A Users Guide
for the DAQ operator

The Experts

April 28, 2025 - 16:22

Contents

Part I.

Daily News for the Operator

2024/03/08

- If you have a problem immediately after DAQ restart, and a second try doesn't help: First fix the SEU problems reported (i.e. MDC 1/2 resync, RICH, RPC, ECal reboot).
- If a board in MDC is missing: Missing boards with a 0x8e7* and 0xa7** address currently can't be solved by a 'resync'. If a DAQ restart doesn't help, use "MDC 34 LV" -> "211x" instead.
- If MDC board 0x8e7b or 0xa7b* makes continuous trouble, contact the DAQ or MDC expert.
- If any **"reload" script produces several errors**, don't wait for it to finish, just close it. Try doing a power cycle of the problematic subsystem instead. An expert could try some manual reloads as well.
- If a box in the **tactical overview is white** while everything is running, just "Restart Hmon".

Part II.
General Advice

1. Main Tasks

- Operate the data acquisition, mainly using the Control GUI.
- Monitor the status of the whole system, mainly using the Tactical Overview.
- Monitor some detailed performance data using the Hmon Plots (see ”the main windows“).
- Make entries to the logbook about configuration changes and important issues.
- Monitor the beam quality, e.g. its intensity and position.

2. General To-Do’s

- Don’t hesitate to **call the professional / expert** if there is a problem you can’t solve or you don’t fully understand!
- Almost **everything can be accessed** from the web page (`http://hades33/mon` and the Control GUI (icon on desktop)
- At the end of the shift, make a summary entry in the logbook about DAQ issues. To take notes during shift, there is a **paper logbook** you can use to keep track of minor issues or error statistics.
- The DAQ operator should always be present in the **Mumble channel** “Operators Corner” - DAQi will provide some audible (sometimes even recognizable) hints if something is wrong.
- If you notice something noteworthy in the monitoring, use the **“Hmon Snapshot”** button to store the current plots for later analysis.

2.1. DAQ Shifts

- Your first shift should be one of the day shifts, not a night shift. During the day availability of experts is better, so you can get more help.
- Before your first shift, you are asked to stay in the counting house for one shift as a ”trainee“, together with another operator. This is necessary to learn how the system looks like, how errors show up and how to get to the right procedure to solve them.
- There will always be a DAQ expert or DAQ professional on call. We’ll try to arrange shifts in a way that a knowledgeable operator is ”close by“ (e.g. online) for new operators.
- If you do a remote shift (e.g. during a cosmics run), make sure you have access to the DAQ VNC (hades70:1) and the main web server (`http://hades33/mon`). Access from outside GSI needs an SSH tunnel made with your account. Some hints are listed here.

2.2. Workspace Setup

The DAQ and QA corner in the counting house has 3 computers with 4 screens each. The right one is dedicated to QA, the other two to the DAQ.

DAQ Left All main windows can be opened using the icon "DAQ Screens LEFT" on the desktop. The machine also runs Mumble for communication and for DAQ error messages.

DAQ Right All main windows can be opened using the icon "DAQ Screens RIGHT" on the desktop.

QA There's an icon on the screen to open the main windows for QA and Vertex reconstruction. On the QA window (VNC) there are more icons: to start the two QA processes and to conveniently arrange windows.

- Closing, opening and arranging windows will take up to 20 seconds. Please be patient.
- If you open a browser for your own browsing, make sure you never select the "DaqOnly" profiles. These are reserved for the DAQ windows. Do not reuse any of the DAQ windows.
- Make sure your own windows don't overlap the default monitoring windows and hide important information.
- Before you open new windows, please check if they are already open.

3. More Remarks

(Please read these once you got a bit familiar with the system)

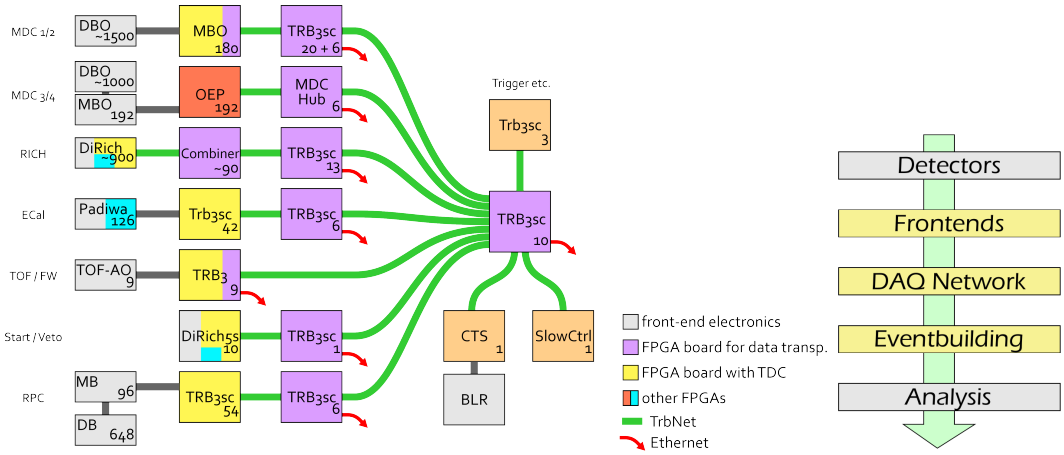
- **Before making changes** to configuration or doing a power cycle, don't forget to stop triggering (Start Stop Trigger) to prevent corrupted data from being recorded.
- Whenever there is a **beam pause** of more than 2-3 minutes, switch eventbuilders to "No Files". When beam comes back, check in the EB Summary monitor that all building nodes are still active after switching back to "beam" files.
- **If one board is missing, do not panic!** Do not risk many seconds of possible data taking for one missing board. As a rough guide 2 MDC and/or 4 RICH boards missing is acceptable. If a board goes missing after an hour of data taking, you can restart the DAQ, but don't do it too often in case of frequent failures.
- Please don't do any power cycle without asking an expert – unless it is explicitly stated in the manual or help texts.
- Whenever possible, but at least once a day, when there is a break >15 minutes, a **full restart** of the system should be performed. Talk to the DAQ expert for this!
- Please **keep an eye on the rate plots** ("Main Screen 4" on the web page). If you notice any asymmetry between sectors / parts of detectors, try to do a reload of thresholds for the detector. If this doesn't help, talk to the detector expert, e.g. a power cycle of the frontends might be necessary.

  - e.g. in ECal a row of 8 green dots appear (-> ECal Padiwa Powercycle)
  - e.g. in TOF one sector has a lower/higher rate (-> Thresholds TOF)

  Special attention is needed after a power cycle!
- Actions should be done in the right order of severity, as shown in the next section. In particular:
  - In most cases a **reboot of a subsystem is the better option** compared to a power cycle. If all boards of a subsystem are present, do a reboot, but not a power cycle. Check the missing endpoints - **if the boards you want to reboot are missing, it won't work** (apart from MDC).
  - Some actions can be done **without a DAQ restart**:
    * All actions from the "Settings" column can be done while DAQ is running
    * All "Reboot" and "Powercycle" requires you to stop trigger before, load thresholds after and start trigger again.
  - After a break, **Eventbuilders need some time to recover**. Wait a bit and don't try to reset them more than once per minute.

4. System Structure

There are two major building blocks that need to be treated separately: The DAQ electronics in the cave and the event builders (computers in the counting house). Problems with event builders and the computer network can usually be summarized as some or all data is not written into files, while all other problems mostly come from problems in the data acquisition hardware.



Structure of DAQ - red arrows point towards the eventbuilder computers. Right: simplified data flow view

For every problem that occurs, the troubleshooting follows an escalation pattern that ranges from the least possible and quickest intervention to a complete restart of the entire system.

1. A few problems can be solved on the fly: Minor hiccups, or threshold settings. These are typically solved within a second.

2. Many issues can be solved with a DAQ restart - reconfiguring and resetting the whole set of DAQ electronics in the cave. This typically takes about 30 seconds.

3. Rebooting parts of the electronics. Sometimes it is necessary to restart the electronics to get them into a clean state again (e.g. caused by radiation effects). For most systems this takes another 10 seconds before a DAQ restart, but old systems like MDC and CTS need several minutes for this.

4. Powercycling of the electronics. If communication failed boards can't be commanded to reboot, so a power cycle is needed. For most systems this takes about 10 seconds, but MDC again takes longer and needs some aftercare until all boards are back in a working state.

5. The last step is the full power cycle - a set of instructions switching down most of the system and powering it up again. This might take 10 minutes.

Obviously, the more severe actions should be avoided as much as possible.

For eventbuilders a similar scheme applies when they fail to write complete events to disk. This often happens directly after a DAQ restart.

1. Wait a bit. Sometimes (especially at trigger rates below 50 Hz or above 20 kHz) it can take half a minute until all buffers are synchronized again and events can be built.
2. "Reset EB" can help to speed up the process by dropping existing buffers. Use it after $\sim$20 seconds of waiting.
3. "Restart EB" will restart the software - this will take a minute and is usually not necessary.
4. "Restart BNet control" is the more severe action - restarting the main controller of the event builders.

Part III.
Control and Monitoring

5. DAQ control window

Update for 01.2024

Most control tasks can be done using the DAQ Control GUI, only few actions need access to other tools.

