# Development of a Resistive Plate Chamber Test Facility at Shanghai Jiao Tong University

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## Resistive Plate Chamber

Resistive Plate Chambers (RPC) (Fig.1) are gaseous parallel-plate detectors that combine :

- Good spatial resolution
- Good time resolution ($\sim 1\,\mathrm{ns}$)
- Large area ($\sim \mathrm{m}^2$)
- Low cost

They are therefore well suited for fast space-time particle tracking, as required for the muon trigger or Particle Flow Algortihm (PFA) They are used in many experiments such as ATLAS, CMS and are planned to equip detectors in ILC and CEPC projects.

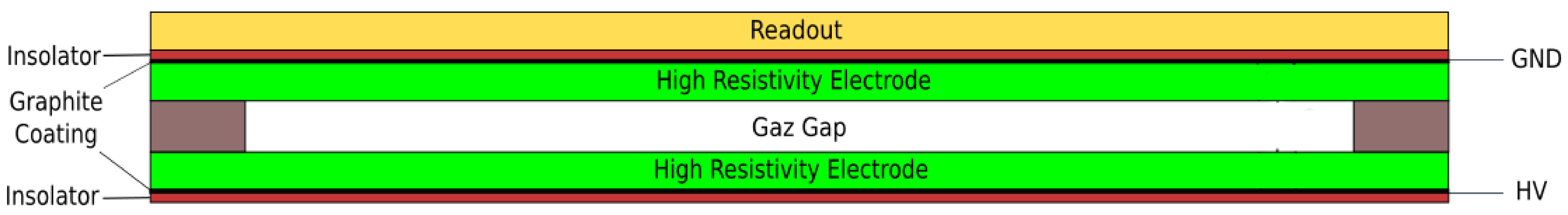


Fig. 1: Scheme of the simplest RPC

Many possibilities concerning the RPCs design, building process, electronics, electrode materials, gas mixture have to be investigated in order to adapt the RPCs to the specific requirements of each experiments.
The necessity to have Resistive Plate Chamber Test Facility to test the chambers and validate the decision made on the RPC prototypes is then crucial.

## Slowcontrol

RPC characteristics are dependent of the environment conditions ( pressure, temperature, humidity). This conditions can even deteriorate the electrodes or accelerate the ageing process.
The RPC Test Facility uses Raspberry PI 3 B+ and Bosch® BME280 to monitor and store the environment conditions and the inside gas-pipe conditions in a database (Fig.2).

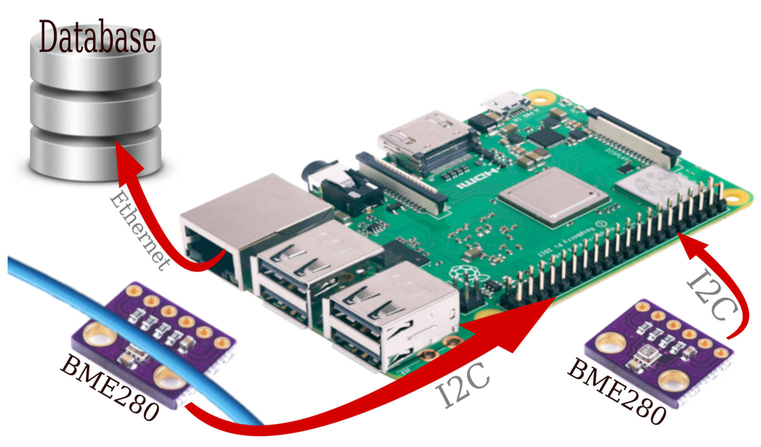


Fig. 2: Scheme of the slowcontrol

## Gas System

The Gas system is composed of a mixer and a dispatcher that can be control remotely using a Raspberry Pi connected through DAC/ADC to the system (Fig.3). Values are store in a database for data quality control.

