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CalibrationVerifications withthenew(PPC)CalorimeterDAQ beforeHERA-IILuminosity

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Abstract

After the installation and commissioning of the new PPC-based Calorimeter DAQ [1] hardware, intensive checks of the calibration procedures in the standalone datataking mode, formerly called “OS9/Vax standard calibration”, have been performed. The results were compared to the results, that had been recorded with the old system. Although our studies clearly suffered from the unstable high voltage and electronics situation during shutdown time, the overall agreement was found to be better than 1 ‰ and comparable to the fluctuations observed in two consecutive calibrations on the same hardware. Furthermore the new calibration procedure was measured to be roughly a factor of two faster than the old one. Hence with the new Calorimeter DAQ a full calibration can be done between two HERAfills.

1 CalibrationProcedure

Principle

The high precision of the H1 LAr Calorimeter is maintained among others through a regular calibration procedure. During luminosity datataking, the frontend ADC counts are transformed online by the frontend DSPs into a calibrated charge measurement by applying calibration factors after the zero suppression. The precision and stability of these values are therefore essential for the reliability of the calorimetrymeasurementsandhavebeenintensivelyverifiedafter thehardwarechanges.

Figure.1 displays the dataflow and the interaction between the different har dware and software components of the calorimeter DAQ for the calibration procedure: It is circular in the sense that the calibration factors are evaluated from raw datataking in the DSPs ("transparent" mode) and finally used in those same DSPs for the online data correction during luminosity. The ADCs, which digitize the analog signals from the ANRU (analog readout unit) boards, are controled by DSPs through a private bus. The DSPs prepare the readout data in buffers for the eventbuilder. The eventbuilder boards were equipped with 29K processors in the past, but for calibration readout only a 68k CPU on a FIC board by CES was used until beginning of 2001. Both types of processors are replaced by a PPC CPU in the new Calorimeter DAQ [2]. The PPC eventbuilder is controlled through a TCP/IP socket client program, called MenuDAQ. This program receives the calibration banks ADQR via Internet and stores them in the RAMP file format. The RAMP file is transformed by the calibration performing auxiliary program `calib_f` which issues four calibration parameters and one noise descriptor (sigma) per channel. Exactly these five channel dependent parameters are stored in a so called `.par4` files (one per partition) and are used by the DSP in its online *zero suppression and correction* mode. The auxiliary `dsph` makes the transcription (number framing [3]) into the hardware adapted `.cal` file, which containsthecorrectiontablesinaDSPreadableformat.

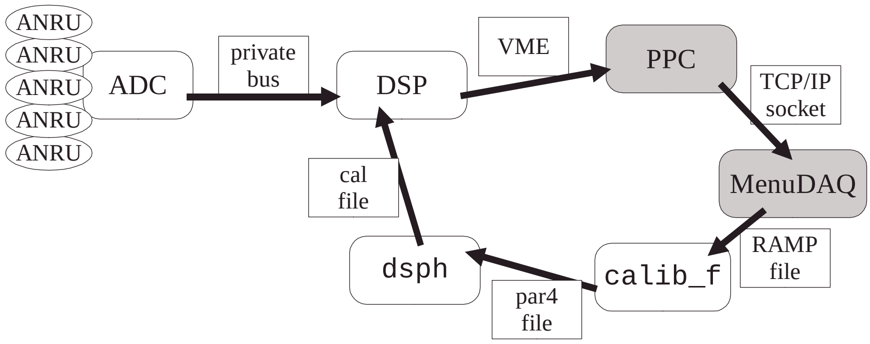


Figure 1 : Data Flow in CaloDAQ during the calibration process; the data readout by the DSP from the ADCs are transformed into the calibration tables which are finally loaded as "cal file"s into the DSPs for online data correction. Replacedhardwareparts("newCaloDAQ")areshaded grey.

The parts of electronics which have been changed are displayed in gray. They are pure digital hardware, and assuming a correct transfer of all programs, no change in the measurements should be observed. However, a higher speed in data processing inevitably implies changes in the readout and pulsing sequence,whichmighthavehadtinyeffectsontheresults.

Fitprocedures

Energies from the calorimeter cells are measured and digitally converted by ADCs which are sequenced and read out from the DSPs[4]. The complete electronic chain from the calorim eter to the ADC is regularly calibrated by injecting well defined pulses from a DAC system[5]. Therefore the DSPs are running in a *transparent and summing* mode and a series of pulse events at different generator levels is taken, which is called a *ramp*. Note that the precision of these calibration measurements is improved by taking the average over 100events for a given ramp point. The average value and the est imator of the standard variation, in other words the sum of values $\sum_i x_i$ and sum of the squared values $\sum_i x_i^2$, enterthecalibrationfit.

The PPC receives the sums over 100 measured values and their sums from the DSP and transmits them totheMenuDAQprogram.Twokindsoffitscanbeperformedwiththere ceiveddata:

linear regression within the MenuDAQ application for a fast and simple check
third order fit through the bias of a ramp file which is saved by the MenuDAQ application and read in by the `calib_f` program.

The result of the linear regression are three parameters for each channel:

1. slope of the regression curve (P1) for each channel,
2. the intersection (pedestal) value at “no pulse” and
3. a noise estimator (sigma), which will be used as a factor for the zero suppression level.

The result from the third order polynomial fit yields two further parameters

4. second order fit parameter (P2)
5. third order fit parameter (P3).

These calibration files are used by the DSPs in the “full correction” mode, which is used for zero suppression and online data correction during luminosity data taking.
Previously the calibration ramp procedure was executed by a FIC running OS9 (h1cal6.desy.de) for datataking and a Solaris 2.7 Sun (madura.desy.de) building the ramp files. The Sun was preceeded by a Vax cluster system (CaloVax) in earlier days.
In our newly installed system, the datataking is performed by a PPC running LynxOS (ambon.desy.de) and the ramp files are generated by the Java application called MenuDAQ, which has been tested to run reliably on Linux (2.2) and Solaris (2.7) under Java2 (1.2).

Ramp file and data formats

BOS banks

Ramp files contain a series of plain BOS [6] banks, which in turn contain the average ("mean") values and standard deviations ("sigma") of the measured ADC response. In fact these BOS banks don't conform fully to the standard, as they are sensitive to byte order; no BOS library is actually involved until their storage to file. Depending on the the originating system and thus numerical format of the values, three different bank names are used:

RAMP	Vax	(floating point, little endian)
RAMB	UNIX	(floating point, b_ig endian)
CALI	OS/9	(fixed point, integer multiplied by 16)

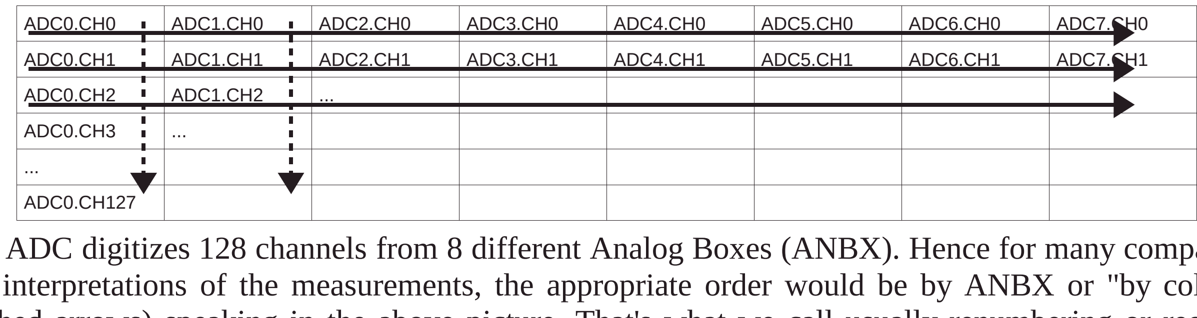
All numerical formats extend on 32 bits. These BOS banks contain a mini header with:

number of columns, number of rows, control length and control fields (date, time, number of events, partition, number of channels, status of the Orsay sequencer and calibration board status).

