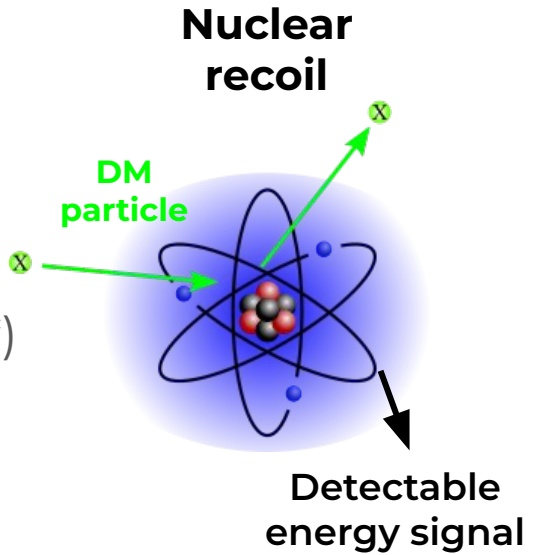
Rare events searches (RES) as counting experiments

Experiments looking for neutrinos (ν) or dark matter (DM) are usually:

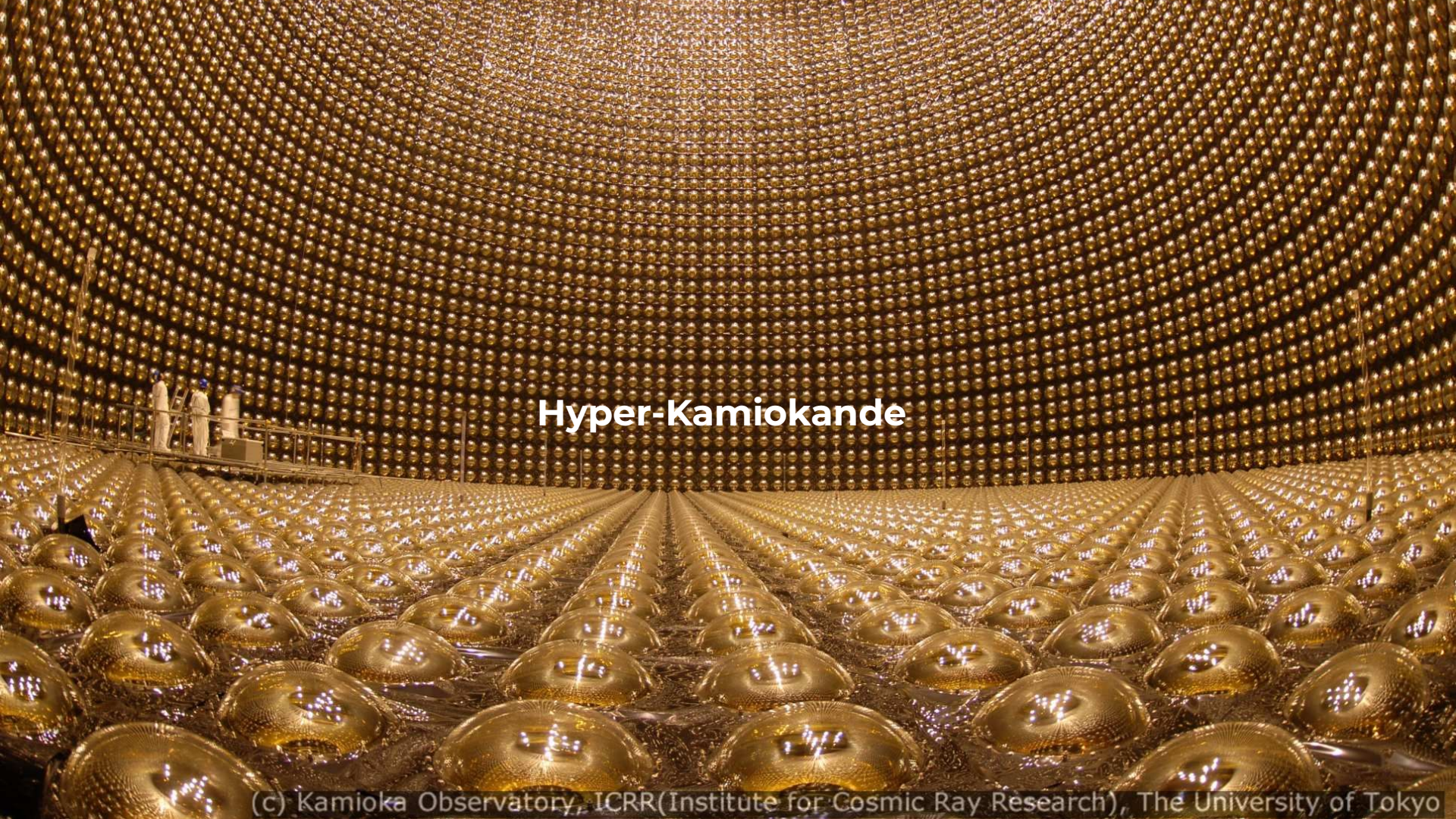
♕ Huge (higher mass → higher exposure)

