

Progress Report on ASO-S*

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Abstract The Advanced Space-based Solar Observatory (ASO-S) started officially its engineering phases at the beginning of 2018. In the past two years from 2020 to 2022 ASO-S completed smoothly the Phase-C study and is now undertaking the Phase-D study. The launch date is finally set in October of 2022. We here briefly summarize the progress of ASO-S from the late Phase-C to the current Phase-D studies, and plan the scientific affairs around the launch.

Key words Space astronomy, Solar physics, Spacecraft

Classified index P171

1 Introduction

ASO-S is the first comprehensive solar mission in China^[1], which was officially approved at the end of 2017 by the Chinese Academy of Sciences (CAS) via the Strategic Priority Research Program of Space Science. The scientific goals of ASO-S could be summarized as 1M2B, *i.e.*, on a single platform to observe simultaneously the solar magnetic field, solar flares, and Coronal Mass Ejections (CMEs), so as to investigate the origin mechanisms of solar magnetic field, solar flares and CMEs and possible causality among them. To fulfill these goals, three payloads were deployed, which are the Full-disc vector Magneto Graph (FMG), the Lyman-alpha Solar Telescope (LST), and the Hard X-ray Imager (HXI), respectively.

The details of ASO-S up to the end of Phase-B can be found in the special issue in the journal *Research in Astronomy and Astrophysics* (RAA), which includes a total of 14 papers^[2–15], describing the general framework, the scientific objectives, systematic designs, payload schemes, prototype models, engineering models, scientific systems, the synthetic studies, and so on. In 2020, a

special issue in Chinese, as a supplement of that on RAA, was published in *Acta Astronomica Sinica*, which includes a total of 15 papers^[16–30], describing even more details like the designs for some key issues of the sub-systems.

In the last progress report^[31] two years ago, we briefly introduced the history of ASO-S, its scientific objectives, its payload deployments, the whole mission, as well as the Phase-B study and early Phase-C study. Here we continue along this way, but extend to the late Phase-C and Phase-D stages.

2 Late Phase-C Study

According to the last report^[31], the Phase-C study should have been finished in August 2020. But in practice the whole system finished the Phase-C study with a delay of almost one year. The COVID-19 epidemic was obviously one of the main reasons resulting in such a long delay. In addition, each payload has its own problems. For FMG, the original detector contractor was changed and then the newly-supplied detector (CMOS) was partially damaged in an environmental test. For HXI, the import

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of chip IDE 3381 in the electric control box took quite a long time and the beam test to check the behavior of fine grids needed a new X-ray source, which also took some time to satisfy the requirement. The longest delay was for LST. Due to the complexity of LST, the workload was much more than ever thought, especially on how to suppress the stray light. After a series of studies and simulations, finally both the original designs in hardware and software (like the exposure time modes) have to be changed, so as to meet the design objectives of the LST.

Based on the Phase-C pass of both HXI and FMG in April 2021 and LST in August 2021, the satellite system as a whole moved officially from Phase-C to Phase-D in September 2021 after all required tests were well made, like desktop joint commissioning, assembly performance, vibration, vacuum, thermal balance, thermal cycle, and so on.

3 Phase-D Study

Although the Phase-D was officially started only in September 2021, as a matter of fact, quite a number of Phase-D works had already been begun during the Phase-C study. This style of parallel working saves quite a lot of time required for the Phase-D study, which was set from September 2021 to August 2022. Then with over one month preparation for the transportation and all the works at the launch site, ASO-S is scheduled for launch in October 2022.

During the Phase-D study, there are almost no changes for all technical status. Everything goes smoothly as planned although it is always tense in time. No major harmful issues have appeared except for FMG which met again a damage of the detector in the environmental test of thermal-vacuum. The luck is that there is a backup of the detector. Up to March 2022, all the desktop debugs between each flight model of payloads and the platform, as well as that as a whole have been finished. In May 2022 the integration of the whole system will be undertaken and then the final environment, performance and communication tests will be made. If everything goes as expected, the ASO-S will be transported to Jiuguan launch site at the beginning of September 2022.

4 Scientific Preparations

With approaching to the launch time, scientific prepara-

tions have become more and more important. In fact, with the initiation of the engineering phases, the scientific preparations had unfolded at the same time. There are two parallel aspects, one is so-called Science Operation and Data Center (SODC), as a part of mission engineering, supported by the Strategic Priority Research Program of Space Science, CAS; the other is the researches related directly to the usage of future ASO-S data, supported via grants from both the National Natural Science Foundation of China (NNSFC) and the CAS. Up to March 2022, SODC finished most of the work set in the four categories of scientific operation, data management, data analysis center, and user service. A major research project supported by a joint grant of NNSFC and CAS has been finished at the end of 2021. Now the science teams are working hard and try to complete the pipeline with version 1.0 (in which the basic functions should be wholly covered and operationable) in both the data production and data analysis tools by the end of May 2022. Then updating and improving will be kept on until to an advanced status that the team itself can work smoothly when the data are available and the users outside the team can make use of the data and tools without any difficulties.

Due to the influence of COVID-19 epidemic, the planned international workshop of ASO-S in 2021 has to be cancelled. How to arrange the following domestic and international cooperation is still under investigation. Anyway, to ensure a successful launch in 2022 is of primary importance. An open training course for the usage of the ASO-S data is planned to hold either in-person or in virtual forms at a suitable time between the launch and the open release of the data.

5 Conclusions

By now ASO-S is undertaking its Phase-D study. All the works look smooth and are on the track of the schedule, although the itinerary shows to be very tense. Let's express our best wishes for a successful launch in October 2022. Let's wish all the payloads working well in orbit, and bringing us a series of exciting observations. Meanwhile we hope that more and more colleagues could be interested in ASO-S mission and make use of the data, in order to realize its scientific objectives.

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