Title: Status of the XENON100 Dark Matter Search

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Abstract: The XENON100 detector, currently taking data at the Laboratori Nazionali del Gran Sasso in Italy, is a dual-phase xenon time projection chamber used to search for dark matter by simultaneously measuring the scintillation and ionization signals produced by nuclear recoils. These two signals allow the three-dimensional localization of events with millimeter precision and the ability to fiducialize the target volume, yielding an inner core with a very low background. As the energy scale is based on the scintillation signal of nuclear recoils, the precise knowledge of the scintillation efficiency of nuclear recoils is of prime importance. I will briefly discuss the results of a new measurement of the relative scintillation efficiency of nuclear recoils in LXe, Leff, performed with a new single phase detector, designed and built specifically for this purpose. Finally, I will present the recent XENON100 results obtained from 100 live days of data acquired in 2010 and discuss the current status of the experiment and its evolution into XENON1T.

Status of the XENON100 Dark Matter Search

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on behalf of the XENON Collaboration

Unravelling Dark Matter, Perimeter Institute, September 22-24

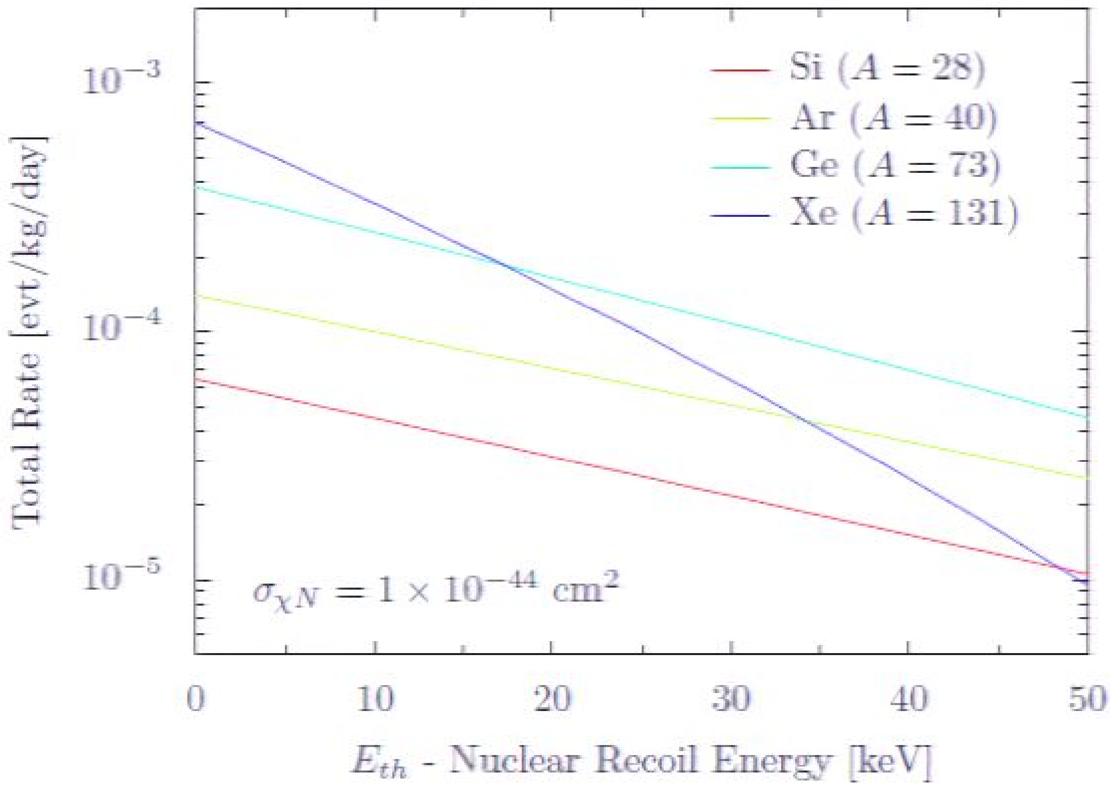
XENON100 Collaboration

Columbia Rice UCLA Zurich Coimbra LNGS SJTU

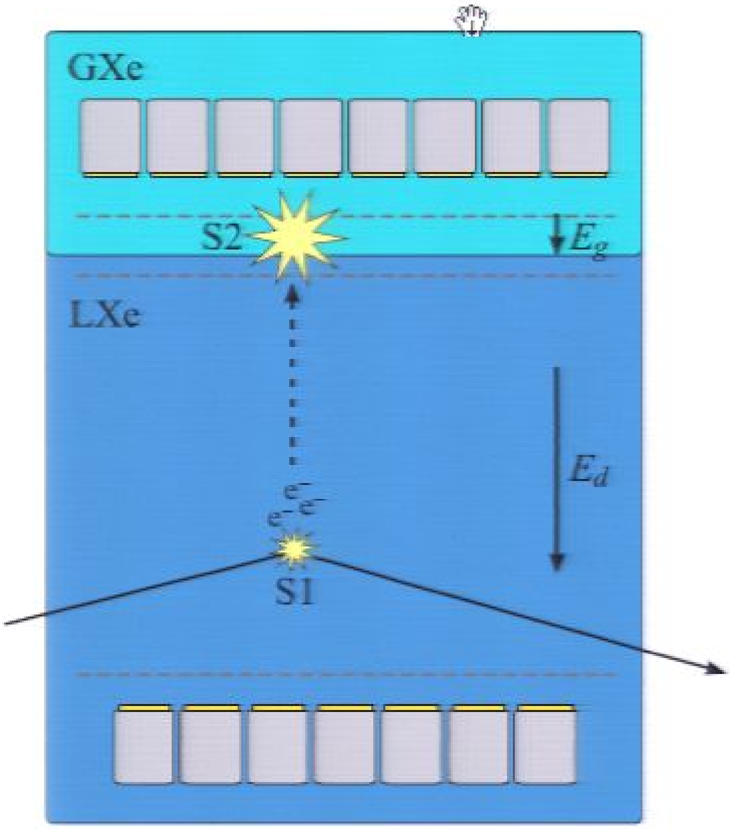
Mainz Bologna MPIK NIKHEF Subatech Münster WIS

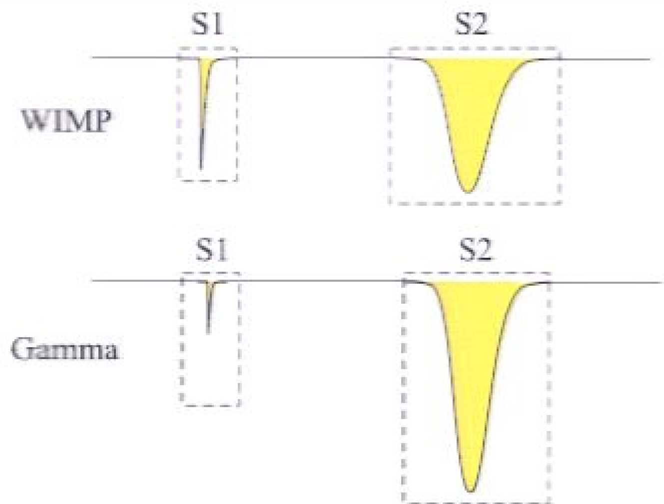
Why Xenon?

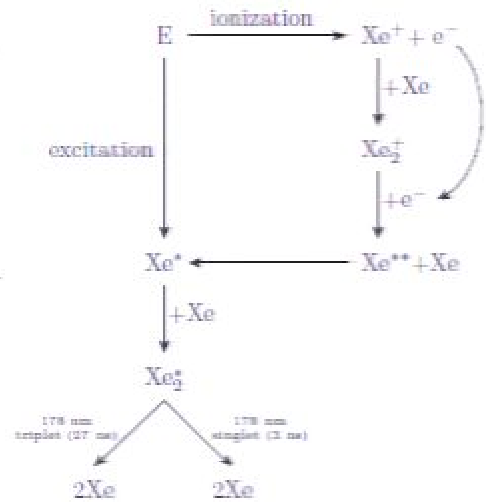
- Large mass number A (~131), expect high rate for SI interactions ($\sigma \sim A^2$) if energy threshold for nuclear recoils is low
- ~50% odd isotopes (^{129}Xe, ^{131} Xe) for SD interactions
- No long-lived radioisotopes, Kr can be reduced to ppt levels
- High stopping power ($Z = 54$, $\rho = 3\,\mathrm{g\,cm^{-3}}$), active volume is self shielding
- Efficient scintillator (~80% light yield of NaI), fast response
- Nuclear recoil discrimination with simultaneous measurement of scintillation and ionization



Principle







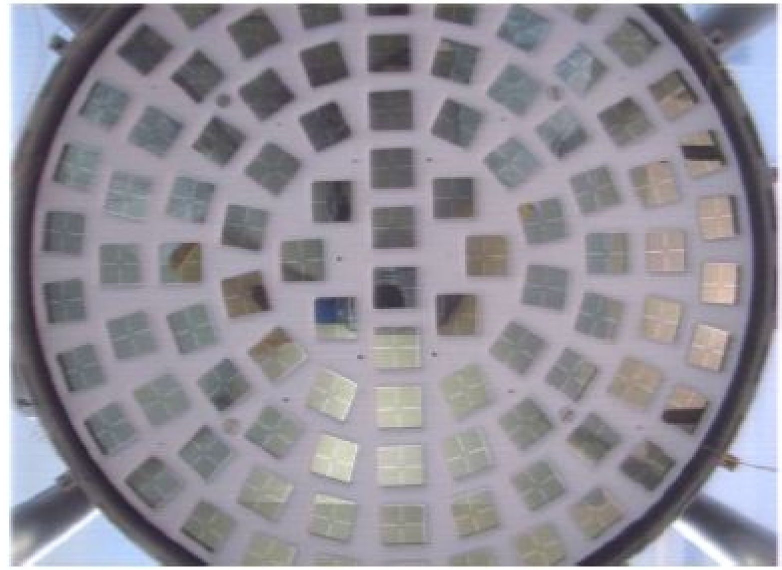
- Bottom PMT array below cathode, fully immersed in LXe to efficiently detect scintillation signal (S1).
- Top PMTs in GXe to detect the proportional signal (S2).
- Distribution of the S2 signal on top PMTs gives xy coordinates $(\Delta r < 3\,\mathrm{mm})$ while drift time measurement provides z coordinate $(\Delta z < 300\,\mu\mathrm{m})$ of the event.
- Ratio of ionization and scintillation (S2/S1) allows discrimination between electron and nuclear recoils.

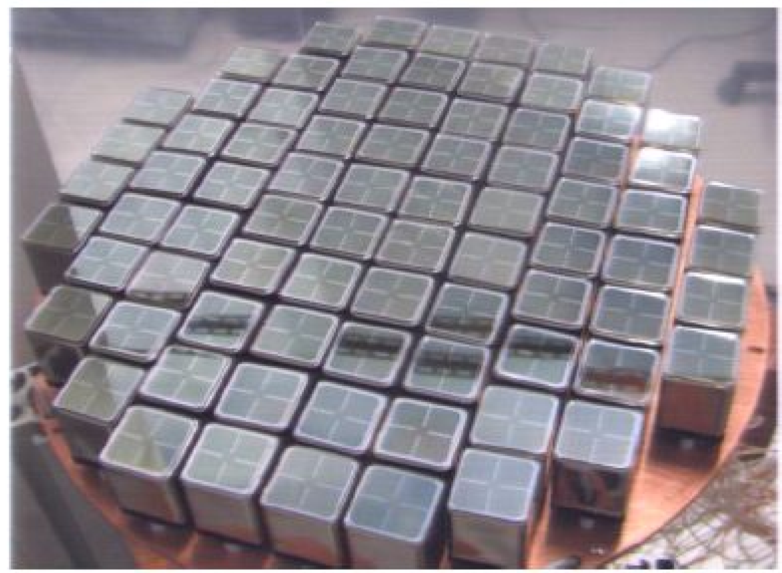
XENON100: TPC

- Goal was to build a detector with a $\times 10$ increase in fiducial mass and a $\times 100$ reduction in background compared to XENON10.
- All detector materials and components were screened in a dedicate low-background counting facility
- 161 kg LXe total mass consisting of a 62 kg target surrounded by a 99 kg active veto. 15 cm radius, 30 cm drift length active volume.
- TPC inner volume defined by 24 interlocking PTFE panels. Drift field uniformity ensured by 40 double field shaping wires, inside and outside the panels.
- Cathode at -16 kV, drift field of 0.533 kV/cm. Anode at 4.5 kV, proportional scintillation region with field ~12 kV/cm. Custom-made low radioactivity HV feedthroughs.
- Instrument paper Aprile *et al.*, `arXiv:1107.2155`

XENON100: PMT Arrays

- 242 low activity Hamamatsu R8520-06-Al 1" square PMTs,
- 98 tubes on top (QE ~23%), in concentric circles and enclosed in a PTFE structure,
- 80 high QE (~33%) tubes on bottom, on a rectangular grid to maximize photocathode coverage,
- 64 tubes in the LXe veto, in two rings, alternating inward and down (up) to allow them to view the top, bottom and sides of the shield.





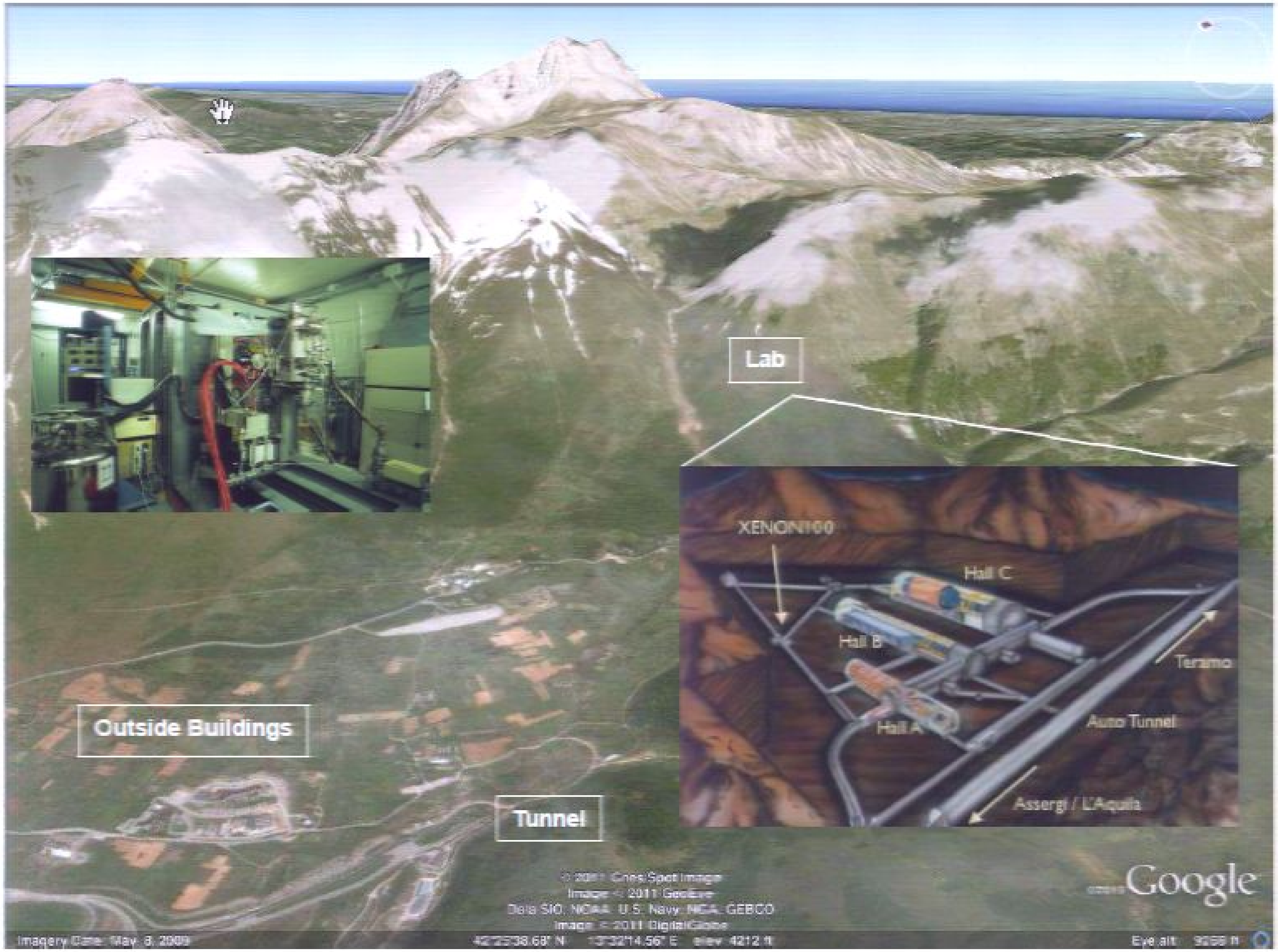
XENON100: Shield

- XENON100 installed in a passive shield to suppress external backgrounds:
  - 20 cm of H_2O to moderate neutrons produced in the cavern rock
  - 20 cm Pb (inner 5 cm with low radioactivity Pb) to stop gamma rays
  - 20 cm polyethylene to moderate neutrons produced in the Pb
  - 5 cm Cu to stop gamma rays from the polyethylene
  - Shield cavity continuously purged with N_2 to keep ^{222}Rn level $< 1\,Bq/m^3$.

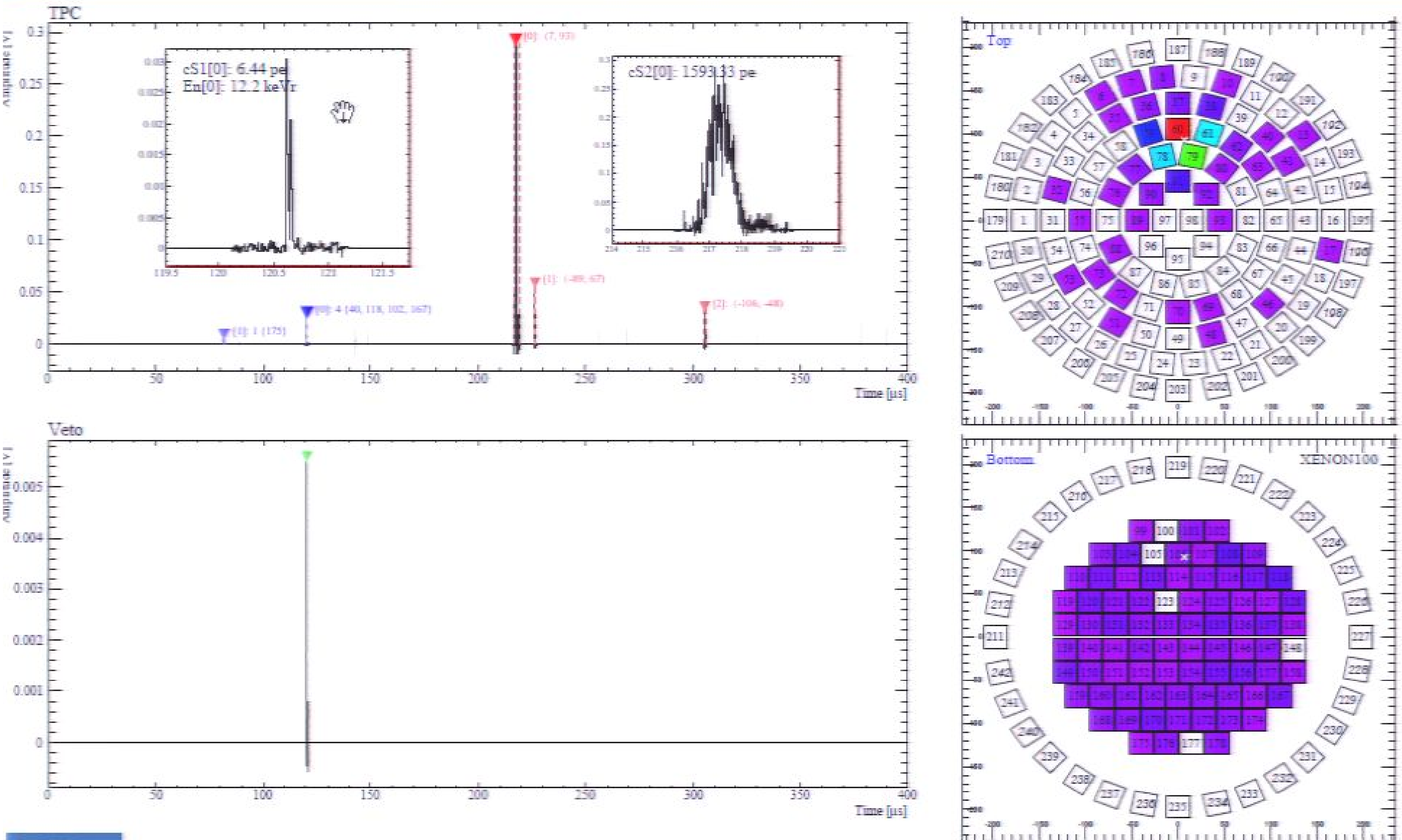
XENON100: Krypton Removal

- Xe has no long lived isotopes but contains traces of $^{85}\mathrm{Kr}$ (β^-, $E_{\mathrm{max}} = 687\,\mathrm{keV}$, $\tau_{1/2} = 10.7\,\mathrm{y}$), present in natural Kr with an isotopic abundance $\sim 10^{-11}$.
- XENON100 goal requires ~50 ppt Kr contamination.
- Kr contamination of commercial Xe filled in XENON100 measured to be 7 ± 2 ppb (delayed coincidence analysis).
- A distillation column is installed next to the XENON100 to reduce the Kr concentration in Xe to ppt levels.
- Initial purification reduced the Kr concentration to $\sim 120\,\mathrm{ppt}$. However, additional Kr was introduced by an air leak during maintenance work on the recirculation pump (2009/11).
- Comparison of the measured background rate with Monte Carlo simulations of the XENON100 gamma background gave a concentration of $\sim 700\,\mathrm{ppt}$.
- The current Kr concentration has been reduced to its previous level with a new purification cycle (2010/09).

