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Some results of the amplifier performance modeling in the full range of input signal amplitudes

Abstract: the FEB amplifier performance is simulated for the input signals of up to 5 TeV. With the input cables connected, the pulser data is predicted to reproduce the amplifier response to real calorimeter signals up to 1 TeV. With a simple hardware modification of the pulser, one can reduce the non-linearity effects observed when the input cables are disconnected.

In connection with the input cables on/off problem [Ref.1], John Rutherfoord suggested to extend the model study to investigate

- a calibration with DAC ≥10000 for cables ***on*** | ***off***;
- a possibility of using the measurements done with cables ***off*** to evaluate the input impedance of the amplifiers.

It is also interesting to see what the model predicts for a non-linearity in the entire range of the input physical signals.

The schematics for the model are given in [Ref.1], Figures 16 and 17.

Physics signal
Fig. 1 (blue line) shows the result for the case of physics signals in the range 10 GeV – 5 TeV. An integral non-linearity of up to 2% is predicted by the model. Note that in real life there will be no signals of the order of 1 TeV in a single cell, because of the shower lateral spread. Hence, a typical response non-linearity will be smaller than 2%.

Calibration pulser signal, input cables *on*
Fig. 1 (red line) shows the model prediction for pulser calibration with the input cables connected. In a wide range of input amplitudes (up to 1 TeV), the observed non-linearity is the same, within a fraction of a percent, for pulser and physics inputs. Therefore, using the pulser data as a correction, one can reduce the response non-linearity in case of physics signals.

Calibration pulser signal, input cables *off*
As Fig. 2 shows, the non-linearity further keeps increasing for higher DAC. Model parameters *Cpar* and *track length* are explained in [Ref.1].

A possibility of using measurements with input cables *off* for estimation of the input impedance of the amplifiers. Two options can be considered:

- the integral non-linearity for DAC<1000 does not exceed 2%. This is predicted by the model and confirmed by data (Fig. 3). Therefore, one **can** use the measurements with DAC<1000 for the impedance estimates;
- as an alternative, one can change the pulser signal shape. The modification is very simple: a capacitor of ~300 pF has to be added in parallel to the 1.8 μH inductance (Fig. 4). The problem with cables ***off*** largely disappears (Fig. 5).

References

1. V. Epshteyn, P. Gorbunov, "A study of non-linear effects in FCAL pulser calibration data", ATLAS-FCAL beam tests 2003 Internal Note 5, 2003-12-21, http://atlas-fcaltb.web.cern.ch/atlas-fcaltb/Memos/ (Analysis section).

Figures

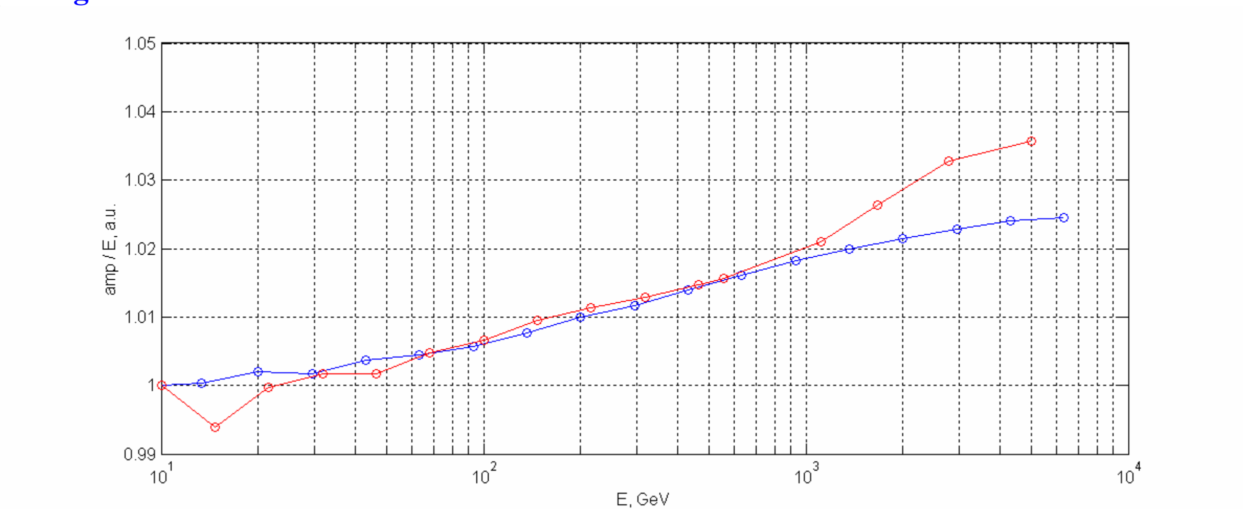

Figure 1: Signal amplitude after the shaper, as function of the energy deposited in one FCAL-1 cel.l The electromagnetic calorimeter - 1GeV ∝ 1.5μA, 100GeV ∝ DAC=1000. Signals:
___physical - triangle, Δt=50ns,I=15μA÷8mA,
___calibration - input cables ***on****, DAC=100÷60000.*