♘ Extremely sensitive (ν and DM do not interact a lot*)

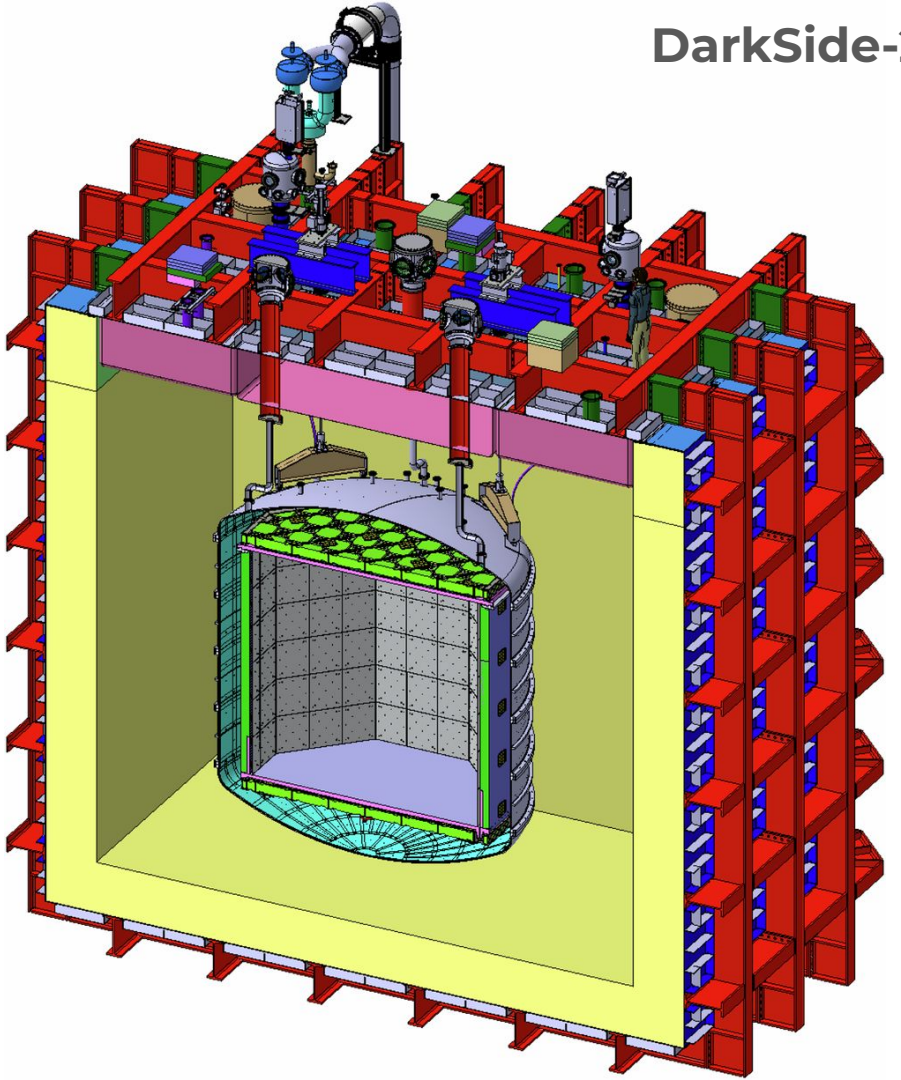
♗ Extremely *quiet* (to measure these feeble signals)



