^{14}C Concentration Measurements

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^{14}C Concentration Measurements

Introduction & Motivation

- Measurements of ^{14}C concentrations in various liquid scintillator samples
- Collaboration between
  - university of Oulu, Finland
  - university of Jyväskylä, Finland (Wladek Trzaska *et al.*)
  - Russian Academy of Sciences, Institute of Nuclear Research, Moscow (Bayarto Lubsandorzhiev *et al.*)
- Two independent measurements
  - Pyhäsalmi mine, Finland (Callio Lab), at 4100 mwe
  - Baksan Underground Laboratory, Russia, at 4900 mwe
  - $\sim$similar method, $\sim$similar shielding
- The decay energy of ^{14}C is low (Q=156 keV)
  - often below the threshold
- If the ^{14}C concentration too large $\Longrightarrow$ pulses may pile-up

^{14}C Concentration Measurements

Earlier measurements for the concentration

$^{14}C/^{12}C$ ($\times 10^{-18}$)	Liquid Scintillator	Experiment	[Ref]
(1.94±0.09)	PC+PPO	Borexino CTF	[1]
(9.1±0.4)	PXE+p-Tp+...	Borexino CTF	[2]
(3.98±0.94)	PC-Dodecane+PPO	KamLAND	[3]
(12.6±0.4)	PXE+p-Tp+...	Dedicated setup	[4]

[1] G. Alimonti *et al.*, Physics Letters B 422 (1998) 349

[2] H.O. Back *et al.*, Nuclear Instrum. Methdos A 585 (2008) 48

[3] G. Keefer, arXiv:1102.3786

[4] C. Buck *et al.*, Instrum. and Experim. Techniques 55 (2012) 34

^{14}C Concentration Measurements

A Dedicated Experiment

ISSN 0020-4412, Instruments and Experimental Techniques, 2012, Vol. 55, No. 1, pp. 34–37. © Pleiades Publishing, Ltd., 2012.
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NUCLEAR EXPERIMENTAL TECHNIQUE

Measuring the ^{14}C Isotope Concentration in a Liquid Organic Scintillator at a Small-Volume Setup

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Received June 7, 2011

Abstract—A low-background scintillation setup situated in the Gran Sasso National Laboratory is described. The facility is composed of nine identical cells, each 2 L in volume. The ^{14}C content of a PXE-based scintillator has been measured using this setup; the value obtained is $R(^{14}C/^{12}C) = (12.6 \pm 0.4) \times 10^{-18}$. This result can be used for comprehensive investigation of possible ^{14}C production channels in organic scintillators.

DOI: 10.1134/S0020441212010022

^{14}C Concentration Measurements

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NUCLEAR EXPERIMENTAL TECHNIQUE

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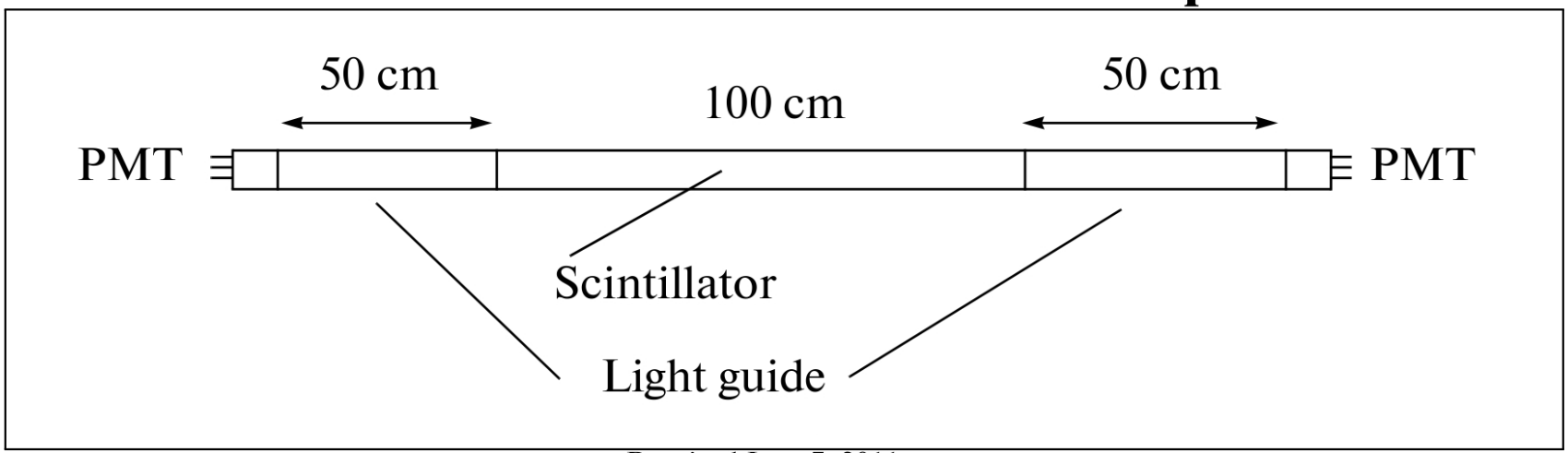

