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300mK Straps Subsystem Development Plan

# **300mK Straps** Subsystem Development Plan

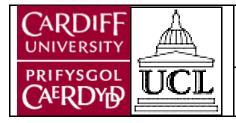
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Prepared by: Pete Hargrave Last Modified on: 12 February 2001 Approved by:

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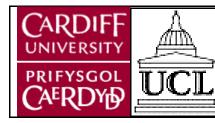
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# **Update history**

Date	Version	Remarks
8/01/01	Draft 1.0	Creation of document

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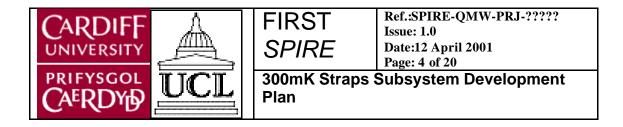


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## 1. Scope

This document describes the development plan for the FIRST/SPIRE 300mK straps subsystem.

It is a preliminary version, which will be updated as the design matures.

# 2. Documents

#### 2.1. Applicable documents

	Title	Author	Reference	Date
AD1	300mK Straps Subsystem Specification Document	To be written		
AD2				
AD3				

#### 2.2. Reference documents TBW

	Title	Author	Reference	Date
RD1	Instrument Requirements Document	B.M.Swinyard	SPIRE-RAL-PRJ-000034 Issue 0.30	May 2000
RD2	Instrument development plan	K.J.King		

## 2.3. Glossary TBW

AD Applicable Document	FS Flight Spare
ATC Astronomy Technology Centre	FTS Fourier Transform Spectrometer
BDA Bolometer Detector Array	
CBB Cryogenic Black Body	
	LAS Laboratoire d'Astronomie Spatiale
CDR Critical Design Review	MGSE Mechanical Ground Support Equipment
	MSSL Mullard Space Science Laboratory
CoG Centre of Gravity	NA Not Applicable
CQM Cryogenic Qualification Model	OGSE Optical Ground Support Equipment
DDR Detailed Design Review	PCAL Photometer CALibrator
	PFM ProtoFlight Model
DM Development Model	RAL Rutherford Appleton Laboratory
DRCU Digital Read-out and Control Unit	RD Reference Document
EGSE Electrical Ground Support Equipment	SCAL Spectrometer CALibrator
FIRST Far InfraRed Space Telescope	WE Warm Electronics
FPU Focal Plane Unit	

# 3. Subsystem Description

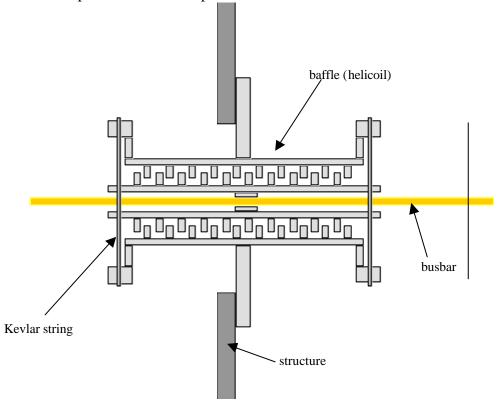
Updated sketches/drawings from JC/BW needed

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The 300mK straps subsystem comprises all thermal straps between the <sup>3</sup>He cooler head and the BDAs, all supports for these straps (which should provide a high degree of thermal isolation from the 2K structure), and all light baffles (used where the straps go from a 4K environment to a 2K environment).

A conceptual design for the light baffles is shown in figure (1). These are used to prevent 4K radiation from entering the 2K boxes, and also provide thermally isolated mechanical suspension for the straps.



#### Figure 1

The conceptual design for the photometer straps is shown in figures (2) and (3). The photometer straps are suspended from the 2K structure, and run along the walls of the 2K photometer box. The suspension of these straps must provide excellent thermal isolation from the 2K structure, whilst retaining high mechanical strength.

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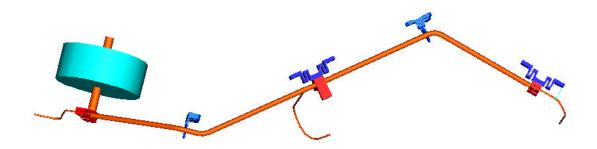


Figure 2 Updated drawing needed – Kevlar suspension

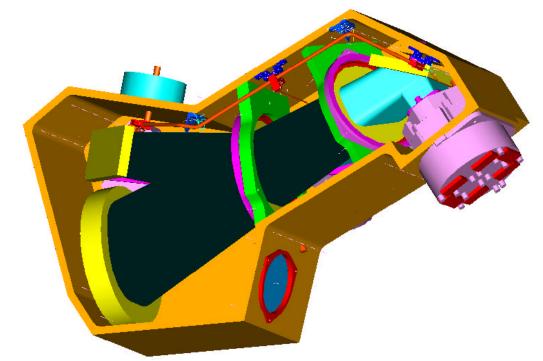
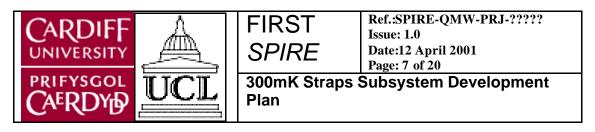


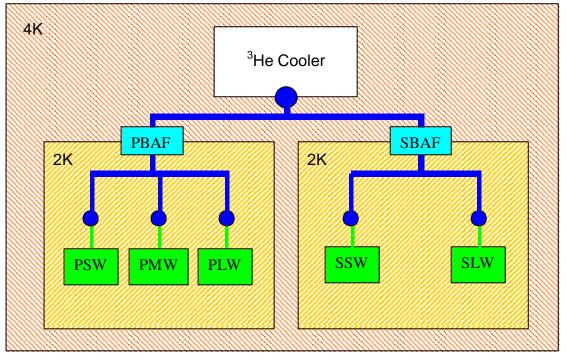
Figure 3 Updated drawing needed – Kevlar suspension

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#### 3.1. Block diagram



**Figure 4** Block diagram of 300mK strap sub-system. The straps are shown in dark blue, thermal interfaces to other subsystems are shown as blue circles, and PBAF & SBAF are the photometer & spectrometer light baffles.

