Crilin FEE and SiPMs: laser test and timing

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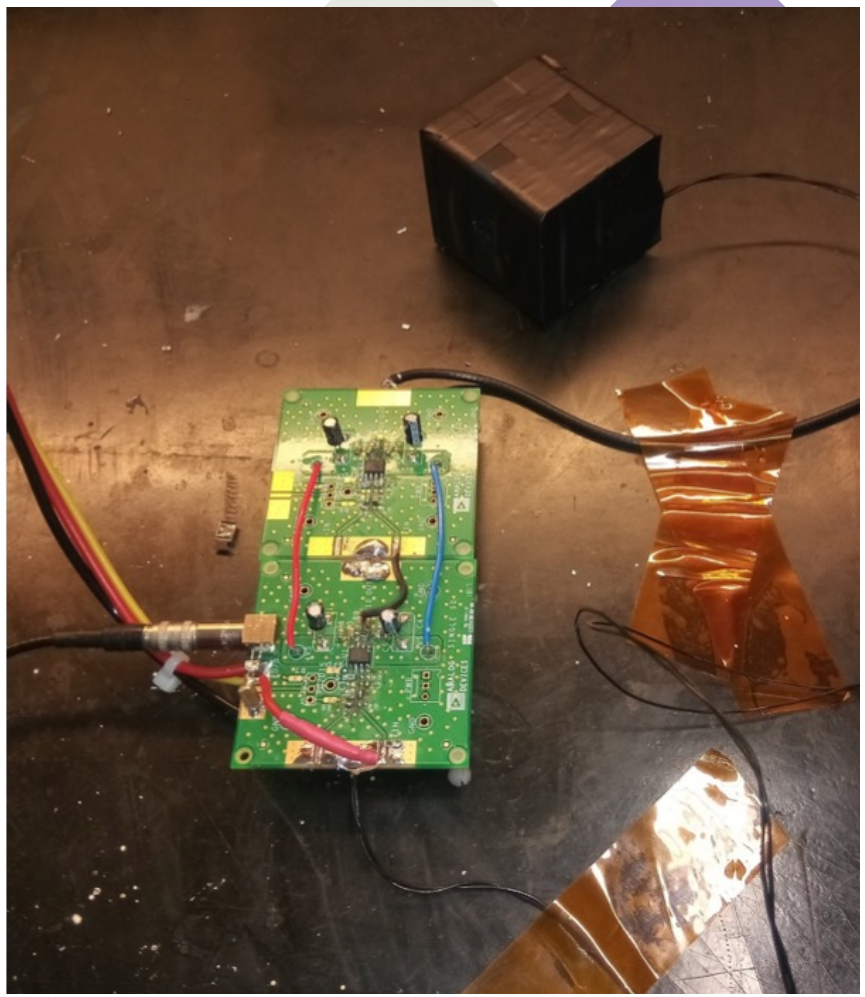
Front End Electronics prototype

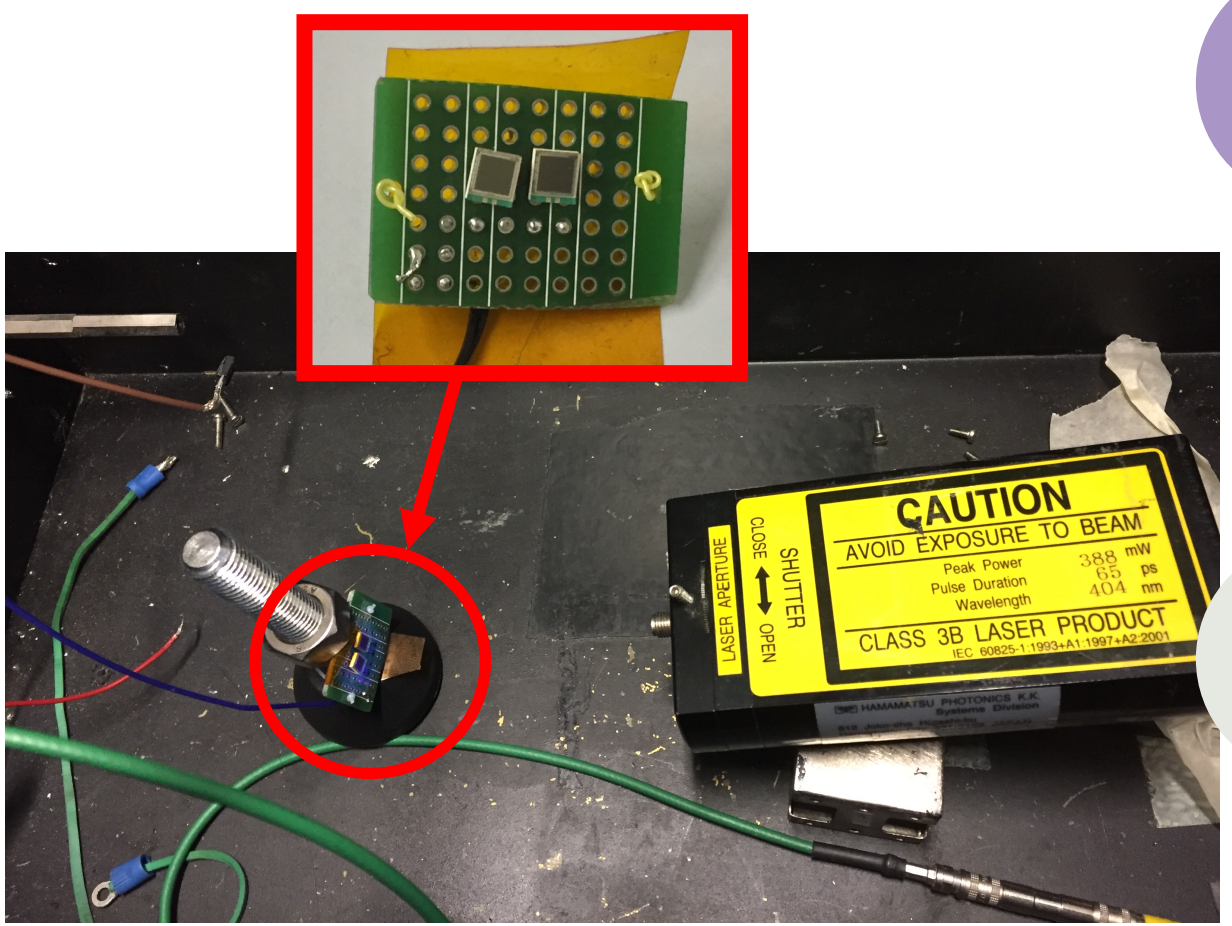
New front end electronics:

- Two stage amplifier + pole-zero cancellation network;
- FE prototype assembled on development protoboard;
- Electronics gain=7;
- SiPMs where bias using an external HV supply.

