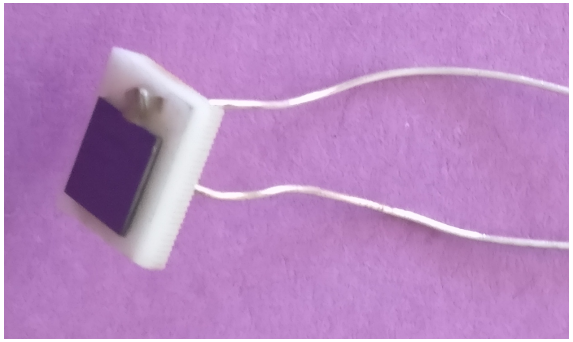
Timing with Delay Line

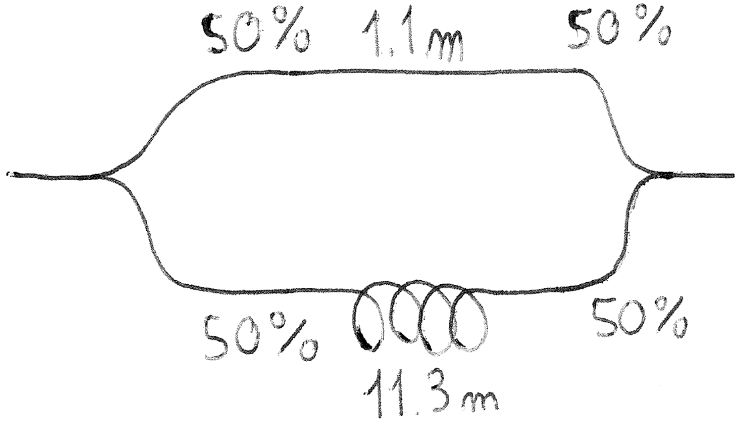
CERN group

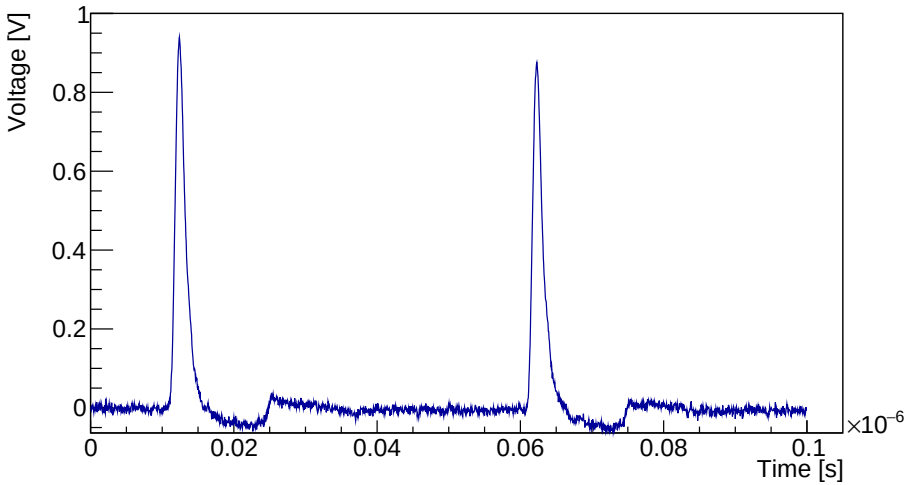
10.11.2017
APD Meeting

Setup

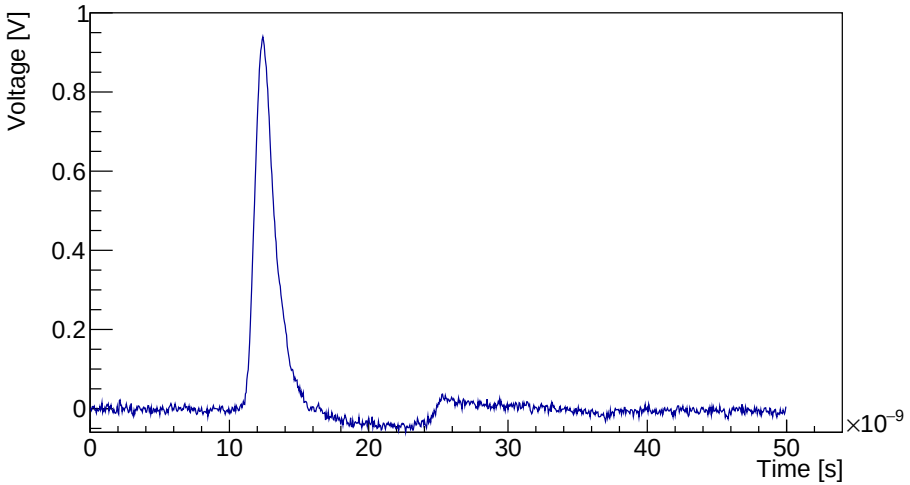
- 2×2 mm^2 APD, non-irradiated
- 2 kV version Cividec ampli
- n-side bias and readout
- 1745 V
- 3000 repetitions, no average
- IR back illumination
- 50 ns delay line between laser and first splitter
  $\rightarrow$ can use calibration from before
- Ref amplitude 0.245 mV
  $\rightarrow$ **0.8 MIPs**
- Amplitude difference of less than 4 %

