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Status of the Auger Engineering Array

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Abstract. In order to test the design of the Pierre Auger Observatory, as well as different construction alternatives, a small subset of the full array is being built in Malargüe, Argentina, and will be put into operation this year. It will consist of 40 surface detectors, covering an area of 46 km^2, and 2 fluorescence telescopes with an angle of view of 30° x 30° each. We present a description of this engineering array and report on the advances achieved so far and on future prospects.

1 Introduction

The Pierre Auger Project is an international effort to observe cosmic rays of the highest energies. Two similar observatories, covering an area of 3000 km^2 each, will be constructed in both hemispheres, in order to get a full sky coverage. The first one is being built in Malargüe, Province of Mendoza, Argentina, and the second one will be located in Millard County, Utah, USA, at a later stage.

The Pierre Auger Observatory is of hybrid type, as it combines two complementary techniques: a surface detector (SD) array will record cosmic ray showers that hit the ground, and a fluorescence detector (FD) system will observe the nitrogen fluorescence light produced by the shower in the atmosphere above the SD array.

The SD system will consist of 1600 water Cerenkov detectors, arranged on a hexagonal grid with a 1.5 km spacing, covering an area slightly larger than 3000 km^2. The fluorescence detectors will be arranged in 3 peripheral and one central "eyes", holding each 6, respectively 12, fluorescence telescopes, each of them covering a solid angle of 30° (horizontal) x 30° (vertical). [Pierre Auger Design Report (1996)]

Before proceeding to the construction of the full-size observatory, a subset of it, the "Engineering Array", is being built at the southern site near the city of Malargüe in Argentina. It consists of an array of 40 surface detectors and two fluorescence telescopes.

The objective of this "small" scale observatory is to test the individual components and their integrated operation, including the communications and data acquisition systems, in order to optimize the design, overcome assembly and deployment difficulties and reduce construction time and costs in the production phase. Furthermore, the acquisition of some preliminary data, including a few events recorded in hybrid mode, is expected.

The Engineering Array will allow the testing of a large variety of parts and subsystems:

- Tanks and their components design (materials, hatch-covers, battery boxes, solar panels and their mountings, liners) and their behavior outdoors (temperature, environment)
- Deployment strategy
- Water production and quality
- Photomultiplier tubes, tube fittings and electronics
- SD triggering and software, data acquisition
- Solar power system (performance, power consumption)
- Monitoring packages
- Radio communications (bit error rates, packet error rates, path loss statistics)
- Materials and coatings for FD mirrors and filters
- FD optics, corrector plate, shutters

2 Present Status of the Engineering Array

The fluorescence detector building for the engineering array has been located on Cerro Los Leones, a 40 meter high ridge, 12.5 km southeast of Malargüe city.

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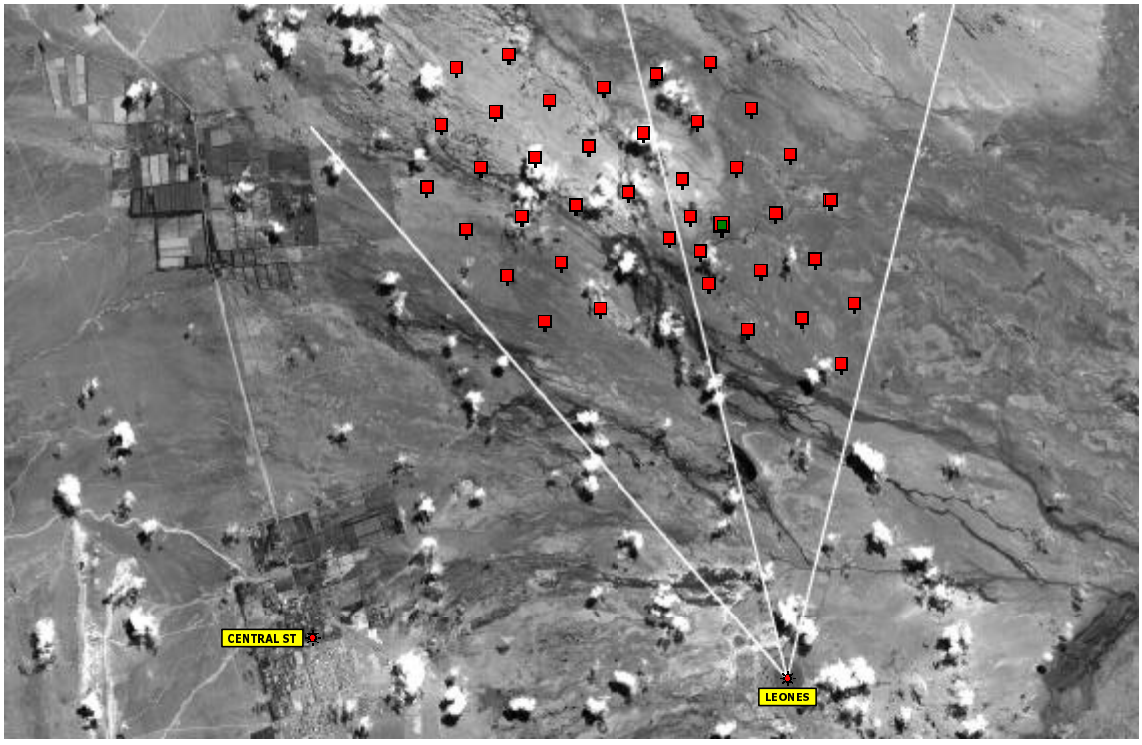

Fig. 1. Partial satellite view of the Southern Pierre Auger Observatory site, showing the location of the first fluorescence detector building at Cerro Los Leones and the central campus at the northern entrance to the city of Malargüe. Squares show the locations of the deployed surface detector stations corresponding to the Engineering Array. The larger square corresponds to the double detector. The infill tanks can be seen next to it. The lines represent the field of view (30°) of the first two fluorescence telescopes, the middle one pointing exactly to the North. The scale of the image can be inferred from the distance between neighboring tanks (1.5 km).

