



SCUBA-2 FTS Project Office

University of Lethbridge
Physics Department
4401 University Drive
Lethbridge, Alberta
CANADA
T1K 3M4

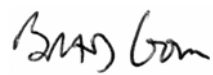
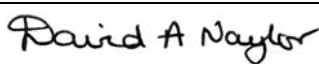

Tel: 1-403-329-2771
Fax: 1-403-329-2057
Email: brad.gom@uleth.ca
WWW: <http://research.uleth.ca/scuba2/>

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Document Prepared By:	B. G. Gom FTS Project Manager	Signature and Date:	 10/11/06
Document Approved By:	D. A. Naylor FTS 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
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
2.0	06/06/05	All	PDR version
3.0	6/11/06	All	CDR version
3.1	7/11/06	All	Minor corrections and wording revisions
3.2	10/11/06	6	Fixed typo in milestone years

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Applicable and Referenced Documents

<i>Document Number</i>	<i>Title</i>	<i>Version</i>
Top_Level_4thOct- 06_v17.0.mpp	SCUBA-2 Top Level Plan	17
SC2/FTS/PM500/003	FTS-2 Project Plan	

Purpose of this document

This document is the Project Management Plan (PMP) for developing and building an imaging Fourier Transform Spectrometer (FTS-2) for use with the SCUBA-2 detector system. The PMP provides a project managerial perspective of the FTS-2 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-2 development team and among the various sub-projects of the SCUBA-2 development project. This document tracks the financial status of the FTS-2 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.

1. Executive Summary

The mechanical, optical, and software design of FTS-2 is 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 FTS-2 instrument design 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 the FTS-2 Functional and Performance Requirements document (SC2/FTS/SRE/001). Figure 1 shows a simplified mechanical layout of the FTS, mounted just outside the left Nasmyth elevation bearing. More images can be found on the U of L [FTS-2 webpages](#).

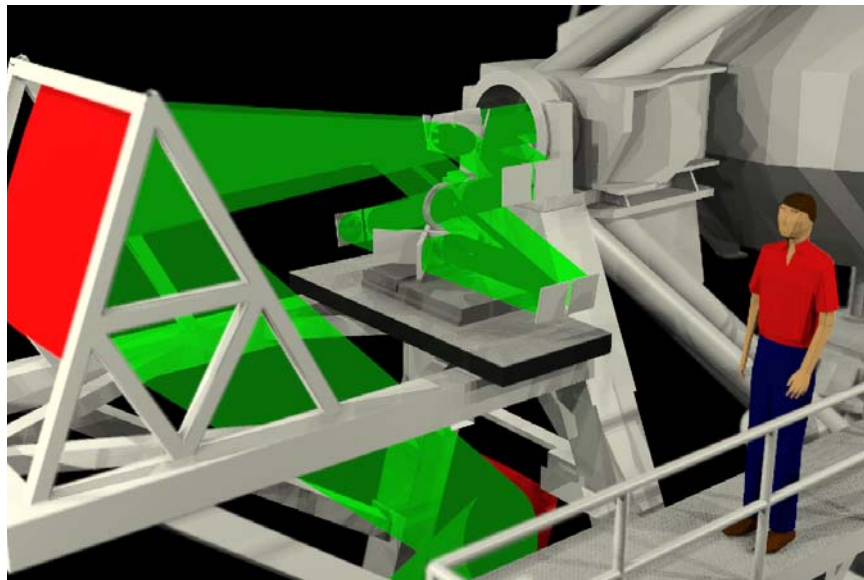


Figure 1. Conceptual model of the FTS mounting location. SCUBA-2 optics are shown in red.

2. Interfaces with SCUBA-2 and JCMT

Mechanical: The FTS will sit within the mounting framework for mirror N1, and has tight clearances with the dish backing structure and cabin access walkway. The SCUBA-2 N1 mirror mounting framework has been designed with mounting pads to accommodate the FTS-2 instrument. The JAC and FTS-2 design teams will cooperate closely in mechanical engineering to ensure that the FTS can be installed, aligned, operated and maintained with relative ease. Details of the mechanical design are found in document SC2/FTS/MEC/001.

