Auxiliary Detector Systems + luminosity – Slow Control

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L3-Manager 6.10.11

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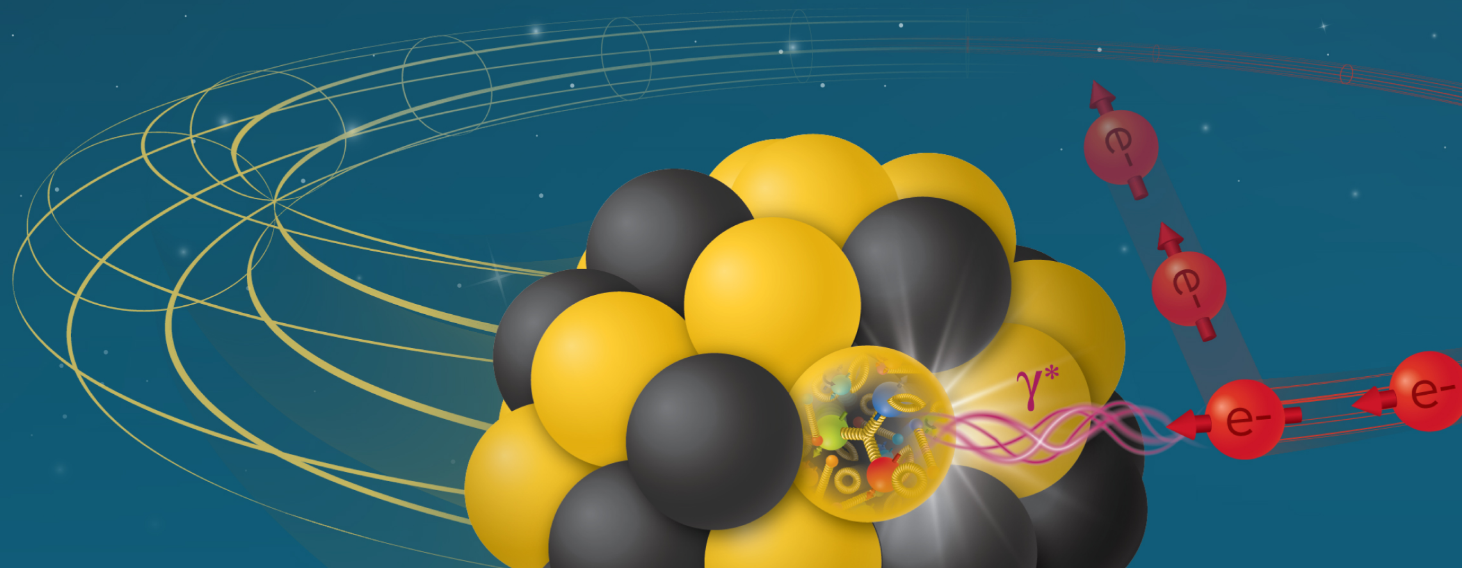
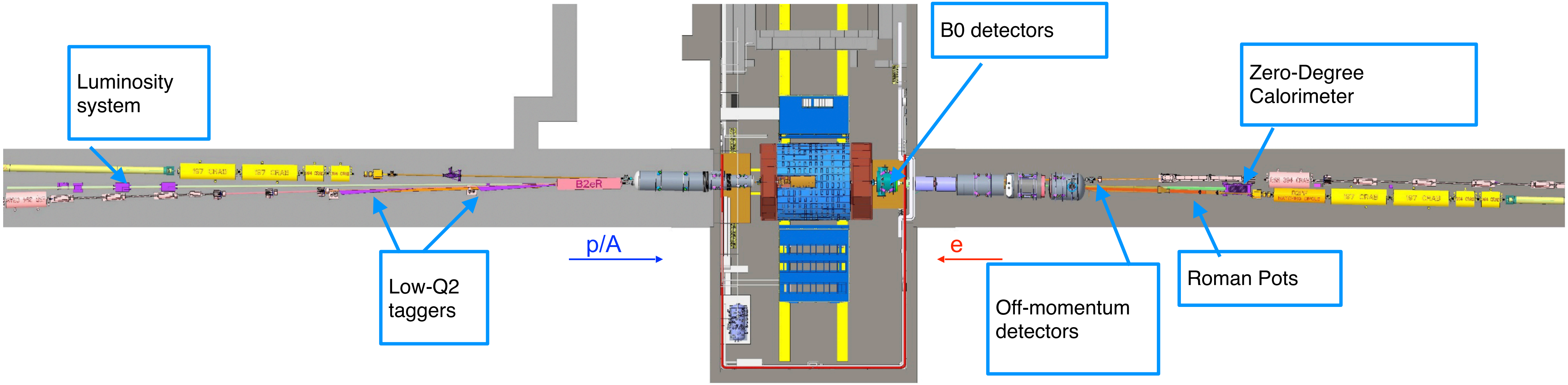
Electron-Ion Collider

