Large Underground Xenon Experiment

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New Collaboration

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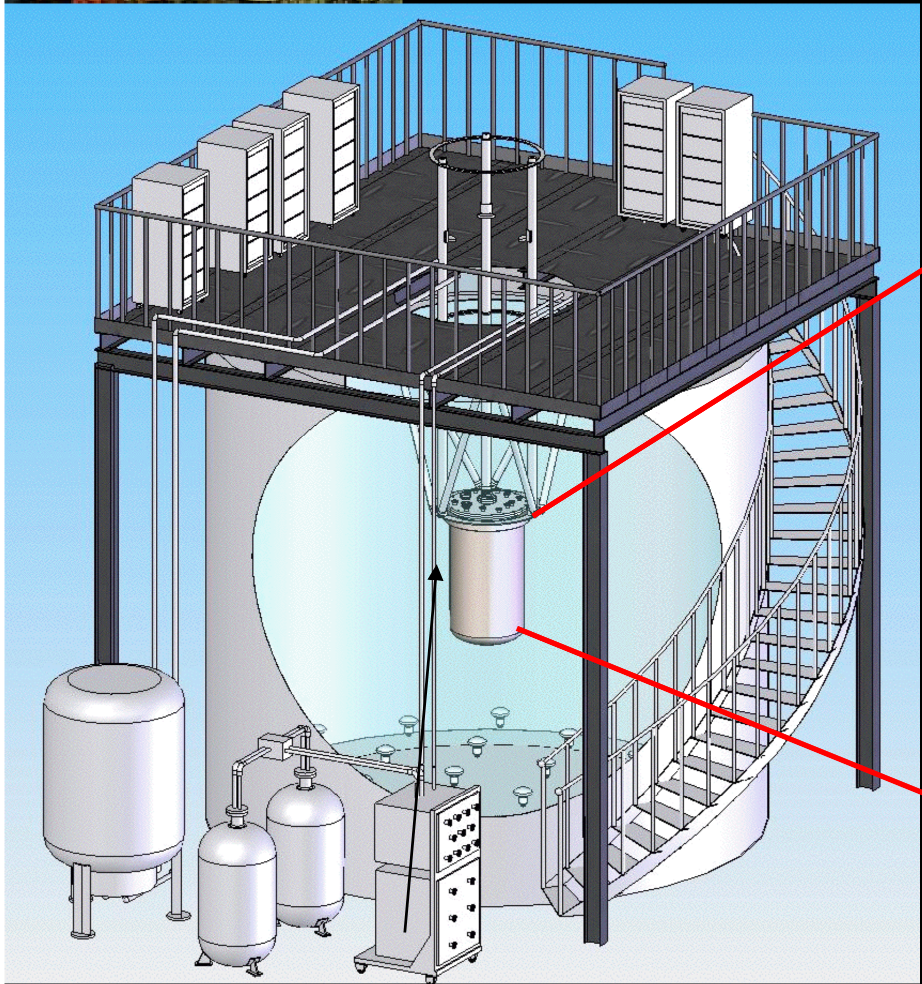
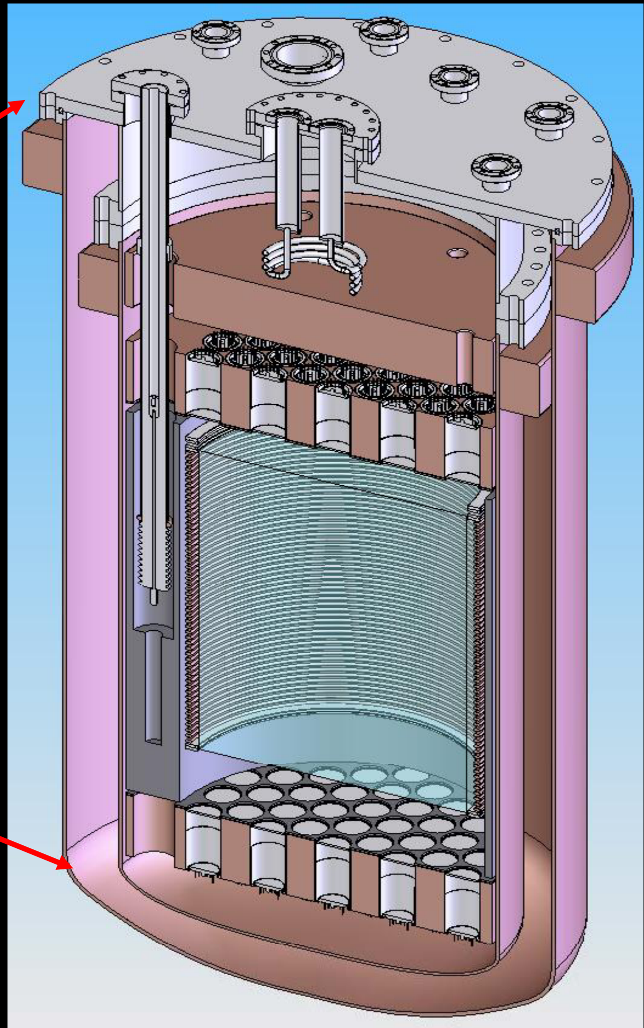
The LUX detector