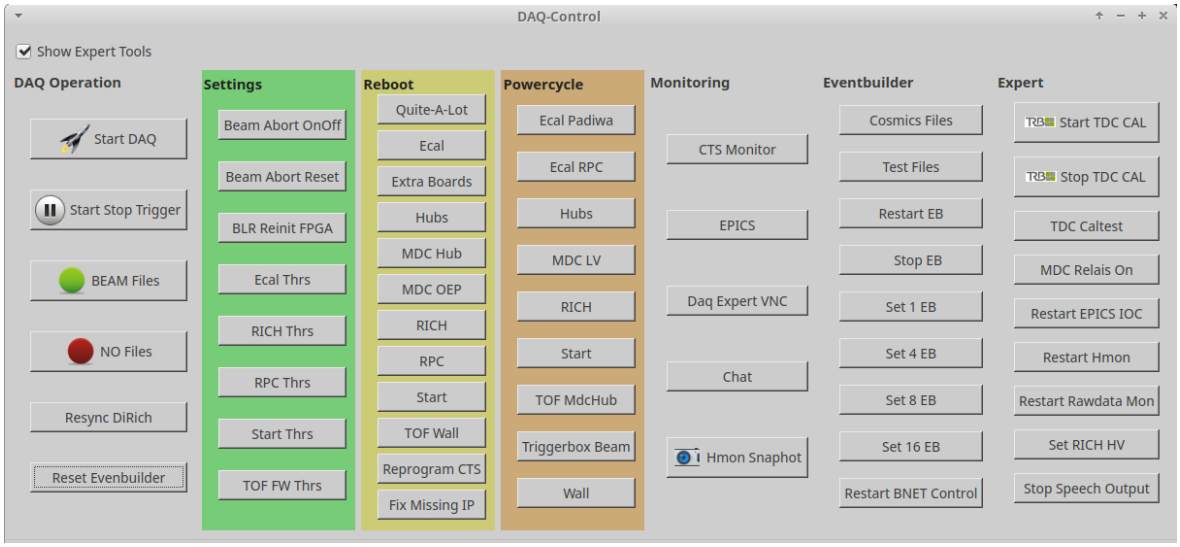


Figure 1: DAQ Control Window

DAQ Operation

These are the main buttons to start data taking and to recover from minor problems.

Start DAQ The main script to restart the DAQ. Standard solution if some problems appear (red blinking).

Start Stop Trigger Interrupt sending triggers to stop data taking for a while

BEAM files Start recording files triggered with accelerator beam. These appear with prefix ”BE” in eventbuilder monitor and are accounted in the runtime database (logbook).

NO FILE Stop recording any kind of file. This will close previous files. Note that eventbuilders are not stopped by this, but continue running without writing files. However, the QA and raw DAQ monitoring clients are still delivered with data in this state.

Reset EB Resets the eventbuilder, e.g. empties all buffers.

Resync DiRich Tries to recover failing RICH front-ends

Settings

All these buttons will not interrupt data taking. You can use them while the system is running.

Beam Abort OnOff Toggles the beam-abort (in-)active

Beam Abort Reset Reset the beam abort error message in the tactical overview

BLR Reinit FPGA Reconfigures the analog trigger collection board from TOF / RPC. Use when rates in the CTS from TOF/RPC or M2 are wrong.

XXX Thrs Reload thresholds for the named detector. Use if something seems to be wrong with frontend settings

Reboot

All these buttons will interrupt data taking, but their execution only takes a few seconds. These buttons will automatically stop the trigger. A DAQ restart is needed afterwards.

Reprogram CTS Reprograms the CTS with its firmware

Fix missing IP Sometimes some boards lose their network connection. This checks for the issue and reboots them selectively.

MDC OEP Special reboot procedure for MDC front-ends - takes a while, should only be used if necessary

XXX Reboots FPGA boards of the named system. Only affects boards that are currently online (not "missing endpoints"), takes just a few seconds.

Quite-A-Lot Combines the reboots done by Ecal, RICH, RPC, Start, TOF buttons.

Powercycle

All these buttons will switch power to a part of the detector first off and then on again. These buttons will automatically stop the trigger. A DAQ restart is needed afterwards. Check 11 for more details. This section offers buttons to cycle the low voltage supplies of several detector systems. These are convenience shortcuts to avoid operations on the full detector control system GUI. Be aware that some powercycles need to deactivate the beam abort (cf. 1), you need to enable the beam abort manually afterwards again. A power cycle may be necessary in some situations to reset the DAQ front-end boards.
MDC LV opens a new window to cycle the electronics of an individual chamber.

Monitoring

CTS Monitor The monitor for CTS settings and scalers. One instance should be open for experts, but usually not needed by the operator

Epics Opens a VNC with the EPICS control for power supplies and links to other detector controls mainly for experts

Daq Expert VNC This VNC is typically used by experts to remotely control the system. In the control room only used to see actions by the expert.

Chat A terminal based chat window, not used during beam time

Hmon Snapshot Creates a copy of all plots and windows in Hmon for documentation

Eventbuilder

COSMICS files Start recording files triggered without beam by cosmic radiation. These appear with prefix ”CO” in eventbuilder monitor and are accounted in the runtime database (logbook).

TEST file Start recording any kind of test files. These appear with prefix ”TE” in eventbuilder monitor and are NOT accounted in the runtime database. Test files are not stored permanently on Lustre!

Restart EB Start eventbuilders again (with most recent settings). It needs to be followed by clicking ”BEAM file” (or ”TEST file” or whatever) to start recording data again.

Stop EB Stop eventbuilders, i.e. kill all EB processes. To stop data taking, use "No Files" instead. For expert and testing purpose only!

Set N EB Sets the number of running instances of eventbuilders and restart the building network with the new configuration. Change only on request. E.g. 1 EB for cosmics, 16 EB for beam data.

Restart BNET Control Restart the DABC master process that controls the building network (BNET). This process also delivers the eventbuilder monitoring at http://hades33/eb

Expert Tools

This section is visible only when the ”Show Expert Tools” box on the upper left corner is ticked.

Start TDC CAL Start calibration run for the trb3 TDCs. This will disable the regular CTS trigger inputs and send special calibration events with a 500 Hz pulser. At the same time, the eventbuilders will record files of prefix ”TC”.

Stop TDC CAL Stop the calibration run for trb3 TDCs that was started with the above button. This button has to be pressed when all DAQ input subsystems shown in the eventbuilder input nodes have turned from blue to green color. On pressing, the ”TC” files are stopped and the new calibration is used for the next data taking runs. For more info see sec. 20.

TDC Caltest Records a file with calibration triggers to test current calibration. Will be stopped automatically after 30 seconds. **Note: do not stop data taking manually during the calibration test!** Otherwise the calibration test analysis (displayed on http://hades66:8092 and in Hmon *TdcCalMon*) will not be started properly.

MDC Relais On Makes sure electronics in all MDC chambers are powered. Use if one complete chamber is missing or an error is shown in "MDC LV Status".

Restart Hmon use to activate changes in main monitoring

Restart EPICS IOC Restarts main parts of the detector control system (DCS, IOC, EPICS). Use with care, it will affect all controls, e.g. HV, for several minutes.

Set RICH HV Switches on all RICH HV lines and sets all HV modules to the correct supply voltage setting. If only one module is already switched on, this button will ramp down all HV modules instead. During ramp up keep an eye on hades33/mon/monitor.cgi?6-RichRatev2 maximum rate should not exceed 1 MHz for longer times

Stop Speech Output Silence speech output of DAQ issues - please use only during longer, planned breaks

6. Tactical Overview

Figure 2: Tactical Overview

The Tactical Overview gives a comprehensive view of the status of the DAQ system. During normal operation all fields should be green indicating a normal status. Colors change as errors get more severe (green - yellow - orange - red - red blinking).

Hovering the mouse over a field shows more details, and a click opens a window with some further information and troubleshooting advice.

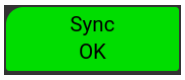
Please note:

- Under certain conditions (e.g. one subsystem not working perfectly, no beam or cosmics data taking) not everything will be green. Try to memorize the pattern to find out if anything changes during the run.
- Not all colors are working perfectly. Some vary between error and good states - this can be either acceptable or not. Check the documentation of each field to see which applies.
- Note the special colors: black - unused field. white - failure of script. olive - acknowledged non-perfect condition.
- Often several errors appear at once - you'll have to find out what is the cause and what is just a result. Some help texts tell you to "look elsewhere". Eventbuilder problems can't be fixed while there is a DAQ problem.

- Errors are often listed with the network address of the corresponding front-end board. Check the table of addresses [17] to find out which subsystem it belongs to.

- The error handling guides are usually written to be executed step by step. If the system is back to normal, there is no need to do the remaining steps (but be sure to read the full text either way).

6.1. Some important boxes



If the DAQ doesn't run, usually several boxes get red or red flashing which seems to indicate a huge problem. The "sync" box near the top right is important: If a board from RICH shows up, the problem can be solved very quickly ("Resync DiRich").

The running status of event building.

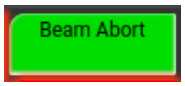
1. Number of running input and builder nodes (5/1 for cosmics, 5/16 for beam) and the type of file written (e.g. "be" for beam files). Make sure this shows the right file type

2. Event rate as seen by DAQ compared to EB. These numbers will always be slightly different (buffers, integration time) but should be mostly identical. Note the long averaging time.

