Subject:	**SPIRE INSTRUMENT BUDGETS**

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Hardware Manager

CHANGE RECORD

ISSUE	DATE	CHANGE(S) MADE
1.0	11-Jun-00	First Issue following IID meeting with ESA
1.1	14-Jun-00	Change to JFET box allocation
2.0	12-Apr-01	Revised following interface review
3.0	15-Mar-01	New Information fron Sub-Systems
3.1	28-Mar-01	Cooler Mass change
3.2	3-Apr-01	Details
3.3	16-Jul-01	Structure Mass Update. BMS
3.4	24-Jul-01	JFET/BDA Update BMS
3.5	10-Mar-02	For IBDR. ECRs 5 and 6. New telemetry table J.D.
3.6	20-Mar-02	After IBDR info. J.D. For IID-B 2.2
3.7	22-Feb-03	Deleted shutter, reduced JFET mechanical mass but itemised backharness, added 200gr for CEA FCU thermal power planes.. ECR 48
3.8	4-Apr-03	Included 30/9/02 FCU and DCU actual masses. Revised JFET racks to again include their backharness masses. Removed envelope TBCs.
4.0	1-Jun-03	For IHDR
		Put a “document” format back on top of Excel, 3.x issues just used Excel.
		Issuing Institute changed from ATC to RAL, but Livelink digits unchanged.
		Included updated DPU actual mass, and RD1 source note..

ACRONYM LIST

Term	Meaning
ADC	Analogue to Digital Converter
AIV	Assembly, Integration and Verification
AME	Absolute Measurement Error
AOCS	Attitude and Orbit Control System
APART	Arizona's Program for the Analysis of Radiation Transfer
APE	Absolute Pointing Error
ASAP	Advanced Systems Analysis Program
AVM	Avionics Model
BDA	Bolometer Detector Array
BFL	Back Focal Length
BRO	Breault Research Organization
BSM	Beam Steering Mirror
CDMS	Command and Data Management System
CDMU	Command and Data Management Unit
CDR	Critical Design Review
CMOS	Complimentary Metal Oxide Silicon
CPU	Central Processing Unit
CVV	Cryostat Vacuum Vessel
DAC	Digital to Analogue Converter
DAQ	Data Acquisition
DCU	Detector Control Unit = HSDCU
DPU	Digital Processing Unit = HSDPU
DSP	Digital Signal Processor
DQE	Detective Quantum Efficiency
EDAC	Error Detection and Correction
EGSE	Electrical Ground Support Equipment
EMC	Electro-magnetic Compatibility
EMI	Electro-magnetic Interference
ESA	European Space Agency
FCU	FCU Control Unit = HSFCU
FIR	Far Infrared
FIRST	Far Infra-Red and Submillimetre Telescope
FOV	Field of View
F-P	Fabry-Perot
FPGA	Field Programmable Gate Array
FPU	Focal Plane Unit
FTS	Fourier Transform Spectrometer
FWHM	Full Width Half maximum
GSFC	Goddard Space Flight Center
HK	House Keeping
HOB	Herschel Optical Bench
HPDU	Herschel Power Distribution Unit
HSDCU	Herschel-SPIRE Detector Control Unit
HSDPU	Herschel-SPIRE Digital Processing Unit
HSFCU	Herschel-SPIRE FPU Control Unit
HSO	Herschel Space Observatory
IF	Interface
IID-A	Instrument Interface Document - Part A
IID-B	Instrument Interface Document - Part B

