Appendix XII
Poster / Handout Designs

Appendix XIII
Website Structure

Project Brief –

Original Proposal (pdf document)
Aims and Objectives (html document)
Useful Links (Websites and Books)

The Group –

Members (List of group members + e-mail addresses)
Meetings **- time of meetings**
- Minutes from each meeting *- 17/01/03* *-28/02/03*
- 24/01/03 *-07/03/03*
- 31/01/03 *-14/03/03*
- 07/02/03 *-21/03/03*
- 14/02/03
- 21/02/03

Construction of Detector -

- Research

- *Composition of Cosmic Rays*
- *Origin of Cosmic Rays*
- *Flux Distribution*
- *Scintillators*
- *Spark Chambers*
- *Cherenkov*
- *HTML*

- Test Apparatus Results

- *Initial Results - 23/01/03*
- *Adjusting Initial Results for Noise - 23/01/03*
- *Noise - 24/01/03*
- *Detection of Noise Source - 29/01/03*
- *More 950v results - 29/01/03*
- *PMT Warm Up Time - 30/01/03*
- *Various 3 way Coincidences - 03/02/03*
- Various 2 Way Coincidences and Comparison with 3 Way Coincidences - 04/02/03
- *Area Testing - 11/02/03*
- *Single Scintillator Results - 11/02/03*
- *Moveable Scintillator Results - 13/02/03*

- Pictures

- Test Apparatus Pictures
- Construction of the Detector

- Final Design

- *Calculating the Scintillator Size Using Solid Angle Programme (Java Script Included)*
- *Blueprint of Detector*
- *Detector Logic/VHDL code*
- *Costs*
- *Time Plan*
- *Final Report Outline + Links to Material*
- *Presentation Material*

Appendix XIV
Budget

Description	Cost (
PMT	Pre-exist
Scintillator	Pre-exist
Discriminator	Pre-exist
High Voltage Power Supply	62.33
Optical fiber	Pre-exist
WLS fiber	Pre-exist
FPGA	125.00
LEDs	29.92
Chips for LED board	20.00
Screws	3.00
Polycarbonate	114.74
Black acetal	47.00
Studding	5.59
Tooling - drills	20.00
Brackets	3.00
Glues	5.00
Total	435.58

- The above is an estimate without taking into account the cost of manpower.
- It is within the project budget of £500
- The engineers estimate that if this detector was built from scratch it would cost around £4000

Appendix XV
Original Timeplan

Week 1: Research, familiarise ourselves with test stand, decide upon group roles. Decide upon detection method.

Week 2: Initial research using MINOS test stand.

Week 3: Continue testing and decide upon final design

Week 4: Start building design

Week 5: Continue building

Week 6: Define final logic, continue building

Week 7: Continue building, start programming, start report writing

Week 8: Continue building, carry on with report, start on presentation, start posters

Week 9: Continue building, carry on with report, presentation and posters. Four of the group have Java exam

Week 10: Complete report and detector

Week 11: Final tests, practise presentation. Four of the group have Java exam

Appendix XVI
Agendas and Minutes from Group Meetings

Brigitte Burt

Agenda
17th January 2003

- Presentations by each group member on background research undertaken during Christmas holidays followed by further discussion of the topics.
- Consideration of advantages/disadvantages for different detector types and selection of detector for the basis of the project.
- Identification of the various areas the project could be broken down into.
- Election of chairman, secretary and webmaster
- Any other suggestions

Minutes
17th January 2003

All group members present

The meeting commenced with presentations given by each group member on the various areas allocated for research over the Christmas period. Simon began with his presentation on the composition of cosmic rays followed by Marco on the origin of cosmic rays. Manuel presented information he had researched on the flux and energy distribution of cosmic rays at the surface of the earth from which it was gathered more in depth calculations would be involved as the project developed with further information required about the expected flux and hence the rate as a function of angle. The flux data would be used to establish the area of the scintillator pieces assuming different efficiencies of the scintillators which are presently set up in the test stand. The presentations then moved to the principles of cosmic ray detection looking in particular at scintillators, spark (or proportional) chambers and Cherenkov radiation presented by Brigitte, Rebecca and Caroline respectively.

The group discussed the advantages and disadvantages of each detector type concluding the scintillator detector would be the most practical for the group project since the other detectors were too big, too expensive and could potentially be unreliable. The scintillator was the only feasible detector since the group resources consisted of a budget of £500 plus photocopy cards. For the benefit of the group the information researched on scintillation detectors would be provided for the group website for ease of reference.

The project was broken down into three main areas which included research of possible detector designs, flux data and electronics. The electronics would involve research into Field Programmable Gate Arrays (FPGA), VHDL (language) and Xilinx. This section of the project would also require coincidence logic to be determined.

