Pierre Auger Project
Progress Report

January/February 2002

Summary (photo album link)

The Engineering Array is now in more or less routine operation. About 20 hybrid events are being recorded during the dark period each month. The EA hybrid run will end after the March dark period in order to begin installation of the production telescopes at Los Leones. Calibration and timing studies continue to improve the quality of the data. Several groups are making good progress on analyzing events.

The construction of the new fluorescence building at Coihueco was delayed owing to the uncertainties in the availability and cost of materials. The work, however, is now proceeding at a good pace. All of the walls are up. Construction of the adjacent communications tower will begin shortly. Telescope components for the fluorescence buildings at Los Leones and Coihueco are in full production with the first shipments expected in Malargue in a few weeks. The first lidar installation at Los Leones is nearly complete.

The surface array operation is increasingly stable with about 30 stations in operation. As a consequence maintenance trips to the field are becoming less frequent. Improvements continue to be made to the trigger and, in particular, the time over threshold trigger is being added. The detector tanks of the final design are beginning to arrive at the site and they look very good. Sixteen are at the site and 8 more are on the way. Production of the liners is keeping pace. The first of the pre-production PMT assemblies have been tested and are on their way to the site.

Project funding remains a cloud on the horizon.

WBS 1.1 Fluorescence Detector System

Glass Mirrors (J. Ridky)

We have passed test of compatibility of Czech mirror segments and the German stand (in January). It matches perfectly. Now we are in full production of mirrors for Coihueco. In the end of March we are going to ship the stand, 60 mirror mounts from Prague, 185 mounts from Krakow and possibly two full telescope mirrors. We have also produced rather large quantities of various mirror mount parts (clamps, hollow shafts etc.). The photos of stand test are at our innovated web page: http://www-hep.fzu.cz/~auger/activities.html

Aluminum Mirrors and Mirror Stands (H. Klages)

At the end of January the first 40feet container with telescope hardware for Los Leones was sent to Argentina and is now in customs in Buenos Aires.

At Karlsruhe the preparations for the mirror mass production were continued according to schedule. Also most of the hardware parts for slow control for Los Leones and for Coiheco have either been sent or have been ordered.

The second 40feet container with hardware mainly for Coiheco left Karlsruhe on February 22. It should arrive in Malargue end of March, hopefully.

On February 27. Rainer Gumbsheimer came to Malargue for 3 months stay. Until May 15. we will always have at least 3 technicians from FZK-IK at the site.

Work on DAQ, CORSIKA and other software was continued in Karlsruhe.

Camera (G. Matthiae)

The production of components is going on. The new mercedes design, allowing removal of the mercedes from the front has been finalized and is in production.

Calibration (Jennifer Markus, Georgianna Martin, John A.J. Matthews, Bill Miller, and Michael Roberts)

1) Relative optical calibration system (at Los Leones)

The main effort during this period was the continued development of analysis software to rocess the nightly calibration runs based on the (relative) optical calibration system at Los Leones. Recall these include 3 separate light sources that send light to 3 different places on each telescope:

1) channel A to mirror centers
2) channel B to sides of cameras
3) channel C to reflect off TYVEK targets on the doors

Each light source is monitored by two light pickoffs: one called the MONITOR pickoff and one called the OUTPUT pickoff. The MONITOR observes light optically split before any filter wheels etc. The OUTPUT monitors the same light that goes to the 6 telescopes. To 0th order the light outputs continue to be stable to within ~+/-1% variation over the last year of operation.

Problems that limited the channel A and C light sources in November were fixed in January. The problem was with mechanical shutters which would not remain open for the many-minute time periods of the "A" and "C" fiber calibration sequence.

