Detailed study of radioactive decay properties of ^{249}No, ^{250}No

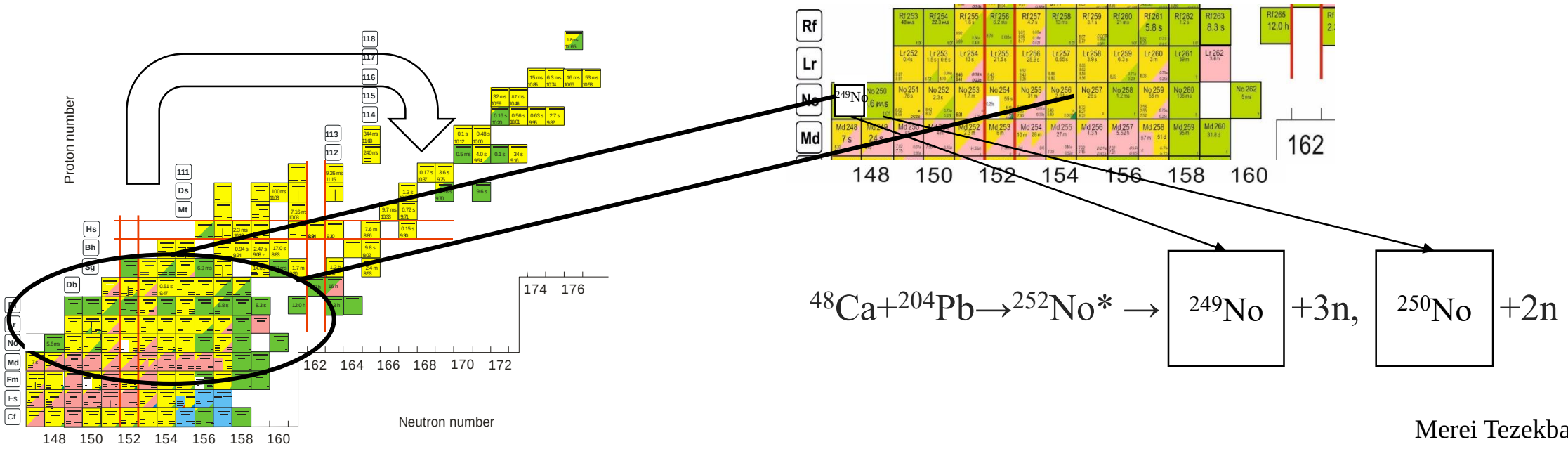
with α, β, γ-spectroscopy method

JOINT INSTITUTE FOR NUCLEAR RESEARCH

1956

SCIENCE BRINGS NATIONS TOGETHER

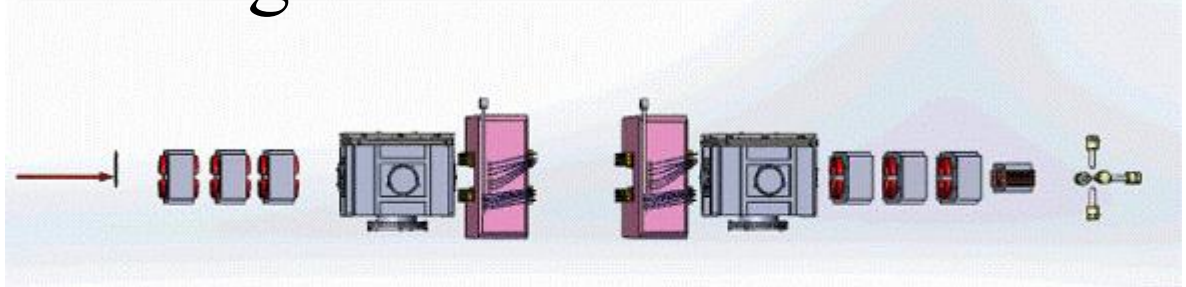
Heaviest SHE - limited experimental data (E_a, $T_{1/2}$). Deformed mid-shell nuclei: opportunity for detailed nuclear structure studies



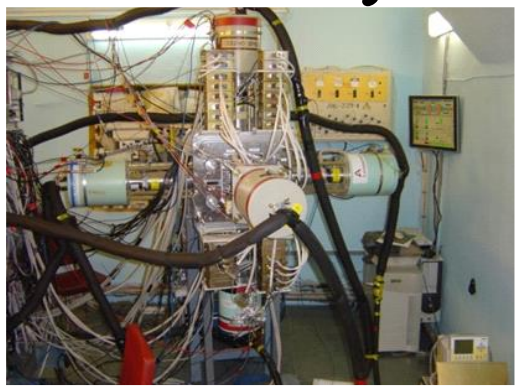
Merei Tezekbayeva
FLNR, sector №2

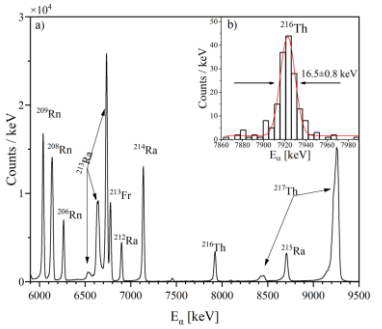
Spectroscopy of transfermium elements in Dubna

