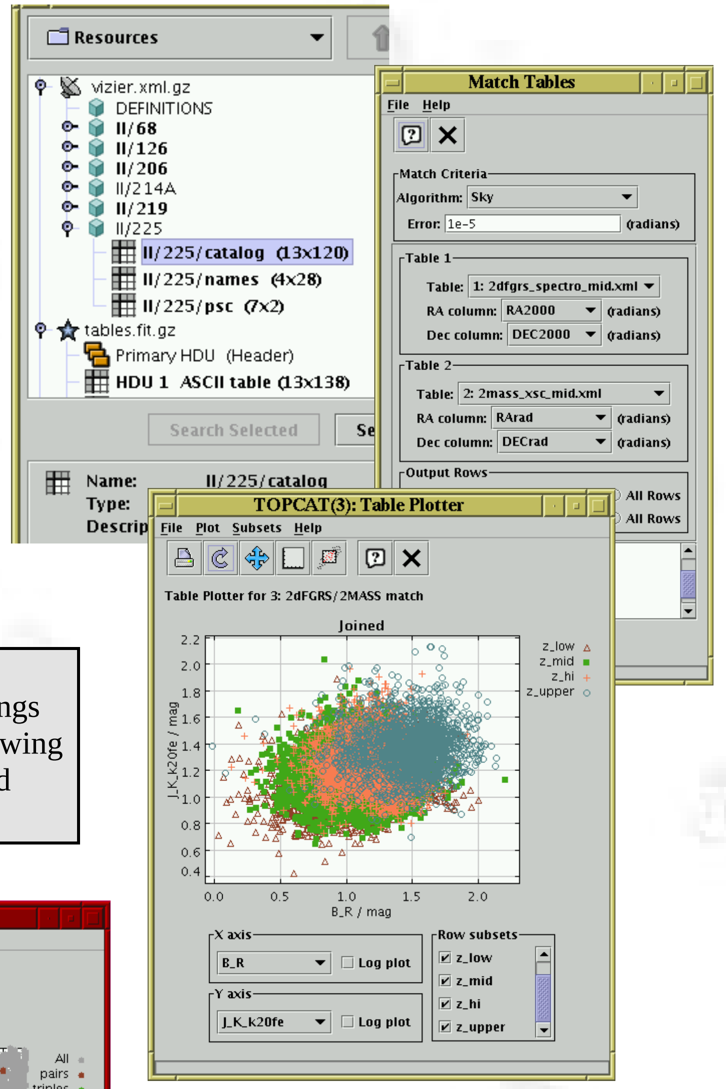
# TOPCAT: New Features

## TOPCAT is a Java app for dealing with Tables and Catalogues

### New TOPCAT Capabilities

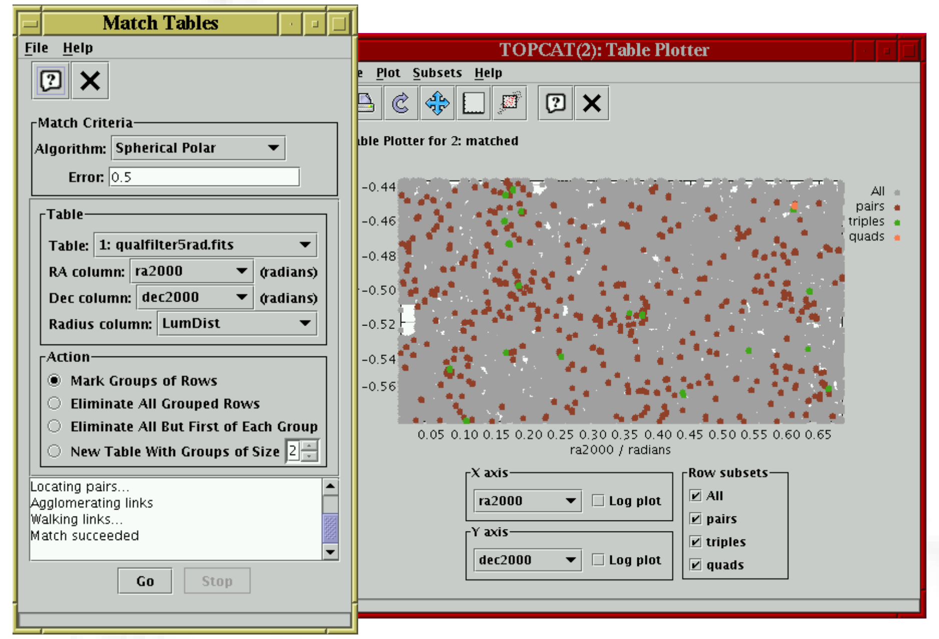
- Cross-matching function to join tables
  - Select columns to match and maximum error
  - Co-ordinates may be Sky, Sky+radius or *N*-d Cartesian
  - Locates pairs/groups of *N* objects
  - Performs inter- or intra-table matching
  - Fast, scalable algorithm
- Treeview-like browser for tables
  - Locates individual tables within complex VOTable documents or multi-extension FITS files
- Filename or URL, handles compression, looks inside tar/zip archives…
- New top-level window for better control of multiple tables
- Concatenation of tables
- Radian/Sexagesimal angle conversions


Resources
vizier.xml.gz
DEFINITIONS
II/68
II/126
II/206
II/214A
II/219
II/225
II/225/catalog (13x120)
II/225/names (4x28)
II/225/psc (7x2)
tables.fit.gz
Primary HDU (Header)
HDU 1 ASCII table (13x138)
Name: II/225/catalog

