Minutes of the 47^{th} Meeting of the PRC

DESY 29-30^{th} June 1999

PRC members present:

M.Albrow (FNAL), J.Arvieux (IPN-Orsay), S.Bethke (Aachen), S.Bertolucci (INFN-Frascati), W.Buchmüller (DESY), D.Froidevaux (CERN), U.Gensch (DESY-Zeuthen), G.Heinzelmann (Hamburg), E.Hughes (Caltech), K.Jakobs (Mainz), R.Klanner(Hamburg, Wissenschaftlicher Rat), C.Kleinwort (DESY,HERA expt. coordinator), L.Rolandi (CERN), H.v.d.Schmidt (DESY), A.Wagner (DESY,chairman), N.Wermes (Bonn), C.Youngman (DESY,secretary).

Non PRC members attending closed session items:

HERA - F.Willeke and E.Gianfelice-Wendt (DESY).

HERMES - E.Steffens (Erlangen), J.Steward (Liverpool), A.Simon (DESY) and N.Makins(Illinois).

H1 - J.Dainton (Liverpool), C.Niebuhr (DESY), E.Elsen (DESY), D.Pitzl (ETH-Zurich), A.Schoening (ETH-Zurich), and H.-Ch.Schultz-Coulon (DESY)

ZEUS - B.Foster (Bristol), B.Loehr (DESY), and D.Krakauer (Argonne).

AMANDA - Ch.Spiering (DESY-Zeuthen).

HERAB - A.Schwarz (DESY), J.Spengler (DESY), B.Schmidt (Heidelberg), and T.Lohse (Humboldt-Berlin).

POL 2000 - T.Behnke (DESY).

The PRC received the following documents:

PRC 99/05. POL2000 Status and Plans - An Appendix to the POL2000 proposal. (POL2000).

PRC 99/06. A Fast Track Trigger with High Resolution for H1. (H1).

Agenda:

Open session. June 29^{th}, 10:00-13:00, Main Auditorium

HERA status report. E.Gianfelice-Wendt (DESY).

HERAB status report. T.Lohse (Humboldt-Berlin).

HERMES status report. N.Makins (Illinois).

ZEUS status report. D.Krakauer (Argonne).

H1 status report. H.-Ch.Schultz-Coulon (DESY).

Closed sessions: January 29-30^{th}

Item 1. Approval of the minutes and matters arising from the last meeting.

Item 2. Review of HERA

Item 3. Review of H1

Item 4. Review of ZEUS

Item 5. Review of AMANDA

Item 6. Review of POL2000

Item 7. Review of HERMES

Item 8. Review of HERAB

Item 9. Miscellaneous

Item 1. Approval of the minutes and matters arising.

The chairman opened the session by stating that the tragic death of B.Wiik still lay heavily over DESY. A memorial to his memory had been organized for the 7th July.

J-J.Aubert, A.Buras and L.Foa could not attend the meeting. This would have been the last attendance of L.Foa and he and the other retiring member, S.Bethke, were thanked for their contributions. D.Saxon who left the PRC after the last meeting was also thanked.

The minutes of the 46th PRC were approved subject to the corrections requested.

Item 2. Review of HERA.

The chairman thanked the open session speaker for her presentation and during the discussion of the material presented the following points were addressed.

The production and delivery schedule for the magnets to be installed during the luminosity upgrade was summarized.

A winding machine required for the production of the super conducting magnets has been finished and tested at Brookhaven. A prototype magnet will now be produced and its field measured after which it is expected that the first magnet can be delivered by Nov. 1999 and the second magnet is scheduled to arrive in May 2000.

The production and delivery of the new warm magnets is progressing. The electron beam focussing magnets, made in St. Petersburg, have been delivered and the septum magnets have still to be delivered, a tight control of their quality is required. An additional high field magnet is not yet delivered.

Orders have been placed for the modifications required to existing magnets.

