DEVELOPMENT OF TOOLS TO ANALYZE THE DATA DESCRIBING THE RPC DETECTOR STATUS RECORDED BY THE DCS

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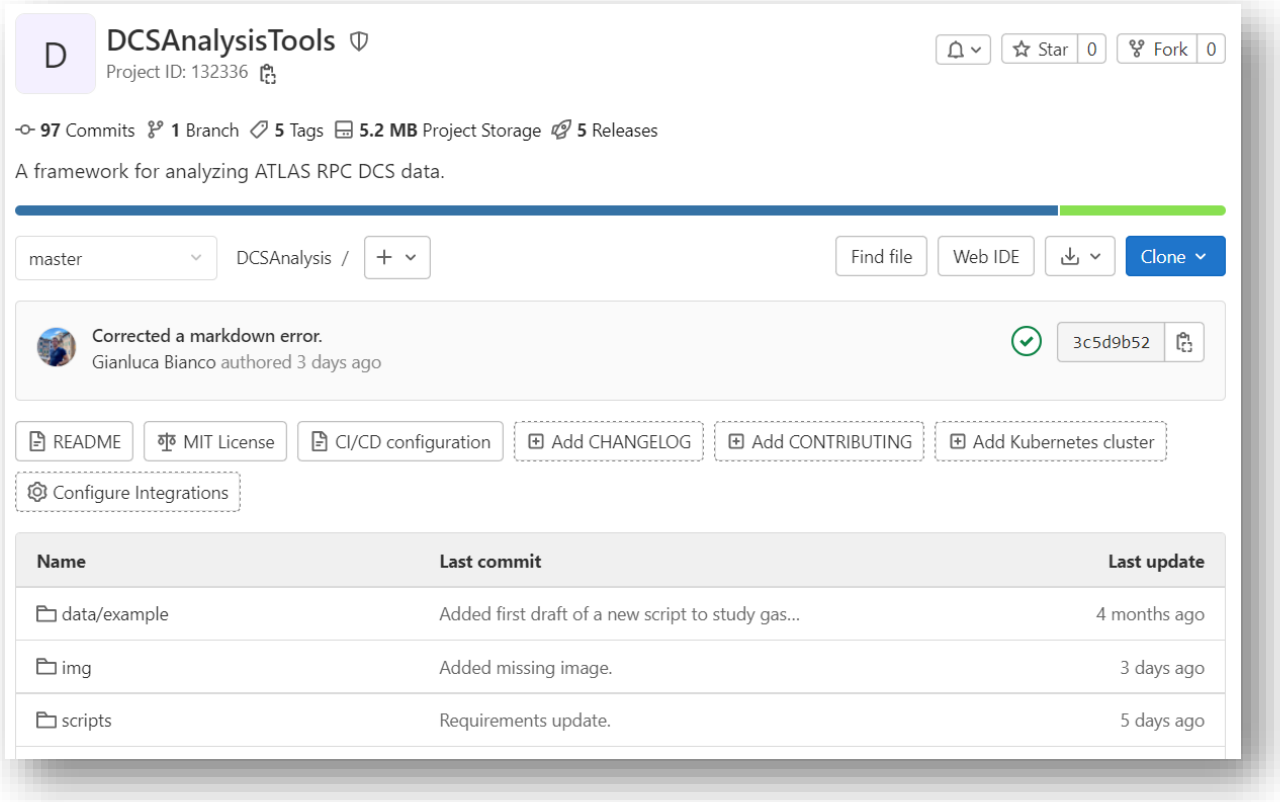
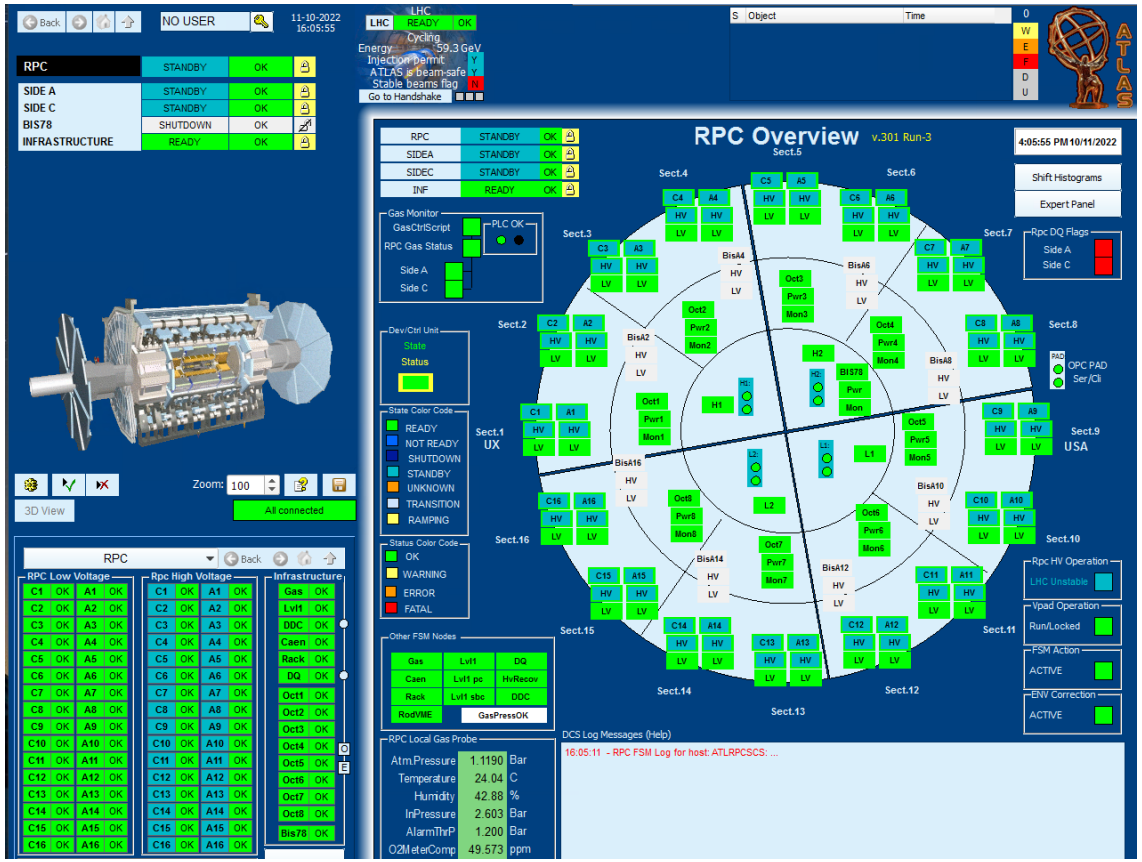
INTRODUCTION

