MEG II実験液体キセノン検出器のインストール~~及びセンサー~~試験

→ 次のトークで

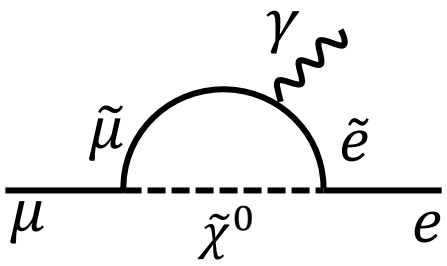
東大素セ 家城 佳、
他 MEG II コラボレーション

$\mu \to e\gamma$ search

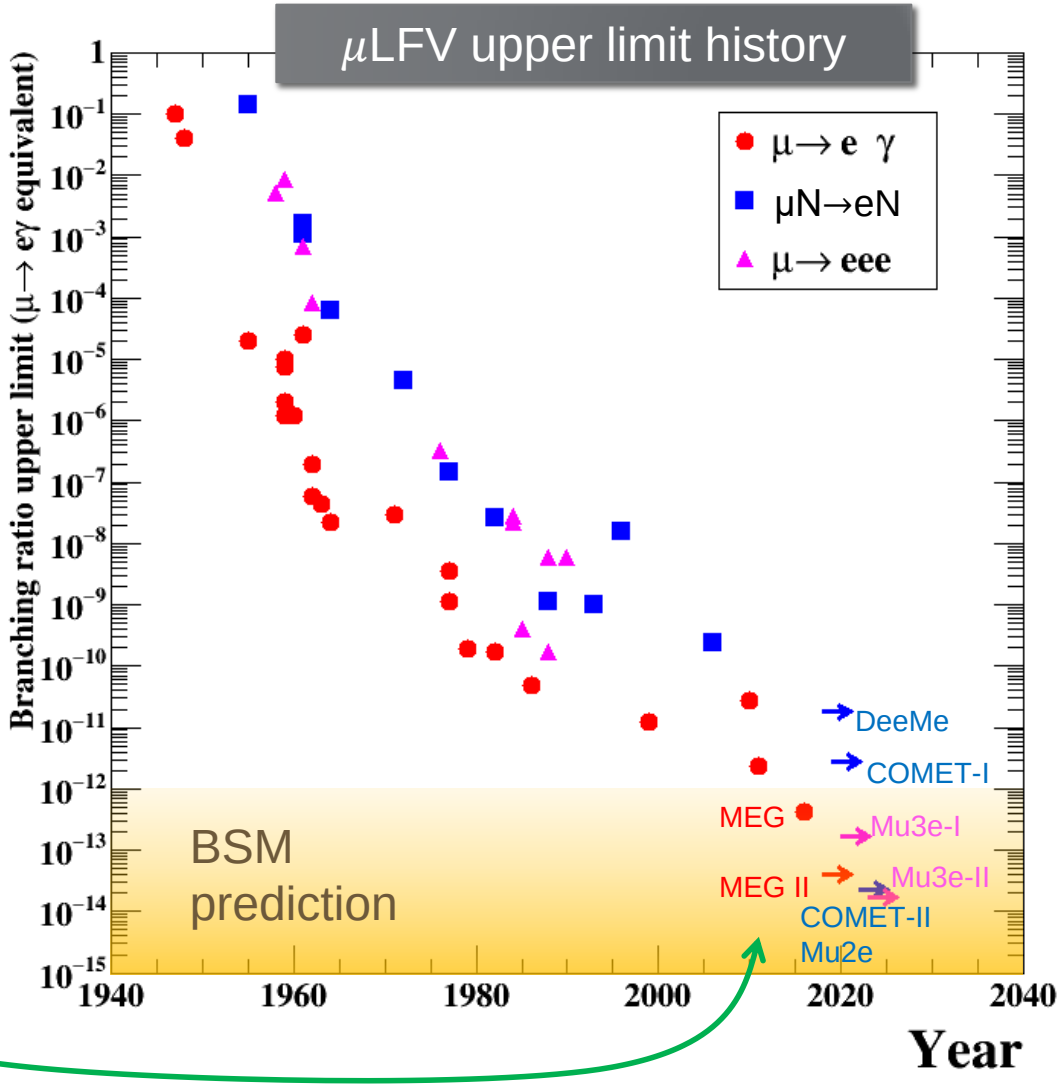
Observation of
lepton flavor violation (LFV)
decay $\mu \to e\gamma$

Evidence of new physics!

