XENON100

Paul Scovell
On behalf of the XENON100 collaboration

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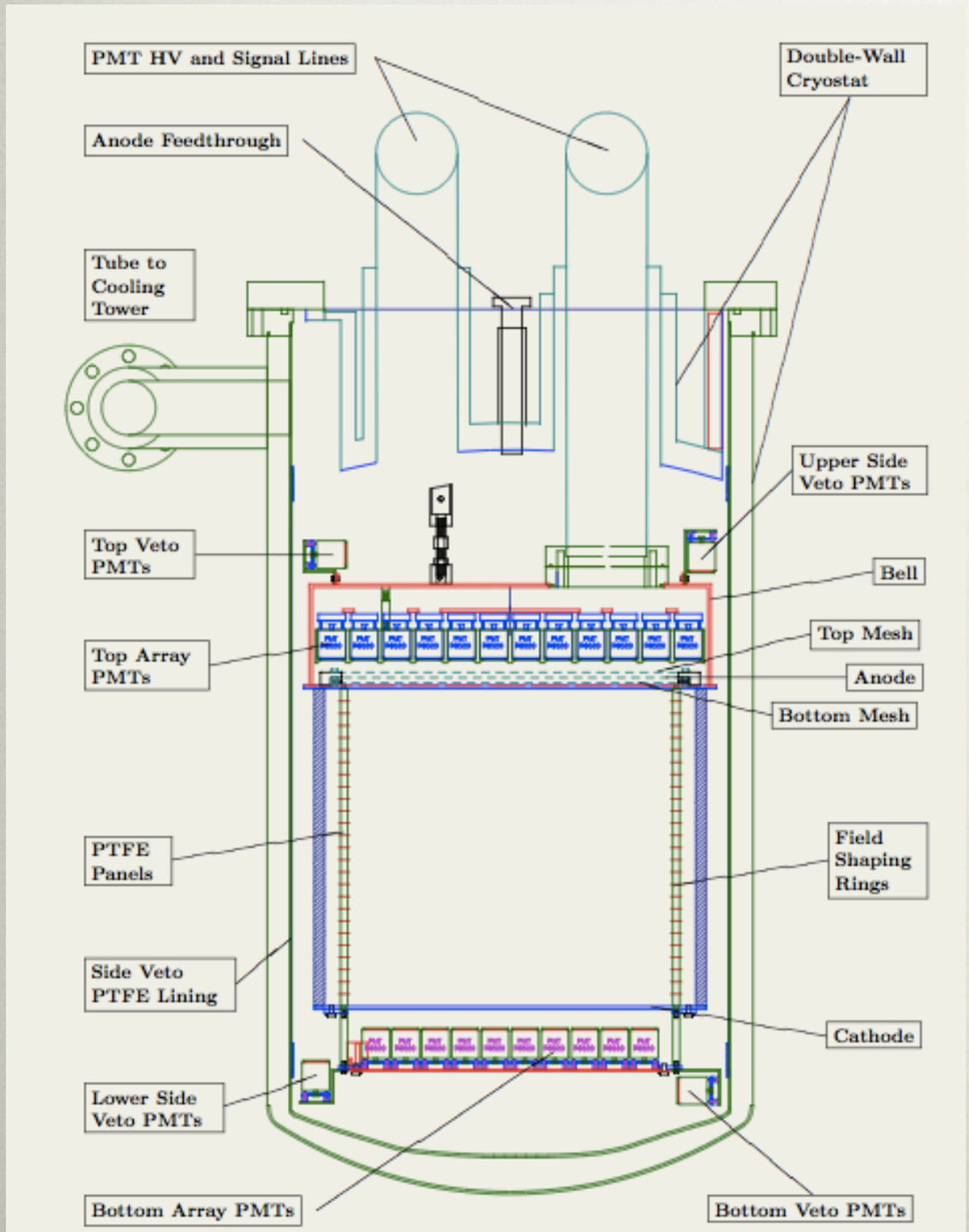
XENON100 Collaboration

Columbia · Rice · UCLA · U Zürich · Coimbra · LNGS · SJTU

Bologna · MPIK · NIKHEF · Mainz · Subatech · Purdue · Münster · WIS

XENON100



- Compared with XE10:
  - x10 fiducial mass increase
  - x100 background decrease

- All components screened at dedicated screening facilities at LNGS

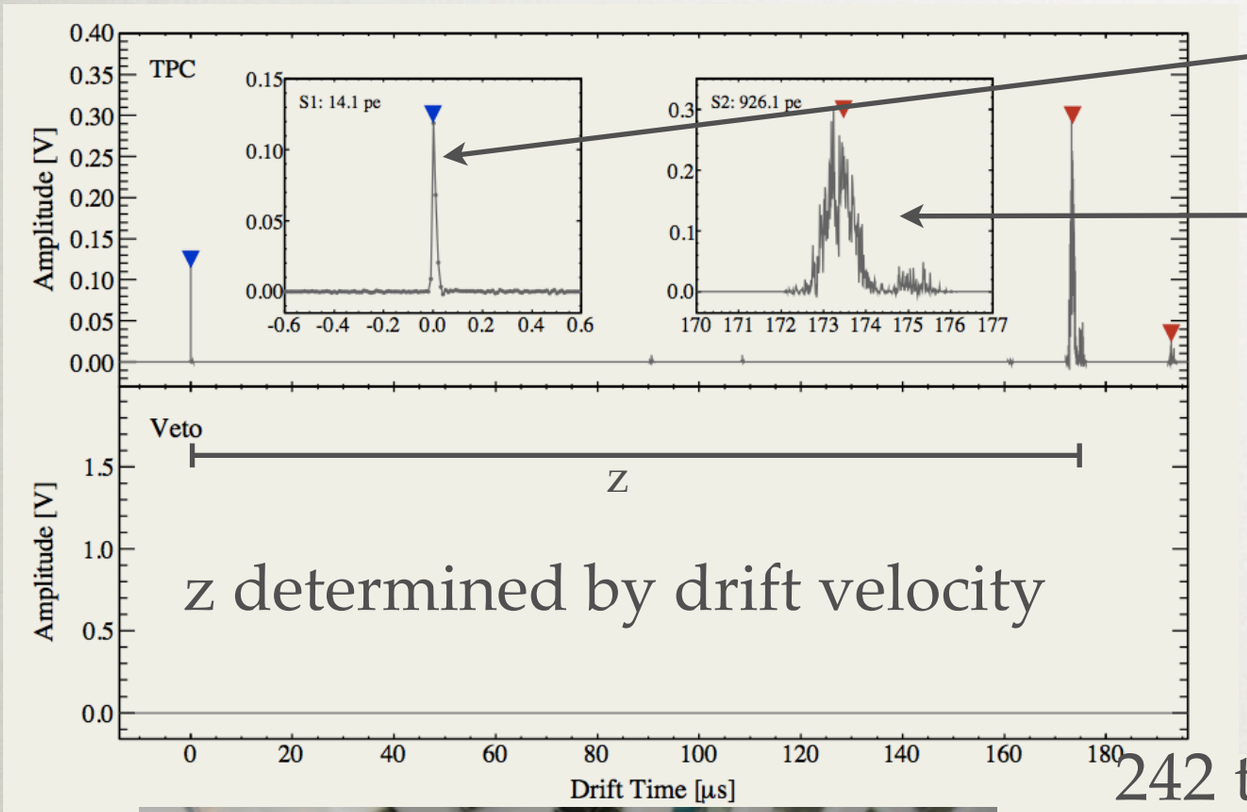
- 161kg LXe total, 62kg target volume, 99kg LXe veto. 15cm Radius, 30cm drift

- Cathode at -16 kV, drift field of 0.533 kV/cm. Proportional scintillation region with field ~12 kV/cm.

- Custom-made low radioactivity HV feedthroughs.

