Micro gas recirculation systems

About small gas recirculation systems for laboratory applications and Grafana monitoring

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Motivation

Small laboratory gas detector setups
→Typically flushing with gas or no flow at all

Proposal: gas recirculation system

- Recirculation?
  - Gas is pumped around in closed loop
  - To reduce gas consumption
- Requirements
  - For detector volumes up to 100L
  - Compact and portable: fits on a desk / in a box
  - Modular: every setup has different needs (optional purifier, flow monitoring, analyzers etc.)
  - Starting price ~ O(10^3) CHF
  - Easy to build, use and maintain
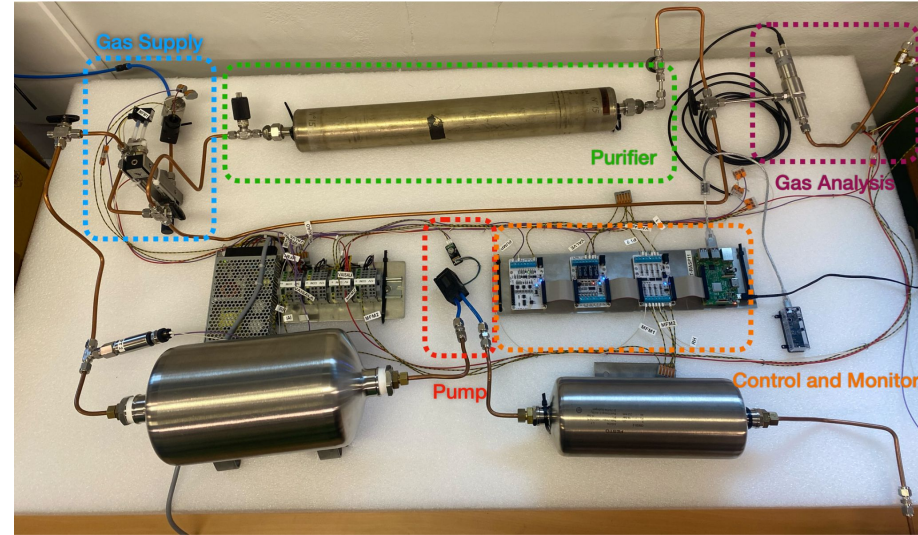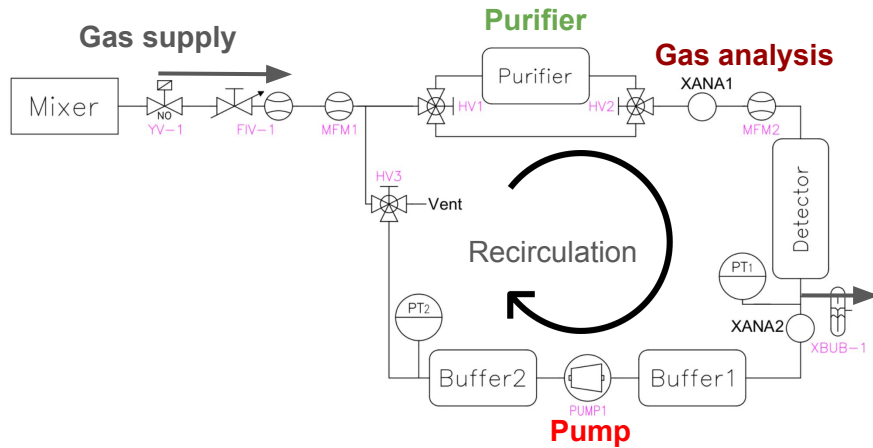 - Simple control and monitoring

