Observation of the pionic 1s state in lead in the ^{206}Pb(d,^{3}He) reaction

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Experimental studies of the ^{208}Pb(d,^{3}He) reaction at the GSI Fragment Separator FRS in recoil free kinematics lead to the first observation of deeply bound pionic states in heavy atoms [1]. Although this discovery opened a new field of spectroscopy in the investigation of pionic atoms and deepens the understanding of the pion-nucleus potential [2], the 1s and 2p levels could not be clearly resolved.

Very recently, also the ^{206}Pb(d,^{3}He) reaction was studied in order to determine the binding energy of the 1s state and the widths of both 2p and 1s states more precisely and thus to set more significant constraints on the pion-nucleus optical potential. The ^{206}Pb(d,^{3}He)$\pi^-\otimes^{205}$Pb reaction was expected [3] to be better suited to separate the $(1s)_\pi$ from the $(2p)_\pi$ component than the ^{208}Pb(d,^{3}He)$\pi^-\otimes^{207}$Pb reaction because of a reduced contribution of the $p_{1/2}$ neutron hole state.

Besides the use of a ^{206}Pb target several experimental improvements were introduced in the recent measurement which improved the instrumental resolution by nearly a factor of two. As a result the pionic 1s component could be observed as a well separated peak in the ^{3}He momentum spectrum as illustrated in Fig. 1. Obviously, this will considerably reduce the uncertainty in the determination of the pionic binding energy in the 1s state, which has the largest overlap with the nuclear density distribution and is therefore most sensitive to the s wave pion potential and the π^- mass shift in the nuclear medium. In addition, the comparison of the 2p binding energies in ^{207}Pb and ^{205}Pb may give indications on the influence of the neutron density distribution on the deeply bound pionic states. First results on the binding energies and widths for the pionic 1s and 2p states in ^{205}Pb will be presented and their implications for the pion-nucleus potential will be discussed.

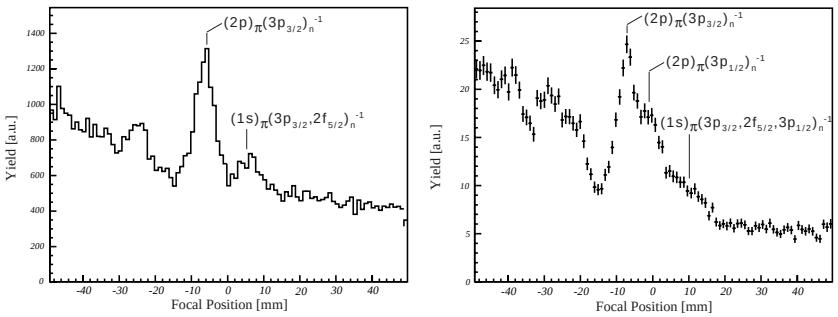

Fig. 1. Comparison of the ^{3}He position spectra on the FRS focal plane, obtained in the present ^{206}Pb(d,^{3}He) (left panel) and the previous ^{208}Pb(d,^{3}He) experiment (right panel)

References

[1] T. Yamazaki *et al.*, Z. Phys. A355 (1996) 219, H. Gilg *et al.*, to be submitted to Phys. Rev. C.

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[3] S. Hirenzaki and H. Toki, Phys. Rev. C55 (1997) 2719.