# Integration Plan SPIRE Structure

**Distribution List:**

| | | |
|---|---|---|
| **RAL** | Ken J. King | |
| | Bruce M. Swinyard | |
| | Judy Long (Project Office) | |
| **ATC** | Colin Cunningham | |
| **QMW** | Matt Griffin | |
| | Pete Hargrave | |
| **CEA-Grenoble** | Lionel Dubant | |
| **JPL** | G Lillienthal | |
| | Jamie Bock | |
| **CEA-Sap** | Jean-Louis Auguères | |
| **LAM** | Dominique Pouliquen | |
| | Pascal Dargent | |
| | Kjetil Dohlen | |
| **MSSL** | Alan Smith | |
| | Berend Winter | |

# Revision Record

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| April 2001 | 0.1 | Creation of the document |
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# Table of contents

# 1 Scope of the document

This document describes the integration plan of the SPIRE structure.

The SPIRE instrument consists of a monocoque shell holding a bending stiff optical bench. This optical bench supports a photometer and a spectrometer. All parts of these two measurement devices are mounted on the optical bench. The instrument is mounted on the FIRST optical bench via three interfaces. Two A-frames and a conical fixed point. These interfaces ensure a controlled contraction of the instrument when it is cooled down. The optical bench panel is on one side mounted on the fixed point, the side closest to the optical axis of the telescope. The two A-frames are mounted on the two corners the furthest away from the fixed point. The bending flexible direction of the A-frames is pointing towards the fixed point. Thus making the whole suspension kinematic.

The integration of the Spire structure is a very delicate operation. During the whole process great care has to be taken not to compromise the (future) alignment of the optical components. For this, during the manufacturing of the different parts and especially the optical bench, stress relaxation is required. In between various stages of machining the parts need to be heat treated. This to release as far as possible residual stress left behind after cutting the metal. The machining stages of the parts can be split between the first rough cutting and the final fine cutting. Before the final cutting, where the part is machined within its final tolerances, it is essential to have it heat treated.

The inaccuracy of machining of the various parts will lead to a build up of alignment errors of the structural interfaces upon which the various optical components will be mounted. The build up of this misalignment runs through the whole structure. It starts with the mounting of the instrument, continues through the covers and the optical bench. It is therefore of paramount importance that during integration the build-up of misalignment is minimised and moreover, to ensure that the construction and integration is done such that what ever the misalignment is, it will not change significantly after dismounting and re-mounting the covers.

The total allowable misalignment (error budget) of the optical components is given in RD1. The development plan, giving a listing of the various models required, is AD1. A more detailed description of the structure can be found in AD2.

This document addresses the issues surrounding the integration (parts, sequence and MGSE), straylight attenuation, thermal and electrical isolation as well as alignment issues. Not specifically manufacturing issues, apart from the ones mentioned above.

# 2 Documents

## *1.1. Reference documents*

| | Title | Author | Reference | Date |
|---|---|---|---|---|
| RD1 | FIRST SPIRE: Optical Error Budgets | K. Dohlen | | |
| RD2 | FIRST SPIRE assembly and integration | B. Swinyard | | April 2001 |
| | | | | |
| | | | | |

## *1.2. Applicable documents*

| | Title | Author | Reference | Date |
|---|---|---|---|---|
| AD1 | SPIRE Structure Subsystem Development Plan | B. Winter | SPIRE-MSS-PRJ-0000426, issue 1.2 | March 2001 |
| AD2 | SPIRE Structure Subsystem Specification Document | B. winter | SPIRE-MSS-PRJ-0000427, issue 1.3 | April 2001 |

### *1.3. Drawings*

| | Title | Author | Reference | Date |
|---|---|---|---|---|
| DR1 | | | | |
| DR2 | | | | |

