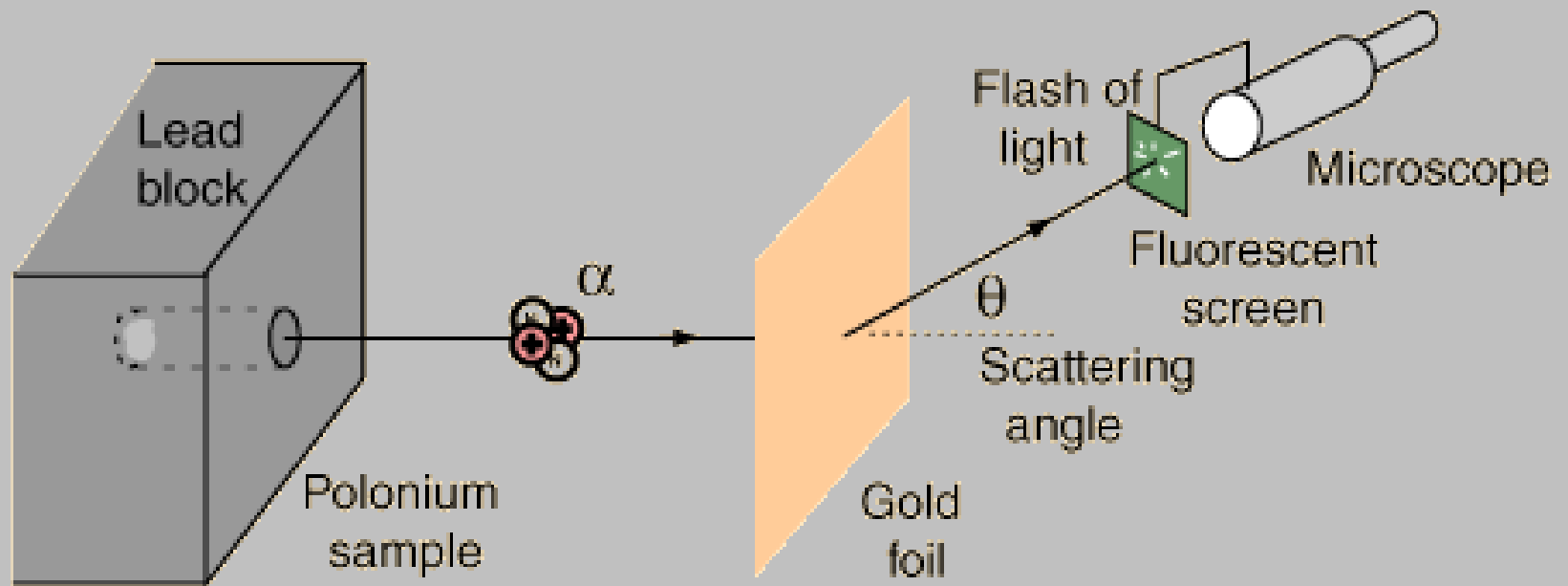
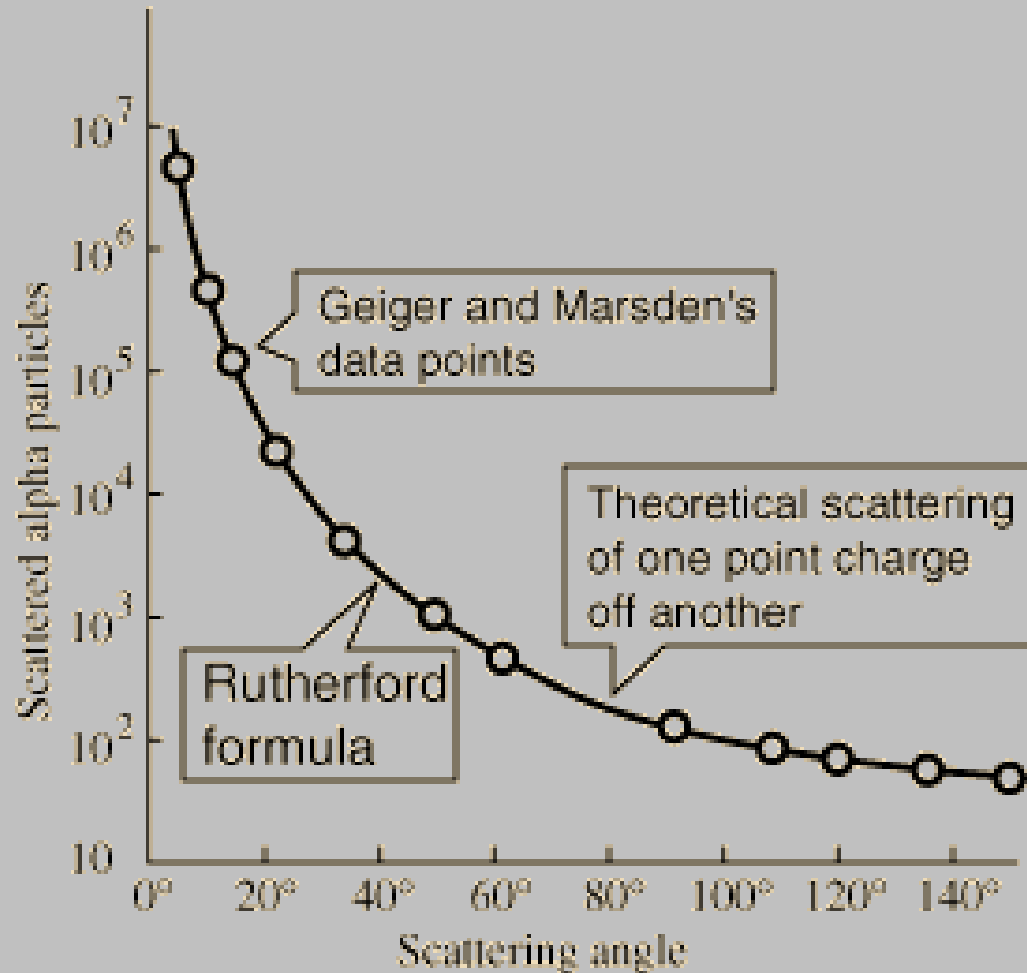


