6 Very High Energy Gamma Ray Astronomy with CTA

F. Canelli, D. Florin, A. Gadola, A. Murtezani, S. Steiner, U. Straumann, A. Vollhardt, D. Wolf

in collaboration with: MPI für Kernphysik Heidelberg, Universität Erlangen, Universität Innsbruck, Universität Tübingen and over 210 institutes from 32 countries

(CTA)

The Cherenkov Telescope Array (CTA) represents the next generation of Imaging Atmospheric Cherenkov Telescopes (IACTs). IACTs, like the present H.E.S.S. [1], MAGIC [2], and VERITAS [3] are ground-based mirror telescopes used to detect gamma rays of energies from several 10 GeV up to hundreds of TeV. Sources of such very high energy (VHE) gamma rays are both galactic and extragalactic, including quasars, supernovae and their remnants, gamma-ray bursts, and possibly dark matter annihilations. The signal is a faint (100 photons/m^2 @ E_γ = 1 TeV) and very fast (few ns) Cherenkov light flash, produced in the shower developing in the Earth's atmosphere after an initial $\gamma \rightarrow e^+e^-$ pair production, allowing the reconstruction of the primary gamma ray's energy and direction. With more than 100 telescopes which will be located in the northern and southern hemispheres, CTA will be the world's largest and most sensitive high-energy gamma-ray observatory. A comprehensive survey of planned research activities with CTA has recently been published [4].

The CTAO gGmbH ("gemeinnützige Gesellschaft mit beschränkter Haftung" according to German law) with official seat in Heidelberg is the interim legal entity to prepare construction and operation of the CTA observatories. In the past year the organisation concentrated to work towards creating a final legal entity in the form of an European Research Infrastructure Consortium (ERIC) with Italy as hosting country. It is expected, that sometime in 2019 the ERIC could officially start. Meanwhile the headquarters have been established in Bologna, Italy, with a growing number of employees, including a CTA project manager. The detailed planning of the infrastructure on the two observatory sites in La Palma (Canary Islands) and at the European Southern Observatory (ESO) area in Chile made significant progress and first geotechnical studies of the sites have revealed promising results. U. Straumann, acted as the director of the CTAO gGmbH until February 2018.

The Zurich group continued to be involved in the design and prototype construction of three projects for CTAO: Camera frontend electronics and mechanical body with safety and power for FlashCam, mirror actuators as well as the master clock for the whole telescope array.

In 2017 our longstanding mechanical technician, Stefan Steiner, went to retirement. Thanks to his wide technical experience, and his strong commitment and dedication the Zurich designs of the mirror actuators and the camera bodies have reached technical maturity and prototypes are now being tested by several other groups. We are happy to welcome his successor Afrim Murtezani in the Zurich CTA team.

[1] B. Opitz *et al.*, (HESS collaboration), AIP Conf. Proc. 1223 (2010) 140.

[2] J. A. Coarasa *et al.*, (MAGIC collaboration), J. Phys. Soc. Jap. Suppl. 77B (2008) 49.

[3] D. Hanna *et al.*, (VERITAS collaboration), J. Phys. Conf. Ser. 203 (2010) 012118.

[4] B.S. Acharya *et al.*, (Cherenkov Telescope Array Consortium), arXiv:1709.07997.

6.1 FlashCam camera body

The FlashCam camera [5] is the first fully digital Cherenkov telescope camera and will suit the mid-size telescope of CTA. The UZH group contributions to the camera have been the development and production of prototype series of the photon-detector modules, which have been handed over to the University of Erlangen for a future mass-production. The second large contribution is the design and production of the whole camera body mechanics including the camera safety control, the power control and distribution, as well as the cooling. The first prototype body was tested in 2015 on a telescope prototype in Berlin and staffed with electronics in Heidelberg during 2016 and 2017. In autumn 2017 the camera was mounted again on the telescope in Berlin, where it became fully operational in a very short period of time and was commissioned successfully in all aspects.

Based on lessons learned the camera body and safety cabinet was slightly improved in several aspects and two new bodies (see Fig. 6.1) have been assembled during 2017. They are considered to be the final versions and will be subject to a review to be organized by the CTAO management. If things go well the two bodies could become the first production camera bodies.

