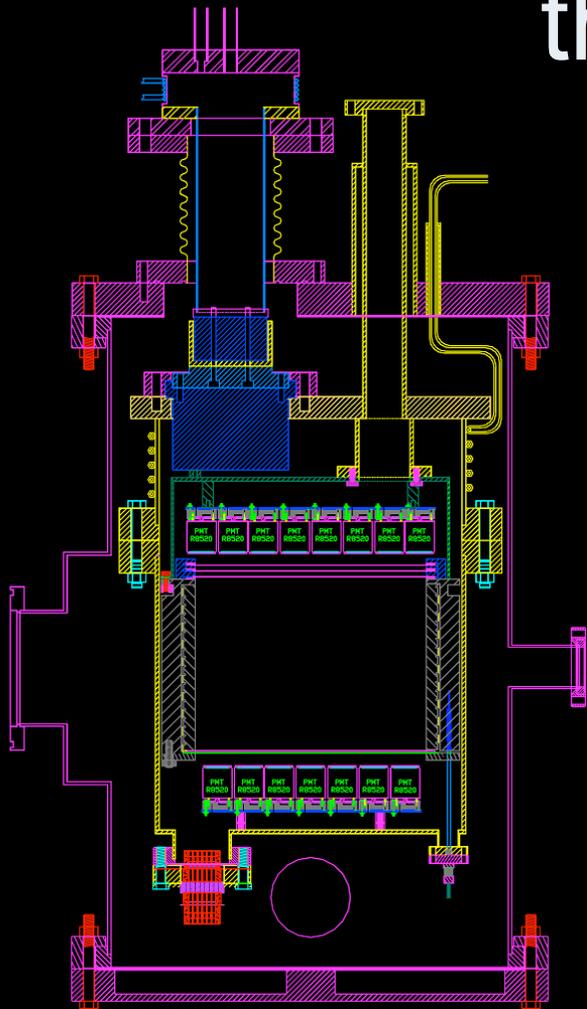


Nuclear Recoil Discrimination in the Xenon10 Detector

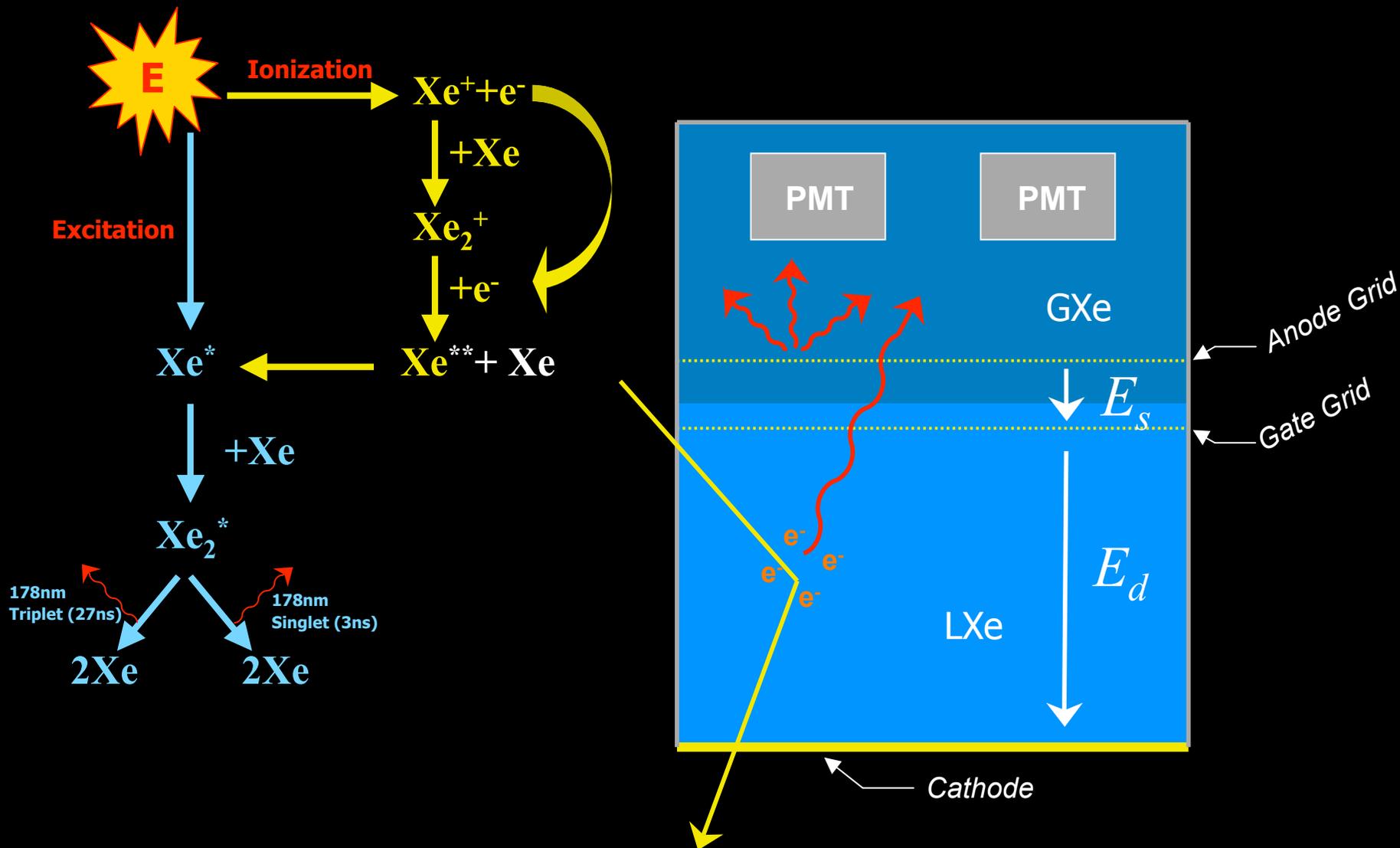