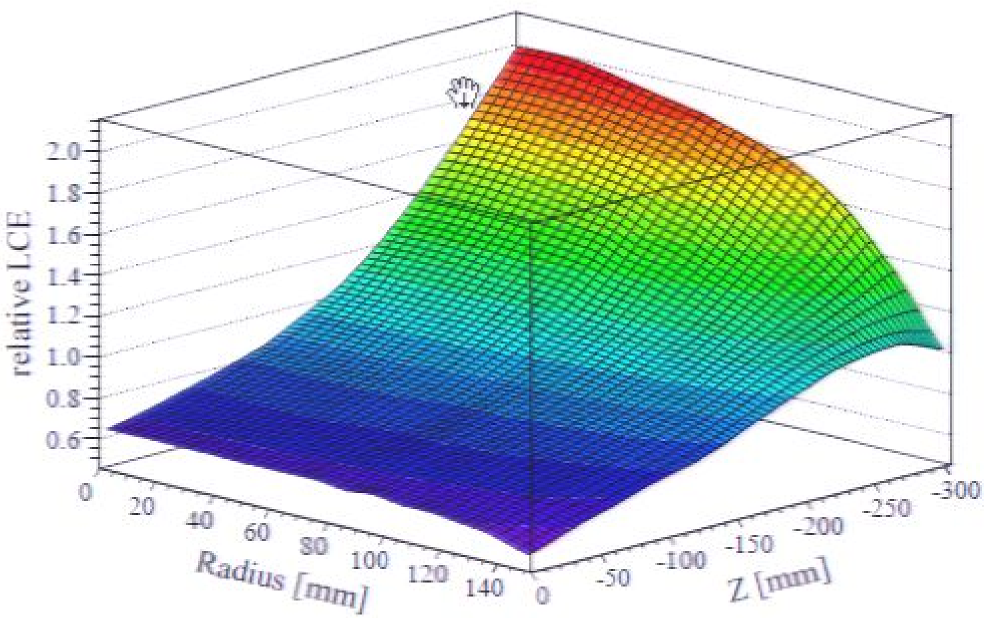
XENON100: Gran Sasso

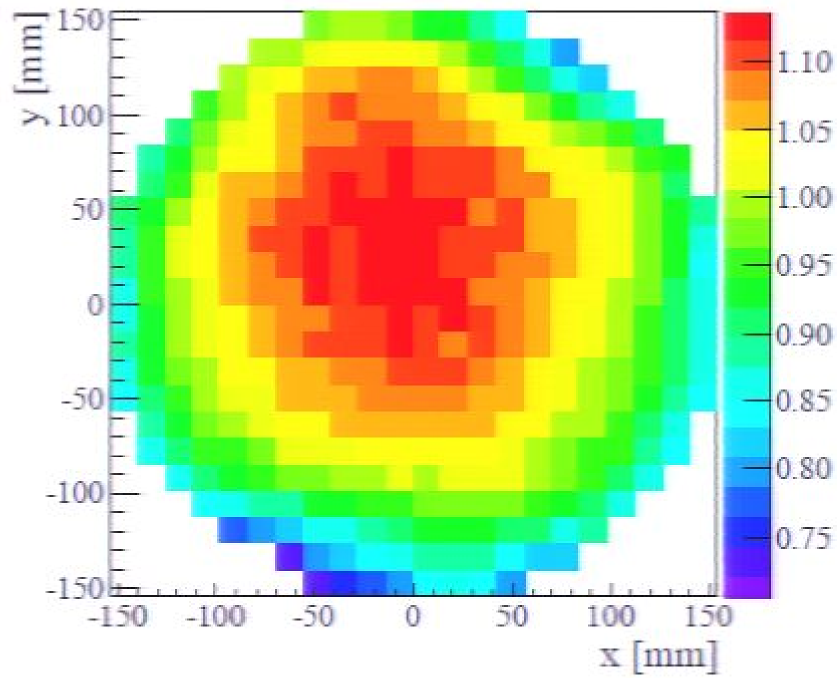


XENON100: Typical Low Energy NR Event

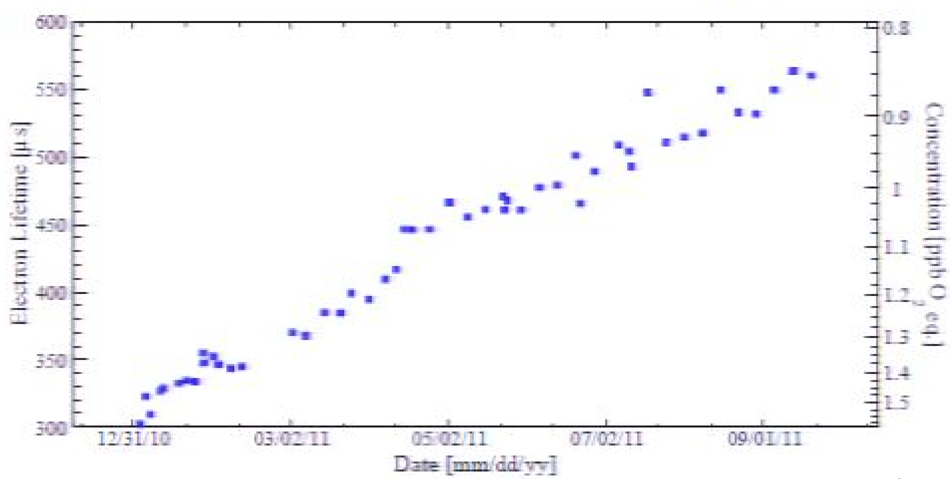


XENON100: Position Dependent Corrections

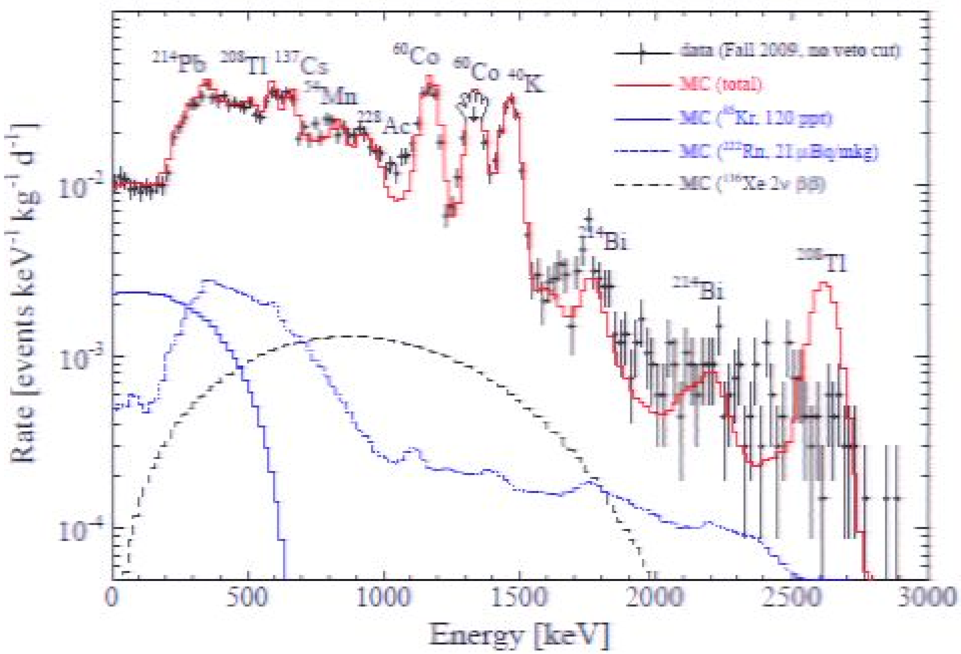


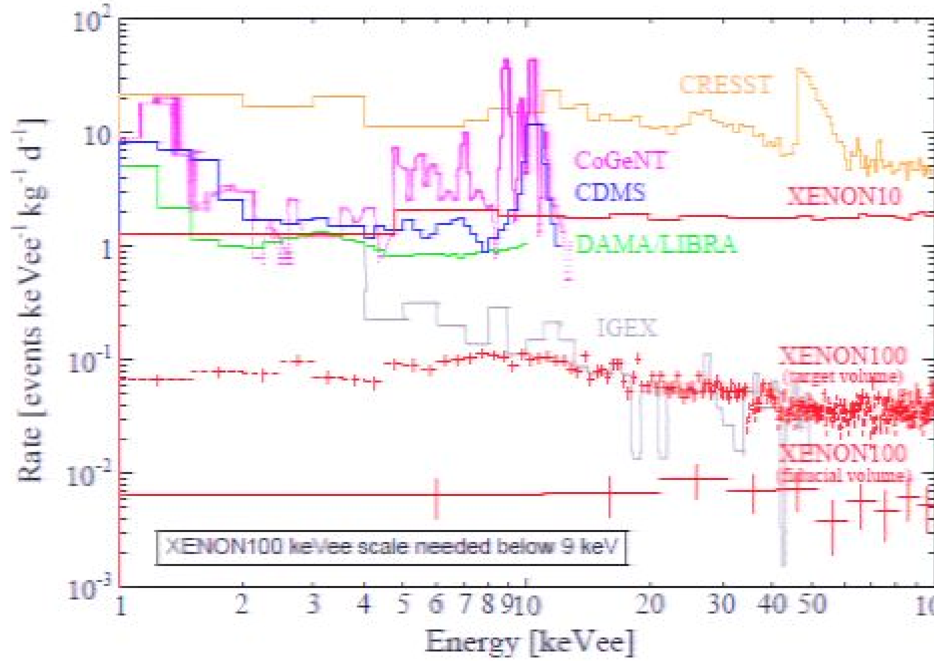


- Corrections from measurements with $^{137}\mathrm{Cs}$, AmBe (40 keV inelastic), $^{131m}\mathrm{Xe}$ (164 keV), with agreement better than 3%.
- S1 rz and S2 xy correction due to spatial dependence of the light collection.
- S2 z correction due to finite electron lifetime.



XENON100: ER Background

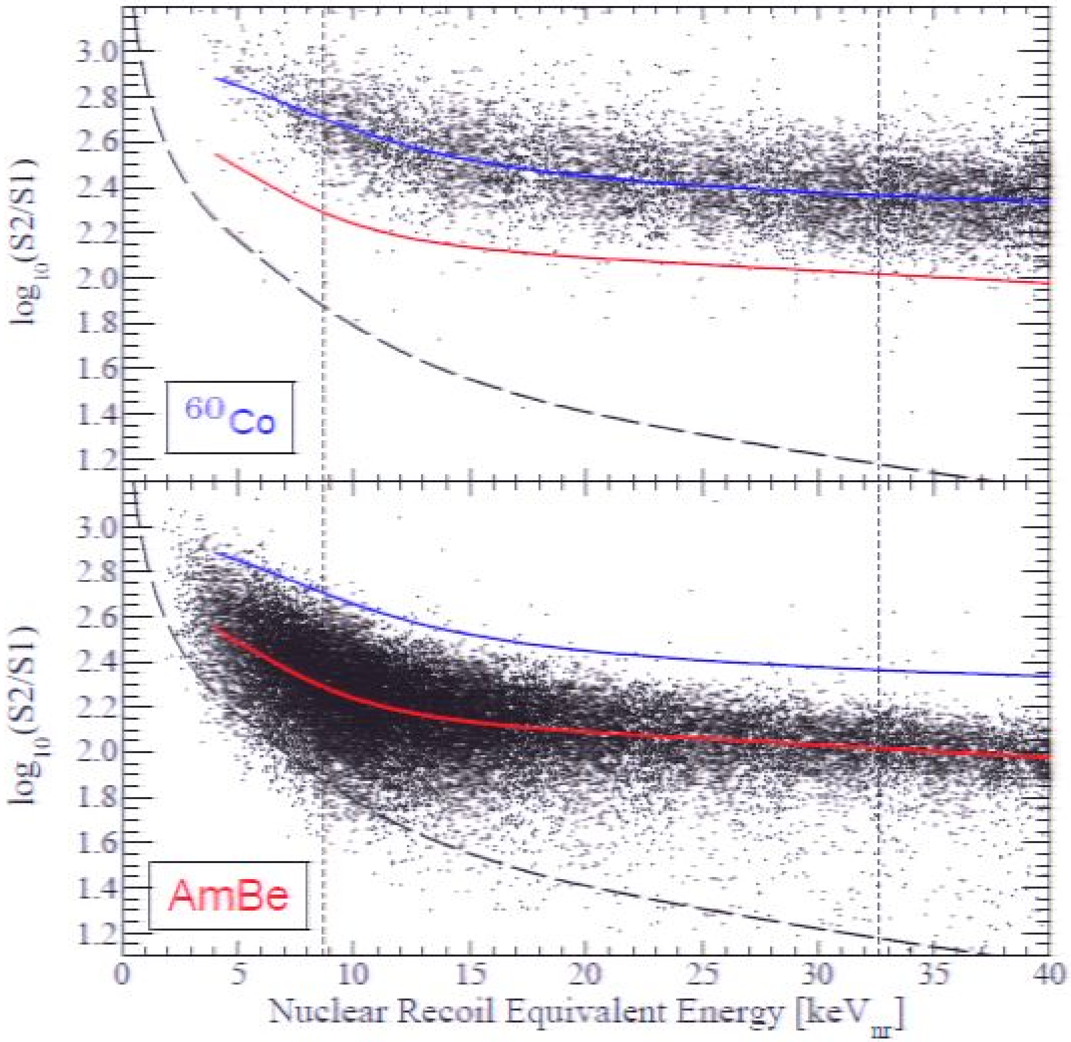




- Measured and predicted ER background without veto cut and for a 30 kg fiducial volume.
- Measured ER background (9.6×10^{-3} events/keVee/kg/d) is in good agreement with Monte Carlo predictions (no tuning). Background from materials is dominated by PMTs.
- ER background level in fiducial volume is $\times 100$ lower than XENON10 (0.6 events/keVee/kg/d).
- Details in Aprile *et al.*, Phys. Rev. D **83**, 082001, 2011

XENON100: Calibration

- Electronic recoil band calibration performed with high energy gammas from ^{60}Co (1.17 Mev, 1.33 MeV).
- Background in the energy region of interest is due to low energy Compton scatters from high energy gamma rays or β decays.
- Nuclear recoil band calibration performed with 3.7 MBq (220 n/s) AmBe neutron source.
- Since WIMPs are expected to elastically scatter off of nuclei understanding the behavior of single elastic nuclear recoils in Xe is essential.



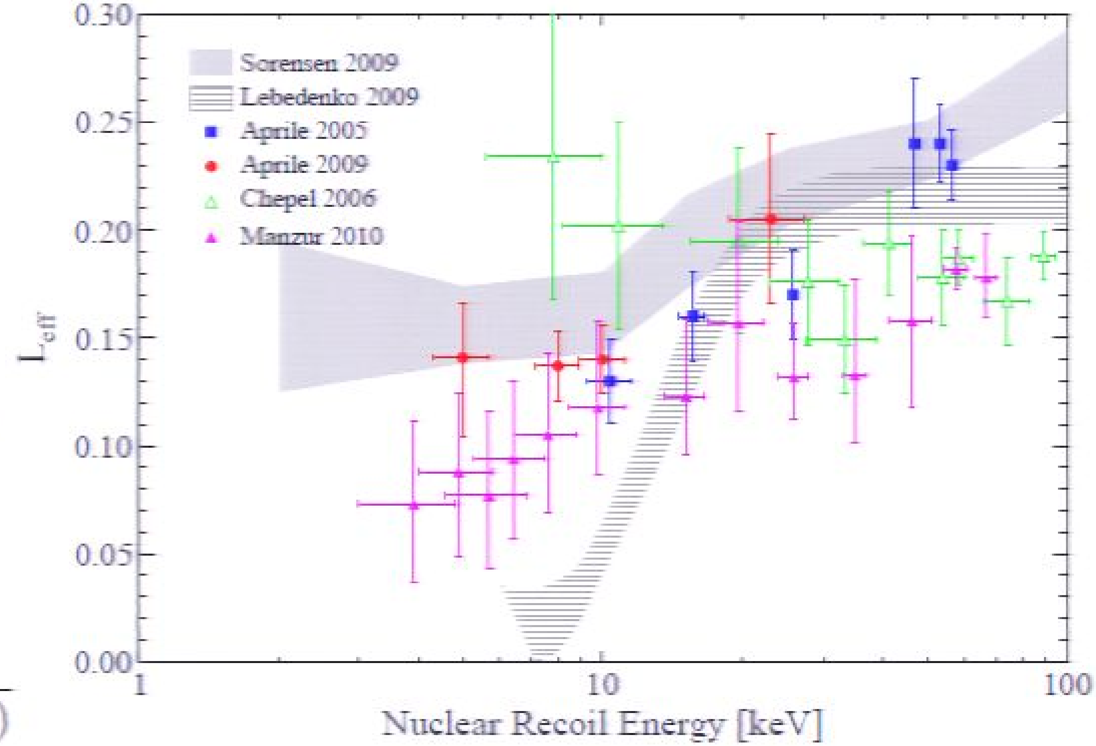
Nuclear Recoil Equivalent Energy

- Nuclear recoil equivalent energy $E_{\rm nr}$ is obtained from the S1 signal

$$E_{\rm nr} = \frac{S1}{L_y}\frac{1}{\mathcal{L}_{\rm eff}}\frac{S_e}{S_r}$$

- L_y, light yield of electron recoils from 122 keV γ rays
- S_e, S_r, scintillation light quenching due to drift field
- Relative scintillation efficiency $\mathcal{L}_{\rm eff}$

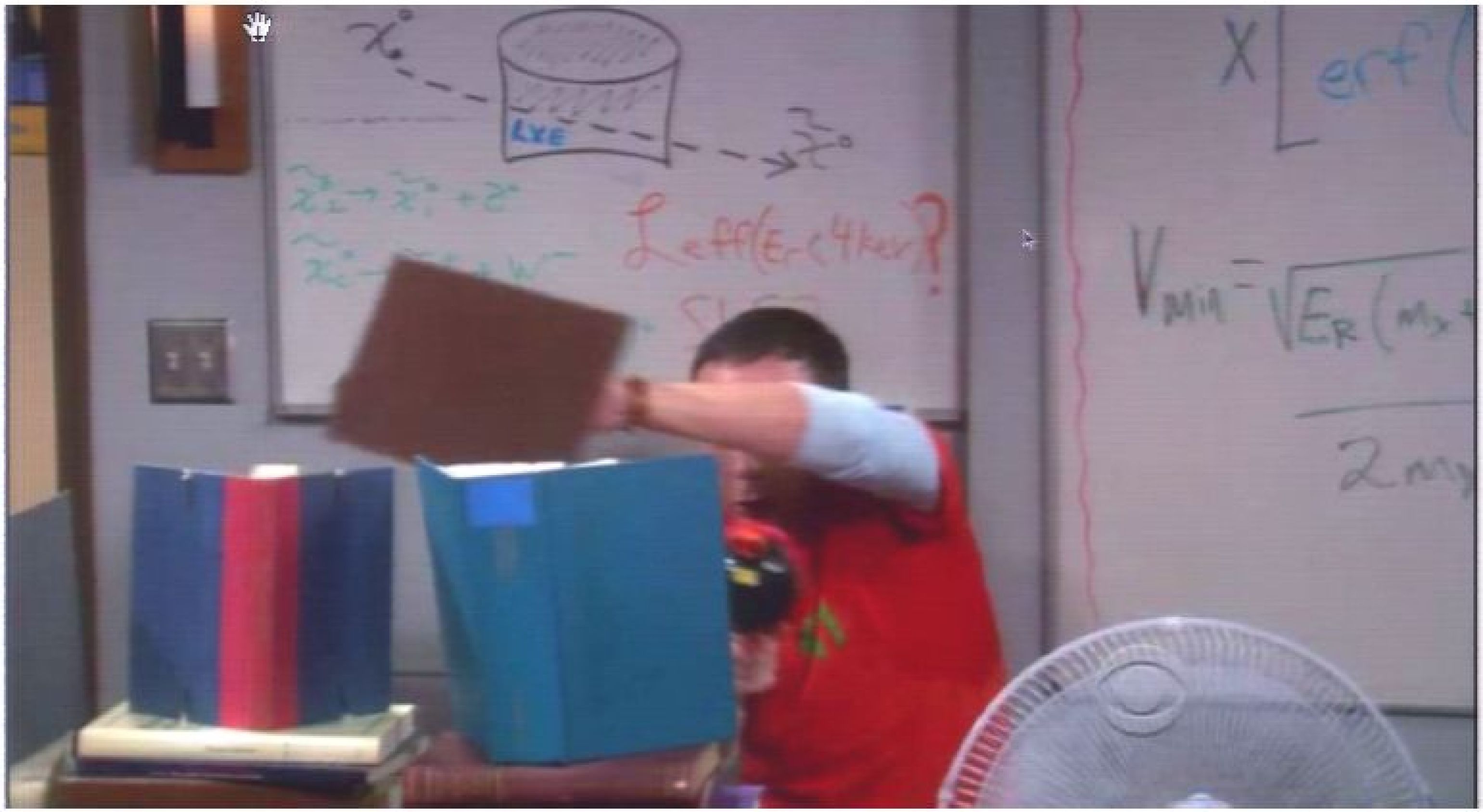
$$\mathcal{L}_{\rm eff}(E_{\rm nr}) = \frac{L_{y,\rm nr}(E_{\rm nr})}{L_{y,\rm er}(E_{\rm ee} = 122\,\mathrm{keV})}$$



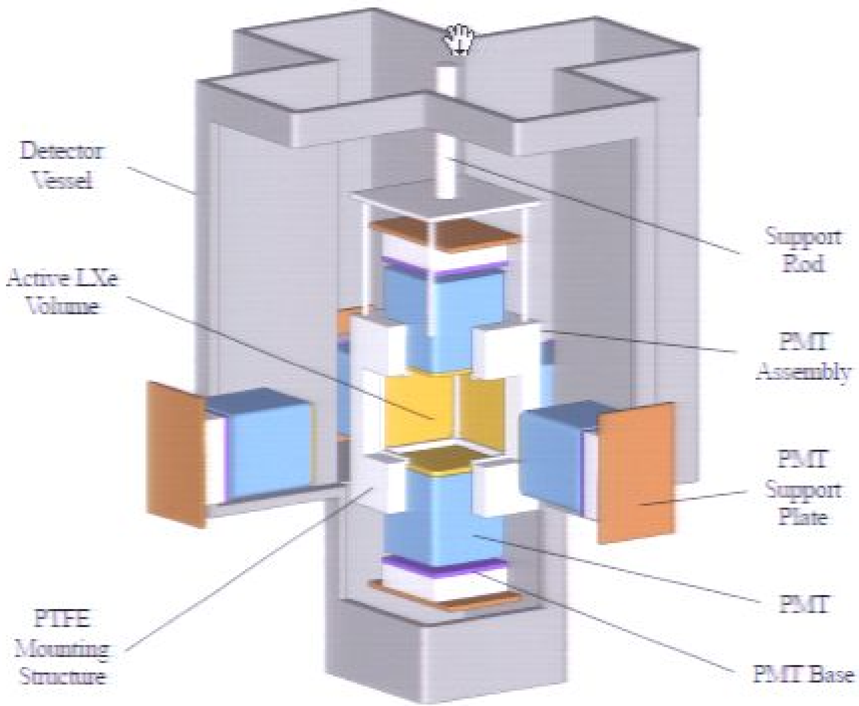
- The uncertainty in $\mathcal{L}_{\rm eff}$ at low energies is the largest systematic uncertainty in the reported results from LXe WIMP searches at low WIMP masses.
- Recent measurement performed at Columbia University, lowest energy measured 3 keV.

Additionally. . .

