Uniformity Measurements on New Back MB/SB

The Uniformity measurements have been done with the new back Motherboard (eta=0.0-0.2) at BNL. The measurements were made with a NEW Back Mother Board and a NEW back Summing Board (which included the design changes to minimize cross-talk effects).

Setup:

The uniformity measurement used a HP pulser to inject a pulse of 1V using a 1K injection resistor. The output was shaped with a CR-RC2 shaper (30nsec, corresponding tpo a time constant tau=15nsec) and measurements made on a LeCroy scope after averaging over 1000 waveforms and using the "high resolution" averaging feature of the scope.
For each measurement, we ensured that the input signal had not fluctuated by also measuring it directly.

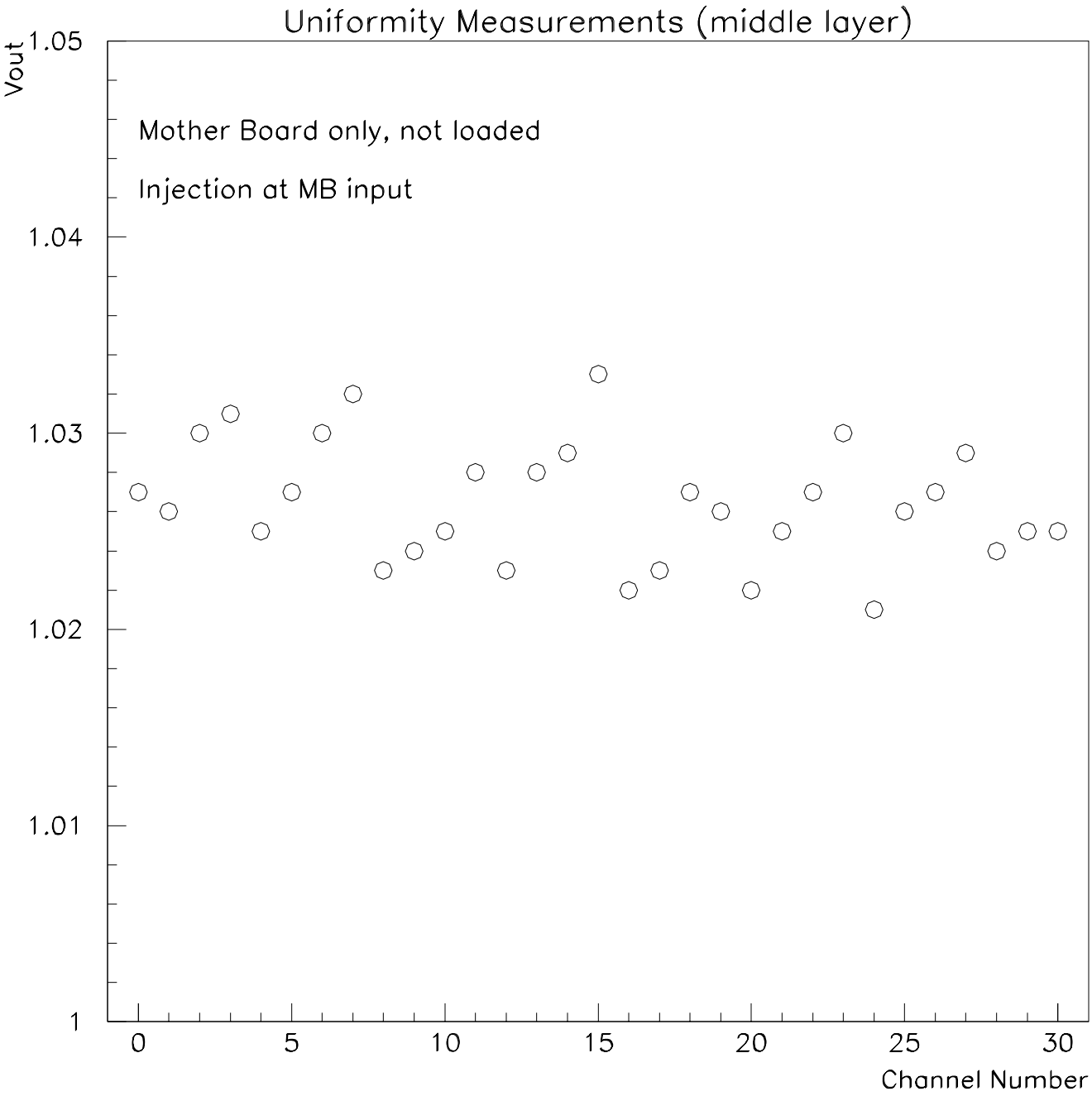

Figure 1: The measurement was made on the top half of the board for channels corresponding to the "middle" section. This is a total of 32 channels. For each measurement, the injection was made at the input of the MB with NO LOAD (to avoid non-uniformity effects due to capacitance tolerance). The measured output for each of the 32 channels is shown.
Figure 1 (which is a function of the channel number) is effectively a plot against eta. There are 32 channel which covers a full MB (delta_eta=0.2). The 32 channels is 8 eta bins x 4 phi bins. There are 4 phi points for every eta point. You can make out the groups of 4 points in this figure. The first four points is the spread in phi for the first eta bin, the second four points is the spread in phi for the second eta bin and so on. There is a larger variation within each group of 4 phi points (of the order of +- 0.4%] than between successive eta-bins).
There is NO 1.5% non-uniformity effect seen in this plot as a function of eta.

