Studies of surface and bulk ^{210}Po in metals

K. Pelczar, M. Wójcik, G. Zuzel

Institute of Physics Jagiellonian University, Cracow, Poland

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Outline

- Motivation
- Apparatus
- Surface and bulk ^{210}Po in metals and in Teflon
- Conclusions

Motivation

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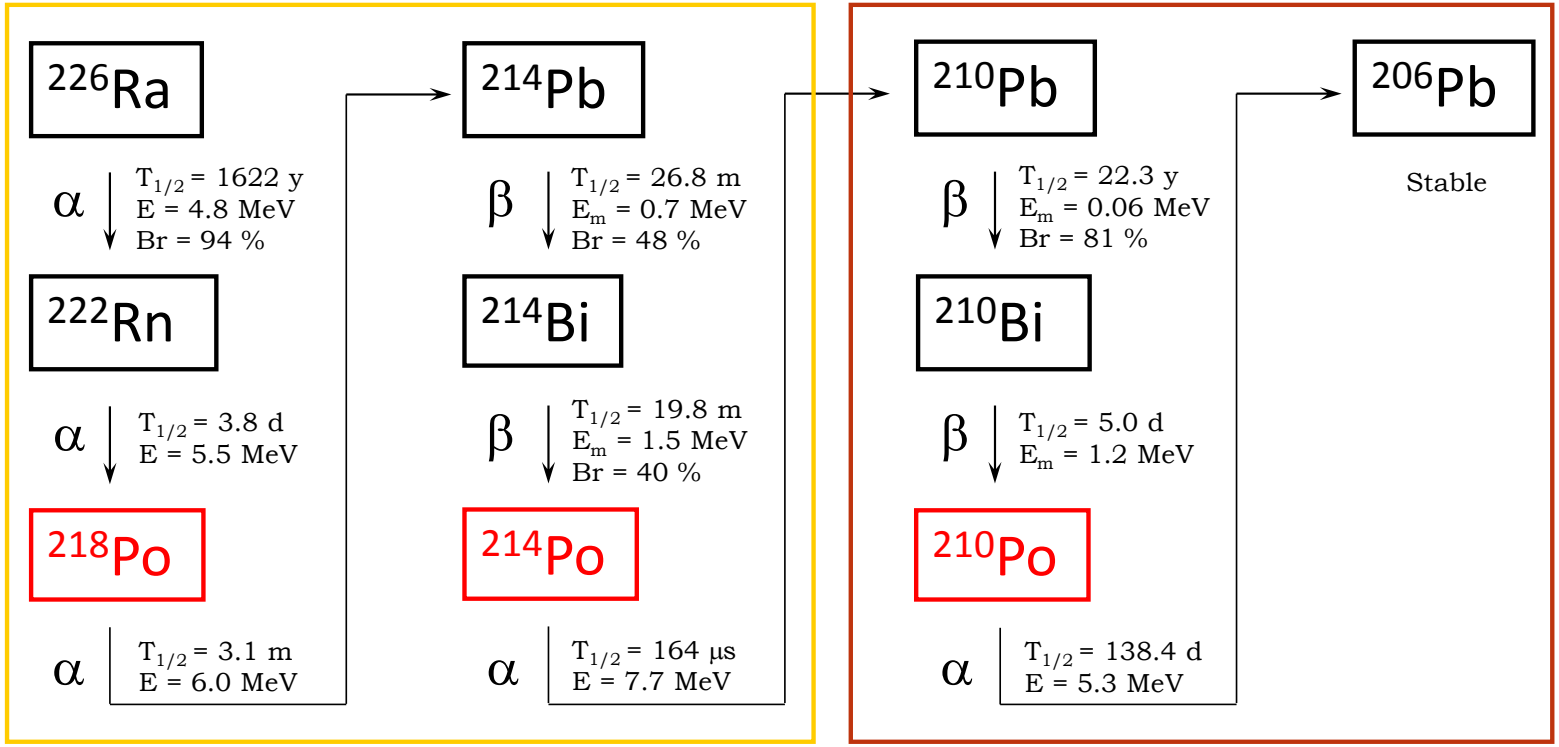
Apparatus
^{210}Po in metals
Conclusions



- Assay of „natural" alpha surface/bulk specific activities
- Alphas / degraded alphas – potential background source in experiments looking for rare events
- Investigations of disequilibrium in the chain
- Development effective cleaning surface procedures

Apparatus: XIA UltraLow-1800

Motivation

Apparatus

^{210}Po in metals

Conclusions

- Low background alpha spectrometer
- Ar used as counting gas (3.5 l/min)
- Sample size: 43×43 cm / 30 cm diam. disc, a few mm thick
- PSD + veto guard (discrimination of background events)

^{210}Po energy spectrum

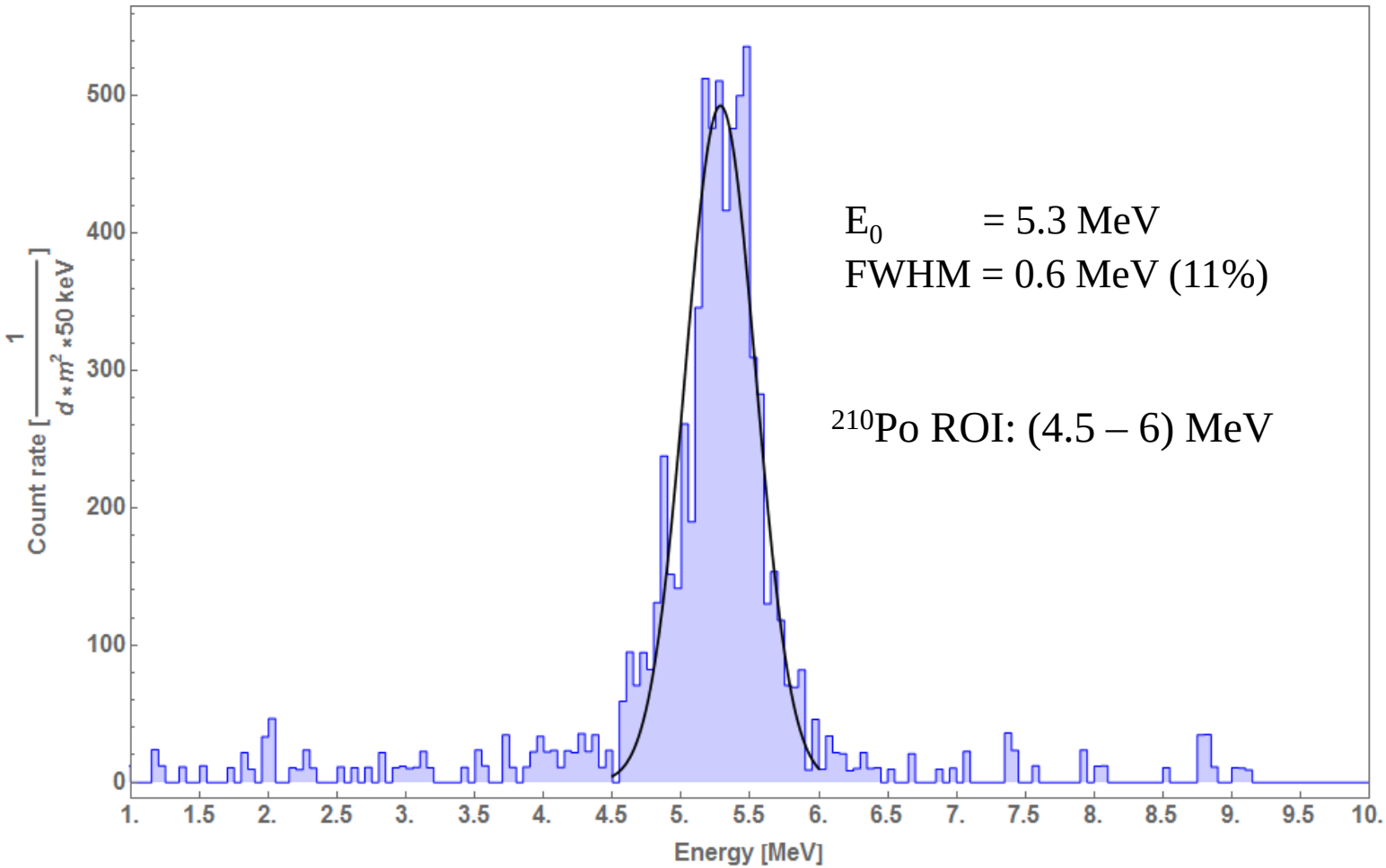
Motivation

Apparatus

^{210}Po in metals

Conclusions

Copper sheet with surface ^{210}Po (air-born)