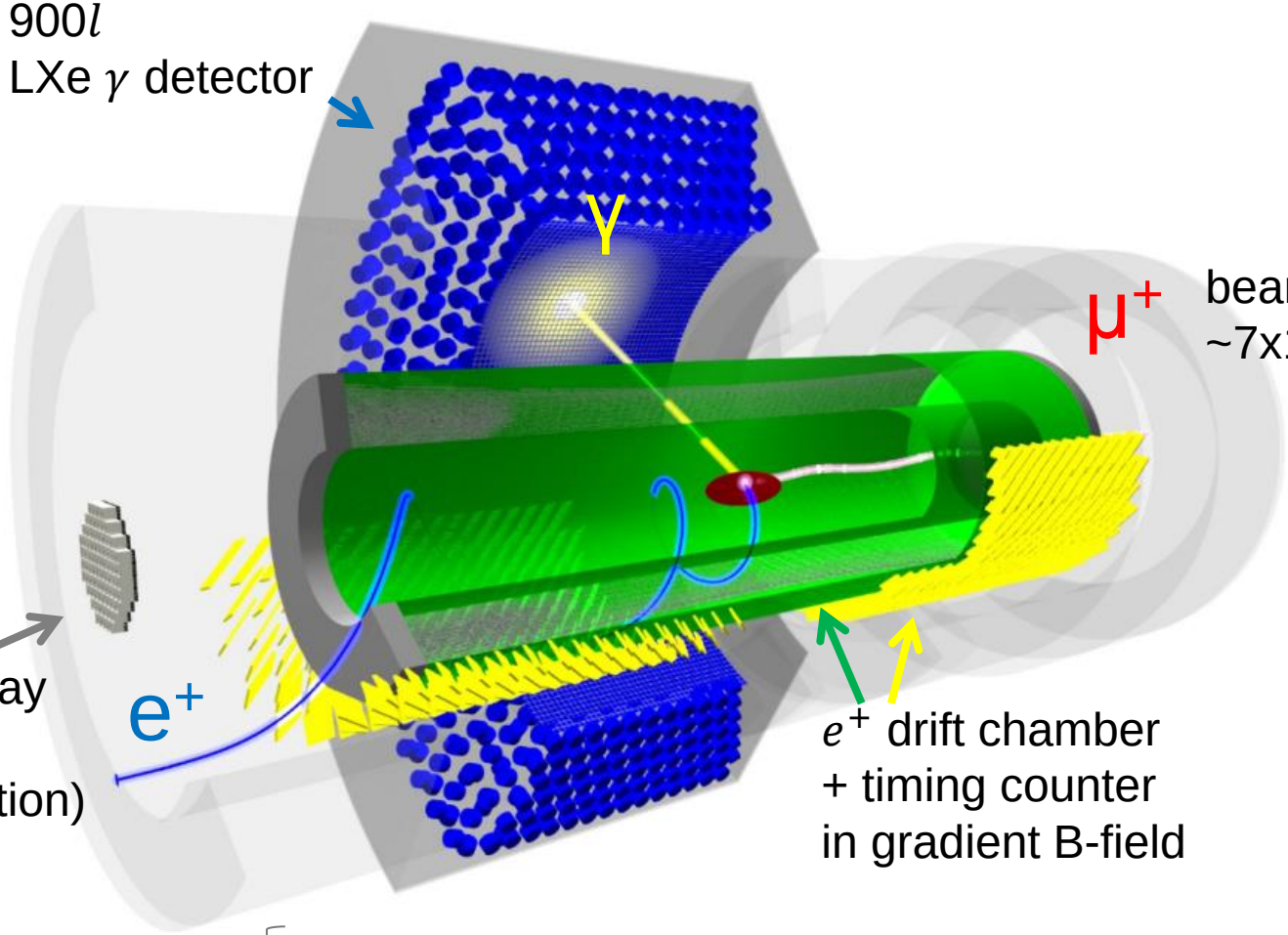
e.g. $\mu \to e\gamma$ with SUSY



New generation LFV experiments
can explore the region predicted
by BSM



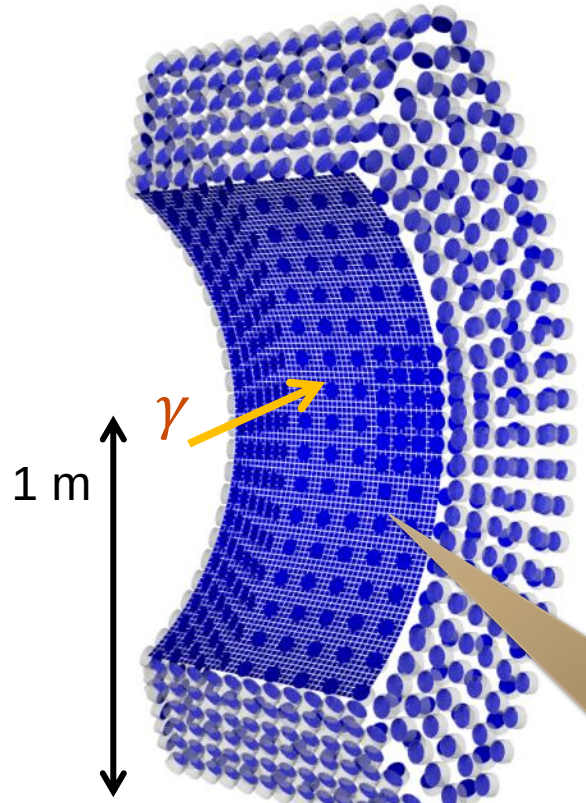
MEG II



Upgrades from MEG:
- x2 beam rate
- x2 detector resolution and efficiency

→ x10 sensitivity (4×10^{-14})

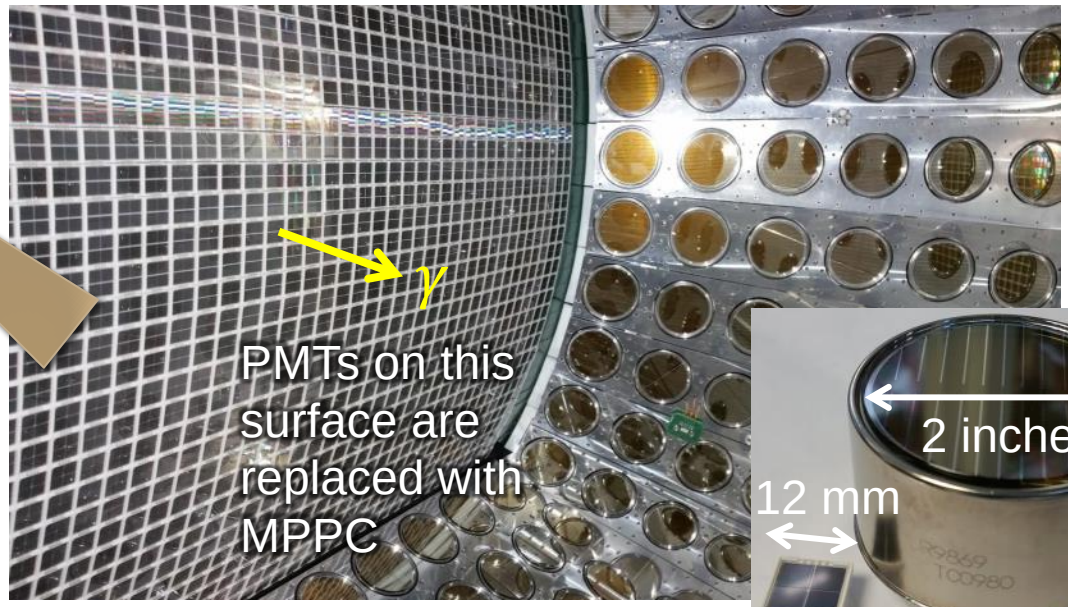
LXe detector



- Measures the { energy, position, timing } of γ-rays.
- Readout: 2” PMTs × 668 + 12mm MPPCs × 4092
  → Granular & uniform coverage
  → x2 resolution improvement expected from MEG

