

<b>L.A.M.</b>	<b>FIRST</b>	Ref : <b>LAM.PJT.SPI.SPT.200007 Ind 4</b>	Page : <b>1 / 12</b>
<b>FRE 2243</b>	<b>SPIRE</b>	Author : <b>K.Dohlen and D.Pouliquen</b>	Date : <b>18 Dec 2000</b>
<b>SPIRE Mirrors Specification</b>			

**Distribution List :**

<b>RAL</b>	Colin Cunningham	<b>X</b>	Ken J. King	<b>X</b>
	Bruce Swinyard	<b>X</b>		
<b>CNES</b>	Martine Joubert		Yvan Blanc	
<b>CEA-Sap</b>	Jean-Louis Auguères			
<b>DESPA</b>	Guy Michel			
<b>GSFC</b>	Don.E. Jennings			
<b>LAM</b>	Armand Artinian		Jean-Paul Baluteau	<b>X</b>
	Claude Colin		Pascal Dargent	<b>X</b>
	Kjetil Dohlen	<b>X</b>	Didier Ferrand	
	Michel Jevaud		Patrick Levacher	
	Alain Origné	<b>X</b>	Dominique Pouliquen	<b>X</b>

## Update

Date	Indice	Remarks
5 June 2000	1	Creation of the document
12 Oct 2000	2	Updated mirror dimensions. Spec P5 added.
28 Nov 2000	3	Corrected illustration of CM3 (p. 9)
18 Dec 2000	4	Remodified CM3 dimension. Spec P6 added (RoC)

Host system	Windows 95
Word Processor	Microsoft Word 97
File	D:\Dohlen\first\OptoMech\SpecOpt\LAM.PJT.SPI.SPT.20000704_Miroirs_Specifications.doc

## Table of contents

1.	Scope of the document .....	4
2.	Documents .....	4
2.1.	Applicable documents .....	4
2.2.	Glossary .....	4
3.	The mirrors .....	5
3.1.	Mirrors description .....	5
3.2.	Mission profile .....	5
3.3.	Product tree .....	6
4.	Requirements .....	6
4.1.	Functional requirements .....	6
4.1.1.	Performance requirements .....	6
4.1.2.	Technical requirements .....	6
4.2.	Operational requirements .....	11
4.2.1.	Reliability .....	11
4.2.2.	Lifetime .....	11
4.2.3.	Operating modes .....	11
4.2.4.	Telemetry .....	11
4.2.5.	Telecommands .....	11
4.3.	Interface requirements .....	12
4.4.	Design and manufacture requirements .....	12
4.4.1.	Design requirements .....	12
4.4.2.	Design rules .....	12
4.4.3.	Manufacture requirements .....	12
4.5.	Logistic requirements .....	12
4.6.	Environment requirements .....	13
4.6.1.	Natural environment .....	13
4.6.2.	Operating environment .....	13
4.7.	Verification requirements .....	13

## 1. Scope of the document

This specification defines the requirements applied to the performances, the design and the qualification of the SPIRE mirrors. It is applicable to the PFM and the FS.

SPIRE (Spectral and Photometric Imaging REceiver) is one of the three instruments which will equip the Far Infrared Space Telescope (FIRST), an ESA mission planned to be launched in 2007. It will provide astronomical images in the 200-670  $\mu\text{m}$  band.

## 2. Documents

### 2.1. Applicable documents

	Title	Author	Reference	Date
AD1	Instrument Requirements Document	B.M.Swinyard	SPIRE-RAL-PRJ-000034 Issue 0.21	30 nov 1999
AD2	Structure/Optics Interface		SPIRE 1.1/1.2	
AD3	SMEC / Optics Interface		SPIRE 1.2/1.5.2	

### 2.2. Glossary

AD	Applicable Document	LAM	Laboratoire d'Astrophysique de Marseille
BSM	Beam Steering Mirror		
BSMm	BSM cryogenic mechanism		
CEA	Commissariat à l'Energie Atomique	MGSE	Mechanical Ground Support Equipment
CDR	Critical Design Review	MM	Mechanical Model
CNES	Centre National des Etudes Spatiales	MSSL	Mullard Space Science Laboratory
CoG	Center of Gravity	NA	Not Applicable
CQM	Cryogenic Qualification Model	OGSE	Optical Ground Support Equipment
DDR	Detailed Design Review	PDR	Preliminary Design Review
		PFM	Prototype Flight Model
DM	Development Model	RAL	Rutherford Appleton Laboratory
		RD	Reference Document
		SMEC	Spectrometer mirror MECHANISM
		SMECm	SMEC cryogenic mechanism
		SMECp	SMEC cold preamplifier
		SPIRE	Spectral and Photometric Imaging REceiver
FIRST	Far InfraRed Submillimeter Telescope	TBC	To Be Confirmed
FPU	Focal Plane Unit	TBD	To Be Defined
FS	Flight Spare model	TBU	To Be Updated
FTS	Fourier Transform Spectrometer	TBW	To Be Written
GSFC	Goddard Space and Flight Center	WE	Warm Electronics



