



# Beetle: Noise Measurements at



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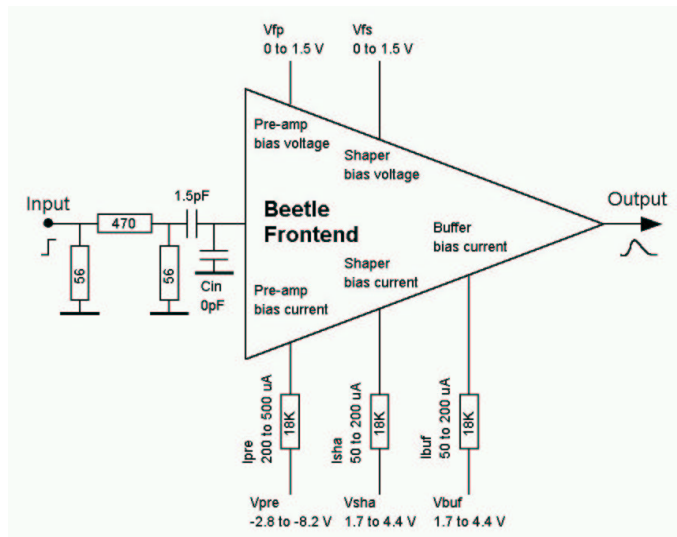
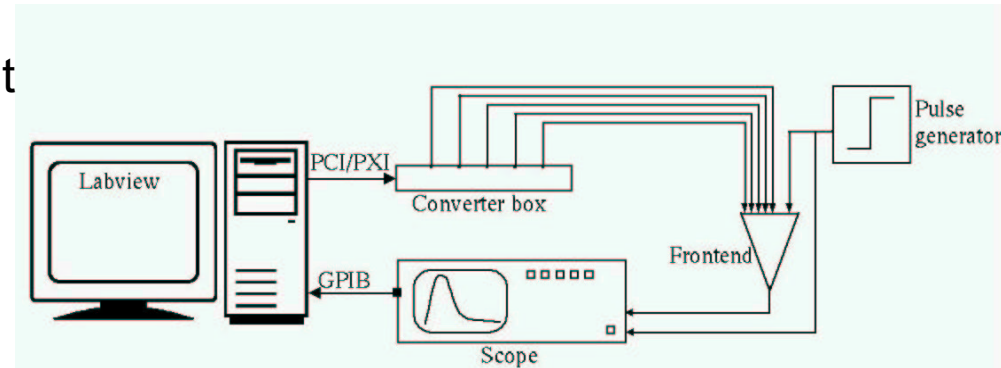
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# The Setup

- PC for GPIB readout and bias adjustment
- NI 7671 DAC board for bias
- HP 16500C Logic Analyzer for readout
- Pulse generator @ 17mV (160 000e)



$C_{in}$ [pF]					
0.0	4.9	7.2	15.7	22.5	27.9

$V_{fp}$	$V_{fs}$	$I_{pre}$	$I_{sha}$	$I_{buf}$
1.0V	0.5V	350 $\mu$ A	80 $\mu$ A	100 $\mu$ A



