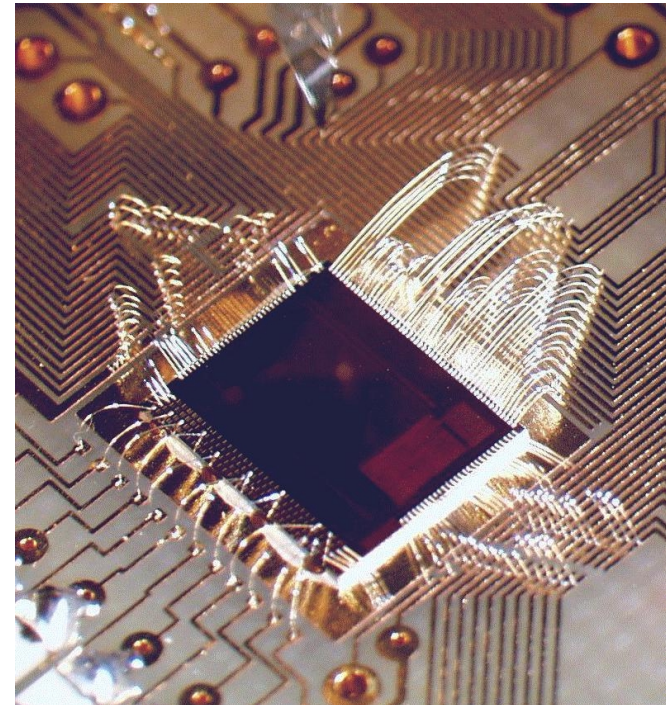




# Lab measurements with the Beetle 1.2

**Daniel Baumeister  
and  
Sven Löchner**

*(Max-Planck-Institute for Nuclear Physics, Heidelberg)*

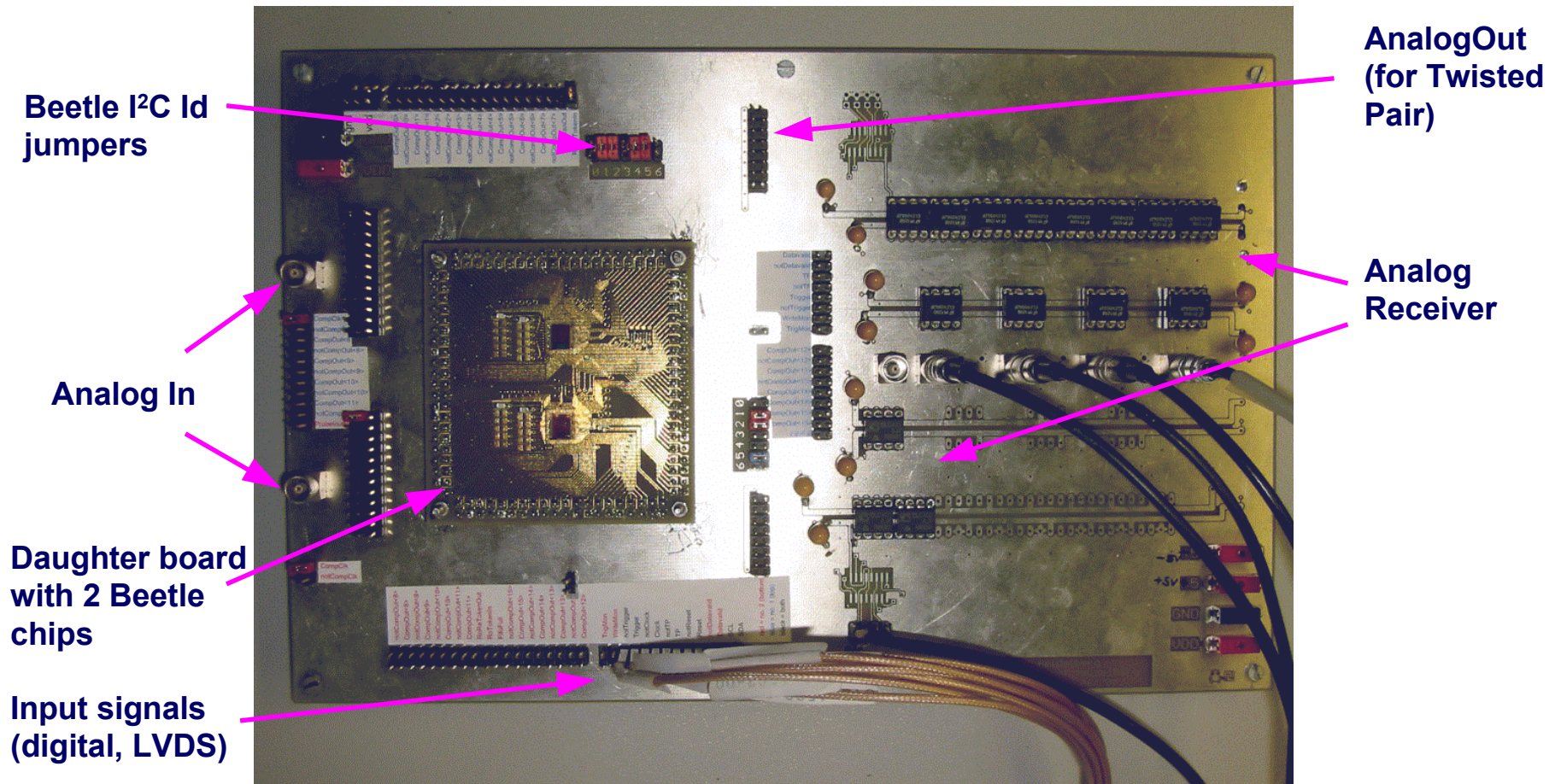


Beetle 1.2 on a test PCB



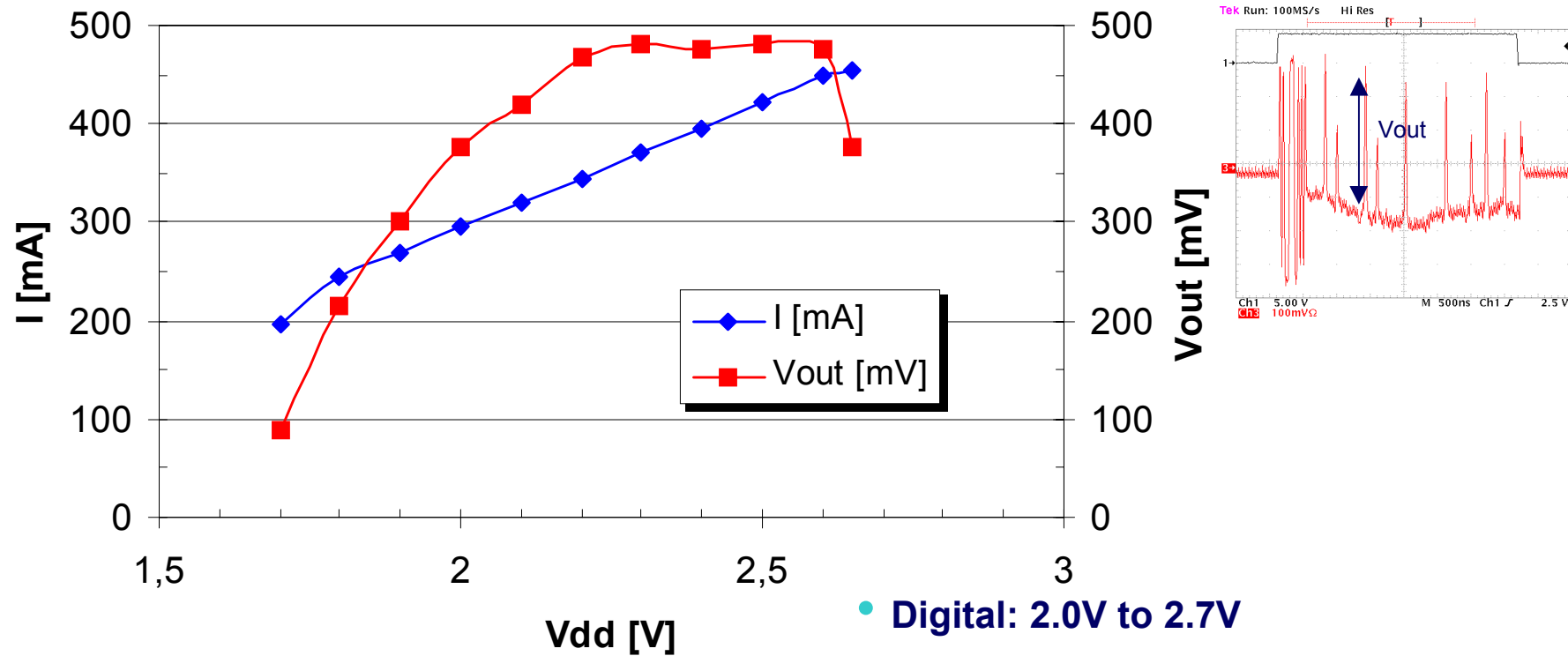


# Beetle 1.2 Lab Setup





# Power Supply Operation



- Digital: 2.0V to 2.7V
- Analog: 2.2V to 2.6V





# Total Power Consumption

Power consumption [mW/ch.]	Minimal	Nominal	Max. operation	Max. DAC
without clock	2,03	4,14	5,57	16,12
only clock	3,04	5,17	6,55	16,88
clocked + 1.1 MHz trigger	3,09	5,32	6,71	17,03





