Effect of Fission Yield Libraries on Irradiated Fuel Composition in Monte Carlo Depletion Calculations

E.F. Mitenkova and N.V. Novikov

Nuclear Safety Institute of Russian Academy of Sciences
B.Tulskaya 52, Moscow, 115119, Russia
mit@ibrae.ac.ru

Energy grid ^kE in fission yield sources

Source	**^kE, MeV**	**FP nuclides**	**Comment**
ENDF/B-VII	$2.53\ 10^{-8}$, 0.5, 14.0	1321	Ti (z=22)
JEFF-3.1	$2.53\ 10^{-8}$, 0.4, 14.0	1355	no data for ^{239}Pu, ^{241}Pu at ^kE =14 MeV Ca (z=20), Light elements
GEFY 3.3	$2.53\ 10^{-8}$, 0.4, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	907	Mn (z=25)
Koldobsky	$2.53\ 10^{-8}$, 0.5, 1.0, 2.5, 5.0, 7.5, 10.0, 14.0	820	no data for ^{235}U, Cr (z=24)
JENDL-4	$2.53\ 10^{-8}$, 1.0, 14.0	1241	V (z=23), Light elements
TENDL-2010	$2.53\ 10^{-8}$, $1.0\ 10^{-6}$, $1.0\ 10^{-4}$, 0.5, 1.0, 14.0	1772	Ar (z=18)

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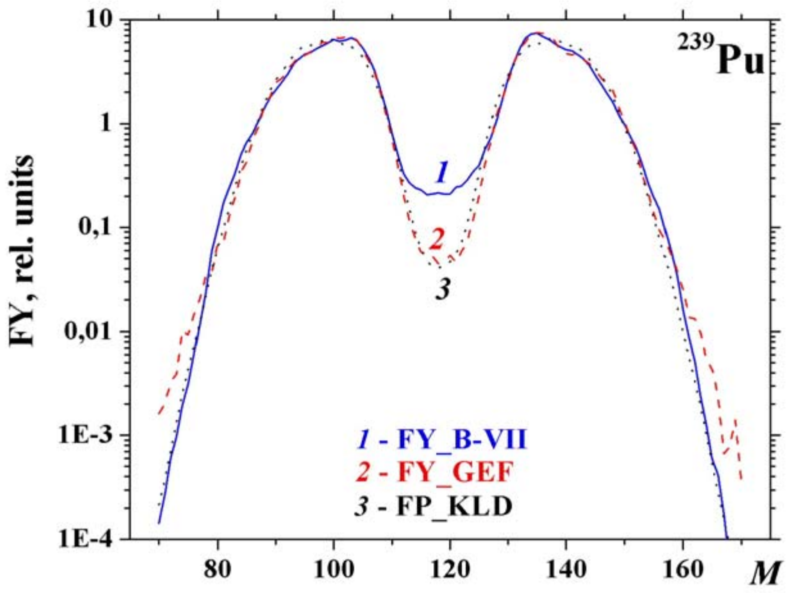
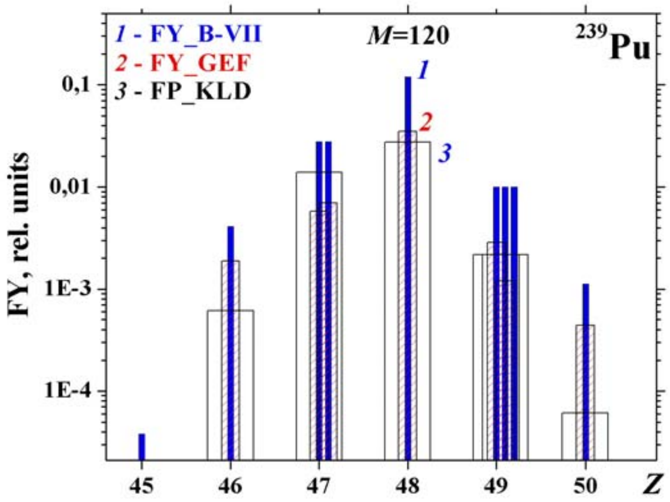
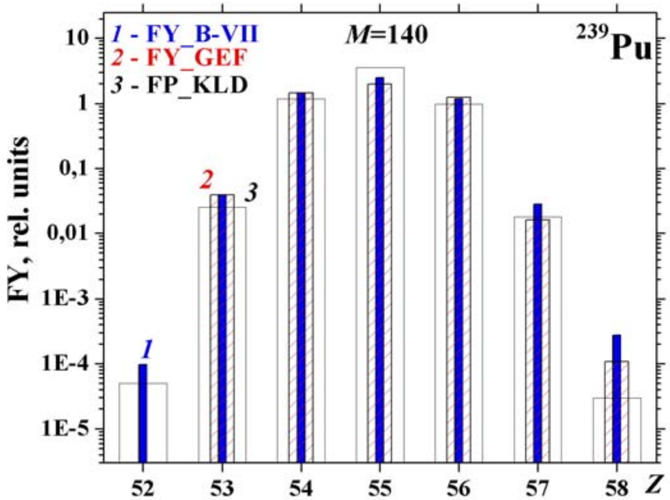
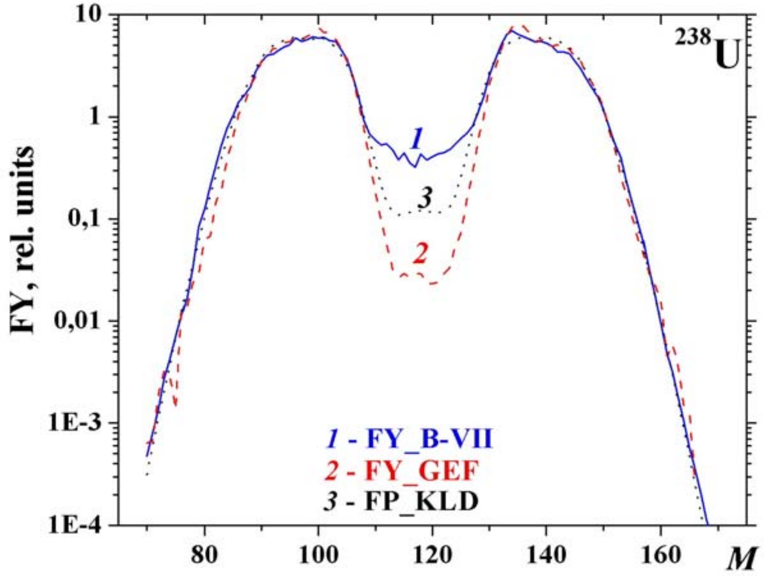
Comparative analysis of fission product yield for ^{239}Pu