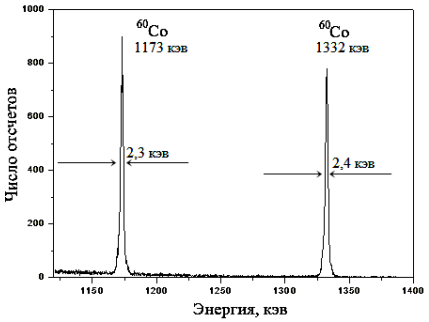
- High intensity heavy ion beams 0.5 – 1.0 pμA – cyclotron U400.
- Experimental set up – recoil kinematic separator VASSILISSA / SHELS with good background conditions at the focal plane

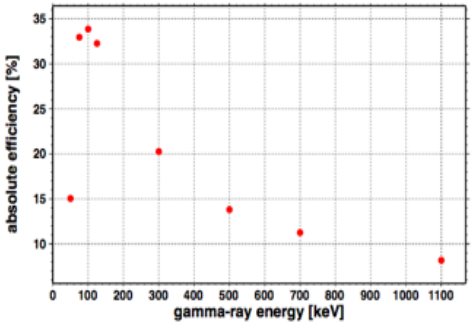


- Sophisticated detector systems at the focal plane-GABRIELA.









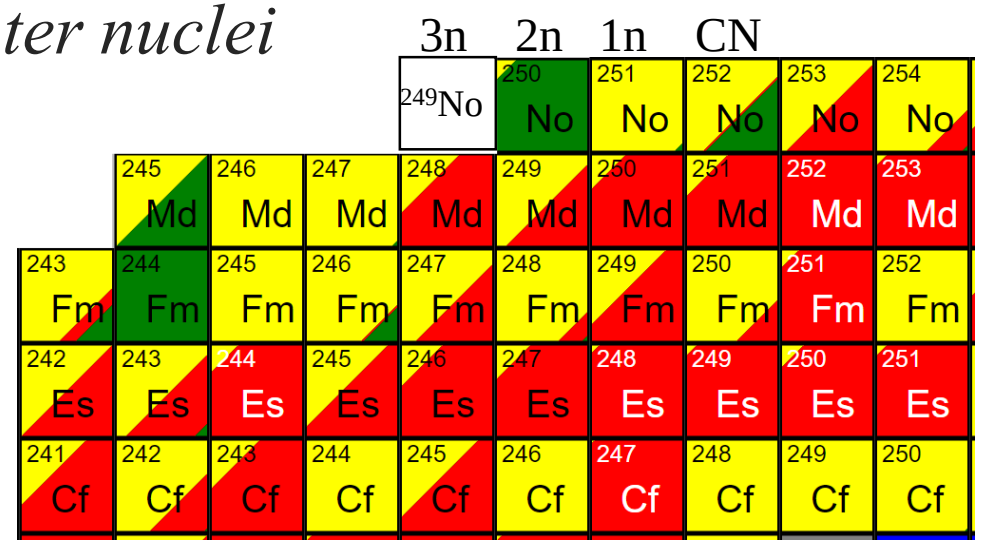
SHELS results: *The new isotope ^{249}No and its daughter nuclei*

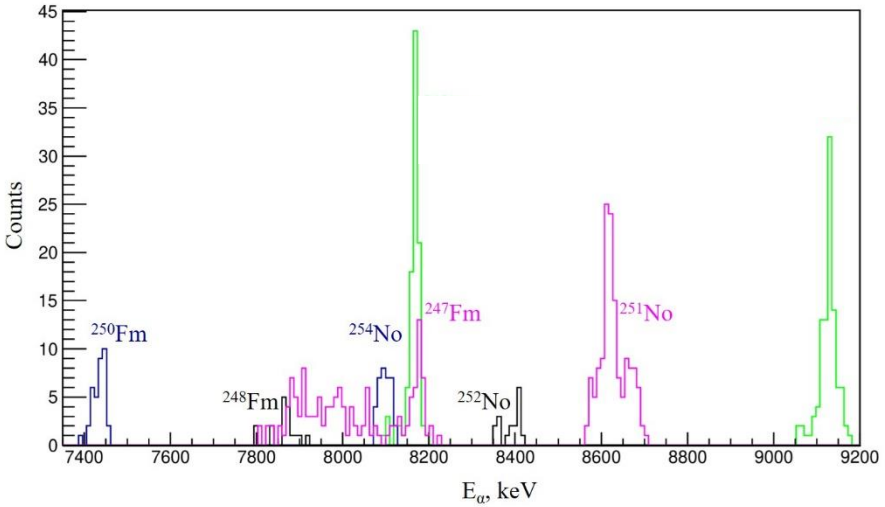
$$^{204}Pb(^{48}Ca,xn)^{252-x}No$$

The enrichment of the target material was 99.94% (^{206}Pb – 0.04%; ^{207}Pb – 0.01%; ^{208}Pb - 0.01%).

