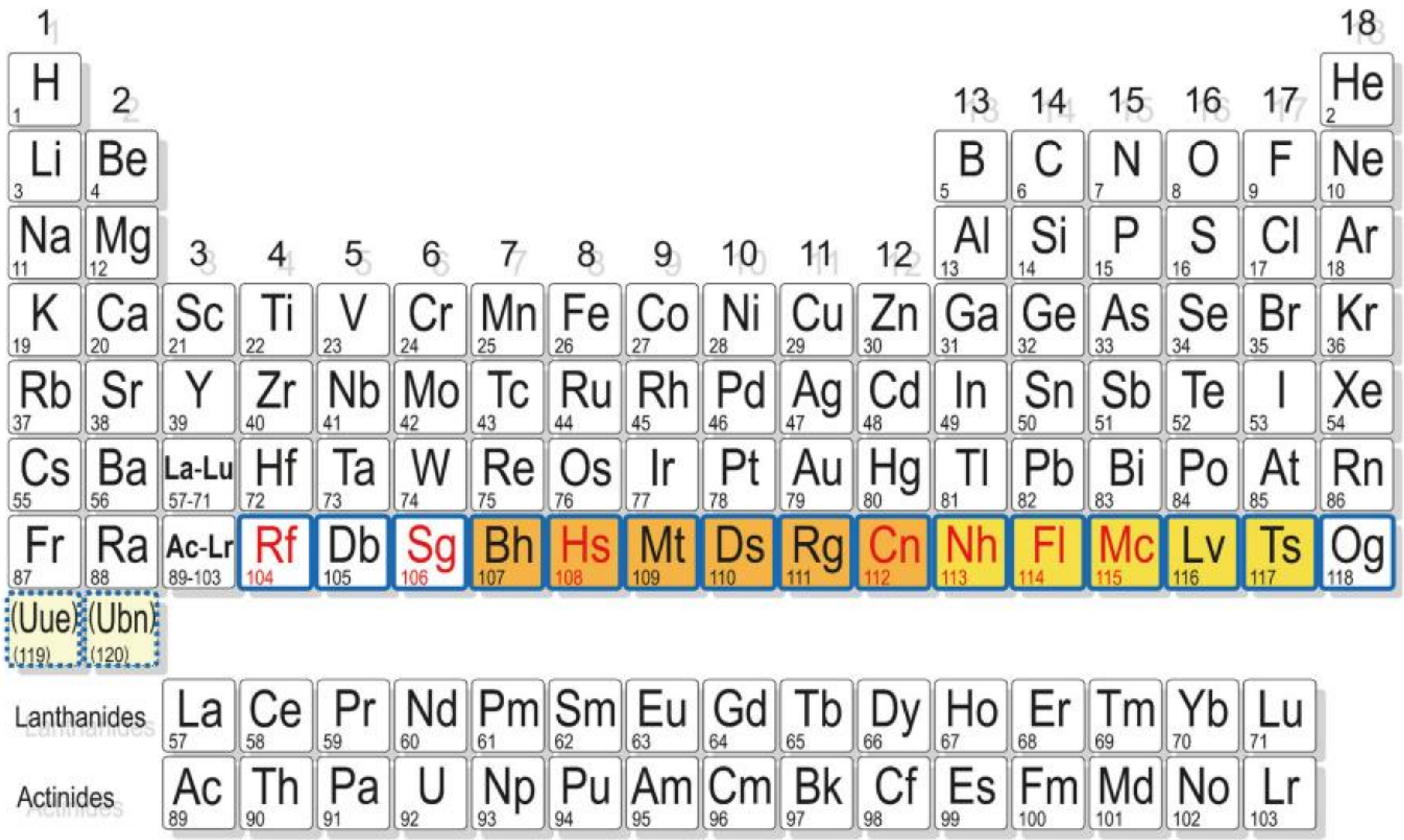
Możliwości wytworzenia pierwiastków o Z > 118

Autor Autor

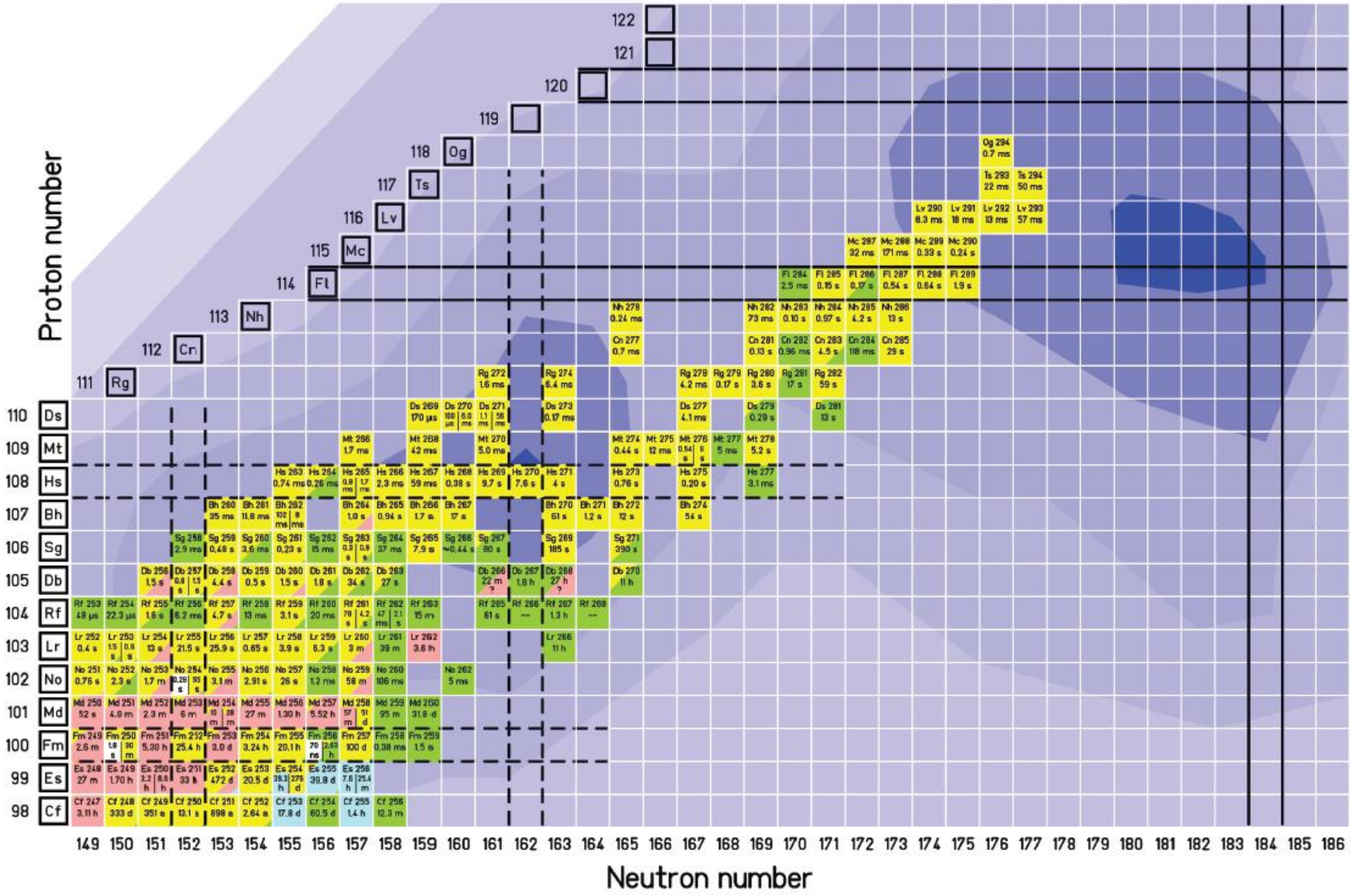
T. Cap

NATIONAL CENTRE FOR NUCLEAR RESEARCH ŚWIERK

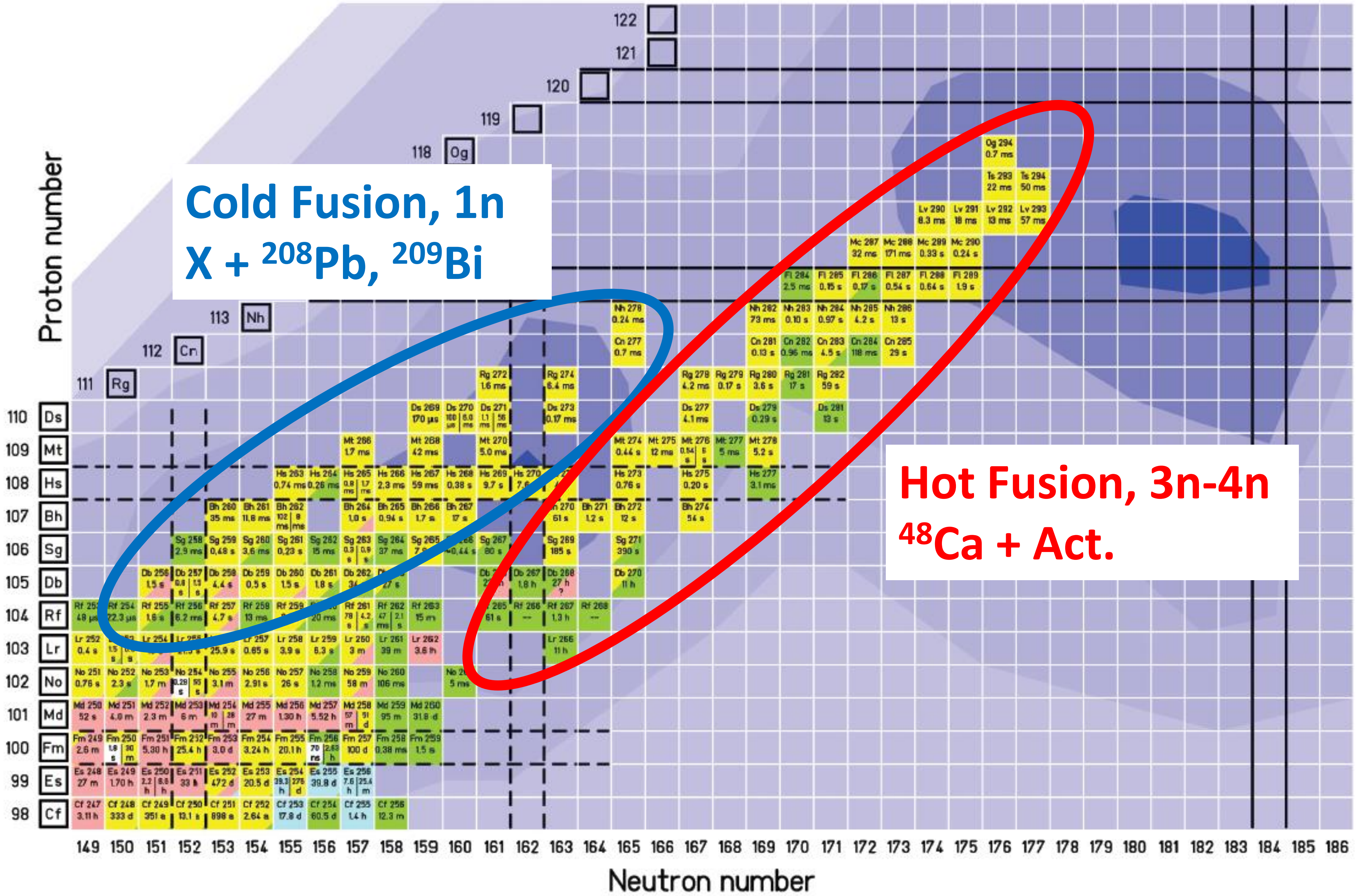
Seminarium
Wydział Fizyki UW, 01.12.22



‘Discovery of a chemical element is the experimental demonstration, beyond reasonable doubt, of the existence of a nuclide with an atomic number Z not identified before, existing for at least 10^{-14} s.



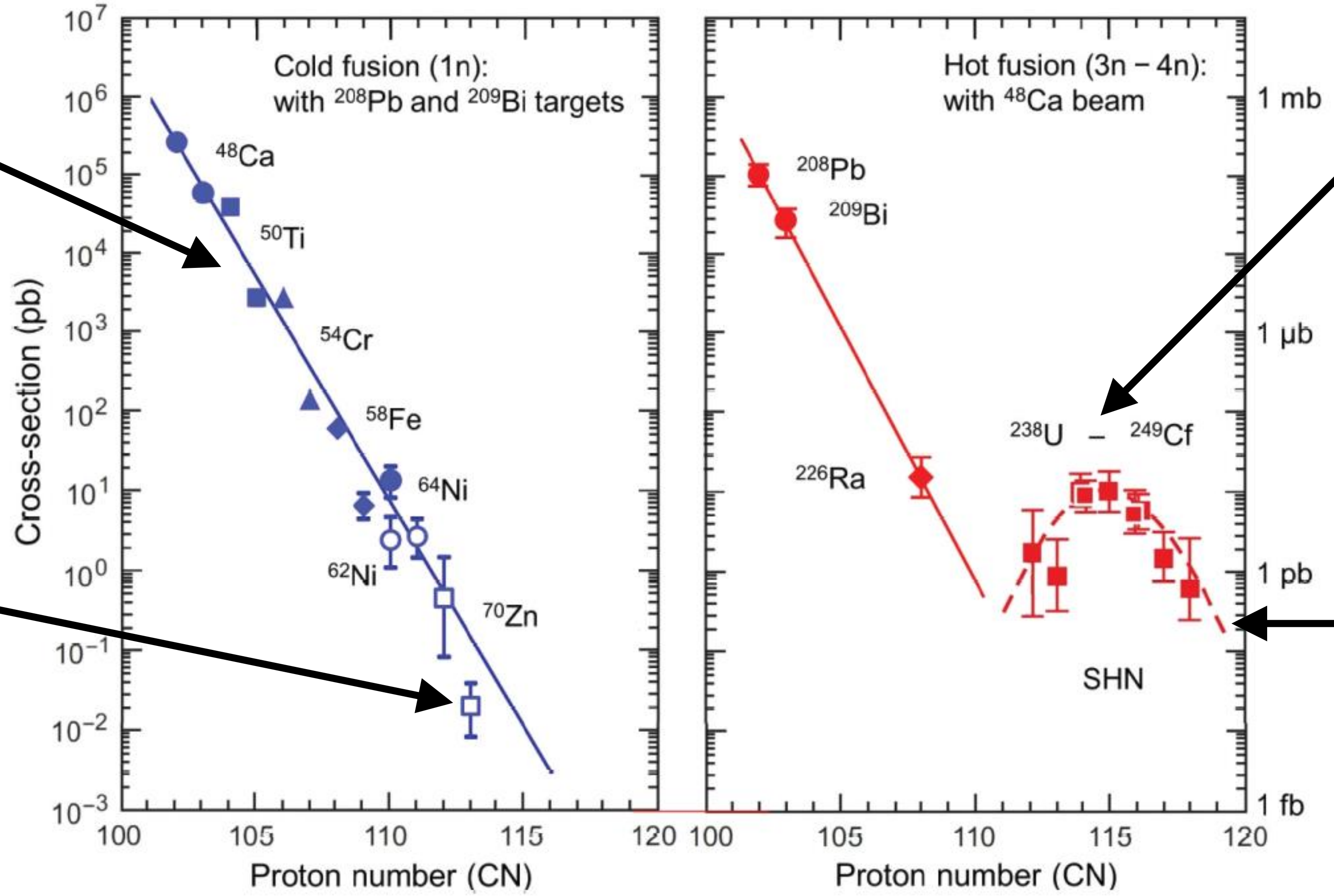
NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK



NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK

Cross section drops **7** orders of magnitude with the change from Ca to Zn.

Z=113, 22 fb, only 3 atoms in 576 days of irradiation



No heavier target than Cf (Z=98) is available.

Es (Z=99) is too radioactive but can possibly be used.

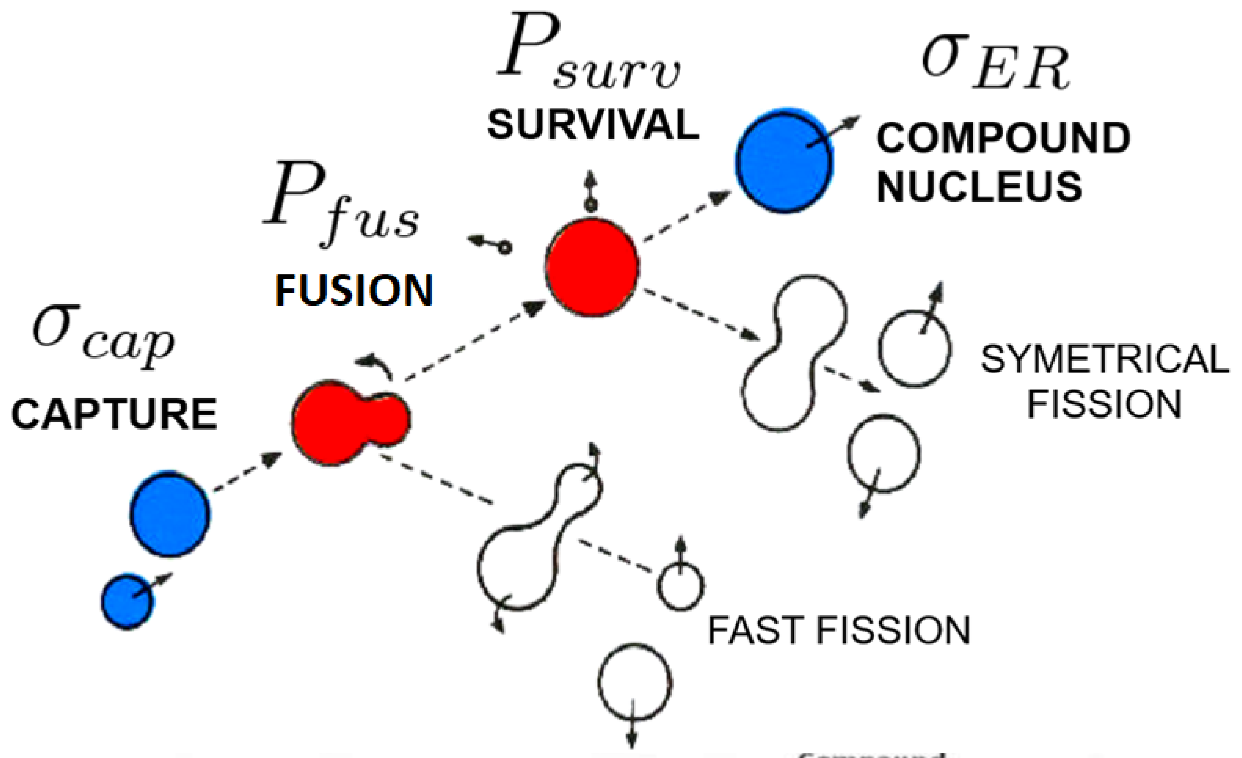
Experiments with 50Ti, 54Cr, 58Fe and 64Ni beams have not succeeded so far.

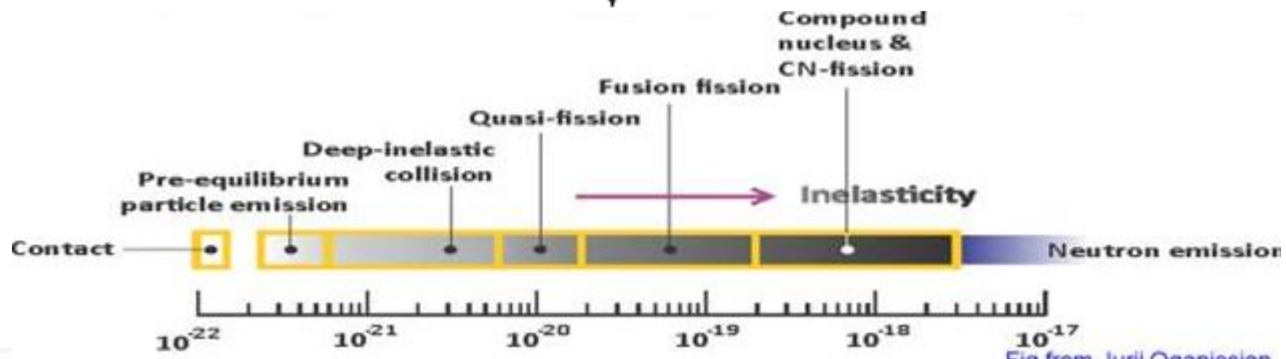
Sigurd Hofmann, Sergey N. Dmitriev, Claes Fahlander, Jacklyn M. Gates, James B. Roberto and Hideyuki Sakai
Report of the 2017 Joint Working Group of IUPAC and IUPAP, Pure Appl. Chem. 2020; 92(9): 1387–1446

Hot fusion synthesis experiments leading to elements 119 and 120

$^{48}Ca + {}^{254}Es \rightarrow {}^{302}119^*$	Limit of 300 nb	R. W. Lougheed *et al.,* Phys. Rev. C **32**, 1760 (1985)
$^{50}Ti + {}^{249}Bk \rightarrow {}^{299}119^*$	Limit of 65 fb	J. Khuyagbaatar *et al.*, Phys. Rev. C **102**, 064602 (2020)
$^{51}V + {}^{248}Cm \rightarrow {}^{299}119^*$		ongoing experiment in RIKEN
$^{50}Ti + {}^{249}Cf \rightarrow {}^{299}120^*$	Limit of 200 fb	J. Khuyagbaatar *et al.*, Phys. Rev. C **102**, 064602 (2020)
$^{58}Fe + {}^{244}Pu \rightarrow {}^{302}120^*$	Limit of 400 fb	Yu. Ts. Oganessian *et al*., Phys. Rev. C **79**, 024603 (2009)
$^{64}Ni + {}^{238}U \rightarrow {}^{302}120^*$	Limit of 90 fb	S. Hoffmann *et al.*, GSI Report 2009-1
$^{54}Cr + {}^{248}Cm \rightarrow {}^{302}120^*$	Limit of 580 fb	S. Hoffmann *et al.*, Eur. Phys. J. A 52, 180 (2016)

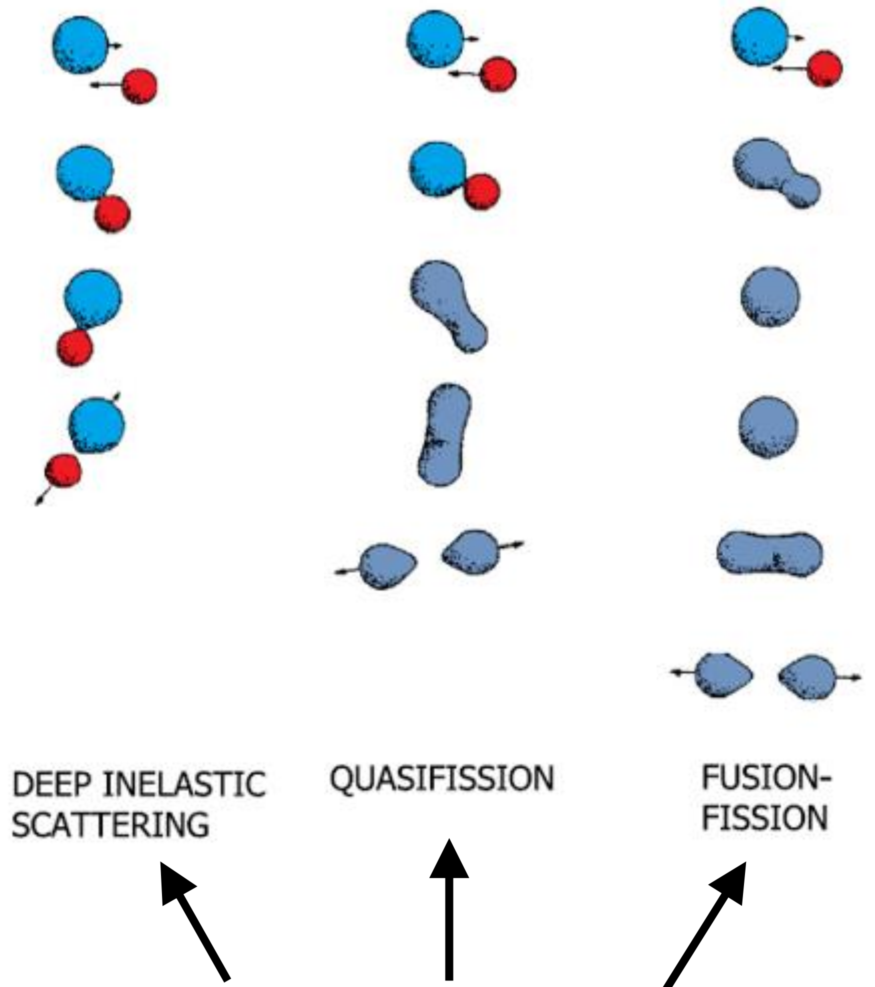
Different mass – angle correlations and different TKE



