Forward Endcap

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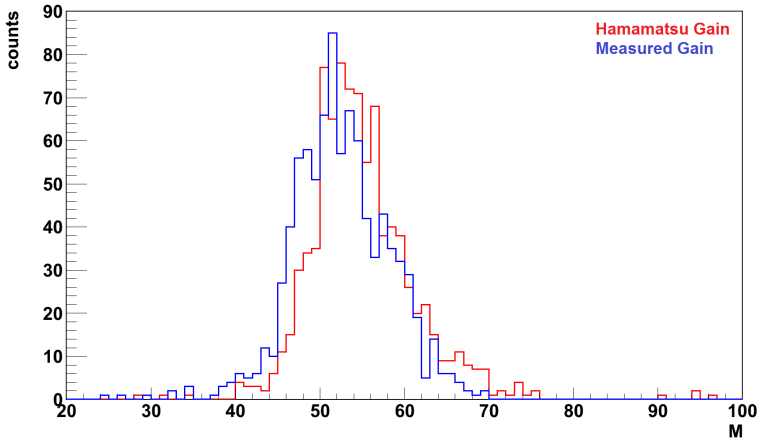
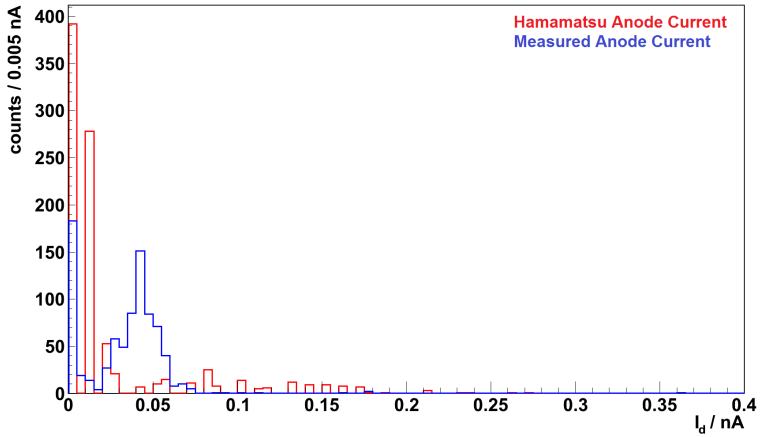
RUHR UNIVERSITÄT BOCHUM RUB

Topics

- VPTTs
  - All PANDA units screened now
  - Determination of preamp gain (incl. Bonn cosmics setup)
- APD preamps
  - Stability vs. gain
- Signal shaping in forward endcap
- APD subunit output differences
  - Some more understanding
  - Some more questions
- APDs - Pulsed vs. DC measurements
- Inner hole walls material?
- Crystal damage
- Summary

VPTTs

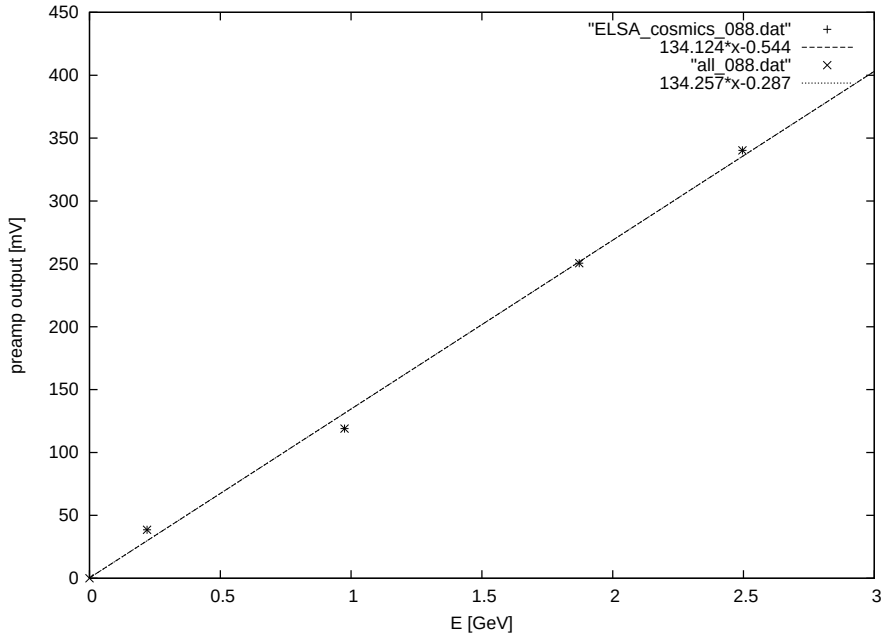




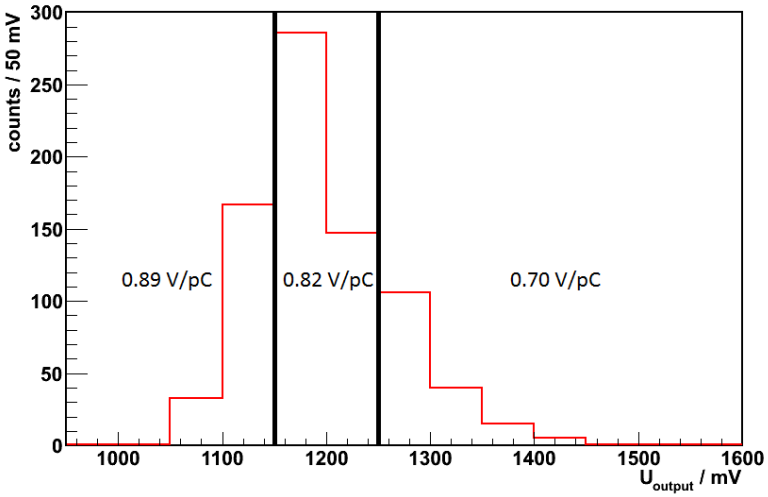
- All PANDA VPTTs screened now
- Gain and dark current distributions fully acceptable
- Ready to sort by gain and start to build subunits
- All 1500 V-voltage divider PCBs already available from Basel

