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**Document Title: SCUBA-2 Data Reduction SW
 Risk Assessment and Mitigation Plan**

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Change Record

Issue	Date	Section(s) Affected	Description of Change / Change Request Reference / Remarks
0.1	8/27/2003	All	draft version
1.0	9/10/2003	All	Pre-Released version
1.1	9/10/2003		Released version
1.2	10/27/2003		Re-evaluated modifications, based on PDR feedback
1.3	11/21/2003	Added Risk	Starlink-specific risk
1.4	09/21/04	All	Update
1.5	10/11/04	Risks 3,4,7,8, 9,10,	Feedback from Dennis Kelly
1.6	04/28/05		Draft update for the CDR

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Purpose of this Document

The Data Reduction SW for SCUBA-2 is a *high-risk*, high-reward project.

Although this document is a supplement to the overall Project Risk Assessment document SC2/PRJ/PM600/03, the risk items in this document are managed and reported on separately.

The SCUBA2 Data Reduction SW development project has a fixed budget, *significant interruption in the development due to delayed hiring of an experienced software developer*, geographically distributed development team and an inflexible delivery date, which is not ideal for a project with such a degree of technical development and risk. It is also complex in terms of involving a large number of users and various requirements, and hence there are interfaces to manage which drives up risk and cost and tends to lengthen schedules. For all of these reasons, risk identification and management is extremely important for the Data Reduction SW for SCUBA-2 project.

After the initial review of the Data Reduction SW requirements projects typically start with a high level of risk that is then reduced by the implementation of mitigation steps within the project plan, changing the requirements or developing a better understanding of the engineering/programmatic challenges.

To help manage risk the project management team has adopted the standard UK ATC risk management strategy which:

- a) identifies the key risks in the project
- b) assigns a severity level to each risk on a scale of 1 to 5 (5 is very high severity and would be terminal to the project if it occurred - infinite schedule delay).
- c) assigns a probability of occurrence of the risk (0 to 4) (5 is > 50% probability),¹
- d) multiplies the two numbers to come up with the risk level (Impact)
- e) tracks, with regular updates, all risks with a level of 6 or higher (9 is regarded as high risk)
- f) assigns cost and schedule impact to all tracked risks
- g) puts in place risk mitigation steps designed to bring the risk down to the acceptable level, estimates the risk level after the implemented steps and forecasts the date when the risk will reach the acceptable level and is eliminated

Although successful to date, it is entirely possible that some unforeseen technical problem might yet be uncovered that would put the delivery date in jeopardy or require additional funds to overcome. The risks applicable to the Data Reduction SW development may be added to the main project risk register and are described in the following tables.²

¹ If probability of occurrence is higher, than 0.5, the risk will be treated as certainty and be part of the development plan



List of Identified Risks

Risk Number	DR_SW/1		Status	<i>Retired</i>
Date Logged	Aug 2003		Date Cleared	<i>Jan.2005</i>
On Critical Path	No		WBS Ref. No.	210
Owner	DS			
Original Risk Factor	Prob: 4	Severity: 4	Impact (P*I) = 16	Cat = high
Mitigated Risk Factor	Prob: 2	Severity: 2	Impact = 4	Cat = medium
Updated Risk factor as of Jan.2005	Prob: 0	Severity: 2	Impact = 0	Cat = 0
Date when risk is forecast to be passed:	<i>From September 2004 to January 2005</i>			
Description of risk: Fail to successfully hire PDRA at UBC				
Impact on project cost, schedule or quality if risk realised without mitigation:				
<ul style="list-style-type: none"> • Science effort to work on science data simulation and testing not available. • Research effort for SCANMAP data reduction not available. • Only Quick Look quality data is available <p>Schedule Delay: N/A Cost: N/A</p>				
Mitigation action:				
<ol style="list-style-type: none"> 1. Hire experienced graduate student for the next 9 months with clear mandate and expected outcomes, which later can be incorporated into a PDRA's development work. 2. Use current quality of simulated data (sufficient for benchmarking). 3. Implement basic scan processing as outlined in SC2/ANA/S100/038. 				
September 2004 update:				
<p>1. Hired experienced graduate student, who prepared solid report on useful atmospheric models and how to extract its impact from observed data. Used SHARC-II data to prove-in model. His activities covered the short-medium term goals, set out for him. The long term goals still need to be achieved before he leaves, now forecast for early 2005</p> <p>Hence the re-assessment is that the probability and the severity of this risk has been greatly reduced.</p>				
January 2005 update:				
<p>We have made a formal offer to Ed Chapin and he has accepted. He will start 1st July for a 2 year appointment, splitting his time 50/50 between SCUBA-2 and BLAST.</p>				