It was decided during these meetings that Caroline would act as chairman, Brigitte as the secretary and Simon would be the group's webmaster. The group had decided to

meet next week in the lab in order that they may be shown the scintillator test stand by Dr Waters and Dr Lancaster in order to go into more detail and begin tests. Tasks were set for next week with the awareness that there were 10 weeks left till the completion of this project.

Agenda
24th January 2003

- Begin by letting everyone observe how the scintillator works in lab 3.
- Allow everyone to report back on individual tasks undertaken during the week.
- Possible ideas for scintillator designs (advantages/disadvantages)
- Theoretical calculations which need to be undertaken
- Discussion of experimental readings which need to be taken with the apparatus
- Ideas on communicating science at the appropriate level for school demonstrations
- Any other suggestions

Minutes
24th January 2003

All group members and Dr. Aylward present at meeting

The meeting commenced with discussion of results obtained by Simon and Caroline during the week. They reported that frequent bursts had occurred during the gathering of data and were unable to account for the causes. Proposed using an oscilloscope, which would provide a visual idea of the outputs of various components. Three different coincidence units had been interchanged to observe whether the electronics were causing the problem but the problem was still occurring. A large number of counts were even observed when the empty16th patch channel was connected. The group was not sure whether to attribute this effect to noise or electrical interference. It was noticed that occasionally bursts would occur when someone entered the dark room and it was proposed that it may be caused by the interference of mobile phones. It was agreed that a source of noise needed to be investigated. The results complete with graphs were administered to the group.

Manuel attempted data flux calculations but units were in steradians which need to be converted to counts/m^2 so Marco agreed to team up with him to tackle the problem together through integrating over area and solid angle. Muons with energies in excess of 1Gev were expected to have an incidence rate of 70/m^2/sr.

Marco had retrieved some information on xilinx and FPGAs but was still trying to wade through most of the material. The material Brigitte obtained on possible scintillation designs similarly required sifting through but on the basis of a design that had been set up by SLAC Simon was keen to go with this design which was octagonal in shape. Simon proposed that using two way coincidence, within the octagonal arrangement there would be a smaller inner core of scintillators. Inner and outer core would both consist of 8 scintillator pieces. Logic would have to be programmed so that as soon as one of the sides is hit by a muon the others are turned off. There was

consideration of inserting electronics into centre of octagon but it is necessary to ensure that interference would not occur. LEDs would be used to show the direction of the incoming muon through an array of point LEDs or an arrangement of strip LEDs. The scintillator panels being hit could be shown directly if each strip LED were to correspond to each of the scintillator panels. Experimental data still needed to be obtained to determine whether it was best to opt for two or three way coincidence.

Brigitte and Rebecca still had not seen the equipment in operation since it had been moved up to lab 3 so quick explanations of the coincidence and discriminator units were given.

Tasks to be achieved for the following week were addressed and split up between the group. The meeting finished slightly earlier than the allotted time so the entire group went up to lab 3 to ensure everyone new how to work the equipment. The group agreed to meet in lab 3 Wednesday 29th January from 2 till 5.

Agenda
31st January 2003

- Discussion of the experimental results obtained during the week/factors accounting for noise
- Development of flux data treatment
- Information gathered around VHDL systems
- Advancement with detector designs
- Assign tasks for the forthcoming week
- Any other suggestions

Minutes
31st January 2003

Manuel was absent from meeting but the rest of group members were present

The discussion began with progress on lab equipment. On Wednesday afternoon (29/01/03) investigations included running the empty channel (the 16th channel) and it was discovered high count rates were obtained. The source of these counts was unknown but it was believed that interference between the grey wires coming out of the Photomultiplier tube (PMT) may have given rise to this effect. Caroline and Brigitte made an attempt to separate the wires as much as possible to try and reduce this effect. It was later discovered that the wires were apparently shielded to 50O so the intertwining wires should not produce this effect. After the separation of the wires no more bursts were observed when channels 1, 6 and 11 were run in coincidence.

The number of counts was observed for several 20 minute intervals where 4 counts/min seemed to be the average count rate for 3 way coincidence.

It was collectively decided by the group that it is important to measure 2 way coincidences as well as other combinations of 3 way coincidences so that comparisons could be made. In each of these modes the timing of counts would be noted whilst detector is running for an hour duration. Collecting data from 2 and 3 way coincidence for separated scintillators should indicate the level of noise from the

electronics. Rotating one of the layers would allow tests to determine whether coincidences are random. There should be an area dependency for the non noise coincidence rate.

Graphs from the data obtained on Wednesday were observed by the group and it was noticed that the results produced graphs which had an elongated s-shape.

