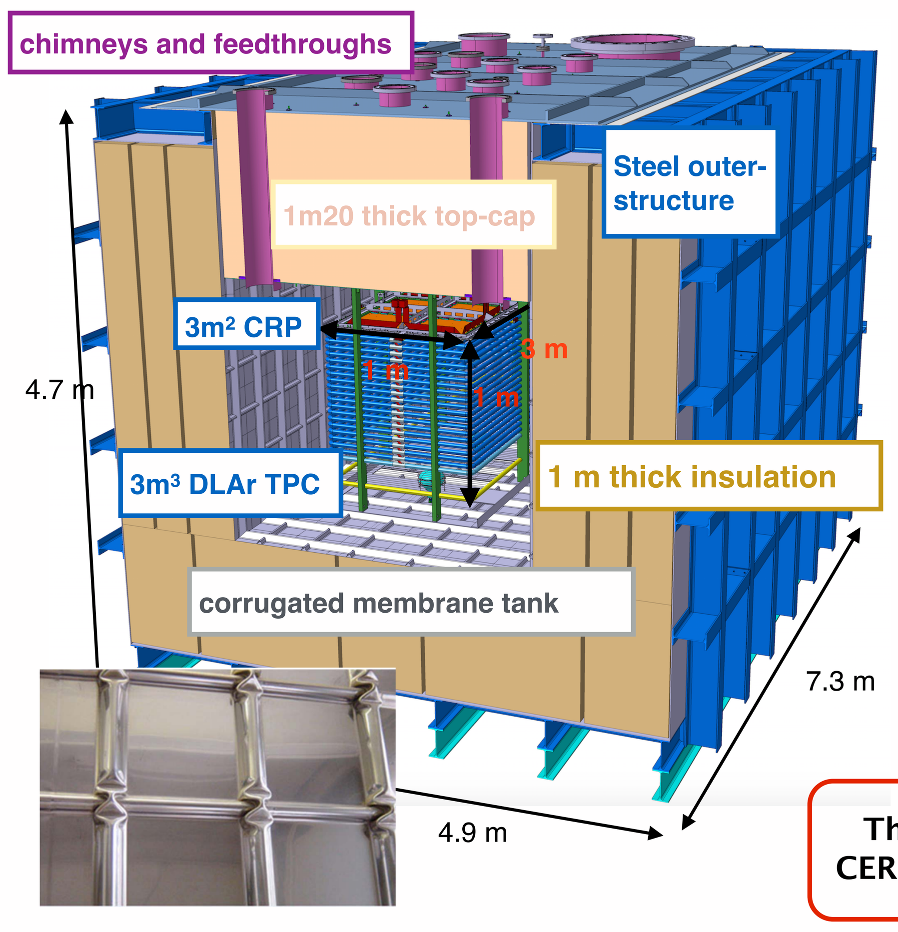
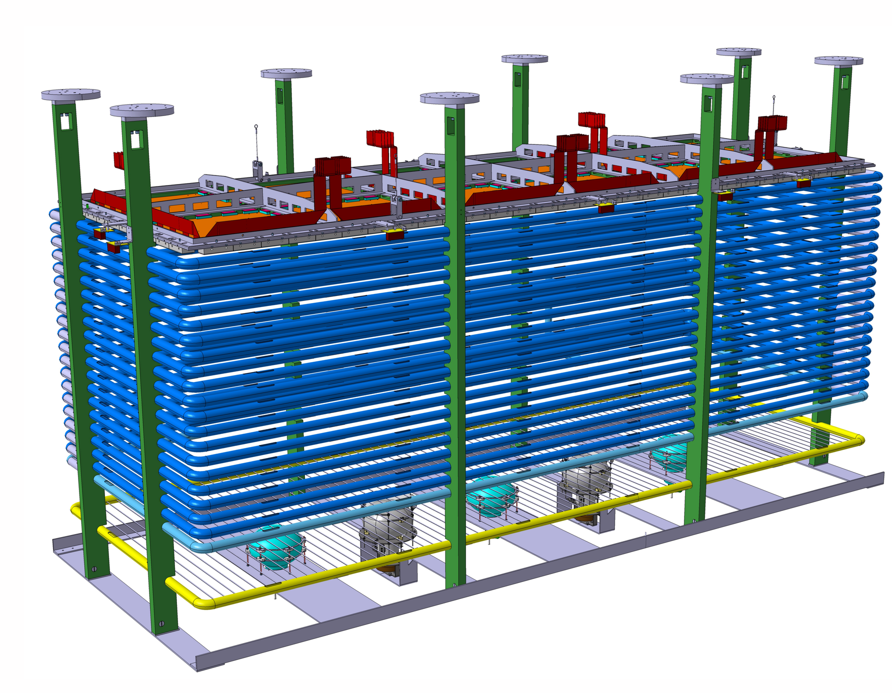
Novel techniques for monitoring and calibration of very large volume liquid Argon TPC