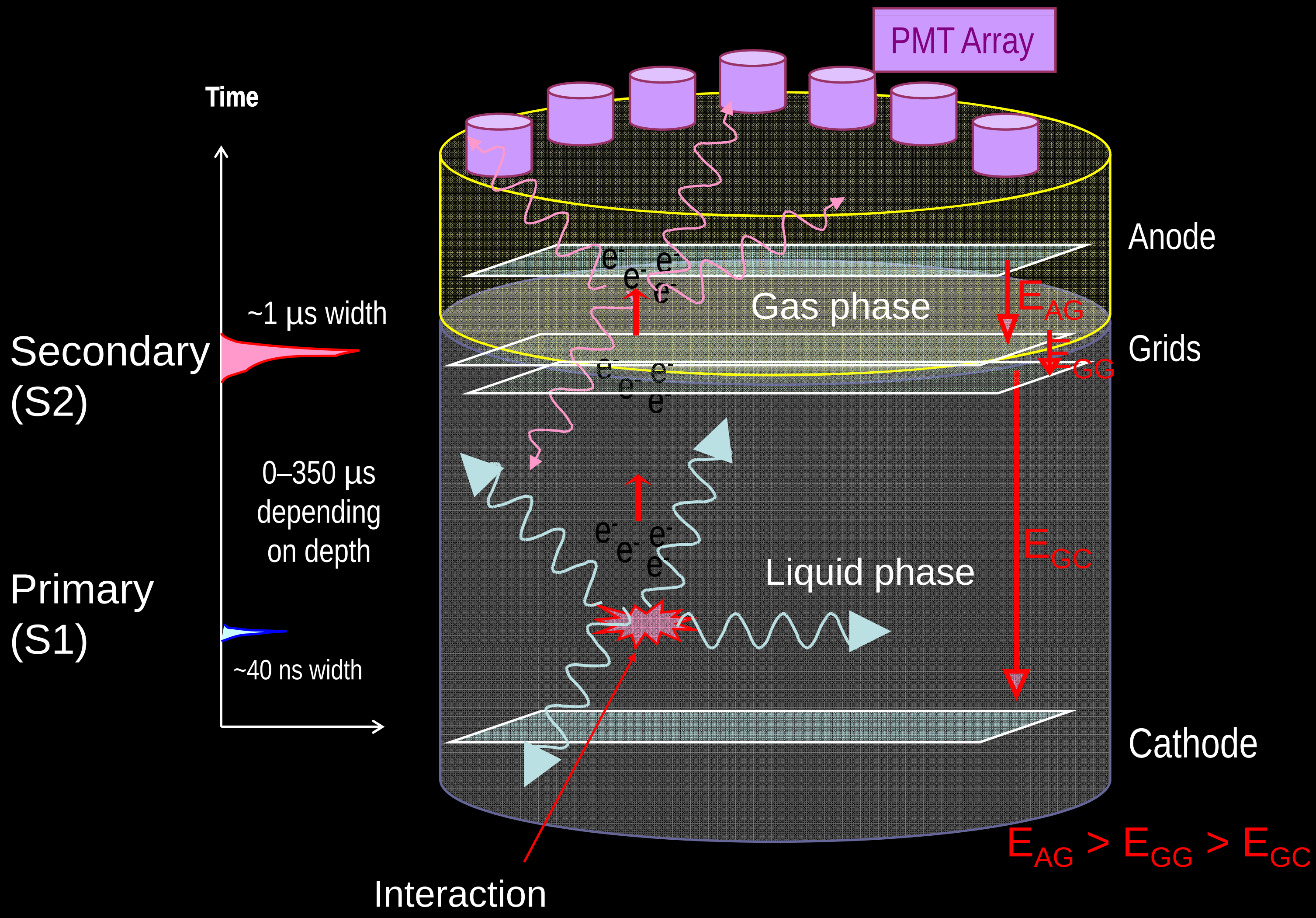




~ 6m diameter Water Cerenkov Shield.

Dual phase detector - aspect ratio ~1.2

Two Signal Technique



LUX Parameters

- 350 kg Dual Phase liquid Xe TPC
- 2 KV/cm field in liquid, 5 KV/cm for extraction and 10 KV/cm field in gas phase
- 60 PMTs (Hamamatsu R8778) each in top and bottom arrays
- 3D-imaging TPC eliminates surface activity, defines fiducial
- ~100 kg achievable in the fiducial volume

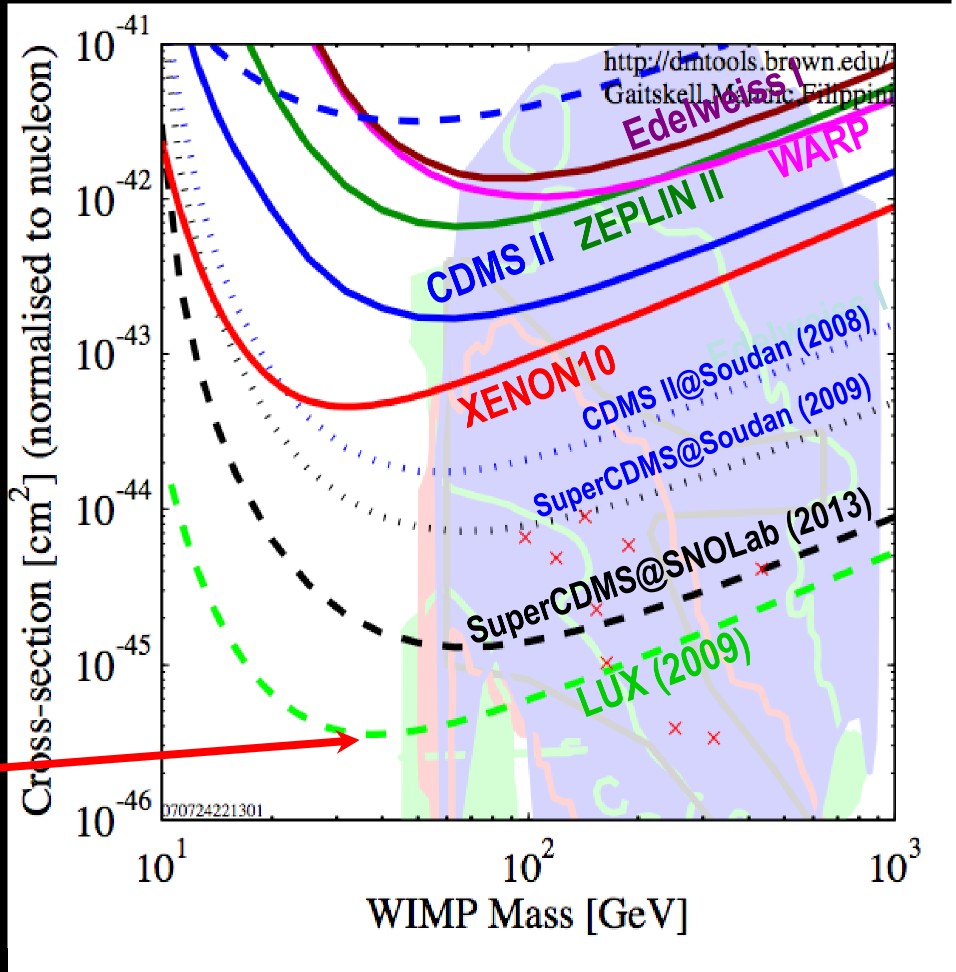
LUX Goals

- 99.3 – 99.9% Electron Recoil background rejection for 50% Neutron Recoil acceptance, in the range 5 keVr < E < 25 keV

- $\gamma + \beta$ rate < 8 x 10^{-4} events/kg/keVee/day with 99.4% rejection (conservative)

- 10 month run w/ 50% NR acceptance (net 15,000 kg-days)

- <u>DM reach</u> $\sigma \sim 4\times10^{-46}$ cm^2 (Equivalent to an event rate of ~0.4/100kg/month in 100kg fiducial)



(SuperCDMS Goal @ SNOLab: Gross Ge Mass 25 kg (x 50% fid) for 1000 days running)

