Database utility and SiPM leakage current studies for sPHENIX physics data-taking

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Edward Abel-Guobadia, Georgia State University *for the sPHENIX Collaboration*

Abstract

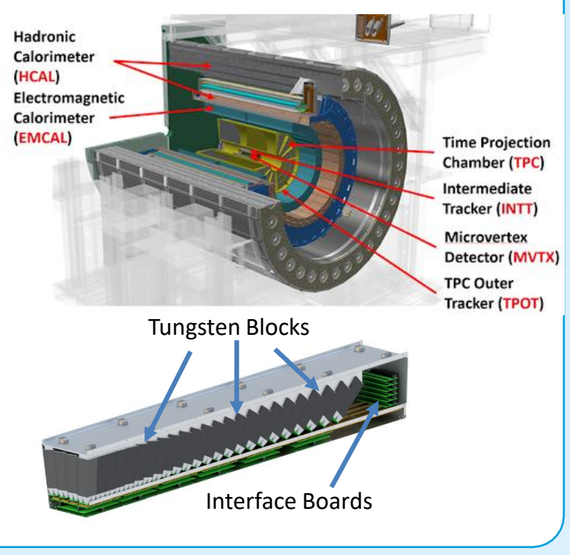
The sPHENIX detector, at the Relativistic Heavy Ion Collider (RHIC), was designed to study hard probes of the quark-gluon plasma. To this end, sPHENIX handles data, in the hundred petabyte range, obtained from the collisions of high energy nuclear matter annually. Storing, sorting, and processing this data is crucial to achieving the scientific goals of the sPHENIX program. We develop software, using databases in a number of ways, to track the conditions of the sPHENIX detectors sub-systems throughout the course of data-taking, and to provide a repository of physics-quality data for offline analysis. This poster will present the database tool we developed to maintain lists of good data runs for physics analysis. As one specific aspect of the monitored detector conditions, this poster will also present our studies on SiPM leakage currents in the calorimeters to quantify the effect of radiation on the detector.

sPHENIX Electromagnetic Calorimeter Sector

EMCal consists of 64 sectors
(32 azimuthal × 2 longitudinal)

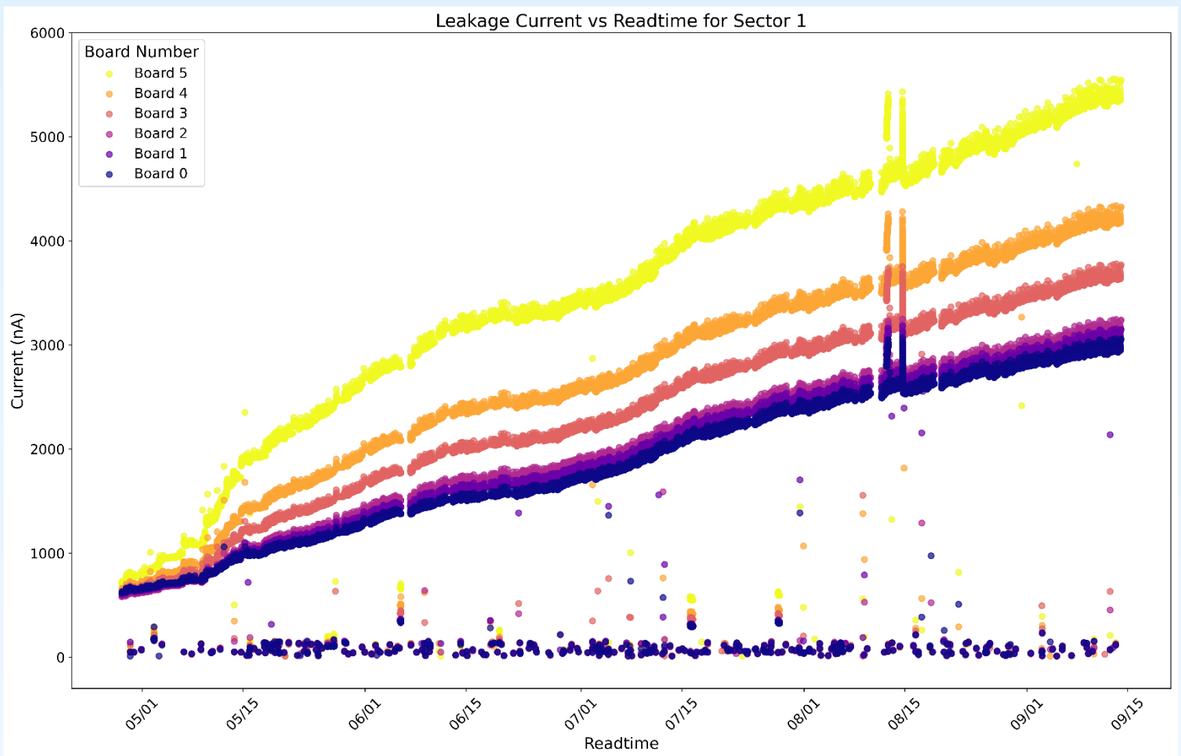
Each sector consists of 5 interface boards