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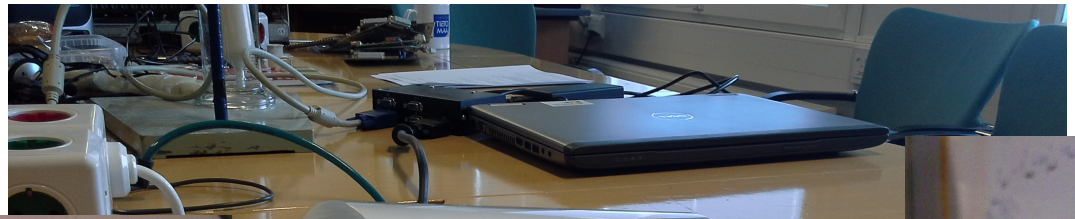
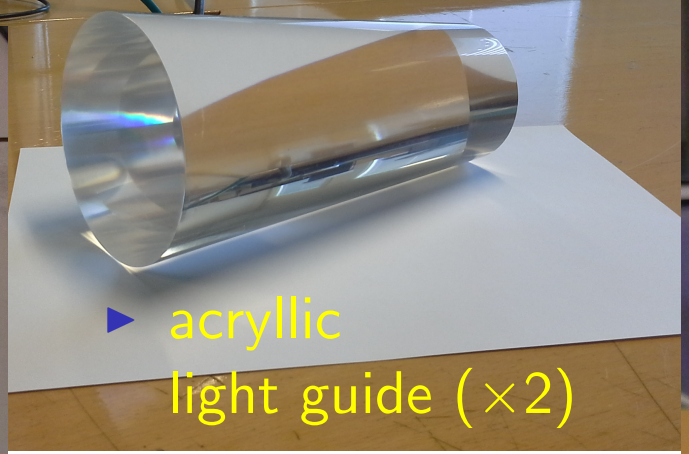
^{14}C Concentration Measurements

