

# APD Failure Modes at Beam Test and Laser Timing Measurements

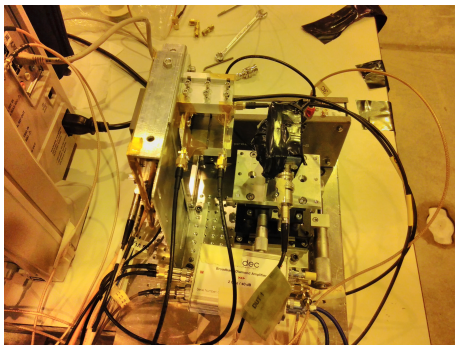
CERN SSD group

23.05.2017  
APD meeting



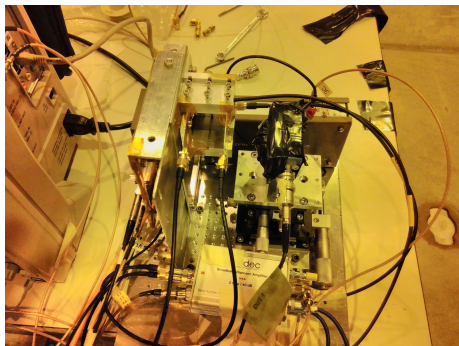
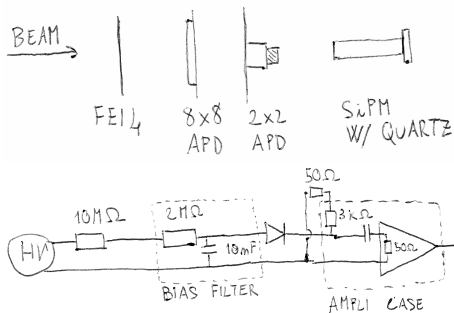
# APDs in Beam Test

- Sofia and me took part in a LGAD beam test
- Participated in data taking
- Got some beam time for two APDs
- One day preparation of our devices:
  - Mounting on PCBs
  - Short time biasing till 1800 V



# Setup

120 GeV/c  $\pi$



All detectors, bias filters, and amplifiers housed in temperature controlled light-tight box. Readout using scope.



# Conclusions

- Got 6 runs with the 8x8 APD (900, 1000, 1100 V, to be analyzed)  
In these runs the APD seemed very inefficient
- 8x8 APD broke at 1700 V in test beam
- 2x2 APD is unstable under bias: trip of the power supply after some minutes, remains alive (observed multiple times)

8x8 APD, we think that the breakdown of the device left a crater



Crater in “safe” area

Next possibility to be on the beam in July  
**Better planning and testing are needed**



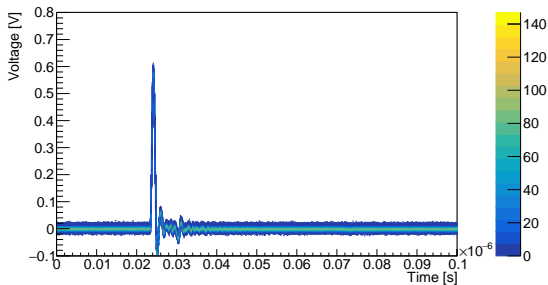
# Laser Timing Measurements

- Use our TCT setup for timing
- 1064 nm laser, 200 ps pulses
- There is a photodiode to monitor laser intensity → timing reference
- Test done using 300  $\mu\text{m}$  pad-diode
- Both diode and reference signals are amplified
- 5 mV ref amplitude before amplification
- $\approx 12.5$  MIPs
- No averaging in the scope
- 1000 WF for each bias setting
- 2 different readout schemes
- Thresholds optimized in analysis

