The CRESST Dark Matter Search

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for

the CRESST collaboration

XL meeting of the Gran Sasso Scientific Committee
29 – 30 October 2013, LNGS

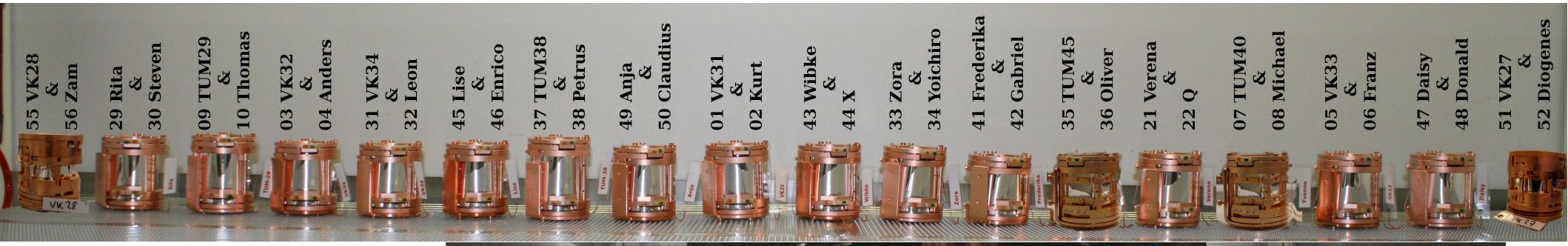
Outline

- Status of the current run
- Outcome of the previous CRESST run
- Actions to achieve background reduction
- First glance through the collected data
- Schedule and Perspectives

Status

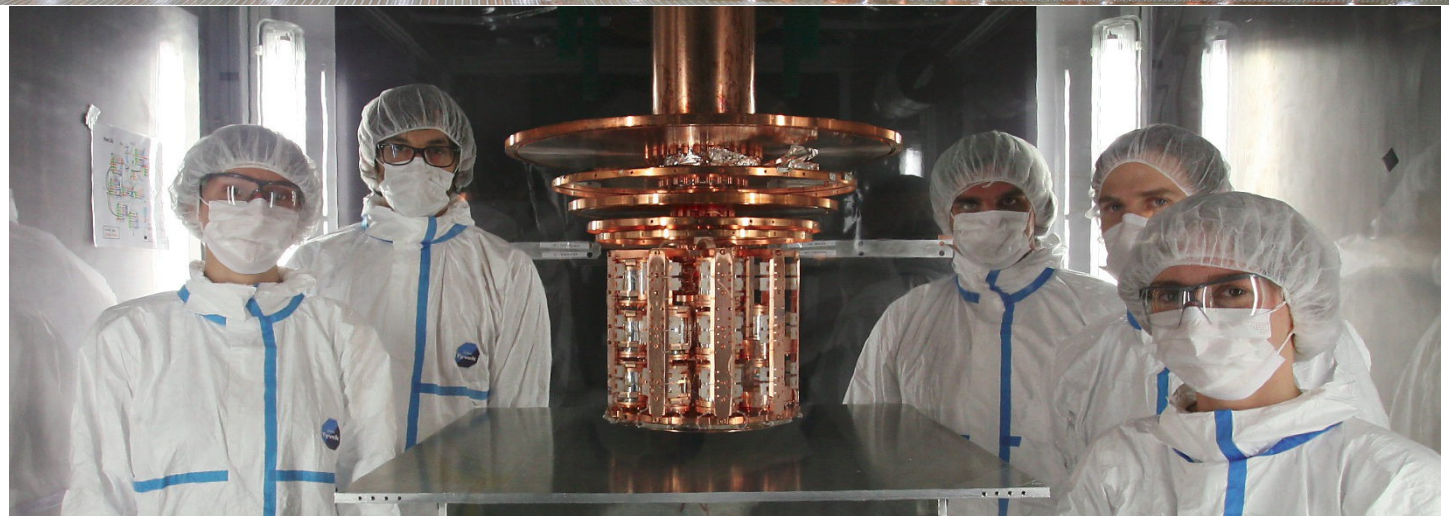
Status of run 33:

18 detector modules mounted



Cooling of cryostat in May

- 100% operational detectors



Setting up detectors and calibration in June and July

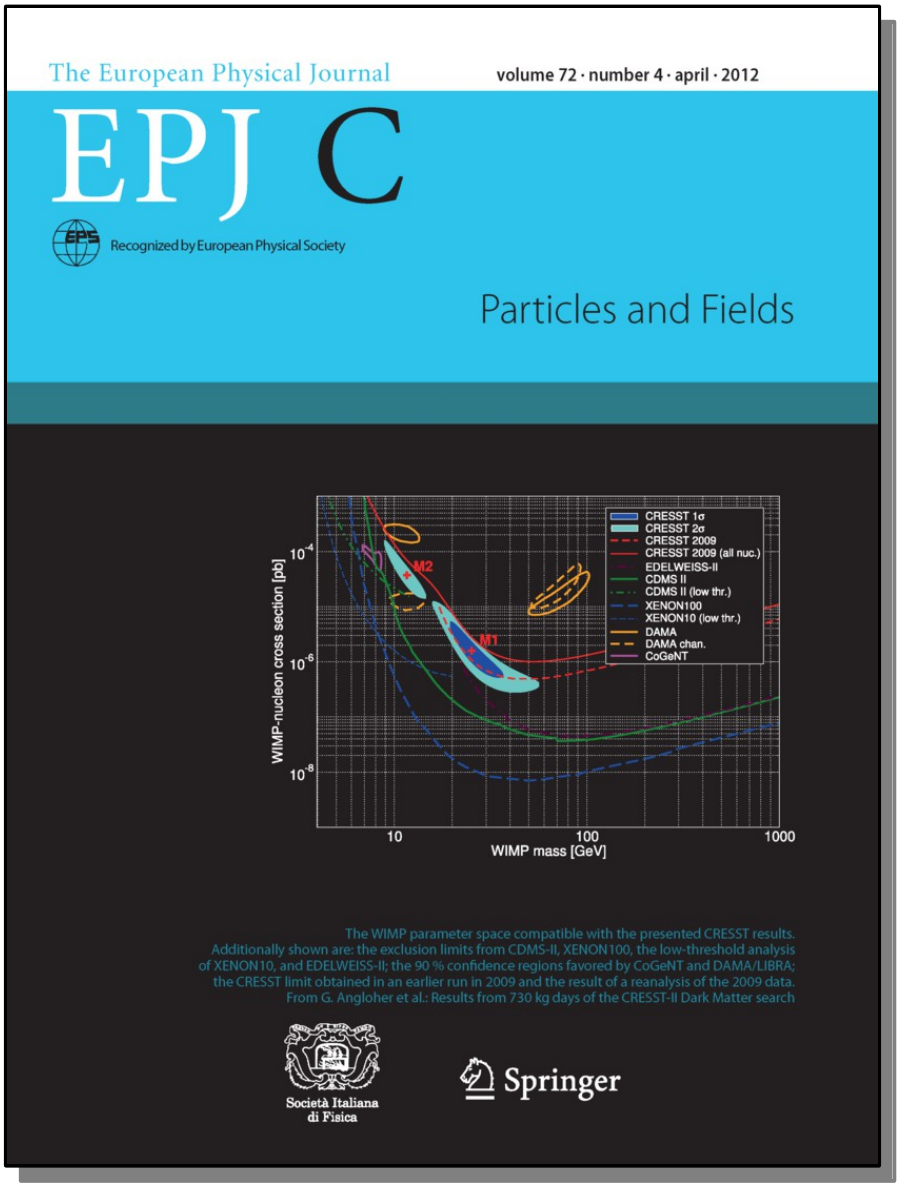
- Heater of one Light Detector disturbs stability of carousel – used for temperature control