Even Sheldon from the “Big Bang Theory” is interested in the value of $\mathcal{L}_{\text{eff}}$ below 4 keVr



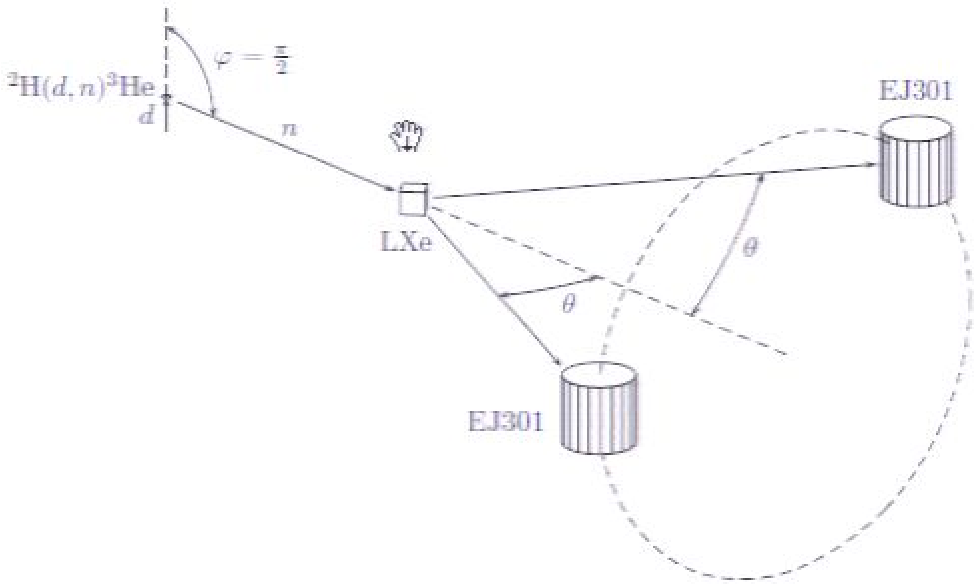
New Measurement of $\mathcal{L}_{\mathrm{eff}}$: Detector

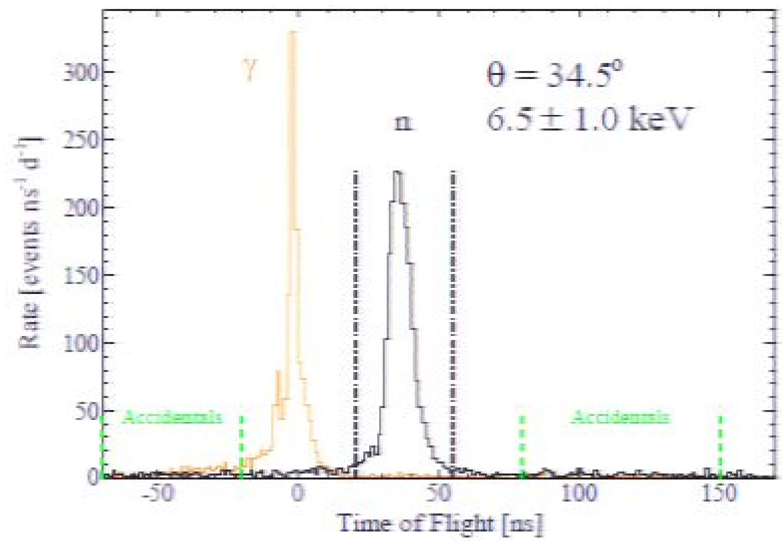


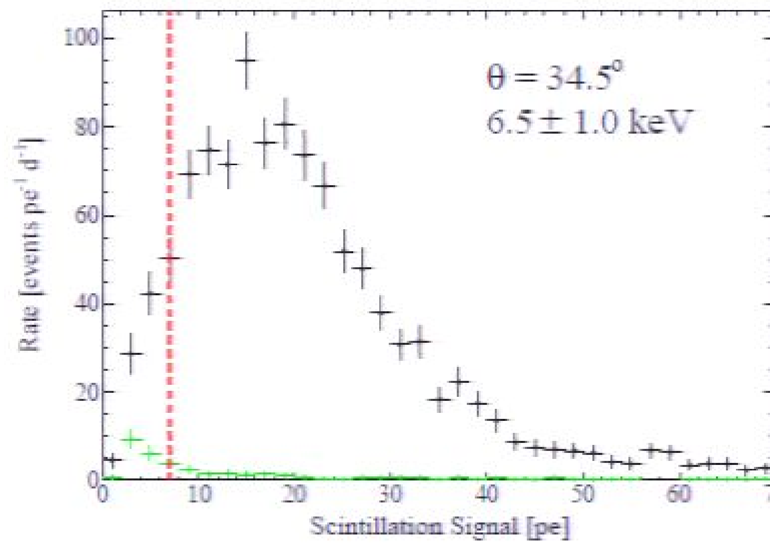
- Built a new special purpose LXe detector with maximized scintillation light detection efficiency

- Cubic sensitive volume with six 2.5 x 2.5 cm Hamamatsu R8520-406 SEL High QE PMTs
- Calibration with 122 keV γ rays from a $^{57}\mathrm{Co}$ source gives a light yield of $L_y = 24.14 \pm 0.09(\mathrm{stat}) \pm 0.44(\mathrm{sys})\ \mathrm{pe/keVee}$ with a resolution (σ/E) of 5%
- Very high light yield, enables a measurement with a low energy threshold

New Measurement of $\mathcal{L}_{\rm eff}$: Setup



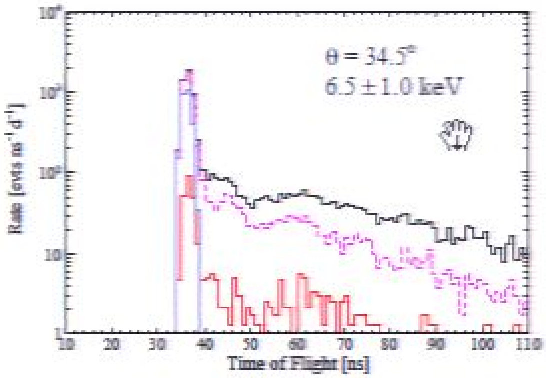


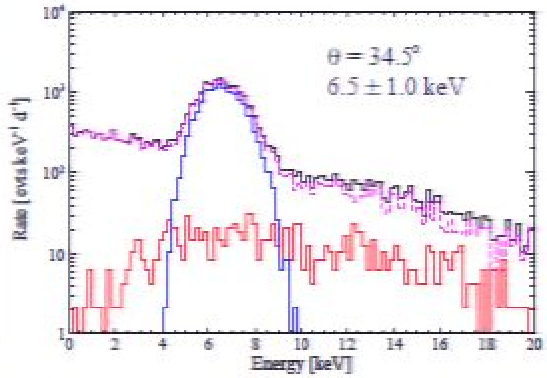


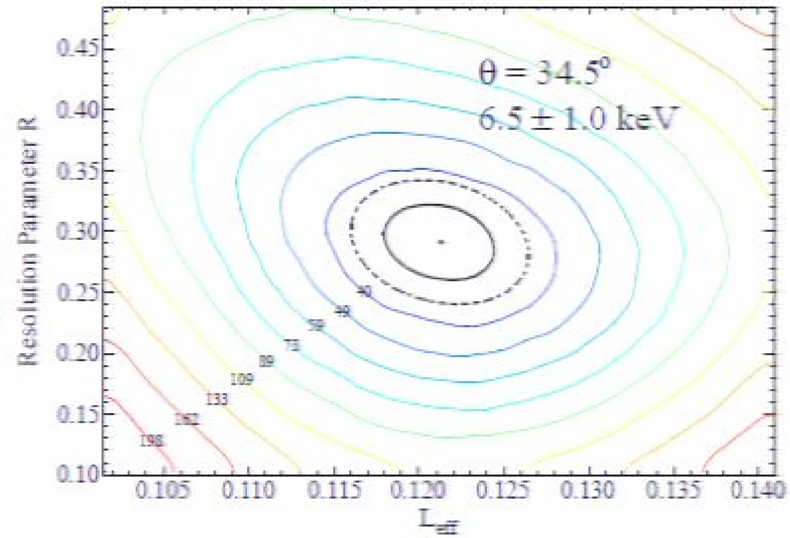
- Record fixed-angle elastic scatters of monoenergetic neutrons tagged by organic liquid scintillators with n/γ discrimination
- Use $^2\mathrm{H}(d,n)^3\mathrm{He}$ 2.5 MeV neutrons from a compact sealed-tube neutron generator
- Recoil energy is fixed by kinematics

$$E_r \approx 2E_n \frac{m_n M_{\rm Xe}}{(m_n + M_{\rm Xe})^2}\,(1-\cos\theta)$$

New Measurement of $\mathcal{L}_{\rm eff}$: Extracting $\mathcal{L}_{\rm eff}$

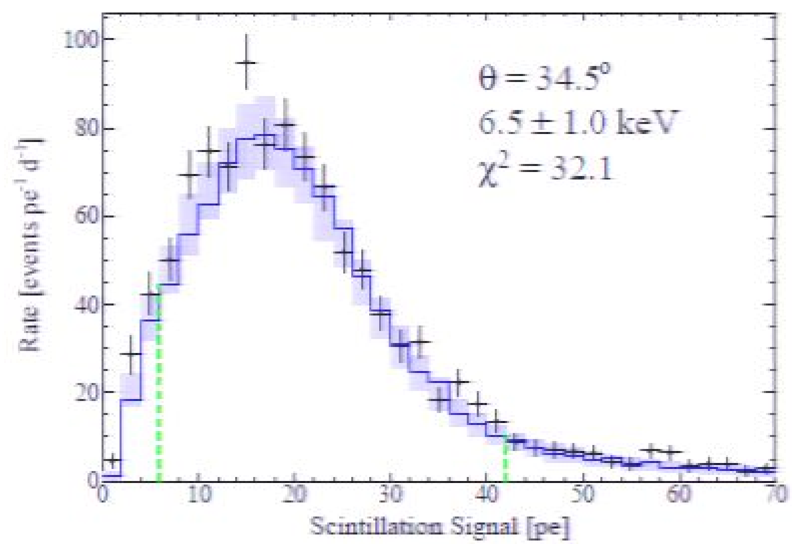




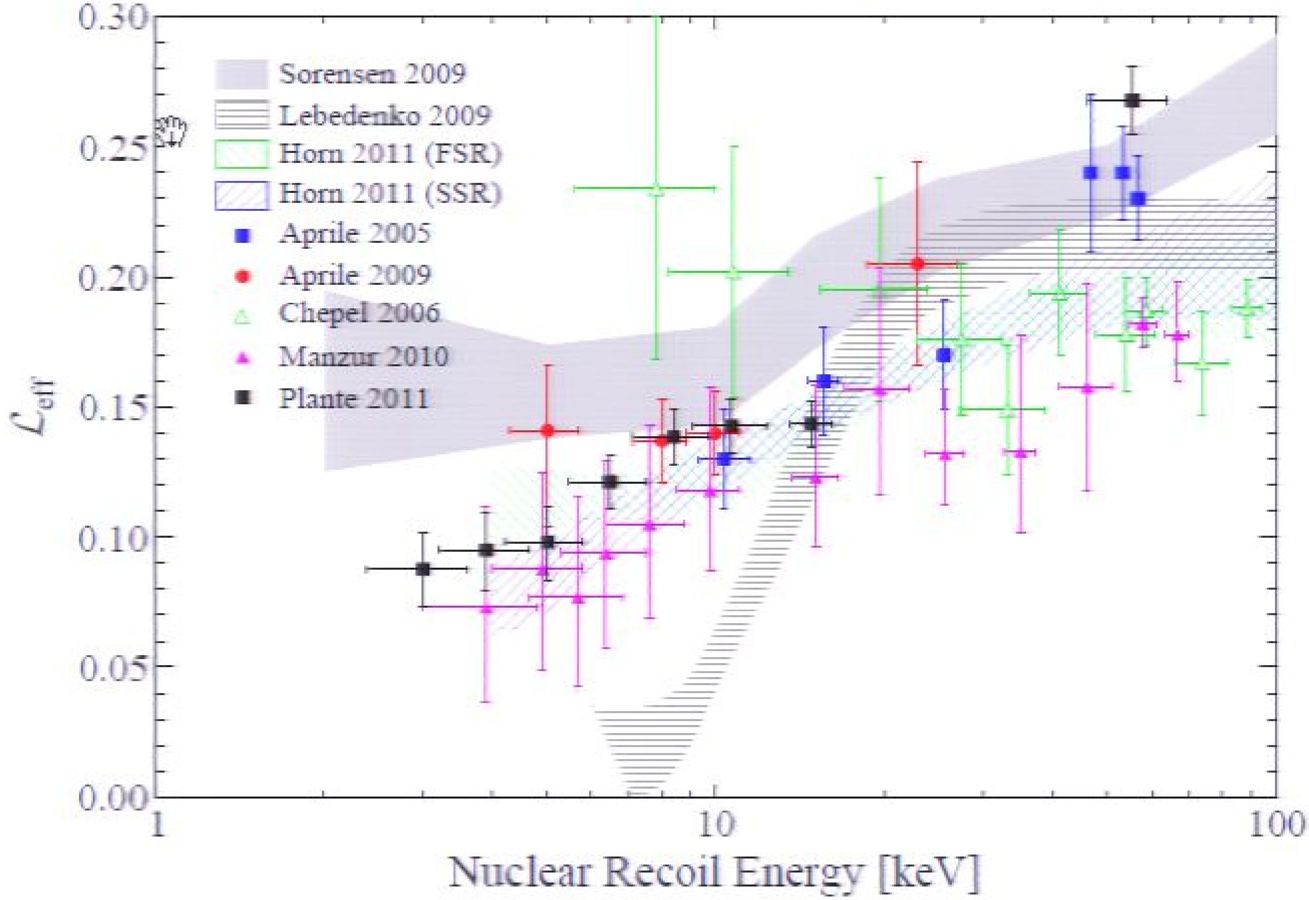


- Transform the MC recoil energy spectrum into a simulated scintillation spectrum g using $S1 = L_y \cdot \mathcal{L}_{{\rm eff},j} \cdot E_r$, with gaussian energy resolution $\sigma = R\sqrt{E_r}$, PMT gain fluctuations, and applying trigger efficiency
- Extract the energy dependence of $\mathcal{L}_{\rm eff}$ by minimizing the χ^2 between the measured and simulated spectra, h and g

$$\chi^2(\mathcal{L}_{{\rm eff},j}, R_j) = \sum_{i=0}^{N} \frac{\left[h_i - g_i(\mathcal{L}_{{\rm eff},j}, R_j)\right]^2}{\sigma^2_{h,i} + \sigma^2_{g,i}\,(\mathcal{L}_{{\rm eff},j}, R_j)}$$

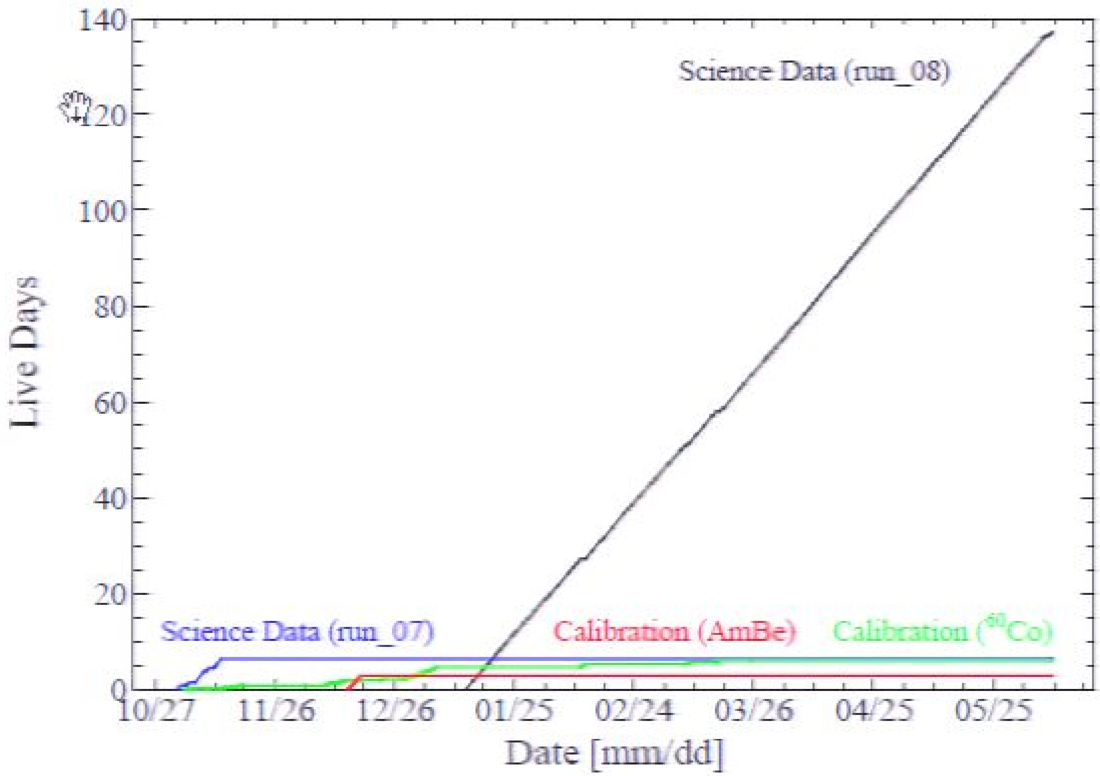


New Measurement of $\mathcal{L}_{\rm eff}$: Result



- Lowest energy (3 keV) and most precise $\mathcal{L}_{\rm eff}$ direct measurement achieved to date.
- For details see Plante *et al.*, `arXiv:1104.2587` (accepted by Phys. Rev. C)

XENON100: Data Taking 2009/2010



- Results from 11.2 days unblinded data in Aprile *et al.*, Phys. Rev. Lett. **105**, 131302, (2010).
- Data taken in the first half of 2010, blinded region of interest, 100.9 live days
- Results from the blind 100.9 days in Aprile *et al.*, Phys. Rev. Lett. **107**, 131302, 2011

XENON100: Data Selection

Basic quality cuts

Designed to remove noisy events, events with unphysical parameters. Very high acceptance.

- S1 coincidence cut
- S2 threshold cut
- S2 saturation cut
- Signal/Noise cut

Scatter cuts

Designed to remove events with multiple interactions (multiple S2s), with delayed coincidences (multiple S1s) or misidentified S1s.

- S1 single peak cut
- S2 single peak cut
- Veto cut

Fiducial volume cut

Because of the high stopping power of LXe, fiducialization is an extremely effective way of reducing background. Fiducial volume chosen:

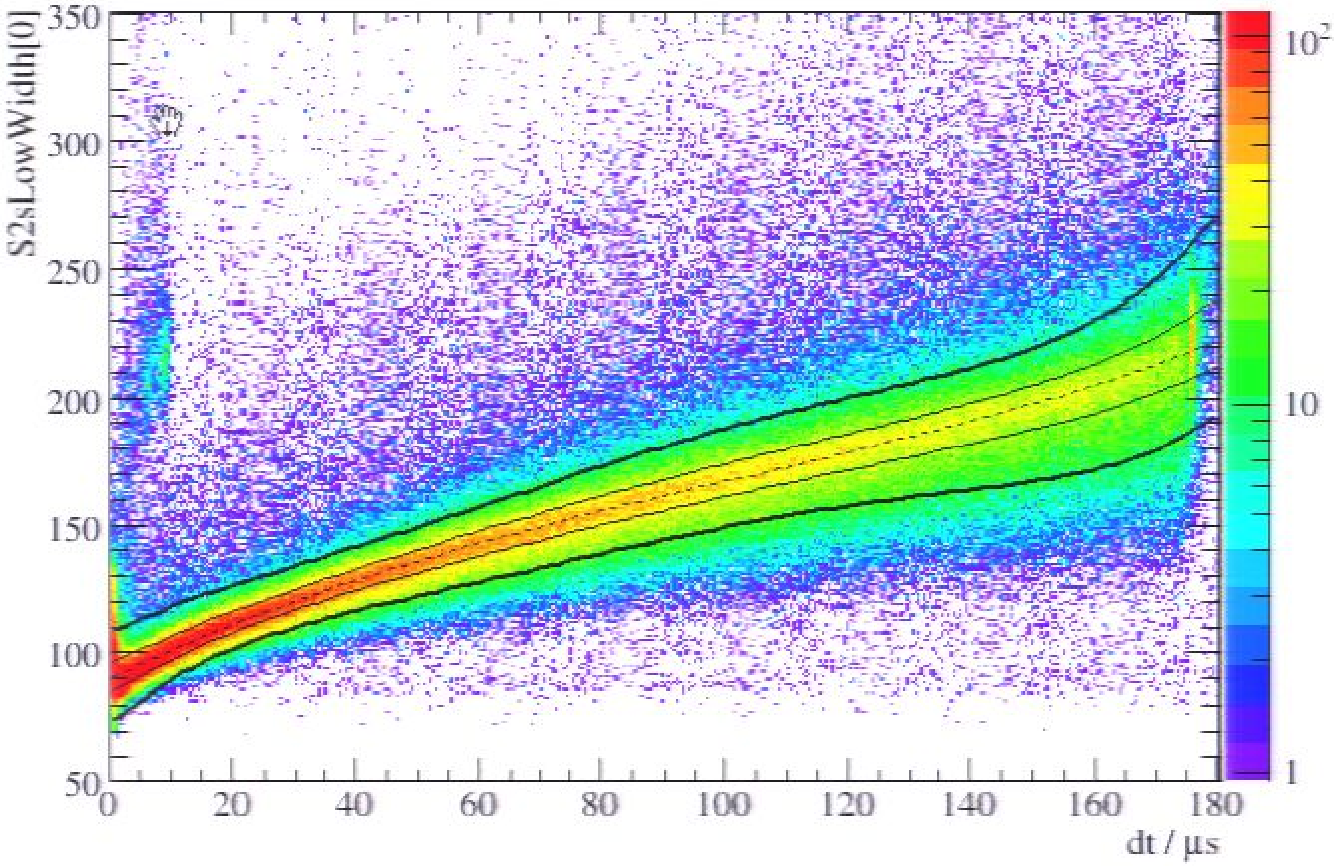
- 48 kg super-ellipsoid

Advanced cuts

Designed to remove events which fail consistency checks, e.g. mismatch in positions from different algorithms, or with S1 PMT patterns not consistent with their position in the TPC

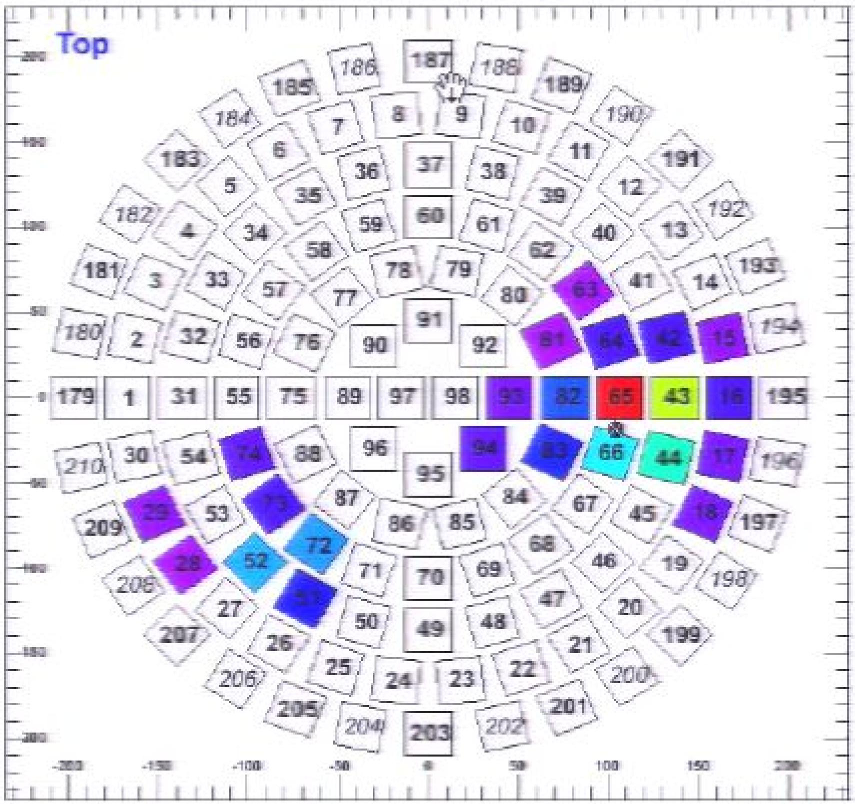
- S1 PMT pattern cut
- S2 width consistency cut
- Position reconstruction cut

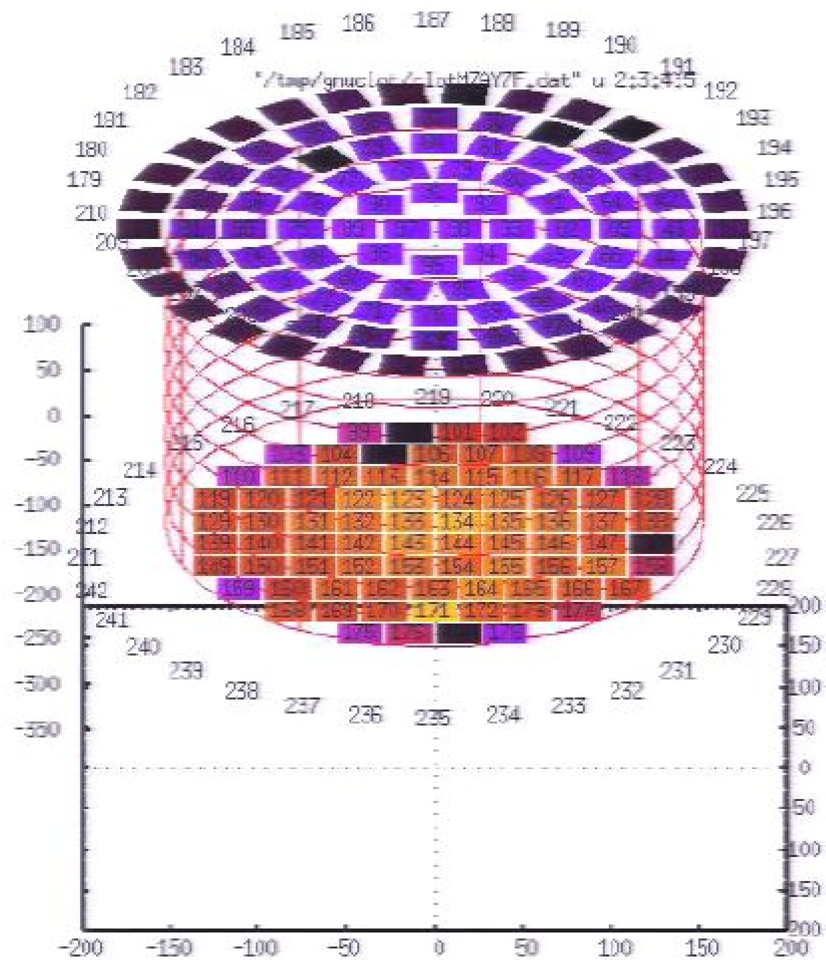
XENON100: S2 Width Consistency Cut



- The diffusion of the electron cloud makes the width of the S2 signal depend on the drift time.
- Measure the distribution from the nuclear recoil band and build a cut on the S2 width as a function of depth and S2. Ensure that the S2 width is consistent with the event depth.

