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SPIRE Mirrors Specification

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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 10
4.2.1. Relialibility 10
4.2.2. Lifetime 10
4.2.3. Operating modes 10
4.2.4. Telemetry 10
4.2.5. Telecommands 10
4.3. Interface requirements 10
4.4. Design and manufacture requirements 10
4.4.1. Design requirements 10
4.4.2. Design rules 11
4.4.3. Manufacture requirements 11
4.5. Logistic requirements 11
4.6. Environment requirements 11
4.6.1. Natural environement 11
4.6.2. Operating environment 11
4.7. Verification requirements 11

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.

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	

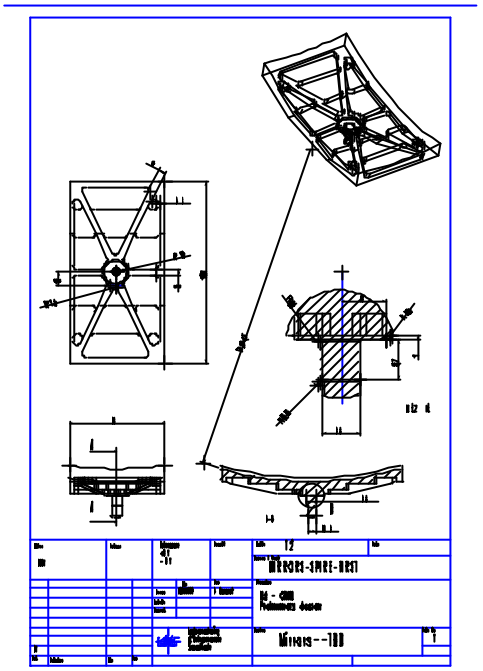
2.2. Glossary

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

3. The mirrors

3.1. Mirrors description

The basic design of the mirrors is the same as the one used for ISO-LWS.
The mirrors are made in Aluminium 6061.
They all have a standard interface with the structure, i.e. an M8 screw and a pin.
Each mirror is machined in a single block of aluminium (diamond cutting). The screw part of the attachment exerts pressure only on the shoulder part of the mirror, avoiding deformation of the optical surface.
The mount of each mirror is located on the optical bench by means of a pin.
This pin ensures that in case of dismounting of the mirror it will be mounted again in the same position.
During integration of the mirrors in the SPIRE structure, the mirrors are mounted on brackets which are provided by MSSL.
The figure below gives a drawing of the CM5 mirror, which is the heaviest one.



The interface between the corner cube mirrors and the SMEC mechanism is TBD.

3.2. Mission profile

Here are the successive phases of the subsystem life from the end of manufacturing to the end of life.
These are for information only. Discrepancies with actual AIV and operation plan are allowed.
Durations are TBC.

Operation	Where	Duration	Note
Bakeout	LAM	1 week	
Control	LAM	4 weeks	
Warm Vibrations	LAM	1 week	On the CM5 mirror only
Thermal cycles	LAM	4 weeks	
Control	LAM	4 weeks	
Transport	From LAM to RAL	2 days	
Integration in the SPIRE Structure	RAL	TBD	
Bakeout	RAL	1 week	

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 performance requirements are listed in [AD1]