Data taking since July 30

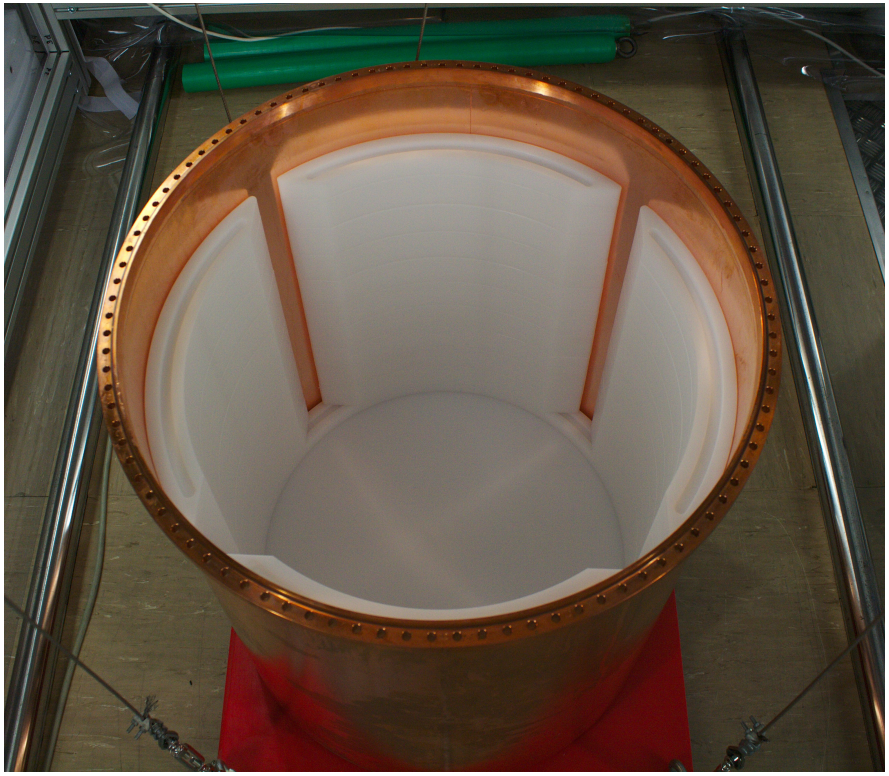
The previous CRESST run

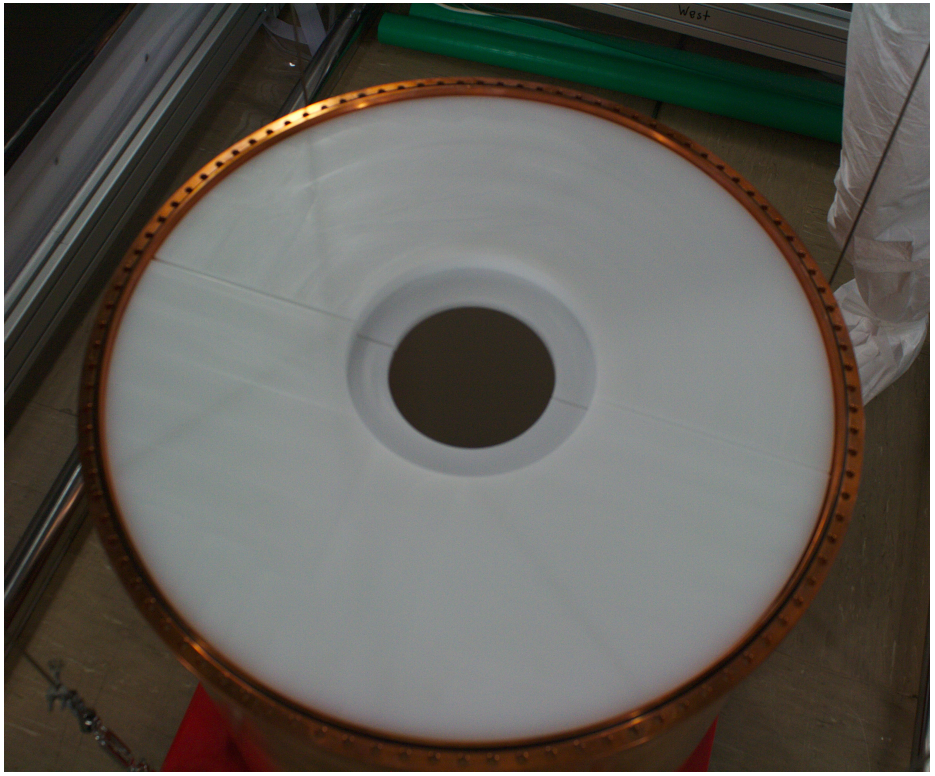
- Extended physics run from June 2009 to April 2011
- 8 $CaWO_4$ modules used for Dark Matter analysis
- Net exposure after cuts: 730 kg days
- 67 events observed in WIMP search region
- Data analyzed with 2d likelihood fit of signal and background model

	M1	M2
e/γ-events	8.00 ± 0.05	8.00 ± 0.05
α-events	$11.5\,^{+2.6}_{-2.3}$	$11.2\,^{+2.5}_{-2.3}$
neutron events	$7.5\,^{+6.3}_{-5.5}$	$9.7\,^{+6.1}_{-5.1}$
Pb recoils	$15.0^{+5.2}_{-5.1}$	$18.7\,^{+4.9}_{-4.7}$
signal events	$29.4\,^{+8.6}_{-7.7}$	$24.2\,^{+8.1}_{-7.2}$
m_χ [GeV]	25.3	11.6
σ_{WN} [pb]	$1.6 \cdot 10^{-6}$	$3.7 \cdot 10^{-5}$



Passive background reduction – neutrons



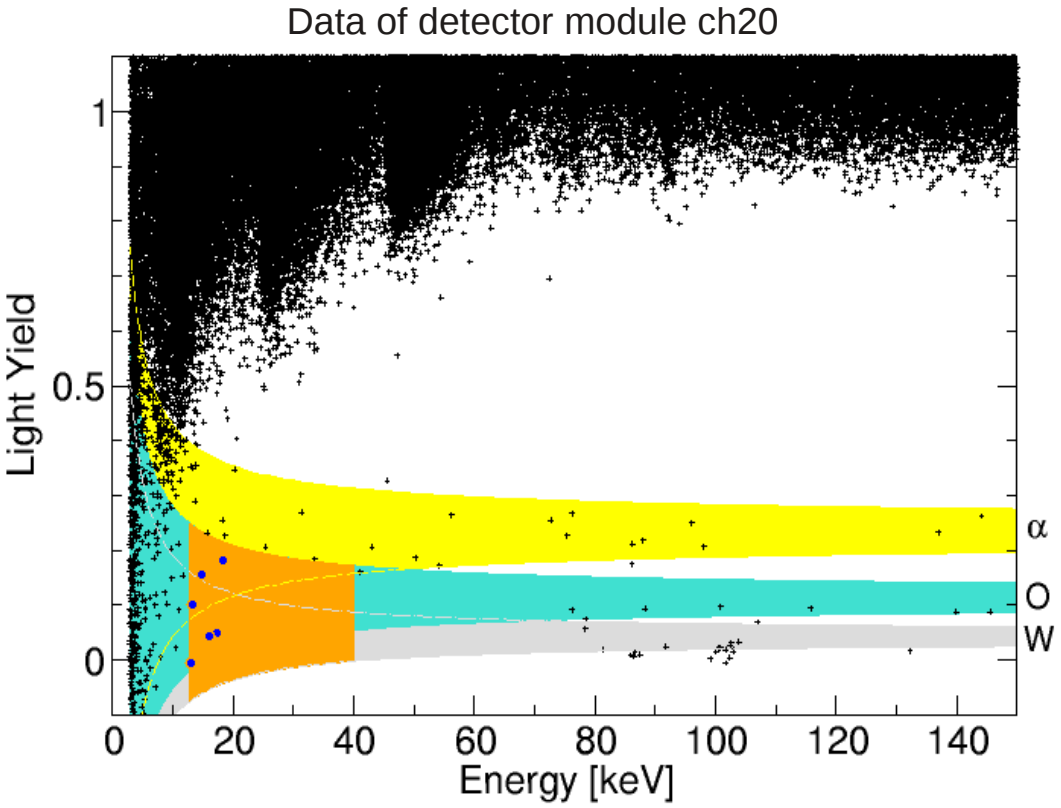


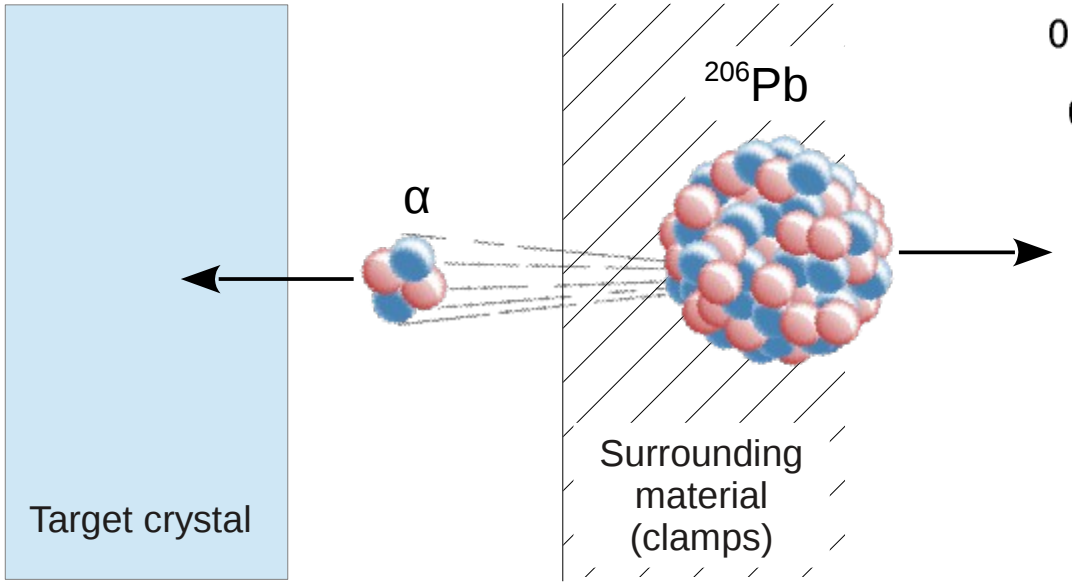
Additional 5cm PE layer inside the Pb/Cu shield

- reduce background from neutrons originating in the Pb/Cu shield

The previous CRESST run – low energy α

- α-events at low energies down to ROI from ^{210}Pb contamination of bronze material of clamps





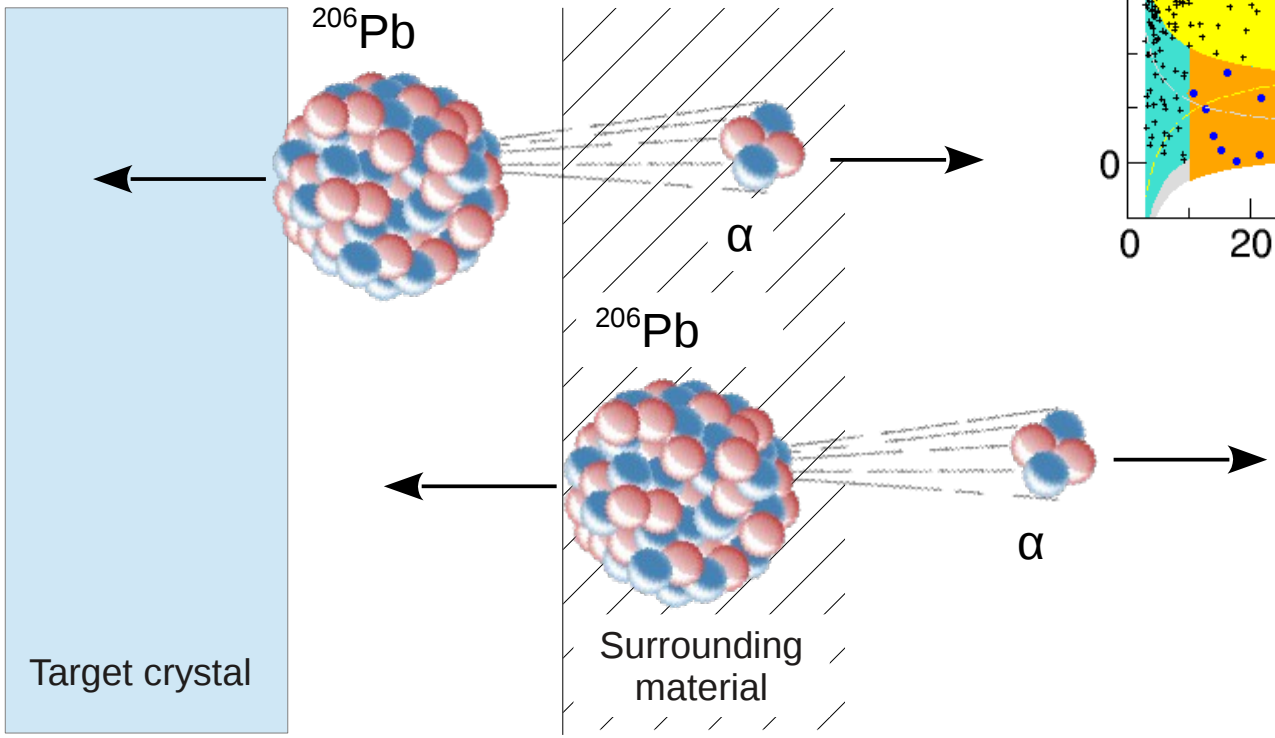
The previous CRESST run – ^{206}Pb recoils

