Pierre Auger Project
Progress Report
April 2000

Summary (with illustrations!)

Important work was accomplished at the site during April. A second detector tank was installed in the Engineering Array. All of the first ten detector sites now have antenna masts. The Comms group spent nearly a month installing equipment at the Los Leones tower and at the surface detector sites. Several days of heavy rains made access to the site rather difficult. Some scenes from the April site activity can be seen at http://www.auger.org/admin/Reports/scenes_from_site.pdf

The second Malargue Collaboration Meeting was held April 12-17. A brief summary of the meeting may be found at http://www.auger.org/admin/Reports/malargue.pdf

Minutes of the Collaboration Board meeting may be found at http://www.auger.org/admin/Reports/collaboration_meeting_17apr00.pdf

Construction has started on the first assembly building, the Los Leones fluorescence detector building and the power lines to Los Leones.

1.0 Fluorescence Detector

The main activity for Auger FD in April was the collaboration meeting in Malargue. A summary from the FD standpoint was distributed to the fluorescence_group mailing list and is posted at the FD web site www.physics.utah.edu/~sommers/hybrid/ under the "meetings" page. It mentions many of the recent FD activities that were reported at the workshops and plenary sessions.

The contract for the Los Leones building was signed by the Governor of Mendoza on April 18th.

The group at Rome has developed a PMT test box that tests 24 tubes at a time. They are acquiring additional PMTs, having at least 450 by the end of April.

First tests of the electronics with analog and digital boards combined were performed at Karlsruhe in April and preliminary results were presented at Malargue. Although there were some glitches in those first tests, the functionality was demonstrated and plans for "sunflower" tests with light signals were scheduled

for May.

The Milan group tested the anode current monitor by measuring star transits from a position in the hills near Torino.

1.2.2 Roving Flasher (Louisiana State University, Southern University)

Prototype diffusing ball constructed and tested for leaks. Preparing to manufacture second prototype to be sent to UNM for testing with laser system.

1.2.4 Flat Field Illuminator (Louisiana State University, Southern University)

Performed computer simulations of a redesigned dome, one with a flatter cylindrical geometry. It will be far easier to manage in the field than a hemisphere of this large size. Cylinder will work if interior surface is modestly isotropically reflective. Tyvek may be suitable. Lab tests planned.

1.3 Atmospheric Monitoring/Calibration (University of New Mexico)

All groups with WBS responsibilities for Auger South FD Optical Calibration and Atmospheric Monitoring wer1e asked to make (short) presentations at the recent collaboration meeting in Malargue. As a guide each WBS task was to be summarized as follows:

i) BRIEF statement of the task: what, why, how well, ...
ii) baseline design (as you now envision it)
iii) what your institution is contributing and progress since September 1999
iv) schedule for delivery and installation at the site

The tasks and scheduled speakers were as follows:

I) optical calibration
a) relative "day to day" calibration component:
o WBS 1.2.1 = central eye calibration system ..... (J.A.J. Matthews)
b) absolute "once a month" calibration component:
o WBS 1.2.3 = calib. flux mon. and central calib. facility .. (J. Brack)
o WBS 1.2.4 = uniform (Schmidt aperture) illuminator .... (Jim Matthews)

II) atmospheric monitoring
a) quantitative atmospheric monitoring (NON cloud)
o WBS 1.3.1 = UV backscattered LIDARs at each eye ..... (M. Zavrtanik)
o WBS 1.3.3 = horizontal attenuation length monitors ..... (B. Fick)
o WBS 1.3.5 = local aerosol phase funct. monitor(s) .. (J.A.J. Matthews)
o WBS 1.3.8 = local weather stations ..... (K. Gibbs)
b) cloud monitoring
o WBS 1.3.7 = IR (10um) cloud monitors (fixed + scanning) .... (R. Clay)

= Micro-LIDAR ..... (R. Shellard for S. Perchine)