Term	Meaning
IMF	Initial Mass Function
IR	Infrared
IRD	Instrument Requirements Document
IRTS	Infrared Telescope in Space
ISM	Interstellar Medium
JFET	Junction Field Effect Transistor
ISO	Infrared Space Observatory
LCL	Latching Current Limiter
LIA	Lock-In Amplifier
LVDT	Linear Variable Differential Transformer
MAC	Multi Axis Controller
LWS	Long Wave Spectrometer (an instrument used on ISO)
MCU	Mechanism Control Unit = HSMCU
M-P	Martin-Puplett
NEP	Noise Equivalent Power
NTD	Neutron Transmutation Doped
OBS	On-Board Software
OMD	Observing Modes Document
OPD	Optical Path Difference
PACS	Photodetector Array Camera and Spectrometer
PCAL	Photometer Calibration source
PID	Proportional, Integral and Differential (used in the context of feedback control loop architecture)
PLW	Photometer, Long Wavelength
PMW	Photometer, Medium Wavelength
POF	Photometer Observatory Function
PROM	Programmable Read Only Memory
PSW	Photometer, Short Wavelength
PUS	Packet Utilisation Standard
RMS	Root Mean Squared
SCAL	Spectrometer Calibration Source
SCUBA	Submillimetre Common User Bolometer Array
SED	Spectral Energy Distribution
SMEC	Spectrometer Mechanics
SMPS	Switch Mode Power Supply
SOF	Spectrometer Observatory Function
SPIRE	Spectral and Photometric Imaging Receiver
SRAM	Static Random Access Memory
SSSD	SubSystem Specification Document
STP	Standard Temperature and Pressure
SVM	Service Module
TBC	To Be Confirmed
TBD	To Be Determined
TC	Telecommand
URD	User Requirements Document
UV	Ultra Violet
WE	Warm Electronics
ZPD	Zero Path Difference

DISTRIBUTION LIST

Institute	Holder	Issue													
Issue		**1.0**	**1.1**	**2.0**	**3.0**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**	**3.7**	**3.8**	**4.0**	
Date		11/6 2000	14/6 2000	12/4 2001	15/3 2001	28/3 2001	3/4 2001	16/6 2001	24/6 2001	10/3 2002	20/3 2002	22/2 2003	4/04 2003	1/6 2003	
QMWC /Cardiff	Matt Griffin	x	x	x	x	x	x	x	x	x	x	x	x	x	
	Peter Hargrave	x	x	x	x	x	x	x	x	x	x	x	x	x	
RAL	Ken King	x	x	x	x	x	x	x	x	x	x	x	x	x	
	Eric Sawyer													x	
	Bruce Swinyard				x	x	x	x	x	x	x	x	x	x	
	John Delderfield				x	x	x	x	x	x	x	x	x	x	
	Doug Griffin				x	x	x	x	x	x	x	x	x	x	
MSSL	Berend Winter	x	x	x	x	x	x	x	x						
	Chris BrockleyBlat									x	x	x	x	x	
JPL	Gerald Lilienthal	x	x	x	x	x	x	x	x	x	x	x	x		
	Jamie Bock				x	x	x	x	x	x	x	x	x	x	
	Marty Herman													x	
LAM	Dominique Pouliquen	x	x	x	x	x	x	x	x	x	x	x	x	x	
CEA	Lionel Duband	x	x	x	x	x	x	x	x	x	x	x	x	x	
IFSI	Riccardo Cerruli	x	x	x	x	x	x	x	x	x	x	x	x		
	Renato Orfei				x	x	x	x	x	x	x	x	x	x	
CEA	Jean-Louis Augueres	x	x	x	x	x	x	x	x	x	x	x	x	x	
ATC	Ian Pain	x	x	x	x	x	x	x	x	x	x	x	x		
	Philip Parr Burman													x	
USK	Don Peterson	x	x	x	x	x	x	x	x	x	x				
ESA	Jean Bruston				x	x	x	x	x	x	x				
	Astrid Heske											x	x		
	CarstenScharmberg													x	
Alcatel	Glenn Lund				x	x	x	x	x	x	x	x	x		
	Guy Dubrovnick													x	

REFERENCE DOCUMENTS

RD1	**STRUCTURE SUBSYSTEM SPECIFICATION**	SPIRE-MSS-PRJ-000427
RD2	**CRYOGENIC THERMAL CONFIGURATION CONTROL DOCUMENT**	SPIRE-RAL-PRJ-000560

