Pierre Auger Project
Progress Report
May 2000

Summary

See link for this month's photo album:
http://www.auger.org/admin/Reports/album_may.pdf.

An important milestone was passed in May in Karlesruhe when Groups from Karlesruhe, Milan, Romeand Torino performed a successful system test of the Fluorescence Detector Electronics. A seven photo tube array, the "Sunflower" test involved the head electronics, analog first end and trigger logic. (See Test Report http://www.auger.org/admin/Reports/sunflower_test.pdf.)

We received word from Malargüe that the construction of the Los Leones Fluorescence Detector building and the Assembly building has begun. Mild weather has allowed the contractor to get off to a good start.

A series of tests were performed at the site to understand the problems of site access. A truck with three driving axles was loaded with concrete slabs to simulate a tank filled with 6 tons of water. The truck was able to move most of the time on the pampa but left deep ruts in some places. At one point a large wheeled front end loader had to help the truck (see photos). It will be harder to work at the site in bad weather we expected.

The Auger project was discussed at a meeting of President Clinton and President de la Rue at the White House.

1.1.1.2.1.2 Optical Filter and Frame (National University of Athens)

1. Optical Filter

Emmanuel Fokitis reported evaluations of alternative filters, including a design by OCJ specifically for Auger at the Malargüe meeting.

2. Atmospheric Monitoring

Emmanuel Fokitis reported on equipment for night sky spectral measurements and on the possibility to use a spectrometric devise based on a Hamamatsu 931B phototube to obtain the horizontal attenuation or by pointing towards "South polaris region" (Octans constellation) to obtain average attenuation length at the angle corresponding to this zenith angle.

3. Further activity after Malargüe Meeting:

a) 4 Filter pieces of OCJ (50 mm x 50 mm each) were delivered to NTUA (end of April). They were subjected to the following tests:

b) Transmittance Spectroscopy [at NTUA by S. Maltezos , UOA by Th. Geranios and CERN by A. Braem - also at OCJ). Special tests at NTUA and CERN measured the Transmittance in the filter stop band region.

c) The microstructure of these samples was studied by Rutherford Backscatetring at Tandem Accelerator at Democritos (M. Kokkoris and R. Vlastou).

d) Some hybrid filters have been studied besides RBS , by Raman scattering and Ellipsometry. The Raman spectroscopy (D. Papadimitriou) has identified some characteristic peaks indicating the type of crystallization of ZrO_2. More detailed study is expected to reveal level on internal mechanical stresses. The Ellipsometry analysis (carried our by Liana Drakaki) gave the two dimensional profile of the total thin film thicknesses. The is a quality criterion related to the uniformity of the optical properties of the filter. The same test will be carried out at the main candidate filters.

e) Optical Performance tests for comparison of OCJ, ZC&R Blacklite and OCJ custom filter.

The optical tests were done :

a) In the lab using optical light noise, absorption and N_2 emission experimental emulators.

b) In a very dark place outside Eretria (45 km from Athens) where we were able to measure the night sky spectrum. It will be compared to spectra at astronomical sites and at Malargüe (when available). The main (preliminary) conclusion of the tests is that the relative improvement factor, i.e. the ratio of improvement factor of this filter to the ratio of a typical absorption filter proposed for AUGER FD, is around 1.35+-0.08. A more detailed report is being prepared. The relative advantage of this filter is that with this good performance only 1 square meter is needed per telescope and should be placed just in front of the camera. This leads to smaller weight and less complicated mounting than covering a large part of the entrance of telescope with 2.25 m x 2.25 m filter. An order or total surface to equip 2 telescopes (2 square meters) is being negotiated with commercial companies.

1.1.1.2.1.2.3 Optical Filter Frame (National University of Athens)

A mechanical frame is being designed to support a number of filter plates needed to form a spherical surface of radius of curvature 1740 mm. It appears that 36 pieces of 170mx170mm are capable to provide 100 mm x 100 mm square curved filter surface just in front of the camera. The details of the design is to ensure minimum or zero obscuration due to matching the above pieces to form an approximation to spherical surface (Work is being done by S. Maltezos and K. Razakias).

