CLIC booster linac studies

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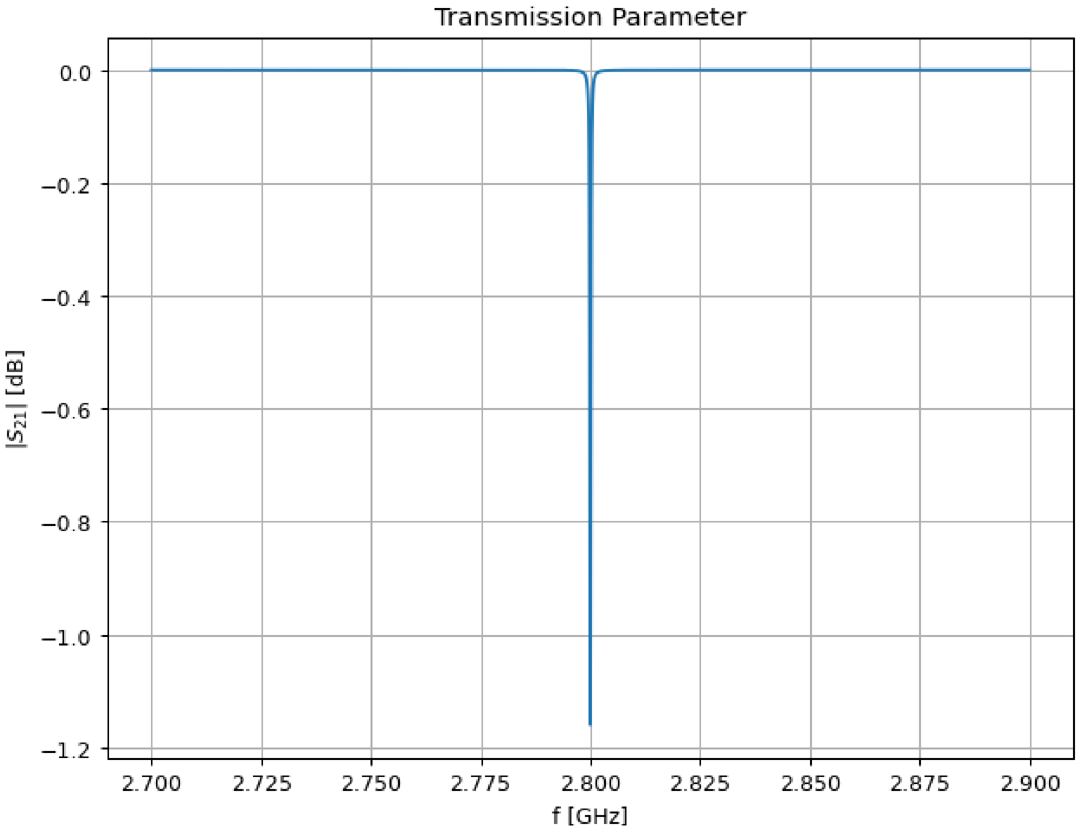
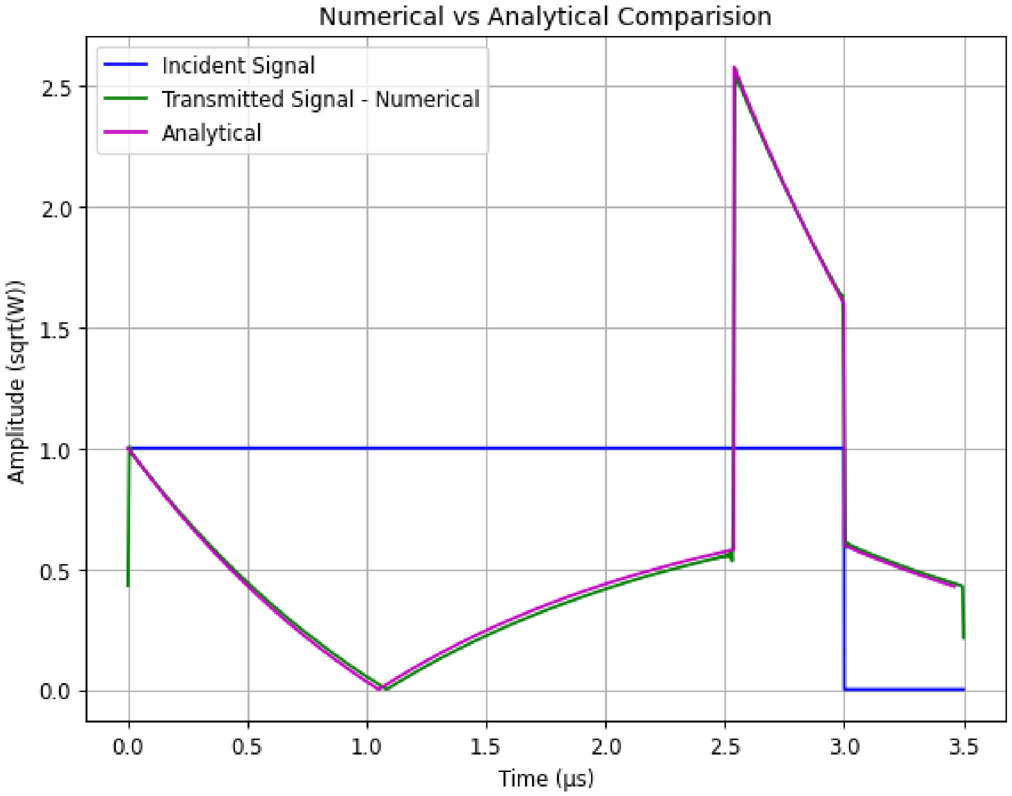
- **Frequency Response studies:**

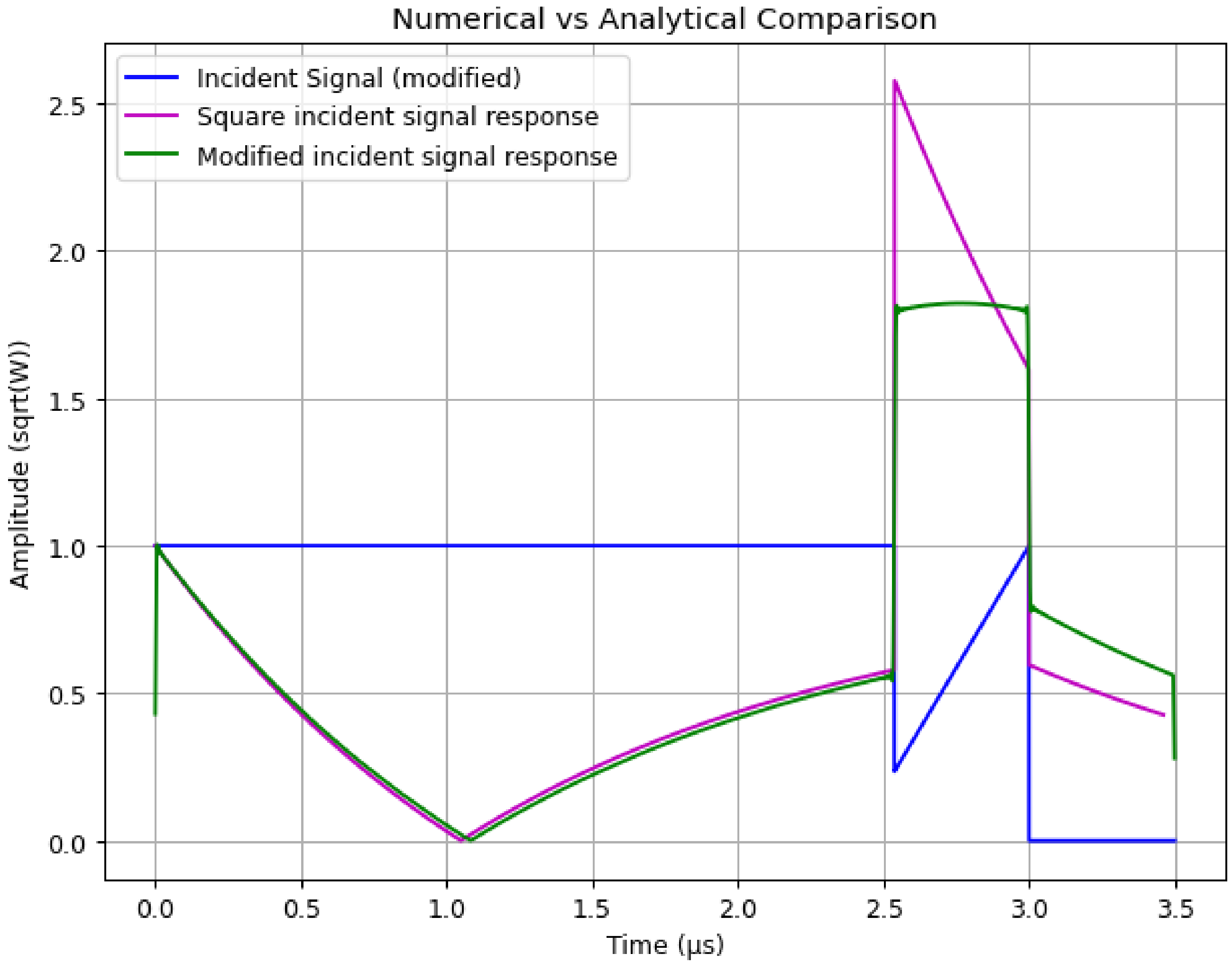
- f = 2.8 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 3 us





