



First Results from the Engineering Run

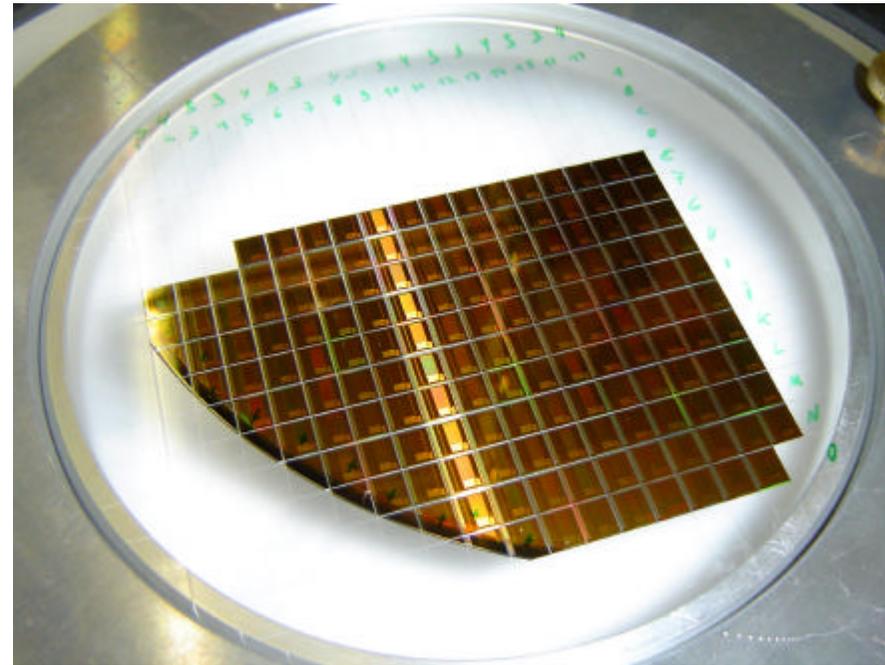
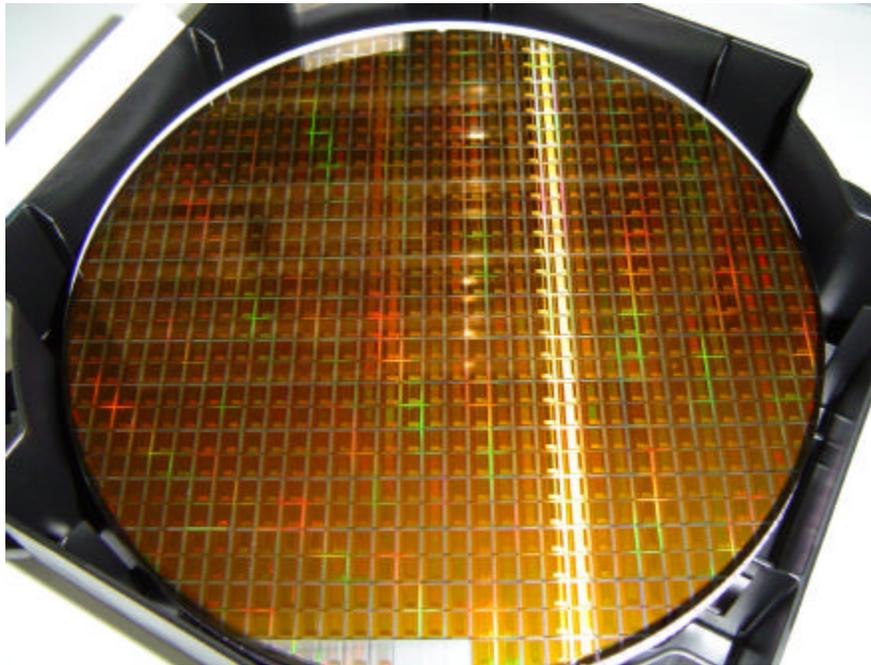
Sven Löchner