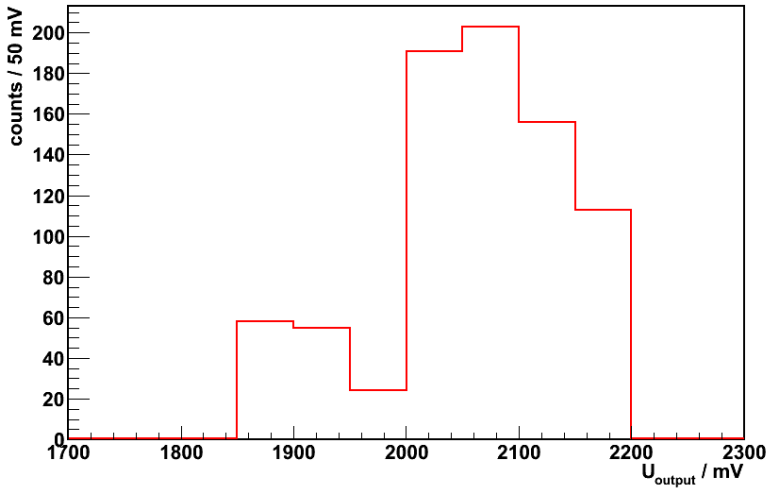
VPTT preamps

- Problem: What gain (mV/pC output) should the preamps have in order to properly cover the dynamic range needed (2 V @ 12 GeV), taking tube gain distribution and B-field losses of tube gain into account
- Last year's ELSA beam time data finally consistent with recent Bonn cosmics setup measurements



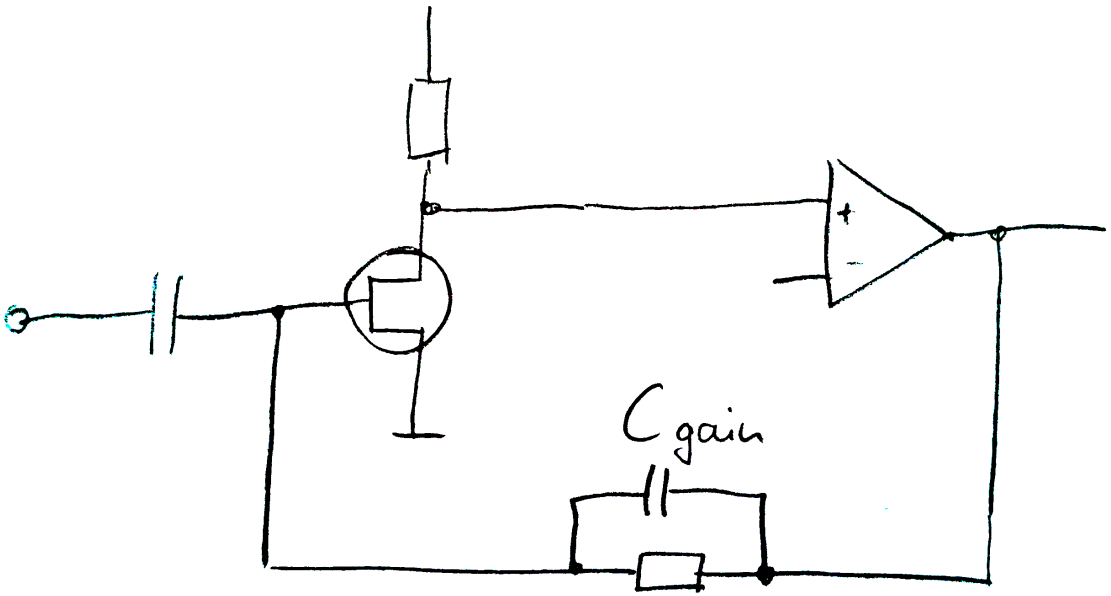
VPTT preamps





- Idea: Narrowing the distribution by manufacturing three different preamps (higher gains)
- Resulting in a use of the full dynamic range and a somewhat narrower distribution

VPTT preamps



- Gain determined by capacitor in negative feedback loop
- Some test pieces in the estimated gain range manufactured in Basel and given to Bochum

VPTT preamps

s/n	C_{gain}	$gain_{BSL}$	$gain_{BO}$	$t_{rise,BSL}$	$t_{rise,BO}$	$noise_{BSL}$
504	0.5 pF	800 mV/pC	880 mV/pC	250 ns	32.7 ns	2.5 mV
516	0.5 pF	830 mV/pC	933 mV/pC	220 ns	37.2 ns	2.7 mV
616	0.6 pF	800 mV/pC	769 mV/pC	220 ns	33.0 ns	2.5 mV
640	0.6 pF	760 mV/pC	760 mV/pC	220 ns	32.2 ns	2.6 mV
700	0.7 pF	660 mV/pC	676 mV/pC	170 ns	29.8 ns	2.6 mV
774	0.7 pF	690 mV/pC	677 mV/pC	180 ns	29.7 ns	2.9 mV