III) Optical calibration and atmospheric data bases and related data base software:

- **WBS 1.2.5 = rel. and abs. calib. data bases + software -PLUS- WBS 1.3.9 = atmos. and cloud mon. data base + software (R. Shellard)**

IV) Other (monitoring and FD cross checks plus near term studies):

- **WBS 1.2.2 = tethered light source(s) [abs. calibration] . (P. Sommers + Jim Matthews)**
- **WBS 1.3.2 = collimated, pulsed (xenon) light sources .... (P. Sommers)**
- **WBS 1.3.6 = roving steerable laser/LIDAR ..... (P. Sommers)**
- **WBS 1.3.4 = star monitor (at Los Leones ?? site) ..... (Jim Matthews)**

To first order the reports showed clear progress. It was reported that the optical calibration and atmospheric data base (and related software) tasks, WBS 1.2.5 and 1.3.9, have not yet been started. To keep the meeting on time the report on weather stations, WBS 1.3.8, by Gibbs was skipped as he had privately reported that a subset of the weather stations were on hand at the U. of Chicago ... if not yet at the site.

For brevity we will focus on the couple of areas of some concern.

A) One "behind the scenes" concern was the problem of shipping equipment to Argentina. This problem needs to be solved in a more or less communal way, and not individual by individual. Individual solutions will be a disaster for the many distributed tasks in the FD optical calibration and atmospheric monitoring subgroup. In this regard we recommend that Auger import/export CENTERS be formed, eg at Fermilab for the US, perhaps at Karlsruhe for the EU, etc to coordinate the import/export to/from Argentina.

Individuals in those regions would then only need to coordinate with the CENTERS. All import/export would otherwise be handled by the CENTERS.

B) One concern is the obvious 6~12 month delay in the FD building and also the concern with shipments to Argentina that are slowing down some of the work at the site. While we have confidence in the proposed solutions for FD optical calibration and atmospheric monitoring we need to "begin to try out the solutions." Final implementations will likely be somewhat different from our plans. This is of course the purpose of the engineering array. Our point is that the time slippage is in most cases only being somewhat compensated for by progress at the home institutions.

C) A critical component of the atmospheric monitoring is the use of lasers to monitor various aspects of the atmosphere. Several groups are interested and involved (at least at some level) in this monitoring. Coordinating the overall effort is one important issue. To help further progress

we urged the groups to focus on their "primary" goal (rather than trying to solve several monitoring problems). The problem of where to site UV (355nm) lasers/LIDARs is the other major issue. The most cost effective to to site these very near/at the FD sites. However firing these lasers will produce immense signals in the PMTs which at a minimum causes dead-time and at a maximum may result in PMT performance degradation.

A possible, but not confirmed, solution is as follows:

i) Green (532nm) back scattered LIDARs will monitor the vertical profile (of aerosols) ... [the horizontal atten length monitor will measure the ground level aerosols].
Caveat: There is concern that measurements at 355nm (near the middle of the FD acceptance) will be different from measurements at 532nm (well outside the FD acceptance). This is certainly true for the measurement of the aerosol total cross section (which we propose to evaluate using the horizontal atten length to skirt this problem). The vertical profile of the aerosols may be less sensitive to the wavelength at which it is monitored. Furthermore the vertical profile need be monitored only to a precision of for example 10~15%. Will the vertical profile of aerosols differ by less than this or more than this? TO ANSWER THIS QUESTION, the Slovenians were asked to compare vertical aerosol profiles measured at 355nm and 532nm ASAP. As this measurement must be made in low humidity, desert like atmosphere, other groups may also need to be involved. THIS IS POSSIBLY THE MOST CRITICAL ATMOSPHERIC MONITORING TEST AT THIS TIME.