² Probability factors with asterisk (*) indicate that the designers were not comfortable with defining the probability, so the Project Manager substituted them with the value of 2. The probability numbers will be updated and this document re-released before the Critical Design Review (CDR)



Impact on project cost, schedule or quality if risk realised with mitigation action:

- Quality of pipeline data reduction *and schedule can be maintained until PDRA is hired.*
- Pipeline product suitable only for online use (pipeline product not of archival or publication quality).

Schedule Delay: N/A

Cost: N/A



Risk Number	DR_SW/2		Status	<i>Retired</i>
Date Logged	Aug 2003		<i>Date Cleared in Sep.2004</i>	
On Critical Path	Yes		WBS Ref. No.	210
Owner	JM			
Original Risk Factor	Prob: 2	Severity: 4	Impact (P*I) = 8	Cat = High
Mitigated Risk Factor	Prob: 1	Severity: 3	Impact = 3	Cat = medium
<i>Updated Risk factor as of Sep.2004</i>	<i>Prob: 0</i>	<i>Severity: 2</i>	<i>Impact = 0</i>	<i>Cat = 0</i>
Date when risk is forecast to be passed:	<i>Moved from January 2004 to Sep.2004</i>			
Description of risk: Fail to successfully hire programmer at UBC by Jan.2004				
Impact on project cost, schedule or quality if risk realised without mitigation:				
<ul style="list-style-type: none"> • Can not complete work package at UBC <i>on time</i> <p>Schedule Delay: > 3 months Cost: > \$ 60.000</p>				
Mitigation action:				
<ol style="list-style-type: none"> 1. Intensify search for programmer 2. Relax hiring criteria and add learning period to the project plan 3. Widen search to allow hiring highly qualified programmer even if it takes a bit longer and costs more 3. Outsource programming 4. Move programming work to where the technical lead is located (JAC) 				
September 2004 update:				
<ol style="list-style-type: none"> 1. Hired experienced programmer, who is familiar with JAC environment 2. Reviewed project plan and confirmed its viability to be finished by March 2006 <p>Hence the re-assessment is that the risk has been eliminated.</p>				



Impact on project cost, schedule or quality if risk realised with mitigation action:

- Impact depends on mitigation solution
- If programming moved to JAC, quality of work would be high with higher expense and longer delivery time

Schedule Delay: 0-18 months
 Cost: \$0- 100.000

Risk Number	DR_SW/3		Status	Live
Date Logged	Aug 2003		Date Cleared	
On Critical Path	Yes		WBS Ref. No.	210
Owners	JM			
Original Risk Factor	Prob: 3	Severity: 5	Impact = 15	Cat = High
Mitigated Risk Factor	Prob: 1	Severity: 3	Impact = 3	Cat= Medium
<i>Updated Risk factor as of Apr.2005</i>	<i>Prob: 1</i>	<i>Severity: 3</i>	<i>Impact = 3</i>	<i>Cat= Low</i>
Date when risk is forecast to be passed:	December 2005			
<u>Description of risk:</u>				
Critical staff not available for the entire duration of the project				
<u>Impact on project cost, schedule or quality if risk realised without mitigation:</u>				
Design complexity requires stable working team. Team members must have thorough understanding of the JAC environment, the intricacies of Data Reduction tasks in light of various observation modes as well as SCUBA2 capabilities. Replacing a critical team member with someone, who lacks the above combination of skill sets <i>will</i> impact the project significantly				
Schedule Delay: 5 months				
Cost: \$US 100,000				



Mitigation action:

1. Establish framework among participating institutions to ensure availability of critical staff.
2. Minimise work overload and eliminate burn-out.
3. Demand detailed and clear design documentation at every stage of the design
4. Store all design information in clearly structured and easy to use secure database
5. Duplicate responsibilities
6. Hire new staff with critical experience or include intensive on-the-job training to obtain critical experience quickly.

