Latest Results and Status Report of the Beetle Chip(s)

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Outline

- Results from TID irradiation test
- Noise measurements
- Random trigger test
- Known limitations
- Steps towards Beetle1.2

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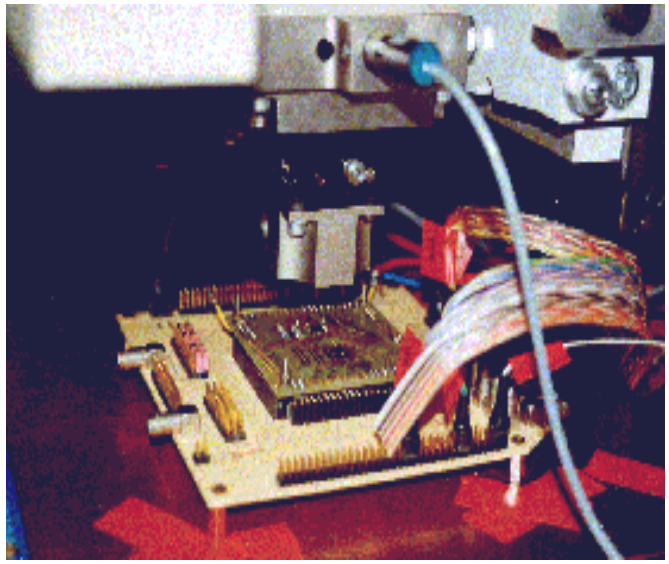
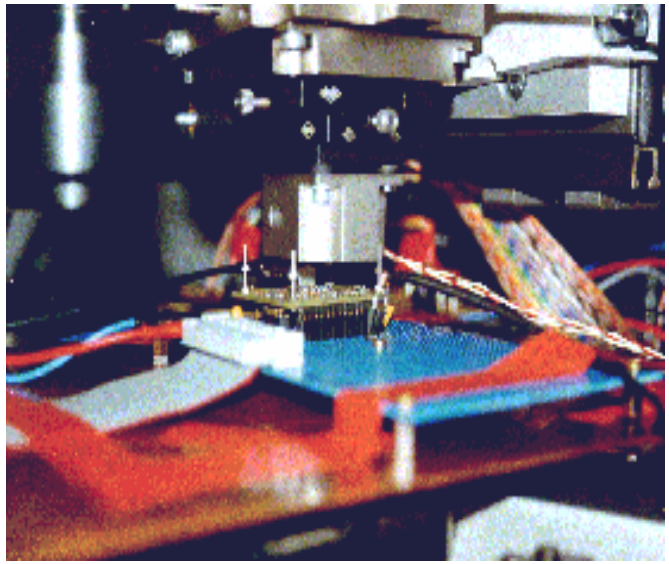
Total Ionizing Dose (TID) irradiation test

done at the X-ray facility of CERN´s Microelectronics Group





Irradiated Chips:

- **4 Beetle1.1 chips**
  - 2 chips being kept at room temperature
  - 2 chips being annealed at 100 C
- **2 BeetleFE1.1 chips**
  (containing FE prototypes with a NMOS input transistor)
- **2 BeetleFE1.2 chips**
  (containing FE prototypes with a PMOS input transistor)

Accumulated Dose:

Beetle1.1: 10 Mrad, 10 Mrad, 30 Mrad, 45 Mrad

BeetleFE1.x: 10 Mrad

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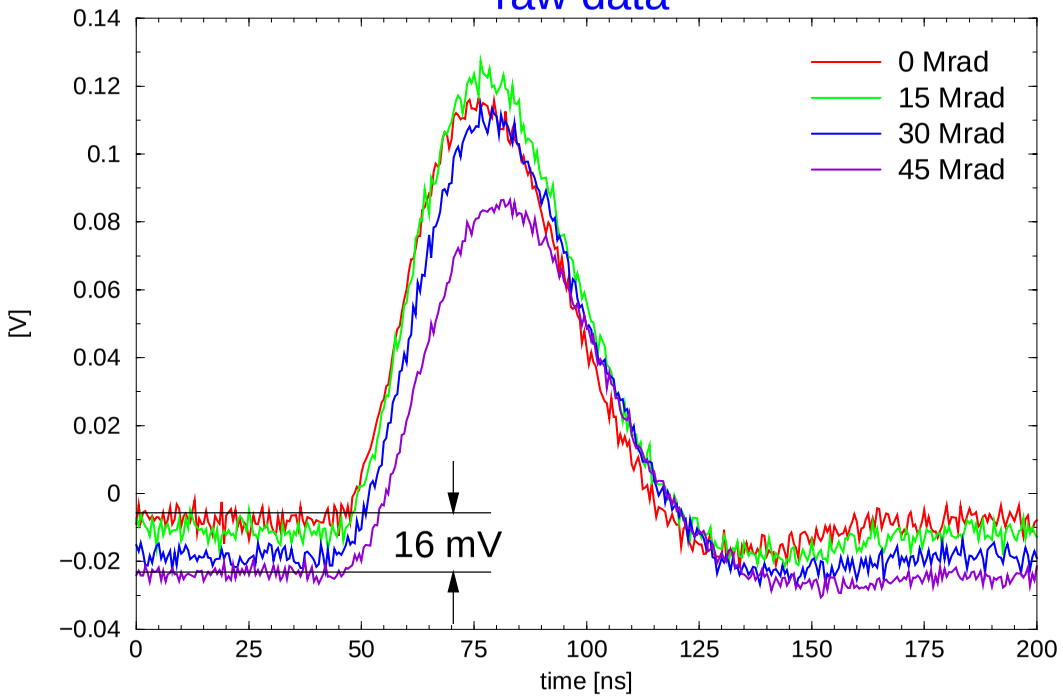
TID irradiation test: Results of Beetle1.1

Beetle1.1 showed full functionality up to 45 Mrad!

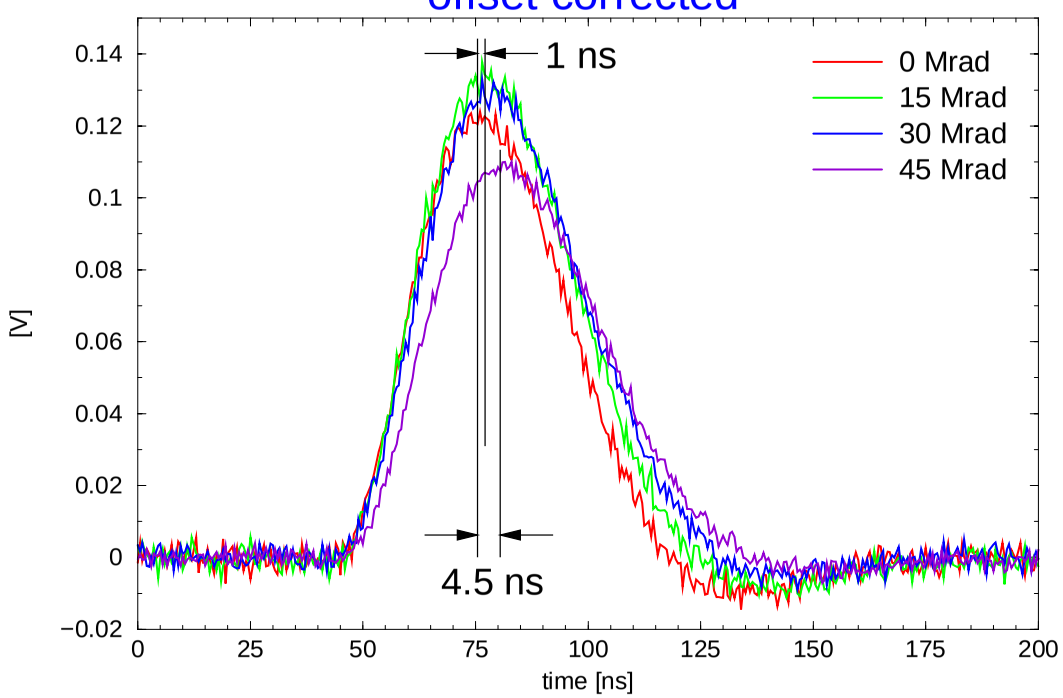
- full trigger/readout functionality
- full slow control functionality
- performance degradations are small

