1 Electronics

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1.1 General

The electronics hardware consisted of NIM and CAMAC modules for signal processing and trigger logic and FASTBUS and VME modules for readout of ADC's, TDC's and Scalers.

- **HMS side**
  Standard electron trigger logic, except that (refering to the diagram) `ELREAL` was the electron trigger instead of `PRETRIG`, which means that the Pion trigger circuit was bypassed. This was done to compensate for the early arrival of the neutron detector signals.

- **NDET side**
  The trigger logic (main and cosmics) was formed in separate NIM and CAMAC crates which were installed additionally. FASTBUS and VME crate of the SOS were used for ADC, TDC and Scaler readout.

- **Trigger**
  The trigger section was extended by a second 8LM module in order to handle the increased number of trigger types. The programming of the Trigger Supervisor had to be changed to handle the larger variety of different trigger patterns.

- **Helicity**
  The helicity signals were provided by accelerator. The helicity pattern was pairwise randomized with a flip frequency of 1 Hz. During the period of potential helicity transition physics triggers were disabled for 600 μs and helicity gated scalers, located in a special VME crate, were read out. The helicity state for each event was recorded via a VME FIFO register and for redundancy also with a Multihit TDC.
  After run 21334 a third (not helicity gated) Struck scaler was added counting the same signals as the two helicity gated scalers. This was done to have crosscheck possibilities.
  Before run 21354 the helicity levels were fed into the trigger supervisor

and thus part of the trigger pattern (helicity dependent event types). They were removed from there when the FIFO module became available.

1.2 Documentation

Below the location of documentation about the electronics is itemized by category. The following shortcut is used for the main documents location:
`GENDOC = cdaqs2:~cdaq/gen/Documents`
For the neutron detector some documents exist in two versions (before and after the experiment). The later versions reflect the status of the system at the end of the experiment and some changes during the period of "good" data taking might be undocumented.

- **Map Files,Cabelling**
  The map of physical detector channels to the electronics (ROC, module, slot, channel) is time dependent and the files can be found in `cdaqs2:~cdaq/gen/replay/MAPS/`.
  `GENDOC/ndet/ndet_cabling.ps`: Neutron detector layout and cabling July 28. 1998
  `GENDOC/n-detector/ndet_cabling.ps`: Neutron detector layout and cabling Nov 21. 1998
  `GENDOC/ndet/ndet_fb_roc3`: Ndet channel assignements in the Fasbus crate, May 26. 1998
  `GENDOC/ndet/ndet_patch_panel`: Ndet Channel assignements at the patch panel, July 24. 1998

- **Scalers**
  Information about scaler gating is described in
  `GENDOC/Helicity/scaler.ps`.
  Channel assignments of scalers are documented in `GENDOC/`:
  `gen_hd_scalers_vmec8`: Helicity gated scalers
  `hms_scalers_vmec3`: HMS scalers
  `ndet_scalers_roc5_v2`: NDET scalers

- **HMS Electronics**
  Diagrams can be found in `GENDOC/hms/`:

cerenkov.ps: Cerenkov electronics
hodoscope.ps: Hodoscope electronics
shower.ps: Shower Counter electronics
hms_crates.ps: Modules and crates
trigger.ps: Electron trigger electronics. This diagram does not reflect the situation during the experiment. Due to timing considerations the electron trigger which was fed into the Trigger Supervisor was not PRETRIG but ELREAL, i.e. the Pion trigger was excluded.

- **NDET Electronics**
  GENDOC/ndet/ndet_cosmictrig.ps: Cosmics trigger scheme June 18. The cosmics trigger was changed several times (see e.g. hclog entry 8111, 8/21/98) and not each change might be documented properly. Since the main purpose of cosmics running was detector testing and gain matching, it's not worth tracking down all the details in cosmics trigger history. However this should not be seen as a disrespection of the heroic attempts of various individuals in ultimate cosmics trigger design. This diagram gives a good idea, how the cosmics trigger logic might look like in a future version of this experiment.
  GENDOC/ndet/ndet_logic2.ps: Neutron detector logic, May 26. 1998
  GENDOC/Timing/ndet_logic_eoe.ps: Neutron detector logic, Dec 3. 1998
  GENDOC/ndet/ndet_splitters.ps: Setup at the splitter after the patch panel, May 26. 1998