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





Beetle Engineering Run



- **Beetle engineering run submission:**
 - 27.7.2004: 6 wafers with 786 chips each arrived in Heidelberg (1.3: 264, 1.4/1.5: 261)
 - 9.8.2004: a quarter of one wafer was sawed and than diced manually in the ASIC-Lab





First lab setup

- **First Beetle test with a probe card:**
25 chips from each version were tested on a manual wafer probe station with a special probe card
 - I²C-Interface (Write, Read, General Call, Register values)
 - Digital signals (FifoFull, DataValid, WriteMon, TrigMon)
 - Analog signals (1 port / 4 port readout mode, internal test pulse, non-consecutive / consecutive readout)
- **All chip versions behaved as expected.**
 - e.g. PCN-Parity bit is right encoded in both readout modes (1 / 4 port)





First lab setup - Yield

- **First Yield estimation for different chip version – but keep in mind the less statistic...**
- **Pipeline-defects: From Beetle 1.3 to 1.4/1.5 the layout of a pipeline cell has changed to a more conservative design. Perhaps this is a reason for a better yield ins this part.**

| | Beetle 1.3 | Beetle 1.4 | Beetle 1.5 |
|-----------|------------|------------|------------|
| Frontend | | 2 | 1 |
| Pipeline | 3 | | |
| Register | 2 | | |
| Digital | | 1 | 1 |
| RO-Header | 1 | | |
| Summary | 6 | 3 | 2 |

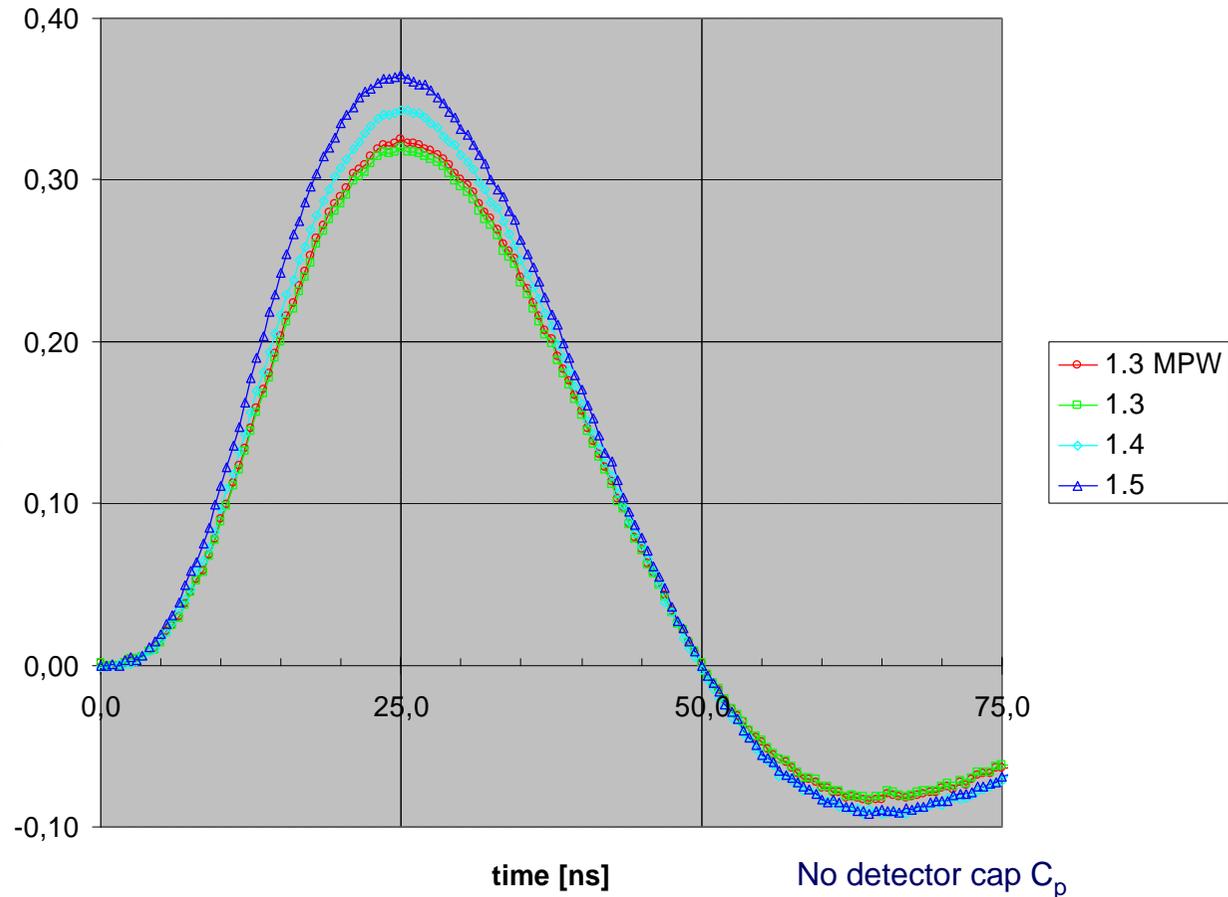
No. of defects found on different versions