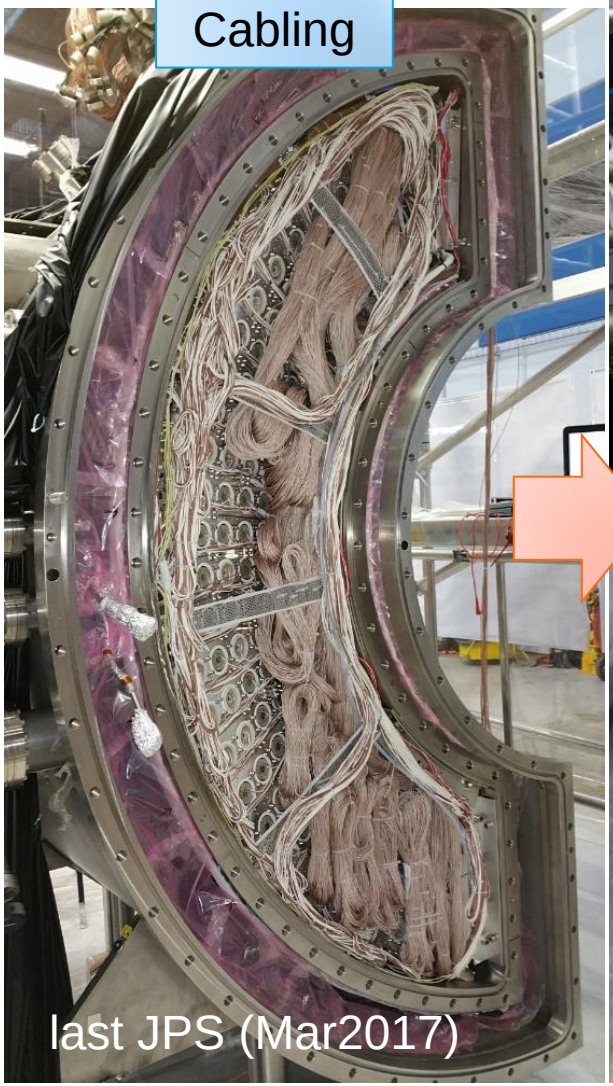
Energy resolution ~1%

Position resolution ~2.5mm



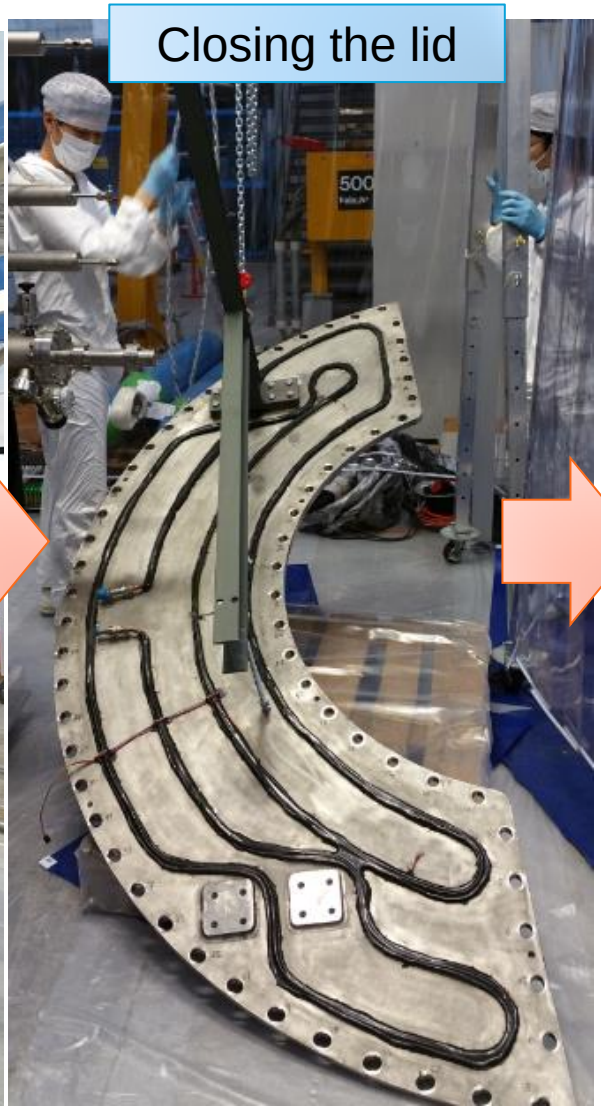
Final stage of construction

Cabling

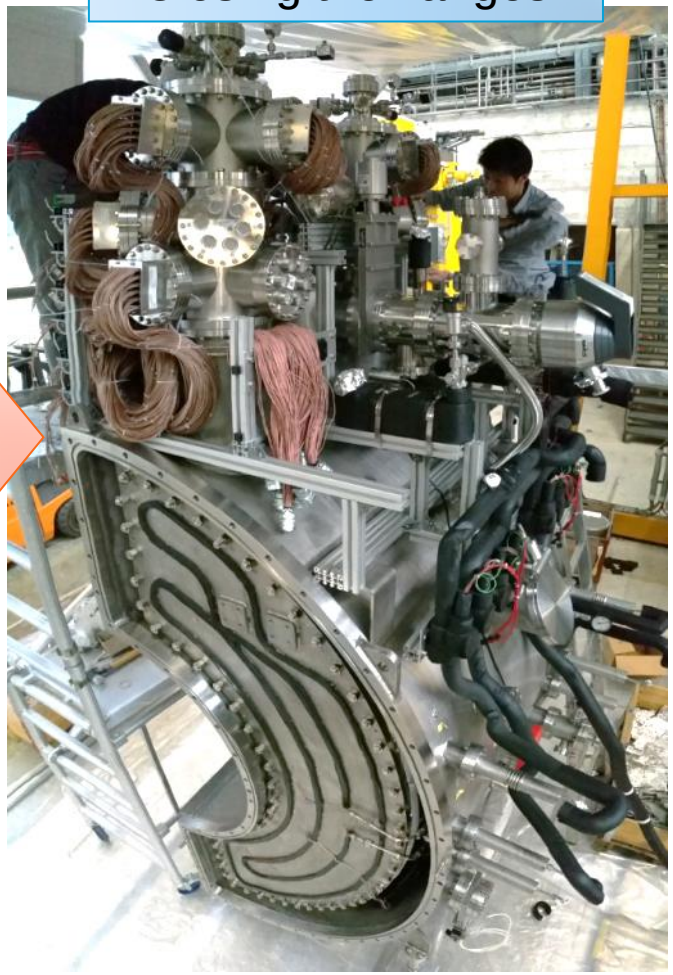


last JPS (Mar2017)

