

Recent Updates (Gamma-X, SLAC work, MDC, etc.)

Jonathan Nikoleyczik

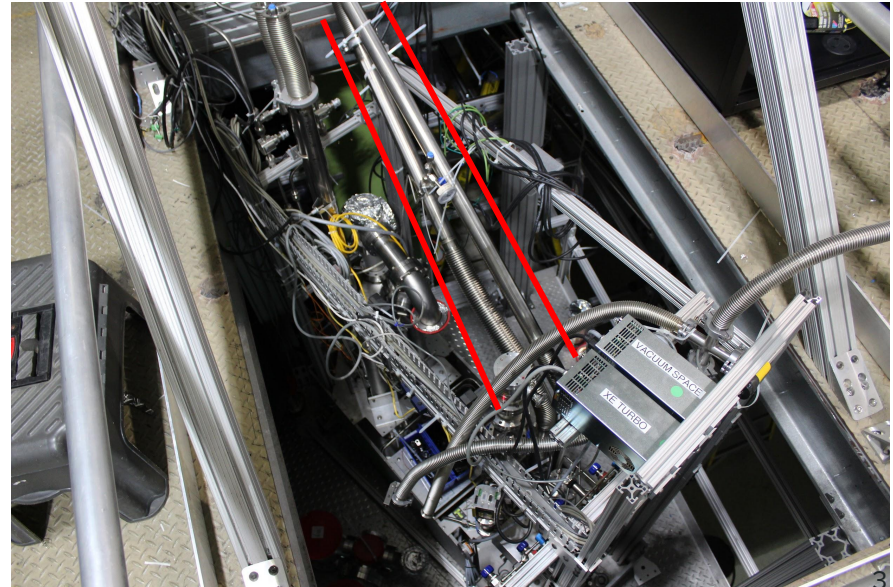
Today's update starts on [slide 15](#)

Summer in review

- “Finished” Gamma-X studies
 - More on this next
- Built Gas test and Phase 2 clean rooms
 - Gas test clean hood is currently in use
 - Phase 2 clean room is assembled but not cleaned
- Participated in MDC1
 - Calculated the electron lifetime for 30 days of simulated data which will hopefully look similar to real LZ data
 -

Thermosyphon lines

Replaced thermosyphon lines (marked in red) to make room for new Phase 1 breakout



Clean rooms



Gas test hood

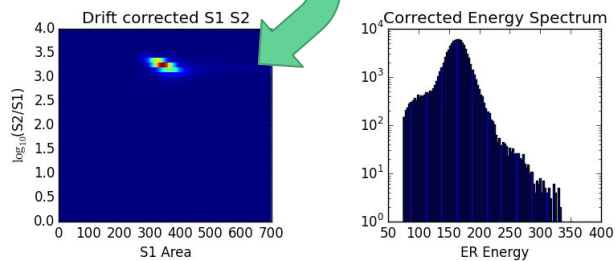
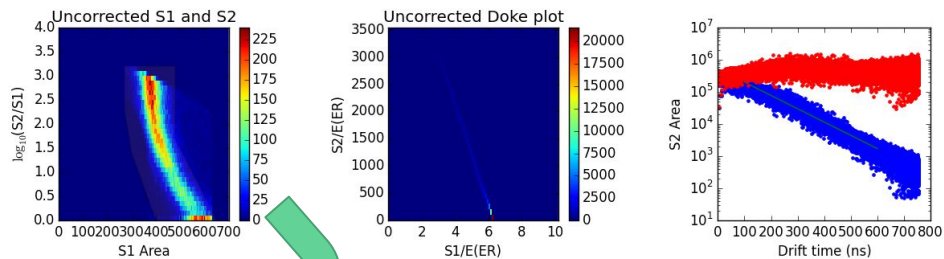
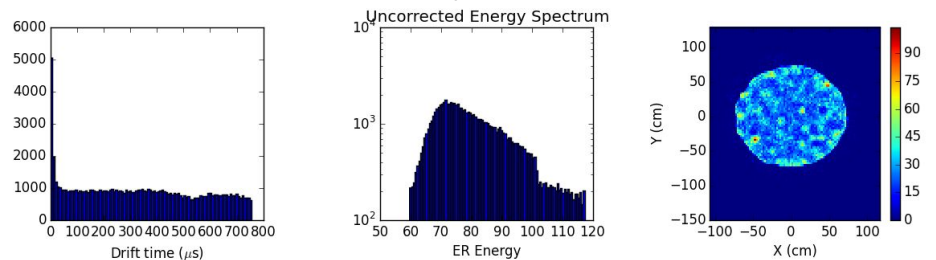