"An experimental Method to Investigate the Optimal UV Filter for the AUGER Fluorescence Detector "(by S. Maltezos and E. Fokitis). This is a GAP NOTE for year 2000.

1.2.1 Fluorescence Detector (optical) Calibration (University of New Mexico)

1. Progress Report

Our present focus is on the control and monitoring of the optical calibration light source(s). The hardware has been ordered. The goal is to provide robust hardware (e.g. with no moving parts such as fans, disks, ...) that can be power cycled remotely (if/when required). The related software (in C) should be written this summer.

2. Atmospheric Monitoring

The prototype light source has being assembled. We are learning how to manipulate the (outgoing) light beam.

3. Other

A DRAFT paper for Journal of Physics G on "Fluorescence Detector Optical Calibration and Atmospheric Monitoring for the Pierre Auger Experiment" is posted at: http://www-hep.phys.unm.edu/~johnm/jpg_draft_v13.ps

1.2.3 Calibration PMT (University of Colorado Nuclear Physics Laboratory)

A complete monochromator system is now operational. Code (Tcl/Tk) has been written to control the monochromator scans and the 3 channel data acquisition system, with graphics to view the results. We have an uncalibrated (cheap) Si detector, identical to the calibrated (expensive) detector we will eventually get from NIST (UDT Sensors UV100 Si detector). A mount to the monochromator has been made for this detector, and for a PMT, and we are experimenting with repeatability of scans and necessary ND filters to attenuate the PMT arm of the split beam. We have a Hammamatsu PMT (R4607-06; 2-inch) which is a candidate for the monitor detector on the flat dome illuminator, but are still waiting for shipment of the base for this PMT. We have purchased a CCD camera (Starlight Express MX516 - same as used for horizontal attenuation measurements) for use in measuring the properties of the diffuse surface flat dome illumination source. We are in the process of constructing a small dummy illuminator using a piece of Tyvek and a sandblasted glass for diffuse surfaces, and will use this dummy to develop calibration techniques.

1.3.1.1 Lidar Subsystem (Ljubljana)

We are planning a series of test measurements in July to study differential scattering of 350nm YaG laser beam. In order to do that, a mirror support with ~ 1 degree angular resolution is under construction. A new PC and an oscilloscope were acquired for DAQ. A remote wireless system for triggering DAQ using laser signal was ordered. Software to perform online calculations of attenuation length as well as relative scatterer densities is under development.

1.3.2 Vertical Flasher (University of Utah)

We tested several Fresnel lenses and re-designed the housing to accommodate a 13-inch lens, which provides a significantly greater light intensity in the beam column than was achieved with the inexpensive parabolic reflector. The electronics was upgraded to turn off the power supply between flashes (probably to be set to 3 minute separation) to conserve battery power. The GPS trigger system was verified to be operational with the flashbulb power supply.

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

We constructed the main enclosure for the detector unit. We fabricated a inch reflector f/2 optical system. We made the fine pointing mechanisms. Installed the filter wheel. We built the lamp housing. Built the steering mechanism. Installed the lamp and reflector and lamp ballast. Installed the preliminary power electronics. Installed the light sensor and monitoring device.

1.3.4 Vertical Star Monitor (National University of Athens)

Evaluation of various spectra taken in Eretria area and at NTUA are being continued. An effort is being made to improve the optics of the spectrometer so that it has better sensitivity. The spectra can be fitted with climatorlogical models which are described in the LOWTRAN code and take as input the night sky radiation and in particular the moon radiation. The LOWTRAN code in windows form is purchased by a group at NOA (National Observatory of Athens) and, it hoped that a fit of our data with the computer simulation code can give the average atmospheric extinction.

1.3.4 Star Photometry Atmospheric Monitor (Michigan Technical University)

This is a new task added to MTU in May. J. Bruce Rafert is leading this effort. During May work was done on budgets and schedules and discussions with John Matthews were held. The first parts order was prepared.

2.0 Surface Detector Task Summary

No new tanks have been deployed since April. Part of the reason for this new delay is the decision that the shipment of the mold and machine from Mexico to Argentina would be delayed until the tanks are satisfactory.