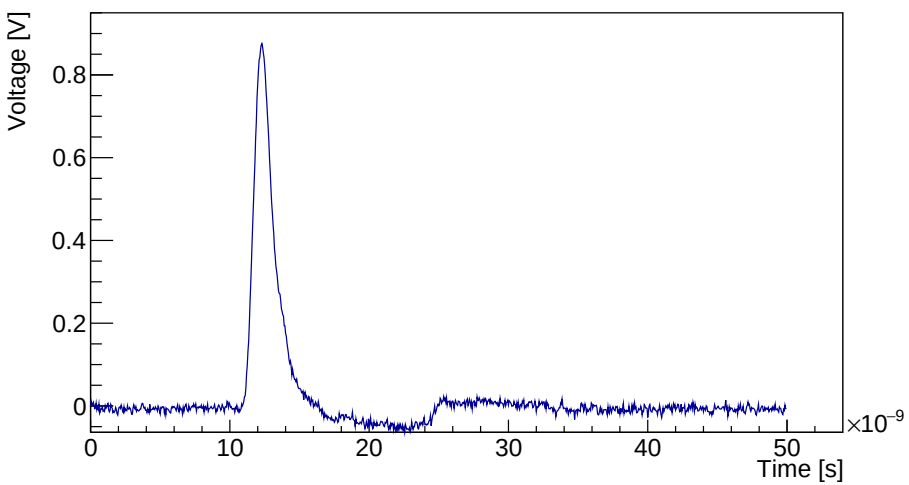




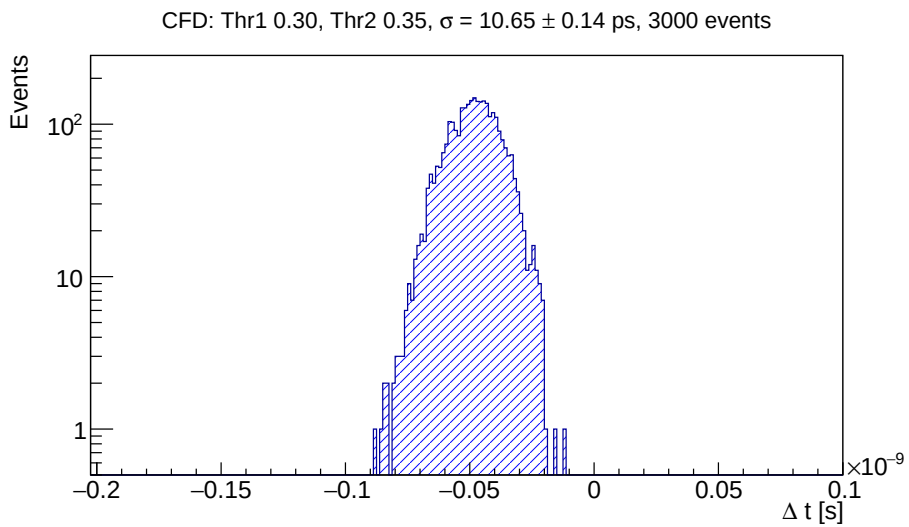


Analysis





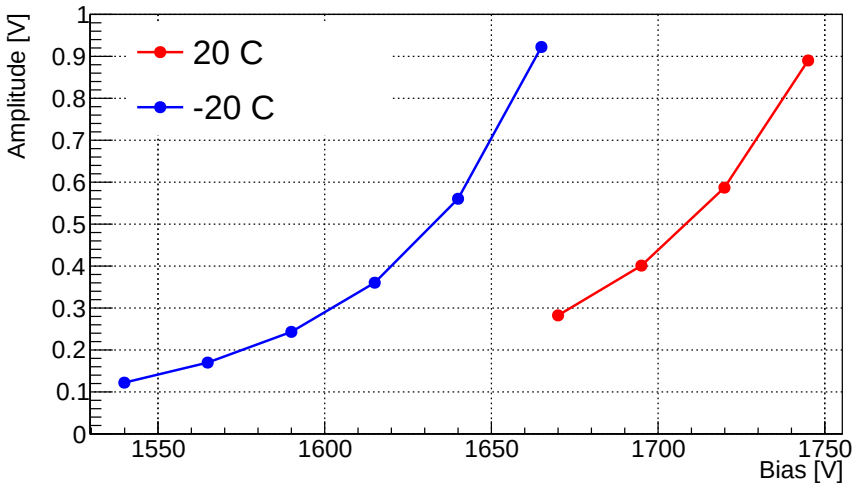
- Divide waveform in two parts
- Apply different thresholds to estimate time difference
- Select best threshold combination



