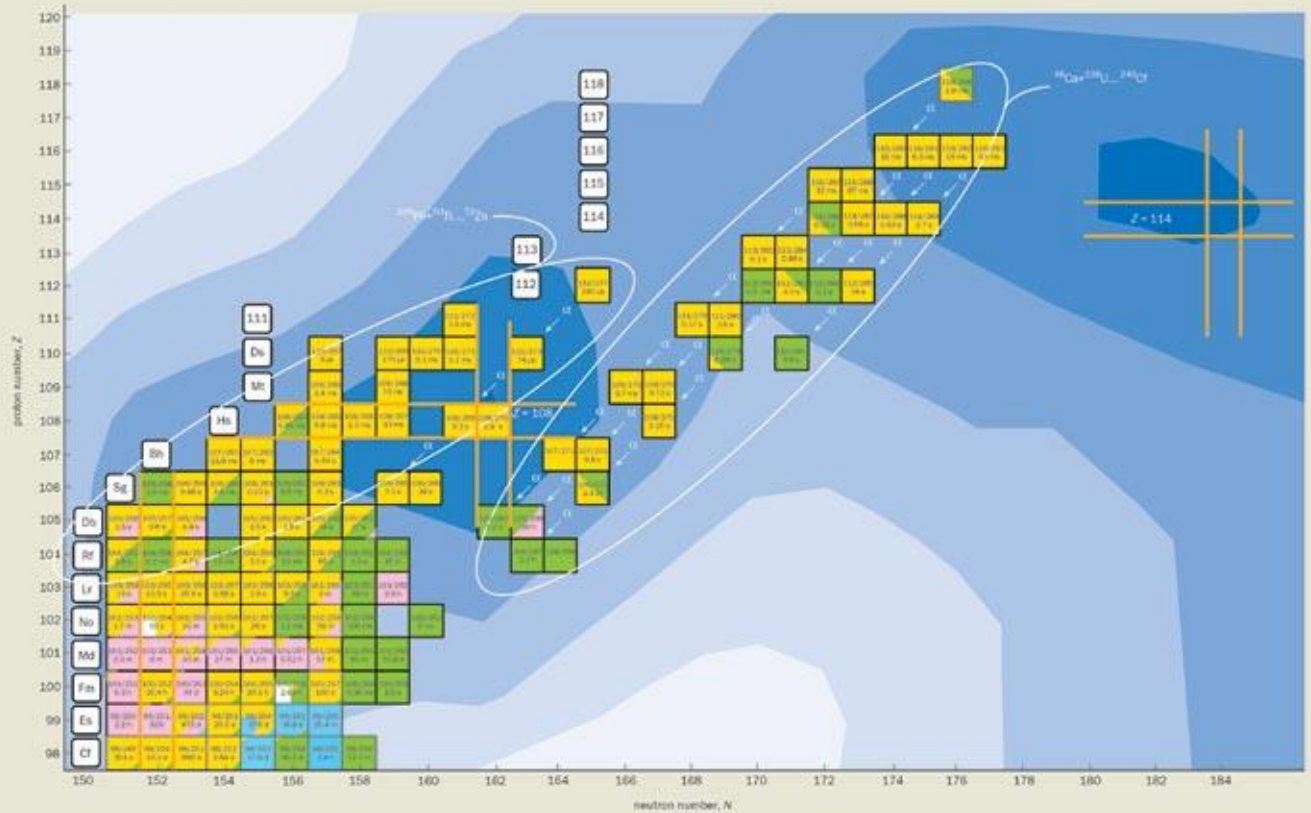
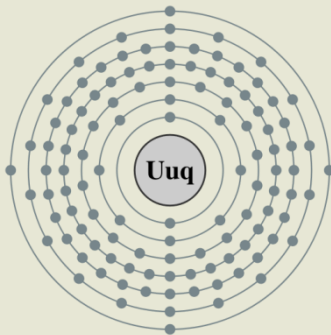


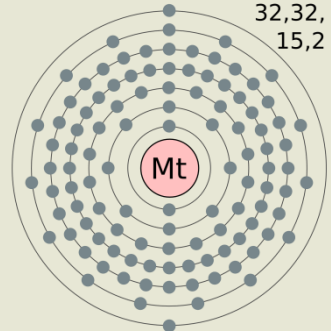
Szupernehéz elemek előállításása



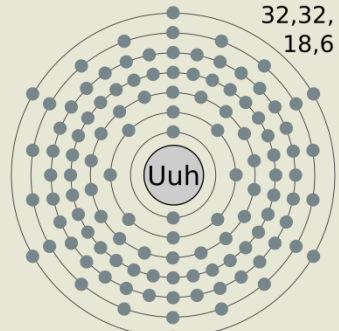
114: Ununquadium 2,8,18,32,32,18,4



109: Meitnrium 2,8,18,32,32,15,2

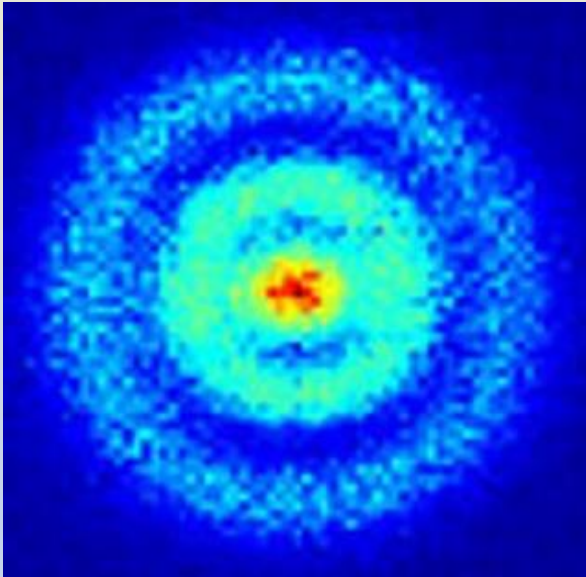


116: Ununhexium 2,8,18,32,32,18,6

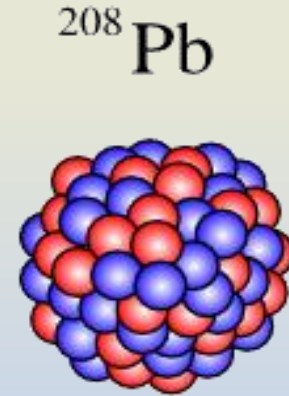
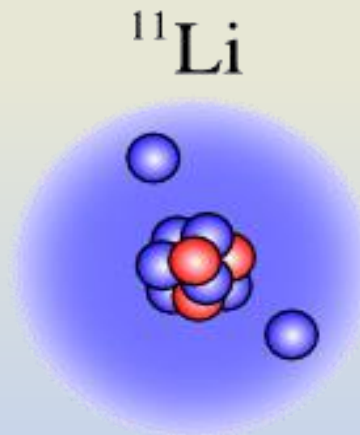