Experimental components



- quartz vessel, 1.6 ℓ

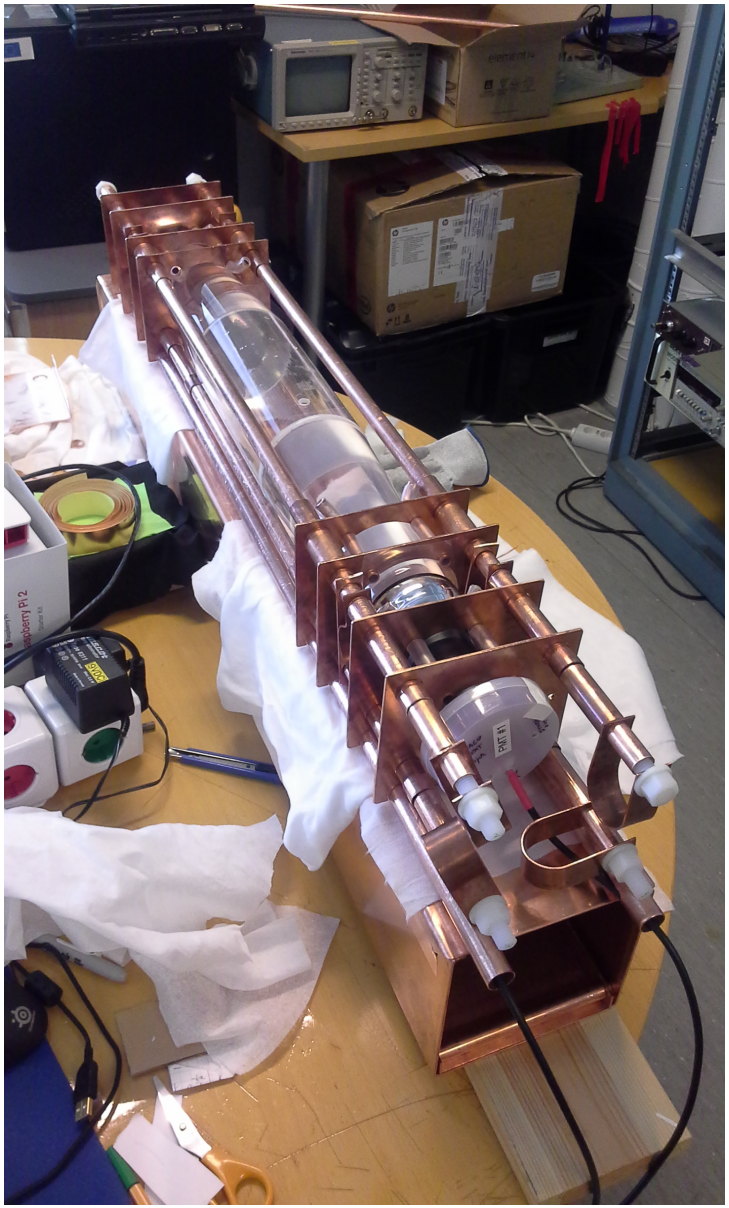


- acryllic light guide ($\times$2)