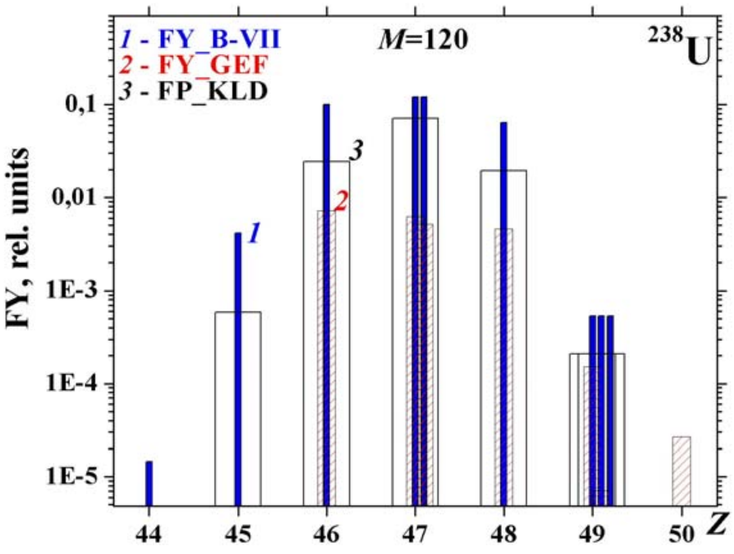


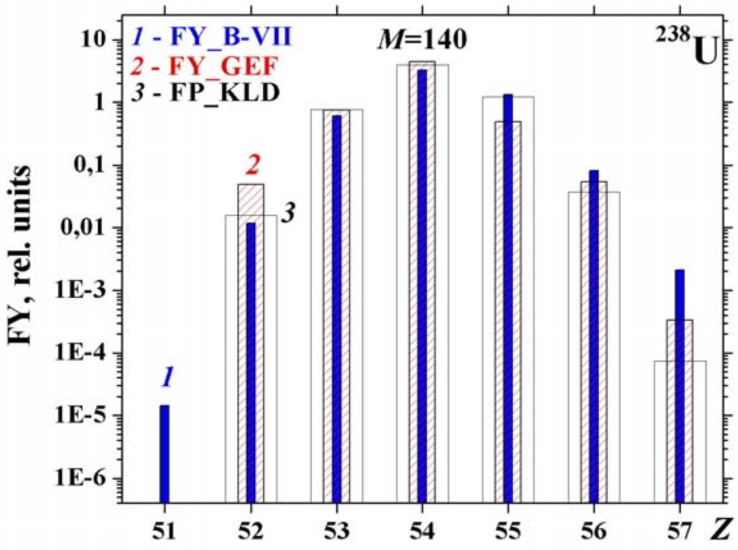




