Metadata/SC data handling experience: Streaming DAQ

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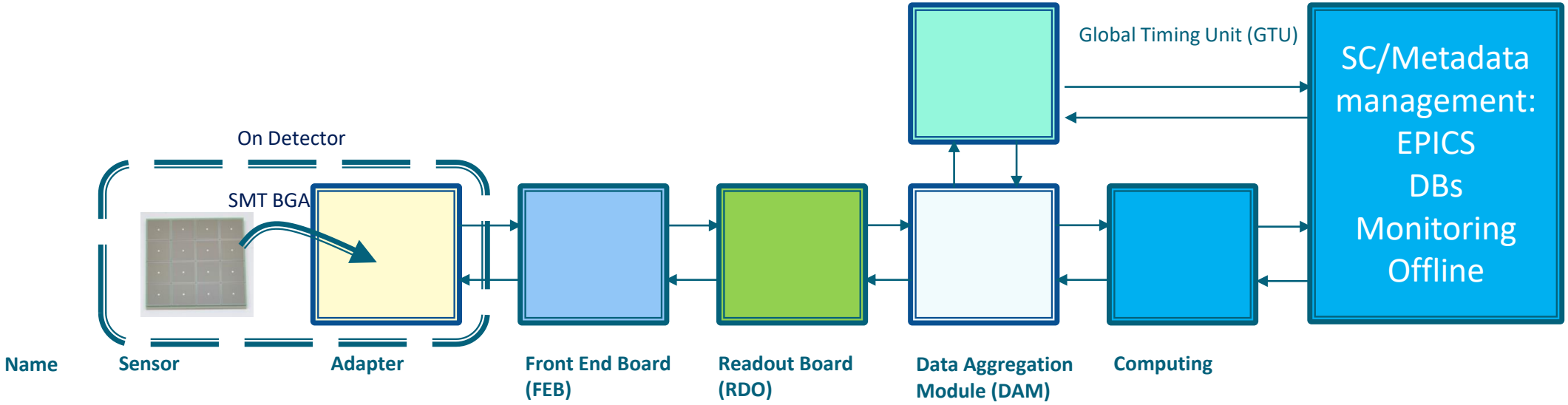
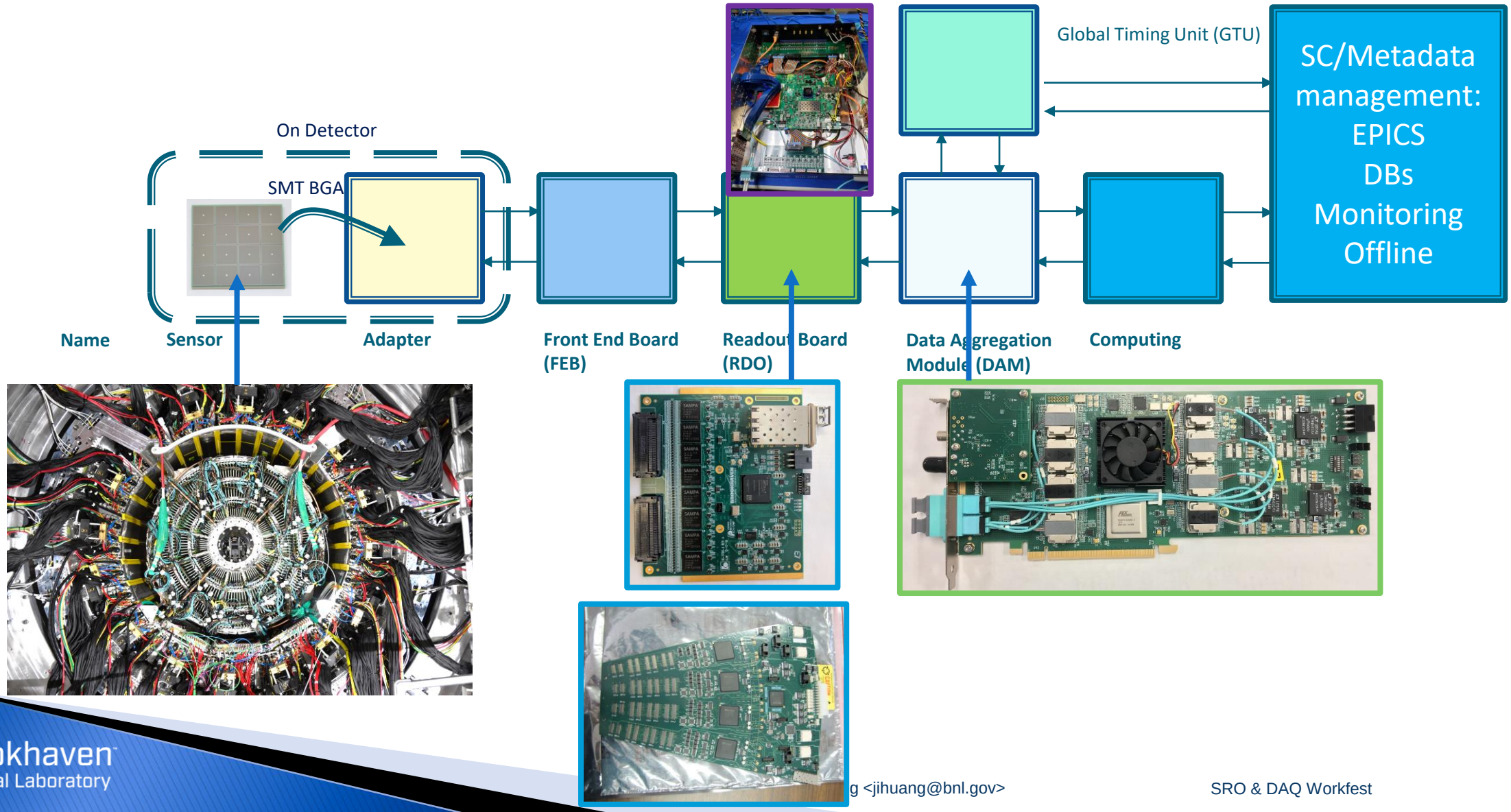
ePIC SRO Readout Chain and slow control



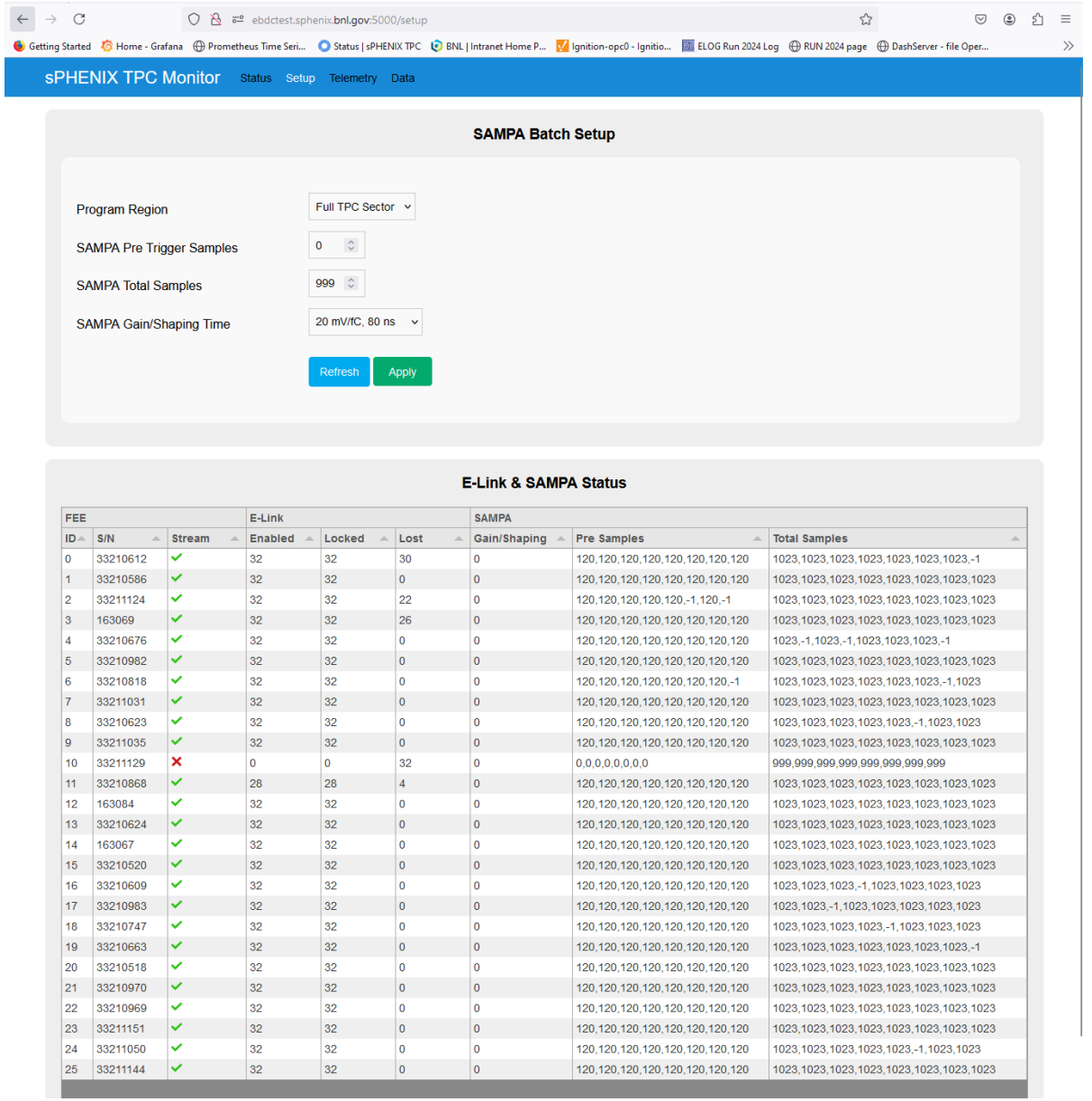
- ePIC SRO readout chain double as the SC pathway for FEB/RDO/DAM configuration, as well as continuous metrics collection
- Work in concert with experiment SC system, such as PLC-based detector environment control, HV/LV control, and interlocks

Scheme very similar to my past/current SRO detectors: Forward si tracker@PHENIX, TPC @ sPHENIX



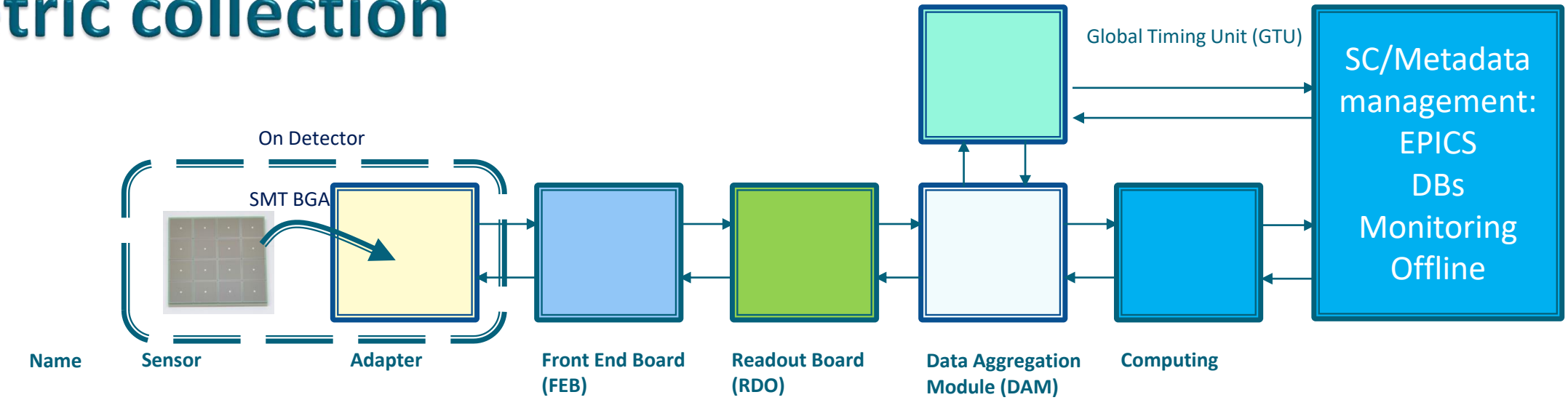
Configuration interfaces

- Lower level interface:
  - Talk to FELIX/RDO/ASIC via register read/write
  - sPHENIX TPC: gRPC interface to FELIX kernel module
- GUI:
  - For expert control and debugging
  - Linux GUI, and I like web GUIs
- Programmatic interface:
  - Used by DAQ software or batch configuration
  - Loading default configuration from file or DB

