



PRISMAP SERVICES FOR RADIONUCLIDE PRODUCTION AND THEIR BIOMEDICAL APPLICATION

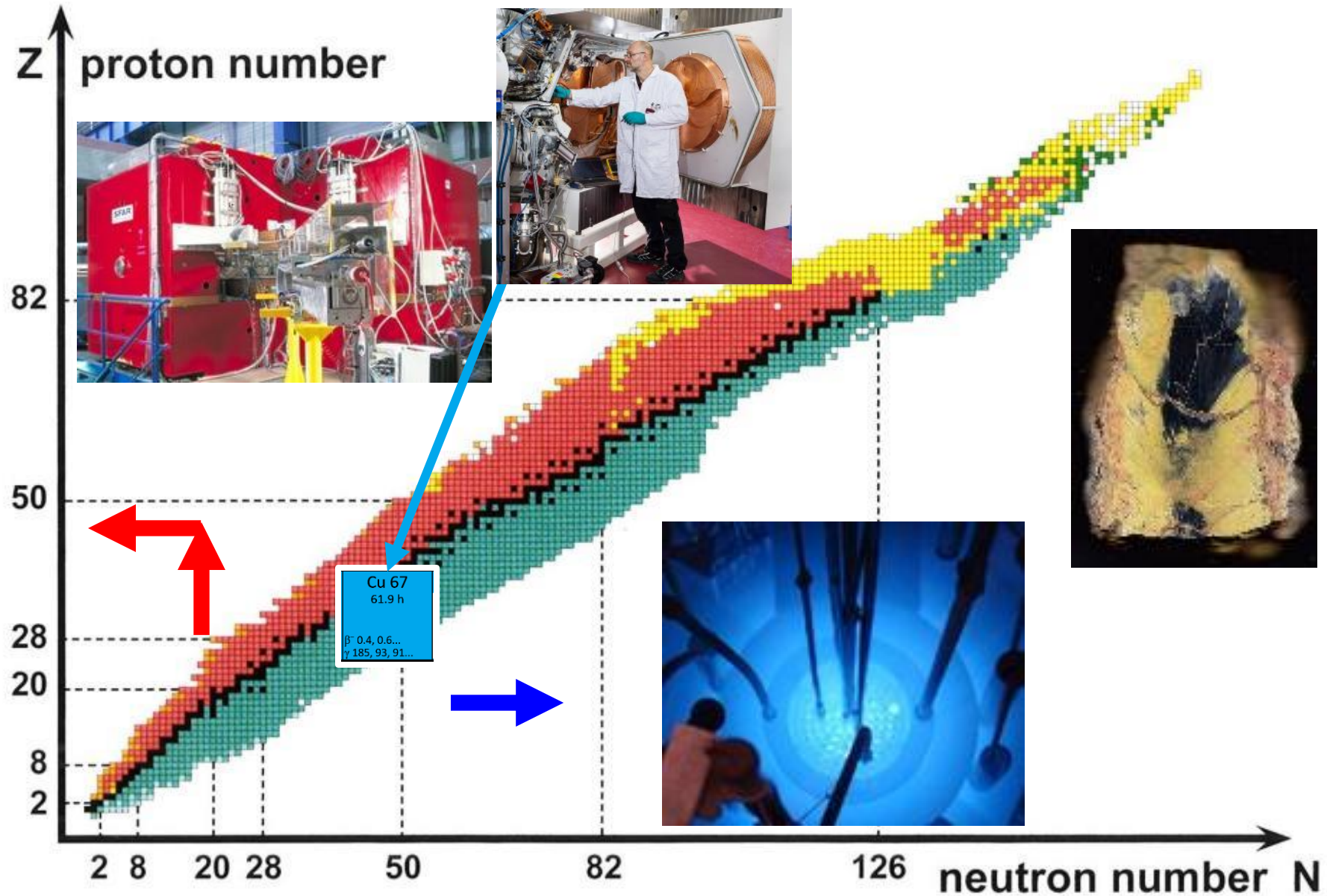
PRISMAP Collaboration Meeting 9

Ulli Köster, ILL Grenoble

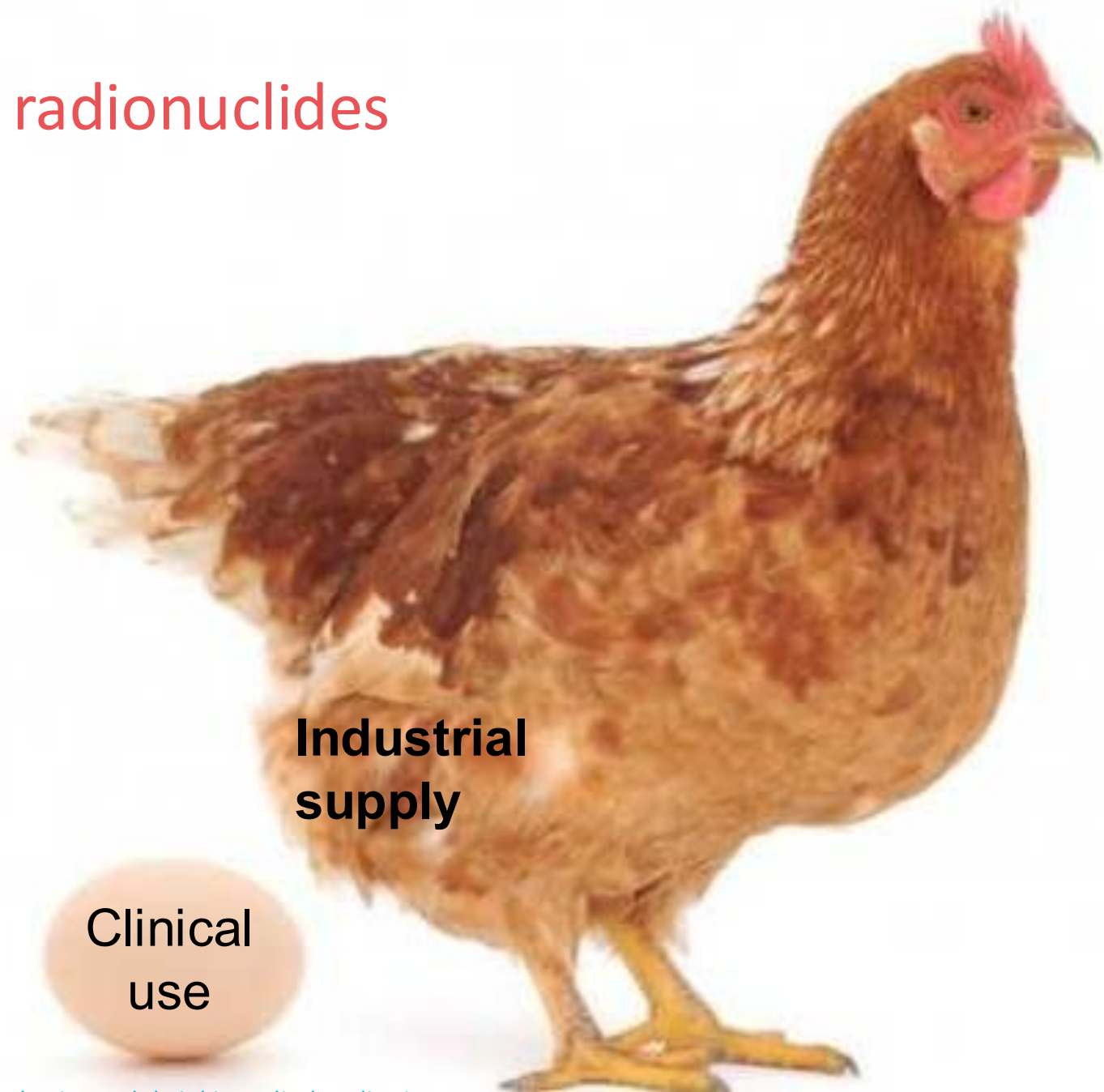
The PRISMAP radionuclide portfolio (grown by user demands)

43 Sc Scandium	44 Sc Scandium	47 Sc Scandium	52 Mn Manganese	64 Cu Copper	67 Cu Copper	103 Pd Palladium
111 Ag Silver	128 Ba Barium	128 Cs Caesium	135 La Lanthanum	153 Sm Samarium	149 Tb Terbium	152 Tb Terbium
155 Tb Terbium	161 Tb Terbium	165 Tm Thulium	165 Er Erbium	169 Er Erbium	175 Yb Ytterbium	199 Au Gold
203 Pb Lead	211 At Astatine	213 Bi Bismuth	223 Ra Radium	224 Ra Radium	225 Ac Actinium	227 Th Thorium