Closing the lid

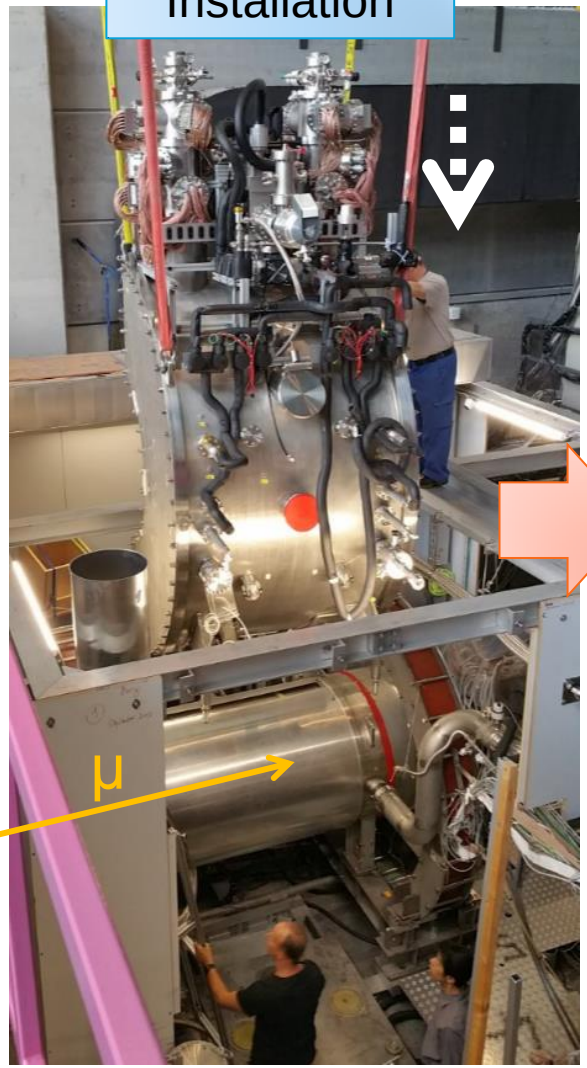


Closing the flanges

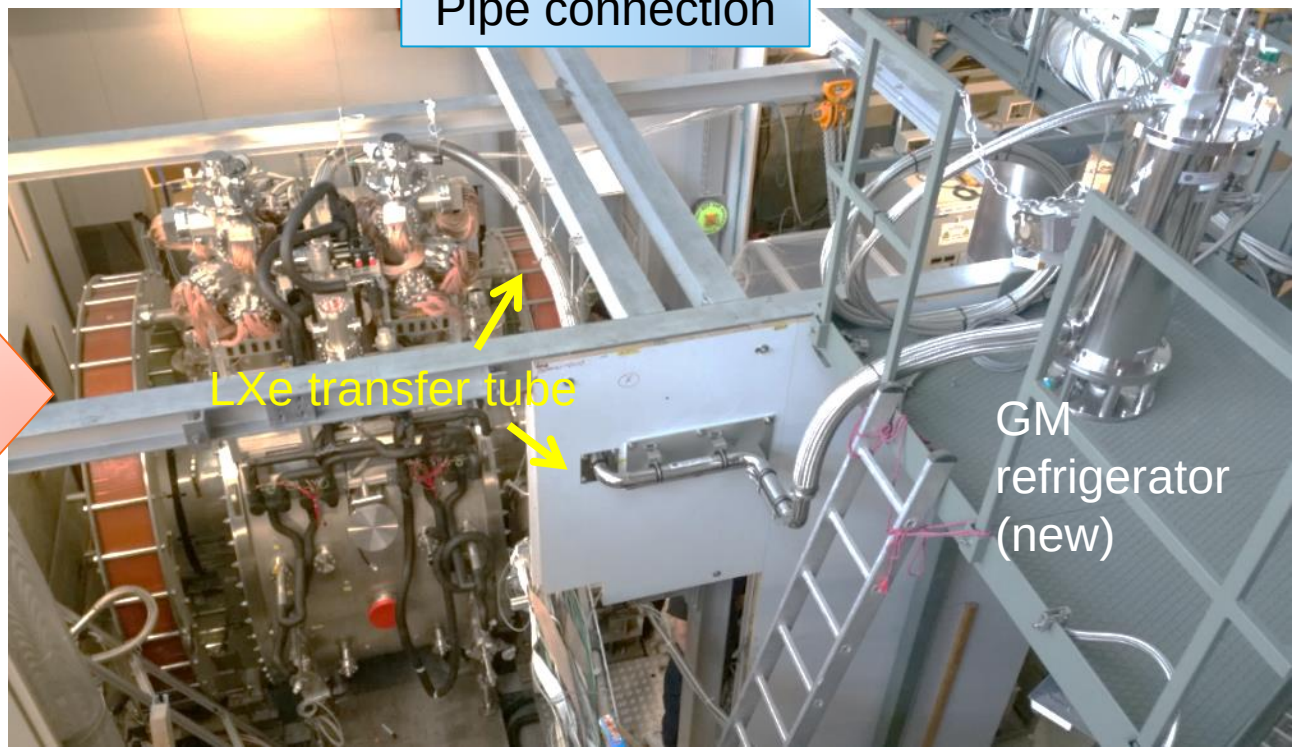


Installation & pipe connection

Installation

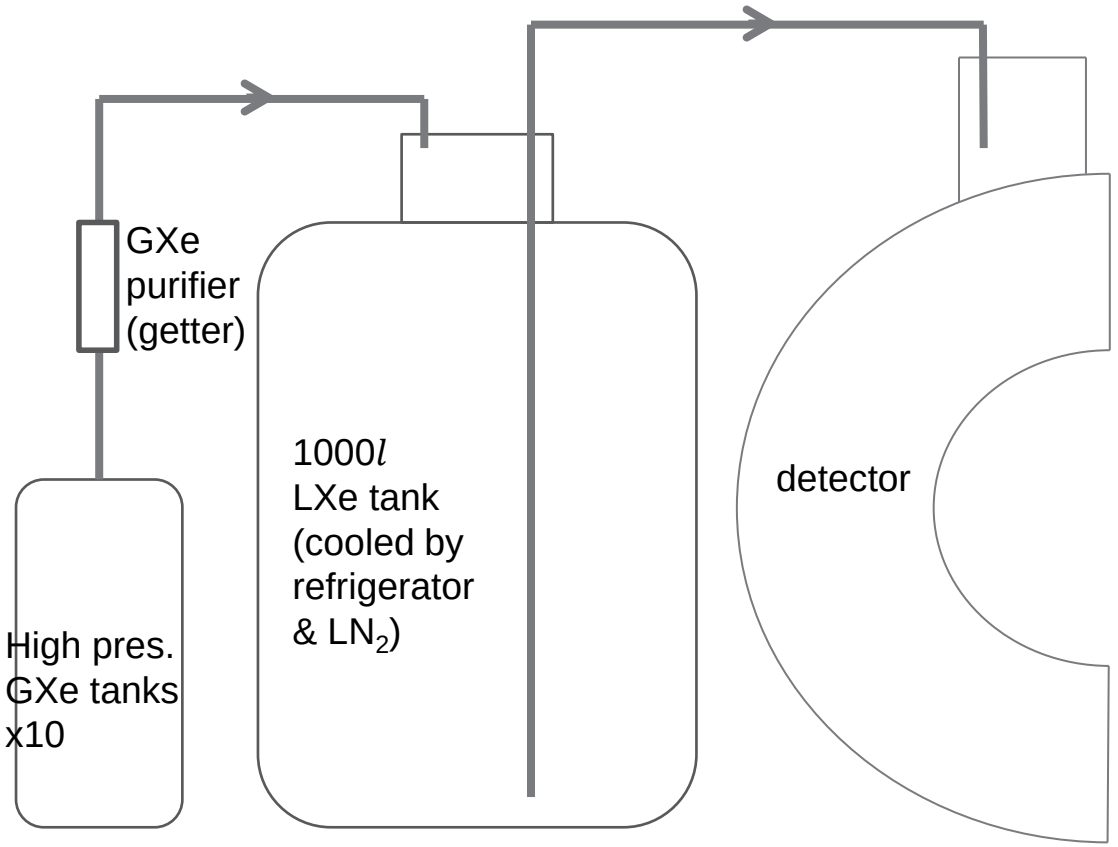


Pipe connection



Filling LXe to the detector

1. Liquefaction (GXe storage tanks → 1000l LXe tank)
2. Vacuum evacuation of the detector (to ~2x10^{-3} Pa)
3. Pre-cooling of the detector (~175K)
4. LXe transfer from 1000l tank to the detector

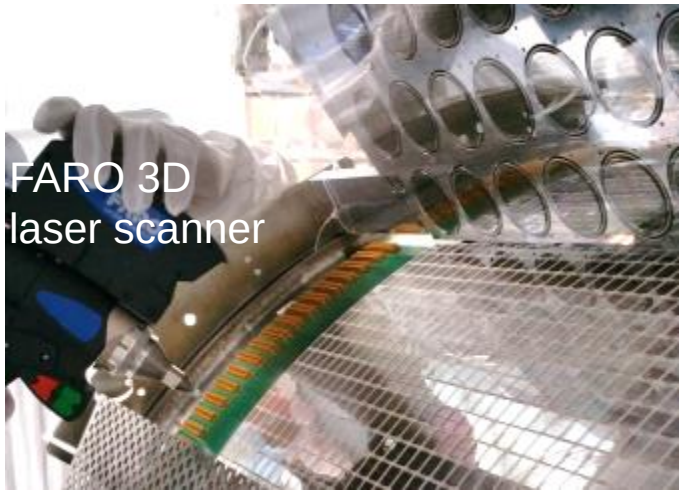


LXe transfer

View from a USB camera installed inside the detector

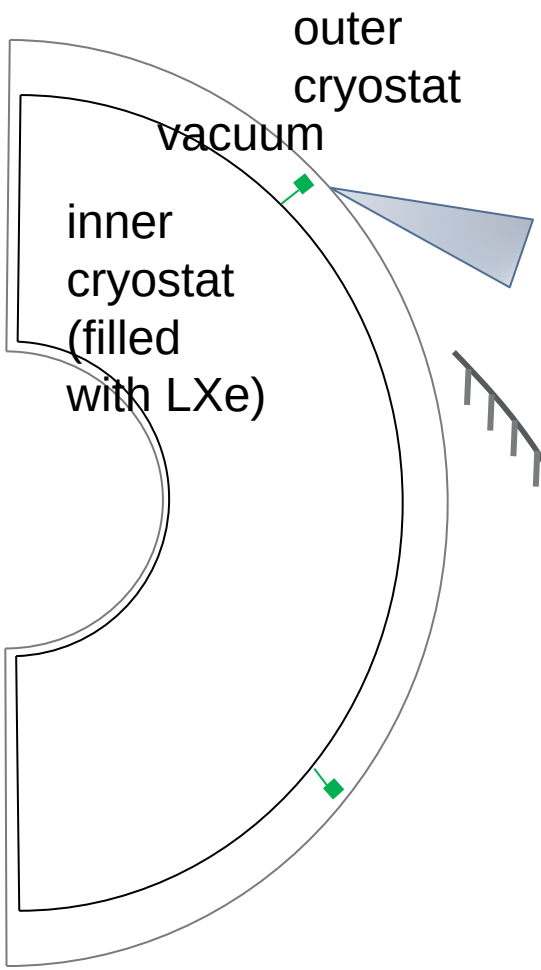
Position monitoring

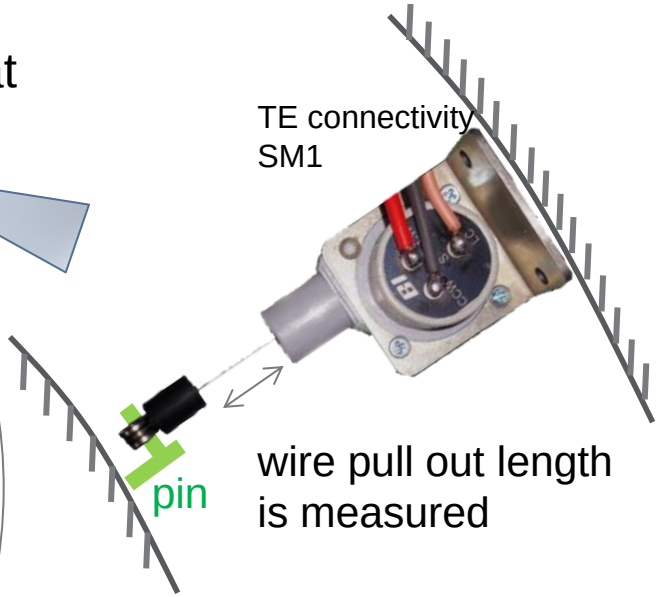
MPPC position was scanned with laser after installation↓



However, inner cryostat deforms by heat shrink and LXe load.