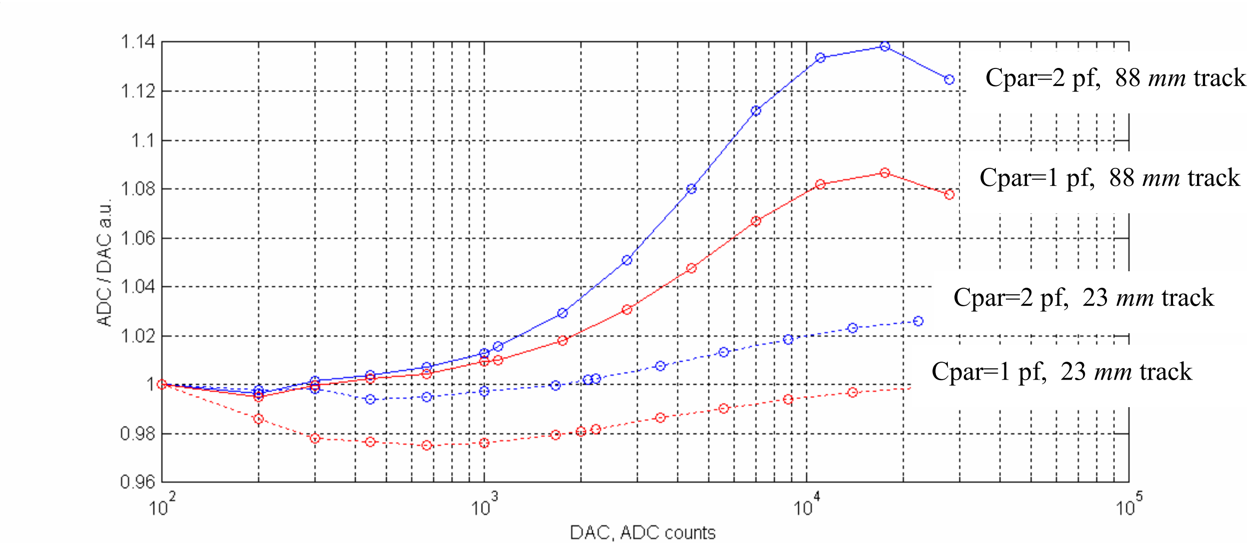

Figure 2: Signal amplitude after the shaper, as function of the pulser DAC, with input cables ***off*** *and different parasitic capacitance (Cpar) and FEB PCB track length.*

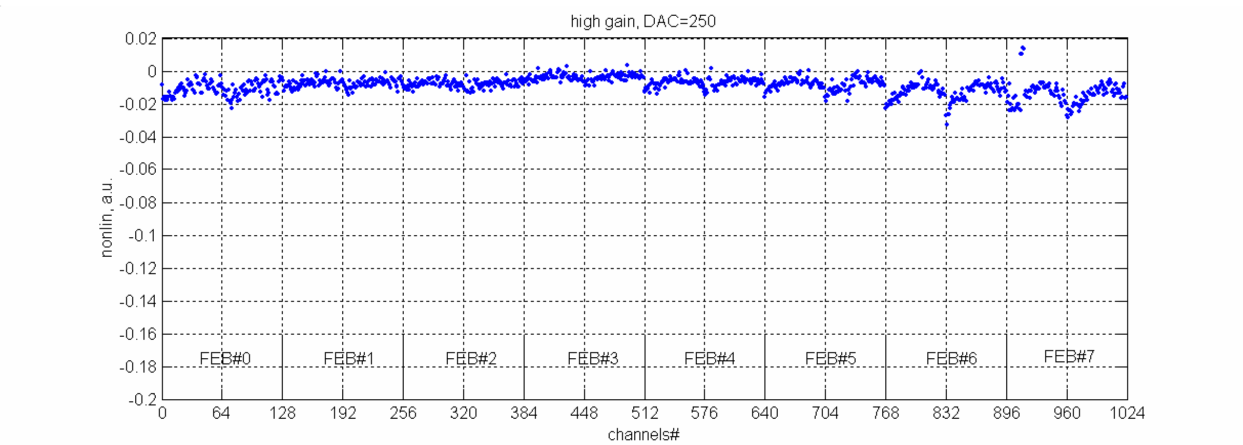

Figure 3: The non-linearity in the calorimeter channels for DAC=250, with high gain, input cables off. DAC_max=1000.