Phase 2
cleanroom

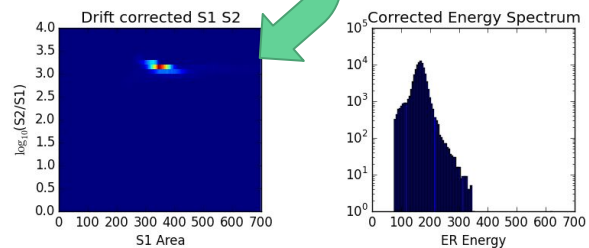
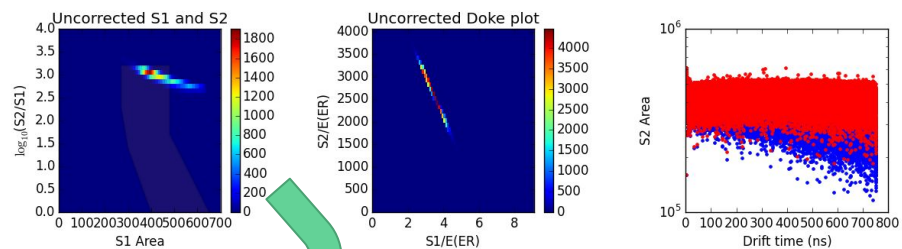
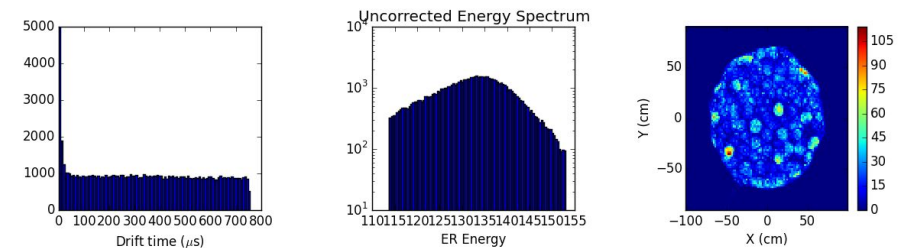