XENON100: S1, S2 Pattern Consistency Cuts

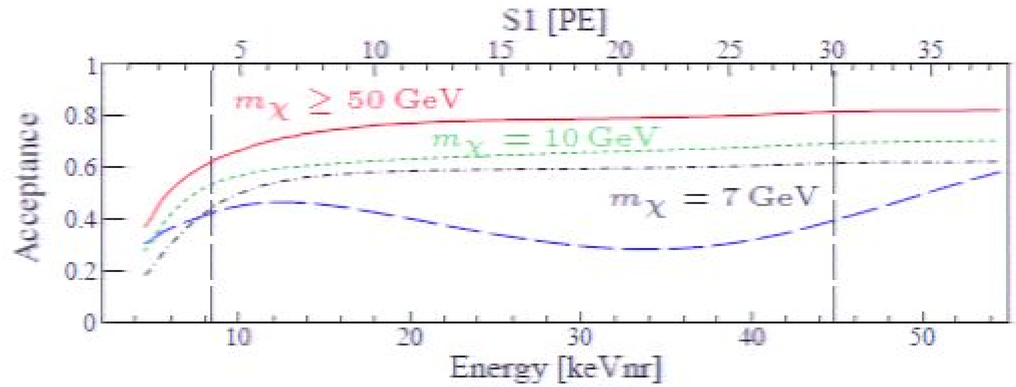


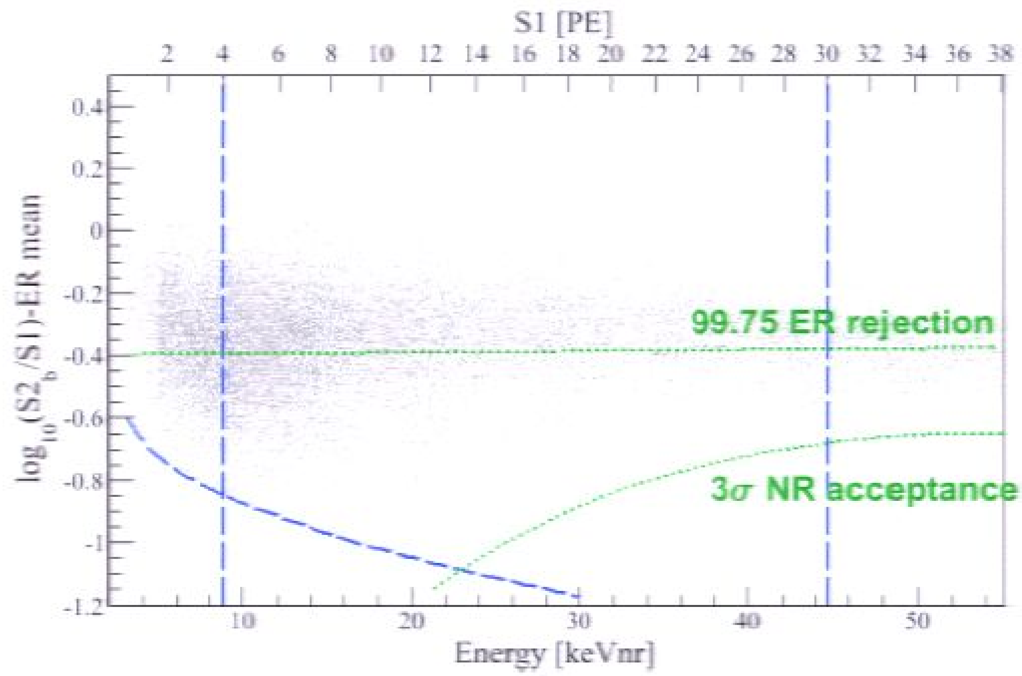


- S2 PMT pattern should be consistent with the pattern of an event at that position
- S1 PMT pattern should match the expected pattern at that position

XENON100: Nuclear Recoil Acceptance

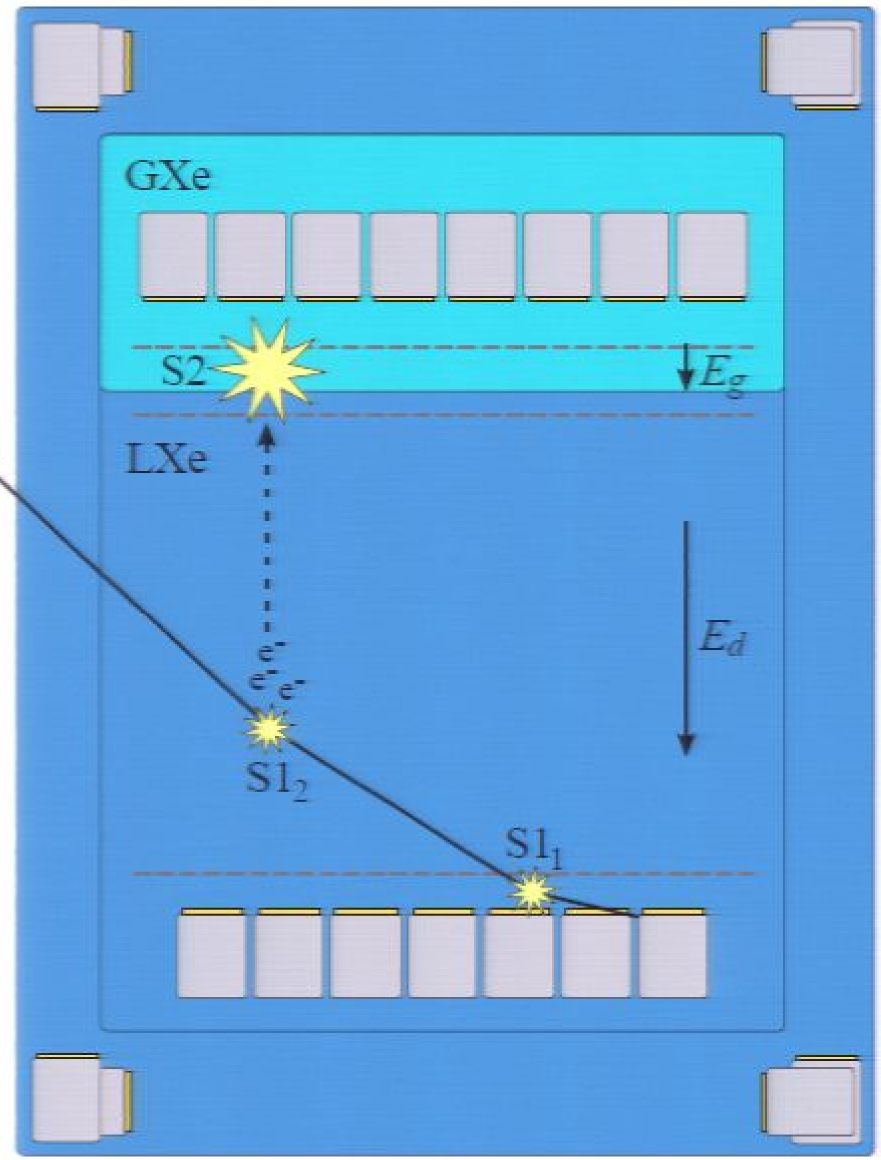
- Keep acceptance high (think discovery)
- Data quality cuts acceptance estimated from AmBe and ^{60}Co calibration data, MC simulations, and ERs outside the WIMP search energy range
- Decided a priori to use Profile Likelihood approach and test both background only and signal+background hypotheses
- No S2/S1 rejection cut in the Profile Likelihood approach
- Define a benchmark WIMP region for a parallel cuts-based analysis
  - 99.75% ER rejection line
  - S2 threshold
  - NR band lower 3-σ





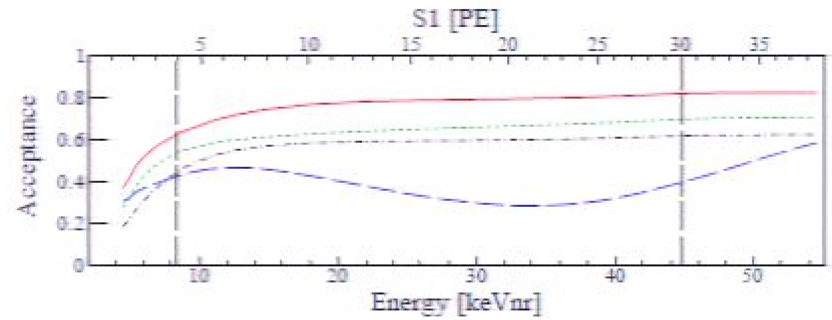
XENON100: Anomalous Leakage

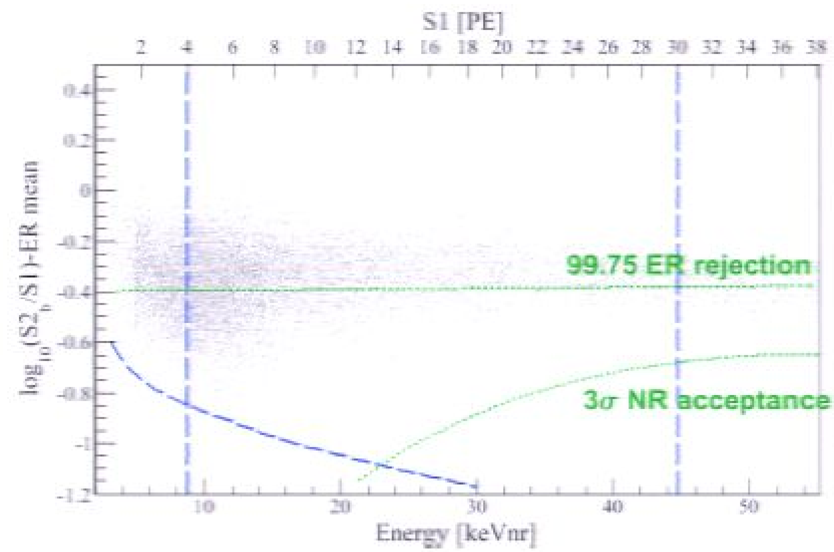
- Two types of leakage from the ER band, statistical leakage and anomalous leakage
- We assume the ER band is Gaussian in $\log(S2/S1)$, fixed discrimination at 99.75% gives the expected statistical leakage
- Events with low non-Gaussian S2/S1 also in gamma calibration data, e.g. $^{60}\mathrm{Co}$
- One source for those “anomalously leaking” events is multiple scatter events where one or more scatter occurs in a charge insensitive region of the detector
- Use the S1 Pattern likelihood cut to remove events likely due to two energy deposits
- Compute the expected anomalous leakage in background using $^{60}\mathrm{Co}$ as reference



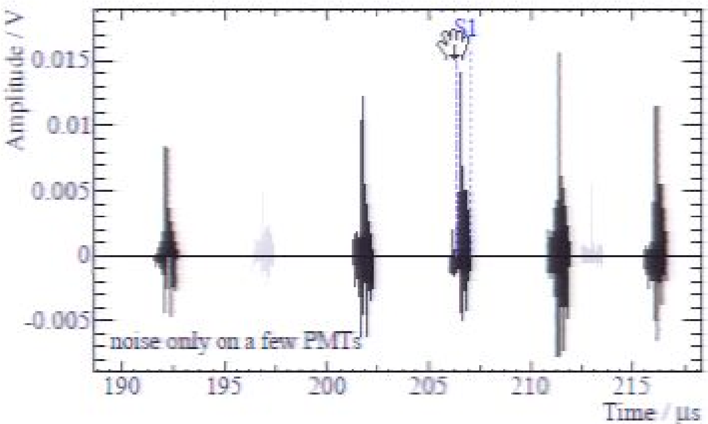
XENON100: Background Prediction

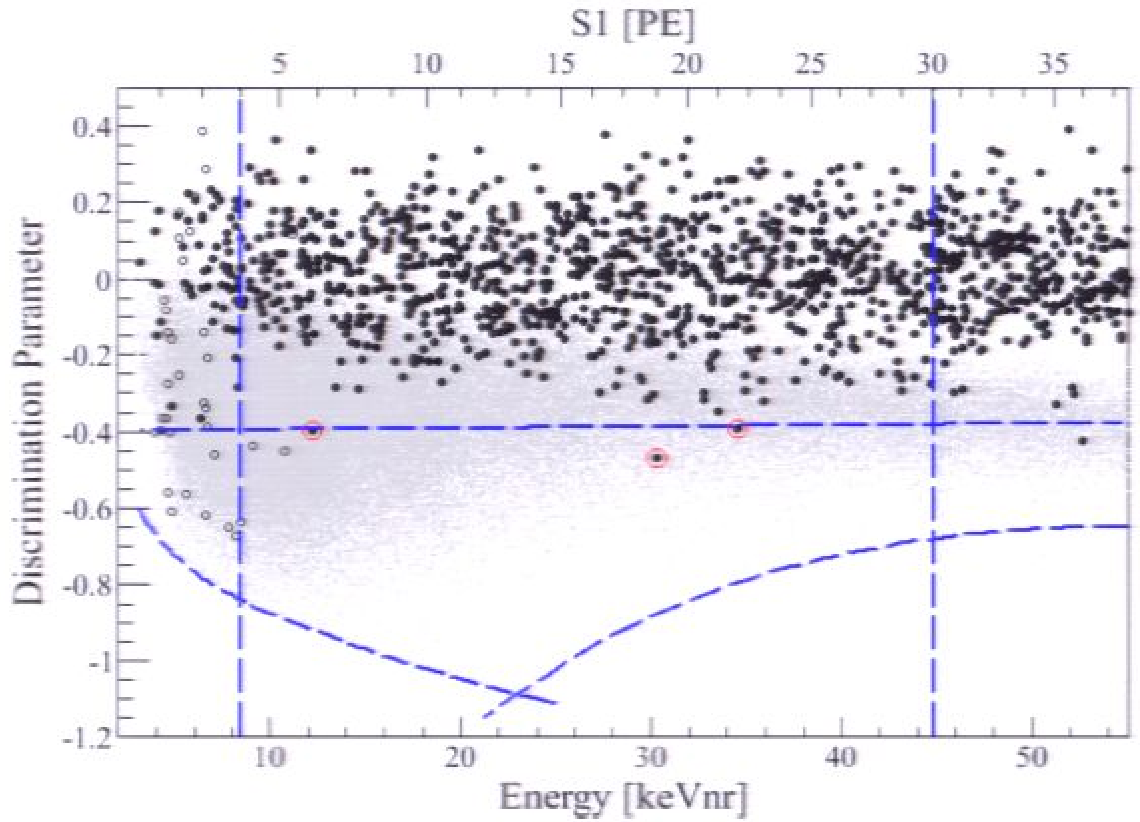
- Expected background: 48 kg fiducial mass, 99.75% electronic recoil rejection, 100.9 live days
- Statistical leakage (from electronic recoil events)
  - 1.14 ± 0.48 events, estimated from the non-blinded electronic recoil band from background
  - Dominated by $^{85}\mathrm{Kr}$ (Kr concentration $\sim 700\,\mathrm{ppt}$) due to a previous leak
- Anomalous leakage
  - 0.56 ± 0.25 events, estimated using data and MC from $^{60}\mathrm{Co}$ and background
- Neutron prediction from MC
  - 0.11 ± 0.08 events, muon-induced fast neutrons and neutrons from (α, n) reactions and spontaneous fission
- Total 1.8 ± 0.6 events in 100.9 days





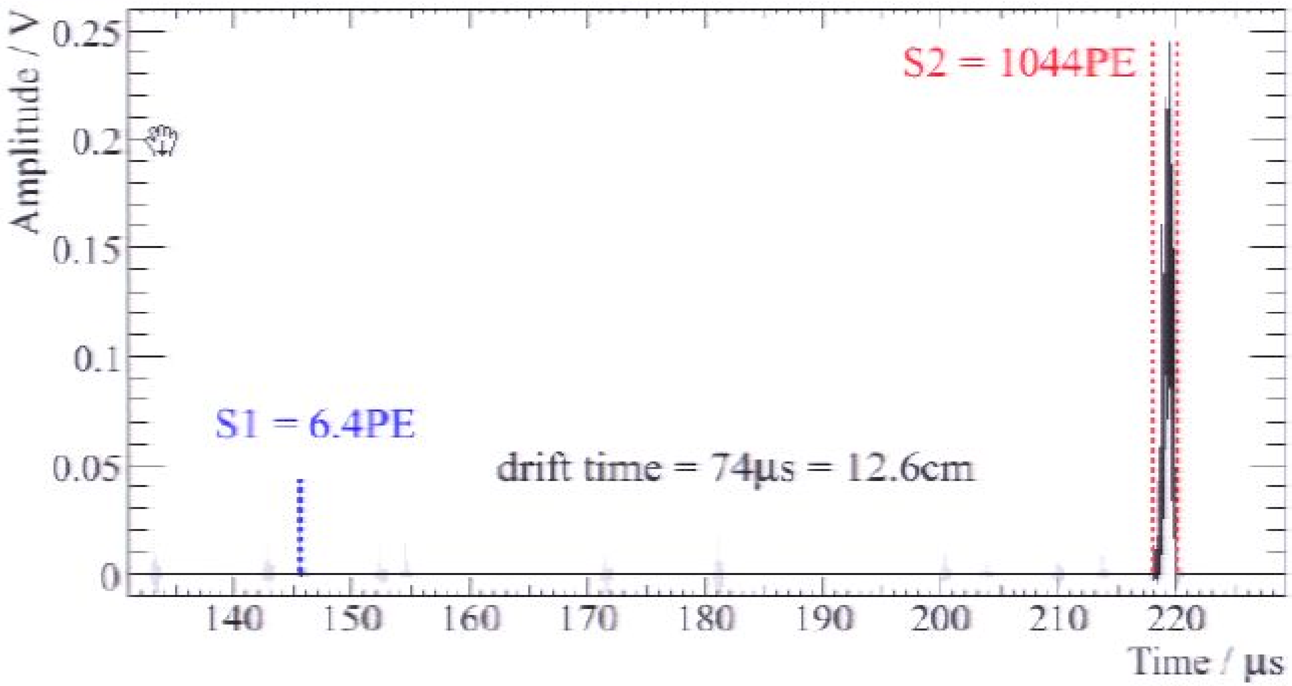
XENON100: Unblinding

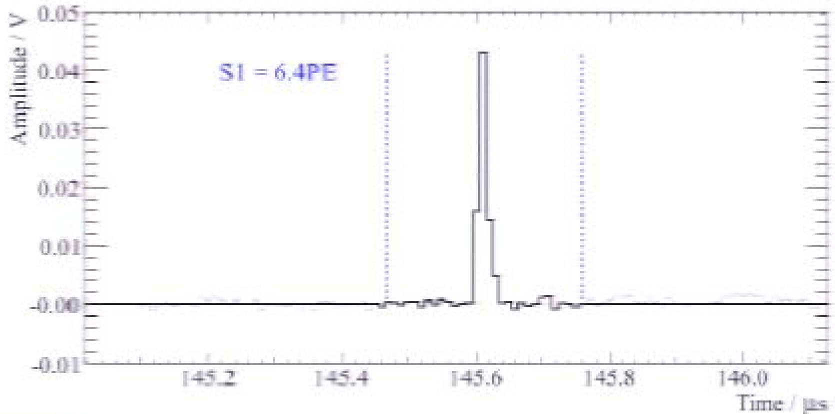


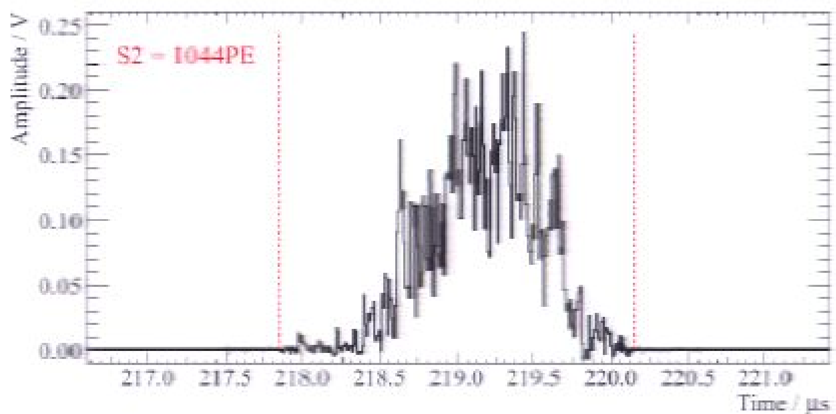


- 6 events in the signal region after unblinding, inspection reveals 3 are due to electronic noise
- Population of noise events near threshold, leaks into signal region
- Remove population with noise post-unblinding cut, 3 candidate WIMP events remain

