Slow Control System

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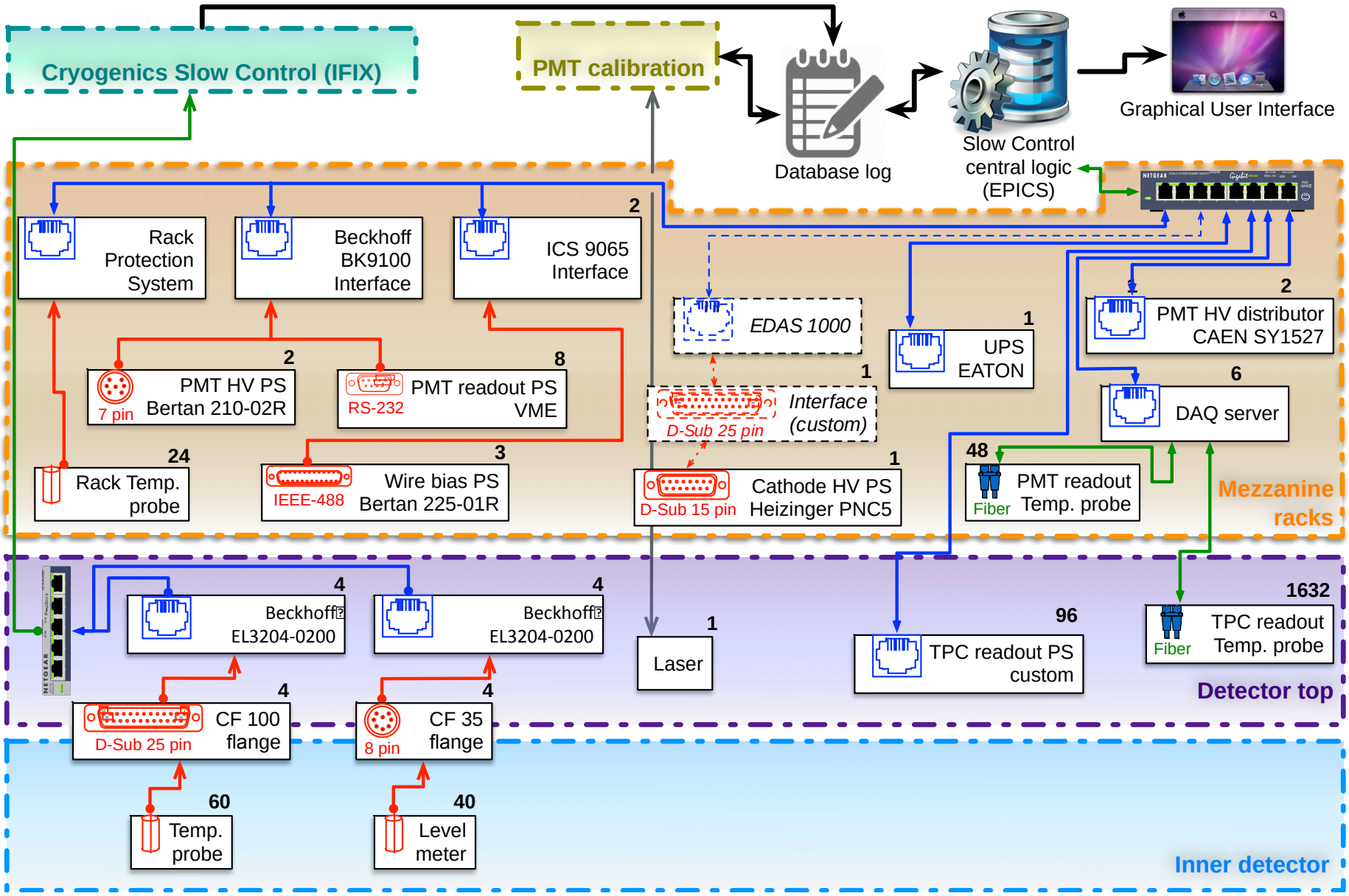
… more people welcome!