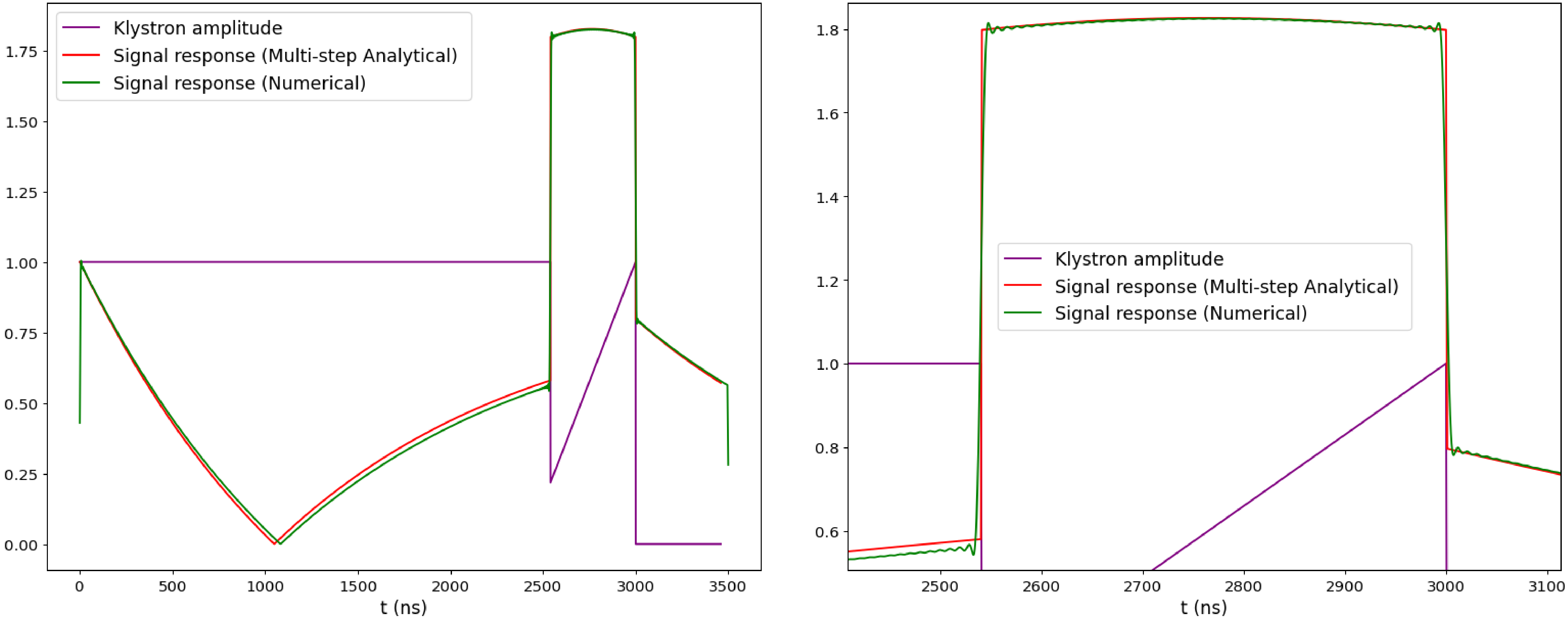
- **Modifying the incident signal**

- f = 2.8 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 3 us



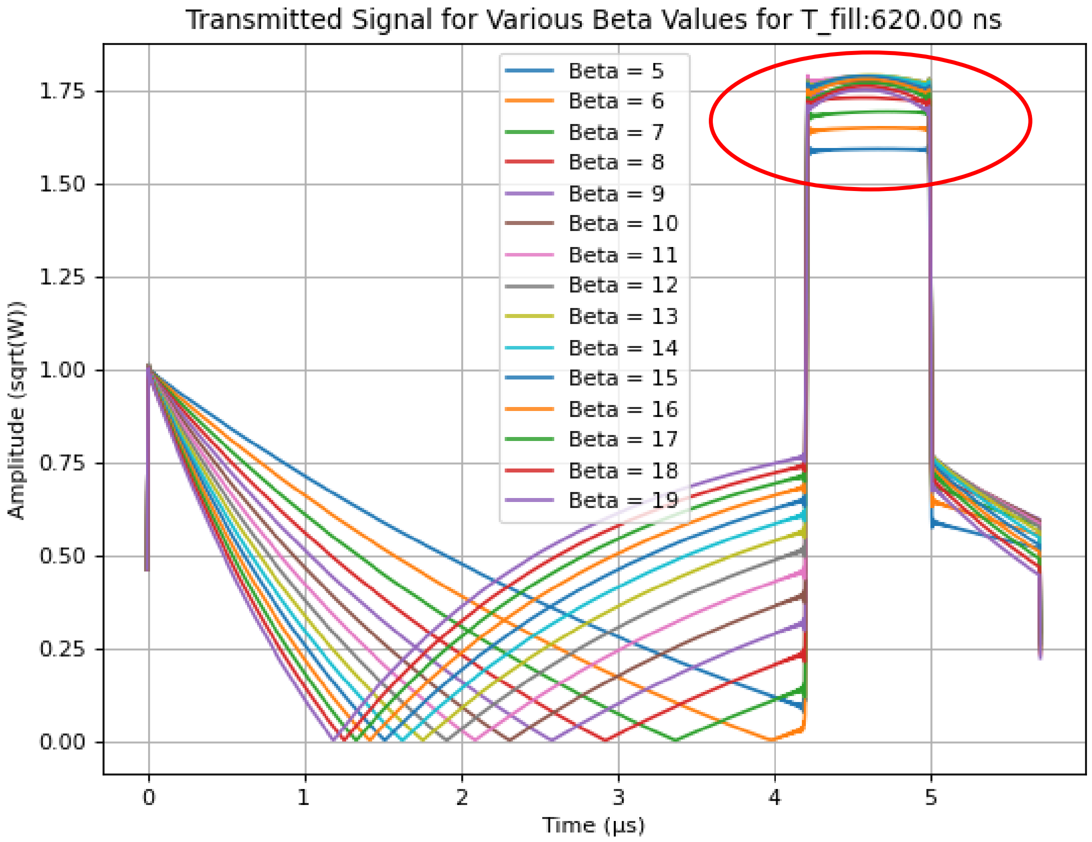
- **Reconstructing signal response with multi-step analytical calculation**

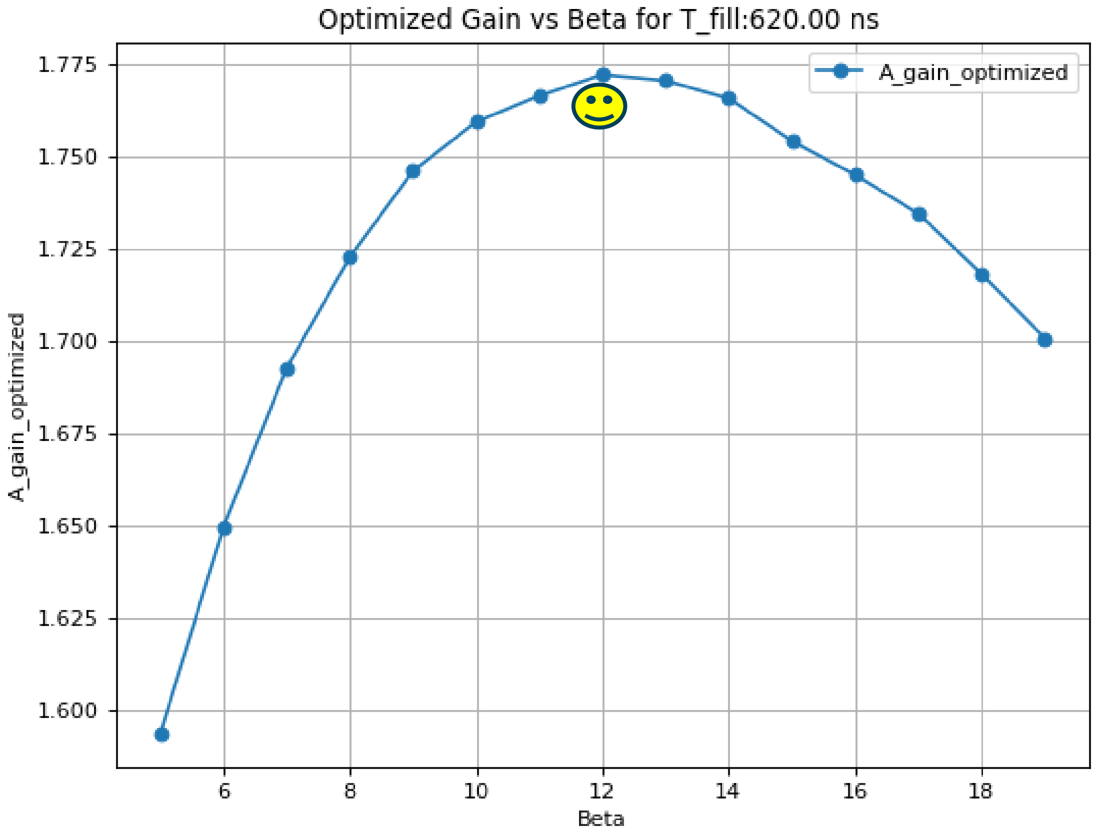
- f = 2.8 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 3 us



- **Pulse compressor coupling optimization:**
- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us

