1. INTRODUCTION
The Spectral and Photometric Imaging Receiver (SPIRE; Griffin et al. 2010) operated aboard ESA’s Herschel Space Observatory (Pillai et al. 2010). SPIRE’s Fourier transform spectrometer (FTS) provided wide sub-millimetre coverage (~450-1550 GHz, 194-671 μm), which allowed multiple lines to be simultaneously captured. Observations of FTS faint targets (<500 mJy) present a strong challenge to reliably extract spectral lines, but exciting opportunities to probe high redshift starforming galaxies. We present methods for improving S/N and continuum shape over standard pipeline products.

2. SCIENCE
The ISM of mid-to-high-redshift starforming galaxies has been probed using the FTS, via important cooling lines (e.g. [CII], [OI], [OIII]), by Valtchanov et al. 2011, Ivison et al. 2010, Rigopoulou et al. 2013 and George et al. 2013. However a significant fraction of the whole FTS observing time was dedicated to faint targets and achieving the intended science goals for many of the observations is still in progress.

3. THE CHALLENGE: NOISE
Three main contributing factors to FTS noise:
And 2 dominate faint sources observations. When digging for faint lines (<50) the main challenge is to reliably distinguish real over noise peaks, as both manifest themselves on the same scale. Figure 3 shows three lines from science observations and three peaks from dark sky. Can you identify which is which? (Solution below).

4. BESTE RSRFS
One route to attempt to improve S/N (and shape) is by creating observation specific telescope RSRFs. Dark sky observations (after instrument correction) divided by the telescope model provide a daily RSRF. These RSRFs can be grouped by time or temperature and simply averaged and applied in the standard pipeline. Figure 4 shows an example in noise reduction using this approach, grouping by temperature.

5. THE CHALLENGE: FLUX DROP
During the SPIRE cooler recycle, detector temperature exhibits a steep rise, which leads to certain detectors (including the central LW detector) suffering a droop in flux density. An empirical correction based on the correlation between detector temperature and flux density can be applied at the telescope model subtraction stage. Figure 5 shows an example of a faint source observation taken in the cooler recycle phase and the corrected spectrum.

6. LINE RELIABILITY
Visual assessment can be used to establish line reliability with a Jackknife approach. Using an averaged point source calibrated data, the scans are split into groups of sequential subsets. Each scan subset is averaged and examined at expected line positions and compared to the results over all subsets. This process is repeated for subsets of decreasing numbers of scans, i.e. sets of 100, then sets of 50, down to sets of 1 scan. Peaks due to real signal should show peak-like consistency throughout the scan sets, except for sets of ~10, where a more random distribution should be found. Figure 6 shows subset examples.

7. LINE MEASUREMENTS
Unresolved lines in an FTS spectra are well approximated by a sinc function. A sinc can be fitted to extract line measurements. For faint lines a statistical approach to measure line flux etc. can be made by bootstrapping the data. Unaveraged level 2 data is randomly sampled until the number in the parent population is reached. The scans are averaged and the line measurements taken from the best fit sinc. This process is repeated a statistically significant number of times (e.g. 10,000) and a Gaussian fitted to the resulting line measurements distributions to obtain the mean measurements and line uncertainties. Random frequency positions can be generated and the same process applied for a reliability check. Due to the nature of FTS noise, the obtained distributions for random position are indistinguishable to those for faint lines, however, a background level can be established, above which a real spectral feature is strongly supported, as shown in figure 7.

8. CONCLUSIONS
We have shown that by careful processing of SPIRE FTS spectra it is possible to reliably detected faint lines beyond the original expectations of the instrument. Figure 8 compares a standard pipeline product for a faint source observation, the SPIRE photometer photometry and the final best effort, after applying the methods presented in this poster (and Hopwood et al. in prep.).