Key aspects of the SABRE South experiment

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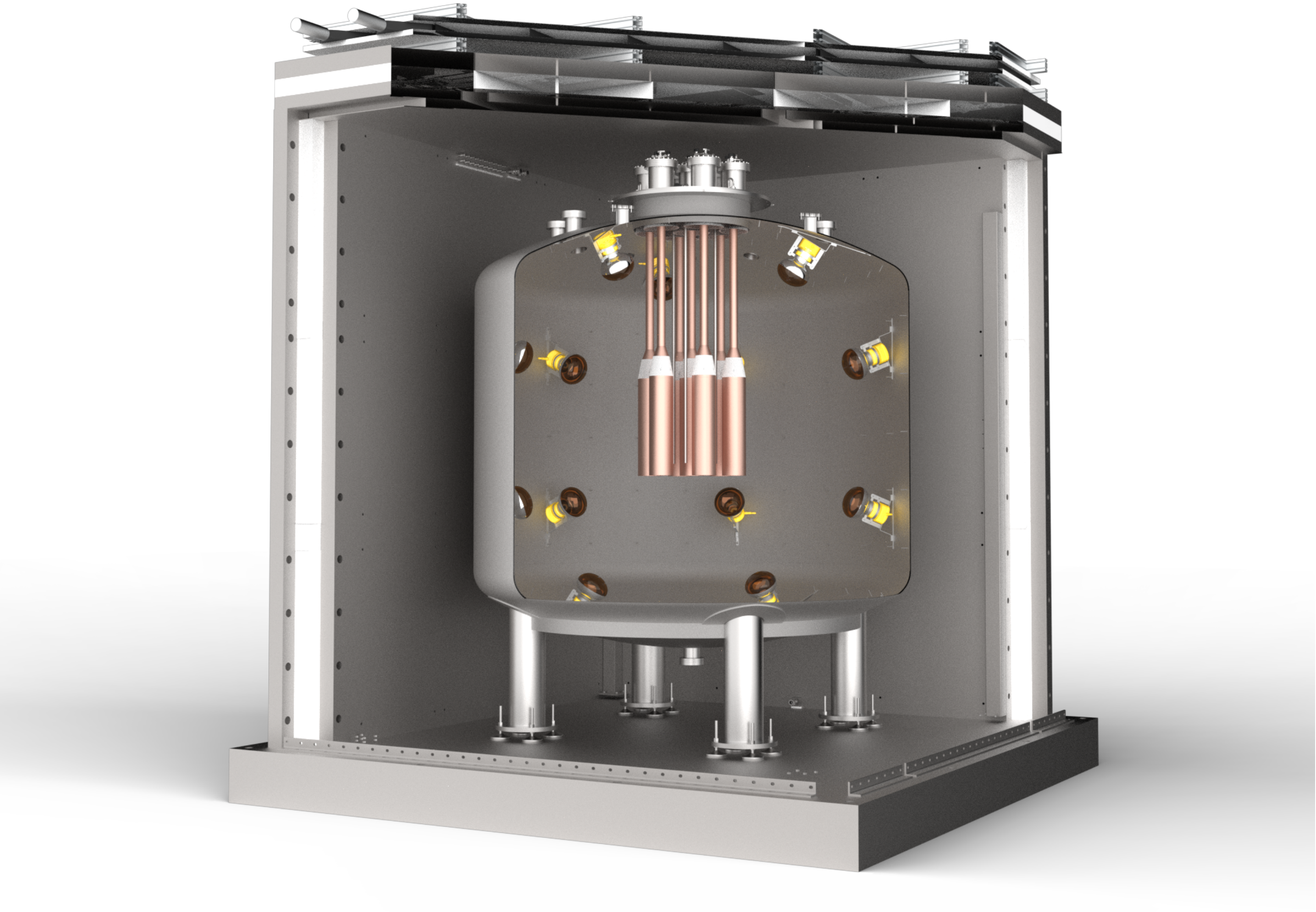
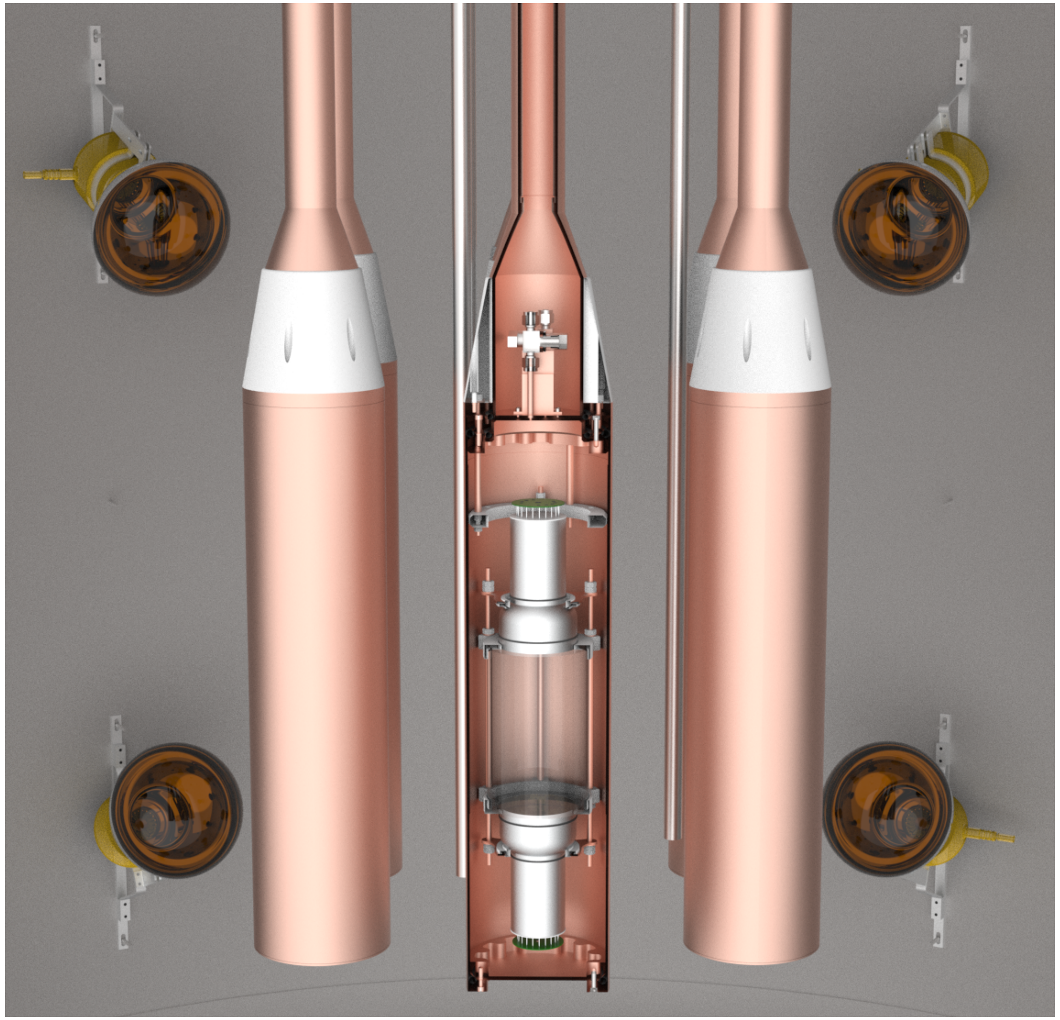