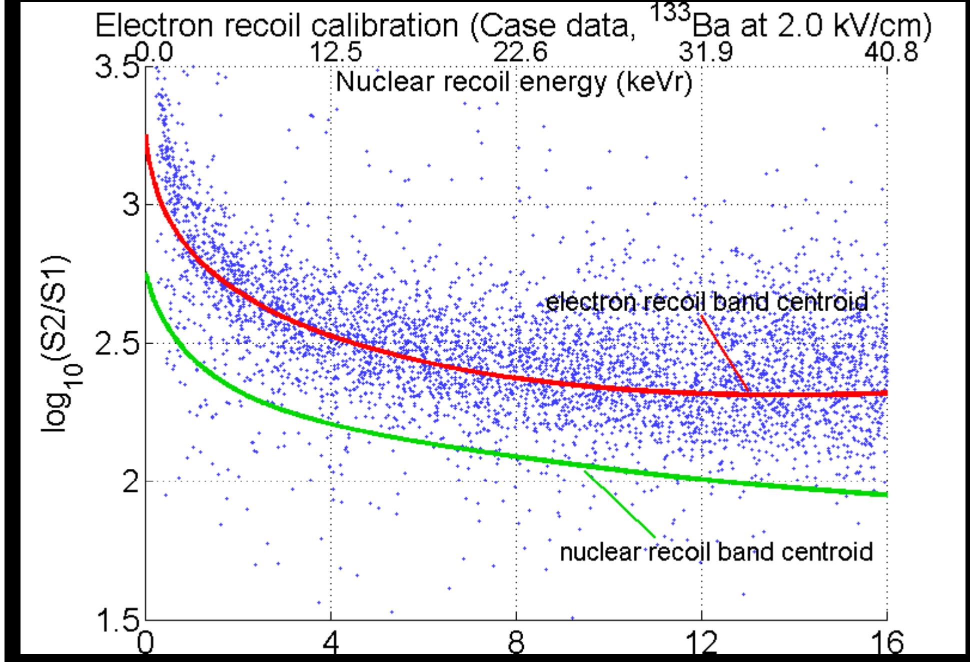
Goals (Contd.)

GOAL FOR WIMP SIGNAL SENSITIVTY AND REFERENCE LEVELS (UPPER LIMITS) FOR BACKGROUNDS (5–25 keVr, 1.3-8 keVee)	NR Avg. Diff. Rate evts/keVr/kg/day	ER Avg. Diff. Rate evts/keVee/kg/day	Total Rate for a FV exposure of 30,000 kg-days (net live)
WIMP (m = 100 GeV, $\sigma = 7\text{x}10^{-46}$ cm^2)	$1.4\text{x}10^{-5}$		8.6
WIMP (after NR acceptance of 45%)	$6.5\text{x}10^{-6}$		3.9
ER Flat Spectrum (before ER rej.)		**$8.3\text{x}10^{-4}$**	180
ER Flat Spectrum (after ER rej. 99.4%)		$4.8\text{x}10^{-6}$	1.0
NR Neutron Spectrum	**$3.7\text{x}10^{-6}$**		2.2
NR Neutron Spectrum (after NR acceptance of 45%)	$1.7\text{x}10^{-6}$		1.0

Conservative

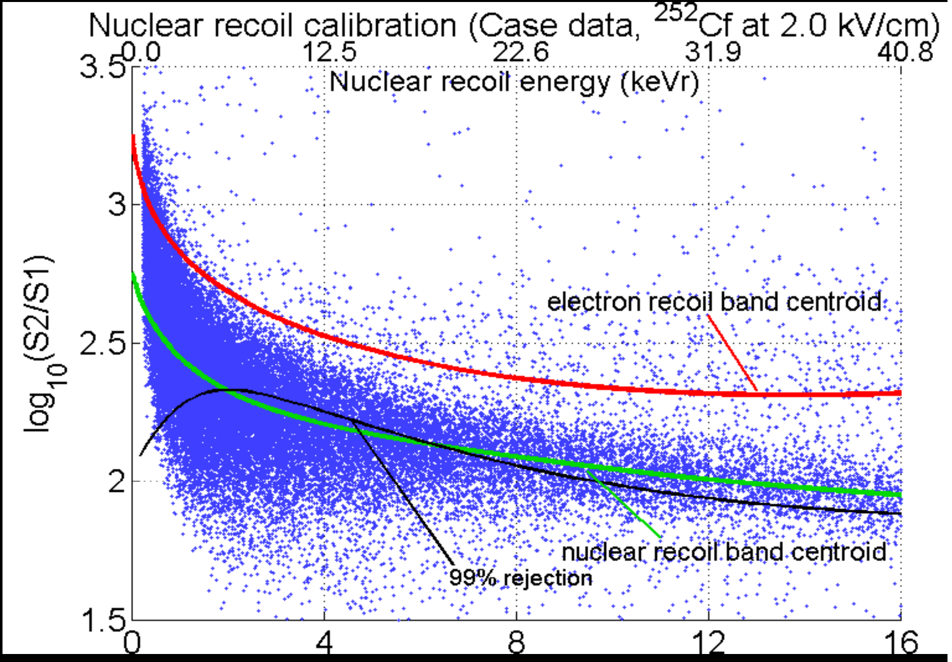
Calibration Data (Prototype Cell at Case)

^{133}Ba Electrons



Recoil Energy (keVr)

