Polarization at HERA
Status and Plans

Meeting of the POL2000 Group [1] on Thursday, 14-02-2002
Summary of the meeting by Ties Behnke, DESY

1 Introduction

The purpose of this meeting was a review of the state of the POL2000 projects for the transverse and the longitudinal polarimeters. The agenda of the meeting was:

Status report of the TPOL

DAQ Status	Stefan Schmitt
SI detector status	Fabio Metlica
Fiber tracker status	Kunihori Mazukawa
TPOL hardware status and status of sys studies	Vahagn Garibyan
Status LPOL	
LPOL status	Benni Zihlmann
LPOL upgrade status	Marie Jacquet

2 Transverse Polarimeter

2.1 DAQ Status: Stefan Schmitt

Stefan reported on the state of the upgrade of the DAQ system. The new DAQ is in place and has been operating for some time. The structure of the system is highly modular. Individual components communicate with each other via TCP/IP connections, such that – at least in theory – they can run on different computers, if needed. The complete system can be operated remotely from any system on the network.

The information from the system is stored in a temporary database, which maintains a record of the system for up to 10 hours, and written into a central ORACLE database. This database is the main information center for data from the polarimeters, except

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for the real raw data. They are written onto disk using the disk cache system from DESY. Under normal circumstances a user from any of the different groups involved only needs to worry about the information in the ORACLE system. Only for a major re-analysis of the data is an access to the raw data needed.

The different components of the DAQ are controlled by a run control system, which is implemented as a set finite state machine with rules. Every subsystem has a number of well defined states (e.g., for a collimator these states might be close → opening → open → closing. The only information the run control gets is this state. This is then used to define actions within specified rules. In this way a rather clean and transparent system can be designed.

As an interface for the user a JAVA based program has been developed. It provides a means to display status information, to monitor the data quality, and – via an expert mode – to access the run control functionality. This program is available on the pctpol03.desy.de server, and can be run by everyone inside the DESY domain. In addition access to an electronic log book is given, which allows the user to watch the different messages from the system, and to also input messages if desired.

Stefan showed a few results from recent tests of the system. The light polarisation can be measured automatically. Results reproduce the behaviour of the old system. First runs with electrons in HERA show decent behaviour and acceptable spectra. The new DAQ has been exercised with the LED pulser system, and a speed of 100 kHz with negligible deadtime has been demonstrated.

In conclusion Stefan reported that the TPOL is ready to take polarisation data whenever HERA is ready.

2.2 SI Detector Status: Fabio Metlica

Fabio reported the status of the SI detector system. Over the last two years a SI strip detector has been developed which is installed in front of the TPOL calorimeter. The design of the system was tested and refined in two major test beams, one at DESY, one at CERN.

In the DESY test beam electrons with energy up to 6 GeV were used. A SI strip detector telescope installed in the beam allowed the precise tracking of the beam particles before they hit the TPOL SI detector. The first tests were performed using a small 1×1 cm^2 strip detector, which later on was replaced by a larger 6×6 cm^2 device.

Using the DESY data it was possible to determine a $\eta - y$ transformation curve. The transformation is slightly different from the one measured at CERN some 5 years ago. This can be understood since a preradiator of approx. 1 radiation length was installed in front of the SI detector. Monte Carlo studies have confirmed the effect and – at least qualitatively – are able to reproduce the reduction in analyzing power.

During the CERN test beam which was done with the large detector, it was discovered that around 9% of the strips of the y-detector and 50% of the strips of the x-detector were faulty. Later tests at DESY revealed that one complete APV25 chip for the x-detector did not function. For the y-detector no clear cause was found. It was observed that individual strips, which were dead at CERN, were alive again at DESY, and vice versa. The current theory is that the pitch adapter has problems, connecting the SI detector to the input of the APV. This is currently under investigation at ICL.

In November of last year the SI detector was installed in the TPOL. Data were accumulated for some brief runs with low intensity of positrons in the ring. Correlations between the SI detector and the calorimeter were seen, but further tests have to wait for more statistics.

