Calibration Online Method

- Introduction
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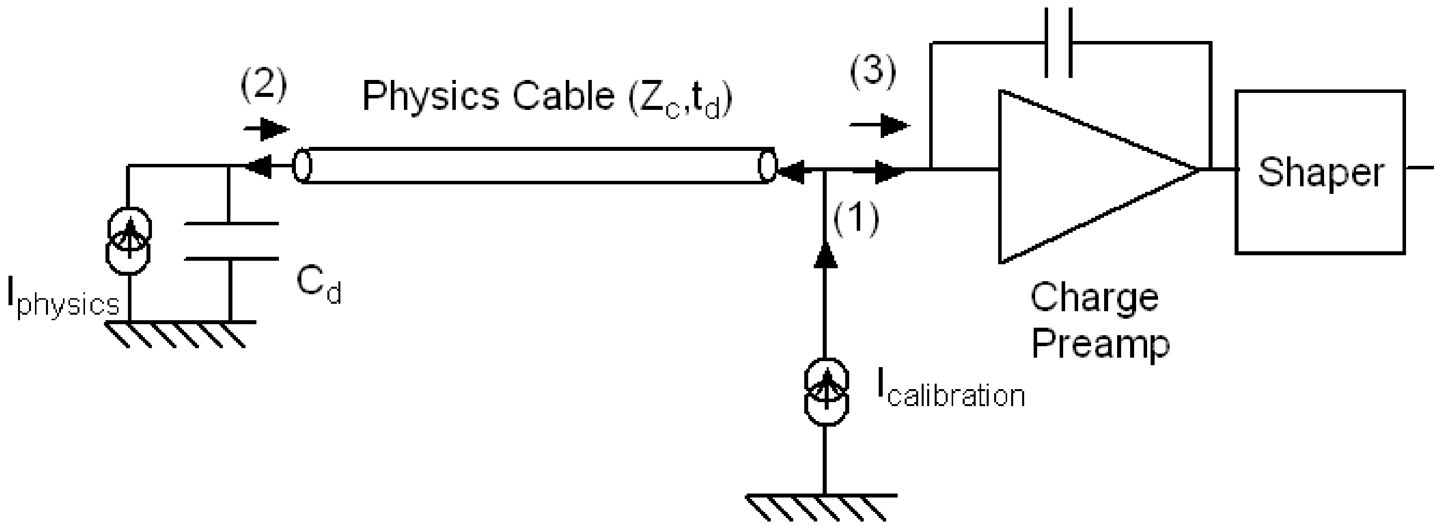
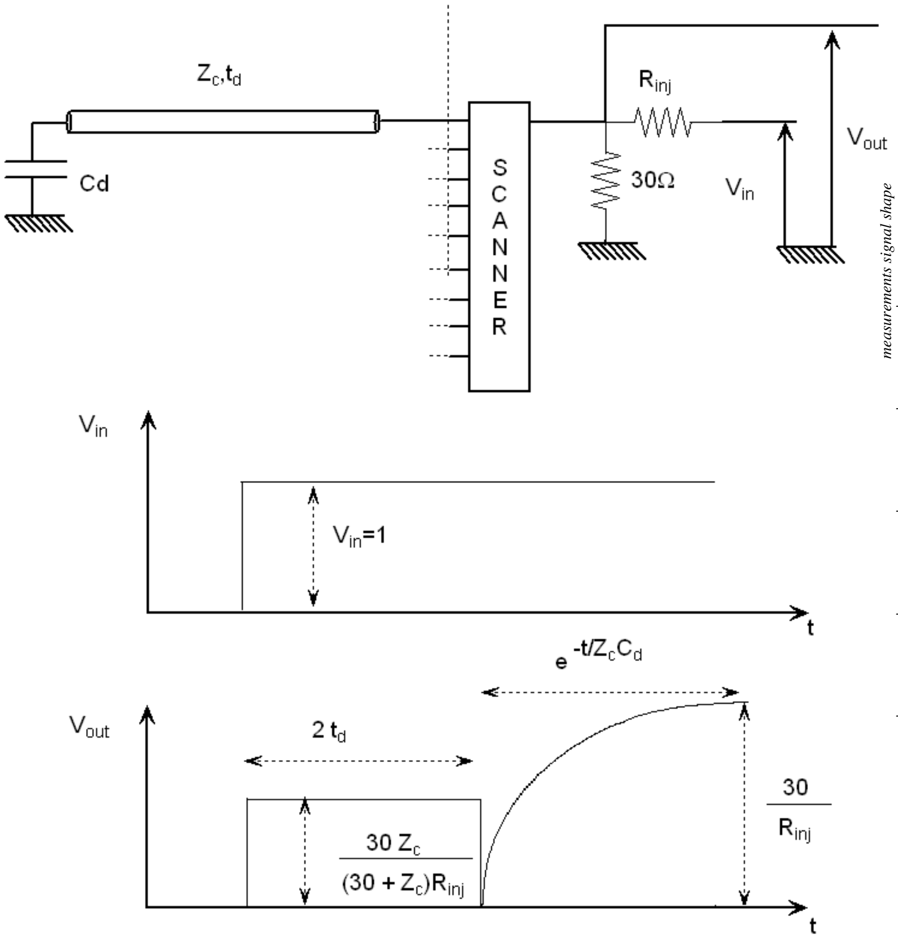
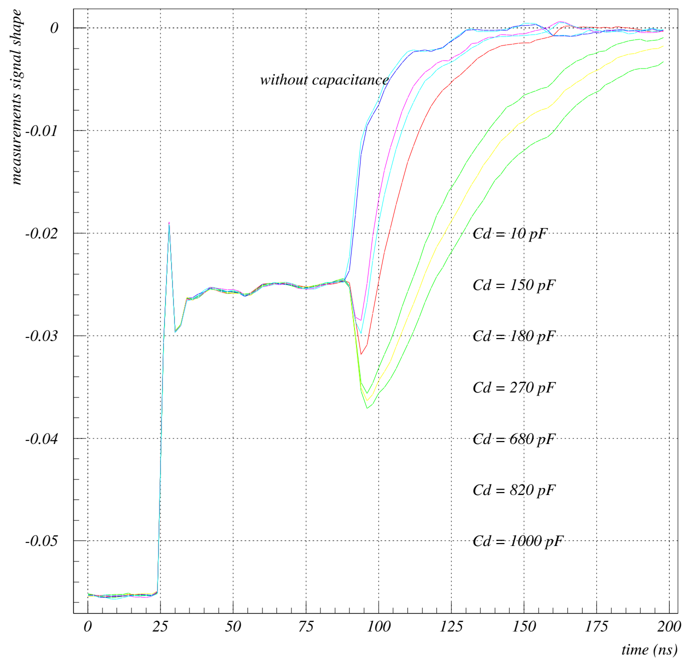
Introduction