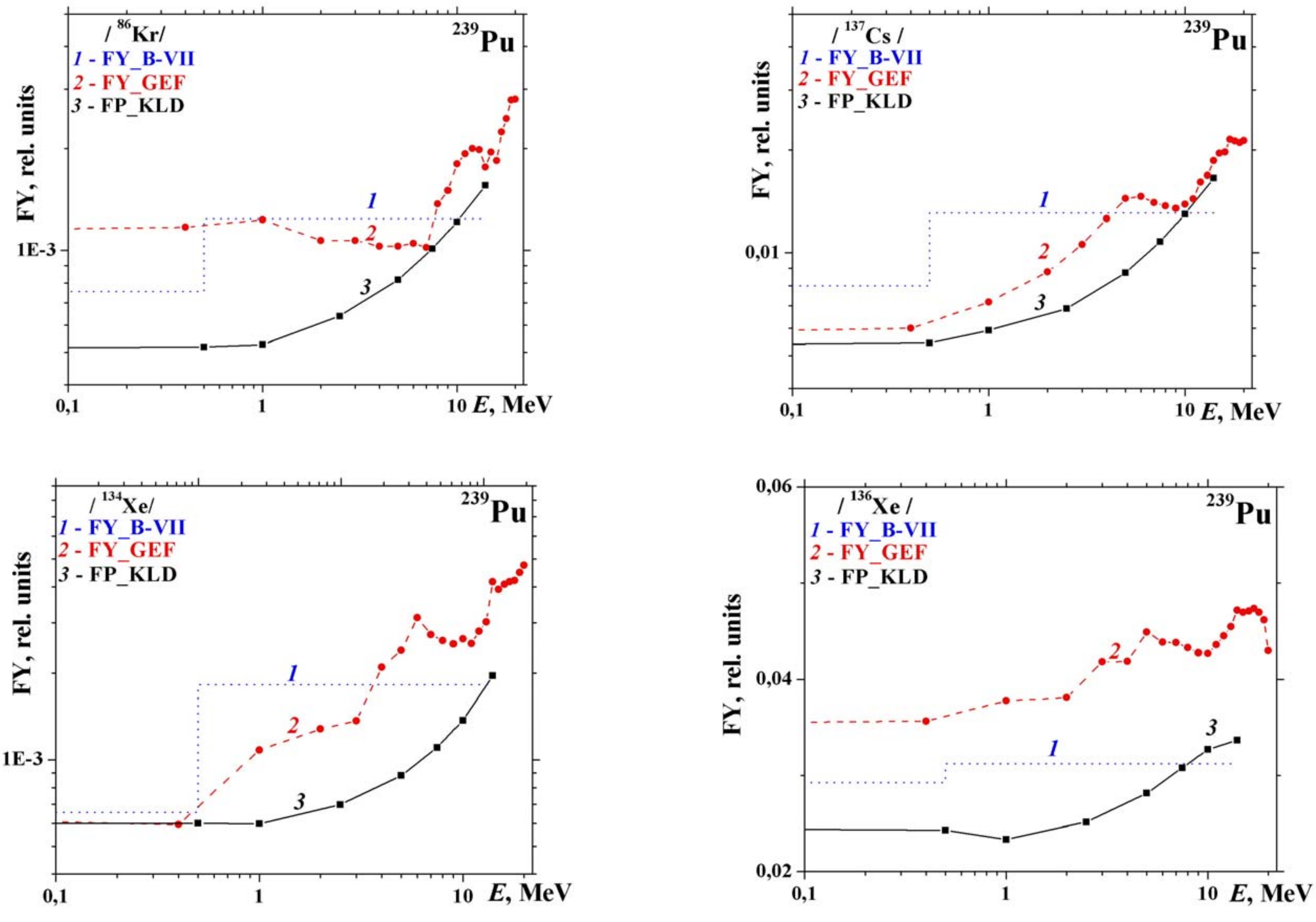
Comparative analysis of fission product yield for ^{238}U