LHC gas system
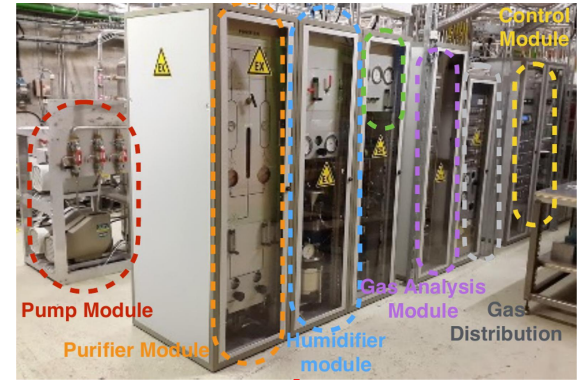
Miniaturization

Micro recirculation system
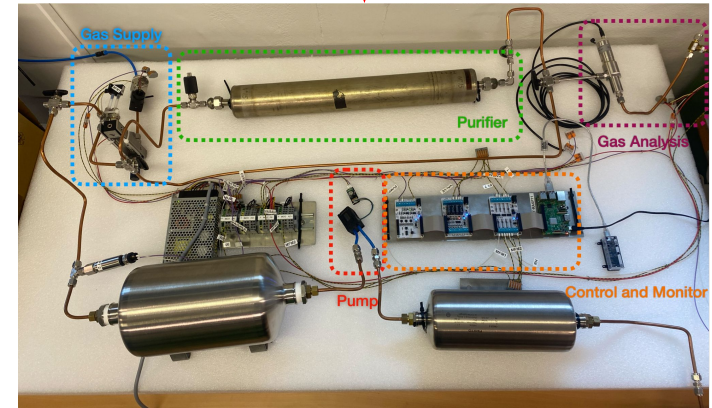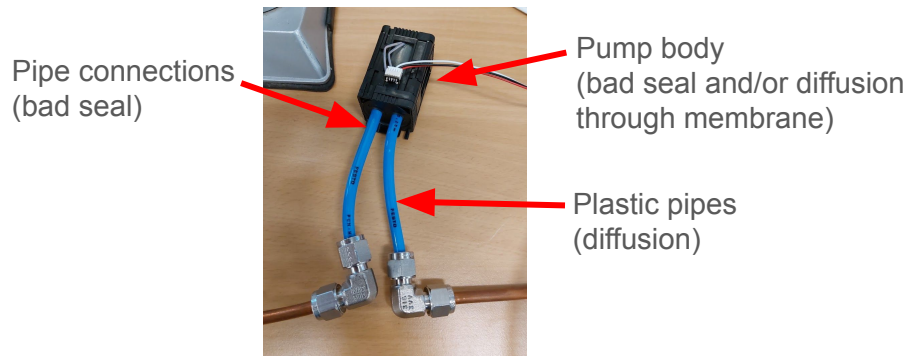
Description of modules

- Gas Supply Module → Controlled through an electrovalve with a rotameter for fine-tuning.
- Purifier Module → Optional module to remove O2, H2O.
- Gas Analysis Module → Sensors for monitoring the gas quality, e.g. dewpoint, O2.
- Pump Module → Micro-pump remotely controlled providing the recirculation.
- Exhaust Module → Bubbler connected at the output of the detector.

Component selection: pump

Many micropumps were considered

- Xavitech P200 & P1500 range
- KNF NMP range

However, these pumps are not suitable due to intake of air (i.e. humidity/N2/O2). Reasons:

Xavitech P200   Xavitech P1500

NMP03KPDC-L   NMP03KPDC-B1

Pipe connections
(bad seal)

Pump body
(bad seal and/or diffusion
through membrane)

Plastic pipes
(diffusion)