#	Parameter	Value	IRD	Note
P1	Infrared relflectivity	>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

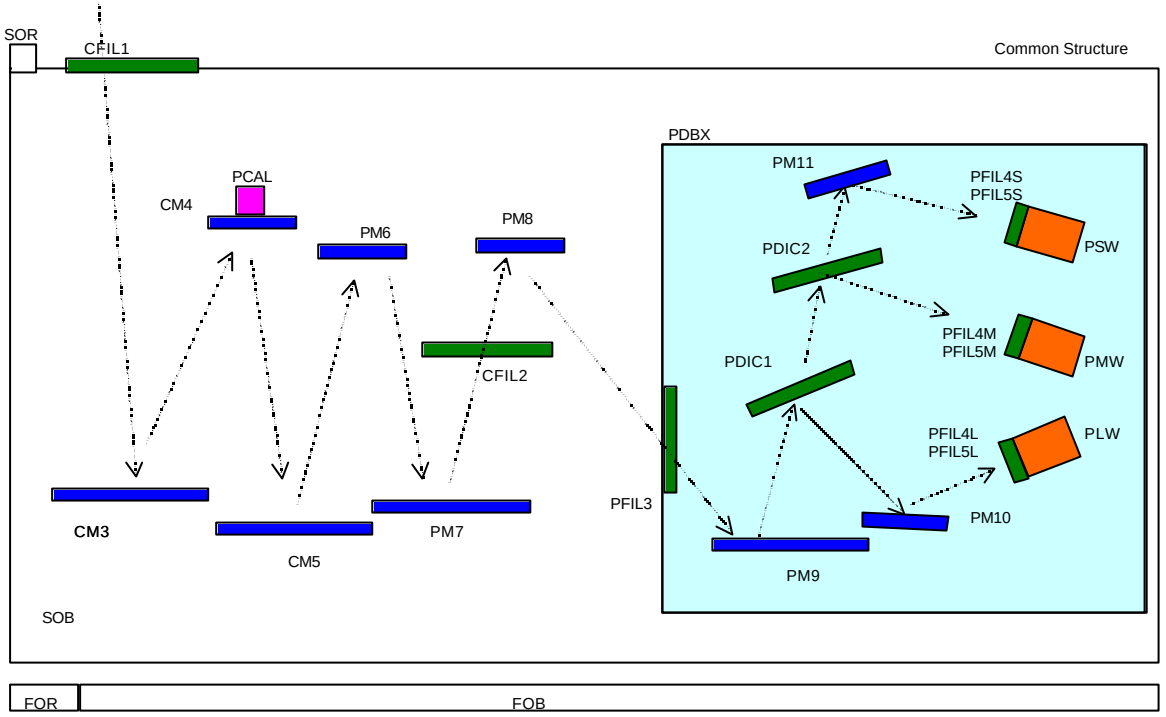
4.1.2. Technical requirements

#	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	2.51 kg including 20% margin		See table 1 below
Tm6	Inertia	TBD		

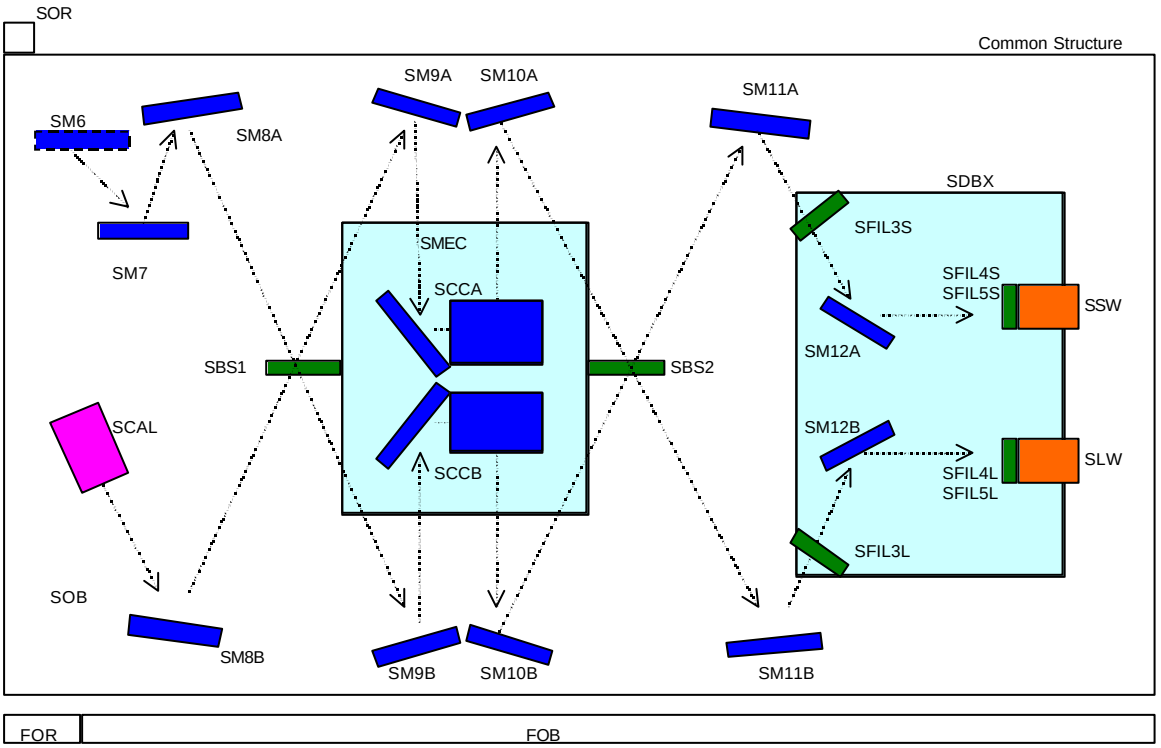
Table 1 : Mirror characteristics, excluding margins