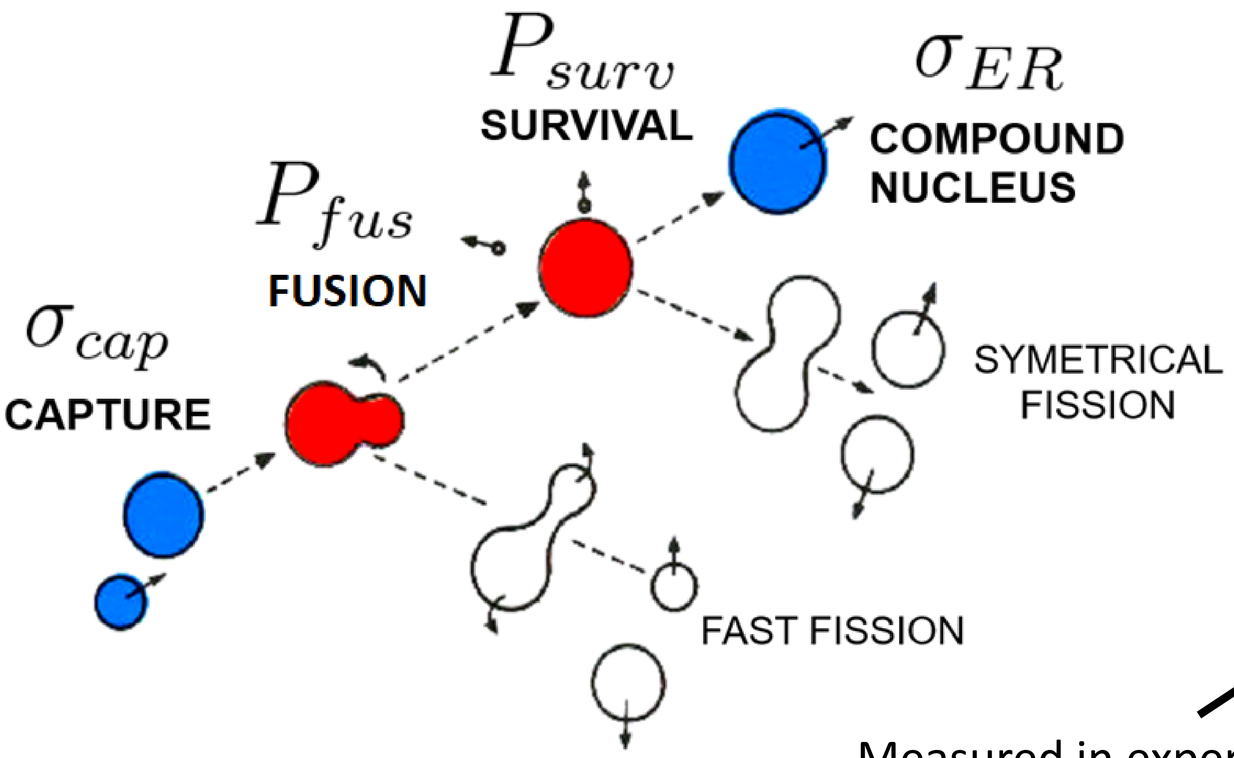


Time (s)

Fig from Jurij Oganiesian



$$\sigma_{ER} = \sigma_{cap}\, P_{fus}\, P_{surv}$$



FBD (fusion-by-diffusion)

Synthesis of SHN can be described as a **3** step process:

$$\sigma_{\mathrm{ER}} = \sigma_{\mathrm{cap}} \times P_{\mathrm{fus}} \times P_{\mathrm{surv}}$$

Measured in experiments, can be calculated using various models

Diffussed barrier formula (Entrance channel barrier is given by a Gaussian distribution)

Not measured directly, difficult to calculate

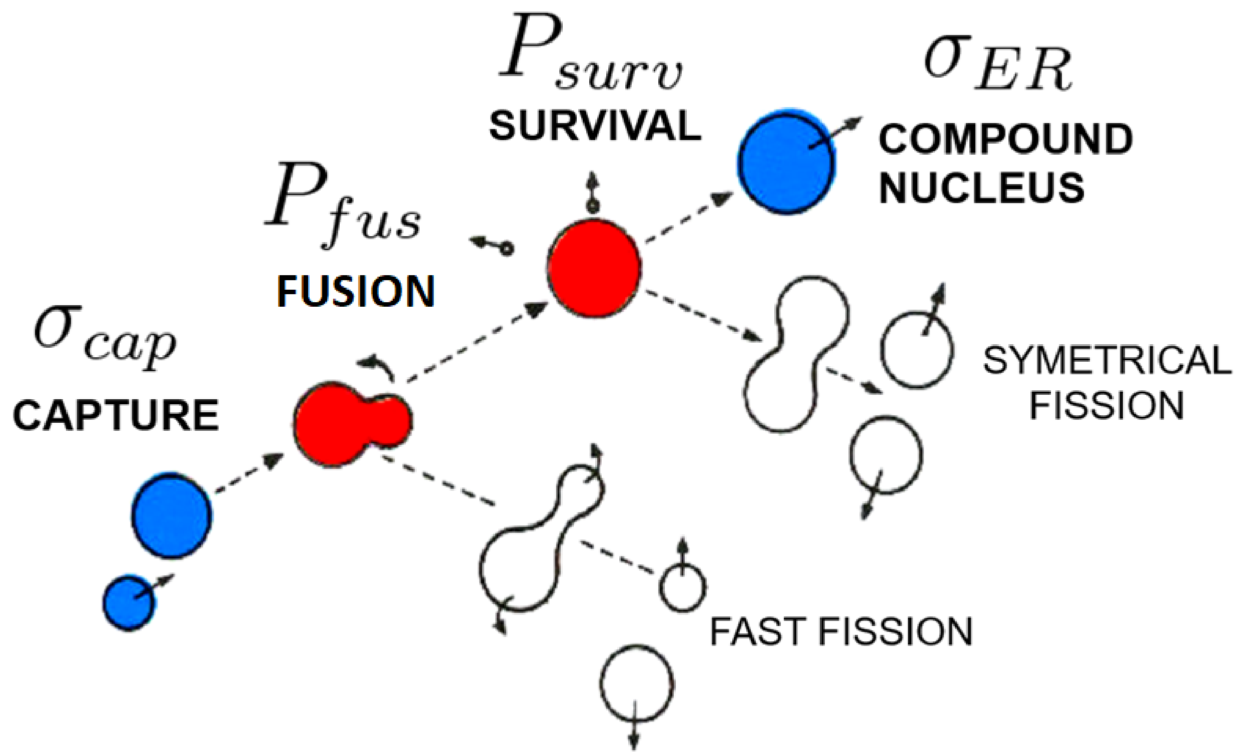
Smoluchowski Diffusion Equation

Well established theory and formulas
Monte Carlo Statistical model

masses, fission barriers, deformations from Warsaw Micro-Macro model

W. J. Świątecki, K. Siwek-Wilczyńska, J. Wilczyński, **PRC 2005**

T. Cap et al., **PRC 2011**
K. Siwek-Wilczyńska et al. **PRC 2012**
T. Cap et al., **PRC 2013**
K. Siwek-Wilczyńska et al. **PRC 2019**



FBD (fusion-by-diffusion)

Synthesis of SHN can be described as a **3** step process:

$$\sigma_{ER} = \sigma_{cap}\, P_{fus}\, P_{surv}$$

ℓ-dependent FBD

$$\sigma_{\mathrm{ER}} = \pi \lambda\!\!\!^{-2} \sum_{l=0}^{\infty} (2l+1) T(l) \times P_{\mathrm{fus}}(l) \times P_{\mathrm{surv}}^{\mathrm{xn}}(l)$$

W. J. Świątecki, K. Siwek-Wilczyńska, J. Wilczyński, **PRC 2005**

T. Cap et al., **PRC 2011**
K. Siwek-Wilczyńska et al. **PRC 2012**
T. Cap et al., **PRC 2013**
K. Siwek-Wilczyńska et al. **PRC 2019**

Atomic Data and Nuclear Data Tables 138 (2021) 101393

Contents lists available at ScienceDirect

Atomic Data and Nuclear Data Tables

journal homepage: www.elsevier.com/locate/adt

Properties of heaviest nuclei with $98 \leq Z \leq 126$ and $134 \leq N \leq 192$

P. Jachimowicz [a], M. Kowal [b,*], J. Skalski [b]

[a] Institute of Physics, University of Zielona Góra, Szafrana 4a, 65-516 Zielona Góra, Poland
[b] National Centre for Nuclear Research, Pasteura 7, 02-093 Warsaw, Poland

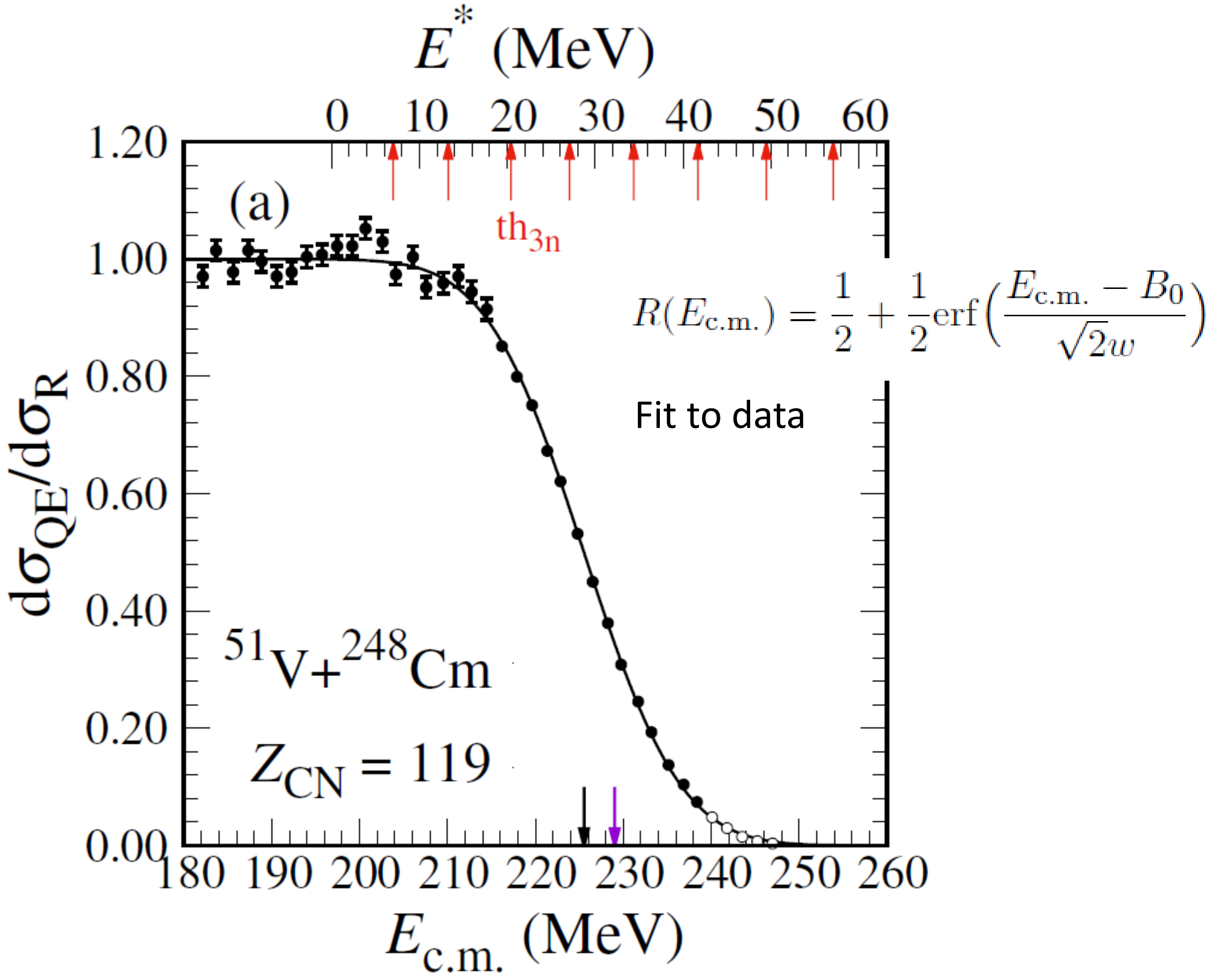
Ground-state and saddle-point shapes and masses for 1305 heavy and superheavy nuclei including odd-A and odd–odd systems. Static fission barrier heights, one- and two-nucleon separation energies, and Qα values.

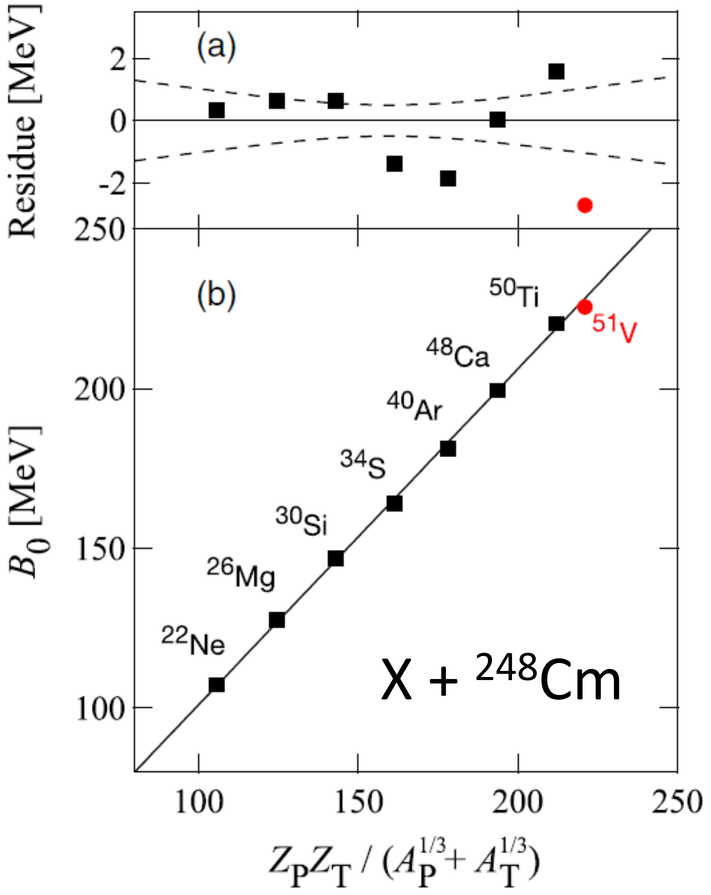
Microscopic–macroscopic method with the deformed Woods–Saxon single-particle potential and the Yukawa-plus-exponential macroscopic energy taken as the smooth part.

Ground-state shapes and energies are found by the minimization over seven axially-symmetric deformations.
A search for saddle-points was performed by using the "imaginary water flow" method in three consecutive stages, using five- (for nonaxial shapes) and seven-dimensional (for reflection-asymmetric shapes) deformation spaces.

Good agreement with the experimental data for actinides.

capture cross section for ^{51}V + ^{248}Cm





B_0 from the FBD is in agreement with the systematics, which gives:

228.3 $\pm$ 1.1 MeV

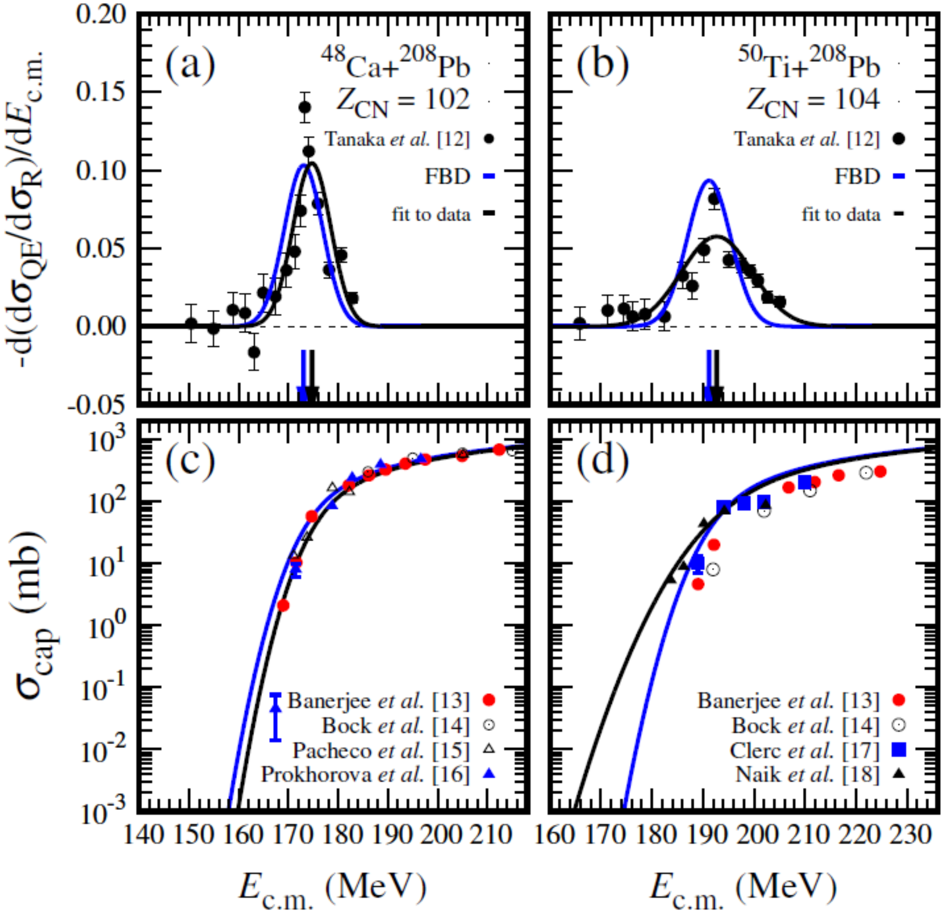
and 3.5 MeV above the exp. value

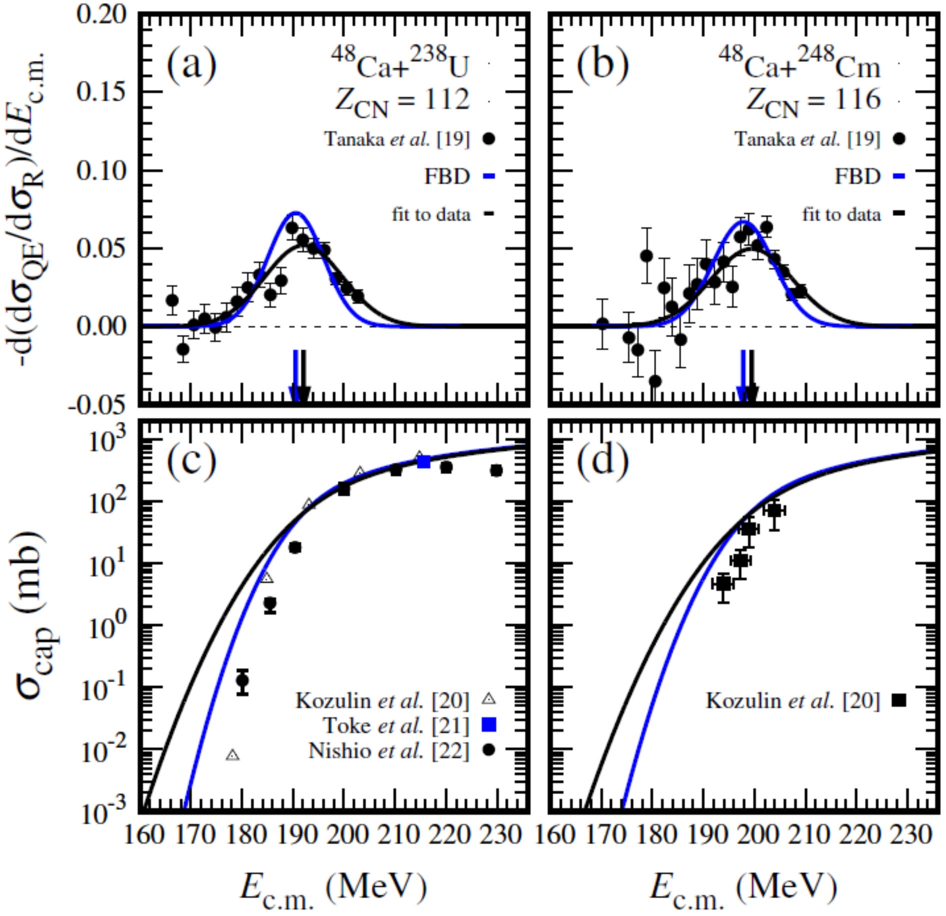
Data taken from:
M. Tanaka *et al.*, J. Phy. Soc. Jpn 91, 084201 (2022)

M. Tanaka *et al.*: B_0 = 225.6 $\pm$ 0.2 MeV
Fit to data: B_0 = 225.53 $\pm$ 0.13 MeV $\quad \omega$ = 8.71 $\pm$ 0.18 MeV
FBD model: B_0 = 229.03 MeV $\quad \omega$ = 6.90 MeV (only β_2 Cm deformation)

capture cross section

$$D(B) = \frac{1}{\sqrt{2\pi}\omega} \exp\left(-\frac{(B-B_0)^2}{2\omega^2}\right)$$





Barrier dist. data taken from:

T. Tanaka *et al.*, J. Phy. Soc. Jpn 87, 014201, 2018

T. Tanaka *et al.*, PRL 124, 052502, 2020

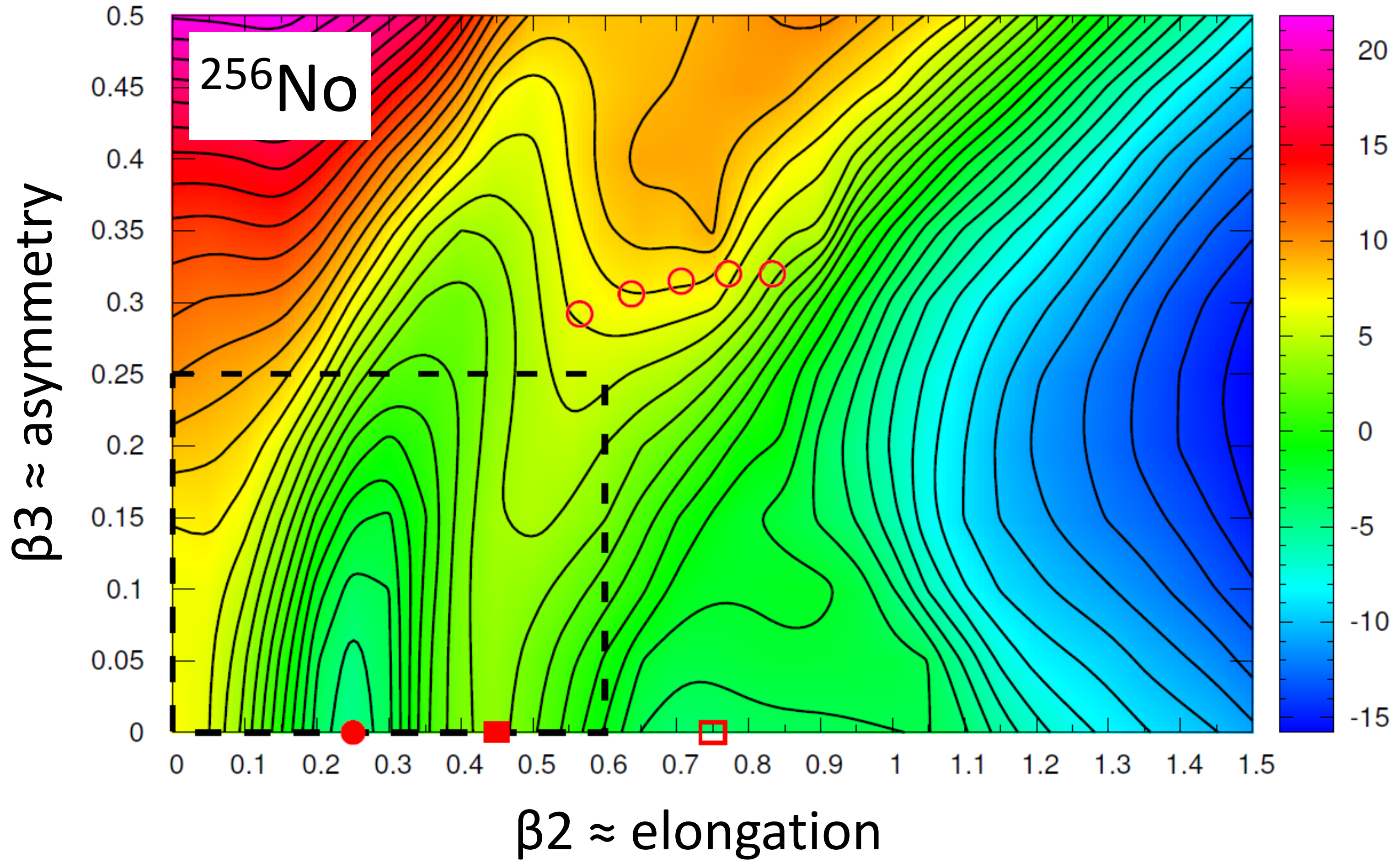
$$\sigma_{\mathrm{cap}}(E_{\mathrm{c.m.}}) = \pi R^2 \frac{w}{\sqrt{2\pi}E_{\mathrm{c.m.}}}\left[\sqrt{\pi}X(1+\mathrm{erf}\,X)+\exp(-X^2)\right]$$