Pulse Shape

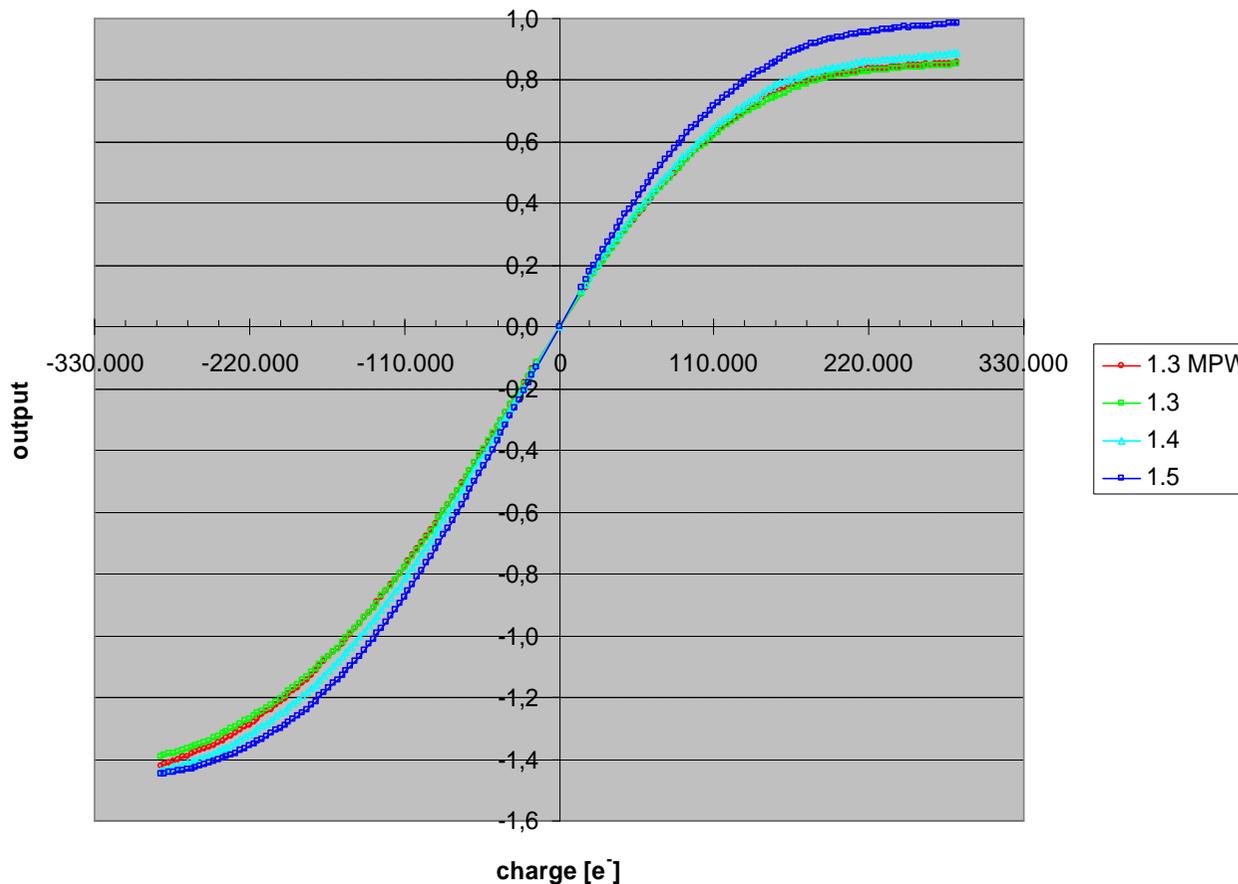
- **Pulse Shape Scan of all Beetle Engineering Run versions**
- **Beetle 1.3 from MPW run and Beetle 1.3 shows a good agreement of the pulse shape**
- **1.4: gain is slightly higher**
 - Expected due to reduction of parasitic capacitances in the layout of the pipeline
- **1.5: gain is higher than 1.3/1.4**
 - Expected due to the effect of 1.4 and the new layout geometry (n-well under nmos => increase the dynamic range of the pipeline-capacitance)