Pulse shape scan @ Cp = 3 pF

raw data



offset corrected



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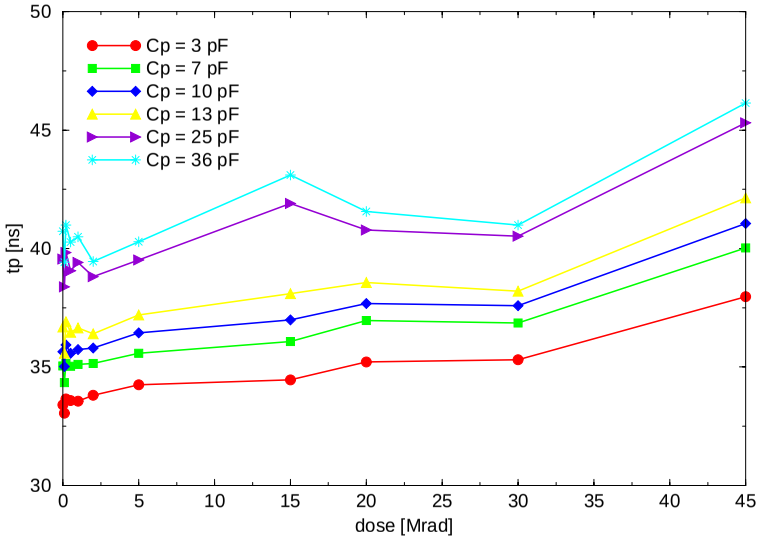
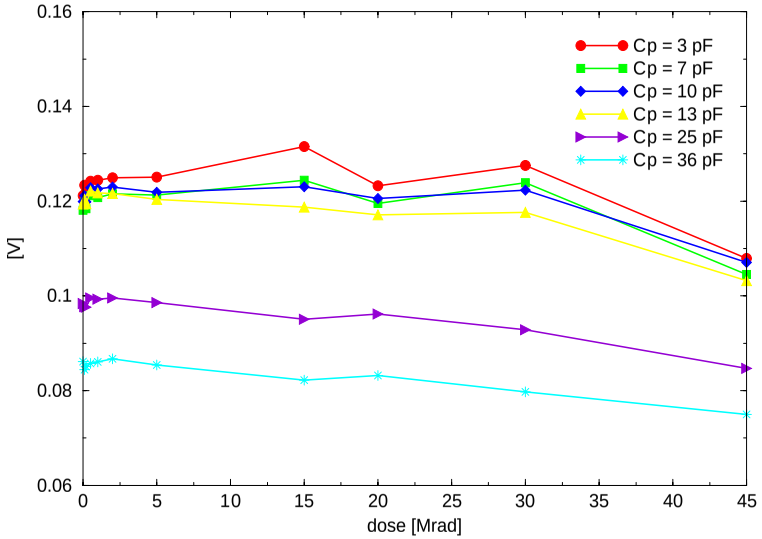
TID irradiation test: Results of Beetle1.1

