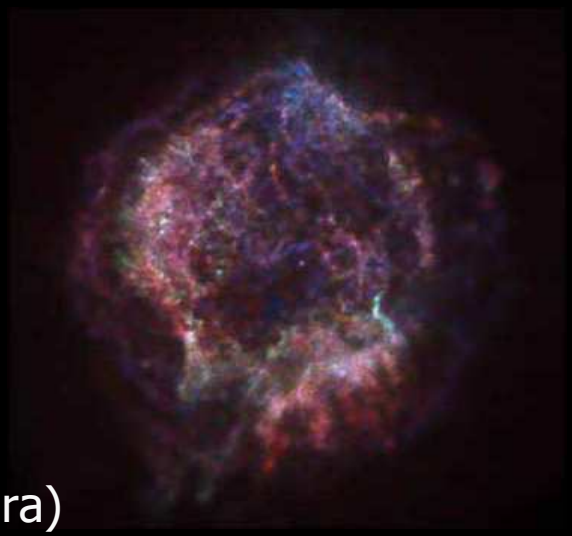
	sdss-spec	
MinAxis	AcRef	TargetName
		SDSS J122849.31-0112000.00
52.9		SDSS J135516.06+59354000.00
14.3 15.5		
19.9		SDSS J123121.78+57342000.00
38.8		
26.7		SDSS J115610.33+60360000.00 SDSS J115610.33+60360000.00

Data integration

Optical (HST) CasA supernova remnant

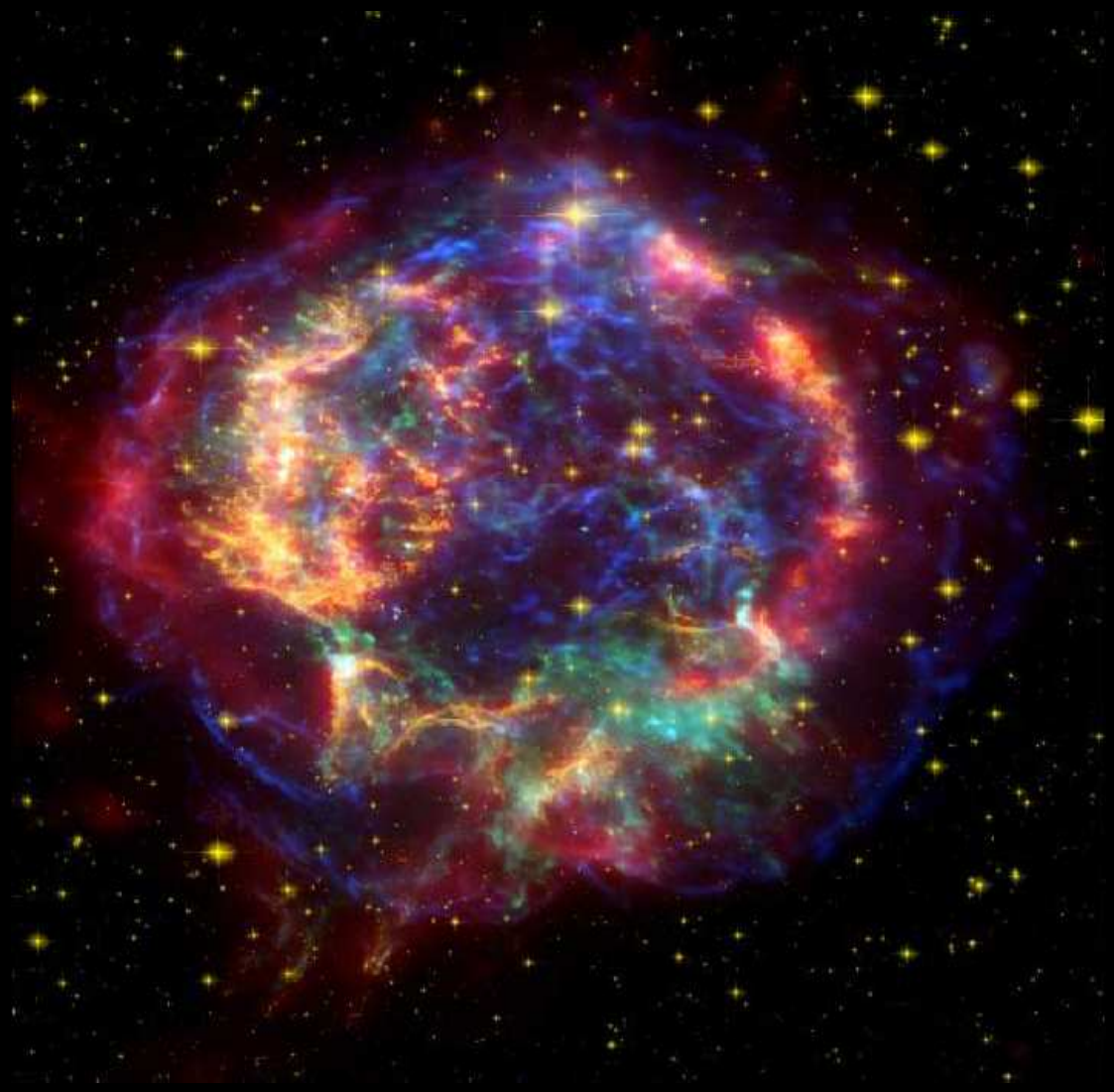


Radio (VLA)



X-ray (Chandra)

Data integration



Why not just use Google?

- Very little astronomical data is text-based
- Text-based searches are unstructured
- Need to get inside data archives and databases to find the actual measurements and their uncertainties
- Google just leads you to web sites; the VO finds data and delivers it

How does it work?

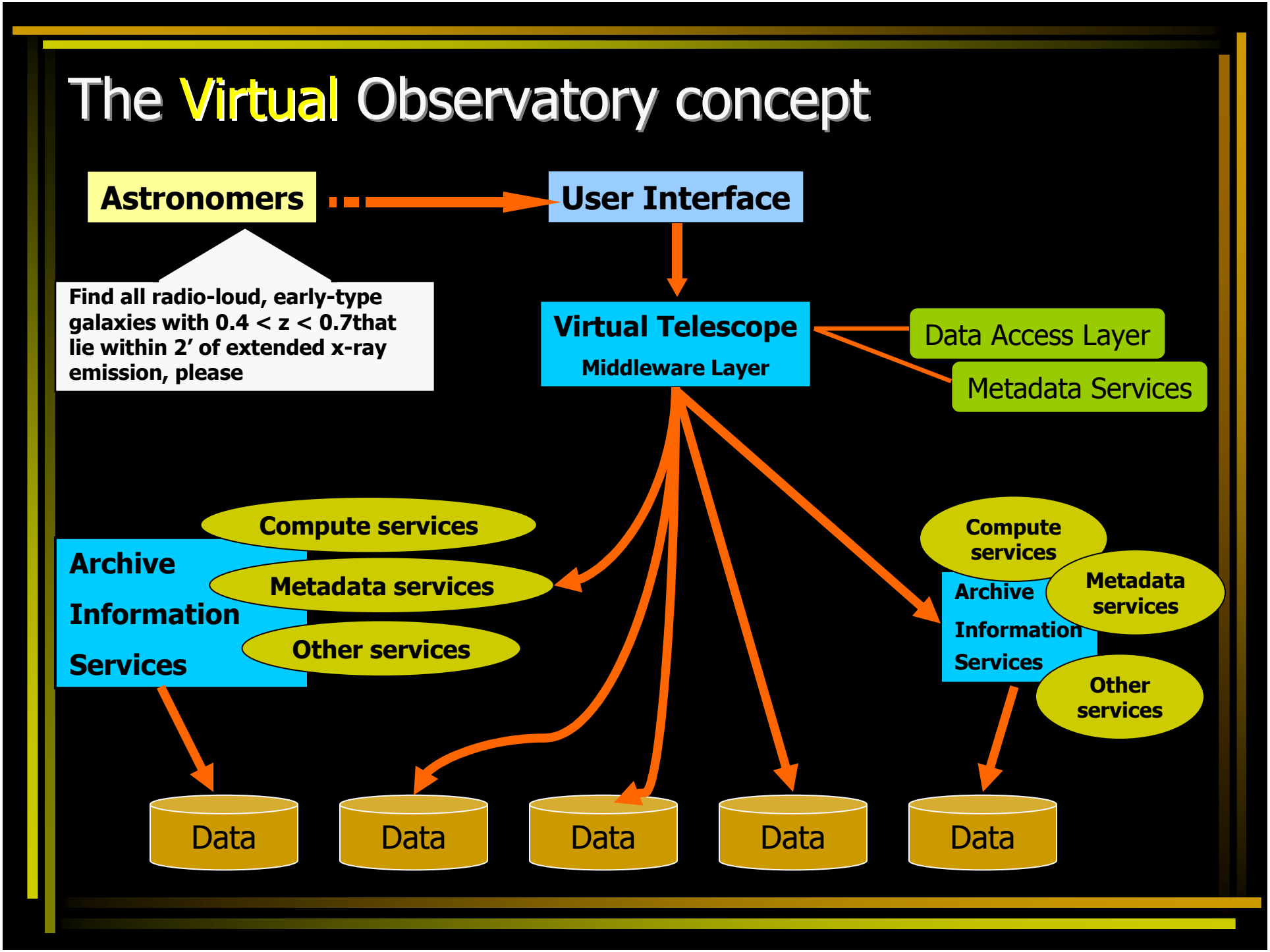
How Do You Build a Virtual Observatory?

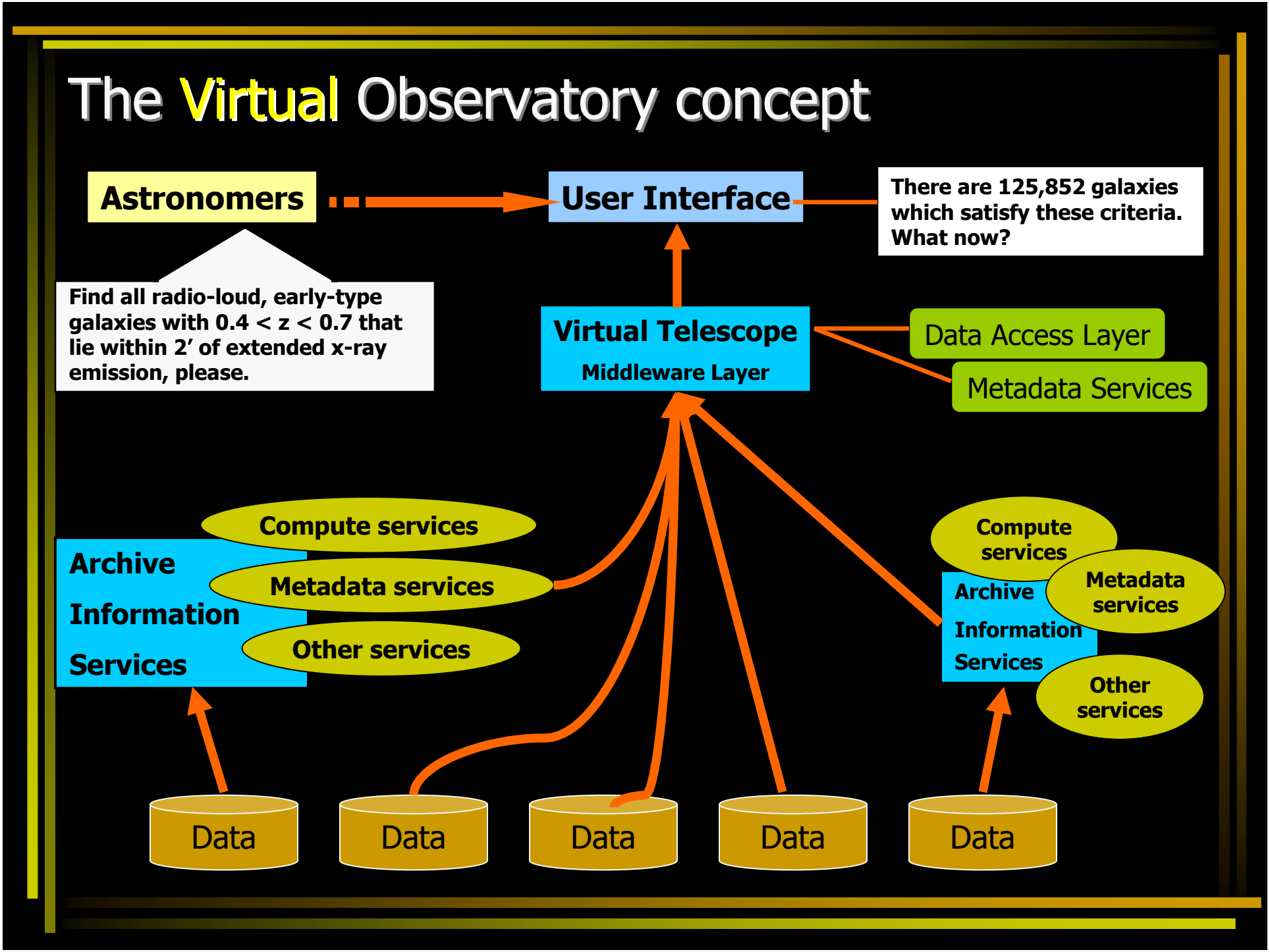
Good news- do not have to invent everything from scratch