K. Siwek-Wilczyńska and J. Wilczyński, PRC 69, 024611 (2004)

T. Cap et al., PRC 2011

Fusion process on the Potential Energy Surface (PES)

E(β) = Binding Energy – E(sphere)



Macro-Micro model

P. Jachimowicz, M. Kowal and J. Skalski

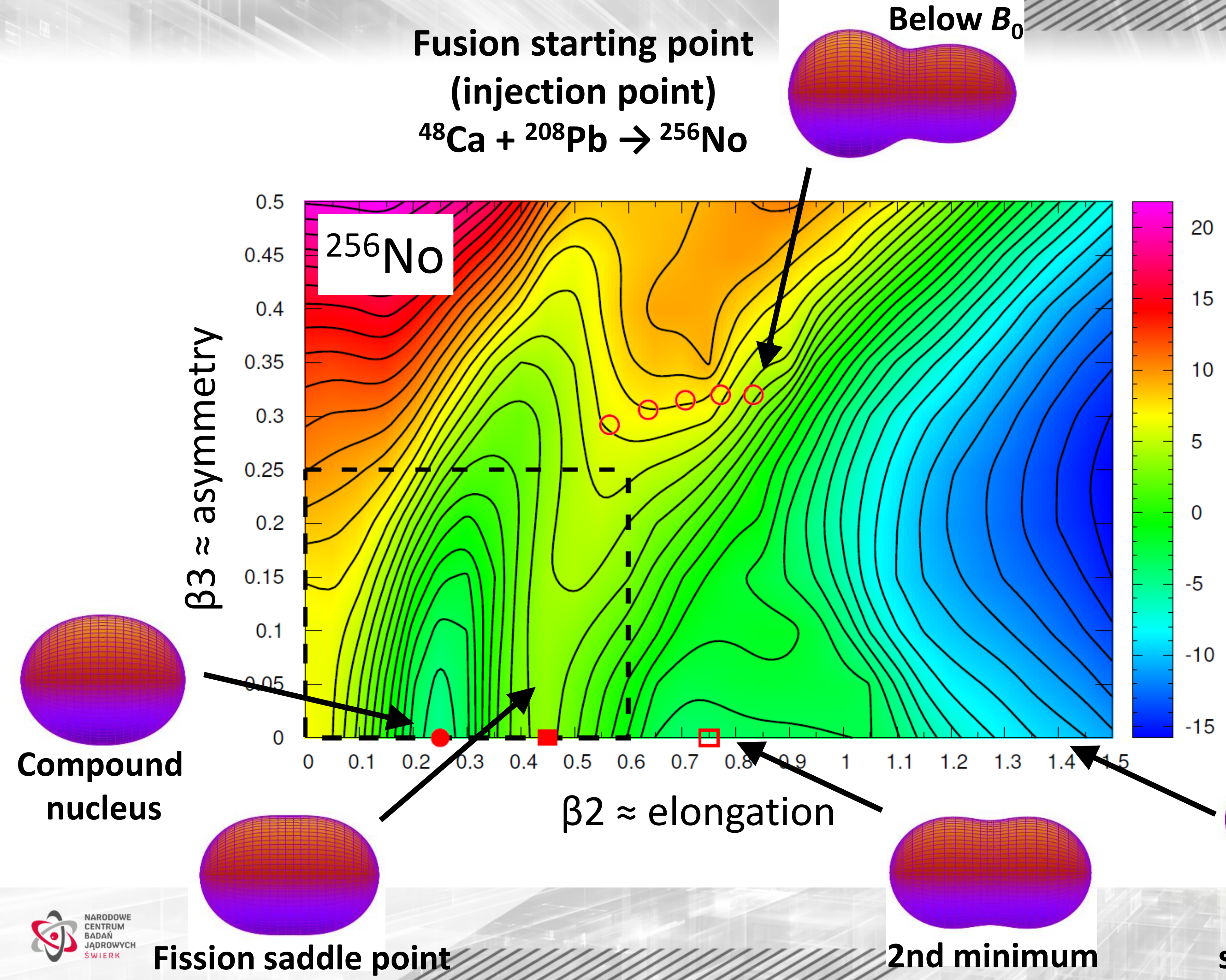
ADNDT 138, 101393 (2021)

β1 – β8 deformation space

β1 –real shape variable

2D representation of 8D deformation space (124M point)

Calculations done by Aleksander Augustyn in CIŚ (Świerk Computing Centre)



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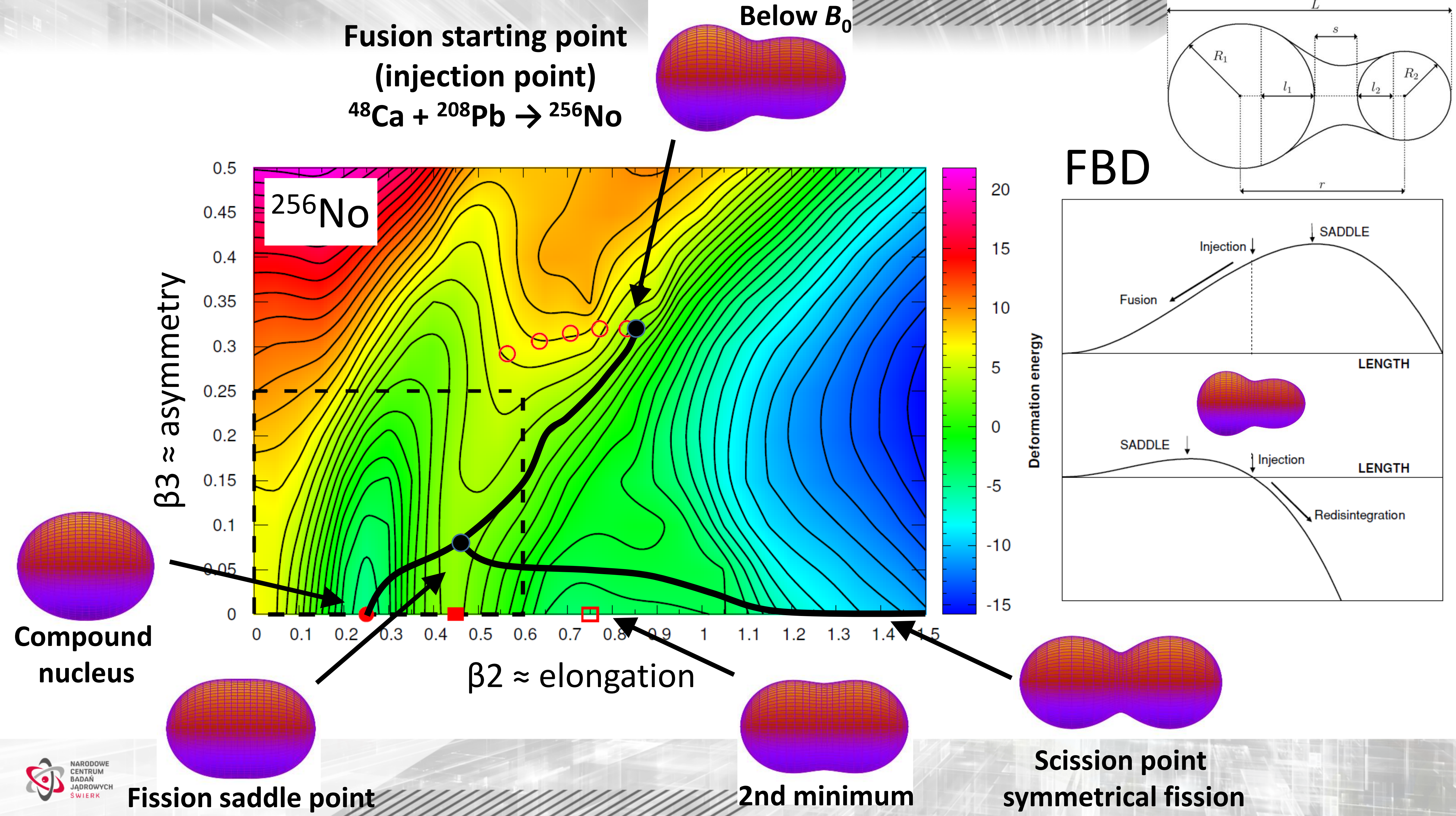

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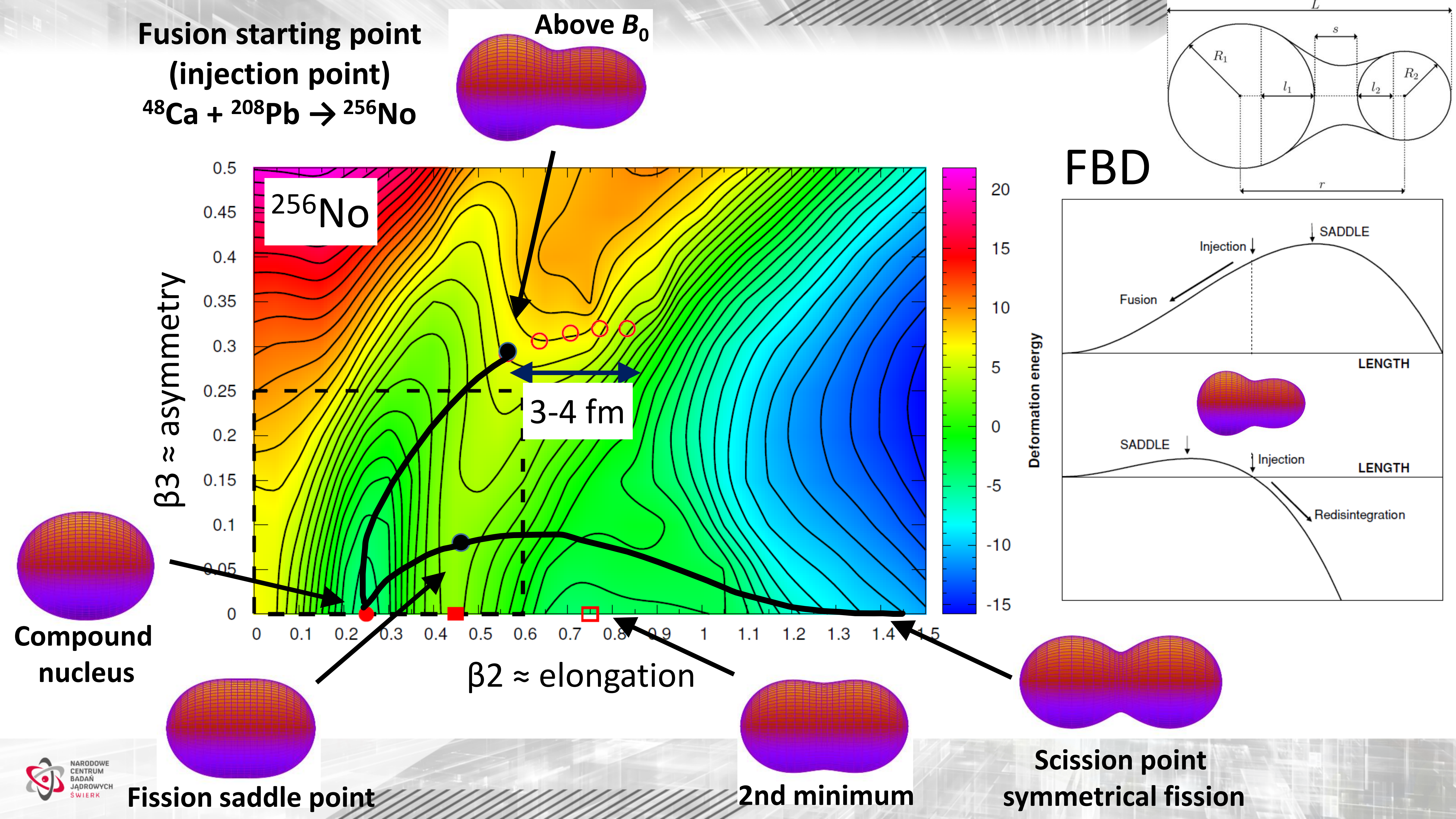
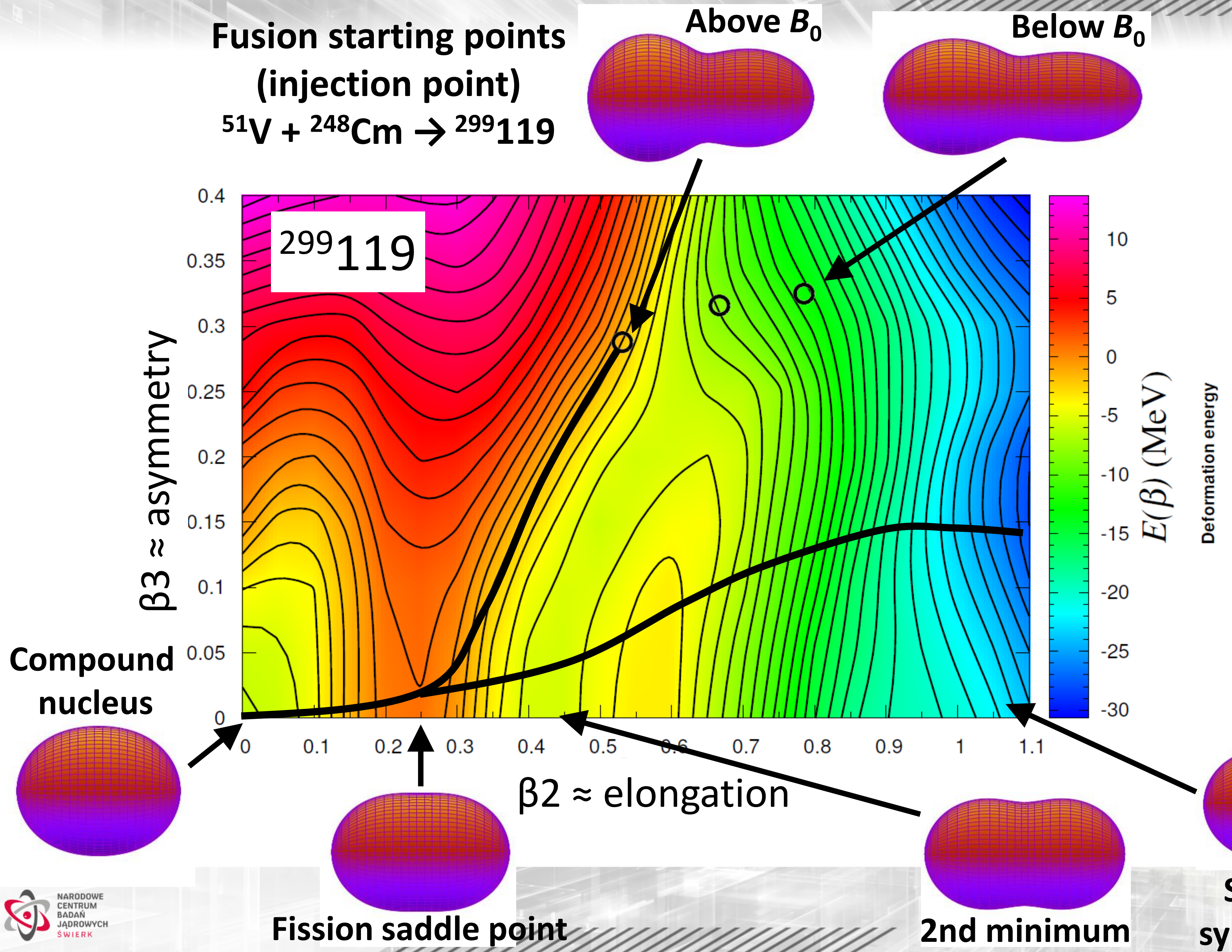
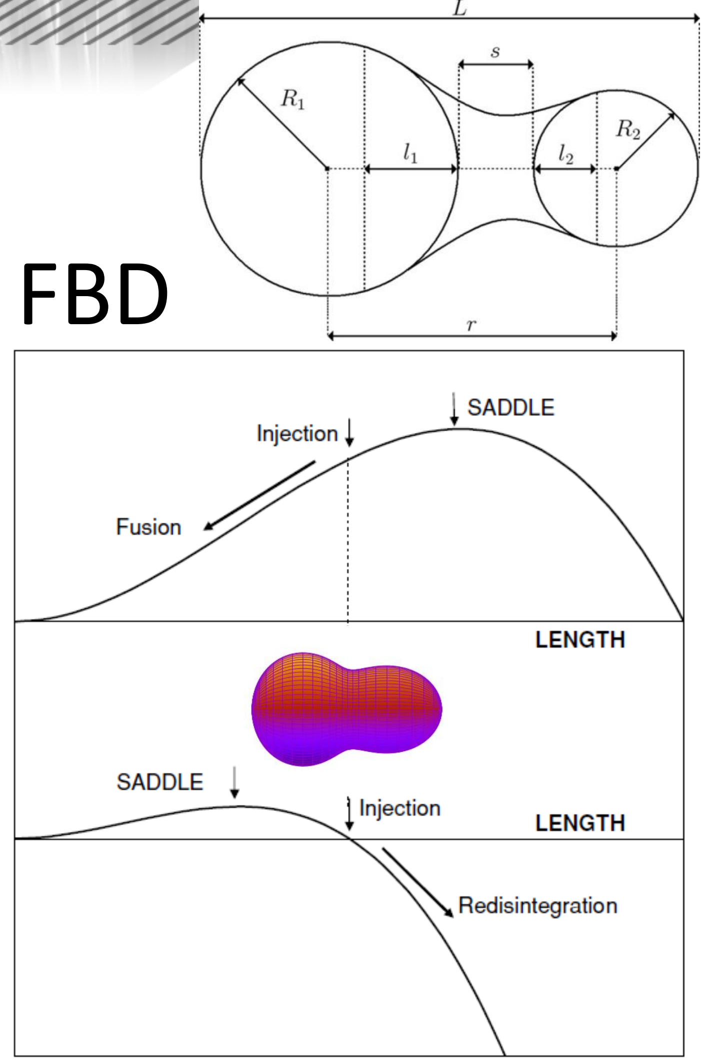
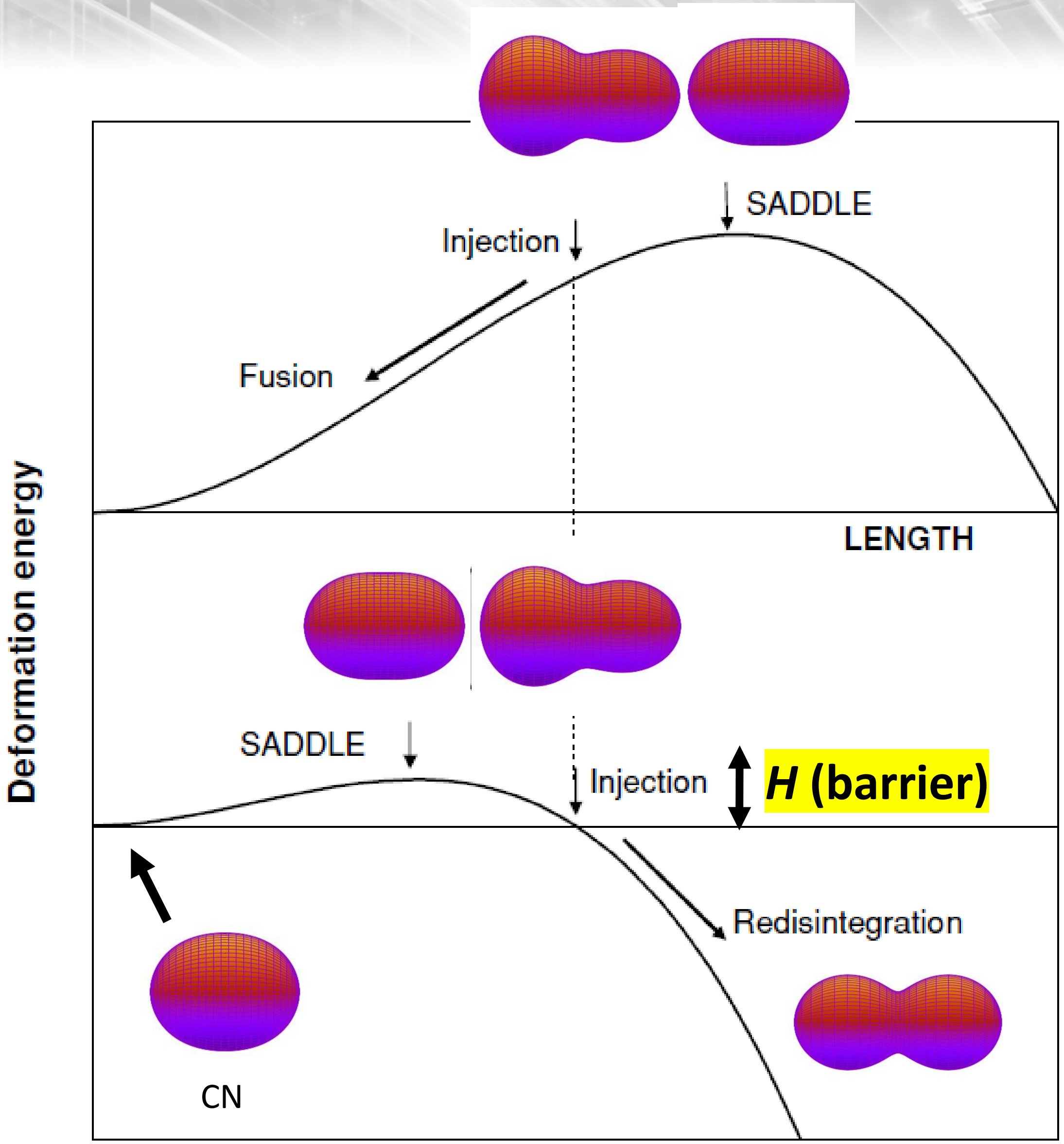


Fusion starting point
(injection point)
$^{48}Ca + ^{208}Pb \rightarrow ^{256}No$
Above B_0
^{256}No
3-4 fm
β3 ≈ asymmetry
β2 ≈ elongation
Deformation energy
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5
20
15
10
5
0
-5
-10
-15
Compound nucleus
Fission saddle point
2nd minimum
Scission point symmetrical fission
FBD
L
s
R_1
R_2
l_1
l_2
r
SADDLE
Injection
Fusion
LENGTH
SADDLE
Injection
LENGTH
Redisintegration
NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK



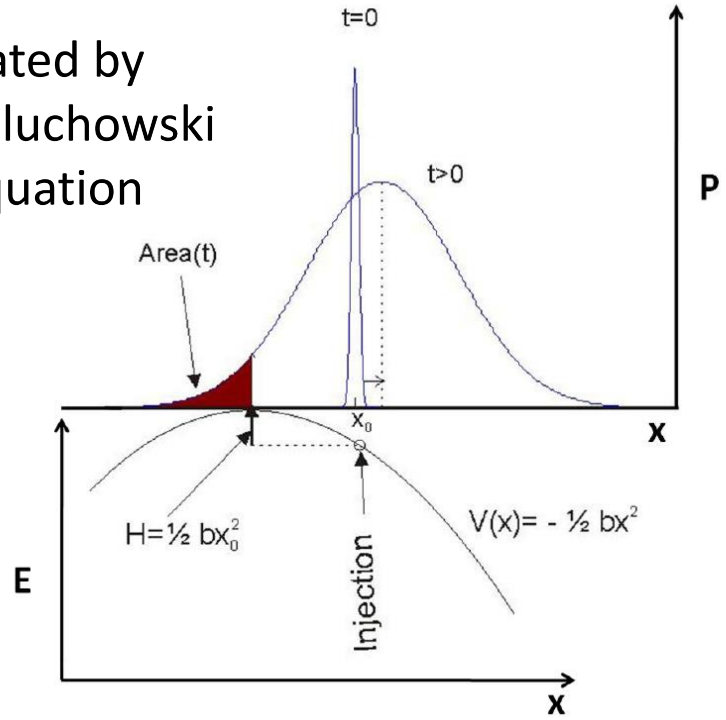


NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK



L is the effective elongation (along the fusion path)

