Extracting and Analyzing Data from Detector Control System to investigate the behavior of High Voltage channels at the ATLAS Experiment

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ATLAS EXPERIMENT

NRF National Research Foundation

University of Zululand

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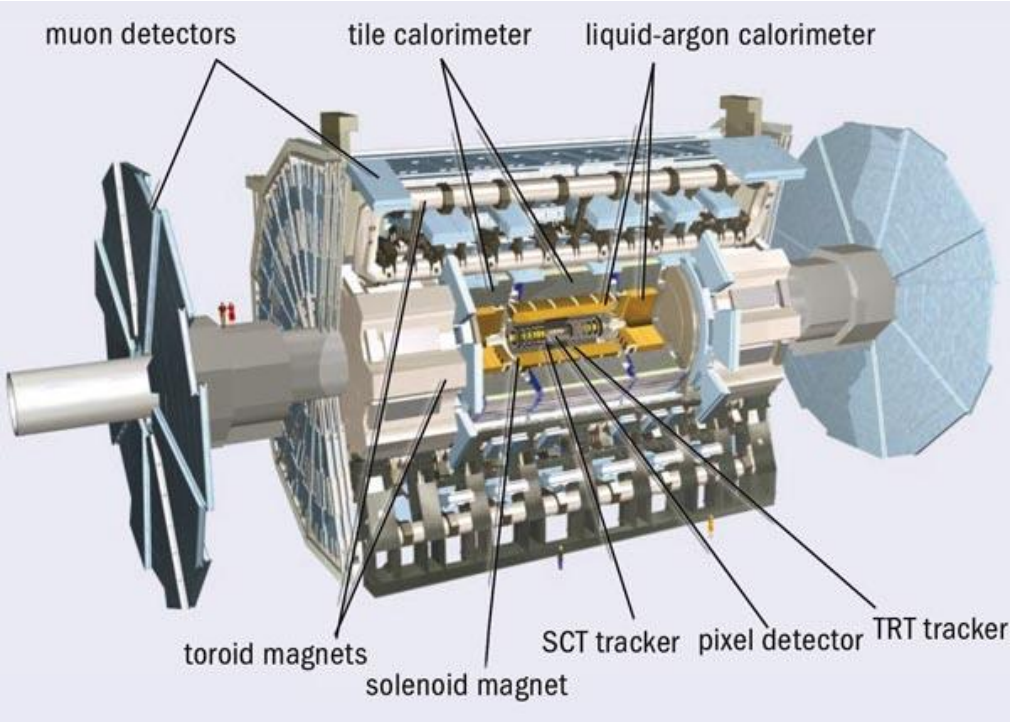
Introduction

- CERN - European Organisation for Nuclear Research.
- CERN was founded in 1954 by 12 countries.

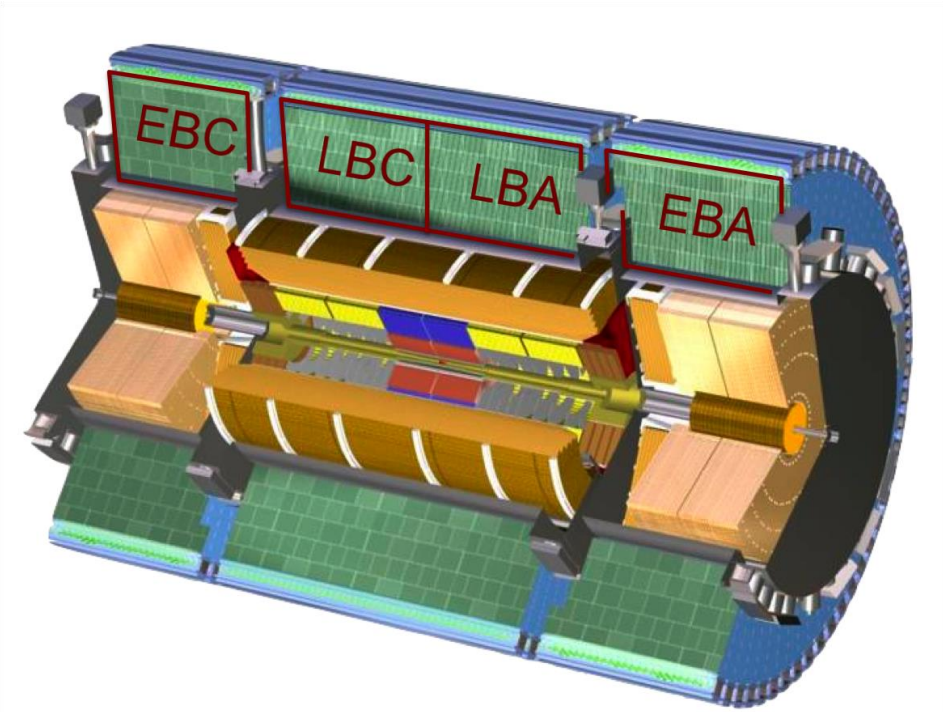
Figure 1: Large Hadron Collider (LHC) complex