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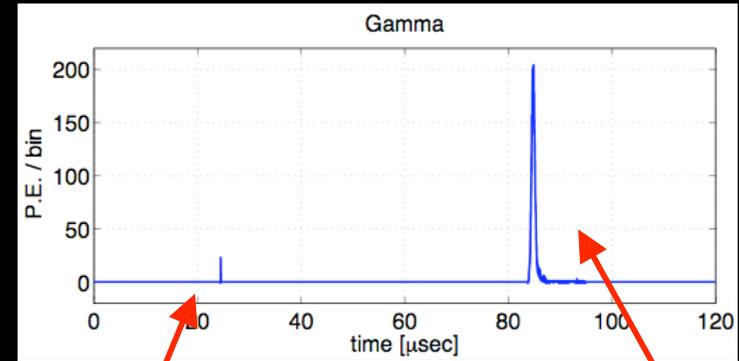
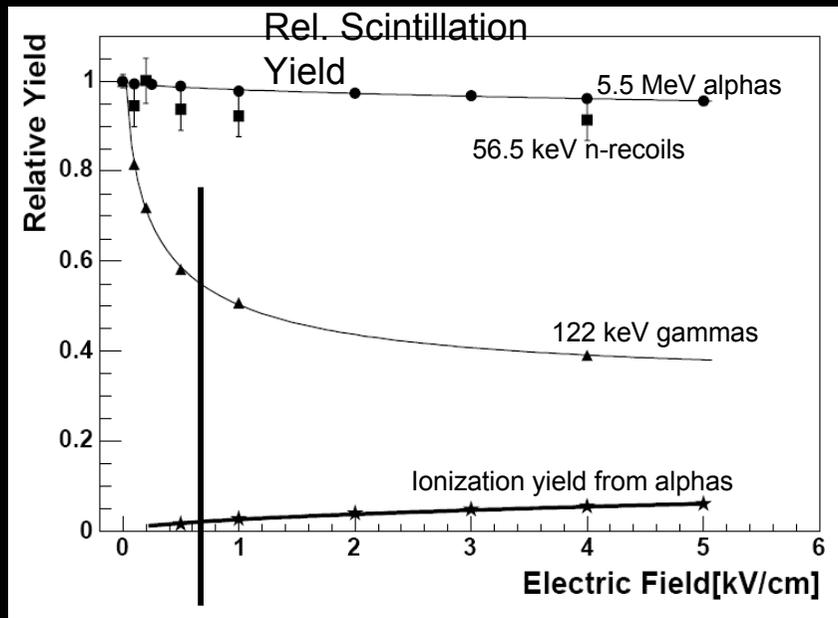
APS, April 14 2007, Jacksonville FL