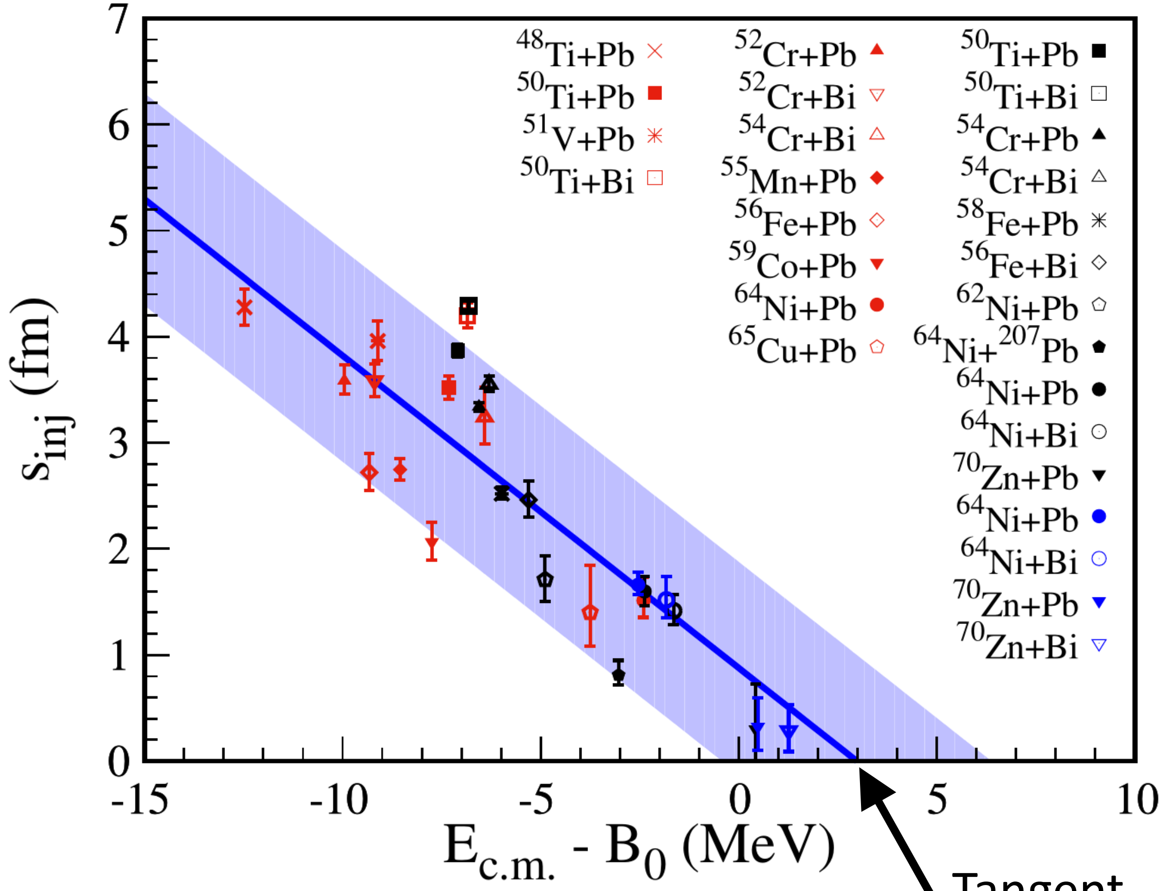
P_{fus} is calculated by solving 1D Smoluchowski Diffusion Equation



$$P_{fus}(l) = \frac{1}{2}\begin{cases} 1+\mathrm{erf}\sqrt{\dfrac{H(l)}{T}} & : L_{inj} < L_{sp} \\ 1-\mathrm{erf}\sqrt{\dfrac{H(l)}{T}} & : L_{inj} \geq L_{sp} \end{cases}$$

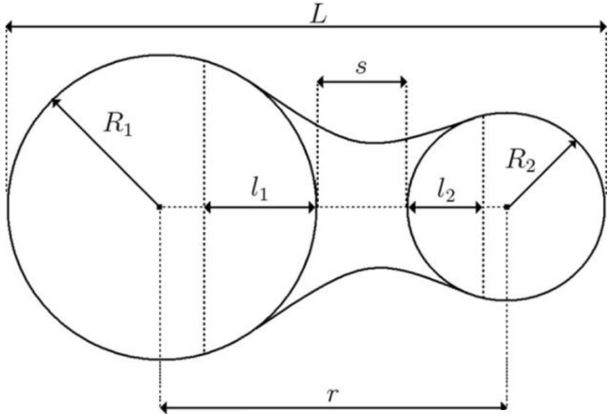
H(l) – the function of angular momentum and bombarding energy
T – the temperature depends on available energy

$$s_{inj} = 0.878\ \text{fm} - 0.294 \times (E_{c.m.} - B_0)\ \text{fm/MeV}$$

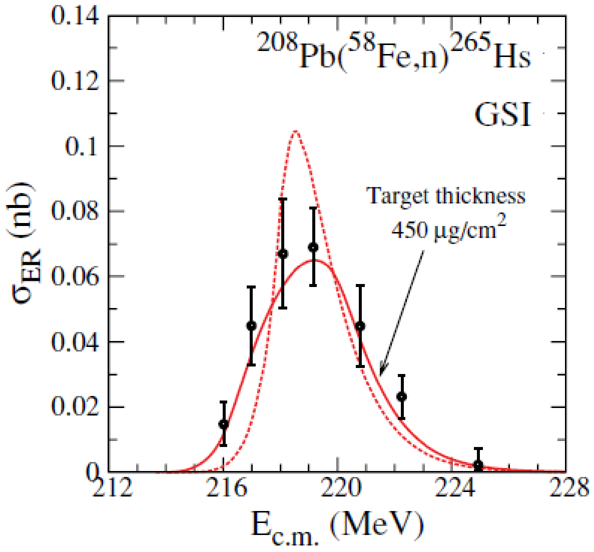


Tangent configuration

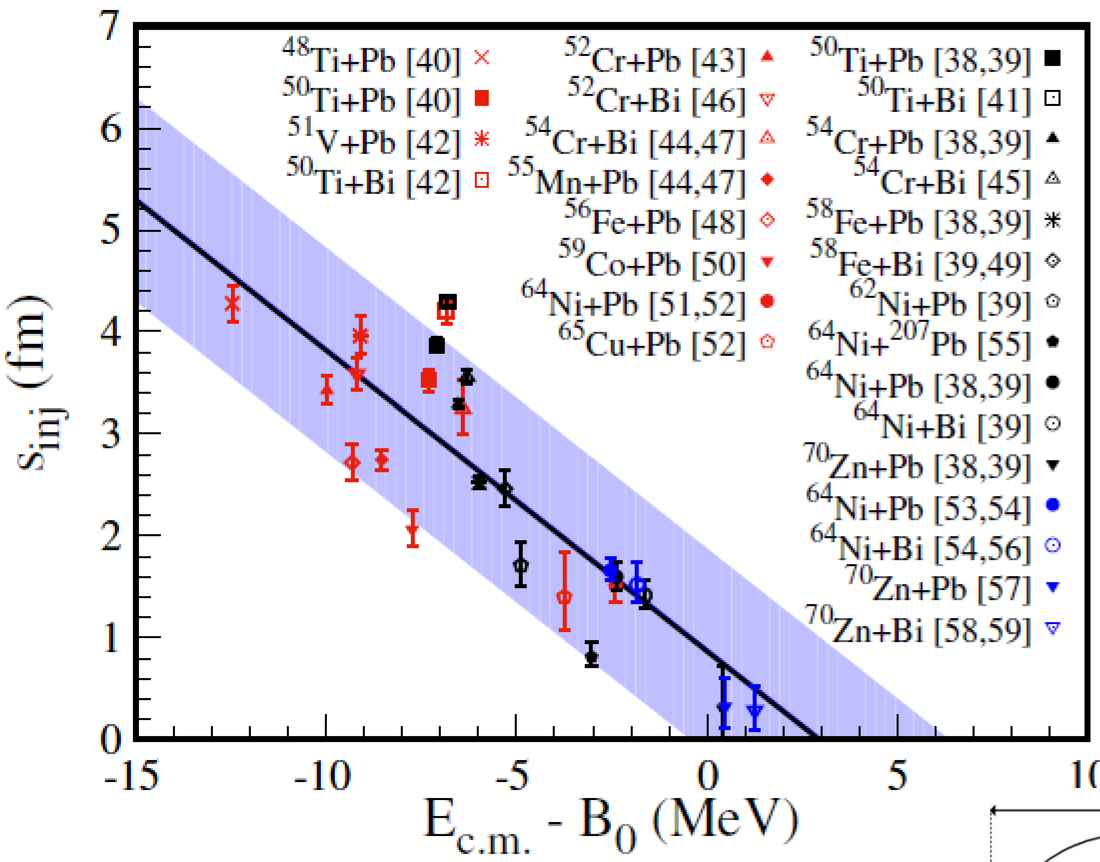
Energy relative to the entrance channel barrier B_0



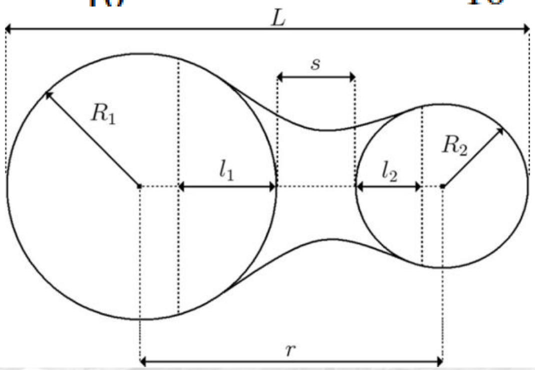
The distance between the nuclear surfaces of two colliding nuclei at the **injection point** s_{inj} is the only adjustable parameter of the model.

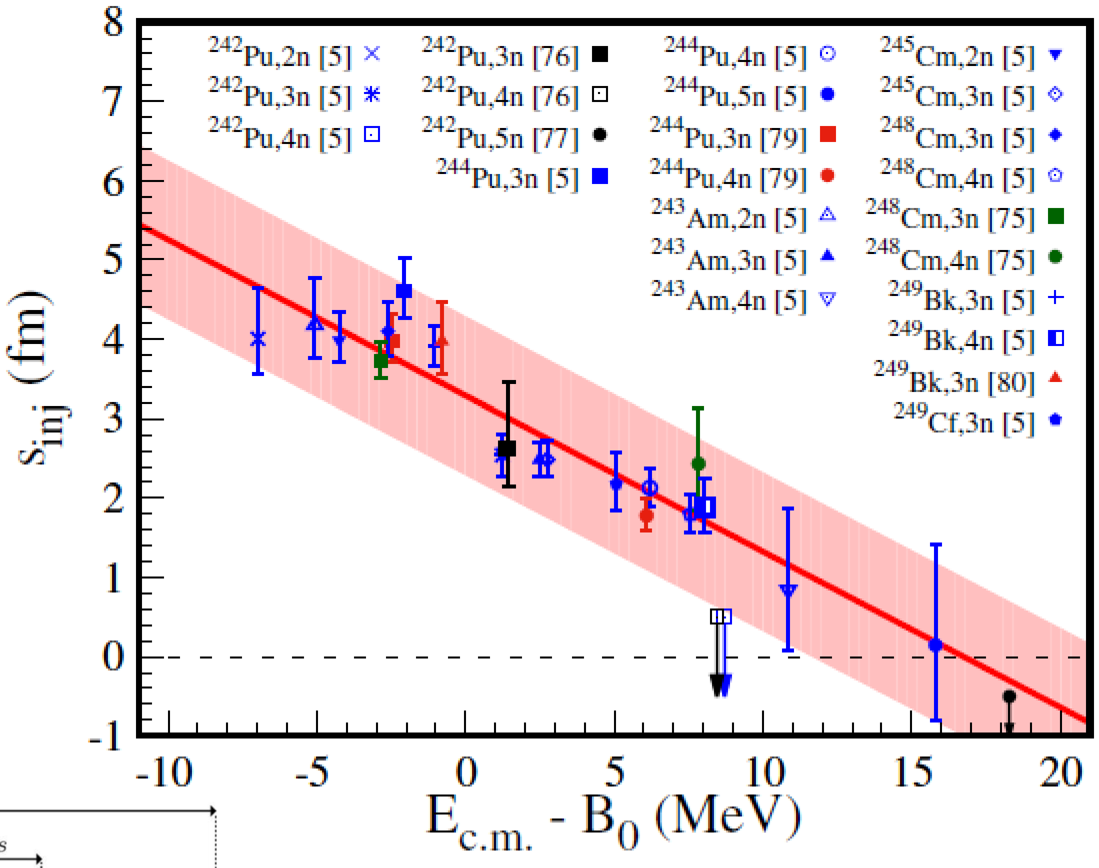


s_{inj} distance was parametrized by analyzing 27 cold fusion reactions.

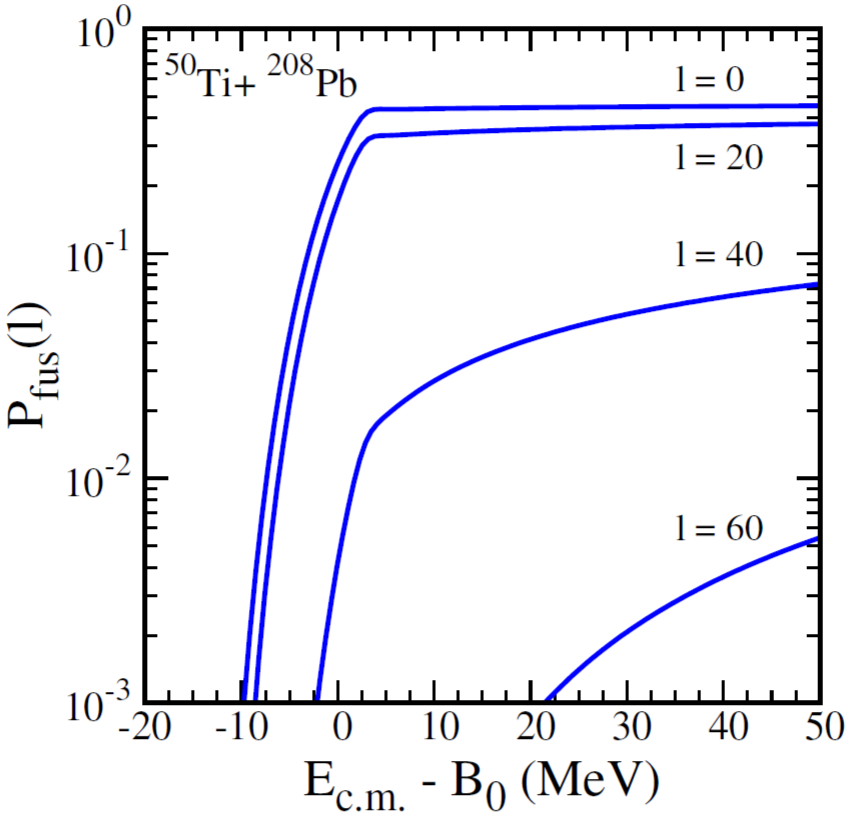


$$s_{inj} = 0.878 \text{ fm} - 0.294 \times (E_{c.m.} - B_0) \text{ fm/MeV}$$



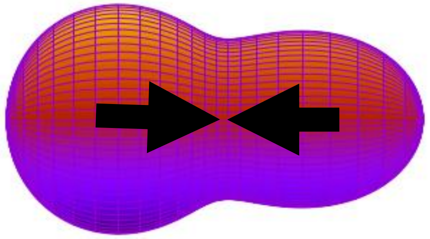


$$s_{inj} = 3.291 \text{ fm} - 0.196 \times (E_{c.m.} - B_0) \text{ fm/MeV}$$

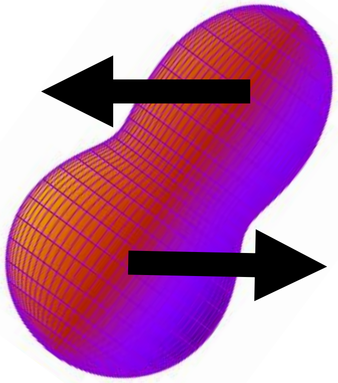


Energy relative to the entrance channel barrier B_0

l = 0
Central collision



Peripheral collisions



Higher partial waves l
=
Higher rotational energy
=
Higher barrier *H(l)*
=
Lower *Pfus(l)*

Fusion probability averaged over l

$$< P_{\rm fus} >= \frac{1}{(l_{\max}+1)^2} \sum_{l=0}^{l_{\max}} (2l+1) \times P_{\rm fus}(l)$$

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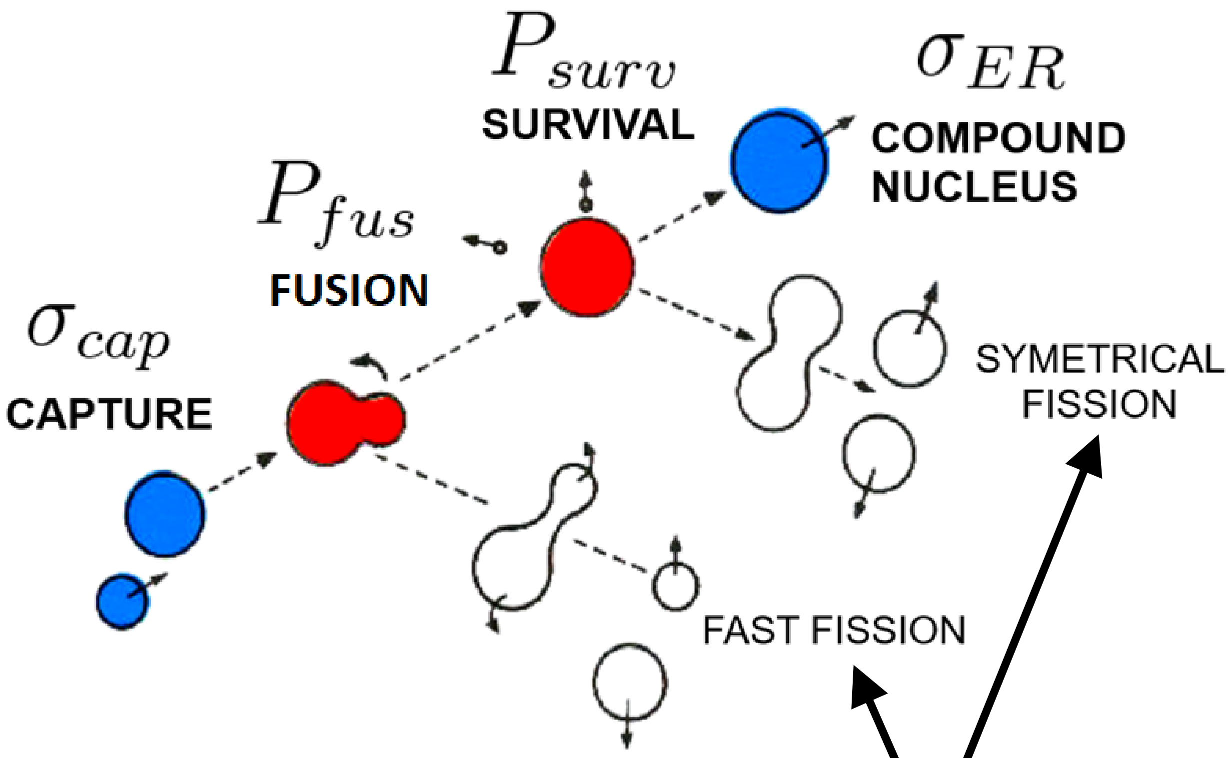
Reactions: ^{48}Ca, ^{50}Ti, ^{54}Cr + ^{208}Pb



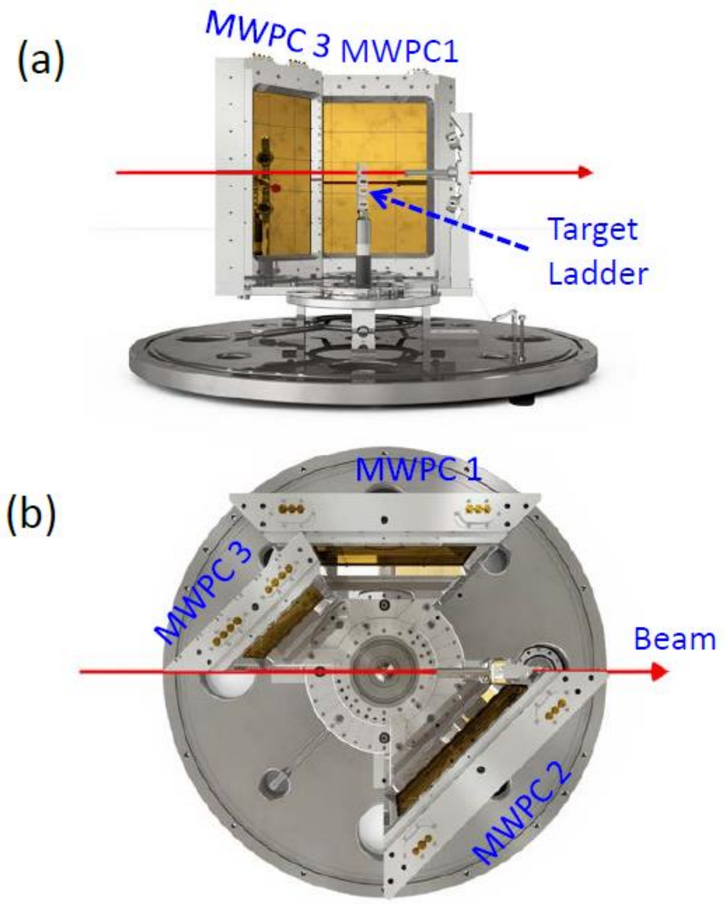
measured in the experiment

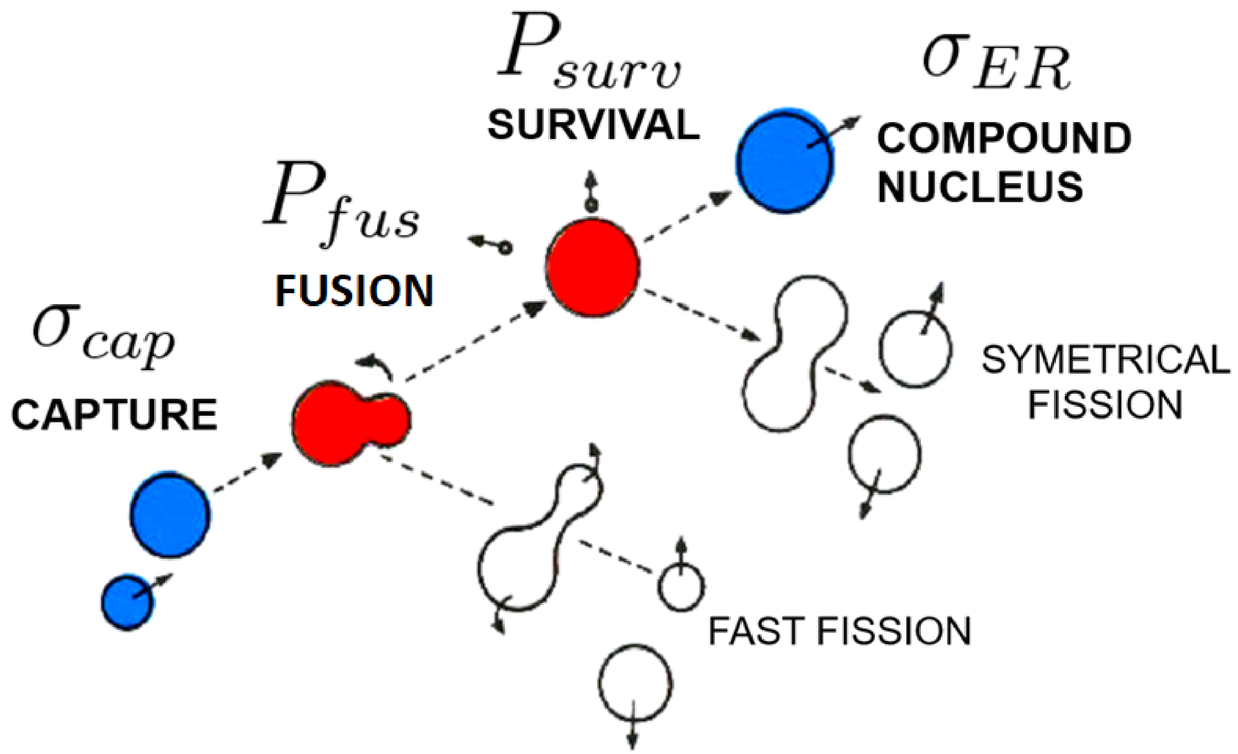
Review Progress in Particle and Nuclear Physics 118 (2021) 103856