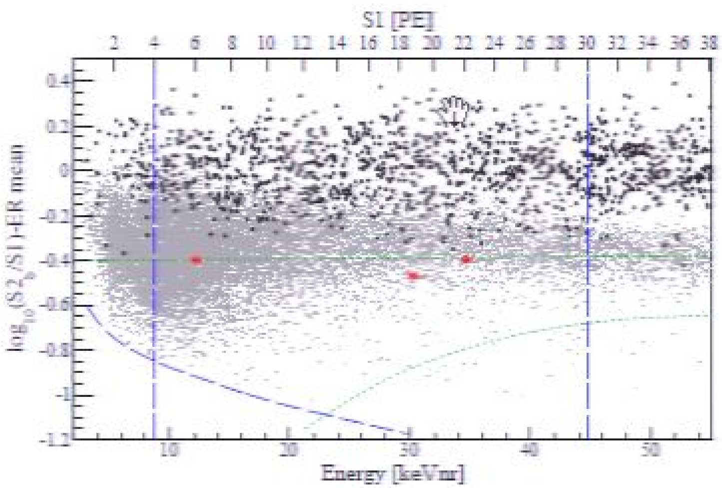
XENON100: Candidate Event

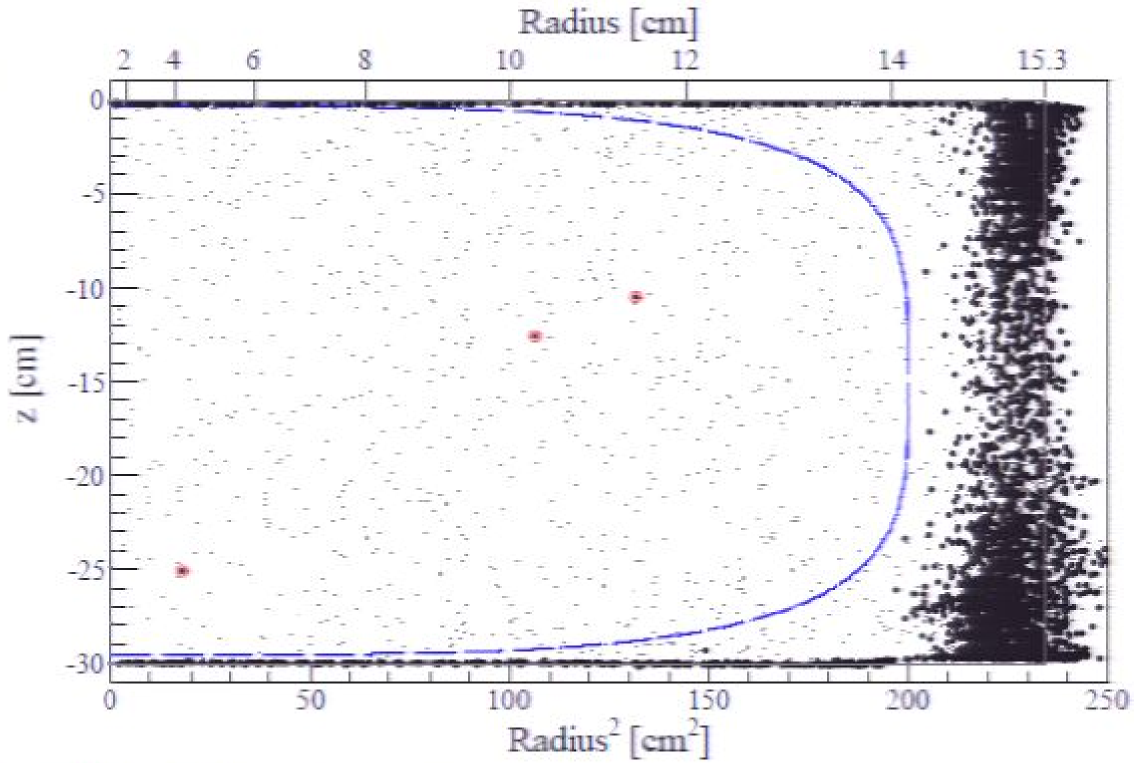






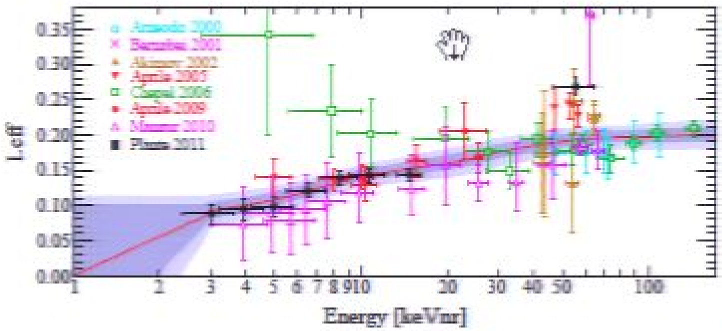
XENON100: Event Distribution

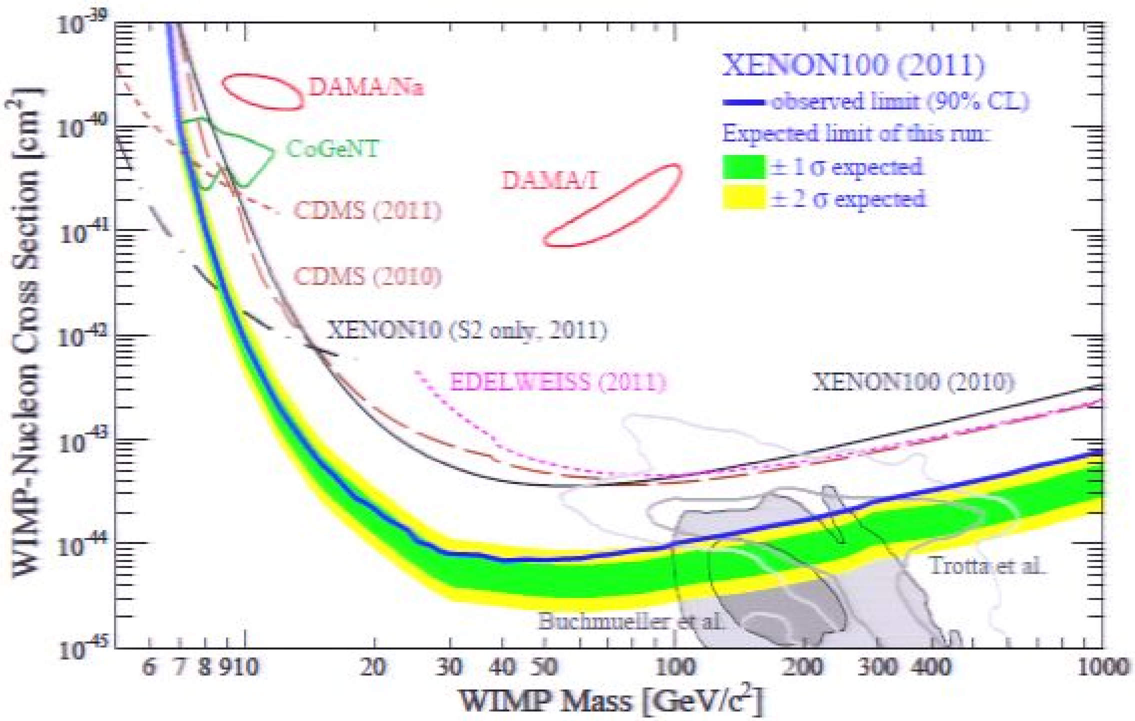




- 3 candidate events clearly inside the 48 kg fiducial volume
- Probability (Poisson) to observe 3 or more events when expecting 1.8 ± 0.6 is 28%
- Profile Likelihood analysis does not yield a significant signal excess either, background-only hypothesis has a p-value of 31%

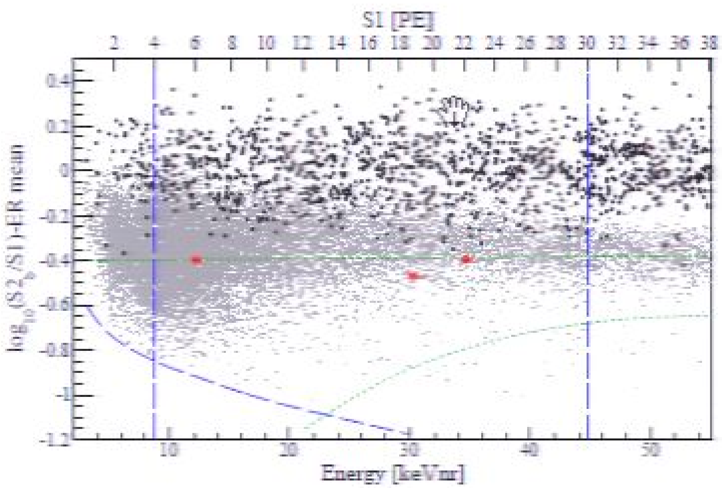
XENON100: Limit

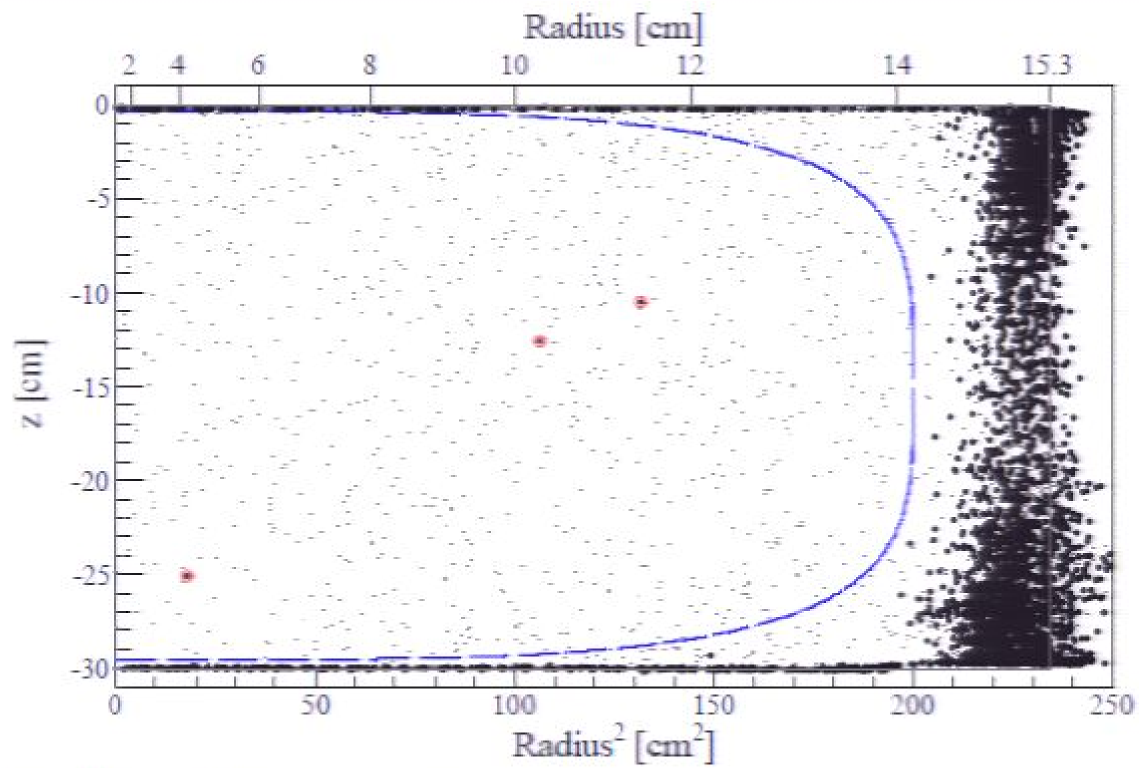




- For each mass, convolve WIMP spectrum with Poisson (S1 CE) then apply cut acceptances
- Use Profile Likelihood approach to calculate limit Aprile *et al.*, Phys. Rev. D **84**, 052003, 2011
- Strongest limit to date over a large WIMP mass range, challenges the interpretation of CoGeNT and DAMA signals as being due to low mass WIMPs
- Results recently published Aprile *et al.*, Phys. Rev. Lett. **107**, 131302, 2011

XENON100: Event Distribution

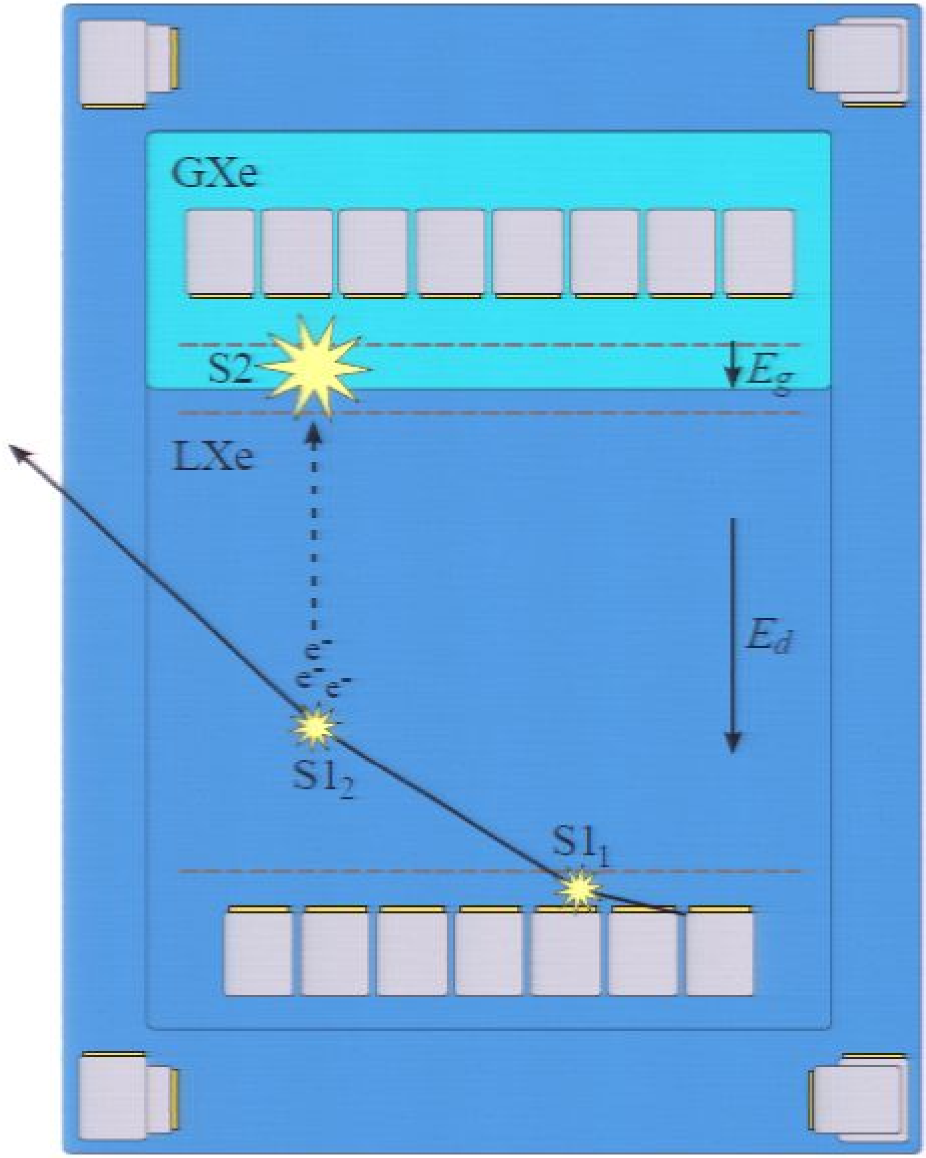




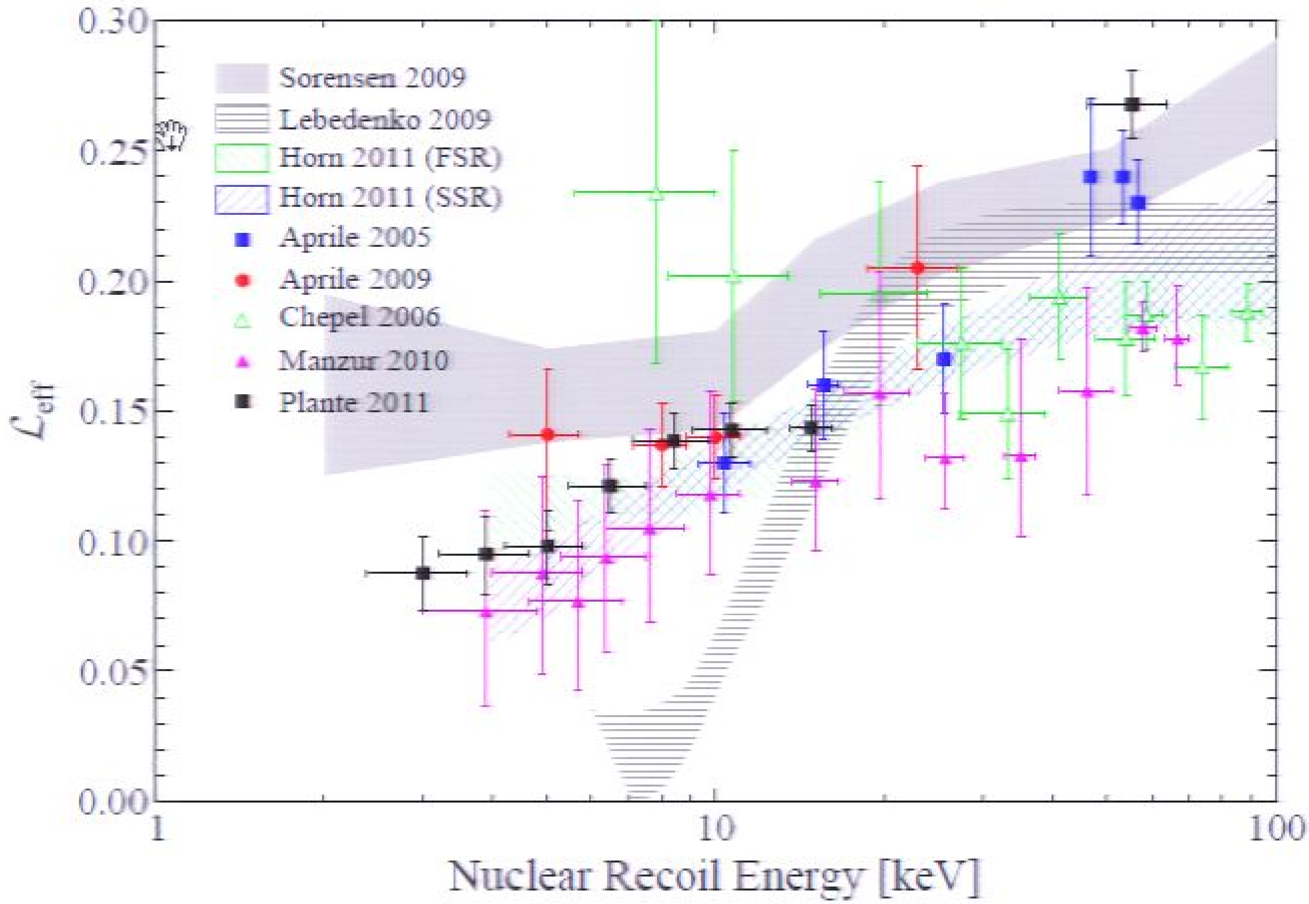
- 3 candidate events clearly inside the 48 kg fiducial volume
- Probability (Poisson) to observe 3 or more events when expecting 1.8 ± 0.6 is 28%
- Profile Likelihood analysis does not yield a significant signal excess either, background-only hypothesis has a p-value of 31%

XENON100: Anomalous Leakage

- Two types of leakage from the ER band, statistical leakage and anomalous leakage
- We assume the ER band is Gaussian in $\log(S2/S1)$, fixed discrimination at 99.75% gives the expected statistical leakage
- Events with low non-Gaussian S2/S1 also in gamma calibration data, e.g. $^{60}\mathrm{Co}$
- One source for those “anomalously leaking” events is multiple scatter events where one or more scatter occurs in a charge insensitive region of the detector
- Use the S1 Pattern likelihood cut to remove events likely due to two energy deposits
- Compute the expected anomalous leakage in background using $^{60}\mathrm{Co}$ as reference



New Measurement of $\mathcal{L}_{\rm eff}$: Result



- Lowest energy (3 keV) and most precise $\mathcal{L}_{\rm eff}$ direct measurement achieved to date.
- For details see Plante *et al.*, `arXiv:1104.2587` (accepted by Phys. Rev. C)

XENON100: Data Selection

Basic quality cuts

Designed to remove noisy events, events with unphysical parameters. Very high acceptance.

- S1 coincidence cut
- S2 threshold cut
- S2 saturation cut
- Signal/Noise cut

Scatter cuts

Designed to remove events with multiple interactions (multiple S2s), with delayed coincidences (multiple S1s) or misidentified S1s.

- S1 single peak cut
- S2 single peak cut
- Veto cut

Fiducial volume cut

Because of the high stopping power of LXe, fiducialization is an extremely effective way of reducing background. Fiducial volume chosen:

- 48 kg super-ellipsoid

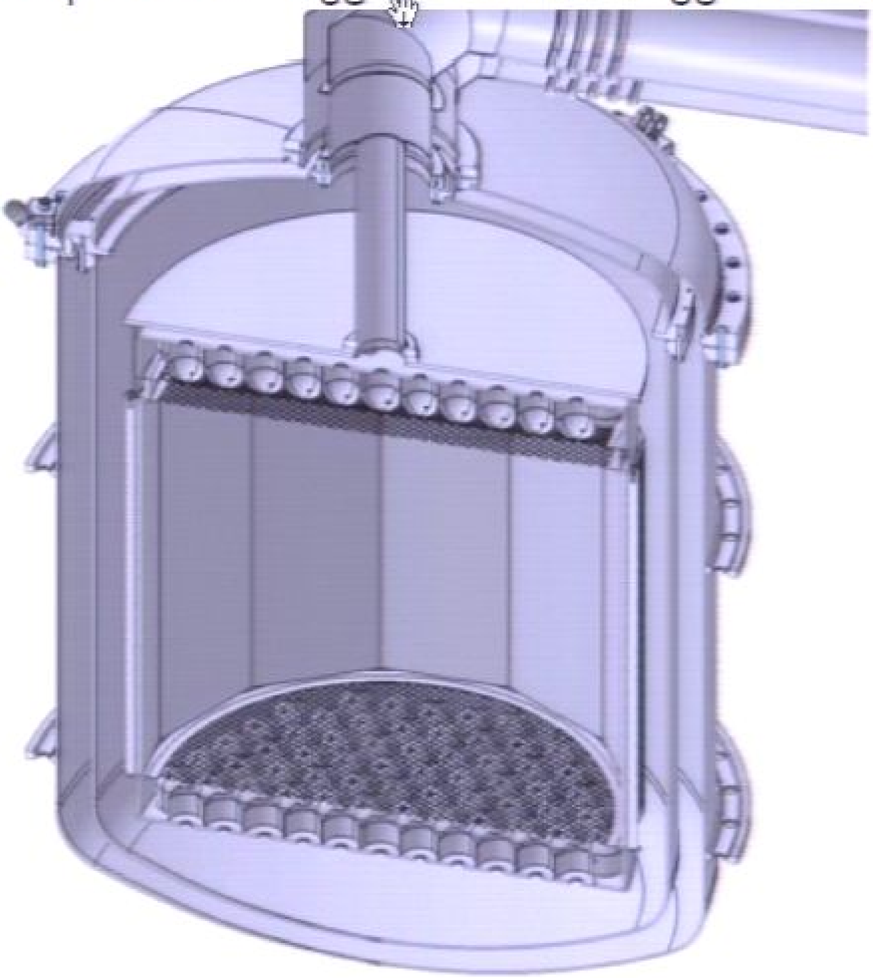
Advanced cuts

Designed to remove events which fail consistency checks, e.g. mismatch in positions from different algorithms, or with S1 PMT patterns not consistent with their position in the TPC

- S1 PMT pattern cut
- S2 width consistency cut
- Position reconstruction cut

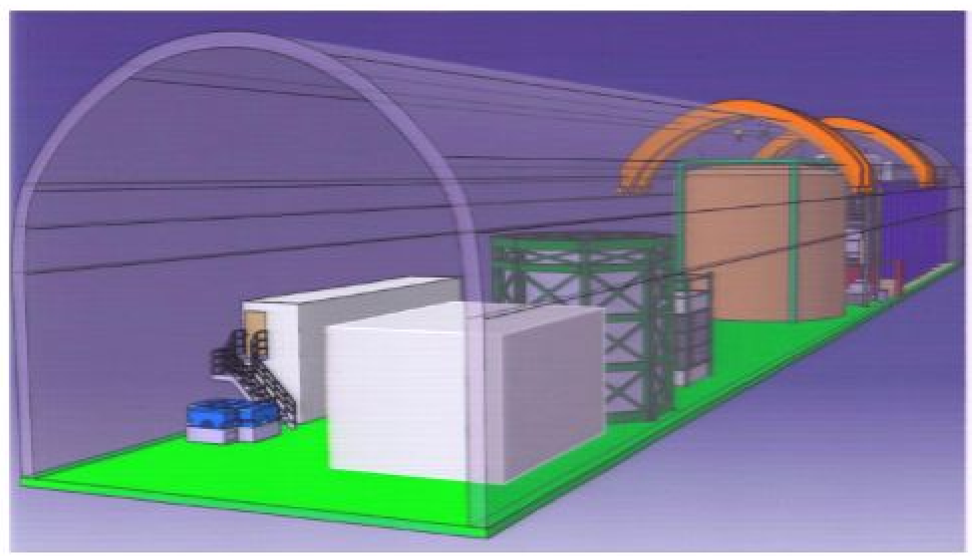
XENON100: Current Data Taking Status

- Kr concentration reduced by > $\times 5$ ($\sim$50% background reduction)
- Improved S2 trigger with lower trigger threshold

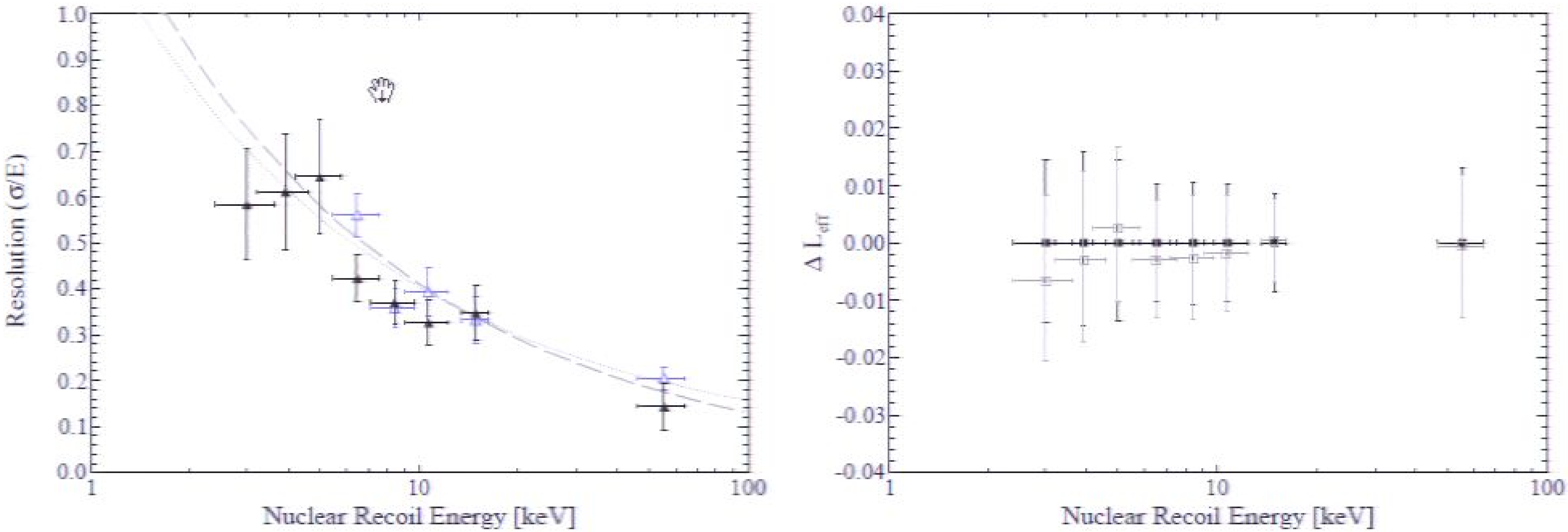


XENON100

- Low radioactivity photosensors
- 10 m water shield
- Currently in design phase, construction 2012
- Approved for construction in Hall B at LNGS



New Measurement of $\mathcal{L}_{\text{eff}}$: Resolution Effect



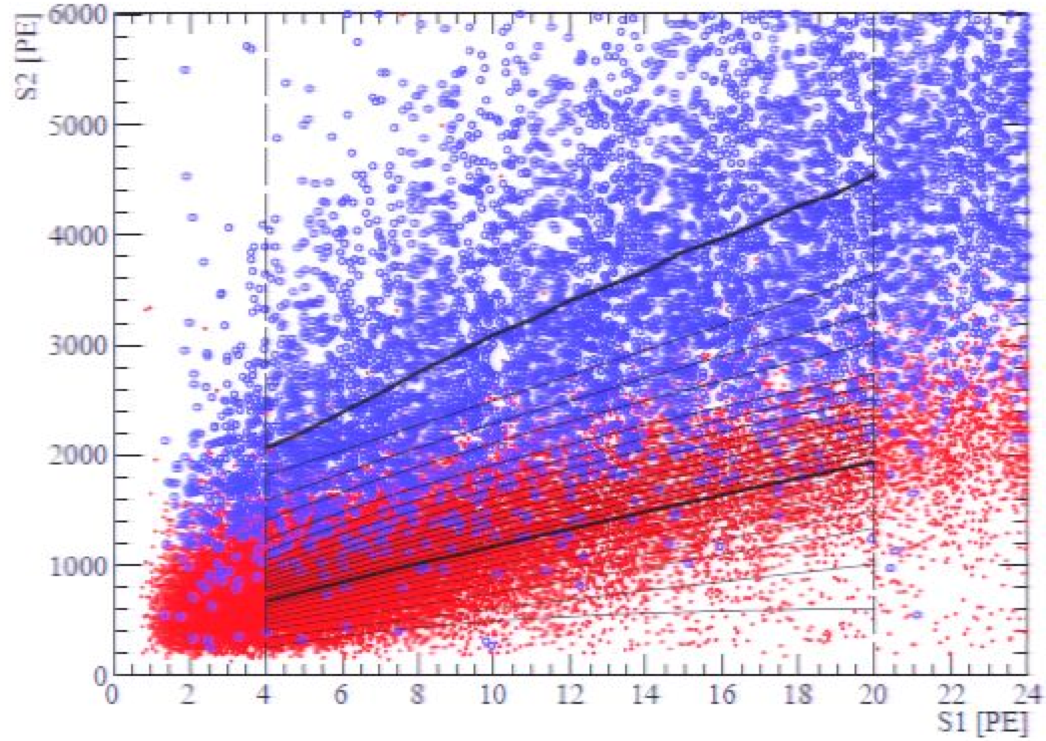
- Measured spectra at which the single elastic recoil peak is visible are fitted with a gaussian on top of an exponential background (blue triangles).
- Measured energy dependence of the resolution (σ/E) fitted with $aE^{-1/2}$ (dashed line) or $aE^{-1/2} + b$ (dotted line) and $\mathcal{L}_{\text{eff}}$ χ^2 repeated with a fixed resolution parameter R.
- The effect on the calculated $\mathcal{L}_{\text{eff}}$ values is not significant.

