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Specification and Usage of the TiMon rate server in the Calorimeter Eventbuilder

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Abstract

The SpaCal cell rates are measured continously and independently from the main readout for the H1 Central DAQ by a Macintosh program (TiMon), which uses the scalers in the SCM and THM modules of the SpaCal TDC system, which have been foreseen for monitoring purposes. The TiMon program writes the acquired rates back into a VIC memory, which is accessible for the main Calorimeter DAQ via VME. Thus they can be read out by the Eventbuilder of the Calorimeter ADC branch and fed into the Central DAQ datastream as well as distributed to other clients.

This note describes the setup and focusses on the client-server protocol for the luminosity rate display, which interfaces important measured H1 rates to the HERA shiftcrew on a graphical display with the possibility of history logging and retreiving. It is meant to be a documentation of the processes, which are involved, and to give a hand to experts, who might want to modify details of the selected rates later.

1 H1 SpaCal TDC system

The H1 experiment contains a Spaghetti Calorimeter (SpaCal) [1] in its backward part, which is designed for the precision measurement of scattered electrons or positrons. Furthermore, this subdetector provides a very precise time measurement with a resolution below 1 ns. For monitoring purposes, the signals of each SpaCal cell can be counted without influence on the actual time or energy measurement for the H1 physics datataking. This monitoring task is performed on a Macintosh in the H1 control room by the TiMon program.
Since April 2002, the monitoring program writes the measured cell rates partially back into VME memory, from where the Calorimeter Eventbuilder for the ADC branch (CDAQ branch #3) can read them back and distribute them into the main datastream as well as to any TCP/IP client through a dedicated server process, which is running with low priority on the LynxOS system of the Eventbuilder.

2 Dataflow

The hardware setup is sketched in fig. 1. The TiMon Macintosh reads the scalers of the THM [9] boards (Crate #0 and Crate #1) and the SCM [8] board (Crate #0 only) regularly for monitoring purposes and displays the results on its screen. The complete system is described in the references [6-9]; the relevant functions for the mechanisms described in this note are:

SCM: overall scaling (HClk) and eventual selection of specific trigger bit pattern

THM: scaling of CFD input pulses to the TDC modules by one scaler per group of sixteen SpaCal channels respectively (for details see sec. 3).

The access to VME is happening through a MacVEE interface. The VIC memory of TDC Crate #0 is used for data exchange with the CaloDAQ EventBuilder. The VICs of the TDC Crates are also used for online datataking through the eventbuilder, which is their primary purpose. They are mounted on a VICbus together with the DSP crates and other hardware of the ADC Calorimetry branch.