^{252}Cf Neutrons



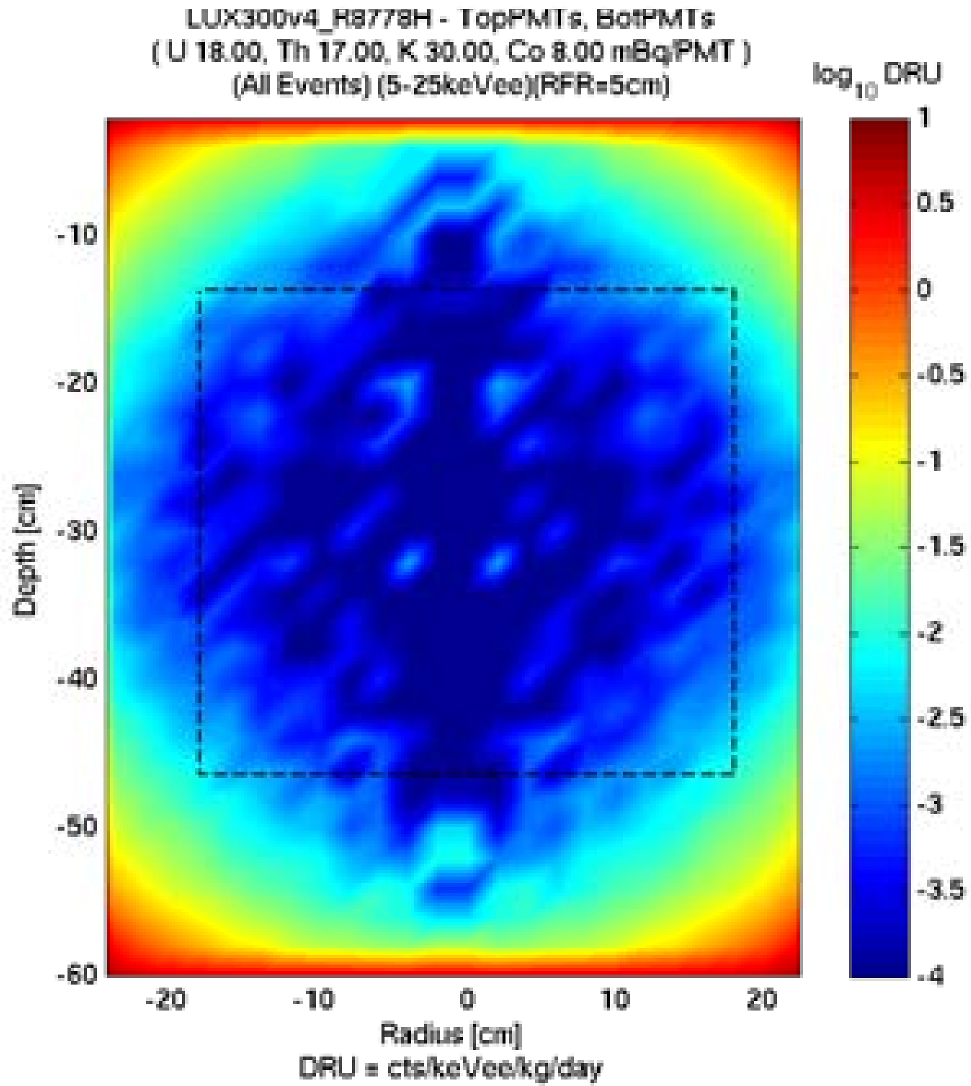
Recoil Energy (keVr)

These measurements were made above ground, but agree well with Xenon10 experience.

Backgrounds (Gamma)

- Internal strong self-shielding against PMT activity (main source of background events). Double Compton scatters are rejected.

- External large water shield with muon veto.
    - Very effective for cavern γ -- Very low gamma backgrounds with readily achievable $<10^{-11}$ g/g purity for water.



Backgrounds (Neutrons)

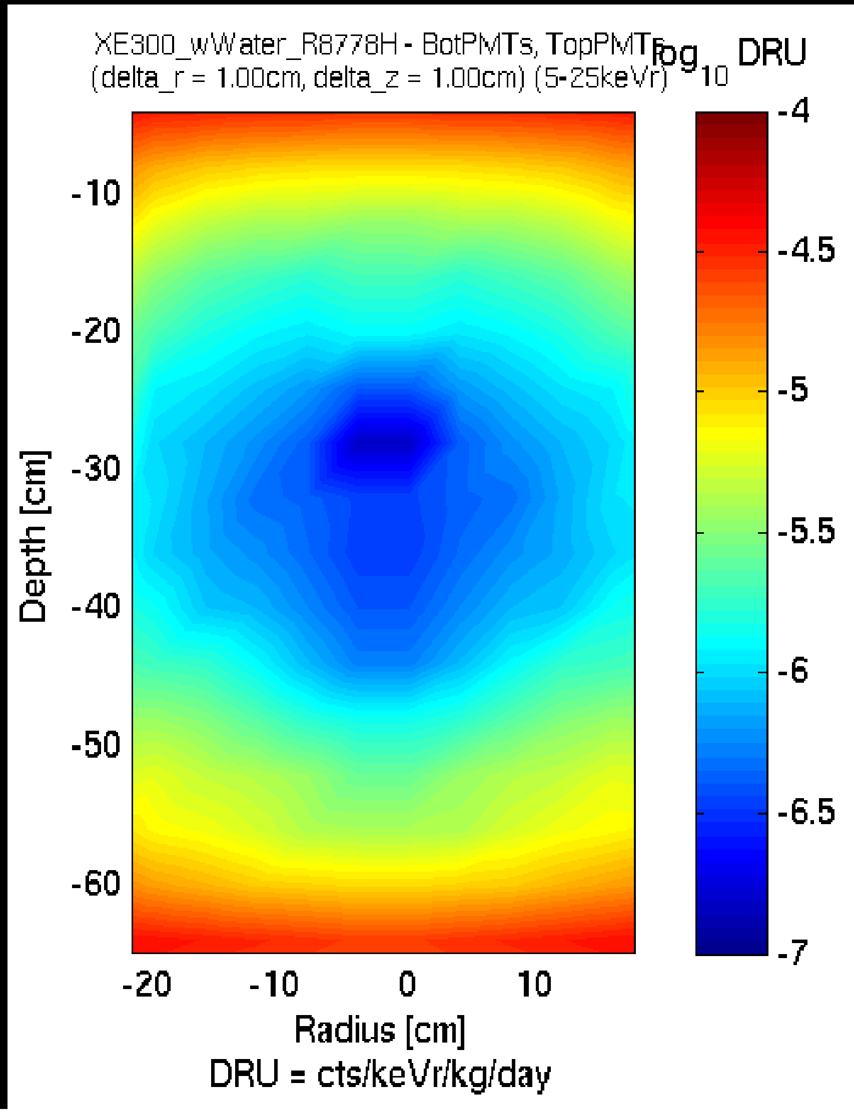
- Internal

  Neutrons (α,n) & fission << γ + β.

  ~65% double scatter.