Interaction and Detection

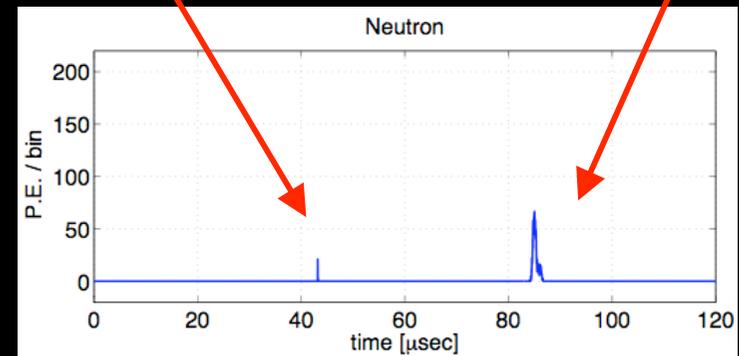


Field Quenching -

As the drift field is increased, fewer and fewer electrons recombine with their parent ions. Due to differences between the track structures of recoiling electrons and recoiling nuclei, the two species experience different amounts of quenching.



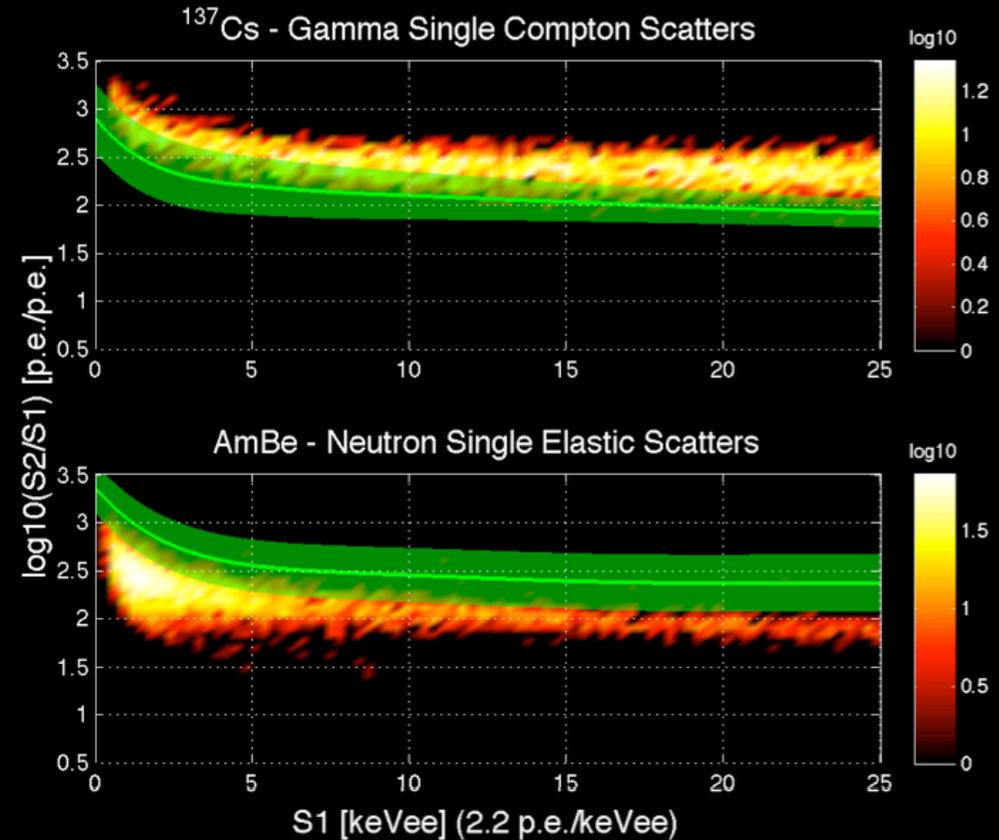
S1 (PMT Output) S2



Electronic and Nuclear Recoil Bands

The effects from differing field quenching can be seen in the shape and position of the electronic and nuclear recoil bands.

In both plots, the green line represents the centroid of the opposite band, and the shaded region gives the ± 2 sigma of that band.