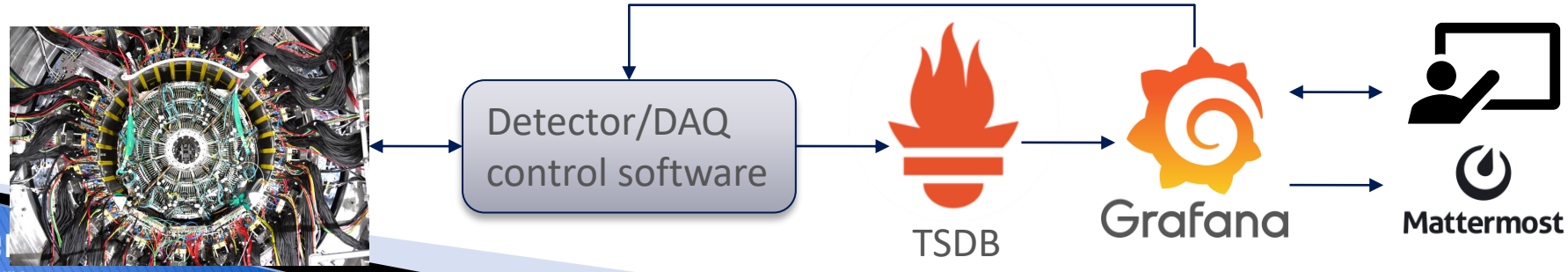


FEE			E-Link			SAMPA		
ID	S/N	Stream	Enabled	Locked	Lost	Gain/Shaping	Pre Samples	Total Samples
0	33210612	✓	32	32	30	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,-1
1	33210586	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
2	33211124	✓	32	32	22	0	120,120,120,120,120,-1,120,-1	1023,1023,1023,1023,1023,1023,1023,1023
3	163069	✓	32	32	26	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
4	33210676	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,-1,1023,-1,1023,1023,1023,-1
5	33210982	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
6	33210818	✓	32	32	0	0	120,120,120,120,120,120,120,-1	1023,1023,1023,1023,1023,1023,-1,1023
7	33211031	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
8	33210623	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,-1,1023,1023
9	33211035	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
10	33211129	✗	0	0	32	0	0,0,0,0,0,0,0,0	999,999,999,999,999,999,999,999
11	33210868	✓	28	28	4	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
12	163084	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
13	33210624	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
14	163067	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
15	33210520	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
16	33210609	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,-1,1023,1023,1023,1023
17	33210983	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,-1,1023,1023,1023,1023,1023
18	33210747	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,-1,1023,1023,1023
19	33210663	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,-1
20	33210518	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
21	33210970	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
22	33210969	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
23	33211151	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023
24	33211050	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,-1,1023,1023
25	33211144	✓	32	32	0	0	120,120,120,120,120,120,120,120	1023,1023,1023,1023,1023,1023,1023,1023

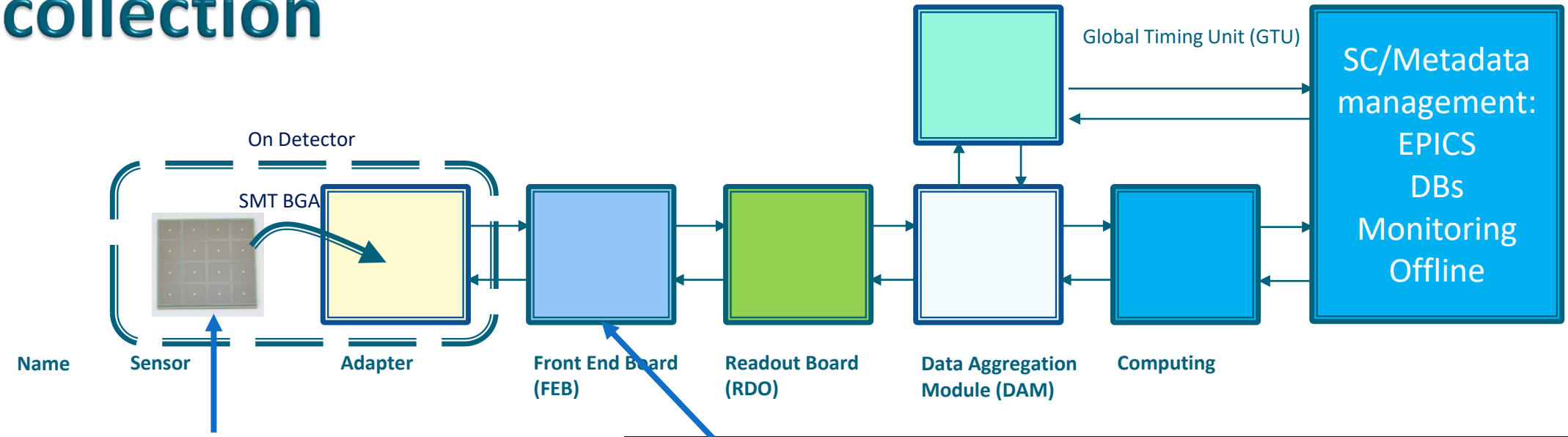
Metric collection

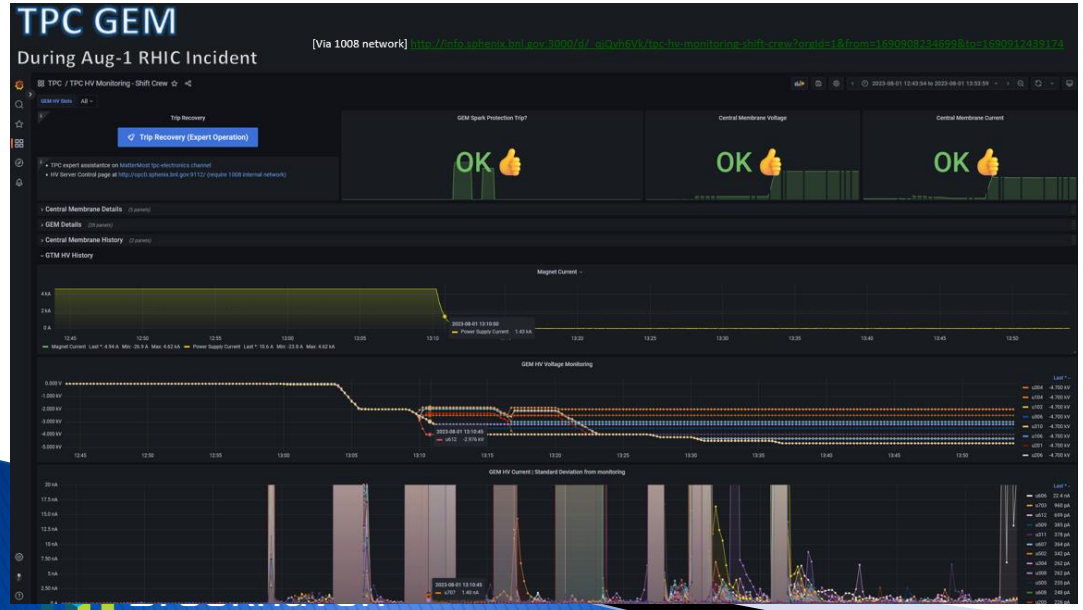


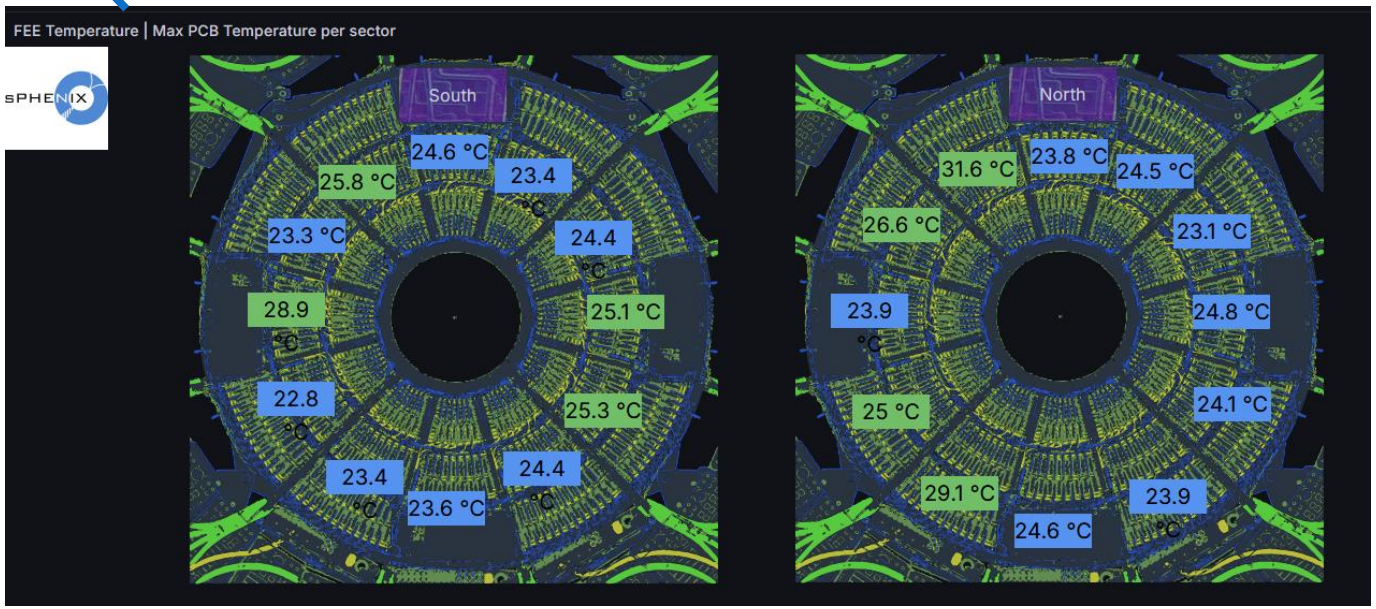
- SRO Readout collect continuous detector response → detector/accelerator feedback
- Readout pipeline health monitoring: critical for maintain a stable SRO pipeline
- I am big fan of using open-sourced monitoring stack, such as Time-Series DB+Grafana
  - High rate, O(second), metrics collection for online control; digestion for offline reco. DBs
  - 300k time series collected so far on sPHENIX



