KLM Database Interface and Background Monitoring using Slowcontrol

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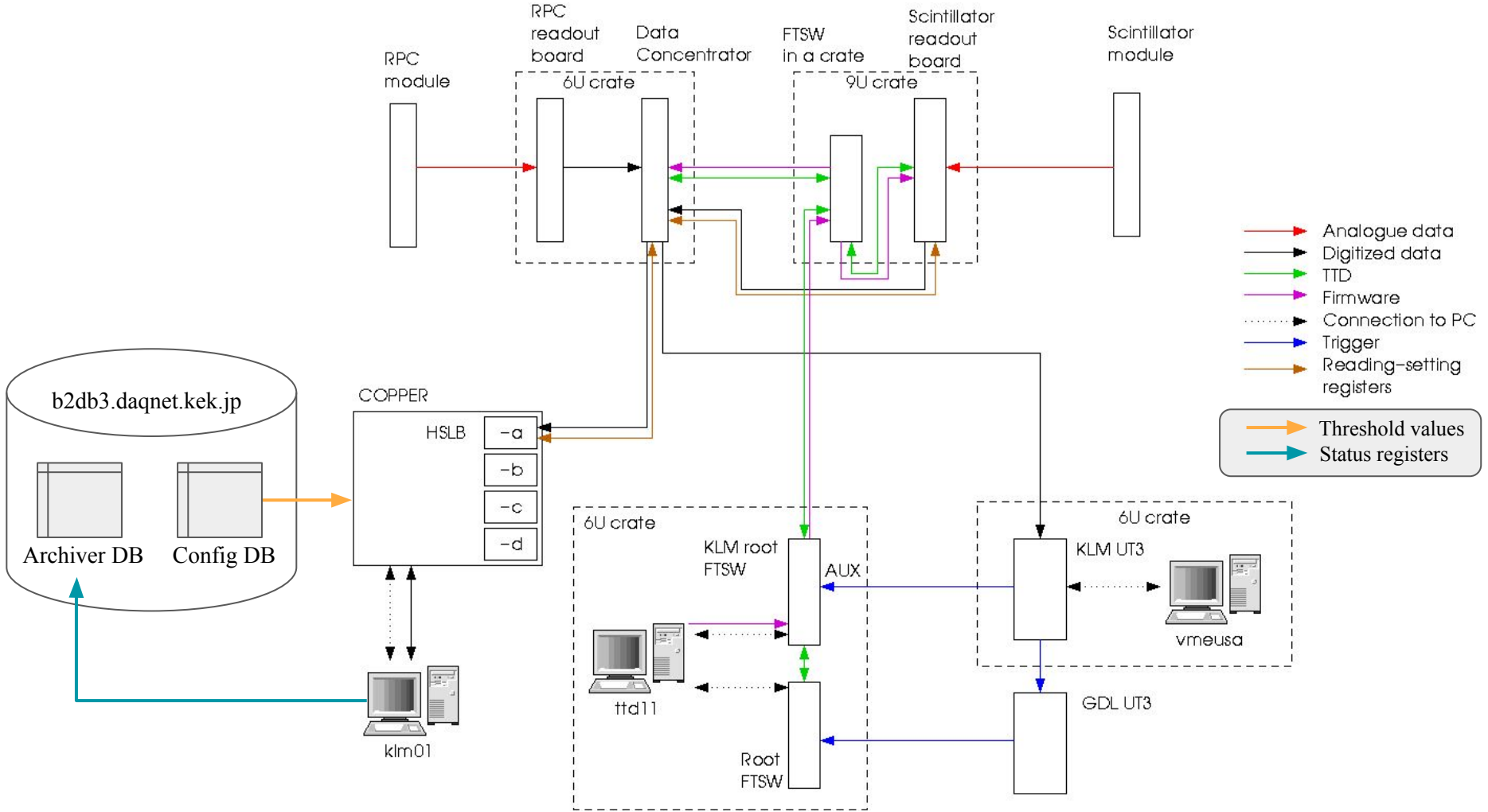
KLM Database Interface

Introduction: Overview of KLM DAQ


RPC module
RPC readout board
Data Concentrator
FTSW in a crate
Scintillator readout board
Scintillator module
6U crate
9U crate
Analogue data
Digitized data
TTD
Firmware
Connection to PC
Trigger
Reading-setting registers
Threshold values
Status registers
b2db3.daqnet.kek.jp
Archiver DB
Config DB
COPPER
HSLB
-a
-b
-c
-d
klm01
6U crate
KLM root FTSW
AUX
ttd11
Root FTSW
6U crate
KLM UT3
vmeusa
GDL UT3

The Goal

- To create an system for monitoring and logging the contents of the KLM Data Concentrator status registers.
- There are three parts of this system -
  - ➢ Contents of these status registers are fetched and assigned to appropriate NSM2 variable
  - ➢ These NSM2 variables are then converted to EPICS PVs.
  - ➢ These EPICS PVs are monitored and archived using the official Belle II EPICS Archiver Appliance.
- The existing method to access the contents of these registers is to use a script called ***~/run/scripts/dcregs.sh*** on ***b2klm@klm01*** machine.
  - ➢ This script uses ***reghs*** command on different COPPER machines - cpr7001, … cpr7004.
  - ➢ Displays the register contents from all the HSLB links (-a, -b, -c, -d) from those COPPERs.
- The goal was to build an automatic system using slowcontrol.