# 4. Organisation

This work package is largely shared between Cardiff and MSSL, with design input, in the form of thermal and optical modeling, from RAL.

Cardiff are responsible for:-

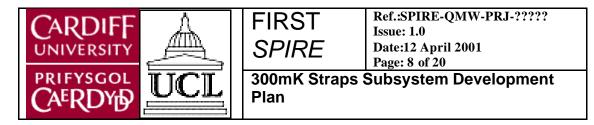
- Thermal testing
  - Thermal conductivity of prototype materials
  - Thermal interface study to find optimal interface configuration.
  - Thermal testing of prototype 300mK system.
- Optical testing
  - Testing the performance of prototype stray light baffles.
- System design (thermal)

MSSL are responsible for:-

- System design (mechanical)
- Mechanical testing.
- Procurement & manufacture of the 300mK system for STM/CQM, PFM & FS.

RAL are responsible for:-

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- Thermal modeling.
- Stray light analysis.
- Input from RAL will be used by Cardiff and MSSL in the preliminary design phase.

# 5. Deliverables

The current SPIRE model philosophy dictates that flight representative thermal straps are delivered for integration to the structure for STM testing. This STM structure will then become the CQM structure. It is proposed that the CQM structure is then refurbished for the flight spare, once received back from ESA. This would imply that only two 300mK strap models are necessary – one for the STM/CQM and FS, and one flight model. However, we are concerned about the thermal cycling and vibrations that the STM/CQM model will have been subjected to. High vibrational levels may cause creep of the proposed Kevlar support, as well as work-hardening of the straps. We have assumed the provision of a separate FS model, which may be integrated to the FS structure as a replacement for the STM/CQM system.

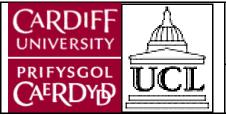
The concept of a deliverable needs clarification in this case. It is yet to be decided whether the 300mK strap system will be integrated to the structure at MSSL, prior to delivery to RAL, or whether the straps and structure will be delivered to RAL as separate entities, and integrated there (*Berend/Bruce – comments please – clean room facilities etc*). If the straps are integrated at MSSL, then there is no deliverable from this work package to SPIRE (apart from documentation) – it becomes an internal milestone. Rather than deliverable dates, I have quoted "available for integration" dates in table (1).

Model	Description	Required date	Available for integration	Difference from flight model	Responsible Institute
STM	300mK system	1/1/02 TBC	16/4/02	None	MSSL
CQM	300mK system	Not required			
PFM	300mK system	11/7/03	27/8/03	None	MSSL
FS	300mK system	Not required	22/10/03	None	MSSL
<sup>*</sup> Note, these may become "internal" deliverables if the straps are integrated to the structure at MSSL prior to delivery of the structure to RAL.					

Table 1 SPIRE deliverables for each instrument model

Table 2 contains a list of "internal" deliverables. These are defined as deliverables between Cardiff and MSSL during the development, test and manufacture phases. These are not deliverable to SPIRE.

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 Table 2 Internal deliverables

Interna	Internal Deliverables					
Model	Description	Required	Deliver to	Responsible		
LBP1	Prototype 1 light baffles (2 off)	11/4/01	Cardiff	MSSL		
LBP2	Prototype 2 light baffles (2 off)	5/7/01	Cardiff	MSSL		

# 6. Constraints

## 6.1. Technical constraints

The performance requirements for the 300mK straps are listed below, and are extracted from RD1.

Requirement ID	Description	Value
IRD-COOL-R01	Temperature at the detectors	The <sup>3</sup> He cooler , in conjunction with the associated 300mK architecture, shall maintain all BDAs at less than 310mK (goal – 300mK)
IRD-COOL-R02	Operating temperature control	Desirable to be able to vary the temperature of the detectors up to 320mK and below 300mK if this is permitted by the temperature drop across the thermal link.
IRD-COOL-R03	Temperature drop across thermal link between detectors and evaporator cold tip	Maximum of 20mK

6.1.1. 300mK strap performance requirements

## 6.2. System constraints

The system requirements for the 300mK straps are listed below, and are extracted from RD1.

Additional overall system constraints are:-

- SPIRE orbital lifetime 4.25 years
- Volume envelope/strap routing = TBD

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- Mass = 900g for the photometer straps this needs clarification there is nothing in the mass budget for spectrometer straps Colin has been informed
- Vibration level =
- Shock level =
- Cleanliness =
- Transit loads =
- Storage =
- Bake-out temperature on AIV integration =  $80^{\circ}$ C for 48 hours

#### 6.2.1. 300mK straps system requirements

There are no stated system requirements on the 300mK strap sub-system.

#### 6.3. Calendar constraints

The major SPIRE project dates are (RD2):-

PDR	26/27 Jun 2000
DDR – Interface Review	28/29 Nov 2000
QMW Programme Review	16 Jan 2001
STM 300mK straps delivery to RAL	17 Jan 2002 TBC
CDR	3 Feb 2003
SPIRE CQM delivery to ESA	Apr 2003
PFM 300mK straps delivery to RAL	17 Jun 2003
SPIRE PFM delivery to ESA	1 Jul 2004
FS 300mK straps delivery to RAL	10 Sept 2003
SPIRE FS delivery to ESA	1 Jul 2005
FIRST launch	2007

# 7. Work Description

## 7.1. Model philosophy

The model philosophy is compliant with the revised SPIRE project model philosophy.

