The MIDAS telescope for microwave detection of ultra-high energy cosmic rays

J. Alvarez-Muñiz[1], A. Berlin[2], M. Bogdan[2], M. Boháčová[3], C. Bonifazi[4], W. R. Carvalho Jr.[1], J. R. T. de Mello Neto[4], P. Facal San Luis[2], J. F. Genat[2], N. Hollon[2], E. Mills[2], M. Monasor[2], P. Privitera[2], L. C. Reyes[5], B. Rouille d'Orfeuil[2], E. M. Santos[4], S. Wayne[2], C. Williams[2], E. Zas[2], and J. Zhou[2]

[1] Universidad de Santiago de Compostela, Departamento de Física de Partículas, Campus Sur, Universidad, E-15782 Santiago de Compostela, Spain

[2] University of Chicago, Enrico Fermi Institute & Kavli Institute for Cosmological Physics, 5640 S. Ellis Ave., Chicago, IL 60637, USA

[3] Charles University, Faculty of Mathematics and Physics, Institute of Particle and Nuclear Physics, Prague, Czech Republic

[4] Univ. Federal do Rio de Janeiro (UFRJ), Instituto de Física, Cidade Universitaria, Caixa Postal 68528, 21945-970 Rio de Janeiro, RJ, Brazil

[5] Department of Physics, California Polytechnic State University, San Luis Obispo, CA 93401, USA

We present the design, implementation and data taking performance of the MIcrowave Detection of Air Showers (MIDAS) experiment, a large field of view imaging telescope designed to detect microwave radiation from extensive air showers induced by ultra-high energy cosmic rays (energy ¿ 1018 eV). This novel technique may bring a tenfold increase in detector duty cycle when compared to the standard technique based on detection of UV fluorescence photons from nitrogen molecules excited by the cosmic ray shower particles. The MIDAS telescope consists of a 5 m diameter dish with a 53-pixel receiver camera, instrumented with feed horns operating in the commercial extended C-Band (3.4 GHz–4.2 GHz). The RF signal from each receiver is fed in a power detector and sampled by a 20 MHZ custom built FADC. A self-trigger capability is implemented in the digital electronics through FPGAs, based on topology and timing. A first level trigger select in each channel pulses above a threshold level, which is self-regulating to keep the trigger rate to 100 Hz. Pixels with a track topology and a timing evolution from a few hundreds to tens of microseconds across the chamber, compatible to a cosmic ray shower, are then selected by a second level trigger. The main objectives of this first prototype of the MIDAS telescope - to validate the telescope design, and to demonstrate of a significant detector duty cycle - were successfully accomplished in a dedicated data taking run at the University of Chicago campus. We will also report on the commissioning and first data taken by MIDAS at the Pierre Auger Observatory in Argentina.