October 2004 update:

1. Hired experienced SW developer, who works very well with the Technical Lead
2. Technical Lead's participation is supported, his other responsibilities at JAC don't let him work on the project 50% of his time as was originally planned for.

April 2005 update:

1. Technical Lead has been given sufficient time to work towards the CDR

Impact on project cost, schedule or quality if risk realised with mitigation action:

Schedule Delay: 4 month
Cost: \$US 80,000

Risk Number	DR_SW/4		Status	Live
Date Logged	Sep 2003		Date Cleared	
On Critical Path	Yes		WBS Ref. No.	210
Owners	DS, JM			
Original Risk Factor	Prob: 4	Severity: 5	Impact = 20	Cat = High
Mitigated Risk Factor	Prob: 1	Severity: 3	Impact = 3	Cat= Medium
Updated Risk factor as of Sep.2004	Prob: 1	Severity: 3	Impact = 3	Cat= Medium
Date when risk is forecast to be passed:	December 2005			
<u>Description of risk:</u> Multi-site development introduces miscommunication, delay in problem recognition, problem resolution				



Impact on project cost, schedule or quality if risk realised without mitigation:

Multi-site development, with significant geographic and time-zone differences make communication more cumbersome, prone to misunderstanding. Integration various blocks of SW and fixing problems uncovered during SW integration is more time-consuming to accomplish.

Schedule Delay: 5 months
Cost: \$US 100,000

Mitigation action:

1. Establish clear SW development rules.
2. Establish clear interface documentation.
3. Establish convenient file-sharing and SW streaming mechanism
4. Establish effective communication media(set-up video conferencing equipment)
5. Plan for co-located collaboration (frequent visits by team members)

October 2004 update:

1. So far communication problems have not impacted the development.
2. Established convenient file-sharing between JAC and UBC
3. Frequent visits are part of collaboration.

Impact on project cost, schedule or quality if risk realised with mitigation action:

Schedule Delay: 1 month
Cost: \$US 20,000



Risk Number	DR_SW/5		Status	Live
Date Logged	Sep 2003		Date Cleared	
On Critical Path	No		WBS Ref. No.	210
Owner	DS			
Original Risk Factor	Prob: 2*	Severity: 3	Impact = 6*	Cat = High
Mitigated Risk Factor	Prob: 2	Severity: 1	Impact = 2	Cat = Low
Updated Risk factor as of Sep.2004	Prob: 2	Severity: 1	Impact = 2	Cat= Low
Date when risk is forecast to be passed:	Jan 2005 (SW tested on recycled HW) <i>moved to Nov.2005</i>			
<u>Description of risk:</u>				
Prototype cannot reduce simulated DREAM/STARE data at operational speed (12 hours to reduce data taken in 12 hours of operation)				
<u>Impact on project cost, schedule or quality if risk realised without mitigation:</u>				
<ul style="list-style-type: none"> • Pipeline useless for data quality assessment in time for observational decisions to be taken. • Full potential of SCUBA2 can not be realised <p>No impact on schedule or project cost</p> <p>Schedule Delay: N/A</p> <p>Cost: N/A</p>				
<u>Mitigation action:</u>				
1. Reduce file dump rate from the currently suggested 1 Hz to an elevation-appropriate value.				
<u>Update in Sep.2004:</u>				
1. Due to delay in starting the project we are not in a position to change our assessment.				
<u>Impact on project cost, schedule or quality if risk realised with mitigation action:</u>				
<ul style="list-style-type: none"> • This would result in data taking at a rate that is 3-5 times slower • Quick Look updates slightly less frequently (every 3-5 seconds rather than 1 second) • This isn't known to cause any specific problem <p>Schedule Delay: N/A</p> <p>Cost: N/A</p>				



