Final milestone for the upgraded H.E.S.S. telescopes in Namibia

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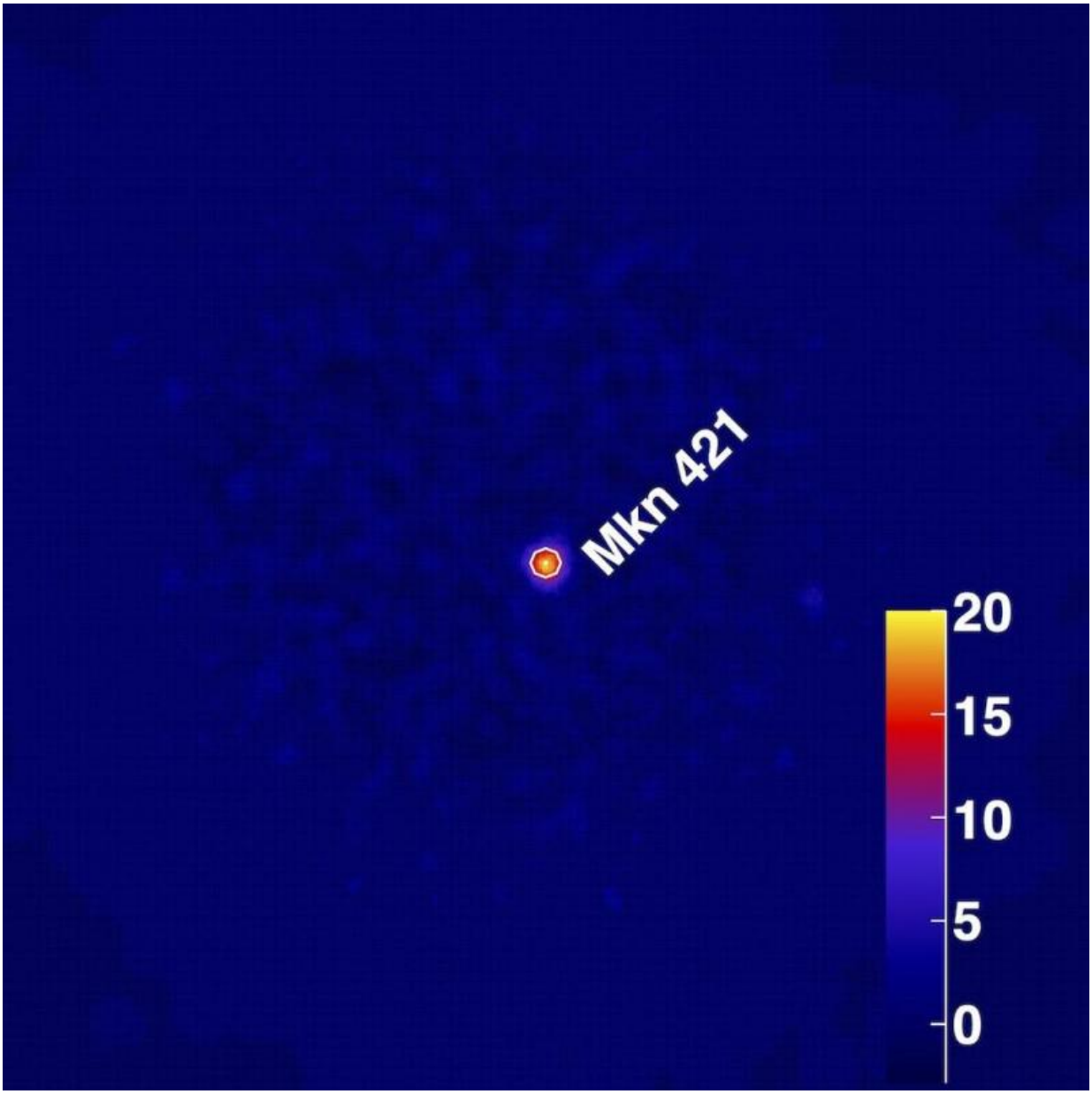


Cosmic gamma radiation from the active galactic nucleus Markarian-421, recorded by the new H.E.S.S. cameras. Credit: H.E.S.S.

The newly refurbished cameras of the H.E.S.S. gamma-ray telescopes in Namibia have detected their first signals from a cosmic particle accelerator: The new cameras recorded Markarian 421 as their first target, a well-known blazar in the constellation of Ursa Major. The active galactic nucleus, 400 million light years away, was detected during an active state and at high significance. After four years of development, testing, production and deployment, this is the last big milestone of the H.E.S.S. I camera upgrade project, which was led by DESY. The success is also an important test for the next generation gamma-ray observatory, the Cherenkov Telescope Array CTA, which will use the same camera technology.

When H.E.S.S. explores the mysteries of the high-energy sky, it actually does not look into the Universe, but at the upper atmosphere. Cosmic gamma-rays are absorbed there and produce short, faint, violet Cherenkov light flashes that can be detected from the ground using large mirrors and ultra-fast electronics. The exposure times per image are as short as 16 nanoseconds (billionths of a second), and H.E.S.S. is recording about 300 of such events per second. Since some images only consist of a few handfuls of light particles (photons), the technical requirements to build such cameras are very challenging.

In the ten years for which the original H.E.S.S. I cameras have been operated, their fragile electronic components have suffered a natural level of ageing, which degraded their performance. In parallel, also the technologies available on the market have developed much further, like faster Ethernet solutions, and smaller and faster readout chips. One of these chips is the NECTAr chip, which has been developed for the next

big experiment in the field, CTA. Therefore, in 2012 the H.E.S.S. collaboration placed an order with their new collaborators at DESY in Zeuthen to team up with colleagues from the Paris area and Universities of Leicester and Amsterdam to make use of this chip and design a new, modernised version of the four H.E.S.S. I cameras.

