

Virtual Observatory Standards in Action

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Turning point into the VO era

- Essential for imminent data volumes and rates
- Multi- λ science requires
 - Data from different telescopes
 - Analysis tools
 - on-line services
 - archived information

to be readily compatible
- VO = framework for interoperable systems
- VO Vision: *All Astronomy resources as if they were on your desktop*

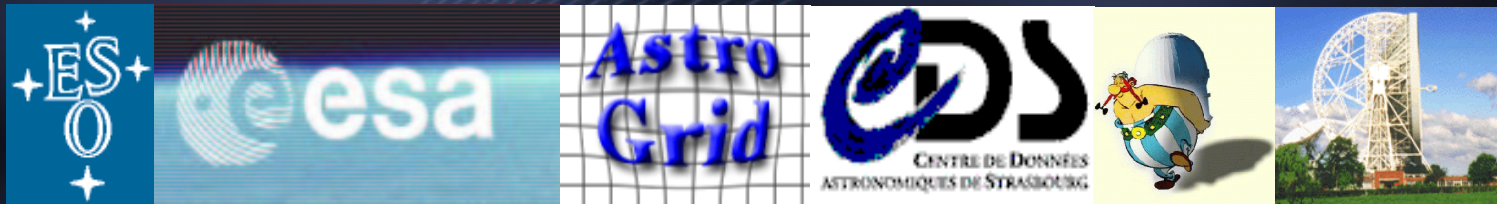
Standards – Key for Interoperability

- **Formats and protocols -**
 - **Necessary links between VO components**
- IVOA is rapidly moving towards v1.0 standards
- VOTable, SIA, SSA, UCD, Registry
- **Coming: Data Model, VOQuery, GRID**





- R&D on scientific requirements and technology for building a VO



- Phase-A, 2001-2004/5
- Driven by strategy of scientific VO demonstrations
- Prototyping: Standards in Action
 - Implementing new and emerging standards



'First Science' (Jan 2004)

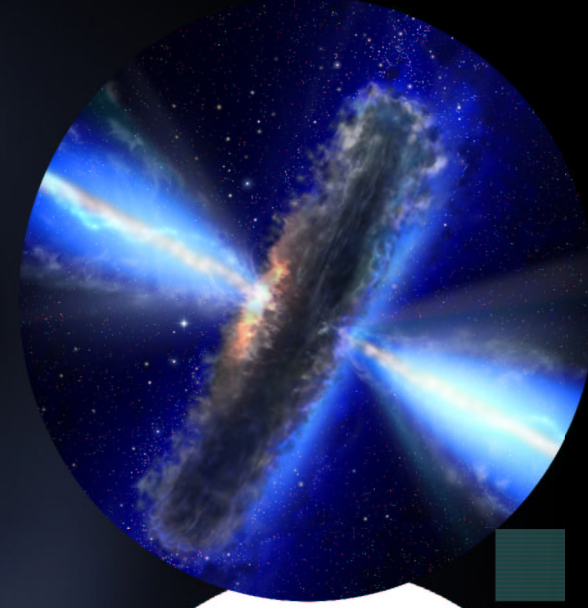
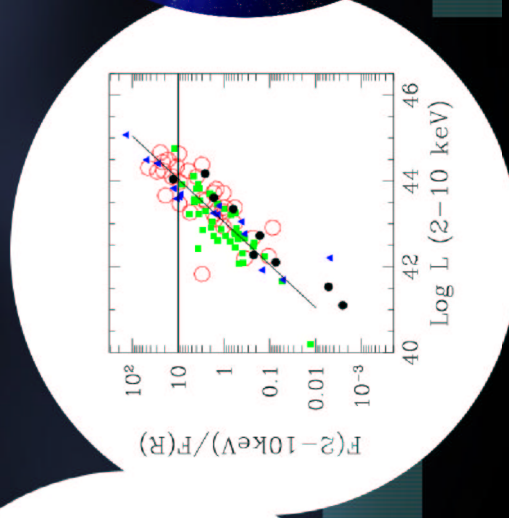
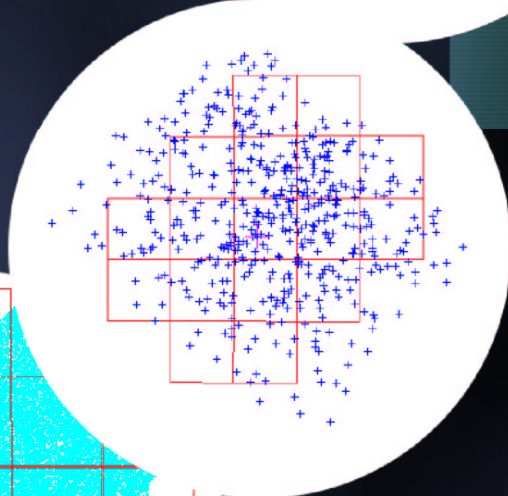
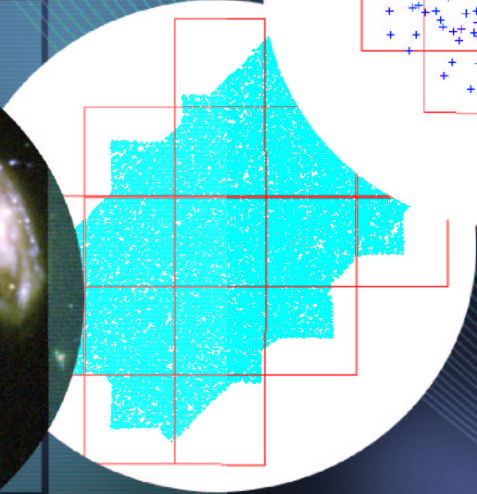
- **Prototype VO tools for science**
 - *Led to Discovery of Type 2 QSOs*
 - *Padovani, Allen, Rosati & Walton – A&A 2004*
- **Enabled by real gains in standards for:**
 - Data access
 - Manipulating image and catalogue data
 - Remote calculations