Orders must still be made for the magnet power supplies and at the suggestions of J.Arvieux the possibility of obtaining some of these from Saclay (Saturne) would be investigated.

The beamline vacuum chamber design has been checked and the last components are scheduled to arrive in April 2000.

The preparations for luminosity are progressing well inspite of the breakage of a cavity window in PETRA. More RF cavities have been installed and the average positron current should reach 45 mA, ie. 20-30% more than for electrons, during the running period. The 1999 HERA efficiency, which at 46% has been high, may fall during the June-July holiday period.

The deterioration of the electron beam lifetime observed with larger currents is reminiscent of the effect attributed to trapped dust which was corrected by replacing the original vacuum pumps with NEG pumps. The new observation requires more study to determine the cause.

The choice of positron beam was made by the experiments ZEUS and H1 on physics analysis grounds. HERMES will profit from the higher positron current and HERAB are presumably not affected.

Backgrounds caused by the proton beam are mostly due to coasting beam particles which are no longer accelerated by the RF. These have a buildup time of 4-5 hrs and can be removed by scraping the beam with the HERAB wires. This cure is likely to disappear during HERAB modifications and will be replaced by activating kicker magnets on empty pilot bunches. The cause of the effect remains unknown and there exists an uncertainty as to when the phenomenon was first seen.

Item 3. Review of H1.

The chairman thanked the open session speaker for his presentation and asked the spokesman, J.Dainton, to outline the H1 reviews that would be given before the discussion on the Fast Track Trigger (FTT) proposal.

The technical coordinator, C.Niebuhr, reviewed the data taking status seen sofar in 1999. The 92% average efficiency is high, but a number of problems exist:

- The Central Jet Chamber (CJC) has cells where high currents, proportional to the electron beam current, are seen and which persist after beam loss. The discharge is stopped by cycling the chamber HV.

- The Central Silicon Tracker (CST) has probably been damaged by radiation during machine studies. The damage is seen in the readout chip's pipeline calibrations constants and a large correction now has to be applied. No recovery is seen due to annealing. Provided no additional damage occurs the 4% drop in hit efficiency to 87% is acceptable and the readout chips will be replaced in the luminosity upgrade shutdown.

- Despite the improvements made w.r.t. the beam induced backgrounds seen during the electron running it is assumed that positron running will be more efficient.

J.Dainton then reviewed the reasons why ZEUS and H1 requested HERA to provide positron beam after the May-June shutdown. No compelling standard model physics reasons currently exist to accumulate more than the 15 pb-1 electron data sample. The d quark is analysed with a positron beam and as this is the less well known proton density function its further study is useful. Beyond the standard model physics, i.e. understanding the existing high x anomaly and searching for new effects, require positron beam. A recent paper by A.Zarneki shows that the s-channel fermion anti-fermion interactions are more sensitive to new physics.

A.Schoening then reviewed the FTT proposal. The existing H1 trigger suppresses non ep related events but has little sensitivity to exclusive final states and D^* events are currently accepted through the DIS electron trigger. The FTT will enhance the J/ψ selection by using track segments found in 12 CJC layers to evaluate an invariant mass which can be triggered on. The trigger efficiency has been measured by applying the algorithm to found D^* events and is high. The FTT also improves the experiment's Pt trigger. The review was completed with a detailed description of the technical implementation a novel feature of which is the use of Content Addressable Memory (CAM) units. The prime physics benefits, of the FTT, are the enhancement of bottom and charm physics.

The referee's report was given by M.Albrow. The FTT physics case is good provided that there is a guarantee of success. Problems which can occur are: trigger inefficiencies due to noise or other backgrounds, a reduction in efficiency due to a degradation in CJC performance (reduction in HV as seen in 98 and 99), and worries about whether the timing resolution was sufficient. The referees recommended that more studies are made before the proposal can be accepted. Non FTT related issues were that the Backward Silicon Detector (BSD) chip submission was progressing and that no serious problems existed w.r.t. the use of Helix chips in the CIP upgrade.

