LUX DETECTOR, INSTALLATION AND OPERATION

M. Carmen Carmona-Benitez
Case Western Reserve University

On behalf of the LUX collaboration

July 25, 2012 - IDM

The LUX Collaboration

Brown

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David Malling	Graduate Student
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Markus Horn	Postdoc
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University College London

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Vladimir Solovov	Senior Researcher
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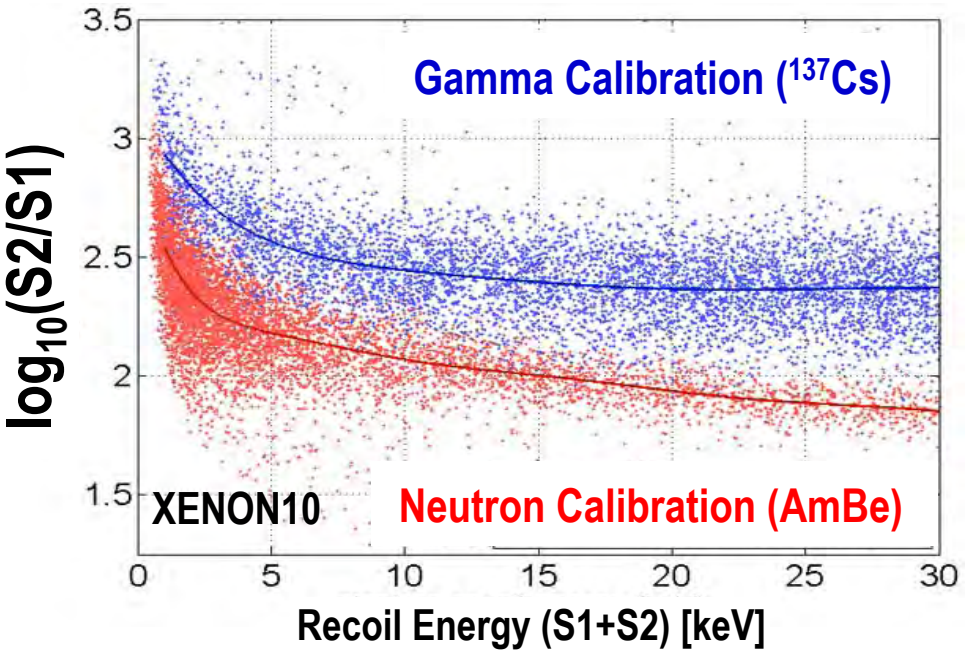
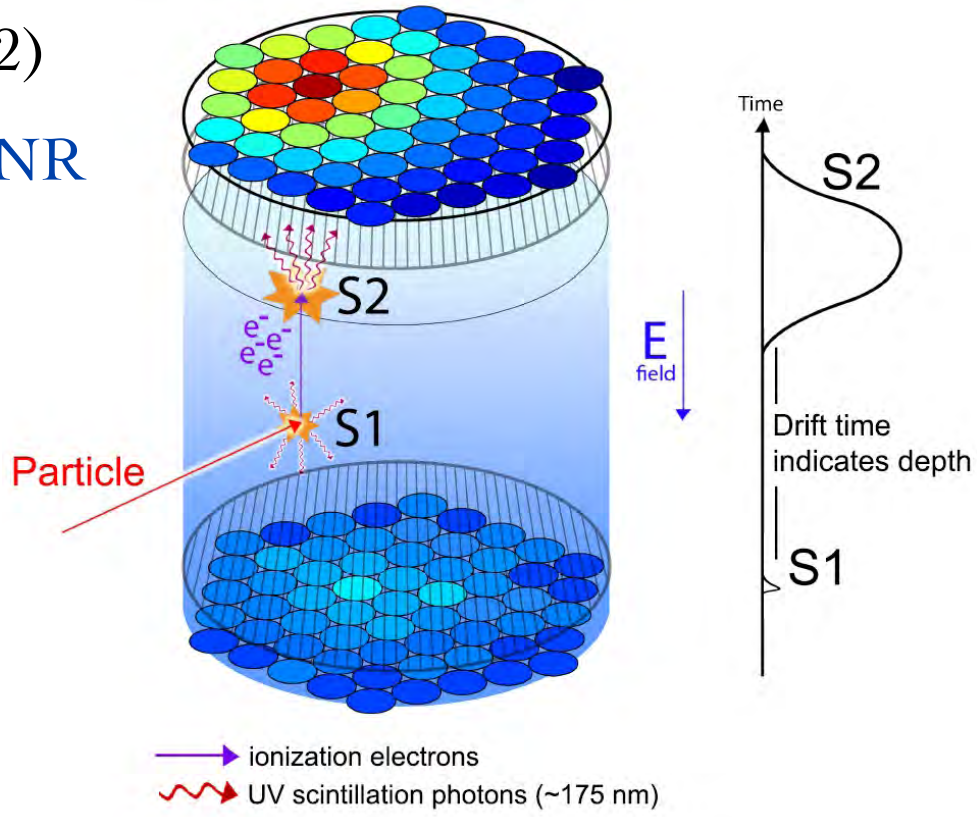
Alexander Lindote	Postdoc
Francisco Neves	Postdoc
Claudio Silva	Postdoc

LUX: Dual Phase Xenon TPC

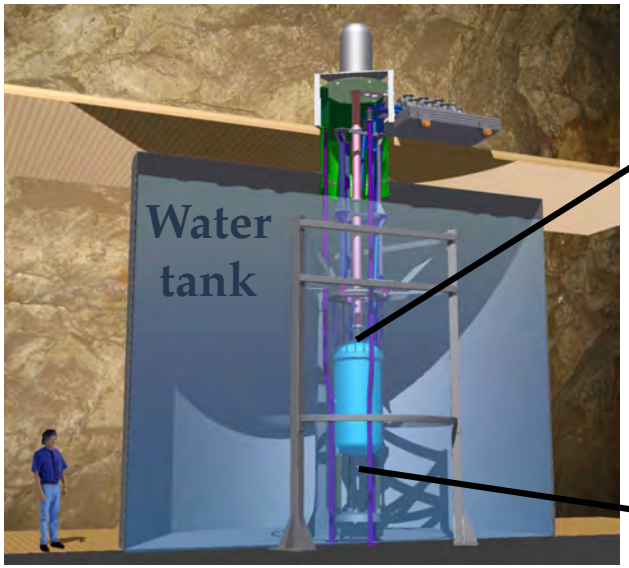
- Dual Phase: Gas and Liquid Xe
  - High density (~3 g/cm^3) and high Z
- Scintillation Light (S1) and Charge (S2)
  - S2/S1 discrimination : 99.5% ER/NR (50% NR acceptance)
- Excellent 3D imaging

