Virtual Observatories

Introduction for VO Workshop
Krakow, Poland, June 16-18, 2014

Mark Allen - Observatoire de Strasbourg, France

CoSADIE Project

Vision

- Archives and databases form a 'digital sky'

- New possibilities via data discovery, efficient data access and interoperability

Driven by:

- Exploding data rates

- Multi-λ, time-domain & survey science

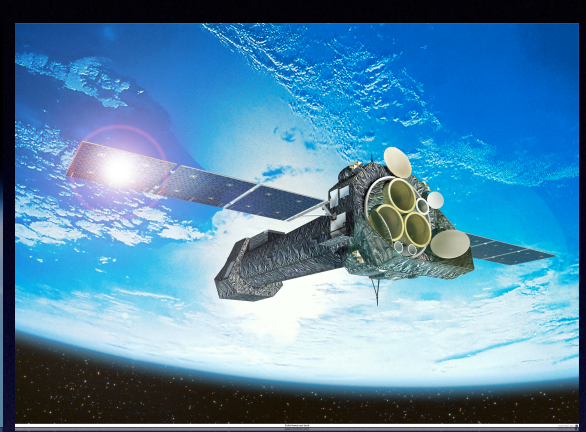- Astronomers demand/expectation of interoperability

data data data

- Science goals require very large data sets

  ⋆ large number of objects - data mining / statistics

  ⋆ large objects! - star streams in the Milky Way

- Sky surveys ~100 TB, high data rates coming
e.g. LSST 5 PB/yr
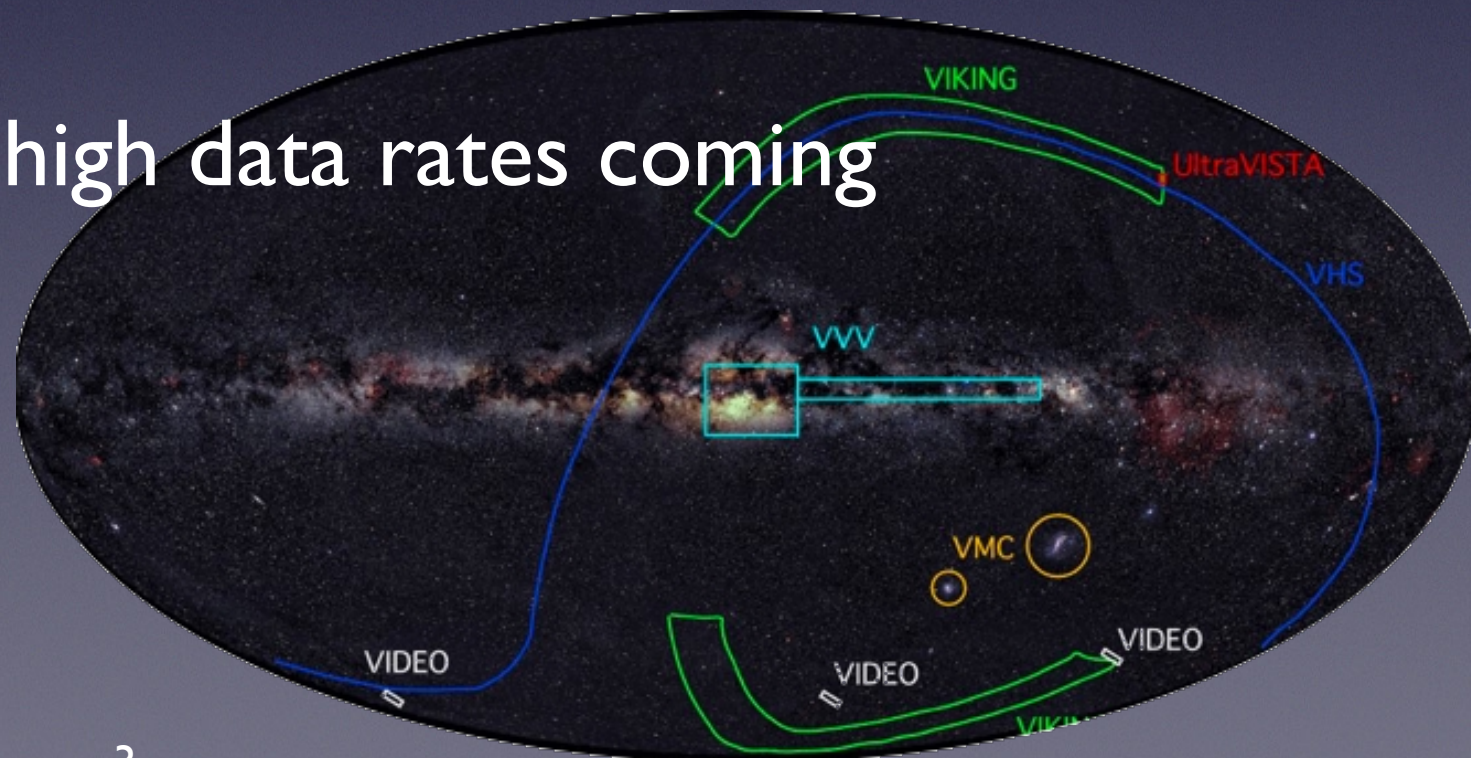
Multi-λ Astronomy

- Different data types and formats

- Customised archive interfaces and data access methods

- Different analysis tools and techniques

VO aims to

- Take advantage of the data explosion

- Allow astronomers to interrogate multiple data centres in a seamless way

- Permit remote computing and data analysis

- Foster *new science*

Virtual Observatory

- Framework for interoperable and efficient access to astronomical data and services

- *e-Science* for Astronomy

- Based on global standards

  - co-ordination via IVOA

  - Science Priorities

- Connections to data centres

European Status

- National VO projects + ESA-VO

- Coordinated by Euro-VO **EURO VO**

- Recognised in ASTRONET infrastructure roadmap

- Series of EC funded projects from ~2001

- CoSADIE : Collaborative and Sustainable Astronomical Data Infrastructure for Europe

CoSADIE aims

- Two aspects

  - Continue the coordination of European VO activities - Hands-on schools, Engage Data Centres, Tech-development, Education

  - Study all aspects of Euro-VO sustainability: assess the needs and establish a plan for a sustainable Euro-VO, in close collaboration with ASTRONET

How does it work?

