

ALICE O2 setup for TPC read-out tests for the LHC run 3



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Introduction

The Time Projection Chamber (TPC) is one of the first detectors to build a small test setup which is comparable to the run3 Online-Offline (O2) computing system. The setup consists of 5 First-Level-Processing servers (FLPs) as input nodes, with multiple Common Readout Units (CRUs) and 2 Event-Processing-Nodes (EPNs). The primary goal is to verify the whole readout chain in a realistic scenario as close as possible to the expected running conditions during run3. This is one of the first small scale setups with the CRU to readout Frontend Cards (FECs), where 4 CRUs are used in a single setup. The setup will be extended to 10 cards this year and even further during LS2 to enable the commissioning of the TPC sectors in the clean room. In addition, this test can be seen as a reference installation of the O2 system and will be used to verify the O2 software and readout framework in a realistic scenario.

Main objectives of the TPC test setup

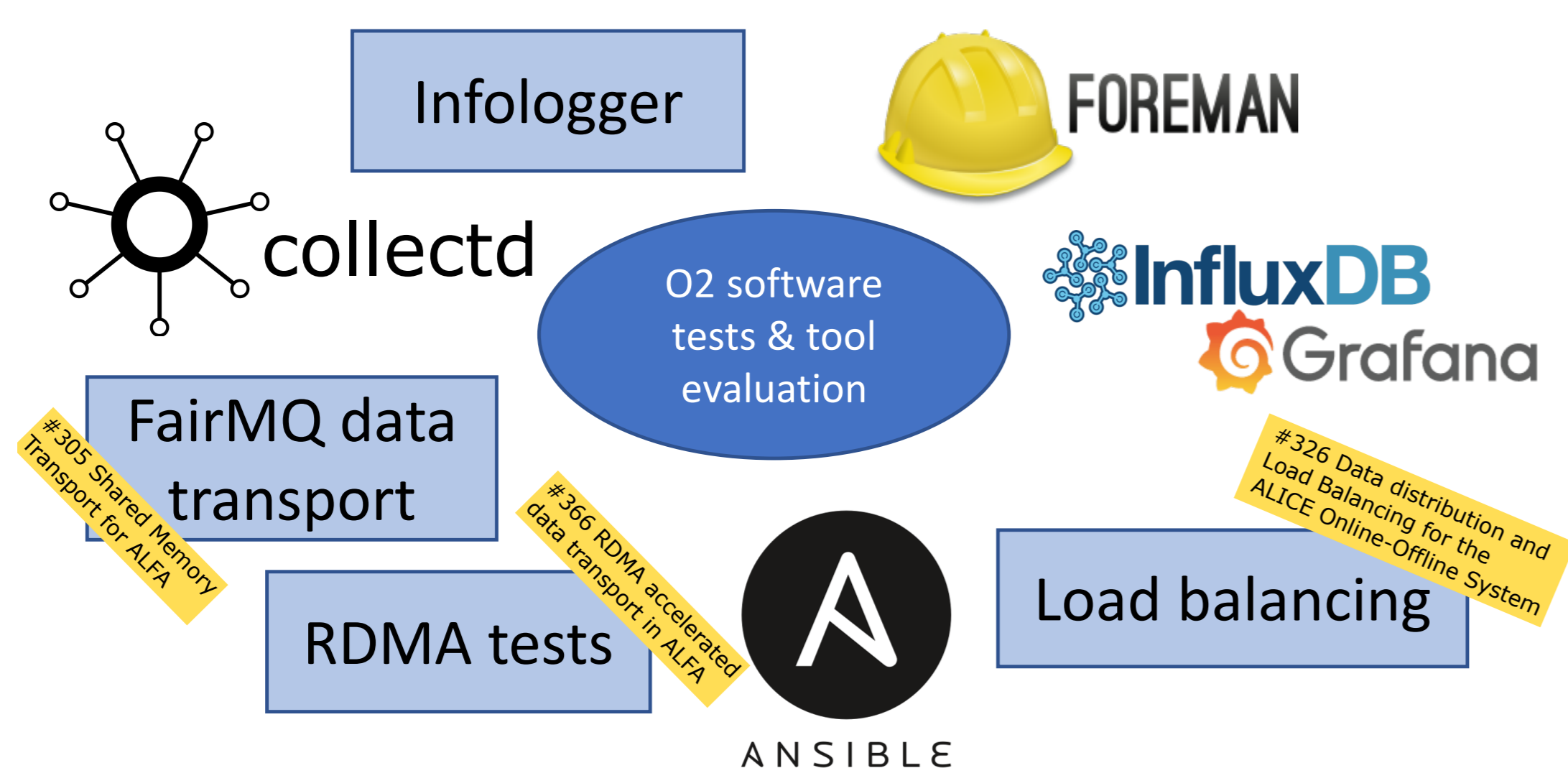
Primary goals for the TPC group

- Testing of a fully equipped Inner Readout Chamber (IROC) with High Voltage (HV) and source.
- TPC FEC readout test with CRU in a realistic run3 hardware setup.
- Later this year testing of a whole TPC sector including readout.
- TPC sector commissioning starting during Long Shutdown 2 (LS2) 2019.

Secondary goals as an O2 reference system

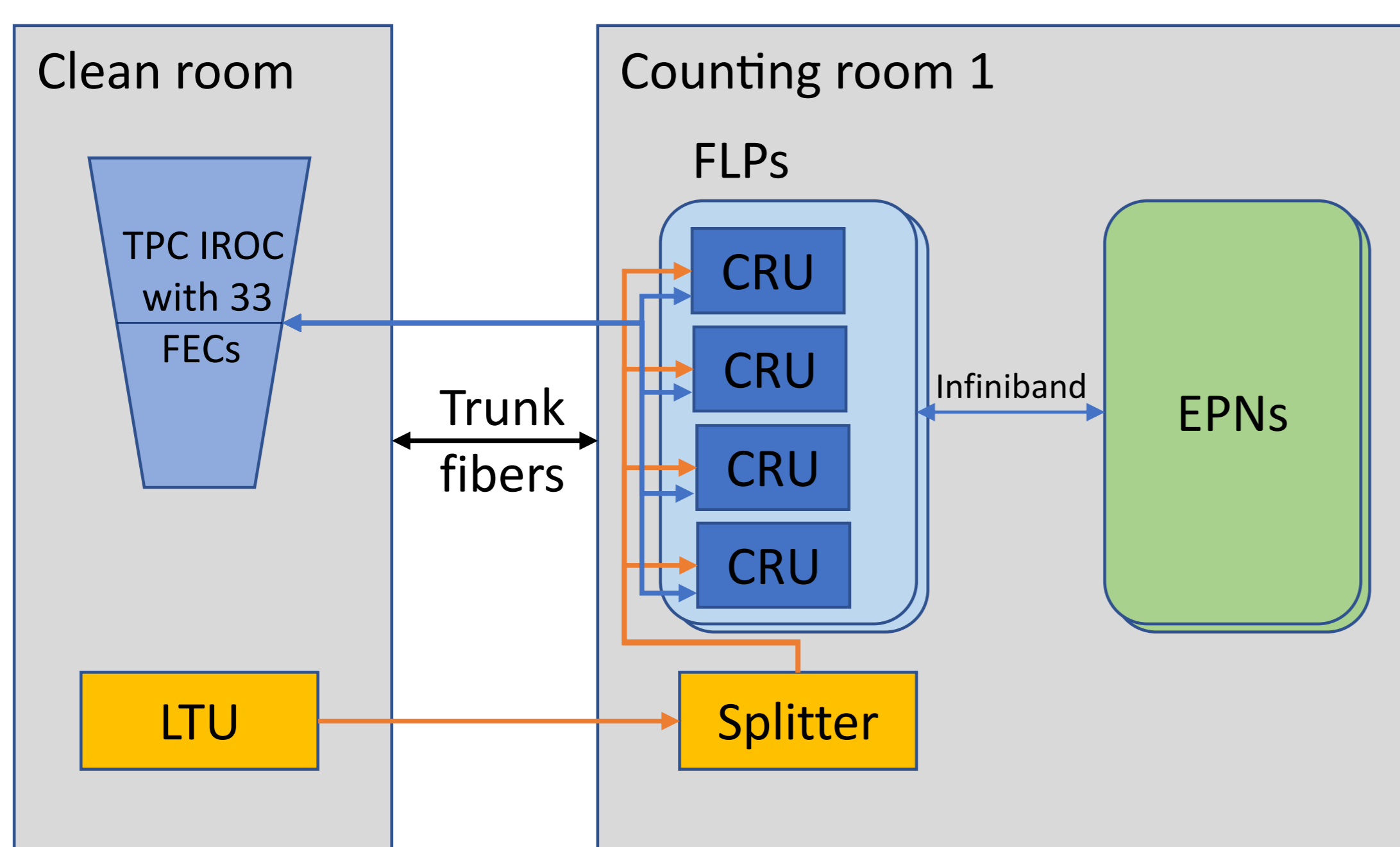
- Providing the O2 software environment which is as close to the run3 O2 framework as possible.
- Demonstrating O2 software and tools with the whole detector readout chain as input.
- Integrate as much functionality as possible.
- Gain experience with the complete software stack and gather feedback to further improve.