- Build on existing data archives, on-line catalogs
- Exploit advances in computer and networking technology
- Utilize new grid technologies for high performance computing

But there are challenges-

- Metadata standards
- Data quality and completeness
- Cross-correlation of TB-scale databases at different locations
- Visualization of large parameter spaces


The Virtual Observatory concept
Astronomers
User Interface
Find all radio-loud, early-type galaxies with 0.4 < z < 0.7that lie within 2′ of extended x-ray emission, please
Virtual Telescope
Middleware Layer
Data Access Layer
Metadata Services
Compute services
Archive Information Services
Metadata services
Other services
Compute services
Archive Information Services
Metadata services
Other services
Data
Data
Data
Data
Data


The Virtual Observatory concept
Astronomers
User Interface
There are 125,852 galaxies which satisfy these criteria. What now?
Find all radio-loud, early-type galaxies with 0.4 < z < 0.7 that lie within 2′ of extended x-ray emission, please.
Virtual Telescope
Middleware Layer
Data Access Layer
Metadata Services
Compute services
Archive Information Services
Metadata services
Other services
Compute services
Archive Information Services
Metadata services
Other services
Data
Data
Data
Data
Data

VO Standards & Protocol

VO Standards & Protocol

VOTable -
The VOTable is an XML standard for representing tabular data.

SDSS ID	RA	Dec
587722952230175145	236.35011657	-0.59824048
587722952230175173	236.36935401	-0.57445286
.....	.....	.....
.....	.....	.....

VO Standards & Protocol

This XML file does not appear to have any style information associated with it. The document tree is shown below.

