Starlink Software Developments

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Introduction

In 2005 Starlink software came under the auspices of the Joint Astronomy Centre, Hawaii, where it plays a vital role in real-time data-reduction pipelines. The software has continued to be developed for the data reduction and analysis for new instruments at JAC, particularly for spectral cubes from the James Clerk Maxwell Telescope. This poster outlines the changes made since 2005, but not presented in other posters or at earlier ADASS conferences.

KAPPA – Kernel Package

Three-dimensional support:
CHANMAP plots a two-dimensional tiled map of channels from a cube
CLINPLOT draws a spatial grid of line plots for an axis of a cube
COLLAPSE many new estimators targetted at cube analysis
MFITTREND fits independent trends to data lines in a cube
Smoothing and rotation to all planes in a cube
SQORST can resample to specified WCS scales per pixel

Other new tasks:
BEAMFIT Fits up to five Gaussians to beam features with various optional constraints such as width or separation
INTERLEAVE forms higher-resolution data by interleaving a set of files
WCSMOSAIC aligns and co-adds a group of NDFs using WCS information

Improved applications:
REGRID and **WCSALIGN** have optional flux conservation
Improved surface fitting:
SURFIT uses SVD to obtain polynomial-fit errors
FITSURFACE and **MAKESURFACE** fit and evaluate bi-cubic splines
Statistics:
More ways to compute the mode with **HISTAT**
Reporting of positions of extreme values in world co-ordinates
Cumulative histogram in **HISTOGRAM**
Non-sticky changes to plotting style in some tasks
Support for AST SpecFrames and FluxFrames
Alignment of plots with old plots via any suitable co-ordinate system

SPLAT – spectral analysis

+ Fuller support for dual-sideband spectra
+ A synopsis of the properties of the current spectrum
+ More standard sub-millimetre lines
+ Interoperate with the VO, using SSAP Version 1 queries
+ PLASTIC support for sending and receiving spectra from other PLASTIC-enabled applications
+ Support for data units, including transformations between common flux systems
+ Region statistics tool
+ New smoothing filters, Hann, Hamming, Welch and Barlett
+ Useability improvements, mostly many more keyboard interaction

GAIA – image display and analysis

Major upgrade to support three-dimensional data presented at a Forum last year, and also see P1.067 (P.W. Draper) for further developments. Some of the non-3D enhancements include the following.

+ Display of FITS in-line compressed images.
+ PLASTIC enabled so can send and receive images and receive catalogues
+ Various new default on-line catalogues available
+ Rotatable box item now available as a catalogue plotting symbol