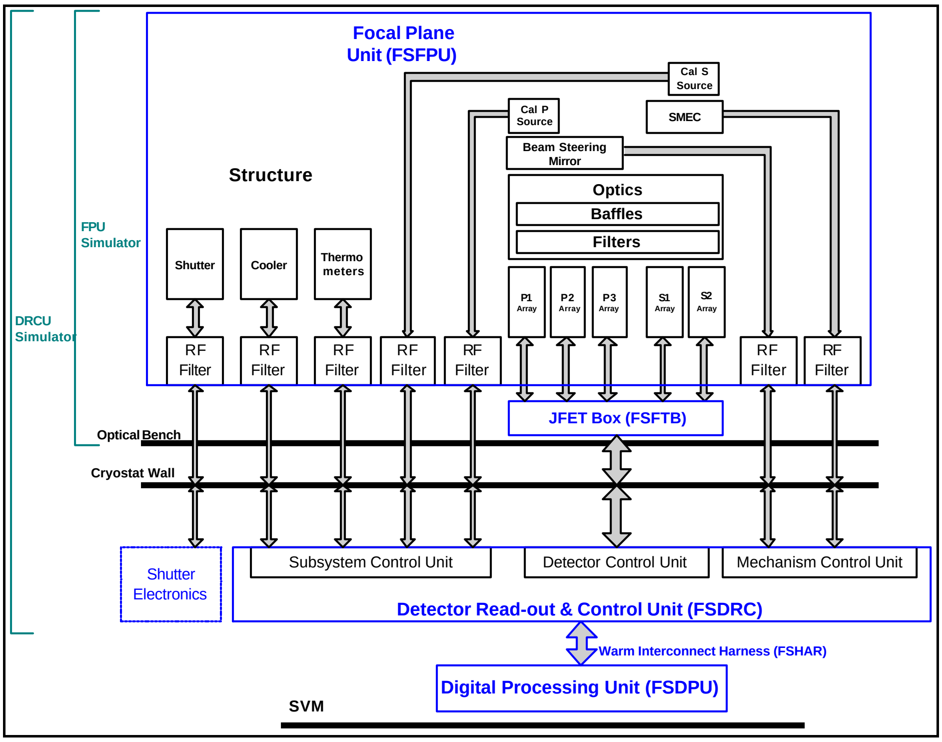
### *1.4. Glossary*

| | | | |
|---|---|---|---|
| AD | Applicable Document | LAM | Laboratoire d'Astronomie Marseille |
| CEA | Commissariat à l' Energie Atomique | MGSE | Mechanical Ground Support Equipment |
| CDR | Critical Design Review | MSSL | Mullard Space Science Laboratory |
| CNES | Centre National des Etudes Spatiales | NA | Not Applicable |
| CoG | Centre of Gravity | OGSE | Optical Ground Support Equipment |
| CQM | Cryogenic Qualification Model | PFM | ProtoFlight Model |
| DDR | Detailed Design Review | RAL | Rutherford Appleton Laboratory |
| DESPA | Département des Etudes SPAtiales | RD | Reference Document |
| DM | Development Model | SMECe | SMEC warm electronics |
| DRCU | Digital Read-out and Control Unit | SMECm | SMEC cryogenic mechanism |
| EGSE | Electrical Ground Support Equipment | SMECp | SMEC cold preamplifier |
| FIRST | Far InfraRed Submilimeter Telescope | SMEC | Spectrometer mirror MEChanism subsystem |
| FPU | Focal Plane Unit | SPIRE | Spectral and Photometric Imaging REceiver |
| FS | Flight Spare model | TBC | To Be Confirmed |
| FTS | Fourier Transform Spectrometer | TBD | To Be Defined |
| GSFC | Goddard Space and Flight Centre | | |
| IIR | Instrument Interface Review | WE | Warm Electronics |