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<VOTABLE version="1.1" xsi:noNamespaceSchemaLocation="http://www.ivoa.net/xml/VOTable/VOTable/v1.1">
 <RESOURCE name="imported table">
  <TABLE name="imported table">
   <DESCRIPTION>
    http://cas.sdss.org/dr5/en/tools/search/form/form.asp: select top 10 p.objid, p.ra, p.dec from galaxy p, specobj s where p.objid=s.bestobjid and p.r lessThan 17
   </DESCRIPTION>
   <FIELD name="ID" id="col1" datatype="char" ucd="meta.id" arraysize="*"/>
   <FIELD name="RA" id="col2" datatype="char" ucd="pos.eq.ra" arraysize="*"/>
   <FIELD name="Dec" id="col3" datatype="char" ucd="pos.eq.dec" arraysize="*"/>
   <DATA>
    <TABLEDATA>
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      <TD>587722952230175145</TD>
      <TD>236.35011657</TD>
      <TD>-0.59824048</TD>
     </TR>
     <TR>
      <TD>587722952230175173</TD>
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     <TR>
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      <TD>238.20399508</TD>
      <TD>-0.52655693</TD>
     </TR>
     <TR>
```

VO Standards & Protocol

- VOTable -
  The VOTable is an XML standard for representing tabular data.

- Cone Search -

  This protocol defines a simple query protocol for retrieving records from a catalog of astronomical sources. The query describes sky position and an angular distance, defining a cone on the sky.

- SIAP - Simple Image Access protocol

  This specification defines a protocol for retrieving image data from a variety of astronomical image repositories through a uniform interface.

Many more – FITS, ADQL, UCD, DAL…

VO Tools And Services

- Web-based applications
- Stand-alone applications
- Scripting and programming environments –

  IDL, java, Python and IRAF

VO Tools And Services

- Plotting – provide variety of display options

includes some analysis facilities – statistics, filtering, corssmatching

VOPlot	http://vo.iucaa.ernet.in/~voi/voplot.htm	(VO-India)
TOPCAT	http://www.star.bris.ac.uk/~mbt/topcat/	(Astrogrid)

- Visualization – image display, catalogue overlay …….

Aladin	http://aladin.u-strasbg.fr/aladin.gml	(CDS)
Mirage	http://cm.bell-labs.com/who/tkh/mirage/index.html	

VO Tools And Services

- Data discovery – locate (find), compare & retrieve data from variety of VO-accessible data archive… one-stop shopping

Datascope (NVO)	http://heasarc.gsfc.nasa.gov/cgi-bin/vo/datascope/init.pl
SkyView	http://skys.gsfc.nasa.gov/

- Analysis Tools – provide sophisticated analysis capabilities for making queries, cross-correlating catalogues, spectrum analysis……

Open SkyQuery	http://openskyquery.net/Sky/skysite/browse/Browse.aspx
VOSpace	http://esavo.esa.int/vospecapp
VOSed	http://sdc.laeff.inta.es/vosed/jsp/form_search.jsp
SPLAT	http://star-www.dur.ac.uk/~pdraper/splat/splat-vo/

MySpace

PLASTIC

Helioscope

Topcat

EURO-3D

Astro Runtime

VizieR

VOSpec

Web Service

Yafit

VOEventNet

Workflow

Specview

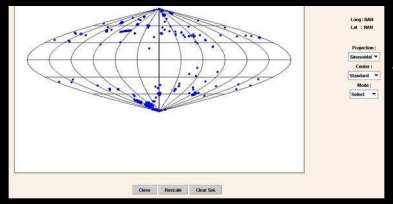
SIA

Simbad

representative and by no means complete!

Aladin

Astrogrid Workbench



VOPlot

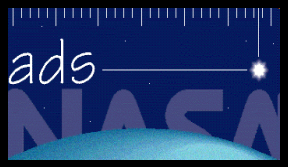
VOTable

VisIVO

Open SkyQuery

SPLAT

ADS



Astroscope

STILTS

Registry

Datascope

SSA

VOSED

VO-enabled research

Current VO-based research

- Studies of merging galaxies
- Automated supernova detection
- Environments of starburst galaxies and relationship of starbursts with active galaxies
- Quasar discovery and analysis
- Search for clusters of galaxies and distance estimation