LEVEL 0

COMPUTERS

USER LAYER

USING

F
I
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G

VO
CORE

G
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SHARING

RESOURCE LAYER
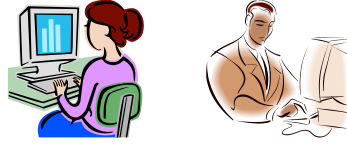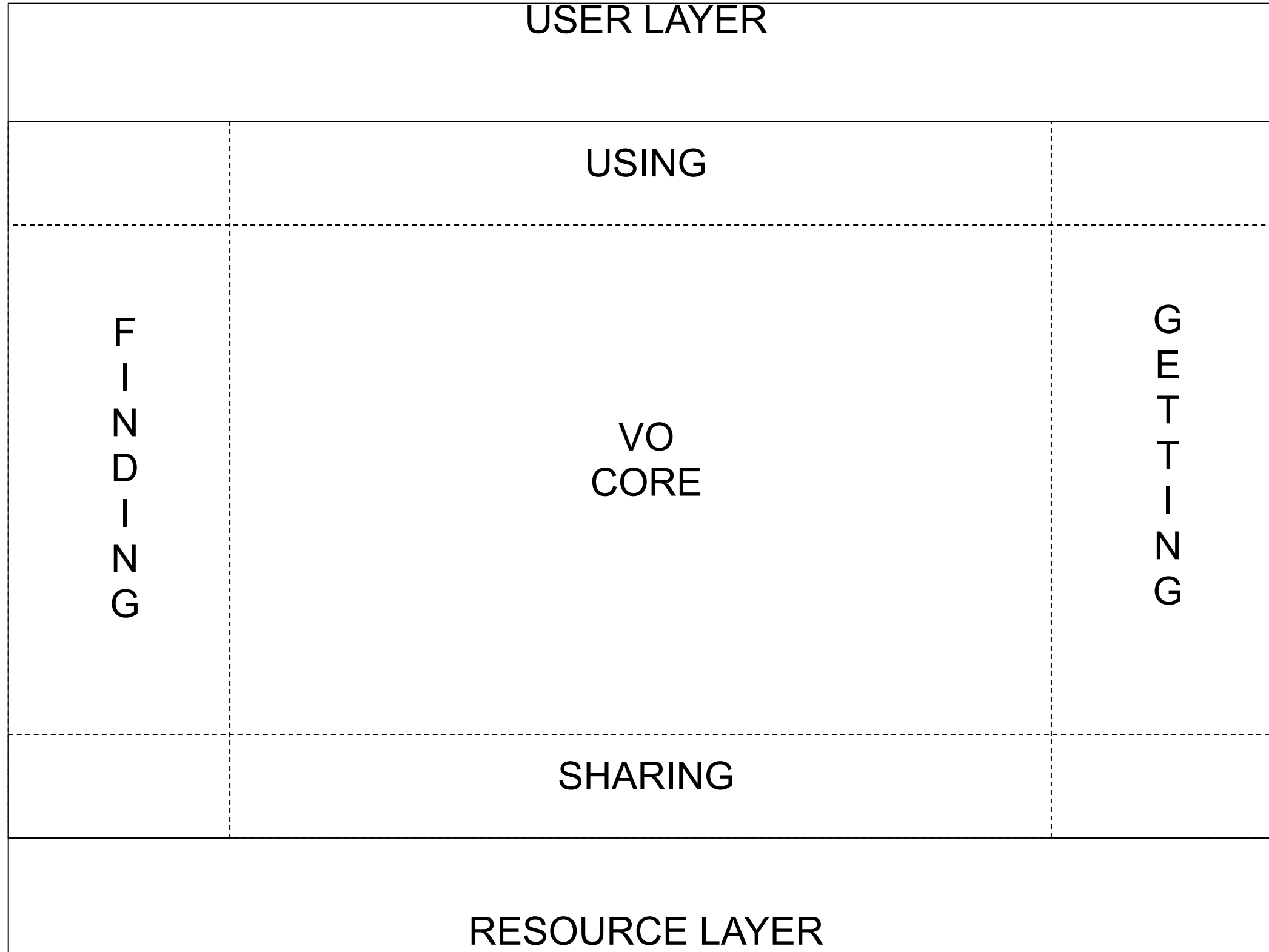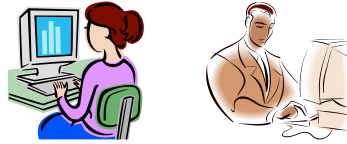
PROVIDERS

