

CRAB : high-precision calibration of neutrino and dark matter cryo-detectors

Corentin Doutre - MAYORANA School - June 2025







- Signal expected in V/DM experiments = low-energy nuclear recoil (~ 100 eV)
- Several experiments use gram-scale bolometers, which can achieve ~ 10 eV energy threshold
- No existing technique to calibrate nuclear recoil in the 100 eV range ...

<u>A bit of context</u>



It stands for Calibrated Recoil for Accurate Bolometry

<u>What is the CRAB calibration method ?</u>

- Thermal neutron radiative capture on target nucleus
- De-excitation of the produced compound nucleus via single MeV γ-ray emission (escaping the detector)
- Nuclear recoil in the order of 100 eV according to 2-body kinematics

 $E_{recoil} = \frac{E_{\gamma}^2}{2Mc^2}$

- Suitable most of the detectors used in the v/DM communities
 - \checkmark CaWO₄ (Nucleus)
 - \sim Al₂O₃ (also Nucleus)
 - Ge (Ricochet)
 - Si (Super-CDMS)



Does it actually work?

- Phase 1 of CRAB \rightarrow 1st observation of (n, γ) induced nuclear recoil using a CaWO₄ detector from Nucleus and a commercial ²⁵²Cf neutron source
- Signal confirmed by CRESST with higher statistics





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And it will work even better with our new setup !

• Better statistics

Cez

• Reduce fast neutron and γ backgrounds

Our commissioning paper : *http://arxiv.org/abs/2505.15227*





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Rate analysis

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Good understanding of all the contributions to our signal :

- Capture-induced events
 - → Neutron capture
 - ➤ W activation
- External backgrounds
 - Ambient γ
 - Argon activation

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What a coincidence !

Our commissioning paper : *http://arxiv.org/abs/2505.15227*



- Observation of a nuclear recoil in coincidence with a γ -ray
- Major validation of our setup for high-precision measurements



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Perspectives and future of CRAB



Measurement campaign with Ricochet/Tesseract's Ge detectors : calibration + study of quenching factor in the 100 eV range





10

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Thank you for your attention !

11

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