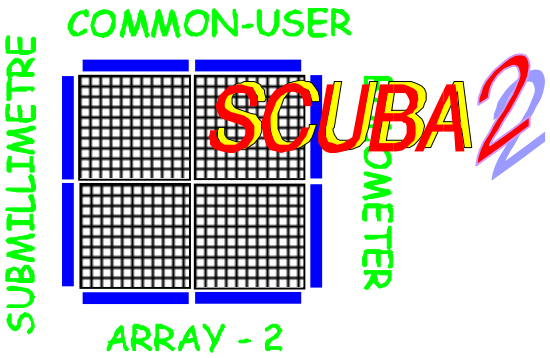

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Document Title: **SCUBA-2 FTS Project Management Plan**

Document Number: **SC2/FTS/PM500/002**

Issue: **Version 1.1**

Date: **28 July 2003**

Document Prepared By:	B. G. Gom FTS Project Manager	Signature and Date:	16/07/03
Document Approved By:	D. A. Naylor FTS Project Lead	Signature and Date:	16/07/03
Document Released By:	J. Molnar Canadian Project Manager	Signature and Date:	16/07/03

Change Record

Issue	Date	Section(s) Affected	Description of Change / Change Request Reference / Remarks
0.1	07/07/03	All	draft version
0.2	15/07/03	All	Format changes, minor corrections
1.0	16/07/03	All	First release version
1.1	28/07/03	Milestone dates, budget justification	Revised key milestone dates. Added descriptions of the budget items

Purpose of this document

This document is the Project Management Plan (PMP) for developing and building an imaging Fourier Transform Spectrometer (FTS) for use with the SCUBA-2 detector system.

The PMP provides a project managerial perspective of the FTS development. It includes the major milestones, all the essential deliverables for the major milestones with their owners, as well as all interdependencies within the FTS development team and among the various sub-projects of the SCUBA-2 development project. This document tracks the financial status of the FTS project and includes all team members with their responsibilities.

The PMP is updated for each major milestone and whenever a significant change occurs relative to the approved plan.

Executive Summary

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.

The mechanical, optical, and software design of the SCUBA-2 FTS will be much more complicated than that of a standard non-imaging FTS. Also, since the FTS was not included in the initial design of SCUBA-2, the layout of the SCUBA-2 feed optics is not optimal for inclusion of an FTS.

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 operating at the JCMT. See details in SCUBA-2 FTS Requirements Document

Figure 1 shows a potential mechanical layout of the FTS, mounted just outside the left Nasmyth elevation bearing. More images can be found on the U of L SCUBA-2 FTS webpages.

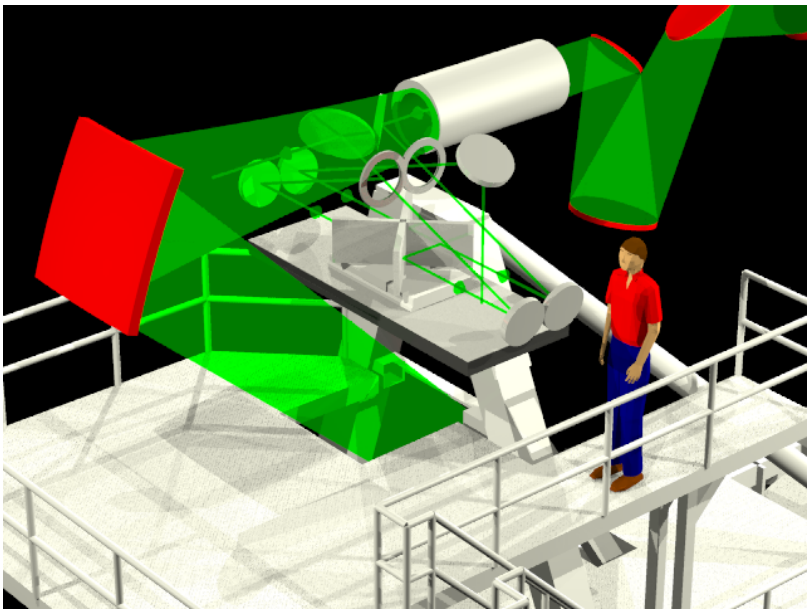


Figure 1. Conceptual model of the FTS mounting location. SCUBA-2 optics are shown in red.