Match Tables
Match Criteria
Algorithm: Sky
Error: 1e-5 (radians)
Table 1
Table: 1: 2dfgrs_spectro_mid.xml
RA column: RA2000 (radians)
Dec column: DEC2000 (radians)
Table 2
Table: 2: 2mass_xsc_mid.xml
RA column: RArad (radians)
Dec column: DECrad (radians)

TOPCAT(3): Table Plotter
Table Plotter for 3: 2dFGRS/2MASS match
X axis: B_R ☐ Log plot
Y axis: J_K_k20fe ☐ Log plot
Row subsets: ☑ z_low ☑ z_mid ☑ z_hi ☑ z_upper

**Cross-matching capability**:
*below*—table cross matched with itself showing 3-d groupings
*to the right*—an infrared-optical colour-colour diagram showing different redshift ranges of cross-matched 2MASS XSC and 2dFGRS spectroscopic catalogues in the NGP region.


Match Tables
Match Criteria
Algorithm: Spherical Polar
Error: 0.5
Table
Table: 1: qualfilter5rad.fits
RA column: ra2000 (radians)
Dec column: dec2000 (radians)
Radius column: LumDist
Action
● Mark Groups of Rows
○ Eliminate All Grouped Rows
○ Eliminate All But First of Each Group
○ New Table With Groups of Size 2

```
Locating pairs...
Agglomerating links
Walking links...
Match succeeded
```

TOPCAT(2): Table Plotter
Table Plotter for 2: matched
X axis: ra2000 ☐ Log plot
Y axis: dec2000 ☐ Log plot
Row subsets: ☑ All ☑ pairs ☑ triples ☑ quads

### Starlink Table Interface Library (STIL)

provides TOPCAT's core table functionality, is available as a separate library for use in your own programs. Some STIL features are:

- Pure Java implementation for portability
- Format-independent, network-transparent, compression-aware table I/O
- Extensibility (you can write your own handlers for new formats)
- The only full implementation of VOTable I/O
- Large table support (doesn't necessarily load tables into memory)
- Supports many formats—input and output

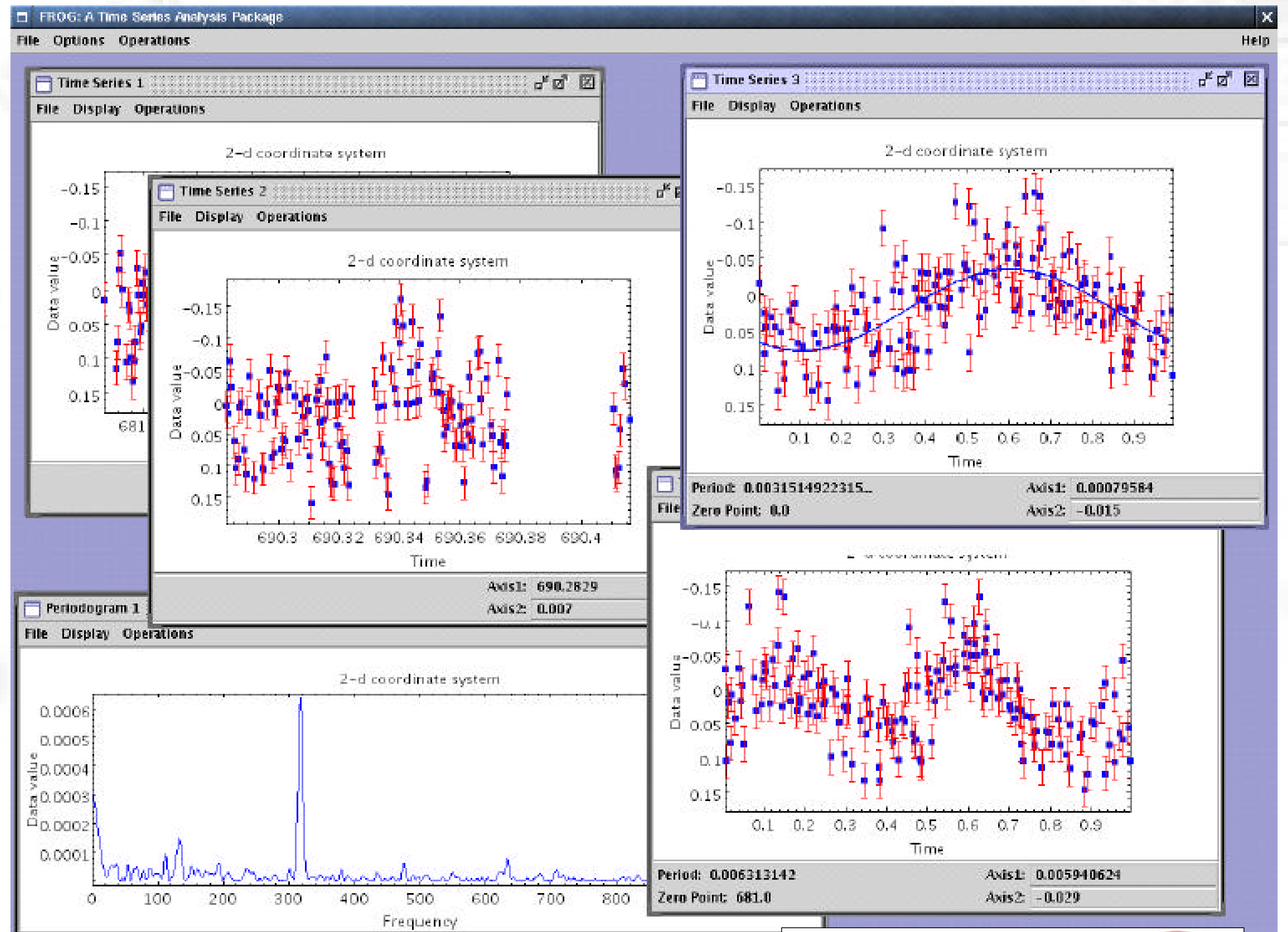
### As well as lots of improvements in its well known capabilities

