

SPICA

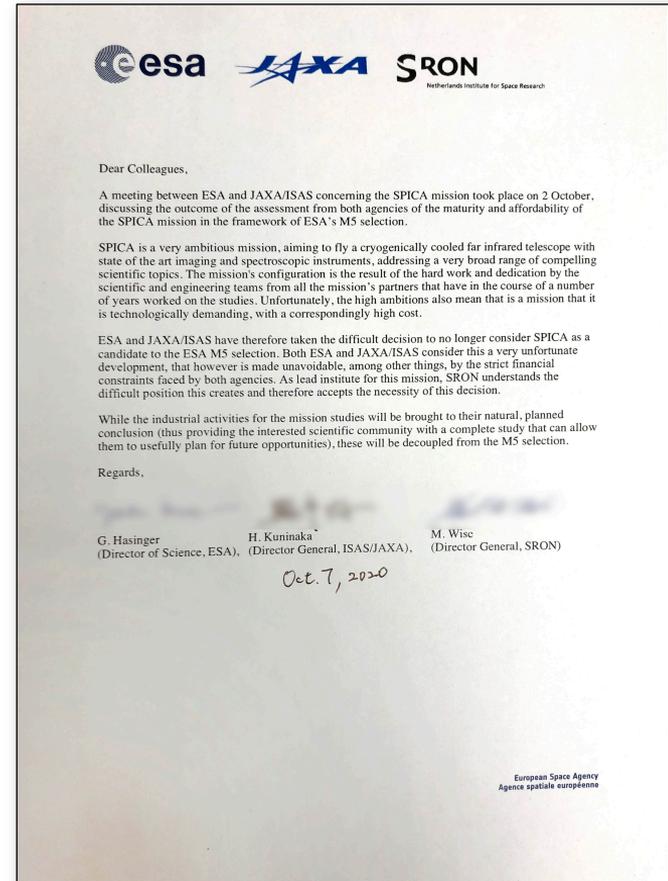
Günther Hasinger
Debriefing SPICA SST
20. 10. 2020



Introduction



- Following a meeting between ESA and ISAS/JAXA, the difficult decision was taken to remove SPICA from the M5 selection competition
 - The reason being that the Estimated-Cost-at-Completion of the mission exceeded the cost cap of *both* agencies
- On 7 October a joint statement, signed by ESA, ISAS/JAXA and SRON was sent to the SPICA collaboration lead scientist, informing him of the decision.
- This decision was not taken lightly, and today I would like to explain the reasoning behind it



SPICA history within ESA



- SPICA was first proposed to ESA in 2007 as an M-class mission with the character of a *Mission of Opportunity* contribution to the JAXA-led mission
 - CDF Study performed, followed by 1 year industrial study of the cryogenic telescope assembly
- SPICA was then re-proposed to ESA in late 2009/early 2010 with a more significant ESA contribution to the JAXA led mission
 - ESA to provide the cryogenic telescope, SAFARI instrument and ground stations
- Joint decision between JAXA and ESA in 2013 concluded that the scheme for SPICA was not compatible with a timely and robust implementation of the mission
 - More balanced sharing of responsibility between JAXA and ESA was required to reduce risk, leading to a more robust mission
- ESA instigated a CDF study of a joint ESA/JAXA mission in 2014
 - Known as the Next Generation Cryogenic Telescope mission (NG-CryoT)
 - This was to study a joint mission in preparation for the next M-class mission call
- SPICA was re-proposed to ESA in 2016 as a candidate for the M5 launch slot
 - M5 SPICA was selected for study in 2018



NG-CryoT CDF study (2014-2015)



