

Radiopurity measurement of acrylic for DEAP-3600

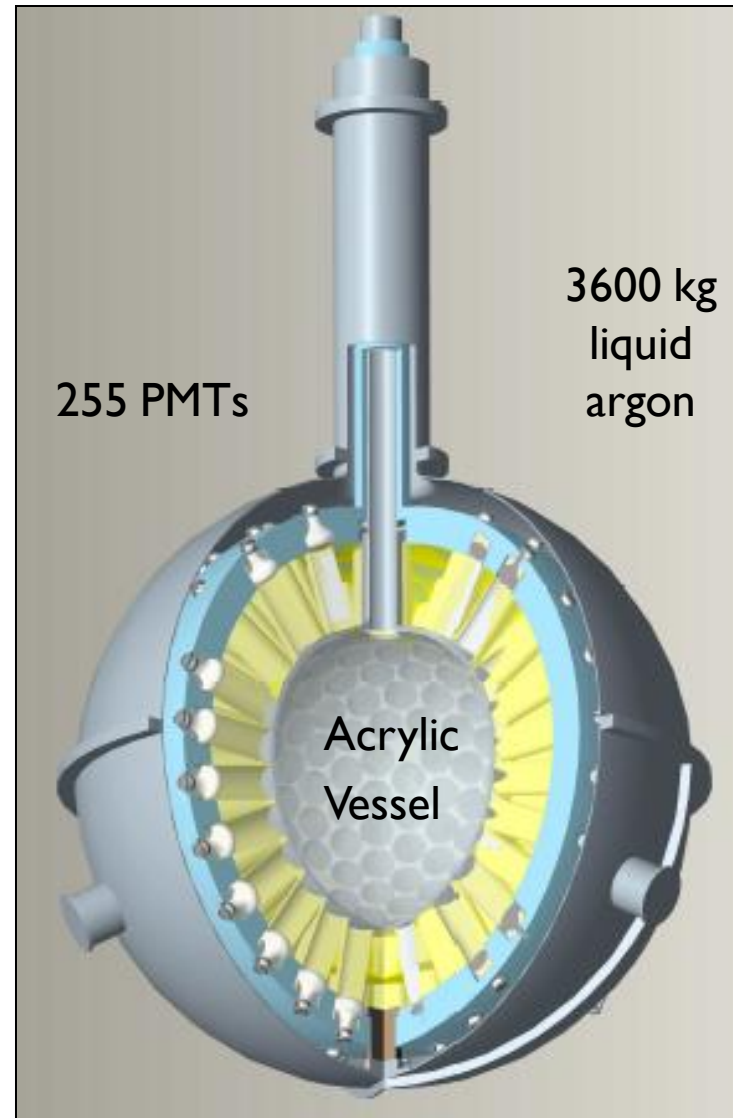
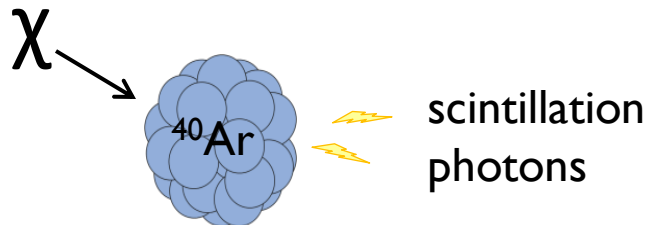