Warm vibrations	RAL	1 week	
Transport	From RAL to ?	TBD	
Cold vibrations	?	3+ weeks	
Transport	From ? to RAL	TBD	
Thermal cycles	RAL	TBD	
Calibrations	RAL	TBD	
Transport	From RAL to ESA	TBD	
Satellite tests	ESA	TBD	
Storage	ESA	2 years (TBC)	
Launch	Kourou	TBD	
Beginning of operation	Orbit	TBD	
Operations	Orbit	4.25 years	
End of operations	Orbit	TBD	

### 3.3. Product tree

Each mirror is made of three parts : the mirror, a dowell pin and a nut.  
The corner cubes are not yet defined.

## 4. Requirements

### 4.1. Functional requirements

#### 4.1.1. Performance requirements

The overall instrument performance requirements are listed in [AD1] and have been translated into the following requirements for the mirrors.

#	Parameter	Value	IRD	Note
P1	Infrared reflectivity	>0.99		
P2	Infrared emissivity	<0.01		
P3	Visible reflectivity	>0.8 (TBC)		For vis. alignment purpose
P4	Surface roughness	< 10nm RMS		For vis. alignment purpose
P5	Surface shape	< 1 μm RMS (TBC)		Corresponds to 2 μm on the reflected wave, i.e., λ/100 at 200μm
P6	Radius of curvature	$\Delta R/R < 10^{-3}$		For non-flat surfaces
P7				
P8				
P9				
P10				

#### 4.1.2. Technical requirements

#	Parameter	Value	IRD	Note
Tm1	Axis definition	TBD		
Tm2	Alignment tolerances	0.5arcmin, 0.05mm		
Tm3	Dimensions			See table 1 below
Tm4	Center of gravity	TBD		
Tm5	Mass	2.5 kg including 20% margin		See table 1 below
Tm6	Inertia	TBD		

**Table 1 : Mirror mass, excluding margins**

Current baseline designs are BOLPHT154B and BOLSP501E.

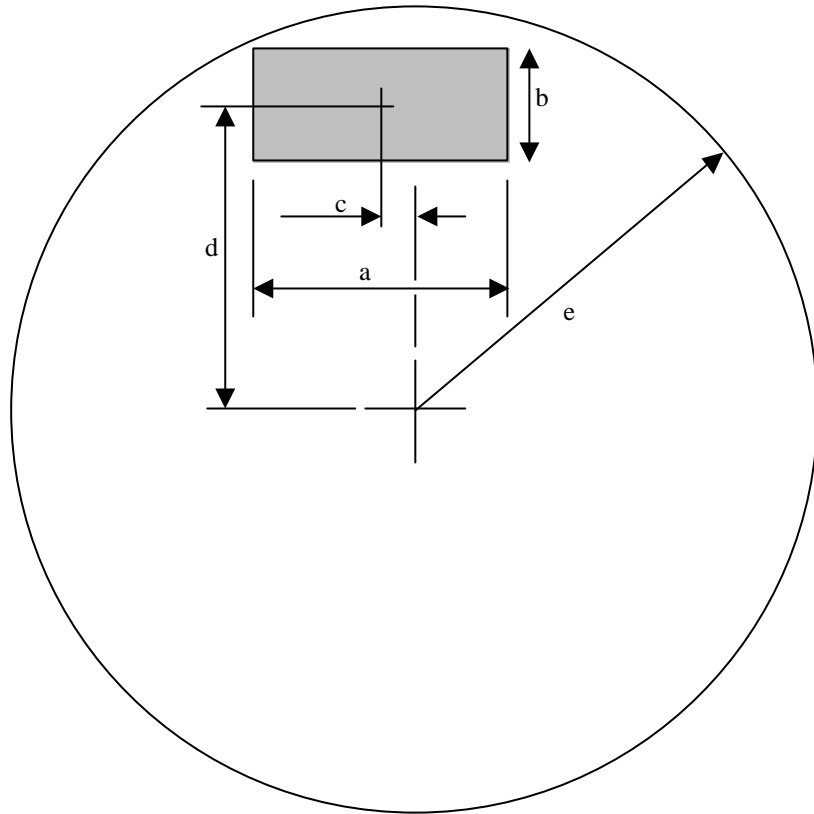
Positive radius of curvature signifies concave mirror.