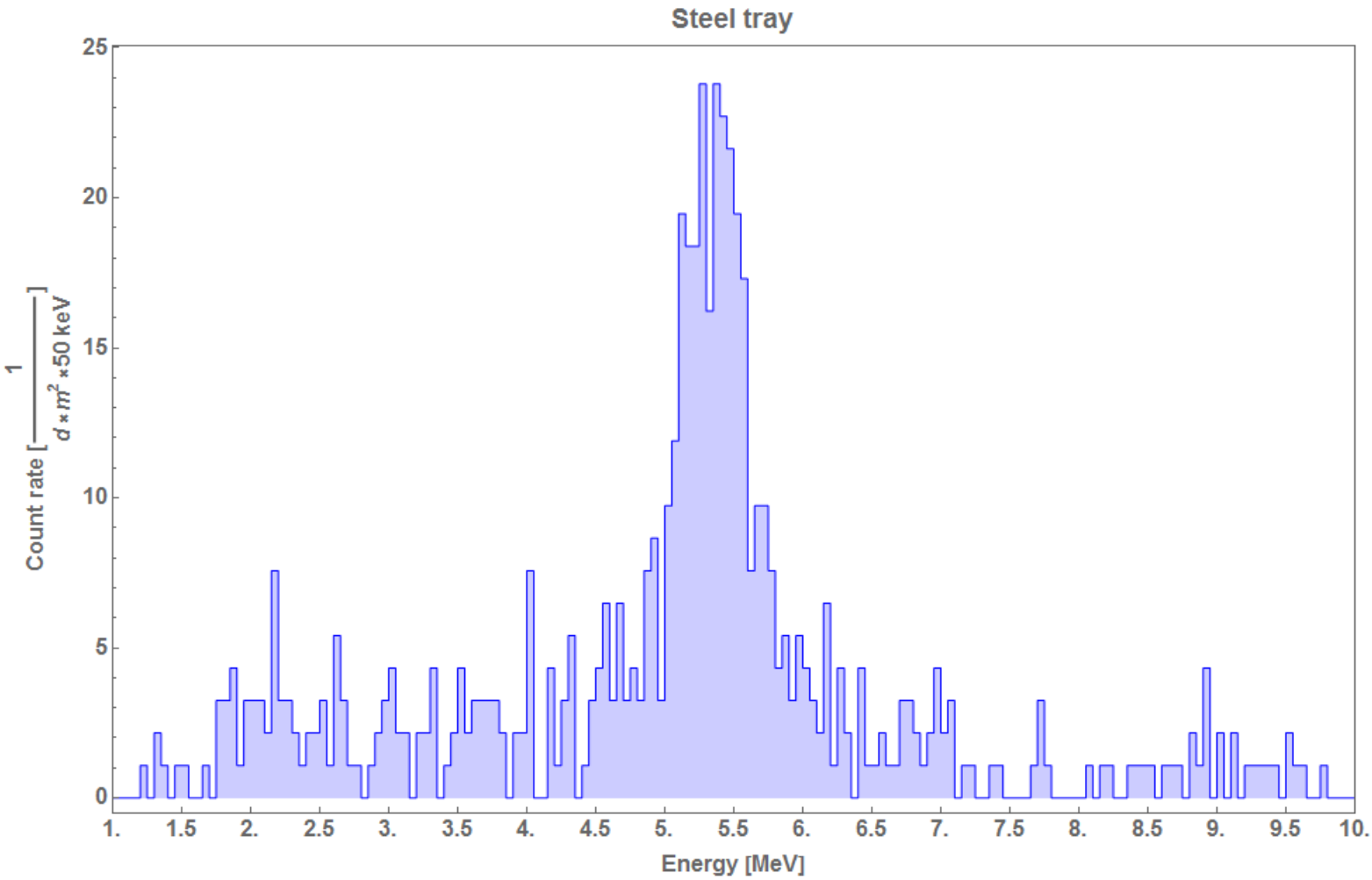
Background spectrum

Motivation

Apparatus

^{210}Po in metals

Conclusions



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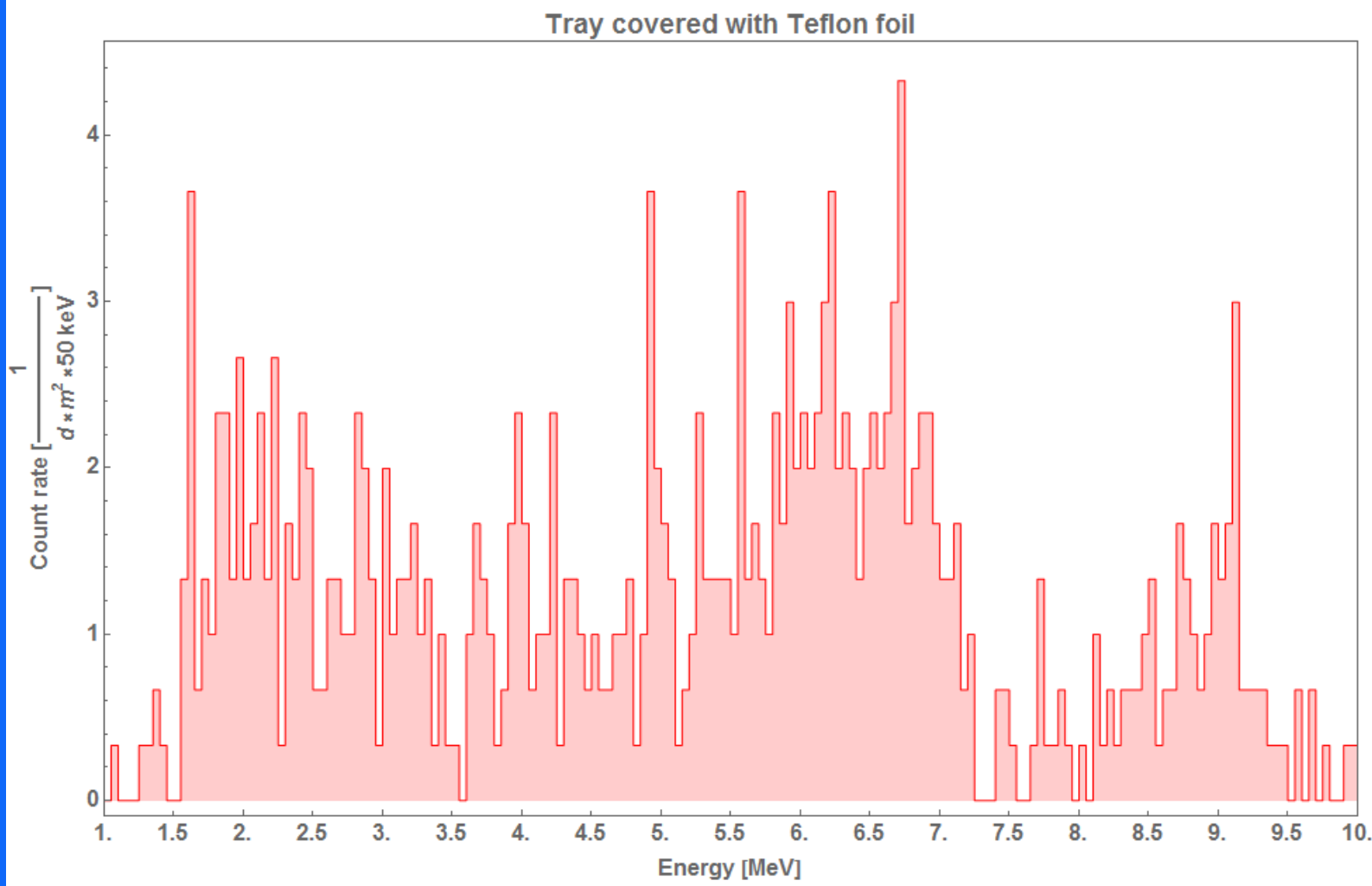
Motivation