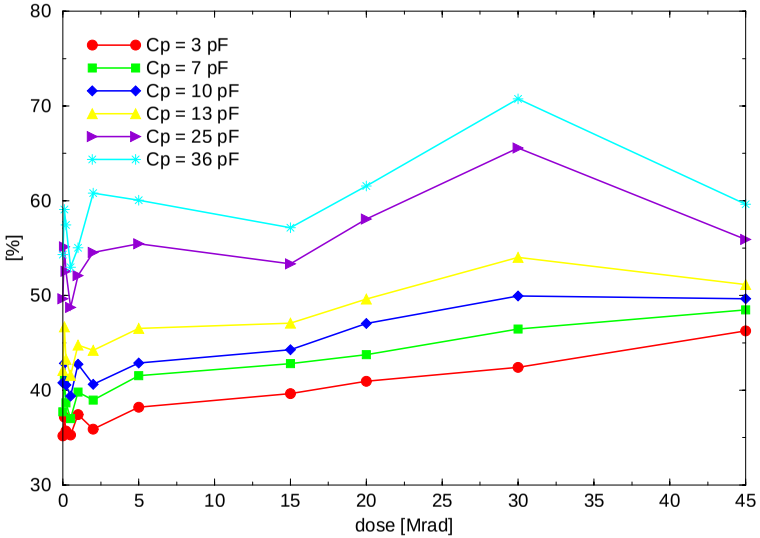
peaking time



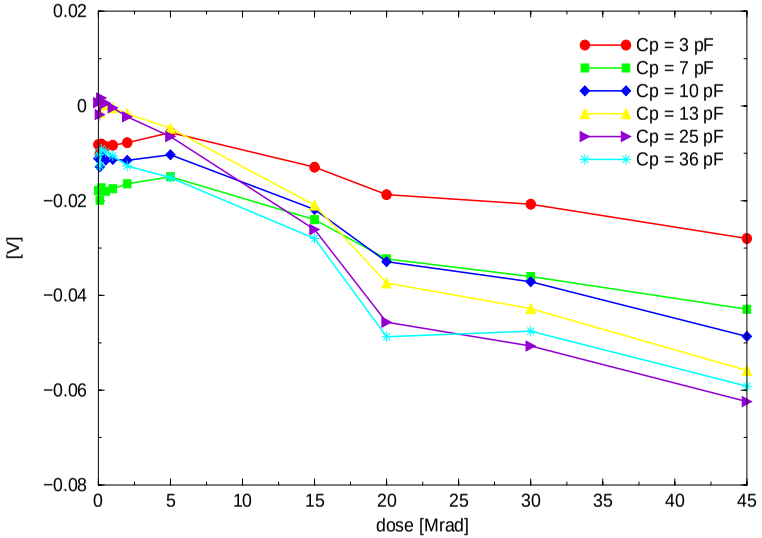
peaking voltage



remainder after 25 ns



offset voltage



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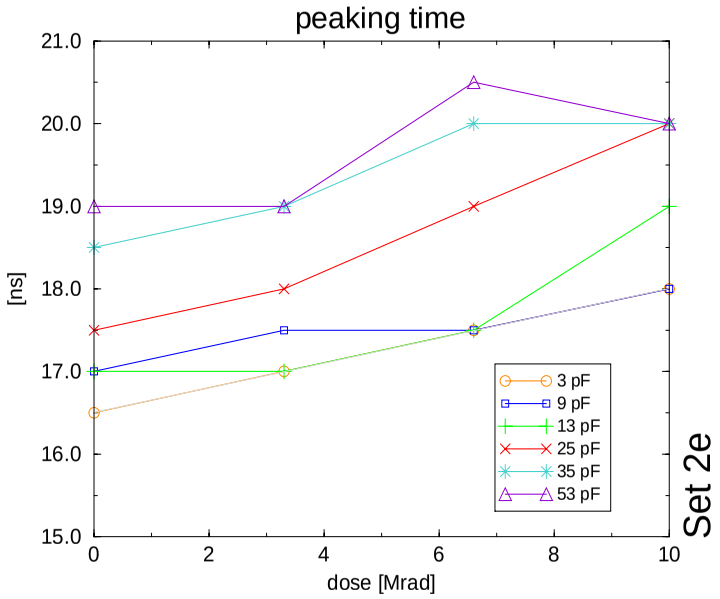
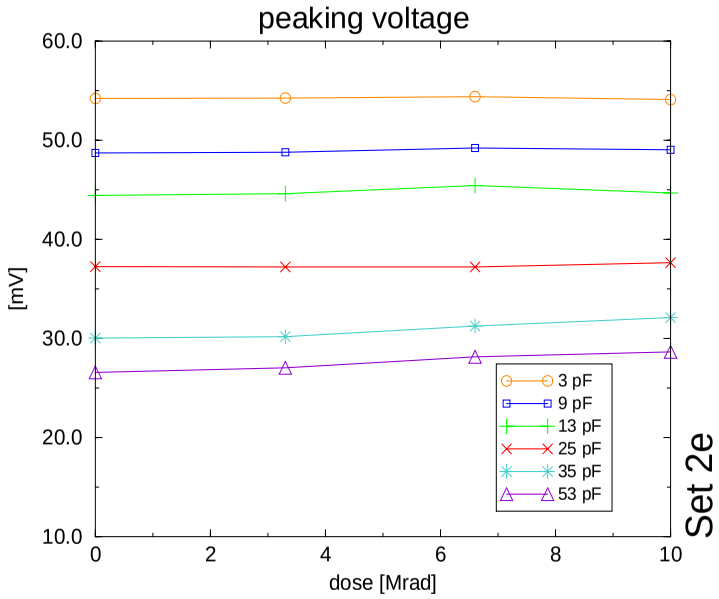
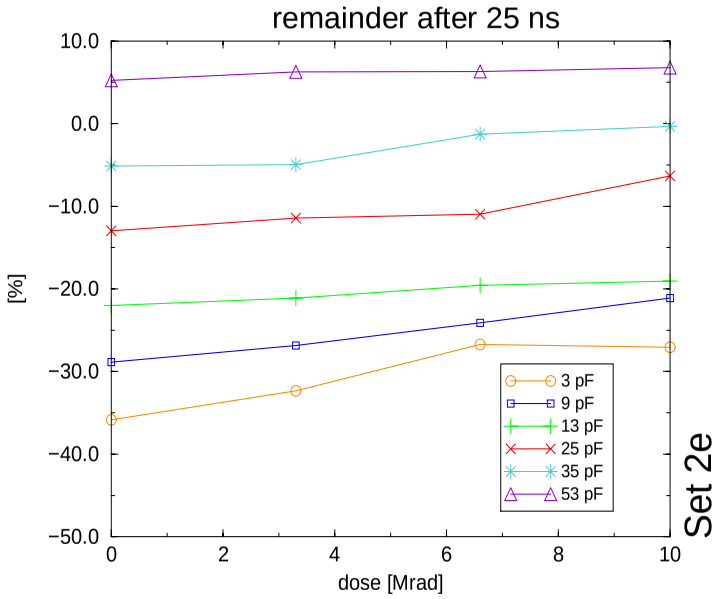
TID irradiation test: Results of BeetleFE1.1