→ Monitor the movement by position sensors

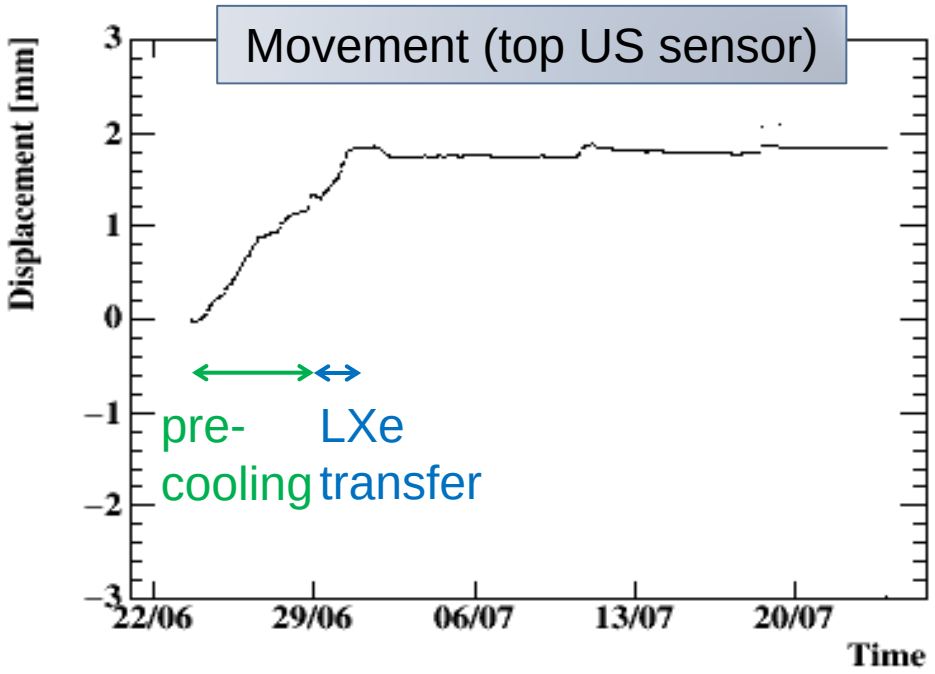




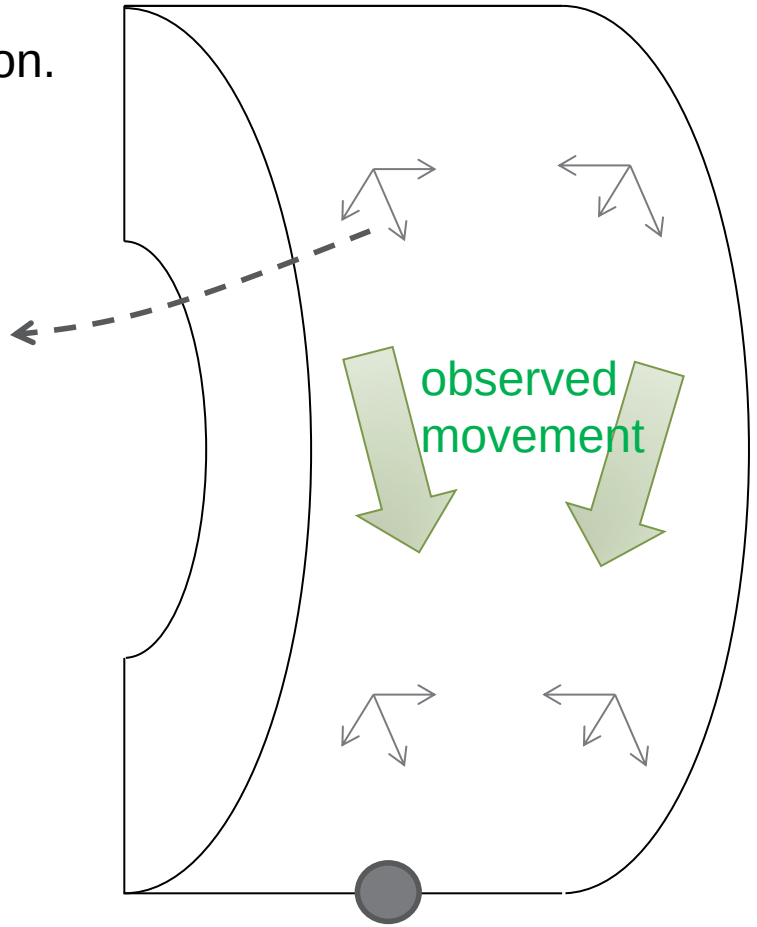
wire position sensors are attached to the outer cryostat.

Position monitoring

3 sensors are installed at 4 different position.

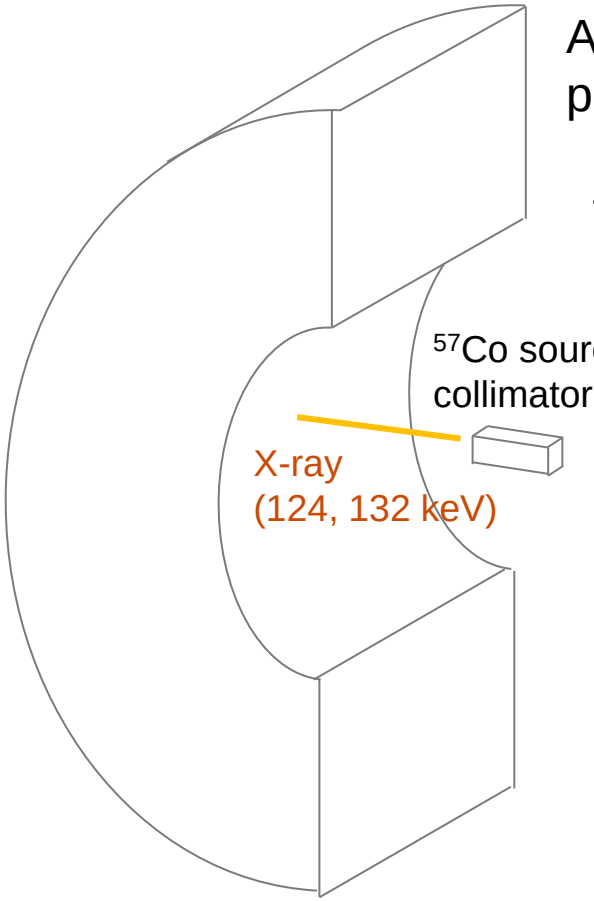


Moved mostly during the pre-cooling due to heat shrink. Result was roughly consistent with what we expect (~1.6x10^{-3}mm/m/K heat shrink to bottom direction)

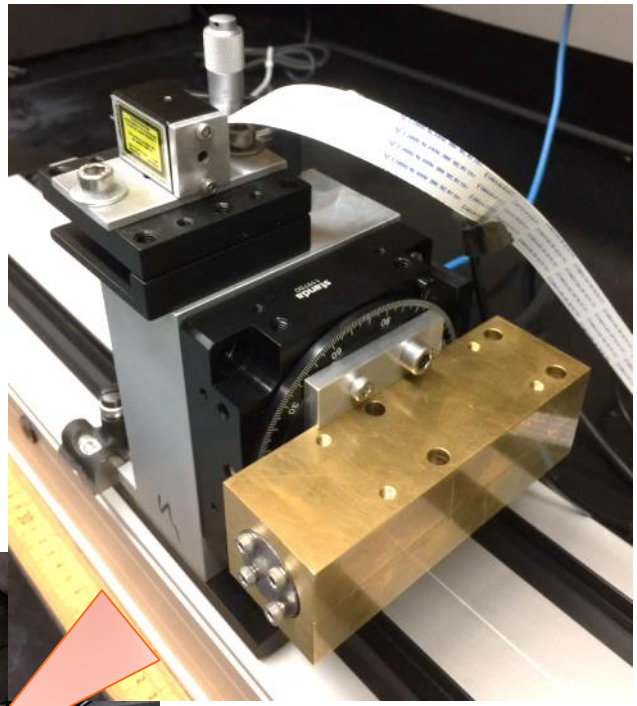


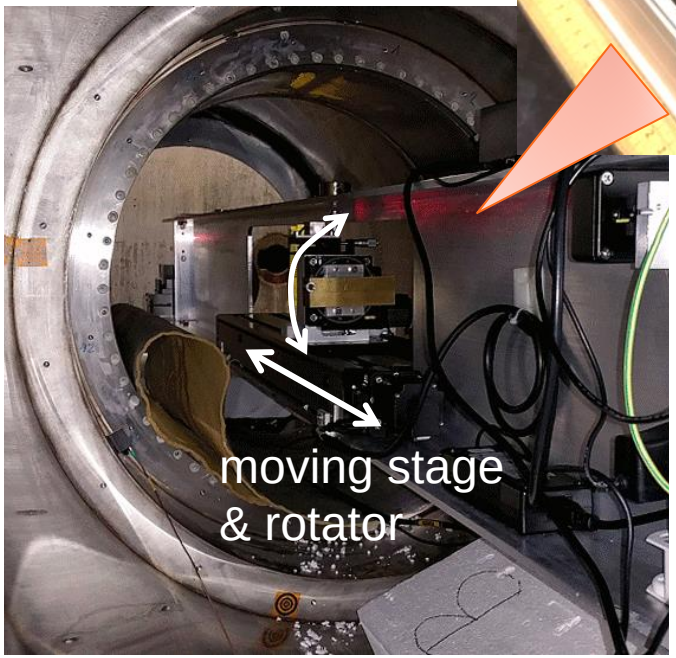
Cryostat is fixed at the bottom middle.