- Development of tools to monitor ATLAS RPC performance using DCS data
  - Data are extracted from DCS database and then analysed
  - Complementary work with the analysis of *Antonio Giannini* (USTC group)
- Work done up to now:
  - *Mapping* of HV and I_{gap} channels
  - Monitoring gas fluxes of the RPC system
- Software developed on GitLab: link
- Activity of my Qualification Task (end *this November,* but will go on during all my PhD)



THE RPC DETECTOR CONTROL SYSTEM (DCS)

- Used to monitor the **RPC conditions**
- Control all related *subsystems*:
  - Supply of low and high voltages
  - Trigger electronics
  - Detector infrastructure
  - Environment conditions
- **DCS variables**: HV, I_{gap}, gas variables…
- Store all the relevant information into the ATLAS **database** for future analyses

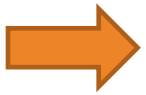


The RPC DCS

MAPPING OF HV AND I_{gap} CHANNELS

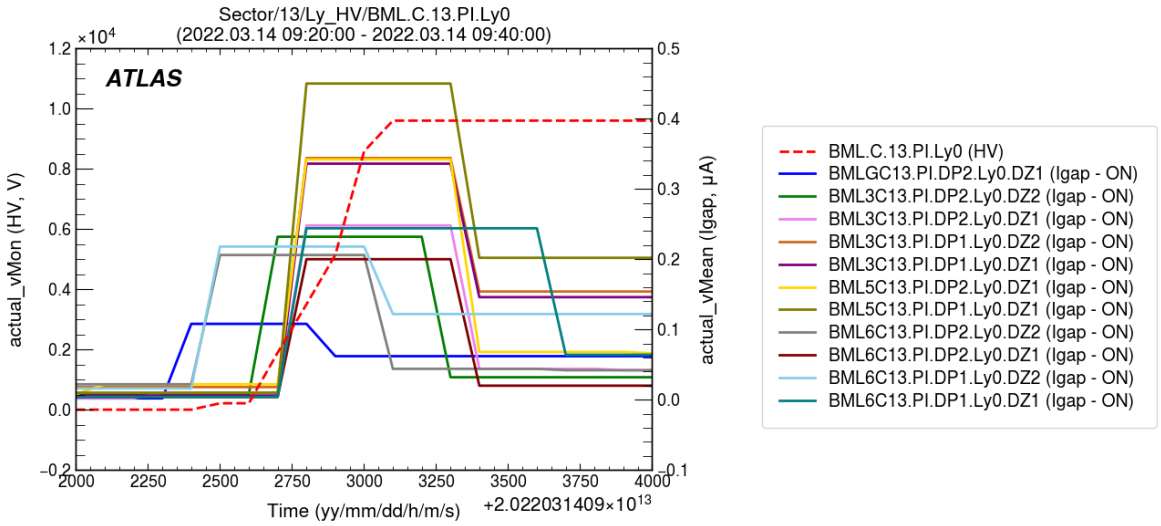
A TOOL TO CHECK MAPPING OF HV AND I_{gap} CHANNELS

- Due to the HV boards increase during *LS2*, to improve the granularity of the HV distributions, mapping of the DCS channels needs to be checked
- Goal: check that Igaps response follow HV values
- Production of **2D plots** with 1 x-axis (time) and 2 y-axes (HV and I_{gap} variables):
  - HV – *actual.vMon* variable
  - I_{gap} – *actual.vMean* variable

