Calorimeter Read Out Puzzles

Thomas Held

Ruhr-Universität Bochum
Institut für Experimentalphysik I

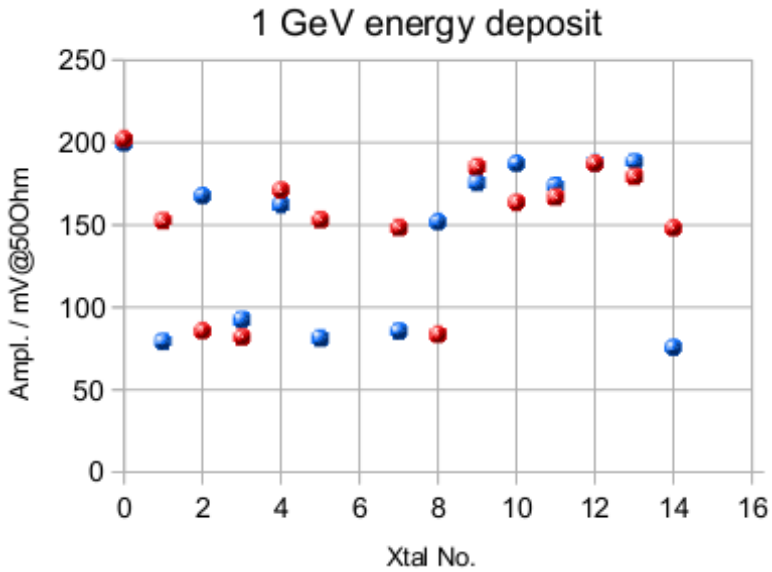
LI. PANDA Collaboration Meeting, FZ Jülich
December 9th, 2014

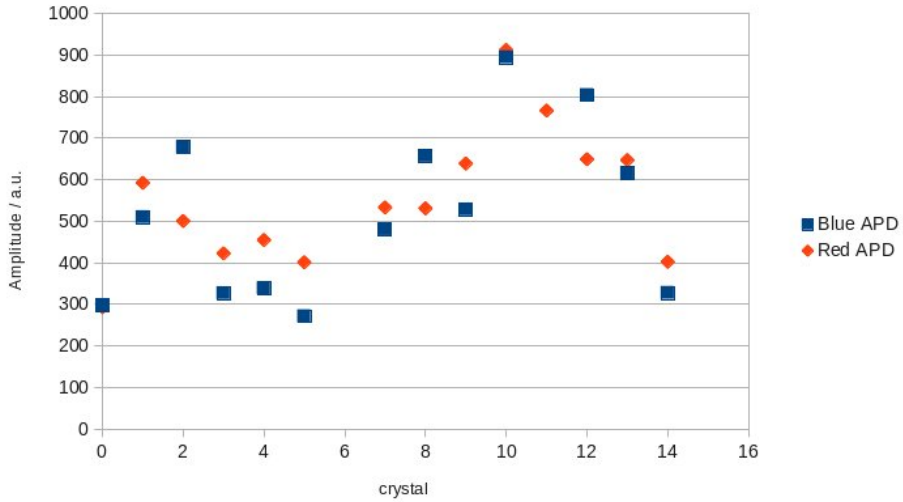
RUHR UNIVERSITÄT BOCHUM RUB

Proto192: 2014 ELSA beam time

- Remember:

  Response of the two APDs on most of the crystals in the 'final' APD-equipped subunit of the Proto192 differs seriously!
  - All APDs gain measured
  - All APDs biased to gain 200
    (within 'pairing deviations' of up to 2 V)
  - Different deviations for beam data and light pulser runs