Background of Pb recoils due to radon exposure

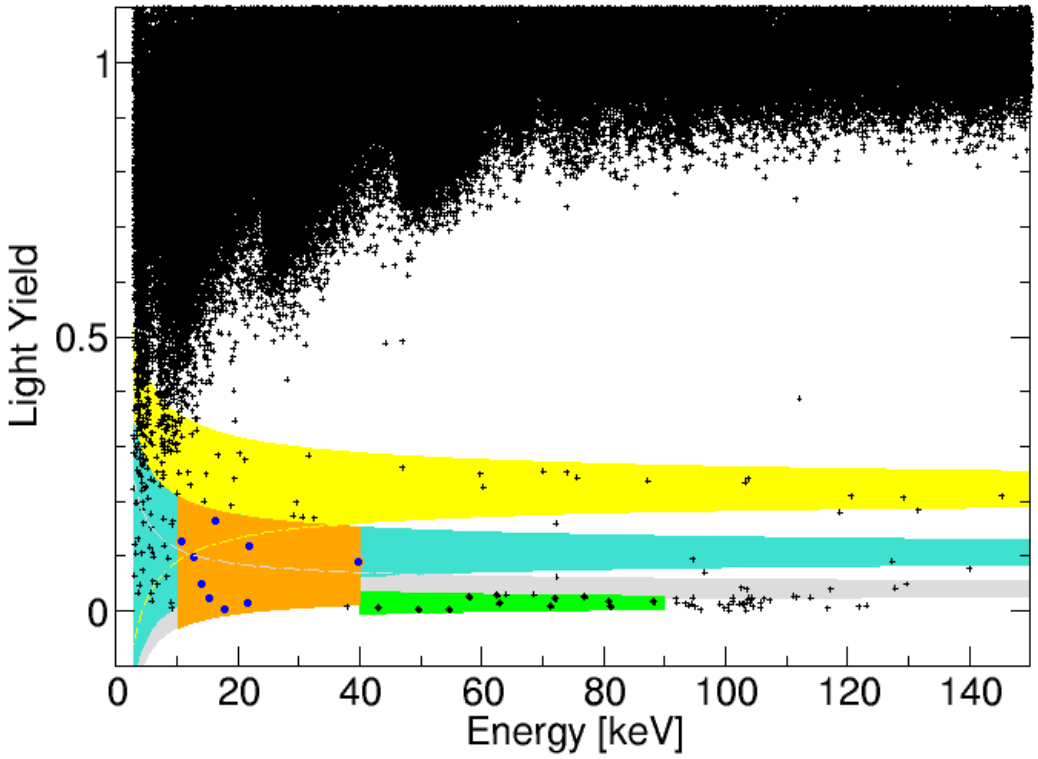
^{210}Pb on surfaces of crystal
- E ≥ 100keV

^{210}Pb on surrounding surfaces
- E ≤ 100keV

Light yield of Pb similar to W recoils



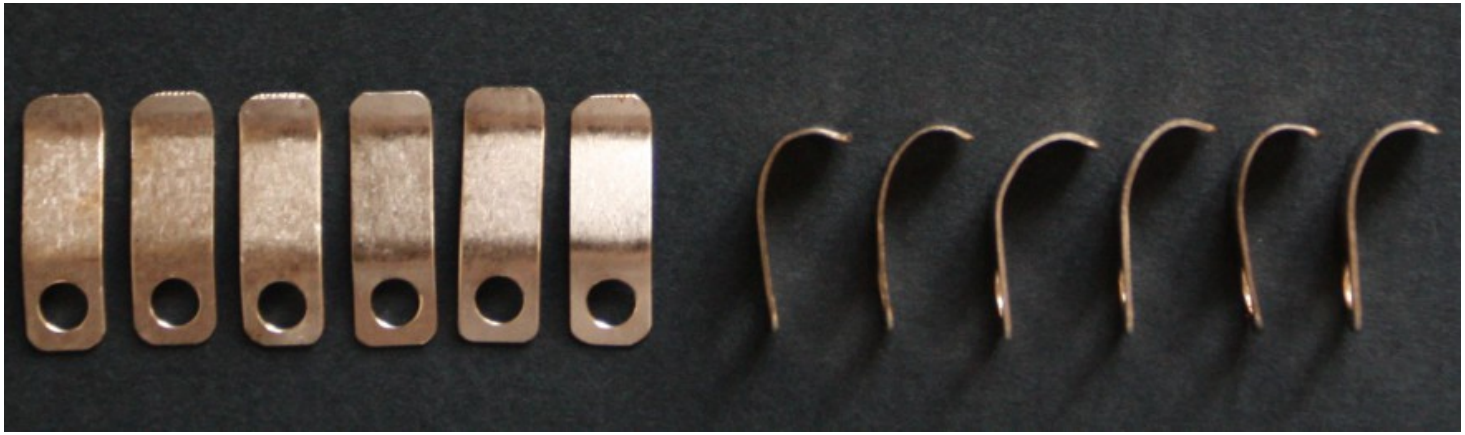
Module with highest ^{206}Pb background

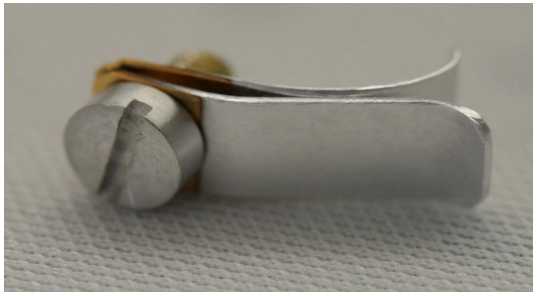


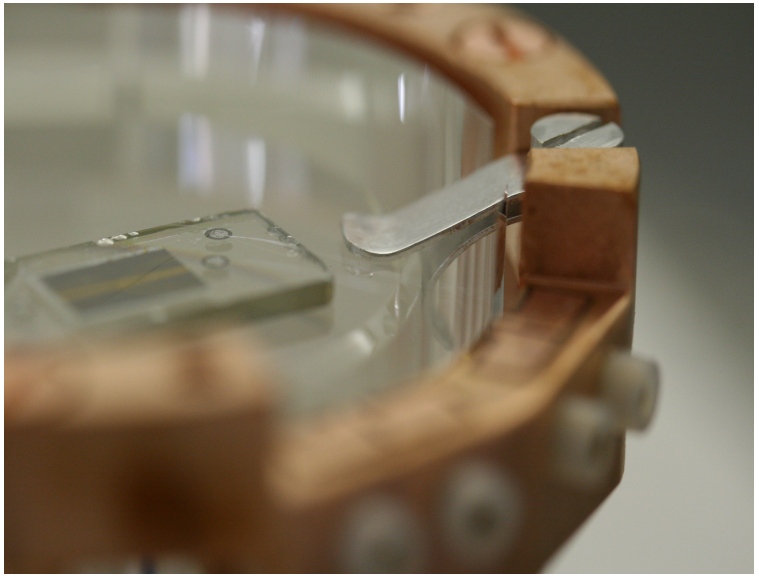
Passive background reduction – low energy α

New CuSn6:

- ultra pure (7n) Sn + low background Cu and careful monitoring of all production steps (*)
- sputter coating with high purity Al







(*) Thanks to the support of chemistry service and special techniques of LNGS.