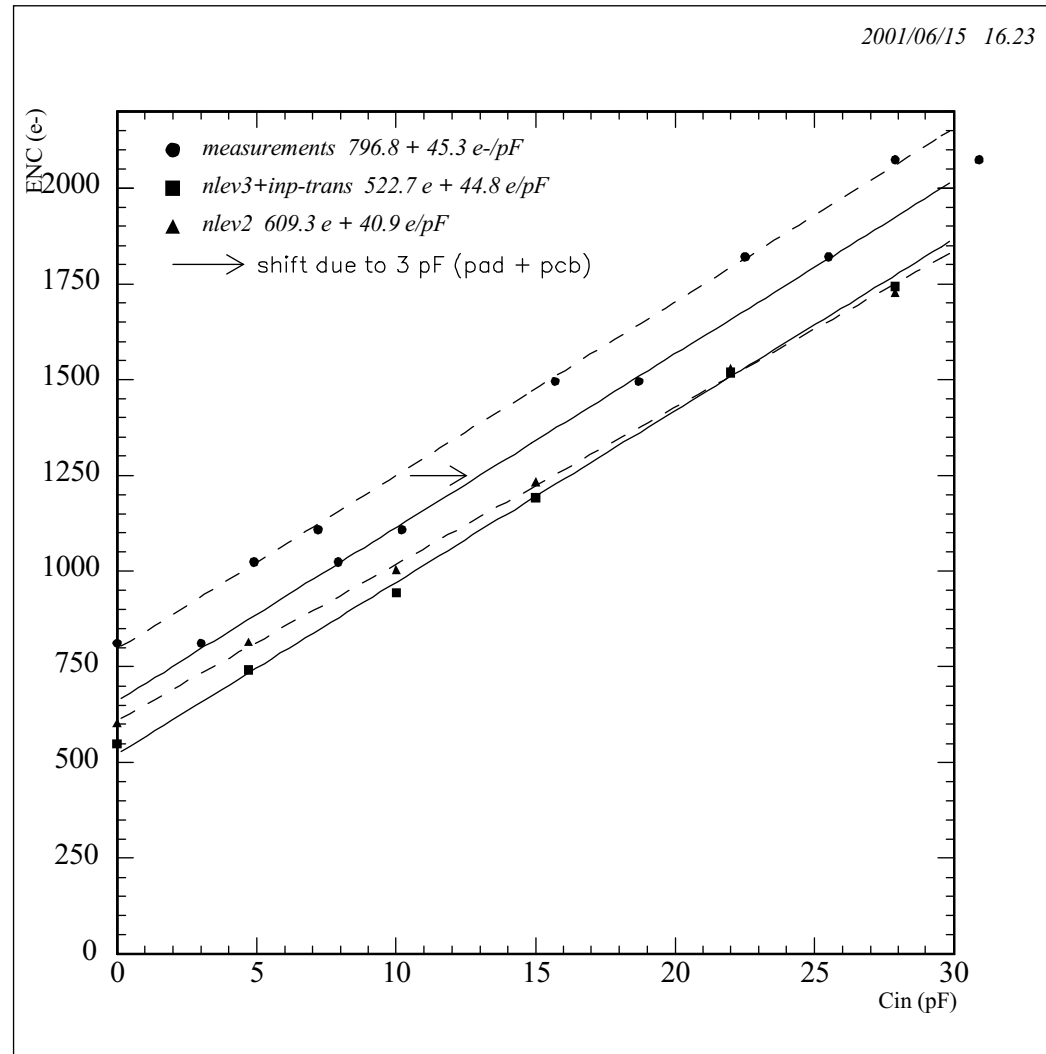


# Results

Gain: 1.77 mV/11000e (@50Ω)

