Warsaw University of Technology

ISE

EUROPEAN SPALLATION SOURCE

PRL Gas Pressure and Humidity Stabilization

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PRL Critical Design Review

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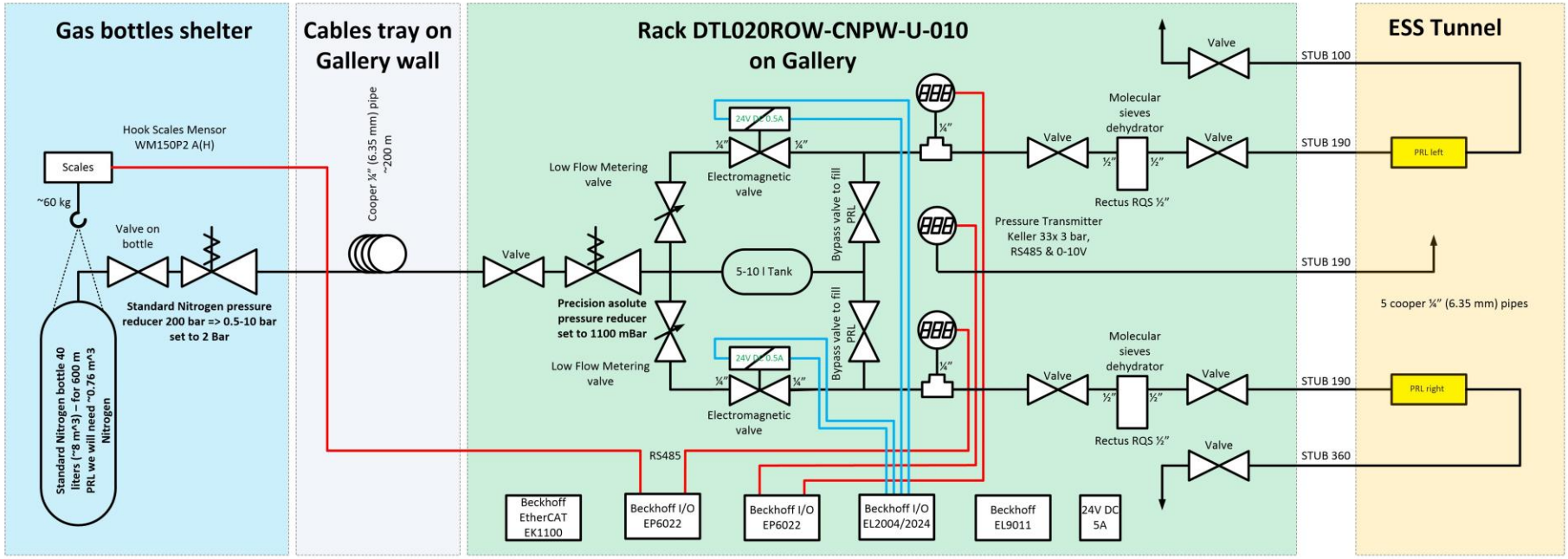
Requirements and solutions

- To be filled with dry gas (air, Nitrogen, etc.) during operation, to avoid phase drift caused by humidity and pressure changes.
- Continuous pressured gas with precise regulation is needed to feed into main line. We intend to use Nitrogen to fill the PRL sections.
- Pressure changes inside the PRL will affect the dielectric constant of Nitrogen and change the mechanical length of the PRL.
- The change of dielectric constant with Nitrogen pressure will shift the reference (704 MHz) signal phase by ~0,0002 °/m x mbar. This coefficient has been calculated and simulated, should be proved with measurements on long rigid line.
- It is necessary to stabilize the Nitrogen pressure with accuracy of ~16 mbar for~600 m long PRL to fulfil requirement: phase drifts between any PRL outputs for LLRF: 0.33 °/100m. Pressure control system should stabilize the Nitrogen pressure within ± 1-2 mbar.
- The PRL is gas tight but some small leakage through N connectors (at the both ends and couplers) result in pressure drop of ~2 mbar/day. Amount of Nitrogen to stabilize pressure can be estimated to ~1 l/day for one PRL arm. Assuming ~2 l/day, one 40 l Nitrogen bottle will be emptied after ~3250 days (~9 years).

Scheme of Nitrogen PRL supply and stabilization

- The pressure of Nitrogen will be reduced to ~2 Bar in gas bottles shelter. The Nitrogen bottle will be hang up on the scales with RS485 interface to measure the remaining amount of gas.
- Precision absolute pressure reducer will provide gas pressure set to 1100 mbar.
- Absolute pressure in both PRL arms will be controlled using Keller 33x digital pressure transmitters with accuracy of ± 0.75 mbar (FS 3 bar) and resolution of 0,06 mbar (for FS 1.2 bar accuracy ± 0.3 mbar and resolution of 0.024 mbar) .
- Beckhoff I/O RS485 modules EP6022 will be used for pressure data transmission and EL2024 for electromagnetic valves control.



Next steps

- Measurement of phase versus pressure coefficient in ISE prototype (~16 m).
- Order of all necessary components (a list is ready) for prototype.
- Build a prototype of gas pressure and humidity stabilization.
- Test the prototype in ISE and in ESS tunnel on long PRL.
- Build a final version of gas system.
- Install gas system in rack on gallery.
- Tests in ESS will depend on Bottles Shelter readiness, pipes installation on Gallery and Stubs.
- Final tests needs temperature stabilization of PRL (cabling in tunnel).