- Three groups of preamps with nominal the same gain
- Pulse shape (rise time) slightly depends on gain (adjusted by C), absolute values depend on pulser rise time
- Signal to noise ratio seems to even slightly improve with rising gain

VPTT preamps

- All gain determining capacitors in feedback loop +/- 0.05 pF (about 10 % of nominal value)
- The necessary three preamp gains (0.89, 0.82, and 0.70 V/pC) just differ in the range of 10 %
- However, the measurements imply more precise components
- Even finer gain adjustment impossible (C_{gain} already in sub-pF range)
- Real preamp gain will be measured for every single piece
- There is still some room for afterwards group-wise gain tuning by varying HV (+/- 20 %)
- So we finally order the three nominal gain ranges defined by 0.5, 0.6, and 0.7 pF C_{gain} (quantities $\rightarrow$ Tobias)

APD preamps

- Problem: Achieve low enough preamp gain
  w/o oscillation susceptibility
  (in order to be able to maintain an APD gain
  as close as possible to 200)
- Gain change: vary capacitance in negative feedback loop
- It is very hard to tell what causes a preamp or a setup with preamps to start oscillating:
  - Temperature
  - Shielding
  - Cabling (propagation via power supply)
  - High or low intensity light pulser signal injection

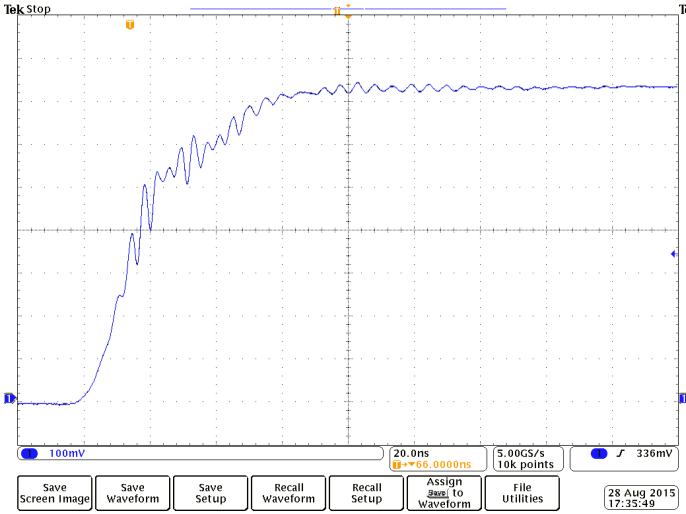
APD preamps

serial number	C [pF]	gain [mV/pC]	rise time [ns]
1002	2.2	210	17.2
1005	1.5	364	20.5
1008	1.8	324	20.0
1013	2.2	212	17.0

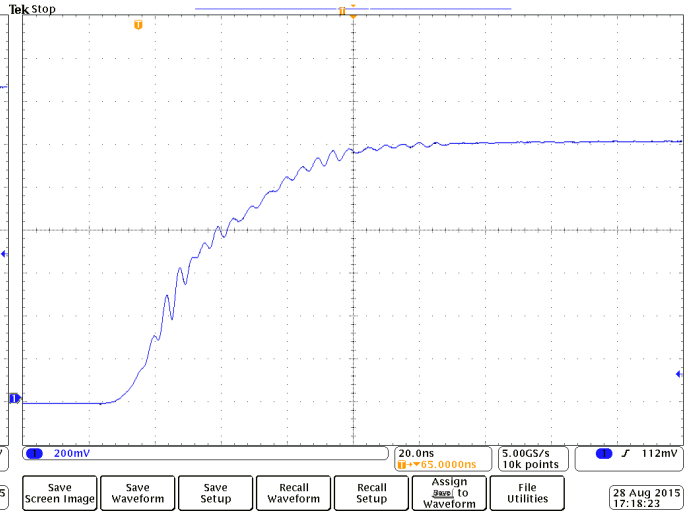
- Preamp # 1013 was the most stable 'low gain' one so far (getting oscillating below -20 ^{o}C only - in the past)
- However, we were not able to cause any of the preamps listed to oscillate recently (not even the one oscillating in the past)
- In certain cases all preamps show ringing with oscillation frequency in rising edge

APD preamps

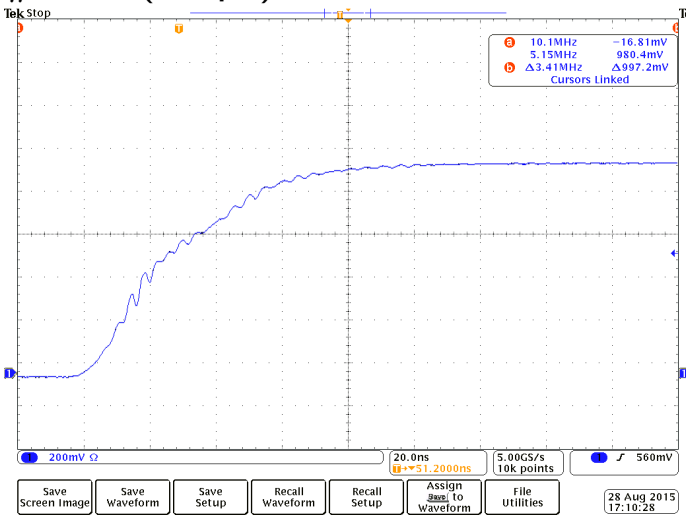
1013 (2.2) pF)