3. Amount of data written to disk and average event size. Shows 0 if no files are written.

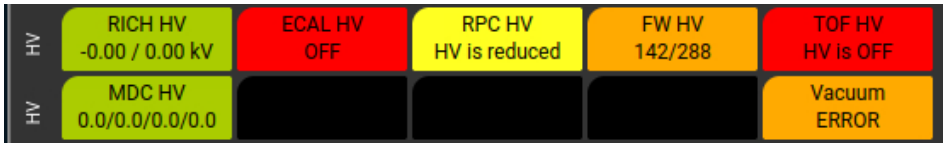
4. Events lost in the eventbuilders. Should be less than 1% of all events.

Error colors might change quickly between good and bad - make sure to check the issue and don't assume that there is no problem.



Make sure that the beam abort system is turned on when there is beam in the cave. Disable it before doing a power cycle of CTS or RPC. If beam abort is triggered, call accelerator staff.

Sometimes boards get hit by radiation which causes their configuration to change. This button is monitoring the number of those so called single event upsets. They can usually be removed by re-booting the corresponding detector. Many SEUs are not immediately harmful and it is better to keep the DAQ running if it is stable. Action should be taken if this button turns orange/red or if a high number of boards from the same detector are affected it can be wise to reboot that detector.



These buttons show the high voltage status of each detector. They should all be green during data taking. While the beam tuning is ongoing, most sub-detectors should be turned off. Inform the people on detector shifts if beam tuning is planned so they can turn off the HV and when the beam is stable again so they can ramp up the HV. Especially important for MDC.

Most of the time the magnet doesn't need active monitoring. Sometimes it might be necessary to inform the expert about a problem - quick information might be helpful, e.g. if the cooling system misbehaves like in 2022.

7. Hmon Plots

Most monitoring can be accessed via the main web interface, available on http://hades33/mon. The most important windows to be open at all times are the "Tactical Overview" and the ones listed in the "Operator Monitor" box. They should be arranged on the upper left screens so that they can be seen from everywhere in the counting house.

A detailed description of all plots and windows can be found in the separate HmonWindows.pptx document.

8. Daqtools

!Experts only!

Detailed data and tables are available from using Daqtools (http://hades33/daqtools). These pages make direct accesses to the DAQ, so that a few access rules are necessary:

- Close windows you don't use
- Set the update rate to a reasonable value (Settings don't change every second!)
- Always have "Use Cache" activated
- Be careful. All changes to registers have a direct effect on the system

Part IV.
Handling Procedures

9. DAQ Restart

1. Check the Tactical Overview and user guide to see if there is a more appropriate solution to the problem you experience.
2. check if other actions need to be done as well. E.g. if the number of SEU is high, do a reload of the main systems before the DAQ restart. ("Quite-a-Lot" is a good start, but doesn't include central parts and MDC 3/4).
3. Press **Start DAQ** to restart DAQ. An orange window appears and should disappear after 30s-40s if the restart was successful.
4. An unsuccessful attempt is indicated by an error message in the orange window. Try a second DAQ restart, if the first one failed.
5. After the DAQ restart, check the Eventbuilder Overview to see if files are written to disk properly.

Error messages seen during the DAQ restart

"Reset failed. retrying ..."	Just wait
"compile time too old"	Do a Reload of MDC OEP
"clearbit of register failed"	Try again.
"Invalid"	Many "invalid" messages point to some communication problem with some undefined subsystem. Try a reload of Hubs and "Quite-a-Lot". Maybe a powercycle is needed.
"extrap123 unknown"	These can usually be ignored. Reload of CTS and BLR will not work until a power cycle is done.
any "Continue?"	Don't continue unless you know what the error message means. Try another restart first.
Problem persists after DAQ restart	If you note the same boards missing / not working again after a DAQ restart (see row "Endp" and "DAQ"): Do a power cycle of the corresponding subsystem. In case of MDC, follow the description in the power cycle section.

10. Beam Abort and Beam Request

Hades has an automatic beam abort system that stops the beam if too much radiation is seen in the cave. If our beam abort activated, it is shown at the top of the Tactical Overview as "Beam Abort: ABORTED".

- To **activate beam again** it's necessary to talk to the main accelerator control room, identify the problem that lead to the abort and ask them to remove the interlock again.
- The display in the Tactical Overview does not provide feedback from the control room nor does it reset itself. Use "Beam Abort Reset" to **clear the error** message.
- You can **deactivate the system** using "Beam Abort OnOff". This should be done e.g. before adjusting settings of TOF and RPC or if a power cycle is about to be done.
- There is a **hardware override** function to manually activate or disable beam abort. In the back part of the counting house, straight ahead, is a white panel with eight BNC connectors. Two of them are for the beam abort - when disconnected, one activates the abort signal, and the other deactivates the system completely.

If you want to **deactivate beam on purpose**, don't use the abort system, but one of the proper ways:

- Phone the main accelerator control room - keep them informed about what you plan! They might want to get a coffee during the break.
- On the terminal at the left side of the back counting house: A large button can be clicked to enable or disable the beam request. Beam will be stopped after one or two spills.

11. Power Cycles

The main power supplies can be controlled. A full list for the experts can be found in section 18.

- Before doing a power cycle the Trigger is stopped automatically, it is automatically started again during the next DAQ (re-)start.
- Some power cycles require to disable the beam abort system before doing them.
- Procedures for MDC 3/4 and CTS are more complicated and described below.
- After a power cycle, always check the rates seen in the respective detectors and the trigger system in detail to make sure all settings have been restored properly.
- Some powercycles deactivate the beam abort (as indicated below), you need to manually enable it again afterwards (button S̈ettings→Beam Abort OnOff)̈

System	DAQ Restart	BeamAbort	To do next
Start	X	-	
Central Hubs	X	-	check RICH LV in EPICS
RICH Group	X	-	check in EPICS
MDC/TOF/Trg	X	X	
MDC LV/Group	X	-	follow detailed guide
RPC Group	-	X	Load RPC thresholds
ECal Padiwa	-	-	Load ECal thresholds
ECal / RPC	X	X	
FWall	X	-	
CTS	X	X	Reprogram CTS and BLR
Trg	X	X	

Table 1: Summary table for power cycles - check the detailed description for details.

MDC 1/2

In most cases "Resync MDC 1/2" can be used to power cycle and recover problematic boards. A full chamber can be "hard cycled" as described for MDC 3/4. The whole detector can be switched using the last power supply (set to 15V) in the MDC group in EPICS.

MDC 3/4

If a DAQ restart is not sufficient to get boards working again or after some minutes the exact same MDC boards go missing again, you should consider a LV power cycle of the respective sectors when you restart the DAQ next time.

Read the address of the failing board (e.g. 2045) from the Tactical Overview. Use the Icon "MDC 34 LV" and select the corresponding button (here 204x).

Afterwards, the correct FPGA design needs to be loaded to the OEP. Click the “RebootOEP” button. After 10 seconds all OEP are rebooted and DAQ can be started again. If rebooting of the OEP

fails, first run a DAQ start-up until the script complains “OEP design too old”. Close the window and try “Reboot OEP” again.

Check "MBO w/o data" in the tactical overview for errors. These often appear as a result of the power cycle (which is the reason to do the selective power cycle described above instead of a full one).

Full MDC

If it’s unclear which part of MDC causes an error, or if there is a larger number of boards failing, you can do a complete MDC power cycle using "MDC Group" in EPICS instead of using the "MDC LV Powercycle".

RICH

All boards of the RICH subsystem (addresses 7xxx and 82xx) are powered by the supplies in the "RICH Group". Use the button "RICH Powercycle" to switch them off and on again. When all power supplies are active again (see the list in EPICS -> “RICH LV”), do a DAQ restart.

Sometimes the power cycle triggers the temperature interlock for RICH power supplies. The 3.3V supply might be blocked and doesn’t switch on - restart DAQ, then try to switch on this powersupply again manually in EPICS.

After the first DAQ restart you should press the Fix missing IP preemptively as otherwise the EB might fail.

ECal / RPC

After an ECAL powercycle often an ECAL Padiwa powercycle is needed. You can check this by looking at the ECAL rate plot seeing weird structures (e.g. 8 green dots in a row) or completely missing parts.

After the first DAQ restart you should press the Fix missing IP preemptively as otherwise the EB might fail.

TOF / FW

After the TOF powercycle check if the rates in all sectors are equal - if not a "Thresholds TOF" is needed. If settings thresholds doesn’t work in the first try, repeat it a couple more times.

CTS

After a power cycle the CTS needs to be programmed manually using “Reprogram CTS” and “BLR Reinit FPGA” to set up the analog multiplicity board again.

Other Subdetectors

Use the buttons in the control GUI or check section 18 to see which power supply to switch.

Full Powercycle

A full powercycle should only be done after contact with an expert. Follow the guide for the “Daily DAQ reboot”.

12. Full Power Cycle / Daily DAQ reboot

This should be performed at least once a day, when there is a break of 15 minutes. Steps listed under the same item can be done in parallel.