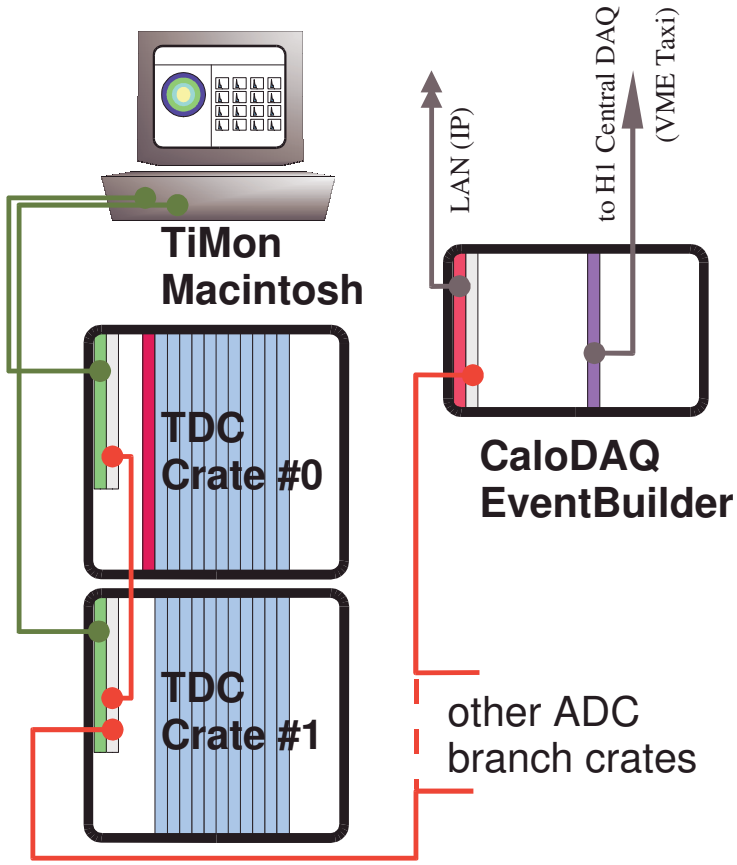

Figure 1: Data Connections between the TDC system (TDC Crate #0 with 11 THM modules, 1 SCM module; TDC Crate #1 with 11 THM modules) , the TiMon Macintosh and the CaloDAQ EventBuilder for the ADC branch.

The EventBuilder crate contains the VIC master for the VICbus. The readout is performed on a RIO2 board with a 400 MHz PPC, which has a 100BaseT interface to Ethernet on board. Online datataking delivers data to the Central data aqcuisition system of H1 through a VmeTaxi board, which is an element of a glass fiber ring for data transfer.

3 TDC Scaler Readout, Data Contents and Restrictions

TiMon Procedure

The SpaCal contains 1300 photomultipliers after the HERA-II up(down)grade. One of the 22 THM modules receives the signals of up to 64 SpaCal channels. Due to hardware constraints, there are however only four scalers on one THM board as monitoring counters. Thus one scaler can count all or part of its 16 associated channels. The selection can be done in full flexibility through a 16 bit mask. The TiMon

monitoring procedure works as follows:

1. Set mask for channel #0 of each THM scaler, thus selecting 88 different SpaCal channels.
2. Count the rates of these 88 channels for a given laps of time, which can be adjusted in the TiMon program (expert options).
3. Set the mask to count all channels in each scaler (0xFFFF), thus effectively summing 16 channels.
4. Count the summed rates for the same laps of time as in 2.
5. Set the mask to channel #1 of each THM scaler.
6. Count these 88 channels.
7. ... (Count channels #2-#15 in the same way, with interleaved sum counting.) ...
8. Update the data structures of TiMon.
9. Display the updated data.
10. Go back to 1

A typical time constant for the individual counting periods is 0.5 to 1 s. Hence, individual channels are updated with a turnaround time of the order of 10^1 s, whereas sums of 16 channels are updated on a per second basis, which had been requested by the HERA operation staff.

Mapping

About a dozen different numbering schemes are necessary to describe the SpaCal hardware in all respects. Therefore we give here a short summary of the mapping from THM channels to the geometric position of the SpaCal cells in the region around the beampipe. The TiMon program presently only copies summed scaler values into the VIC memory. Hence we restrict to the mapping of the sum modules.

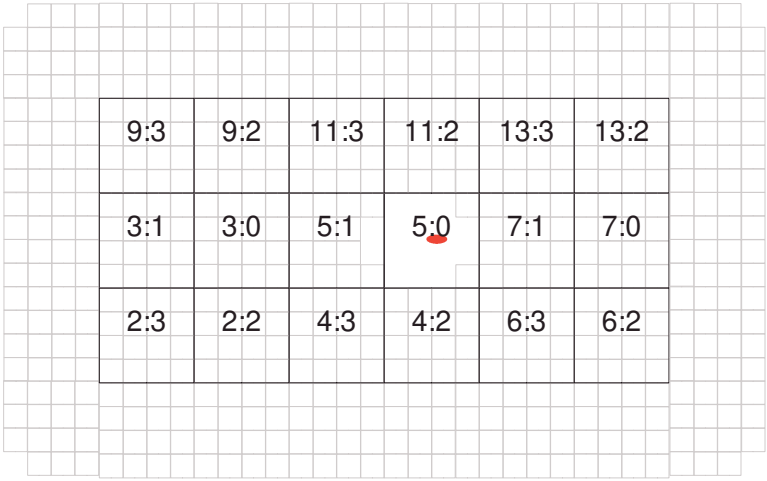

Figure 2: SpaCal cells around the beam ellipse. A total of 16 cells are missing in the regular pattern around the beam spot, which leads to a certain asymmetry in the summing scheme of the rates. Numbers in the big overlayed squares indicate the THM module and the scaler within a given THM module.