Reliable Viton
gaskets & seals

Compatible with compression fitting
& metal pipe

KNF N 86

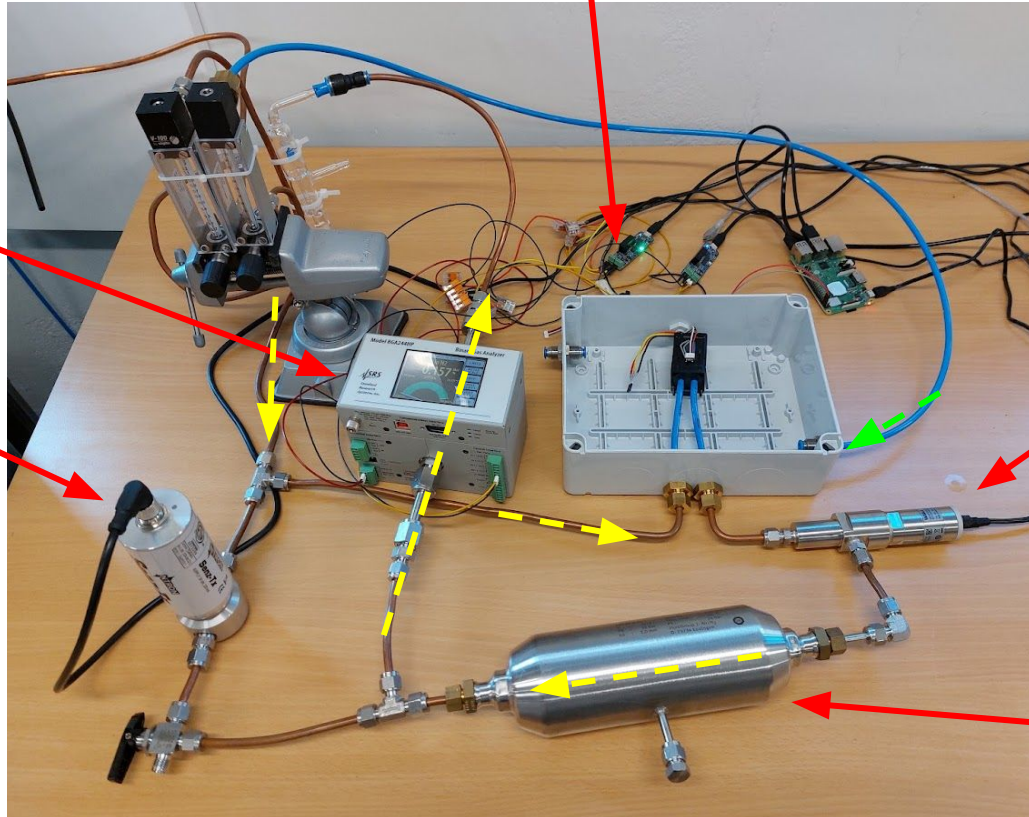# Setup for pump validation

Flushing box (can be closed with lid) with pump and RH sensor

Binary gas analyzer (BGA244)
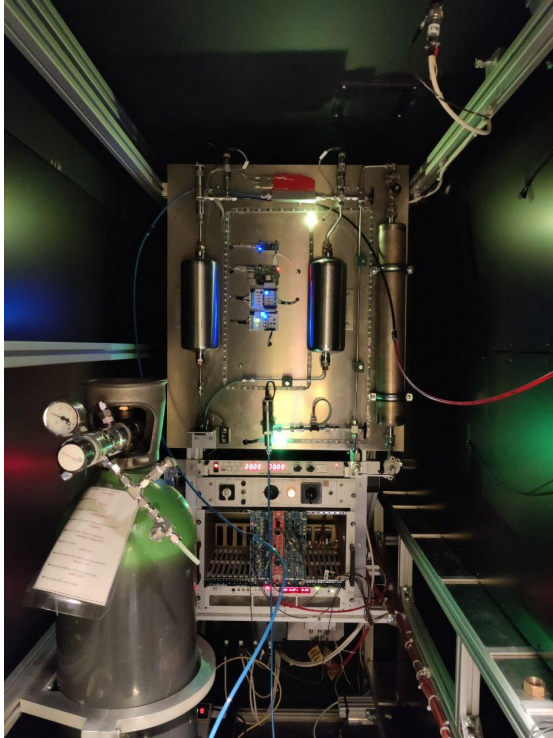
Oxygen monitoring (Ntron SenzTx)

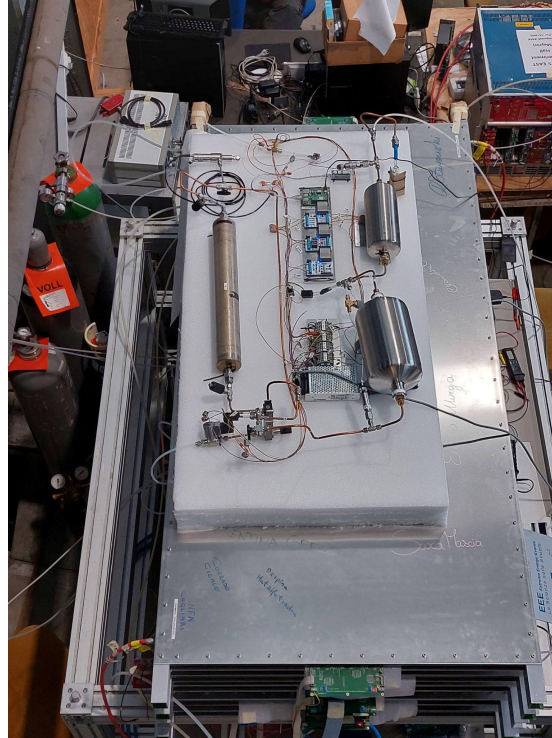Humidity monitoring (Vaisala DMT143)

Dummy detector volume

Existing micro recirculation setups in production

Installation at Science Gateway
for Spark Chambers (2023)

Installation for EEE project for MRPCs (2024)