Scope of the Slow Control System

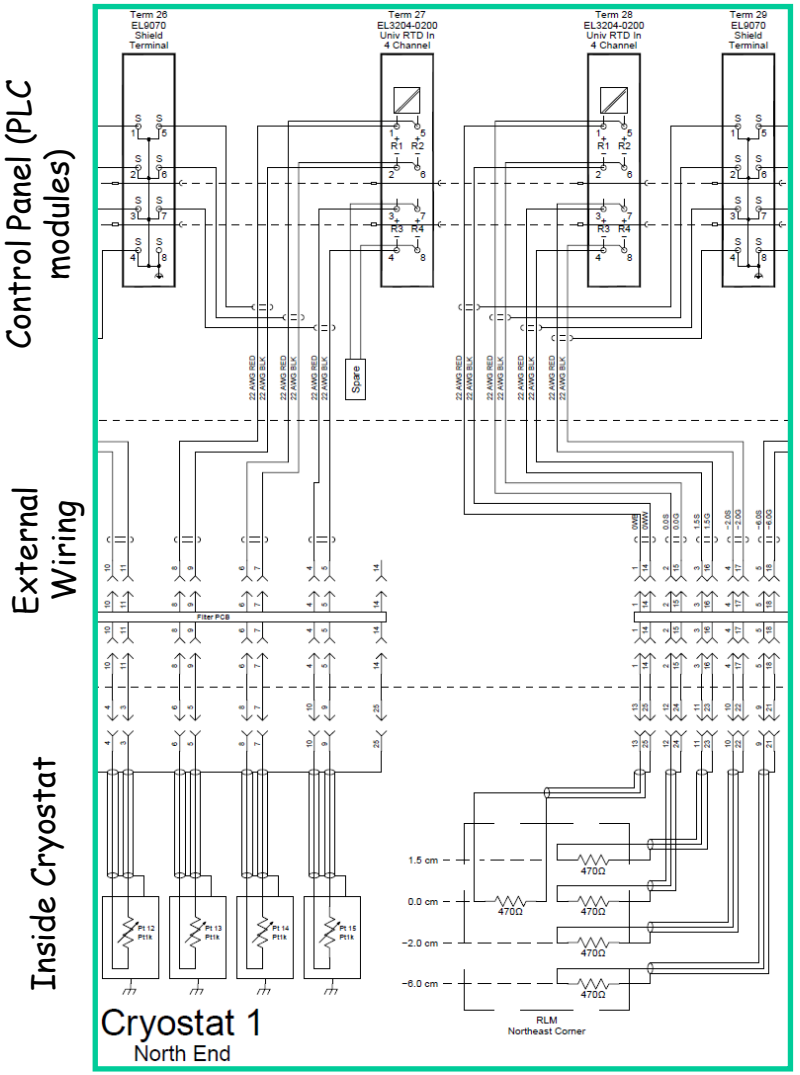
- Remote control of several components of ICARUS-T600 detector and environment is mandatory for:
  - ✓ guaranteeing the proper operation conditions continuously for the entire data taking period (3 years at least);
  - ✓ minimizing potential hardware damages by taking prompt actions;
  - ✓ complying with the safety guidelines at Fermilab;
  - ✓ have offline access to the history of detector conditions.
- Slow control means:
  - ✓ measure the value of operational parameters (ex. temperatures, voltages and currents, status, etc.);
  - ✓ generate alarms (light, sound, email, sms…) under pre-defined circumstances;
  - ✓ take actions, such as switch on/off modules or regulate voltages, upon either manual or automatic input;
  - ✓ log the operational parameters, alarms, actions and changes of status.

