# A few numbers

## kT/C noise: limits the dynamic range

Sampling capacitor: 60 fF (seen by the switch, post-layout)

kT/C = sqrt(1.38 $10^{-23}$ * 300K * 60fF) = 262 $\mu$V
One 8-bit LSB is 4mV ok.

## Analog bandwidth: limits the timing resolution

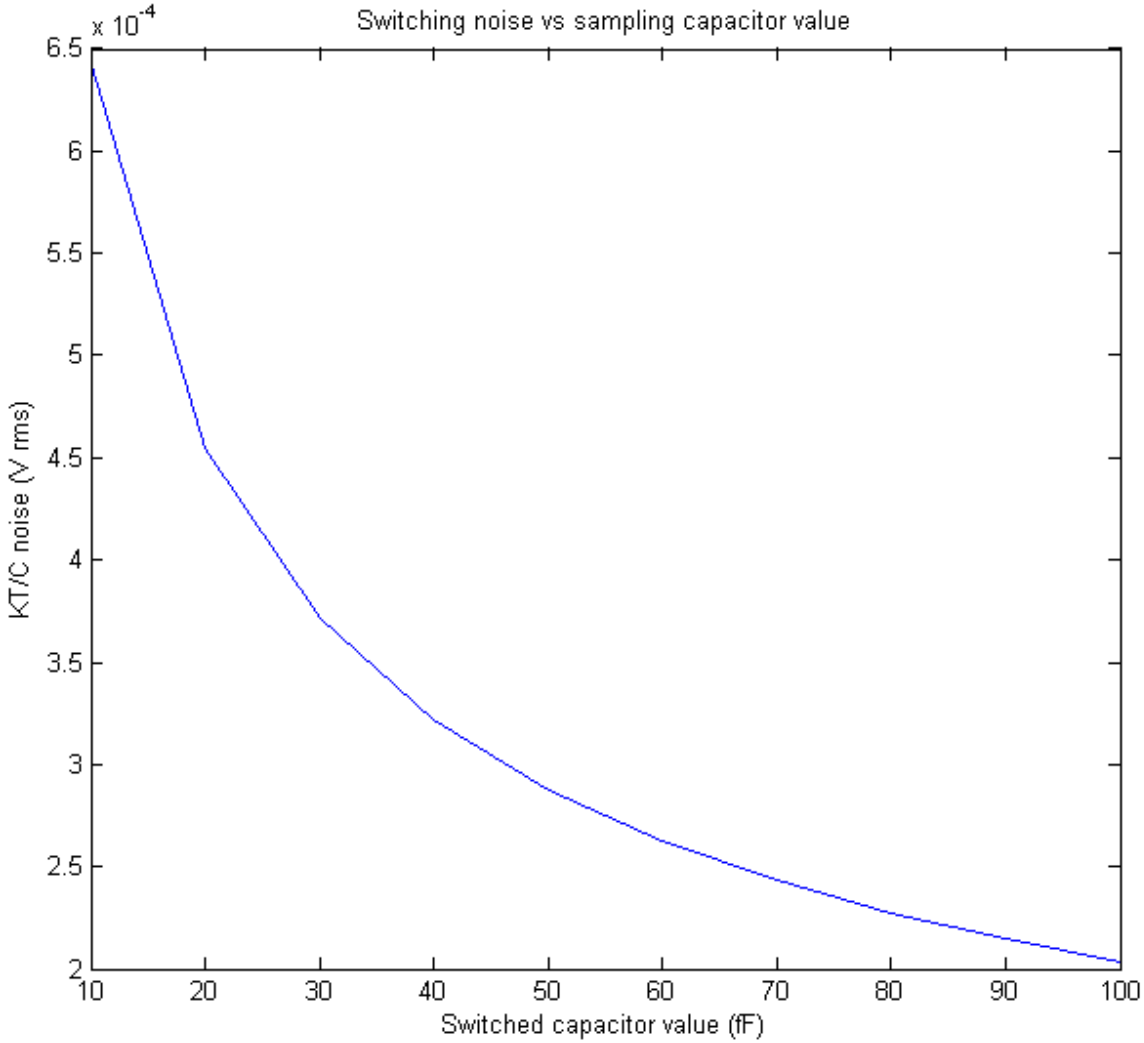
Analog pad capacitance: post-layout 100fF… (?)
We believe it's more…
If 100fF, no impact on the analog bandwidth since $1/2\pi$ RC = 30GHz. Could be 1GHz @ 3pF…
RC of the sampling cap: Assume R= 1k$\Omega$, $1/2\pi$ RC = 2.6 GHz, ok.