- Structure of the Milky Way halo
- Infrared properties of radio galaxies
- Super star clusters in nearby galaxies

Current VO-based research

Some Examples -

- Using VO tools to investigate distant radio starburst hosting obscured AGN in the HDF(N) region, Richards et al., A&A, 2007, 472, 805
- Albus 1: a very bright White Dwarf candidate, Caballero & Solano, ApJ, 665, L151 (2007)
- Flare produ http://www.euro-vo.org/pub/fc/papers.html ive regions, Dalla, Fletcl http://www.us-vo.org/pubs/notable_pubs.cfm
- Radio-loud Narrow-Line Type 1 Quasars, Komosaa et al., AJ, 132, 531 (2006)
- Luminous AGB stars in nearby galaxies. A study using VO tools, Tsalmantza et al., A&A, 447, 89 (2006)
- Discovery of optically faint obscured quasars with Virtual Observatory tools, Padovani et al., 2004, A&A, 424, 545

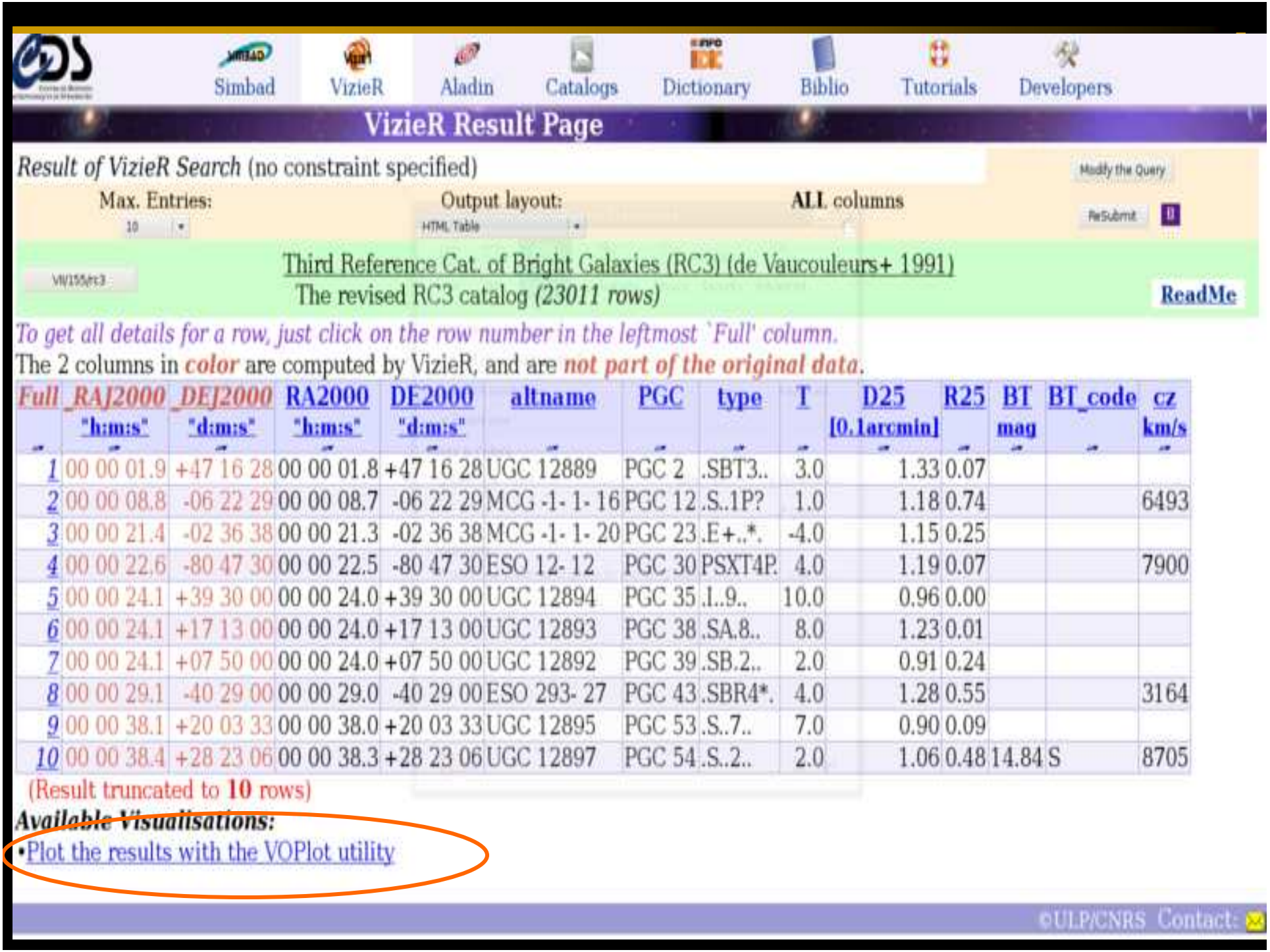
Introduction to VO Tools

- VOPlot
- Aladin
- TOPCAT
- VO Desktop
- VOStat

VOPlot

- VOPlot is a tool for visualizing astronomical data.
- VOPlot is developed in JAVA.
- VOPlot can be used to –
  - To plot two data fields against each other
  - Display the distribution as a histogram - 3D Histogram Plot
    - Surface Plot
    - 3D Scatter Plot
- Simple transformations can be applied to data
- Simple statistical analysis

VOPlot is fully integrated with VizieR



Simbad VizieR Aladin Catalogs Dictionary Biblio Tutorials Developers

VizieR Result Page

Result of VizieR Search (no constraint specified)

Modify the Query

Max. Entries: 10 Output layout: HTML Table **ALL** columns

ReSubmit

VII/155/rc3

Third Reference Cat. of Bright Galaxies (RC3) (de Vaucouleurs+ 1991)

The revised RC3 catalog *(23011 rows)*

ReadMe

To get all details for a row, just click on the row number in the leftmost `Full' column.

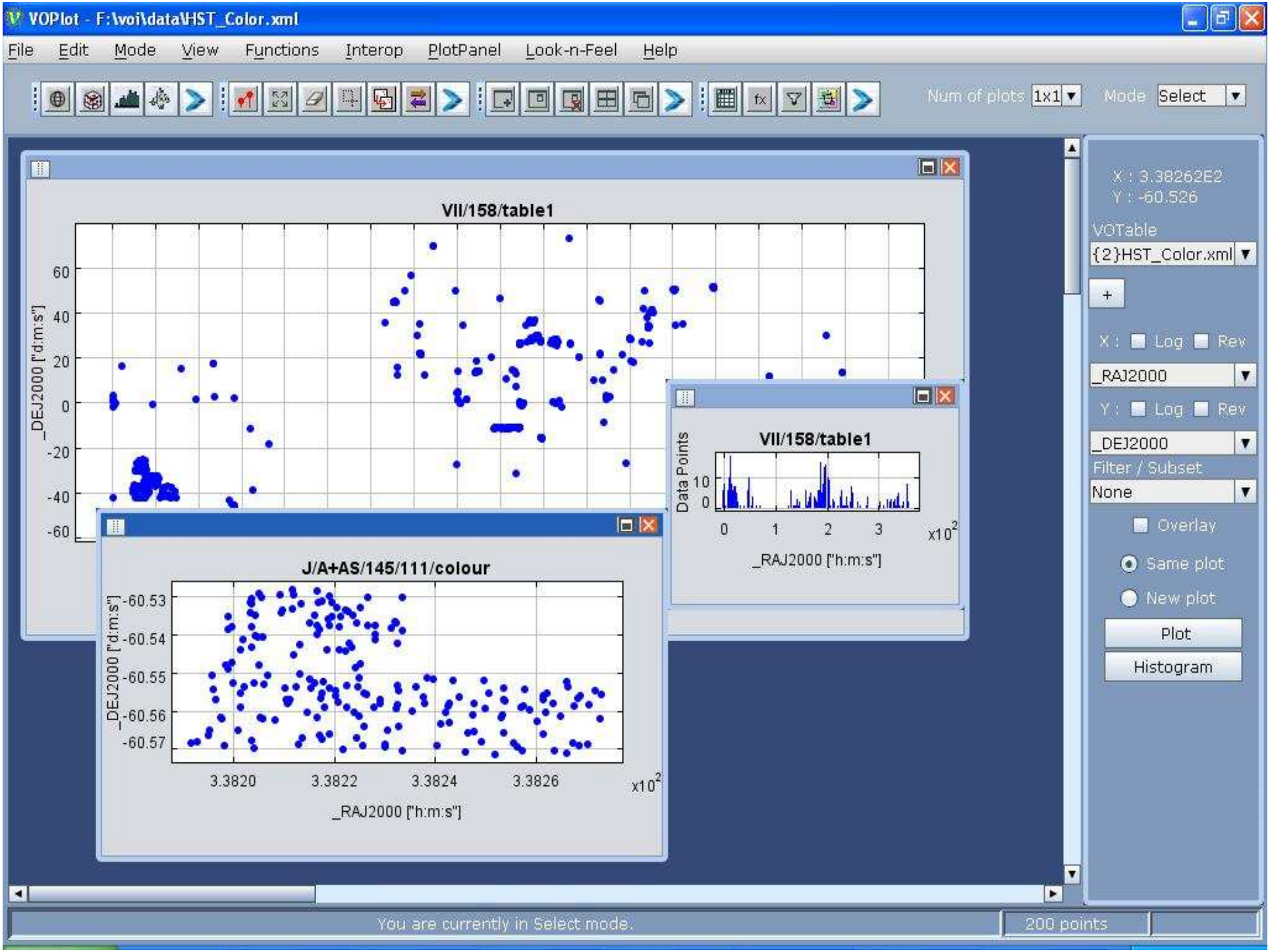
The 2 columns in **color** are computed by VizieR, and are **not part of the original data.**

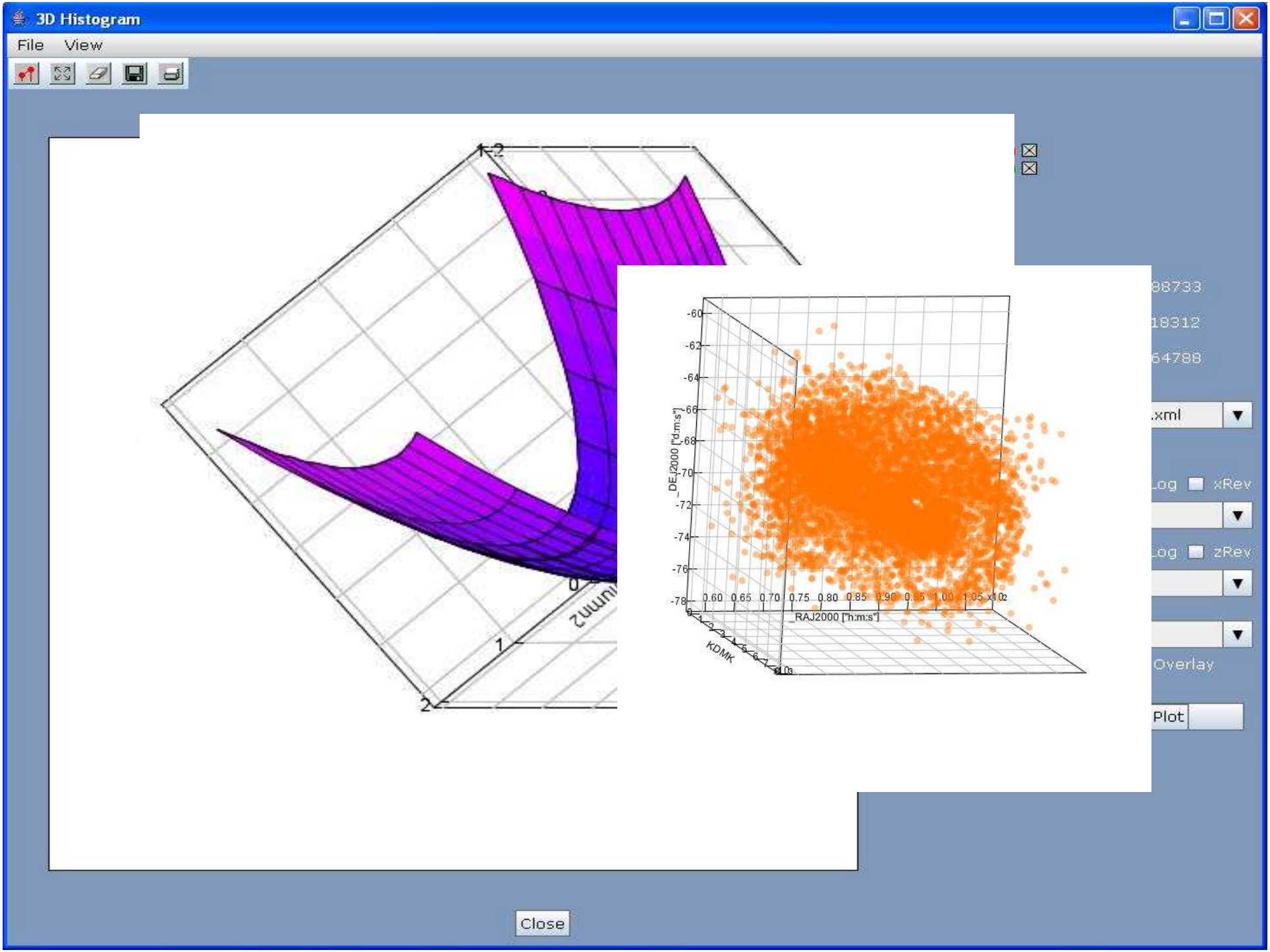
Full	_RAJ2000 "h:m:s"	_DEJ2000 "d:m:s"	RA2000 "h:m:s"	DE2000 "d:m:s"	altname	PGC	type	T	D25 [0.1arcmin]	R25	BT mag	BT_code	cz km/s
1	00 00 01.9	+47 16 28	00 00 01.8	+47 16 28	UGC 12889	PGC 2	.SBT3..	3.0	1.33	0.07			
2	00 00 08.8	-06 22 29	00 00 08.7	-06 22 29	MCG -1- 1- 16	PGC 12	.S..1P?	1.0	1.18	0.74			6493
3	00 00 21.4	-02 36 38	00 00 21.3	-02 36 38	MCG -1- 1- 20	PGC 23	.E+..*.	-4.0	1.15	0.25			
4	00 00 22.6	-80 47 30	00 00 22.5	-80 47 30	ESO 12- 12	PGC 30	PSXT4P.	4.0	1.19	0.07			7900
5	00 00 24.1	+39 30 00	00 00 24.0	+39 30 00	UGC 12894	PGC 35	.I..9..	10.0	0.96	0.00			
6	00 00 24.1	+17 13 00	00 00 24.0	+17 13 00	UGC 12893	PGC 38	.SA.8..	8.0	1.23	0.01			
7	00 00 24.1	+07 50 00	00 00 24.0	+07 50 00	UGC 12892	PGC 39	.SB.2..	2.0	0.91	0.24			
8	00 00 29.1	-40 29 00	00 00 29.0	-40 29 00	ESO 293- 27	PGC 43	.SBR4*.	4.0	1.28	0.55			3164
9	00 00 38.1	+20 03 33	00 00 38.0	+20 03 33	UGC 12895	PGC 53	.S..7..	7.0	0.90	0.09			
10	00 00 38.4	+28 23 06	00 00 38.3	+28 23 06	UGC 12897	PGC 54	.S..2..	2.0	1.06	0.48	14.84	S	8705

(Result truncated to **10** rows)

Available Visualisations:

•Plot the results with the VOPlot utility

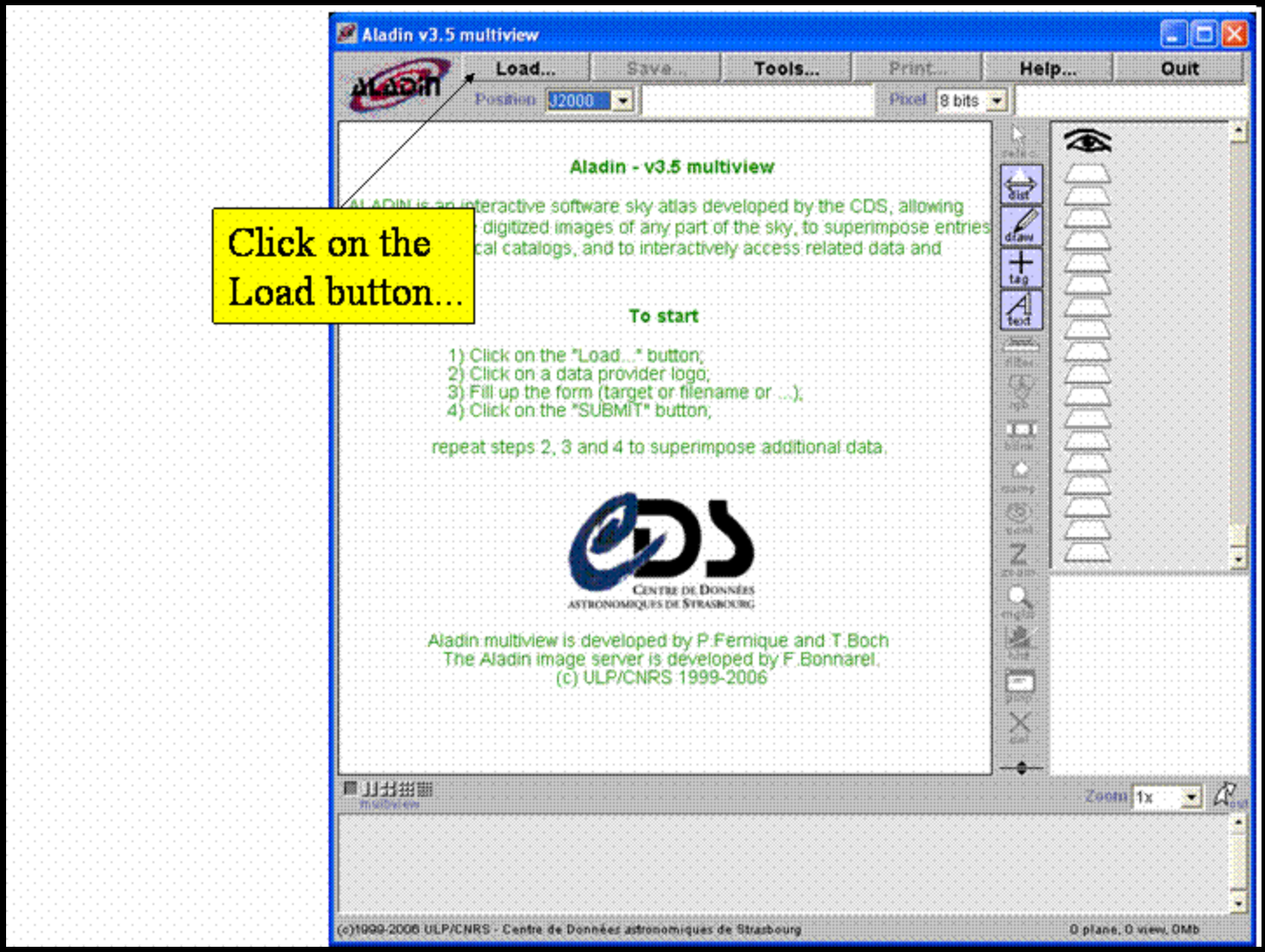

VOPlot - F:\voi\data\HST_Color.xml
File Edit Mode View Functions Interop PlotPanel Look-n-Feel Help
Num of plots 1x1
Mode Select
VII/158/table1
_DEJ2000 ["d:m:s"]
60
40
20
0
-20
-40
-60
VII/158/table1
Data Points
10
0
0 1 2 3
x10^2
_RAJ2000 ["h:m:s"]
J/A+AS/145/111/colour
_DEJ2000 ["d:m:s"]
-60.53
-60.54
-60.55
-60.56
-60.57
3.3820 3.3822 3.3824 3.3826
x10^2
_RAJ2000 ["h:m:s"]