- Issues :
  - Physics Signal and Calibration Signal do not use the same path $\Longrightarrow$ not the same sensitivity to the preamp. impedance (Z_{in}) variations.
  - Calibration of the electronics after the preamplifier.
  - Model Parameters (time-independent $\neq Z_{in}$) not well known (Z_c, t_d, C_d).

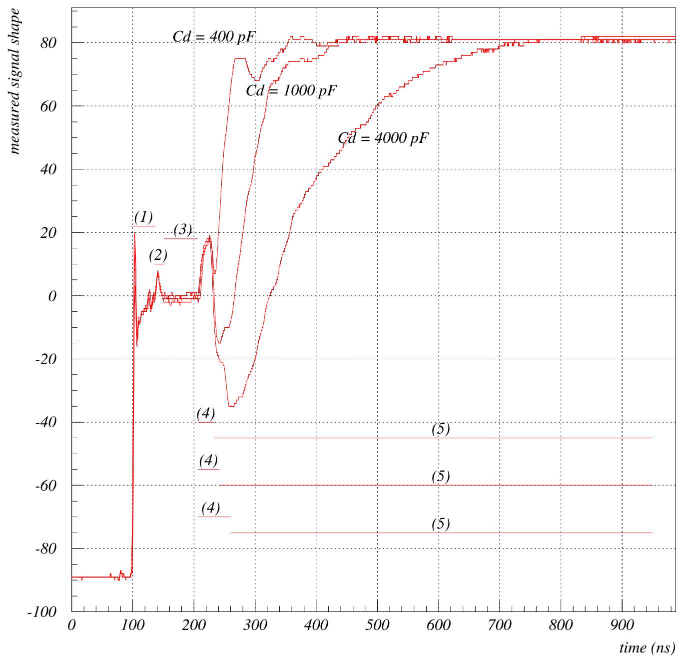
Reflectometry Principle





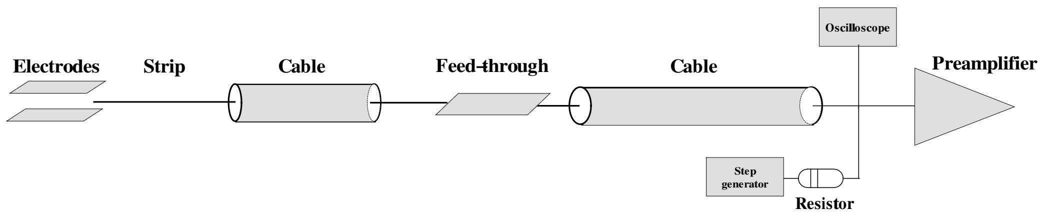
- In principle, all the time independent parameters can be extracted from those measurements because Z_{in} is fixed at 30Ω by the reflectometry card which replaces a preamplifier card.
- On the left, expected signal for a lossless cable, on the right, signals obtained on test stand.