Control fields are followed by the sums and sums of squares as described in the part above.
The new DAQ being Unix (Solaris) and PPC based, only the RAMB format is presently being used. That excludes for example compatibility with Intel CPUs! The Java convention is compatible with the PPC (and could be changed by software), but the byte order is explicitely constructed in the application.

Channel numbering

Due to the hardware architecture [4;7], the DSP reads 1024 values from eight ADC s according to the following scheme (horizontal, continous arrows).



One ADC digitizes 128 channels from 8 different Analog Boxes (ANBX). Hence for many comparisons and interpretations of the measurements, the appropriate order would be by ANBX or "by columns" (dashed arrows) speaking in the above picture. That's what we call usually renumbering or reordered channel numbering. It's an option in the MenuDAQ application. In this note, only reordered numbering will be used, thus displaying channels of the same ANBXes and the same ADCs next to each other in all plots, which is not the case for the file formats. The reordered numbering eases detection of problems in the electronic chain.

Cold and Warm Calibration channels, Crosstalk

The usual (cold) calibration lines leading signals into the cryostat are supplemented by (warm) optional calibration lines leading the calibration pulses only until the ANBXes outside the cryostat. Thus, H1 keeps the possibility of calibrating cells with broken cold lines from an extrapolation of the calibration with warm lines. A total of 992 generators are used for pulsing. According to the lines used for calibration, the calibrations are said to be "cold" or "warm" for short. During cold calibration cross talk between lines is significant and 1/16 of the 992 generators are pulsed at once. This means that each point in the ramp file is built from 16 pulses and 16 readouts. The MenuDAQ application thus reconstructs one point from 16 separate DSP readouts with one out of sixteen groups of generators activated.
In order not to depend on database contents and to reflect exactly the hardware situation during a calibration, the saturation trick is used in standard H1 calibrations: In standard ramp files the first and third DAC point are pedestal measurements. The second point is pulsed at a very high level in order to saturate the ADC responses. Thus the relation generator—channel is established and the resulting conversion table is used from the 4^{th} to the 32^{nd} point to combine the sixteen measurements to one.
The DAC pulse levels are described in /h1/iww/idet/icalo/daq/MenuDAQ/Input/Request, file levstand.req. The CB partition is the only partition which does not contain ¼ gain ANBX, and all its ANBX are saturated at the 22^{nd} point (24676 DAC counts). Therefore CB ramp files contain only 22 points instead of 32 points like the others partitions.
All pulsed points are measured in mean-sigma with 100 events, in order to avoid saturation of the sums of squares (24 bits). However, pedestal points can be and are measured with 1000 events.

2 Comparison method for the Fit parameters

A detailed graphical and numerical comparison of the calibration parameters issued by the calibration procedure with OS9 and PPC has been performed for each partition. For each partiton the parameters has been plotted versus the reordered channel number for OS9 and PPC results separately. One example for this kind of plots is shown in Figure 2.

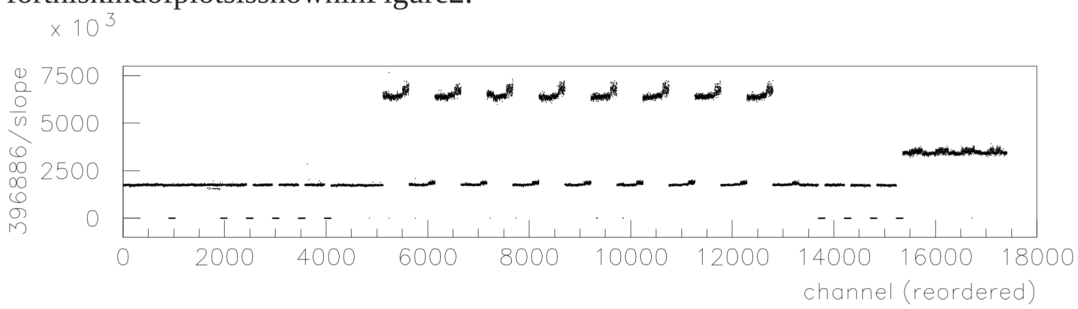


Figure 2: The slope values for the FB partition as a function of the reordered channel number taken with the OS9 system. The two groups of different gains (simple, quadruple) are clearly visible. The last channels have a "double" gain factor.

Instead of the direct value for the calibration slope, the correction factor for the reverse calibration,

$$396866/\text{slope},$$

which will be multiplied to the ADC output in online mode, is stored in the ramp file. In Figure2 these values are displayed for the FB partition. They are taken with the new PPC system. The two different groups of gain factors are clearly visible. The distribution for the OS9 system looks of course very similar; comparisons on a visual basis are hardly possible. For the comparison of the results the relative difference

$$\frac{\text{New hardware} - \text{Old hardware}}{\text{New Hardware}}$$

has been calculated as a function of the reordered channel number. The results are shown in Figure 3.

For characterization of the comparision we used the projection of the relative difference on the *y* axis. It

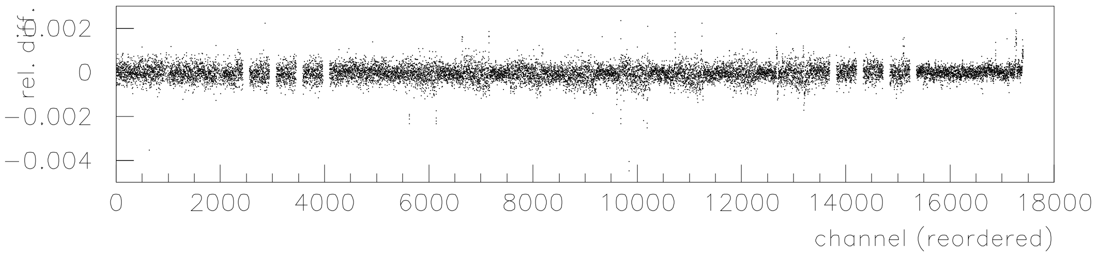


Figure3:Relative differencesforthe slopeparameterof theFBpartition versusthereordered channelnumber. Shownarethevalues (PPC-OS9)/PPC

permits to observe possible shifts. This distribution for the inverse slopes of the FB partition is shown in Figure4. The mean and RMS values are calculated in PAW [8] and extracte d as the characteristic values ofagivencomparison.

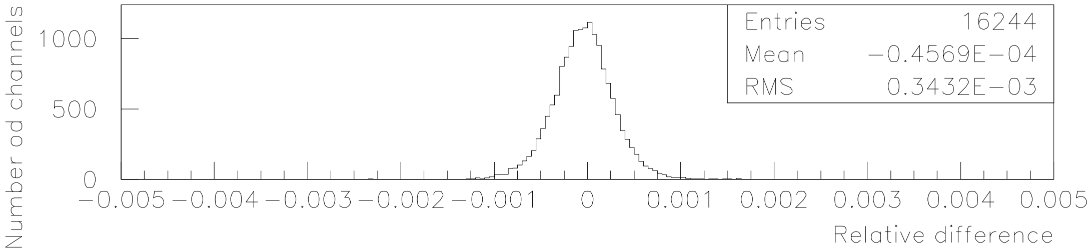


Figure4: Distributionofthe relativedifference betweenOS9and PPCfortheslope valueoftheFB partition.

In the following, we exploit two different types of fit procedures for the calibration factors, which are available in the MenuDAQ Java application for the new hardware and in menu_daq program and Vax/Sun client for vax_server respectively for the OS/9. The simplest approach is a linear fit (three parameters: pedestal, slope, noise) which easily allows to detect evident problems, for example in the hardware or croos talk effect between partitions. It minimizes the number of involved programs, because onlyMenuDAQisused.