AVO prototype overview

- Registry of services (GLU)
- CDS Aladin interface
 - Interactive manipulation of image and catalogue data
 - “Portal” for access to services/data
- Cross-matching service for catalogues
- Conventions for accessing remote data
- Remote calculations
- Interoperable with other VO tools

Discovery of QSO 2s with VO tools

- GOODS Optical ACS data & catalogues
 - Chandra X-ray catalogues
 - Select absorbed X-ray sources
 - Cross-match X-ray and optical
 - Apply empirical estimator for L_x
 - Check against spectroscopy
- $L_x > 10^{44}$: QSO 2



Results : NEW Type 2 AGN

- 68 new type 2 AGN candidates
- 31 have $L_x > 10^{44} \text{ erg s}^{-2}$: QSO 2
 - Only 9 previously known in GOODS fields
- Now 40 QSO 2s: Quadrupled the QSO 2s in the GOODS fields !

Standards/Protocols used

- **Data and Information Discovery & Access**
 - Registry – GLU
 - Data Model – IDHA
 - Data Tree + SIA, SSA
- **Data and Catalogue Manipulation**
 - VOTable
 - UCDS for filtering, and X-matching
 - WCS coordinates, FITS

2MASS
ESO-WFI
Chandra
VLT-ISAAC
HST-ACS
DSS
My Data

Data Tree

- GOODS-WFI
 - DEEP2C-FY 38.1 'x37.3' 2000-10-26
 - DEEP2C-FY 8.2 'x8.2' 2000-10-26
- GOODS-ACIS
 - ACISMCDFSM000 1.2 'x1.2' 1999-10-14
- GOODS-ISAAC
 - GOODS-10 2.5 'x2.5' 08/04/2002
 - GOODS-11 2.5 'x2.5' 08/04/2002
 - GOODS-14 2.5 'x2.5' 08/04/2002
 - GOODS-15 2.5 'x2.5' 08/04/2002
 - GOODS-20 2.5 'x2.5' 08/04/2002
 - GOODS-16 2.5 'x2.5' 08/04/2002
 - GOODS-21 2.5 'x2.5' 08/04/2002
 - GOODS-9 2.5 'x2.5' 08/04/2002
- GOODS-HST-ACS
 - F775W
 - epoch1
 - epoch2
 - epoch3
 - epoch4
 - epoch5
 - version1.0
 - CDF-SOUTH-SECT32-VERSIO
 - CDF-SOUTH-SECT25-VERSIO
 - CDF-SOUTH-SECT23-VERSIO
 - CDF-SOUTH-SECT21-VERSIO
 - CDF-SOUTH-SECT44-VERSIO
 - CDF-SOUTH-SECT14-VERSIO
 - CDF-SOUTH-SECT42-VERSIO
 - CDF-SOUTH-SECT12-VERSIO
 - CDF-SOUTH-SECT35-VERSIO
 - CDF-SOUTH-SECT33-VERSIO
 - CDF-SOUTH-SECT31-VERSIO
 - CDF-SOUTH-SECT24-VERSIO
 - CDF-SOUTH-SECT22-VERSIO
 - CDF-SOUTH-SECT45-VERSIO
 - CDF-SOUTH-SECT43-VERSIO
 - CDF-SOUTH-SECT13-VERSIO
 - CDF-SOUTH-SECT11-VERSIO
 - CDF-SOUTH-SECT34-VERSIO

