Background Model Status and Improvements for the LUX Experiment Dark Matter Search

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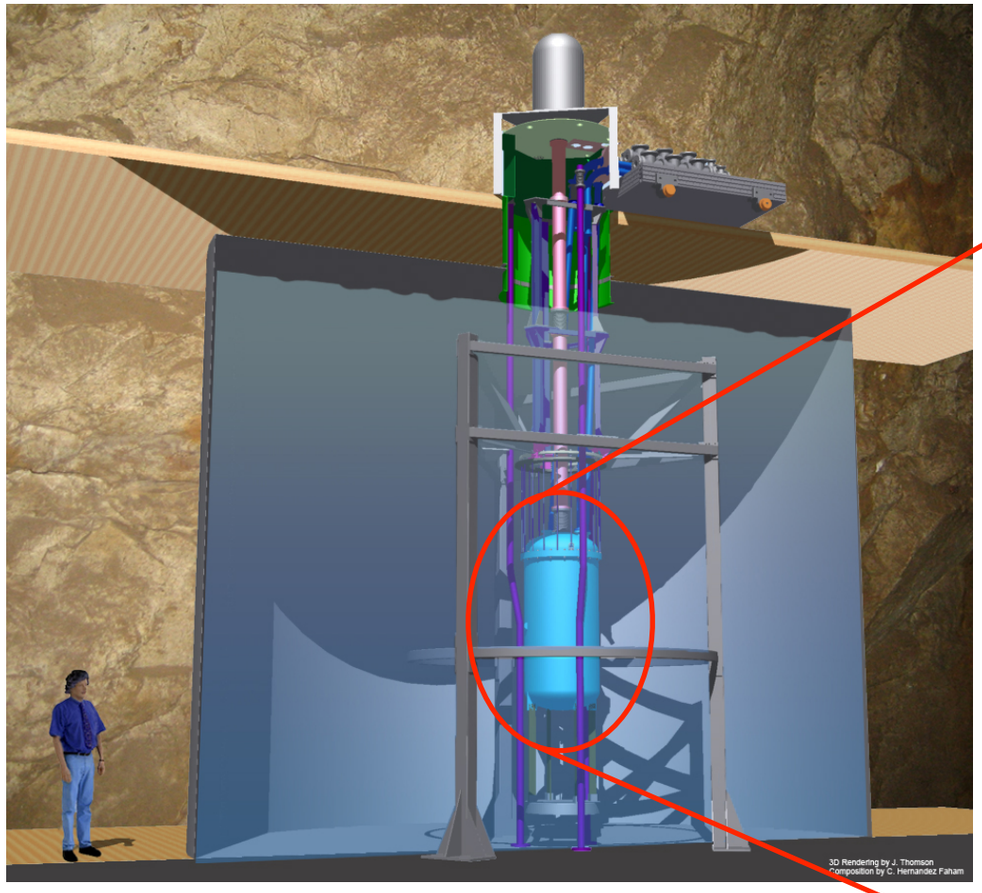
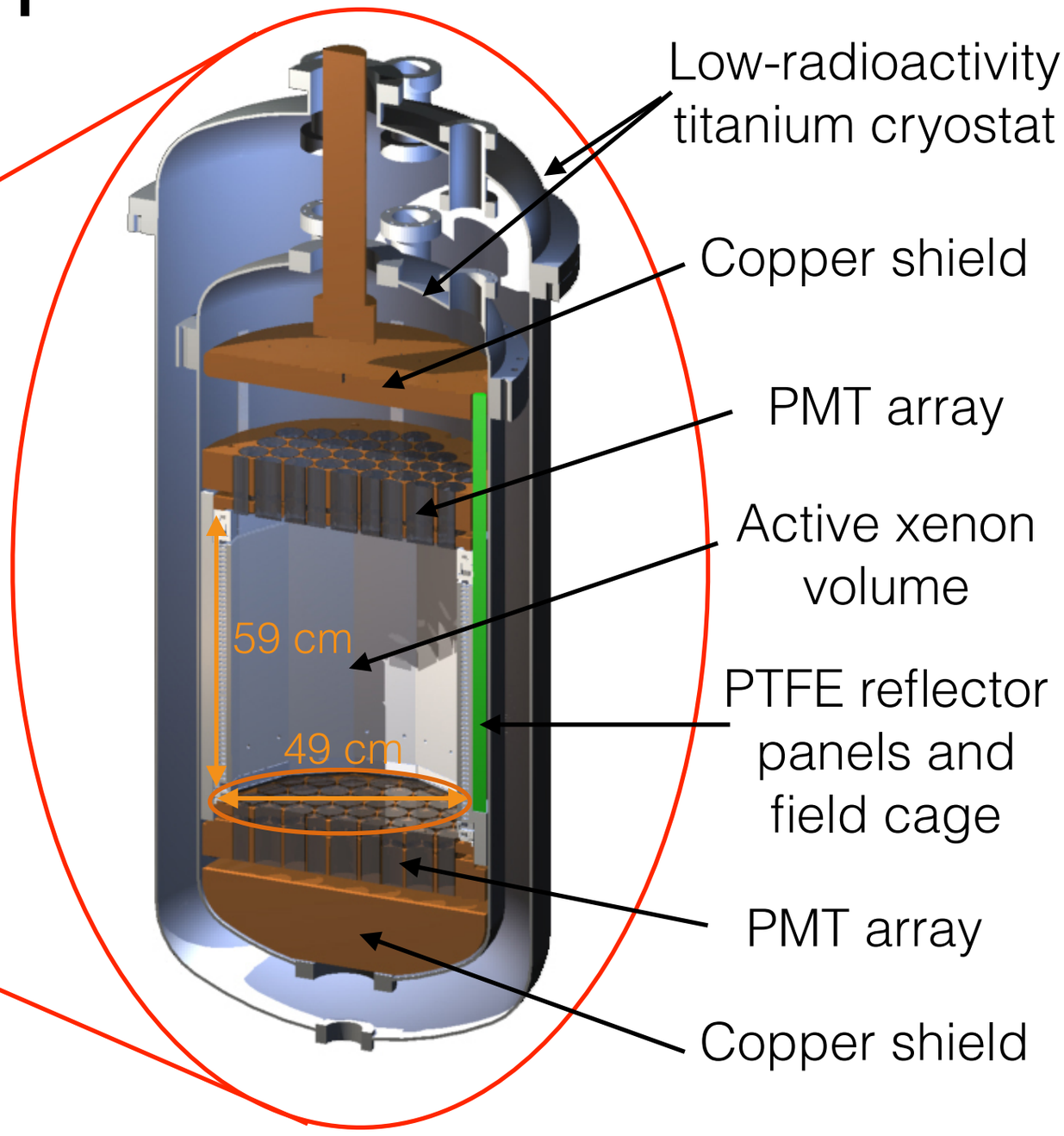
On behalf of the LUX Collaboration

