



# Ground vibration monitoring at CERN as part of the international seismic network

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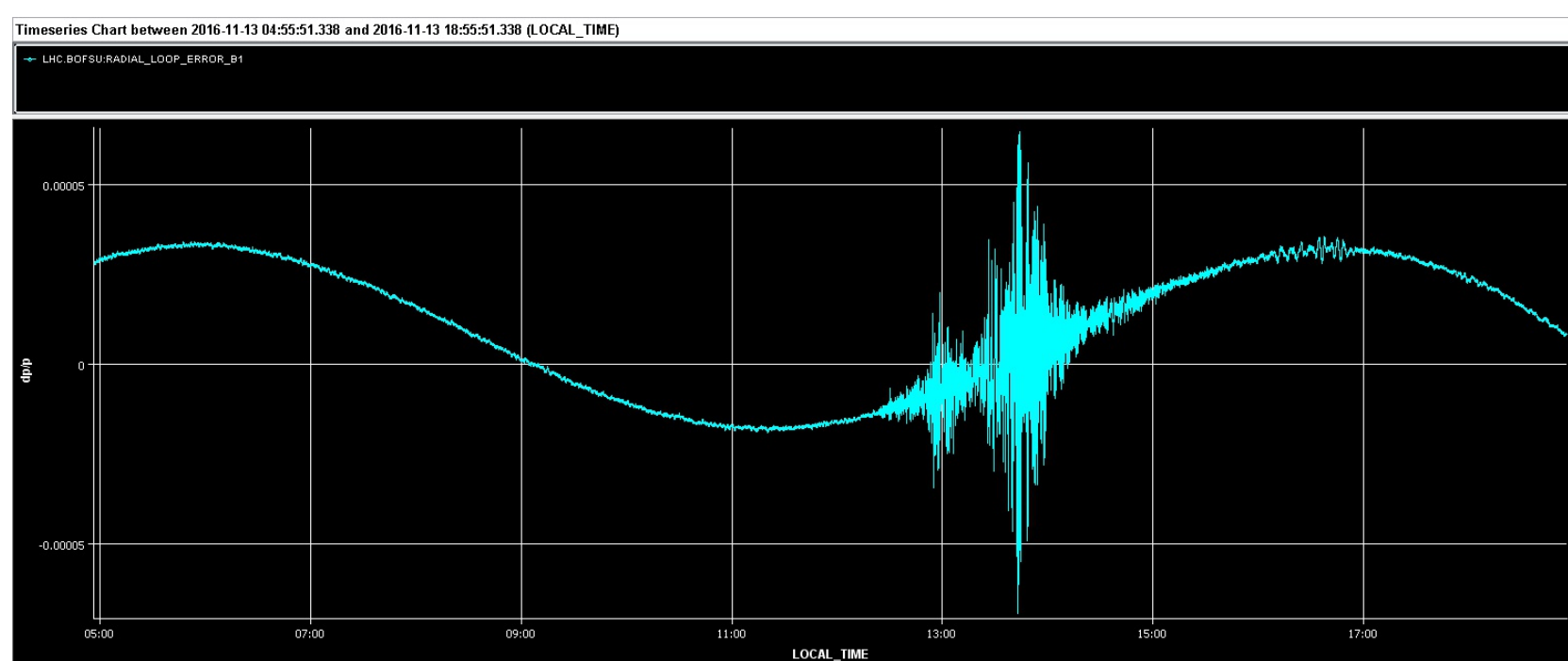
## ABSTRACT

The civil engineering activities in the framework of the High Luminosity LHC project, the Geneva Geothermie 2020 and the continuous monitoring of the LHC civil infrastructures triggered the need for the installation of a seismic network at CERN. A data acquisition system has been deployed in 3 places at CERN: ATLAS, CMS and the Prévessin site. The system is sending all the raw data to the Swiss Seismological Service (SED) and performs FFT on the fly to be stored in the LHC database.