Discrimination Technique

Calibration Stats:

Cs137: 8576 Events (0-37 keVee)

2126 Events (2-12 keVee)

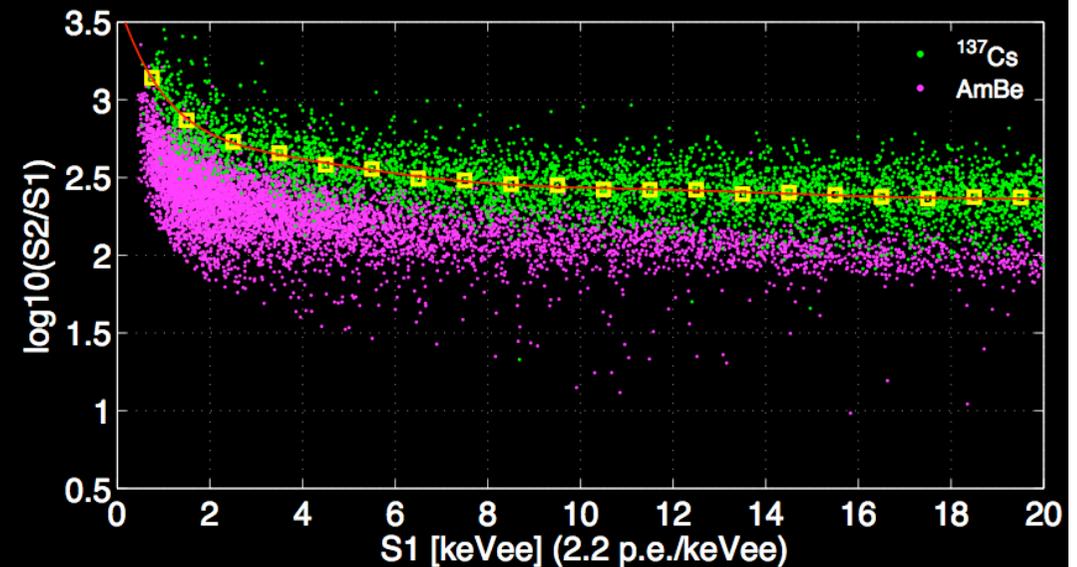
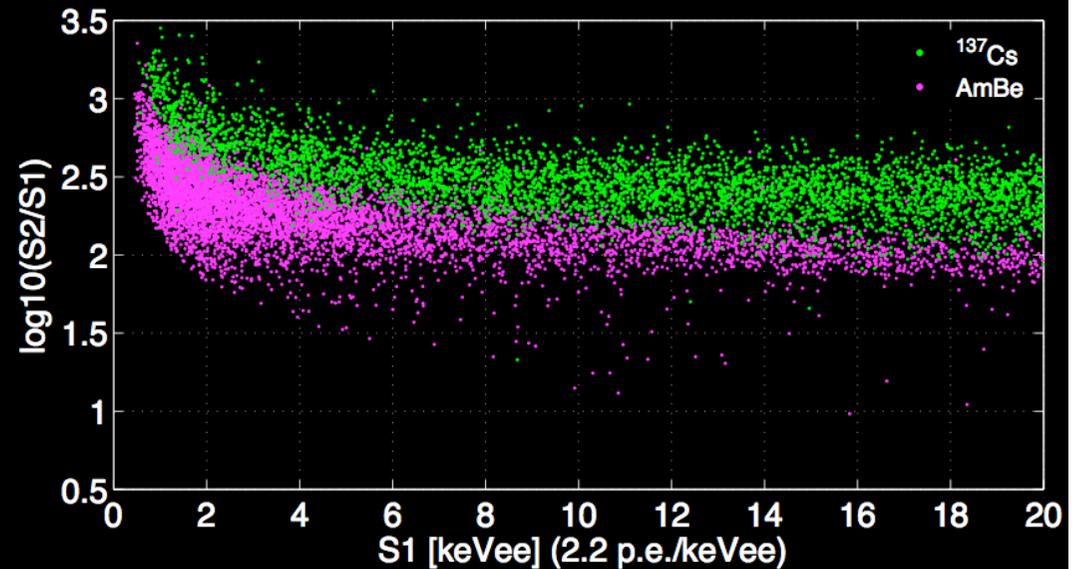
AmBe: 7442 Events (0-37 keVee)

3668 Events (2-12 keVee)

The discrimination is performed using the following steps:

-The Electronic Recoil (ER) band (green dots in both plots at right) is split up into vertical slices. For each slice a gauss fit is applied to its $\log_{10}(S2/S1)$ spectrum. The yellow squares in the bottom plot represent the gauss mean given from the fit for each vertical slice.

-In order to obtain an analytical form for the ER band, the yellow squares are fit with a polynomial (red line).

