



CASE WESTERN RESERVE
UNIVERSITY EST. 1826



LUX CRYOGENICS AND CIRCULATION

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TIPP2011

DETECTING GALACTIC WIMP DARK MATTER

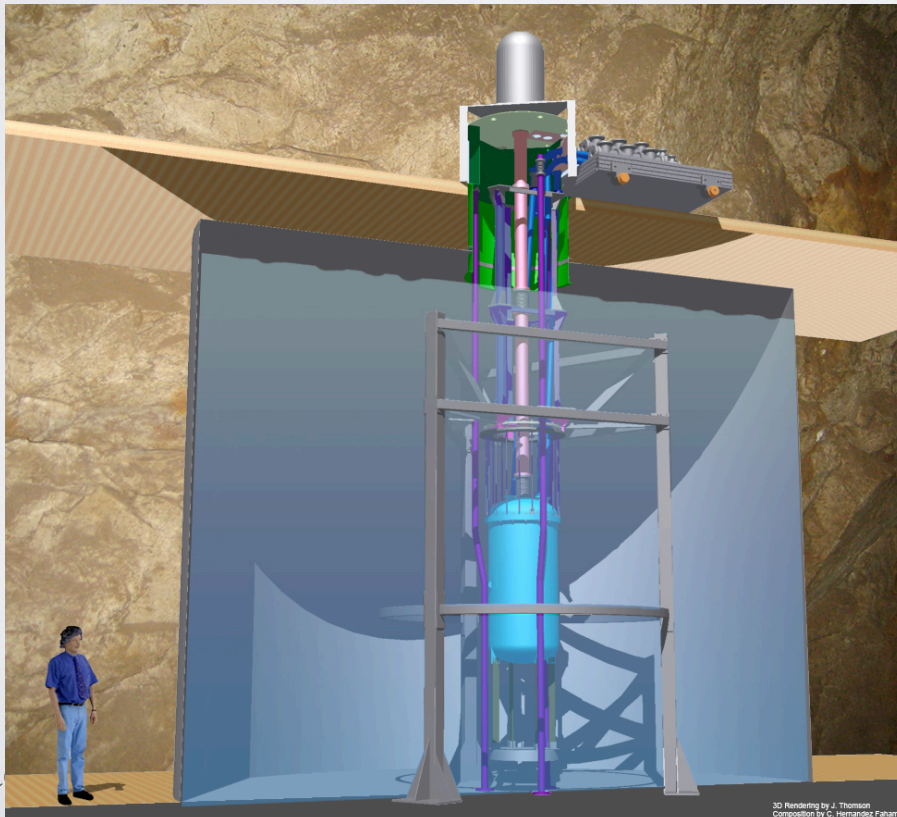
- Dark Matter “halo” surrounds all galaxies, including ours
- Density at earth:
 - $\rho \sim 300 \text{ m}_{\text{proton}}/\text{liter}$
 - $m_{\text{WIMP}} \sim 100 \text{ m}_{\text{proton}}$
- Typical orbital velocity:
 - $v \sim 230 \text{ km/s} \sim 1 \text{ e-}3 \text{ speed of light}$
- Coherent scalar interactions: A^2



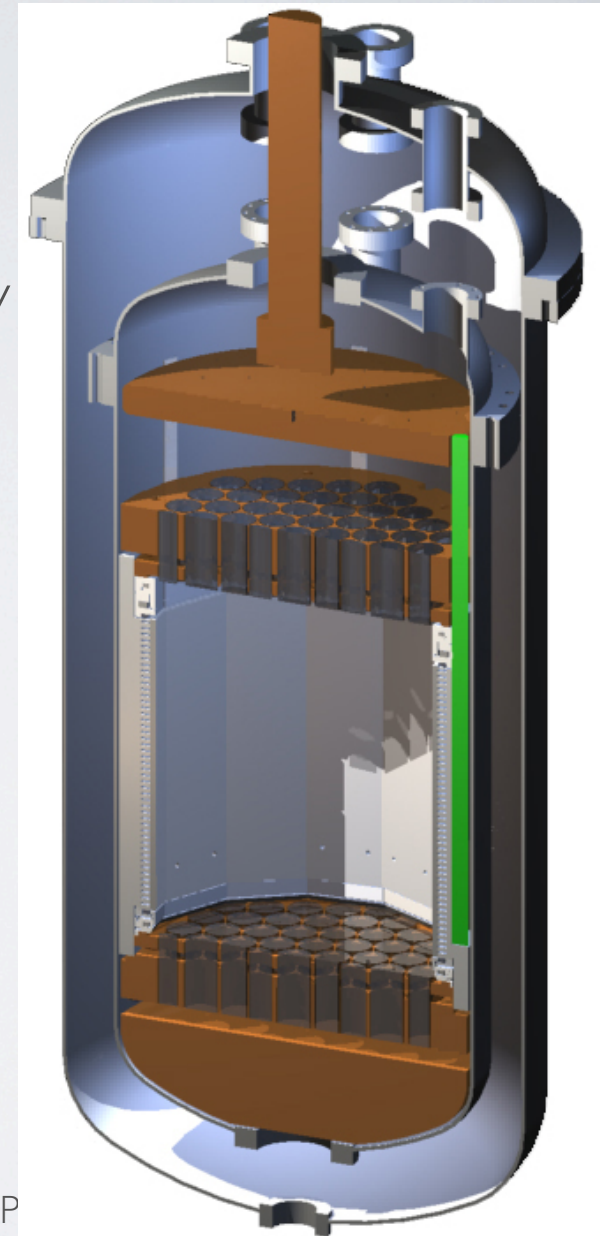
Rate: <0.06 events/kg/day, or much lower

