TECHNISCHE UNIVERSITÄT DRESDEN

DRESDEN concept

CELLAR community meeting 2022

A new ultra low-level HPGe activity counting setup

in the Felsenkeller shallow-underground laboratory

Steffen Turkat

29.11.2022

On behalf of: D. Bemmerer, A. Boeltzig, A. Domula, J. Koch, T. Lossin, M. Osswald, K. Schmidt, **K. Zuber** and many more

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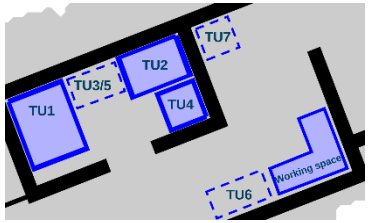
ChETEC INFRA

INSTITUTE OF NUCLEAR AND PARTICLE PHYSICS

HZDR HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

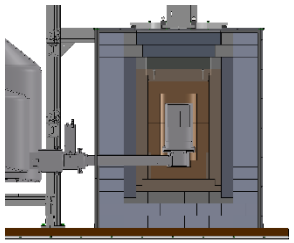
Konrad Adenauer Stiftung

Outline



The counting bunker at Felsenkeller

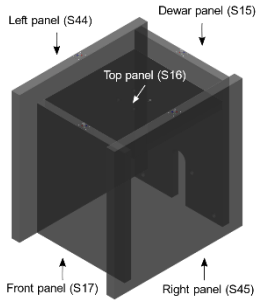
→ HPGe, SAGe Well, SDD, PIPS, LaBr, CeBr, GaGG, CsI, CZT, NaI…



Setup of the new TU1 detector

→ Appropriate passive shielding

→ Active muon veto



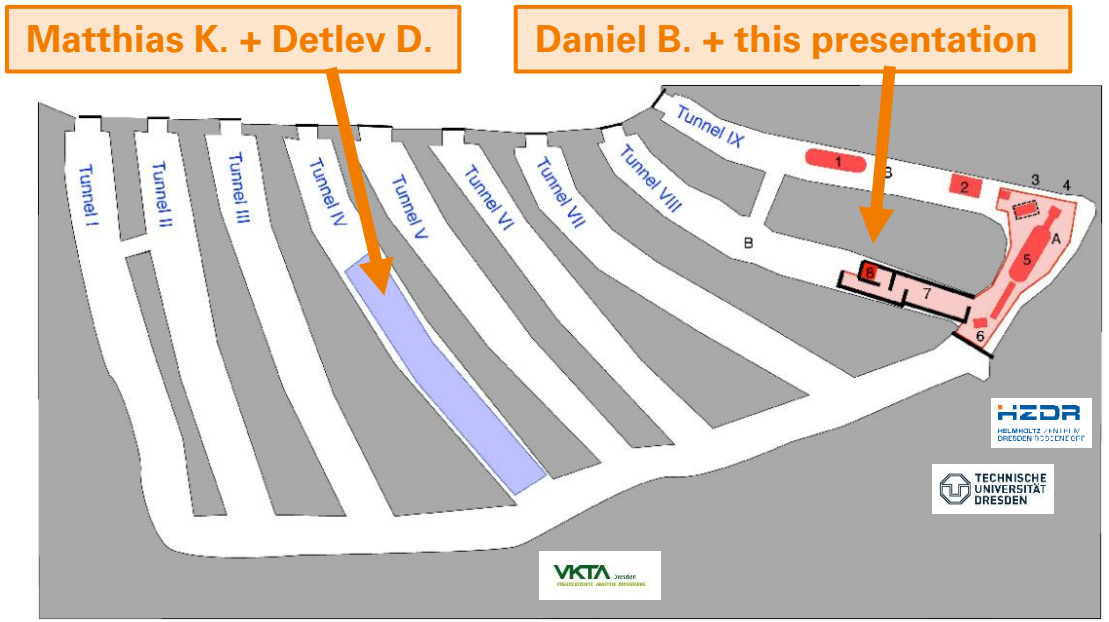
Fun with coincidences

→ How to veto muons in a shallow-underground lab

Felsenkeller shallow underground laboratory

- Located in Dresden/Germany
- 45 m rock overburden (140 m.w.e.)
- 40x less muons, 180x less neutrons, 70x less γ-rays

Source: https://stadtplan.dresden.de/



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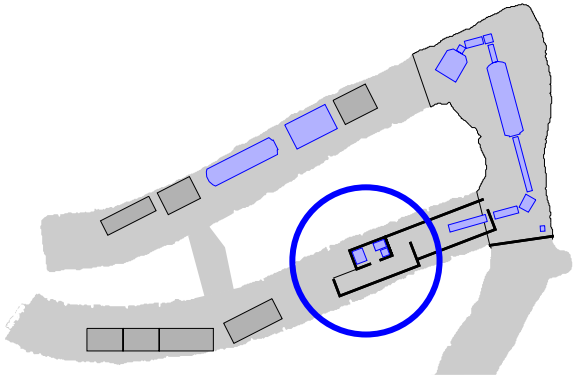

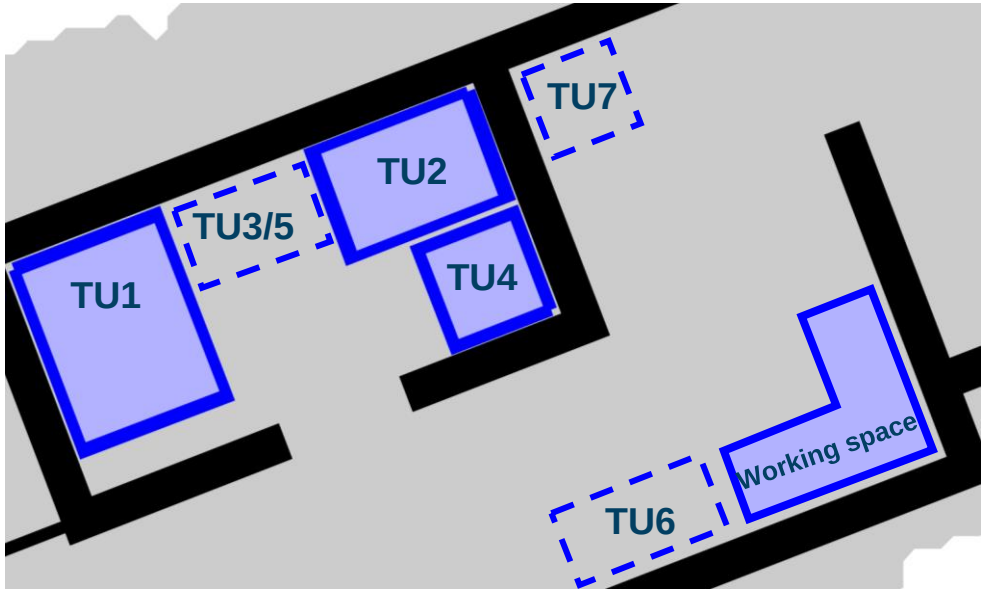

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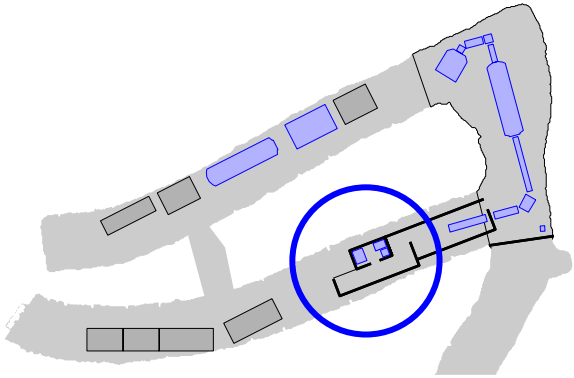

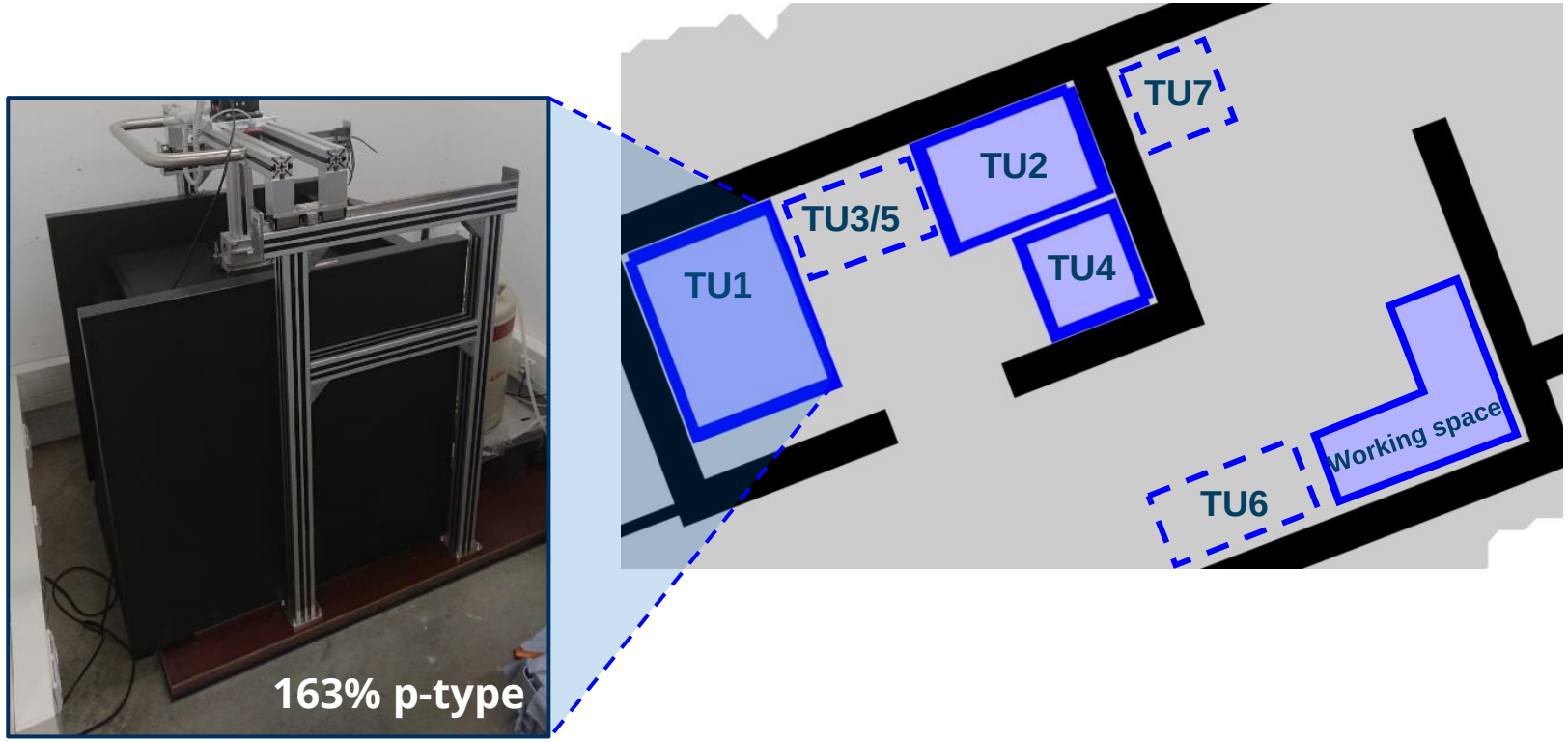

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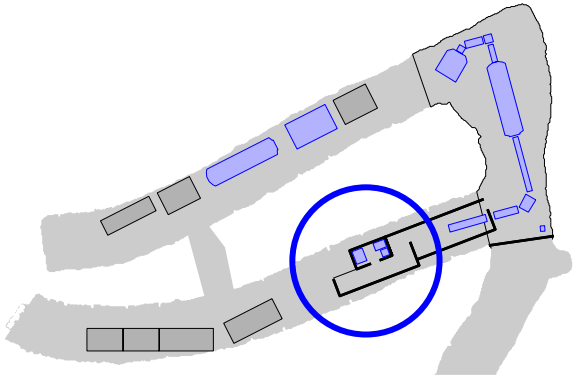