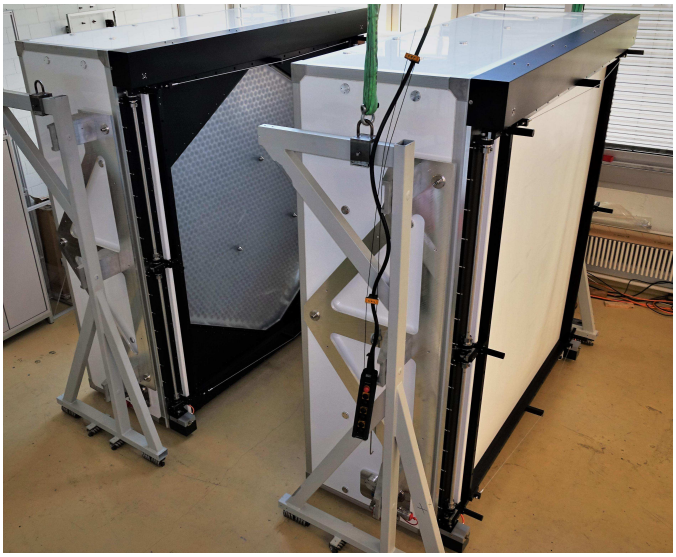

FIG. 6.1 – Two prototype camera bodies for FlashCam cameras in the Zurich workshop, ready-to-ship. The front lid is closed on the right box and opened on the left box.

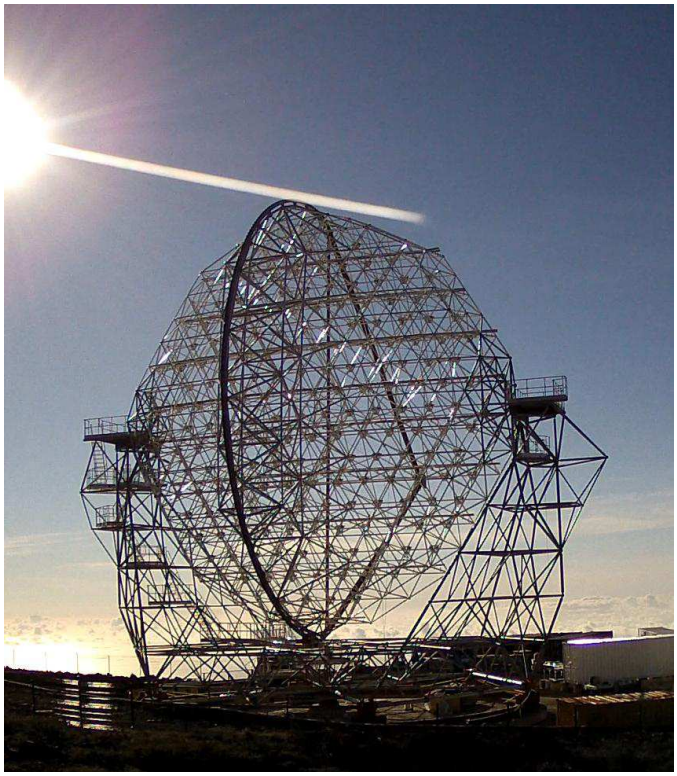

FIG. 6.2 – Prototype LST under construction on La Palma (Canary Islands), picture taken on April 3, 2018

6.2 Mirror actuator

The 220 actuator sets, which were produced in 2015 are now being installed on the first large scale telescope prototype (LST) which is presently under construction on La Palma (see figure 6.2). First operation is foreseen during summer 2018.

Each set of actuators consists of two actuators and one fix point, allowing to control the direction of a single mirror facet. During the past year several small aspects of the design have been improved, including adjustments of mechanical construction tolerances, stability against corrosion, maintainability and measures to optimise mass production. Several details on the mechanical interfaces to the telescope structures have been adjusted as well.

As a next step the Zurich group prepares the production of a new series of 60 prototype sets of actuators to be tested against the specifications as input for the upcoming reviews to be organized by the CTAO management. In parallel to these activities the planning and coordination of the mass production of roughly 12'000 single actuators has started in very close contact with the CTAO management.

[5] G. Pühlhofer *et al.*, (FlashCam Collaboration), arXiv 1211.3684 [astro-ph.IM] (2012).