AMANDA-II DAQ

- STATUS March 2001 -

- The current Setup / Muon-DAQ
- Summer-00/01 & New Features
- Status & Performance
- Future DAQ-Upgrade(s) $\longrightarrow$ Afternoon-Session
- Conclusions

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Setup as of March, 2001

- **Muon-Readout**
  - **B 1-10:** (302 OMs) 10 CamTDC-3377, 19 CamADC-7164
  - **B 11-19:** (378 OMs) 3 VMETDC-V693, 23 CamADC-7164
  - **Special:** (8 trigger + 19 OMs) 1 VMETDC-K32 (ADC, CamTDC)
  - **Total:**
    42 ADC-7164, 10 TDC-3377, 1 TDC-K32, 3 TDC-V693
    in 1 VME- and 4 CAMAC-Crates.
  - **VME-Counter:**
    for 16 trigger signals (SIS-3808) for deadtime-free monitoring.

- **DMAD:**

  3 Crates with 53 Discriminator Boards, remote-controlled.
  Extended debugging / measurements by Pavel/Jan/T.Feser/Marc.

  Trigger: Majority = 24, String-Trigger = 7/11 (6/9 B-4).

  Excluded are String-17, Up/Low section Str11-13, OM 444,509.

  In 2000:
  444,463,509=OFF, 11-13=ON (Up/low section were in trigger).

- **SuperNova (SN) System:**
  - VME-SN-1/2000: B-10, str14-16, str19. See Mainz-Talk.
  - New VME-SN-2/2001: all remaining OMs & some A-A.

- **CAN Bus:** logging Temperatures and Crate parameters.

  May be of use for transient feature analysis.

  See Torsten's Temperature plot for TDCV693-failure in March,2001...

Summer00/01 - Activities:

- VME-GPS tested and installed. GPS is correct from first Event.
- CAM-GPS upgraded for "rollover problem". First event still wrong, else ok. Perfect agreement with VME-GPS. (Rellen checks statistics.)
- Now 3 GPS-Clocks running: 2 CAMAC, 1 VME.
  In addition: 1 UNIX time (LYNX/VME-CPU, ntp synchronized).
- Absolute Calibration of VME- and CAMAC TDCs:

  VME-TDC - 1000/960 nsec/count
  CAM-TDC - 1nsec/count

  Done for all VME-TDC chips (4/board) and 1 CamTDC.

  TDC LongTerm drift is now monitored by "TDC-Calib events", which are at 0.1Hz in the data stream.
- VME-TDC debugging: V693 error diagnostics introduced.

  VME-V693TDC still give "wrong buffer structure" cases (1/few hours).
  Needs offline debugging 2000/2001; also present in for K32 in 98/99 !
  This may also be the reason for "misordered hits in TDC buff"
  (seen as "wrong" LE/TOTs in f2k, e.g. negative values !!).
- Introduced Downscaled low multiplicity events (as also in 1999), with $N \geq 4$. (Did someone looked at the 99-data ?)
- Re-Installed Rate-Monitoring via VME-Counter;
  True rates of all sub-triggers, and the true OR-rate of all.
  Rate of triggered events.

  The true deadtime is now directly measured in 2 ways:

  1. As counts per 1 sec intervall,

  2. Sampling number of lifetime windows within 1 sec intervall (100μsec resolution).

  Note: since 1999 we are running with Scaler rate measurements !
  Useful for independent and precision cross checks.
  They do not require stable DT-fit; and they exists for every second !

- New histograms online/ (and in reader offline):
  For TDC: Nedges/ Noverflow. Inclusive trigger rate for all bits.
- Installed new PC's as DAQ-Hosts.
  DAQ is running RedHat7 now, like all Pole-PC's.
- Hardware spare pool enlarged:
  2-3 Camac Crates spare,
  2 VME crates spare, ...

  !! ... need to order LECroy spares by March (June) ... !!
- Checked for mismapping, as found by T0-crew in 11/2000.
- Preliminary DAQ-Timing/Performance measurements done (see below).

Status / Performance

- Trigger rate $\sim$ 90 events/sec
  Data rate 100kB/sec
  Efficiency $\sim$ 80% (τ $\sim$2.2 msec).
- System is running stable, no serious maintenance interruptions so far.
- One V693TDC died in March (String 17-19).

