A fully automated data reduction pipeline for the FRODOSpec integral field spectrograph

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The Liverpool Telescope 1

The Liverpool Telescope (LT, Steele et al. 2004) is a 2.0 metre robotic telescope that is operating unattended at the Observatorio del Roque de Los Muchachos Observatory on La Palma, Spain. Achieving first light in April 2009, the Fibre-fed RObotic Dual-beam Optical Spectrograph (FRODOSpec, Morales-Rueda et al. 2004) succeeded the now decommissioned Meaburn Spectrograph and has been a common user instrument since 1st February 2010.

What is FRODOSpec? 2

FRODOSpec is a bench mounted spectrograph with two optical paths, known as arms, that are utilised by separating the incident light around 5750Å into two bandwidths using a dichroic beam-splitter. The light is collected by a 12x12 fibre integral field unit (IFU) covering 10"x10" at the focal plane of the telescope. Two dispersive elements are available for each arm: a conventional diffraction grating and a higher resolution Volume Phase Holographic (VPH) grating. The specifications for each arm are shown in Table 1.

Arm / Dispersive Element	Wavelength Start (Å)	Wavelength End (Å)	Resolution	Dispersion (Å/px)
Red Grating	5800	9400	2200	1.6
Red VPH	5900	8000	5300	0.8
Blue Grating	3900	5700	2600	0.8
Blue VPH	3900	5100	5500	0.35

Table 1. Wavelength ranges, resolving powers and dispersions for the different FRODOSpec arms/dispersive elements.

Pipeline Objectives 3

- To have full quality control over the data products produced.
- To autonomously produce a composite raster image previewing the data products (e.g. Panel 7).
- To autonomously produce a science-ready data product.

Coding Platform and Output Data Products 4

Data taken by FRODOSpec is reduced by two sequentially invoked pipelines: the L1, a generic CCD processing pipeline, and the L2 (of which this poster details), which performs the processes specific to the reduction of data taken using an integral field spectrograph.

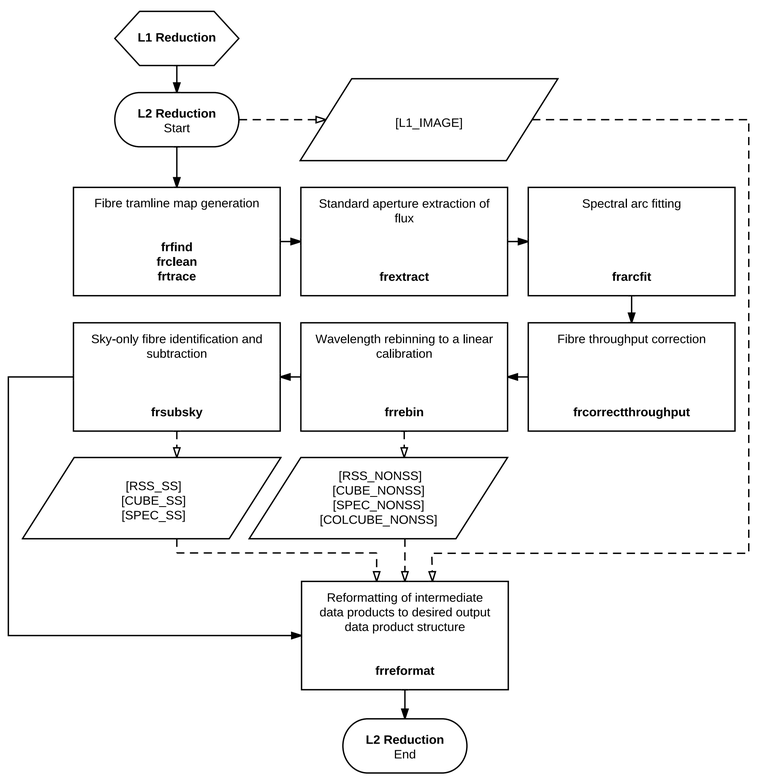
The L2 consists of a series of programs written in C using the GNU Scientific Library (GSL, Galassi et al. 2009) and CFITSIO (Pence 1999) library. The binaries are linked by scripts written in TCSH, with the composite image preview generation scripts requiring ImageMagick and GNUplot.

The output science-ready data product (Table 2) is an eight part multi-extension FITS (Hanisch et al. 2001) file with each extension containing a snapshot of the data taken at key stages of the reduction process.

HDU Index	EXTNAME	Format	Wavelength Calibrated?	Throughput Corrected?	Sky Subtracted?
0	L1_IMAGE	Image			
1	RSS_NONSS	RSS	✓	✓	
2	CUBE_NONSS	Datacube	✓	✓	
3	RSS_SS	RSS	✓	✓	✓
4	CUBE_SS	Datacube	✓	✓	✓
5	SPEC_NONSS	Spectrum	✓	✓	
6	SPEC_SS	Spectrum	✓	✓	✓
7	COLCUBE_NONSS	Image		✓	

Table 2. The output data product format. Row Stacked Spectra (RSS) frames are used to display each extracted spectrum as a single row of height one pixel. Datacubes reimage the focal plane at each wavelength using the IFU input to output head mappings (two spatial axes, x and y, and the dispersion axis, z). The final extension is an IFU fibre matrix image of the focal plane, which is the CUBE_NONSS extension with a collapsed dispersion axis.

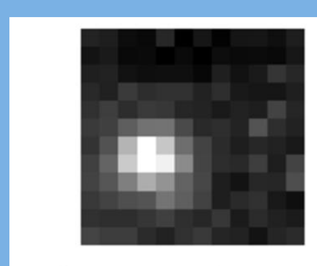
L2 Reduction Method Overview 5



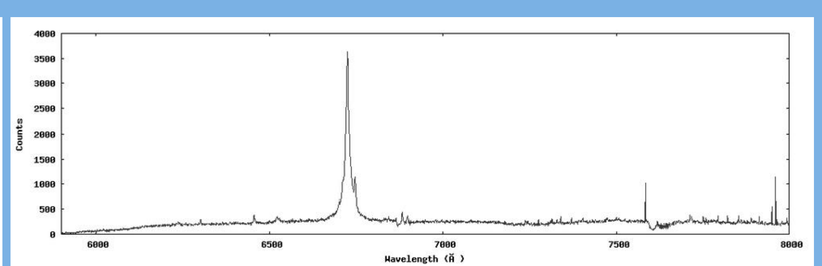
Considerations and Conclusions 6

- Currently no removal of scattered light (contributes <2% of total distribution)/cosmic rays, or correction for DAR.
- Assuming a single gaussian for the shape of the spatial fibre intensity profile, cross-talk can be considered negligible given the projected fibre width and separation.
- A possible future enhancement to the L2 is the optimal extraction of flux (Horne 1986).
- >99% of observations are reduced to an extracted, wavelength calibrated and throughput corrected spectrum with an execution time of ~ half a minute.
- More information can be found on the instrument page: http://telescope.livjm.ac.uk/Info/TelInst/Inst/FRODOspec

Image Preview Example 7



Bundle reconstruction (COLCUBE_NONSS)



Non sky subtracted spectrum (SPEC_NONSS)

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