(part I) BOL/ARC/M/0035.10

BOL Consortium Meeting, Firenze, 8, 9 January 1998

Day 1 (8 January) Agenda

Plenary session

1. Introduction and aims of meeting	Griffin	09.30	
2. FIRST status and schedule	King	09.45	
3. Overview of the BOL project - Instrument design for AO response - Consortium make-up	Griffin	10.00	
Coffee		10.15	
4. Brief review of status of proposal			
Required format for the proposal	Griffin	10.30	10 min.
§1 Scientific case	Griffin	10.40	10 min.
§2 Technical description	Swinyard	10.50	15 min.
§3 Data red./science analysis plan (and SIP)	King	11.05	15 min.
§4 Test and calibration plan	Swinyard	11.20	10 min.
§5 System level AIV	Swinyard	11.30	10 min.
§6 Flight operations	Swinyard	11.40	10 min.
§7 Qualifications and experience	Griffin	11.50	5 min.
§8 Organisation and management	Griffin	11.55	5 min.
IID-B	Cunningham	12.00	15 min.
Management and funding	Griffin	12.15	10 min.
Production of the final documents	King	12.25	5 min.
Lunch + visit to LENS Laboratory		12.30	

Parallel sessions

A. Review of draft proposal		14.00-16.30
A1: Scientific case	Vigroux	
A2: Technical description; Test and Calibration; AIV; Flight operations	Swinyard	
B. Others		17.00-18.30
B1: Consortium organisation and management; Funding proposal	Griffin	[Co-Is only]
B2: FTS sampling and data processing requirements	Ade	

BOL Consortium Meeting, Firenze, 8, 9 January 1998

Day 2 (9 January) Agenda

Parallel sessions

C. Review of draft proposal (continued)		09.00-11.30
C1: Data red./ science analysis plan; Science Implementation Plan	King	
C2: IID-B	Cunningham	

Plenary session

1. Reports on parallel sessions and summaries of actions

- Scientific objectives, capabilities	Vigroux	11.45
- Technical description etc.	Swinyard	12.00
- Data red. . . plan; SIP	King	12.15
- IID-B	Cunningham	12.30
- Management and funding	Griffin	12.45

2. Conclusions and summary of actions and deadlines	Griffin	13.00
End of meeting		13.30

BOL Instrument Design

Photometer

- 3-band imaging photometer 250, 350, 500 μm
- Basic optical design is more or less firm
- 4 x 4 arcmin. field of view
- Baffling, stray light requirements will depend on choice of array type

Spectrometer

- FTS
- Design is not so mature as for photometer, but we have a credible base-line for the AO
  - Martin-Puplett interferometer
  - Output ports used for two separate sub-bands
  - 2 x 2 arcmin field of view
  - λ = 200-400 μm (wider range can be considered later)
  - $\Delta\sigma = 0.1\ cm^{-1}$ ($\lambda/\Delta\lambda$ = 400 at 250 μm)

Cooler

- ^3He sorption cooler
- Any chosen detector technology must be compatible with this

Detector array options

- Base-line: Filled arrays: SAp/LETI micromachined arrays
  Caltech/JPL spider-web (NTD Ge or TES)
  Goddard SPUD (TES)

Fall-back: Feedhorn arrays: 2.0Fλ or 1.0Fλ
NTD Ge or superconducting TES

Instrument sensitivity

- AO will use figures based on 2Fλ feedhorn option, with more ambitious goals based on filled arrays (factor of 2-3 in mapping speed).

BOL Consortium

Bolometer arrays	SAp, Saclay / LETI or Caltech/JPL or NASA, Goddard
Focal plane units	QMW
Filters, dichroics, polarisers	QMW
Photometer on-board calibrator	QMW
Spectrometer on-board calibrator	ROE
Chopper	ROE
Optics and FTS mechanism	LAS
Cold readout electronics	SAp, Saclay
^{3}He cooler	CEA, Grenoble
Signal processing electronics	SAp, Saclay; DESPA; IAC (TBC)
Digital Processing Unit	IFSI
Structure	MSSL
Instrument simulator	Stockholm Obs.
On-board software	IFSI; SAp, Saclay
EGSE	Imperial College
AIV and ground calibration facilities	RAL
ICC Operations Centre	RAL
ICC DAPSAS Centres	Imperial College; SAp, Saclay
Operations Centre manpower	UK (IC, MSSL, ROE, QMW) France Italy (Arcetri, Padua) (Sweden, Spain, USA)?

All hardware groups expected to support and participate ICC development and operations

Proposal Format

- Part 1: Scientific and Technical Plan
  - 100 pages max. (excluding Cover page, Table of contents, Executive summary)
- Part 2: IID-B
- Part 3: Funding proposal
- Draft Science Implementation Plan (SIP)

1: Scientific and Technical Plan

Cover page

Executive summary — Griffin/Vigroux

Table of contents

1. Scientific objectives and capabilities — 20 pages — Griffin
2. Technical description — 25 pages — Swinyard
   - Instrument design
   - Compatibility with IID-A technical constraints
   - Design options
   - Instrument lifetime, reliability, redundancy
   - Status of key technologies
   - Development risks and options
   - Operating modes (max. 3 - 5)
3. Data reduction and scientific analysis plans — 20 pages — King
   - ICC detailed description
     - Means of fulfilling SIRD requirements
     - Justification of deviations from SIRD and SMP
     - Technical description
     - Infrastructure and hardware configuration
     - Management
   - Programme
     - Development
     - Operations
     - Resources
     - Schedule
   - Commonality between Operations and Instrument Testing

4. Test and calibration plans — 6 pages — Swinyard

- Ground tests
  - Subsystem-level tests
  - Instrument-level tests
  - Test and calibration facility
- Pre-launch tests
  - Satellite-level tests
- In-Orbit tests

5. System-level Assembly, Integration and Verification — 4 pages — Swinyard

- Compliance with satellite AIV plans
- Services required from launch vehicle

6. Flight operations — 3 pages — Gear

- Operational concept
  - Calibrations
  - Mode changes
- Requirements for flight operations support

7. Qualification and experience of PI team — 4 pages — Griffin

- Experience of PI, Co-Is, key technical personnel

8. Organisation and management structure of PI consortium — 6 pages — Griffin, Vigroux

- Functional organisational chart
- Management structure and organisation
  - Instrument development phase
  - ICC development phase
  - Post-launch operations
- Management organogram
- Names/experience of Project Manager and key personnel
- Post-operations phase
- Archive phase

Total no. pages above = 88 (margin of 12 pages)

BOL Consortium Meeting
Firenze
8, 9 January 1998

Purposes of this meeting

1 Review the draft BOL proposal

2 Identify FINAL alterations and FINAL deadlines for the FINAL document

Deadlines

Submission of proposal	Monday Feb. 16
Completion of final document for printing	Friday Jan. 30

SCIENTIFIC CASE

- INTRODUCTION
- SCIENTIFIC CAPABILITIES OF BOL

} NEED SOME REVISION

- SCIENTIFIC GOALS:
  - DISTANT GALAXIES & QUASARS
  - NEARBY GALAXIES & AGN
  - PROTOSTARS & YSOs
  - MAIN SEQUENCE & EVOLVED STARS
  - THE ISM
  - THE SOLAR SYSTEM

} NEAR COMPLETION

- [redacted] REVIEW TODAY SHOULD LEAD TO THE FINAL VERSION WITH MINIMAL CHANGES

QUALIFICATIONS & EXPERIENCE

- SHORT BIOGRAPHIES OF CoIs + — IN HAND
- EXPERIENCE / TRACK RECORD OF BoL INSTITUTES IN FIR / SUBMM ASTRONOMY & SPACE INSTRUMENTATION } SHORT PARAGRAPH PER INSTITUTE

ORGANISATION & MANAGEMENT

- ORGANOGRAMME
- DESCRIPTION OF MANAGEMENT STRUCTURE, ROLES & IDENTITIES OF KEY PERSONNEL, INSTITUTES, ETC.
- LIST OF Co-Is

- DRAFT SECTION 8 WILL BE REVIEWED TODAY
- TO BE FINALISED:
  - Co-I LIST
  - PUTTING NAMES TO SOME POSITIONS
  - SPANISH PARTICIPATION
  - VARIOUS OTHER DETAILS

Data Reduction and Scientific Analysis Plans

First Draft Distributed 5th Jan - still requires:

- DAPSAS centres implementation and operation section
- Management section
- Schedule
- Resources
- Discussion on responsibilities in the ICC

Science Implementation Plan

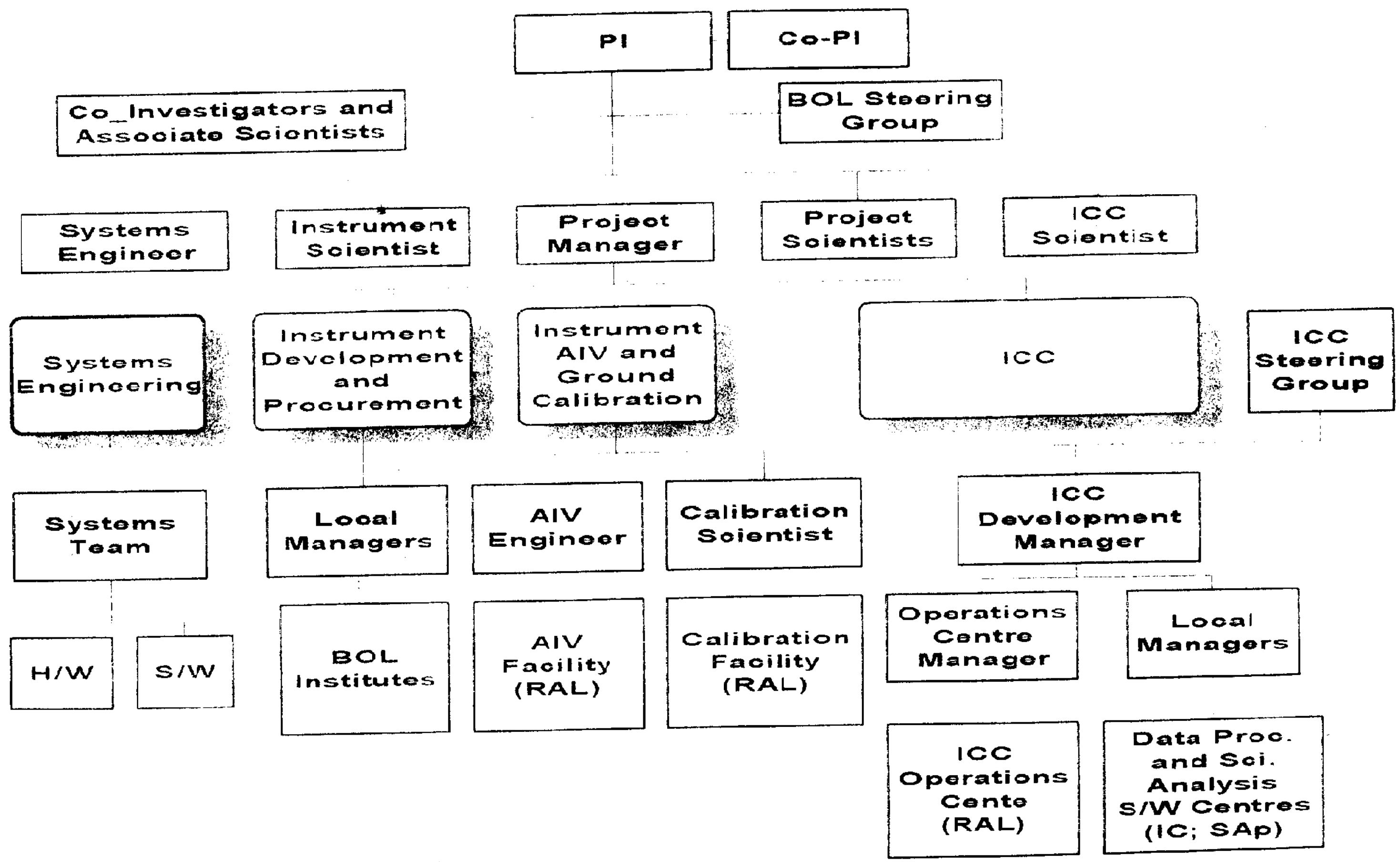
- Response to the SIRD distributed with the AO
- Draft only required - can be based on the Data reduction Plans, plus any other information we can generate (schedule, WBS, budget etc)
- Table of Contents:
- proposed to be common (as far as possible) with other instruments - but no input yet. To be discussed at meeting.

Production of the Final Documents

- **Format**
  - Plastic Ringbound
  - Photographic Cover with Text
  - Text printed double sided, 11pt
  - Electronic format: Adobe pdf files

- **Schedule (delivery required by 16th Feb)**
  - Jan 26th - Cover photograph and Text available
  - Feb 2nd - Final delivery of documents - allows bulk reproduction.
  - Feb 6th - Final delivery of updated pages (should not change pagination)
  - Feb 12th - Shipment of hard copies, availability of documents on WWW.

- **Deliverable formats**
  - MS Word documents (Preferred)
  - Postscript will be considered if necessary for images
  - Plain text files as a last resort (these will need to be delivered early as they will need incorporating into Word documents).


PI
Co-PI
Co_Investigators and Associate Scientists
BOL Steering Group
Systems Engineer
Instrument Scientist
Project Manager
Project Scientists
ICC Scientist
Systems Engineering
Instrument Development and Procurement
Instrument AIV and Ground Calibration
ICC
ICC Steering Group
Systems Team
Local Managers
AIV Engineer
Calibration Scientist
ICC Development Manager
H/W
S/W
BOL Institutes
AIV Facility (RAL)
Calibration Facility (RAL)
Operations Centre Manager
Local Managers
ICC Operations Cento (RAL)
Data Proc. and Sci. Analysis S/W Centres (IC; SAp)

FIRST Status

Update to IID-Part A

- Definition of Model Philosophy
  - Electrical Model
  - Qualification Model
  - Proto-Flight Model
  - Flight Spare (FPU) + cards
- Definition of Testing Requirements
  - Vibration testing at temps representative of launch conditions (10-20K)

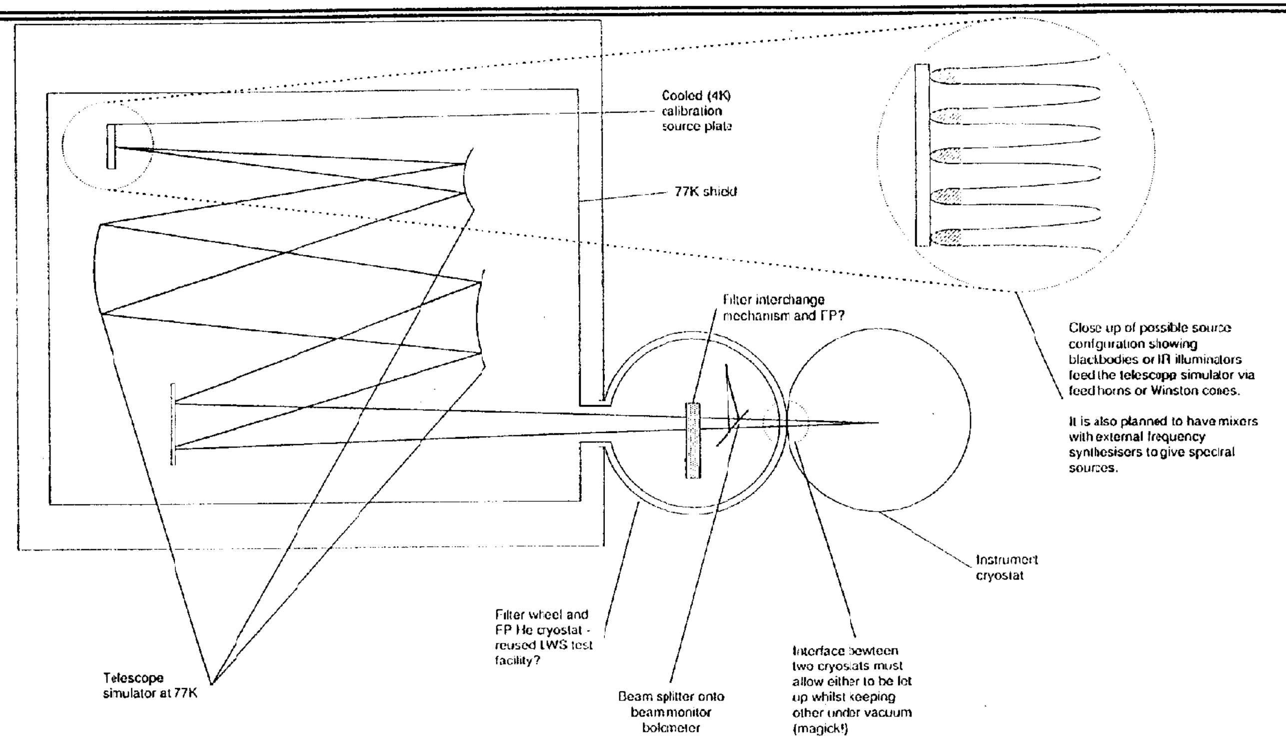
AO Clarification Meeting (3rd Dec)
(see: FIRST/ESA/M/0034.10)

- Confirmation of merged mission as the baseline
  - Phase 2 (Detailed Design) started with the merged mission
  - Technical Challenges (e.g AOCS) but still the cheapest
  - Phase 3 (Cost and Schedule Analysis) to be completed by March
  - Separate missions are being investigate - with low cost launch options - Phase 3 to be completed by March
- Public Relations
  - ESA concern over lack of communication with general public (c.f. NASA)
  - A Communications Plan for each project requiring PIs and CO-Is to provide 'a significant contribution' to the ESA communications programme. This will have to be signed
  - ESA will provide a dedicated communications advisor to the project

FIRST Status

FIRST Schedule

	AO Date	'Clarification' Date	Proposed Date
Proposal Submission	16 Feb 1998		....
Recommendation and review by AWG	End Apr 1998		....
'Pre- Selection' of PIs by SPC	End May 1998		....
Final Payload Confirmation by SPC	Feb 1999		....
MGSE/EGSE & Software Readiness	Apr 2001		
EM Delivery	Jul 2001	....	Dec 2001
QM Delivery	Jan 2002	....	Jul 2002
PFM Delivery	Jan 2004	....	Jul 2004
FS Delivery	Jan 2005		Jul 2005
ICC Readiness	Dec 2004		
Flight Acceptance Review	Jul 2005	Apr 2005	
Launch	Dec 2005	Jul 2006	....



