SPIRE-QMW-NOT-000124-10BOL/QMW/N/0001-1

FIRST Bolometer Instrument Development Schedule

Assumptions

1. The international instrument consortium is fully formed, staffed and funded at the time of instrument selection, and able to commence detailed design work immediately. In this respect, the selection process must be effectively just a formality.

2. To allow early commencement of the QM construction, a mid-term QM design review is assumed (in June 1999), after which QM manufacture can start on those elements of the instrument for which the design has been have been frozen. This means that he essential features of the instrument design are finalised at the time of this QM mid-term design review, only one year after the instrument selection.

3. The schedule does not permit any serious investigative or development work in parallel with instrument design and construction. The instrument must therefore be as conservative as possible, incorporating only proven technology.

   This would probably require the early decision to use the spider-web bolometer technology and preclude the use of any of the new bolometer technologies currently under development. Note that the spider-web bolometers are available through collaboration with the Caltech/JPL group, who would therefore need to be part of the instrument consortium.

Comments on the schedule

1. There is an inevitable overlap between the QM testing and the FM manufacture. This will (a) increase the pressure of work for the consortium and (b) make it difficult to incorporate in the FM any essential modifications arising from QM evaluation.

2. In reality, there will need to be some overlap as possible between activities which are shown as sequential on the schedule: e.g., manufacture of some "safe" parts of the FM might be started before the FM CDR. Or perhaps the CDR could be spread over time with different elements of the hardware being reviewed and approved at different times.

3. The flight spare schedule requires return of the QM by ESA in Sept. 2003, and its rapid refurbishment to form the FS. The amount of time available for its manufacture and characterisation is very short.

4. To save time and money, as much common work as possible should be shared by the PHOC and BOL consortia.

Critical issues

A. **Fundamental technology:** areas in which fundamental advances are needed in order to make the instrument concept feasible.

None: the instrument does not rely on any as-yet-unproven techniques or devices.

B. **Hard work:** areas in which significant development work remains to be carried out, but which are otherwise not seen as risky.

1. Dilution refrigerator space qualification

2. Microphonics and EMC suppression (cryo-cooler option)

   Note: 1 and 2 are currently being worked on and no major problems are foreseen.

Note however, that for the BOL, the required operating temperature may actually be in excess of 200 mK, and possibly high enough that a helium-3 refrigerator could be used instead of the dilution system. This is currently being studied.

3. Stray light and optimisation of the filtering and optical design of the instrument and the focal plane.

   This is a critical issue for a low background bolometer instrument. It will be difficult to test and learn from a real system given the constraints of the schedule, so a reliable concept must be perfected by design.

4. Cryogenic mechanisms

   If the tandem Fabry-Perot instrument flies, major development is needed for the cryocooler option (to reduce instantaneous power dissipation. Some development will still needed for cryostat option. In either case, ultra-high reliability needed.

5. Fabry-Perot optimisation for good efficiency and F-P order-sorting

Note: With some changes to the scientific requirements, as discussed by the SAG recently, there is also the possibility of making the BOL a grating instrument, which would probably result in considerable simplifications in the mechanisms and optical design. This is currently being studied.

6. Mounting and alignment of the 4-K box with constraints of the strict thermal budget

C. Long lead-time items:

The instrument calibration and test facility must be ready in December 2000, requiring an immediate start in mid-1998.

Conclusions

Instrument development and delivery in time for a launch of FIRST at the end of 2005 is feasible, but the following points must be considered.