X : 3.38262E2
Y : -60.526
VOTable
{2}HST_Color.xml
+
X : Log Rev
_RAJ2000
Y : Log Rev
_DEJ2000
Filter / Subset
None
Overlay
Same plot
New plot
Plot
Histogram
You are currently in Select mode.
200 points


3D Histogram
File
View
-60
-62
-64
-66
-68
-70
-72
-74
-76
-78
DEJ2000 ["d:m:s"]
0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00 1.05 x10^2
RAJ2000 ["h:m:s"]
KDMK
88733
18312
64788
.xml
Log
xRev
Log
zRev
Overlay
Plot
Close

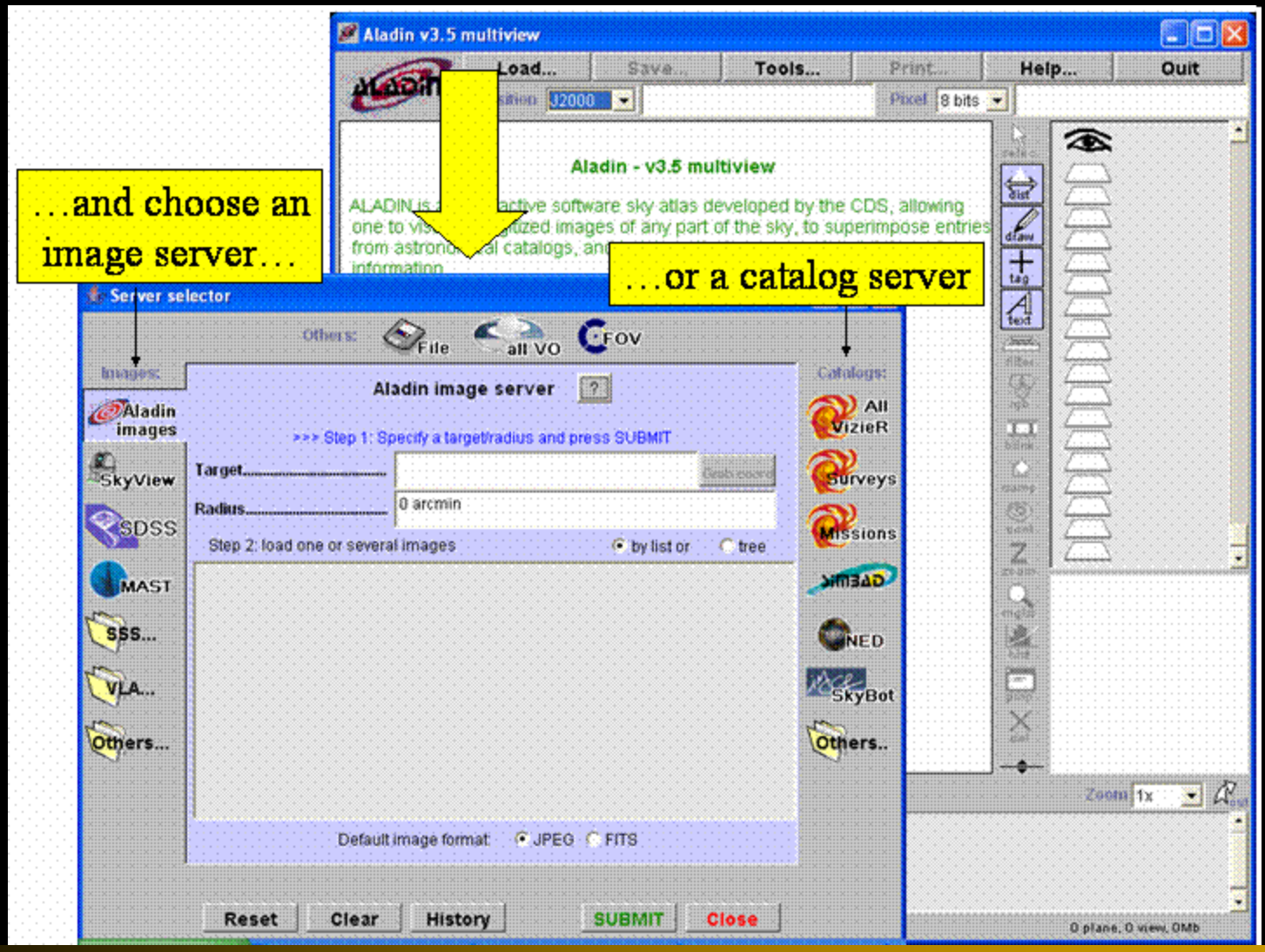
Aladin

Aladin is a VO tool allowing one to visualize images of the sky and to superimpose entries from catalogs.

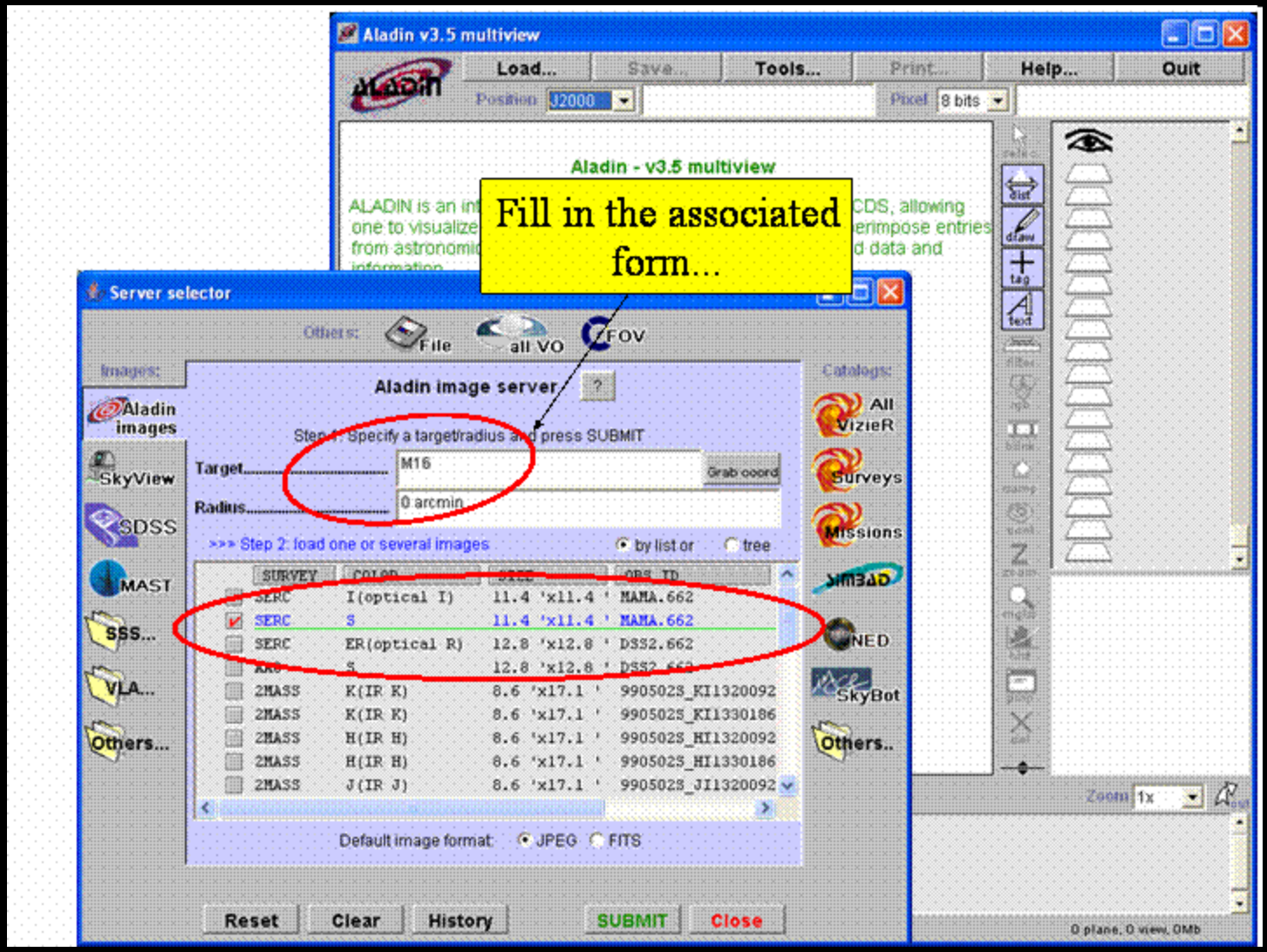
Aladin


Aladin v3.5 multiview
Load...
Save...
Tools...
Print...
Help...
Quit
Position J2000
Pixel 8 bits
Aladin - v3.5 multiview
ALADIN is an interactive software sky atlas developed by the CDS, allowing
digitized images of any part of the sky, to superimpose entries
cal catalogs, and to interactively access related data and
Click on the Load button...
To start
1) Click on the "Load..." button;
2) Click on a data provider logo;
3) Fill up the form (target or filename or ...);
4) Click on the "SUBMIT" button;
repeat steps 2, 3 and 4 to superimpose additional data.
Centre de Données astronomiques de Strasbourg
Aladin multiview is developed by P.Fernique and T.Boch
The Aladin image server is developed by F.Bonnarel.
(c) ULP/CNRS 1999-2006
Zoom 1x
(c)1999-2006 ULP/CNRS - Centre de Données astronomiques de Strasbourg
0 plane, 0 view, 0Mb

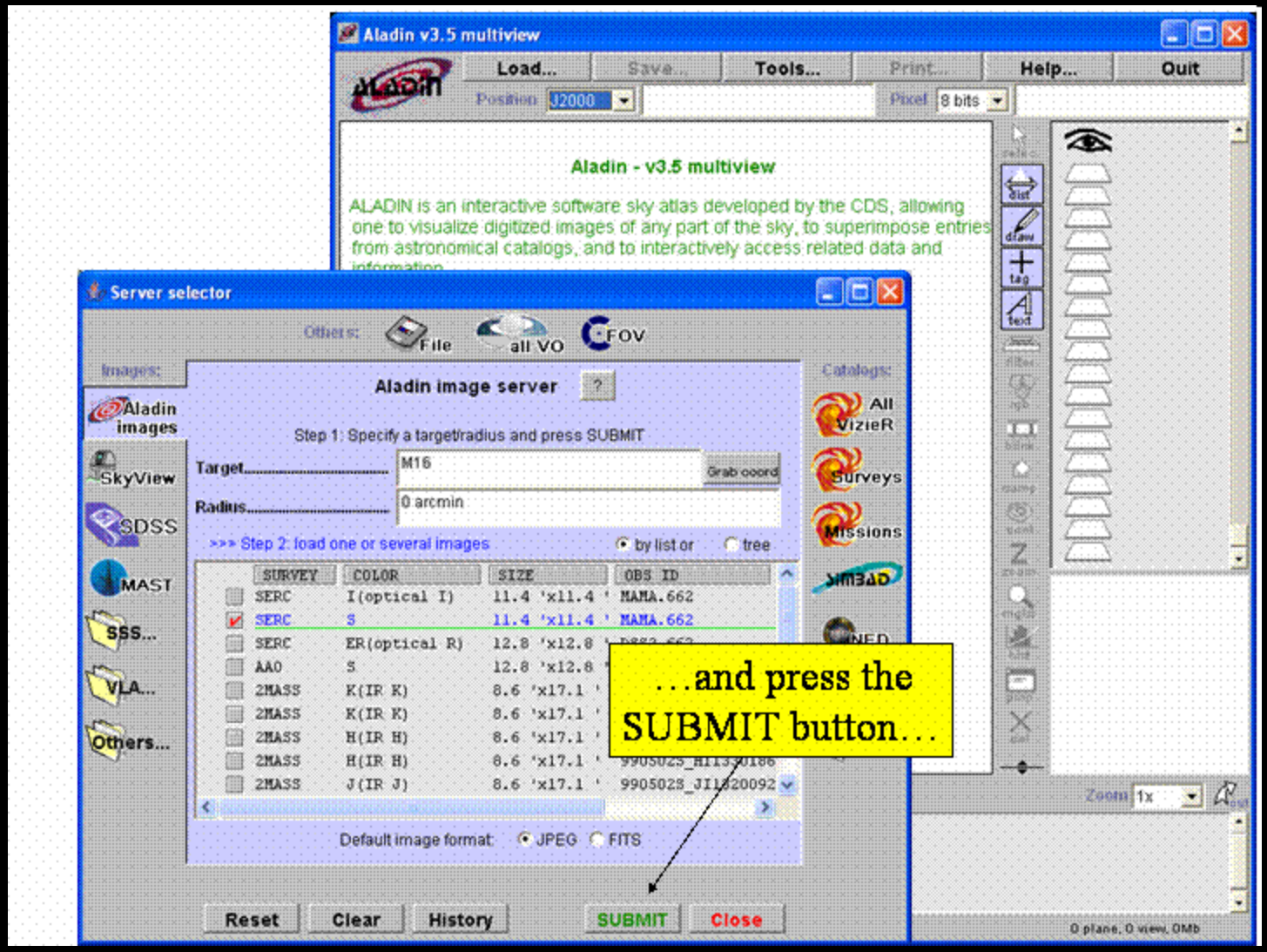
Aladin


Aladin v3.5 multiview
Load...
Save...
Tools...
Print...
Help...
Quit
J2000
Pixel
8 bits
Aladin - v3.5 multiview
…and choose an image server…
…or a catalog server
Server selector
Others:
File
all VO
FOV
Images:
Aladin images
SkyView
SDSS
MAST
SSS...
VLA...
Others...
Aladin image server
>>> Step 1: Specify a target/radius and press SUBMIT
Target
Radius
0 arcmin
Step 2: load one or several images
by list or
tree
Default image format:
JPEG
FITS
Catalogs:
All VizieR
Surveys
Missions
NED
SkyBot
Others..
Reset
Clear
History
SUBMIT
Close
Zoom
1x
0 plane, 0 view, 0Mb

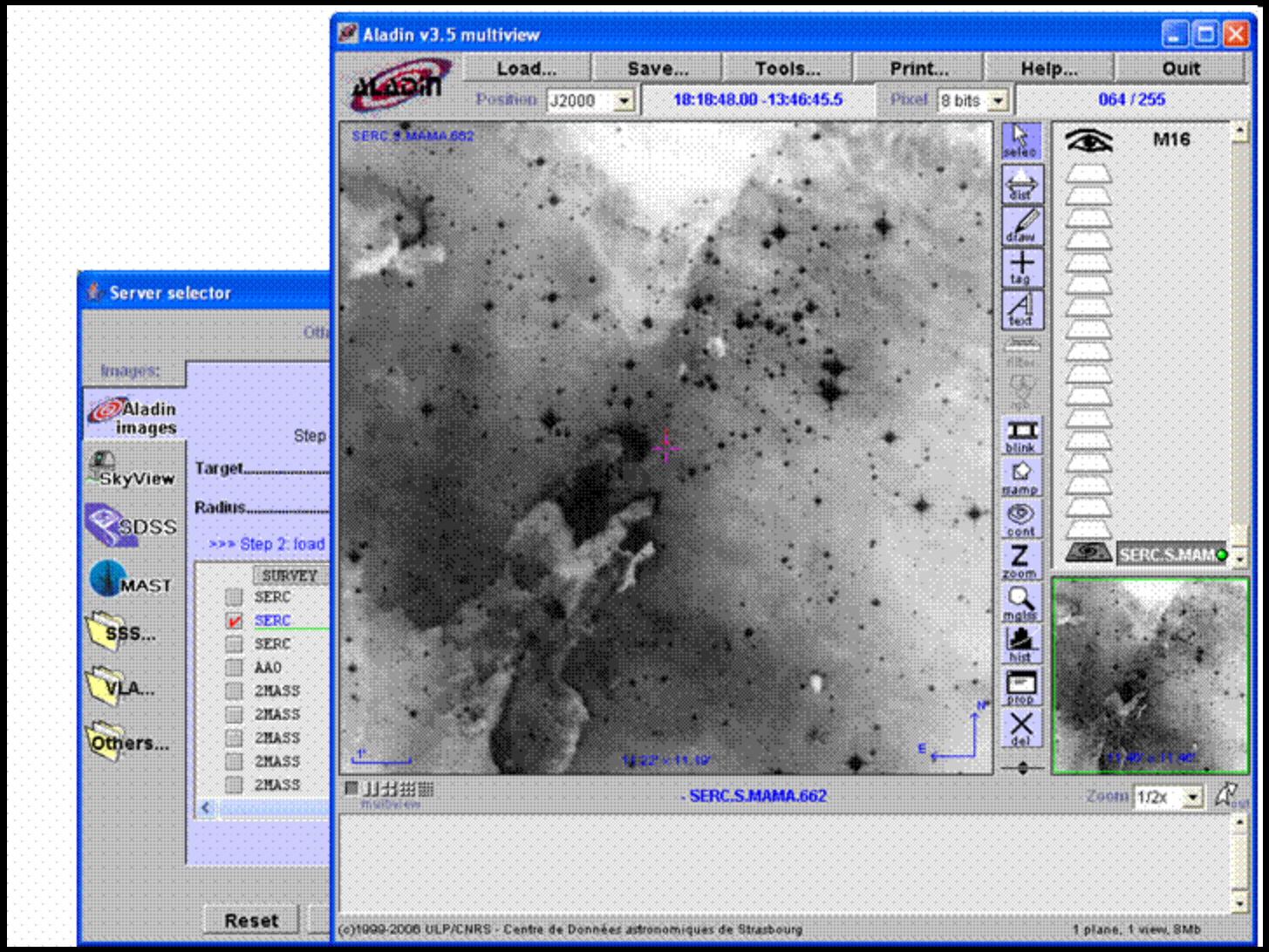
Aladin


Aladin v3.5 multiview
Load...
Save...
Tools...
Print...
Help...
Quit
Position
J2000
Pixel
8 bits
Aladin - v3.5 multiview
Fill in the associated form...
Server selector
Others:
File
all VO
FOV
Images:
Aladin images
SkyView
SDSS
MAST
SSS...
VLA...
Others...
Aladin image server
Step 1: Specify a target/radius and press SUBMIT
Target
M16
Grab coord
Radius
0 arcmin
>>> Step 2: load one or several images
by list or
tree
SURVEY
COLOR
SIZE
OBS_ID
SERC
I(optical I)
11.4 'x11.4 '
MAMA.662
SERC
S
11.4 'x11.4 '
MAMA.662
SERC
ER(optical R)
12.8 'x12.8 '
DSS2.662
2MASS
K(IR K)
8.6 'x17.1 '
9905025_KI1320092
2MASS
K(IR K)
8.6 'x17.1 '
9905025_KI1330186
2MASS
H(IR H)
8.6 'x17.1 '
9905025_HI1320092
2MASS
H(IR H)
8.6 'x17.1 '
9905025_HI1330186
2MASS
J(IR J)
8.6 'x17.1 '
9905025_JI1320092
Default image format:
JPEG
FITS
Catalogs:
All VizieR
Surveys
Missions
SIMBAD
NED
SkyBot
Others...
Reset
Clear
History
SUBMIT
Close
Zoom
1x
0 plane, 0 view, 0Mb

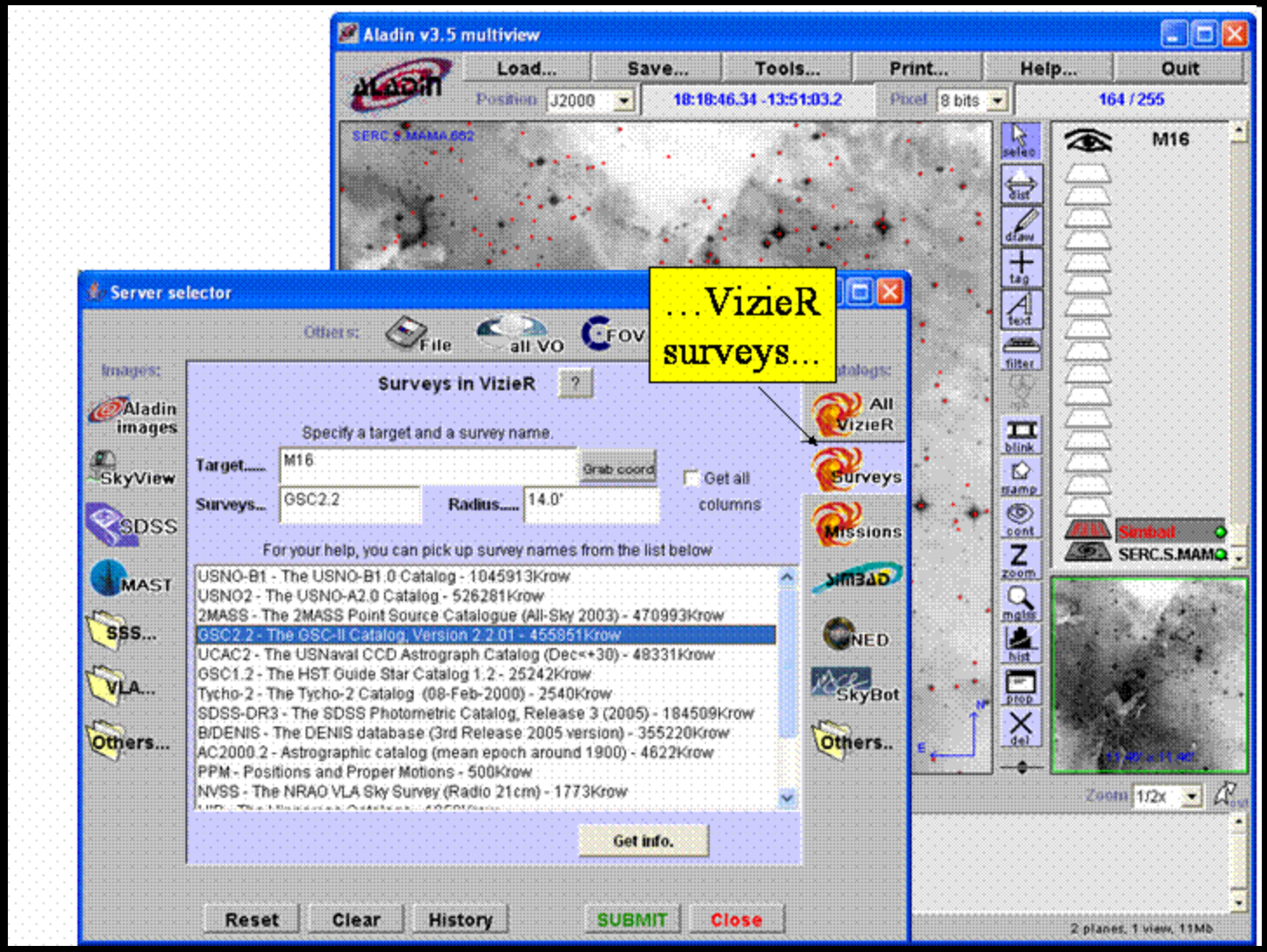
Aladin


Aladin v3.5 multiview
Load...
Save...
Tools...
Print...
Help...
Quit
Position J2000
Pixel 8 bits
Aladin - v3.5 multiview
ALADIN is an interactive software sky atlas developed by the CDS, allowing one to visualize digitized images of any part of the sky, to superimpose entries from astronomical catalogs, and to interactively access related data and
Server selector