Nevertheless, Rotoplas has made new improvements to their mold (smooth top area to avoid accumulate dirt) and is learning how to control the tank production process to match the specifications of the tank design. A new set of Rotoplas tank production will begin for prototype tests at BUAP, including opacity tests and water studies. Revision C of the tank drawing was produced as alternative to solve some problems appearing in the tank fabrication with open flame technique.

Quality control and documentation steps for resin were defined for all tank providers, and should be applied for the EA stage.

Plastrong (Argentina) is still working on the mold .

As backup prevention for the 40 EA tanks, we will buy enough resin to produce more Alpina tanks after the next 18.

Following a request from the San Rafael landowners, an article to the contract specifying the land usage by us was prepared. Although the deployment procedure has not reached a stable routine with only two tanks deployed, we arrived at a proposal in regards to the landowners contracts.

A drawing specifying the layout of the detector tank and antenna mast was developed. Further development work should be develop to improve mast design according to the soil types and conditions throughout the various regions of the site. National Technical University, San Rafael’s, offer of participation in solving the problem of mast antenna installation is extremely timely.

Important work on water and tank transportation has been made. Following the drawing prepared by J.C. Meza, two vehicles were used and several tests were made at the worst places.

A preliminary call was made to selected vendors to advance technical-economical proposals for a water purifying system. The proposals fell within the expected budget and fulfilled the technical requirements. From these documents a final technical specification is being completed. During the present week this information will be given to the Foundation, suggesting to make an open bidding request for purchase of the specified system.

As preliminary information we are willing to install a system able to produce very clean water, with a resistively higher than 15 Mohms-cm, and with a production capacity enough for 3 detector tanks per day.

2.1.1.1 Tank Engineering and Specification; Parts Fabrication (Fermilab)

Production of more tanks by Alpina in Brazil is delayed until resin can be delivered from the compounder. Alpina is expected to make up to 18 more tanks approximately at the end of August. The tank manufacturing company in Mexico, Rotoplas, has modified it`s mold and is continuing to refine their molding techniques although the tanks produced are not yet satisfactory. The Argentine molding company has modified their mold and made it closer to the specifications. They have molded one tank using inexpensive "practice resin" to learn about the parameters required to make our tanks. Resin is on order by Brazil and the order is expected to be increased to include enough resin to continue making tanks beyond the first 18 if that should become necessary to meet the EA schedule. Resin will be ordered from the same lot to make the first tank(s) from Plastrong. Parts are being accumulated for the brackets which will support the solar panel and electronics. Ninety percent of parts have been ordered and delivery to Fermilab of components for the brackets for the EA is expected to be complete in early July.

2.1.1.3 Liner Engineering, specification, and QA (Fermilab)

The ten liners made in China have been shipped to Malargüe and have arrived in Argentina. Efforts are underway to optimize the shipping and customs arrangements to reduce costs for future tanks.

2.1.2.1 Water Purity Studies (Fermilab)

The operation of the full size tank at Fermilab continues for water purity studies. Final input has been provided to Argentina for specification of the water purification plant.

2.2.3 Prototype Tube Assemblies (University of Colorado Nuclear Physics Laboratory)

Modifications to the fez molding technique, and to the flange mold, will allow the brim to be molded with the fez instead of being assembled after production. At present we are still vacuum molding the fez. The injection mold is on hold until a final shape is determined.

2.3.1.1.1 Front End Analog Section (EA) (Michigan Technical University)

Met with Fermilab engineers and task leaders to get assistance of Fermilab engineers in doing the first version of this layout. Passed on schematics and simulation results. Worked with Mark Kozlovsky bring him up to speed on the design. Distributed documentation and posted on web site.

2.3.1.1.2 Front End Analog Section Testing (EA) (Michigan Technical 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 (Michigan Technical University)

In May we completed a design phasing document, distributed to SDE task, and posted on web site. Work continued on PLD and ASIC paths as described below.

PLD prototype:

PCB of 1st revision of the PLD daughter card received from vendor in April. The last of the overdue parts arrived in mid-May and stuffing continued. Board is expected to be complete for testing in June.