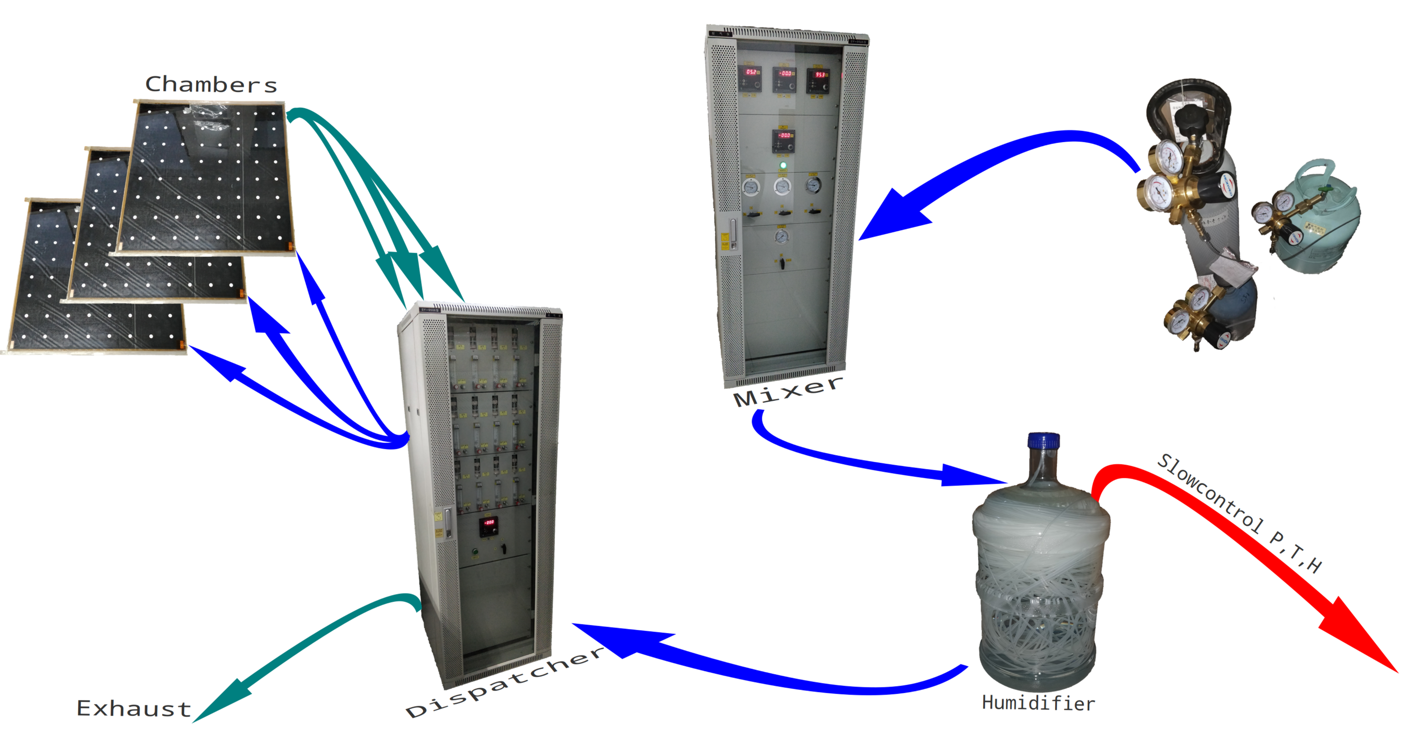


Fig. 3: Scheme of the gas system

Some electrodes need to be humidified, in this case an humidifier system is added between the mixer and the dispatcher.

## High and Low Voltages

A high voltage must be applied to the electrodes in order to create an electric field inside the gas gap, allowing primary ionisations and avalanche process. In addition, RPC front-end electronics need low voltage.
To maintain the uniformity of gas gain, the high voltage have to be adjusted to correct the changes in temperature and pressure [4] :

$$V_{corrected} = V(t)_{applied}\frac{T(t)}{T_0}\frac{P_0}{P(t)}$$

where $P_0$ and $T_0$ are some reference values for pressure and temperature respectively. This adjustment should be done regularly, thus the necessity for a computer controlled system. In addition, the value of these tensions and currents have to be stored to study the ageing effect of the chambers.
In laboratory it is common to have different HV and LV modules from different companies. To control them in a uniform way, a library have been developed (Fig.4) [1].

This library allows:

- To hide the different connection processes to the user.
- To group the modules in a real-life laboratory situation (racks, crates ...)
- To name Racks, Crates, Modules in order to simplify the user programs.
- To store values of voltage, intensity in databases
- To monitor the voltages to correct them given external conditions