The following models will be produced:-

- Light baffle prototypes. Two generations of light baffles will be produced:-
  - LBP1 The first generation will be designed with input from RAL (stray light analysis and thermal modeling) and built under MSSL responsibility. Three identical models of LBP1 will be built two will be sent to Cardiff for optical and thermal tests, while one will stay at MSSL for mechanical tests.
  - LBP2 after completion of tests on the LBP1 models, a two week period of re-design follows before the manufacture of three models of

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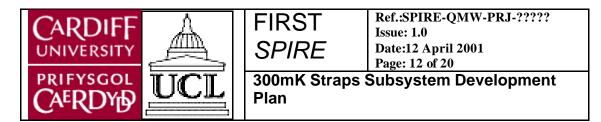


LBP2 starts. The LBP2 models will also be tested in parallel, as for LBP1.

- Strap and suspension prototypes. Two strap and suspension prototypes will be built:-
  - CSTM this is the Cold Strap Thermal Model. This will be built under Cardiff responsibility, and designed with input from RAL (thermal modeling). This model will be thermally representative of the 300mK strap system, replicating the thermal characteristics of all thermal paths in the final system. It will not be structurally representative, as it has to be tested in a cryostat with limited internal volume.
  - CSSM this is the Cold Strap Structural Model. This will be designed and built under MSSL responsibility. CSSM will be structurally representative of the 300mK system, with, for instance, dummy masses to represent the light baffles.
- 300mK strap STM/CQM Because of the high degree of risk associated with this development programme, in that the first overall system test will take place once the system is installed in the STM, two STM/CQM systems will be built. One will be left unassembled in component form as a back-up in the event of STM strap system failure. The STM models will be designed with information from the prototype testing, and a design review will be held on 23/1/02 (TBC). Manufacture of components will commence after this review and should be complete by 20/3/02. Manufacture and acquisition of these components is the responsibility of MSSL. Following assembly of the components, the 300mK system STM will be ready for integration to the structure by 18/4/02. The 300mK STM system will remain in the STM/CQM structure throughout the STM and CQM test campaigns.
- 300mK strap PFM Manufacture of the PFM straps will commence after the CDR, under the responsibility of MSSL. These will be ready for integration in August 2003.
- 300mK strap FS The present SPIRE model philosophy proposes refurbishing the CQM FPU for the FS. However, the 300mK straps in this system will have been subjected to all of the STM and CQM tests (thermal cycles, cold vibrations etc), and we are concerned that this will adversely affect the performance of the 300mK straps (work-hardening, Kevlar creep etc). Therefore, we will provide a replacement 300mK sub-system for CQM → FS refurbishment. This will be delivered to RAL in October 2003.

## 7.2. Preliminary design phase

The PDR freezes the technical specifications/requirements, while the interfaces are frozen at the interface review.



#### 7.2.1. Materials testing

A dedicated <sup>3</sup>He cryostat has been assembled for thermal conductivity tests on candidate materials for the straps and supports. These tests will take place between January and March 2001, and include:-

- Thermal conductivity of Copper nominally high purity (99.999%) Copper from Goodfellows as a function of material treatment (level of annealing, Gold plating etc)
- Thermal conductivity of Kevlar, Vespel & Torlon the materials to be tested will be from the proposed suppliers for the flight model (eg Goodfellows, DuPont). The Vespel and Torlon data will also be used for the SCAL development programme.

#### 7.2.2. Interface study

The thermal test dewar will also be used to study the thermal impedance of different interface configurations, with the goal of finding the optimal configuration for thermal conductivity across interfaces. This is necessary to meet the 20mK thermal drop requirement (IRD-COOL-R03) between the detectors and the evaporator cold tip.

#### 7.2.3. Modeling

A MathCad model has been produced for simple thermal/mechanical analysis of design concepts. The thermal analysis is compared to results from ThermXL (Alstom technology). This is used as the first step in the design process.

Detailed thermal analysis of candidate designs will then be carried out by RAL using ESATAN. Detailed mechanical FE analysis will be carried out at MSSL using the IDEAS Master Series CAD package.

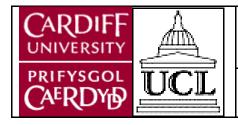
#### 7.2.4. Prototyping

Prototype light baffles and strap/suspension systems will be built, as detailed in section 7.1, in order to verify the design.

#### 7.2.5. Testing

The prototype light baffles and straps will undergo the following tests (as a minimum):-

- Thermal tests (CSTM, LBP1(A&B), LBP2(A&B))
  - Thermal drop between evaporator cold tip and detector interface points (CSTM only)
  - Parasitic heat load from 2K to 300mK. The test dewar will, as a default, run with a 2K pumped Helium bath. This is because the whole 300mK system will only be suspended from 2K structure in SPIRE. This test will tell us about the efficacy of the thermal isolation of the strap supports, including the light baffles, which incorporate internal supports for the straps.





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- Mechanical tests (CSSM, LBP1(C), LBP2(C))
  - Resonant frequency (warm)
  - Cold vibration (at RAL) TBC

## 7.3. Procurement of long lead-time components

Once a preliminary design has evolved, long lead-time items will be procured. *Note – need to clarify CPP procedure & items* 

#### 7.4. Detailed design phase

The detailed design of the STM/CQM straps will proceed in parallel with the prototype test campaign, with test results being used to modify the design. The detailed design should therefore be available shortly after prototype component tests are complete.

A design review will be held in January 2002, which will freeze the STM/CQM design.

## 7.5. STM/CQM manufacture & test

The detailed design is presented at the Detailed Design Review. The DDR and 300mK strap design review must have happened before STM/CQM manufacture can begin.

STM/CQM manufacture takes place between January 2002 and March 2002.

There is no way of testing the performance of the whole, assembled STM/CQM 300mK system prior to integration to the structure. The first test of the performance of the whole system will therefore coincide with the STM tests. This obviously introduces an element of risk to the program. This will be minimized by rigorous testing of the prototype components (materials, interfaces, CSTM, CSSM, LBP1, LBP2).

