

**EUROPEAN SPACE AGENCY**

**SOLAR SYSTEM WORKING GROUP**

**Recommendation on the magnetometer experiment for the BepiColombo mission**

Following the recommendation formulated at the Solar System Working Group meeting held on 8<sup>th</sup> September 2005, the MERMAG team was required to confirm, through presentation or written report, that the scientific objectives and basic hardware elements are not markedly different from that proposed by the MERMAG team in response to the BepiColombo AO. This would have allowed to approve formally the change of the PI position from Prof. A. Balogh (UK) to Prof. K.-H. Glassmeier (D).

At the last SPC meeting a discussion ensued on the opportunity for HIMAG to be reassessed in the light of the new boom configuration with respect to the AO.

Reports on the documentation supplied by the MERMAG and HIMAG teams, provided by the PRC and by the BepiColombo System and Accommodation Panel, were presented to the SSWG:

- The PRC “sees no reason to change its recommendation to select the MERMAG proposal for the MPO magnetometer”;
- it also noted that the corresponding funding agencies have expressed their support for the new management scheme;
- the System and Accommodation Panel recommends also to stay with the selected but updated MAG design.

**In view of the documents presented, the SSWG, at its 119<sup>th</sup> meeting held on 6<sup>th</sup> October 2005 at ESA Headquarters, Paris, unanimously recommends that the MERMAG team be confirmed as the magnetometer team for the BepiColombo MPO and that Prof. Karl-Heinz Glassmeier (Technical University of Braunschweig, Germany) be confirmed as PI of the experiment.**

The SSWG notes that the PRC pointed out the benefits of strengthening the MERMAG team with internal magnetic field specialists. Prof. K.-H. Glassmeier, following the initial steps by his predecessor as MERMAG PI, has renewed invitations to the HIMAG team. Both the PRC and the SSWG support this approach.

**Recommendation of the MPO Payload Review Committee  
on the status of the MPO magnetometer**

Y. Langevin (Chairman of the PRC) - 5<sup>th</sup> October 2005

In October 2004, the MERMAG proposal for the MPO magnetometer had been recommended for selection by the SSWG, then the SSAC to SPC, following a recommendation of the Payload Review Committee of the Mercury Planetary Orbiter. During the first half of 2005, it became apparent that the funding agency of the PI, Andre Balogh (UK) would not support this experiment. During its September 2005 meeting, the SPC requested a delta review on the status of the MPO magnetometer.

The recommendation of the PRC in September 2004 was the following:

*The PRC considered the specific interest of the magnetic field determination for planetary science, which is the primary field of interest of the MPO, the risk assessment, the impact on other experiments (in particular the important geodesy investigations), the scientific inputs from the teams and the overall balance of the MPO science mission, within a tightly constrained mass budget. From these elements, the PRC recommends a fixed boom with adequate rigidity and the implementation of a two sensor approach. With a dual sensor approach, a boom length of 1.5 m (3.4 kg) is considered as a minimum requirement for a reliable determination of the dynamo fields, with a first estimate of 160 nT for the residual DC field at the boom tip. The PRC supports the ROSETTA-type EMC program proposed by the project so as to minimize the impact of spacecraft induced fields, in particular (but not only) the variable components. The PRC is confident that this program, which should be continued with the magnetometer team after selection, will be successful in securing a science return on crustal and induced fields in addition to the characterization of the dynamo field.*

*From these boundary conditions, and considering the experience of the MERMAG team for dealing with EMC issues on spacecraft not primarily dedicated to magnetic field measurements, the PRC recommends the MERMAG proposal for selection. A trade-off between system and payload responsibilities is being considered by the project for command and data formatting tasks.*

*The HIMAG team was considered highly competent, and could provide a back-up solution in the framework of the PRC-recommended approach for the MPO magnetometer. The PRC notes the strong scientific qualifications of the MIME team for internal and crustal magnetic fields. However, the MIME team has limited experience in building magnetometers for solar system exploration missions.*

*The PRC notes that magnetic fields investigations around Mercury involve a wide range of scientific objectives, from dynamo fields to crustal fields, induced fields and external fields. The PRC therefore recommends that the science support for the magnetometer investigations be made as strong as possible in all these domains.*

Following the funding difficulties in the UK, the MERMAG consortium provided a modified management plan with increased contributions by Germany and Austria and K.-H. Glassmeier (IGEP) as PI of the MPO magnetometer. The corresponding funding agencies have expressed their support for this new scheme during the September SPC. The HIMAG team has also indicated its willingness to provide a back-up solution in a letter to ESA (23/09/05).

