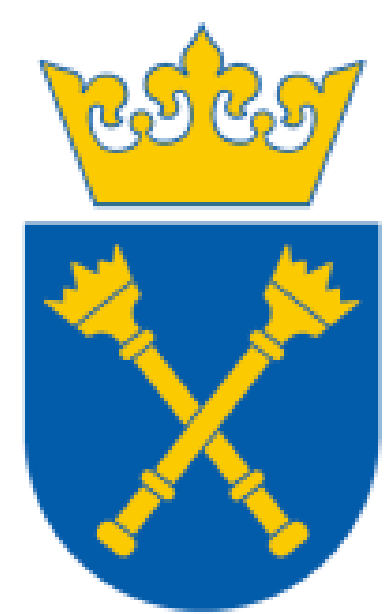




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Background Mitigation in the DarkSide-20k Experiment

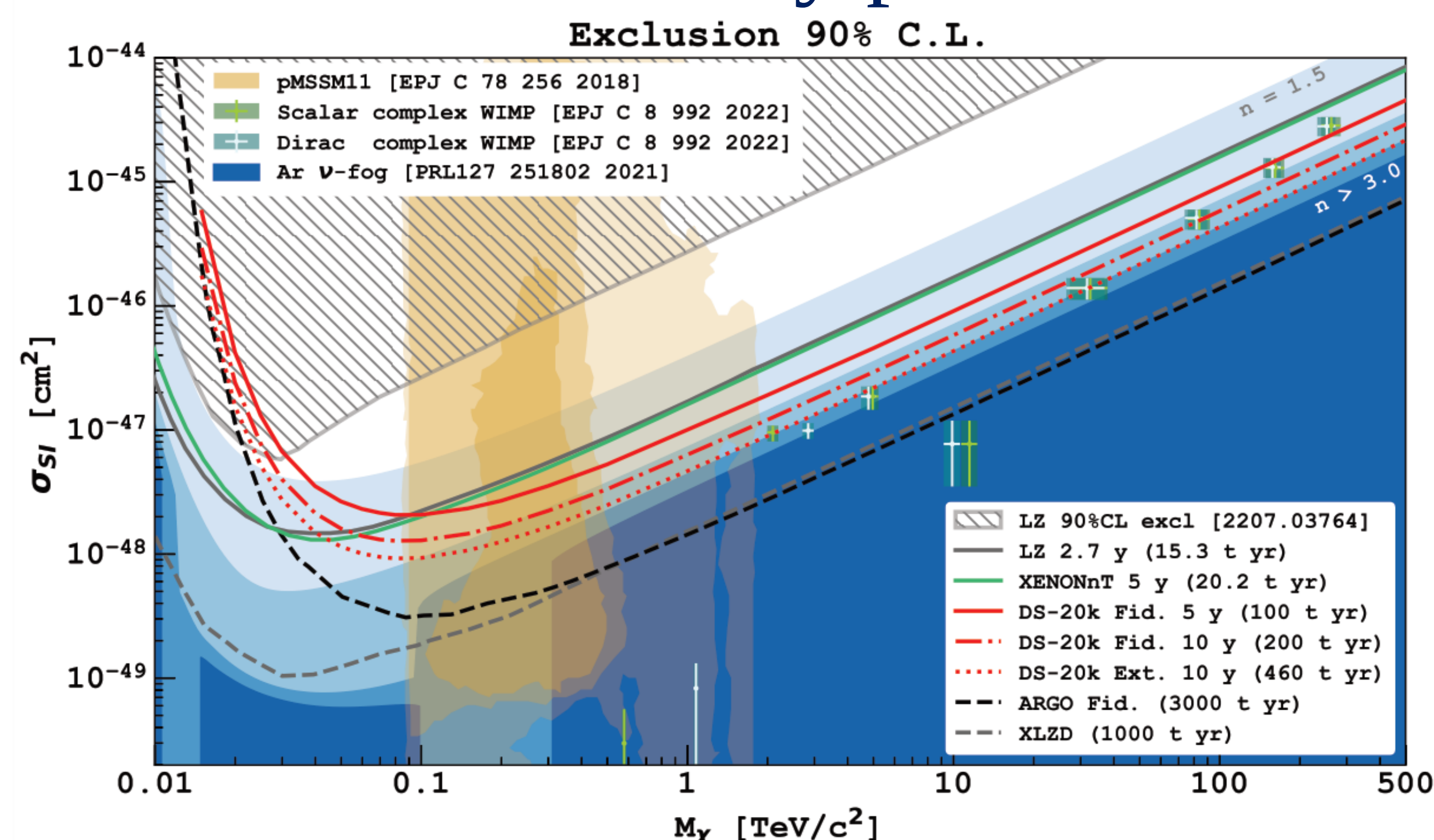
Grzegorz Zuzel for the DarkSide-20k Collaboration