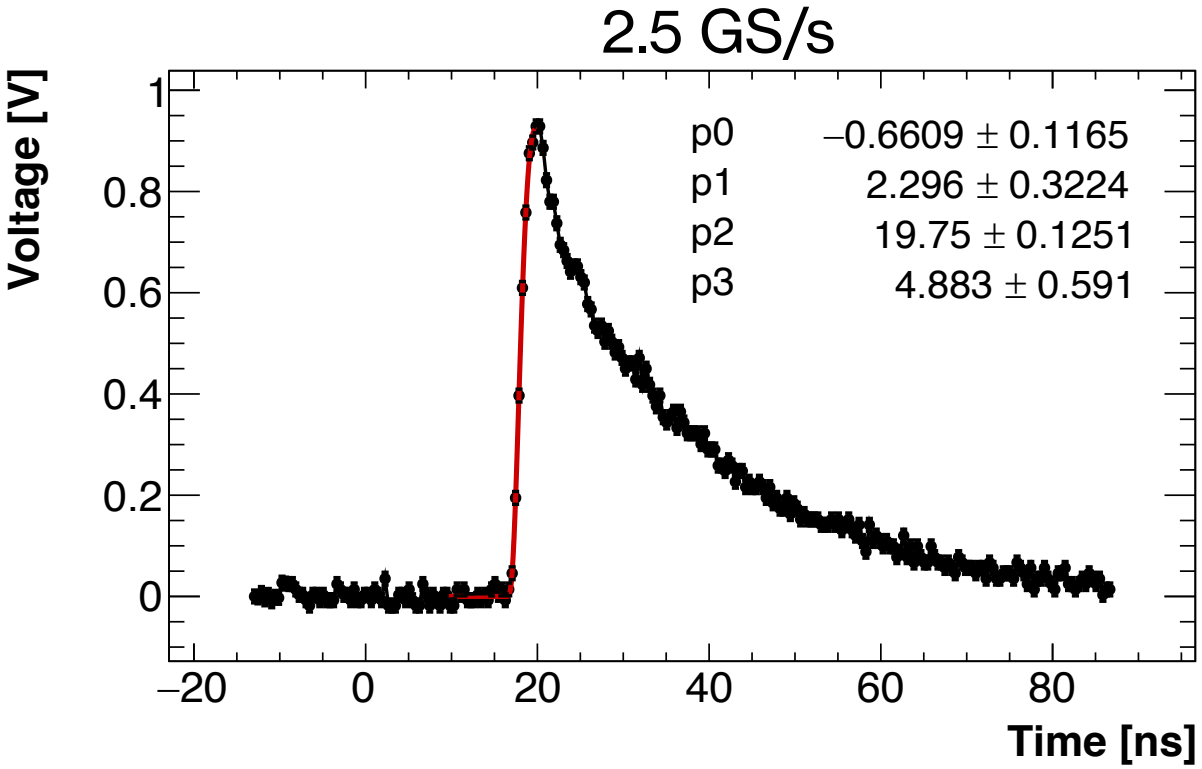


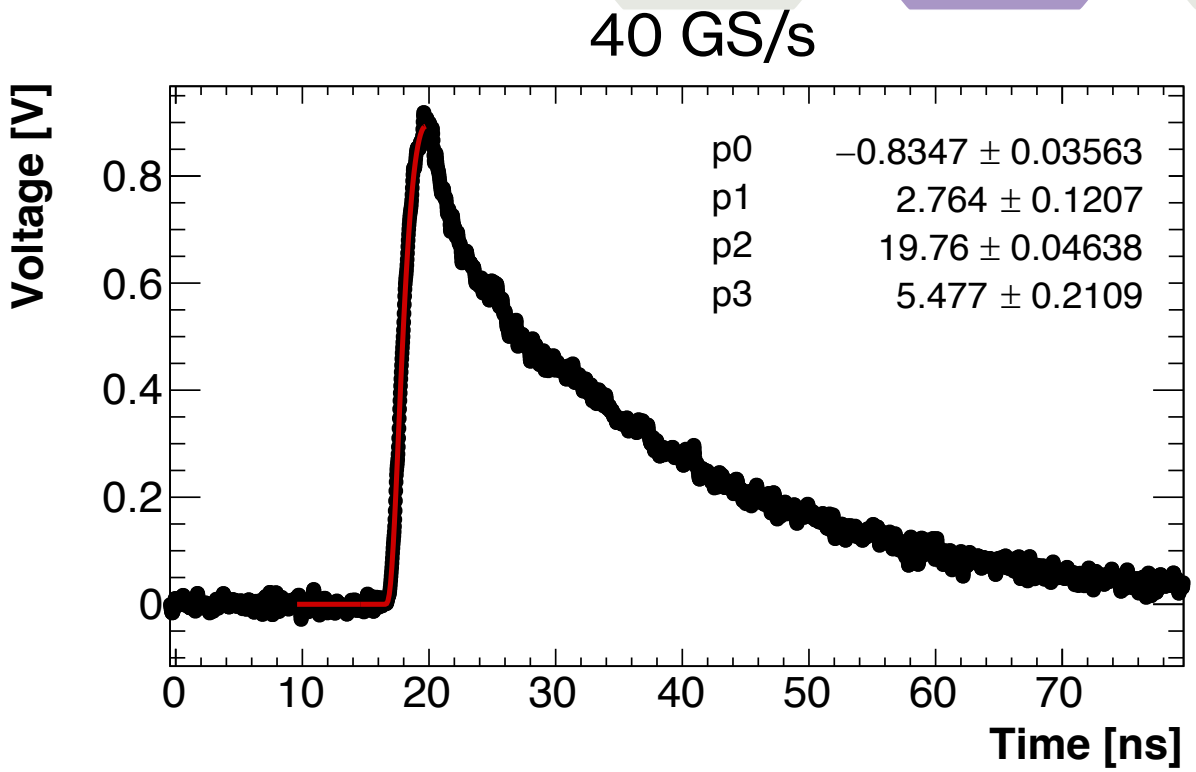
Laser test: setup

- Two 15 μm SiPM in series
- Picosecond UV laser source by Hamamatsu.
- SDA820Zi-B - Teledyne LeCroy Oscilloscope (40GS/s) for data taking.