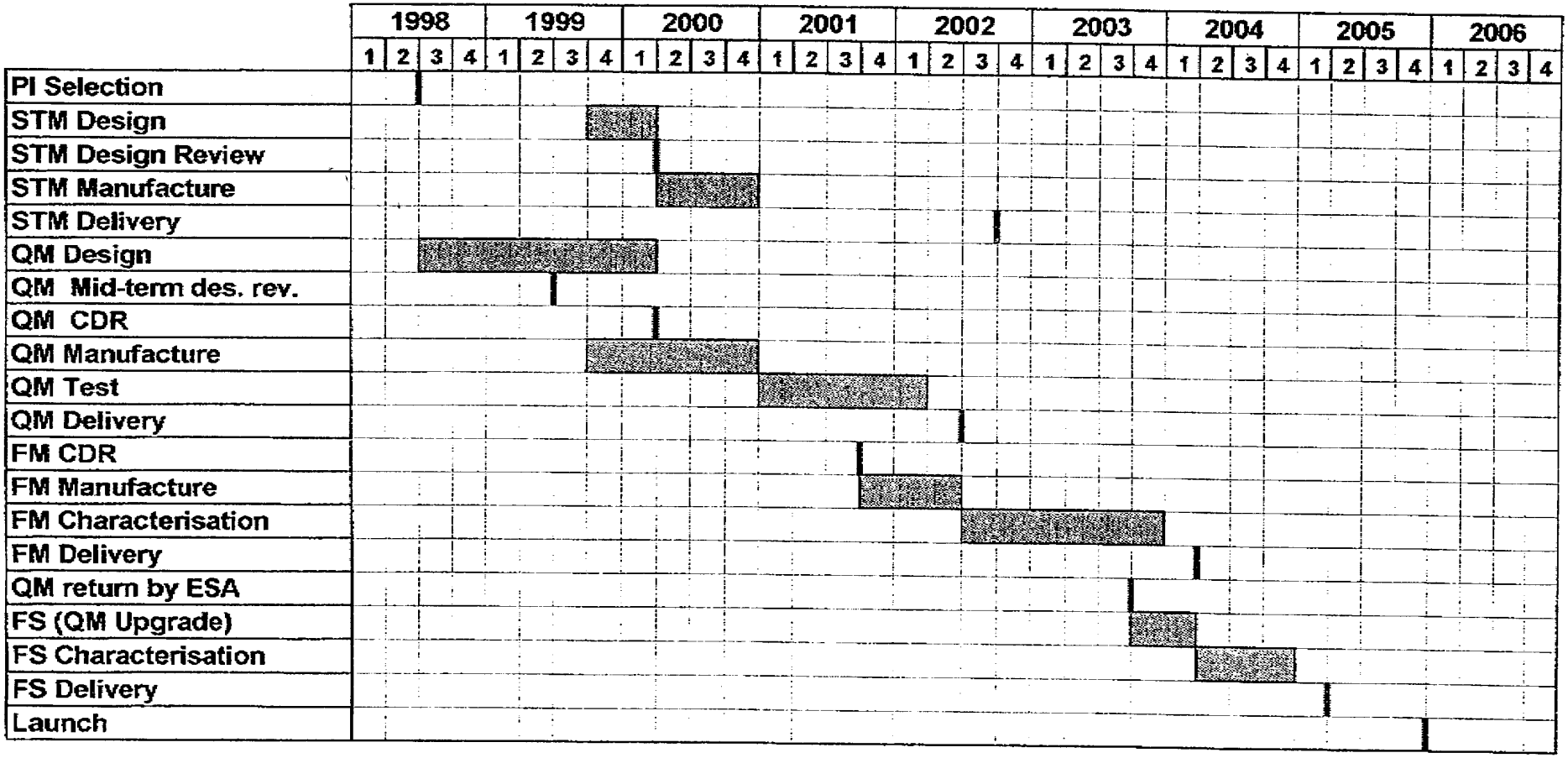
(i) There is no margin whatsoever in the schedule.

(ii) The real work must effectively begin before instrument selection. Consortium formation and funding must therefore be taking place beforehand.

(iii) A most conservative approach must be taken to the instrument design: in this respect, the schedule is probably incompatible with the cryo-cooler option which poses many more difficult design challenges than the cryostat option.

(iv) A realistic programme of work must deal with the fact that it will be difficult or impossible to adopt the traditional procedure of awaiting the successful outcome of a comprehensive Critical Design Review before embarking on flight hardware manufacture. Some means will need to be devised to distribute the review activity over time so that building of some parts of the hardware can start as early as possible. This will pose a lot of project management problems, and impose further pressure to freeze designs early, but it should be possible in principle.

FIRST POSSIBLE BOL INSTRUMENT DEVELOPMENT SCHEDULE



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