Data available at selected point are highlighted in tree

Info Frame

CDF-SOUTH-SECT23-VERSION1.0

Observation_Name	CDF-SOUTH-SECT23-VERSION1.0
ObservingProgram_Name	GOODS-HST-ACS
FilterName	F775W
Size_alpha	4.1'
Size_delta	4.1'
Angular Pixel Size	0.029"
Origin	STSCI
OriginalCoding	FITS
CentralPoint_RA	03:32:38.72
CentralPoint_DEC	-27:48:18.3
DateAndTime	2002-08-01
Position Angle	0.0°

Cutout Target: 03 32 33.50 -27 47 36 [Grab]

[Stick] [FoV in stack] [LOAD] [Close]

A.V.O demonstration prototype v1.0

Field: 03:32:25.77 -27:48:07.4 38.08"x37.2"

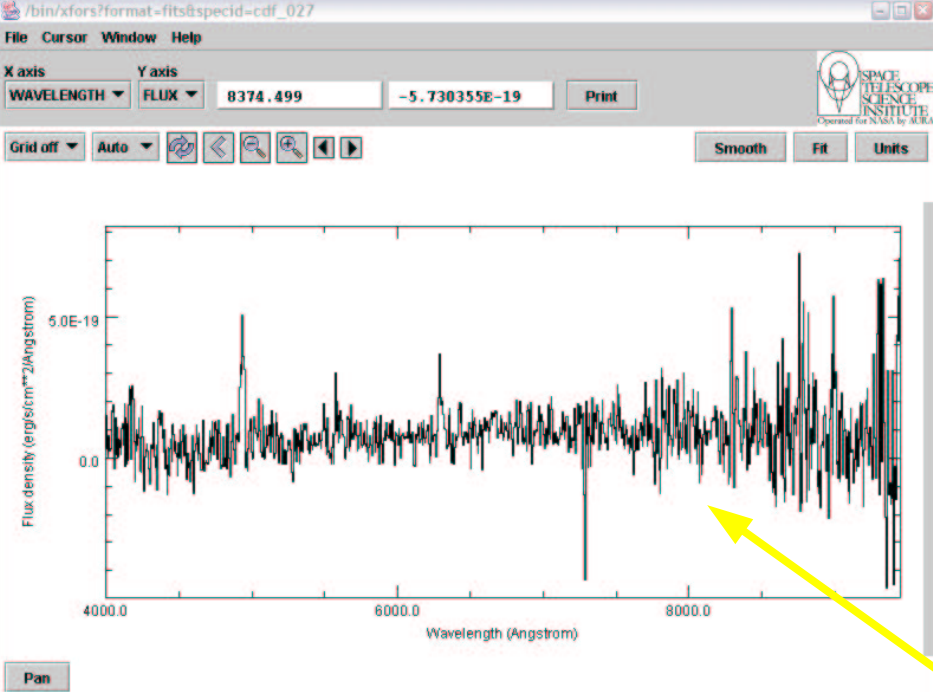
Field of view (FoV) plot showing observation outlines (red and blue) overlaid on a grayscale image. The plot includes a coordinate system with North (N) and East (E) directions.

