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Contents

Introduction

This document defines the interfaces between the FTS-2 instrument and the JCMT systems. Some requirements on the JCMT systems by the FTS-2 project are defined here. The requirements placed on the FTS-2 systems, however, are defined in more detail in the FTS-2 Functional and Performance Requirements document (SC2/FTS/SRE/001).

Acronyms and abbreviations

CFI	-	Canadian Foundation for Innovation
EMI	-	Electromagnetic Interference
FTS	-	Fourier Transform Spectrometer
ICD	-	Interface Control Document
JAC	-	Joint Astronomy Centre
JCMT	-	James Clerk Maxwell Telescope
OCS	-	Observatory Control System
PC	-	Personal Computer
RTS	-	Real Time Sequencer
SCUBA	-	Submillimetre Common User Bolometer Array
U of L	-	University of Lethbridge
UBC	-	University of British Columbia
UKATC	-	UK Astronomy Technology Centre
ZPD	-	Zero Path Difference

Applicable and referenced documents

Document Number	**Title**	**Number & Issue**
SC2/FTS/SRE/001	FTS-2 Functional and Performance Requirements	Version 3.0
SC2/FTS/SYS/005	FTS-2 to RTS ICD	Version 2.0
SC2/FTS/SOF/002	FTS-2 to OCS ICD	Version 2.0
SC2/FTS/SYS/004	FTS-2 OCD	Version 3.0
	Design and Construction Policies - JAC, Hale Pohaku, JCMT & UKIRT	
	JAC Health and Safety Manual	
SC2/CAN/PM500/01	SCUBA-2 Canadian Safety Plan	Version 0.2

1. Interface Requirements

1.1. Requirements for the U of L

The U of L shall produce the FTS such that it conforms to the interface requirements detailed in the Interface Design section of this document. In addition, the U of L shall ensure that all the requirements detailed in the "FTS-2 Functional and Performance Requirements" document (SC2/FTS/SRE/001) are met.

1.2. Requirements for the JAC

The JAC shall make provisions for mounting of FTS-2 within the SCUBA-2 optics framework, as well as for the necessary infrastructure to hoist the FTS-2 system or components into their mounting location.

1.3. Requirements for SCUBA-2 System SW

The SCUBA-2 System SW shall make provisions to ensure that a 32-bit mirror position value from the FTS can be recorded with every image frame while the FTS in use. Other FTS-2 diagnostic parameters in the frame headers are TBD.

1.4. Requirements for SCUBA-2 DR SW

The FTS-2 data reduction code shall be called mid-stream in the SCUBA-2 DR pipeline. Depending on the FTS observing mode in use, some of the normal processing steps may not be required. However, FTS-2 will still require some pre-processing of the raw data files, such as flat-fielding, de-rotation, etc.:

- In the low-res mode, scans will take place on timescales shorter than the image rotation, so in principle a single derotation can be applied to the slices of the output spectral cube if this is more efficient.
- In the high-res modes, scans will take longer to complete, so the interferogram frames will each need to be derotated before the FTS-2 processing.
- For Rapid Scan observations, de-spiking will be done in the FTS processing.
- In the Step-and-Integrate mode (if implemented) the input frames will be STARE images that have been de-spiked and derotated.

2. Interface Definition

2.1. General

This document defines the interfaces to the FTS-2 instrument. FTS-2 consists of a series of optics mounted on a damped optical breadboard, and enclosed by a structural framework. A moving mirror assembly consisting of a pair of back-to-back corner-cube mirrors mounted on a linear motor translation stage is located in the centre of the breadboard, while other stationary mirrors and beamsplitters are mounted to the to the breadboard and framework. Two pairs of retractable, remotely adjustable mirrors are mounted on the top of the system to redirect a portion of the SCUBA-2 beam through the instrument. A framework that will support the optics and allow the system to be hoisted as a unit will surround the entire FTS. More details can be found in the FTS requirements document (SC2/FTS/SRE/001) and the FTS OCD document (SC2/FTS/SYS/004).