Others:
File
all VO
FOV
Images:
Aladin images
SkyView
SDSS
MAST
SSS...
VLA...
Others...
Aladin image server
Step 1: Specify a target/radius and press SUBMIT
Target
M16
Grab coord
Radius
0 arcmin
>>> Step 2: load one or several images
by list or
tree
SURVEY
COLOR
SIZE
OBS ID
SERC I(optical I) 11.4 'x11.4 ' MAMA.662
SERC S 11.4 'x11.4 ' MAMA.662
SERC ER(optical R) 12.8 'x12.8
AAO S 12.8 'x12.8
2MASS K(IR K) 8.6 'x17.1
2MASS K(IR K) 8.6 'x17.1
2MASS H(IR H) 8.6 'x17.1
2MASS H(IR H) 8.6 'x17.1
2MASS J(IR J) 8.6 'x17.1 ' 9905028_J1320092
Default image format:
JPEG
FITS
Catalogs:
All VizieR
Surveys
Missions
SIMBAD
NED
...and press the SUBMIT button...
Reset
Clear
History
SUBMIT
Close
Zoom 1x
0 plane, 0 view, 0Mb

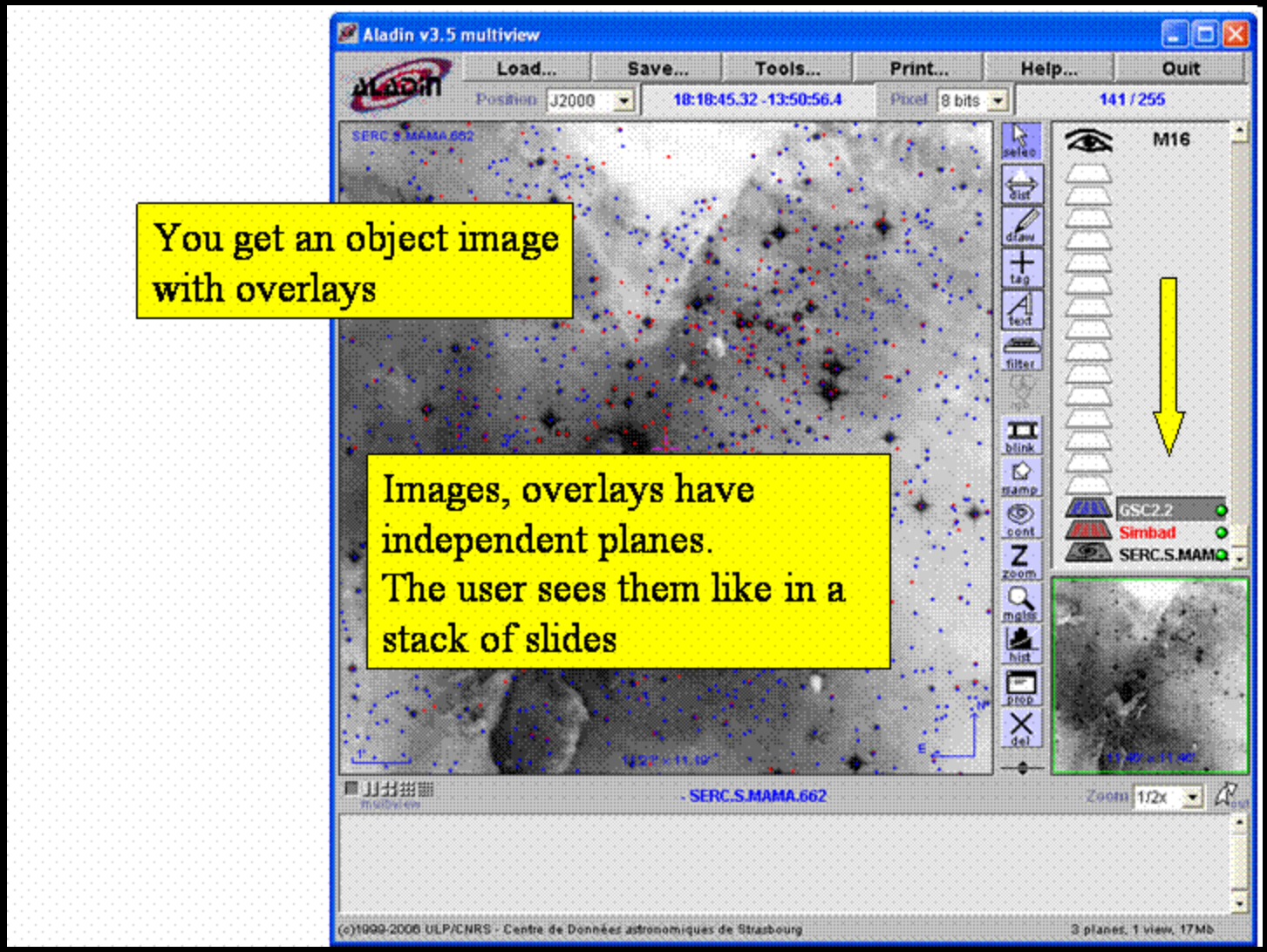
Aladin


Aladin v3.5 multiview
Load...
Save...
Tools...
Print...
Help...
Quit
Position J2000
18:18:48.00 -13:46:45.5
Pixel 8 bits
064 / 255
M16
Server selector
Images:
Aladin images
SkyView
SDSS
MAST
SSS...
VLA...
Others...
Step
Target.....
Radius.....
>>> Step 2: load
SURVEY
SERC
SERC
SERC
AAO
2MASS
2MASS
2MASS
2MASS
2MASS
Reset
- SERC.S.MAMA.662
Zoom 1/2x
(c)1999-2006 ULP/CNRS - Centre de Données astronomiques de Strasbourg
1 plane, 1 view, 8Mb

Aladin


Aladin v3.5 multiview
Load...
Save...
Tools...
Print...
Help...
Quit
Position J2000
18:18:46.34 -13:51:03.2
Pixel 8 bits
164 / 255
M16
Server selector
Others:
File
all VO
FOV
Images:
Aladin images
SkyView
SDSS
MAST
SSS...
VLA...
Others...
Surveys in VizieR
Specify a target and a survey name.
Target..... M16
Grab coord
Get all columns
Surveys... GSC2.2
Radius..... 14.0'
For your help, you can pick up survey names from the list below
USNO-B1 - The USNO-B1.0 Catalog - 1045913Krow
USNO2 - The USNO-A2.0 Catalog - 526281Krow
2MASS - The 2MASS Point Source Catalogue (All-Sky 2003) - 470993Krow
GSC2.2 - The GSC-II Catalog, Version 2.2.01 - 455851Krow
UCAC2 - The USNaval CCD Astrograph Catalog (Dec<+30) - 48331Krow
GSC1.2 - The HST Guide Star Catalog 1.2 - 25242Krow
Tycho-2 - The Tycho-2 Catalog (08-Feb-2000) - 2540Krow
SDSS-DR3 - The SDSS Photometric Catalog, Release 3 (2005) - 184509Krow
B/DENIS - The DENIS database (3rd Release 2005 version) - 355220Krow
AC2000.2 - Astrographic catalog (mean epoch around 1900) - 4622Krow
PPM - Positions and Proper Motions - 500Krow
NVSS - The NRAO VLA Sky Survey (Radio 21cm) - 1773Krow
Get info.
...VizieR surveys...
All VizieR
Surveys
Missions
SIMBAD
NED
SkyBot
Others..
Reset
Clear
History
SUBMIT
Close
Simbad
SERC.S.MAMA
Zoom 1/2x
2 planes, 1 view, 11Mb

Aladin

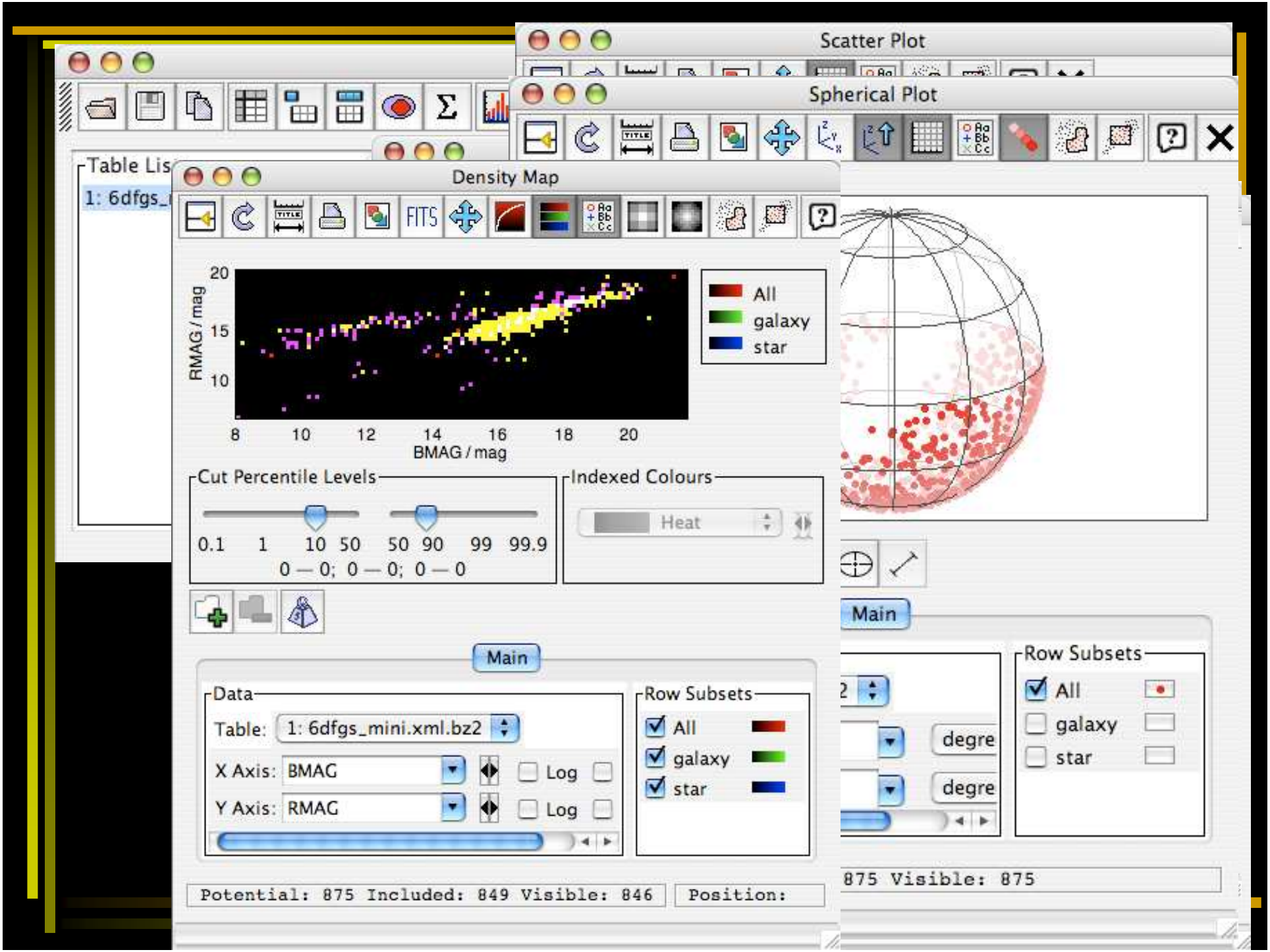

You get an object image with overlays
Images, overlays have independent planes.
The user sees them like in a stack of slides
Aladin v3.5 multiview
Load...
Save...
Tools...
Print...
Help...
Quit
Position J2000
18:18:45.32 -13:50:56.4
Pixel 8 bits
141 / 255
M16
GSC2.2
Simbad
SERC.S.MAMA
SERC.S.MAMA.662
Zoom 1/2x
(c)1999-2006 ULP/CNRS - Centre de Données astronomiques de Strasbourg
3 planes, 1 view, 17Mb

Aladin

- allows the user to visualize digitized images of any part of the sky.
- to superimpose entries from the CDS astronomical catalogues and tables.
- to interactively access related data and information from SIMBAD, NED, VizieR, or other archives for all known objects in the field.

Topcat

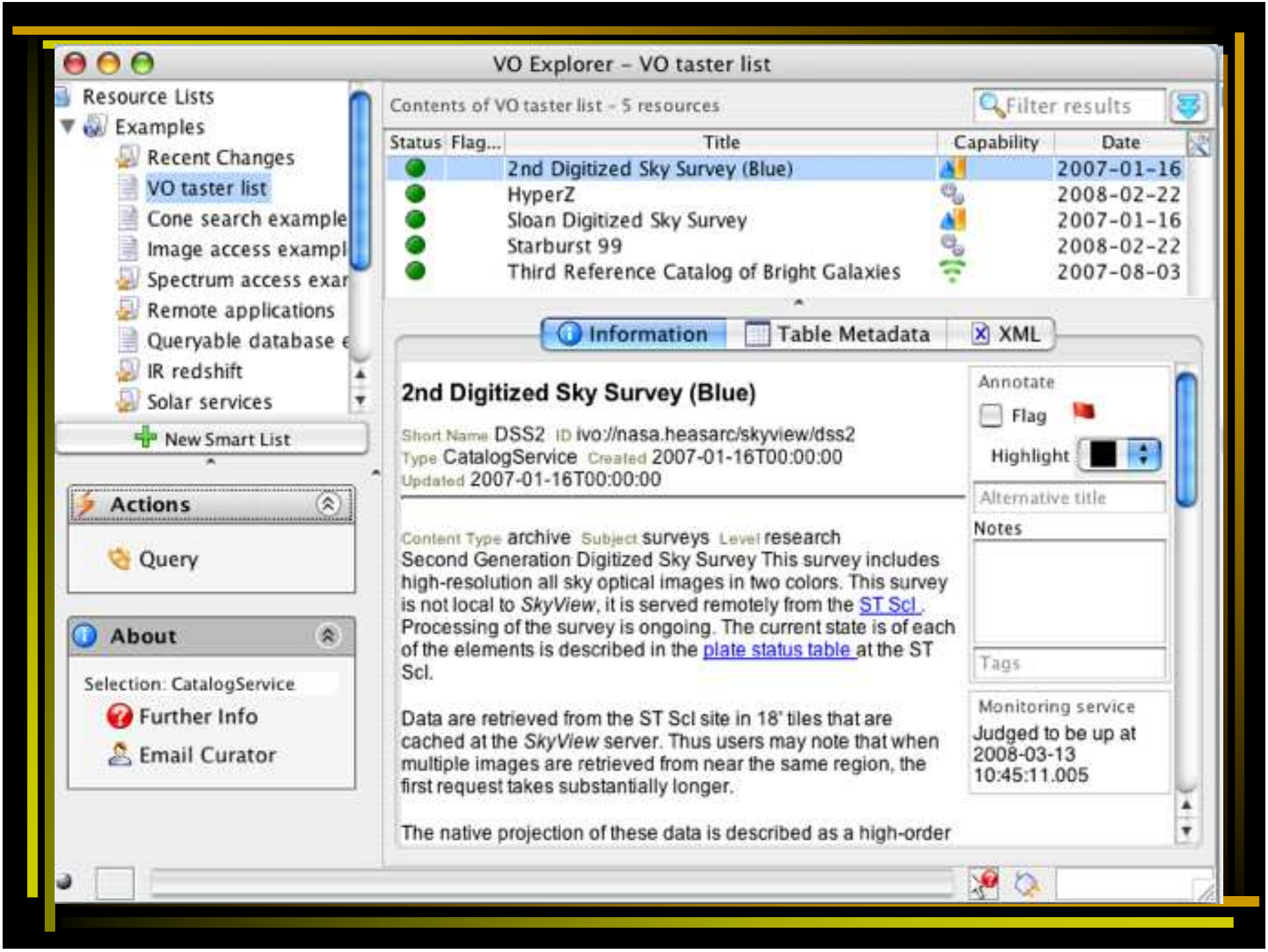
Tool for OPerations on Catalogues And Tables; is all about tables; view and manipulate tables, and make plots in many different formats; cross-match catalogues.


Scatter Plot
Spherical Plot
