BRAHMS Zero-Degree Calorimeters Time and Energy Calibration

K. Hagel, T. Keutgen, A. Makeev, M. Murray, J. B. Natowitz and R. Wada

One of the three BRAHMS "global" detector systems is a set of two Zero-Degree Calorimeters (ZDC) [1], which are placed at ±18 meters apart from the interaction point, and designed to measure the energy of forward going (non-interacting) neutrons. The ZDCs measure the beam-luminosity, collision centrality and interaction vertex.

During the summer of 2000 RHIC runs with gold ion beams at 65 GeV/A energy we collected enough data to perform a timing and energy calibration for BRAHMS ZDCs.

Timing-calibration for the ZDCs LRS 2228A time-to-digital converter (TDC) and slewing-corrections have been employed to improve the timing (and vertex) resolution of the Zero-Degree Calorimeters.

We used an Ortec precise time-generator to produce a "picket-fence" time distributions with 20 points in 10 – 200 ns range with a 10 ns step. The corresponding average TDC response was recorded for each point. Then a linear fit to TDC (channel) vs Time (ns) function was done for eight TDC channels. Such a calibration allows us to get "true" time from the detector, while before we were using a hardcoded value of 100 ps for the TDCs "time tick" for all the channels. This should remove possible time-scaling disagreements (if these come from the ZDC), when measuring time (or vertex position) with different detectors.

In order to reduce the correlation of discriminator time versus signal amplitude (Fig.1), slewing-correction procedure, has been done for six modules of the two Zero-Degree Calorimeters. The correction was made by fitting an analytic form to the time difference

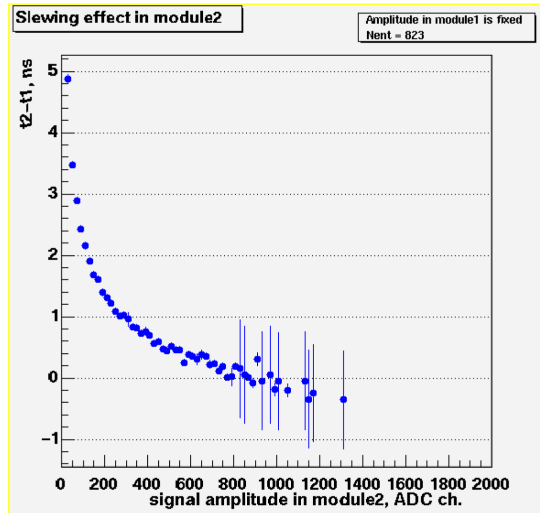

Figure 1

between two ZDC modules versus the amplitude in one of them, at fixed amplitude in another. This relationship can be well described as a 3rd order polynomial if one uses a $1/\sqrt{amplitude}$, *time* coordinates. Then slewing-functions were subtracted from the original time distributions, giving the corrected time values. The effect of slewing correction is shown on the Fig.2; the detector's timing resolution has been improved from ~ 500 ps to ~ 260 ps, implying vertex resolution of less than 8 cm.

The ZDCs energy calibration can be done using the fact that the position of the one-neutron peak should be at 65 GeV. The position of the two-neutron peak should correspondingly be at 130 GeV. Data from most recent BRAHMS runs with both beams well-tuned was used for this purpose. In order to get as much statistics as possible the only constraint applied to selected events was the requirement for the

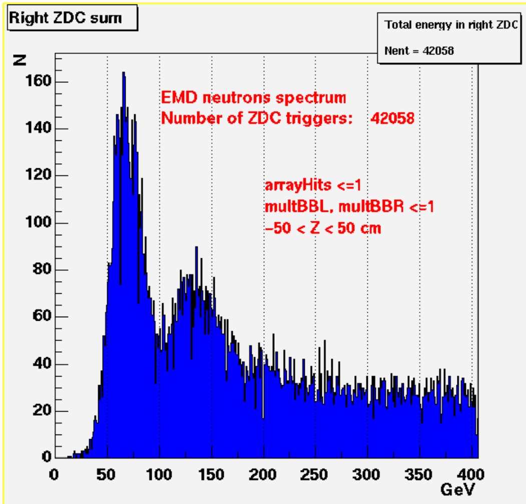

Figure 3

ZDCs measured z-position to be in the range ±60 cm, which ensures separation of one-neutron distribution from background events. Assuming the detector's response linearity in this energy range the linear extrapolation has been done for both ZDCs.

Fig.3 shows a typical neutron spectrum in the ZDC for Electro-Magnetic events. The requirement of no-multiplicity in the Tiles-Array and both Beam-Beam Counters is imposed.

Corresponding updates to the BRAHMS online/offline software have been done, to make calibrated data (GeV, ns, cm) from the ZDC available to everyone, using the standard BRAHMS Analysis Toolkit (BRAT).

Our current efforts are concentrated now on (1) getting high statistics as possible from the existing BRAHMS runs for deeper analysis of EMD and (2) working on the ZDCs database module.

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