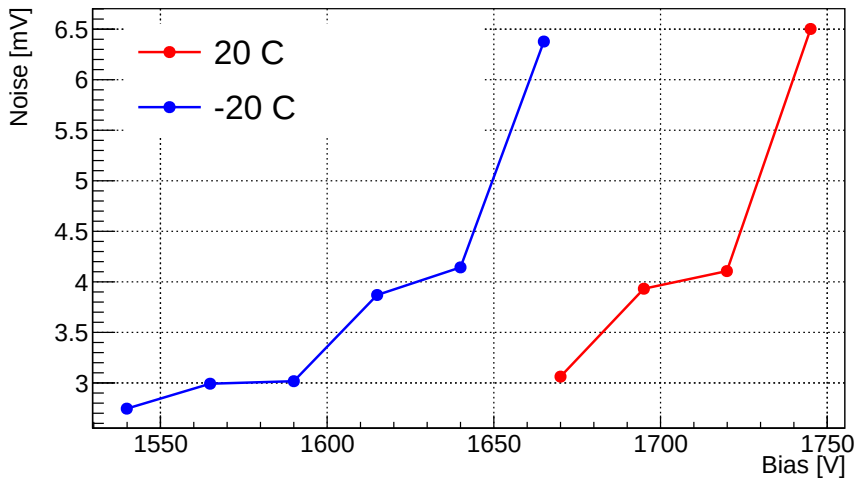
Divide by $\sqrt{2}$ to get single pulse resolution: 7.5 ± 0.1 ps
(Same detector and same pulse intensity justify this)