ATLAS Tile Calorimeter

- The ATLAS detector is one of the huge general-purpose detectors at the LHC.



- Tile Calorimeter (TileCal) is the central hadronic calorimeter of ATLAS.
- Contributes to the measurement of energies of hadrons, jets, taus and missing transverse energy.
- Divided into four partitions: EBC, LBC, LBA and EBA.
- Each partition consist of 64 wedge modules (one module host up to 48 PMTs).



TileCal HV System

- The HV distribution system is associated with online monitoring
- The main specifications for the HV distribution system:
  - Supply different HV values to each PMT ranging from 600 V to 950 V
  - Ensure the stability of PMT gain by providing a stable HV with 0.5V rms
  - Deliver a current of up to 350 μA/PMT.
- The stability of HV is the most important:

$$G = \alpha^{i} \times \left(HV_{out}^{i}\right)^{\beta^{i}} \qquad (1)$$

- Where α^{i} and β^{i} are parameters that are specific to each PMT, in TileCal usually ß ~ 7.

Channels behaviour

- To detect the unstable channels [2]:

$$\Delta HV^{i}(t) = HV^{i}_{nom}(t) - HV^{i}_{meas}(\mathrm{t}) \qquad (2)$$

- Channels are considered unstable if any of the following conditions should be satisfied:

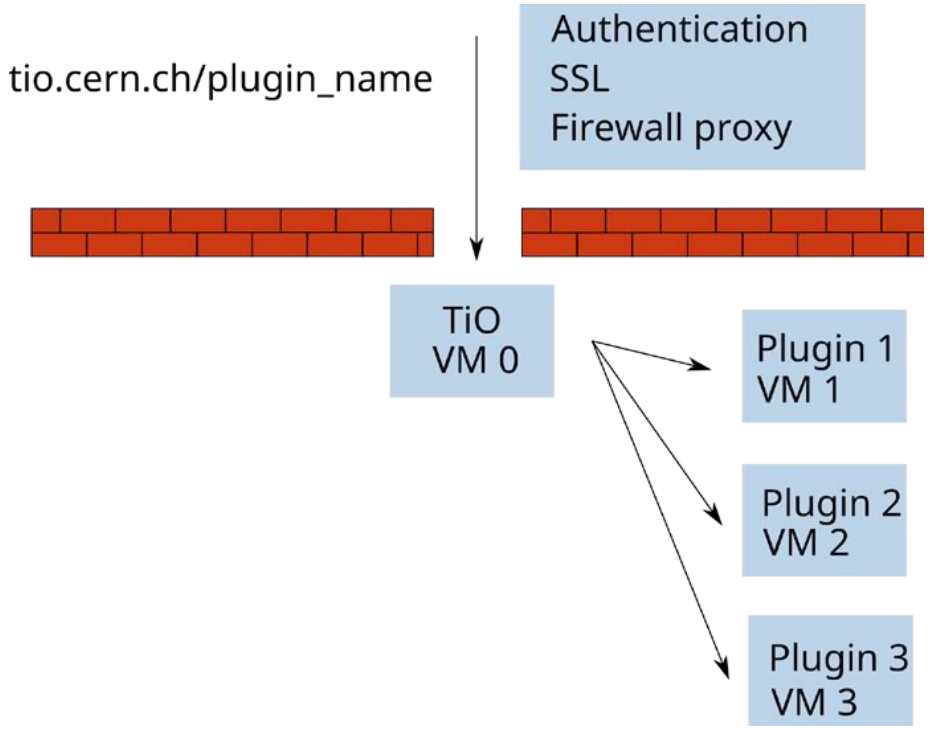
➢ If $\sigma^{i}_{\Delta HV}$ is not less than or equal to 0.5 V