The design verification tests (once incorporated in the STM structure) include:-

- Verification of the basic mechanical parameters (Mass, stiffness, resonance frequencies).
- Performance verification thermal drop, parasitic heat load.
- Warm and cold vibrations.

After the 300mK strap STM/CQM delivery, the SPIRE STM is tested at project level. The STM structure and straps will then serve as the CQM structure and straps – i.e. they will be the same components used for STM testing.

The results of the qualification tests are to be presented at the SPIRE CDR, which is the start point of the PFM and FS manufacture.



Then, the SPIRE CQM is delivered to ESA for cryogenic tests of the FIRST FPU.

## 7.6. PFM & FS manufacture & test

Following the SPIRE CQM tests, some modifications may have to be implemented in the design.

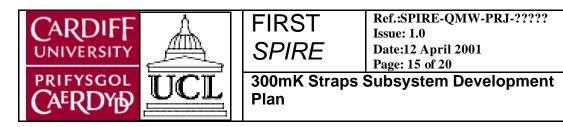
The design changes are to be implemented in the flight design and be validated using the prototype components (CSSM, CSTM, LBP1, LBP2).

The 300mK strap PFM is then manufactured and undergoes acceptance tests.

The FS model is a duplicate of the PFM and is assembled after the PFM, although the components will be manufactured simultaneously. The FS model undergoes the acceptance tests after the PFM delivery.

# 7.7. Work flow

A cross-functional work flow diagram is shown in figures 5, 6 & 7. Figure 5 is the top level work flow, while figures 6 and 7 show more detail with regard to the strap and baffle prototyping phases.



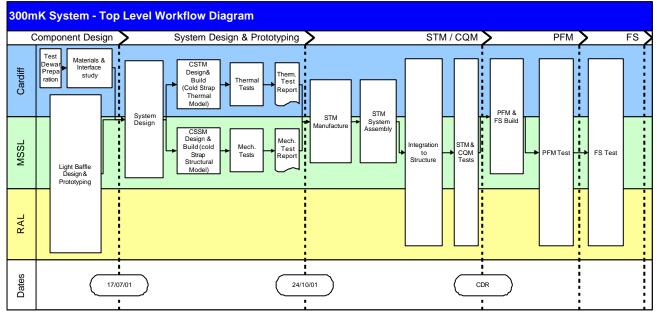


Figure 5 Top level workflow diagram

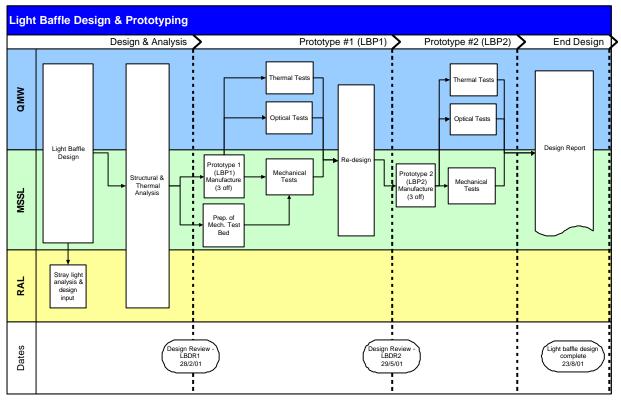
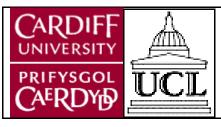


Figure 6 Detail of the light baffle prototyping phase

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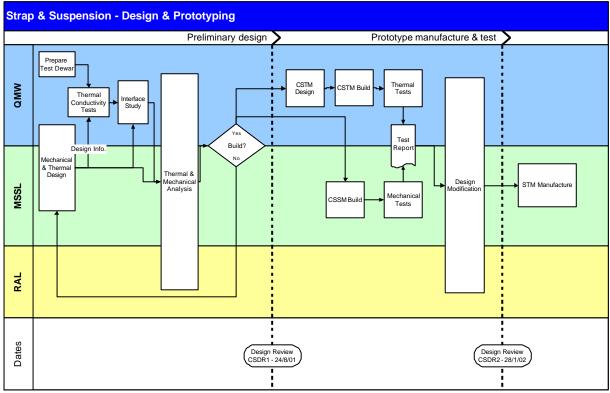
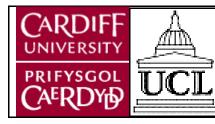


Figure 7 Detail of the strap and suspension prototyping phase

## 8. Risk analysis

Risk	Impact		Preventative Action	Notes
Damage during component assembly.	Development pla must be updated Delivery dates m be delayed (marg has been built in schedule).	nay gin	Clearly written & detailed integration plan.	Most likely damage would be bending (hence work- hardening) of straps, or damage to Kevlar suspension.
Failure during STM/CQM testing.	Major SPIRE schedule impact. Spare strap syste will need to be assembled after failed system has been removed an analysed for failu mode.	em s id	Extensive testing of prototype components. Impact of failure will be minimized by the provision of spare components.	MSSL are working to make integration of the 300mK strap system as simple as possible.
Failure of test	TBD		Spare cryostat	This cryostat is a
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Cardiff general lab. He-3
-
system – it could
be used for strap
testing in an
emergency, with
little modification.
One person is
Cardiff identified as
responsible for the
he test plan at Cardiff,
but other group
members will be
involved to such a
level that they can
replace the missing
person.
of new Resource analysis
has been
completed. Two
new PDRA
positions have been
created, of which
1.5 post-docs will
be working on
SPIRE.

# 9. Verification plan – To Be Updated

The verification plan must be compliant with the project verification plan [Refs – AD??, RD??].

300K vibrations are conducted at Cardiff - TBD

Cryovibrations are conducted at RAL under MSSL responsibility (TBC).

Vacuum cycles, soak cycles, thermal cycles are conducted at Cardiff.

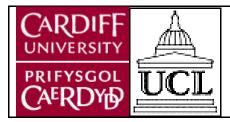
Lifetime tests are conducted at Cardiff.