Aprile *et al.*, Astropart.Phys.35:43-49,2011

XENON100 Waveforms



Primary

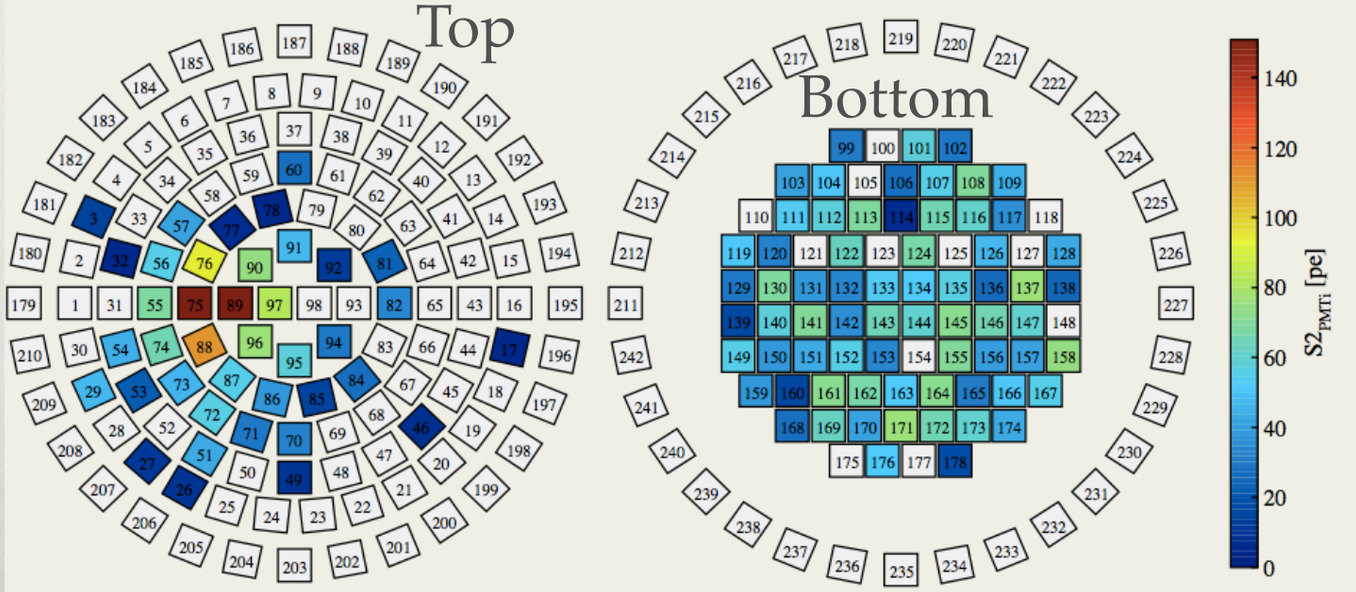
Secondary

z determined by drift velocity

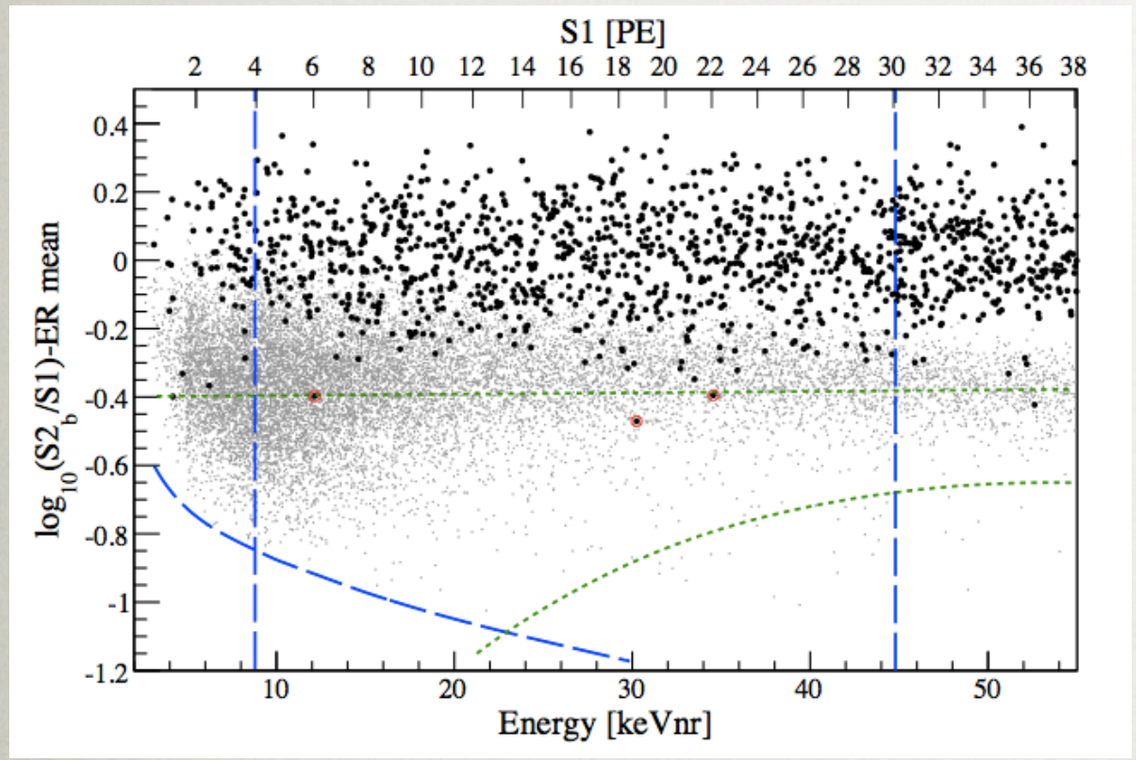
Position determined by top array

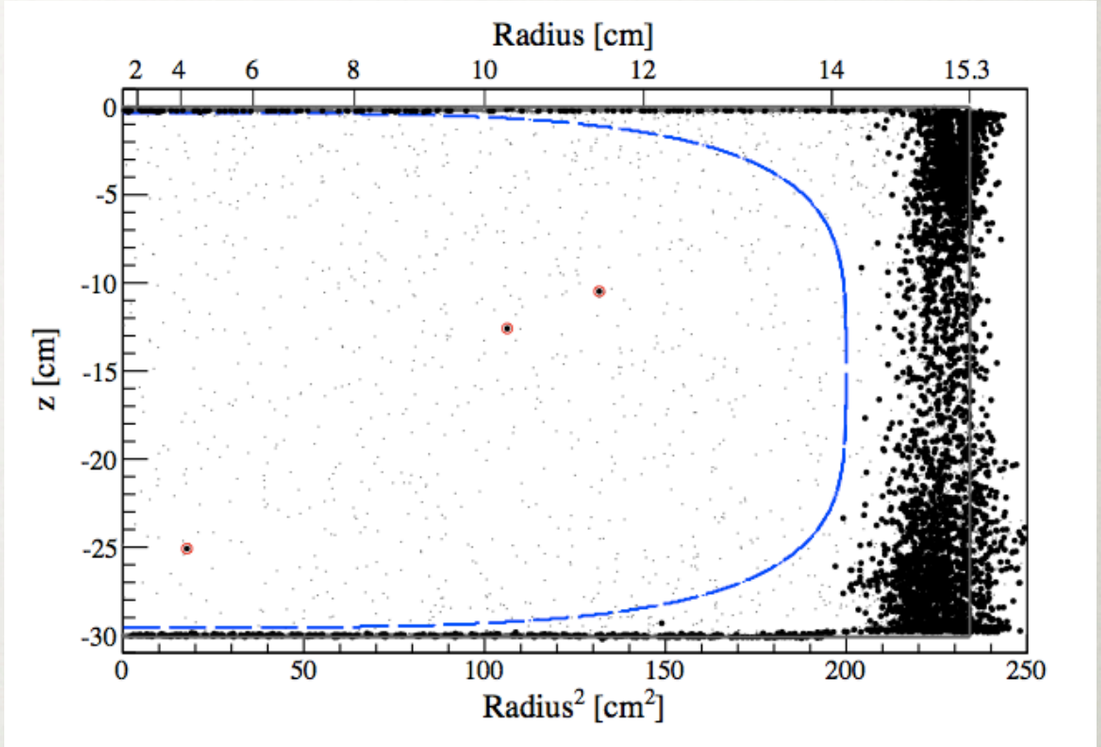
Checks performed using bottom array

242 total PMTs. 178 in active TPC volume



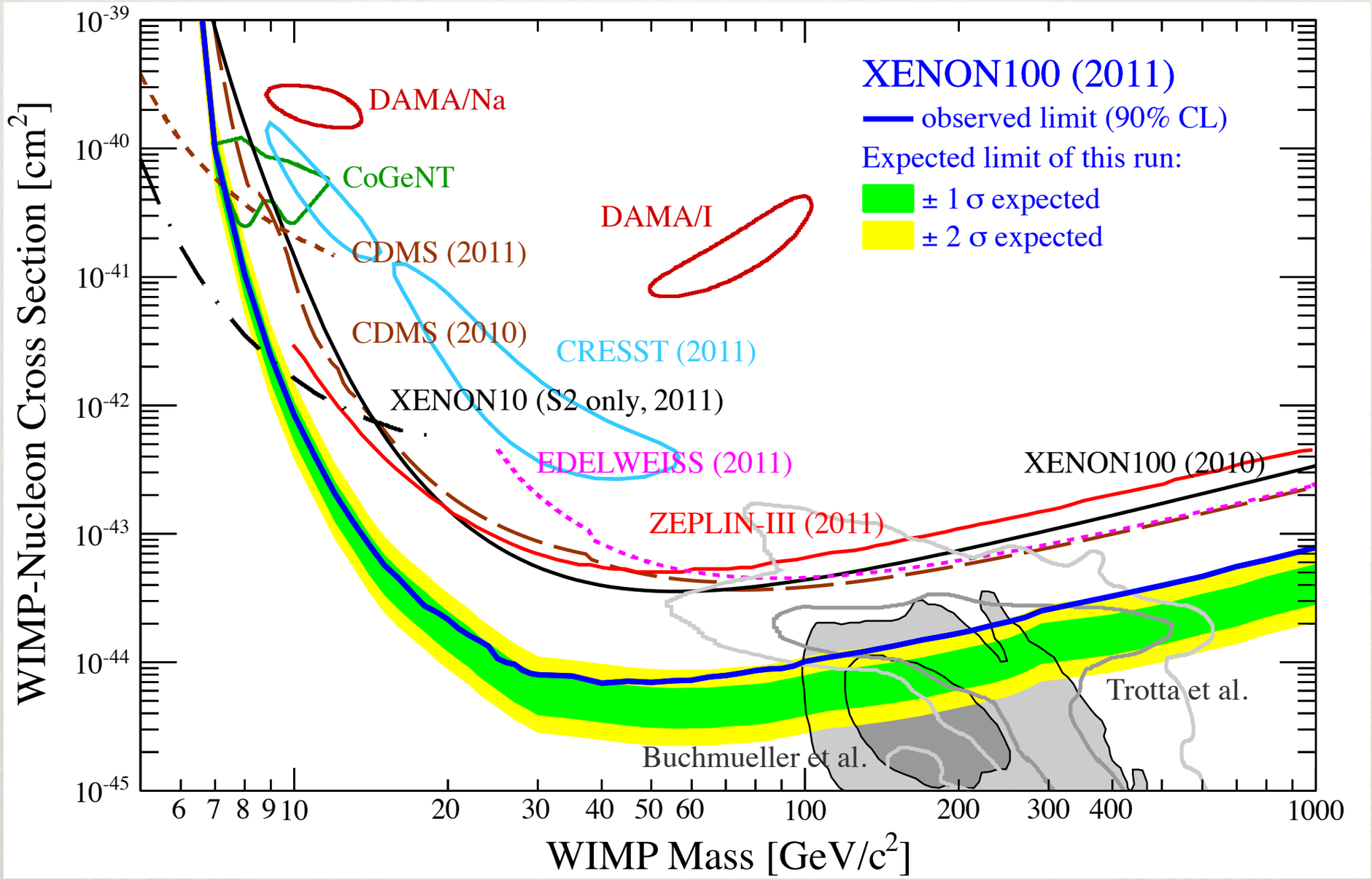
First Results From XE100





- After unblinding and application of a new noise removal cut, 3 events remain with expectation of 1.8±0.6.
- Uniform in r and z.
- Consistent with background leakage