- Following earlier internal and industrial studies, a joint CDF study was run in 2014 to investigate a joint ESA/JAXA mission with a smaller diameter telescope than the original JAXA-led SPICA proposal
 - ESA requested this additional CDF study in order to prepare for the future M5 mission call
- Assumptions going into the study:
 - Effective area and other requirements (including operational temperature of the telescope) to be compatible with the **M-class mission** envelope for the ESA contribution
 - Two instruments to be accommodated: SAFARI and SMI
- Baseline design was a **2 m cold telescope** (<10K), using passive cooling (V-grooves, ~50K) and cryocoolers
 - Additional (less detailed) study of larger diameter telescope (3x2.6m) also performed
- CDF output to help identify possible JAXA contributions based on technical and programmatic interfaces

Conclusions of NG-CryoT CDF Study



- The CDF study has shown that a 2m class telescope operating below 6K using a passive V-groove system, as used on Planck, and an active cooling system, as considered for SPICA, is deemed feasible
- Split of responsibility between ESA and JAXA will drive the design and influence the overall cost share
- From CDF Report:
 - *"Even considering international contribution, SPICA is an L-class mission"*
 - *"While the ESA M-call cost envelope remains a challenging target, the study outcomes provide a good starting point for M-class call preparations."*
 - *"The target of fitting the mission into an ESA M-class mission envelope remains a major challenge and requires an increased contribution from JAXA with regards to the study assumptions. Discussions took place between JAXA and ESA after the CDF study, which identified promising solutions (e.g. increased workshare on the S/C PLM and a Japanese contribution to the operations). This scheme, or other potential cooperation schemes, needs to be further studied consolidated in a future study."*

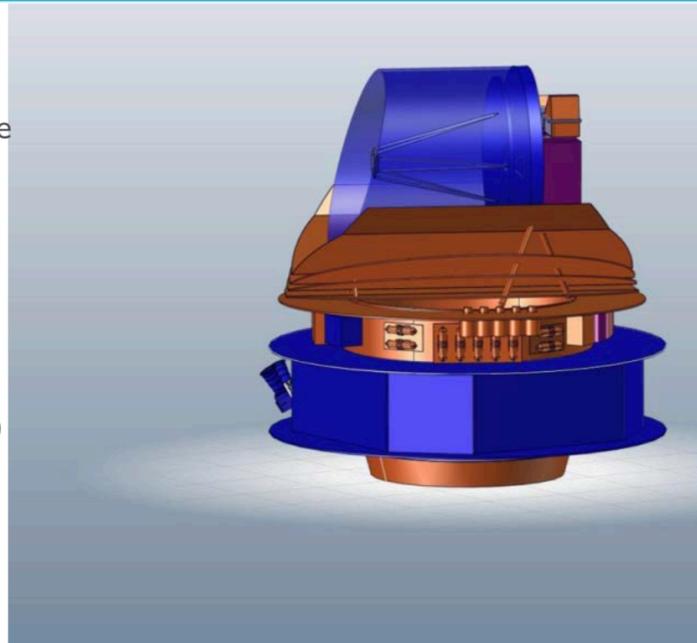


Cost



May 2015

- With the workshare assumed (JAXA provides the launcher, the active cooling, the Fine Attitude Sensor and the SMI instrument) the mission is above the M-class boundary
 - larger contribution of JAXA is required
 - Discussions took place between JAXA and ESA after the CDF study, which identified a promising solution.
 - Combined operations (MOC and SOC)
 - Launcher: JAXA
 - PLM integration and verification JAXA
- This needs to be further studied in a potential phase A



M5 Call for Proposals (April 2016)



The boundary conditions applied to the M5 mission selection were listed in the call for proposal published in April 2016

2 BOUNDARY CONDITIONS

The proposals submitted in response to the present “M5 Call” for mission concepts must be compatible with the boundary conditions spelled out in the present section.

2.1 Cost and schedule

The present “M5 Call” solicits proposals for a mission with a cap to the ESA Cost at Completion (CaC) of 550 M€. Proposals with a cost below this cap would be considered with no prejudice, both for stand-alone missions and for contributions to partner-led missions. Proposals with a cost to ESA exceeding the cap would be considered as non-feasible.