The location of the Surface Engineering Array has been chosen such that its center is 10 km north of the first FD building. 40 detector tanks have been deployed in the field, 37 of which are positioned on a hexagonal grid, covering an area of 46 km^2 (see Fig. 1). The mean deviation of these tanks from a perfect grid is of 21 m, with a maximum deviation of 90 meters for one of the stations. One detector position near the center of the Engineering Array has been doubled: it consists of two identical, independent detector tanks 10 m apart. This doubling will allow to compare the response of two tanks with identical features and to get a high rate of events at much lower shower energies, in order to study coincidences and triggering conditions. Additionally, two "infill" detectors have been deployed in the middle of the interspaces of the regular detector grid, i.e., at a distance of 860 meters from their three nearest neighbors. In this way, valuable test data are anticipated, as the ratio of lower energy shower signals to random coincidences will be considerably improved.

The 40 deployed tanks have been equipped with liners and filled with purified water delivered by the Auger water plant installed at the Observatory Central Campus in Malargüe. Although the water plant is designed to deliver water of a resistivity $\rho > 15$ MΩ·cm, most of the tanks in the Engineering Array have been filled with water quality ranging from $\rho = 1$ MΩ·cm to 9 MΩ·cm.

The solar power system (solar panel mountings, panels, batteries and regulators and cabling) has been installed on all the detectors. As of May 2001, photomultiplier tubes have been mounted in 8 of the Engineering Array SD tanks, the remaining ones are expected to be installed in June. Different PMT models are being used and tested, as well as different domes coupling them to the water surface. Electronics is being installed on these stations and first tests on the integrated electronics, software and GPS systems are taking place. Communications antennas are already mounted on 38 detectors. For these stations, radios will be installed and commissioned in the forthcoming days.

At the Los Leones fluorescence detector building, two out of the 6 bays are being equipped with fluorescence telescopes. They are oriented in such a way that each telescope observes the atmosphere above 20 SD stations (see Fig. 1). The con-

struction of two fluorescence telescopes, instead of only one, will allow the observation of showers crossing the field of view of both telescopes, thus permitting a test of the performance at the interface and a direct comparison of their detection capabilities.

The construction of the first telescope is finished. The mirrors have been fitted to their mountings, the camera has been installed, equipped with the corresponding 440 PMT's and their electronics and aligned with respect to the reference point. All the components of the aperture (supports, protective glass, filter, corrector lens and shutters) are in place. At the end of May 2001, the first FD telescope is being commissioned and is recording its first atmospheric shower event candidates, at a rate of approximately 5 per hour with the corrector ring in operation. A study of the influence of the corrector lens on the spot size is now being performed.

Progress is underway with the installation of the calibration systems and atmospheric attenuation monitors.

A large proportion of the infrastructure for the full observatory was already completed. The assembly building in the central campus at the entrance of Malargüe City has been finished in November 2000. This 850 m^2 building is being used for reception of detector tanks and components, assembly of surface detectors, and temporarily also for hosting the central data acquisition computers and internet equipment, as well as the project offices.

The first fluorescence detector building at Cerro Los Leones has been finished at the beginning of 2001. The six telescope bays, plus workshops, storage rooms and common areas comprise 300 m^2. Next to the building, a 42 m high communications tower has been erected and equipped with antennas to receive the radio signals from the SD detectors in the field and establish the microwave link to the 50 m communications tower at the central campus. The microwave link between Cerro Los Leones and the central campus is fully operational.

The data acquisition system has been installed in January 2001 and is operative now, ready to receive signals from the detectors. It has already received and processed successfully some tens of hours of monitoring data from surface stations in the field. The trigger sequence has been tested with a fully equipped detector that has been installed next to the central station for trial and evaluation purposes.

3 Future Prospects

The Pierre Auger Engineering Array is expected to be completed and commissioned by the end of 2001. By that time, it is envisaged to have observed an appreciable number of cosmic ray events of energy above 10^{18} eV, including some recorded in hybrid mode.

The construction of the office building and visitors center is well under way, with their completion expected by October 2001. A second telescope building at Cerro Coihueco, 40 km north of Malargüe city and at the northwest border of the full array, will be completed by the end of 2001. The experience gained during the construction and deployment of the Engineering Array will already be capitalized in the next southern summer season: starting in October 2001, the pre-production phase will be devoted to the assembly, deployment and commissioning of 100 additional surface detectors.

References

Pierre Auger Design Report, November 1996. See also accompanying Auger papers in these Proceedings.