The possibility of writing a simulation type programme was later discussed as well as trying to save data from SLAC on the Stanford website from the last 24 hours to see how results compare and may indicate whether flux is of a random nature. Information obtained regarding possible scintillation designs also showed experimental consideration of that fact that muons may collide with atoms emitting electrons causing them to be detected by the scintillators and consequently directly affecting the count rates obtained.

It was noted that placing steel in between layers of scintillators should not affect the flux rate since the mean free path of muons is several metres in steel

A piece of new scintillator is to be built with dimensions 4 x 17 cm with wavelength shifting fibre (WLS) inserted into groove down the middle of the scintillator strip which is to be attached to the spare channel of the PMT and should be ready in approximately 1 week.

Consideration of the design required thinking about the mechanical properties of the WLS which is fairly brittle so can only be bent to a small extent. This may cause problems to arise with the design since each scintillator piece requires one to be connected with each WLS converging on the PMT. Using scintillators which are square in shape with one fibre down the middle it was thought may cause a reduction in the efficiency due to edge effects. A suggestion which emerged was perhaps the WLS could double back on itself to form a looped type path but the degree to which fibre could be bent due to brittle nature means the suggestion is not feasible and as a consequence it would be necessary to use scintillator strips rather than squares.

Two possibilities for the arrangement of the scintillator strips in an octagonal geometry were proposed. One of the designs was aesthetically better than the other and would be preferable for the purpose of a demonstration model but its geometry resulted in a larger space at the centre leading to a smaller angular detection range. The large space makes it applicable to containing the electronics and display in the middle and with a handle attached would allow convenience for transportation. The other design although less visual has the advantage of detecting muons incident from a wide range of angles.

At the end of the session the group decided on the size of the scintillator that needed to be ordered with the option of reducing depending on what the most effective size is found to be. Information on VHDL systems as well as flux data calculations were still being worked on. The group are hopeful to try jhal.org to obtain program that allows VHDL to be written in JAVA and converted. Individual assignments for the week were decided.

Agenda
Friday 7th February

- Update on experimental progress for results obtained with two way and three way coincidence.
- Possible ideas for the scintillator design and dimensions.
- Criteria which needs to be included in the progress report of the group we are reviewing.
- Flux data calculation progress
- VHDL information
- Tasks for next week
- Any other suggestions time permitting

Minutes
7th February 2003

All group members were present with additional attendance of two members from group 1 to review group performance (mid term).

Meeting commenced with discussion of the results obtained during the week. Three way coincidence measurements were performed by Rebecca and Brigitte. Simon analysed the results and found that performance was higher on one side of the scintillator than the other as the scintillators were moved across from left (0,5,10) to right (4,9,14) with a range of 20 to 25 counts in the 5 minute interval for which readings were recorded. In the region of 1.5 to 3 minutes a gap tended to arise between counts which occurred frequently and was most prominent at 1.5mins. The reason for the occurrence appeared to be unclear since the only thing that was changed before each data set was taken were the resetting of the counter and the exchange of the patch leads which was consistent over all data sets. It had been suggested that build up of charge in the PMT after it had been exposed to the light could be responsible for the bursts observed so advised to open box as little as possible. For two way coincidence a period of two days passed before the optical box was opened. Each set of data gave a straight line.

Caroline then gave a brief overview of the experiment for the benefit of the group reviewers and an explanation of the coincidence unit.

Next the discussion moved to the results obtained for two way coincidence carried out by Caroline and Simon with the reading recorded every 10 seconds during the 5 minute interval due to the rapid count rate. The jumps were taken out but results for the two way coincidence seemed to be more consistent. There was not so much of a gap occurring between counts with two way coincidence compared to three way. One of the group reviewers thought the result was reasonable but then a board member (Waters) explained that Cosmic Rays are regular rather than in bursts. In comparison last weeks data showed a gap of about 2 minutes. Reviewers enquired whether the group were planning to undergo experimental work but it was decided that the detector would purely be for demonstrations rather than experimental work.
High counts were recorded for single channels along the top with differences observed between results obtained last week and this week. Affects single channel rate a lot so need to compensate.

Caroline explained that Derek had machined a piece of scintillator which was slightly thinner although it has the same area and had been drilled down the middle with depth allowing for WLS and glue. The optical cement had a similar refractive index to both the scintillator and the WLS so that matching of impedance occurs and effectively there is no interface. The scintillator was wrapped in polythene and a special type of paper combination that has the trade name tyvek which was good for reflecting light back in. In addition electricians tape will be used as protection from ambient light. The new scintillator in place enables comparisons to be drawn between it and the existing scintillators. An estimation of the timescale involved with making one scintillator requires 10 min to cut to size with 2.5 hours to macine the groove into which WSF is laid. This is followed by polishing edges, gluing in the fibre, allowing glue to set and finally wrapping in tyvek paper which takes ½ hour, 20 min, 24 hours and 20 min respectively.

