



# Fourier Transform Spectrometer

## Conceptual Design Review

University of Lethbridge, July 30, 2003

## **1. Meeting details and list of attendees**

**Date:** July 30<sup>th</sup>, 2003

**Location:** via conference call

**Review Panel:** Per Friberg (JAC), William Duncan (ATC), Mark Halpern (UBC), Don Jennings (NASA Goddard)

### **In attendance:**

U of L:	David Naylor, Brad Gom
UBC:	Mark Halpern, Janos Molnar,
ATC:	William Duncan, Wayne Holland, Trevor Hodson
JAC:	Gary Davis, Per Friberg,
NASA:	Don Jennings
CSC:	tbd

## 2. Draft agenda

<b><u>Commence Review</u></b>	<b><u>09:00 (MST)</u></b>
Introduction and welcome (DN)	10 mins
Discussion - Functional & Performance Requirements (led by DN)	20 mins
SCUBA-2 FTS - top-level description (BG)	30 mins
Review Panel's finding, questions (Chair)	20 mins
Response to Review Panel's findings (DN, BG)	20 mins
Other questions from participants with response by design team	50 mins
<b><u>Break for review panel's closed telecon and lunch</u></b>	<b><u>11:30</u></b>
<b><u>Restart</u></b>	<b><u>13:30</u></b>
Panel feedback	20 mins
Plan to proceed	20 mins
<b><u>Adjourn</u></b>	<b><u>14:00</u></b>

### 3. Review documentation

The documentation provided for the CoDR is summarised in the following table.

It is intended that this documentation will first provide the Panel with an understanding of the design proposal and requirements relevant to the SCUBA-2 Fourier Transform Spectrometer (FTS). Where appropriate Project Management documents have been included and the sections with particular relevance to the FTS design have been highlighted within each document. A top-level description of the design completes the introductory information. The main body of documents covers the detailed description of the FTS design and its interface functionalities. Finally an initial plan for assembly, integration and test is presented. Supporting documentation is also provided in the appendices. This includes background material, more detailed analyses, Interface Control Documents, as well as some additional management information.

Section	Document title	Reference number
<b>Introduction</b>		
1.	Terms of reference for CoDR	This document
2.	FTS Science Case	SC2/FTS/SCE/001
<b>Requirements</b>		
3.	FTS Requirements and Recommendations	SC2/FTS/SYS/001
4.	FTS SW Requirements and Recommendations	SC2/FTS/SYS/003
<b>Top-level description</b>		
5.	SCUBA-2 FTS Operational Concept Definition (OCD)	SC2/FTS/SYS/004
<b>Appendix 1: Drawings</b>		
6.	See <a href="http://research.uleth.ca/scuba2/cad.shtml">http://research.uleth.ca/scuba2/cad.shtml</a>	
<b>Appendix 2: Additional design documents</b>		
7.	SCUBA-2 Data Acquisition to Data Processing Interface	SC2/SOF/S200/008
8.	SCUBA-2 Operational Concepts Definition Document	SC2/SRE/SC200/003
<b>Appendix 3: Interface control documents</b>		
9.	SCUBA-2 FTS ICD	SC2/FTS/SYS/002
<b>Appendix 4: Management documentation</b>		
10.	SCUBA-2 FTS Project Management Plan	SC2/FTS/PM500/002
11.	SCUBA-2 FTS Risk Assessment	SC2/PR/PM500/001

## **4. Terms of reference**

The purpose of the meeting is to review the design proposal for the SCUBA-2 Fourier Transform Spectrometer (FTS). The conceptual design review is intended to establish that all major risks have been identified and preliminary development specifications (performance requirements and interfaces) have been produced for each sub-element of the FTS before preliminary design commences.

The review panel is asked to consider the following guidelines as a basis for the review:

1. Does the current FTS design, as presented by the Project Team, comply with the relevant scientific and technical specifications?
2. Does the preliminary design address the required standards with respect to good engineering practices?
3. Are there any uncertainties in the conceptual design that need clarification before progress to preliminary design can be made?
4. Are the relevant interfaces suitably identified and defined so as to minimise risk to the project?
5. Is the development plan realistic to deliver a working FTS ready for verification according to schedule?

Confirmation that the current design concept addresses the formal requirements and is sufficiently advanced to CoDR stage is sought in order that the Project may proceed to the next stage of the instrument development with confidence i.e. the preliminary design can commence.

### **The review process**

The SCUBA-2 FTS design will be primarily reviewed via documentation. The review panel will be provided with a full set of documentation in soft copy to arrive no later than 17<sup>th</sup> July, well in advance of the Review date; July 30<sup>th</sup>, 2003. The soft copy of all documentation will be followed by hard copies no later than July 20<sup>th</sup>, 2003. The agenda for the meeting will be agreed with the Chairman of the review panel and published no later than TBD. It is our intention that the formal review process will be conducted via conference call, working largely from hardcopy documents and drawings. Any questions for clarification to the documentation should be passed onto the Project Manager (Brad Gom) in preparation for the formal review by July 25<sup>th</sup>. The aim is to maximize the time spent in interactive discussion of major issues in the meeting itself.