The “water divide” of radionuclide production



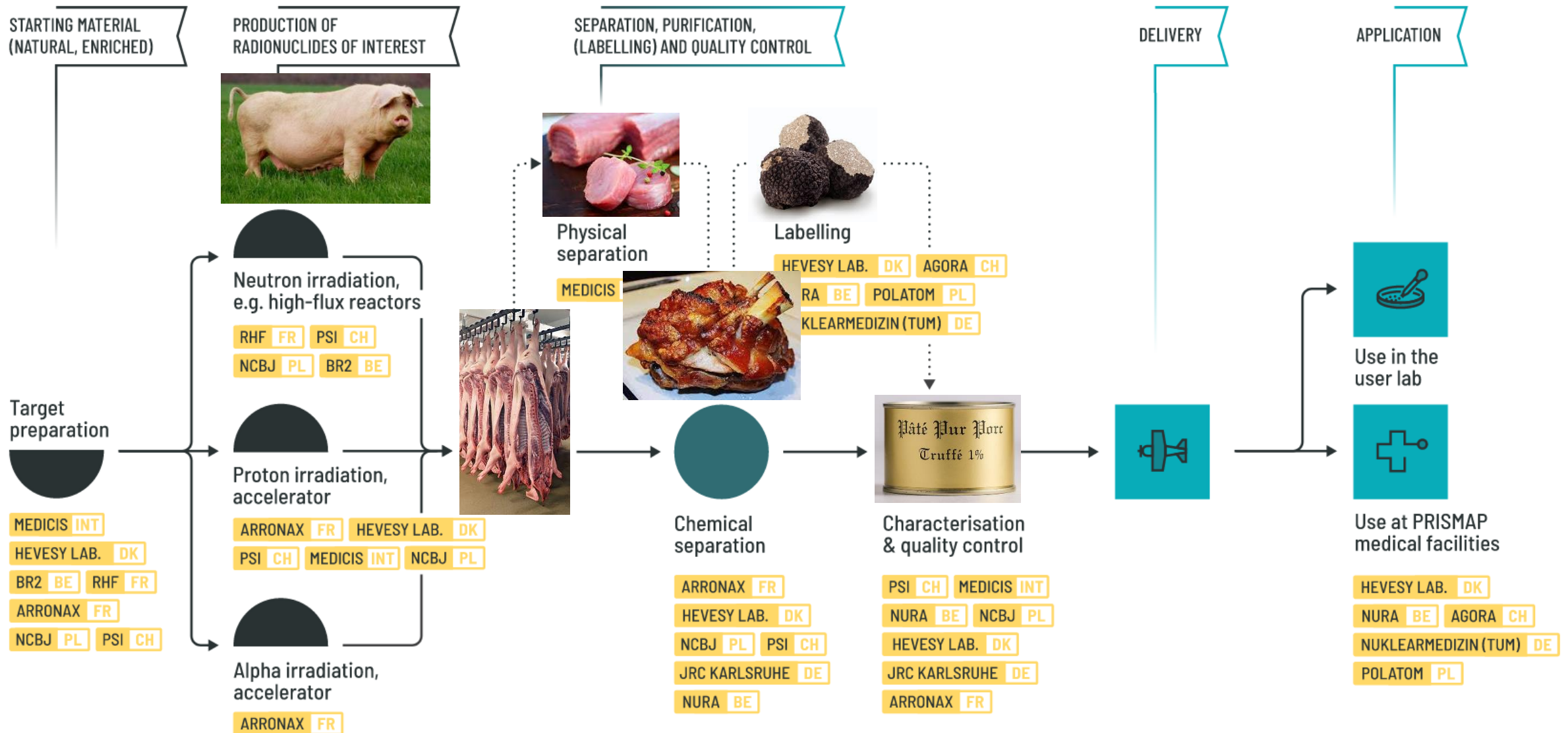
Introducing novel radionuclides



**Industrial
supply**

**Clinical
use**

The flowchart of PRISMAP facilities



The PRISMAP Biomedical Facilities

Hevesy Laboratory

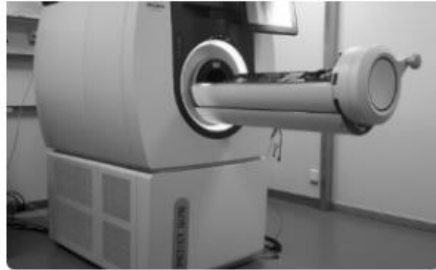
Danmarks Tekniske
Universitet – DTU



Radiochemistry
Nuclear spectrosc.
Cell cultures
 μ SPECT/CT

AGORA

Centre hospitalier
universitaire vaudois
— CHUV



μ PET/ μ SPECT/CT
MRI
Translational
Clinical scanners

NURA

Studiecentrum voor
Kernenergie / Centre
d'étude de l'énergie
nucleaire — SCK CEN



Cell cultures
 μ SPECT/CT
Longitudinal trials

Nuklearmedizin

Klinikum rechts der Isar der
Technischen Universität
München — TUM



μ PET/MRI
 μ SPECT/CT
GMP Radiopharm.
Clinical scanners

POLATOM

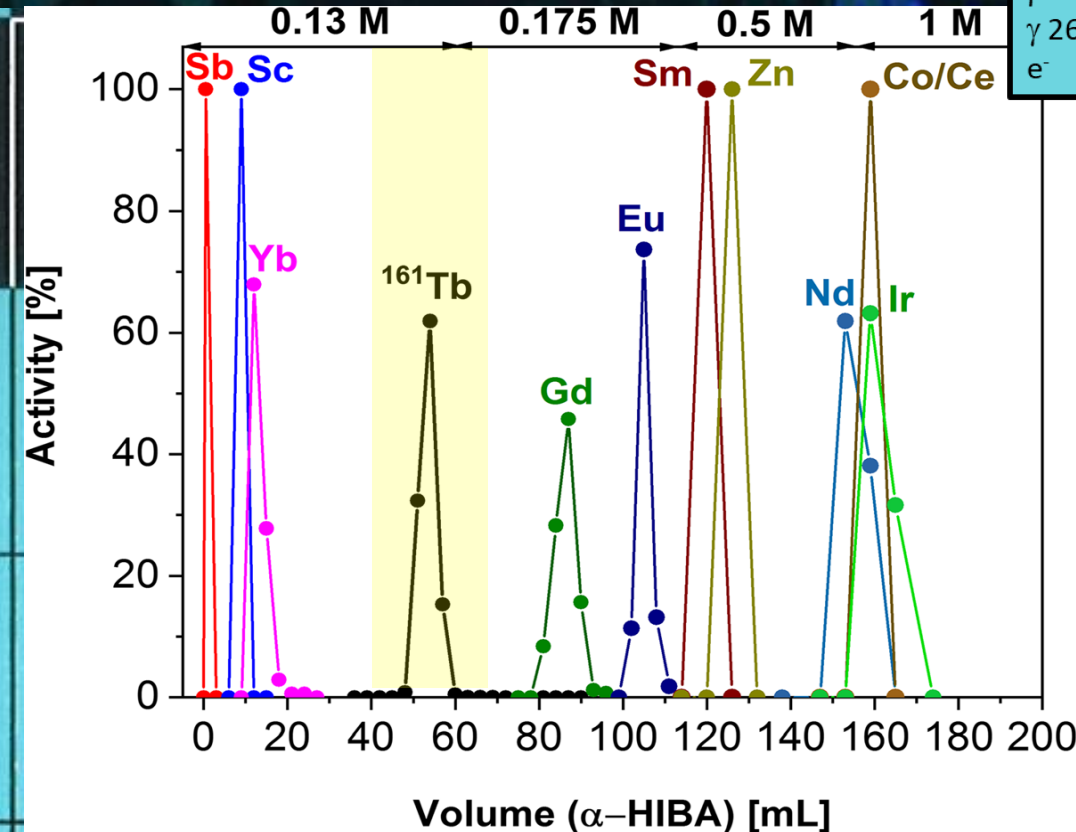
Narodowe Centrum Badań
Jądrowych – NCBJ



Radiochemistry
Cell cultures
Optical imag. (Ch.)
GMP Radiopharm.