3. Mechanical Interfaces

For purposes of this document, the following orthonormal coordinate system is defined:
Origin = axis of elevation bearing, at the outer face of the bearing tube at the left Nasmyth, (4.15 m radially from the Azimthal axis)
X Axis = positive along the axis of the elevation bearing towards the azimuthal axis of the telescope
Y Axis = positive in the horizontal plane towards the front of the telescope
Z Axis = positive in the vertical direction

3.1. Space Envelope

The FTS-2 system will be a large (roughly 0.9 m deep x 2.3 m wide x 1.3 m tall) instrument weighing ~400 kg, and will require significant planning to ensure it can be mounted, aligned, and maintained at the telescope. The FTS-2 space envelope will extend over the coordinates X:+0.0,-0.85 Y:-1.2,+1.2 Z:-.92,+0.45. The centre of mass will be roughly at coordinates X:-0.41 Y:-0.019 Z:-0.67. Refer to the mechanical design document for detailed specifications.

3.2. Handling

FTS-2 will be provided with suitably rated lifting eyes or hoist attachments, such that it may be safely lifted onto the mounting structure on the telescope framework.

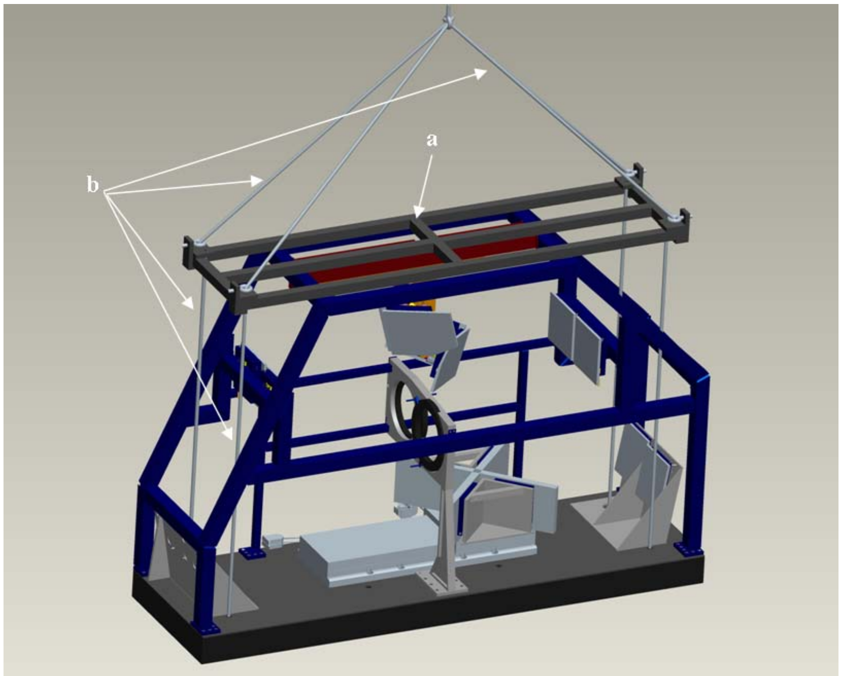

Figure 1. FTS-2 with lifting structure (a) and cables (b).

3.3. Mounting Structure

The most practical location that a FTS of sufficient resolution could be mounted between SCUBA-2 and the JCMT dish, without a redesign of the SCUBA-2 optics, is just outside the left Nasmyth elevation bearing within the mounting framework for mirror N1. The N1 mounting structure will need to support the mass of the FTS (~400 kg), as well as tolerate the inertial forces (~100 N at ~1 Hz TBD) generated by the moving mirror assembly, while maintaining alignment tolerances of the N1 mirror. Further mechanical design work is required before the precise centre of mass and dynamic force vectors can be specified.

The FTS-2 system will be supported on the N1 framework with 7 adjustment screws, which will also allow levelling of the system.