IF green lasers CAN BE USED:
o The green lasers/LIDARs would be "invisible" to the FDs and thus could be sited at the FD sites.
o A green backscattered LIDAR would provide a good "fast response" system to check for clouds near "just triggered FD events" ... they could also monitor the vertical height of clouds.
o At least one, simpler, "steerable UV (355nm) laser" should be sited on a raised hill someone on the edge of the site and 15~20km from the nearest FD site. The "side" scattered light will be observed by the FDs. The predicted VS observed signal provides the essential cross check of the horizontal atten length, the vertical profile of aerosols, the aerosol normalized differential cross section and the "early" and "late" multiple scattered light. AT LEAST ONE STEERABLE UV LASER IS NEEDED EVEN IF THE GREEN BACKSCATTERED LIDAR SOLUTION IS USED TO MONITOR THE VERTICAL PROFILE OF AEROSOLS.

IF green lasers WILL NOT DO THE JOB
o We need to re-think our placement of steerable lasers ... and in

particular consider siting them well away from FDs. This will increase the cost of these devices ... however it may be that siting steerable UV LIDARS ~1km from a FD site would be acceptable. WE NEED TO DETERMINE WHAT A SAFE DISTANCE IS TO SITE A ~10mJ/pulse LASER FROM A FD SITE.

- **o If a LIDAR at ~1km results in acceptable backgrounds (at the nearby FD), then backscattered LIDAR techniques should continue to be developed. If a LIDAR must be much more than ~1km, then we need to re-think our our use of back-scattered LIDAR to monitor the vertical profile of aerosols ... and in particular consider using side-scattered LIDAR techniques to monitor the vertical profile of the aerosols. This will decrease the cost of these devices.**

ii) Red wavelength "micro-LIDARs" would coordinate with the fixed and steerable IR-cloud monitors as follows:

- **o the IR-cloud monitors locate the positions of the clouds in "X-Y" above the array ... these also provide some height "Z" information**

- **o the micro-LIDARs measure more precisely the height "Z" of the cloud (layers)**

1.3.2 Vertical Flasher (University of Utah)

We performed initial tests with the xenon flash lamp and the parabolic reflector. The beam cross section was measured at a distance of 150 feet from the reflector using a CCD camera. It was found to be inadequately collimated. We will test an alternative Fresnel lens optical system.

1.3.3 Horiz. Att. Mon. (University of Utah)

We continued construction of the first unit consisting of lamp and camera subsystems, and began work on the second system. We also procured a second CCD camera for the second system ($1400).

1.3.6 Roving Laserscope (University of Utah)

We received equipment previously ordered (beam depolarizer, beam splitter, beam diverger, pulse energy probe and Joule meter. We performed tests on the laser, making an absolute energy measurement of 7.5 mJ with 4% RMS fluctuations. There are two satellite beams due to internal crystal reflections, but those amount to less than 0.0005 of the total energy.

2.1.1.1 Tank Engineering and Specification; Parts Fabrication (Fermilab)

The third tank manufactured by Alpina was installed in the Engineering

Array and filled with water. Brackets to support the solar panels, cloud monitor, and electronics were installed. New plastic hatchcovers were installed on the two tanks in the field using two different methods of attachment. More tanks will be made by Alpina for installation as weather permits during the Argentine winter. Resin is on order for these tanks. Rotoplas has made the modifications to their mold for further tank production which will begin for BUAP in early May. Shipment of the mold and machine to Argentina will be delayed until the tanks are satisfactory. Plastrong has had difficulties making the mold to meet Auger specifications and a schedule for completion is uncertain.

2.1.1.3 Liner Engineering, specification, and QA (Fermilab)

The third liner from China was installed in the second Engineering Array tank and filled with water. Another ten liners have been fabricated in China and preparations for shipment to Malargue are underway.

2.1.2.1 Water Purity Studies (Fermilab)

The operation of the full size tank at Fermilab continues for water purity studies. A draft specification for purchase of a water purification plant has been prepared by Tandar, Fermilab, and Argonne and is being presented to potential vendors by Tandar.