Performance tests are conducted at Cardiff.

In the table below,

X =	a real test is conducted
A =	an analysis is conducted
NA =	Non applicable

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Plan

	DM	STM/CQM	PFM	FS
Massmeasurement	Х	Х	Х	Х
CoG measurement	Х	Х	Х	Х
Thermal drop measurement	Х	А	А	А
Vibrations 300K	Х	Х		
Vibrations 4K	Х	Х	Х	Х
Thermal/Vacuum cycle	Х	Х	Х	Х
Accelerated lifetime (12,000 operations)	N/A	N/A	N/A	N/A
Radiation tolerance**	N/A	N/A	N/A	N/A
Microphonics	N/A	N/A	N/A	N/A
EMI / EMC	N/A	N/A	N/A	N/A

## **10.** Development calendar & schedule

The major project milestones pertinent to the 300mK straps sub-system are:-

STM/CQM straps to RAL	01/01/02
PFM straps to RAL	11/07/03
FS straps to RAL	not defined

Internal milestones and delivery dates are:-

ID	Milestone	Date	Status	Comment
306	GRTs from Lakeshore	25/1/01	Complete	
304	He-3 fridge shield ready	12/02/01	On schedule	
313	Test dewar ready	27/2/01	On schedule	
326	Design Review – LBDR1	28/2/02	On schedule	Light baffle DR1
328	LBP1 to Cardiff	12/4/01	On schedule	Light baffle prototype 1 (2 off)
322	Interface study complete	9/5/01	On schedule	
334	Design Review – LBDR2	29/5/01	On schedule	
336	LBP2 to Cardiff	11/7/01	On schedule	
340	Design report	2/8/01	On schedule	Light baffle design report
342	Light baffle design complete	23/8/01	On schedule	
347	Design review – CSDR1	24/8/01	On schedule	Cold strap design review 1
353	Cold strap prototypes – test report	10/12/01	On schedule	Report on CSSM and CSTM tests
357	STM design review – CSDR2	28/1/02	On schedule	
362	STM/CQM straps ready for integration	23/4/02	On schedule	
Department of Physics and Astronomy, University of Wales, Cardiff, 5, The Parade, Cardiff, CF24 3YB.Q:\Project Office\Internal_Docs\000629_PRJ_QMW\QM\ 300mK_Straps_Development_Plan_(09Mar01).doc Last updated 12/04/01 15:24 by Pete Hargrave		_(09Mar01).doc		





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300mK Straps Subsystem Development Plan

370	PFM straps ready for integration	3/9/03	On schedule	
374	FS straps ready for integration	03/09/03	On schedule	

								2003
ID	Task Name	Duration	Start	Finish	Resour	Predecessor	Qtr 3 Qtr 4 Qtr 1 Qtr 2 Qtr 3 Qtr 4 Qtr 1 Qtr 2 Qtr 3 Qtr 4	Qtr
295	300mK straps	847 days?	Fri 01/12/00	Mon 01/03/04				
296	STM/CQM 300mK system to RAL	1 day?	Tue 01/01/02	Tue 01/01/02			01/01	
297	PFM 300mK straps to RAL	1 day?	Fri 11/07/03	Fri 11/07/03				
298	FS 300mK straps to RAL	1 day?	Mon 01/03/04	Mon 01/03/04				
299	Design	281 days?	Fri 08/12/00	Fri 04/01/02				
300	Test dewar	47 days?	Fri 08/12/00	Mon 12/02/01				
304	He-7 fridge shield ready	1 day?	Mon 12/02/01	Mon 12/02/01	ohnson		12/02	
306	GRTs from Lakeshore	5 days?	Thu 25/01/01	Wed 31/01/01			25/01	
313	Test dewar ready	1 day?	Tue 27/02/01	Tue 27/02/01		312	27/02	
322	Interface study complete	1 day?	Wed 09/05/01	Wed 09/05/01		321	09/05	
323	Light baffle concept	136 days?	Wed 24/01/01	Wed 01/08/01				
326	Design Review - LBDR1	1 day?	Wed 28/02/01	Wed 28/02/01		325	28/02	
328	LBP1 to Cardiff (2 off)	3 days	Thu 12/04/01	Mon 16/04/01		327	<b>12/</b> 04	
334	Design Review - LBDR2	1 day?	Tue 29/05/01	Tue 29/05/01		333	29/05	
336	LBP2 to Cardiff (2 off)	1 day?	Wed 11/07/01	Wed 11/07/01		335	<b>11/07</b>	
340	Design report	1 wk	Thu 02/08/01	Wed 08/08/01	SL[50%]	323	02/08	
342	Light baffle design complete	1 day?	Thu 23/08/01	Thu 23/08/01		341	23/08	
343	300mK system design	153 days?	Wed 09/05/01	Fri 07/12/01				
346	Prototype light baffle design	1 day?	Thu 23/08/01	Thu 23/08/01		341,345		
347	Design Review - CSDR1	1 day?	Fri 24/08/01	Fri 24/08/01		346	L <b>N</b> 2408	
353	Cold strap prototypes - Test Report	2 wks	Mon 10/12/01	Fri 21/12/01	SL[50%]	343	10/12	
355	STM/CQM Manufacture	76 days?	Mon 07/01/02	Mon 22/04/02				
357	STM design review - CSDR2	1 day?	Mon 28/01/02	Mon 28/01/02		356,353	28/01	
361	STM/CQM Integration & Test	276 days?	Tue 23/04/02	Tue 13/05/03				
362	STM/CQM straps ready for integration	1 day?	Tue 23/04/02	Tue 23/04/02		360	23/04	
367	PFM manufacture	81 days?	Wed 14/05/03	Wed 03/09/03				
370	PFM straps ready for integration	1 day?	Wed 03/09/03	Wed 03/09/03		369		
371	FS manufacture	121 days?	Wed 14/05/03	Wed 29/10/03				
374	FS straps ready for integration	1 day?	Wed 29/10/03	Wed 29/10/03		373		

Figure 8 300mK strap sub-system milestones.





