Pierre Auger Project
Progress Report

September, 2000

Progress Report Summary:

The finishing work on the Assembly building is underway. The windows and doors, however, are not yet in place. We hope to have an open house for the Assembly Building at the time of the Collaboration Meeting in November.

The Communications tower at the Central Campus is complete. We are ordering a voice communications repeater for the tower for use with hand held walkie-talkies.

The construction company is struggling to complete the Los Leones fluorescence building by mid November. The first set of shutters for the building is on the way to the site from Poland.

Surface detector tanks are being produced in Brazil. The first batch of six tanks have arrived in Malargüe and are being readied for deployment. The tanks will not yet be filled with water as the water plant and the associated well has been delayed.

The customs/importation log jam seems finally to be broken! The diplomatic waiver progress seems to work smoothly so far. Customs are being cleared in San Rafael.

Fluorescence Detector

1.1, 1.2 Report on the FD Camera-Electronics Integration Test
(University of Rome II-Paolo Privitera)

Overview

The test involved the integration of the camera and the electronics. The camera was equipped with photomultipliers and light collectors, covering one quarter of the focal surface. PMTs were connected to the distribution boards placed behind the camera. The distribution boards were connected to the front end electronics with 4m long cables. The mounting and test of the camera was performed during the week before the beginning of the test, so that the integration with the electronics could start immediately.

The electronics system brought from Karlsruhe included the crate, a Second Level Trigger board, and five front end boards, each serving 22 channels. A PC with the DAQ system under WinNt was also installed. The hardware integration of the camera and the electronics was performed in one day.

The HV power supply was the same which will be used in Los Leones. A standard LV power supply was used for the PMT electronics during the first week of the test. During the second week, the LV distribution system developed by the Catania group for Los Leones was installed and tested.

The camera and electronics were sitting in a large dark room. A blue LED with a filter wheel and a calibration flash Xenon lamp (from J. Matthews) were placed in the position corresponding to the center of the mirror, illuminating the camera. The DAQ system was installed in a small counting room, which was separated from the camera dark room. The HV were controlled from the counting room, with a VME system.

Tests and Main Results

***Basic functionality test**

The first test after integration involved basic checks of all the functionalities of the system. The currents from the HV and LV power supplies were measured. The channels on each front end board (analog+digital board) were checked by feeding a pulse into the corresponding connector on the back of the crate, and observing the presence of the pulse on the data. All channels were ok. Connectivity between the PMT and the front end boards was checked by pulsing the LED, and observing in the data for each channel the presence of the pulse. In a few channels the pulse was absent. The problem was found in a loose connection between the third and the second PCB on the PMT. D. Camin recognized the problem and will fix it for the rest of the head electronics. After intervention all the channels worked. The test pulse for the head electronics, implemented in the distribution boards placed behind the camera, was also tested.

***Grounding**

We tested the grounding scheme: the camera body and support were connected to ground, the ground planes of the distribution boards were connected to the camera. The LV power supply was floating. The influence on the noise level was measured.

***Noise**

The noise level was checked by introducing each component (grounding, LV, HV) one by one. The total noise level was measured in conditions analogous to the sunflower test: the analog boards (MI-TO-PV board A) with transformers and the same channels gain. The total noise was around 0.9 ADC counts, roughly 10 percent better than the one measured in the sunflower test. The noise was also measured with the analog test boards (board B) developed in Karlsruhe. These boards use standard receivers instead of transformers, like the final version of the analog boards from MI-TO-PV will have. The noise level was higher, as expected, than the one obtained with boards A, but consistent with the specifications. A few channels were quite noisy. The noise was linked to the analog boards. For example, in board A the virtual channel was very noisy, as already observed in the sunflower test. According to E. Menichetti, the origin of the noise is understood, and it will be fixed.

***Trigger**

Two possible options for the data taking were implemented, one using an external trigger, the other using the second level trigger. Both options were extensively tested. The basic functionality of the trigger was tested. The setting as well as the automatic regulation of trigger thresholds was used. The triggered patterns were visually inspected. The trigger pattern generator, implemented for the moment only in board B, worked nicely. The second level trigger was tested on noise as well as signal. To simulate an "event", a mask with holes having the approximate shape of a shower was placed in front of the camera. The blue LED was flashed, and the triggered patterns were found consistent to the expected shape. Also, in order to study the trigger threshold, the light was attenuated with the filter wheel. The overall performance of the trigger was found to be consistent with the design specifications.