The 27 status registers in KLM Data Concentrator

Register Name	Address
DAQ_PKTSZ1	0x632
DAQ_PKTSZ2	0x636
EVNT_RDCNT1	0x06A9
EVNT_RDCNT2	0x06AA
EVNT_WDCNT	0x06AD
EVNT_WRCNT1	0x06AB
EVNT_WRCNT2	0x06AC
FIFO_FLAGS1	0x630
FIFO_FLAGS2	0x634
HSL_CHAN_UP	0x614
LKBK_STOP_C	0x31
LKBK_STOP_F	0x33
LKBK_STRT_C	0x30
LKBK_STRT_F	0x32

Register Name	Address
MISSED_TRG	0x06A0
RPC_DELAY	0x06A6
RPC_EVTAG	0x06A7
RPC_FLAGS	0x06A1
RPC_TRGTAG	0x06A3
SCNT_EVTAG	0x06A8
SCNT_FLAGS	0x06A2
SCNT_TRGTAG	0x06A4
SCNT_TTERR	0x06A5
STS_PKTSZ1	0x633
STS_PKTSZ2	0x637
TRG_PKTSZ1	0x631
TRG_PKTSZ2	0x635

Implementation Details

- The KLM Front End Electronics (KLMFEE) code is modified to define and assign these NSM2 variables.
- The KLMFEE::init() method defines these NSM2 variables.
- The KLMFEE::monitor() method reads the registers using HSLB::readfee32() API call and assigns the NSM2 variables.
- This code runs parallelly on each of the 8 COPPERS
  - ➢ CPR7001, CPR7002, CPR7003 and CPR7004 for BKLM
  - ➢ CPR8001, CPR8002, CPR8003 and CPR8004 for EKLM
  - ➢ Each COPPER has 4 HSLB links (-a, -b, -c, -d)
- So, total 27x8x4 = 864 NSM2 variables are defined and they are assigned using 32 parallel KLMFEE::monitor() function call.