It was concluded that the number one priority had to be to produce a final design due to the time consuming nature of the actual making. Channel efficiency needed to be considered, how often a hit was obtained out of the PMT so that data can be adjusted accordingly relative to their sensitivities. The possibility of 1, 2, 3 or even 4 way coincidence needed to be considered also. The new scintillator strip could be moved making it possible to see how count rate varies with the overlap area by positioning it so that ¼, ½, ¾ and eventually all of one of the fixed scintillators are covered. The non-noise coincidence will depend upon the area. A measurement of the distance between scintillator layers is required in order that solid angle subtended could be calculated.

Next on the agenda was the more theoretical side of the project, the flux data. Important since a prediction of the rate allows a comparison to be made with the results obtained. A much higher result would imply a subsequent amount of noise. Flux data calculation was worked on both by Manuel and Marco. A demonstration of the calculation was performed by Manuel with the assumptions:

- the detector is a point on the earth's surface
- the muons arrive radially

The second point was said to be untrue by board member (Waters) since muons could arrive from any direction. Approach considered was to calculate angle subtended by solid angle in each elemental area dA and then to integrate over whole surface. It was suggested that it may be simpler to use Monte Carlo methods to simulate the probability distribution to calculate the dimensions and spacing of the scintillator.

For current designs, drawings were made on the board. Ideas which need to be considered included the fact that closely spaced planes would allow a bigger solid angle coverage and the positioning of the electronic components and structural support. A Perspex frame was suggested due to its transparency and its strength with design taking the shape of an inner and outer octagonal core separated by the Perspex frame resulting in four way coincidence. An alternative to building a frame was to use octagonally shaped end plates which the scintillators could slot into. The octagonal basis would be complete with stand at bottom.

Meeting concluded with tasks for next week followed by questions from the group reviewers.

Agenda
14th February 2003

- Discussion of experimental results
- Flux data calculation-Monte Carlo/original calculation
- Final designs for scintillator
- Reviewing costs of equipment(budgeting)
- Ideas for poster design
- Tasks for next week
- Any other suggestions

Minutes
14th February 2003

David Waters absent from meeting but the rest of group members all present

The FPGA board had arrived and was demonstrated to the group by a screensaver which had been programmed into it by Matt.

Meeting commenced with Simon summarising the results with particular attention being paid to the graphs representing the relationship between count rate and overlap area. It was noticed that the results obtained by Rebecca and Brigitte were completely different from that obtained from Caroline. Initially the only thing that seemed to have differed in the experimental procedure was the fixed scintillator which the moving scintillator was moved relative to but it was agreed that this should not have produced such an adverse effect on the count rates obtained. After discussion Caroline had remembered that the apparatus was connected through the OR gate prior to use and suggested that perhaps that whilst carrying out the experiment it had been left through the OR gate. This seemed to be the case and meant that the results for the overlap count rate response obtained by Brigitte and Rebecca could be disregarded.

The 2 way coincidence of the new scintillator and fixed scintillator number 2 showed that the count rate increased as the common surface area increased. Another problem seemed to be the fact that the counts obtained on the bottom layer seemed to be too high in comparison with the 1st and 2nd layer. The single count rates of the individual scintillators were thought to consist mainly of noise so were meaningless. The probability of two coincident noise signals is 1 in 10 000 as the digital pulse produced by the discriminator is ~10ns long. It was emphasized during the meeting that the efficiency of the new scintillator was the same if not higher than that of the old scintillator. The new scintillator was doped in a special way resulting in it having better quality. This means the two types of scintillators were comparable. Wires from the PMT output to the discriminator were moved off the floor for experiments proceeding during the week.

Next it was proposed that perhaps 8 scintillators could be used rather than 16 since the same solid angle coverage would be achieved with two cables emerging from each scintillator which is subsequently fed into the same pixel. Overall the group was not completely convinced that this would save any significant time.

Caroline warned at the meeting that Brian the electrician would be on jury duty for two weeks from 03/03/03 and at some point will need to supervise our gluing techniques. The group was also made aware of the fact that the other project that Derek was working on would take priority of the two.

A problem that had been addressed during the week was that light was leaking from the ends of the scintillator. The solution seemed to be to place an end cap where the optical fibre goes through the hole. The scintillator would be wrapped in tyvek and electrician type tape. The group was also advised that the connectors would be unable to go right at the end of a scintillator so a gap needs to be left and that black sheath would need to go around the WLS. It was suggested that measurements using two WLS could possibly be made.