$C_{in}$ [pF]	ENC [e]
0	812
4.9	1023
7.2	1107
15.7	1495
22.5	1820
27.9	2073

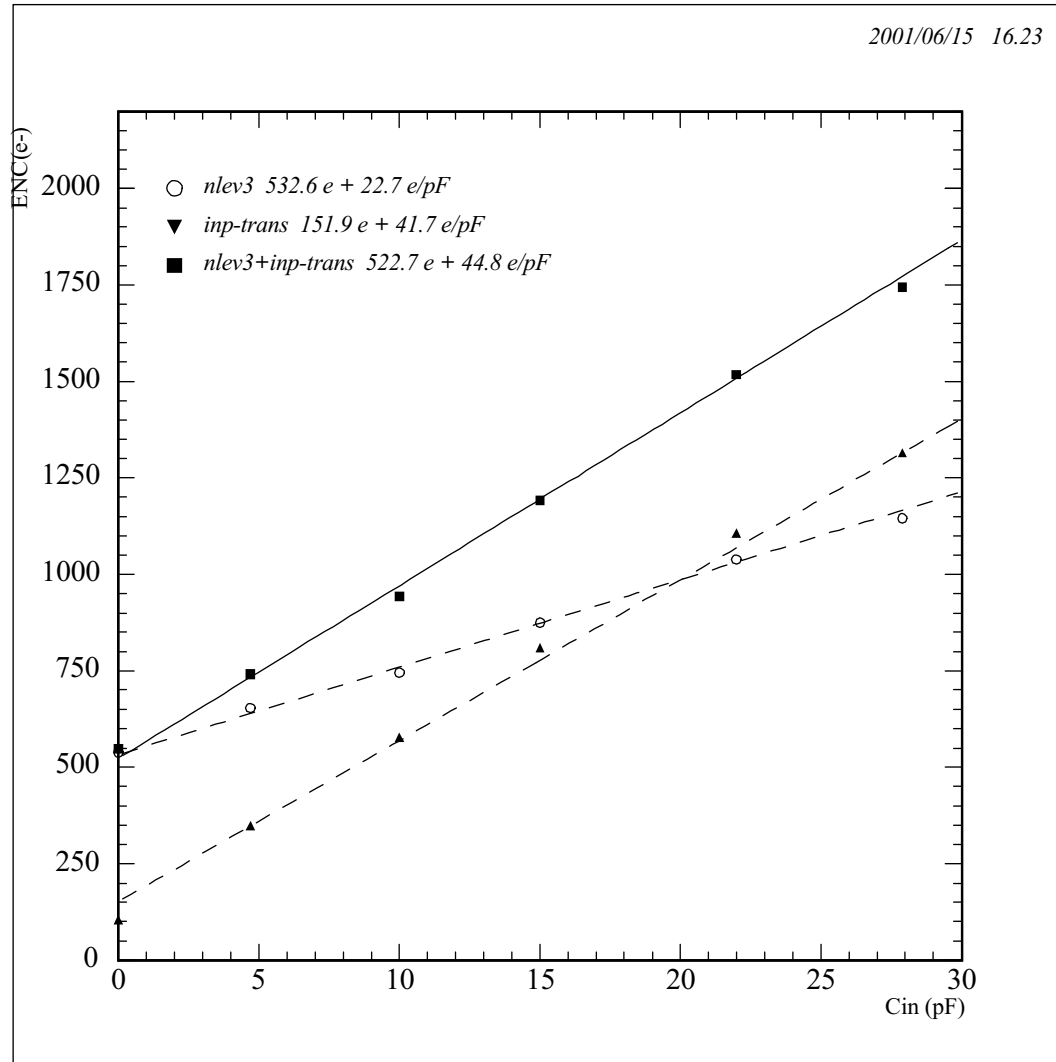
**$ENC=796.8e+45.3e/pF$**





# SPICE Simulation

2001/06/15 16.23



SPICE nlev3:  
 Input transistor's operating point  
 below threshold  
 → does not include channel noise!