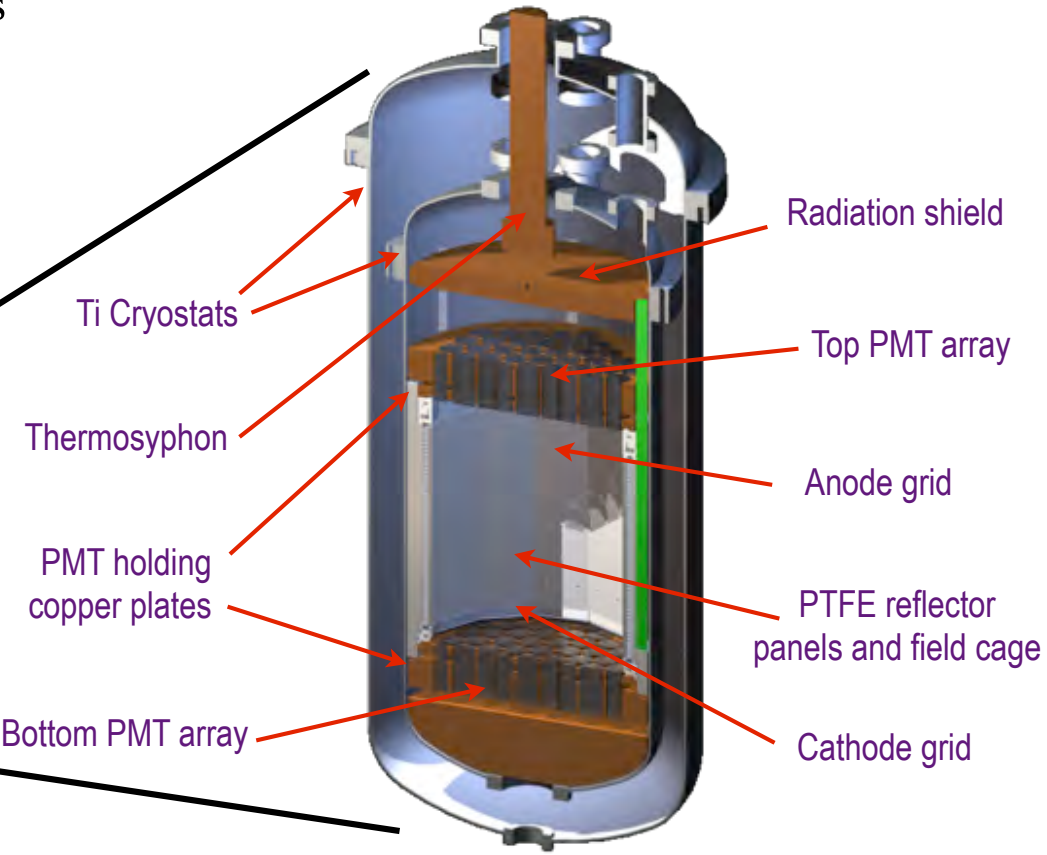




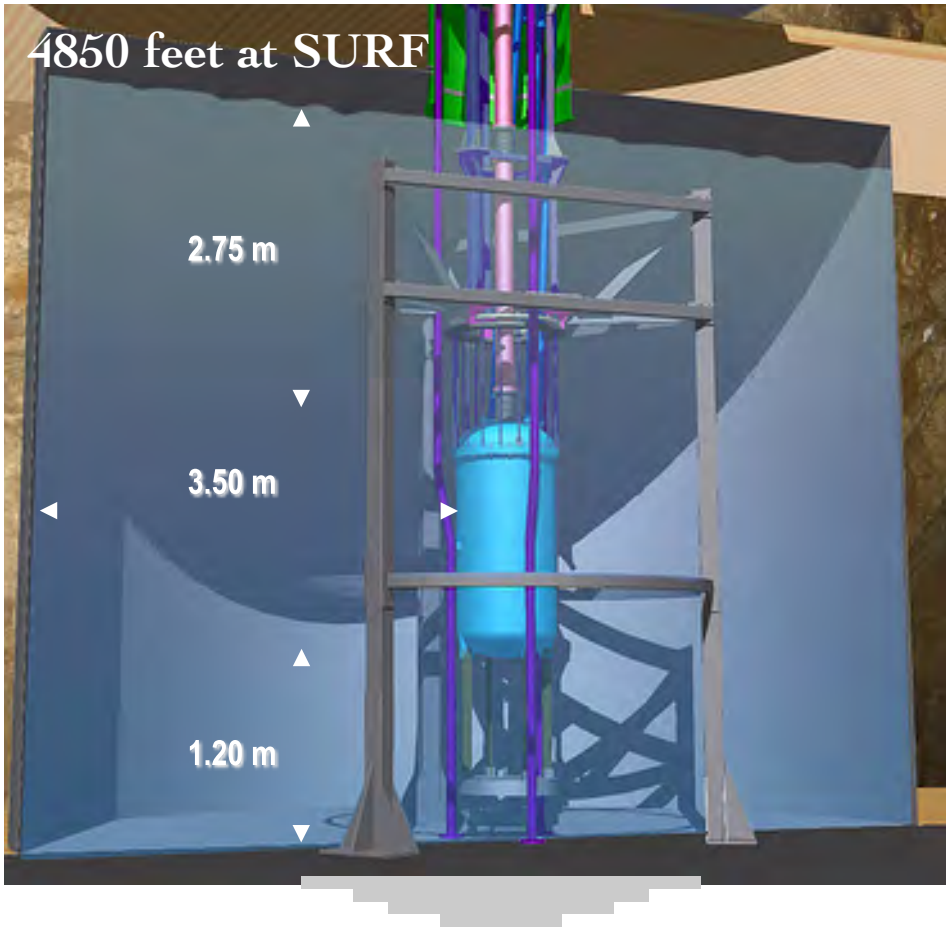
The LUX Detector

- **350 kg xenon detector** (300 kg active region, 100 kg fiducial)
- Maximum drift length 50 cm
- High flow plumbing and heat exchanger for rapid circulation(35 SLPM) through external purifier
- 122 Ultra low background PMTs
- Titanium cryostat (<0.2 mBq/kg)



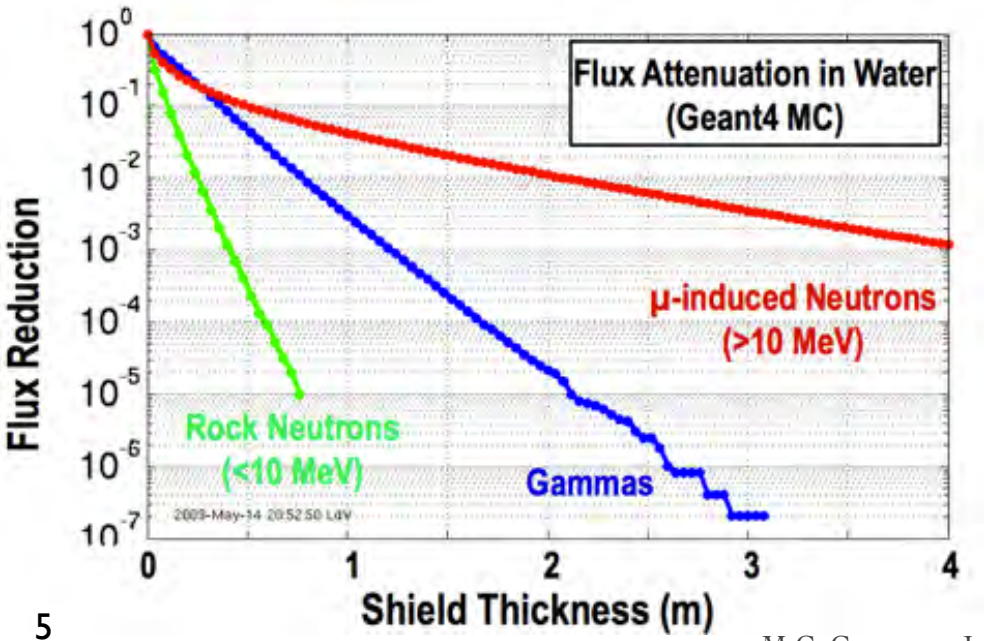


LUX Water Tank



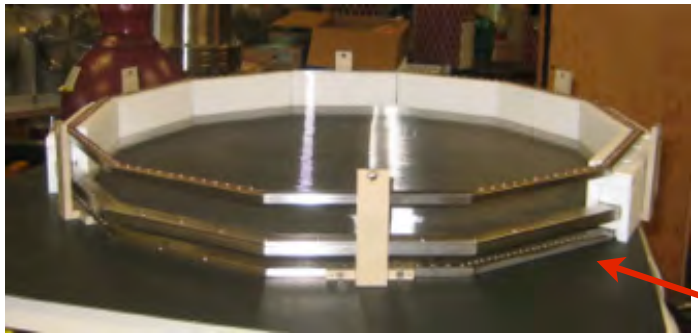
Inverted steel pyramid

- Large water shield
  - Tank: ∅=8m, h=6m; **300 tonnes of water**
- 20 ton steel inverted pyramid below detector
- Cherenkov muon veto
  - 20 PMTs (10" diameter)
- Background reduction

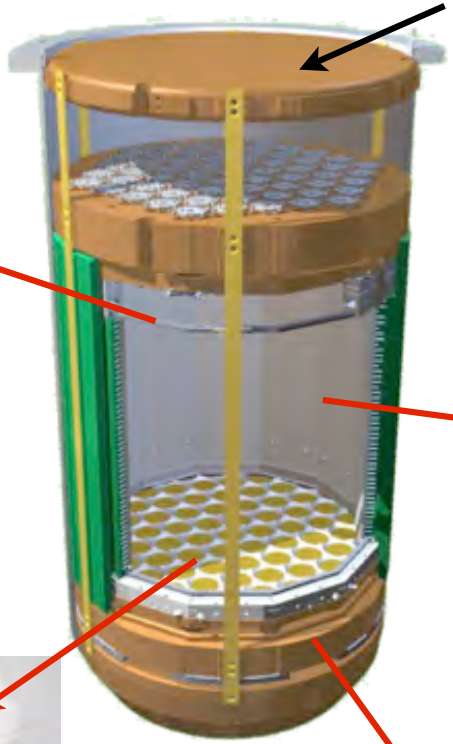


All external backgrounds sub-dominant

LUX Internals



HV Grids



Radiation shield

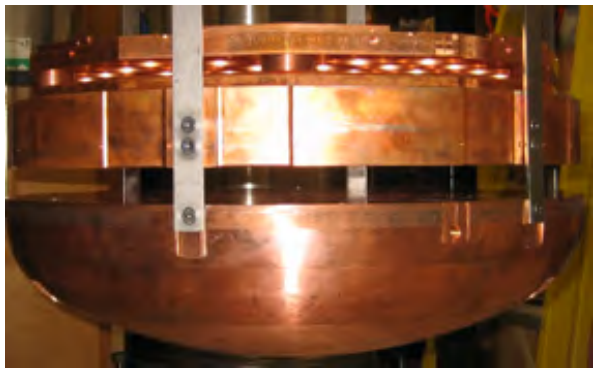
Dodecagonal field cage + PTFE reflector panels

122 2" PMT R8778

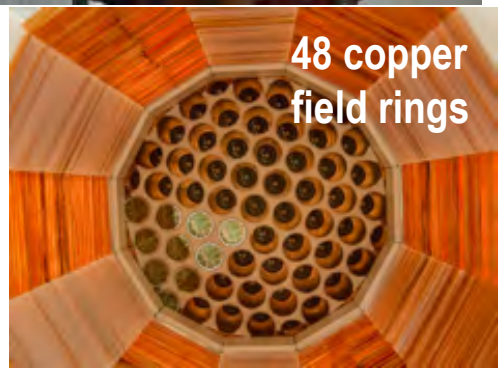
- QE (175 nm) ≥ 30%
- U/Th ~9/3 mBq/PMT

PTFE "trifoils"

Copper PMT holding plate



Counterweight



48 copper field rings

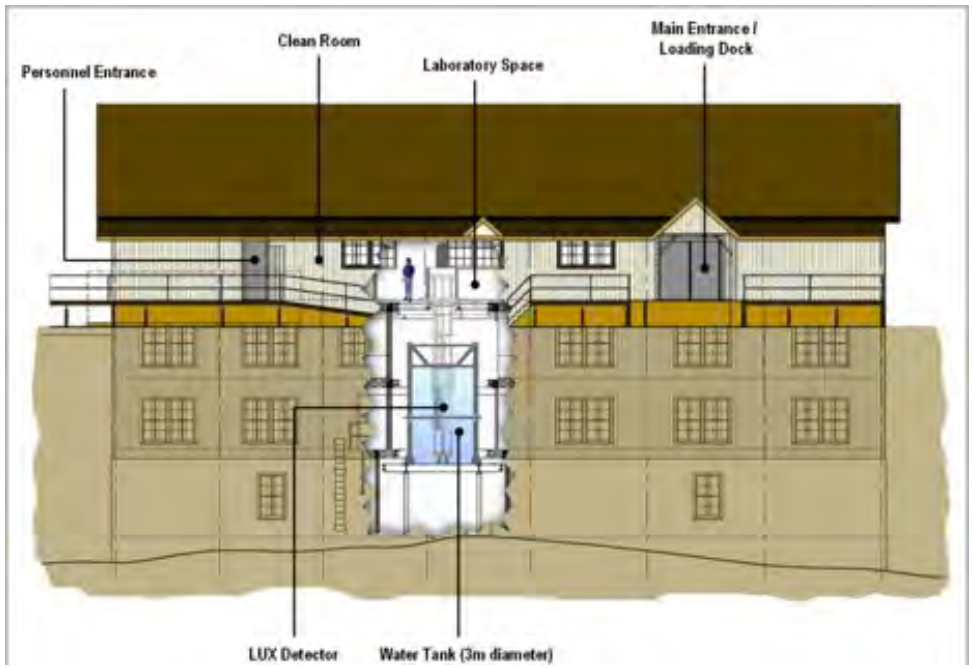
LUX SURFACE RUN

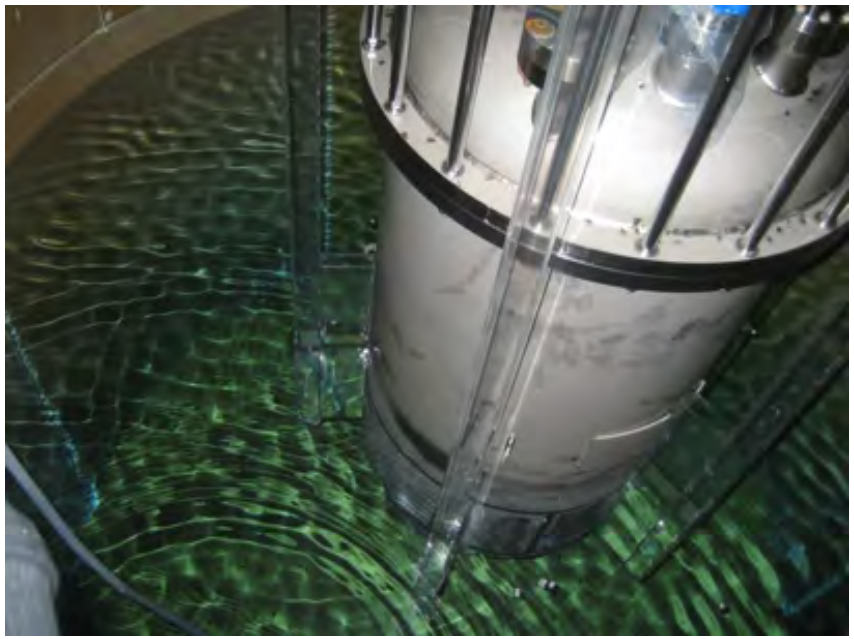
Deployment: July 31 - Aug 31, 2011; Operation: Sep 1, 2011 - Feb 14, 2012