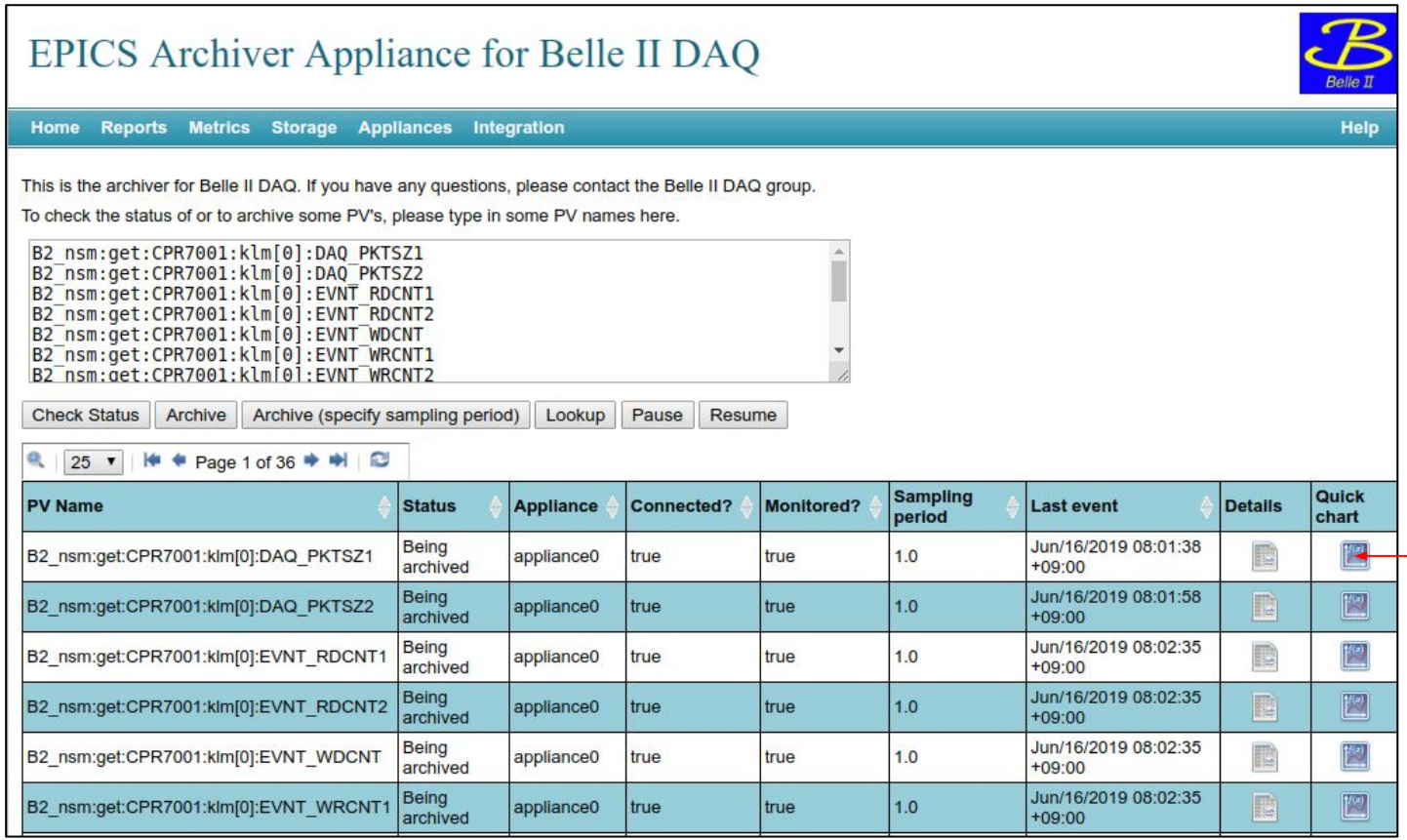
Implementation Details

- These 864 NSM2 variables are converted to EPICS PVs using nsm2cad tool.
- The nsm2cad tool runs on the 3 readout PCs - klm01, klm02, klm03.
  - ➢ klm01 is the host for - CPR7001 and CPR7002
  - ➢ klm02 is the host for - CPR7003 and CPR7004
  - ➢ klm03 is the host for - CPR8001, CPR8002, CPR8003 and CPR8004
- Three nsm2cad scripts klm01.cmd, klm02.cmd and klm03.cmd runs on these three readout machine in screen sessions and converts the NSM2 variables from those 8 COPPERs to corresponding EPICS PVs.
- The EPICS PVs have the following naming convention -
  - ➢ CPRxxxx:klm[n]:<register_name>
  - ➢ xxxx = 7001, 7002, 7003, 7004, 8001, 8002, 8003 and 8004
  - ➢ n = 0, 1, 2 and 3 which corresponds to HSLB links -a, -b, -c and -d.

Implementation Details

- The readings of 27 registers (followed by assignment to corresponding NSM2 variable) are performed without any delay in between.
- If reading of some register fails, a 3 ms delay is given before retrying.
- Total 3 readings are tried for each register. If all 3 of them fail, a TIMEOUT or DEADBEEF value is assigned to the NSM2 variable.
- The EPICS PVs are archived using EPICS Archiver with 10 seconds interval.

Obtaining Plots from EPICS Archiver Appliance



EPICS Archiver Appliance for Belle II DAQ

Home Reports Metrics Storage Appliances Integration Help

This is the archiver for Belle II DAQ. If you have any questions, please contact the Belle II DAQ group.

To check the status of or to archive some PV's, please type in some PV names here.

```
B2_nsm:get:CPR7001:klm[0]:DAQ_PKTSZ1
B2_nsm:get:CPR7001:klm[0]:DAQ_PKTSZ2
B2_nsm:get:CPR7001:klm[0]:EVNT_RDCNT1
B2_nsm:get:CPR7001:klm[0]:EVNT_RDCNT2
B2_nsm:get:CPR7001:klm[0]:EVNT_WDCNT
B2_nsm:get:CPR7001:klm[0]:EVNT_WRCNT1
B2_nsm:get:CPR7001:klm[0]:EVNT_WRCNT2
```

Check Status | Archive | Archive (specify sampling period) | Lookup | Pause | Resume