- PMT ($\times$2), ET9302B 3", low active

^{14}C Concentration Measurements

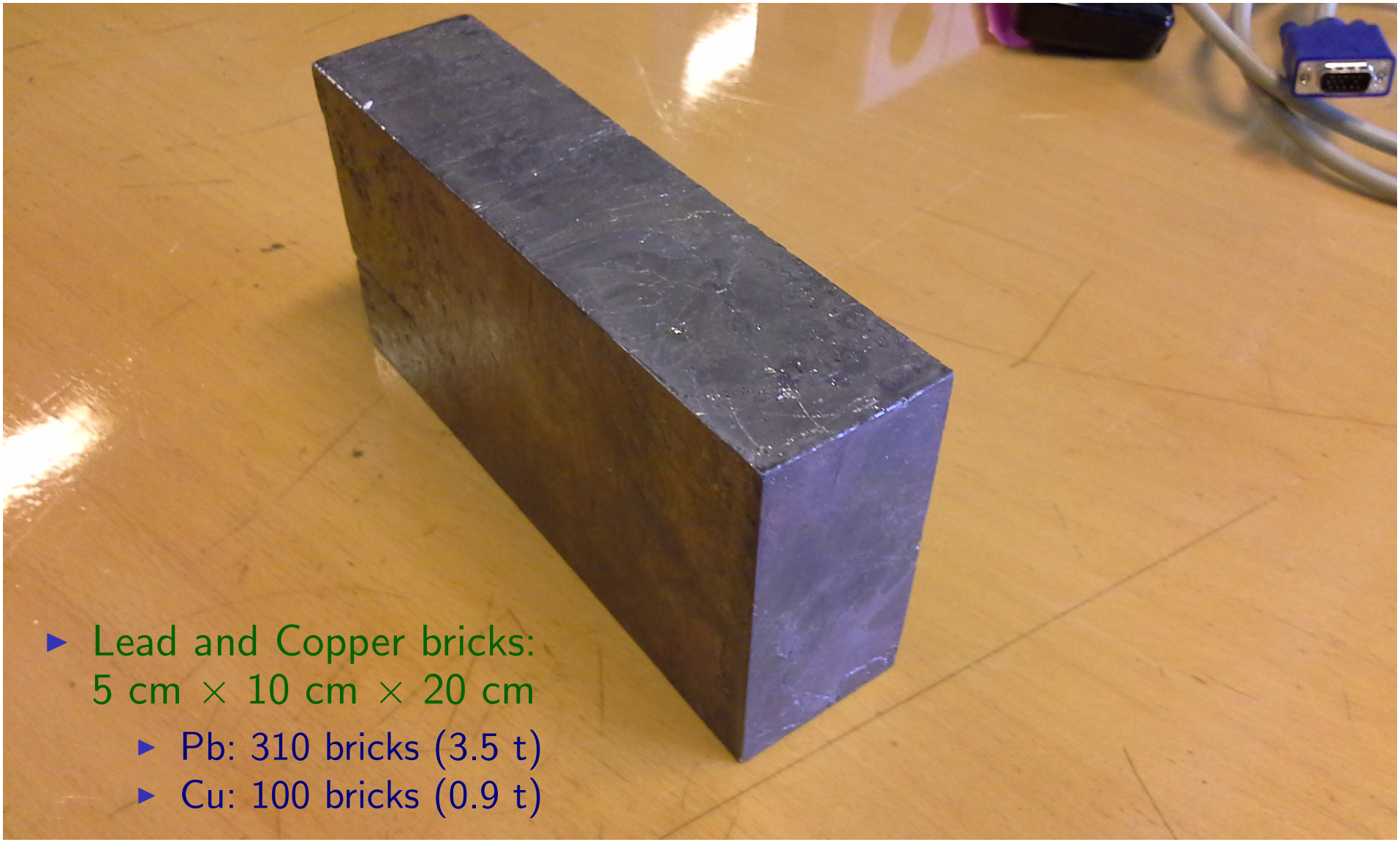
Black Box



- The black box and the rail is made out of Copper
- Size: 15 cm $\times$ 15 cm $\times$ 100 cm
- No screws, no glues
- The PMT-Lightguide-Vessel system easy to move in and out