Interfaces with SCUBA-2 and JCMT

Mechanical interface: The FTS will sit within the mounting framework for mirror N1, and will likely encroach on the receiver cabin access walkway. The SCUBA-2 mounting framework will be completely redesigned and rebuilt from the current configuration. It is absolutely essential that the JAC and FTS design teams closely cooperate in mechanical engineering to ensure that the FTS can be installed, aligned, operated and maintained with relative ease. The mass of the FTS is roughly estimated to be 600 kg, and the volume will be approximately 3 m x 1 m x 1.3 m. The JAC should prescribe limits for the inertial forces in all three axes that the FTS can exert on the mount during operation in order to prevent misalignment of mirror N1.

Electronics. Construction of the FTS will require very little custom electronics; the major electronic component is the microcontroller based motion controller for the moving mirror linear stage and for the pickoff mirrors. The motion controller and electronics for the blackbody source will be interfaced to a control PC. This PC will be interfaced with the SCUBA-2 network so that the 32 bit stage position is recorded in the header of each frame when an FTS observation is in progress.

Software. The FTS control PC will take commands from the RTS Client to initiate a scan, and will send commands to the motion controller to move the mirror at the required speed and distance, and return the mirror position to the software pipeline. The control PC will also monitor the various limit switches and FTS housekeeping parameters.

Responsibilities

The U of L will acquire and/or produce all the mechanical and optical components required to build the FTS, as well as the FTS control PC. The optical and mechanical design will be done at the U of L. The optics, blackbody, linear stage, optical breadboard, and other components will be purchased from suitable vendors, but there will be many mechanical components and mounts that will be manufactured at the U of L.

Software to control the FTS, as well as the data reduction routines, will be provided by the U of L. Provisions must be made so that suitable FTS commands will be delivered to the FTS control PC, and table position values are recorded with each frame. Significant cooperation will be required with the Data Analysis Software group in order to implement FTS processing in the SCUBA-2 software pipeline. Details are presented in the FTS software requirements document.

Dependencies

Information: Optical, mechanical, electronics and software interfaces (ATC, JAC, UBC)
Approval: CSC
Acceptance: Design will be presented to, and acceptance sought from ATC and JAC throughout the development process.
Components: Beamsplitters will be manufactured by Cardiff. The optics will be custom machined by a suitable shop. Most other components are easily acquired from commercial sources.
Infrastructure: Lab space and time at U of L for initial construction and testing. Use will be made of U of L electronics fabrication equipment and personnel.
Funding: Provided by the CFI budget.

Risks

FTS development risks will be managed by the team, headed by the Project Manager. See the SCUBA-2 Fourier Transform Spectrometer Risk Assessment document (SC2/FTS/PM500/001) for details.

Major milestones

The following milestones dates are given with the assumption that the current spending freeze for descoping contingency will be lifted by April 2004. Any extra delay in funding beyond this date will result is 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.

The following major milestones will be implemented with their corresponding deliverables:

Conceptual Design Review (CoDR) - July 30th, 2003

Deliverables	Owner	Due Date	Status
Operational Concept Document (OCD)	BGG	July 16th, 2003	ok
FTS Requirements Document	BGG	July 16th, 2003	ok
Conceptual layouts	BGG	July 16th, 2003	ok
Initial draft Interface Control Document (ICD)	BGG	July 16th, 2003	ok
Project Cost (part of PMP)	BGG	July 16th, 2003	ok
Project Schedule (part of PMP)	BGG	July 16th, 2003	ok
Risk Assessment and mitigation Plan	BGG	July 16th, 2003	ok

Preliminary Design Review (PDR) - May 2004

Deliverables	Owner	Due Date	Status
Updated OCD			
Updated FTS Requirements Document			
FTS Engineering Specification			
Preliminary Design Drawings			
Design Analysis Reports			
Initial Draft Test Requirements			
SW Architecture Definition			
Preliminary Safety Plans			
Updated ICD			
Updated Project Cost (part of PMP)			
Updated Project Schedule (part of PMP)			
Updated Risk Assessment and Mitigation Plan			
Long lead-time items Procurement Plan			

Critical Design Review (CDR) - October 2004

Deliverables	Owner	Due Date	Status
Updated OCD			
Updated FTS Requirements Document			
Updated FTS Engineering Specification			
Detailed Design Drawings			
Design Analysis and Development test Reports			
SW Integration and Test Plans			
Draft Acceptance Test Procedures and criteria			
Updated Safety Plans			