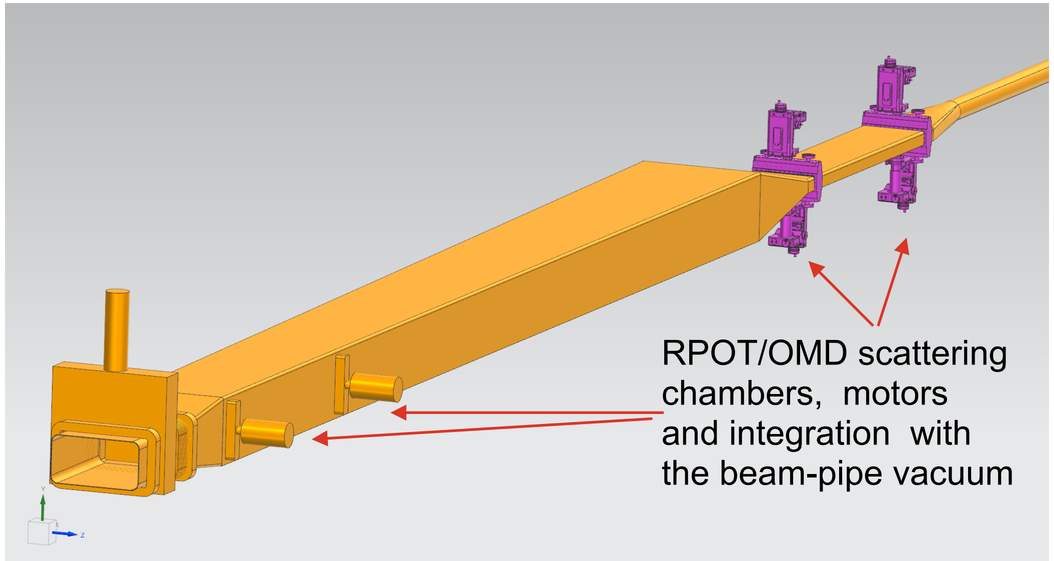


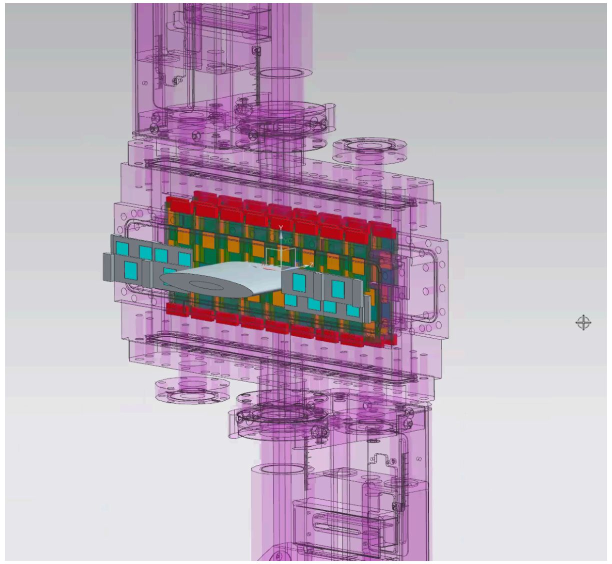
Auxiliary Detectors



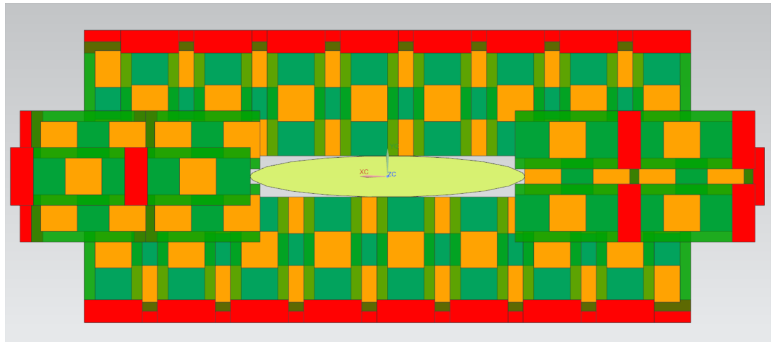
RPOT/OMD: Slow control

Roman pots are unique devices - they ‘belong’ to both experiment and accelerator.
A coordination with various accelerator groups (optics, machine protection, collimators, vacuum etc.) is essential.
Some failures during the operation may impact not only data taking, but also an operation of the accelerator.





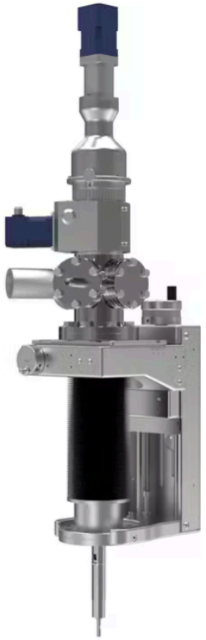
$0.0* (10\sigma cut) < \theta < 5.0$ mrad



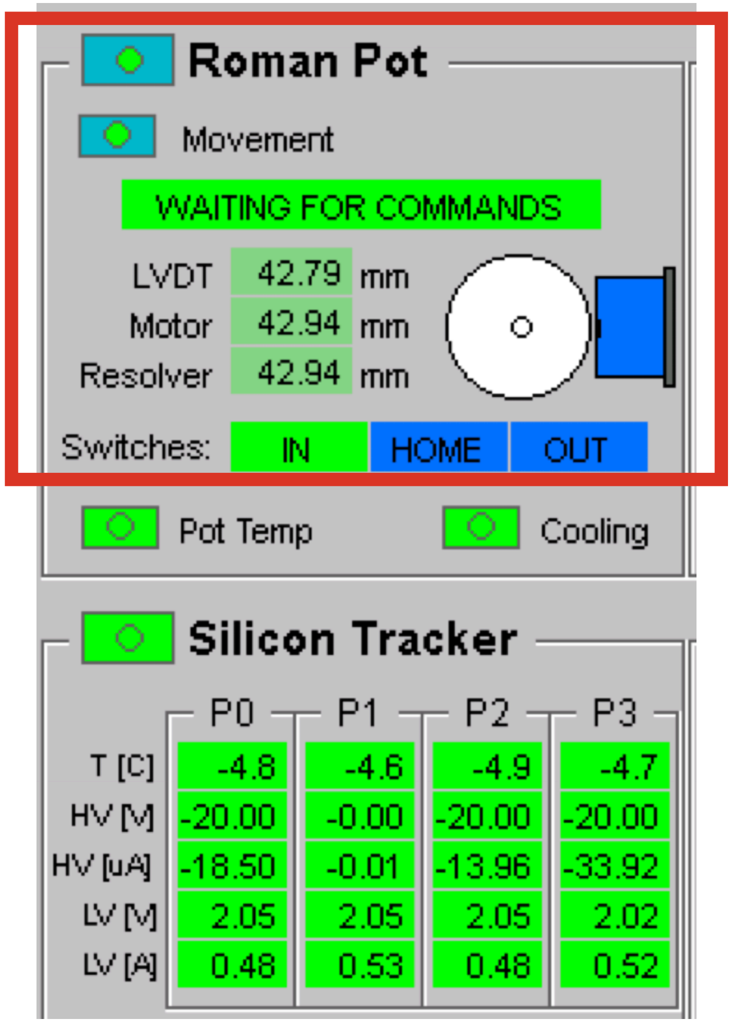
RPOT/OMD: Motion control

1) Permission from accelerator for movements (INTERLOCK)
2) **Commands for movement**: IN, OUT, HOME
   Sensors/switches:
      "IN" switch
      "OUT" switch
      HOME switch
      Electrical Stop
3) Position (from the step-motor)
   Plan to use moving stages from UHV design (https://www.uhvdesign.com)
4) Electrical motor stoppers (to prevent sensor damage)