Apparatus

^{210}Po in metals

Conclusions



Tray covered with conductive PTFE foil W/D-105 (DeWAL INDUSTRIES)

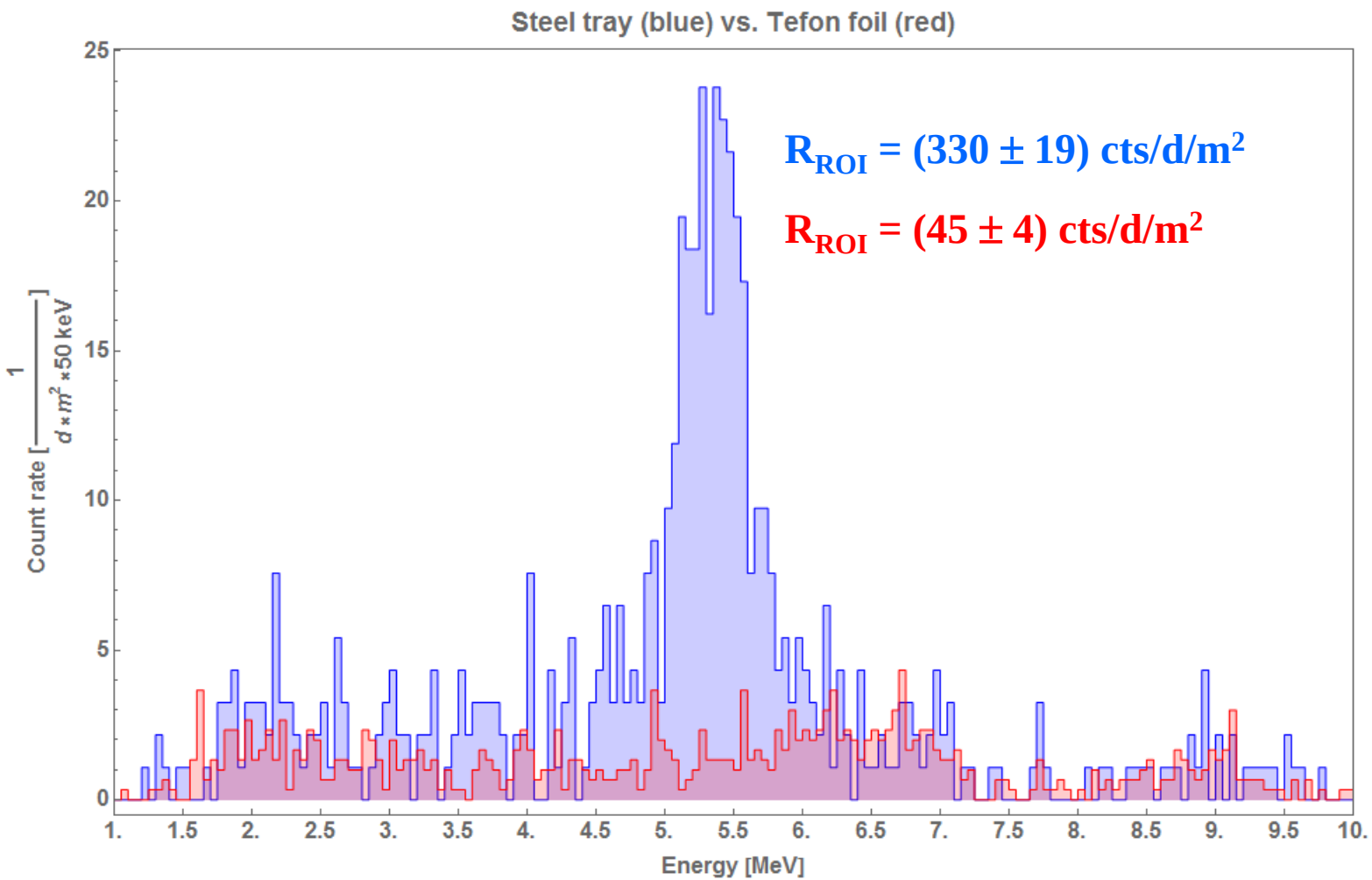
Background spectrum

Motivation

Apparatus

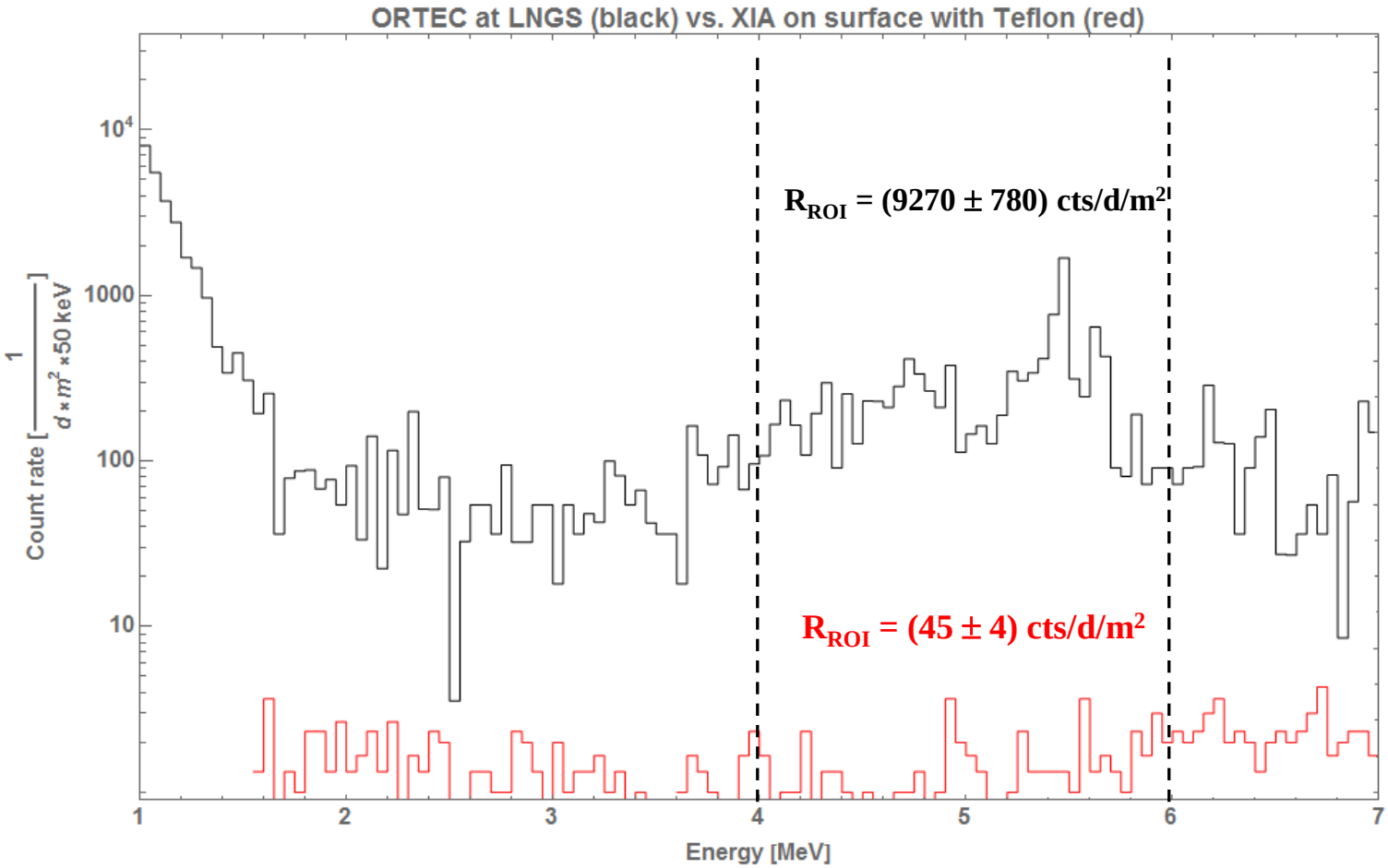
^{210}Po in metals

Conclusions



Background spectrum

Low background ORTEC α detector (40 mm diameter) at LNGS (Appl. Rad. Isot. 81 (2013) 146) vs. XIA Ultra-low 1800 on the surface: **factor ~200 improvement**.



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^{210}Po in DARKSIDE Teflon

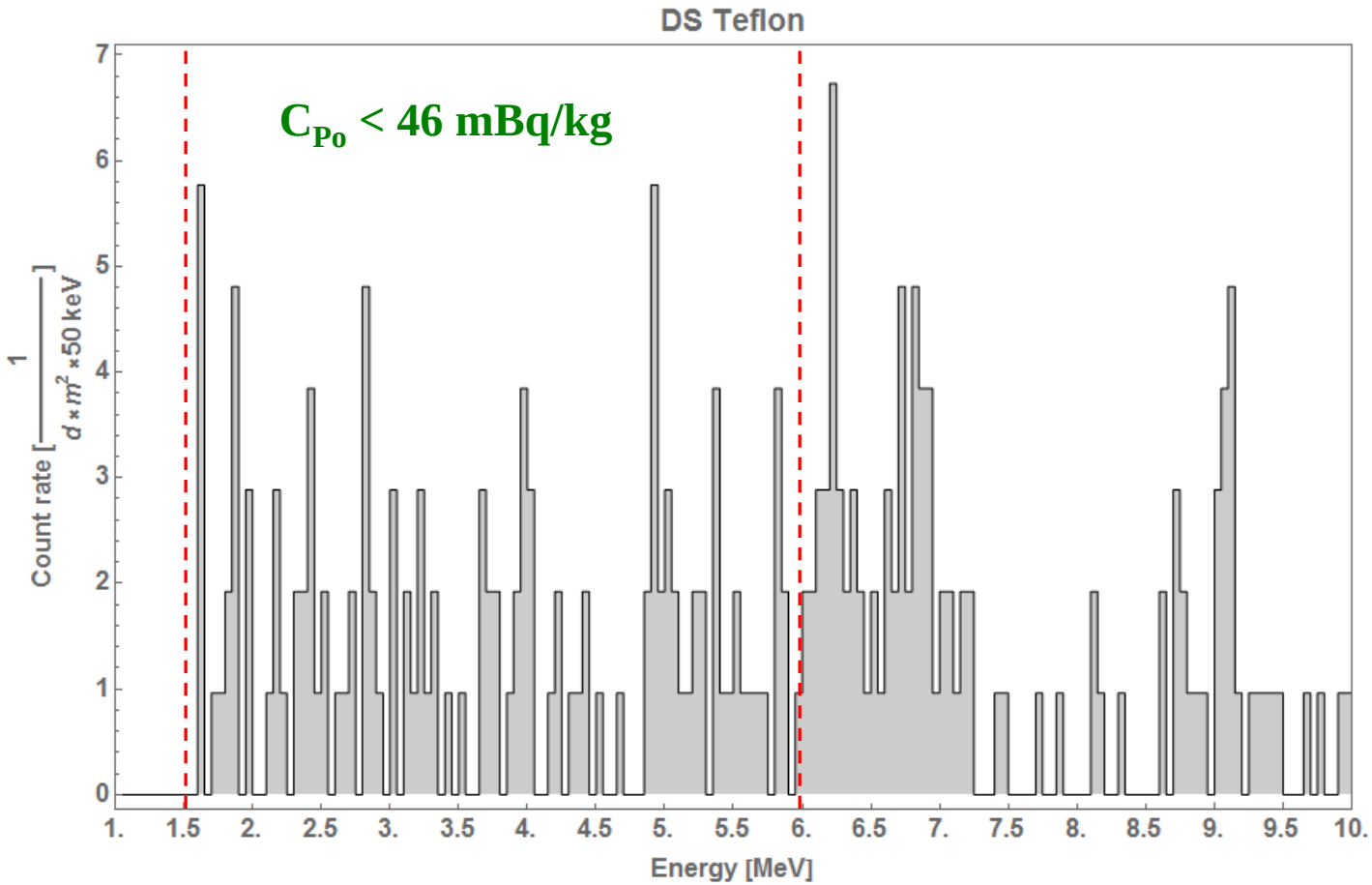
Motivation

Apparatus

^{210}Po in Teflon

Conclusions

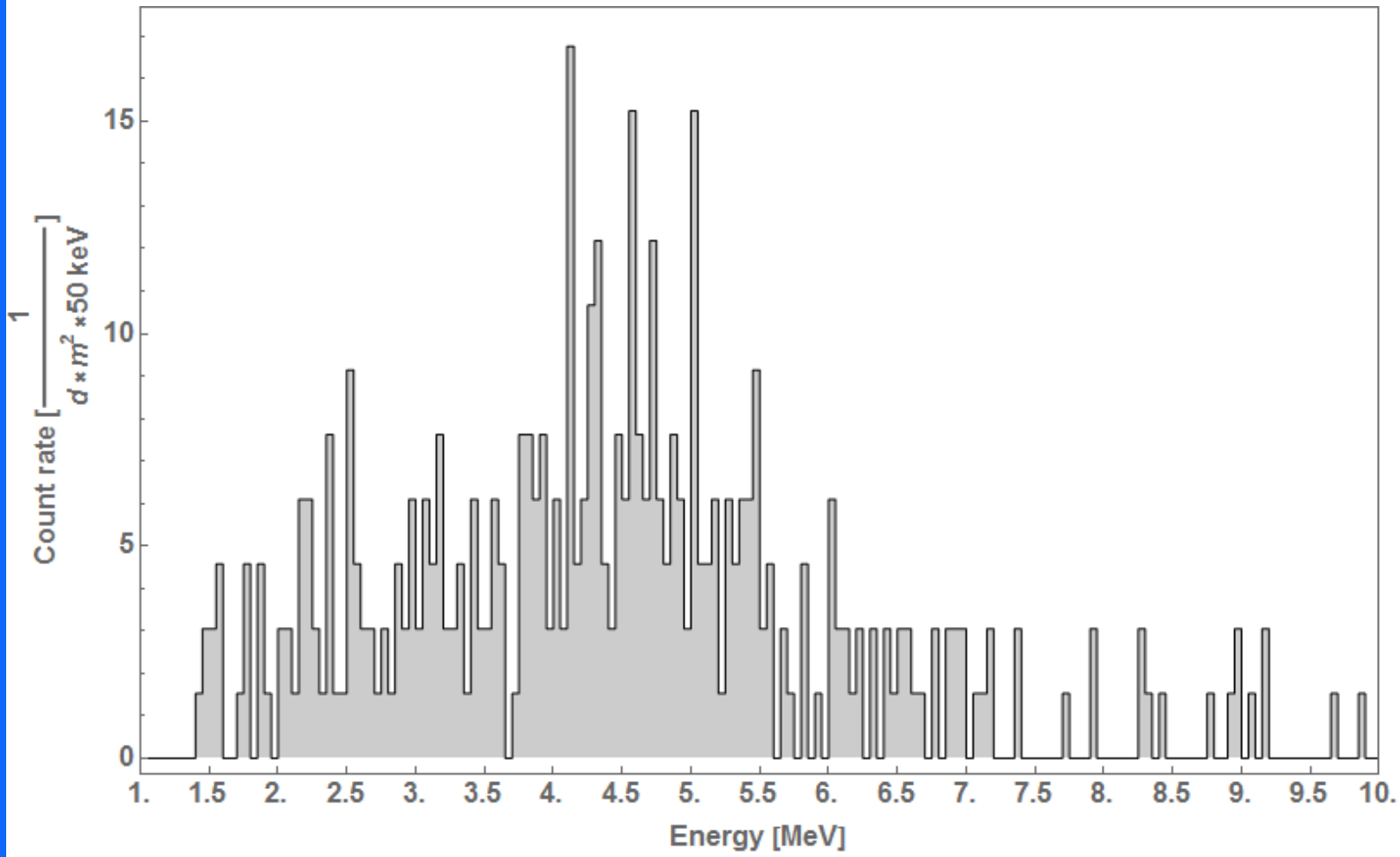
DS Teflon from Applied Plastic Technology: 3 strips: 45×15×0.1 cm