- **Trigger Supervisor (TS) and Retiming**
  GENDOC/Timing/ts_setup.ps: Details about 8LM and TS programming
  GENDOC/Timing/gen_ts7.ps: Diagram of final 8LM and TS setup with detailed timing information (delays and pulse widths), Nov, 17 1998
  GENDOC/ndet/ndet_timing2.ps: Thomas thoughts about the timing of ADC and TDC gates, around June 17. 1998
  GENDOC/Timing/retiming.ps: Settings of delay boxes for retiming, Nov, 17 1998

- **Helicity** The helicity scheme (including scaler gating) is documented in GENDOC/Helicity/:

`scaler.ps`: General scheme
`helicity_circuit_1.ps`: More detailed
`helicity_circuit_2.ps`: More detailed continued

1.3 Procedures and Studies

Below a list of additional information that is related to the electronics:

- **NDET Electronics Deadtime**
  After the experiment a study was done about electronics dead time on the neutron detector side. It was shown that the high bar rates introduced an electronics dead time in the order of 2% which is however not a problem for the calculation of asymmetries. Results and findings are reported in `GENDOC/n-detector/n-el_deadtime.ps`.

- **NDET High Voltage**
  HV setting of the neutron detector was closely connected to the choice of thresholds (see below). Furthermore the gains were matched such that a given ADC value corresponds to the same energy deposit for each counter. For this purpose a cosmics runs had to be taken at three different voltages followed by an analysis procedure which is described in detail in `GENDOC/gainmatching.ps`.

- **NDET Discriminator Thresholds**
  Beginning with run 21343 the thresholds of bars (paddles) were left constant at 75 mV (30 mV). These settings were verified several times when production data taking had started (after run 21816):
  before run 21955 (9/4/98)
  during run 22131 (9/9/98)
  before run 22252 (9/14/98)
  before run 22287 (9/16/98)
  before run 22434 (9/27/98)
  during run 22446 (9/27/98)
  before run 22525 (9/30/98)
  In all these checks the observed drifts were typically less than 1 mV, in a few cases up to 5 mV.
  The initial (before run 21140) typical setting of the thresholds was 50 mV (20 mV) for bars (paddles).

For run 21140 - 21163 the thresholds of bar 1 to 32 was 100 mV, else 50 mV (20 mV) for bars (paddles).
After run 21163 the typical setting was 75 mV (20 mV) for the bars (paddles).
The optimal settings of the thresholds were determined in connection with the High Voltage settings in test series:
run 20143, 20144, 20150 - 20152
run 21188 - 21203
run 21227 - 21243
run 21300 - 21342
The setting of the thresholds is a compromize between achieving high detection efficiencies and keeping the rates at a reasonable level.

1.4 Problems and possible improvements

- **Prescaled HMS Singles, Open Trigger**
  To keep the dead time low the HMS singles were prescaled typically by a factor 4 to 8 and the idea of an open trigger was discarded. Thus the whole experiment had to rely on a properly working eN-coincidence trigger. The eN-coincidence trigger suffered from the huge rate from the neutron detector side. After the experiment we discovered that this trigger was affected by electronics deadtime, which is however not a problem for the calculation of asymmetries but also not something one is favourable of.
  The solution to this problem is a strict Open Trigger, i.e. no prescaling of the HMS singles. To keep the deadtime at a reasonable level it might be necessary to run the data acquisition in buffered mode. Buffered mode is not standard yet in Hall C and the DAQ people have to do some additional work and advertisement to make sure that everybody feels safe to run buffered.

- **Hot *B* line and Coincidence Trigger**
  A coincidence trigger should only serve diagnostic puposes and not be a hardware cut (see previous item). To avoid a coincidence between the electron and one hot B line one could alternatively think of several coincidences which are done with each bar plane or even each half plane. This would require additional electronic modules und change the timing. Additional NDET delay in form of cables would become

necessary.