APS April Meeting 2015 — Baltimore, MD —12 April 2015

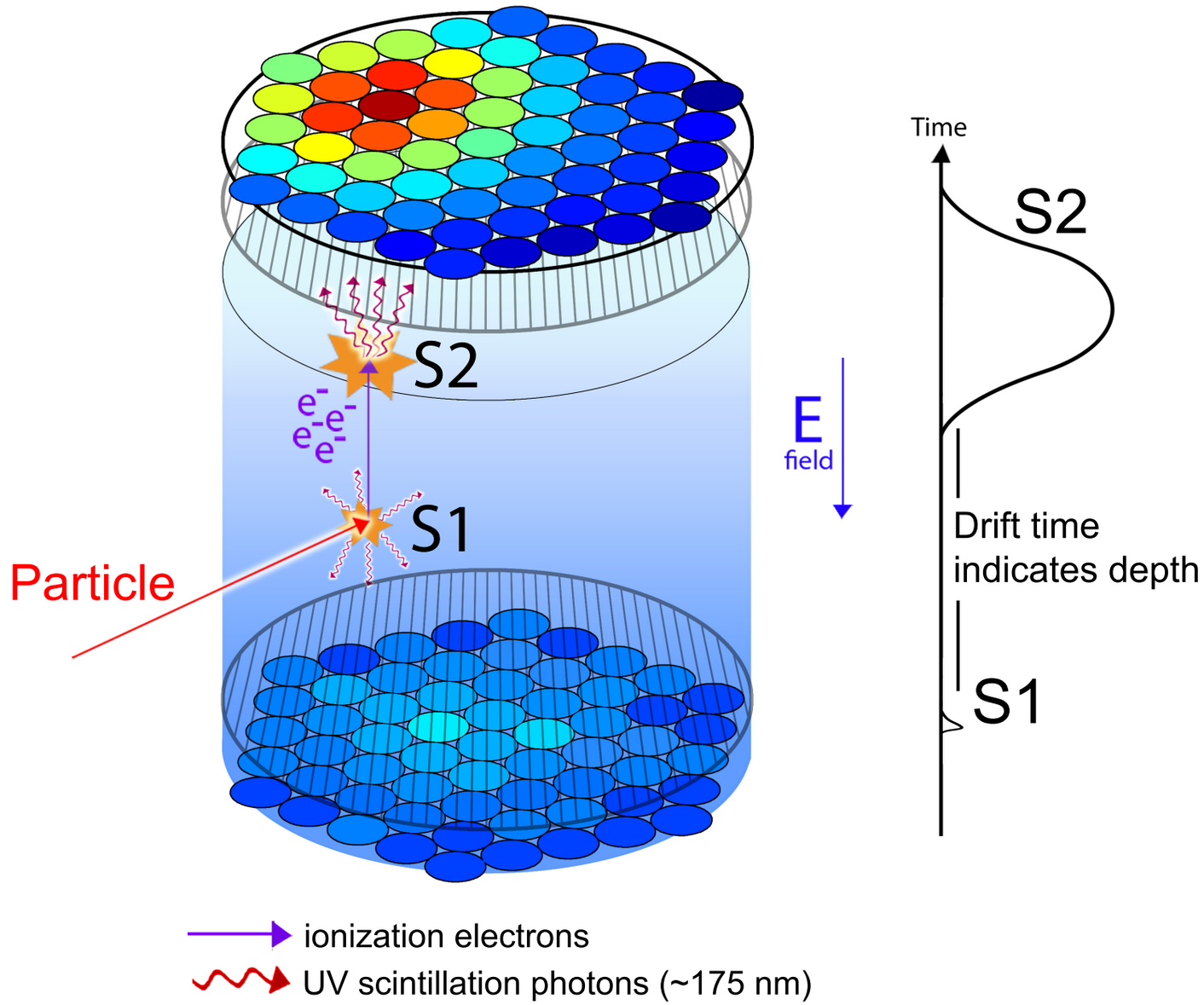
The Large Underground Xenon Experiment





370 kg total xenon mass
250 kg active liquid xenon
118 kg fiducial mass

How the LUX Detector Works



Signal and Background in LUX

- Dark matter signal we're looking for: Single-scatter nuclear recoils (NR) with energy less than 25 keV_{nr} (~5.3 keV_{ee})

- Our backgrounds: Events that will mimic a dark matter response in the detector, such as:
  - Neutrons that scatter once in the detector
  - Electron recoil (ER) events, statistically leaking (0.4%) into NR area of parameter space (The focus of this talk)

- We construct models for candidate WIMP signals and these expected backgrounds and use a Profile Likelihood Ratio (PLR) analysis to achieve our science result

