Slow controls

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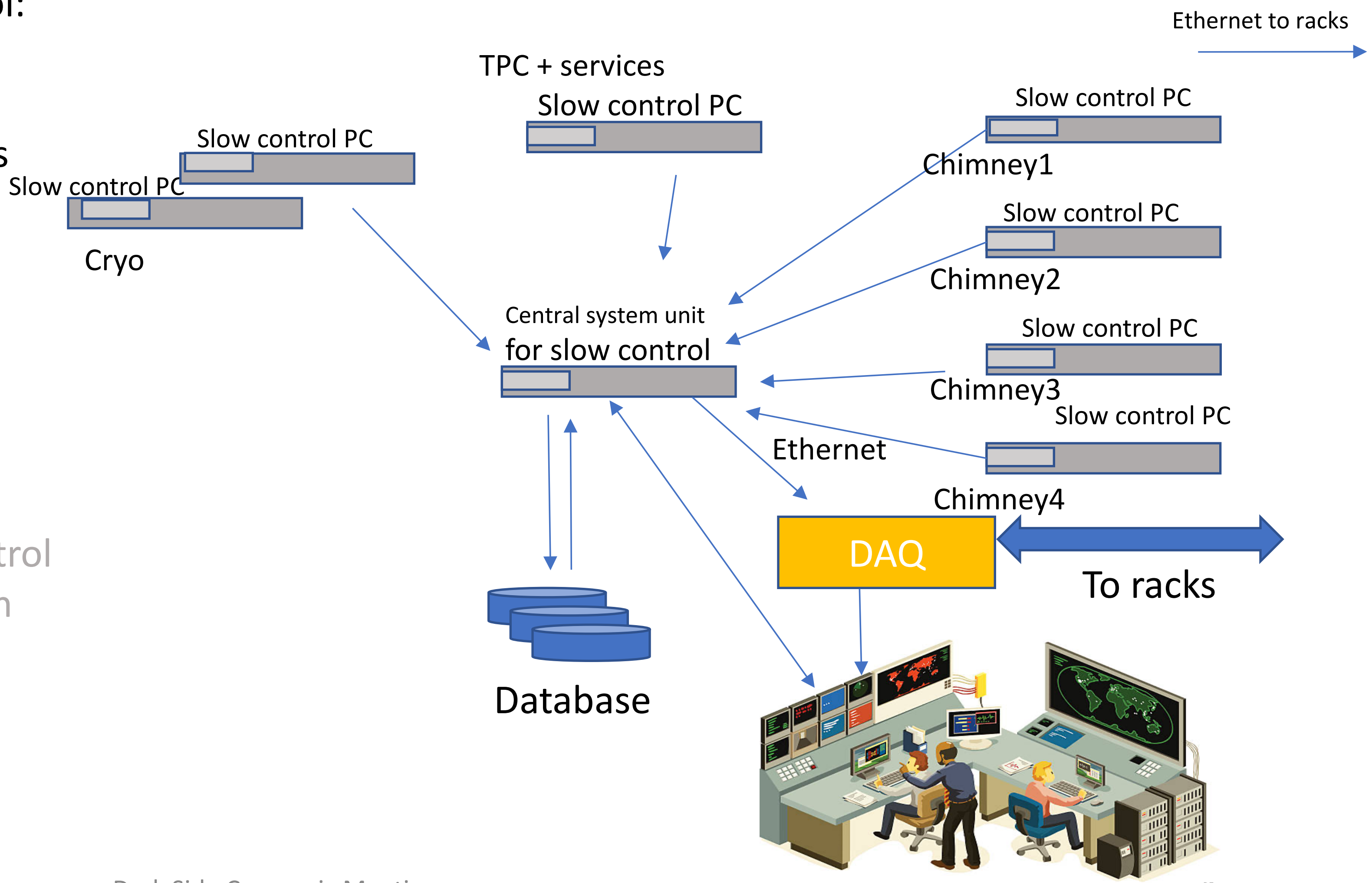
Slow controls summary

Status:

- Architecture and scope: converged on a plan
- Survey of parameters to monitor and control:
  - in progress
- Survey of available SCADA tools
  - WinCC as baseline for cryo and services
  - MIDAS for PE during physics runs
- License agreements and costs:
  - being investigated
- Development plan
  - Start with cryo system and HHV and services
  - Include “double commands”
  - When in RUN MIDAS has exclusive control
  - When not in run possible to kick in with WinCC
  - Pro: not require shut down when DAQ upgrade, safety net; MIDAS developed, WinCC lots of experience and easily scalable
  - Con: duplication of system

A possible layout



Slow controls

Project counting:
1. Cryo: combining both UAr and AAr ?
2. TPC (HHV, gas pressures, calibration tools)
3. Photoelectronics
4. Services (Rack cooling, UPS…)

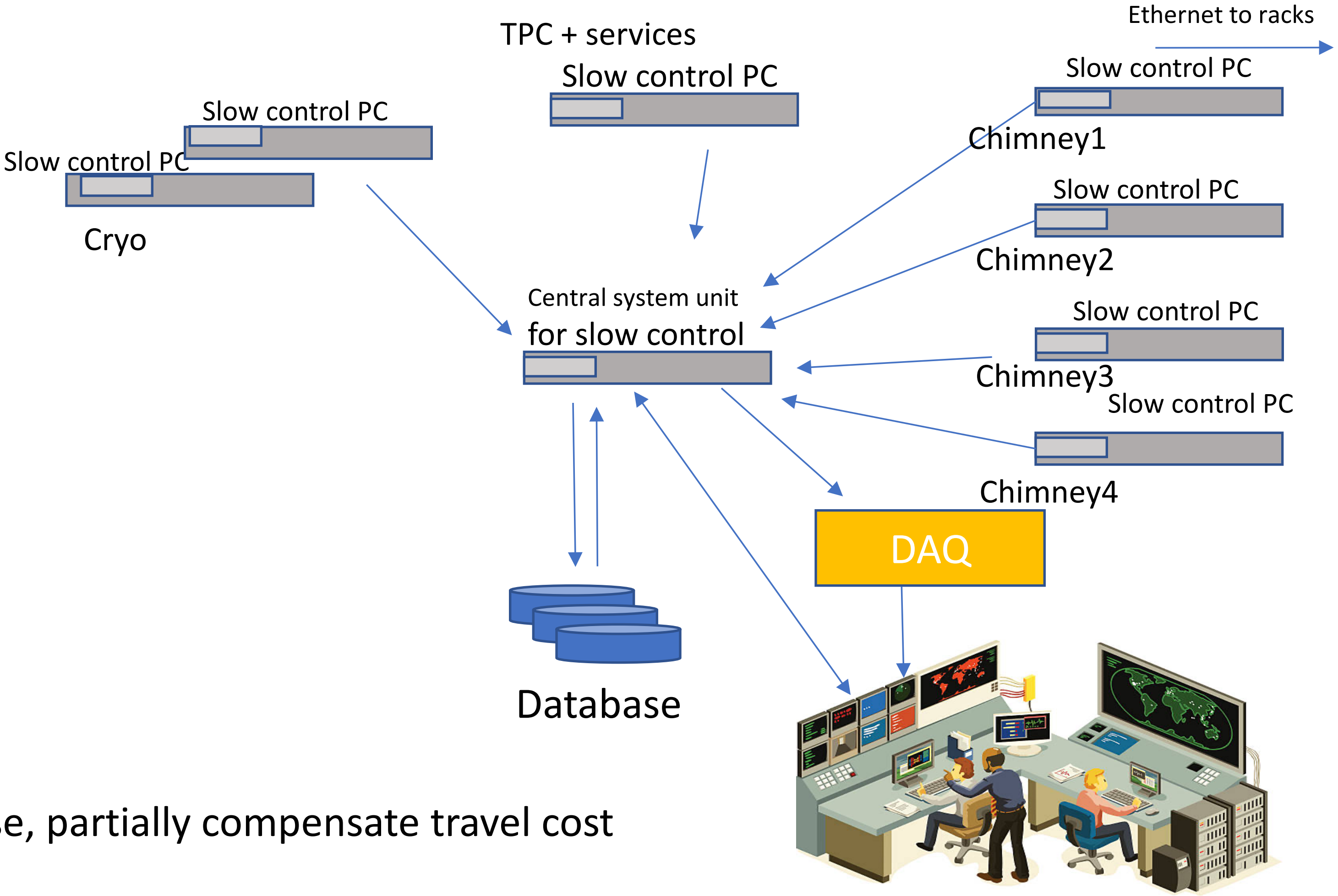
(2) and (4) may be combined

PC counting
- Cryo: 1 PC + 1 mirror (hot swap redundancy)
- PE: one PC per chimney 4 + 1 global
- TPC and Services 1 PC
- Global server: 1 PC

Total: 9 PCs

Developers counting:
3 FTE, in 4 locations.
Developing on CERN premises does not require license, partially compensate travel cost

A possible layout



Slow controls

Manpower requirement

Development:

4 FTE for 2 years (one per “project”) (2.5 VT, 0.5 INFN, +???)

1 FTE (shared) coordination (VT, INFN)

Initial development for cryo at CERN   funding/subsistance, but no license required.

Data taking and maintenance:

1 FTE for data taking expert on call (shared)

License cost case A or B

A] may be entirely covered by CERN-INFN agreement

B] not covered by CERN-INFN agreement

Assuming a cost:

1. per production PC,
2. per production “project”
3. Per development environment

Monitoring parameters

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A preliminary list of **parameters to monitor**

Rack and crate status: power, heat dissipation, temperature, cooling system
For each PDU 264 + 264 + 120 = 648 + outer detector

- Low voltage value state (On/OFF) status (ok, warning, alert, fatal)
- LV current, status (ok, warning, alert, fatal)
- SiPM bias voltage state (ON/OFF) status (ok, warning, alert, fatal)
- SiPM current, status (ok, warning, alert, fatal)

All DCS data also directly available to DAQ
Financial resource requirement not assessed yet

For each tile:

- state LV/HV ON/OFF (10368 channels)

TPC:

- HHV value,
- HHV current
- HV value (gain)
- Vessel pressure
- Vessel Temperature
- Thickness of gas layer

Cryogenic system
Possibly under different access list, but same environment
Order of 200 parameters to monitor (estimation)