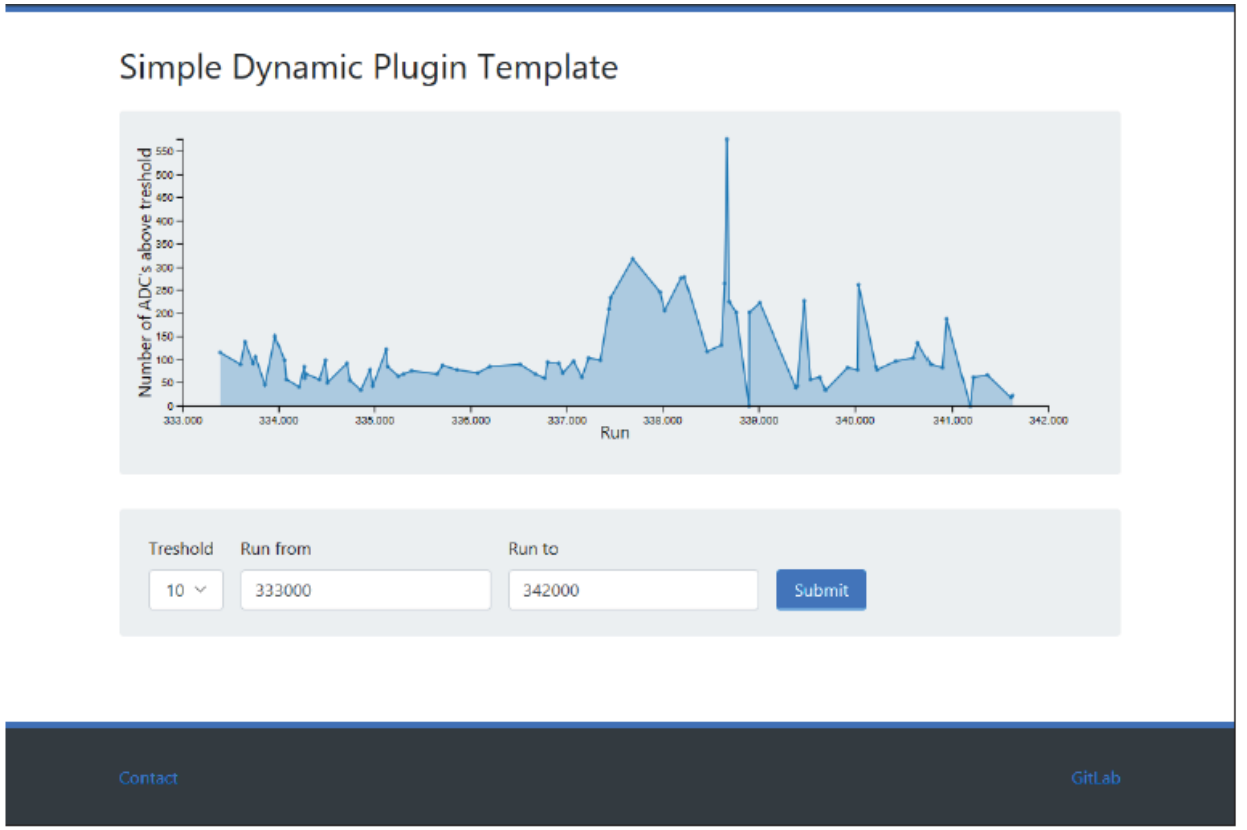
➢ If average of ΔHV^{i} computed for each day satisfy the following condition for more than 25% of the days:

$$| \overline{\Delta HV^{i}} - \mu^{i}_{\Delta HV} | > 0.5 \text{ V} \qquad (3)$$

Tile-in-One

- The Tile-in-One (TiO) is a web platform where the main purpose, is to integrate different TileCal web tools into one platform.





- To help the plugins developers there are two plugin template provided for the development: Simple Static Plugin Template and Simple Dynamic