Secondly, the H1 official procedure goes through all programs, which were mentioned in the introduction and yields five parameters from a third order polynomial fit as explained above. They allowed us to detect tiny errors like the crosstalk effect in one partition due to simultaneous pulsing of allchannelsorsequencerorpulsertiming.Thismethodyieldsaprec isionbetterthan1 ‰.

3 Studyonlinearfit

The MenuDAQ program allows to generate a first order calibration with a simple, linear regression fit. The generated files contain only 3 fit parameters: pedestals, thresholds and gain, the two other parameters being set to 0 in order to keep the same format as any ramp files. Figure5 presents a summary for each partition of the mean difference of all the channels and its width for the three parameters.

Two different calibrations have been compared to illustrate the fluctuations observed in two consecutive calibrations on the same system and the differences due to hardware changes (PPC-OS9). In Figure 5 one can see that for all three conbinations of the systems the results are very similar. The pedestals do not show significant shifts and are stable with in 1 ‰. The width of the noise distributions is approximately 10% for all comparisons. This value is expected because of the small number (100) of events which are taken for the width determination. For the gain the result are very similar as well. The differences in the comparison OS9-PPC are comparable to the fluctuations of two calibrations on the samesystem.

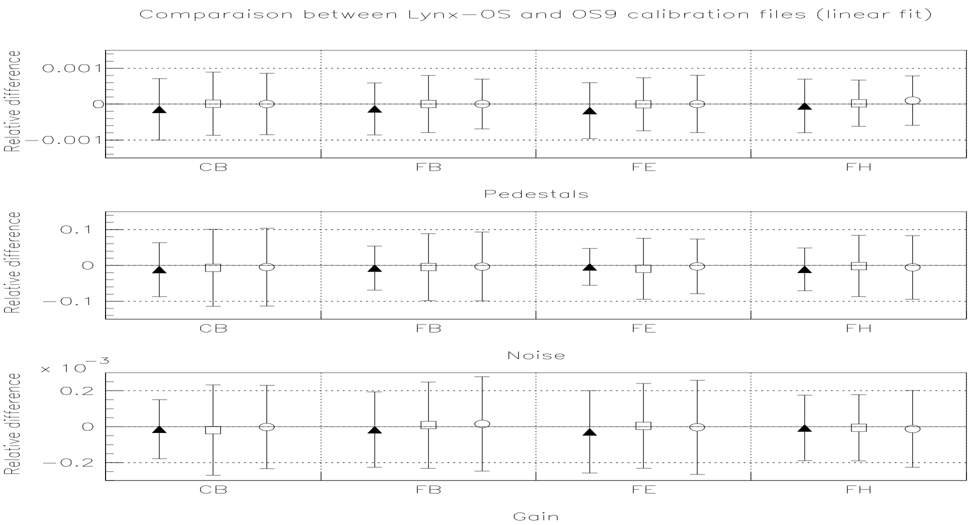


Figure 5: Summary of relative differences of the three fit parameters between the different systems:

OS9-OS9;
OS9-PPC,
PPC-PPC.

The mean (value) and the width (error) of distributions as extracted from plots equivalent toFigure4areshown.

Pitfalls

As a demonstration of the crosstalk effect in a cold calibration, Figure6 shows the comparision of the slope parameters for FB, comparing the case with other partitions activated to a calibration with FB only.

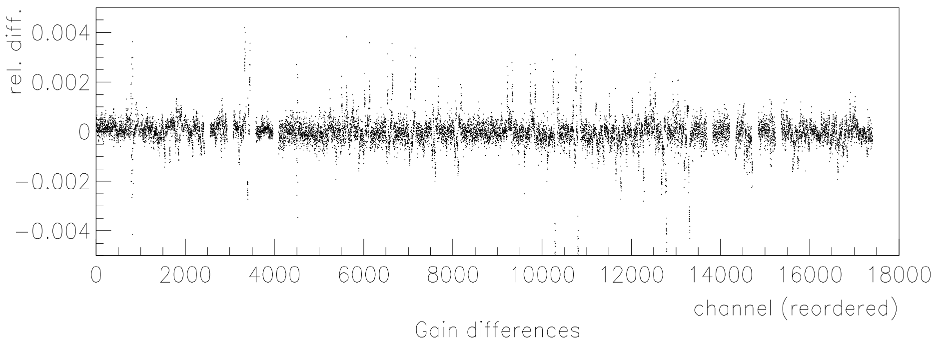


Figure 6: Relative difference of the slope calculated from FB data when just FB was activated and FB data when all four partitions were activated. The cross talk effect clearly corruptstheresults.

We found accordingly on the PPC and the OS9 system, that the hardware setup of the FH partition sometimes needs a first dummy event to be valid for datataking. This will be subject of further studies, as no trace of such a behaviour has been found in previous documentations or calibration results. For the timebeing,adummyeventisintroducedinthe `MenuDAQ`procedureforthispartition.

During these simple tests with a linear fit it has been observed that the pedestals and the ADC counts measuredforagivenDAClevelvarywithtime,morethanweexpe cted.

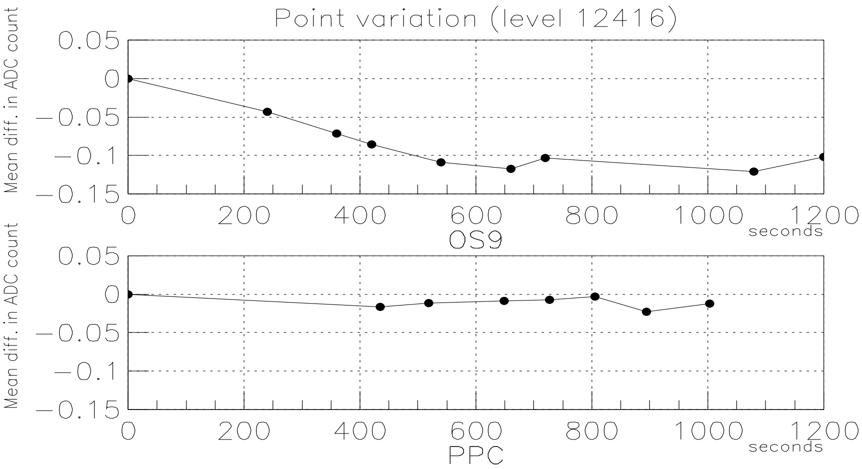


Figure7: Variation of the ADC counts for a DAC level of 12416 for the OS9 (upper diagram) and the PPC (lower diagram) with respect to an arbitrary zero point in time.Thedriftintimebecomesevidentand is obviously not an artefact of the new DAQ(PPC).

This is illustrated in Figure7, where the mean value of the channels on PPC and on OS9 in a short period of a few minutes is presented. In order to increase the measurement precision, points of 2000 events have been taken at DAC level 12416 (approx. 2800 ADC counts). Each point on the plots represent the difference, averaged over all channels, between the current point and the original

(0seconds)point.
We attribute this behaviour (confirmed by further measurements) to pedestal shifts, which are obviously of the same order when measured with the old or new system. Their relatively high amplitude is probably due to the unstable situation of high voltage and electronics during the shutdown. Therefore we recommendtorepeatthiskindofstudiesinamorestablesituation,a fterluminositystartupforexample.

4 Studyonthecompletecalibrationprocedure

After this first simple test with a linear fit, the complete calibration procedure has been tested with the H1 official procedure which yields five parameters from a third order polynomial fit. A study has been performedoncalibrationfilesresultingfromthefullcalibration chain:

- generationof22points(CB)or32pointsrampfiles(FB,FE,FH),see Section1.
- framingoframpfilesandgenerationof `par4`filesby `calib_f`.
- generationofcalibrationfilesbythe `dsph`program.