100.9 Day Results From XE100



7×10^{-45} cm^2 at 50 GeV/c^2

Aprile *et al.*, Phys. Rev. Lett. **107**, 131302, 2011

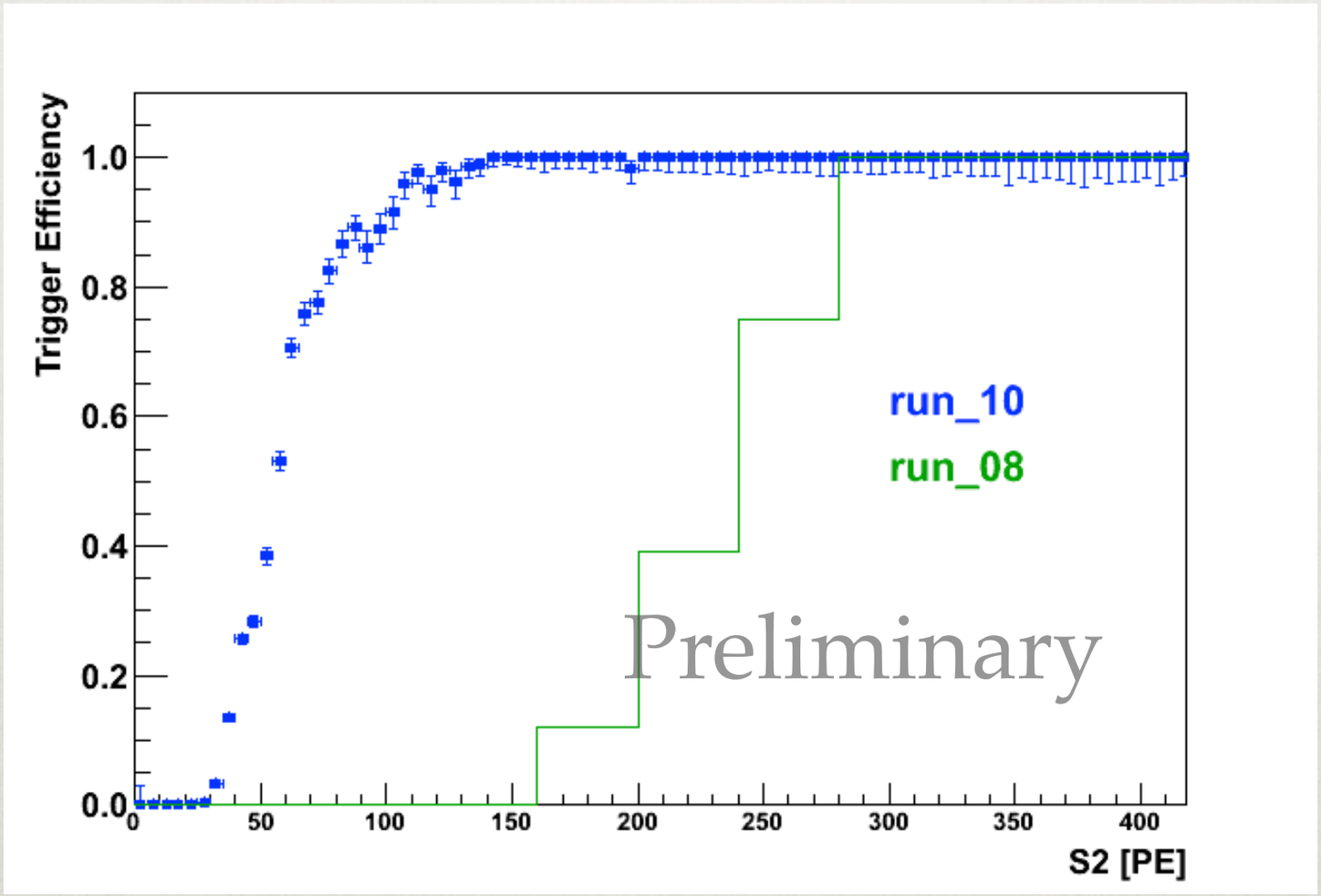
Update Since 100.9 Day Run

After analysis of 100 days of data:

- No changes made to TPC - detector not opened between runs
  - Improved trigger
  - Able to probe to lower energies
- Reduction of Krypton background
  - Circulation of Xe through dedicated distillation column
- Improved methods to tackle anomalous background
  - Multiple scintillation, single ionisation
  - Electronic noise
- Improved statistics in electron and nuclear recoil calibrations
  - Now using regular Co-60 and Th-232 measurements
  - Cs-137 still taken regularly to monitor electron lifetime. Lifetime now up to ~0.5ms

Trigger Improvements

- 100% efficiency down to 150 PE in S2

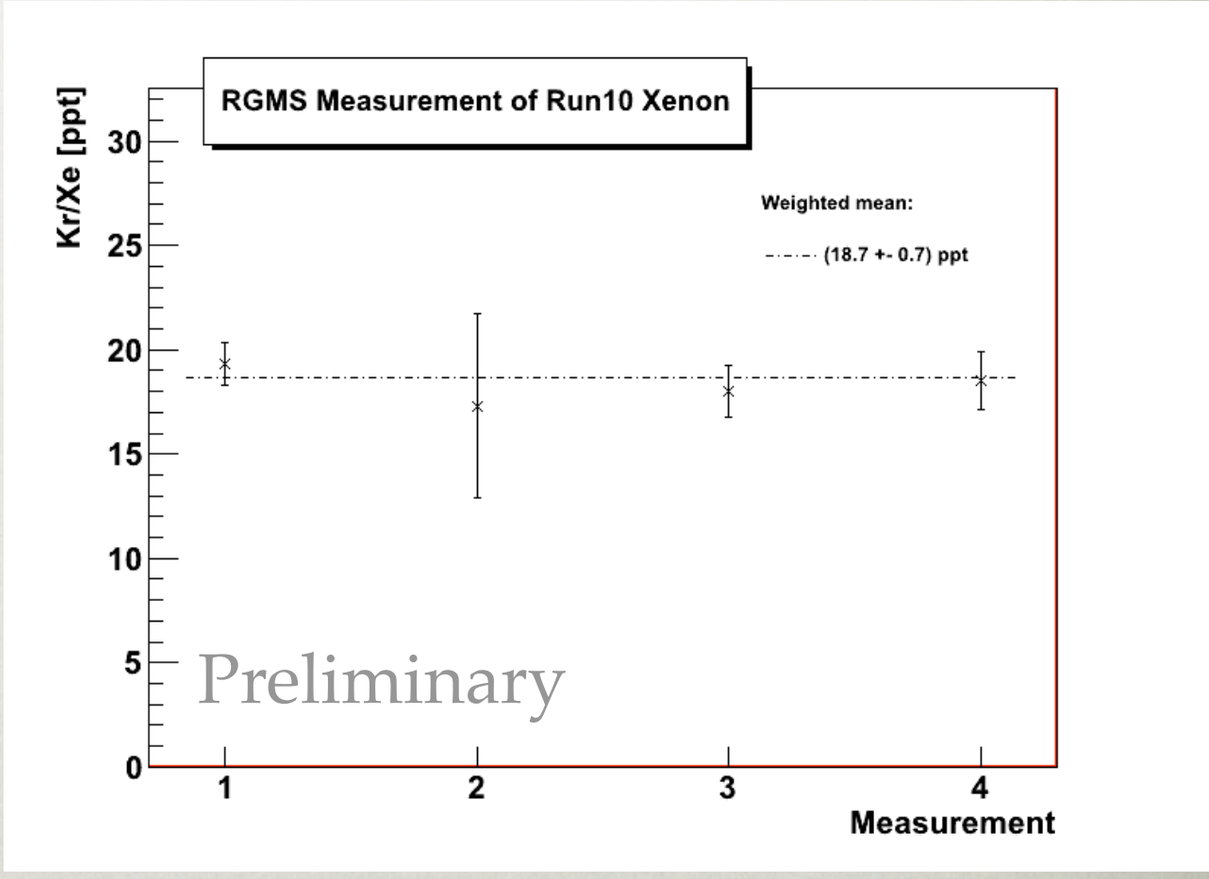


- Improvement in trigger electronics and increased electron lifetime allows extension of reach to lower energies