## Sampling cap leaks: limit the readout time

600pA (from simulations) on sampling cell cap
One 8-bit LSB drop being 1/256 = 4mV, $\delta$t = 4mV x 60 fF/600pA = 0.4$\mu$s

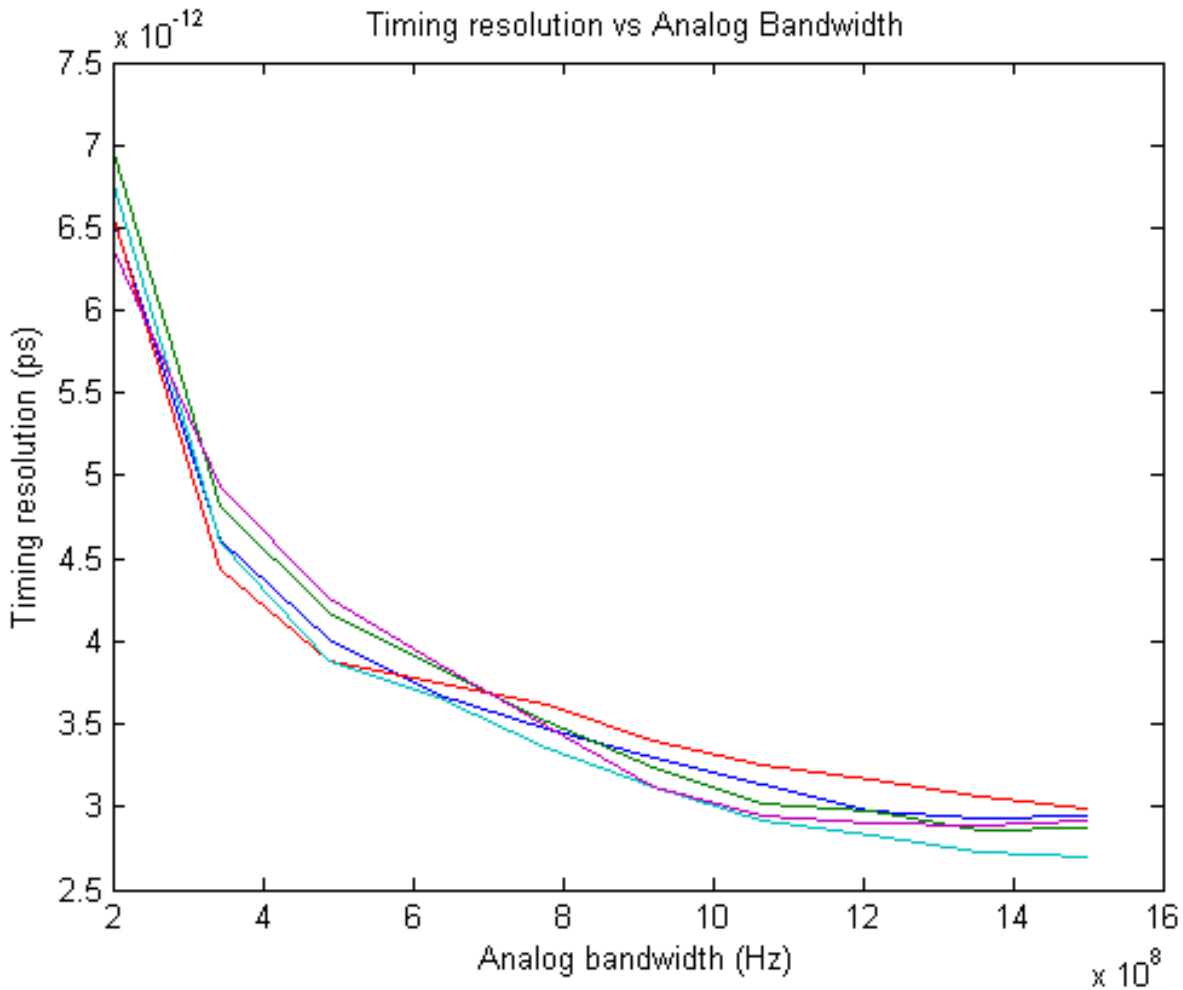
Digitization takes at more 3 $\mu$s. The drop will be an error of 8 LSBs at more, for which we can calibrate, since the digitization time is known.