Aim

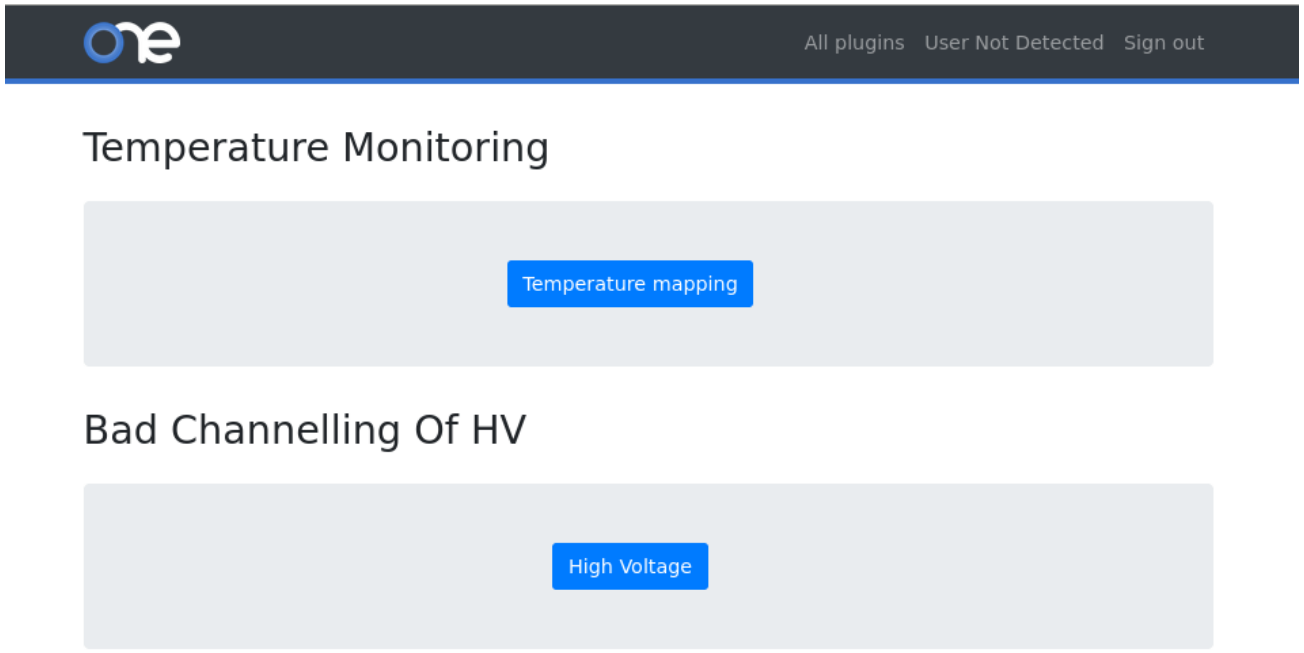
The aim of this project is to extract data from the DCS of the ATLAS Experiment and use the TiO web platform for visualization and statistical analysis of the data in order to observe the behavior of the HV channels.

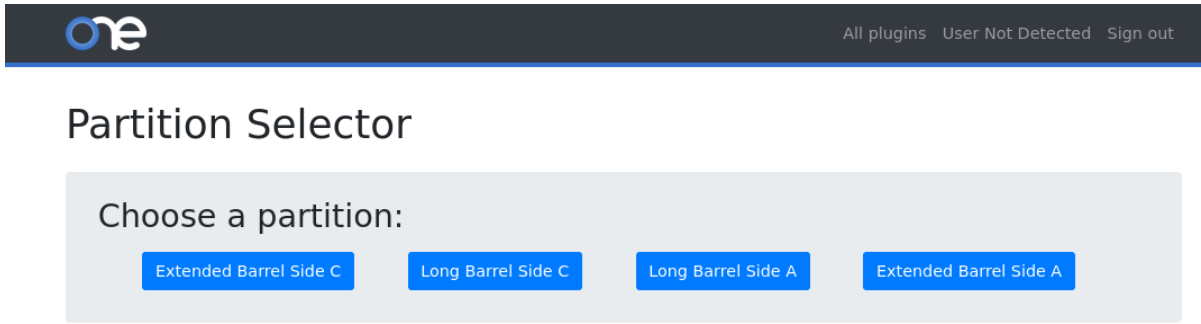
Objectives

- Establish a reliable way to connect to the machines inside the CERN firewall
- Query data from DCS Data Viewer (DDV) server and transform it to the form needed by plotting the library
- Develop a plugin interface with interactive plots is the main feature
- To do statistical calculations from requested data in order to detect anomalies.