X-ray survey

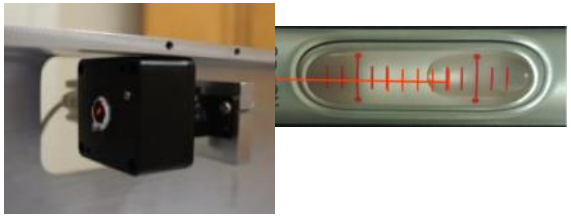


Another method for position check:
Measure MPPC signal from the X-rays.



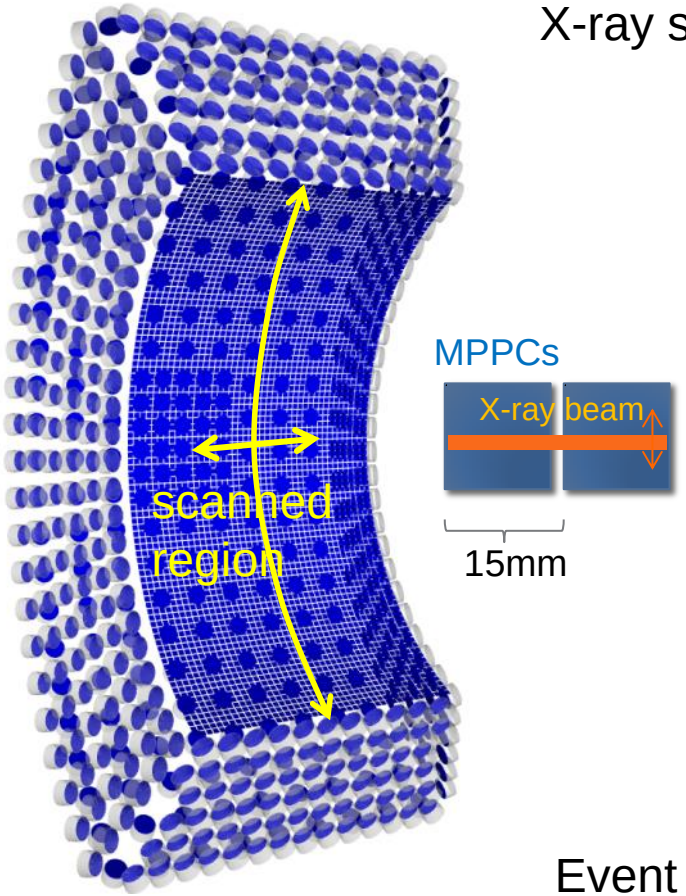


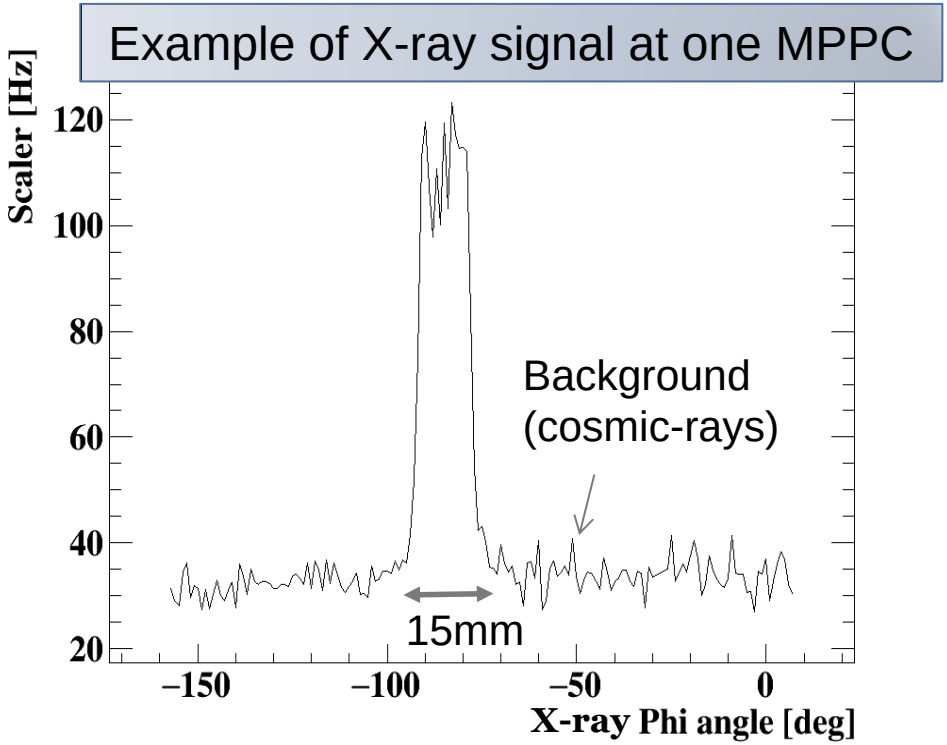
Position of the stage is measured by laser and monitored by laser and bubble level + camera.



X-ray survey

Scan was performed in two directions in 1mm step.
X-ray spot size ~ 2 mm x 30 mm

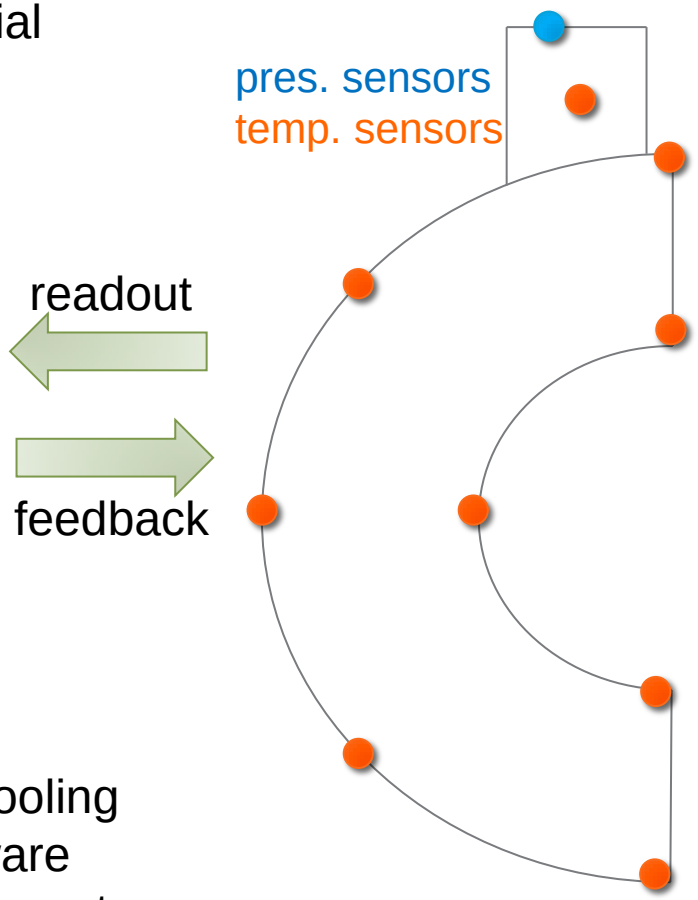




Event rate increase was successfully observed around X-ray irradiated region.
Analysis is ongoing.