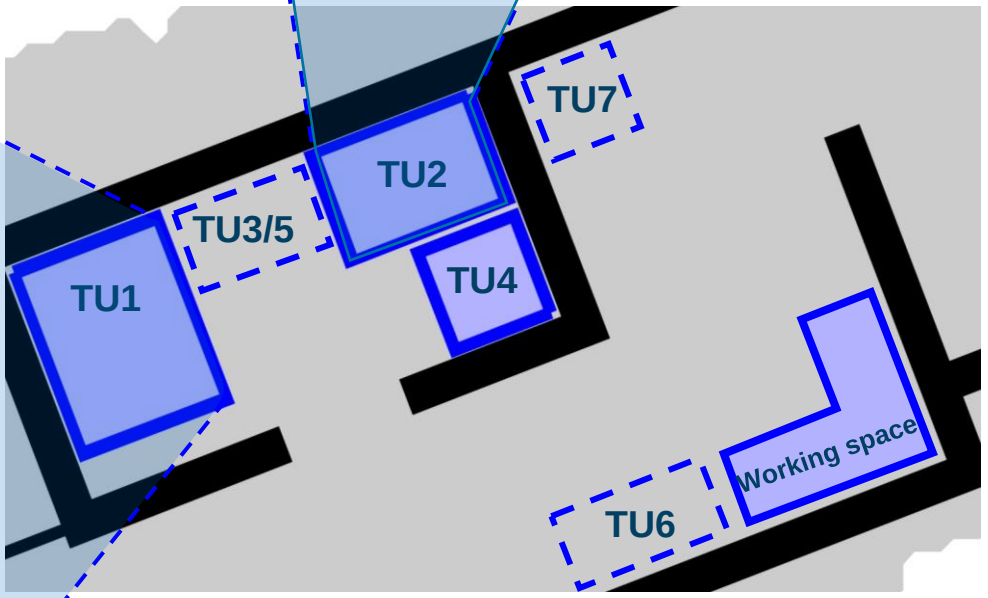

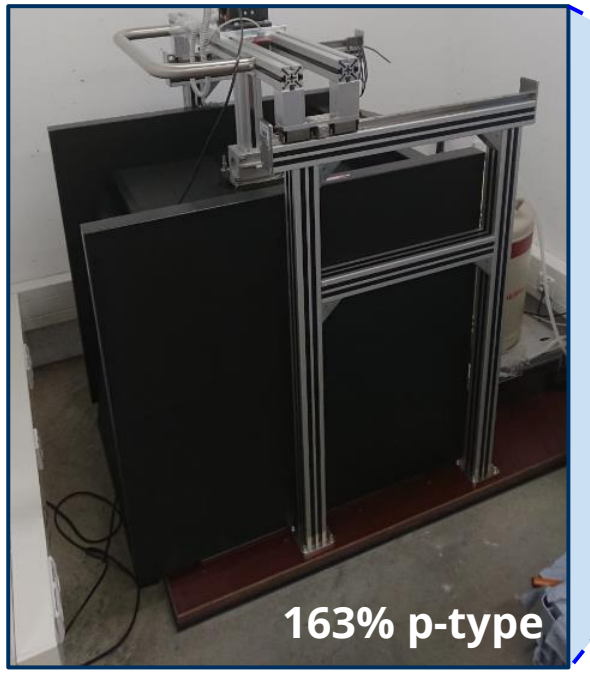

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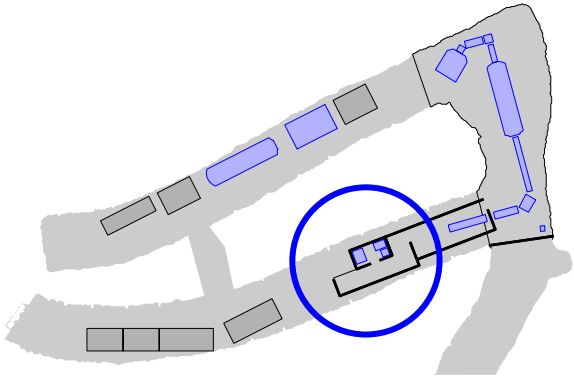
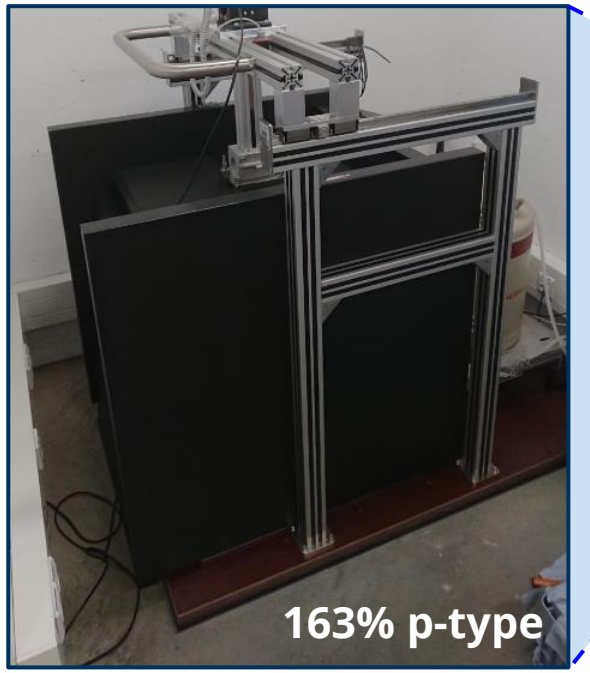
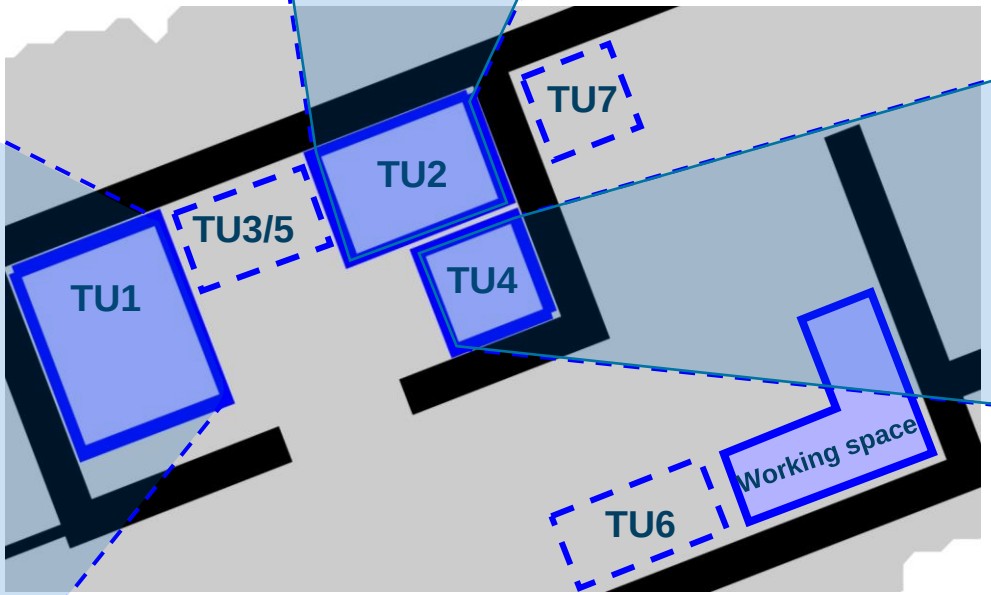
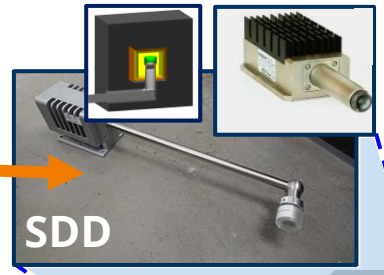


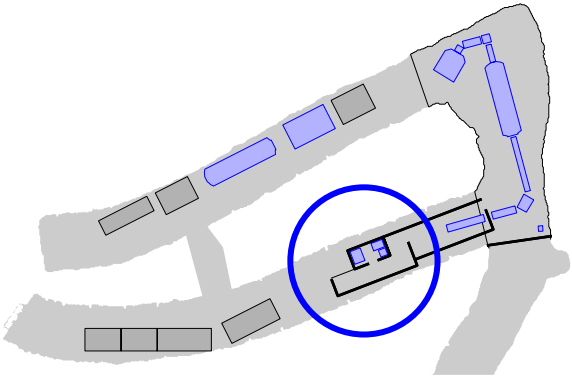


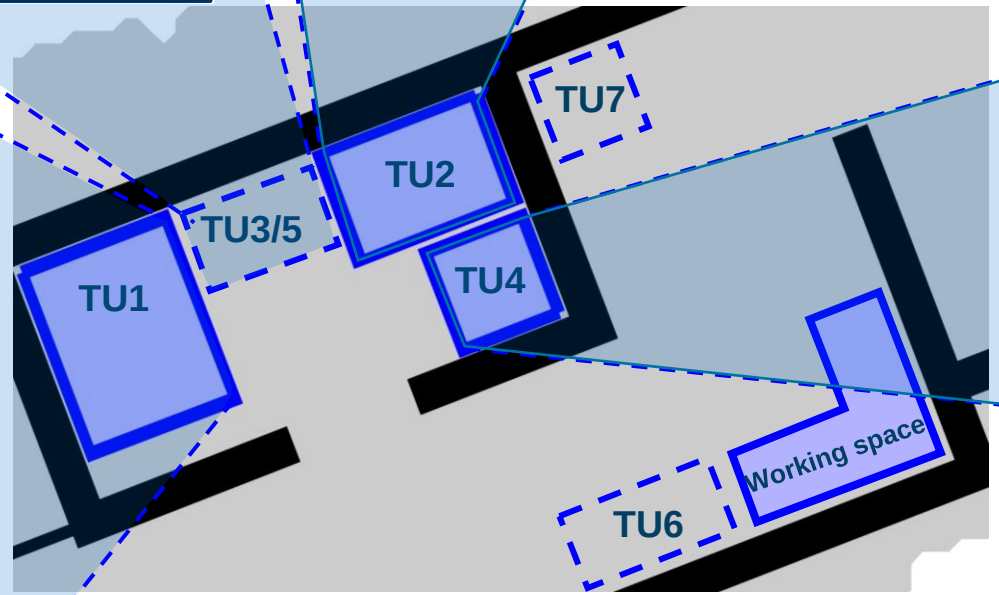


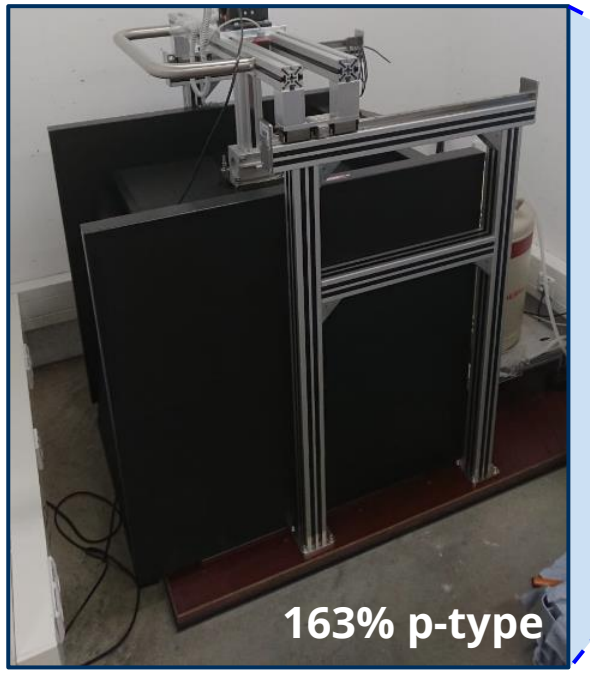
The counting bunker at FK

Low BG X-ray setup
Poster by C. Seibt









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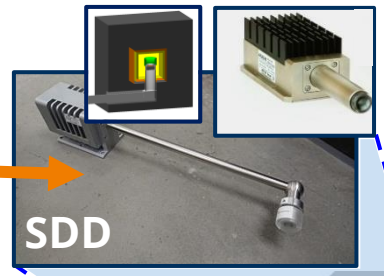