Concept for the FIRST Bolometer Instrument Calibration Facility

Figure 1:

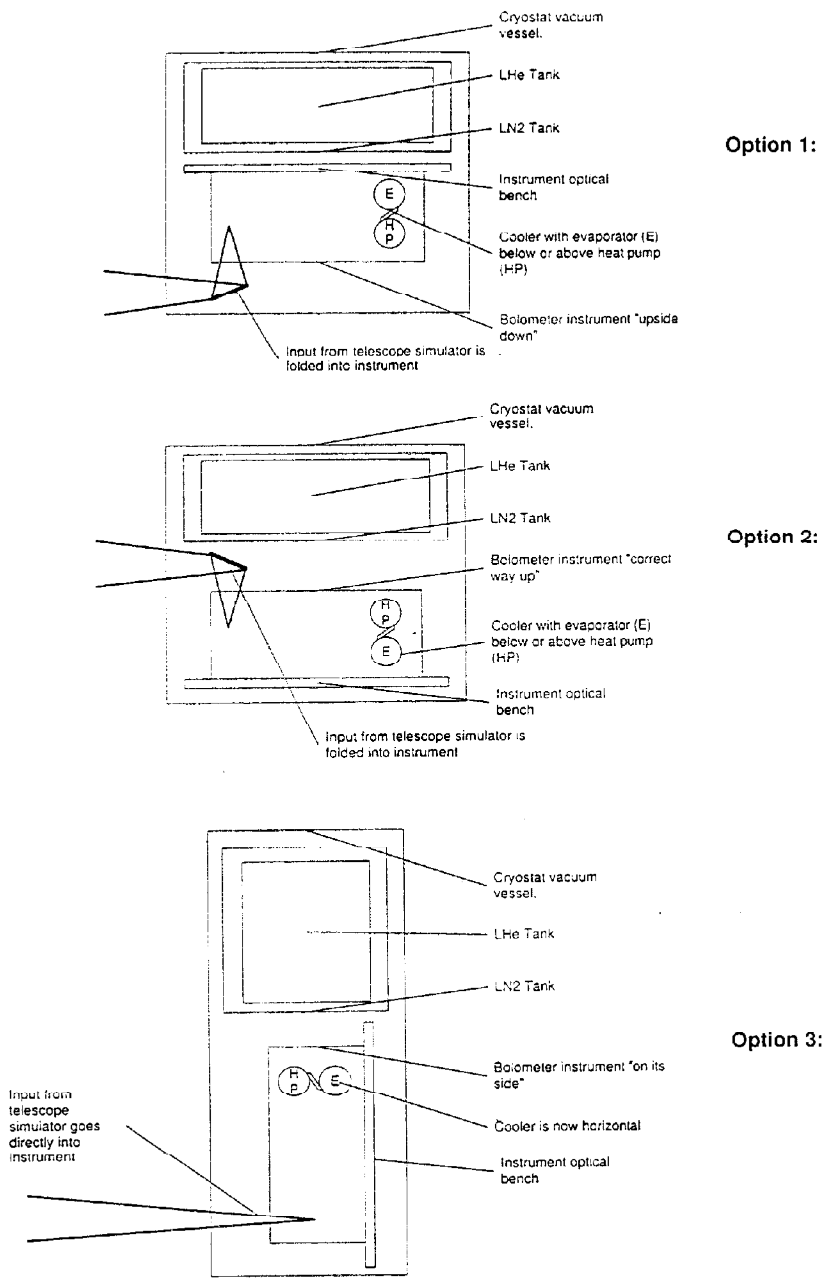
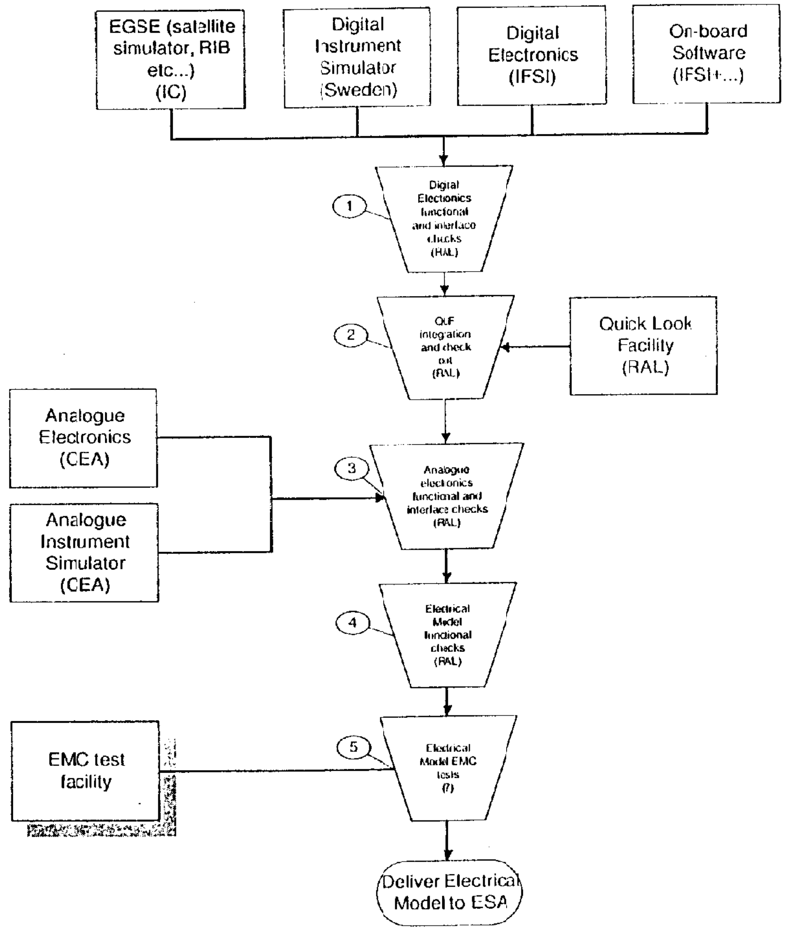
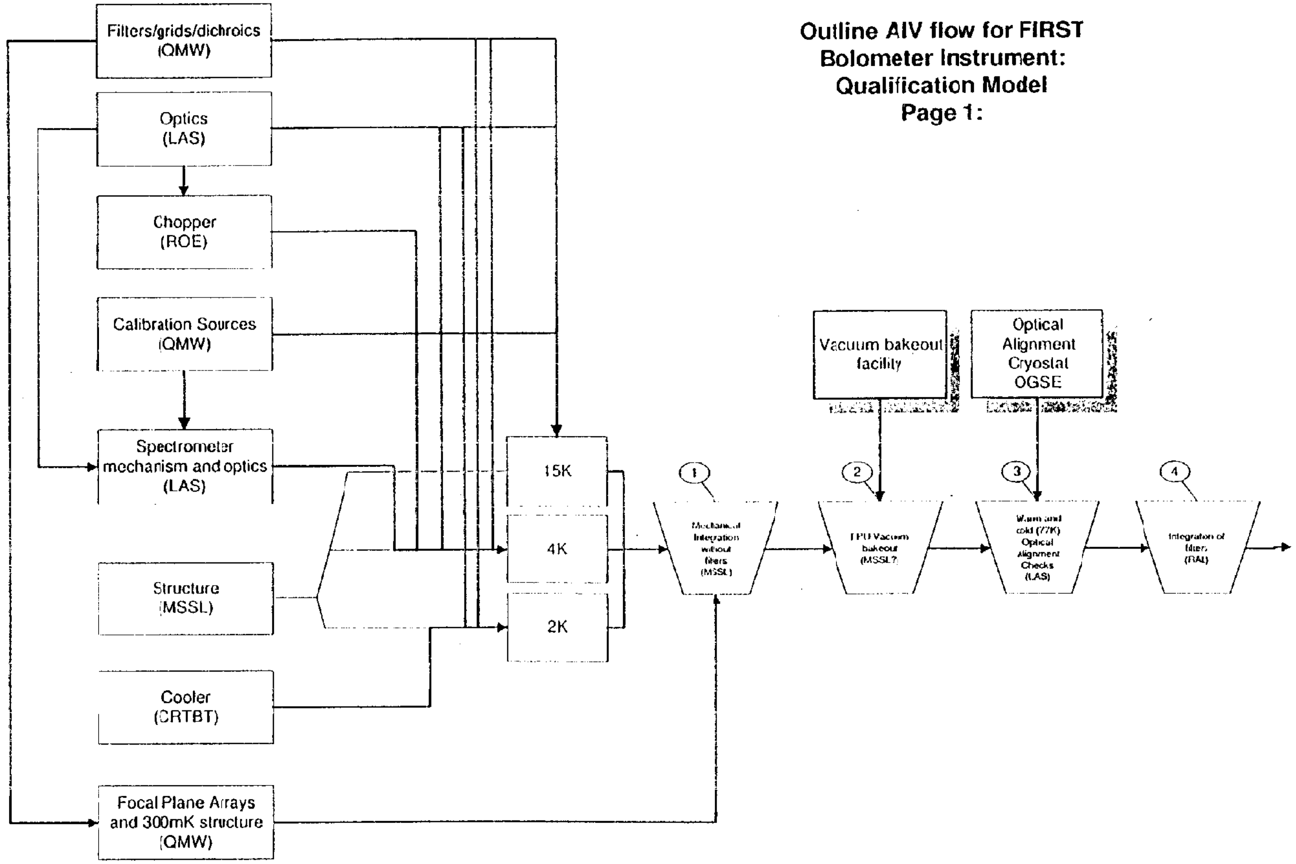


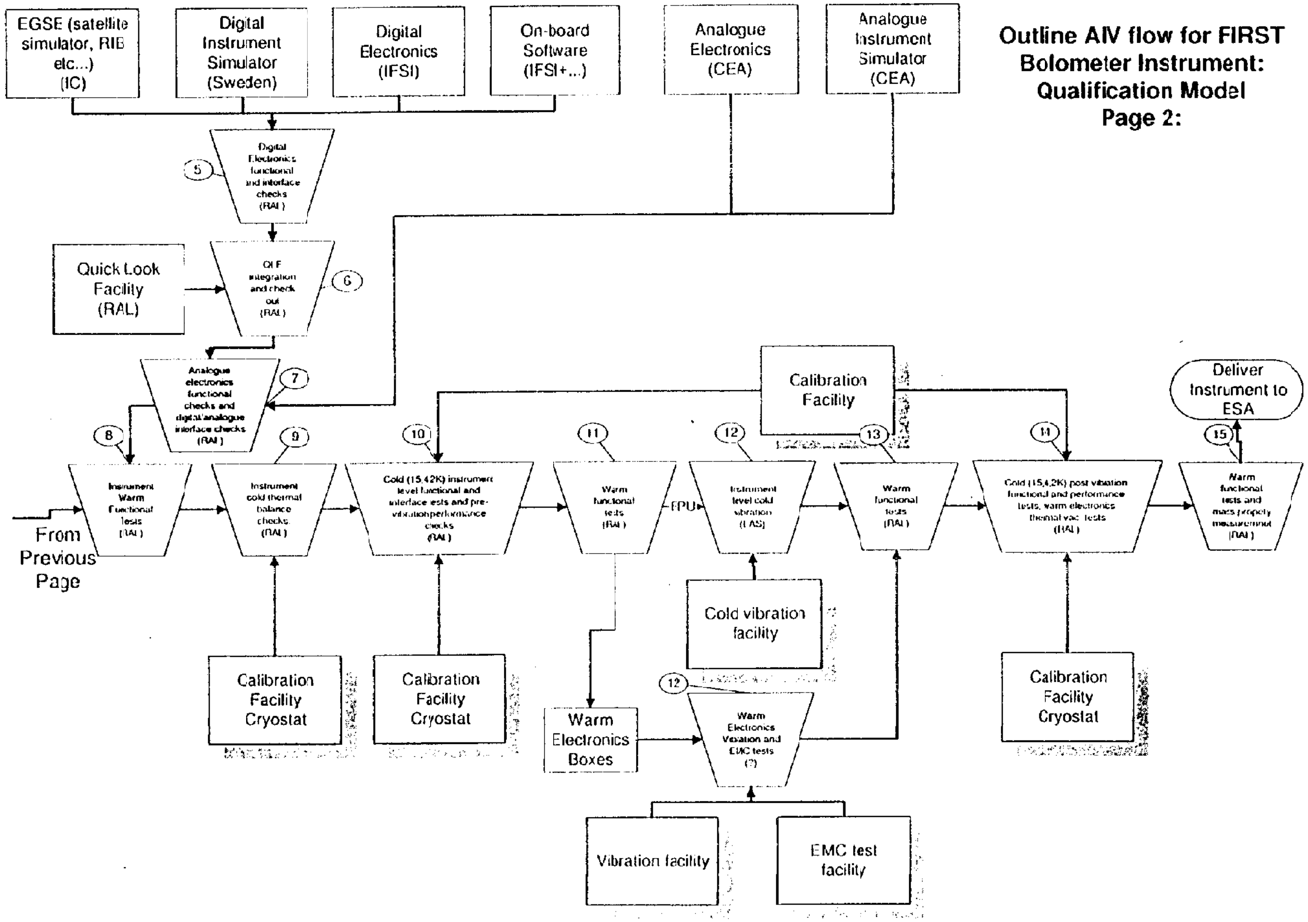
Figure 2: The three options for the orientation of the instrument in the facility cryostat.