>100 days - stable operation

LUX Surface Run at Homestake

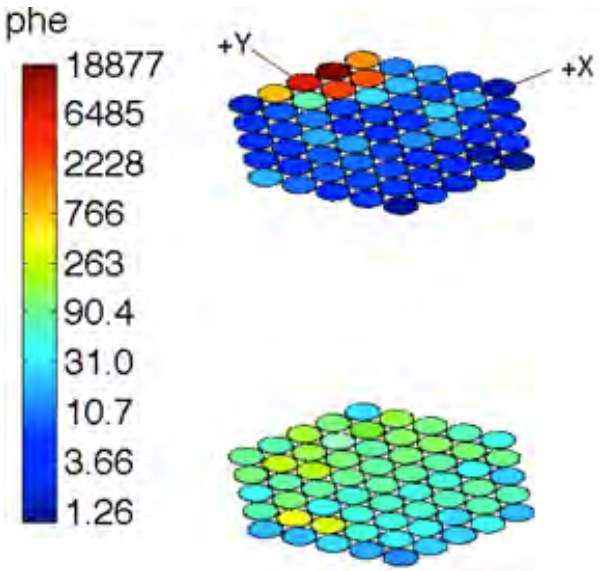
- Stable cryogenic operation for > 100 days
  - Ended on Feb 2012, to prepare detector for underground
- First successful use of technologies proposed for tonne-scale detectors:
  - Biggest double phase Xe detector in operation: 350 kg, 122 PMTs
  - Low background Ti vessel, < 0.2 mBq/kg (arXiv:1112.1376)
  - Thermosyphon cooling
  - High flow Xe circulation (35 SLPM)
  - Full scale deployment in water tank



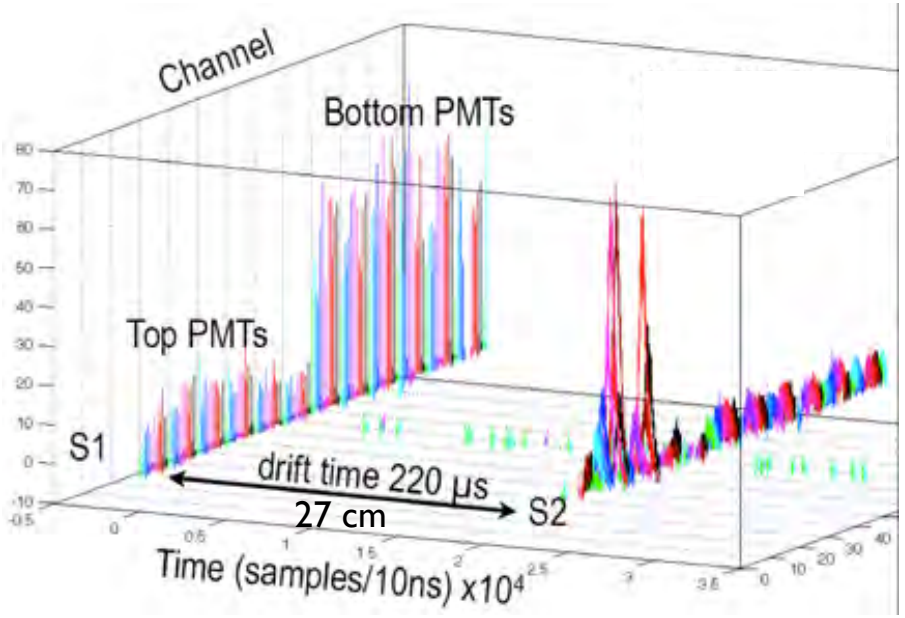


LUX Surface Run - Signals

- Functional trigger, DAQ, analysis chain:
  - 3 TB of data generated and processed - backgrounds and gamma source calibrations
  - Low gain PMT operation
- Light collection: ~ 8 phe/keV$_{ee}$, at center of detector, zero field (IDM talk by M. Szydagis)
- Xe purity measurements (Electron lifetime)
  - Muon tagging system using plastic scintillator panels
  - Alphas from ^{222}Rn injection (IDM talk by C. Faham)
  - External gammas sources: ^{137}Cs