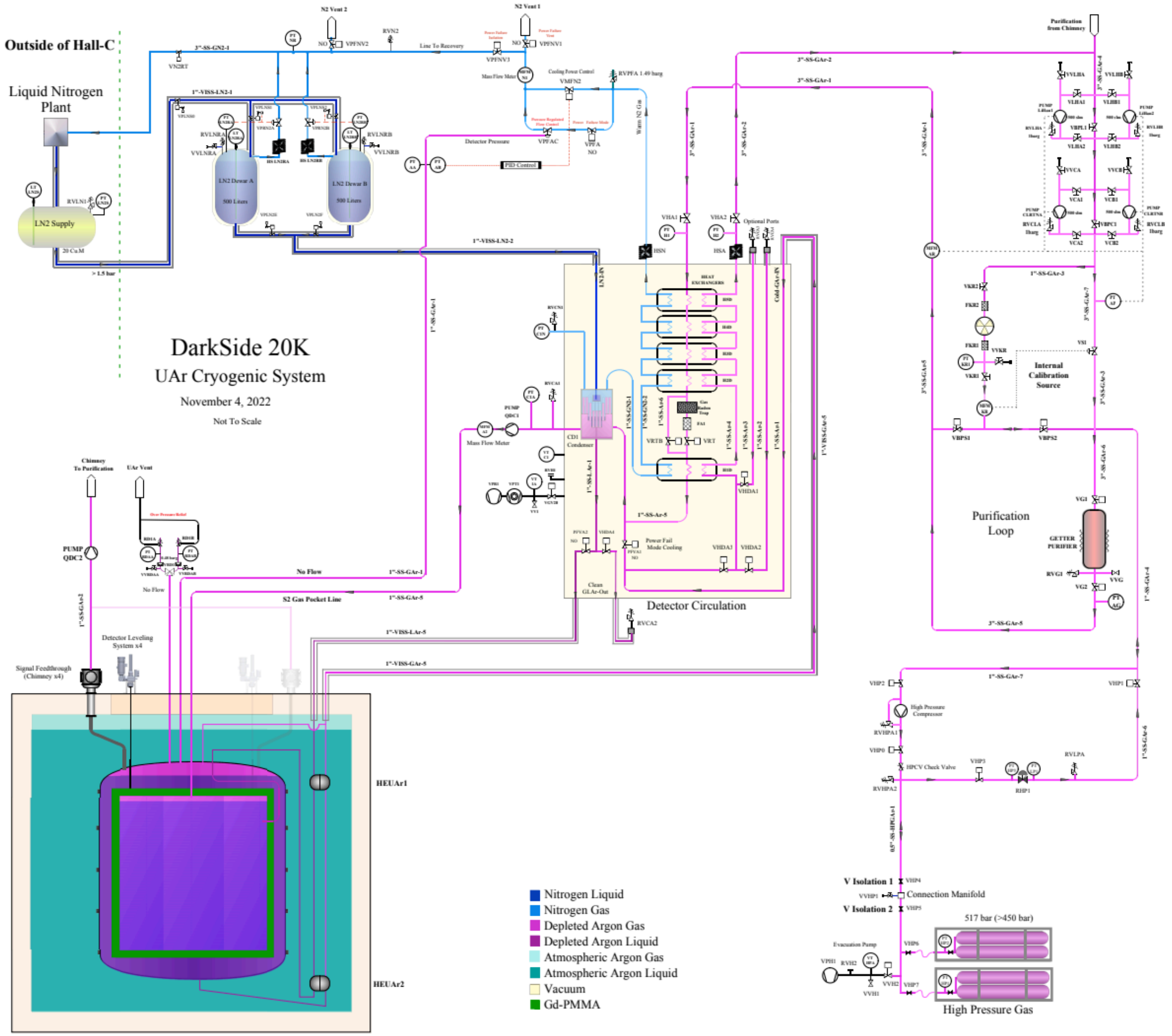
- Pressure
- Temperature
- Flow, purity, oxygen….

Data taking at low frequency (typical 1 read/sample per second) considered adequate

Total estimation of
3000 analog parameters +
20700 binary states

- Write to database
- Set individual alert and alarm value
- Show trend on terminal

Cryo system



Cryogenic system

Under different access list, but same environment

Order of 200 parameters to monitor (estimation)

- Pressure
- Temperature
- Flow
- purity, oxygen….