5) In case of emergency
   – (power-loss) retraction with springs to the HOME position
   -(beam-loss or high radiation) - Power-Off sensors,

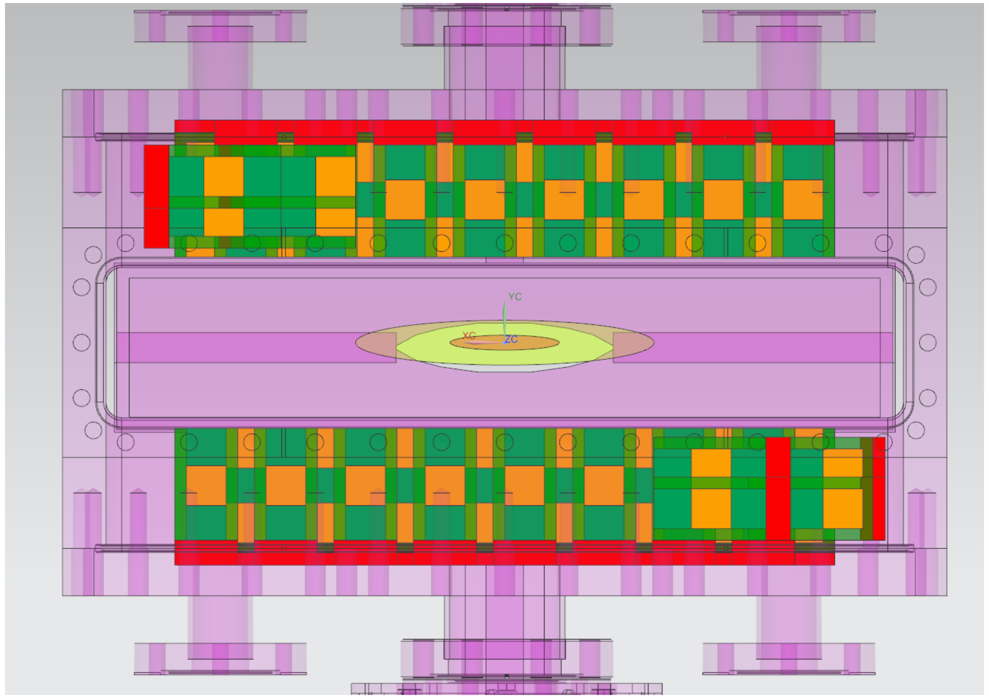


Example from LHC

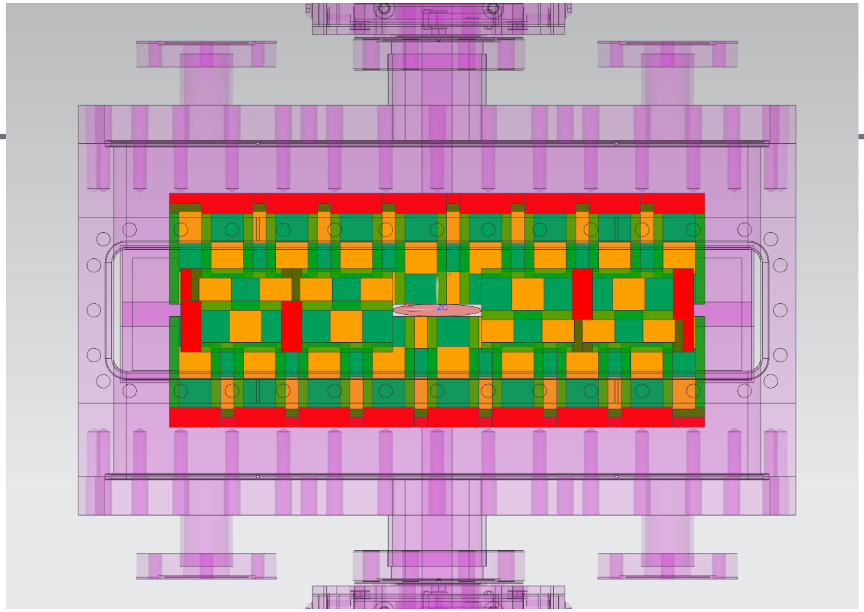


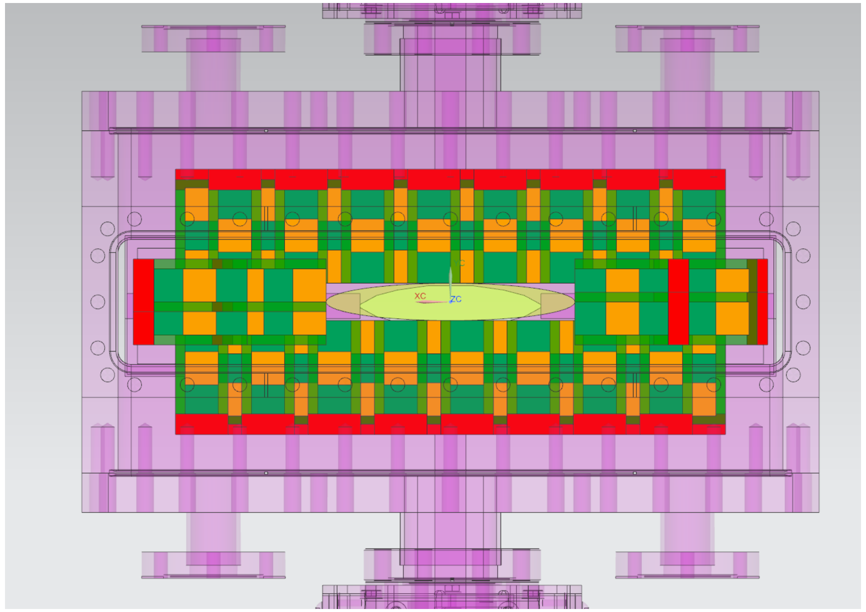
RPOT/OMD: Motion control

Home position



