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PROGRESS REPORT

U of L FTS

Summary

Work in February included data processing tests and writing data simulation software. Results of last October's FTS run at the JCMT are presented.

Detailed Description

Project Management
The current FTS project plan has been posted at: http://research.uleth.ca/scuba2/reports
David Naylor will be observing at the JCMT for the first week of March. This will be the last run for the U of L FTS, and our last chance to test the step-and-integrate and aliasing observing modes with an astronomical system before SCUBA-2 is delivered.

Software
We have secured funds to purchase a fast 80x80 pixel CCD camera system and calibration target for software prototyping. This will increase the speed and dynamic range of our prototype IFTS, and allow more detailed tests of our data processing algorithms. We expect delivery of this system in late March or early April.

Software has been written which generates simulated interferogram data cubes. These data sets will allow us to test future pipeline software. The simulation does not yet include the frequency response of the bolometers, and will need to be modified to calculate the signal time series when, for example, the mirror moves quickly between successive step-and-integrate positions.

Data Analysis
During an observing run last October, we managed to acquire back-to-back observations of the Orion KL region with the U of L FTS in both the normal rapid-scan and the aliased step-and-integrate modes. We have finally analysed these data, and the results of the aliasing and step-and-integrate techniques are promising. A brief discussion of the results follows below; the full analysis will be presented in an upcoming paper.

The weather during the run was particularly bad, and the only data that we were able to get was taken under 7 mm PWV. Approximately 30 minutes of rapid-scan data and 30 minutes of step-and-integrate data was taken. The rapid-scan data was taken alternately on-source and off-source, with an offset of 2340" in RA. Source and background observations were composed of an 'up' scan and a 'down' scan, referring to the direction of travel of the moving mirror. The time for each of these scans was on average 73 seconds, giving a total time for one pair of on-source/off-source observations of 2:26 minutes. In total, there were 24 scans taken (12 pairs of on-source/off-source observations) over ~30 minutes. The corresponding spectra are shown in Figure 1.

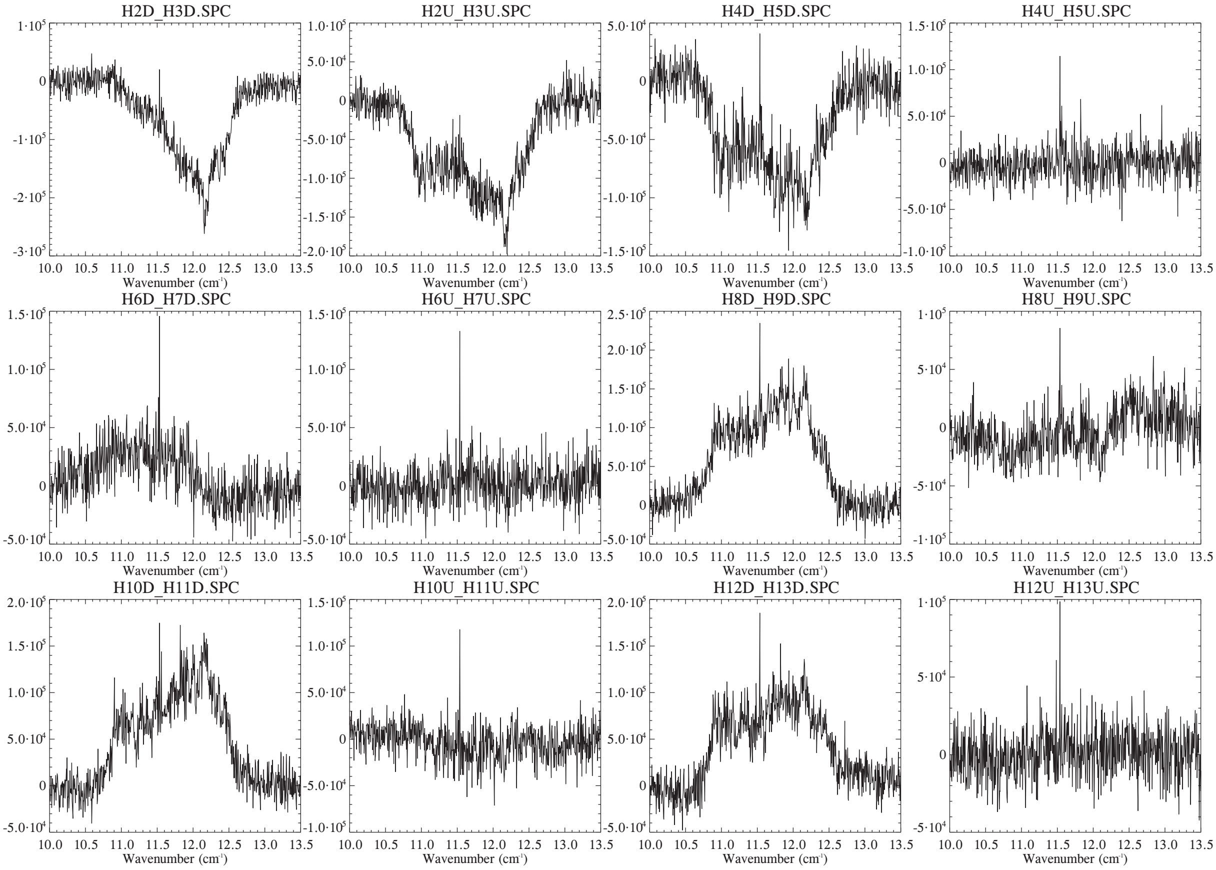

Figure 1. Difference between 12 pairs of rapid-scan spectra.