Szokody Márk

Atom - Atommag



Hidrogénatom



Z: rendszám (protonok száma)

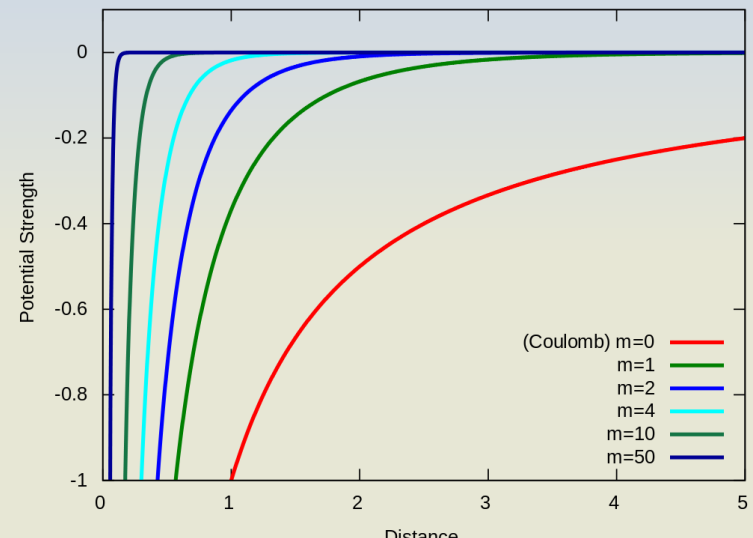
N: neutronsám

A = N+Z Tömegszám (nukleonok száma)

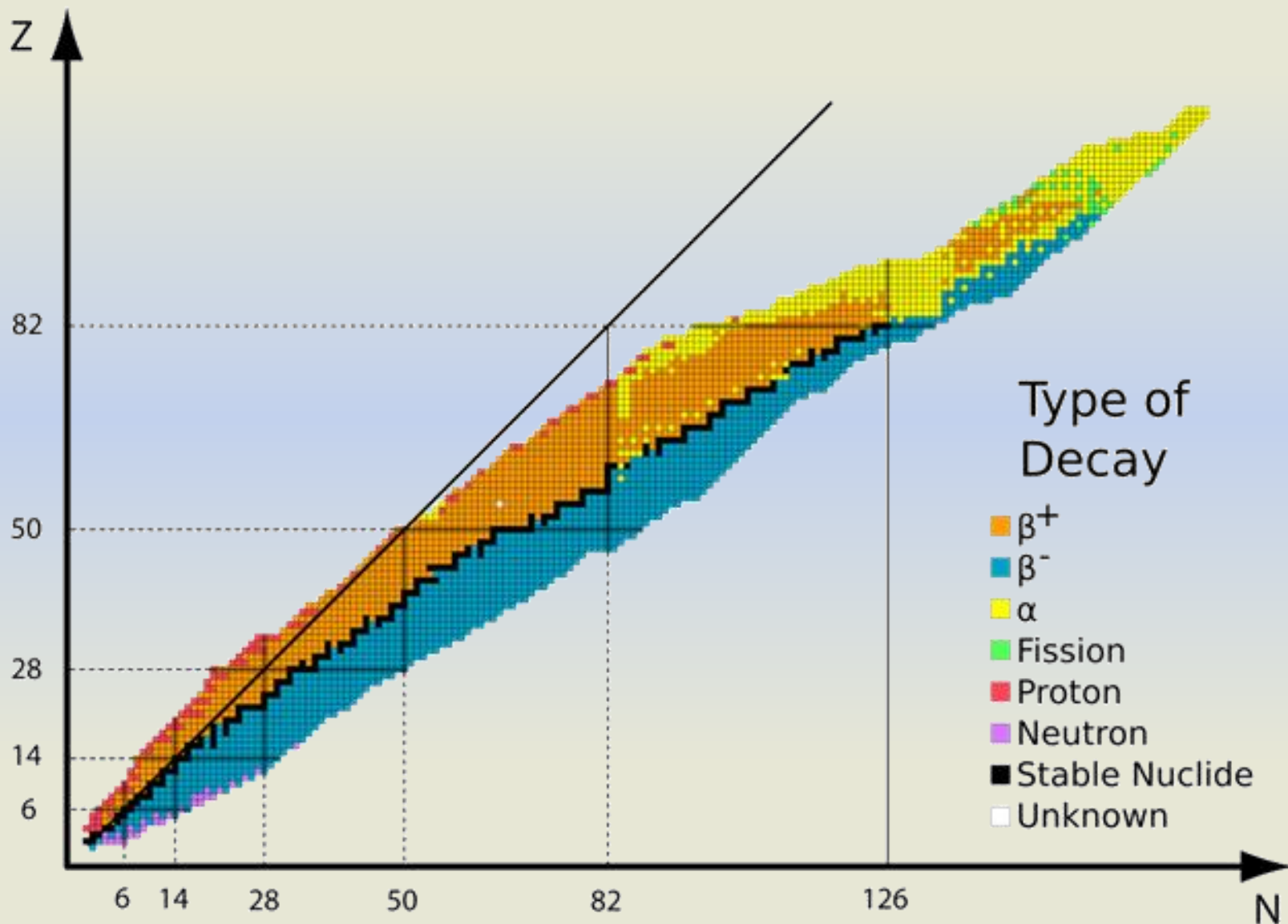
Magerők:

- Másodlagos erős kölcsönhatás
- Kis hatótávolság
- Yukawa-potenciál:

$$V(r) \sim \frac{e^{\alpha r}}{r}, \quad \alpha = k \cdot m$$



Izotóptérkép

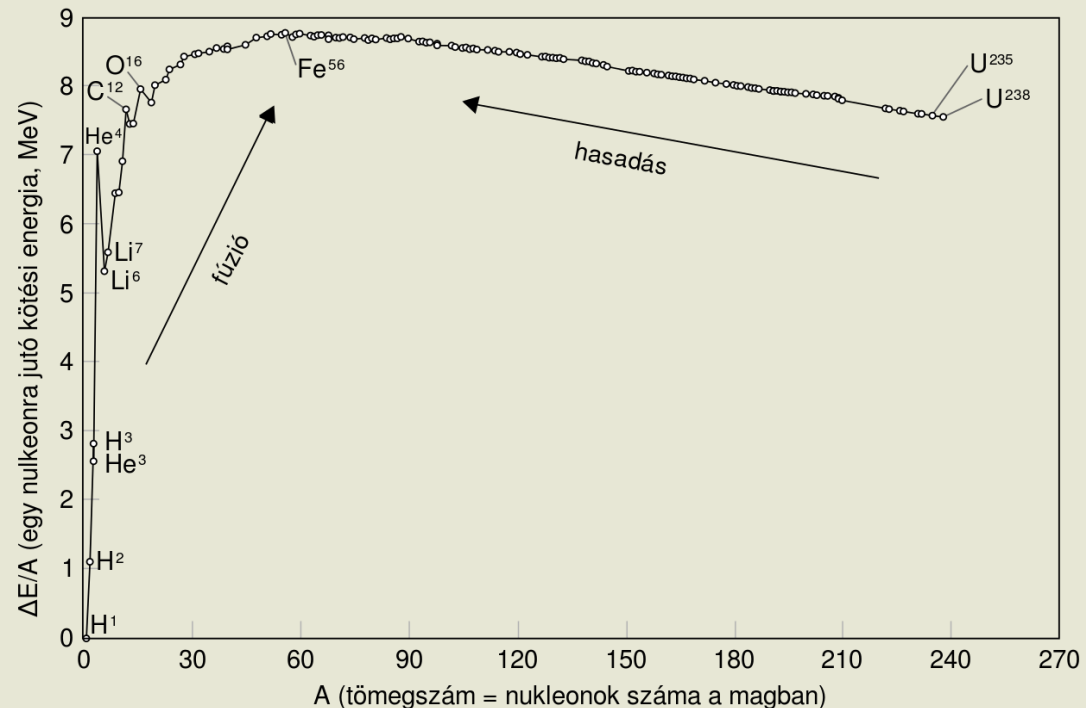
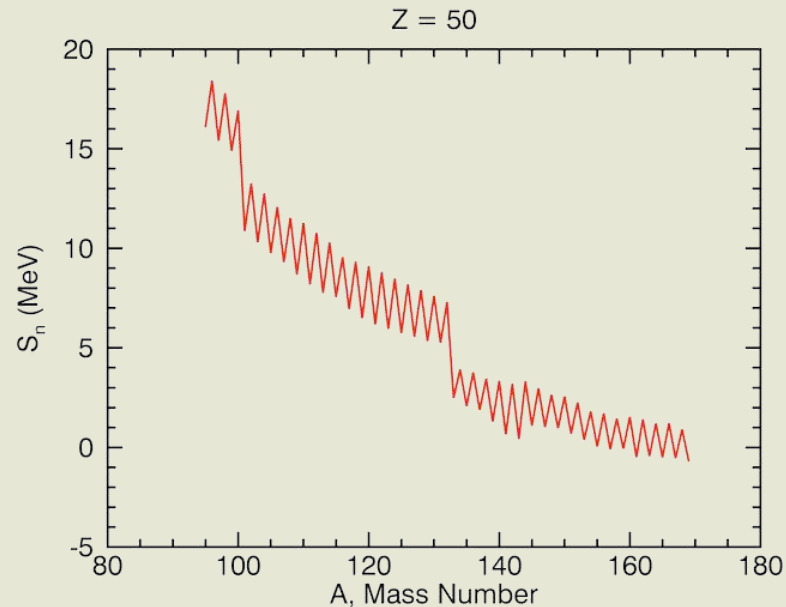


Egy nukleonra jutó kötési energia

Félempirikus kötési formula:

$$E_{kot} = a_V A - a_S A^{2/3} - a_C \frac{Z(Z-1)}{A^{1/3}} - a_A \frac{(A-2Z)^2}{A} + \delta(A, Z)$$