Dynamic Range

- **Dynamic range for 1.3 (MPW), 1.3 and 1.4:**
 - nearly the same because on all three versions the pipeline cell uses the same layout structure
- **Beetle 1.5**
 - Much better dynamic range for positive pulses
 - Also slight more for negative pulses
 - => because of new pipeline cell layout





Beetle ENC

Results of Beetle ENC measurements

- **Beetle 1.3 MPW** (from Beetle User Meeting, 26.11.2003, CERN):
 $547.7e^- + 52.6e^-/pF$
- **Beetle 1.3:**
 $(542.4 \pm 61.8)e^- + (51.7 \pm 4.2)e^-/pF$
- **Beetle 1.4:**
 $(531.1 \pm 53.4)e^- + (50.6 \pm 3.8)e^-/pF$
- **Beetle 1.5:**
 $(521.1 \pm 55.1)e^- + (49.7 \pm 3.1)e^-/pF$

- **Slightly better performance for 1.4 and 1.5**





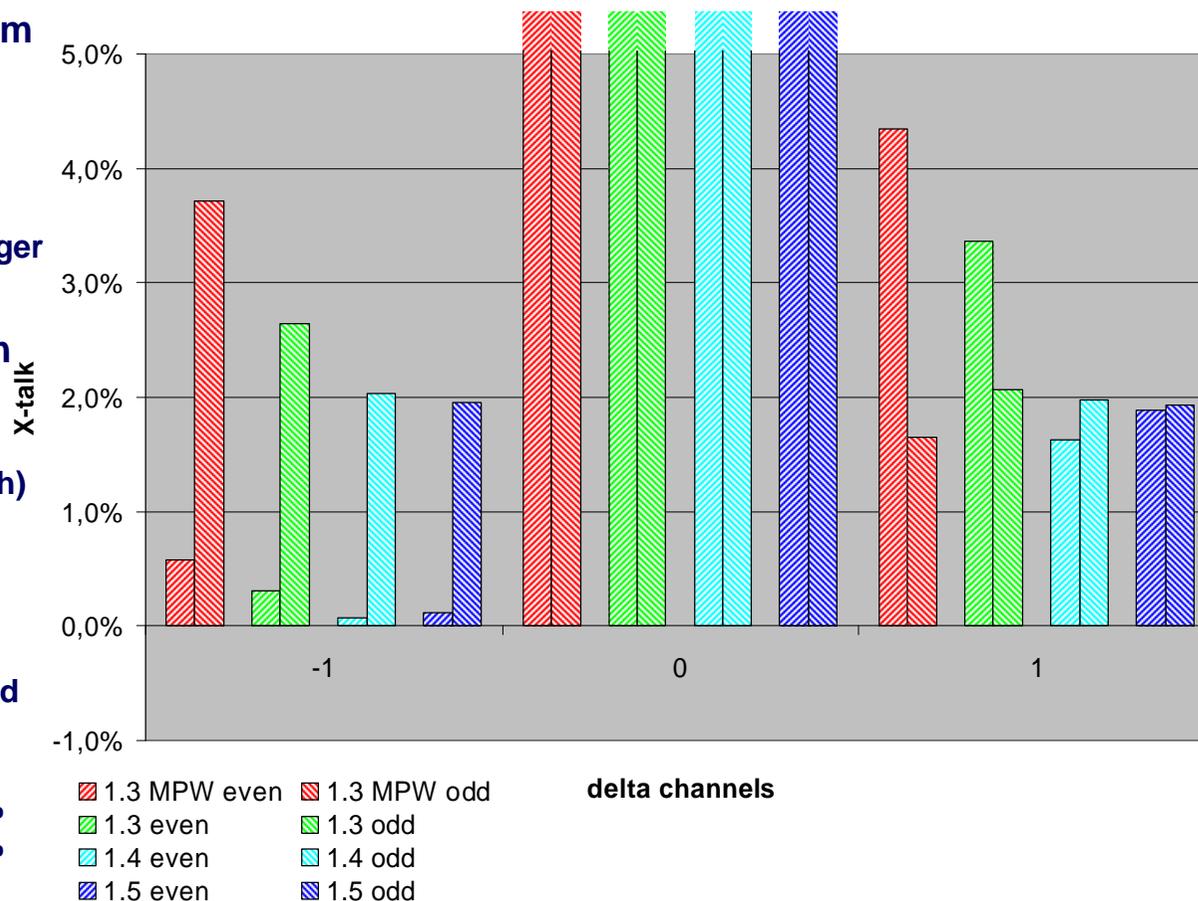
Crosstalk between channels

● **Crosstalk slightly improved from 1.3 to 1.4/1.5**

- This is a result of the new pipeline layout
- But simulation announced a smaller crosstalk (perhaps bigger $C_{\text{parasitic}}$ than expected)

● **Signal crosstalk: a combination of at least 3 different crosstalk:**

- X-talk into next channel (somewhere in the readout path) $1.79\% \pm 0.25\%$
- X-talk into neighbour channel (input pads, front-end) $1.52\% \pm 0.35\%$
- X-talk depending from even/odd channel number (pipeline readout path)
 - Beetle 1.3: $1.60\% \pm 0.26\%$
 - Beetle 1.4/1.5: $0.50\% \pm 0.24\%$





First readout bit (header X-talk)

- On Beetle 1.3 (MPW) there was a slight crosstalk from the last header-bit into the first bit of the analog readout. This crosstalk still exists on all version with nearly the same crosstalk factor:
 - Beetle 1.3 (MPW): $2.2\% \pm 0.2\%$ of the positive or negative header size
 - Beetle 1.3: $2.1\% \pm 0.2\%$
 - Beetle 1.4: $2.4\% \pm 0.3\%$
 - Beetle 1.5: $2.3\% \pm 0.3\%$