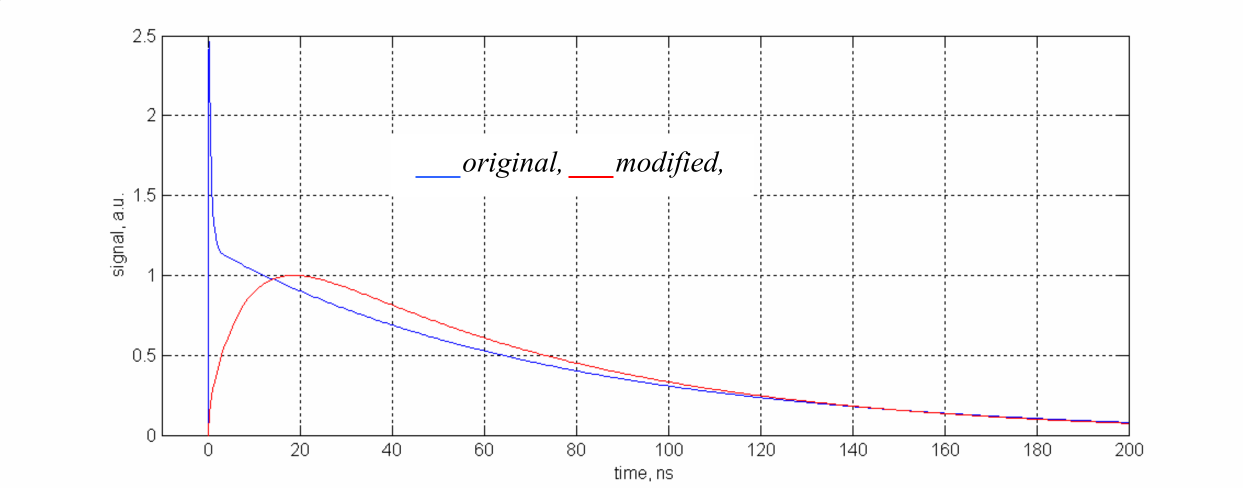

Figure 4: The pulser signal shape, with and without modification (see text), for Cpar=2 pF. The waveform is observed at the point where the pulser and the physical signals meet: before the T2 delay ([Ref.1], Fig. 16). To exclude the influence of the pre-amplifier, T2 is set to 200 ns.

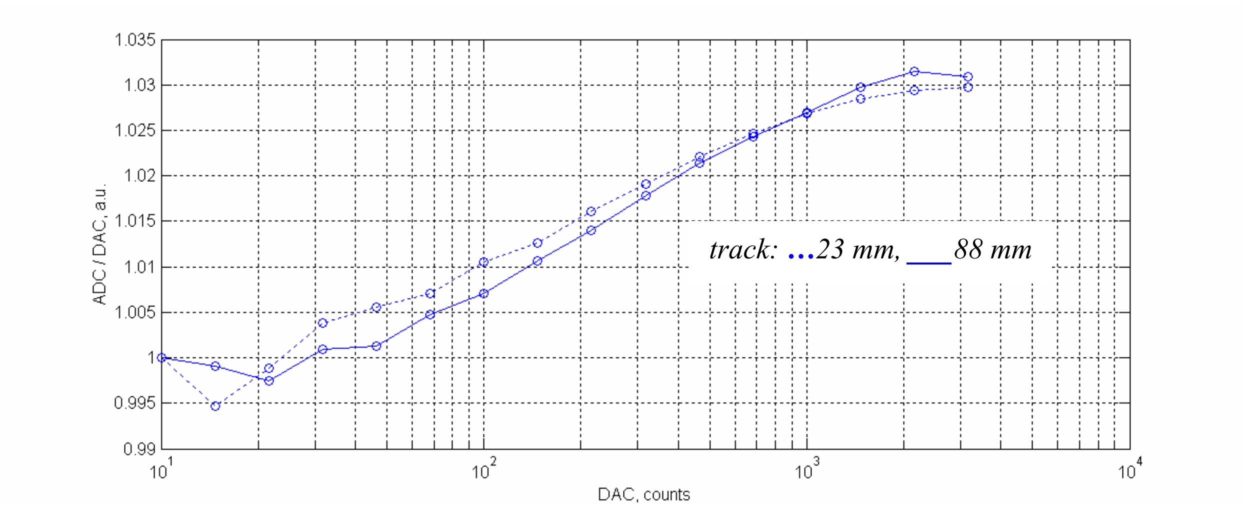

Figure 5: Signal amplitude after shaper, with cables ***off*** *and a modified calibration pulse shape. Cpar= 2pF, track: ...23mm, ___88mm.*