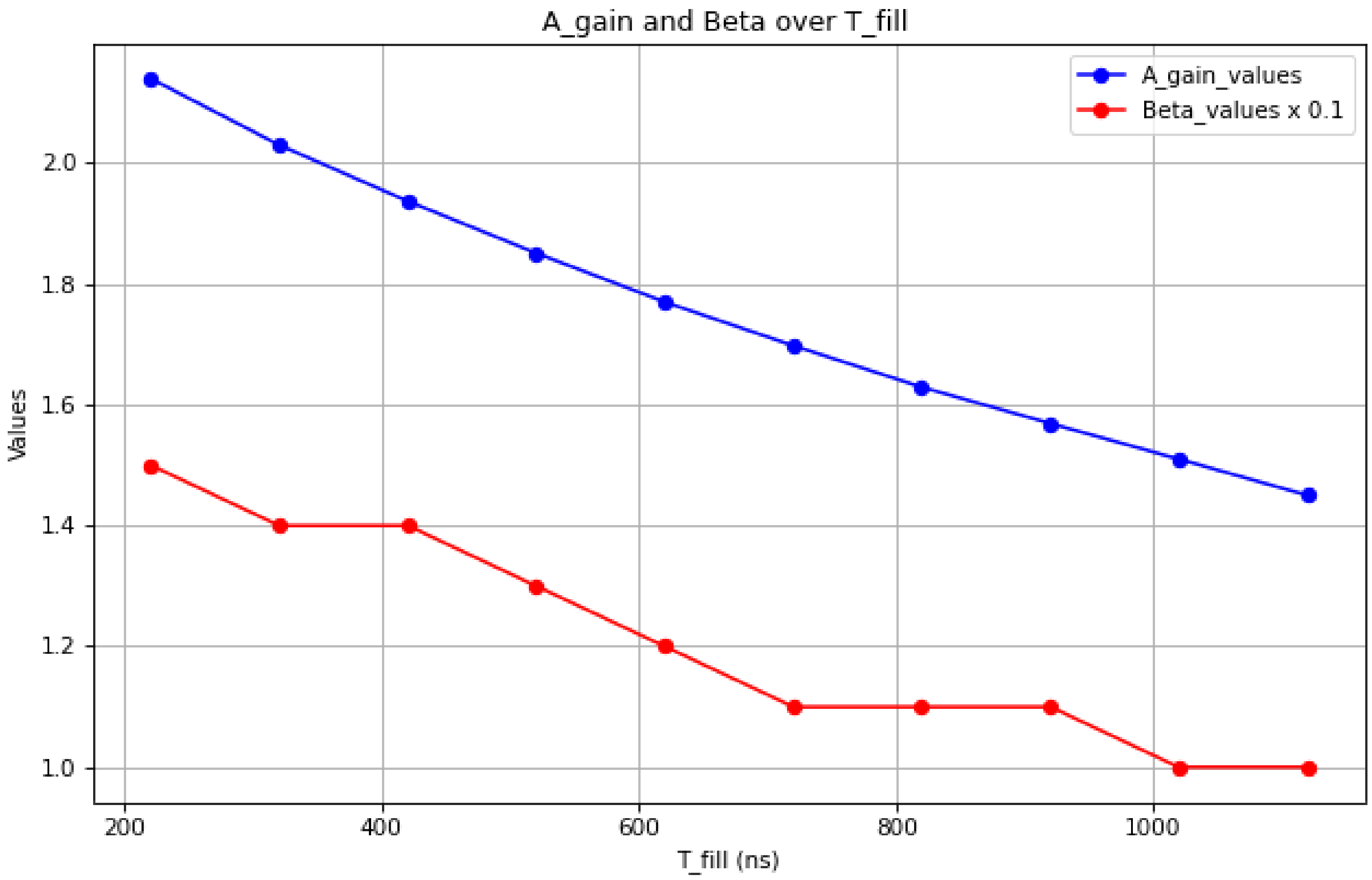
Flat part is the A_gain. Rsh can be directly calculated as SS now.



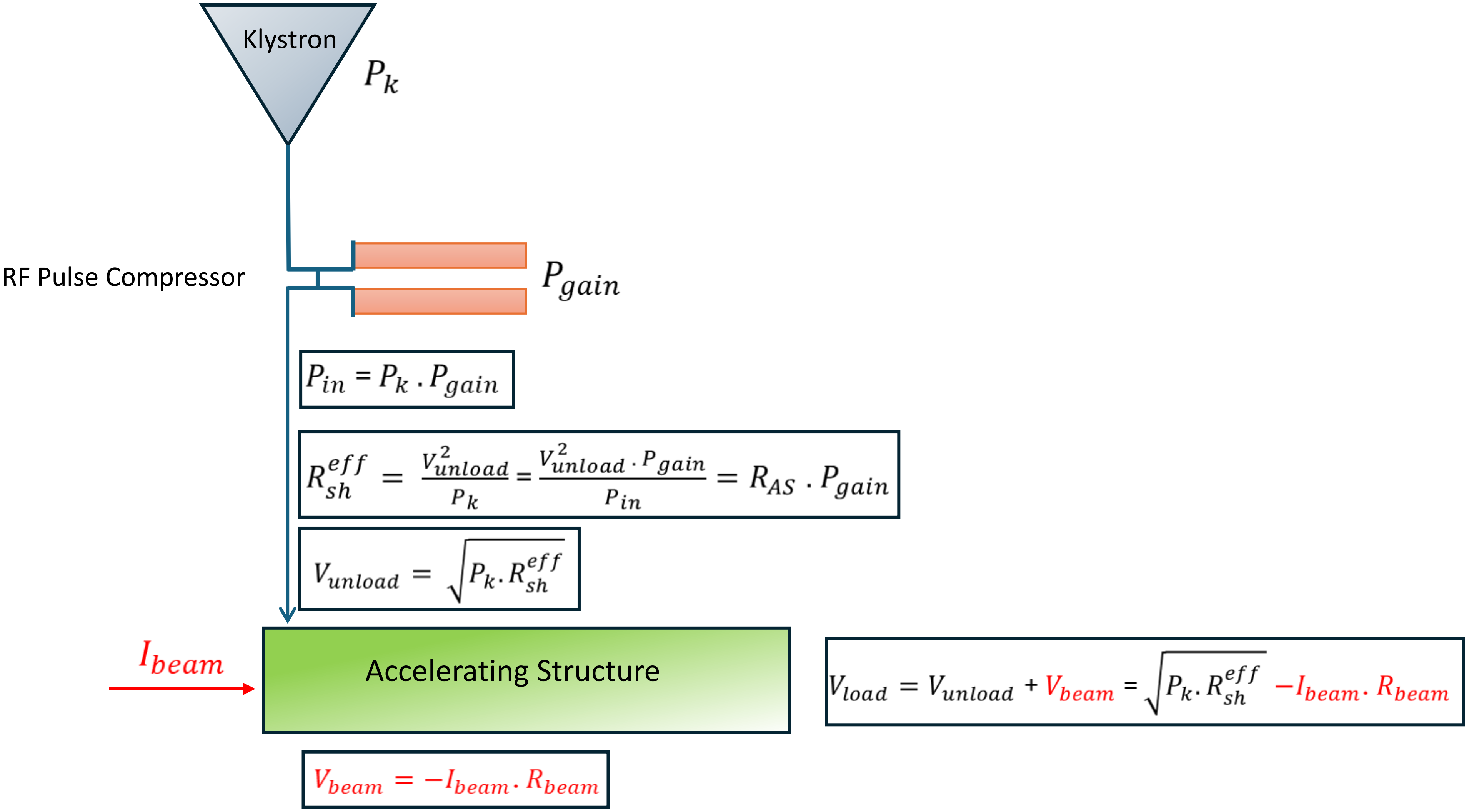


- Outcome for the structure T_fill= 620 ns.

- **Pulse compressor coupling optimization:**
- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us



- **Effective Shunt Impedance Calculation:**
- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us

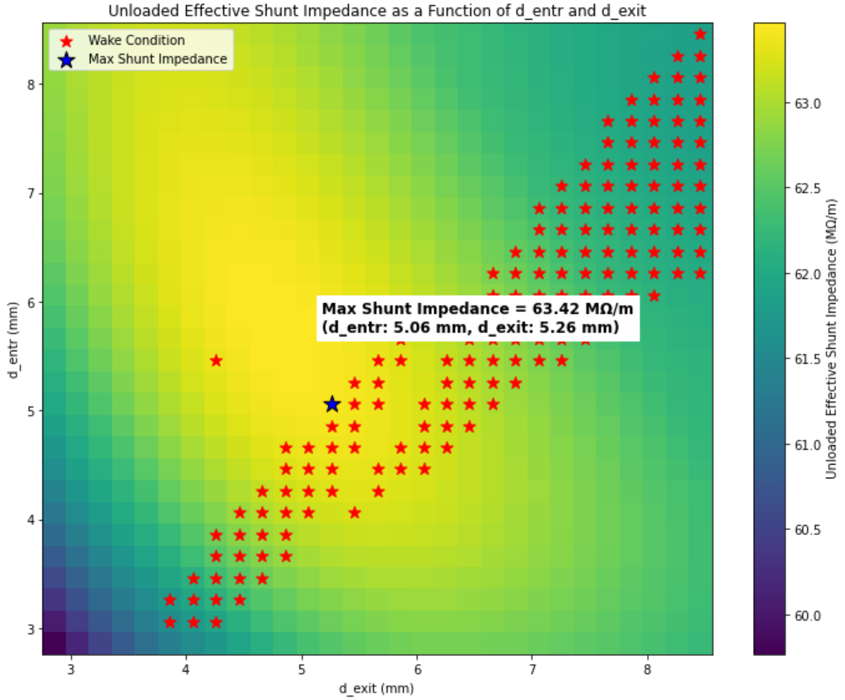


Unloaded Voltage

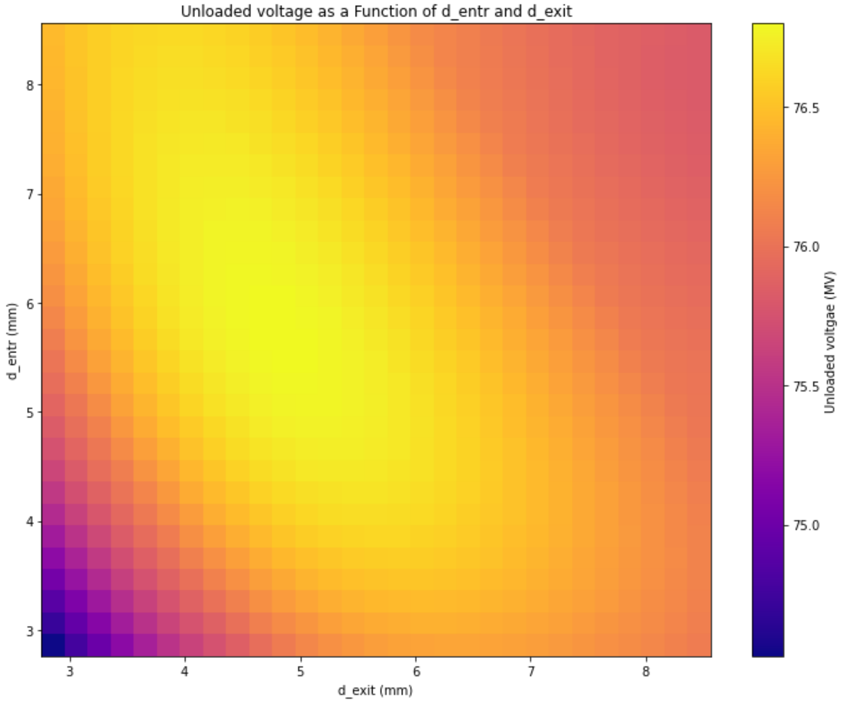
- **Effective Shunt Impedance Calculation:**
- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us, P_klystron = 31 MW
- Avg. Aperture = 16mm with delta = 3mm:

