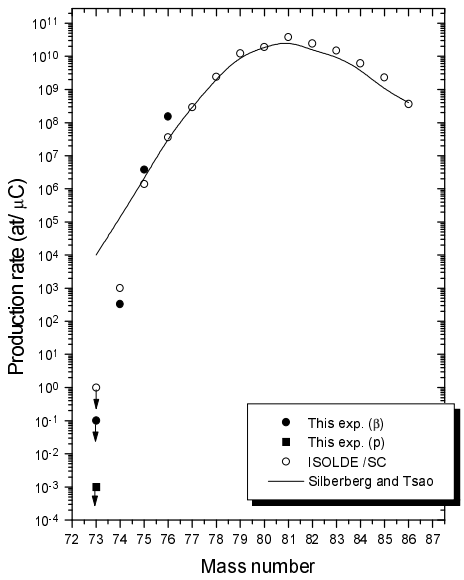


The mass models predict ^{73}Rb to be proton unbound. However, very large deformation and their change predicted for the ^{73}Rb → ^{72}Kr transition could lead to additional hindrance of the proton decay. To search possible decay via low energy proton emission or high energy β-decay the setup (Fig. 2) has been used [5]. Neither β-particles (Fig. 5), nor γ-rays belonging to ^{73}Rb decay have been observed. The combination of gas telescope with 300 keV threshold for proton identification and thick β-detector gives strict limit for the production rate of ^{73}Rb (Fig. 6).

The most restrictive production limit is equal to $8\cdot10^{-4}$ protons/μC for ^{73}Rb. This limit leads to make the conclusion about proton instability of the ground state of ^{73}Rb [6].

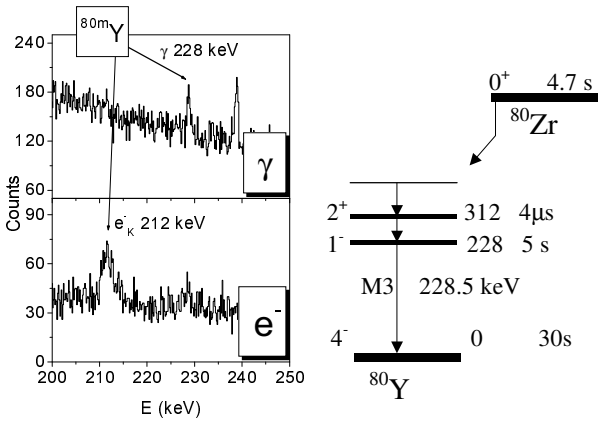
Fig. 6. The behaviour of the yields for various Rb – isotopes. The yields obtained at ISOLDE II installation are also presented there for comparison. The most restrictive production limit is equal to $8\cdot10^{-4}$ protons/μC for ^{73}Rb

4. Astrophysical application

The role of ^{73}Rb and ^{70}Kr

The binding energy and the decay modes are critical for the *rp*-process. The negative proton binding energy of ^{73}Rb have to suppress the consecutive proton capture over this nuclide, then the process can proceed from ^{72}Kr via β-decay or two proton capture. The identification of proton instability of ^{73}Rb means that the slit to produce heavier nuclides became much more narrow.

The two-proton capture is the alternative way to pass the *rp*-process through a proton-unbound nuclide. The role of this mechanism around waiting points ^{68}Se and ^{72}Kr is essentially influenced by half-life of ^{70}Kr. No information about the decay property of ^{70}Kr has been previously published. The superallowed decay chain ^{70}Kr→ ^{70}Br → ^{70}Se has been studded at ISOLDE with setup (Fig. 2b). The measured half-life for ^{70}Kr decay is equal to 60(40) ms, that is consistent with pure Fermi decay. At the same time this value is significantly shorter than the value used in the recent network calculations for rapid capture process. The shorter value results in a higher effective rate for bridging the waiting point at ^{68}Se via two-proton capture at temperatures higher than 1.5–2 GK [7].



Search for ^{80m}Y

A careful investigation of the internal decay modes of the long-lived isomeric state at 228 keV excitation energy in ^{80}Y has been done [8]. The measured conversion electron coefficient for the 228.5 keV isomeric transition $\alpha_K = 0.50(7)$ allows unambiguous 1^- identification for the isomeric state in ^{80}Y. Since we did not observe the 84 keV γ and *e*-line belonging to this transition we can conclude that the 228.5 keV state is the first isomeric excitation in ^{80}Y. The half-life was measured as 5.0(0.5) s in a good agreement with previous value.