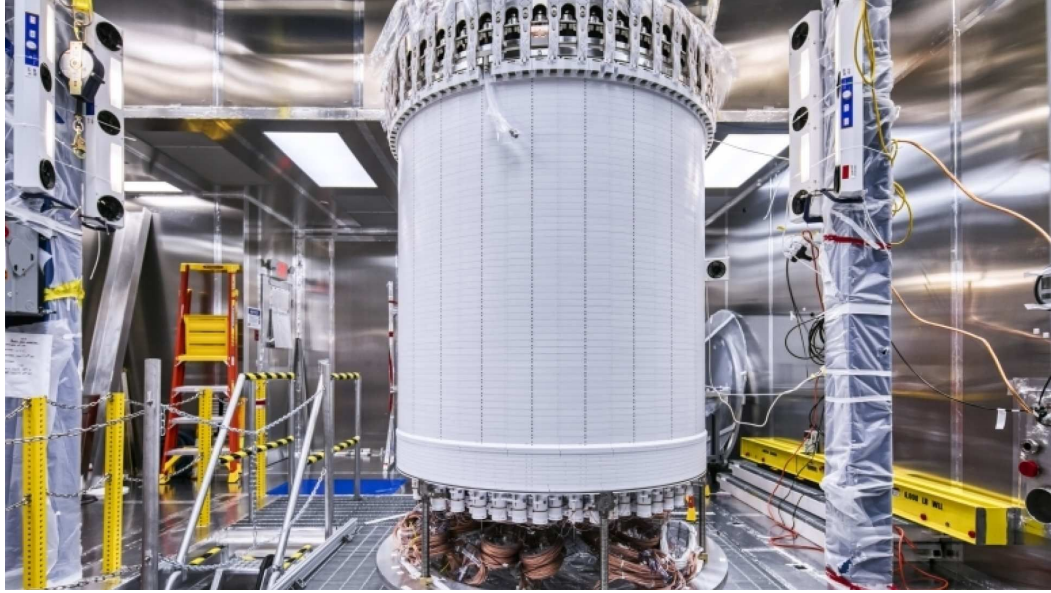
* especially DM...



DarkSide-20k



Xenon nT



LZ

CRESST

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Some with electrons, shell electrons, conducting electrons, valence electrons...

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They measure ionization, phonons, light, charge transportation, light propagation, they use photomultipliers, superconductors, semiconductors, non-conductors, gas, solids, fluids, superfluids, sometimes just water, sometimes just plastic, some of them will even go to space...

But they all measure one thing:

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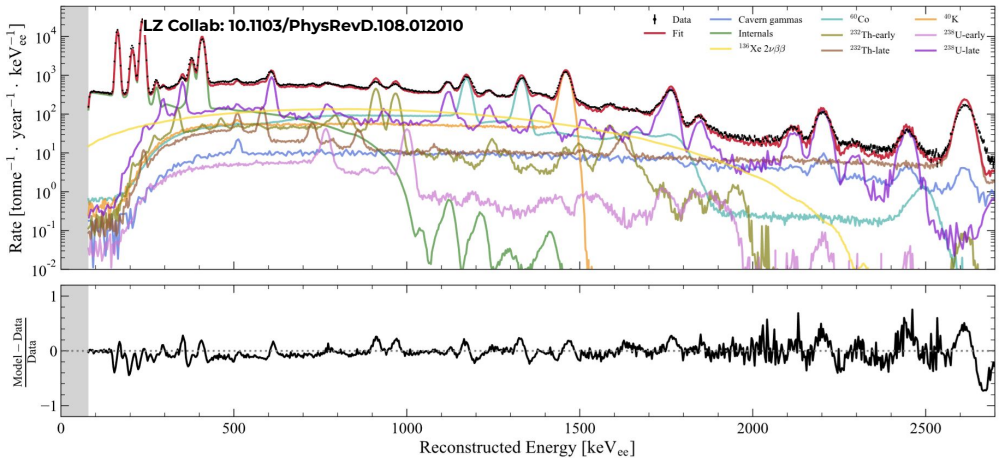