Rutherfordův rozptyl: α částice (7.7 MeV) na Au
Geiger, Marsden + Rutherfordova interpretace, 1909-1913



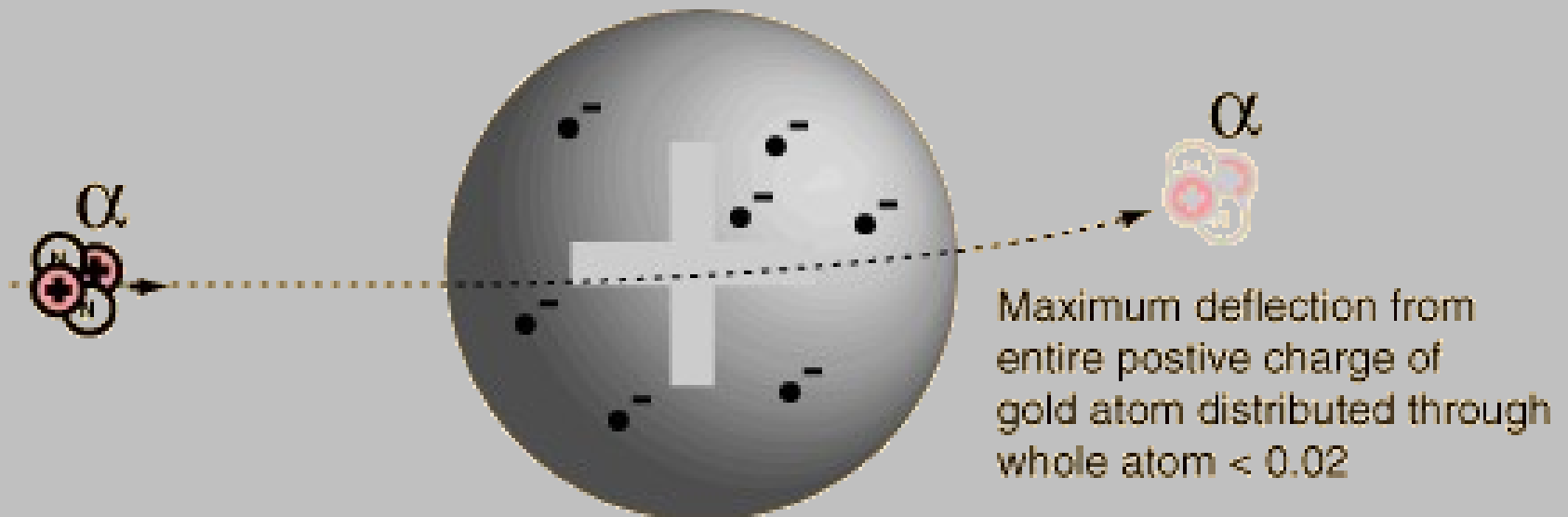
Rutherfordův rozptyl: α částice (7.7 MeV) na Au:
zhruba rozptyl na „bodovém“ náboji



Rutherfordův rozptyl s Thomsonovým modelem atomu („hrozinkový puding“):
zanedbatelný rozptyl zpět

Rutherford's remark:

"It was quite the most incredible event that ever happened to me in my life. It was almost as incredible as if you had fired a 15-inch shell at a piece of tissue paper and it came back and hit you."



Rutherfordův rozptyl s max. energií 7.7 MeV na lehkých jádrech (Al): odhad rozměrů jádra

A famous remark by Rutherford to his graduate students

"There is no money for apparatus -. we shall have to use our heads!"

(dnešní údaj: 3.6 fm)

Diagram illustrating the Rutherford scattering experiment setup. An alpha particle (α) with kinetic energy $KE = 7.7 \text{ MeV}$ is shown approaching an aluminum nucleus (Al , $Z = 13$). The distance of closest approach is labeled r_{\min} .

The potential energy equation is given as:

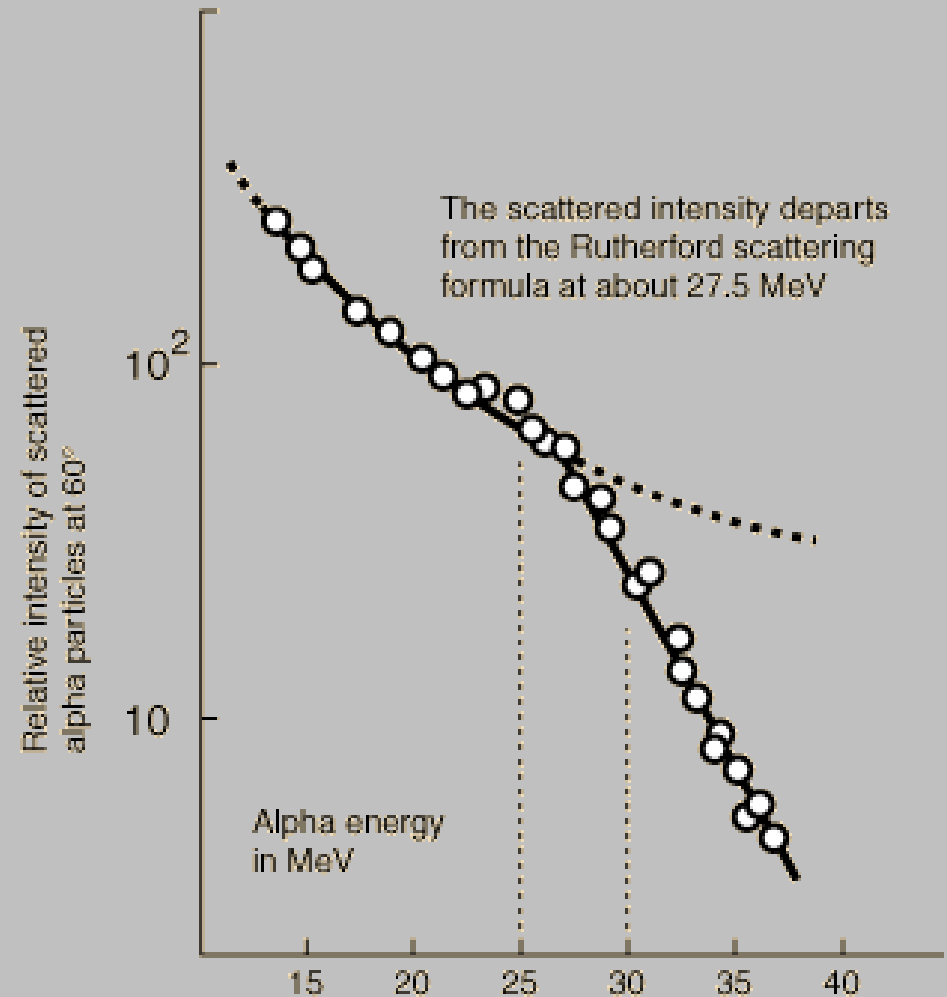
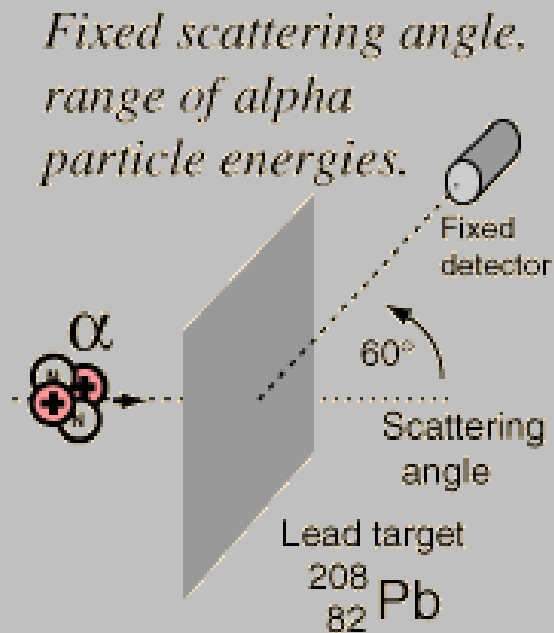
$$PE = \frac{ke^2(2)(13)}{r_{\min}}$$

The calculation for r_{\min} is shown as:

$$r_{\min} = \frac{ke^2 Z_1 Z_2}{KE} = \frac{(1.44 \text{ MeV} \cdot \text{fm})(2)(13)}{7.7 \text{ MeV}}$$

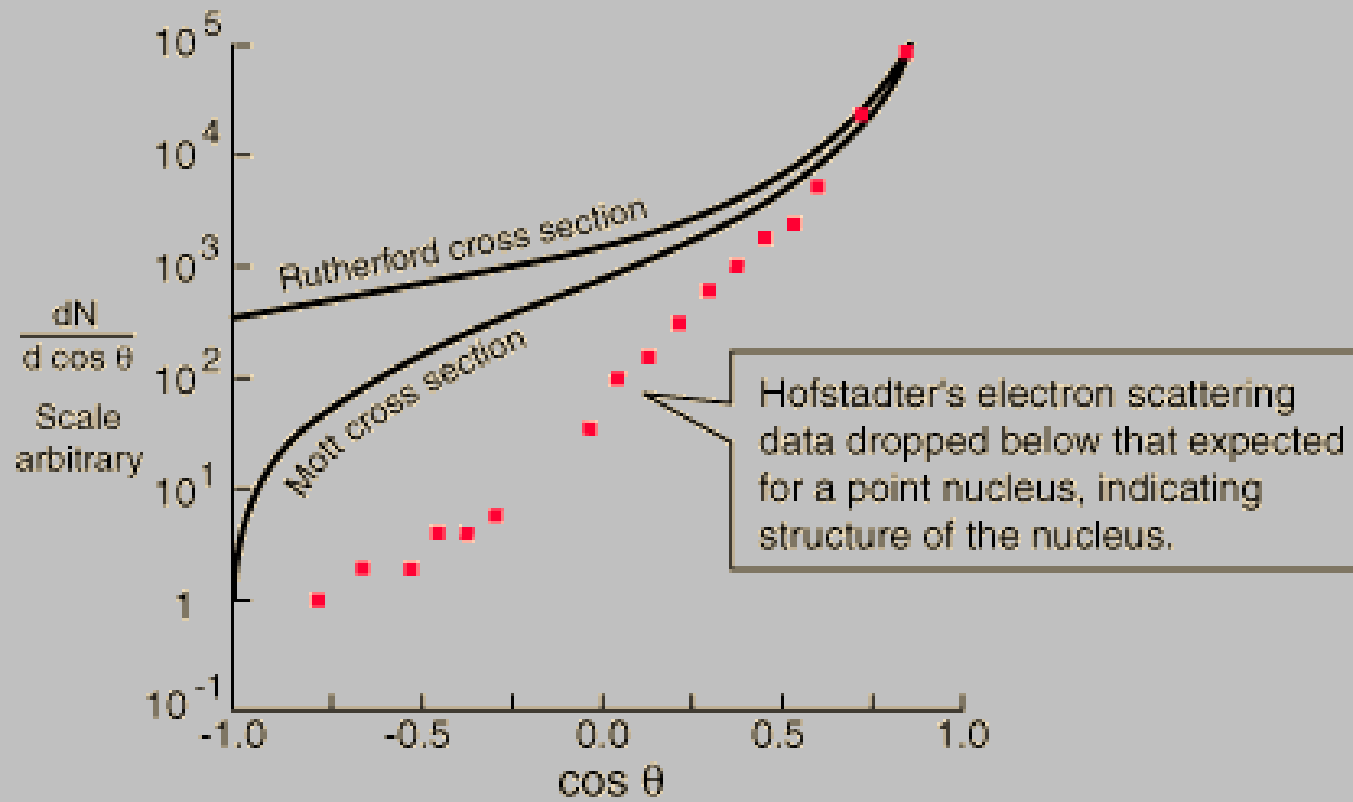
$$r_{\min} = 4.86 \text{ fermi} = 4.86 \times 10^{-15} \text{ m}$$