Outline AIV flow for FIRST Bolometer Instrument: Electrical Model

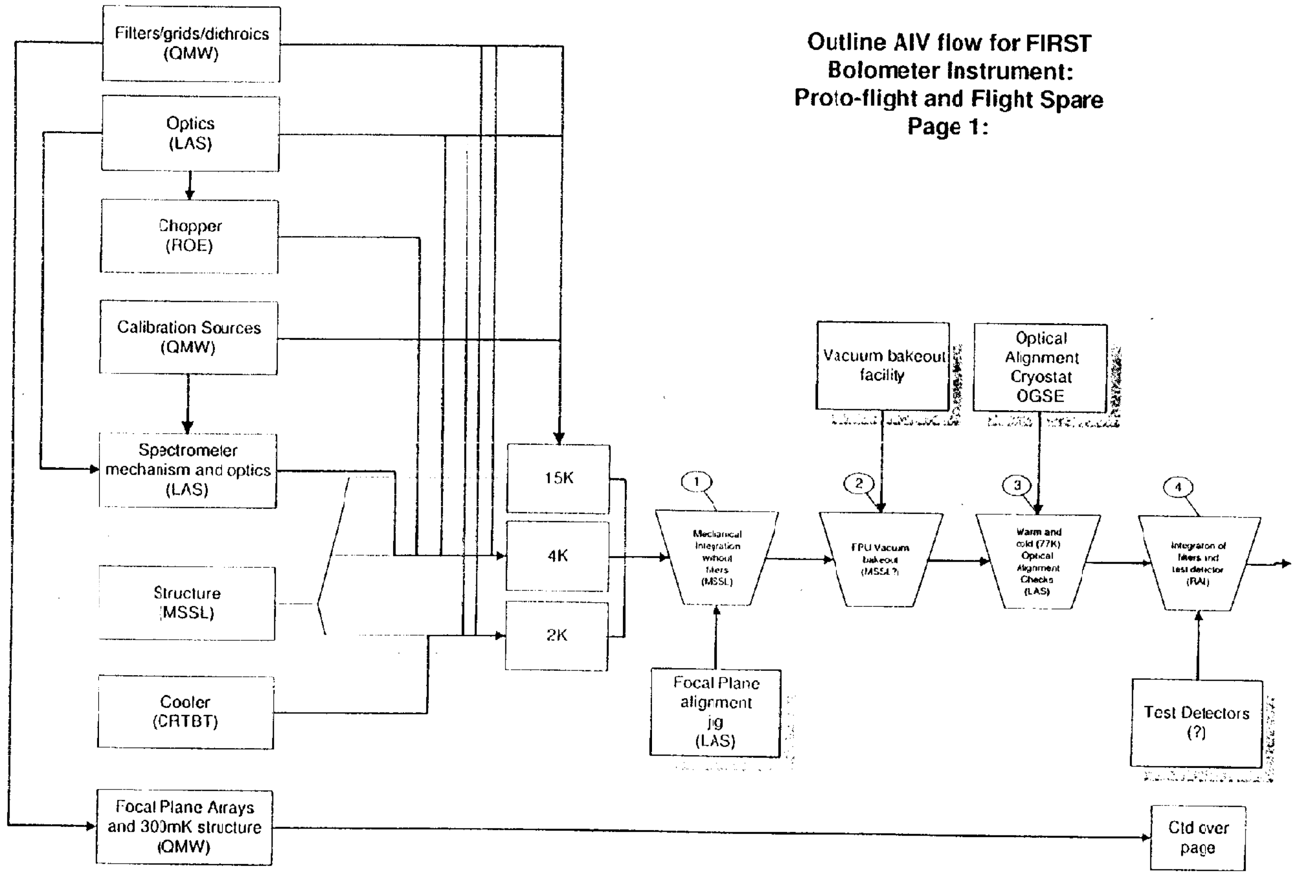



Outline AIV flow for FIRST Bolometer Instrument: Qualification Model Page 1:
Filters/grids/dichroics (QMW)
Optics (LAS)
Chopper (ROE)
Calibration Sources (QMW)
Spectrometer mechanism and optics (LAS)
Structure (MSSL)
Cooler (CRTBT)
Focal Plane Arrays and 300mK structure (QMW)
15K
4K
2K
1
2
3
4
Vacuum bakeout facility
Optical Alignment Cryostat OGSE

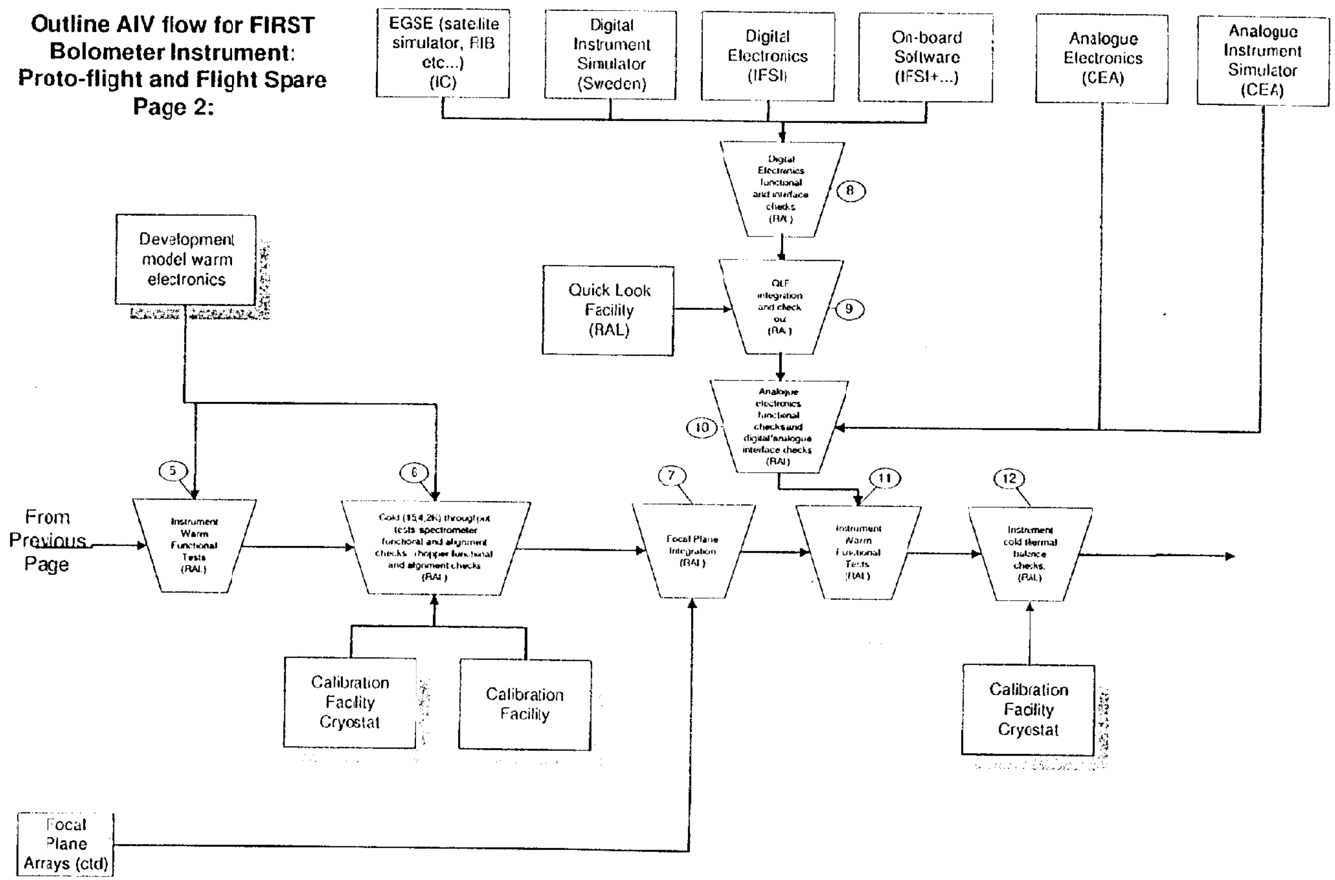
Outline AIV flow for FIRST Bolometer Instrument: Qualification Model Page 2:



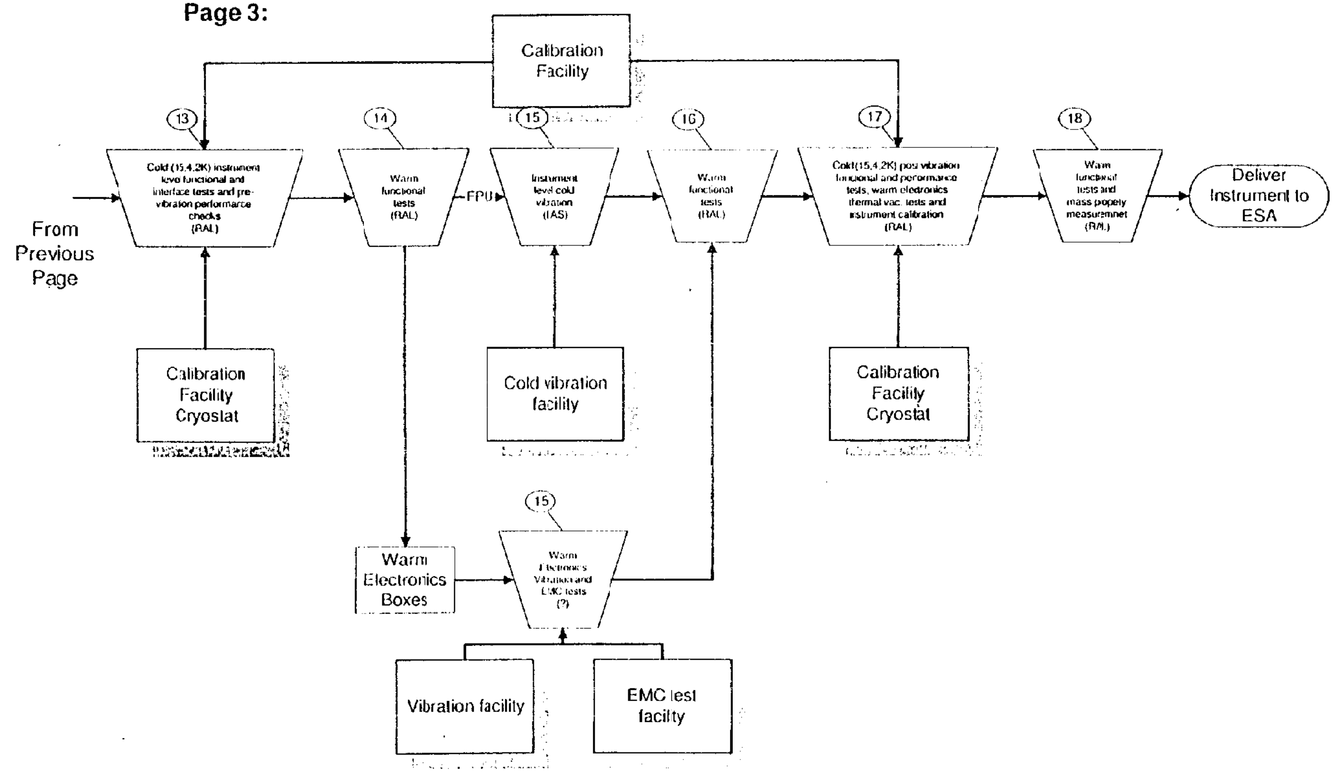
Outline AIV flow for FIRST Bolometer Instrument: Proto-flight and Flight Spare Page 1:



Outline AIV flow for FIRST Bolometer Instrument: Proto-flight and Flight Spare Page 2:



Outline AIV flow for FIRST Bolometer Instrument: Proto-flight and Flight Spare Page 3:



Firenze 8/9 Jan 1998
B. Swinyard

Flight Operations Concept

What I think we have to do/write in the AO response.....

- Define the operations modes.....not just astronomical but engineering, commissioning, calibration etc, etc.
- Define the requirements these set on spacecraft operations - as best we can.
- Decide how we are going to deal with "autonomous" operations - define the requirements this sets on the spacecraft systems - as best we can.
- Define the method of translation between "engineering" or "astronomical" inputs and commands to the instrument - some form of script "language" seems best.
- Outline the general requirements we expect to set on the spacecraft operations - parameter monitoring, switch us off etc etc....
- Define the general types of telemetry packet we expect to implement.

ITD B JAN 98

DRAFT

4. INSTRUMENT DESCRIPTION

4.1 INTRODUCTION

For low background direct detection at wavelengths longer than around 200 µm, the most sensitive detectors are cryogenic bolometers operating at temperatures in the 0.1 - 0.3 K range.

The FIRST BOLometer instrument (BOL) comprises a three-band imaging photometer covering the 200-500 micron range and an imaging Fourier Transform Spectrometer (FTS) with a resolution of order 1000 covering wavelengths between 200 and 400 µm. The detectors are bolometers cooled to 300 mK using a ^{3}He refrigerator. The photometer is optimised for deep photometric surveys, and can observe simultaneously the same field of view in all three bands.

4.2 SCIENTIFIC RATIONALE

The wavelength range 200 - 500 µm is largely unexplored. The thermal emission from many astrophysical sources peaks in this part of the spectrum, including comets, planets, star-forming molecular cloud cores, and starburst galaxies. The short submillimetre region is also rich in atomic and molecular transitions which can be used to probe the chemistry and physical conditions in these sources.

Wavelengths between 200 and 350 µm are not observable from the ground and have not be observed by ISO. Low transparency submillimetre windows allow some observations to be made with difficulty from the ground, but with far lower sensitivity than can be achieved from space.

One of the most important scientific projects for the FIRST mission is to investigate the statistics and physics of galaxy formation at high red shift. This requires the ability to carry out deep photometric imaging at far-infrared and submillimetre wavelengths (100-500 µm) to discover objects, and the ability to follow up the survey observations with spectroscopy of selected sources. The FIRST bolometer instrument is essential for this programme, and is being designed so as to be optimised for these extragalactic imaging and spectral surveys. Another key scientific project for the BOL is a sensitive unbiased search for proto-stellar objects within our own galaxy.

4.3 OVERALL CAPABILITIES

The BOL instrument contains a three-band imaging photometer and a Fourier Transform spectrometer. The detectors are bolometer arrays cooled to 300 mK by a re-cyclable ^{3}He refrigerator which runs from the 2-K temperature level provided by a direct thermal strap to the FIRST cryostat helium tank. It has a hold time of at least 48 hrs (TBC) and a re-cycle time of less thatn 4 hrs (TBC).

4.3.1 Photometer

The imaging photometer operates at nominal wavelengths of 250, 350 and 500 μm with a spectral resolution of around 3. Three bolometric detector arrays observe the same approx. 4.5-arcminute field of view simultaneously, with dichroic beam dividers separating the bands. The 250 , 350 and 500 μm arrays have 32 x 32, 24 x 24 and 16 x 16 detectors, respectively. The pixel size is 0.5Fλ, where F is the focal ratio, providing full (Nyquist) sampling of the point spread function in the focal plane. Cryogenic readout and multiplexer electronics in the focal plane unit are used to read out the detector signals. A chopping mirror within the instrument is used to modulate the signals at a frequency of 5 Hz or less.

Several detector array technology options are under development, and a decision on which one to fly has not yet been made. This must wait for evaluation of the various options, and is not likely to happen until 1999 or 2000 - i.e., well after instrument selection. A less powerful fall-back option, based on proven technology (spider-web bolometers and feedhorns), has been studied, and can be used if the large-format array technology is not sufficiently well developed for flight on FIRST.

4.3.2 Spectrometer

The Martin Puplett polarising FTS covers the range 200 - 400 μm (25 - 50 cm^{-1}) with a spectral resolution of at least 0.1 cm^{-1} ($\lambda/\Delta\lambda$ = 500 at 200 μm; 250 at 400 μm). The FTS uses a moving mirror to modulate the signal and generate the interferograms. By adjusting the length of travel of the mirror, the spectral resolution can be varied between 20 and 400 to match the scientific requirements of a particular observation. Two 16 x 16 arrays of detectors at the FTS output each cover different parts of the 200-400 μm range with a field of view of 2 (TBC) arcminutes. The detector arrays are of the same type as used in the photometer.

4.4 HARDWARE DESCRIPTION

The BOL consists of:

BOL1: A cold Focal Plane Unit (FPU) which interfaces to the 15-K, 4-K and 2-K temperature stages provided by the cryostat. If the back-up array option is chosen, an additional thermal interface will be needed, to a cryostat stage at around 30K for cooling the JFET module. Within the unit, further cooling of the detector arrays to a temperature of around 300 mK is provided by a ^{3}He refrigerator which is part of the instrument.

BOL 2: A warm analogue electronics box for mechanism control and ^{3}He refrigerator operation.

BOL3: Signal Processing Unit (SPU): a warm analogue/digital electronics box for detector signal conditioning and processing and housekeeping data.

BOL4: Digital Processing Unit (DPU): a warm digital electronics box for signal processing and instrument commanding and interfacing to the spacecraft telemetry.

BOL5: Warm interconnect harness between the electronics boxes.

BOL 2, 3 , 4 and 5 are located in the service module (SVM) at 300 K.

4.5 SOFTWARE DESCRIPTION

TBD

4.6 OPERATING MODES

4.6.1 Primary operating modes

In Primary mode, the instrument is actively making pointed astronomical observations. Science and housekeeping data are produced at a rate compatible with the OBDH.

4.6.1.1 Photometer field or raster mapping

This mode produces a fully sampled (half-beam spacing) map of an area equal to the BOL field of view, or of a larger area if raster mapping is carried out.