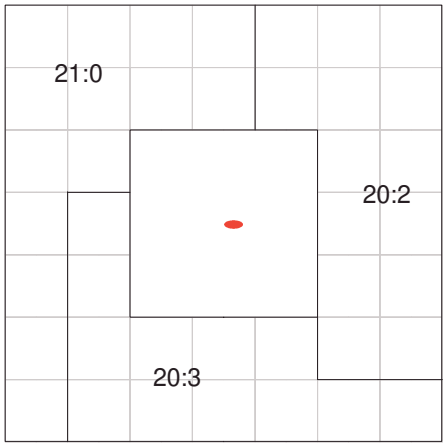

Figure 3: SpaCal cells of the hadronic section around the beam ellipse. The geometric association doesn't contain any symmetry.

As explained in the previous paragraph, one THM module contains four scalers. Each of them is specified by an expression of the form

TH:SC

where TH is the THM module number and SC runs from 0 to 3 and designates the scalers for the sumsof channels 0-15, 16-31, 32-47 and 48-63 respectively. Fig. 2 shows the association of SpaCal cells in the electromagnetic part into the different THM scalers; fig. 3 contains the corresponding mapping for the hadronic part.

4 Server Architecture

A server for the redistribution of the TiMon rate data has been designed following the specifications, which were already in use by the H1 Lumi Server. The timonsrv process on ambon.desy.de performs the following tasks:

Bind socket 2060 and listen for connections,
allow up to three clients to connect,
on request, read the rates copy of the VIC memory,
send the result back to the client.

The source code of the server is maintened in the CaloDAQ-CVS under the project name `calodaq/timonsrv`.

Protocol specification

The protocol for requesting the SpaCal sum rates consists of a simple exchange of two messages. The notation of the C programming language is used for the description of text strings and special characters.

Client request

After or while being connected to the port `ambon:2060`, the client sends a request

```
"spacalrates\n"
```

The complete request has to be sent coherently, because the server doesn't accept fragmented request, i. e. it doesn't compose several datachunks to form a request. If this turns out to be a problem, it will be changed later.

A client can stay connected to the server and issue several requests. Note however that there is a maximum number of clients, which are accepted simultaneously.

The actual text of the request is presently not decoded. Any text which is terminated by a newline character will do the job.

The server will react within one second to each connected client. In order to keep the load on the EventBuilder low, the server process has however a lower priority than the DAQ tasks, which can lead to delays.

Server response

After being scheduled, the server will access the VME for the readout of the present copy of rates in the VIC memory. Then it sends the request confirmation string

```
"spacalrates 352\n"
```

which contains also the size (in bytes) of the following data.

The text will reproduce *exactly* the text of the request message. As the actual content is not checked (see client request specification above), be careful to send what you expect or expect what you send. In any case, do not to send a request containing space characters, for they are used as a separator as follows:

A space character after the confirmation text separates the following indication of the data length in bytes. For this server, the length is constantly `sizeof(float)*88 = 4 * 88 = 352`.

As for the request, the character string is terminated by a newline character.

The request confirmation is followed by 88 floating point values. The binary representation of the floating point number originates from the C++ program on Macintosh and is compatible with PPC and Sun. Therefore it should be comptible with Java. But the more commonly used Intel CPUs with Linux or Windows do have a different native format!

Data come for the THM modules as follows:

THM 00:00	THM 00:01	THM 00:02	THM 00:03
THM 01:00	THM 01:01	THM 01:02	THM 01:03
THM 02:00	THM 02:01	...	
THM 03:00	...		
...			
THM 21:00			

The arrows indicate the order of the data, starting with the beginning of the stream after the confirmation text. Only few of them are probably helpful for beam tuning. But any combination, sum, difference or ratio can be used by any application for any monitoring purpose. Refer to section 3 for the geometrical mapping of the channels.