Passive background reduction – ^{206}Pb recoils

Background of Pb recoils due to radon exposure of clamps after production

1- Avoid any radon exposure of clamps and detector material after production
- Detector modules assembled in clean room facility at Gran Sasso in radon free air (*)
- Detector modules mounted inside cryostat in radon free air
- Reflecting foils and scintillator rings of 6 modules covered with Parylene (*) to reset radon exposure history

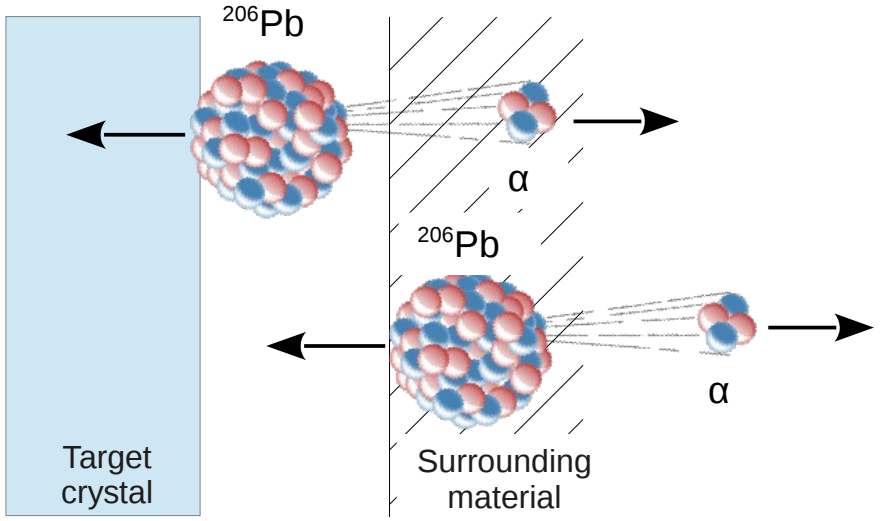
12 conventional modules in present run entirely relying on radon prevention

(*) Thanks to the CUORE collaboration for the radon free air plant and for the Parylene coating system

Active background reduction – ^{206}Pb recoils

2- Detect the emitted α to veto the events

- New detector layouts with active rejection of Pb recoils

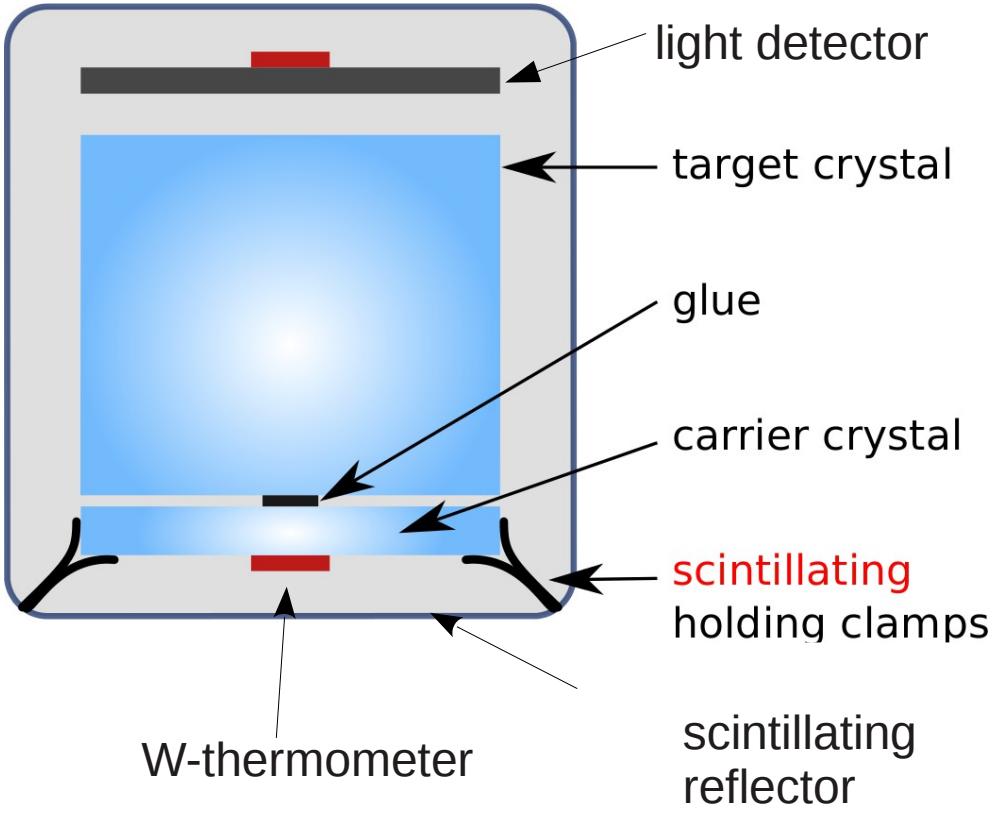


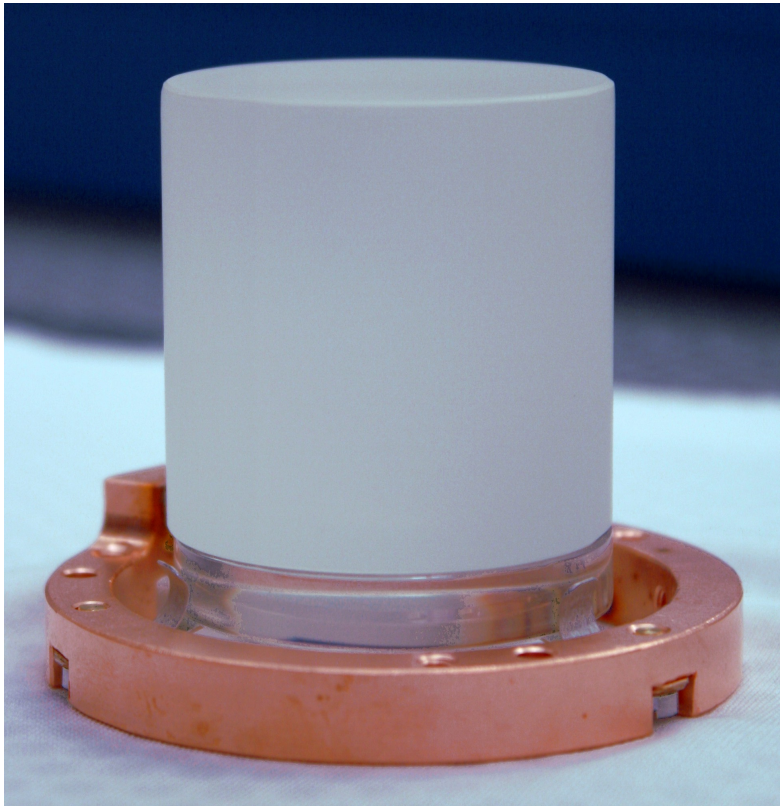
6 modules with 3 different designs in present run

Active background reduction – Design I

Crystal clamped on carrier:

- fully scintillating holder design
- clamps covered with Parylene - not in contact with the target crystal



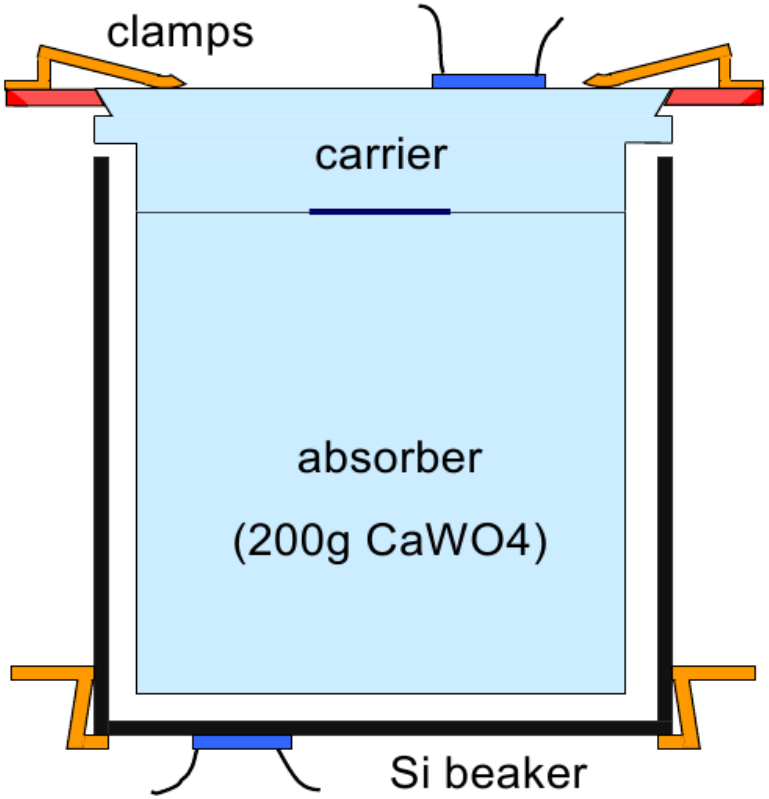


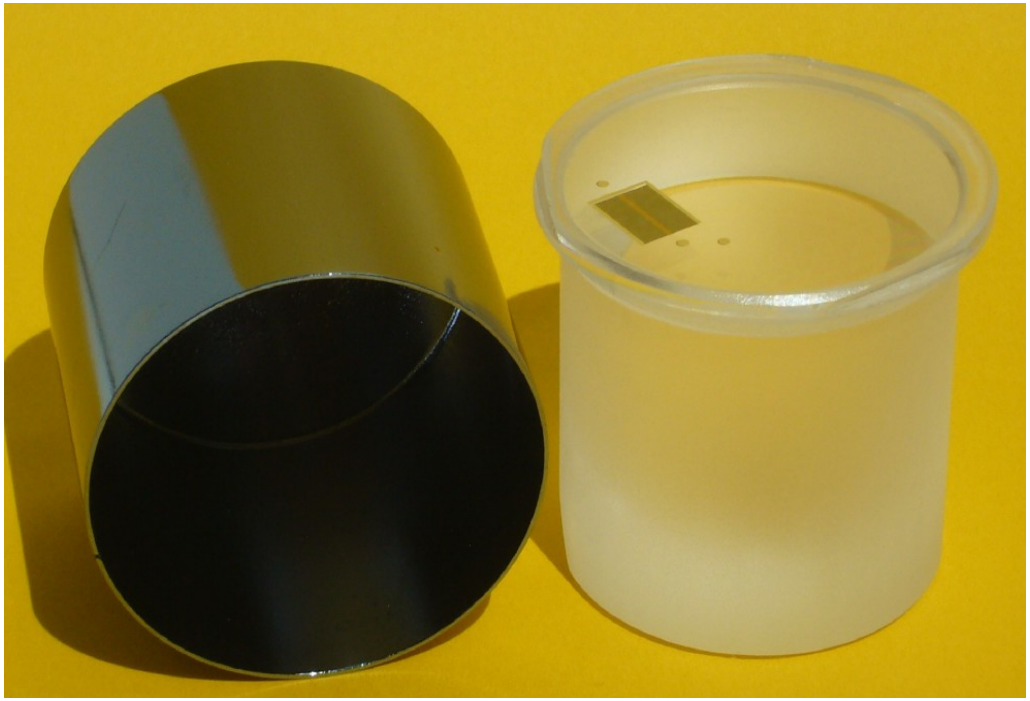
Additional light signal of the α in the scintillating surrounding as veto