LUX DETECTOR DESIGN

- 350-kg dual phase TPC
 - See M. Szydagi's talk next session
- 6 m x 8 m water tank for neutron shielding
- Instrumentation and cooling breakout meters away



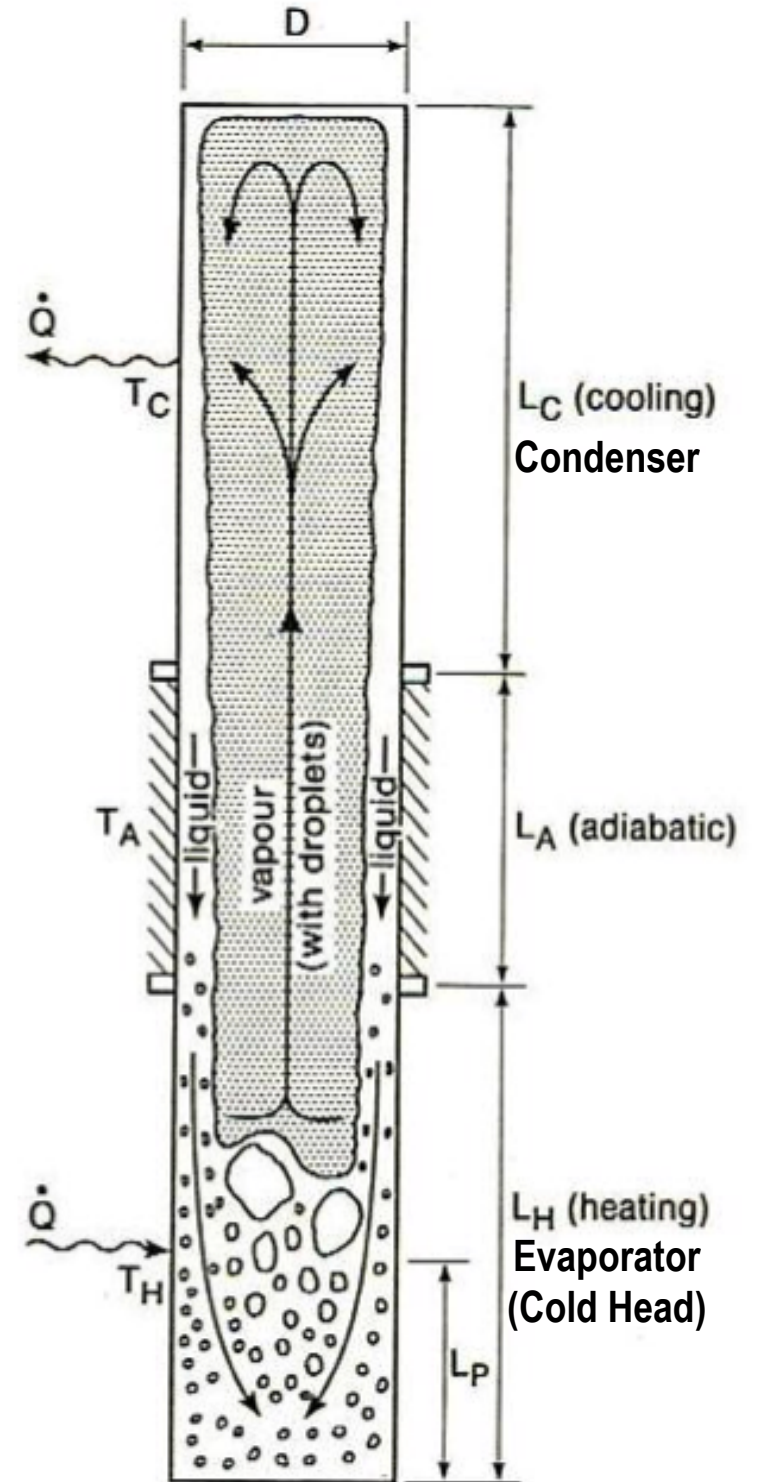
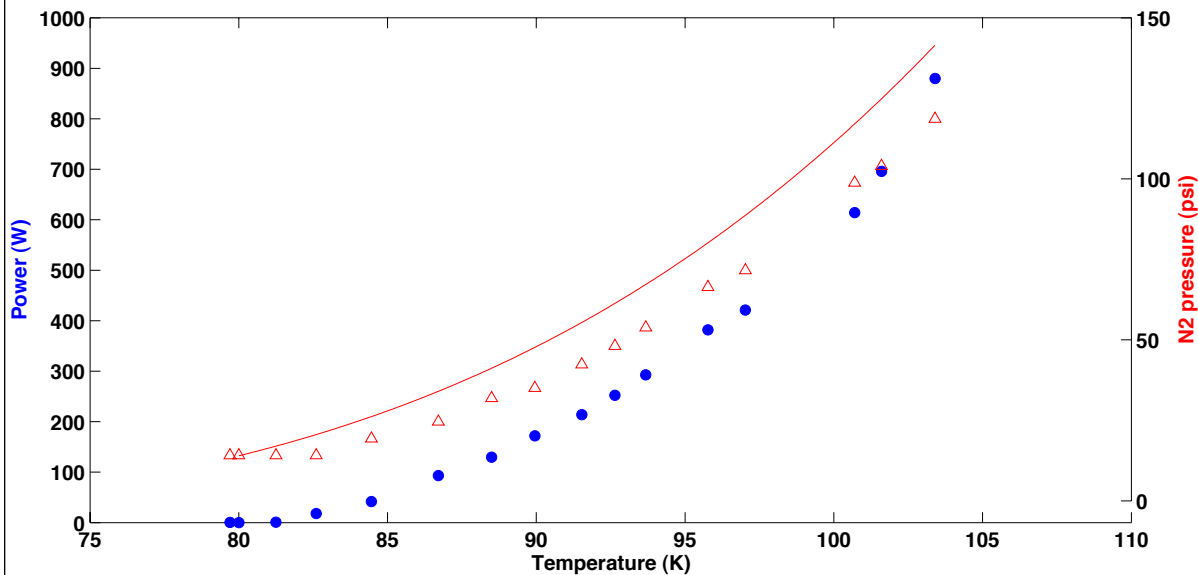
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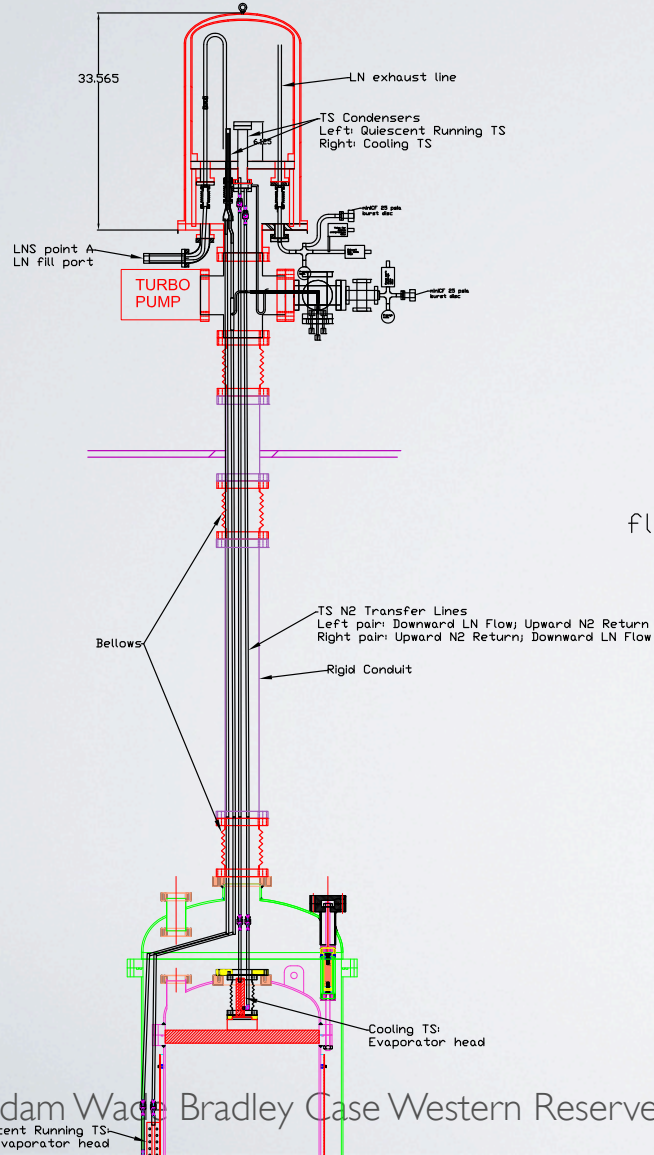
TIP