Subroutine Libraries

AST: Major developments. See poster P1.054 (D.S.Berry)
**ARD:** Can refer to regions within time or spectral co-ordinate systems
GRP, **HDS**, and **NDG** have official C interfaces
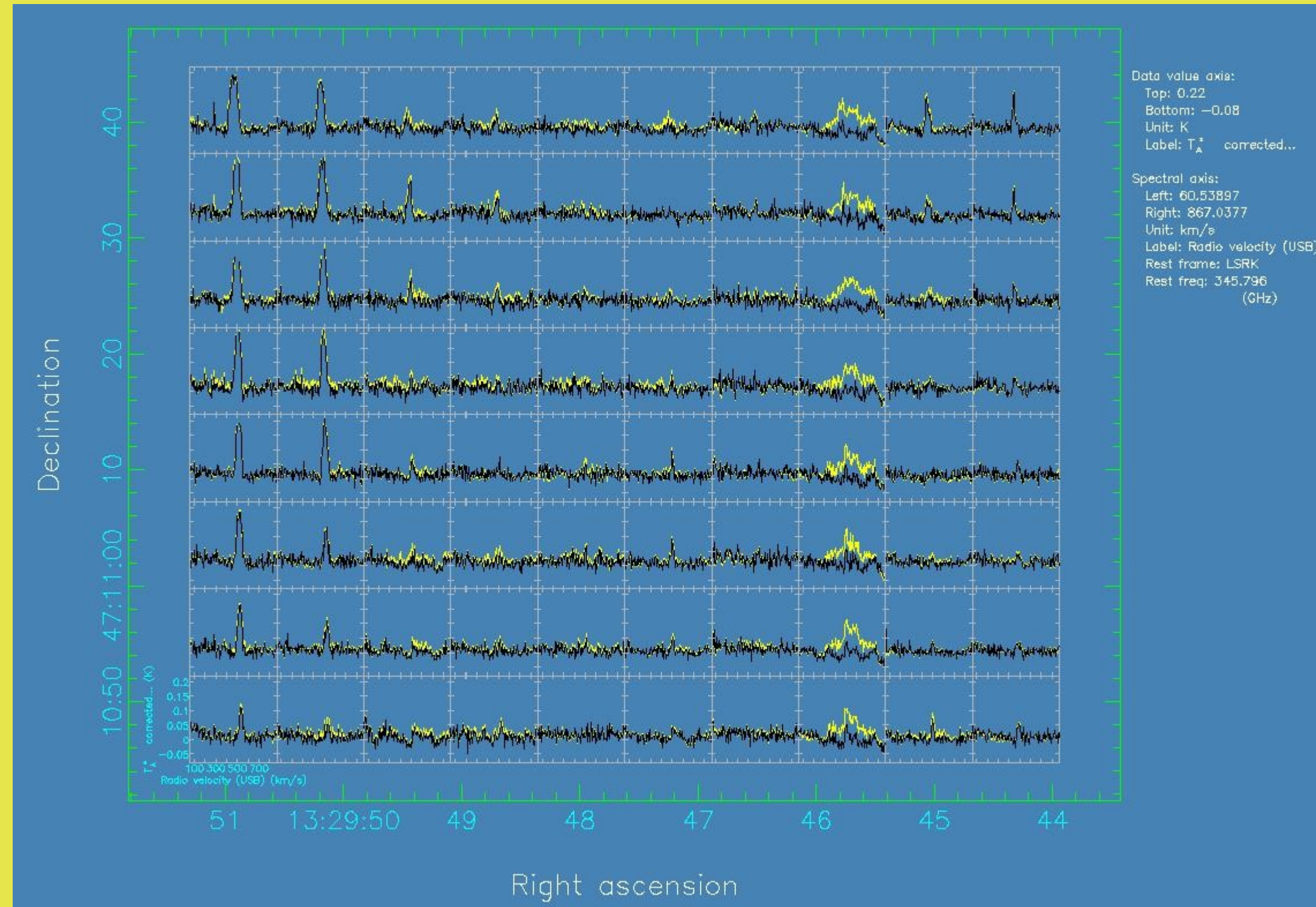
An example of CLINPLOT. Each box shows a raw spectrum (in yellow) at the spatial position given by the outer axes. The annotations around the lower-left spectrum are the axes for each line plot. The dark-green curves overlaid have the line trends removed automatically (algorithms still under development). The combination of WCS knowledge and a graphic database allows different datasets to be compared on the same plot.
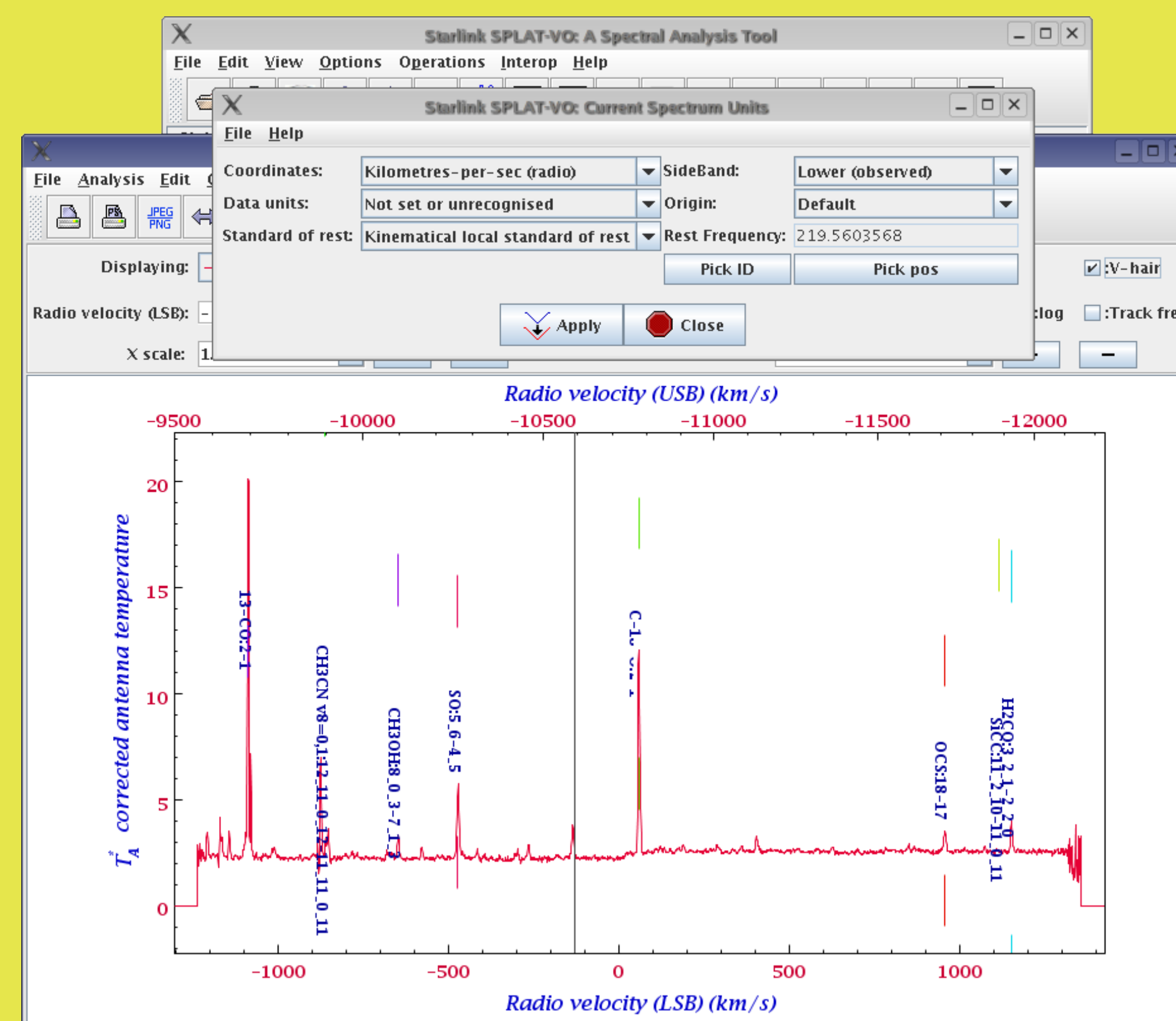