CM4 (BSM) is furnished by ROE.

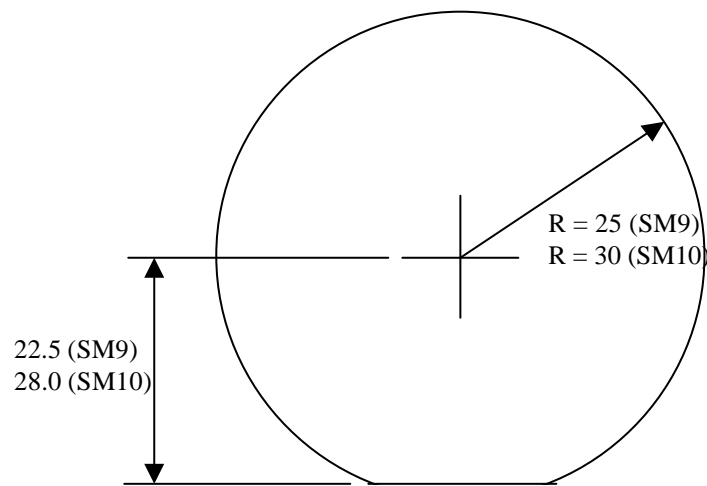
Subass'y	Mirror	Type	R or Ry (mm)	CC or Rx (mm)	Shape	Dimension s a x b or dia decenters [c , d] (mm)	Nb. of parts	Mass (kg)	Total Mass (kg)
Fore optics	CM3	Off-axis asphere	365.963	-0.5095	Rect	139x62 [-19.5, 145] See fig.	1	0.256	
	<i>CM4 (BSM)</i>	<i>Flat</i>			<i>Ellipt.</i>	<i>15x16</i>	<i>1</i>	<i>0.021</i>	
	CM5	Toric	294.638	278.418	Rect	161x85 [19.5, -1.5]	1	0.360	<b>0.637</b>
Photometer	PM6 (Pick-off)	Toric	-307.49	-359.42	Rect	46x27	1	0.027	
	PM7	Sphere	330.70		Rect	118x101 [0, -1.0]	1	0.300	
	PM8	Sphere	-286.651		Circle	Ø 60	1	0.056	
	PM9	Sphere	350.851		Circle	Ø 112	1	0.223	
	PM10 (Fold mirror)	Flat			Rect	78x40 [2.5, 0]	1	0.065	
	PM11 (Fold mirror)	Flat			Rect	56x53 [0, -2.75]	1	0.060	<b>0.731</b>
Spectrometer	SM6 (Pick-off)	Toric	523.79	269.92	Ellipt	9x12 [0, 1.0]	1	NB a corriger	
	SM7 (Fold mirror)	Flat			Rect	40x57 [0, 4.0]	1	0.044	
	SM8A, B (Relay in)	Toric	230.34	202.00	Circle	Ø 60	2	0.112	
	SM9A, B (Collimator)	Sphere	259.50		Special see fig	Ø50 see fig	2	0.074	
	CC face1	Flat			Special see fig	40x60 see fig	2	0.044	
	CC face2	Flat			Special see fig	28x68 see fig	2	0.070	
	CC face3	Flat			Special see fig	28x68 see fig	2	0.070	
	SM10A, B (Camera)	Sphere	260.00		Special see fig	Ø60 see fig	2	0.112	
	SM11A, B (Relay out)	Toric	196.99	169.84	Circle	Ø 74 [0, 1]	2	0.194	
	SM12A, B (Fold mirrors)	Flat			Ellipt	21x16 [-1, 0]	2	0.050	<b>0.799</b>
<b>Total</b>							<b>27</b>		<b>2.167</b>