Density Map
Table Lis
1: 6dfgs_
FITS
RMAG / mag
BMAG / mag
All
galaxy
star
Cut Percentile Levels
0.1 1 10 50 50 90 99 99.9
0 — 0; 0 — 0; 0 — 0
Indexed Colours
Heat
Main
Data
Table: 1: 6dfgs_mini.xml.bz2
X Axis: BMAG
Y Axis: RMAG
Log
Row Subsets
All
galaxy
star
degre
Potential: 875 Included: 849 Visible: 846
Position:
875 Visible: 875

VO Desktop

This is the core application, containing : VOExplorer, Astroscope/Helioscope, File Explorer, Task Runner, and Query Builder. It also provides the background services - Astro Runtime and PLASTIC.

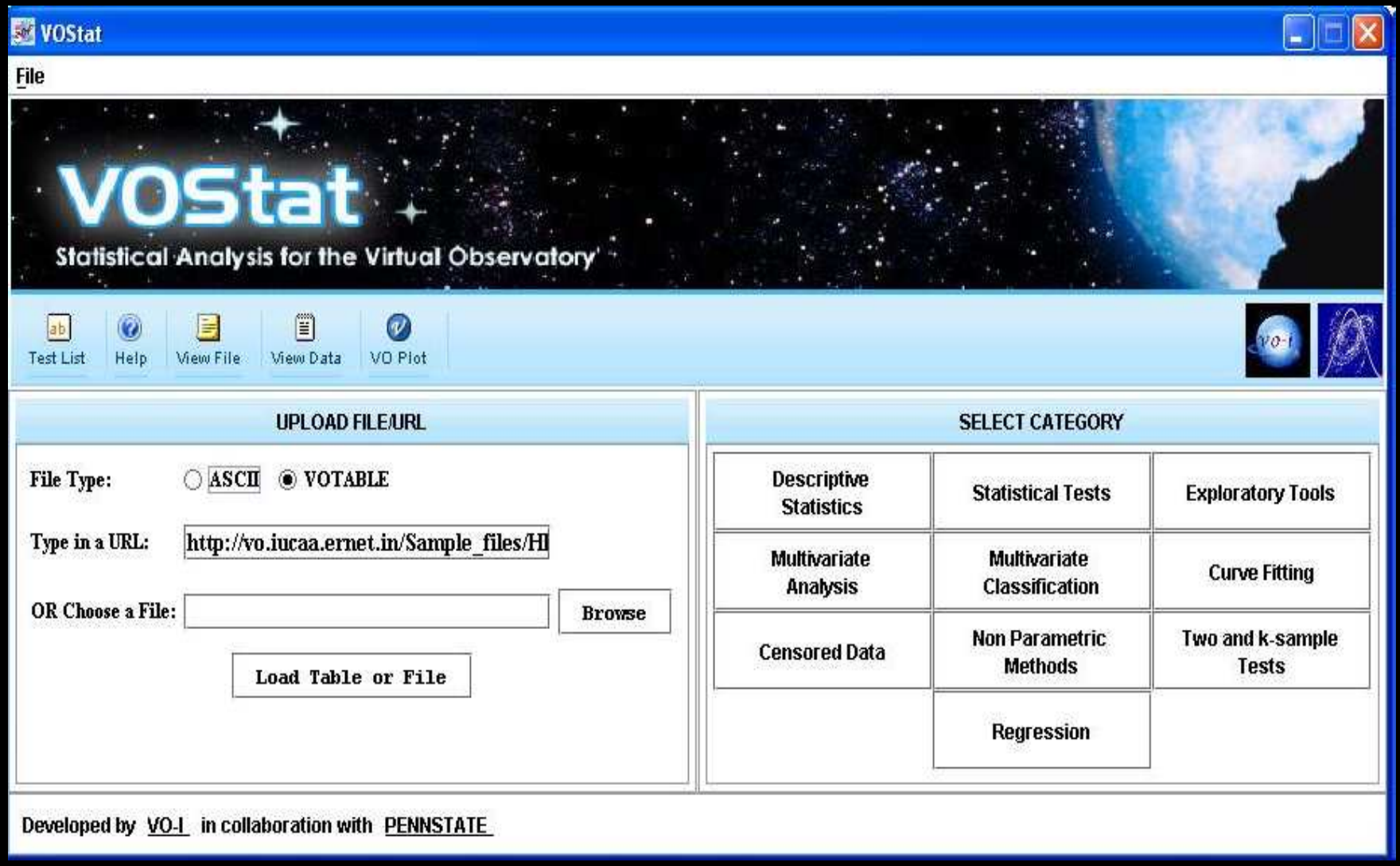
- Search for resources and data in the VO;
- bookmark your favourites;
- fetch images, spectra and catalogues;
- run queries on databases;
- save and share files in VOSpace; and
- invoke remote applications.


VO Explorer – VO taster list
Resource Lists
Examples
Recent Changes
VO taster list
Cone search example
Image access exampl
Spectrum access exar
Remote applications
Queryable database e
IR redshift
Solar services
New Smart List
Actions
Query
About
Selection: CatalogService
Further Info
Email Curator
Contents of VO taster list – 5 resources
Filter results
Status
Flag...
Title
Capability
Date
2nd Digitized Sky Survey (Blue) 2007-01-16
HyperZ 2008-02-22
Sloan Digitized Sky Survey 2007-01-16
Starburst 99 2008-02-22
Third Reference Catalog of Bright Galaxies 2007-08-03
Information
Table Metadata
XML
2nd Digitized Sky Survey (Blue)
Short Name DSS2 ID ivo://nasa.heasarc/skyview/dss2
Type CatalogService Created 2007-01-16T00:00:00
Updated 2007-01-16T00:00:00
Content Type archive Subject surveys Level research
Second Generation Digitized Sky Survey This survey includes high-resolution all sky optical images in two colors. This survey is not local to SkyView, it is served remotely from the ST ScI . Processing of the survey is ongoing. The current state is of each of the elements is described in the plate status table at the ST ScI.
Data are retrieved from the ST ScI site in 18' tiles that are cached at the SkyView server. Thus users may note that when multiple images are retrieved from near the same region, the first request takes substantially longer.
The native projection of these data is described as a high-order
Annotate
Flag
Highlight
Alternative title
Notes
Tags
Monitoring service
Judged to be up at 2008-03-13 10:45:11.005

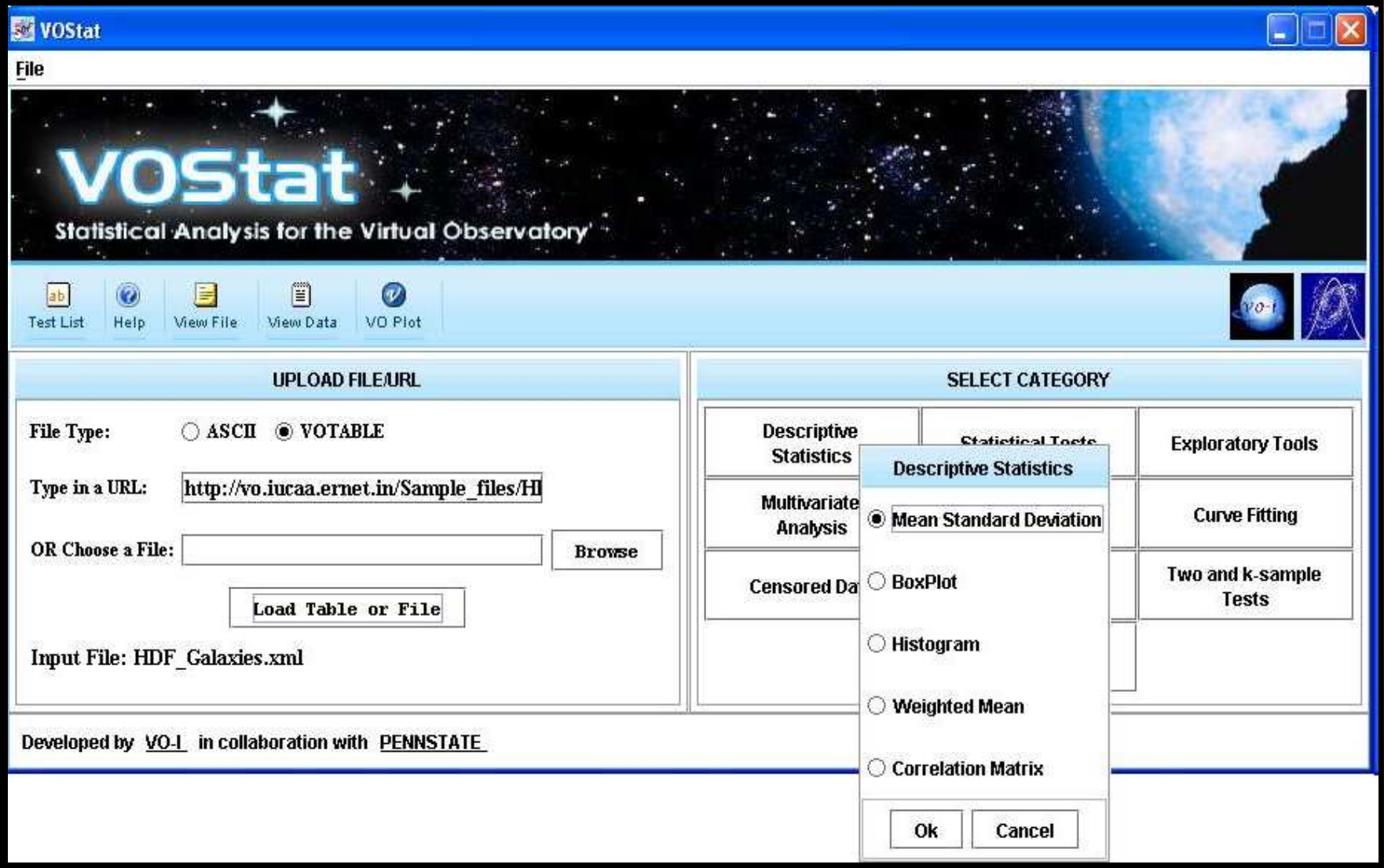
VOStat

- Simple and sophisticated statistical routines on large datasets.
- Uses statistical computing package called R.
- Developed jointly by VO-I and the Center for Astrostatistics at Penn State

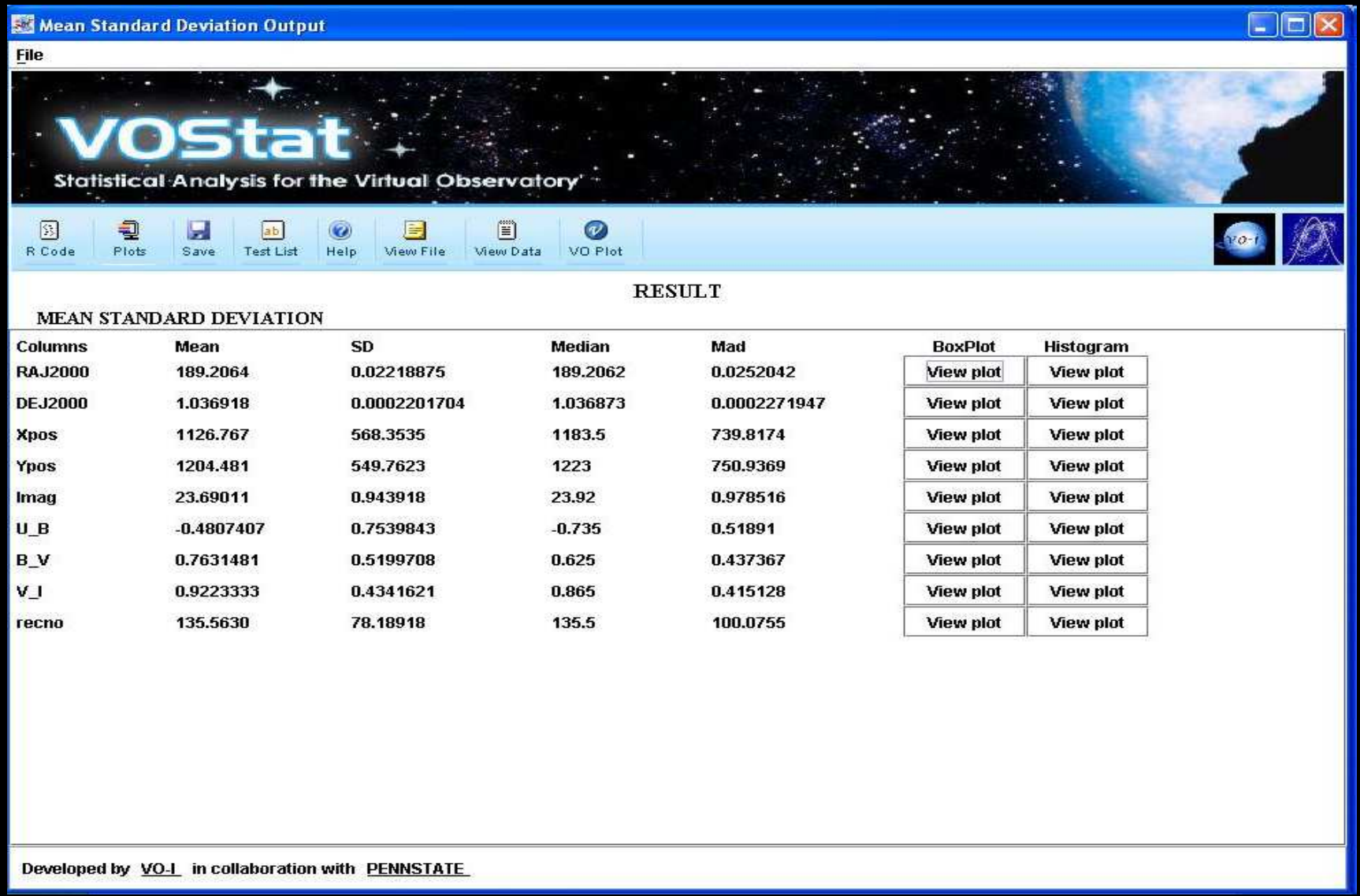
VOStat


VOStat
File
VOStat
Statistical Analysis for the Virtual Observatory
Test List
Help
View File
View Data
VO Plot
UPLOAD FILE/URL
File Type:
ASCII
VOTABLE
Type in a URL:
http://vo.iucaa.ernet.in/Sample_files/HI
OR Choose a File:
Browse
Load Table or File
SELECT CATEGORY
Descriptive Statistics
Statistical Tests
Exploratory Tools
Multivariate Analysis
Multivariate Classification
Curve Fitting
Censored Data
Non Parametric Methods
Two and k-sample Tests
Regression
Developed by VO-I in collaboration with PENNSTATE

VOStat


VOStat
File
VOStat
Statistical Analysis for the Virtual Observatory
Test List
Help
View File
View Data
VO Plot
UPLOAD FILE/URL
File Type:
ASCII
VOTABLE
Type in a URL:
http://vo.iucaa.ernet.in/Sample_files/HI
OR Choose a File:
Browse
Load Table or File
Input File: HDF_Galaxies.xml
SELECT CATEGORY
Descriptive Statistics
Exploratory Tools