Waveform at different samplings



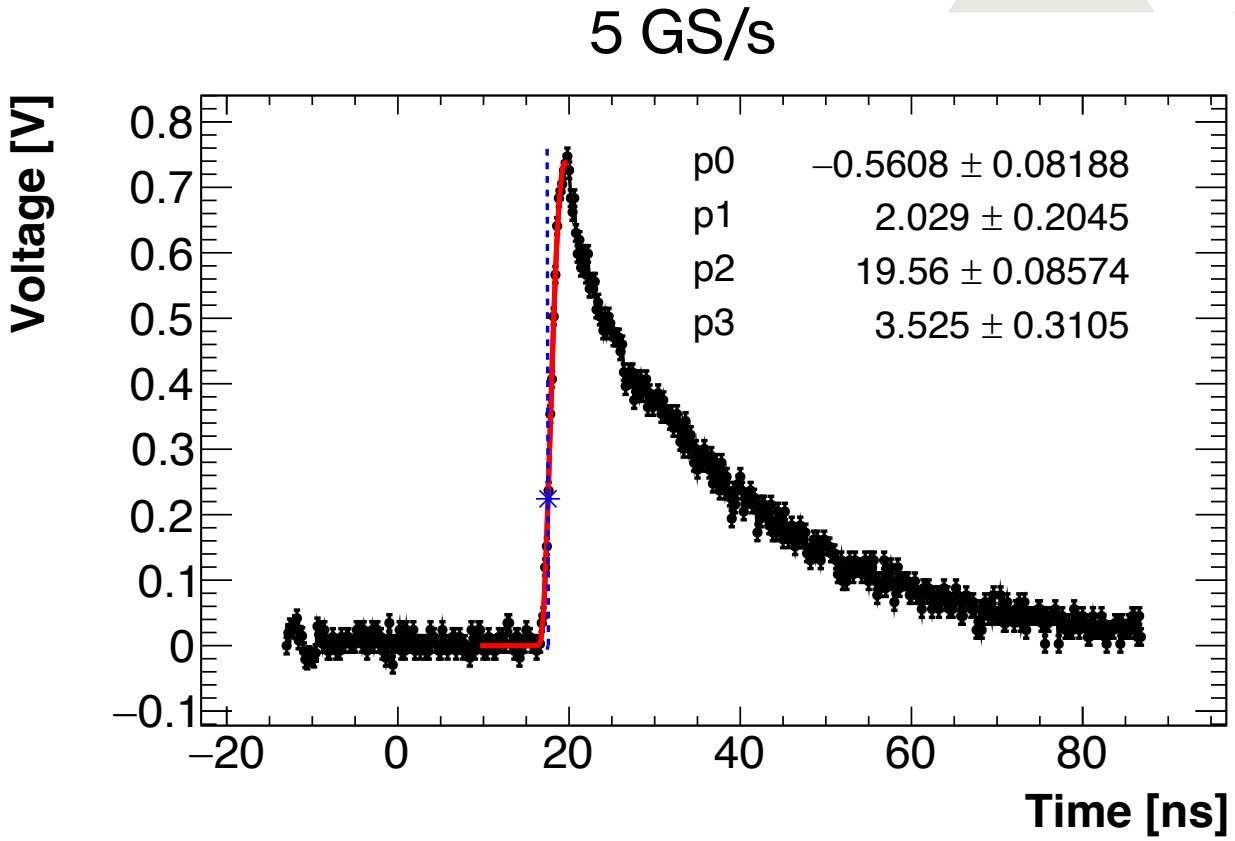


Fist fit attempt: lognormal

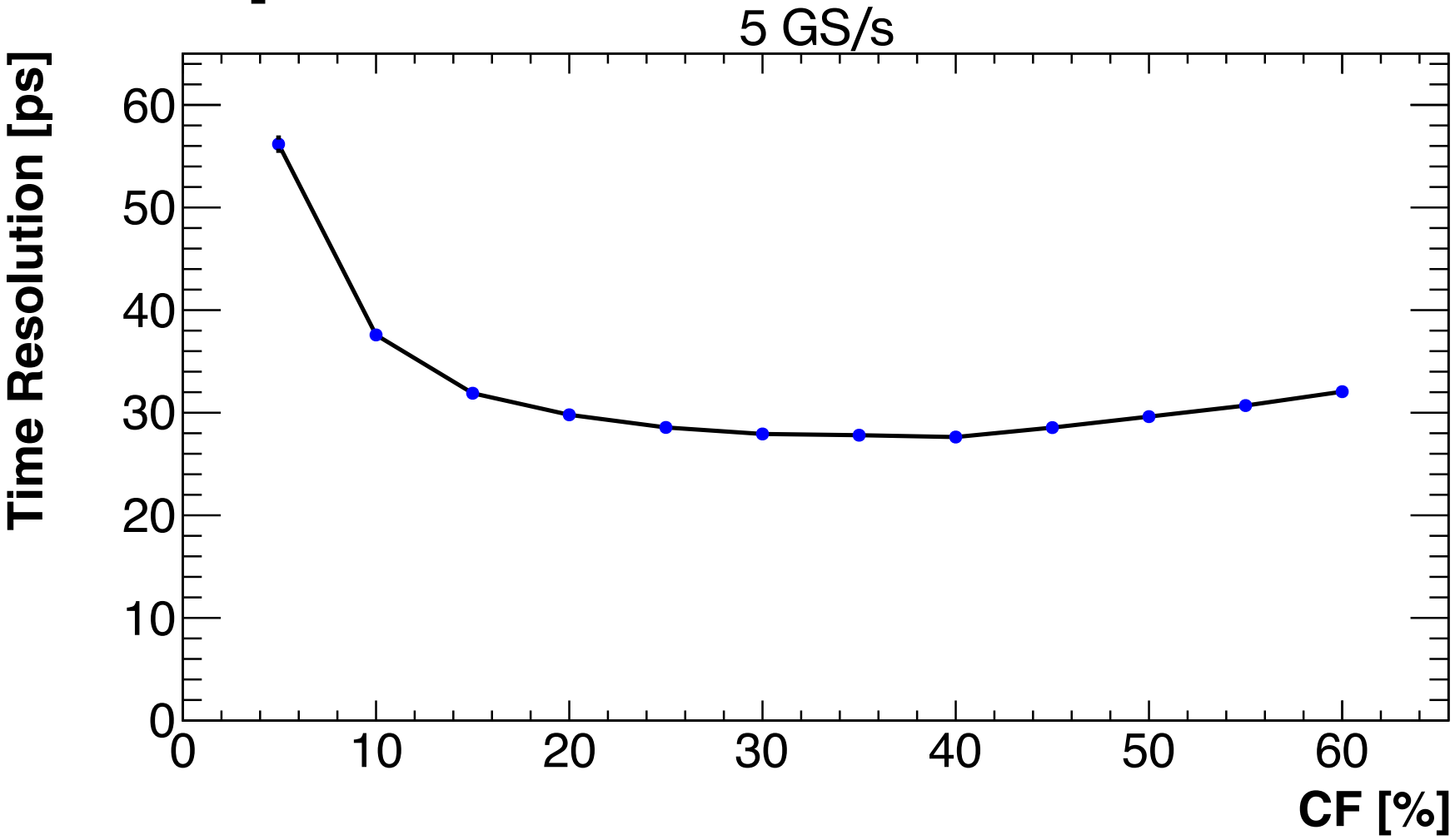
We used the constant fraction method in order to find the time resolution.