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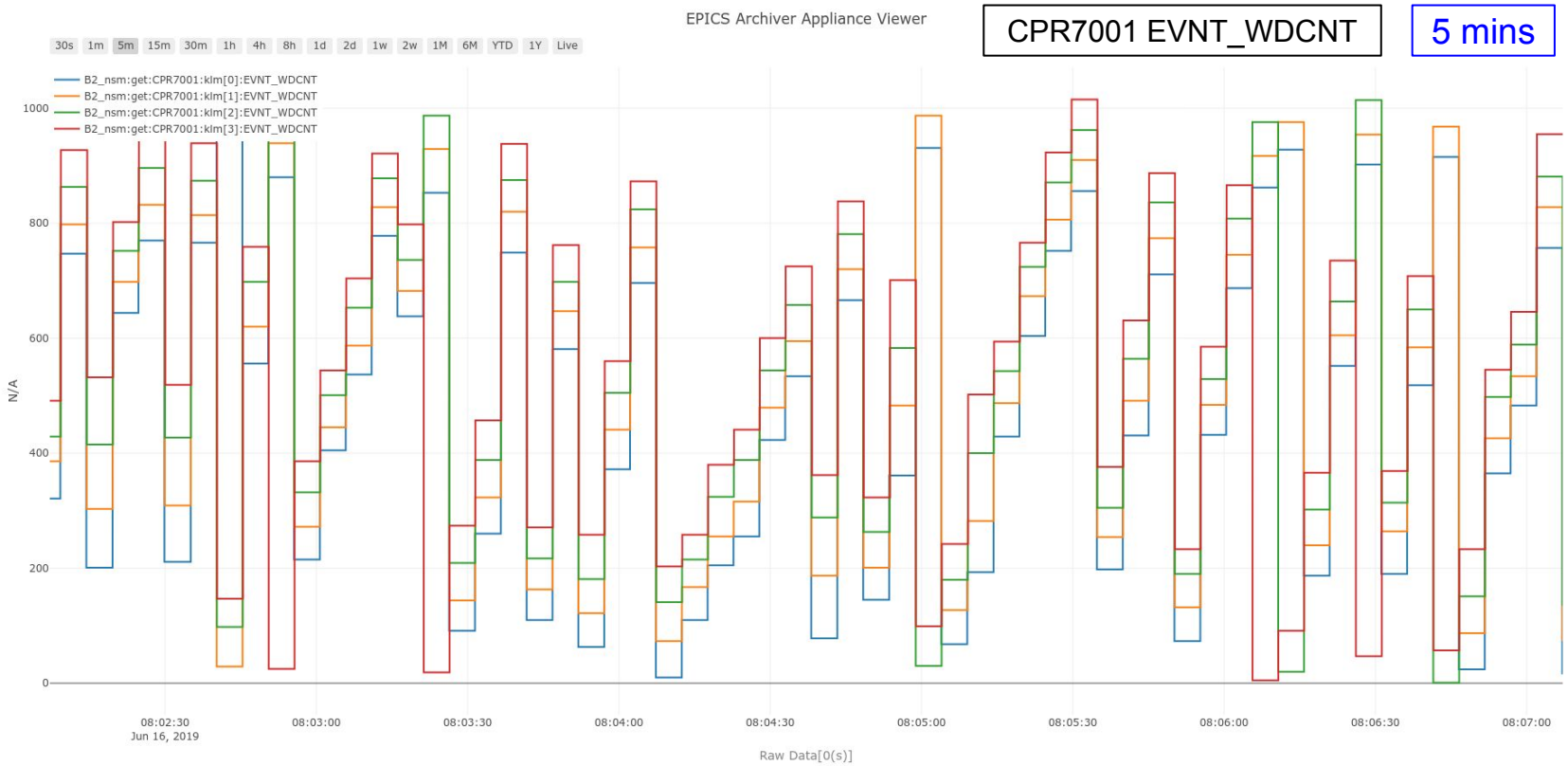
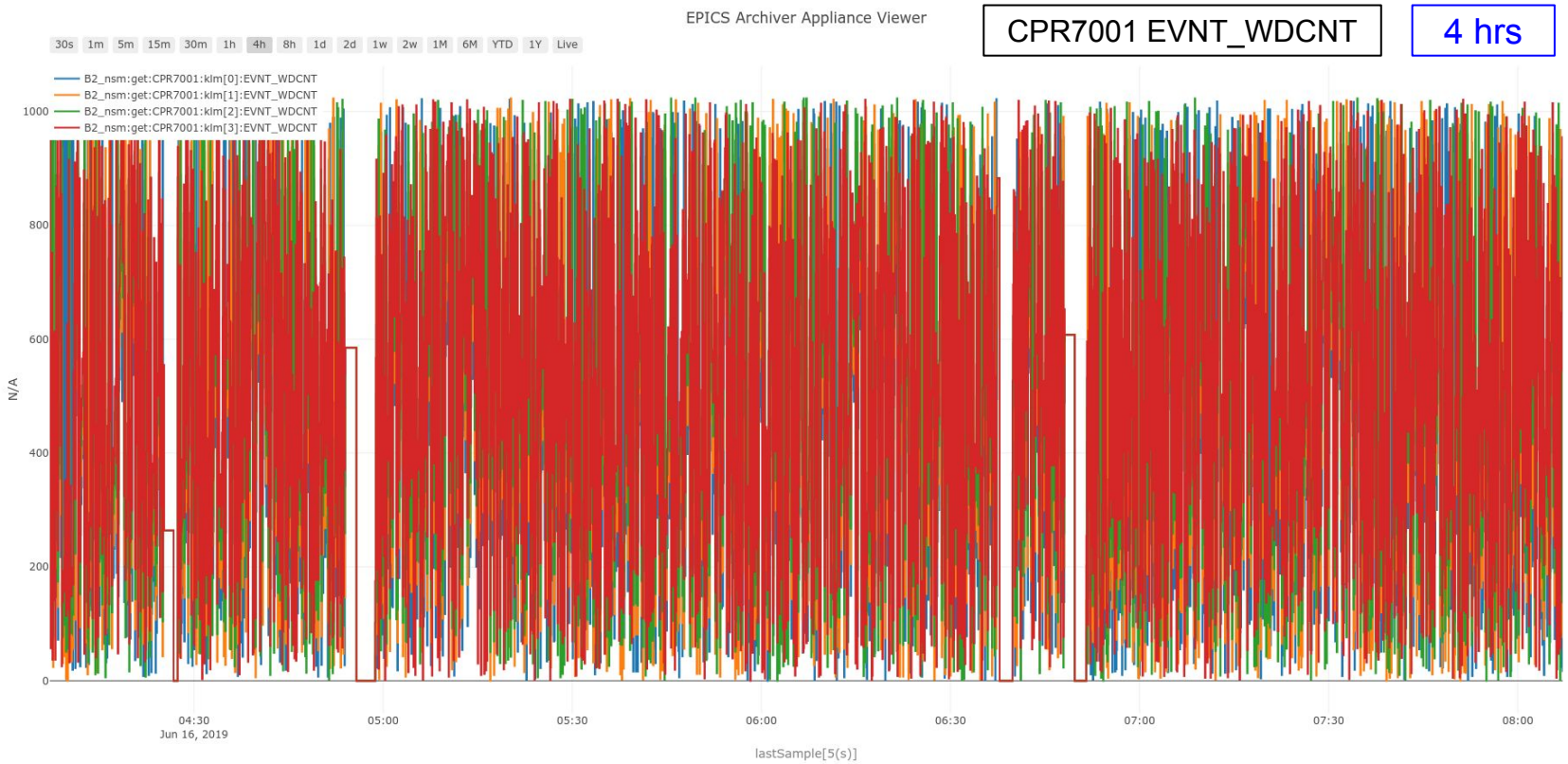
PV Name	Status	Appliance	Connected?	Monitored?	Sampling period	Last event	Details	Quick chart
B2_nsm:get:CPR7001:klm[0]:DAQ_PKTSZ1	Being archived	appliance0	true	true	1.0	Jun/16/2019 08:01:38 +09:00		
B2_nsm:get:CPR7001:klm[0]:DAQ_PKTSZ2	Being archived	appliance0	true	true	1.0	Jun/16/2019 08:01:58 +09:00		
B2_nsm:get:CPR7001:klm[0]:EVNT_RDCNT1	Being archived	appliance0	true	true	1.0	Jun/16/2019 08:02:35 +09:00		
B2_nsm:get:CPR7001:klm[0]:EVNT_RDCNT2	Being archived	appliance0	true	true	1.0	Jun/16/2019 08:02:35 +09:00		
B2_nsm:get:CPR7001:klm[0]:EVNT_WDCNT	Being archived	appliance0	true	true	1.0	Jun/16/2019 08:02:35 +09:00		
B2_nsm:get:CPR7001:klm[0]:EVNT_WRCNT1	Being archived	appliance0	true	true	1.0	Jun/16/2019 08:02:35 +09:00		