  Same failure as 1 year ago (same strings read out !).

  MAPO temperature dropped at same time !

  Replaced by (the only) spare V693TDC.

  (Still have $\geq$ 4*K32 TDCs as spares.)
- Uptime / Data Quality: see Mainz monitoring report....

DAQ - A brief history

1997 DAQ developed from scratch by 3 “amateurs” in 6 months:
1 physicist & 2 undergraduates (Heiko,Steffen,Ralf).

Installed in Jan/Feb, 1998.

1998/99 Debugging/performance upgrade (St/R)

1999/00 New DMADD, new V693TDC, Timing Meas. (H/R)

Mainz-SN System with VME-PC/Linux (Marc)

2000/01 New F/E-Boards, upgrades/tests. (M/St/R)

Plan: Interrupt Control tests & Timing measurements (LagunaBeach).

$\Longrightarrow$ **Success:**

We have a stable, good performing and flexible system, with good online monitoring capabilities, when compared to the total nb. of man-years put into (since people worked hard, when working was possible).

$\Longrightarrow$ **Drawbacks:**

DAQ98 is an “expert system”, needs full assistence of developers (“system programmers”) for installation/ maintanence and also for minor upgrades.

Not very user-friendly, even in minor trouble situations.

Not well documented.

Difficult to get e.g. a small scale DAQ-system running for a new group (e.g. as laboratory test setup fro new harware development and pole preparations).

Timing / ReadOut-efficiency is not fully satisfacory for A-II now;
and fully inadequat for near future (expecting much higher data rates).

DAQ - Upgrade

- Decision depends on decision of A-II near future (next 1/2 years).
- Does AMANADA-II want a serious performance upgrade as standalone detector ?
- Does A-II wants to operate in coincidence with Part-of-Icecube, i.e. at much lower trigger threshold and higher rate: ≥ 10 times current rate at few percent deadtime ?
- How is the manpower situation:
  is there enough resources to continue the expensive “private system” approach, and at same time guarantee the longterm maintenace of the system from within the collaboration ?

  You need: 2 “system programmers” and 2 physicists (Not full time, but always fully available for summer seasons and upgrades).

DAQ - Timing measurements

- When designing the DAQ in 1997, we did
  - focus on highest speed components for all RO-parts:
    - Fastest Camac-VME solution: CBV-610 by GSI Darmstadt.
    - Fastest VME access VME-Controller: CES RIO-2.
    - A VME-Camac solution that is naturally "branchable" to smaller subsystems for parallelization.
      See DESY Proposal 1997 for all details
      (`http://www-zeuthen.desy.de/~ wischnew/amanda/daq.html`).
  - guarantee hardware compatibility with professional GSI-MBS DAQ.
- **Basic timing measurements :**
  - Single Camac W/R Cycle 2.3μsec; 2 byte (w/o Q/X response).
  - Single VME W/R Cycle 1.05μsec; 4 byte.
    The Mainz-board has 2-3μsec.
    So far, no faster VME-Controller is on the market !
  - A Camac access through Non-CES board (like Mainz VME-CPU) is at least $\sim$ 3 times longer than with CES-RIO-2, depending on memory mapping setup.
  - In 2/2001 achieved first measurement of RIO-2 Camac speed with STR725 adapter (avoiding VSB interface on RIO-2):
    For "same Crate" access **identical** with VSB-RIO-2 speed:
    $\sim$ 1μsec. Exception: Crate switch (memory-reload costs 14 μsec.)
    (Measruements done with Marc.)

DAQ - Timing

Where can readout time be lost ?

- Readout the Hardware:

  Camac: replace by VME compoments (if faster)

  VME: go to block transfer, use faster VME-controller (if exist)

  Parallelization.

- Data Handling/Transport

  - optimize the system (prioritize/ task switching/ use threads)

  - Minimize control and readout checks (compromise: safety)

  - CPU board performance (200...500Mhz)

  - CPU is inefficient due to concurrent processes: R/O polling of trigger board

- To quantify the event-wise RO-dynamics,
  we introduced in 2000 (Heiko/Ralf) the direct measurement of the true RO and Buffer time by double-usage of the CORBO-VME-Triggerboard (with its local 10 MHz clock).

