INTRODUCTION

This note updates and supercedes section IV of BOL/RAL/N/0022.10, "The FTS Option for SPEC-BOL". Here the baseline design that will be incorporated into the AO response is briefly described (in the absence of a detailed optical design !) and its operating parameters laid out.

OUTLINE DESIGN

The baseline design for the spectroscopy channel of the FIRST bolometer instrument will employ an imaging FTS with a field of view of at least $2x2^{\circ}$. The un-apodised resolution of the instrument will be 1000 to allow for an apodised resolution of at least 500. The mirror mechanism is based on a swinging arm design - although this may change in the light of detailed analysis - which, although it only offers a folding factor of four, is compact, can be made light and relies on known flexure pivot technology to provide the movement. The basic idea for the design is sketched in figure 1.

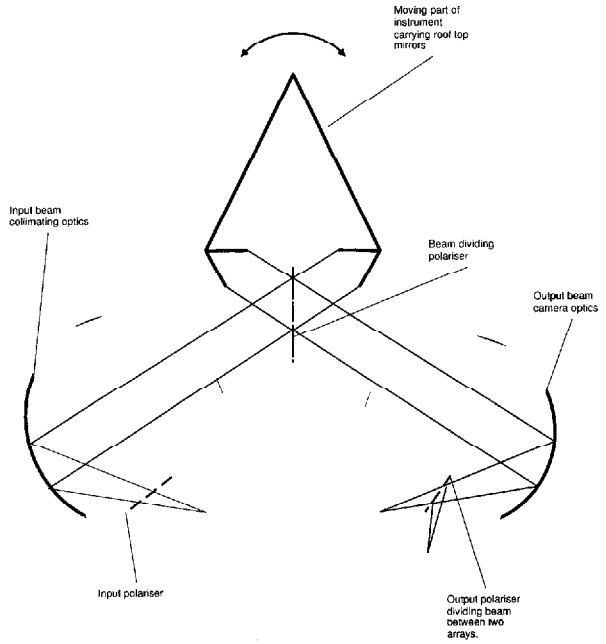

Figure 1: Sketch of the outline design for the FTS

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 - 400 μm or 25 - 50 cm^{-1} The instrument design should not preclude going to longer or shorter wavelengths
Required resolution	$\lambda/\Delta\lambda$ = 1000 at 250 μm (40 cm^{-1}) $\Rightarrow\Delta\sigma$ = 0.04 cm^{-1}
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} = $1/(2\sigma_{max})$ $\Rightarrow \Delta x_{max}$ = 1/(2 x 38) = 0.013 cm for band 2 $\Rightarrow \Delta x_{max}$ = 1/(2 x 50) = 0.010 cm for band 1
Over-sampling factor	3 $\Rightarrow \Delta x$ = 43 μm band 2 $\Rightarrow \Delta x$ = 33 μm band 1
No. of samples per interferogram	N_{samp} = (14 cm)/(43 μm) = 3255 band 2 N_{samp} = (14 cm)/(33 μm) = 4242 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	25 - 38 cm^{-1} $\rightarrow$ 10 - 15 Hz 38 - 50 cm^{-1} $\rightarrow$ 15 - 20 Hz
Time per scan	t_{scan} = (14 cm)/(0.4 cm s^{-1}) = 35 s
Sampling rate	(3255 samples)/(35 s) = 93 samples s^{-1} - band 2

	(4242 samples)/(35 s) = 121 samples s^{-1} - band 1
Number of detectors	512 (two arrays of 16x16)
Position measurement:	OPD accuracy required = 1/50 of step minimum = 33/50 = 0.66 μm Actual position measurement = 0.66/4 = 0.165 μm Sampling required = same as single detector in band 1
Internal read-out rate:	Band 2: 93 Hz x 256 dets = 24 kHz Band 1: 121 Hz x 256 dets = 31 kHz Position measurement = 0.12 kHz Total = 55 kHz
No. bits required to sample signal	Max signal = twice that from telescope background $\Rightarrow 6\times10^{-12}$ W Background limited NEP = 7×10^{-17} W $Hz^{-1/2}$ Detection bandwidth = 20 Hz Dynamic range required = $6\times10^{-12}/(7\times10^{-17}\sqrt{20})$ = 19166 14 bits = 16384 (near enough) - or a couple of gain stages and 12 bits would also do if we can't get a fast 14 bit ADC. We'ed still have to use some extra bits to encode the gain so it doesn't really save on the telemetry though!
Bit rate per frame	328 kbits/s - band 2 434 kbits/s - band 1 (hmmmm!)
Total bits per scan	26670 kbit Digital filtering should give factor 3 (oversample factor?)
Integration time required to fit this into telemetry	26670/(3x40) = 3-4 minutes (6 scans - perfect for median filtering of glitches!) **OR - can only take 1 scan per 3-4 minutes BUT CAN telemeter 1/6 of a scan - low res mode (R ≤ 150) o.k.?**