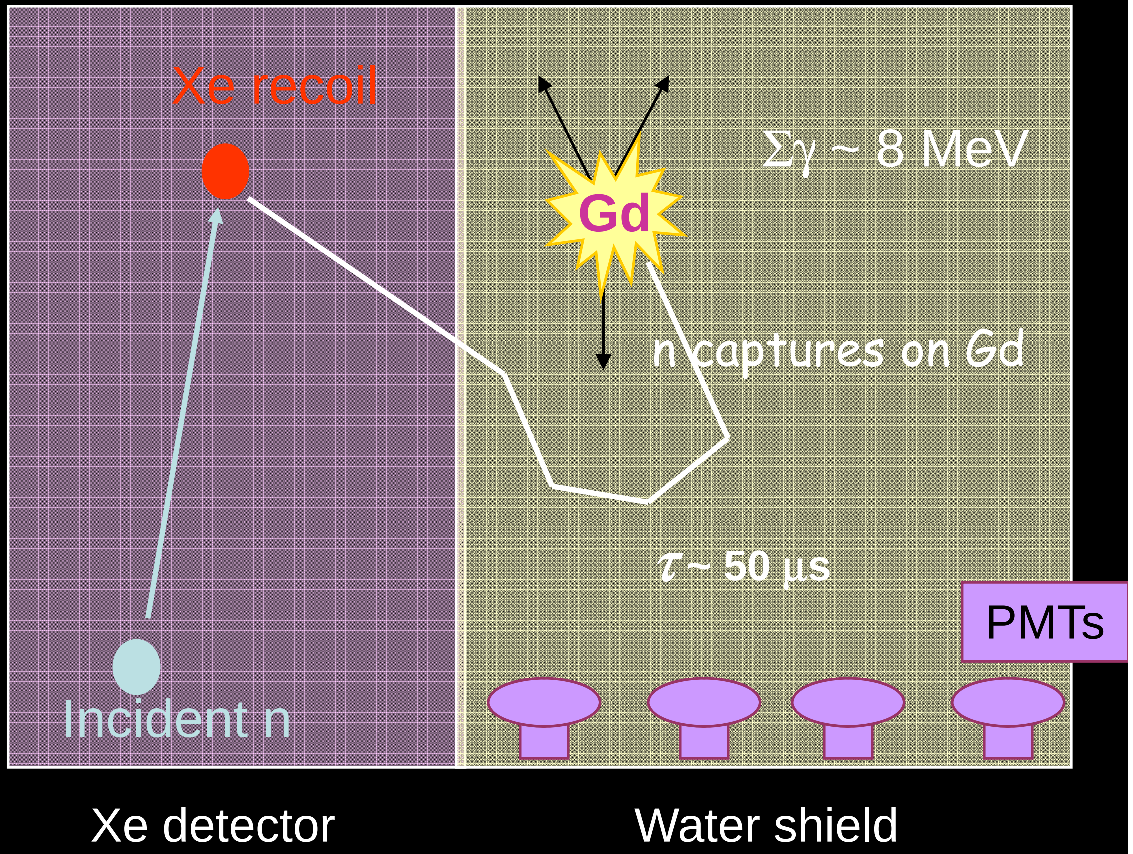
  (PMTs are the main source)

- External large water shield with muon veto.
  - Very effective for cavern n, and HE neutrons from muons
  - Possible upgrade of adding Gd to the water.

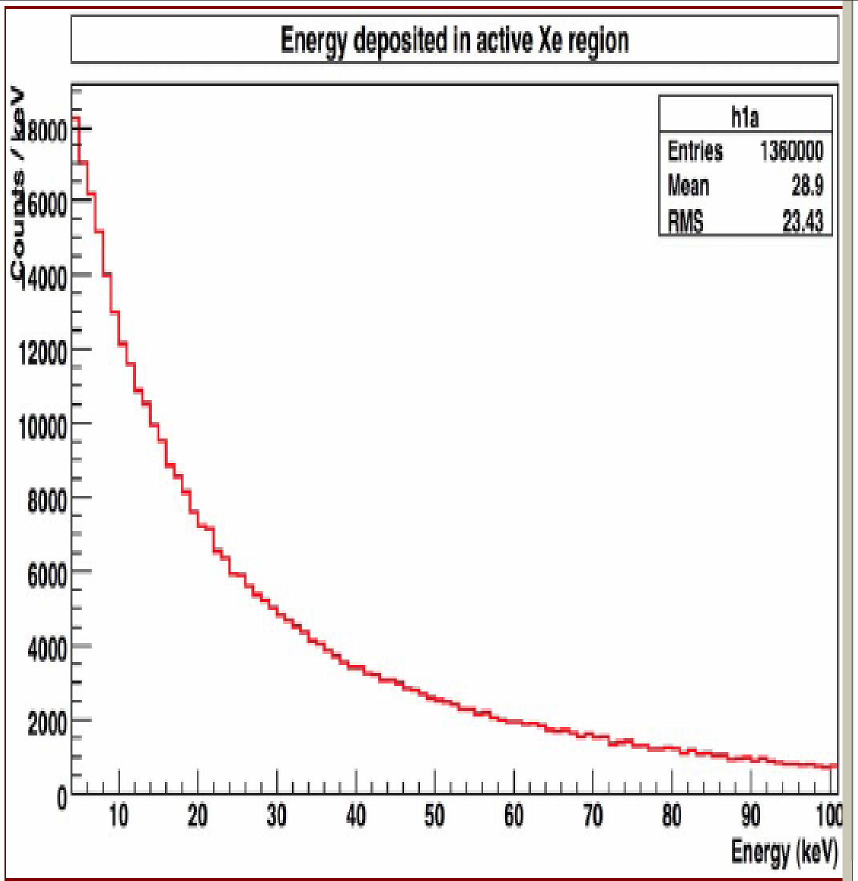


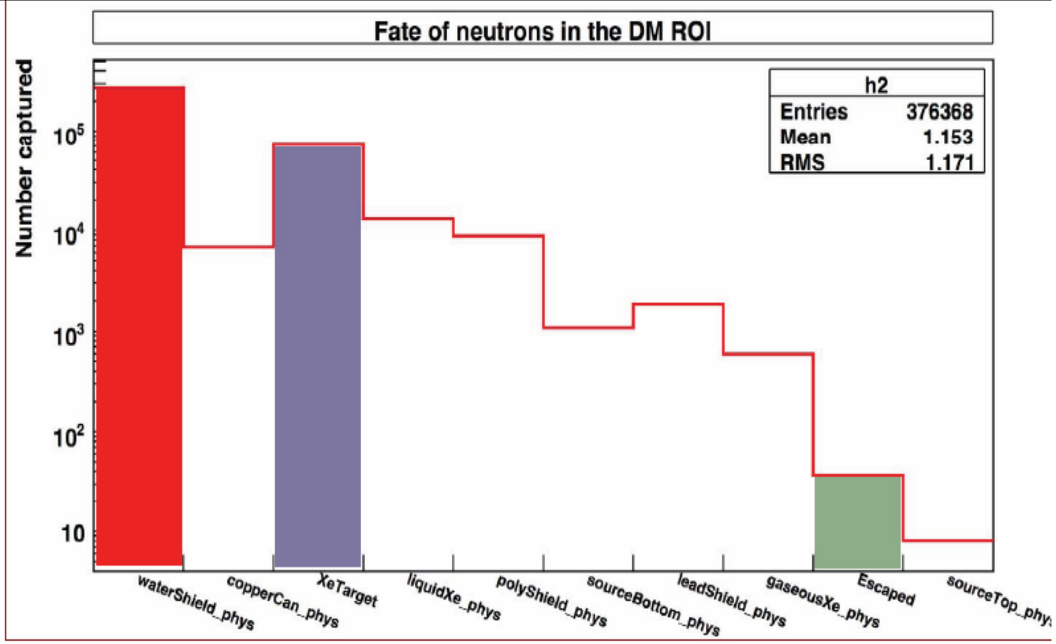
Water Shield & Veto

- Veto on incoming muons via Cherenkov light signal.
- Tag thermalized neutrons generated within the detector
- Gd (0.2%) in water gives a capture efficiency of > 90% for thermal neutrons, followed by an 8 MeV gamma cascade



Water Shield (Contd.)