Click here

Example Plots from the EPICS Archiver Appliance



Example Plots from the EPICS Archiver Appliance



Summary of the KLM Archiver Interface

- The contents of KLM Data Concentrator status registers are being archived in using EPICS Archiver with 10 seconds interval.
- Total 864 values are being archived every 10 seconds.
  - ➢ 27 status registers in each HSLB link.
  - ➢ 4 HSLB links per COPPER.
  - ➢ Total 8 COPPERs (4 for BKLM and 4 for EKLM).
- The KLMFEE module was modified to implement this functionality.
  - ➢ KLMFEE::init() method defines the 27 NSM2 variables.
  - ➢ KLMFEE::monitor() updates these variables.
- With the latest version of KLMFEE code, the cprcontrold is running normally and the data flow rate through KLM COPPERs is as expected.

KLM Dark Current Monitoring for Beam Background Estimation

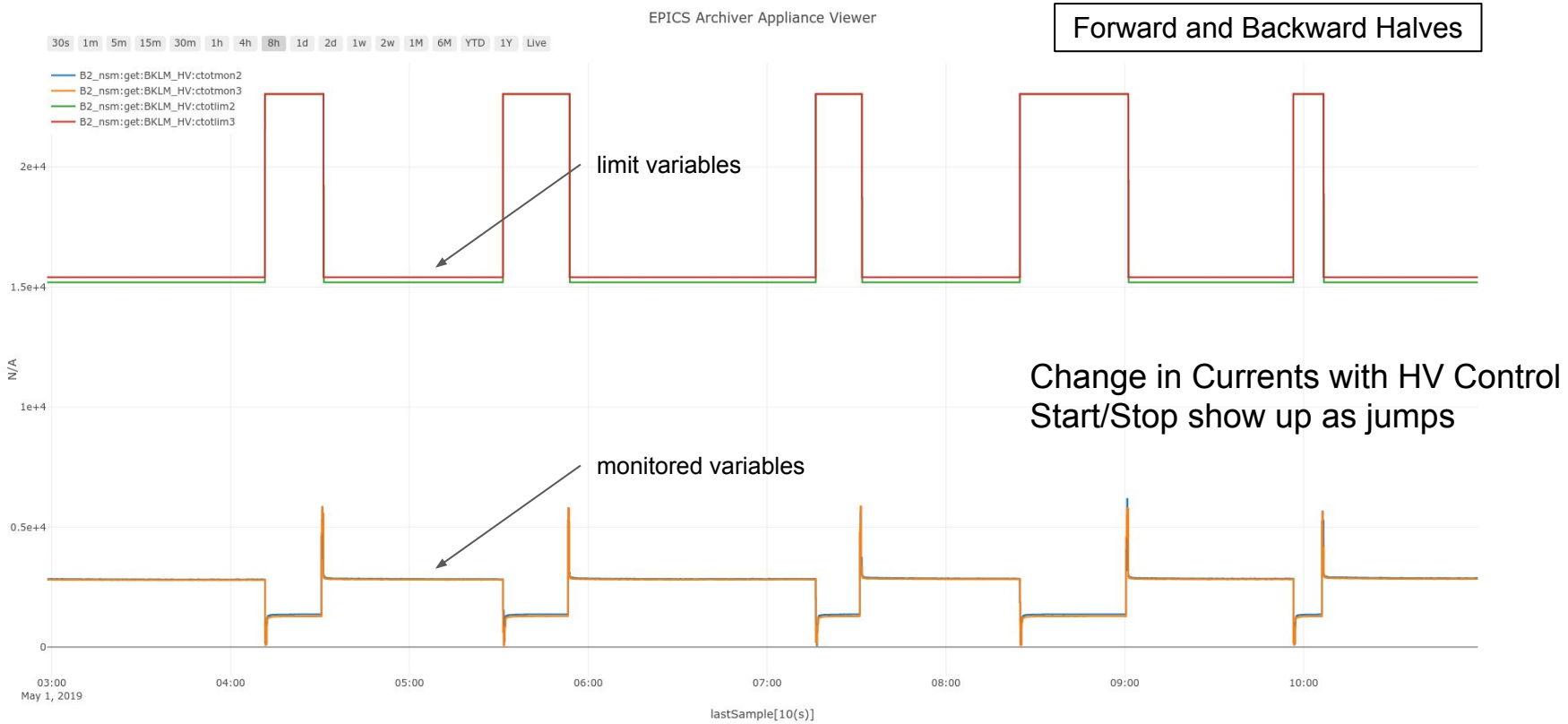
What is Dark Current?