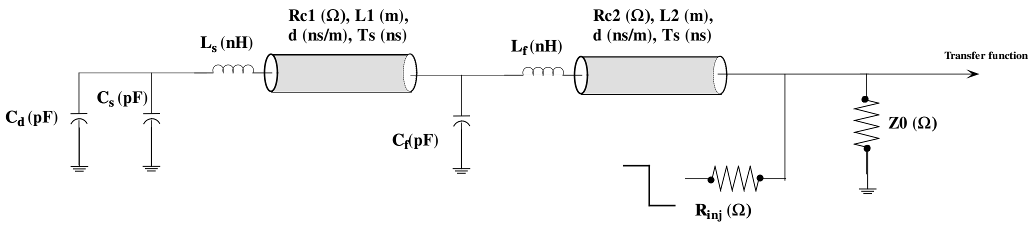
D0 Measurements and Consequences



$\Downarrow$

Front-end model

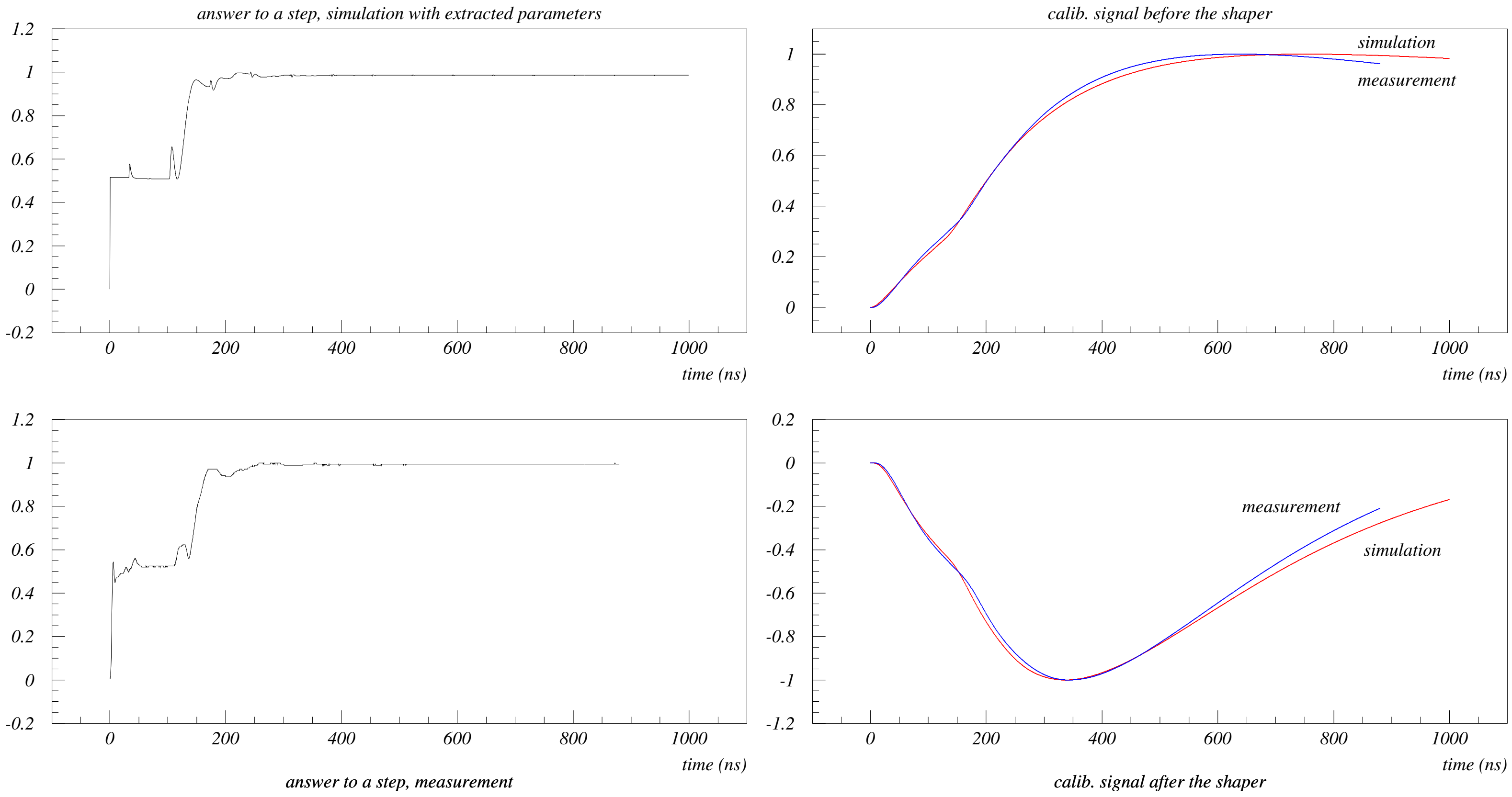




Parameters Extraction

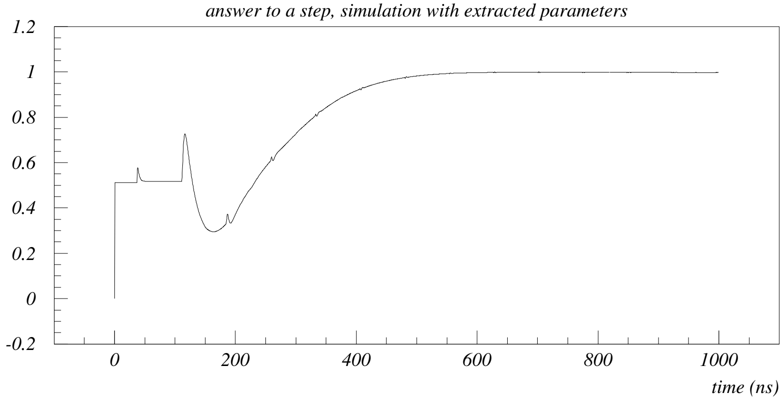
- First cable: exponential fit for the impedance, length known using channels not connected.
- Feedthrough: constant inductance
- Second cable: linear fit for the impedance, length known using channels not connected for one side and start of the strip for the other side.
- Strip inductance: from a fit with the theoretical model using only the part of the measurement driven by the strip inductance and using the previously extracted parameters as an input to the simulation.
- Capacitance: from a fit with the theoretical model using only the last part of the measurement and using the previously extracted parameters as an input to the simulation.
- Skin effect: arbitrary fixed and unique time constant.
- Simulation: performed by using all the extracted parameters + convolution + filtering + transfer functions (preamp., switch, ...) + measured shaper.