Commands

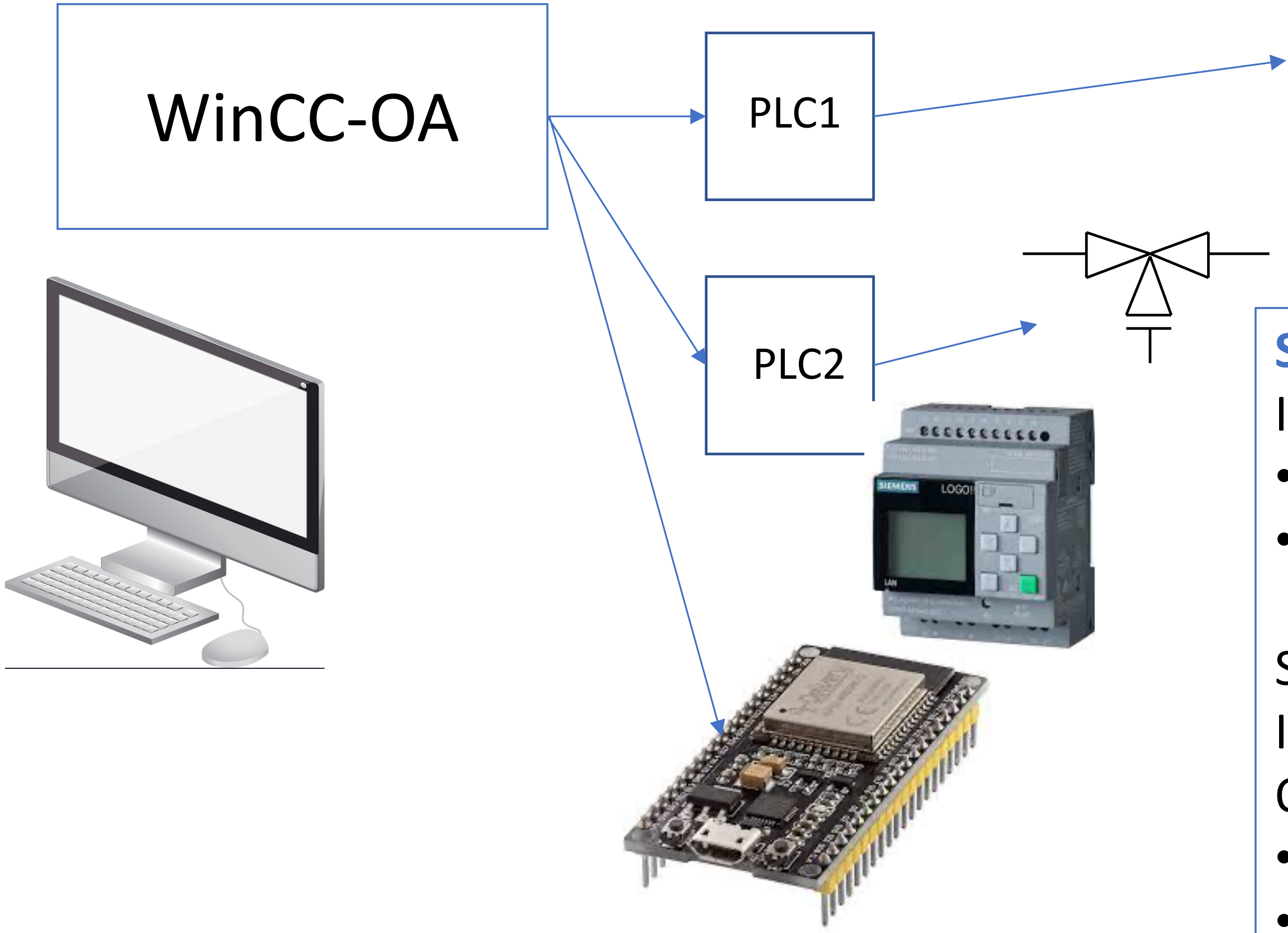
- open/close/regulate valves O (100)
- Pressure regulators
- Pumps

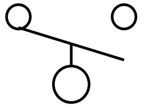
Summary of equipment based on cryogenic review document: on-going

Digesting the document

Operation document and FSM description welcome

Cryo system





SCADA system

Interface with PLC's: modbus or Ethernet

- Procedure in PLC's
- activated by WinCC commands

Sensors read out by microcontrollers

Interface to microcontrollers via WinCC-OA

OPC server direct interface with instruments

- via ethernet
- For high-end instruments (e.g. oxygen monitor)
- Re-using existing interface ported to OPC

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DARKSIDE

Cryo system

Choice of PLC's

Unified PLC is a plus

PLC programmers scarce

Best use of rare skills

Optimize choice of protocol:

- modbus popular but old and slow
- Ethernet faster
- Proprietary systems also possible (Siemens family?)

Choice of microcontrollers

"Industry grade" microcontrollers (ST or ESP32)

Prefer not to install a real operating system

Keep system simple

Use just one type of microcontrollers would be a plus

Status & Plans

Architecture design

Low-level programming needs to be done by system experts
Full documentation of the finite state machine and internal feedback
SCADA (WinCC-OA)

- communicates high level commands to PLC's (or directly via OPC)
- Receives back state and readout values, directly or via microcontrollers (ADCs)