$$V_{unload} = \sqrt{P_k . R_{sh}^{eff}}$$

Effective Shunt impedance



Unloaded Voltage

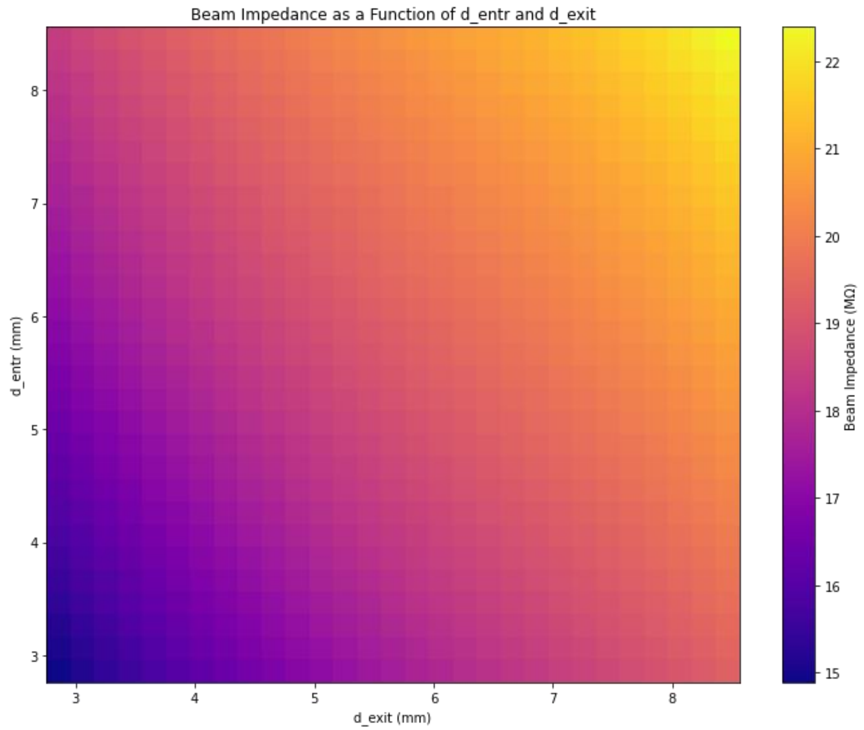


Beam Voltage

- **Effective Shunt Impedance Calculation:**
- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us, P_klystron = 31 MW
- $I_{beam} = 1.67\ A$ for 352 bunches with Q_{bunch} = 0.83 nC, $T_{bunch\_seperation}$ = 0.5 ns
- Avg. Aperture = 16mm with delta = 3mm:

$$V_{beam} = -I_{beam} \cdot R_{beam}$$

R_{beam}



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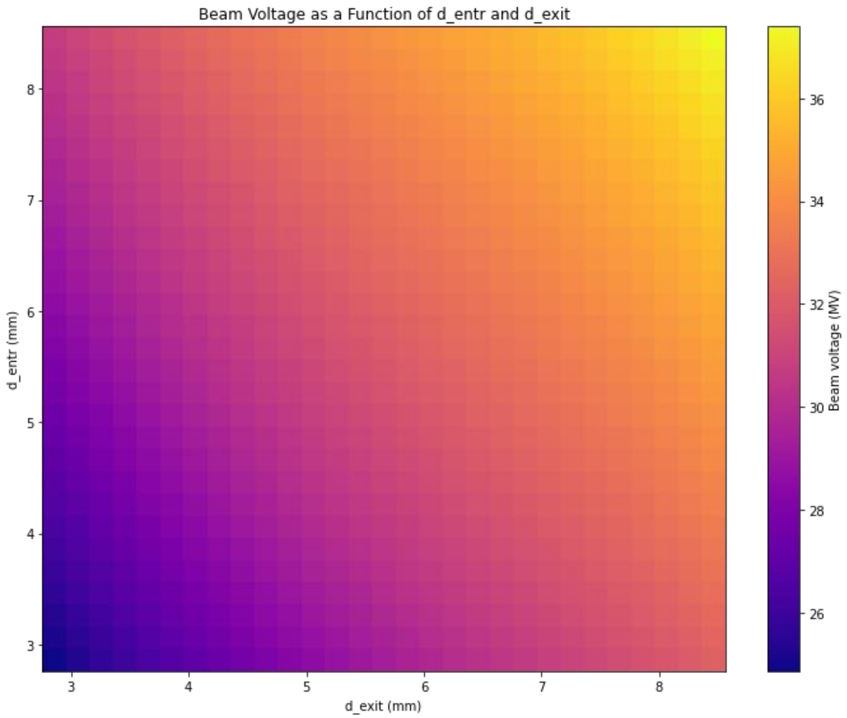
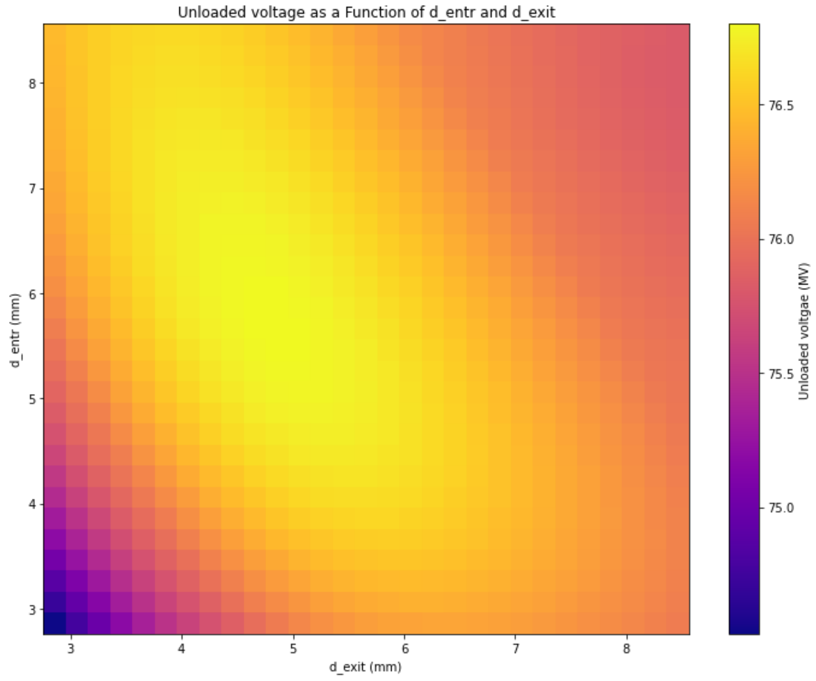


Loaded Voltage

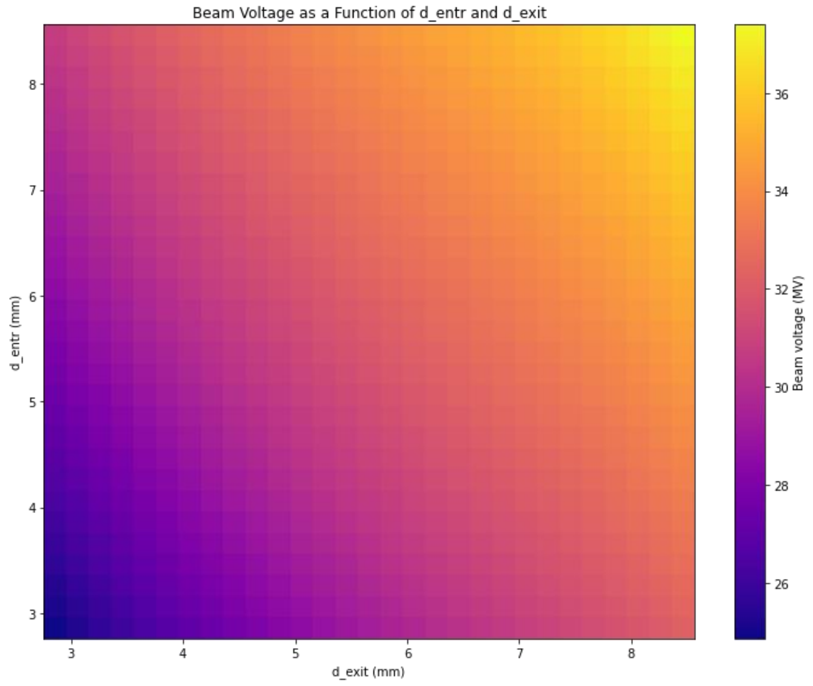
- **Effective Shunt Impedance Calculation:**
- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us, P_klystron = 31 MW
- $I_{beam} = 1.67\ A$ for 352 bunches with Q_{bunch} = 0.83 nC, $T_{bunch\_seperation}$ = 0.5 ns
- Avg. Aperture = 16mm with delta = 3mm:

$$V_{load} = V_{unload} + V_{beam} = \sqrt{P_k . R_{sh}^{eff}} - I_{beam} . R_{beam}$$

