Experimental and Theoretical Studies of Cherenkov Radiation Angular Distributions from Relativistic Au Beam at SIS-18 GSI*

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Several experiments [1-3] on detection of the Cherenkov radiation (ChR) from ~0.9 GeV/u Au relativistic heavy ions (RHI) were performed during 1996-2001 at SIS-18 heavy ion accelerator, GSI.

An unusual relation between ChR angular distribution width and radiator thickness was observed in [2]. Unusual means, that the width of the standard Tamm-Frank angular distribution of ChR should decrease with increase of the radiator thickness, while the experiment showed larger broadening of the ChR ring width in the case of the thicker radiator compared to the thinner one (Fig. 1, top). Both ChR images on the photographic films were recorded under the same conditions but for different radiator thicknesses. Therefore, the difference in widths of both rings may be only due to different energy loss in the radiators L_1 and L_2, i.e. due to different exit velocities of RHI. At that time, obtained experimental data were explained only qualitatively, as the influence of RHI slowing-down in a radiator, but both quantitative theory and numerical calculations have not been developed.

In our work [4] the analysis of these experiments is performed and the experimental data are compared with numerical calculations which take into account the RHI slowing-down in a radiator [4]. Our calculations are based on the theory developed in [5-6] except that RHI mean ionization energy loss is calculated now using the computer code ATIMA [7].

Our numerical calculations (Fig. 1, bottom) are performed with the same parameters of RHI beam and radiator as in [2]. To take into the fact that ChR was detected in a definite wave length range (photographic film), we summed up the ChR intensities over optical wave length range. Besides, we took into account the initial energy spread of Au beam. The black curve in the Figure 1 (bottom) is calculated using the Bethe-Bloch formula for RHI ionization energy loss, while the red one is calculated using ATIMA. The Bethe-Bloch formula gives lower values of ionization energy loss (for the RHI energy ~ 1 GeV/u) – that is why the ChR intensity is greater and angular distribution is broader in the case of red (ATIMA) curve.

Our numerical calculations are in quantitative agreement with experiment, especially if the calculated ChR angular width is recalculated to obtain the experimentally observed ChR spatial distribution, using the fitting function from [2]. So, for several GeV/u RHI, an unusual relation between ChR angular distribution width and radiator thickness is now explained quantitatively as an effect of RHI slowing down in radiator.

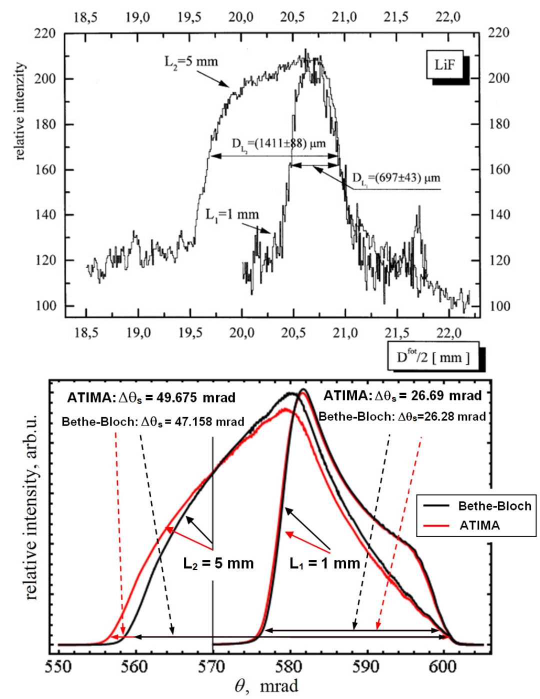

Figure 1: Experimentally recorded [2] ChR spatial distribution on a photographic film (top) and calculated [4] ChR angular distribution (bottom) for 2 different radiator thicknesses.

References

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