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An electrostatic positron beam for atomic and molecular collision experiments

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Synopsis A new electrostatic positron beam at UCL is described. The beam incorporates a re-moderator to achieve brightness enhancement, time of flight facility for beam energy determination and improved signal to background ratio and a position sensitive detector for 2-D imaging of the beam spot. The apparatus is being employed for measuring the total cross section of positron scattering from krypton and helium in the energy range of $(10-200)$ eV. Results will be presented at the conference.

Positrons are valuable tools in the understanding of the fundamental physics interactions between matter and antimatter, an endeavour which is of relevance also in material science, astrophysics and biological chemistry. Collision dynamics, in particular, may be revealed by performing energy- and angular-resolved measurements of the final-state particles following a scattering event. Such investigations are best performed in absence of external fields. The new electrostatic positron beam is being used to carry out total cross section, σ_T, measurements for positron scattering from He and Kr in a field-free region. This work has been stimulated by recent results [1, 2] of positron σ_T from helium and neon, also determined using an electrostatic beam. In these works, discrepancies in the range between $(3-20)$ eV have been found with respect to previous measurements on systems employing magnetic fields.

Table 1. Present angular discrimination, θ, in comparison with previous experiments

Experiment	θ
Present work	$\simeq 2^o$
Nagumo et al., [1, 2]	$\simeq 3^o$
Makochekanwa et al., [5]	$\simeq 18^o - 3^o$
Zecca et al., [6]	$\simeq 17^o - 5.4^o$
Dababneh et al., [7]	$\simeq 15^o - 20^o$
Beale et al., [8]	$\simeq 12^o - 6^o$

In these transmission experiments, the largest source of systematic errors comes from the accidental inclusion of forward scattered particles in the transmitted beam. This error leads to an artificially lower σ_T. In the current experiment, a Position Sensitive Detector (PSD) detects the transmitted positrons at the end of the beam line allowing for a significantly better angular discrimination against forward scattered particles when compared to others e.g., [5, 6, 7, 8] and comparable to that of [1, 2], as shown in table 1.

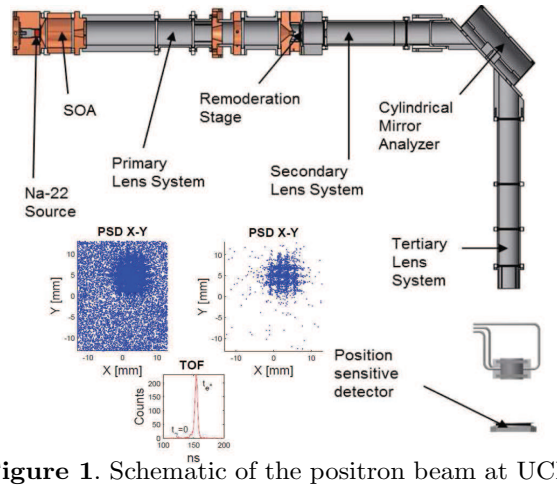

Figure 1. Schematic of the positron beam at UCL [3]. Refer to the text.

Secondary electrons at the re-moderator initiate a timing sequence terminated at the PSD, allowing for Time Of Flight (TOF) analysis. In figure 1, an overview of the positron beam is shown, together with a PSD image of the beam spot, before and after TOF selection. In the TOF plot, the γ-peak from positron annihilation against the gas cell walls (t=0), is easily separated from the incident positron peak.

References

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