Manuel and Marco thought it possible that they would be able to obtain the dimensions necessary for the scintillator by the end of the day using SLAC data but assuming efficiency was the same. The computer model in java was soon to be complete also. The group proposed to meet on Tuesday 18th February to discuss the final dimensions of the scintillator pieces and the distance between them and final adjustments to the design enabling templates for the end plates to be drawn up.

In terms of the design it was necessary that the plates have to go at the back and the electronics at the front so that it is running in sequence in the order that each event occurs. It was highly favoured that blue LED's would be used in our display. The need to order black polycarbonate was considered as well as measuring the resistance of the PMT since the power supply needs to be sufficient to support it. A factor which was raised by board member Mark Lancaster was whether the PMT obeyed Ohms law so it would be necessary to investigate how the voltage varies with current. The initial enquiry was to see if Bernard had a manual in lab.

The discussion returned to 8 scintillators versus 16 scintillators. The group needed to justify the extra machining for 16 scintillators. The extra time was not critical regarding the group deadline but would be more time consuming for Derek who would be machining the pieces. The majority of the group believed that 16 scintillators would be more aesthetically pleasing which was a criteria in mind for demonstrations in schools. The fact that with the 16 scintillator design that 2, 3 or even 4 way coincidence could be used was highlighted as opposed to the 8 scintillator design which limits use to 2 way coincidence preventing the count rate efficiency of the scintillators being adjusted. 4 way coincidence would further reduce the likelihood of noise coincidences.

It was noted that to complete each groove took 2.5 hours followed by ½ hour to polish each scintillator but the extra 4 days that would be required to produce the 16 scintillators would not be critical to our project. It is important for the group to get the design right first time and so for this reason it was decided that it would be a safer option to go for the 16 scintillator design. There was a brief discussion of the separation between the plates with consideration that nothing would be placed inside the barrel. Finally tasks were assigned for the week.

Agenda
21st February 2003

- Discussion of final design – Any problems that may be seen to arise with the design and how the group may overcome them
- Any useful feedback from Caroline and Simon regarding group dynamics that they gathered from group 3 that may benefit our group
- Brainstorm ideas for the electronic components to be placed inside the detector.
- Thoughts on the logic the group may use with the FPGA system.
- Need to start laying out a budget sheet so that the group uses the most cost effective approach.
- List all the tasks that need to be achieved to complete the project from which the group can begin to prioritise and propose deadlines
- Tasks for next week
- Any other suggestions – time permitting

Minutes
21st February 2003

David Waters absent from meeting but all the other group members were present.

Caroline presented her drawings to the group with the dimensions for the inner scintillator plates measuring 5 x 15 cm and the outer scintillator plates measuring 6.5 x 15 cm explaining any queries group members had. There was a template design drawn also for Derek which would be given to him on Monday. The scintillators each have one groove to accommodate the WLS. In terms of the polycarbonate which needed to be purchased it was expressed that the smallest size which could be obtained was 2ft x 4ft at a cost of £97 + vat. When combined with the 12mm thick piece of delrin which was required total costs amounted to £161.74 including VAT. In order to reduce costs for the group it was proposed that scrap pieces of Perspex would be used from the department which would go around the electronics. In light of expenses incurred it was agreed that a spreadsheet accounting for expenses would be relevant to include in the report

The group was informed that the electronics required to go inside the detector would be quite small and that £150 went towards buying the circuit board but there would be a possibility of applying for more funding. Making a box to house the electronic components was also under consideration. Digitisation would be incorporated into the amplifier, discriminator and power supply unit. It was proposed that tin foil could be used rather than tyvek since it has a similar effect and would still look effective. The importance of asking Derek to machine some of the scintillator pieces as soon as possible was recognised since Brian would soon be leaving for jury duty and so needs to supervise the groups gluing technique so the progress of the project is not hindered during his absence. The gluing would be shared equally by group members on rotation till it was completed.

One of the main tasks which still needed to be addressed was to determine the logic that would be used. The number of LEDs which were to be used had to take into consideration the power output and it was advised that no more than 64 should be

used with ideas to perhaps extrapolate to the middle. Simon and Manuel have agreed to work on this during the course of the week. Once the logic has been planned out, someone in the hep group will be able to help us put it into VHDL.

A general discussion was had concerning the review on group 3 done by Caroline and Simon on the structure of the meetings and their progress with the project. It enabled the group to gain an insight of alternative methods. The review was emailed to Dr Aylward on Wednesday 19th February.

Work on the poster designs would commence shortly so the group had a glance at some posters within the room where the meeting was taking place to get an idea of the standard required and also discovered there are some printers on the campus which will print to the required size. Mark also suggested that he would be able to provide some links for scintillators to add to the poster. A poster illustrating the origins and composition of cosmic rays and their detection techniques were the themes for the two posters to be designed. Marco, Caroline, Rebecca and Brigitte will be meeting on Wednesday to develop ideas further and come up with some rough designs. Further information on WLS was also to be provided by Brian.