Fig. 7. Excited states of ^{80}Y observed in the decay of ^{80}Zr. Energies of states are given in keV. Gamma and conversion electron spectra are shown

The astrophysical *rp*-process in *X*-ray bursts is passing through the nuclide ^{80}Y. In the stellar plasma ^{80m}Y is expected to be fully ionized. A "bare" half-life of this state is determined to be equal to 6.6 s. This bare isomeric state is strongly populated in the rp-process from ^{80}Zr and has therefore to be taken into account in *X*-ray burst model calculations. Because of the similarity of the β-decay half-lives of "bare" ground and isomeric states we find a maximum reduction in the effective β-decay lifetime of ^{80}Y of only 17%.

Our results pave the way for a future investigation of the impact of the isomeric state on the "effective" ^{80}Y proton capture rate.

The full list of PNPI physicists participated in this work is given below:
A.V.Popov, Yu.N.Novikov, D.M.Seliverstov, V.I.Tikhonov.

References

[1] M.Oinonen, A.Knipper, U.Koster, G.le Scornet, C.Miehe, A.Nieminen, T.Nilsson, Yu.Novikov, K.Perajarvi, E.Poirier, A.Popov, D.M.Seliverstov, T.Siiskonen, H.Simon, O.Tengblad, P.VanDuppen, G.Walter, L.Weissman, K.Wilhelmsen-Rolander, J.Aysto, and the ISOLDE Collaboration, Phys. Lett. **B 511,** 145 (2001).

[2] P.Dendooven, A.Honkanen, M.Huhta, A.Jokinen, G.Lhersonneau, M.Oinonen, J.M.Parmonen, J.Persson, A.Popov, and J.Aysto, in *Contrib. Int. Conf. on Exotic Nuclei and Atomic Masses, Arles, France, 19–23 June 1995.*

[3] M.Oinonen, R.Beraud, G.Canchel, E.Chabanat, P.Dendooven, A.Emsallem, S.Hankonen, A.Honkanen, J. Huikari, A.Jokinen, G.Lhersonneau, Ch.Miehe, A.Nieminen, Yu.Novikov, H.Pentilla, K.Perajarvi, A.Popov, D.M.Seliverstov, J.C.Wang, and J.Aysto, Nucl. Instr. Meth. **A 416,** 485 (1998).

[4] J.Huikari, P.Dendooven, R.Beraud, Ch.Miehe, Yu.N.Novikov, M.Oinonen, A.V.Popov, J.Aysto, P.Baumann, G.Canchel, Ph.Desagne, A.Emsallem, W.Huang, A.Jokinen, A.Knipper, V.Kolhinen, A.Nieminen, H.Penttila, K.Perajarvi, I.Piqueras, S.Rinta-Antila, D.M.Seliverstov, J.Szeripo, G.K.Vorobjev, and Y.Wang, in *Proc. Int. Conf. on Exotic Nuclei and Atomic Masses (ENAM 2001), Hameenlinna, Finland, 2–7 July 2001.*

[5] M.Oinonen, A.Jokinen, P.Baumann, F.Didierjean, A.Honkanen, A.Huck, M.Huyse, A.Knipper, G.Marguier,Yu.N.Novikov, A.V.Popov, M.Ramdhane, D.M.Seliverstov, P.VanDuppen, G.Walter, and the ISOLDE collaboration, Phys. Rev. **C 56,** 745 (1997).

[6] A.Jokinen, M.Oinonen, J.Didierjean, P.Hoff, A.Huck, A.Knipper, G.Marguier, Yu.N.Novikov, A.V.Popov, M.Ramdhane, D.M.Seliverstov, P.van Duppen, G.Walter, and the ISOLDE collaboration, Z. Physik **A 355**, 227 (1996).

[7] M.Oinonen, J.Aysto, A.Jokinen, P.Baumann, F.Didirjean, A.Huck, A.Knipper, M.Ramdhane, G.Walter, M.Huyse, P.van Duppen, G.Marguier, Yu.Novikov, A.Popov, D.M.Seliverstov, H.Shatz, and the ISOLDE collaboration, Phys. Rev. **C 61**, 03581 (2000).

[8] Yu.N.Novikov, H .Schatz, P.Dendooven, R.Beraud, Ch.Miehe, A.V.Popov, D.M.Seliverstov, G.K.Vorobjev, P.Baumann, M.J.G.Borge, G.Canchel, Ph.Desagne, A.Emsallem, W.Huang, J.Huikari, A.Jokinen, A.Knipper, V.Kolhinen, A.Nieminen, M.Oinonen, H.Penttila, K.Perajarvi, I.Piqueras, S.Rinta-Antila, J.Szeripo, Y.Wang, and J.Aysto, Eur. Phys. J. **A 11** (2001).