The CaC cap includes the cost of the mission’s nominal operations and can include a contribution to the payload, including the case of a mission with payload fully funded by ESA (à la Gaia).

Call for the “M5 Mission”

April 2016



Call for a Medium-size mission opportunity in ESA’s Science Programme (M5)

1 INTRODUCTION

The ESA Science Programme is based on long-term planning of scientific goals. The Cosmic Vision plan (available as ESA BR-247) was established in 2005 on the basis of a bottom-up process that started with a consultation of the broad scientific community and contains the wide-ranging and ambitious scientific questions to be addressed by missions in the ESA Science Programme.

The definition of the actual space missions that will address the science themes in question is based on the competitive, peer-reviewed selection of Large (L) and Medium (M) missions.

Through the present Call for Missions the Director of Science solicits from the broad scientific community proposals for the competitive selection of mission concepts to be candidate for the implementation of the “M5” Medium mission. The present Call is open to missions in all areas of Space Science.

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The development schedule and therefore the launch date will be driven by the mission’s complexity (and, in case of international partnerships, by the partner’s schedule). It is

Page 1/9

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SPICA M5 Proposal (October 2016)

- SPICA M5 proposal called for a **2.5m telescope** with operational temperature $<8\text{K}$, utilising both mechanical and passive cooling (V-grooves)
 - NB: Telescope diameter larger than CDF study recommended
- Two instruments:
 - SAFARI (joint European, Canadian, US collaboration)
 - At time of proposal, B-BOP was part of SAFARI. Shortly after selection, B-BOP was added as a separate instrument
 - SMI (Japanese)
- Launcher: JAXA H3
 - Orbit: $\sim 800,000\text{km}$ semi-major axis around Sun-Earth L2
- 3 years operational lifetime (5 year goal)



M5 SPICA CDF (July 2018)



- € M5 SPICA CDF focused on *strawman* mission contained in the proposal
 - € 2.5m telescope assembly, with mechanical coolers combined with passive V-groove cooling
- € Mission was deemed technically feasible, albeit complex
- € Estimated Cost-at-Completion was slightly over the M5 cost cap, however CDF does not have a fully consolidated schedule, nor a detailed AIVT flow
 - € Costs are further detailed by Industry during the Phase A studies, and minor cost over-runs can be recovered in a *design-to-cost* approach
 - € Mid-Phase A review (the Mission Consolidation Review) is implemented to allow the industrial studies (technical and programmatic) to be reviewed
 - € Allows the industrial activities to be re-directed in the latter half of Phase A if required.

Mission Consolidation Review (MCR, 07/20)



- ☉ MCR for SPICA was delayed due to the necessary re-design of the platform and instrument (SAFARI) to reduce mass to make the mission compatible with the launcher capability
 - ☉ MCR scheduled to be held in March 2020, but was delayed until June 2020
- ☉ The MCR is specifically to assess the initial detailed design from industry, and to assess if the mission fits within the mass, technical and programmatic constraints
 - ☉ MCR consists of two parts: 1) technical review to assess the technology readiness; 2) programmatic review to assess the budget and schedule
 - ☉ Technical Review (Board meeting on 2 July) found that the mission was technically feasible
 - ☉ Programmatic review (mid July) found the cost of the mission was *significantly* above the M5 cost cap
- ☉ Major findings
 - ☉ Industrial costs of the telescope assembly were significantly higher than CDF estimate
 - ☉ MCR cost estimate based on Euclid telescope (which was not available at time of CDF)
 - ☉ FGS was essential for the science operation. Requirements were better defined during industrial study



Mission Consolidation Review (MCR, 07/20)