Concluded with a brief discussion of what should go into the group report with the drafting of a skeleton outline with who would be possibly working on each section. Tasks were set for next week. The query that the resistance of the PMT may be non ohmic was checked out with Brian and the group were informed that the resistors would only be out by 10% at the most and as the power supply to be ordered operates at either 750 or 1000 µA it should not produce an adverse effect on the output.

Agenda
28th February 2003

- Display the ideas for poster designs to the entire group. Opportunity for the rest of the group to make further suggestions.
- Progress developed for logic to be used for electronic circuit. Any problems that may need addressing.
- Ensure each group member is aware of the section of the report they will be working on.
- Assign deadlines for each of the tasks left which need to be carried out for completion of the project.
- Elect a group member to produce a costing/expenses sheet.
- Any other suggestions

Minutes
28th February 2003

All group members present

The meeting commenced with an introduction by Derek who is constructing our design and wished to raise some issues with the design as it stood. Firstly he raised the point that the studding which holds everything together has to move to the outside since the spanner is unable to fit around the studding in its proposed location physically limiting the design. Next Derek proposed than instead of incorporating the

base piece of the scintillator stand into the octagonal structure that it would save time if the octagon shape was built with the base piece attached to the baseline of the octagon after. The final design prints will need to be slightly altered to accommodate the new adjustment for the base.

The progress with the manufacturing of the design presently is that the inner core scintillators have been machined to the required width of 50mm and the machining of the outer scintillators to a width of 65mm has begun which will be subsequently followed by the machining of the lengths. A fly cutter is used to cut the surfaces of the outline. Derek then explained the initial processes involved in the manufacturing of the design in order that the group obtains an idea of the time scales required. The groove along a scintillator alone took 2 hours to perform on a test piece since it was necessary to pass the fly cutter across the scintillator 6 times to obtain the required depth. It was proposed that perhaps by Tuesday that 3 of the scintillator pieces would be ready for the gluing of the optical fibre and commencement of the wrapping process. The aim is to achieve a production line set up so that as soon as the scintillators have been prepared the gluing and wrapping can begin, taking into account the time that the glue takes to set. The Delrin plate for the polycarbonate has been ordered so awaiting delivery at present.

It was explained that aluminium would now be used instead of tyvek since the tyvek envelope does not fall down as well and also because aluminium looks more effective. The scintillator lengths would be advantageous at 17cm rather than 15cm the group was advised since the cutting device is already set to that dimension and the results would be easier to compare with those previously obtained. It was also proposed that photographs would be taken with a digital camera for ease of importing into the report document to show the working progress of the detector through its various building stages. At this point Derek left to continue work on the detector since his input at the meeting was solely to provide a clearer understanding of the situation at present to all the group members.

The next item on the agenda to be raised was that of the poster design. Marco, Rebecca, Caroline and Brigitte had met up earlier in the week to discuss the designs of the two posters and relayed the ideas raised to the rest of the group. Two posters were to be produced one covering the range of detectors used for detection of cosmic rays and the other for the origin of cosmic rays. The posters were to be of A1 size and would be shown at the group presentation and potentially at schools. It was proposed that a first draft would be ready for next week. Further ideas were discussed by the rest of the group.

Manuel and Simon since the last meeting had been working on the logic that could be used for the LED display. Two possible designs for the LED display were considered one involving a 121 LED square array which correspond to particular scintillator panels and will light up accordingly when struck by a muon. The design enables the path of a muon to be traced through the LED display. The other design had a star shape configuration and used considerably less LEDs with one LED per scintillator and one in between each coincidence. It was queried whether there was an LED display that was compatible with both designs. It was considered feasible that the different modes could be tested by downloading different logic schemes onto VHDL chip and switching between them which would allow the best design to be chosen.

The discussion moved onto how the LEDs would be integrated into the scintillator design possibly by drilling holes and mount LEDs on or working on the scintillators which have already been glued and wrapped.

As David Waters hadbeen absent from the previous two sessions he was interested to know the final developments for the flux data calculations. Marco and Manuel had used two different approaches to arrive at their final answers which showed discrepancies. Time permitting they will try to obtain an agreement.

Meeting was concluded with tasks for next week which includes contemplating a back up in the event that the electronics are not ready for the final presentation.

