Spectroscopy of the Pb^{81+} $Ly_{\alpha 2}$ Line by Absorption Edge Technique

C.Strietzel [a], V.Bartoldus [a], H.J.Besch [a], H.F.Beyer [b], M.Czanta [b], P.Indelicato [d], A.Krämer [b], D.Liesen [b], T.Ludziejewski [b], X.Ma [b], B.Manil [d], N.Pavel [a], T.Stöhlker [b], S.Toleikis [b], J.Tschischgale [c], A.H.Walenta [a]

[a] Universität Siegen, [b] GSI Darmstadt, [c] FSU zu Jena, [d] Université de Paris

The absorption edge technique introduced by [1] provides the combination of high precision and large detection efficiency in energy measurements of x rays emitted by fast, highly charged ions. The potential of this method at the ESR has been evaluated in a parasitic experiment at the internal gas target with 42.3 MeV/u Pb^{82+} ions. At this projectile energy and an observation angle of 145° the $Ly_{\alpha 2}$ line coincides with the well known 57.4856 keV K-edge of erbium [2]. The $Ly_{\alpha 2}$ x rays were detected in a position-sensitive detector which has been developed by the University of Siegen in collaboration with GSI [3]. It works on the principle of the Time-Projection-Chamber (TPC) at high gas pressures (90% Ar and 10% methane at 20 bar) with a 20 mm wide and 100 mm high entrance window. The position resolution for this gas-mixture is 500 µm in the plane of Fig. 1 which shows the experimental set-up at the internal gas target of the ESR.

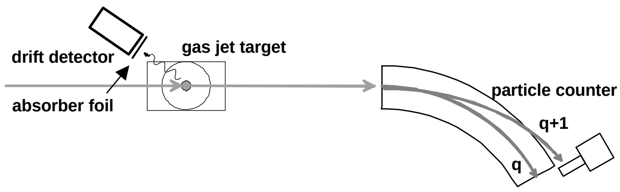

Fig. 1: Apparatus for the absorption-edge experiment at the internal gas target of the ESR

The signals induced in a particle counter by down-charged Pb^{81+} ions after electron capture in the target were used as time triggers for the TPC.

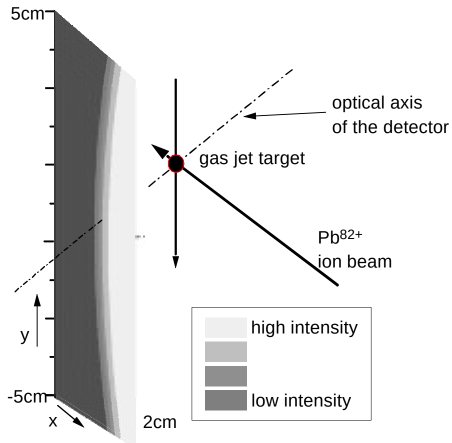

Fig. 2: Geometry of the set-up with a simulated intensity distribution at the entrance window of the detector

Due to the Doppler effect, the energy of the $Ly_{\alpha 2}$ x rays varies over the width of the entrance window of the detector from 57.42 keV to 57.28 keV. This energy range fully covers the K-edge region of the 100µm thick erbium absorber which is mounted in front of the window. As a result a change of the x-ray intensity should be detected by the TPC along the horizontal extension of the entrance window. Since the x-ray energy does not depend on the azimuthal emission angle, the intensity variation should exhibit a curvature in the perpendicular direction. A simulation of the expected intensity distribution is shown in Fig. 2.

By an integration of this 2-dimensional intensity along the vertical direction one obtains the intensity-function shown in Fig. 3 together with the experimental data points. Obviously, shape and height of the measured and the calculated intensity step nicely agree with each other. The jump ratio is, besides the thickness of the absorber, mainly determined by the intensity of closely spaced x-ray lines like $Ly_{\alpha 1}$, Ly_{β} and so on. A preliminary analysis of the data leads to the conclusion that the energy resolution of the absorption techniques in combination with a TPC is better than 30 eV. The finally achievable accuracy will mainly depend on the uncertainties of the observation angle and the beam velocity. A beam time envisaged in the year 2000 using

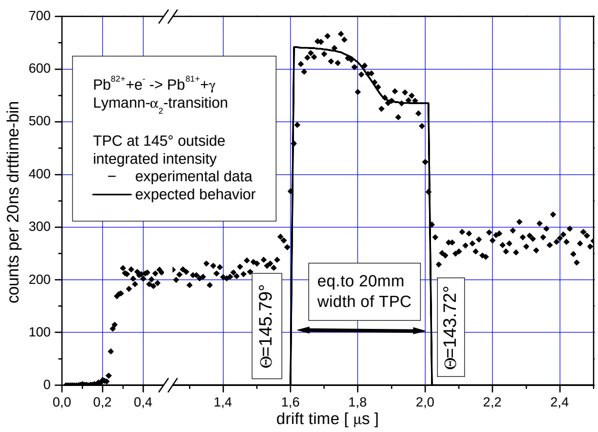

Fig. 3: Integrated intensity function (TPC-spectra)

three detectors with different absorbers and at different velocities should give a precision of less than 30 eV.

References

[1] R.W.Schmieder and R.Marrus, Nuc. Instr. Meth. 110, 459 (1973)

[2] G.Lum et.al., Phys. Rev. D23, 2522 (1981)

[3] G.Menzel, Thesis, Universität Heidelberg 1998