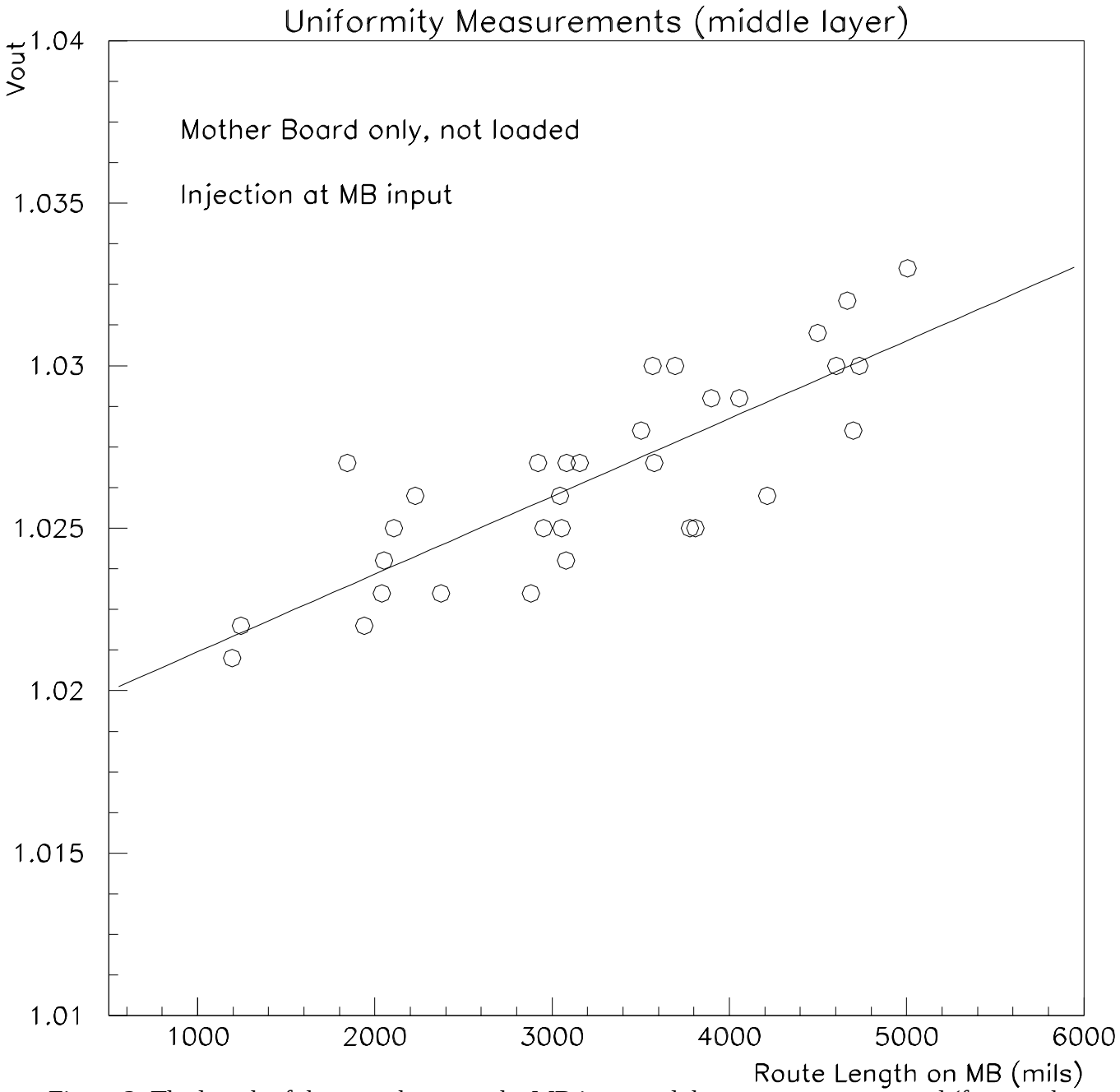

Figure 2: The length of the route between the MB input and the output was measured (from gerber data). The measured response is plotted as a function of the length of the trace. A clear correlation is seen. Note that the trace lengths are equalized only in the section between the calibration input and the input of the MB. The trace lengths between the MB input and MB output are not