Steps:

1. We used a spline for a first coarse identification of the peak time and CF time;
2. We fitted with lognormal function;
3. We optimized σ_t looking for the best CF and fit window.



CF optimization

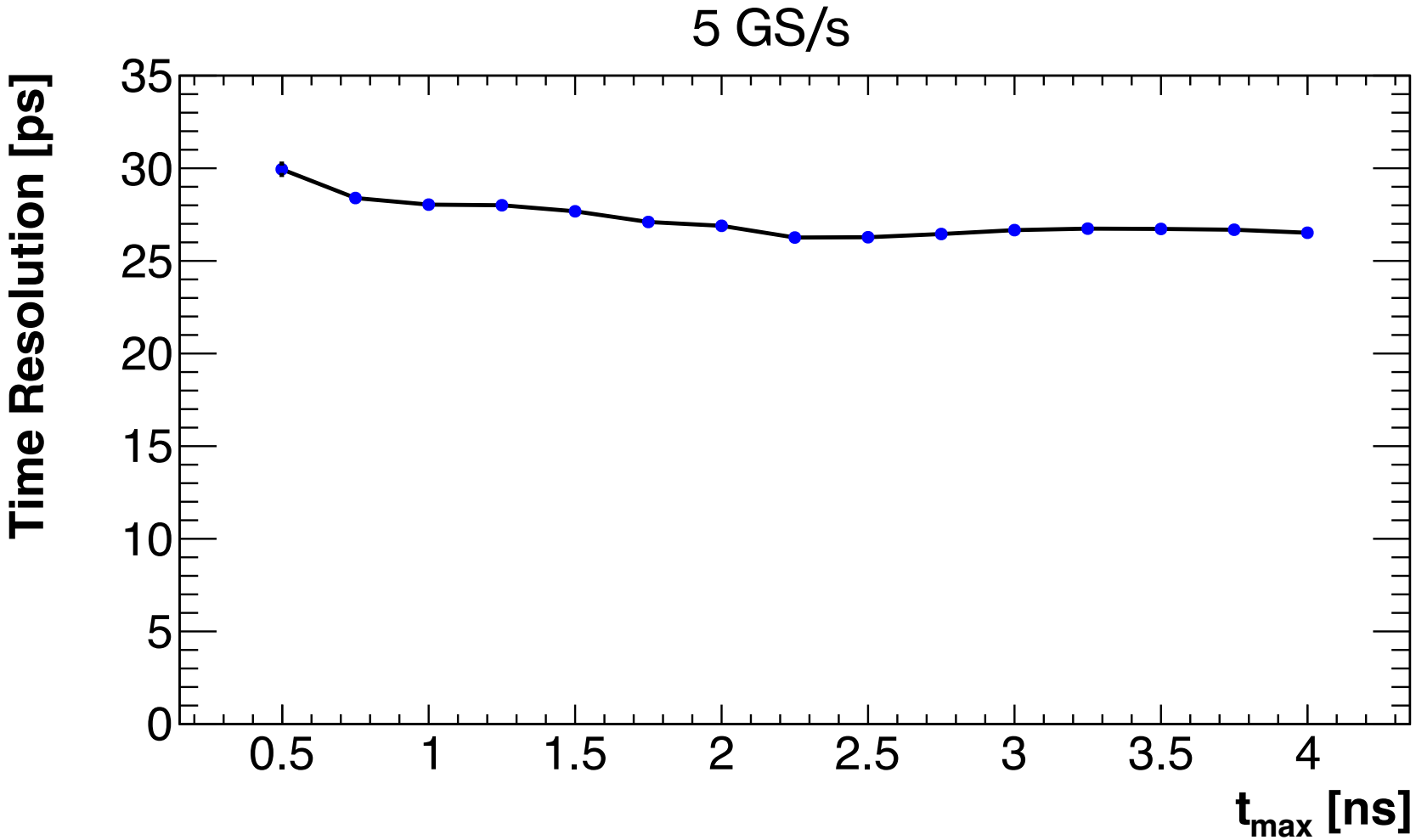


Best constant fraction:
30%

Fit window optimization

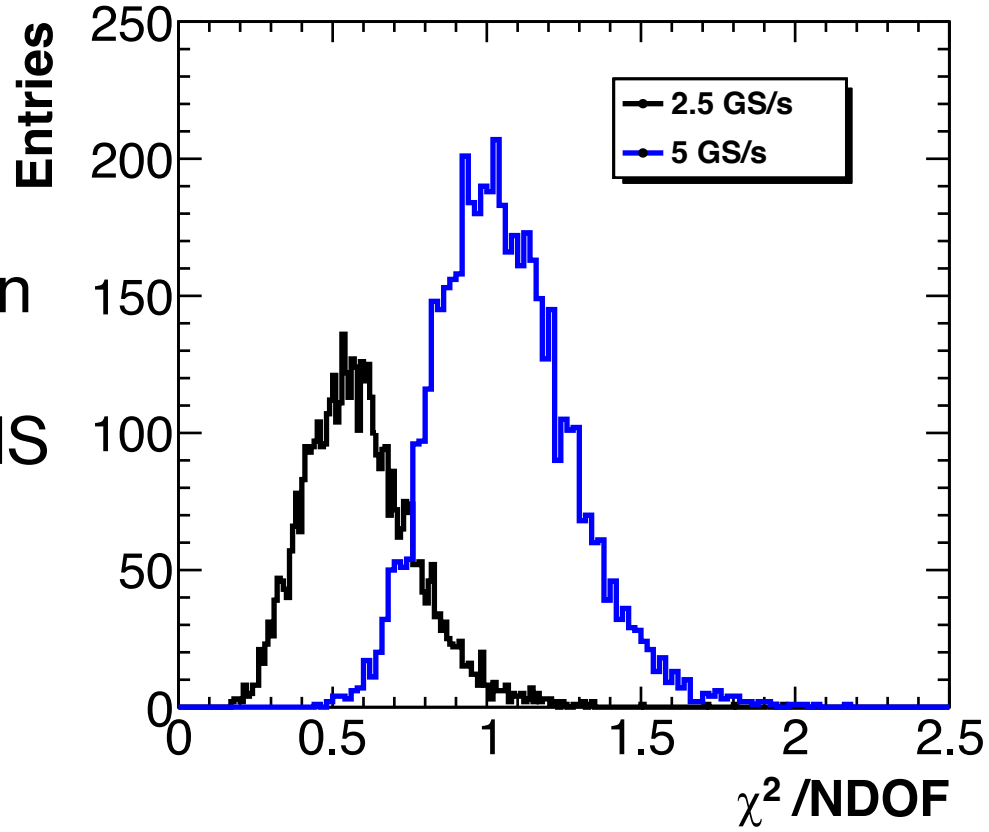
Using the CF Time as reference our fit window is given by:
$[t_{CF} - 8\ \text{ns}\ ,\ t_{CF} + t_{max}]$