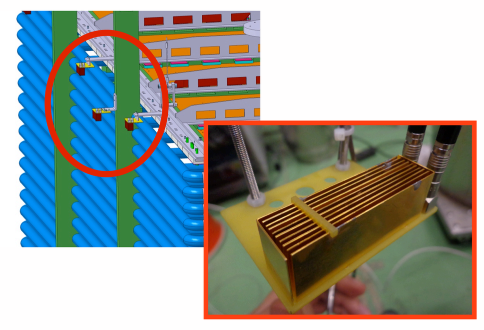
Cosimo Cantini on behalf of the WA105 collaboration
ETH Zürich, Institute for Particle Physics.

The WA105 3x1x1 m^3 Detector at CERN and future double phase liquid argon TPCs





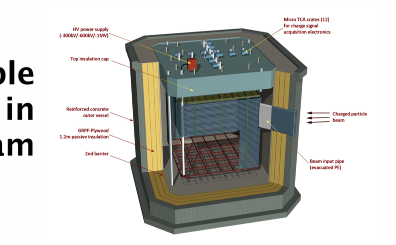
The WA105 311 Detector is now in commissioning phase at CERN, with a first gas Ar test planned by the end of April 2016.



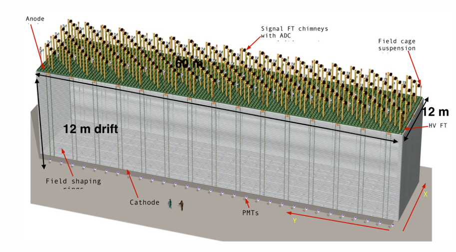
Capacitive Level meters on Charge Readout Plane

The ultimate goal is to build double phase LAr TPCs at the 10 kton scale for long baseline neutrino experiment searching for the neutrino mass hierarchy and the direct CP phase. Thanks to their large size and high signal to noise ratio, giant double phase LAr TPCs located deep underground would also be sensitive to lower energy events such as proton decay and astrophysical neutrinos.

- **6x6x6 m^3 (~300 ton) double phase LAr demonstrator in charged-particle test beam at CERN.**



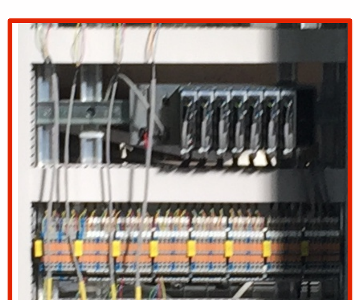
- **10 kton fiducial DUNE far detector (12x12x60 m^3).**



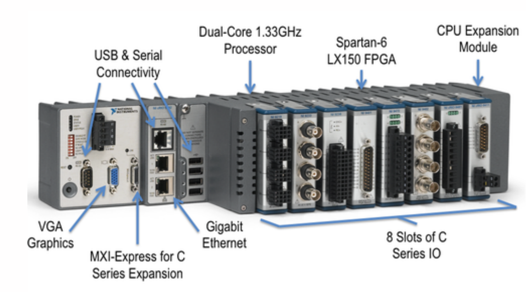
Slow Control System implemented with National Instruments modules