These calibration files (`.cal`) contain integer constants* which are used for the z*ero suppression and online data correction* by the DSPs (see Section1). The relative differences of these parameter s for the

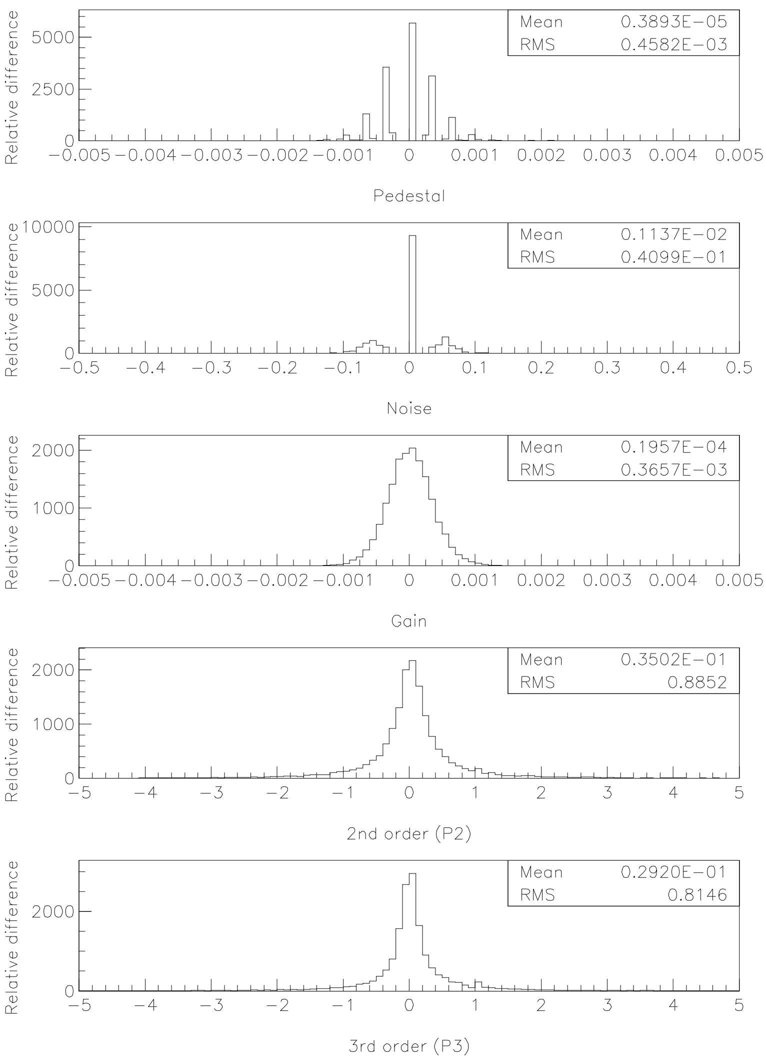
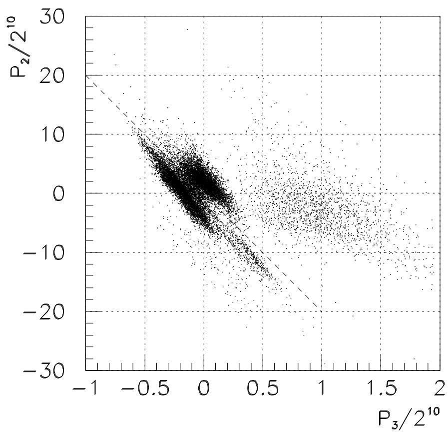


Figure 8: Distributions of the relative difference of the five fit parameters in data taken with OS9 and PPC for the CB partition. The pedestal and noise values (first and second subfigure) are small integer values (200 and 1 respectively) and therefore cause a discretized difference distribution.

The second and third order fit parameters (subfigure 4 and 5 lhs.) are strongly correlated and therefore show generally strong fluctuations each, which are mostly compensated among themselves. As an illustration of this fact we show the correlation plot for these two parameters in arbitraryunits(cf.[3])below.



CB partition are shown as an example in Figure8, comparing a measurement on OS9 with a measurementbythePPC.
The distributions of the pedestal and noise parameters, which are relatively small in their absolute

* Theseintegerconstantsarepreciselyfixedcomma constants:Thatmeansinpracticeafloatingcomma constantcomputed fromthemeasurementandfitprocedure,whichismu ltipliedbyafactor $2^n, n$ $Nset$ beforetakingtheintegerpartof theresult.

values, are discretized due to their integer format. The single peaks are broadened due to the division $\frac{n \quad m}{n}$. As for the linear fit procedure the distributions of the width is smaller than 1‰. The sigma distribution is even more distorted due to the intrinsic integer nature of the measured values (typically 1ADC count). It's the least critical value of the three principal values. The m ost critical value, the slope, isreproducedwithaprecisionofbetterthan0.5 ‰.

The distributions of the higher order parameter (P2 and P3) show variations with a characteristic width of 20-30% because they are strongly correlated; the 3rd order of the fit over-determinates the calibration curve,ashasbeenextensivelydiscussedinearliernotesandmeeti ngs.

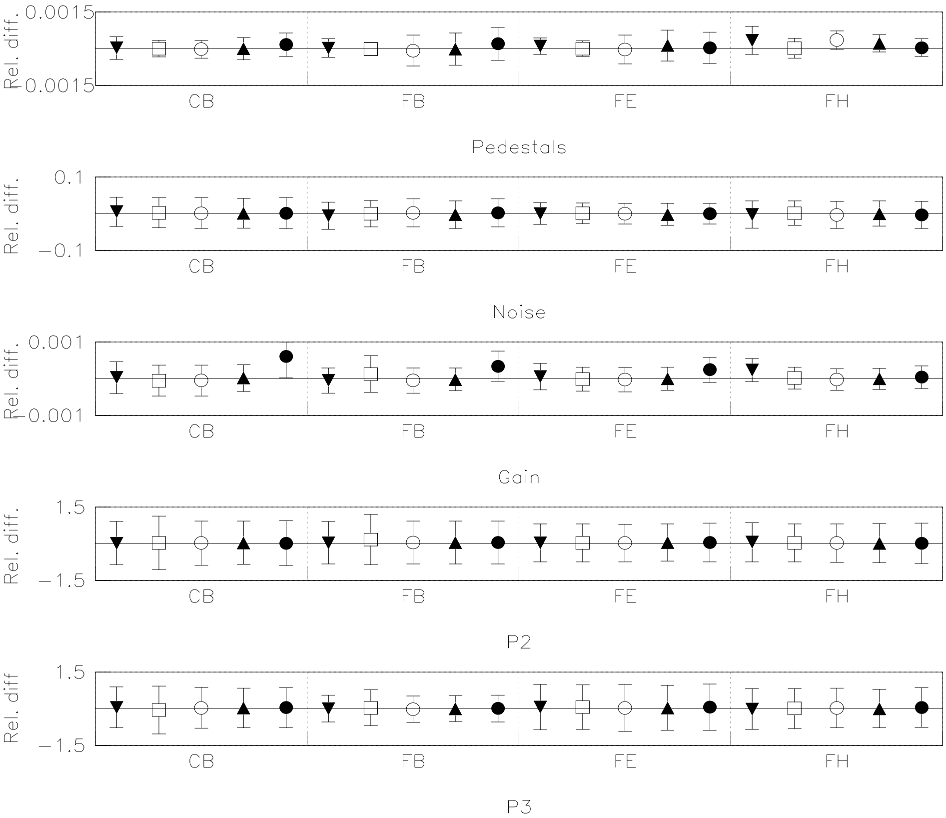


Figure 9: Summary of the relative differences for all fit parameters of calibrations withtwosystems:

OS9-OS9,
OS9-PPC(slow),
OS9-PPC(fast),
PPC-PPC(fast),
PPC(slow)-PPC(fast)

Extracted values of the mean and the width of the five distributions for each partition (calculated by PAW[8] as explained above) are shown in Figure 9. It displays the all combinati ons of relative differences of the resulting fit parameters taken with the OS9 system and with the PPC system and of two calibrations on the same system. The two options "slow" and "fast" for the PPC calibration are explained in the next chapter. One can see that the PPC system and the OS9 system yield identical results within statistical errors. For all parameters the variations due to the hardware changes and the statisticalfluctuationoftwocalibrationsonthesamehardware arecomparable.