72% of ROI neutrons capture in the Gd-H_2O shield

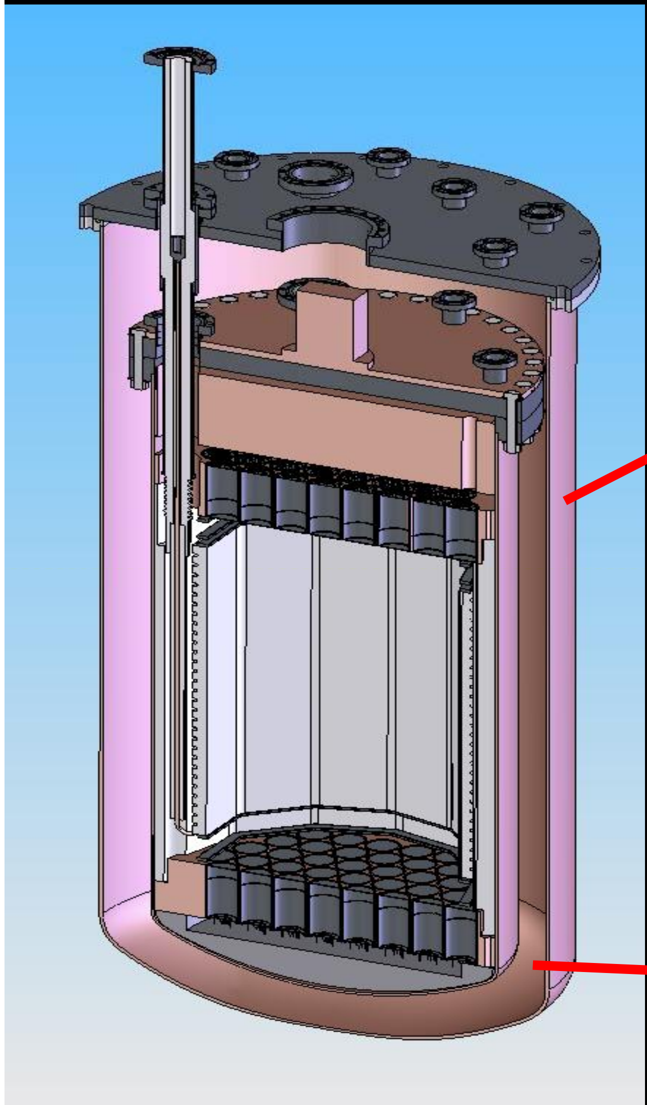
19% of ROI neutrons capture in the active Xe target

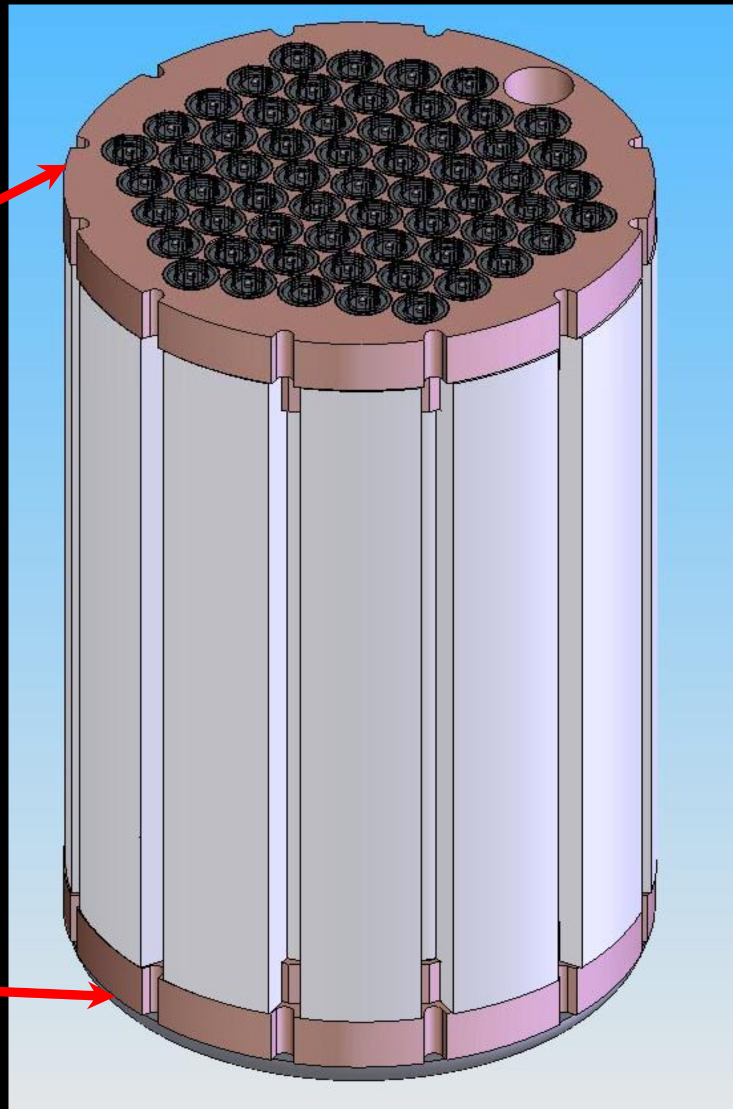
99% reduction!

Status

- A revised proposal is being submitted to NSF/DoE.
- DUSEL site selection => LUX can deploy as part of Homestake's Early Implementation Program.
- Considerable progress has been made in ironing out design issues over the past six months.
- Prototypes have been developed for several sub-systems/components.
- The cryostat has been assembled at Case and has undergone cooling cycles.
- Next few slides show progress.