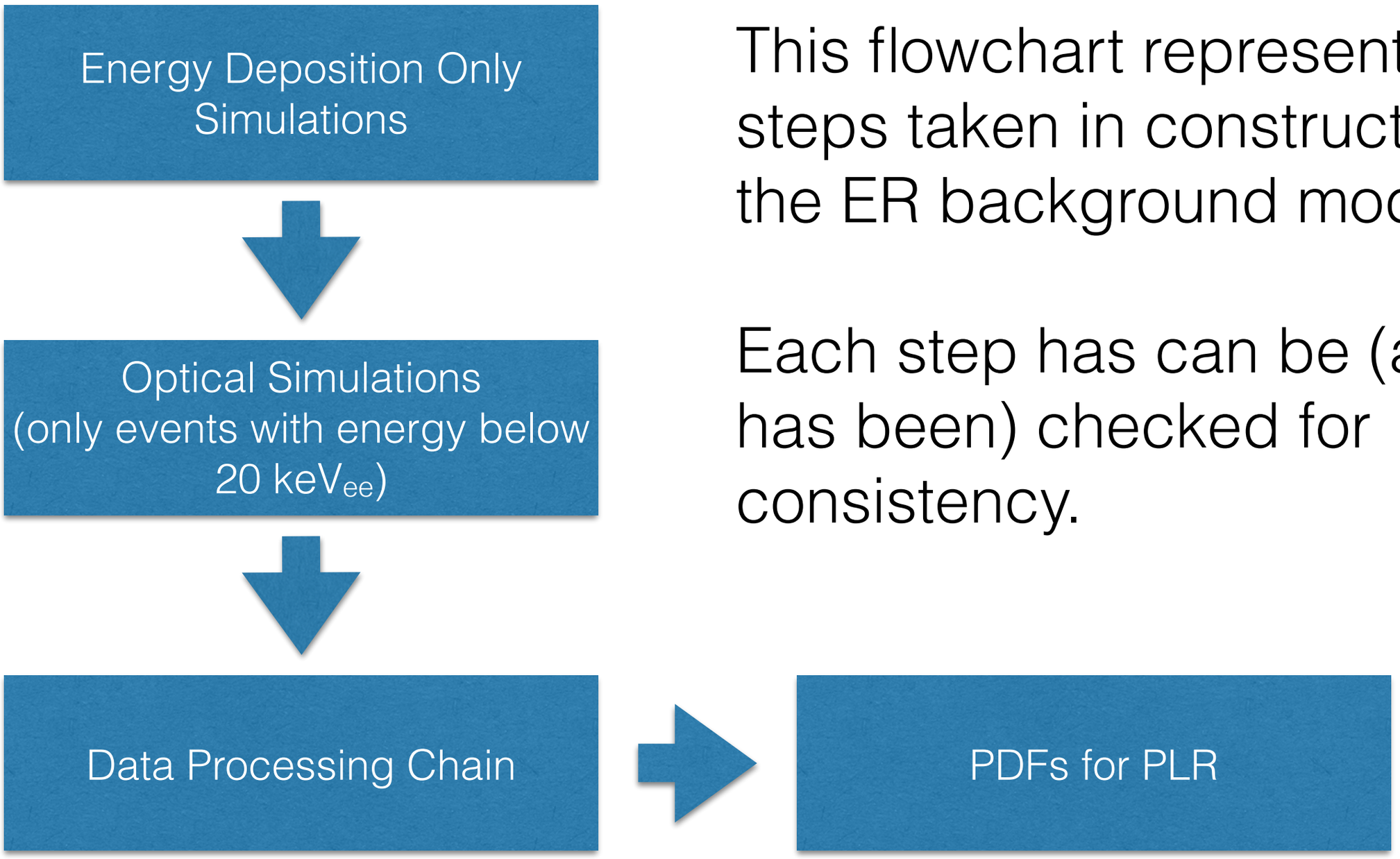
ER Background Model

- Needs to include:
  - Sources of gamma radiation near the detector (i.e. construction materials)
  - Sources of beta radiation and gamma radiation within the xenon itself (e.g. activated xenon lines)
- Values and limits for these activities are reached by counting activity in the construction material before construction

Sources of activity in model (mBq/unit)