Profile Likelihood Approach

- Construct the Likelihood function

$$\mathscr{L} = \mathscr{L}_1(\sigma, N_b, \epsilon_s, \epsilon_b, \mathcal{L}_{\text{eff}}, v_{\text{esc}}; m_\chi) \times \mathscr{L}_2(\epsilon_s) \times \mathscr{L}_3(\epsilon_b) \times \mathscr{L}_4(\mathcal{L}_{\text{eff}}) \times \mathscr{L}_5(v_{\text{esc}})$$

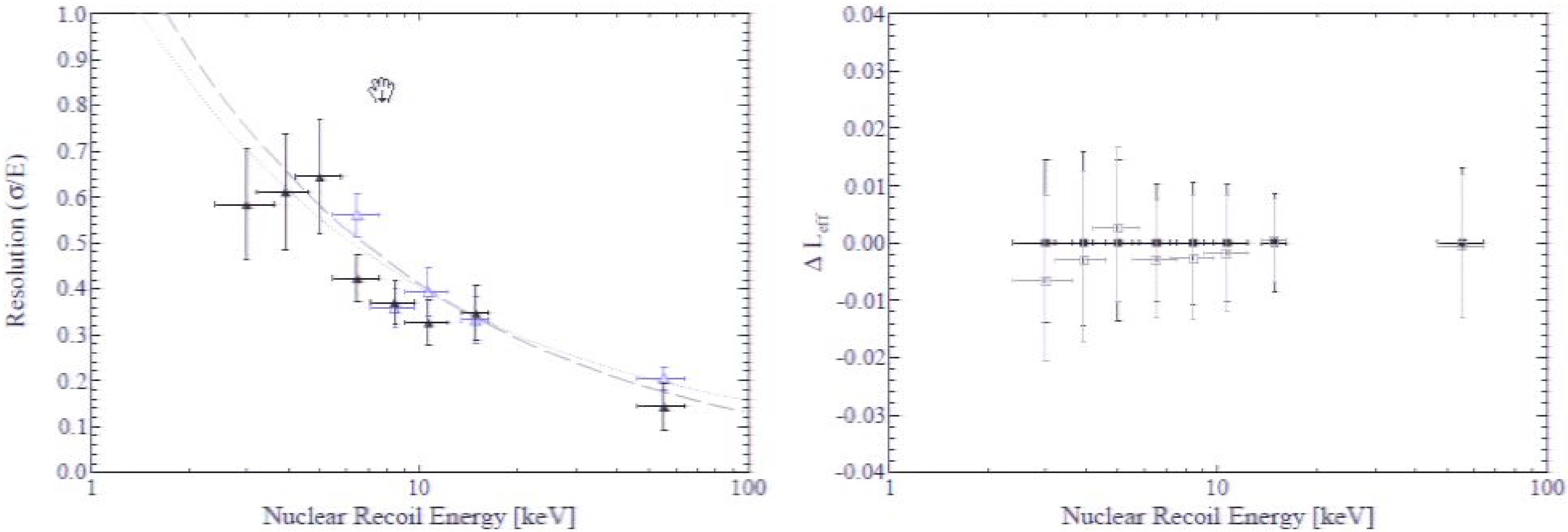
- Main term contains only one parameter of interest, the signal cross-section σ, other parameters are nuisance parameters and profiled out
- Additional terms constrain the nuisance parameters in the main term
- Makes use all observed events in the WIMP search data, no sharp S2/S1 discrimination cut, energy distribution
- Allows systematic uncertainties to be incorporated in a consistent manner



- More details in

Aprile *et al.*, Phys. Rev. D **84**, 052003, 2011

New Measurement of $\mathcal{L}_{\rm eff}$: Resolution Effect



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New Measurement of $\mathcal{L}_{\rm eff}$: Uncertainty

$$\sigma^2_{\mathcal{L}_{\rm eff}} = \sigma^2_{\mathcal{L}_{\rm eff},{\rm fit}} + \left(\frac{\partial \mathcal{L}_{\rm eff}}{\partial L_y}\right)^2 \sigma^2_{L_y} + \left(\frac{\partial \mathcal{L}_{\rm eff}}{\partial E_{\rm nr}}\right)^2 \sigma^2_{E_{\rm nr}} + \left(\frac{\Delta \mathcal{L}_{\rm eff}}{\Delta \epsilon}\right)^2 \sigma^2_{\epsilon} + \left(\frac{\Delta \mathcal{L}_{\rm eff}}{\Delta r_g}\right)^2 \sigma^2_{r_g} + \left(\frac{\Delta \mathcal{L}_{\rm eff}}{\Delta r_s}\right)^2 \sigma^2_{r_s}$$

- The total uncertainty on $\mathcal{L}_{\rm eff}$ is computed from
  - $\sigma_{\mathcal{L}_{\rm eff},{\rm fit}}$, uncertainty from the fit
  - σ_{L_y}, uncertainty $^{57}\mathrm{Co}$ light yield
  - $\sigma_{E_{\rm nr}}$, spread in nuclear recoil energies
  - σ_ϵ, liquid scintillator cut efficiency uncertainty
  - σ_g, neutron generator position uncertainty
  - σ_s, liquid scintillator position uncertainty
- $\partial \mathcal{L}_{\rm eff} / \partial E_{\rm nr}$ is computed from a logarithmic fit to the measured values
- $\Delta \mathcal{L}_{\rm eff} / \Delta \epsilon$, $\Delta \mathcal{L}_{\rm eff} / \Delta r_g$, and $\Delta \mathcal{L}_{\rm eff} / \Delta r_s$ are calculated from MC simulations
- At all energies, the dominant contribution is from $\sigma_{E_{\rm nr}}$ Below 6.5 keV, the second largest contribution is from σ_ϵ. At 6.5 keV and above, the second largest contribution is from $\sigma_{\mathcal{L}_{\rm eff},{\rm fit}}$

New Measurement of $\mathcal{L}_{\mathrm{eff}}$: Setup

New Measurement of $\mathcal{L}_{\rm eff}$: Uncertainty

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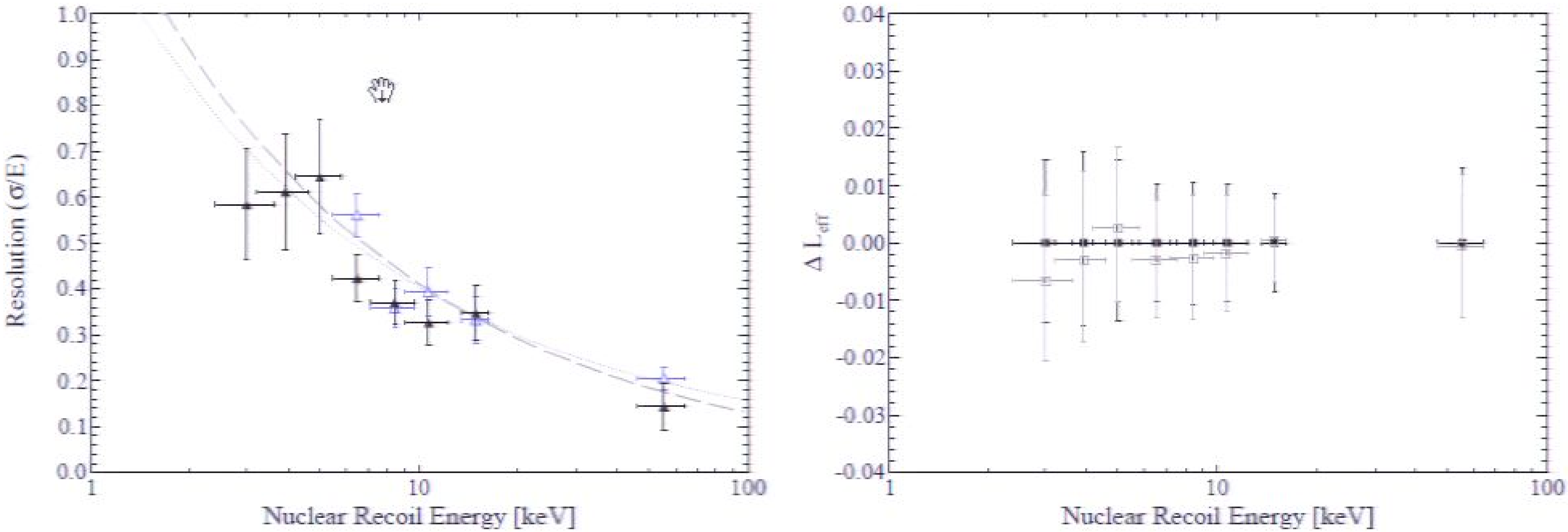

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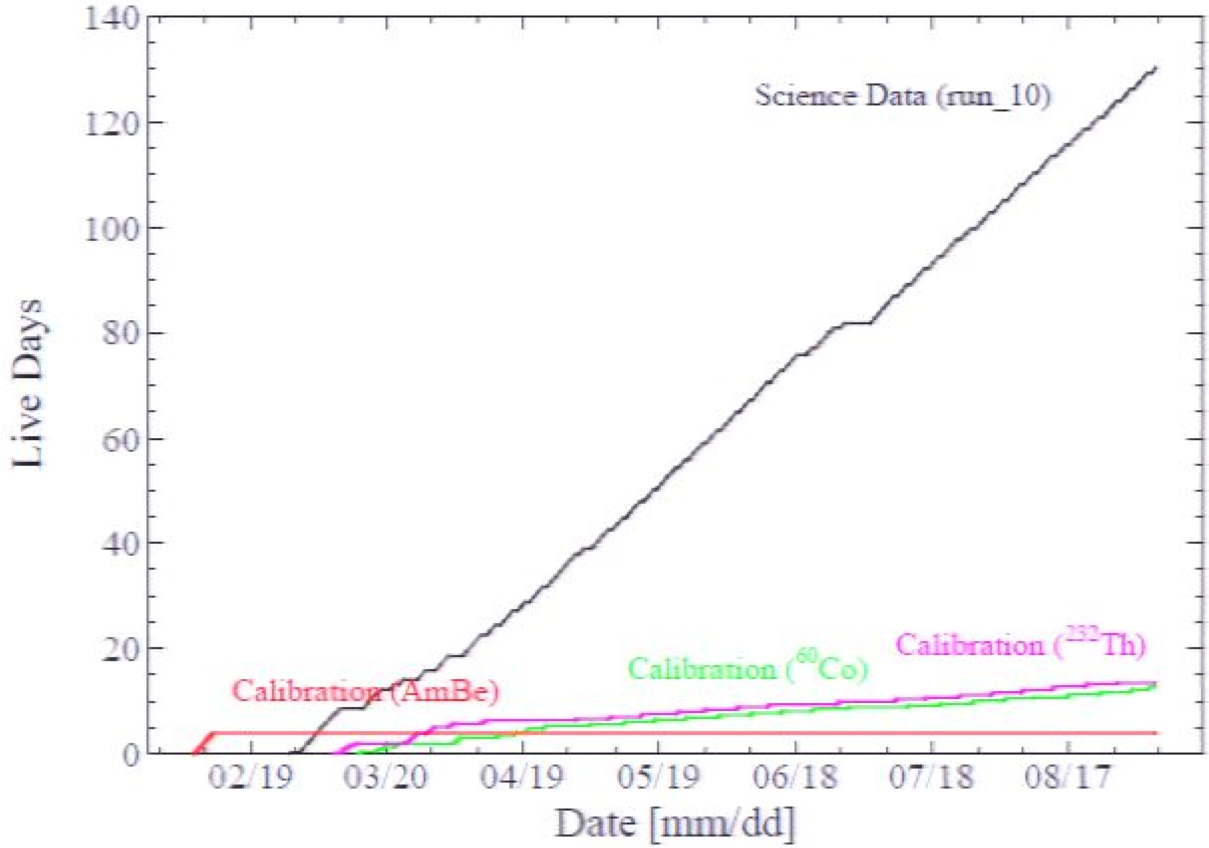
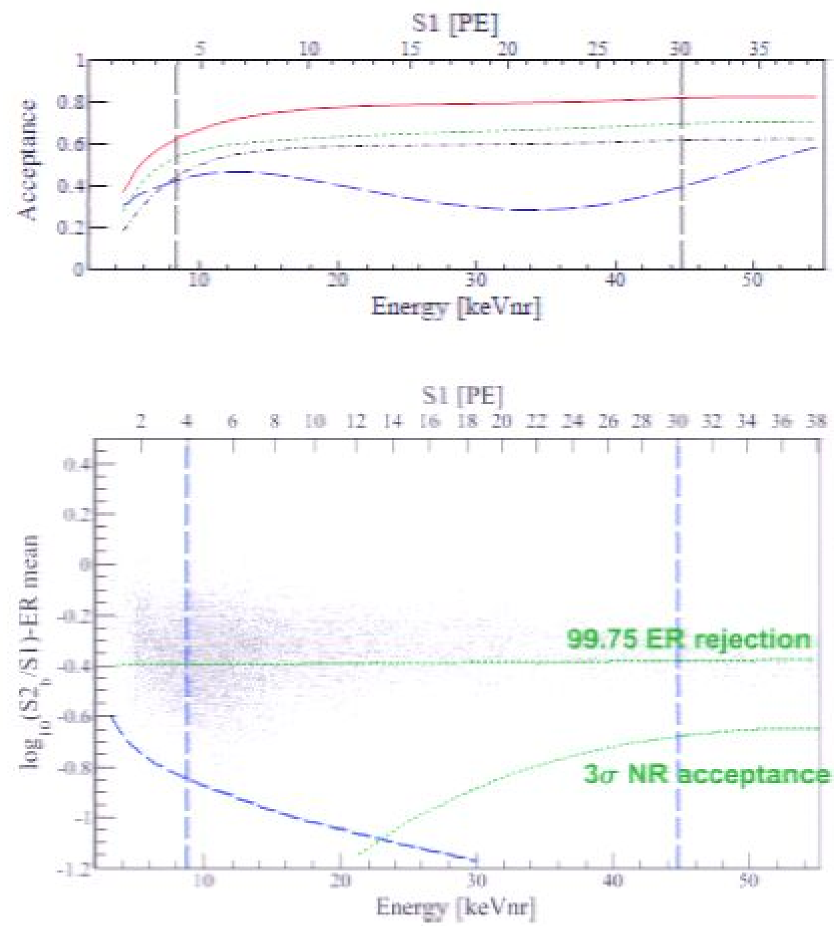
XENON100: Current Data Taking Status

- Kr concentration reduced by > $\times 5$ ($\sim$50% background reduction)
- Improved S2 trigger with lower trigger threshold
- New dark matter run started early 2011, $\sim$140 live days accumulated
- Much more ER calibration data, already $\sim$15 live days ^{60}Co and $\sim$15 live days ^{232}Th



XENON100: Background Prediction

- Expected background: 48 kg fiducial mass, 99.75% electronic recoil rejection, 100.9 live days
- Statistical leakage (from electronic recoil events)
  - 1.14 ± 0.48 events, estimated from the non-blinded electronic recoil band from background
  - Dominated by $^{85}\mathrm{Kr}$ (Kr concentration $\sim 700\,\mathrm{ppt}$) due to a previous leak
- Anomalous leakage
  - 0.56 ± 0.25 events, estimated using data and MC from $^{60}\mathrm{Co}$ and background
- Neutron prediction from MC
  - 0.11 ± 0.08 events, muon-induced fast neutrons and neutrons from (α, n) reactions and spontaneous fission
- Total 1.8 ± 0.6 events in 100.9 days



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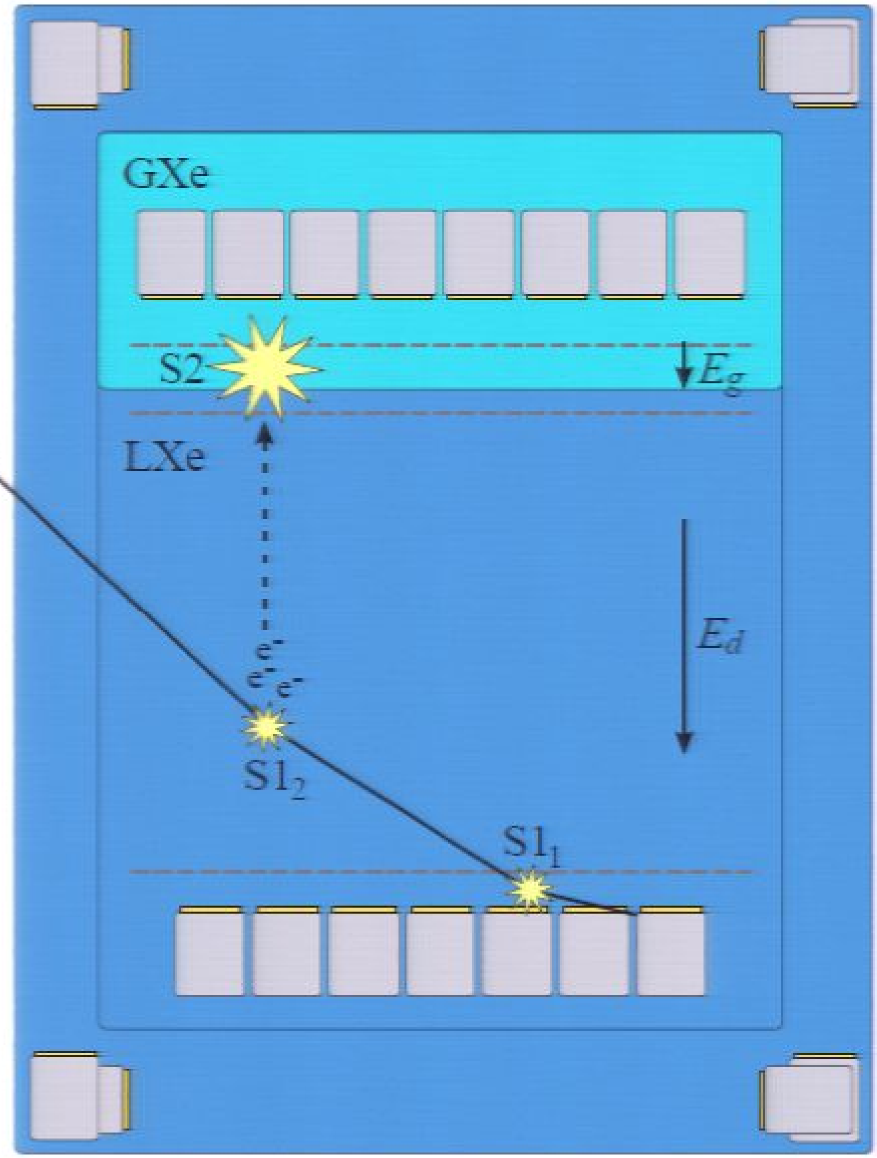
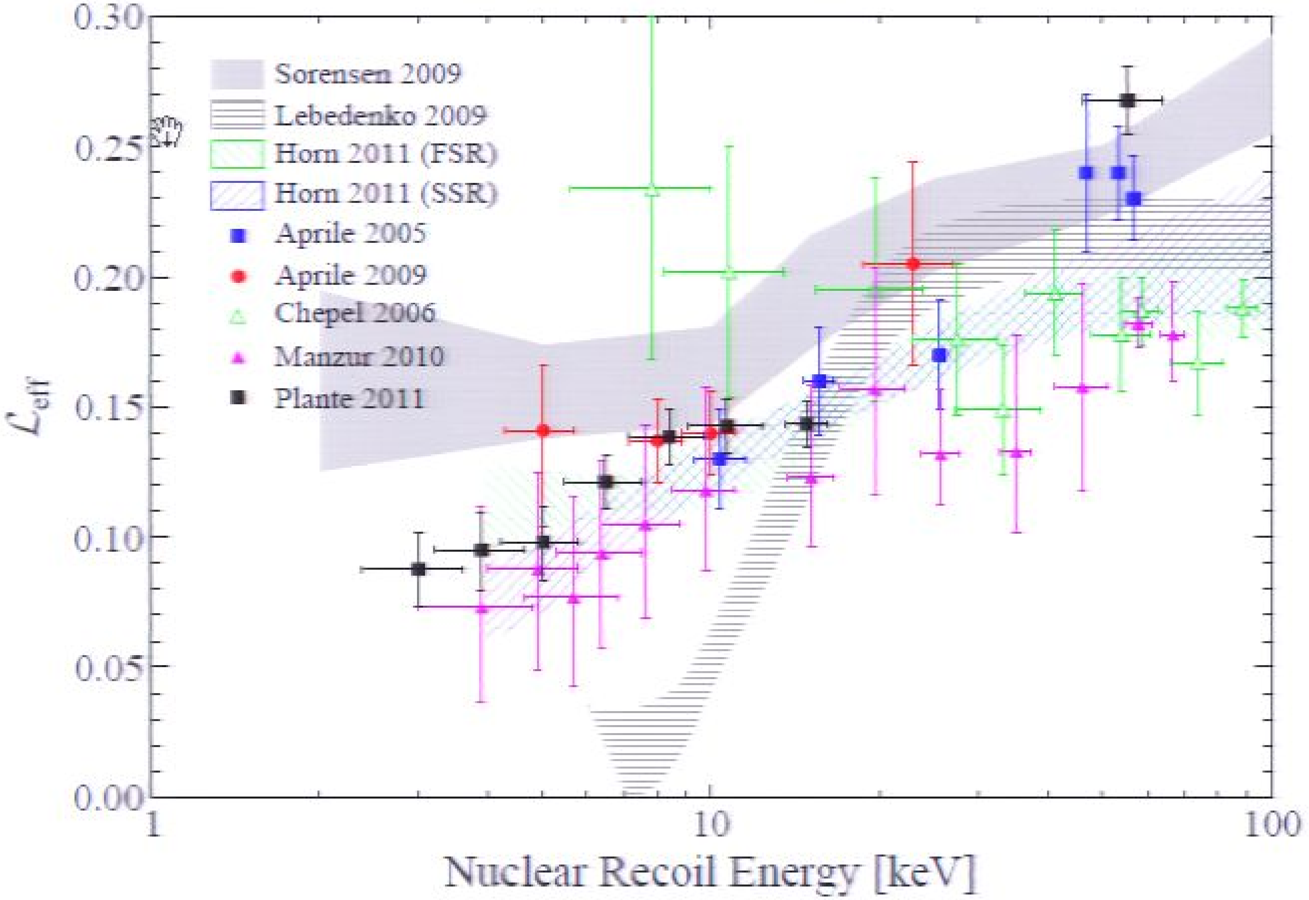