- Chopper on
- Chop throw
  - array size (approx. TBD arcmin) if full map of field requierd
  - less than array size if only observation of a point source in the field is required
- FTS mechanism off
- Three photometer arrays on
- Two spectrometer arrays off
- Nodding (optional)
- Raster mapping (optional)
  - Step size > 2 arcmin. (TBC)
  - Interval between steps: > 5 sec. (TBC)

4.6.1.2 Photometer scan mapping

This mode produces a map of an area typically much larger than the BOL field of view.

- Chopper on (optional)
- FTS mechanism off
- Three photometer arrays on
- Two spectrometer arrays off
- Telescope moves continuously
- Scan direction fixed in spacecraft co-ordinates
- Normal line scanning:

Normal line scanning:	No. of lines	N $\geq$ 1
	Length of lines	D1 > 5 arcmin.
	Line-line sep.	1 < D2 < 4 arcmin.
	Scan rate	TBD

4.6.1.3 Spectrometer field or raster mapping

This mode produces a full spectral image of a single field or of a larger area if raster mapping is carried out.

- FTS mechanism on
- Three photometer arrays off
- Two spectrometer arrays on
- Chopper off
- Nodding not required (TBC)
- Length of observation: > 60 sec. (TBC)
- Raster mapping (optional)
    - Step size > 1 arcmin. (TBC)
    - Interval between steps: > 10 sec. (TBC)

4.6.2 Serendipity modes

In Serendipity mode, the instrument is actively making astronomical observations while the telescope is slewing. Science and housekeeping data are produced at a rate compatible with the OBDH. It may be possible to run without the chopper in this mode (TBD).

The BOL photometer can take data during telescope slews, producing strip maps at three wavelengths. The BOL spectrometer does not take data while the telescope is slewing.

4.6.2.1 Partner mode with PHOC

A "partner mode" in which the PHOC and the BOL operate simultaneously in imaging mode for deep mapping of large areas of sky would lead to increased observing efficiency for FIRST surveys. It will need to have both instruments operating at high efficiency and sensitivity (i.e., both effectively prime). At present, the feasibility of this mode is TBD. It will depend on both the PHOC and the BOL having an efficient operating mode similar to 4.6.1.1 or 4.6.1.2 above which are compatible in terms of

(i) telescope raster step size or scan rate;
(ii) integration time per position;
(iii) simultaneous operation of mechanisms in the focal plane;
(iv) data-rate constraints.

4.6.2.2 BOL operation in parallel with HET

TBD: this mode may not prove practical for EMC reasons - undisturbed operation of the BOL may not be feasible while the HET local oscillators are switched on.

4.6.3 Stand-by mode

This is a warm-up mode in which the BOL is ready to operate in one of its primary modes. Housekeeping data only are produced.

- FPU powered
- Chopper and FTS mechanism both in rest positions

- ^3He refrigerator is at base temperature
- Either 3 photometer arrays or 2 spectrometer arrays powered
- Data rate can be restricted to housekeeping only

4.6.4 Off mode

FPU and warm electronics are not powered

4.6.5 FPU operations at ambient temperature

(i) The chopper and FTS mirror drive mechanisms can be operated and checked, but note that the coil impedances will be higher than they are cold, so drive electronics must be able to generate sufficient voltage for this condition.
(ii) The detectors and cold readout electronics can be powered (TBC) but do not function.

4.7 INSTRUMENT SCIENTIFIC PERFORMANCE

This part is to be considered as containing information which needs to be verified by test, analysis or a combination of the two and shall serve the purpose of demonstrating that the instrument will operate as intended for the particular mission. Para 9.5 "Scientific Performance Verification" of the IIDs provides more information on this subject.

4.7.1 Optical parameters

TBD

4.7.2 Spectral resolution

Photometer: R = 3
Spectrometer: R = 20 - 400

4.7.3 Modes of operation

See section 4.6

4.7.4 Sensitivity

TBD
Question: should we put in table of sensitivities here, with TBC proviso?

5. INTERFACE WITH SATELLITE

5.1 IDENTIFICATION AND LABELLING

Each individual instrument unit is allocated two unique identification codes:

(i) a project code which is the normal reference used for routine identification in correspondence and technical descriptive material;

(ii) a spacecraft code allocated by the spacecraft contractor in accordance with the computerised configuration control system to be implemented, and used in particular for connector and harness identification purposes. The project code is part of the spacecraft code. (See IID-A item 5.1).

The project codes allocated to the BOL are:

Project code	Instrument unit
BOL1	Cold Focal Plane Unit
BOL2	Warm electronics box for mechanism and ^{3}He fridge operation
BOL3	Warm electronics box for science and housekeeping data
BOL4	Warm digital processing unit
BOL5	Interconnect harnesses between warm boxes

5.2 COORDINATE SYSTEM

Compliant with requirements in IID-A. Unit specific definition shown in the External Configuration Drawings.

5.3 FPU LOCATION AND ALIGNMENT

Figures 1 and 2 show the concept of the location of the BOL Focal Plane Unit (FPU) on the Optical Bench (OB).

5.3.1 Instrument location

5.3.1.1 Inside cryostat

TBD

5.3.1.2 Outside cryostat

NA

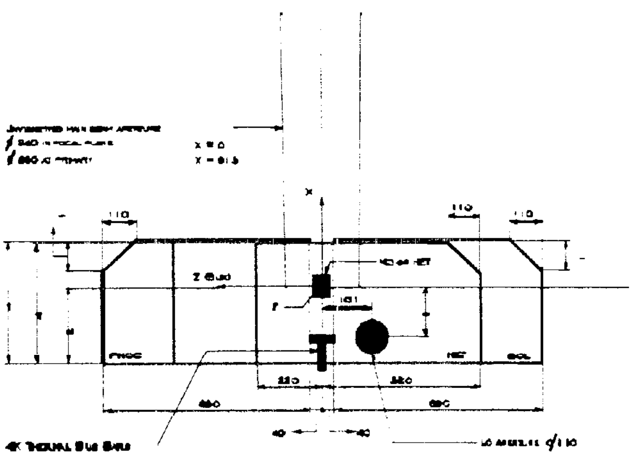


Fig. 2 The First Focal Plane, side view towards +Y

5.3.1.4 On PLANCK module

NA

5.3.1.3 On SVM

There are no location requirements for units on the SVM.

5.3.2 Instrument Alignment

There are no alignment and/or alignment stability requirements except for the focal plane unit BOL1.

5.3.2.1 Absolute Requirements

The absolute alignment requirements to the Optical Bench at operating conditions are covered in the FIRST Alignment Plan (Ref. TBD). This is an applicable document to the IID-A.

5.3.2.2 Stability Requirements

The absolute alignment stability requirements under operating conditions also are covered in the FIRST Alignment Plan (Ref. TBD). This is an applicable document to the IID-A.

5.4 EXTERNAL CONFIGURATION DRAWINGS

Drawing from Wilf Oliver to insert here.

5.5 SIZES AND MASS PROPERTIES

The table below shows for each unit its size, mass (one unit) and the number of units:

Project code	Instrument unit	No.	Dimensions (mm)	Mass (kg)
BOL1	Cold Focal Plane Unit	1	690 x 410 x 410 (irregular shape)	34 (TBC)
BOL 2	Warm electronics (mechanisms and ^{3}He fridge)	1	200 x 200 x 100 (TBC)	4 (TBC)
BOL3	Warm electronics (science + housekeeping data)	1	200 x 200 x 100 (TBC)	4 (TBC)
BOL4	Digital Processing Unit	1	200 x 200 x 100 (TBC)	4 (TBC)
BOL 5	"Warm" interconnect harnesses: BOL2-BOL4 and BOL3-BOL4	2		2 (TBC)
TOTAL				**48** (TBC)

Note that dimensions and mass do not include margins. The S/C shall apply a margin of TBD %.

5.6 MECHANICAL INTERFACES

5.6.1 Inside cryostat

The Focal Plane Unit, BOL1, will have 6 (TBC) holes for fixation by bolts to the Optical Bench. One of these holes is the reference hole, as marked in the External Configuration Drawing. The interface is such as to allow unit alignment and alignment-stability requirements to be fulfilled.

5.6.2 Outside cryostat

NA

5.6.3 On SVM

Units mounted on the SVM will have attachment points for fixation to the equipment platform. Units with a mass <1.5 kg will not have more than 4 of these points. For units with a mass >1.5 kg and units with a specific structural, dynamic or thermal requirement for more than 4 attachment points, the number will have to be approved by the Project.

5.6.4 On PLANCK module

NA

5.7 THERMAL INTERFACES

5.7.1 Inside cryostat

The various instrument stages require 3 different temperatures. This will be achieved by strapping the stages to various "cold" parts of the cryostat.

These cryostat parts are:

- The He II tank for temperatures at the 1.7-K level
- A wheel-shaped heat exchanger cooled by the He-flow from the tank for the 4.3-K level
- A connection to the He-ventline for the 15-K level
- A connection to the cryostat radiation shield at 30K for the back-up array option

The table below shows the required temperatures at the interface of the instrument unit with the cryostat or parts thereof:

Project code	Operating		Start-up	Switch-off	Non-operating	
	Min. K	Max. K	^0C	^0C	Min. ^0C	Max. ^0C
BOL1 (15-K enclosure)	4	20	NA	NA	NA	+ 60 * TBD**
BOL1 (4.3-K enclosure)	Strapped to a 4.3-K cryostat level		NA	NA	NA	
BOL1 (2-K enclosure)	Strapped to a 2-K cryostat level		NA	NA	NA	
BOL1 (30-K enclosure)***	Strapped to a 30-K cryostat level		NA	NA	NA	+ 60 * TBD**

*   Continuous temperature limit.

**   Short-duration temperature limit for bake-out during a maximum of TBD hours.

***   Back-up option

During cryostat warm-up or cool-down, the rate of temperature change shall not exceed TBD K/hr.

5.7.2 Outside cryostat

NA

5.7.3 On SVM

The table below shows the required temperatures at the interface of the instrument unit with the mounting platform or parts thereof:

Project code	Operating		Start-up	Switch-off	Non-operating	
	Min. ^0C	Max. ^0C	^0C	^0C	Min. ^0C	Max. ^0C
BOL3	- 15	+ 45	- 30	+ 50	- 30	+ 60
BOL4	- 15	+ 45	- 30	+ 50	- 30	+ 60
BOL5	- 15	+ 45	- 30	+ 50	- 30	+ 60

5.7.4 On PLANCK module

NA

5.7.5 Temperature channels

The table below shows information relevant to the measurement of instrument temperatures. The column "Power" indicates whether the relevant channel is part of the instrument HK or of the S/C HK. In the latter case temperature information would also be available when the instrument is in the OFF state.

Unit	Power		Location	Acronym	Sensor Type	Temp.Range	TM ref.
	S/C	Instr		(all TBC)		(all TBC)	
BOL1		X	200 μm array	AR1	TBD	0.2K>5K	TBD
BOL1		X	350 μm array	AR2	TBD	0.2K>5K	TBD
BOL1		X	500 μm array	AR3	TBD	0.2K>5K	TBD
BOL1		X	FTS array 1	AR4	TBD	0.2K>5K	TBD
BOL1		X	FTS array 2	AR5	TBD	0.2K>5K	TBD
BOL1	X		2K[1] box	TBD	TBD	1K>300K	TBD
BOL1	X		2K box	TBD	TBD	1K>300K	TBD
BOL1	X		4K box	TBD	TBD	3K>300K	TBD
BOL1	X		4K box	TBD	TBD	3K>300K	TBD
BOL1	X		15K box	TBD	TBD	3K>300K	TBD
BOL1	X		15K box	TBD	TBD	3K>300K	TBD
BOL1		X	FTS	FTS1	TBD	3K>300K	TBD
BOL1		X	FTS	FTS2	TBD	3K>300K	TBD
BOL1		X	FTS BB	FTSBB1	TBD	3K>300K	TBD
BOL1		X	FTS BB	FTSBB2	TBD	3K>300K	TBD
BOL1		X	Pump	P1	TBD	3K>300K	TBD
BOL1		X	Pump	P2	TBD	3K>300K	TBD
BOL1		X	Evaporator	E1	TBD	0.2K>5K	TBD
BOL1		X	Evaporator	E2	TBD	0.2K>5K	TBD
BOL1		X	Pump heat switch	PHS1	TBD	1K>50K	TBD
BOL1		X	Pump heat switch	PHS2	TBD	1K>50K	TBD
BOL1		X	Evap. heat switch	EHS1	TBD	1K>50K	TBD
BOL1		X	Evap. heat switch	EHS2	TBD	1K>50K	TBD
BOL1		X	Chopper (TBC)	CH1	TBD	3K>300K	TBD
BOL1		X	Chopper (TBC)	CH2	TBD	3K>300K	TBD

Total number of temperature sensors is 24.

5.8 OPTICAL INTERFACES

5.8.1 Straylight

Instrument straylight model TBD.

5.9 POWER

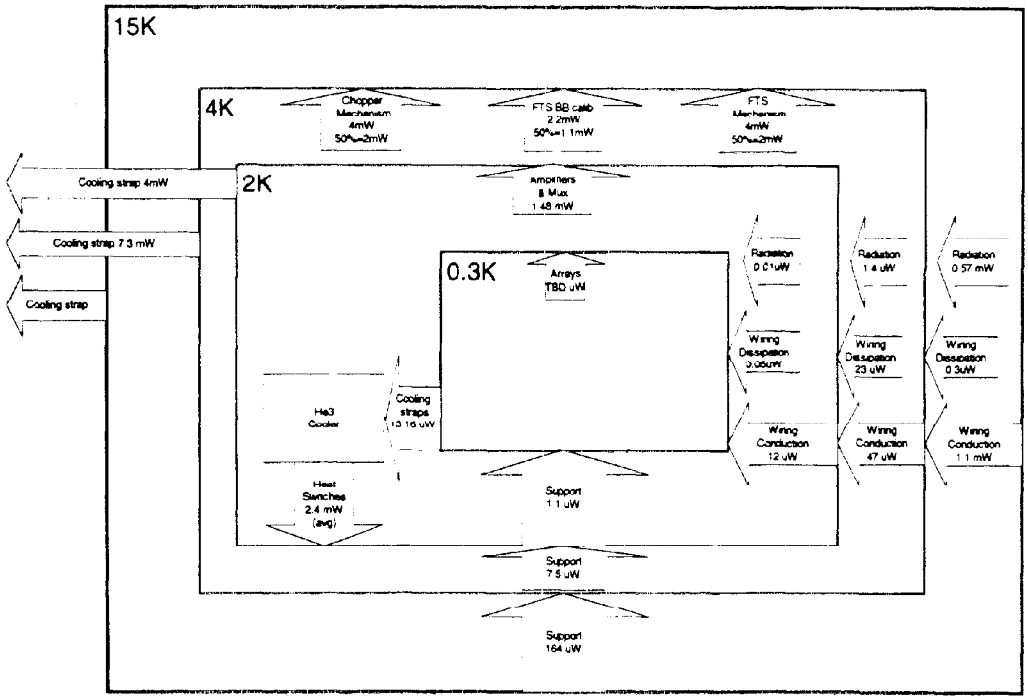
5.9.1 Inside cryostat

The tables and models below show the heat dissipation of the units mounted inside the cryostat:

Project code	Instrument unit	Power Dissipation
BOL1	Cold Focal Plane Unit	See Thermal Table and Thermal Model

[1] Note: we need to define names for the 2K, 4K and 15K boxes, as their actual temperatures may be different

5.9.1.1 Thermal model BOL1



BOL Thermal block diagram: CEA arrays

TBC

5.9.1.2 Thermal table BOL1

4 versions:

1) CEA array:

Temp. level (K)	"15 K" level (K)	Off (mW)	Primary (mW)	Standby (mW)	Serendipity (mW)
2	Any	2.4	4	4 ***	TBD
4*	10	0.6	6.1	2.1	TBD
	15	1.8	7.3	3.3	TBD
	20	4.2	9.6	5.6	TBD
15	10	0 **	0 **	0 **	TBD
	15	0 **	0 **	0 **	TBD
	20	0 **	0 **	0 **	TBD

2) GSFC1 array (SQUIDs at 2K):

Temp. level (K)	"15 K" level (K)	Off (mW)	Primary (mW)	Standby (mW)	Serendipity (mW)
2	Any	2.4	4	4 ***	TBD
4*	10	0.75	6.2	2.2	TBD
	15	2.1	7.6	3.6	TBD
	20	4.7	10.1	6.1	TBD
15	10	0 **	0 **	0 **	TBD
	15	0 **	0 **	0 **	TBD
	20	0 **	0 **	0 **	TBD