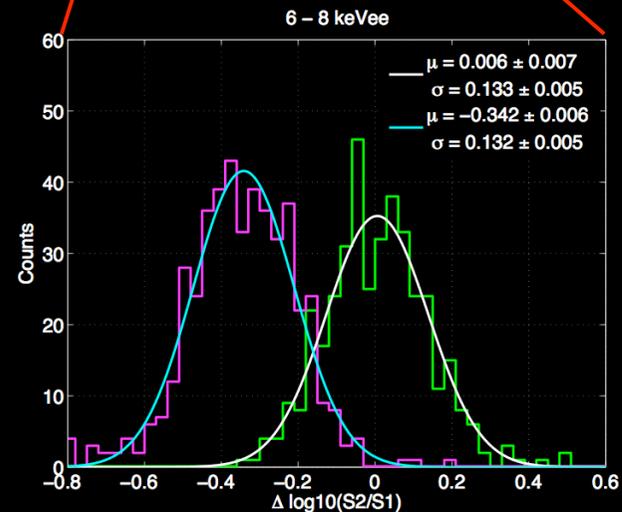
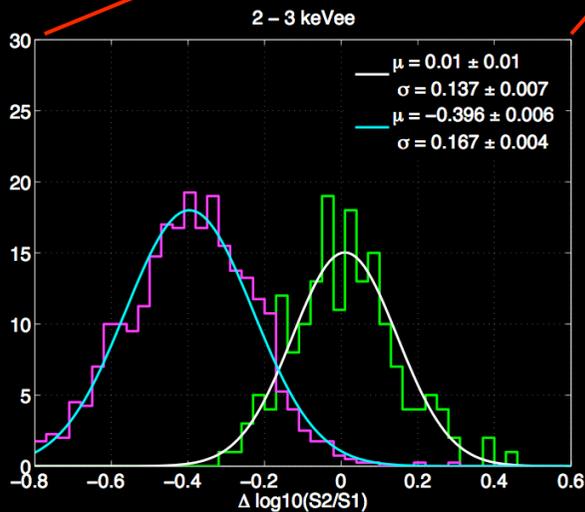
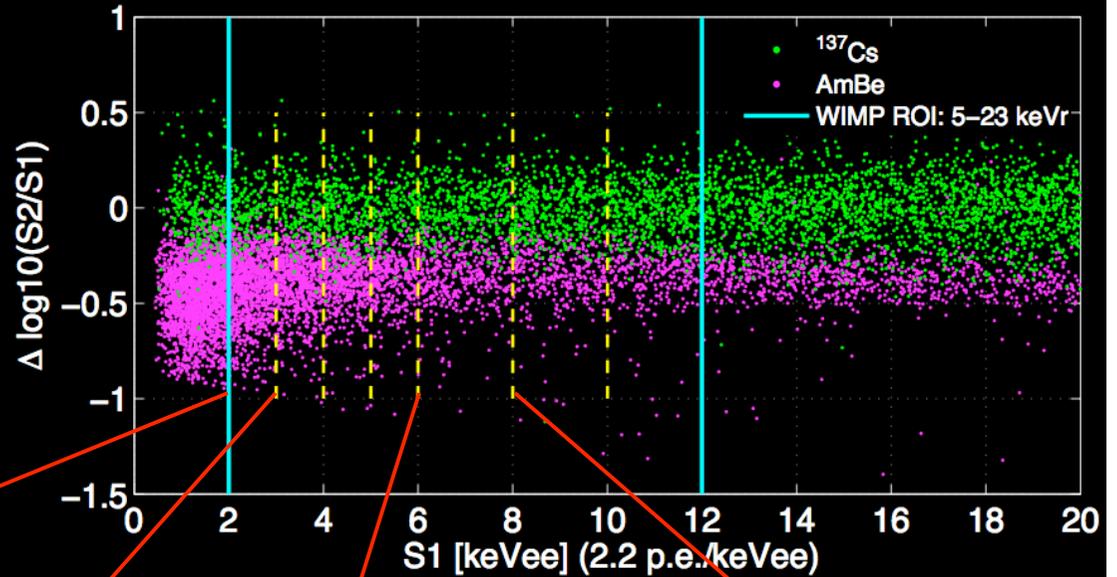


Discrimination Technique

-The ER centroid is then subtracted from every data point, giving the parameter $\Delta \log_{10}(S2/S1)$. This removes much of the energy dependence of the bands.