Web Interfaces

- The detector plugin is divided into two parts: Bad channeling of HV and Temperature monitoring.
- The web tabs shown are for the HV:

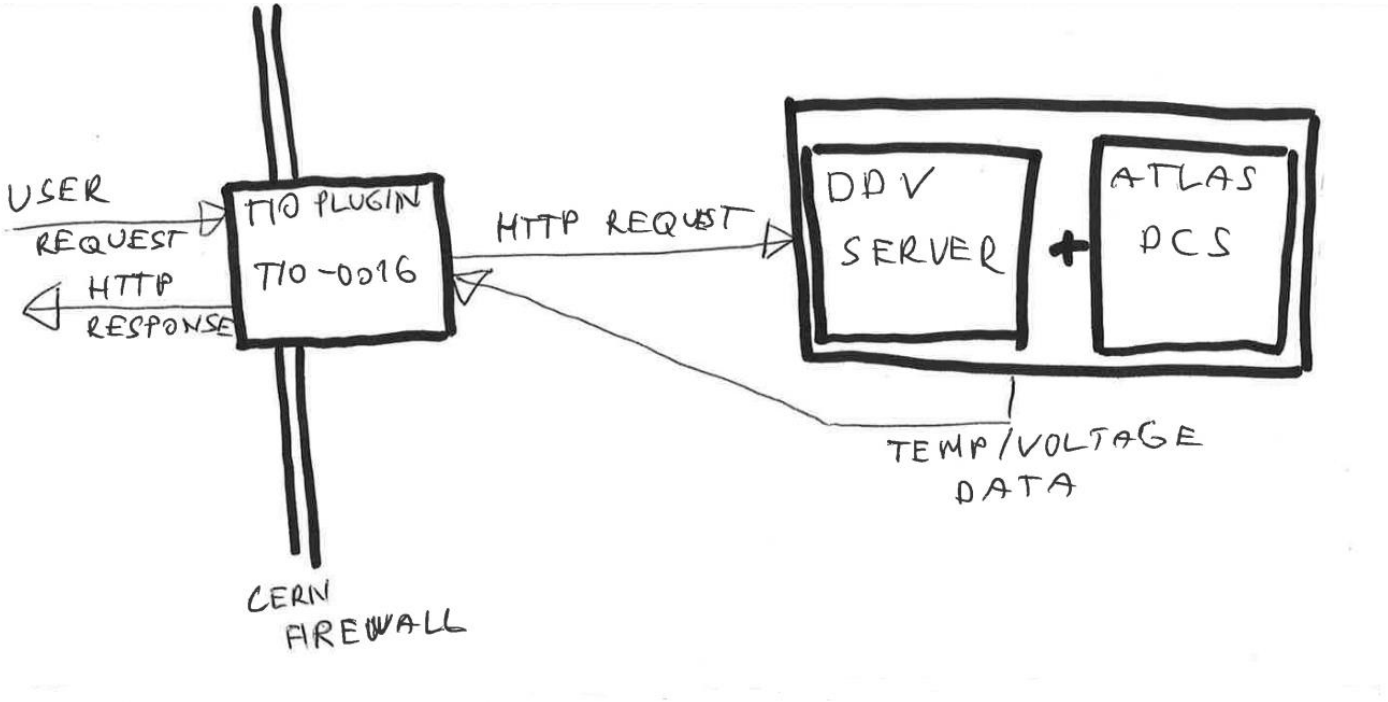




Web Interface - 2

Data Collection

- The data is called using the HTTP requests

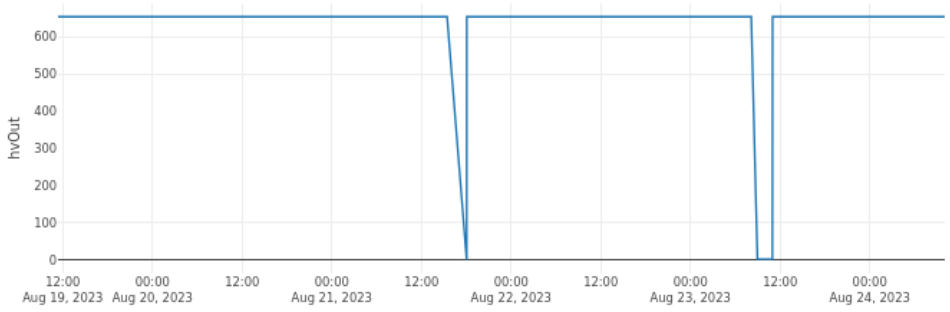


- Request script (python) is created, whenever the user make the request. The request is investigated and required data is requested from DDV server.
- Then data from DDV are parsed and prepared for the plotting library.
- Prepared data is cached and the response is made to the user.

Results

- This is visualization of the data from DDV server requested by the user.
- It shows some statistical calculation on the output data the user requested.