Production of non-carrier-added Tb-161

Dy 160 2.329 σ 60 $\sigma_{n, \alpha} < 0.0003$	Dy 161 18.889 σ 600 $\sigma_{n, \alpha} < 1E-6$	Dy 162 25.475 σ 170	Dy 163 24.896 σ 120 $\sigma_{n, \alpha} < 2E-5$
Tb 159 100 σ 23.2	Tb 160 72.3 d β^- 0.6; 1.7... γ 879; 299; 966... σ 570	Tb 161 6.90 d β^- 0.5; 0... γ 26; 49; 5... e^-	Tb 162 7.76 m β^- 1.4; 2.4... γ 260; 808; 888...
Gd 158 24.84 σ 2.3	Gd 159 18.48 h β^- 1.0... γ 364; 58...	Gd 160 21.86 σ 1.5	Gd 161 3.66 m β^- 1.6; 1.7... γ 361; 315; 102... σ 20000



Tb 161
6.96 d
 β^- 0.5; 0.6
 γ 26; 49; 75...
 e^-

Tb-161: $\approx 30\%$ of PRISMAP deliveries

1 Tb-161 atom in $\sim 10^4$ Gd atoms

Irradiation in high flux reactor, then radiochemical separation

N. Gracheva et al., EJNMMI Radiopharm Chem 2019;4:12.

Local production versus centralized production

Project P14 = INCA_16111 project, Alexis Broisat et al.
Development and preclinical evaluation of a mesothelin-targeting theranostic agent