- KLM is made of Resistive Plate Chambers (RPC)
  - RPCs consist of two parallel plates, a positively-charged anode and a negatively-charged cathode, both made of a very high resistivity plastic material and separated by a gas volume.
- Since an RPC is not an insulator, some current is always flowing through it.
  - When charged particles fly towards either plate of RPC, they ionize gas and create additional discharge, increasing the current.
- This current is called ***Dark Current***.
  - This way by measuring the average (or total) current from a number of RPCs we can **estimate the particle flux.**
- Similarly, SiPMs (Silicon PhotoMultiplier) present in KLM also have some contribution towards total dark current.
- Consequently, Dark Current acts as a good measure of **beam background for KLM sub-detector.**

KLM Dark Current Monitoring

- For BKLM
  - ➢ Total dark current is monitored for forward and backward barrel halves.
  - ➢ The total monitored current and total current limits are stored as NSM2 variables.
  - ➢ 4 EPICS PVs are exported
    - BKLM_HV:ctotmon2 - Total monitored current in forward barrel half.
    - BKLM_HV:ctotmon3 - Total monitored current in backward barrel half.
    - BKLM_HV:ctotlim2 - Total current limit in forward barrel half.
    - BKLM_HV:ctotlim3 - Total current limit in backward barrel half.
  - ➢ Ratio of total monitored dark current (ctotmon2 + ctotmon3) and total dark current limit (ctotmon2 + ctotmon3) is being used as KLM background level in BCG control room.

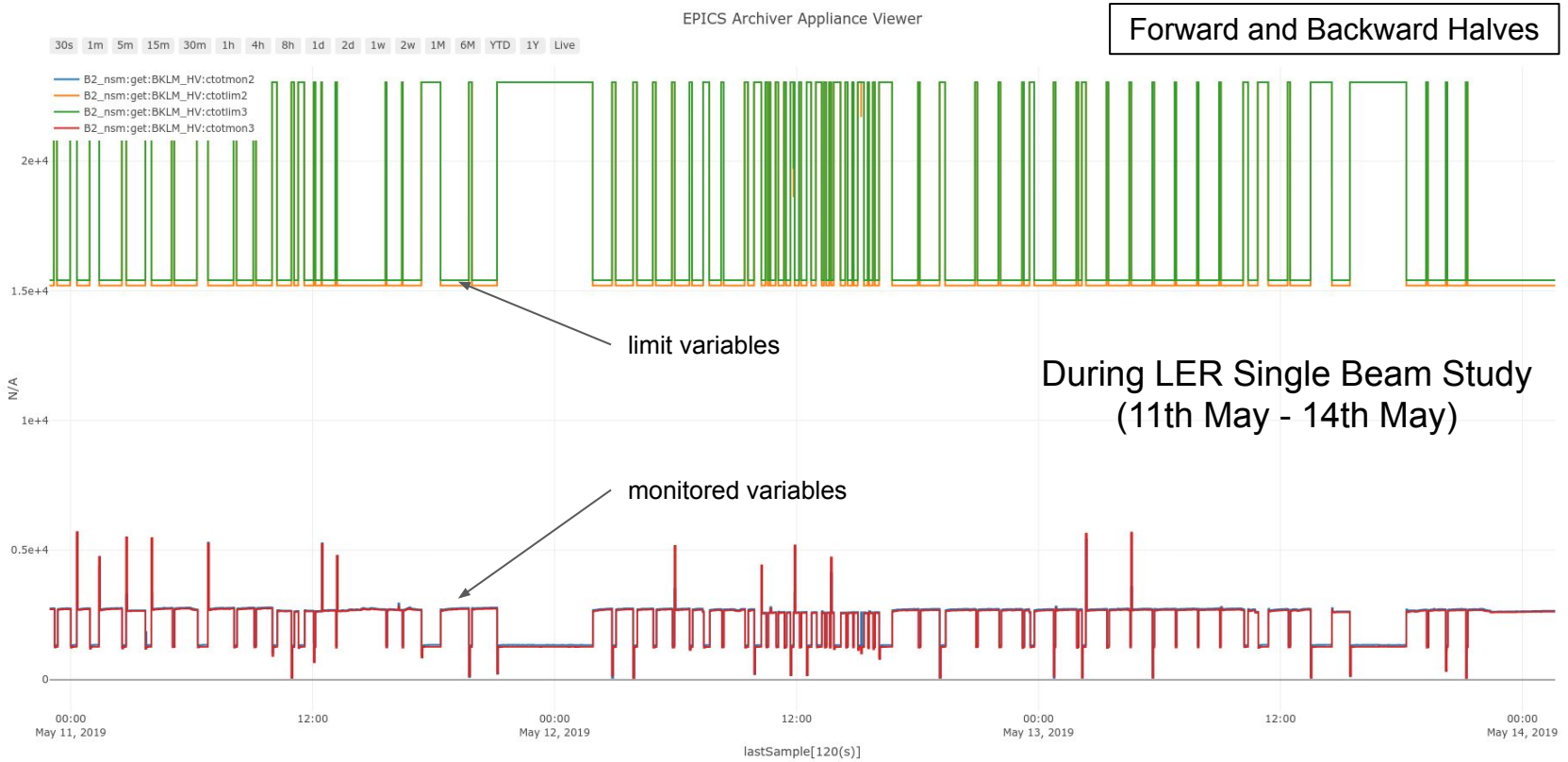
Example Plots from the EPICS Archiver Appliance



