Using detuning only, can we find a solution with:

- Little BBU amplification
- Loose misalignment tolerances (structure to structure)
- Little sensitivity to frequency errors
- For both the nominal (2.8 ns) and alternate (1.4 ns) bunch spacings

- For alternate bunch spacing (1.4 ns) need \( f_s = 4.012 \times (0.975) \) GHz

- Have a solution with trapezoidal \( \frac{dn}{df} \), with \( \frac{df_s}{f_s} = -10\% \), \( \alpha = -0.3 \)

  but it results in a parallel alignment tolerance of 25 \( \mu \)m for 10\% of

- Try a different solution with only one structure type

\( \frac{df_s}{f_s} = 7\% \), \( \alpha = -0.2 \)
Wake of Uniform Distribution

\[ W = \sum \sin \omega t \text{ for a uniform distribution} \]

If \( Q >> 1 \Rightarrow W = \sin \omega t \frac{\sin \omega t}{2N} \]

Note: uncoupled calculation, coupled will be slightly different.
What sort of Sran do we require?

BBU:

\[
\Gamma_{\text{max}} = e^2 NL S_{\text{max}} \frac{R_o}{2E_0} f \left( \frac{E_e}{E_0}, \alpha \right)
\]

\[
\delta_e \approx \frac{\Gamma_{\text{max}}^2}{2}
\]

For \( \delta_e = 10\% \Rightarrow \Gamma_{\text{max}} = 0.45; \) Prelinac \( \Rightarrow S_{\text{max}} = 0.28 \text{ V/pc/mm/m} \)

[Compare with main linac:

\[
N \propto \frac{B_0}{V_{E_0}} f
\]

x/s: 1 16 1.5 0.2 0.2 multiply = 1]

Structure Misalignments:

\[
\frac{1}{t_{\text{bb}}^2} = e^2 NLa S_{\text{rms}} \sqrt{\frac{N_{\text{f}_{\text{imp}}}}{E_0}} \left[ \frac{E_0}{2} \right] \left[ \frac{E_e}{E_0} \cos \theta_{\text{lin}} \right] g \left( \frac{E_e}{E_0}, \alpha \right)
\]

\[
N \propto \frac{1}{V_{E_0}} \sqrt{N_{\text{f}_{\text{imp}}}} \sqrt{B_0} \sqrt{E_e} g
\]

x/s: 1 0.45 0.2 5.7 1.2 7.1 0.15 multiply: 0.66

Prelinac: For 1% emittance growth

\[
S_{\text{rms}} \leq 5 \text{ V/pc/mm/m} \text{ [2.8 ms spacing; trapezoidal distribution]}
\]

\[
\Rightarrow t_{\text{bb}} = 1.5 \mu\text{m}
\]
$\frac{\delta f_1}{f_1} = 7\%$ very tilted

$\alpha: I-I, I$

One structure type

\[\Delta t = 1.4\text{ns}\]

\[\Delta t = 2.8\text{ns}\] all scaled in x-band
\[ \alpha = -0.25 \]
Trapezoidal Distribution: \( \bar{f}_5 = 4.012 \times (1.75) \text{ GHz} \),

\( \frac{\Delta f}{f_5} = 7.6 \), \( \alpha = -0.2 \)

At \( t = 2.8 \text{ ns} \)
$\Delta t = 1.4 \mu s$

Scaled to $x$ band

bunch number
### Linear BBU simulations: 10 oscillation

<table>
<thead>
<tr>
<th>Time</th>
<th>Prel</th>
<th>( \xi )</th>
<th>( \frac{\text{de/pc}}{\xi} )</th>
<th>Analytic</th>
<th>( \xi )</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8ns</td>
<td>Prel</td>
<td>0.025</td>
<td>0.0033%</td>
<td>0.066</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( e^+D )</td>
<td>0.058</td>
<td>0.021%</td>
<td>0.172</td>
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</tr>
<tr>
<td></td>
<td>( e^-B )</td>
<td>0.032</td>
<td>0.0057%</td>
<td>0.094</td>
<td></td>
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<tr>
<td>1.4ns</td>
<td>Prel</td>
<td>0.024</td>
<td>0.0044%</td>
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<tr>
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<td>( e^+D )</td>
<td>0.058</td>
<td>0.027%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( e^-B )</td>
<td>0.032</td>
<td>0.0076%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Scaled to x 6000

$\text{opt-omega}_{\text{total}}$

$\beta L / 2\pi$

$15$ $16$ $17$

$\text{1st cell geometry}$

$\text{Last cell}$
Srns, 1.4ns (scaled to xband) [V/pC/mm/m]
Srms_2.8ns (scaled to xband) [V/pC/mm/m]
$\Delta t = 0.8 \mu s$

2 structure types

Srms_2.8ns(scaled to xband) [V/pc/mm/m] vs fserr_rms/fsbar [$10^{-4}$]