only minor performance variations during irradiation







typical slope: 0.1 ns/Mrad

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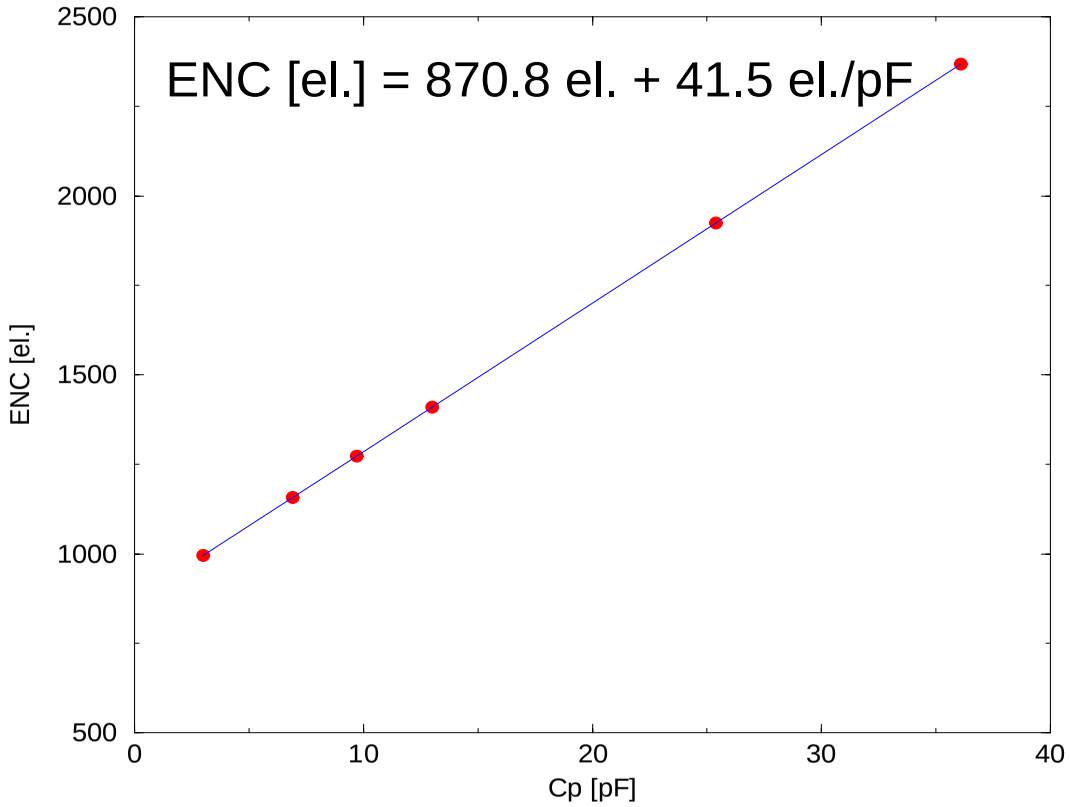
Beetle1.1: Noise (preliminary)



slope is OK

high offset has to be verified!

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Beetle1.1: Random trigger test

Beetle1.1 processed 1E+12 random triggers correctly!