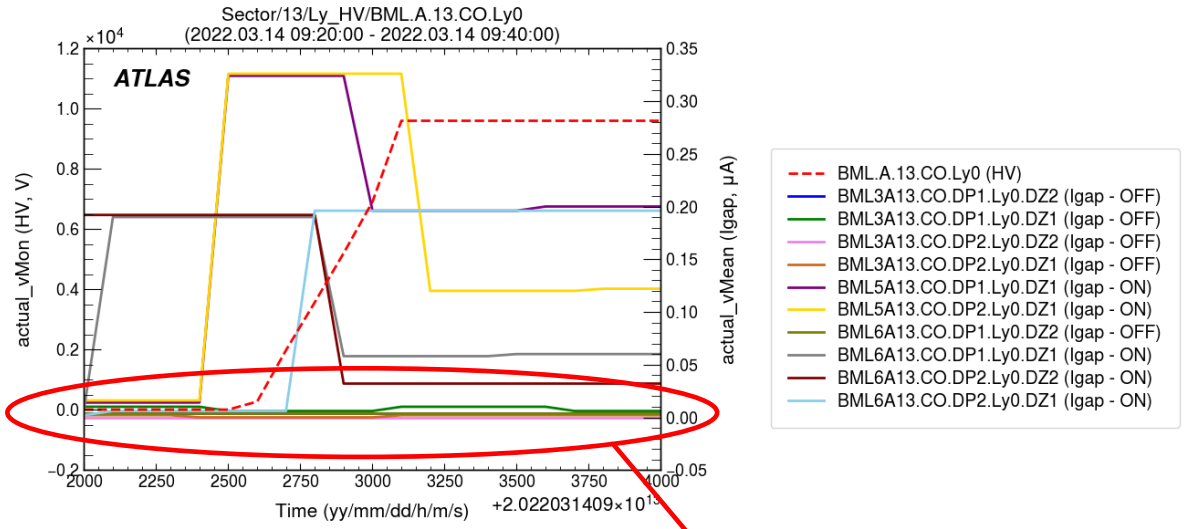
  

  DCS variables
  - Plots have been produced for each HV channel with respect to each of the corresponding I_{gap} ones
- I_{gap} channels which variation was less or equal than **0.01 μA** have been considered as "OFF" (not mapped), otherwise have been considered as "ON" (correctly mapped).

EXAMPLE PLOTS FOR OF HV AND I_{gap} CHANNELS MAPPING



Example of HV channel with **correct mapping**



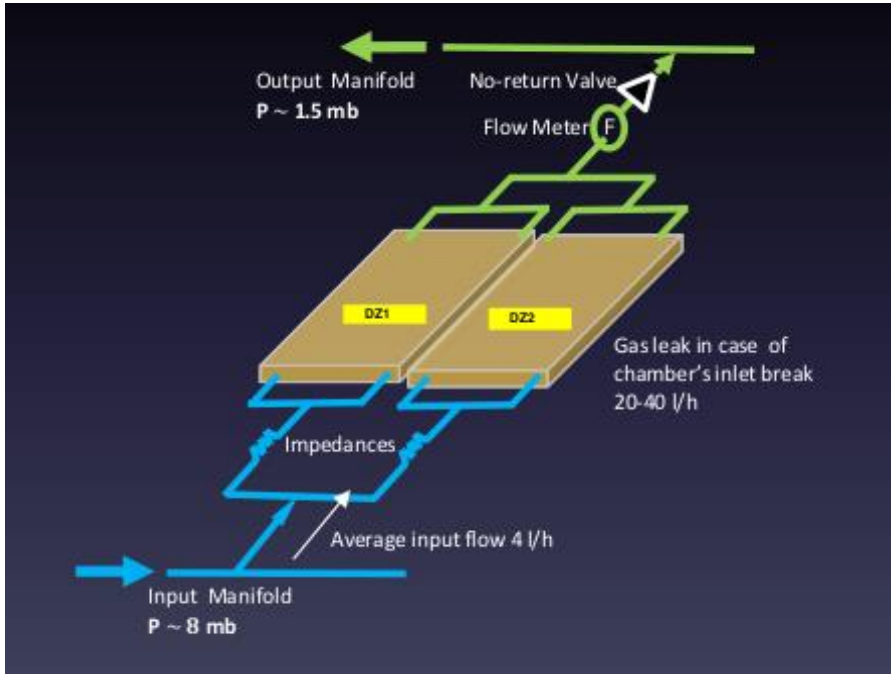
Example of HV channel with **mapping problems or disconnected channels**

The mapping will be **validated** with a dedicated run with HV channel turned on at different time

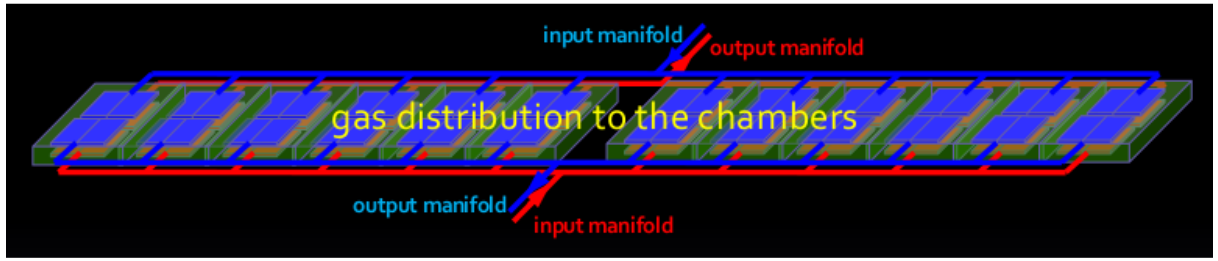
GAS LEAKS STUDIES

GAS MANIFOLDS

- Main components of the gas mixture: $C_2H_2F_4$ (94.5%), C_4H_{10} (5%), SF_6 *hexafluoride* (0.5%)
- The gas is distributed by 128 **input manifold** lines (*flowmeters*) (*fig. 1*) with 24 RPC layers each
- It is recuperated by 128 **output manifolds**
- A single gas layer is connected through two **inlets** and two **outlets** (*fig. 2*)
- 2136 independent **gas layers** in total
- Two sensors group in the gas system
  - 1168 chambers sensors (one sensor each two layers) → study the FullFlow
  - 128 flowmeters sensors → study the InFlow and OutFlow