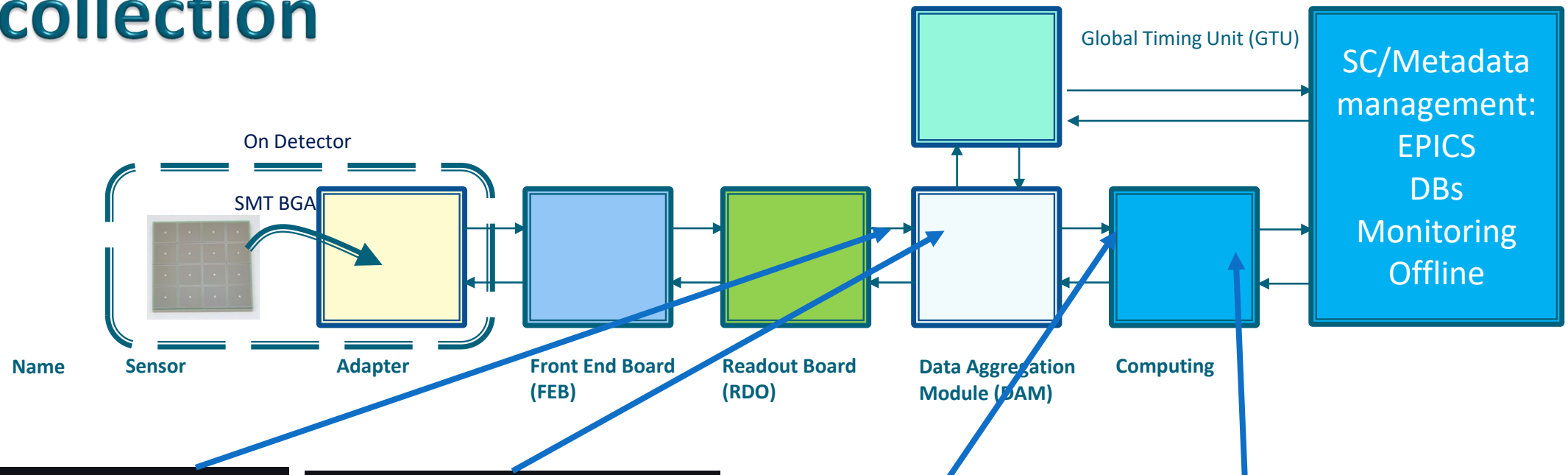
Metric collection

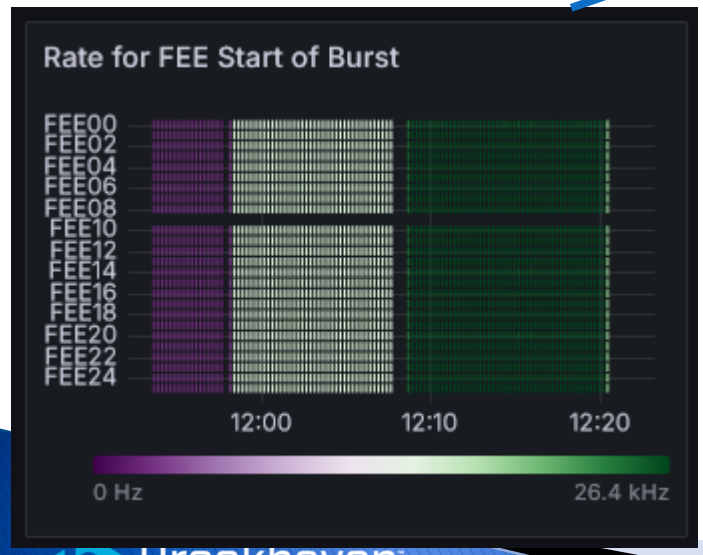


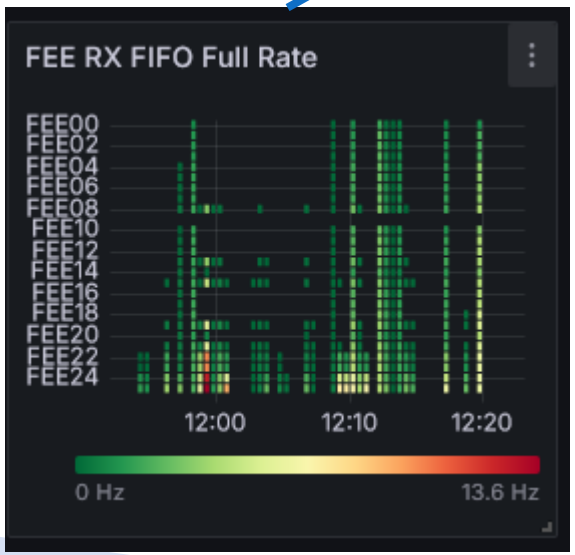


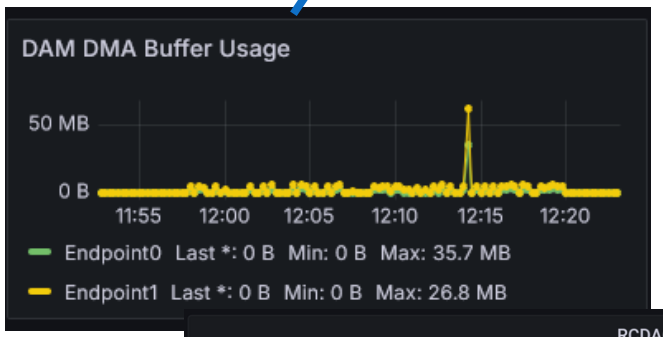


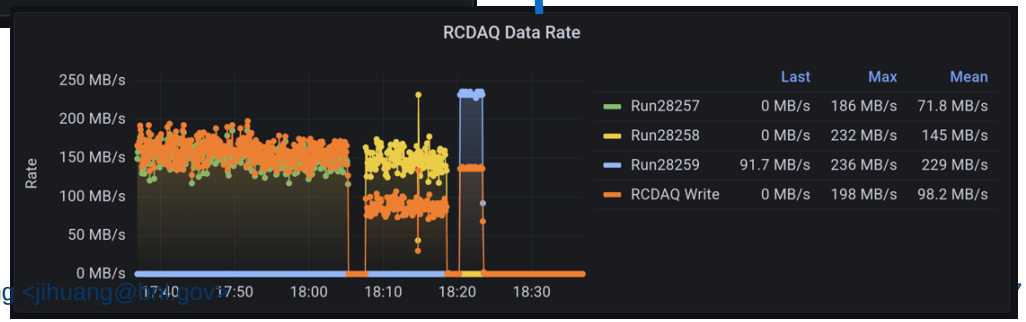
Metric collection











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Example in SRO used for detector and beam feedback