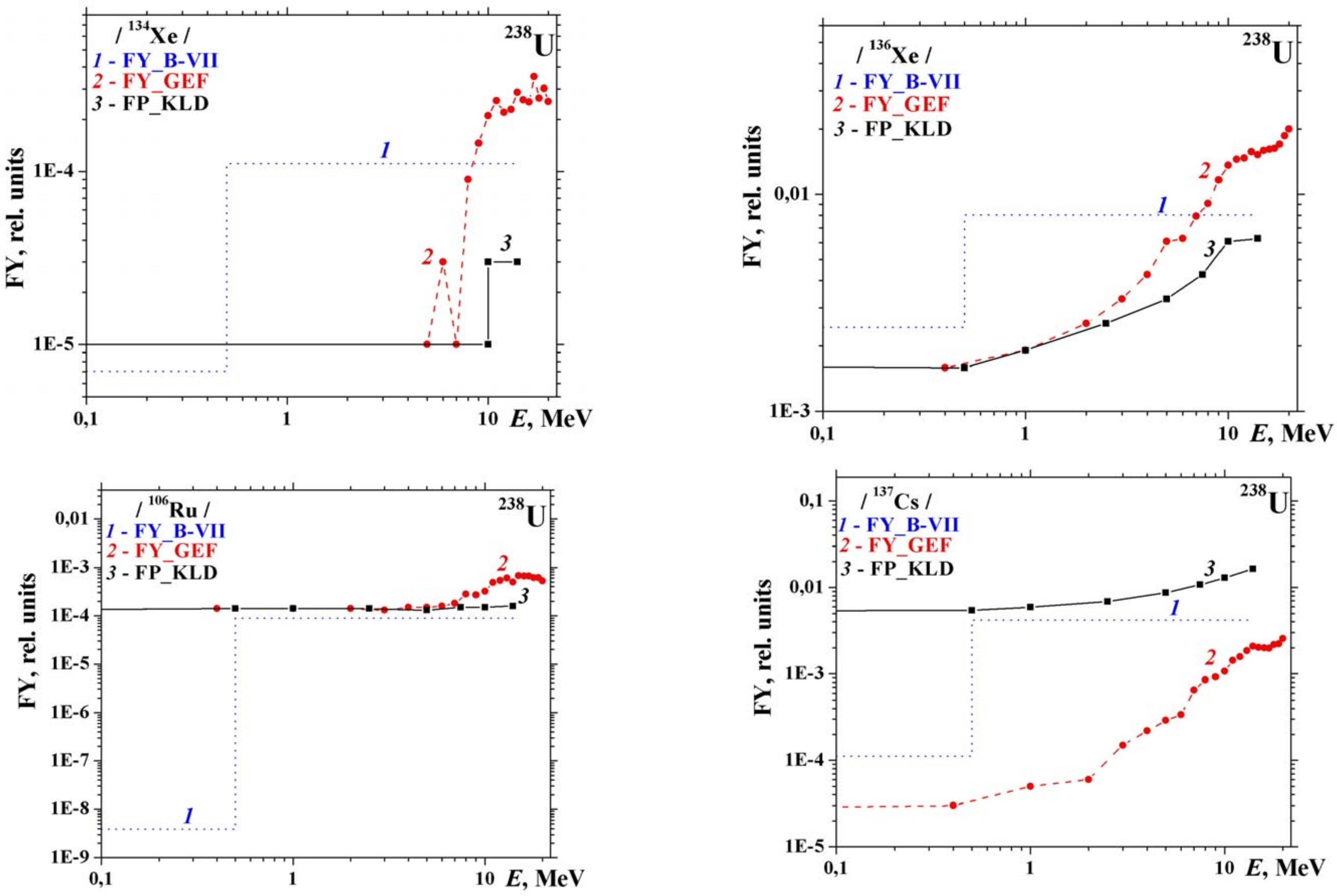




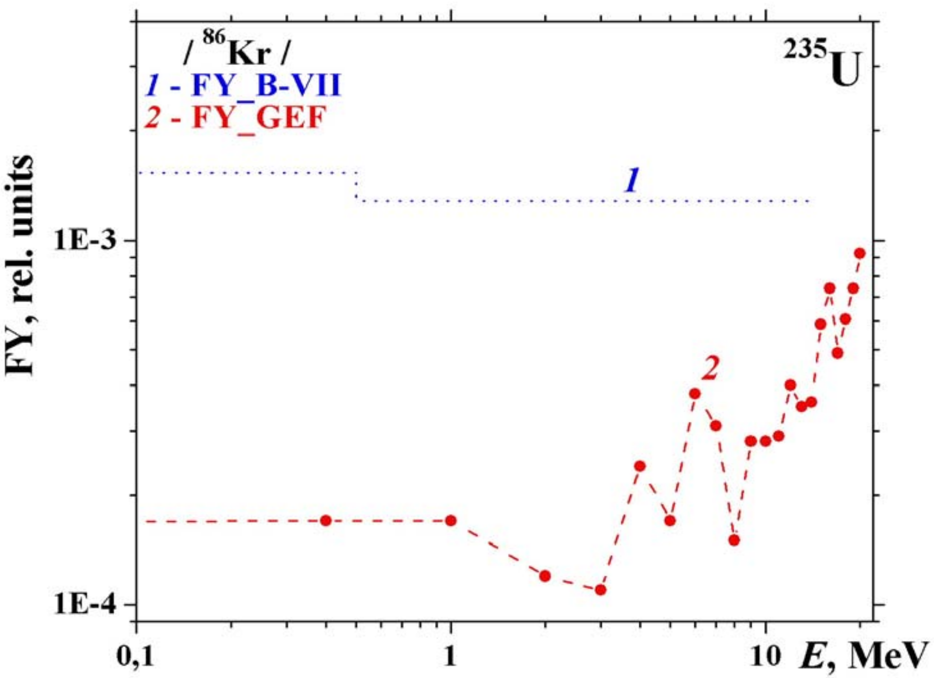
Independent fission yield of isotopes Kr, Xe, Cs in ^{239}Pu