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300mK Straps Subsystem Development Plan

# 11. 300mK straps sub-system schedule

							2001 2002 2003
D	Task Name	Duration	Start	Finish	Resour	Predecesso	Qtr4 Qtr1 Qtr2 Qtr3 Qtr4 Qtr1 Qtr2 Qtr3 Qtr4 Qtr1 Qtr2
295	300mK straps	847 days?	Fri 01/12/00	Mon 01/03/04			
296	STM/CQM 300mK system to RAL	1 day?	Tue 01/01/02	Tue 01/01/02			01/01
297	PFM 300mK straps to RAL	1 day?	Fri 11/07/03	Fri 11/07/03			
298	-	1 dav?	Mon 01/03/04	Mon 01/03/04			
299	FS 300mK straps to RAL		Fri 08/12/00	Fri 04/01/02			
	Design	281 days?					
300	Test dewar	47 days?	Fri 08/12/00	Mon 12/02/01			
301	Dewar stripout	1 day?	Fri 08/12/00	Fri 08/12/00			
302	Housekeeping wiring	5 days	Mon 11/12/00	Fri 15/12/00		301	Raul Hermoso[20%]
303	He-10 fridge wiring	5 days	Mon 08/01/01	Fri 12/01/01	e[20%]	302	Pete Hargrave[20%]
304	He-7 fridge shield ready	1 day?	Mon 12/02/01	Mon 12/02/01	ohnson		12/02
305	Wire He-7 fridge	2 days	Thu 18/01/01	Fri 19/01/01	e[30%]		Pete Hargrave[30%]
306	GRTs from Lakeshore	5 days?	Thu 25/01/01	Wed 31/01/01			L 18 25/01
307	Assemble & test DAQ system	5 days	Mon 15/01/01	Fri 19/01/01	e[20%]		Pete Hargrave[20%]
308	Acqn. Software	5 days?	Mon 22/01/01	Fri 26/01/01	e[20%]	307	Pete Hargrave[20%]
309	Sample mounting hardware	1 wk	Mon 11/12/00	Fri 15/12/00	50%]	301	ete Hargrave[20%],Geoff Gannaway[50%]
310	Housekeeping thermometry	5 days?	Mon 18/12/00	Fri 22/12/00	e[20%]	302	Pete Hargrave[20%]
311	RF filters	1 day?	Mon 15/01/01	Mon 15/01/01	argrave	302,303	Pete Hargrave
312	Margin	2 wks	Tue 13/02/01	Mon 26/02/01		300	l 🖬
313	Test dewar ready	1 day?	Tue 27/02/01	Tue 27/02/01		312	27/02
314	Materials & thermal interface study	40 days	Wed 28/02/01	Tue 24/04/01	[50%]	313	
315	Cu	1 mon	Wed 28/02/01	Tue 27/03/01			
316	A	1 mon	Wed 28/02/01	Tue 27/03/01			
317	Kevlar	1 mon	Wed 28/02/01	Tue 27/03/01			
318	Vespel	1 mon	Wed 28/02/01	Tue 27/03/01			
319	Torlon	1 mon	Wed 28/02/01 Wed 28/02/01	Tue 27/03/01			
320	Interface study	1 mon	Wed 28/02/01 Wed 28/03/01	Tue 24/04/01		317.318.319	<sup>™</sup> <b>*</b>
320	Margin	2 wks	Wed 25/03/01	Tue 08/05/01		317,318,319	<mark>"</mark> +
321	Interface study complete		Wed 25/04/01 Wed 09/05/01	Wed 09/05/01			09/05
322		1 day?				321	
	Light baffle concept	136 days?	Wed 24/01/01	Wed 01/08/01	1000/2		MSSL[80%],Pete Hargrave[20%]
324	Detailed prototype design following Tony Richards gui	3 wks	Wed 24/01/01	Tue 13/02/01			MSSL
325	Structural/Thermal analysis	2 wks	Wed 14/02/01	Tue 27/02/01	MSSL	324	
326	Design Review - LBDR1	1 day?	Wed 28/02/01	Wed 28/02/01		325	<b>1</b> 28/02
327	Prototype manufacture (LBP1 - 3off)	6 wks	Thu 01/03/01	Wed 11/04/01	MSSL	326	
328	LBP1 to Cardiff (2 off)	3 days	Thu 12/04/01	Mon 16/04/01		327	12/04
329	Prep. of mech test bed	6 wks	Wed 28/02/01	Tue 10/04/01	MSSL	325	
330	Thermal tests	4 wks	Tue 17/04/01	Mon 14/05/01	e[50%]	328	Pete Hargrave[50%]
331	Optical tests (BACUS dewar)	4 wks	Tue 17/04/01	Mon 14/05/01	e[50%]	328	Pete Hargrave[50%]
332	Mechanical tests	4 wks	Thu 12/04/01	Wed 09/05/01	MSSL	327,329	
333	Revised design	2 wks	Tue 15/05/01	Mon 28/05/01	[30%]	330,331,332	MSSL[70%],Pete Hargrave[30%]
334	Design Review - LBDR2	1 day?	Tue 29/05/01	Tue 29/05/01		333	29/05
335	2nd prototype manufacture (LBP2 - 3off)	6 wks	Wed 30/05/01	Tue 10/07/01	MSSL	334	MSSI.
336	LBP2 to Cardiff (2 off)	1 day?	Wed 11/07/01	Wed 11/07/01		335	11/07
337	Thermal tests	3 wks	Thu 12/07/01	Wed 01/08/01	e[50%]	336	Pete Hargrave[50%]
338	Optical tests (BACUS dewar)	3 wks	Wed 11/07/01	Tue 31/07/01		335	Pete Hargrave[50%]
339	Mechanical tests	3 wks	Wed 11/07/01	Tue 31/07/01	MSSL	335	MSSL
340	Design report	1 wk	Thu 02/08/01		[50%]	323	L_02 08
341	Margin	2 wks	Thu 09/08/01	Wed 22/08/01	[0010]	340	
342	Light baffle design complete	1 day?	Thu 23/08/01	Thu 23/08/01		341	23/08
343	300mK system design	153 days?	Wed 09/05/01	Fri 07/12/01			
344	Preliminary strap design from MSSL	3 wks	Wed 09/05/01	Tue 29/05/01	MSSL	321	MSSL
345	Approval by QMW (following thermal tests & analysis)	0 1110			maaa		
		5 wks	Wed 30/05/01	LICE 03/07/01	[50%]	344	- Hete maigrave[50%],RAL[50%]
