A Small Data Acquisition System for the KOALA Experiment in Jülich

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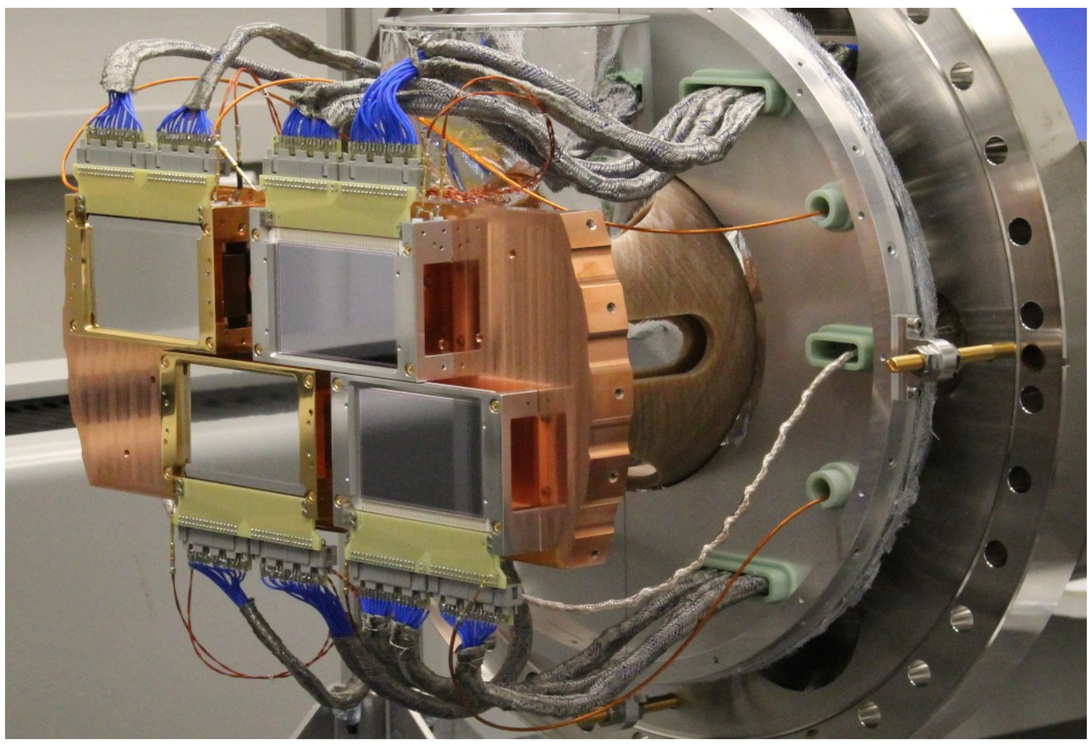
The KOALA (**K**ey experiment f**o**r P**A**NDA **L**uminosity determin**a**tion) experiment will be an independent experiment at HESR (Darmstadt) to measure antiproton-proton elastic scattering in order to gain the differential cross section which is a crucial input for the PANDA luminosity determination.
The KOALA experiment will measure the elastically scattered beam particles in forward area and recoil protons from the target near 90 degrees. One of the recoil detectors has been designed and built. It was installed and commissioned by measuring proton-proton elastic scattering at COSY in Jülich.
The data aquisition system is currently running with a small amount of channels (240 ADC, TDC and scaler channels, plus trigger and synchronisation logic).



Germanium and silicon strip detectors of one arm of the recoil detectors
(H. Xu, 2013)

Detector:

the final detector will consist of two arms perpendicular to the beam equipped with semiconductor detectors and one detector in forward direction.

Recoil Part:
- two arms for recoil protons (only one built up to now)
  each arm:
  - two germanium strip detectors (thickness 5 and 11 mm, pitch 1.2 mm, active area 80.4 x 50 mm)
  - two silicon strip detectors (thickness 1 and 1.2 mm, pitch 1.2 mm, active area 76.8 x 50 mm)
  - cooled between 70 and 300 K

Forward Part:
- possible use of the PANDA luminosity detector (in Jülich plastic scintillators were used instead)

Acquisition Hardware:

Analog Part:
- MESYTEC MPR16 (multichannel preamplifier)
- MESYTEC MSCF16 (shaping/timing amplifier + constant fraction discriminator)