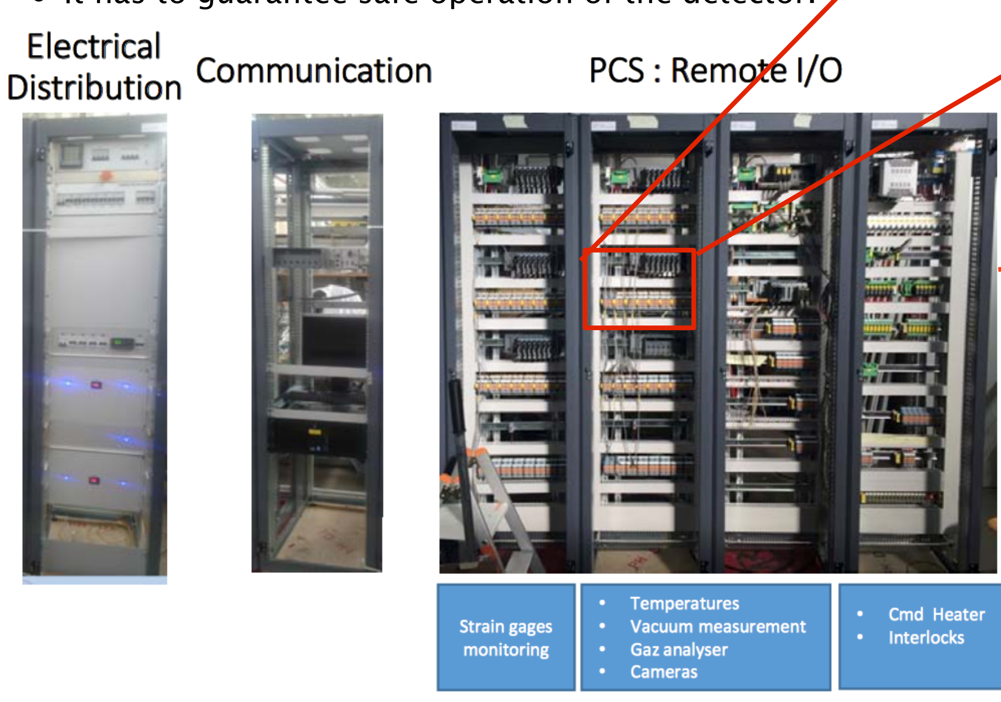
General goals of Slow Control System:

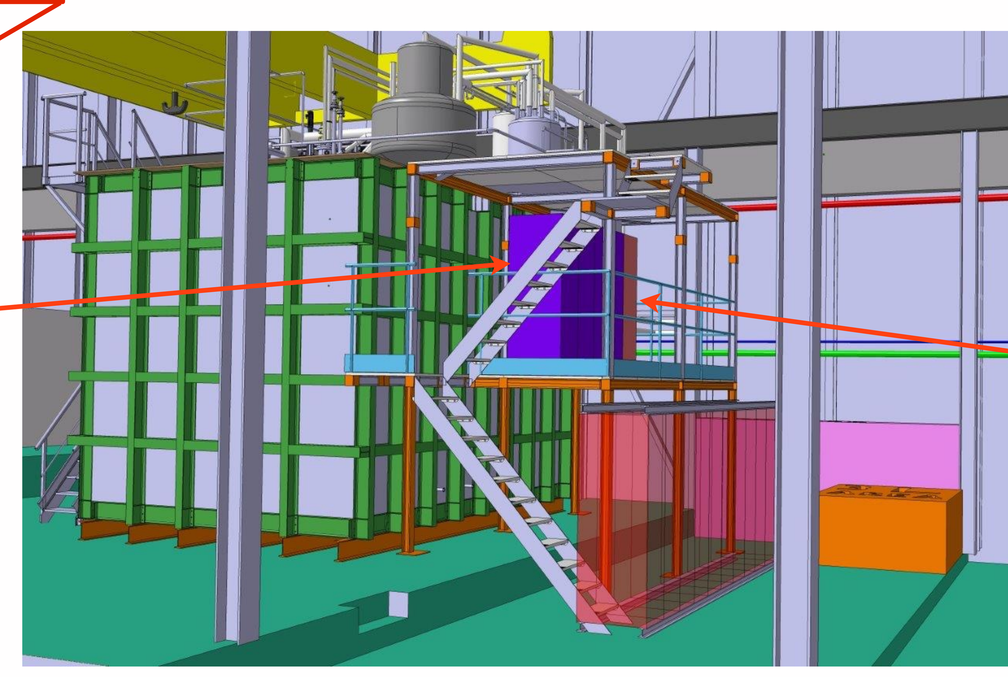
- Monitor the status of the Detector: temperature, pressure, impurities in gas and liquid phase, deformation of material in cold, status of the tank and of the insulation space, thermodynamic condition of LAr.
- Control of HV power supply.
- Provide key information for offline data reconstruction.
- It has to guarantee safe operation of the detector.