Installation for Picosec Micromegas detector
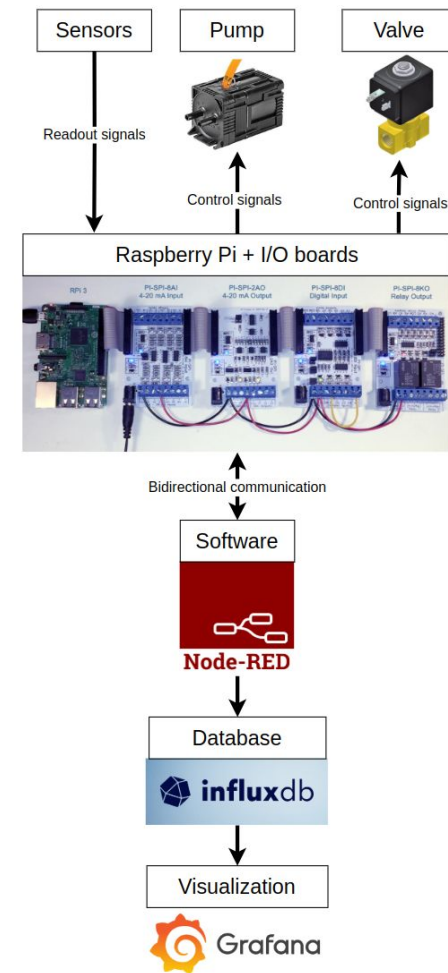for GDD group (2024)

Data flow

Electronics for readout and control

- Raspberry Pi
- [Widgetlords](#) I/O boards
  - Pi-SPi-8AI+ for analog inputs (voltage & current)
  - Pi-SPi-2A0 for analog output signals (voltage & current)
  - Pi-SPi-8KO for relay output signals

Software

- Node-RED: graphical programming tool
- InfluxDB: time-series database
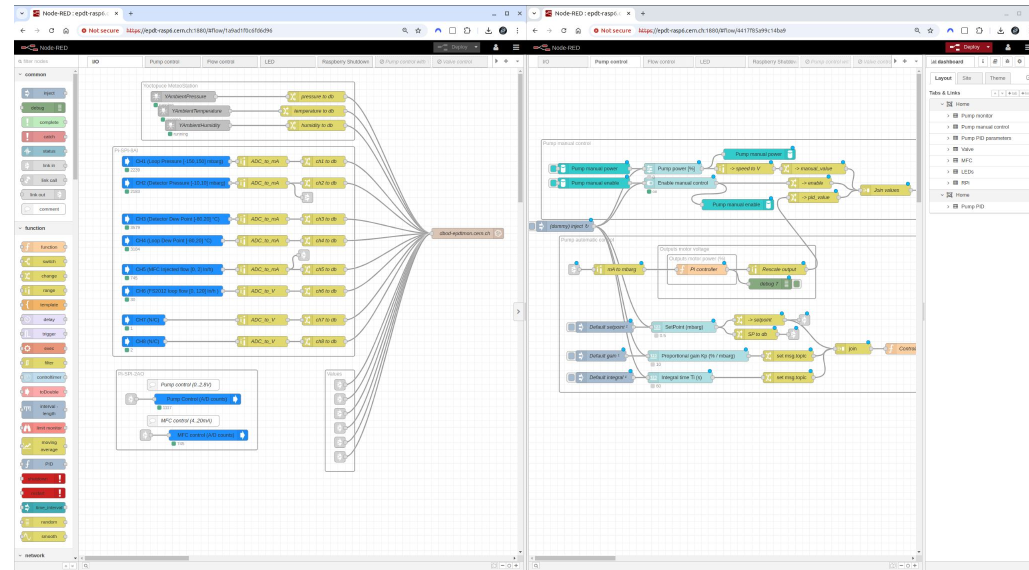- Grafana: visualization tool

Node-RED

Graphical programming tool

- Browser-based
- Easy to use
- Open-source

Built-in plugins for

- Interfacing with I/O boards
- Uploading sensor data to InfluxDB

Uploading sensor data to DB   Pump control
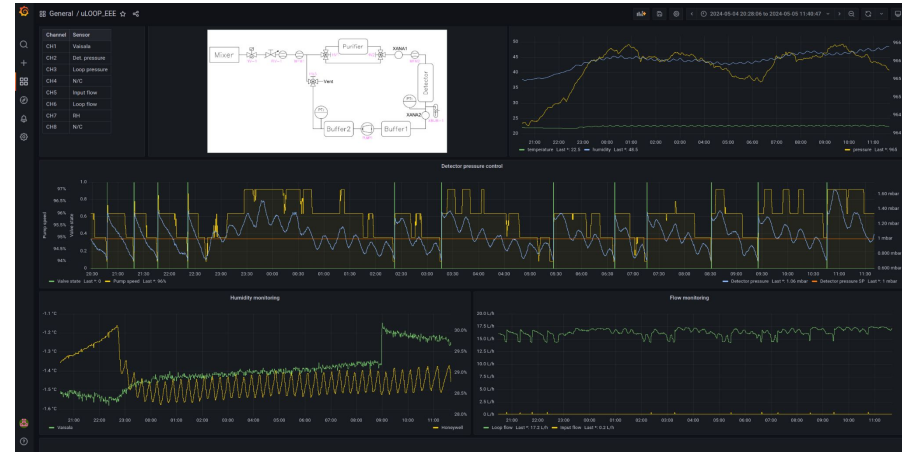
Grafana