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The DarkSide-20k experiment has been designed to search for direct interactions of cold dark matter particles in liquid argon depleted in ^{39}Ar . The detector, based on a two-phase time projection chamber, is currently under construction at Laboratori Nazionali del Gran Sasso in Italy. One of its key parameters, as in any dark matter detector, is background, which has to be suppressed nearly to zero to maximize the discovery sensitivity. One of most important background sources in DarkSide are neutrons. The latter can be produced via (α, n) reactions. Therefore, minimizing the amount of alpha-emitting isotopes in construction materials – primarily ^{210}Po supported by ^{210}Pb – is one of the most important topics in the experiment.

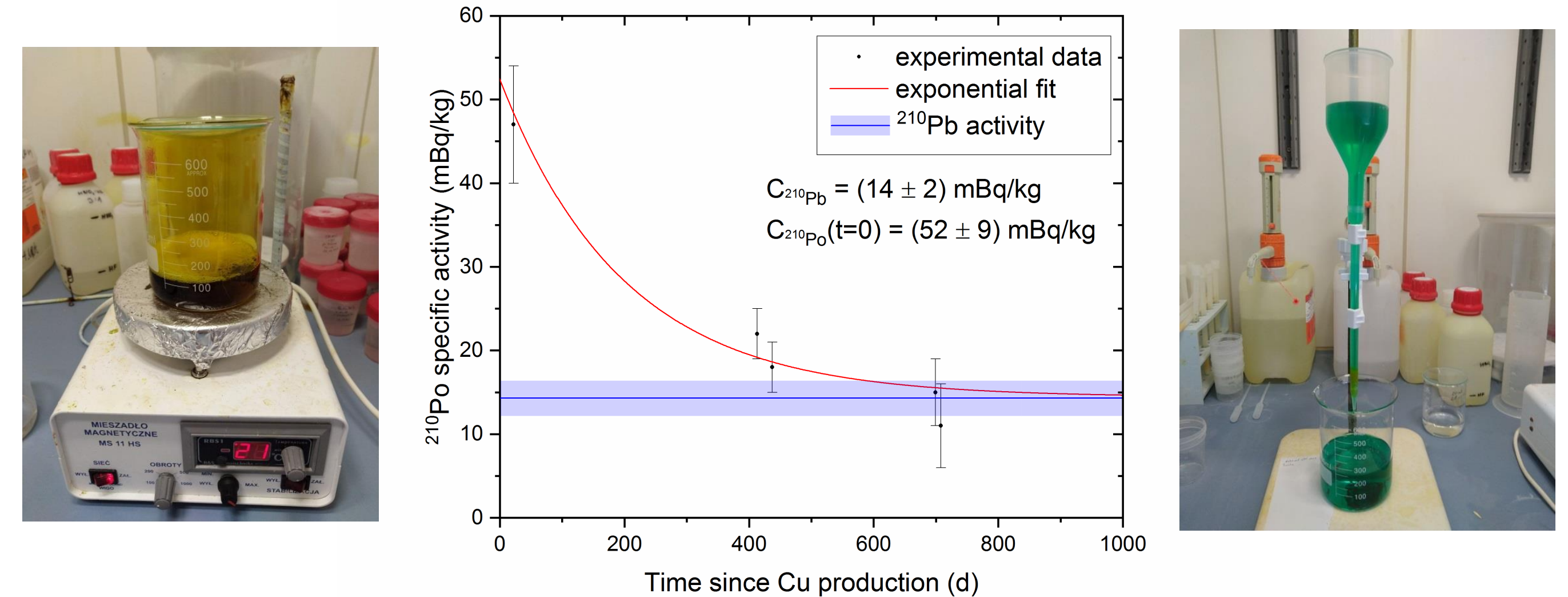
Sensitivity plot



Allowed number of neutrons and β/γ s after all cuts (and 10 y exposure): < 0.1 and 0.05, respectively