Problematicmeasurements

We obtained overall satisfying results from the whole study. However, it also allowed to point some troublescorrespondingtosomeADCchannels.Wedocumentherealistof problematiccases.

As an example of such a case Figure10 shows the behavior of the slopes for the FB part ition. Data have been taken with the OS9 DAQ on the 18th and 21st of June2001. Eleven analog boxes have shown a strange pattern in the difference distribution. We conclude that this is not due to the new DAQ software orhardware,buttotheunstablehighvoltageandelectronicsituationduri ngthetestperiod.

The study prooved that the behavior appears only on single dates and equally on both systems (PPC and OS9).

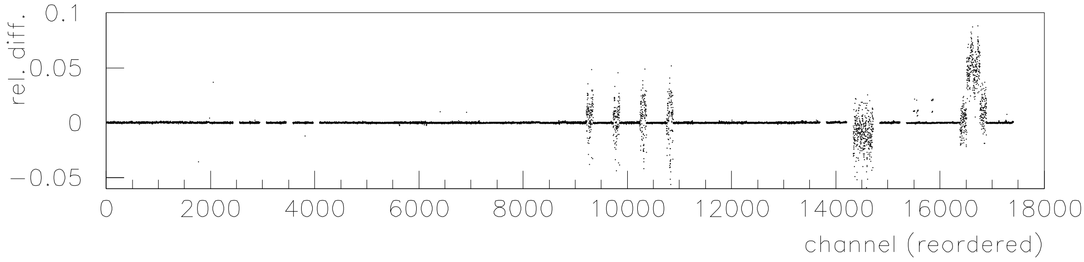


Figure 10: Example of comparison for a corrupted measurement: Shown are the relative differences of the slopes from calibrationstakenonOS9on18.06.2001and21.06.2001 fortheFBpartition.Elevenanalogboxesshowsignificantdifferences withrespecttothereference.Behaviorlikethisappearedwiththe PPCaswell.

A list of all analog boxes which have shown problems during our checks are given for reference with somedetailsinthefollowingtable:

ANBX	partition	problematicvalues(bigdifferences)
1. h1cal6CBcalibrationfileof01/06/18:		
15	CB1H	pedestals,thresholdsandgains
2. h1cal6FBcalibrationfileof01/06/18:		
252	FB2E	pedestals
447	FB1E	gains
448	FB1E	gains
450	FB1E	gains
451	FB1E	gains
452	FB1E	gains
453	FB1E	gains
454	FB1E	gains
455	FB1E	gains
3. ambonFEcalibrationfileof01/06/21:		
126	IF1E	pedestals
223	IF1E	gains
289	IF1E	gains
290	IF1E	gains
4. ambonFHcalibrationfileof01/06/21:		
291	IF1E	pedestals
292	IF1E	pedestals

5 Timingconsiderationsofthecalibrationprocedure

The OS9 software formerly kept track of all changes in the hardware setup during a calibration by a shadowing local memory structure with the last configuration of the VME hardware. For a new configuration, only the necessary hardware parts with changes were touched, in order to save significantly time. Although with that method only a small probability of desynchronized hardware and shadow memory remains, we decided for the PPC software to setup most of the hardware every time a datataking request is made, because this simplifies the program architecture, if other measures are taken toavoidconflictsbetweenmultipleusers[9].

However, this implies that setup intensive tasks like a calibration ramp take longer than they have to. Indeed, the naïve approach with a setup/readout couple for every single point of the calibration would take longer on the PPC than it took on the OS9 system before. This is in particular true for the H1 official procedure where only one out of 16 generator groups are pulsed at a time because of the crosstalk (see Section1). Therefore we implemented a datataking mode where a given number of different generator groups are activated between the readout of distinct data points. This results in a two times faster calibration compared to the OS9 procedure. There is potential to improve this further, if needed and wanted, for example by changing also the calibration level within in the readout program.

Thissectiongivessomedetailsonmeasuredtimeconstantsandourpr esentlybestresults.

Setuptiming(RQS)

RQS (ReQuest Setup) is the hardware setup program. In the ramp procedure, RQS is mainly called to reconfigurethethefrontendelectronicsbetweeneachpoint.

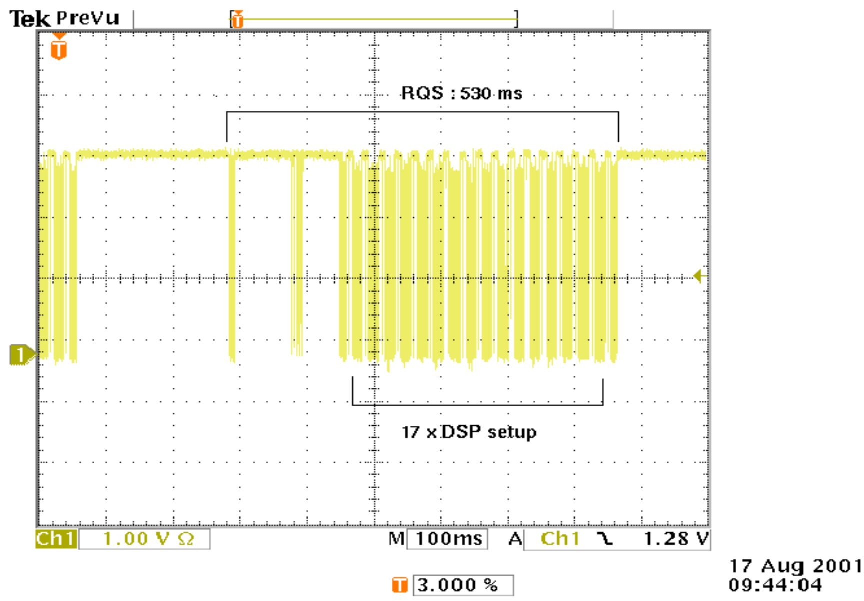


Figure11: VME Address strobe signal during one Setup Request of the CB partitioninthenewCaloDAQ.

The total setup time on VME is 530ms after a pause of about 250ms from the last previous VME access. The pattern allows to distinguish 17 DSP setups of about25mseach.

The time behaviour was measured by monitoring the VME accesses of the program: The AS (address strobe) signal was used in all following plots to indicate VME activity of any case in the DAQ system. Figure11 shows the AS during one RQS execution. From this we derive the time 530ms as the total "time on VME". We clearly distinguish the setup of the 17DSPs from the other ha rdware accesses (STC, sequencer, pulser). Obviously, with this method we do not measure the program overhead needed for reading the configuration files (`config.vme` et al.) or for context switches in the LynxOS. From theplotsitcanberoughlyestimatedto250ms.