LEVEL 1

USERS

COMPUTERS

USER LAYER

Browser Based Apps

Desktop Apps

Script Based Apps

USING

R E G I S T R Y

Semantics

VO Query Languages

VO CORE

Data Models

Formats

D A T A   A C C E S S

P R O T O C O L S

SHARING

Data and Metadata Collection

Storage

RESOURCE LAYER

Computation

20101004
IVOA Architecture

PROVIDERS

$a^2 + b^2 = c^2$
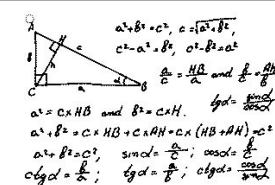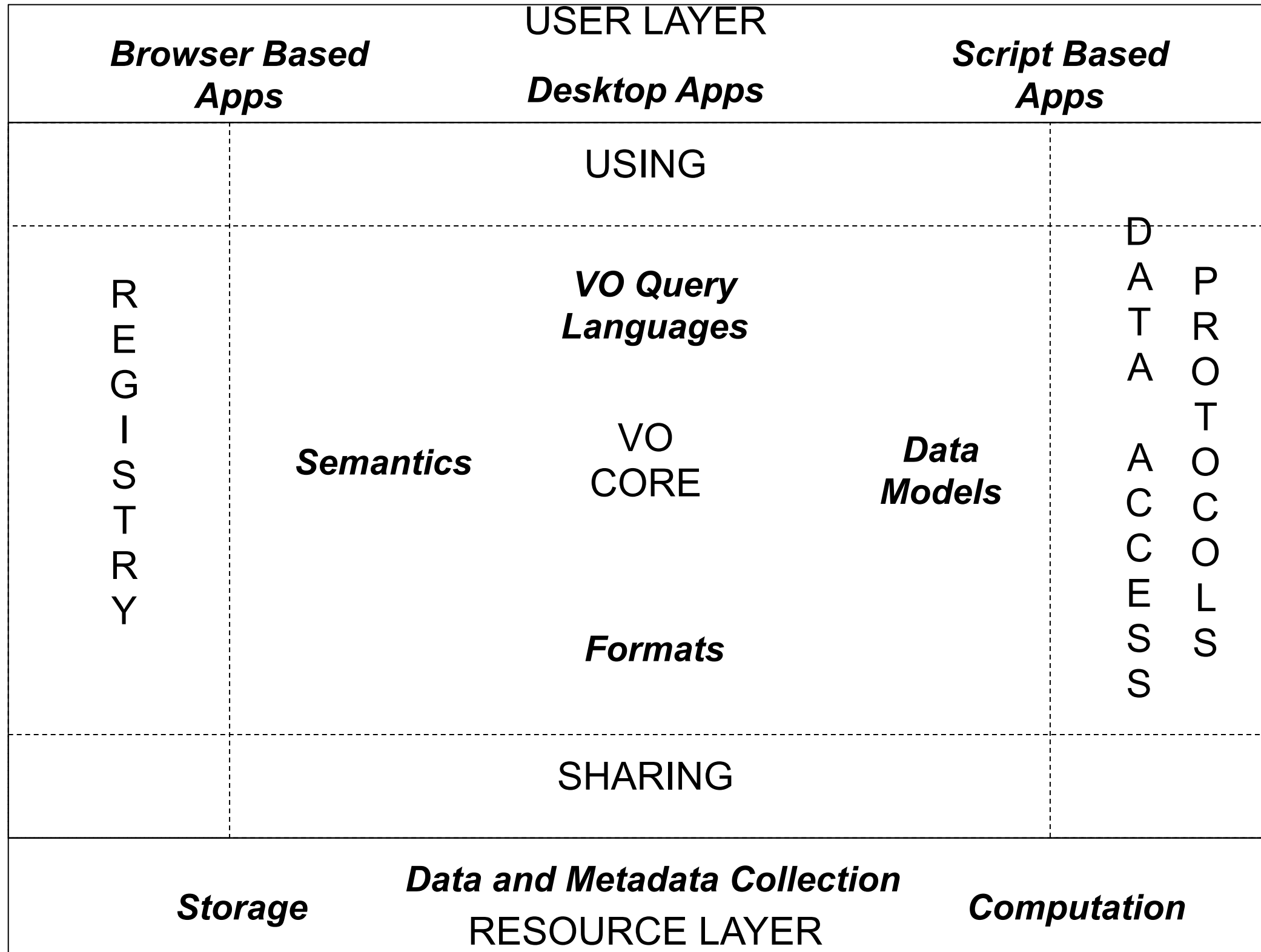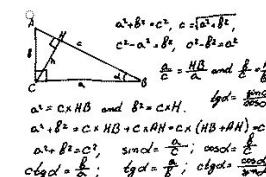
LEVEL 2

USERS

COMPUTERS

REC

InProgress

USER LAYER

Browser Based Apps

Desktop Apps

Script Based Apps

USING

SAMP

SSO

CDP

WS BP

R E G I S T R Y

Registry Interface

Resource Metadata

VOResource

VODataService

ApplicationRegExt

StandardRegExt

SimpleDALRegExt

VOSI

ADQL

PQL

VO Query Languages

UCD

Semantics

Vocabularies

VO CORE

CharDM

STC

Utypes

Units

SpectrumDM

Data Models

ObsCoreDM

ObsProvDM

SSLDM

PhotDM

VOEvent

SimDM

Formats

Resource Identifier

VOTable

SIAP

SCS

SSAP

TAP

SLAP

SEAP

SimDAL

FAP

D A T A   A C C E S S

P R O T O C O L S

VOSpace

VOPipe

SHARING

UWS

Data and Metadata Collection

Storage

RESOURCE LAYER

Computation

**20101004
IVOA Architecture**

PROVIDERS

12

Science Priorities

- Gathered from Astro community via national projects

- Focused on specific scientific areas:

  - *Time Series*

  - *Multi-dimensional Data (Radio/IFU/simulation...)*

  - *Spectral Energy Distributions*

  - *Query by object classification and lists*

  - *Query via core observational parameters*

Multi-dimensional Data

Radio astronomy, Integral Field Spectroscopy, high energy, polarization, simulation, data mining datasets + ...

Time Domain Astronomy

Time Series, light curves, transient event reports, +...

- Need to ensure that these are accessible and useable within the VO

VO Standards implemented in the CDS Data Centre

Registry Interface
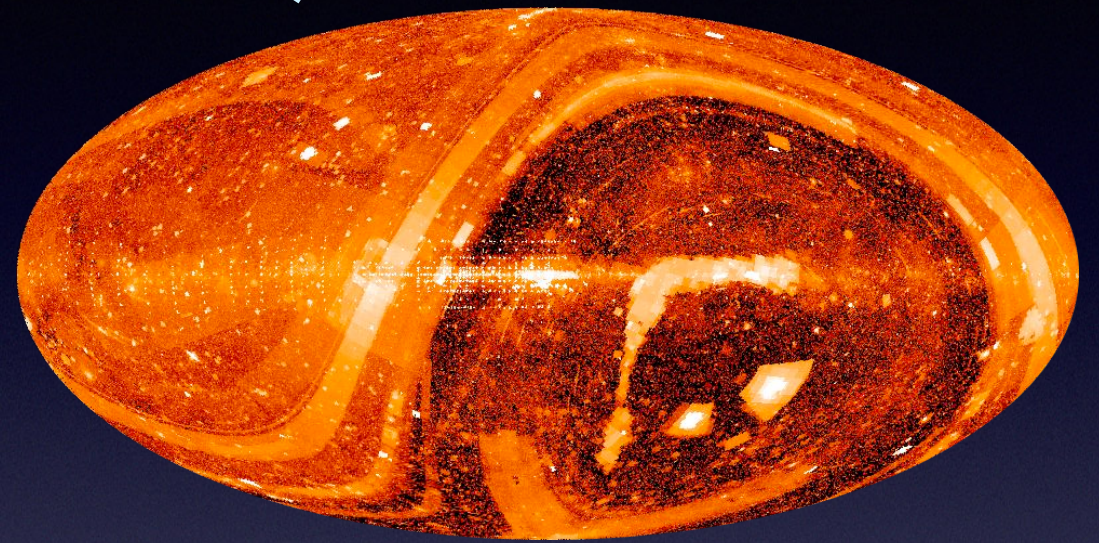
TAP
VOTable
Reference service for object names