Work continued on an improved PLD design which will operate at full speed. Various alternatives were re-examined ranging from using small PLDs with external FIFOs, a mix of use of internal and external memory, and large PLDs with no external memory. The high cost of the external FIFOs and the added number of components again caused us to drop those options and concentrate on a single PLD version.

ASIC version:

Installed new version of Cadence Design software. Developed specification for simplified first phase chip and began design. Flushed out large portions of the revised design.

Test chip layout proceeded towards June 12 submission to MOSIS.

2.3.1.1.3 Trigger ASIC (Michigan Technical University and Technical University in Warsaw)

Fermilab has recommended to prepare a new, full synchronous design of a trigger for the surface detector. Such a approach allows to improve the speed of a trigger, which is important from physical point of view. The new design has been developing in MTU. The main criteria for the new digital trigger are high speed, reliability, flexibility and cost-effectively. The newest Altera PLD families seems to be an ideal choice to implement flexible and even sophisticated design. To prevent high-speed and flexibility the APEX family has been chosen. Chips from this family have large enough size of internal memory, working as a high speed buffer, as well as have sufficient resources to implement a complicated logic into one chip only. The implementation of whole trigger into one chip reasonably improves a reliability of a system. Additionally APEX family based of the newest technology is relatively cheap (~290$), so the design based on PLD VLSI chip only is comparable in price with the design based on many standard non-reconfigurable chips (~200$). The possibility of reconfiguration of a trigger on line is possible in design based on PLD only and seems to be is very important for the future experiment working for 20 years. The configuration file will be loaded to additional Flash memory (~8$) from net (reconfiguration of the trigger in all 1600 detectors, PLD will be configured via Power PC uC).

The first version of the digital trigger implemented fast channel only (without Zero suppression, two switching buffers) has been completed. The design has been prepared for two versions (FLEX - EPF10k200SBC600-2 commercial temp. range and APEX - EP20k200RI240-2 industrial temp. range)

The board for testing is ready for the FLEX chip (the board has been prepared for previous design with six 8-bit ADCs), so tests allowing the verification the logic and timing start soon, just after my return from Poland. The new board for APEX is preparing in MTU and should be finished to the end of June. The parameters of both families have similar, AHDL code can be compiled with no changes for both families. Small differences in timing can be neglected due to much more higher max frequency in register performance than needed for our goals.

2.3.1.1.5 Front end board (EA) and 2.3.1.1.6 Testing of same. (Michigan Technical University)

Fermilab is helping by providing layout of front end board platform. Met with Fermilab engineers and provided them with current status of design.

2.3.1.1.7 ASIC Test Fixture(Louisiana State University, Southern

University)

Developed new version and layout of test board as per discussions with Michigan Tech (versions 4a and 4b). These reflect new design of FADC and PLD which will be used. We are now preparing specifications for transmittal to board manufacturer

2.3.7.1.1 Cables (Louisiana State University, Southern University)

Began detailed planning for connectors and cabling based on documents distributed by P.Tuckey from FNAL meeting. These were the first detailed layouts of all the electronics and enclosures.

2.3.7.1.2 Sensors (Louisiana State University, Southern University)

Began detailed design of requirements based on review at FNAL (see comments on "cables" wbs 2.3.7.1.1)

2.5.1 Procure 40 Solar Panels and Regulators (Fermilab)

Enough solar panels for 35 more surface detector installations (in addition to the three operating systems on tanks in the field, two as part of the EA) have been ordered and enough regulators to complete the EA have been ordered. A research program has begun at Fermilab to measure the effects of shading by the communications antenna mast. The result should be information to determine the optimum location of the mast at each station.

2.6.1 Site Survey (CNEA)

1. We have obtained the SPOT-satellite images for the whole site. I managed to visualize them with Adobe Illustrator.

2. We are negotiating with the DOADU (provincial office for urbanistics and environmental ordering) about the possibility that they do the GPS-Survey of the site for us (depending on the conditions).

3.0 Communications (Leeds University)

Report on Communications Task Activity Undertaken at the Southern Observatory Site during site visit April 10th to May 12th 2000

This report briefly summarizes a number of activities undertaken by the Leeds University communications team and other collaborators during our recent April/May 2000 site deployment. Whilst I consider the deployment a success, the report contains both tears and laughter in almost equal measure.