Different timing results depending on the readout scheme

# Reference Signal

1k repetitions

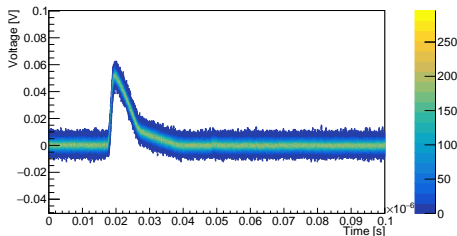


	Reference
Amplitude	579 mV
Noise	6.0 mV
Risetime 20% 80%	313 ps

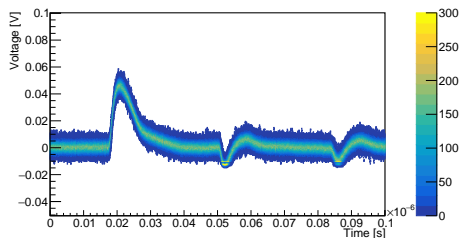
# Diode Signals

1k repetitions at 100 V

Front readout and bias



Back bias, front readout



Front bias and readout

Back bias, front readout

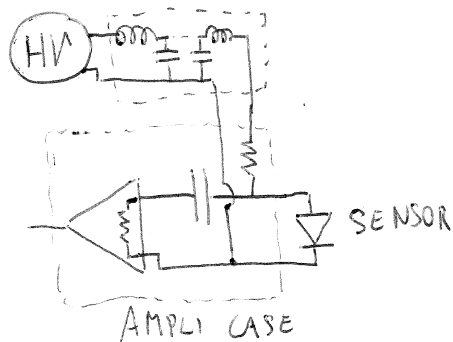
Amplitude	54.5 mV	49.5 mV
Integral	3.55e-10 Vs	3.60e-10 Vs
Noise	2.8 mV	2.9 mV
Risetime 20% 80%	854 ps	1361 ps

Difference in: amplitude, risetime, reflections

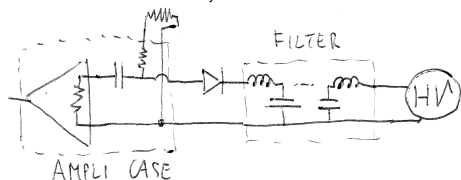
# Readout schematics

Front readout and bias

FILTER



Back bias, front readout



The resistor inside the amplifier case has a value of  $3\text{ k}\Omega$ , the amplifier input should be  $50\text{ }\Omega$ .

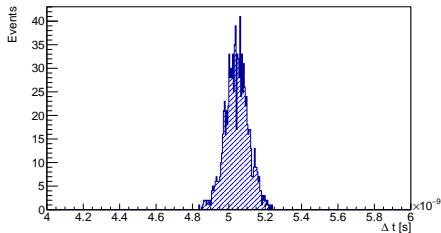
The resistor outside the amplifier case is  $50\text{ }\Omega$ .

# Time Difference Distribution

1k repetitions at 100 V

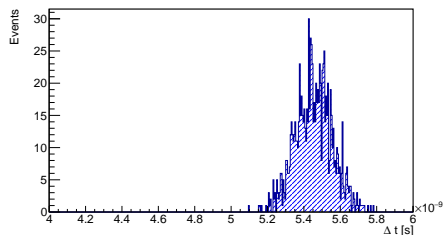
Front readout and bias

CFD: Thr1 0.50, Thr2 0.20,  $\sigma = 64.07 \pm 1.47$  ps, 1000 events



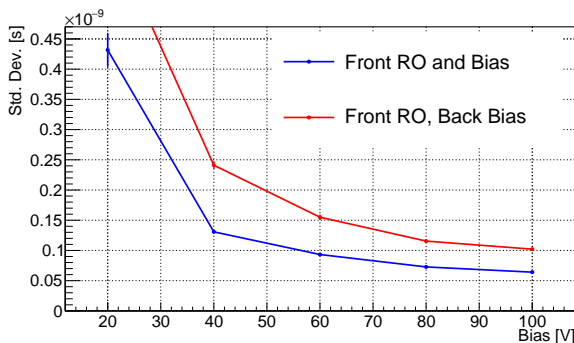
Back bias, front readout

CFD: Thr1 0.35, Thr2 0.70,  $\sigma = 102.12 \pm 2.31$  ps, 1000 events



# Timing vs Bias

CFD algorithm, thresholds optimized for each bias



Different time performance due to different readout scheme

# **Backup Material**