In Beam positions depends on the beam configuration

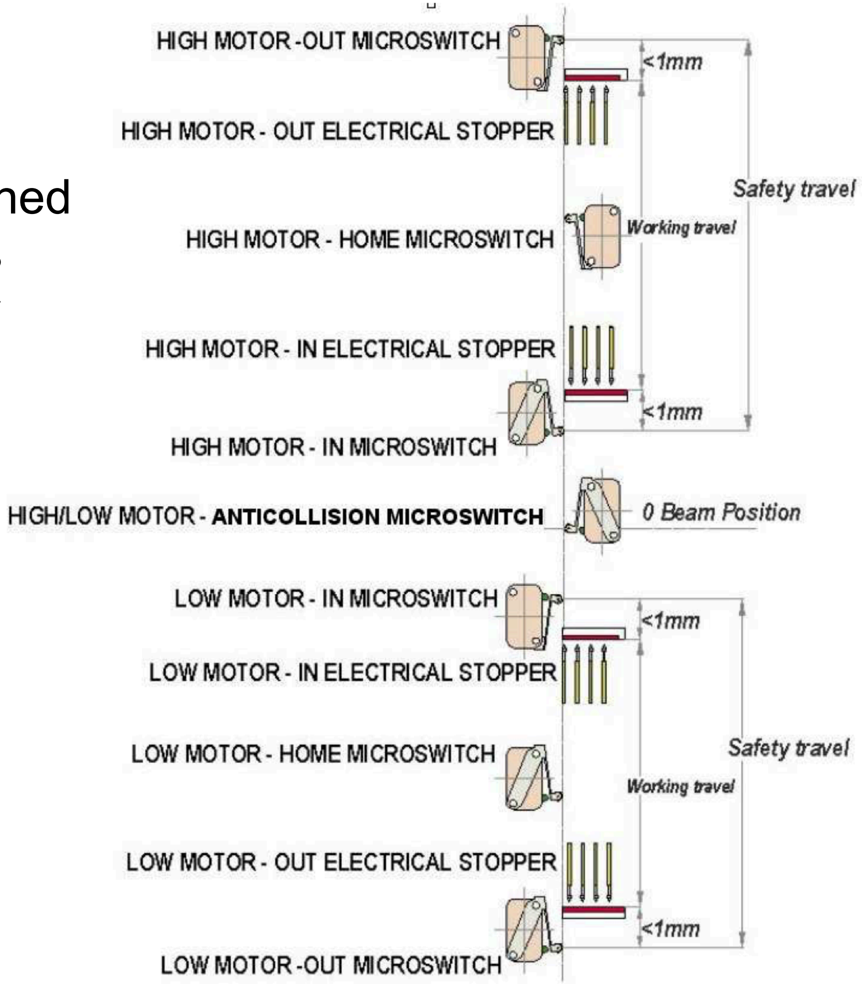


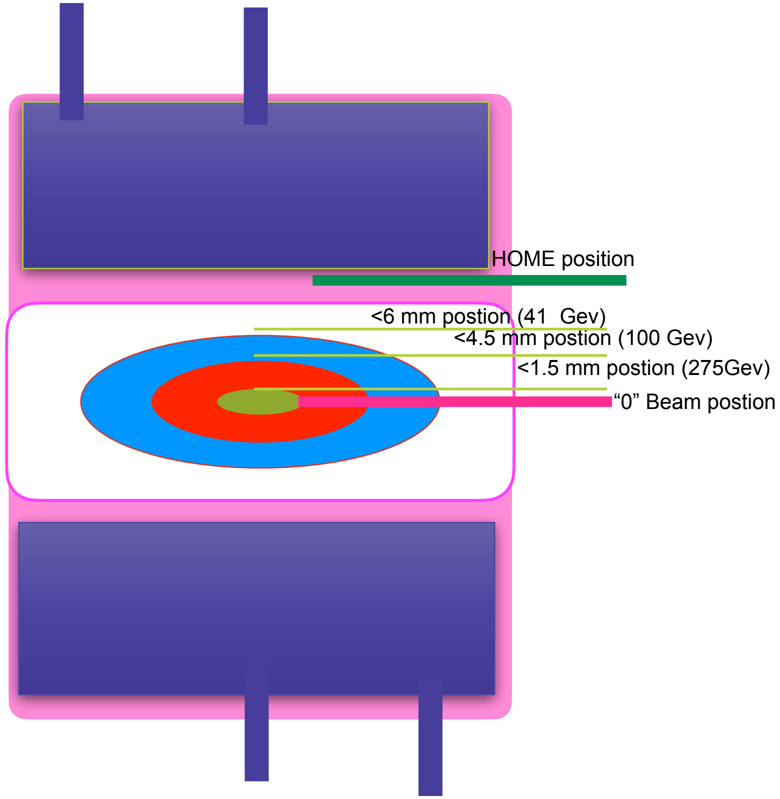


Motor controls/ sensors/switches https://arxiv.org/pdf/1110.5808

LHC experience
https://arxiv.org/pdf/1110.5808

For EIC: Multiple sensors/switched for various beam configurations incorporated into the step-motor