Readouttiming(RQR)instandardmode

RQR (ReQuest Readout) is the readout procedure of the new CaloDAQ system. In normal mode, RQR performs one readout and exits. Figure12 shows the "VME traffic" during a standa rd RQR. The time consumption for the readout is measured to be about 530ms, with a program overhead for st artup comparable to that of the setup program request (RQS) 250ms, containing also the time needed in the

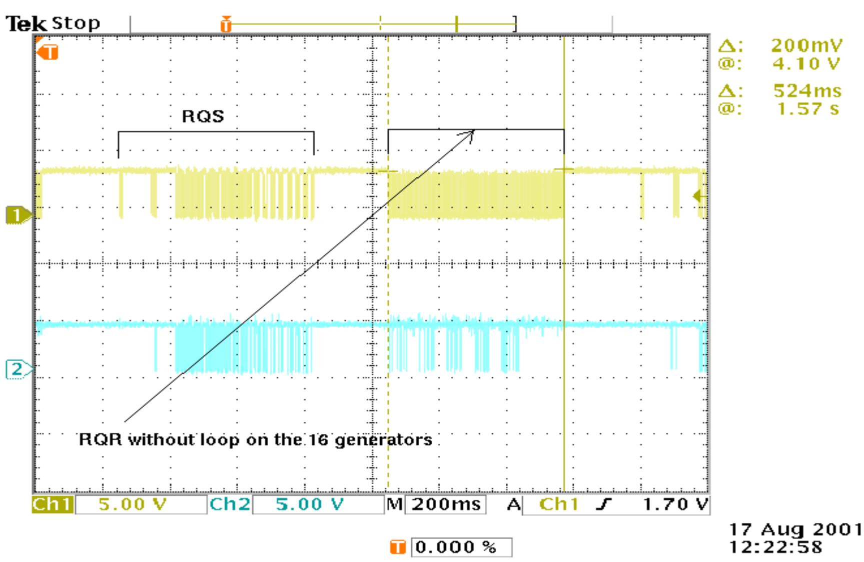


Figure12: VME Address strobe signal during one Setup (RQS) and standard Readout (RQR) Request of the CB partition (upper signal) and the VME write signal.

The total "time on VME" for the readout ismeasuredtobe524msinthiscase.

frontendforthedigitisationintheADCsandthesequencingintheDSP s.

RQRtimingimprovement:generatorloop

For all MenuDAQ menus, each readout is preceeded by a setup. For instance, a simple ramp menu performs ten points with a different calibration level for each point. In order to change the pulse level between each point, a setup request (RQS) is performed. From the measurements cited above, we calculate(andmeasure)

16RQSà530ms	8.5s
16RQRà530ms	8.5s
32VMEgapsà250ms	8.0s
Totaltime	**25 s**

For an official H1 standard calibration ramp, the procedure contains 32 ramp points. Moreover, for each point, only one out of sixteen generators is pulsed at a time in order to avoid the cross talk. This implies that for each point the setup can be kept constant, if only the activation of the generators is changed between several readout requests. Therefore we implemented the "generator loop" mode within the RQR program, in order to make the consecutive pulser setup and readout for each of 16 groups of generators asforeseenintheofficialH1procedure.Theresultisillustrat edonFigure13.

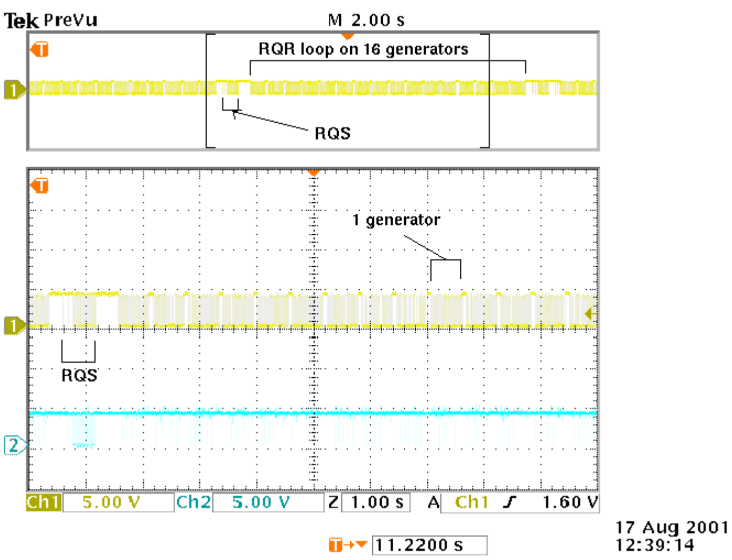


Figure 13: VME Address Strobe (AS) and Write (WR) signal during a setup and seadout sequence with the improved readout program. The setup (RQS) is unchanged with (230+530)ms, whereas the program context start overhead and the obsolete setups are saved and VME accesses occur with maximum speed onthebus.

The lower plot with the AS and WR signals is a magnification of the part between brackets of the upper plot fortheASsignal.

The time needed for one generator group setup and successive readout is measured to be 550ms and the complete RQR execution 9.5seconds. For one standard ramp point, we need 10.4 seconds ins tead of 23.5secondswiththeexplicitloopthroughRQS+RQR.Hence,thegainisa napproximatefactoroftwo. The time computed from these values for a complete ramp run with the loop on 16 generators and the necessarypedestalpointsasexplainedaboveis:

62VMEgapsà230ms	14.3 s
32RQSà530ms	17.0 s
2RQR(1000events)withoutloop:4500ms	9.0 s
30RQR(100events)withgeneratorloop:9500 ms	285.0 s
Totaltime	**≈325.0 s**

Thatisaround5½minutesandconfirmedbymeasurementsasdiscussedi nthefollowingsubsection.

Timing gain for the full calibration

In Figure14, we compare the running time as a function of the eight consecutive phases of the complete calibration for the PPC and the OS9 procedure. The new calibration procedure is about two times faster than on OS9 in all eight phases separately, and thus in total.

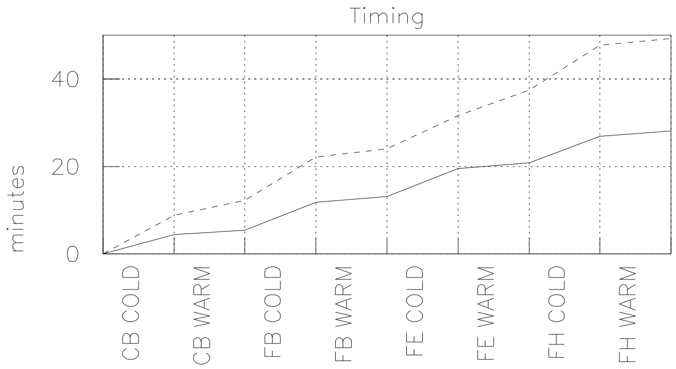


Figure 14: Time consumption of the eight phases of the full calibration with the OS9 system (dashed line) and with the new PPC system (full line). The time needed with the new system has shrunk to about half the time of the previous system.

This improvement will allow us to run the full calibration level ramps for the whole LAr calorimeter always between two HERA fills now. This important result implies that the short calibration described in the following part becomes obsolete.
We observed a net downgrade of this performance with increasing load on the Sun (madura.desy.de). It is obvious that also increased network traffic will downgrade the performance.

6 Standard Check Tools

Calibration

Due to the long duration of the full ramp calibration (~50min) with Sun and OS9 a s o called short level ramp procedure with just a charge measurement at DAC=9600 and measurements of pedestal and noise for all channels, was used for crosschecks before the change to the new DAQ system. With these short ramps a fast check was done every day to verify that the full calibration results, which were regularly taken once a month, were still within reasonable limits.
In these "standard tests" of the calibration the charge at DAC level 9600, the pedestal and the noise of the short level ramp was compared to the results (`.par4` file) of the full calibration. In case of deviations a new full calibration was done again and the results were updated.

Exactly these tests have now been used by us to check the consistency of the calibration taken with the new PPC and with the old OS9 system. The final results (.par4 file) of the PPC (taken on 30.07.2001) have been compared to a short level calibration file (29.07.2001), that was taken with the old OS9 system. As an example the results for the CB partition are presented in the Figure15. These plots are identical to the former standard calibration check plots checked regularly by the “calo experts” on the web. For all partitions equivalent plots have been checked and similar distributions have been found. Extracted values for the mean and the width of each distribution are shown in Figure16. The calibration values obtained with the new PPC DAQ do not show significant deviations. These deviations are comparable to the fluctuations usually observed in two consecutive calibrations on the same hardware. As done before with the OS9 system, the distributions of charge at DAC=9600 and of the pedestal have a width smaller than one per thousand and the noise is stable within 4% for each partition.