A scalable system based on National Instruments acquisition cards has been **implemented for Slow Control of WA105 Detectors at CERN in collaboration with PH/DT**; it **integrates all the measurement for Slow Control.**







Layout of the 311 Detector in building 182 at CERN and position of racks.

300 kV Heinzinger Power Supply

Slow Control System is composed by:

Detector Safety System: dedicated to the safety of the experiment, high reliability, hardwired cabling, PVSS & Unicos. Similar to the NA62 DSS.

Detector Control System: dedicated to the High & Low voltage crate, PVSS & JCOP framework. Similar to the LHC DCS application.

Process Control System: dedicated to the processes and monitoring of the experiment, PVSS & Unicos. Similar to ArDM PCS.

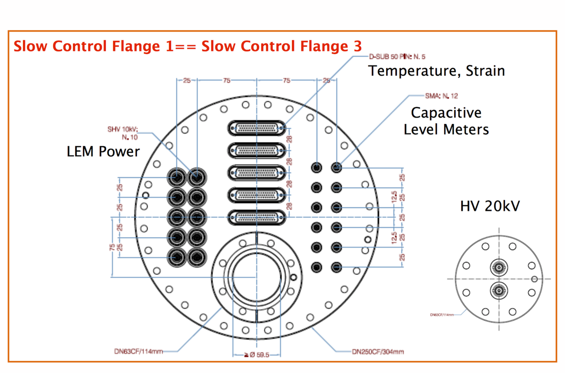
The PVSS supervisor is the standard HMI of SCADA at CERN (EN/ICE support for PVSS), exchange data by DIM or DIP protocol between systems, the PVSS project are installed in a data server near CCC (BE/CO support for Data Server), data points are stored in CERN Oracle Database (IT support).

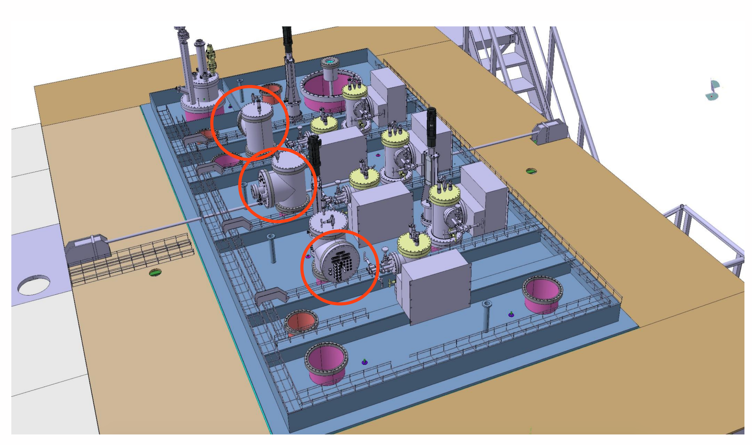
Close racks: on platform, implement the acquisition of physical quantities and Process Control through NI Remote I/O

Far racks: downstairs, host Detector Safety System, power distribution, communication and Cryogenics

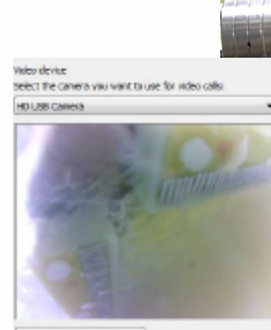
This approach guarantees minimum amount of cabling from top cap to far racks and ease of subsequent installation of new instrumentation.