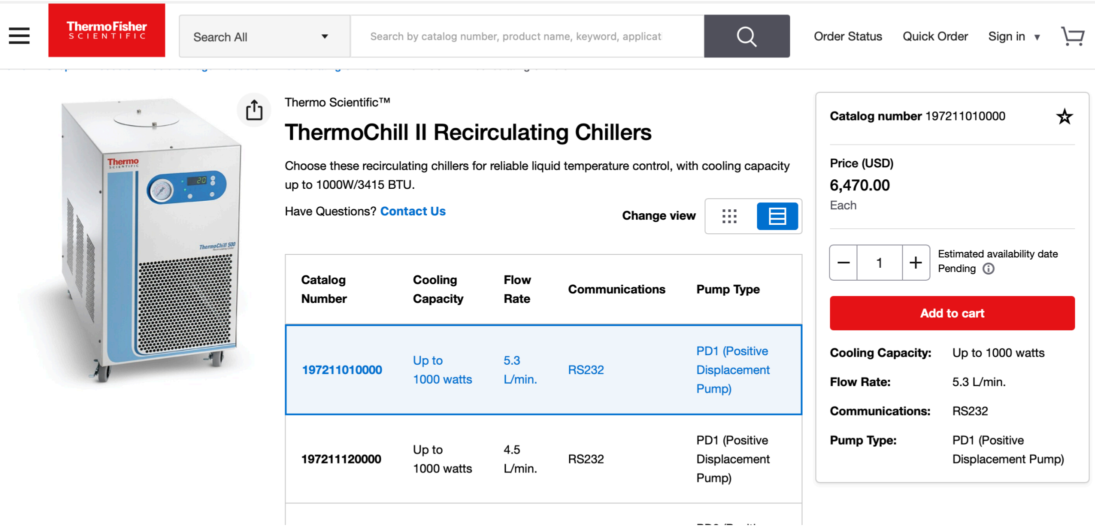
Similar for bottom and X movements

RPOT/OMD: Cooling and Detector settings

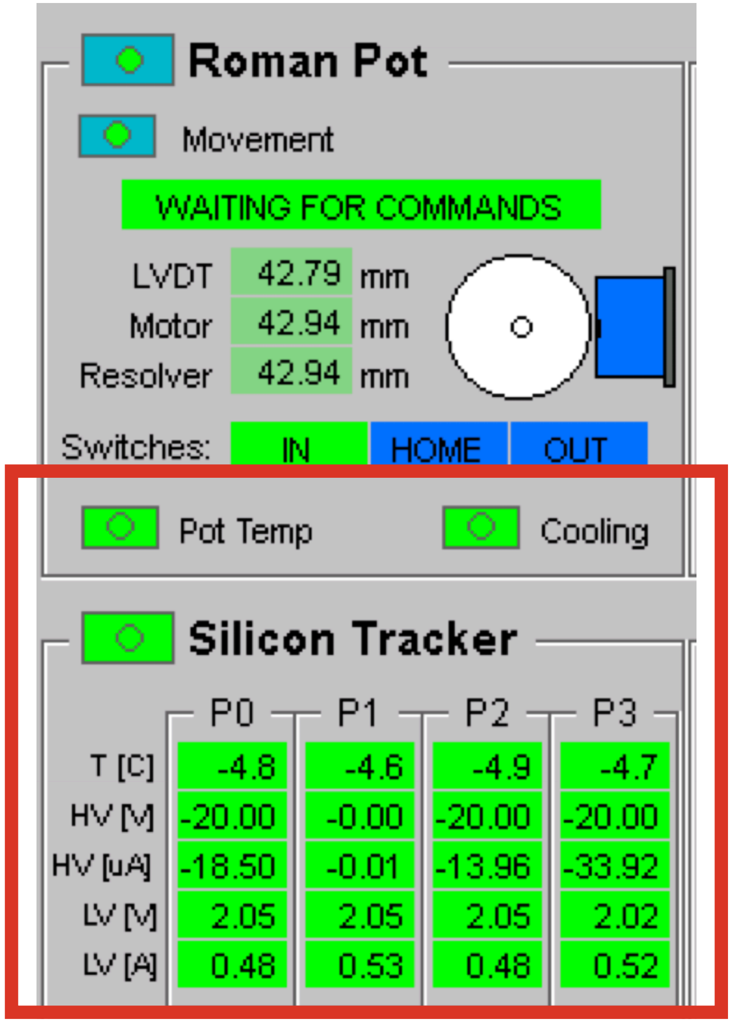
- Cooling
  Temperature control
  (monitoring and
  recording)
  Temperature settings

- overall scattering
  chamber temperature

- HV/LV
  HV/LV control
  (monitoring and recording)
  HV/LV settings



Example from LHC



Slow (< few seconds) controls needs for RP and OMD (from ePIC control room)

- Need link to accelerator to monitor loss rate, etc. to determine when safe to inject RP/OMD into beamline. → Normally, the main accelerator control room (MCR) has the ability to **"enable" the motion** of the RP/OMD using an **interlock** → potential for automation, currently we literally call the MCR from STAR to have them enable the control.

- Use real-time hits on RP/OMD planes to monitor overall detector rate → slowly withdraw detector by ~ few mm to reduce rates if e.g. collimation under performing to remove beam tails (say, if rates go above ~ few hundred Hz).
  - If rates become truly severe, need to withdraw detectors further – need some limiting information from the accelerator in real-time (e.g. loss monitoring) – does rapid withdrawal of RP from beam cause beam instability (rapid change in impedance).
- Collimation system (see Andrii's talk)