- Comprehensive illustrated user document
  - Context-sensitive display within the program
  - Available off-line in HTML or PDF format
- Improvements to algebraic expressions (for synthetic columns etc)
  - Full null value handling
  - Plug in user-supplied java code at runtime
- More table output formats
  - Plain ASCII, HTML, LaTeX
  - All flavours of VOTable (TABLEDATA, FITS, BINARY)
- Column hide/reveal function
- Integral demo data (-demo flag)

~~Probably~~ the best VOTable library in the World

# New Time Series app: FROG

## FROG is a new Java application for dealing with Time Series


FROG: A Time Series Analysis Package
Period: 0.003151492231S... Zero Point: 0.0 Axis1: 0.00079584 Axis2: -0.015
Period: 0.006313142 Zero Point: 681.0 Axis1: 0.005940624 Axis2: -0.029
Axis1: 0 Axis2: 0.0003074619

V0.6.0+WS

FROG: A Time Series Analysis Package
Copyright 2002-2003 CCLRC
Developed under Linux i386 2.4.7-10smp
Sun JDK version 1.4.1_02

Author: Alasdair Allan <aa@astro.ex.ac.uk>
http://www.astro.ex.ac.uk/people/aa/

### Features

**Series Manipulation**
- combine individual time series and perform basic arithmetic functions
- detrend series (multiple methods)
- the data can also be exported directly into the Starlink TOPCAT application for further manipulation if needed

**Periodograms**
- try to predict sensible initial values to start exploration of frequency space for each dataset
- best (highest power) frequency can be identified automatically, and the originating series can be folded around this period with only two mouse clicks

**Folding & Binning Data**
- supports folding of the time series data, both binned and unbinned
- error bars, if available for the unfolded data, are propagated correctly

**Fake Data Creation**
- facilities for fake data creation

**Fitting Data**
- provides automated curve fitting for time series

**Easily extended**
- very easy for users to add support for their own favourite algorithms,
- easy to use the application as a display tool from their own code by creating a FROG instance

The FROG main window showing two time series in the upper left. The bottom shows a periodogram of one of these series, with the folds around the best two periods being displayed on the right. The upper of the two folds has been fitted with a *sin* and *cos* function.

**For more information see**
***http://www.starlink.ac.uk/frog***
**Suggestions for additional features are welcome**

Starlink bulletin

RUTHERFORD APPLETON LABORATORY August 2004 Issue No. 24

# Lifeboat for Starlink Software!

## Preparing for a Future without Starlink

**Starlink's role as a supplier of hardware and system administration services ended two years ago. Starlink software, on the other hand, has continued to be written and maintained, to meet the needs of its many users in the UK community and of UK-run observatories such as JAC. However, even the software service may have only 6 months left: current PPARC plans show no funding for Starlink after March 2005. The PPARC *UK Computing Applications Software Requirements Review* is to assess the current and likely future needs of the UK community for applications software, but, at the time of writing, this has yet to convene.**

**As we all know, the future belongs to the Virtual Observatory. Starlink has responded by working actively with the international VO community and by making its extensive suite of astronomical reduction and analysis applications VO-ready, and is in fact the only major provider to be doing so.**

**Starlink software is used extensively and has unique capabilities. The danger that the community faces is that a dispersal of Starlink's world-class team is looming and the software will consequently die.**

**To prepare for the worst, we have recently completed the major task of putting all the code in an open source repository (details overleaf) and making the system build like other very large and complex open source projects. Although this "lifeboat" will keep the many Starlink applications safe, the software will no longer move to keep up with astronomers' research needs.**

## What about AstroGrid?

**AstroGrid is not developing general astronomical applications—instead it assumes these are obtained from other sources. It has yet to announce how such applications might be integrated.**

## Be Prepared

- **Are you ready for the Virtual Observatory era?**
- **What applications will you use?**
- **What infrastructure will you use?**
- **How will you process all the data?**

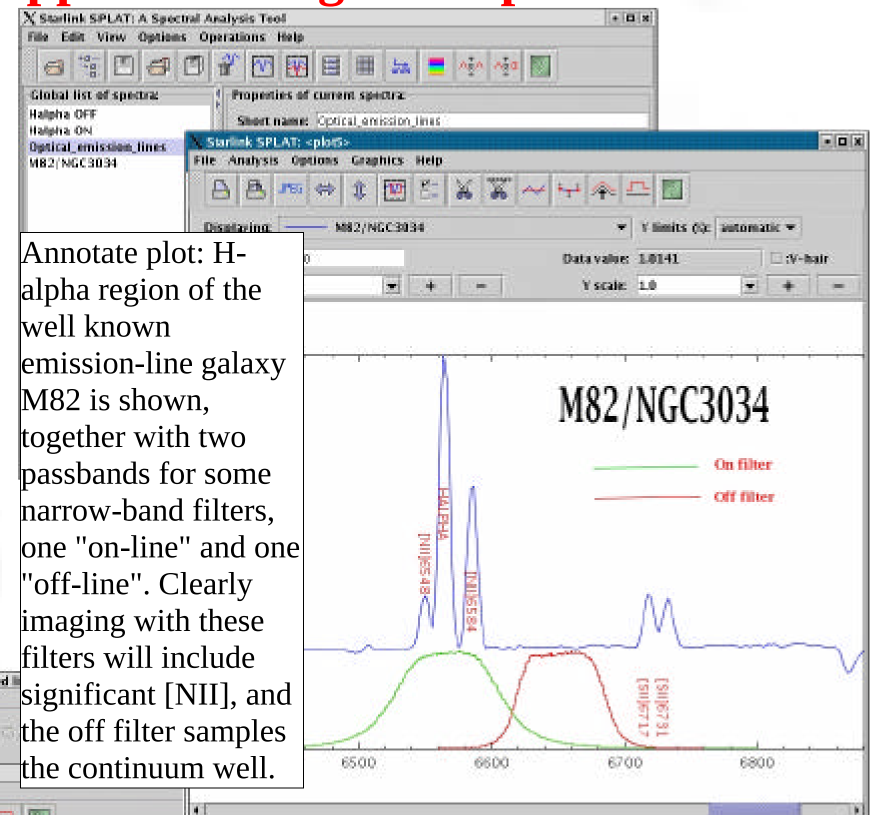
**Make sure you have real software for the Virtual Observatory.**