SHELS separator transmission: 34%

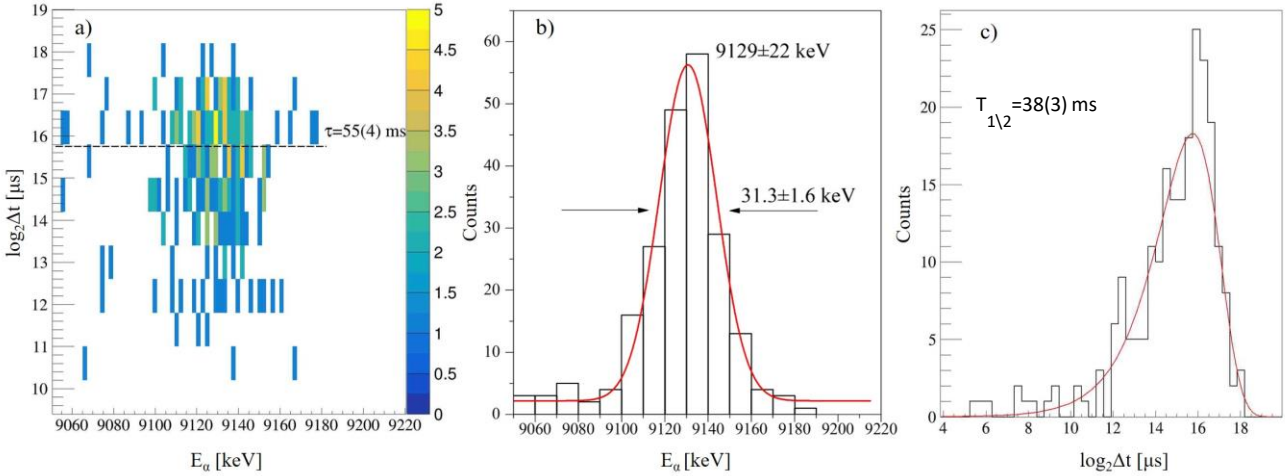
Beam energy, MeV	**E_{lab} (mid-target beam energy), MeV**	**Projectile dose**	**Target thickness, mg/cm^2**
225	213.4	$1.05 \cdot 10^{18}$	0.47(10) on 1.5μTi backing
230	218.5	$2.6 \cdot 10^{17}$	
237	225.4	$1.8 \cdot 10^{18}$	
242	232	$6.3 \cdot 10^{17}$	
246	235	$1.6 \cdot 10^{17}$	





Decay energies of No and Fm isotopes produced in the interaction of ^{48}Ca ions on the main material (^{204}Pb) and other Pb-impurities of the target. Each color denotes a different No isotope and its correlated Fm daughter.

SHELS results: *The new isotope ^{249}No and its daughter nuclei*



Beam energy in the mid. target, MeV	Number of ER-alpha	Production cross-section σ(3n), nb
218.4	2	0,03
225.4	193	0,47
232	22	0,15
235	1	0,04