Multivariate Analysis
Curve Fitting
Censored Da
Two and k-sample Tests
Descriptive Statistics
Mean Standard Deviation
BoxPlot
Histogram
Weighted Mean
Correlation Matrix
Ok
Cancel
Developed by VO-I in collaboration with PENNSTATE

VOStat



Columns	Mean	SD	Median	Mad	BoxPlot	Histogram
RAJ2000	189.2064	0.02218875	189.2062	0.0252042	View plot	View plot
DEJ2000	1.036918	0.0002201704	1.036873	0.0002271947	View plot	View plot
Xpos	1126.767	568.3535	1183.5	739.8174	View plot	View plot
Ypos	1204.481	549.7623	1223	750.9369	View plot	View plot
Imag	23.69011	0.943918	23.92	0.978516	View plot	View plot
U_B	-0.4807407	0.7539843	-0.735	0.51891	View plot	View plot
B_V	0.7631481	0.5199708	0.625	0.437367	View plot	View plot
V_I	0.9223333	0.4341621	0.865	0.415128	View plot	View plot
recno	135.5630	78.18918	135.5	100.0755	View plot	View plot

VO at SAAO

The Beginning….

VO at SAAO

Connecting South Africa internally and to the world

(in collaboration with staff from AstroGrid)

VO activities at SAAO-

- SAAO Virtual Observatory webpage – http://www.saao.ac.za/resources/virtual-observatory
- Installing, running and maintaining AstroGrid software's /applications as well as VO tools from various VO projects.

A new updated version of the AstroGrid desktop software's (V1.2.2) for astronomers are available locally at SAAO through http://www.saao.ac.za/~barway/vo/astrogrid/feb09

- The training of the South African students/astronomers/technical personal in the-

1. use of AstroGrid and various other VO tools and applications
2. preparation and the storage of the data for access via VO (AstroGrid)

- Adopting PySALT pipeline to VO tools.
- Ensuring that SALT data can be accessed through VO to-

1. SALT partners
2. South African astronomical community
3. rest of the world

- Coordinating VO activities with South African National Grid and Centre for High Performance Computing (CHPC).

Summary

- VO relies on data collected and archived from real observatories.
- All astronomical databases one click away.
- All major data centers provide or planning VO-compatible interface to their data.
- VO enables research that cannot be done with one telescope or instrument.
- VO provides a computational framework that supports research questions that are now difficult, if not impossible, to carry out.
- Foe less than 1% of the cost of building new telescopes, the VO allows astronomers, educator, and the public to explore, synthesize, and learn. Add value to all observational facilities.
- The final goal is Science.

VO exercise

Each student has to do one exercise. Students should produce report on the project with all relevant text and figures. For assistance, a brief write-up is provided for all exercises can be download from –

http://www.saao.ac.za/~barway/vo/vo_project/nassp

VO exercise

Here is the list – (http://www.saao.ac.za/~barway/vo/vo_project/nassp)

- Astrometric calibration with Aladin.
- The HI shells of the Small Magellanic Cloud.
- Looking for optical counterparts of X-ray sources.
- Photometric calibration with Aladin.
- Quasars in SDSS.
- Galaxy Clusters from SDSS.
- H-R Diagram of a Globular Cluster.
- Open cluster membership.
- Red objects in the Pelican nebula (IC 5070).
- Proper motion of stars with Aladin.
- Search for high-Z quasar from the SDSS.
- Surface Photometry of galaxy.

Thank You!

Acknowledgements- Much of the text, figures and images has been drawn from articles and presentations given by members of various VO projects and I thank all of them.