Background Reduction

Reduction of intrinsic background - Kr85

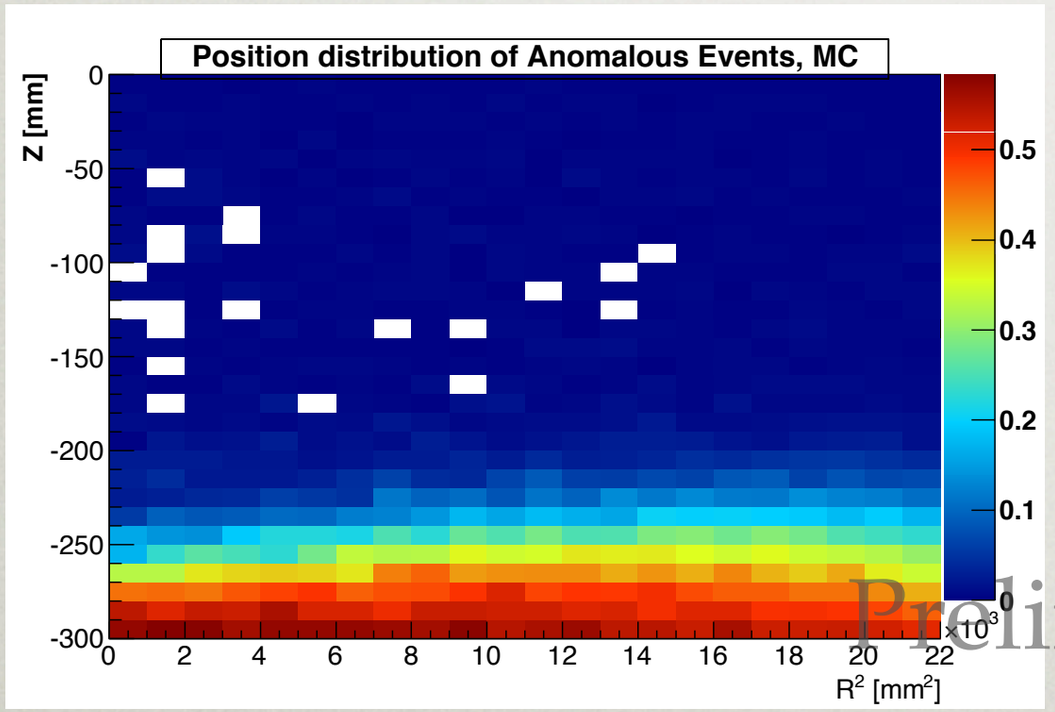
- Kr 85 is internal background
- Decays via electronic process, indistinguishable from gamma background
- 100 days run suffered in sensitivity due to increased Kr/Xe from accidental leak
- In Autumn 2010, xenon circulated through dedicated distillation column
- Kr/Xe reduced significantly with respect to 100.9 days run
- Dedicated measurement gives - (19±1) PPT



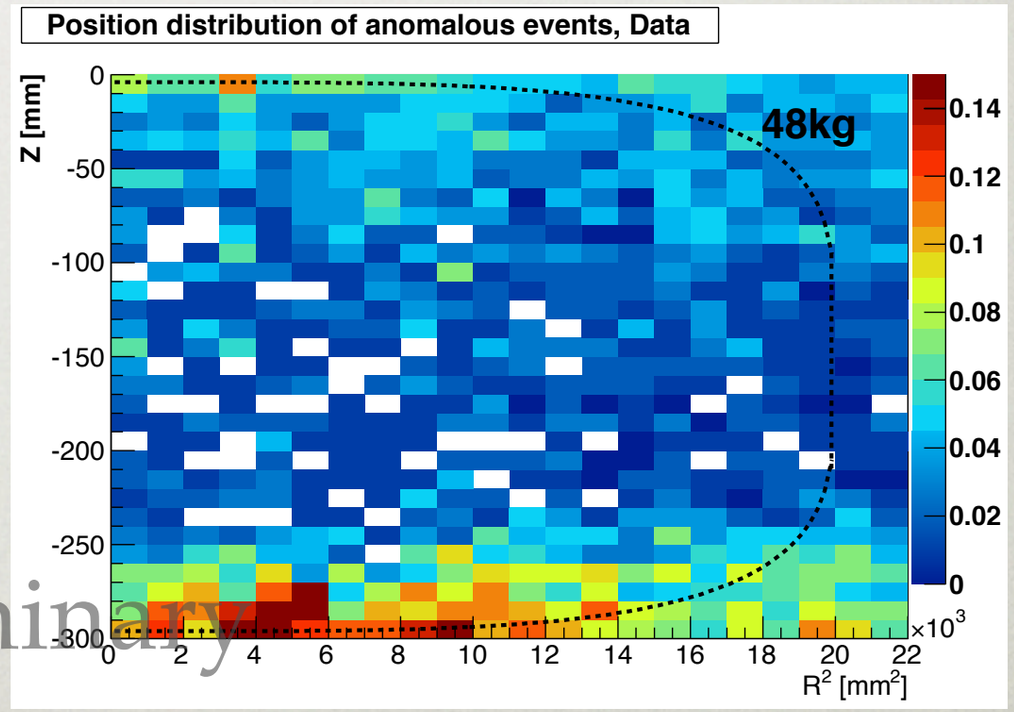
Background Reduction

Removal of anomalous background

Pattern likelihood algorithm applied
compares S1 light pattern to expected
Trained using Monte-Carlo simulation



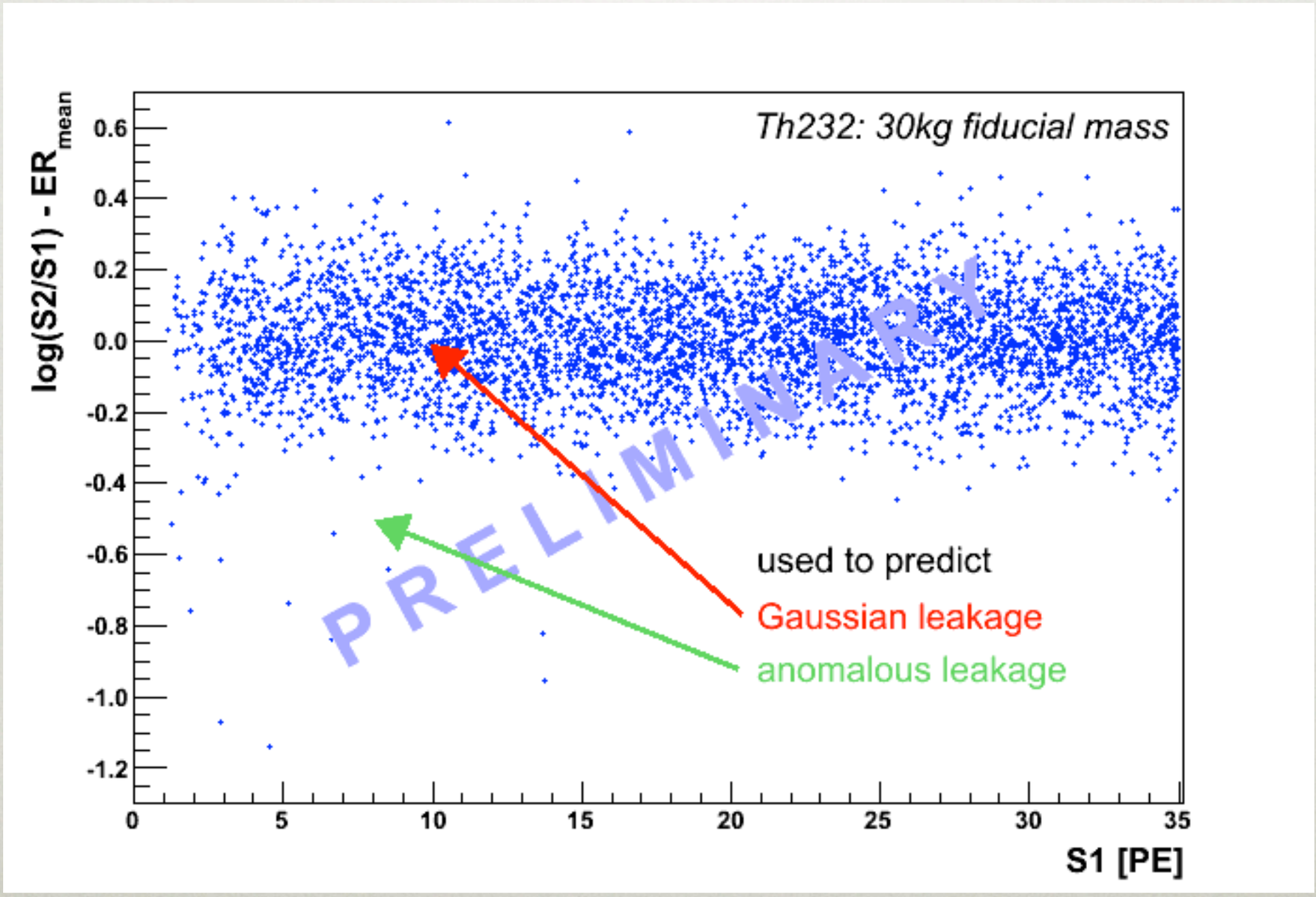
Co60 Monte-carlo



Co60 Data

Calibrations - Gammas

Major component of background comes from gamma-ray emission.
Sources used to model expected background.