equalized since they are calibrated away. There is a significant contribution to the uniformity variation from the different route lengths --> which is calibrated away.

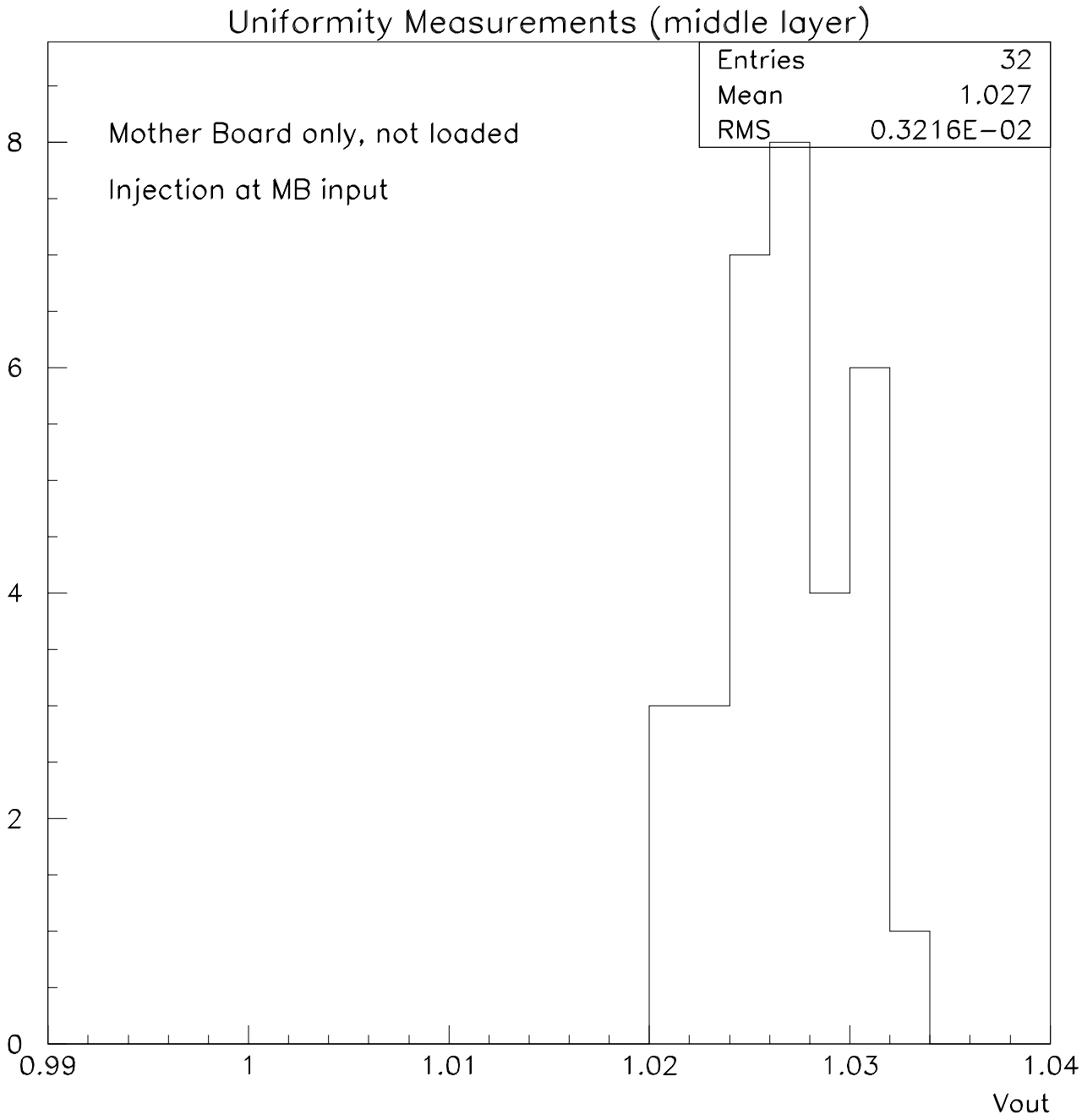

Figure 3: The measurements in Figure 1 is plotted as a 1-dim histogram. A sigma of the fluctuation is 0.32%. The min-to-max variation is approximately +/- 0.7% (overestimated due to the histogram binning effect).