(*1*) A single flowmeter overview

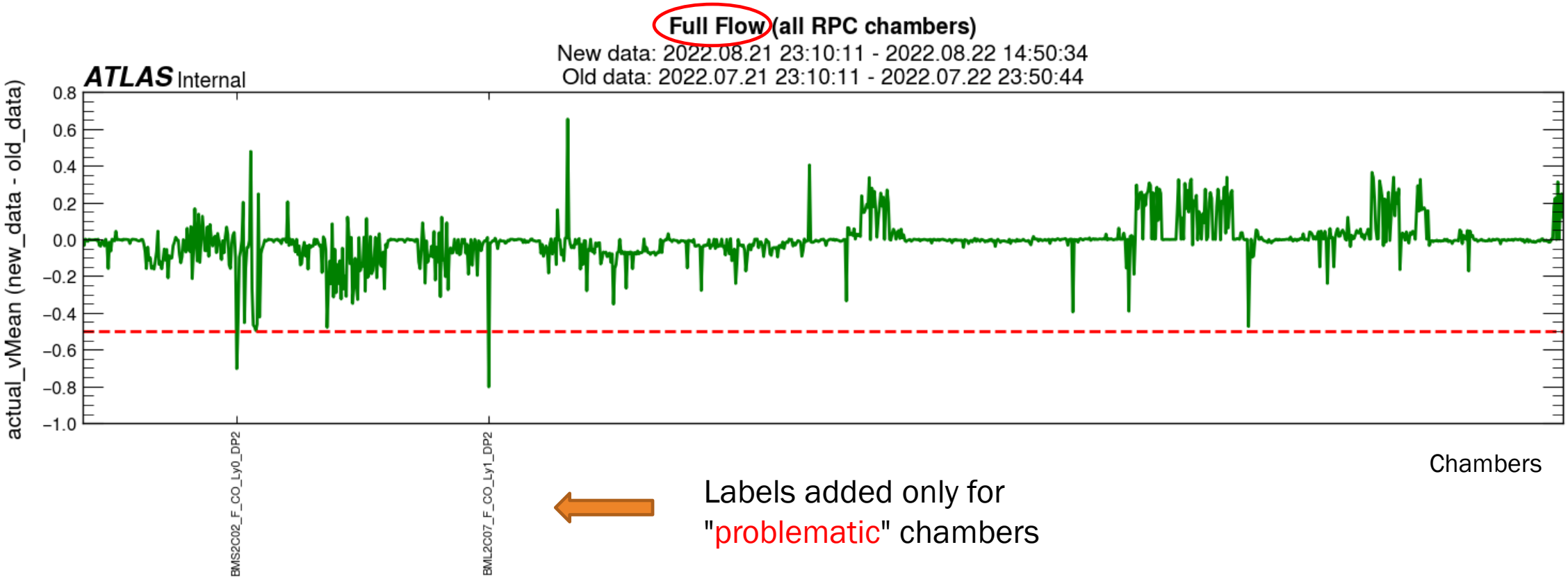


(*2*) Gas distribution throught the chambers

A TOOL TO MONITOR GAS LEAKS

- Goal: identify chambers having negative gas flux as candidate for leaking chambers, i.e study:
  - FullFlow from the 1168 chambers sensors
  - InFlow and OutFlow from the 128 flowmeters sensors
- Procedure:
  - Compute the mean of each channel data of **newer dataset** for a given time-period (ex: *22/08/22*)
  - Compute the mean of each channel data of **older dataset** for a given time-period (ex: *22/07/22*)
  - Compute the **difference** between each *mean-value* of newer and older data-points and add a point to a bar plot for each channel
- Bar plots with **Y-axis** difference between mean values, **X-axis** channel names
- Production of histograms of mean differences fitted with normal distribution
- Problematic channels classification:
  - Criteria: difference between mean values < - 0.5
  - Channel aliases and corresponding data are saved in a separate txt file
- Only periods in which the system was **stable** have been considered (i.e any study during *technical stops* periods have been performed)