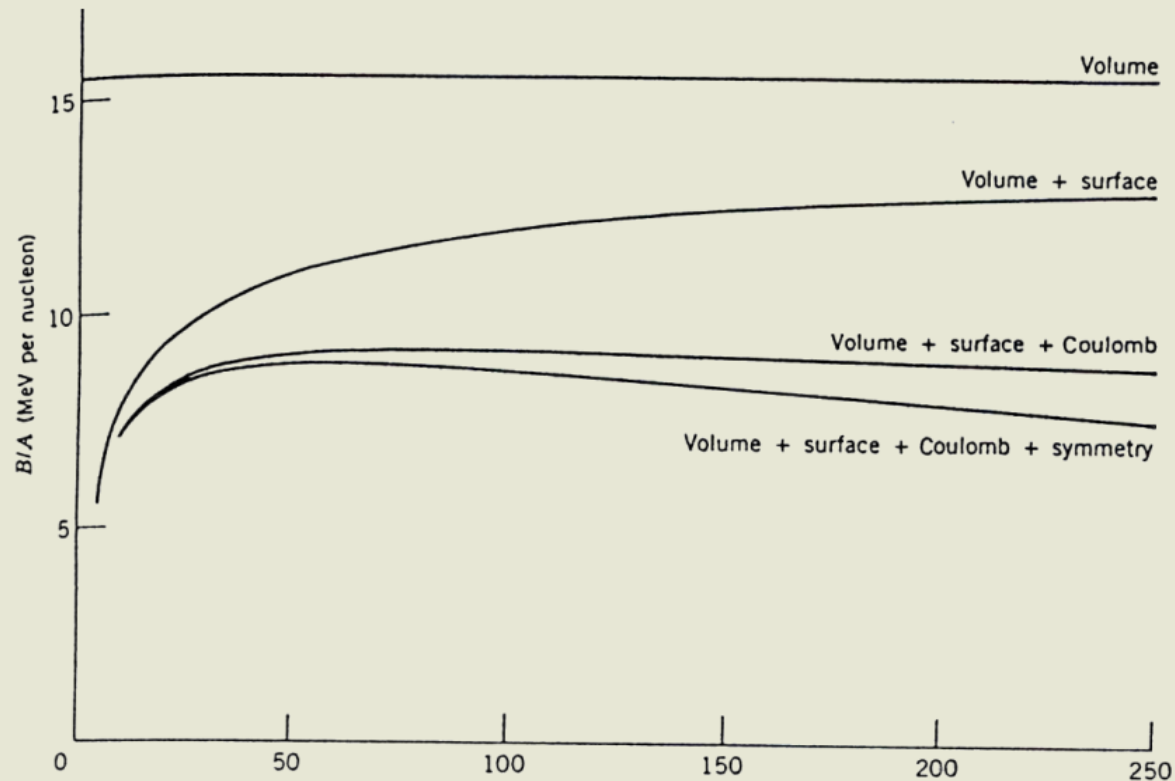
Neutron szeparációs energia:



Egy nukleonra jutó kötési energia

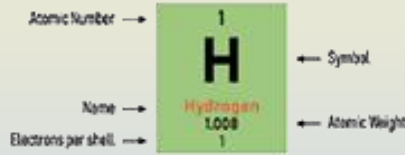
$$E_{kot} = a_V A - a_S A^{2/3} - a_C \frac{Z(Z-1)}{A^{1/3}} - a_A \frac{(A-2Z)^2}{A} + \delta(A, Z)$$

$$\left. \frac{\partial E_{nukleon}}{\partial Z} \right|_{A=const} = 0 \Rightarrow Z^* \approx \frac{A}{2} \cdot \frac{1}{1 + \frac{a_C}{4a_A} A^{2/3}}$$