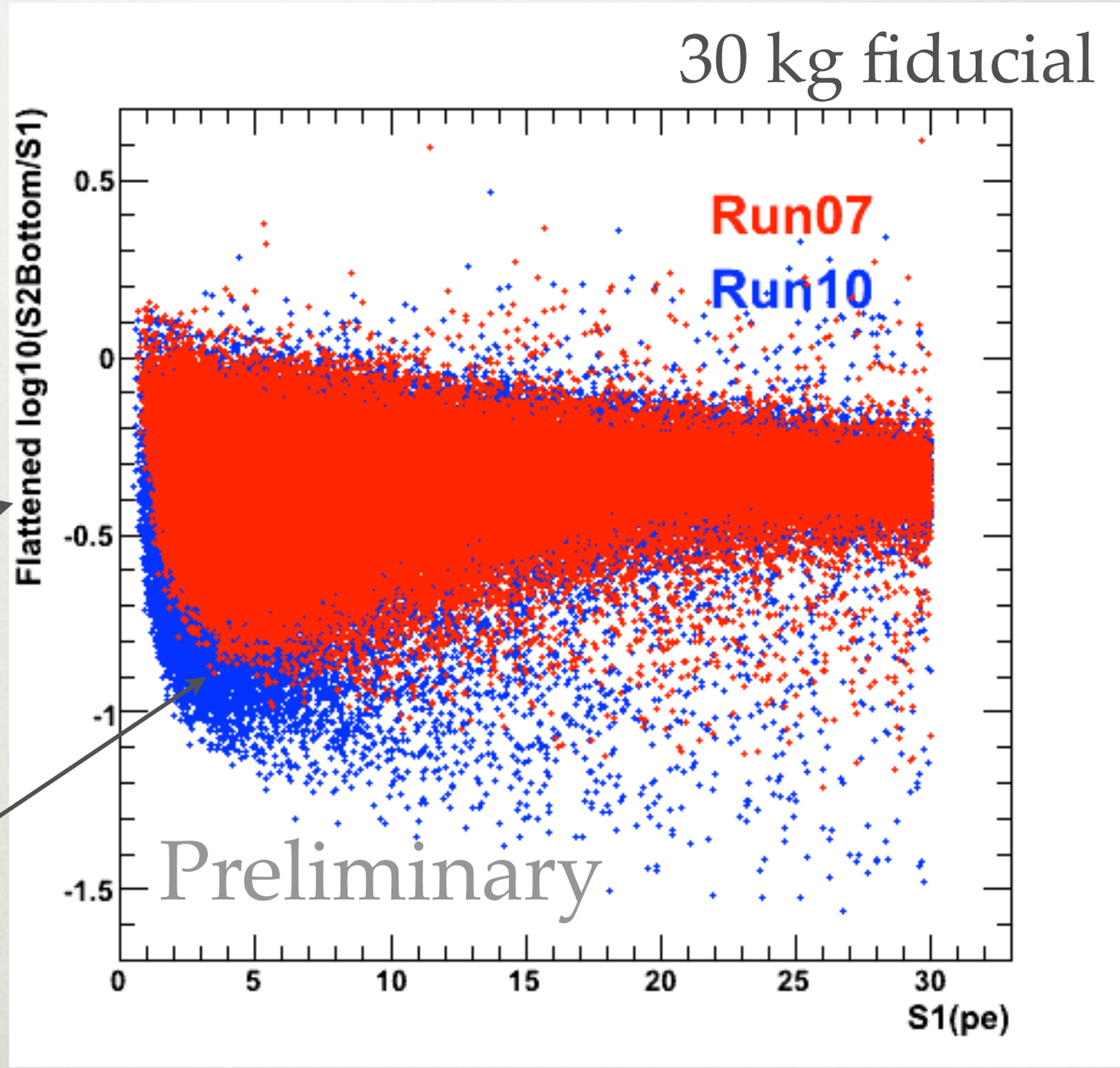


Calibrations - Neutrons

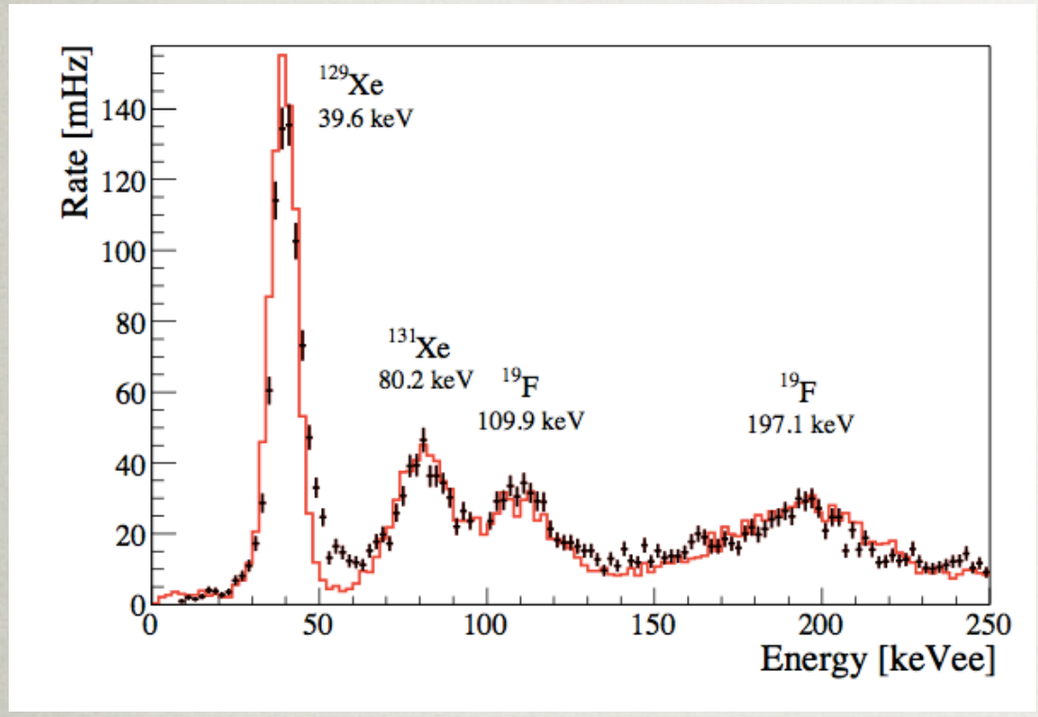
S2 taken from lower PMT array

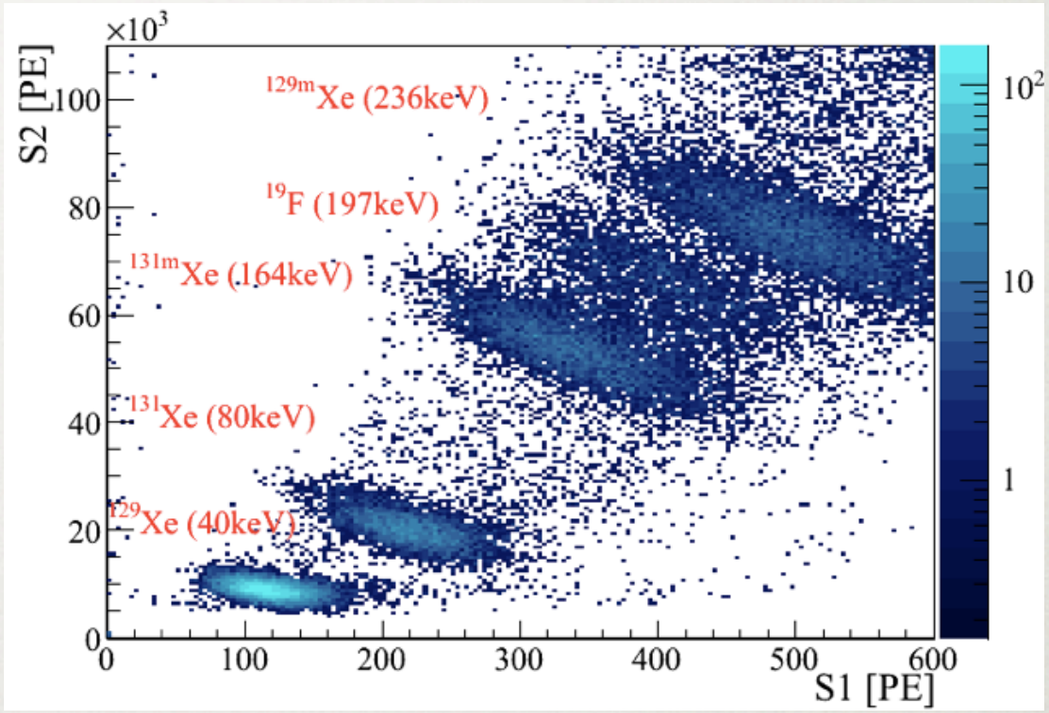
Using ER mean

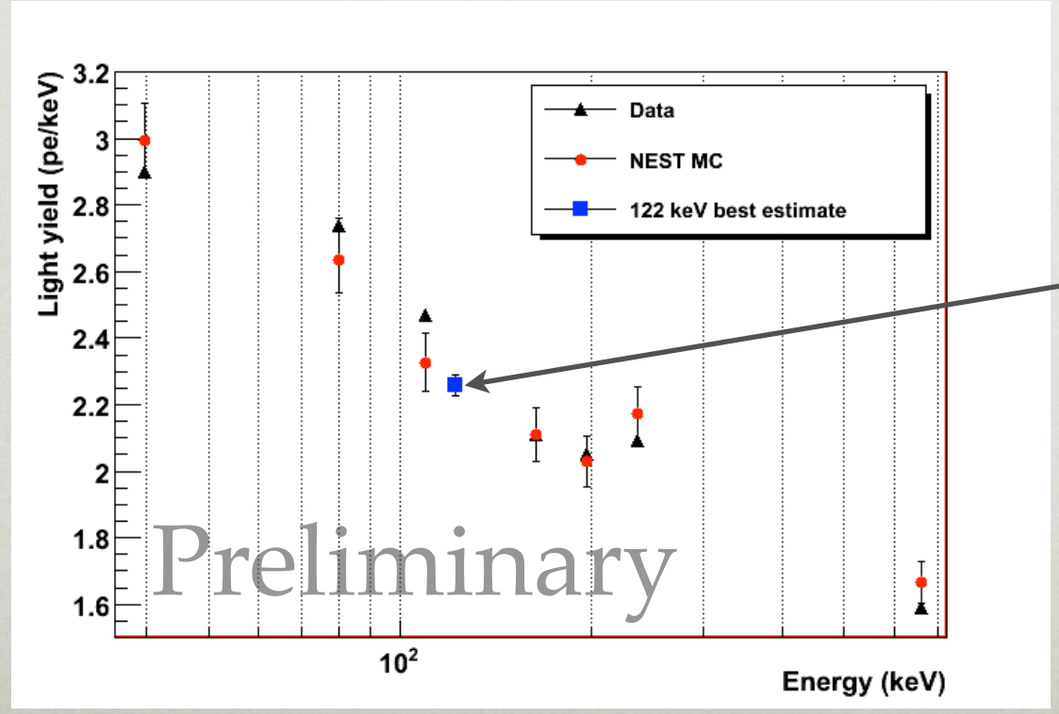
Improved threshold in S2



Calibrations - Neutrons







L_{eff} input
2.26±0.03 PE/keVee

Leff

- Energy scale ($E_{\rm nr}$) is set using the S1 signal

$$E_{\rm nr} = \frac{S1}{L_{y,\rm er}} \frac{1}{\mathcal{L}_{\rm eff}(E_{\rm nr})} \frac{S_{\rm er}}{S_{\rm nr}}$$