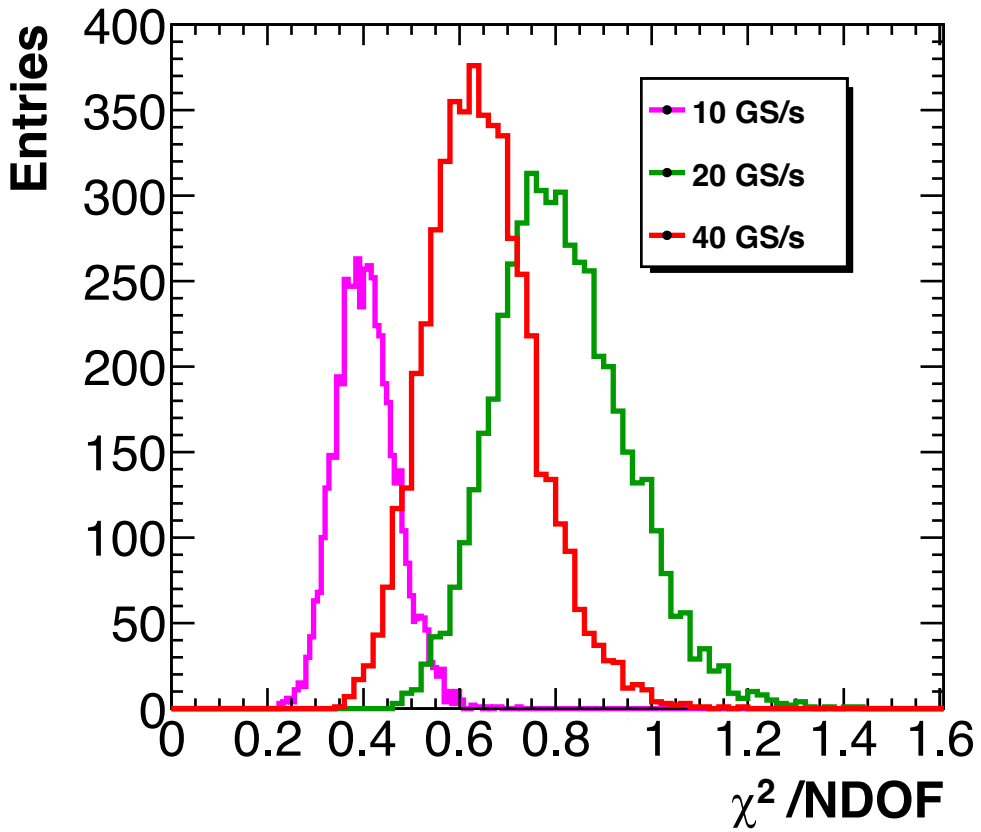
Best t_{max}: 2.25 ns



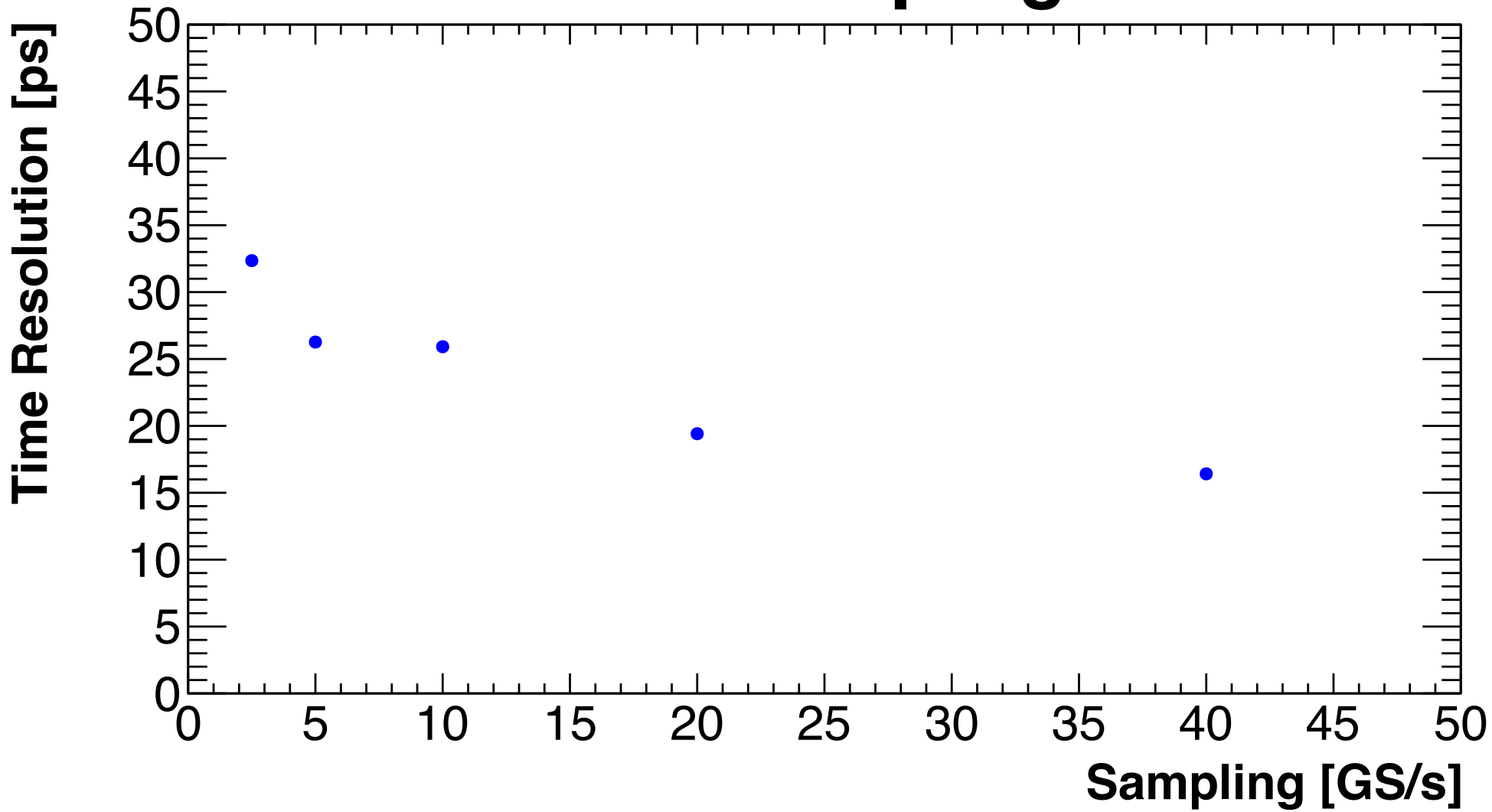
χ^2 test

Error on voltage given by the baseline RMS ~ 10 mV

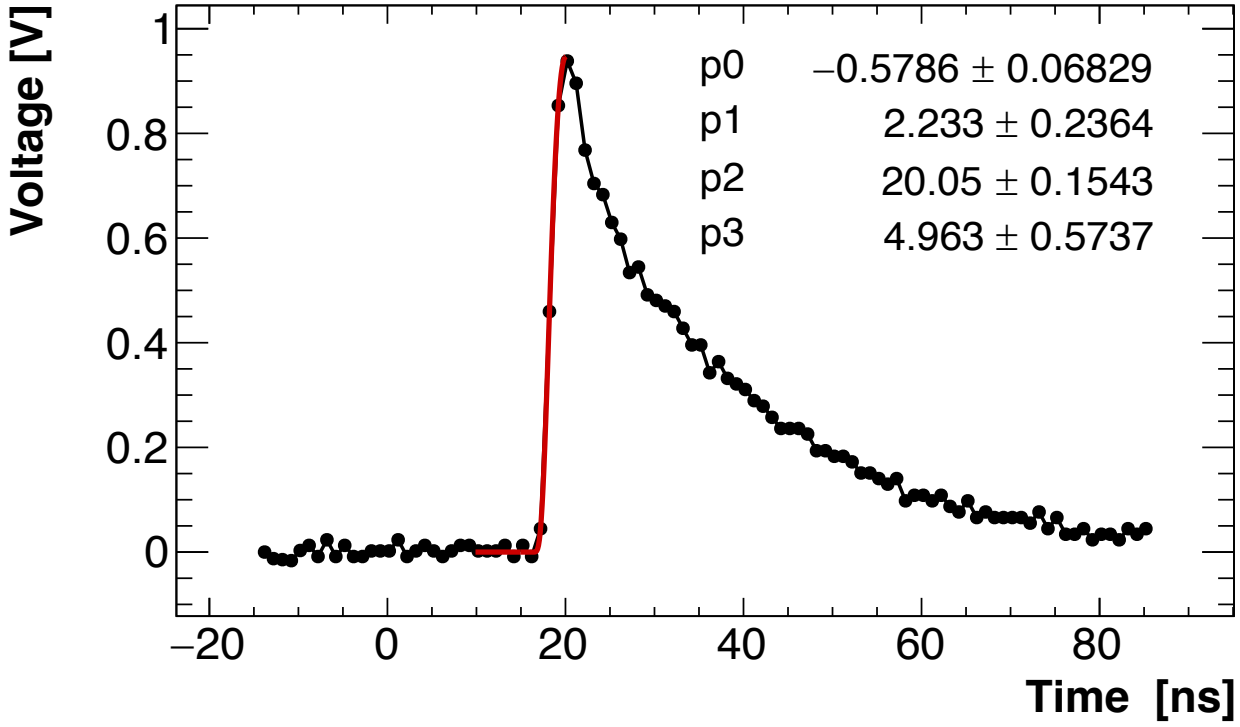


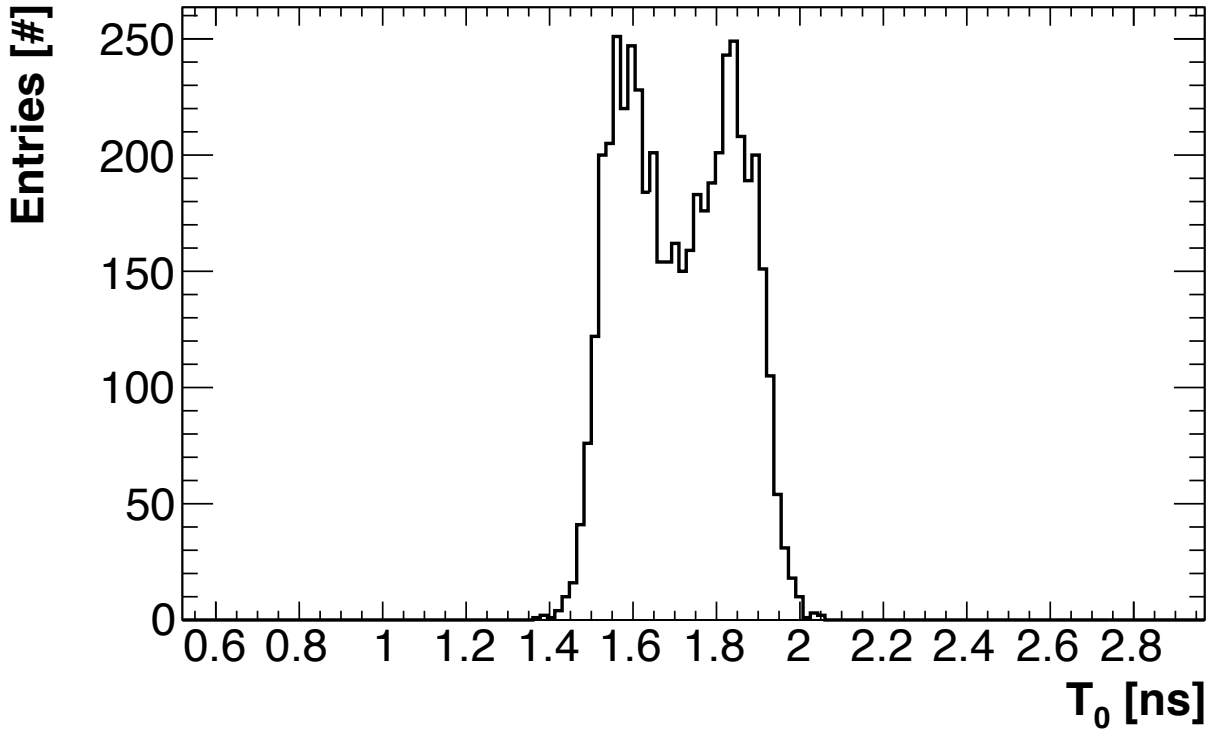


Time Resolution w.r.t. Sampling

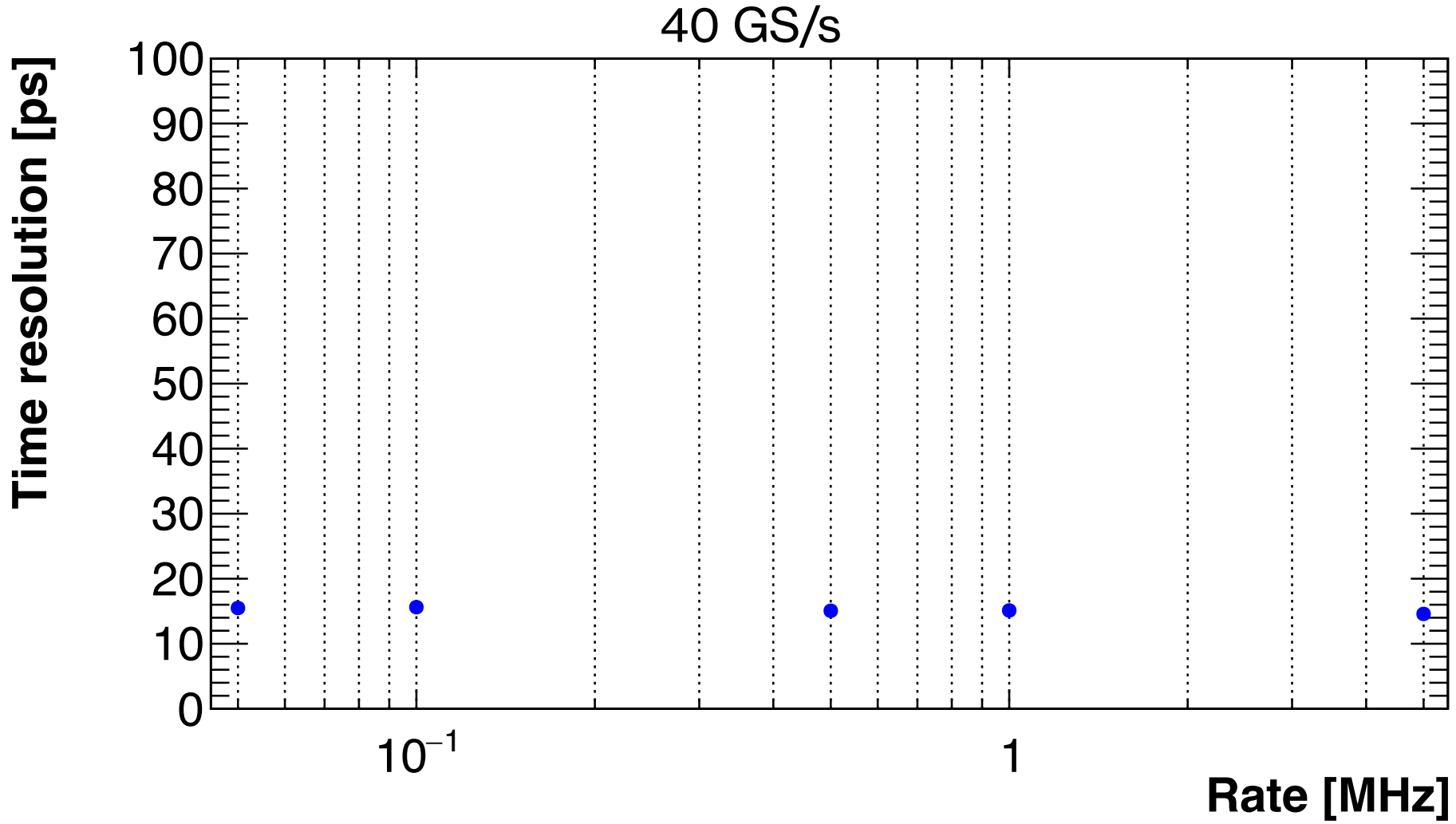


At 1GS/s