Preparations: O2 integration cluster



- Provisioning and configuration tools as baseline for run3: Foreman¹ and Ansible².
- Monitoring stack: Collectd³ on the nodes, Influxdb⁴ as the database and Grafana⁵ for visualization.
- Data transport demonstration on a medium scale.
- Framework logging: Infologger, a custom development already used in run2.
- RDMA demonstration with OpenFabrics Interfaces (OFI).
- Evaluation of the run3 load balancing algorithm.

TPC read-out setup at Point 2

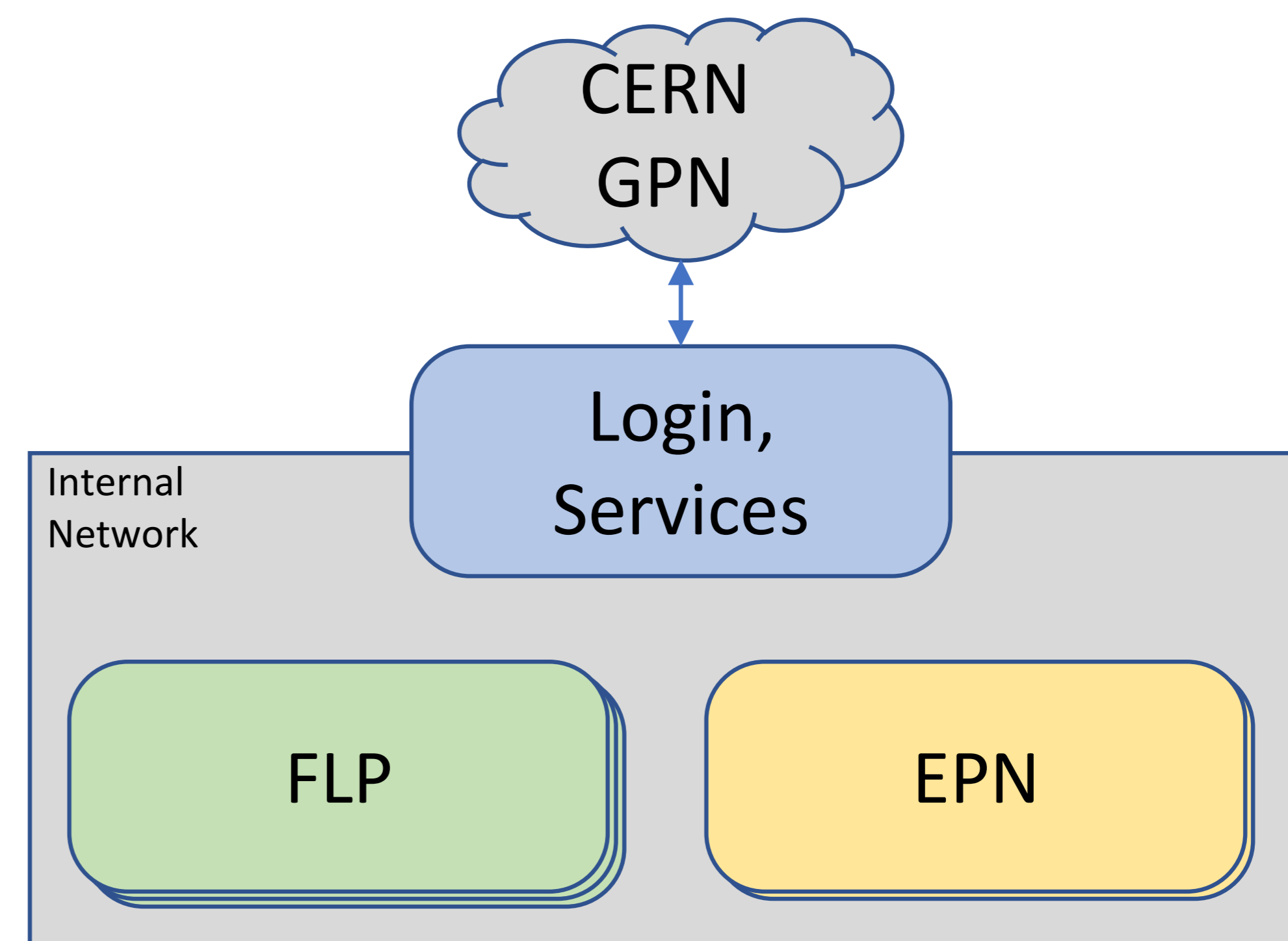


Clean room:

- TPC Inner Readout Chamber (IROC) with 33 Frontend Cards (FECs) mounted on the chamber.
- High Voltage connected and radioactive source to get real detector data as input.
- Each FEC has two GBT uplinks and one downlink (4.8 GBit/s each).
- Local Trigger Unit (LTU) to trigger readout.