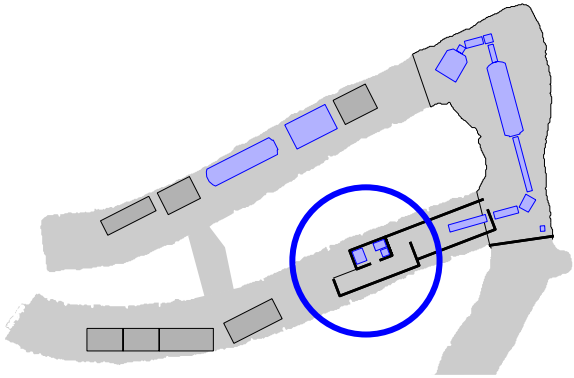

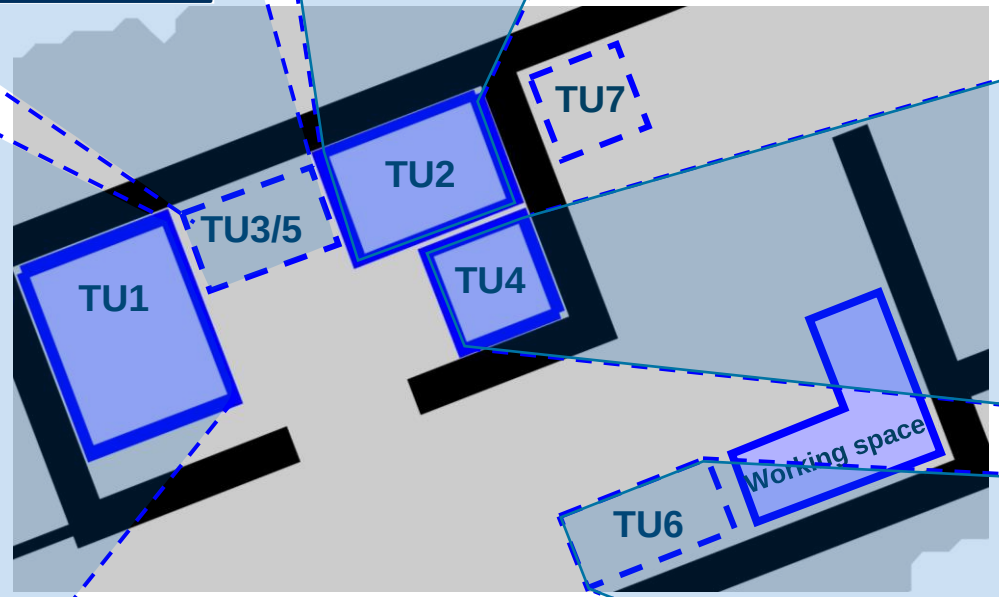

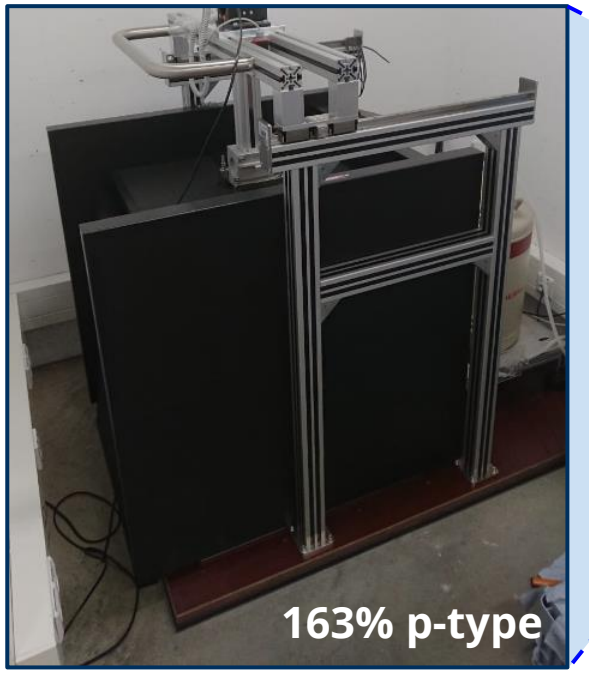

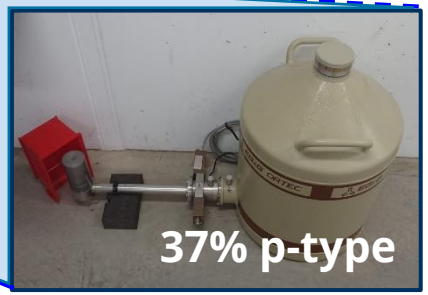

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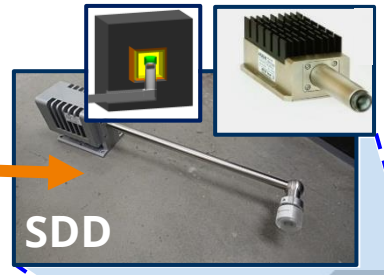
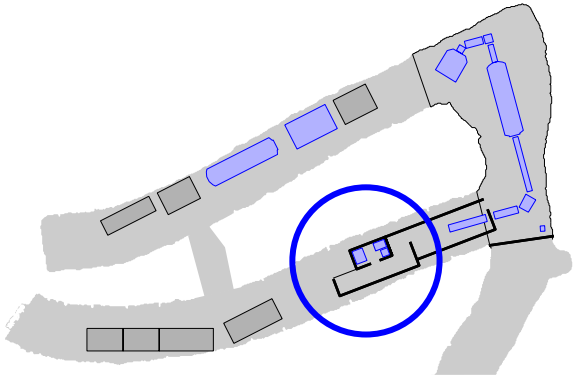
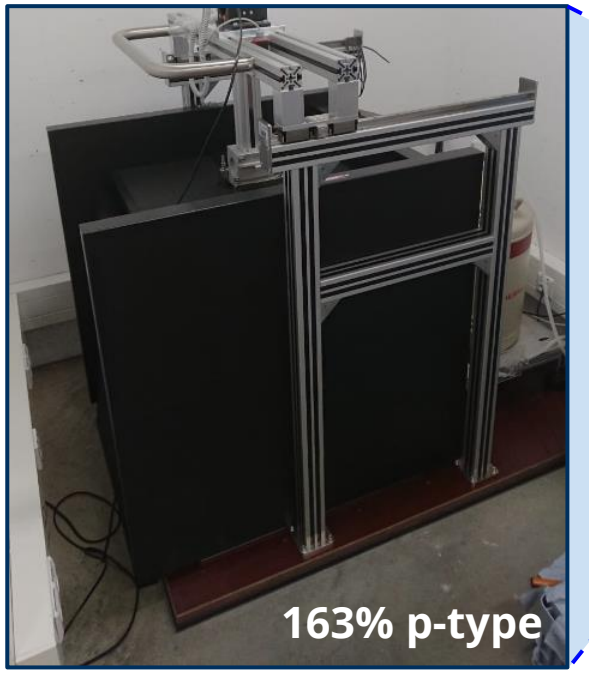
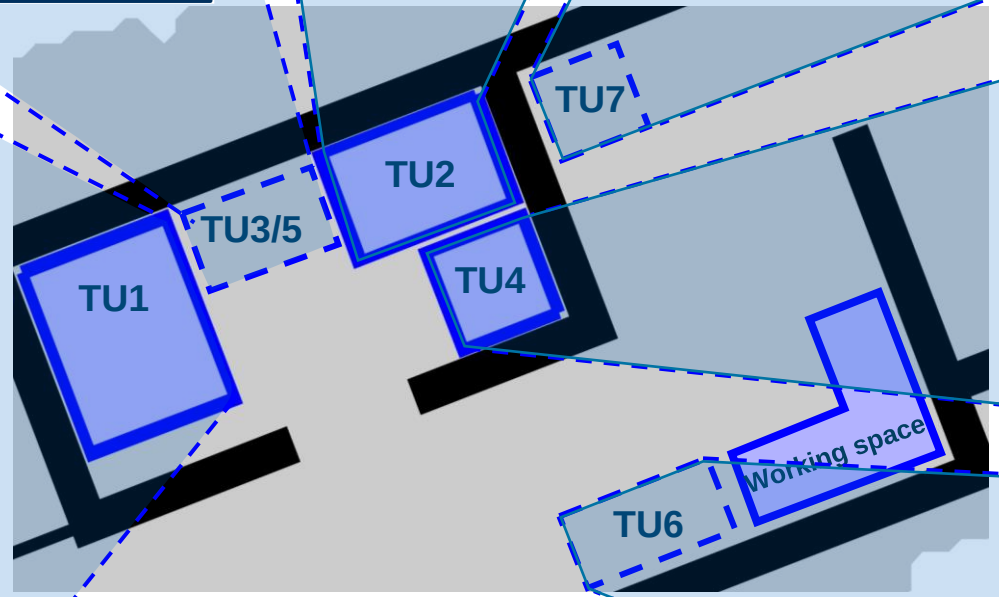
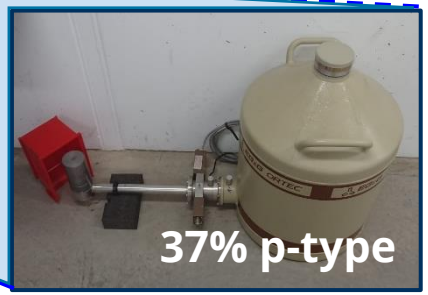






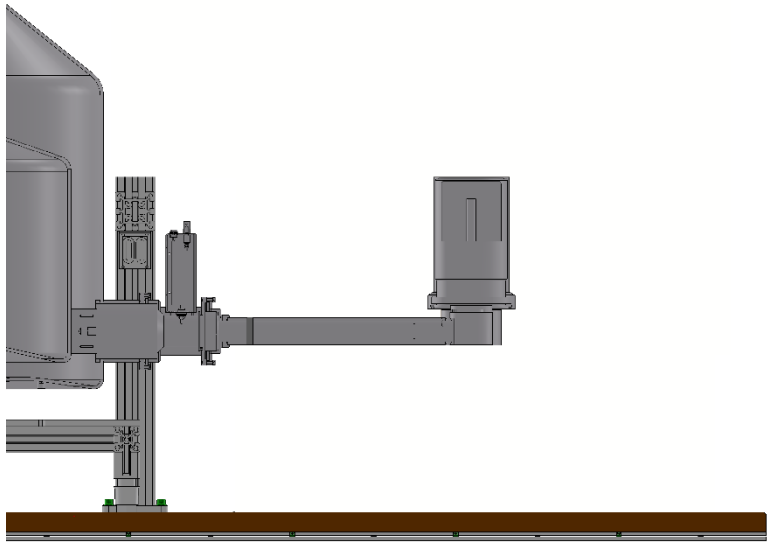




Passive shielding of TU1

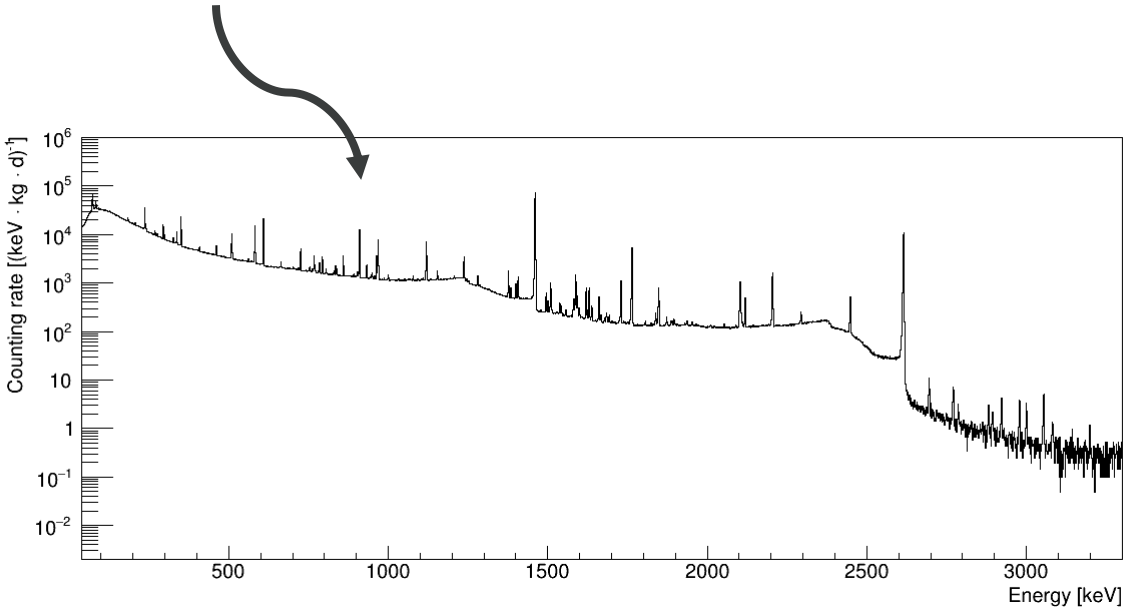
Some numbers for the TU1 detector

- Canberra GX 150-250-R (ULB)
- HPGe with 163% relative efficiency
- Diameter: 90 mm, Length: 90 mm