^{249}No

E_α=9129(22) keV

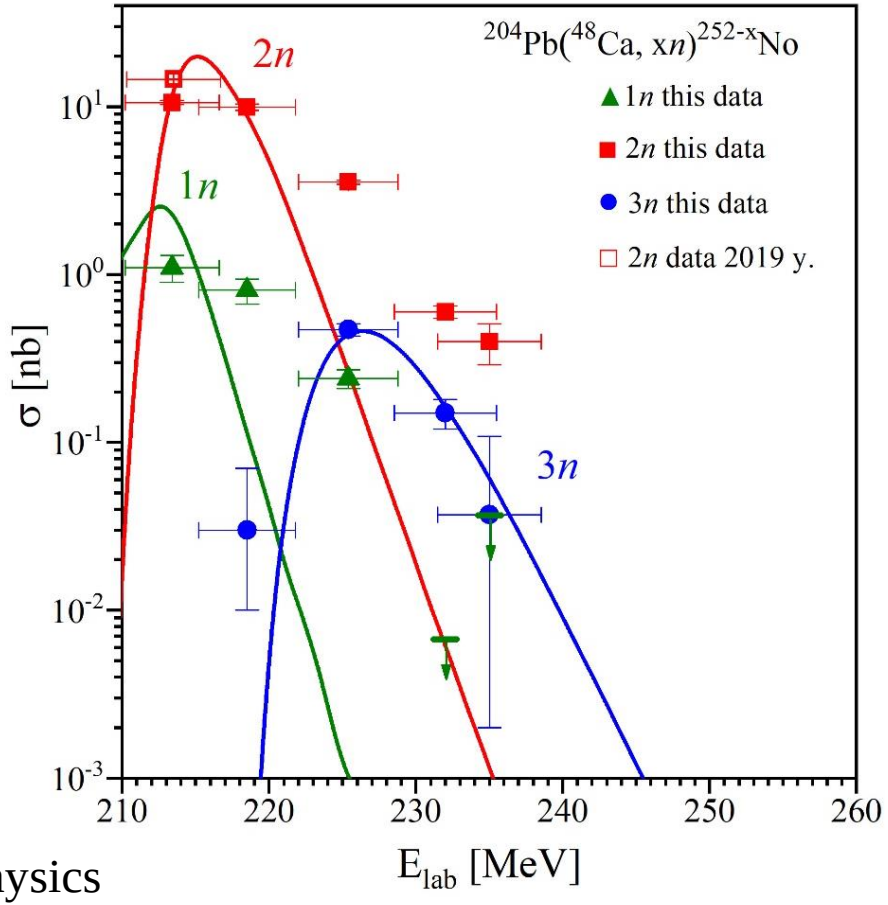
Q_α=9276(22) keV

$T_{1/2}$= 38.1(2.8) msec

$^{48}Ca+^{204}Pb \rightarrow ^{252}No^* \rightarrow ^{249}No+3n$

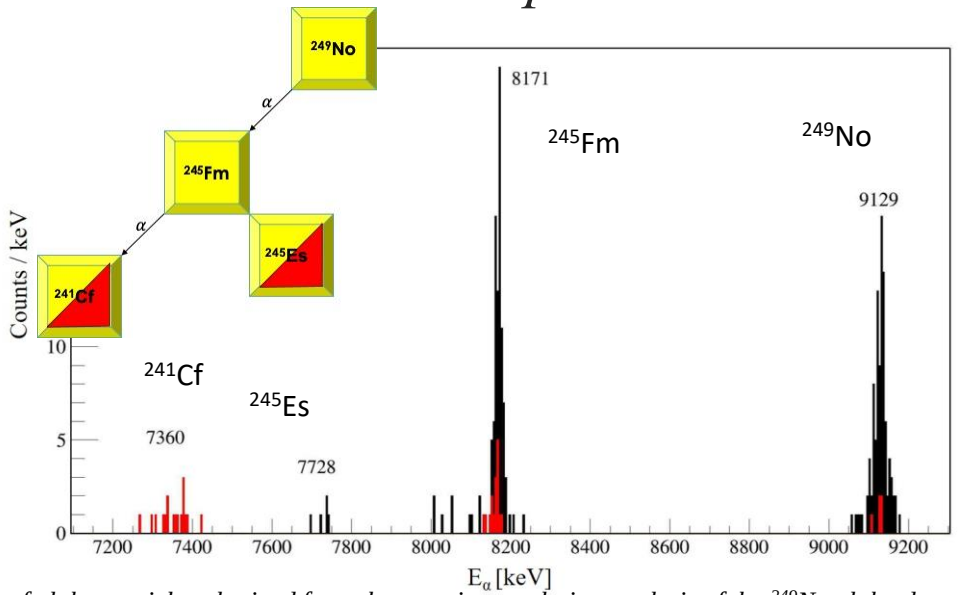
218 ER-α events

$^{48}Ca+^{204}Pb \rightarrow ^{252}No^*$

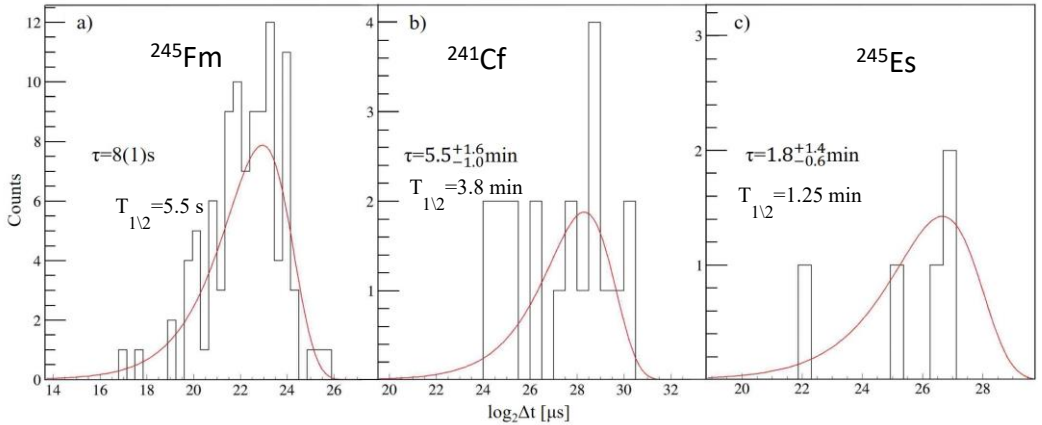


*Q_α^{tabl}=9175(344) keV

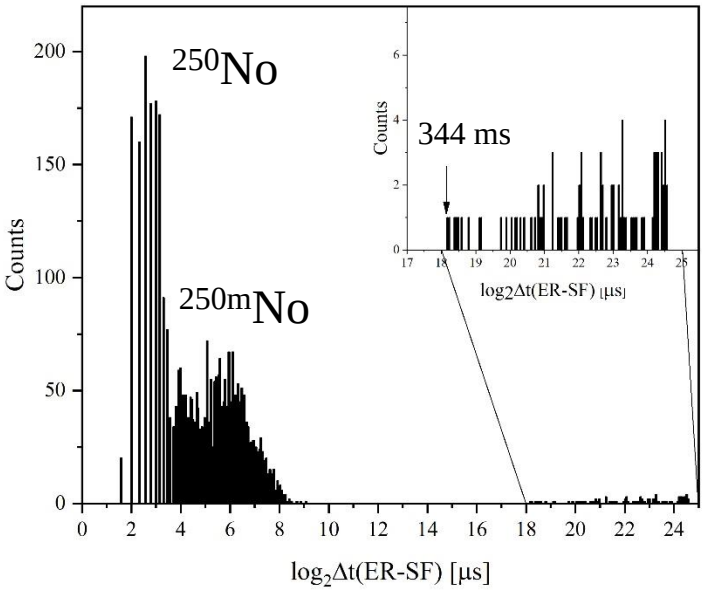
SHELS results: *The new isotope ^{249}No and its daughter nuclei*



Energy spectrum of alpha particles obtained from the genetic correlation analysis of the ^{249}No alpha decay into known ^{245}Fm (8171 keV) and ^{241}Cf (7360 keV). An alpha activity with energy 7728 keV related to decay