Conclusions

The integration of approximately one quarter of the FD camera and its corresponding electronics was successfully performed in Rome. The integrated system passed all the basic functionality tests. The noise level was found to be adequate for the FD requirements, and consistent with the one obtained with the sunflower in Karlsruhe. The first and second level trigger were tested in a variety of conditions, performing as expected from the design. The outcome of the test indicates that the current design of the FD camera and electronics can reliably be operated in a data-taking condition. Zbigniew spent a good part of the end of September and the beginning of October at LSU attempting to test the

PLD adapter board. Unfortunately, tests were not completed due to delays in the LSU test rig. Another attempt is planned for the end of this month. We have received 15 copies of the revision 1 "Field Trigger Board." One board is loaded with PLD and memory. We are making some initial simple checks before loading more boards. Evaluation of the test chips continues. We have completed evaluation of simple gates and pads and believe that we understand and can reasonably model the observed behavior. We are now moving on to evaluate some of the more complex circuits implemented on the test chips. The layout of the phase one trigger ASIC is now nearly complete. During the past month we have been doing analog simulations of the chip. During this process one small error (swapped control bits) was discovered and corrected. In all the modules we have simulated so far, the full analog simulation has agreed with our Verilog simulation to an accuracy of ~1ns. One major module remains to be successfully simulated. We have had some difficulty with the Cadence software in attempting to simulate the fifo memory. We are working with Cadence to try to resolve software crashes in this simulation, and simultaneously attempting some work-arounds. Completion of the final steps in the layout and chip submission are on hold until the memory simulation issue is resolved. We anticipate we will be able to resolve these issues in time to now make the November submission date.

1.1 Fluorescence Detector (FZK-Jonny Kleinfeller)

I have recently visited Malargüe mainly to check on the progress of the building and to measure some dimensions which are critical for the installation of the prototype telescopes.

The building is clearly behind schedule, mainly due to bad weather. The structure is going to be completed by the end of October, internal installations of mains, cable trays and air conditioning etc. will start at the beginning of November. The building is most likely ready for the installation of prototype components at the end of November.

This means, there will be no installation of prototype components this year, except for one of the external shutters. The first shutter is scheduled to arrive in Malargüe at the end of November. The group from Krakow will install it during the first two weeks of December. Karlsruhe is going to survey all critical dimensions in bay 4 and bay 5 during the collaboration meeting in November. The first components to be installed in January 2001 are the reference points for bay 4 and bay 5. Any other component can't be installed, before the reference points are in place.

The dimensions we checked are to a few millimeters identical to the dimensions indicated in the drawings, except for the height of the present floor level.

This is in some areas higher than indicated in the drawings (near the window in bay 1 and bay 4 already at the nominal final level) and the floor is not very even. The final 30mm of concrete and the rubber coating of 3-5mm thickness have not been applied, yet. This means, the final floor level will be higher than indicated in the drawings. This can't be corrected. The contractor agreed to make the final concrete layer as thin as possible but it can't be thinner than 10mm, and the rubber coating should be at least 3mm.

We have to expect the final floor level at nominal 0.00 + 13mm +-15mm (worst case 0.00 +35mm +-15mm), the contractor will try to keep the unevenness within +- 5mm, but this is not guaranteed.

The edges of the windows are within a few millimeters at the correct (nominal) position relative to the datum points. The reference point will be installed at its nominal position and height as well. The higher level of the final floor has to be compensated by the height adjustment of the prototype stands!

Some months ago I suggested to foresee a height adjustment +-50mm in the design of the telescope components, if you did so, you won't have a problem with the new floor level. In case your equipment is designed to compensate only the unevenness of the floor of +-15mm, adjustment to the nominal height may be tight. Equipment should be modified if possible to adopt to the new situation. For some components it might be to late or impossible to make any modifications and we must live with the effects of this higher floor on the alignment of the prototype telescopes.