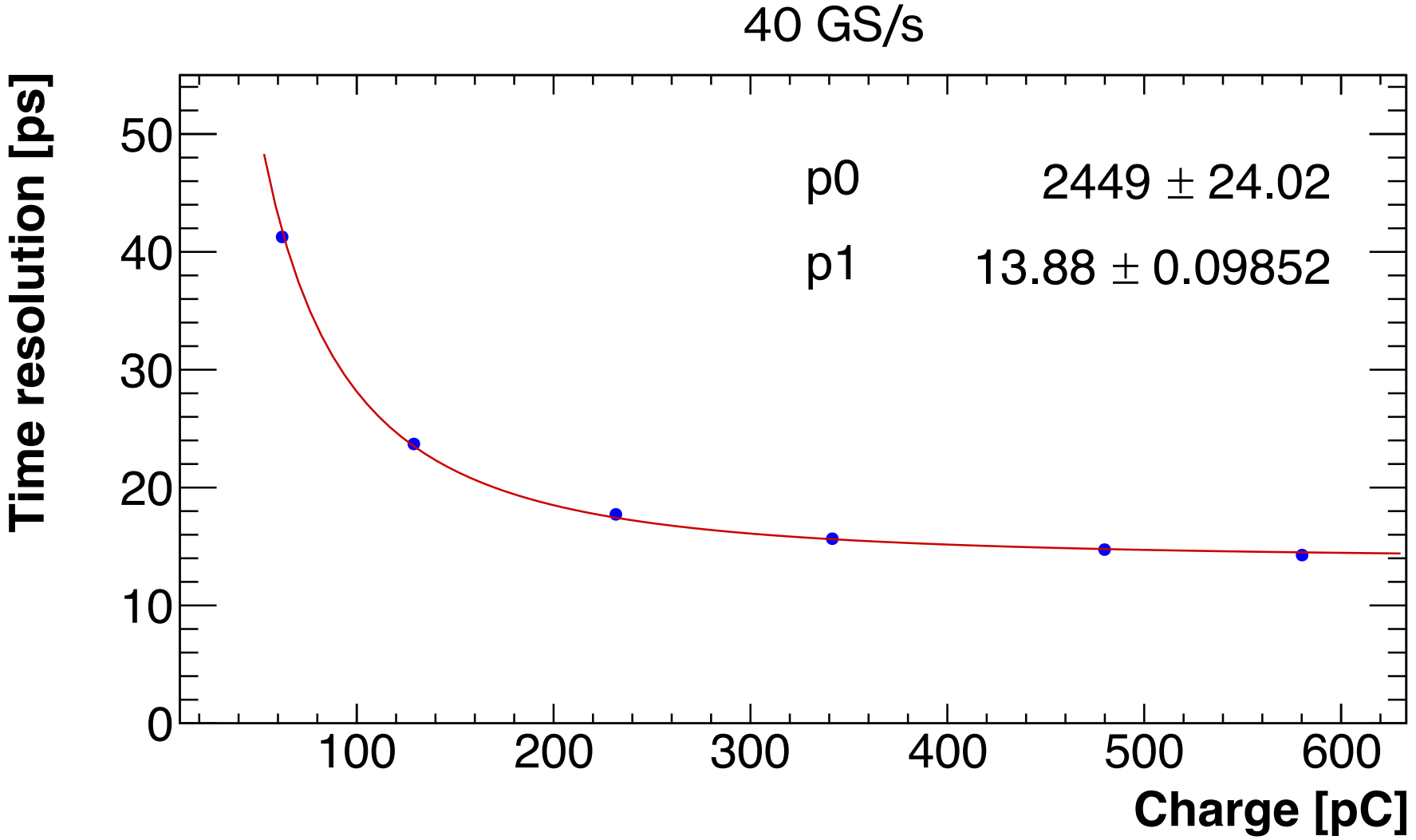

Voltage [V]
1
0.8
0.6
0.4
0.2
0
−20
0
20
40
60
80
Time [ns]
p0 −0.5786 ± 0.06829
p1 2.233 ± 0.2364
p2 20.05 ± 0.1543
p3 4.963 ± 0.5737


Entries [#]
250
200
150
100
50
0
0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8
T0 [ns]

Time Resolution w.r.t. Rate

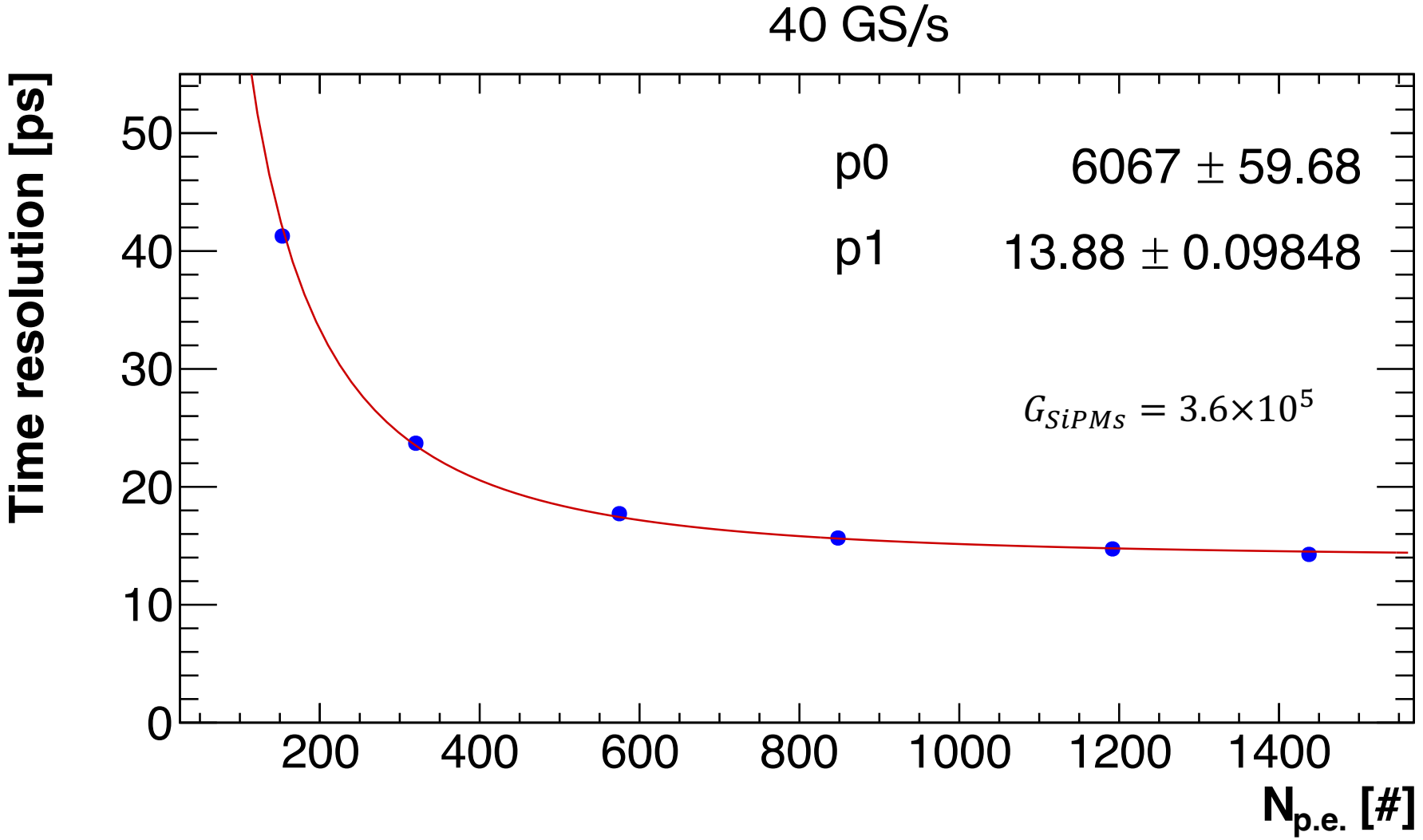


Time Resolution w.r.t. Charge



$$\sigma_t = \frac{p0}{C} \oplus p1$$

Time Resolution w.r.t. photo-electron number



$$\sigma_t = \frac{p0}{N_{p.e.}} \oplus p1$$

Conclusions

We tested our SiPMs and FEE and estimated the time resolution using the constant fraction method on a lognormal optimized fit:

- We analyzed the dependences of the time resolution to the Sampling, Rate and Charge;
- We were able to reach a time resolution $\backsim$15 ps.

Next steps:

- Try changing timing method to the Time over Threshold one;
- We will irradiate the SiPMs and analyze the dark current behavior;
- There will be a dedicated test beam at CERN in summer 2022.