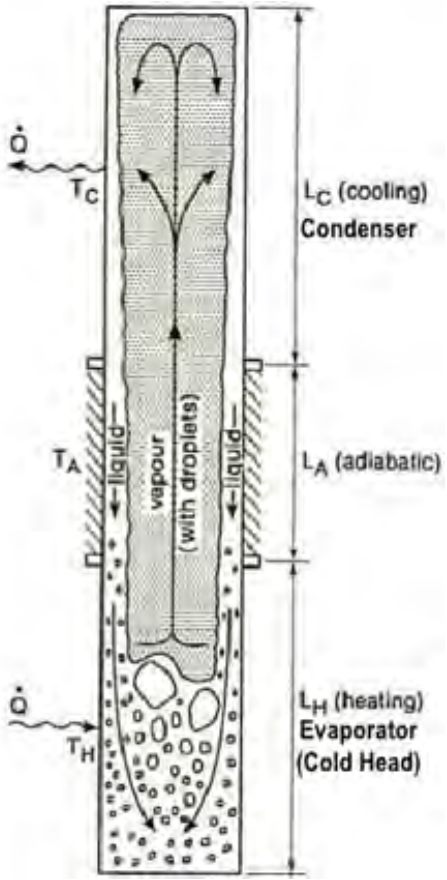


Sample event

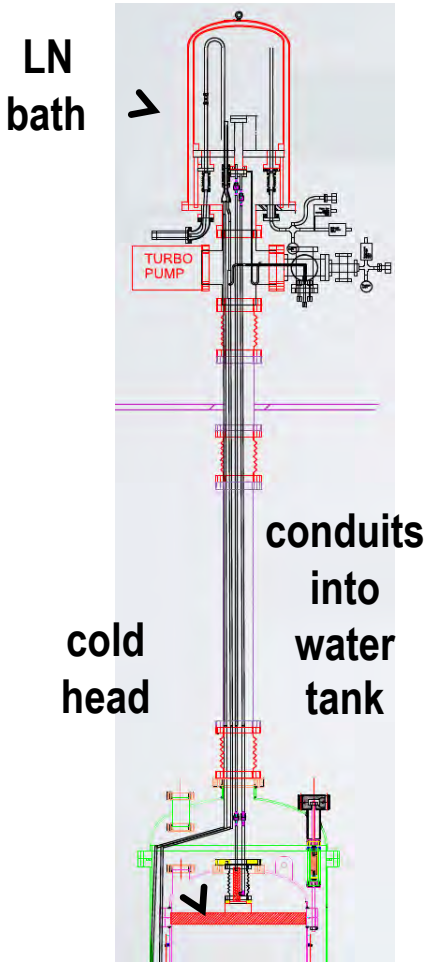


LUX Cooling system

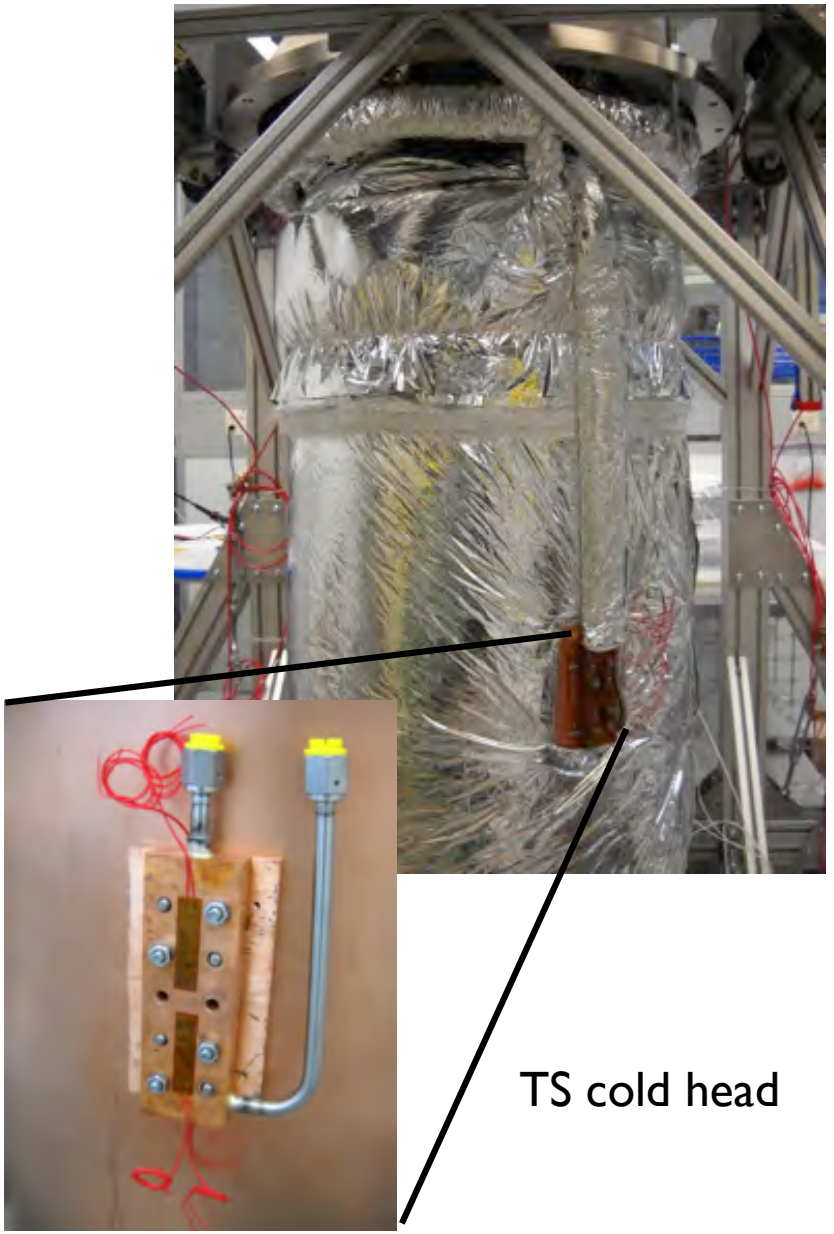
Thermosyphons



Thermosyphon principle



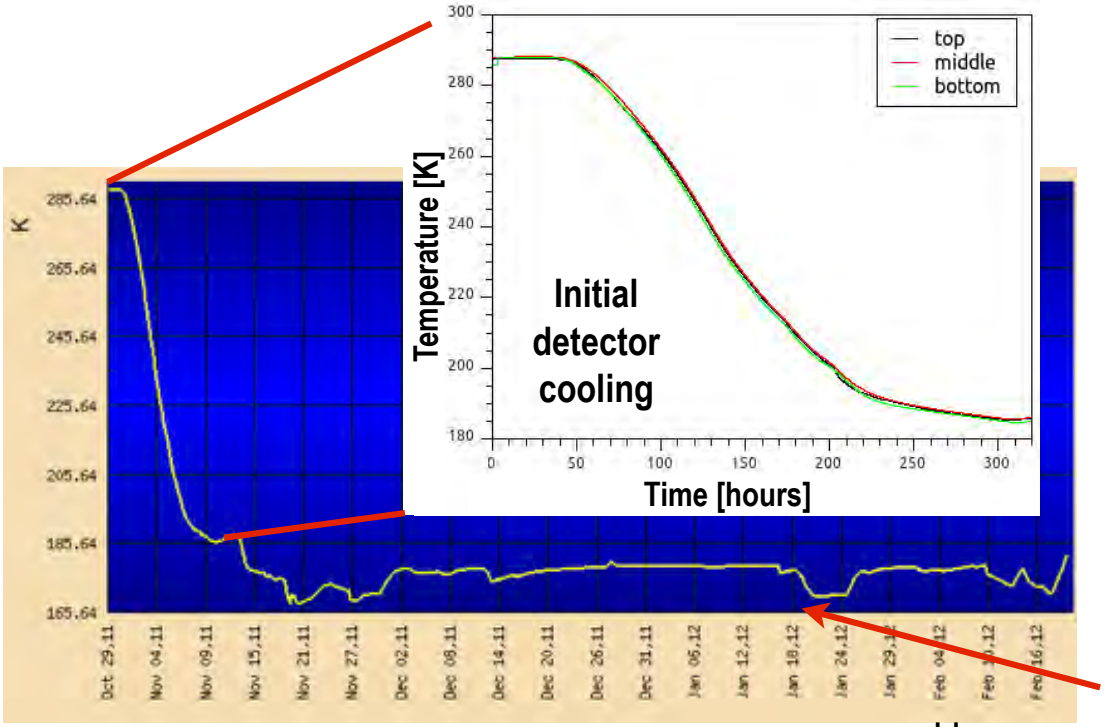
LUX thermosyphon

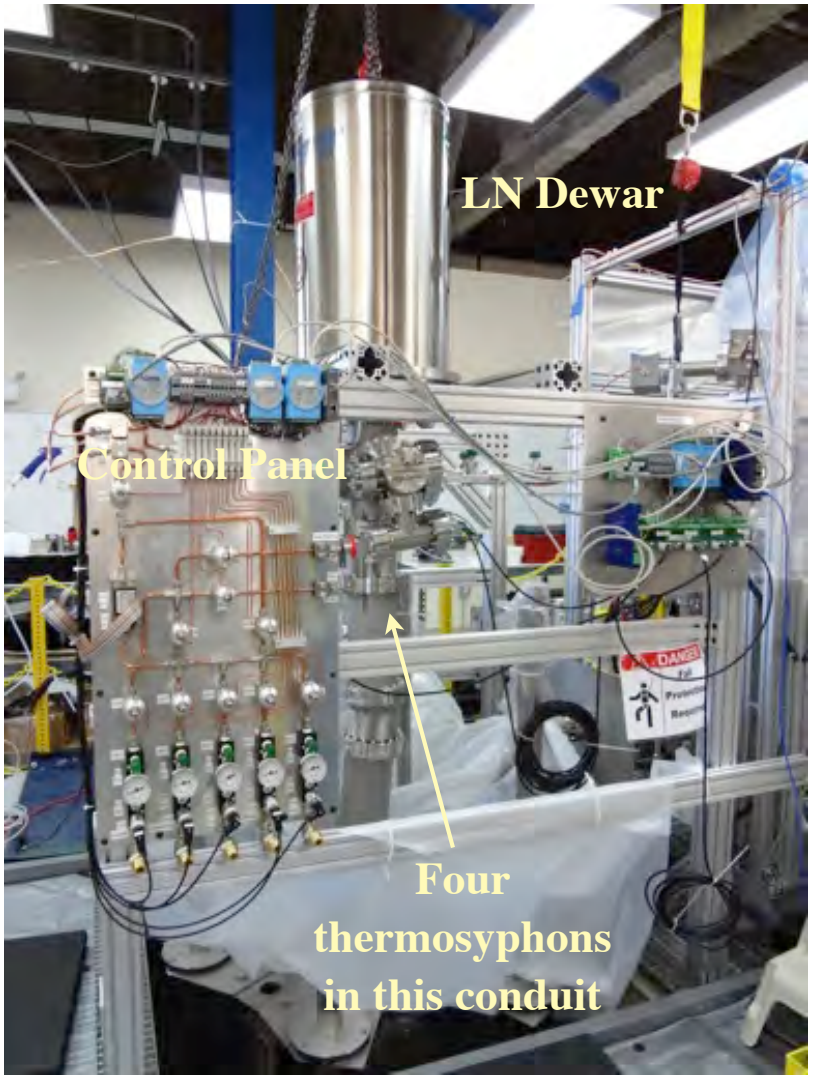


TS cold head

Cooling system: Thermosyphons

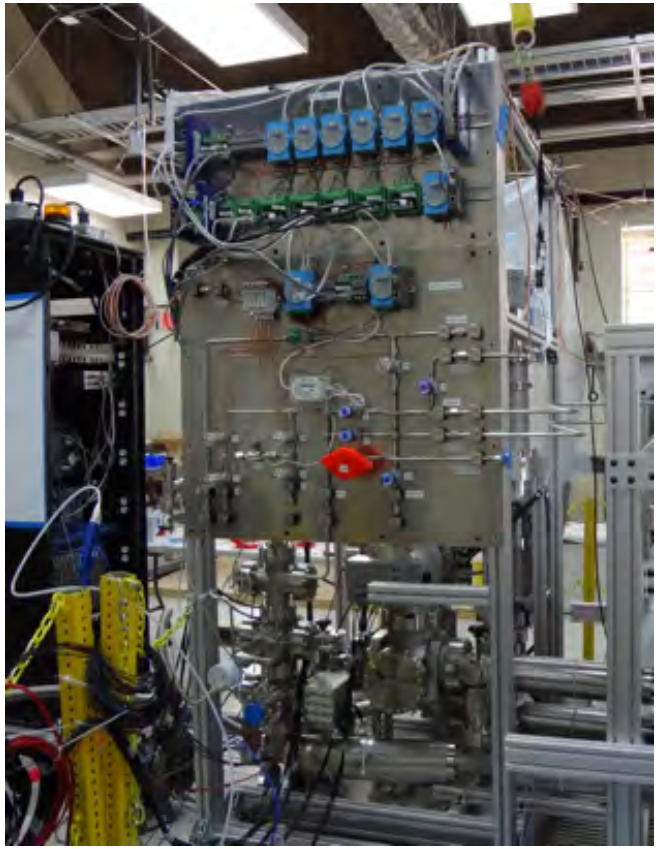
- Demonstrated cooling of ~800 kg (entire detector mass)
- Uniquely suitable for very large scale