Simulation - Measurement Comparison

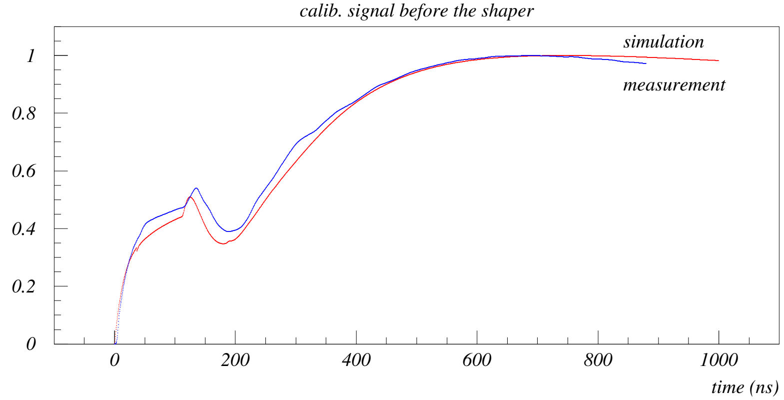


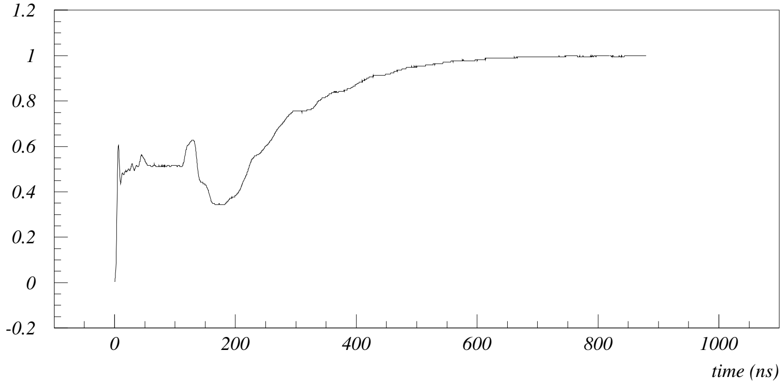
Simulation - Measurement Comparison

answer to a step, simulation with extracted parameters

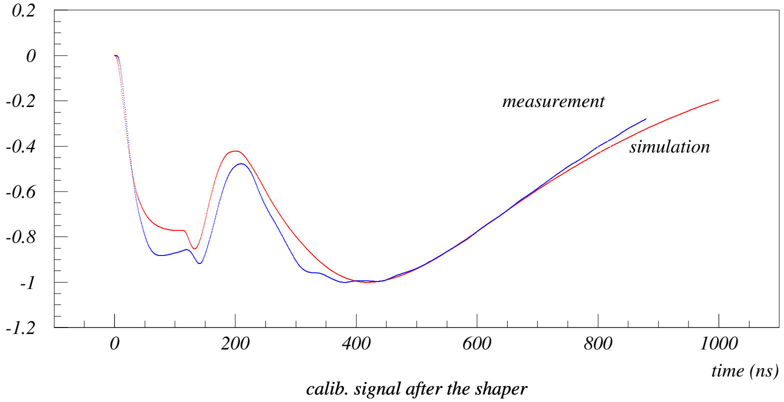


calib. signal before the shaper



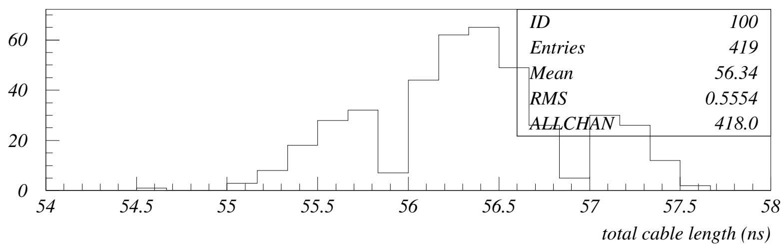


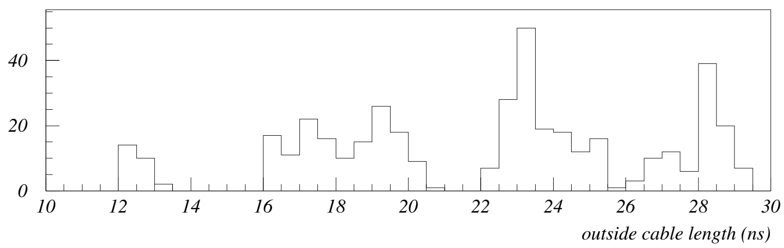
answer to a step, measurement

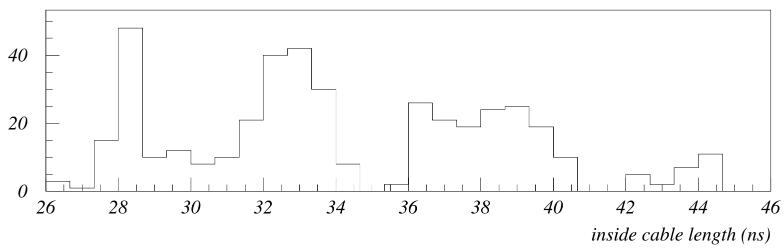