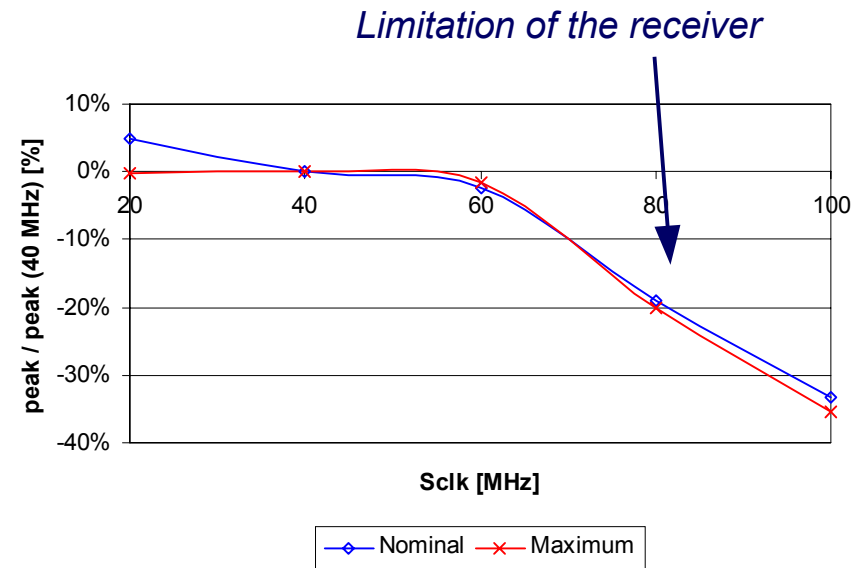
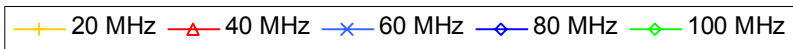
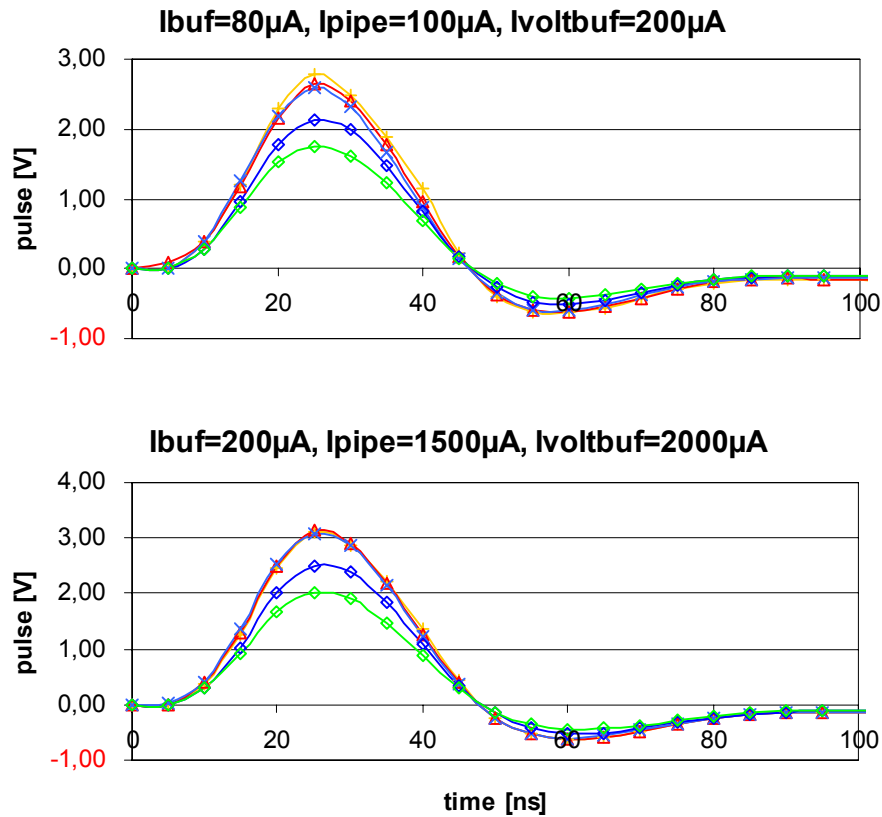
# Temperature Test

- **Start-up tests (~ 10 times each chip):**
  - **3 Beetle 1.2 (non-irrad., 10 Mrad, 30 Mrad)**
  - **@ T=- 44°C, 60°C, 80°C** (facility temperature)
  - **Programming (I<sup>2</sup>C)**
  - **1.1 MHz trigger + analog readout**
- **Longtime operating tests (~2 days):**
  - **non-irrad. Beetle 1.2** (because this is the only chip with a Pt100 on the surface)
  - **@ T=-44°C, 60°C, 80°C**
  - **1.1 MHz + analog readout**
- **Self-Heating test:**
  - **non-irrad. Beetle 1.2**
  - **@ room temperature**
  - **max. DAC settings**
  - **⇒ T<sub>surface</sub>=131,5°C, Operating over ~ 1 hour**





