CERN test beam experience with the CALICE calorimeter prototype

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The CALICE collaboration is an international collaboration with 38 institutes in 13 countries and more than 150 participants. The main objective of the collaboration is the development of the next generation of calorimeters for future HEP detectors, based on innovative technologies to allow unprecedented granularity and segmentation of all detector components. In the four months between July and November 2006 in the H6B experimental area at the SPS, the CALICE collaboration has successfully commissioned and operated, a full calorimeter chain of prototype detectors for the future International Linear Collider composed of a Si-W electromagnetic calorimeter (ECAL), an analogue scintillator-steel calorimeter (AHCAL) with SiPM readout and a tail-catcher/muon tracker (TCMT) based on the same technology. The system, with more than 12000 channels and an acquisition rate capability of 120 Hz is a compact HEP experiment in itself.

This test beam effort has two main purposes: the establishment of the detector technologies in a large scale application and the collection of hadronic shower data with unprecedented granularity. The results of these measurements will have impact on the validation of hadronic shower simulations as well as the development of clustering and particle flow algorithms. They should provide a first experimental proof-of-principle for the particle flow approach and serve as guidance for the final design of the calorimetry system of an ILC detector.

Having a system composed of electromagnetic and hadronic calorimeters, the particle types required for the tests are both electrons and hadrons (pions / protons) with very good identification coming from an independent device, i.e. during the 2006 tests a Cherenkov detector was used for e/pi separation, and for future tests a pi/p separation is desirable. The relevant beam energies are in the range between 6 and 80 GeV with a stronger emphasis on the range 6 to 20 GeV where the discrepancies between hadronic models are largest.

Fig. 1. Simulated pion shower in the CALICE setup with ECAL, AHCAL, and TCMT (left), view of the installation area at the CERN test beam (middle), and a pion event in the on-line display (right).

In 2006, three main data taking periods had been granted to the collaboration totalling 36 beam days. Unfortunately, only 21 days of beam were provided due to the work on the PS septum magnet. During the data taking period the CALICE detectors had more than 90% up-time and the beam duty cycle was estimated to be about 60%. The collaboration collected more than 65 million beam events and 90 million calibration events, enabling completion of the muon calibration of all components, the electromagnetic programs of both ECAL and AHCAL and the first part of the hadronic program for the combined detector at zero degree incident angle of the beam. Data have been collected with both positive and negative beam polarities, covering the required range of 6-45 GeV for electrons and 6-80 GeV for hadrons. Higher statistics in the range 6-20 GeV would have been desirable but was not possible due to the constraints of other beam line users.

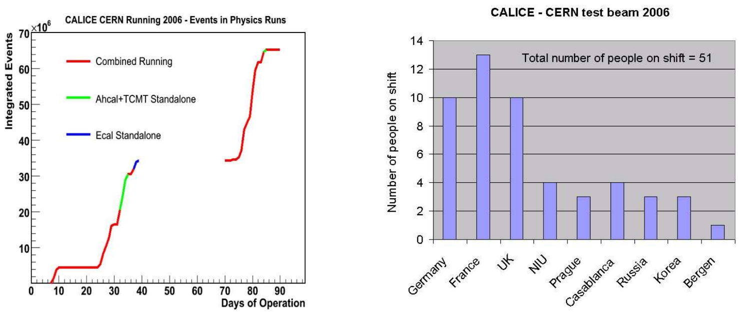

Fig. 2. Integrated beam events in the CALICE calorimeter system during the period Jul.-Nov. 2006 (left). Shift sharing among the countries member of CALICE (right).

In summary, the 2006 CERN test period was very fruitful for the collaboration. The expected amount of data were collected with a very high detector efficiency and a good beam duty factor. The data are being analyzed at present; first studies show the quality is good and exciting results can be expected. Next year a continuation is being proposed, with completed instrumentation for maximum lateral and longitudinal shower containment and enhanced capabilities for variations of the beam incidence angle.