3) GSFC2 array (SQUIDs at 0.3K):

Temp. level (K)	"15 K" level (K)	Off (mW)	Primary (mW)	Standby (mW)	Serendipity (mW)
2	Any	2.4	4	4 ***	TBD
4*	10	0.75	6.2	2.2	TBD
	15	2.1	7.6	3.6	TBD
	20	4.7	10.1	6.1	TBD
15	10	0 **	0 **	0 **	TBD
	15	0 **	0 **	0 **	TBD
	20	0 **	0 **	0 **	TBD

4) Back-up array: (must now include chopper at 4K)

Temp. level (K)	"15 K" level (K)	Off (mW)	Primary (mW)	Standby (mW)	Serendipity (mW)
2	Any	2.4	3.8	3.8 ***	TBD
4*	10	0.63	6.1	2.1	TBD
	15	1.9	7.3	3.3	TBD
	20	4.7	9.5	5.5	TBD
15	10	6.8 **	7.2 **	7.2 **	TBD
	15	5.8 **	6.2 **	6.2 **	TBD
	20	4.5 **	4.9 **	4.9 **	TBD
30	15	182	268	268	TBD

* Note that 4 K heatloads depend on 15 K level.
** Excludes conductive and dissipative heatloads from cryo harness connecting to 300K level
*** Includes average dissipation of ^{3}He refrigerator

5.9.2 Outside cryostat

NA

5.9.3 On SVM

The table below shows the heat dissipation of the units mounted on the SVM:

Project code	Instrument unit	Power dissipation (W)
BOL2	Warm electronics (mechanisms and ^{3}He fridge)	10 (TBC)
BOL3	Warm electronics (science + housekeeping data)	10 (TBC)
BOL4	Digital Processing Unit	10 (TBC)
BOL5	"Warm" Interconnect Harness	
TOTAL		30 (TBC)

5.9.4 On PLANCK module
NA

5.9.5 Instrument Operating Modes

The table below shows the status of the instrument subsystems in the various instrument modes:

Unit	Subsystem	Off	Primary	Standby
BOL 1	Read-out Cooler Chopper FTS Mechanism	**OFF** **ON** **OFF** **OFF**	**ON** **ON** **ON** **ON**	**ON** **ON** **OFF** **OFF**
BOL 2	Mechanism drive Electronics	**OFF**	**ON**	**ON**
BOL 3	Read-out electronics	**OFF**	**ON**	**ON**
BOL 4	Digital Electronics	**OFF**	**ON**	**ON**

5.9.6 Load on main-bus

The power load on the 28-V main bus for this instrument is as follows:

Operating mode	Average BOL (beginning of life) (W)	Average EOL (end of life)(W)	Peak (W)
Primary mode	TBD	TBD	TBD
Parallel/Serendipity mode	TBD	TBD	NA (Why?)
Stand-by mode	TBD	TBD	NA (Why?)

5.9.7 Keep Alive Line (KAL)

TBD

5.9.8 Interface circuits

TBD

5.10 CONNECTORS, HARNESS, GROUNDING, BONDING

5.10.1 Connectors

TBD

5.10.2 Harness

5.10.2.1 S/C Harness

The S/C harness provides the interconnection between the instrument and two other subsystems i.e. the Power subsystem and the Datahandling subsystem. The harness is supplied through the S/C Contractor. On the instrument side, pin functions are specified in Annex A to this document.

5.10.2.2 Instrument Harness

The "warm" harness (i.e., the interconnect harness between the various "warm" instrument units) will be delivered by the instrument teams, manufactured to agreed requirements as specified in the IID-A under item 5.10.2.2. Pin functions and wiring characteristics are specified in Annex A to this document. The Contractor will specify length and routing as soon as an SVM lay-out is available. A Configuration Drawing will be included under item 5.4

5.10.2.3 Cryo-harness

The cryo-harness, interconnecting the 15- to 300-K instrument parts, will be delivered through the S/C Contractor, manufactured to agreed requirements. The cryo harness interconnecting the 4- to 15-K instrument parts is considered part of the instrument and therefore to be manufactured by the instrument teams. Pin functions are specified in Annex A to this document.

The block diagram and the tables below show the cryo harness composition both for the 4 to 15 K and the 15 to 300 K interfaces.

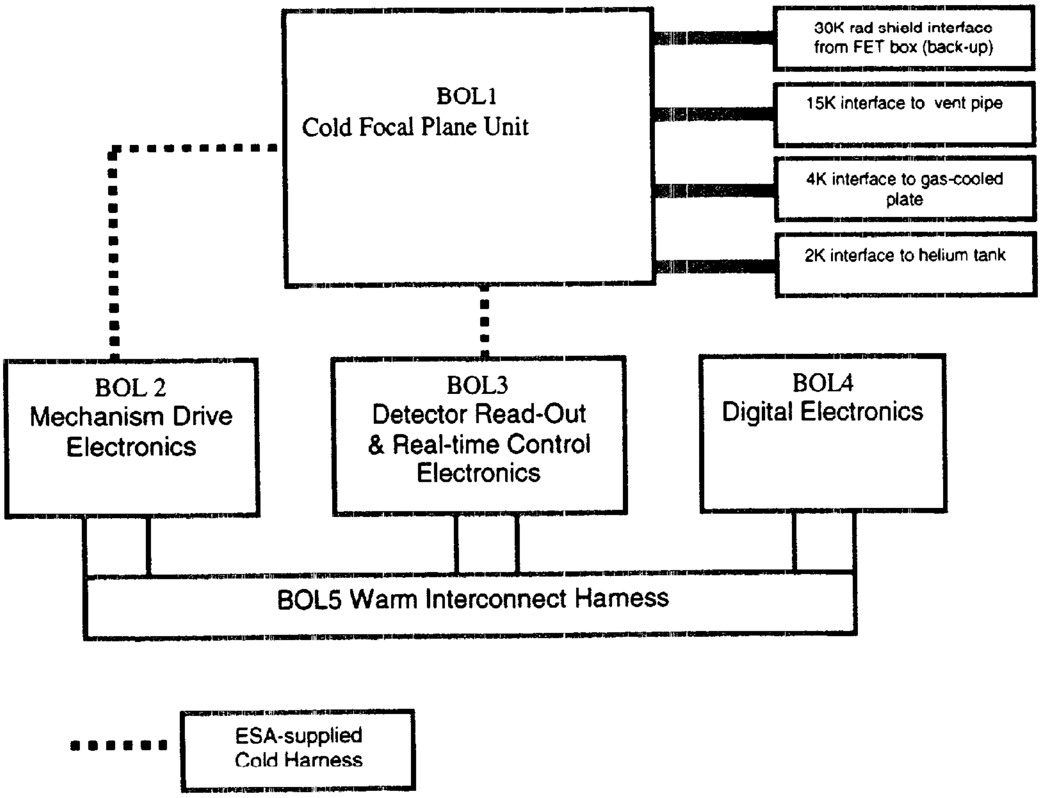


Figure 3 BOL Block Diagram (needs interface cable Ids as in draft 4 IID-B)

BOL cryo-harness list for 15 K-300 K interface level (CEA option)

ID	Instrument: BOL 15-K to 300-K interface Signal definition	Name	No. of Cond.	No. of shields	Max. allowed Res. (Ω)	Current (A)	Duty Cycle (t*T)	Max. Line Volt (V)	Remarks
1	Det. signals	Bols	431	43	**TBD**	**1.0E-0.9**	1	TBD	SST AWG38
2	0.3-K therms. (5)	TH-300	20	5	1000	1.0E-5	1	TBD	SST AWG38
3	2-K therms (2)	TH-2	8	2	1000	1.0E-5	1	TBD	SST AWG38
4	4-K therms (2)	TH-4	8	2	1000	1.0E-5	1	TBD	SST AWG38
5	15-K therms (2)	TH-15	8	2	1000	1.0E-5	1	TBD	SST AWG38
6	FTS temp sensors	F_Temp	8	2	1000	1.0E-5	1	TBD	SST AWG38
7	FTS posn sensors (main)	F_Posn_M	5	1	1000	1.0E-4	0.5	TBD	SST AWG38
8	FTS posn sensors (red)	F_Posn_R	5	1	1000	0.0E+0	1	TBD	SST AWG38
9	FTS drive coils (main)	F_Drive_M	4	0 TBC	10 TBC	8.0E-3	0.5	TBD	Br. AWG38
10	FTS drive coils (red.)	F_Drive_R	4	0 TBC	10 TBC	0.0E+0	0	TBD	Br. AWG38
11	FTS BB calibrator (main)	F_BBC_M	2	0 TBC	10 TBC	3.0E-3	0.5	TBD	Br. AWG38
12	FTS BB calibrator (red.)	F_BBC_R	2	0 TBC	10 TBC	0.0E+0	0	TBD	Br. AWG38
13	FTS BB therms (2)	F_BBC_T	8	2	1000	1.0E-5	1	TBD	SST AWG38
14	Pump heater (main)	PH_M	2	0	10 TBC	1.4E-2	0.014	TBD	Br. AWG38
15	Pump heater (red.)	PH_R	2	0	10 TBC	0.0E+0	0	TBD	Br. AWG38
16	Pump therm. (main)	PT_M	4	1	1000	1.0E-5	1	TBD	SST AWG38
17	Pump therm. (red.)	PT_R	4	1	1000	1.0E-5	1	TBD	SST AWG38
18	Evap. therm. (main)	ET_M	4	1	1000	1.0E-5	1	TBD	SST AWG38
19	Evap. therm. (red.)	ET_R	4	1	1000	1.0E-5	1	TBD	SST AWG38
20	Pump heat SW heater (main)	PHSWH_M	2	0	10 TBC	2.0E-3	0.96	TBD	Br. AWG38
21	Pump heat SW heater (red.)	PHSWH_R	2	0	10 TBC	0.0E+0	0	TBD	Br. AWG38
22	Evap. heat SW heater (main)	EHSWH_M	2	0	10 TBC	2.0E-3	0.04	TBD	Br. AWG38
23	Evap. heat SW heater (red.)	EHSWH_R	2	0	10 TBC	0.0E+0	0	TBD	Br. AWG38
24	Pump heat SW therm. (main)	PHSWT_M	4	1	1000	1.0E-5	1	TBD	SST AWG38
25	Pump heat SW therm. (red.)	PHSWT_R	4	1	1000	1.0E-5	1	TBD	SST AWG38
26	Evap. heat SW therm. (main)	EHSWT_M	4	1	1000	1.0E-5	1	TBD	SST AWG38
27	Evap. heat SW therm. (red.)	EHSWT_R	4	1	1000	1.0E-5	1	TBD	SST AWG38
28	Chopper drive coil (main)	CH_DR_M	4	1	10 TBC	2.5E-3	0.5	TBD	Br. AWG38
29	Chopper drive coil (red.)	CH_DR_R	4	1	10 TBC	0	0	TBD	Br. AWG38
30	Chopper pick-up coil (main)	CH_PU_M	5	1	1000	1E-3	0.5	TBD	SST AWG38
31	Chopper pick-up coil (red.)	CH_PU_R	5	1	1000	0.0E+0	0	TBD	SST AWG38
32	Chopper them (main)	CH_T_M	4	1	1000	1.0E-5	1	TBD	SST AWG38
33	Chopper them (red.)	CH_T_R	4	1	1000	1.0E-5	1	TBD	SST AWG38
34	Phot BB Calibrator (main)	P_BBC_M	2	0 TBC	10 TBC	3.0E-3	0.5	TBD	Br. AWG38
35	Phot BB Calibrator (red.)	P_BBC_R	2	0 TBC	10 TBC	0.0E+0	0	TBD	Br. AWG38
36	Phot BB therms (2)	P_BBC_T	8	2	1000	1.0E-5	1	TBD	SST AWG38
	Total		?	?	?	?			

Notes: Allowed resistance values are at "operational temperatures"
In column "Duty cycle", t = part of T in which signal is active.
T = time for which BOL is in Primary mode.
Harness definition for 4-K to 15 K is identical with the following exceptions:
(i) Item 5 in the above table does not apply

5.10.3 Grounding

TBD

5.10.4 Bonding

TBD

5.11 DATA HANDLING

5.11.1 Telemetry rate

The instrument produced 'raw' housekeeping and science data rates (before compression), given for information purposes only, are as follows:

Description	Telemetry rate (kbs)
Housekeeping data rate	2 (TBC) *
Science data rate: photometer only	46 (TBC)
Science data rate: spectrometer only	180 (TBC)
Science data rate: in partner mode with PHC	16 (TBC)
Science data rate: serendipity mode	TBD

The resultant housekeeping and science data rate requirements for TM/storage are as follows:

Housekeeping data rate	2 Kbps *
All science data rates	To be made compatible with overall available S/C resources through suitable compression, presently a factor 2 for photometer modes and 3 for spectrometer (TBC), resulting in 23, 60 and 8 Kbps respectively.

* Housekeeping data shall not be compressed.

5.11.2 Timing and synchronisation signals

TBD

5.11.3 Telecommand

TBD

5.11.4 Interface circuits

TBD

5.12 ATTITUDE AND ORBIT CONTROL/POINTING

5.12.1 Attitude and orbit control

TBD

5.12.2 Pointing

TBD

5.12.3 On-target-flag (OTF)

TBD

5.13 ON-BOARD HARDWARE/SOFTWARE AND AUTONOMY FUNCTIONS

5.13.1 On-board hardware

TBD

5.13.2 On-board software

TBD

5.13.3 Autonomy functions

TBD

5.14 EMC

5.14.1 Conducted Emission/Susceptibility

TBD

5.14.2 Radiated Emission/Susceptibility

TBD

5.14.3 Frequency Plan

TBD

5.15 TRANSPORT AND HANDLING PROVISIONS

5.15.1 Mechanism positions

For reasons of possible damage caused by vibration during transport. environmental testing and launch, mechanisms shall be placed in the TBD position. This position is shown in Table TBD.

5.16 DELIVERABLE ITEMS

5.16.1 Instrument Models

5.16.2 Electrical Ground Support Equipment (EGSE)

5.16.3 Mechanical Ground Support Equipment (MGSE)

5.16.4 Optical Ground Support Equipment (OGSE)

5.16.5 System Test Software

5.16.6 Hardware for the Observatory Ground Segment

5.16.7 Software for the Observatory Ground Segment

5.16.8 Instrument Software Simulator

5.16.9 Test Reference Data

5.16.10 Instrument Characterisation Data

5.16.11 Technical Documentation

Telemetry rates for FIRST BOL options

Colin Cunningham ***December 31, 1997***

1. Introduction

Telemetry rates are severely limited by the need to transmit stored data to ground in 2 hour blocks. Maximum allowable data rate to S/C mass memory is of the order of 50 kbps.

2. Photometer

Assumptions:

Data word length:

$\text{Data\_word} := 16$

Number of imager bolometers:

$n_{im} := 32\cdot 32 + 24\cdot 24 + 16\cdot 16$

$n_{im} = 1856$

Frame frequency (photometer):

$f_{ch} = 1\cdot \text{Hz}$

Assuming imager/phot data is pre-processed to give image frames at this frequency, including demodulation and spike removal, but with no data compression:

Number of operating parameter channels to measure position of chopper or FTS mechanism:

$n_{op} := 10$ (TBD)

but these cannot be read as slowly as the bolometers - because we need time-resolved data on the chopper & FTS mechanism drives

Sampling rate for operating parameters:

$f_{op} := 100\,\text{Hz}$

Data word size for operating parameters:

$\text{op\_word} := 16$ (TBD)

Science data rate (imager/photometer):

$\text{Data}_{phot} := n_{im}\cdot \text{Data\_word}\cdot f_{ch} + n_{op}\cdot f_{op}\cdot \text{op\_word}$

$\text{Data}_{phot} = 45.7\cdot \text{Kbps}$

Note that it would be possible to transmit a subset of these data (for instance in a partner mode with PHOC) by either limiting the wavelength coverage to one or two arrays, data compression, or limiting the field of view transmitted. It will probably not be possible to read-out a subset of an array, but it will be possible to only transmit a subset. This will be important for testing spike removal algorithms, where it will be necessary to transmit raw data from a few pixels collected at a sampling rate of around 100Hz. Compression of a factor 2 can be assumed.