- 7 equivalent NaI(Tl) detectors for a total mass of ~35 kg
- Liquid scintillator (LAB) detector with 18 PMTs
- Plastic scintillator plane on top of the detector optimized for cosmic ray counting
- 1025 m below surface (3000 w.m.e.)

Crystal Detector

- Crystal size: 10 cm diameter, 15-25 cm length
- Double PMT readout
- Electromagnetic interaction threshold ~1 keV
- Nuclear recoil threshold ~10 keV
- Detector positioned in a hexagonal configuration
- 26 cm distance between crystal (axis), 16 cm gap



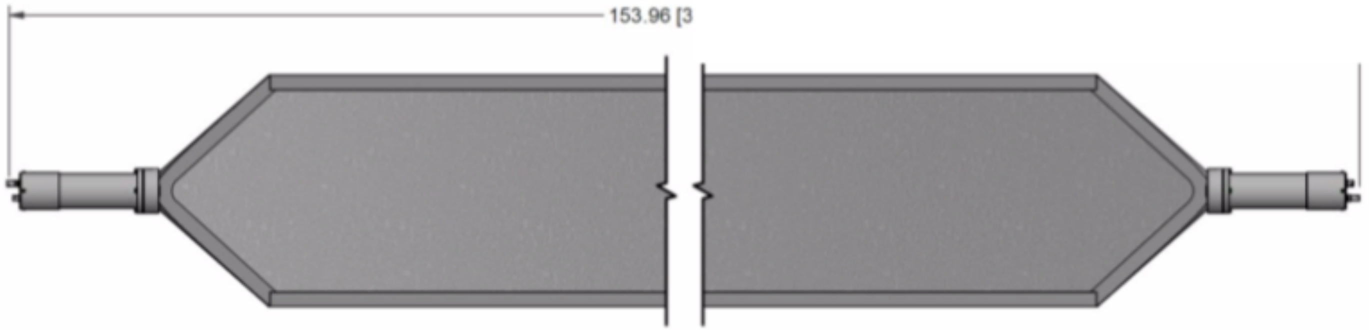
Liquid Scintillator Detector

- vessel size: ~2.6 m diameter, ~2.6 m height
- 10 tons of linear alkyl benzene scintillator
- electromagnetic interaction threshold ~50 keV
- nuclear recoil threshold ~500 keV
- Some spatial localization of interaction might be possible combining the 18 PMT signals

ARC CENTRE OF EXCELLENCE FOR DARK MATTER PARTICLE PHYSICS

Muon Detector

- 8 panels: 3000 x 400 x 50 mm3
- Plastic Scintillator EJ200 (Polyvinyltoluene)
- Some spatial localization of interaction might be possible with limited resolution