UCD
VOTable
TAP
Resource Identifier
Resource Metadata
Access to journal catalogue data

SIAP
SAMP
SCS
CharDM
ObsCoreDM
An interactive 'portal'
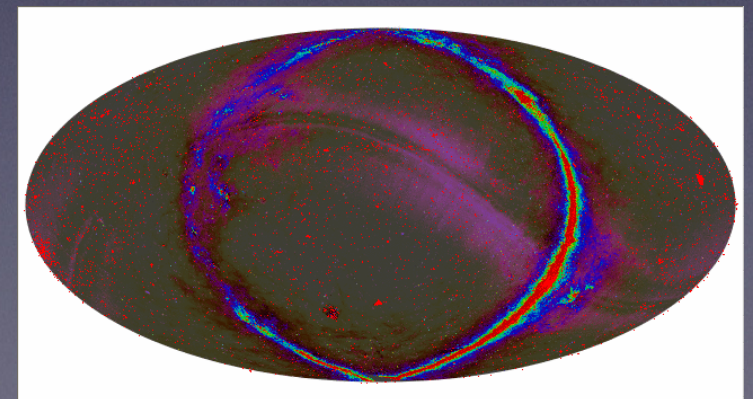
Total Usage
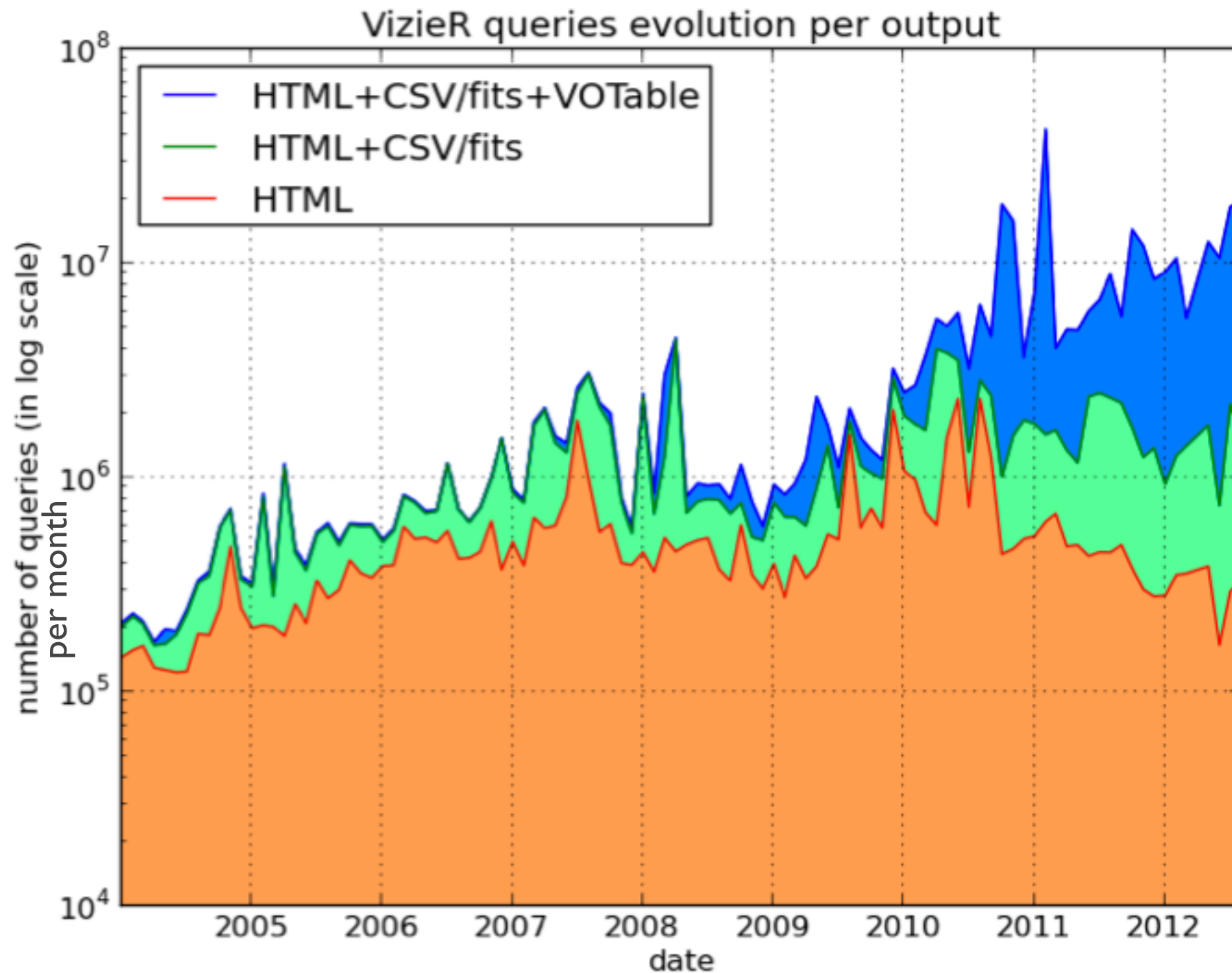
Finding data with Aladin:

- A service can be found and used by tools that access the registry

Metadata describes data properties e.g. FoV

Images
Catalogues
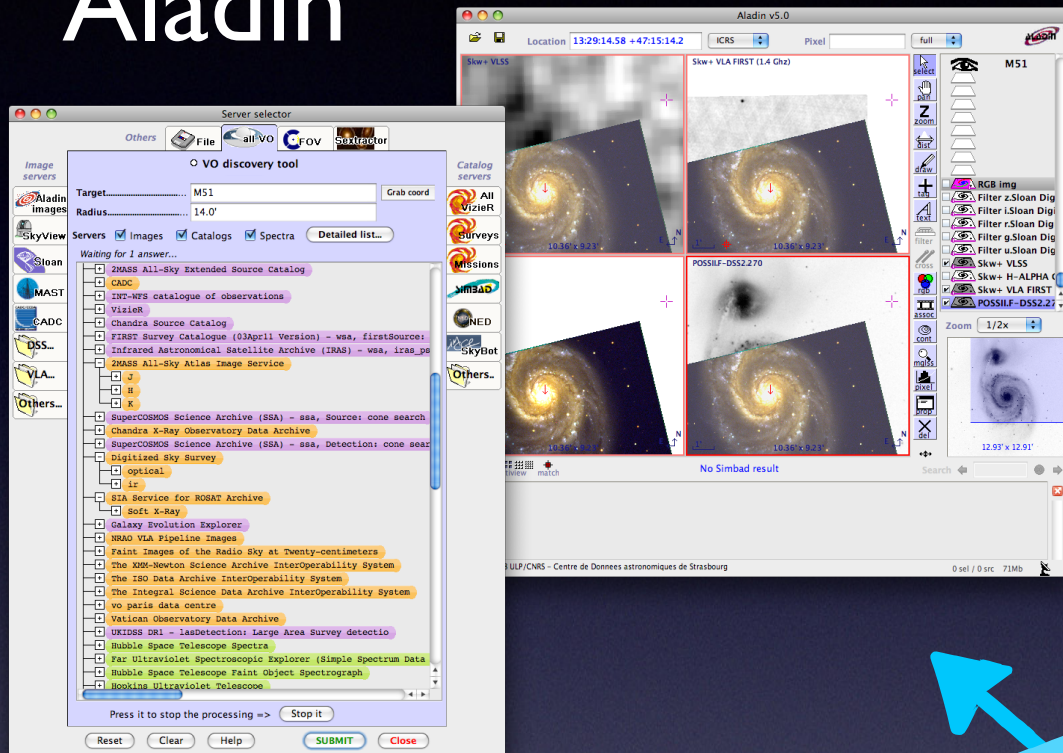