Использование экстракционной хроматографии в радиофармацевтической химии и исследованиях окружающей среды

Application of extraction chromatography for environmental studies and nuclear medicine

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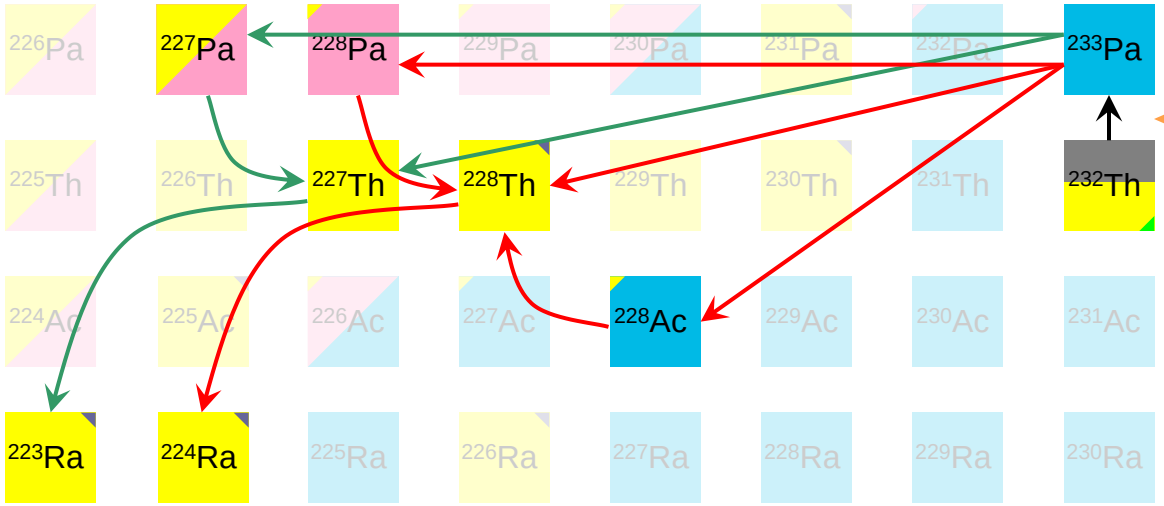
Accelerator facilities

- 120-cm cyclotron of SINP MSU, 7.5 MeV/nucleon, α-particles, deuterons, protons.
- Race-track microtron, bremsstrahlung photons up to 70 MeV
- Processing of targets, irradiated in INR RAS (Troitsk) on linear accelerator of protons (energy up to 120 MeV)

Main Nuclear Reactions Resulting in ^{223}Ra and ^{224}Ra



Proton Energy up to 141 MeV

^{223}Ra

^{232}Th (p, p5n) ^{227}Th

^{232}Th (p, 6n) ^{227}Pa (38 min, EC, 15%) → ^{227}Th

^{227}Th (18.7 d, α, 100%) → ^{223}Ra

^{224}Ra
(chemically inseparable impurity)