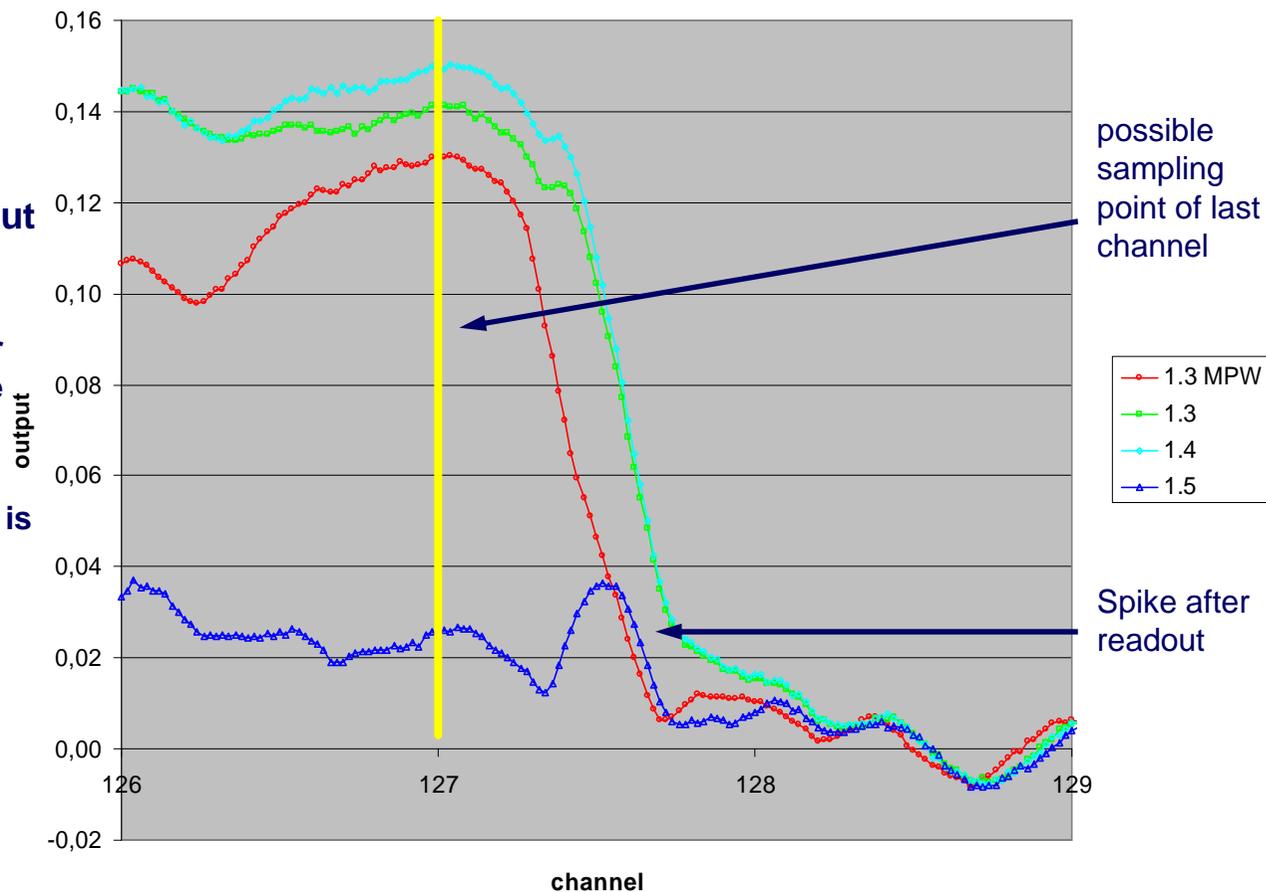




Last readout bit

Last readout bit after the last sampled readout bit

- Only seen at the end of a readout and with no further Trigger stored in the Beetle
- Shouldn't effect the LHCb data acquisition because it is out of the sampling region.