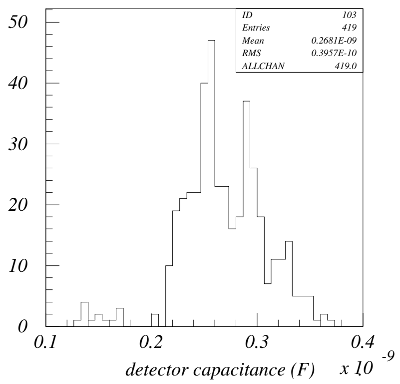
calib. signal after the shaper

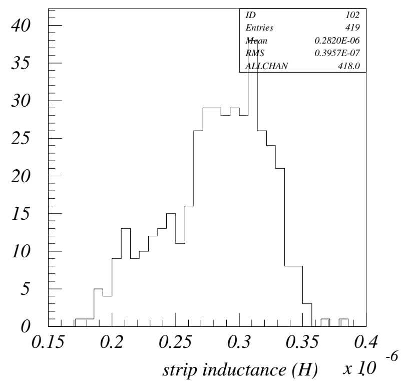
Calibration Method: type E preamp.

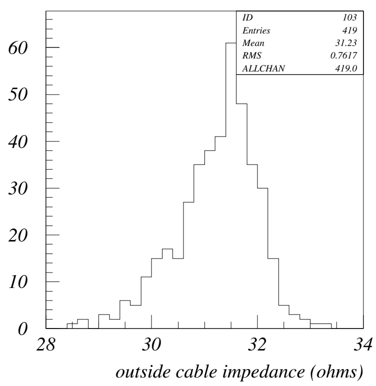


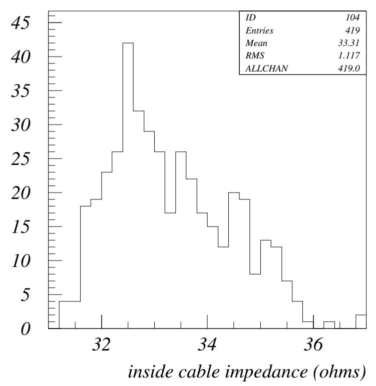




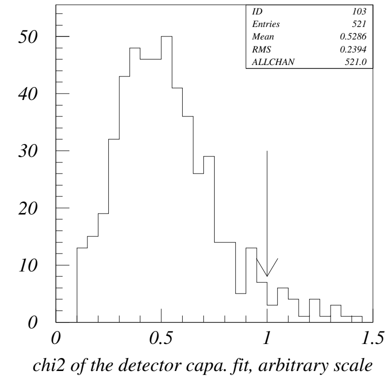


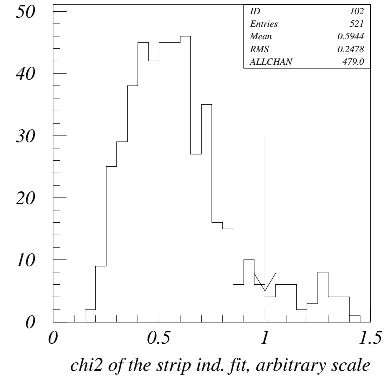


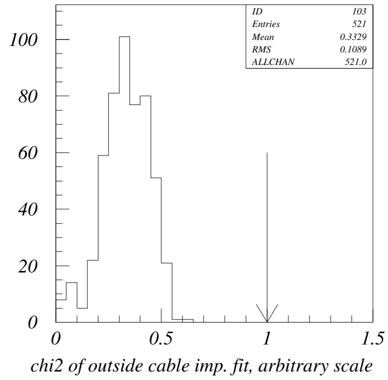


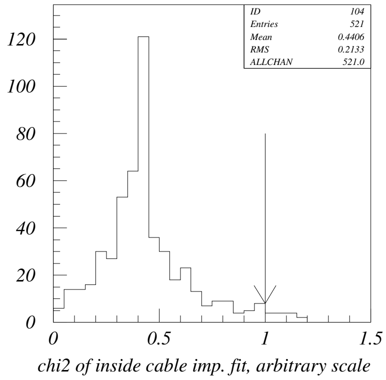


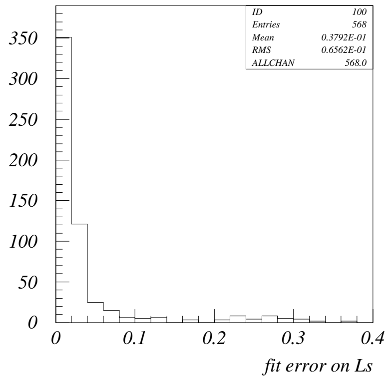
Calibration Method: type E preamp.