1. Work on Los Leones Tower and Shelter

We had hopes that our Andrews tower equipment would be waiting for us in Malargüe. on our arrival for a 30-day deployment. In the final event after accumulated delays due to shipping, customs, public holidays and transport industrial action, the equipment actually arrived with 9 days of our time remaining. We then lost a further 3 working days due to high winds, rain and snow. Consequently, we were unable to complete all the planned installation work at the tower. However, much was achieved in a short space of time;

a) Four out of 6 panel antennas were installed. Modifications to the vertical feeder cable ladder were designed fabricated and installed.

b) A horizontal feeder cable bridge was designed fabricated and installed. The tower grounding system was designed and installation by Martinez contractors was supervised.

c) The communications shelter was moved to its final position. One of the top panel antennas was connected to the shelter via a single 39 meter RF feeder.

We were unable to fit more than 1 RF feeder to the tower as the necessary feeder lightning protectors were not included in the main Andrew shipment. These items were delayed in their passage through customs (temporarily seized) and did not reach Malargüe. before our departure to the UK. It made no sense to fit additional feeders without the appropriate protective equipment. The lack of lightning protection and grid power at the shelter also prevented us from installing a permanent digital data link with the engineering array.

The high level tower work progressed smoothly with no injuries or equipment damage sustained and with no major safety problems encountered though much was learned about the risks and difficulties posed by high access work in unpredictable weather conditions. The vast bulk of the remaining tower equipment is now waiting at the Galpon for our return in November where we should be able to complete the installation work within a single clear weather week (which is equal to 2 'real-world' site weeks).

2. Surface Array Radio Network Installation

We were unable to conduct the vast majority of the planned installation work within the surface array. Once again, I very much hope that our painful experiences enlighten and benefit other members of the collaboration. The main problems were as follows;

a) Radio Software: Software problems with our radios caused delays to their being ready for installation until near the end of our deployment. This of course is solely a Leeds problem that we now have under control. Our pre-departure software development schedule was badly disrupted by our tower climbing training and hardware problems with our latest batch of radios.

b) Customs: I was asked by E. Altmann 2 days before our departure from the site to remove ALL 14 of the radios that we had brought with us due to customs problems. Specifically, we had been denied the necessary insurance bond to leave equipment behind temporarily due to an unrelated problem via the same customs broker with a temporary equipment importation by L. Barbosa & colleagues. I will not again attempt to bring any permanent or 'bonded stay-behind' equipment into Argentina via the temporary importation route, it is just not worth the hassle. The only good news is that there are no remaining customs paperwork issues whatsoever from our April/May deployment (the Collaboration's first 'clean' customs experience?). We were able to leave a single radio behind as we had a suitable older substitute radio from our September '99 deployment available to make up the 14 radios required by the paperwork.

c) Enclosure fixings: Believe it or not we waited nearly 3 weeks to obtain the necessary 3 1/2" exhaust clamps required to attach the radio boxes to the masts. The boxes were supplied in advance (SDE group) but no means of mast attachment were available on our arrival. In the end, due to a vast accumulation of delays (mainly due to the Easter holidays), the clamps didn't show up before we left. The lesson for other collaborators is unfortunately that you cannot assume that you will be able to procure ANYTHING in a timely fashion. I will certainly try my best to bring everything I need with me in future. This is not good for local business but I just don't think they are able to cope with the delivery time pressure that we are under during deployments. They also have great difficulty in obtaining unusual items as they are at the end of a long and often slow supply line. Even items that you have purchased in the past may be out of stock when you arrive and may take a very long time to reach Malargüe.

d) Safe Mast Access: No safe means of access to the top of the mast to fit the antennas and feeders could be found other than very laborious hand climb using slings and harnesses. This problem has been addressed by the selection and purchase of a large ladder that will be available in time for the November deployment.

