A method has been devised to use this peak for a precise determination of the calorimeter energy scale for electrons. The method has been successfully applied to the high statistics data sample collected in the 1993 and 1994 running periods [95]. The calibrated energy distribution observed in the BEMC is shown in Figure 34. The data points are compared to a simulation program taking into account energy losses in dead material as well as spatial inhomogeneities and all known contributions to the energy resolution.

3.2.4 Performance

The overall electromagnetic energy scale of the BEMC has been determined using the data taken in the 1994 run period. In figure 34 a comparison of the measured energy distribution of the leading cluster with a simulated one (shaded area) using the GRV structure function is shown after adjustment of the calibration for each individual stack using the kinematic peak method. Good matching of the data and the simulation proves the quality of the BEMC calibration and of the understanding of the detector response. In the 1994 luminosity period the global energy scale for electrons in DIS was adjusted using the kinematic peak method with a precision corresponding to 1 % dominated by systematical errors.

The energy resolution of the BEMC has initially been determined in test beam studies carried out with electron beams ranging from 1 GeV to 60 GeV. A sampling term of $10\%/\sqrt{E}$ has been found in agreement with expectations from the mechanical design. The average noise per calorimeter stack was measured to be 130 MeV in the real H1 environment. Energy clustering is carried out over stack nonets giving rise to a contribution of 390 MeV from noise for each cluster. The constant term in energy resolution for a single stack was found to be 1.7 %. Using the observed shape of the kinematic peak the residual stack-to-stack calibration uncertainty has been determined to be 0.3% for electrons depositing more than 95% of their energy in a single stack.

The inherent mechanical non-uniformities in the stack construction due to the wavelength shifters cause an impact point dependent response to electromagnetic showers. Extensive studies carried out with test beam data and shower simulations exhibit a regular pattern of inhomogeneities with losses up to 8 % close to the wavelength shifters. A look-up table has been created to correct this impact point dependence. Electrons sharing their energy among many stacks receive an additional contribution of 3 % to their effective resolution caused by imperfections in the correction procedure.

The matching of electron tracks measured in the tracking detectors to the cluster position reconstructed in the BEMC has been determined from DIS events with the electron scattered into the BEMC. Based on the known attenuation properties of light in the scintillator plates a position resolution of 7 mm transverse to the beam has been achieved.

Interacting hadrons deposit typically 45 % of their energy in the BEMC. A satisfactory hadronic resolution of $\approx 80\%/\sqrt{E}$ has been estimated in detector simulations by combining the measurements in the BEMC and in the instrumented iron structure behind it with proper weighting.

3.3 The plug calorimeter.

The plug calorimeter (PLUG) has been designed to close the gap of acceptance for the energy flow measurements between the beam pipe ($\theta \approx 0.6$ °) and the forward part of the LAr calorimeter ($\theta \approx 3.5$ °). Its main task is to minimise the missing part of the total transverse momentum due to hadrons emitted close to the beam pipe. In addition the energy, emitted into a narrow cone

Position	$+476 \leq z \leq +545$ cm
Overall radius	$6 \leq r \leq 32$ cm
Radius of detector planes	$6 \leq r \leq 25$ cm
Polar angular range	$12.5 \leq \theta \leq 58$ mrad
Number of detectors	$8 \times 84 = 672$
Number of electronic channels	$4 \times 84 = 336$
Total length	69 cm $\equiv 4.25\lambda_{abs} \equiv 44.6X_0$
Weight	1.48 t

Table 9: Global parameters of the PLUG calorimeter

around the beam pipe can be used to separate the proton jet as well as to veto beam gas and beam wall background.

Owing to the geometrical constraints – the available space inside the return yoke of the H1 magnet was restricted to a cylindrical hole of ≈ 0.7 m length and a diameter of ≈ 0.7 m around the beam axis – only a most compact calorimeter could fit. Facing the physical requirements of good angular resolution, nearly full containment and linearity, the solution was a sampling calorimeter consisting of nine copper absorber plates interleaved with eight sensitive layers of large area silicon detectors [57]. The most important construction parameters are given in Table 9.

Figure 35 shows a schematic view of one of the two half-cylindrical parts of the PLUG calorimeter, each mounted in one half of the return yoke. The detector modules are placed within 15 mm wide slots between the absorber plates. These are sealed and easy to replace entities, which contain one half of a detector plane each. Between two 5 mm copper plates a G10 readout board, equipped with 42 silicon detectors of 400 μm thickness, is placed (Figure 35, left part). A detailed description of the detector technology can be found in [96]. Typical characteristics of single silicon detectors, as measured in the laboratory, are given in Figure 36. Due to a special edge-protection procedure 32 quadratic (5×5 cm^2), six triangular and four rectangular detectors cover one half of the detector plane in a mosaic structure nearly completely, leaving only 4% of the total area inactive. A total of 672 detectors have been installed.

The readout electronics of the PLUG are included in the analog chain of the H1 calorimeters and use the same components (see Section 3.1.6). The 672 detectors are read out in 336 pairs of channels. Trigger towers are built by merging the signals from subsequent channels in the $z-$direction.

The calibration of the ADC output in units of visible energy rests on an absolute energy measurement using α-particles. Its conversion into total absorbed energy is based on detailed MC-simulation studies of electromagnetic and hadronic shower developments in silicon instrumented calorimeters in comparison with test measurements [97, 98, 99, 100, 101].

Since March 1994 the PLUG was operated with 8 instrumented detector planes. During luminosity operation sharp increases of detector dark currents up to 15 % were observed which could be correlated with failures of HERA machine components and consequential increase in proton-related backgrounds (see references [102, 103]).

The energy resolution of the PLUG calorimeter suffers from both the amount of dead material in front of the device and the energy leakage. Nevertheless its value of about $150\%/\sqrt{E}$, evaluated from experiment supported MC-calculations [100], turns out to be sufficient for the tasks within the H1 experiment. As an illustration of the PLUG-calorimeter response to selected low-Q^2 events the distribution of the total energy is shown in Figure 37. It compares remarkably well with MC-simulations produced using the Colour Dipole Model (LEPTO 6.1 MEAR, see reference [104]).