



# ***SCUBA2 Data Reduction Software***

## ***Critical Design Review***

**University of British Columbia,  
Vancouver May 31<sup>st</sup>, 2005**

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

**Date:** May 31<sup>st</sup>, 2005

**Location:** University of British Columbia, Hennings Bldg. Room 309B

**Review Panel:** Mark Thompson (Herts) Chair, Craig Walther (JAC), Séverin Gaudet(HIA),

### **Data Reduction SW development team members:**

UBC: Douglas Scott, Andy Gibb, Janos Molnar,

JAC: Tim Jenness

### **In attendance:**

UBC: TBD

ATC: Dennis Kelly, Mike MacIntosh, Wayne Holland

JAC: Frossie Economou

CSC: Daphne Summers

HIA:

CADC:

UoL: Brad Gom

UdeM:

## 2. Agenda

<b>Commence Review</b>	<b>09:00</b>
Introduction and welcome (DS)	5 mins
SCUBA-2 Instrument overview (WH)	15 mins
SCUBA-2 Data Acquisition System ((DK)	15 mins
SCUBA-2 Data Reduction Software - top-level description (DS)	25 mins
<b>Break for coffee</b>	<b>10:00</b>
<b>Restart</b>	<b>10:15</b>
Development / Project Details	105 mins
Data Acquisition/Data Reduction Pipeline Interface control Document (TJ)	
Pipeline Architecture (TJ)	
SCUBA-2 Data Display System (TJ)	
SCUBA-2 Data Processing (TJ)	
SCUBA-2 Data Simulation and Testing (DS)	
SCUBA-2 Data Reduction SW Project Management Plan (JM)	
SCUBA-2 Data Reduction SW Risks (JM)	
<b>Break for lunch</b>	<b>12:00</b>
<b>Restart</b>	<b>13:30</b>
Discussion	30 mins
Panel closed session	30 mins
Panel feedback	30 mins
Next steps, closing remarks	30 mins
<b>Adjourn</b>	<b>15:30</b>

### 3. Review documentation

The documentation provided for the CDR is summarized in the following table.

It is intended that this set of documentation will first provide the Panel with an understanding of the design implementation relevant to the SCUBA-2 Data Reduction SW. The detailed design description starts with the updated Interface Control Document and also covers the Pipeline Architecture, the selected Display Modes, partial Data simulation and SW test results, as well as the different recipes and primitives. Supporting documentation is also provided in the appendices. This includes background material, more detailed analyses, as well as some additional project management information.

Section	Document title	Reference number
<b>Introduction</b>		
1.	Terms of reference for CDR	
<b>Requirements</b>		
2.	Data Reduction Software Requirements Document	SC2/SRE/S210/001
3	Compliance Matrix	SC2/SRE/S210/002
<b>Detailed design description</b>		
4.	Data Acquisition/Data Reduction Pipeline Interface control Document	SC2/SOF/IC210/01
4.a	Data Acquisition and Data File format	
4.b	Pipeline Data Products	
4.c	Algorithm Engine Interface	
5.	SCUBA-2 Pipeline Architecture	SC2/SOF/S210/001
6.	SCUBA-2 Data Display System	SC2/SOF/S210/002
7.	SCUBA-2 Data Simulation and Pipeline Testing	SC2/SOF/S210/003
8.	SCUBA-2 Data Reduction Recipes and Primitives	SC2/SOF/S210/004
9.	Stripchart Tool	SC2/SOF/S210/006
10.	Internal Task API	
<b>Analysis documents</b>		
11.	Map-making in different noise regimes	
12.	Analysis of Atmospheric Emission using SHARC-II Data and Implications for the SCUBA-2 Simulator	
13.	Data throughput testing for DREAM or Stare images	
14.	A Correlation Study using SCUBA Data, with implications for SCUBA-2 data reduction	SC2/ANA/S210/004
15.	Scan modes and Data Reduction Strategies for SCUBA-2	SC2/ANA/S210/005
<b>Appendix 1: Supplementary requirements</b>		
15.	Science Requirements for SCUBA-2	SC2/SRE/SC200/01
17.	Operational Concepts definition for SCUBA-2	SC2/SRE/SC200/03
<b>Appendix 2: Additional design documents</b>		
18.	Software architectural design	SC2/ANA/S100/45
19.	SCUBA-2 Data Output	SC2/SOF/S200/007
20.	SCUBA-2 Data Acquisition to Data Processing Interface	SC2/SOF/S200/008

21	SCUBA-2 data simulation.	SC2/SOF/S200/016
22.	Map making in different noise regimes.	SC2/ANA/S210/001
23.	Image processing and least-squares reconstructions.	SC2/SOF/S200/015
<b>Appendix 4: Management documentation</b>		
24.	SCUBA-2 Data Reduction SW Project Management Plan	SC2/SOF/PM210/01
25.	SCUBA-2 Data Reduction SW Risk Assessment and Mitigation Plan	SC2/SOF/PM210/02
26.	SCUBA-2 Data Reduction SW Detailed Project Plan	SC2/SOF/PM210/04

Note: Documents are accessible through: <http://scuba2.jach.hawaii.edu/cdr.html>

## **4. Terms of reference**

The purpose of the meeting is to review the ongoing design implementation of SCUBA-2 Data Reduction SW. 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 for each sub-element of the Data Reduction SW as detailed design progresses.