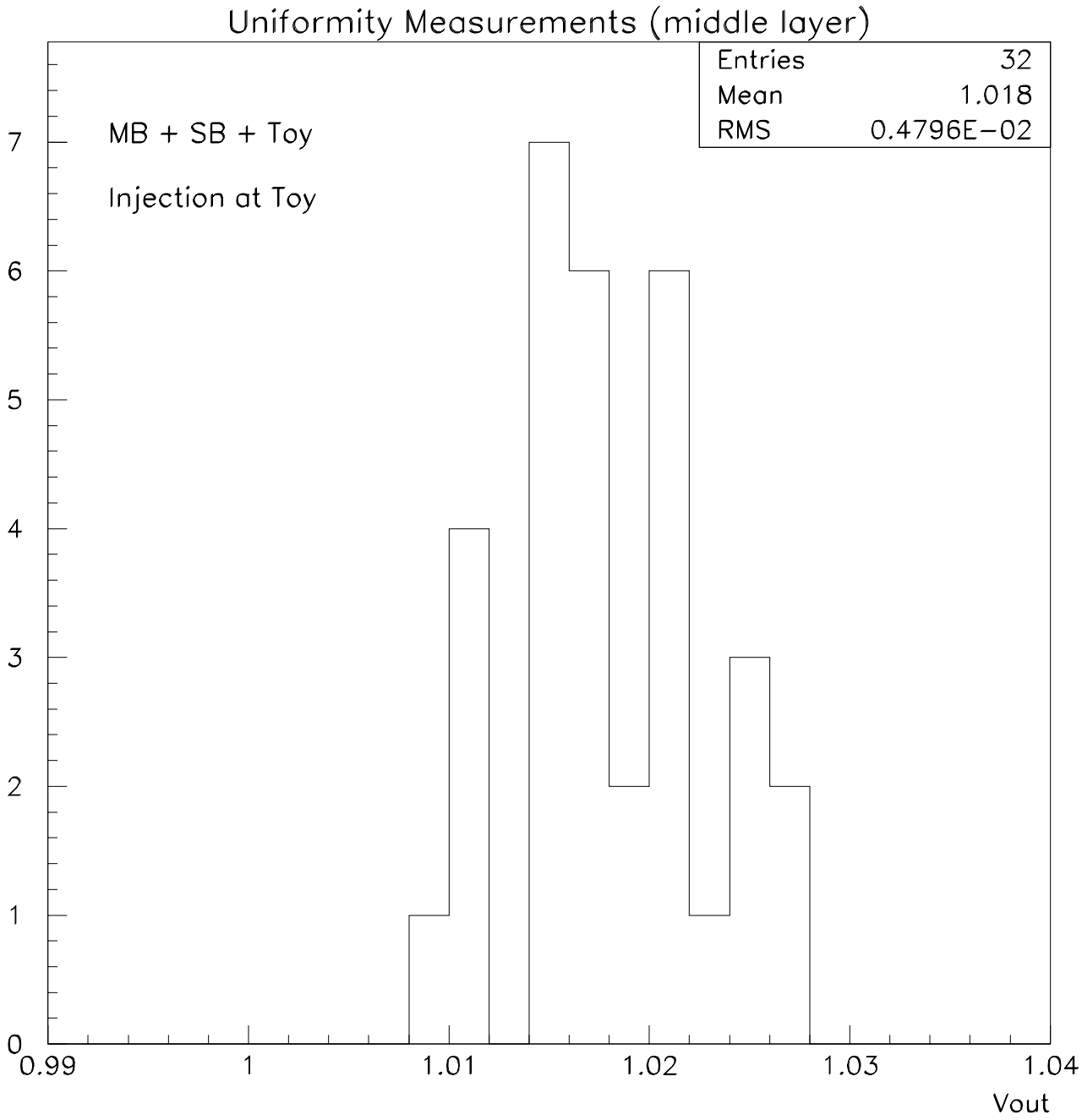

Figure 4: The MB is connected to a Summing Board and a toy calorimeter.
Each input point of the toy (hence the SB) is loaded with a 270 pF capacitor (Note that 4 capacitors are in parallel for the back, for a total of 1.080 nF).
The capacitor tolerance is 5%. The pulse injection is made on the farthest point of the toy calorimeter for all the 32 channels in the middle layer. The resulting distribution is shown in this figure. The sigma of the variation has gone up to 0.48% and the min to max variation is about +/- 1%.