Partner mode could probably operate at a factor 3 lower data rate:

$\text{Data}_{part} = 16\ \text{Kbps}$

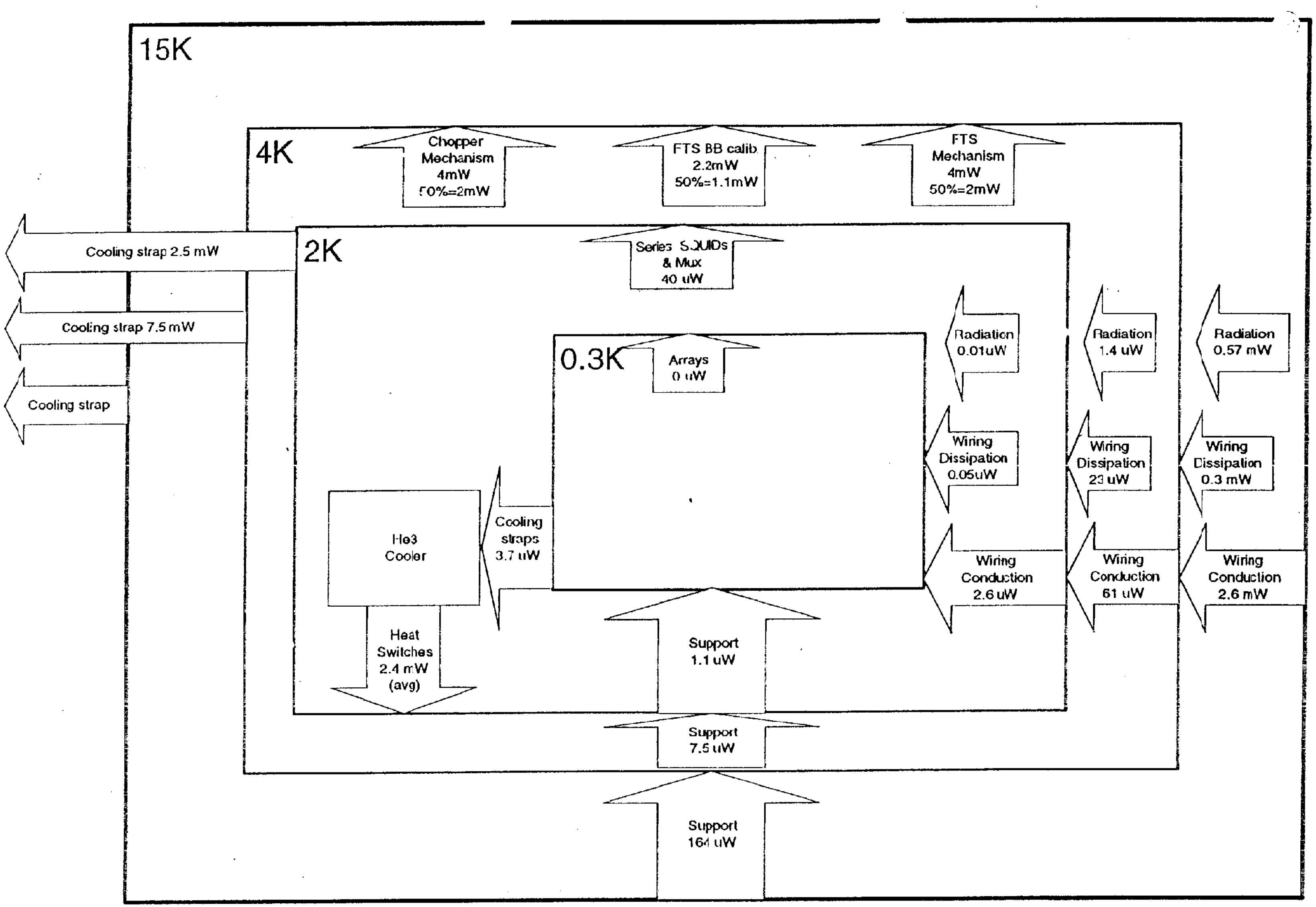
BOL CONSORTIUM MEETING

FIRENZE, 8/9 Jan. 1998

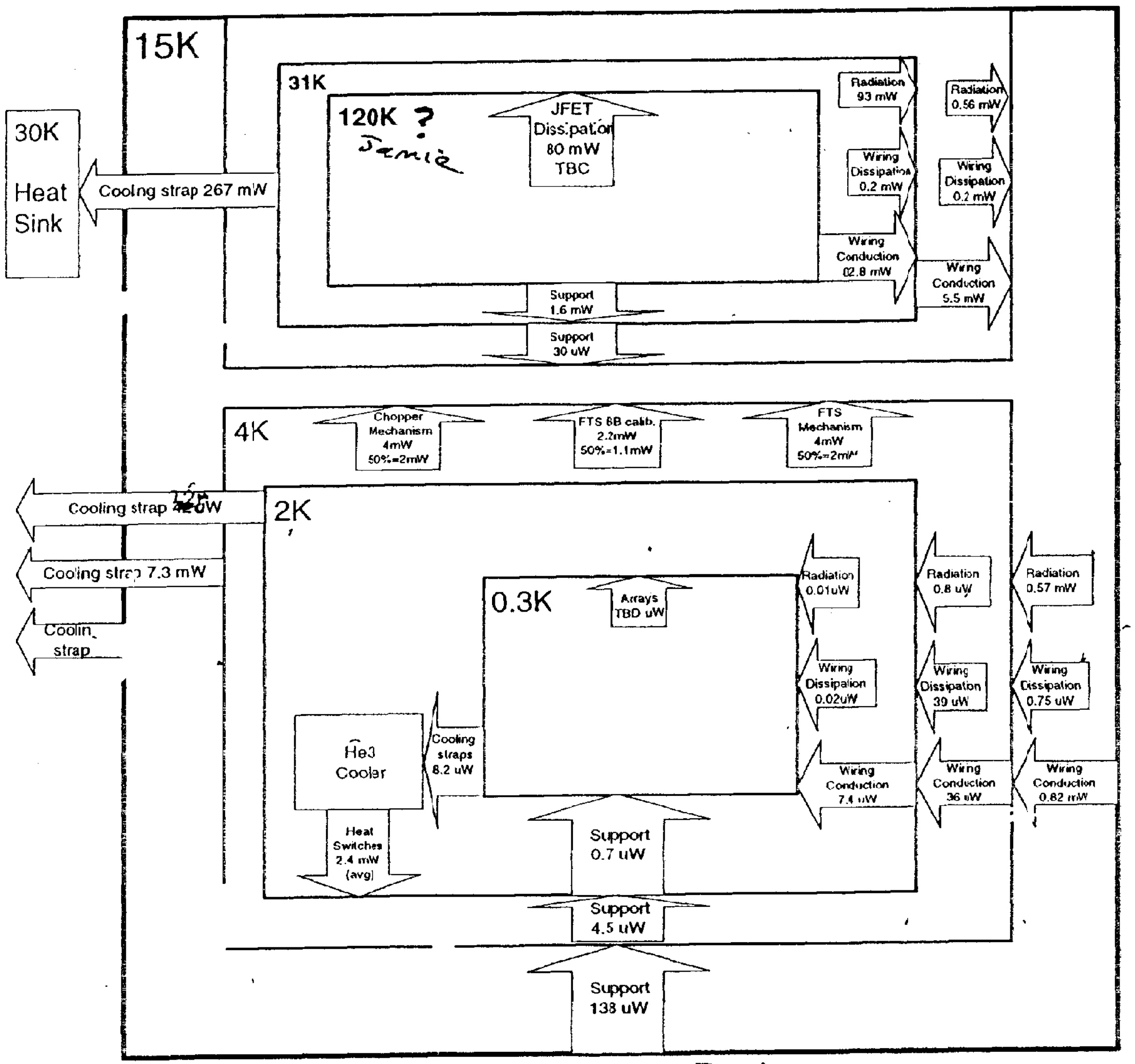
(part II)

ACTIONS ARISING FROM IID-B MEETING

* LOUIS ROD. PROVIDE NUMBER FOR THE MINIMUM VOLTAGE CORRESPONDING TO 1 BIT ON THE ADC FROM THE CRE
* MATT ✓ DETERMINE WHO WILL BE RESPONSIBLE FOR HARNESS
* FRASER MASS ESTIMATE FOR BACKUP OPTION
* LOUIS ROD PROVIDE DETAILS OF INTERFACE BOX (MASS, POWER, SIZE) BOL2
* JOSÉ-MIGUEL PROVIDE DETAILS OF "SPU" BOX (MASS, POWER, SIZE TEMPERATURES ..)
* LOUIS ROD UPDATE FIGURES FOR ANALOGUE ELECTRONICS (MASS POWER, SIZE ...) BOL3
* CRC UPDATE BLOCK DIAGRAM + CABELLING
* KJK PA PLAN
* BMS IDENTIFY WHO IS RESPONSIBLE FOR MGSE + OGSE.
* TIM SUMNER WRITE SECTION ON EGSE
* BMS WRITE PARA ON AIU
* KJK " " " COMMONALITY
* BMS UPDATE PRODUCT TREE
* WKF OLIVER WRITE PARA ON INTERNAL INTERFACE CONTROL
* KJK PROVIDE SCHEDULE



BOL Thermal block diagram: GSFC1 arrays V1.0 Date: 23/12/97



BOL Thermal block diagram: Back-up V1.0 Date: 29/12/97

Thermometers:

Unit	Power		Location	Acronym	Sensor Type	Temp.Range	TM ref.
	S/C	Instr		(all TBC)		(all TBC)	
BOL1		X	200 µm array	AR1	TBD	0.2K>5K	TBD
BOL1		X	350 µm array	AR2	TBD	0.2K>5K	TBD
BOL1		X	500 µm array	AR3	TBD	0.2K>5K	TBD
BOL1		X	FTS array 1	AR4	TBD	0.2K>5K	TBD
BOL1		X	FTS array 2	AR5	TBD	0.2K>5K	TBD
BOL1	X		2K[1] box	TBD	TBD	1K>300K	TBD
BOL1	X		2K box	TBD	TBD	1K>300K	TBD
BOL1	X		4K box	TBD	TBD	3K>300K	TBD
BOL1	X		4K box	TBD	TBD	3K>300K	TBD
BOL1	X		15K box	TBD	TBD	3K>300K	TBD
BOL1	X		15K box	TBD	TBD	3K>300K	TBD
BOL1		X	FTS	FTS1	TBD	3K>300K	TBD
BOL1		X	FTS	FTS2	TBD	3K>300K	TBD
BOL1		X	FTS BB	FTSBB1	TBD	3K>300K	TBD
BOL1		X	FTS BB	FTSBB2	TBD	3K>300K	TBD
BOL1		X	Pump	P1	TBD	3K>300K	TBD
BOL1		X	Pump	P2	TBD	3K>300K	TBD
BOL1		X	Evaporator	E1	TBD	0.2K>5K	TBD
BOL1		X	Evaporator	E2	TBD	0.2K>5K	TBD
BOL1		X	Pump heat switch	PHS1	TBD	1K>50K	TBD
BOL1		X	Pump heat switch	PHS2	TBD	1K>50K	TBD
BOL1		X	Evap. heat switch	EHS1	TBD	1K>50K	TBD
BOL1		X	Evap. heat switch	EHS2	TBD	1K>50K	TBD
BOL1		X	Chopper (TBC)	CH1	TBD	3K>300K	TBD
BOL1		X	Chopper (TBC)	CH2	TBD	3K>300K	TBD

Total number of temperature sensors is 24.

[1] Note: we need to define names for the 2K, 4K and 15K boxes, as their actual temperatures may be different

5.11 DATA HANDLING

5.11.1 Telemetry rate

The instrument produced 'raw' housekeeping and science data rates (before compression), given for information purposes only, are as follows:

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Science data rate: in partner mode with PHC	16 (TBC)
Science data rate: serendipity mode	TBD

The resultant housekeeping and science data rate requirements for TM/storage are as follows:

Housekeeping data rate	2 Kbps *
All science data rates	To be made compatible with overall available S/C resources through suitable compression, presently a factor 2 for photometer modes and 3 for spectrometer (TBC), resulting in 23, 60 and 8 Kbps respectively.

* Housekeeping data shall not be compressed.

Section 7 Integration, Testing and Operations

7.1 Integration Bruce

Status: see test plan – how much to put in IID-B?

7.2 Testing Bruce

Status: see test plan – how much to put in IID-B?

7.3 Operations

Status: ? Ken

7.4 Commonality

Status: ? Ken

Section 8 Product Assurance

Status: Refer to document ?? being prepared by Ken

Ken

Section 9 Development and Verification

Status: Part A not yet complete. Bruce has draft plan

WE WILL COMPLY FULLY WITH A Bruce

Section 10 Management Programme, Schedule

10.3.2 Product Tree

Status: done ~~Bruce~~ UPDATE

WBS

Status: ? Ken

10.4.1 Master schedule

Status: ? Ken

10.6.1 Instrument Internal Configuration control *Status: none!* ~~Colin~~ WILF

5.10.3 Grounding

Status: Basic principles need stating eg single point ground, isolated interfaces both electrical and thermal Colin/Laurent

5.10.4 Bonding

Status: Basic principle needs stating, eg single bond to ~~optical bench~~? S/C PSU Colin/Laurent

Section 5.11 Data Handling

5.11.1 Telemetry Rate

Status: for discussion 40kbps Colin

Sections 5.11.2 > 5.12.3

Status: Can we leave these TBD? → SYS TECH INPUT

5.13

Section 5.14 EMC

Status: none! Some principles and ground rules need spelling out, including test plan for section 9.7

Colin/Laurent

Section 6 Ground Support Equipment

6.1 MGSE

Status: not started? TBD Bruce

6.2 EGSE

Status: ? TIMESHARED Bruce

6.? OGSE

Status: not in IID-A or B! Bruce

6.3 Commonality

Status: report from meeting in Paris? Ken

5.7 Thermal Interfaces

5.7.3 On SVM

Status: confirmation of max & min temperatures of
BOL2 & 3 needed — Laurent
BOL 4 complete — Renato

5.8 Optical Interfaces

5.8.1 Straylight Model

Status: TBC — Martin

5.9 Power

5.9.1 Inside Cryostat

5.9.1.2 Thermal table

Status: done (checked?) — Bruno/Colin

5.9.3 On SVM

Status: BOL2, BOL3 not done — Laurent
BOL 4 done — Renato

5.9.5 Load on main-bus

Status: BOL2, BOL3 TBD — Laurent
BOL 4 TBD — Renato

5.10 Connectors, Harness, Grounding, Bonding

5.10.2.1 S/C Harness

Status: TBD — Laurent/Renato

5.10.2.3 Cryo-harness

Status: done — Bruno
Block diagram done — Colin

BOL IID-B for AO response

Florence Jan 98 Colin Cunningham

4 Instrument Description — Matt & Bruce
Status: Complete

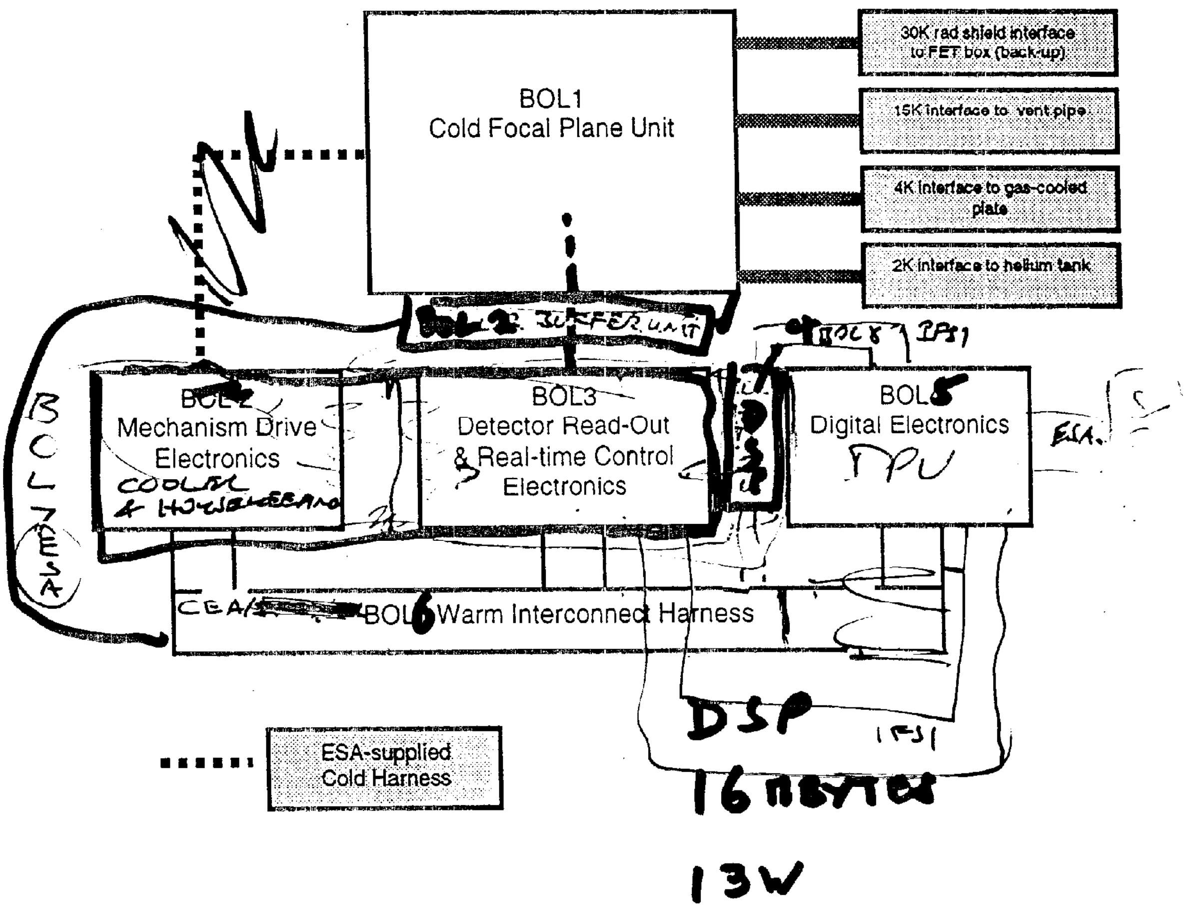
5.3 FPU location and alignment — Wilfred
Status: Figures 1 & 2 require update