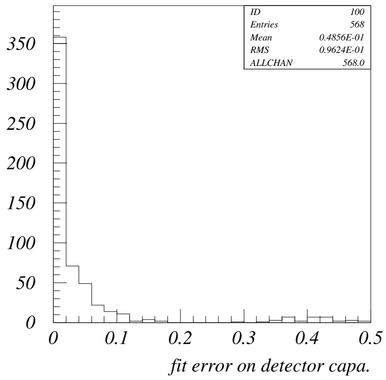


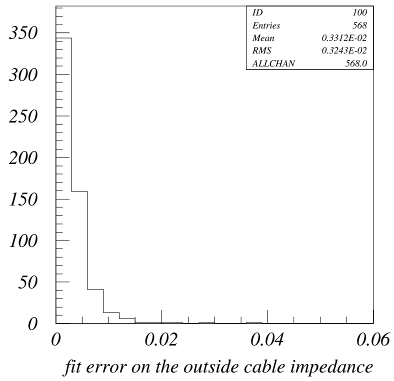


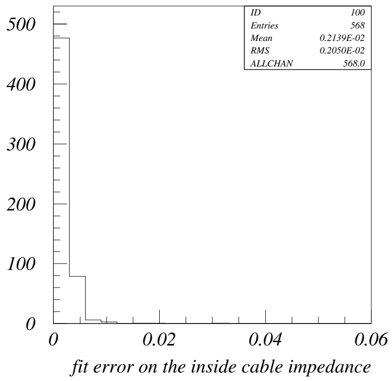




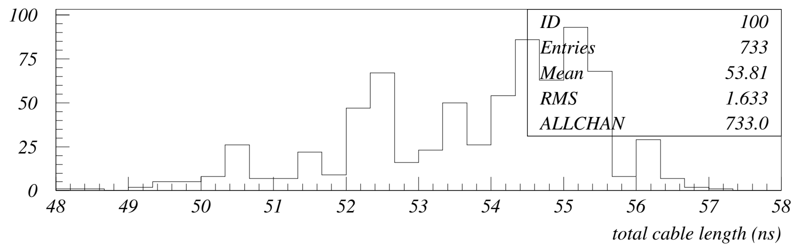


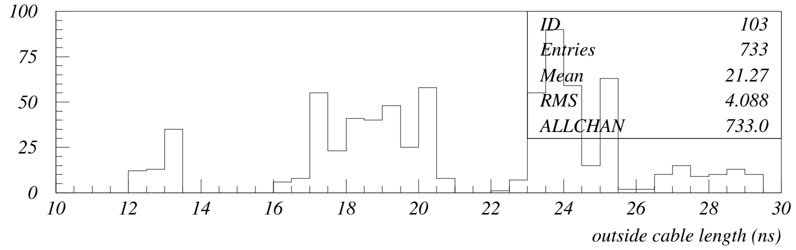


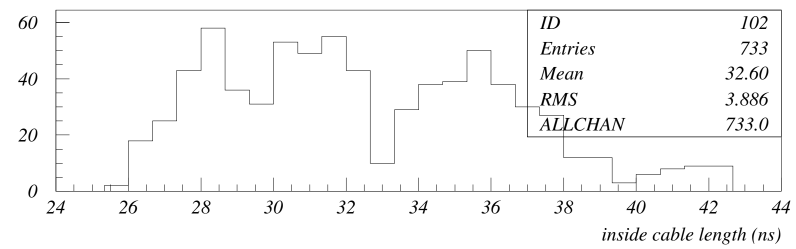


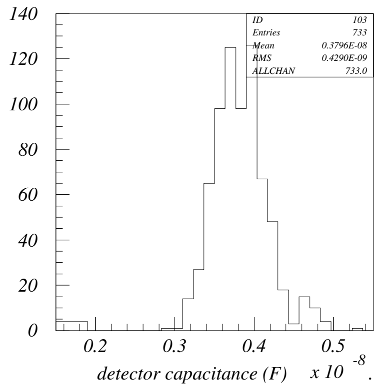


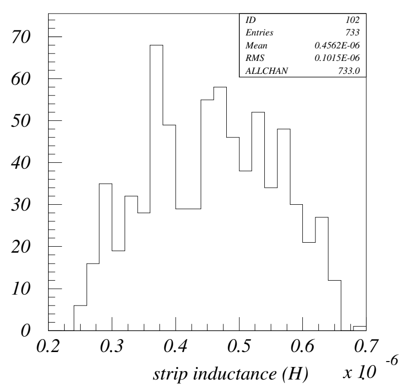
Calibration Method: type D preamp.