Non-irradiated 2x2 APD, 0.8 MIPs, 2k reps

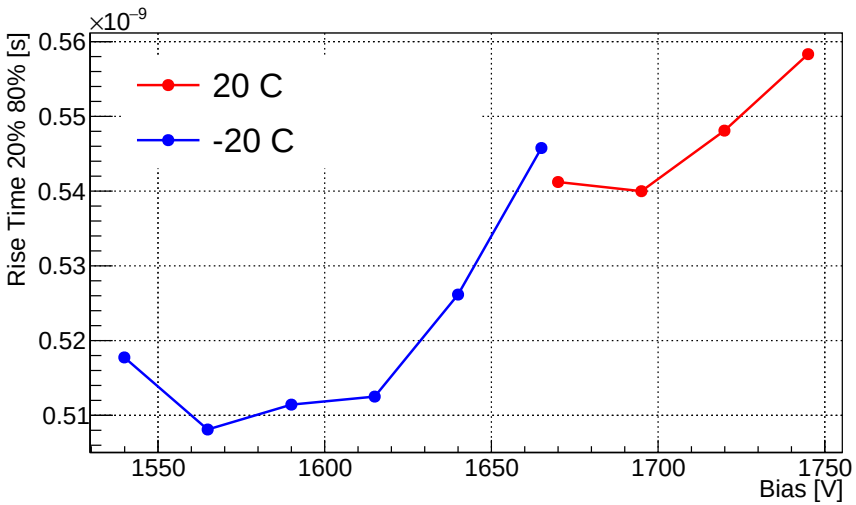
Amplitude



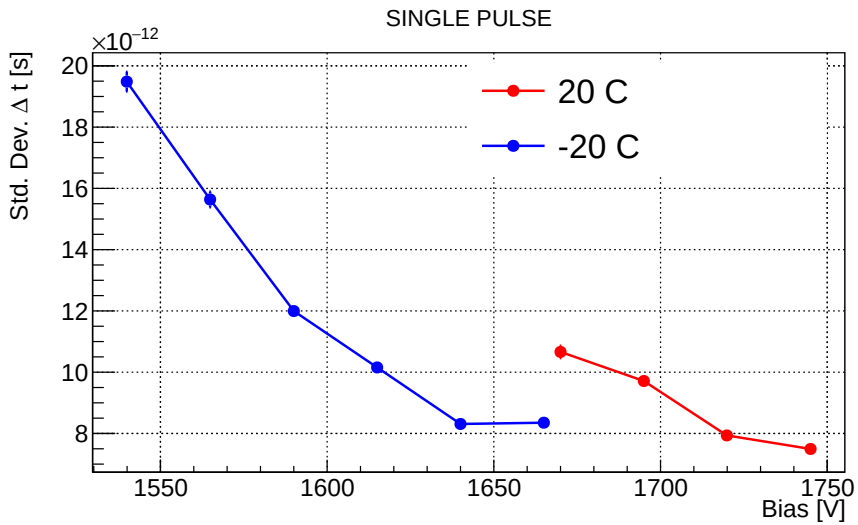
Noise



Rise time 20% 80%



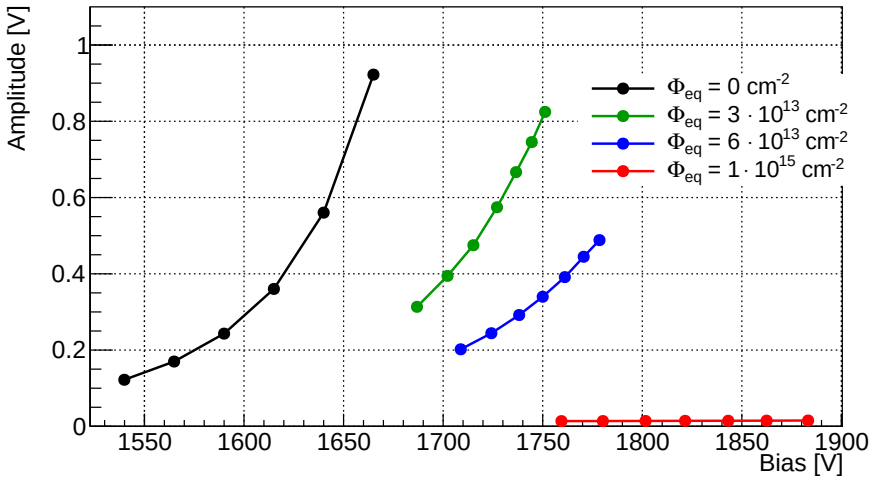
Time resolution



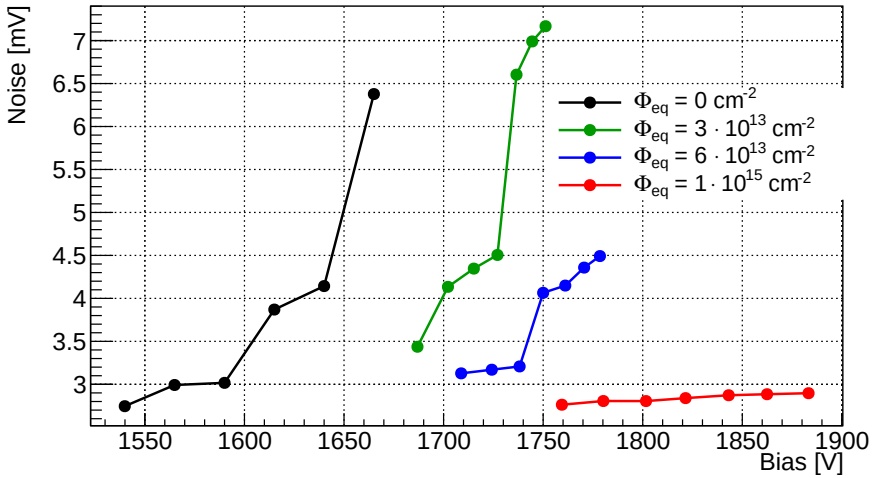
Amplitude and noise dominated by multiplication coefficients