5 Client Applications: Debug Programs and H1/HERA Display

Three applications have been programmed for reading and displaying the SpaCal rates. Two of them are not recommended for non-experts and serve especially for debugging and as a model for similar TCP/IP clients. The latest, but most important application is embedded in the H1 Java Lumi Client Applet, which is accessible at the address

`http://h1lumiserver.desy.de:8080/main/h1mon.html`

or the corresponding link from the “H1 shiftcrew tools web page”. It uses the sums 5:1, 7:1, 11:2, 4:2 (cf. fig. 2) in order to evaluate the four main directions and is described in the following paragraph, whereas the other two applications are mentioned only for reference lateron.

SpaCal Rate Display in the H1 Lumi Client Applet

A Java applet for H1 luminosity rates and HERA machine optimization can be started in a browser like Netscape from the address given above. Among a variety of different displays, the SpaCal rates, which are the subject of this note can be displayed by activating the the menues

Trends • Rates • SpaCal left-right or Trends • Rates • SpaCal top-bottom

respectively.

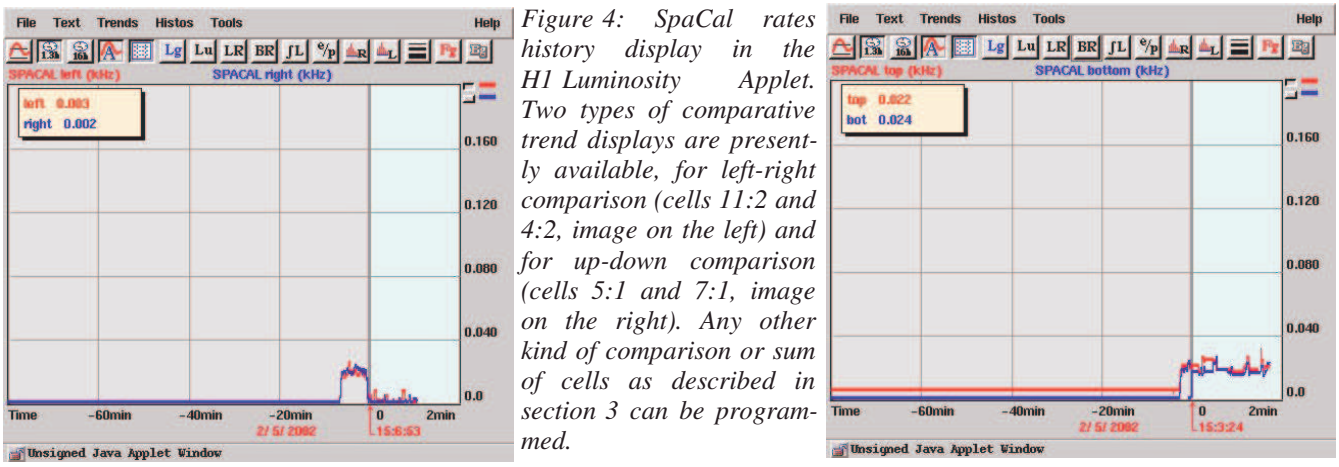

Figure 4: SpaCal rates history display in the H1 Luminosity Applet. Two types of comparative trend displays are presently available, for left-right comparison (cells 11:2 and 4:2, image on the left) and for up-down comparison (cells 5:1 and 7:1, image on the right). Any other kind of comparison or sum of cells as described in section 3 can be programmed.

This applet launches a thread, which becomes the TCP/IP client of the rate server, as has been described in the previous section. If a read failure occurs in the socket communication, it tries to connect again to the server as long as the display is visible. Thus it is immune against server reboots (which are CaloDAQ Eventbuilder reboots in fact).

Some words on the vertiacl scale adjustment, which is not obvious to novices, have to be written here: In order to make changes of the vertical scale (rate minimum and maximum on display), press first the left most button (“mouse drag control”) in the display, if it is not yet in this position. Then adjust the scale with the mouse and the left mouse button as follows:

1. Select the curve for which you want to modify the scale (blue or red) with the buttons above the ordinate labels.
2. Click in the diagram. If you hit the upper half, you modify the upper limit (maximum), if you hit the lower half, you modify the lower limit (minimum) of the ordinate scale.
3. Whatever value you decided to change, it will be displayed as long as you hold the mouse button down. The place where you clicked represents the original minimum or maximum. Moving up or down will raise and lower this limit respectively. Releasing the button will validate it for display.

