TOWARDS HIGHER SENSITIVITY AT THE RITU FOCAL PLANE* **

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The recently reconstructed focal plane detector system for the gas-filled recoil separator RITU was used to observe a new proton emitter ^{164}Ir. The nuclide was produced via the $p5n$ fusion evaporation channel using a ^{64}Zn beam on a ^{106}Cd target. The proton energy $E_p = 1817(9)$ keV and half-life $T_{1/2} = 113^{+62}_{-30}$ μs were used to characterize the decaying state to be $[\pi h_{11/2} \nu f_{7/2}]9^+$. The new focal plane detector system and the results of the proton decay studies will be discussed.

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1. Detector setup

Several technical developments have recently taken place at the RITU [1] focal plane detector system. Due to these developments the gas-filled recoil separator RITU is now, in the best case, up to an order of magnitude more sensitive than before.

The first improvement was the installation of a gas counter, a multi wire proportional avalanche counter, in front of the position sensitive silicon detector. This allows detection of particles passing through the gas counter and hitting the silicon detector. It is now possible to obtain clean alpha decay spectra without beam pulsing, which results in a loss of a part of the accelerator beam. In addition, it is usually possible to discriminate between low-energy scattered beam particles and fusion-evaporation residues

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(recoils) because of their different energy losses in the gas counter. In the data analysis this reduces the number of possible fusion products which, in turn, lowers the number of accidental recoil-α correlations.

In addition to the gas counter construction, a new kind of silicon detector chamber was used during the JUROII [2] project. The new chamber allowed the use of five, instead of only one, Compton-suppressed Ge detectors around the silicon detector. The five detector setup was about twice as efficient as the earlier setup.

The present effort aims specifically at detection of proton emitters but this development also helps in alpha spectroscopic measurements. In the latest design the gas counter is placed very close to the silicon detector so that it is also able to detect so-called escape alphas. Because typical escaping alpha particle energies seen in the silicon detector fall in the same region as typical proton decay energies, *i.e.* 1–2 MeV, it is very helpful if those alphas are detected and suppressed. Between the gas counter and silicon detector it is possible to use degrader foils. Degraders are needed to choose a suitable recoil implantation energy and to stop very low-energy beam particles before they hit the silicon detector. This lowers the total counting rate of the silicon detector which is very useful provided the required products are still collected. Behind the silicon detector two quadrant silicon detectors are installed. The quadrant detectors are mainly used to detect very energetic light particles (protons and α-particles, identification shown at left hand side of the figure 1) which are able to go through (punch through) the first

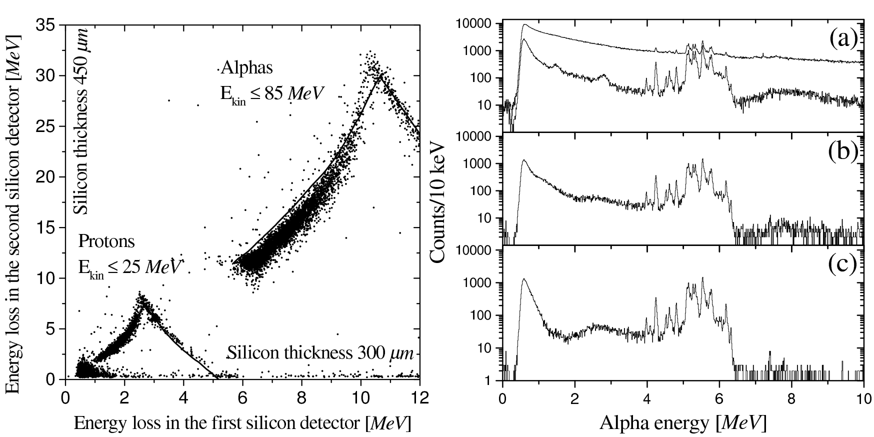

Fig. 1. Identification of the punch through particles using energy loss curves on the left figure. Solid lines are the simulated curves. At the right hand side of the figure: (a) — total and beam particle suppressed alpha decay spectrum (b) — with punch through suppression (c) — with escaping alpha particle suppression.

silicon detector. Due to the very low stopping power the gas counter is not very efficient for those particles (especially protons) and therefore the punch through particle detectors are needed. From the maximum energies of the particles it could be concluded that they are scattered by the full energy beam.

At the right hand side of figure 1 the alpha decay spectra without any suppression and after several different kinds of suppression combinations are shown.