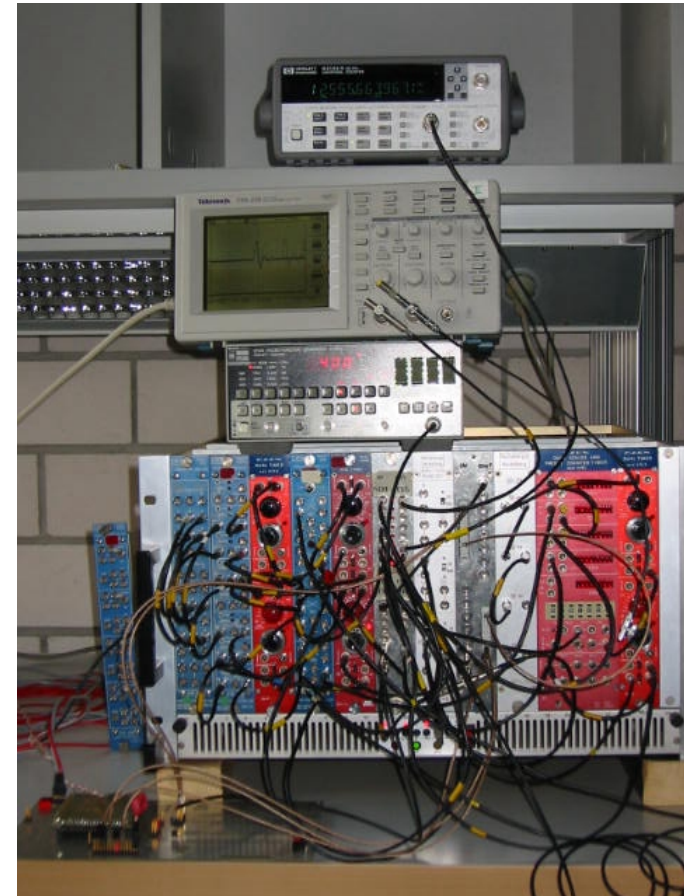
# Overclocking Test





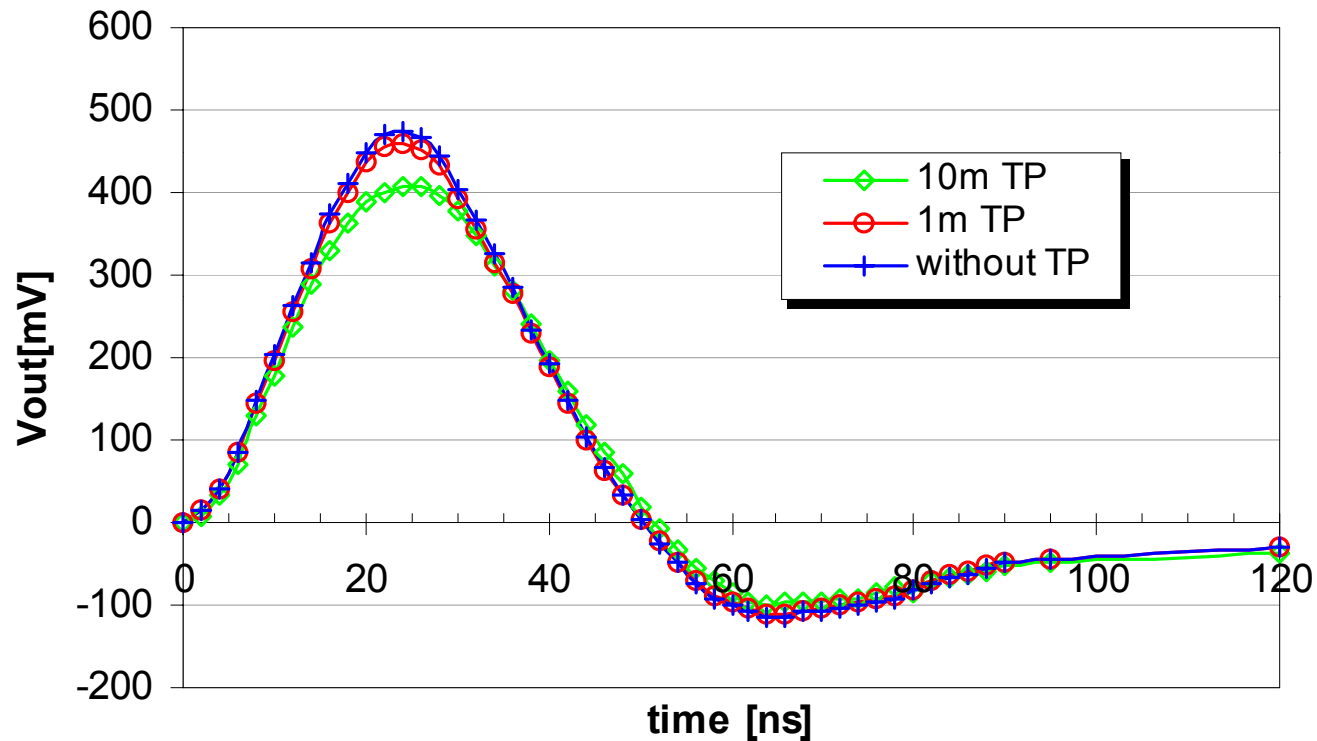
# Random Trigger Test

- 2 Beetle 1.2 @ 40 MHz, both irradi. (10 Mrad)
- 2 x  $2.5 \cdot 10^{12}$  random triggers
  - 168h ( $1.814 \cdot 10^{12}$ ,  $\Rightarrow$  2.99 MHz)
  - 72h ( $2.933 \cdot 10^{11}$ ,  $\Rightarrow$  1.13 MHz)
  - 132h ( $3.911 \cdot 10^{11}$ ,  $\Rightarrow$  0.82 MHz)
- no triggers lost