The (optical) calibration data files are routinely copied to the U. of New Mexico and processed to extract the xenon pulse intensities as viewed by all 440 pixels (pmts) in camera m04 and m05. The signals are then averaged and processed in several ways to yield:

a) "flat" field gain factors ... using a semi-empirical model for the distribution of light across the camera from fiber "A" b) pixel to pixel signal variations with time ... using fiber "A" and "B" data c) 440 pixel "common" variations with time ... using fiber "A" and "B" data d) comparison of fiber "B" results ``normalized by fiber "A" results"

The preliminary results include

i) based on items b) and c) m04 pixels appear significantly less stable with time than m05 pixels over the period of November 2001 through February 2002 data. Sasha Menshikov is aware of this and looking into it.

ii) Based on item d) the relative "B" to "A" intensities are very stable with time with the exception of a (possible) step (increase) in the fiber "B" signals about January 8 ~ 10. This would be consistent with cleaning the mirrors ... but there is no record of a cleaning in the logbook. The "step" is not large and will be studied further.

iii) Based on a) preliminary flat field gains were produced. These include a distinctive structure in m04 for pixels in the first few readout boards (pixel numbers <90) which is seen, although differently, in the fiber "A" and "B" data. This is not understood (at this time) and could be an artifact of the Mercedes.

In summary, the optical calibration system shows that it can already monitor the time variation of the pixel gains at the few percent level. Approximate "flat" fielding should work for most pixels ... but the problem with pixel numbers <90 in camera m04 indicates that there may be significant systematic effects for some pixels.

2) Atmospheric Monitoring:

2a) Backscattered LIDAR (M. Roberts)

The original schedule was for mechanical construction to be finished by Feb 5th, followed by DAQ installation and testing. At this stage, this schedule looks like it will be delayed by 1 to 1.5 months. All serious delays have been due to problems in getting import waivers and delays due to shipping and customs clearance.

The status is that the LIDAR control building is installed, the LIDAR support platform is completed and the EAS-TOP steering mechanism has been assembled. The mechanism has been balanced and the protective cover has been installed.

(see http://www.to.infn.it/~mostafa/auger/lidar/February2002/news21.html for pictures).

Currently the LIDAR is run from a generator. Jonny has a plan for connecting power via the line that runs to our neighbor and this should be done soon. The ethernet link back to the FD also needs to be installed, but this shouldn't be a critical problem during early testing.

The DAQ system from Slovenia is arriving.

2b) Roving laser/LIDAR:

Several of our Mendoza collaborators have been trained in the operation of the roving laser.

2c) Aerosol Phase Function (APF) Light Source:

The purpose of the APF light sources are to provide light beams to monitor the aerosol (normalized) differential scattering cross section at ~3 wavelengths in the acceptance of the fluorescence detectors. Two APF light sources are proposed ... the first to be sited near the Coihueco FD. Each APF source will produce a near-horizontal, pulsed light beam directed across most of the FOV of the near-by FD. The source use interference filters to produce beams at nominal wavelengths of 330nm, 360nm and 390nm. The plan is to produce atmospheric monitoring beams from this source every hour during data taking.

The site for the APF light source at Coihueco requires some work to install culvert pipes at the major "washout" of the north-south seismic road that would provide access to the site. Mike Roberts and Jennifer Markus discussed this with Noberto Fazzini et al during their recent visit. Carlos Hojvat helped obtain an estimate for the road repairs that seemed well within alloted budgets. A concept for the enclosure, to house the APF light source, and the positioning of the enclosure were both provided to Noberto and Jonny.

Data Analysis (P. Sommers et al)

Brian and I have done extensive work on the analysis of the December and January hybrid events. For now, we are working in parallel with others who are doing similar analyses. We are developing alternative algorithms for various tasks:

* Pixel pulse identification.
* Pixel ADC sum determination.
* Pixel pulse time center determination.
* Noise pixel identification.
* Shower-detector plane reconstruction.
* Monocular reconstruction of the shower axis within the SDP.
* Hybrid reconstruction of the shower axis.
* Longitudinal profile reconstruction.
* Energy and Xmax determination.

We are only doing superficial work on the shower-by-shower longitudinal profile, energy, and Xmax. We use a simplistic atmospheric model and ignore wavelength dependences. We

derive only a crude profile to use as a sanity check on the more complicated analyses done by Bruce et al.