Overall architecture



Inner sensors

- 60 temperature probes, 8 level meters.
- 4 control panels on top of the cryostats, near corner chimneys. Beckhoff EL3204-0200, universal RTD modules (100Ω to 240kΩ).
- Controlled by a PLC, Beckhoff CX5120-0115 performance CPU, on the mezzanine.
- Electrical isolation between panels for grounding.
- DC excitation current to sensors (low noise).
- Connected to main cryogenic controls.
- Data accessible through cryogenic control system (iFIX HMI), and available over Fermilab network (i.e. can be read by EPICS)

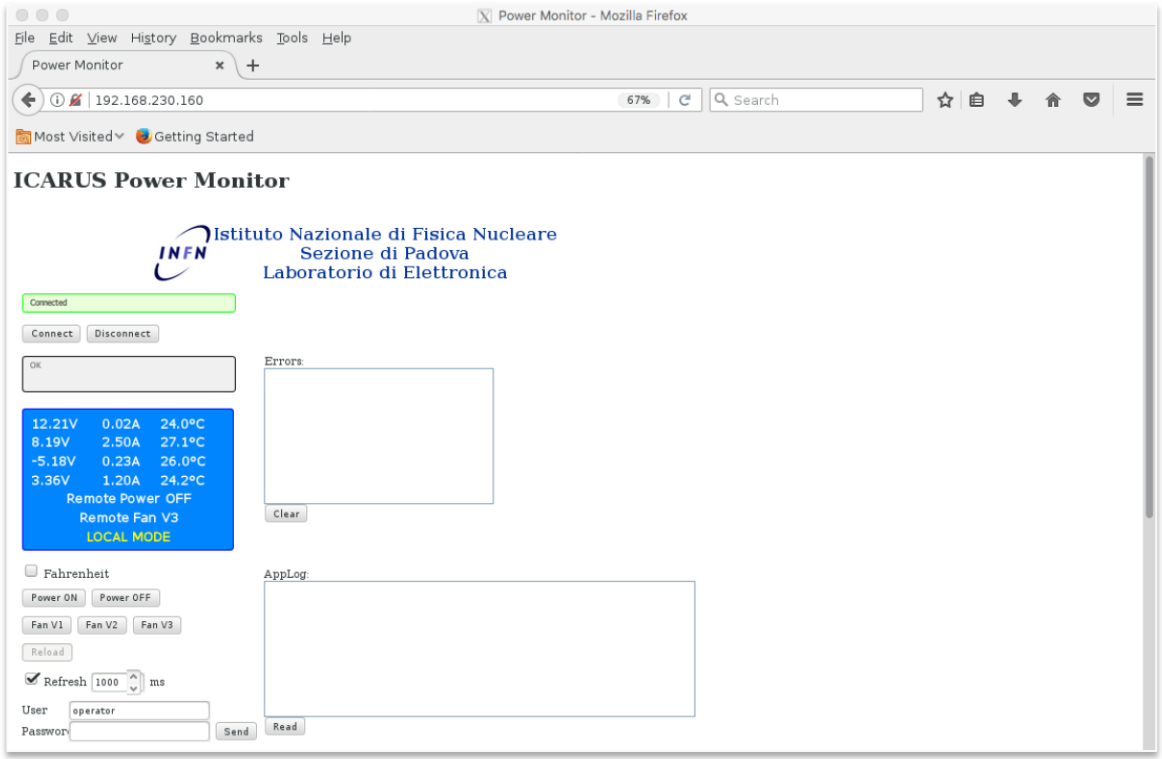


Electrical Schematic

Power Supply for TPC readout electronics