  - Extremely high capacity: ~ kW
  - Multiple cold heads
  - Tunable at low power
  - Insensitive to loss of electricity



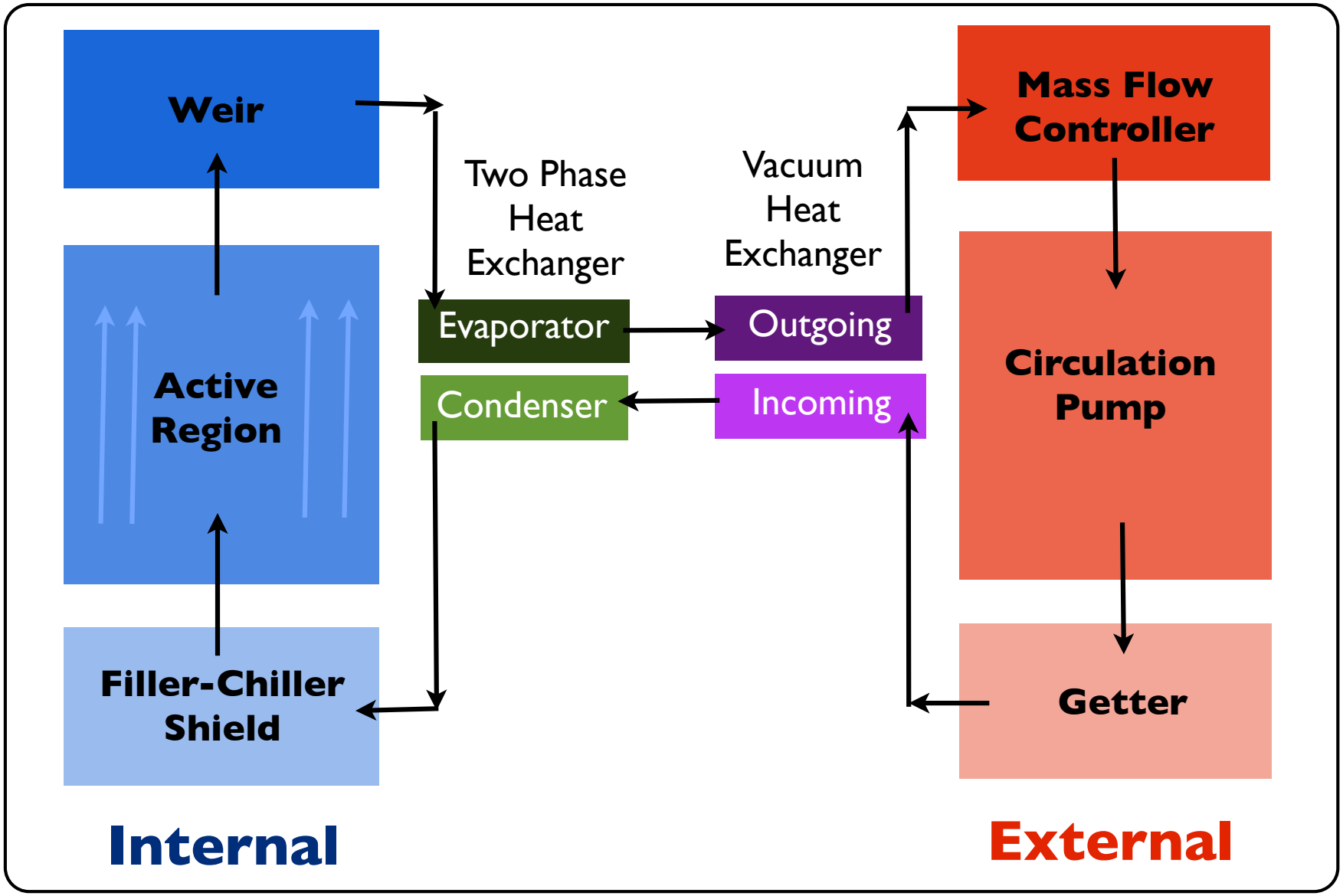


Xenon Circulation: 300 kg/day

- Well instrumented
  - 15 Pressure sensors
  - 60 Thermometers
  - 9 Level sensors
  - 5 Mass flow controllers
- 3 heat exchangers in flow path
- High flow plumbing and getter
- In-situ Xenon purity analysis
- Technology scalable to tonne-scale detectors

