Study of the optimal structure of the TRD radiator

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We present results of a study aiming to find the optimal radiator for the CBM-TRD, taking into account peculiarities of the transition radiation (TR) and results of worldwide investigations on the development of optimal radiator structures.

The standard version of the CBM-TRD consists of three stations located at 5 m, 7.25 m and 9.5 m downstream of the target, respectively. Each station consists of four modules, each of which containing a layered radiator consisting of N_f alternating layers of polypropylene foils of thickness t_f and air gaps of thickness t_g for producing the transition radiation from high-energy electrons and positrons, and a multi-wire proportional chamber (MWPC) for the registration of the energy loss of charged particles (by ionization and transition radiation) and for the measurement of the coordinates of their intersection with the MWPC plane.

To estimate the quality of the TRD radiator structure, the pion rejection factor at a fixed level of electron efficiency was used. We applied different methods for the discrimination of electrons from pions: the mean value (MV) method, the likelihood functions ratio (LFR) test, the ω_n^k goodness-of-fit criterion, the modified ω_n^k test, the combined method (MV + ω_n^k), and a three-layered perceptron from the JETNET and ROOT packages [1]. Table 1 shows the pion rejection factor at 95% electron efficiency for different momenta p as obtained for the GSI-Bucharest radiator model (N_f = 220, t_f = 25 μm, t_g = 250 μm, total width = 6.05 cm).

Table 1: Pion rejection factor at 95% electron efficiency for different momenta, calculated for the GSI-Bucharest radiator model with different methods for electron-pion discrimination

p [GeV/c]	1.5	3	5	7
MV	10	15	18	18
ω_{12}^6	22	32	33	25
MV + ω_{12}^6	90	219	265	277
mod ω_n^6	64 (n=6)	240 (n=6)	282 (n=7)	254 (n=7)
LFR	168	524	1075	1150
root	218	833	1212	1228
jetnet	255	1176	1290	3071

For technological and geometric considerations, we assumed the total thickness of the radiator to be $\approx$ 6 cm. Taking into account both this thickness and the fact that the radiator must efficiently generate and simultaneously weakly absorb the transition radiation, computations were performed aiming to optimize the structure of the radiator. According to the recommendations in [2], we varied the foil thickness (see Fig. 1 a) and the size of the TR formation zone in the air gap of the radiator (see Fig. 1 b). As a result of this study, the optimal structure of the radiator with the total width of 6.24 cm was found to be N_f = 320, t_f = 15 μm and t_g = 180 μm. The pion rejection factors obtained for this radiator are given in Table 2, demonstrating that a gain by a factor of 4 - 8 w.r.t. the GSI-Bucharest radiator model is obtained.

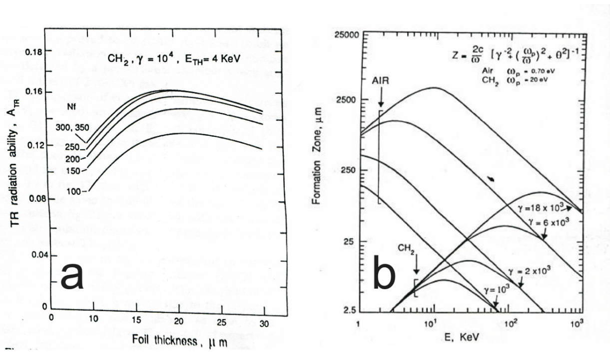

Figure 1: (a) TR radiation ability as a function of the foil thickness for different numbers of foils; (b) size of the TR formation zone in air.

Table 2: Pion rejection factor at 95% electron efficiency for different momenta, calculated for the optimized radiator model with different methods for electron-pion discrimination

p [GeV/c]	1.5	3	5	7
MV	17	21	22	22
ω_{12}^6	98	110	94	77
MV + ω_{12}^6	390	686	762	770
mod ω_7^6	521	1715	2118	2073
LFR	1143	3921	3813	3593
root	1451	1622	4516	8483
jetnet	2250	17300	10840	10180

References

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[2] B. Dolgoshein, Nucl. Instr. Meth. Phys. Res. **A 326** (1993) 434; T. P. Akishina, O. Yu. Derenovskaya and V. V. Ivanov, JINR Communication P10-2009-61, Dubna 2009