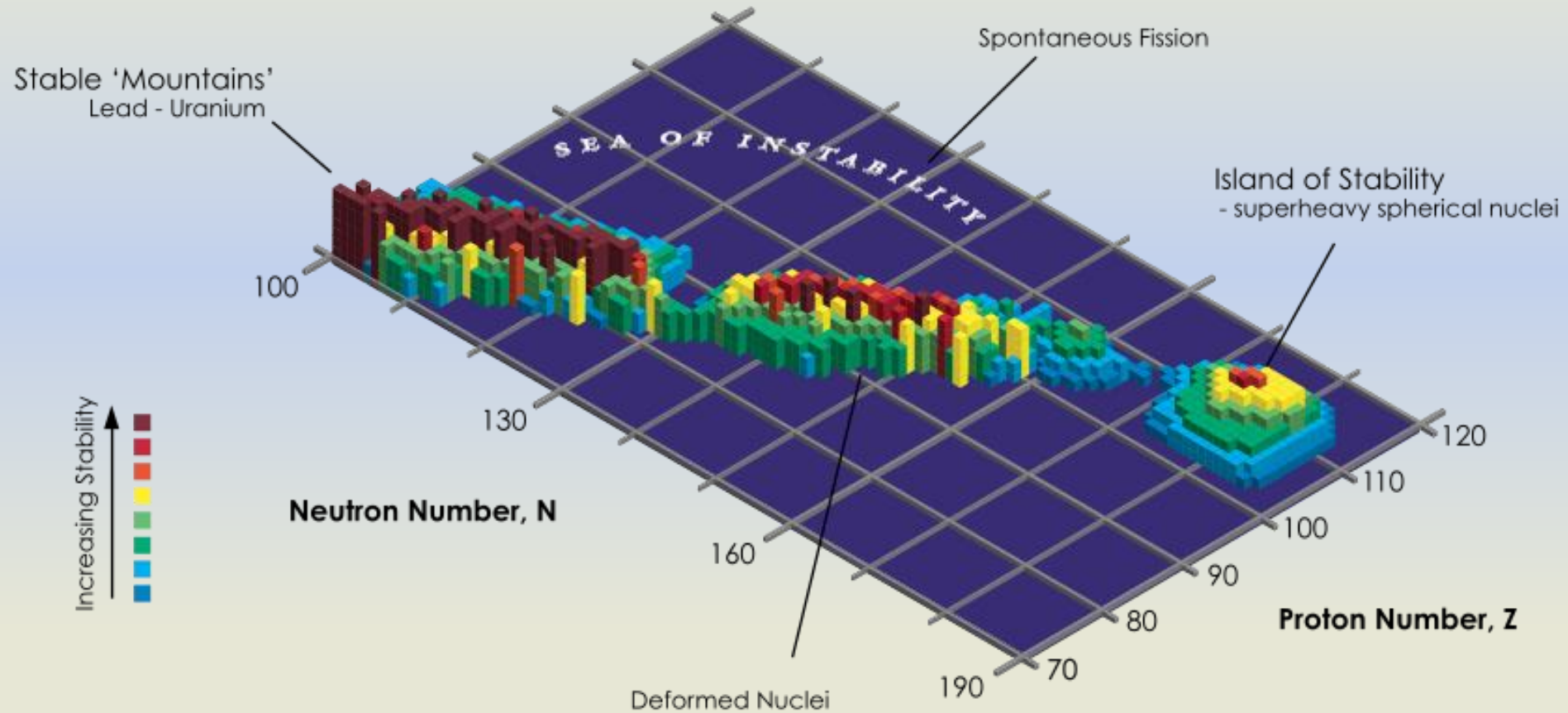
Periódusos rendszer

1 1A H Hydrogen 1.008 1																	18 VIIIA He Helium 4.0026 2
3 Li Lithium 6.941 3	4 Be Beryllium 9.0122 4											5 B Boron 10.81 5	6 C Carbon 12.011 6	7 N Nitrogen 14.007 7	8 O Oxygen 15.999 8	9 F Fluorine 18.998 9	10 Ne Neon 20.180 10
11 Na Sodium 22.98976928 11	12 Mg Magnesium 24.305 12	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IIB	13 Al Aluminium 26.982 13	14 Si Silicon 28.0855 14	15 P Phosphorus 30.974 15	16 S Sulfur 32.06 16	17 Cl Chlorine 35.45 17	18 Ar Argon 39.948 18
19 K Potassium 39.0983 19	20 Ca Calcium 40.078 20	21 Sc Scandium 44.955908 21	22 Ti Titanium 47.887 22	23 V Vanadium 50.9415 23	24 Cr Chromium 51.9961 24	25 Mn Manganese 54.938044 25	26 Fe Iron 55.845 26	27 Co Cobalt 58.933 27	28 Ni Nickel 58.693 28	29 Cu Copper 63.546 29	30 Zn Zinc 65.38 30	31 Ga Gallium 69.723 31	32 Ge Germanium 72.6305 32	33 As Arsenic 74.9216 33	34 Se Selenium 78.9718 34	35 Br Bromine 79.904 35	36 Kr Krypton 83.798 36
37 Rb Rubidium 85.4678 37	38 Sr Strontium 87.62 38	39 Y Yttrium 88.90584 39	40 Zr Zirconium 91.224 40	41 Nb Niobium 92.90637 41	42 Mo Molybdenum 95.95 42	43 Tc Technetium (98) 98.90625 43	44 Ru Ruthenium 101.07 44	45 Rh Rhodium 102.91 45	46 Pd Palladium 106.42 46	47 Ag Silver 107.87 47	48 Cd Cadmium 112.41 48	49 In Indium 114.82 49	50 Sn Tin 118.710 50	51 Sb Antimony 121.76 51	52 Te Tellurium 127.60 52	53 I Iodine 126.91 53	54 Xe Xenon 131.29 54
55 Cs Cesium 132.90545196 55	56 Ba Barium 137.327 56	57-71 Lanthanides	72 Hf Hafnium 178.49 72	73 Ta Tantalum 180.94788 73	74 W Tungsten 183.85 74	75 Re Rhenium 186.21 75	76 Os Osmium 192.22 76	77 Ir Iridium 192.22 77	78 Pt Platinum 195.08 78	79 Au Gold 196.966569 79	80 Hg Mercury 200.59 80	81 Tl Thallium 204.38 81	82 Pb Lead 207.2 82	83 Bi Bismuth 208.9804 83	84 Po Polonium 209 84	85 At Astatine (210) 210 85	86 Rn Radon (222) 222 86
87 Fr Francium (223) 223 87	88 Ra Radium (226) 226 88	89-103 Actinides	104 Rf Rutherfordium (261) 261 104	105 Db Dubnium (262) 262 105	106 Sg Seaborgium (263) 263 106	107 Bh Bohrium (264) 264 107	108 Hs Hassium (270) 270 108	109 Mt Meitnerium (270) 270 109	110 Ds Darmstadtium (285) 285 110	111 Rg Roentgenium (288) 288 111	112 Cn Copernicium (285) 285 112	113 Nh Nihonium (284) 284 113	114 Fl Flerovium (289) 289 114	115 Mc Moscovium (288) 288 115	116 Lv Livermorium (293) 293 116	117 Ts Tennessine (294) 294 117	118 Og Oganesson (294) 294 118
57 La Lanthanum 138.905 57	58 Ce Cerium 140.12 58	59 Pr Praseodymium 140.90766 59	60 Nd Neodymium 144.24 60	61 Pm Promethium (145) 145 61	62 Sm Samarium 150.36 62	63 Eu Europium 151.964 63	64 Gd Gadolinium 157.25 64	65 Tb Terbium 158.92534 65	66 Dy Dysprosium 162.50 66	67 Ho Holmium 164.93032 67	68 Er Erbium 167.259 68	69 Tm Thulium 168.93002 69	70 Yb Ytterbium 173.0547 70	71 Lu Lutetium 174.967 71			
89 Ac Actinium (227) 227 89	90 Th Thorium 232.04 90	91 Pa Protactinium 231.04 91	92 U Uranium 238.03 92	93 Np Neptunium (237) 237 93	94 Pu Plutonium (244) 244 94	95 Am Americium (243) 243 95	96 Cm Curium (247) 247 96	97 Bk Berkelium (247) 247 97	98 Cf Californium (251) 251 98	99 Es Einsteinium (252) 252 99	100 Fm Fermium (257) 257 100	101 Md Mendelevium (258) 258 101	102 No Nobelium (259) 259 102	103 Lr Lawrencium (260) 260 103			



- State of matter (color of name)
 GAS LIQUID SOLID UNKNOWN
- Subcategory in the metal-metalloid-nonmetal trend (color of background)
 Alkali metals Lanthanides Metalloids Unknown chemical properties
 Alkaline earth metals Actinides Reactive nonmetals
 Transition metals Post-transition metals Noble gases

Stabilitás szigete



Transzurán elemek



Element name ↕	Chemical Symbol ↕	Atomic Number ↕	First definite synthesis ↕
Americium	Am	95	1944
Curium	Cm	96	1944
Berkelium	Bk	97	1949
Californium	Cf	98	1950
Einsteinium	Es	99	1952
Fermium	Fm	100	1952
Mendelevium	Md	101	1955
Nobelium	No	102	1966
Lawrencium	Lr	103	1971