# Driving Capabilities



- Pulse shape characteristics**
- without Twisted Pair cable
  - 1m Twisted Pair cable
  - 10m Twisted Pair cable



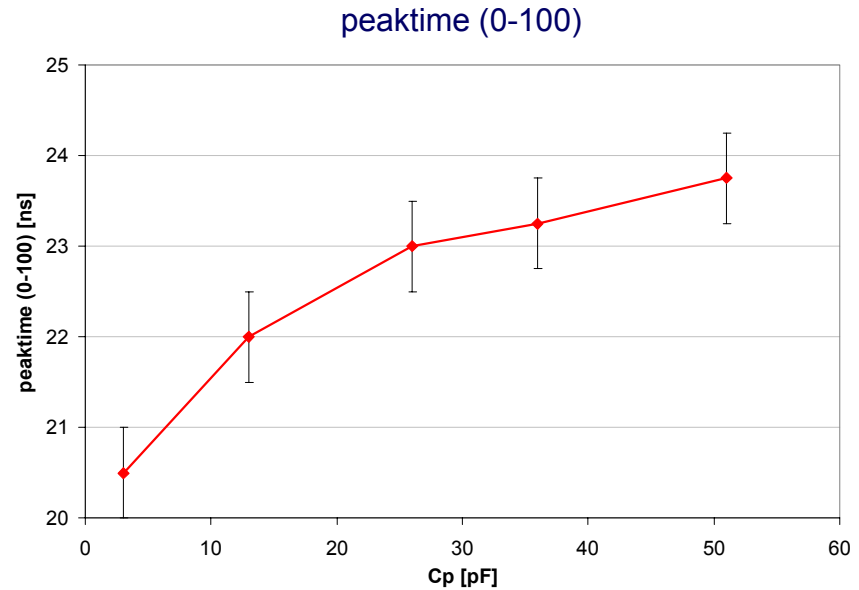
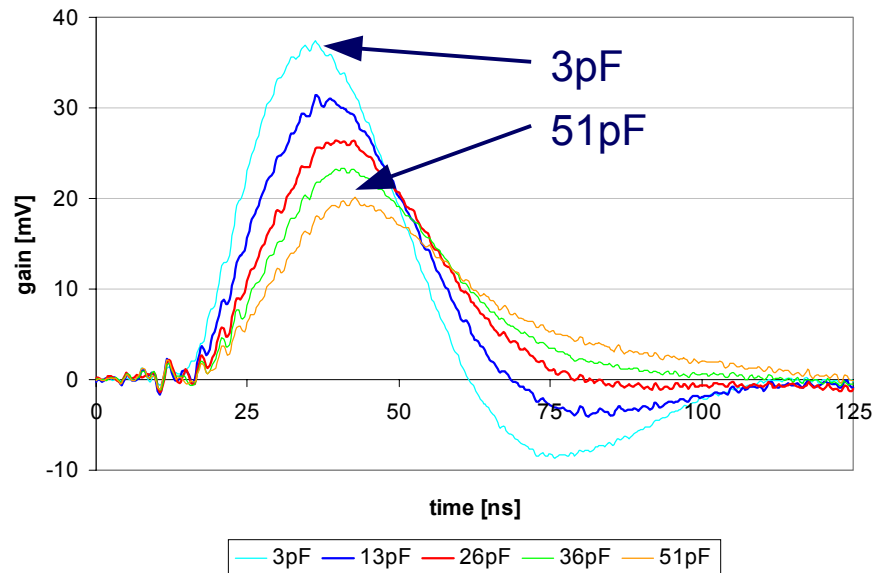




# Front end: Pulseshape

## Front end behaviour of the Beetle 1.2 (measured with different $C_p$ )

$I_{pre}=600\mu A$ ,  $I_{sha}=80\mu A$ ,  $I_{buf}=200\mu A$ ,  $V_{fp}=0V$ ,  $V_{fs}=0V$