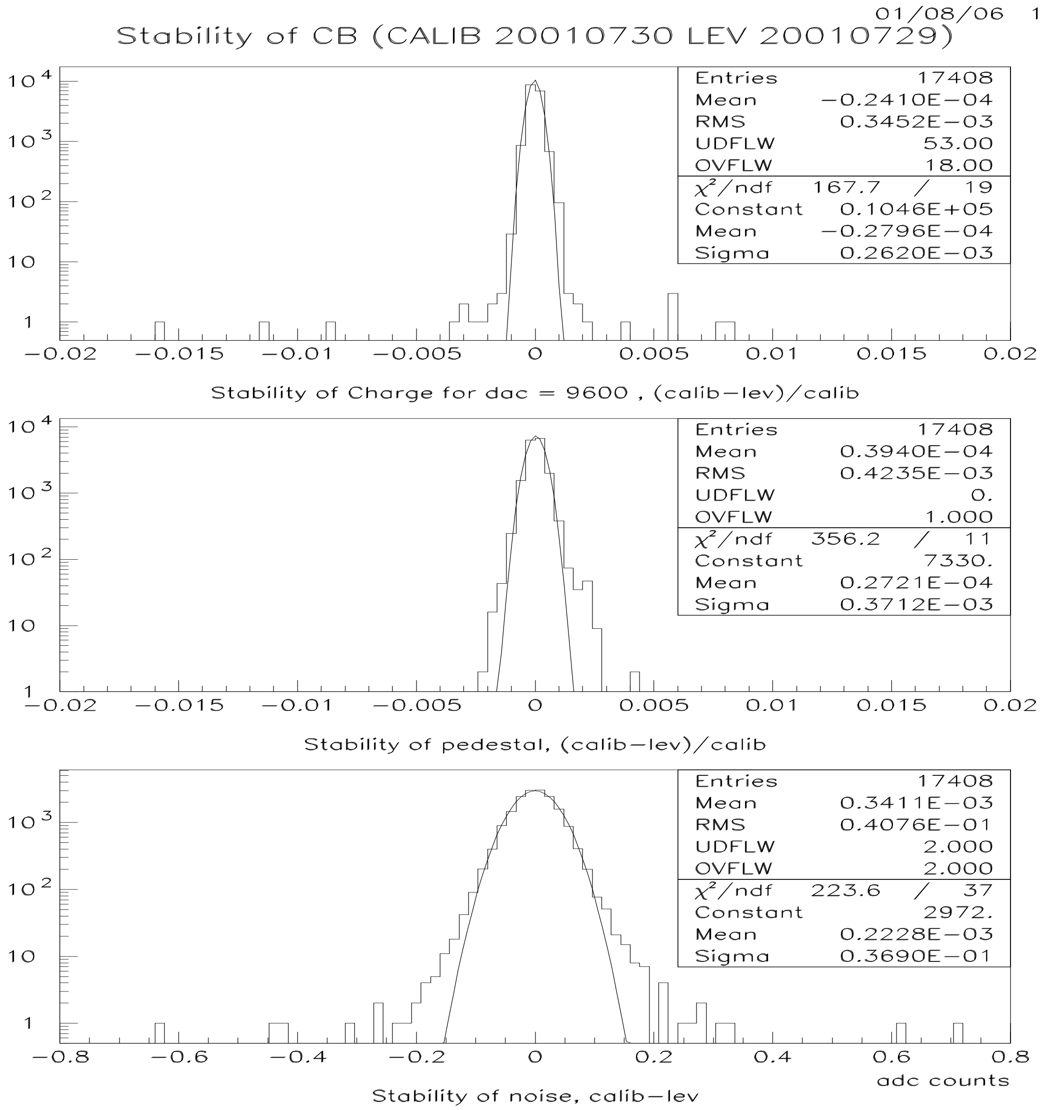


Figure15: The former standard control plot for the short calibration ramps. Here a short calibration taken with the old hardware setup (07.29.01) is compared to a full calibration taken with the new PPC DAQ (30.07.01). Shown are the stability of the charge at DAC level 9600, the pedestal and the width. As an example the distributions for the CB partitionareshown.

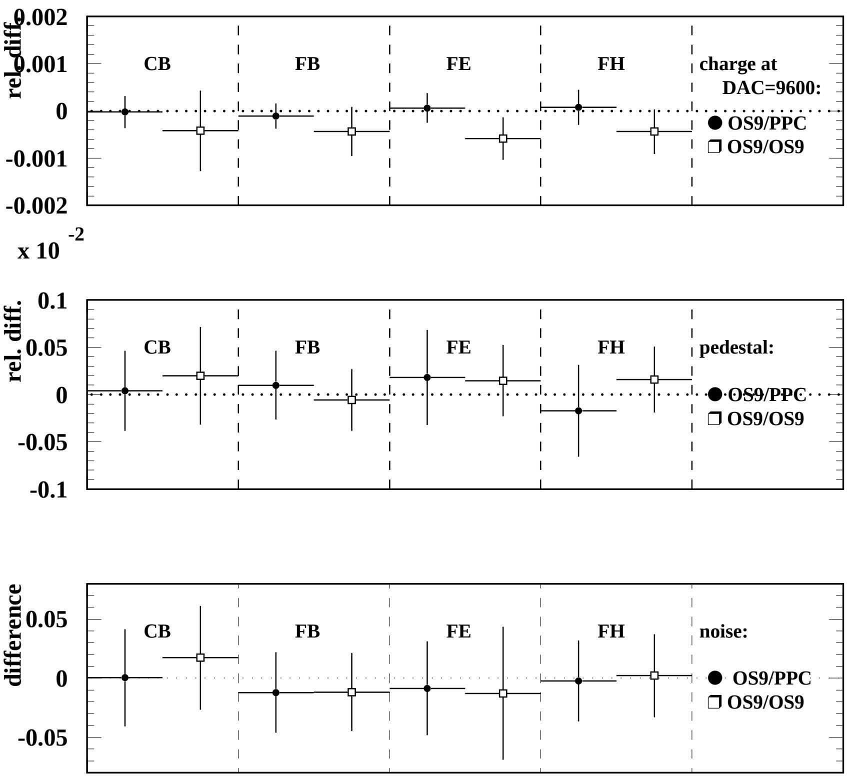


Figure16: Extracted value for each partition from the former standard control plots of the short calibration ramps. These values have been obtained from distributions as in Figure 23. Shown are the mean (value) and the width (error) of the difference distributions for each partition. The values for a comparison OS9/PPC as shown in Fig.17 and typical results of a comparison of two OS9 runs (short ramp 26.08.2000, full ramp 16.08.2000) are displayed.

Timing

Another check was done approximately every day in order to survey the timing and the shape of the signal of each calorimeter channel with so called delay ramps. In these delay ramps the shape of the signal after a pulse of a generator is recorded by taking the signal level for several delay values. A fit is performedtothisshapeandissuestwovalues:

pointintimeforthesignalmaximumand

thewidthofthesignal.

These two values characterize the signal treatment by the calibration and shaper electronics in each channel. They are compared to a reference, the standard reference file for the last datataking period beingtakenon02.04.1999.