Transzaktinoidák = Szupernehéz elemek

Periodic table of the elements

$Z \geq 104$: transactinide elements
superheavy elements

1																	18
1																	2
H																	He
3	4											5	6	7	8	9	10
Li	Be											B	C	N	O	F	Ne
11	12											13	14	15	16	17	18
Na	Mg											Al	Si	P	S	Cl	Ar
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116		118
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	112	113	114	115	116		118
Lanthanides	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71		
	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
Actinides	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103		
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

Szupernehéz elemek előállítása

U400 gyorsítókomplexum , Flerov Laboratory of Nuclear Reactions (Dubna)



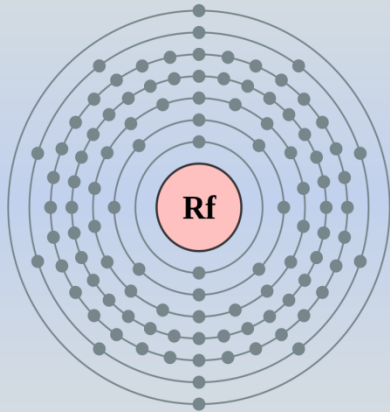
Szupernehéz elemek előállítása

Z = 104 - 106

„Forró” nehézion-indukált fúzió:

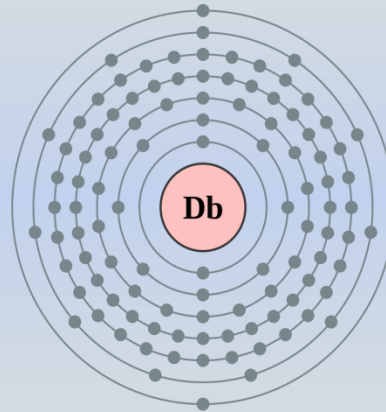
Dubna

104: Rutherfordium 2,8,18,32,32,10,2



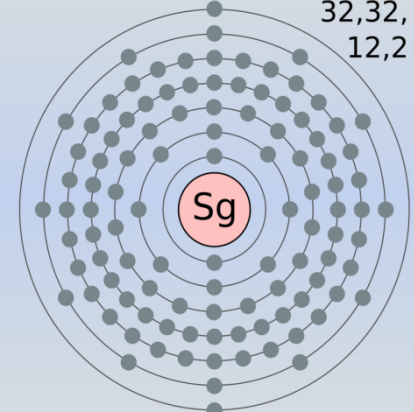
3-4s felezési idő

105: Dubnium 2,8,18,32,32,11,2



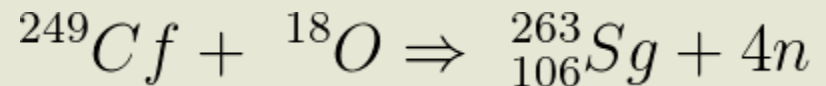
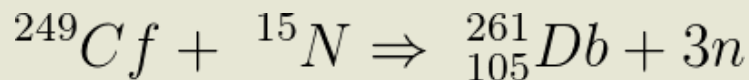
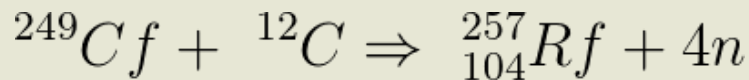
1.6s felezési idő

106: Seaborgium 2,8,18,32,32,12,2



1s felezési idő

Néhány reakció:



Szupernehéz elemek előállítása

Z = 107 - 113

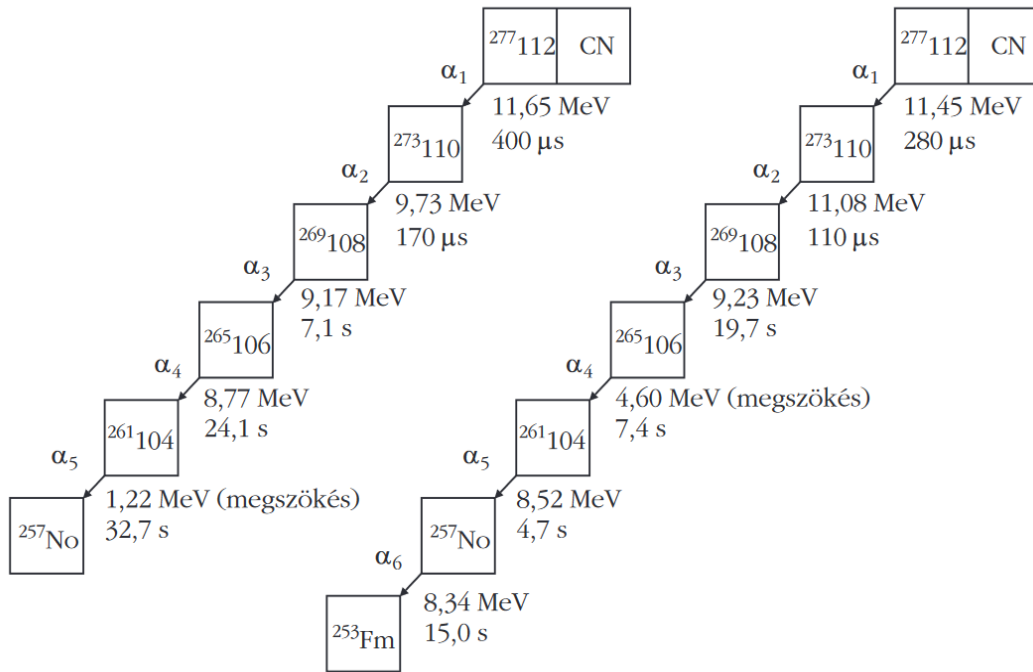
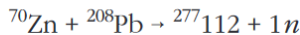
Dubna, RIKEN, GSI

„Hideg” nehézion-indukált fúzió:

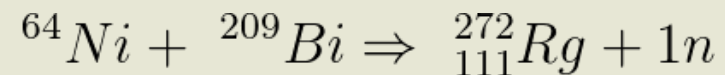
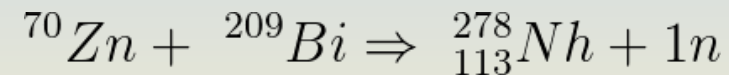
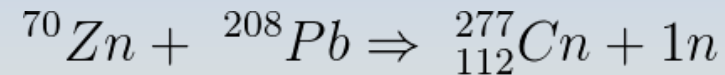
Bizmut és ólom targetek és Zn, Ca, Na, Ni nyaláb (lezárt vagy majdnem zárt héjak)