Electronics: The major electronic components in the FTS-2 instrument are the microcontroller based motion controller for the moving mirror linear stage and the actuator controllers for the pickoff mirrors. The motion controllers will be interfaced to a control PC. This PC will be interfaced with the SCUBA-2 network and synchronized with the RTS system so that the 32 bit stage position is recorded with each frame when an FTS observation is in progress. Details of the electronics interfaces are found in SC2/FTS/SYS/005 and SC2/FTS/SYS/007.

Software: The FTS control PC will act as an RTS Client and will receive OCS commands to initiate a scan, 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. A data reduction engine will also be delivered which will exist within the main SCUBA-2 pipeline to reduce the FTS-2 data cubes. Details of the software design are found in SC2/FTS/SOF/001, SC2/FTS/SOF/002 and SC2/FTS/SYS/005.

3. Responsibilities

The U of L will acquire and/or produce all the mechanical and optical components required to build the FTS. The FTS-2 control PC will be shared with the POL-2 system, with only one system active at any given time. A spare PC identical to the unit delivered by the POL-2 group will be supplied by the U of L. The optical and mechanical design is be the responsibility of the U of L. The optics, 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 required data reduction engine code, 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 stage position values are recorded with each frame. Significant cooperation is required with the Data Analysis Software group in order to successfully implement the FTS-2 processing in the SCUBA-2 software pipeline.

4. 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 diamond turning shop. The linear stage and controller has been purchased from Aerotech Inc. 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, as well as optical test equipment and infrared detector systems.

Funding: Provided by the CFI budget.

5. Risks

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

6. Major milestones

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 16 th , 2003	ok
FTS Requirements Document	BGG	July 16 th , 2003	ok
Conceptual layouts	BGG	July 16 th , 2003	ok
Initial draft Interface Control Document (ICD)	BGG	July 16 th , 2003	ok
Project Cost (part of PMP)	BGG	July 16 th , 2003	ok
Project Schedule (part of PMP)	BGG	July 16 th , 2003	ok
Risk Assessment and mitigation Plan	BGG	July 16 th , 2003	ok

Preliminary Design Review (PDR) – July 8th 2005

Deliverables	Owner	Due Date	Status
Updated OCD	BGG	June 20 th , 2005	ok
Updated FTS Requirements Document	BGG	June 20 th , 2005	ok
FTS Engineering Specification	DH	June 20 th , 2005	ok
Preliminary Design Drawings	DH	June 20 th , 2005	ok
Initial Draft Test Requirements	BGG	June 20 th , 2005	ok

SW Architecture Definition	BZ	June 20 th , 2005	ok
Preliminary Safety Plans	BGG	June 20 th , 2005	ok
Updated ICD	BGG	June 20 th , 2005	ok
Updated Project Cost (part of PMP)	BGG	June 20 th , 2005	ok
Updated Project Schedule (part of PMP)	BGG	June 20 th , 2005	ok
Updated Risk Assessment and Mitigation Plan	BGG	June 20 th , 2005	ok
Long lead-time items Procurement Plan	BGG	June 20 th , 2005	ok

Critical Design Review (CDR) - November 2006

Deliverables	Owner	Due Date	Status
Updated OCD	BGG	Nov 13, 2006	ready
Updated FTS Requirements Document	BGG	Nov 13, 2006	ready
Updated FTS Engineering Specification	BGG	Nov 13, 2006	ready
Design Analysis and Development test Reports	BGG	Nov 13, 2006	ready
SW Integration and Test Plans	BGG	Nov 13, 2006	TOC
Draft Acceptance Test Procedures and criteria	DN	Nov 13, 2006	TOC
Updated Safety Plans	BGG	Nov 13, 2006	ready
Updated ICD	BGG	Nov 13, 2006	ready
Updated Project Cost (part of PMP)	BGG	Nov 13, 2006	ready
Updated Project Schedule (part of PMP)	BGG	Nov 13, 2006	ready
Updated Risk Assessment and Mitigation Plan	BGG	Nov 13, 2006	ready
Vendor Data for critical items	BGG	Nov 13, 2006	ready