Neutron irradiated 2x2 APD, -20 C, 0.8 MIPs, 2k reps

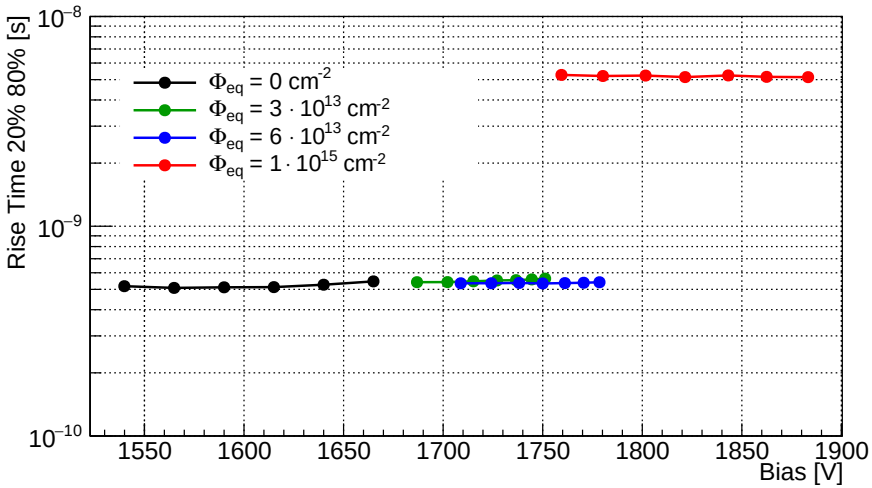
Amplitude



Noise

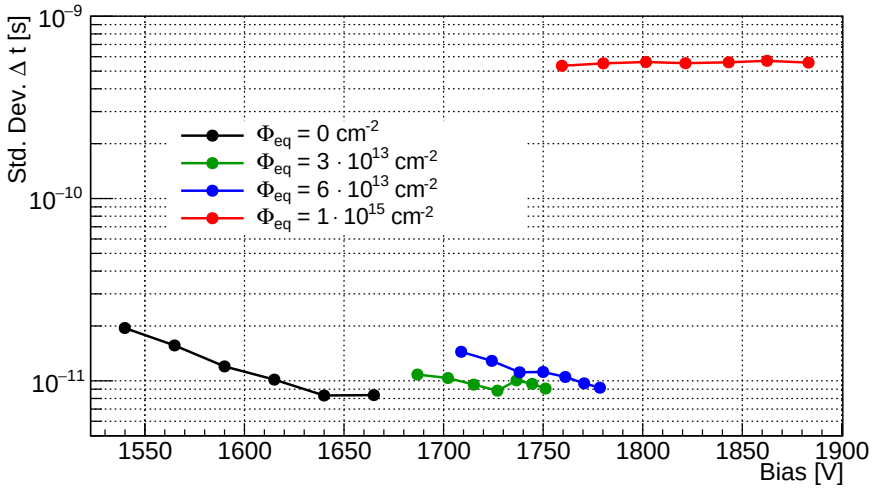


Rise time 20% 80%