Experimental studies of the competition between fusion and quasifission in the formation of heavy and superheavy nuclei

D.J. Hinde *, M. Dasgupta, E.C. Simpson
Department of Nuclear Physics, Research School of Physics, Australian National University, ACT 2601, Australia

Mechanisms Suppressing Superheavy Element Yields in Cold Fusion Reactions
Banerjee *et al.*, PRL 122, 232503 (2019)





Mechanisms Suppressing Superheavy Element Yields in Cold Fusion Reactions
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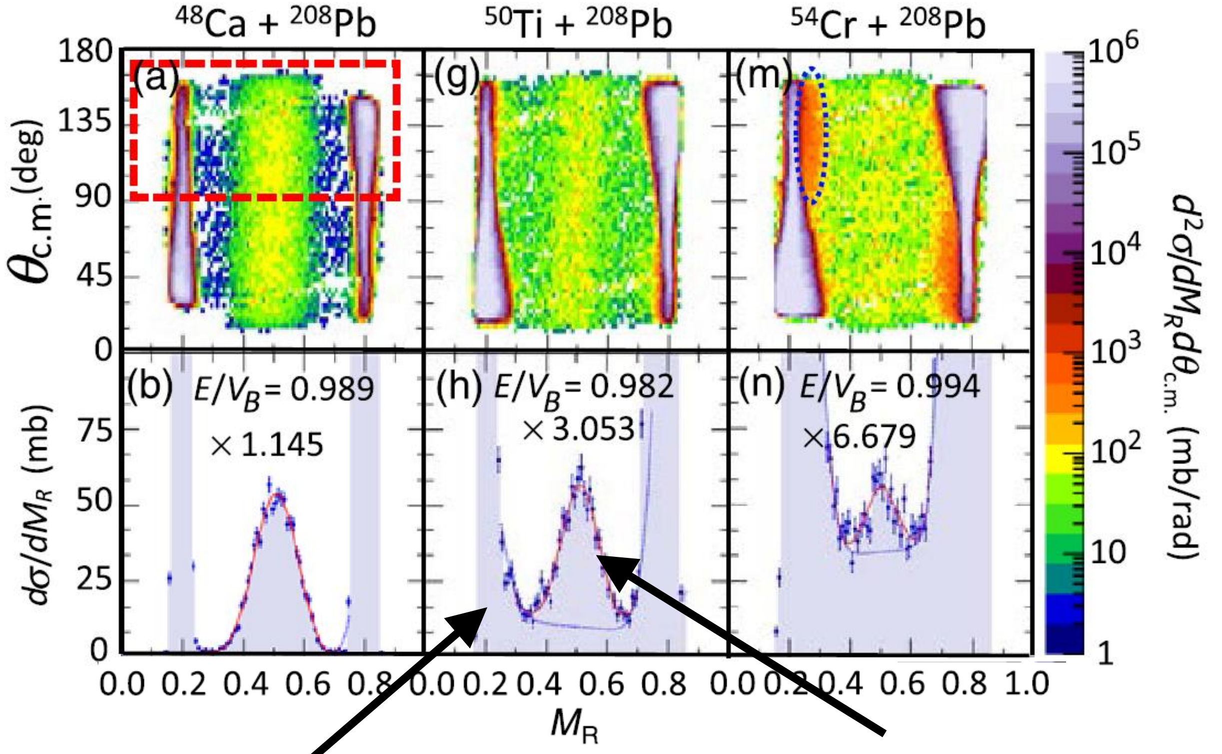


Fast Fission cross section

Mass ratio, symmetric split: $M_R = 0.5$

Fusion-Fission cross section (symmetrical fission)

Pfus can be experimentally estimated:

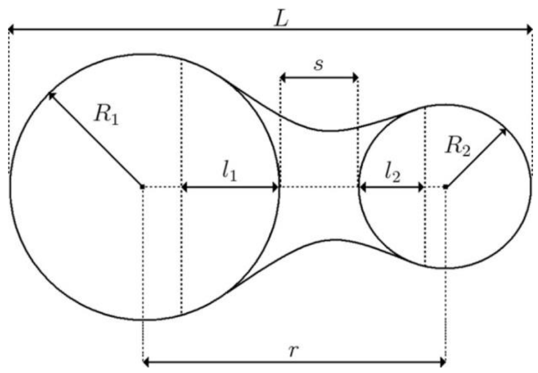
$$Psym = \frac{\textbf{Fusion–Fission}\text{ cross section}}{\textbf{Capture}\text{ cross section}}$$

Fusion probability averaged over l

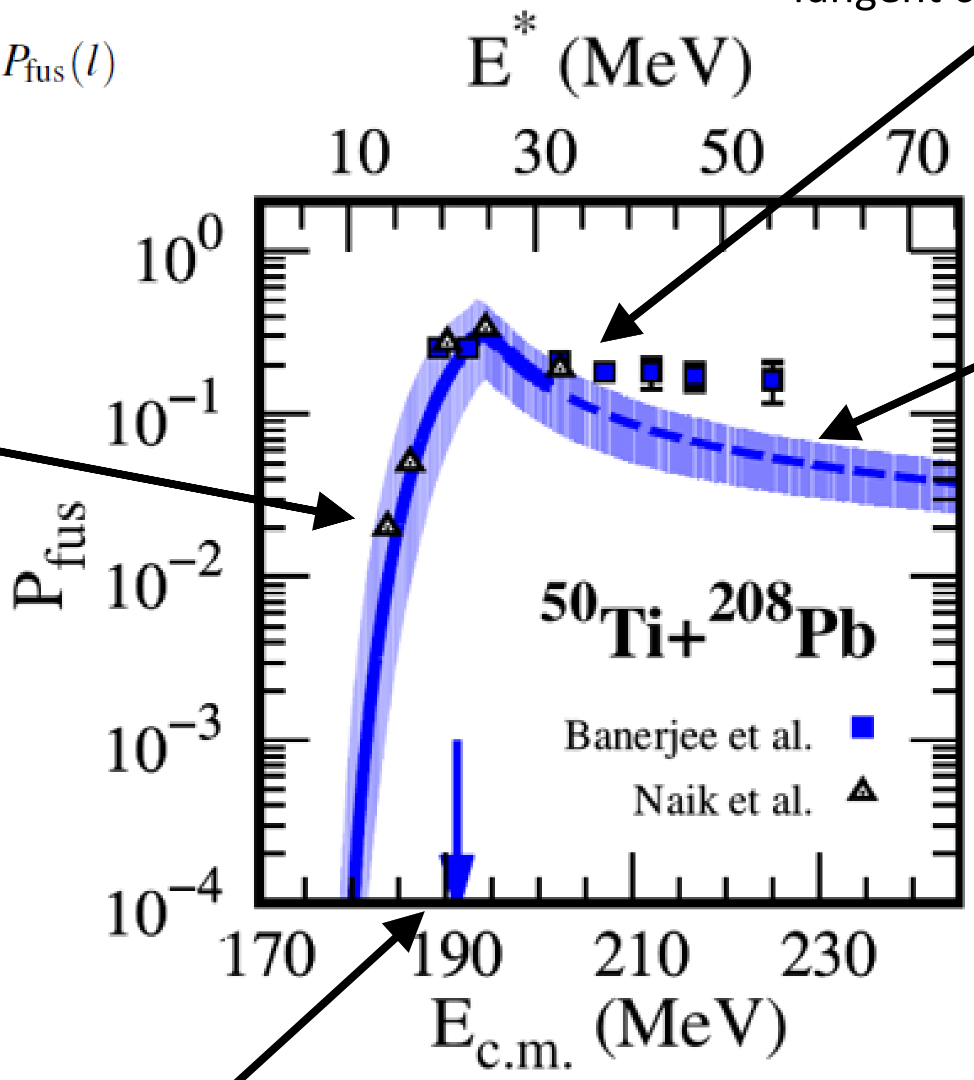
$$< P_{\rm fus} >= \frac{1}{(l_{\max}+1)^2} \sum_{l=0}^{l_{\max}} (2l+1) \times P_{\rm fus}(l)$$

Below B_0, the $<P_{fus}>$ growth comes from the reduction in the height of the internal barrier opposing fusion.

$s_{injection} > 0$ fm



Tangent configuration of projectile and target ($s_{injection}$ = 0 fm)



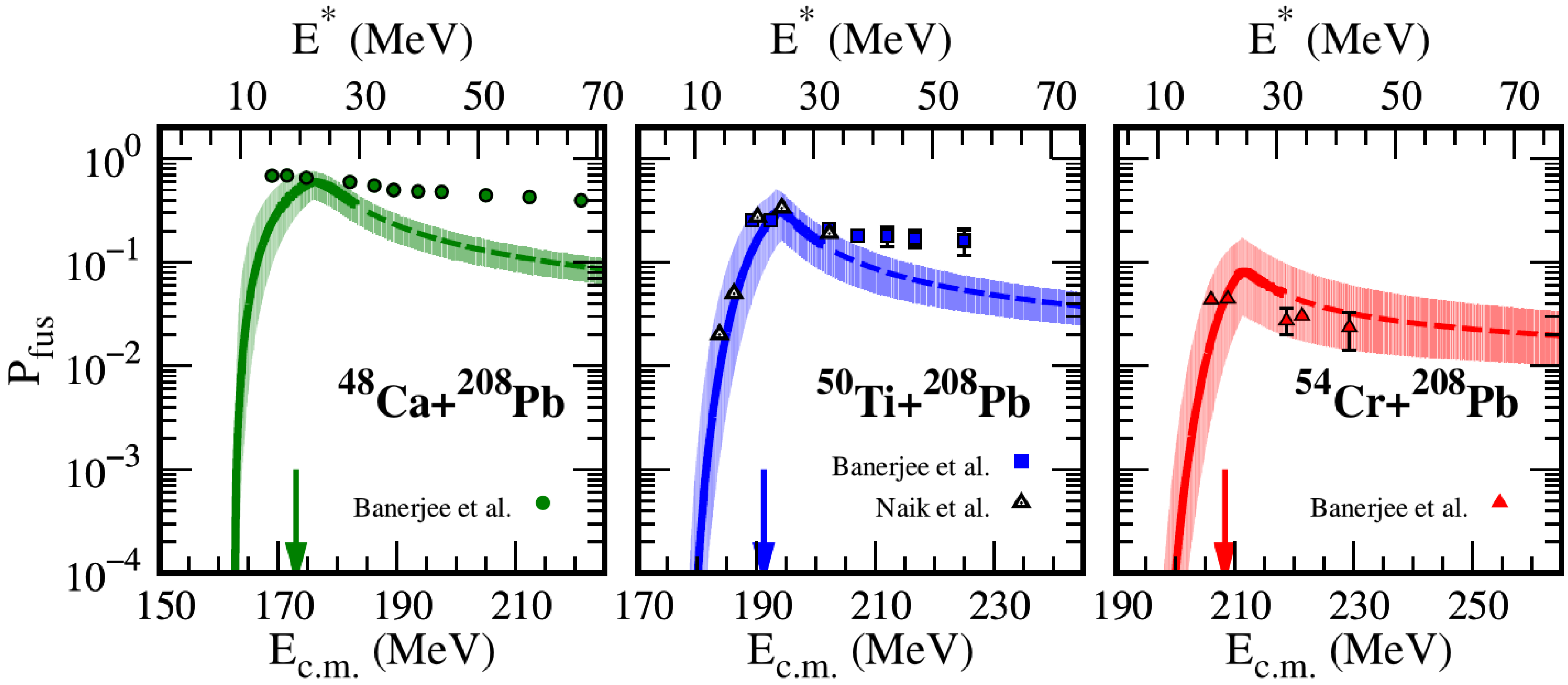
The $<P_{fus}>$ saturation above B_0 results from suppression of the contributions from higher partial waves and can be linked to the critical angular momentum.

The difference between rotational energies in the fusion saddle and the contact (sticking) configuration plays a major role in CN formation at energies above B_0.

B_0 - entrance channel barrier (Coulomb + Nuclear potential)

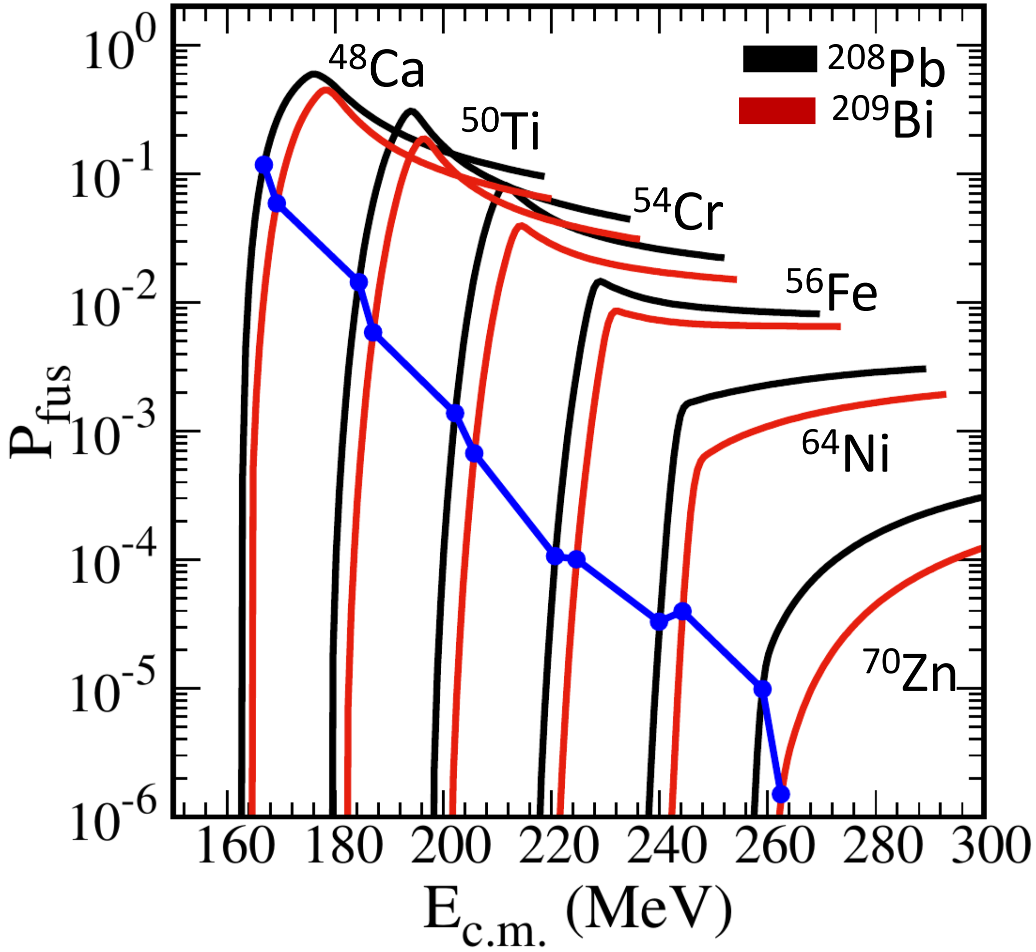
Fusion probability averaged over l

$$< P_{\text{fus}} >= \frac{1}{(l_{\max}+1)^2} \sum_{l=0}^{l_{\max}} (2l+1) \times P_{\text{fus}}(l)$$

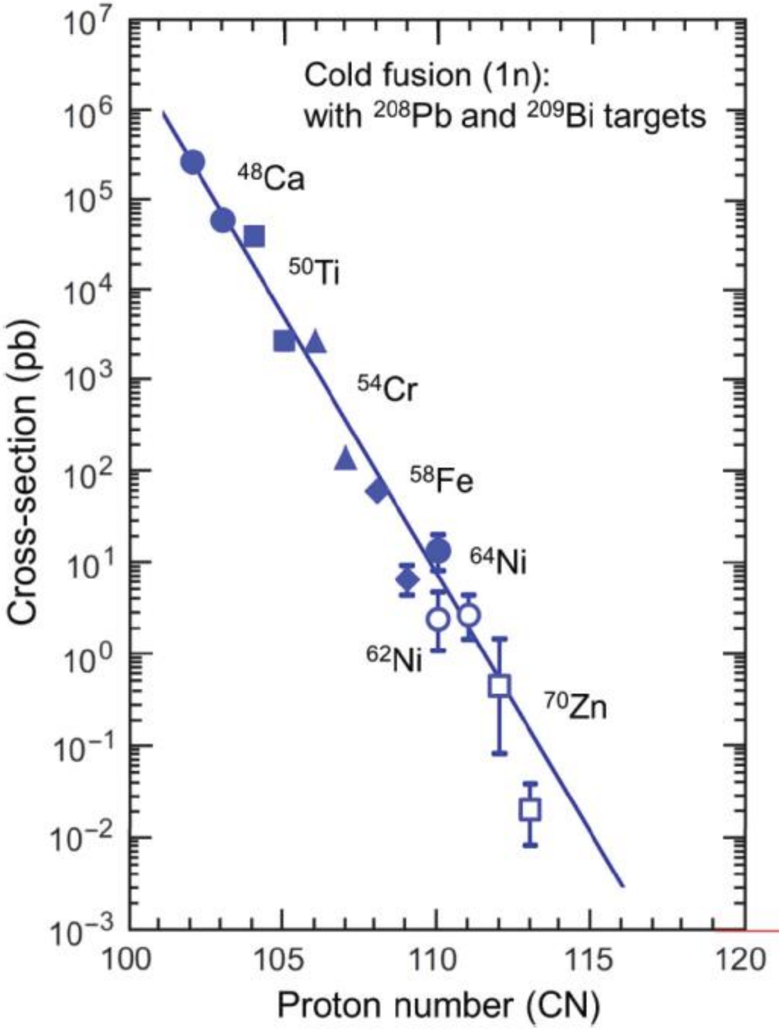


Diffusion as a possible mechanism controlling the production of superheavy nuclei in cold fusion reactions

T. Cap, M. Kowal, and K. Siwek-Wilczyńska
Phys. Rev. C **105**, L051601 – Published 16 May 2022



Blue line – *Pfus* at the predicted optimal bombarding energies for the *1n* channel



The Fusion-by-Diffusion model as a tool to calculate cross sections for the production of superheavy nuclei

Eur. Phys. J. A (2022) 58:231

T. Cap[a,1], M. Kowal[b,1], K. Siwek-Wilczyńska[c,2]

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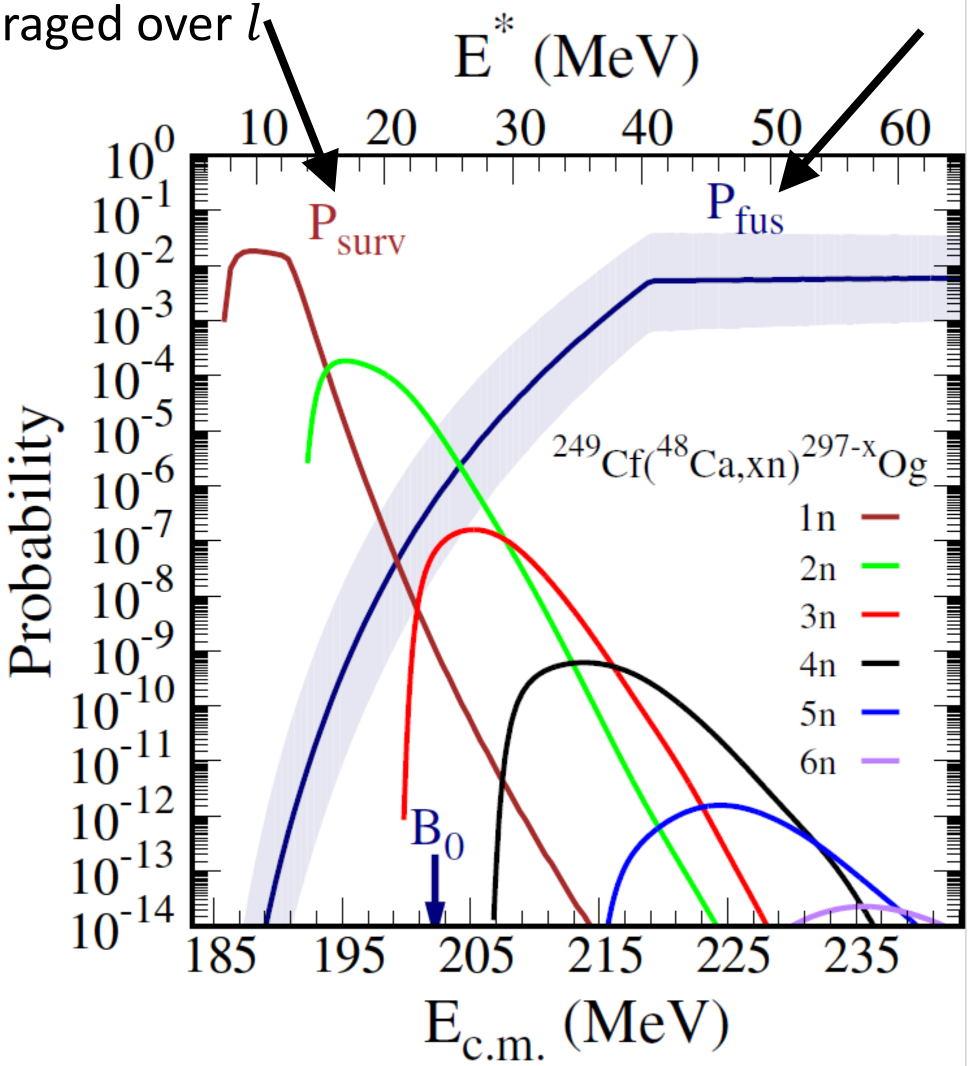
$$< P_{\mathrm{surv}} > = \frac{1}{(l_{\max}+1)^2} \sum_{l=0}^{l_{\max}} (2l+1) \times P_{\mathrm{surv}}(l)$$

Survival probability averaged over l

Fusion probability averaged over l



For hot Fusion reactions

P_{surv} is calculated using Monte Carlo methods:

$$P_{\mathrm{surv}}^{xn}(l) = \prod_{i=1}^{x} \left(\frac{\Gamma_n}{\Gamma_n + \Gamma_f} \right)_i \times P_<$$

Competition between neutron emission and fission

Weisskopf formula

$$\Gamma_n = \frac{g m_n \sigma_n}{\pi^2 \hbar^2 \rho_{G.S.}} \int_0^{X_n} \rho_n (X_n - \varepsilon_n) \varepsilon_n d\varepsilon_n$$

$$X_n = E^* - B_n - E_{rot}^{A-1}(l)$$
$$X_f = E^* - B_f - E_{rot}^{sp}(l)$$

Transition-state theory

$$\Gamma_f = \frac{1}{2\pi \rho_{G.S.}} \int_0^{X_f} \rho_f (X_f - \varepsilon_f) d\varepsilon_f$$

Properties of heaviest nuclei with $98 \le Z \le 126$ and $134 \le N \le 192$

P. Jachimowicz [a], M. Kowal [b,*], J. Skalski [b]
[a] Institute of Physics, University of Zielona Góra, Szafrana 4a, 65-516 Zielona Góra, Poland
[b] National Centre for Nuclear Research, Pasteura 7, 02-093 Warsaw, Poland