1.
   - Switch off beam on control panel
   - Disable beam abort
   - Switch EB to No File
2.
   - MDC power supply group off (EPICS)
   - Common Group power supply power off (EPICS)
3. Common Group power supply power on (EPICS)
4. (wait 10 seconds)
5. RICH power supply group power on (EPICS)
6. Check that all RICH supplies are on. Sometimes the 3.3V supply doesn't switch on due to an interlock.
7. Start DAQ (it won't run, that's fine)
8.
   - Reprogram CTS
   - BLR Reinit FPGA
   - ECAL Padiwa Powercycle
   - Start Powercycle
   - Triggerbox Beam Powercycle
9. Start DAQ
10. Run Fix Missing IP
11. MDC power supply group on (EPICS)
12. Expert -> MDC Relais On
13. Reboot -> MDC OEP
14. Start DAQ / fix all reported problems
15.
   - Check Eventbuilders getting data
   - Check all FEE to deliver proper signals. Load thresholds or do another Fee/Padiwa powercycle
   - Check if there are no 'MBO without data' or 'FEE error' in MDC - otherwise do a powercycle for this chamber
16.
   - Switch on beam
   - Switch beam abort on

13. Eventbuilder Control

During beamtime shift, data taking can be controlled by the main DAQ Operator GUI (Fig. 1). The GUI box **Eventbuilder Tools** offers all relevant commands as shortcut buttons.

Restart with different number of builder nodes

Depending on the data rate delivered from the DAQ, it may be necessary to adjust the number of builder nodes, i.e. parallel files written. For cosmics usually only 1 builder is enough, for full beam operation it may be 16 builders.

To restart the builder network with different number of parallel files, use the buttons **Set N EB** in the ”Eventbuilder” box of the DAQ control GUI (section 5).

Restart of BNET master control process

The master control process handles the run synchronization and overall monitoring of all nodes of the event buiding network (BNET). **It is necessary to restart the BNET master whenever the setup of the server processes have been edited, or the DABC installation has been updated!**

To restart it, press the button **Restart BNET Control** in the expert section of the DAQ control GUI. Please note that after restart of the BNET control process, also the hmon should be restarted by the **Restart Hmon** button in the "Expert" section! Otherwise the eventbuilder displays in the tactical overview will not get a new connection to the BNET master web server and are not updated.

TDC calibration

The calibration of the trb3 TDC finetime counters is currently handled in the eventbuilder input nodes with the DABC software. The eventbuilder software has to aquire calibration information for each trb3 channel with special ”calibration runs”. In these runs the CTS will operate a pulser trigger of a few 100 Hz with a dedicated *calibration trigger* of type D. The trb3 boards will then produce special calibration data that is used to find out the channel-specific corrections. This calibration information is stored by DABC and will be used in all subsequent runs to mark the raw data from trb3 systems with correction factors for each hit message. The calibration meta information extracted from the calibration run is kept as file for each input subsystem on the eventbuilder server. It is also archived automatically to the tsm and /lustre storage into the subfolder *cal*

Since the TDC fine time calibration may change due to temperature changes or other long term drifts, it is necessary to repeat the calibration sometimes. The Tactical Overview shows information about the last calibration. If this display turns red, usually a calibration run has to be performed. Don’t do a calibration without an expert present.

On top, regular *Calibration Test* runs should be done to monitor the status of the calibration.

Part V.
Online Monitoring

14. Hydra QA monitor

General access to the Online QA is via web browser:

- http://hades33/mon/qawindows/ with a list of all windows also available on the main display in the counting house
- http://hades33/qaweb/?layout=tabs&monitoring=2000 to access the Root interface with all available plots individually

14.1. Online QA Restart Procedure

1. On the lower left screen click on the button "Online Monitoring 2" (rocket icon). Wait for 10 seconds, two VNCs and two browser windows open. In the accelerator status window click on "Aktuelle Schicht".
2. On the top left VNC click "Online Vertex Reconstruction"
3. On the large VNC click "OLM", "OLM http" and after 10 seconds "Arrange Windows"
4. If there are any stray windows, or windows are not arranged properly, close all windows manually and use buttons again.

14.2. QA Expert Knowledge

1. The two VNCs running are hades66:66 and hades66:67. If they are not running, restart them manually as user hades-qa. Commands can be found using crontab -e
2. Local server can be modified in hades66:/home/hades-qa/bin/online/5.34.38/apr25/online. It consists of server and client parts. Input source and histogram parameters can be modified in dir/server, and histogram plotting can be modified in dir/client. After that execute /bin/updateOnline.sh script and relaunch the OLM.

15. Raw data monitor

Monitoring of raw DAQ data is provided by a separate tool. This low level analysis of the frontend readout will deliver histograms of data sizes, TDC channels, error markers etc for each single channel, and in 2d overview plots for the whole system. All histograms are available via a web server at http://hades33/rawmon/. The tree view on the left side allows to browse to any detail histogram. It is organized in subfolders indicating the data hub (*TRB_XXXX*) with all trb3 or MDC TDCs as subfolders (TDC_YYY, MDC_ZZZZ). All units are identified by their address in the TrbNet.

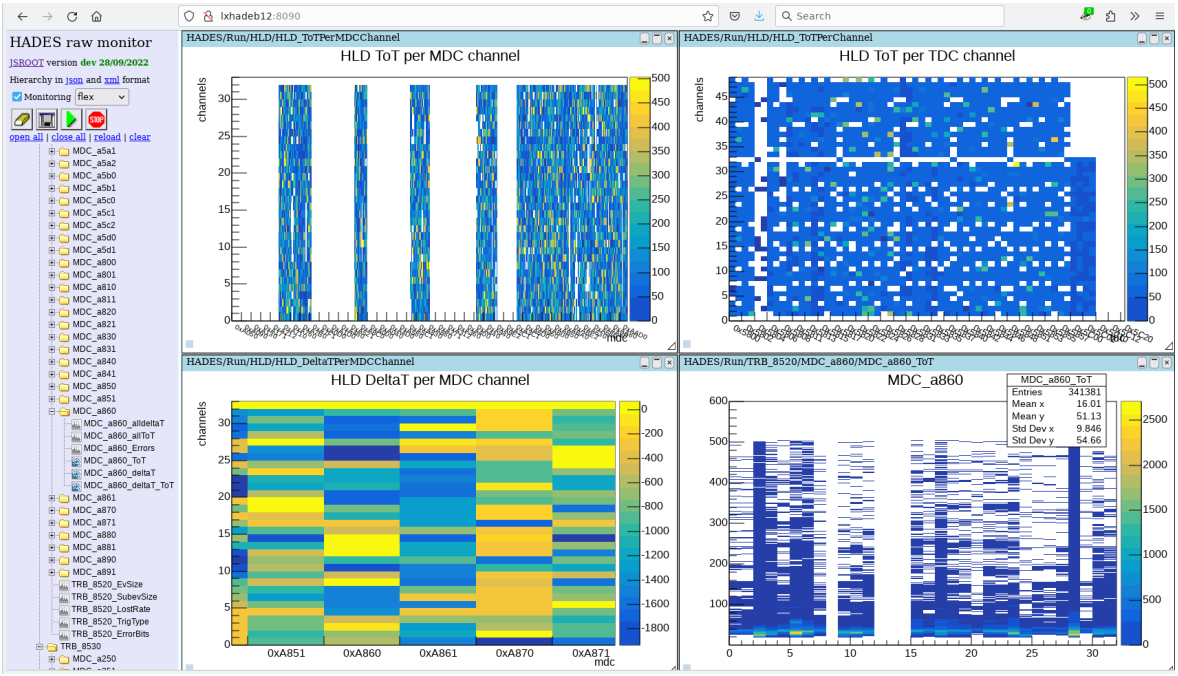


Figure 3: The raw data monitor web display with example histograms shown.

15.1. Raw Monitor Details

- The raw monitor server is a DABC process running on *lxhadeb12*.
- The data is taken directly from the first event builder process via a "stream server" socket at *lxhadeb08:8101*. No intermediate files are required. Especially, raw data monitoring works even if no hld files are written by the event builders.
- The actual webserver runs at `http://lxhadeb12:8090` (see figure, todo), `http://hades33/rawmon/` is the external link to it.
- The actual raw monitor configuration is done by files in the working directory *lxhadeb12://data01/monitor/hades/dabc*
  - **first.C** defines the parameters of the stream analysis used for monitoring
  - **dabc.exe** defines the actual runtime environment and the web server specs, like port number

15.1.1. Restarting procedure

There is no button on the DAQ operator GUI available, because restart of raw data monitor should be done by the expert. Since the setup of the TDC entities of such analysis is done dynamically at startup, it should be granted that all DAQ frontends deliver any data.

1. Put DAQ into the "TDC Calibration mode" by applying own trigger type D and a moderate pulser frequency like 1000 Hz in the CTS gui (reference here). Alternatively, the raw monitor

may be newly started during the TDC calibration or calibration test procedure (see REF)

2. invoke script *lxhadeb12:/home/hadaq/bin/restart_rawmon.sh*. This will setup the environments of DABC and stream frameworks, kill the old process and start a new one.

3. reload the website display. Be aware that it can take some minutes until the full display is available again, since all analysis objects are just created "on the fly" from the incoming data stream.

Part VI.