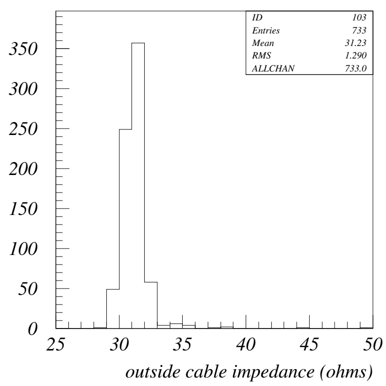


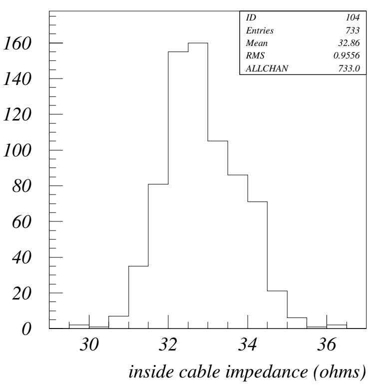










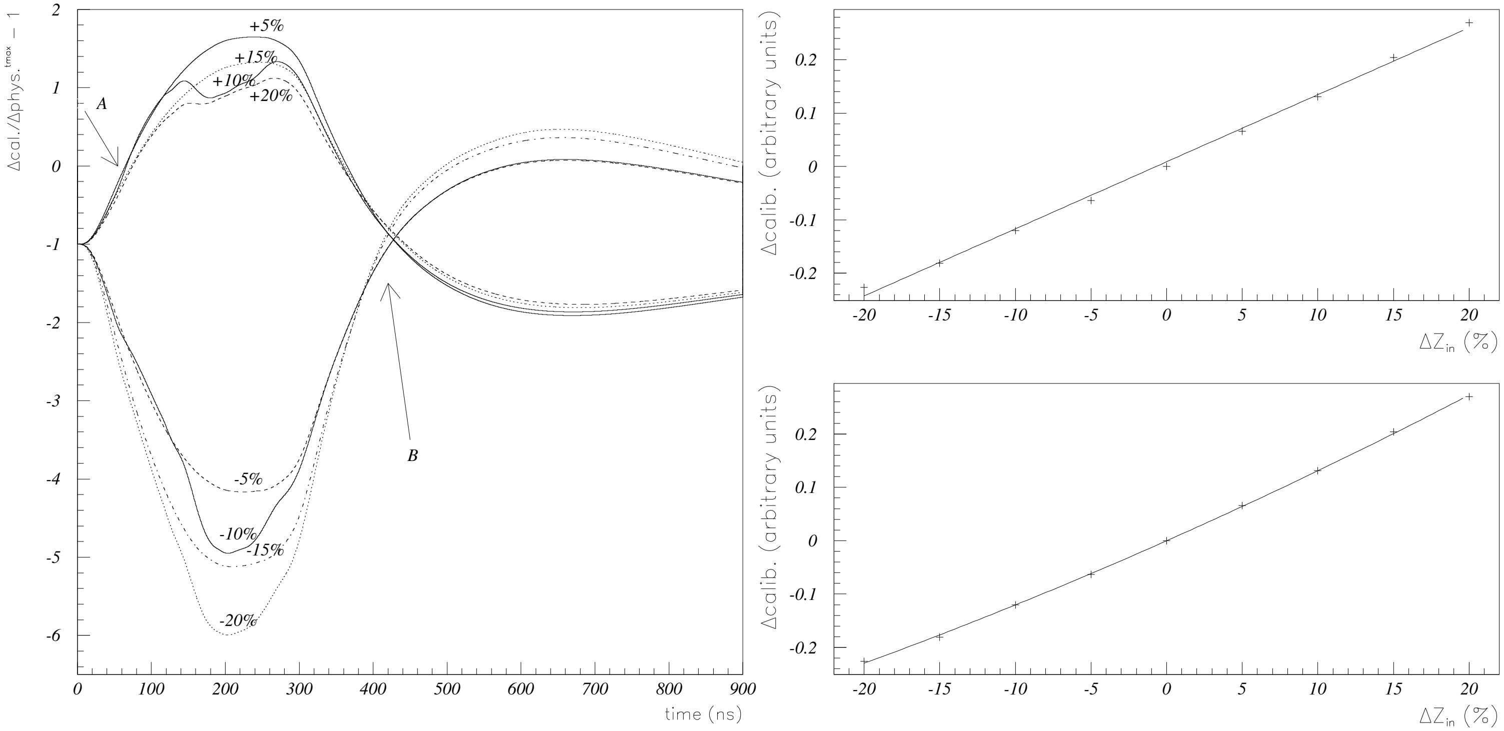


$\pm$ 1 σ on :	$\delta(\Delta_{cal}^{t=t_{max}})$	$\delta(\Delta_{phys}^{t=t_{max}})$
$L_1 + L_2$	0.08%	0.014%
R_{c1} or R_{c2}	0.18%	0.12%
L_s	0.004%	0.024%
C_d	0.1%	0.04%

