How thin can you go: Does metal thickness affect recombination times?

INTRO
- Design study to approach low NEP’s needed for Galaxy Evolution Probe [1]
- Want: long time constants and low volume
- Time constant \( \tau \): how long it takes quasiparticles to recombine

METHODS
- Detectors: 1/4 (grounded) and 1/2 \( \lambda \) (ungrounded) coplanar waveguide aluminum kinetic inductance detectors
- 20, 30, 40, 50 nm thick films
- Center conductor widths 0.6, 1.5 µm and 3 µm
- Fiber-optic carries IR LED pulses 300 K -> 100 mK
- Average 240 pulses
- Fit the following to decay[2]:

\[
X(t) = \frac{A}{[1 + 1/\tau_{\text{opt}}(0)] \exp(\delta \tau_{\text{opt}})} - 1
\]

RESULTS
- \( \tau \) similar for 30-50 nm films:

<table>
<thead>
<tr>
<th>Thickness [nm]</th>
<th>( \tau ) [ms]</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>2.5-5</td>
</tr>
<tr>
<td>30</td>
<td>1-2.5</td>
</tr>
<tr>
<td>40</td>
<td>1-1.8</td>
</tr>
<tr>
<td>40 1/2 ( \lambda )</td>
<td>1-2.2</td>
</tr>
<tr>
<td>50</td>
<td>1-1.8</td>
</tr>
</tbody>
</table>
- \( \tau \) decreases with readout power

DISCUSSION
- Diffusion of quasiparticles into ground plane doesn’t seem to matter
- High readout powers suppress time constants
- \( X(t) \) parameterization fits well but sensitive to noise

For 1/4 wavelength aluminum CPWs, 40 and 50 nm thick films have same time constant: ~1-1.8 ms.

Time constants decrease with readout power

Quasiparticle diffusion into ground plane does not seem to matter for grounded devices:
- 1/2 \( \lambda \) ungrounded CPWs have ~ same \( \tau \) as 1/4 \( \lambda \) grounded CPWs
- Center conductor width does not affect \( \tau \) for a given array