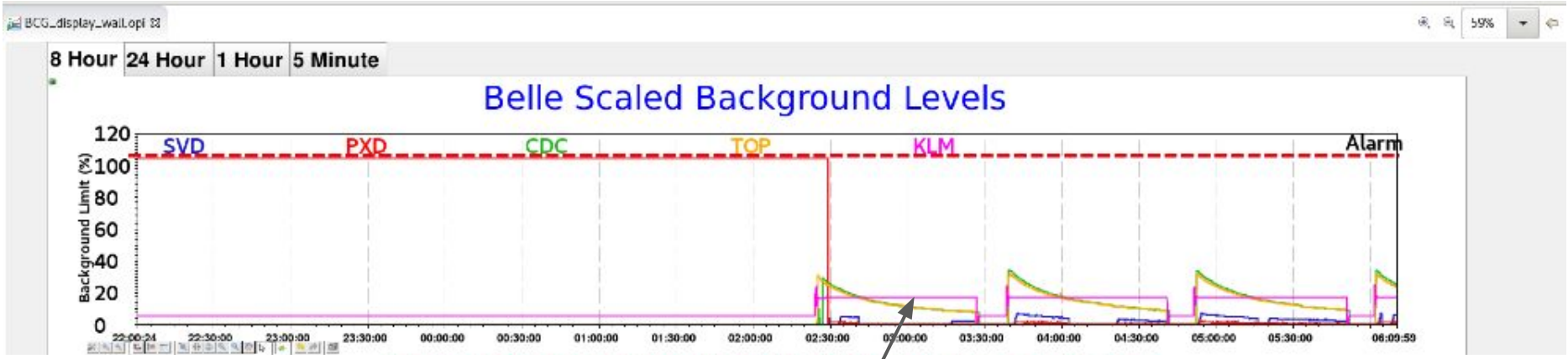
Forward and Backward Halves

Change in Currents with HV Control Start/Stop show up as jumps

Example Plots from the EPICS Archiver Appliance



Example Screenshot from BCG Control Room



The pink line is for KLM

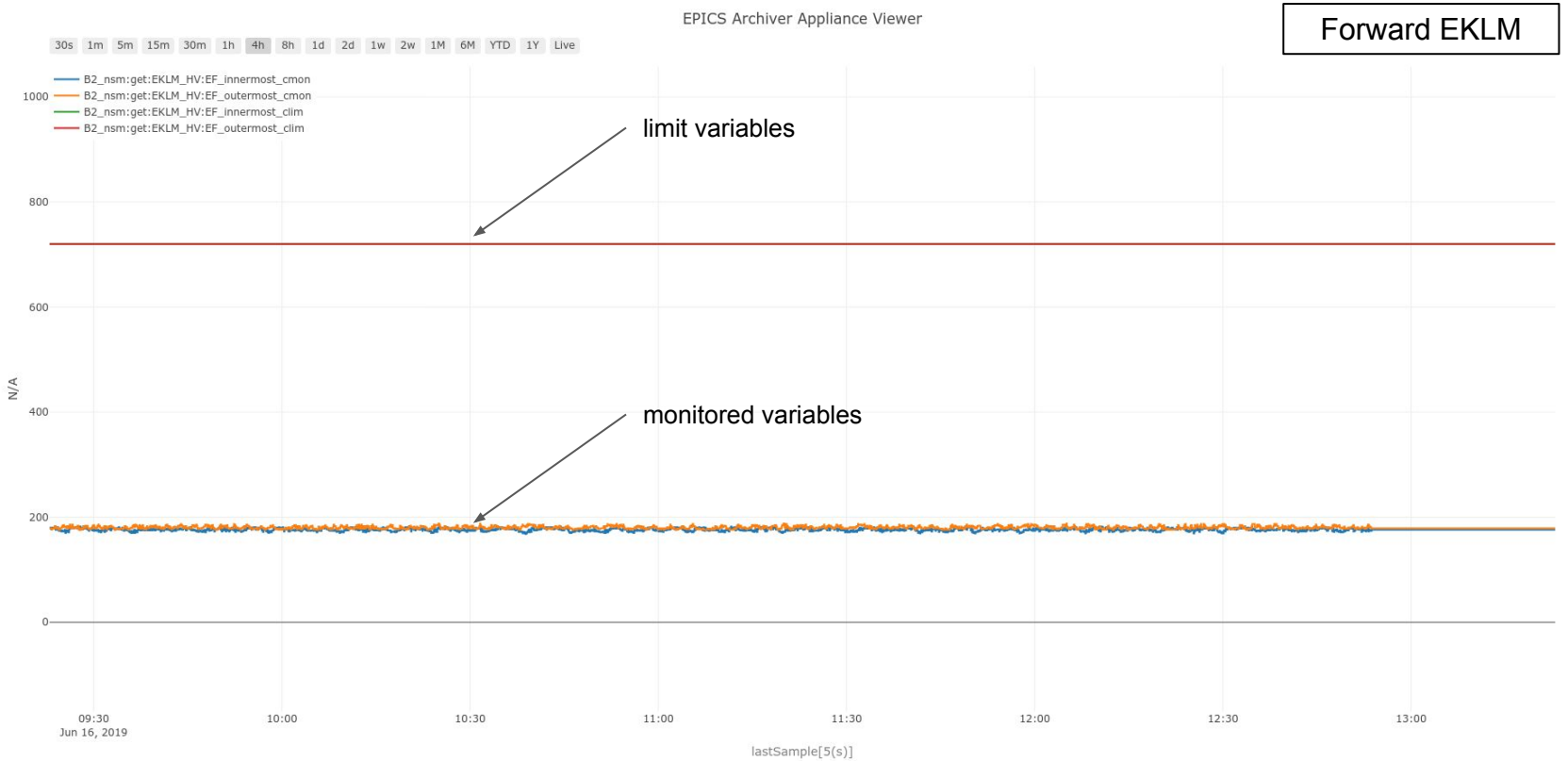
KLM Dark Current Monitoring

- For EKLM
  - ➢ Total dark current is monitored for the innermost and outermost layers of the forward and backward endcaps.
  - ➢ The total monitored current and total current limits are stored as NSM2 variables.
  - ➢ 8 EPICS PVs are exported
    - EKLM_HV:EB_innermost_cmon
    - EKLM_HV:EB_innermost_clim
    - EKLM_HV:EB_outermost_cmon
    - EKLM_HV:EB_outermost_clim
    - EKLM_HV:EF_innermost_cmon
    - EKLM_HV:EF_innermost_clim
    - EKLM_HV:EF_outermost_cmon
    - EKLM_HV:EF_outermost_clim
  - ➢ The PVs with suffix ‘_cmon’ and ‘_clim’ refers to the monitored current and the corresponding current limit respectively.