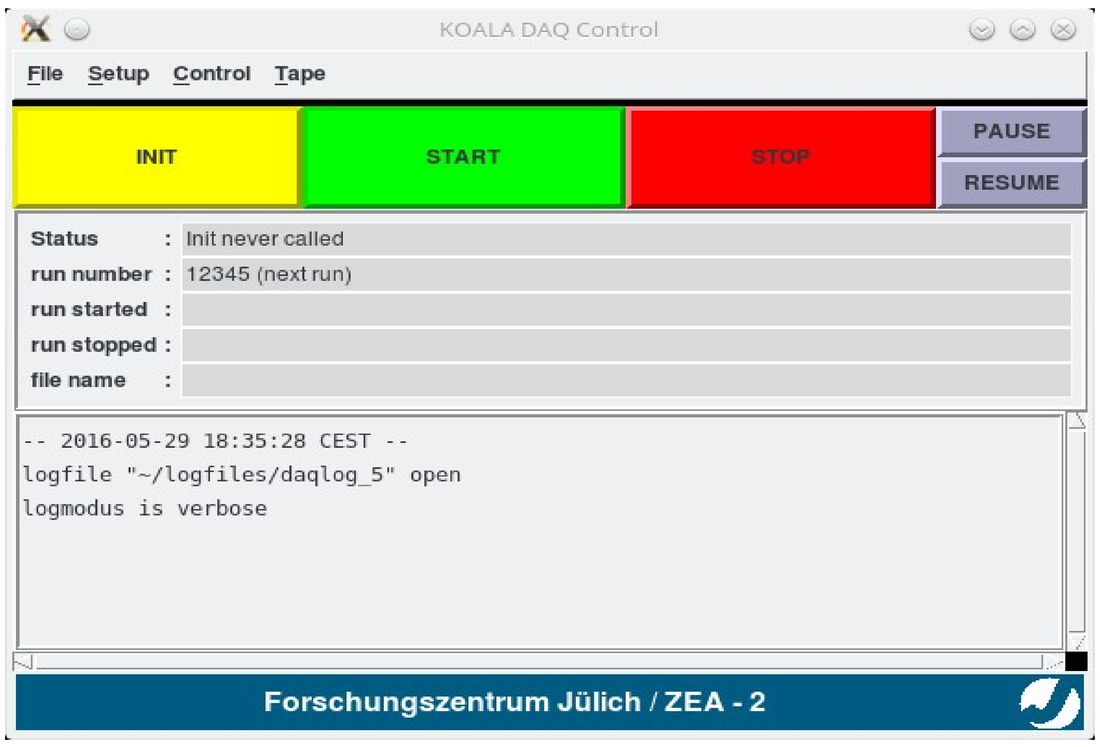
Digitisation:
- one single VME crate
- controller: SIS3100/SIS1100 combination
- MADC-32 (32 channel peak sensing ADC, six modules)
- MTDC-32 (32 channel TDC)
- MQDC-32 (32 channel charge integrating ADC with individual gates)
- SIS3820 (32 channel scaler)
- CAEN V1495 (multipurpose FPGA module; used for generating the trigger)

Acquisition Software

EMS (Experiment Message Specification)
- written in C, C++, TCL/TK
- actively enhanced since about 20 years and used for most major COSY experiments

Server Side:
- pure C (very portable!)
- code for all buses and modules used in the past years in COSY experiments

Client Side:
- arbitrary number of clients possible
- with or without graphical user interface
- very flexible setup (setup files written in TCL)



EMS control window; written in TCL/TK, using C and C++ libraries

Synchronisation:

The Plan:
- synchronisation (in theory) simply using the timestamps generated for each event in the acquisition modules
- internal clock counters use the 16 MHz VME clock
- starting the clock counters using VME multicast

The Reality:
- reset via VME multicast not working, switch to hardware reset not possible (because of insufficient time for development and testing)
- modules not reset at exactly the same time, therefore the timestamps of different modules have an (unknown) offset, varying from run to run
- in addition not all modules generate a (possibly empty) event for each trigger
- difficulties matching the timestamps of the diffent modules

The Solution:
- computing the time offsets for 'nearest' subevents regardless of correct matching
- using the median value of these offsets for reconstruction