SPLAT displaying a dual-sideband (see P1.054) sub-millimetre spectrum from the JCMT, with the two sideband velocity systems shown. Standard lines have been overlaid and corrected for the source velocity. Note that the rest frequency can be trivially changed to that of one of the lines, or a picked velocity, as can the co-ordinate system and selected sideband.
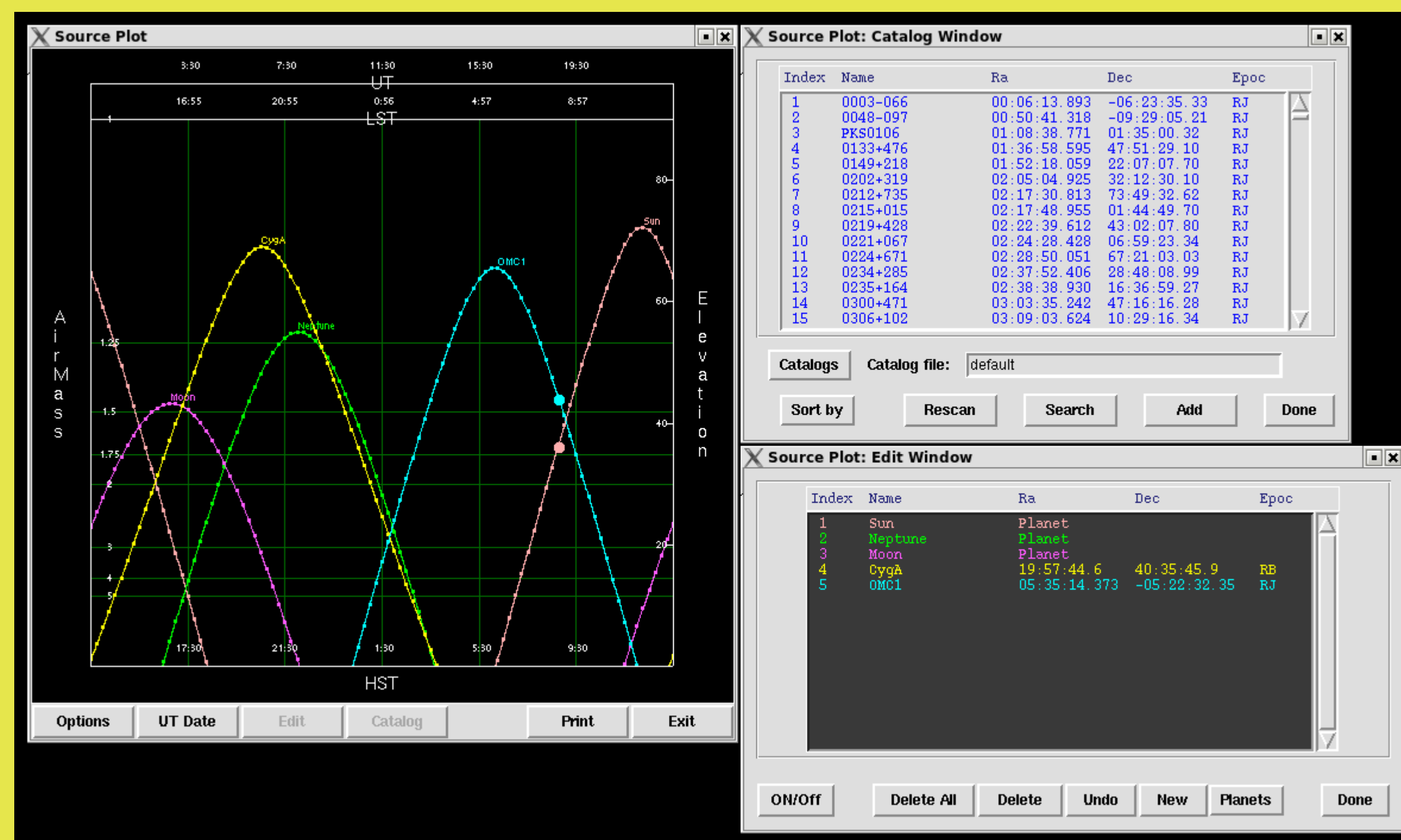
Example SOURCEPLOT graphics that shows the positions of the Sun, Neptune, the Moon, Cygnus A, and OMC-1 from the JCMT for 2007 September 19. Also shown is the default source catalogue, which includes 383 astronomical sources. All of the planets, the Sun, and the Moon are available for plotting as well, and you can add your own sources or import your own catalogue.