During the ensuing discussion of the FTT proposal it was pointed out that the trigger is rather restrictive w.r.t. the physics channels that can be used (J/ψ,etc.).

The discussions continued in closed session.

In view of the many unanswered questions the PRC decided not to make a specific recommendation. In order to speed up the review process the referees agreed to collect all open questions and forward them to the collaboration as soon as possible. H1 would then provide written answers to the PRC members who would make a recommendation before the next meeting.

Item 4. Review of ZEUS.

8. Review of ZEUS.

The chairman thanked the speaker for his presentation and asked the spokesman, B.Foster, to report on the status of the experiment.

The data analysis has passed an important threshold and results from the analysis of the large 1997 and 1998 datasets are now reaching the publication stage. The number of papers published had dropped during 1999 to 5, but many papers are in the pipeline and 40 abstracts were submitted for Tampere.

The experiments data taking efficiency, which had dropped in 1998 due to background and tracking chamber HV supply problems, returned to the 70-80% level for data written to tape. The decision to request positron running after the May-June shutdown was made on physics grounds similar to those outlined by H1.

Both H1 and ZEUS have decided to install Al/Be beampipes during the HERA luminosity upgrade shutdown and a joint order with Brush-Wellman has been placed.

The silicon Micro Vertex Detector (MVD) upgrade has entered the production phase. A total of 240 barrel detectors have been delivered. Of the 59 devices which have passed through the quality control, two were rejected with leakage currents greater than 2 μA. The HELIX 3.0 pipeline readout chip has been tested successfully and no leakage is observed from switches in the analogue pipeline. The ADC and clock and control systems have been prototyped and tested and the DAQ readout system has been exercised with dummy ADC boards and trigger systems. Gluing and bonding of the detector modules has started in Hall 1 at DESY. Nevertheless some problems have been encountered: the flexible kapton readout strips are found to have micro-shorts which means that all contacts must be checked and detectors are warped slightly beyond the specification.

The Straw Tube Tracker (STT) upgrade has now been fully funded and a Tel Aviv group has joined the project. Some simplifications to the original design have been made: the dE/dx measurement will not be made and the readout multiplexing has been simplified. The additional electronics required is being designed and the ASDQ chips will be ordered in October with board production finished by June 2000. Construction of the tubes and associated mechanical structures has started and the detector should be fully assembled by August 2000.

The luminosity monitor upgrade is still in the prototyping and ideas phase. A reuse of the scintillator tungsten sandwich calorimeter technology is borderline, due to the higher synchrotron radiation rates to be expected, and new technologies are being investigated. The decision has however been made to add a 6m tagger which will be useful in cross calibrating the upgraded luminosity monitor and in photoproduction analysis.

The referee's report was given by E.Hughes. No major installations were made during the last shutdown and the running in 1999 was successful. A number of issues should be monitored in the MVD : the treatment of the mechanical warp seen in the detectors, additional radiation damage tests and detector dark currents. The MVD and STT software effort must also be reinforced. A luminosity monitor upgrade, 1-2% accuracy, is required and the referees recommend that a status report be give at the next PRC.

A number of points were raised during the discussion of the ZEUS presentations.

Although more software effort could be used in the MVD upgrade the existing group had developed a full MC simulation package and tracking algorithms linking MVD and CTD track elements were being developed.

The H1 luminosity monitor design could be reproduced at ZEUS, but the group responsible were also looking at other technologies.

The discrepancy between the measured D* production in low W tagged photoproduction and the NLO MC calculation, shown in the open session, is real and the closest fit is obtained with a choice of MC input parameters (renorm. scale, charm mass, etc.) which are at the limits of what is allowed. The scale dependence and the poor prediction of the eta angular distribution indicate that there is a need to include fragmentation effects or higher order terms into the existing calculation.

The discussion continued in closed session.