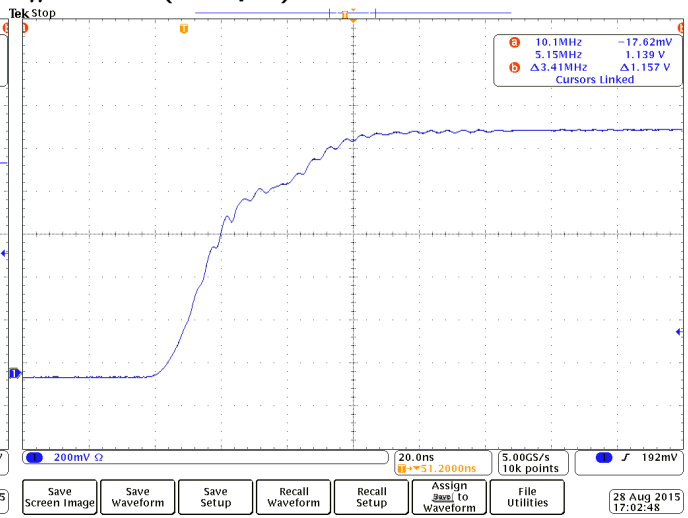
1005 (1.5 pF)



1008 (1.8 pF)



1002 (2.2 pF)

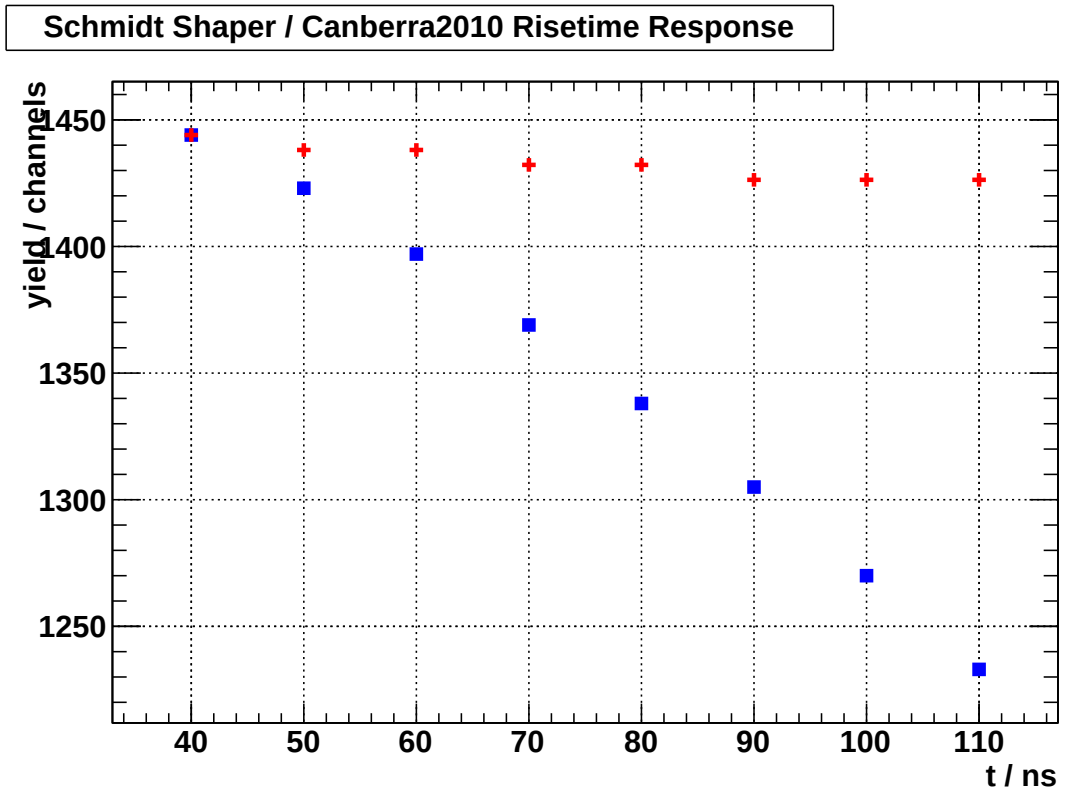


APD preamps

- In order to go on building a new APD unit we decided for 32 pieces with 1.8 pF gain determinating capacitor to be build by Basel
- This is the version a little higher in gain (hence a little more stable) as the one we observed oscillating in the past...
- Mount this unit to Proto192 as this is the best test bed for oscillation susceptibility
- What APD gain will this preamp version finally allow to use? (Answer depends on some other problems to be solved...)