Although the CO line is visible in all the spectra, several spectra exhibit non-physical continuum levels. This is due to atmospheric variation within the 2 minutes between on-source and off-source scans. The key, then, is to acquire interferograms as quickly as possible so that the on-source and off-source scans are taken under similar sky background. Since the continuum in the spectrum is determined by the ZPD region of the interferogram, and the scan speed is limited by the detector frequency response, there is a limit to how quickly successive interferograms can be acquired and how well we can cancel the atmospheric background in the rapid-scan mode.

The alternative is the step-and-integrate mode, where the secondary mirror chops on and off-source and a lock-in amplifier provides the difference signal at each interferogram sample position. This mode has the drawback of taking a second at each sample position, so a 5000 point scan with a Nyquist frequency equivalent to the rapid-scan interferogram would take over 80 minutes and would therefore be susceptible to variations in atmospheric transmission. Our technique is to make use of the well-defined bandpass of the filters to sample the interferogram more sparsely by a factor of 4, intentionally 'aliasing' the spectral band into 0-5 cm^{-1} instead of 0 to 20 cm^{-1}. This reduces the scan time to a more reasonable 28 minutes. Figure 2 shows the resulting spectrum (black trace), shifted back to the proper frequency range, and overlaid with the average of the difference of the three good pairs of rapid-scan data (red trace).

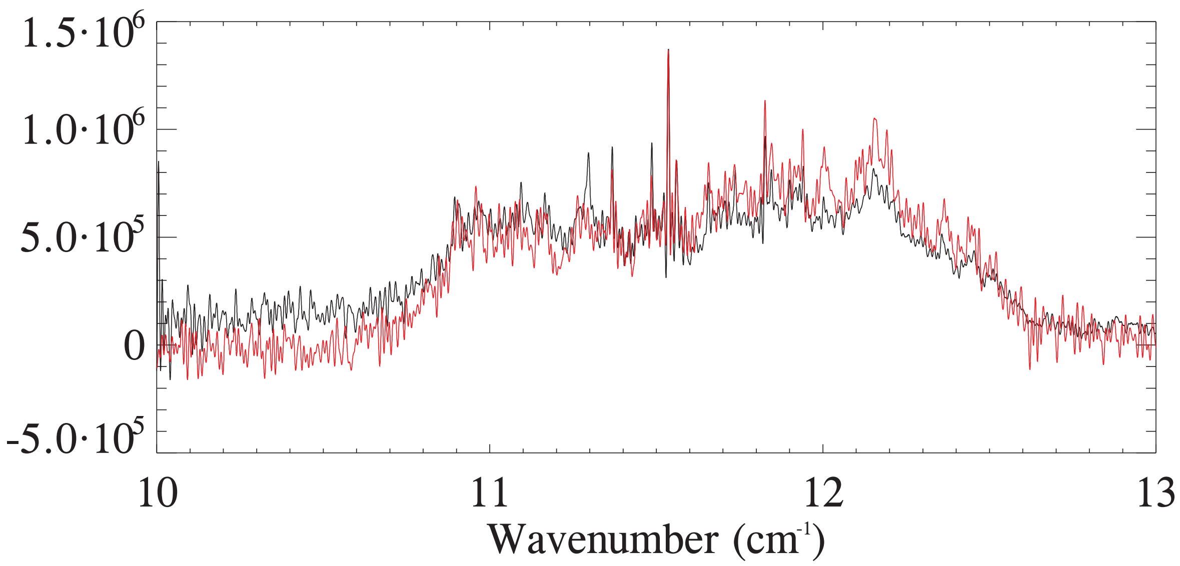

Figure 2. Step-and-integrate spectrum (black) and averaged rapid-scan spectra (red).

It can be seen from the figure that there is good agreement between the two techniques and, as expected, the continuum is better behaved in the step-and-integrate data. There is an improvement in the signal to noise of about a factor of two in the step-and-integrate data, for an equivalent integration time. Figure 3 shows a small spectral region of the step-and-integrate (black), the rapid-scan (red), and B3 heterodyne spectra (green) convolved to the FTS resolution, each offset for clarity.