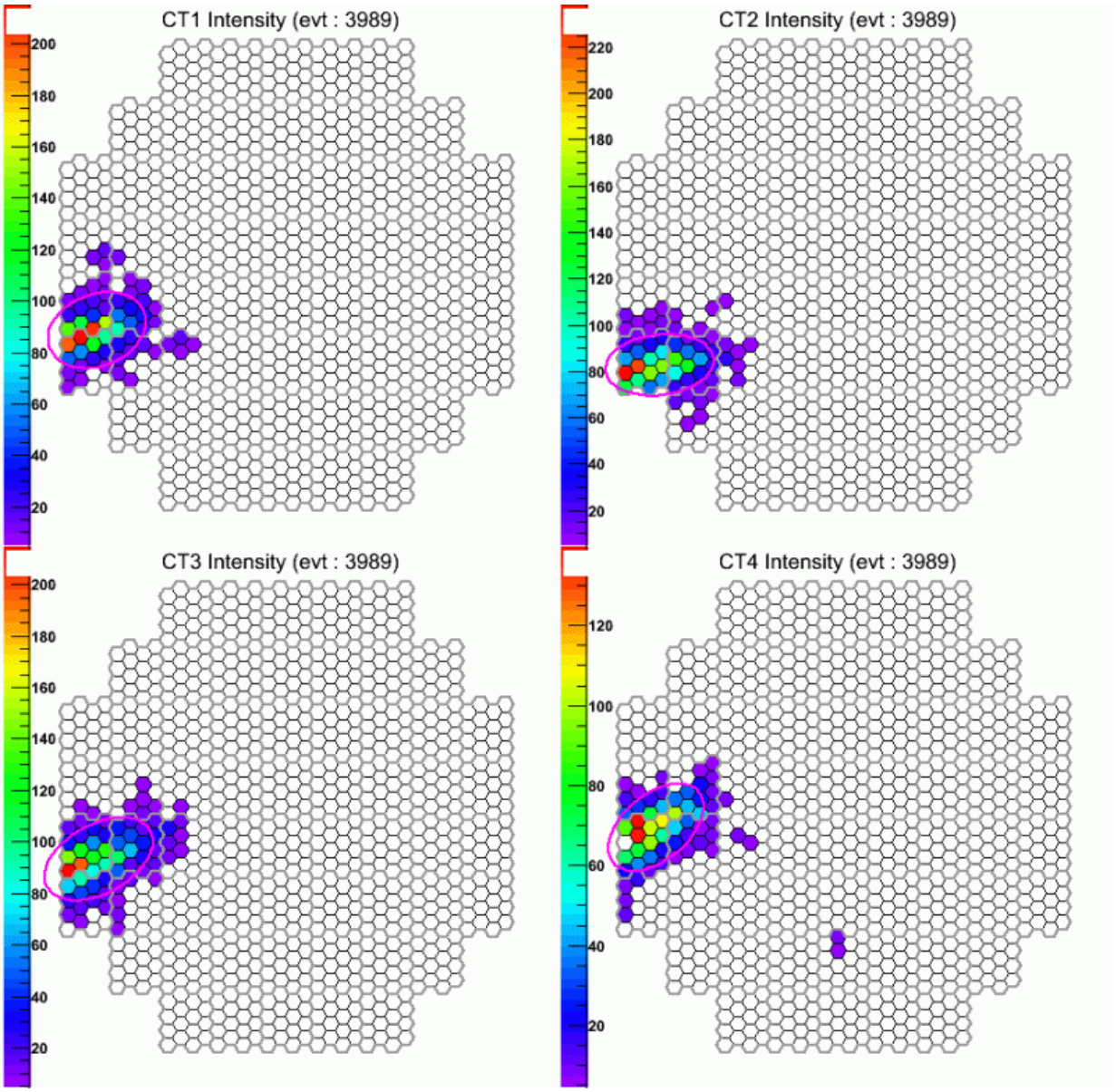
Installation of the new cameras in Namibia. Credit: Stefan Klepser, DESY

The engineers lost no time and developed a holistic modernisation concept that foresaw not only the replacement of single electronics boards, but also a better cabling, pneumatics and ventilation scheme. The first of the cameras was installed in July 2015, the other three were

brought to Namibia in September 2016. "The installation went extremely well. Although it's a very isolated work situation, out there in the remote countryside of Namibia, the team was really performing great and the atmosphere was very good", summarises Stefan Klepser, DESY project leader of the upgrade. "Also, I am happy to say that we stayed well within the budget and the time frame we were aiming at."

After the installation, software needed to be adjusted, network connections to be established, and real-life, unexpected issues needed to be trouble-shooted. Around Christmas 2016 the systems were all fit for observation, and as luck would have it, an old friend in the gamma-ray sky, the blazar Markarian 421 was reported to show increased activity. Despite being located in the Northern sky, in the constellation of Ursa Major, it was within reach for observations by H.E.S.S. The scientists turned the four telescopes at it and could record thousands of images.

"The refurbished cameras delivered the first large scale demonstration that the NECTAr technology is fit for teraelectronvolt astronomy", summarises Christian Stegmann, head of the DESY institute in Zeuthen. "This makes us look forward to the final years of H.E.S.S., where the new cameras will provide us with enhanced performance at both very low and very high energies. And it is a promising outlook at the next major gamma-ray observatory CTA, where DESY is an important partner."



Examples of Cherenkov light images by the four cameras. Credit: H.E.S.S.

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