	Units	Amount	^{226}R	^{232}Th	^{40}K	^{60}Co	^{46}S	^{85}Kr	^{127}Xe	^{220}Rn	^{222}Rn
PMTs	PMT	122	9.5	2.7	66	2.6	-	-	-	-	-
PMT Bases	Base	122	1.4	0.13	1.2	0.03	-	-	-	-	-
Reflector Panels	kg	9.3	5.0	1.3	-	-	-	-	-	-	-
Field Shaping Rings	kg	28	0.5	0.8	-	0.3	-	-	-	-	-
Field Ring Supports	kg	33.5	0.5	0.35	-	-	-	-	-	-	-
Field Grids	kg	4.5	1.4	0.23	0.4	1.4	-	-	-	-	-
Grid Supports	kg	15.5	3.0	1.0	-	-	-	-	-	-	-
Cryostats (Ti)	kg	231	0.37	0.8	1.6	-	4.4	-	-	-	-
PMT Mounts (Cu)	kg	169	2.2	2.9	-	1.7	-	-	-	-	-
Copper Shields	kg	414	2.2	2.9	-	1.7	-	-	-	-	-
Weir (Cu)	kg	3.2	0.4	0.2	-	0.17	-	-	-	-	-
Superinsulation	kg	2.2	73	14	640	-	-	-	-	-	-
Thermal Insulation	kg	6.0	130	55	100	-	-	-	-	-	-
Xenon	kg	370	-	-	-	-	-	0.0013	0.49	0.007	0.049

How the background model is generated:



This flowchart represents the steps taken in constructing the ER background model.

Each step has can be (and has been) checked for consistency.

Updates to the background model

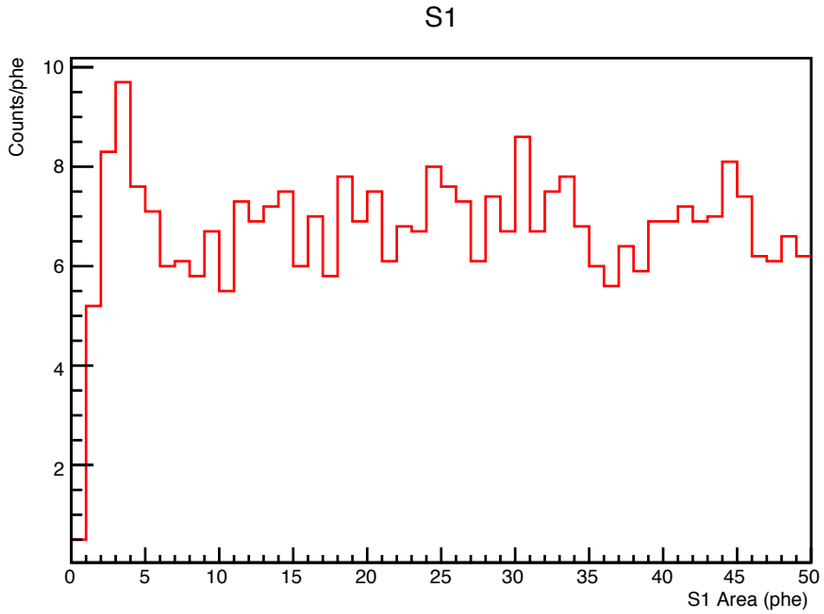
- An earlier version of the background model was constructed for our original science result in 2013

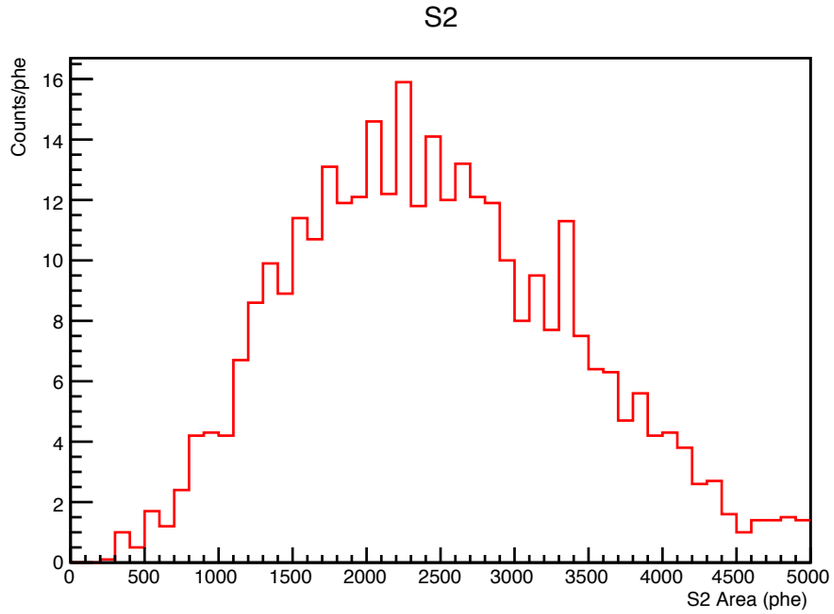
- Our work represents an improvement over this model in the following ways:
  - Increased simulated statistics to 10x live time
  - Added step of processing simulated background data through same data processing chain as real data