There is a set of recent (25. September 2000) photographs of the building of Los Leones at the Karlsruhe Auger Home Page (Auger.de, then follow the link "IK1-page from the FZK", then "NEWS" and then "PICTURES").

1.1.1 Fluorescence Detector Optics (Benemérita Universidad Autónoma de Puebla - Humberto Salazar)

Corrector rings engineering.

A flat glass six millimeters thick was polished and its shape was tested using Newton rings methods. We should select the right curvature

radius of the mold depending on the refraction index of the plastic material to be used for corrector rings. We urge the collaboration to specify the refraction index of the corrector rings.

Mirrors engineering.

We are testing to use metallic mold to construct slumped mirrors of bad quality and then to polish the slumped glass by usual techniques in any optical shop. To test the quality of the mold we are using a glass template.

1.1.2.1.5 FD External Shutter (Institute of Nuclear Physics, Krakow - Henryk Wilczynski)

The external shutter for the first prototype telescope at Los Leones was completed in INP Krakow. The shutter is designed to protect the telescope window: it should withstand winds up to 200 km/h, and be reasonably light-and dustproof. The sliding doors are moved by electric motors with UPS power supply units, so that the shutter can be closed even when the external power is lost. The import customs waiver was obtained through the Polish Embassy and Argentinean Foreign Ministry. The complete set of shutter parts has now been shipped and should arrive San Rafael in November. The current plan is to install the shutter at Los Leones during December.

1.1.3.1.1.2 Fluorescence Detector (optical) Calibration (University of New Mexico-John Matthews)

The recent work is on ordering all remaining hardware for the Los Leones site and on writing/debugging the control software for the optical calibration light source. The model for the optical calibration system component interconnections and control software was presented at the Bad Liebenzell workshop. A (second) portable xenon light source was assembled and shipped to the University of Colorado for use in "dome" tests for the absolute optical calibration system.

1.1.3.1.1.2.1 Calibration (University of Utah-Paul Sommers)

Paul Sommers worked with Rishi Meyhanden (LSU), Jeff Brack, and Gertjan Hofman at Boulder Colorado September 29-30, to test procedures for the absolute calibration. We tested 3 different shells, each half the linear size of the real calibration shell. One shell is a Tyvek bag with a diffusing sheet at the diaphragm. Another shell is an approximate hemisphere made from Tyvek. The third shell is a perfect

polystyrene hemisphere. Lateral and angular uniformity of the dome reflections seemed to be limited only by imperfections in the Teflon ball diffuser at the light fiber end. Further tests with the cylindrical shell are needed to determine if that simpler type of shell can do the job as well as a dome. The pulse integrators and software developed at Colorado worked well. The xenon flash lamp provided by John Matthews worked well for injecting filtered light into the fiber. We found, however, that we will need a brighter source in order to calibrate the unimpeachable PMT (with neutral density filter) against the NIST-calibrated photodiode using the realistic distribution of incidence angles from the shell. We may do this PMT calibration with a strong DC light injected into the fiber and using long integration times. An absolutely calibrated PMT will be able to measure the absolute light intensities in coincidence with monitor PMTs using the Colorado charge integrators and software.

1.1.3.1.1.3 Atmospheric monitoring (University of New Mexico- John Matthews)

Progress report: Hardware to do a better measurement of the intensity of the light source have arrived. The measurements will be done as time permits. As the first aerosol phase function monitor light source will NOT be used/deployed at Los Leones this is a background task at this time.

1.1.3.1.1.3.3 Horizontal Attenuation Monitor (University of Utah- Paul Sommers)

We have been lured into adopting a new light source for the Horizontal Attenuation Monitor. The present baseline design incorporates a standard 100 W mercury vapor lamp with ballast and 30.5 cm parabolic reflector. The unit is bulky and marginally power hungry for remote operation. This is due to both the lamp power draw and the requirement of a 10 minute warm up period. The new lamp is a low-power (35 W) HID lamp with 10 second power up time. These kinds of lamps (with uv shielding) are commonly used as headlights on certain brands of luxury automobiles. The lamps can use a much smaller focusing reflector (152 cm dia), making them less bulky and easier to handle in the field. We tested the stability of the lamps in our lab at Utah. The lamps have a microprocessor controlled ballast which stabilizes the overall light output which consists of a continuum and a series of mercury lines. But the lines and the continuum may individually vary by significant amounts. Fortunately, we found that the set of uv/blue lines all vary in step with each other so it is possible to monitor the line variations by monitoring a single convenient line. We recorded the brightness of the 436 nm line