Rutherfordův rozptyl s velkou energií (Eisberg&Porter, Brookhaven)

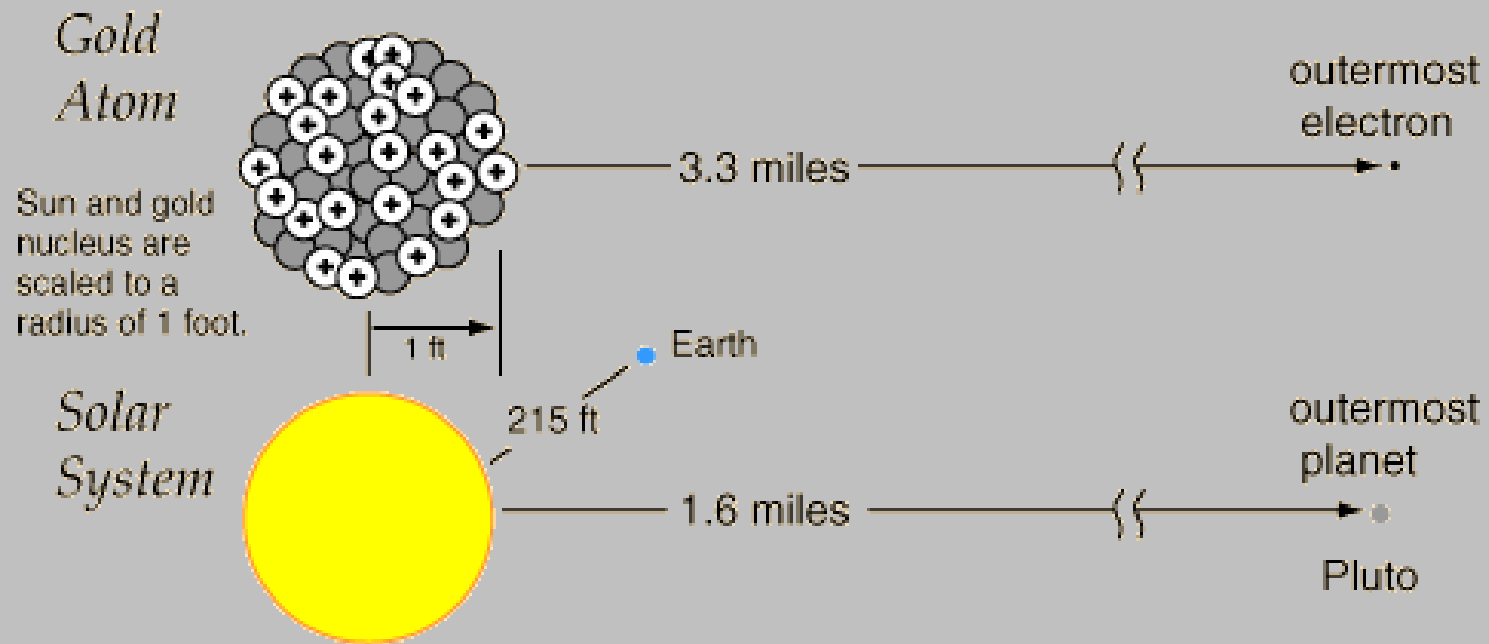


Rozptyl vysokoenergetických elektronů – struktura jádra