THERMOSYPHON CRYOGENICS

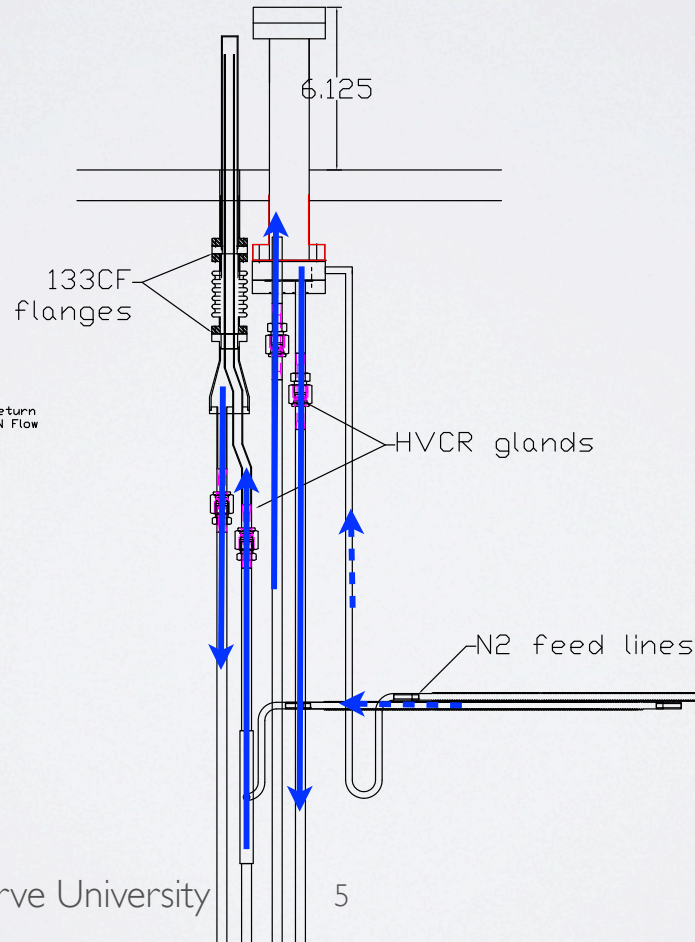
- Suitable for very large scale
 - ~kW capacity
 - Multiple cold head deployment
- Measured thermal conductivity
 - ~55 kW/K-m