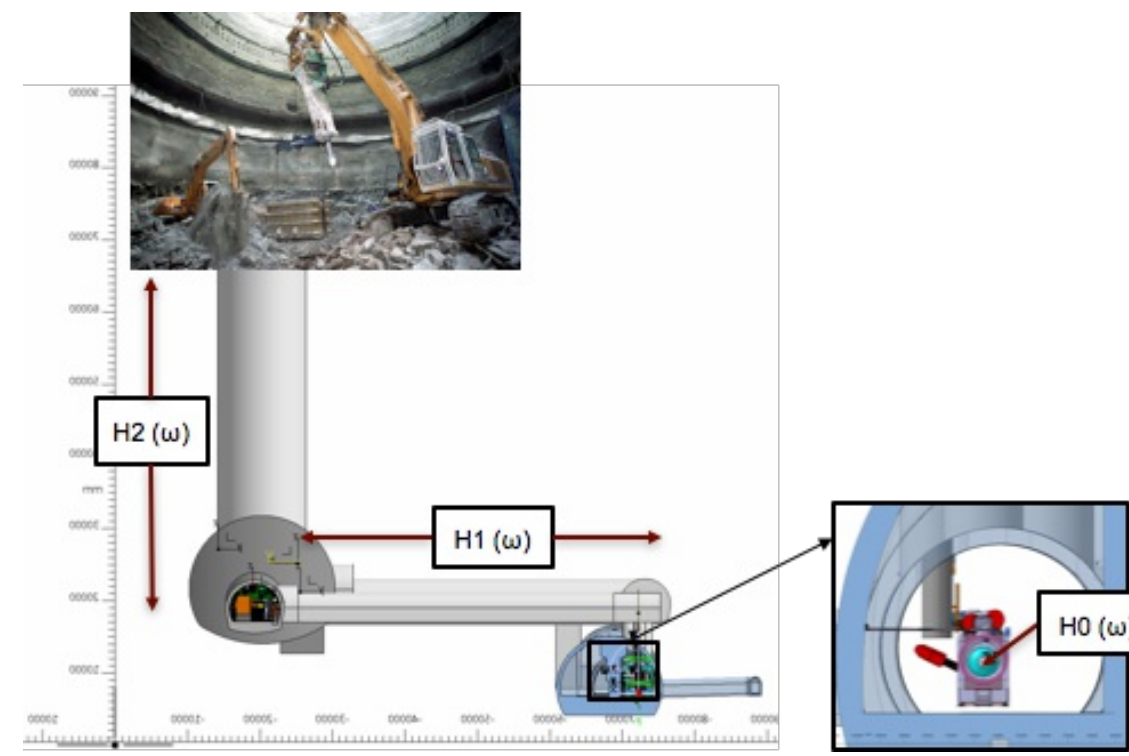
## REQUIREMENTS

### Seismic wave impact on the LHC

The LHC beam position is influenced by the moon gravity and by a series of earthquake waves which propagate through the Earth's crust.