Build/Test/Rework FTS - June 2007

Deliverables	Owner	Due Date	Status

Acceptance Readiness Review (ARR) - September 2007

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 - October 2007

Deliverables	Owner	Due Date	Status
All tested HW, SW, documentation			

Commissioning tools equipment and documentation			
Support Agreement			

Commissioning – date TBD

Deliverables	Owner	Due Date	Status
TBD, negotiated between U of L and JAC			

FTS Support - until SCUBA-2 decommissioning

Deliverables	Owner	Due Date	Status
To be determined, negotiated between U of L and JAC			

7. Project Financials

FTS-2 Development is 100% funded by the Canadian Foundation for Innovation with a budget of CDN\$ 996,740. The project is now fully funded, and funding is granted through the Canadian Lead Institute; the Physics and Astronomy Department of the University of Waterloo. Moneys are being disbursed according to the Inter Institutional Agreement (IIA) between the Lead Institution and the University of Lethbridge in quarterly payments as spending occurs at the U of L.

The current development cost and spending profile corresponds to the above IIA and is a snapshot as of October 2006.

7.1. Budget

The FTS-2 project budget is summarized in the following table. Descriptions of the various items are given below, listed according to the CFI budget item numbers. The original CFI budget was revised in July 2006 to reflect the delays in the schedule and re-evaluation of the workpackage budgets. The total amount for the FTS-2 project remains \$996,740 however, the project timeline has been extended and the relative allocations for the various line items have been adjusted. The currently forecast total spending leaves a contingency of ~\$55K CDN.

CFI Items		2002	2003	2004	2005	2006 (forecast)	2007 (forecast)	Total	Budget
		1/4/02 – 31/3/03	1/4/03 – 31/3/04	1/4/04 – 31/3/05	1/4/05 – 31/3/06	1/4/06 – 31/3/07	1/4/07 – 31/3/08		
9,8,57	Salaries	47,523	72,708	101,055	155,901	139,897	84,000	601,084	660,000
1,2,10-16	Optics and Hardware	0	0	0	31,433	191,209	0	222,643	206,000
3	Large aperture cold blackbody	0	0	0	0	10,000	0	10,000	10,000
4	Control PC	0	0	0	133	0	4,000	4,133	4,000
19	Development software	5,822	673	1,145	945	0	0	8,585	9,000
5	Machine shop time	0	0	0	0	30,000	0	30,000	30,000
6	Electronics design and fabrication	0	0	0	0	5,000	0	5,000	15,000
17	Consumables for laboratory testing (LHe, LN2 etc)	0	0	0	0	0	0	0	0
7	Misc.items (lifting gear, alignment tools, etc)	0	0	0	0	0	5,000	5,000	5,000
18	Travel (ATC, Cardiff, Hawaii, Canadian partners)	10,939	3,456	0	3,725	3,000	25,000	46,121	50,000
20	Shipping crates for FTS system	0	0	0	0	0	3,000	3,000	3,000
21	Shipping FTS to Hawaii	0	0	0	0	0	5,000	5,000	5,000
TOTAL		\$64,284	\$76,837	\$102,200	\$192,138	\$379,106	\$126,000	\$940,565	\$997,000