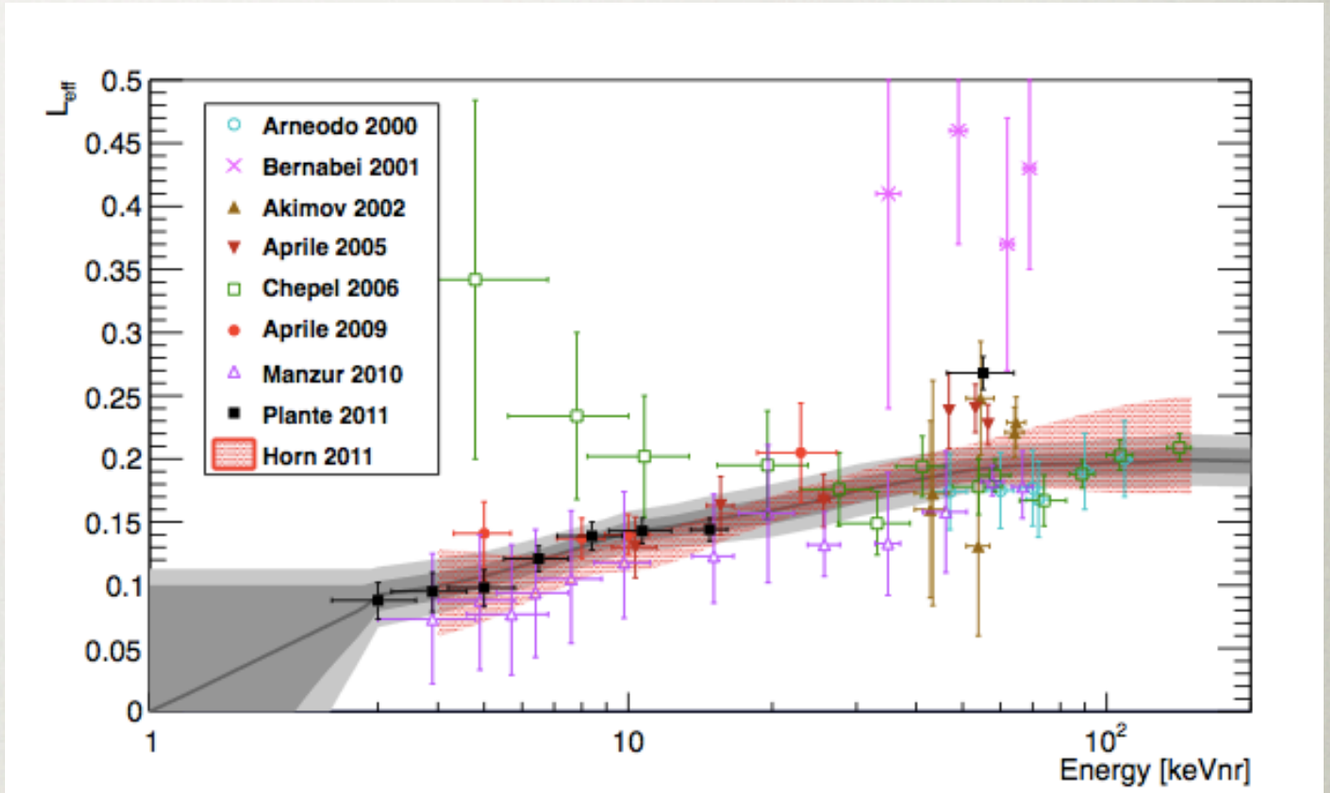
- Light yield ($L_{y,\rm er}$) is the light yield for electron recoils of 122keVee

- Snr and Ser represent quenching factors due to application of drift field

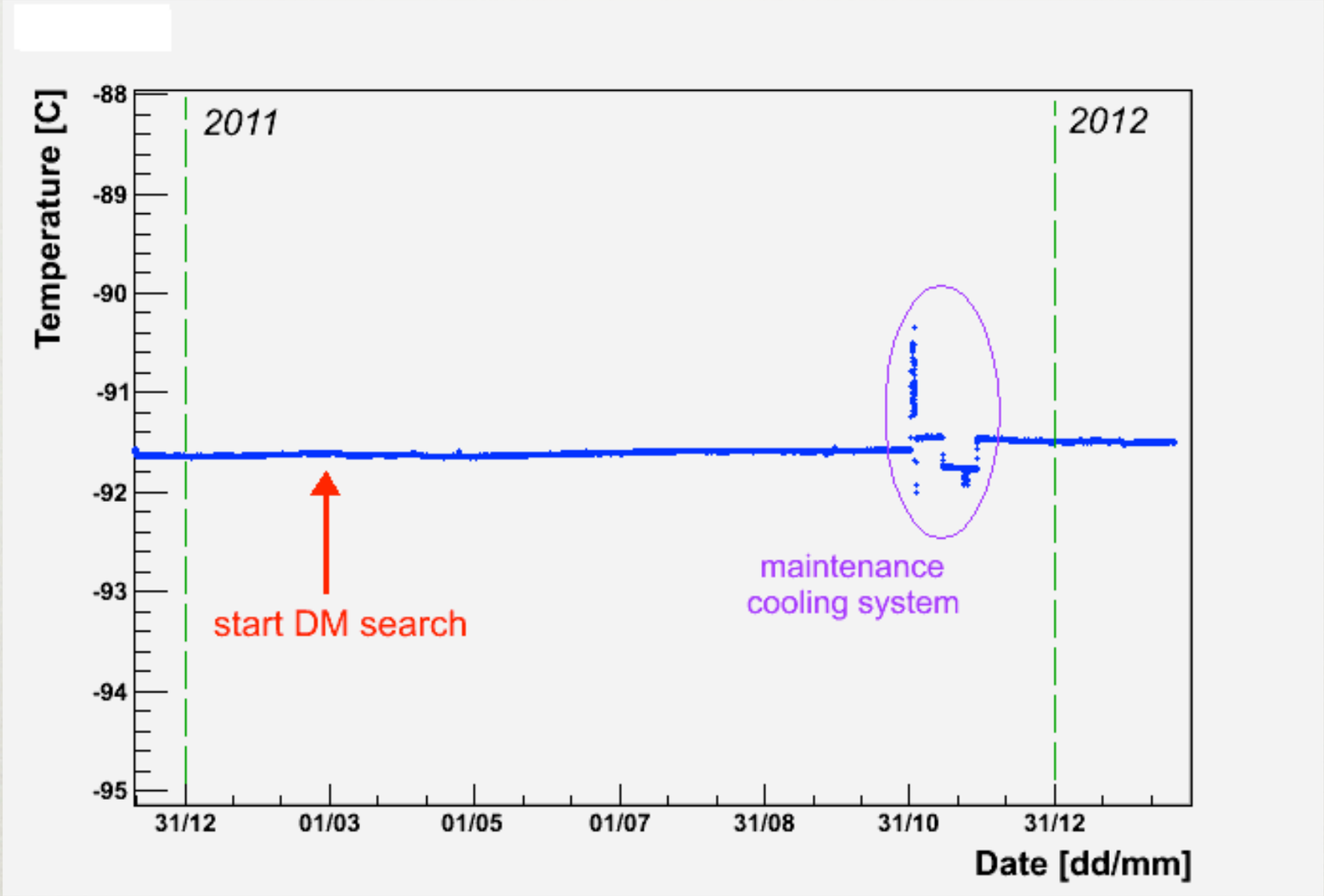
- Relative scintillation efficiency given as:

$$\mathcal{L}_{\rm eff}(E_{\rm nr}) = \frac{L_{y,\rm er}(E_{\rm nr})}{L_{y,\rm er}(E_{\rm ee} = 122\ \rm keV)}$$