The PRC took note of the progress made by ZEUS, both analysis and detector upgrades for the HERA luminosity upgrade. In this context the PRC recommends that the collaboration provide, at the next PRC, a written status report on the upgrade of the luminosity monitor.

Item 5. Review of AMANDA.

Ch.Spiering gave a review of the status of AMANDA and ICECUBE to the PRC.

First results from AMANDA's B10 string arrays have now been published and a significant number of contributions have been made to conferences. A number of technical measurements have been finished including new measurements on the properties of the ice and the variation in the seasonal muon flux which is proportional to the density of air above the detector. The detectors sensitivity to supernova explosions was explained. These explosions typically have the same power output as the 1987a supernova and can be detected at distances up to the center of the galaxy.

Problems have, nevertheless, been encountered with the newly deployed long strings 11, 12 and 13. The twisted pair readout shows cross-talk which can be corrected offline and, more worryingly, the signals coming from the detectors show a deterioration in gain by factors of 2-3 and the PM HV has been increased to its limits. Tests with identical PMs and bases have been made in the laboratory, but the effect has not be reproduced. These tests were however not carried out with the relatively few PMs which come from the same production batches as those deployed as the risk of destroying the tubes was considered too great. Understanding these problems is an important issue, but pressure exists from within the collaboration to deploy additional strings in the coming time window for drilling.

The review was concluded by a summary of the funding which will be required to finance participation in the proposed ICECUBE experiment.

The signal gain problem dominated the ensuing discussion. The fact that no quality control tests were, apparently, carried out on the tubes delivered after the first series of string deployments was considered a mistake. As was the relatively small number of tubes held back from deployment for monitoring purposes. If the collaboration could not quickly determine the cause of the problem a review, allowing the PM manufacturers and other experts in the field to address the problems found, should be considered. Additional deployments should only be carried out if the tubes to be installed passed acceptance tests.

As stated at the last PRC a prerequisite for a go-ahead of the ICECUBE experiment is the successful analysis of AMANDA II data. The schedule presented will be discussed at the next PRC when the AMANDA referee is present.

The discussion continued in closed session.

The PRC made the following recommendations:

- **The collaboration should try, on the shortest possible time scale, to organize a review of the gain problem by experts for large systems of photomultipliers (Super-K, SNO, Hamamatsu, ZEUS, OPAL, etc.), asking them for advice.**
- **The collaboration is asked to provide the PRC with a well defined strategy on how to reach a meaningful decision w.r.t. a new deployment in 1999/2000. The PRC was of the unanimous opinion that given the present situation in understanding the performance of the strings deployed last, any new deployment would not be meaningful. The collaboration is asked to put clean test procedures and acceptance criteria into place.**
- **The PRC recognises the strong time pressures the collaboration is facing. However, the future of AMANDA and ICECUBE depends strongly on the successful deployment of high quality strings. So any hasty action would be counterproductive for the longterm goal.**

Item 6. Review of Polarization 2000.

T.Behnke reviewed the status of the transverse polarimeter (TPOL). The currently operating detector measures the average polarization of all bunches using Compton scattered photons in single photon mode. The uncertainties for a 1 minute measurement are 1% statistical and 4% systematic (point-to-point 1% and energy scale 3%).

The TPOL upgrade foresees a complete upgrade of the electronics, readout and DAQ systems as well as the installation of a position sensitive detector in front of the photon calorimeter. This will allow bunch polarizations to be measured with 1%/min statistical and 1% systematic errors.

The manpower situation remains tight and few people are committed fulltime to the project. HERMES still provides the most significant contribution although H1 and ZEUS are now organizing additional effort.

A number of items were discussed. The scale uncertainty can be improved by making more measurements of the polarization rise time which requires dedicated machine running without spin-rotators and ep collisions. The most significant source of uncertainty in the photon asymmetry is the analysing power of the calorimeter and this is being studied by comparing test beam data from an identical calorimeter and MC.

The uncertainty due to the finite beam size can be reduced by measurement. The calorimeter shows small scale radiation damage effects which recover through annealing.