140 mwe. rock overburden

+ 40 cm concrete
(low activity)



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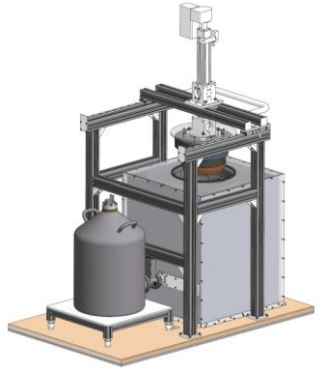

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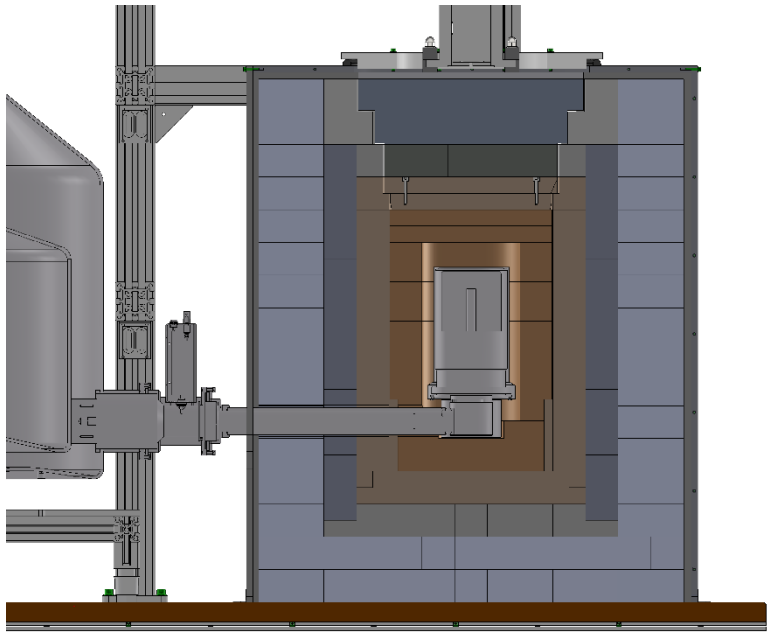
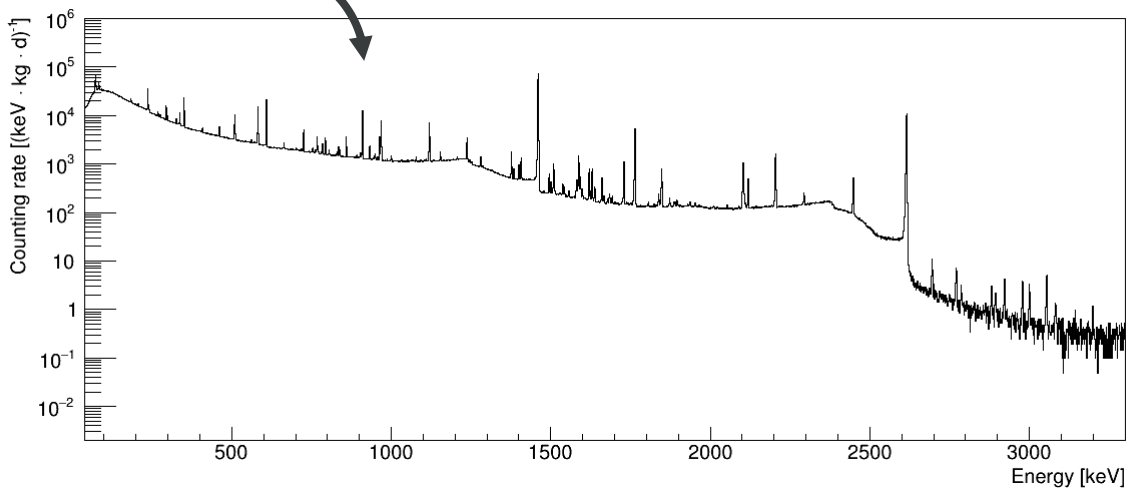
+ Anti radon box

+10 cm Pb
(21Bq/kg)

+5 cm Pb
(2.5Bq/kg)

+10 cm OFRP Cu





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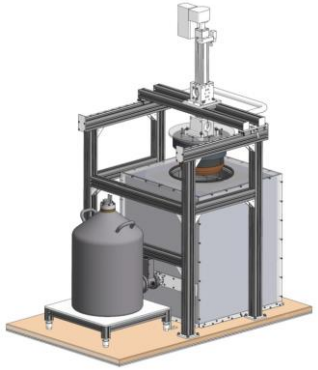

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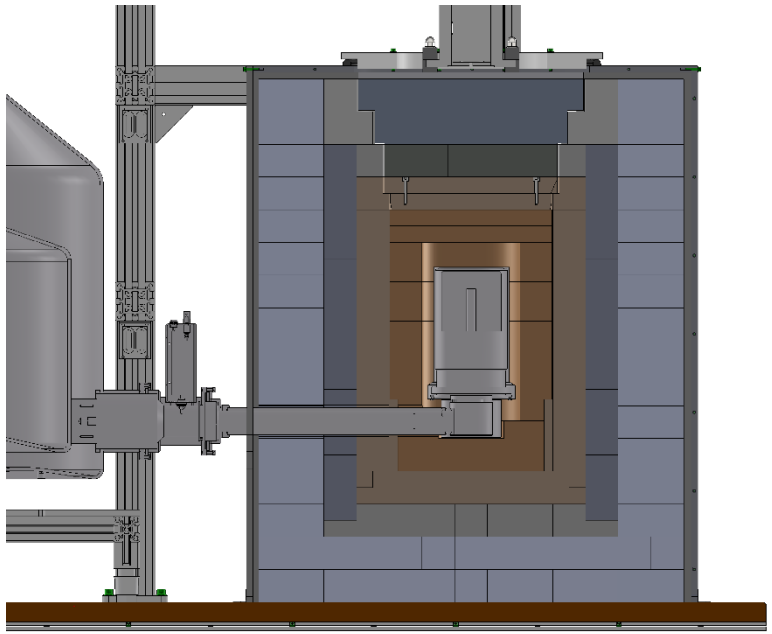

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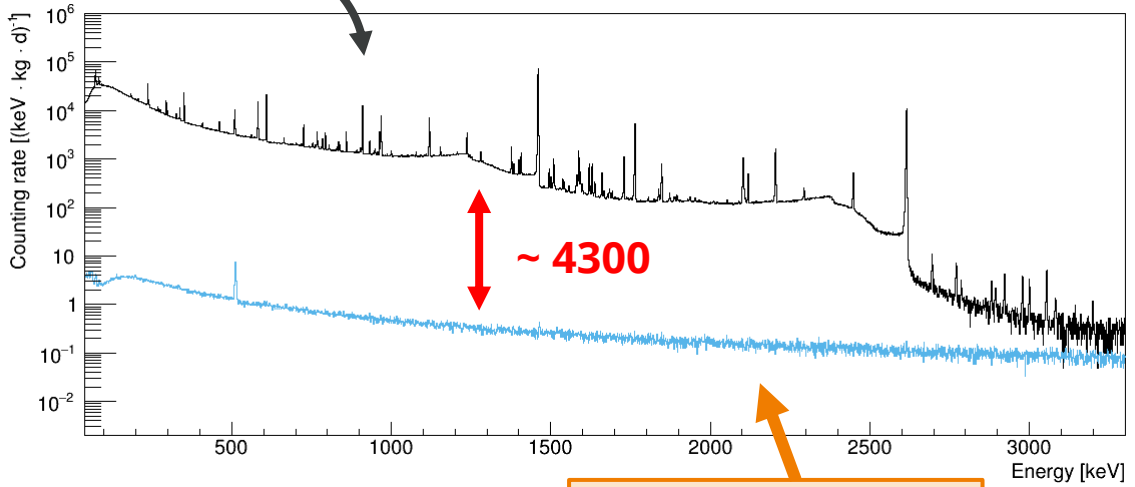
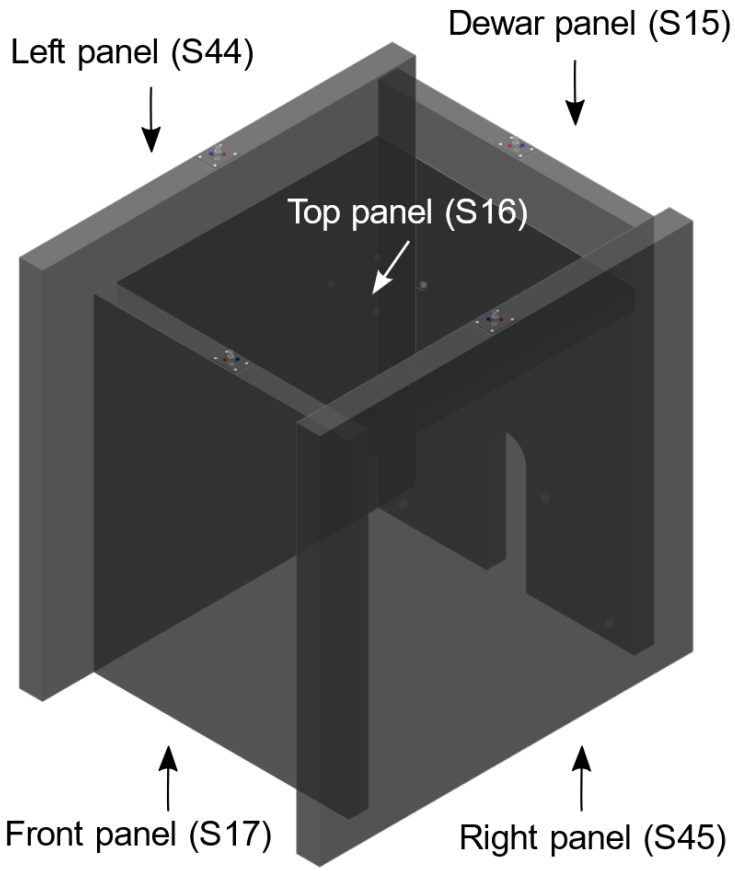


Cf. e.g. Alexandru G.