For each hybrid event, we evaluate how much error in the core location occurs for each 100ns of error in our estimate of the FD/SD clock offset. It is highly desirable to monitor the clock offset in order to eliminate this uncertainty.

It will be important in the very near future to have realistic simulated events for the purpose of comparing different reconstruction algorithms. I hope that FDSim++ will be able to provide realistic FD data and that realistic SD data can be generated for those same artificial shower events. Reconstruction techniques cannot be evaluated using real data where the correct answers are unknown.

An essential part of all of the shower analyses is detector calibration. A reliable shell calibration is not yet available. As an alternative end-to-end calibration, we have worked on a method using laser shots. Vertical shots from the Los Leones symmetry point (behind the telescopes) give diffuse light pulses that can be used to "flat field" the telescopes and intercalibrate bay-4 and bay-5. Vertical shots from 3 km in front of Los Leones can provide an absolute normalization. The amount of Rayleigh-scattered light is exactly calculable from the known laser energy and geometry. The aerosol effects are small and tend to change the shape of the longitudinal profile more than its average normalization. A GAP note by Dawson, Matthews, Fick, Roberts, and Sommers is in an advanced state of preparation. The limitations on this calibration at present are primarily from (1) uncertainty in the laser energy (up to 30%) and (2) absence of the optical filter in bay-5 when the diffuse shots were done in October. In principle, this method can provide an accurate cross check on the shell calibration. We hope to get better laser calibration data during the upcoming March run.

EA Data Taking

The data taking at Los Leones went rather smoothly during January and February, with typical rates of 20-hybrid events/month. The data taking was extended to March.

WBS 1.2 Fluorescence Detector Electronics

1) Analog Electronics, reported by D. Camin :

-Introduction

Our efforts were concentrated in completing in time the first set of new components (post-CDR version) to reach the schedule agreed with our FZK colleagues. It seems now that this will be possible. We give below details on the components of interest, namely:

1.2.2.1: Head Electronics
1.2.2.2: Analog Board

1.2.2.7: HV-LV System

Authorization to proceed with the calls for tender are expected to be delivered at the next meeting of the Scientific Committee II of INFN, by March 21.

1.2.2.1: Head Electronics: (D.Camin, Milano)

The first two new telescopes will be equipped with the present Cameras (using HE v1), which demonstrated to function correctly. PMTs equipped with the new HE v2 will be made available in a second time. Not changing all components at the same time will be beneficial to better understand the origin of possible bugs eventually found in the new installation. At the same time, the two-month delay in the launch of the call for tender would be tolerable. In the mean time, 40 HE's of the new version are now under fabrication and will be evaluated soon.

1.2.2.2 Analog Board (E.Menichetti, Torino).

Five units of the AB version 3 are now under test in Torino and some will be sent next week to FZK. A test with the FEcrate was organized to evaluate the whole functionality of the ABv3 and is now being prepared. Measurements of the cross-talk sensitivity between neighbor boards will be performed. The readout noise, which was picked up in AB's version 2, might now be reduced. Soon we will know that.

According to schedule, completion to 20 AB's will be necessary by end of April. The 15 boards necessary to reach this milestone will be ordered most probably out of the tender which is now delayed.

A test system for the full production, based on Lab View, is under preparation in Torino. The test itself will be performed at INFN Torino. This graphical programming software is now widely used in HEP environment and has already been used with success in the implementation of the test system for the HE v1. Lab View allows also remote readout of the test data, via TCP/IP.
Eliot has planned to participate with collaborators from Torsion to the full-crate test in FZK, which is estimated to take place around mid May.

At present the Torino group is setting up the test system for the FLT+AB (single board) received from FZK (for the old version). The aim is to investigate the noise induced by the readout. This test system is now ' up and running, so that it will be operative immediately [it took a couple of weeks to set it up, due to difficulties found both in HW and SW]

Regarding mass production, completion to 200 boards (for 10 FEB's) is expected to be ready within August.