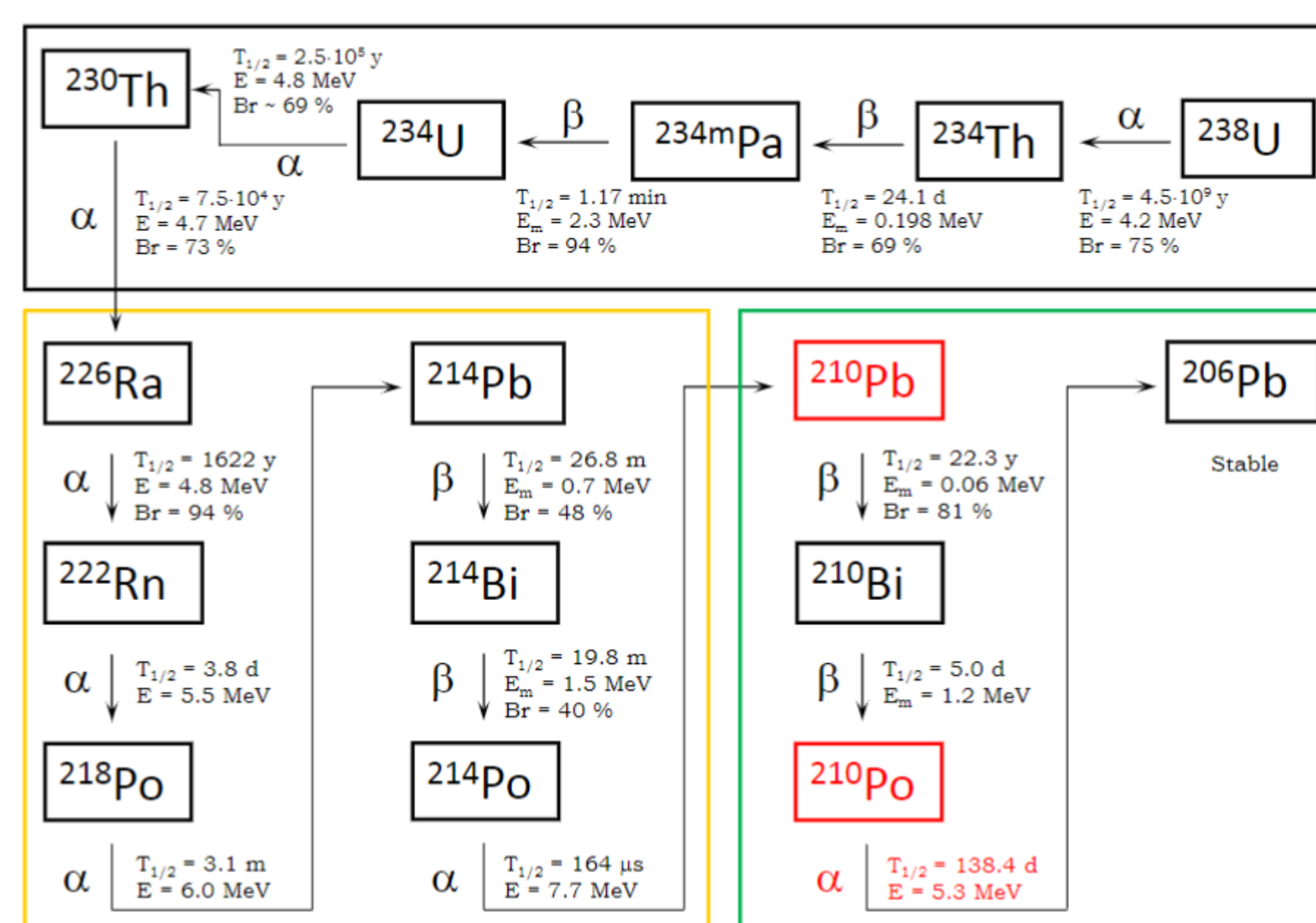
Radiochemical determination of ^{210}Po

Procedure of polonium separation from bulk material is based on three steps: sample dissolution, purification and source preparation. Procedures for various materials (copper, arlon, electronics components etc.) have been developed. Sensitivities down to **single mBq/kg** have been achieved (also for ^{210}Pb).



