

5 Instrument system-level Assembly, Integration and Verification (AIV)

5.1 Model philosophy

The model philosophy to be adopted for the AIV of the FIRST bolometer instrument will be in accordance with the requirements of the FIRST IID-A. The instrument models to be produced are as follows.

1. **The Electrical Model (EM):** This is an electrical representation of the instrument consisting of models of the warm electronics boxes built using the applicable flight processes but with commercial parts where possible, and an electrically representative simulator to replace the focal plane unit. The warm electronics units will undergo a partial EMC test. The cold FPU will be replaced by electronic simulators that will provide a realistic commanding and data response environment.
2. **The Engineering Qualification Model (EQM):** This will be built to flight standards for both the cold FPU and the warm electronics. The performance capabilities of this instrument model may be less than the proto-flight model (e.g., it may contain non-science-grade focal plane arrays) but it will mimic as exactly as possible the optical, thermal, electrical and mechanical properties of the flight instrument and will be capable of undergoing the full environmental qualification programme.
3. **The Proto-Flight Model (PFM):** This will be the instrument model that is intended for flight. It will be built to full flight standards and will only have minor differences in thermal, electrical and mechanical properties to the EQM. It will have the same mechanical, thermal and electrical interfaces to the satellite as the EQM but, may, however, have minor internal design changes compared to the EQM. For instance the bolometer arrays will be of flight standard. The PFM will therefore undergo environmental test to proto-flight levels (this applies to both the warm electronics boxes and the cold FPU).
4. **The Flight Spare Model (FS):** Full flight spare FPU and warm electronics boxes will be built. These may consist of refurbished parts from the EQM to save cost but will be identical in function and build standard to the proto-flight models. They will therefore undergo acceptance level environmental test only.

The naming of the models given here is slightly different from that given in the IID-A. We prefer the description “Engineering Qualification Model” rather than “Qualification Model”, as the latter implies an entirely “flight-like” build. It is not anticipated that the bolometer instrument EQM will be entirely flight-like. Similarly, we prefer to name the instrument model that is intended for flight the “Proto-Flight Model” as this will have small design or build changes compared to the EQM and will undergo a more rigorous test regime than a normal flight model.

5.2 AIV procedure guidelines

Detailed procedures for the assembly, integration and test of the instrument are beyond the scope of the present document. We give here instead the general guidelines that will be followed in constructing the instrument AIV programme:

1. The instrument will be fully tested in compliance with the satellite level AIV plans as set out in the IID-A and reference documents therein.
2. The AIV flow will be designed to allow the experience gained on each model to be fed into both the design and construction of the next model and into the AIV procedures to be followed for the next model.

3. A cold test facility to house the instrument will be constructed that will represent as nearly as possible the conditions and interfaces within the FIRST cryostat.
4. A cold vibration facility will be used that will simulate the launch temperatures for the bolometer instrument and provide the specified vibration levels.
5. The instrument Quick Look Facility and commanding environment will be the same as or accurately simulate the in-flight environment, to facilitate the re-use of test command scripts and data analysis tools during in-flight operations.
6. The EGSE and instrument Quick Look Facility will interface to FINDAS.
7. ICC staff will participate in the instrument functional checkout to allow an early experience of the instrument operations and to facilitate the transfer of expertise from the ground test team to the in-flight operations team.
8. Detailed procedures for the sub-system level AIV will be produced by all sub-system responsible groups and submitted for project approval.
9. Sub-systems will undergo individual qualification or acceptance programmes before integration into the instrument.
10. Sub-systems will be operationally and functionally checked at the appropriate level before integration into the instrument.
11. A more detailed description of the system level AIV procedures is given in reference document BOL/RAL/N/0020.
12. This document will form the basis of the *SPIRE Integration and Test Plan* which will provide the baseline instrument test plans and detailed procedures and will be submitted for ESA approval.