Debug and Expert Clients

VME access and updates of the VIC memory can be checked through the program `timonv` on ambon. For users without a home directory or login on this machine, there is a special account (login: timon, password available from DH on request), which allows to execute only this command in the permanent-update mode. Otherwise it can display once all TiMon rates, which have been presently copied into the VIC memory. The permanent-update mode refreshes the rates of the four main directions (cf. previous subsection or next paragraph) on the screen. They are displayed as follows:

```
H1 SpaCal rates around beampipe (text interface - preferredly use graphics!)
   Dirk Hoffmann - CPPM, April 2002
_____________________________________________________________________________

                        5.42 Hz

                          Y ^
          5.42 Hz           + > X           3.61 Hz


                        5.42 Hz
```

The x and y axes are symbolised by characters, and the rate values are arranged at the appropriate places around them. On some terminals with weak cursor steering capabilities, the refresh may not work correctly and the updates will scroll over the screen instead. As a very rudimentary tool, this program is helpful for debug of higher level tools.

A graphical Perl/Tk interface is available, which displays the rates of the four principal cells, 11:2 (up), 4:2 (down), 5:1 (left, □*x*) and 7:1 (right, □*x*) as arrows in real time with an update cycle of little more than one second. The arrows become red, if they exceed the preselected scale. The scale can be adjusted with the slider bar below the arrow cross by steps of tenth of logarithms to the base of 10, thus varying over a range from $10^{0.0}$ = 1 Hz to $10^{5.0}$ = 100 kHz by step factors of $10^{0.1} \approx 1.26$ approximately.

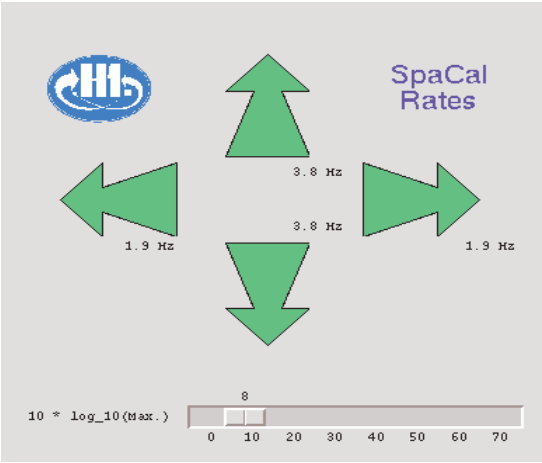

Figure 5: Graphical SpaCal rates display for debug purpose. The length of the arrows is proportional to the measured rate in each direction. The maximum length is determined by the scale.
Scale adjustement is made with the slider bar in steps of tens of ten-logarithms (see text). The higher the scale (maximum), the shorter the arrows will become.Arrows which exceed the maximum are displayed in red.

Hence a value of 50 means 10^5 = 10kHz for the biggest validly displayed arrow. The higher the scale value is choosen, the shorter the arrows will become.

6 Conclusion, Prospects

A real time rate display for the H1 SpaCal rates has been designed and implemented in record time. This was possible due to the modular (object oriented) design and extensibility of the two end members of the chain, the THM-DAQ (better known as TiMonApp) with the VIC interface and the Lumi Rate Display with the Client/Server socket interface. A unified database for all H1 Luminosity Rates, which will allow to correlate and compare any rates in time is being prepared at the time of writing of this note.

7 Acknowledgements

Warm thanks go to Murrough Landon, who implemented the necessary changes in the TiMon program in a minimal time. We would also like to thank Benno List and Daniel Pitzl for pushing the initial idea to the final concept within one day, allowing for the implementation in almost less than one week.

8 Bibliography

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Further documents on upgrade under `https://www-h1.desy.de/idet/icalo/daq/` in internal H1 webpages

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