LXe monitoring & control

We built a slow control system using special modules (SCS2000) developed at PSI



SCS2000 can:

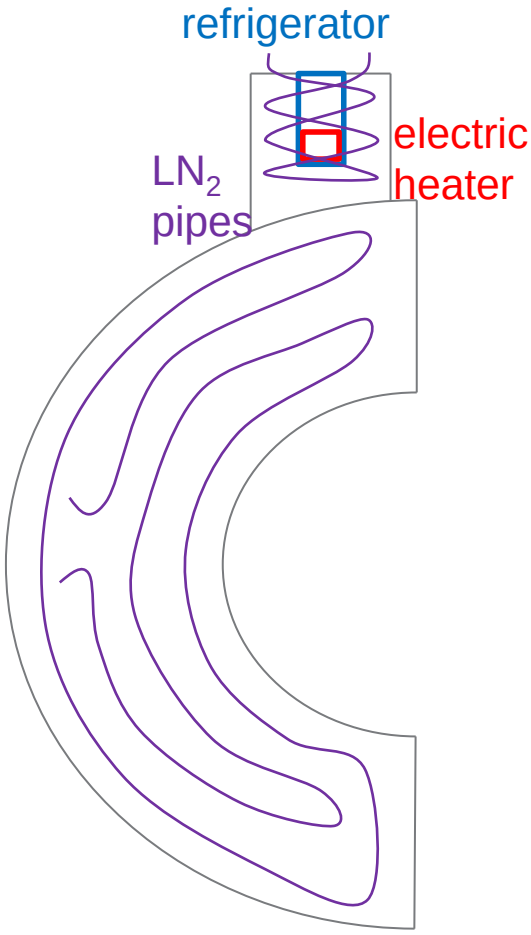
- readout the sensors (bias & ADC)
- automatically or manually adjust the cooling power (refrigerators and LN_2) by firmware
- allow users to monitor & control via internet

LXe monitoring & control

Normal (stable) operation:
Temperature & pressure is maintained by adjusting electric heater power.

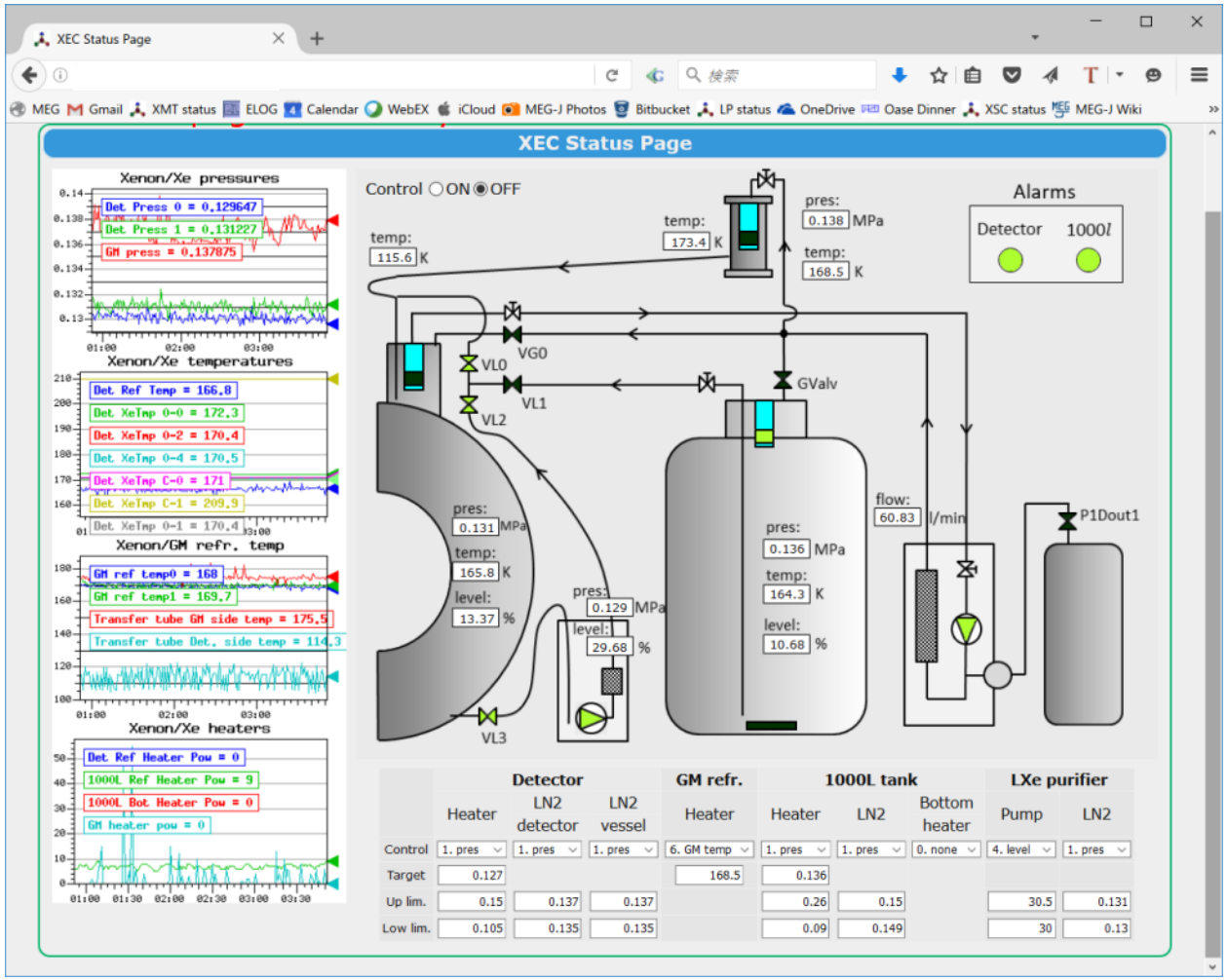
Emergency or special operation:
Open LN_2 valves for additional cooling

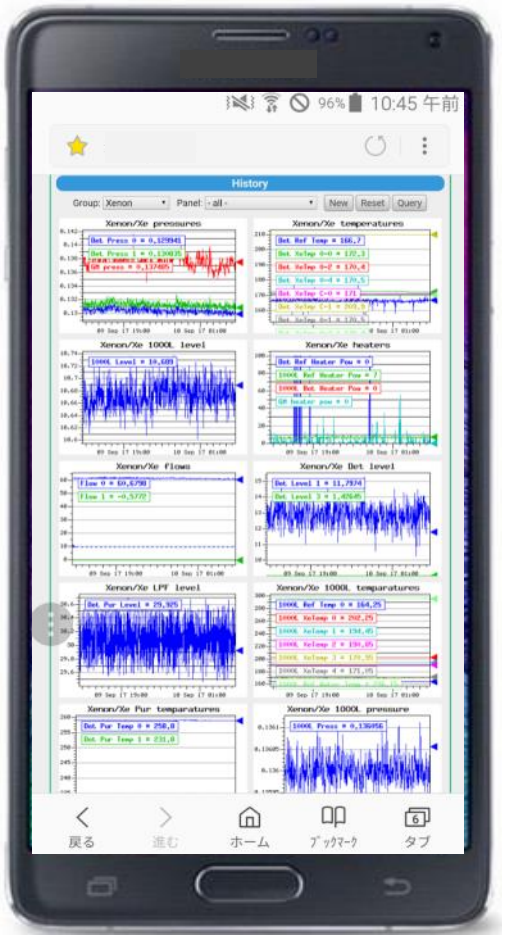
Firmware of SCS2000 does the control automatically.
- Heater power adjustment (PI control)
- LN_2 valve open at high temp. or high pres.
- Issue an alarm in case of emergency



LXe monitoring & control

Overall system is monitored & controlled from web browser.