^{238}U decay chain

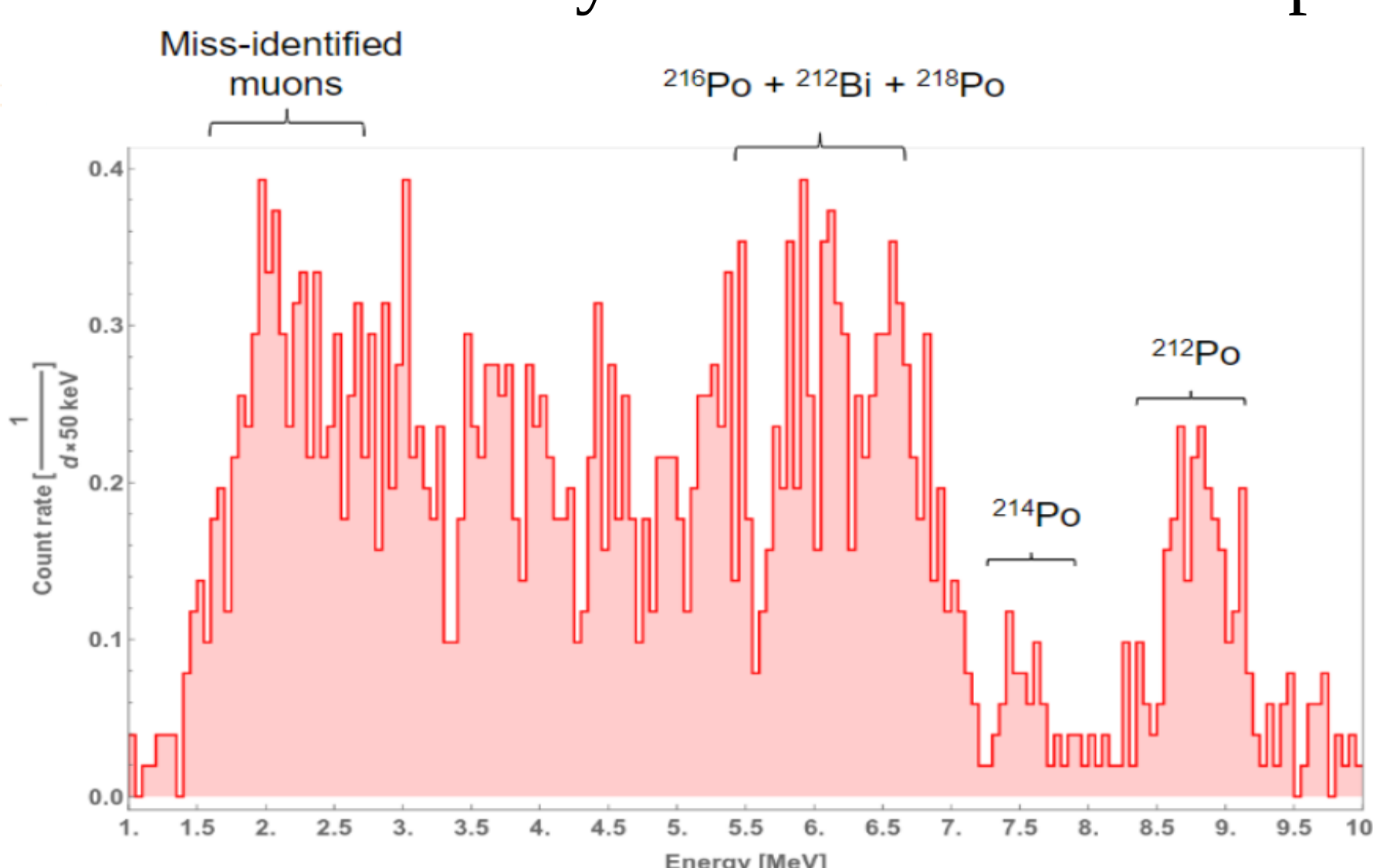
The ^{238}U decay chain may be divided into three parts, which are usually not in secular equilibrium. The upper one is analyzed by **ICP-MS**, the middle one by **γ -ray spectrometry / ^{222}Rn emanation** and the bottom one by alpha spectroscopy.