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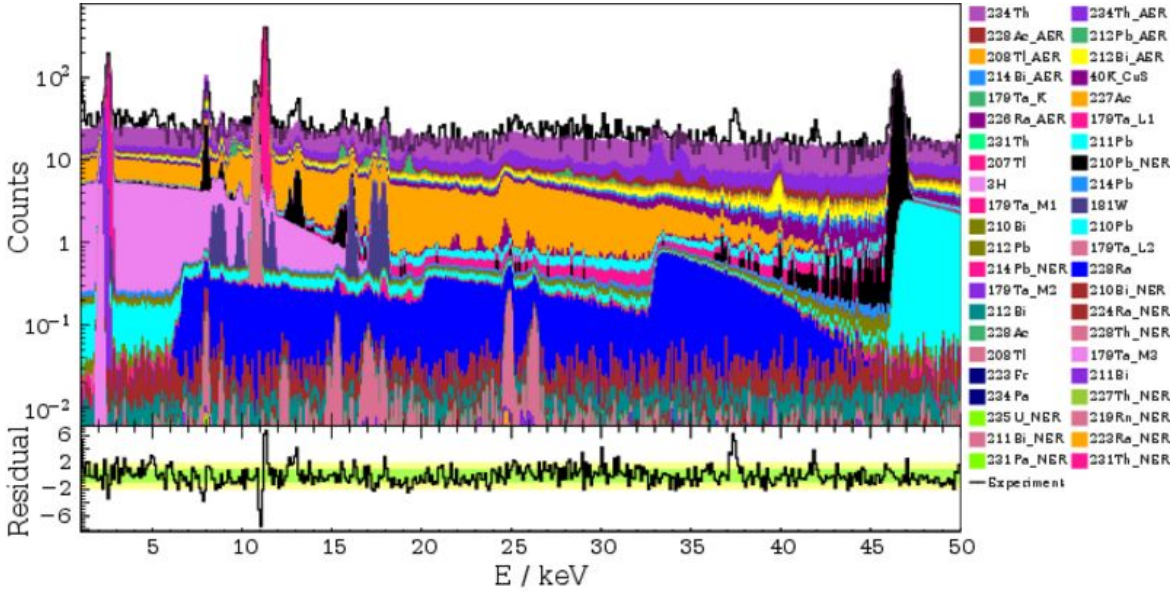
Background subtraction

Moreover, this has already been done in our group for CRESST



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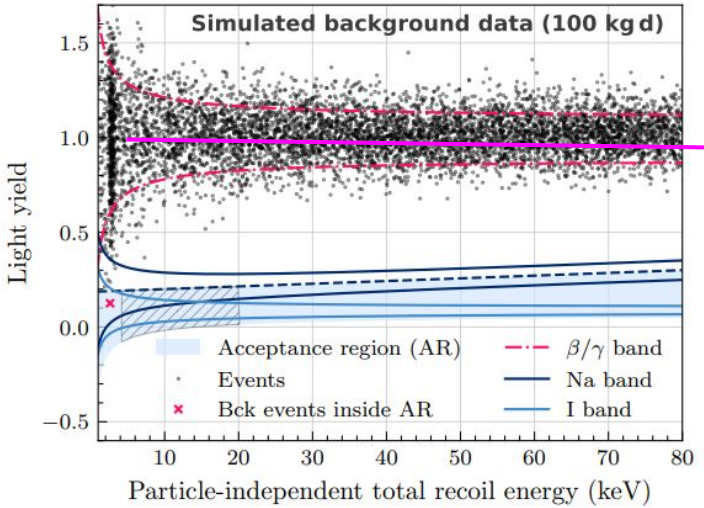