Expert Section

16. DAQ Network Devices

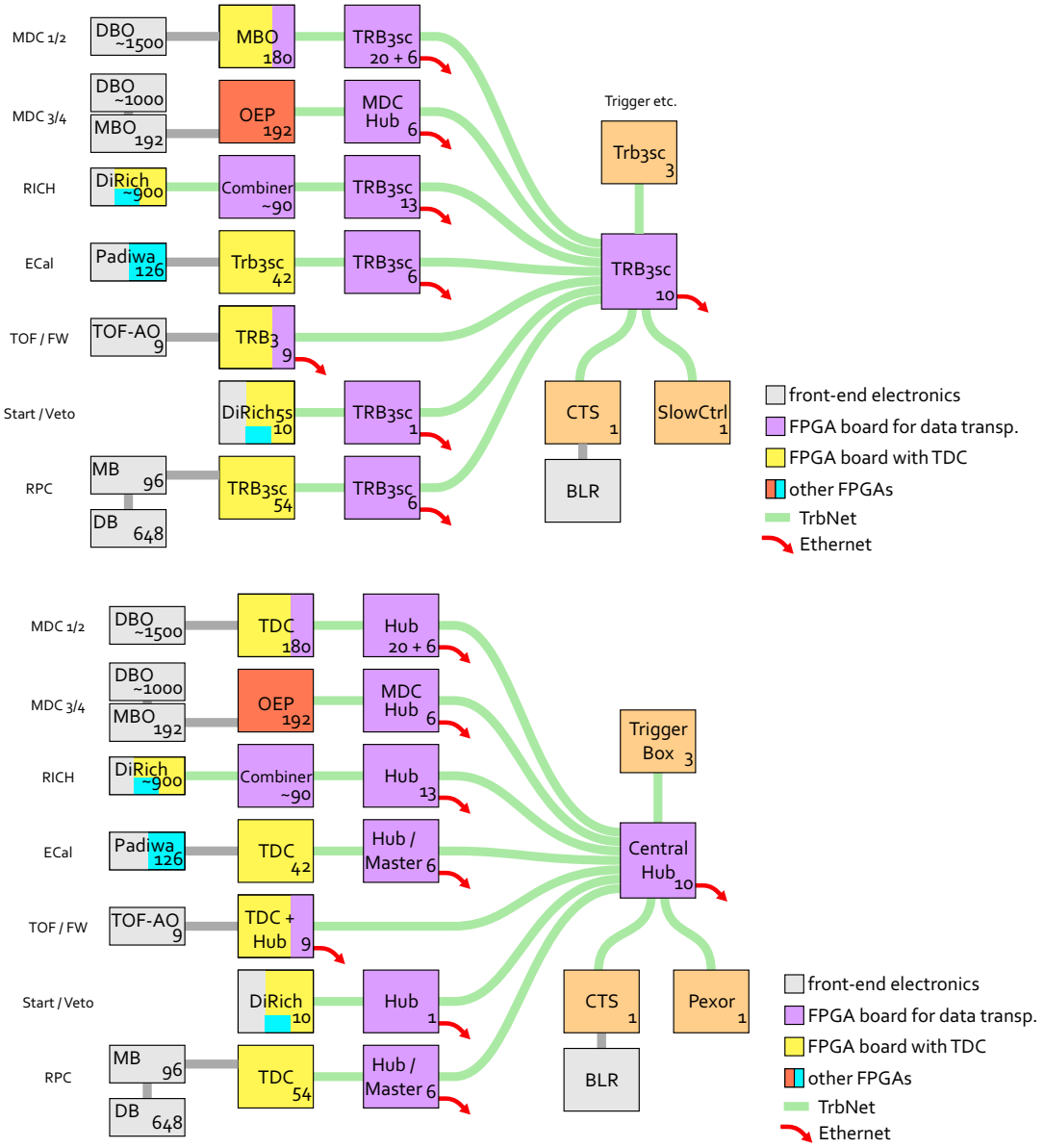


Figure 4: DAQ network with different labels. Labels by type of board and by function (names as often shown in Hmon). Numbers show the amount of boards in Hades

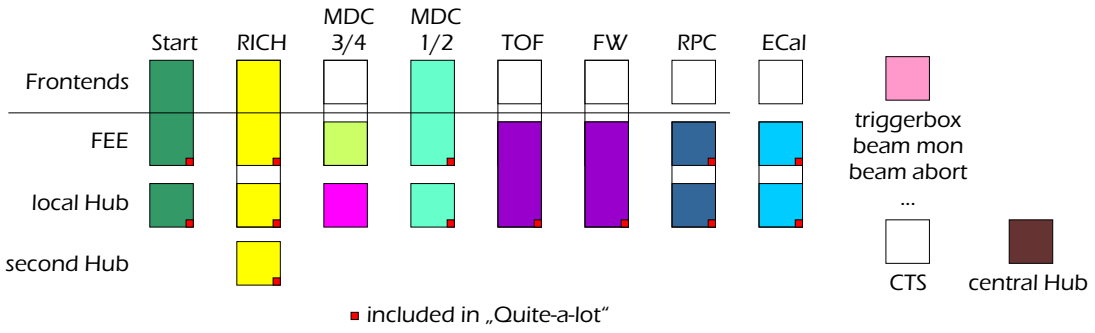


Figure 5: Regions the various reload scripts affect.

17. Addressing scheme

Completely updated as of 07.01.2025

Address(es)	Board(s)	Description
0000 - 01FF	Trigger	CTS: 0002, 0003; Triggerbox 0010; 2nd Triggerbox 0100, Beam Abort 0130, RICH Control 0110, ECal pulser 0120
1100 - 11FF	MDC Concentrator	3rd digit: sector (0-5), 4th digit FPGA (0-4)
2200 - 2FFF	MDC OEP	2nd digit: MDC layer (2-3); 3rd digit: sector (0-5); 4th digit MBO (0-F)
5000 - 50FF	Start	Start/Veto. 3rd digit: 0: Start, 1: Veto, 4th digit: FPGA (0-7)
5800 - 58FF	RPC	3rd digit sector (0..5), 4th digit TDC (0..8)
5C00 - 5CFF	TOF	3rd digit sector (0..6), 4th digit TDC (0..3)
5D00 - 5D0F	iTOF	4th digit TDC (0..5)
6000 - 60FF	Ecal	Ecal read-out. 3rd digit: Sector, 4th digit: Readout Board (0-6)
6400 - 64FF	STT	3rd digit detector part (0-7), 4th digit FPGA (0-6)
6700 - 67FF	Wall	3rd digit board (0..2), 4th digit TDC (0..3)
6800 - 68FF	f-RPC	3rd digit board number (0-1), 4th digit FPGA (0-3)
7000 - 7FFF	RICH	DiRich modules. 2nd/3rd digit backplane number, 4th digit: DiRich (0-11)
8000 - 80FF	Central Hub	central hub
83C0 - 83DF	RICH Hubs	Hubs for RICH, 4th digit: hub number (0..13)
84C0 - 84CF	RPC Hubs	Hubs for RPC, 4th digit: sector (0..5)
8500 - 85BF	MDC Hubs	Hubs for MDC, 3rd digit: crate number (0..5 (MDC I/II), 6..B (MDC III/IV))
86C0 - 86CF	TOF Hub	Hubs (central FPGA TRB3), 4th digit: sector(0..6)
8700 - 870F	Wall Hub	4th digit: board(0..2)
8800 - 88FF	Central Hub	Central Hubs with GbE
8880 - 888F	Start Hub	
8890 - 889F	Hodoscope Hub	
8A00 - 8AFF	Ecal Hubs	4th digit: pseudo-sector
8B00 - 8BFF	STT Hubs	3rd digit board number (0-9)
8C00 - 8CFF	f-RPC Hubs	3rd digit board number (0-1)
8D00 - 8D00	iTOF Hub	
8E00 - 8FFF	MDC MBO	2nd digit: inner (E)/outer (F) MDC, 3rd digit: sector (0..5 MDC I/III, 6..B (MDC II/IV)), 4th digit: MBO
A000 - BFFF	MDC TDC	1st digit inner(A)/outer (B) MDC, 2nd digit: sector (0..5 MDC I/III, 6..B (MDC II/IV)), 3rd digit: MBO, 4th digit: TDC
F000 - FDFF	Test Setups	
FD00 - FFFF	Broadcasts	Broadcast addresses, see next table

Table 2: Network Addresses

Address	Description
ff7f	all boards with GbE
fffe	all boards with Hubs
fe40	Hubs: Trb3 central FPGA (TOF, fRPC, FW)
fe61	Hubs: Trb3sc crate master (ECal, RPC, iTOF, Start, new MDC)
fe65	Hubs in central crate and new MDC
fe66	RICH Hubs
fe11	old MDC Hubs, peripheral FPGA
fe15	old MDC Hubs, central FPGA
fffd	old MDC OEP
fe51	RICH: DiRich
fe52	RICH Combiner
fe58	Start
fe4c	TDC: Veto, STS
fe47	TDC: TOF, fRPC, FW
fe71	TDC: ECal
fe73	TDC: RPC
fe90	new MDC: OEP
fe91	new MDC: TDC
fffb	new MDC: OEP+TDC

Table 3: Broadcast Addresses

18. Power Supply control

There are several interfaces for control, depending on the supply.