Agenda
7th March 2003

- Discussion of the progress made in the construction of the detector and the status of the ordered parts.
- Development of poster design by Marco- Any problems
- Explanation of the programming using VHDL to determine the logic to be employed in the detector.
- Discussion of the problems encountered with the electronics and the probability of them being ready for the final presentation.
- Consideration of the preparation required for the final presentation
  - What needs to be included in the presentation?
  - Choosing the section each person is going to speak on
  - The format of the presentation, powerpoint, overhead projecter, any demonstrations etc…
  - Prior rehearsal
- Decide final deadline for group report
- Set tasks for next week
- Any other suggestions

Minutes
7th March 2003

First on the agenda was to discuss the progress of the programming of the FPGA board and the electronics. The rest of the group were informed that the crate and board work but the problem remained in reading PMTs on the circuit output since it was not working. The coincidence and logic on FPGA should work in principle. Once the scintillators are wrapped it was suggested they may then work. Through test stand experiments earlier on in the project a maximum of three channels were being used but ultimately all 16 channels will need to be used. To obtain electronic modules group needs to make requests to Brian or alternatively try teaching laboratory.

Caroline was available to begin wrapping the scintillator plates this afternoon and informed the group that all the materials ha ve been received so the machining of the octagonal plate can commence soon.

The posters designed in powerpoint by Marco were shown to the rest of the group with one displaying the origin of cosmic rays and the other showing different detector

types for detection of cosmic rays. The posters were distributed amongst the group in A4 size but for the purpose of the presentation will be in A1 format. Estimation for the cost of printing the posters should be possible to obtain from media reprographics.

The final report requires that a hard copy is submitted but group is in favour of using a zip disk for storage with consideration of using a CD as a back up. The board supervisors possibly have spare zip disks which can be used by the group so no further costs incurred for this reason.

Concerning the FPGA board Matt had made a template but a counter needs to be acquired that can be worked on locally. The programming itself is thought not to be difficult but the problem lies more in getting it to work. Simon needs to obtain an account to enable him to use the local unix cluster.

Logic used involves 4 green LEDs in a row combined together in a strip which subsequently can be drilled into place within the detector. An additional blue LED is to be located at centre of middle octagon shape. Arrangement of LED strips includes 4 straight down, horizontal or at 45? angles. Ultimately want to be able to switch between 2, 3 and 4 way coincidence and can change from a hex to a decimal counter. Eventually want everything on FPGA board.

The board supervisors explained that the scintillator detector would not be dismantled after presentations as the intention of designing detector was to actually demonstrate the detection of cosmic rays at schools. Should the electronics not be ready by the final presentation subsequent efforts following the presentation would be made to achieve task. The purpose of using a crate is to attain analogue to digital conversion.

It was initially proposed that group presentation would take the form of that which would be given to a target audience consisting of school children with the website created during the project to be shown using projector. Board members made the group aware that content of information in presentation is important along with the style of the talk. Advised that school talk option probably not the best to go for due to the associated time limitations and the fact that many basic principles would need to be explained but a certain level of knowledge could be assumed for the audience the talk will actually be delivered to.

Meeting concluded with group deciding which section of the report each member would be speaking on with a view to take some pictures in the lab with digital camera which can be shown during presentation. Important to ensure laptop terminal to be used will be compatible with projector.

Agenda
14th March 2003

- Progress report on the electronics and the FPGA board and possibility of completing for final presentation.
- Discussion of tasks which need to be undertaken in the lab and the stage reached in the construction of the plates.
- Review preparation and content of oral presentations and set dates for rehearsals and schedule time to produce in powerpoint

- Set final dates for completion of report
- Any other suggestions

Minutes
14th March 2003

All group members present with attendance by Dr Aylward

The development with the FPGA and eletronics has seen the commencement of conversion to binary units. The configuration at present meant that at a touch of a button the counter will be able to detect directions of $0^{?}$, $45^{?}$, $90^{?}$ and $180^{?}$ or all together. A crate needs to be used rather than modules since the miniature version of the electronics which the group wished to use in the final design was experiencing difficulties when trying to work it although upstairs in the lab a module with 32 channels on the discriminator can be obtained. The testing has already begun as far as possible as we do not want simultaneous flashing to occur.

Scintillators have all been wrapped since the last meeting and Brian has glued optical fibres into PMT but requires a pixel to connector map which Simon and Manuel have agreed to determine.

Caroline made a proposed timeplan for the completion of the report but due to the stage the FPGA has reached, it made it difficult to have write up for that section completed by that date. This led to many of the proposed dates having to be revised as sufficient time to allow for the document to be bound is necessary due to increased workload to the binders with the onset of end of term deadlines. The tasks to be achieved by the final deadline require a lot of available manpower towards the end of next week.

There is increased pressure on the group time wise since 4 out of the 6 members have a java exam on the last Monday of term which is a heavily weighted component of the course so a balance needs to be struck between the two. Rebecca and Brigitte will continue soldering on Monday which should take the best part of the day to complete. The other group members are unavailable due to java lessons running for the whole day.

