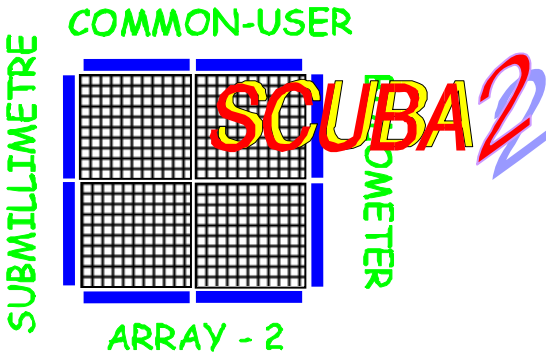

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Document Title: FTS-2 CDR Terms of Reference

Document Number: SC2/FTS/SYS/009

Issue: Version 1.3

Date: 10 November 2006

Document Prepared By:	B. G. Gom FTS-2 Project Manager	Signature and Date:	10/11/06
Document Approved By:	D. A. Naylor FTS-2 Project Lead	Signature and Date:	10/11/06
Document Released By:	J. Molnar Canadian Project Manager	Signature and Date:	10/11/06

Change Record

Issue	Date	Section(s) Affected	Description of Change / Change Request Reference / Remarks
1.0	17/10/06	All	CDR version
1.1	1/11/06	4	Document list updated
1.2	9/11/06	Agenda, 5	Revised agenda, added section 5.
1.3	10/11/06	6	Fixed typo in milestone years

Contents

Change Record 2
Contents 2
1. Meeting details and list of attendees 2
2. Draft Agenda 3
3. Terms of Reference 4
The review process 4
Panel report 4
4. Review Documentation 5
5. Meeting Focus 7
Mechanical Interfaces 7
Electrical Interfaces 7
Control Software 7
DR Software 7
Commissioning 8
Planning for final phase 8
6. Executive Summary 8

1. Meeting details and list of attendees

Date: November 13th, 2006
Location: University of Lethbridge

Review Panel: Per Friberg (JAC), Wayne Holland (ATC), Don Jennings (NASA Goddard), William Duncan (NIST)

In attendance:

U of L:	David Naylor, Brad Gom, Baoshe Zhang
UBC:	Janos Molnar
ATC:	Wayne Holland (Videocon)
JAC:	Per Friberg (local)
	Gary Davis, Tim Jenness, Craig Walther, Simon Craig, Tomas Cylek, Tim Chuter (Videocon)
NASA:	Don Jennings
NIST:	William Duncan
UofW:	Daphne Summers

2. Draft Agenda

Commence Review	**09:00 (MST)**
Introduction and welcome (DN)	10 min
FTS-2 top-level description (BG, DN)	15 min
FTS-2 mechanical and optical design (BG)	15 min
FTS-2 control software (BZ)	10 min
FTS-2 DR engine (BZ)	10 min
Coffee	**10:00**
Discussion - Functional & Performance Requirements (led by DN)	45 min
Review Panel's finding, questions (Chair)	30 min
Response to Review Panel's findings (DN, BG, JM)	45 min
Break for lunch	**12:30**
Restart	**13:30**
Continued Q/A	30 min
Review panel's closed session	**14:00**
Restart	**14:45**
Panel feedback	20 min
Plan to proceed:	45 min

- Test results required during integration phase
- Timeline for resolving remaining interface issues
- Deliverables for ARR

Adjourn	**16:00**

3. Terms of Reference

The purpose of the meeting is to review the ongoing design of FTS-2. The critical design review is intended to establish that all design requirements are defined, all identified major risks are under control and development specifications (performance requirements and interfaces) have been adhered to.

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

1. Does the current instrument design, as presented by the Project Team, comply with the relevant scientific and technical requirements as laid out in the PDR?
2. Does the current design address the required standards with respect to good engineering practices?
3. Are there any uncertainties in the ongoing design that need clarification before the design can be concluded?
4. Are the relevant interfaces suitably identified and defined so as to minimise risk to the project?
5. Are the development and testing plans still realistic to deliver a working instrument according to schedule?

Confirmation that the current design addresses the formal requirements and is sufficiently advanced to CDR stage is sought in order that the Project may proceed with the final design stage and construction can commence.

The review process

The FTS-2 design will be primarily reviewed via documentation. The review panel has been provided with electronic copies of the documentation prior to the review. Hard and bound copies of documents will be available for the CDR. The final version of the documents may incorporate recommendations, provided during the pre-CDR review process. There will be the final set of documents, which incorporate ALL accepted recommendations by the panel and the scientific community at large. The final documents will be posted on the FTS-2 website.