18.1. EPICS Power from the control GUI

MDC/TOF/Trigger	MDC Hubs, TOF Trb & Fee,
ECAL/RPC	ECal Trb, RPC Trb, ECal pulser, Trigger distribution in ECAL
Central	RICH Hubs, Central Hubs
ForwardWall	Forward Wall Trb & FEE
RPC LV	Group of 2 supplies: RPC Fee (no DAQ), RPC DCS
RICH LV	Group of 9 supplies: RICH Fee
MDC LV	Group of 6 supplies: MDC Fee. The last supply is for MDC 1/2, the others for MDC 3/4

18.2. Webbrowser `http://hades33:2222`

RichFans	Coolings fans on RICH
ECal 1/2/3	ECal Padiwa (two channels per sector)
CentralControls	Channel 2: Trigger fanout at CTS, Triggerbox, Beammonitor Channel 3+4: CTS Trb, BLR, some DCS modules
Start	
Veto	Hodo Trb, Hodo Fee

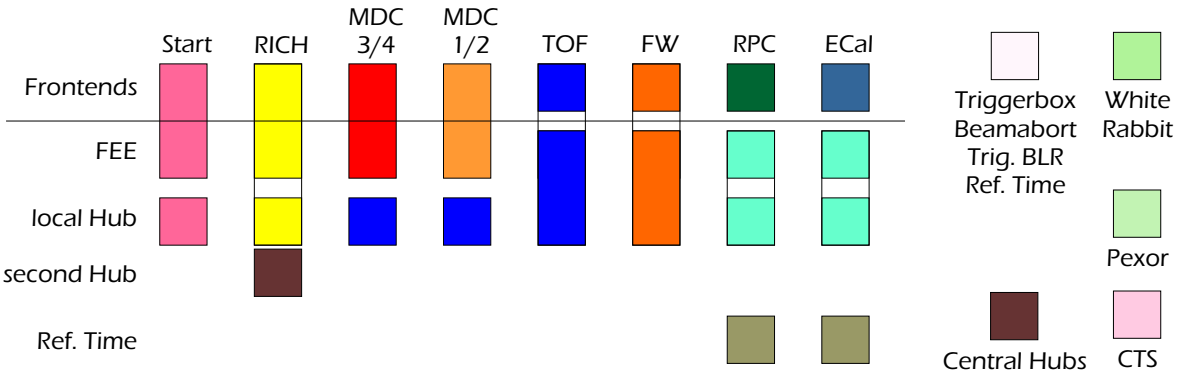
18.3. Power Switches

Some devices can be remotely switched on/off using a web interface:

ECal Laser	`http://haepcp15`
White Rabbit PC	`http://haepcp10`
Pexor PC	`http://haepcp02`
Trigger Scope Network	`http://haepcp11`

Some reference values can be found at in the document repository under `DAQ/PowerSupply.xlsx`

18.4. Power Supply Regions



Power Supply Name	GUI Button	Procedure
Start	Start	DAQ restart
Central	Hubs	DAQ restart
RICH Group	RICH	DAQ restart
MDC/TOF/Tri	TOF MdcHub	2x DAQ restart
MDC Group	MDC 34	see MDC powercycle
MDC Group	MDC 12	see MDC powercycle
RPC Group		RPC thresholds
ECAL/RPC	ECAL RPC	see Ecal powercycle
EcalRack		
FWALL	WALL	DAQ restart
ECal 1-3	ECal Padiwa	ECal thresholds
CentralControls -> RefFan		DAQ restart
CentralControls -> CTS		DAQ restart
haepcpXXX		DAQ restart
haepcpXXX		none

access via EPICS
access via Web GUI
switch via own GUI
no remote access

Figure 6: Regions and names of power supplies for most parts of the DAQ system

18.5. Error Handling

The power supplies controlled by EPICS sometimes stop responding. To recover them the IOC on lxhaddcs11 can be restarted as described in 19.1.2.

19. DCS -Detector Control System

19.1. Detector Control System - DCS

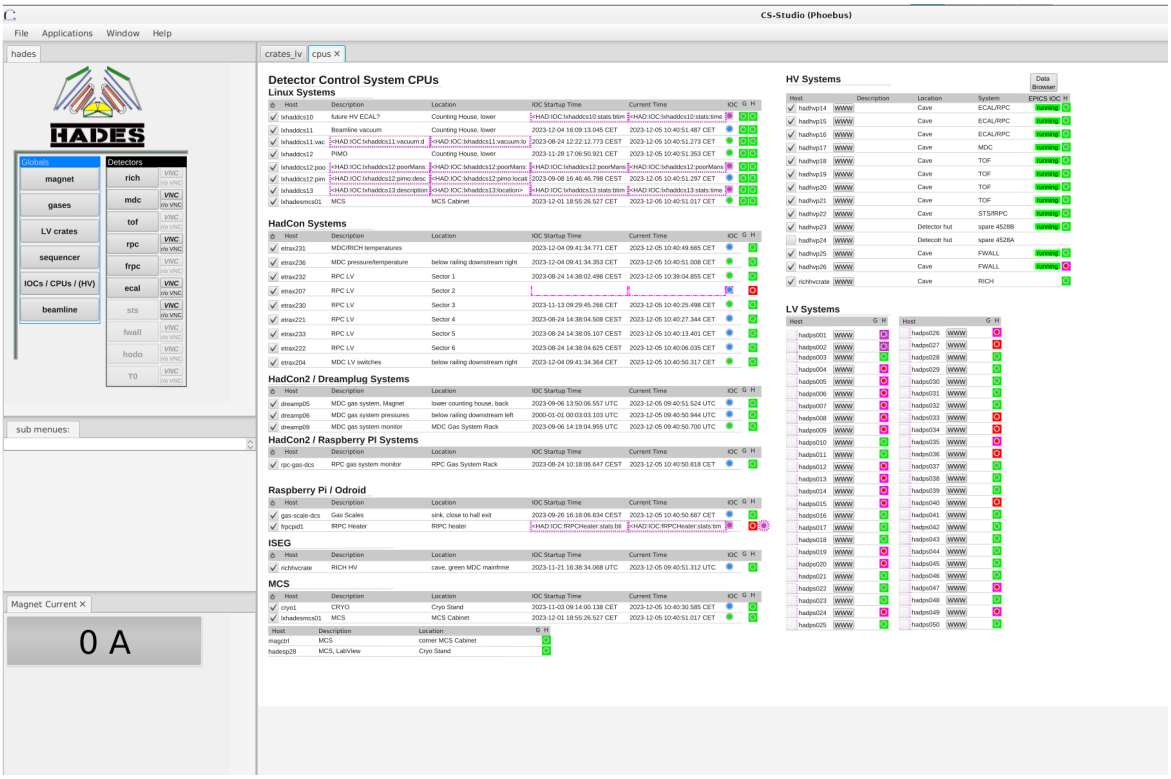


Figure 7: Starting page of the DCS

EPICS IOCs

Currently the DCS comprises more than 20 EPICS Server (*IOCs*, **I**nput **O**utput **C**ontroler) plus 15 additional embedded IOCs of the CAEN and ISEG Crates.

Although direct client access could be possible - since EPICS represents an online, distributed set (databases) of *Process Variables*, PVs, on different servers accessible from different clients - at the moment **two** main IOCs retrieve *raw* data PVs from the frontend IOCs and provide them in a coherent form.

These are:

- lxhaddcs11p.hades.gsi.de

  HV TOF, DIAMOND, fRPC, IOC, iTOF, MDC, RPC, STS

  Detector Systems / Tasks CAVE, Common, DAQ, DIAMOND, fRPC, FWALL, HV, INFRA, IOC, iTOF, LV, MDC, RICH, RPC, STS, T, TARGET, TEMP

- lxhaddcs12p.hades.gsi.de

  HV ECAL, FWALL

19.1.1. EPICS ready servers

The four DCS servers

- lxhaddcs10p
- lxhaddcs11p
- lxhaddcs12p
- lxhaddcs13p

are prepared to run EPICS services and applications. several groups already have users, or use hadaq to operate via VNC from those servers. (Details on request)

19.1.2. How to restart an IOC

All non-embedded IOCs run in a *procServ* environment, with automatic restart activated by default. To restart the child process, the IOC, a CTRL+X has to be issued.

The dirty option is to send this (locally) via *nc*.

- locally:
  - `printf "\x18"| nc -w 180 localhost 4813`
- remote:
  - `ssh lxhaddcs11 "printf \"\x18\"| nc -w 180 localhost 4813"`

The timeout (-w 180) of 3 minutes fits lxhaddcs11p/lxhaddcs12p

20. TDC Calibration procedure

Completely updated as of 17.11.2023

WARNING

The calibration needs to be done by an expert, because the output of the Eventbuilders needs to be checked carefully. An error done during calibration will have an immediate effect on all recorded data rendering it useless if no extensive post-processing is done.

The calibration procedure might take a while and therefore should only be done during planned breaks, e.g. periods without beam.

1. Be sure that the beam is off and no other data source may interfere with the calibration pulser!
2. If possible, ramp down HV in the detectors to minimize the contribution of noise and cosmics in the recorded data.
3. **Remove old calibration** files, as they will corrupt the new calibration is some larger changes happened. There is /bin/deletecalfiles.sh to help. Use **Restart EB** to disable the old calibration.
4. Do a **reboot of the TDC** boards, especially of ECAL
5. **DAQ restart**.
6. Make sure all boards (MDC can be ignored) are up, running and delivering data.
7. Disable the ECal threshold setting script (kill ecal_set_thresholds.pl on hades33)
8. Click the Button **Start TDC Cal** in the DAQ operator GUI. This will disable all inputs of the CTS and put it into the special calibration mode (trigger type D, 500 Hz pulser). The eventbuilders will start writing files with prefix ”TC”.
9. **Change pulser** to 1500 Hz in the CTS GUI to speed up data taking.
10. Check the Tactical Overview for an increasing calibration status (orange field in the last row). For details, check the eventbuilder BNET GUI (Fig. **??**). The ”Input nodes” box shows for each eventbuilder server the subsystems (”HUBs”) which send data to them from the cave. These are labeled with their trbnet hub address, e.g. ”0x83c1”. During calibration, the trb3 systems will turn to a blue color. The ”Run control” caption of the webpage will show the state ”Calibrating”.
11. When the calibration status reached 100%, calibration can be stopped by pressing the **Stop TDC Cal** button in the DAQ control GUI. Don’t issue any other EB-related command and wait.
    In the BNET GUI all of the input hubs have turned to green color, the calibration statistics is sufficient. In this state the ”Run control” state will show ”Ready”. It can take several minutes until this is reached, depending on the configured calibration precision in the setup.