Design of Flanges for Slow Control and Instrumentation



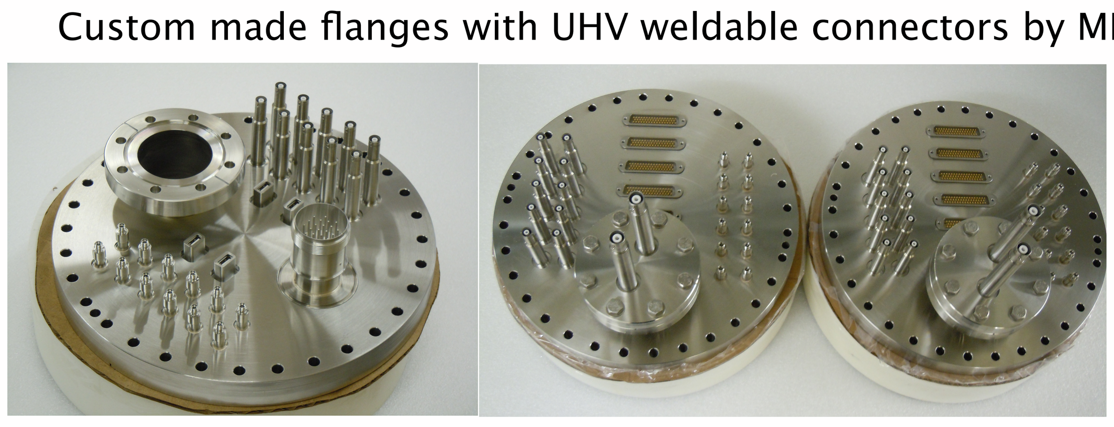


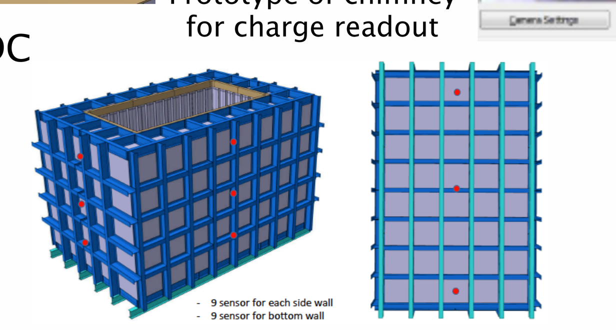
Prototype of chimney for charge readout



Cryogenic camera
PWM control of temperature of the USB camera in a sealed volume

Custom made flanges with UHV weldable connectors by MDC





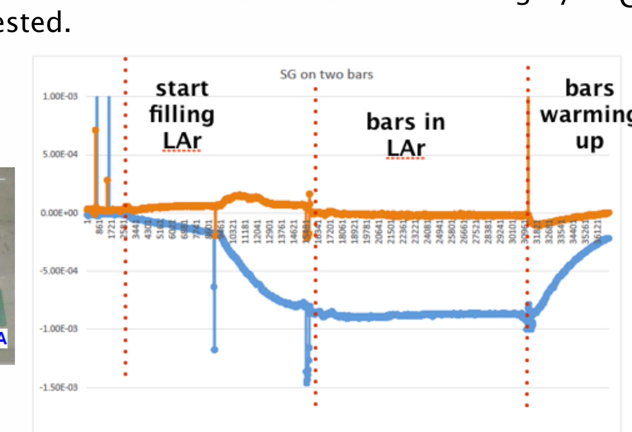
Insulation Space has a dedicated monitor system with 45 temperature sensors, inlet and outlet for gas flushing and gas analyzer, we are adding IR cameras also.

Calibration and precision of sensors

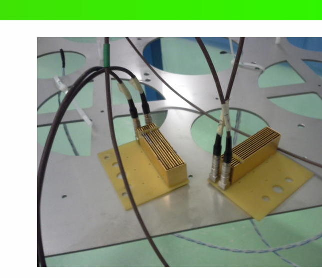
Calibration of the acquisition chain for temperature sensors.

Test on G10 and SS bars to measure shrinkage with strain gauges.

