WP2: Large-format high-speed low-noise detectors

Description

Work package number	WP2	Lead beneficiary	4 - MPG
Work package title	Large-format high-speed low-noise detectors		
Start month	1	End month	36

Objectives

- Development of an imaging large-format camera
- Development of a high-precision polarimetric camera
- Study and testing of a large-format wavefront sensing camera

Description of work and role of partners

WP2 - Large-format high-speed low-noise detectors [Months: 1-36] (MPG, IAC, INAF, QUB, UCL, ANDOR TECHNOLOGY PLC)

WP2 is divided into the three sub-WPs according to the different purpose cameras that are proposed for development, study, and testing:

- sub-WPs 2.1: Development of an imaging large-format camera (QUB, UCL-MSSL, ANDOR)
- sub-WPs 2.2: Development of a high-precision polarimetric camera (MPG)
- sub-WPs 2.3: Study and testing of large format wavefront sensing camera (INAF)

The sub-WPs are distributed among the different partners according to their expertise. IAC will have a close contact with all of the partners involved to ensure the contact with the EST project, to make sure that the sub-WPs are made in accordance to the EST requirement and to coordinate the impact the results may have on the EST design.

Sub-WP 2.1: Development of an imaging BSI large format camera (ANDOR, QUB, UCLMSSL)

The development the large-format back-side illuminated (BSI) prototype will be based on the scientific Complementary Metal Oxide Semiconductor (sCMOS) technology. We will work with a sensor design house that has the capability to provide a fully depleted high quantum efficiency (QE) sCMOS sensor that will match closely current CCD QE and Modulation Transfer Function (MTF) for an equivalent thickness. In order to keep the costs to a minimum, we work on the adaptation of a pre-existing format and apply suitable modifications so that it meets the required specifications.

The main tasks that will be undertaken for the development of the BSI sensor can be summarized as follows:

- Agree and approve a final set of sensor specification.
- Develop the sensor architecture using a detailed design and simulations.
- Tape-out, manufacture, wafer test, die slicing and packaging.
- Design the camera electronics for the sensor, manufacture and test.
- Adapt the FPGA to accommodate the BSI sensor pinout.
- Implement changes an existing mechanical design to compensate the BSI sensor.
- Modify optical tests required to characterize the BSI sensor and analysis of results.
- Build camera prototype for evaluation and test.
- Integration of SW, FPGA and HW and detailed testing of same.
- Acceptance tests in the laboratory prior to prototype camera delivery.
- Acceptance tests in a solar telescope facility.

tip. *You can check the descriptive brochure at the bottom of this page.

Sub-WP 2.2: Development of a high-precision polarimetric camera (MPG)

The Zurich Imaging Polarimeter (ZIMPOL, e.g. Gandorfer et al. 2004), is so far the only available charge-caching polarimeter. It is based on charge-shifting between open and covered CCD columns and has a proven photon-limited polarimetric accuracy of order 10-5. However, this CCD technology from the 1990s can by far not fulfill the requirements in terms of spatial resolution, FOV and time cadence, and thus an investment in new technology is clearly needed. We propose to explore the novel DEPFET charge-caching technology in terms of a feasibility study, which will lay the foundation of a potential next-generation science-ready camera for high precision spectro-polarimetry.

The study will be limited to the investigation of a small test sensor of about 32 x 32 superpixels, which will allow testing the practicality of the concept for high-precision polarimetry in the lab. Based on the existing prototype design study, different layout variants will be generated and verified. Based on simulation results, the most promising layout variants will be used to produce the prototype sensor. The produced sensors will then be functionally verified, and the best variants will be tested with respect to their application in high-precision polarimetry.

The outcome of the study will be a solid feasibility statement including:

- Scalability of a potential science-ready sensor array in terms of format (number of pixels)
- Scalability of the sensor in terms of pixel sizes
- Definition of optimised fabrication technology
- Evaluation and tradeoff analyses of different layout options
- Costs

Sub-WP 2.3: Study and testing of large format wavefront sensing camera (INAF)

This sub-WP consists of the study and testing for the purpose of potential application in EST of the sCMOS technology currently under development and testing at the ESO for the wavefront sensing system of the night-time E-ELT, specifically the massively parallel sCMOS camera such as the NGSD (Natural Guide Star Detector), a 880x840 pixels, large field-of-view, high QE (>90%), low read out noise (< 3 e-), and very fast frame rate sensor.

sub-WP 2.3 includes the following activities:

- Definition of study and test procedures. Definition of evaluation criteria.
- Laboratory setup.
- Study and laboratory tests of the modulation schemes (rolling shutter).
- Study and laboratory tests of the data handling (data compression, FPGA real-time preprocessing).
- Study and laboratory tests of the camera specifications in Shack-Hartmann wavefront sensing of extended sources.
- Study and laboratory tests of the camera performance in high precision polarimetry with 10-4 noise level measurements (camera noise, possible systematic errors and artifacts).

Documentation

At the footer of this page you can find next documentation of this workpackage:

- OT EST QuB.pdf: "High-speed & high-sensitivity imaging in Astronomy" Technical brochure.

Files

OT EST QuB.pdf	532 KB	2018-01-09	GREST EST