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NEW HIGH GRANULARITY CALORIMETERS for HIGH ENERGY PHYSICS

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Making calorimeters to be highly granular devices has been the subject of decades of R&D work within the High Energy Physics international community and is actively pursued worldwide.This is strongly motivated by the needs of the Physics to be explored in the particle accelerators.
The contribution of Dr Barney to this School includes two lectures:

Lecture 1: High-Energy Physics Calorimetry by Examples
In the first of two lectures on calorimetry, we give an overview of electromagnetic and hadronic shower development and how they lead to the design of modern calorimeters for energy measurements of high-energy particles. We explore the differences between sampling and homogeneous calorimeters and present the pros and cons of each. We focus on some real-world examples from the state-of-the-art detectors designed and operating at the Large Hadron Collider, and explore methods to increase the information content from future calorimeters and the challenges that these new calorimeters pose to detector physicists and engineers.

Lecture 2: The CMS High Granularity Calorimeter for High-Luminosity LHC
Calorimetry in high-energy physics is rapidly evolving, with new challenges and a wide variety of technologies being employed, both for signal creation and detection. Advances in large-area highly-segmented detectors are providing possibilities for high-granularity calorimetry. The CMS HGCAL, being designed to replace the existing CMS endcap calorimeters for the HL-LHC era, is one example. It is a sampling calorimeter, featuring unprecedented transverse and longitudinal readout segmentation for both electromagnetic (CE-E) and hadronic (CE-H) compartments. This will facilitate particle-flow calorimetry, where the fine structure of showers can be measured and used to enhance pileup rejection and particle identification, whilst still achieving good energy resolution. The CE-E and a large fraction of CE-H will use hexagonal silicon sensors as active detector material. The lower-radiation environment will be instrumented with scintillator tiles with on-tile SiPM readout. These concepts borrow heavily from designs produced by the CALICE collaboration but the design of such a detector at a hadron collider is considerably more challenging than at the linear colliders.

Dr David Barney is Senior Research Physicist and Group Leader at CERN (European Centre for Particle Physics), System & Beam Test Coordinator for High Granularity Calorimeter upgrade for the CMS experiment at the LHC: CMS is one of the two large multipurpose experiments at the LHC at CERN.

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