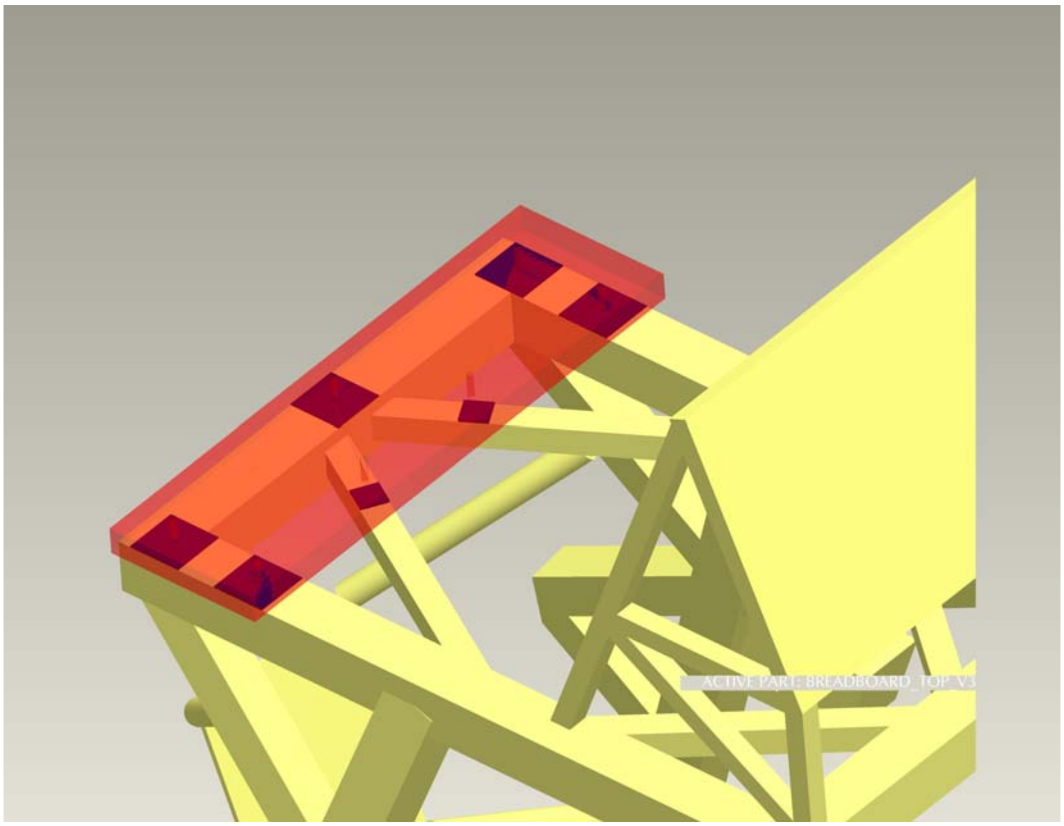

Figure 2. N1 platform (tan) with breadboard (transparent red) and mounting pads (blue).

3.4. Electronics and PC Location

The motion control unit must be located as close as possible to the FTS in order to minimize noise and servo problems associated with excessive cable lengths. Cable length must not exceed 10 m and will be shielded to minimize EMI. The translation stage control unit (Soloist®, Aerotech Inc.) is a self-contained system measuring 65 mm x 200 mm x 170 mm, with a power supply unit measuring 90 mm x 235 mm x 195mm and will be mounted to the FTS-2 framework. The Soloist controller communication interface uses a standard 100BaseT Ethernet connection. Control of the retractable pickoff mirrors is achieved with another Ethernet connection. A control PC is also part of the FTS-2 system, and will be located at a convenient remote location. This PC is shared with the POL-2 system, but only one instrument will be active at any given time. The control PC will be a fully compliant RTS Client, and will interface with the RTS system via a converter board. The FTS-2 RTS Client will accept DRAMA commands from the JCMT OCS.

3.5. Thermal

There are no anticipated thermal issues with the SCUBA-2 system or the JCMT dish due to power dissipation from the FTS mechanisms or electronics.

3.6. Actions

There will be the following possible actions for the FTS mechanisms, all of which will be under computer control:

- Inserting or retracting the FTS pickoff mirrors into or out of the main SCUBA-2 beam
- Adjusting the alignment of the pickoff mirrors.
- Moving the linear motion stage which supports the FTS rooftop mirrors to a given position at a given speed and acceleration
- Inserting or removing the internal blackbody shutter into one port of the FTS.