Risk Number	DR_SW/6		Status	Live
Date Logged	Sep 2003		Date Cleared	
On Critical Path	No		WBS Ref. No.	210
Owner	DS			
Original Risk Factor	Prob: 2*	Severity: 4	Impact = 8*	Cat = High
Mitigated Risk Factor	Prob: 2	Severity: 1	Impact = 2	Cat = Low
<i>Updated Risk factor as of Sep.2004</i>	<i>Prob: 2</i>	<i>Severity: 1</i>	<i>Impact = 2</i>	<i>Cat= Low</i>
Date when risk is forecast to be passed:	Jan 2005 (SW tested on recycled HW) <i>moved to Nov.2005</i>			
<u>Description of risk:</u>				
Prototype cannot reduce simulated SCANMAP data at operational speed (12 hours to reduce data taken in 12 hours of operation)				
<u>Impact on project cost, schedule or quality if risk realised without mitigation:</u>				
<ul style="list-style-type: none"> • Pipeline useless for data quality assessment in time for observational decisions to be taken. • Reduced data cannot be provided to PIs by JAC and PIs may not have the facility to reduce the data at their own institution. • Full potential of SCUBA2 can not be realised 				
No impact on schedule or project cost				
Schedule Delay: N/A				
Cost: N/A				
<u>Mitigation action:</u>				
1. Re-cast data reduction problem in a parallelized architecture.				
<u>Update in Sep.2004:</u>				
1. Due to delay in starting the project we are not in a position to change our assessment.				
<u>Impact on project cost, schedule or quality if risk realised with mitigation action:</u>				
<ul style="list-style-type: none"> • Slip in schedule while parallelization is introduced into ORAC-DR. 				
Schedule Delay: 3 months				
Cost: \$60.000 +30.000 for HW duplication				



Risk Number	DR_SW/7		Status	Live
Date Logged	Sep 2003		Date Cleared	
On Critical Path	No		WBS Ref. No.	210
Owner	DS			
Original Risk Factor	Prob: 2*	Severity: 3	Impact = 6*	Cat = High
Mitigated Risk Factor	Prob: 2	Severity: 2	Impact = 4	Cat = Medium
Updated Risk factor as of Oct.2004	Prob: 2	Severity: 2	Impact = 4	Cat= Medium
Date when risk is forecast to be passed:	Jan 2005 (SW tested on recycled HW) <i>moved to Nov.2005</i>			
<u>Description of risk:</u>				
Simulations show that it is impossible to reduce SCAN data to an acceptable quality at operational speeds without performing matrix inversion.				
<u>Impact on project cost, schedule or quality if risk realised without mitigation:</u>				
<ul style="list-style-type: none"> • Pipeline requirements shift radically during instrument commissioning, and delivered reduction algorithms will no longer be appropriate. • Reduced performance until new pipeline requirements are fulfilled* • Increased support cost, which now includes additional Pipeline S/W development*t 				
Impact on schedule or project cost				
Schedule Delay: N/A				
Cost: N/A				
<u>Mitigation action:</u>				
1. Develop algorithm suitable for a parallelized hardware architecture (eg. Beowulf cluster).				
<u>Update in Oct.2004:</u>				
1. Due to delay in starting the project we are not in a position to change our assessment.				



Impact on project cost, schedule or quality if risk realised with mitigation action:

- Hardware cost increases.
- Delivery schedule slips

Schedule Delay: 4 months

Cost: \$80.000 + 30.000 for HW duplication



Risk Number	DR_SW/8		Status	<i>Retired</i>
Date Logged	Aug 2003		<i>Date Cleared</i>	<i>March 2005</i>
On Critical Path	No		WBS Ref. No.	210
Owners	DS			
Original Risk Factor	Prob: 1	Severity: 3	Impact = 3	Cat = Medium
Mitigated Risk Factor	Prob: 1	Severity: 1	Impact = 1	Cat= Low
<i>Updated Risk factor as of Mar.2005</i>	<i>Prob: 0</i>	<i>Severity: 1</i>	<i>Impact = 0</i>	<i>Cat= 0</i>
Date when risk is forecast to be passed:	December 2004 moved to March 2005			
Description of risk: Cannot perform QUICK-LOOK functionality at 1Hz				
Impact on project cost, schedule or quality if risk realised without mitigation:				
Quick Look cannot be delivered to spec				
Schedule Delay: N/A				
Cost: N/A				
Mitigation action:				
<ul style="list-style-type: none"> • Reduce amount of data to be displayed by QL 				
Update in Sep.2004:				
1. Due to delay in starting the project we are not in a position to change our assessment.				
Update in March 2005:				
2. Initial throughput testing by Andy Gibb confirmed that QL can run under 1 sec.				
Impact on project cost, schedule or quality if risk realised with mitigation action:				
<ul style="list-style-type: none"> • Quick Look updates slightly less frequently (every 3-5 seconds rather than 1 second) • Some data won't get displayed on the QL (drop frames) • This isn't known to cause any specific problem 				
Schedule Delay: N/A				
Cost: N/A				