Field of view outlines are plotted automatically

Image metadata

Data Tree

- **Scalable data access**
 - Interoperability of large archives to small data sets
- **Image metadata – FOV browsing**
- **Access to any image available by URL**
 - Automatic generation of image data set description in XML
- **Efficiently get to the relevant pixels**



- FORS2 1d spectrum GOODS J033214-274825
 - FORS2 1d spectrum GOODS J033214-274825
 - FORS2 1d spectrum GOODS J033214-275124
 - FORS2 1d spectrum GOODS J033214-275257
 - FORS2 1d spectrum GOODS J033214-275258
 - FORS2 1d spectrum GOODS J033215-274633
 - FORS2 1d spectrum GOODS J033217-275113
 - FORS2 1d spectrum GOODS J033217-275228
 - FORS2 1d spectrum GOODS J033217-275234
 - FORS2 1d spectrum GOODS J033217-275247
 - FORS2 1d spectrum GOODS J033217-274721
 - FORS2 1d spectrum GOODS J033217-274807
 - FORS2 1d spectrum GOODS J033217-274810
 - FORS2 1d spectrum GOODS J033217-274811
 - FORS2 1d spectrum GOODS J033217-274823
 - FORS2 1d spectrum GOODS J033217-274838
 - FORS2 1d spectrum GOODS J033217-274844
 - FORS2 1d spectrum GOODS J033217-275024
 - FORS2 1d spectrum GOODS J033218-274743
 - FORS2 1d spectrum GOODS J033216-275238
 - FORS2 1d spectrum GOODS J033216-275241
 - FORS2 1d spectrum GOODS J033217-274122
 - FORS2 1d spectrum GOODS J033217-274602
 - FORS2 1d spectrum GOODS J033218-274619
 - FORS2 1d spectrum GOODS J033218-274619
 - FORS2 1d spectrum GOODS J033218-274705
 - FORS2 1d spectrum GOODS J033218-274705
 - FORS2 1d spectrum GOODS J033218-274705
 - FORS2 1d spectrum GOODS J033218-274718
 - FORS2 1d spectrum GOODS J033218-274743
 - FORS2 1d spectrum GOODS J033218-274850
- Submit Reset Clear Close

A.V.O demonstration prototype v1.0

Load... Save... Plugins... Print... Help... Quit

J2000 03:32:39.67 -27:48:50.5 Field: 03:32:40.38 -27:48:49.2 1.03"x1.03"

Spectrum FORS2 1d spectrum GOODS J033239-274850 53.165297222222 -27.8140630555556

Spectrum FORS2 1d spectrum GOODS J033239-274851 53.1648288888889 -27.8143688888889

Spectrum Sp / l 1d spectrum GOODS J033239-274851 53.1648288888889 -27.8143688888889

Spectrum FORS2 1d spectrum CDF 027 53.1652916666667 -27.8140277777778

CDS - ESO - AstroGrid - ST-ECF - UMAN/Jodrell Bank - CNRS/DR1 - VD-India - ST-Sci

Simple Spectrum Access

Image / Spectrum / Catalog interoperability

Manipulating Data and Information

- VOTable: **enables interoperability**
 - As a rich interchange format
 - VOIndia VOPlot, Starlink TOPCAT
- UCDs: Uniform Content Descriptors
 - **Enables identification of common information in many contexts**
 - Data selection, X-matching, filtering, photometry

Cross-matching

- **Simple positional cross-match implemented**
 - Options: closest, multiple, or no-matches
 - Result: joined table
- **Efficiency comes from interoperability with other tables and original image data**
 - eg. X-match GOODS optical with X-ray sources taking positional error into account
- **VOTable**
- **UCDs for identifying coordinate columns**

Tree view

Data Tree

- cdfs
 - Aladin
 - GOODS-WFI
 - ICLWP
 - V89
 - B99
 - RC162
 - U38
 - GOODS-ACIS
 - LR. 1-10KEV
 - HR. 1-10KEV
 - 2MASS
 - K
 - H
 - J
 - GOODS-ISAAC
 - J
 - H
 - KS
 - GOODS-HST-ACS
 - F775W
 - epoch1
 - epoch2
 - epoch3
 - epoch4
 - epoch5
 - version1.0
 - F606W
 - F435W
 - epoch1
 - version1.0
 - F850LP
 - epoch1
 - epoch2
 - epoch3
 - epoch4
 - epoch5
 - version1.0
 - SERC
 - J
 - AAO
 - R
 - 03 32 27.26 -27 47 44.8
 - SSA server for VLT/FORS spectra