Signal shaping in forward endcap

- Old Proto192 shaping circuit inappropriate
  - Non-linear I/O curve
  - Band pass edge in signal region
    $\rightarrow$ very sensitive to signal rise time (LP vs. scintillation pulse)
  - Improper I/O impedance matching

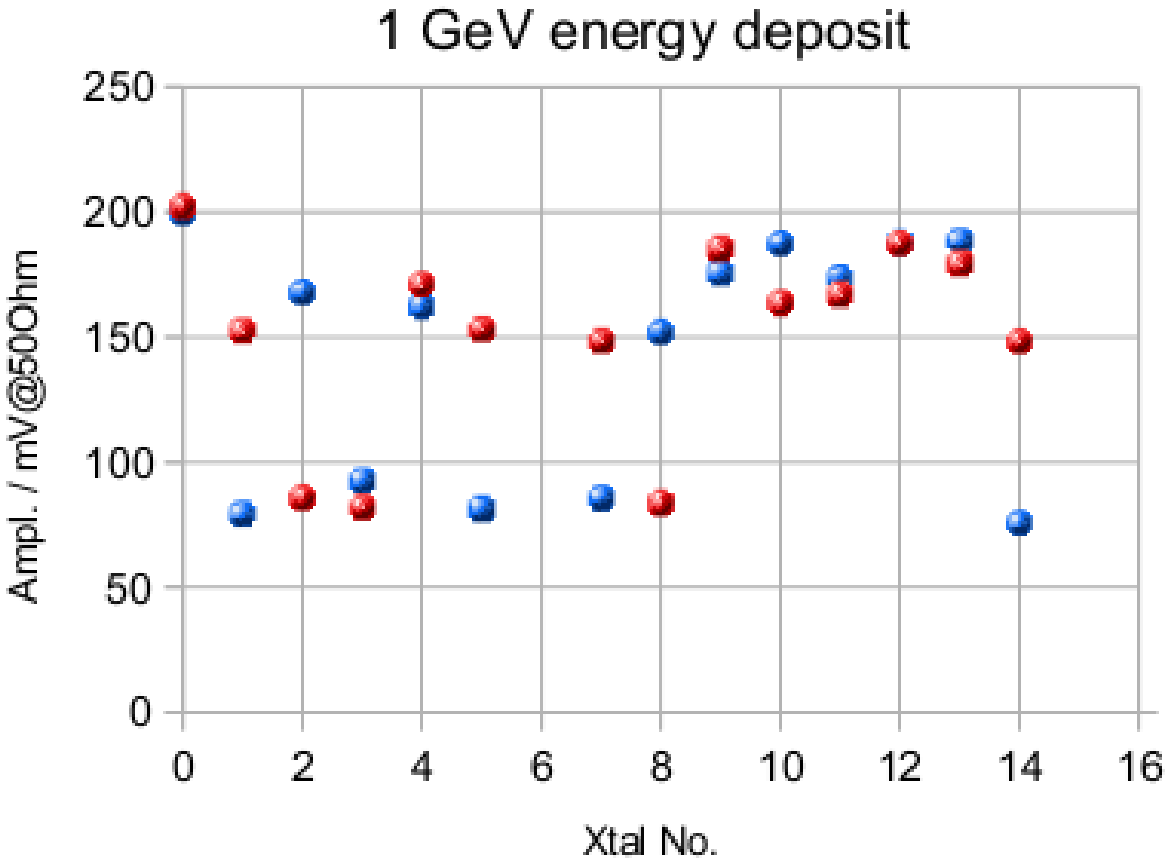


Signal shaping in forward endcap

- New design necessary
  - Transfer shaping (completely) to digital regime (FPGA)?
  - At least one analog hardware shaping stage needed
  - Otherwise blocking of x16-range by high output preamp signals
  - $\rightarrow$ blind to small signals piling up on large ones
  - Matching of 2.2 V single ended preamp output (w/ floating baseline) to 1 V differential ADC input
  - Is a perfect matching ADC board really unaffordable? (Instead of a reuse of the barrel design)

APD subunit output differences

- It is still not fully understood where the differing output signals of two APDs sitting on one crystal come from
- ELSA 2014 beam time results:



APD subunit output differences

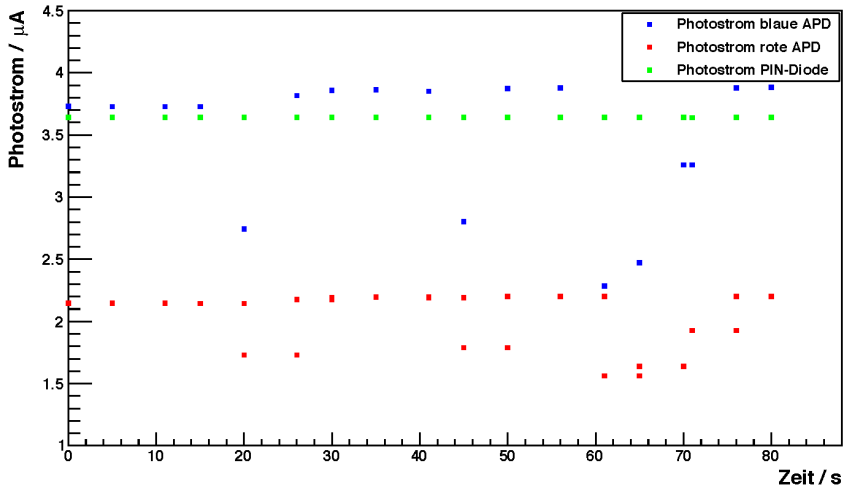
- Checking relative APD quantum efficiencies
  (gain already checked to be properly adjusted by correct HV)
- Some APD-preamp units of the subunit fell off due to
  insufficient curing time of the coupling adhesive (3, 5, 7, C)
- Setup:
  PIN-referenced light pulser $\rightarrow$ light mixer $\rightarrow$ APD-Preamp unit
  precise postitioning!
- Relative quantum efficiencies turn out to be very similar
  for all units checked!
- Deviations in percent range:
  3: 0.99%, 5: 0.84%, 7: 1.63%, C: 2.41%