DIFFERENCE IN FULLFLOW FOR A GIVEN TIME-PERIOD FOR ALL CHAMBERS

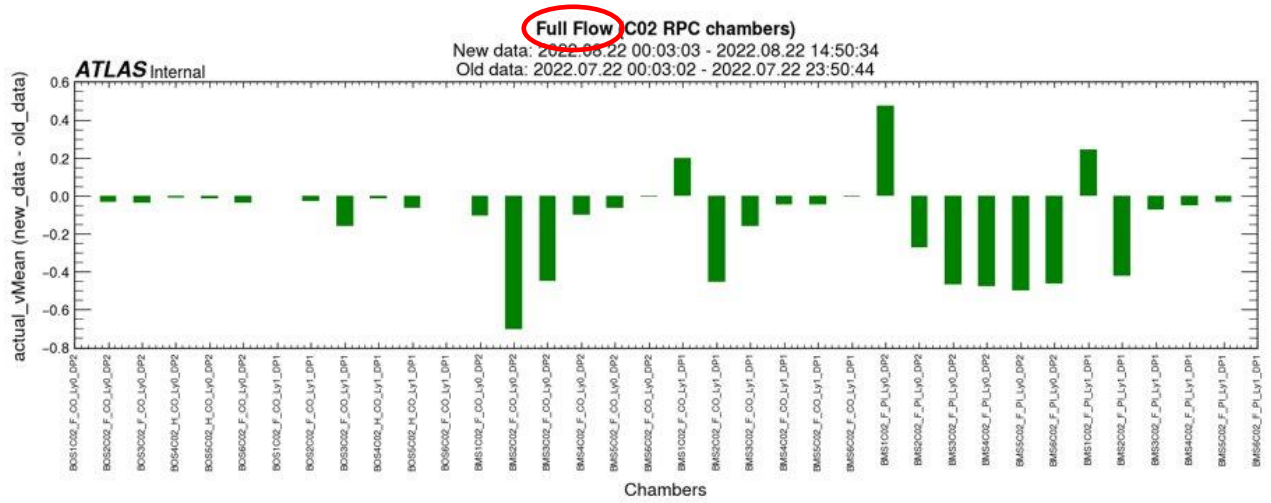


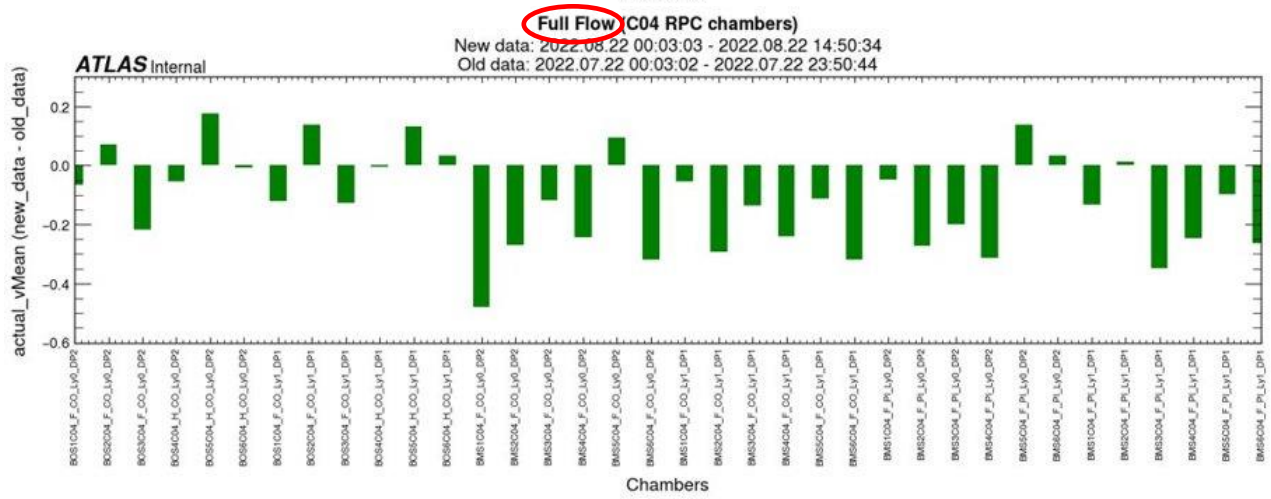
Labels added only for "problematic" chambers

In this plot , **malfunctioning** sensors are still included, but they will be excluded