-Both bands, in Δ -space, are broken up into 7 slices (yellow-dashed) within the WIMP ROI. For each, a gauss fit is applied to the spectrum of BOTH ER and NR bands (see insets).

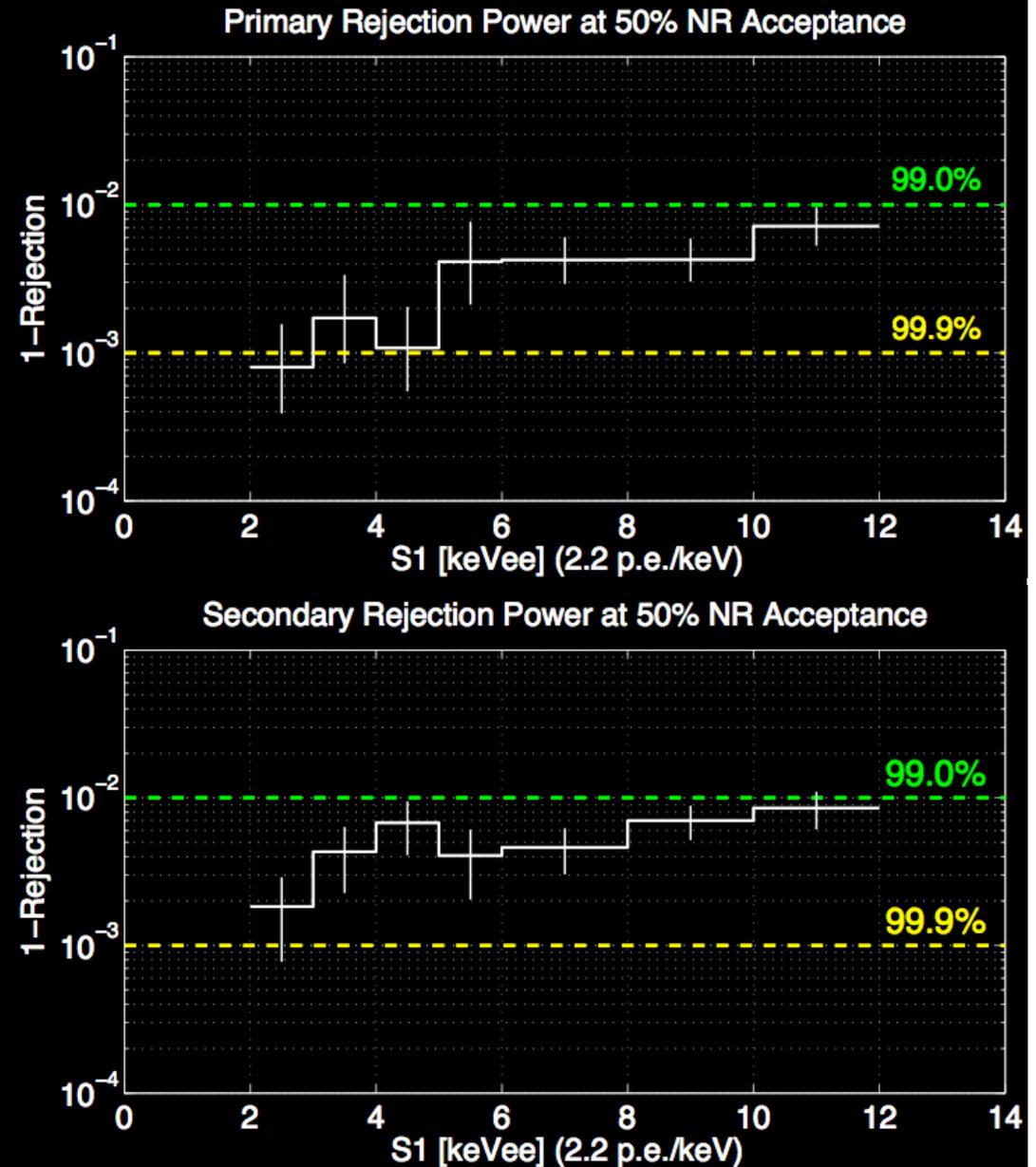
-We take 50% acceptance of the NR band, and find the ER rejection for each bin.