  $\Longrightarrow$ we have the true readout for individual events

  (which may be interesting for Physics analysis as well !)

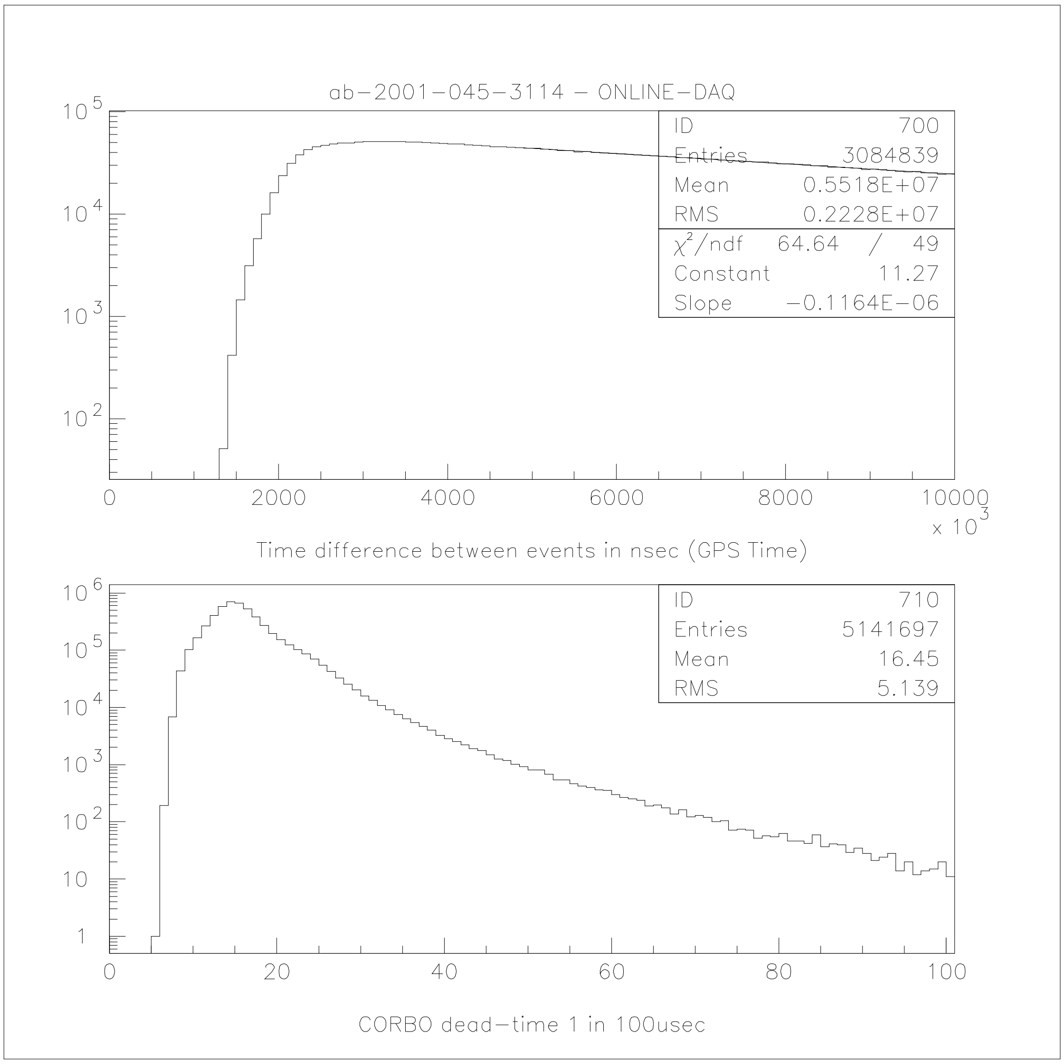

Figure: Time difference between events and CORBO-measured Readout time.

Consider the True Readout Time spend (before VETO is released), as measured by CORBO trigger board.
(True minimal deadtime is $\geq$200nsec larger, as seen from time-difference plots. Why ?)