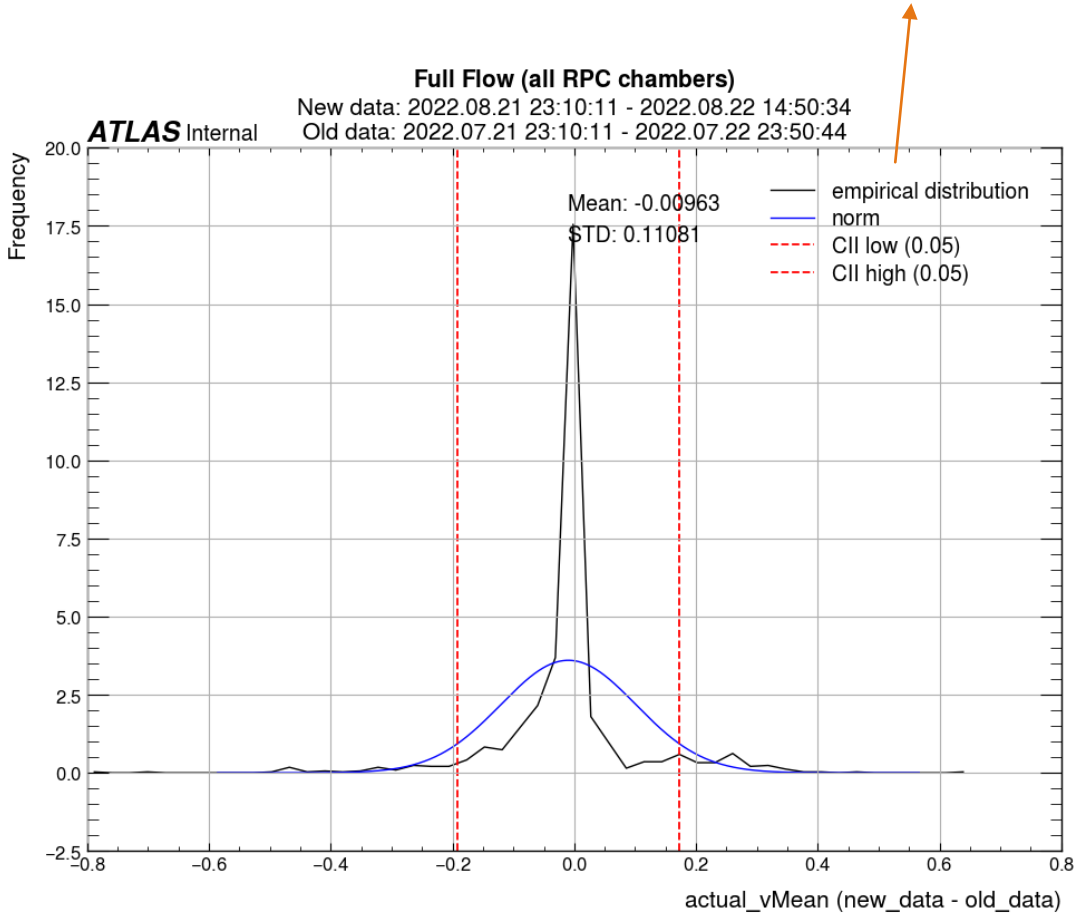
DIFFERENCE IN FULLFLOW FOR A GIVEN TIME-PERIOD FOR SPECIFIC SECTORS

Production of bar plots also for **single sector** channels (ex: **C02** and **C04**)