	Spent to date	% spent of forecast to date	% spent of budget to date	Remaining of forecast to date	Remaining of budget to date	Forecast contingency
Salaries	477,084	79%	72%	124,000	182,916	58,916
Optics and Hardware	69,143	31%	34%	153,500	136,857	-16,643
Large aperture cold blackbody	0	0%	0%	10,000	10,000	0
Control PC	133	3%	3%	4,000	3,867	-133
Development software	8,585	100%	95%	0	415	415
Machine shop time	0	0%	0%	30,000	30,000	0
Electronics design and fabrication	0	0%	0%	5,000	15,000	10,000
Consumables for laboratory testing (LHe, LN2 etc)	0	0%	0%	0	0	0
Misc.items (lifting gear, alignment tools, etc)	0	0%	0%	5,000	5,000	0
Travel (ATC, Cardiff, Hawaii, Canadian partners)	18,121	39%	36%	28,000	31,879	3,879
Shipping crates for FTS system	0	0%	0%	3,000	3,000	0
Shipping FTS to Hawaii	0	0%	0%	5,000	5,000	0
TOTAL	\$573,065	61%	57%	\$367,500	\$423,935	\$56,435

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. This item has been removed from the design and replaced with a much simpler ambient blackbody load within the FTS-2 instrument.

Item 4 Computer for the shared FTS-2/POL-2 RTS client. This machine will be a duplicate of the unit delivered with the POL-2 instrument, and will act as a spare.

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

Item 6 Electronics shop time to design and build the control interface electronics for the FTS. This includes any signal converters for the control system, as well as the custom internal blackbody mechanism, limit switches, etc.

Item 7 Miscellaneous items related to installing and operating the FTS, including hoist cables, etc.

Items 8 and 57 Control software programmer(s) responsible for developing the FTS-2 control software, which must interface with the JCMT observatory control software, and the FTS-2 analysis software, which must interface with the SCUBA-2 data product. Also includes mechanical engineering students to assist with the mechanical design.

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. 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 and precision micrometer adjusters, including machining costs.

Item 12 Custom large beamsplitter mounts and precision micrometer adjusters, including machining costs.

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

Item 14 Planar aluminum steering mirrors to direct telescope beam into the FTS. These mirrors will be ~100 mm diameter and diamond turned for optical quality finish necessary for alignment.

Item 15 Planar aluminum mirrors for FTS moving mirrors, diamond turned for optical quality finish necessary for alignment

Item 16 Aspherical aluminum mirrors for the FTS fixed mirrors, diamond turned for optical quality finish necessary for alignment.

Item 17 This item is ineligible for CFI funding and has been removed.

Item 18 Travel for FTS-2 team primarily to ATC and Cardiff but also to Hawaii. Also includes travel expenses for project reviews.