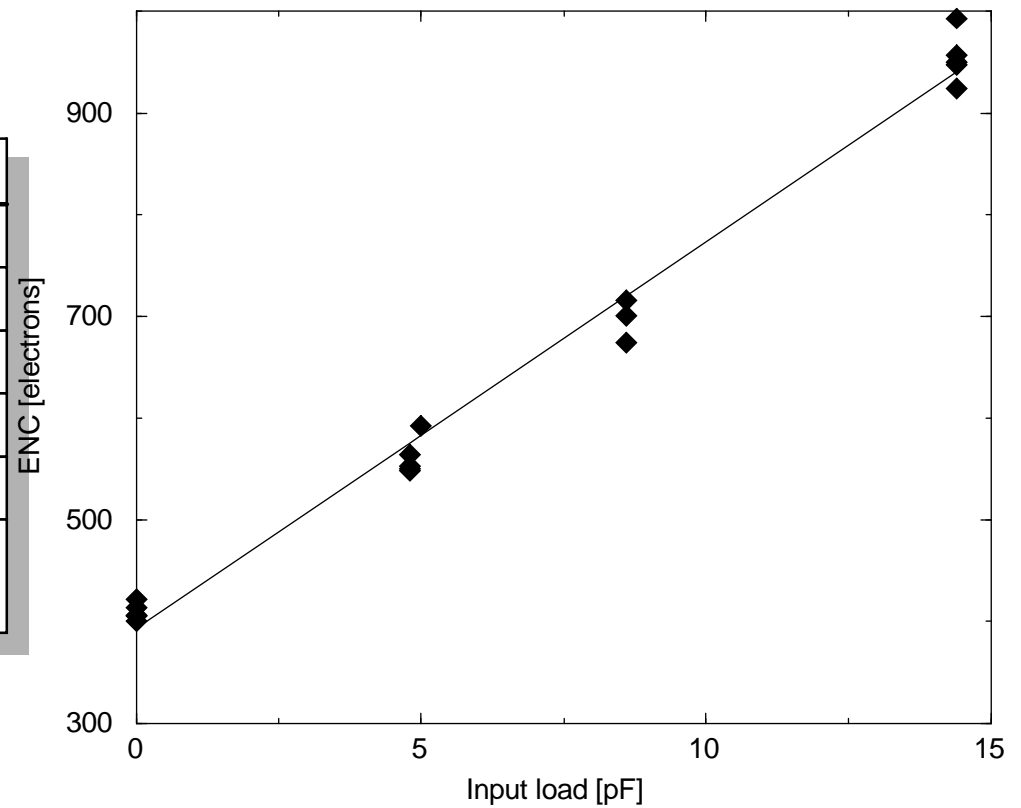
# Comparison

ENC	[e]	[e/pF]
Nygård		52
Anelli		45
nlev2	609.3	40.9
nlev3+inp-transistor	522.7	44.8
NIKHEF	796.8	45.3
E. Sexauer (poor statistics)	409	38