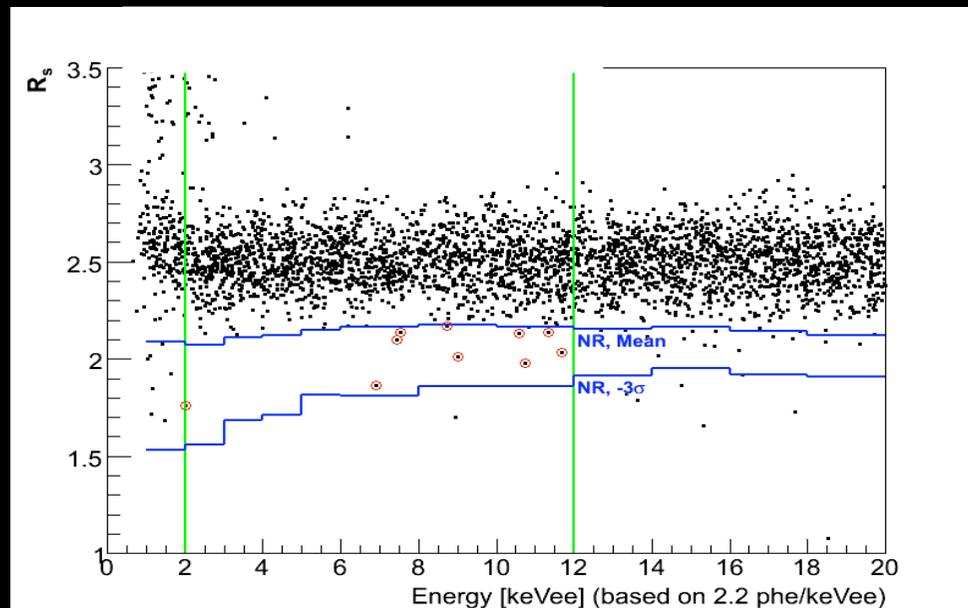
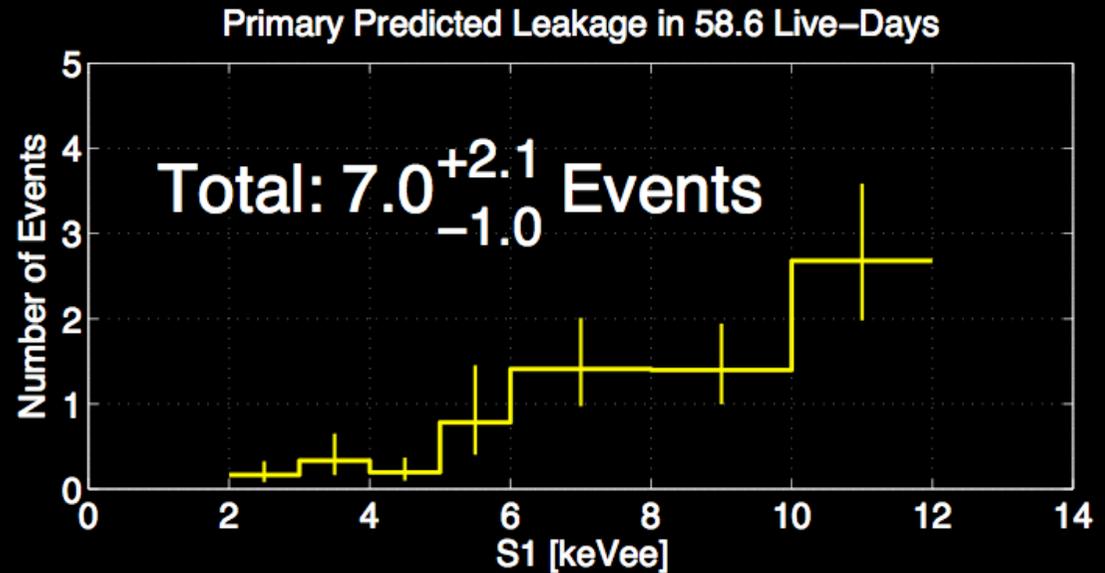
Rejection and Predicted Leakage

For each energy bin, the ER rejection at 50% NR acceptance is calculated based on the Gaussian fits to the bands in Δ -space.

Shown are the ER rejection powers for both primary and secondary analyses.



Given the calculated rejection, the WS 3+4 livetime (58.6 days), and background rate in the fiducial region, we can find a value for the predicted statistical leakage for each energy bin.



Summary

- Discrimination exploits differing field-quenching of S1.
- Allows us to veto the vast majority of background events, due to gammas.
- Contrary to expectation, Rejection power actually IMPROVES at lower energies, to better than 3 - NINES at ~ 5 keVr !