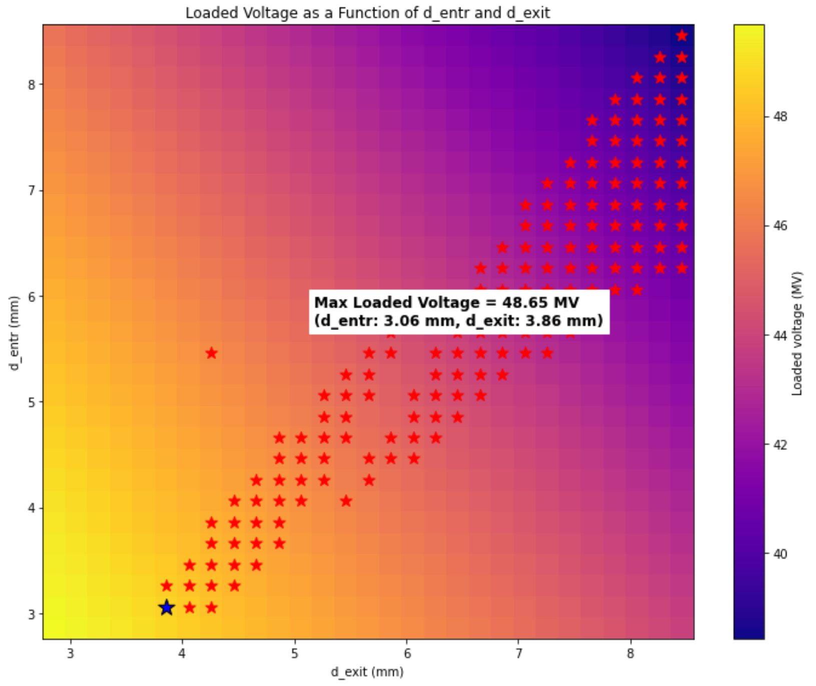
Unloaded Voltage



Beam Voltage



Loaded Voltage



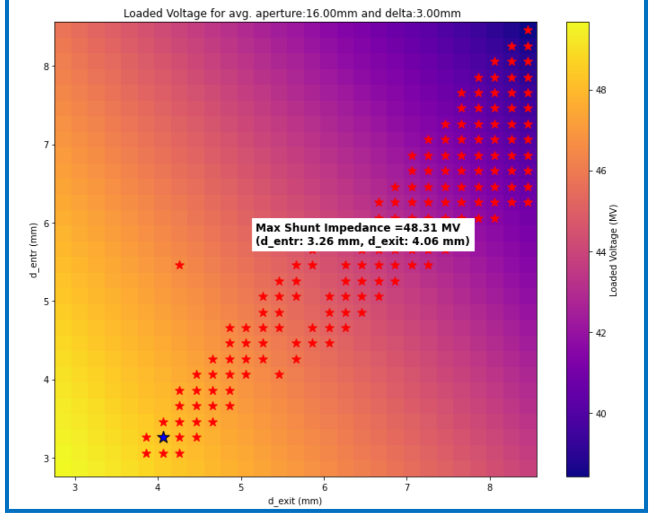
CLIC Booster Linac Loaded Voltages

CLIC Booster Linac Loaded Voltages

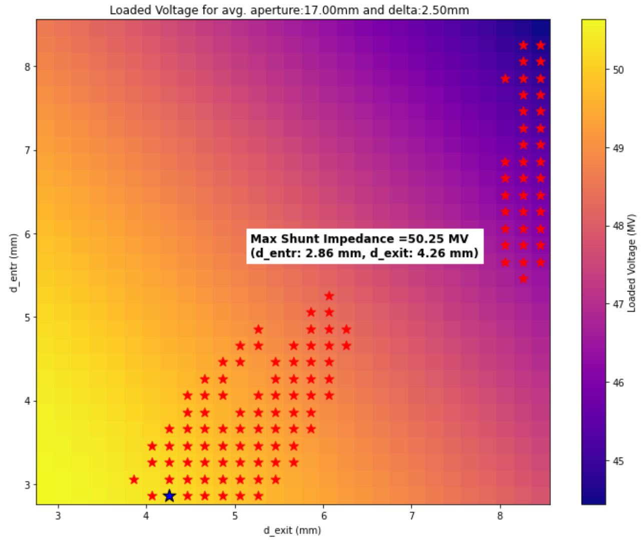
Scanned from avg. aperture 12 mm to 19 mm.
Avg. Aperture 16 mm and above satisfy the wake conditon.

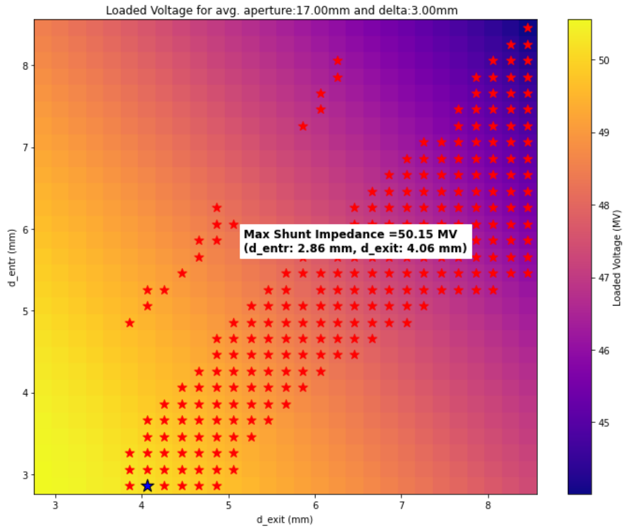
- **Parameters for the structure:**
- f = 2 GHz, Length = 3m, Phase advance = $2\pi/3$, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us, P_klystron = 31 MW (2 acc. Struc. Per klystr.)

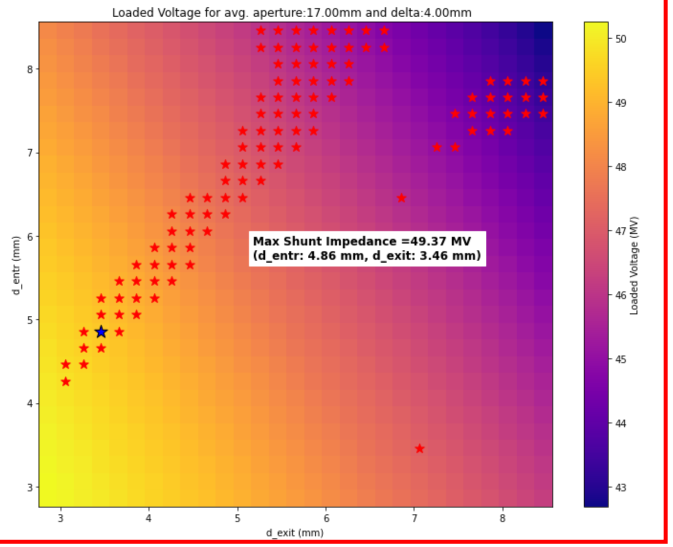
16 mm



17 mm







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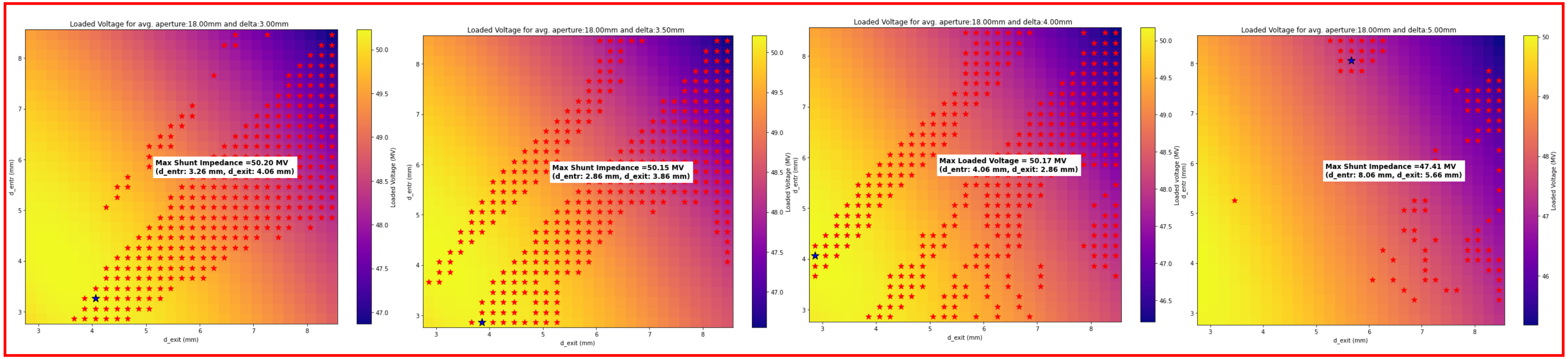
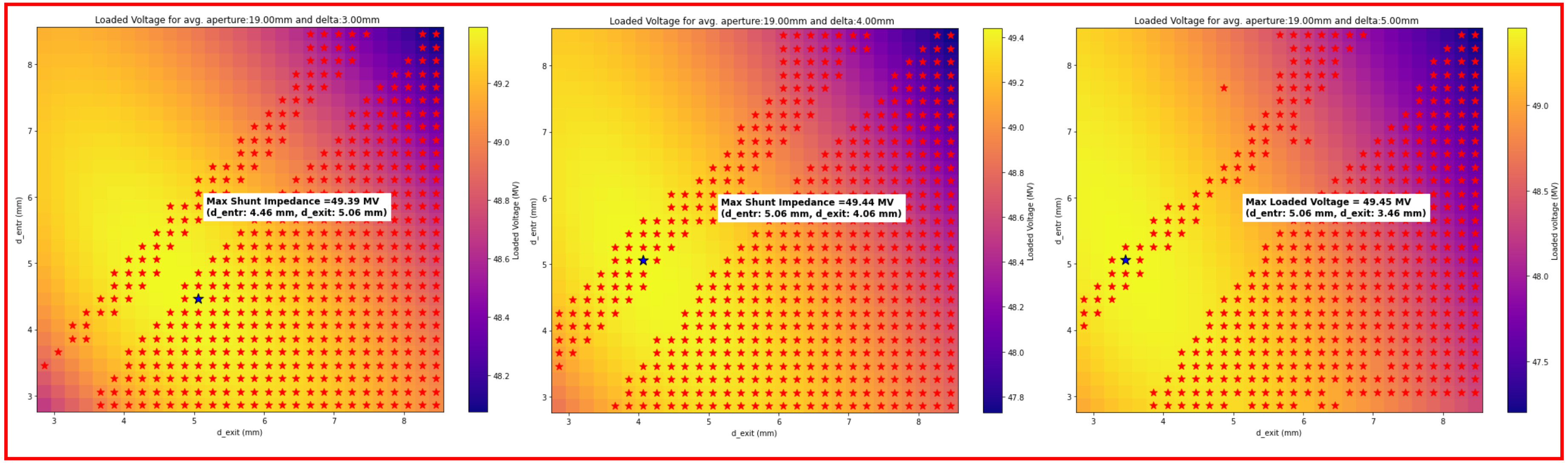
18 mm