(every minute) as the lamp was cycled through 4 30-minute sessions over a period of 12 hours. The lamps were run off a battery supply for the tests just as they would be in the field. The light output varied by 4.9% rms and exhibited a total range variation of +/-6.5% during the course of the test. For a 50 km baseline and a perfect Rayleigh atmosphere this would yield an uncertainty in the attenuation length of no more than 1.5%. So even without local monitoring the new light source should give us what we need.

We tested the visibility of the light source, especially in the near uv, in the field at Millard County on September 20. Present were John Matthews, Paul Sommers, Zhen Ciao, and Brian Fick. Of concern was the efficiency of the parabolic reflector in concentrating the light. We were able to record the flux at 365 nm using the baseline receiver system placed 37 km from the light source. The reflector system performed much better than required. The flux at the receiver was approximately 30 times greater than required in the original design.

We also tested the angular uniformity of the beam. During the calibration procedure the lamp must be viewed from a near point(5km) and a far point(50km). The light from the same ray must be observed in both cases so the lamp must be repointed during the operation. A badly behaved angular distribution for the beam will make it necessary to point the lamp "too" accurately. We were able to measure the angular distribution at 7 km over a +/- 0.3 degree pointing range. Over this range the flux varied randomly as a function of angle by about 7% rms. There was no trend or peak in the distribution. We conclude that with a pointing accuracy of an arc minute (easily attained with a standard telescopic finder scope.) we should be able to adequately calibrate the system. We plan to make a more careful mapping of the light's angular dependence.

1.3.4 Star Photometry Atmospheric Monitor (Michigan Technological University - David Nitz)

Apogee Instruments has informed us that shipping of the CCD will occur later this month. They have been asked for an exact date and have indicated that they will inform us in a few days. This is the third delay. Other program elements are in place but progress now awaits/depends upon receipt of the CCD.

Fortran/data manipulation tools as previously developed have been debugged and are ready for use. Procurement of the PC to operate the star monitor is proceeding. The extinction Star selection and data base is complete.

Surface Detector

2.1.1, 2.1.5 Surface Detector Design (Benemérita Universidad Autónoma de Puebla - Humberto Salazar)

Rotoplas has developed a new version of the mold (modified P.Mazur version D) and will start production of a new set of tanks for prototypes tests at Puebla University next week. I enclose de drawings of the new mold. Rotoplas tank engineering production in Argentina is expected to start in December.

Liner Engineering

We have found a vendor to develop liners in Mexico. Some developmental work will be make on Tyvek-Poyethylene laminate and liner fabrication. This vendor will develop also dome kits of soft plastic (ACLAR & ACLAM film)

2.2.3.1.1.5.4 GPS Software (LPNHE Université Paris 6 France - Z.Strachman)

A skeleton version of the GPS software (communication between the station controller and the GPS receiver, interpolation of the pps) is ready and implemented in the station controller processor

Communications

3.1.4.2, 3.1.5.3 Telecommunications Software (LPNHE Université Paris 6 France - A.Castera)

Overview

The P.A.O. communications are aimed at:

Routing data and control back and forth the Surface Detector Local Stations (LS) and the Central Data Acquisition System (CDAS) located at the Central Station (CS).

Routing IP communications between the different Fluorescence Detector buildings and the CS. The P.D.R. splits the communication network in two parts:

A legacy network links the LSs to concentrators located near each FD buildings. It is composed of Subscriber Units (SUs, connected to the LSs), Base Stations Units (BSUs, the concentrators) and the associated internal protocol. This part is handled mainly by a team from Leeds, in association with the LPCC for the connection to the Local Stations.