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1 Mass Budget

Project Code	Instrument Unit	Dimensions in mm3	Nominal Mass	Allocated Mass
HSFPU	HS Focal Plane Unit*	Non-rectangular	44.81 Kg†	47.20 Kg†
HSJFP	HS JFET Rack-Photometer	124.6 x118.2 x 274.5	2.51 Kg	2.80 Kg
HSJFS	HS JFET Rack-Spectrometer	114.2 x 114 x 112.5	0.89 Kg	1.00 Kg
	Total Mass for units on HOB		48.21 Kg	**51.00 Kg**
HSDPU	HS Digital Processing Unit	274 x 274 x 194	7.18 Kg	7.00 Kg
HSFCU	HS FPU Control Unit	325 x 370 x 335	15.28 Kg	15.00 Kg
HSDCU	HS Detector Control Unit	490 x 285 x 305	15.68 Kg	15.50 Kg
HSW1-8	HS Warm Inter-unit Harness	To Alenia layout	1.50 Kg	1.50 Kg
	Total Mass for units on SVM		39.64 Kg	**39.00 Kg**
	Spire TOTAL MASS		87.84 Kg	**90.00 Kg**

* includes attached flying leads and any FPU thermal strap supports.

† includes 32.07Kg Nominal and 34.77Kg Allocation for Structure mass elements, see Iss 1.4 of RD1 as DDR

The drawings for all these items are in SPIRE-RAL-DWG-001409, the Spire ICD IID-B annex.

Dimensions are given in the order X x Y x Z

2 Power Budget

Project Code	Item	Mode	Estimate	Allocation	IID-B spec
HSDPU	Digital Processing Unit	All	12	15.3	15.3
HSDCU	Detector Control Unit	Phot Spect	36.8 14.8	37 Not worst case	37
HSFCU	SCU modules MCU modules PSU at 72% efficiency	 Scanning Phot	7.5 15.0 max 22.4	7.5 13 22.4	42.9
HSWIR	SVM Warm Interconnect Harness	N/A	0.1	0.1	0.1
TOTAL			93.8	95.3	95.3

Project Code	Instrument Unit	Mean Load per LCL
HSDPU	HS Digital Processing Unit	15.3W
HSFCU	HS FPU Control Unit	80W

No significant (>3%) BOL to EOL changes are expected.
At this resolution, all power put into a warm electronics unit is dissipated there, not passed on to the HSFCU.
Operating mode changes other than switching photometer/spectrometer have little effect, and within any given mode power transients are very small.

3 Telemetry Data Budget

Budget

Maximum total data rate	**130000**	**bits/sec**
Maximum packet rate	**25**	**packets/sec**
Maximum packet data field size	**8144**	**bits**

Note:Overheads on PUS TM packets	
Packet header	48
Data header	80
Error control	16

Maximum Data Rate for Chopping Observatory Functions:

POF1, POF2, POF3, POF4, POF6, POF7

DCU Science	Nominal	
Number of data channels	292	
Bits per channel	16	bits
Frame size	4672	bits
Frames per packet	1	
Packet size	4896	bits
Sampling rate	20	frames/sec
Packets per sec	20	

MCU Science	Nominal	
Number of data channels	10	Chop&Jiggle
Bits per channel	16	bits
Frame size	160	bits
Frames per packet	32	
Packet size	5344	bits
Sampling rate	64	frames/sec
Packets per sec	2	

SCU Science	Nominal	
Number of data channels	0	
Bits per channel	16	bits
Frame size	0	bits
Frames per packet	1	
Packet size	224	bits
Sampling rate	0	frames/sec
Packets per sec	0	

DPU Science	Nominal	
Number of data channels	8	TBC
Bits per channel	16	bits
Frame size	128	bits
Frames per packet	8	
Packet size	1248	bits
Sampling rate	4	frames/sec
Packets per sec	0.5	

Housekeeping	Nominal	
Parameter field length	480	Octets
Frame size	3856	bits
Frames per packet	1	
Packet size	4000	bits
Sampling rate	1	frames/sec
Packets per sec	1	

		% Budget Used
Total packet rate	**23.50**	**94.0%**
Total data rate	**113232.00**	**87.1%**

Maximum Data Rate for Non-Chopping Observatory Functions:

POF5

DCU Science	Nominal	
Number of data channels	292	TBC
Bits per channel	16	bits
Frame size	4672	bits
Frames per packet	1	
Packet size	4896	bits
Sampling rate	24	frames/sec
Packets per sec	24	