All alphas registered in the region of (1.5 – 6) MeV are assumed to come from the bulk ^{210}Po and the depth of ~26 μm (range of 5.3 MeV α in PTFE).

ETP copper

- Electrolytic Tough Pitch (ETP) Copper, half hard (z4): sheet 43×43×0.1 cm



C_{bulk} ~ 75 mBq/kg, $C_{sf} \leq 3$ mBq/m^2

Motivation
Apparatus
^{210}Po in metals
Conclusions

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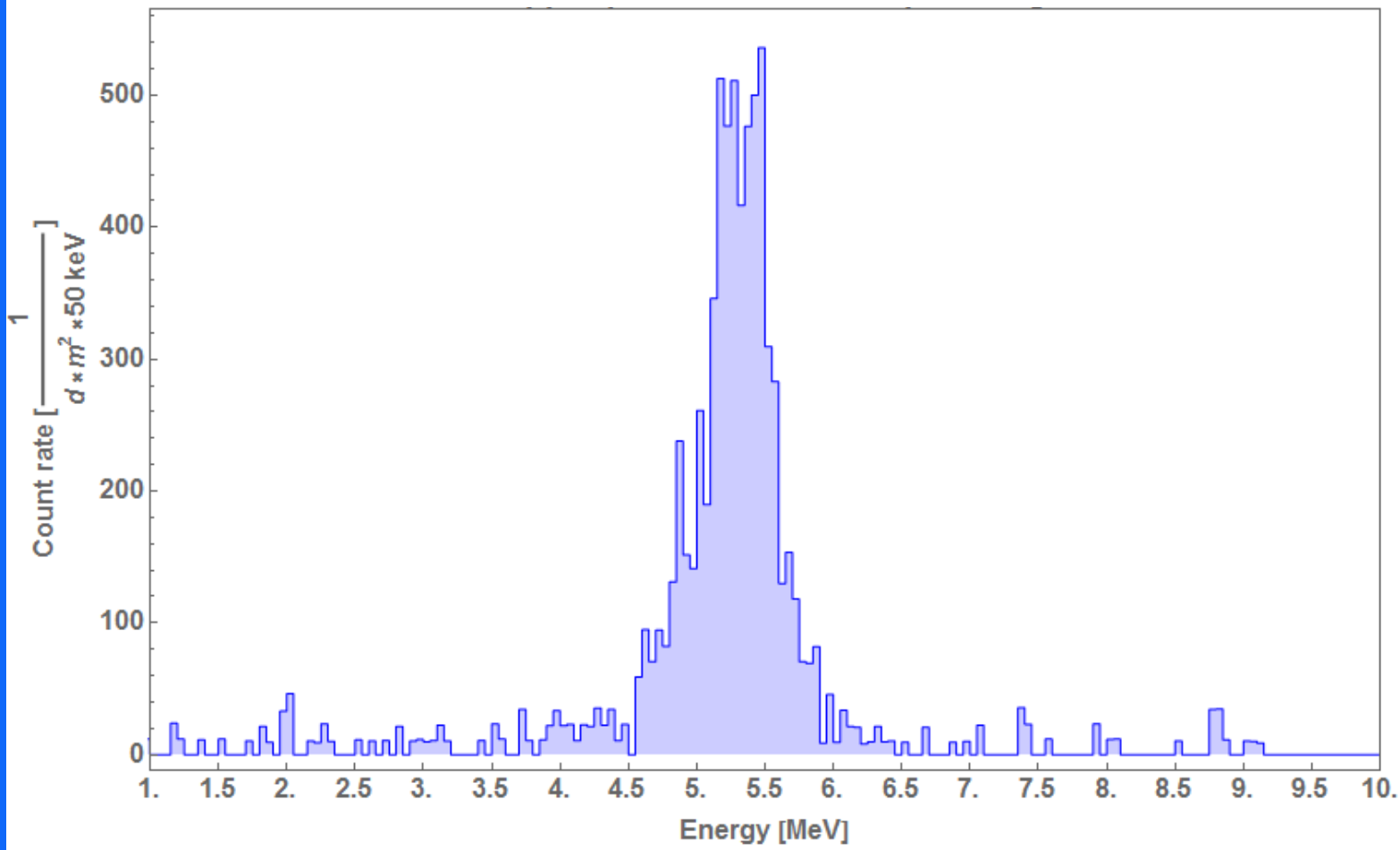
ETP copper

- Old copper foil, stored for many years (~ 20 y) in air, ETP (z4)