12. The eventbuilders will close the calibration run files and will archive the most recent calibration information. The trigger settings of the CTS will be restored to the values just before the calibration procedure.

13. Wait about two minutes to make sure the calibration procedure has been completely finished. Then do a quick TDC Calibration Test as detailed in the next section.

14. Be sure that the beam or the desired trigger source is switched on before starting beam or cosmics files again!


WARNING

While there is some output from eventbuilders about the quality of the calibration procedure, the only reliable way to generate a detailed report on the quality is the test procedure described below.

20.1. TDC Cablibration Test

The easiest way to check that TDC deliver proper data is a calibration test run. It can be done at any time, and requires to stop data taking for about one minute. Noise and signals from the detectors will have an influence on the results - this either needs to be taken into account when checking the plots or high voltage needs to be switched off.

1. If possible, use more than one Builder node to write the data to disk - one node will work, but decreases the available statistics for analysis.

2. Make sure all boards (MDC can be ignored) are up, running and delivering data

3. Make sure beam is off and no other data source (noise, pulser) can interfere with the calibration pulser

4. Disable the ECal threshold setting script (kill ecal_set_thresholds.pl on hades33)

5. Use The **TDC Caltest** button to make a short test run. It records data for about 30 seconds (10k-15k events).

6. After the run stops, CTS settings are restored to normal values automatically.

7. Go back to normal data taking - do a DAQ restart, check HV, beam etc.

8. Root analysis of the data starts automatically. Plots are published on `http://hades33/calib`. The whole analysis runs for a couple of minutes (about 50s per GB of data)

9. After this has finished, data is further analyzed by hmon_tdcchanerrors_monitor.pl. It starts automatically and outputs its plots in Hmon - Calibration Test Plots.


WARNING

Do not try to judge the calibration quality from the main plots seen on `http://hades33/calib`. You might use this interface to look at some detailed data. Only the overview plots on "Calibration Test Plots" contain the information (and presentation) needed to see possible issues.

Manual File Selection

You can also run a manual analysis with any hld files as input:
Connect to hades63, screen 'tdccalib'. Create a list of all files to analyse, e.g. 'ls /store/*/*/*/tc22018114* | tee list22018.hll. link this file to list.hll and run dabc_exe tdcmon.xml, and wait 50 seconds per GB of data. Plots are published on http://hades33/calibtest. Afterward, run hmon_tdcchanerrors_testmonitor.pl (with edited data source in the script) in the hmon directory, then check the resulting plots in Hmon - Calibration Test Plots.

21. Eventbuilder

21.1. EB Controls

The BNET master server of offers a monitoring and control GUI on a webserver at the address http://lxhadeb12:8099/?browser=fix. It is also available as part of the hmon webserver at http://hades33/eb/. When this address is opened in any web browser (e.g. firefox, chrome), the default GUI displays the state of the BNET as shown in figure 8. This screenshot explains the main graphical elements and the functionality of the most important buttons. Besides the control buttons, Clicking on any active object gui elements (i.e. the text is underlined as a hyperlink), an appropriate plot or text information will show up in the main display area. Just holding the mouse over a display element will after few scondes usually open a hover window showing additional information, or a tooltip help. Note that the checkbox for "Monitoring display" has to be enabled to update the display frequently every 2 seconds.

For each BNET input node row, the UDP receiver ports are listed with the trbnet address of the sending hub (if any data has yet been received!). The color of each hub shows the actual state of data receiving:

Green : Data is received properly (TDC calibration runs: Calibration is sufficient)

Yellow/Red : No data is currently received (TDC calibration runs: Calibration is not ready, or calibration file not yet existing)

Blue : TDC calibration runs only: Calibration is ongoing, but statistics not yet sufficient)

Dark green : Data is received properly, but an error in the TDC calibration of this hub has been acknowledged by the expert

Figure 9 describes the GUI elements related to data taking and file writing. The respective buttons on top allow to select the next run type and to start and stop datataking at any time. Note that the BNET processes are not restarted when changing the run type as with the old eventbuilders, but continue even when writing to files is stopped. In this case, just the filename display will become empty and the builder node color turns yellow. Clicking on any of the rate and file size numbers allows to watch the trending graph of the assigned value in the display area.

21.2. Eventbuiler Streaming Interface

The eventbuilders provide a streaming interface to access individual events online on port 8101, e.g.:
`hldprint lxhadeb08:8101 -num 1 -sub -onlytdc 0x6003`

22. BNET Configuration

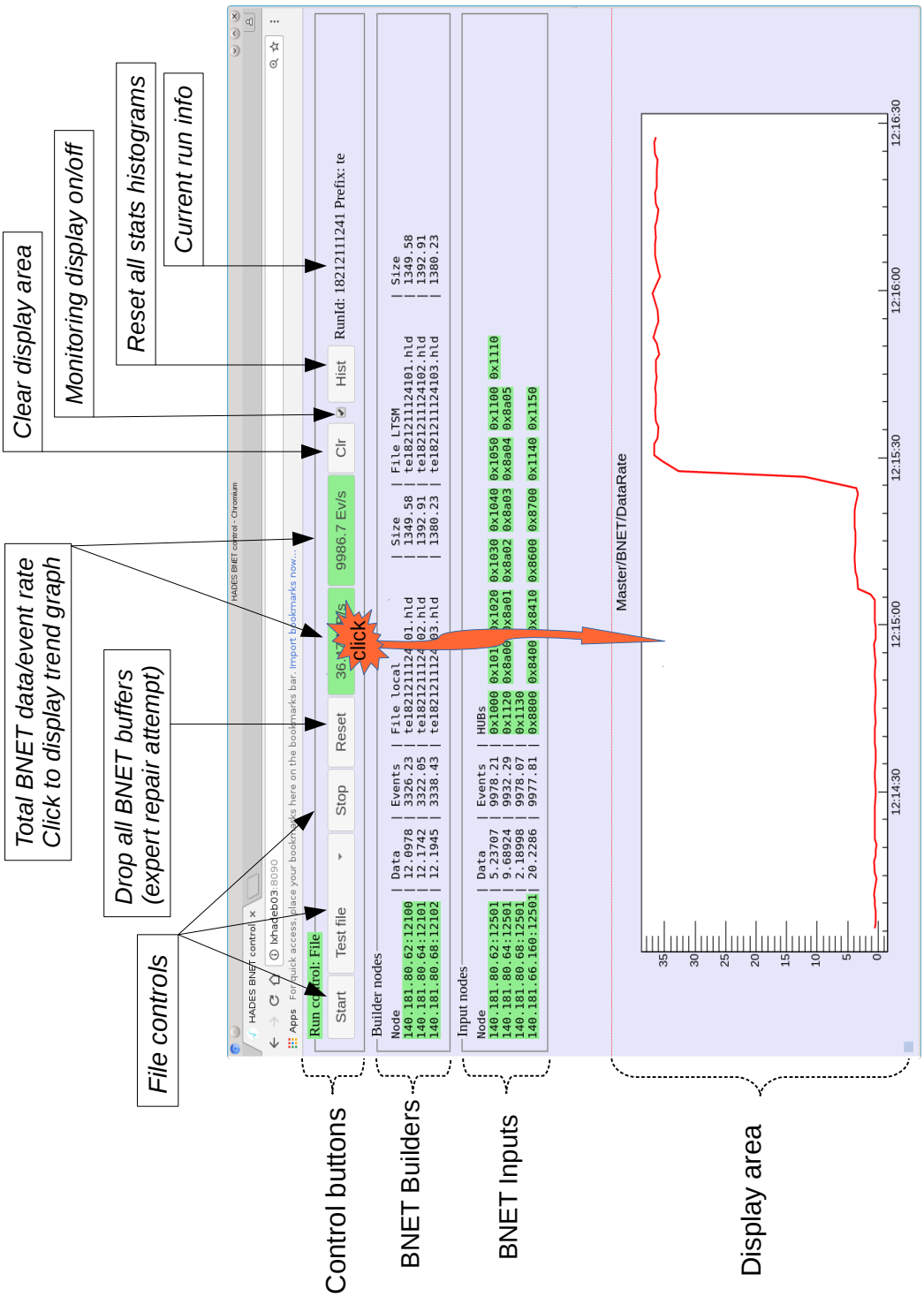
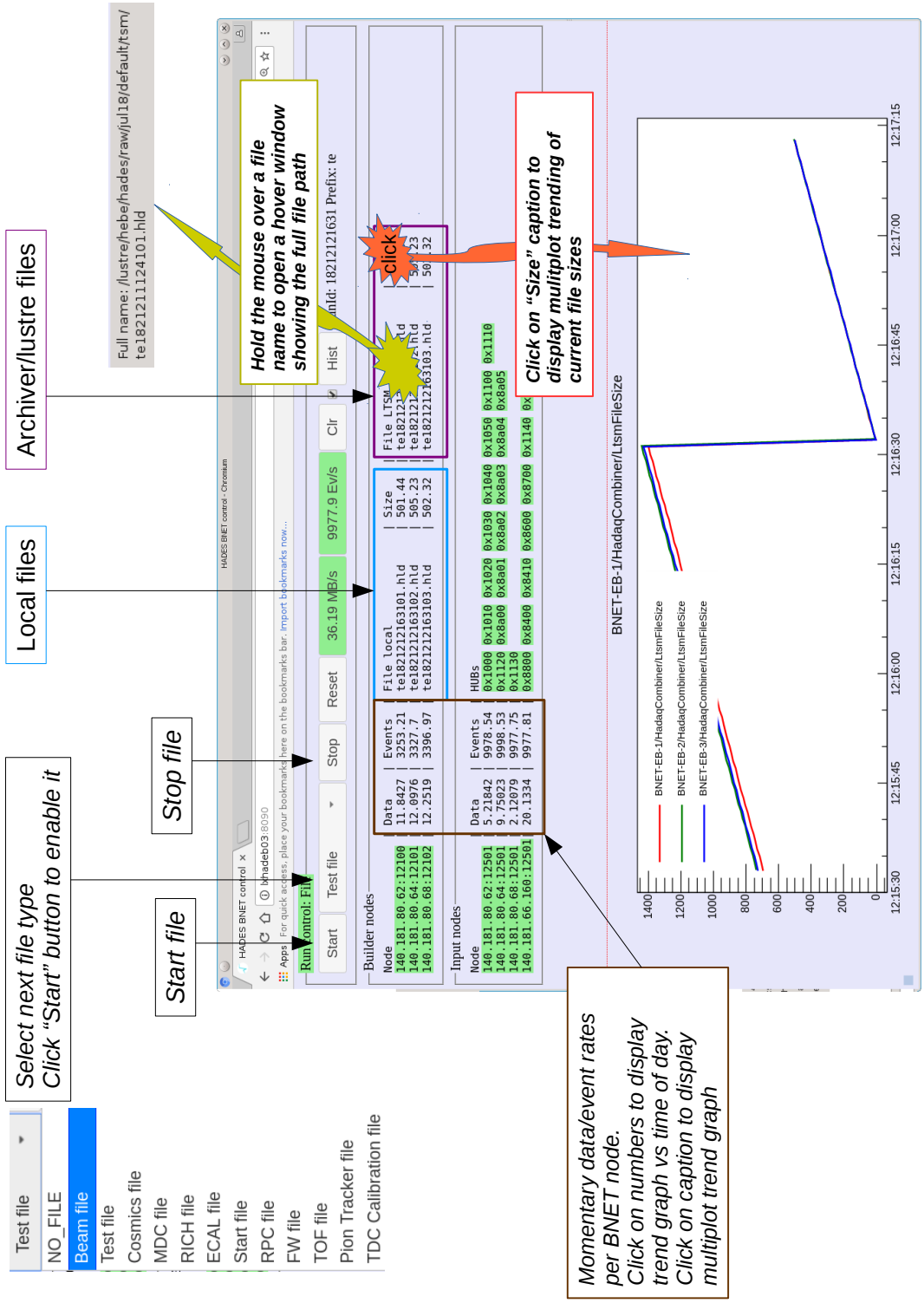