APD subunit output differences

- With the QE test setup we can as well do the measuremnt including crystal (for the APD units still attached)
- Units measured that way show much larger differences!
- One unit (# 5) fell off after first measurement (incl. crystal) $\rightarrow$ second measurement w/o crystal
- W/o crystal we measure very similar QE values on the same 2-APD unit!
- There seems to be a geometrical/optical effect causing the two APDs on one crystal to receive different amounts of light!
  - Tapering? (Very subtle in forward endcap) $\rightarrow$ Simulation...

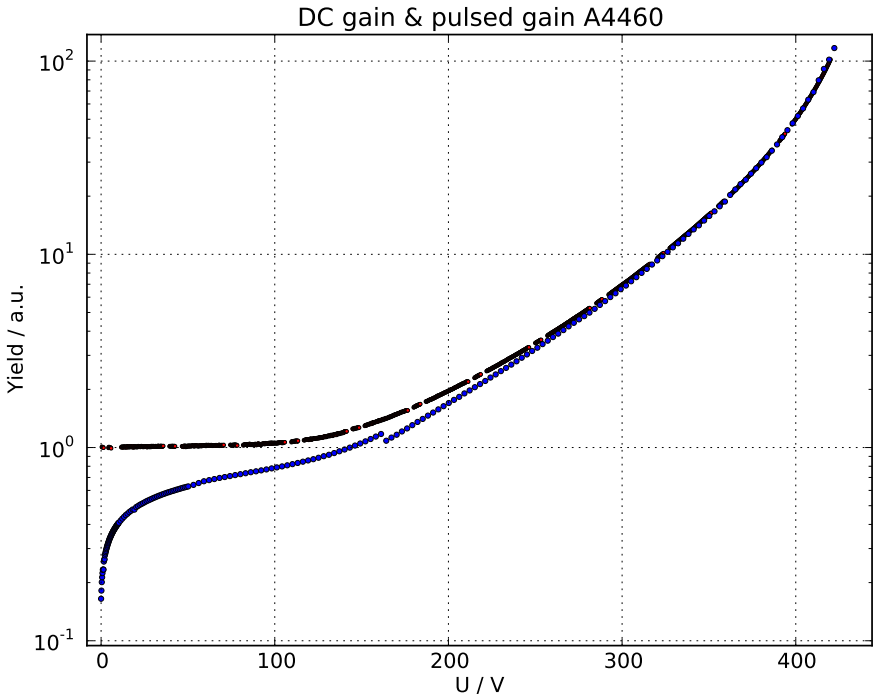
APD subunit output differences

- Previous "w/ crystal" vs. "w/o crystal" measurement done on a 'naked' crystal (no reflective foil)
- The DF 2000 MA crystal cover is an additional source of problems
- Pressing the foil to crystal surface drastically changes signal outputs (20-40 %)
- How does this result translate to the situation inside a subunit (e.g. horizontal vs. vertical mounting)?



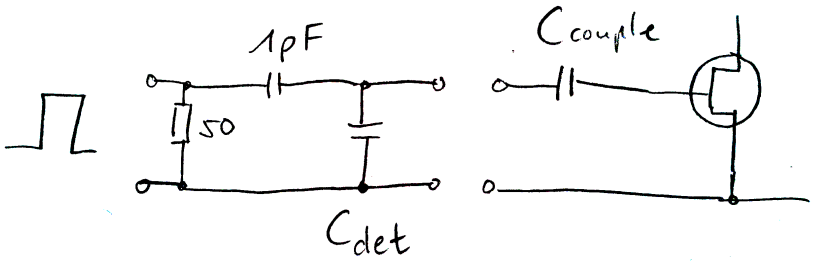
APDs - Pulsed vs. DC measurements

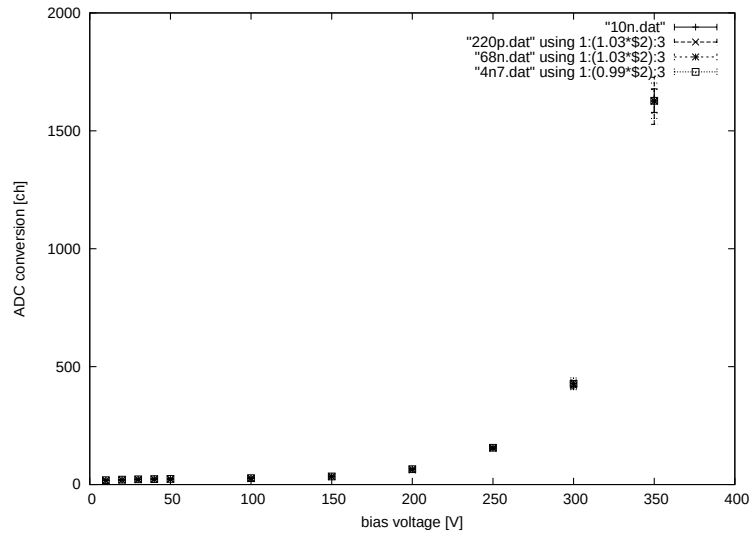
- Some input to the still puzzling “DC” vs. “pulsed” APD characteristic curve differences
- Some time ago there was the idea to check if the HV dependent APD capacity in conjunction with the fixed coupling capacitor may cause differences