C_{bulk} ~ 280 mBq/kg, C_{sf} ~ 170 mBq/m^2

Motivation
Apparatus
^{210}Po in metals
Conclusions

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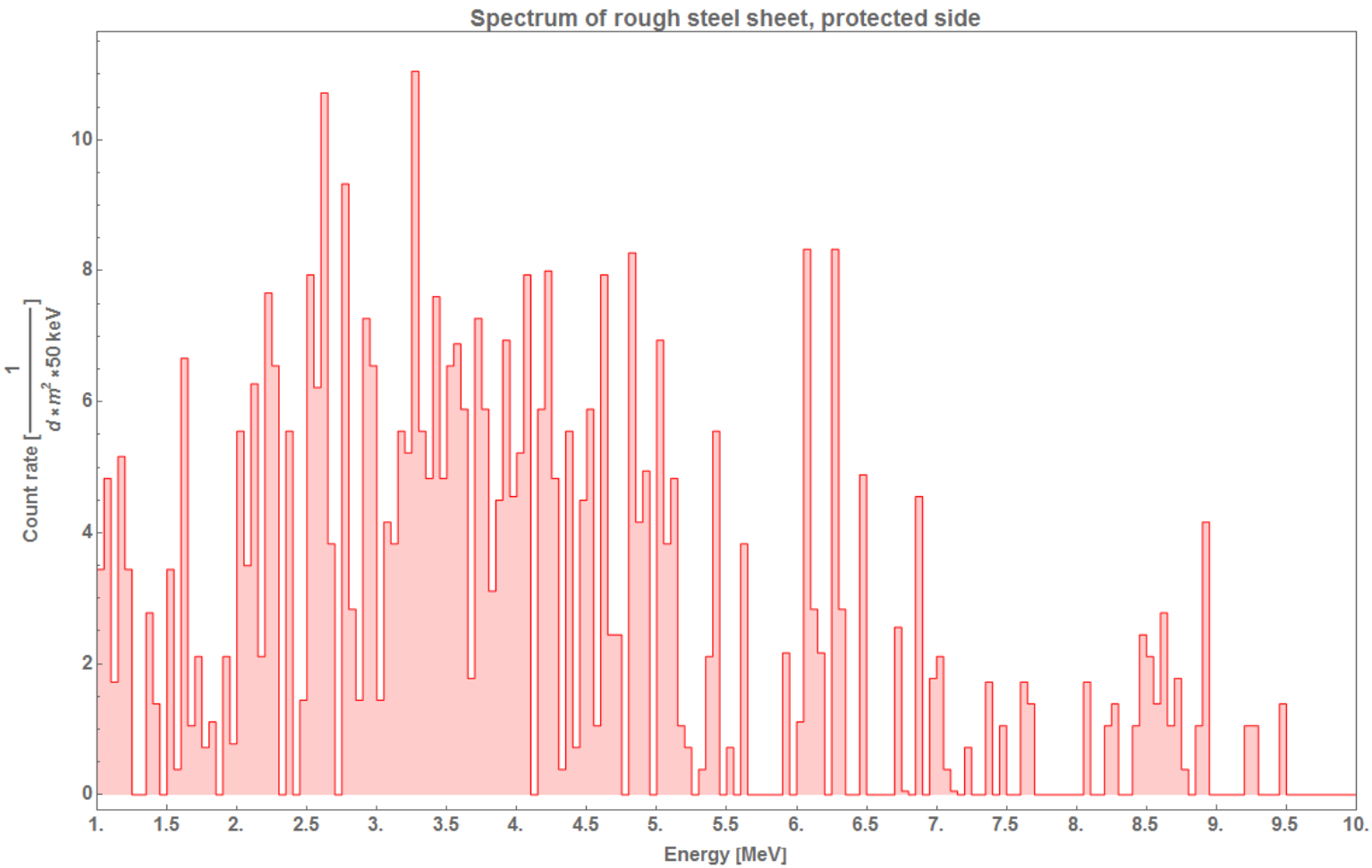
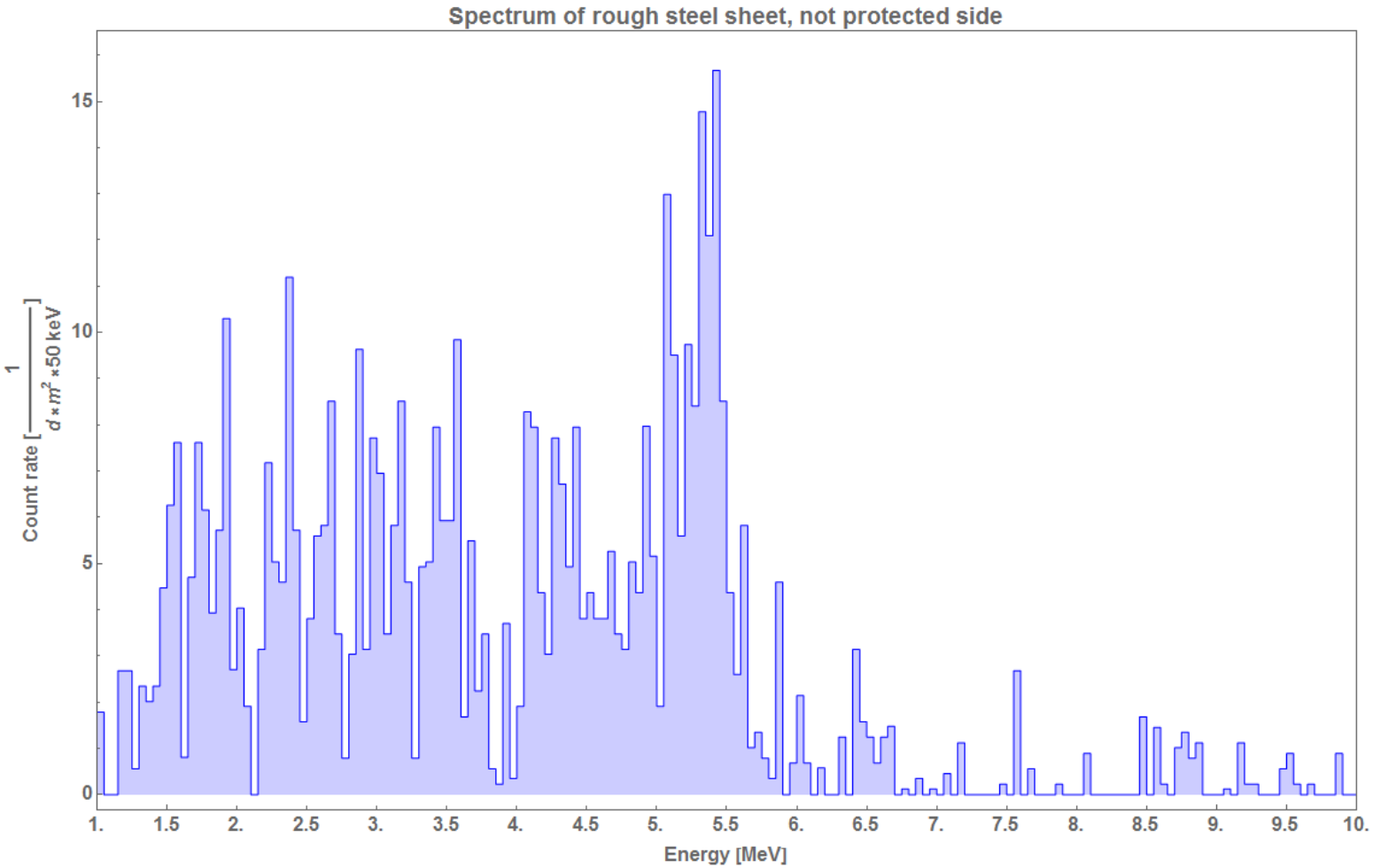
Stainless steel (304)

- Covered by the mill with a PVC protective foil, no indication for surface ^{210}Po



Stainless steel (304)