^{232}Th (p, p4n) ^{228}Th

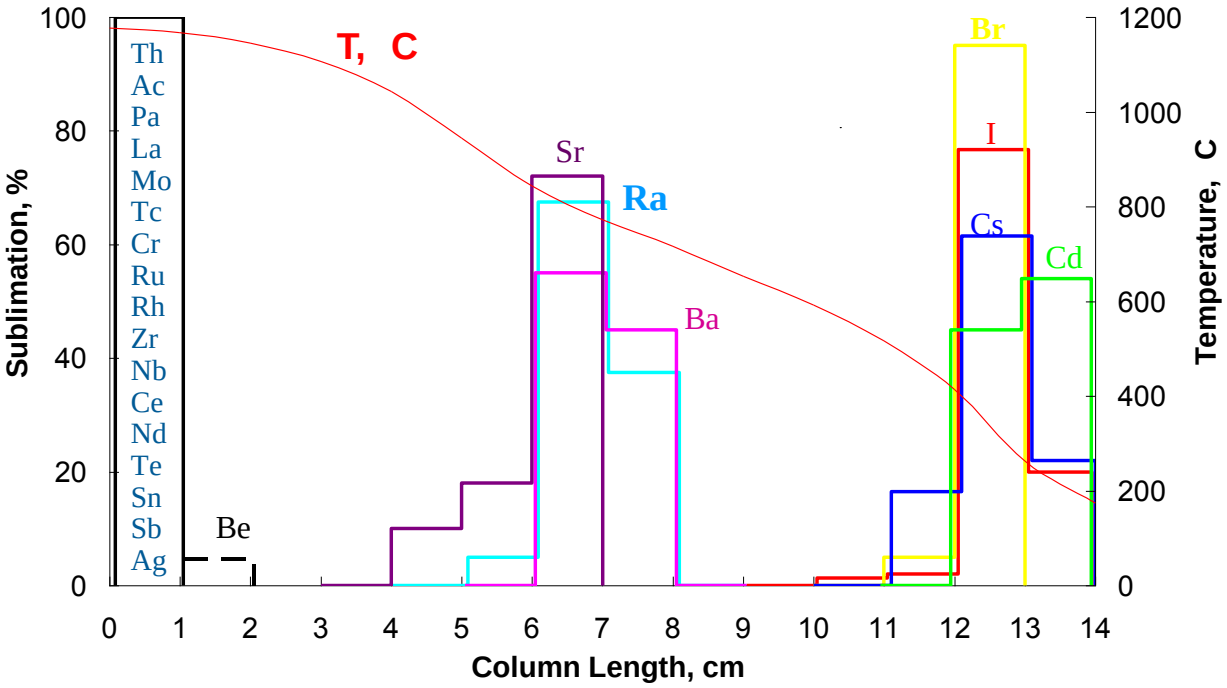
^{232}Th (p, 5n) ^{228}Pa (22 h, EC, 98%) → ^{228}Th

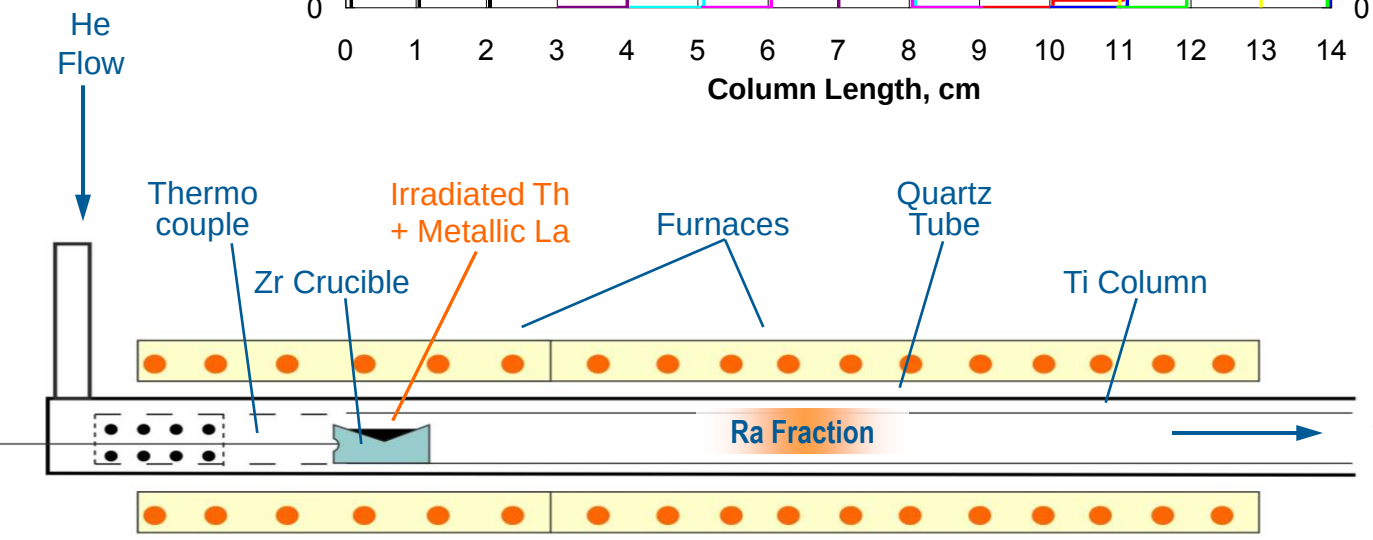
^{232}Th (p, x) ^{228}Ac (6.1 h, β$^-$, 100%) → ^{228}Th