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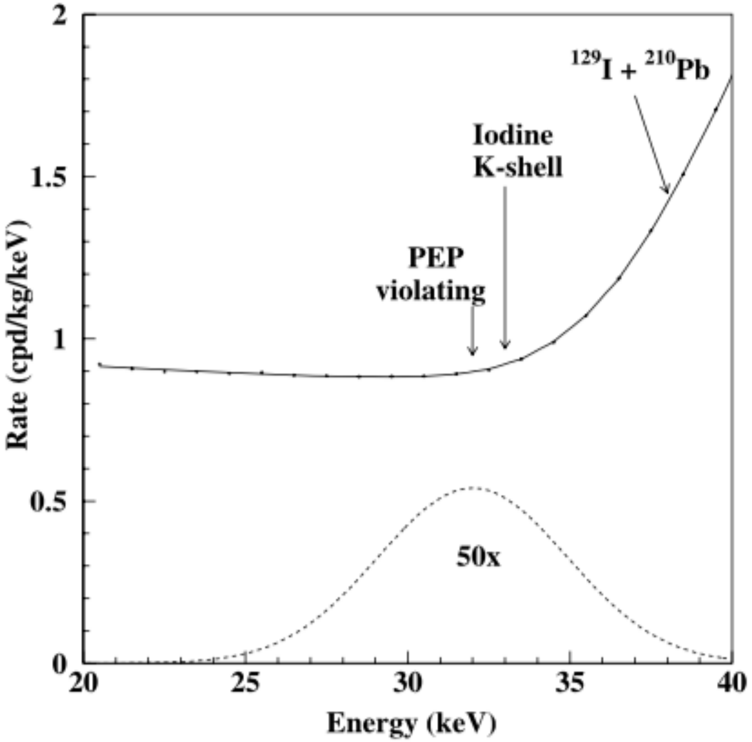
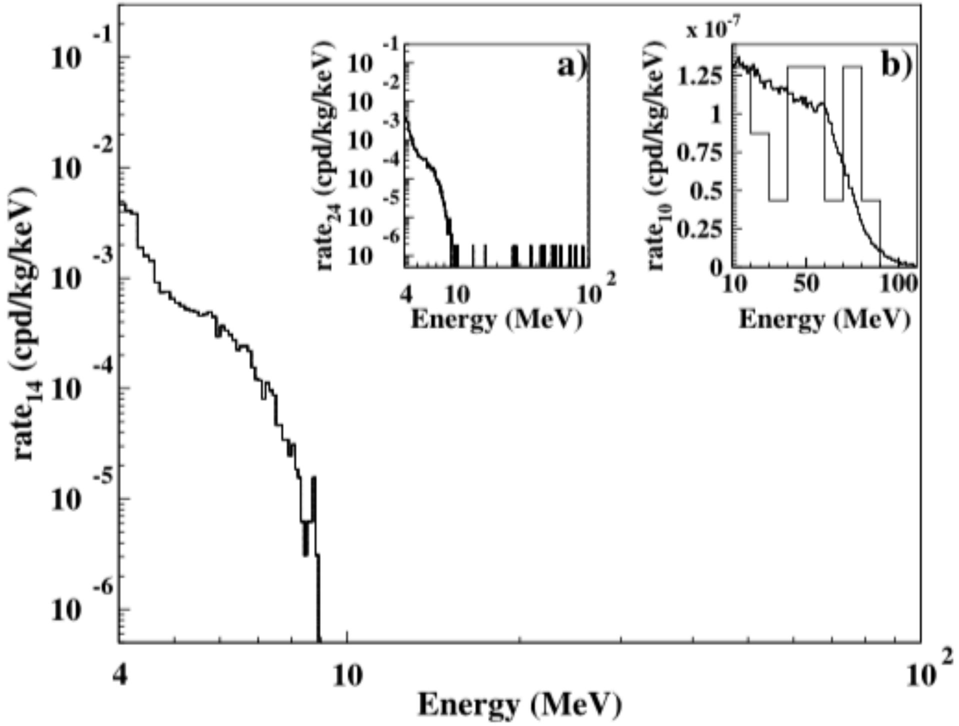
Overview of non-WIMP measurements from similar experiments

Pauli Exclusion Principle Violation

R. Bernabei, Eur. Phys. J. C (2009) 62: 327–332

- PEP-violating K-shell electron transitions in iodine atoms
- Non-Paulian emissions of protons with Ep ≥ 10 MeV in ^{23}Na and in ^{127}I