1pb körüli hatáskeresztmetszet, azaz 1-2 esemény 24 órás folyamatos besugárzás esetén

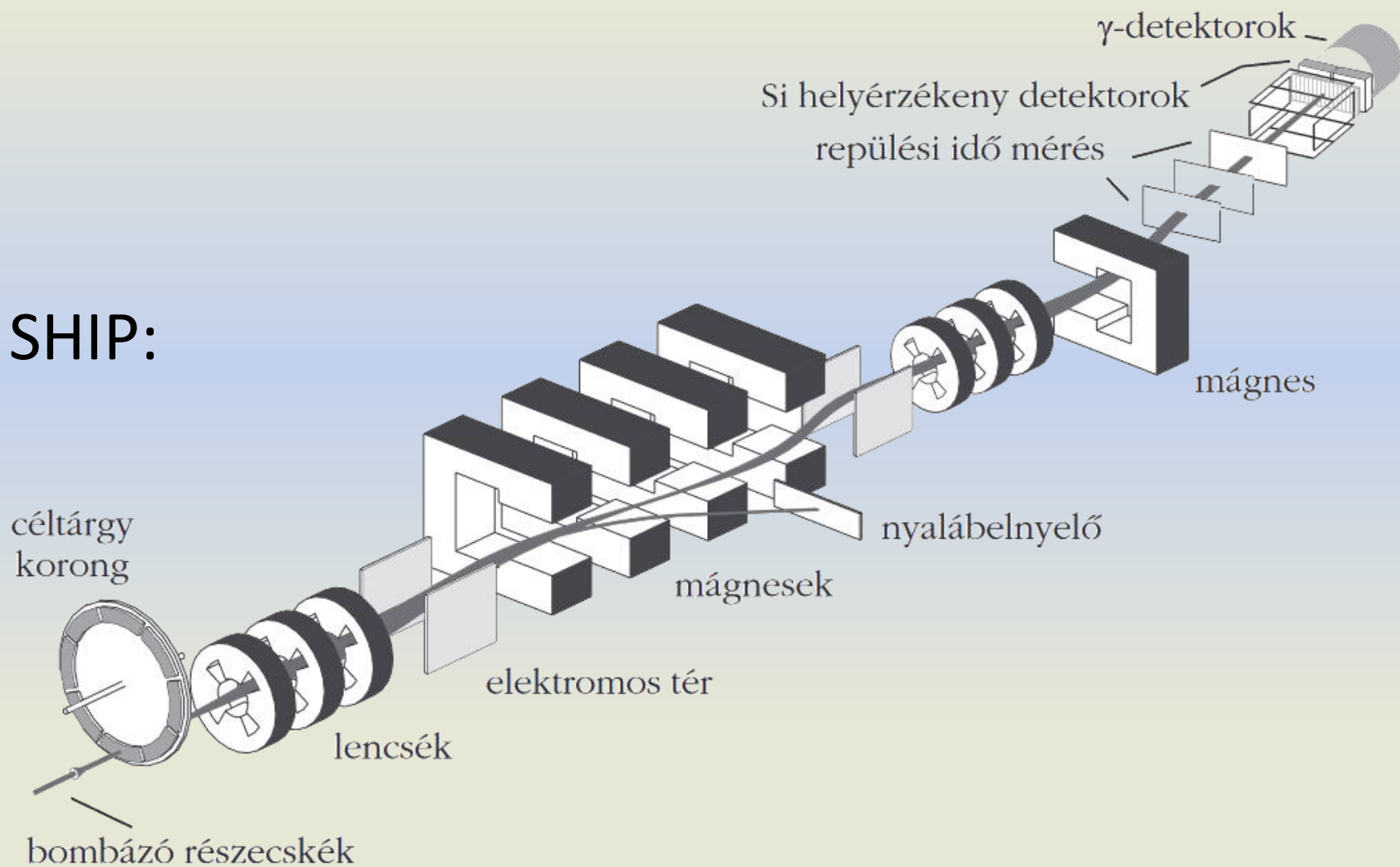
Azonosítás bomlási láncon keresztül:



Néhány reakció:



Szupernehéz elemek előállítása



Szupernehéz elemek előállítása

Z = 114 - 118

Dubna, GSI

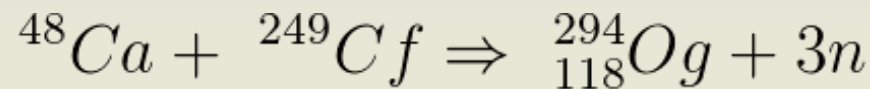
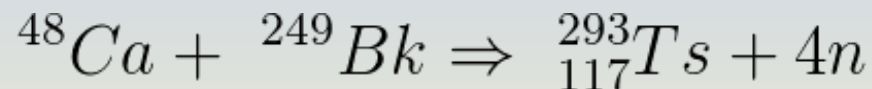
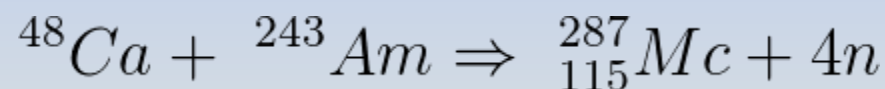
„Forró” nehézion-indukált fúzió:

Nagyenergiájú Ca nyalábbal bombáznak nehéz aktinoida célpontot.