1.2.2.7 HV/LV Power Supply system (R.Fonte, Catania)

The HV and LV will be delivered by an integrated CAEN system, the SY1527. The system has 16 slots in which HV and LV modules can be plugged-in. Remote access to data and control is possible also via TCP/IP. The present HV distribution scheme foresees 5 modules (12 channel each) delivering the HV power to all bays. A single module serves 6 different telescopes.

Jonny K. requested to consider a scheme which would destinate one HV module per bay. This scheme is possible and compatible with a rational LV distribution. A LV distribution scheme was already advanced by Milano during the December FDE videoconference. Roberto promised to study it and to deliver a new scheme, which shall be ready soon.

At present there is already 1 Crate at INFN Catania. Three HV modules A1735P and 5 LV modules CAEN A1517 are expected to arrive by end of March or at most by April 10. By June, all necessary modules for both Los Leones and Cohiueco will be received in Catania.

Initially the interface with the slow control, which is under FZK responsibility, will be very limited due to lack of enough manpower to develop full SC software. To be safe, Matthias suggests that the first crate, fully operative HW/SW, is sent directly to Malargue. The second crate could be sent to FZK to allow them to try the interfacing with the slow control.

WBS 1.2 (continued) FD digital electronics and readout system (Matthias Kleifges)

Status and progress in Los Leones

The regular data taking continued during the new moon phases. A. Menshikov participated at the January measurements, but most of his time he concentrated on:

- Find and fix a bug in the SLT firmware, which had produced time jumps of 100us.
- Measurement of the relative timing of the camera pixels.
- Measurement of the absolute timing of the system for bay 4 and 5. He found a shift of a few nanoseconds, but could not confirm the analysis from B. Fick and P. Sommers derived from laser shots.
- Measurement of the sensitivity (ADC-counts/p.e.) for each pixel with 2% accuracy by illumination of the camera with 100 LED flashes. His results were already distributed by email.

Progress in Karlsruhe

The crew in Karlsruhe concentrated on the design, the production and test of the hardware to be used in the final design (revision 3). As the layout of all PCB´s was changed, we will first go into the 'pre-production' of a sample sub-rack before mass production. Following items were modified compared to the prototype: (WBS-No. from production)

First Level Trigger (FLT) Board

After the circuit diagram of this board was finished in January an external company developed the 10 layer PCB. We ordered a small quantity of 10 boards which will be equipped with

components from March 11. All components are already delivered and we also have designed, produced and tested the 'FLT/SLT' test board, which will be used as test jig for the first produced samples.

Second Level Trigger (SLT) Board
The circuit diagram of this board was finished and we ordered the necessary components. First samples of this board are expected until mid of April.

Interface SLT ←→ PC (SIB) Board
We plan to change the interface to the PC from PBUS+ (using a MicroEnable plug in card) to a commercially available FireWire or USB2 interface. For now, the SIB board is based on our original design (PBUS+). We designed the board and have 10 PCB's in house for mounting of components. This boards a adjaced to the SLT and will also be needed until mid of April.

Mechanic of sub-rack & power supply / digital and analog backplane
WIENER is producing the front-end sub-rack and the power supplies. They have finished their design and are waiting for the digital backplane from TreNew, which is expected to arrive at March 11. The analog backplane was developed completely in IPE. We have 5 PCB`s in house, one completely mounted board was send to WIENER.

Clock and Control Board (CCB)
The FD electronic will be equipped in near future with the GPS receiver UT+ Oncore from Motorola - the same as used for the SD electronics. This will require a totally new design for the distribution of the clock and control signal. Just recently additional demands were setup for logic signals to handle different type of calibration sources (Xe flasher, lasers and Lidar). The 7 GPS receivers were ordered. An evaluation kit is already in use to explore the functionality's and develop software.

We expect to complete the first sub-rack (= preproduction) until end of April 2002.

WBS 2.1 SD and survey (I. Allekote)

Tanks

The surface detector tank production continues in Brazil, with 16 tanks delivered to Malargue and 8 more completed. The new Preproduction design and improved production procedures have resulted in tanks superior to the Engineering Array version. The photograph shows tanks in Malargue ready for final assembly.