2. Results

The detector system described above was used in a test experiment where five different proton emitters were identified including the new proton emitter ^{164}Ir. The experiment was performed using a ^{64}Zn beam with four different bombarding energies on a 550 μg/cm^2 thick ^{106}Cd target. The two lowest bombarding energies were used to measure the two known proton lines ^{167g}Ir, E_p=1064(6) keV and ^{165m}Ir, E_p=1707(7) keV [3] which were used for the proton decay energy calibration.

The results of the calibration runs are shown in figure 2. Figure 2 (a) shows the decay spectrum of the events in the silicon detector which are spatially correlated with recoils within a 120 ms time interval and which are followed by ^{166}Os alpha decay within a 600 ms time interval and spatially correct position. Figure 2 (b) is the same but the time intervals are 2 ms and 200 ms and now events were followed by ^{164}Os or ^{160}W alpha decay. Using the properties of the decay chains the activities were identified as shown in figure 2. Figure 3 presents a two dimensional plot with all recoil-mother–

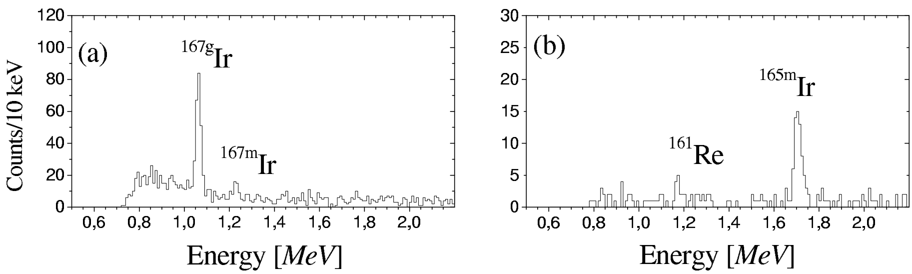

Fig. 2. The correlated decay spectra collected during the calibration runs.

daughter decay type correlated chains in which maximum time differences for mother and daughter decays were 2 ms and 100 ms, respectively. The plot includes runs with all four bombarding energies and therefore the activities shown in figure 2 are also present even though the correlation times are unsuitable for them.

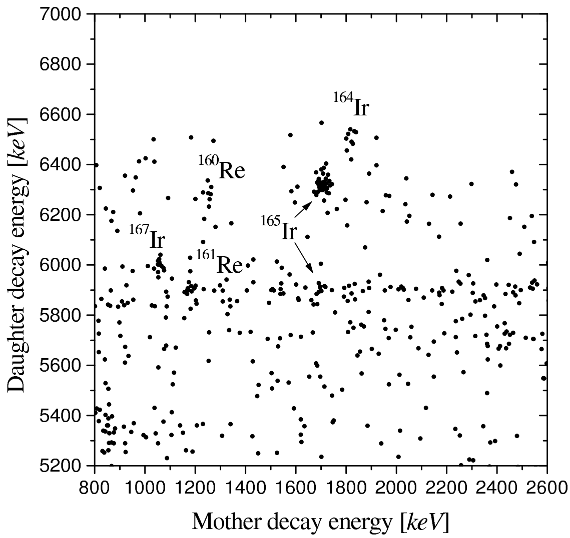

Fig. 3. Two dimensional plot for all recoil-mother–daughter decay type correlated chains. Maximum time differences allowed for mother and daughter decay were 2 ms and 100 ms, respectively.

Five different proton emitters could be identified from the plot: four previously known (^{161}Re [4], ^{160}Re [5], ^{167}Ir and ^{165}Ir [3]) and, in addition, the new proton emitter ^{164}Ir. The new radioactivity was seen to be followed by an alpha decay with the decay energy E_α=6493(11) keV and half-life $T_{1/2} = 7.5^{+4.2}_{-2.0}$ ms which are well compatible with the decay properties of ^{163}Os E_α=6514(10) keV and $T_{1/2} = 5.5(6)$ ms [6]. Because the decay properties of the new radioactivity E=1817(9) keV and $T_{1/2} = 113^{+62}_{-30}$ μs cannot represent an alpha decay it corresponds to the proton decay of ^{164}Ir.

The measured half-life can only be explained by l=5 emission, corresponding to $[\pi h_{11/2} \nu f_{7/2}]9^+$ configuration. The measured spectroscopic factor $S_p^{\rm exp}$=0.19(7) is in agreement with the theoretical spectroscopic factor of $S_p^{\rm th}$=0.33 predicted by the low-seniority shell model [3].

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