Résumé

Measure what is measurable, and make measurable what is not so.

Galileo Galilei

The scope of detection techniques is very wide and diverse. Depending on the aim of the measurement, different physics effects are used. Basically, each physics phenomenon can be the basis for a particle detector. If complex experimental problems are to be solved, it is desirable to develop a multipurpose detector which allows one to unify a large variety of different measurement techniques. This would include a high (possibly 100%) efficiency, excellent time, spatial and energy resolution with particle identification. For certain energies these requirements can be fulfilled, e.g. with suitably instrumented calorimeters. Calorimetric detectors for the multi-GeV and for the eV range, however, have to be basically different.

The discovery of new physics phenomena allows one to develop new detector concepts and to investigate difficult physics problems. For example, superconductivity provides a means to measure extremely small energy depositions with high resolution. The improvement of such measurement techniques, e.g. for the discovery and detection of Weakly Interacting Massive Particles (WIMPs), predicted by supersymmetry or cosmological neutrinos, would be of large astrophysical and cosmological interest.

In addition to the measurement of low-energy particles, the detection of extremely small changes of length may be of considerable importance. If one searches for gravitational waves, relative changes in length of $\Delta\ell/\ell \approx 10^{-21}$ have to be detected. If antennas with a typical size of $1\,\mathrm{m}$ were chosen, this would correspond to a measurement accuracy of $10^{-21}\,\mathrm{m}$ or one millionth of the diameter of a typical atomic nucleus. This ambitious goal has not yet been reached, but it is expected to be attained in the near future using Michelson interferometers with extremely long lever arms.

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Since it would be bold to assume that the physical world is completely understood (in the past and also recently [1] this idea has been put forward several times), there will always be new effects and phenomena. Experts in the field of particle detection will pick up these effects and use them as a basis for the development of new particle detectors. For this reason a description of detection techniques can only be a snapshot. 'Old' detectors will 'die out' and new measurement devices will move to the forefront of research. Occasionally an old detector, already believed to be discarded, will experience a renaissance. The holographic readout of vertex bubble chambers for three-dimensional event reconstruction is an excellent example of this. But also in this case it was a new effect, namely the holographic readout technique, that has triggered this development.

Reference

[1] S.W. Hawking, *Is the End in Sight for Theoretical Physics? – An Inaugural Lecture*, Press Syndicate of the University of Cambridge (1980)

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