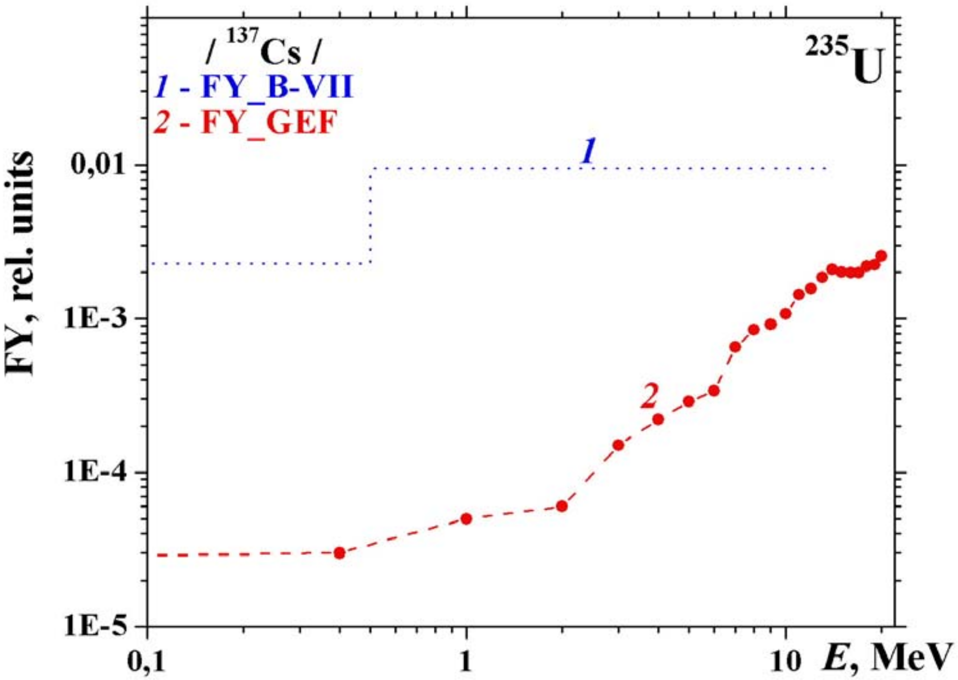


Independent fission yield of isotopes Xe, Ru, Cs in ^{238}U

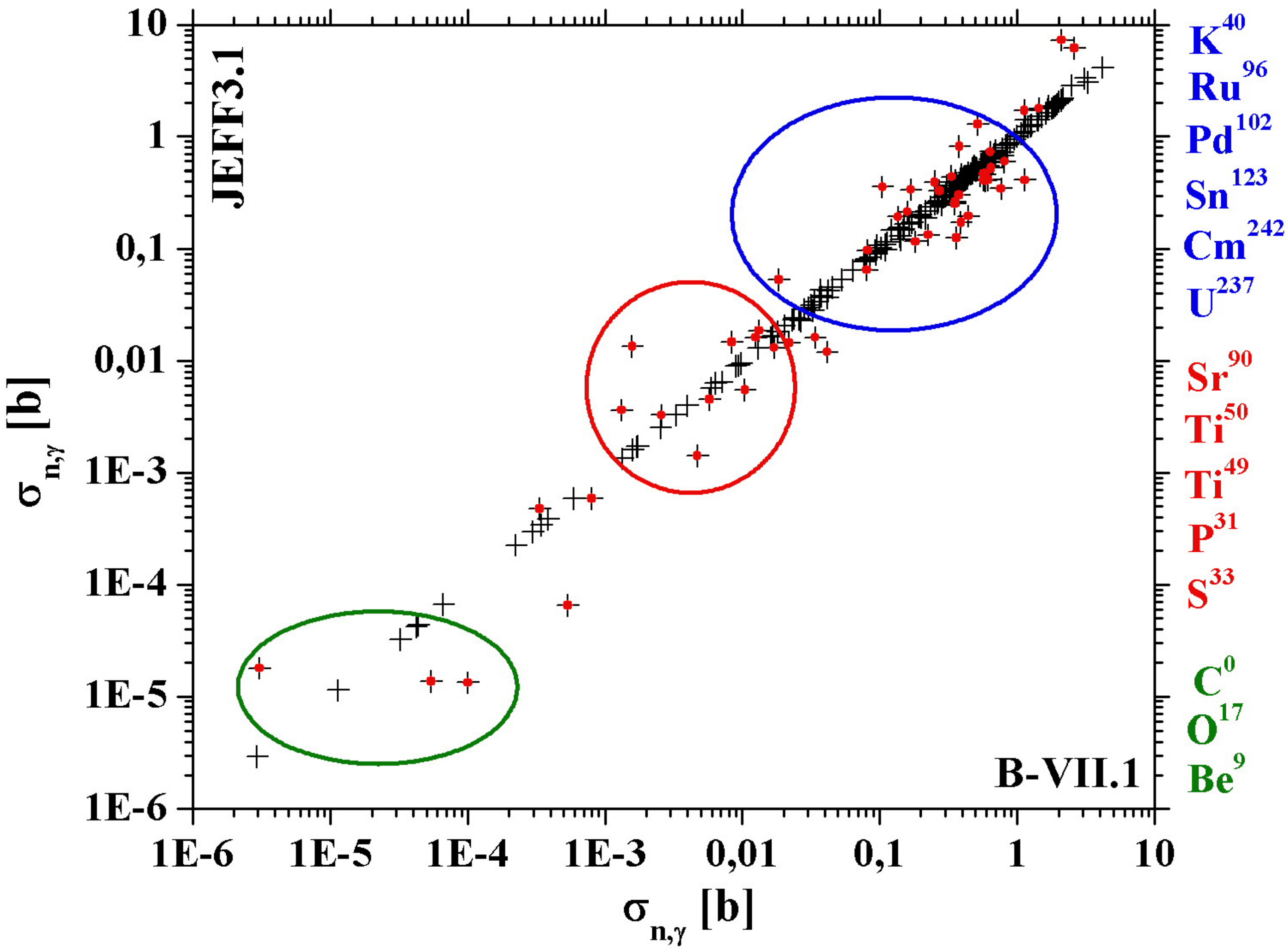


Independent fission yield of isotopes Kr, Cs in ^{235}U





One-group constants in depletion calculations



Ratios of fission gases accumulation in MOX fuel

Burnup = 5.0% h.a.			