Open-source visualization platform

- Many different types of panels: graphs, stats, gauges, heatmaps etc.
- Powerful query functionality (templates)
- Supports annotations, alerting
- Compatible with many data sources
- Easy user management

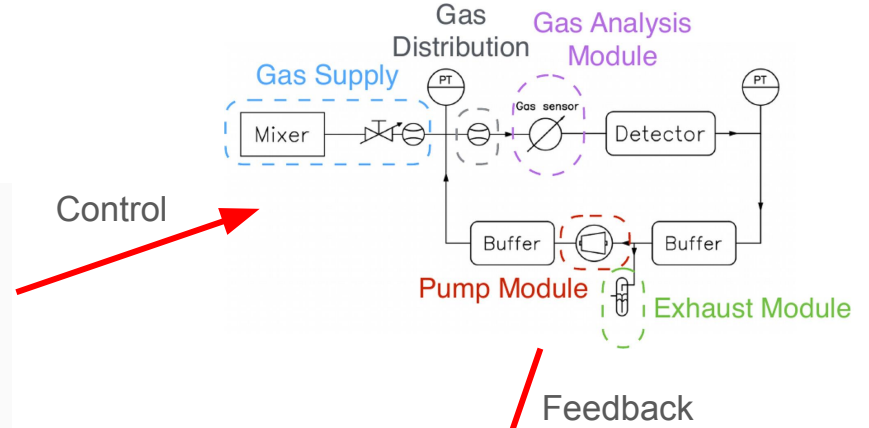The IT department provides services that make it very easy to set up Grafana:

https://grafana.docs.cern.ch/

Control & monitoring

## Node-RED control dashboard

Control

Feedback

Grafana monitoring

Conclusion

We realized several small gas recirculation systems

- Compact
- Cost-effective
  - Initial investment is paid back through a reduction of gas consumption
- Modular
  - Every system has different requirements
- We received positive feedback on how users interact with the system
  - Grafana monitoring
  - Node-RED control dashboard
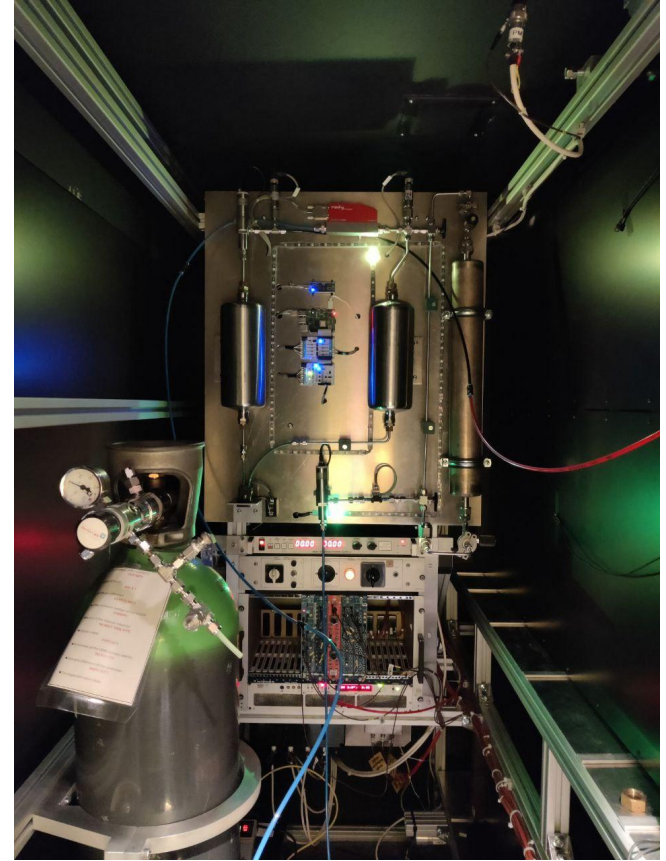
Upcoming Grafana workshop

Next year, we are planning to organize a workshop on how to use Grafana for monitoring.

This involves creating data sources, writing queries, configuring the visualization, adding [alarms](#) etc.

Date: TBD