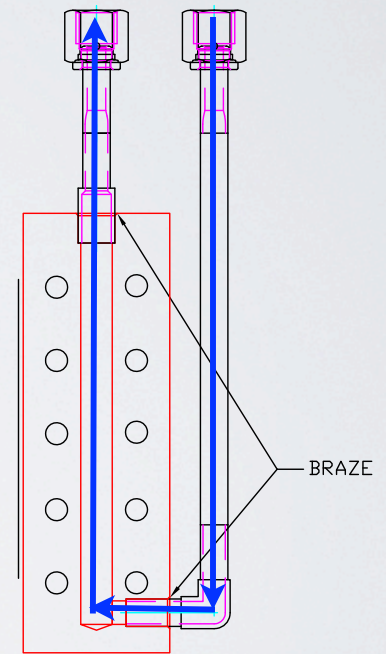
LUX THERMOSYPHON DEPLOYMENT



Condensers

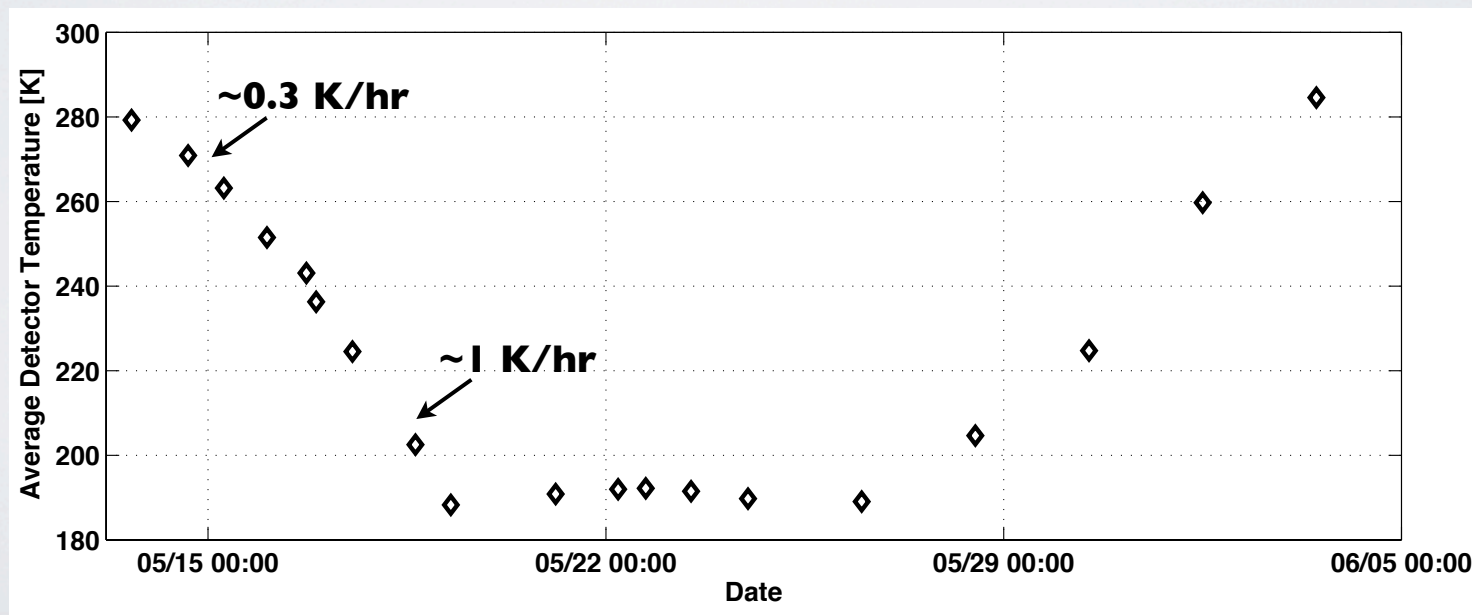


Evaporator



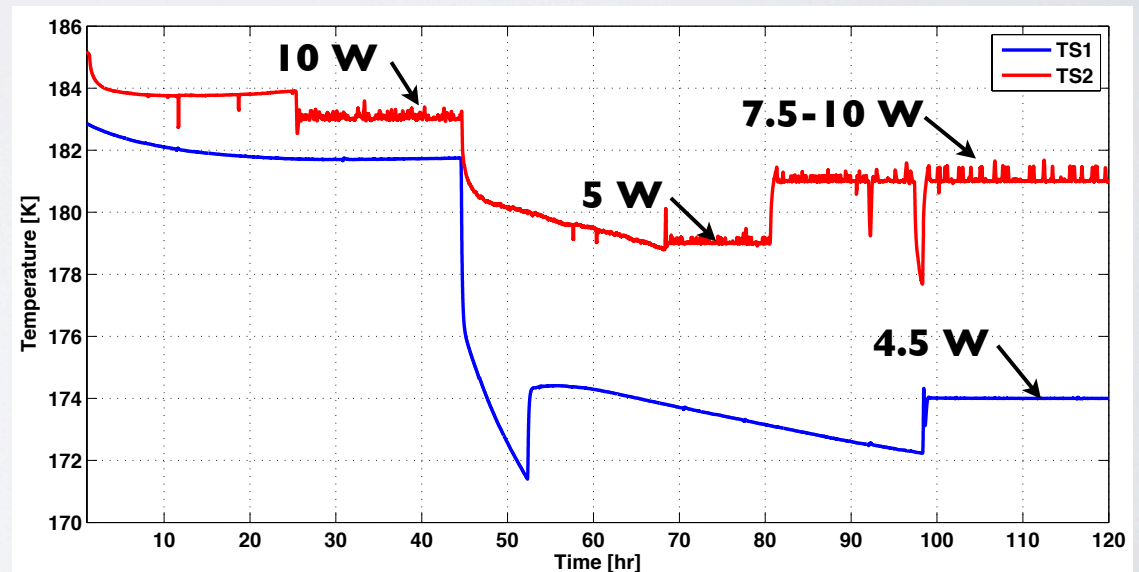
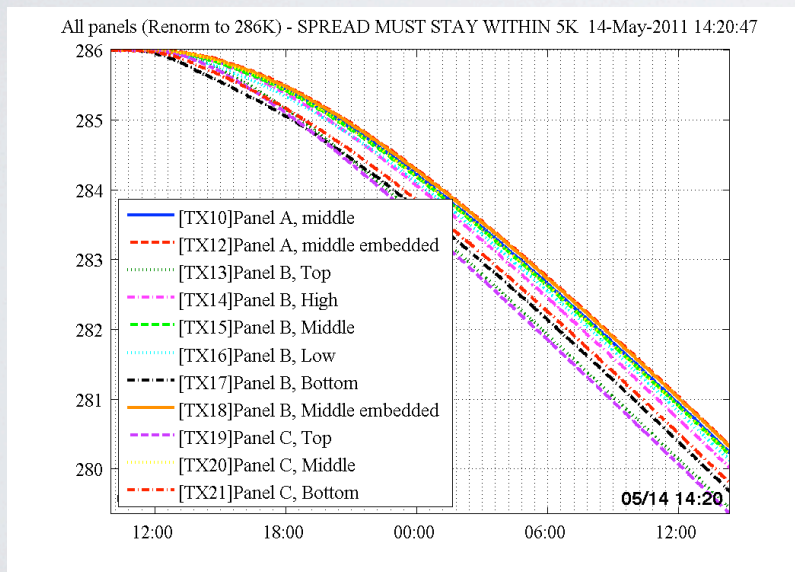
FIRST COOLDOWN OVERVIEW