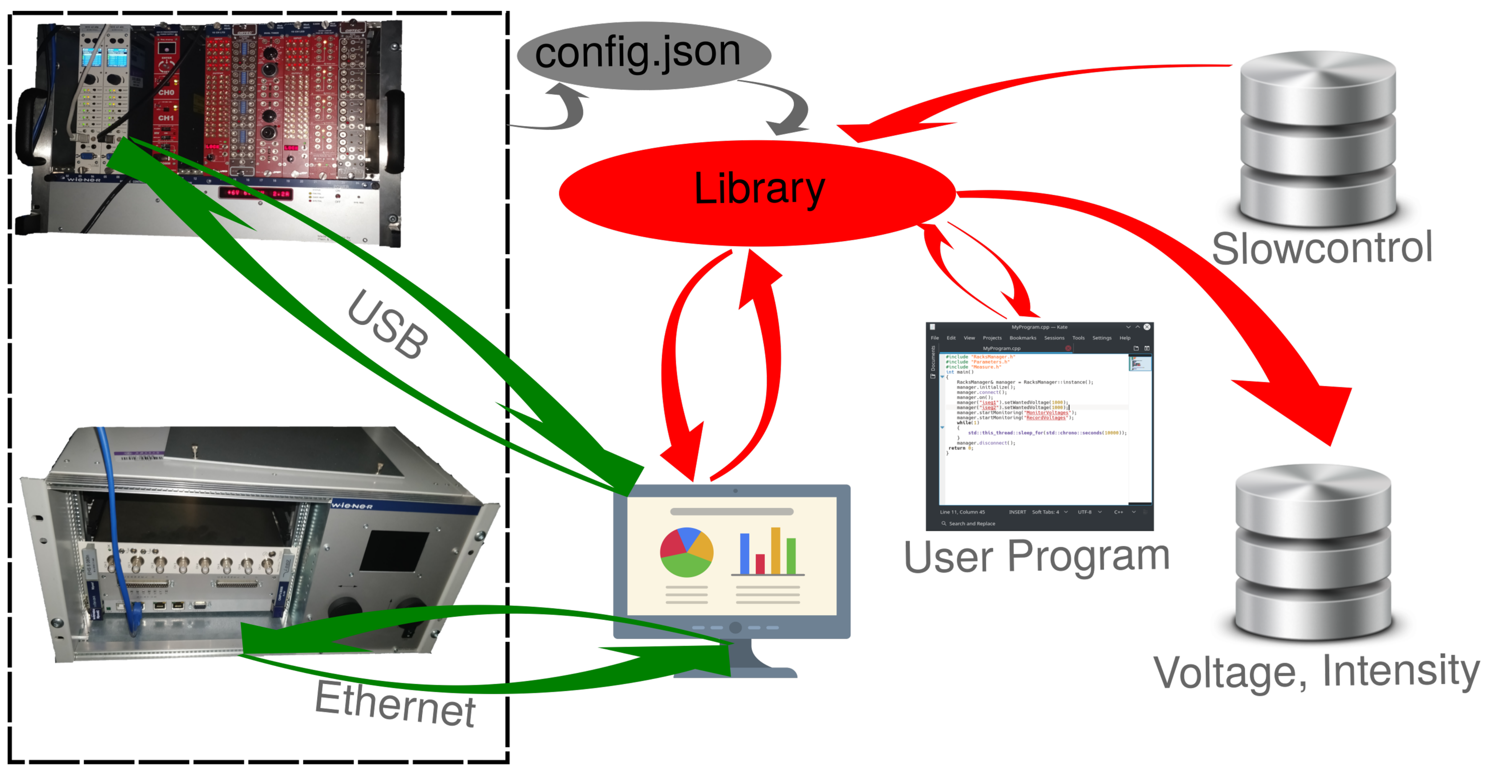


Fig. 4: Scheme of HV and LV system

## Conclusion

The development of a Resistive Plate Chamber test facility at Shanghai Jiao Tong University began some months ago :

- All the sub-system needed for the characterisation of RPC are set up
- All the informations necessary for data quality control ( slowcontrol, HV, Intensity...) can be monitored and stored in databases.
- The test facility is ready to characterize the RPC prototypes for CEPC and the ATLAS Phase II.

Some work have to be done in order to couple the data taking modules to the Data Acquisition Framework EUDAQ[3] and Data quality monitoring for high energy physics (DQM4HEP)[2] software.

## Bibliography

[1] Lagarde F. 2018. url: https://github.com/RPClab/Sauron.

[2] A. Irles et al. DQM4HEP - A Generic Online Monitor for Particle Physics Experiments. Tech. rep. AIDA-2020-CONF-2017-008. IEEE NSS/MIC 2017 Conference Record. Geneva: CERN, Oct. 2017. url: https://cds.cern.ch/record/2296574.

[3] Yi Liu. EUDAQ2 User Manual. Tech. rep. AIDA-2020-NOTE-2018-001. Geneva: CERN, Sept. 2017. url: http://cds.cern.ch/record/2314266.

[4] Fonte P. Peskov Vladimir Abbrescia Marcello. Resistive Gaseous Detectors: Designs, Performance, and Perspectives. Wiley.