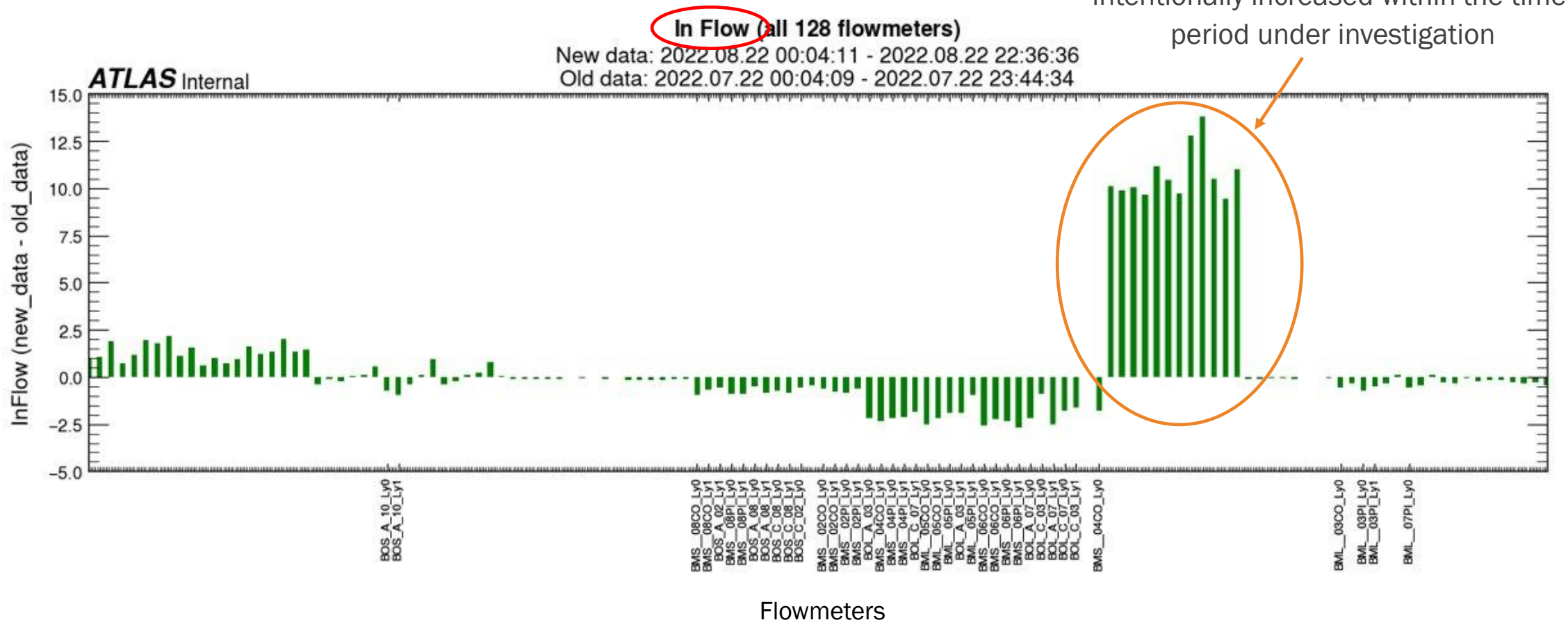
Fitted with normal distribution



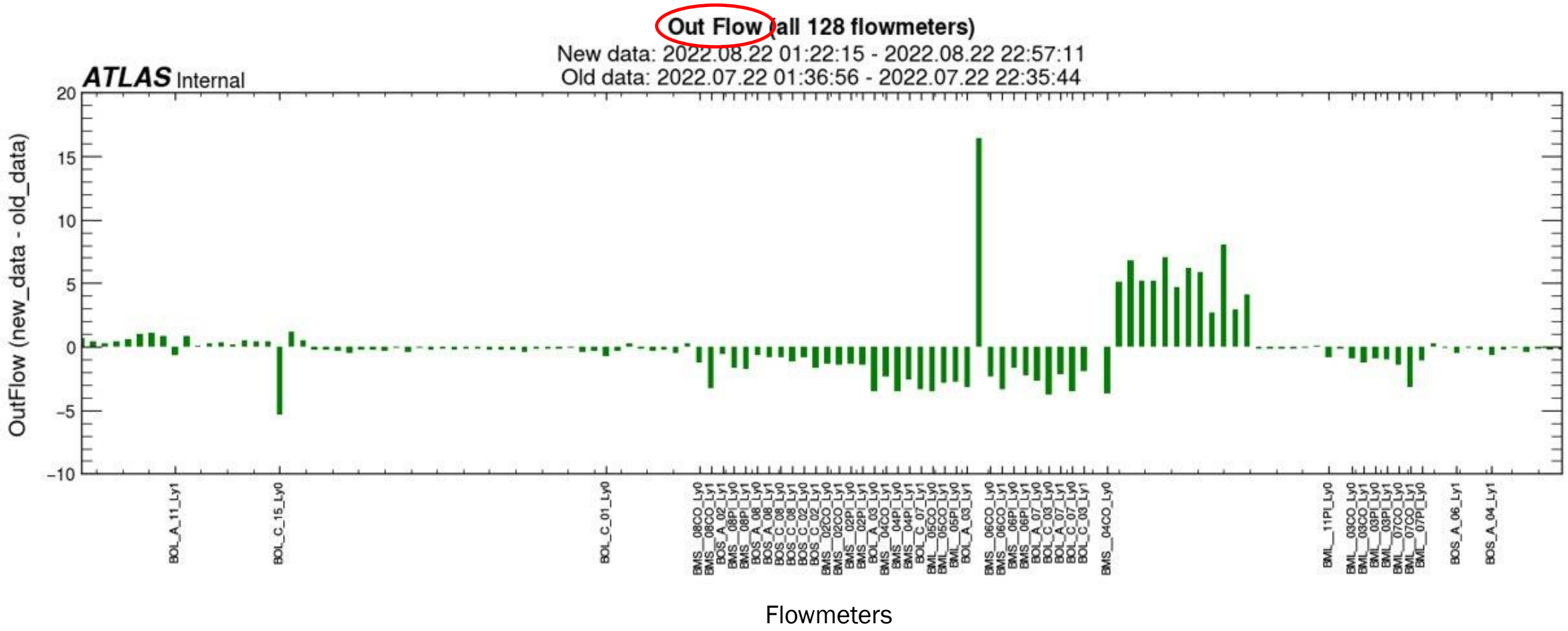
FullFlow distribution (tbc)

DIFFERENCE IN INFLOW FOR A GIVEN TIME-PERIOD FOR 128 FLOWMETERS

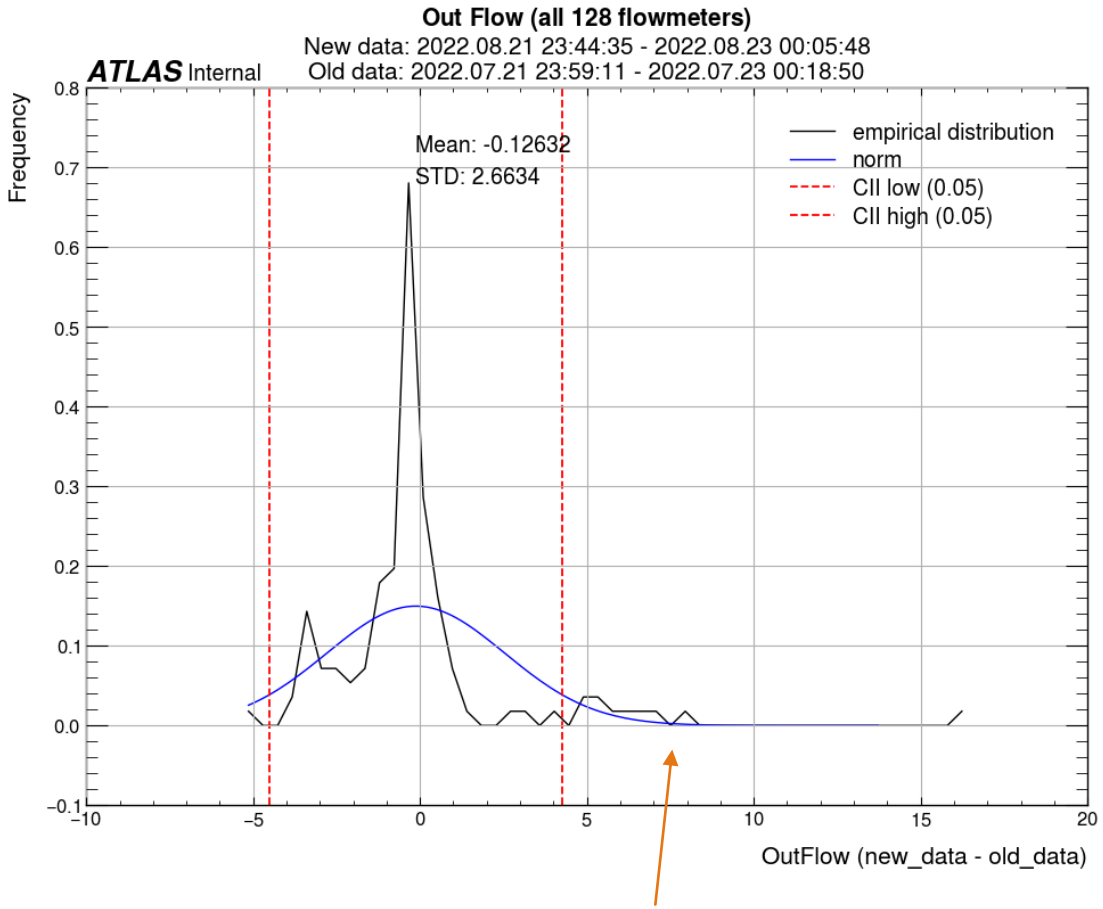
The flux of these chambers was intentionally increased within the time-period under investigation