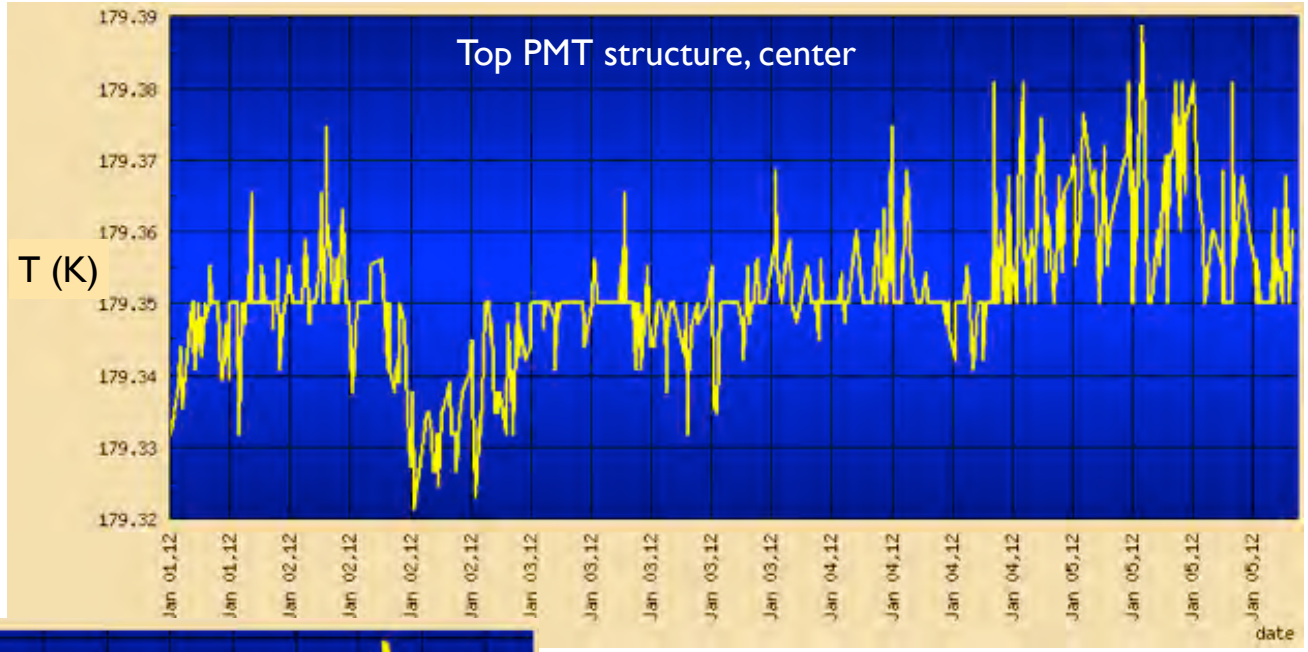


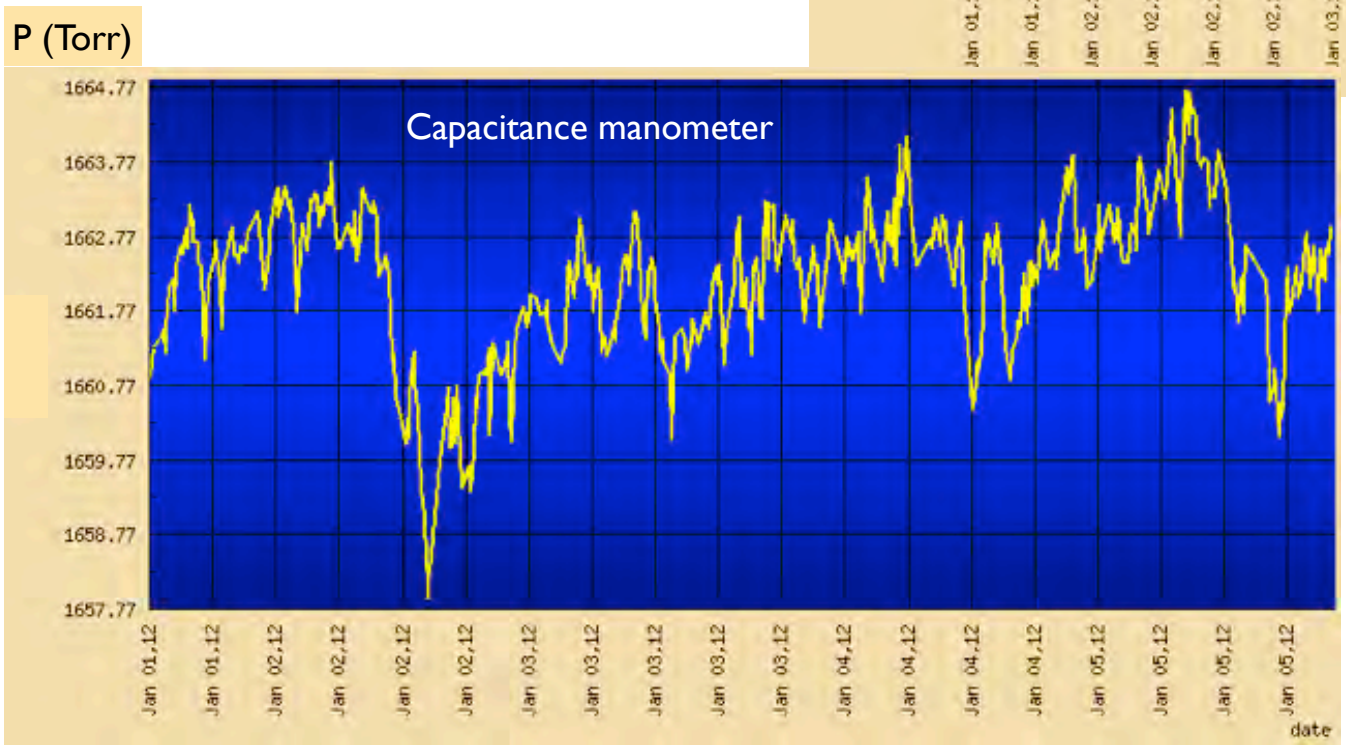
Xenon Circulation



LUX Surface Run - Highlights

Temperature stability:
$\Delta T \sim 0.06K$

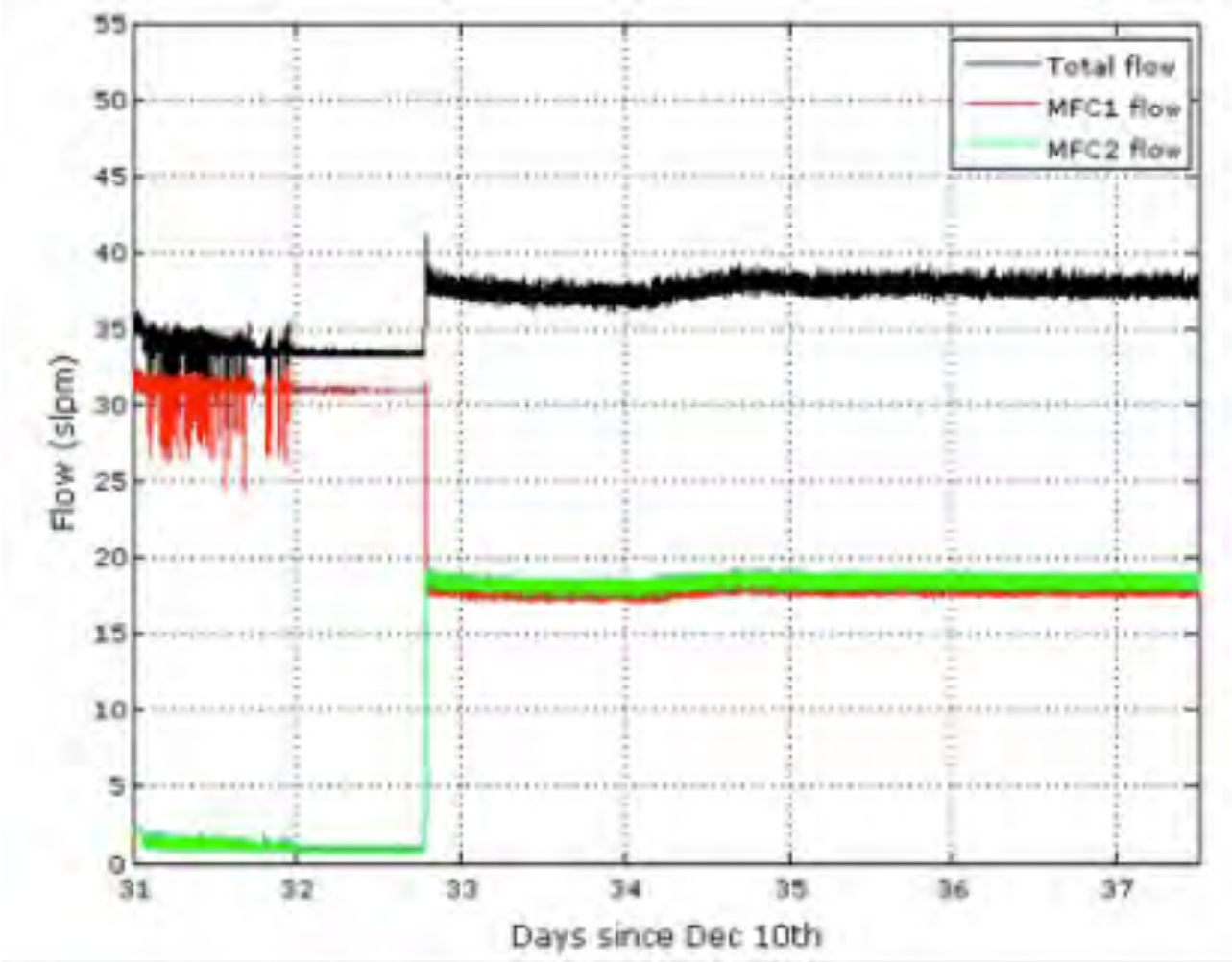




Pressure stability:
$\Delta P \sim 0.4\%$

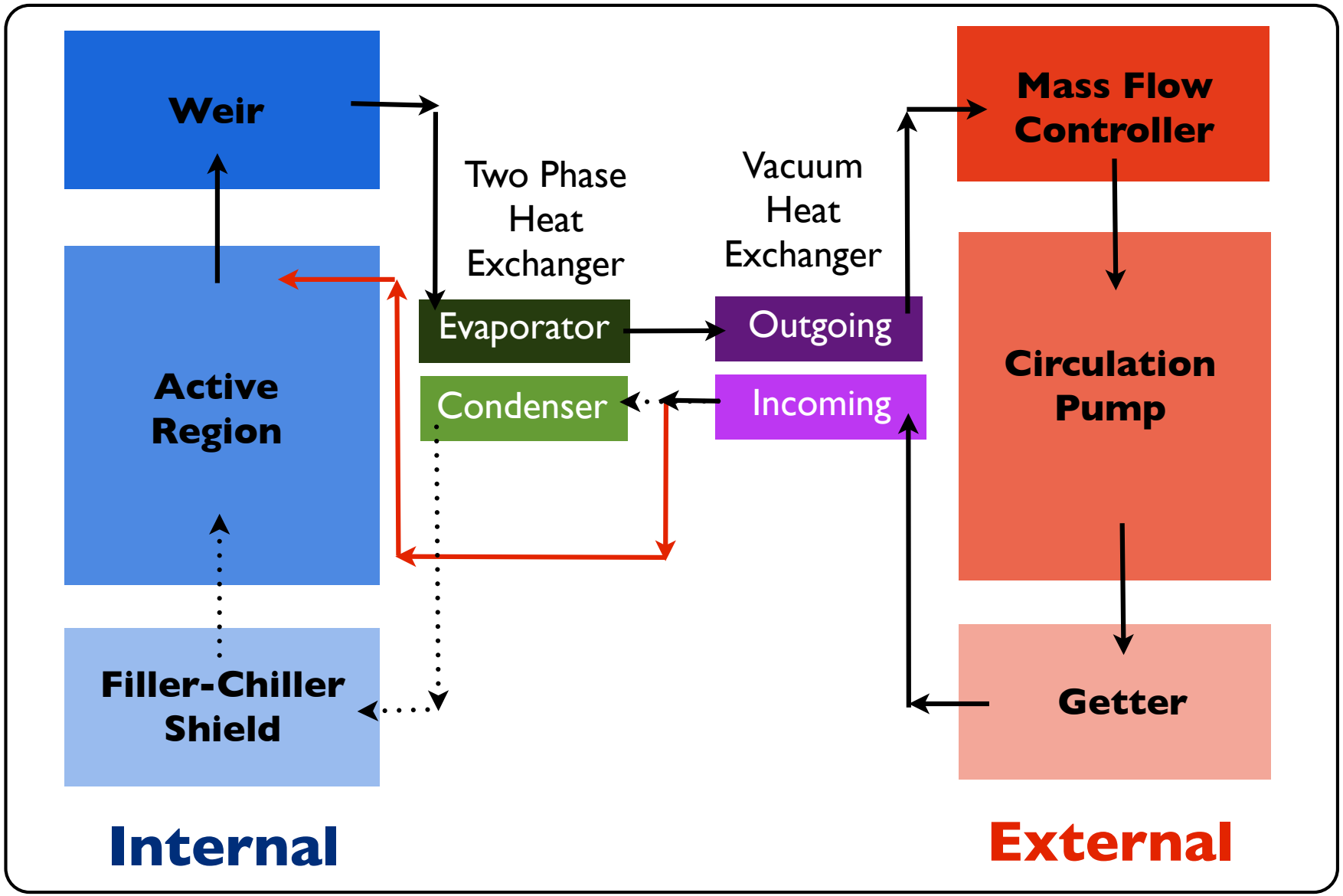
LUX Surface Run - Highlights

Circulated stably at ~35 SLPM (300 kg/day)