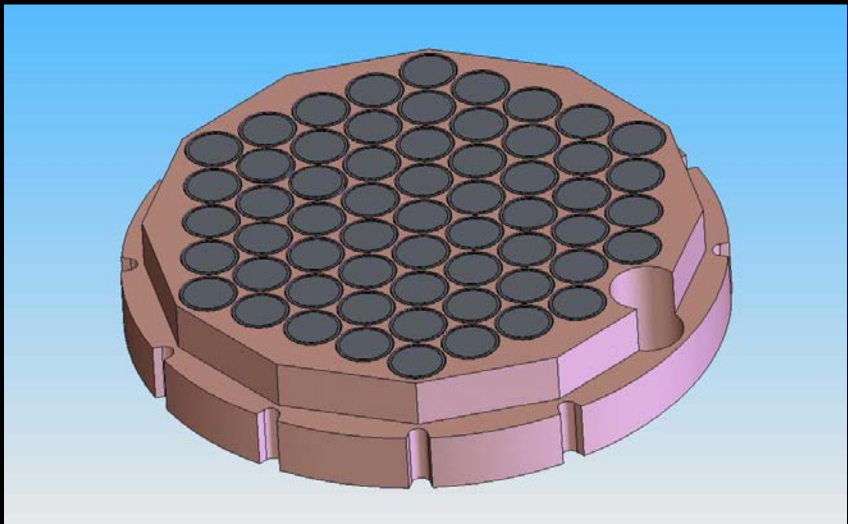
Detailed Design (UCLA)

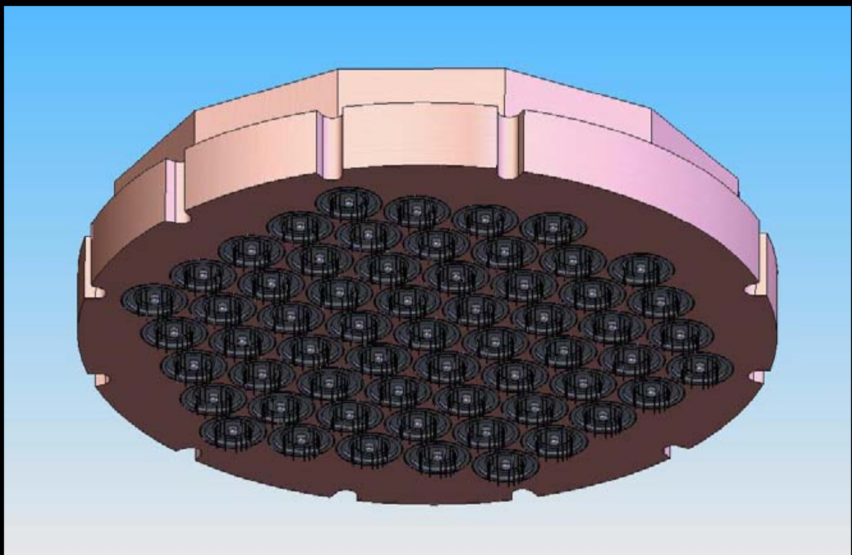


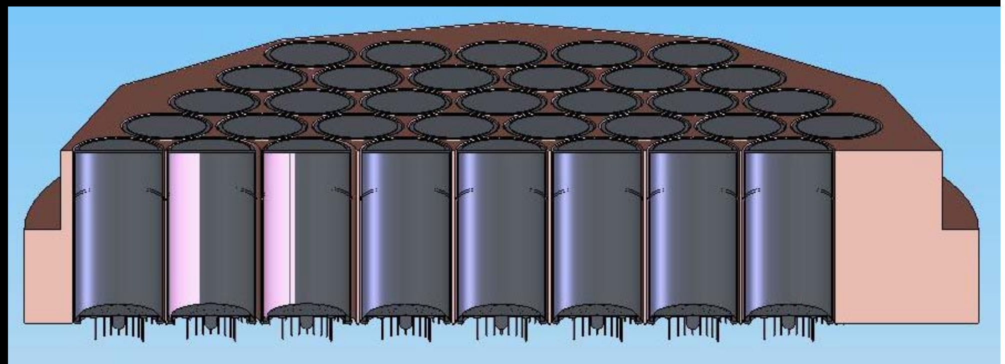


Cryostat Assembly (Case)

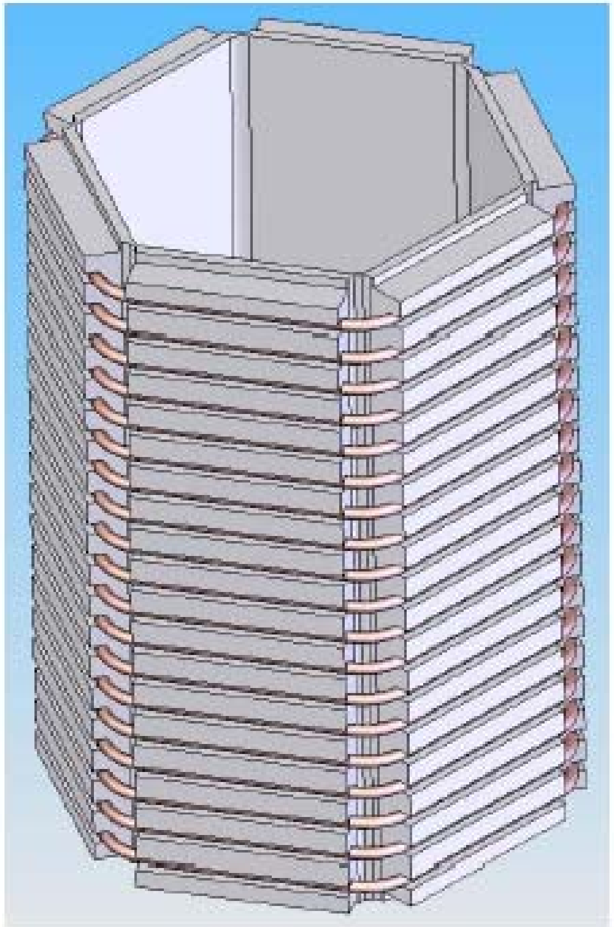
PMT Mounts (Livermore)