Any questions for clarification to the documentation at the CDR should be passed onto the FTS-2 Project Manager (Brad Gom). The aim is to maximize the time spent in interactive discussion of major issues at 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 panel can draw on clerical resources, provided by the Canadian Steering Committee. The report will be the common property of U of L and JAC and remain confidential. The Panel will produce a final report within four weeks 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 the 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 panel and specific roles, if any

4. Review Documentation

The documentation provided for the CDR is summarised in the table on the following page.

It is intended that this documentation will first provide the Panel with an understanding of the instrument design and requirements relevant to FTS-2. Where appropriate, Project Management documents have been included. The top-level description of the design is part of the documentation. 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.

All referenced documents can be found at the FTS-2 project webpage:
http://research.uleth.ca/scuba2/documents.shtml

Document Name	Document number	Version	New for CDR	Modified
Introduction				
FTS-2 CDR Terms of Reference	SC2/FTS/SYS/009	1.0	New	1/11/06
FTS-2 PDR Panel Report	informal		New	30/10/06
Top Level Documents				
FTS-2 Operational Concept Definition	SC2/FTS/SYS/004	3.0	Modified	30/10/06
FTS-2 Survey Time Estimation	SC2/FTS/SYS/006	1.0		6/06/05
FTS-2 Observation Scheduling	SC2/FTS/SYS/007	1.0	New	31/10/06
Requirements				
FTS-2 Functional and Performance Requirements	SC2/FTS/SRE/001	3.2	Modified	9/11/06
FTS-2 Compliance Matrix	SC2/FTS/SRE/002	2.1	Modified	7/11/06
Interface Control Documents				
FTS-2 to OCS ICD	SC2/FTS/SOF/002	2.1	Modified	2/11/06
FTS-2 to RTS ICD	SC2/FTS/SYS/005	2.0	Modified	3/11/06
FTS-2 to JCMT ICD	SC2/FTS/SYS/007	2.0	Modified	8/11/06
Hardware Documents				
FTS-2 Mechanical Design	SC2/FTS/MEC/001	2.1	Modified	9/11/06
FTS-2 Optical Design	SC2/FTS/OPT/001	2.1	New	6/11/06
FTS-2 Optical Alignment	SC2/FTS/OPT/005	draft	New	7/11/06
FTS-2 Mirror Mount Tests	SC2/FTS/MEC/002	1.0	New	30/10/06
FTS-2 Port Optical Coordinates	SC2/FTS/OPT/002	1.0	New	2/11/06
INO Optical Modelling Report	INO 060140 R/09	9	New	3/11/06
FTS-2 Optical Prescription	SC2/FTS/OPT/004	1.0	New	3/11/06
FTS-2 Input Port Rotation	SC2/FTS/OPT/003	1.0	New	30/10/06
Software Documents				
FTS-2 DR Engine	SC2/FTS/SOF/001	2.2	Modified	2/11/06
FTS-2 Java Package	SC2/FTS/SOF/004	1.2	New	2/11/06
FTS-2 Display System	SC2/FTS/SOF/003	2.0	New	1/11/06
FTS-2 Phase Correction Algorithm	SC2/FTS/SOF/006	1.1	New	2/11/06
FTS-2 Tune-up Tool	SC2/FTS/SOF/007	1.1	New	2/11/06
Management Documentation				
FTS-2 Project Management Plan	SC2/FTS/PM500/002	3.0	Modified	6/11/06
FTS-2 Commissioning Plan	SC2/FTS/INST/001	1.0	New	10/2/06
FTS-2 Test Strategy	SC2/FTS/TST/001	2.0	Modified	7/11/06
FTS-2 Test Plan	SC2/FTS/TST/002	1.0	New	7/11/06
FTS-2 Risk Assessment	SC2/FTS/PM500/001	3.1	Modified	7/11/06
FTS-2 Project Plan	SC2/FTS/PM500/003		Modified	6/11/06
FTS-2 Procurement Strategy	SC2/FTS/PM500/004	2.0	Modified	2/11/06
SCUBA-2 Canadian Safety Plan	SC2/CAN/PM500/01			30/10/06
Appendix 1: Externally Produced System Documents				
SCUBA-2 Operational Concept Definition	SC2/SRE/SC200/003	1.1		6/10/02
SCUBA-2 Architectural Design Document	SC2/ANA/S100/045	1.0		9/09/02
DA/DR ICD	SC2/SOF/IC210/01	1.38		24/05/05
FTS-2 and POL-2 Coordination	SC2/SOF/S200/026	1.0		25/5/04
SCUBA-2, Polarimeter and FTS Observing Problems	SC2/SOF/S200/030	1.0		22/06/04
SCUBA-2 Pixel Naming and Coordinate Transforms	SC2/SOF/S200/042	1.0	New	25/04/05