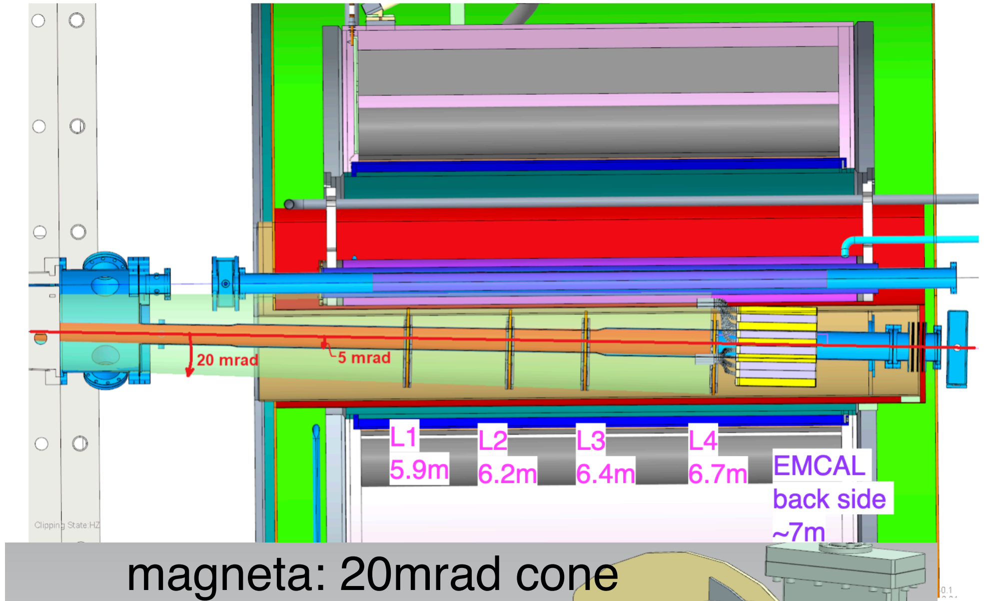
Fast (< few ns) controls for the RP/OMD

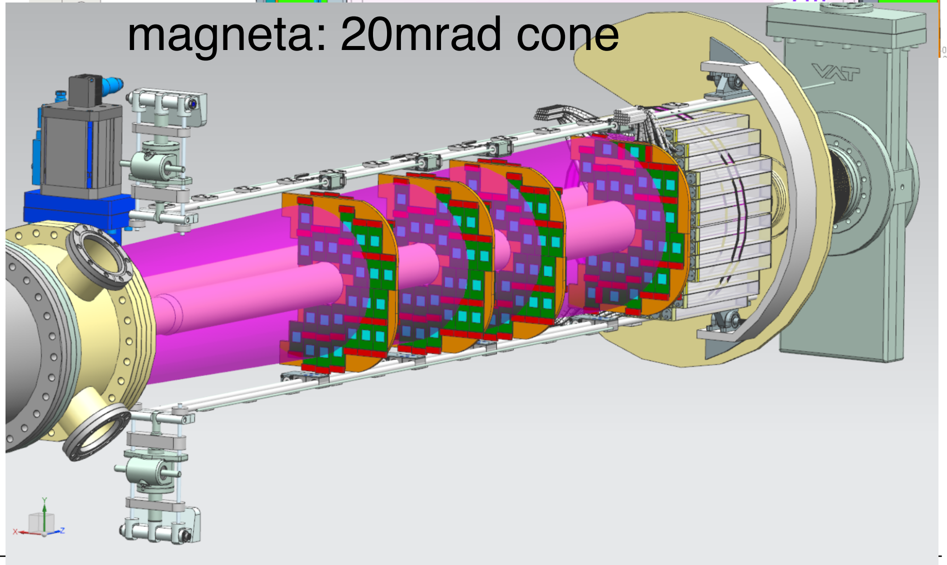
- Beam conditions could change rapidly enough to where RP cannot be safely protected using conventional slow controls (e.g. and issue which manifest over a few accelerator turns).
  - Need link from say **loss monitors** to FEB of RP **to rapidly cut HV bias** to sensors. → not perfect, but could protect detectors from catastrophic damage if rates increase by > x100 rapidly.
  - Alternatively, something on the FEB that monitors the data rate to see if it exceeds some threshold value to open a relay/analog switch to cut the HV and protect the silicon.

B0-detectors: Slow-control

➢ B0-magnet status and field settings (from accelerator)

- Tracker (AC-LGADs)
  - Monitor & record temperature at precision of 0.1°C
  - Control for cooling system (possibly including flow monitoring etc)
  - Monitor & record voltages at precision of 10/100 mV (LV/HV)
- Calorimeter (PbWO4)
  - Monitor & record temperature at precision of 0.1°C
  - Control for cooling system (possibly including flow monitoring etc)
  - Monitor & record voltages at precision of 10mV (LV/HV)
  - Monitor & record leakage current at 10mA precision
  - Control for LED pulsing/ Calibration
- **Monitor rates**, have connection the loss monitors or BPMs and to the have a feedback to turn HV-off if rates are too high for a protection.