3. Surface Array Masts

We were very pleased to arrive and see the first 10 masts installed within the EA. However, several problems exist with the current solution. The diameter of the new masts was reported to us to be 2 7/8 inches (73mm) but on physical inspection was actually found to be 3 1/2 inches (88mm). The installed masts are made of the same heavy-duty old surplus oil drilling tubing that is used in the radio propagation experiment. If we had had 73 mm brackets made to fit the tubes we would have been in trouble, as it is, the fact that our antenna suppliers ignored our sizing information and supplied 3 1/2" brackets meant that all was well but only by a double misadventure!! An inspection of the identical masts used for our radio propagation experiment that have now spent 9 months in the elements reveals very serious paint flaking and deep underlying corrosion. I believe that this second-hand material is simply not suitable for this application and I would not advocate the installation of any further masts until a source of a suitable alternative new deep-galvanized steel tube material has been located. One possible supplier could be the Martinez tower company in Mendoza who supplied some very large diameter (5 inch) 5 meter tubes for our cable bridge at Los Leones. They could probably supply smaller diameters if contacted. Another alternative would be lighter weight aluminum tubing with a steel insert at the base to embed in the concrete. Someone urgently needs to get hold of this subtask and produce a fully specified, costed and sourced design.

In the light of site experience gained and considering the hassle that this mast is causing, I propose that we CONSIDER a shorter mast integrated with a strengthened version of the solar panel mounting bracket (rather than directly to the tank as was originally proposed some time ago). I noted at Priscilla that the top of the solar panel bracket is something like 2.25 to 2.5 meters above the ground which was higher than I expected. This is quite a good height for the top support of a short 'stub mast' which could also be anchored at the bottom of the solar bracket. The mast material could be thin due to the shorter unsupported run of tubing (2.5 metros instead of 5 meters). This solution would put more burden on the solar panel design team but would have the following advantages;

a) It would bring the mast design back 'under our control.'

b) It would permit us to at least evaluate an alternative to the separate mast solution.

c) It MAY be cheaper (shorter RF feeder with integrated cable clamps and a shorter mast).

d) It would remove concerns about different soil types and interference between the edge of the tank and the concrete base.

At the end of the day, one of the purposes of the EA is to evaluate competing solutions to see which makes most sense and which enhances the all important showers-per-dollar ratio. I think it makes sense to try both solutions.

4. EA Site Access & Safety

We lost 2 working days due to getting our vehicle stuck in the marsh in the engineering array. This event was well documented by J. Kleinfeller , K. Gibbs and myself and will not be further described here, except to say that the provision of a pair of cell phones and multiple farm gate keys should prevent future problems from becoming more serious than lost time and inconvenience. The incident again highlighted the need for our own special purpose vehicle and in this context I hope that our 12km dusk route-march was not in vain!

5. Campus Tower & Shelter

Several design issues regarding the forthcoming campus tower and shelter building were resolved in a meeting with N. Fazzini. We have been able to reduce costs for this second tower by applying lessons learned in building the first one. It is hoped that the procurement and construction of the campus tower will proceed smoothly during the winter months and that the tower will be ready well in advance for final inspection and installation work during our next visit in November. A series of ground conductivity/resistivity tests were conducted at Los Leones and the Campus. This work was undertaken to establish the grounding system requirements for the campus tower. The ground at Los Leones had a resistivity of 10 kohms signifying extremely poor conductivity and justifying the need for the extensive tower grounding system for our first tower. By contrast, the campus ground readings were around 280 ohms which indicates ground of good-to-medium quality which will require a less extensive tower grounding system. Future visits will take ground resistance measurements at Coihueco and Los Morados.

6. Campus-to-Los Leones Microwave Link

a) Detailed path survey

A detailed path survey of the line of sight radio path between the proposed site of the campus tower and the Los Leones communications tower was conducted. This essential piece of work was required to establish/confirm the required height of the campus tower to guarantee reliable communications on the main radio path from the observatory to the campus. Careful measurements of the position and height of all objects considered to obstruct the radio beam were made with a view to save costs by minimizing the height of the campus tower. The survey work was conducted by P. Clark and P. Walker and essentially reconfirmed the earlier survey work of K. Gibbs, D. Nitz et al. The primary result of the survey was that a reduction in the required height of the campus tower from 50 to 47 meters was made. N. Fazzini is discussing this height reduction with the tower contractors to see if a cost saving can be made.