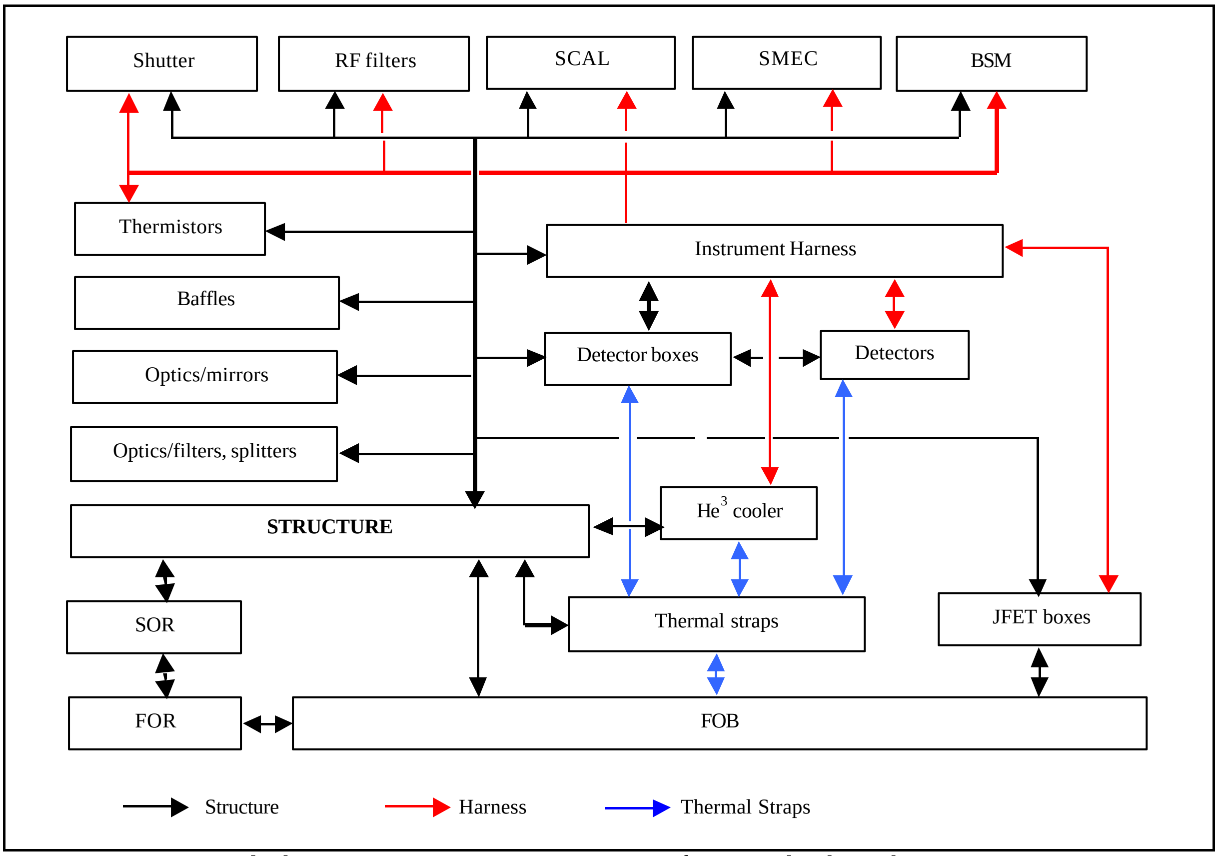
# 3

# 4 Short System and Subsystem description

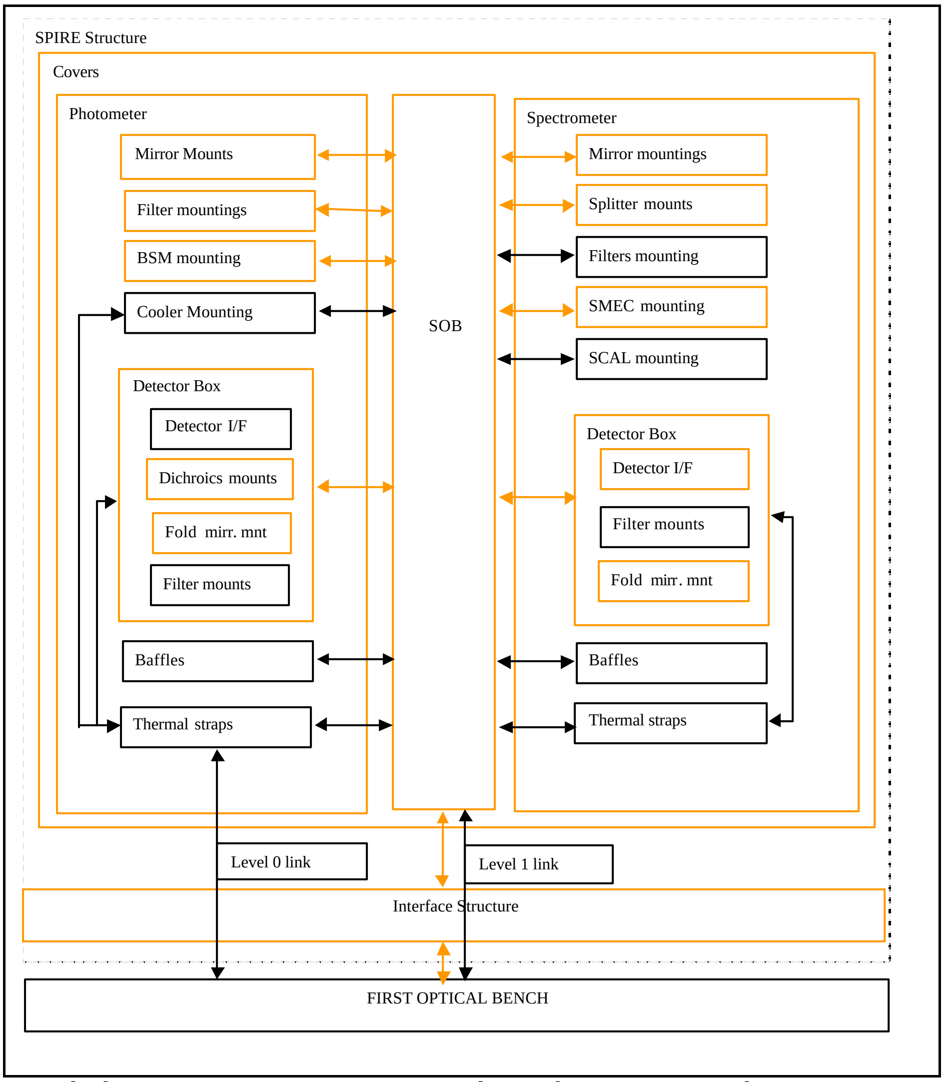
The following bock diagrams describe subsequently the position of the structure in the whole SPIRE system, A breakdown of the structure with its various subsystems and a breakdown of the structure hardware.