### ***Procedure and boundary conditions***

The PRC was provided relevant delta documentation on both the revisited MERMAG proposal and HIMAG, in particular:

- an updated interface document and management plan for MERMAG
- the letter from HIMAG formalizing the resubmission of the proposal; documentation on the impact of boom length on the science return was also provided

Given the extremely short time available for the review (two weeks) and the severe problems of several of the members (in particular our three Japanese colleagues) to participate at such a short notice, it was considered inappropriate to convene a formal meeting of the PRC. An electronic mail forum was initiated between all members. This resulted in a draft recommendation, which was submitted to the PRC members before finalization.

In september 2004, the Payload Review Committee explicitly recommended that back-ups should only be considered “*in the framework of the PRC-recommended approach or the MPO magnetometer*”. This approach is presented in the first paragraph of the PRC recommendation: “*From these elements, the PRC recommends a fixed boom with adequate rigidity and the implementation of a two sensor approach. With a dual sensor approach, a boom length of 1.5 m (3.4 kg) is considered as a minimum requirement*”.

As a consequence, the PRC did not reopen the discussion on boom length. However, the PRC notes with interest that the nominal boom length is now 2 m, and that the ROSETTA type EMC program recommended in September has already been initiated. These positive developments strengthen the science case for the approach recommended in September 2004.

### ***Discussion***

The new MERMAG scheme fits the definition of a back-up under these boundary conditions, as the requirements on the spacecraft are unchanged, in particular the accommodation scheme for the two sensors. The MERMAG team assumed a boom of only 1.5 m length in their original proposal. A rigid 2 m boom thus surpasses the MERMAG requirements. The letter which resubmits HIMAG states that “*the proposed magnetometry complex is compatible with the presented range of contractor boom designs*”. However, this proposal still relies on a star sensor for determining the attitude of the magnetometer at the tip of the boom. The HIMAG team also indicates that “*a 3m (or longer) boom will considerably relax the S/C magnetic requirements for full science data quality return*”. As it stands, the resubmitted HIMAG proposal is therefore not fully compliant with the PRC recommended approach for a back-up.

*Table I: mass and power resources*

	MERMAG (initial)	MERMAG (revised)	HIMAG
Mass (with 20% margin)	1.901 kg	2.010 kg	2.078 kg
Power	4.1 W	2.7 W	4.3 W

The major issue is therefore whether the revised MERMAG management scheme could have a negative impact on the expected science return of the investigation. Given IGEP's record, this change in management is not affecting the strength of the team. Consistent with this change in responsibilities, the team has adopted a magnetometer sensor design pioneered at IGEP, which has a long successful heritage. This design is identical with that selected for MMO, which was given very high marks during the review process of MMO instruments. The mass and power resources (table I) are similar to the previous MERMAG configuration, with a slight increase in mass and a significant decrease in power. During its extensive discussion of science issues in the summer of 2004, the Payload Review Committee noted that the coordination of MMO and MPO measurements, in particular when the spacecraft are close together (every 4<sup>th</sup> orbit) are critical for separating variable and fixed components. Measuring at two points with identical sensors, as proposed in the revised MERMAG scheme, will significantly facilitate the important comparisons between MPO and MMO measurements.

In September 2004, the Payload Review Committee noted that the emphasis of the MERMAG team was mainly on magnetospheric physics aspects, and that it would be beneficial to strengthen the team with internal field specialists. Such a process was initiated by A. Balogh, and K.H. Glassmeier has renewed these invitations. The Payload Review Committee supports this approach.

### ***Recommendation***

The revised MERMAG management scheme should provide a science return similar to that of the initial proposal, with the additional asset of using the same sensors on both spacecraft. Therefore, the MPO Payload Review Committee sees no reason to change its recommendation to select the MERMAG proposal for the MPO magnetometer. The PRC considers that HIMAG sensors could be used as back-ups, but in our view this should not lead to reconsider the fixed boom, dual sensor configuration without a star tracker at the tip of the boom.