A number of technologies (Si., diamond and scintillating fibre) are being investigated for use in the position detector. These must survive the 1 rad/s dose rate. The assumption is that the device will be used in calibrating the calorimeter since the detector's 100kHz trigger rate is probably too high for event-by-event readout.

A.Simon reviewed the longitudinal polarimeter (LPOL) tests made since the last PRC. The 25% LPOL/TPOL scale mismatch has been understood. Removing the photon attenuation filter and correcting the non linear response of the NBW calorimeter reduces the mismatch to 4%. The possibility of operating the detector in single photon mode was investigated using tests beam runs with NBW and sampling calorimeters and comparing the results with MC. The mode can be used at very low trigger rates, but higher rates would require a complete upgrade of the readout and DAQ systems. Interestingly the scintillator calorimeter showed superior performance.

J.Arvieux gave the referee's report. LPOL operation in single photon mode has been tested. The DAQ may require an upgrade if the systematic uncertainty is to be reduced. The 25% scale uncertainty appears to have been understood and TPOL/LPOL measurements agree to a few %. No conclusion has been reached about future use of a sampling calorimeter. The LPOL background will be improved by upgrading the vacuum system (more pumps, removal of the closest cavity, etc.). The TPOL position sensitive device will improve the accuracy and is strongly recommended. The outlook is good and problems are being understood, but more manpower will be needed.

During the ensuing discussion a number of items were addressed. A silicon strip detector seemed to be the most likely technology for the TPOL position detector given the high radiation doses. A decision is required w.r.t. the LPOL use of NBW or sampling calorimeter.

The PRC proceeded with it's discussions in closed sessions.

The PRC agreed with the observations and recommendations of the referee.

Item 7. Review of HERMES.

11. Review of HERMES.

The chairman thanked the open session speaker for her presentation and proposed that the spokesman, E.Steffens, review any outstanding issues.

A test has been made with a transversely polarized target which successfully avoided beam depolarization. The magnet and target system needed was tested last week and preliminary results for hydrogen and deuterium targets are encouraging.

The long range HERMES plan is being finalized and will be available for the next PRC. Alternatives for the post 2000 running are to continue with a complete longitudinal target program which requires good electron polarization, or to use the transverse target which is less demanding w.r.t. good beam polarization. The collaboration is actively addressing issues related to maintaining the level of expertise in view of the long HERA shutdown and perusing discussions on new ideas and upgrades. The retirement of the DAQ expert is also being addressed.

The referee's report was given by J.Arvieux. The good beam polarization in 1999 (typically 50-60% and above 40% for 90% of runs) was extremely productive. The Charm-2 upgrade has been delayed but will be finalized by the installation of the missing half in August. The RICH detector is fully integrated within the experiment and producing excellent results. Signal bursts seen whilst operating the muon hodoscope have disappeared and may be a result of improved shielding or more stable beam operation. Running with a smaller, denser, target appears possible in spite of the accident with the test target. As previously reported the use of limited streamer tube chambers in the Charm-2 upgrade has been rejected and a simplified scintillator based system will now be installed. The lambda wheel upgrade is now fully funded and operational. The feasibility of the transverse target has been demonstrated. The outlook for the experiment remains good.

During the discussion a number of points were raised.

The time required to swap the longitudinal and transverse targets is estimated to be 2-3 days, but this will soon be known from practice.

The discussion of the open session presentation produced a lively exchange regarding the application of QCD to strongly bound systems. A wealth of precision measurements now exists on the unpolarized structure functions of the nucleon, and the knowledge of the polarized structure functions continues to grow. Nevertheless, theoretical interpretation of these measurements remains very limited. Numerous global fits to the data have been performed, and perturbative QCD has been applied to the Q^2 dependence of the measured structure functions. However hadronic structure is a non-perturbative problem, and few models of nucleon structure have taken on the task of explaining the body of available data from first principles. Calculations based on bag models and chiral perturbation theory have made some headway into the explanation of the moments of these distributions, but not their x-dependence. The theory of strong interaction QCD may still, therefore, be considered to be in its infancy.