Proto192: Back in Bochum

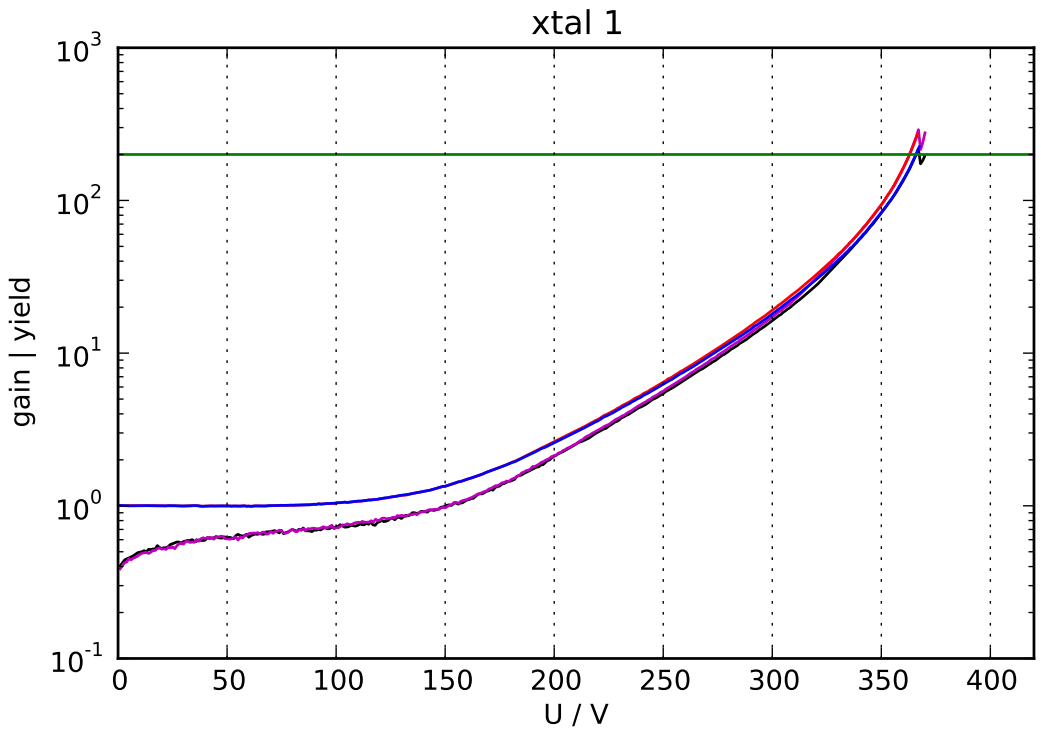
- Rewiring to individual bias supply for each APD
  in order to get rid of 'pairing deviations'
- Measuring gain of every single shaper channel
  (some % deviation)
  $\rightarrow$ Picture slightly modified but basically remains the same
- Cosmics taken in Bochum: same deviations as Bonn beam data
  $\rightarrow$ LED light pulses too different to scintillation light pulses?
- Comparison of risetimes of preamp pulses:
  - response to light pulser: (45$\pm$1/52$\pm$1) ns
  - response to cosmics: (80$\pm$2) ns
- (There are preamps that clearly respond with different output pulse shapes to the same LED light pulses!)

Proto192: Back in Bochum

- Feeding the shaper with pulses of those different rise times (45 vs. 80 ns from a function generator) results in about 30% pulse height difference!!
- However, the response ratios of the two APD-read out channels of one crystal is almost unaffected
- What effect does the difference between LED and szintillation light wavelength peak (420/430 nm) and width (LED much narrower) have?
- What is the spread of spectral response QE(λ) of the APDs?
- Neither a gain reduction of the APDs to 100 nor intensity variations with the light pulser (5...80%) do change the results