# SPLAT: New Features

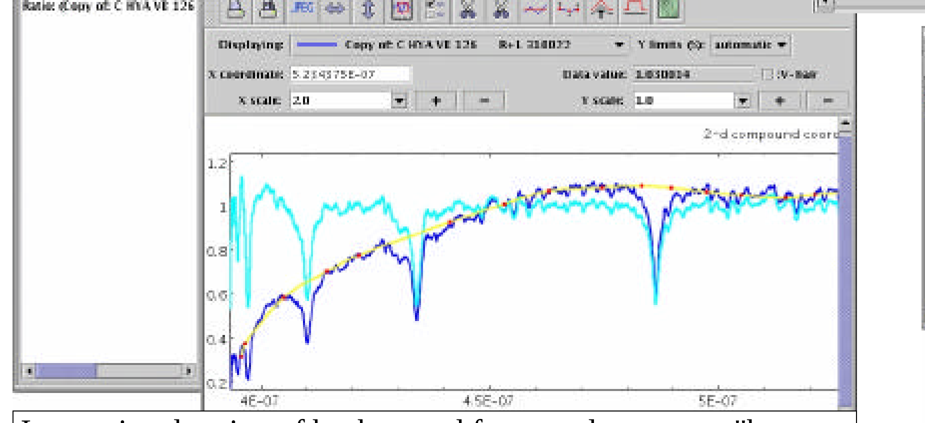
## SPLAT is a Java app for dealing with Spectra

### Major changes to SPLAT in the Spring 2004 release are:

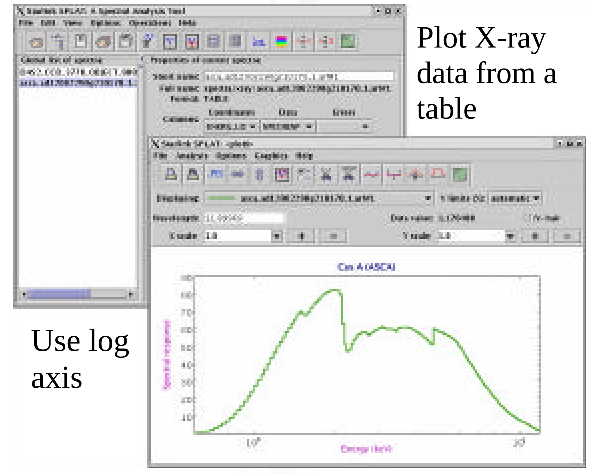
- **Tables support**
- **Fit multiple components to blended lines**
- **Enhanced background fitting**
- **Allow users to annotate plots**
- **Data selection via built-in Treeview data explorer**
- **Drag and drop with Treeview**
- **Log plots**
- **User can select columns in table for X, Y and error**


Starlink SPLAT: A Spectral Analysis Tool
Global list of spectra: Halpha OFF, Halpha ON, Optical_emission_lines, M82/NGC3034
Properties of current spectra: Short name: Optical_emission_lines
Starlink SPLAT: <plot5>
Displaying: M82/NGC3034 Y limits (X): automatic
Data value: 1.0141 X scale: 1.0 Y scale: 1.0

Annotate plot: H-alpha region of the well known emission-line galaxy M82 is shown, together with two passbands for some narrow-band filters, one "on-line" and one "off-line". Clearly imaging with these filters will include significant [NII], and the off filter samples the continuum well.

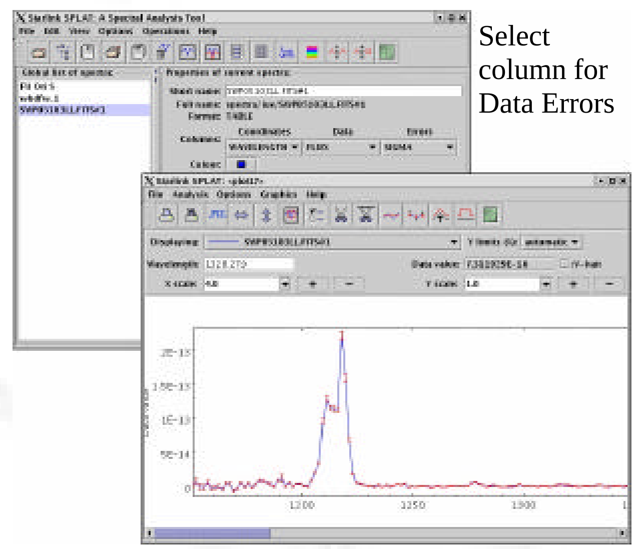

Starlink SPLAT: Panner for <plot4>
Starlink SPLAT: Generate spectra from interpolated line
Subtract line from spectrum: ● No ○ As base line
Divide spectrum by line: ☑
Interpolated line: 4
Ratio: (Copy of: C HYA VE 126
Starlink SPLAT: <plot4>
Displaying: Copy of: C HYA VE 126 R=1 310022 Y limits (X): automatic
X coordinate: 5.2343375E-07 Data value: 1.030014
X scale: 2.0 Y scale: 1.0

Interactive drawing of background for complex spectra "by hand" using popular spline-like interpolation (Hermite, Akima and natural). You can see the result of drawing such a line, converting it to an interpolating spectrum and then using that to normalize the absorption spectrum.