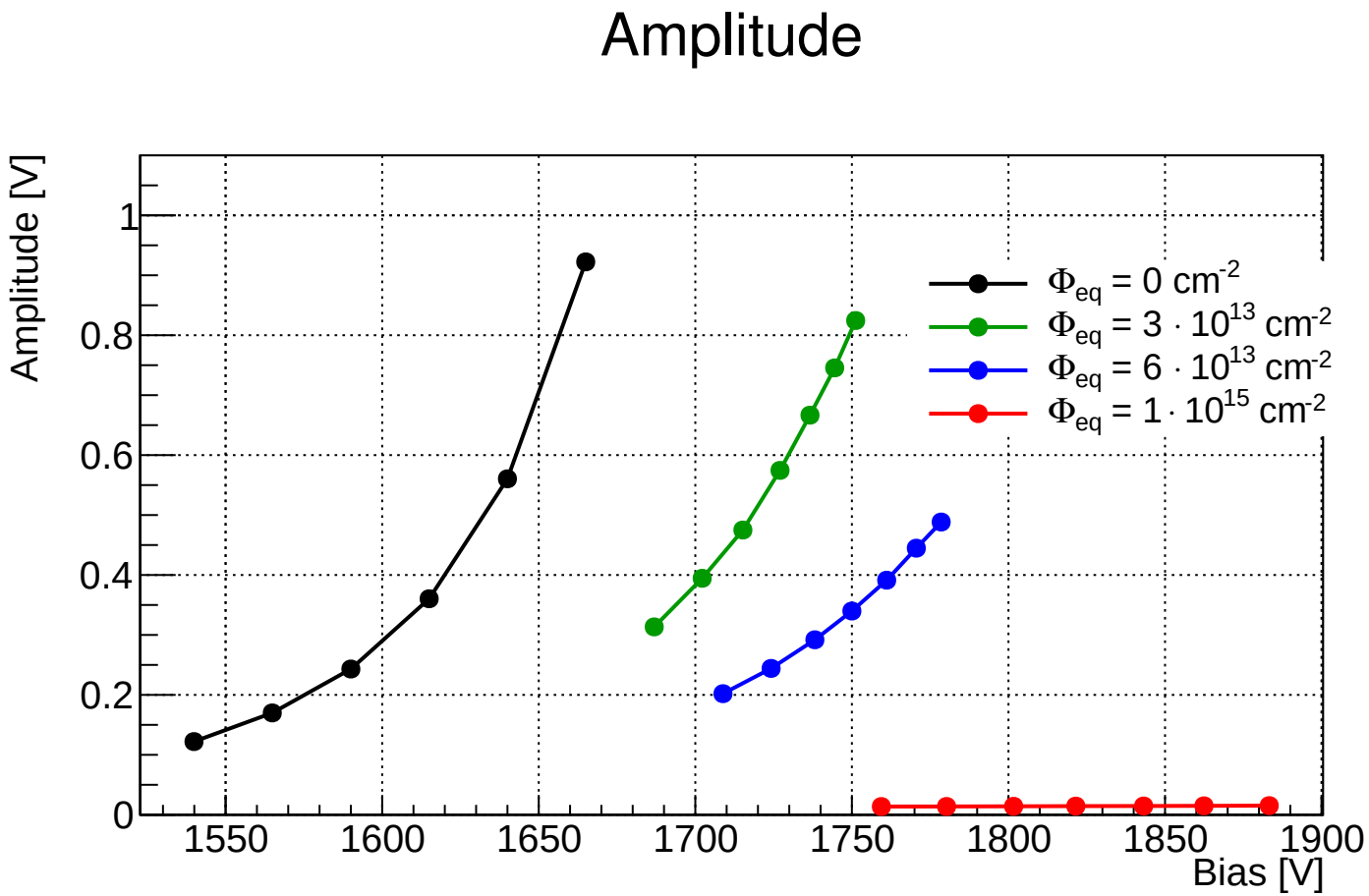


Time resolution

SINGLE PULSE

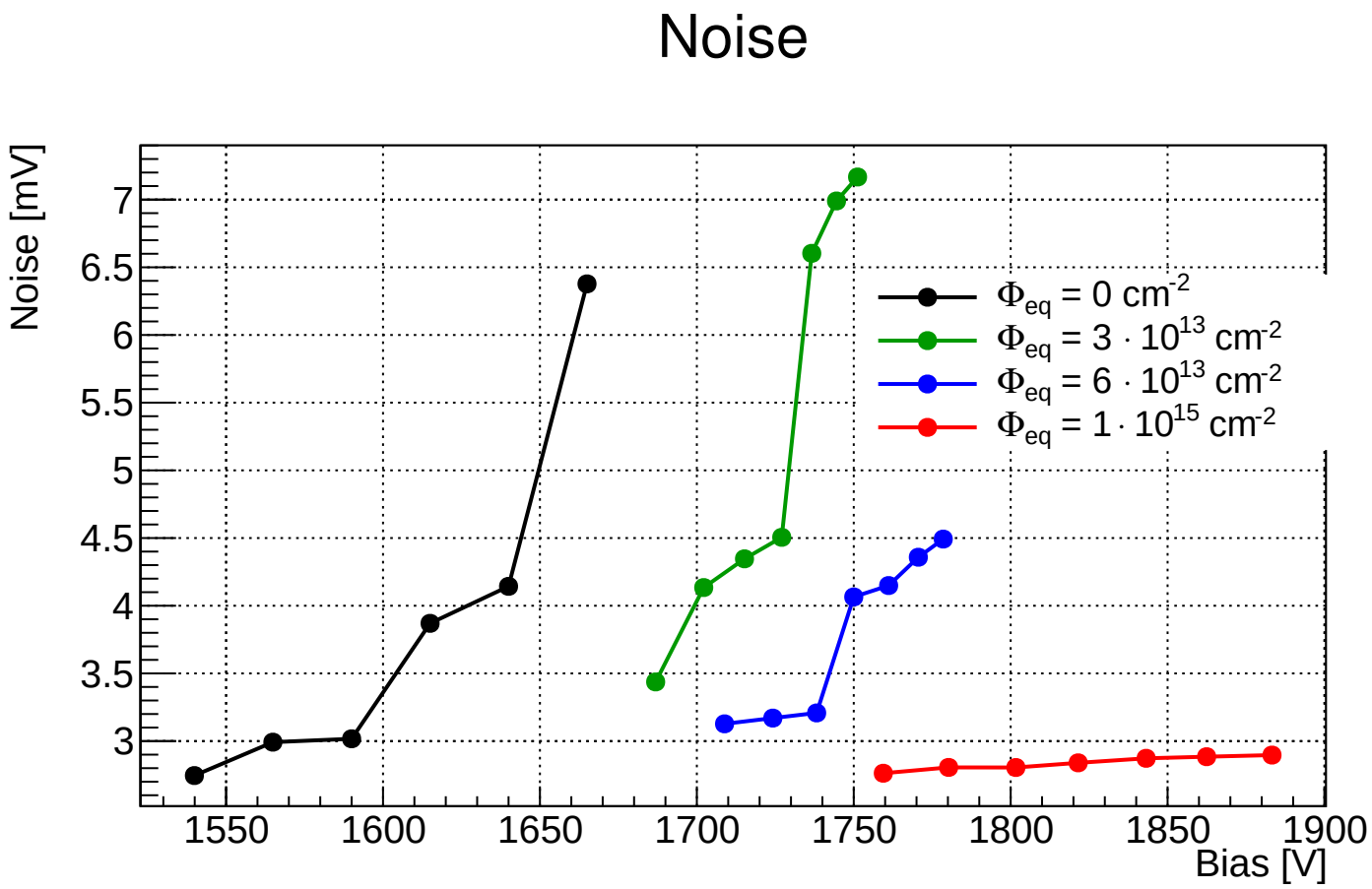


Neutron irradiated 2x2 APD, -20 C, 0.8 MIPs, 2k reps