"Standard" network devices build up the "back-bone" connecting the BSUs and FD Ethernet segments to the CS. It is mainly composed of routers, fiber optic and microwaves links. This part is handled by LPNHE, together with LPCC and LAL. Later on, the French team took in charge the definition of the higher level communications protocols used on these links, up to and included the application layer and the network management and monitoring system (the "Supervisor"). This now includes the topological aspects of the Campus Ethernet network. A GAP note is under preparation to describe more precisely the activities of the French groups regarding P.A.O. communications. LPNHE coordinates the French efforts. Present Status:

- Hardware

+ Microwave link - The microwave link between Malargüe and Los Leones for the Engineering Array will be based on DMC type XP4 equipment. At time of writing, the frequency band is not yet attributed by the Argentina telecom regulation authority. This information is needed for the equipment to be built. We are doing our best to get the equipment installed by mid of November, but no definitive date can be assessed.

+ Routers - The routers for the E.A. are under test at LPNHE. Some configuration troubles still persist, but no extra delay is foreseen.

+ Buildings to shelters links - The optical ethernet transceivers are at lab, waiting for test. The fiber must be returned to the manufacturer. No extra delay is foreseen.

+ UPS and Batteries - They will be shipped together with the microwave link.

+ LSX/BSX - This is the interface between the collection network and the backbone. It consists of a local station processor card equipped with its ethernet interface (LSX, from LPCC) and a BSU processor/E1 interface card adapted to be plugged onto the PowerPc bus (BSX, from Leeds). The LSX hardware should be made available by LPCC for installation in November. The BSX should not be ready at that time, but a temporary solution should be provided by Leeds.

- Design & Software - The design of the backbone is now almost frozen. The Application Level Protocol is defined and implemented in local stations and CDAS codes, but still needs some minor adjustment. Further change may occur during the CDAS tests. A preliminary IP numbering scheme is defined and used by the CDAS. LSX code development is starting.

Work related to DPA task:

Developments have been performed on the simplified chain working on ground particle files of simulated showers (sampling + surface detector simulation + signal analysis) described in GAP-2000-025. In particular, these packages were adapted to quasi-horizontal showers, either tails of normal hadronic showers, or deeply induced (neutrino interaction or decay of a tau produced in a nu_tau interaction in the earth). On the other hand, we are working on the design of classes and their associated functions, in order to build the "standard" chain using ROOT objects in input/output files.

4.0 Central Data Acquisition System - (LPNHE Université Paris 6 France - Antoine Letessier-Selvon)

The members of the CDAS team or participants in the CDAS activities at LPNHE: Antoine Letessier-Selvon, Xavier Bertou, Alain Castera, Sylvie Dagoret-Campagne, Cyril Lachaud (new post-doc), Edgar Linares (new post-doc), Olivier Deligny (Ph.D. student), and Geraldo Cernicchiaro (On partial leave from CBPF), at Besancon: Fran?s Meyer, at LAL: Christian Arnault, Oleg Lodygensky, Ren?Billot, at College de France: Jean-Michel Brunet, at Fermilab: Eileen Berman.

The Hardware

Hardware components have been bought and installation is proceeding in the lab.

We have had some hardware failures:

Two disks of our RAID system (one has been replaced the other one is being processed).

Our UPS unit burned at installation. A new unit has been delivered but has not been installed yet.

The following component should be finally tested by October 15th and then shipped to Malargüe:

Malargüe CDAS system (WBS 4.2)

- 4 PC (20GB of disk, 256 MB RAM, Intel Biprocessors, 450 MHz)

- 1 Yamaha 16x4x6 CD engraver,

- 1 Cisco switch 24 channels 100Mb/sec for the CDAS LAN,

- 1 RAID system (10 36GB disk, 360 GB raw, 300GB Raid5 with hot spare)

- 1 Transtec DAT DDS4 with 6 cartridges autoloader giving 240 GB of backup space. We have bought 18 DDS4 cartridges ($50 a piece!)