ATLAS WORK ON PROGRESS



Offset Information:

Offsets above threshold 0.5 V:

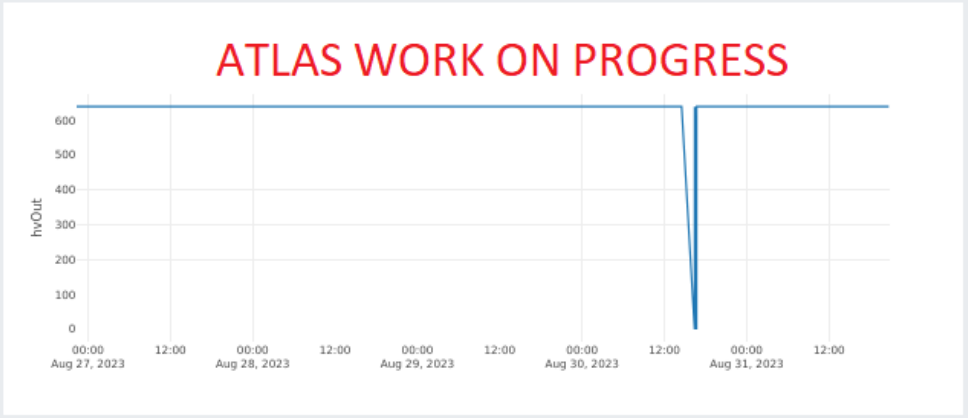
Offset at 2023-08-21 18:03:20: 654.2 V
Offset at 2023-08-21 18:03:31: 2.1 V
Offset at 2023-08-21 18:04:11: 652.1 V
Offset at 2023-08-23 08:58:07: 651.9 V
Offset at 2023-08-23 10:59:41: 652.2 V

Largest offset found at 2023-08-21 18:03:20: 654.2 V
Mean Value: 627.26

Standard Deviation: 129.85

Differences between Nominal and Actual Voltage

Timestamp	Nominal Voltage	Actual Voltage	Difference
2023-08-19 11:20:03	654.599976	654.200012	0.39996399999995447
2023-08-19 12:20:12	654.599976	654.200012	0.39996399999995447
2023-08-19 13:20:18	654.599976	654.200012	0.39996399999995447
2023-08-19 14:20:25	654.599976	654.200012	0.39996399999995447
2023-08-19 15:20:32	654.599976	654.200012	0.39996399999995447



Offset Information:

Offsets above threshold 0.5 V:

Offset at 2023-08-30 16:23:51: 638.8 V
Offset at 2023-08-30 16:24:01: 2.8 V
Offset at 2023-08-30 16:24:41: 635.8 V
Offset at 2023-08-30 16:40:45: 638.6 V
Offset at 2023-08-30 16:40:53: 2.9 V
Offset at 2023-08-30 16:41:44: 635.9 V

Largest offset found at 2023-08-30 16:23:51: 638.8 V
Mean Value: 618.03

Standard Deviation: 113.05

Differences between Nominal and Actual Voltage

Timestamp	Nominal Voltage	Actual Voltage	Difference
2023-08-26 22:20:27	638.799988	638.700012	0.09997599999996964
2023-08-26 23:20:34	638.799988	638.799988	0
2023-08-27 00:20:41	638.799988	638.799988	0
2023-08-27 01:20:49	638.799988	638.799988	0
2023-08-27 02:20:56	638.799988	638.799988	0
2023-08-27 03:21:04	638.799988	638.700012	0.09997599999996964
2023-08-27 04:21:11	638.799988	638.700012	0.09997599999996964

Conclusion

- The plugin is able to successful extract data using HTTP request at the DCS Data Viewer (DDV) server.
- The extracted data is visualized using plotly.js library.
- The data extracted is for the last 5 days.

Future Work:

- Implement in depth analysis of the visualized data in order to categorize the high voltage channels as stable or unstable channels.

References

1. Tile-in-One: An integrated system for data quality and conditions assessment for the ATLAS Tile Calorimeter, Yuri Smirnov and Juraj Smiesko, 20 August 2019
2. The High Voltage distribution system of the ATLAS Tile Calorimeter and its performance during data taking, D. Calvet, S. Calvet, R. Chadelas, etc., 16 August 2018
3. The TileCal Detector Control System, Joao Pina, Agostinho Gomes, Nuno Marques etc.
4. Stability of the TileCal High Voltage distribution system in 2015 and 2016, D. Calvet and M. Marjanovic, 20 November 2016

THANK YOU

QUESTIONS AND ANSWERS