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

1. Does the current Data Reduction SW design, as presented by the Project Team, comply with the relevant scientific and technical requirements as laid out for the PDR?
2. Does the current design address the required standards with respect to good SW 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 data reduction SW ready for pipeline verification 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 to the final stage of the SW development with confidence i.e. the detailed design can continue.

## **5. The review process**

The SCUBA-2 Data Reduction SW design will be primarily reviewed via documentation and simulation results. The review panel will be provided with a set of documentation to be available no later than May 20<sup>th</sup>, 2005, in advance of the Review date (May 31<sup>st</sup>, 2005). There might be one or two documents, which will be released to the review panel May.24<sup>th</sup> to allow the authors to apply last minute changes without impacting the CDR date. Hard copies of the documents can be provided if requested.

The agenda for the meeting will be agreed with the Chairman of the review panel and published no later than May 24<sup>th</sup>. It is our intention that the formal review process will be conducted as a round-table discussion, working largely from hardcopy documents (presented in real-time via PC projector). Any follow-up questions to the documentation should be passed onto the Project Director (Douglas Scott) by May 27<sup>th</sup>. The aim is to maximise the time spent in interactive discussion of major issues in the meeting itself.

## 6. 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 day. The report will be the common property of UBC, JAC and PPARC and remain confidential. The Panel will produce a final report within two 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 the design meeting the requirements
- iii. Recommendation on how the design should be allowed to proceed to the final 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

## 7. 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 2<sup>nd</sup> half of 2006. With 10,240 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. SCUBA-2 is expected to have a huge impact on many areas of astronomy from studies of galaxy formation and evolution in the early Universe to understanding star and planet formation in our own Galaxy. Crucially, SCUBA-2 will also act as a “pathfinder” for the new generation of submm interferometers (e.g. ALMA) by performing large-area surveys to an unprecedented depth.

To maximise the scientific return SCUBA-2 must be operational in 2006, well before the tripartite agreement (UK, Canada, Netherlands) to run the telescope ends in 2009. Although discussions are ongoing to extend the operational life of SCUBA-2 beyond 2009, it doesn't alter the urgency of commissioning the instrument in 2006.

To achieve this goal, the instrument is being designed and constructed in parallel with the Software development programme, including Data Reduction SW. Developing the Data Reduction SW and instrument in parallel is clearly a high risk, high reward strategy with the possibility of considerable expenditure. To minimise the financial risk to the funding institutions the project is subject to a number of reviews. This particular review will focus on the predictable outcome of the critical elements of the SCUBA-2 Data Reduction SW.

Engineers and scientists at the Department of Physics and Astronomy of the University of British Columbia and at the Joint Astronomy Center in Hilo, with close cooperation with the system house at UK ATC, are designing the SCUBA-2 Data Reduction SW.

The SCUBA-2 Data Reduction SW Software consists of 3 main parts: the Pipeline data reduction; Off-line data reduction; and Data Display System.

The Pipeline runs at the summit, and delivers the observer a set of high quality images each night. The goal of the Pipeline is to keep up with the acquisition of data to produce co-added images for near real time estimation of signal-to-noise ratios. An addition goal is to reduce each night's data within 24 hours, providing images, which are already calibrated and as free of instrumental and atmospheric artefacts as possible.

The Off-line system uses the same set of routines, but will offer enhanced data reduction capabilities when run at the observer's home institution later.

The Data Display System delivers near real-time, approximate co-added images and other diagnostics to the observer as the data come in. How these Software Systems interface with the Data Acquisition System is described in the Interface Control Document.

The SCUBA-2 Software will run on top of the JAC Observing Tool and other JCMT software. Hence the 'look and feel' from the point of view of the observer should be similar to using SCUBA with ORAC-DR,2 but with some important differences, particularly because of the volume of data. The total expected data-rate is approximately 8MBs-1 (4 bytes per detector,  $40 \times 32$  detector sub-arrays, 4 sub-arrays at each of 2 wavelengths, all read at 200 Hz).

For DREAM and STARE modes the data reduction pipeline will be using the 1 Hz images. However, in SCAN mode (and the raw data for the other modes) 1GB will be generated approximately every 125 seconds. Since the data will accumulate at a greater rate than for SCUBA, the Pipeline data reduction must have a level of automation which is at least as good as currently available using ORACDR with SCUBA. It should not be necessary for astronomers to be familiar with sub-mm data reduction techniques in order to successfully use the instrument. However, the Software also needs to be flexible enough for the expert user to be able to develop more sophisticated algorithms to reduce their data off-line.

The key milestones associated with Data Reduction SW development are summarised as follows:

DR SW PDR	Sep.24, 2003
DR SW CDR	May 31 <sup>st</sup> , 2005
Acceptance Readiness      Review	July 2006
Delivery of SCUBA-2 to telescope	June 2006
DR SW Support ends	SCUBA2 decommissioning