APDs - Pulsed vs. DC measurements

- Characteristic curves for four different coupling capacities (220pF, 4.7nF, 10nF, 68nF), light pulser → APD
- I.e. variation of coupling capacity at every single HV position
- No differences observable

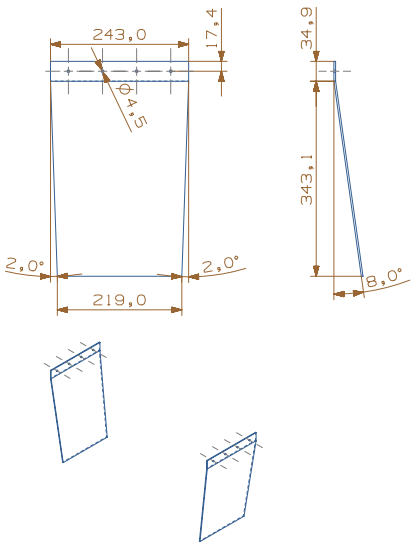




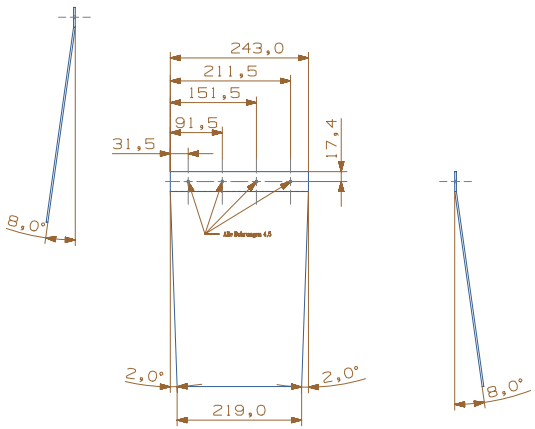
- We also varied the equivalent capacity (modelling the APD w/ and w/o bias) on a charge injection circuit while keeping the coupling capacity constant → no effect!

Inner hole walls material?

- Low density (no metal),
  shadows acceptance of forward spectrometer
- Thermoplast (thin, kinked shape - no milling)
- Non hazardous
  (halogen free, flame retardant: CERN approved)
- If anyone has an idea - please tell us