An earthquake in New Zealand (M 7.8) at 11:02 UTC on November 13th 2016



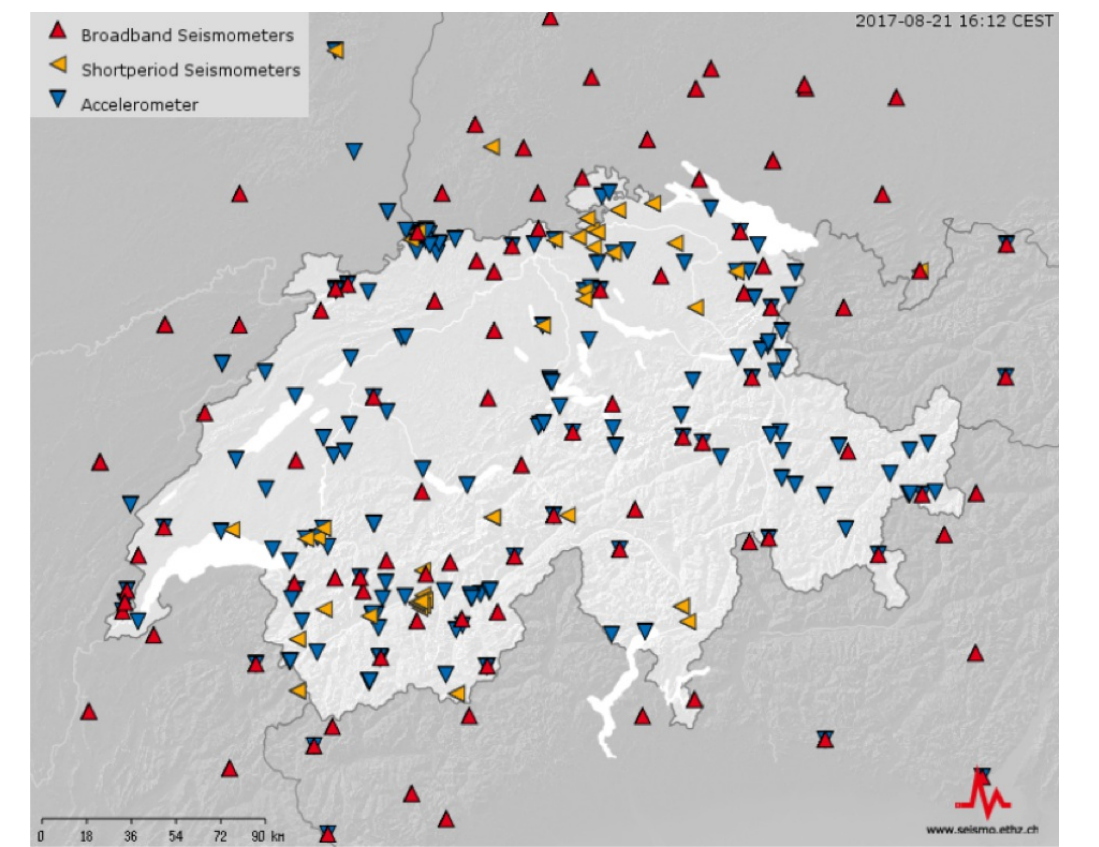
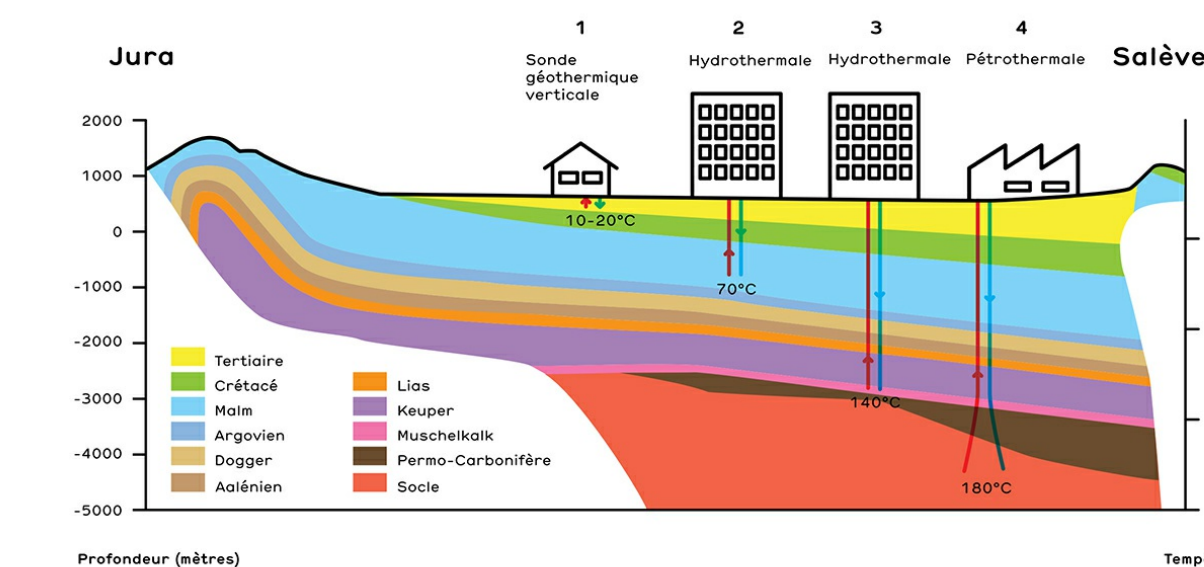
### HL-LHC civil engineering activities

Installation monitoring to anticipate risks on the beam stability generated by civil engineering activities.

Studies are ongoing to determine the best excavation technique.