Updated ICD			
Special tooling and support equipment definitions (special facility requirements)			
Updated Project Cost (part of PMP)			
Updated Project Schedule (part of PMP)			
Updated Risk Assessment and Mitigation Plan			
Vendor Data for critical items			

Build/Test/Rework FTS - October 2005

Deliverables	Owner	Due Date	Status

Acceptance Readiness Review (ARR) - January 2006

Deliverables	Owner	Due Date	Status
Complete set of FTS drawings			
Interface drawings and documents			
Spares list			
Test and Analysis Reports			
Acceptance Test Plan			
Commissioning Plans			
Special tooling and support equipment documentation			
Preliminary operation and maintenance documentation			
Maintenance Manual			
Safety Documentation and Procedures			

Delivery to telescope - March 2006

Deliverables	Owner	Due Date	Status
All tested HW, SW, documentation			
Commissioning tools equipment and documentation			
Support Agreement			

Commissioning - 2-3 months after SCUBA-2 commissioning

Deliverables	Owner	Due Date	Status
To be determined by the PDR and negotiated between U of L and JAC			

FTS Support - until SCUBA-2 decommissioning

Deliverables	Owner	Due Date	Status
To be determined by the PDR and negotiated between U of L and JAC			

Project Financials

FTS Development is 100% funded by the Canadian Foundation for Innovation with a budget of CDN$ 996,740. Funding is granted through the Canadian Lead Intitute; the Physics and Astronomy Department of the University of Waterloo. Moneys will be disbursed according to the Inter Institutional Agreement (IIA) between the Lead Institution and the University of Lethbridge per the established schedule.

The current development cost and spending profile corresponds to the above IIA and is a snapshot as of July 2003.

Budget

The FTS project budget is summarized is the following table. Descriptions of the various items are given below, listed according to the CFI budget item numbers.

Items	CFI Items		Year 1 1/4/02 – 31/3/03	Year 2 1/4/03 – 31/3/04	Year 3 1/4/04 – 31/3/05	Year 4 1/3/05 – 31/4/06	Year 5 1/3/06 – 31/8/06	Total	Spent up to date	Remaining
17,16,23	9,8,57	Salaries	42,000	73,260	172,671	177,370	134,939	600,240	65,539	534,700
1 - 9	1,2,10-16	Optics and Hardware (mirrors, stage, laser, etc)	0	0	219,500	0	0	219,500	0	219,500
10	3	Large aperture cold blackbody	0	0	55,000	0	0	55,000	0	55,000
11	4	Control PC	0	4,000	0	0	0	4,000	0	4,000
12	19	Development software (IDL , Optical CAD package)	10,000	0	0	0	0	10,000	5,822	4,178
13	5	Machine shop time : ~3 month	0	0	24,000	0	0	24,000	0	24,000
14	6	Control/data acquistion electronics design and fabrication	0	0	9,000	6,000	0	15,000	0	15,000
15	17	Consumables for laboratory testing (LHe, LN2 etc)	2,000	2,000	2,000	2,000	0	8,000	0	8,000
18	7	Misc.items (eg FTS frame, lifting gear, alignment tools, etc)	0	0	0	0	3,000	3,000	0	3,000
20	18	Travel (ATC, Cardiff, Hawaii, Canadian partners)	10,990	8,802	12,500	12,500	5,208	50,000	11,783	38,217
21	20	Shipping crates for FTS system	0	0	0	0	3,000	3,000	0	3,000
22	21	Shipping FTS to Hawaii	0	0	0	0	5,000	5,000	0	5,000
								Grand Total		
		YEARLY TOTALS	**$64,990**	**$88,062**	**$494,671**	**$197,870**	**$151,147**	**$996,740**	**$83,144**	**$913,596**
		Spent so far	$64,284	$18,860						
		Delta	$706	$69,202	$494,671	$197,870	$151,147	**$913,596**		

Item 1 Aerotech precision translation stage and controller. This is a precision interferometer translation stage (300mm minimum travel) with Heidenhain linear encoder, control electronics and low EMI brushless DC linear motor.

Item 2 Motorized alignment laser assembly system that can be remotely inserted accurately and repeatedly into FTS to check alignment.

Item 3 Large aperture cold blackbody calibration source is required for the second input port of the Mach-Zehnder FTS. This will be based around a standard Infrared Laboratory dewar.