346		5 wks 1 dav?	Wed 30/05/01 Thu 23/08/01	Tue 03/07/01 Thu 23/08/01	[50%]	344 341.345	- Pere Hargrave[50%],RAL[50%]
346	Prototype light baffle design	1 day?	Thu 23/08/01	Thu 23/08/01	[50%]	341,345	<b>3/08</b>
347	Prototype light baffle design Design Review - CSDR1	1 day? 1 day?	Thu 23/08/01 Fri 24/08/01	Thu 23/08/01 Fri 24/08/01		341,345 346	23/08 900 24/08
347 348	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM)	1 day? 1 day? 3 wks	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01	Thu 23/08/01 Fri 24/08/01 Fri 14/09/01	i0%]	341,345 346 347	306 2408 Pete Hargrave[50%],Geoff Gannaway[50%]
347 348 349	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM)	1 day? 1 day? 3 wks 6 wks	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 17/09/01	Thu 23/08/01 Fri 24/08/01 Fri 14/09/01 Fri 26/10/01	i0%] 30%]	341,345 346 347 348	24/8 5408 G. Pete Hargrave[50%],Geoff Gannaway[50%] Pete Hargrave[20%],Geoff Gannaway[50%]
347 348 349 350	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Marufacture (CSTM) Thermal tests at OMW	1 day? 1 day? 3 wks 6 wks 6 wks	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 17/09/01 Mon 29/10/01	Thu 23/08/01 Fri 24/08/01 Fri 14/09/01 Fri 26/10/01 Fri 07/12/01	i0%] 30%] e[50%]	341,345 346 347 348 349	2016 2408 Pete Hargrave[50%],Geoff Gannaway[50%] Pete Hargrave[20%],Geoff Gannaway[80%]
347 348 349 350 351	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM) Thermal tests at OMW Mechanical Prototype manufacture (CSSM)	1 day? 1 day? 3 wks 6 wks 6 wks 6 wks	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 17/09/01 Mon 29/10/01 Fri 24/08/01	Thu 23/08/01 Fri 24/08/01 Fri 14/09/01 Fri 26/10/01 Fri 07/12/01 Thu 04/10/01	i0%] 30%] e[50%] MSSL	341,345 346 347 348 349 346,345	24/8 Set 2408 G. Pete Hargrave[50%],Geoff Gannaway(50%) Pete Hargrave[20%],Geoff Gannaway(80%)
347 348 349 350 351 352	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM) Thermal tests at OMW Mechanical Prototype manufacture (CSSM) Mechanical tests at MSSL/RAL	1 day? 1 day? 3 wks 6 wks 6 wks 6 wks 6 wks	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 27/08/01 Mon 29/10/01 Fri 24/08/01 Fri 05/10/01	Thu 23/08/01 Fri 24/08/01 Fri 14/09/01 Fri 26/10/01 Fri 07/12/01 Thu 04/10/01 Thu 15/11/01	i0%] 30%] e[50%] MSSL MSSL	341,345 346 347 348 349 346,345 351,329	A208 A408 P408
347 348 349 350 351 352 353	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM) Thermal tests at OMW Mechanical Tests at MSSLRAL Cold strap prototypes - Test Report	1 day? 1 day? 3 wks 6 wks 6 wks 6 wks 6 wks 2 wks	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 27/08/01 Mon 29/10/01 Fri 24/08/01 Fri 05/10/01 Mon 10/12/01	Thu 23/08/01 Fri 24/08/01 Fri 14/09/01 Fri 26/10/01 Fri 07/12/01 Thu 04/10/01 Thu 15/11/01 Fri 21/12/01	i0%] 30%] e[50%] MSSL MSSL	341,345 346 347 348 349 346,345 351,329 343	20/8 2408 Gree Hargrave[50%],Geoff Gannaway[50%] Fete Hargrave[20%],Geoff Gannaway[80%] Fete Hargrave[20%],Geoff Gannaway[80%] MSSL
347 348 349 350 351 352 353 354	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM) Thermal tests at OMW Mechanical tests at MSSURAL Cold strap prototypes - Test Report Margin	1 day? 1 day? 3 wks 6 wks 6 wks 6 wks 6 wks 2 wks 2 wks	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 27/08/01 Fri 24/08/01 Fri 05/10/01 Mon 10/12/01 Mon 24/12/01	Thu 23/08/01 Fri 24/08/01 Fri 14/09/01 Fri 26/10/01 Fri 07/12/01 Thu 04/10/01 Thu 15/11/01 Fri 21/12/01 Fri 04/01/02	i0%] 30%] e[50%] MSSL MSSL	341,345 346 347 348 349 346,345 351,329	20/8 24/8 44/9 44/9 4/9 Pete Hargrave[50%],Geoff Gannaway[50%] Pete Hargrave[20%],Geoff Gannaway[80%] Pete Hargrave[50%] Pete Hargrave[50%] MSSL
347 348 349 350 351 352 353 354 355	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM) Thermal tests at OMW Mechanical Prototype manufacture (CSSM) Mechanical tests at MSSL/RAL Cold strap prototypes - Test Report Margin STM/CQM Manufacture	1 day? 1 day? 3 wks 6 wks 6 wks 6 wks 6 wks 2 wks 2 wks 2 wks 76 days?	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 27/08/01 Fri 24/08/01 Fri 05/10/01 Mon 10/12/01 Mon 24/12/01 <b>Mon 07/01/02</b>	Thu 23/08/01 Fri 24/08/01 Fri 14/09/01 Fri 26/10/01 Fri 07/12/01 Thu 04/10/01 Thu 15/11/01 Fri 21/12/01 Fri 04/01/02 <b>Mon 22/04/02</b>	i0%] i0%] e[50%] MSSL [50%]	341,345 346 347 348 349 346,345 351,329 343 353	20/8 2408 UP Pete Hargrave[50%],Geoff Gannaway[50%] Pete Hargrave[20%],Geoff Gannaway[80%] Pete Hargrave[50%] MSSL MSSL