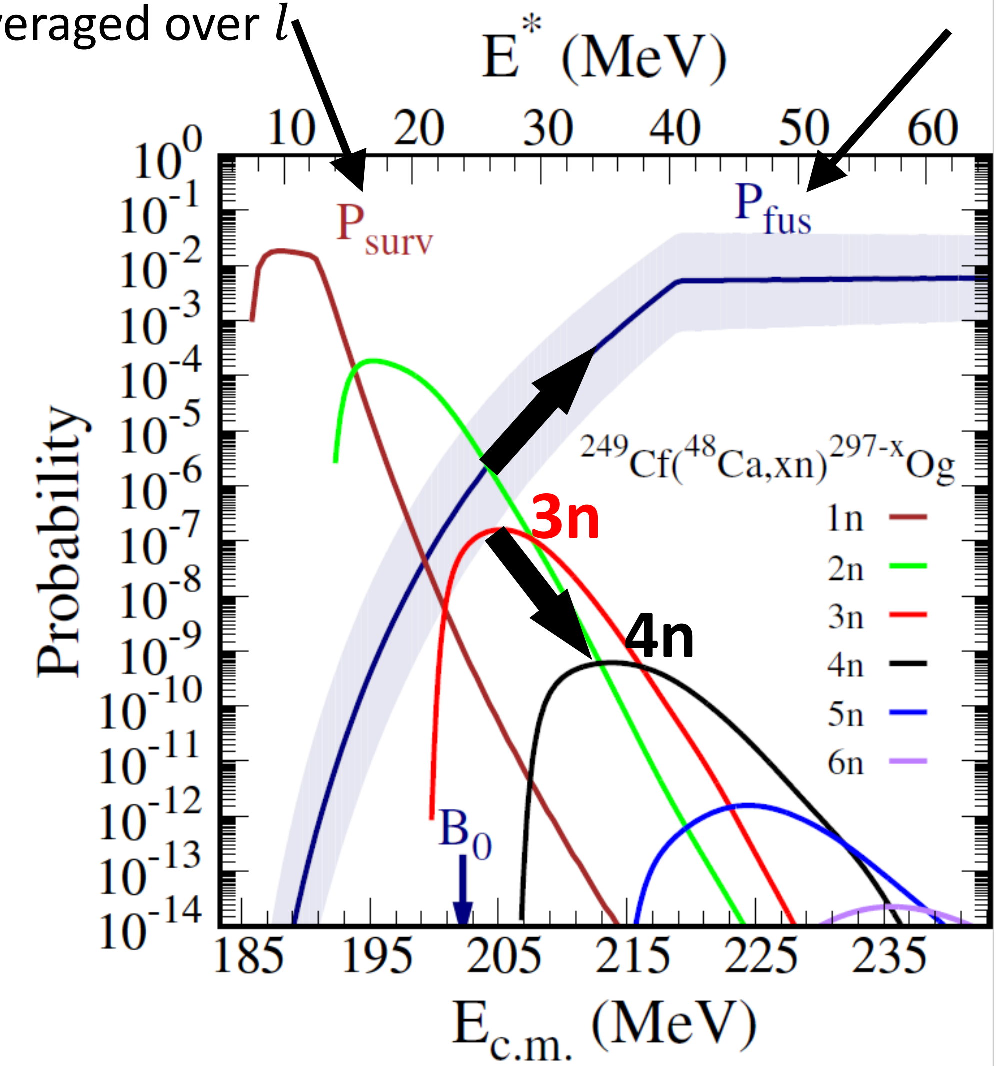
Adiabatic fission barriers

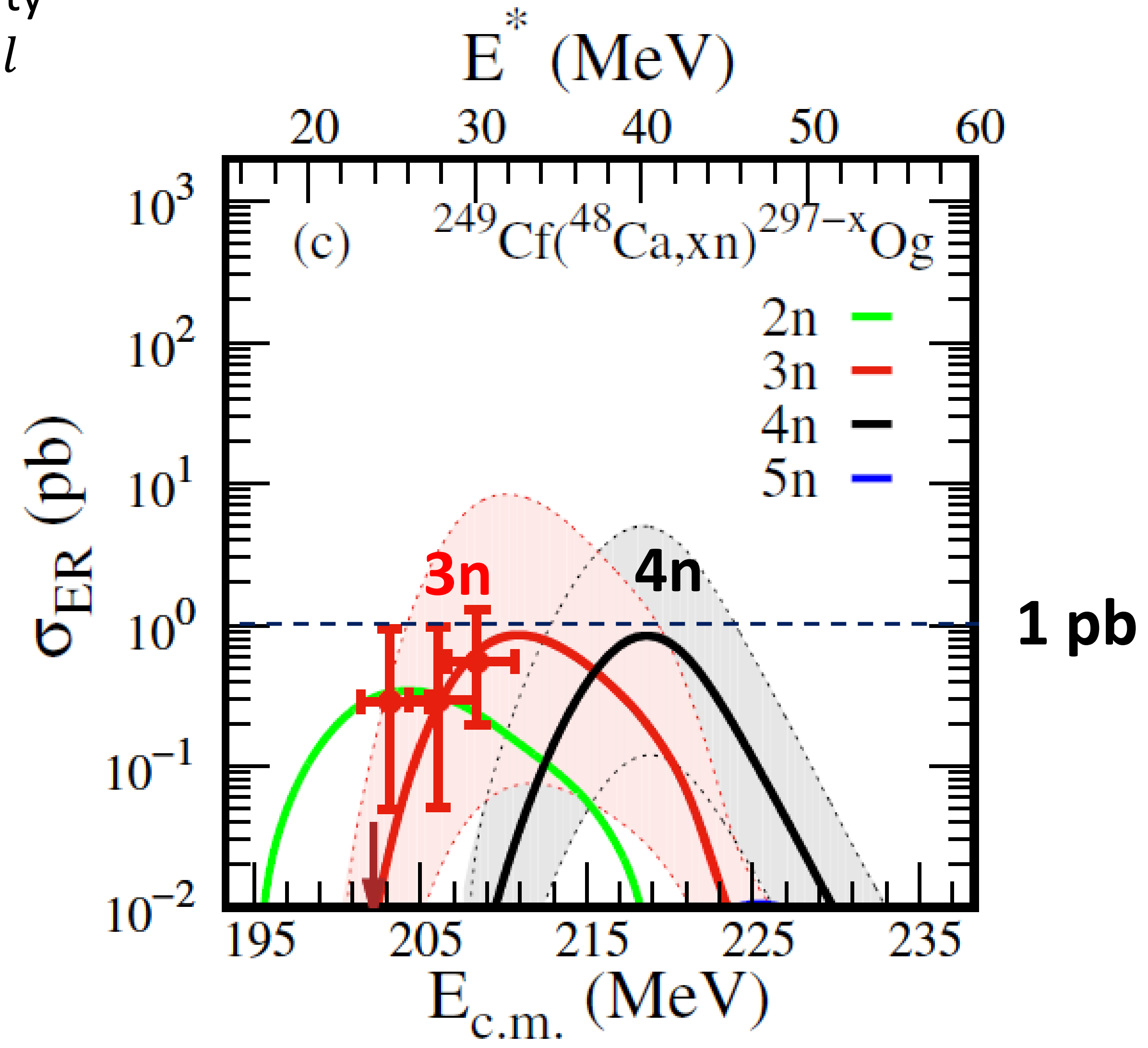
T. Cap, M. Kowal, and K. Siwek-Wilczyńska, EPJ

$$< P_{\text{surv}} > = \frac{1}{(l_{\max}+1)^2} \sum_{l=0}^{l_{\max}} (2l+1) \times P_{\text{surv}}(l)$$

Survival probability averaged over l

Fusion probability averaged over l

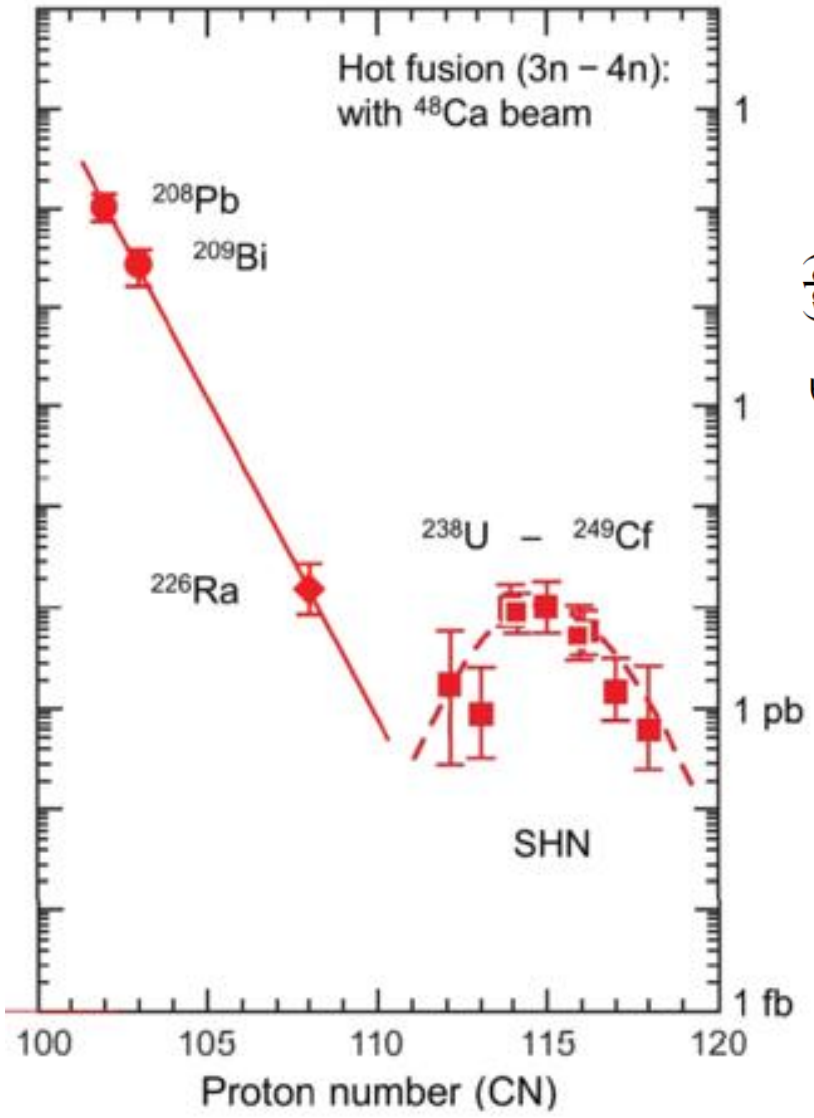


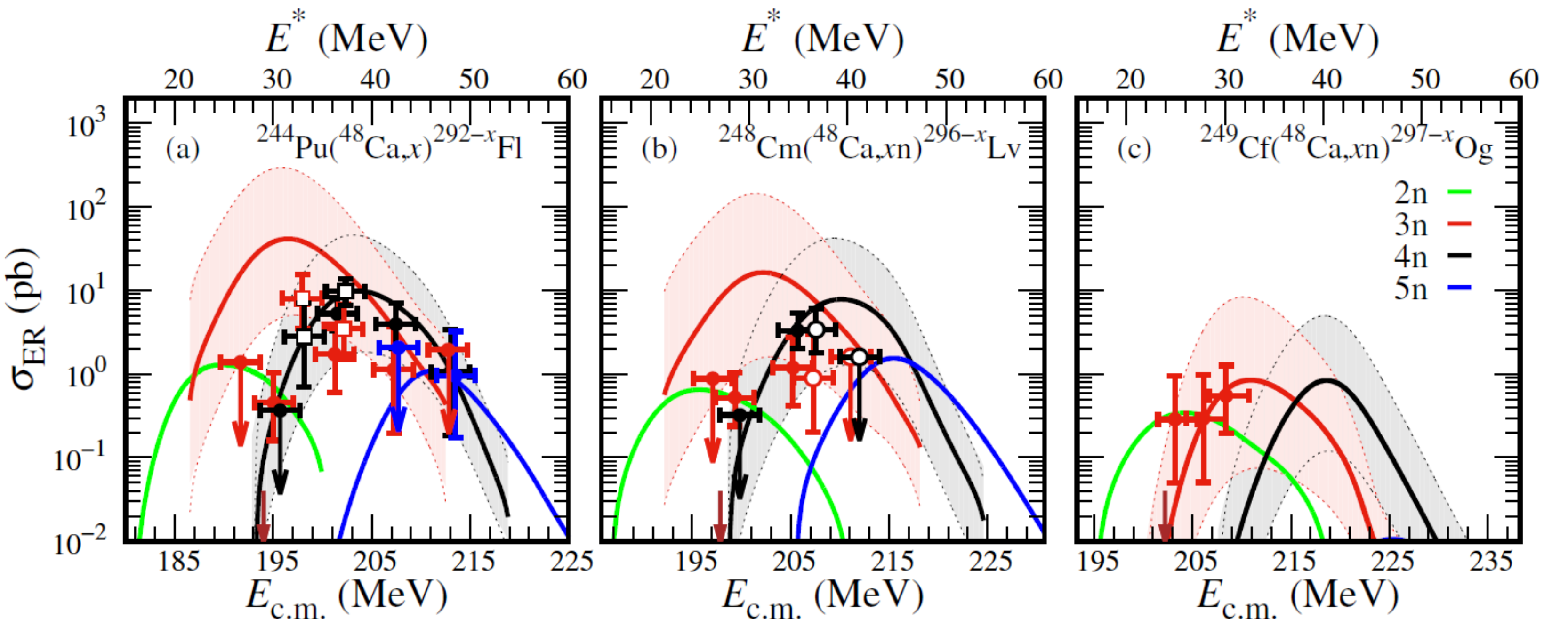


Yu. Ts. Oganessian and V. K. Utyonkov. Rep. Prog. Phys. 78(3):036301, 2015

T. Cap, M. Kowal, and K. Siwek-Wilczyńska, EPJ

Yu. Ts. Oganessian and V. K. Utyonkov. Rep. Prog. Phys. 78(3):036301, 2015





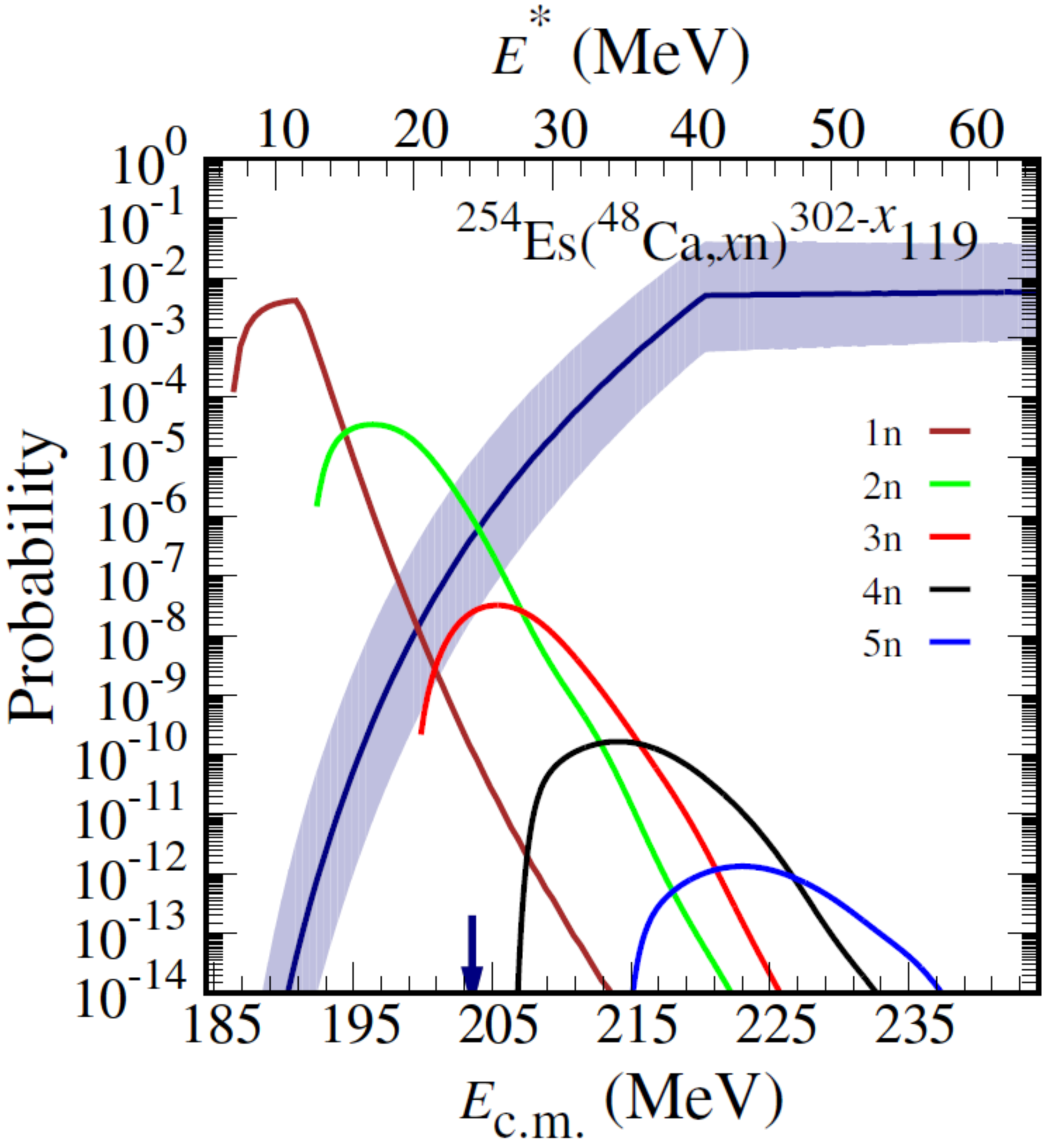
Systematic decrease of the 3n and 4n ER cross sections for the synthesis of the elements 114 – 118 is reproduced in the model.

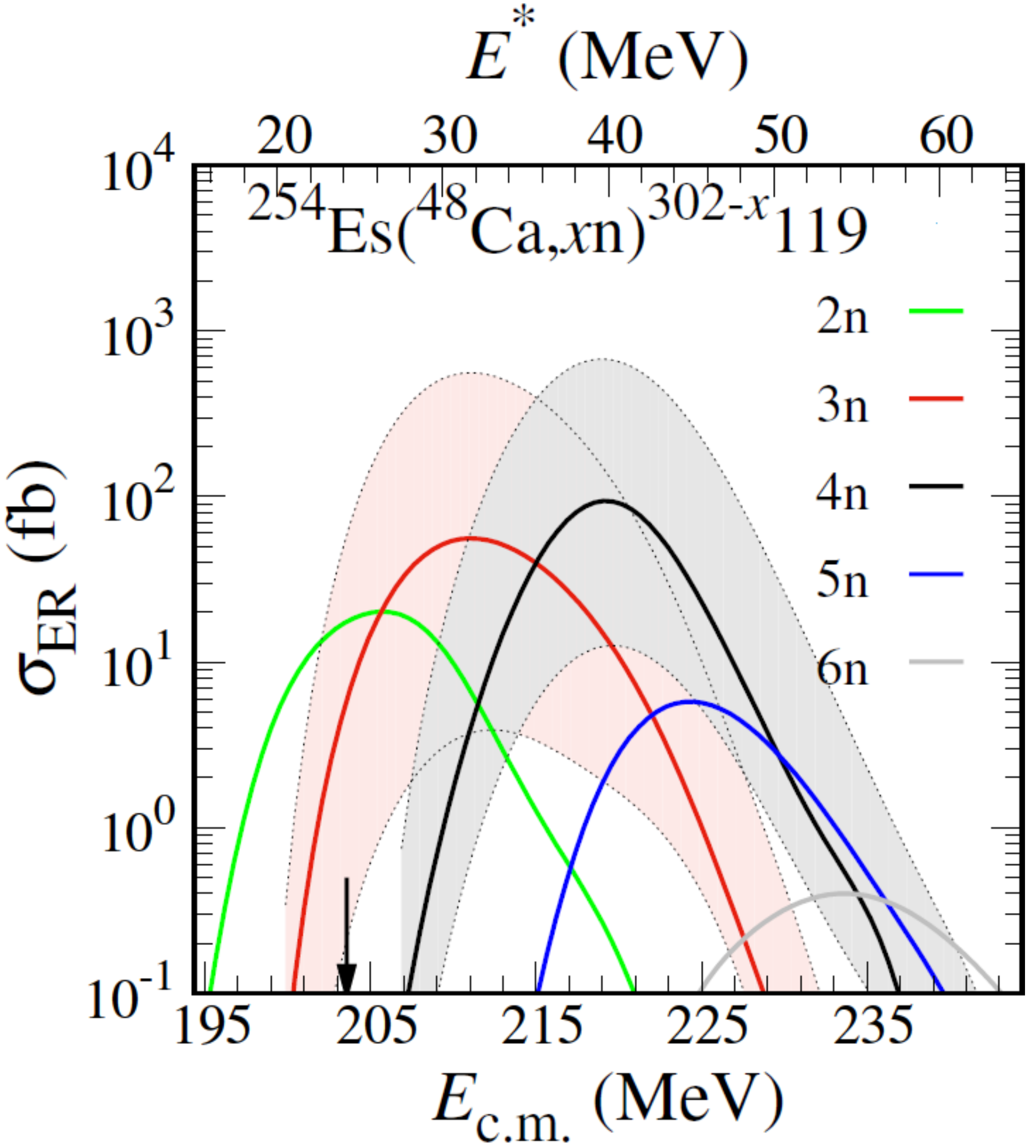
Is synthesis of elements 119 and 120 possible?
Can we use the same approach for ^{50}Ti and ^{51}V?

The cross section for ^{48}Ca+^{254}Es should be around 100 fb.

NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK

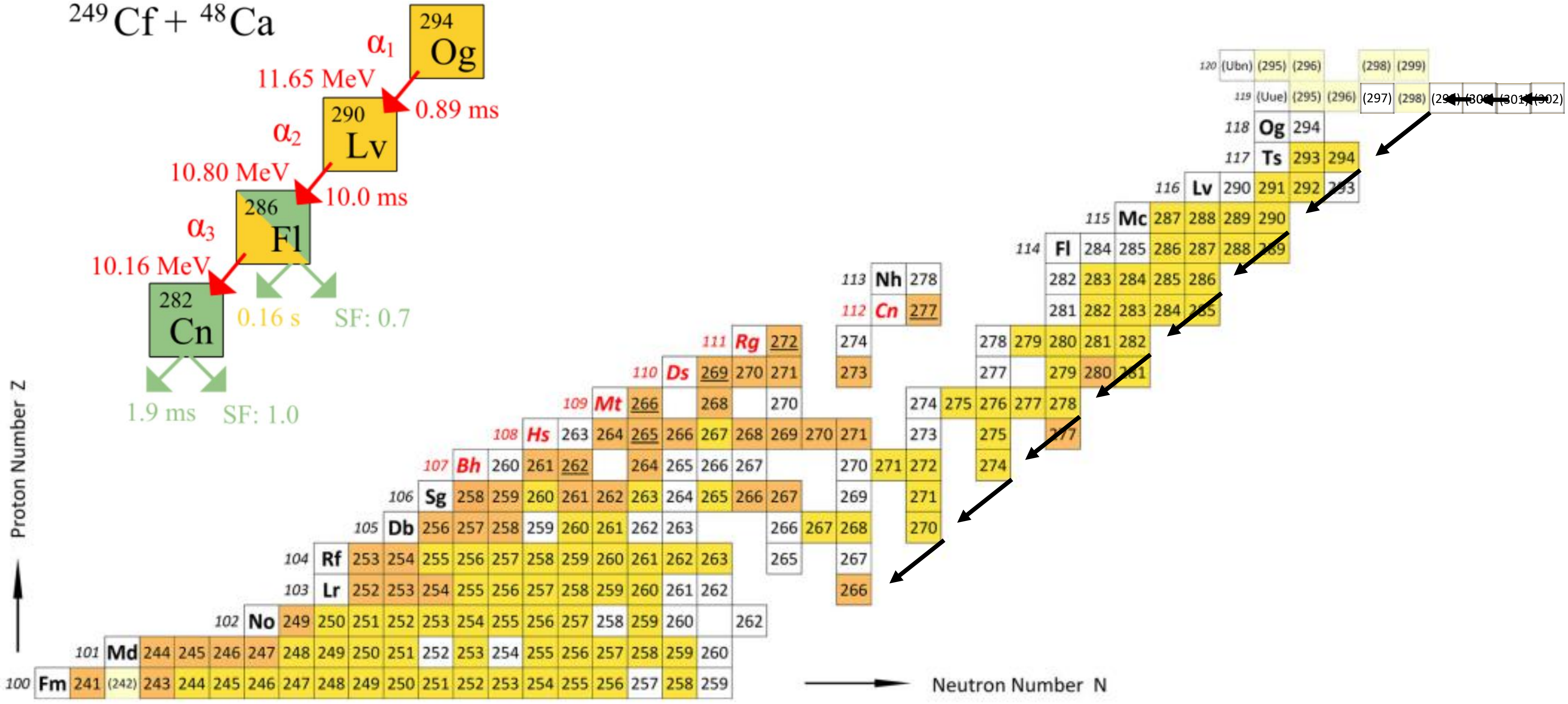
T. Cap, M. Kowal, and K. Siwek-Wilczyńska, EPJ



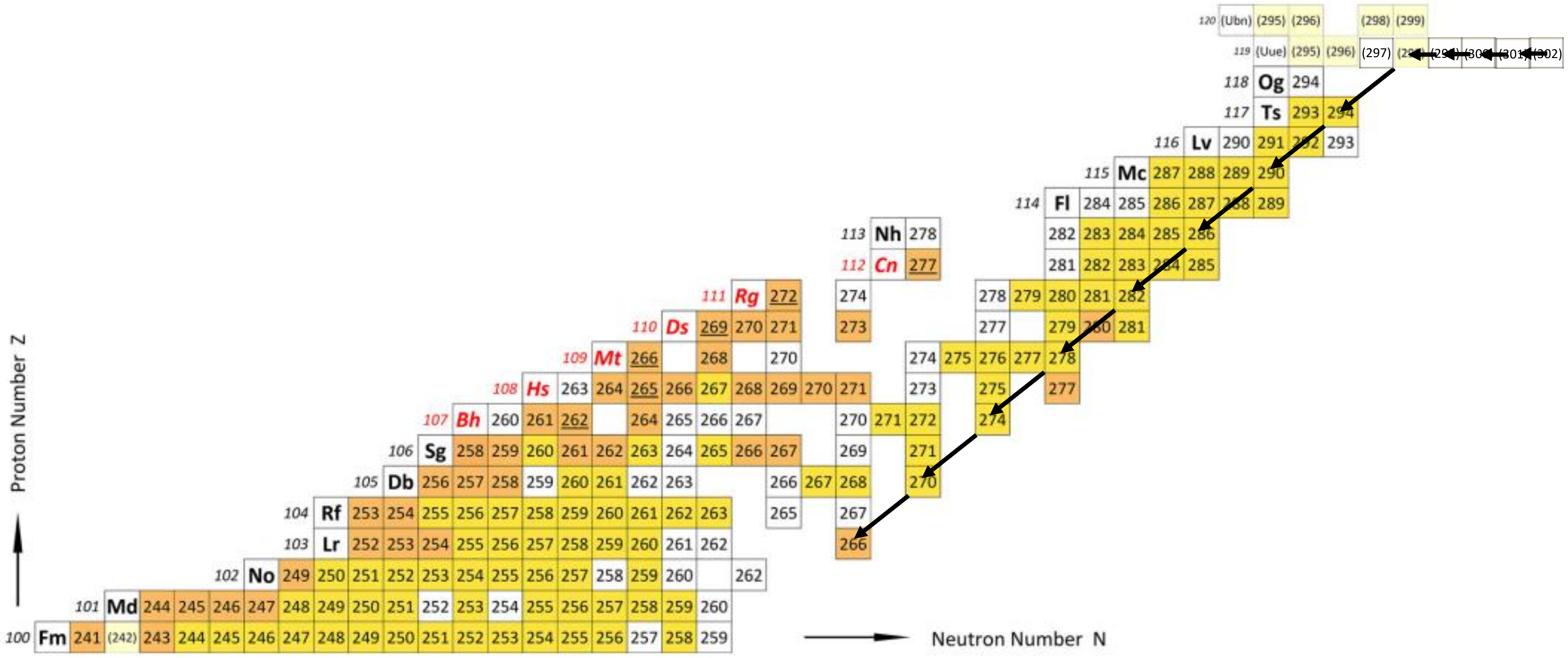


NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK

$^{48}Ca + ^{254}Es \rightarrow {}^{299}119 + 3n$



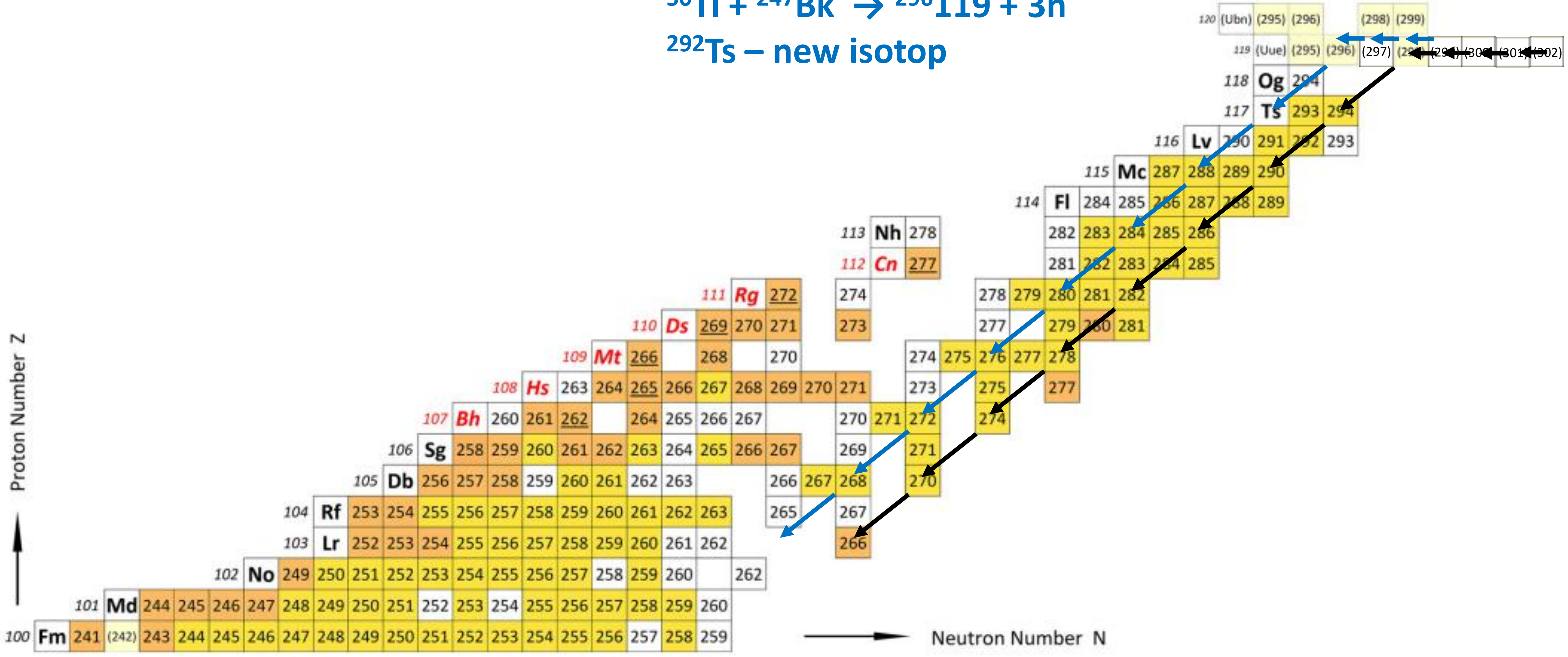
$^{48}Ca + ^{254}Es \rightarrow ^{298}119 + 4n$



$^{51}V + ^{248}Cm \rightarrow ^{296}119 + 3n$

$^{50}Ti + ^{247}Bk \rightarrow ^{296}119 + 3n$

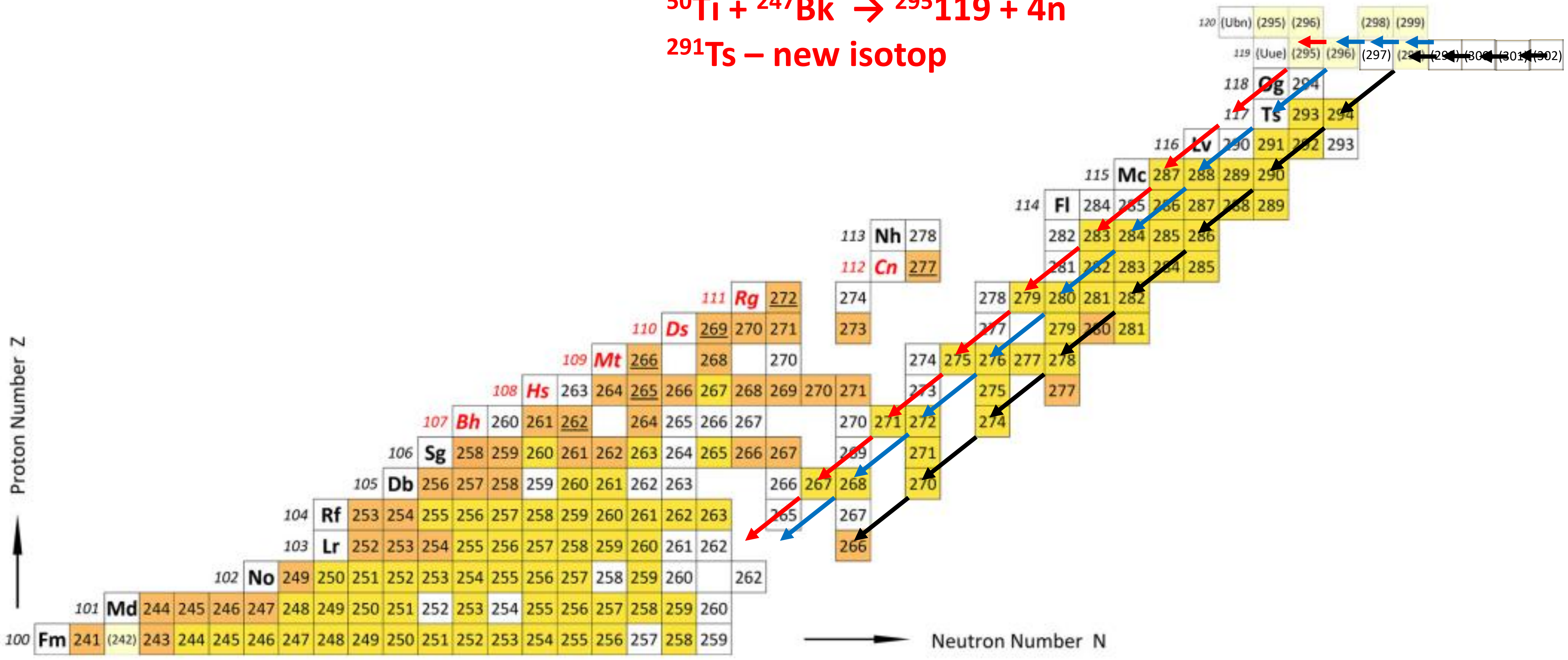
^{292}**Ts – new isotop**



$^{51}V + {}^{248}Cm \rightarrow {}^{295}119 + 4n$

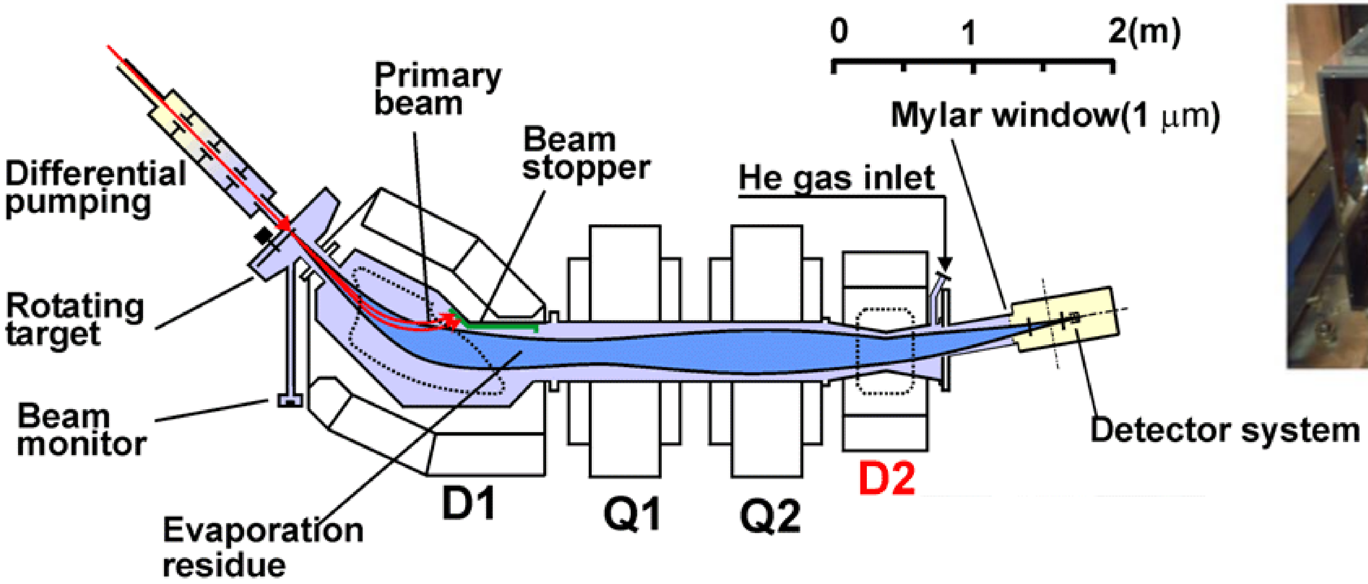
$^{50}Ti + {}^{247}Bk \rightarrow {}^{295}119 + 4n$

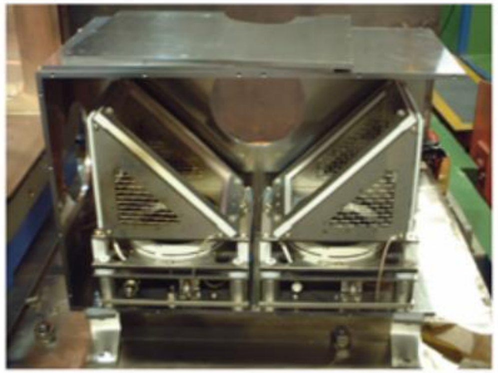
^{291}Ts – new isotop

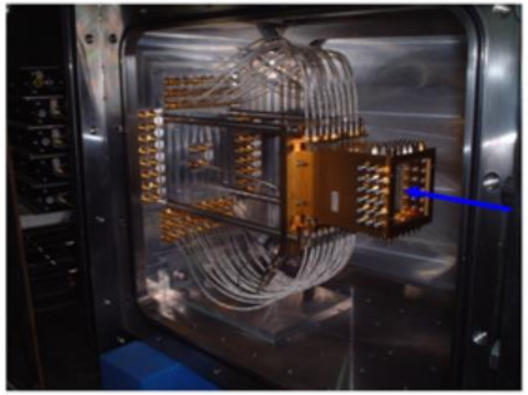


RIKEN GARIS(Gas-filled Recoil Ion Separator)

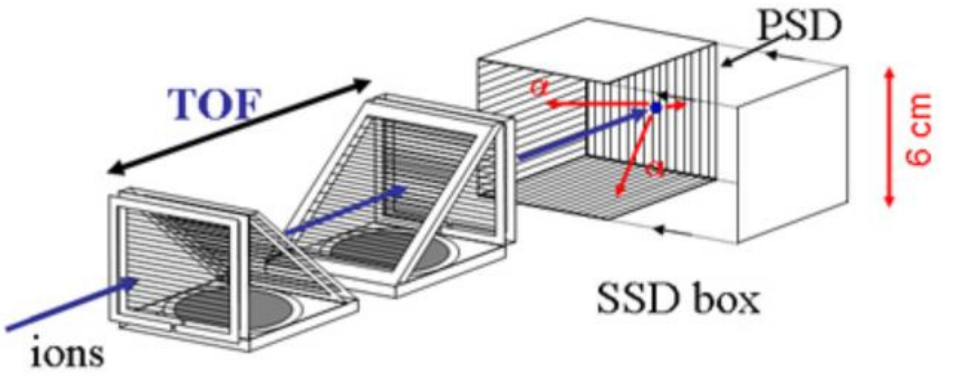
$^{51}V + ^{248}Cm$







Magnification	X	-0.76
	Y	-1.99
Dispersion		0.97 cm/%
Total length		5760 mm
Acceptance	Δθ	±68 mrad
	Δϕ	±57 mrad
	ΔΩ	12.2 msr



Target from ORNL: ^{248}Cm (97%), 500 μg/cm^2
Projectile: ^{51}V, up to 5 pμA
GARIS transmition: 80%

Figure 13: Assembled TASCA target wheel with four target segments, containing a total amount of about 12 mg ^{249}Bk, deposited by molecular plating on 2 µm Ti backings [144]. The total ^{249}Bk ß$^{-}$-activity was $6{\cdot}10^{11}$ Bq at the beginning of irradiation [86]. (Reprinted by permission from Springer nature Customer Service Centre GmbH: Nature Springer J. Radioanal. Nucl. Chem. 299, 1081–1804 (2014), “Preparation of actinide targets for the synthesis of the heaviest elements”, https://doi.org/10.1007/s10967-013-2616-6, J. Runke et al., © 2014).

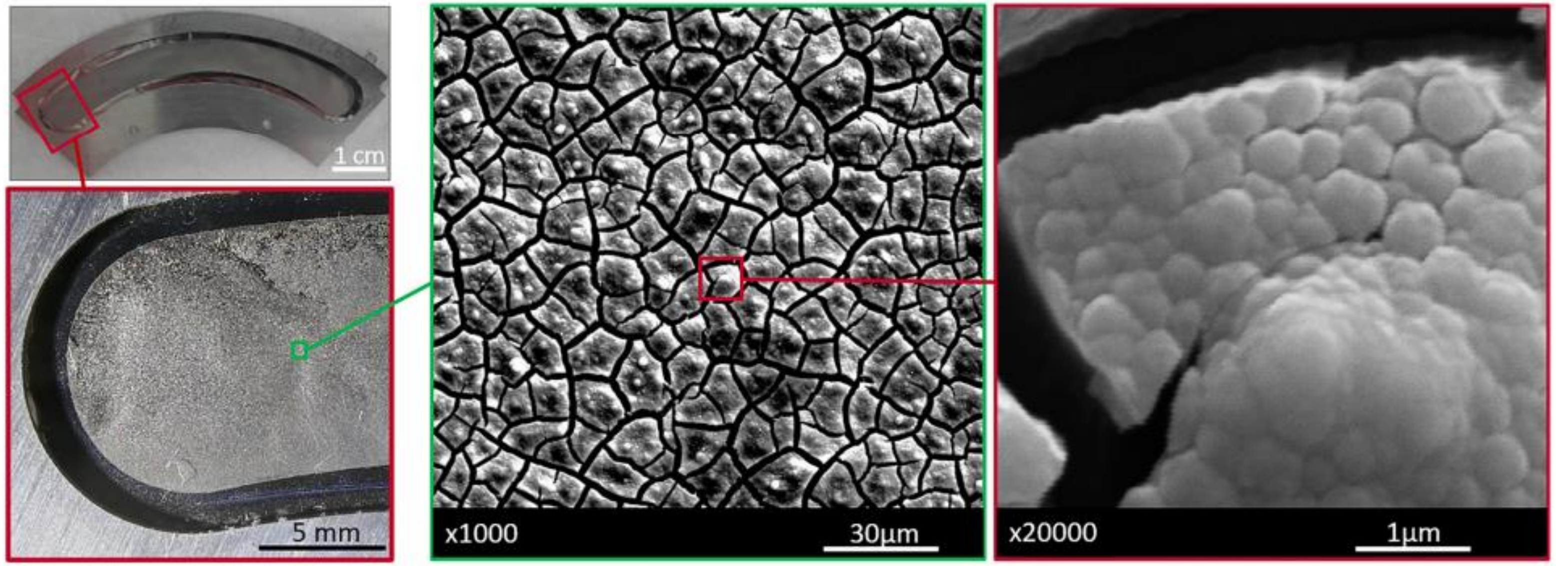


Figure 14: Photographies (top and bottom left) and SEM pictures (center and right) of a 500 µg/cm^2 La target on a TASCA target frame.

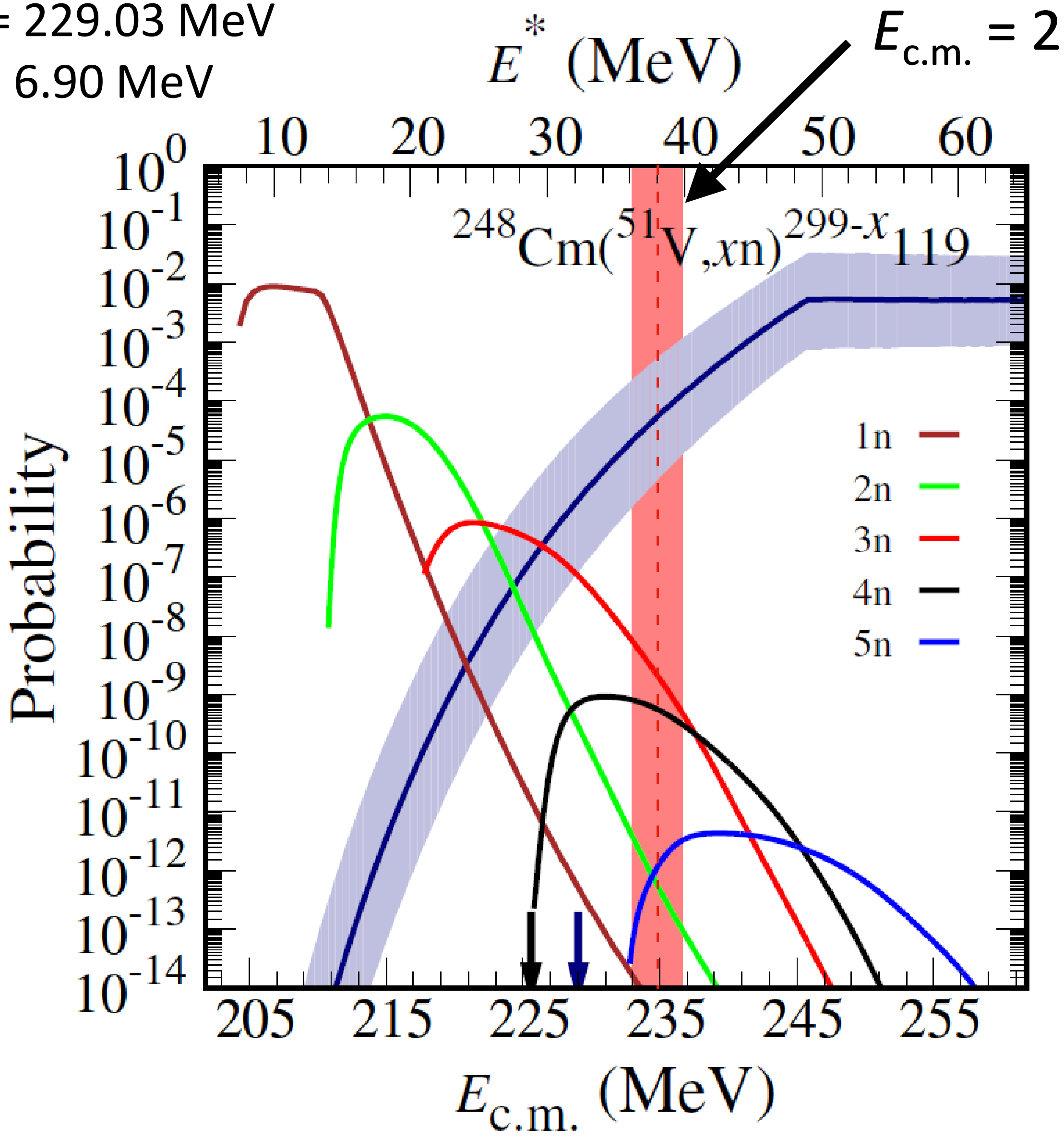
FBD model:

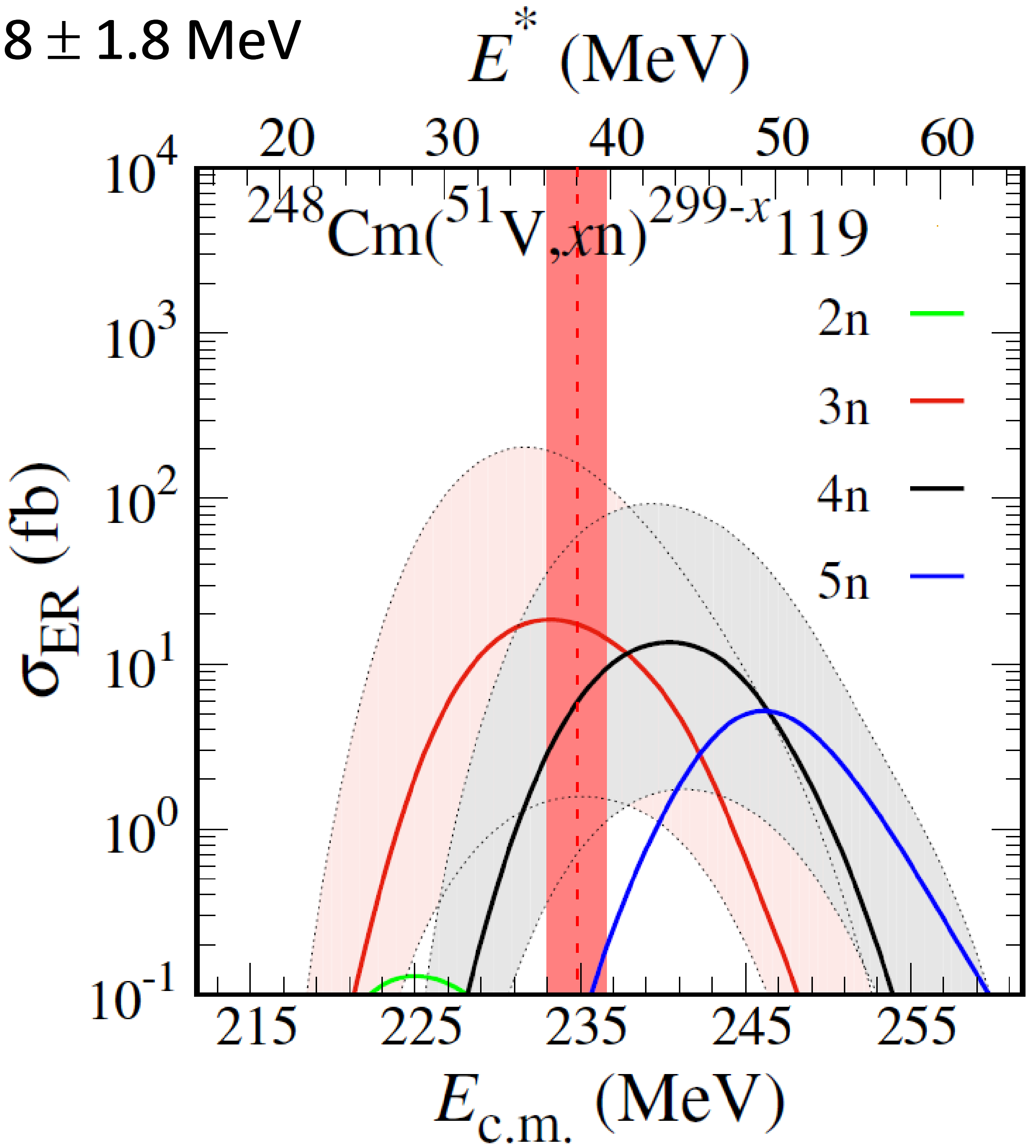
B_0 = 229.03 MeV

ω = 6.90 MeV

M. Tanaka *et al.*, J Phys. Soc. Jpn. 91, 084201 (2022)

$E_{c.m.}$ = 234.8 ± 1.8 MeV



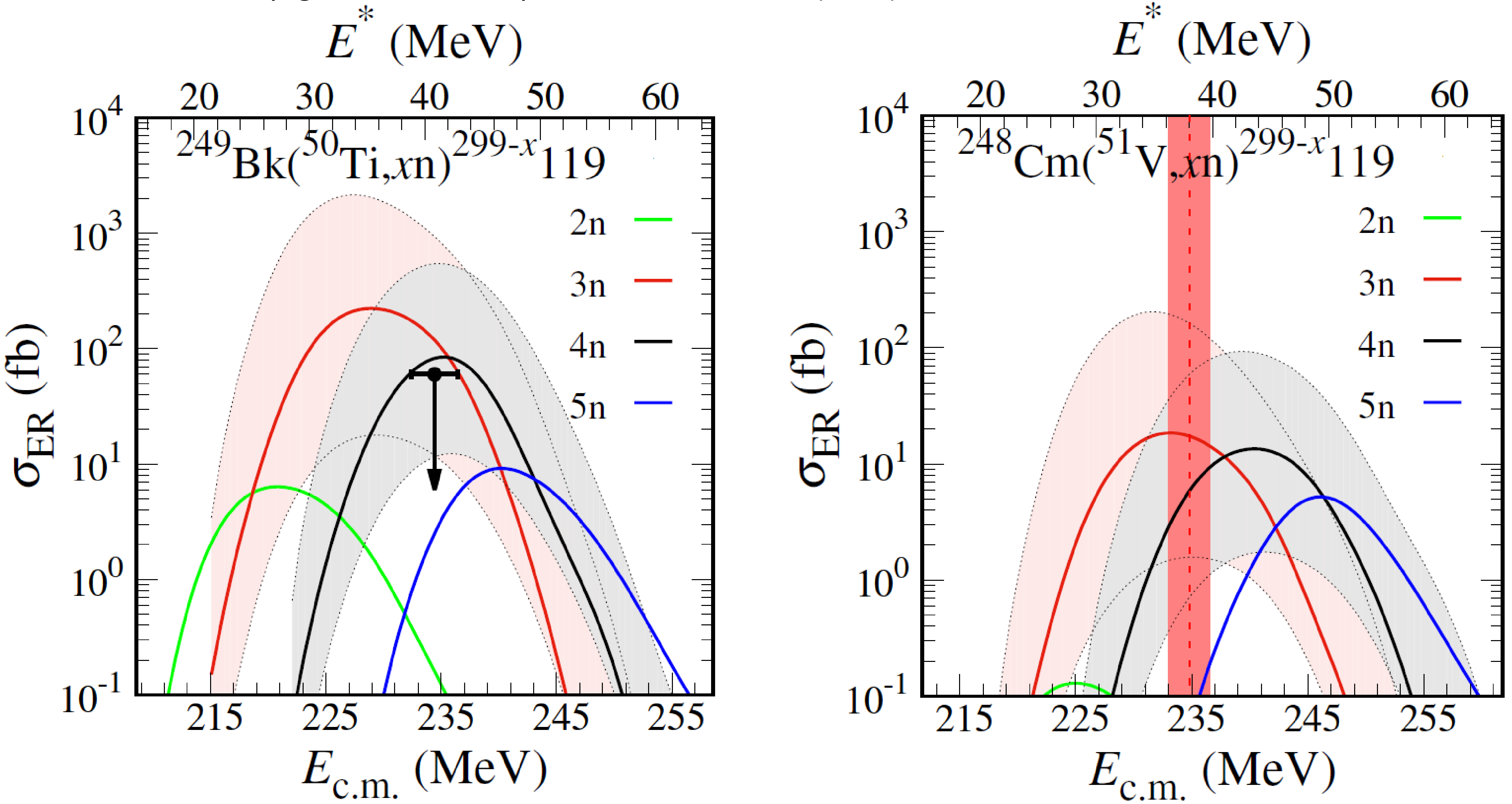


NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK

B_0 for V + Cm is 25 MeV higher than for Ca + Es

σ = 10 fb => 1 event in 200 days

Exp. Limit of 65 fb J. Khuyagbaatar *et al.*, Phys. Rev. C 102, 064602 (2020)

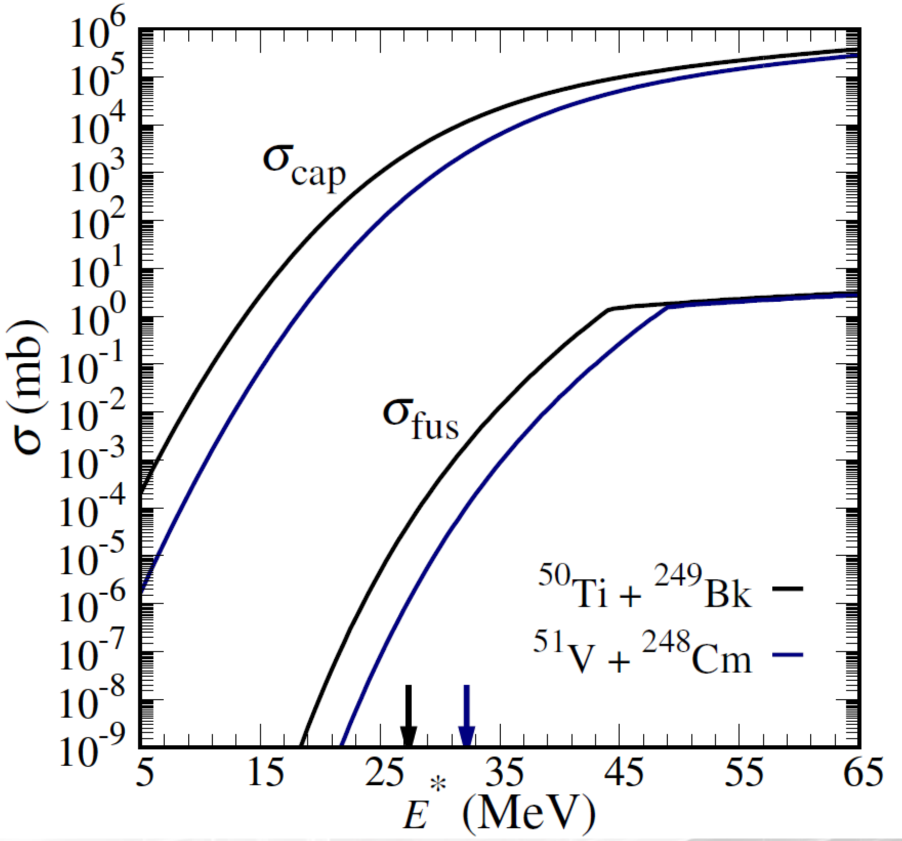


σ = 10 fb => 1 event in 200 days

Evaporation residue cross sections

Reactions $^{51}V + ^{248}Cm$ and $^{50}Ti + ^{249}Bk$ both lead to the same compound nucleus $^{299}119$, but with different cross sections.

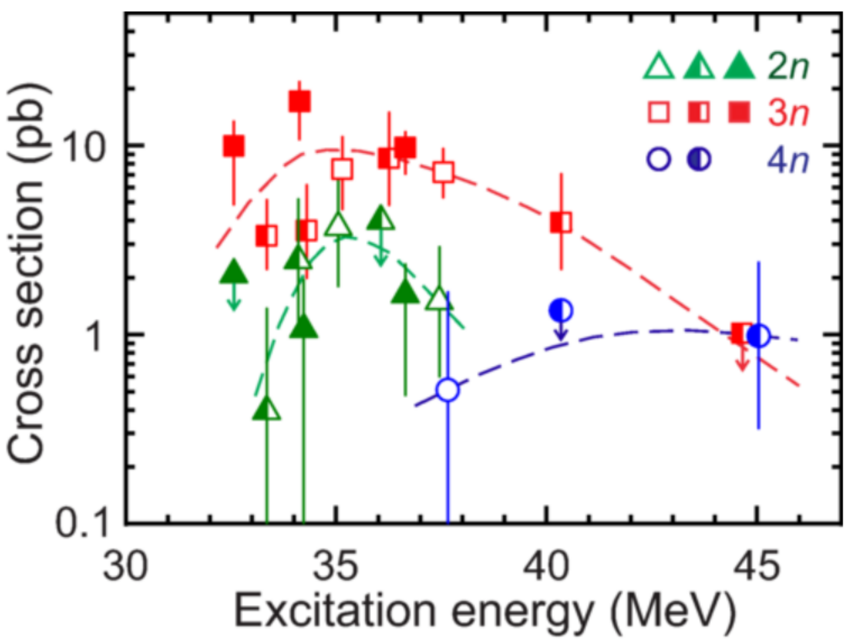
	^{48}Ca systematics		Lower limit – more probable values	
$^{51}V + ^{248}Cm$	$\sigma_{MAX}(3n) = 20$ fb	$\sigma_{MAX}(4n) = 15$ fb	$\sigma(3n) = 2$ fb	$\sigma(4n) = 2$ fb
$^{50}Ti + ^{249}Bk$	$\sigma_{MAX}(3n) = 250$ fb	$\sigma_{MAX}(4n) = 100$ fb	$\sigma(3n) = 20$ fb	$\sigma(4n) = 15$ fb



Entrance channel effect

$^{51}V + ^{248}Cm$ is more „charge symmetric" than $^{50}Ti + ^{249}Bk$
→ greater Coulomb repulsion (8 MeV difference in B_0)

This makes the fusion cross section for the $^{51}V + ^{248}Cm$ reaction one order of magnitude smaller than for the $^{50}Ti + ^{249}Bk$ reaction at the excitation energies less than 45 MeV (3n and 4n channel).



First experiment at the Super Heavy Element Factory: High cross section of $^{288}\mathrm{Mc}$ in the $^{243}\mathrm{Am} + {}^{48}\mathrm{Ca}$ reaction and identification of the new isotope $^{264}\mathrm{Lr}$

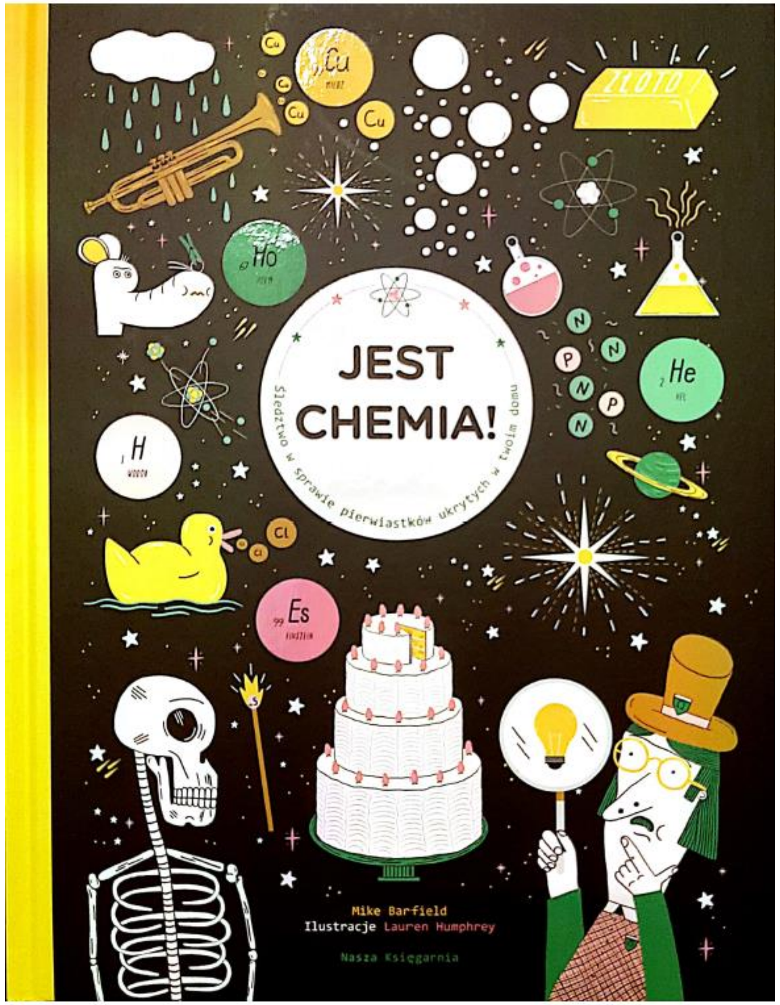
Yu. Ts. Oganessian *et al.*
Phys. Rev. C **106**, L031301 – Published 29 September 2022

Search for element 120 in 2023?

54Cr + 248Cm

σ(3n), σ(4n) < 1 fb

Low P_{surv}



ZŁOTO
Cu
Ho
He
H
Cl
Es
JEST CHEMIA!
Śledztwo w sprawie pierwiastków ukrytych w twoim domu
Mike Barfield
Ilustracje Lauren Humphrey
Nasza Księgarnia

ATOMOWY KOMIKS
DETEKTYWI Z PROJEKTU MANHATTAN: ZAGADKA BOMBY ATOMOWEJ
10
JAK WIECIE, STAROŻYTNYM UDAŁO SIĘ ODKRYĆ WIELE WYSTĘPUJĄCYCH NATURALNIE PIERWIASTKÓW...
Oo!
NIEKTÓRE SZCZĘŚLIWYM TRAFEM ZNALEŹLI ALCHEMICY...
Oo!
A CAŁE MNÓSTWO ZIDENTYFIKOWAŁ ŚWIADOMIE SIR HUMPHRY DAVY...
Znalazłem 1 Arr!
ORAZ, NATURALNIE, INNI WIELCY CHEMICY...
OD POWSTANIA FIZYKI JĄDROWEJ* ZSYNTETYZOWANO WIELE SZTUCZNYCH PIERWIASTKÓW, ZARÓWNO ŁĄCZĄC, JAK I ROZBIJAJĄC CZĄSTKI...
Bombowe atomy!
Rzeczywiście tłiczne
* PATRZ ATOMOWY KOMIKS 9
AUSTRIACKO-SZWEDZKA FIZYCZKA LISE MEITNER I NIEMIECKI CHEMIK OTTO HAHN PIERWSI ROZSZCZEPILI ATOM
Rozbiliśmy go
Razem!
LISE MEITNER (1878–1968)
OTTO HAHN (1879–1968)
W ROKU 1938 HAHN Z POMOCĄ MEITNER BOMBARDOWAŁ NEUTRONAMI ATOMY URANU. JĄDRO URANU WCHŁONĘŁO NEUTRON I ROZPADŁO SIĘ NA DWA MNIEJSZE ATOMY.
235 U
Kr
Ba
Rozstańmy się!
TEN PROCES NAZYWAMY OBECNIE ROZSZCZEPIENIEM ATOMU
UWOLNIŁA SIĘ PRZY TYM OGROMNA ILOŚĆ ENERGII, ZGODNIE Z NAJSŁYNNIEJSZYM RÓWNANIEM W NAUCE, $E = mc^2$
Które sformułowałem ja, genialny* Albert Einstein!
UR. W NIEMCZECH W 1879 ROKU, ZM. W USA W 1955. * ALE TA FRYZURA!
W 1944 ROKU NAGRODĘ NOBLA Z CHEMII OTRZYMAŁ OTTO HAHN – LECZ NIE LISE MEITNER! WIELU UZNAŁO TO ZA BARDZO NIESPRAWIEDLIWE.
Otto był wielkim chemikiem, ale nie ma swojego pierwiastka. A ja tak!
POTRAFISZ GO ZNALEŹĆ?
NAUKOWCY ZROZUMIELI, ŻE DZIĘKI ROZSZCZEPIENIU ATOMU MOŻNA ZBUDOWAĆ BOMBĘ ATOMOWĄ. ALIANCI* PODCZAS II WOJNY ŚWIATOWEJ STARALI SIĘ UPRZEDZIĆ NAZISTOWSKIE NIEMCY ADOLFA HITLERA. SUPERTAJNA MISJA OTRZYMAŁA NAZWĘ...
Projekt Manhattan, psst!
* USA, WIELKA BRYTANIA I KANADA.
PROJEKT PRZYCIĄGNĄŁ NAJWIĘKSZYCH UCZONYCH TAMTYCH CZASÓW. BYŁ WŚRÓD NICH EDWIN MCMILLAN...
W 1940 roku stworzyłem pierwszy w dziejach transuranowiec – „pierwiastek 93", nazywany dzisiaj neptunem*
UR. W USA W 1907 ROKU, ZM. TAMŻE W 1991
* OD PLANETY NEPTUN. PATRZ STR. 56
...I DR GLENN T. SEABORG
„Seaborg", nie „cyborg"!
UR. W USA W 1912 ROKU, ZM. TAMŻE W 1999
W 1940 ROKU SEABORG Z MCMILLANEM ORAZ INNYMI ODNIÓSŁ SUKCES, BOMBARDUJĄC URAN JĄDRAMI WODORU WYSOKIEJ PRĘDKOŚCI, I OTRZYMAŁ NOWY PIERWIASTEK 94...
Nazwiemy go „plutonem" od Plutona
Hau!*
* NIE OD PSA PLUTO, ALE OD PLANETY!
WYTWORZENIE PLUTONU BYŁO GŁÓWNYM CELEM PROJEKTU MANHATTAN. PIERWIASTEK ZNAJDOWAŁ SIĘ W BOMBIE ZRZUCONEJ NA JAPOŃSKIE MIASTO NAGASAKI 9 SIERPNIA 1945 ROKU.
ZAKOŃCZYŁO TO WOJNĘ Z JAPONIĄ, LECZ DOPROWADZIŁO DO ŚMIERCI 70 TYSIĘCY LUDZI – W WIĘKSZOŚCI CYWILÓW
WTEDY OSTATNI RAZ UŻYTO BRONI JĄDROWEJ W CZASIE KONFLIKTU... DO TEJ PORY.
JEDNYM ZE ZNAKOMITYCH FIZYKÓW W ZESPOLE BYŁ ALBERT GHIORSO...
Mówcie mi Al
UR. W USA W 1915 ROKU, ZM. TAMŻE W 2010
ON I SEABORG STWORZYLI KOLEJNE 2 PIERWIASTKI*, ALE ZE WZGLĘDU NA WOJNĘ ZACHOWALI TEN FAKT W TAJEMNICY.
* AMERYK (95) I KIUR (96). PATRZ STR. 58–59
PO ZAKOŃCZENIU WOJNY NIC NIE MOGŁO ICH POWSTRZYMAĆ...
Współodkryłem 10 pierwiastków!
A ja 12!
ZNAJDZIESZ JE NA STRONACH 58–60!
ALBERT GHIORSO DO DZIŚ JEST ODKRYWCĄ NAJWIĘKSZEJ LICZBY PIERWIASTKÓW
Pokonałeś mnie. Arr!
DAVY 7
GHIORSO 12
6 Z NICH OTRZYMAŁO NAZWY NA CZEŚĆ INNYCH SŁAWNYCH UCZONYCH
To znowu ja!
NA CAŁYM ŚWIECIE CIĄGLE TWORZY SIĘ NOWE PIERWIASTKI. CZASEM JEST TO ZALEDWIE KILKA ATOMÓW ISTNIEJĄCYCH PRZEZ UŁAMEK SEKUNDY.
Gdzie on się podział?
LIWERMOR (116) MA CZAS POŁOWICZNEGO ROZPADU WYNOSZĄCY 60 MILISEKUND!
NOWE ODKRYCIA MUSZĄ ZOSTAĆ POTWIERDZONE PRZEZ MIĘDZYNARODOWĄ UNIĘ CHEMII CZYSTEJ I STOSOWANEJ Z SIEDZIBĄ W ZURYCHU I CHICAGO.
I U P A C
SZCZĘŚLIWIE NAZYWANĄ W SKRÓCIE IUPAC
RÓWNIEŻ ONA DECYDUJE, JAKĄ NAZWĘ DOSTANIE NOWY PIERWIASTEK...
Mogę go nazwać Fred? Eric? Agatha? Bimbleshanks?
Non
NAJWIĘKSZYM ŻYJĄCYM WSPÓŁCZESNIE TWÓRCĄ PIERWIASTKÓW JEST JURIJ OGANIESIAN ZE ZJEDNOCZONEGO INSTYTUTU BADAŃ JĄDROWYCH W DUBNEJ W ROSJI
Współtworzyłem ich dotąd 5!
Ha! Ja byłem lepszy! Arr!
JURIJ JAKO JEDYNY ŻYJĄCY CZŁOWIEK MA WŁASNY PIERWIASTEK. UMIESZ GO ZNALEŹĆ?
Z PEWNOŚCIĄ BĘDĄ TWORZONE KOLEJNE. MOŻE PEWNEGO DNIA TO TY JAKIŚ ODKRYJESZ! TYLKO JAK GO NAZWIESZ?
Og
MOŻE OD WŁASNEGO NAZWISKA?
POWODZENIA!


NAJWIĘKSZYM ŻYJĄCYM WSPÓŁCZEŚNIE TWÓRCĄ PIERWIASTKÓW JEST JURIJ OGA-NIESIAN ZE ZJEDNOCZONEGO INSTYTUTU BADAŃ JĄDROWYCH W DUBNEJ W ROSJI.
Współtworzyłem ich dotąd 5!
Ha! Ja byłem Lepszy! Arr!
JURIJ JAKO JEDYNY ŻYJĄCY CZŁOWIEK MA WŁASNY PIERWIASTEK. UMIESZ GO ZNALEŹĆ?
Z PEWNOŚCIĄ BĘDĄ TWORZONE KOLEJNE. MOŻE PEWNEGO DNIA TO TY JAKIŚ ODKRYJESZ! TYLKO JAK GO NAZWIESZ?
8
Og
GANESON
MOŻE OD WŁASNEGO NAZWISKA?
POWODZENIA!

Thank you for your attention

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