Item 4 Dedicated computer for FTS control and analysis software development

Item 5 Machine shop time to fabricate and mount optical components, construct framework and lifting harness, and some shipping crates. Estimated time 3 months.

Item 6 Electronics shop time to design and build the control interface electronics for the FTS. This requires extracting the Heidenhain encoder signal from the linear stage and time stamping the optical retardation with the JCMT RTS signal.

Item 7 Miscellaneous items related to installing and operating the FTS.

Items 8 and 57 Control software programmer(s). Software scientist responsible for developing the FTS control software, which must interface with the JCMT observatory control software, and the FTS analysis software, which must interface with the SCUBA-2 data product. This is an important position where continuity is critical throughout the project. This person must be knowledgeable about Fourier analysis, fluent in RT Linux, C++ and IDL and be able to work effectively with the FTS project manager as well as JAC and UBC personnel.

Item 9 Project manager and instrument engineer. This person will be the first point of contact with the FTS and assume the responsibility for overseeing the development and testing of the FTS. This will involve working closely with collaborators at ATC, Cardiff and Hawaii and the software scientist in the team. Specific tasks include producing technical drawings and specifications for the overall FTS design and its interface with the JCMT, drawings for all the optical and mechanical components, finding suitable vendors and/or custom manufacturers, overseeing the work in the electronics and machine shops at the University of Lethbridge and preparing monthly progress reports. This person will report to the Canadian project manager and work closely with ATC and Cardiff personnel.

Item 10 Custom Damped optical table to mount interferometric components.

Item 11 Custom large mirror mounts with precision micrometer adjusters.

Item 12 Custom large beamsplitter mounts with precision micrometer adjusters.

Item 13 2 Mylar beamsplitters for optical alignment of the FTS and 2 equal intensity beamsplitters.

Item 14 Large aluminum steering mirrors to direct telescope beam into FTS. These mirrors will be ~0.5m diameter

Item 15 300mm diameter aluminum plane mirrors for FTS, with mounting adaptors. Diamond turned for optical quality finish necessary for alignment

Item 16 300mm diameter aluminum aspherical mirrors for FTS, with mounting adaptors. Diamond turned for optical quality finish necessary for alignment.

Item 17 Lab testing the FTS (@ $2K per year x 4 years). Cryogens, general lab supplies.

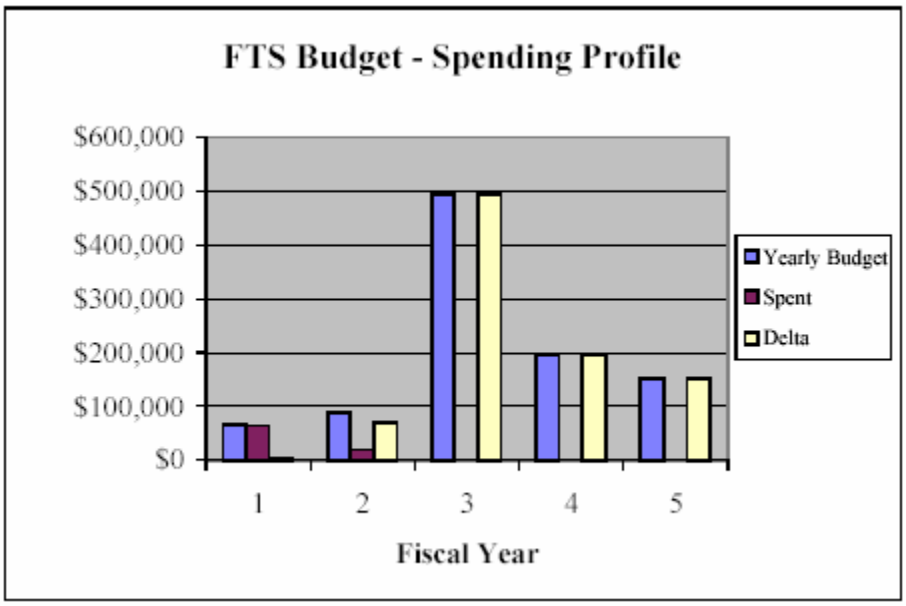
Item 18 Travel (@ $12.5K per year x 4 years). FTS team travel primarily to ATC and Cardiff but also to Hawaii.

Item 19 Development Software: IDL software package and an optical CAD package to produce interface drawings for the ATC

Item 20 Custom shipping crates for the FTS components.

Item 21 Shipping costs of the FTS to Hawaii.

Spending Profile



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