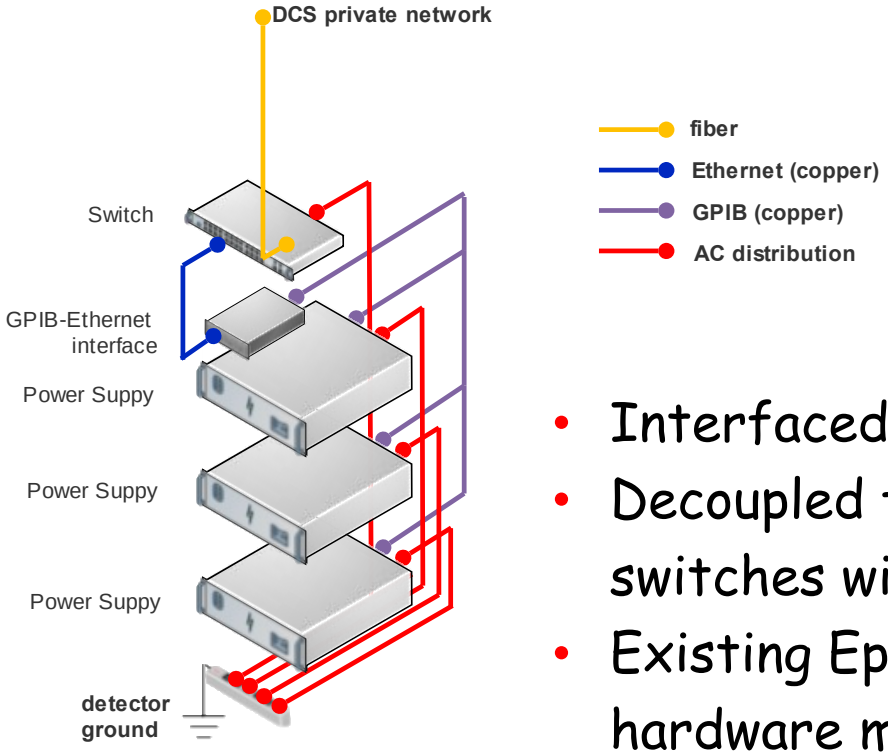
- 96 Power Supplies, custom design of INFN-Padova, with Ethernet connectivity.

- Web-based interface for remote monitoring of voltages, currents and temperatures and remote setting of voltages and fan speed.
- Integration with Epics still to be worked out.



Power supply for wire bias

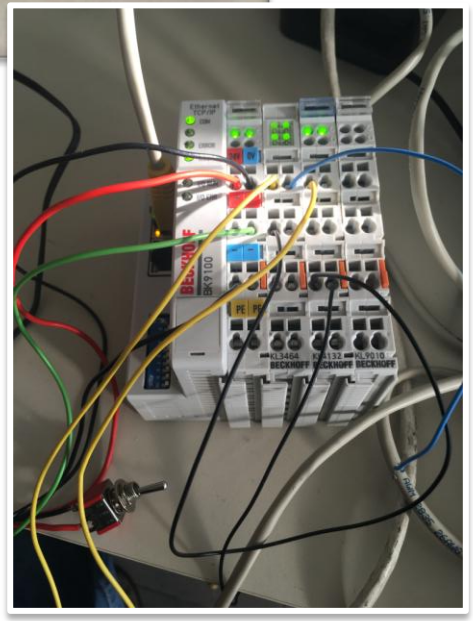
- 6 Bertan 225-01R from past operations.
- IEEE-488 (GPIB) connectivity, cabled in daisy chain.



- Interfaced to Ethernet via ICS-9065 device.
- Decoupled from building ground through 4-port switches with fiber uplink.
- Existing Epics software (for a different hardware model of the interface) to be adapted.