- Unprotected, clear indication for surface ^{210}Po



Motivation

Apparatus

^{210}Po in metals

Conclusions

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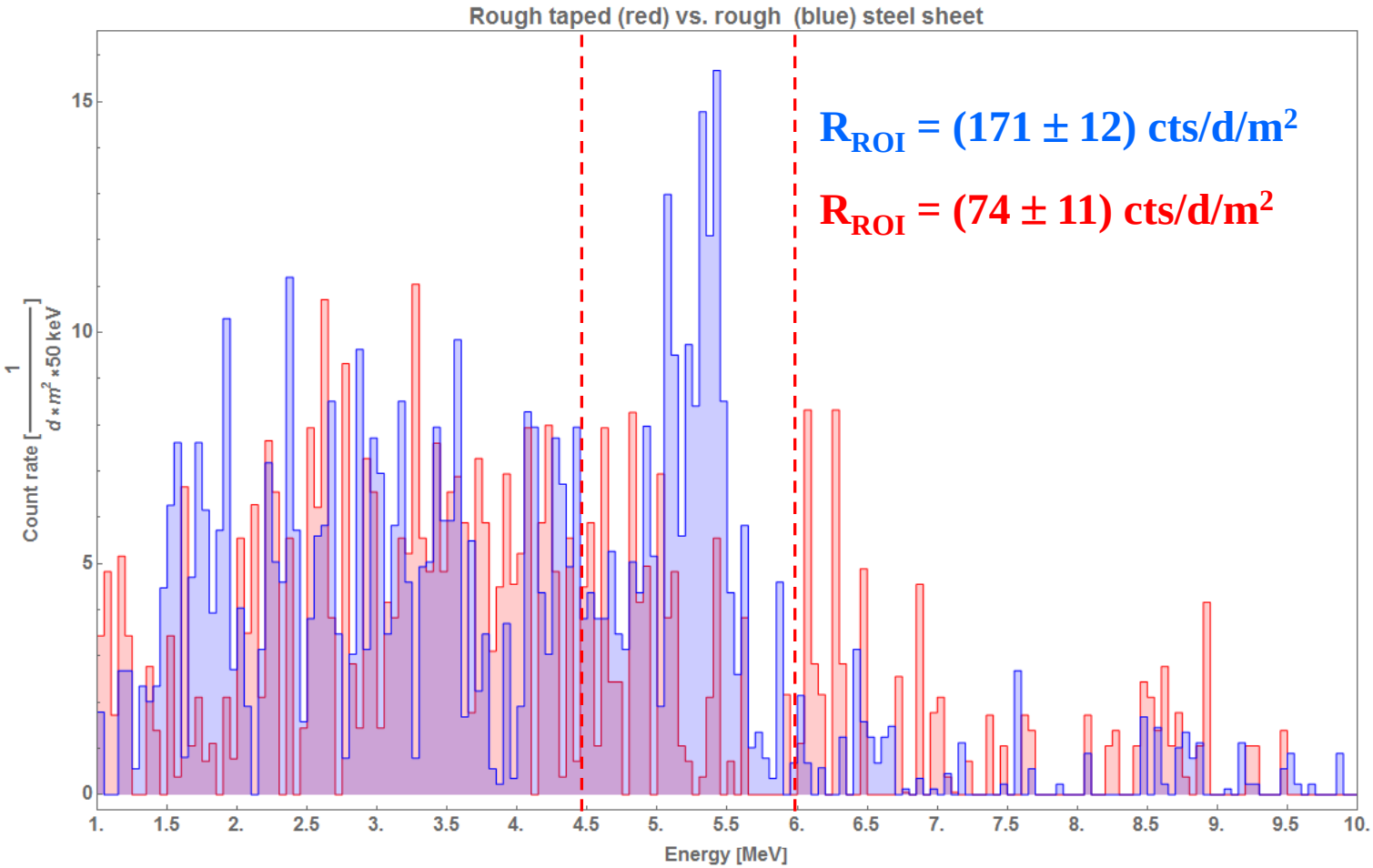
Stainless steel (304)

Protected vs. unprotected steel surface



C_{bulk} ~ 80 mBq/kg, $C_{sf} \leq 3$ mBq/m²

Motivation

Apparatus

^{210}Po in metals

Conclusions

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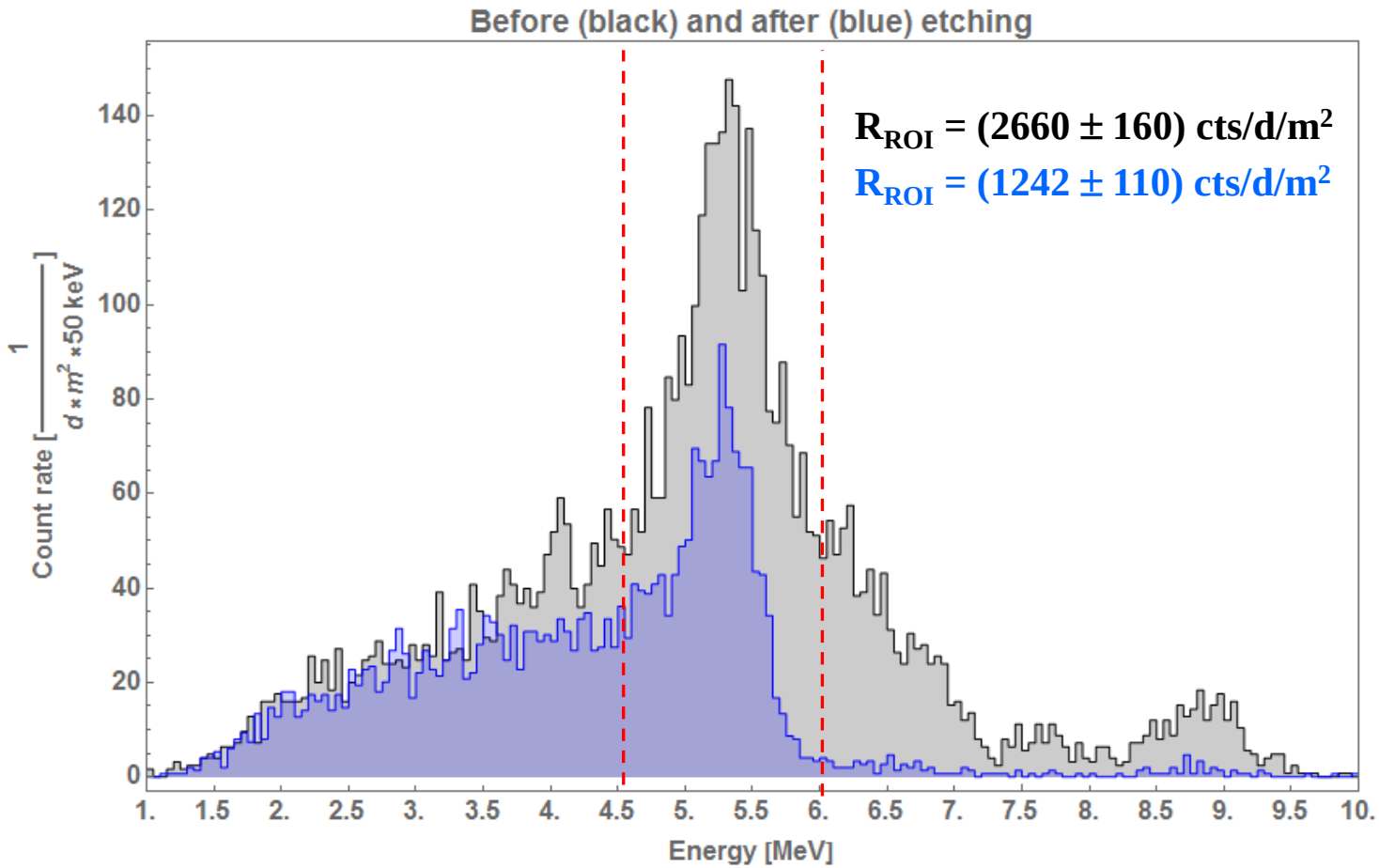
Titanium (GR2)

Motivation

Apparatus

^{210}Po in metals

Conclusions



- Etching procedure: 4 min in a mixture of: 15% HNO_3 + 5% HF
- Washing in high-purity deionized water (18 MΩ×cm)
- Significant (x ~2) decrease of surface ^{210}Po and U/Th (> 6 MeV)