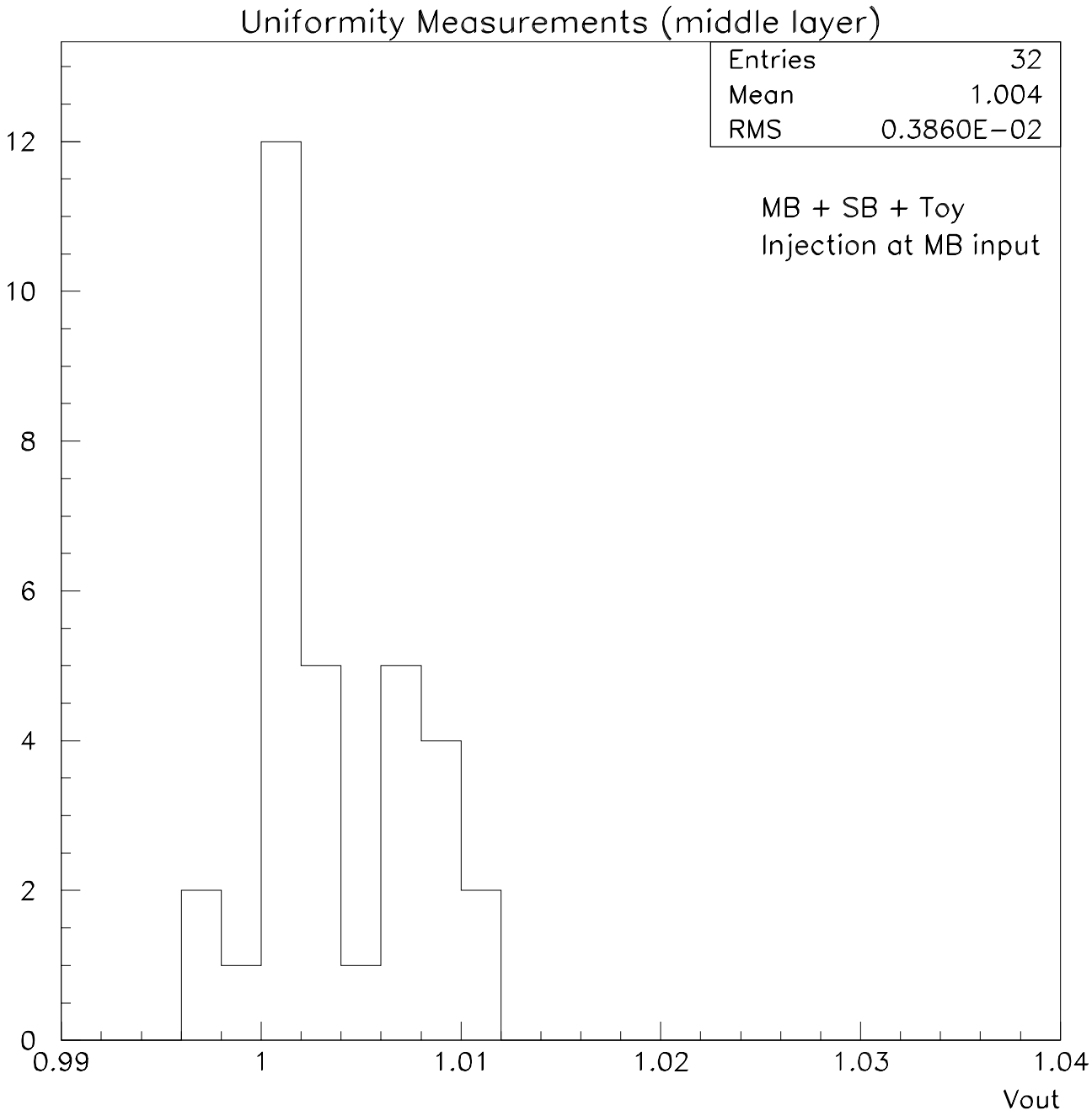

Figure 5: We repeat the measurement in Figure 4 - but this time injecting at the MotherBoard input - hence simulating a real calibration condition. The same SB and toy calorimeter are connected. The resulting distribution is seen in this figure. Sigma is 0.39% and a min to max variation is +/- 0.8%