^{228}Th (1.91 a, α, 100%) → ^{224}Ra (3.7 d)

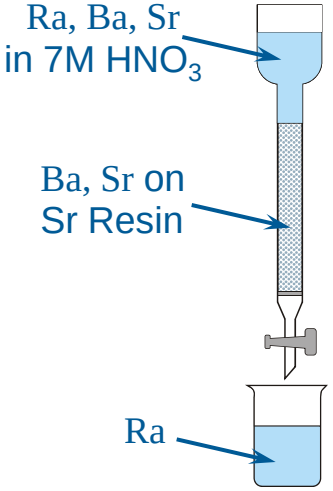
INR and MSU collaboration

Separation of Ra isotopes from irradiated Th target



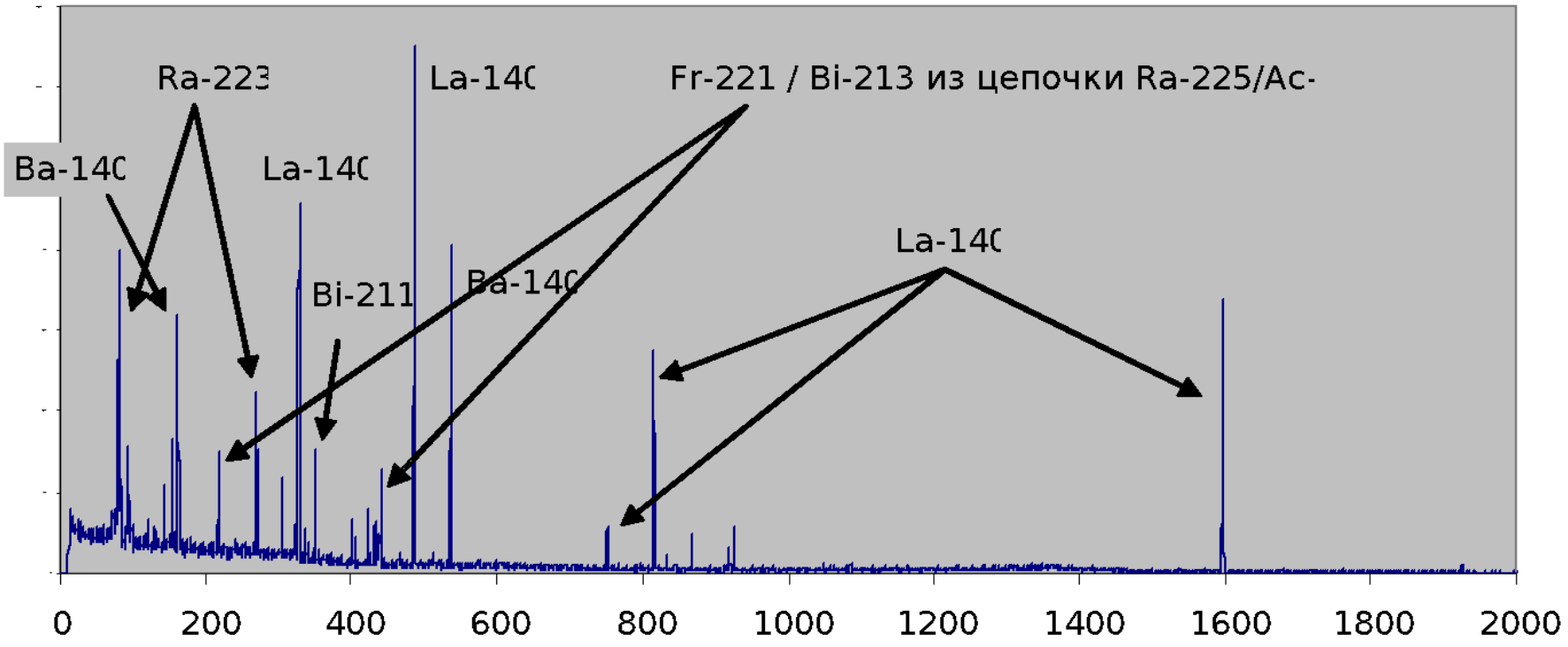


Final Purification on **Sr Resin**