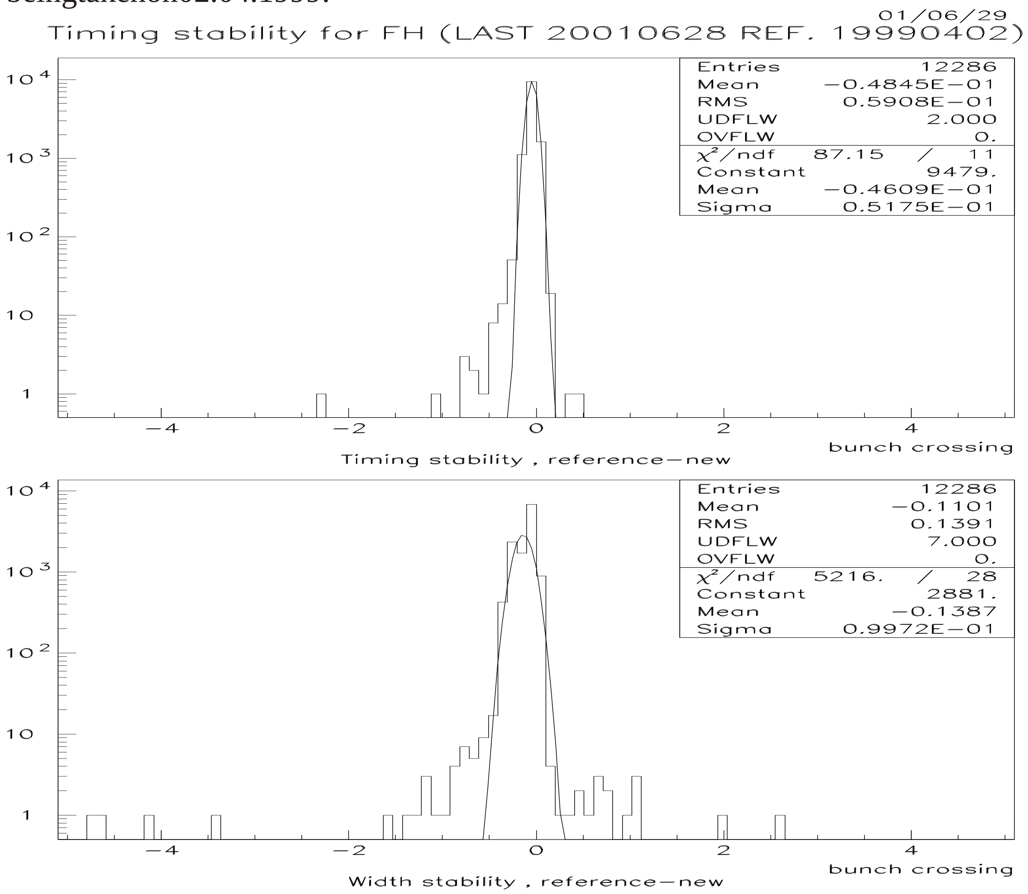


Figure17: The former standard plots to survey the timing and the shape of the signal. A delay ramp taken with the new DAQ (28.06.01) is compared to the standard reference ramp taken with theoldDAQ(02.04.99).

Shown above are the differences of the measured time of signal maximum. Below we display the differences of the measured pulse width for each channel. As an example just the results for the FH partitionareshown.

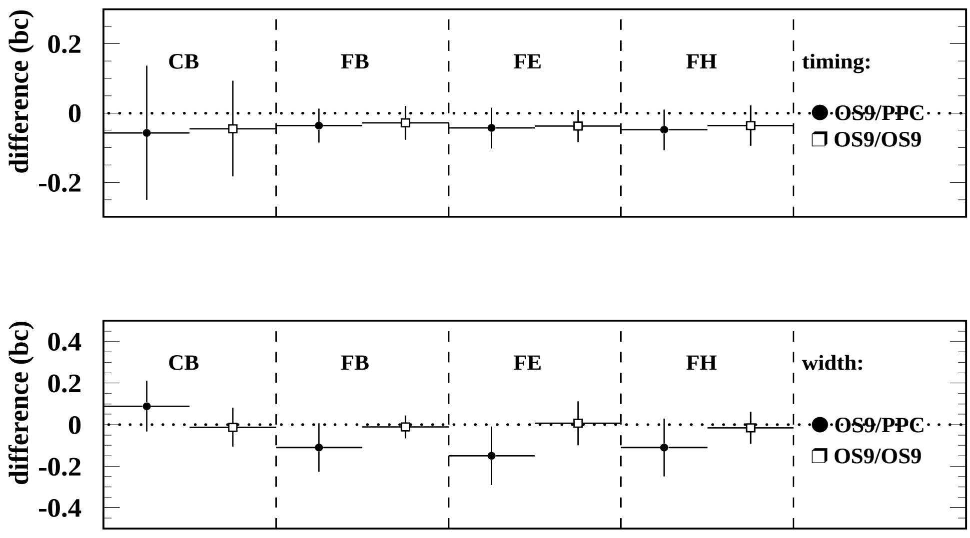


Figure18: Extracted optimal delay values in HERA bunch crossings (bc) for the standard test to check the timing and the shape of the signal. These values have been obtaind from distributions as in Figure24. One can see here the mean (value) and the width (error) of these distributions for each partition. We show comparisons of OS9 to PPC as in Fig.17 and a typical comparison of two OS9 runs (reference 02.04.1999, delay ramp 23.08.2000).

These tests have been repeated with the new PPC system. The results of this timing analysis (taken on 28.06.2001) have been compared to the old standard reference file (02.04.1999) from the OS9 system. As an example the results for the FH partition are shown in Figure17. It conta ins the differences of the

time parameter for the signal maximum and the width between the reference file and the file taken with the PPC system. These plots are identical to the former standard timing check plots on the web, which are well known to calorimeter experts. Plots of this kind have been checked for all partitions and extractedvaluesofthesedistributionsareshowninFigure18foreachpartition.
As before with the old system the time at the signal maximum shows deviations compared to the reference that are comparable to fluctuations that are usually observed in two consecutive timing sudies on the old OS9 system. The widths of the distributions are compatible with the behavior of the old systemaswell.

7 StatusofTailCatcherandSpaCalcalibrations

The“standardcalibration”fortheTailCatcherhasbeenimplementedintheMenuDAQapplicationand isregularlyusedbytheexperts(see:SamKazarian).

A SpaCal calibration (of the electronic signal path) had only be performed at the installation of the SpaCal in 1995. As the variation of the photomultiplier amplification is predominant for the precision of measurements, the monitoring with LED pulses and appropriate high voltage adaptation is the actual calibration procedure[10]. However, the pedestal shift is determined per channe l with random events in an analogous manner to the LAr procedure. The determination of the channel pedestals and the generation of the appropriate calibration files for the DSP are implemented in the MenuDAQ application.

Similarly, the TDC calibration has been performed for the last time in 1996 [11]. A new delay card has been designed [12] and will be commissioned soon. A direct comparison with the hardware in CAMAC andNIMelectronicswillthereforenotbepossible.

8 Conclusion

We demonstrated that the calibration procedures with new and old hardware produce equivalent results within the usual limits. Fluctuations between consecutive calibrations have been measured to be less than 1‰ as well as the difference between old and new calibrations. The standard checks to control the calibration on a daily basis which had been developed for the old OS9 system equally confirm our detailedcomparisonswithspeciallydevelopped tools

This study gives results comparable to tue usually cited values for the calibration stability [13] allowed us to brush aside the idea of possible software problems or incompatibilities of the new system. However, it should be noted that the calorimeter electronics were unstable during our tests, due to numerous maintenance and upgrade jobs in the detector. We therefore recommend to repeat the comparisonsonceduringtheluminosityperiodwithstablehighvoltageanddetectornoise.

A solution has been given to decrease the full calibration time by almost a factor2 leading to less than 30min for a full ramp of all LAr partitions. Thanks to this improvement, full ca libration between two HERAfillscanbeconsideredandshouldbecomeautomatedassoonaspossible.Itresultsfromthisgain of speed that the short calibration ramps are no longer needed. This will ensure a better quality of the future datataking and accordingly better physical measurements. The formerly developped standard checkswillbereplacedbyatoolcomparingtwofullcalibrations.

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