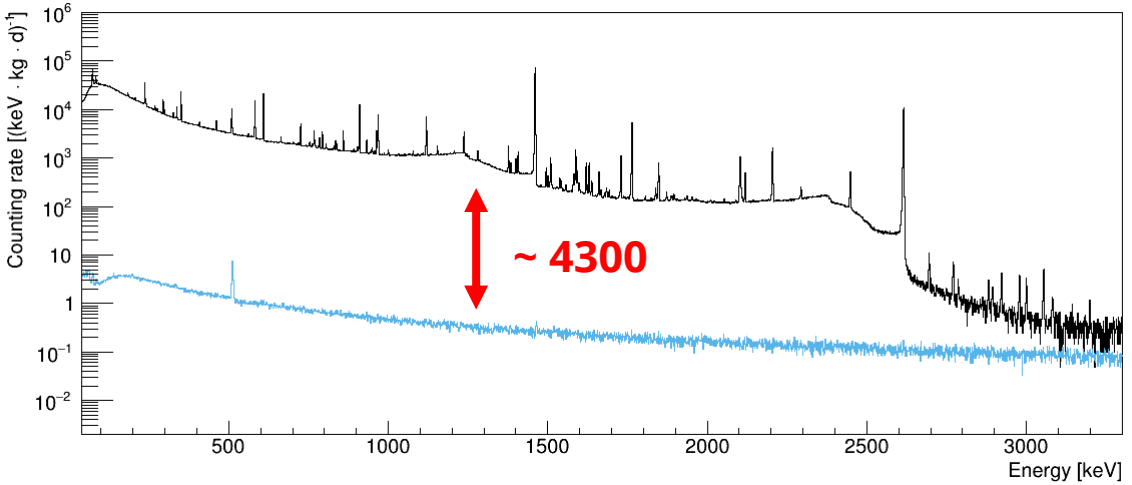
Active shielding of TU1

GIOVE, DLB, GeMSE…



Setup of the active shielding

- Five scintillation panels
- Surrounding the passive shield
- **DAQ**: Digitizer with list mode
  - Veto the muon-induced events
  - Make nice physics **with** coincidences



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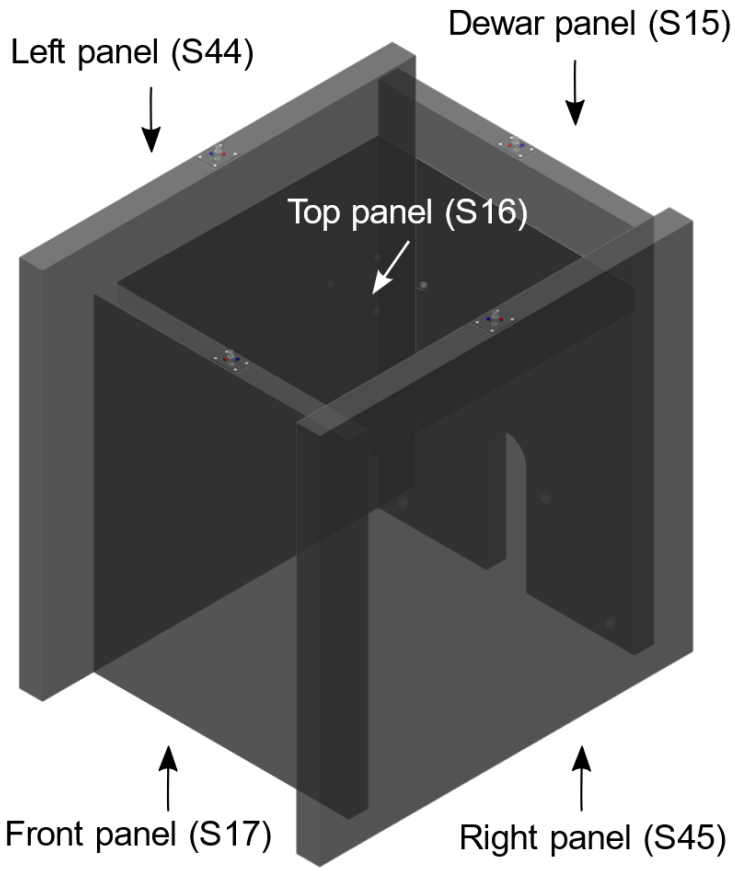
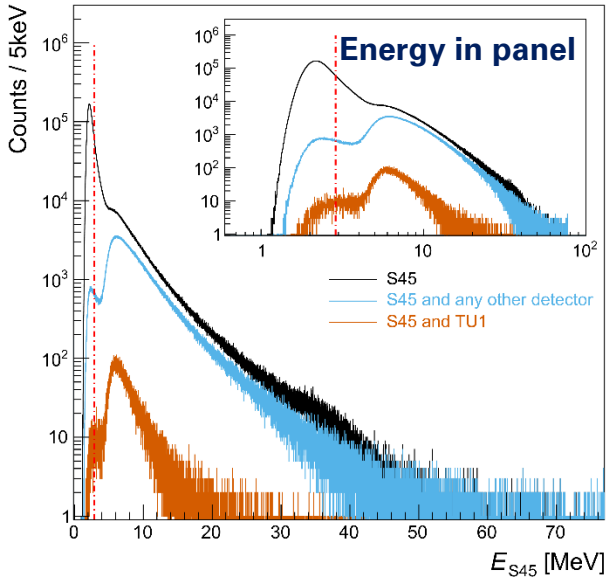
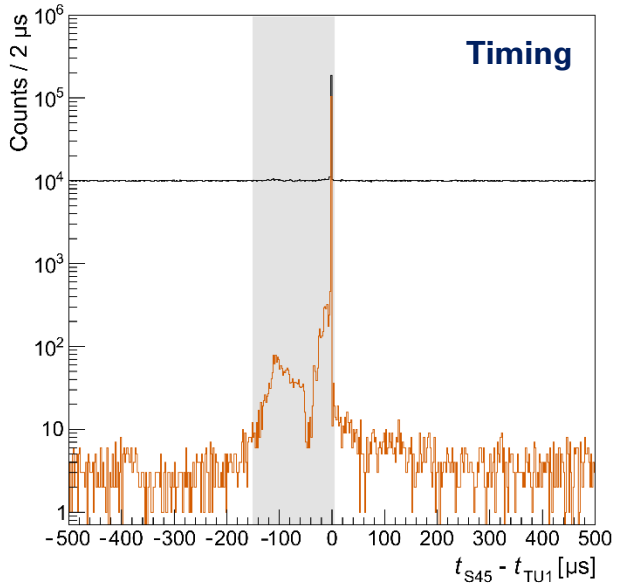
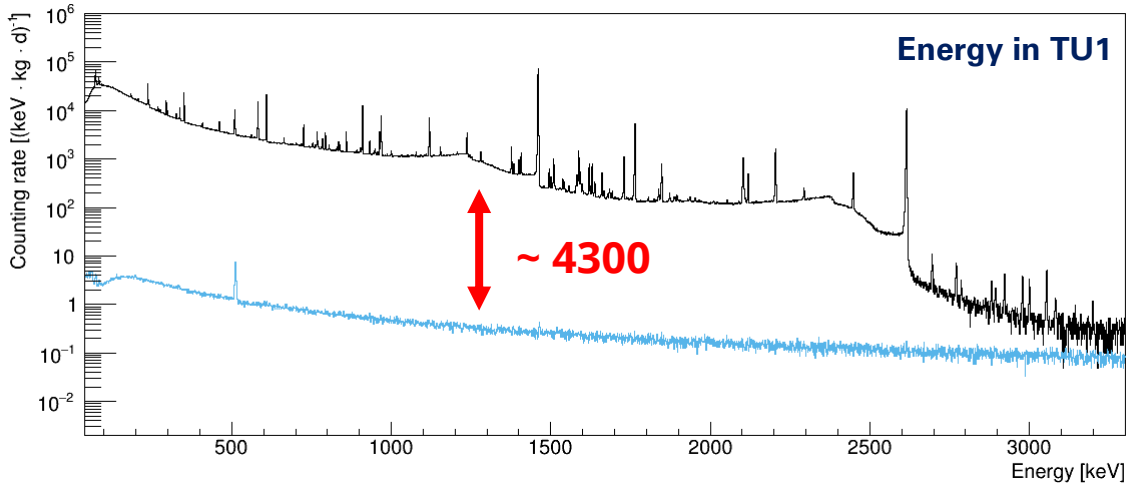
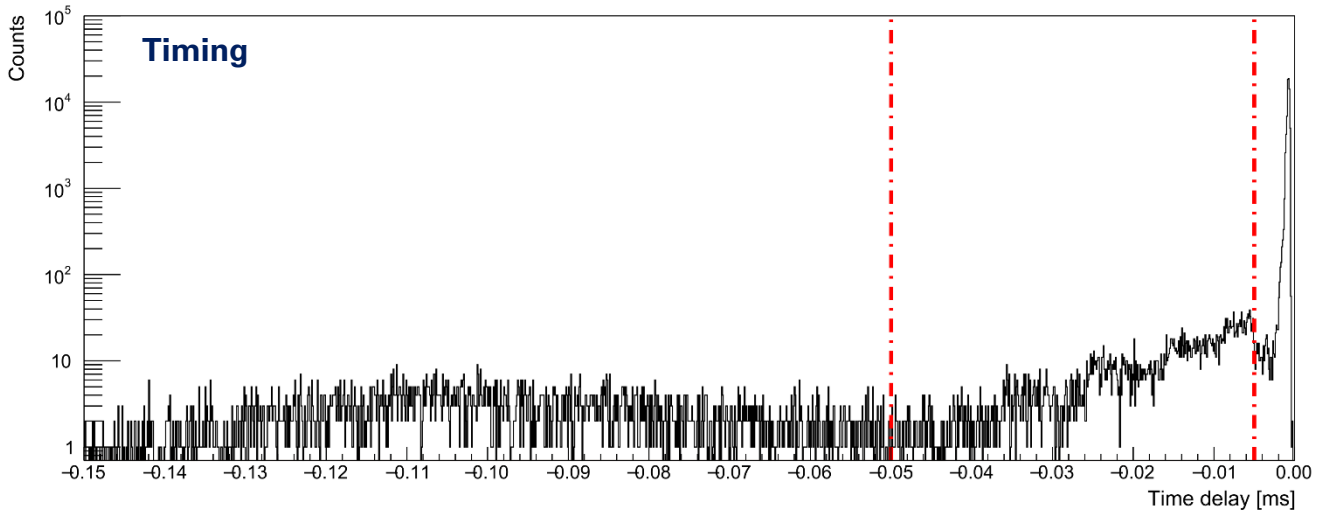


