平成２９年度国立天文台滞在型共同研究報告書
Activity Report for NAOJ Visiting Joint Research in FY 2017

2017年　8月　18日

申請者 Applicant	氏　名 Name	かつかわ　ゆきお 勝川　　行雄
	所属・職 Division・position	SOLAR-C準備室　・　助教
研究課題名 Research Title	SUNRISE-3偏光分光装置制御システムの開発研究	
研究場所 Place	国立天文台三鷹	
共同研究者 氏名・所属・職名 Joint researcher's Name・Institution・Position/ Graduate Student year	Juan Pedro Cobos Carrascosa Institute of Astrophysics of Andalusia –IAA- (Spain) Computer Engineer (Ph. D.)	

１．研究概要（Summary of research）

In the collaboration between NAOJ and IAA context for the new SUNRISE-3 balloon mission, the IAA is developing the main electronic for the SCIP instrument. SCIP is basically a spectropolarimeter that uses two main mechanisms (scan mirror and a polarization modulator) and three cameras (two for polarimetric use and one slit-jaw camera). To control the instrument and to process the images is necessary to develop a specific Data Processing and Control Unit (DPU) which will contain hardware devices (processors and FPGAs) and embedded software. Precisely, in these tasks was concentrated the work carried out by the invited researcher during his stay.

The invited researcher studied the scientific requirements about image rate and the kind of processing to carry out to them in order to design the most convenient hardware. The preliminary DPU design before staying at NAOJ was basically based on a multicore CPU and a frame grabber using FPGA. However, to adjust an optimal hardware design to the available resources during the flight (space, weight, power consumption, etc.) was not possible without a severe knowledge about the instrument. For it, he studied in detail the frame rate, the data range and the needed processing like accumulation, demodulation, and image compression. These operations impose several requirements at a hardware level as bandwidth between the different devices as well as memory and power processing capabilities.

SCIP will take images that have to be demodulated and integrated on board using different exposure times. The integrated images will be compressed for being stored in the centralized massive storage of the Sunrise platform, which is certainly much reduced. So, the invited researcher has studied deeply how to compress the information and the necessary hardware for it. The final decision is to use a scheme based on bit and image compression working together sequentially.

In short, the feedback and communication with the NAOJ scientific personnel has been essential to clarify several aspects about the SCIP performance what will be fundamental for the DPU design and software. And it also will be valuable for the SCIP development. The fluent communication between the scientific SCIP team and the invited researcher has produced the gathering of all necessary details about the expected scientific images, acquisition schemes, and the observing modes for producing an optimal DPU design.

２.研究成果(Research achievements)

The continuous discussions with NAOJ scientist during the invited researcher stay was fundamental to reach some clear agreement as:

- A full agreement has been reached about how the polarized images are generated by SCIP and how the DPU has to synchronize, control, process and manage the polarization modulator and the scan mirror.

- A more accurate knowledge about SCIP has permitted to specify strongly the necessary bandwidth between the difference interfaces (type and capabilities of CoaxPress, PCI Express, SATA or USB buses). This information also will define the frame grabber requirements (FPGA and adjacent memory size).

- The SCIP performance, together with the communication interface with the *Sunrise* platform, imposes some requirements to the DPU internal elements as the size and kind of the internal memory.

- The most part of the image processing (demodulation, integration and compression) will be carried out by the frame grabber on FPGA for reaching the real time requirement.

- The DPU will act as an image buffering whether the communication interface suffers a momentary overload or misbehavior.

The study about the SCIP image processing requirements has been very fruitful. It was very well known that the SCIP images have to be compressed before being stored in the massive storage of Sunrise platform. So, the invited researcher focused deeply in to study this task. Using simulated images by NAOJ, we decided to use a data compression strategy based on a preliminary bit compression method and, after that, on an standard image compression, because the data range in the integrated images is higher than the expected input by the standard compression algorithm. The bit compression has been tested and a technical note has been generated. Another technical note will be generated about the reached compression factor by different lossless and lossy compression algorithms. All this work has generated important tests that will be the base for the incoming work line.

On the other hand, a first proposal about the communication between the Scan Mirror Mechanism driver and the SCIP electronic has been described. This will permit to finish the SMM definition by NAOJ and JAXA, and to mark the instrument development.

３．本制度に対する意見、要望など【申請者記載欄】
(Any comments on this program【For applicant】)

１ヶ月という短期間の滞在ではあったが、SUNRISE搭載偏光分光装置の制御、及び、機上画像処理について、日本側の求めている機能をスペイン側に理解してもらうことができ、今後のハードウェア、ソフトウェア実装に向けて重要なステップとすることができた。今回の渡航は家族同伴であったが、コスモス会館のファミーリームが満杯だったため、キャンパス外の部屋を借りた。その手続にあたっては、サポートデスクの方の支援は必須であった。

４.本制度に対する意見、要望など【本事業で来訪した共同研究者記載欄】
(Any comments on this program【For joint researcher】)

The close communication between researchers provided by this program will contribute significantly in the development of this project. In the invited researcher case, he appreciated hugely this opportunity as a great mean of professional growth. According to his opinion, the support desk help was very important and fundamental.

５.共同研究者の滞在日程(Joint research period)

氏名・所属 （Name・Institution）	Juan Pedro Cobos Carrascosa Institute of Astrophysics of Andalusia (Spain)
滞在日程（Period of stay）	日数(days)
2017年　7月　10日　～　2017年　8月　5日 YYYY/MM/DD　～　YYYY/MM/DD	27 日間(days)
年　月　日　～　年　月　日 YYYY/MM/DD　～　YYYY/MM/DD	日間(days)
合　計（Total）	27 日間(days)