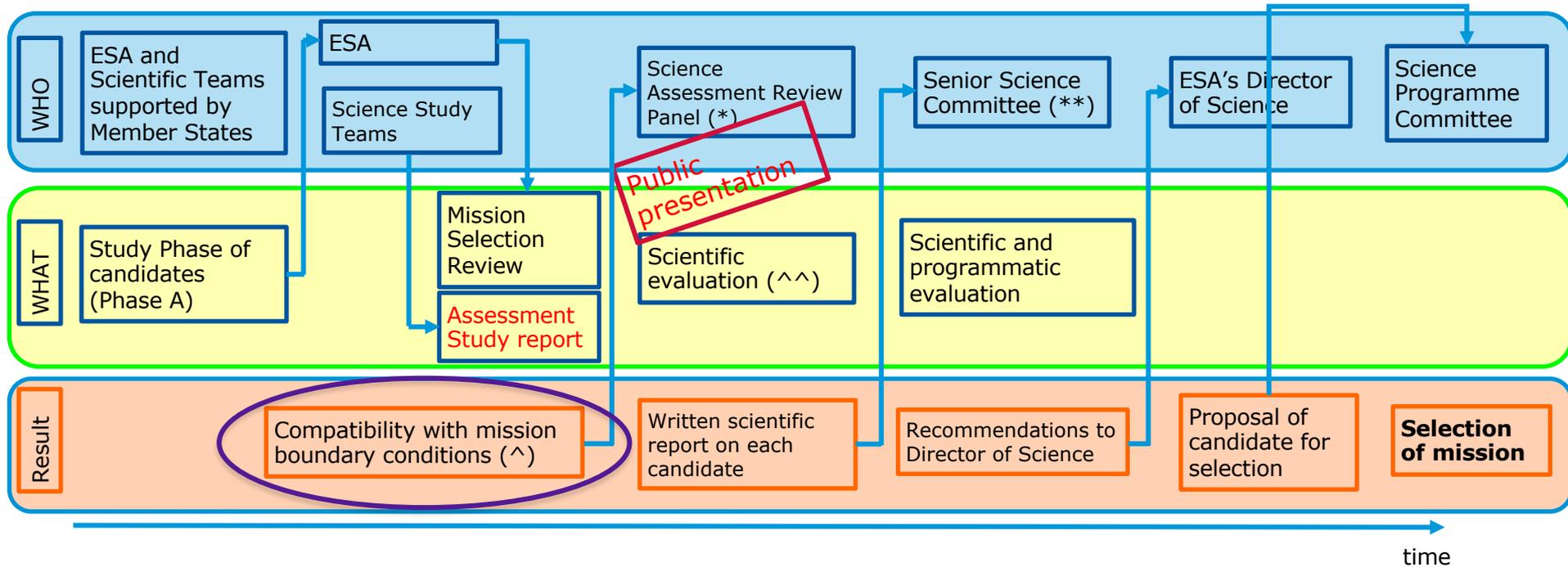


- Conclusion:
 - MCR considered as failed as mission did not fit within cost envelope of the M5 mission
 - Cost of mission with 2.5m telescope, and *not* including FGS or SIA activities was *significantly* over the M5 cost cap
 - No *simple* descope option was possible to bring the mission back to affordability in M5 competition
 - Required major redesign of the mission, as well as re-appraisal of the share of responsibilities with JAXA



- ☉ In order to maintain SPICA in the M5 competition, several drastic actions were required to attempt to significantly lower the EaC to ESA, while maintaining a scientifically compelling mission (beginning of August 2020)
- ☉ Mitigating Activities:
 - ☉ Reduction of telescope diameter from 2.5m to 1.8m
 - ☉ Industry tasked with estimating the mission cost with smaller telescope and correspondingly smaller platform. Initial estimate would still not bring SPICA back within M5 budget
 - ☉ Inclusion of the FGS in SMI (under JAXA)
 - ☉ Transfer of SIA activities back to JAXA
 - ☉ Consolidation of schedule
- ☉ JAXA also have similar affordability issues with their SPICA contribution, and are therefore unable to take on the new activities (end September 2020)
- ☉ This has led to the difficult decision, due to the affordability of the mission at both JAXA and ESA, to remove SPICA from the M5 competition (beginning October 2020)