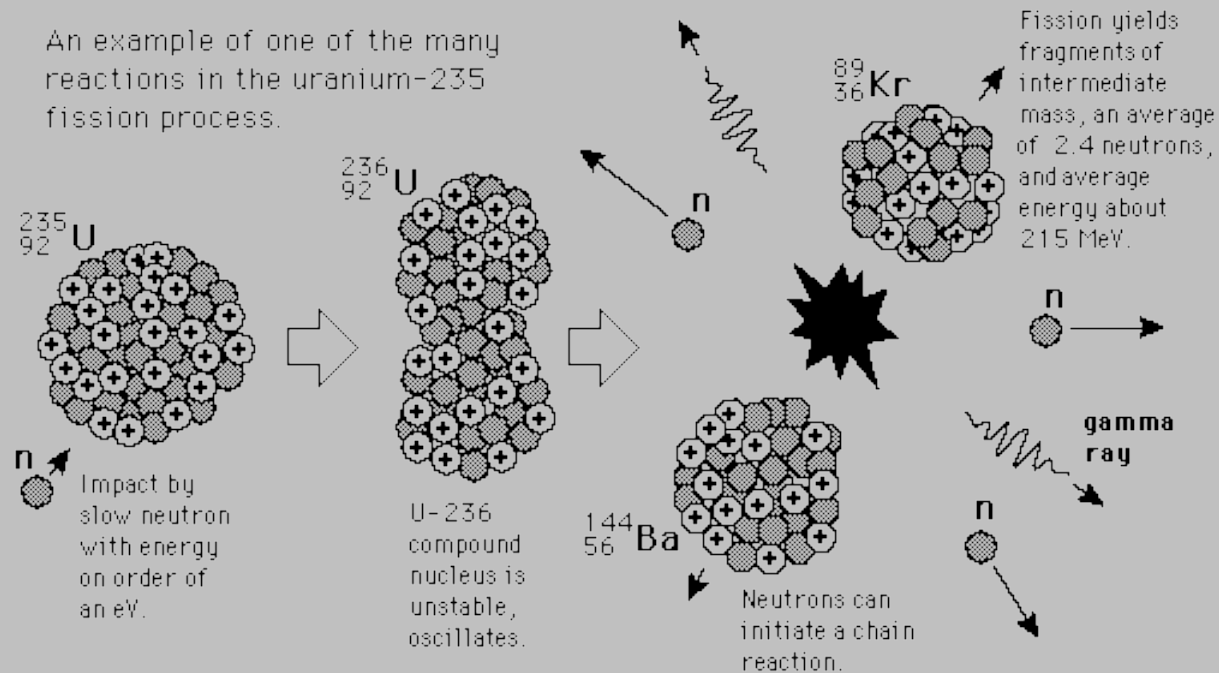
125-150 MeV, Stanford Linear Accelerator



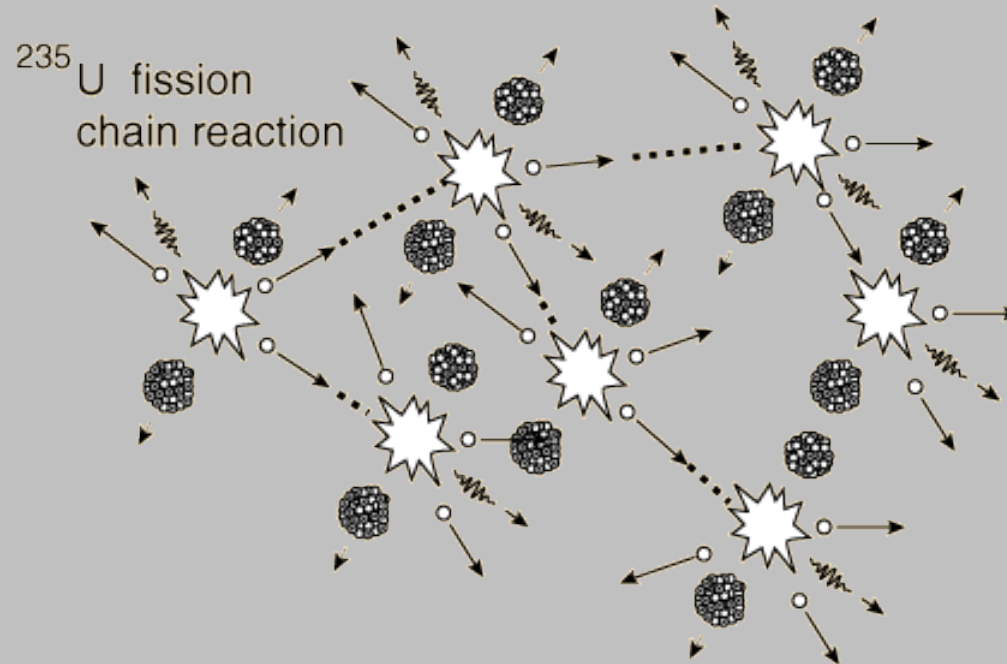
Relativní rozměry, atom a sluneční soustava