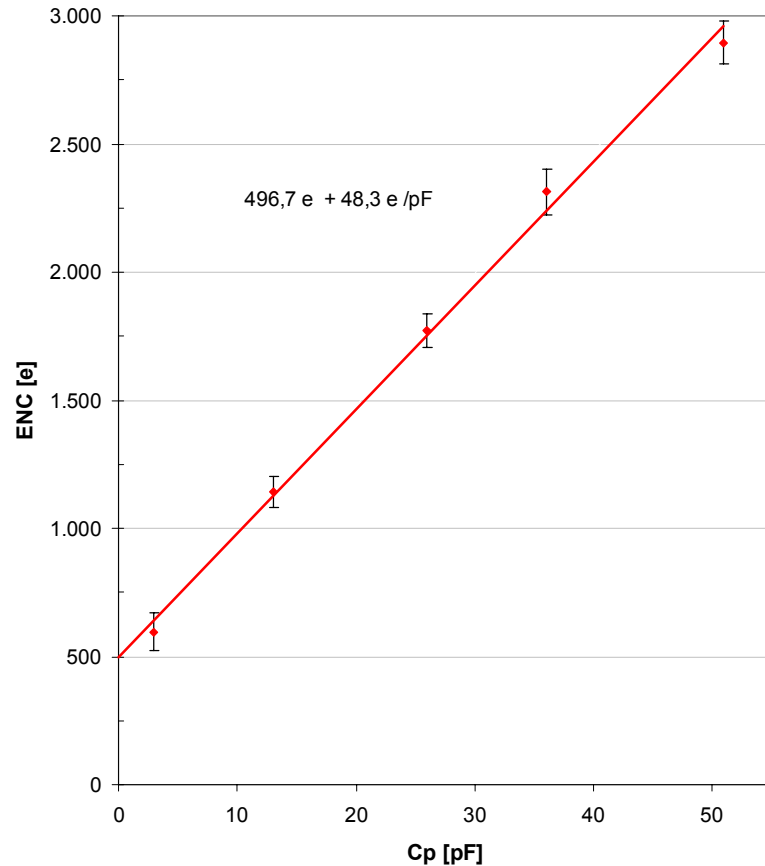
• peaktime  $\leq 25$  ns for  $C_p \leq 51$  pF

**1 measurement out of more than 100, all with different settings**





# Front end: ENC



**measured ENC of the new front end on a complete readout chip Beetle 1.2:**

Heidelberg: 497 e<sup>-</sup> + 48.3 e<sup>-</sup>/pF

**measured ENC of the new front end on a test chip BeetleFE 1.1:**

NIKHEF:	429 e <sup>-</sup> + 47.0 e <sup>-</sup> /pF
Zurich:	436 e <sup>-</sup> + 47.7 e <sup>-</sup> /pF
Heidelberg:	483 e <sup>-</sup> + 45.7 e <sup>-</sup> /pF