A.V.O demonstration prototype v1.0

Load... Save... Plugins... Print... Help... Quit

J2000 03:32:38.84 -27:48:49.9 Field: 03:32:40.38 -27:48:49.2 1.03"x1.03"

15.0"

926	53.16252	-27.81176	25.1155	0.0389	1.62192	0.0581602	0.182936	27.4848
931	53.1623	-27.81185	23.9426	0.0256	4.77723	0.112694	0.634461	26.1345
938	53.16494	-27.81163	29.2926	0.2438	0.0346089	0.00776921	0.0176615	30.0230
942	53.16498	-27.81171	26.8381	0.0758	0.331873	0.0231517	0.251987	27.1371
992	53.16245	-27.81267	24.9009	0.0328	1.9763	0.0597371	0.241543	27.1830

CDS - ESO - AstroGrid - ST-ECF - UMAN/Jodrell Bank - CNRS/DR1 - VD-India - STSol

Cross-match service

Positional cross-match

Only positional offset is used to find the matches.

List A: Selected sources from filter Absorbed_Sources_Filter RA: RAJ2000 DEC: DEJ2000

List B: Ext.App13 RA: RA DEC: DEC

Threshold is the distance in arcsec

0 <= threshold <= 4

Choose match method

- Best matches
- All matches
- Sources not matching

Perform cross-match Close

Cross-match interface

Submit Reset Clear Close



Data Tree

- cdfs
 - Aladin
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 - HR. 1-10KEV
 - 2MASS
 - K
 - H
 - J
 - GOODS-ISAAC
 - J
 - H
 - KS
 - GOODS-HST-ACS
 - F775W
 - epoch1
 - epoch2
 - epoch3
 - epoch4
 - epoch5
 - version1.0
 - F606W
 - F435W
 - epoch1
 - version1.0
 - F850LP
 - epoch1
 - epoch2
 - epoch3
 - epoch4
 - epoch5
 - version1.0
 - SERC
 - J
 - AA0
 - R
 - 03 32 27.26 -27 47 44.8
 - SSA server for VLT/FORS spectra

A.V.O. demonstration prototype v1.0

Load... Save... Plugins... Print... Help... Quit

J2000 03:32:39.38 -27:48:18.8 Field: 03:32:40.38 -27:48:49.2 1.03"x1.03"

Selected sou: z_szoloky XMatch results szoloky_cat Selected sou: Absor.. 100% Selected sou: HR_fl. 100% JAJ126/5390 FoV for version RGB img GOODS-HST GOODS-HST GOODS-HST fields.xml GOODS-WFI

Zoom 1/4x

ACE C:\Documents and Settings\allen\My Documents\AVO2004Demo\AVO_1.0\demo\F775W-v1-config.ace

Open Save SaveAs Edit

Image Extraction Photometry Separation Background Output Advanced

Image to extract Set Paste Ex

Dual Image mode

CCD Photo

Passband Ignore Generic Mag EIS Single Mag EIS X-Matched Mag Physical Units Generic Passband I

ACE Server Cambridge Edit List Edit Extract Cancel

Submit Reset Clear Close

• *SExtractor service*

• *Remote calculation - AstroGrid*

• *VOTable output*

• *Prototype distributed computing interface*

Summary

- **VO milestone:**

Prototype VO tools β Scientific Results
Discovery of QSO 2s



- **Standards in Action**

- Demos: Provide real tests of standards
- Feedback into standards process

- This work enabled by the First VO interoperability gains
 - Scalable Data Access
 - Catalogue/image manipulation
 - X-match, filtering, link to original data
- Coming soon:
 - Distributed workflow
 - AVO move from *phase A* to build EURO-VO
 - IVOA: v1.0 Standards, working registries

VO tools

- Prototype tools available
 - www.euro-vo.org
 - www.ivoa.net
 - cdsweb.u-strasbg.fr
- Stabilised AVO prototype components migrate into the public version of CDS Aladin.