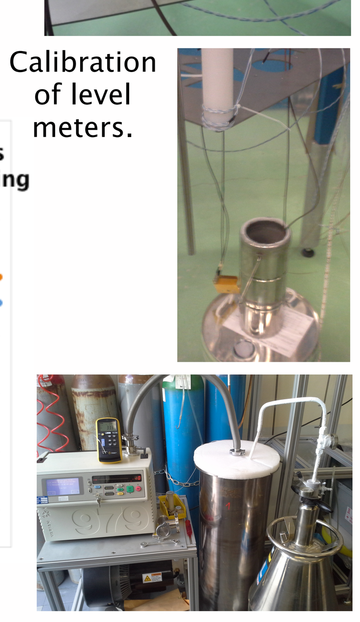
The 3x1x1 m^3 Prototype Detector has o(100) temperature sensors, 15 level meter, pressure sensors, purity monitors for H2O, O2 and N2 contamination.
To guarantee precision and stability in the measurement and equalize the response of sensors, calibration procedures for each sensor have been identified and thoroughly tested.



Materials in LAr have stringent requirements in term of outgassing properties and cold resistance: each component has to be tested!



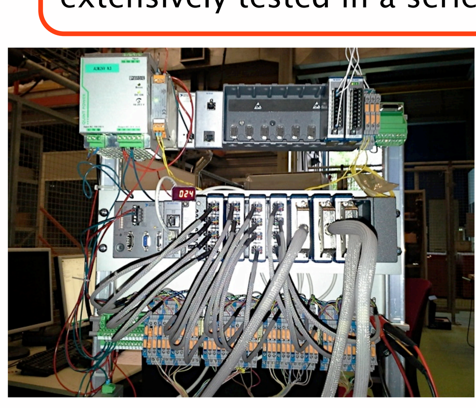
Calibration of level meters.



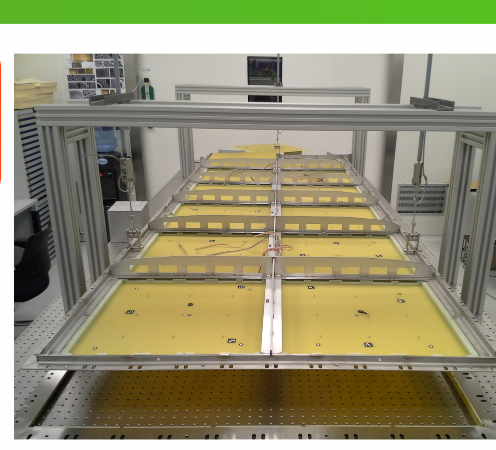
Testing tightness of UHV parts in cold.

Validation of each element of Slow Control through dedicated test benches

Proposal of the usage of NI modules as building blocks of an entire Control System for LAr detector has been extensively tested in a series of dedicated test benches.

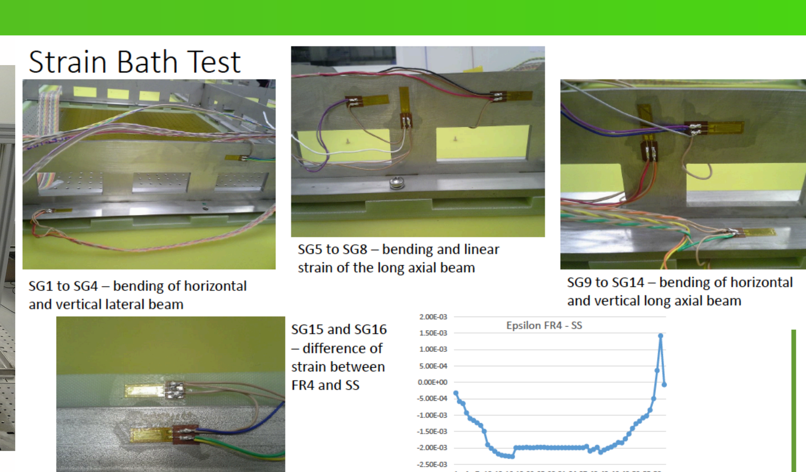


A prototype of Control System was developed in collaboration with PH/DT Group at CERN; it implements on a smaller scale all the measuring capabilities of our Slow Control and allows fast testing on sensors.



Assembled Charge Readout Plane in our cleanroom.