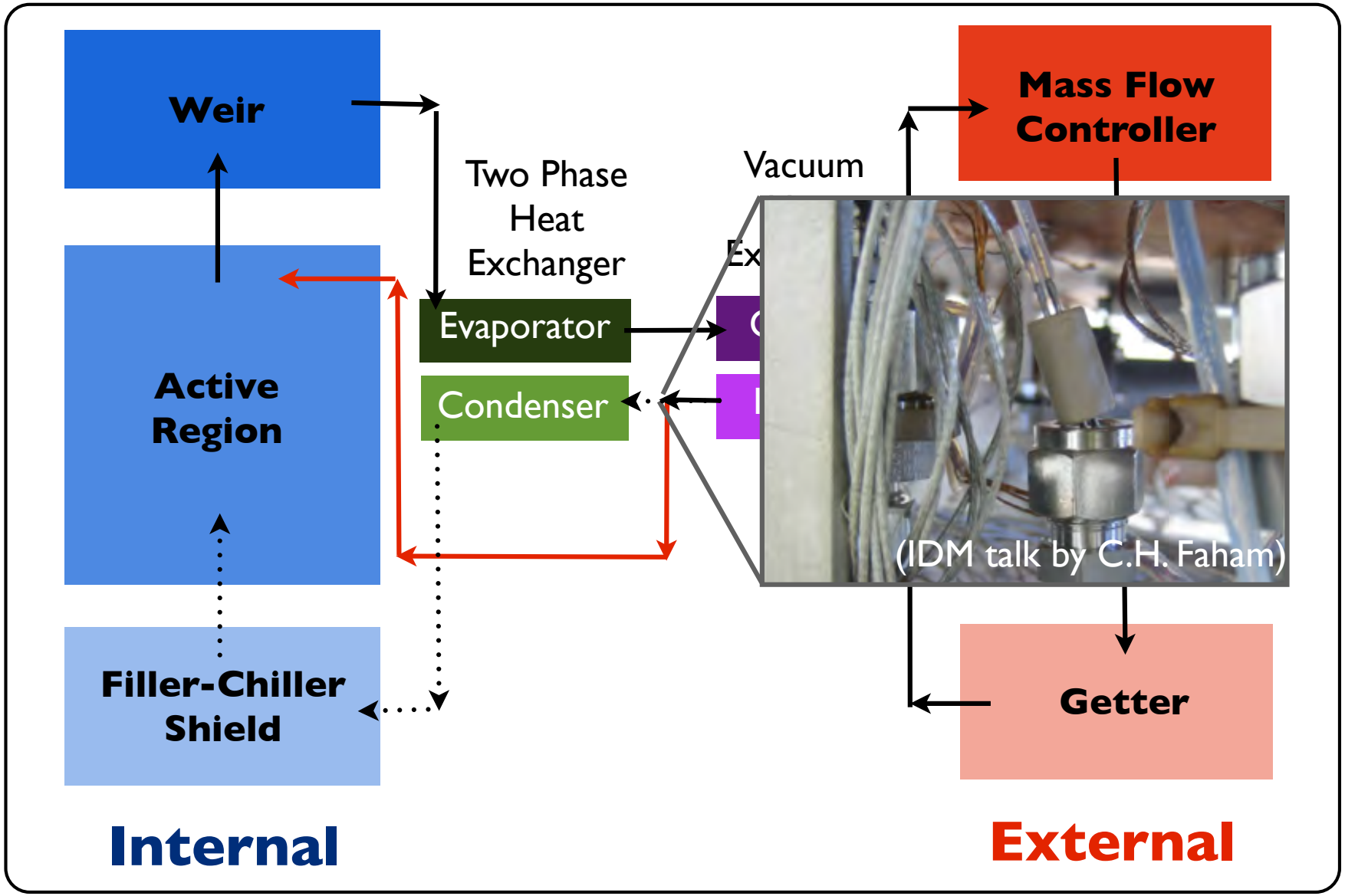
Xenon Circulation

Surface run circulation path



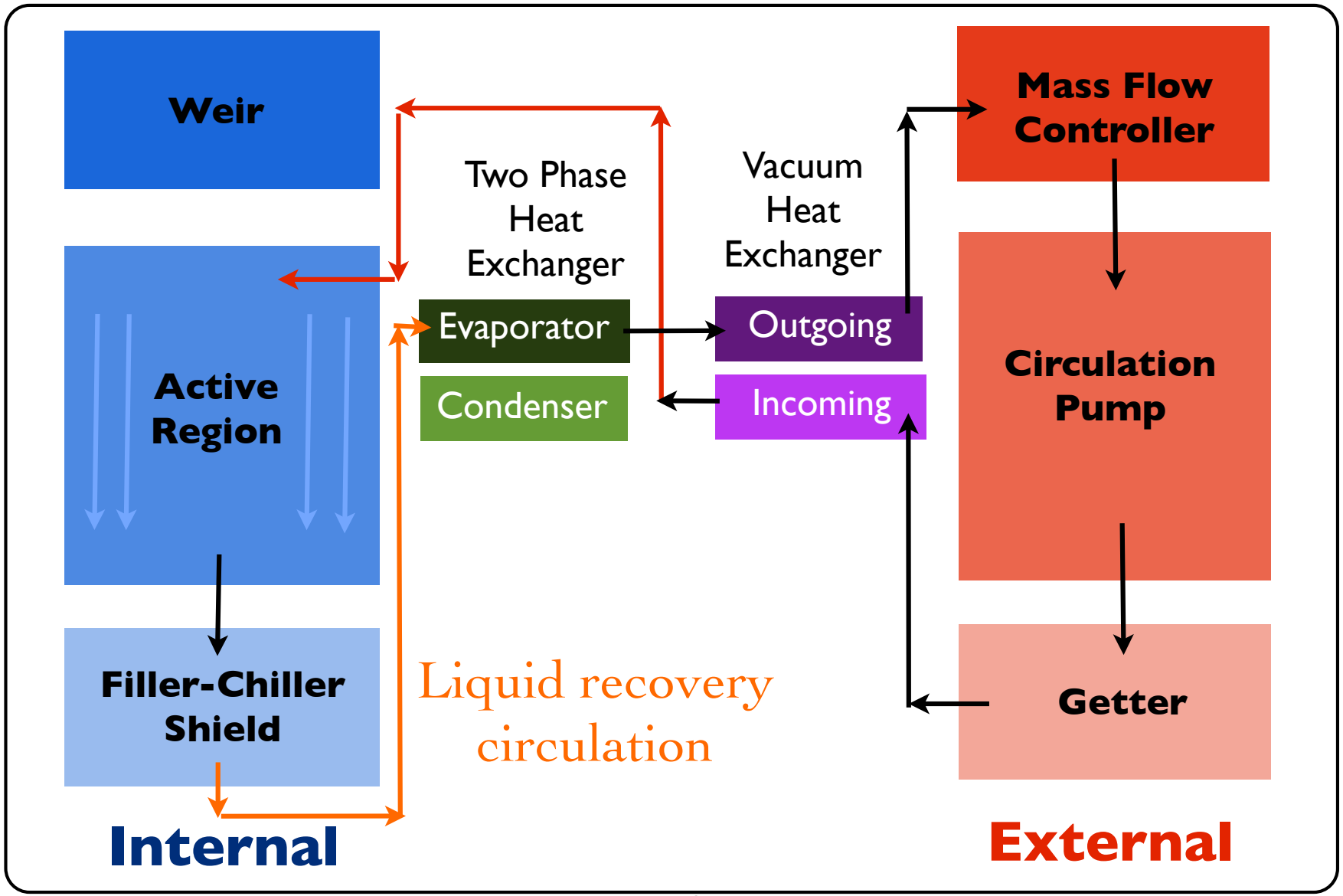
Xenon Circulation

Surface run circulation path

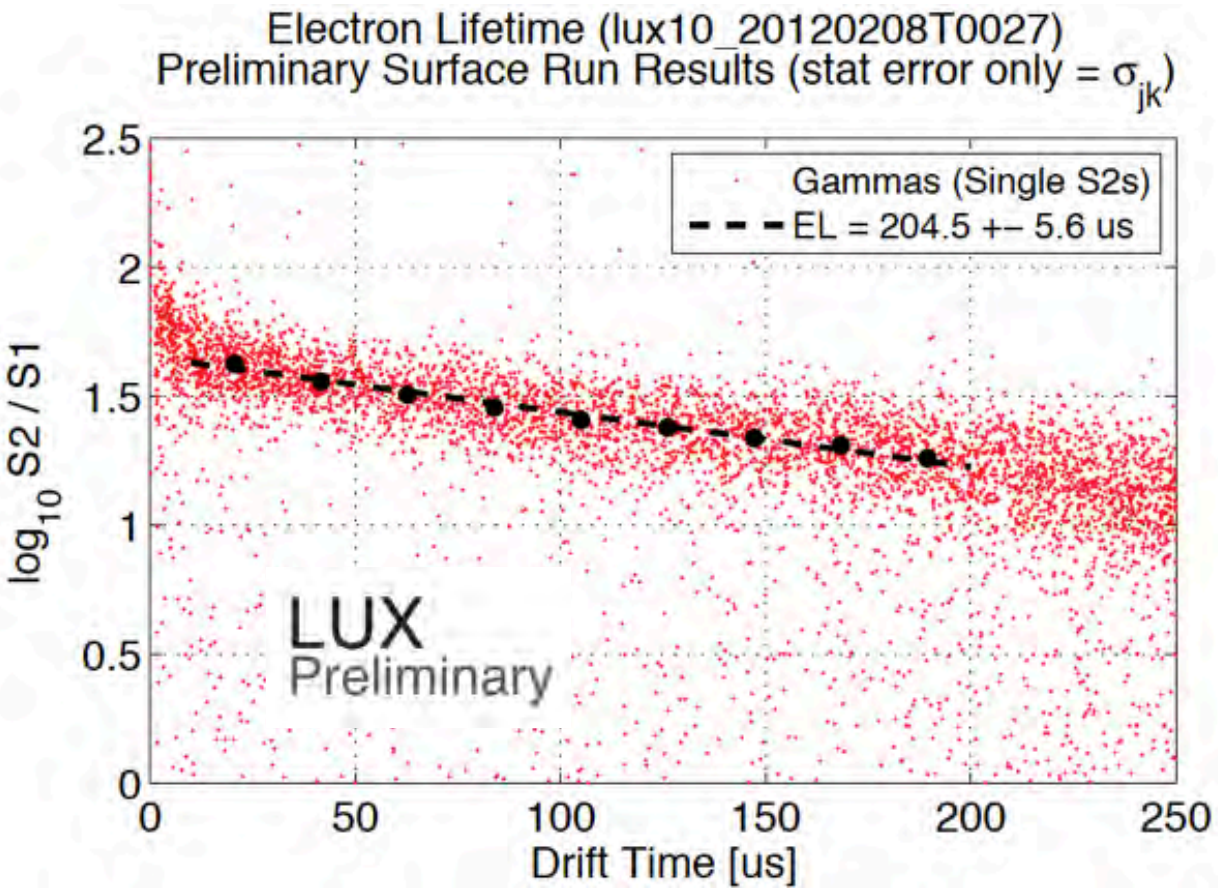


Xenon Circulation

Recover full active region

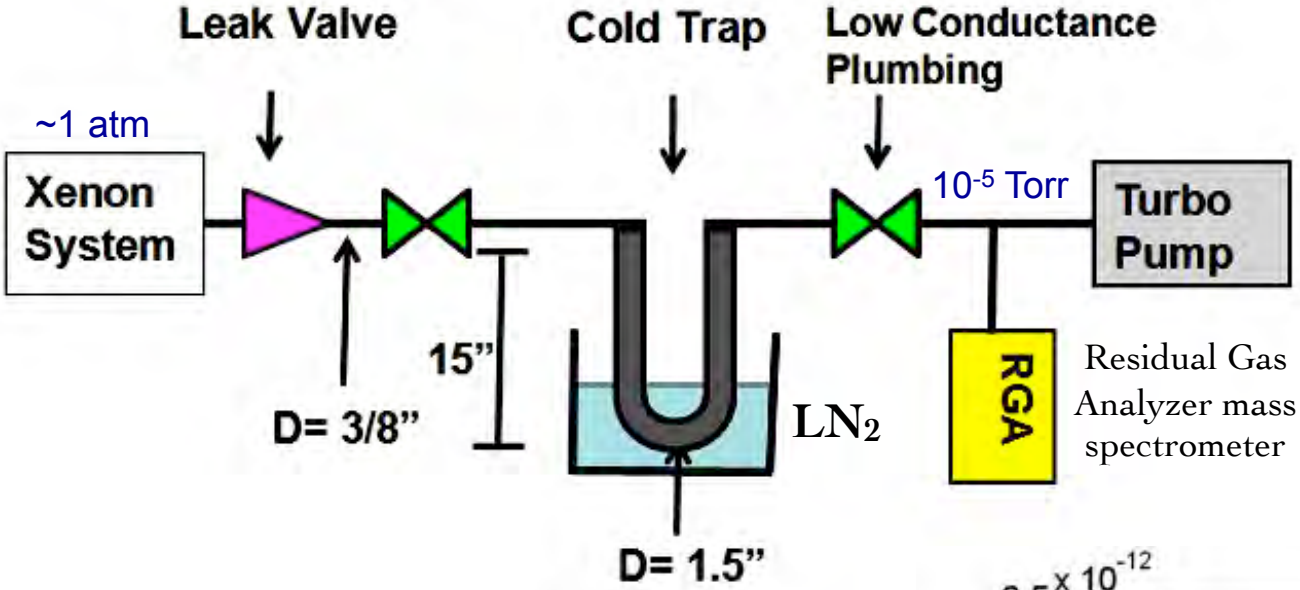


LUX Surface Run - Electron Lifetime



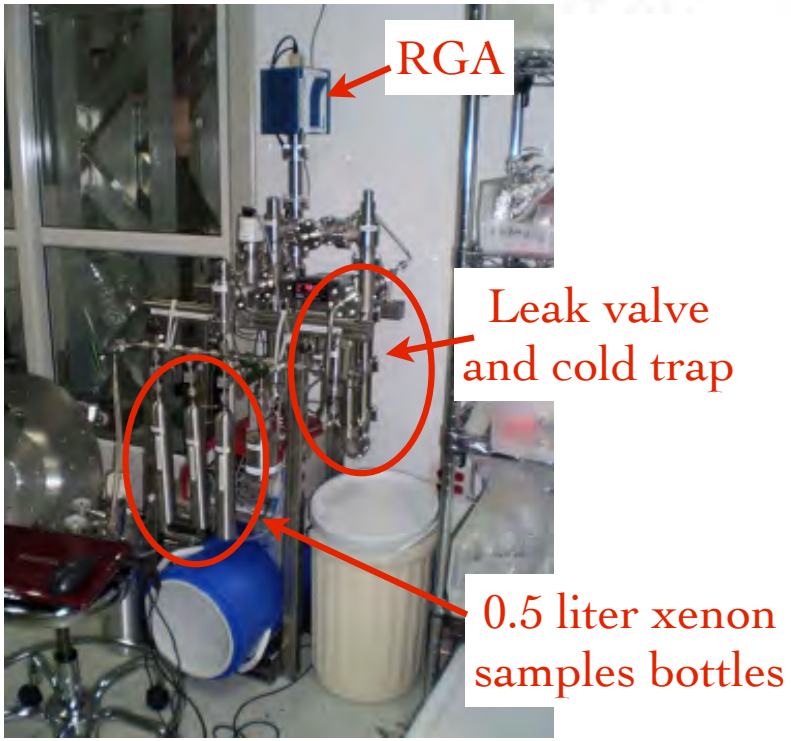
Measured by gammas:
204 μs electron lifetime
(25 cm drift length)