M5 Mission – selection process



(^) Including financial envelope, TRL of mission elements and readiness of Funding Agencies to fund mission elements proposed not to be under ESA's responsibility

Programmatic and technical review is ongoing throughout Phase A



Communication between ESA and SPICA team



☉ MCR Technical Board Meeting (2 July)

- ☉ Instrument Team leads and JAXA representatives were invited as observers (2 July)

☉ Email to SPICA Collaboration lead scientist (Peter Roelfsema) following conclusion of programmatic review (6 August)

- ☉ Explained that SPICA, as reviewed in MCR, was not compatible with the M5 constraints. Excerpt from email:

"We discussed with both JAXA and the head of SRON, and we discussed the alternatives facing the SPICA study. We all agree that the current mission, with the 2.5+ meter telescope, while scientifically very appealing, is not feasible for the M5 slot, and therefore it cannot be one of the three missions in competition.

We also discussed internally what are the possibilities for an "affordable" mission profile. You will realise that a new, complete optimised study in the short remaining time is simply not achievable. The only thing we can change in a short time is the telescope diameter, and going down to a 1.8 m class mirror we can get in the ballpark of the M5 target (still some 5% above, but within shooting distance) while maintaining the very same configuration, equipments, etc. This assumes that JAXA provides the FGS and the Science Instrument Assembly that was still under discussion (something that JAXA needs to confirm formally). In any case the CDF outcome was that we could afford a mirror at 2 m or below, so this should not surprise anybody."



Communication between ESA and SPICA team



- Bi-lateral telecon between JAXA and ESA took place on 2 October
 - Clear that the total cost of SPICA exceeded the combined cost envelopes of the two agencies, and therefore there was no route to proceed to the M5 selection
- Joint letter from JAXA, ESA and SRON sent to SPICA Collaboration lead scientist on 7 October, notifying him of the decision to remove SPICA from the M5 competition
- ESA proposed meeting between ESA Executive and SPICA Science Study Team on 7 October to explain decision and answer questions from the SST
- Videocon with ESA Director of Science and SPICA Science Study Team held on 20 October



Conclusion [1]



- ☉ Since the time of the initial SPICA studies, it was clear that SPICA was large, complex space observatory
- ☉ The NG-CryoT CDF study concluded that a 2m telescope was technically feasible, but was challenging to fit in to the Medium-class cost envelope
- ☉ M5 mission call sets a hard financial limit of €550M on ESA cost-at-completion
 - ☉ M5 SPICA proposal called for a 2.5m telescope, with extra functionality included in SAFARI (B-BOP)
- ☉ Mission Consolidation Review concluded SPICA Estimated-Cost-at-Completion was significantly above the €550M cost cap
- ☉ Only way to maintain SPICA in the M5 competition was to drastically reduce the cost of the mission
 - ☉ telescope diameter reduced to 1.8m
 - ☉ transfer responsibility of FGS to JAXA in order to fit within M5-cost constraint
 - ☉ SIA transferred back to JAXA
- ☉ JAXA internal review concluded cost of mission also exceeded their cost cap



Conclusions [2]



- Mission Selection Review is a technical/programmatic review – Scientific Assessment and ranking is run in parallel
 - The SST could have continued to work on the science case and Assessment Study Report (Yellow Book) of the descoped (1.8m mirror) mission
 - However, neither JAXA nor ESA could see a way to accommodate the cost of the mission within available budgets, and there was insufficient time to find a third partner agency (NB: NASA had already not approved participation in SPICA)
 - Due to the mission exceeding the M5 budget, one of the fundamental preconditions to enter scientific assessment would have been not met.
 - Hence the mission was removed from competition in October.

Joint decision between JAXA and ESA to remove SPICA from M5 competition due to affordability of the mission at both agencies



Thank you very much!