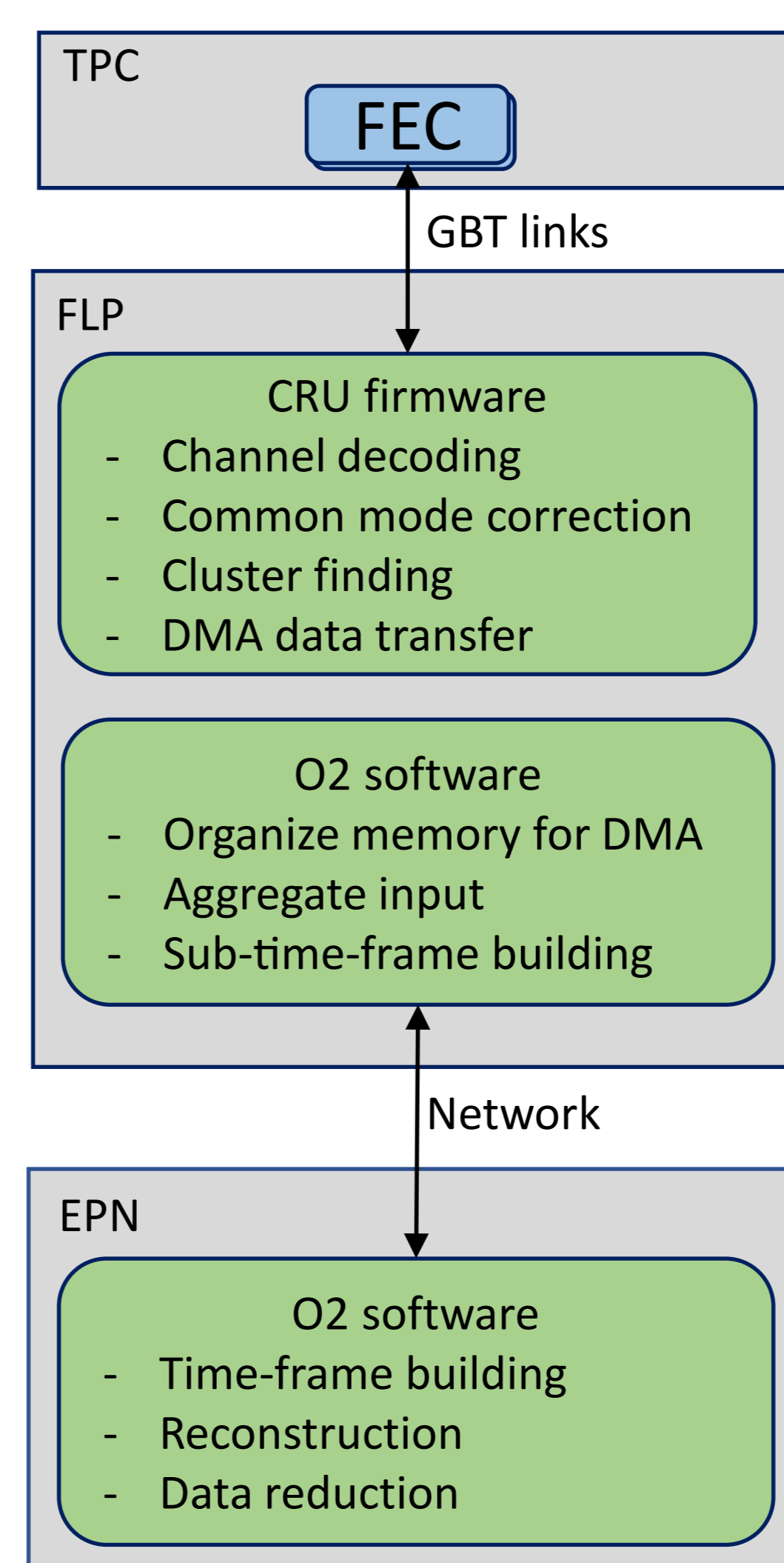
Counting room 1 (CR1)

- FLPs with multiple CRUs connected to the TPC FECs.
- Up to 20 FECS connected per CRU,
- CRUs connected to the LTU so synchronize multiple CRUs.
- EPNs to enable O2 software demonstration including time frame building.



- Login node with GPN connection for remote access to the test system.
- Internal isolated network with fast Infiniband FDR 56GBit/s.
- Internal services like NFS, DHCP, configuration and provisioning.
- 5 FLPs as input nodes, not all with CRUs in the beginning,
- 2 EPNs to test data transport.

Dataflow



TPC

- Continuous raw data from the TPC FECs,
- Data of one FEC split to two CRUs.

FLP

- First processing steps inside the CRU firmware.
- Reduction of the data through common mode correction and cluster finding.
- O2 readout software arranging the data in memory.
- Aggregation of multiple heart beat frames.
- Sub-time-frame building with local available data.
- Data transport and load balancing.

EPN

- Aggregation of all sub-time-frames into a time-frame.
- Reconstruction on the full time-frame.
- Compression for further data reduction.

Next steps

After the initial deployment at Point 2 further testing is needed to ensure everything is working. In the beginning 4 CRUs are available for the IROC readout test. Later this year the setup will be extended to 10 CRUs, for the sector tests as soon as additional CRUs become available. New parts of the O2 software like load balancing will be added step by step when they are available and verified.

During LS2 this setup will be extended further to 20 CRUs to test two sectors in parallel and enable the surface commissioning of the TPC in the clean room at Point 2.

Acknowledgements

Thanks to the TPC group who made their read-out test setup available for the O2 project to build a realistic O2 prototype for further software and integration tests. An early possibility to verify everything even in a small scale is very helpful to improve the software. In addition, thanks to everyone in the O2 project contributing to the setup as well as everyone testing and integrating their software and tools.

References

- [1] <https://www.theforeman.org/> [3] <https://collectd.org/> [5] <https://grafana.com/>
[2] <https://www.ansible.com/> [4] <https://www.influxdata.com/>