Power supplies for PMT HV

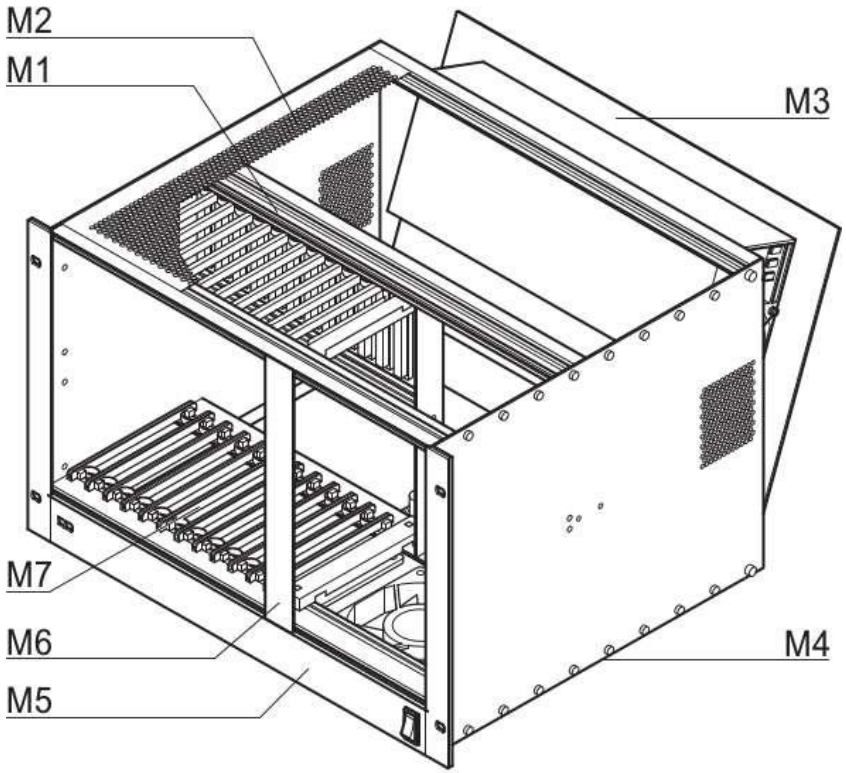
- 2 Bertan 210-02R for primary HV.
- Analogue 7-pin I/O interface.
- Interfaced to Ethernet through Beckhoff analogue I/O modules without PLC (BK9100, KL3132, KL4132, KL9010).
- Control of voltage with ramp up/down [0÷-5 V] @pin B → [0÷2000 V].
  Monitor of current signal [0÷5 V] @pin D
  and voltage signal [0÷5 V] @pin E
- Epics software developed.



- 2 CAEN SY1527 high voltage distribution crates, with Ethernet connectivity.
- Epics software to be developed.