MDC 1

Day 1

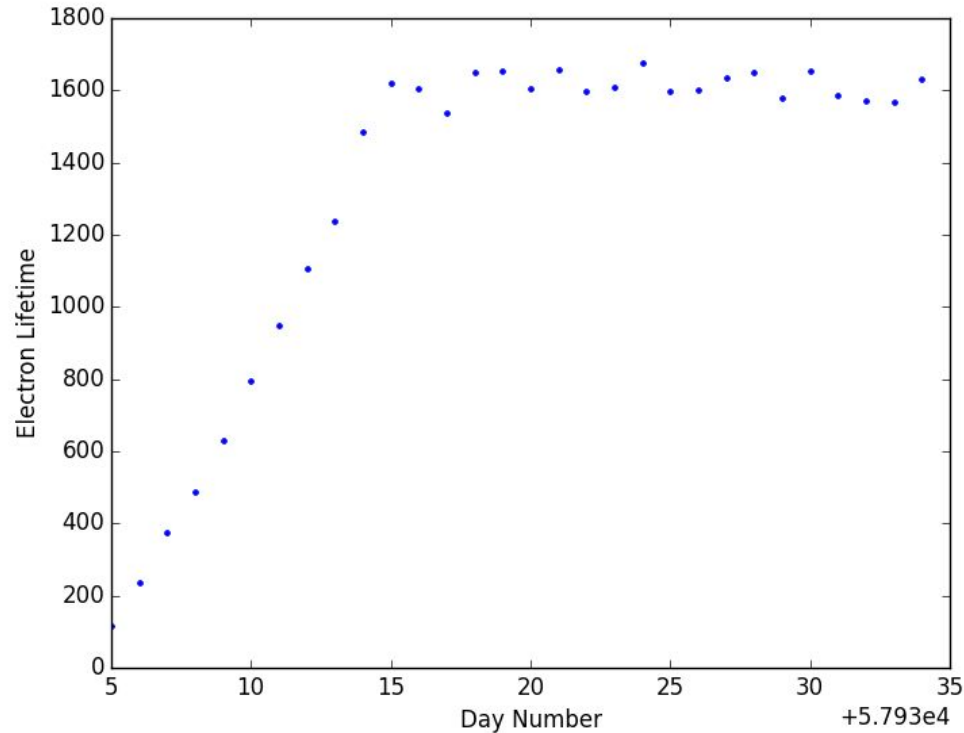


Day 30



MDC 1 Electron Lifetime

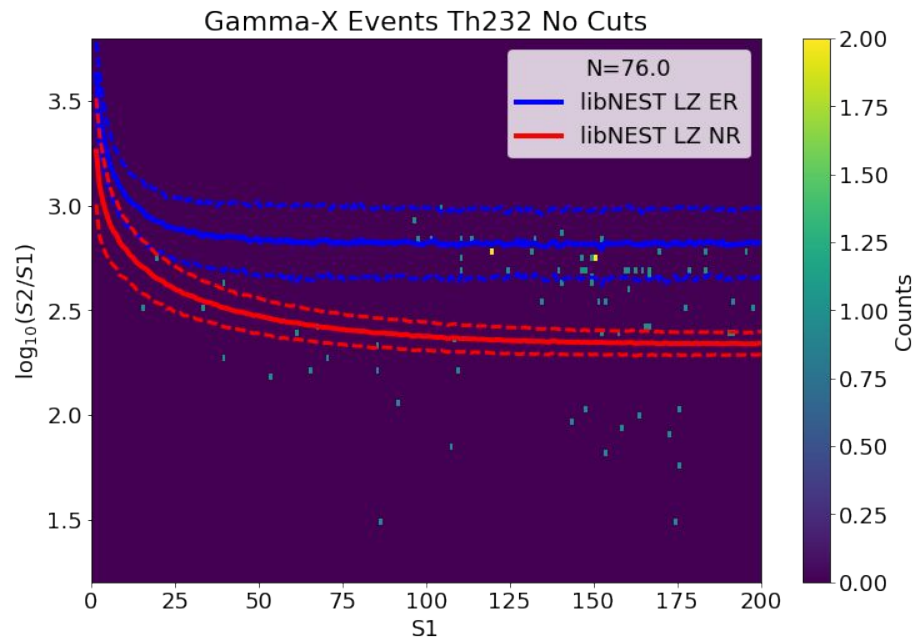
Electron lifetime (μs) as a function of time



Gamma-X

Wrote code to calculate the expected rate of Gamma-X events from the PMT windows.

Produced plots like the one on the right which show a large number of events in the WIMP search region (the left side of the red region)



Previous Gamma-X Results

Higher than all combined
LZ backgrounds

Source	Decays Simulated	Fraction which produce Gamma-X (all)	Fraction in WIMP search region (Depending on S1 S2 cut)	Approximate rate (assuming production from PMT windows and no cuts)
Th-232	14,900,000	0.012887 192507 Events	$\sim 4.0 \times 10^{-7}$	0.24 events per year
U-238	4,150,000	0.013739 57094 Events	$\sim 1.2 \times 10^{-6}$	3.83 events per year
Co-60	9,800,000	0.080683 790704 Events	$\sim 4.0 \times 10^{-7}$	0 (No Co60 in PMT windows)
K-40	9,400,000	0.004208 39559 Events	$< 1.0 \times 10^{-7}$	< 0.13 events per year

Comparing Apples to Apples

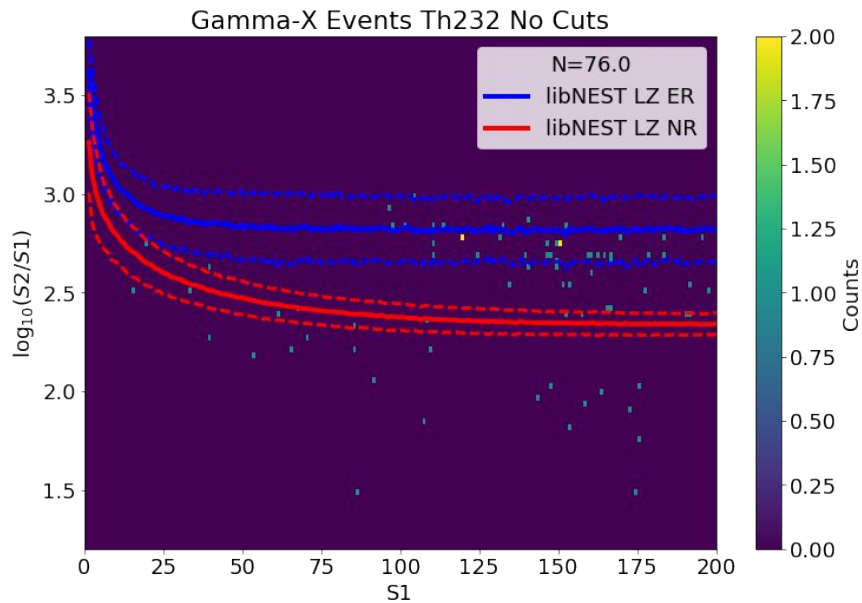
All of the LZ backgrounds are summarized in the backgrounds control table which follows a very specific procedure to generate background rates.