Active background reduction – Design II

Silicon beaker light detector:

- light detector completely surrounding target crystal
- crystal held on carrier
- no line of sight between target crystal and clamps



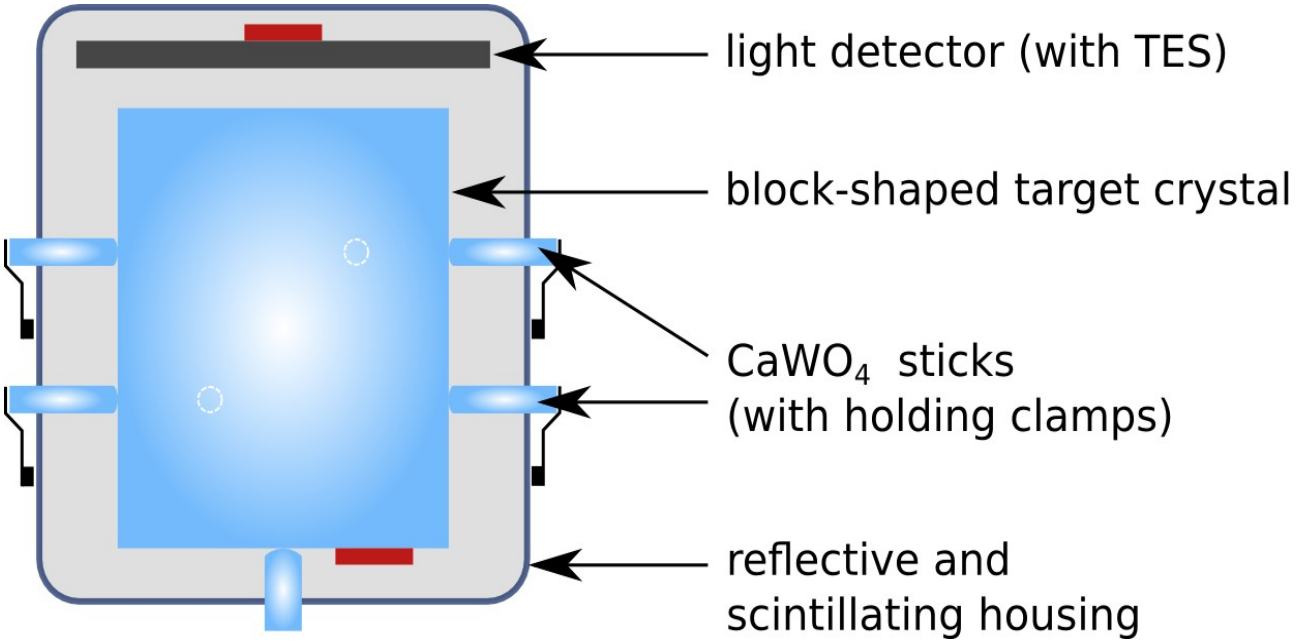


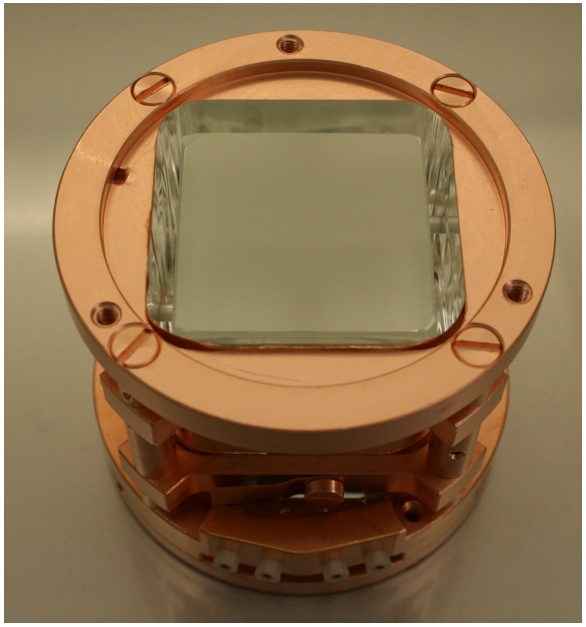
The α detected in the light detector

Active background reduction – Design III

Crystal held by sticks:

- fully scintillating holder design
- $CaWO_4$ sticks to hold the crystal
- block-shaped crystal





Additional light signal of the α in the scintillating surrounding as veto

First glance at data - Active background rejection

Data until December used for defining cuts which then will be applied later in blind analysis

Data from July 30 to October 9

Very preliminary !!

General remarks:

- Exposure per detector between 10kg days and 16kg days
- Hardware trigger threshold ≤ 5keV
  Six with hardware trigger threshold ≤1keV

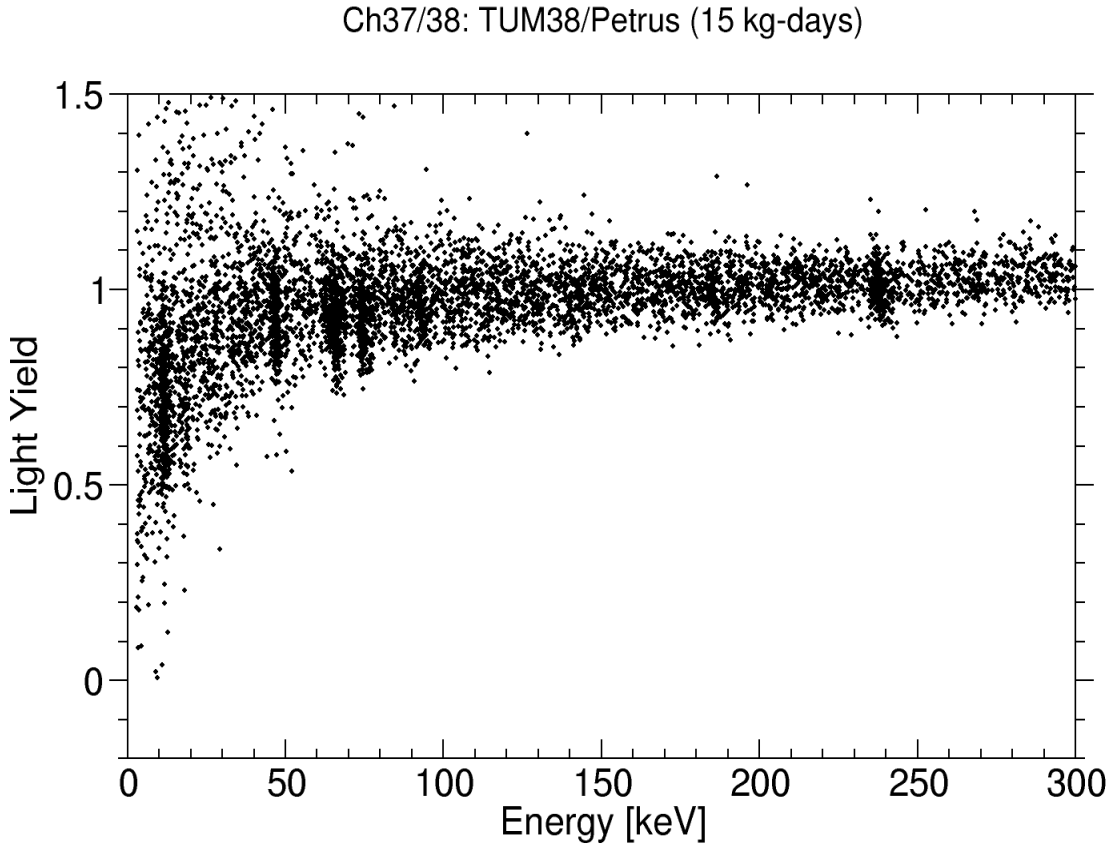
First glance at data - Active background rejection

Data until December used for defining cuts which then will be applied later in blind analysis

Data from July 30 to October 9

Very preliminary !!

Design I: Crystal clamped on carrier



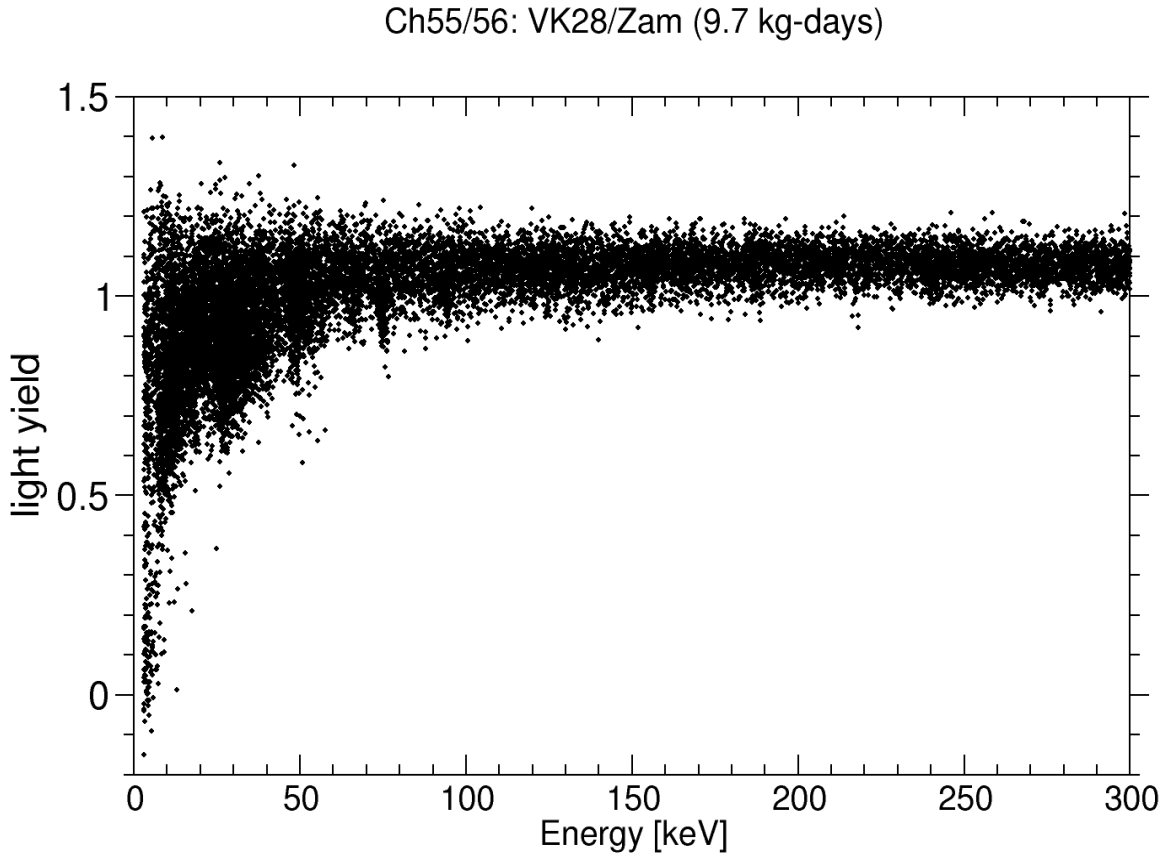
First glance at data - Active background rejection

Data until December used for defining cuts which then will be applied later in blind analysis

Data from July 30 to October 9

Very preliminary !!