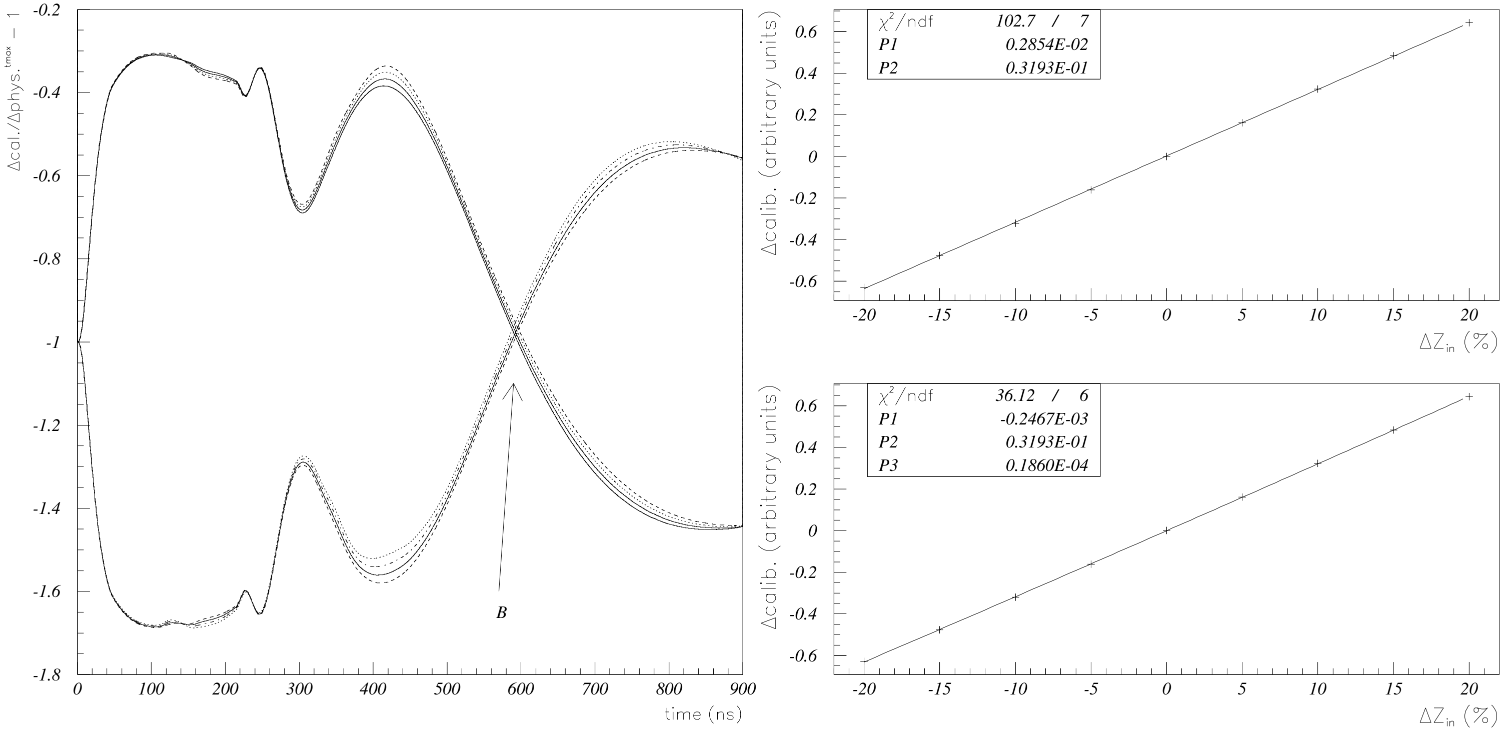
$\pm$ 1 σ on :	$\delta(\Delta_{cal}^{t=t_{max}})$	$\delta(\Delta_{phys}^{t=t_{max}})$
$L_1 + L_2$	0.4%	0.02%
R_{c1} or R_{c2}	0.1%	0.4%
L_s	0.1%	0.9%
C_d	2.5%	2.1%

- Errors on physics and on calibration at $\pm$ 1 σ from the mean value for each parameter.
- In the end calorimeters, 2 groups for each preamp. type is required because of a large dispersion on time.
- Cells for type D preamp. have a large dispersion on their capacitance values.

$\frac{\Delta cal^{\forall t}}{\Delta phys^{t=t_{max}}} - 1$ and ΔZ_{in} versus Δcal, type E preamp.



$\frac{\Delta cal^{\forall t}}{\Delta phys^{t=t_{max}}} - 1$ and ΔZ_{in} versus Δcal, type D preamp.



- For each preamp. type, a fixed point (Z_{in} independent) can allow to calibrate the electronics downstream of the preamplifiers.
- Another point (t_{max} for example) is needed to deduce calibration variation, then Z_{in} variation (from the fit) and then physics variation from simulation.
- A time ramp is needed once to have the initial Z_{in} value (fit with the simulation).

preamp. type	$\delta(\Delta_{phys}^{t=t_{max}})$ ch. by ch.	$\delta(\Delta_{phys}^{t=t_{max}})$ mean value
E (central em.)	0.2%	0.4%
D (central had.)	0.2%	3.5%
F (endcap em.	0.1%	1.3%
C (endcap had.)	0.4%	3.5%

Errors on the calibration presented here are only for Z_{in} variation. The simulation does not help to conclude about the rest of the electronics (after preamp.) calibration.

A DATABASE is needed for the extracted parameters to use the simulation and the calibration method shown here.

In the hadronic region, calibrating individual channels gives a much better results than an average calibration. As a compromise, one could group channels in η bins.

L_s and C_d are the parameters which contribute the most to the degradation. They are correlated because of the fit procedure and are correlated to η. Using η bins reduces the spread of L_s and C_d values and one expects to reduce the calibration uncertainties.