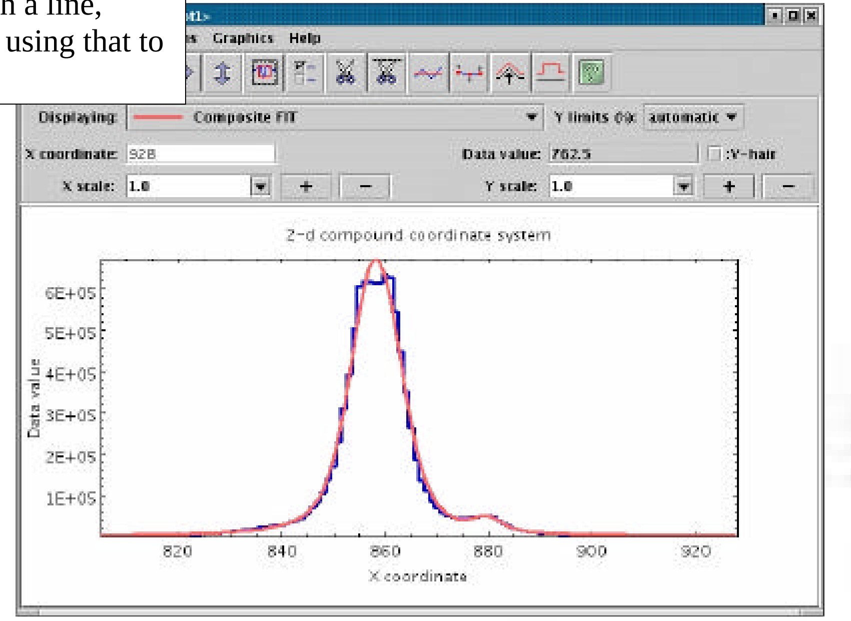

Starlink SPLAT: A Spectral Analysis Tool
Starlink SPLAT: <plot5>

Plot X-ray data from a table

Use log axis


Starlink SPLAT: A Spectral Analysis Tool
Global list of spectra
Properties of current spectra
Short name: SWP05181LLLFITS#1
Format: TABLE
Columns: Coordinates WAVELENGTH Data FLUX Errors SIGMA
Starlink SPLAT: <plot17>
Displaying: SWP05181LLLFITS#1

Select column for Data Errors


Graphics Help
Displaying: Composite FIT Y limits (X): automatic
X coordinate: 928 Data value: 762.5
X scale: 1.0 Y scale: 1.0

Facilities for fitting multiple components to a blend of lines.

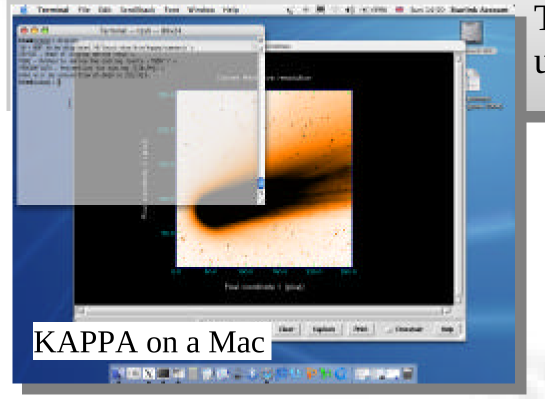
# Real Applications for the Virtual Observatory

## Open Source Starlink

We have changed Starlink into a "standard" Open Source project. This will allow many more people to contribute and allows us to use the many powerful Open Source tools now available.

### *checkout, configure, make*

Another benefit is the ability to build and run Starlink Classic software (KAPPA, GAIA etc) on a greater variety of systems, including the many varieties of Linux, MacOS X and, eventually, MS Windows. This will allow, for example, just about all types of machines to be used in the mini-GRID described below.