Training

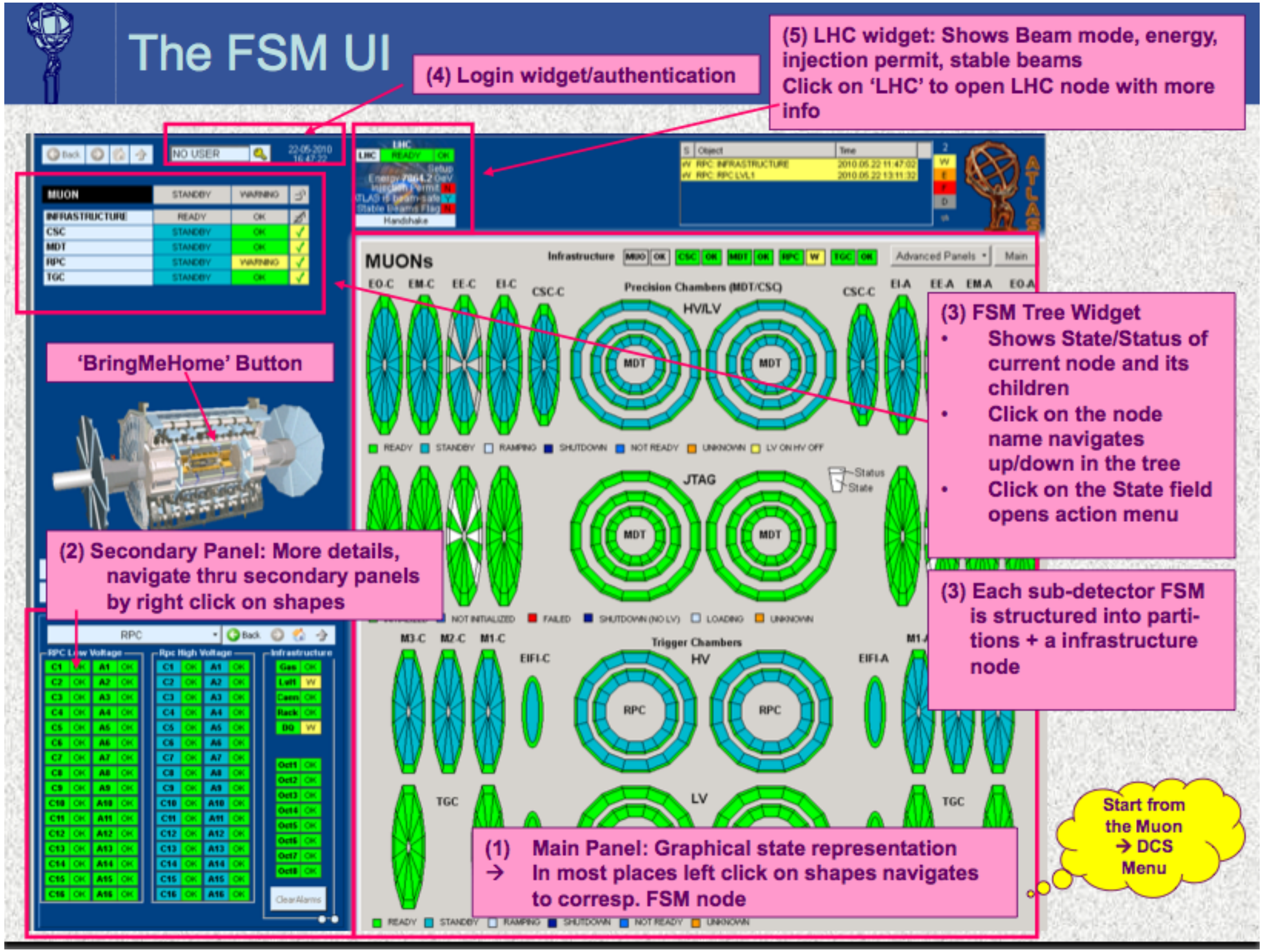
Started training a student (INFN-Mi): CERN WinCC & JCOP course
Student started developing generic interface to instrument (PS) in Milan Lab.

Plan

- Control system team training at CERN 2023
- Survey of equipment to control (mid 2023)
- Choice of PLC's and microcontrollers
- Finite state machine and architecture design finalised
- Apply to LNGS installation: "Mockup" available?

Figure 2: ATLAS FSM operator interface.

An example of “final product”



Questions and discussion