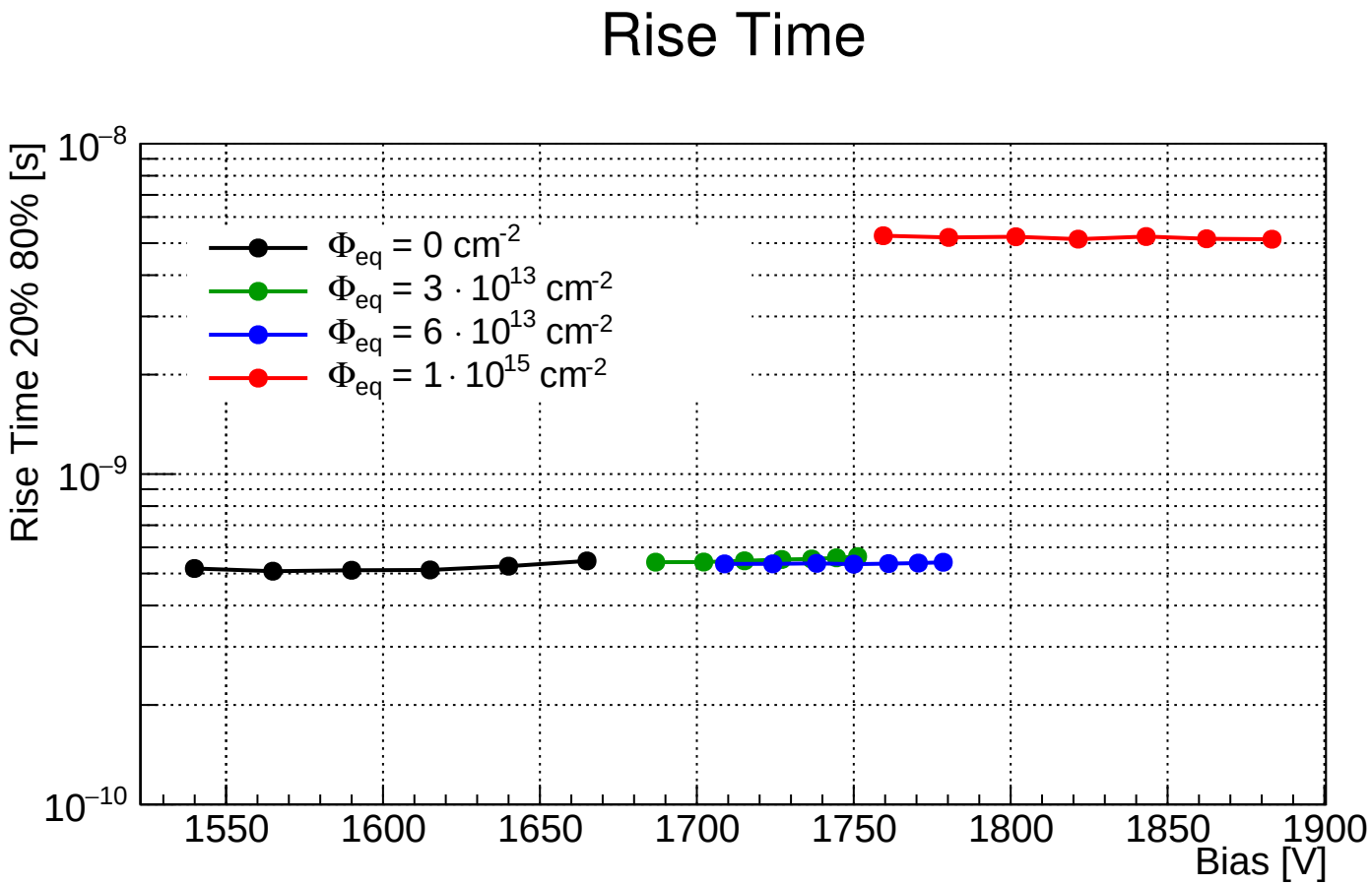
- For $\Phi_{eq} \leq 6 \cdot 10^{13}$ cm^{-2} amplitude recovered augmenting bias
- $\Phi_{eq} = 10^{15}$ cm^{-2} no multiplication?