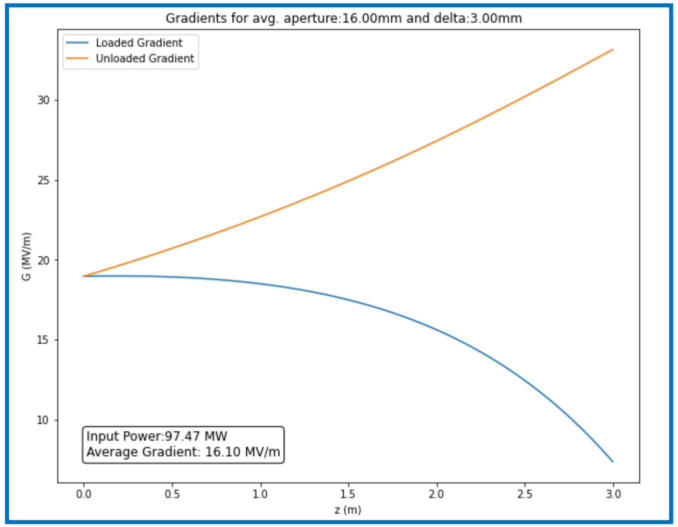
19 mm



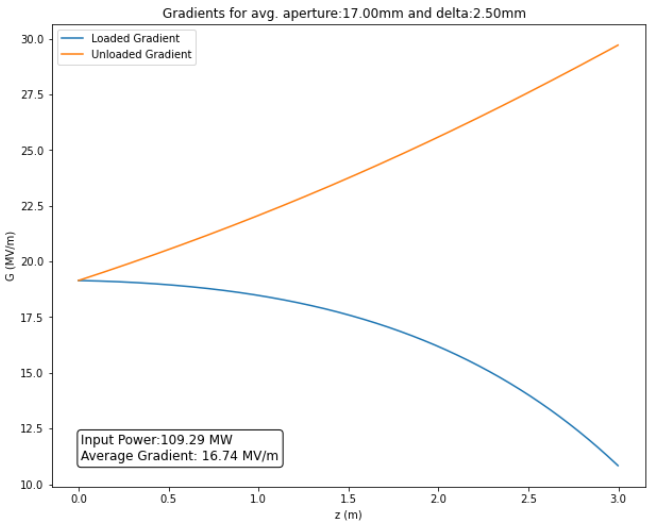
Gradients for the structure scans

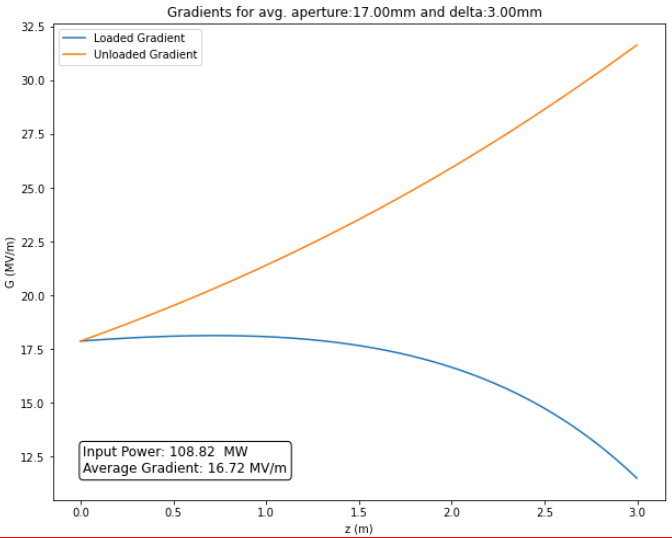
Gradients of the structures

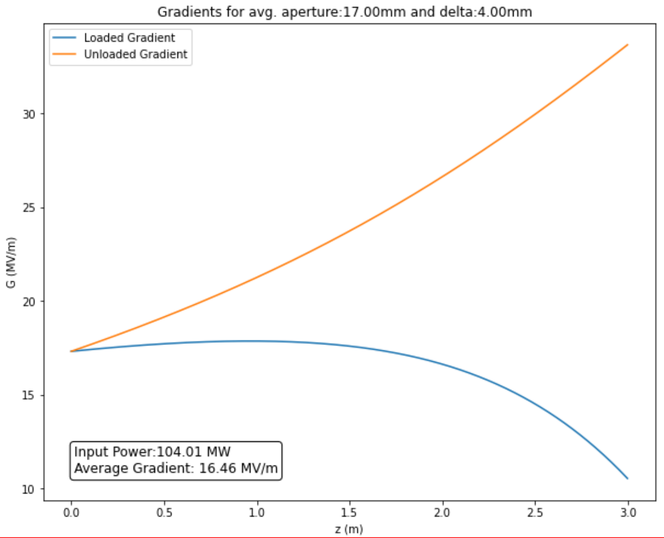
- **Parameters for the structure:**
- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us, P_klystron = 31 MW (2 acc. Struc. Per klystr.)



17 mm







Gradients of the structures

- **Parameters for the structure:**
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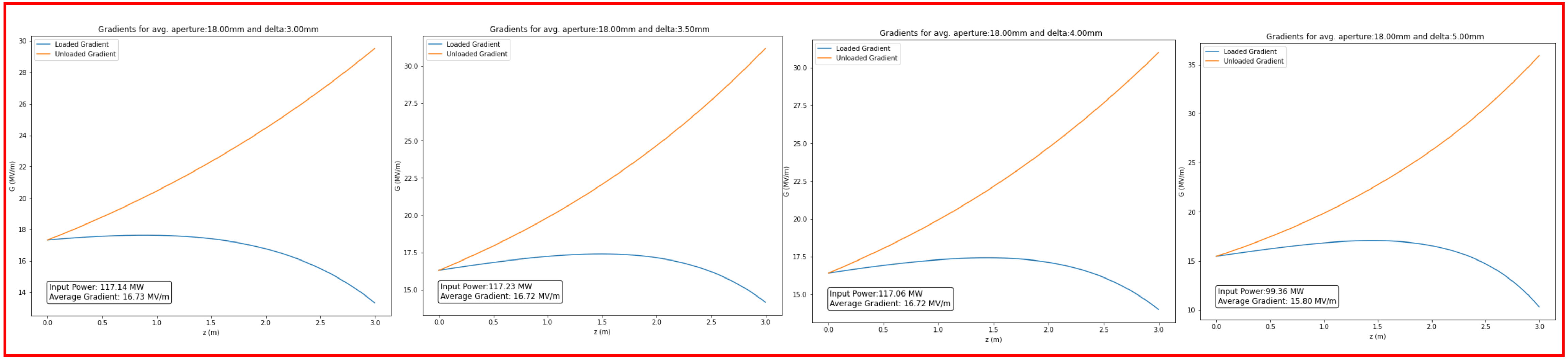
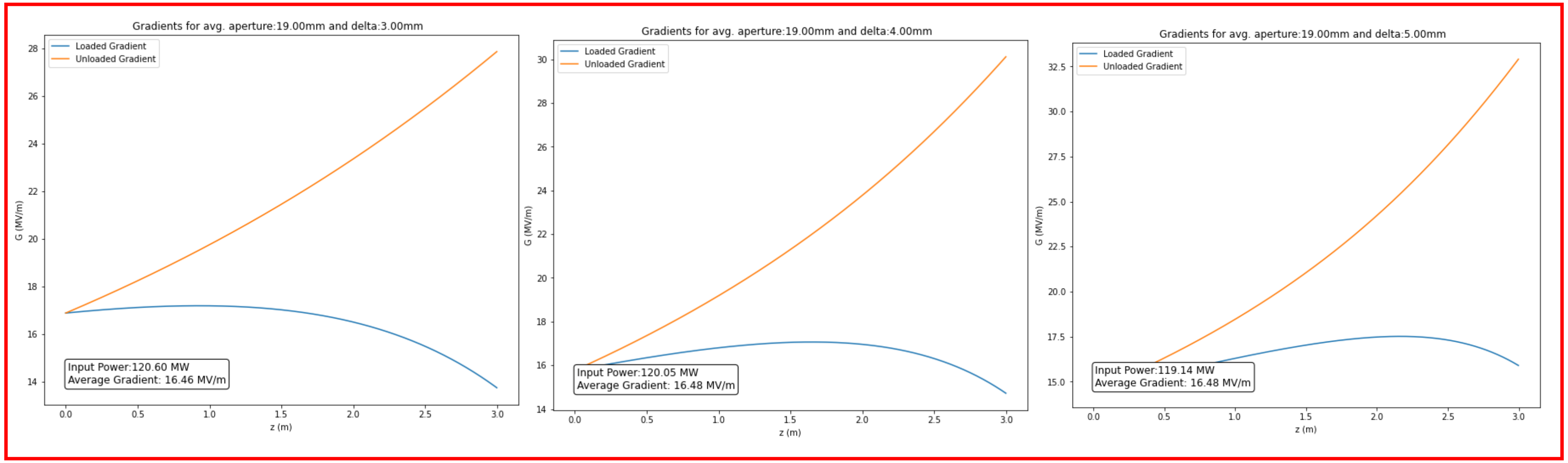
18 mm