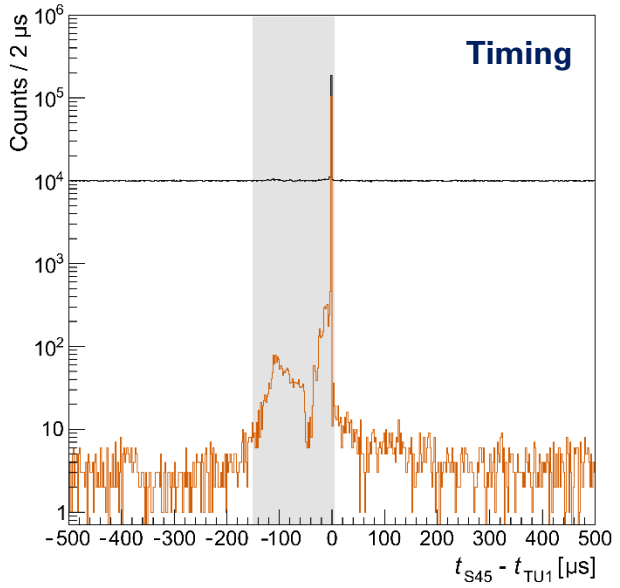


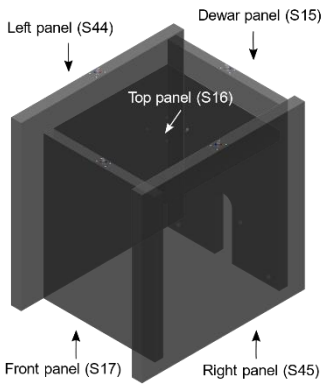




Delayed coincidences







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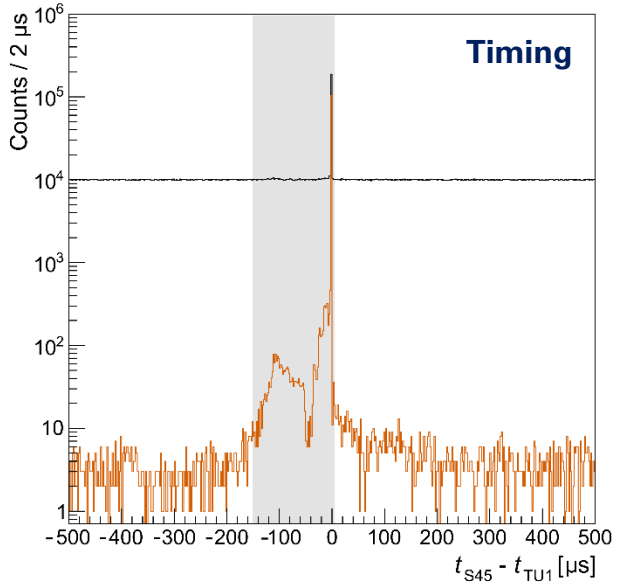
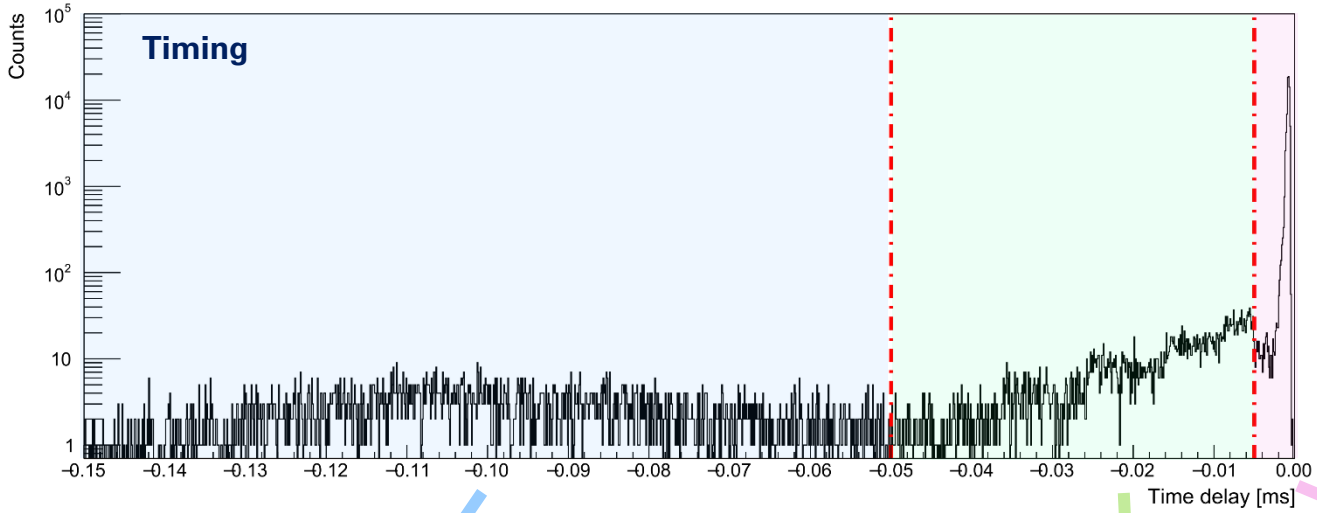
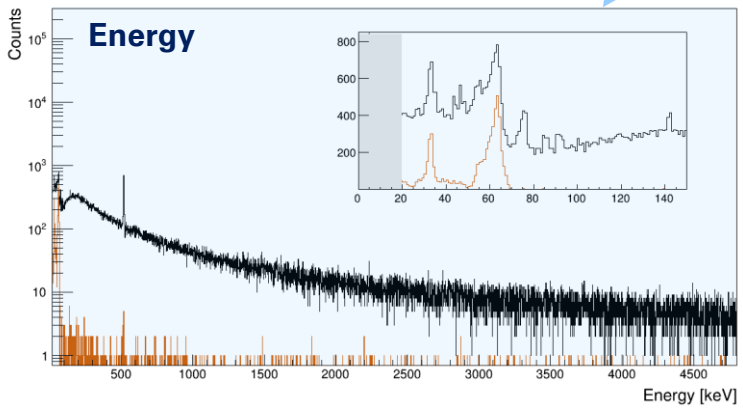
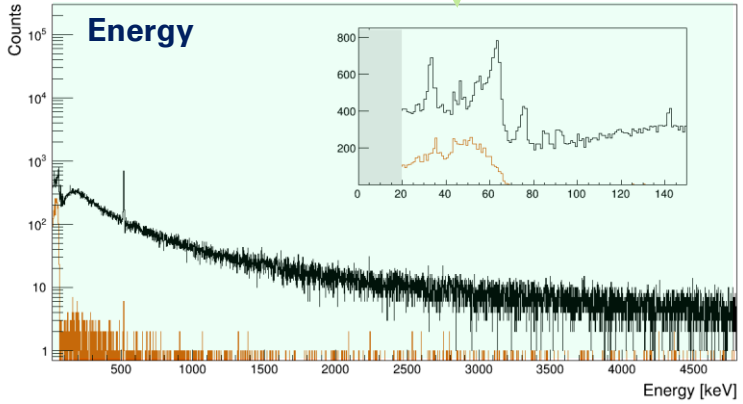
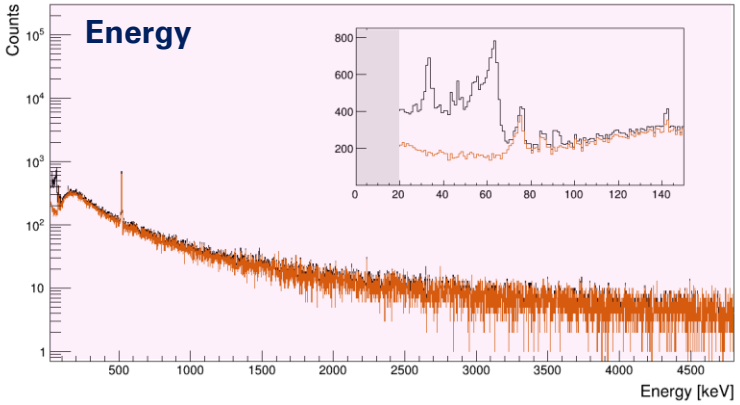