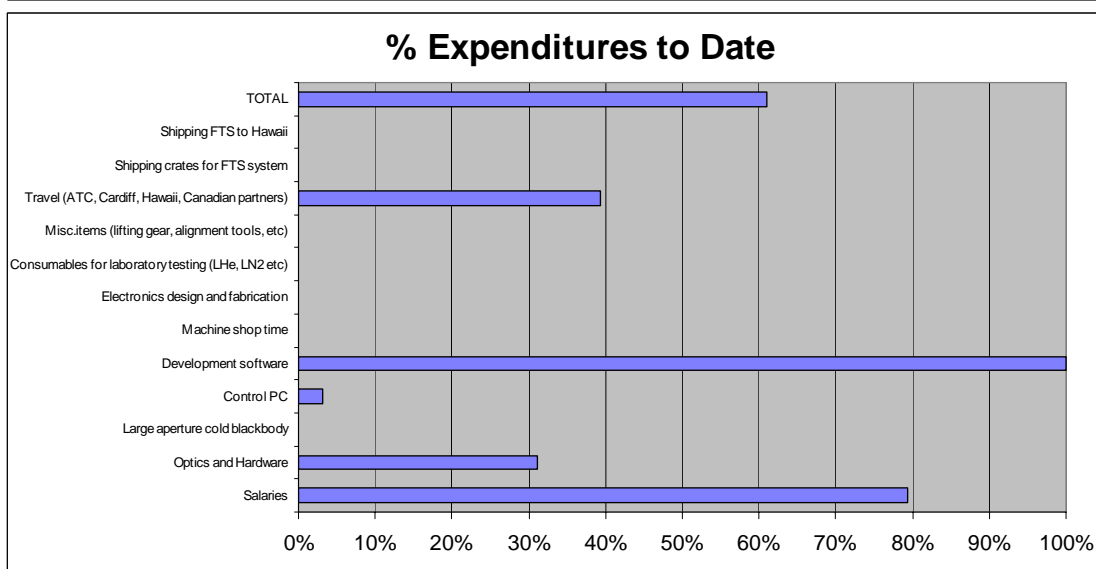
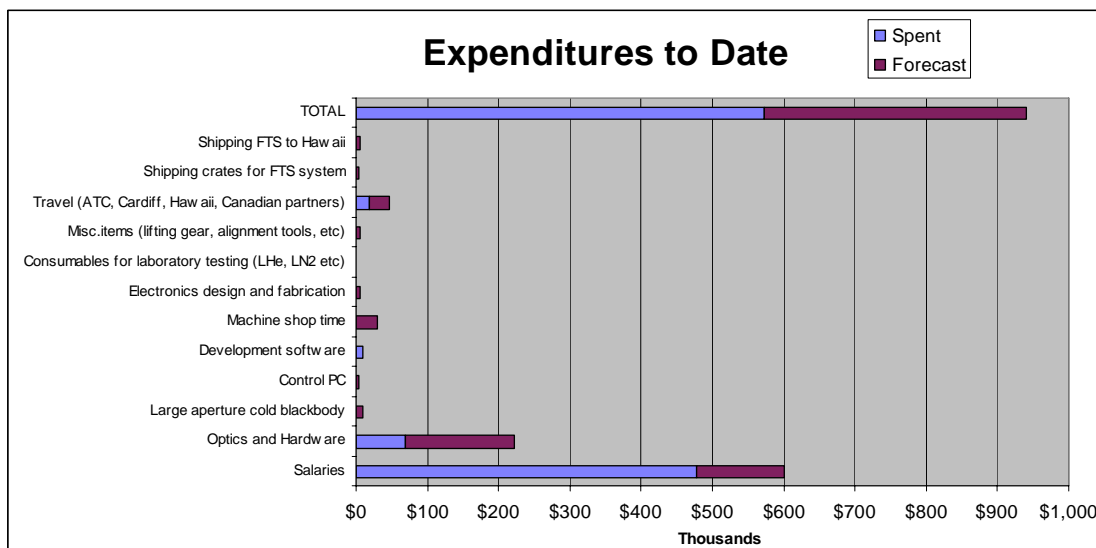
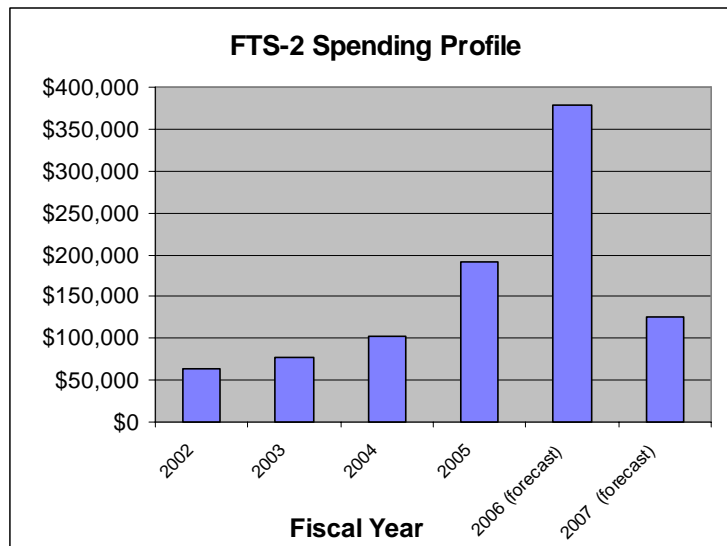
Item 19 Development Software: IDL software package and an optical CAD package to produce interface drawings for the ATC

Item 20 Custom shipping crates for the FTS components.