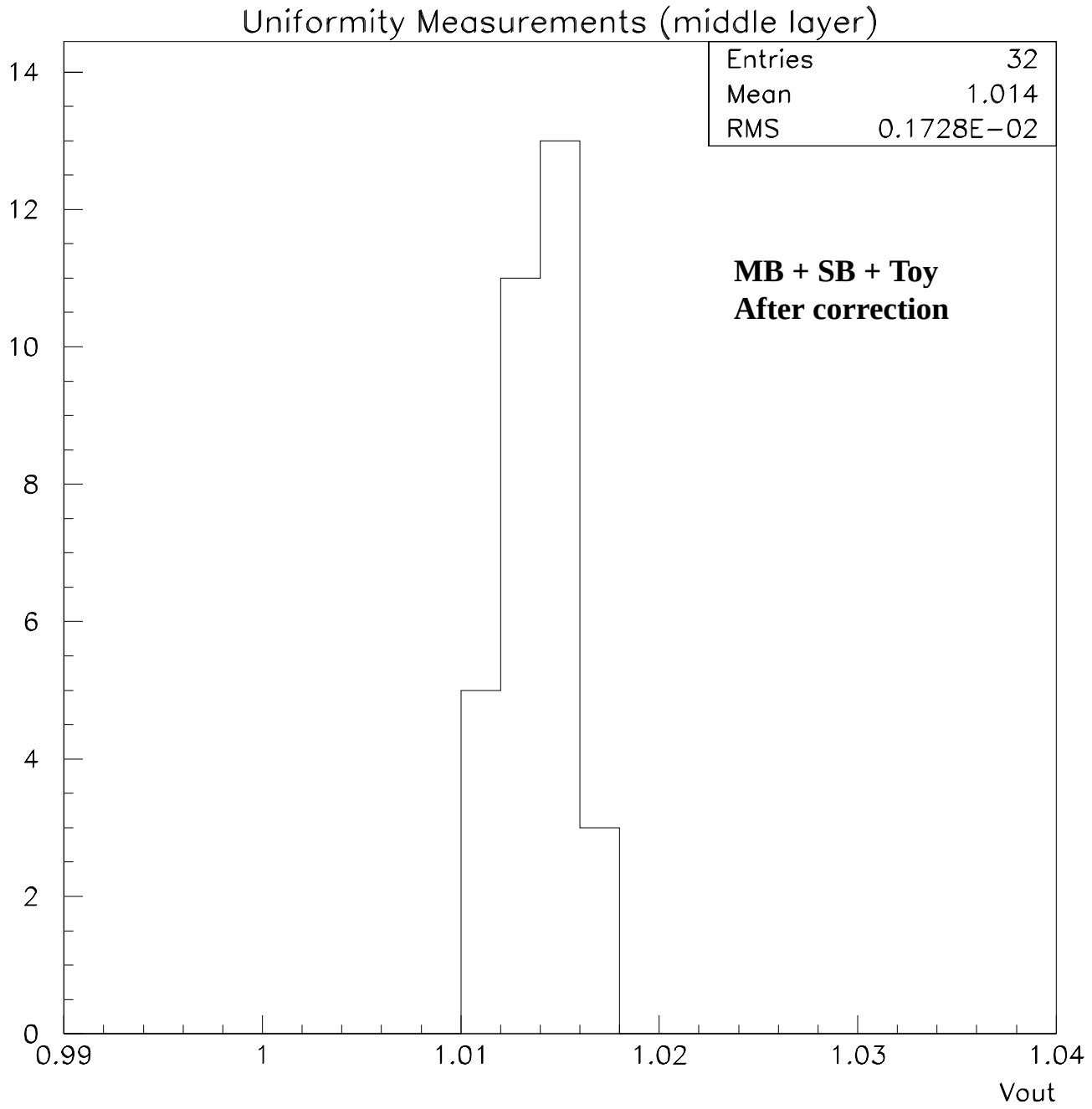

Figure 6: We normalize the results in Figure 4 using the results in Figure 5 (thus effectively plotting the results after calibration, albeit in a highly streamlined system where reflections and mismatches were mostly absent). The sigma of this distribution is 0.17% and an min-to-max variation of +/- 0.4% is observed.