I was doing something similar but not exactly the same.

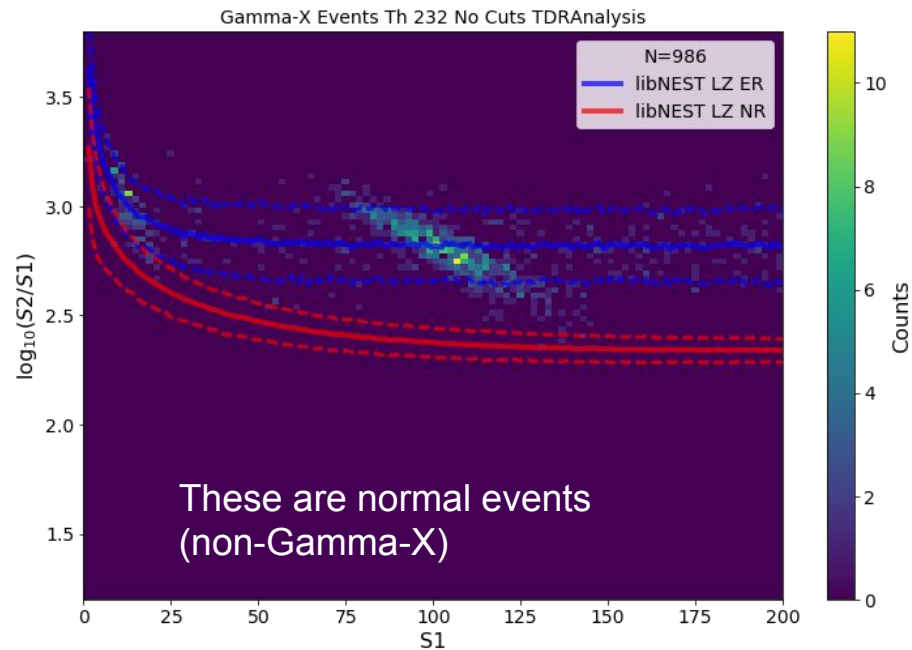
To see how well my rates compare with the total rates I modified the control table to work with gamma-x events.

Source	Mass (g/unit)	Mass (g)	Activity (mBq/kg)	Livetime equivalent	# beamOn	# beamOn E-scaled	# Surv. All	R-factor	Surviving 1000 days	Events Per year
U early (y)	38.0	9158	13.21	1.39E+01	1.00E+07	1.45E+08	17.00	1.68E-08	1.75E-01	6.41E-02
U late (y)	38.0	9158	0.75	2.43E+02	1.00E+07	1.45E+08	17.00	1.17E-07	6.98E-02	2.55E-02
Th (y)	38.0	9158	1.01	1.85E+02	1.02E+07	1.48E+08	36.00	2.43E-07	1.94E-01	7.09E-02 ₉