of ^{245}Es. Black line corresponds to the ER-α_1-α_2, red line includes ER-α_2-α_3, ER-α_1-α_3 and ER-α_1-α_2-α_3 coincidences. FWHM of ^{249}No – 30 keV, for ^{245}Fm – 20 keV.



Type of correlations	ER-α_1	ER-α_1-α_2	ER-α_1-α_2-α_3	ER-α_1-α_3	ER-α_2-α_3
Number of correlation events	218	101	1	4	16



One ER-SF event with τ=344ms

Beam energy, MeV	**E_{lab} (mid-target beam energy), MeV**	**Projectile dose**
237	225.4	$1.8 \cdot 10^{18}$

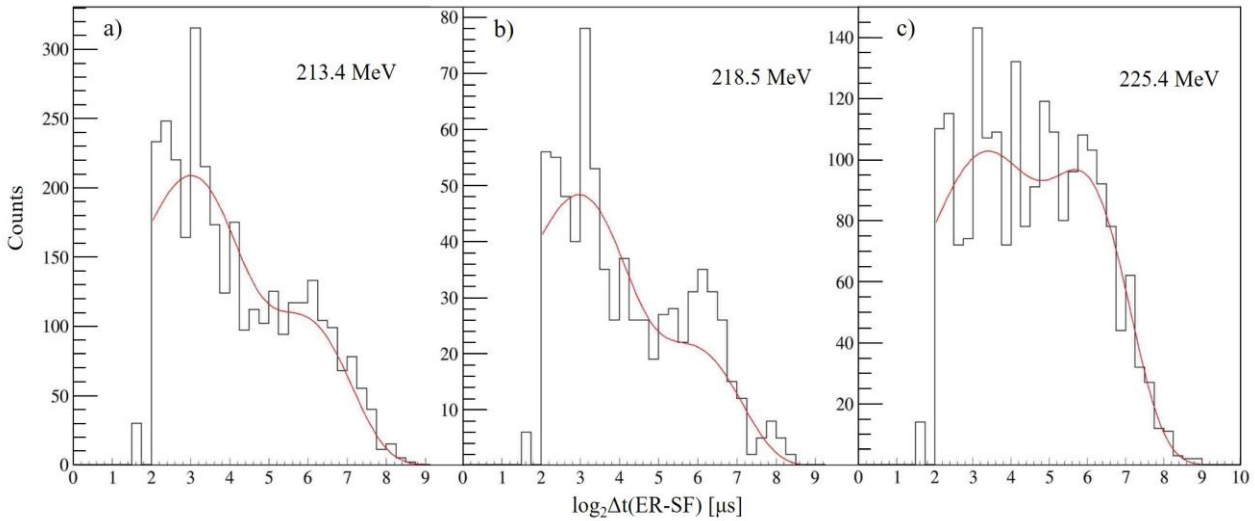
The EC branch of ^{245}Fm was extracted to be $b_{EC} = (11.5^{+6.8}_{-5.0}) \times 10^{-2}$.
Fine structure of ^{249}No.
Limit of $b_{SF}(^{249}\text{No}) = (2,3^{+4.6}_{-2.3}) \times 10^{-3}$