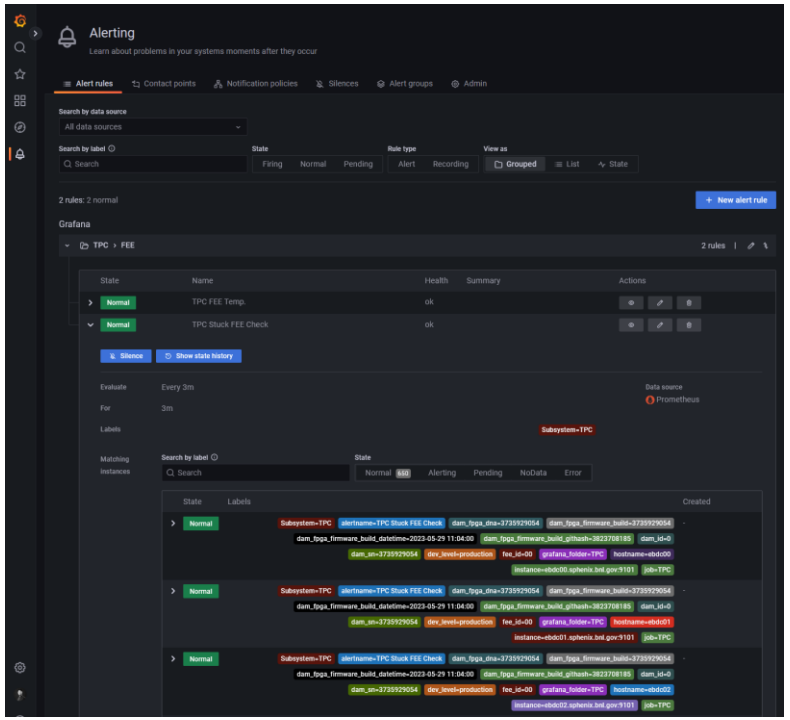
HV

Hit rate

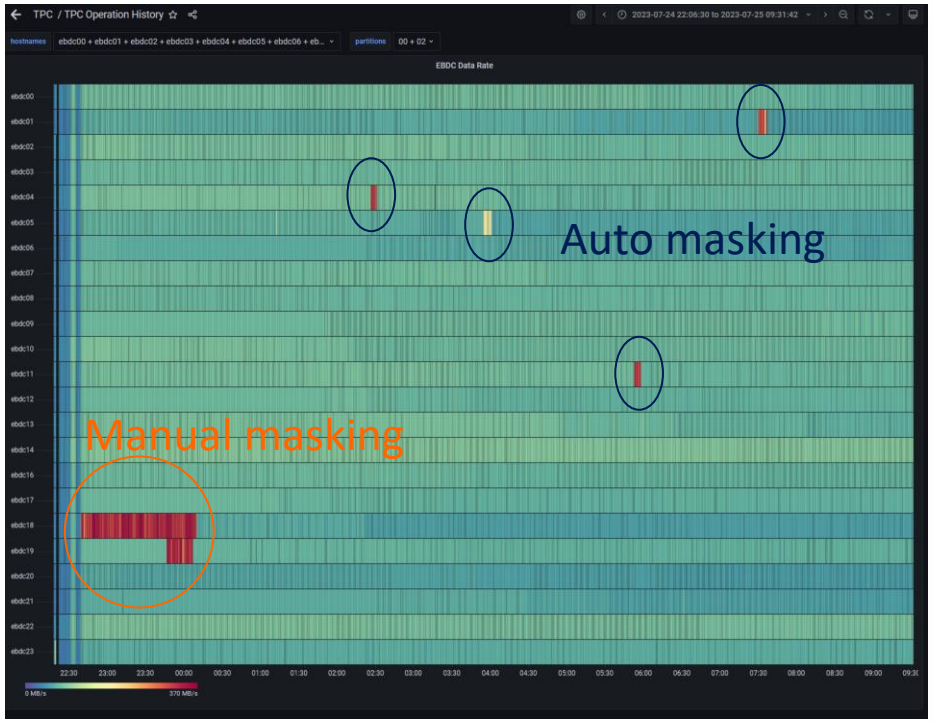
Beam

Automate actions: TPC SEU FEE (RDO) masking

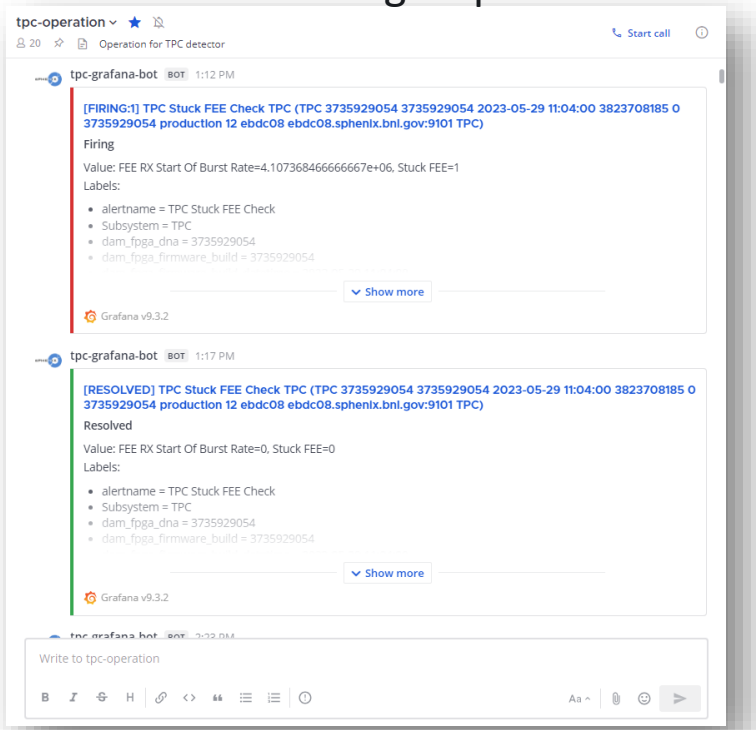
Auto masking configuration in Grafana



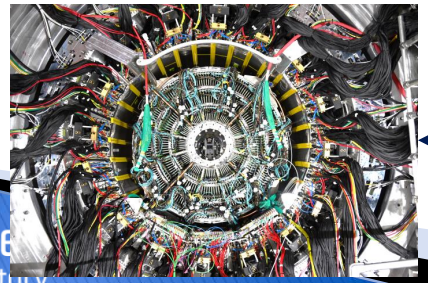
Auto masking enabled at 2AM



Notification to TPC group



Auto masking call to TPC FELIX Slow Control server



Filters + | Host All | partitions All | RHIC Dump/Abort Events | sPHENIX Physics | STAR Physics | CAD Lumi Counting | Pol Meas. Indicator

Latest GL1 Run
49219

GL1 Triggers 1.99 Mil

GL1 Trigger
9.0 kHz

GL1 Live TIme
97.3%

Physics

In Physics for
52.7 mins

ZDC NS (CAD scalars)
19.8 kHz

Bgd
52.1
MBD/ZDC

Magnet
4.61 kA
Magnet Current

Buffer Box Network
In 5.61 GB/s
Out 2.63 GB/s

BBOx: D
69.1%

MVTX | Status
ON

MVTX | Autorecovery
Ok 👍
MVTX Staves in Aut...

TPC | FEE Linked
OFF 😴
TPC FEEs Linked

TPOT | Detector HV State
TPOT On 👍

EMCal | Bias
383 Chan
EMCal IB HV

HCal | Bias
64 👍
HCal HV Channels

MBD | HV
16 👍
MBD HV Channels

sEPD | Status
sEPD Ok 👍

TPC | GEM HV
OFF 😴

TPC | Central Membrane HV
OFF 😴

TPOT | FEE Links (16 is good)
16 👍
TPOT FEEs Linked

TPOT | HV channel count (80
80 👍
TPOT active HV Ch...

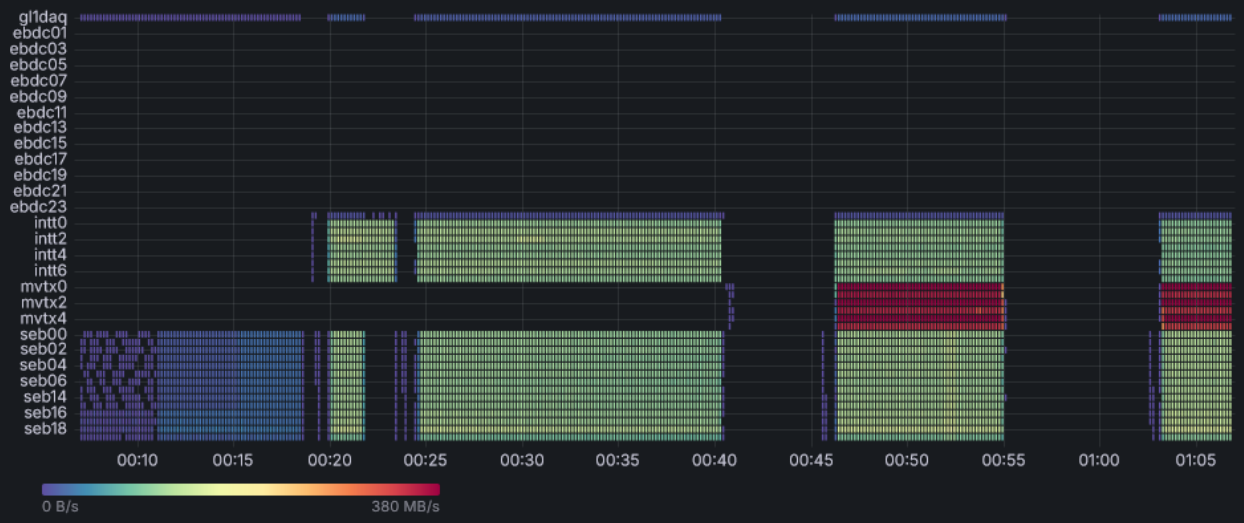
EMCal | LV
384 IB
EMCal IBs

HCal | LV
3072 👍
HCal Towers

sEPD | Bias Supplies
12 👍
sEPD Bias Channels

sEPD | Interface Boards
24 👍
sEPD Interface Boar...

RCDAQ Disk Write Rate Timeline



GL1 & MBD_NS trigger rate; CAD Scalars on ZDC and Background Counters

Name	Last *
GL1 Trigger	9.51 kHz
MBD_NS	1.58 MHz
N2yellow Bgd	8.81 kHz
S2blue Bgd	0 Hz
ZDC N Sum	219 kHz
ZDC N-S	19.8 kHz

Background | MBD Single to ZDC Coincidence Ratio (only available with sPHENIX DAQ operating)

Name	Last	Max
Det Turn On (except TPC)	400	400
TPC Turn On	180	180
MBD N/ZDC_NS	126	187623
MBD S/ZDC_NS	108	948594

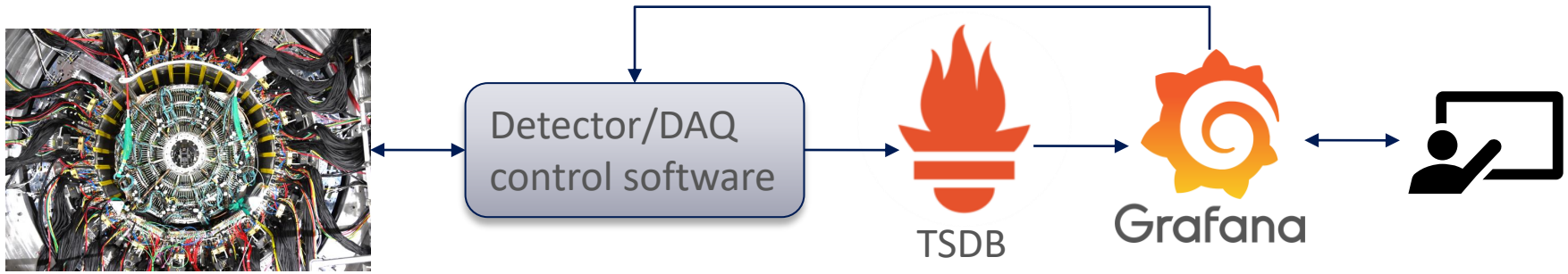
Questions?

- More bonus plots below

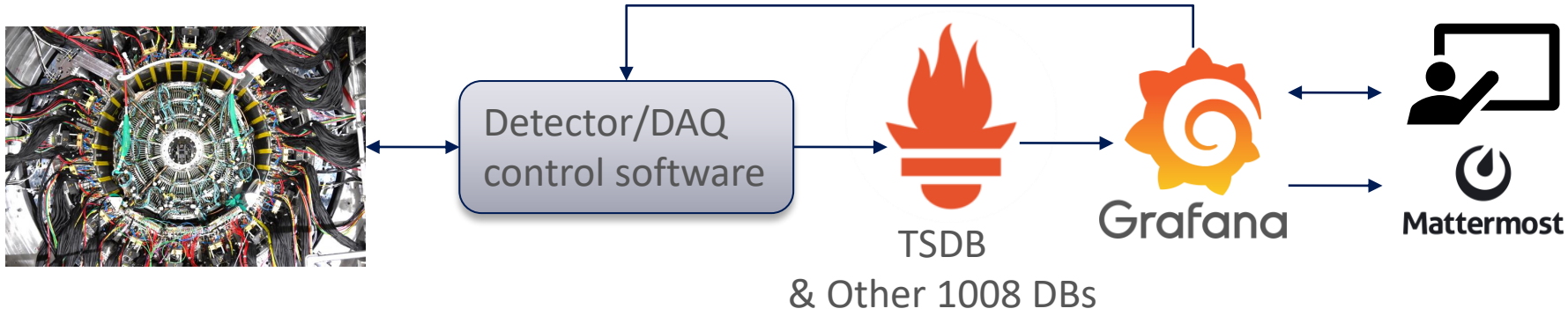
What is Prometheus TSDB And Grafana?

Prometheus is an open-source time series database (TSDB) designed for monitoring and analytics. It stores and queries time-based data, enabling organizations to gain valuable insights for performance optimization and troubleshooting.

Grafana is an open-source tool that provides interactive data visualization and analytics. It allows users to ingest data from various sources, query and display it in customizable charts, and set alerts for abnormal behavior



- Record any time-series data efficiently, every few seconds, and make analytics plot easily
- Identify problems early, diagnostic tool to solve them
- Moden GUI for operational monitoring (and control) for shift crew and experts, view anywhere (access instruction later)
- Substantial preliminary deployment in Run23, covering almost every part of sPHENIX: DAQ, online computing, HCals, EMCal, sEPD, MBD, TPOT, TPC, INTT, MVTX, GTM, and RHIC metric mirroring