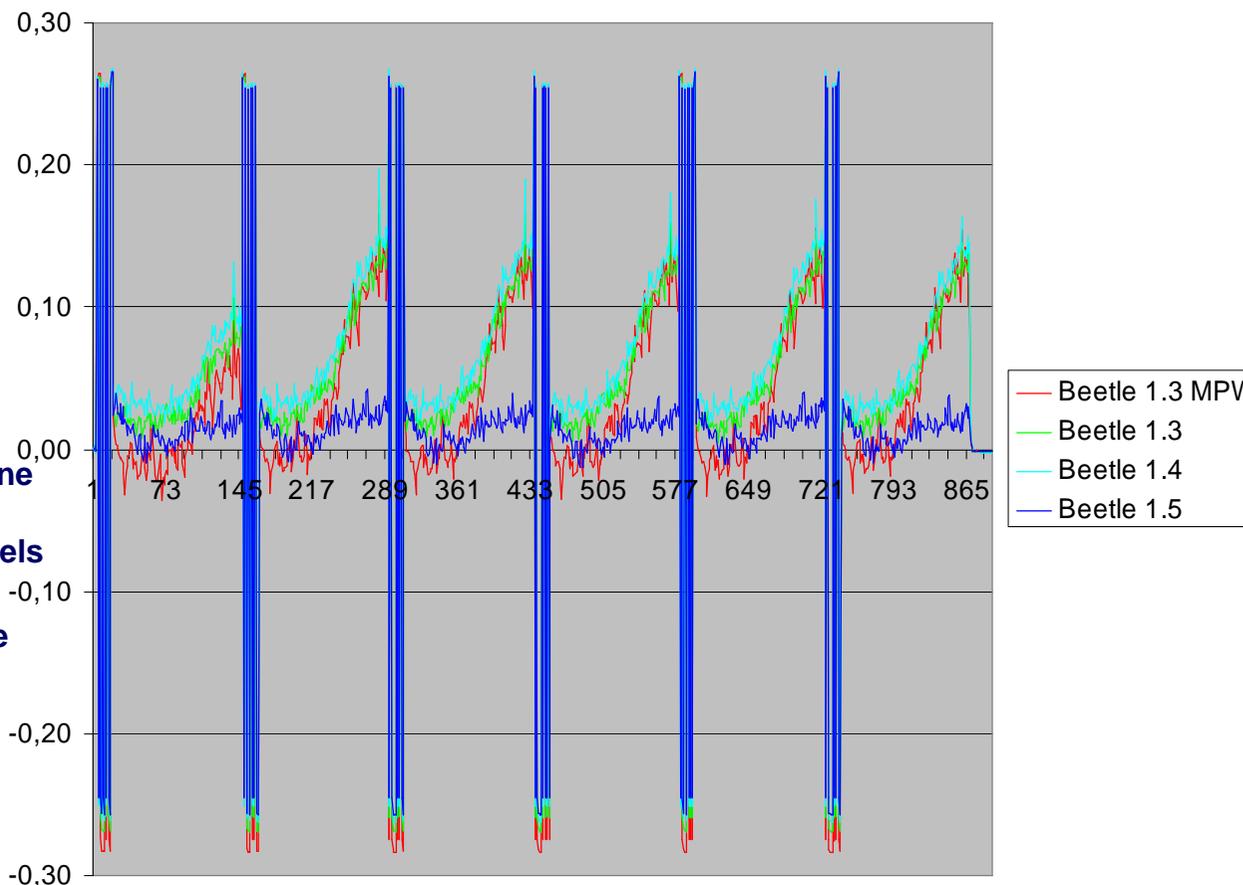




non-consecutive / consecutive I

● **Readout of 4 different chips**

- Beetle 1.3 from MPW run, Beetle 1.3, 1.4 and 1.5 from Engineering Run
- Raw-Data via 4 port readout mode, each port attached behind each other, no baseline correction
=> 16 header bit + 128 channels
- 6 readouts:
1st readout: non-consecutive
following RO: consecutive