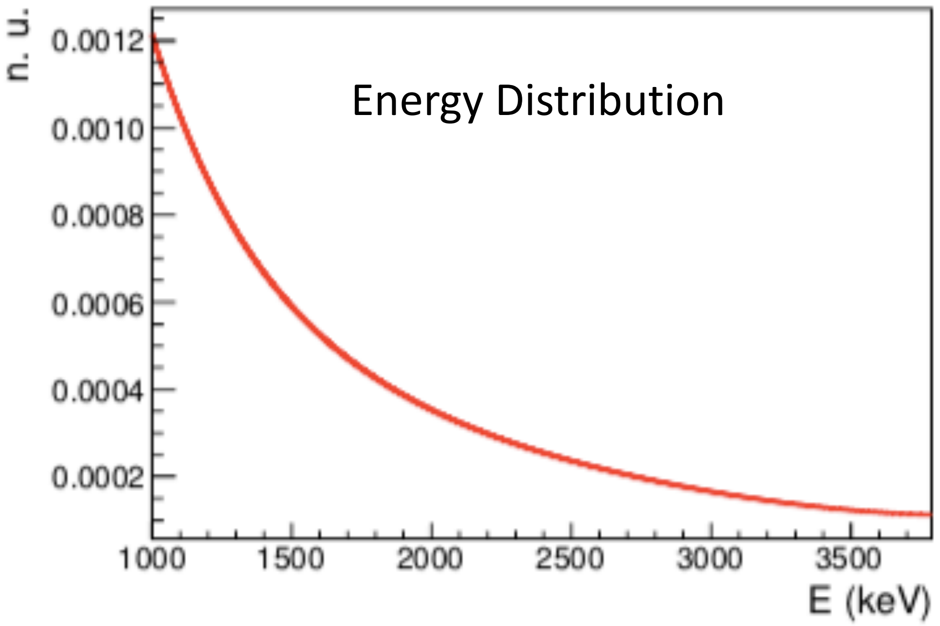
Wave function collapse models

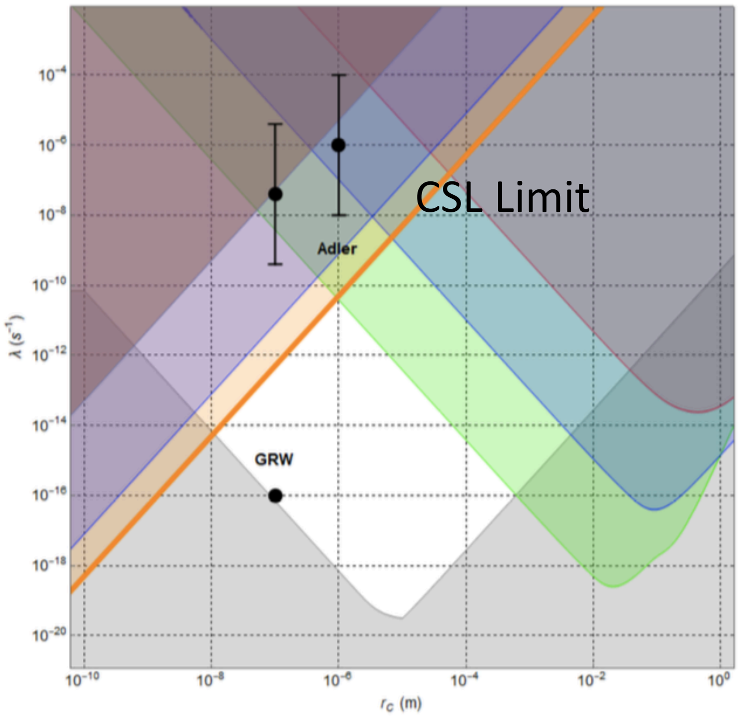
- Provide an explanation for the measurement problem and for the transition from quantum micro world to classic macro one
- Predict spontaneous radiation emission of charged particles generated by interaction with generic noise field or gravity-related field

S. Donadi, arXiv:2107.11237v1

$$\frac{d\Gamma}{dE} = N_{atoms} \times \left(N_A^2 + N_A\right) \times \frac{\lambda \hbar e^2}{4\pi^2 \varepsilon_0 m_0^2 r_C^2 c^3 E}$$

For 10< E<1E+05 keV





Solar Axions

P. Adhikari, arXiv:1904.06860

- Scattering off atomic electrons in the crystal by axioelectric effect
- a + A → e^- + A^+