Berkélium céltárgy:



Néhány reakció:



Szupernehéz elemek előállításása

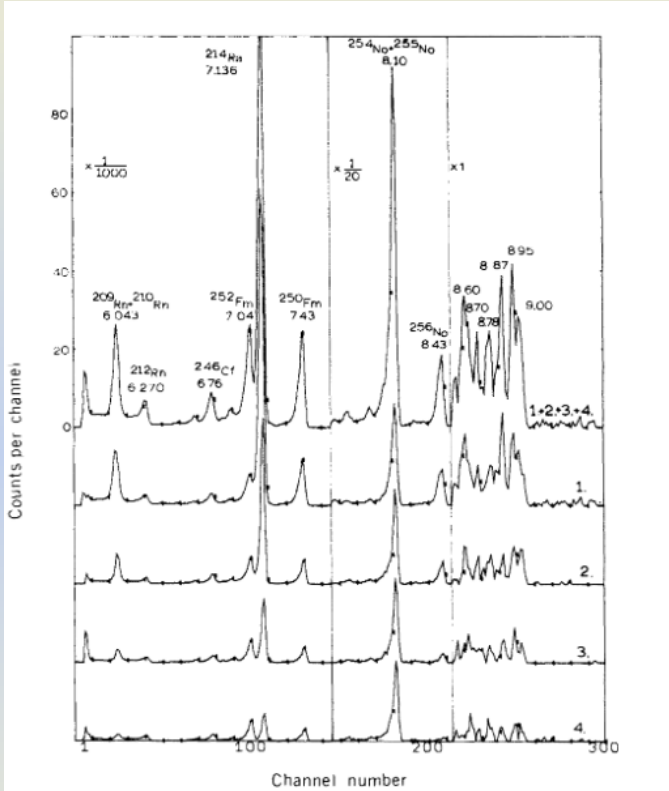
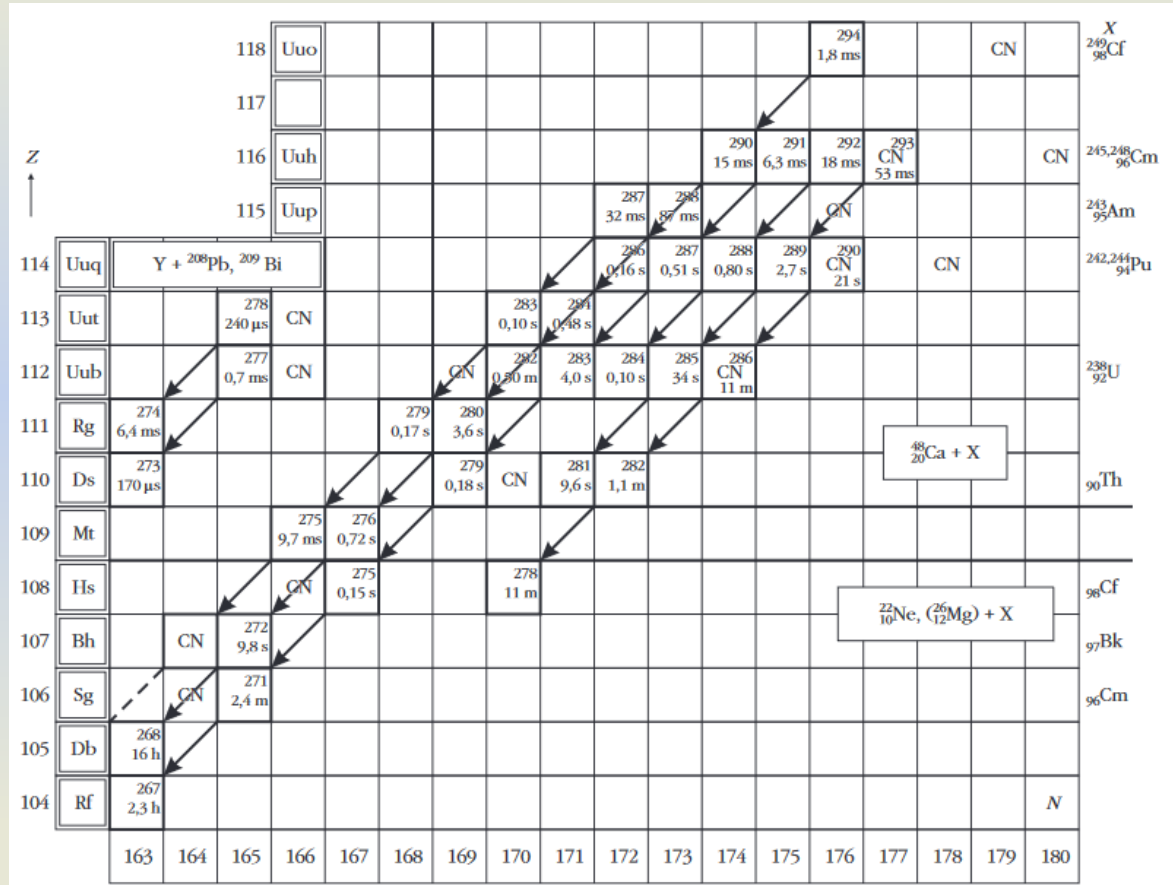


FIG. 1. A series of alpha spectra of the activities produced by bombardment of ^{249}Cf with 71-MeV ^{12}C ions. The top spectrum is the sum of the individual spectra from the four detectors. The 8.60-MeV peak is probably due to ^{258}Lr ; the peaks above that energy belong to $^{257}104$ with the exception of the one at 8.87 MeV whose origin is uncertain.



Köszönöm a figyelmet!

Források:

- <http://fizikaiszemle.hu/archivum/fsz0812/Fenyest.pdf>
- <https://journals.aps.org/prl/transuranium-elements-and-the-physical-review>
- <https://en.wikipedia.org>
- https://mta.hu/tudomany_hirei/a-nemregen-felfedezett-kemiai-elemek-magyar-neve-109907
- <http://flerovlab.jinr.ru>
- <https://www.enfo.hu>
- <https://physicsworld.com/a/superheavy-elements/>
- <https://www.sciencenewsforstudents.org/blog/scientists-say/scientists-say-periodic-table>
- <http://atomfizika.elte.hu/mrf/mrf.html>
- <https://www.geek.com/news/researchers-capture-image-of-hydrogen-atoms-electron-orbital-for-first-time-1556448/>
- https://www.researchgate.net/figure/Photograph-of-the-HILAC-and-BEVALAC-in-Berkeley_fig2_235222455