SHELS results: ^{250}No

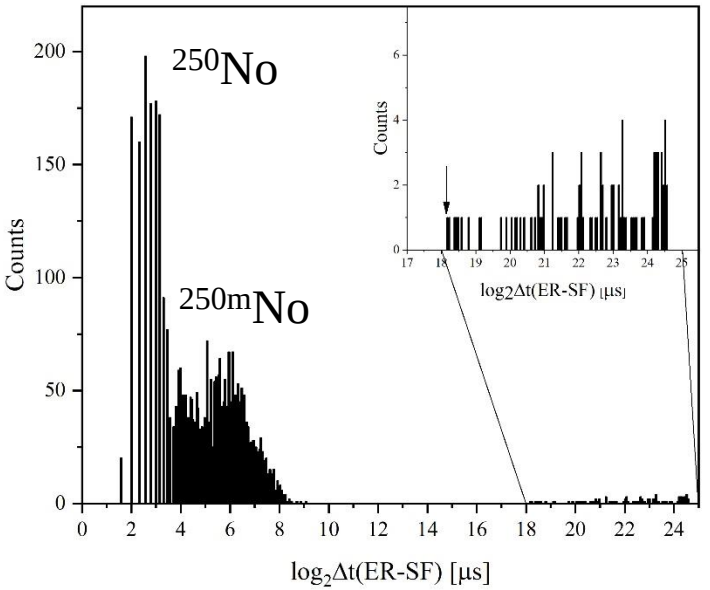
$^{48}Ca+^{204}Pb \rightarrow ^{252}No^{*} \rightarrow ^{250}No+2n$

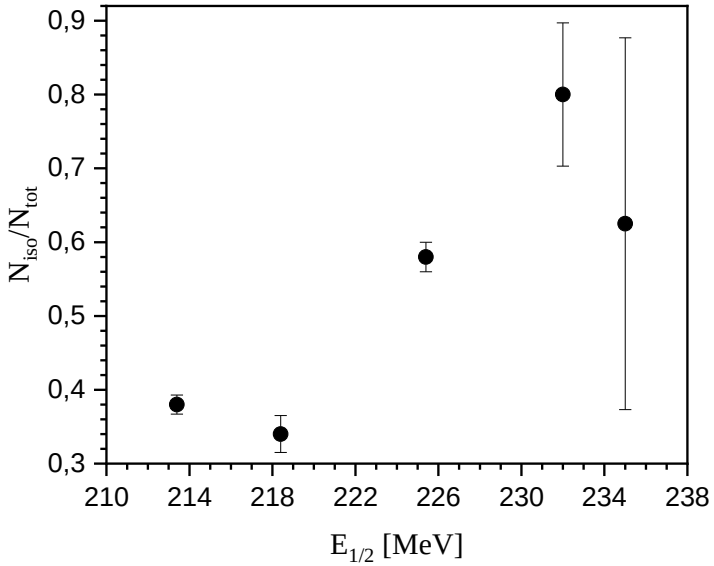
$T_{1/2}$=4.7(1)μs and short-lived state
$T_{1/2}$=37.2(9)μs long-lived high-K isomeric state
σ_{max}(2n)=7.95(14) nb at 213.4 MeV

Oct. 2020 y.



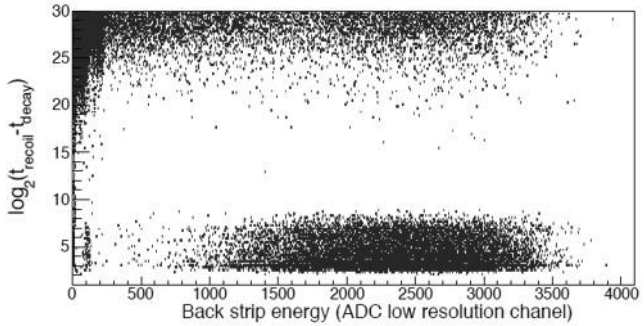
Time distribution of correlated ER-SF events for the ground and isomeric states of ^{250}No at different beam energies: a)213.4 MeV, b)218.5 MeV and c)225.4 MeV. The solid red lines are the fitted two-component exponential decay curves.