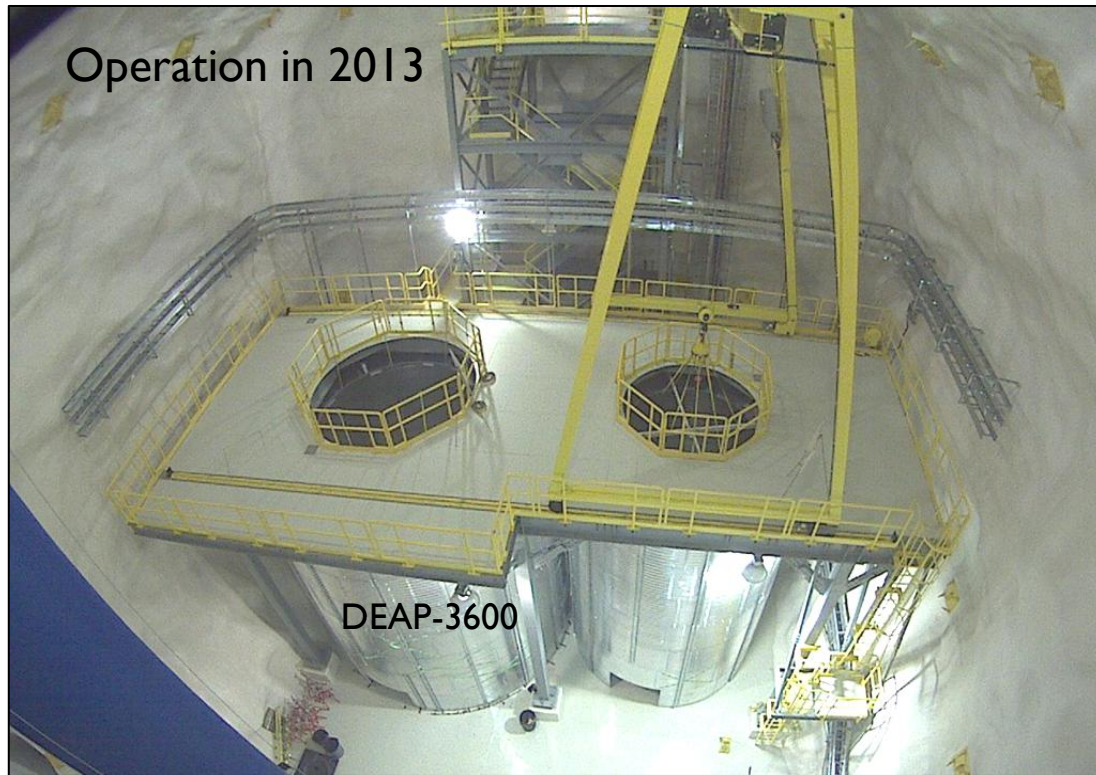
CAP Congress
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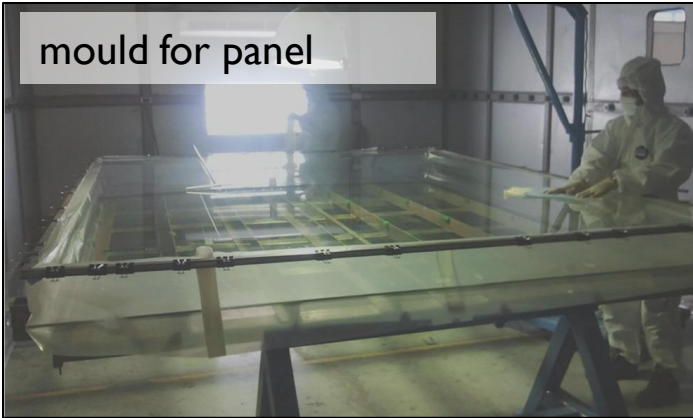
Queen's
UNIVERSITY