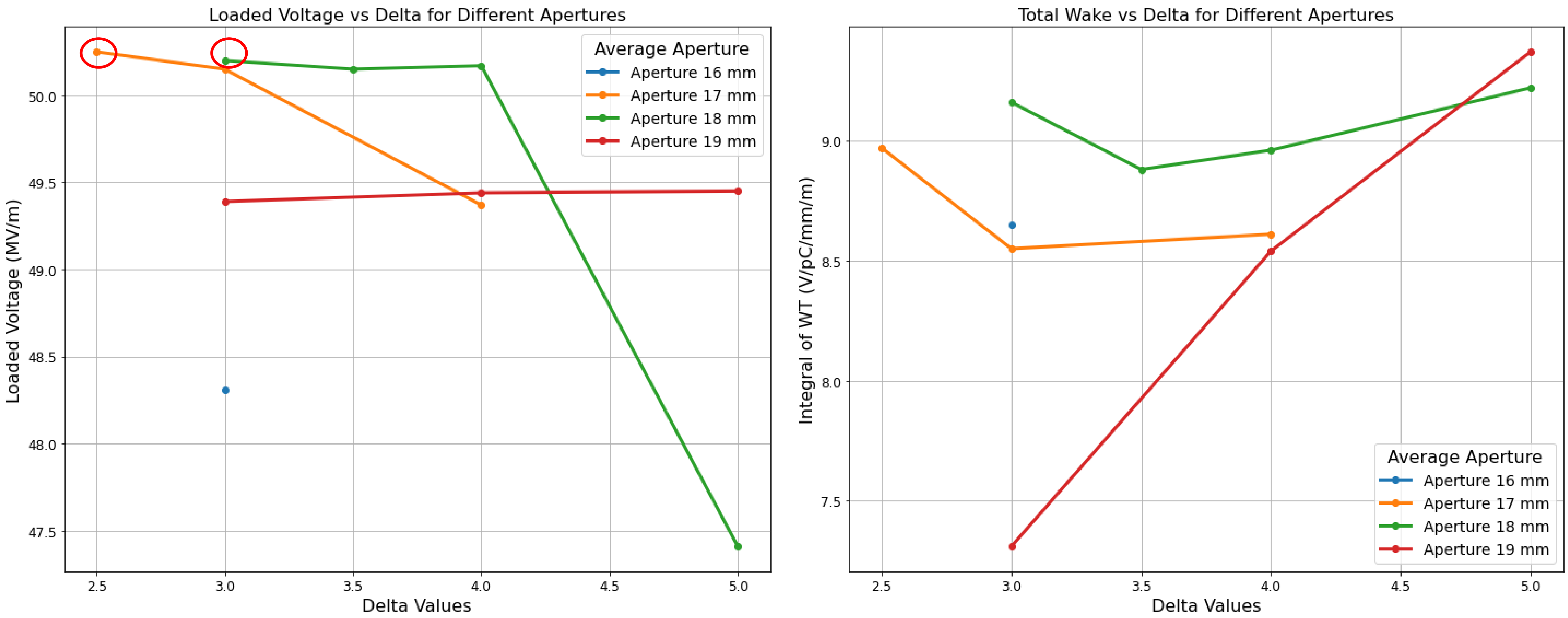


19 mm



Loaded Voltages and Integral of Wake compasions

- Overall there are two candiates based on highest loaded voltages
- Avg. Aperture 17 mm (delta=2.5mm) and Avg. Aperture 18 mm (delta=3mm).



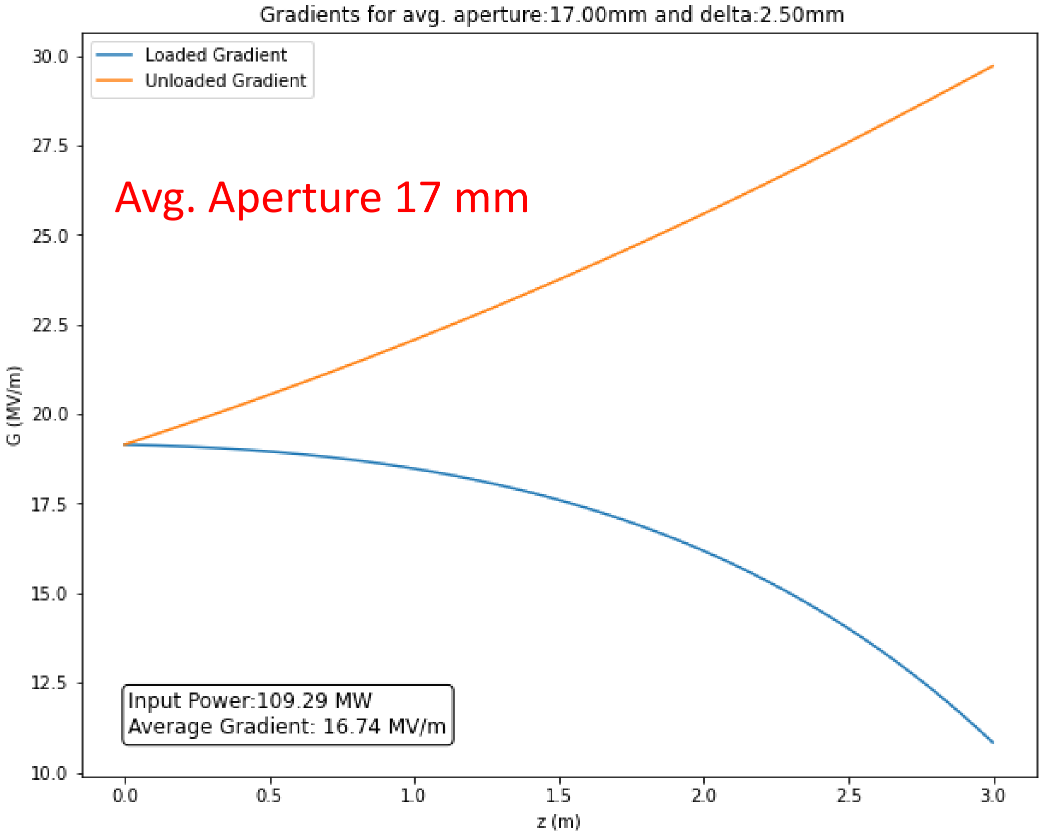
Structure parameters of the candidate TWSs

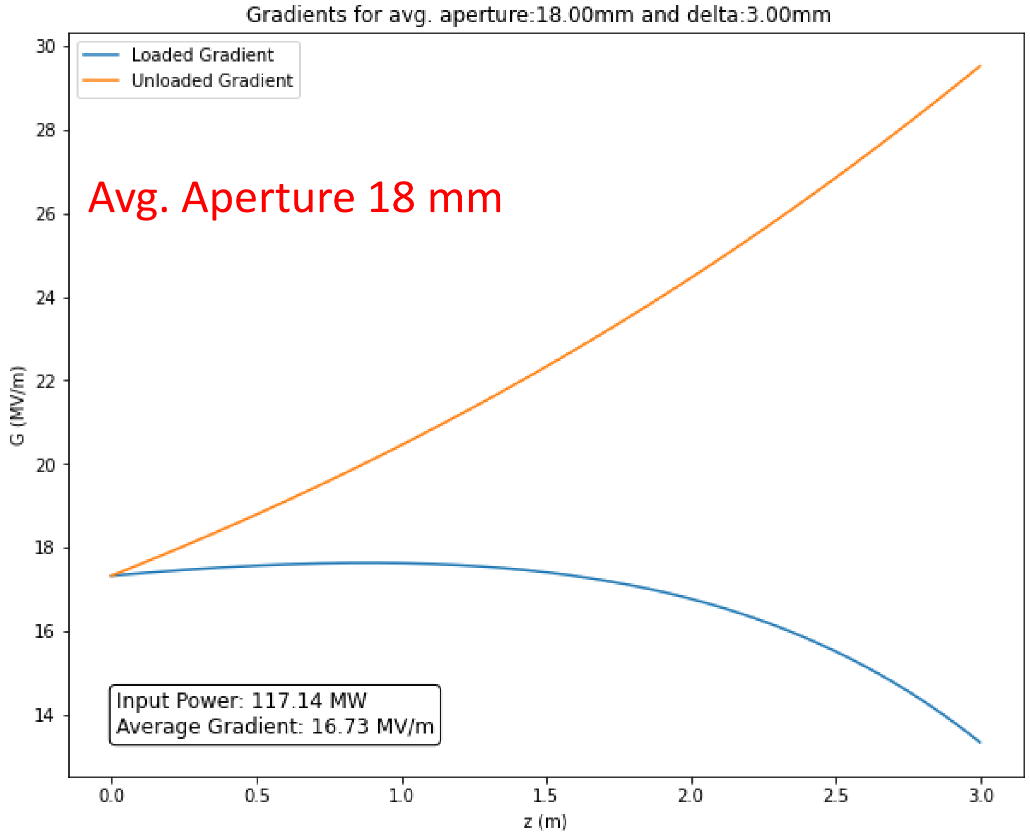
- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us.
- Since Avg. Aperture 17 mm (delta=2.5mm) structure has slightly higher average gradient and lower integral of WT, It is the best candidate so far.

	Avg. Aperture: 17 mm	**Avg. Aperture: 18 mm**
	Delta = 2.5 mm	Delta = 3 mm
Entr., exit aperture	**19.5 mm → 14.5 mm**	**21 mm → 5 mm**
Iris thickness	**2.86 mm → 4.26 mm**	**3.26 mm → 4.06 mm**
Vg (% c)	**3.54→ 1.21**	**4.21 → 1.39**
r/Q (kOhm/m)	**2.72 → 3.27**	**2.58 → 3.22**
Q	**19729 → 19470**	**19799 → 19519**
Filling time	**487 ns**	**416 ns**
SLED coupling	**13**	**14**
Integral of WT (V/pC/mm/m)	**8.97**	**9.15**
Klystron power per structure	**(2 struc. per klyst.) 31 MW**	**(2 struc. per klyst.) 31 MW**
Loaded Voltage	**50.25 MV**	**50.20 MV**
G_{avg}	**16.74 MV/m**	**16.73 MV/m**
E_{max} (instant.)	**97 MV/m**	**96 MV/m**
$S_{c,max}$ (instant.)	**907 mW/µm²**	**951 mW/µm²**