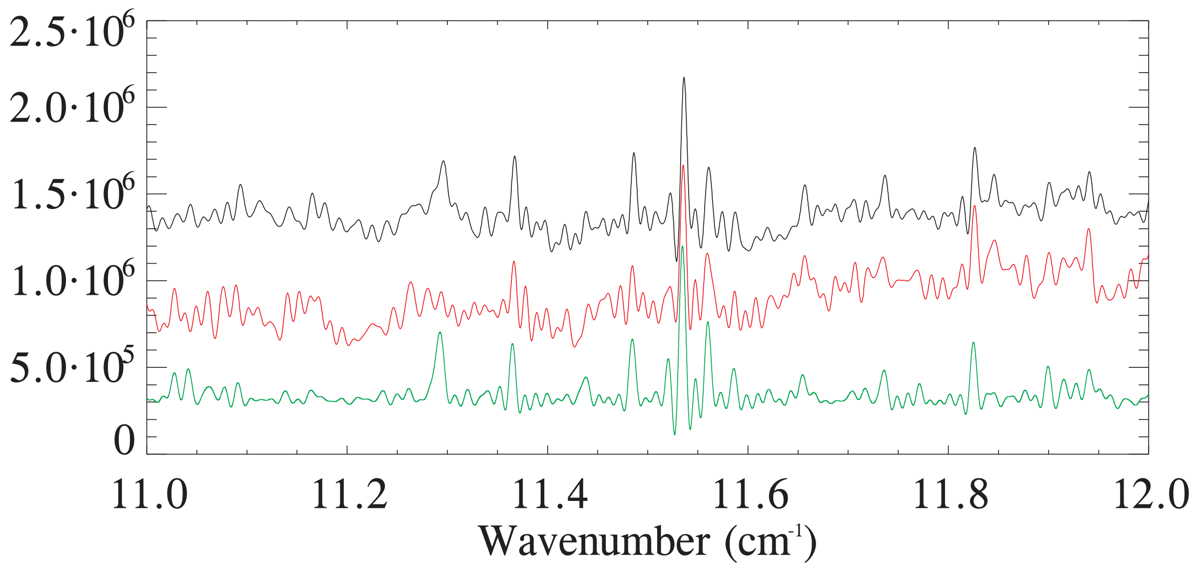

Figure 3. Step-and-integrate spectrum (black), averaged rapid-scan spectra (red) and B3 heterodyne spectrum (green) convolved to match the FTS resolution, each offset for clarity.

There was some concern raised in the CoDR about the feasibility of phase-correction with undersampled or 'aliased' interferograms. We have confirmed that there is no intrinsic difficulty in phase correcting the aliased step-and-integrate data, as evidenced by the spectrum given earlier. The ZPD region of the phase-corrected aliased step-and-integrate interferogram is shown in Figure 4, where the symmetry can be clearly seen.

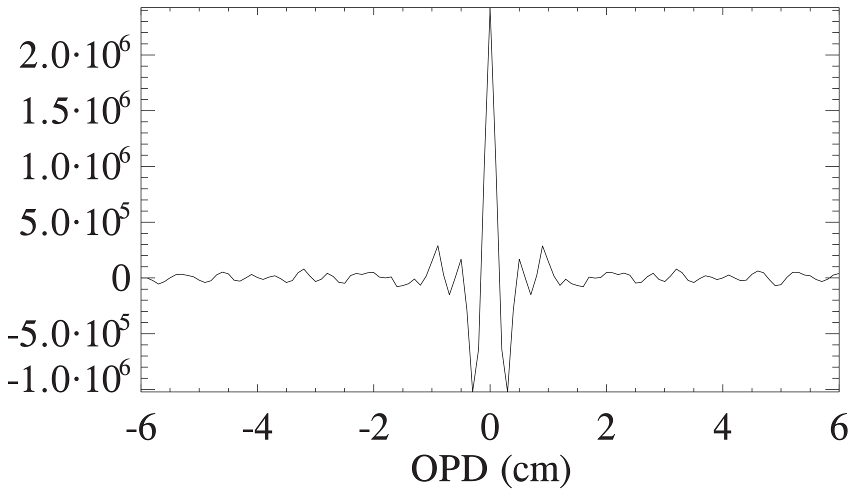

Figure 4. Phase corrected aliased step-and-integrate interferogram.

Successes

- Funds secured for prototype IFTS camera system
- Analysis of step-and-integrate data shows better atmosphere correction than rapid-scan
- Aliasing technique improves signal-to-noise
- Phase correction works properly on aliased interferograms

Opportunities

- The last run of the U of L FTS at the JCMT will provide more observing mode tests, hopefully under good observing conditions

Failures

- None to report.

Threats

- None to report.

Status of Project Milestones - End of February 2004

Baseline Agreed Milestone	Baseline	Scheduled	Actual	Change
FTS CoDR	30 July 03	30 July 03	30 July 03 Completed	
Optical Modelling	30 April 04	30 April 04		
FTS PDR	14 May 04	14 May 04		
Mechanical Modelling	30 September 04	30 September 04		
FTS CDR	8 October 04	8 October 04		

Baseline Agreed Milestone	Baseline	Scheduled	Actual	Change
Optical Integration and Testing	21 April 05	21 April 05		
Deliver FTS processing engine code	20 October 05	20 October 05		
System Integration and Testing	26 January 06	26 January 06		
Deliver FTS Hardware	4 March 06	4 March 06		

The "scheduled" date is that predicted by the current Project Plan. Change indicates the delay (+) or recovery (-) since the last report

Action Items

No outstanding actions.