Risk Number	DR_SW/9		Status	Live
Date Logged	Sep 2003		Date Cleared	
On Critical Path	No		WBS Ref. No.	210
Owners	DS			
Original Risk Factor	Prob: 1	Severity: 3	Impact = 6	Cat = High
Mitigated Risk Factor	Prob: 1	Severity: 1	Impact = 1	Cat= Low
<i>Updated Risk factor as of Sep.2004</i>	<i>Prob: 1</i>	<i>Severity: 1</i>	<i>Impact = 1</i>	<i>Cat= Low</i>
Date when risk is forecast to be passed:	Dec. 2004 moved to Oct. 2005, when sub-array behaviour with MCE has been verified and observing modes selected			
<u>Description of risk:</u>				
Unresolved algorithm issues render certain observing modes untenable.				
<u>Impact on project cost, schedule or quality if risk realised without mitigation:</u>				
To be defined				
Schedule Delay: N/A				
Cost: N/A				
<u>Mitigation action:</u>				
<ul style="list-style-type: none"> • Tbd 				
<u>Update in Sep.2004:</u>				
1. Due to delay in starting the project we are not in a position to change our assessment.				
<u>Impact on project cost, schedule or quality if risk realised with mitigation action:</u>				
<ul style="list-style-type: none"> • TBD 				
Schedule Delay: N/A				
Cost: N/A				



Risk Number	DR_SW/10		Status	Live
Date Logged	Sep 2003		Date Cleared	
On Critical Path	No		WBS Ref. No.	210
Owners	DS			
Original Risk Factor	Prob: 1	Severity: 3	Impact = 6	Cat = High
Mitigated Risk Factor	Prob: 1	Severity: 1	Impact = 1	Cat= Low
<i>Updated Risk factor as of Sep.2004</i>	<i>Prob: 1</i>	<i>Severity: 1</i>	<i>Impact = 1</i>	<i>Cat= Low</i>
Date when risk is forecast to be passed:	December 2005			
<u>Description of risk:</u>	External SW packages won't deliver on time/content			
<u>Impact on project cost, schedule or quality if risk realised without mitigation:</u>				
To be defined				
Schedule Delay: N/A				
Cost: N/A				
<u>Mitigation action:</u>				
<ul style="list-style-type: none"> External dependencies are clearly identified in the project plan and their progress will be followed closely. In case of anticipated delay DR Pipeline S/W tasks will be re-prioritised to minimise impact* Polarimetry-data reduction SW will either be entirely developed within the team or in very close collaboration with it.** FTS S/W developer(s) will work closely with the S/W Technical Lead** 				
<u>Update in Sep.2004:</u>				
1. Due to delay in starting the project we are not in a position to change our assessment. In principle this risk should diminish if other SW packages are delivered in delay, but this analysis hasn't been done as of today				
<u>Impact on project cost, schedule or quality if risk realised with mitigation action:</u>				
<ul style="list-style-type: none"> tbd 				
Schedule Delay: N/A				
Cost: N/A				