At the moment the DAQ for the SI detector is not yet fully integrated into the main TPOL DAQ. It can be operated manually from the control room, but more work is needed to control the complete SI system through the normal TPOL run control.

During the next long shutdown which at the moment is foreseen for June, the cooling unit for the SI detector will be installed in the tunnel.

2.3 Fibre Calibration System: Kunihiro Matsuzawa

Kunihiro summarized the status of the fiber calibration system. The purpose of this device is to allow a cross calibration of the SI detector. In particular significant concern has been expressed that the SI detector might get damaged if exposed to the very intense Photon beam at the polarimeter location. This could cause local changes of the electrical properties of the SI detector, and might result in local distortions of the calibration of the device. This should be monitored with a single fiber detector, which is mounted on a precision stage. The fiber can be moved in front of the SI detector with high precision. By triggering on the fiber a "picture" of the fiber on the SI can be seen, which can then be used to map the calibration of the SI.

The fiber was installed in both test beam setups, starting with a simple prototype system at DESY, and continuing with a full scale system including a precision mechanical stage at the CERN test. The Tokyo group was able to demonstrate that events can be triggered with the fiber, and that the picture of the fiber on the SI can be located with an accuracy of better than $50 \mu m$. This is adequate to monitor the precision of the SI detector, if the connected systematic error of the polarisation should be kept below the one percent margin.

The fiber was installed together with the SI detector into the tunnel in November, and is operational. The final integration of the SI DAQ into the main DAQ is still outstanding.

Once enough data with the fiber have been collected a further optimization of the event selection and the analysis method is planned.

2.4 TPOL hardware and analysis status: Vahagn Garibyian

During the shutdown the old TPOL calorimeter has been exchanged for the "spare" calorimeter which was built some years ago. The calorimeter has been successfully commissioned, and data were collected using the new DAQ. All indications so far are that the performance of the device is as expected, and as good as the previous one.

Vahagn reviewed the current state of understanding of the systematic errors. At the moment the absolute scale of the TPOL is defined primarily through old rise time calibrations. These have an error of around 2%. Additional large contributions to the error come e.g. from the pedestal subtraction in the old DAQ. A careful comparison of the TPOL and the LPOL results using data up to 2000 has revealed a systematic difference between both devices of around 1%. This difference is not understood, and therefore has to be treated as an additional systematic error for both devices.

An alternative to the rise time calibration is the calculation of the analyzing power of the TPOL using Monte Carlo. Intrinsically these calculations at the moment have an error which is also around 2%. However there is always – and has been since many years – a systematic difference between the rise time calibration and the Monte Carlo calibration of around 10%. This difference is not understood. At the moment the rise time calibration is considered more reliable, but the reason for the difference is not clear.

Once enough data are available from the new TPOL it should be possible to learn a lot from the on-line measurement of the analyzing power using the SI detector. Improved Monte Carlo calculations are also hoped to exist, so that hopefully the discrepancy can be resolved.

Vahagn however pointed out that it would be very desirable to redo a rise time calibration at the earliest moment possible so that a cross check of the absolute calibration scale can be made. Unfortunately such a calibration requires dedicated beam time with a magnetically flat machine, and some significant effort from the side of the POL2000 group. At the moment it is not clear whether the manpower needed for this activity can be found.

2.5 Offline Status: Jenny Böhme

Jenny reported on the planned offline data flow of the TPOL. The raw data collected from the TPOL will be stored using the disk cache system being developed at DESY. Normally however the user will not access these data, but rather work with information stored in an ORACLE database. This database will maintain a record of all slow controls information, and of the polarisation measurements. If improved results will become available offline, they will also be written into the database. Thus an user from e.g. H1 can always obtain the latest version of the polarisation from the Oracle database.

She then discussed the state of her analysis of the data from the TPOL. She is attempting an analysis which derives the polarisation from the a-priori knowledge of the cross sections, and of the polarimeter. Fitting the η distributions in different energy bins in theory at least provides enough information to extract the polarisation.

A previous attempt to derive a fully analytical description of the distributions as seen in the detector was not very successful. It turned out to be very complicated to really account for the experimental effects.