### Geothermie 2020

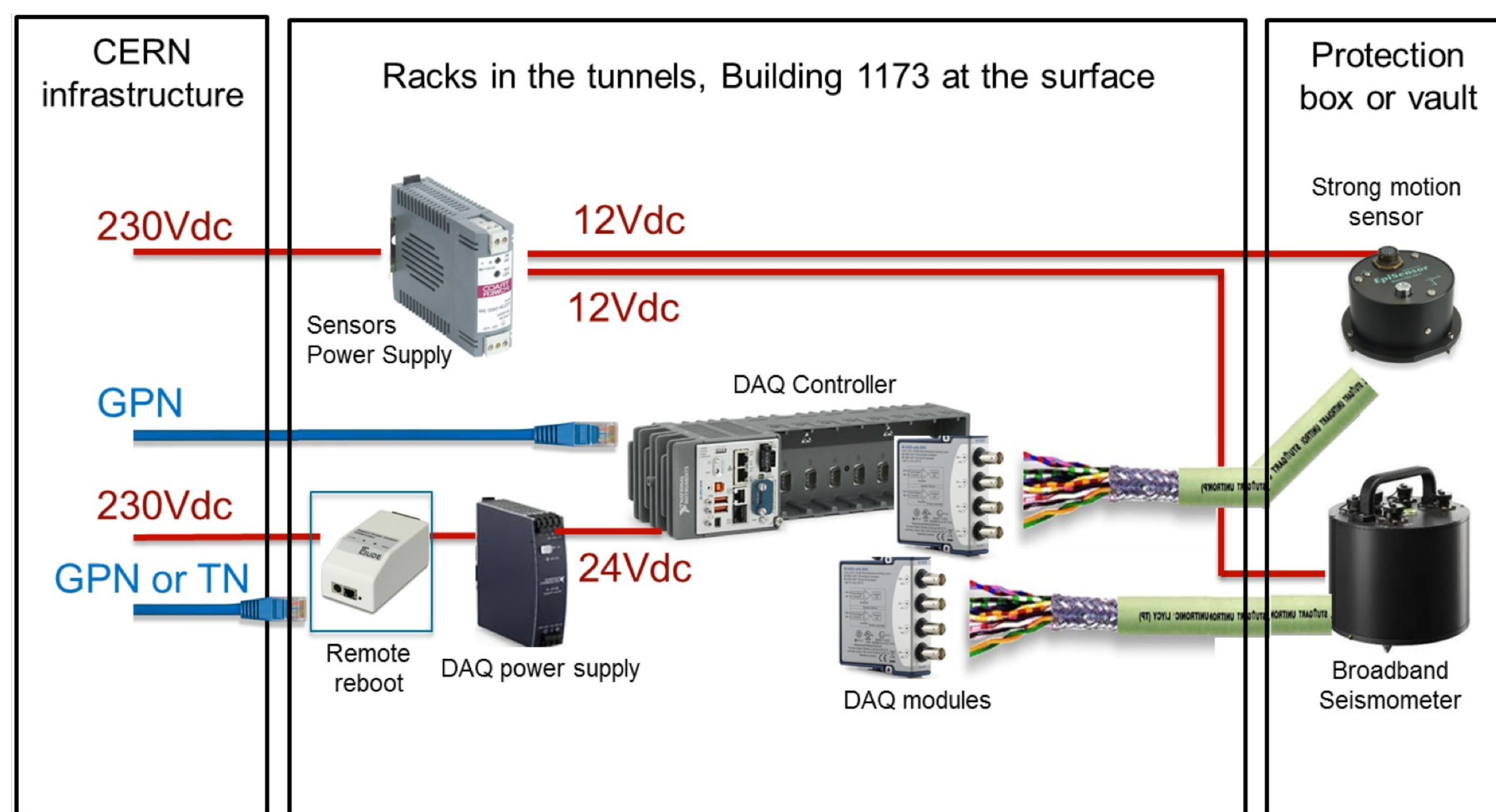
The impact of the possible microseismicity induced by geothermal exploitation on the CERN installation is evaluated and quantified.