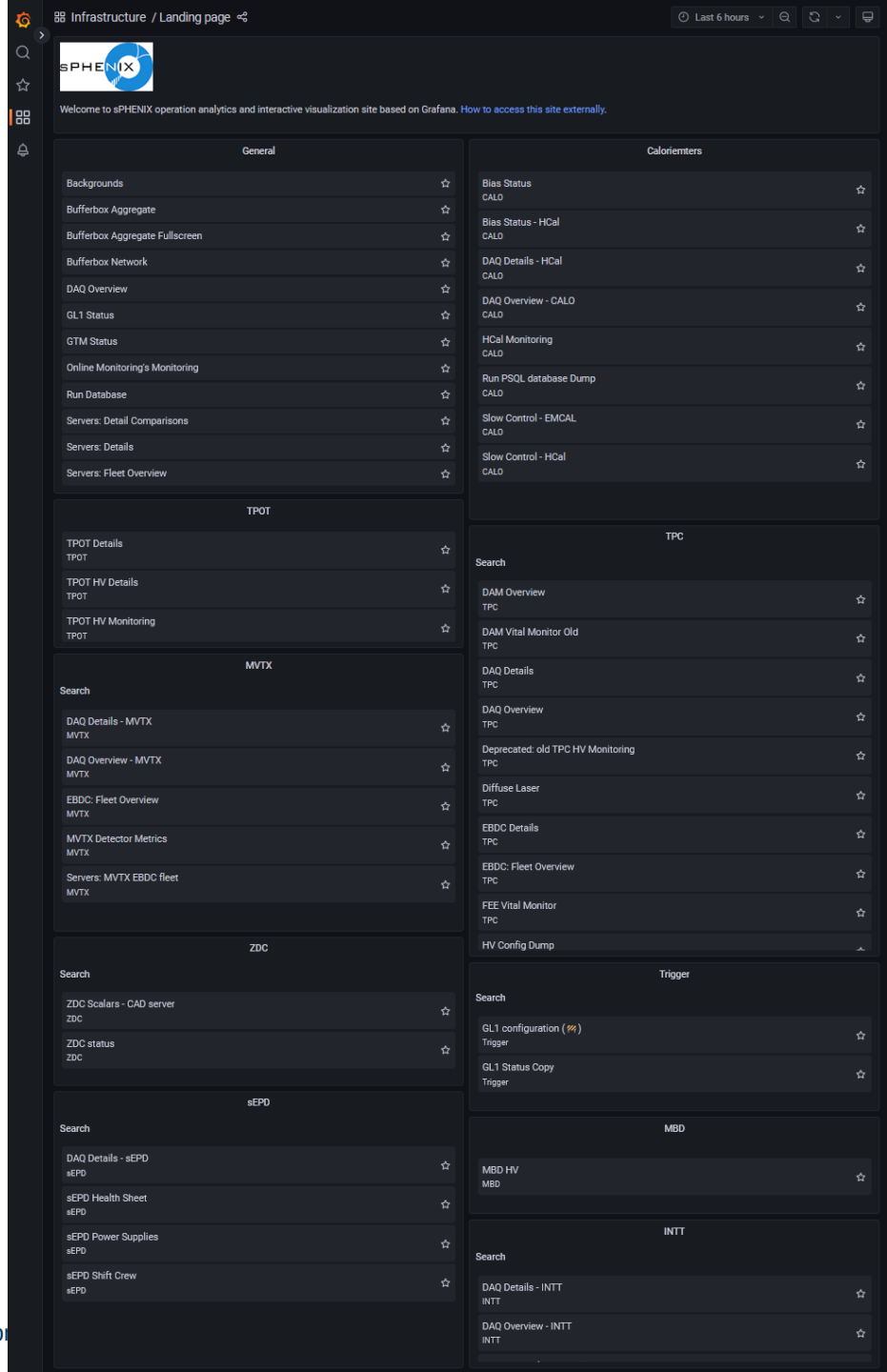


Run23 experience

- Who is behind the setup?
  - Martin performed initial installation
  - Hugo C.: TPOT HV->TSDB, Dashboards
  - Emma M.: Hcal Dashboard
  - John K.: TPC laser->TSDB
  - Thomas M.: TPC services
  - Uconn&Zhaozhong: MVTX service->TSDB, Dashboards
  - Tristan P.: sEPD->TSDB, Dashboards
  - Mickey&Students: MBD monitoring
  - and more
- To date: recorded 206k time series in TSDB from 176 sPHENIX data sources
- You might have seen many Grafana displays on shift station and shift-change reports
- One out-of-service incident:
  - Server hardware failure before Run23 start. Martin recovered it by swapping server hardware
  - Run24 setup will migrate to a powerful new server insight.sphenix.bnl.gov (32 core, 128GB, NVME) , and configure as high availability modes (hot-swappable double TSDB and Grafana instances)

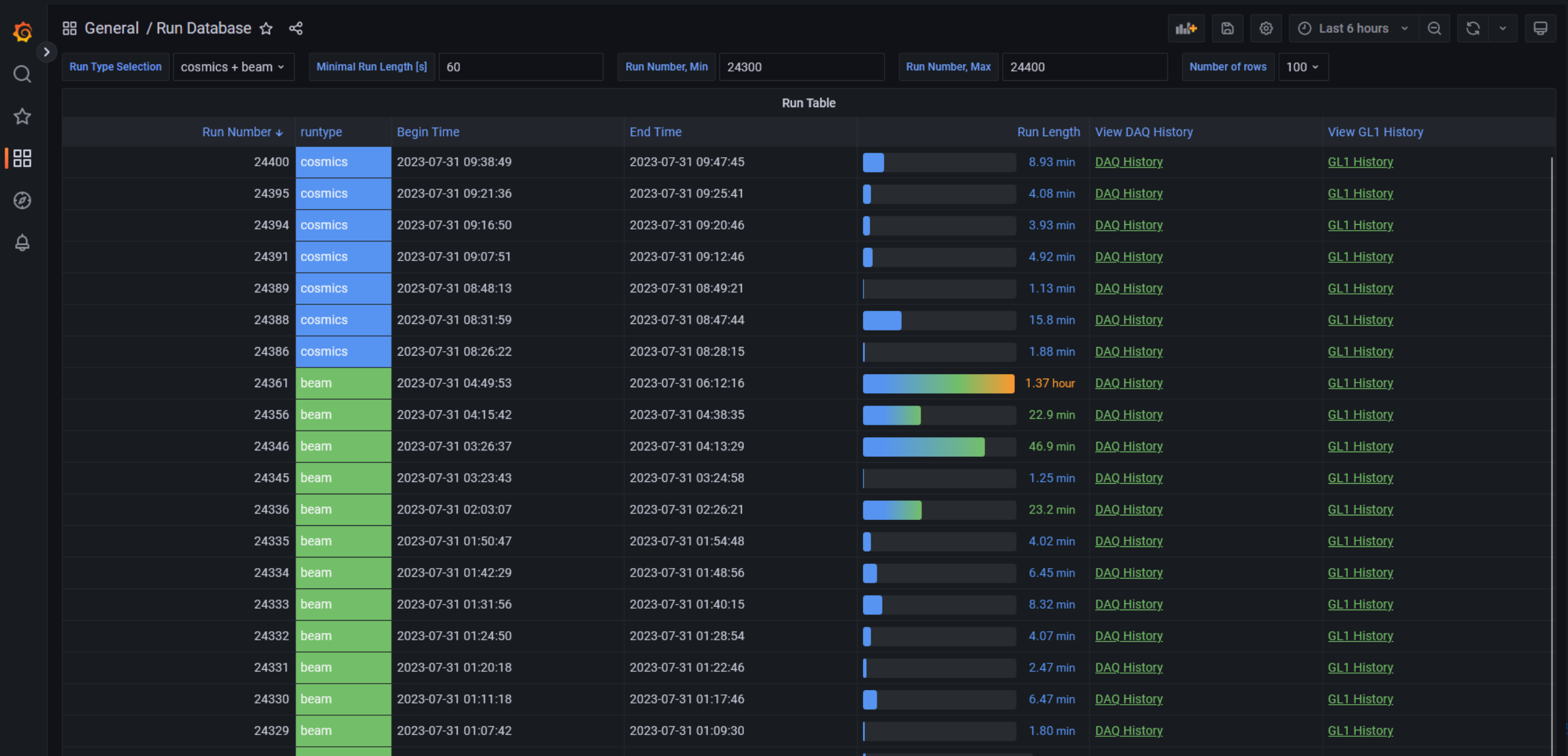
Git repo for TSDB exporters

https://git.racf.bnl.gov/gitea/sphenix/?sort=recentupdate&language=&q=exporter



Run database viewer

[Via 1008 network] http://info.sphenix.bnl.gov:3000/d/pECQaU4Ik/run-database?orgId=1



Run Number	runtype	Begin Time	End Time	Run Length	View DAQ History	View GL1 History
24400	cosmics	2023-07-31 09:38:49	2023-07-31 09:47:45	8.93 min	DAQ History	GL1 History
24395	cosmics	2023-07-31 09:21:36	2023-07-31 09:25:41	4.08 min	DAQ History	GL1 History
24394	cosmics	2023-07-31 09:16:50	2023-07-31 09:20:46	3.93 min	DAQ History	GL1 History
24391	cosmics	2023-07-31 09:07:51	2023-07-31 09:12:46	4.92 min	DAQ History	GL1 History
24389	cosmics	2023-07-31 08:48:13	2023-07-31 08:49:21	1.13 min	DAQ History	GL1 History
24388	cosmics	2023-07-31 08:31:59	2023-07-31 08:47:44	15.8 min	DAQ History	GL1 History
24386	cosmics	2023-07-31 08:26:22	2023-07-31 08:28:15	1.88 min	DAQ History	GL1 History
24361	beam	2023-07-31 04:49:53	2023-07-31 06:12:16	1.37 hour	DAQ History	GL1 History
24356	beam	2023-07-31 04:15:42	2023-07-31 04:38:35	22.9 min	DAQ History	GL1 History
24346	beam	2023-07-31 03:26:37	2023-07-31 04:13:29	46.9 min	DAQ History	GL1 History
24345	beam	2023-07-31 03:23:43	2023-07-31 03:24:58	1.25 min	DAQ History	GL1 History
24336	beam	2023-07-31 02:03:07	2023-07-31 02:26:21	23.2 min	DAQ History	GL1 History
24335	beam	2023-07-31 01:50:47	2023-07-31 01:54:48	4.02 min	DAQ History	GL1 History
24334	beam	2023-07-31 01:42:29	2023-07-31 01:48:56	6.45 min	DAQ History	GL1 History
24333	beam	2023-07-31 01:31:56	2023-07-31 01:40:15	8.32 min	DAQ History	GL1 History
24332	beam	2023-07-31 01:24:50	2023-07-31 01:28:54	4.07 min	DAQ History	GL1 History
24331	beam	2023-07-31 01:20:18	2023-07-31 01:22:46	2.47 min	DAQ History	GL1 History
24330	beam	2023-07-31 01:11:18	2023-07-31 01:17:46	6.47 min	DAQ History	GL1 History
24329	beam	2023-07-31 01:07:42	2023-07-31 01:09:30	1.80 min	DAQ History	GL1 History

DAQ Overview

[Via 1008 network] http://info.sphenix.bnl.gov:3000/d/7FfmSZQ4z/daq-overview?from=1690793333000&to=1690798336000&orgId=1