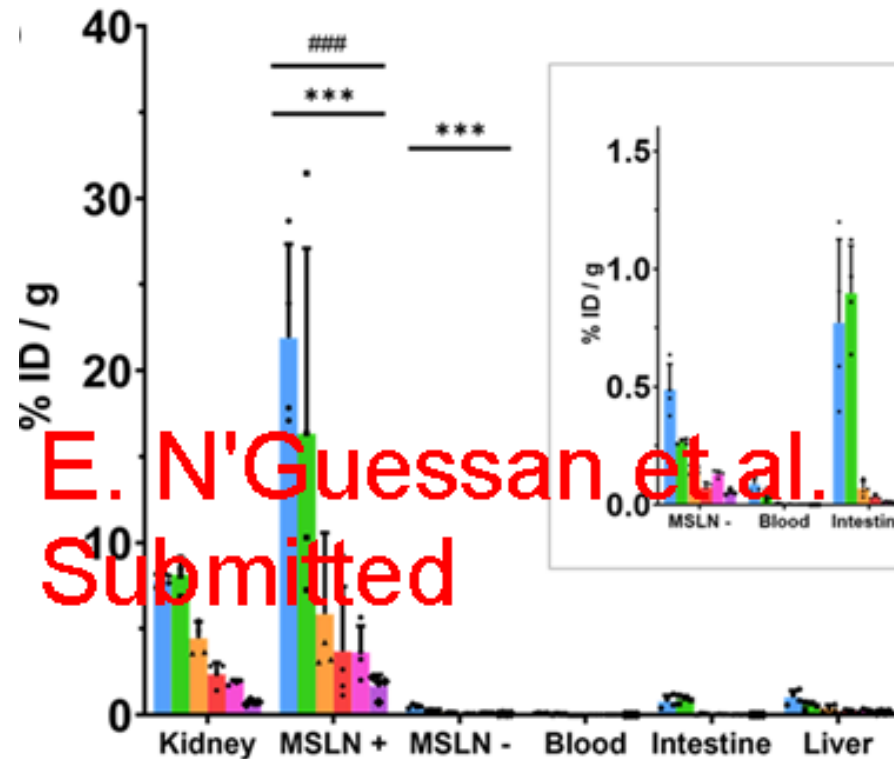
Tb 161

6.96 d

β^- 0.5; 0.6

γ 26; 49; 75...

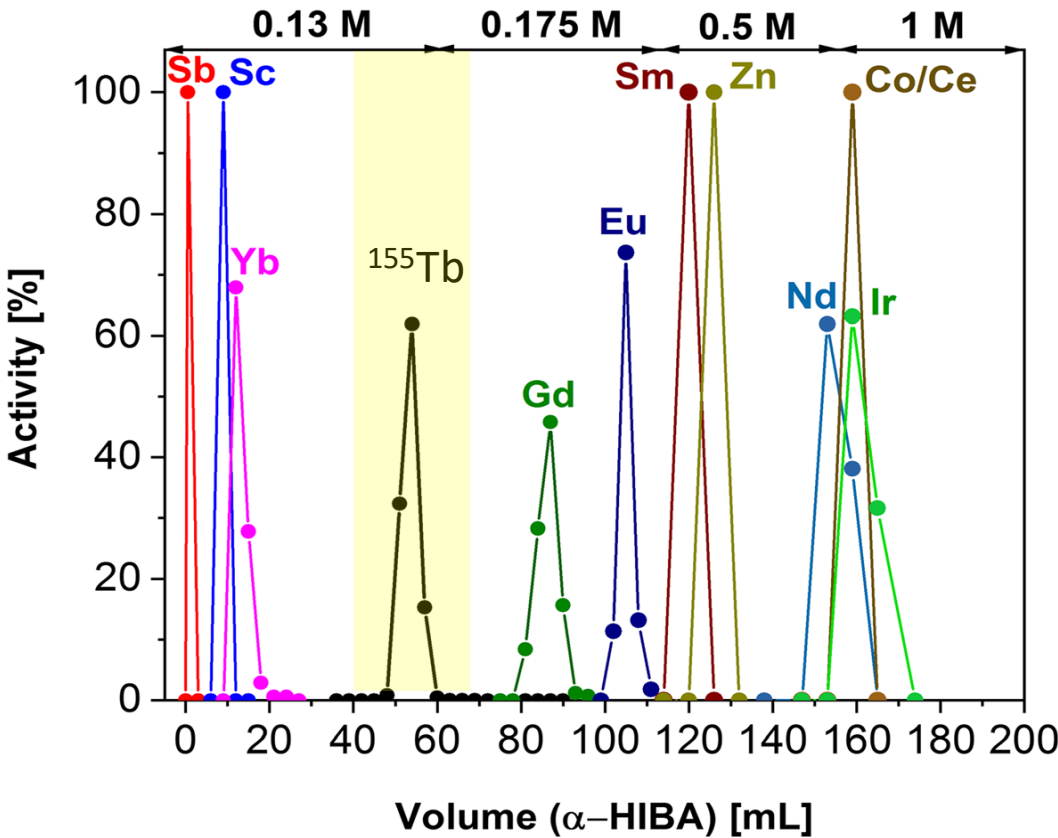
e^-



Centralized production favorable
for long-lived radionuclides !