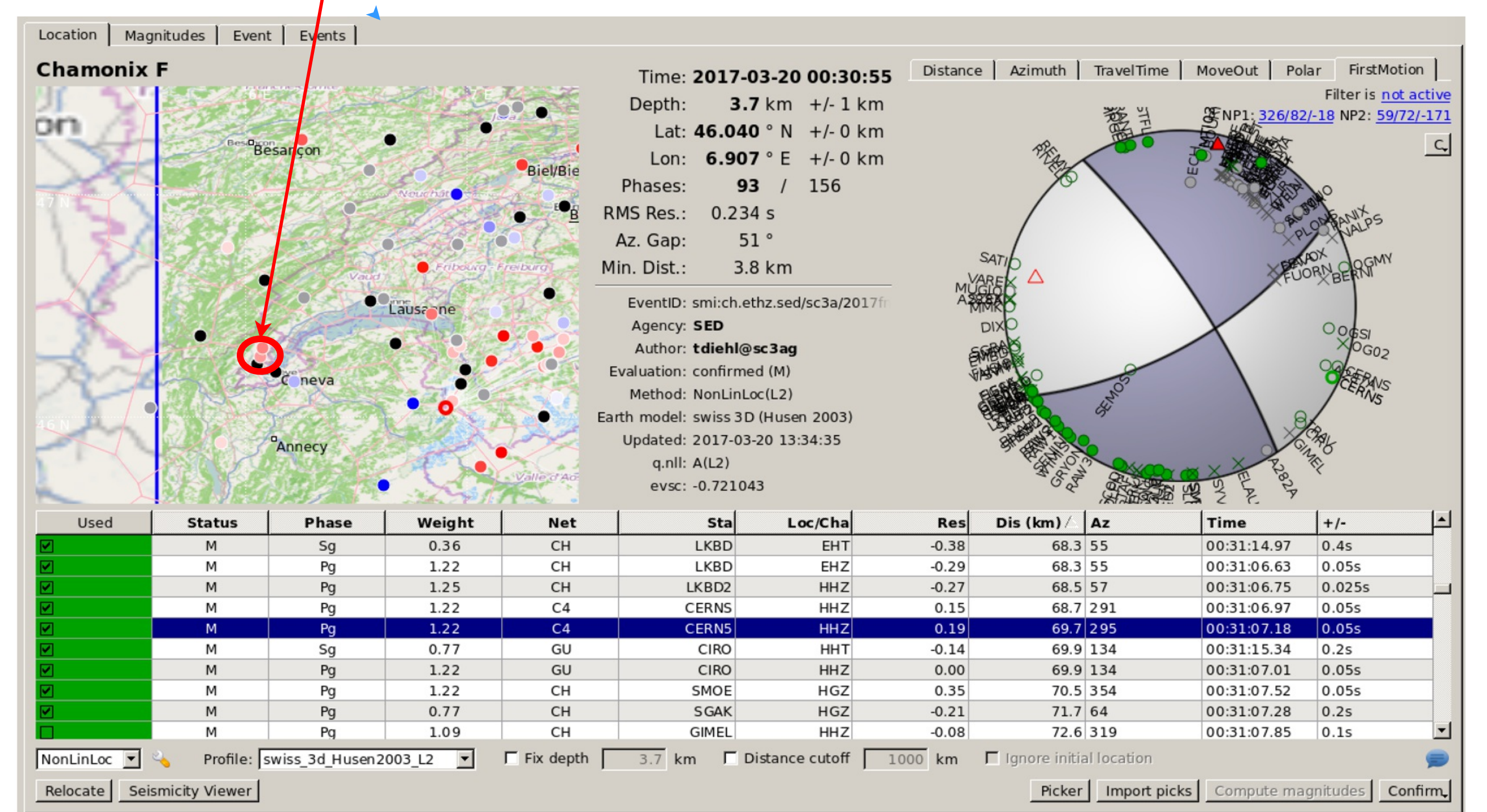
### Swiss Seismic Network

According to the geothermal exploitation project, and the consequent densification of the local seismic network around Geneva and the CERN needs, it was decided to connect the CERN seismic network to the Swiss and Worldwide seismic network.