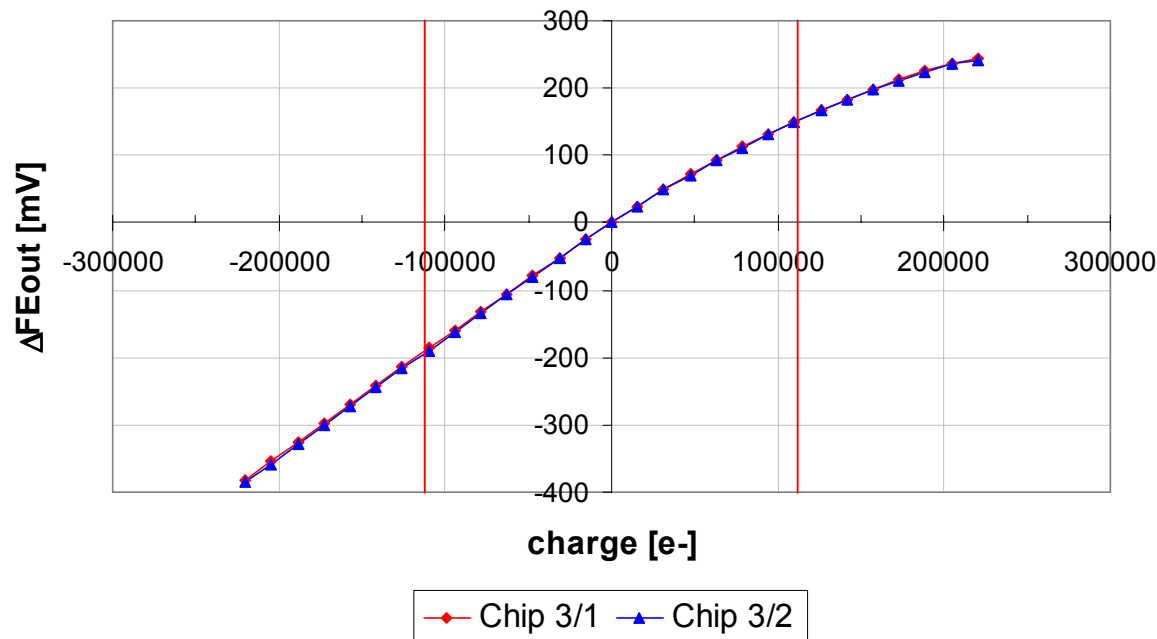
# Front end: Dynamic range

**Dynamic range for both polarities:**

+/- 110.000 e<sup>-</sup>: < 2% for negative pulses

< 5% for positive pulses

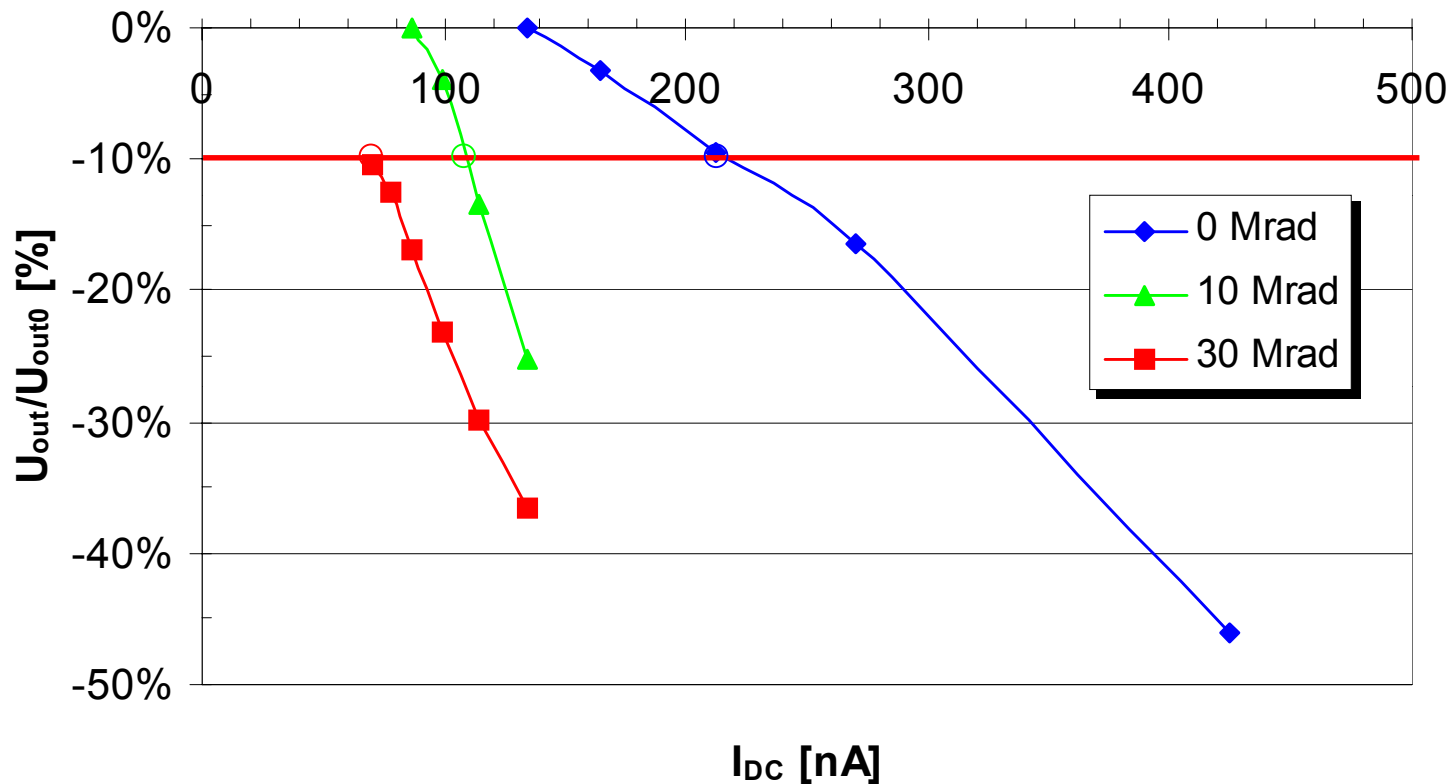
**Beetle 1.2 - Frontend**





# Saturation (1)

### Maximum rate of 22 ke Pulse



**0 Mrad: 218nA**  
⇒ **61.8 MHz**

**10 Mrad: 107nA**  
⇒ **30.4 MHz**

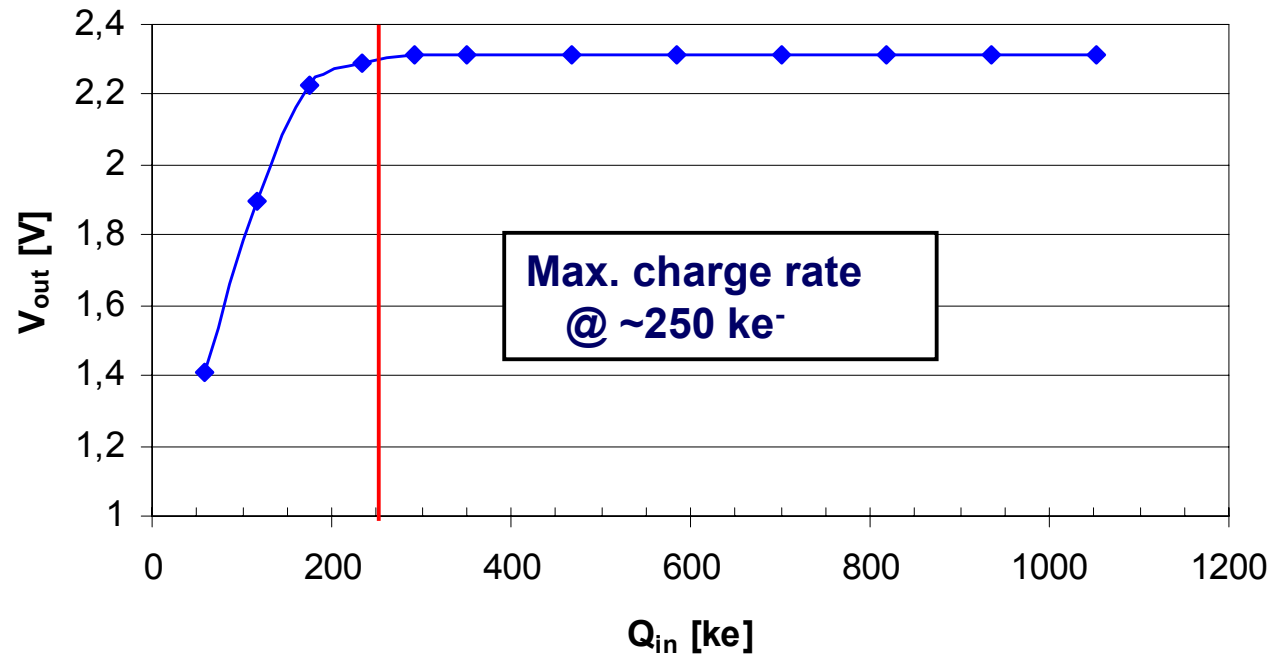