b) Los Leones tower top mounting and grounding point

We were supplied with a parabolic antenna mounting frame for the 1st microwave unit. Unfortunately this mounting frame did not fit the tower and requires modifications. As the manufacturer had the plans for the tower available at the time of supply, we feel that they should rectify this problem free of charge. In any case the mods will be straightforward (some longer beams are required) and we should have the new frame available in Malargüe in good time for the November comms deployment. N. Fazzini and myself are listed with the supplier to sort out this problem. We were able to fit the required grounding point at the top of the tower and it is located at a height of 36.25 meters.

c) First Digital Data Trial Successful

We were able to obtain a few exhaust clamps for our surface detector mast radio boxes and we have fitted Priscilla with a working radio and antenna system. This single radio was used in our first successful digital data trial (with transmission to Los Leones) and is still installed and operating at the site, though without a corresponding receiver at Los Leones at present (see tower work section). A 1/2 day data trial was conducted which revealed an acceptable basic bit error rate in the region of 1x10-6 (full analysis is still ongoing) and demonstrated the correct operation of the digital receiver. The received signal strength from the array was as expected over the 13km link and was greatly enhanced by the use of our tall tower and high gain panel antenna. An irreducible error-rate problem was observed in the receiver due to noise which will be investigated over the coming months. However, the current performance of the WLAN radio is sufficient to service the engineering array so this is not a time critical problem.

d) RF Propagation Measurements Field Data Collection

The field data collection campaign continued with around 5 days of measurements made into the surface array and the El Chacay wooded area from transmitters located on Coihueco and Puntilla. Measurements were made by L. de Bruijn & G. Sager (University of La Platta) with valuable assistance from K. Gibbs & R. Meyhandan. A total of 46 individual measurements were mage and good results were obtained that will be correlated with the RF propagation prediction package. Should these additional results be as compelling as the existing data, the general measurement campaign will be considered to be concluded.

e) RF Propagation Experiment

The installed experiment at Los Leones continues to return data reliably. The eight Leeds WLAN radios in the experiment (2 at Los Leones and 6 in the outstations) have now accumulated over 5 unit-years of continuous operation without failure, theft, or lightning strike (I really hope I'm not tempting providence here!).

5.1.1.3.2 FD reconstruction software (Lodz)

1. We have prepared a Gap note (to be sent in a week or so) on the exact

angular coordinates of the FD camera pixels. This problem is not a trivial one, as it is connected with positioning of the hexagons of the same size on a spherical surface. There is no unique way to do so and the particular solution, chosen for constructing the camera, had to be known. The equation of the 'shower line' (image of the shower axis) on the spherical focal surface has also been derived.

2. We have continued studies on the shower images in the FD camera, both integrated over time and time dependent. The following characteristics have been studied.

a) The fraction of the signal (integrated over time) in side pixels, with the spherical aberration taken into account. (The latter is only important for showers at distances larger than ~20 km, but then, of course, fraction of the signal inside pixels decreases).

b) The time dependence of signals (central and the side ones). It has been shown that quite often not a negligible fraction of the signal will be below the 4 sigma background fluctuation.

c) The longitudinal width of the shower disk; the instantaneous particle density profile (across the disk) has been assumed a gaussian with sigma 30 m (100ns). Apparently it is not more than 100ns. (Strictly speaking it has not been simulated at small core distances relevant here.) It broadens the signal time dependence a little.

d) The disk curvature. It will cause a small delay of signal in the side pixels; e.g. for shower maximum observed from 10 km, about 7% being in side pixels will be delayed by more than 50 ns. It seems that a shower front is well described by a power law (arrival delay vs core distance) with power index in the range 1-2).

A Gap note is in preparation.

3. Analytical solution for the spot size due to the spherical aberration has been found. For the FD camera it has a diameter of 0.50 deg, which agrees well with the value found numerically by other people before. A Gap note is in preparation.

5.1.2.3.2 Shower production (Lodz)

Our group is involved in the shower production at the Lyon Center. Many showers have been simulated by the AIRES program. Now, we have been working on simulations with CORSIKA. One of us (W.Tkaczyk) attended the May meeting in Lyon, organized by J.Knapp.