Brian entered our group meeting and explained that he would not be able to glue connectors on till about Tuesday as he is unavailable on Monday. With regards to the polishing of the fibres they will need to be done horizontally otherwise there would be increased risk of breaking the fibres which are already very easy to break. A jig has been constructed to hold single connector. The gluing of the scintillator into the delrin plate as well as enclosing WLS in blacksheath should not take long but due to delicate nature Brian would prefer to undertake task personally. It is believed that the optical side of the detector up to the PMT is almost sorted and should be completed by Wednesday. Unfortunately it cannot be predicted whether the electronics will work so electronics still quite a problem.

The poster design providing information on detector techniques requires a higher resolution image of a scintillator detector. The image used as the background for the poster currently has low resolution and was obtained from the CANGAROO website

from the Australian outback. There is consideration of taking picture of the group's scintillator detector with digital camera and importing it into poster since the digital camera belonging to Rebecca takes high resolution photographs. It has been noted that any photographs used in the poster from various websites requires acknowledgement.

Everyone to prepare individual presentations for a run through at the next meeting so that appropriate cuts can be made to ensure the group keeps to time schedule. Have to remember that when discussing the java programme designed by Marco that not too much detail can be given since not everyone attending the presentation would be familiar with the java language. The technique employed by Manuel to determine solid angle is to be used to check the validity of the java programme. Hopefully may have an opportunity to have a rehearsal in the Haldane lecture theatre which is the venue for the presentations but definitely need to check the connection point for the laptop in any case to avoid any technical difficulty that could cost the group timewise.

Agenda
21st March 2003

- Commence with rehearsal of presentations to gain a feel for time limitations and to begin editing to ensure presentation maintains interest.
- Update on progress with detector and what still needs to be done.
- Progress with electronics and estimation of time till testing can begin.
- Suggestion of points to include in group self assessment
- Preparation of costs/expenses sheet and action plans indiacting time spent on individual activities to include in the report.
- Progress with report and what sections still need to be dealt with.
- Assign tasks to achieve by Tuesday for handing in of report on Wednesday 26th March.
- Any other suggestions

Minutes
21st March 2003

All group members present

The meeting began by ensuring that everyone was aware of the time and venue for the group presentations on Friday 28th March. In terms of the construction of the scintillator detector it was really beginning to take shape with WLS glued to the connectors and it was looking promising for everything on the optical side of the detector to be completed by Monday.

A current problem remains in obtaining a discriminator unit operating 16 channels with so far only managing to attain units which operate 14 channels. Marco journeyed to Imperial College after a couple of discriminator units were offered to us. Only one of these works and only has 6 working channels instead of eight. The options left are to try out further discriminator units from Imperial or alternatively just to make do with 14 channels for the demonstration.

Manuel and Simon have managed to achieve the task of getting the LEDs to flash in sequence suggesting that they work. They only found one bad connection with the soldering of the components which was quickly rectified. There is not currently a programme formatted in the FPGA board but one can easily be inputted to see how it triggers the LEDs. The group was concerned that the testing required for section 7 of the report may have to be abandoned due to the closeness of the approaching deadline. It was agreed that tests will still need to be done prior to the presentation and factors like the light proofing still need to be checked along with certain components of the detector which could be written up in the test section.

The self assessment required for Thursday 27th March was suggested that it would be appropriate for the group secretary to write up. The assessment requires input by each member so the group will meet during the course of the week to critically assess the successes of the group collectively and the contributions to the project of individual members.

The costs/expenses sheet will be compiled by Rebecca with costs that came directly out of the group budget and in addition the total costs incurred if this project were to begin completely from scratch taking into account expenses amounting from materials used from the department. Rebecca will be inquiring from Brian the total cost of the photomultiplier tube. Information acquired from one of the other groups regarding the cost of printing A1 sized posters have led to consideration of having the posters printed at snappy snaps.

On reviewing the final design of the poster on Marco's laptop the group were still keen to obtain a higher resolution picture for the background of the detector poster. The possibilities of using the picture of the scintillator panels or the alternative picture of the detector at its existing stage of development using the digital camera are very likely options for the background detector poster.

The group will have further meetings on Tuesday, Wednesday and Thursday of next week to proof read the report and rehearse the group presentation. The report document will also be burned onto a CD since not all computers have a zip drive just for convenience. The group plan to acknowledge all the teaching staff that assisted with the project in the report and the presentations. The group are in favour of transporting the detector with the crate to the site of the presentations in a taxi due to its weight and to avoid having to disconnect any components.

The group made their way to Snappy Snaps to enquire the cost of printing the posters and then moved onto the Bland Sutton theatre to establish a connection point with Marco's laptop.