New Measurement of $\mathcal{L}_{\rm eff}$: Result



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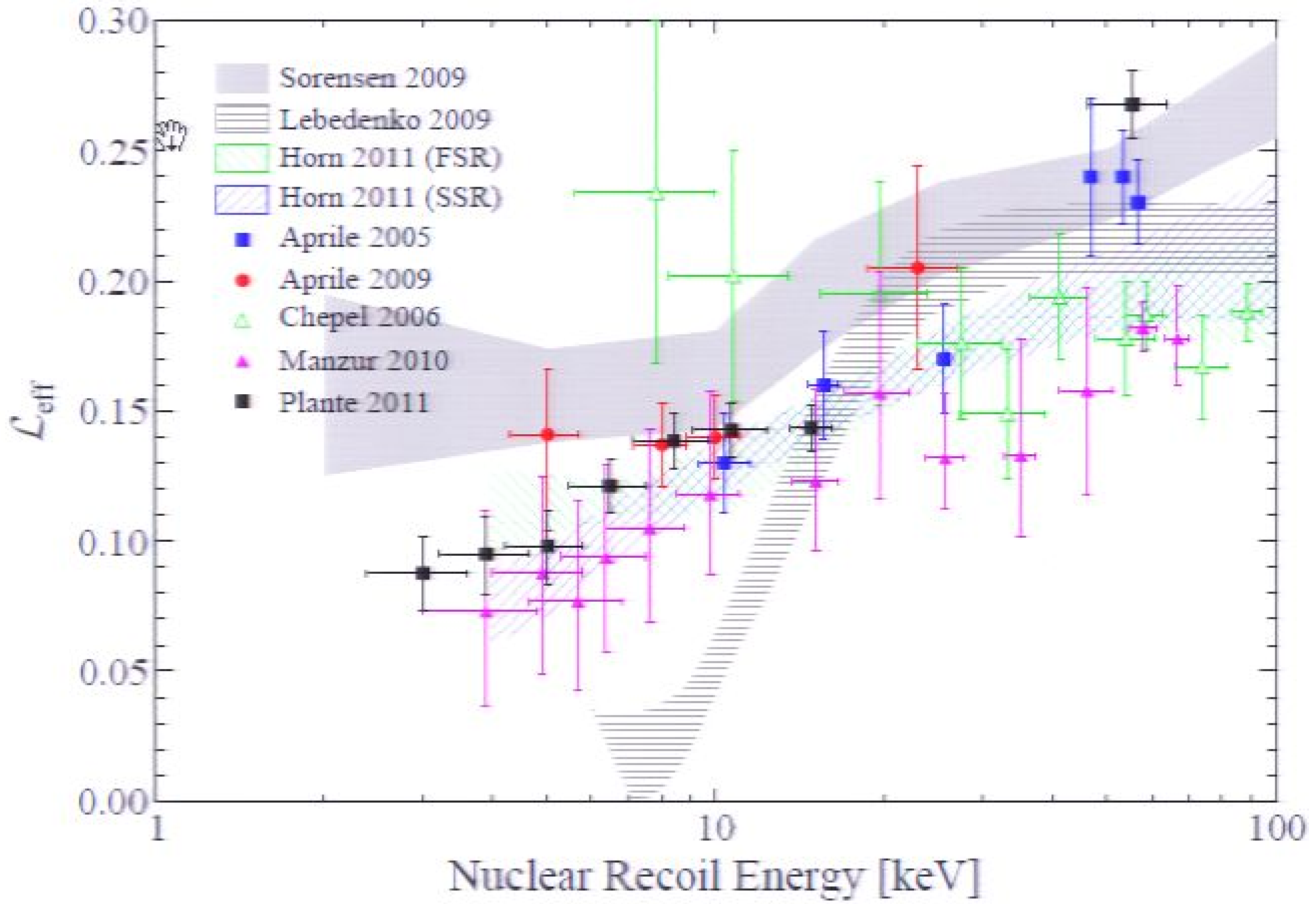

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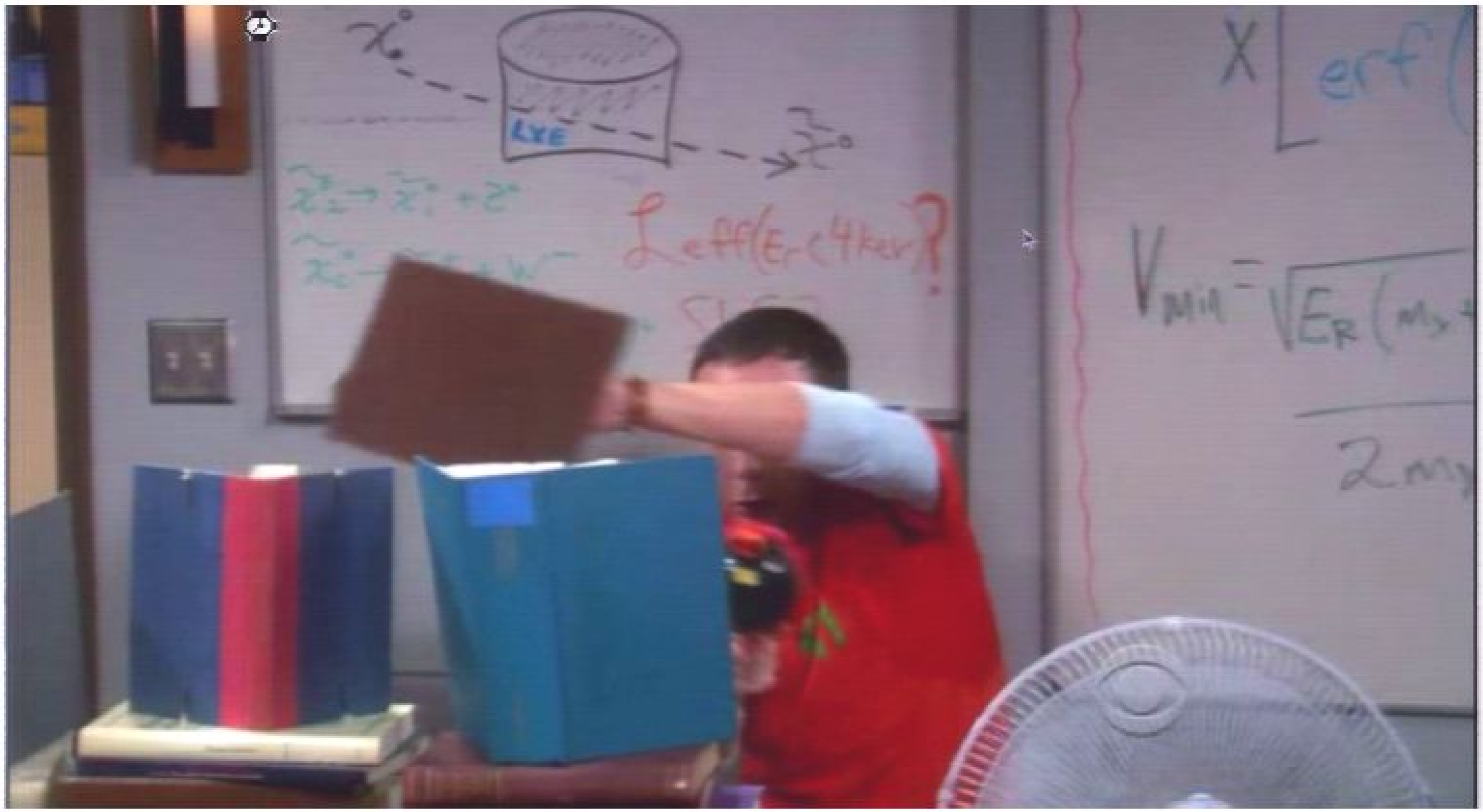
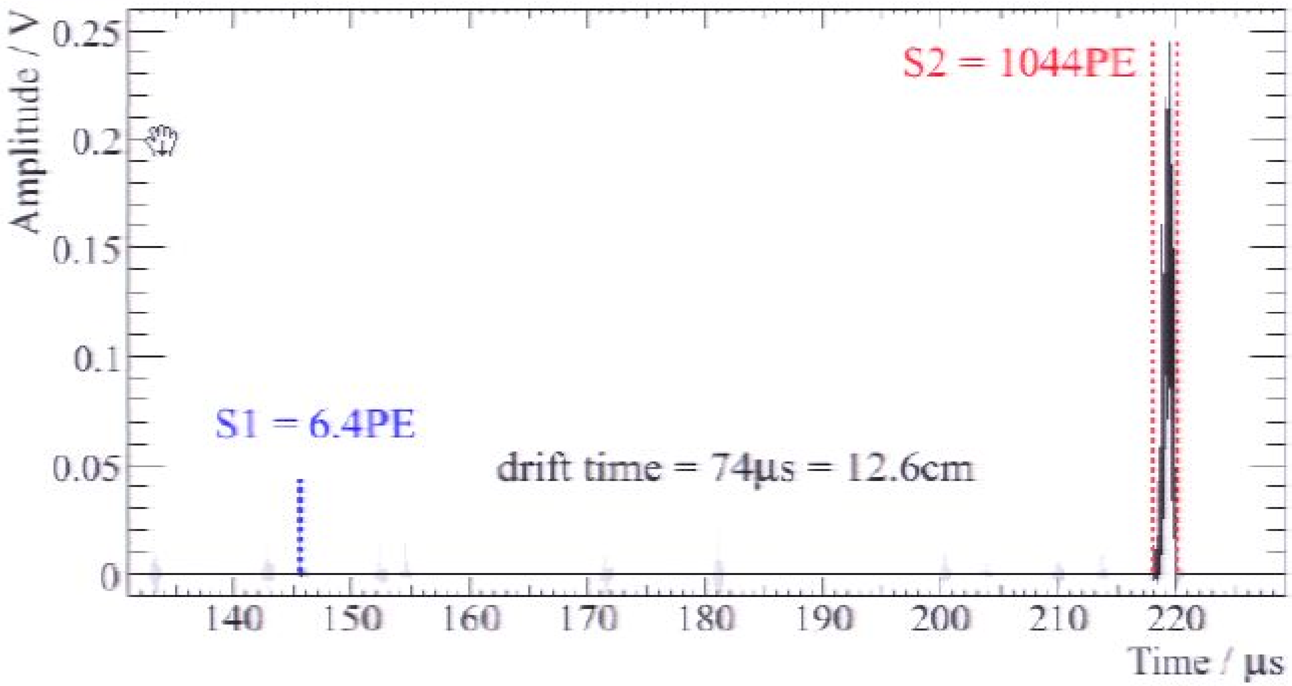
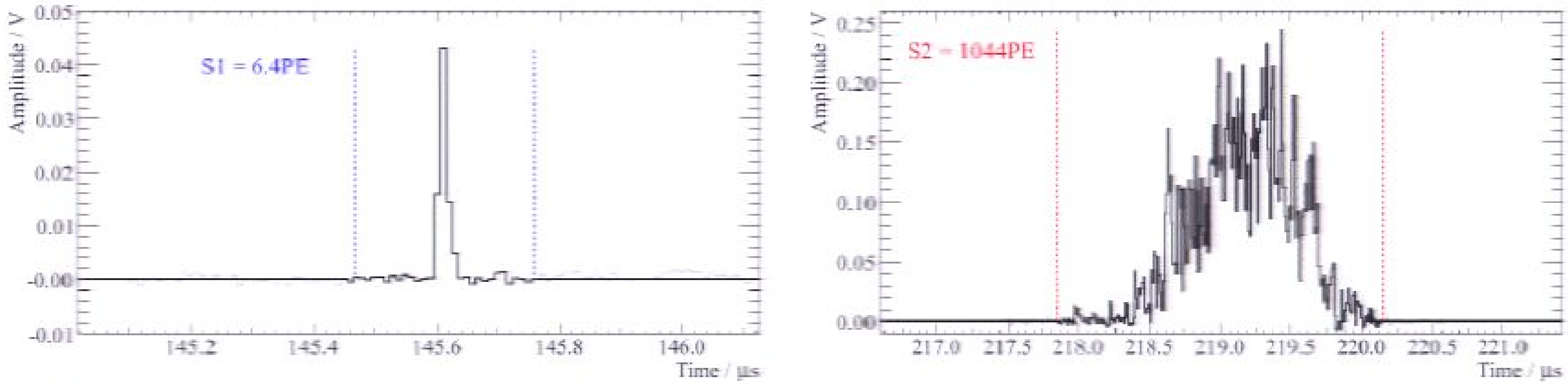
Additionally. . .

Even Sheldon from the "Big Bang Theory" is interested in the value of $\mathcal{L}_{\text{eff}}$ below 4 keVr



XENON100: Candidate Event





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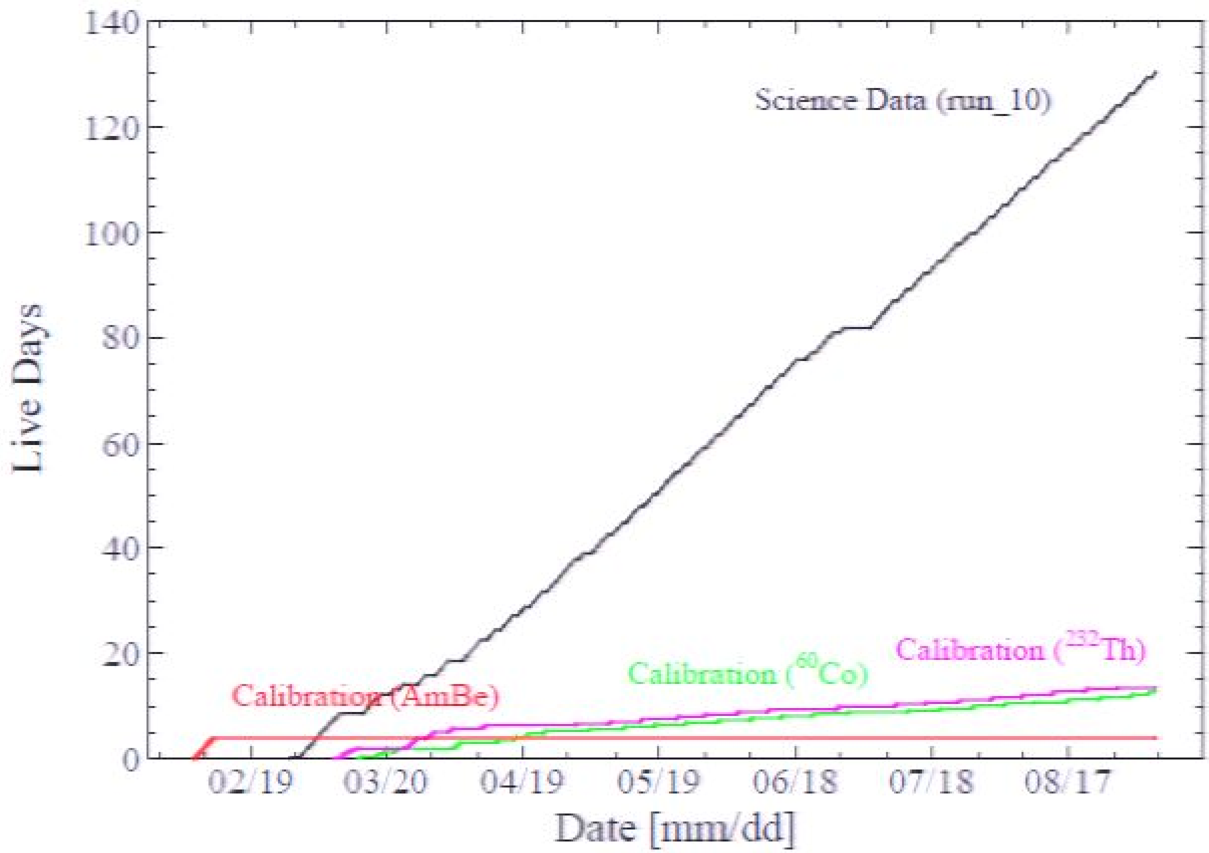
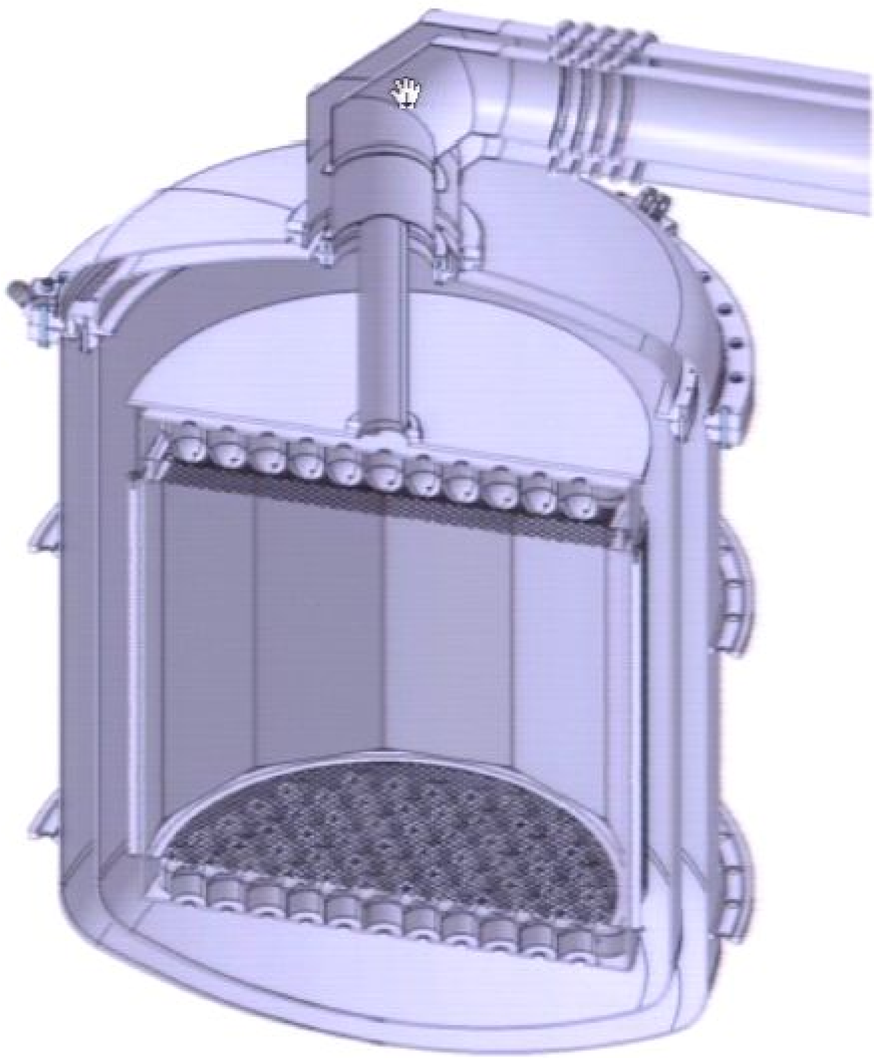


XENON1T: Future



- $1\,\mathrm{m}^3$ TPC, 2.4t LXe, 1t fiducial mass
- $\times 100$ background reduction compared to XENON100
- Low radioactivity photosensors
- 10 m water shield
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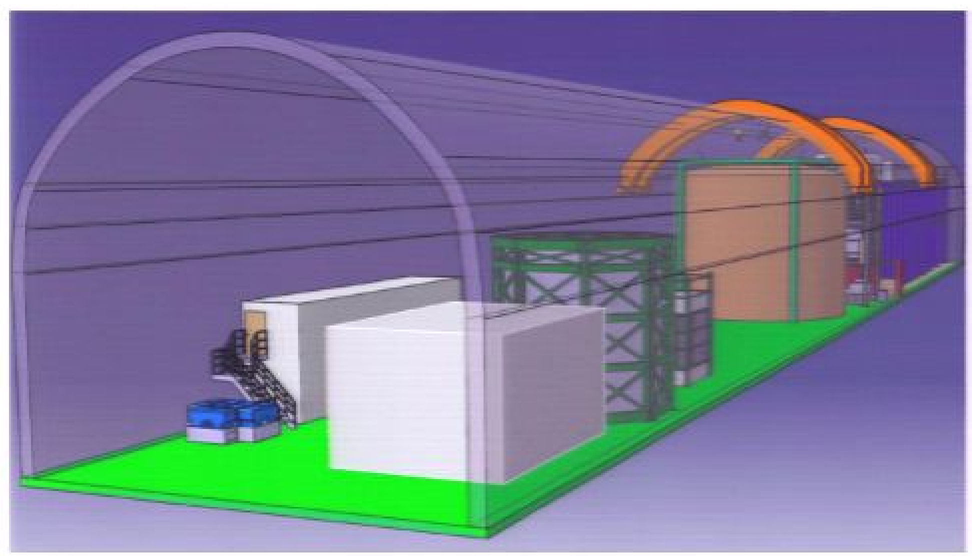

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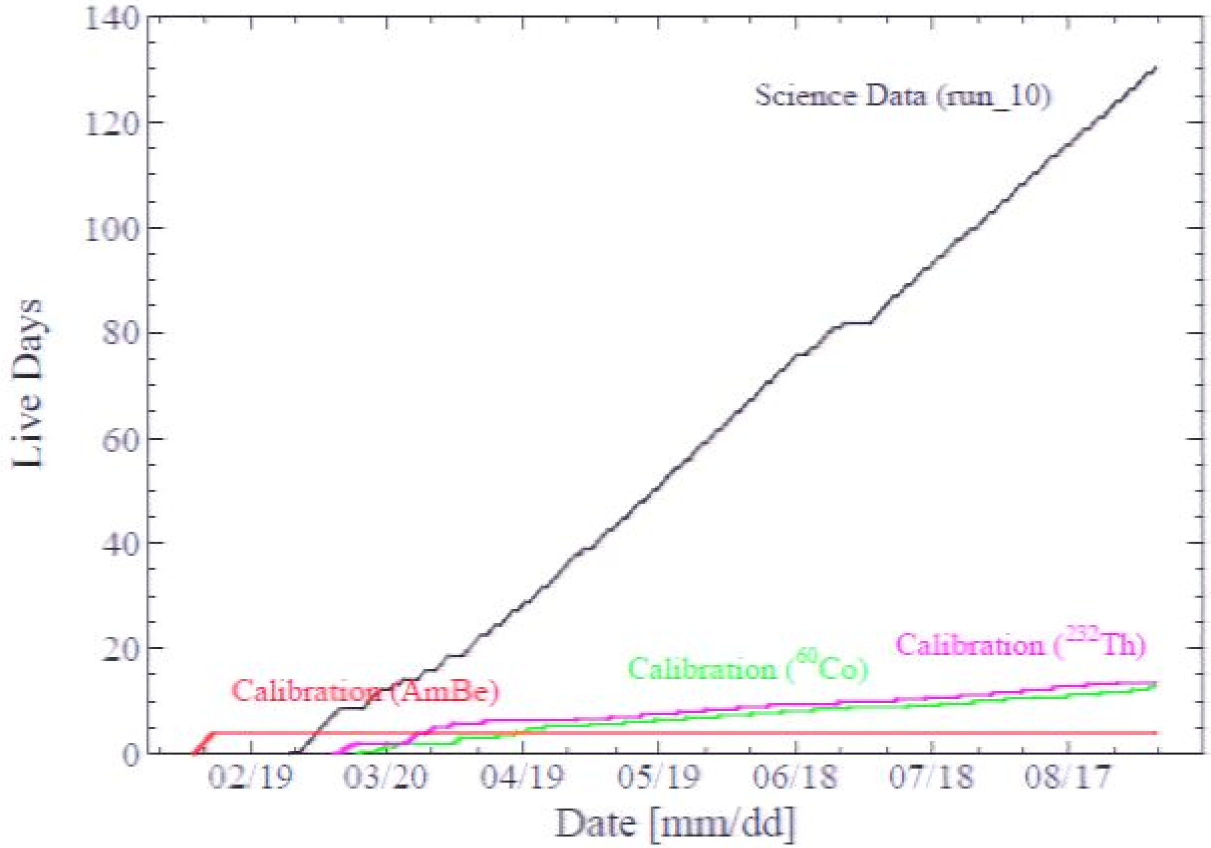