5.4 External Configuration Drawings
Status: Mech. drawing ~~complete~~ TBC — Wilfred
Electrical drawing: TBD — Laurent

5.5 Sizes and Mass Properties
Status: BOL1 done + BACK UP — Fraser
BOL 2 BUFFER *BOL2 (~~Warm elec.~~) incomplete* — Laurent
BOL3 (Warm elec.) incomplete — Laurent
BOL4 (3PU) done 4 kg ? 14W — Renato
5 DPU — JOSE
6 INTERCONNECT 160 5kg

5.6 Mechanical Interfaces
5.6.1 Inside cryostat
Status: complete (6 fixing points) — Wilfred

5.7 Thermal Interfaces
5.7.1 Inside Cryostat — Colin
Status: Extra interface for JFET box
Positions of heat straps defined, but need description



BOL1
Cold Focal Plane Unit
30K rad shield interface to FET box (back-up)
15K interface to vent pipe
4K interface to gas-cooled plate
2K interface to helium tank
BUFFER UNIT
Mechanism Drive Electronics
BOL3
Detector Read-Out & Real-time Control Electronics
Digital Electronics
DPU
ESA
Warm Interconnect Harness
ESA-supplied Cold Harness
DSP
13W

IID-B completed:

- Instrument Description
- Thermal designs
- Mass — BACK UP FEED HORNS # JFET BOX
- Mechanical Interfaces
- Thermal Interfaces
- Wiring details
- Test plan → IID SUMMARY IN SECTION (2)

COLIN
BRUNO
FRASER
WILF
PETER
BRUCE
LUIS
CARLA
JEAN-LUC

IID-B more needed:

- ELI — Agree data rate for FTS
- JOSÉ
- ERULLI — EMC plan & testing
- OMINIQUE
- CJETIL — Back-up JFET module
- Block diagrams for warm electronics
- Power budgets for warm electronics
- Management plan — SCHEDULE ✓ ⇒ CRC; WBS ✓; PRODUCT TREE ✓
- Straylight model
  ↳ REFER TO DOCUMENT.

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Technical Description for AO Response

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MUST BE → WILL BE.

Technical Description - detailed comments

2.1. Overview

100% (FINAL SENSITIVITY FIGURES)

2.2. Instrument description

2.2.1 Cold Focal Plane Unit

2.2.1.1 Photometer

100%

effect

FCAL. SOURCE

* SPECIAL → ESPECIAL
'WILL BE'

→ IMAGE QUALITY

2.2.1.2 Spectrometer

" DIAGRAM OF OPTICAL PATH
→ PRECISION MEASUREMENTS OF CUDT PERFORMANCE IN HAND* → BEING INVESTIGATED,
→ 0.2µm ACHIEVED ×2 REQUIRED.
/EXISTING, FOR EXAMPLE,

CALIBRATION SOURCES MISSING.

2.2.1.3 Common elements

DIAGRAMS OF IFA + SPUD DETECTORS
" " SQUID READOUTS } ELECTRONIC

[CFRP] CRFP

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Technical Description - detailed comments

2.2.2 Warm electronics

ANALOGUE ELECTRONICS → NO INPUT YET

2.3. Instrument operating modes and AOTs.

O.K (?)

2.3.1 Photometer

2.3.2 Spectrometer

2.4. Scientific performance

NO INPUT YET

2.5. Compatibility with IID-A

NOT WRITTEN

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Technical Description - detailed comments

2.5.1 Fail-safe elements, redundancy, reliability, back-up modes etc.

DITTO

2.5.2 Use of space-qualified hardware

DITTO

2.5.3 EMC

DITTO

2.6. Array development and back up option for focal plane

2.6.1 Detector array development

HAVE INPUT - NOT WRITTEN UP YET

2.6.2 Back up option

NO INPUT

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Review of Technical Input

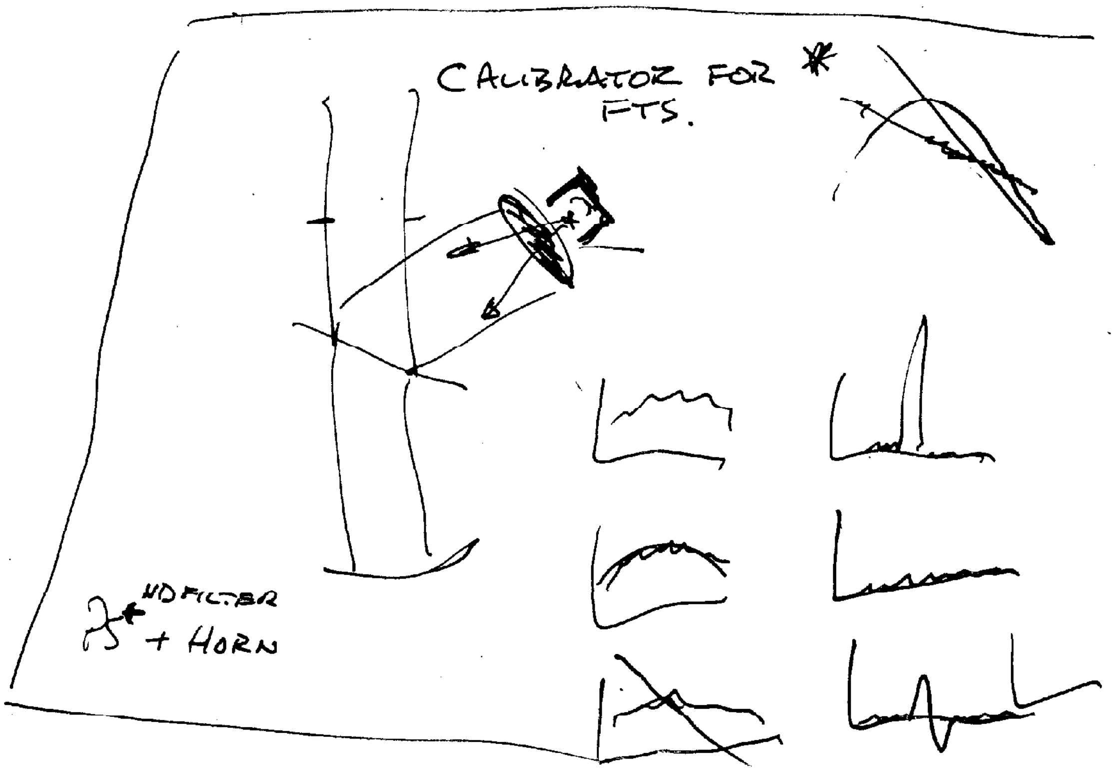
i) Analogue Electronics. ✓
iA) DCU ✓
ii) Calibrators - on-board ✓

iii) Test Programme - AW flow ✓

iv) Calibration - ✓

v) Section/section {Detailed Comments on each. ✓

vi) Mathcad models of Performance [Matt].
vii) Backup option. ✓



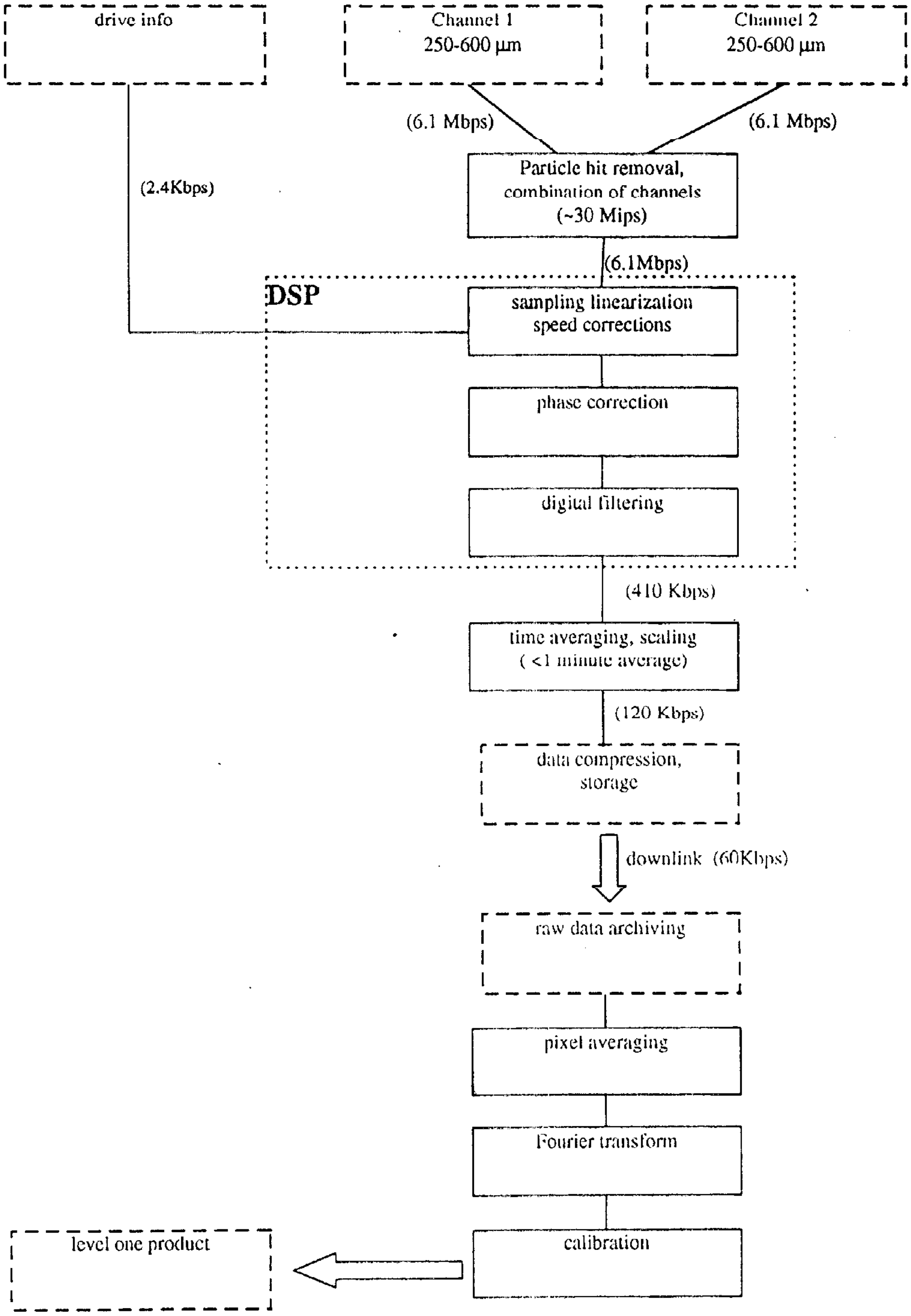
FTS SAMPLING AND DATA PROCESSING REQUIREMENTS

- NEED CREDIBLE SCHEME FOR AO

- NEED TO IDENTIFY CHANGES TO H/W BASELINE

  - ARRAY SIZE (16x16 ; 12x12)
    ⇒ 2 OFF 16x16 SPATIALLY OVERLAPPING
  - REDUNDANCY (NONE)
    ⇒ YES
  - WAVELENGTH COVERAGE (200µm - 400µm)
    ⇒ 200µm → ∞
  - MECHANICAL POSITION READOUT ACCURACY (0.1µ
  - DATA RATE / STORAGE
  - ONBOARD PROCESSING

Proposed Data Processing Schematic

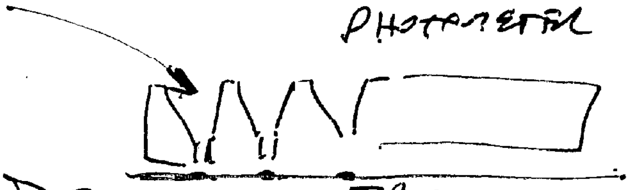


FOCAL PLANE

WINSTON CONES? Fλ or 2Fλ

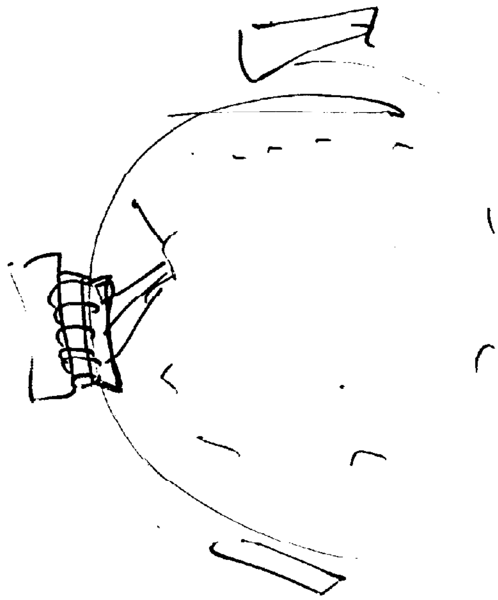
PHOTOMETER FTS?

19 horns & 37 horns.



① DRAWING FROM JAMIE / P. ADE

PHIL?