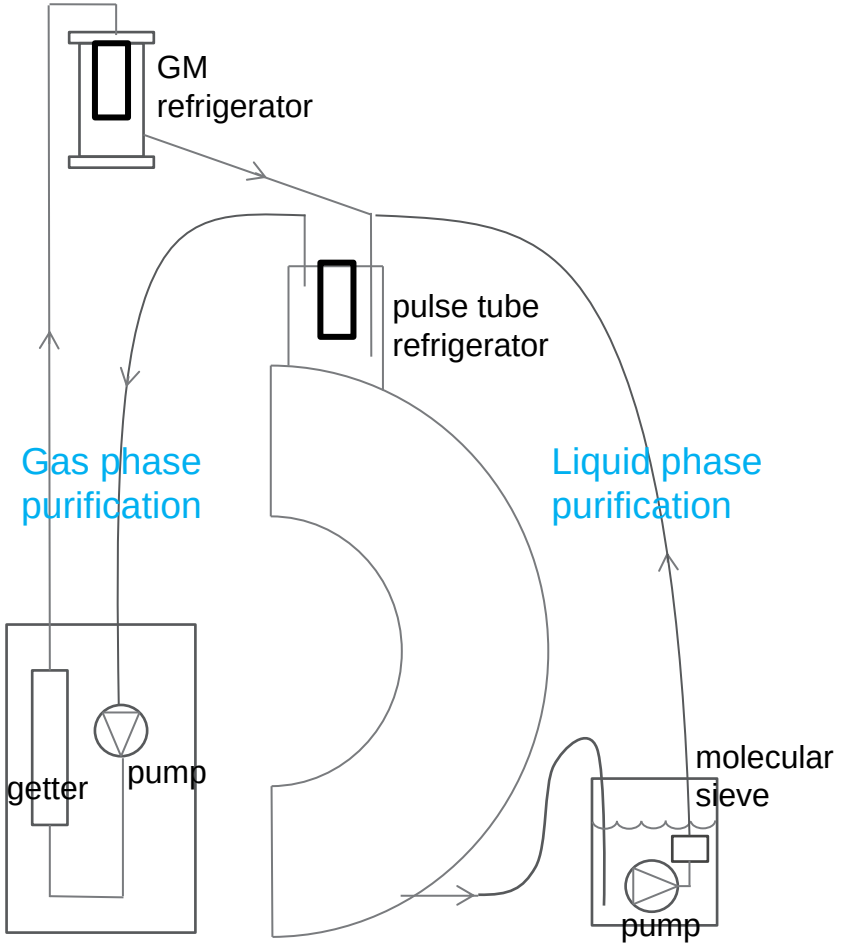


Purification

Purity of Xe affects the scintillation (light yield, attenuation, pulse shape)

Two types of purifications are ongoing in parallel for ~2 months.

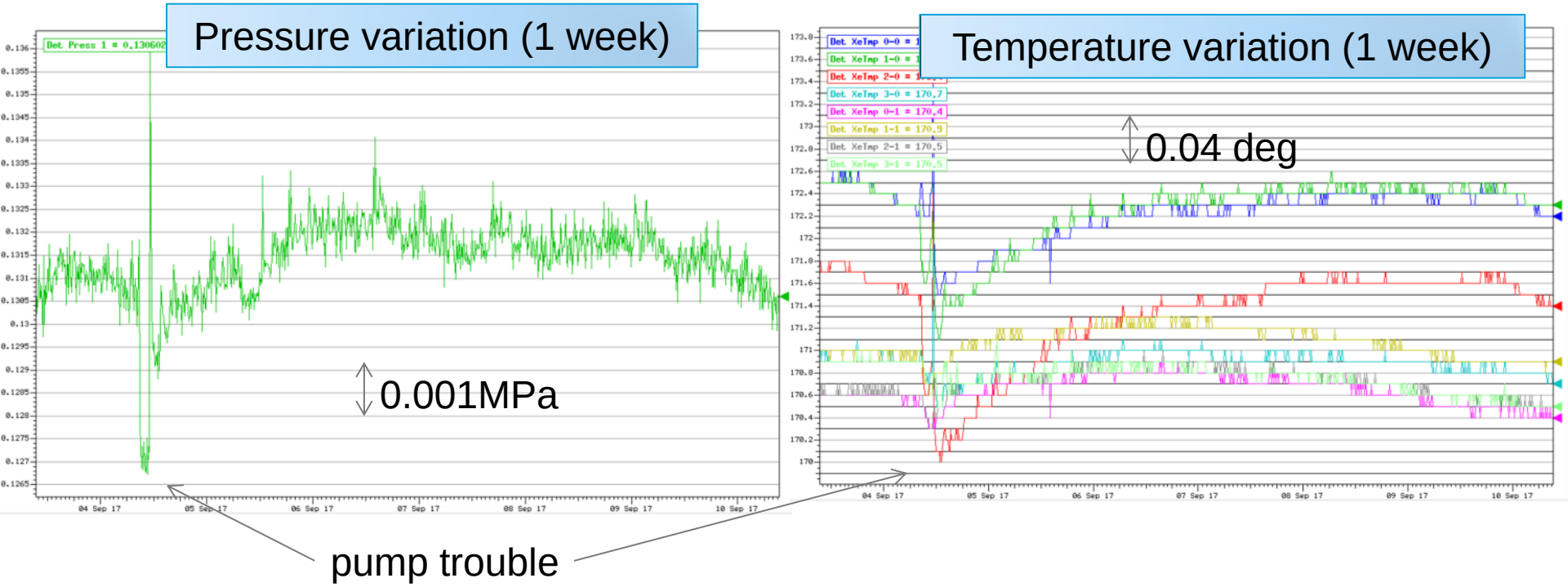
- Gas phase (getter)
  Slow (GXe ~35 l/min)
  Removes H_2O, O_2, CO, CO_2, N_2, H_2 …
- Liquid phase (molecular sieve)
  Fast (LXe ~40 l/hour)
  Removes H_2O



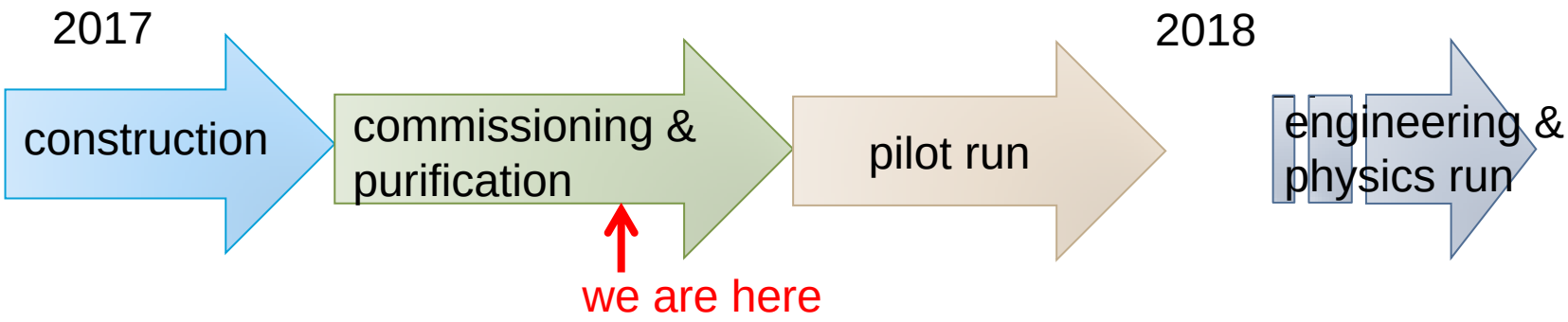
Purification and detector stability

- Xe purity is improving (light yield increased ~10 times over 2 month.) Currently the light yield is ~85% of what we achieved in MEG.
- Temperature and pressure are sometimes unstable due to LXe purification pump trouble and due to heat income in LXe purification line.

→ Once we finish purification, the detector will be more stable.



Status & schedule



- Construction & installation are finished!
- LXe operation started. Purification is ongoing.
- MPPC & PMTs are being tested → Next talk (S. Ogawa)
  with limited amount of DAQ channels available now (~1000ch)
- Detector monitoring is started → Next next talk (N. Matsuzawa)
- Pilot run will start in the end of 2017, followed by the engineering run and physics run in 2018.

Summary

- LXe detector is successfully installed.
- Position of the detector is measured by wire sensors and X-ray.
- Slow control system is built. Purification is ongoing. (so far achieved ~85% of light yield in MEG)
- Commissioning of MPPC & PMTs is also ongoing.
- Monitoring of the detector is started.

Next talks