DEAP-3600 dark matter experiment at SNOLAB



The acrylic vessel is the most critical component

mould for panel



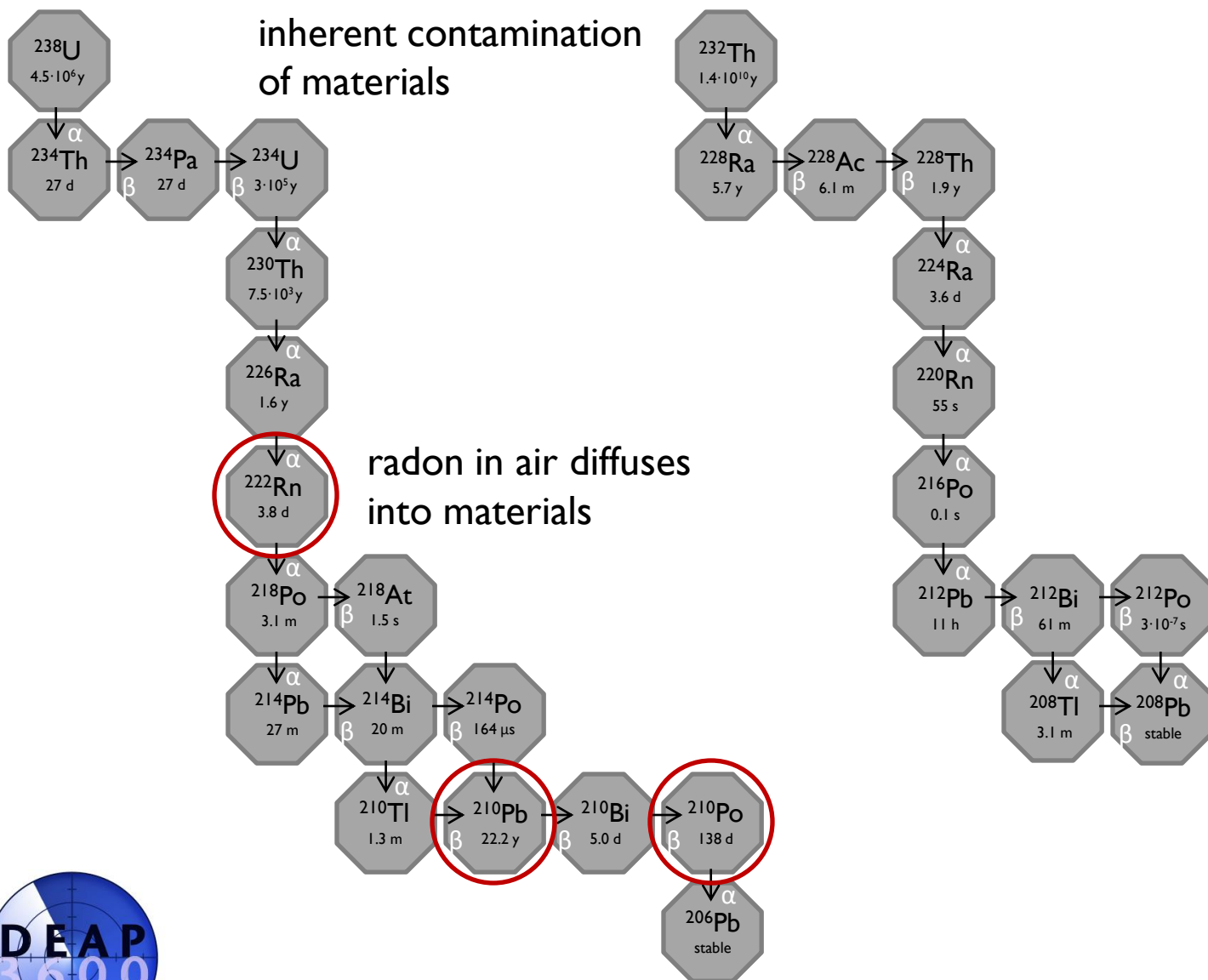
thermoformed panel



bonded to form sphere

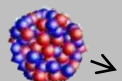


Alpha backgrounds from contaminants at surface



acrylic
vessel

liquid argon



Stringent radiopurity limits for acrylic vessel

Maximum tolerable concentrations:

0.3×10^{-12} g ^{238}U / g acrylic

1.3×10^{-12} g ^{232}Th / g acrylic

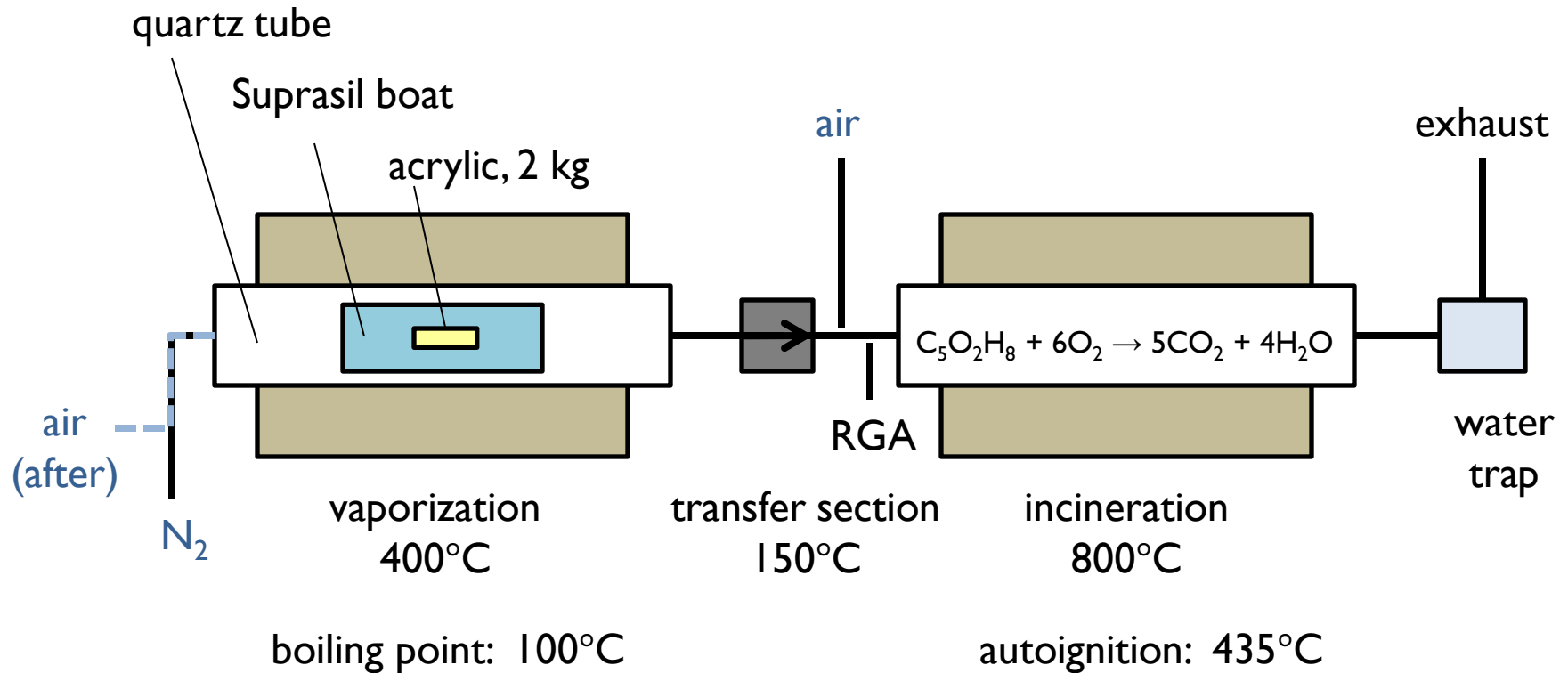
1.1×10^{-20} g ^{210}Pb / g acrylic

1. Vaporize 10 kg acrylic
2. Collect residue
3. Measure gammas from ^{238}U and ^{232}Th with germanium detector
4. Measure ^{210}Pb by counting ^{210}Po daughter with α -counter



Technique based on SNO, Appl. Radiat. Isot. 45, 539-547 (1994)