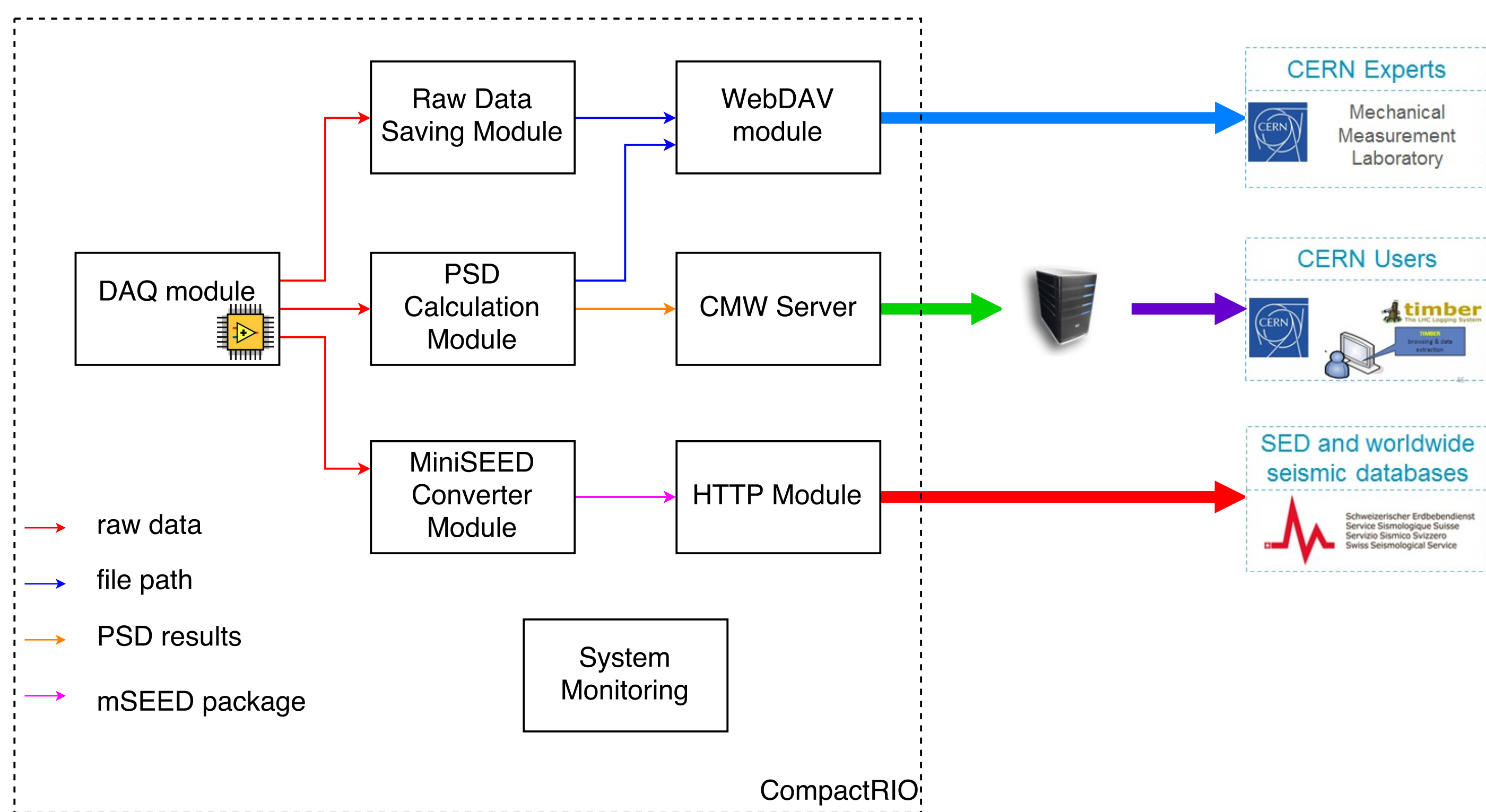
## HARDWARE SETUP



### CERN installations integrated into international seismic network

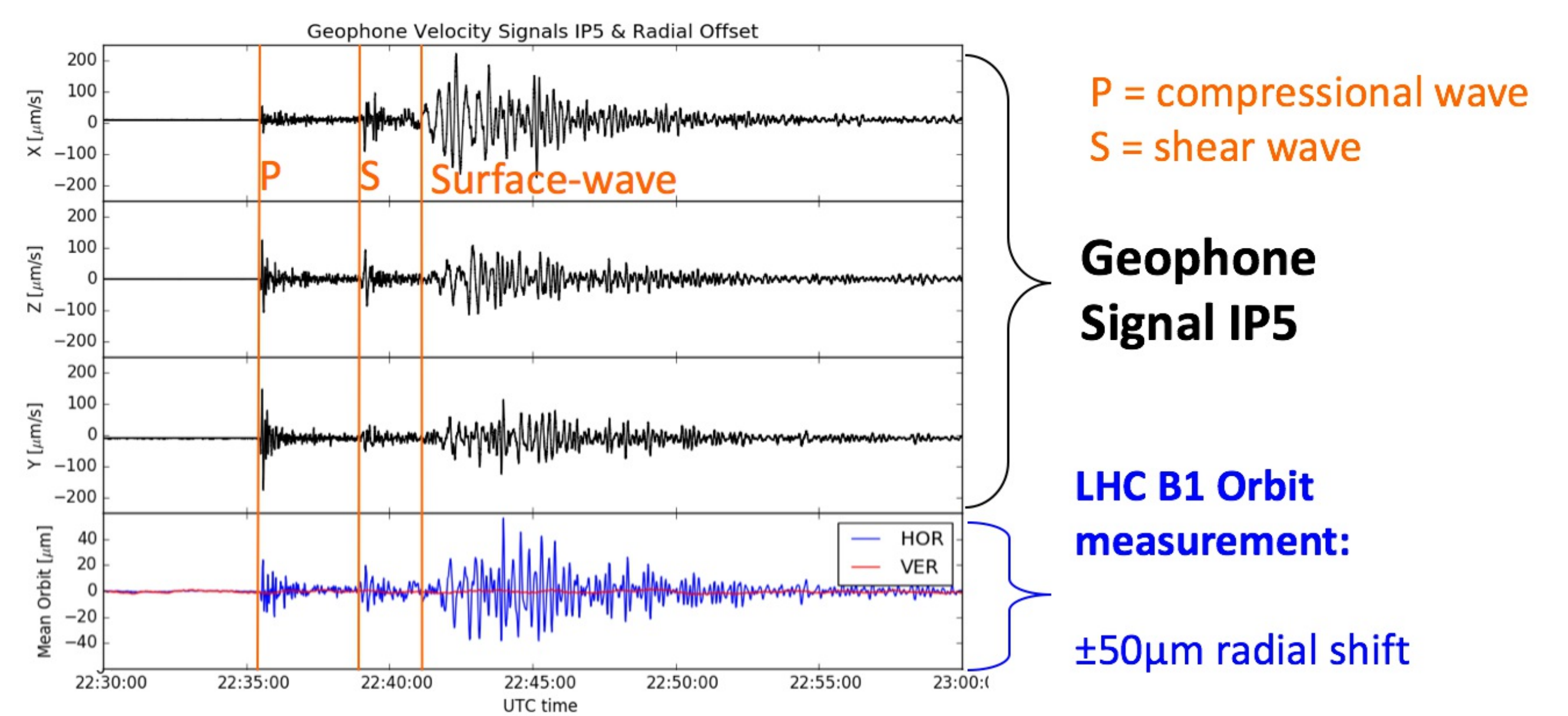


## SOFTWARE ARCHITECTURE



### Correlation on LHC beam

Geophone signal IP5 and beam radial offset.



## CONCLUSIONS

Thanks to the valuable collaboration between CERN and SED, the data, made available at CERN and for worldwide seismic organisations, will be used for very diverse applications. The study of the impact of earthquakes on the LHC will be a guidance for the "Géothermie 2020" project, aiming at developing the use of geothermal energy in the Geneva canton without impacting CERN. The data is planned to be used in the HL-LHC framework, a project to upgrade the LHC. The vibration levels will be of particular interest during the excavation of the new LHC shafts. Finally, the network will be used as a valuable reference to monitor vibration levels in the LHC on a long-term basis. The systems have been running 24/7 for several months and show to fulfil all requirements. Future development aim at transferring data to SED within 2 seconds instead of the actual 10 seconds and maybe adding more stations to increase the spatial accuracy.