DAQ Overview

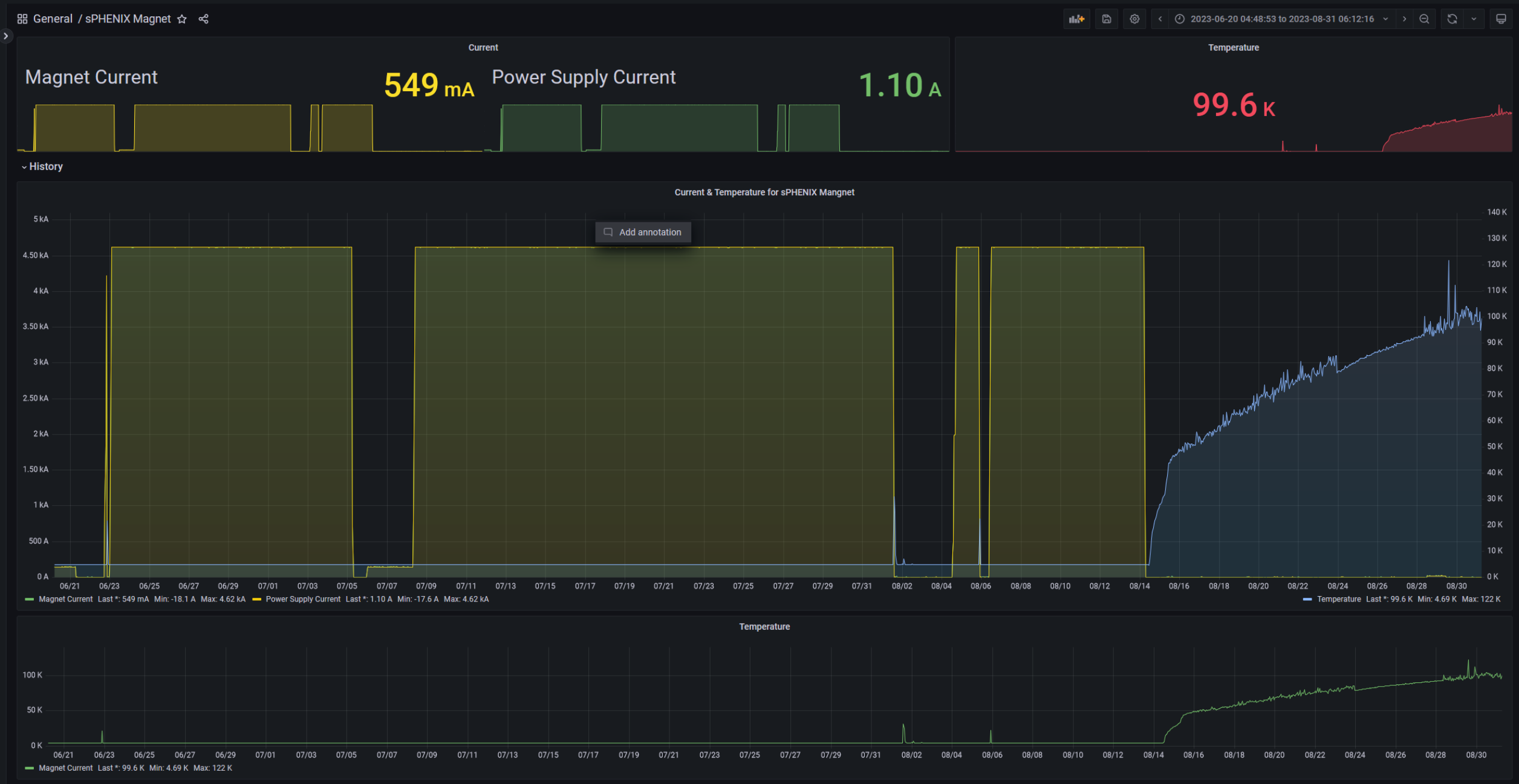
[Via 1008 network] http://info.sphenix.bnl.gov:3000/d/7FfmSZQ4z/daq-overview?from=1690793333000&to=1690798336000&orgId=1

GL1 Overview

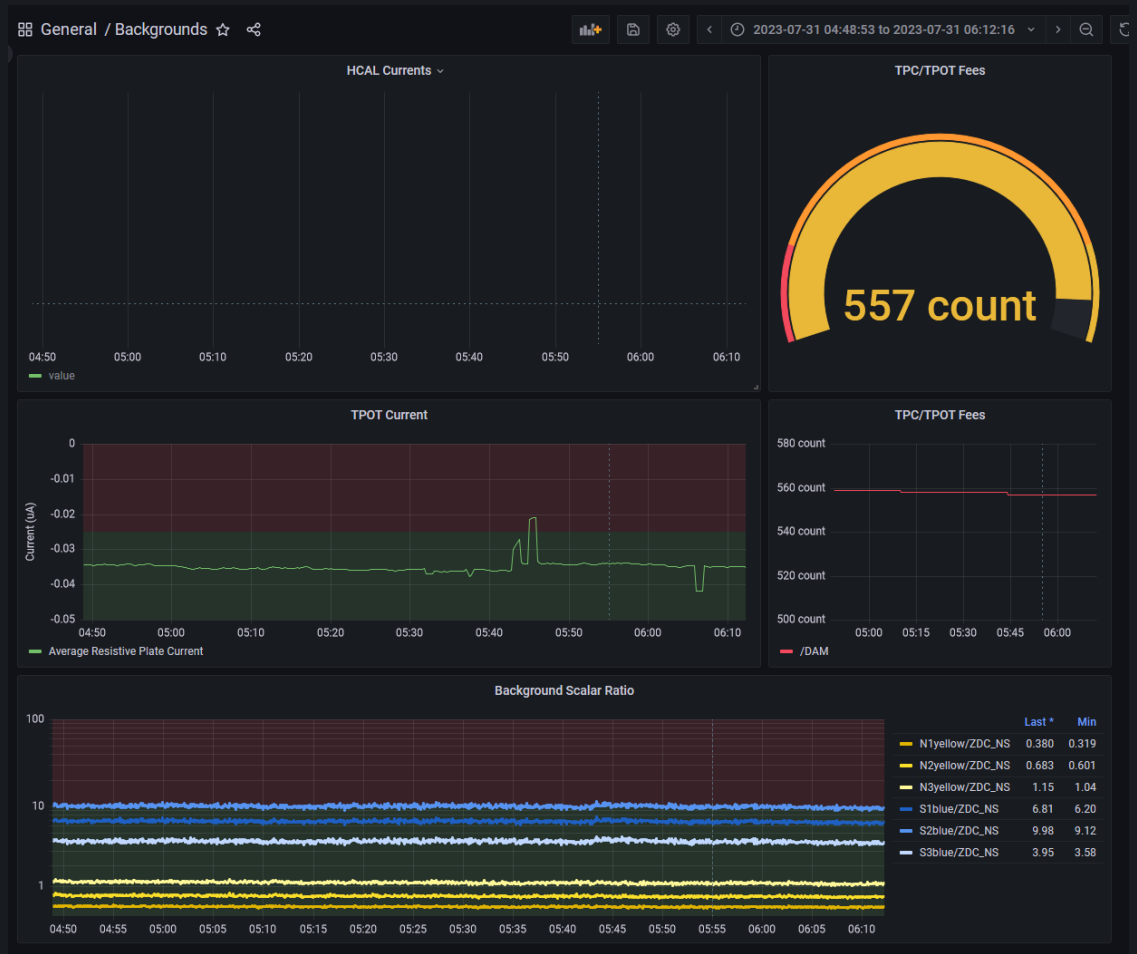
[Via 1008 network] http://info.sphenix.bnl.gov:3000/d/lCNH9KuVz/gl1-status?from=1690793333000&to=1690798336000&orgId=1

sPHENIX Magnet

[Via 1008 network] http://info.sphenix.bnl.gov:3000/d/sK59ghXVk/sphenix-magnet?from=1687250933000&to=1693476736000&orgId=1

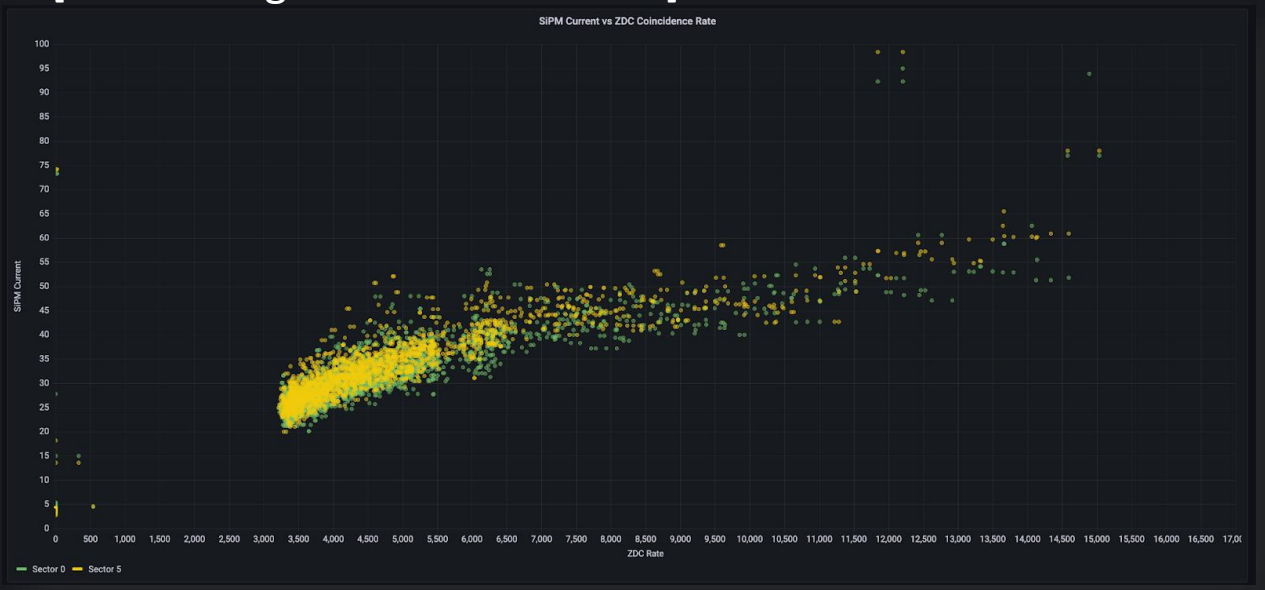


ZDC and background monitors



TPOT and sEPD operation

sEPD SiPM current VS ZDC Rate
[Shift Change Minutes Tristan P.]



http://info.sphenix.bnl.gov:3000/d/ZO0lGms4z/tpot-details?from=1690793333000&to=1690798336000&orgId=1

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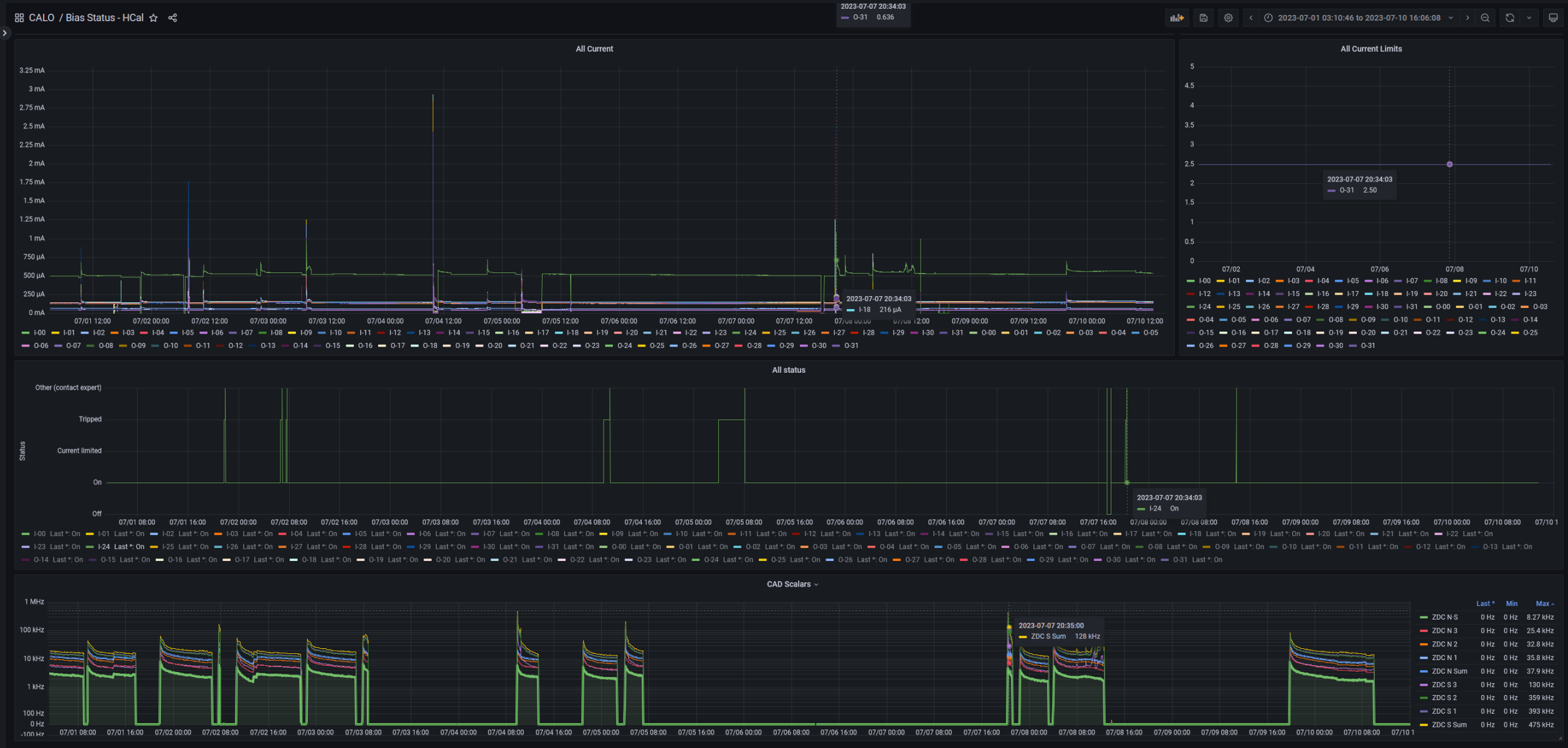
HCal HV