theory    SPICE    measurement

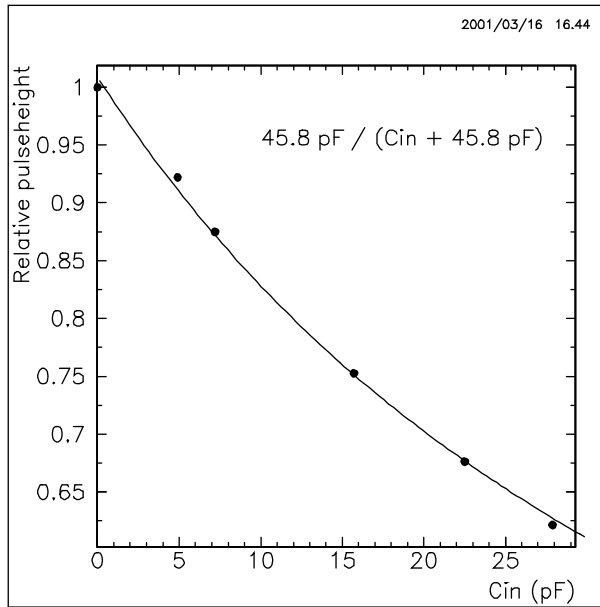
Set4, Ipre=350uA, Tpeak=30ns

$$ENC = 409 e + 38 e/pF$$





# Pulshapes I



$C_{dyn}=45.8\text{pF}$   
 $A_0\approx 115 @ \approx 20\text{MHz}$

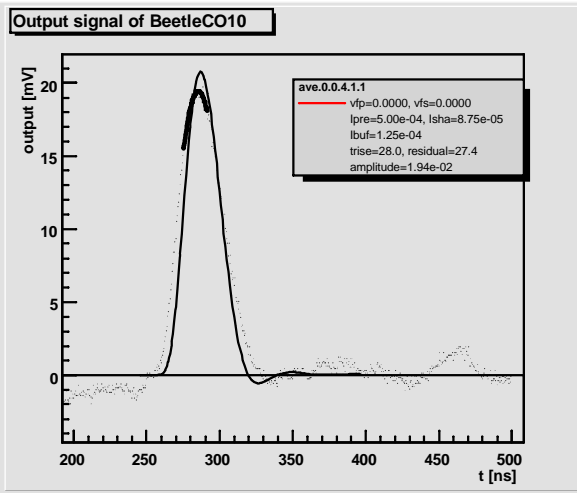
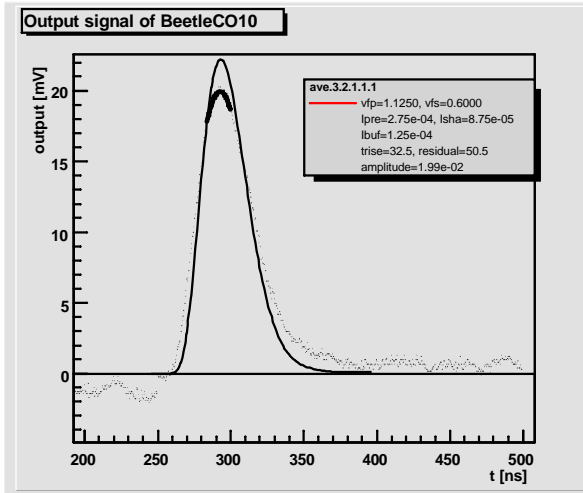
Beetle	measured at	V <sub>f p</sub>	V <sub>f s</sub>	I <sub>pr e</sub>	I <sub>sha</sub>	I <sub>buf</sub>	MIP ( )	t <sub>r ise</sub>	t <sub>f all</sub>	r esidue	A [mV ]	C <sub>input</sub>
		[V ]	[V ]	[A ]	[A ]	[A ]		[ns ]	[ns ]	[%]	[mV ]	[pF ]
FE10	Nikhef	1	0.5	260	100	100	3	12.2	23.87 (u)		16	10+(10 a 15)
CO10	Nikhef	1.125	0.6	275	87.5	125	1.3	32.5		50.5	19.9	3
FE10	Heidelb erg	1	0.5	350	80	100	1	25.6 (22.8)	(u)		22.3 (19.9)	10+?
10	Heidelb erg	0	0	500	80	100	1	30 (19)	(u)		16 (19.2)	?
CO10	Nikhef	0	0	500	87.5	125	1.3	28.0		27.4	19.4	3

(u)=undershoot, (... ) =simulation value, (\*) 1 MIP=12000 electrons

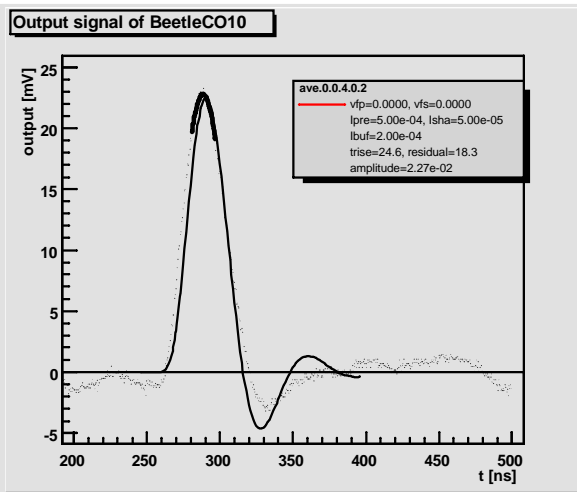
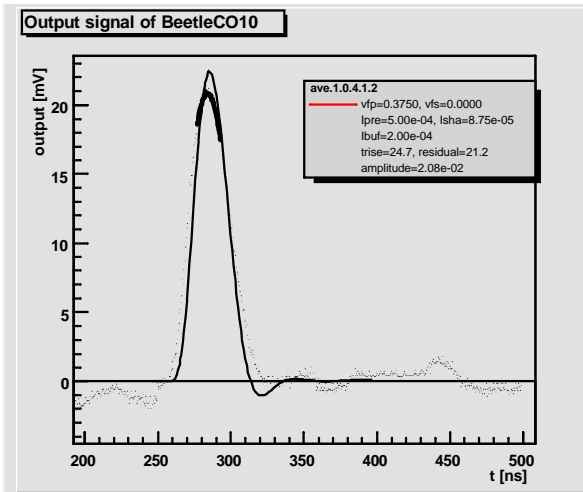




# Pulshapes II



lines: HSPICE  
dots: measurement



8 Bias settings fulfill  
the LHCb requirements  
 $t_{rise} \leq 25ns$   
remainder  $\leq 30\%$