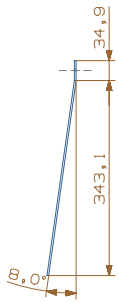


Innerer stiffener ring
Material: PVC t=3
Stck.: 2

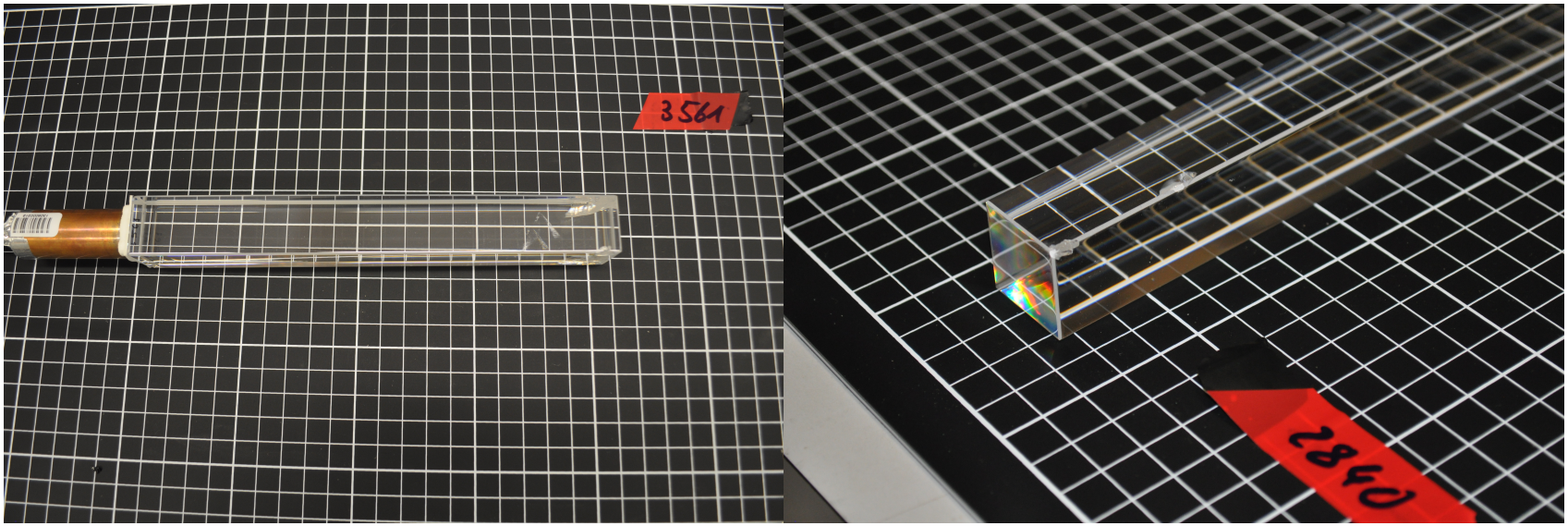


M= 1:5

innerer stiffener ring 1300-17
Material: PVC t=3
Stck.: 2

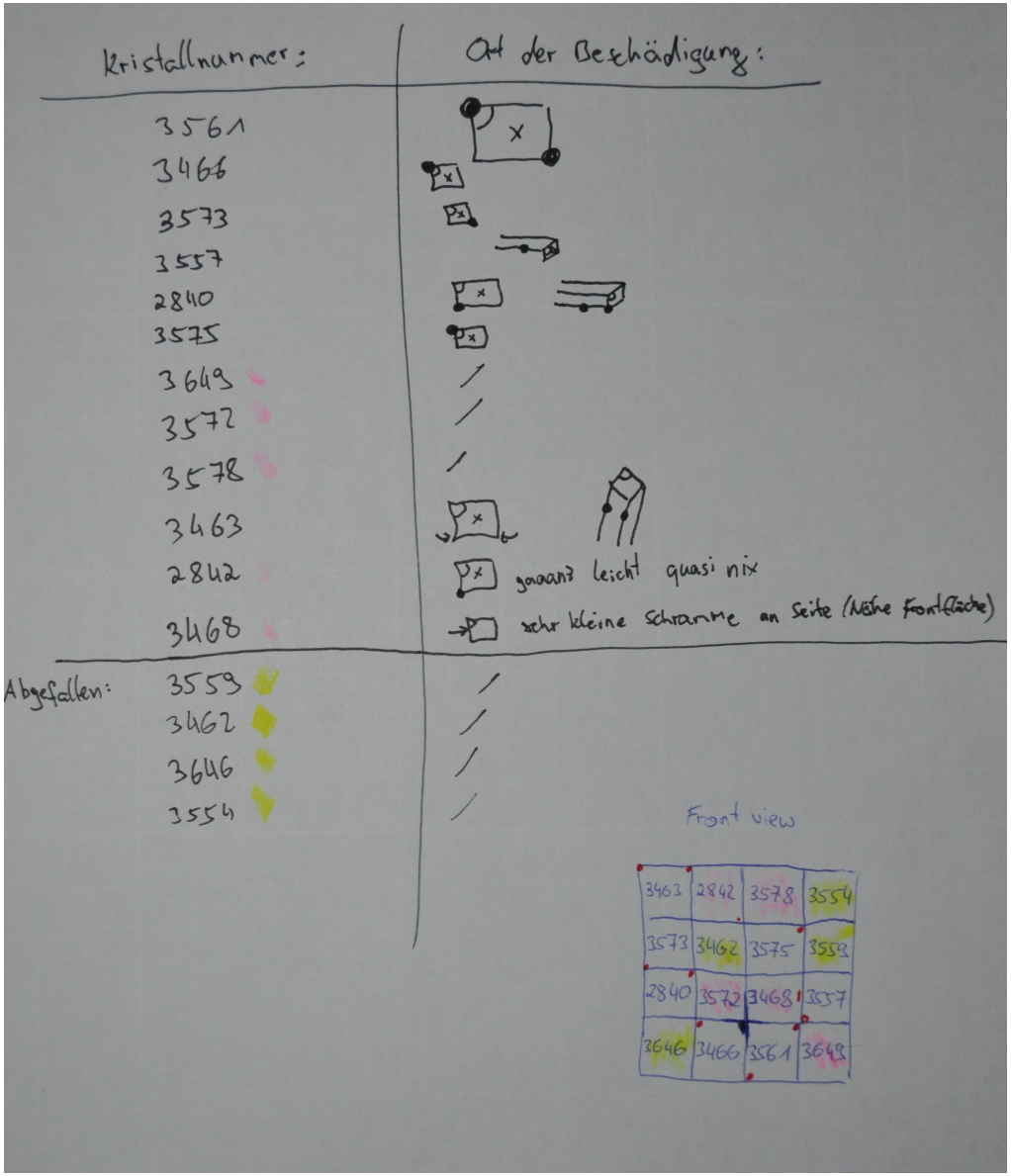


Crystal damage



- There are a lot of damaged crystals in the dismantled APD subunit!
- All damages within the first 4 cm from front face
- Has anyone observed the like before?
- Did the unit accidentally touch ground?

Crystal damage



Summary

- VPTTs
  - All tubes delivered and screened
  - All voltage divider PCBs manufactured by Basel
  - Necessary preamp gains finally determined, ordered
  - All cables delivered
  - So we can start to build all VPTT-units
- APDs
  - 32 gain modified preamps ordered from Basel
  - Received 32 APDs from GSI
  - $\rightarrow$ build new test subunit (stability, ...)
- We need to redo the shaping and test it!
- Quite some (new) problems to be solved
  - Unequal APD outputs (optical/geometrical cause)
  - Understand DC/pulsed APD characteristic curves
  - Suitable plastic for inner endcap hole?
  - What caused the crystal damages in the dismantled APD subunit?