5. Meeting Focus

Admittedly, some aspects of the FTS-2 design may not be at CDR level, however, the CDR date was selected as the earliest date after the completion of the optical model and also the last possible time window where design change decisions could be made without causing significant schedule slippage. With this in mind, the following areas have been identified for discussion during the review:

Mechanical Interfaces

While the final CAD work has not been finished, the locations of all the internal components have been determined, and the overall instrument dimensions have been specified which fit within the JCMT interfaces. We consider there to be sufficient space within the FTS-2 instrument to allow the framework to be designed with sufficient stiffness. However, discussion is needed on the external interfaces, specifically on the cabin walkway interface, as well as defining the hoisting and installation requirements and procedures.

Electrical Interfaces

While these are not seen to be urgent at the moment since they do not significantly impact other design decisions, discussion is required on the electrical interfaces to FTS-2. Specifically:

- Cabling, signal levels, and connector selection for the DV signal interface at the instrument.
- Mains power supply to the instrument
- Location of any power switches on the instrument
- Required grounding considerations

Control Software

The control software has been developed to the point that the internal mechanism communication could be tested, however, in order to proceed with full system tests, the following conditions must be met:

- RTS client PC must be purchased (in concert with the POL-2 system)
- RTS interface card must be purchased or provided by JAC
- Real-time drivers for the RTS interface must be provided by JAC

DR Software

A FTS DR processing engine has been produced and tested, and further optimization is ongoing. Comments are required from the JAC on the functionality and ICD compliance of the processing code, but more importantly, input it required for defining pre and post-processing steps in the FTS-2 data stream. For instance:

- FTS-2 pointing and focussing may involve instrument specific effects
- The requirement for derotating individual interferogram frames in the high res mode is being investigated. If derotation is required, then only the exact FTS-2 coordinate transforms will be different from the normal SCUBA-2 derotation algorithm. If

derotation of each frame is not required, then each output spectral cube can be treated with one transform. Input is required from JAC in deciding on the derotation scheme.

- Support for the commissioning and maintenance of the delivered FTS-2 code needs further discussion, as it has an impact on the project budget.

Commissioning

Details of the required commissioning tests are still being investigated, however, the choice of FTS-2 commissioning dates have serious consequences on the project budget. Slippages in the overall SCUBA-2 project are likely, so a solution which insulates the FTS-2 project is required.

Planning for final phase

The timeline for the remaining FTS-2 development is tight, driven by the currently approved CFI budget and spending timeline. Assuming no major changes to the fundamental instrument design are requested by the panel, a plan for working towards the ARR and delivery is required. This will include defining what instrumental test results are required during the initial integration and lab testing phases to ensure that the ARR schedule is met. A plan is also required for defining the set of deliverables for the ARR, since this will require input from people involved in each of the major FTS-2 interfaces.

6. 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, although discussions are underway to extend the JCMT lifetime beyond 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 ancillary SCUBA-2 FTS instrument (FTS-2) being developed at the Department of Physics of the University of Lethbridge is also subject to a number of reviews. The conceptual design review (CoDR) was passed successfully in July 2003. This particular review will focus on the preliminary design of the FTS-2 instrument.

The FTS-2 instrument 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-2 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 pickoff mirror assembly, 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 engine 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-2 instrument, and will communicate with the RTS and SCUBA-2 network.

There are a number of challenges associated with the FTS-2 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 in a dual-input configuration, with both input ports on the sky.
- Accommodating the sub-optimal optical beam at the mounting location.
- Design of a processing pipeline that will produce a calibrated hyperspectral data cube as a science product.

The key milestones associated with FTS-2 development, installation and support are summarised as follows:

FTS-2 CoDR	July 30th, 2003
FTS-2 PDR	July 8th 2005
FTS-2 CDR	November 13th 2006
Complete Instrument Tests	June 2007
FTS-2 Acceptance Readiness Review	August 2007
Delivery FTS-2 to the Telescope	September 2007
Commissioning FTS-2	TBD
On-site support until	SCUBA-2 decommissioned

In order to ensure seamless collaboration among other teams within the SCUBA-2 development effort, the FTS-2 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.