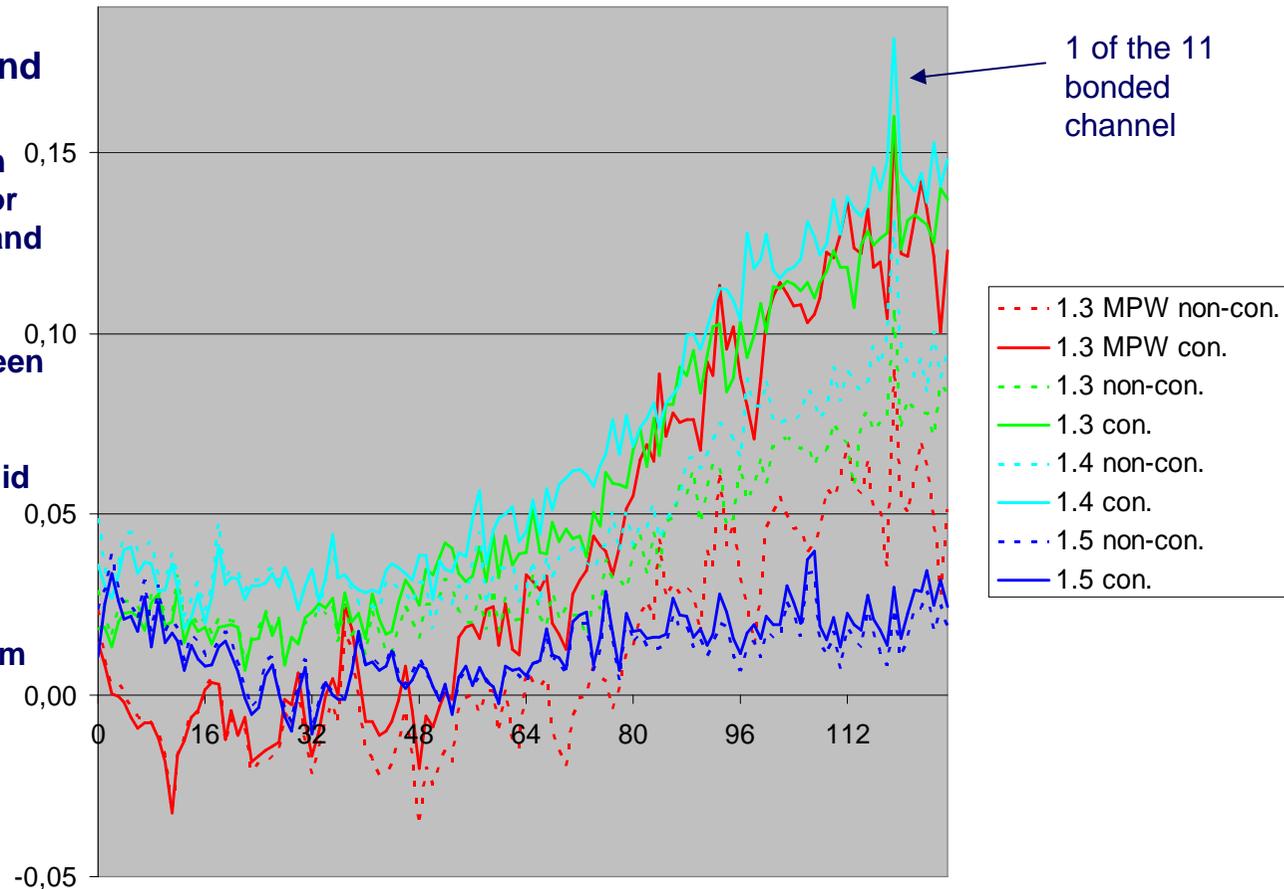




non-consecutive / consecutive II

● **Non-consecutive readout and consecutive readout**

- **Known behaviour between different readout modes for Beetle 1.3 from MPW run and Beetle 1.3, 1.4 from Engineering Run**
- **Nearly no difference between non-consecutive and consecutive readout on Beetle 1.5 (dashed and solid blue lines)**
- **Readout spikes comes from bonded channels**





Summary / Outlook

- All three version on the Beetle Engineering Run works as expected
- Differences were only found in parts presented on the last transparencies
- First yield assumptions are in the normal range (80%)
- Still to be qualified: Different version of the Comparator (1.4 / 1.5)
- Next step: Decision of the Production Run
 - My personal opinion: The Beetle is ready to go on a Production Run because I haven't found any major bugs.