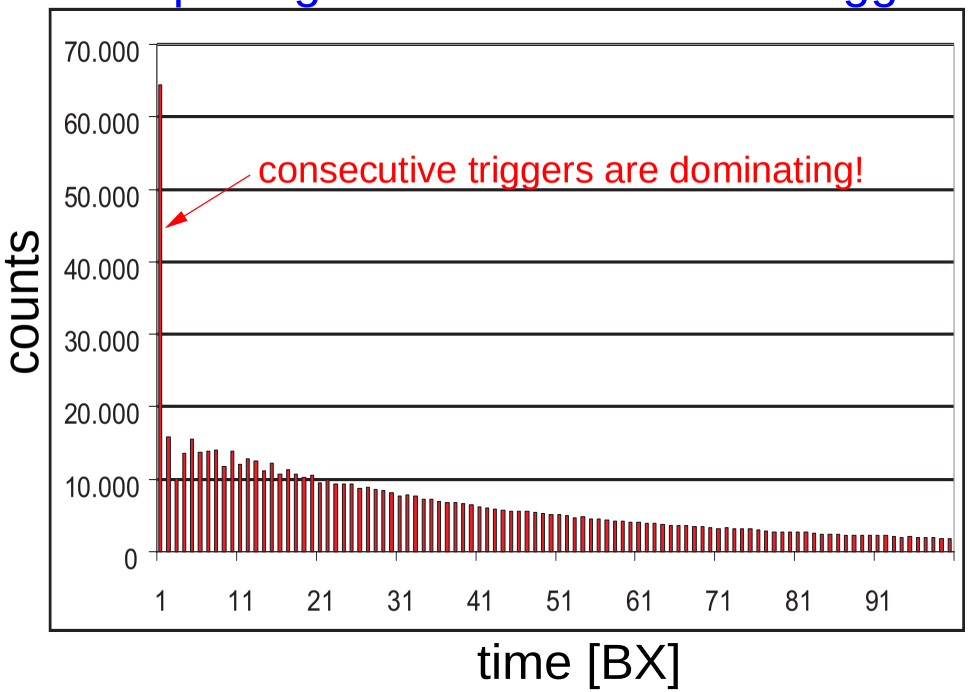
eff. trigger rate 900 - 960 kHz	
generated triggers	**11,261,087,266**
read out events	11,053,715,688
rejected triggers (full derandomizing buffer)	207,371,578
Sum	**11,261,087,266**

→ 1.9 % rejection ratio

eff. trigger rate 200 - 360 kHz	
generated triggers	**102,116,710,063**
read out events	101,954,088,099
rejected triggers (full derandomizing buffer)	162,621,964
Sum	**102,116,710,063**

eff. trigger rate 800 kHz	
generated triggers	**21,573,906,902**
read out events	21,460,346,454
rejected triggers (full derandomizing buffer)	113,560,448
Sum	**21,573,906,902**

time spacing between successive triggers



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Known Limitations

- **"SoftReset"-Feature**

  applying a "SoftReset" at a certain time during readout lets the control logic getting stuck

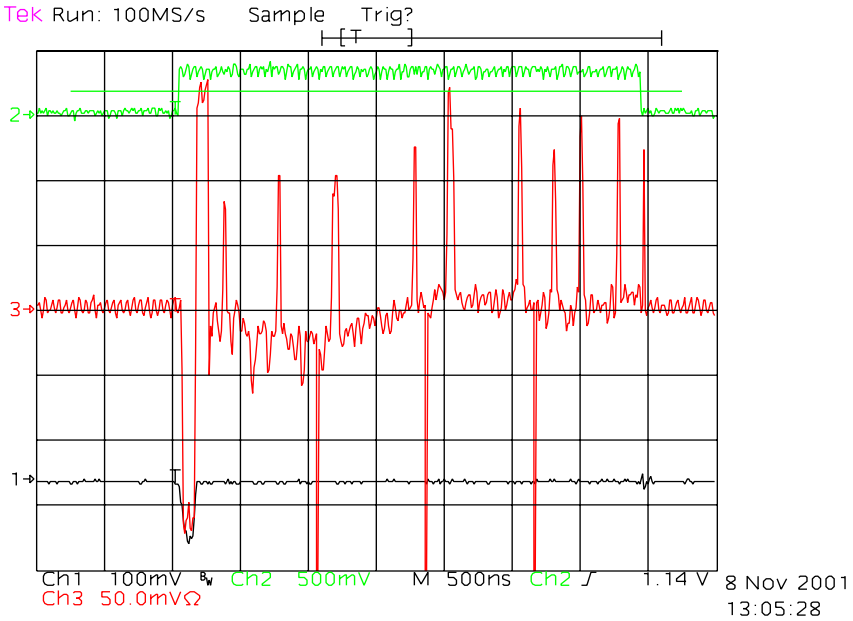
  due to a not reseted part of control logic ⟶ will be fixed in next chip iteration