Gradients along the structure of the candidate TWSs

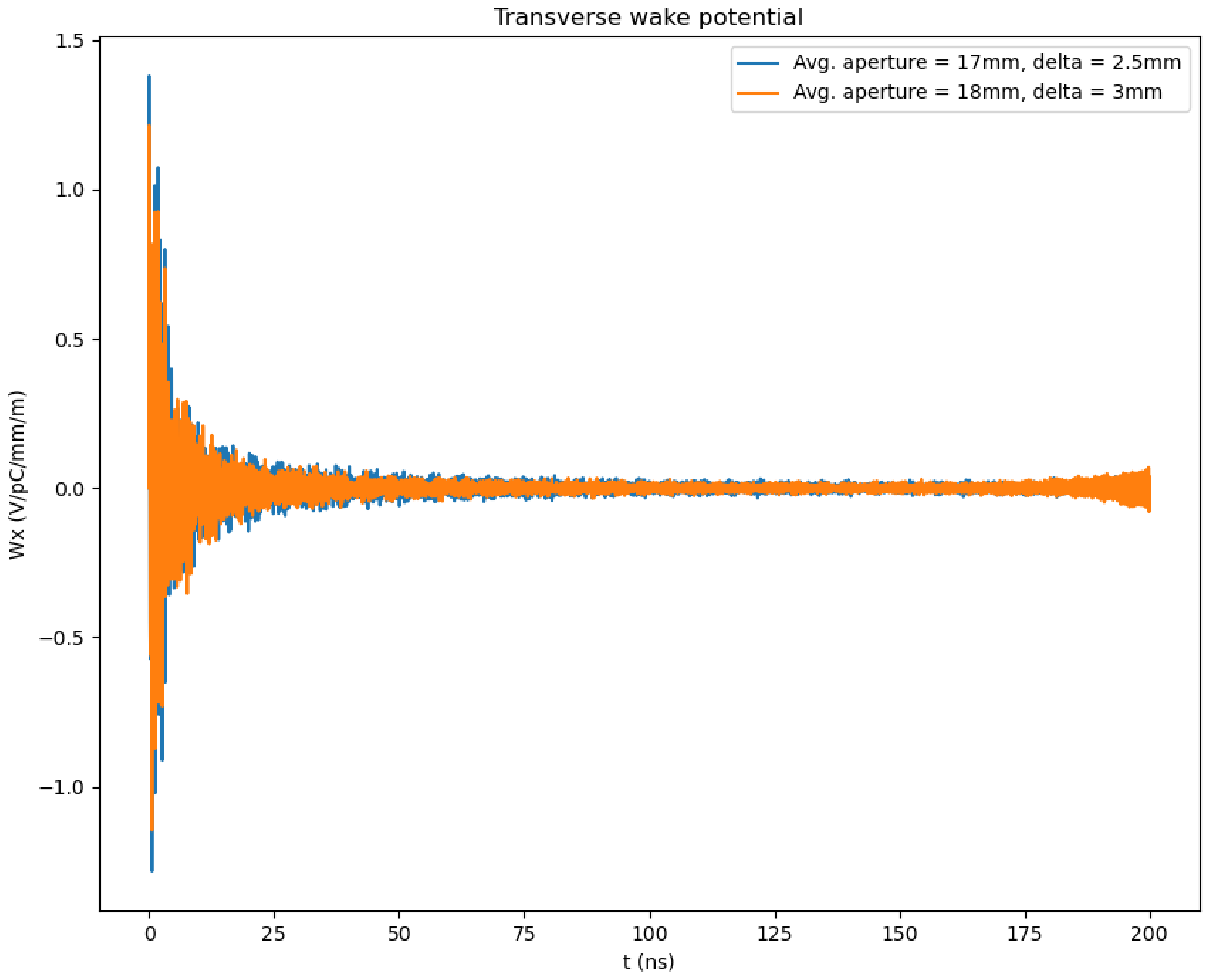
- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us.
- Since Avg. Aperture 17 mm (delta=2.5mm) structure has slightly higher average gradient and lower integral of WT, It is the best candidate so far.

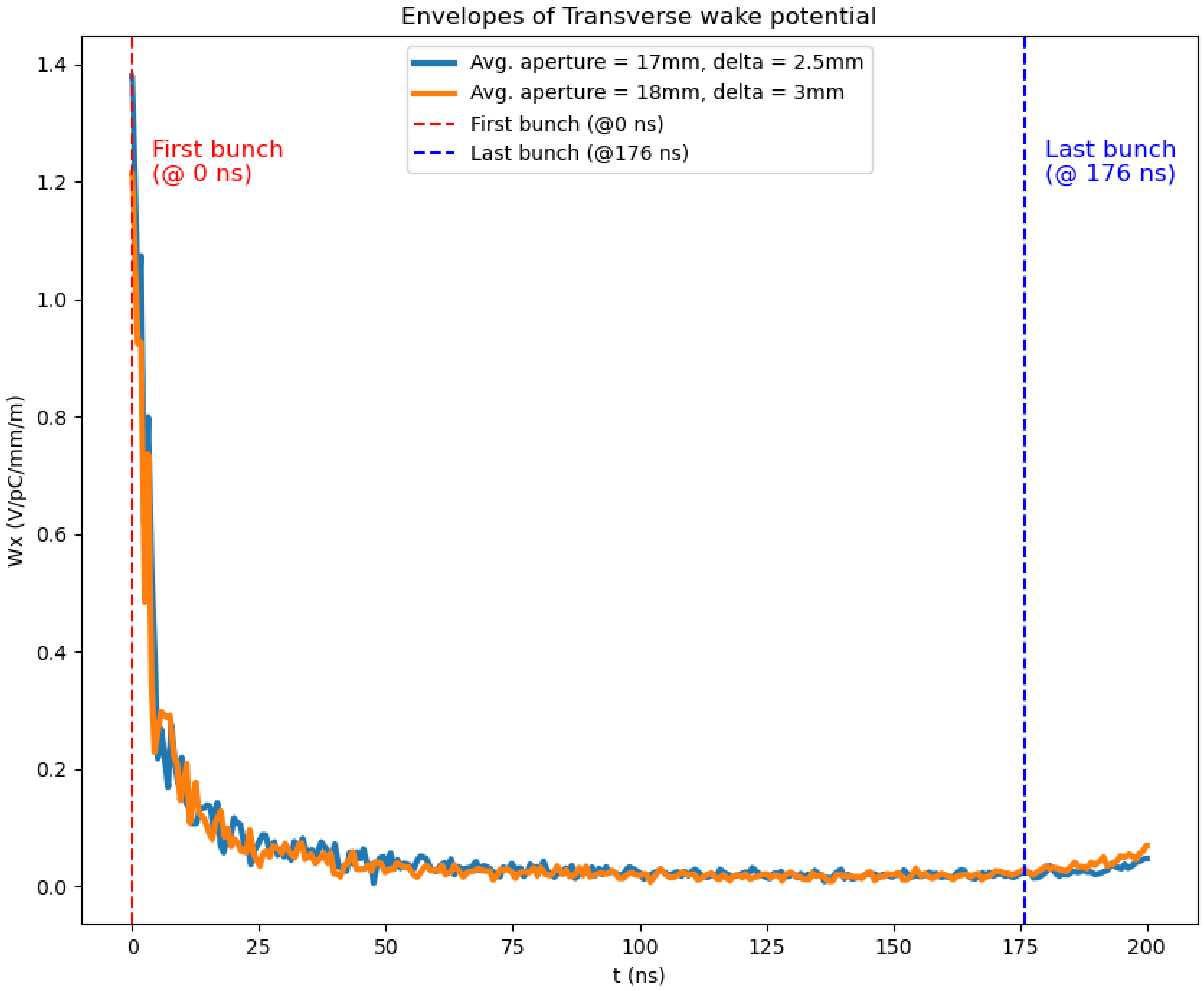




Wakefield Comparisons

- f = 2 GHz, Length = 3m, Phase advance = 2π/3, $Q_{0,SLED}$ = 2e5, $T_{klystron}$ = 5 us, P_klystron = 31 MW
- Wake comparisions of 17mm and 18mm structures.

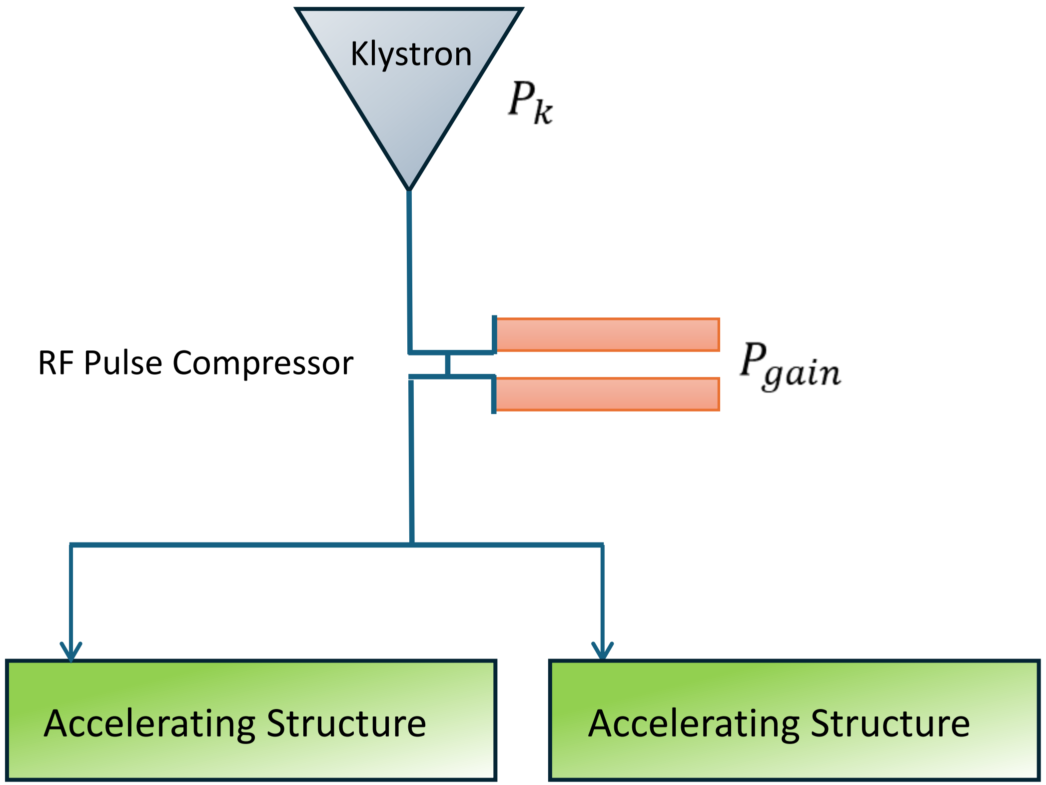




<u>RF Module</u>
<u>(2 struc. Per klystron)</u>

RF Module (2 struc. Per klystron)

$$\Delta E = E_{\text{final}} - E_{\text{initial}} = 9.00\,\text{GeV} - 2.86\,\text{GeV} = 6.14\,\text{GeV}$$



$$\text{Total Length of LINAC} = \frac{\Delta E}{\text{Average Gradient}}$$

$$\text{Number of Structures} = \frac{\text{Total Length of LINAC}}{\text{Length of One Structure}}$$

$$\text{Number of Klystrons} = \frac{\text{Number of Structures}}{\text{Structures per Klystron}}$$

	Avg. Aperture: 17mm
	Delta = 2.5 mm
Klystron power per structure	**(2 struc. per klyst.) 31 MW**
G_{avg}	**16.74 MV/m**
Total length of LINAC	**367 m**
Number of structures	**122**
Number of klystrons (Number of RF module)	**61**