2.3.1.1.1 Front End Analog Section (EA) (Mich. Tech. University)

Completed schematics and added documentation.

2.3.1.1.2 Front End Analog Section Testing (EA) (Mich. Tech. University)

No work has yet been done on this item. Sufficient progress on 2.3.1.1.1 is a prerequisite for 2.3.1.1.2.

2.3.1.1.3 Trigger ASIC (Mich. Tech. University)

We have split the trigger ASIC work into two paths in order to reduce the time to delivery of the first prototype systems.

PLD prototype:

PCB of 1st revision of the PLD daughter card received from vendor and stuffing began. Awaiting delivery of one part which should arrive in May.

Work continued on an improved PLD design which will operate at full speed.

ASIC version:

Developed specification for simplified first phase chip and began design.

Work is proceeding on test chip.

2.3.1.1.5 Front end board (EA) and 2.3.1.1.6 Testing of same.(Mich. Tech. University)

Layout progressed slowly at MTU due to course commitments of students at end of term. Parts ordered and received. (This has now been re-arranged somewhat per discussions at SDE electronics meeting at Fermilab May 4. Fermilab will help by providing layout of front end board platform.)

2.3.1.1.7 ASIC Test Fixture (Louisiana State University, Southern University)

The test board was redesigned, a result of visit to MTU by R.Meyhandan. The redesign in part reflects the revised schedule of ASIC manufacturing at MTU. It also addresses concerns regarding potential cross talk at the high frequencies required. Consequently: A new logic pattern generator (HP16552A) has been ordered, the new layout of the board, has been completed, and the specs have been sent to a manufacturer.

2.3.7.1.1 Cables (Louisiana State University, Southern University)

Specifications for sensors and interfaces underwent some modification at 4/00 Malargue meeting with Beatty, Tuckey, Urban, Matthews. Design finalization underway, with D.Hoffer also.

2.3.7.1.2 Sensors (Louisiana State University, Southern University)

Design respecifications made during 4/00 Malargue meeting with Beatty, Tuckey, Urban, Matthews. New design for water level pressure sensor underway with Mazur. Interfacing specifications underway, with D.Hoffer.

2.5.1 Procure 40 Solar Panels and Regulators (Fermilab)

The second Engineering Array detector station was deployed with a complete solar power system in place. Enough batteries, battery boxes, and regulators for ten solar power systems have been purchased and sent to Malargue for the next set of surface detector stations. Until the stations are ready for deployment, the batteries and battery boxes are being used by the Communications Task for field tests.

5.0 Project Management (Fermilab)

WBS Revisions:

Considerable progress has been made on revising the WBS structure into a form that a schedule can be developed. Many of the task areas are essentially complete like SD, Comms, Site Development and CDAS.

These areas may require only minor changes to finalize the WBS. The FD WBS basic structure is essentially complete but requires expanding the WBS to include lower level detail, which is in process. DPA's WBS is also under revision since their preliminary design review in Malargue. The WBS structure revision process will be completed soon and the effort will shift to schedule development.

Schedule Development: We are currently transitioning the SD WBS into a schedule. This process requires Task and Subtask Leaders to supply task information, such as, activity duration, relationship to other tasks and task owner. The schedule development of the other task areas will be starting shortly, so don't be surprised when you are contacted to supply scheduling information.

Importation:

We are attempting to bring liners from China to Malargue via Mendoza for Customs clearance. We are hopeful that this path plus the use of a customs broker there will be a more cost effective routing. The air shipping of liners is still very costly because their "dimensional weight" is very high. We are hopeful that flexible domes will help us reduce this number.

Drawing Storage System:

We have developed a draft numbering system for the storage of documents (drawing and the like) at CERN. We have scheduled our first video conference with the System Administrators for the storage of CAD data to review this structure and begin storing drawings there. It is anticipated that the first drawing to be stored there will be the SDE block diagram and wiring data. Its difficult to project an availability date, but I am shooting for something like the 1st of July.