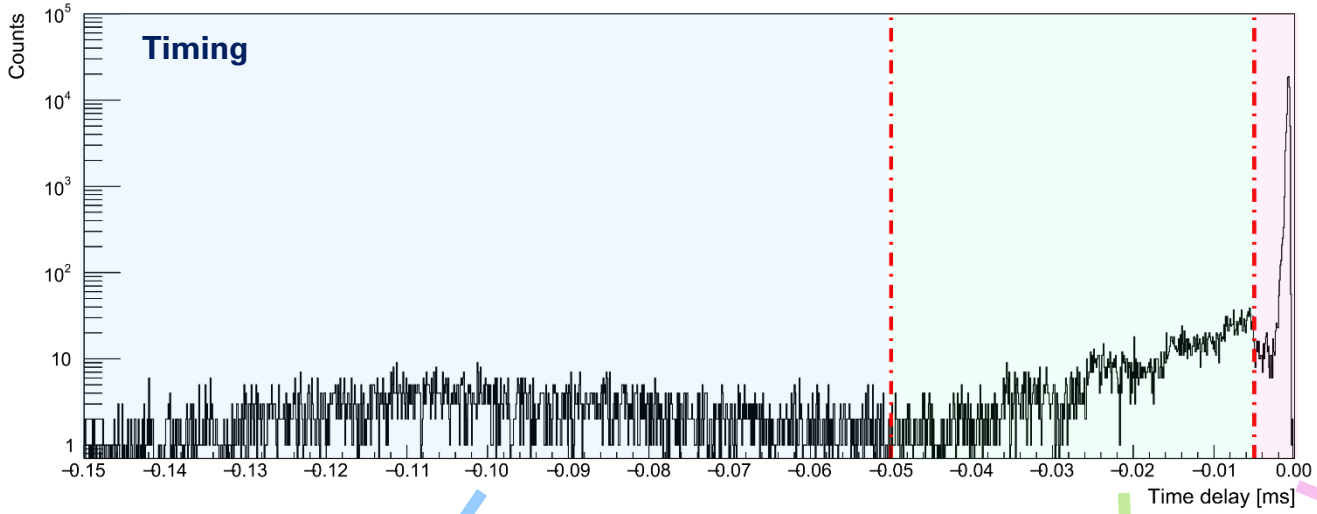


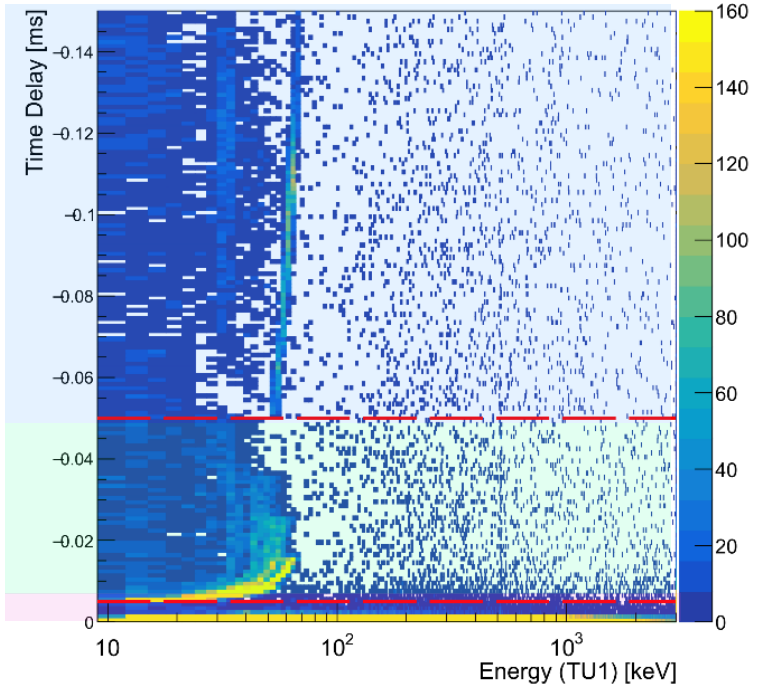


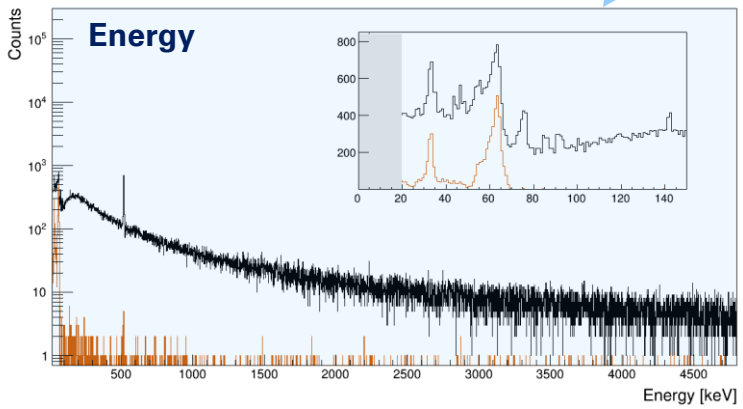


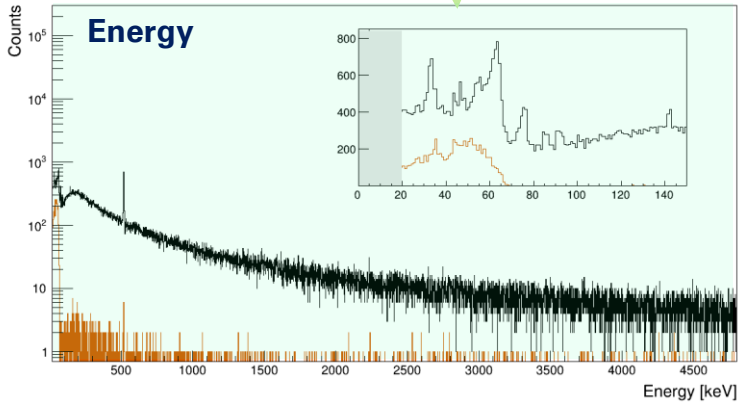


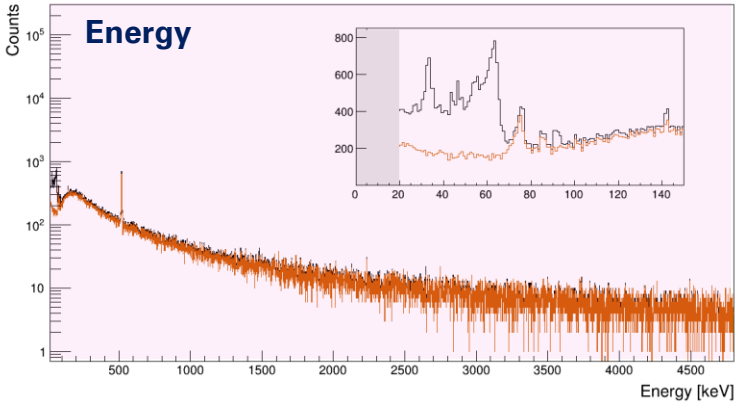
Delayed coincidences







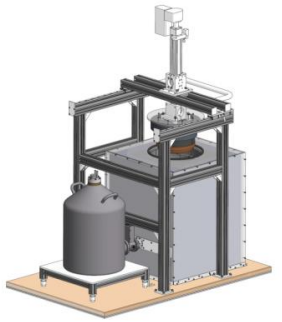


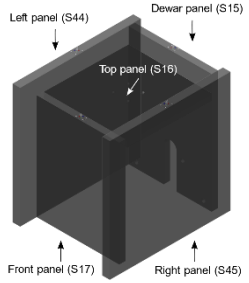


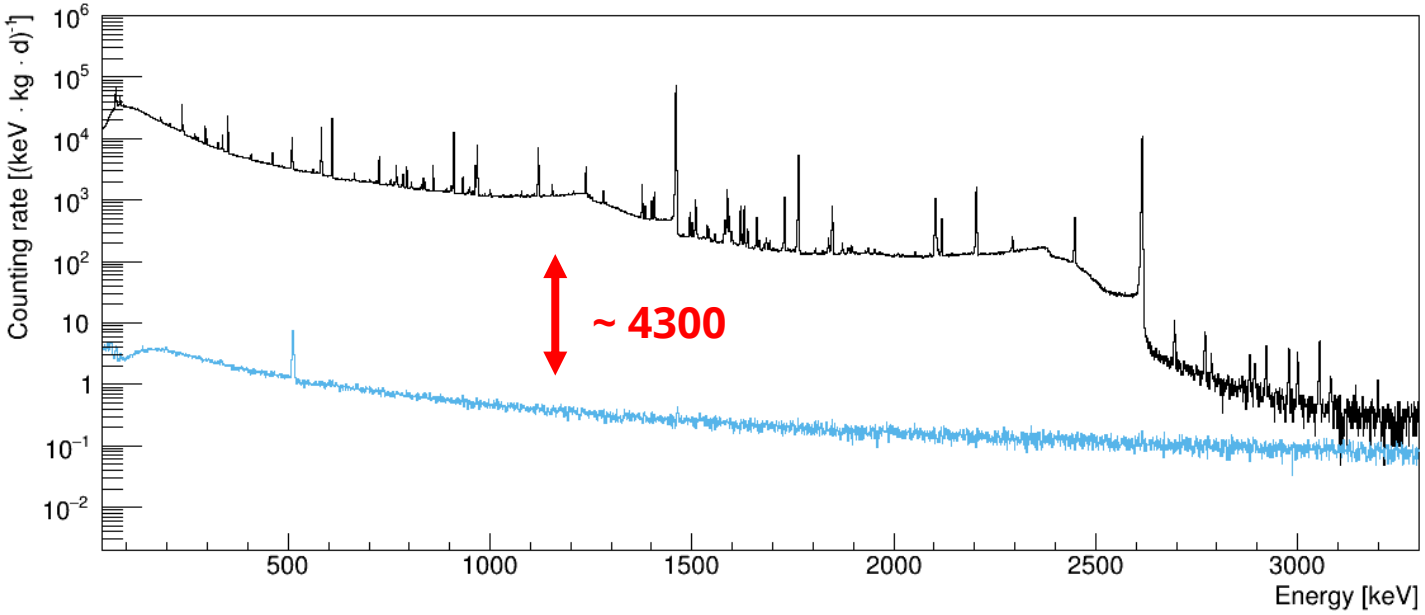
Applying the active veto on TU1

Integrated counting rate [40keV;2700keV]

- **Passive:** $R = 1982(3)\,kg^{-1}d^{-1}$







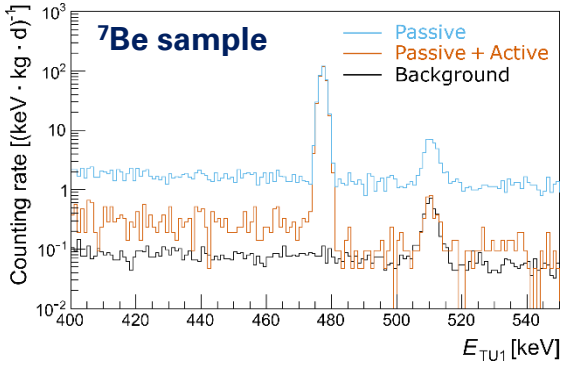
Applying the active veto on TU1

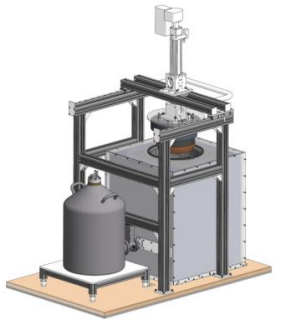
Integrated counting rate [40keV;2700keV]

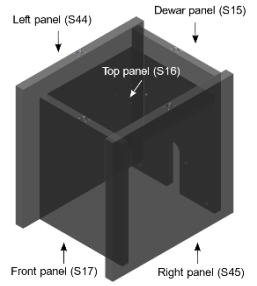
- **Passive:** $R = 1982(3)\,kg^{-1}d^{-1}$
- **Passive & active:** $R = 116(1)\,kg^{-1}d^{-1}$