KAPPA on a Mac

## Self-organising mini-GRID

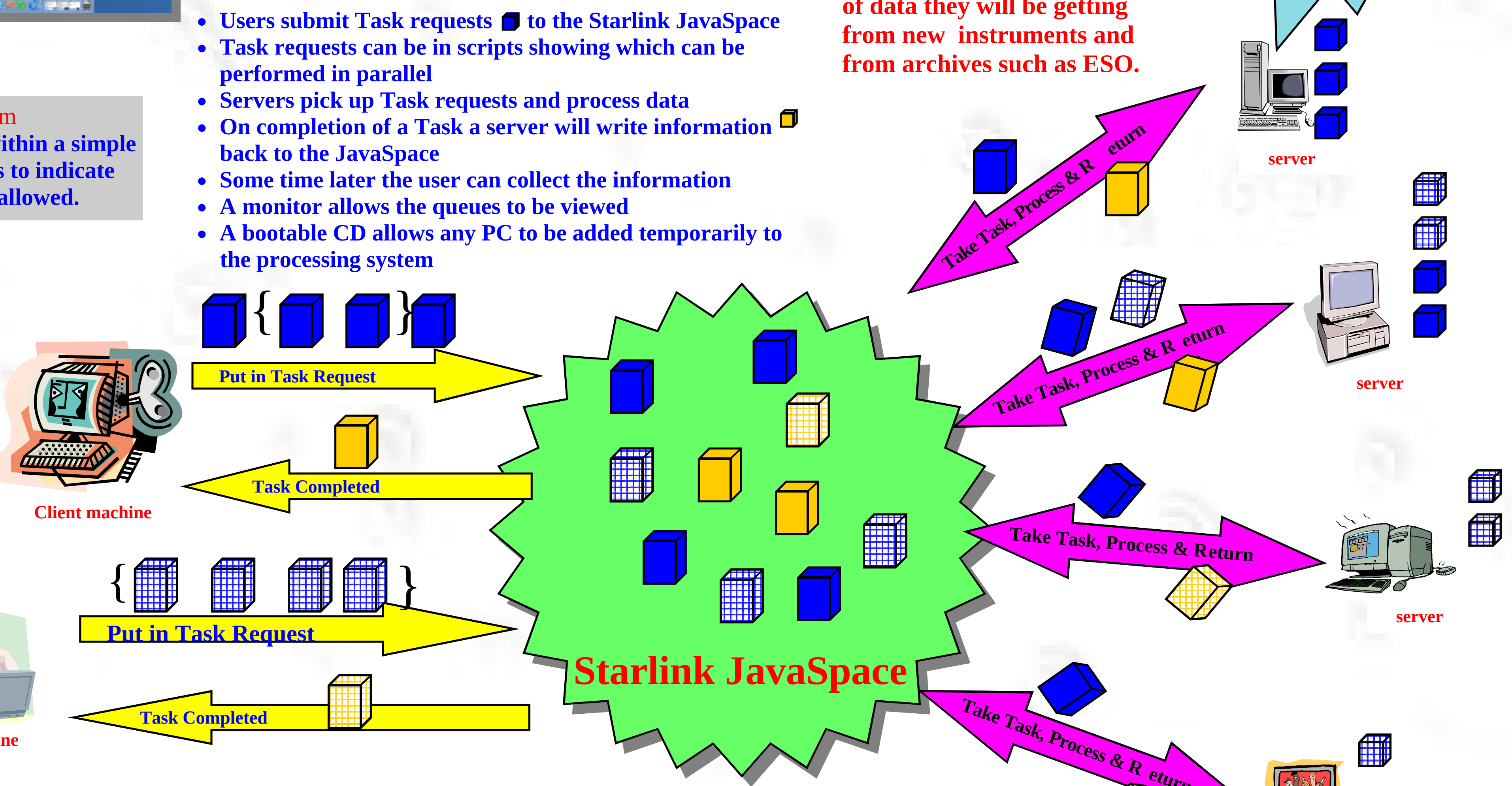
as demonstrated at NAM 2004
and currently being upgraded before release

- Users submit Task requests ■ to the Starlink JavaSpace
- Task requests can be in scripts showing which can be performed in parallel
- Servers pick up Task requests and process data
- On completion of a Task a server will write information ■ back to the JavaSpace
- Some time later the user can collect the information
- A monitor allows the queues to be viewed
- A bootable CD allows any PC to be added temporarily to the processing system

**This type of highly automated workflow controlled "mini-Grid", complementing ORAC-DR, will be necessary for users to process the large amounts of data they will be getting from new instruments and from archives such as ESO.**

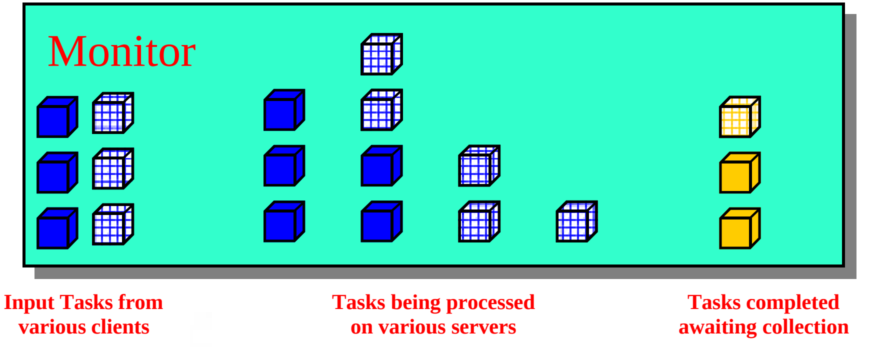
**Distribution and Workflow**

Parallelism
**Tasks can be input within a simple script, using brackets to indicate where parallelism is allowed.**



Pipelines
**ORAC-DR and ORAC-DR related scripts can reduce data in a distributed, parallel system**

Fire and Forget
**Clients can submit Tasks then come back some time later to collect the finished product**


Monitor
Input Tasks from various clients
Tasks being processed on various servers
Tasks completed awaiting collection

Transactions
**In the case of network or server failures, transaction handling will ensure that an incomplete Task is handled by another machine.**

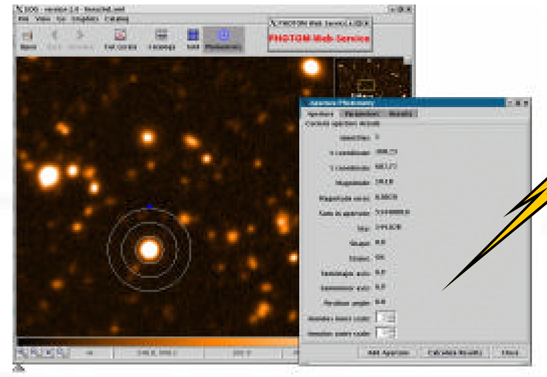
Add Processing Power
**Any PC can be temporarily added to the system by booting from the StarBoot CD. This provides Linux, Starlink applications and server Tasks. The existing OS is untouched.**

## Web Services are being used to integrate Starlink's Classic and new Java applications together, and also into the GRID. This shows some of the new capabilities.