Current baseline designs are BOLPHT153 and BOLSP501B.
Positive radius of curvature signifies concave mirror.

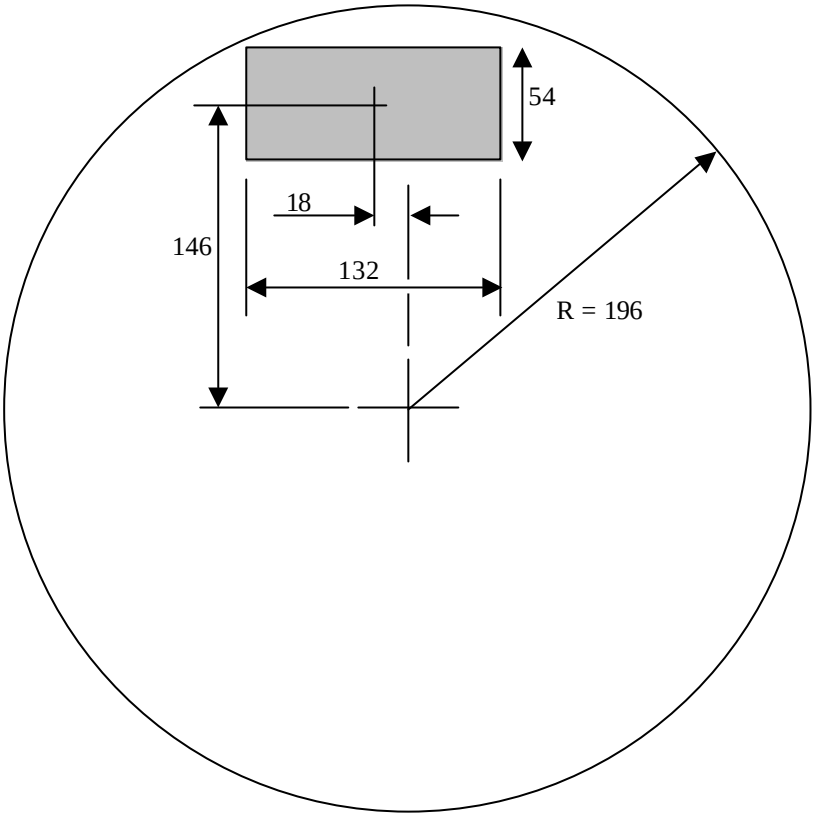
Subass'y	Mirror	Type	R or Ry (mm)	CC or Rx (mm)	Shape	Dimensions [decenters] (mm)	Nb. of parts	Mass (kg)	**Total Mass (kg)**
Fore optics	CM3	Off-axis asphere	365.963	-0.5095	Rect	132x54 [-18, 146] See fig.	1	0.183	
	CM4 (BSM)	Flat			Ellipt.	15x16	1	0.021	
	CM5	Toric	294.638	278.418	Rect	161x85 [19.5, -1.5]	1	0.360	**0.564**
Photometer	PM6 (Pick-off)	Toric	-307.49	-359.42	Rect	46x27	1	0.027	
	PM7	Sphere	330.70		Rect	118x101 [0, -1]	1	0.300	
	PM8	Sphere	-286.651		Circle	Ø 60	1	0.056	
	PM9	Sphere	350.851		Cricle	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	**0.731**
Spectrometer	SM6 (Pick-off)	Toric	523.79	269.92	Ellipt	9x12 [0, 1]	1	NB a corriger	
	SM7 (Fold mirror)	Flat			Rect	40x57 [0, 4]	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	**0.799**
Total							**27**		**2.094**