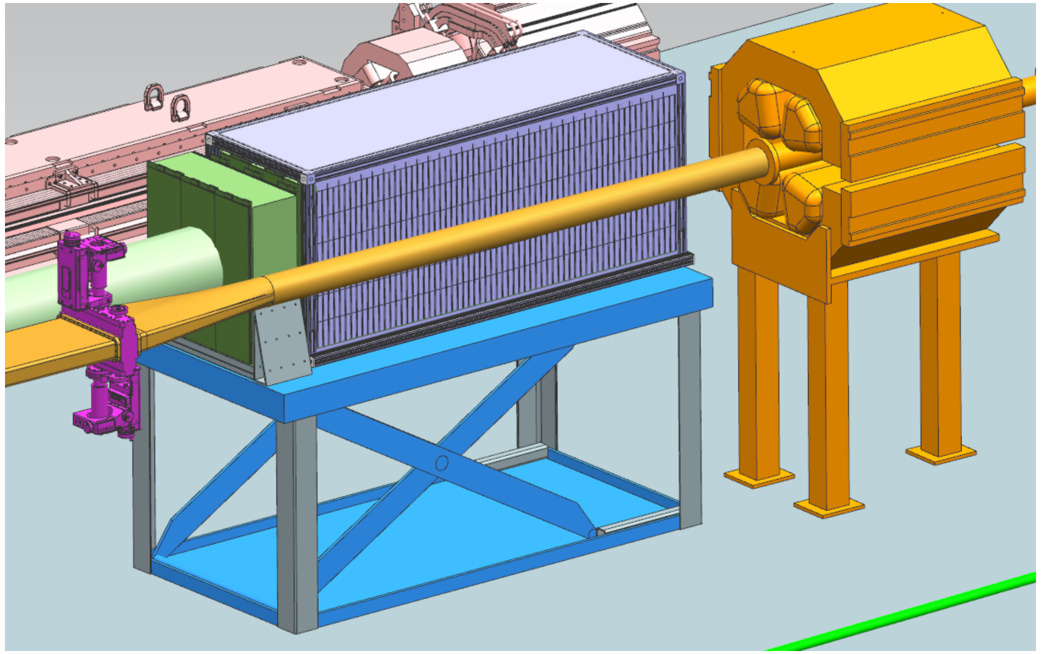


ZDC: Slow Control

➢ Detectors: EMCAL (PbWO4), HCAL(SiPM-on-Tile) :

  - Monitor & record temperature at precision of 0.1°C
  - Control for cooling system (possibly including flow monitoring etc)
  - Monitor & record voltages at precision of 10mV (LV/HV)
  - Monitor & record leakage current at 10mA precision
  - Control for LED pulsing / Calibration

- Movable table control??? Remote control tables should have hard mechanical stops to avoid falling off its table due to poor hardware stop



Low-Q2 slow control

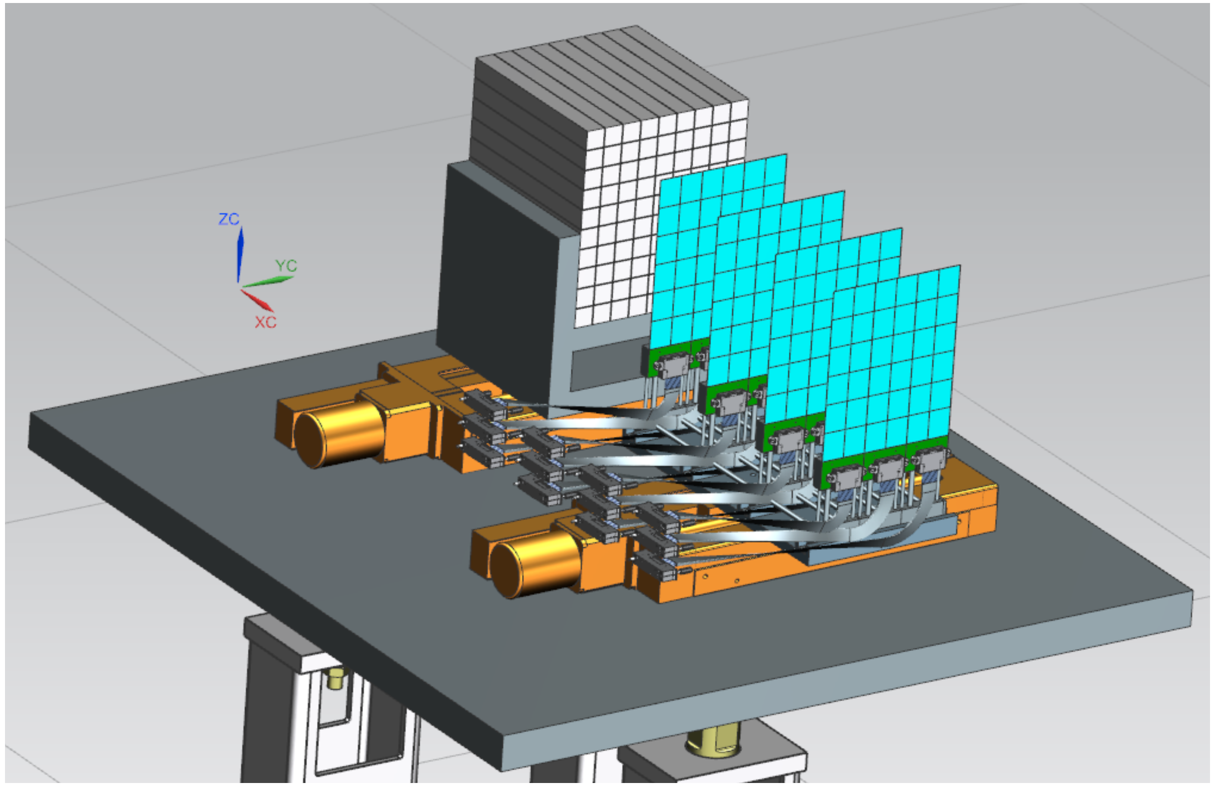
Standard:
- HV, LV,
- Motor Controls for XY movements
- Temperature monitoring/control

Specialised:
- SPIDR4 control / setup, calibration procedures
- Calorimeter Light pulser
- Forced air cooling

Monitor rates.

Calorimeter
Fiber sampling calorimeter
(see Lumi)