**30 Mrad: 71nA**  
⇒ **20.1 MHz**





# Saturation (2)

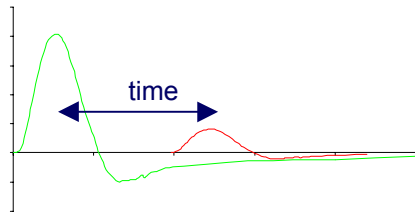
## Maximum charge at low rates (1 Hz)



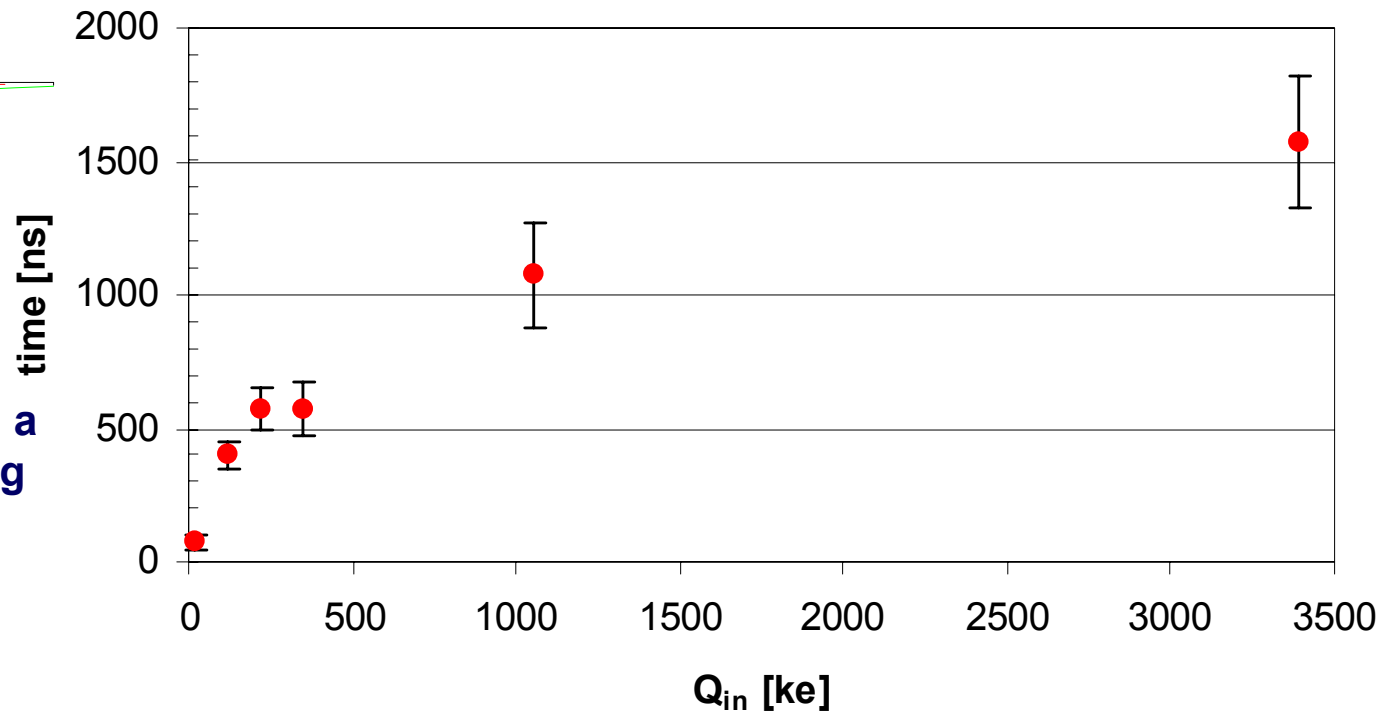


# Saturation (3a)

## Response to heavy ionizing particles



**time between a heavy ionizing particle ( $Q_{in}$ ) and a signal with  $22\text{ ke}^-$  (threshold: 90%)**





# Saturation (3b)

## Response to heavy ionizing particles

Signal overspill  
into next BX