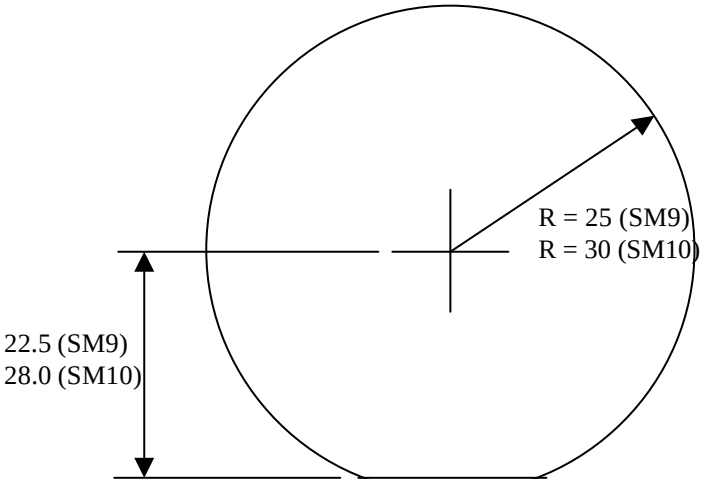
Photometer schematic layout and nomenclature.



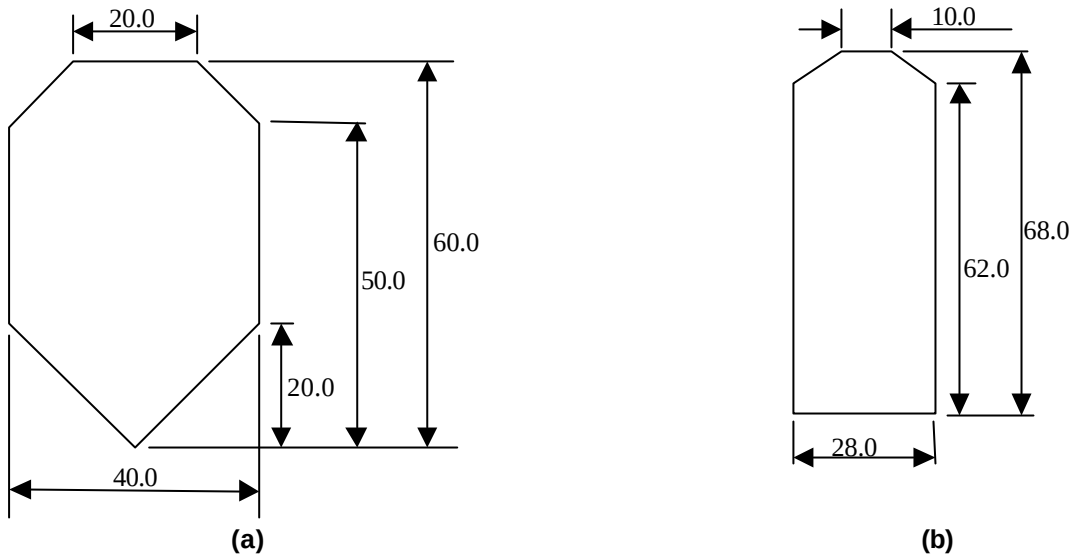
Spectrometer schematic layout and nomenclature.



Mirror CM3, off-axis part of asphere. Symmetric substrate has radius 196mm.



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. Relialibility

TBD

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.

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 wil 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 environement in which the mirrors will live.

4.6.1. Natural environement

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

#	Parameter	Value	Note
EN1	Vacuum	Less than 10-4 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	-20 to +30 °C	Overall, on ground
	Humidity	Less than 45%	In clean room
	Cleanliness	Class TBD	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