CHANGE NOTES:
Version 1: 26-NOV-1997. Total bandwidth limited to 200-400 μm - two 16x16 arrays - oversample factor of 3.

Version 2: 15-JAN-1998. Total bandwidth 200-667 μm - one 16x16, one 12x12 array - oversample factor of 5.

Version 3: 3-MARCH-1999. Update to the Mach-Zehnder intensity beam splitter design.

INTRODUCTION
This note updates and supersedes all versions of BOL/RAL/N/0023. Here the baseline SPIRE spectrometer design that is actively being studied is briefly described and its operating parameters laid out.

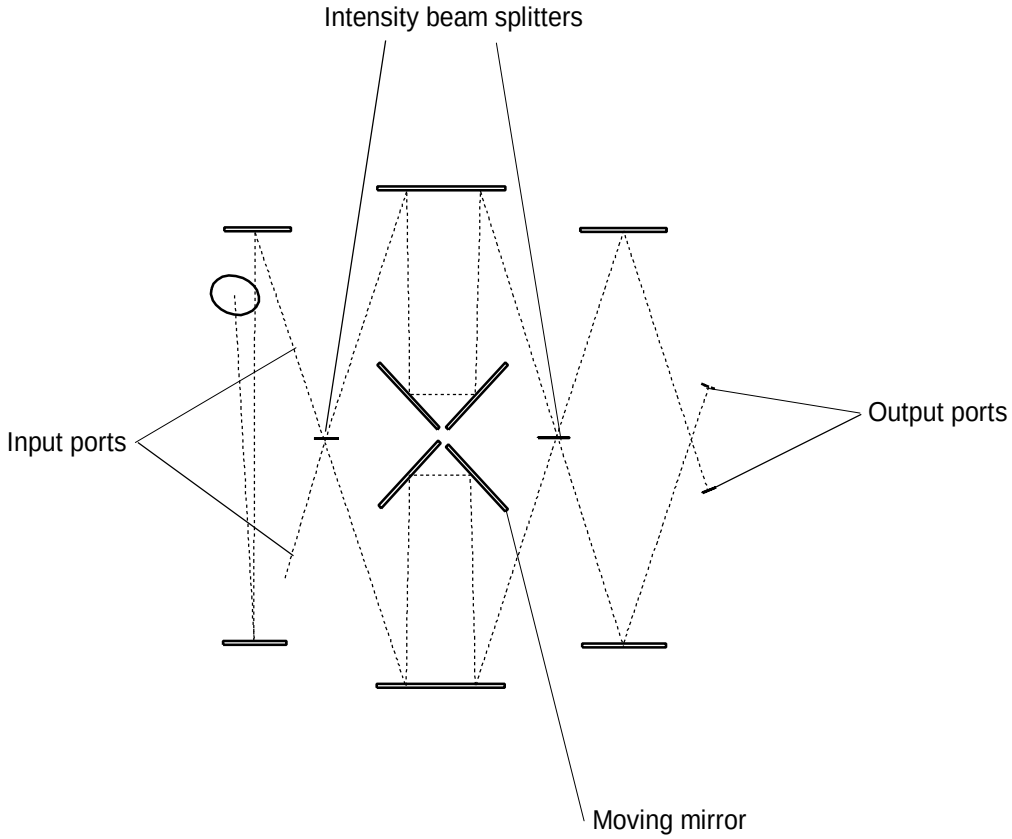

Figure 1: Outline layout for the Mach-Zehnder FTS

OUTLINE DESIGN
The baseline design for the spectroscopy channel of the FIRST bolometer instrument will employ an imaging FTS with two wavelength channels. The instrument is based on a Mach-Zehnder design with broad-band intensity beam splitters – figure 1 shows the general layout. The minimum requirements for the FTS performance are given in Table 2 of the Science Requirements document – they are repeated here for completeness

OPERATING PARAMETERS AND SYSTEM REQUIREMENTS FOR THE FTS

In this section the global operating parameters (scan range, wavelength coverage etc. etc.) are given for the baseline FTS.

Wavelength coverage	λ = 200 - 667 μm or 15 - 50 cm^{-1} Optimised for operation in 200-400 μm band
Bands	Band 1 - 200-299 centred at 240 (33 - 50 cm^{-1}) Band 2 - 299-667 centred at 412 (15 - 33 cm^{-1})
Required resolution	$\lambda/\Delta\lambda$ = 100 at 250 μm (40 cm^{-1}) $\Rightarrow\Delta\sigma$ = 0.4 cm^{-1}
Goal for resolution	$\lambda/\Delta\lambda$ = 1000 at 250 μm (40 cm^{-1}) $\Rightarrow\Delta\sigma$ = 0.04 cm^{-1}

To illustrate the maximum requirements on the systems design, the goal resolution of 0.04 cm^{-1} is used throughout the rest of the document.

Optical path difference	σ = 1/(2L) $\Rightarrow$ L = 12.5 cm assume 14 cm for scan length to allow for measure of zero path difference
Linear travel	(14 cm)/4 = 3.5 cm (± 1.75 cm)
Nyqvist sampling rate:	Δx_{max} = 1/(2σ_{max}) $\Rightarrow \Delta x_{max}$ = 1/(2 x 33) = 0.015 cm for band 2 $\Rightarrow \Delta x_{max}$ = 1/(2 x 50) = 0.010 cm for band 1
Over-sampling factor	5 $\Rightarrow \Delta x$ = 30 μm band 2 $\Rightarrow \Delta x$ = 20 μm band 1
No. of samples per interferogram	N_{samp} = (14 cm)/(30 μm) = 4667 band 2 N_{samp} = (14 cm)/(20 μm) = 7000 band 1
Audio frequencies	f = $v_{opd}\sigma$ where v_{opd} is the rate of change of the optical path difference.
Max. allowed audio freq.	20 Hz (from assumed detector response) $\Rightarrow$ v_{opd} = 20/50 = 0.4 cm s^{-1} $\Rightarrow$ $v_{mirrors} = v_{opd}/4$ = 0.1 cm s^{-1}
Audio freq. band	15 - 33 cm^{-1} $\rightarrow$ 6 - 13 Hz

		33 - 50 cm^{-1} → 13 - 20 Hz
Time per scan		t_{scan} = (14 cm)/(0.4 cm s^{-1}) = 35 s
Sampling rate		(4667 samples)/(35 s) = 133 samples s^{-1} - band 2 (7000 samples)/(35 s) = 200 samples s^{-1} - band 1
Number of detectors	- filled arrays	400 (16x16 + 12x12)
	- feed horns	32 (20 band 1 + 12 band 2)
Position measurement:		OPD accuracy required minimum = 20/50 = 0.4 μm Actual position measurement = 0.4/4 = 0.1 μm Sampling required = same as single detector in band 1
Max. internal read-out rate:		Band 2: 133 Hz x 144 dets = 19.152 kHz Band 1: 200 Hz x 256 dets = 51.200 kHz Position measurement = 0.2 kHz Total = 70 kHz
No. bits required to sample signal		16 – *needs justification – won't need this if the telescope is fully compensated.*
Max. bit rate per frame		1120 kbit/s
Max total bits per scan		39200 kbit Digital filtering should give factor 5 (oversample factor?)
Integration time required to fit this into telemetry		39200/(5x40) = 196 secs (6 scans)

For feedhorn option all this goes down by 32/400 – max readout rate is 90 kbit/s – can almost telemeter this directly to the ground.