Figure 8: BNET web GUI: overview



TdcCalMon

Figure 9: BNET web GUI: file and run control

The setup of the event "Builder NETwork" (BNET) defines which trbnet hub sends data to what `lxhadeb*ø` input node, and how many builder nodes are running to write files in parallel to the storage media.

22.1. Distribution of trbnet data sources and their calibration mode

The main configuration file for this is in `main/data_sources.db` on `lxhadesdaq:/home/hadaq/trbsoft/hadesdaq`. The format looks like this:

```
# Addr     On/Off     Name           DataSize  EBhost TDCflag
0x8800      1         CentralCTS       low     lxhadeb17 0
0x8810      1         CentralAUX       low     lxhadeb17 0
0x8880      0         StartTRB3         low     lxhadeb17 2
0x8890      0         Veto              mid    lxhadeb15 2
0x84c0      1         RPCnew1           mid    lxhadeb14 2
...
0x83c0      1         RICH0             mid    lxhadeb18 11
0x83c1      1         RICH1             mid    lxhadeb15 11
```

Each row defines the data sending behaviour of one data hub. The meaning of the columns is as follows:

Addr: Address of the sending hub

On/off: Switches receiving data from the hub on or off. If set to 0, after a restart of the eventbuilder with the operator gui ("Restart EB" or "Set N EB"), the input EB host will not expect any data from this hub. Useful if a detector system is temporarily not available. If any system is not present for the whole beamtime, it is better to comment the whole line by preceding # , otherwise hmon will warn about "non active datasoures" in the EB tactical overview.

Name: Description of the system belonging to the hub address. For the human editor only

DataSize: May be used for setup of eventbuilder buffers. Deprecated, not used!

EBhost: Hostname of the destination server for this hub. **Note that this entry is evaluated by a secondary script to create a new DAQ configuration.** It is not applied by simply restarting the event builders..

TDCflag: Defines TDC calibration mode for the BNET input software: (0- no calibration, 1: linear calibration, 2: full calibration: 11: full calibration, special for RICH delay). **Note that this entry is evaluated by a secondary script to create a new DAQ configuration.**

To apply these settings for the DAQ and event builders, following procedures should be done **Experts only!**:

1. Edit `main/data_sources.db` accordingly
2. If data sources are only disabled (On/Off flag) or commented: Just restart event builders. For other changes continue.
3. Run script `evtbuild/generate_ebhub_config.pl`. This will create the master network configuration file `hub/register_configgbe_ip.db`.
4. Restart DAQ (with button "Start DAQ" on operator GUI) to apply the setup for trbnet hubs
5. Restart event builders (with button "Restart EB" on operator GUI) to apply the setup for the BNET input nodes

22.2. Builder network and storage destination

EXPERTS ONLY!

The detailed configuration of the builder network is done with configuration file `evtbuild/eb.conf`. Any change in this file requires a restart of the event builders only. DAQ is not affected.

The most important tags:

BNETINP: `0 0 0 0 1 1 1 1 1` - array defining distribution of input processes to the lxhadeb servers. Each entry represents a server from the *@bnetservers* list as defined in the EB start script `evtbuild/start_eb_gbe.pl`. The given number is the maximum allowed number for each server. Note that currently one input process per server is possible only..

BNETBLD: `5 5 5 5 0 0 0 0 0` - array defining distribution of builder processes to the lxhadeb servers. Each entry represents a server from the *@bnetservers* list as defined in the EB start script `evtbuild/start_eb_gbe.pl`. The given number is the maximum allowed number for each server. The actual number of builder processes is set by a command line argument of the EB start script that is called by the "Set N EB" buttons of the operator GUI.

LTSM: `1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1` - array defining which *builder* processes do write files to the LTSM/FSQ storage servers. Each entry represents a builder process, independent of the *lxhadeb** server where it runs. To generally turn off storage to GSI /lustre and tape, put 0 to each entry. Note that storage to local RAID disks is always enabled.

LTSM_PATH: `/lustre/hades/raw/feb24` - base path for raw data storage on /lustre and in tsm archive. May change depending on beamtime period

LTSM_FSD_SERVERS: `lxfsq12 lxfsq09 lxfsq10 lxfsq11 lxfsq12` - hostnames of the destination storage servers for each event builder process. The list is repeated when more builders are used.

DATA_SOURCES: `../main/data_sources.db` - name of the configuration file with active trbnet hubs. Description see section 22.1.

GBE_CONF: `../hub/register_configgbe_ip.db` - name of the DAQ configuration file for trbnet hubs. Contains input host names, port numbers and calibration mode information. Generated as described in section 22.1.

23. Trigger Collection

The documentation of the trigger box can be found in the main document repository as linked on the monitoring web page.

24. Safe Detector Settings

In case of any unforeseen problem, it might be advisable to load safe settings and to reduce the voltages on detectors quickly.

24.1. RICH

The DAQ control GUI has a button "Set RICH HV" in the expert section to toggle the current status of RICH HV.

24.2. MDC

Talk to the MDC operator on shift.

24.3. RPC

In the EPICS GUI, use RPC -> HV -> Groups -> Off as shown in figure 10.

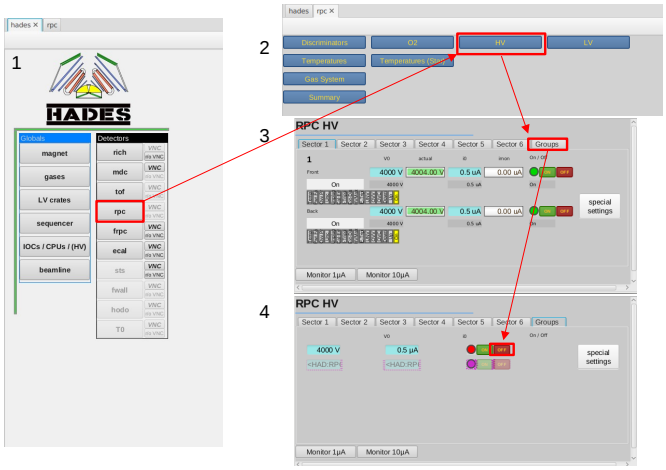


Figure 10: RPC HV off procedure