# kT/C noise


Switching noise vs sampling capacitor value
x 10^-4
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
KT/C noise (V rms)
10
20
30
40
50
60
70
80
90
100
Switched capacitor value (fF)

# Analog bandwith for sampling rate 4-10 GS/s

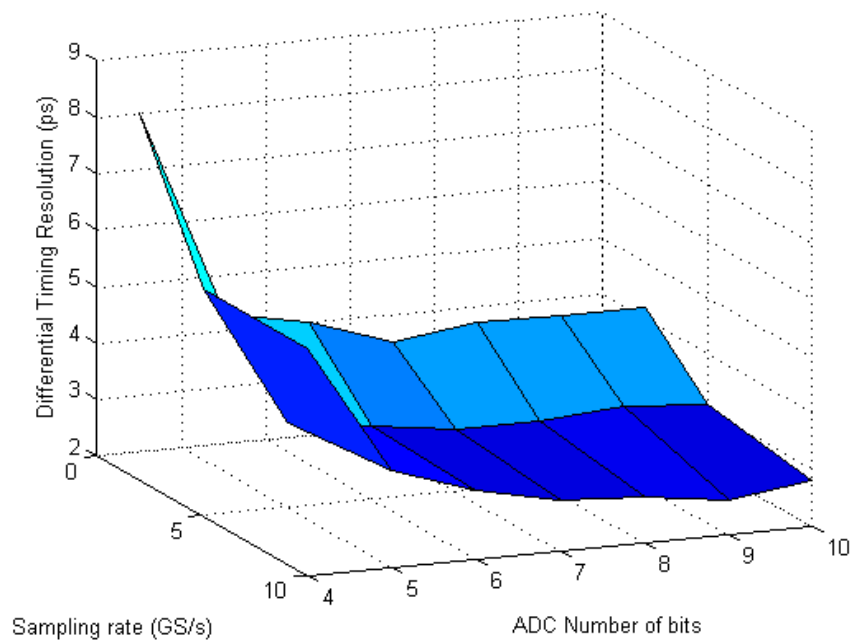
Data taken at Argonne with 10um MCP, 2.5kV,  158PEs



## Number of bits, sampling rate: Timing resolution

At 1GHz analog bandwidth:

| bits | 2GS/s | 5GS/s | 10GS/s |
|---|---|---|---|
| *10* | *4.2ps* | *3.1ps* | *2.8ps* |
| *9* | *4.2ps* | *3.2ps* | *2.6ps* |
| 8 | 4.2ps | 3.1ps | 2.8ps |
| 7 | 4.0ps | 3.1ps | 2.9ps |
| 6 | 4.5ps | 3.3ps | 3.2ps |
| 5 | 4.8ps | 3.5ps | 3.7ps |
| 4 | 8.5ps | 6.1ps | 5.9ps |




Data taken at Argonne with 10um MCP, 2.5kV, 158PEs, 8-bit oscilloscope