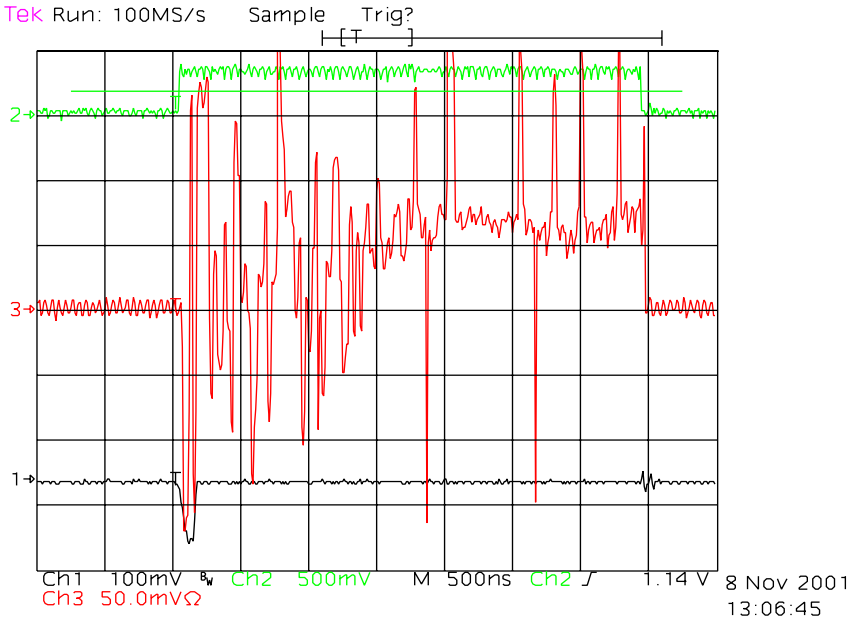
- **Trigger-Phasing**

  bad trigger to clock phasing can violate internal setup times which stops the logic

  will be fixed in next chip iteration

- **Readout @ trigger rates of 10 Hz and below**





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Known Limitations (2)

- **FE-Shaping**

  discrepancy between behaviour of identical frontends on Beetle1.1 and BeetleFE1.1

$Q_{in} \approx 24{,}000$ el.	Beetle1.1		BeetleFE1.1	
	meas.	sim.	meas.	sim.
t_p [ns]	29.2	17.4	17.5	16.7
V_p [mV]	27.0	34.91	33.39	36.14
V_{25+}/V_p [%]	32.6	9.3	28.7	13.1