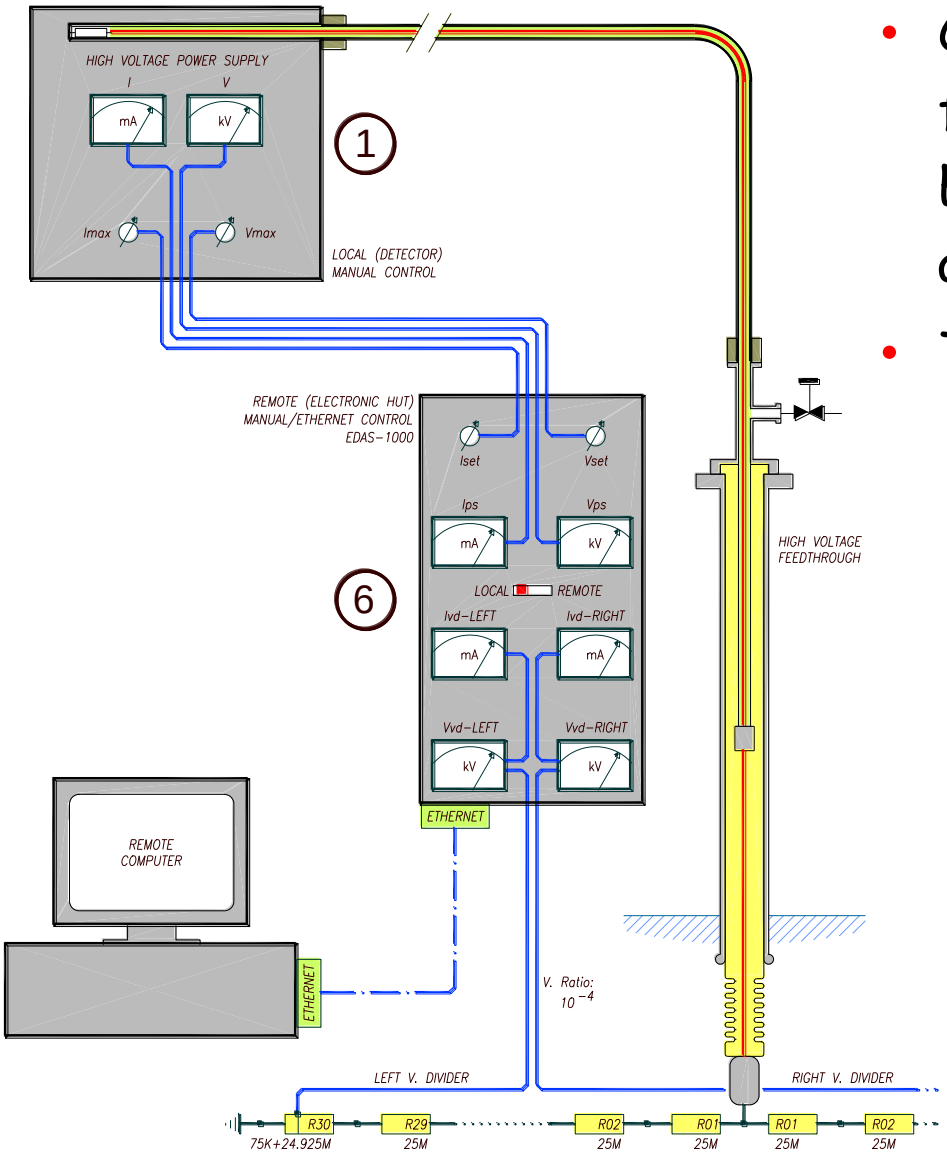
VME crates for PMT readout electronics

- 8 VME crates, containing the CAEN V1730B digitizer boards.
- 9-pin RS-232 I/O interface.
- Interfaced to Ethernet through Beckhoff analogue I/O modules without PLC (BK9100, KL3132, KL4132, KL9010).
- Male 9-pin plug with a voltage divider to bring the 12V down to the 10V of the Beckhoff in preparation.

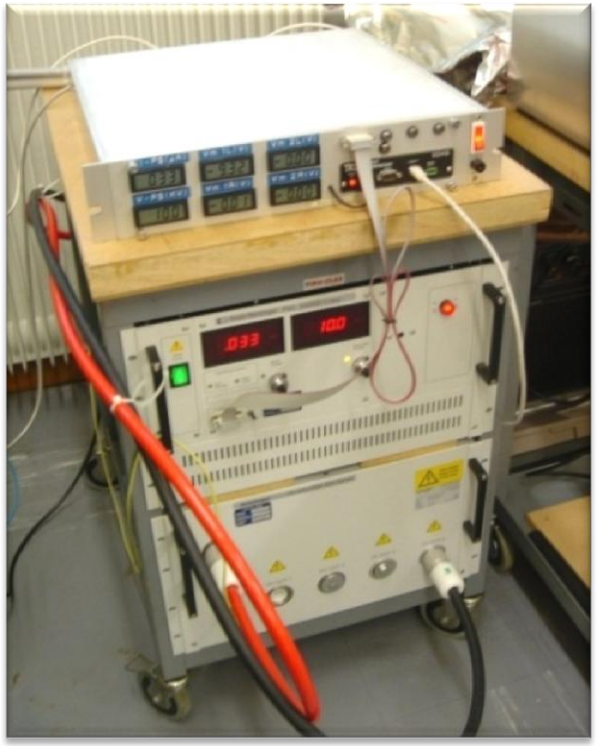


- Control of operation voltages (5 V, ± 12 V) @ pins 1, 2, 3.
- Epics software developed, now under test.