- Slow and careful cooling with 1 atm Ar transfer gas
- Avoid gradients in HDPE and PTFE panels > 10 K vertically and 5 K radially
- Finely control thermosyphons and run stably at target temperature (~ 180 K)



COOLDOWN CHALLENGES

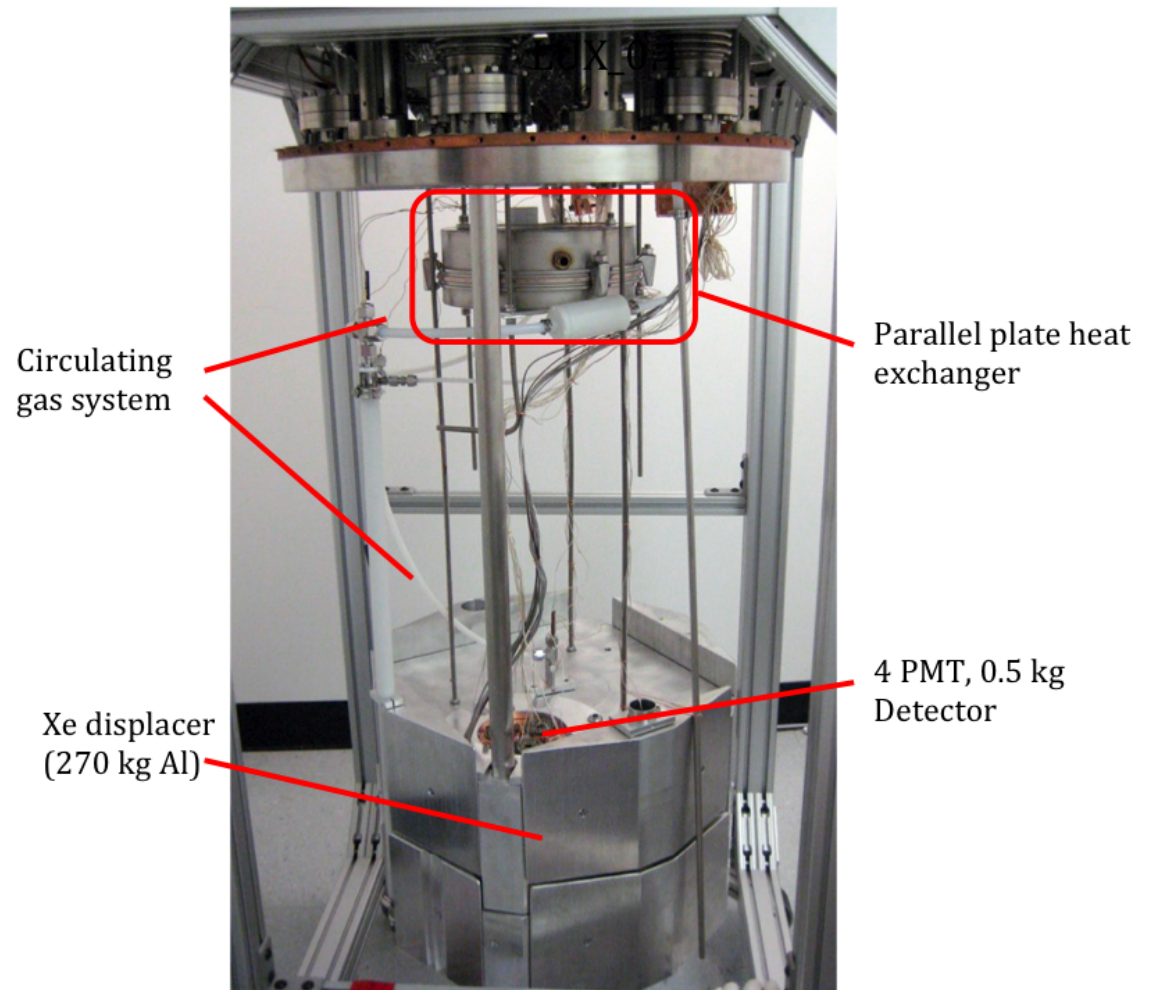
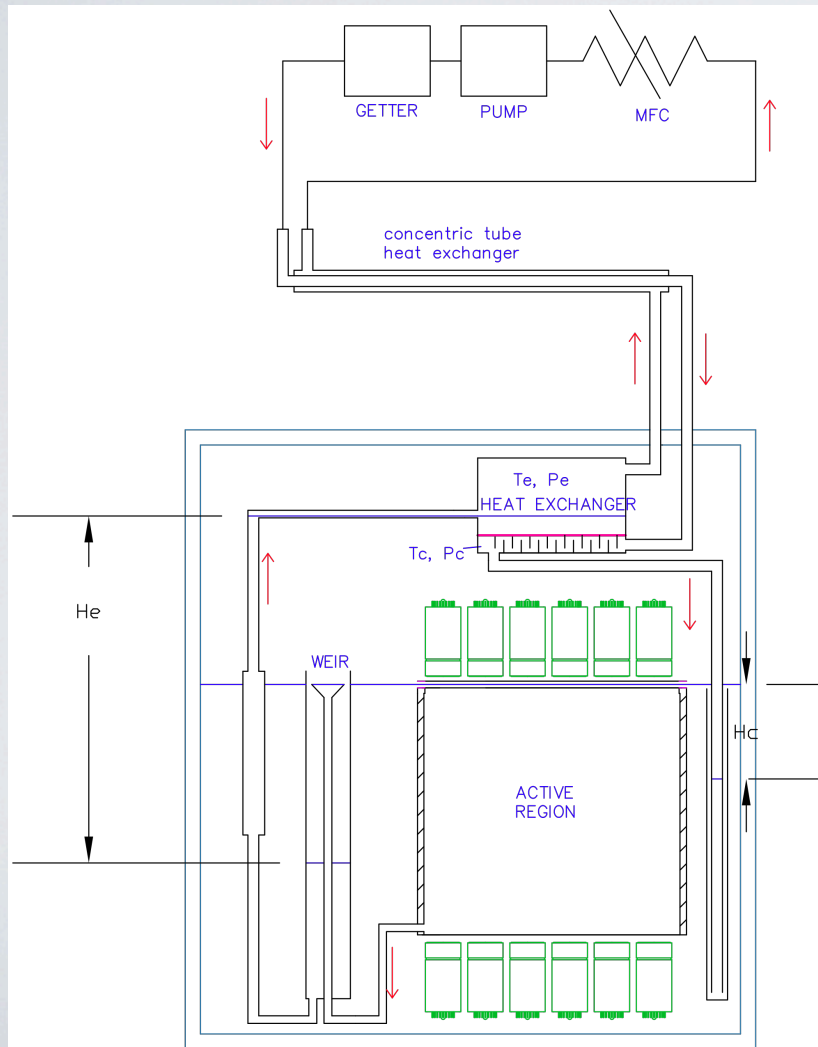
- Maintain safe plastic panel gradients while cooling as fast as possible
- Balance thermosyphon cooling power with heater control power