Neutron irradiated 2x2 APD, -20 C, 0.8 MIPs, 2k reps



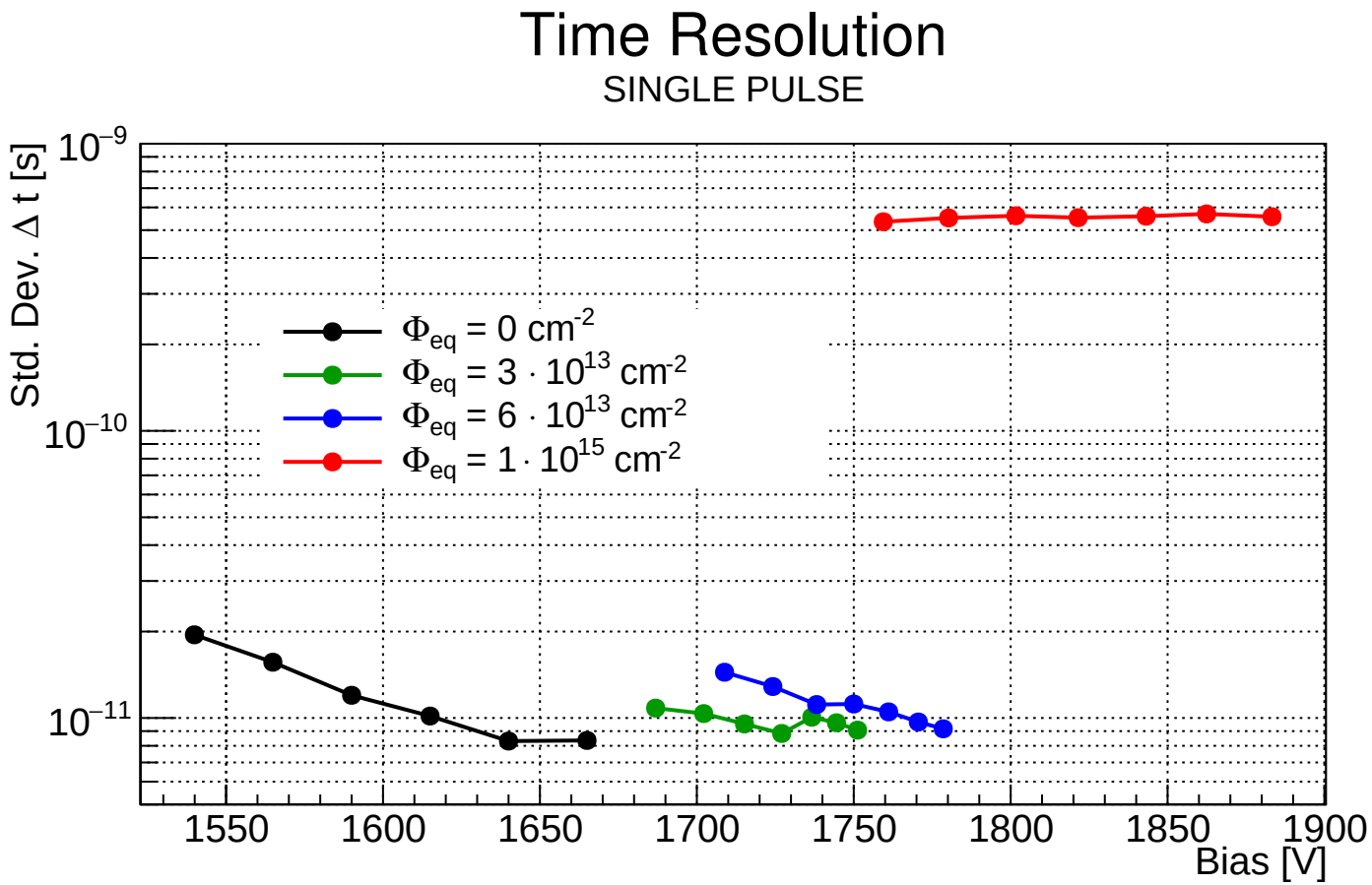
- Product of bulk current and multiplication

Neutron irradiated 2x2 APD, -20 C, 0.8 MIPs, 2k reps



- For $\Phi_{eq} \leq 6 \cdot 10^{13}$ cm^{-2} around 550 ps
- $\Phi_{eq} = 10^{15}$ cm^{-2} dominated by “dark pulses”

Neutron irradiated 2x2 APD, -20 C, 0.8 MIPs, 2k reps



- For $\Phi_{eq} \leq 6 \cdot 10^{13}$ cm^{-2} recovered augmenting bias
- $\Phi_{eq} = 10^{15}$ cm^{-2} dominated by “dark pulses”

Summary

- Method seems to work
- No need to use a reference detector
- **Cross-checks on the data presented today are needed**

Backup Material