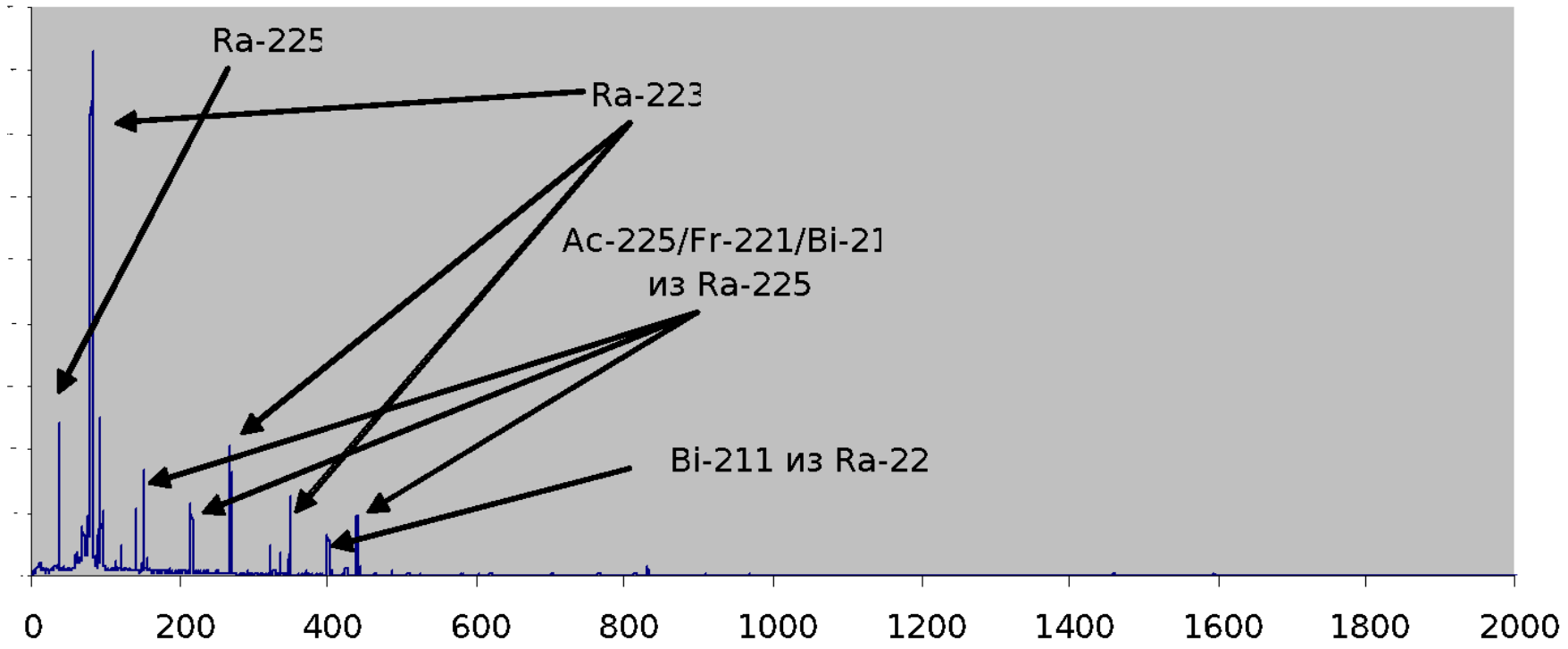


Thermochromatographic separation performed by Ermolayev S. V., INR

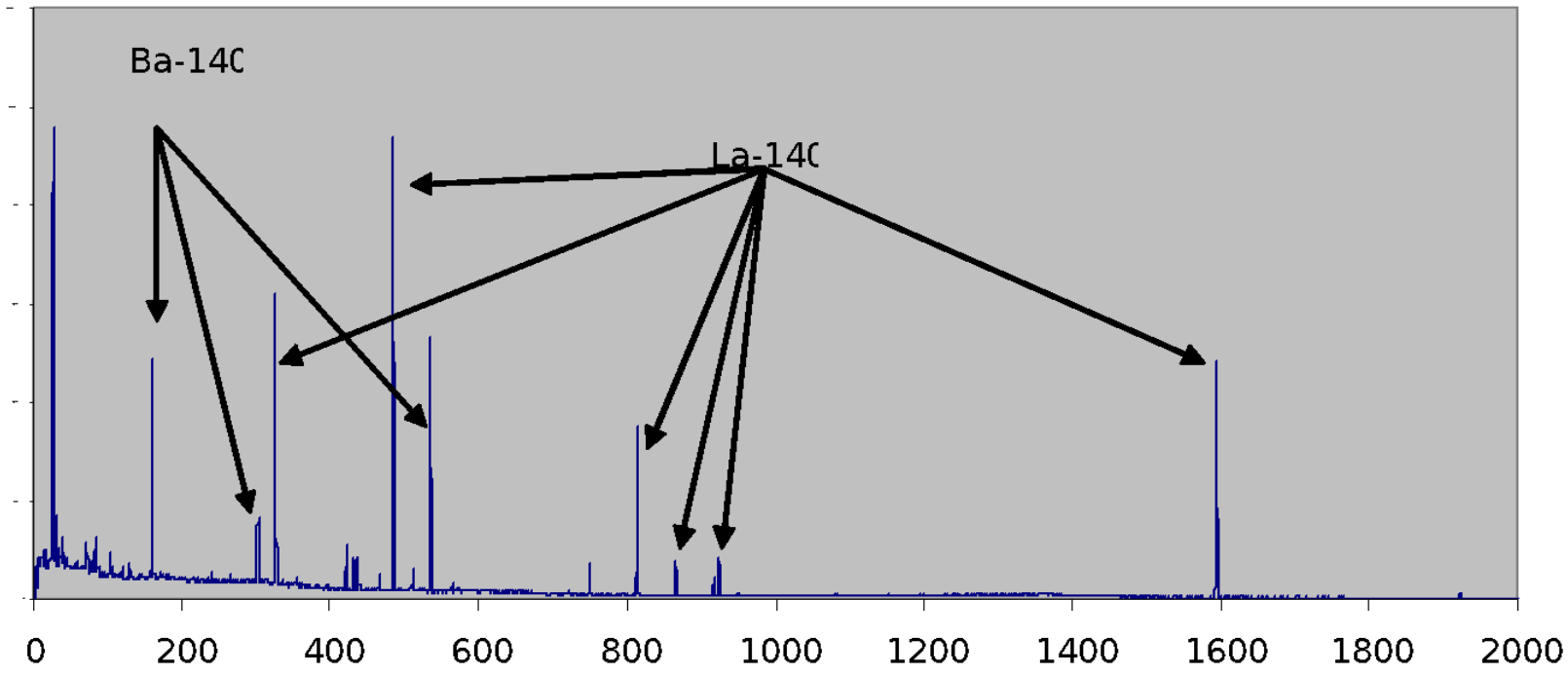
Gamma spectrum of initial solution



Gamma spectrum of Ra fraction



Gamma spectrum of Sr Spec column



Environmental tracers production

Tracer	Radionuclide to determine
^{95g}Tc, ^{95m}Tc, ^{96}Tc (20 h, 61 d, 4.28 d)	^{99}Tc (211 ky)
^{237}Pu (45.2 d)	^{239,240}Pu (24.1 ky, 6.56 ky)
^{75}Se (119.8 d)	^{79}Se (650 ky)
^{85}Sr (64.8 d)	^{90}Sr (28.8 y)
^{207}Bi (31.6 y)	^{210}Pb/^{210}Bi (22,3 y)