MCU Science	Nominal	
Number of data channels	0	Chop
Bits per channel	16	bits
Frame size	0	bits
Frames per packet	64	
Packet size	224	bits
Sampling rate	0	frames/sec
Packets per sec	0	

SCU Science	Nominal	
Number of data channels	0	
Bits per channel	16	bits
Frame size	0	bits
Frames per packet	1	
Packet size	224	bits
Sampling rate	0	frames/sec
Packets per sec	0	

DPU Science	Nominal	
Number of data channels	0	TBC
Bits per channel	16	bits
Frame size	0	bits
Frames per packet	8	
Packet size	224	bits
Sampling rate	0	frames/sec
Packets per sec	0	

Housekeeping	Nominal	
Parameter field length	480	Octets
Frame size	3856	bits
Frames per packet	1	
Packet size	4000	bits
Sampling rate	1	frames/sec
Packets per sec	1	

		% Budget Used
Total packet rate	**25.00**	**100.0%**
Total data rate	**121504.00**	**93.5%**

Maximum Data Rate for Scanning Observatory Functions:
SOF1, SOF2

DCU Science	Nominal	
Number of data channels	70	
Bits per channel	16	bits
Frame size	1120	bits
Frames per packet	4	
Packet size	4704	bits
Sampling rate	80	frames/sec
Packets per sec	20	

MCU Science	Nominal	
Number of data channels	6	
Bits per channel	16	bits
Frame size	96	bits
Frames per packet	80	
Packet size	7904	bits
Sampling rate	240	frames/sec
Packets per sec	3	

SCU Science	Nominal	
Number of data channels	0	
Bits per channel	16	bits
Frame size	0	bits
Frames per packet	4	
Packet size	224	bits
Sampling rate	0	frames/sec
Packets per sec	0	

DPU Science	Nominal	
Number of data channels	0	
Bits per channel	16	bits
Frame size	0	bits
Frames per packet	4	
Packet size	224	bits
Sampling rate	0	frames/sec
Packets per sec	0	

Housekeeping	Nominal	
Parameter field length	480	Octets
Frame size	3856	bits
Frames per packet	1	
Packet size	4000	bits
Sampling rate	1	frames/sec
Packets per sec	1	

		% Budget Used
Total packet rate	**24.00**	**96.0%**
Total data rate	**121792.00**	**93.7%**

Maximum Data Rate for Step-and-Look Observatory Functions:
SOF3, SOF4

DCU Science	Nominal	
Number of data channels	70	
Bits per channel	16	bits
Frame size	1120	bits
Frames per packet	4	
Packet size	4704	bits
Sampling rate	16	frames/sec
Packets per sec	4	

MCU Science	Nominal	
Number of data channels	10	Chop
Bits per channel	16	bits
Frame size	160	bits
Frames per packet	32	
Packet size	5344	bits
Sampling rate	64	frames/sec
Packets per sec	2	

SCU Science	Nominal	
Number of data channels	0	
Bits per channel	16	bits
Frame size	0	bits
Frames per packet	1	
Packet size	224	bits
Sampling rate	0	frames/sec
Packets per sec	0	

DPU Science	Nominal	
Number of data channels	8	TBC
Bits per channel	16	bits
Frame size	128	bits
Frames per packet	8	
Packet size	1248	bits
Sampling rate	4	frames/sec
Packets per sec	0.5	

Housekeeping	Nominal	
Parameter field length	480	Octets
Frame size	3856	bits
Frames per packet	1	
Packet size	4000	bits
Sampling rate	1	frames/sec
Packets per sec	1	

		% Budget Used
Total packet rate	**7.50**	**30.0%**
Total data rate	**34128.00**	**26.3%**

4 Thermal Budgets

All the following are steady state: for detailed Transients see RD2

SPIRE THERMAL BUDGETS WILL GO BACK IN HERE WHEN I'VE FINISHED ECRs 8 & 9, HOPEFULLY AS ISSUE 4.1 IN TIME FOR IHDR.

4.1 Spectrometer Mode.

4.2 Photometer Mode

4.3 HSFPU Off Mode