Design II: Silicon beaker light detector



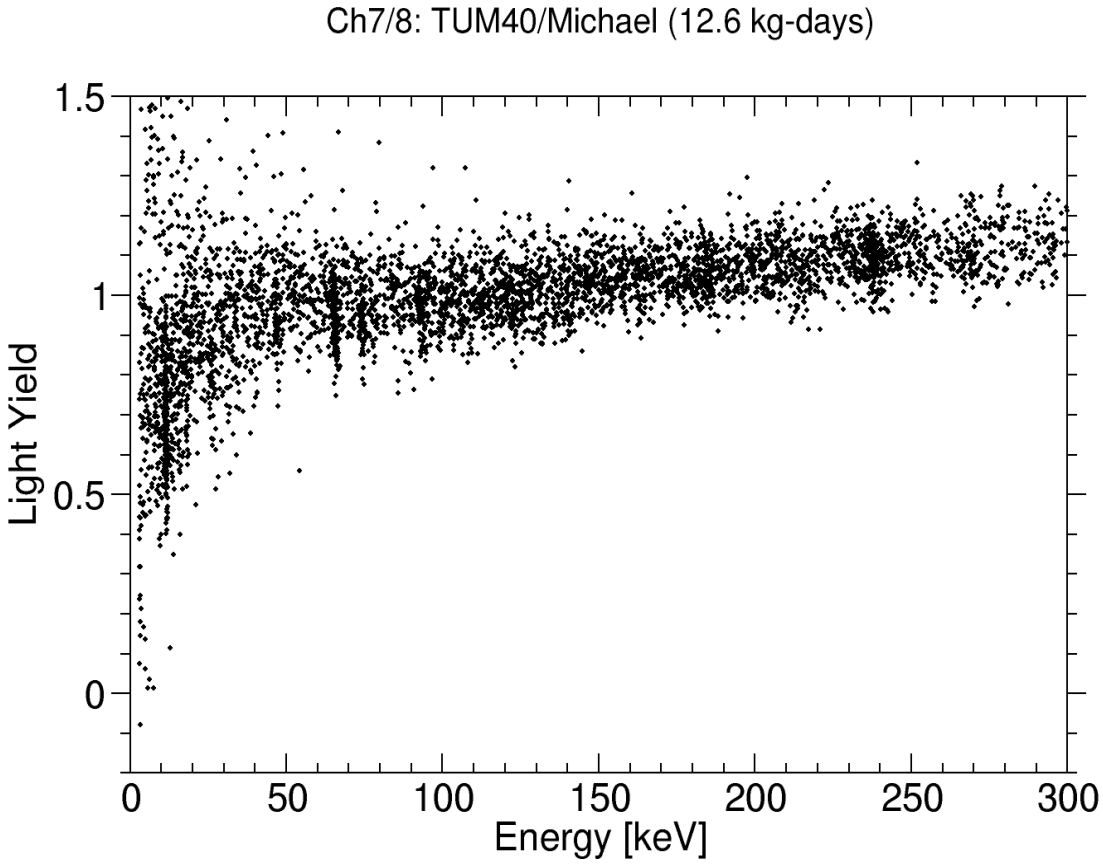
First glance at data - Active background rejection

Data until December used for defining cuts which then will be applied later in blind analysis

Data from July 30 to October 9

Very preliminary !!

Design III:Crystal held by sticks



First glance at data - Active background rejection

Data until December used for defining cuts which then will be applied later in blind analysis

Data from July 30 to October 9

Very preliminary !!

Three modules with active background rejection

- 37.3 kg days
- reference regions defined as in run 32

Neither α nor ^{206}Pb recoils backgrounds in the reference regions

With rate of previous run:

~5 α's expected

5 ^{206}Pb recoils expected

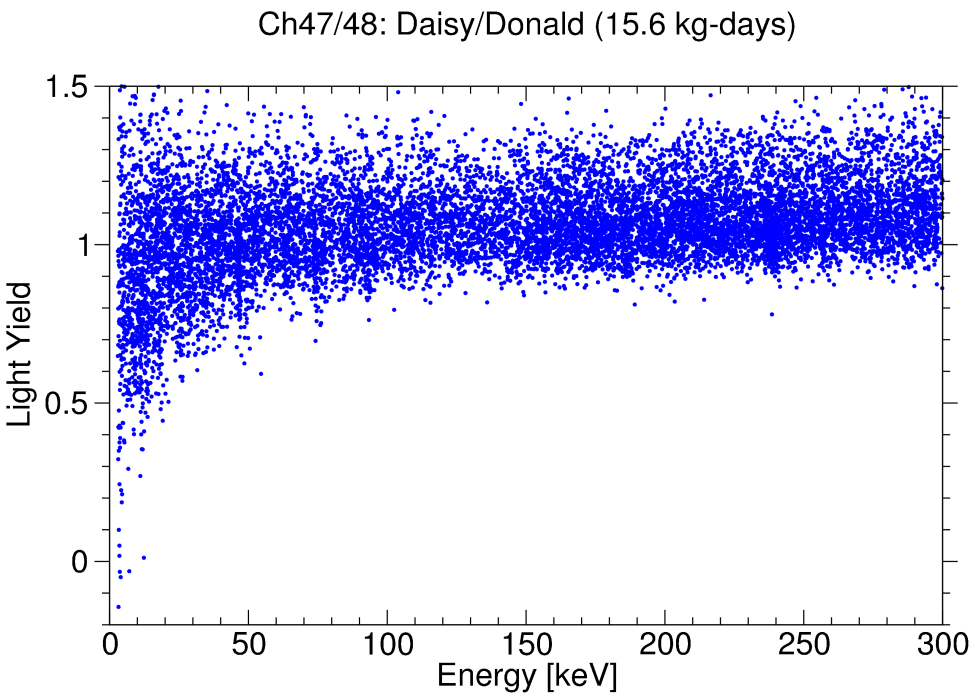
First glance at data - Conventional modules

Data until December used for defining cuts which then will be applied later in blind analysis

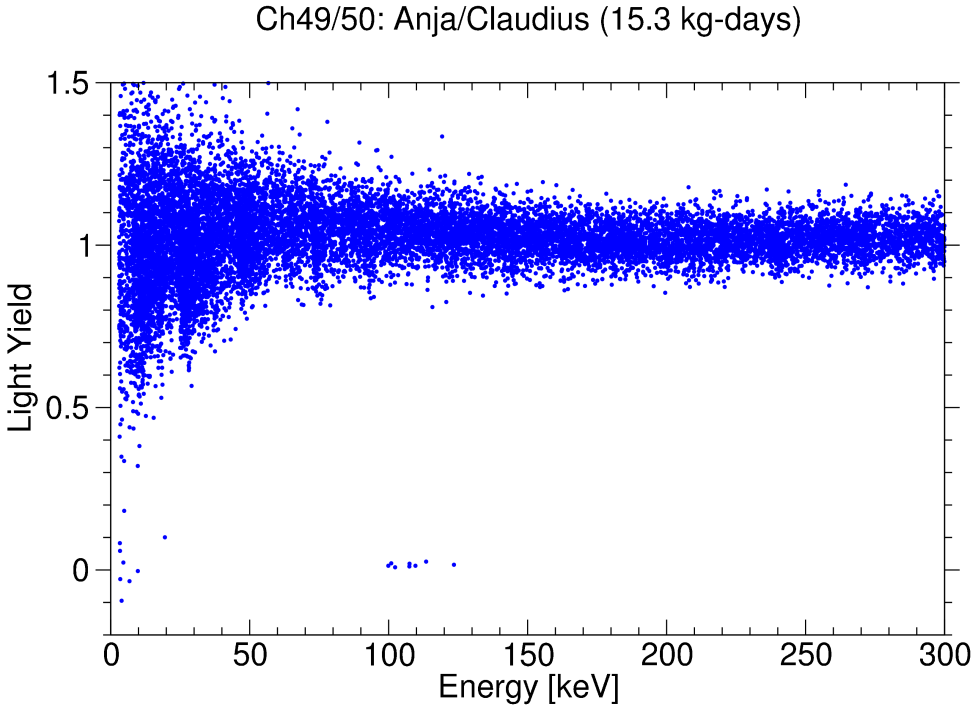
Data from July 30 to October 9

Very preliminary !!