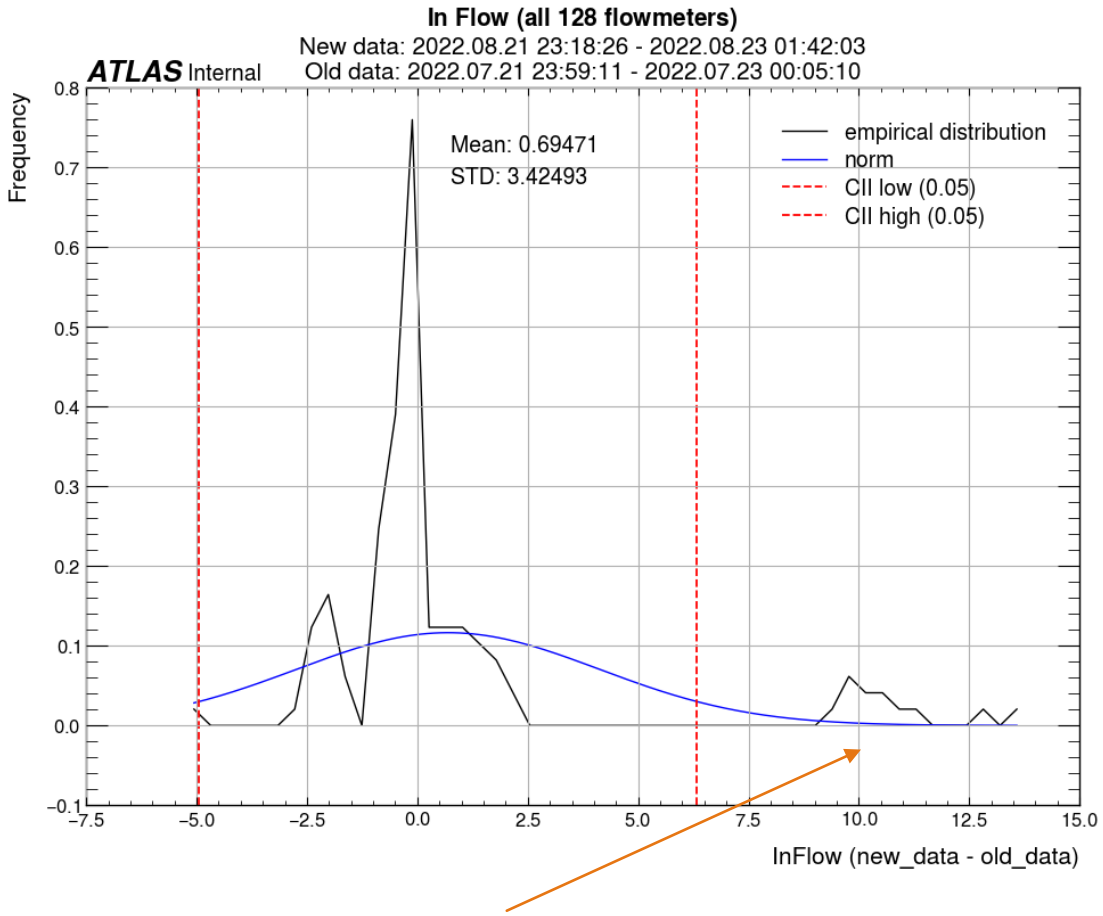


DIFFERENCE IN OUTFLOW FOR A GIVEN TIME-PERIOD FOR 128 FLOWMETERS



INFLOW AND OUTFLOW DISTRIBUTIONS





The reason for these flux outliers with high value with respect to the mean has been explained in slide 12

CONCLUSIONS AND FUTURE STUDIES

- Conclusions:
  - Tools to monitor ATLAS RPC **performance** vs time, analyzing the DCS data being developed
  - Complementary work with the analysis of *Antonio Giannini* (USTC group): study of gas gap current vs luminosity
  - This work continues a long tradition of Bologna (started by Alessandro Polini) in creating software tools that keep the detector under control and promptly report any anomaly
- Todo:
  - Enable production of 2D mapping plots with I_{gap} channels on y-axis and the respective HV one on x-axis
    - Investigate I_{gap} channels distribution and fit them
  - Optimize the **criteria** of the problematic channels selection
  - The monitor will be made **automatic** and will be published on a **web page** link
- For the gas studies we developed this tool inside the RPC gas group as a precious diagnostic instrument