^{14}C Concentration Measurements

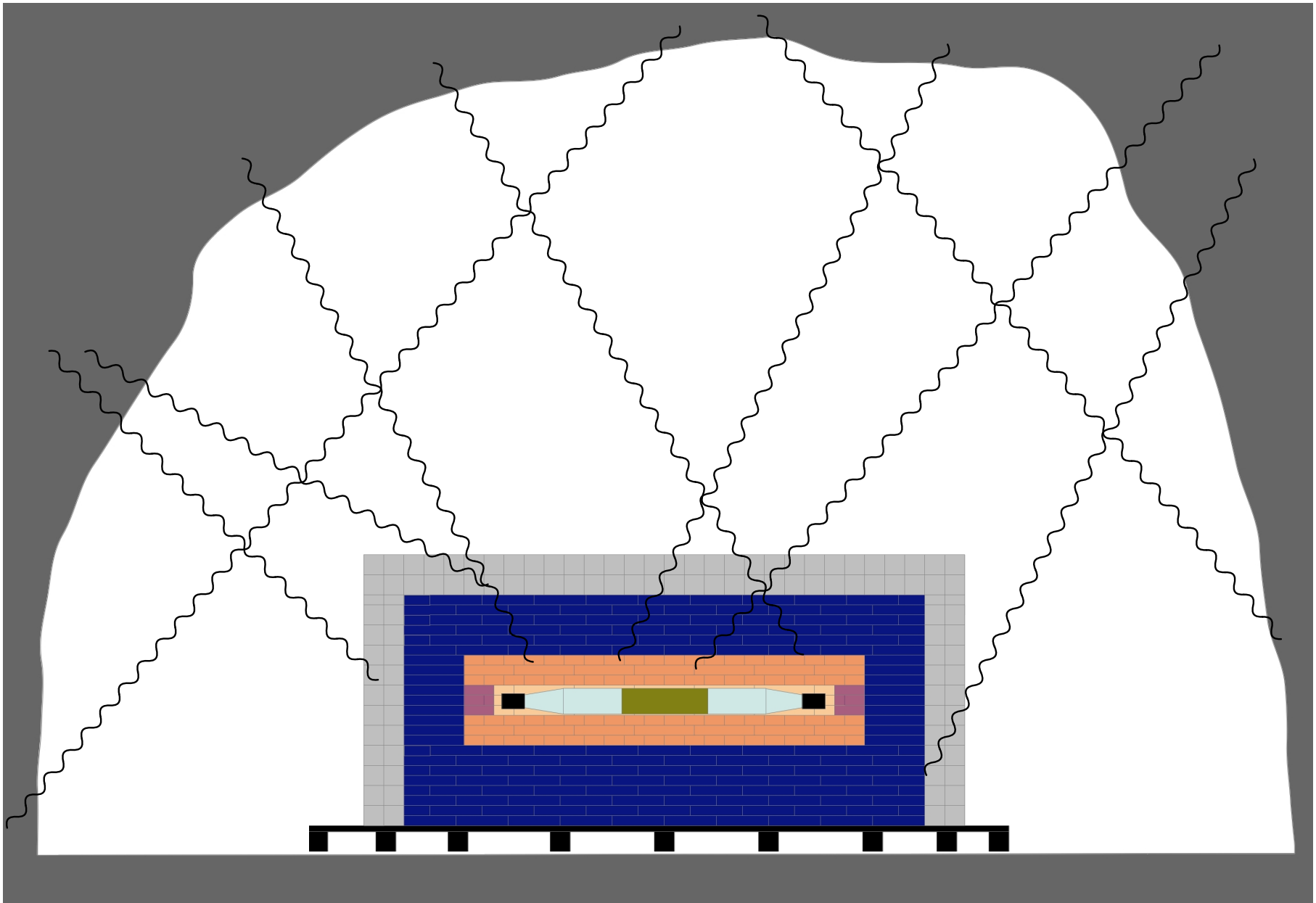
Radiation shielding



- Lead and Copper bricks:
  5 cm $\times$ 10 cm $\times$ 20 cm
  - Pb: 310 bricks (3.5 t)
  - Cu: 100 bricks (0.9 t)