Production of non-carrier-added Tb-155 at PSI

Tb 155 5.32 d ϵ γ 87, 105, 180 262...	Tb 156 24 h? 5.4 h 5.4 d γ 88 e^- ϵ β^+ ... β^- ?	Tb 157 99 a ϵ γ (54) e^-
Gd 154 2.18 σ 60	Gd 155 14.80 σ 61000 $\sigma_{n,\alpha}$ 8E-5	Gd 156 20 47 σ ~2.0

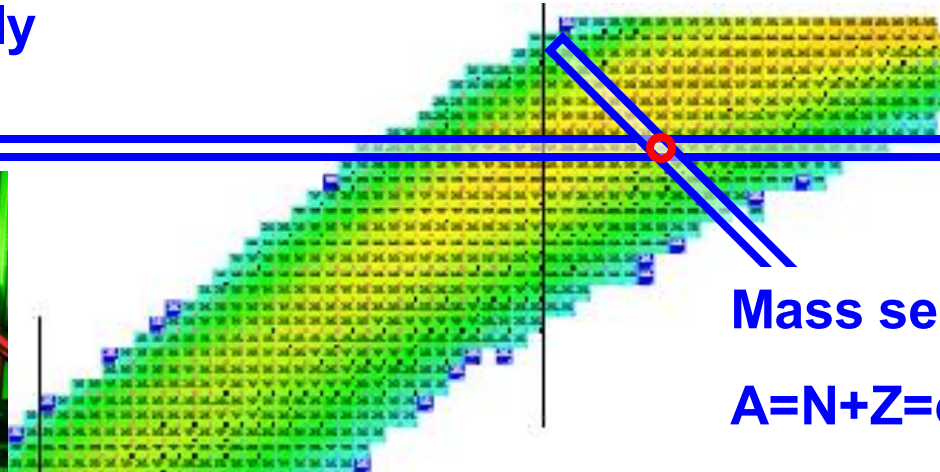
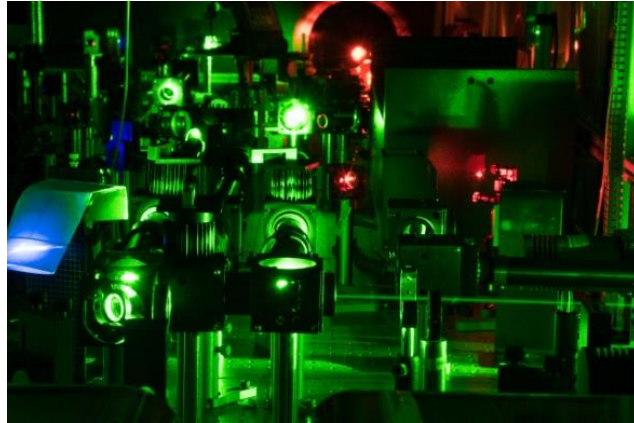
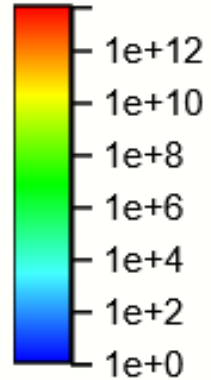


1 Tb-161 atom in $\sim 10^5$ - 10^6 Gd atoms

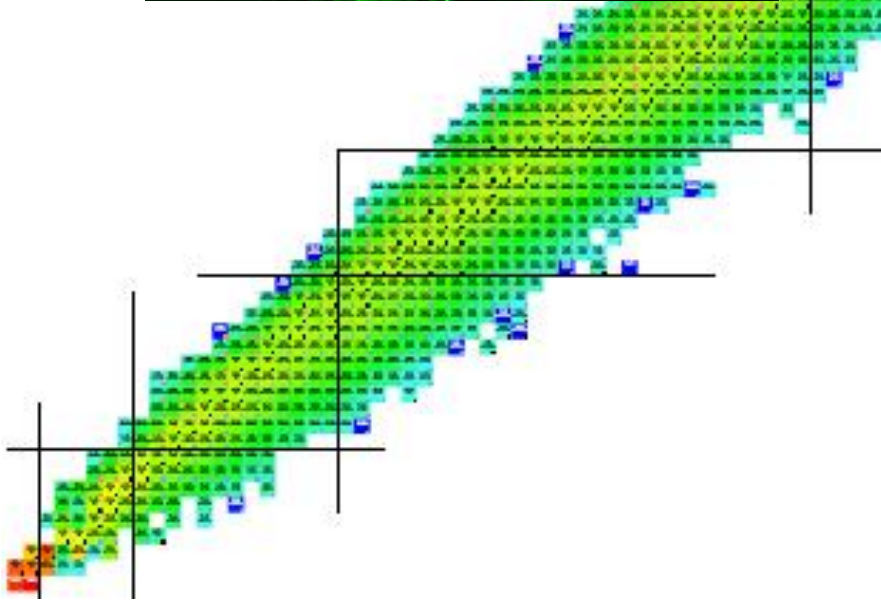
Production of non-carrier-added Tb-155 at CERN

