

# ELECTRONS EMITTED FROM 33 TEV Pb IONS DURING THE PENETRATION OF SOLIDS

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An experiment for capture of electrons generated by pair production (electron capture via  $e^+, e^-$  pair production (ECP)) and their subsequent emission in the forward direction by 33 TeV relativistic Pb nuclei is presented. The aim is to compare momentum distributions of electrons emitted during the passage of thin foils by  $Pb^{81+}$  and by ECP electrons from  $Pb^{82+}$  e.g. to obtain information on the states to which electrons are captured. An additional objective is to determine the momentum distribution of emitted positrons and compare it to that of the electrons.

The so-called vacuum capture or ECP process in which a pair is generated during the collision between two ions and followed by capture of the electron to one of them is of fundamental interest e.g. for the calculation of lifetimes in relativistic heavy ion colliders. Rest-gas scattering may lead to a change of the charge of ions in the circulating beam with imminent loss of the ion. It is a unique feature of the vacuum capture process that its cross section increases with increasing energy of the projectiles and it may therefore become a dominating mechanism for loss of particles at high energies (1-4).

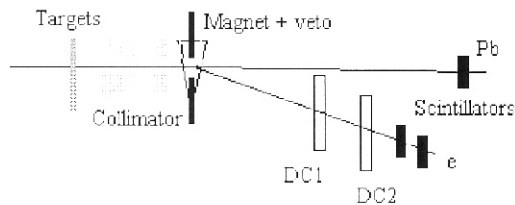


Figure 1 Experimental setup

The experiment was performed in the H2 beam line of the CERN SPS where fully stripped lead ions with a Lorentz factor  $\gamma=168$  are available. The setup is shown schematically in figure 1. The lead beam passes the targets mounted on a remotely controlled target wheel, continues through a collimator which acts to absorb the generated knock-on electrons and traverses a magnetic field until it is finally counted in a scintillator and dumped. The magnetic field deflects only slightly the ions of momentum  $p_i=400$  GeV/c per charge while it serves as a spectrometer for the emitted electrons which are of  $p_e=\gamma\beta mc=86$  MeV/c, where  $m$  is the electron mass and  $\beta$  the ion-speed in units of  $c$ , the speed of light. The deflected electrons are detected in two drift chambers which have a position resolution corresponding to about 0.2 MeV/c in momentum due to the horizontal deflection in the magnetic field. The number of electrons per ion is counted in a coincidence of two scintillators placed downstream of the chambers.

Due to the one-to-one correspondence between emission angle and momentum for  $\delta$ -electrons,

those with a momentum of 86 MeV/c are emitted at an angle of  $7^\circ$ , compared to  $\leq 0.3^\circ$  for the captured electrons. Therefore the knock-on electrons that are not absorbed in the upstream collimator can be vetoed at the entrance of the spectrometer magnet by use of a scintillator with a hole which defines a  $\approx 0.6^\circ$  opening as seen from the target.

To enable a comparison between the momentum distributions from captured electrons and 1s electrons, a measurement was performed where the projectiles were selected upstream of the target to be  $Pb^{81+}$ . In this case, the electrons will be multiply scattered through essentially the entire target as well as through windows etc. The calculated multiple Coulomb scattering (MCS) from known thicknesses is 8.6 mrad, corresponding to 2.7 MeV/c, which compares well with the measured vertical width of 9 mrad ( $\sigma$ ).

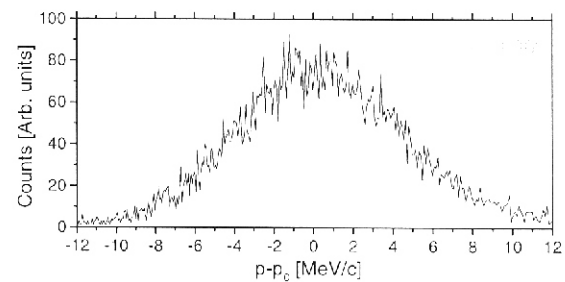


Figure 2 Momentum distribution of  $Pb^{81+}$  stripped in Al

Additional broadening in the horizontal plane is due to angular and momentum distributions of the emitted electrons as shown in figure 2, where direction is converted directly into momentum by use of the spectrometer and thus includes MCS.

## References

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