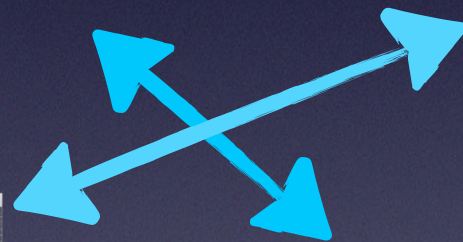Spectra
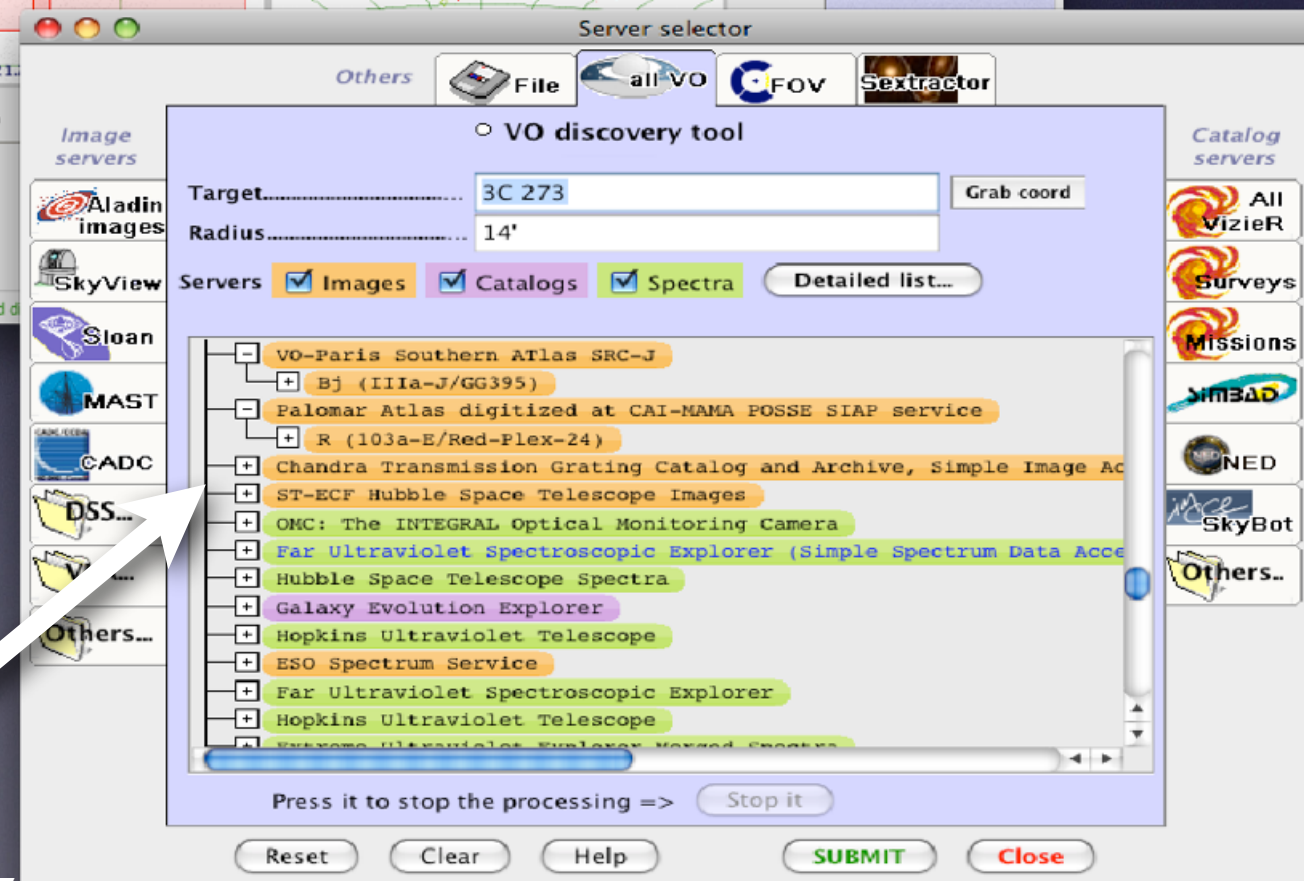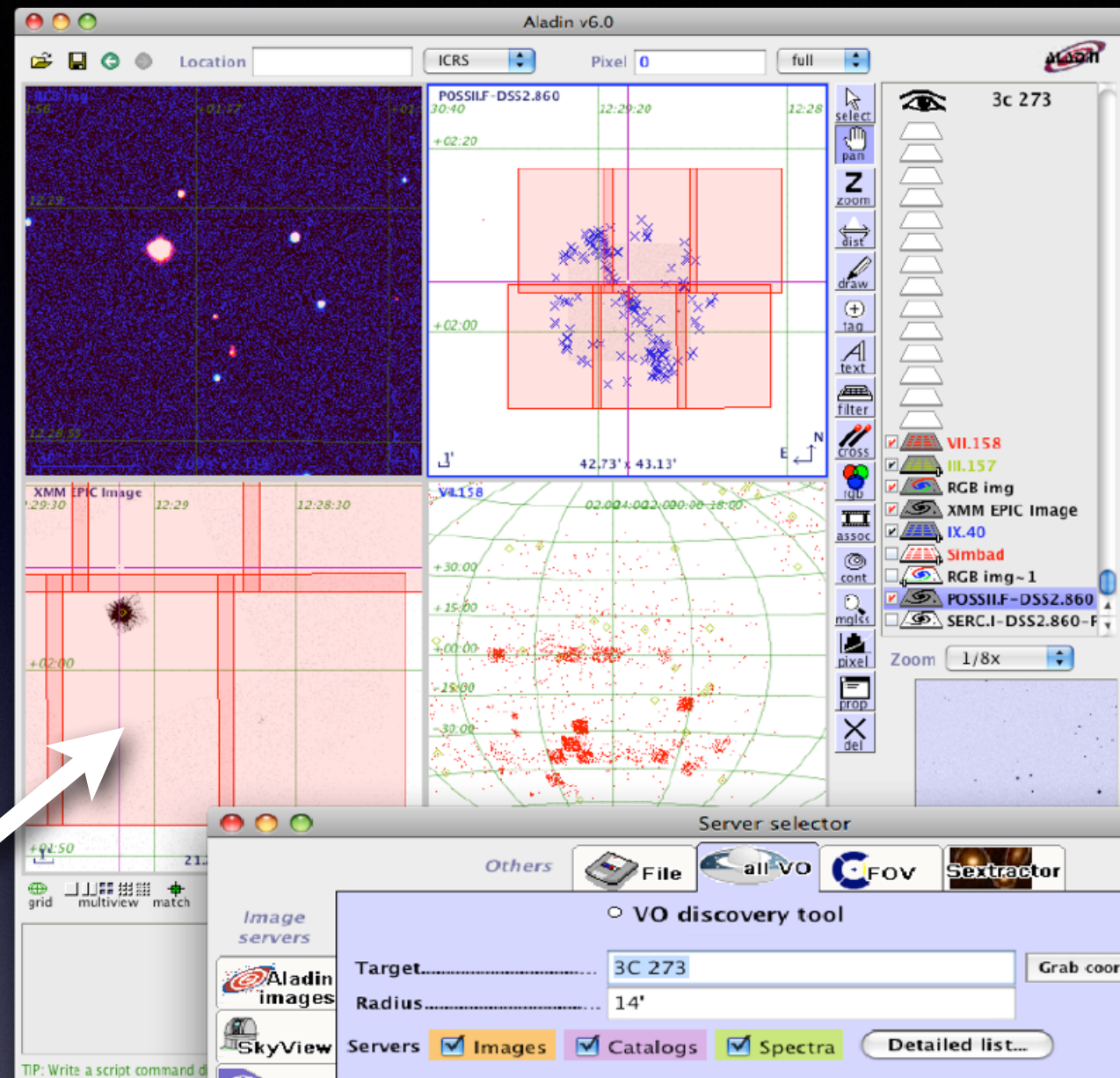
Table Access Tools