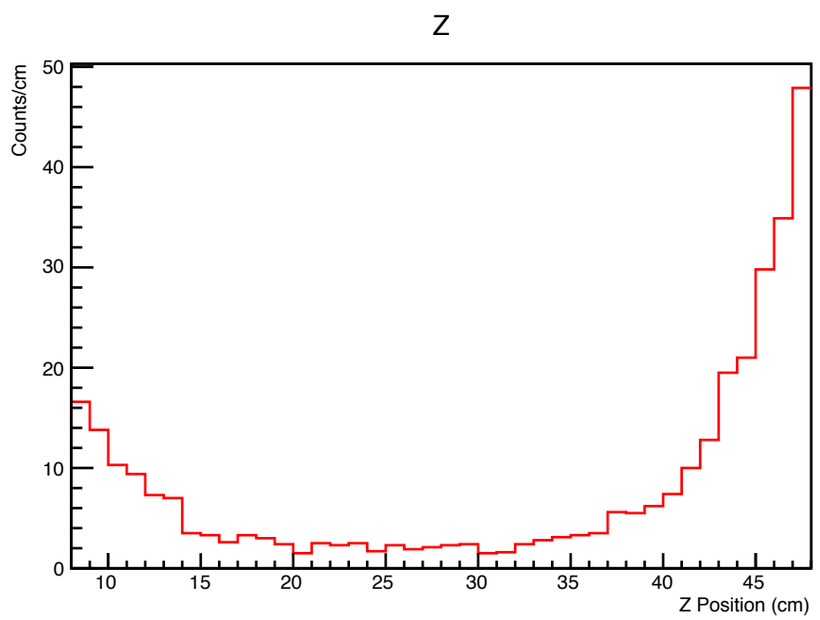
- These additions to the process increase our confidence in the model's ability to accurately predict the backgrounds observed in the LUX detector

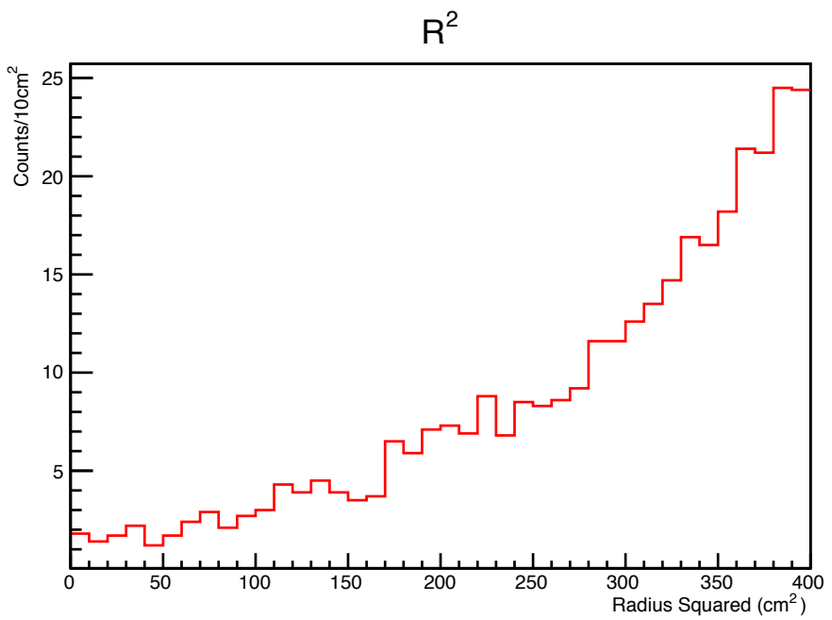
Background Model: Xenon External Backgrounds