Z selection by chemically selective ionization

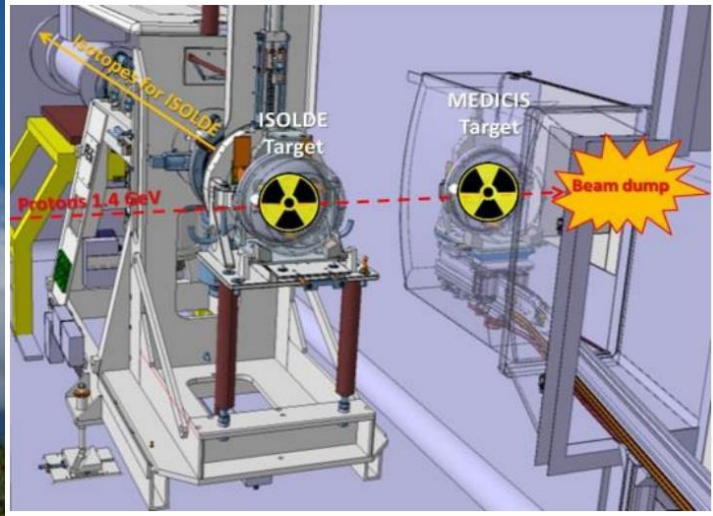
Production (μC^{-1})



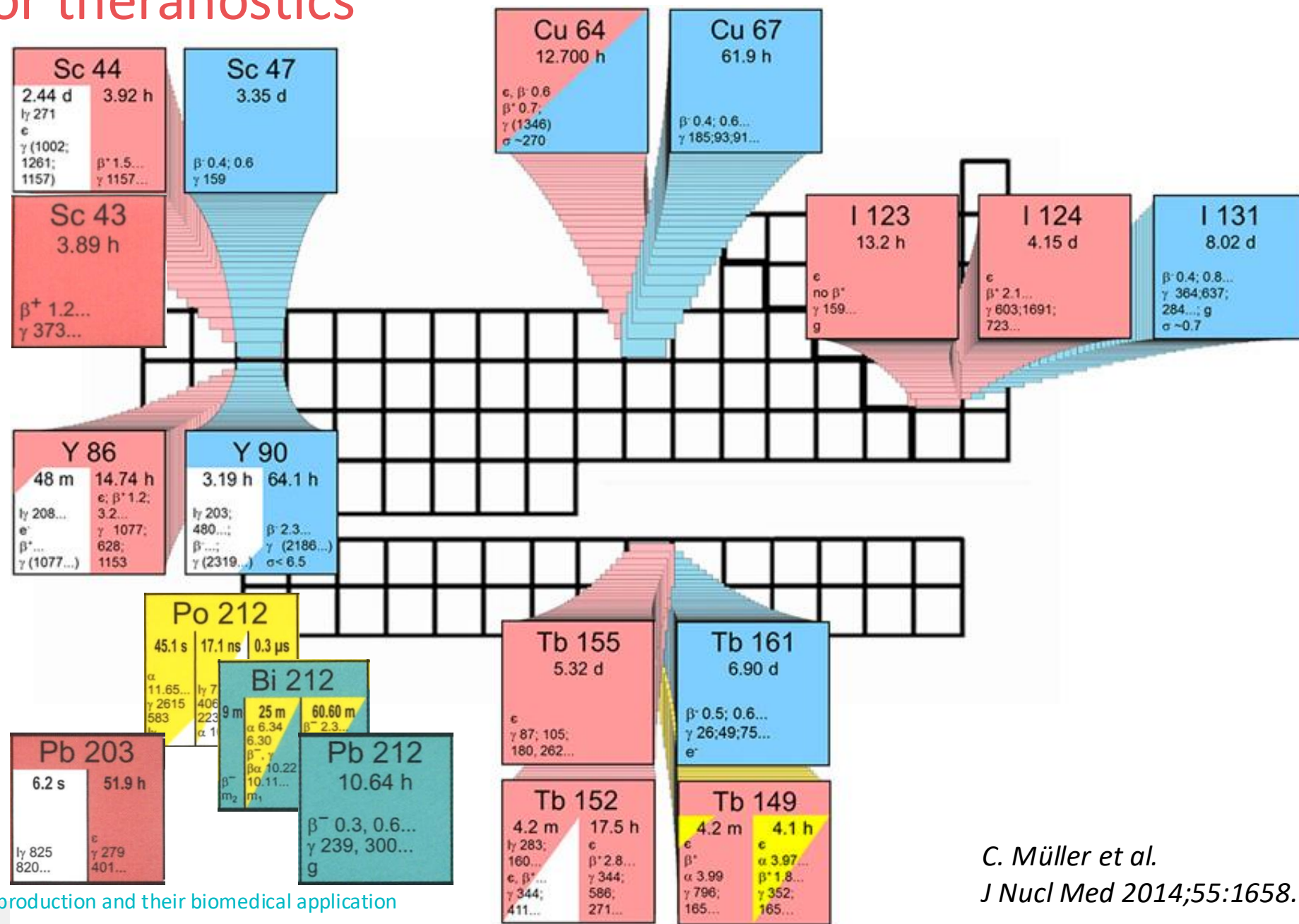
1 A=155 atom in $\sim 10^7$ - 10^8 Ta atoms