Topcat

TAPHandle

TOPCAT

Spectral, SED and Photometry Tools
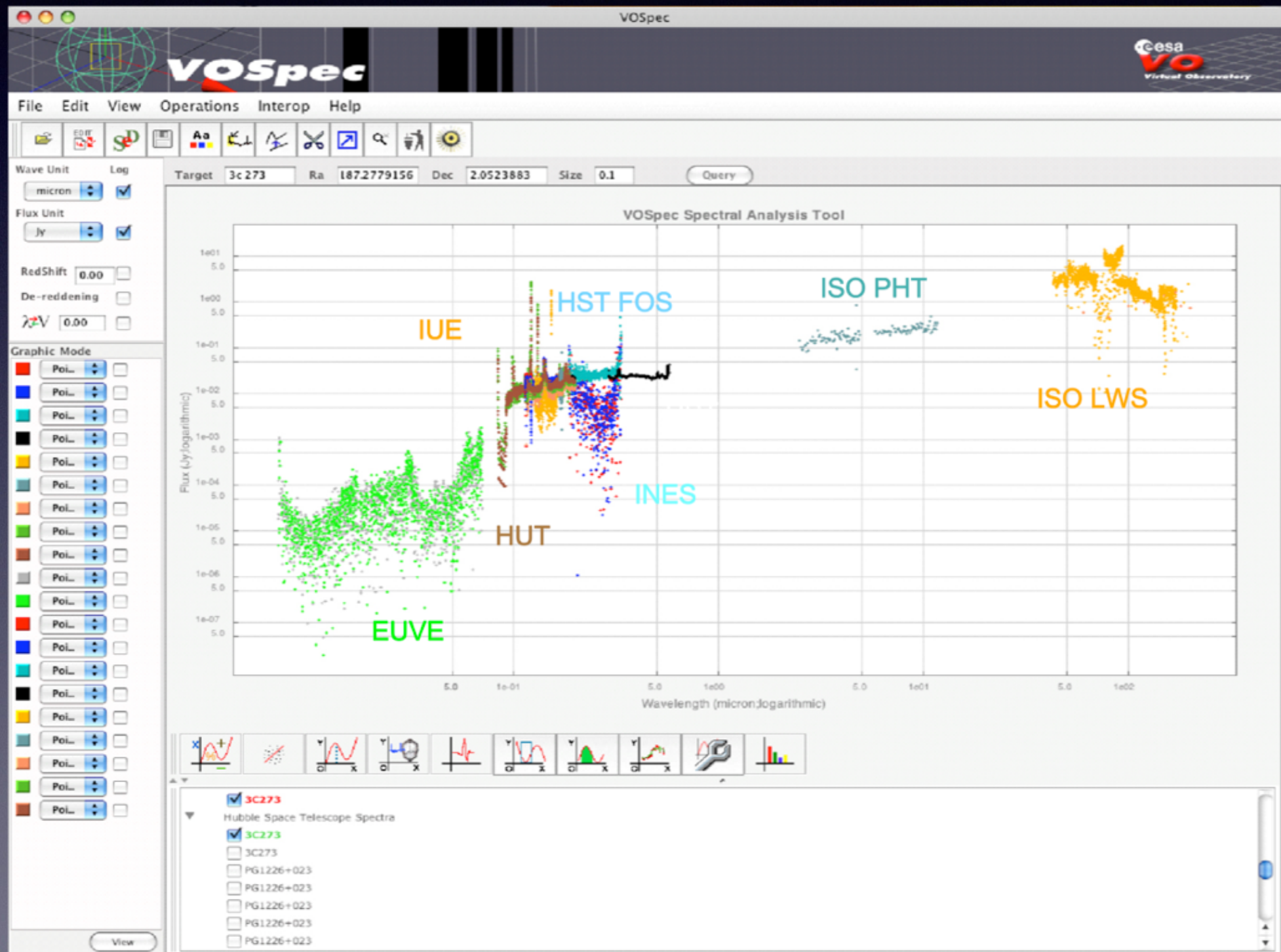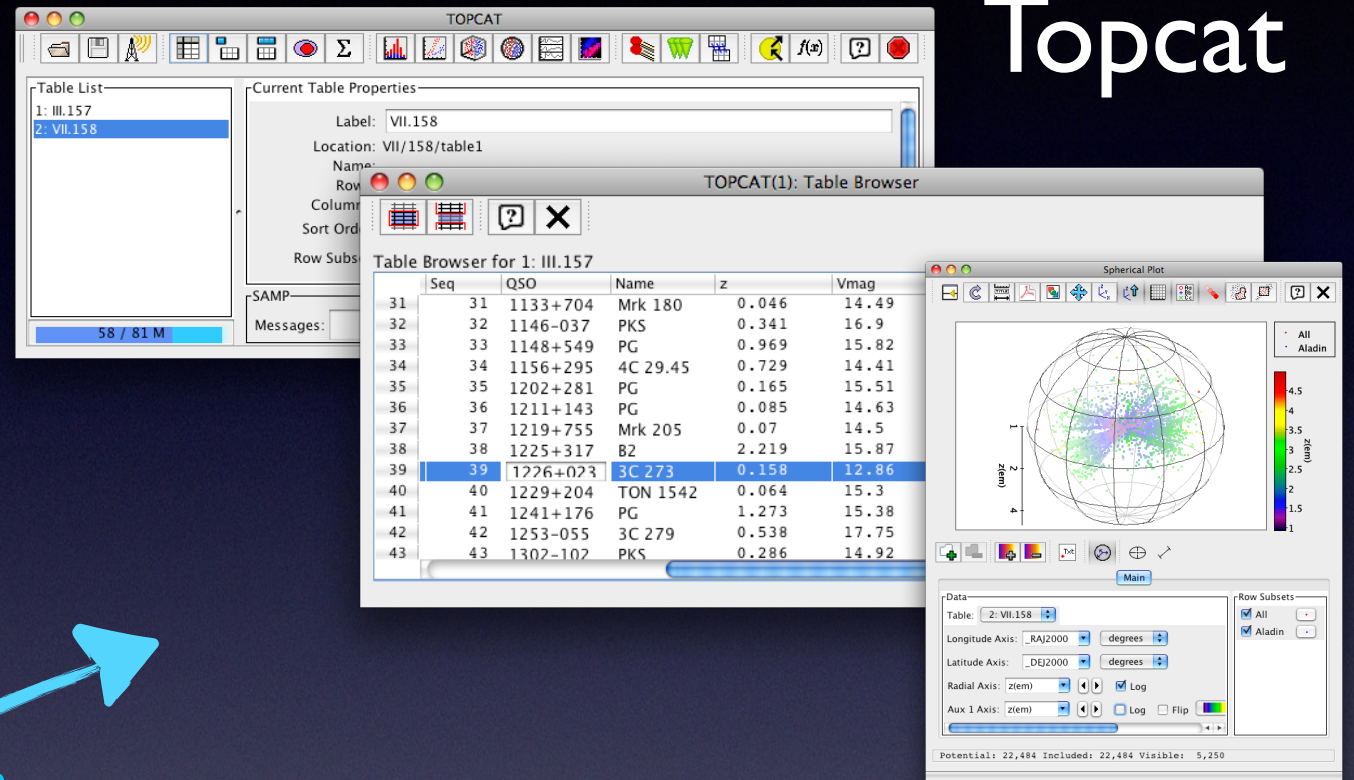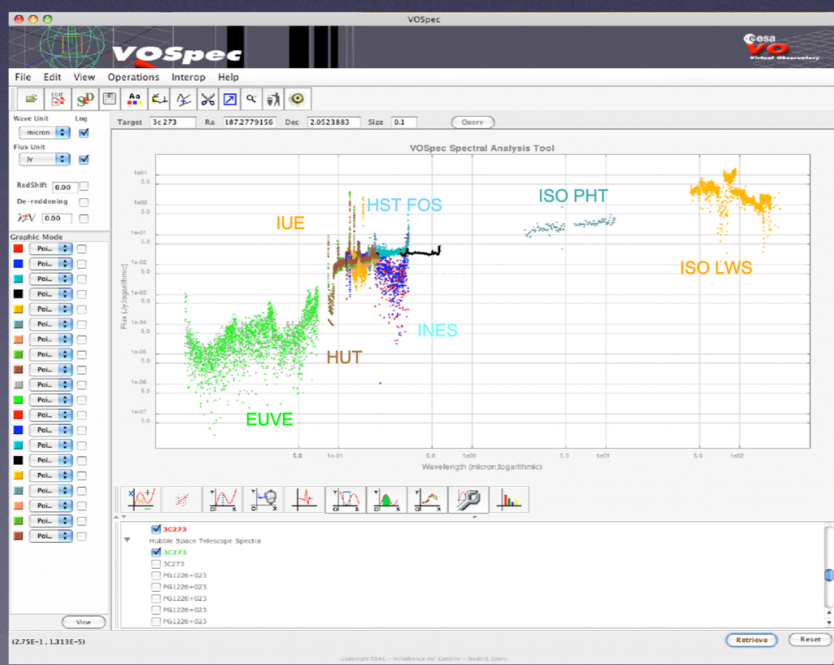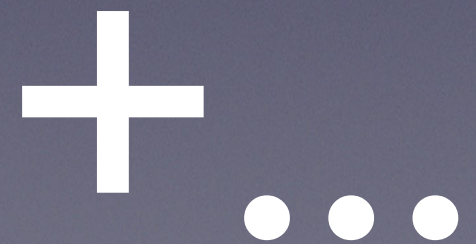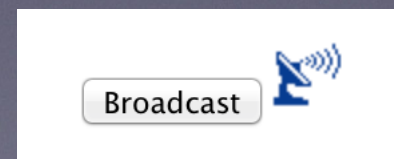
Interoperability - SAMP