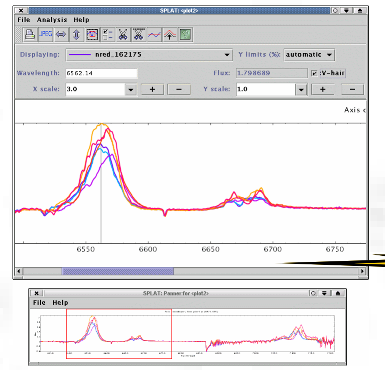
Helper applications are invoked via Web Services if available, or within JVM etc

**Web Services**

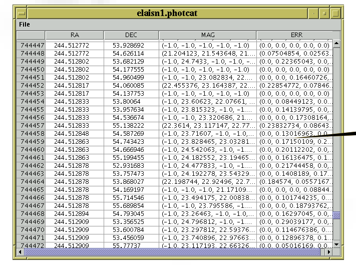
SOG—for detailed image analysis

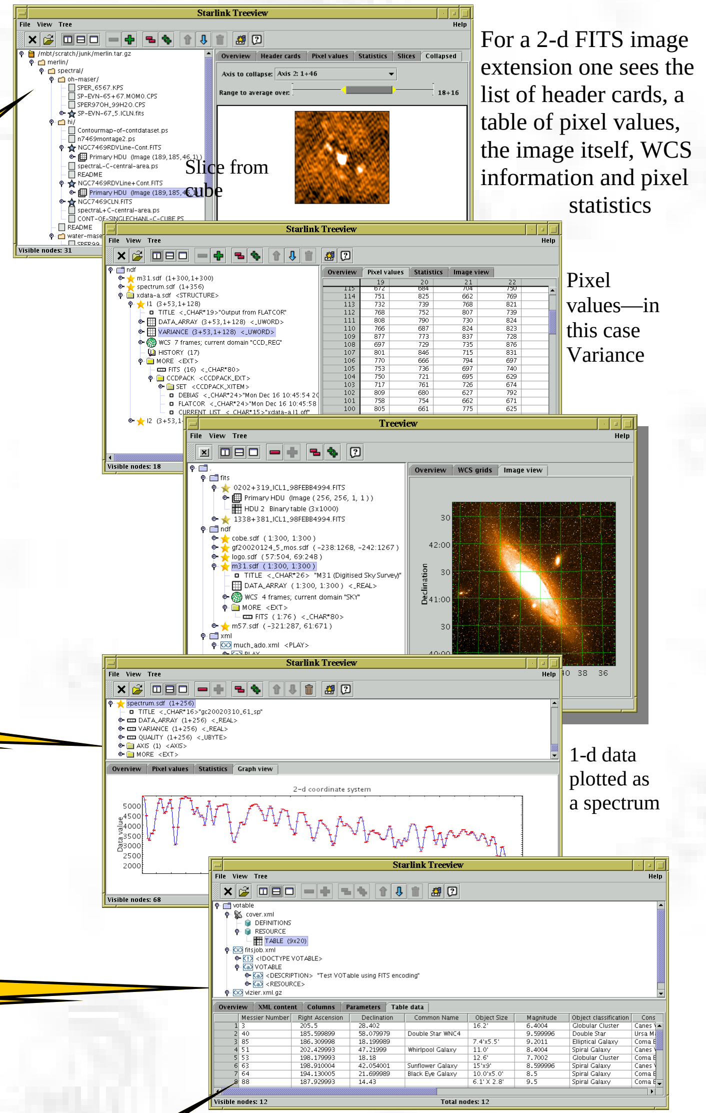


SPLAT—to analyse spectra



TOPCAT for table viewing, plotting and editing





For a 2-d FITS image extension one sees the list of header cards, a table of pixel values, the image itself, WCS information and pixel statistics