[Via 1008 network] http://info.sphenix.bnl.gov:3000/d/1Q6xlejVk/bias-status-hcal?orgId=1&from=1688195446149&to=1689019568918

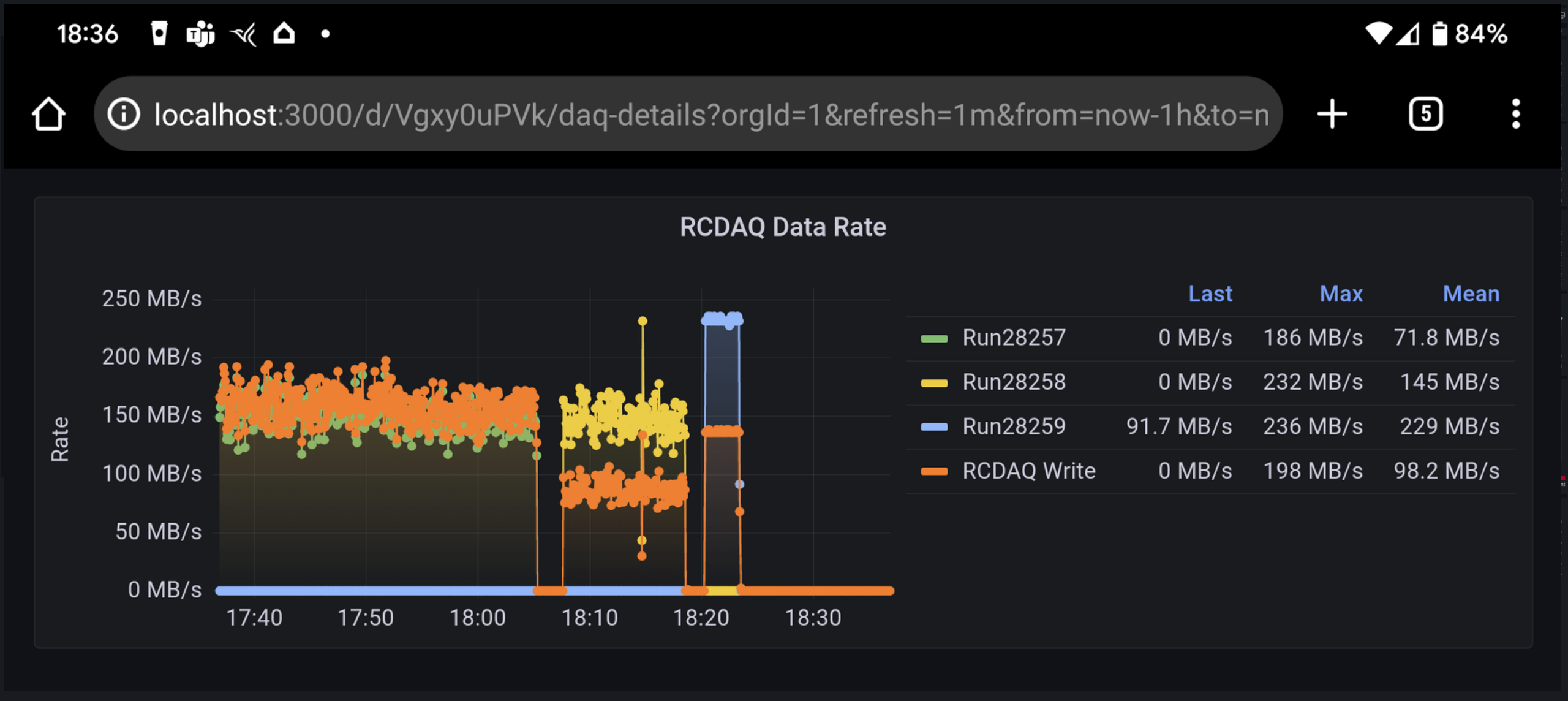


TPC GEM

During Aug-1 RHIC Incident

[Via 1008 network] http://info.sphenix.bnl.gov:3000/d/_qjQyh6Vk/tpc-hv-monitoring-shift-crew?orgId=1&from=1690908234699&to=1690912439174

TPC service and readout pipeline



Server Hardware

[Via 1008 network] http://info.sphenix.bnl.gov:3000/d/UKjaSZf7z/ipmi-exporter?orgId=1&refresh=5m&var-instance=insight.sphenix.bnl.gov:9290

Infrastructure / IPMI Exporter

instance: insight.sphenix.bnl.gov:9290

Last 6 hours | 5m

Power Status

Machine Info

dev_level	instance	job	manufacturer_id	system_firmware_version
production	ebdc39.sphenix.bnl.gov:9290	TPC	Super Micro Computer Inc. (108...	
production	gpuserver0.sphenix.bnl.gov:9290	GLOBAL	ASUSTek Computer Inc. (2623)	

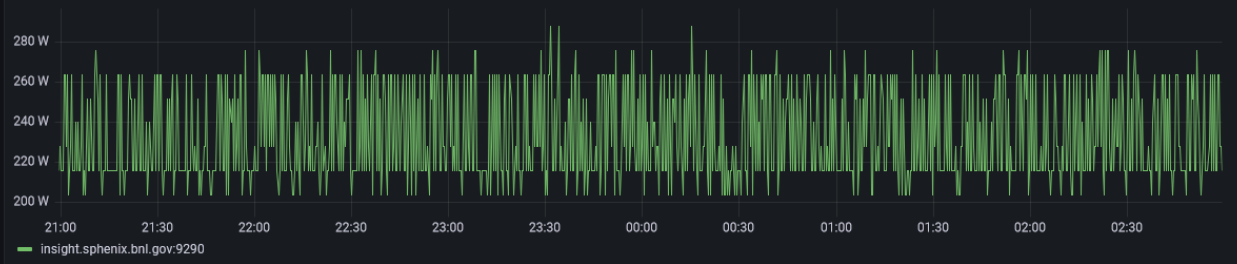
Fan Speed State

FRNT_FAN1	Normal
FRNT_FAN2	Normal
FRNT_FAN3	Normal
FRNT_FAN4	Normal
FRNT_FAN5	Normal
FRNT_FAN6	Normal
FRNT_FAN7	Normal
FRNT_FAN8	Normal

Fan speed in rotations per minute

FRNT_FAN1	FRNT_FAN2	FRNT_FAN3	FRNT_FAN4	FRNT_FAN5	FRNT_FAN6	FRNT_FAN7	FRNT_FAN8
11700	10140	10270	11570	11830	10270	10140	11570

Power Consumption watts



Power State

PSU1 Power In	Normal
PSU1 Power Out	Normal
PSU2 Power In	Normal
PSU2 Power Out	Normal
CPU_Power	Normal
Memory_Power	Normal

Power reading in Watts

PSU1 Power In	PSU1 Power Out	PSU2 Power In	PSU2 Power Out	CPU_Power	Memory_Power
216 W	192 W	12 W	0 W	128 W	56 W

IPMI Sensors State

dev_level	instance	name	type	Value
production	insight.sphenix.bnl.gov:9290	Watchdog2	Watchdog 2	Normal
production	insight.sphenix.bnl.gov:9290	PCIE_Hardware	Version Change	Normal
production	insight.sphenix.bnl.gov:9290	Mem_Hardware	Version Change	Normal
production	insight.sphenix.bnl.gov:9290	CPU_Hardware	Version Change	Normal
production	insight.sphenix.bnl.gov:9290	PowerUnit	Power Unit	Normal
production	insight.sphenix.bnl.gov:9290	BIOS OOB	Version Change	Normal

Temperature State

dev_l	name	Valu
pr...	TR1 Temperature	No
pr...	CPU2 Temperature	No
pr...	DIMMP2_Temp	No
pr...	DIMMO2_Temp	No
pr...	DIMML2_Temp	No
pr...	CPU1 Temperature	No

Temperatures

DIMMC2_Temp	DIMMD2_Temp	DIMMG2_Temp	DIMMH2_Temp	DIMMK2_Temp	CPU1 Temperature
34	34	31	32	33	43

DIMML2_Temp	DIMMO2_Temp	DIMMP2_Temp	CPU2 Temperature	TR1 Temperature
33	33	34	47	27

Reported state of a voltage sensor

+VCORE1	+VCORE2	+VSOC1	+VSOC2	+VDDIO_ABCD_CPU1	+VDDIO_EFGH_CPU1	+VDDIO_IJKL_CPU2	+VDDIO_MNOP_CPU2	+12V	+5V	+5VSB	+3.3V	+3.3VSB	VBAT
Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Voltage reading in Volts

Server Fleet

[Via 1008 network] http://info.sphenix.bnl.gov:3000/d/UKjaSZf7z/ipmi-exporter?orgId=1&refresh=5m&var-instance=insight.sphenix.bnl.gov:9290

TPC / EBDC: Fleet Overview

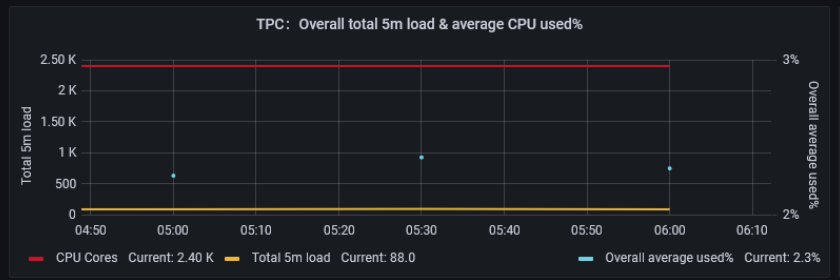
2023-07-31 04:48:53 to 2023-07-31 06:12:16