Vaporize PMMA then incinerate MMA



Acrylic vaporization system at SNOLAB



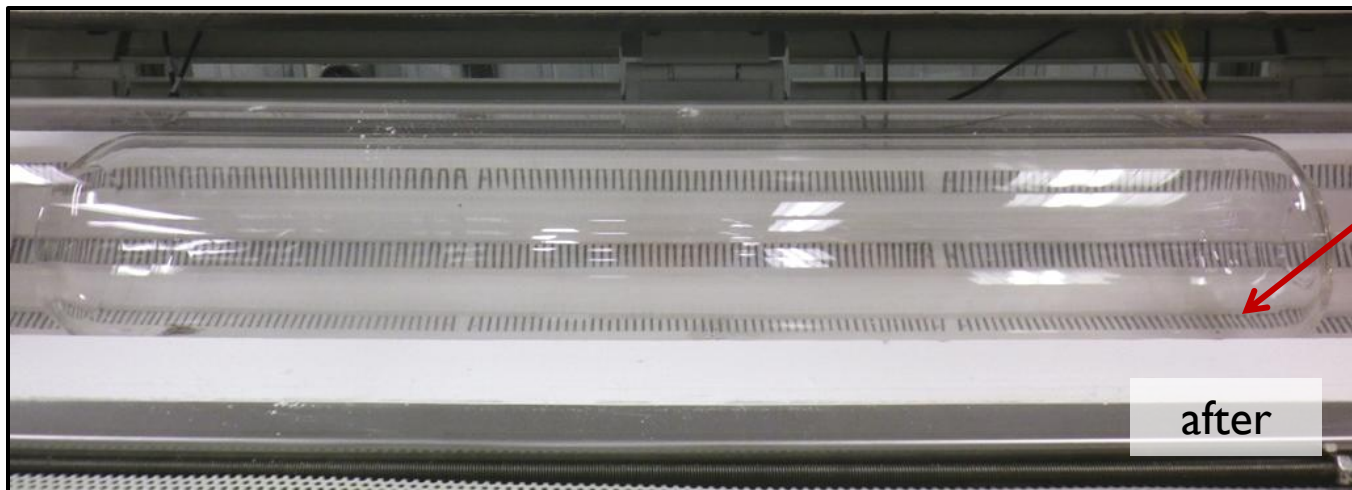
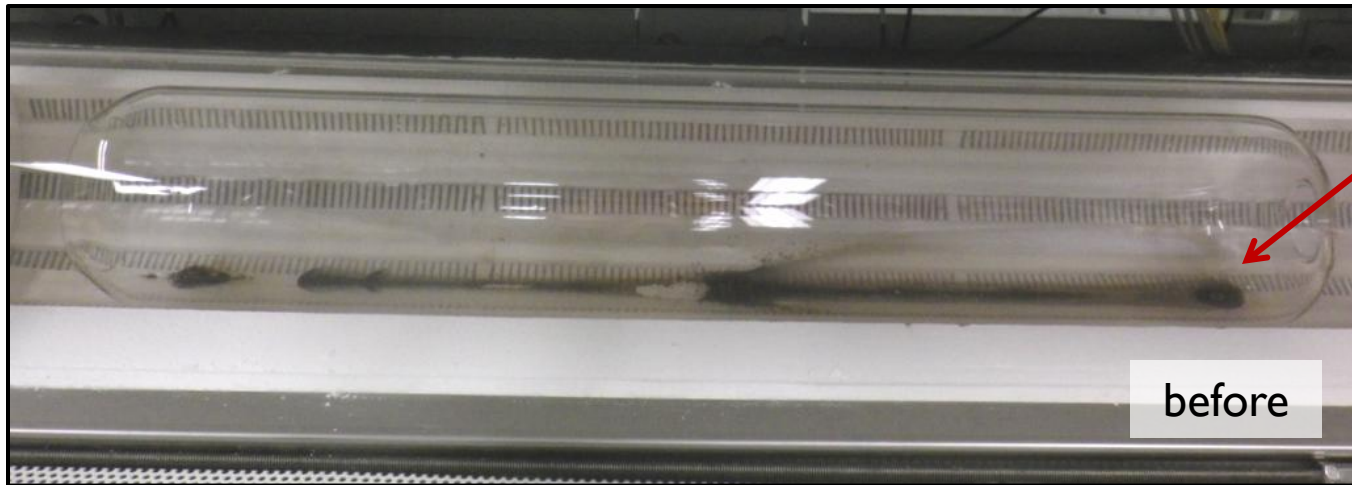
25 vaporizations performed during commissioning phase

Bubbles form on surface, colour changes from clear to yellow, block expands, liquid pools and boils, white vapour flows.



Addition of air after vaporization removes carbon residue

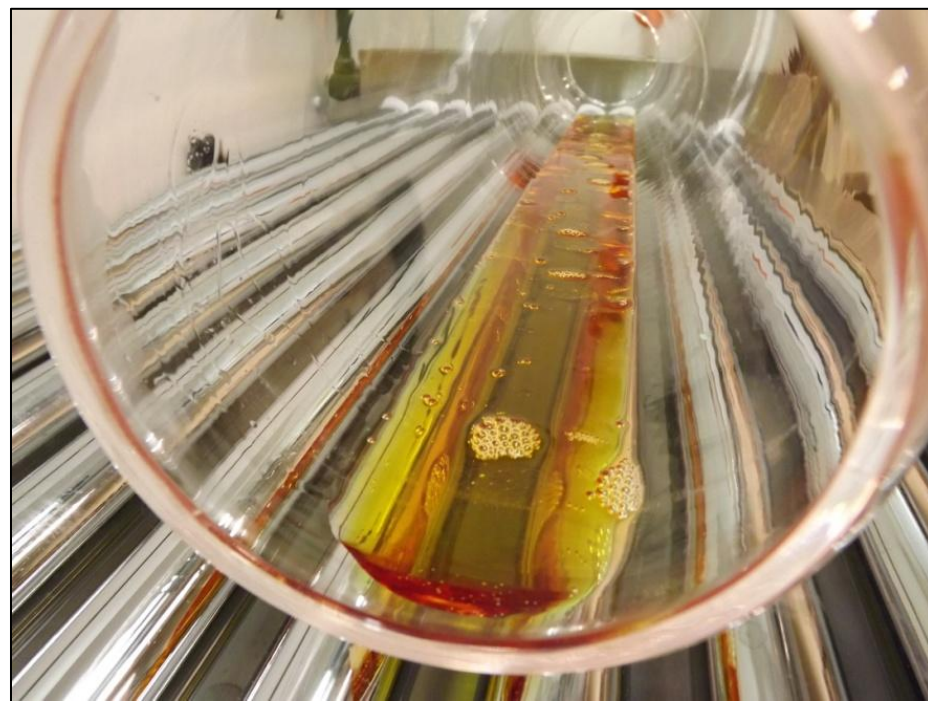
Excessive carbon difficult to manage during acid rinse and counting