Gamma-X Plots With New TDRAnalysis Method

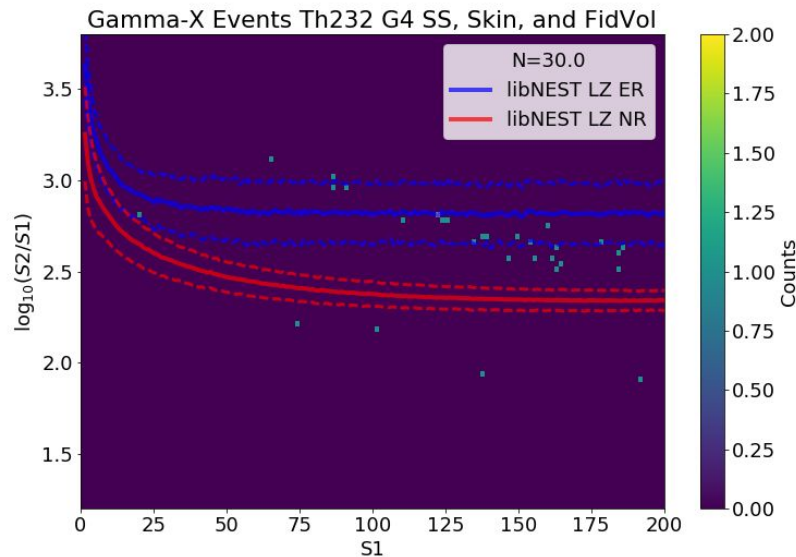


Old Method

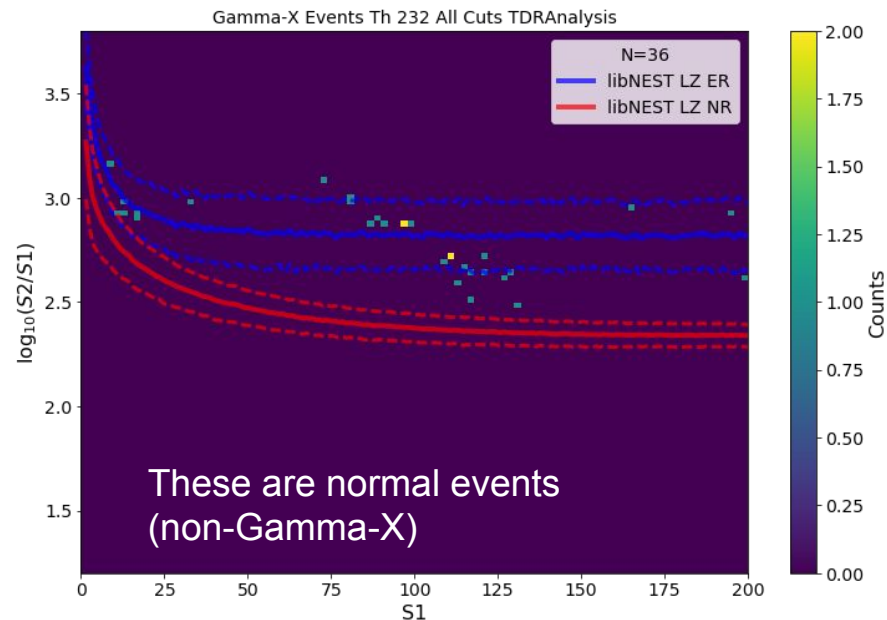


New Method

Gamma-X Plots With New TDRAnalysis Method W/ Cuts



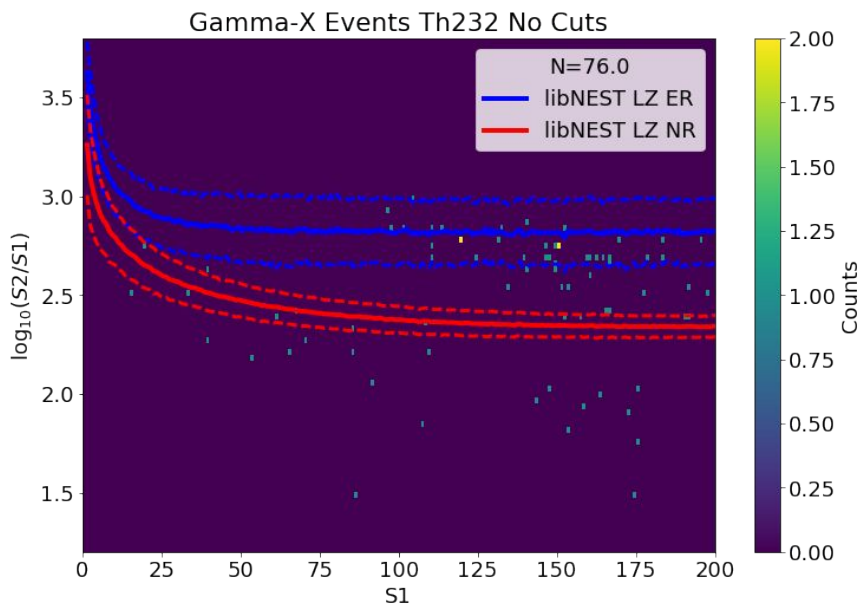
Old Method



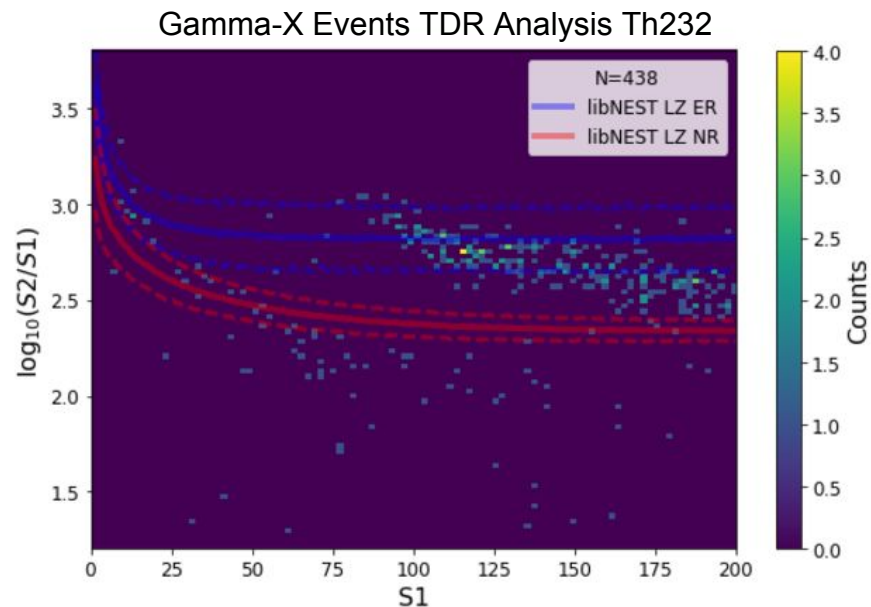
New Method

Latest Gamma-X Update

- Plots shown last week were only “normal” events



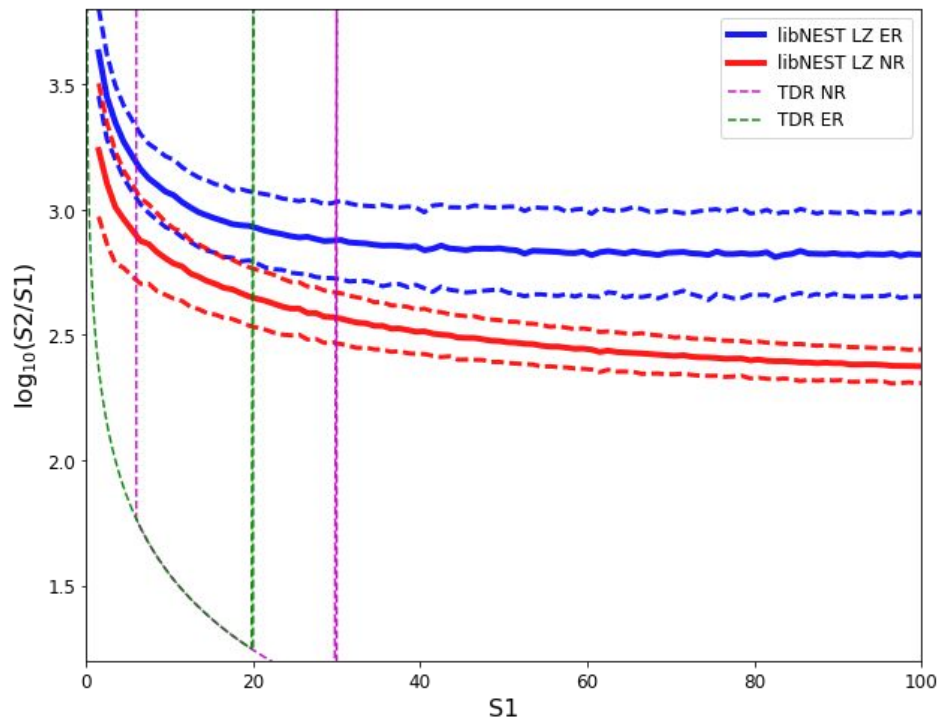
Old Method



New Method

TDR vs. My Cuts

- The TDR Analysis assumes that when ER events are produced that only ER events are seen. With that assumption it can make a more rough cut on S1 and S2. This only works for normal events, but not Gamma-X events.
- I will use all 4 cuts to be able to compare my rate to the TDR as well as provide a more accurate estimate of the rate



Fall 2017 Plan

- Gamma-X
 - Continue to improve and compare the Gamma-X result with those of others
 - Look for Gamma-X events in the MDC 1 data then see if there is some way to discriminate against them.
- Cable making
 - Will soon begin clearing out the server room
- Phase 1 Data Analysis
 - Assist with the Phase 1 analysis in run 7
- Cameras
 - Possibly work on cameras that would be able to run in cold gas or liquid xenon. These would likely need to be different than those used in Phase 2.