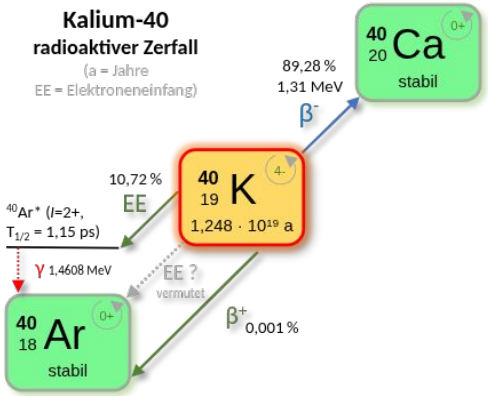

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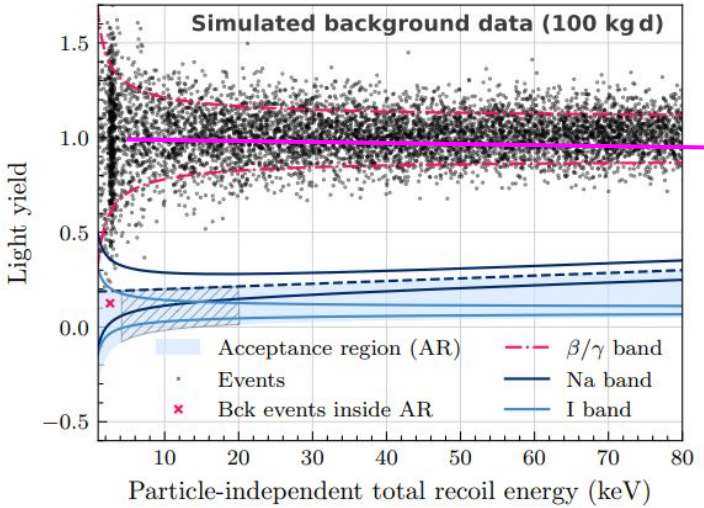
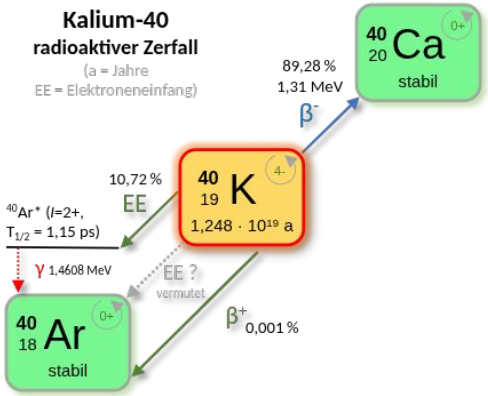




If we can fit our background and know the K-40 activity,
we can greatly suppress the effect of the 3 keV line

Going blind

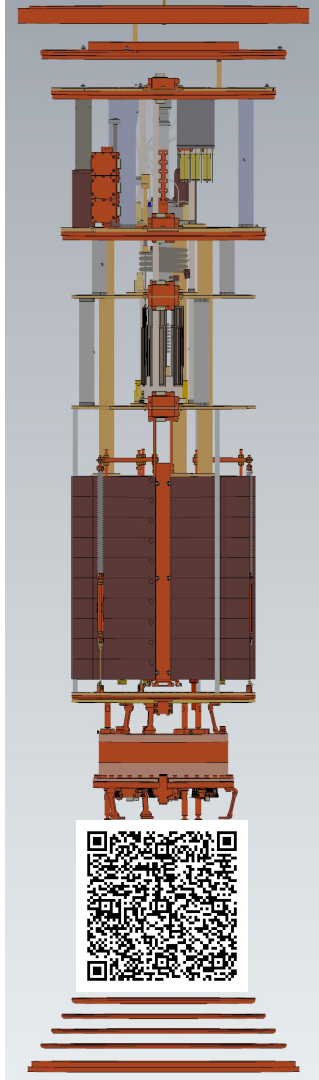
Most DM experiments go blind after some time: they take data for years, without looking at it.

Monte Carlo simulations are then crucial for understanding the backgrounds during this period as they save information of **each event**, **track by track**

💬 Are K-40 decays by-products expected in our detectors? Can we use this as a tagging method?

💬 Is surface roughness something we should be aware of?

💬 Can we give analysts information on the expected background?



*"A world-leading experiment requires **world-leading understanding** of the background via high performance simulations"* (Us, 16.12.2024)

⇒ ImpCRESST (Geant4-based in-house made soft) allows us to detailedly characterize possible backgrounds that could be highly detrimental to COSINUS goals and ***new particles discovery potential***

⇒ Radiogenic backgrounds (nuclear decays), cosmogenic backgrounds (muons and cosmic rays), among others

⇒ Simulations are instrumental to the development of new **cutting-edge** cryogenic-based experiments in **Austria** and **Worldwide**

Projects availability:

♚♛ Background model (see Fig)

♜ Non-proportionality in NaI

♝ Phonon propagation

♞ Supernovae neutrino directionality capabilities

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