Plante *et al.*, Phys. Rev. C **84**, 045805, 2011

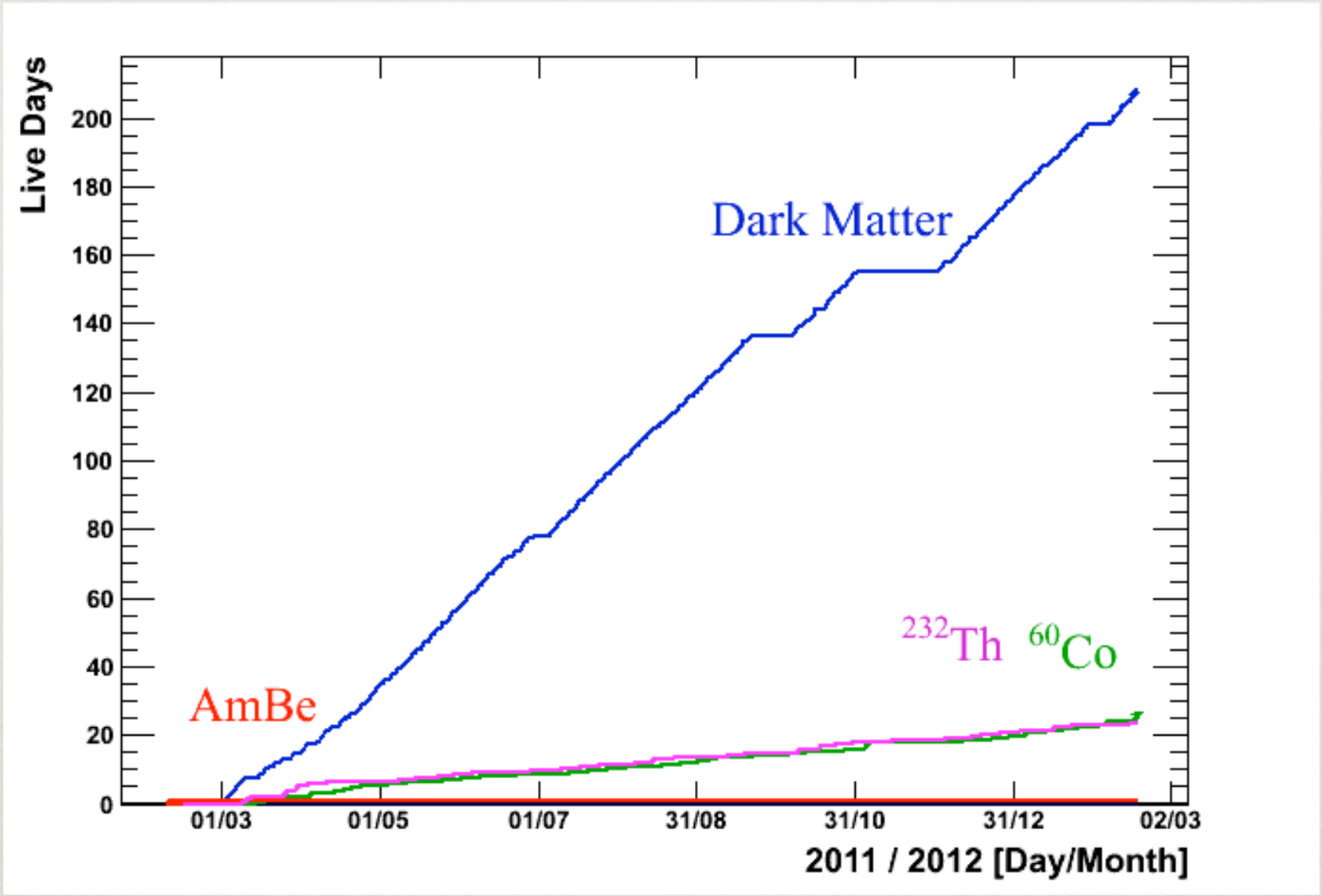


Detector Stability



Detector has been filled since 2010. Temperature plot shows fantastic stability outside of chiller maintenance

Data Status

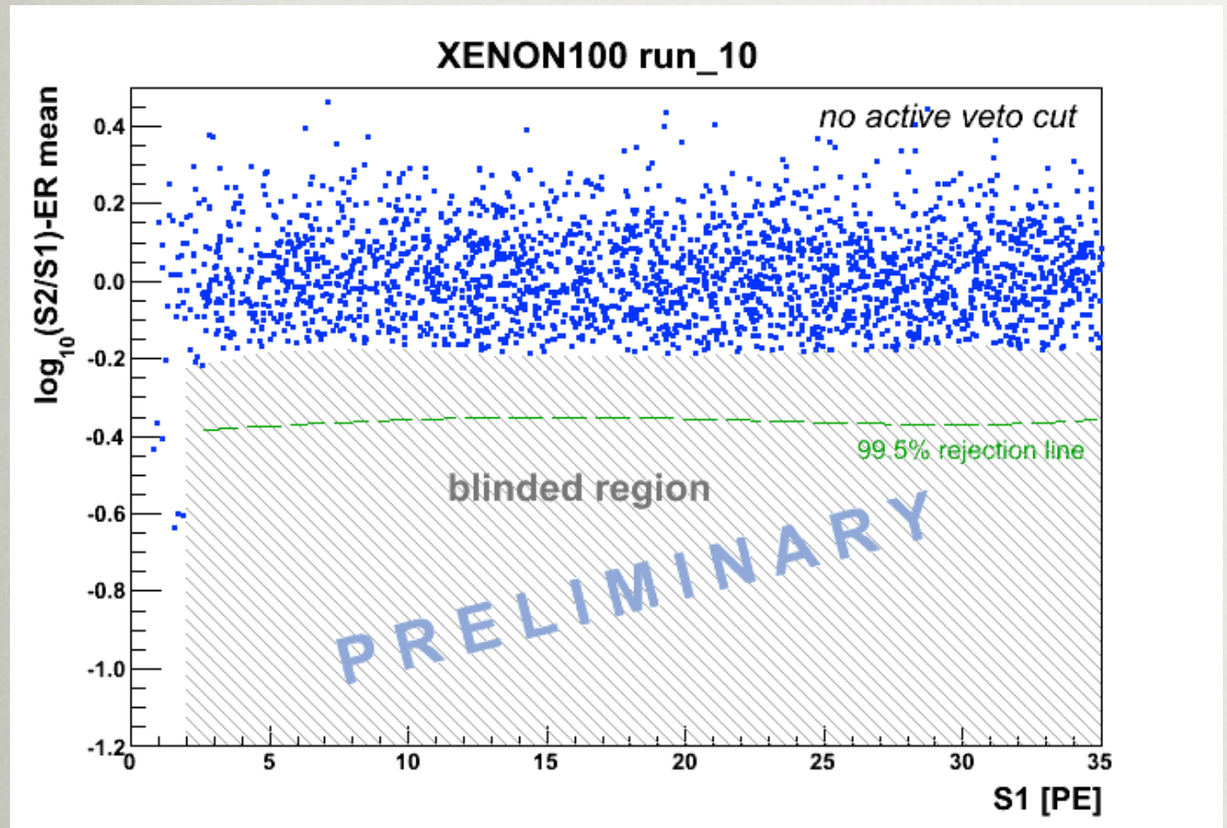


- Dark matter run started March 2011, ~210 live days accumulated
- Much more ER calibration data, ~25 live days 60Co and ~25 live days 232Th