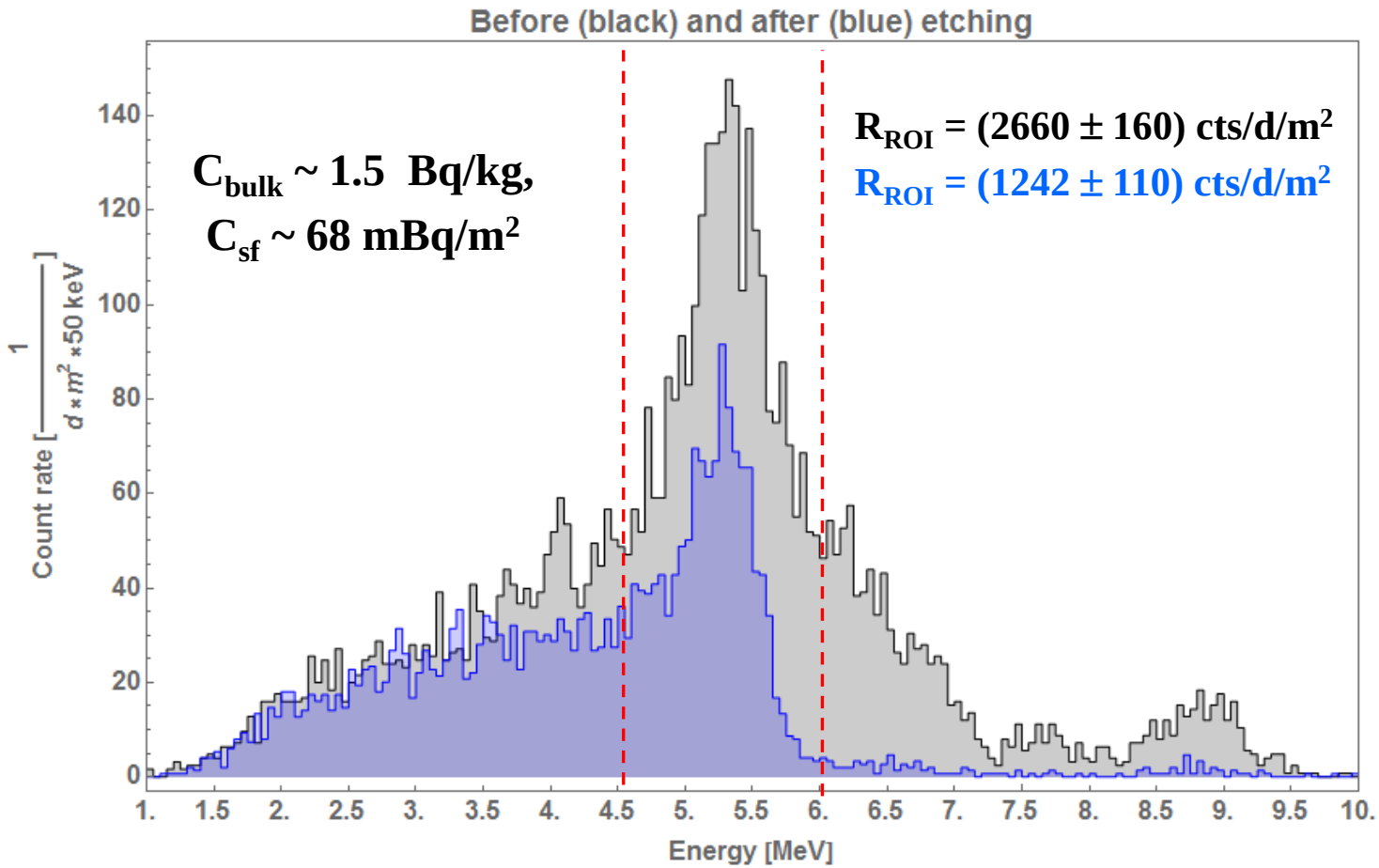
Titanium (GR2)

Motivation

Apparatus

^{210}Po in metals

Conclusions



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Summary

Motivation

Apparatus

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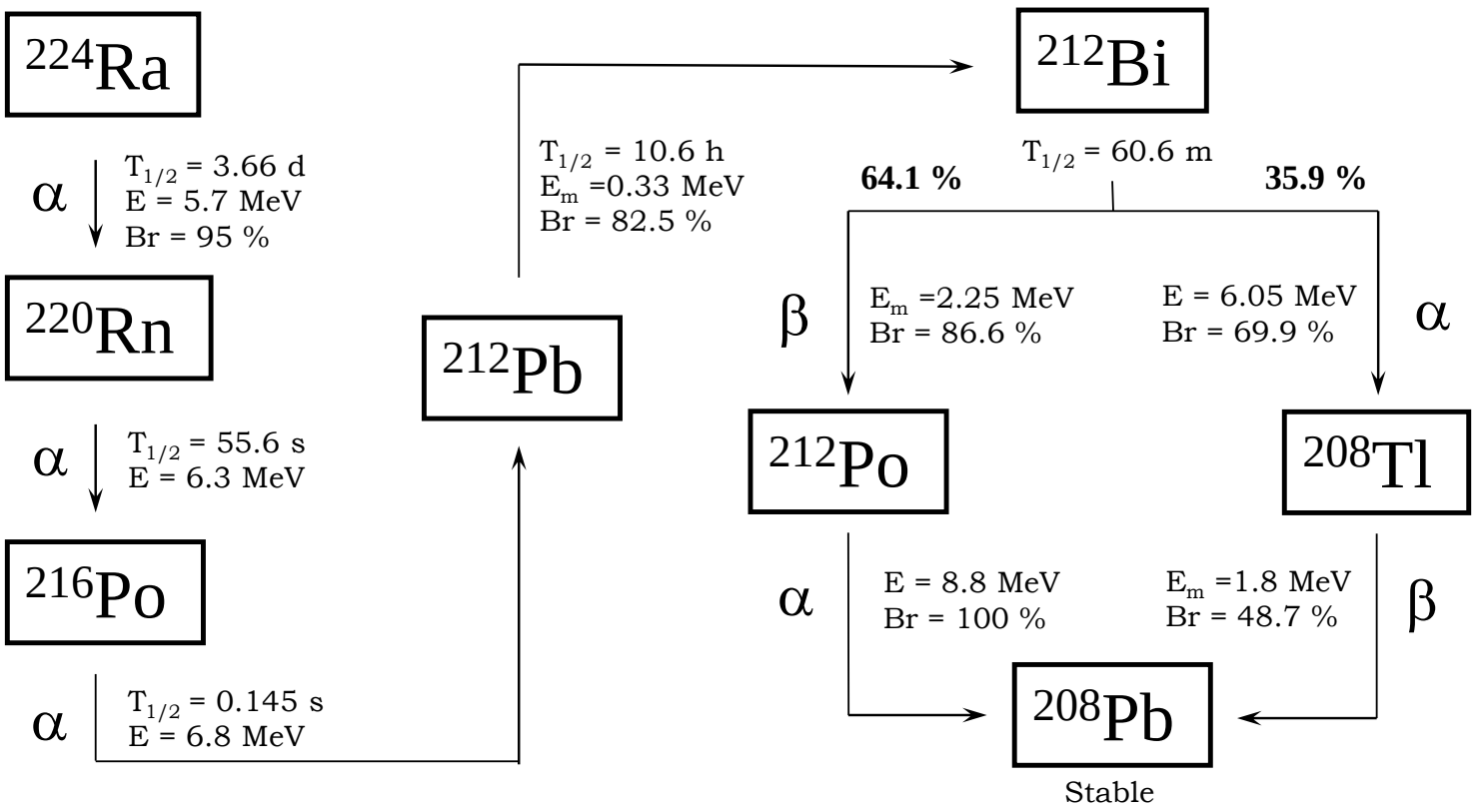
Conclusions

Material	Bulk ^{210}Po [mBq/kg]	Surface ^{210}Po [mBq/kg]	Remarks
OF Copper	≤ 54	≤ 3	z4 (half hard)
ETP Copper	≤ 75	≤ 3	z4 (half hard)
„Old" ETP Copper	280	170	z4 (half hard)
Stainless Steel	≤ 80	≤ 3	Type 304
Titanium	1500	68	GR2
Teflon	≤ 46	–	High purity, ATP

Conclusions

Motivation
Apparatus
^{210}Po in metals
Conclusions

- For the first time the „natural" surface/bulk specific activities for various metals have been investigated
- Surfaces of copper and stainless steel protected against air (^{222}Rn) do not show indications of ^{210}Po
- Bulk ^{210}Po specific activities for copper and stainless steel are in the range of ≤ ?00 mBq/kg
- A limit of 46 mBq/kg on ^{210}Po/^{210}Pb bulk specific activity for APT DS Teflon has been obtained
- Commercially pure GR2 Ti contains ^{210}Po at the level of Bq/kg
- MC model needed to evaluate the bulk/surface detection efficiencies unfold the spectra
- Tests of copper/steel surface cleaning procedures (multi-step etching, electro-polishing) ongoing

Backup – ^{228}Th chain