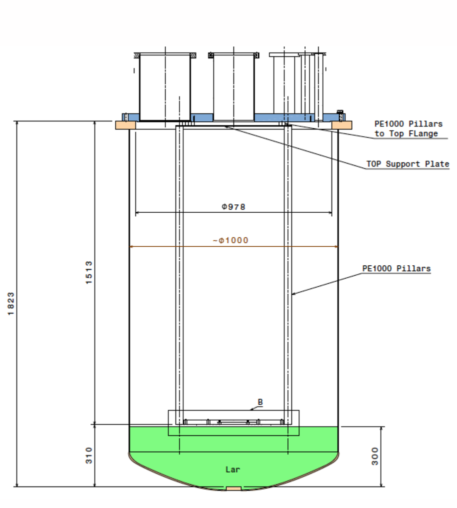
Strain Bath Test

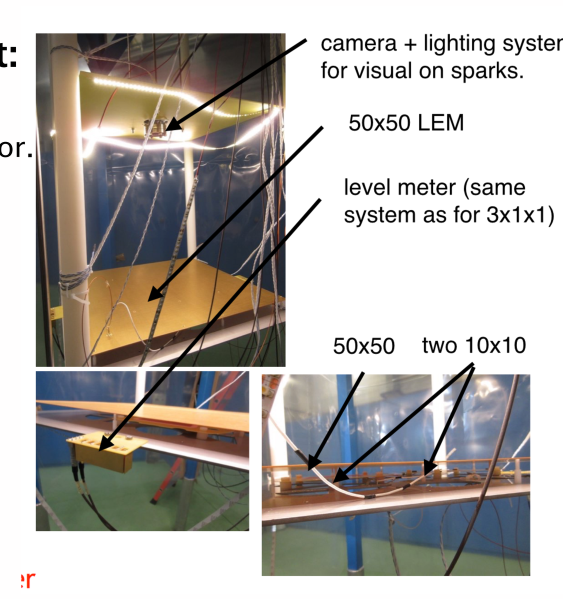


Monitoring the stress induced by shrinkage of CRP during a LN2 bath test thanks to several strain gauges.

50x50 cm^2 Large Electron Multiplier cold test:

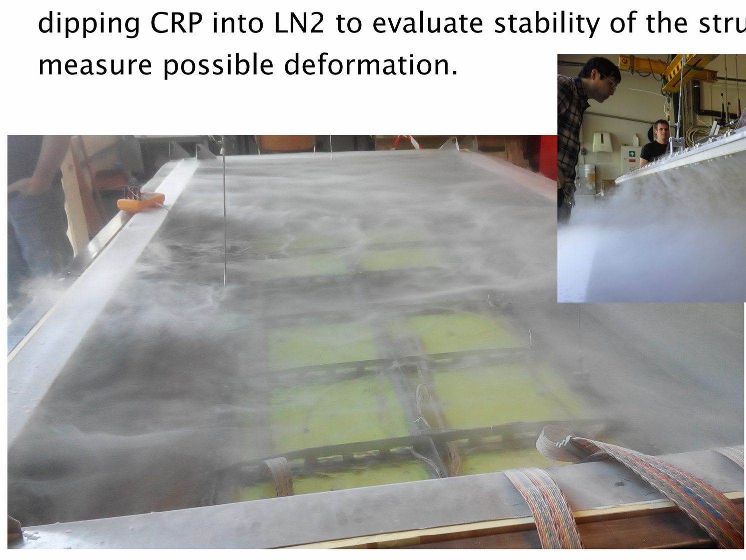
to test the behavior in cold Ar gas of a LEM in a closed and controlled vessel to mimic the final condition in the 311 Detector.