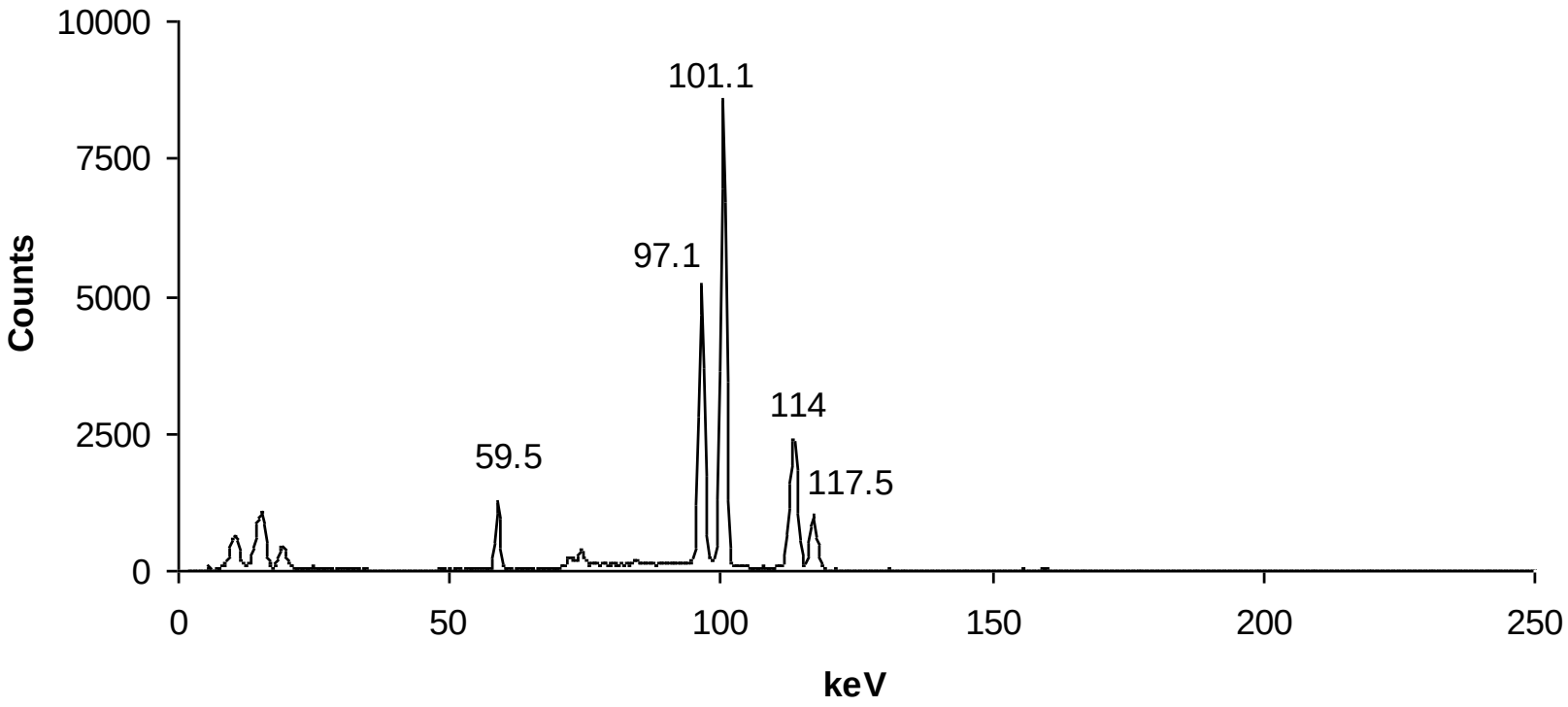
Production pathways

Nuclide	Target	Main reaction	Separation
^{96}Tc	^{nat}Mo	^{94}Mo(α,np)^{96}Tc	LLX MIBK
^{95m}Tc	^{nat}Mo	^{92}Mo(α,p)^{95m}Tc	LLX MIBK
^{237}Pu	$^{235}UO_2$	^{235}U(α,2n)^{237}Pu	LLX TOPO / TRU-Spec
^{75}Se	^{nat}Ge	^{72}Ge(α,n)^{75}Se ^{73}Ge(α,2n)^{75}Se	LLX of Ge by CCl_4
^{85}Sr	$^{nat}Rb_2SO_4$	^{85}Rb(d,2n)^{85}Sr	Sr-Spec
^{207}Bi	^{nat}Pb	^{206}Pb(d,n)^{207}Bi	Anion-exchange