### **Panel report**

The panel will be asked to produce a draft report at the time of the meeting and feed its comments and recommendations to the Project Team at the end of the meeting. The report will be the common property of U of L and JAC and remain confidential. The Panel will

produce a final report within one week of the review meeting. The reports should cover all the points outlined in the terms of reference, as well as any further points that the Panel feel is relevant to the review.

In particular the report should include:

- i. The criteria against which design has been reviewed
- ii. A list of documentation that describes the design being reviewed and any evidence that purports to design meeting requirements
- iii. Recommendation on how the design should be allowed to proceed to next stage
- iv. The basis on which confidence has been placed in the design
- v. A record of any relevant outstanding actions from previous reviews
- vi. Recommendations and reasons for corrective actions, if necessary
- vii. Members of review team and specific roles, if any

## **5. Executive summary**

SCUBA-2 is a highly innovative wide-field camera designed to replace SCUBA and be operational on the James Clerk Maxwell Telescope in 2006. With just under 10,000 pixels in two arrays, SCUBA-2 will map the submillimetre sky up to a thousand times faster than SCUBA to the same signal-to-noise and to reach the (extragalactic) confusion limit in only a couple of hours. By combining a spectrometer with the SCUBA-2 detector array it will be possible to obtain, simultaneously, a spectrum from each point on the sky corresponding to individual pixels in the array. The imaging spectrometer will therefore open a third dimension in astronomical observations by providing spectral information at each point in the object under study (e.g. galaxy, molecular cloud). While SCUBA-2 will provide unprecedented morphological information about such sources, composition and physical conditions can only be determined through imaging spectral measurements. A Fourier transform spectrometer (FTS) has been selected as the optimal design to provide medium resolution spectroscopic capabilities to SCUBA-2.

To maximize the scientific return SCUBA-2 must be operational in 2006, well before the tripartite agreement (UK, Canada, and Netherlands) to run the telescope ends in 2009. This is an aggressive schedule, and several aspects of the system are being designed and constructed in parallel with the detector development programme. In order to minimize the pecuniary risk to the funding institutions the project and instrument is subject to a number of reviews. The FTS, which is an ancillary instrument to the main SCUBA-2 instrument, is also subject to a number of reviews. This particular review will focus on the conceptual design of the SCUBA-2 FTS, which is being developed at the Department of Physics of the University of Lethbridge, with close cooperation with the UK ATC.

The SCUBA-2 FTS will be based on the Mach-Zehnder design which has been adopted for the SPIRE instrument (of ESA's Herschel mission) and the U of L spectrometer currently operating at the JCMT. The FTS project will produce the hardware, electronics and software necessary to implement the instrument at the JCMT. The hardware consists of a damped optical breadboard supporting a series of fixed mirrors, a moving mirror assembly on a linear

stage that produces optical path variations between two interferometric beams, a cryogenic blackbody calibration source, and associated framework. The Electronics consists of a linear motor controller, electronics interface to the JCMT Real Time Sequencer (RTS) and network, and various limit switches and diagnostic systems, all connected to a control PC. The software consists of control code to accept commands of the JCMT Observatory Control System (OCS) and control the FTS electronics, as well as data analysis software in the form of a processing pipeline that will convert interferogram data into hyperspectral image cubes.

The FTS will be mounted within the support structure for the SCUBA-2 mirror N1, just outside the left elevation bearing of the JCMT. The control PC will be mounted at a convenient distance to the FTS instrument, and will communicate with the RTS and SCUBA-2 network via fibre optic links.

Information is provided for the reviewers on the current status of these designs.

There are a number of challenges associated with the FTS design. Key amongst these are:

- Designing a system of acceptable size and resolution that will accept approximately one quarter of the SCUBA-2 field of view
- Construction of a variable temperature large aperture blackbody calibration source
- Design of a processing pipeline that will produce a calibrated hyperspectral data cube as a science product.

The key milestones associated with FTS development, installation and support are summarised as follows:

FTS CoDR	July 30 <sup>th</sup> , 2003
FTS PDR	May 2004
FTS CDR	October 2004
Build/Test/Rework FTS	October 2005
FTS Acceptance Readiness Review	January 2006
Delivery FTS to the Telescope	March 2006
Commissioning FTS	2 months after SCUBA-2 Commissioning
On-site support until	SCUBA-2 decommissioned

These milestones dates are given with the assumption that the current spending freeze for descopeing contingency will be lifted by April 2004. Any extra delay in funding beyond this date will result in a corresponding delay in the overall FTS project. The FTS development is organized so that development activities are minimally impacted by the current spending freeze.

In order to ensure seamless collaboration among other teams within the SCUBA-2 development effort, the FTS development process will closely follow the procedures established by the Astronomy Technology Centre in Edinburgh, Scotland and will be accepted by the entire team. See the ATC Project Management Procedures document (189/PMG/01/001) for details.