Chemical extraction to remove residue from quartz boat

10 kg sample is 5 x 2 kg blocks in same quartz boat

Rinse boat with aqua regia (3:1 by vol. HCl and HNO₃) on heated roller at 1 rpm for 1 h



Measure ^{238}U and ^{232}Th with HPGe detectors



well detector taking data underground



copper and lead shielding

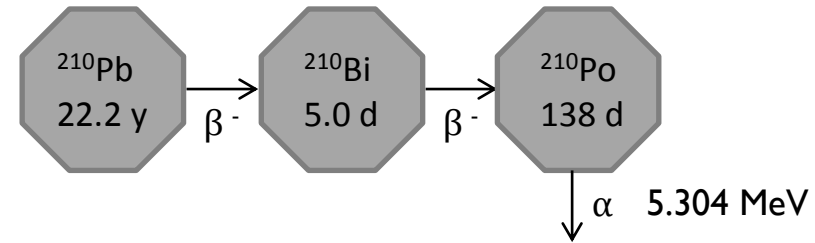
SNOLAB has two coaxial detectors and a well detector for low energy gamma spectroscopy

New coaxial and well detectors are being commissioned now



Measure ^{210}Pb by measuring ^{210}Po alpha decay

Allow ^{210}Po to build up in effluent for 1 month



Spontaneous deposition
of polonium on nickel

J. Environ. Radioact. **102**, 415-419 (2011)

Polonium and
alpha spectroscopy

Nucl. Instrum. Methods Phys. Res. **223**, 218-223 (1984)



new alpha counters being calibrated

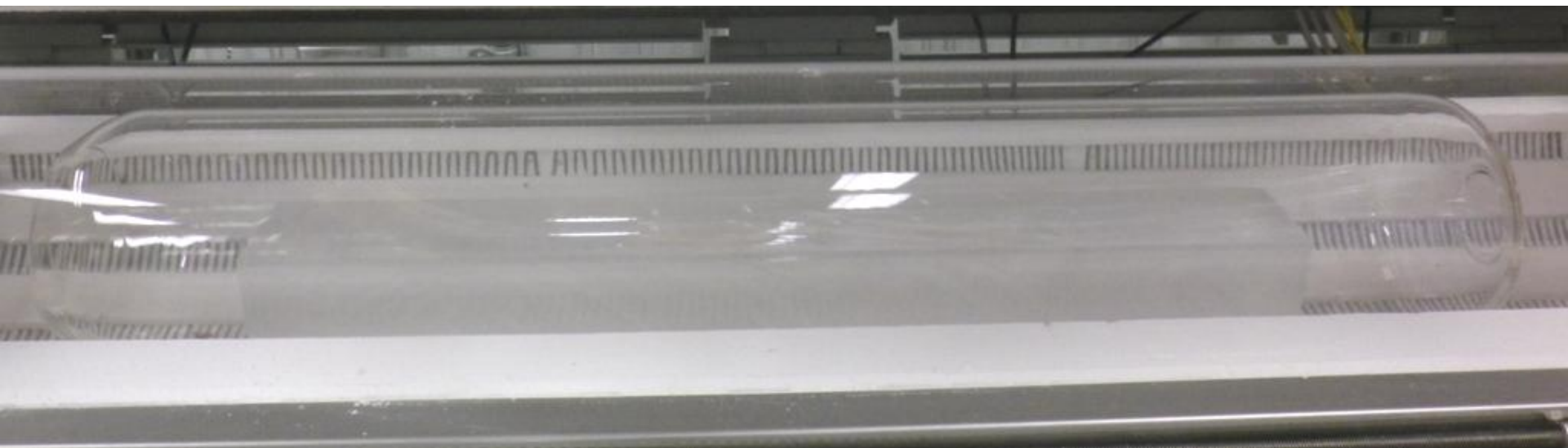


Conclusions

In a direct dark matter search, background control is of utmost importance

The DEAP-3600 acrylic vessel is the most critical detector component and has stringent limits

We have developed an acrylic assay program based on acrylic vaporization



DEAP collaboration

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Collaboration meeting, March 2012