Jenny took an approach where she started from the analytical cross sections, but then used Monte Carlo to fold in the detector response etc.. At each step as much experimental information as possible is fed in. As an example the detector resolution is fit using the Compton edge of the measured spectra, and then transported using Monte Carlo to the different energy bins.

As a snapshot of the current state of the development she presented fits of the η distributions in different energy bins. A quite good description of the distributions has been obtained, with only a few minor problems for the highest energy ones. As this was very much a "work in progress" report, no final conclusions could be drawn, except the statement that so far the method seems promising.

3 Longitudinal Polarimeter

3.1 LPOL status: Benni Zihlmann

Benni summarized the status of the LPOL. No major changes to the hardware were done during the shutdown, but a number of minor improvements were implemented. A long standing problem was finally solved in that the measurement of the polarisation of the laser light in the laser room and behind the interaction point now give the same answer.

The DAQ has been mostly ported from Alpha computers to Linux, with a few exceptions where the close connection to the HERMES central DAQ makes a continued operation on Alphas necessary. In the immediate future more work will be done to improve the information flow between the LPOL and the TPOL DAQ.

A second sampling calorimeter has been build during the shutdown, and was tested in two testbeams. This calorimeter is installed in the beam, together with the crystal one. For the startup the crystal calorimeter is the default device, but eventually a switch over to the sampling calorimeter is planned.

3.2 LPOL test beam data analysis: Wolfgang Lorenzon

Wolfgang reported on the ongoing analysis of the data accumulated during two test beams with the new sampling calorimeter.

At DESY the response and linearity of the calorimeter was measured in electrons up to 6 GeV.

The device was then brought to CERN, and, together with the TPOL, measured at higher energies. Unfortunately due to problems with the beam, and also due to manpower problems, only a few energy points under non-ideal conditions could be recorded. In particular the beam definition was bad, and the beam spot extended beyond the active area of the calorimeter.

Most probably because of the bad conditions the energy resolution measured in the CERN test beam seems significantly worse than expected: $\approx 22\%$ instead of the expected $\approx 14\%$. More studies are needed to fully understand this.

Nevertheless within the limits imposed by the setup no indications were found for unexpected non-linearities of the calorimeter.

3.3 The LPOL cavity project: Marie Jacquet

Marie summarized the state of the cavity project. For some time a test cavity has been setup and been in operation in Orsay. The feedback system acting on the frequency of the laser has been setup and is operating. Stable operation has been achieved. The system has proven to be very stable and robust, and rather insensitive to external influences like noise and vibrations.

The feedback system which is supplied by Saclay is at the moment a prototype system, which in particular does not allow as large a frequency sweep as intended for the final system. This makes the first finding of the resonance a bit difficult, but once found the system is kept in resonance reliably. New electronics has arrived and is currently being debugged.

The control of the different parts of the system is done with a Labview based program. Most of the needed functionality is already there, the rest is under development. The labview program allows a flexible and fast setting and monitoring of the different control parameters needed for the system.

Over the last weeks and months a series of measurements has been performed to understand every part of the system in detail. Since the goal of the project, a measurement of the polarisation at the better than one percent level is very ambitious particular care has to be taken to fully understand every component of the setup.

As an example Marie discussed the measurement of the light polarisation. For two important parts of the system, the photo diodes and the Wollaston prism, the systematic contribution to the final result could be determined to be less than one percent. Work on understanding the $\lambda/4$ wave plate is under way. In this manner all parts of the optical system are being examined.

The data acquisition system for the LPOL cavity is modeled after the new TPOL DAQ. It relies as well on an MFCC as the front end processor, and will use a very similar ADC to record the data. For the slow controls software a commercial package will be used. The cohabitation with the existing HERMES DAQ is under discussion.

The final cavity mechanics has been designed, and the order for building this device has been given to industry. Delivery of the finished cavity to Orsay is expected for early May. This should then allow about one month of time to prepare the installation of the cavity. If the HERA schedule remains unchanged, and if during early June a shutdown is happening for the switch over from positrons to electrons an attempt will be made to install the cavity in the HERA tunnel during this time. Already during the Christmas shutdown the mechanical support structure was installed in the tunnel.