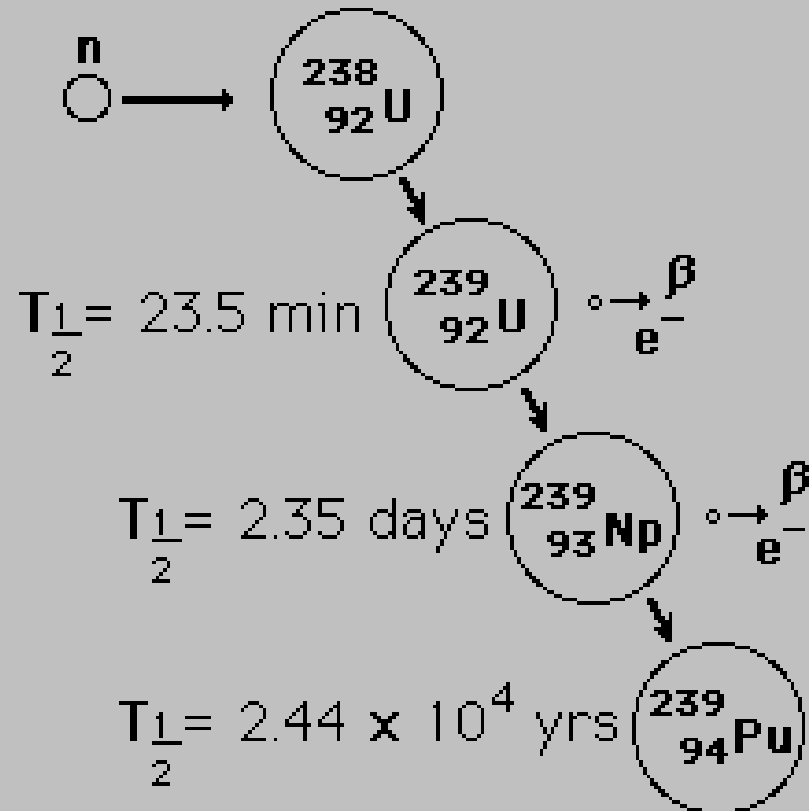
Štěpení ^{235}U po nárazu pomalého neutronu



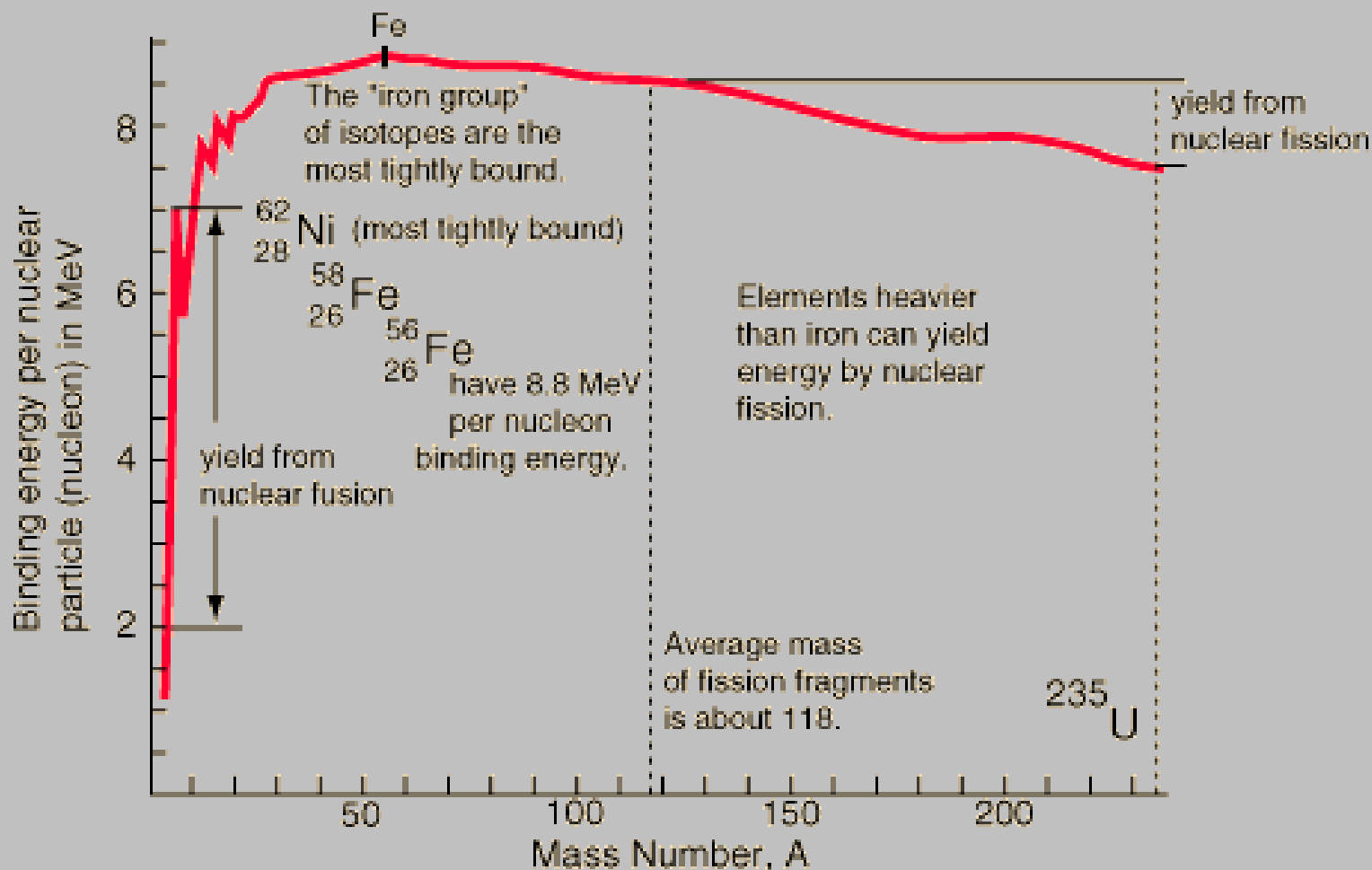
Štěpení ^{235}U – řetězová reakce



Množivá („breeding“) reakce neštěpitelného $^{238}\text{U} \rightarrow ^{239}\text{Pu}$