^{14}C Concentration Measurements

Schematic drawing



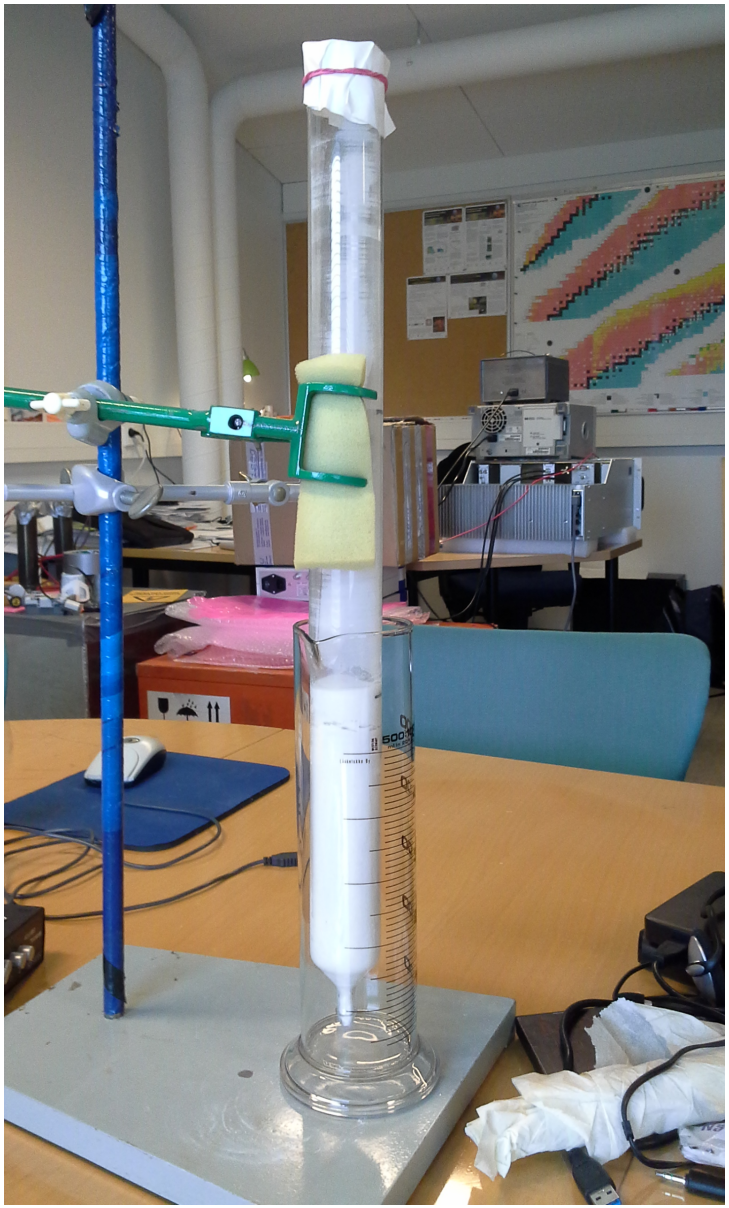
^{14}C Concentration Measurements

DAQ

- A 4-chn DRS4 Evaluation Board (of PSI, Switzerland) is used for the DAQ

^{14}C Concentration Measurements

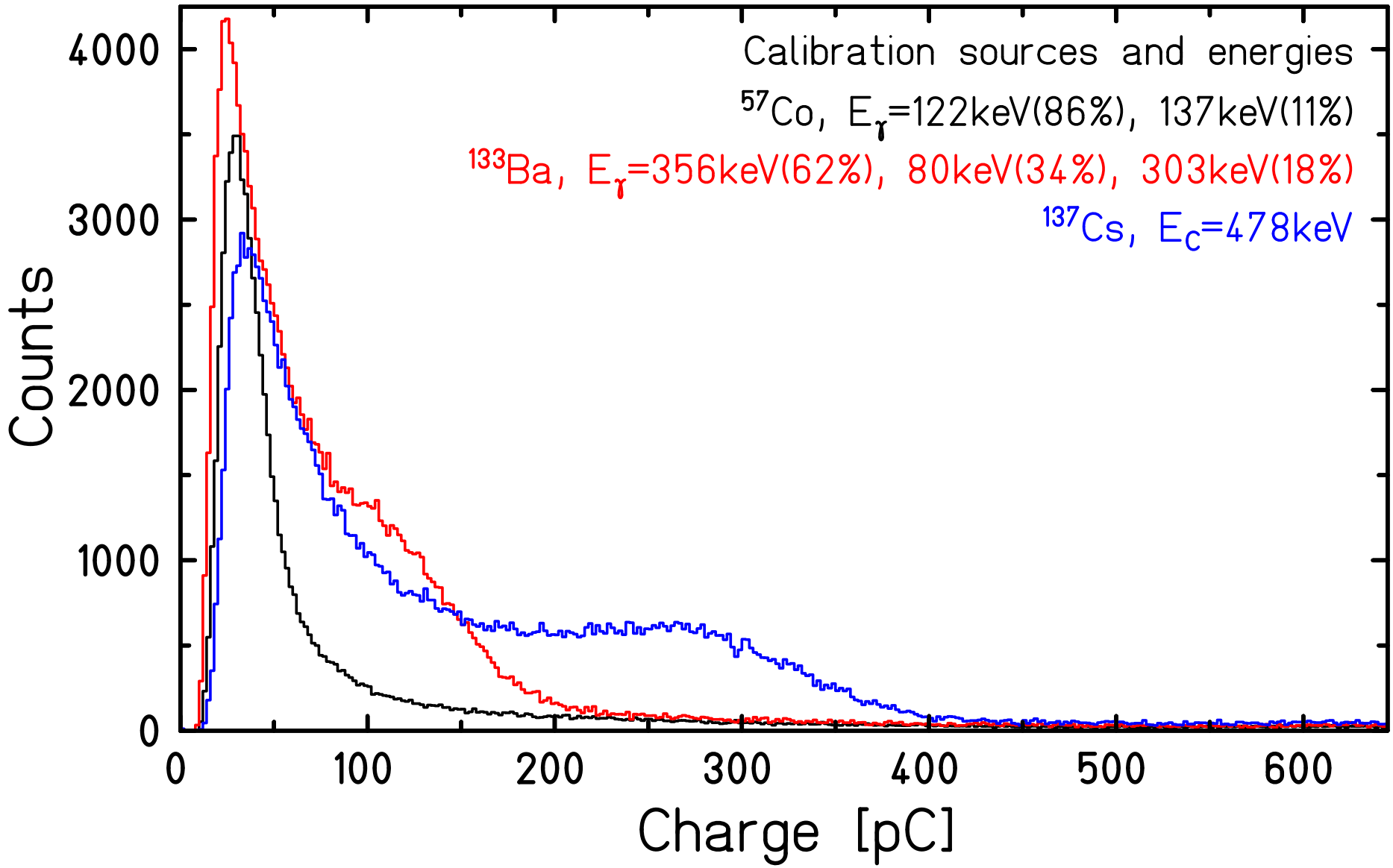
Purification



- Purification of the scintillator is performed with Al_2O_3 column
  - couple of days for 2 liters