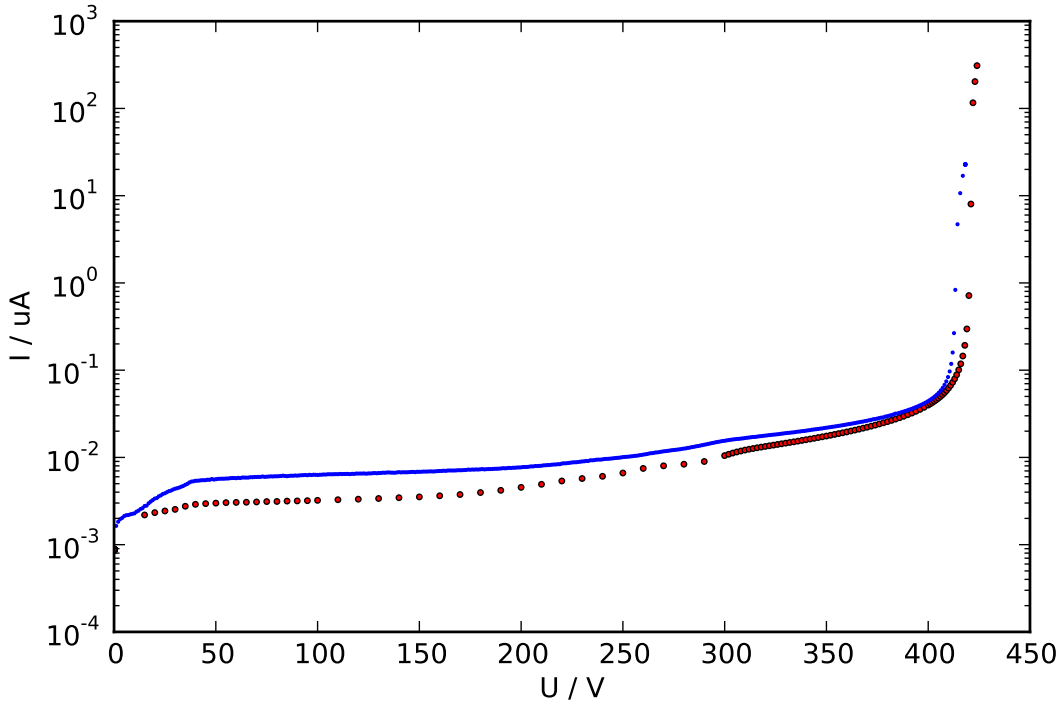
APD screening Bochum

- Example of a screening of the two APDs on crystal 1
  - Blue and red: DC gain curves
  - Black and magenta: AC yield curves (how to normalize?)
- From the -25 ^{o}C gain curves point of view these two APDs should very well match - in fact (Proto192) they do not!



APD screening Bochum

- Example of a dark current curve at +20 °C
  - Blue: Bochum measurement
  - Red: APD lab GSI measurement
  - Where do the differences come from?



Summary

- We see different responses of the two read out channels with most of the crystals in our 'final' APD subunit
- APDs individually biased to gain 200
- The difference in output depends on the source of light:
  - Scintillation light (beam data, cosmics)
  - LED 'PWO-like' light pulses (somewhat less difference)
  - Wavelength and spectral

Summary

- Optical coupling unlikely to cause the effect (Dow Corning glue), even though we can check only after dismantling the subunit
  - VPTTs are coupled with the same adhesive and show uniform responses just as expected
  - However, APDs are placed in capsule before glueing: Can a differing amount of glue or slightly non-parallel positioning in capsule cause trouble?

- The major source of the difference in response of the two read out channels on one crystal seems to come from the APDs
  - The output differs even though the gain is properly adjusted (200 or 100, single APD-HV supplies)
  - How much differ the quantum efficiences and hence the total yields of the APDs?

Conclusion

- Unless there are no further ideas of what still to measure on the APD-subunit in the Proto192 we will take it out and dismantle it for further inspection
- We need detailed APD data (pulsed characteristic curves, QE(λ) curves, capacity curves) in order to sufficiently understand the devices for proper matching
- We need to find the reason for the varying output pulse shapes of the preamps (tolerances of components?)
- We need modified shapers:
  - less sensitivity to input pulse rise time (higher shaper bandwidth)
  - gain maximum at pulse shape relevant frequencies