A very useful beam dump



Matched pairs for theranostics



C. Müller et al.
J Nucl Med 2014;55:1658.

Production of non-carrier-added Pb-203 and At-211 at ARRONAX

Pb 203 6.2 s 51.9 h γ 825, 820... ϵ γ 279, 401...	Pb 204 67.2 m 1.4 γ 899, 912, 375... σ 0.68	Pb 205 $1.5 \cdot 10^7$ a no γ $\sigma \sim 5$	Pb 206 24.1 σ 0.027
Tl 202 12.23 d ϵ γ 440, (520...)	Tl 203 29.52 σ 11 $\sigma_{n,\alpha} < 0.0003$	Tl 204 3.78 a β^- 0.8 ϵ no γ , g σ 22	Tl 205 70.48 σ 0.11

At 210 8.3 h ϵ , α 5.524, 5.442, 5.361... γ 1181, 245, 1483...	At 211 7.22 h ϵ α 5.867... γ (687...) g	At 212 119 ms α 7.84, 7.90... γ 63... e^-	At 213 0.11 μ s α 7.68, 7.62... γ 63... e^- 9.08
Po 209 102 a α 4.881... ϵ γ (895, 261, 263...)	Po 210 138.38 d α 5.30438... γ (803) $\sigma < 0.0005 + < 0.030$ $\sigma_{n,\alpha}$ 0.002 $\sigma_f < 0.1$	Po 211 25.2 s α 7.275, 8.883... γ 570... σ 106...	Po 212 45.1 s α 11.65... γ 2615, 583 γ 728, 406, 223... α 10.22, 8.785
Bi 208 $3.68 \cdot 10^5$ a ϵ γ 2615	Bi 209 100 $1.9 \cdot 10^{19}$ a α 3.077... σ 0.011 + 0.023 $\sigma_{n,\alpha} < 3E-7$	Bi 210 $3.0 \cdot 10^6$ a α 4.946, 4.908... γ 266, 304... σ 0.054	Bi 211 2.17 m α 6.6229, 6.2788, β^- ... γ 351... $\alpha \rightarrow g$, $\beta^- \rightarrow g$



Production of non-carrier-added Mn-52 and Pd-103 at DTU

Mn 50 1.75 m 283 ms β^+ 3.5 3.7... γ 1098 783 1443... β^+ 6.6... γ (3626 2844)	Mn 51 46.2 m β^+ 2.2... γ (749...)	Mn 52 21 m 5.6 d β^+ 2.6... γ 1434... γ 378 ϵ β^+ 0.6... γ 1434 936, 744... ϵ no γ σ 70	Mn 53 3.7·10 ⁶ a ϵ no γ σ 70
Cr 49 42 m β^+ 1.4, 1.5... γ 91, 153, 62...	Cr 50 4.345 σ 15	Cr 51 27.7010 d ϵ γ 320 σ < 10	Cr 52 83.189 σ 0.8

Pd 102 1.02 σ 3.2	Pd 103 16.991 d ϵ γ (357...) m	Pd 104 11.14
Rh 101 4.4 d 3.3 a ϵ γ 307 545... γ 157	Rh 102 2.9 a 207 d ϵ γ 475, 631 697... γ (42), e^- ϵ β^+ 1.3 β^- 1.2 γ 475 628...	Rh 103 56.1 m 100 γ (40) e^- σ 11 + 134



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FOLLOW MARIA SALOMEA'S FOOTSTEPS !



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[PRISMAP PROJECT](#)



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