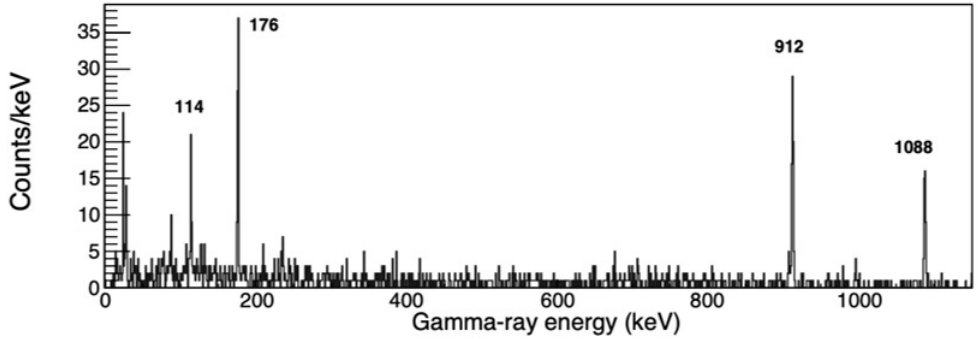


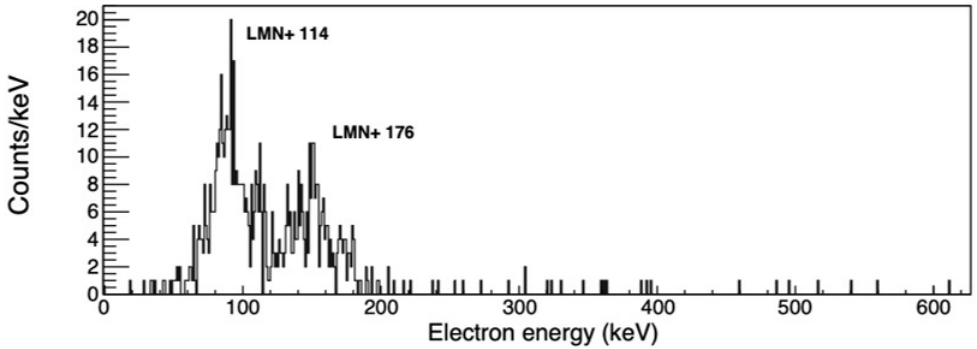
^{250}No levels population N/N_{tot} change depending on mid-target beam energies ($E_{1/2}$). N- short-lived ground state events, N_{tot}- total SF events of ^{250}No during all irradiations.

$^{48}Ca + ^{204}Pb \rightarrow ^{252}No^{*} \rightarrow ^{250}No + 2n$



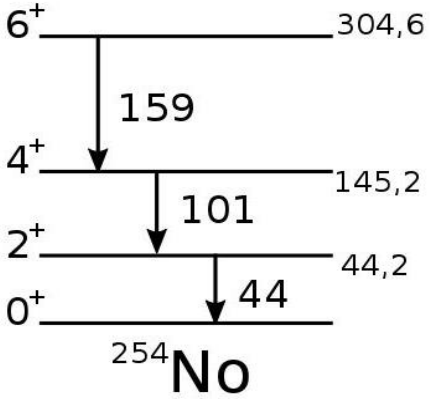
13 days
Flux $2.6 \cdot 10^{18}$
SF = 18 000

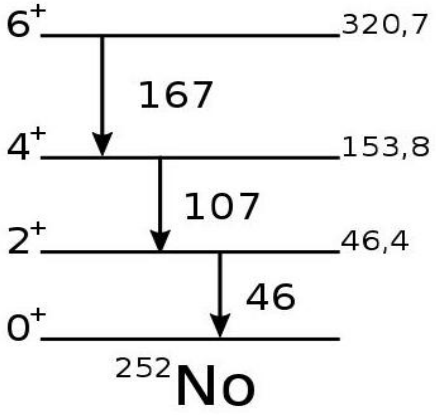


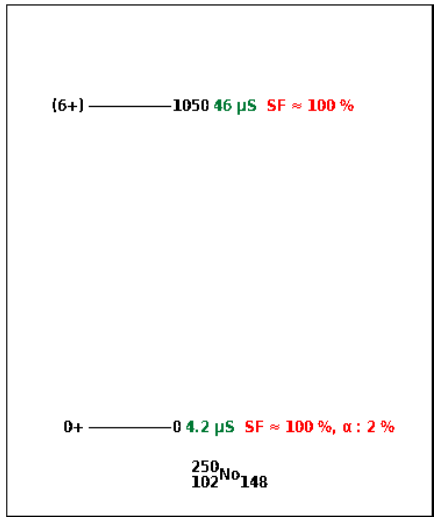


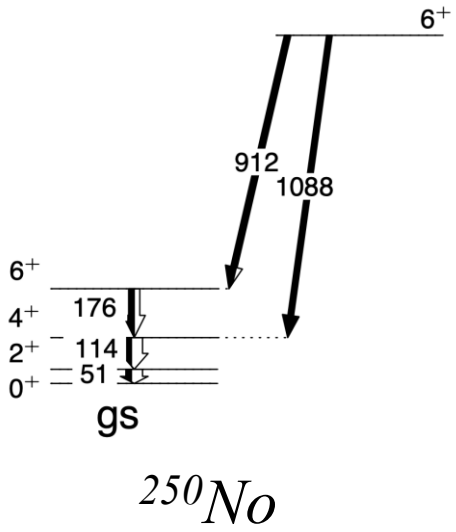
Oct. 2019 y.