^{14}C Concentration Measurements

Energy calibration – ^{57}Co, ^{133}Ba, and ^{137}Cs



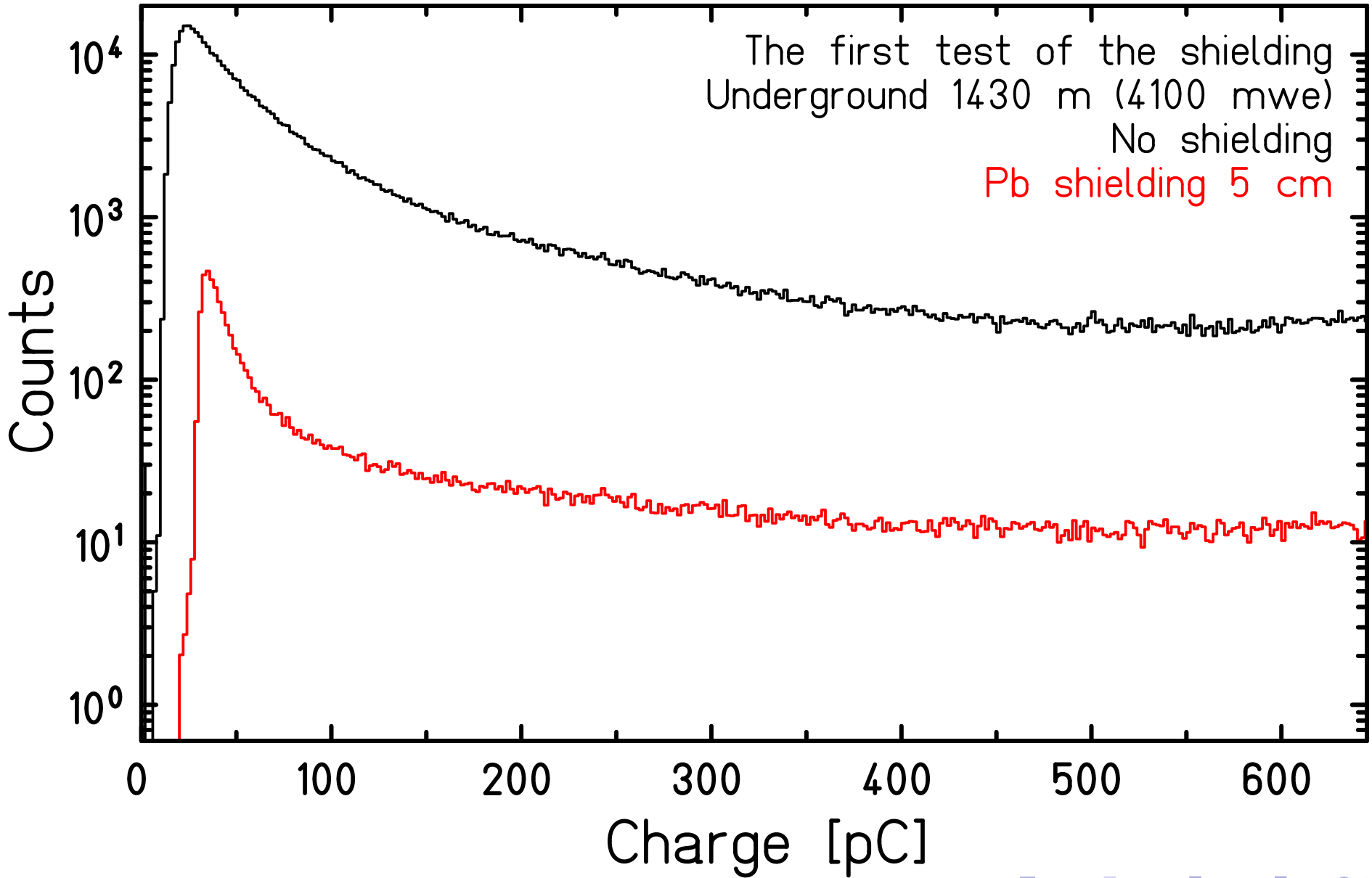
^{14}C Concentration Measurements

Current status – the setup

- The Black Box is currently shielded by 5 cm of lead.
  - in a temporary test bench
- Another 5 cm of lead will be added in the beginning of November

^{14}C Concentration Measurements

Current status – reduction of background (by 5 cm of Pb)