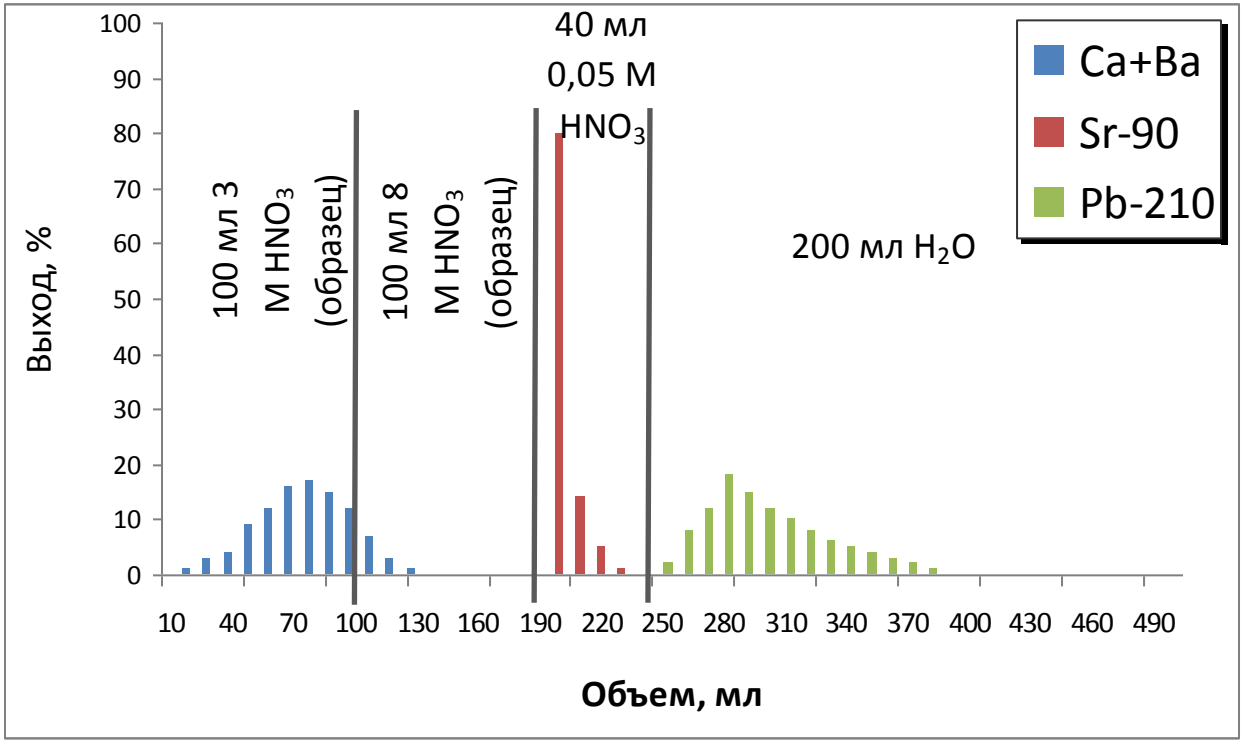
Production of ^{237}Pu

- Irradiation of $^{235}UO_2$ by 30 MeV α-particles
- LLX by 0.1 M TOPO in toluene from 8 M nitric acid. Water phase may be used as multitracer for studies of behavior of fission products
- stripping by 10% ascorbic acid in 1 M HCl
- digestion by nitric acid
- chromatographic purification by TRU-Spec resin
- ^{237}Pu was used for studying of behavior of Pu in ultra low-level concentrations, the same, like in natural conditions
- $^{236}Pu/^{237}Pu$, activity ratio, corrected to EOB was $1.3 \cdot 10^{-4}$, atomic ratio was $2.9 \cdot 10^{-3}$. $^{238}Pu/^{237}Pu$ activity ratio was $1.9 \cdot 10^{-5}$, atomic ratio $1.4 \cdot 10^{-2}$, respectively.

Gamma-ray spectrum of ^{237}Pu



Determination of Sr-90 and Pb-210 in bone tissue



Sample size – 5 g
Column volume (Sr-resin) - 8 mL
Counting - Sr-90 - Cherenkov,
Pb-210 - LS