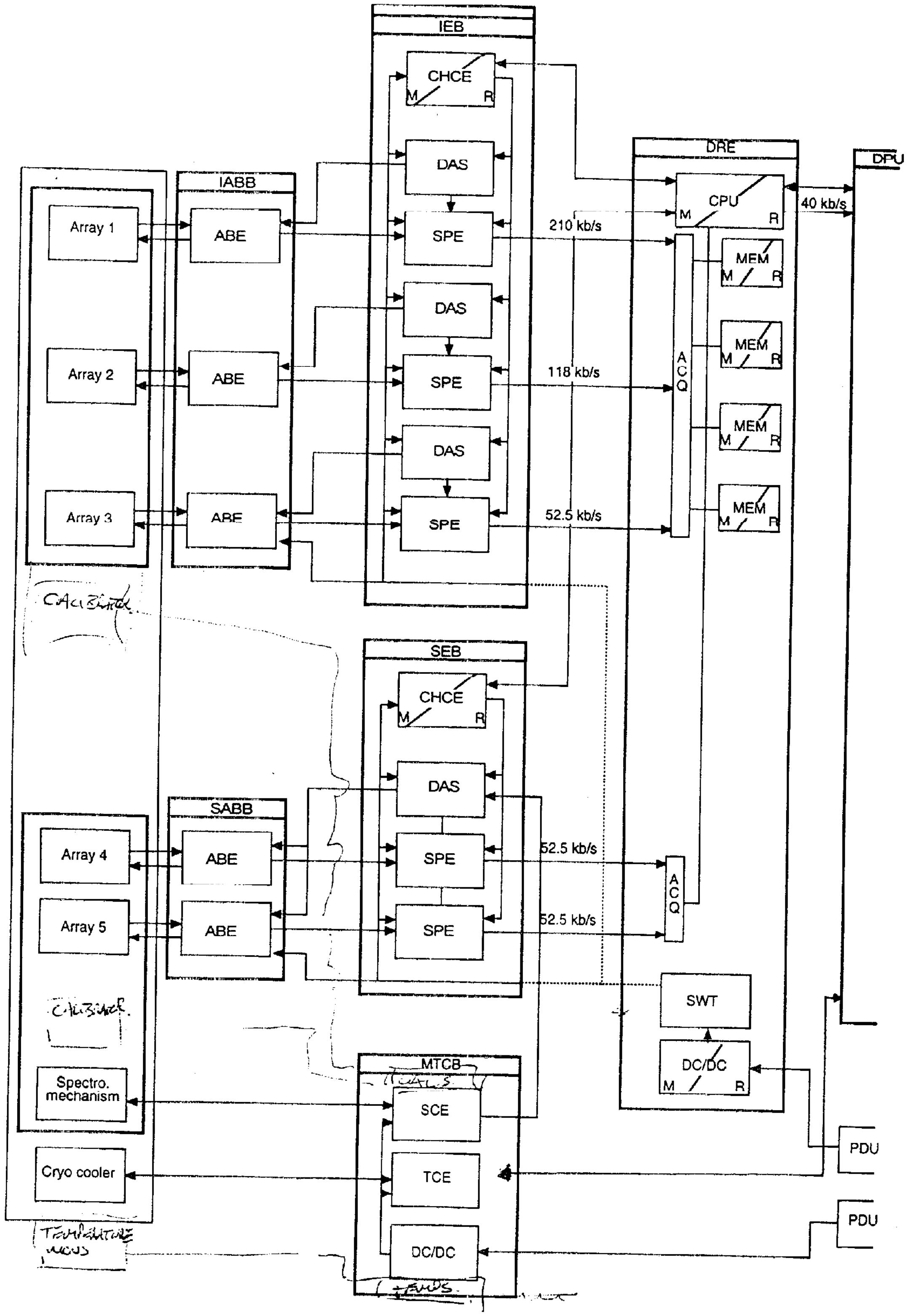


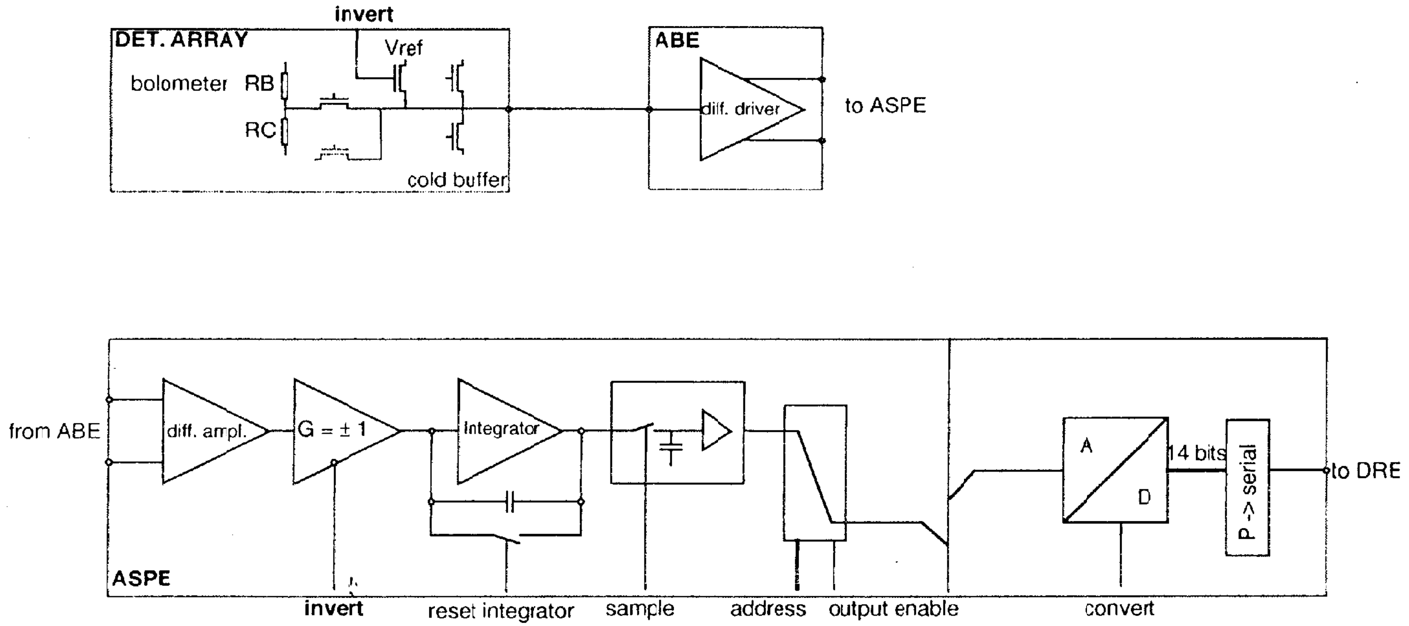
② MASS ESTIMATES P.ADE

③ BLOCK DIAGRAM
BRUCE

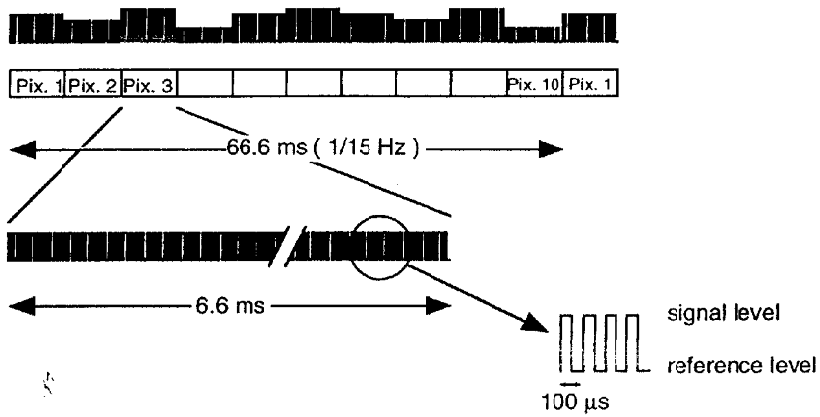
④ NUMBER OF DETECTORS
IN FTS 19 & 37?

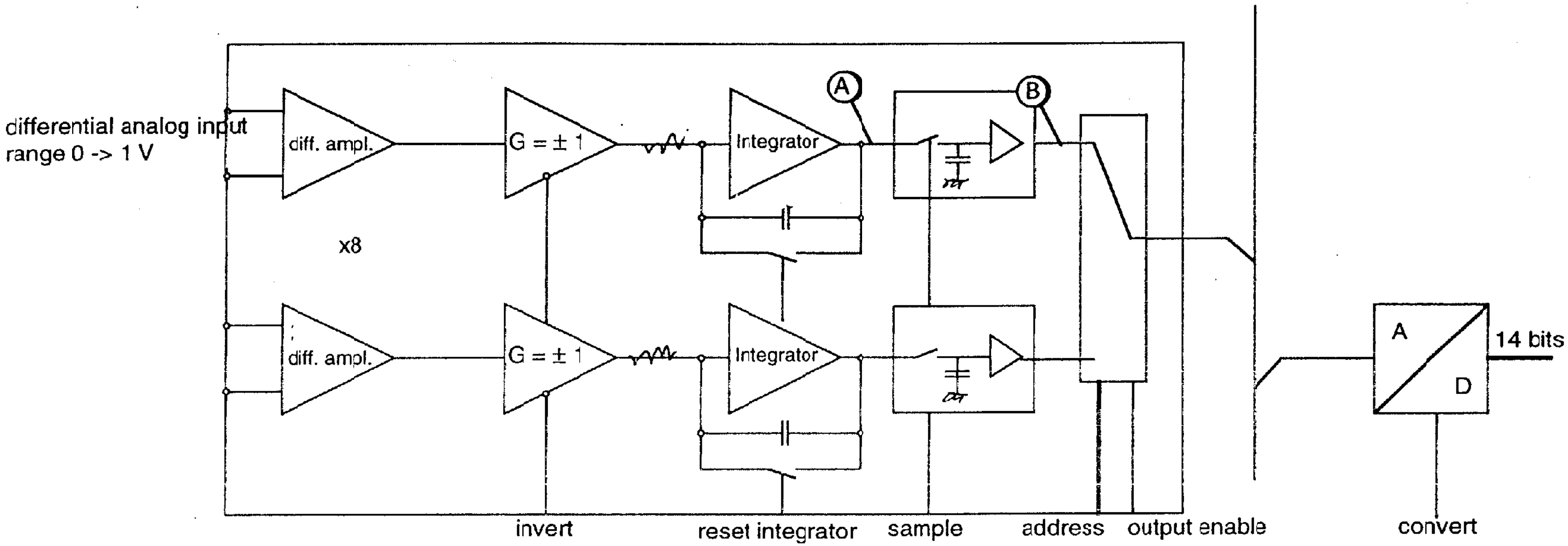
MATT.

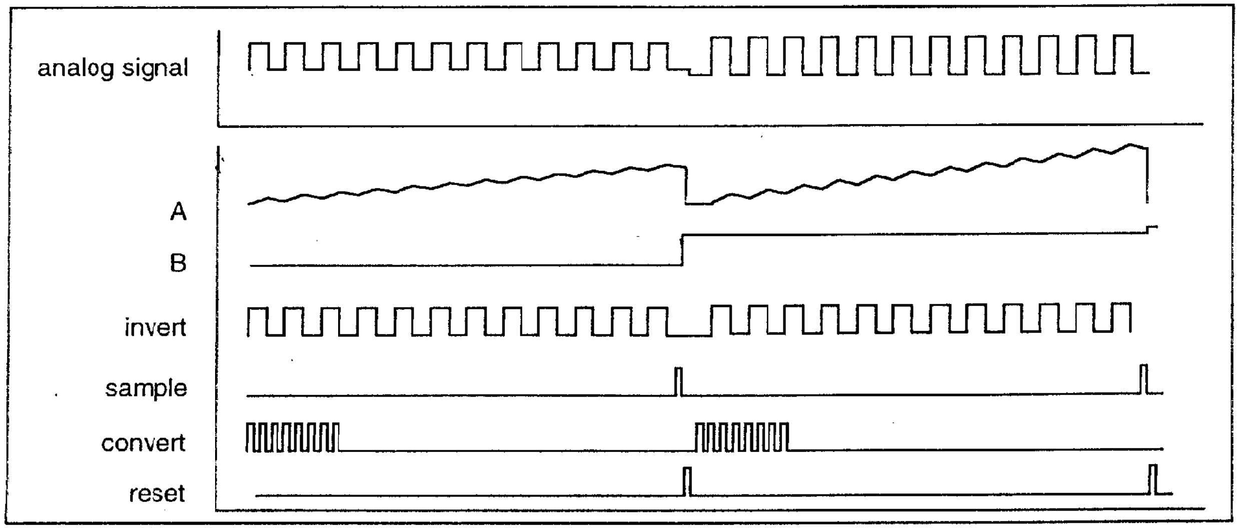

IEB
CHCE
M
R
DAS
SPE
DAS
SPE
DAS
SPE
210 kb/s
118 kb/s
52.5 kb/s
DRE
CPU
M
R
40 kb/s
DPU
MEM
MEM
MEM
MEM
ACQ
IABB
ABE
ABE
ABE
Array 1
Array 2
Array 3
SEB
CHCE
DAS
SPE
SPE
52.5 kb/s
52.5 kb/s
ACQ
SABB
ABE
ABE
Array 4
Array 5
SWT
DC/DC
Spectro. mechanism
Cryo cooler
MTCB
SCE
TCE
DC/DC
PDU
PDU



differertial analog input
range 0 -> 1 V


Pix. 1
Pix. 2
Pix. 3
Pix. 10
Pix. 1
66.6 ms (1/15 Hz)
6.6 ms
signal level
reference level
100 µs


differential analog input
range 0 -> 1 V
diff. ampl.
diff. ampl.
x8
G = ± 1
G = ± 1
Integrator
Integrator
A
B
A
D
14 bits
invert
reset integrator
sample
address
output enable
convert


analog signal
A
B
invert
sample
convert
reset

Box dimension (cm)	Power consumption (W)	Mass (kg)
• Imager Analog Buffer Box 172x172x90	3	3
• Imager Electronics Box 256x180x234 (288 analog chains)	49	10
• Spectro. Analog Buffer Box 165x105x40	1	1
• Spectro. Electronics Box 256x100x234 (64 analog chains)	16	6
• DataReduction Electronics 288x257x234	7 (Imager) 11 (Spectro)	15
• Mech. & Thermal Control Box 256x100x234	?	6
• Total Imager (including 0.85 DC/DC efficiency)	70 W (59)	
• Total Spectrometer	33 W (28)	

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Flight Operations Concept

What I think we have to do/write in the AO response.....

- Define the operations modes.....not just astronomical but engineering, commissioning, calibration etc, etc.
- Define the requirements these set on spacecraft operations - as best we can.
- Decide how we are going to deal with "autonomous" operations - define the requirements this sets on the spacecraft systems - as best we can.
- Define the method of translation between "engineering" or "astronomical" inputs and commands to the instrument - some form of script "language" seems best.
- Outline the general requirements we expect to set on the spacecraft operations - parameter monitoring, switch us off etc etc....
- Define the general types of telemetry packet we expect to implement.

Summary of BOL Managment Structure and Funding Proposal Splinter Meetings

Sect. 7: Qualifications and Experience of Consortium

1. Need brief biographies (e-mail text; already requested) from all key personnel (deadline Jan. 16).

2. Need short (< 200-word) descriptions of each institute's qualifications and experience

   To be provided by e-mail (deadline Jan. 16) by:

QMW	M Griffin
RAL	R Emery
MSSL	Ian Hepburn to arrange
ROE	G Wright
SAp + Grenoble	L Vigroux
LAS	J-P Baluteau
DESPA	E Lellouch
IAS	P Cox
IFSI	P Saraceno
Arcetri	G Tofani
Padua	A Franceschini
Caltech/JPL	A Lange
NASA Goddard	H Moseley
Stockholm	G Olofsson
IAC	I Perez-Fournon

Section 8: Management Structure

- Essential features of the Organogramme and document are agreed

- Steering Group membership:

PI	M Griffin
Co-PI	L Vigroux
Italy	G Tofani (TBC today?)
UK	TBC by Jan. 16
France	J-P Baluteau
Spain	I Perez-Fournon
Sweden	G Olofsson
USA	A Lange (TBC by Jan. 16)

- The Steering Group can revise the Co-I and Associate Scientist lists during the course of the project

- Current Co-I list: Now finalised except:

Arcetri	TBD (today?)
IFSI	Paolo Saraceno
Caltech/JPL	TBD by Jan. 16 (Proposal: One for now but another if Caltech/JPL technology is selected)

- Associate Scientists:

A list of current Associates will be included in proposal. Lists of proposed Associates (*currently involved*) to be provided (deadline Jan. 16) for each country by:

Fr.	L Vigroux
It	P Saraceno
UK	M Griffin
Swe	G Olofsson
Spain	I Perez-Fournon
USA	A Lange.

Example of format:

Dr. Bruno Maffei	QMW	Hardware, Scientific programme
Prof. M Barlow	UCL	Scientific programme

- Fr Project Sci: TBD (today?)
- ICC Scientist TBD by Jan. 16
- Systems Engineer TBD by Jan. 16
- Local Managers: All now identified except Caltech and Goddard (to be nominated by A Lange and H Moseley by Jan. 16)
- ICC Development Manager: K King (TBC by Jan. 16)
- Description of ICC needs some expansion.
- **New drafts of Sections 7 and 8 will be produced by M Griffin (deadline Jan. 22)**

BOL Funding Proposal

- Preferred Approach for endorsement by national agencies:
  Each Agency writes a letter to ESA (Roger Bonnet) describing their position *vis-à-vis* FIRST and the proposed participation of their nation in the BOL. We merely refer to these letters in the proposal.

- Description and justification of resources:

  We will put in: - manpower requirements for each country
  - profiled by year (1998 to end of operations)
  - separate profiles for hardware and ICC

  To be provided (deadline Jan. 16) by

  L Vigroux   P Saraceno   M Griffin   G Olofsson
  I Perez- Fournon   A Lange.

Spanish Participation in the BOL

- Proposal to provide on-board data processing unit

- Options:
  - Separate box
    - same general-purpose box being provided for PHOC
    - unit tailored to particular needs of the BOL
  - Boards/modules to be incorporated within CEA Signal Proc. Electronics Unit

  - Detailed discussion needed between CEA and IAC

- Delivery of hardware to CEA to avoid additional interfaces

LENS Laboratory Participation in the BOLCalibration

- Possibility of provision of sources for the RAL Ground Calibration Facility will be explored

- More definition/discussion of Calib. Facility requirements needed

- The AO response will mention this as an option