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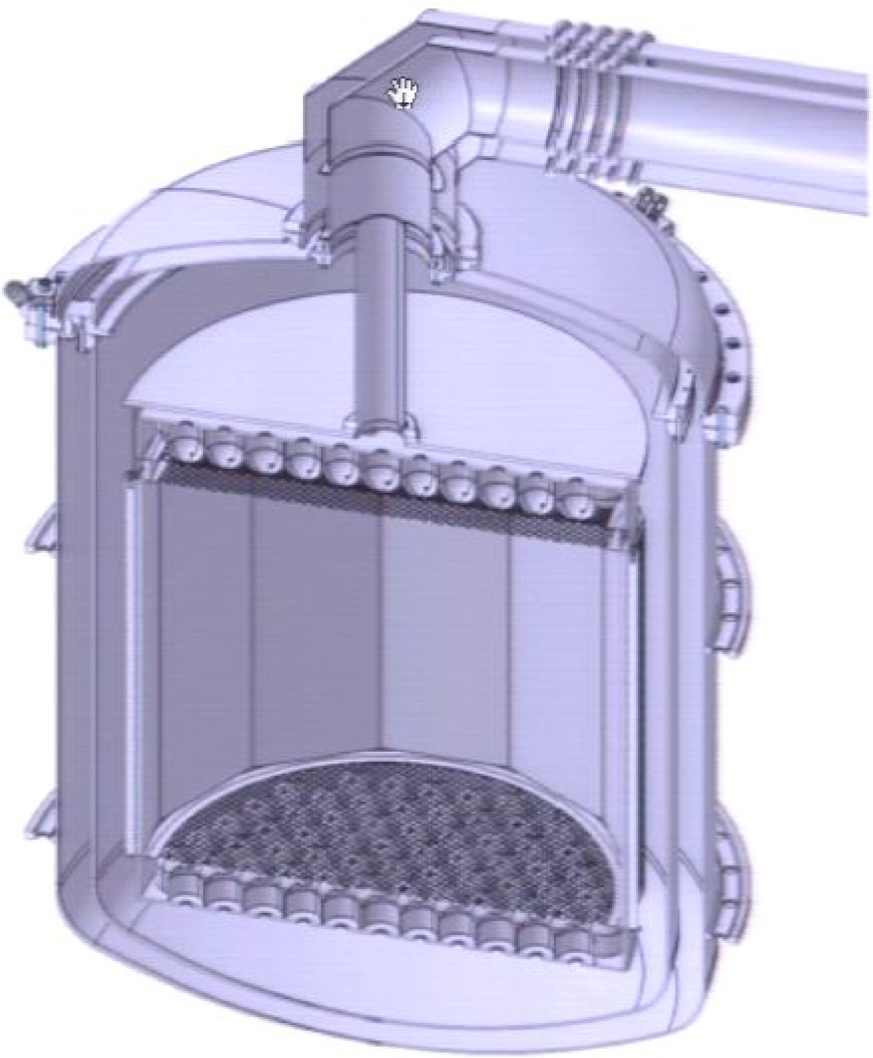

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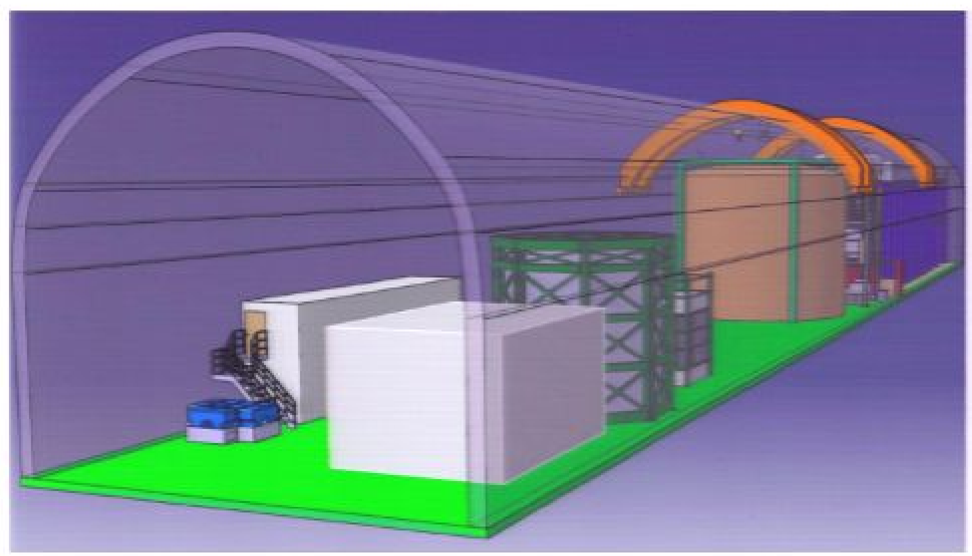
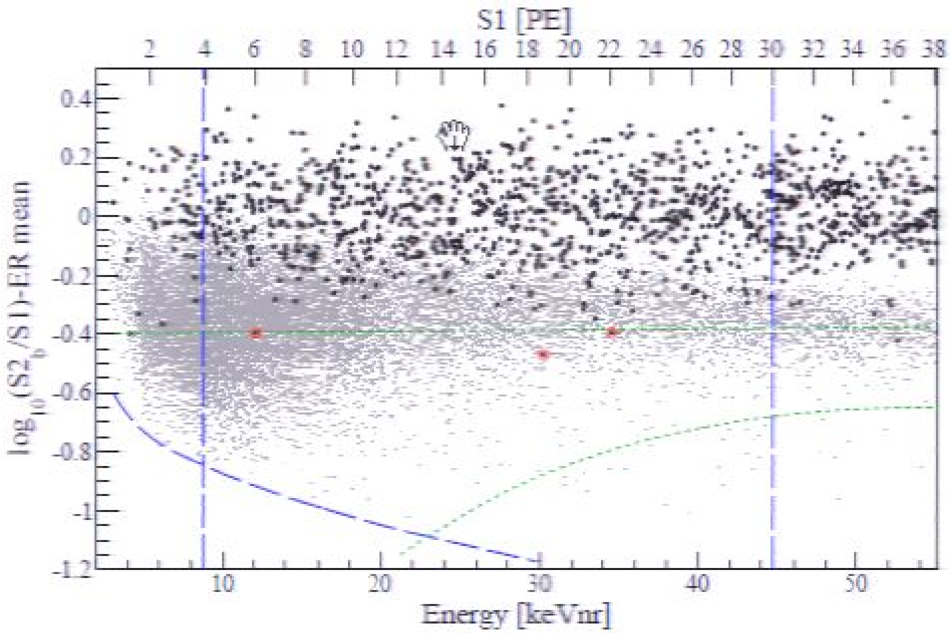
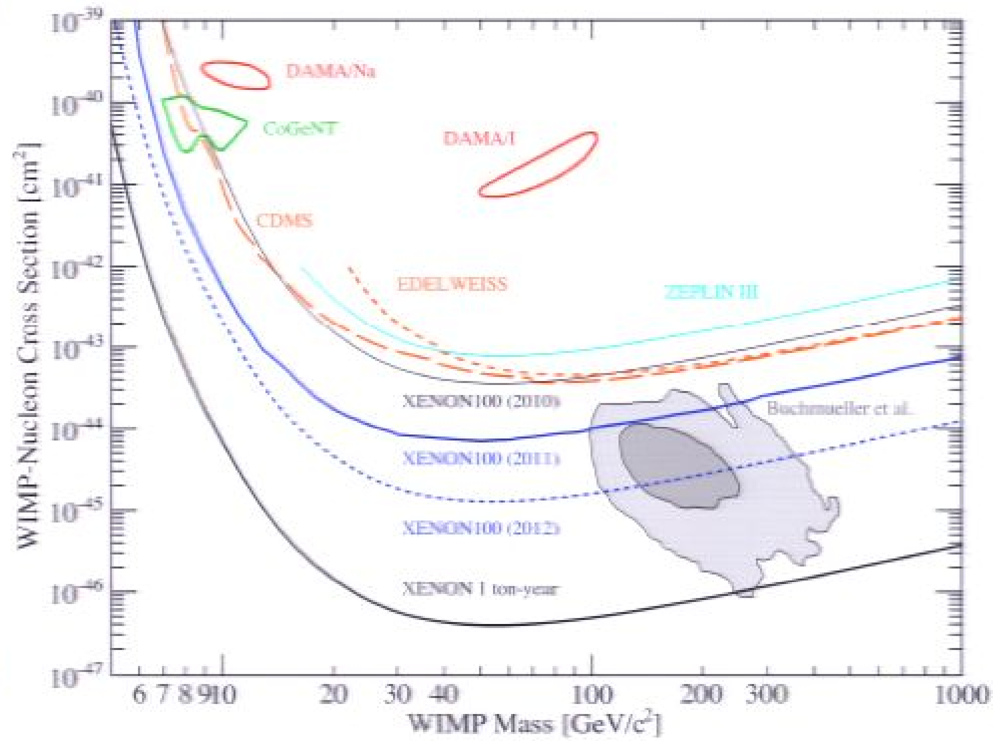


Summary





- XENON100 background level goal achieved, detector is taking dark matter data
- Accumulated 100 days exposure in 2010, 3 events observed with an expectation of 1.8 ± 0.6
- Set the most stringent limit to date on the WIMP-nucleon spin-independent cross section
- Already 140 days exposure accumulated with lower background level and improved trigger threshold, stay tuned for new results

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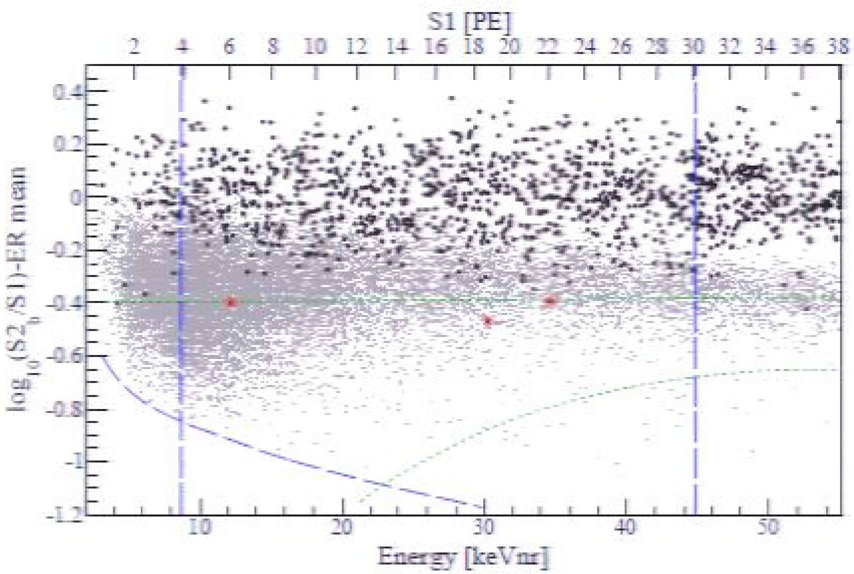
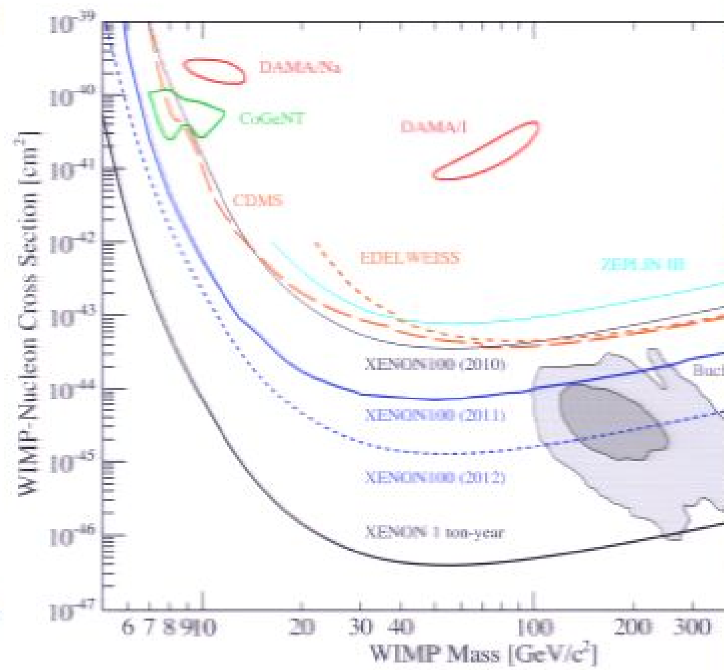
33 (33 of 38) 77.3% Find

Summary





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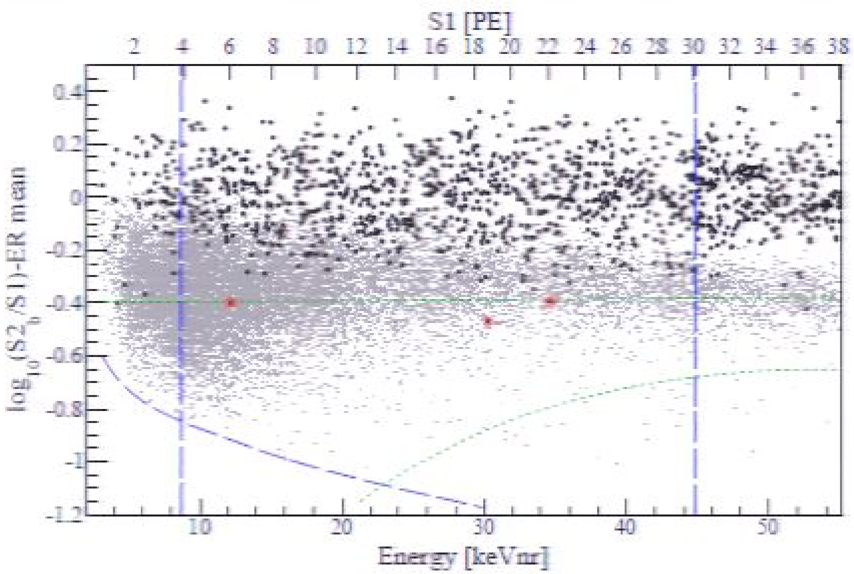
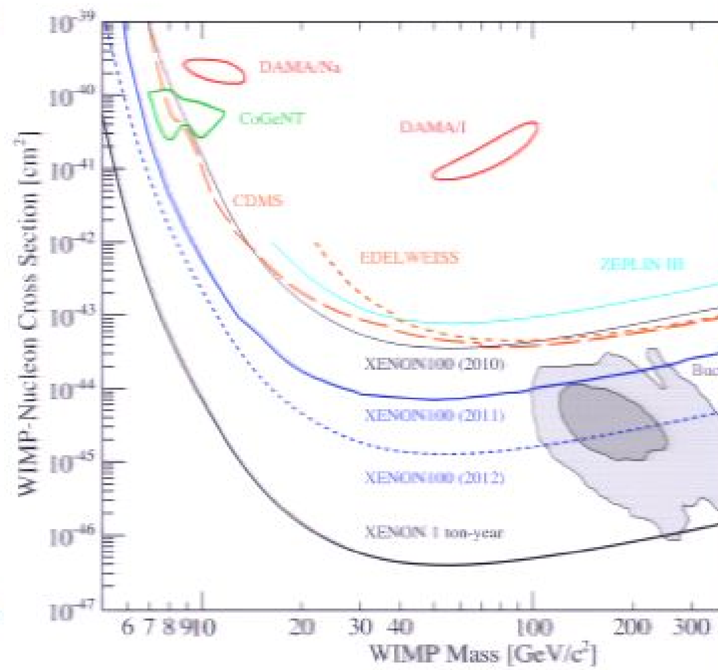
Summary





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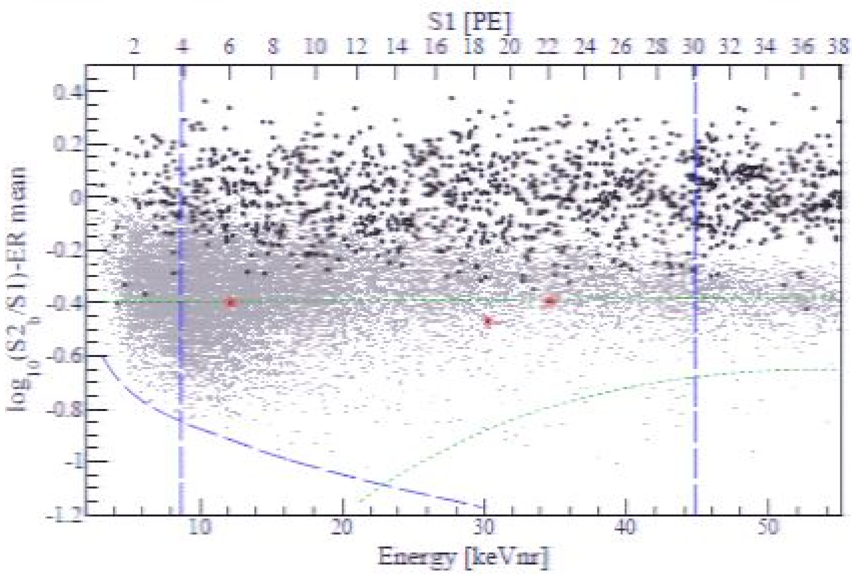

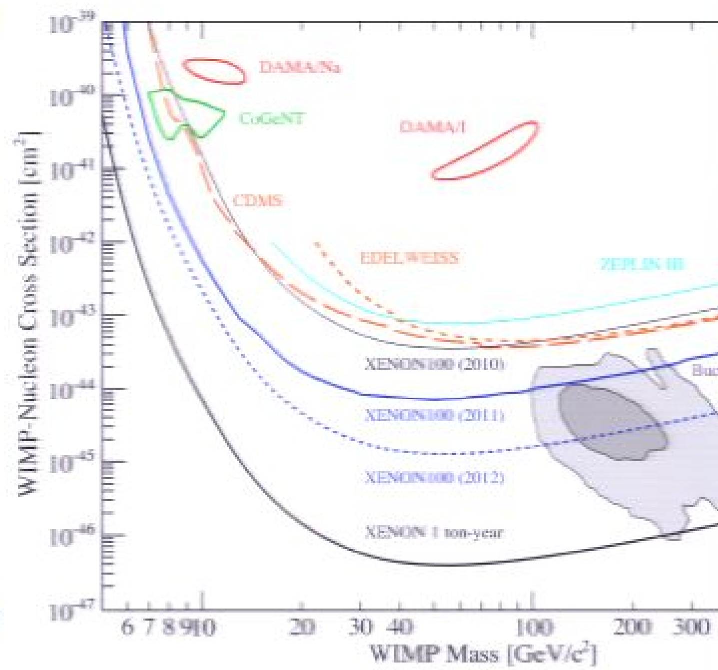

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enterprise
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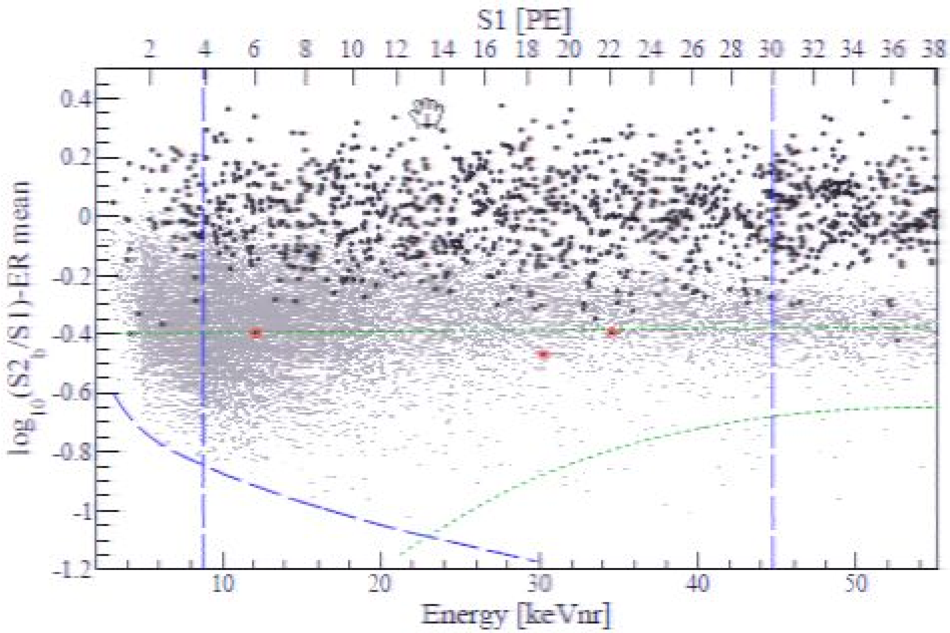
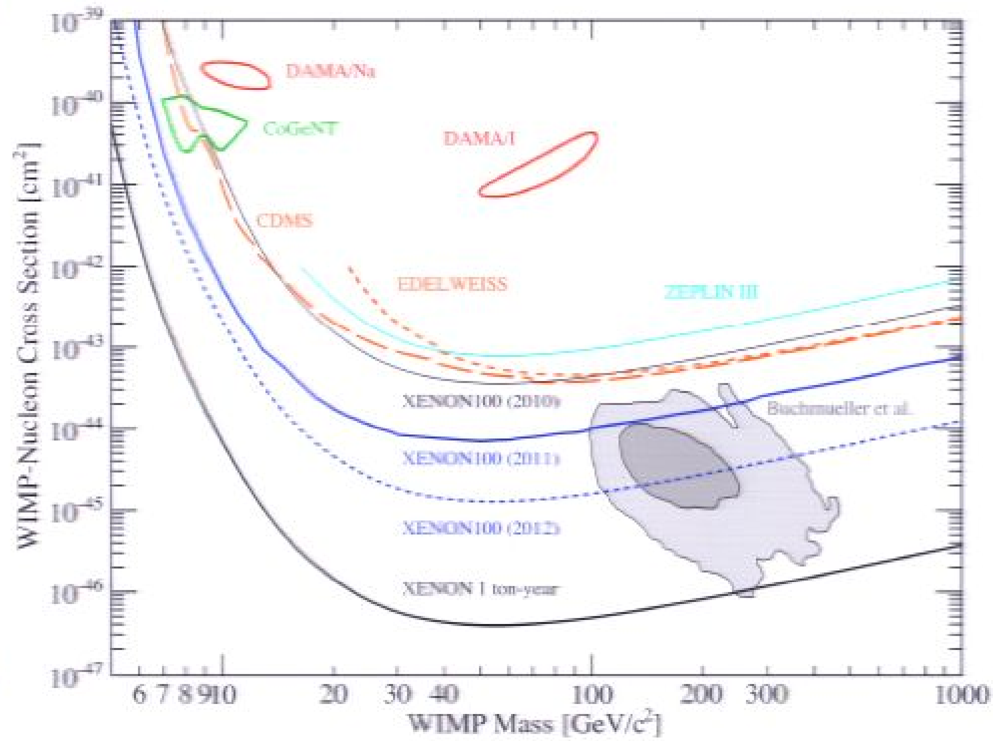
Summary





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