Conventional



Conventional - parylene coated reflector



- ^{206}Pb recoils backgrounds at ≥ 100keV expected from crystal surface
- background in conventional modules lower than in previous run

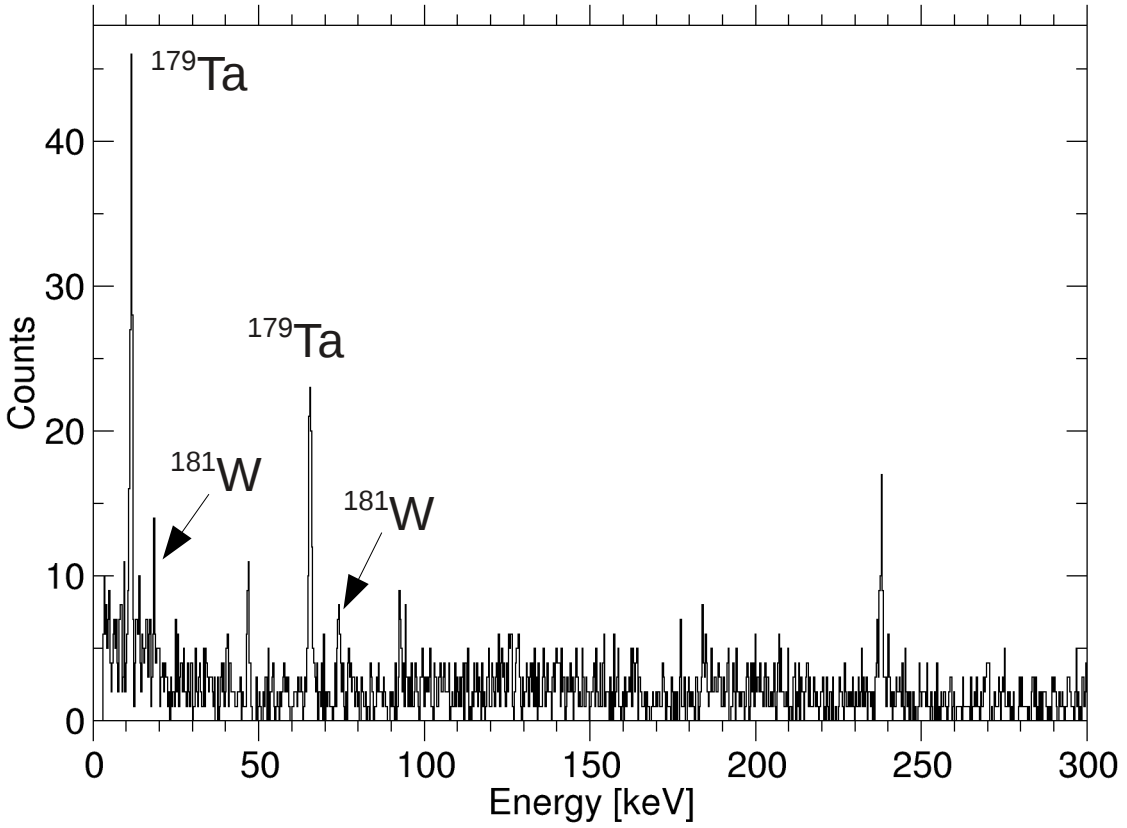
First glance at data – Self grown crystals

Data until December used for defining cuts which then will be applied later in blind analysis

Data from July 30 to October 9

Very preliminary !!

- low intrinsic background level
  - ➡ Possible reduction of discrimination threshold in Dark Matter analysis
- lines from cosmogenic activation
- excellent energy resolution
- precise energy calibration at low energies



Schedule and Perspectives

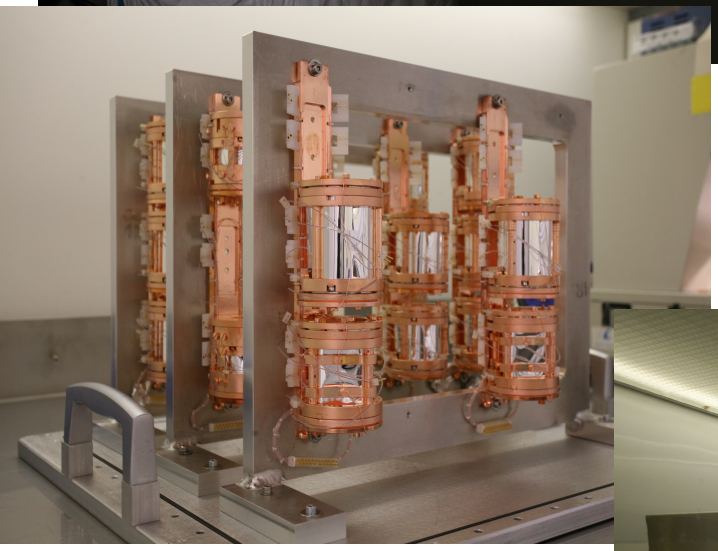
- Data taking since July 30th 2013
  - Stable running conditions during night time/weekend
  - Stability of running affected during day time
- Data until December used for defining cuts (*)
- Expect ~2000 kg-days of data within 2 years
- Either confirm or reject low mass WIMP scenario with high confidence
- Competitive limit if no low mass WIMP is found

In parallel:

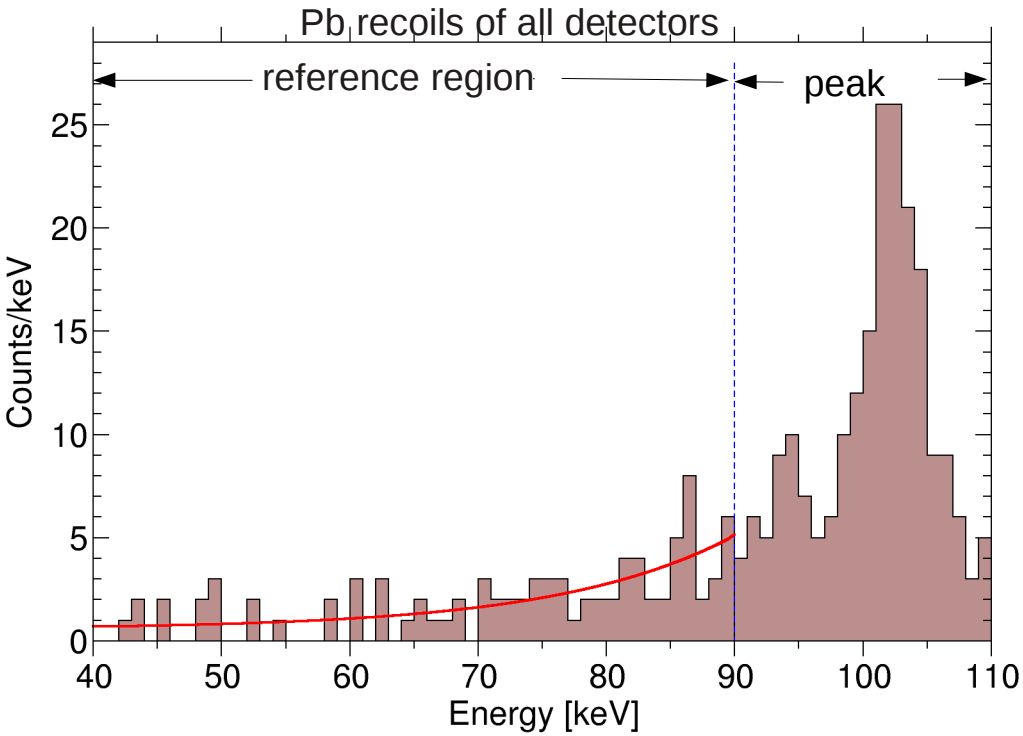
Detectors' development program to go beyond the achievements of run33

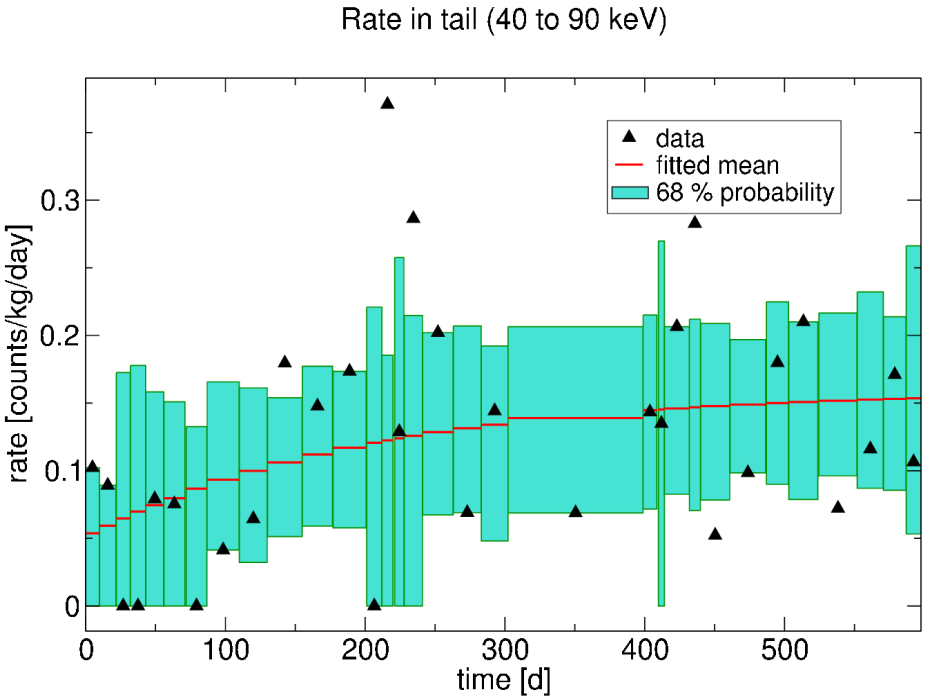
(*)In case of overwhelming superiority of the new designs the possibility of replacing the conventional ones will be considered