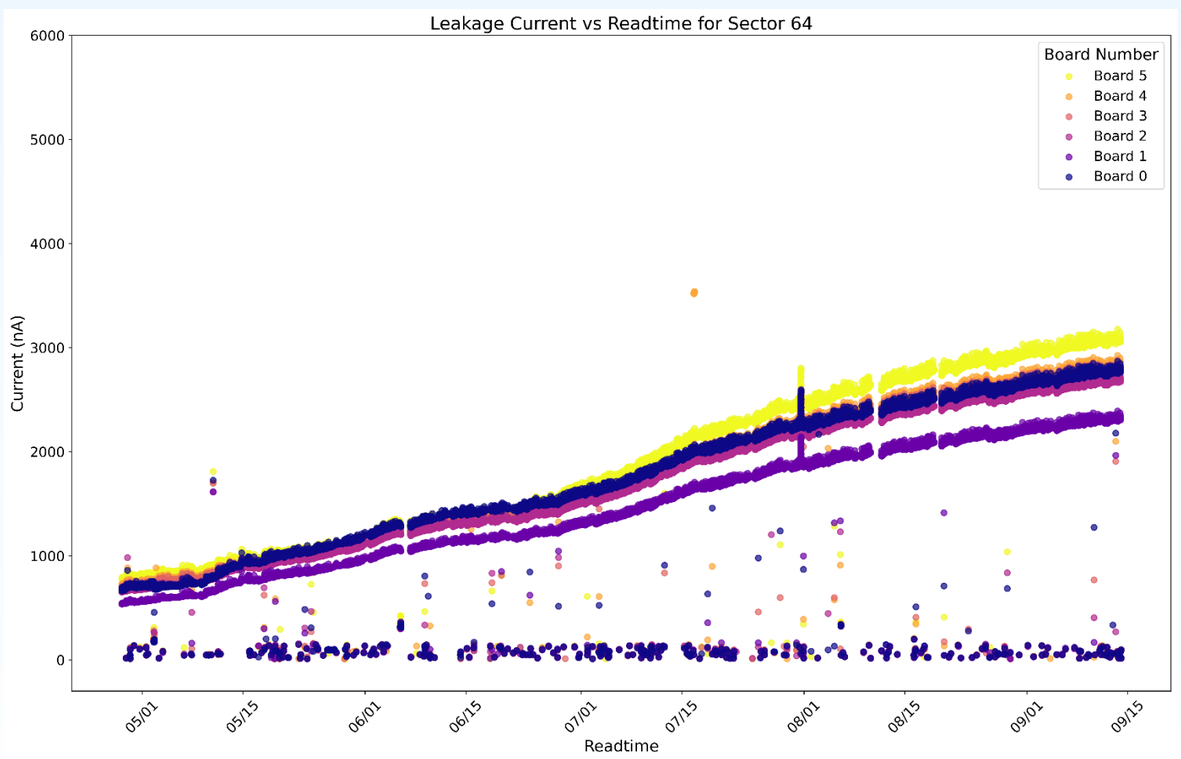
It is important to understand how radiation from collisions affects the sector electronics, interface boards, and measurements