347 348 349 350 351 352 353 354 355 356	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM) Thermal tests at CMW Mechanical Prototype manufacture (CSSM) Mechanical tests at MSSLRAL Cold strap prototypes - Test Report Margin STM/CQM Manufacture STM design modifications	1 day? 1 day? 3 wks 6 wks 6 wks 6 wks 2 wks 2 wks 2 wks 76 days? 3 wks	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 29/10/01 Fri 24/08/01 Fri 05/10/01 Mon 10/12/01 Mon 24/12/01 Mon 07/01/02 Mon 07/01/02	Thu 23/08/01 Fri 24/08/01 Fri 24/08/01 Fri 26/10/01 Fri 26/10/01 Thu 04/10/01 Thu 04/10/01 Fri 04/11/02 Fri 04/01/02 Mon 22/04/02 Fri 25/01/02	i0%] i0%] e[50%] MSSL [50%]	341,345 346 347 348 349 346,345 351,329 343 353 353	20/8 24/9 Pete Hargrave[50%],Geoff Gannaway[50%] Pete Hargrave[20%],Geoff Gannaway[80%] Pete Hargrave[50%] MSSL MSSL
347 348 349 350 351 352 353 354 355 355 356 357	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM) Thermal Prototype Manufacture (CSSM) Mechanical tesis at MSSLRAL Cold strap prototypes - Test Report Margin STM/COM Manufacture STM design modifications STM design review - CSDR2	1 day? 1 day? 3 wks 6 wks 6 wks 6 wks 2 wks 2 wks 2 wks 76 days? 3 wks 1 day?	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 29/10/01 Fri 24/08/01 Fri 05/10/01 Mon 10/12/01 Mon 24/12/01 Mon 07/01/02 Mon 07/01/02	Thu 23/08/01 Fri 24/08/01 Fri 24/08/01 Fri 26/10/01 Fri 26/10/01 Thu 07/12/01 Thu 04/10/01 Thu 15/11/02 Fri 04/01/02 Mon 22/04/02 Fri 25/01/02 Mon 28/01/02	i0%] i0%] e[50%] MSSL [50%] [50%]	341,345 346 347 348 349 346,345 351,329 343 353 354 354 356,353	24)8 24)8 4408 4408 4407 4507
347 348 349 350 351 352 353 354 355 356 357 358	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM) Mechanical Prototype manufacture (CSSM) Mechanical retotypes - Test Report Cold strap prototypes - Test Report Margin STM/CQM Manufacture STM design modifications STM design review - CSDR2 STM/CQM manufacture	1 day? 1 day? 3 wks 6 wks 6 wks 6 wks 2 wks 2 wks 2 wks 76 days? 3 wks 1 day?	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 27/08/01 Mon 29/10/01 Fri 24/08/01 Fri 05/10/01 Mon 10/12/01 Mon 24/12/01 Mon 07/01/02 Mon 07/01/02 Tuo 29/01/02	Thu 23/08/01 Fri 24/08/01 Fri 14/09/01 Fri 26/10/01 Thu 26/10/01 Thu 07/12/01 Thu 15/11/01 Fri 21/12/01 Fri 04/01/02 Mon 22/04/02 Mon 28/01/02 Mon 28/01/02	i0%] i0%] e[50%] MSSL [50%] [50%] [0%] MSSL	341,345 346 347 348 349 346,345 351,329 343 353 353 355 354 356,353 357	24/8 24/08 24/08 24/08 24/04 24/0
347 348 349 350 351 352 353 354 355 356 357 358 359	Prototype light baffle design Design Review - CSDR1 Thermal prototype design (CSTM) Thermal Prototype Manufacture (CSTM) Thermal tests at CMW Mechanical Prototype manufacture (CSSM) Mechanical tests at MSSLRAL Cold strap prototypes - Test Report Margin STM/CQM Manufacture STM design modifications STM design modifications STM design review - CSDR2 STM/COM manufacture 300mK STM system assembly	1 day? 1 day? 3 wks 6 wks 6 wks 6 wks 2 wks 2 wks 76 days? 3 wks 1 day? 8 wks 2 wks	Thu 23/08/01 Fri 24/08/01 Mon 27/08/01 Mon 27/08/01 Mon 29/10/01 Fri 24/08/01 Fri 05/10/01 Mon 10/12/01 Mon 24/12/01 Mon 70/01/02 Mon 28/01/02 Tue 29/01/02 Tue 29/01/02	Thu 23/08/01 Fri 24/08/01 Fri 24/08/01 Fri 26/10/01 Fri 07/12/01 Thu 04/10/01 Thu 15/11/01 Fri 21/12/01 Fri 04/01/02 Mon 22/04/02 Fri 25/01/02 Mon 28/01/02 Mon 28/01/02	i0%] i0%] e[50%] MSSL [50%] [50%] [0%] MSSL	341,345 346 347 348 349 346,345 351,329 343 353 353 354 356,353 357 358	24)8 24)8 4408 4408 4407 4507
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#### Figure 9 300mK strap schedule.

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300mK_Straps_Development_Plan_(09Mar01).doc
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