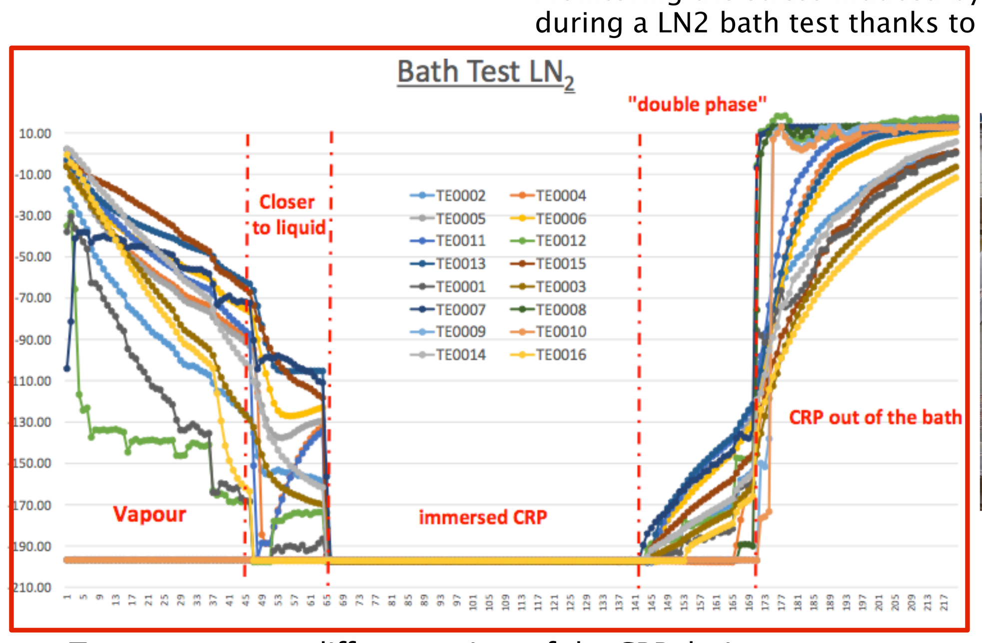




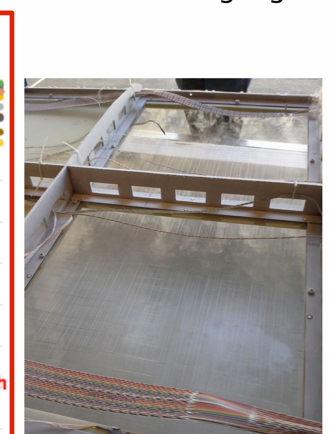
Charge Readout Plane bath test:

dipping CRP into LN2 to evaluate stability of the structure and measure possible deformation.

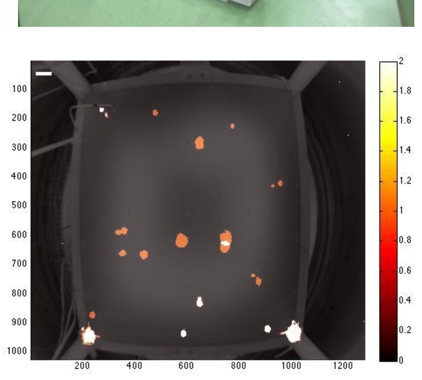


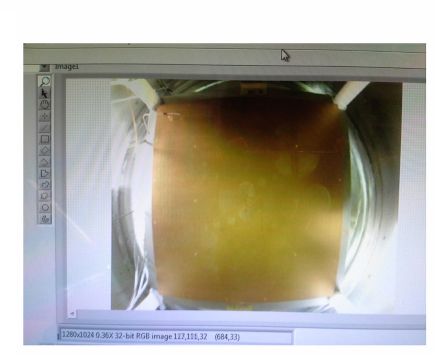


Temperatures on different points of the CRP during test.

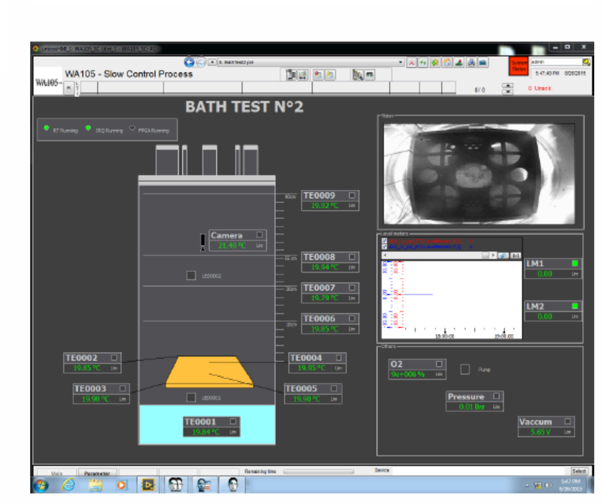


Checking wires tensioning.





Monitoring discharge on the LEM under test.



PVSS interface developed for cold test.

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