Nuclide	**FY_GEF/ FY_B-VII**	**FY_JEFF/ FY_B-VII**	**FY_KLD/ FY_B-VII**
^{1}**H**	0.97	0.88	0.90
^{4}**He**	1.00	1.23	1.00
Kr	0.76	0.99	0.90
Xe	1.04	1.01	0.87
Burnup = 10.3% h.a.			
^{1}**H**	1.02	0.99	1.04
^{4}**He**	1.01	1.22	1.00
Burnup = 20.8% h.a.			
^{1}**H**	1.0	1.16	0.99
^{4}**He**	1.0	1.21	1.0

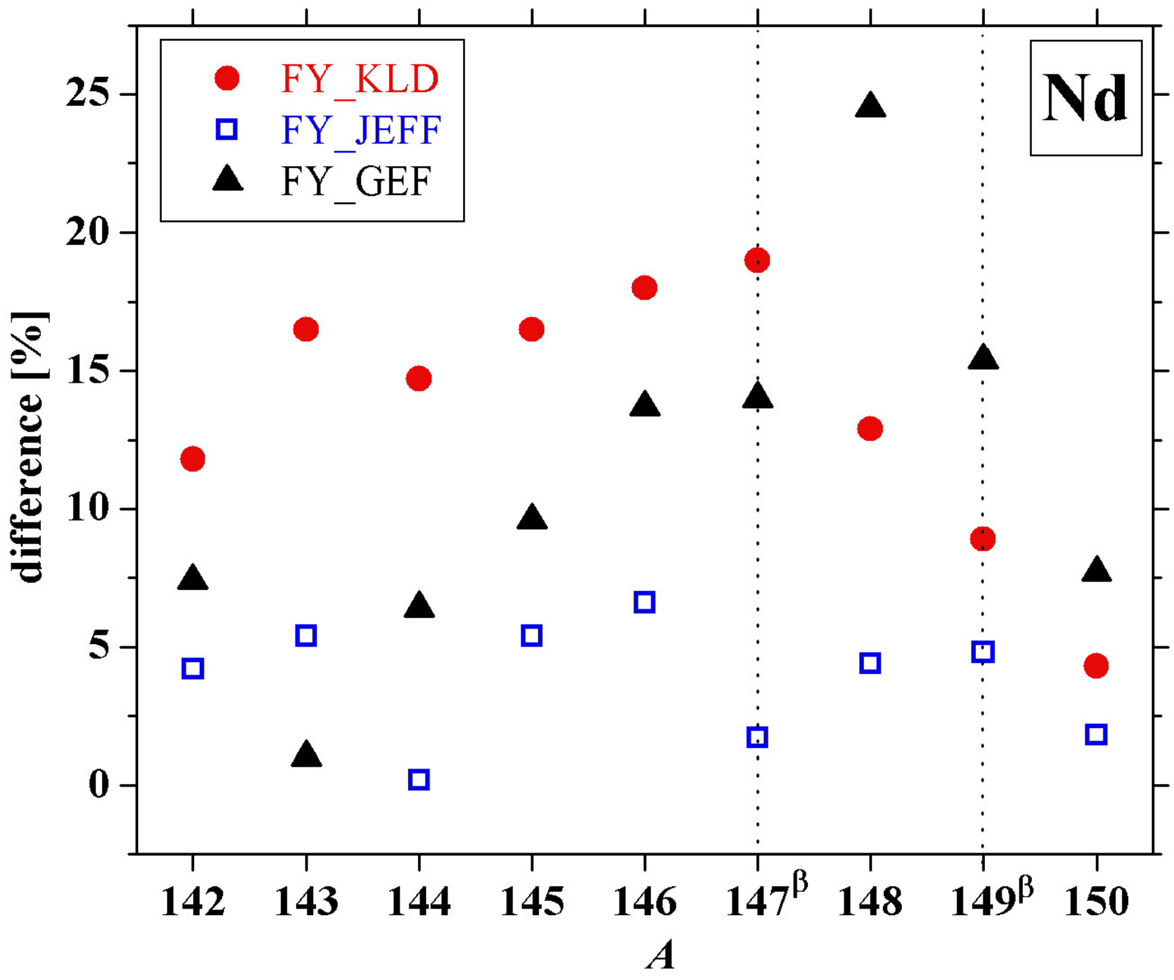
Stable and long-life nuclide accumulation in MOX fuel