Aladin

Topcat

Your programs

VOSpec

Programatic approaches

- Direct programming to access services

- Scripting languages in tools - allow transition from interactive to automated approach

- Python increasingly important

Learning how

- Workshops and schools

- On-line training materials

- From your colleagues

Software

Lists of tools:
- Euro-VO pages
- VAO pages

Applications/Services (alphabetical)	
Aladin	
AstroStat	
CDS Cross-Match Service	
Iris	
Seleste	
Skyview	
SIMBAD	
Specview	
SPLAT	
TAPHandle	
TOPCAT/STILTS	
CDS Cross-Match Service	
VAO Cross-Comparison Tool	
VAO Data Discovery Tool	
VAO Time Series Search Tool	
VisIVO	
VizieR	
VOPlot	

Applications/Services (by function)

Search for Images: Aladin, Data Discovery Tool, TOPCAT

Search for Spectra: SPLAT, Aladin, Data Discovery Tool

Search for Catalogues/Tables: Aladin, Data Discovery Tool, TOPCAT, VizieR, Xamin, TAPHandle

Image Visualisation: Aladin

Catalogue/Table Visualisation: TOPCAT, VOPlot,

Catalogue Cross-matching: Aladin, CDS Cross-Match Service, TOPCAT/STILTS, Cross-Comparison Tool

Scatter, 3D plots and histograms: TOPCAT, VOPlot, VisIVO

Statistics: AstroStat

Coverage Maps: Aladin

Table format conversion: TOPCAT/STILTS

SEDs: Iris, VOSA, VOSpec

IVOA Newsletter

- Bi-annual

- Aimed at Astronomers

- Applications highlights

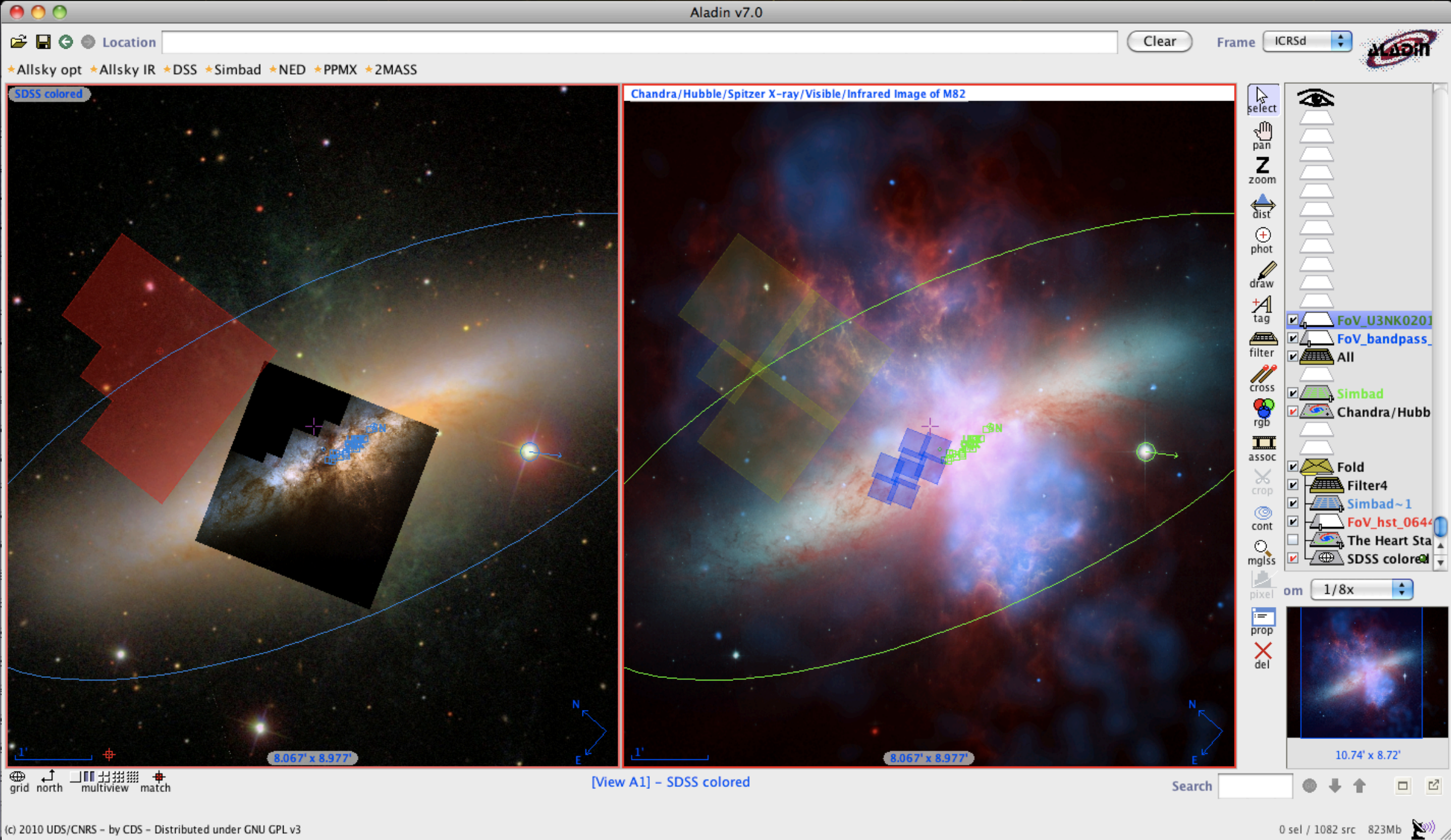- Recent refereed journal papers with significant use of VO

Your help needed

- Feedback on what does/doesn't work

- Suggest new capabilities

- Use it your own science projects

- Tell your colleagues about it

Beautiful ...

... and useful

Links

- IVOA - htp://www.ivoa.net

- EuroVO - http://www.euro-vo.org

- CDS - http://cdsweb.u-strasbg.fr

- Topcat - http://www.star.bris.ac.uk/~mbt/topcat/

- VAO - http://www.usvao.org/