4. Magnetic Interface

The SQUIDs used in SCUBA-2 for multiplexing and amplifying signals are extremely sensitive magnetometers, and must be well shielded from magnetic fields. Measurements with the ATC Gaussmeter have confirmed that the fields from the linear motor and other actuators in the FTS are not above normal ambient levels beyond a distance of ~2 m from the instrument.

To reduce EMI, the motion controller electronics will be located as close as possible to the linear stage so that the motor drive cable length is minimized. FTS-2 will incorporate appropriate EMI shielding will be provided as necessary so that any emissions from the motor drive cables do not interfere with SCUBA-2 systems.

5. Optical Interface

When in use, the FTS will add approximately 8 mirror reflections to the already complex SCUBA-2 optical path. While the FTS will have no impact on the design or alignment of the SCUBA-2 optics, initial alignment of the FTS will pose a significant challenge. The internal FTS optics can be aligned independently; however, alignment of the FTS to the SCUBA-2 system will require the use of laser alignment tools as well as feedback from SCUBA-2 imagery. Specifications for alignment and positional accuracy of the FTS optics will be driven by the overall SCUBA-2 optical parameters. At the time of writing, the decenter tolerance on each of the FTS optics is +/- 200 μm, and the angular tolerance is 0.5°.

6. Data Acquisition Computer Interface

FTS-2 will interface with the SCUBA-2 system via RTS signals, commands from the OCS (and return values), and mirror position values to be recorded by the SCUBA-2 data acquisition system with every frame while the FTS is in use. The FTS-2 control PC will record the position values stamped with the RTS number, and send them via the network to the data reduction computers.

7. RTS Interface

The JCMT RTS system provides co-ordination between the telescope and the attached instruments (see the Real-Time Sequencer User Manual for details). The FTS-2 electronics uses the Data Valid (DV) signal, generated by the RTS master, to control the position sampling of the linear stage. Details of the RTS interface are given in the FTS-2 to RTS ICD (SC2/FTS/SYS/005).

8. Software Interfaces

8.1. Data Reduction Pipeline interface

The U of L will produce the data analysis pipeline engine to reduce interferogram cubes to hyperspectral image cubes. This FTS-2 pipeline engine software will run inside the main SCUBA-2 data reduction pipeline. The FTS-2 engine will take as inputs either the 200 Hz frames or ~1 Hz STARE images from the DA system (with the associated moving mirror position values) and produce as an output a sequence of frames stacked as a function of frequency. Details of the DR Pipeline interface are given in the FTS-2 DR Engine document (SC2/FTS/SOF/001).

8.2. Quicklook Display interface

As a diagnostic tool for the observer, the FTS-2 processing pipeline will produce simplified spectral data to be displayed on the observer display. In-depth analysis of the spectral data cubes will not be possible in real time, but spectra from a few characteristic pixels may be displayed, as well instrumental parameters such as the current mirror positions, noise statistics, etc. in order to monitor the operation of the FTS. Recipes for the QL display will be delivered with the processing engine. The FTS-2 QL system will use display packages specified by the JAC, and will operate in a scheme compatible with the SCUBA-2 pipeline. Details of the FTS-2 QL display are given in the FTS-2 Display System document (SC2/FTS/SOF/003).

8.3. Control Software interface

The FTS will be controlled by a PC which is shared by the POL-2 system. This PC will interface with the FTS sensors and motion controller, as well as the JCMT RTS and network. The control software will accept commands from the OCS to perform fundamental actions such as moving the mirrors, and return appropriate error codes. The U of L will provide the control software such that it conforms to the JAC and JCMT software requirements. The JAC will provide drivers for the RTS interface hardware.

Details of this software interface are given in the FTS-2 to OCS ICD (SC2/FTS/SOF/002).

9. Telescope Electrical Interfaces

9.1. General

The electronics must conform to JCMT safety standards and design construction policies. See the "Design and Construction Policies - JAC, Hale Pohaku, JCMT & UKIRT", and the "JAC Safety Manual" for further information.

9.2. Power inlet

The FTS electronics must provide filtered IEC power inlets, with transient voltage protection. The inlets must accept the JCMT 110V AC, 60Hz mains supply. There will be mains inlets for the translation stage, motors, control PC, and motion controller.