Nuclide (Z)	Half-life, year	FY_GEF/ FY_B-VII	FY_JEFF/ FY_B-VII	FY_KLD/ FY_B-VII
^{112}Cd (48)	stable	0.53	0.42	0.72
^{128}Te (52)	~10^{24}	1.07	0.88	1.45
^{130}Te	~10^{24}	0.94	1.06	1.09
^{127}I (53)	stable	0.85	0.74	1.35
^{137}Cs (55)	~30	1.09	1.03	1.01
^{139}La (57)	stable	0.92	1.05	1.12
^{154}Eu (63)	~10	0.82	0.96	0.82
^{155}Eu	~5	0.73	0.90	0.69
^{161}Dy (66)	stable	1.56	0.77	0.72
^{81}Br (35)	stable	0.41	0.89	0.61
^{113}Cd (48)	~10^{16}	0.34	0.48	0.52
^{114}Cd	~10^{18}	0.27	0.37	0.39
^{116}Cd	~10^{19}	0.22	0.43	0.27
^{121}Sb (51)	stable	0.16	0.44	0.26
^{123}Sb	stable	0.18	0.32	0.40
^{125}Sb	~3	0.41	0.43	0.80

Short-life nuclide accumulation in MOX fuel

Nuclide (Z)	Half-life, min	FY_GEF/ FY_B-VII	FY_JEFF/ FY_B-VII	FY_KLD/ FY_B-VII
^{81}Se (34)	~20	0.42	0.88	0.61
^{80}Br (35)	~20	0.03	0.41	0.06
^{106}Ag (47)	~ 24	0.0003	0.0003	0.0002
^{112m}In (49)	~21	0.04	0.05	0.06
^{135m}Cs (55)	~53	0.23	0.44	0.42
^{163}Tb (65)	~20	4.0	0.75	0.92
^{84m}Br	~ 6	0.07	0.54	0.62
^{119}Cd	~3	0.07	0.16	0.25
^{162}Gd (64)	~8	2.8	0.72	0.23
^{167}Dy (66)	~6	3.61	0.49	1.06
^{168}Dy (66)	~9	6.06	0.66	1.66

Discrepancies of neodymium ratios in MOX (10.3% h.a.)



Conclusion

- ✓ In **MONTEBURNS–MCNP5–ORIGEN2** calculations there is a considerable spread in concentrations of fission products while using different Fission Yield Libraries.

  In MOX fuel the discrepancies: ~ 25% for inert gases, up to 5 times for stable and long-life nuclides, up to 4000 times for short-life nuclides (1 min < $T_{1/2}$ <1 h), and up to 10 orders of magnitude for nuclides ($T_{1/2}$ <10 s).

- ✓ The lack of full-core benchmarks and difficulties in obtaining the experimental data, complicate estimation of the final nuclide accumulations taking into account the considerable discrepancies while using different nuclear data libraries.

- ✓ For improving the accurate depletion calculations the Benchmark-technology is needed first of all for substantiation the final key nuclide accumulations.