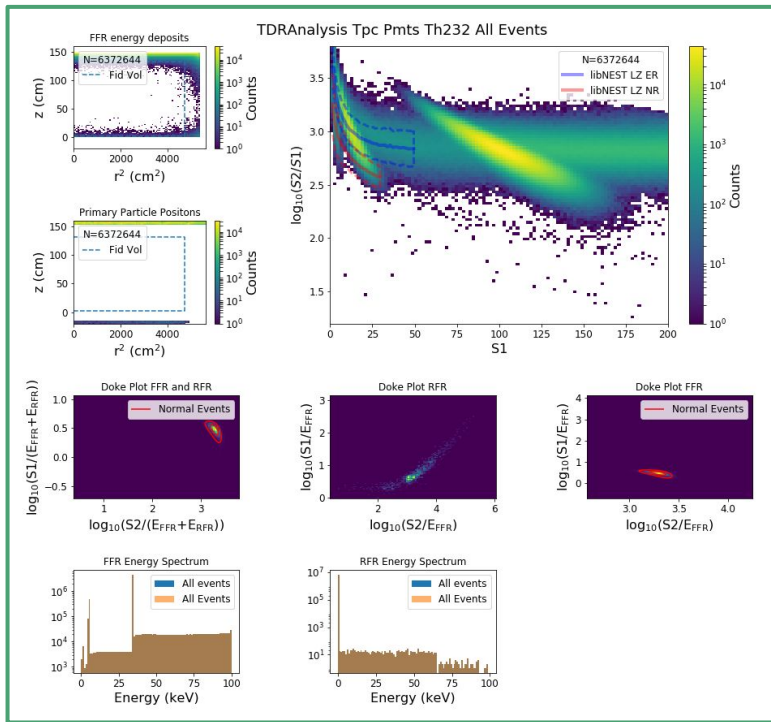
Gamma-X rates

I ran the TDR Analysis which outputs whether or not an event is a Gamma-X

I did the same thing for a few sources (Full PMTs, Bottom Grid, Anode Grid, Cathode Grid, Field Rings, and Vessels)

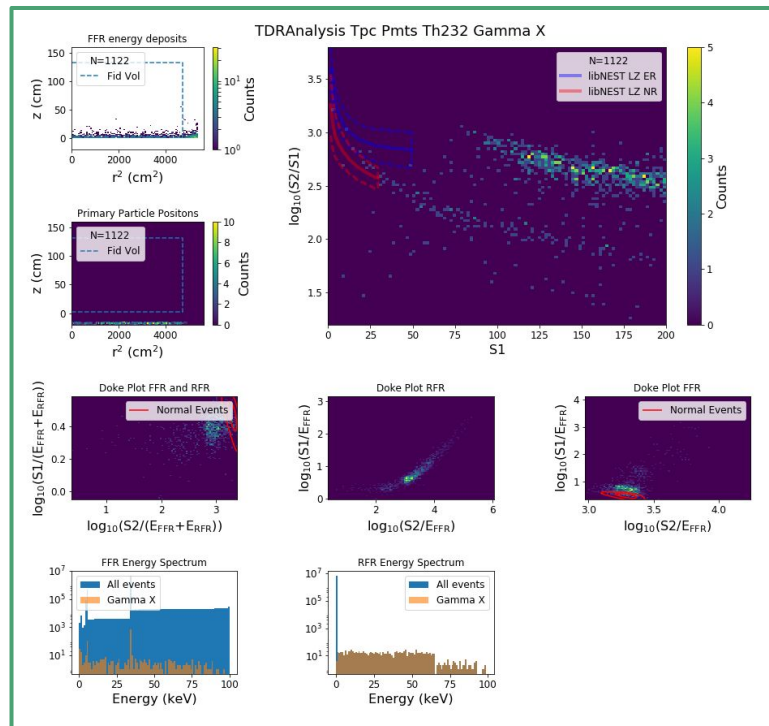
Compare the rates expected after making the three different energy cuts (the TDR ER cut, libNEST ER band cut, libNEST NR band cut)