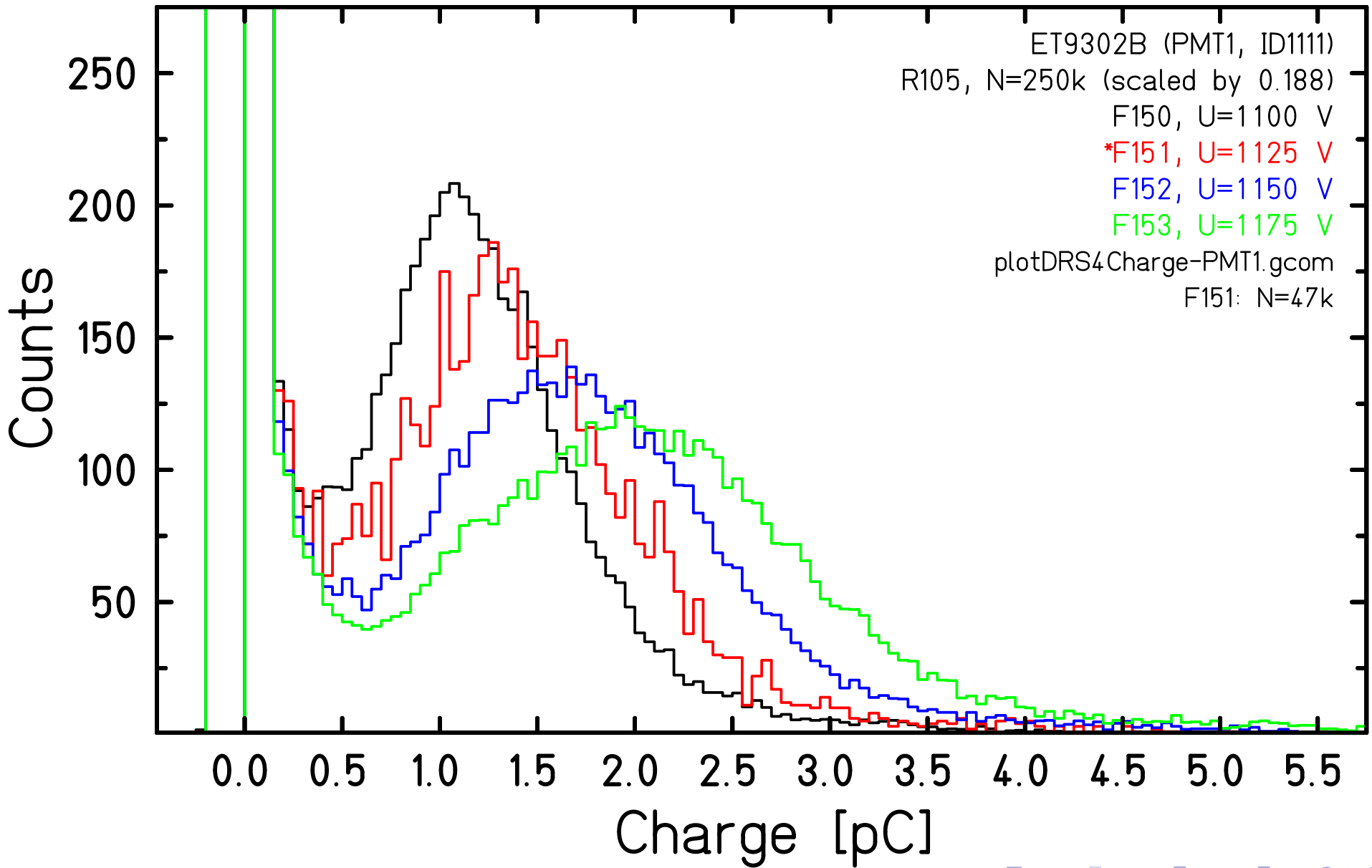
^{14}C Concentration Measurements

Conclusions

- A dedicated setup – consisting of a vessel, two light guides and two PMTs – is used to measure the concentration of ^{14}C in liquid scintillator
  - underground at 1430 m (or 4100 mwe) in the Pyhäsalmi mine, Finland
  - similar setup constructed at Baksan, Russia
- Measurements (background reduction) just started
  - adding the shielding step by step: another 5 cm of Pb will be added in the beginning of November
- Purpose to measure several samples of different origin

^{14}C Concentration Measurements

PMT calibration – ET9302B (PMT 1)



^{14}C Concentration Measurements

PMT calibration – ET9302B (PMT 2)