Decay study of ^{50}Ni

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A few years ago, the very neutron-deficient isotope ^{50}Ni ($T_Z = -3$) has first been identified as a product of a fragmentation reaction and a lower limit of about 200ns was determined for its half-life [1]. This implies that the isotope is either stable against proton emission or has a very small Q value for this decay mode. Its production cross section was determined to be $(6.1^{+3.3}_{-3.0}) \cdot 10^{-8}$ mb for the reaction induced by a 650A MeV ^{58}Ni beam on a ^{9}Be target, but no spectroscopic information could be gained. Based on these results, ^{50}Ni is expected to disintegrate mainly by β^+/EC decay, with a Q_{EC} value estimated to be 13400 keV [2] or 14600 keV [3]. Since its β-decay daughter ^{50}Co is predicted to be proton unbound by 90 keV [2], all ^{50}Co levels populated in β decay of ^{50}Ni should promptly emit a proton. From a comparison with the mirror nucleus ^{50}V [4], the spin and parity of ^{50}Co ground-state can be tentatively estimated to be (6^+). Thus, one expects the population of the ^{50}Co ground-state in ^{50}Ni (0^+) decay to be weak and the branching ratio for β-delayed protons (βp) to be of the order of 100 %.

In this contribution we report on preliminary results from a first spectroscopic investigation of ^{50}Ni. This isotope was produced in the fragmentation reaction of a ^{58}Ni beam at 650A MeV on a 4 g/cm^2 thick ^{9}Be target, and separated by means of the FRS at GSI. The average beam intensity ammounted to about $3 \cdot 10^8$ ^{58}Ni ions per SIS spill. The identification of the fragments was accomplished on the basis of the scatter plot Z versus A/q. In order to get an unambiguos identification, i.e. to suppress background events originating from reaction products closer to the β-stability line, the time-of-flight was measured between the third and fourth focal plane of the FRS, additionally to determining it in the normal way, i.e. between the second and fourth focal planes. At the final FRS focus, the fragments were implanted into a telescope of 8 silicon surface-barrier detectors, each 300 μm thick. The energy resolution amounted to 250 keV for 1.9 MeV βp. Out of a total of 77 ^{50}Ni ions identified at the final FRS focus during the measurement time of 36 hours, 41 were implanted in the telescope. The implantation of such energetic ions leads to saturation of standard preamplifiers for a few hundreds of μs. In order to overcome this problem, a new type of preamplifier has been developed at GSI [5]. They are "blocked" for 2 μs at the beginning of the implantation. In this way the large charge generated by the implantation does not overload the preamplifier which thus can still have the large amplification required for spectroscopy studies.

The preliminary βp energy spectrum of ^{50}Ni, as shown in Figure 1, was obtained by requiring that a low-energy signal was recorded within 100 ms after the implantation of a ^{50}Ni ion. The group of protons that are concentrated around 3−4 MeV could be emitted from the isobaric analog state (I^π=0$^+$, T=3) and neighboring 1^+ levels in ^{50}Co. By assuming an efficiency of (84±8) % for βp detection and by taking into account the 26 βp events recorded and the 41 ^{50}Ni ions implanted, a branching ratio of (75±20) % was tentatively estimated.

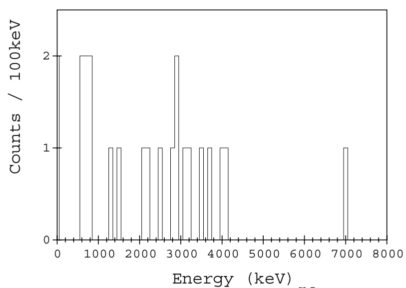

Figure 1: Energy spectrum of ^{50}Ni βp events.

The time distribution of the ^{50}Ni βp data was obtained by evaluating the time difference between the implanted ^{50}Ni ion and the subsequent βp event. The highest rate was 1 event per hour; this is perfectly compatible with the correlation technique applied for half-lives in the 1-100 ms range. The preliminary time spectrum obtained in this way is displayed as Figure 2. The mean life was obtained by applying the maximum likelihood method to an exponential distribution [6]. The best estimate of the mean life is in this case given by the arithmetic average of the time intervals and the uncertainties were estimated according to [6] for an exponential distribution. Its preliminary value was to be $12^{+3.1}_{-2.1}$ ms corresponding to $T_{1/2}$=$8.7^{+2.1}_{-1.5}$ ms.

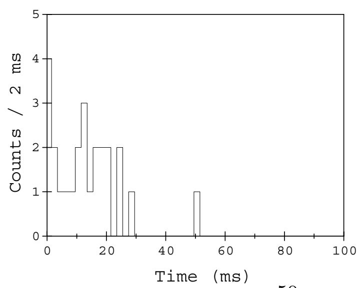

Figure 2: Time distribution of ^{50}Ni βp events.

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