Item 21 Shipping costs of the FTS to Hawaii.

7.2. Spending Profile

The spending profile shown below represents actual spending up to the current date, and forecasted spending for the remaining time. There is no requirement to have spent specific amounts in previous years, so underspending/overspending in previous years is not defined. The largest expenditure will be in the 2006 fiscal year, assuming CDR approval allows major optics and hardware purchasing to begin. Spending in the last year will consist mainly of salaries and travel/commissioning expenses.



Team list

Members of the SCUBA-2 development effort relevant to the FTS-2 project are listed below.

Name	Area of Responsibility	Phone No.	Email address
University of Lethbridge			
Prof David Naylor	Overall responsible for FTS-2 work package	+1 403 329 2426	naylor@uleth.ca
Mr Brad Gom	FTS-2 Project Manager	+1 403 329 2771	brad.gom@uleth.ca
Dr Baoshe Zhang	FTS-2 Control Software Engineer	+1 403 329 2042	baoshe.zhang@uleth.ca
Mr Greg Tompkins	FTS-2 Electronics Technician	+1 403 329 2297	tompkins@uleth.ca
Joint Astronomy Centre (JAC), Hawaii		+1 808 961 3756	
Prof Gary Davis	Director, JAC/JCMT	+1 808 969 6504	g.davis@jach.hawaii.edu
Mr Craig Walther	Head of JAC Software and Computing Services	+1 808 969 6542	c.walther@jach.hawaii.edu
Ms Frossie Economou	Computing Services Manager, OMP project manager	+1 808 969 6536	f.economou@jach.hawaii.edu
Dr Tim Jenness	High Level Software Manager	+1 808 969 6553	t.jenness@jach.hawaii.edu
Dr Per Friberg	Head of JCMT Instrumentation	+1 808 969 6522	p.friberg@jach.hawaii.edu
Mr Simon Craig	Chief Engineer	+1 808 969 6542	s.craig@jach.hawaii.edu
Mr Tomas Chylek	Mechanical Design Engineer	+1 808 969 6540	t.chylek@jach.hawaii.edu
UK ATC		+44 (0) 131 668 8***	
Dr Wayne Holland	SCUBA-2 Project Scientist	389	w.holland@roe.ac.uk
Dr Dennis Kelly	SCUBA-2 Software/ System Analysis	369	d.kelly@roe.ac.uk
Dr Mike MacIntosh	SCUBA-2 Systems Engineer	368	m.macintosh@roe.ac.uk
Mrs Lynn Ritchie	SCUBA-2 Project Assistant	442	l.ritchie@roe.ac.uk
Mr Alasdair Fairley	SCUBA-2 Project Manager	286	aef@roe.ac.uk

Name	Area of Responsibility	Phone No.	Email address
University of Wales at Cardiff		+44 (0) 292 087 ****	
Prof Peter Ade	Head of Lab	4643	Peter.ade@astro.cf.ac.uk
Canadian SCUBA-2 Consortium (CSC) Steering Committee			
Prof Michel Fich, University of Waterloo	Chair, CSC Steering Committee	+1 519 888 4567 , ext 2725	fich@astro.uwaterloo.ca
Prof Mark Halpern University of British Columbia	Head of UBC Engineering Group	+1 604 822 6435	halpern@physics.ubc.ca
Prof Pierre Bastien, Université de Montréal	Responsible for polarimeter module	+1 514 343 5816	bastien@astro.umontreal.ca
Other Canadian Team Members			
Mr Janos Molnar, U. of British Columbia	Canadian Project Manager	+1 604 822 1938	jmolnar@physics.ubc.ca
Prof Douglas Scott, U. of British Columbia	Data Reduction and Pipeline SW lead	+1 604 822 2808	dscott@astro.ubc.ca
Ms Daphne Summers	Canadian Project Assistant	+1 519 888 4567, ext 7273	dsummers@uwaterloo.ca