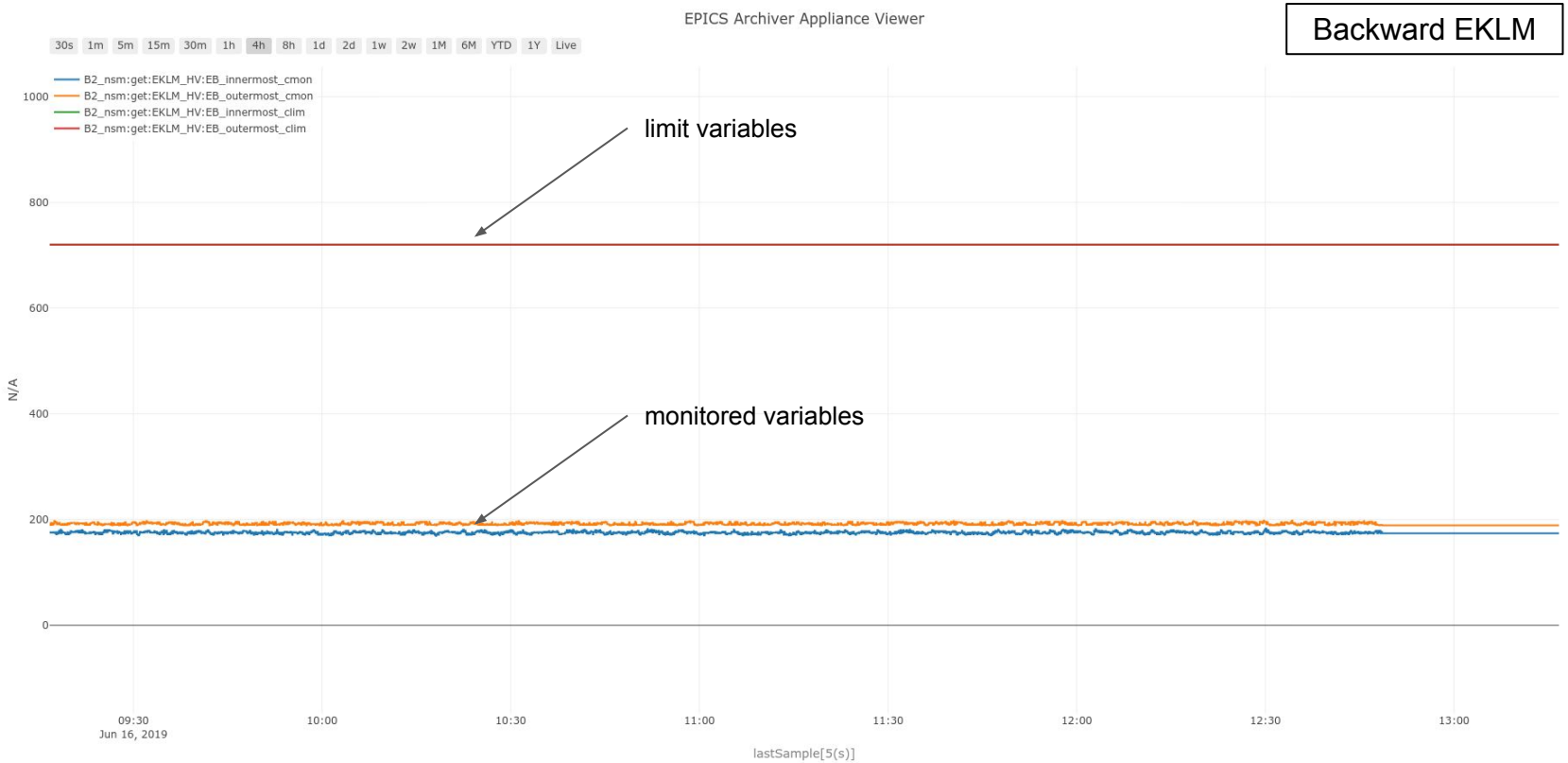
KLM Dark Current Monitoring

- These EKLM dark currents PVs corresponds specific background levels
  - ➢ Forward outermost layer - to measure upstream beam backgrounds from the LER
  - ➢ Forward innermost layer - to measure forward-going backgrounds from the IP
  - ➢ Backward outermost layer - to measure upstream beam backgrounds from the HER
  - ➢ Backward innermost layer - to measure backward-going backgrounds from the IP
- These PVs will be archived using EPICS Archiver every 0.1 second.
- The logged information can be correlated with information from the other detectors, background monitors and SuperKEKB diagnostics.

Example Plots from the EPICS Archiver Appliance



Example Plots from the EPICS Archiver Appliance



Summary of the KLM Dark Current Monitoring

- 4 and 8 NSM2 variables have been defined to monitor BKLM and EKLM dark currents respectively.
- These 12 variables are being converted to EPICS PVs using nsm2cad tool running on klmpc02 for monitoring and logging purposes.
- The BKLM dark current PVs reports the monitored currents in forward and backward barrel halves, along with the corresponding limits.
- The EKLM dark current PVs reports the monitored dark current in innermost and outermost layers of forward and backward endcaps, along with the corresponding limits.
- All these 12 PVs are being archived using the official EPICS Archiver Appliance.