General

+ GPL licence
+ Builds with standard GNU autotools from an SVN repository
+ Works on 64-bit systems
+ Builds on Intel Solaris 10, and with full Intel compiler suite, and gfortran (GCC4.3)

Data System

+ HDS supports files >2GB on 32-bit machines, and individual arrays >2GB on 64-bit systems
+ 64-bit files created by default
+ Can include ".sdf" file extension when supplying the name of an HDS (such as an NDF) file
+ Scaled NDFs for compression
+ NDF sections can be specified using world co-ordinates, for example
  `cube(12:34:56.7,-41:52:09,400.0:650.0)`
  might extract a spectrum from a cube at the given sky position between 400 and 650 km/s, and
  `ifu(1h34m10.1s:1h34m12.4s,2d35m:2d35.5m,656.3)`
  specify a region of sky 2.3s by 0.5 arcminutes at Halpha from an IFU.

CONVERT – format conversion to and from NDFs

+ On-the-fly conversion of compressed FITS
+ **NDF2FITS** supports
  * multi-NDF files,
  * writes CHECKSUM and DATASUM keywords,
  * converts in-line compressed images (RICE, GZIP, PLIO)
+ FITS converters:
  Have AIPS++ and CLASS encodings
  Scaled arrays are converted without loss of compression
+ **SPECX2NDF** can create NDFs with dual-sideband SpecFrame

DATACUBE – scripts for automating spectral cube analysis

Major overhaul and update including User Guide and Cookbook documentation reflecting the state of 3-D tools in early 2006.
+ Generalised to work for arbitrary datacubes not just optical IFUs
+ Support for NDF sections
+ All scripts improved and enhanced, notably **VELMAP**. Improvements include the map output in one of four velocity systems, recognition of dual-sideband spectra and an optional velocity key
+ Addition **GRIDSPEC** averages and plots groups of neighbouring spectra
+ Addition **VELMOMENT** builds a velocity map from collapsed intensity-weighted spectra, it also has optional spatial compression
+ Clearer spectral plots, and more control of contouring

New Packages

CUPID: ClU**m**P **ID**entification in up to three dimensions, introduced at ADASS XVI
SMURF: Sub-**M**illimetre **U**ser **R**eduction Facility. See P1.082 (T.Jenness et al.)
SOURCEPLOT plots astronomical objects in altitude and azimuth for a supplied point on the Earth (example to the left)

ORAC-DR Data reduction pipeline

+ Support for infrared spectropolarimetry
+ Support for WFCAM, including automated astrometry correction
+ Support for ACSIS

For further details and how to obtain the software please visit `http://starlink.jach.hawaii.edu/`

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