HIGH-RESOLUTION ELECTROMAGNETIC CALORIMETRY BASED ON INORGANIC SCINTILLATORS

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The concept and performance of electromagnetic calorimetry is closely related to the development, progress and technology of inorganic scintillator crystals. The elementary interaction processes of the probes to be studied and the experimental conditions and goals of the various physics programs determine the applicability of the different materials. The paper gives an overview of the major calorimeters, which are presently in operation, in construction or outlined in various proposals. The experimental conditions, which incline to higher beam luminosities, interaction rates and projectile energies, favor fast, compact and radiation hard scintillators with sufficient luminescence yield. Presently $PbWO_4$ fulfills most of these requirements, except its light yield. Therefore, new materials, which are under development for medical applications, could come close to the ideal product, if the technology for mass production of large size crystals can be achieved.

Inorganic scintillation detectors have become one of the most widely applied instrumentation techniques in physics - in particular in the fields of nuclear and high-energy physics. The discovery and the need for further development of new material properties are strongly correlated with the growing standards in basic research. In particular, high-resolution electromagnetic (EM) calorimetry, requiring a homogeneous detector volume for complete energy absorption, imposes the most stringent demand.

The first construction of scintillation detectors, made possible by the development of the photomultiplier tube, started with the discovery of activated and pure alkali halide crystals. Nal(Tl) and CsI(Tl), introduced by Hofstadter, provide since the middle of the last century efficient photon and particle detection supported by the technology in growing crystals of sufficiently large volume.

The increase of the energy of detectable probes directed crystal development towards faster response, shorter decay times and more compactness implementing high-Z ions into the crystal matrix. In particular, the discovery of the fast core-valence luminescence in BaF_2, the allowed electric dipole transitions in Ce^{3+} and the short radiation lengths of BGO or $PbW0_4$ provided a significant step in the last decades of the 20^{th} century to find or even engineer the ideal scintillator. The next generation of large volume detector systems might be based on bright materials, such as LSO, LYSO or the Ce^{3+}-doped new chlorides or bromides. The detection of EM probes, such as electrons, positrons or high-energy photons, relies on the measurement of energy and impact location, both with high resolution. In particular, the invariant mass reconstruction of neutral mesons, which decay predominantly into photon pairs, requires the simultaneous measurement of energy and the relative angle between both photon directions. However, only a large solid angle in addition guarantees sufficient coincidence efficiency.

The photon and particle detection is based on the measurement of the energy by complete absorption in the active material. Due to the large difference of the relevant cross sections the hadronic interaction length λ is typically one order of magnitude larger compared to the radiation length X_0, which scales the longitudinal component of the energy loss of electrons or positrons (see Table). Therefore, typical calorimeter arrangements stop charged hadrons only up to a few hundreds of MeV energy. At least for charged particle identification or discrimination, calorimeter modules provide for hadrons information on energy loss AE, position, velocity via time-of-flight technique and particle identification by pulse-shape analysis as in the case of CsI(Tl) or BaF_2, respectively.

The elementary processes such as the photo-effect. Compton scattering and pair-production govern the interaction of photons in the detector material. The cross section of the latter process reaches an asymptotic value at high energies and is just determined by the composition of the material, expressed by the radiation length X_0.

On the other hand, this process leads to the formation of pairs of electrons and positrons, which predominantly undergo bremsstrahlung at energies above a critical value, closing the circle by creating again high-energy photons. In this process, leptons loose their energy on a logarithmic scale, parameterized as well by the radiation length, X_0, until the pure ionization mechanisms begins to take over. Multiple scattering leads to a lateral spread of the secondary products, quantified geometrically by the Moliere-radius. The interplay of these consecutive processes leads to the formation of the EM shower, which requires an active detector volume sufficient to guarantee complete calorimelry.

The selection of the appropriate detector material and the geometrical arrangement, which determine the detection efficiency, position reconstruction of the point of impact and the occupancy to minimize pile-up events with close showers or hadronic probes, have to be adapted to the experimental conditions. Growing beam luminosities and interaction rates, extremely high multiplicities of reaction products in ultra-relativistic heavy ion collisions and/or large radiation doses due to neutrons, charged particles or γ-rays have emphasized the development towards fast, compact and radiation hard inorganic scintillator materials.

OŚWIATA ZDROWOTNA W POLSKIM SYSTEMIE EDUKACYJNYM

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Istnieją dwa modele edukacji zdrowotnej. Pierwszy model nastawiony jest na zapobieganie występowaniu konkretnie określonych jednostek chorobowych. Pokazuje się w nim zdrowotne konsekwencje nieprawidłowego trybu życia. Model ten jest łatwy do zastosowania, ale mało efektywny w edukacji młodych ludzi, dla których perspektywa zaburzeń zdrowotnych pojawiających się po wielu latach jest mało realna. Model drugi ukierunkowany jest na zdrowie w ujęciu biopsychospołecznym. Polega on na wdrażaniu kompleksowych programów edukacji zdrowotnej. Jedną z najważniejszych cech tego modelu jest to, że członkowie danej społeczności współuczestniczą w określaniu najważniejszych zagrożeń oraz biorą udział w rozwiązywaniu problemów [8, 12, 13]. Skuteczna edukacja zdrowotna powinna zatem obejmować różne obszary. Najważniejsze z nich to: stwarzanie warunków sprzyjających korzystnym dla zdrowia wyborom; ukształtowanie właściwego szacunku dla siebie samego i innych; dostarczanie odpowiedniej wiedzy i umiejętności; stworzenie otoczenia sprzyjającemu zdrowiu; ochrona przed produktami zagrażającymi zdrowiu; umożliwienie uczestnictwa w działaniach bezpiecznych i korzystnych dla zdrowia [13]. Można sądzić, że szczególnie ważną rolę w takim sposobie edukacji zdrowotnej odgrywają szkoły. Dlatego też celem tego artykułu jest opis i ocena edukacji zdrowotnej prowadzonej przez szkoły w Polsce. Ważną rolę w edukacji zdrowotnej mają programy przedmiotowe (przede wszystkim programy do nauki biologii), oświata zdrowotna w szkołach, a także ścieżki edukacyjne.

W Polsce dzieci po raz pierwszy mogą trafić do placówek edukacyjno