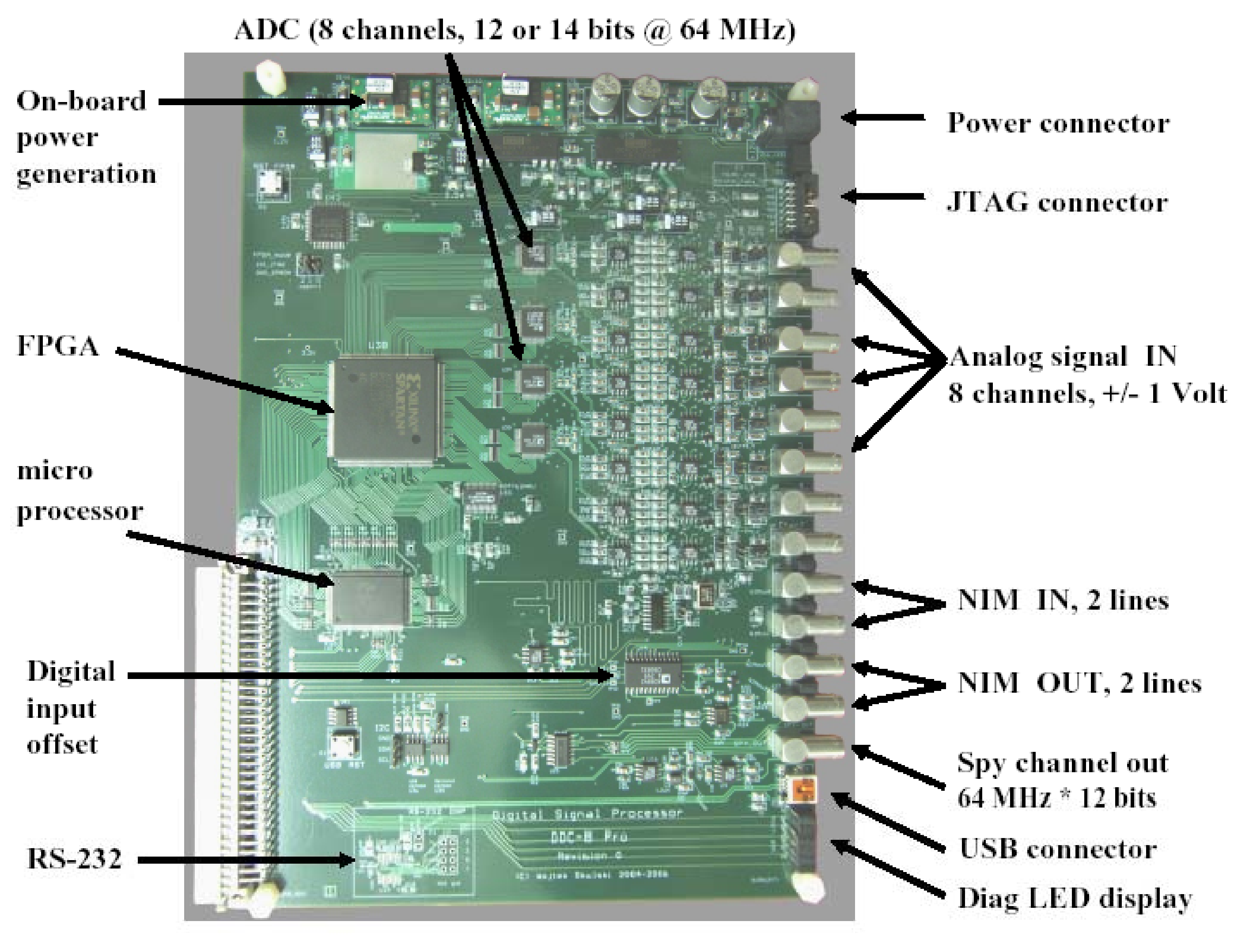




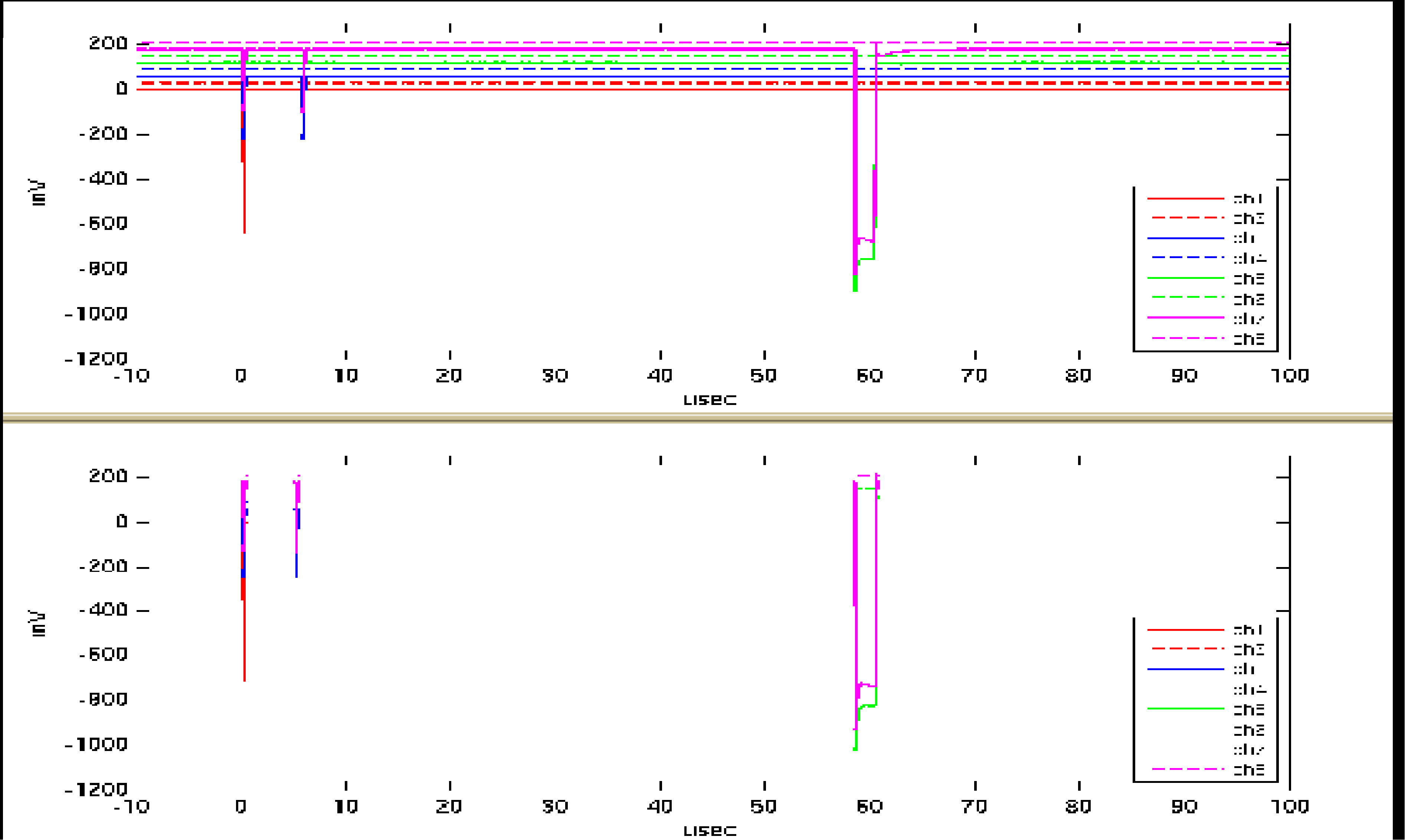
Field Cage Prototypes (UCLA/UCDavis)



Trigger Logic (Rochester)



Zero-suppressed Digitization (Brown)



Summary

The LUX collaboration is firmly in place with a sound management structure and governance plan.

Detector design has matured. Construction can begin immediately.

Cryostat, prototype components, sub-systems are being assembled.

Homestake is projecting initial occupancy in Spring of 2008. Deployment can begin at that point.

With funds in place, physics data can start as early as Fall 2008.