The discussion was continued in closed session.

The PRC is looking forward to the long range plan and a continued discussion about the physics at the next meeting.

Item 8. Review of HERAB.

The chairman thanked the open session speaker and asked K.Jakobs to give the referees's report.

Two one day reviews were carried out prior to the PRC meeting. Considerable progress has been made in many areas.

The 1999 running period has seen all available hardware components integrated into a common DAQ system. ECAL calibration using π^0 has been efficiently carried out at

3kHz trigger rate and 30 MB/s data throughput. Experience has been gained with data acquisition and an energized magnet. The Outer Tracker (OTR) gas system has been tested although not in a closed loop. No J/ψ signal was observed in the 10^6s running time, but the reasons (small trigger acceptance due to missing ECAL trigger boards, missing muon pretrigger, use of beam time for more pressing issues, etc.) are understood and it should not be regarded as a serious omission. Some readout instabilities were observed in the Vertex Detector (VDET) electronics and those channels instrumented with Helix 2.1 chips showed lower efficiency, those with Helix 2.2 seem to be better. Missing VDET silicon detectors have not been installed, since they are being held back to ensure that a full half set exists for 2000 running.

The detector should be fully installed by January 2000 although progress on some components (online calibration and alignment, First Level Trigger (FLT), muon pretrigger, OTR, Inner Tracker (ITR)) will require monitoring.

The Helix 3.0 is now available in small numbers. The cross-talk problems have been reduced, but still prevent efficient ITR triggering. It is hoped that the residual cross-talk comes from the Helix support PCB and that a redesign will cure the problem. The Helix 3.0 pipeline length is 123 and should have been 128. Another Helix design iteration seems likely and a review should be carried out after completion of the July tests.

The OTR slow aging effects (11% loss/$0.5C/cm^2$) reported at the last PRC are due to etching of the gold GEM coating and formation of micro whiskers on the anodes. Further studies are required. The long term operation of the chambers is not yet guaranteed.

The straw tracker backup design for the OTR has converged and production could start in August 1999 with installation in the 2000 long shutdown, but HERAB have decided not to build the straw tracker at the moment.

The ITR will use a Ar-CO2 gas mixture instead of Ar-DME; the former has to be used at lower gain to avoid sparking but does not produce polymer deposits when irradiated. The aging problem of the anode is due to etching of the resistive diamond substrate and accelerated time scale measurements show that three distinctive operation phases exist during the estimated 4 year HERA lifetime of the chambers. The decision has been made to continue mass production and installation and use extensive calibration to keep the ITR useable.

The FLT remains on a very tight schedule but the technical problems associated with the Track Finding Units (TFU) have been solved.

The referees made the following recommendations:

- The OTR requires more studies on aging and an inspection of the chambers which have operated in HERA.
- The efficiency of ITR track finding and noise rates as a function of accumulated dose should be measured at PSI and HERA.
- The impact of the ITR's gain variation on the trigger performance should be

estimated.

- As stated above a review of the Helix readout chip is needed.
- An early, September, measurement of the FLT trigger rejection should be made.
- Sufficient physics analysis effort is required in 1999 to extract a b->J/ψ signal from stable running.
- The machine should be prepared to give HERAB sufficient running time in 2000 to allow a significant CP measurement.

The PRC adopted the recommendations of the referees.

Item 9. Miscellaneous.

The next meeting of the PRC is scheduled for November 18-19th.

The current list of PRC referees is:

H1 - N.Wermes and M.Albrow
HERA-B - D.Froidevaux and K.Jakobs
HERMES - S.Bertolucci and J.Arvieux
ZEUS - S.Bethke and E.Hughes
AMANDA - J-J.Aubert
Polarization 2000 - J.Arvieux

(C.Youngman - 30^{st} July 1999)