Risk Number	DR_SW/11		Status	Live
Date Logged	Sep 2003		Date Cleared	
On Critical Path	No		WBS Ref. No.	210
Owners	DS			
Original Risk Factor	Prob: 1	Severity:>5	Impact > 5	Cat = High
Mitigated Risk Factor	Prob: 1	Severity: 1	Impact = 1	Cat= Low
Updated Risk factor as of Sep.2004	Prob: 1	Severity: 1	Impact = 1	Cat= Low
Date when risk is forecast to be passed:	December 2006			
Description of risk: SW support (Starlink) discontinued				
Impact on project cost, schedule or quality if risk realised without mitigation:				
<p>Starlink is such an integral part of British astronomy research and work done at JAC that JAC has undertaken the role of guaranteeing ongoing Starlink support regardless of SCUBA-2 development.</p> <p>Therefore we mention this risk on SCUBA-2 Data Reduction SW development for completeness only</p> <p>Schedule Delay: N/A Cost: N/A</p>				
Mitigation action:				
<ul style="list-style-type: none"> • None within the framework of SCUBA-2 				
Update in Sep.2004:				
1. No indication so far that Starlink support will cease to exist.				
Update in May 2005:				
1. Starlink will cease to exist on June 30, 2005				
Impact on project cost, schedule or quality if risk realised with mitigation action:				
<ul style="list-style-type: none"> • Unpredictable <p>Schedule Delay: N/A Cost: N/A</p>				



Risk Number	DR_SW/12		Status	Live
Date Logged	Sep 2003		Date Cleared	
On Critical Path	No		WBS No.	Ref. 210
Owners	DS			
Original Risk Factor	Prob: 1	Severity: 3	Impact = 6	Cat = High
Mitigated Risk Factor	Prob: 1	Severity: 1	Impact = 1	Cat= Low
<i>Updated Risk factor as of Mar.2005</i>	<i>Prob: 1</i>	<i>Severity: 1</i>	<i>Impact = 1</i>	<i>Cat= Low</i>
Date when risk is forecast to be passed:	December 2005 moved to March 2006, by when the bulk of development is supposed to have been finished			
Description of risk: Funding is not sufficient to complete DR SW development project				
Impact on project cost, schedule or quality if risk realised without mitigation:				
<ol style="list-style-type: none"> 1. Quality of SW may require increased support and maintenance cost 2. Some selected feature(s) will not be developed, leading to underutilizing the potential of SCUBA-2 				
Schedule Delay: N/A				
Cost: N/A				
Mitigation action:				
<ul style="list-style-type: none"> • Track budget spending closely and predict budget increase ahead of time • Re-use available SW as much as feasible • Use state of the Art SW development techniques, which ensure early error detection and efficient SW debugging 				
Update in Sep.2004:				
<ol style="list-style-type: none"> 1. Overall project funding is an ongoing concern. With the latest development whereby the Chinese Science Authorities have withdrawn their significant financial support from SCUBA-2, the risk of lack of funding slightly increased 				
Update in Mar. 2005:				
<p><i>Sufficient funding has been provided by PPARC to continue the entire project. Funding for the DR Pipeline development project has been adequate from the start.</i></p>				



<u>Impact on project cost, schedule or quality if risk realised with mitigation action:</u>	
<ul style="list-style-type: none"> tbd 	
Schedule Delay:	N/A
Cost:	N/A

Risk Number	DR_SW/13			Status	Live
Date Logged	Aug 2003			Date Cleared	
On Critical Path	No			WBS Ref. No.	210
Owners	DS				
Original Risk Factor	Prob: 1	Severity: 1	Impact = 1	Cat = Low	
Mitigated Risk Factor	Prob: 1	Severity: 1	Impact = 1	Cat= Low	
<i>Updated Risk factor as of Sep.2004</i>	<i>Prob: 1</i>	<i>Severity: 1</i>	<i>Impact = 1</i>	<i>Cat= Low</i>	
Date when risk is forecast to be passed:	December 2004 <i>moved to December 2005</i>				
<u>Description of risk:</u>	Cannot display Movie at 25Hz				
<u>Impact on project cost, schedule or quality if risk realised without mitigation:</u>					
<p>Movie functionality is dropped Full potential of SCUBA2 can not be realised</p> <p>Schedule Delay: N/A Cost: N/A</p>					
<u>Mitigation action:</u>					
<ul style="list-style-type: none"> Reduce frame rate. <p>1. Due to delay in starting the project we are not in a position to change our assessment.</p>					
<u>Impact on project cost, schedule or quality if risk realised with mitigation action:</u>					
<ul style="list-style-type: none"> Improved customer satisfaction <p>Schedule Delay: N/A Cost: N/A</p>					