- 1 GPS antenna with receiver and network time server

- 1 network laser printer,

- 1 UPS power supply 6kVA with 2 battery extension (almost 1 hour of supply at full load). In addition to these acquisition components, LPNHE people have 2 laptops for CDAS maintenance (for use in the lab and in Malargüe). Shipping at the end of October is conditioned by the completion of our test and of the assembly building in Malargüe. A second network is assembled in our lab to reproduce the Malargüe system for home software tests. Its components are the following:

- 3 PC (20GB of disk, 256 MB RAM, Intel Biprocessors, 450 MHz)

- 1 switch (1 hub, 24 channels) for building LAN,

- 1 external hard disk simulating the RAID system,

- 1 network laser printer.

- 2 Software. The CDAS software comprises the following components: CDAS supervisor

"Su" (WBS 4.1.1.3.1) and meta-Supervisor. "Su" must be first launched (will become automatic) on any machine. At launch, "Su" invokes a series of shell scripts:

- to configure CDAS parameters (like shell variable environment),

- to launch underlying Lal servers like "Cm," "Ik," "Db,"

- to launch the CDAS servers like "Pm," "Fd," "Mo." Meta-Su is launched at boot time and will automatically launch Su on the proper machine. This is not yet implemented but should be by the end of October.

"Pm" (WBS 4.1.1.1.1) Current version running with monitoring (Mo), trigger (T2 and Ct), trash (raw service) services implemented on the CDAS side. On the Array side LSblock (data receive) and Broadcast (data send) service are implemented. Trash and T2 template clients need to be coded.

"Ik" (WBS 4.1.1.1.2) Version 2 running we only use the free field format for the moment. (No message objects are being configured and transmitted).

"Mo."(WBS 4.1.1.1.4). Current version connects to Pm and accept monitoring block which can be forwarded to MoR (recorder) and MoC (supervising client) calibration (if needed) of monitoring data is not done yet as we don't have the sensor specifications. MoR formats and controls the set of ROOT files which stores the monitoring data. ROOT format must be finalized. MoC simply verifies the stations status bits but has not been tested yet.

"Db" (WBS 4.1.1.1.5) is complete. A new interface based on GTK (via Glade) has been built for the DbEditor.

"Ct" (WBS 4.1.1.2.1) almost completely implemented but not fully tested with Pm. The T3 output via "Ik" must be done. The monitoring of trigger rates on local station must be done. Will not be part of the November system.

"Eb" (WBS 4.1.1.2.2). Only preliminary tests to store data in Root data structures based on STL collections were done. Will not be part of the November system

"Rc" (WBS 4.1.1.2.3) is partly implemented and tested. It will not be part of the November system.

Task List -

Up to now software tests have been done on one single machine, the development PC. Tests on the distributed CDAS architecture can be undertaken now, as the IP number service policy is implemented. -

"Rc" the adaptation with the new "Ik" version must be done (and tested with "Pm"). The policy of the action to take in case of warnings or alarms during runs must be defined.

"Ct": The Local trigger input from Pm must be pursued. The programming of the recognition for already defined trigger patterns must be done. The T3 output via "Ik" must be done. The monitoring of trigger rates on local station must be done. The Fluorescence triggers from

"Fd" must be accepted. -

"Eb" must be implemented. -

"MoR" Additional monitoring blocks other that the Local station ones can be added easily as new Root Trees, as soon as their data format are defined. User-friendlier Root macros can be developed for monitoring visualization. In a second version it is proposed to use the Root client / server facility in order to receive directly Root tree objects from Mo (this imply the raw data decoding is done once in "Mo").

- a CDAS user interface: a friendly user interface will launch at demand the CDAS applications and start or stop runs.

Schedule for the Engineering Array

***For November 2000 in Malargüe, it is foreseen to have a monitoring facility with "Pm," "Mo" and "MoR" running on the distributed architecture. This allows saving monitoring information from local stations only. This information will be stored on the Raid system and backed up. Automatic copy to FERMILAB or LYON mirror center will be done as soon as the link is available. Otherwise, only local copies will be possible with the CD engraver.**

*** For spring 2001 in Malargüe, it is expected to have a system with "Pm," ("Fd" prototype?), "Mo," "MoR," "MoC," "Rc," "Ct" and a preliminary "Eb" (providing event storage, without on-line event reconstruction) working with "Ik" and "Db." This will allow full data taking. Same remark as above for storage and copying.**