Block Diagram 3-1: SPIRE system




Block Diagram 3-2: SPIRE structure interfacing with other subsytems




Block Diagram 3-3: SPIRE structure, relations between structural components
alignment critical components are coulored dark yellow

# 5 The various models

According to AD1 the folowing models have to be manufactured:

STM - Structural Thermal Model
CQM - Cryogenic Qualification Model
PFM - Proto Flight Model
FS - Flight Spare

RD2 gives the overall view of the use of the different models and lists the various tests and test requirement references for each model. It stipulates that the STM model and the STM testing encompases the qualification of the structure. The various subsystems mounted within and on the structure will have their own seperate qualification tests. The STM test focusses primarily on the structure, thermal hardware and the qualification test serves as a reference for the subsystem qualification tests.

The CQM model and test serves as a reference for the qualification of the various subsystems. The structure CQM model is the same as the STM structure model. The CQM model will be used in conjuction with the other two instruments (HIFI and PACS) at ESTEC for further verification.

The PFM model is the actual flight hardware, it will go through a full proto qualification programme on instrument level and on spacecraft level.

The flight spare is the refurbished CQM model, where fatigue or other critical comonents are replaced to provide for a replacement of the PFM model in case something goes wrong with the PFM model on spacecraft level.

Therefore there are two full integrations of the structure (and two full models) the STM and PFM model. The integration of the CQM instrument consists of replacing the STM models of the various subsystems with their CQM counterparts. For the FS model integration will consist of replacing fatigue sensitive parts and subsystems.

# 6 General Integration of the Structure

In this section the general integration steps for the structure are listed. Figure 5-1 gives the block diagram with the main steps. In broad lines: first the clamp shells are assembled, at the same time or perhaps later the detector boxes are assembled. After the clamp shells are assembled the various structure parts on either side of the optical bench are mounted during which one of the clamp shells remains mounted to maintain the existing alignment. Before the structure is shipped to RAL a coarse alignment check will be performed (more like a extended fit check).