Interface board Leakage currents vs. Time

Leakage current increases as a function of time, suggesting leakage current is commensurable to time under radiation damage Leakage current also shows strong board dependence for northern sectors (1-32) and southern sectors (33-64)





sPHENIX Run Triage System

A database management system was developed to assist in managing and discerning between useful and not useful sPHENIX collision-run data

1. We create a custom composite data type called a triage data type consisting of two strings referring to the run class and run notes respectively.
2. A PostgreSQL database consisting of a table with columns corresponding to each sPHENIX subsystem is created with run number as a primary key and a triage type as the default element for each subsystem column.
3. The database is interfaced with several scripts and programs to assist QA work.
4. Lastly, we construct a website atop the database and interfacing software for use by detector experts

```
Production=> \d goodruns
                                    Table "public.goodruns"
   Column    |  Type   | Collation | Nullable |                                  Default
-------------+---------+-----------+----------+-------------------------------------------------------------------------
 runnumber   | integer |           | not null |
 emcal       | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 ohcal       | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 ihcal       | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 mbd         | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 sepd        | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 tpot        | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 tpc         | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 intt        | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 mvtx        | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 zdc         | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 spin        | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
 emcal_auto  | triage  |           |          | ROW('BAD'::character varying(255), ''::character varying(255))
Indexes:
    "goodruns_pkey1" PRIMARY KEY, btree (runnumber)

Production=> \dT+ triage
                                        List of data types
 Schema |  Name  | Internal name | Size  | Elements | Owner  | Access privileges | Description
--------+--------+---------------+-------+----------+--------+-------------------+-------------
 public | triage | triage        | tuple |          | phnxrc |                   |
(1 row)
```

sPHENIX Run Triage Website

EMCAL - Run Triage

EMCal OHCal IHCal MBD SEPD TPOT TPC INTT MVTX ZDC SPIN -HOMEPAGE-

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1| 2| 3| 4| 5| 6| 7| 8| 9| 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22| 23| 24| 25| 26| 27| 28| 29| 30| 31| 32|

Run Number	emcal Notes	emcal_auto Notes
48646	○ GOLDEN ○ QUESTIONABLE ◉ BAD many bad towers Update	○ GOLDEN ○ QUESTIONABLE ◉ BAD BadTowers Update
48645	◉ GOLDEN ○ QUESTIONABLE ○ BAD BSHT Update	◉ GOLDEN ○ QUESTIONABLE ○ BAD GoodRun Update
48644	○ GOLDEN ○ QUESTIONABLE ◉ BAD no calo Update	○ GOLDEN ○ QUESTIONABLE ◉ BAD Update
48643	○ GOLDEN ○ QUESTIONABLE ◉ BAD RUN NOT FOUND Update	○ GOLDEN ○ QUESTIONABLE ◉ BAD Update
48642	○ GOLDEN ○ QUESTIONABLE ◉ BAD RUN NOT FOUND Update	○ GOLDEN ○ QUESTIONABLE ◉ BAD Update
48641	○ GOLDEN ○ QUESTIONABLE ◉ BAD many bad towers Update	○ GOLDEN ○ QUESTIONABLE ◉ BAD BadTowers Update

Modular development enables customization for each sPHENIX subsystem depending on the needs of the subsystem group, such as the emcal_auto column which automatically triages run data based on specific parameters defined by a group of EMCal detector experts/specialists.

Conclusions

We develop an expansive collision-run data management system to track the conditions of the sPHENIX sub-systems throughout data-taking. We also apply our database methods to study the evolution of the EMCal as a function of time under radiation exposure due to normal collision conditions. We find asymmetries with interface board leakage currents between sectors in the northern or southern half of the detector, likely due to asymmetric backgrounds. We also find strongly correlated leakage current dependence based on individual interface boards. We aim to extend our studies to the Hadronic Calorimeter and leakage current dependence on other factors such as beam luminosity and RMS.

Acknowledgements

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