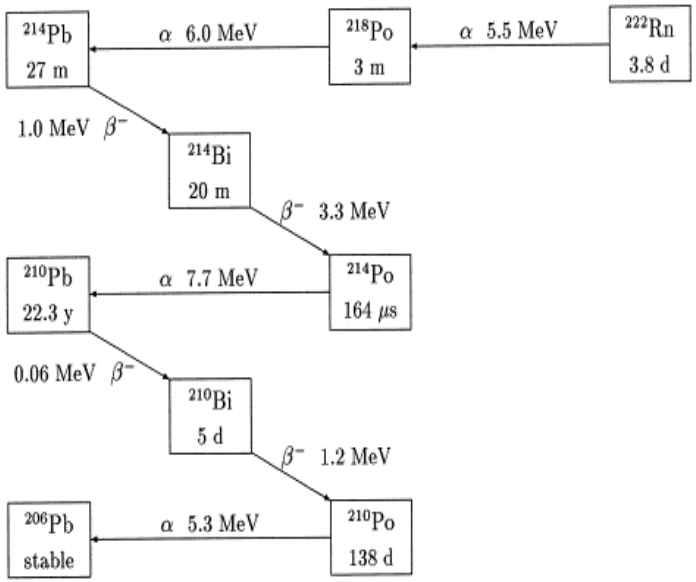
Pictures



Passive background reduction – ^{206}Pb recoils





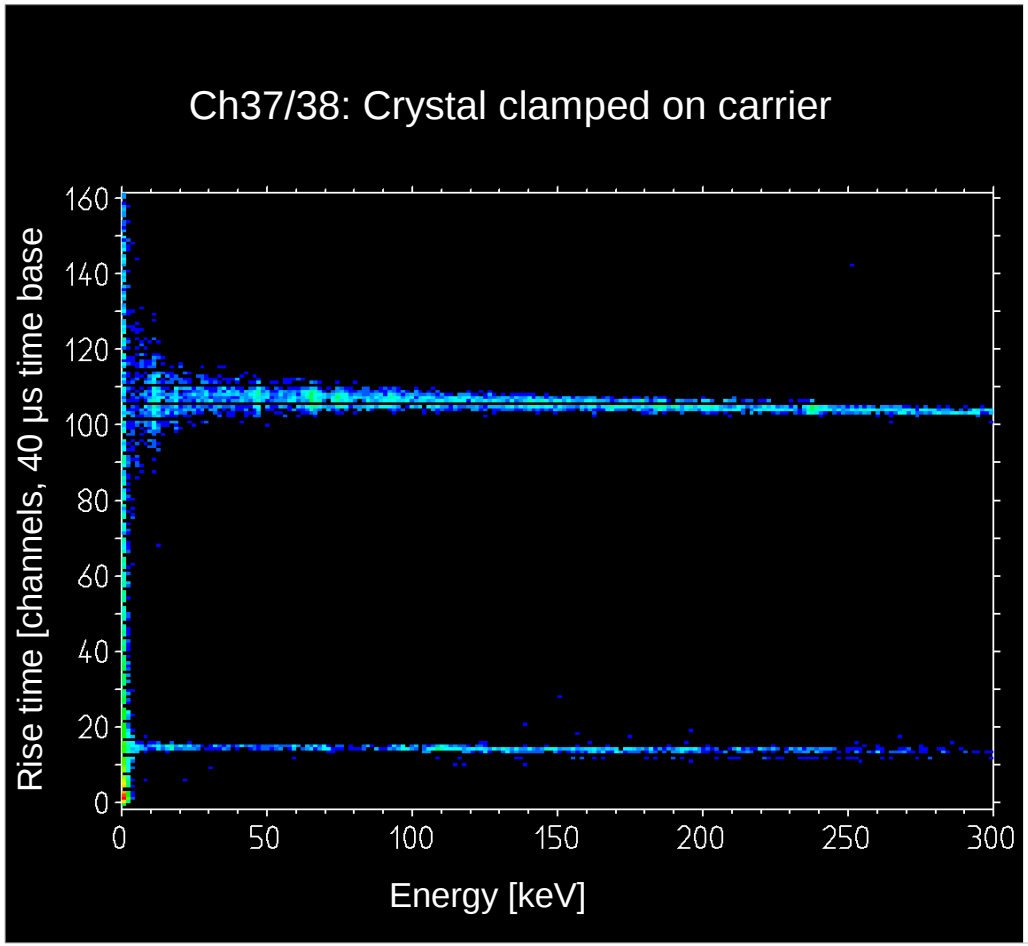


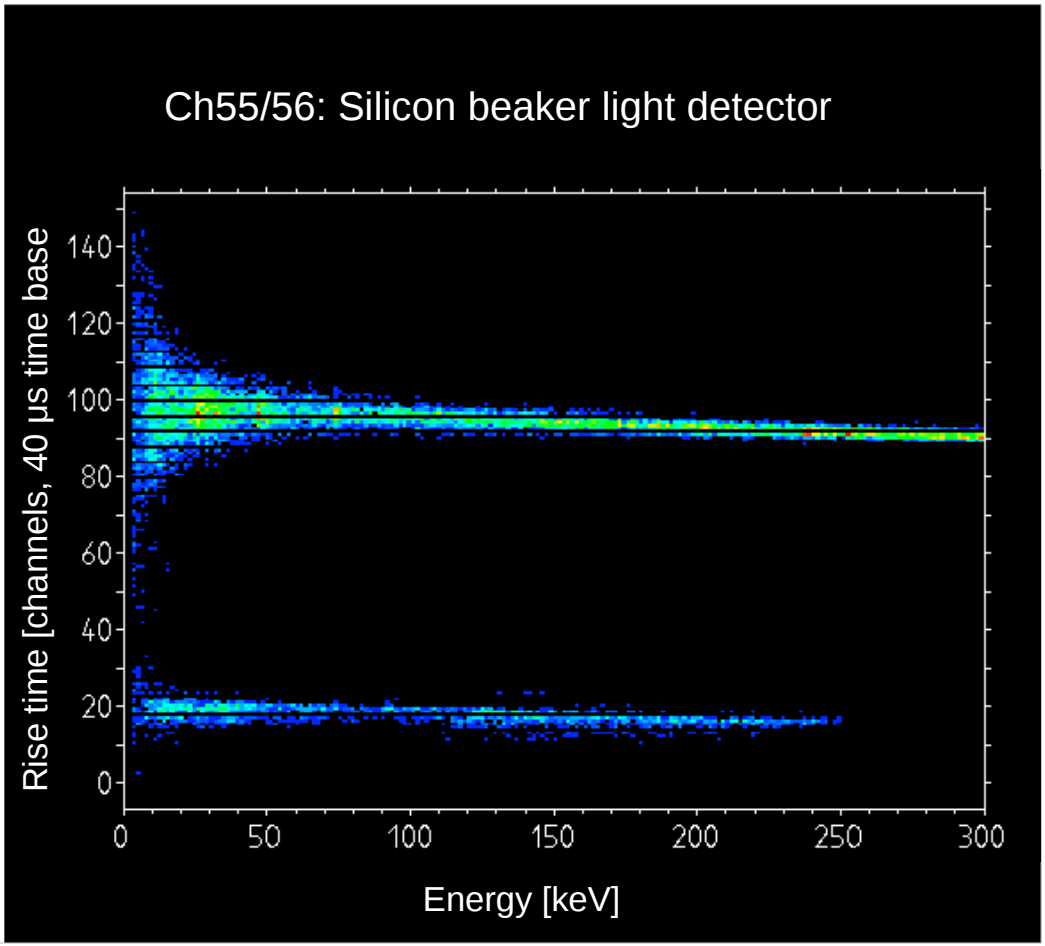
Rate in tail increases with half life of ^{210}Po (138 d)

- ^{210}Pb deposited at surface of clamps shortly before beginning of run
- most likely from exposure of clamps to radon in air

Carrier events discrimination

Simple rise time to pulse maximum efficiently distinguishes events in thermometer carrier



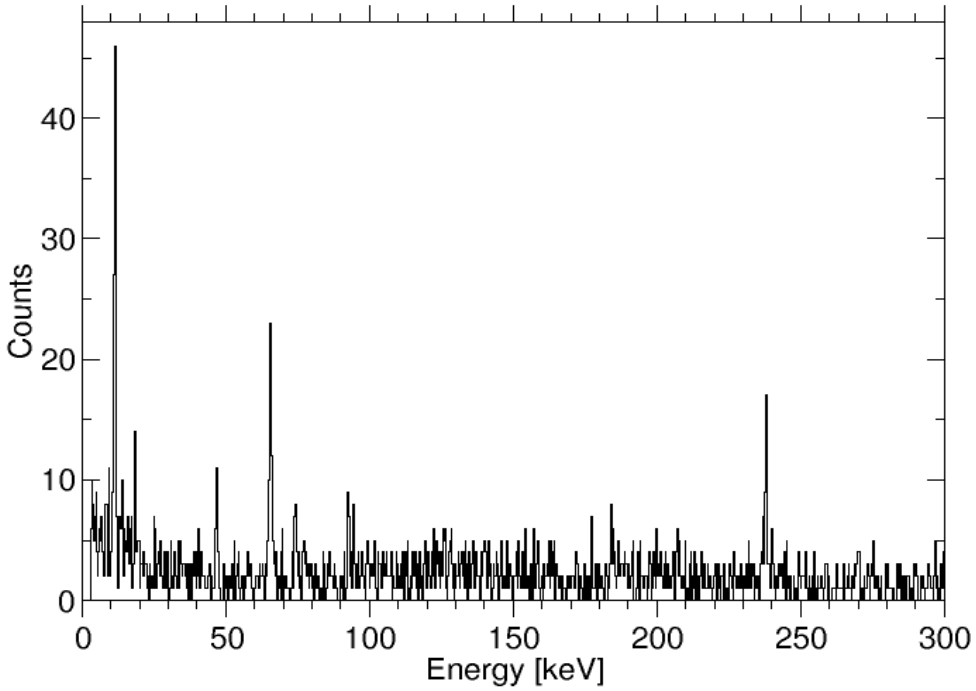


Identify possible stress-relaxation events from contact between Parylene coated clamps and carrier

Identify possible recoiling nuclei in the carrier crystal originating from the clamps

First glance at data – Radiopurity

Ch7/8: TUM40/Michael



Ch21/22: Verena/Q