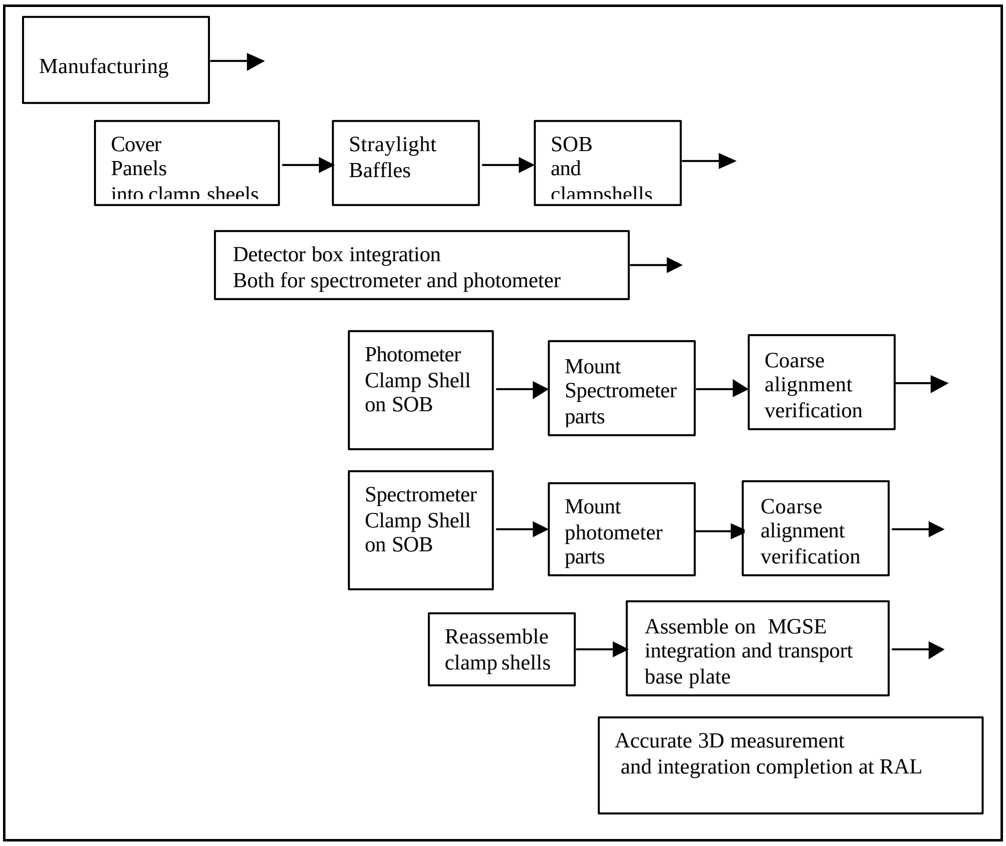



Figure: 5-1: Integration block diagram

**Preparation**

1. Manufacture parts
2. Plating if needed *(Allu-Chrome by default)*
3. Bake out parts if needed
4. Mount optical bench on a stiff base *(MGSE need for a stiff base)*

**First stage: clamp shells (photometer side spectrometer side)**

1. Mount side panels photometer. One by one bolting down on the optical bench
2. Bolt them together
3. Integrate stray-light baffles

4. Check flatness of the interface with the outer panel.
5. Rework if needed
6. Remount if needed
7. Bolt down the outer panel
8. Dowel the position of the photometer cover on the optical bench *(2 dowel pins?)*
9. Repeat procedure for the spectrometer cover with photometer clamp shell mounted

**Second stage SOB mounted components**

1. Remove Spectrometer clamp shell
2. Assemble spectrometer mirror mounts and beamsplitters
3. Mount spectrometer detector box
4. Mount RF-filter boxes
5. Check relative positions and orientation of the interface planes/points
6. Assemble thermal straps
7. Remount spectrometer clamp shell
8. Remove photometer clamp shell
9. Assemble photometer mirror mounts
10. Mount photometer detector box
11. Check relative positions and orientation of the interface planes/points
12. Assemble thermal straps
13. Remount photometer clamp shell

**Third stage mounting on baseplate**

1. Mount fixed cone on base plate
2. Mount A-frames on base plate *(MGSE do we need to provide for extra temporary support for A-frame to protect them)*
3. Lower rest of structure on mounts, finish integration
4. Put baseplate in transport container *(MGSE baseplate is also vibration adaptor)*

# 7 Integration of smaller sub-structures and of subsystems

**Photometer detector box integration**

1. Assemble thermal busbar
2. (Fold) Mirrors
3. Filters
4. Dichroics
5. Mount detectors connect to thermal busbar
6. Close detector box
7. Mount straylight baffle on thermal busbar
8. Mount the detector box unit on the SOB
9. Assemble CSTR3
   *Note the detector box should provide for support of detector harness routing to optical bench.*

**Spectrometer detector box integration**

1. As for photometer box mutatis mutandis

**RF-filter boxes mounting**

1. Mount interface frame with SOB edge
2. Assemble RF-filter boxes in frame

**3He cooler mounting**

1. Bolt the cooler down on the SOB
2. Bolt thermal busbars (photometer and spectrometer) on the cold finger of the cooler
3. Route the harness to RF-filter box

**BSM mounting**

1. Mount BSM on SOB
2. Route harness to RF-filter boxes

**Shutter mounting**

1. Mount Shutter on SOB/Straylight baffle
2. Route harness to RF-filter box

**SCAL mouting**

1. Mount SCAL on straylight baffle
2. Route harness to RF-filter box

**SMEC mounting**

1. Mount SMEC in SOB
2. Route harnessto RF-filter box

**Final mounting of outer covers**

1. Mount covers
2. Bolt down CSTR1 and CSTR2 to 3He cooler
3. Mount straylight baffles on CSTR1, CSTR2 and CSTR3
4. Bolt connector panels on outer panels, remove temporary support
5. Bolt RF-filter boxes on outer spectrometer panel
6. Assemble CSTR4

Notes on final alignment verification

Always one clamp shell on the optical bench
Detector mounting locations are also mounting locations for alignment tools need therefore be accessable