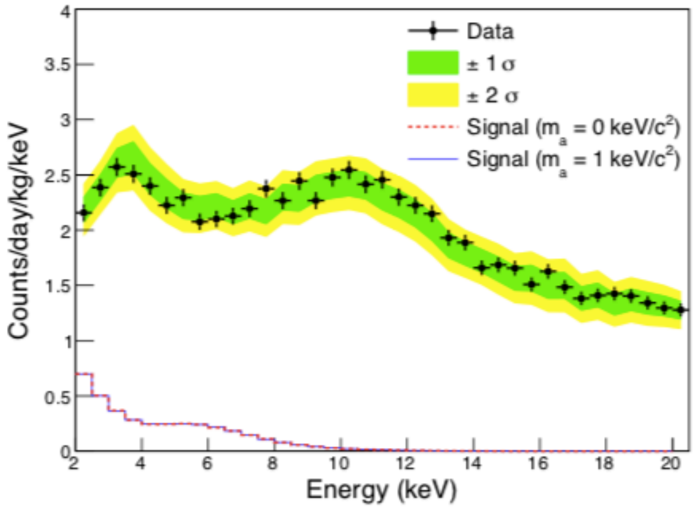
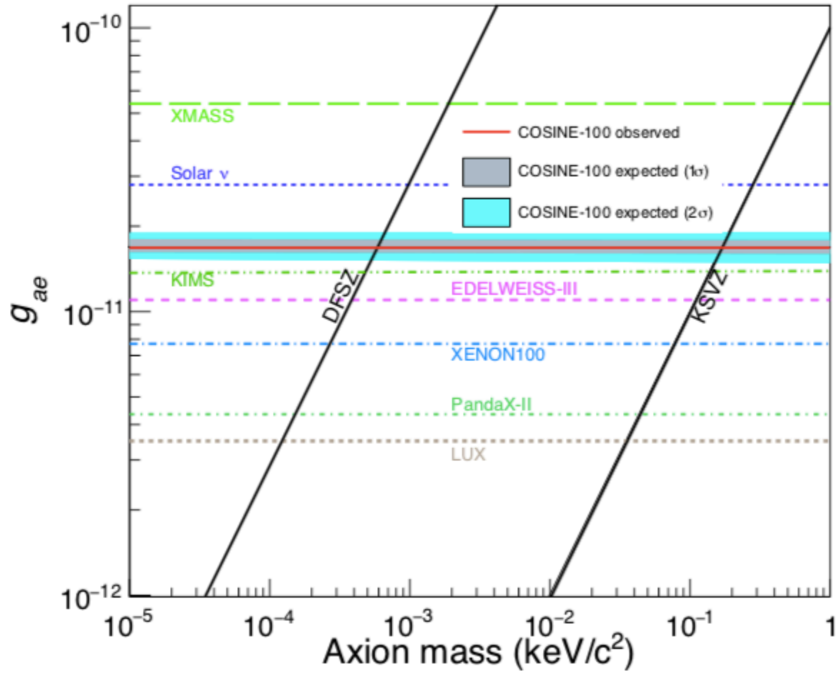
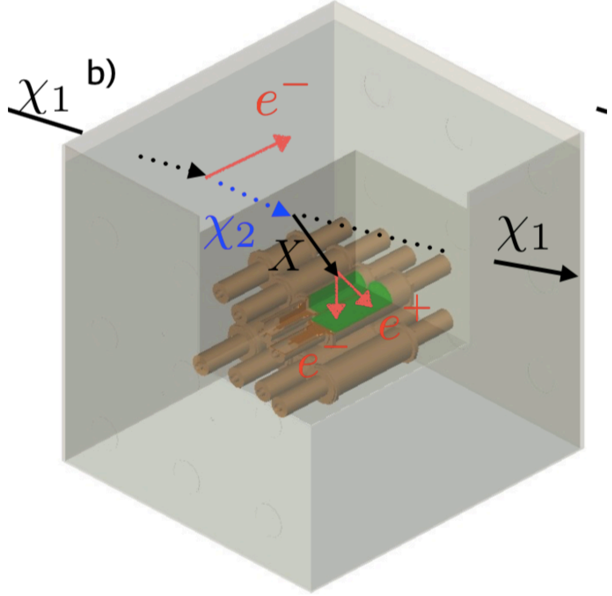