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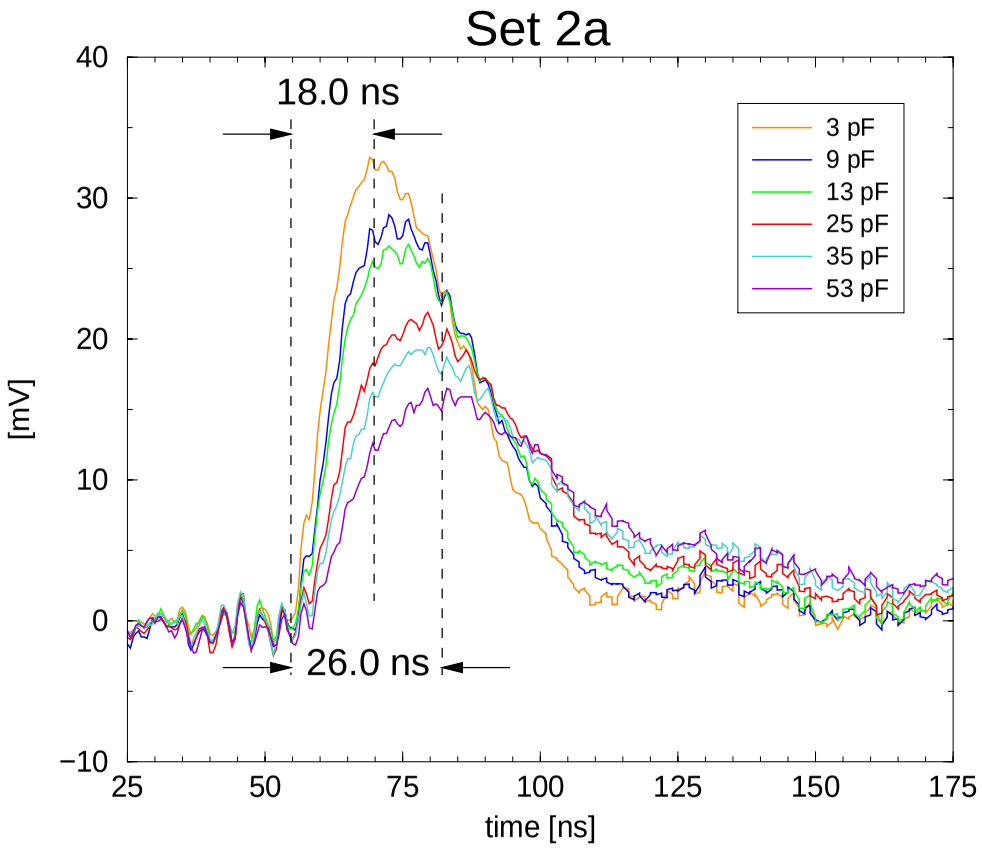
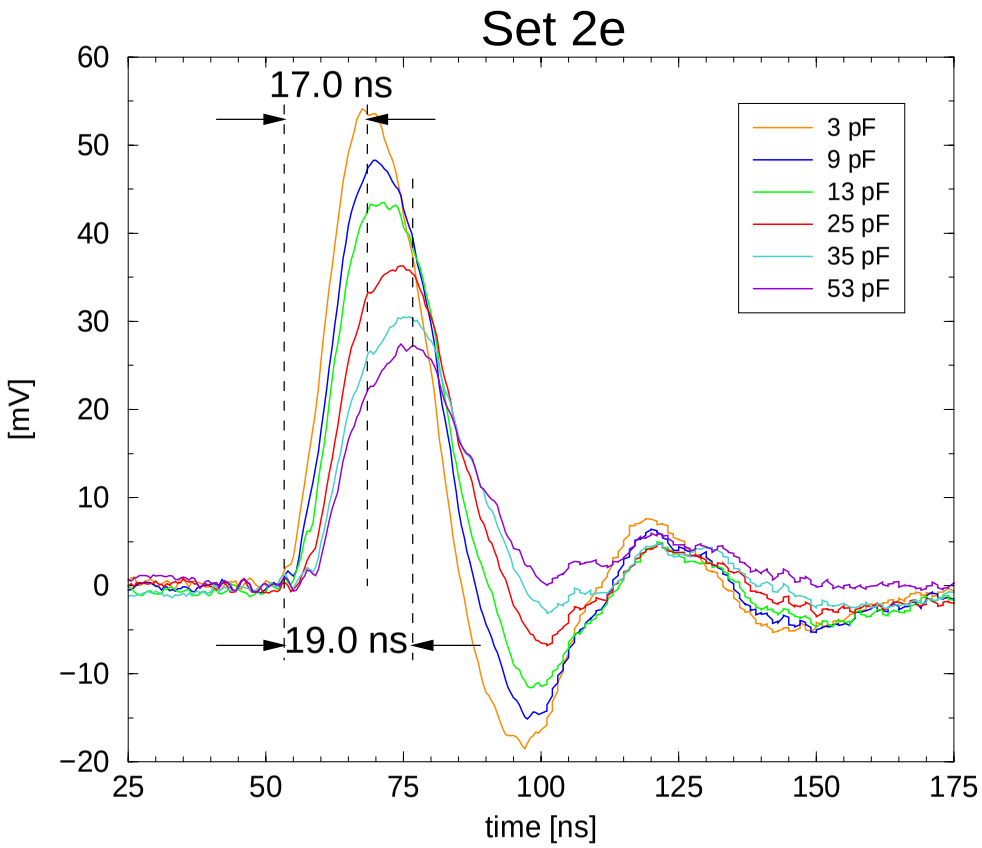
BeetleFE1.1: Measurement results





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Steps towards Beetle1.2

Beetle User Review on 12/19/01 in Heidelberg

items to be discussed:

digital part: daisy chained readout, programming of I2C-ID,
error encoding in readout header, AOB

analog part: new front ends, analog output driver, mask registers, reset operation, AOB

You are invited to participate and to contribute to this meeting!

Design work for Beetle1.2 will start mid of December (submission date: March 2002)

major implementations:

- new front ends
- fully differential output current driver
- SEU redundant logic

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Outlook

- ✓ Beetle chips showed very good performance under TID irradiation
- ● SEU irradiation test is under preparation
- ✓ new features have been revealed and understood
- ✗ some features have still to be studied in more detail
- ✓ control logic passed random trigger test succesfully
- ✗ further investigations before starting design of Beetle1.2: noise, FE discrepancy
- ✓ new front ends on BeetleFE1.1 show very good performance

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