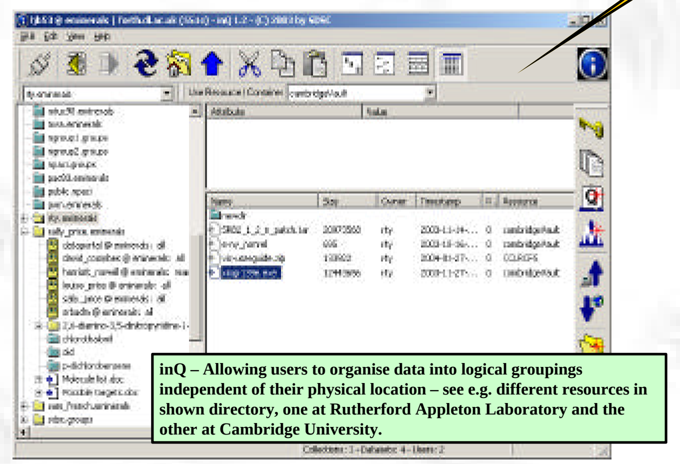
Slice from cube

Pixel values—in this case Variance

1-d data plotted as a spectrum

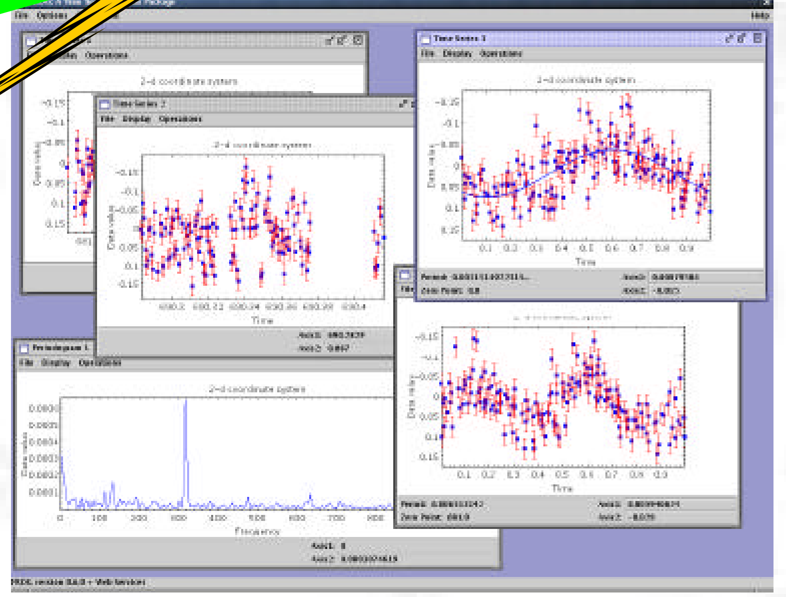
Tabular data and metadata is displayed appropriately

### Storage Resource Broker



inQ – Allowing users to organise data into logical groupings independent of their physical location – see e.g. different resources in shown directory, one at Rutherford Appleton Laboratory and the other at Cambridge University.

FROG for analysing Time Series



## Starlink Classic and Web Services

Starlink Classic applications have been wrapped with Java to allow us to integrate them with

- Virtual Observatory applications;
- new Starlink Java applications; and
- Intelligent Work Flow systems such as ORAC-DR.

### Integrating Starlink applications into *your* favourite VO using Web Services

Because Starlink applications have Web Service interfaces, they can easily be integrated into Virtual Observatory systems.

Applications can used locally as normal, but where appropriate they also expose functionality via a built in web server as a SOAP web service. The web service is language neutral and can be accessed using a variety of SOAP toolkits in languages that include Perl, Python, PHP, Java, C, C++ and even Fortran.

This means that Starlink applications can be used from your own code or scripts for either display, or data processing, without having to learn Java or write a lot of code; client side programs can be a short as a few lines depending on the language and toolkit chosen. We are also

- developing GUIs to allow easy access to the VO registries which are being created; and
- investigating using tools being developed by the many other "GRID" projects, for example Storage Resource Broker (SRB) as a data source for Treeview

### Java applications and Web Services

New Java applications such as Son of Gaia (SOG) use Web services to communicate with Starlink Classic applications to provide additional capabilities such as Photometry measurements.

## ORAC-DR and Web Services

ORAC-DR uses Starlink applications to process data. The messaging system is being converted to Web Services. This allow greater flexibility and when completed will allow ORAC-DR pipeline processing to be distributed between available machines.

**In today's era of vast data rates and massive multi-spectral archives it is important to be able to:**

- **encapsulate knowledge about unfamiliar instruments and wavelength regimes;**
- **create a calibrated spectrum or mosaic with the minimum of fuss; and**
- **reduce large volumes of data automatically.**

**An intelligent pipeline can provide these capabilities. It also is important for quality assessment at a telescope.**

## *In the pipeline:*

- **Integration with International Virtual Observatory Alliance (IVOA) Registries**
- **New data Visualisation and Data Exploration tools**
- **Yet more TOPCAT features**
- **Integration of IVOA Time and Coordinate systems… and lots more …**
- **A steady release of real software for the Virtual Observatory**

## Obtaining Starlink Software

**We are no longer sending out CD-ROMs; instead we are making stable releases available on**

***http://www.starlink.ac.uk/Download***

**and the latest source code and nightly cutting-edge builds for many platforms will be made available on**

***http://dev.starlink.ac.uk***

Please take a look and let us know if you have problems.

### New Features on the latest software release (release 219)

There are many improvements to Starlink **CLASSIC**, including a **major release of GAIA**—now with two new automated astrometry toolboxes, and many other updates.

Bug reports can be made using Bugzilla via ***http://dev.starlink.ac.uk***.

### Site Visits

We have been visiting sites to demonstrate Starlink software and to find out what users need next. If you would like us to visit your site please email ***d.giaretta@rl.ac.uk***.

### New Open Source build and release system

Because of the likely increase in the number of Operating Systems used by UK astronomers—many flavours of Linux, Solaris, Tru64, Mac OSX and even MS Windows, we have changed our build system. If you cannot find a ready-made ISO image then you can download the source code and build it yourself, just as you would any other Open Source software.

### Contact information

| | |
|---|---|
| **World Wide Web :** | *http://www.starlink.ac.uk* |
| **E-mail:** | *ussc@star.rl.ac.uk* **(or** *quick@star.rl.ac.uk* **for small programming requests)** |
| **Anonymous ftp :** | *ftp.starlink.ac.uk* |
| **News service:** | *http://www.starlink.ac.uk/news.html* |
| **Newsgroup:** | *uk.org.starlink.announce* |
| **Software Store:** | *http://www.starlink.ac.uk/cgi-store/storetop* |
| **Telephone:** | *David Giaretta 01235 446235* |

**Don't forget the full range of Starlink software is available as an ISO image, with the new easy installation procedure. Updates for applications and support for new instruments in ORAC-DR are made available on the Web site**

***http://www.starlink.ac.uk***