From gamma correlation spectrum
was observed new transition in ^{250}No!



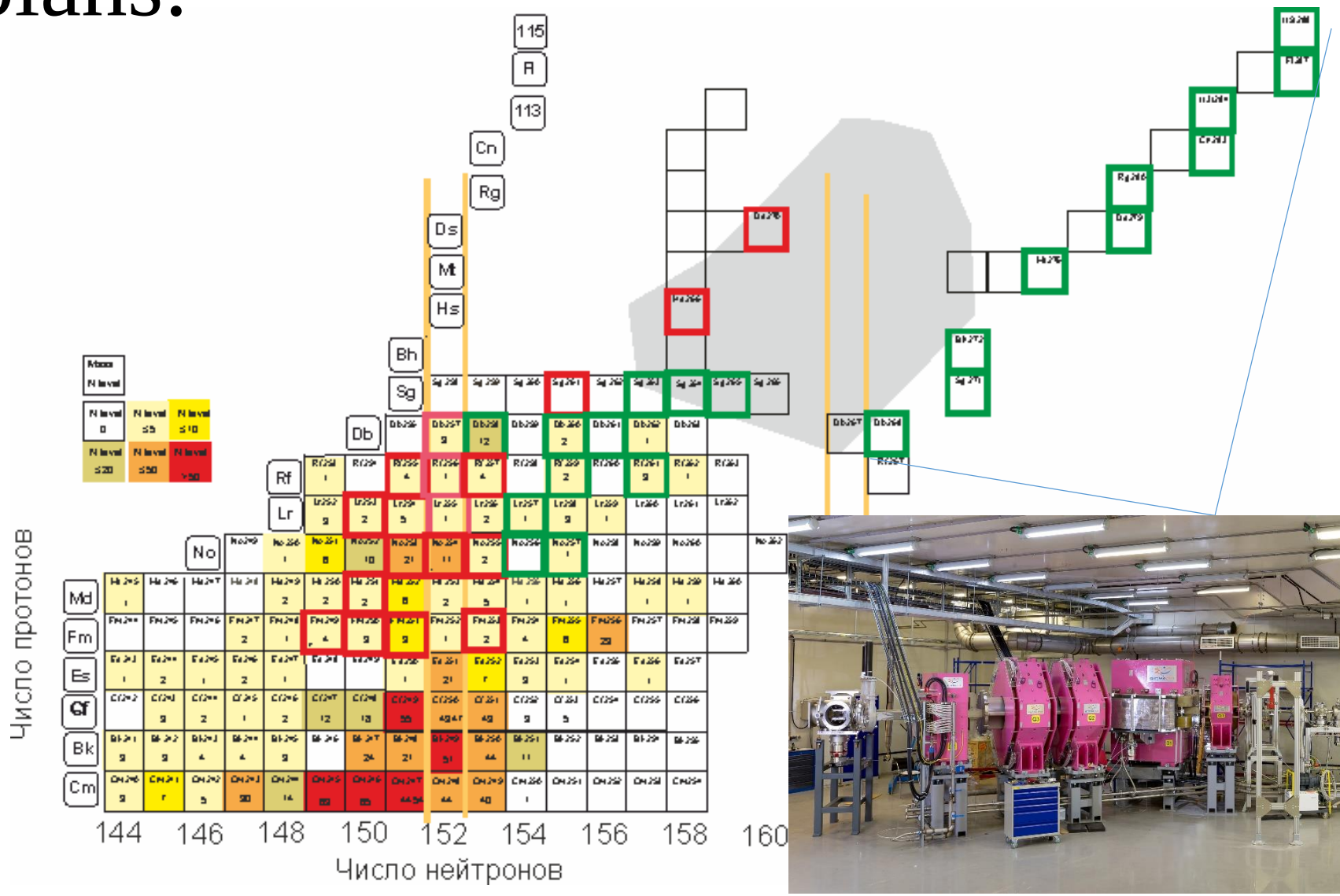






^{250}No

Future plans:



JOINT INSTITUTE
FOR NUCLEAR
RESEARCH

SCIENCE BRINGS
NATIONS TOGETHER

Thank you for your attention

55th meeting of the PAC for Nuclear Physics

Merei Tezekbayeva
FLNR, sector №2
27.01.2022 y.