Development of autonomous observation system for next-generation cosmic ray telescope

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ABSTRACT: CRAFFT is an atmospheric fluorescence telescope with wide viewing pixels for Ultra-High Energy Cosmic Rays next-generation observation facility. We have builded the automatic observation system (for the fluorescence detector) in order to expand detection area of the next generation observatory by the telescope with the fluorescence technique. In Japan, we made a testing machine that reproduces the actual observation equipment installed in Utah, USA. The observation automation system was installed with the testing machine in Japan and has been in operation for more than 9 months. This system also includes an environmental monitor for stable operation and smooth transition to start or stop observation automatically. In this presentation, we will report on the development status of CRAFFT's autonomous observation system.

Hardware concept for global expansion

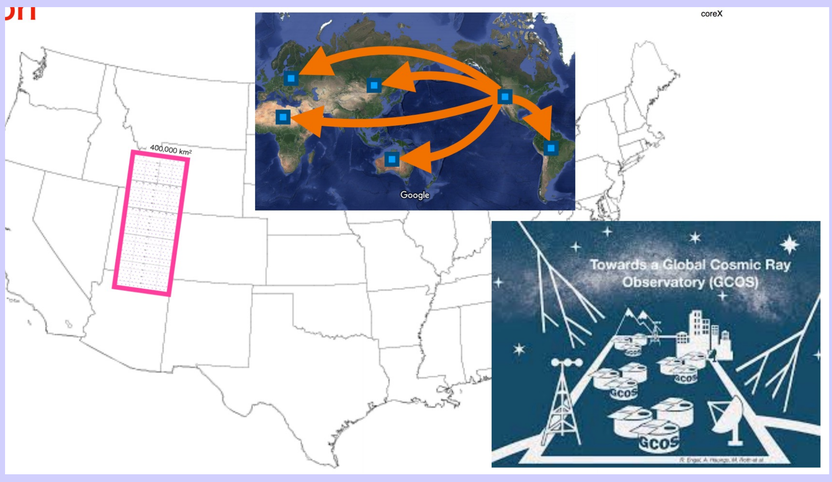
It is possible to observe UHECR with a simple telescope as is well known in the disclosure by prototype CRAFFT and FAST. The current challenges for global expansion can be summarized in two points.

A) Analysis performance by a telescope with a lower field of view unit price
B) Reduction costs of **Production**, **Installation** and **Operation** running

You find many other reports on topic A). I would like to propose a demand for hardware for global expansion. This is the stage of **Production** and **Installation** of the telescope and the stage of **Operation**. A total of hundreds of telescopes need to be manufactured for observation with a simple telescope. To achieve this goal, we should make the idea of production and deployment, not construction. We have experience deploying terrestrial arrays at the TA and the Auger. A similar concept will be needed for next-generation telescope arrays.

Aiming at this goal, we are developing a detector that works only with a telescope that does not require a building. This idea does not require a ground foundation like a concrete pad.

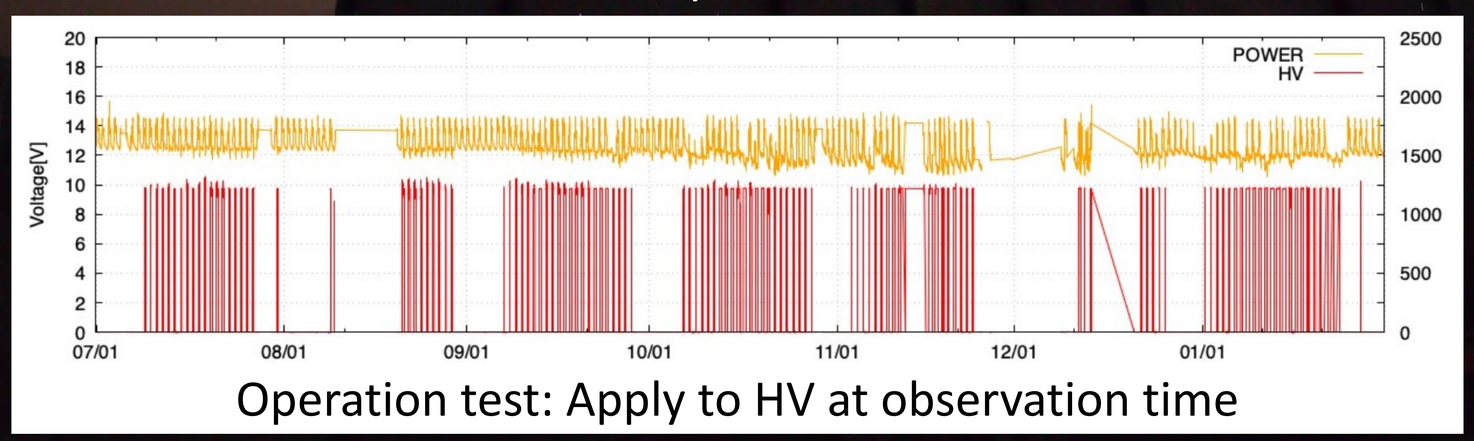
On the other hand, reducing running costs is also essential for continuing operations. UHECR observations with a telescope require a remote installation location without power infrastructure to reduce extraneous light noise. In order to make simultaneous observations with hundreds of telescopes, we should consider operation without an operator. we should aim for is a fully automatic telescope that is self-sufficient in electricity.




TA-SD deployment

Automatic System

At this ICRR, we show that UHECR data that can be analyzed by a telescope with a simple structure and installation are available. The automatic observation system is also progressing extremely smoothly. The operation test of the automatic observation system was installed at Shinshu University(@Nagano Japan) and was carried out for one year from March 2020. It uses the equipment of DAQ used for testing on the TA site and uses a Raspberry Pi as the computer for automated operation. In addition, we have added environmental monitors as needed to determine the implementation of observations. All of them systems were operated by solar power supply. The total power required by the system was less than 25W, and the PV system used a 250W power generation panel connected to two 100Ah batteries. The Nagano City as the test site, was cold enough for the Winter Olympics to be held, and the load on the system was like that of UHECR observations. We should really observe and demonstrate at the TA site.



Operation test: Apply to HV at observation time