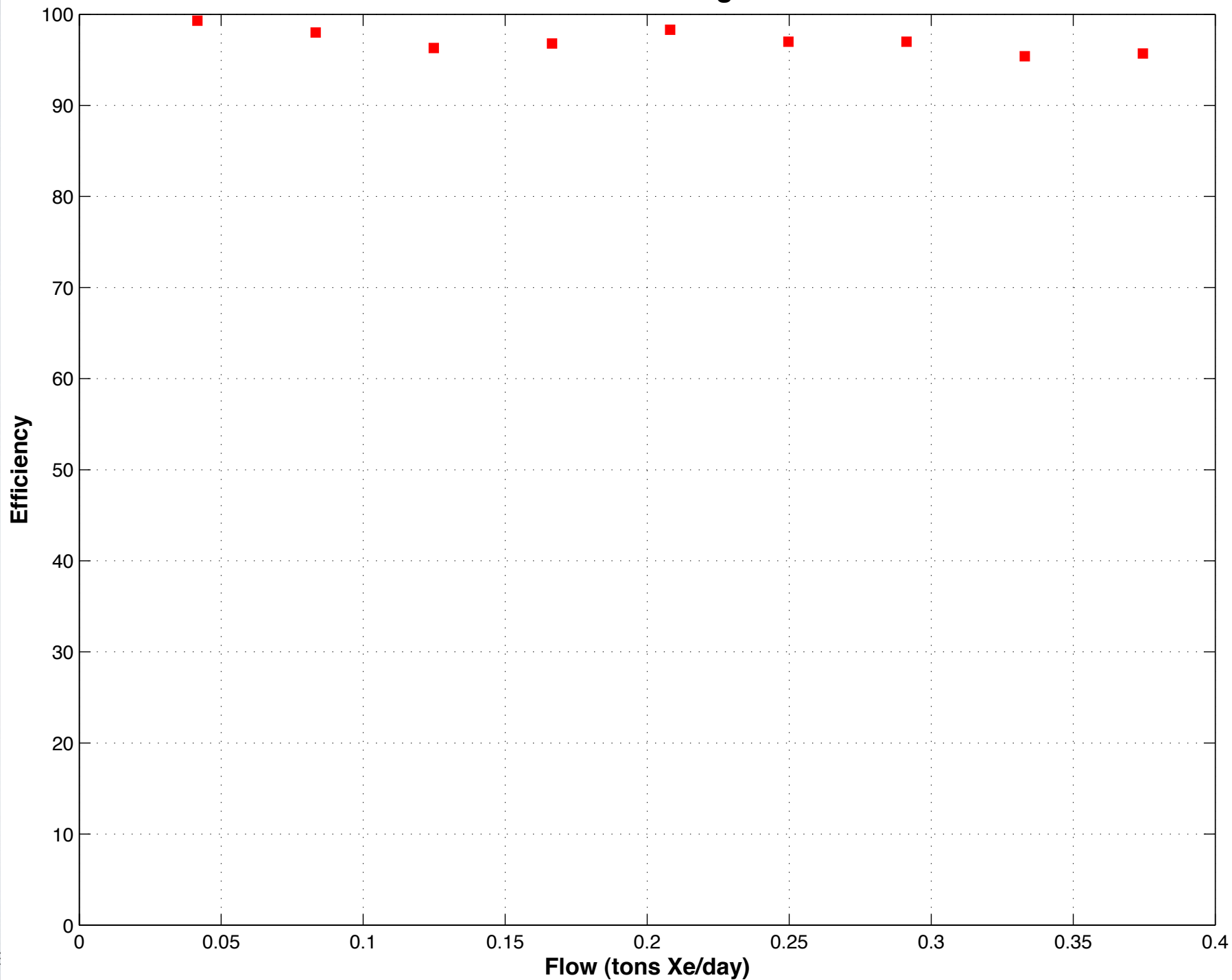
WHAT TO DO WITH EXCESS COOLING ABILITY?