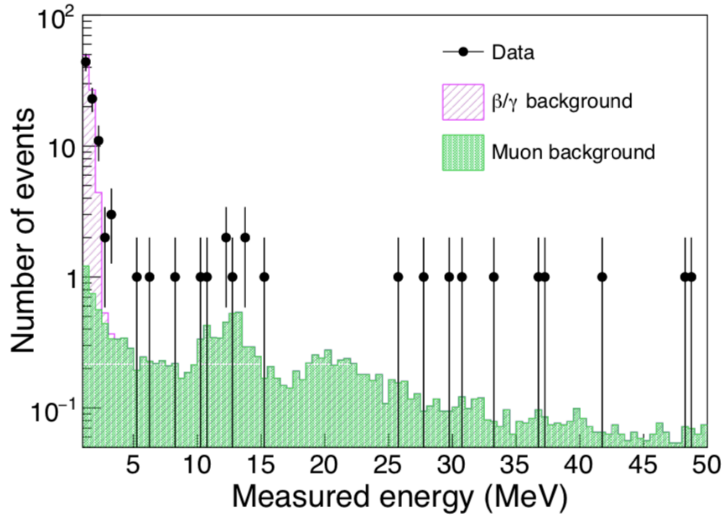
Figure 6: (Color online) Energy spectrum of the data with applied efficiency (points) is compared with the predicted background spectrum for crystal-7, with 1 σ and 2 σ uncertainty bands. The simulated axion energy spectra for m_a of 0 keV/c^2 (dotted red line) and 1 keV/c^2 (solid blue line) for g_{ae} = 1×10^{-10} are overlaid for comparison.



Inelastic Boosted Dark Matter

- Energy of LS > 4 MeV
- No selected muons from the muon detector
- Total energy of the NaI(Tl) crystals > 4 MeV
- No α events in the NaI(Tl) crystals





C. Ha, arXiv:1811.09344

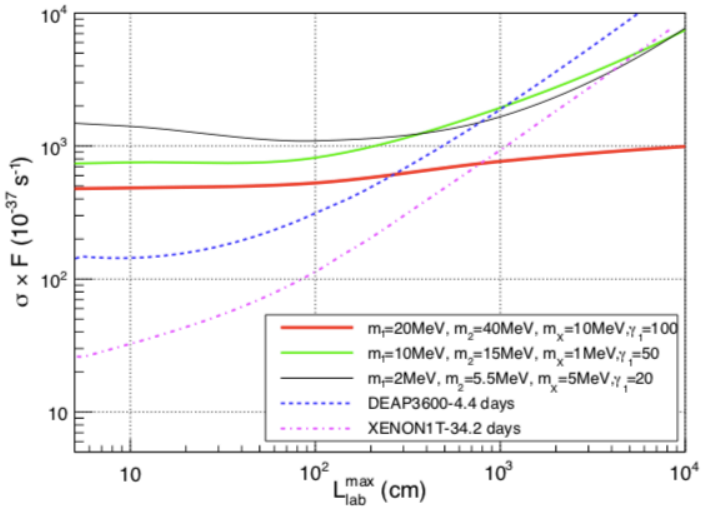


FIG. 5. Measured 90% CL upper limits from 59.5 days of COSINE-100 data in the L_{lab}^{max}-σ plane are presented for three different benchmark models. These results are compared with the experimental sensitivities of XENON1T with 34.2 days data [45] and DEAP-3600 with 4.4 days data [46] calculated in Ref. [22].

Is this process realistic?

- Inelastic recoil of dark matter in one crystal
- SM decay product measured tens of cm away in another crystal
- Can be used to look at lower energies than COSINE Boosted DM paper
- No energy in liquid scintillator
- Can use the delays between crystal signal
- Expected very low background