Due to the low energy of γ -rays emitted in the ^{210}Pb decay and limited sensitivities of beta spectrometers (^{210}Bi decays) detection of alphas from ^{210}Po decays is the best option for high sensitivity determinations of the bottom part of the ^{238}U chain. **A sequence of ^{210}Po in time provides information about ^{210}Pb content.**

Surface assay

Surface alpha activity can be studied using a large area, high sensitivity alpha spectrometer. Its background spectrum measured over several months is shown below. Above 5.3 MeV signal from $^{220}\text{Rn}/^{222}\text{Rn}$ daughters dominates. Below 3 MeV miss-identified muons are visible. Basing on the count rates sensitivities to surface and bulk ^{210}Po may be determined. The spectrometer was also used to study various surface cleaning techniques (etching, electropolishing).



$$C_{sf} < 0.3 \frac{\text{mBq}}{\text{m}^2}$$

$$C_{bl} < \sim 40 \frac{\text{mBq}}{\text{kg}}$$

ICP-MS / HPGe / Rn emanation



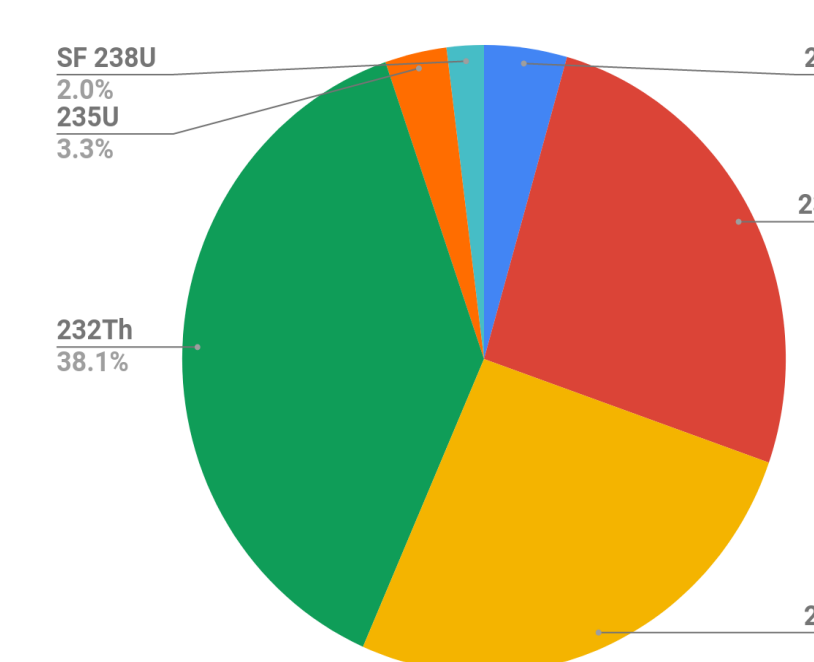
Sensitivities:

ICP-MS: $\leq 0.1 \mu\text{Bq/kg}$ equivalent
HPGe spectrometers: $\sim 10 \mu\text{Bq/kg}$
 $^{222}\text{Rn}/^{222}\text{Rn}$ emanation: $\sim 20 \mu\text{Bq/sample}$



Summary

- DarkSide has access to most sensitive screening instruments
- ^{238}U sub-chains assayed separately to get most precise data, equilibrium broken for most samples
- Dedicated screening web-based DB
- Measured activities used as MC input for background predictions
- Cleaning, bagging, storage, operation protocols defined and implemented
- Sample exposure/tracking DB in place
- DArT at LSC for UAr screening



Neutron background budget. Contributions from ^{232}Th and ^{238}U sub-chains are shown.

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