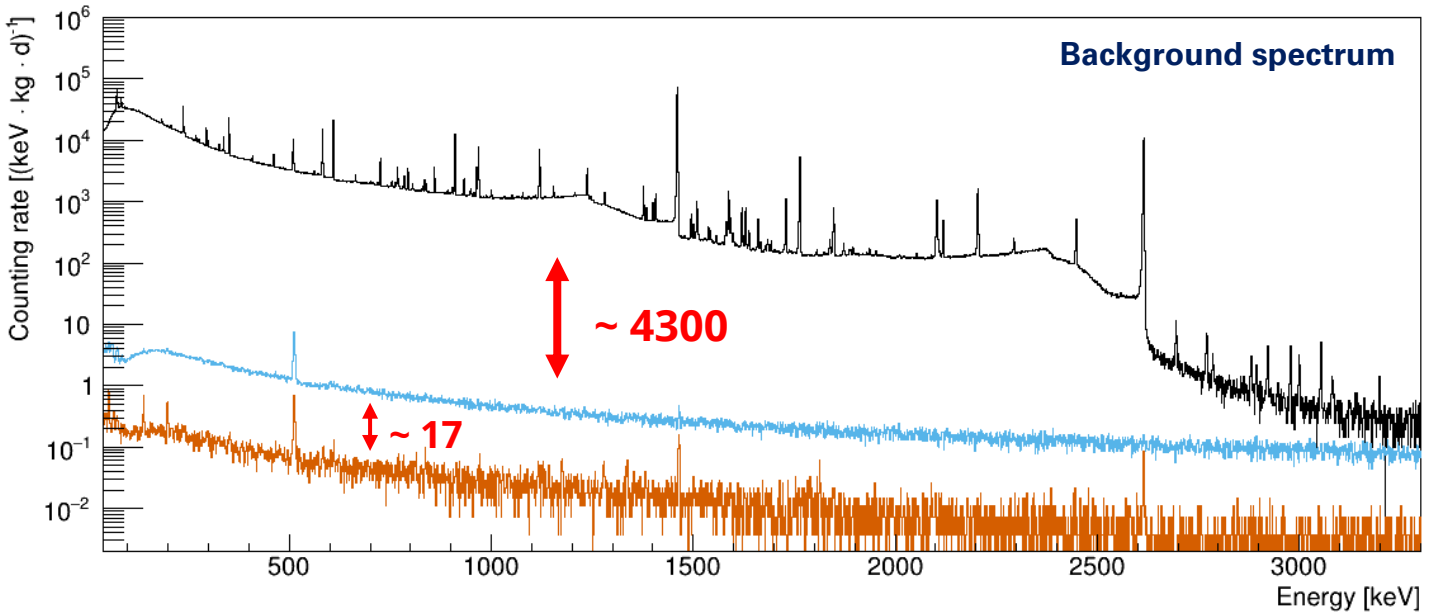
Veto efficiency of the active veto

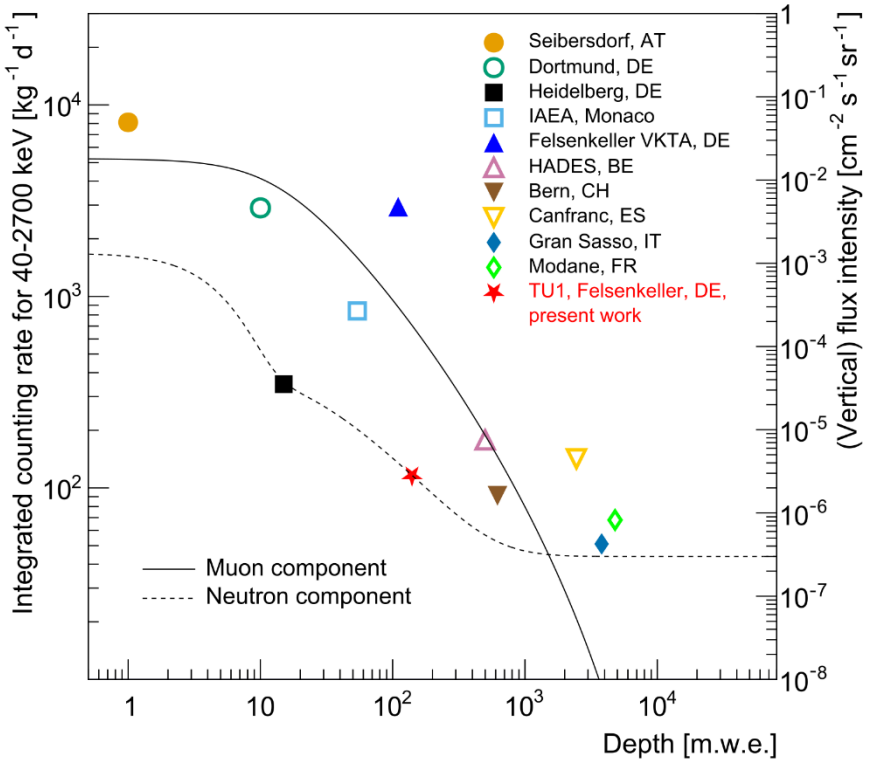
- Efficiency: 99.52(19) %











Remaining TU1 spectrum

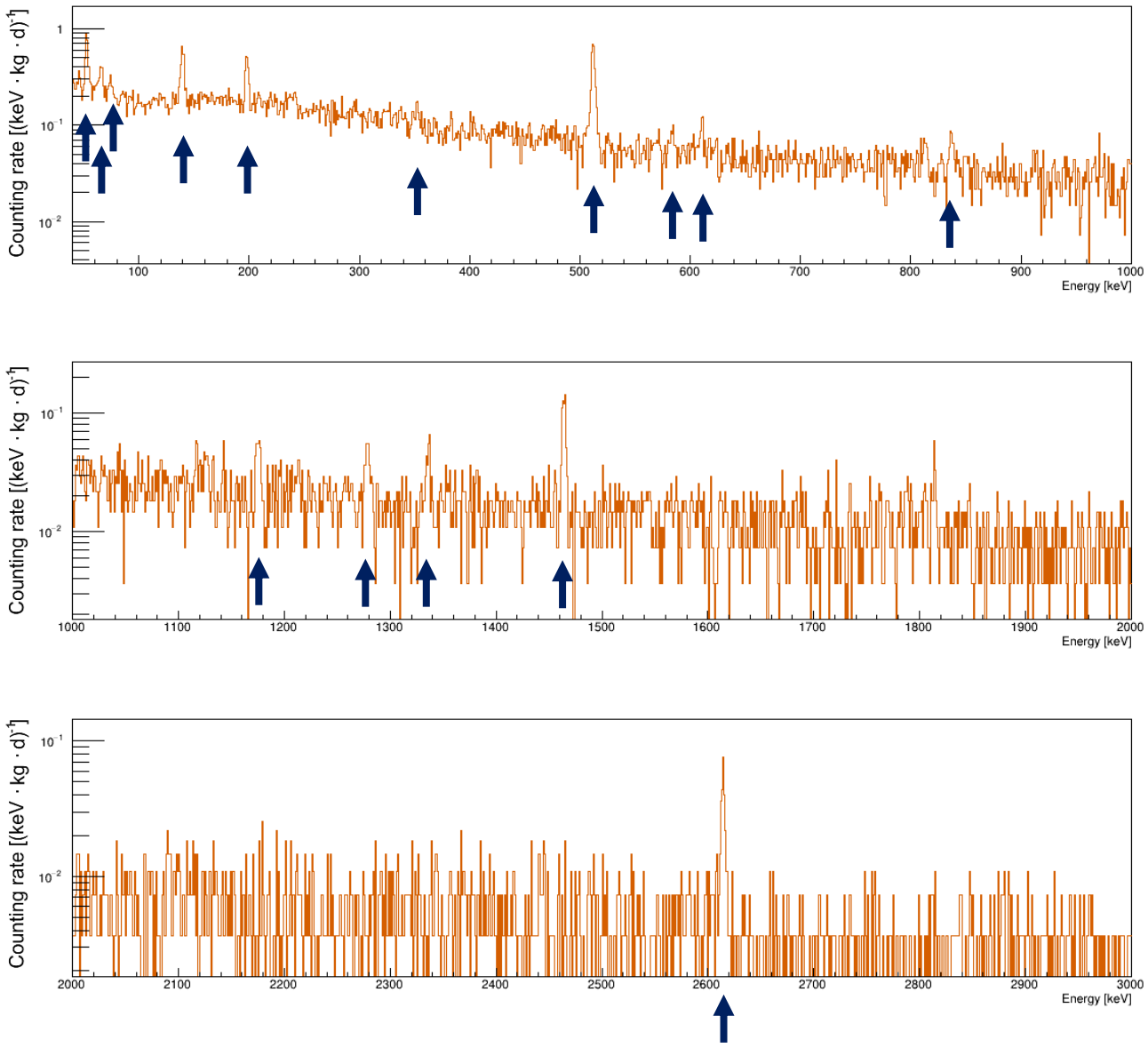
Integrated counting rate [40keV;2700keV]

- **Passive:** R = 1982(3) $kg^{-1}d^{-1}$
- **Passive & active:** R = 116(1) $kg^{-1}d^{-1}$

Veto efficiency of the active veto

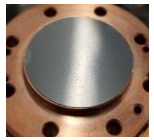
- Efficiency: 99.52(19) %

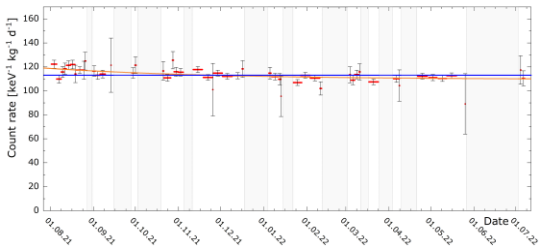
Energy [keV]	Nuclide	Origin	Rate [$kg^{-1}d^{-1}$]
52.0-55.6	^{73m}Ge	^{72}Ge(n,γ), ^{74}Ge$(n,2n)$	1.28(19)
63.9-66.7	^{73m}Ge	^{72}Ge(n,γ), ^{74}Ge$(n,2n)$	0.38(17)
72.8-75.0	Pb X	Lead K_α & K_β X-rays	0.33(12)
139.7	^{75m}Ge	^{74}Ge(n,γ), ^{76}Ge$(n,2n)$	1.34(16)
198.4	^{71m}Ge	^{70}Ge(n,γ), ^{72}Ge$(n,2n)$	1.00(15)
351.9	^{214}Pb	^{238}U decay chain	0.29(11)
511	e^+e^-	Annihilation	2.64(13)
583.2	^{208}Tl	^{232}Th decay chain	0.14(8)
609.3	^{214}Bi	^{238}U decay chain	0.21(8)
834.8	^{54}Mn	^{54}Fe$(n,p)^{54}$Mn	0.17(7)
1173.2	^{60}Co	^{63}Cu$(n,\alpha)^{60}$Co	0.18(5)
1274.5	^{22}Na	Lab-specific nuclide	0.20(5)
1332.5	^{60}Co	^{63}Cu$(n,\alpha)^{60}$Co	0.16(5)
1460.8	^{40}K	Natural radioactivity	0.49(6)
2614.5	^{208}Tl	^{232}Th decay chain	0.22(4)

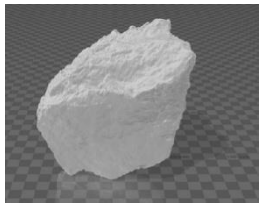


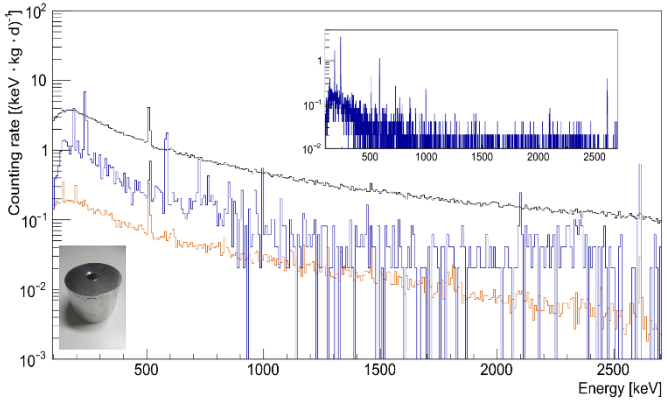
Impression of the beauty of TU1

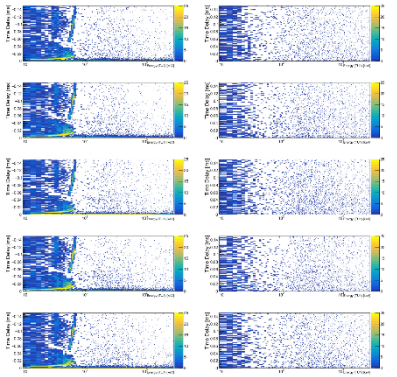
Michèle H. & Daniel B.

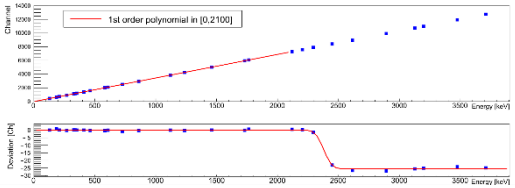


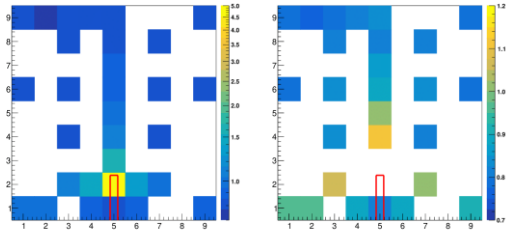


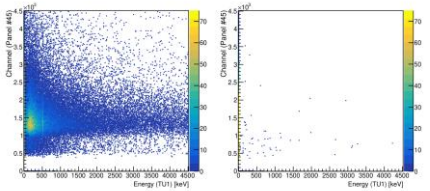


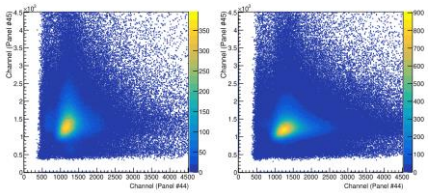


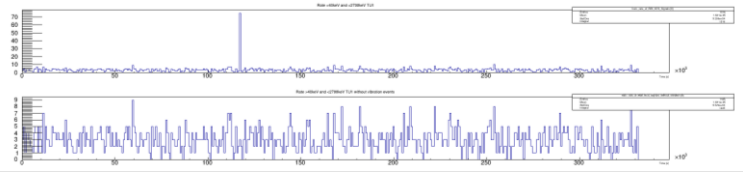


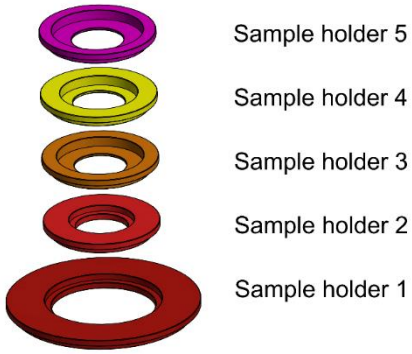












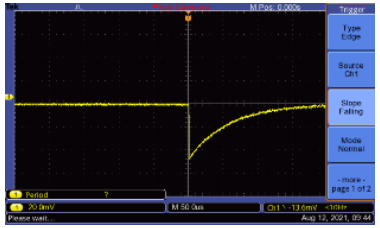
Sample holder 5

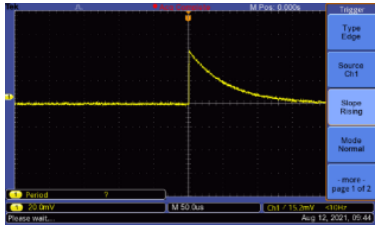
Sample holder 4

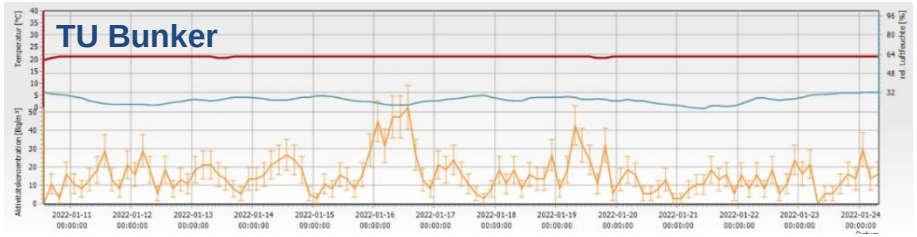
Sample holder 3

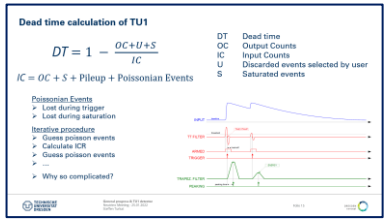
Sample holder 2

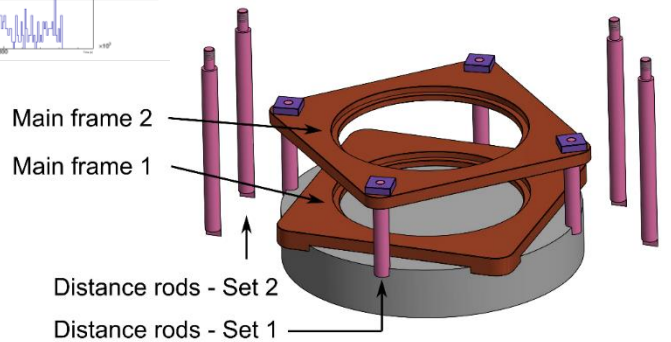
Sample holder 1



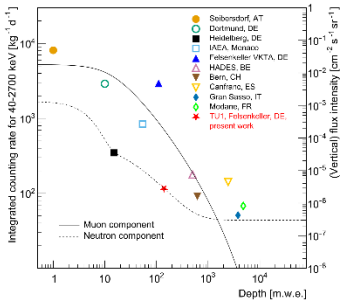






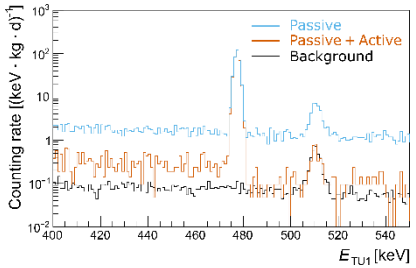


Summary & Outlook



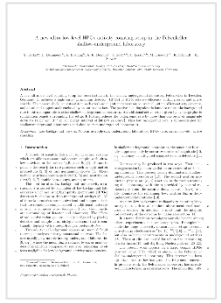
The new TU1 detector

→ Unprecedented counting rates for non-deep underground labs



Active Veto

→ The power of offline optimization



Outlook

→ **Upcoming publication in *Astroparticle Physics***

→ TU1 is also highly interested in non-Dresden samples!!