A few numbers
**kT/C noise:** limits the dynamic range

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

\[
kT/C = \sqrt{1.38 \times 10^{-23} \times 300K \times 60fF} = 262 \mu V
\]
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 \(1/256 = 4mV\), \(\delta t = 4mV \times 60 fF/600pA = 0.4 \mu s\)

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.
A few useful numbers

$\frac{kT}{C}$ noise

Switching noise vs sampling capacitor value
Analog bandwidth 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:

<table>
<thead>
<tr>
<th>Bits</th>
<th>2GS/s</th>
<th>5GS/s</th>
<th>10GS/s</th>
</tr>
</thead>
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<td>10</td>
<td>4.2ps</td>
<td>3.1ps</td>
<td>2.8ps</td>
</tr>
<tr>
<td>9</td>
<td>4.2ps</td>
<td>3.2ps</td>
<td>2.6ps</td>
</tr>
<tr>
<td>8</td>
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<td>3.1ps</td>
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<tr>
<td>7</td>
<td>4.0ps</td>
<td>3.1ps</td>
<td>2.9ps</td>
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<tr>
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<tr>
<td>4</td>
<td>8.5ps</td>
<td>6.1ps</td>
<td>5.9ps</td>
</tr>
</tbody>
</table>

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