Data Status Thus Far

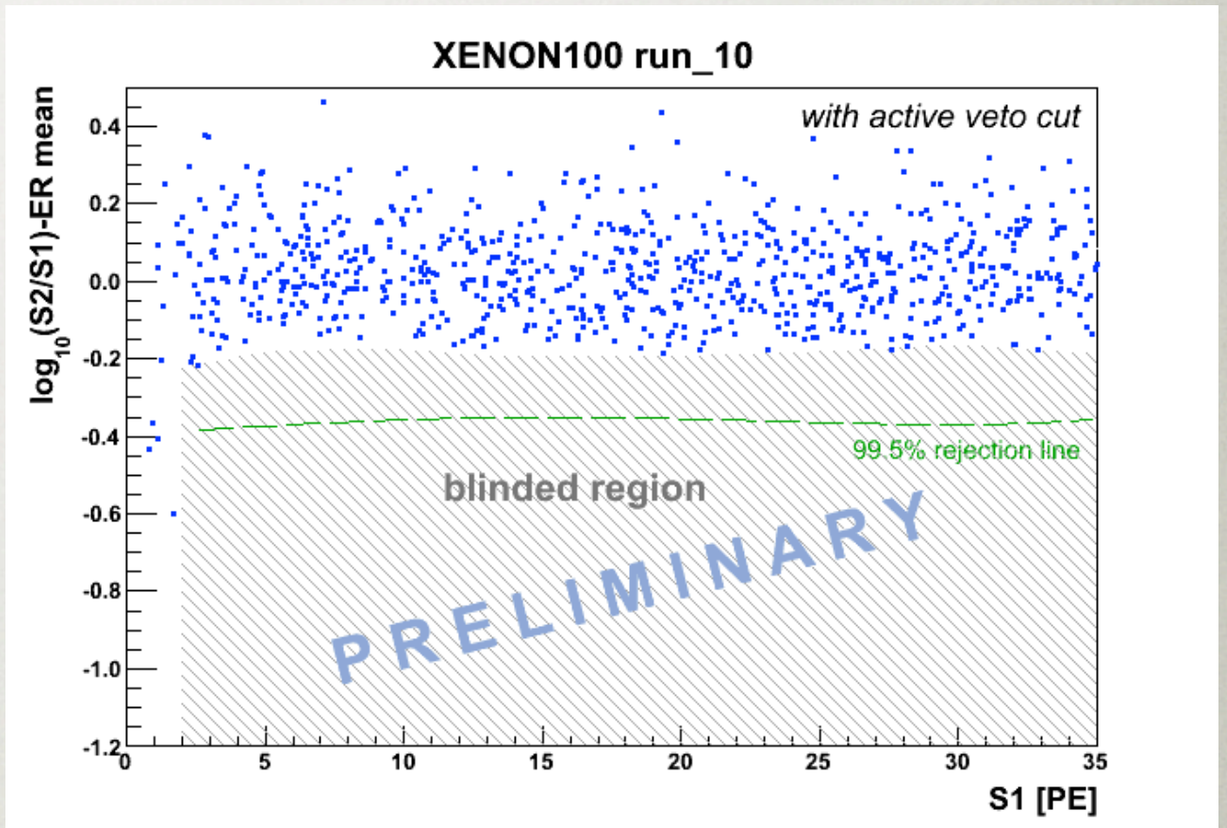
48 kg Fiducial - 198 live days

before veto cut



No noise events, all below 2PE are good

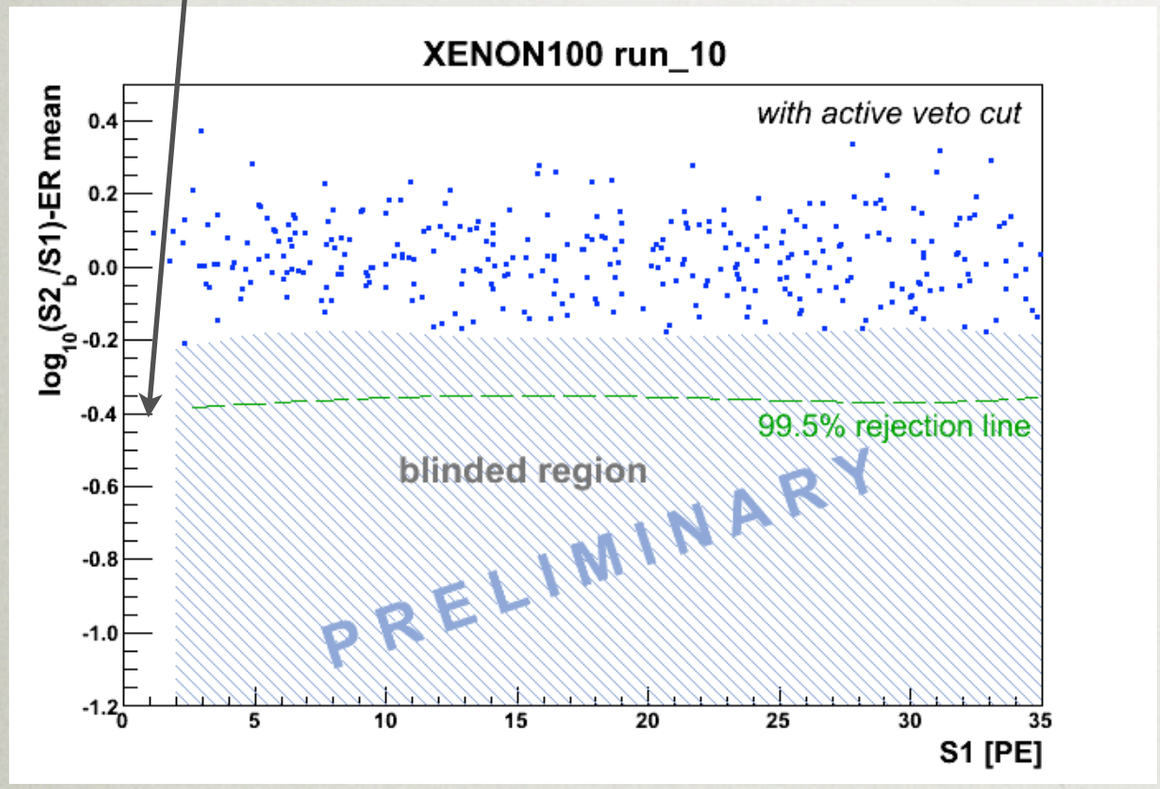
after veto cut



66% background reduction with veto cut

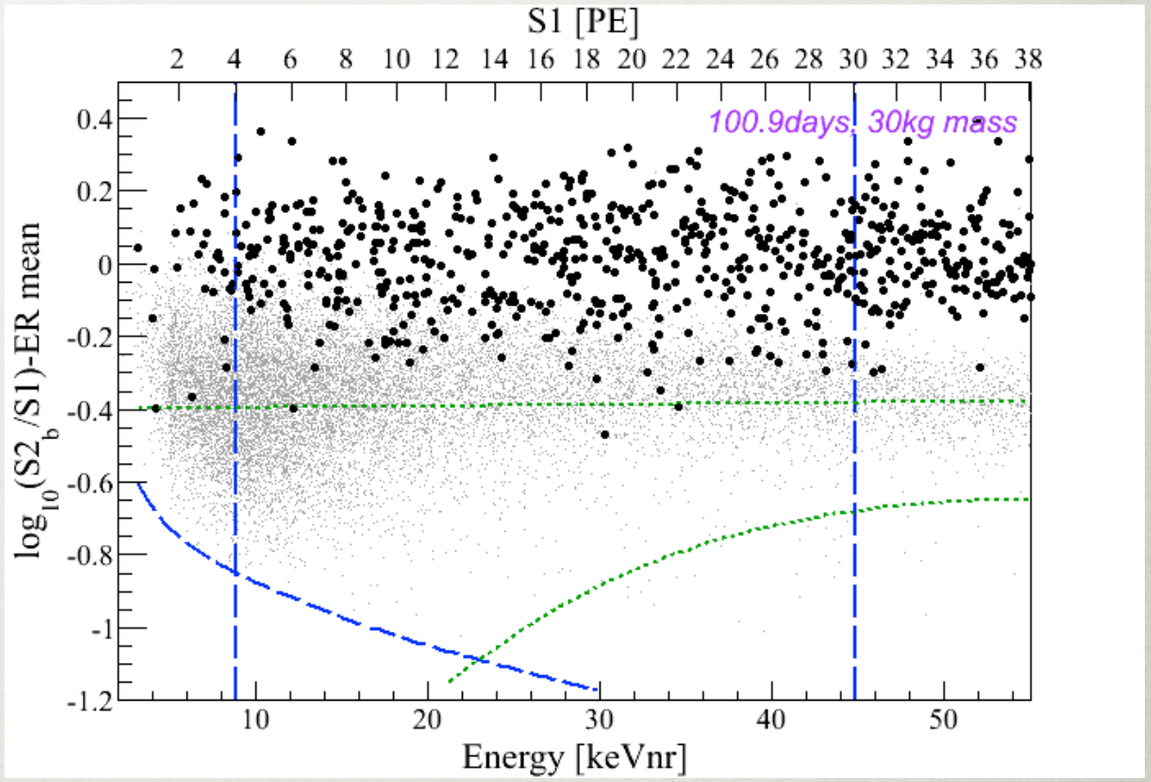
30 kg Fiducial - 198 days

Previously un-vetoed events come from edge



30 kg Fiducial - 100.7 days

Compare with 100 days in previous run

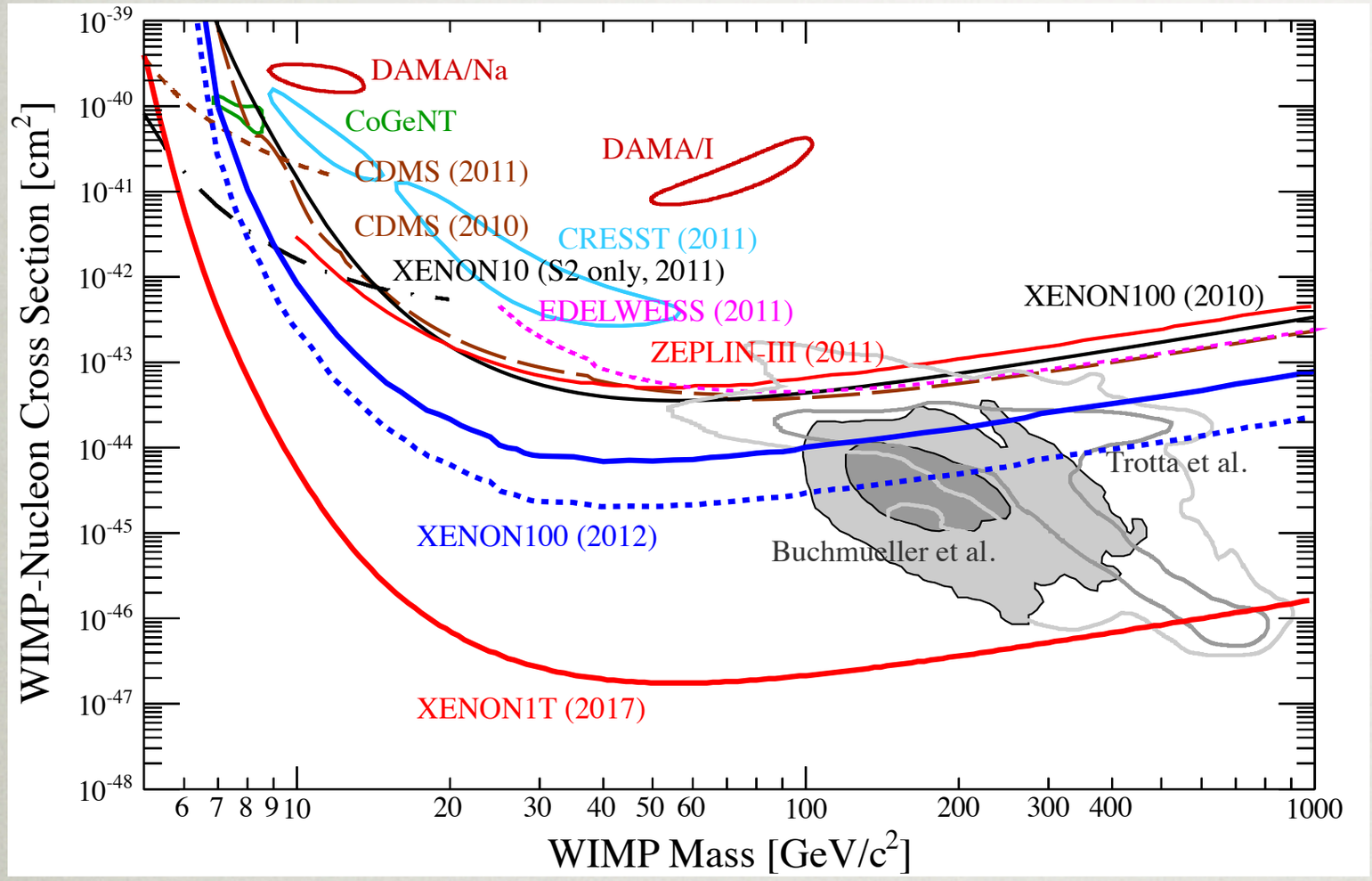


Significant reduction in background rate between the two runs

Background now comparable with that of 11.17 day result

E.Aprile *et al.*, Phys. Rev. Lett. **105,** 131302, 2010

Projected Reach



Limit assumes 200 day run background free and all acceptances included

Blind analysis underway
Result in the spring

Conclusions

- Detector cold and filled > 1 year
  - 210 live days of dark matter
- Kr background reduced to low level
- Improvements in calibration techniques
- Result due in the spring
- Operation of XENON100 will continue through the XENON1T installation at LNGS