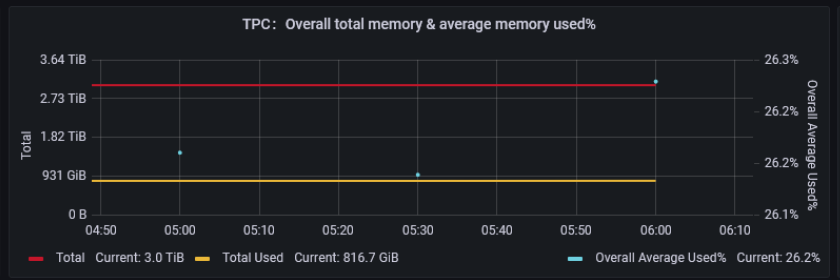
Origin_prom: None | JOB: TPC | Host: All | Instance: ebdc00.sphenix.bnl.gov:9100 | NIC: All | Interval: 30s | Update | GitHub

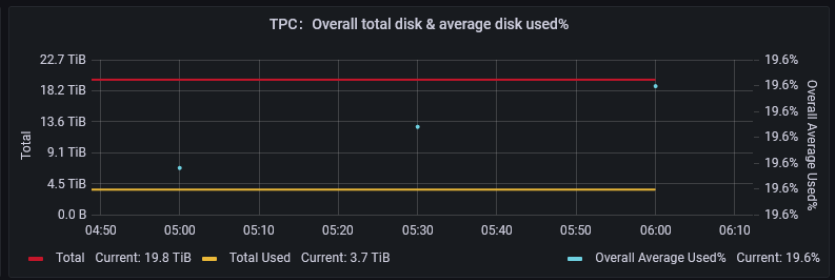
Resource Overview

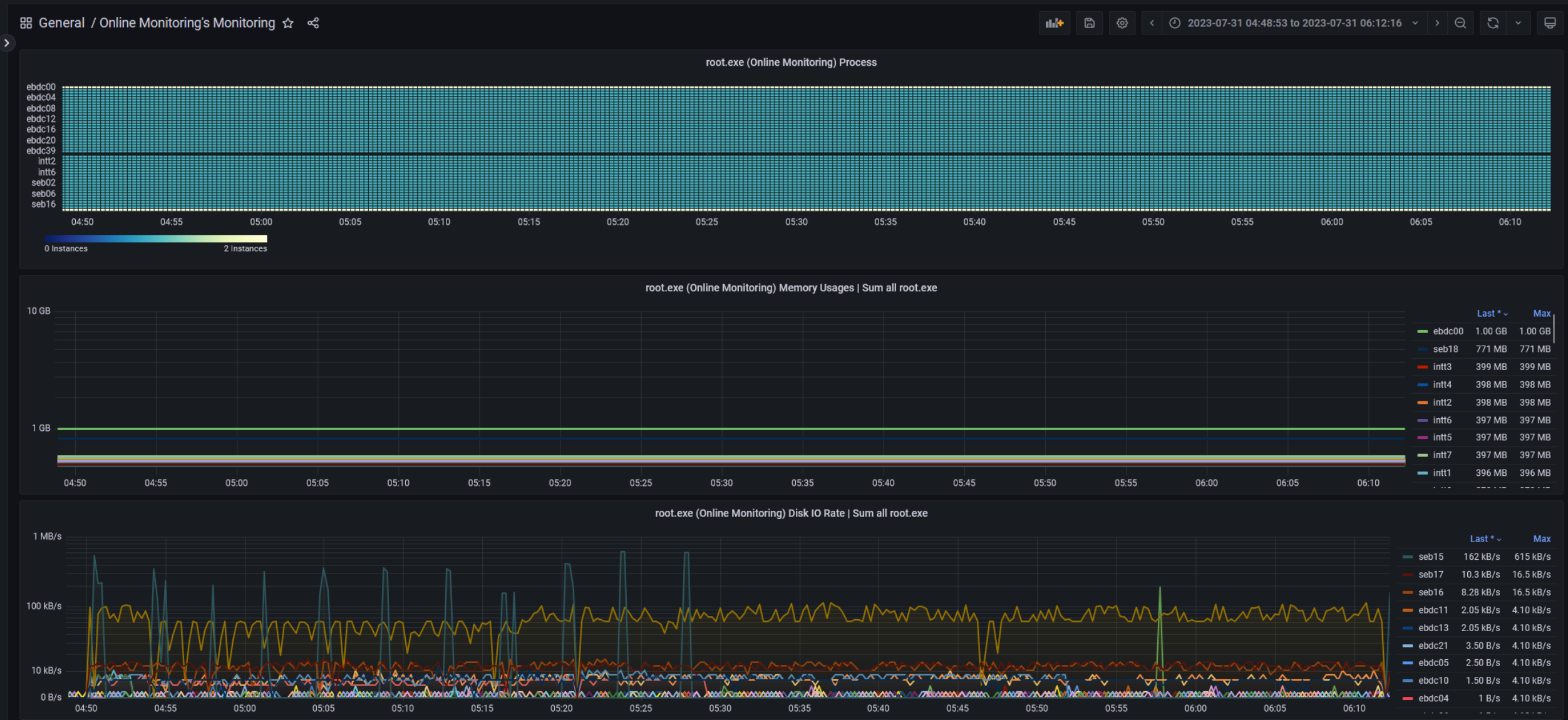
All Node Overview [Job: TPC, Total: 25]

IP(Link to details)	Hostname	Uptime	Mem	CPU	Load(5m)	CPU used%	Mem used%	Part used%	Disk read	Disk write	TCP_estab	TCP_tw	Receive	Transmit
ebdc00.sphenix.bnl.gov:9100	ebdc00	8.47 week	125.81 GiB	96	3.66	2.41%	53.47%	28.96%	0.00 B/s	5.73 kB/s	54	1.54 K	7.68 Mb/s	268.35 Mb/s
ebdc01.sphenix.bnl.gov:9100	ebdc01	8.47 week	125.81 GiB	96	3.07	1.99%	46.27%	28.88%	0.00 B/s	4.10 kB/s	40	95	10.49 Mb/s	209.05 Mb/s
ebdc02.sphenix.bnl.gov:9100	ebdc02	8.47 week	94.31 GiB	96	3.32	2.04%	39.42%	28.81%	0.00 B/s	7.10 kB/s	36	98	7.51 Mb/s	277.33 Mb/s
ebdc03.sphenix.bnl.gov:9100	ebdc03	3.65 week	125.81 GiB	96	3.80	2.19%	52.06%	67.11%	0.00 B/s	7.92 kB/s	41	98	11.19 Mb/s	173.66 Mb/s
ebdc04.sphenix.bnl.gov:9100	ebdc04	8.47 week	125.81 GiB	96	3.46	2.22%	56.22%	28.79%	0.00 B/s	5.19 kB/s	38	99	9.75 Mb/s	272.25 Mb/s
ebdc05.sphenix.bnl.gov:9100	ebdc05	8.47 week	125.81 GiB	96	3.42	2.25%	51.34%	28.79%	0.00 B/s	7.10 kB/s	33	96	9.48 Mb/s	278.29 Mb/s
ebdc06.sphenix.bnl.gov:9100	ebdc06	8.47 week	125.81 GiB	96	3.16	1.87%	53.71%	28.80%	0.00 B/s	7.37 kB/s	33	98	10.02 Mb/s	210.37 Mb/s
ebdc07.sphenix.bnl.gov:9100	ebdc07	8.47 week	125.81 GiB	96	3.67	2.14%	31.22%	28.80%	0.00 B/s	7.65 kB/s	34	98	8.13 Mb/s	286.36 Mb/s
ebdc08.sphenix.bnl.gov:9100	ebdc08	8.47 week	125.81 GiB	96	3.68	2.31%	43.89%	28.79%	0.00 B/s	7.10 kB/s	36	98	11.86 Mb/s	231.74 Mb/s
ebdc09.sphenix.bnl.gov:9100	ebdc09	8.47 week	125.81 GiB	96	3.33	1.89%	54.15%	28.96%	0.00 B/s	4.92 kB/s	35	95	9.66 Mb/s	208.56 Mb/s
ebdc10.sphenix.bnl.gov:9100	ebdc10	8.47 week	125.81 GiB	96	3.29	1.99%	57.55%	28.92%	0.00 B/s	8.74 kB/s	35	99	8.99 Mb/s	272.81 Mb/s
ebdc11.sphenix.bnl.gov:9100	ebdc11	8.47 week	125.81 GiB	96	3.43	2.13%	48.90%	28.99%	0.00 B/s	6.55 kB/s	35	95	10.11 Mb/s	242.45 Mb/s
ebdc12.sphenix.bnl.gov:9100	ebdc12	8.47 week	125.81 GiB	96	3.58	1.98%	55.05%	28.79%	0.00 B/s	6.55 kB/s	35	95	8.97 Mb/s	205.78 Mb/s
ebdc13.sphenix.bnl.gov:9100	ebdc13	8.47 week	125.81 GiB	96	3.13	2.14%	50.64%	29.25%	0.00 B/s	4.92 kB/s	33	98	11.94 Mb/s	207.53 Mb/s
ebdc14.sphenix.bnl.gov:9100	ebdc14	8.47 week	125.81 GiB	96	4.12	2.39%	51.19%	29.68%	0.00 B/s	7.65 kB/s	37	95	9.73 Mb/s	241.26 Mb/s
ebdc15.sphenix.bnl.gov:9100	ebdc15	8.47 week	125.81 GiB	96	2.95	0.71%	6.48%	28.95%	0.00 B/s	3.28 kB/s	38	98	159.70 kb/s	270.40 kb/s
ebdc16.sphenix.bnl.gov:9100	ebdc16	8.47 week	125.81 GiB	96	3.22	2.27%	50.50%	28.85%	0.00 B/s	4.92 kB/s	37	98	10.24 Mb/s	250.26 Mb/s
ebdc17.sphenix.bnl.gov:9100	ebdc17	8.47 week	125.81 GiB	96	3.69	2.12%	53.80%	28.93%	0.00 B/s	7.37 kB/s	34	95	12.49 Mb/s	210.83 Mb/s
ebdc18.sphenix.bnl.gov:9100	ebdc18	8.47 week	125.81 GiB	96	3.25	2.15%	55.02%	28.80%	0.00 B/s	5.19 kB/s	36	95	12.72 Mb/s	214.24 Mb/s
ebdc19.sphenix.bnl.gov:9100	ebdc19	8.47 week	125.81 GiB	96	3.42	1.84%	52.99%	29.00%	0.00 B/s	10.10 kB/s	38	98	11.62 Mb/s	202.08 Mb/s
ebdc20.sphenix.bnl.gov:9100	ebdc20	8.47 week	125.81 GiB	96	3.82	2.64%	54.03%	28.79%	0.00 B/s	7.92 kB/s	37	95	10.10 Mb/s	241.33 Mb/s
ebdc21.sphenix.bnl.gov:9100	ebdc21	8.47 week	125.81 GiB	96	4.29	1.96%	56.37%	28.79%	0.00 B/s	6.28 kB/s	34	95	89.87 Mb/s	753.08 Mb/s
ebdc22.sphenix.bnl.gov:9100	ebdc22	8.47 week	125.81 GiB	96	4.28	2.17%	53.10%	29.58%	0.00 B/s	4.64 kB/s	33	95	9.53 Mb/s	234.49 Mb/s
ebdc23.sphenix.bnl.gov:9100	ebdc23	8.47 week	125.81 GiB	96	3.52	2.45%	54.79%	28.82%	0.00 B/s	7.37 kB/s	36	98	9.20 Mb/s	248.82 Mb/s
ebdc39.sphenix.bnl.gov:9100	ebdc39	2.66 week	125.81 GiB	96	3.60	0.86%	37.13%	29.12%	0.00 B/s	7.37 kB/s	55	332	670.37 kb/s	670.37 kb/s







Online monitor's monitor

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