- Circulate Xe to purify for electron drift
 - Desired circulation rate: 0.40 tons Xe/day (50 slpm)
- Gas phase purification technology - evaporate and recondense Xe
 - Cooling: 21 kJ/kg; Condensing: 93 kJ/kg
 - Condensation heat load: 454 W at full circulation rate

A BETTER SOLUTION: HEAT EXCHANGE!

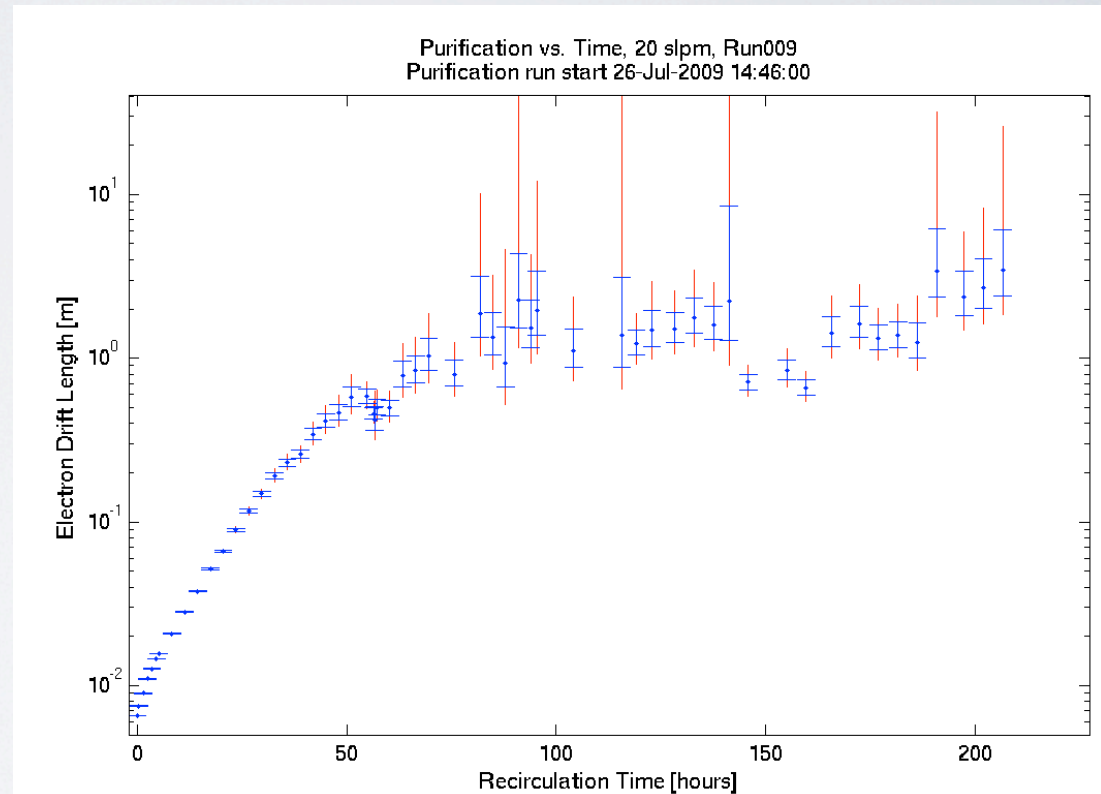


Demonstrated Heat Exchanger Performance



DEMONSTRATED HIGH CAPACITY PURITY

- Standard gas-phase getter + custom heat exchanger
- Method scalable to multi-ton Xe/day processing
- 2-m drift length in 60 kg Xe, achieved with unprecedented speed



CONCLUSIONS

- Successfully demonstrated thermosyphon cryogenics on full detector
- Prototype showed
 - Heat exchange $> 95\%$ efficient
 - Rapidly reached drift length > 2 m
- LUX Run02 this fall will test heat exchange and purity