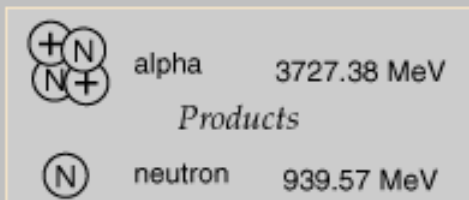
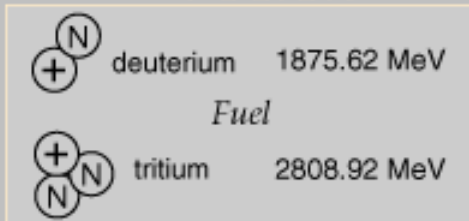


Vazební energie na nukleon: možnosti štěpení a fúze (syntézy)



Srovnání jaderné fúze a štěpení

FUSION



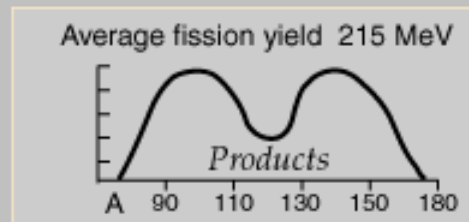
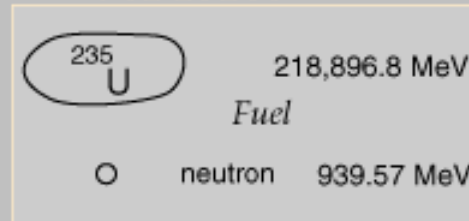
D-T fusion yield: 17.6 MeV

Fractional yield: $\frac{17.6 \text{ MeV}}{4684.54 \text{ MeV}} = .00375$

Calculation of the number of reference units of energy produced from 1 kg of fuel by fusion and fission.

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FISSION



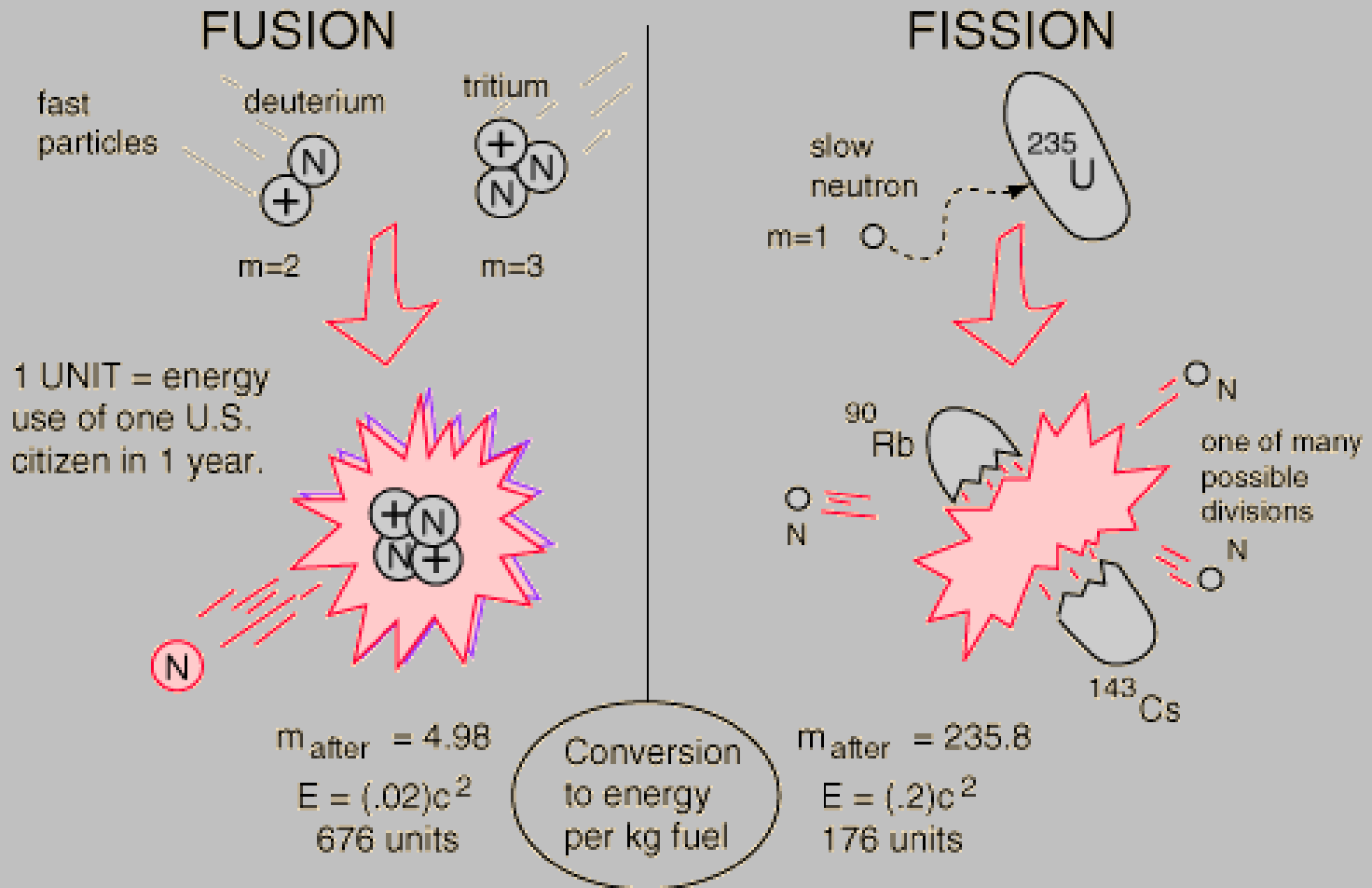
$\frac{215 \text{ MeV}}{219,836.37 \text{ MeV}} = .00098$