Gamma X Update



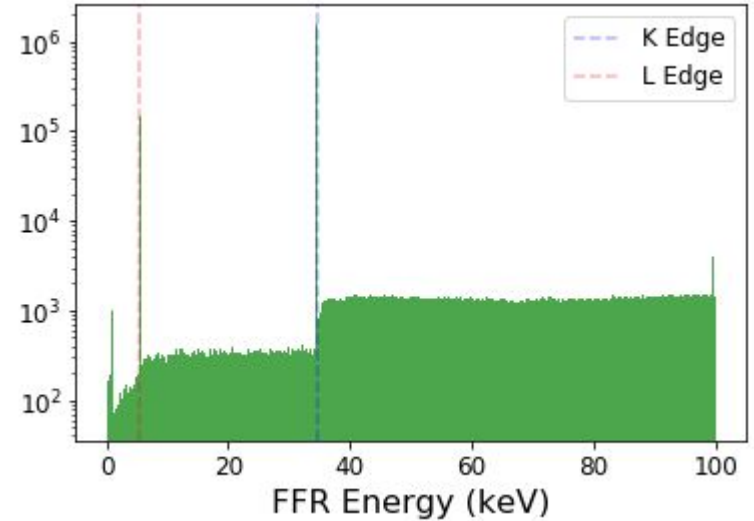
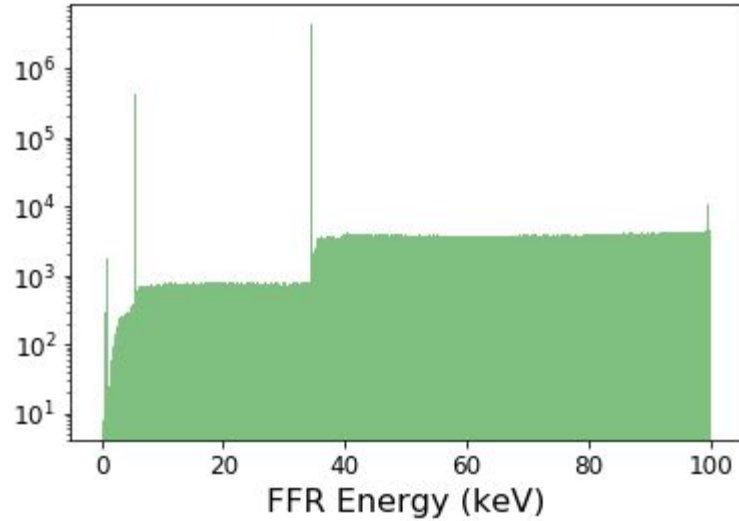
All events (Gamma-X and Normal)

Full PMTs with no cuts



Gamma-X events only

Lines in Energy



Lines in energy deposition correspond to Xenon energy levels

Gamma-X rates All PMTs (including all cuts)

Type of Events	Energy Cut	Events per 1000 days	Fraction of all events that are Gamma-X	BG Table Rate (per 1000 days)	Difference between my results and BG table
Normal Events	TDR ROI	16.80	0.14%	1.46	1055%
	My ER ROI	15.36	0.00%		954%
	My NR ROI	2.14	9.87%		63%
Gamma-X Events	TDR ROI	0.02			
	My ER ROI	0.00			
	My NR ROI	0.23			

Gamma-X rates Anode Grid (including all cuts)

Type of Events	Energy Cut	Events per 1000 days	Fraction of all events that are Gamma-X	BG Table Rate (per 1000 days)	Difference between my results and BG table
Normal Events	TDR ROI	0.50	0.00%	Not Calculated	Not Calculated
	My ER ROI	0.46	0.00%		Not Calculated
	My NR ROI	0.06	0.00%		Not Calculated
Gamma-X Events	TDR ROI	0.00			
	My ER ROI	0.00			
	My NR ROI	0.00			

Gamma-X rates Bottom Grid (including all cuts)

Type of Events	Energy Cut	Events per 1000 days	Fraction of all events that are Gamma-X	BG Table Rate (per 1000 days)	Difference between my results and BG table
Normal Events	TDR ROI	0.132	4.84%	Not Calculated	Not Calculated
	My ER ROI	0.105	4.39%		Not Calculated
	My NR ROI	0.015	42.62%		Not Calculated
Gamma-X Events	TDR ROI	0.007			
	My ER ROI	0.005			
	My NR ROI	0.011			