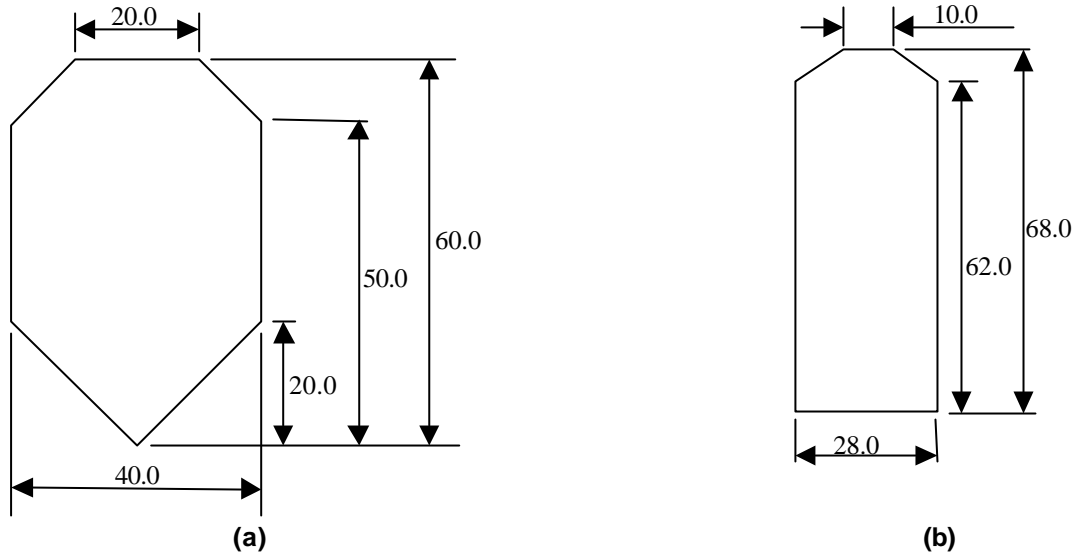




Mirror CM3, off-axis part of asphere. Values of a, b, c and d are given in Table 1. The symmetric substrate radius is calculated by:  $e = \sqrt{(a/2 + |c|)^2 + (b/2 + |d|)^2}$ . Its current value is 202 mm.



Mirrors SM9 and SM10. "Chopped-off" circular apertures.



Corner cube faces. (a): face 1, (b): faces 2 and 3.

## 4.2. Operational requirements

### 4.2.1. Reliability

### 4.2.2. Lifetime

#	Parameter	Value	IRD	Note
OL1	Ground Storage lifetime	2 years		A guess
OL2	Ground Integrated lifetime	4 years		About
OL3	Ground operational lifetime	1.5 years		6 months for subsystem acceptance 6 months for SPIRE acceptance 6 months for FIRST acceptance Under 1g conditions
OL4	On orbit operational lifetime	4.25 years		

### 4.2.3. Operating modes

Non applicable

### 4.2.4. Telemetry

Non Applicable

### 4.2.5. Telecommands

Non Applicable

### 4.3. Interface requirements

The interfaces are defined in the relevant applicable documents.

Part	Interface	With	Document
SMECm	Mechanical	SPIRE Structure	SPIRE 1.1/1.5.2
	Thermal	SPIRE Structure	SPIRE 1.1.1/1.5.2
	Optics	SPIRE Optics	SPIRE 1.2 / 1.5.2
SMECp	Mechanical	SPIRE Structure	SPIRE 1.1/1.5.2
	Thermal	SPIRE Structure	SPIRE 1.1.1/1.5.2
SMECe	Mechanical	DRCU	SPIRE 1.5.2 / 2.2
	Thermal	DRCU	SPIRE 1.5.2 / 2.2
	Electronic	DRCU	SPIRE 1.5.2 / 2.2
MCU	Electronic	MCU	TBW
	Mechanical	DRCU	SPIRE 1.5.2 / 2.2
	Thermal	DRCU	SPIRE 1.5.2 / 2.2
	Electronics	DRCU	SPIRE 1.5.2 / 2.2

### 4.4. Design and manufacture requirements

#### 4.4.1. Design requirements

TBD

#### 4.4.2. Design rules

TBD

#### 4.4.3. Manufacture requirements

These are requirements on accessibility, dismountability, testability and manufacturing processes.

- TBD fluids to be forbidden during manufacture to avoid pollution.
- TO BE COMPLETED

### 4.5. Logistic requirements

The subsystem will be transported to and from RAL.

The containers will have to guarantee that:

- no shocks are greater than those defined for the launch.
- no pollution sneaks to the mirrors
- TO BE COMPLETED

## 4.6. Environment requirements

These requirements describe the environment in which the mirrors will live.

### 4.6.1. Natural environment

This is the description of the natural environment around the mirrors.

#	Parameter	Value	Note
EN1	Vacuum	Less than 10 <sup>-4</sup> Pa	During tests, launch and in operation
EN2	Operating temperature	during system qualif and on orbit = 4K during subsystem qualification = 300K and 20K	
EN3	Storage and handling temperature Humidity Cleanliness	-20 to +30 °C Less than 45% Class TBD	Overall, on ground In clean room In clean room
EN4	Radiations	Less than 3.5 kRAD	On orbit

### 4.6.2. Operating environment

This is the description of the environment imposed by the location of the subsystem in SPIRE and in FIRST.

#	Parameter	Value	IRD	Note
ON1	Vibrations	TBD		At 4K
ON2	Shocks	TBD		At 4K
ON3	Microvibrations	TBD		NA
ON4	Acoustic	NA		Launched under vacuum

## 4.7. Verification requirements

TO BE COMPLETED