Per kg of fuel: Δmc^2 8.80 x 10¹³ J

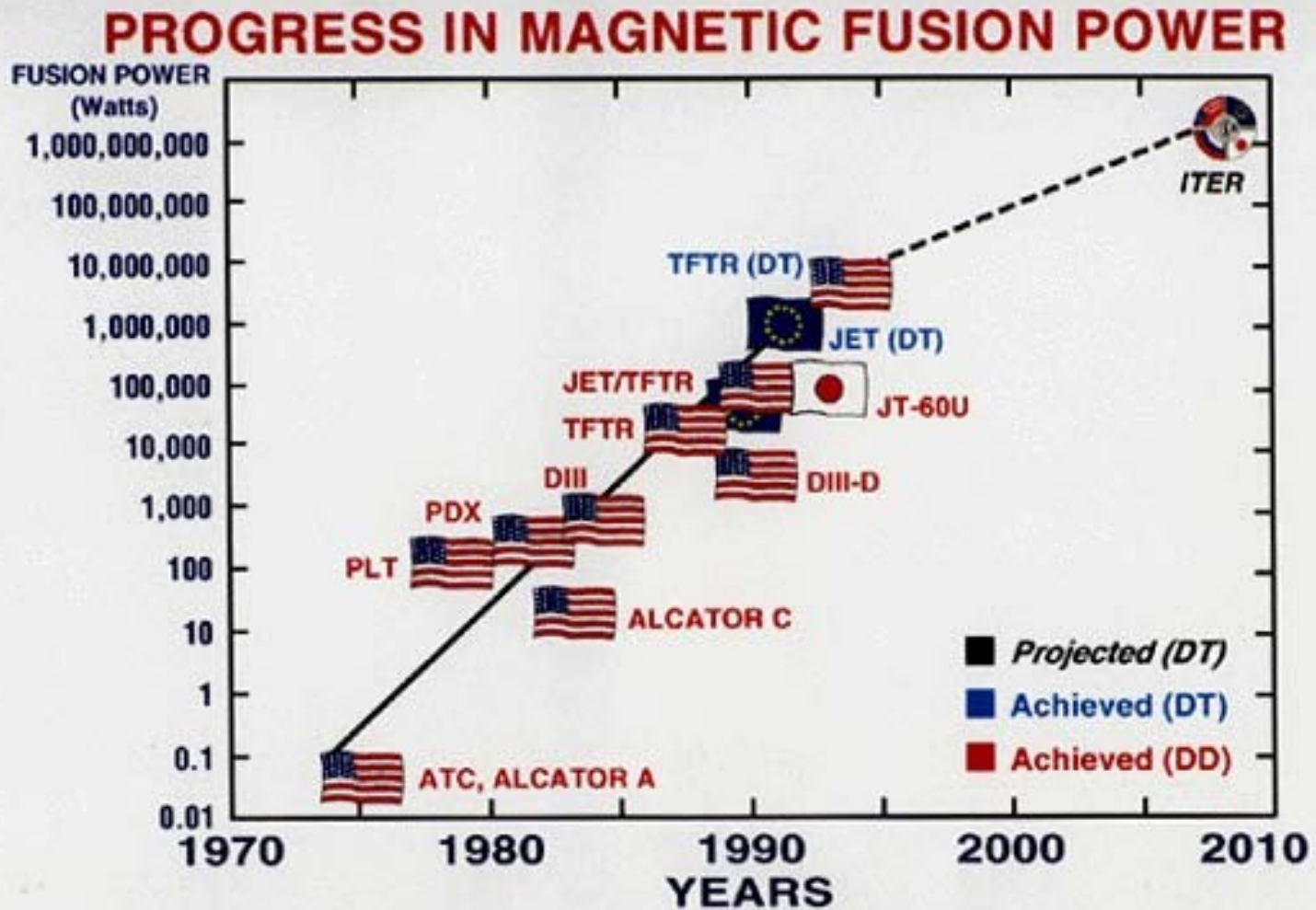
1 UNIT = energy use of one U.S. citizen in 1 year.

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Srovnání jaderné fúze a štěpení



Výkon dosažený jadernou fúzí (rekordní TFTR v Princetonu byl zrušen)



PLT	Princeton Large Torus	ITER	International Thermonuclear Experimental Reactor
PDX	Princeton Divertor Experiment	DIII & DIII-D	General Atomics Tokamak Experiments
JET	Joint European Torus	ATC & TFTR	Princeton Plasma Physics Laboratory
JT-60	Japan	ALCATOR A, C	Massachusetts Institute of Technology

Podmínky pro fúzi

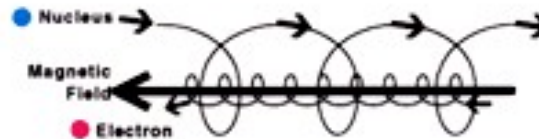
Plasma Confinement

No material walls can contain a plasma millions of degrees hot. Either the plasma will damage the wall, or the wall will cool the plasma.

Gravitational
Confinement



Sun



Magnetic
Confinement

Inertial
Confinement



In the Sun, gravity holds the plasma nuclei close enough together to fuse. At PPPL, we use strong magnetic bottles, shaped like donuts, to confine plasma.