The Rotoplas company in Mexico is ready to begin construction of a new mold top in Mexico City to be shipped to Argentina for making tanks of the Preproduction design in Pilar, near Buenos Aires. High quality resin for the first 25 tanks to be built there is being prepared by the manufacturer and will ship to Argentina in late March.

Preliminary impact tests of a lower cost resin, Cotene, have been disappointing, but studies are continuing, both in the US and Argentina, to determine if the resin might be acceptable. ALPINA in Brazil has made a full tank with Cotene resin. The same cycles as for the Schulman resin were used, with fairly good results. The manufacturers might improve the quality of tanks made with COTENE using different cycles. Alpina tested the new tank by cold impact (-20 Celsius, only) and it performed the same way as the Schulman one. Additional tests of the Cotene resin were done in Bariloche, and four 1000-liter tanks were produced with Cotene resin at Formingplast in Buenos Aires. Characterization of these tanks is still under way.

Concerns had been raised about the maximum temperature reached by the electronics package on hot days in the new weather enclosure, a dome-like structure covering the large hatchcover on the tank. Models of the weather enclosure were fabricated and painted different colors for testing. Temperatures were measured inside the dome on a dummy electronics package, including one that was dissipating the design power of 10 W, as well as the air temperature for comparison. One of the test domes is shown in the photograph. The results allowed the final design of the weather enclosure to be concluded and manufacture to begin.

Two new test tanks (provided by Mexico) were equipped with liner and filled with water at the assembly building.

Solar Panels

Isofoton solar panels from Spain are to be used for the Preproduction phase and 212 of these panels arrived in Malargue. Tests of the panels after receipt and inspection in Malargue by Unversidad de Santiago de Compostela are shown in the photograph. The panels are compared to a calibrated standard panel. The results indicate the panels meet even tighter tolerances than required due to selection by the manufacturer.

Water issues

The water plant has been producing high-quality water without interruption during these two months (see graph).

The water transport tank (12500 lts) and water storage tank (50000 lts) have been cleaned and are being rinsed.

Liners

Production of liners is well under way in both Colorado and Mendoza. Over 50 liners have been produced in Colorado, and 6 have been produced in Argentina.

New design fezzes and PMT plugs were delivered to UCLA for assembly With PMTs and bases into units-- initial tests at UCLA show everything working as planned.

All indications are that liners and PMT housings will be available for surface detector installation per the schedule.

A problem with the seal flange was discovered during testing in Argentina-- a notch sensitivity problem has sufficiently weakened the old design seal flanges such that they can be cracked and break during shipping or testing at high pressures. A revision of the flange design eliminating the flaw was made, and the new design seal flanges were used for ~25 of the Colorado-produced liners, and for all the remaining CAC-SA liners (47 of them). We are investigating whether we need to replace the flange/windows in the assembled liners with old-style flanges.

Survey issues

The positions of the 30 working detectors have been measured to sub-metric precision, with use of a differential GPS receiver system.

WBS 2.2 Surface Detector Electronics

*****No Report*****

WBS 3.0 Comms Task (P. Clark)

Coihueco Tower

We have finally been able to start the procurement of the Coihueco tower during the last period, we hope to have this tower installed before Southern Spring. Continuing financial uncertainty prevents us from starting the procurement of the antennas to go on the tower, but we live in hope!

WLAN radios

The very first v4.1 radio PCB arrived at Leeds this week (end of Feb). After a hectic few days populating and testing this first board, the signs are very promising that we have our final production board. We have an extensive series of tests planned over the next month to put the new design through its paces.

Microwave License

We are close to completing the licensing of the Los Leones campus link that has been operating up to now in a 'test' capacity. We must pass an External inspection in the next month or so to permit final release of the license.

Voice Communications

Applications for additional frequencies for the rest of the voice comms system are proceeding. We hope to start procurement of the next (Coihueco) repeater once we get on indication of the allocated frequency.