Technical description of new MINIBALL DAQ

... draft (version 15.02.2017)

1 General considerations

- based on FEBEX frontend
  Xx bits / xxx Msamp/s per channel

- SAME(!!!) frontend / DAQ for MINIBALL, Si detectors, other detectors

- digital oscilloscope mode needed for checks
- possibility to write plain traces to disk

In order to enable any kind of recoil decay tagging you may think of, the EBIS will not trigger anymore the DAQ. In-beam selection is done in software later on. Since in contrast to stable beam facilities the duty cycle at HIE-ISOLDE is very low, we would write a lot of decay gammas .... if off-beam data are not needed some reduction may be desirable before saving the data to disk?

2 Firmware on FEBEX

2.1 MINIBALL
2.1.1 Ge detectors

- 24 x (6 segments +1 core) channels = 168
- rate: 10 kHz per core (in spill)

- digital filter for time / trigger for Ge signals: CFD or something better
  time resolution: 10-15 ns (FWHM) @ 1.3 MeV (^{60}Co lines)

What to do with the segments? At the moment, they don't trigger and are read out only if the core has fired ... against the philosophy of triggerless DAQ.

- pile-up rejection

- digital filter for energy for Ge signals
  energy resolution: 2 keV (FWHM) @ 1.3 MeV ... too optimistic?

- PSA for positions
  core: time of steepest slope, T30-T90, ...
  segments: net charge signals / transient signals (bipolr signals(!); require other trigger filter; which information may be useful ... maximum, time-to-maximum, ...???)
  We survived 15 years without PSA, so this has lower priority ...

2.1.2 AC shields

- X channels per triple cluster => 8 x X channels
- expected rates ... 10 kHz / (P/T≈20-30%) * efficiency (shield)
  .... better numbers from simulations done in Köln
- PMT signals (one or two per PMT ... probably one as no very fast timing required)
- digital filter for time / trigger for current signals from PMT
- digital filter for energy for current signals from PMT; requires integration / QCD emulation

Is the energy from the AC shields needed? Calorimetric properties of the AC shield are only limited and probably not of interest. Is there any idea to use the BGO as

standalone detector / calorimeter / mult filter without the heavymet (or W or whatsoever material) collimators?

The AC shields will run independently from the MINIBALL detectors, the Compton suppression will be done in software.

2.2 Si detectors
- digital filter for time / trigger for preamp-like Si signals
- digital filter for energy for preamp-like Si signals
... are needed for nearly all Si set-ups

2.2.1 CD
- 4 x (16+12 ...if we keep the 24 -> 12 mapping on the back side) = 112 channels
- count rate per segment xxx/s (in spill) for Coulex highest on inner rings

The CD in SPEDE and the plunger is the same(?).

2.2.2 C-REX
I assume that for Coulex still the "old" C-REX will be used not to damage the new T-REX by heavy ions.

Assuming that the MUXs have to be used for the CDs:

- a digital filter for shaped signals, hence a peak-sensing ADC, has to be implemented
- trigger / time will come as TFA-like signal ... could be treated with filter emulating LE or CFD
- position signal is more rectangular-like shaped ... peak-sensing ADC algorithm will do the job

If, as in 2016, the CDs are coupled together:
- 4 x 2 shaped signals
- 4 x 2 position signals
- 4 x time / trigger signals
- 4 x Si preamp or shaped signals from E-CD
Sum: 24 signals

However, the threshold has to be set manually (little yellow screw driver) or the remote interface of the MUX boxes needs to be connected to the slow control.

Barrel detectors:
- 4 x 16 Si preamp signals
- 4 x 1 preamp or shaped signal from backside of strip detector
Sum: 68 signals

Any other future solution using individual preamps for the CDs or adapting the ASIC board for the "new" T-REX to the "old" detectors, will change this.

As for the CD-only set-up the count rate is governed by the count rate of the innermost rings of the forward CD.

2.2.2 "old" T-REX
May not be used anymore with new DAQ. Differs from C-REX by doubling the barrel channels, adding E detectors for barrel (+ 8 channels) and CDs (2 x 4 channels).

2.2.3 "new" T-REX

Will have ASIC for (pre-amp, shaper, ADC), Special interface board to FEBEX under development (TU München). Anyway, inclusion in slow control is needed.

2.2.4 SPEDE
In addition to the CD (as 2.2.1) xxx channels from the electron detectors required
- digital filter for time / trigger
- digital filter for energy
... signals look the same like signals from the CD (Si detector) ... I guess.

Expected count rate for electrons???

2.3 Beam monitoring
- beam dump
  IC - Si telescope ... 2 energy channels; IC is slow, will require different parameters for digital filters
  Bragg detector ... requires full traces or a particular digital filter
- beam dump Ge detector(s)

Only for T-REX/C-REX chamber
- active collimator ... 4 channels ... particular signal shape
- diamond detector ... 9(+1 back side?) ... particular signal shape
... both read once at the end of an EBIS pulse .. hence, a triggered processing ... or a trace is taken for analysis in software later
Anyway, no topic with priority!

Other ideas ...
- use δ-electrons for beam profile in time
- detector for beam profile in space, similar to old PPAC, e.g. scintillating fibres

For all this not very well defined stuff, we should keep some channels free which may be used later.

2.4 Signals from HIE-ISOLDE
- proton pulse, super cycle
- beam gate signal (not yet used)
- EBIS pulse
- RILIS signals: Laser ON/OFF bit, or do we need / can we get some analogue information
- HF from accelerator: needed for TOF, 0° spectrometer, ...???
  200 MHz (have to look up number?) cannot be processed with FEBEX sampling frequency

- digital filter to obtain flag/bit from rectangular signal (NIM, TTL, ...)
- less than 10 channels, very low data rate (< 100 Hz)

2.5 LaBr$_3$
Number of detectors: now / future??
Data rate: ??
- digital filter for energy for PMT signals ... including integration / QCD
- digital filter for time / trigger for PMT signals ... LaBr$_3$ is pretty fast, problem caused by limitation given by sampling rate?

3 DAQ
... will replace MBS(?)

Total data rate ... MByte/s ???

4 Slow control

... based on MIDAS

GUI for running acquisition

- GUI for setting parameters (like ESONE now)
  enable / disable channels
  toggle list mode / traces
  set parameters
  data base with parameters for digital filters

- HV control
  HV for MINIBALL ... interface to filling system
  HV for Si's (or do we this by "hand" as for the Si's now)
  HV for other detectors, e.g. LaBr$_3$

I would guess we keep the filling system independent.

5 Online analysis

- will replace Marabou and many next-to-on-line analysis programs and scripts
- based on TDR / Grain

- energy calibration
- time alignment and calibration

- event building

- Compton suppression

- spectra
  scalers / rates
  energies
  time differences Ge - particles
  matrix time difference Ge - particle vs. Ge energy
  gating / fitting
  ….