Tracker
4 Layers of Timepix4
pixel detectors



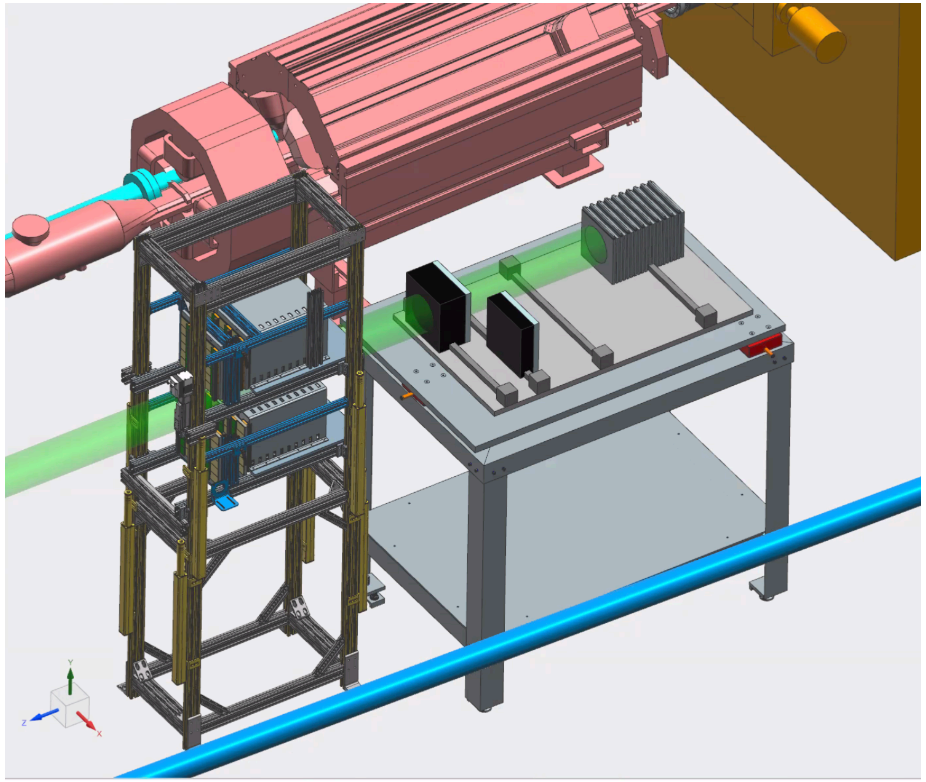
Luminosity detectors and support

Technology: tracker (AC-LGADs) , calorimeter (WSciFi)

- Calorimeters:
  - SiPM temp monitoring (?)
  - SiPM power information
  - LED Pulser system

- PS-tracker (AC-LGADs)
  - Monitor & record temperature at precision of 0.1°C
  - Control for cooling system (possibly including flow monitoring etc)
  - Monitor & record voltages at precision of 10/100 mV (LV/HV)

- Movable stands , position control



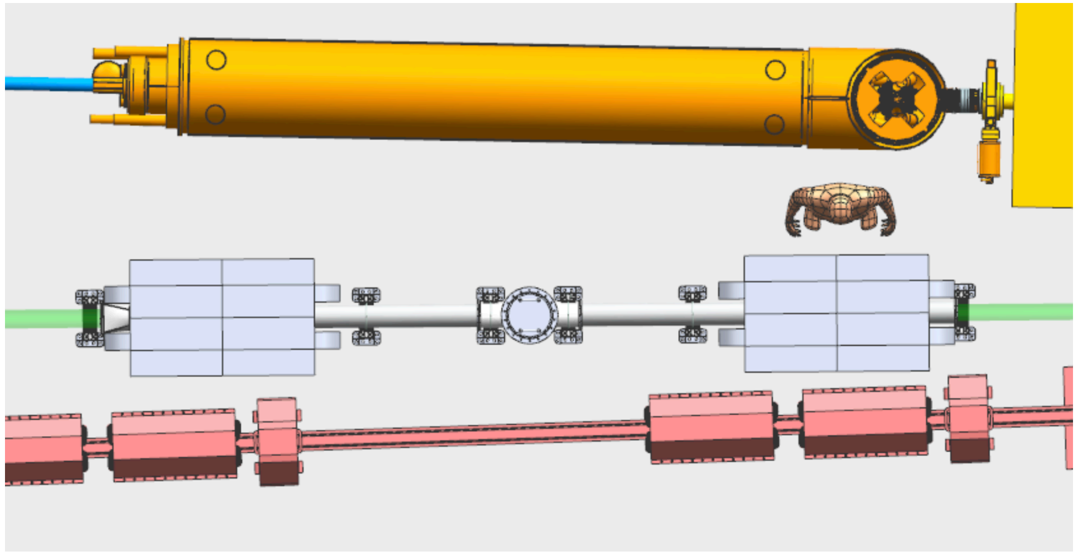
Luminosity PS-magnets and Vacuum

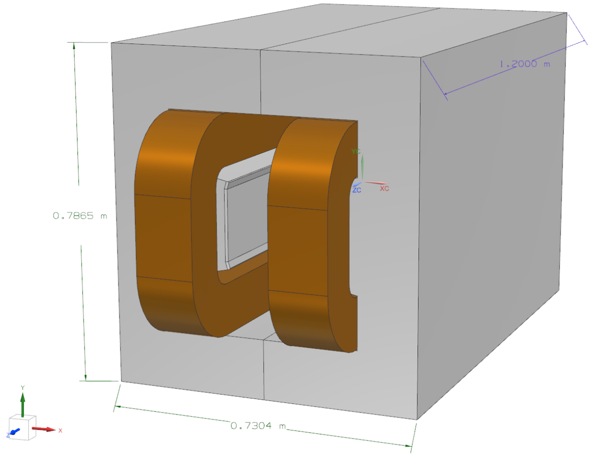
- PS -dipole magnets:
  - Magnet power supplies controls and monitoring
  - Magnet temperature /cooling(?)

- Collimator motion controls

- Converter foil (vacuum):
  - Conversion chamber vacuum monitoring
  - Motion control: position of the foil
  - Temperature control

- Machine may want feedback from subsystem -> Overall detector rates
  - Sudden increase/decrease in rates (with other components working correctly) could indicate a machine issue
  - Motion control of collimator/converter foil will likely require interlocking if rates are tied in to machine in any way
- Synchrotron radiation issues / temperature control for exit windows?





Summary

- **We have to coordinate** to make sure that sub-systems are not re-inventing a wheel, for example, with lightpulsers, where each requiring different specification or slow-controls systems…, chillers, etc..
- Need to monitor an environment inside the tunnel: temperature, humidity and pressure.
- A **coordination** with various **accelerator groups** (interlocks, optics, machine protection, collimators, vacuum etc.) is essential.
- Availability of the SlowControls/DQM monitoring is important not only during the operation, but also during production/QA testing.
- Web-cameras in tunnels to get a visual monitoring of crates.