Table: **Timing measurements (in μsec) with Muon DAQ**
Runs 3078-3084, Feb.2000.
Numbers below are approximate, since
(1) system load not kept constant (Majority set constant)
(2) event-header overhead gets larger for smaller event size
(3) hit-multiplicity is taken as average.
Columns:
- Total Readout Time (R/O tot) per event, in μsec
- Nb. of Channels (Nhits estimated)
- Total Readout Time per Hit-in-Channel, in μsec
- Hardware-Readout (calculated) (HardW-RO), in μsec.

Setup	RO-tot	Nchan	RO-tot/Nhit	HardW-RO
All Boards	1910	111	13.1	850
ADCs only	540	46	12	131
TDCs only	1340	68	14	600
CAM-TDCs only	920	36	18.2	470
VME-TDCs only	430	33	8.7	130

$\Longrightarrow$

1. Cam-TDCs take largest RO-part: 48%
2. ADCs take 28% , but highest processing part (75% of their RO time)
3. VME-TDC take a relatively large fraction. May be RO function may be streamlined (extensive RO-control), after long-term error-rate studied.
   Envisage BlockMode ?

4. Only 850μsec = 45% of total RO-time is due to Hardware Readout (Camac/VME). This number is estimated (average number of hits); it's true value can be different (Bus access, boards w/o ready, etc). But the picture will not change drastically.
   (Steffen got a detailed proposal how and what to measure: code changes, ...).
5. At the cost of safety checks during H/W-readout RO-time can be reduced, with some performance gain expected.
6. Where is the 900 μsec spend that is not true H/W readout ???

   Software overhead ?? Do transport task or Polling eat CPU time ?? Losses do to frequent task switches ?

Timing - Consequences

Following these preliminary estimates of the timing behaviour:

- TDC readout via more VME Channels reduces deadtime:

  500μsec (25%) reduction by swichting B-10 to full VME TDCs, i.e. when abandoning all the CAMAC TDCs.

- A simple parallelisation Camac vs. VME would only gain 430 μsecs of 1910 μsec (the VME-TDC time), with a serious programming and harwdare effort (1 extra CPU). This also assumes no deadtime generated in system software.

- Combined VME-TDC and parallelisation can give 50 % at maximum.

- Understand where the 0.9 msec/event is spend.

Multi Branch System (MBS)

- Is a fully developed "professional DAQ" by GSI,
  the German National Heavy Ion Accelarator Laboratory.
- It combines simplicity a la "labview" with the performance of a dedicated speed optimized system
  (to a level, that amateurs will hardly reach).
- Information ?
  - USER Manual (2000) 160 pages.
  - Reference Manual (2000) 180 pages.
  - `http://daq.gsi.de`
  - call any of the DAQ team there
  - Contact any of the 80 experiments currently using the system:

    45 at GSI, or go to

    LBL, INFN Catania, CERN, TU Darmstadt, Univ. Muenchen,

    Madrid, Freiburg, PTB Braunschweig,....

Conclusions

- DAQ works stable and "efficient".

  (Just as good as most AMANDA components.)
- We made a significant step compared to the 1996/97 DAQ.
- But the drawbacks of a "private developed sytem" are obvious:
  - Huge manpower effort for relatively small performance gain.
  - Permament availability of key persons is an issue;
    for running as well as for upgrades.
- Upgrade to an modestly upgraded A-II system is possible; but

  if a longterm future is foreseen with a serious performance (rate) improvement, then alternative solutions to the current DAQ should be discussed as well.
- The manpower put into DAQ so far was much below critical size !
  The whole list of tasks was done by a very small group:
  - hardware definition

  - implementation at pole and testing

  - check with data

  - responsible for mapping/special channels/ part of triggering

  - maintenance of DAQ software, including offline tools (reader)

  - hardware maintenance, ...

- Now, with an upcoming partial switch to new "DAQ crew members" the manpower issue should be faced from the very beginning.
  You need
  - For the **"Amanda self-made" DAQ:**
    2 software engineers (long-term available !), **and**
    2 "physicists" (half-time).
  - For a **"professional" system a la MBS-DAQ/GSI:**
    2 "physicists" (half-time).
    The overall effort is much reduced at significant performance gain.