118 kg fiducial volume, with an S1 signal < 50 phe



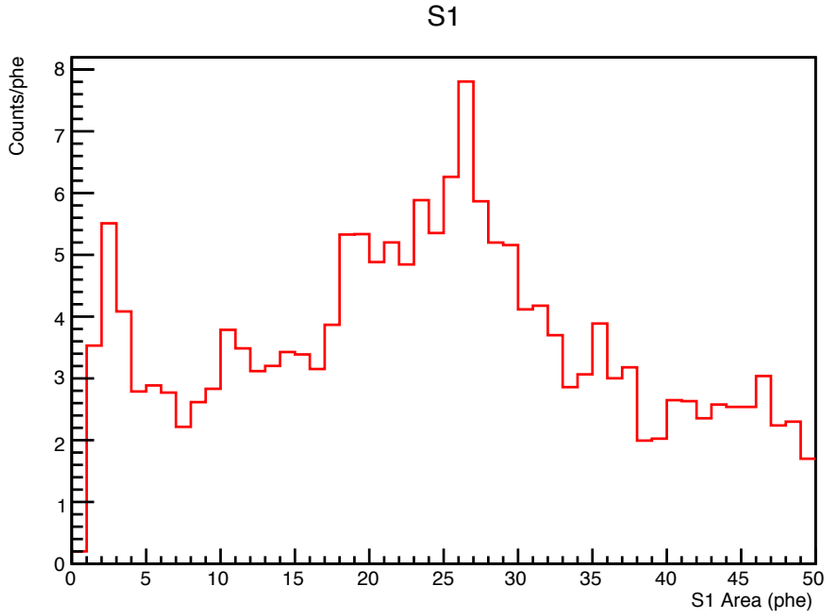


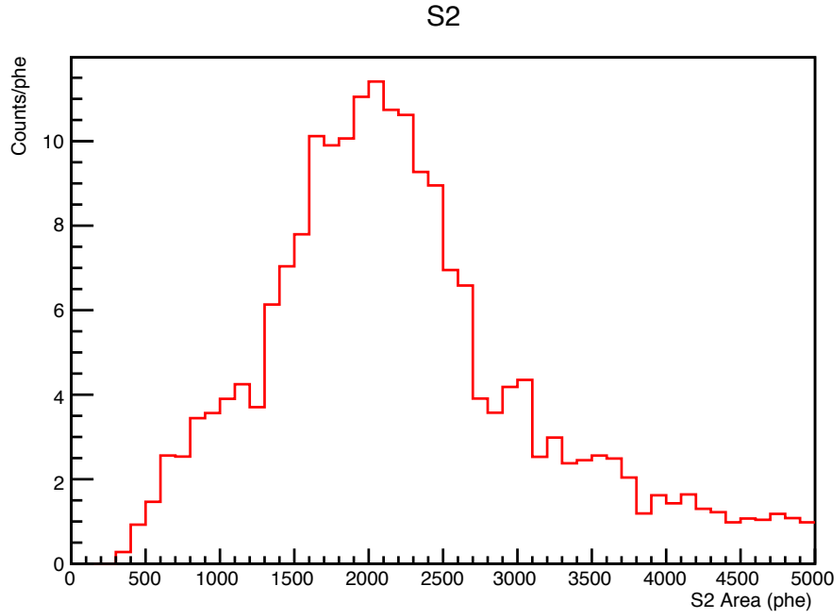


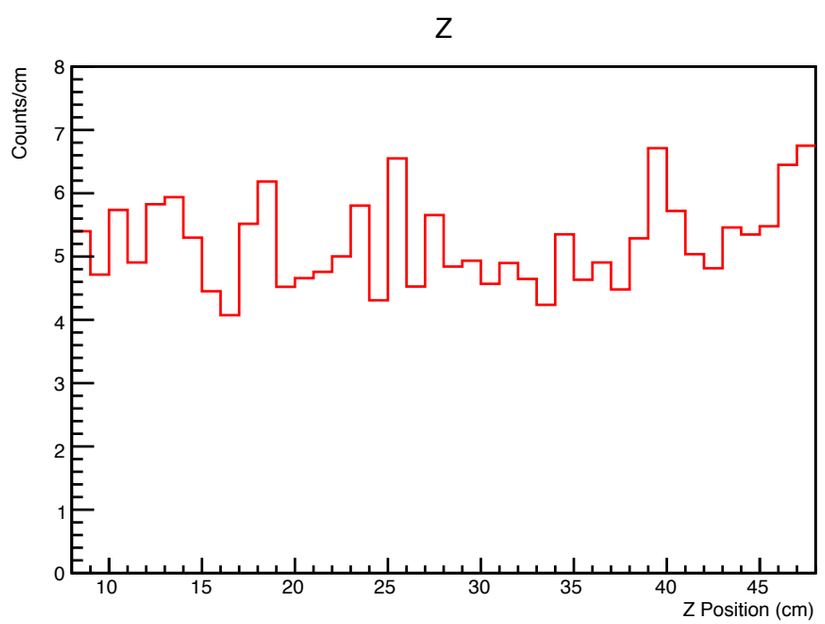


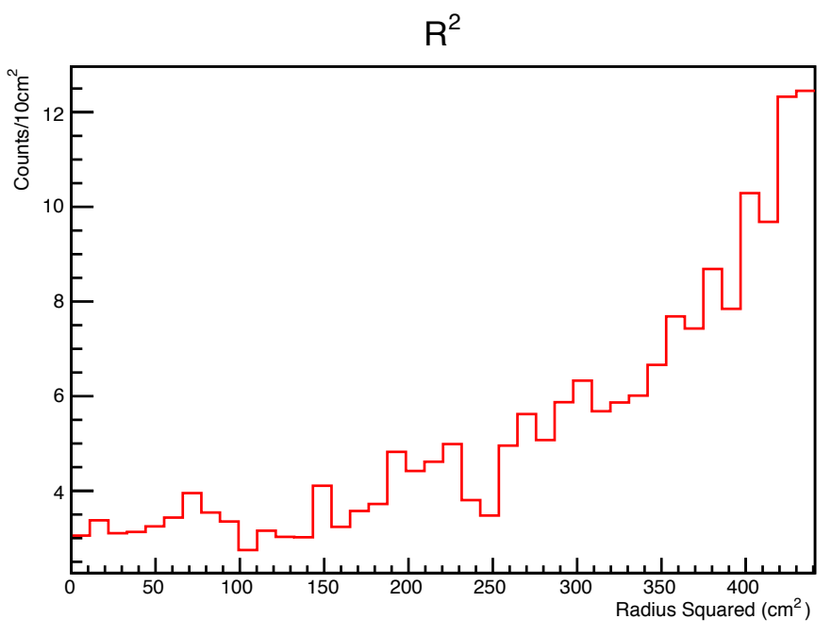
Background Model: Xenon Internal Backgrounds

118 kg fiducial volume, with an S1 signal < 50 phe









Future Work

- For our re-analysis of the first science run:
  - Comparing to data and updating the model as need.
  - Continue to scrutinize and perform more checks on the model
    - (If time allows) Increase the simulated background statistics
    - Expand energy range to allow for analysis to include of non-WIMP dark matter signals
- In preparation for analysis of our ongoing second science run:
  - Understand how activities in the detector will change (decay away of activated Xenon, for example)

Summary

- Signals and backgrounds in the LUX Detector
- ER background model generation
- Improvements to the model
- Extension of background model for further analysis and second science run