HV system for TPC cathode

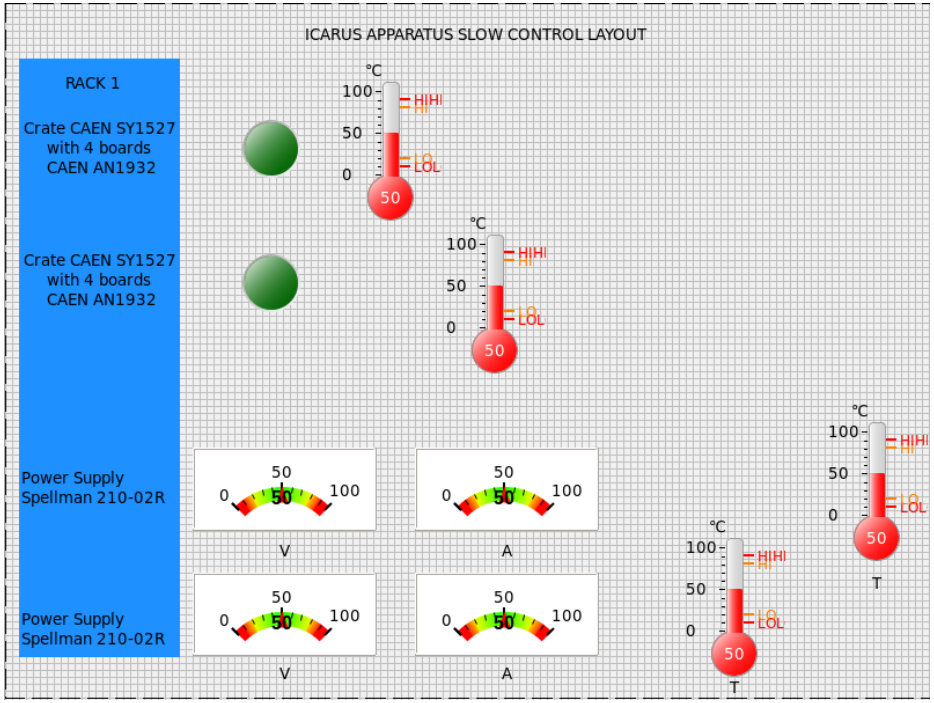


- Control system of the cathode HV from previous operations based on EDAS-1000 interface to Ethernet and LabView software.
- To be integrated with Epics.



Other components and high level software

- Other components (ex: building webcams, managed power distribution units) common with SBND.
- Most of the high level software in common with SBND:
  - ✓ interface from cryogenic control (IFIX) to detector control (Epics);
  - ✓ data log into database;
  - ✓ graphical user interface based on CSS.



- Shared development efforts in the framework of the SBN-DCS working group, still some customization for ICARUS will be needed.
- Test-stand facility set-up at Fermilab D0 building: TPC electronics, power supplies for wire bias, power distribution units and servers.

Backup

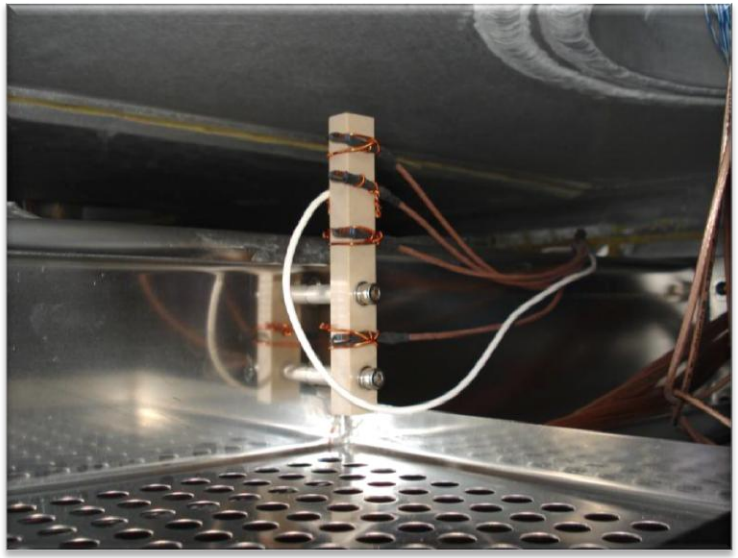
Inner sensors

Resistance Temperature Detector (RTD)

- 30 per T300 cryostat
- Pt1000 in cryostat 1, Pt10k in cryostat 2
- Provide interlock during initial LAr fill ($T_{max}-T_{min}<50^{\circ}$ C)
- Monitor LAr temperature during normal operation

Resistive Level Meters (RLM)

- 4 per cryostat (five 470Ω resistors per RLM)
- Resistance lowers ~25% in LAr
- Alert when nearing top during initial fill
- Monitor LAr level during normal operation



Cathode HV control schematics