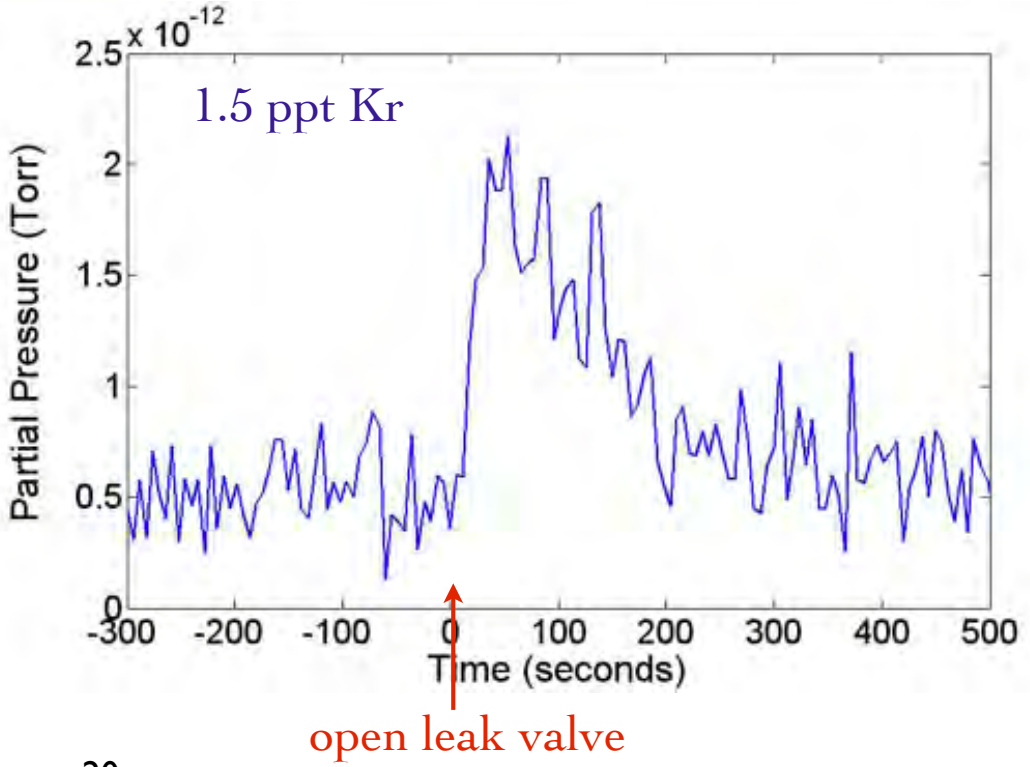
New analytic technique to detect krypton at the ppt level



In-situ residual monitoring:
0.7 ppb O2 mol/mol
0.5 ppt Kr mol/mol

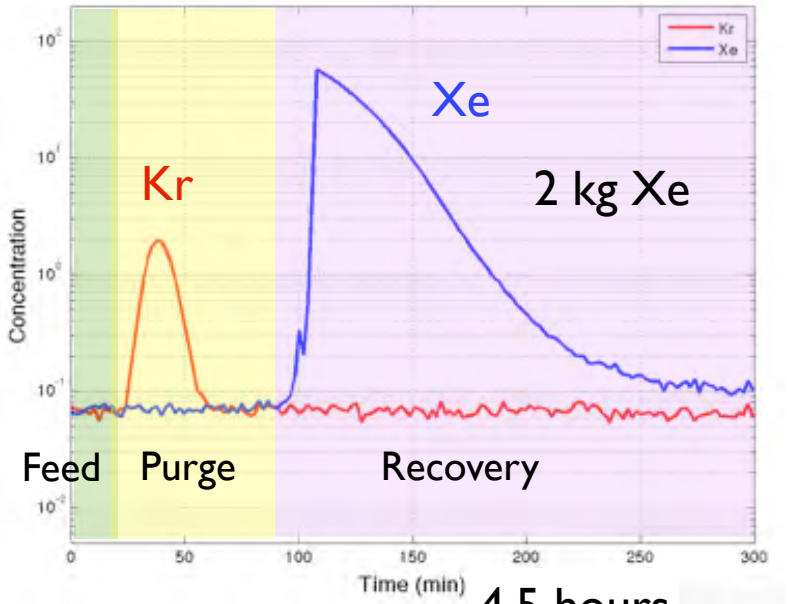
LUX group at Maryland
A. Dobi, et al., arXiv:1103.2714v1





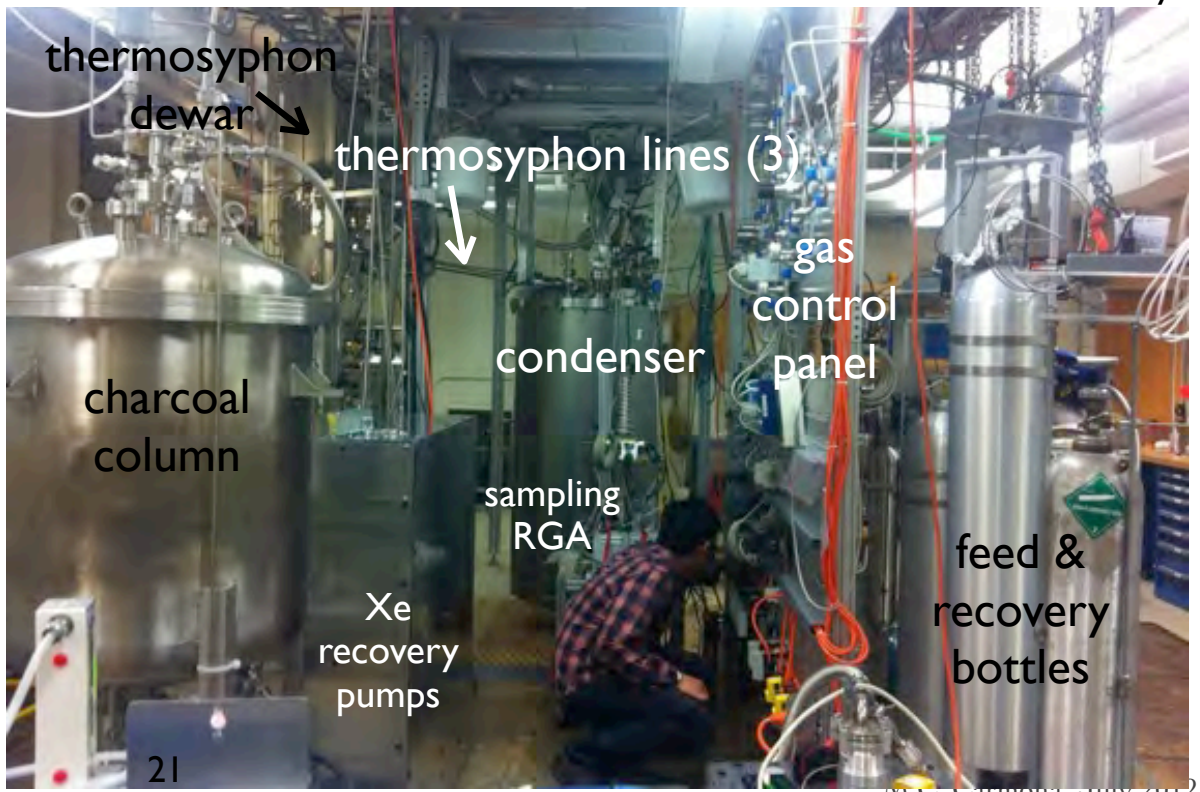
Krypton Removal System

- ^{85}Kr - beta decay
- Chromatographic separation system
  - Goal: < 5 ppt (purchased xenon 100 ppb)
  - New system built at CWRU
  - 400 kg of Xe in ~ 2 months



4.5 hours

Case Western Reserve University



Underground Deployment

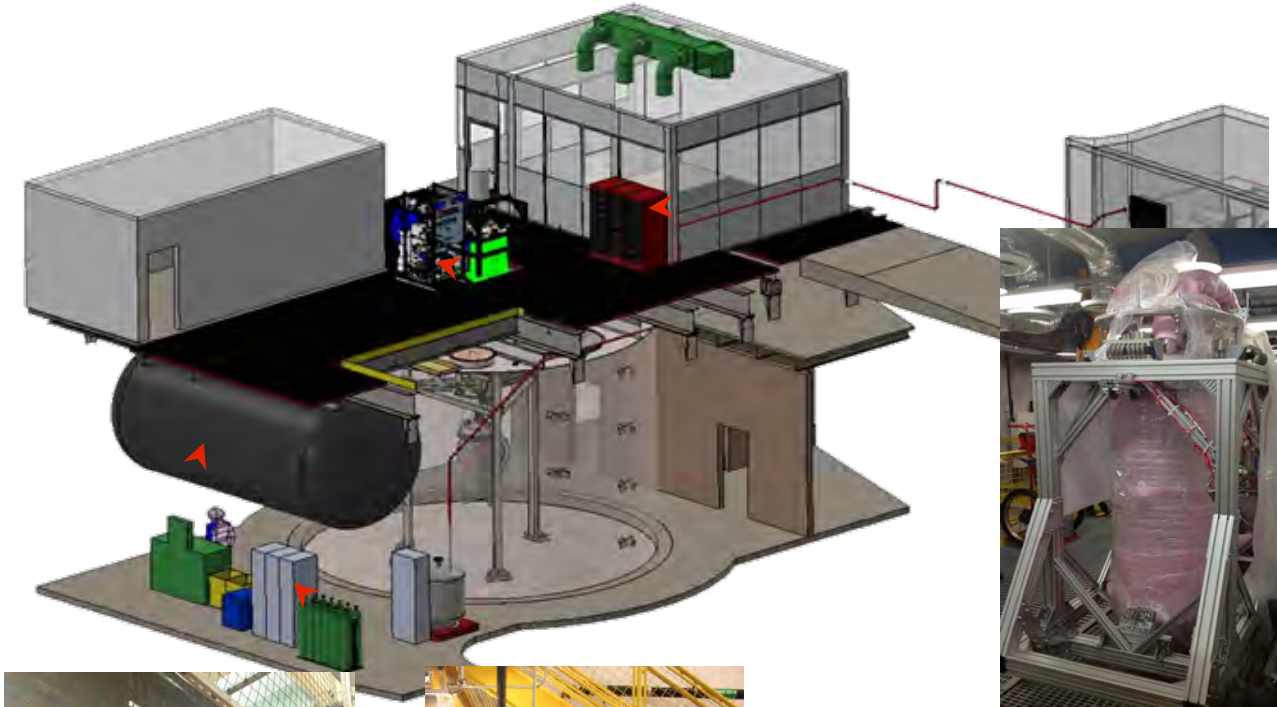
Current Status

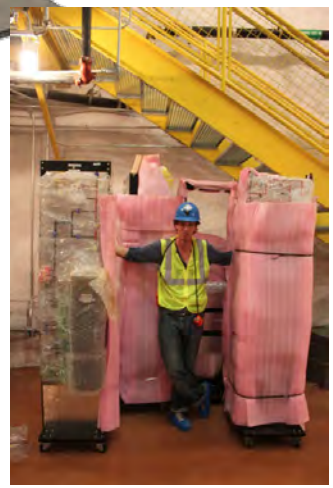
LUX was successfully moved UG two weeks ago!!

Water Tank Veto

Underground Deployment

Current Status





- Davis Cavern now fully occupied by LUX
- Most major subsystems now underground
- Installation of subsystems underway
- First data by the end of the year

On-site this morning

On-site this morning

Thank you!