Towards chromatic calorimetry using nanocomposite scintillators

Vojtěch Zabloudil[1,2], Kateřina Děcká[2], Michael Doser[1,3], Yacine Haddad[1,4], Jan Král[2,5], Anne-Mazarine Lyon[1], Loris Martinazzoli[1], Emanuele Mazzola[6,7], Eva Mihóková[2,5], Matteo Salomoni[1,6], Solangel Rojas[2], Etiennette Auffray[1]

[1]*CERN, Geneva, Switzerland*
[2]*Czech Technical University in Prague, Prague, Czech Republic*
[3]*Massachusetts Institute of Technology, Cambridge, United States*
[4]*University of Bern, Bern, Switzerland*
[5]*Institute of Physics of the Czech Academy of Sciences, Prague, Czech Republic*
[6]*Università degli Studi di Milano-Bicocca, Milan, Italy*
[7]*INFN-Sezione di Milano Bicocca, Milan, Italy*

Corresponding Author Email: vojtech.zabloudil@cern.ch

Chromatic calorimetry is an emerging approach to homogeneous electromagnetic calorimetry based on longitudinally segmented scintillator layers with distinct emission spectra [1]. By exploiting spectrometric readout capabilities, this technique enables the discrimination of scintillation light originating from different layers and, consequently, the reconstruction of the longitudinal development of electromagnetic showers.

The concept aims to leverage recent advances in nanomaterial scintillators, which have enabled the incorporation of nanocrystals embedded within polymer matrices [2]. Owing to the quantum confinement effect, the emission spectra of these nanocrystals are narrow and readily tunable, allowing for fine longitudinal segmentation of calorimeter prototype and, in turn, improved resolution. Moreover, these nanocrystals exhibit ultrafast timing properties, further enhancing their potential for calorimetry or precision timing applications.

This contribution reports on the results of an experimental test beam campaign carried out at the CERN SPS facility in 2025 using electron beams with energies ranging from 10 to 120 GeV. The concept was validated using a single calorimeter cell of a chromatic calorimeter (CCAL) prototype based on commercial scintillators, employed as a performance baseline for future nanocomposite implementations. The prototype consisted of three scintillator layers, EJ-228 (390 nm emission), EJ-262 (490 nm), and GAGG (540 nm), interleaved with PbF_2 crystals acting as transparent absorbers without intrinsic scintillation. The readout system employed a four-anode R7600U-00-M4 multi-anode photomultiplier tube (MaPMT) from Hamamatsu, equipped with three long-pass optical filters to select the scintillation signals from the individual layers.

Results on the shower development, the particle identification capabilities and the energy resolution of the prototype will be presented.

1. M. Doser et al., “Quantum systems for enhanced high energy particle physics detectors”, *Front. Phys.*, **10**, 887738 (2022).
2. J. Král et al., “Towards high loading cesium lead halide nanocomposites for radiation detection”, *J. Phys. Mater.*, **8**, 015007 (2025).

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