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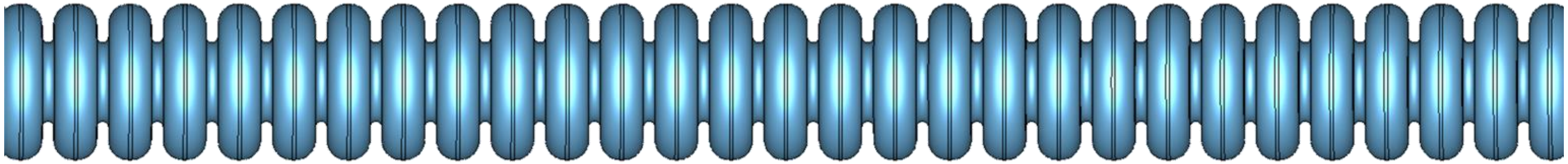

K-Band RF Linearizer Design

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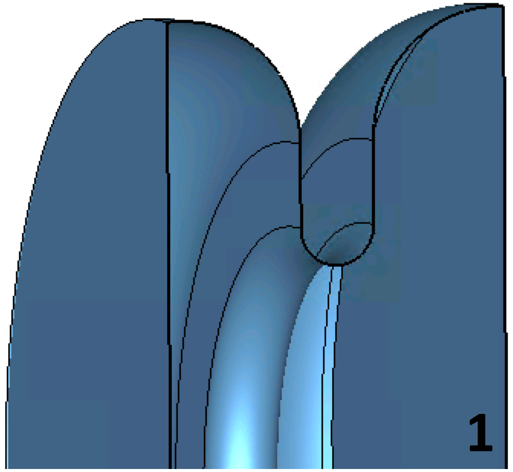
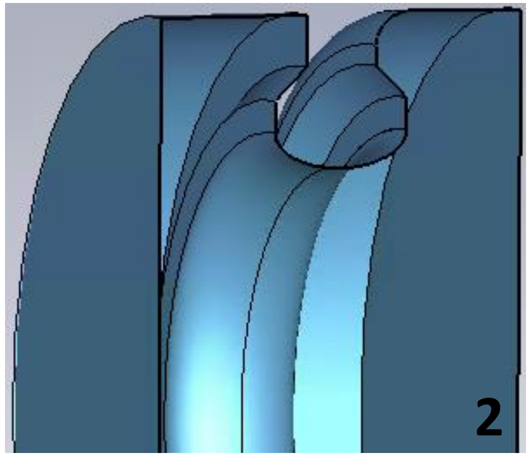
First XLS – CompactLight Annual Meeting, Barcelona 10th – 12th December 2018

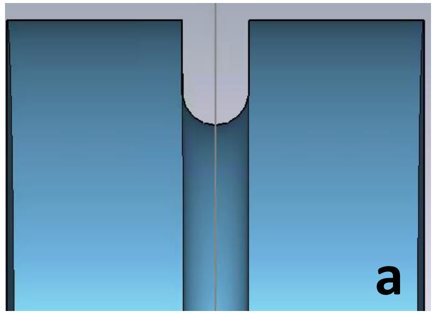
The Cockcroft Institute of Accelerator Science and Technology

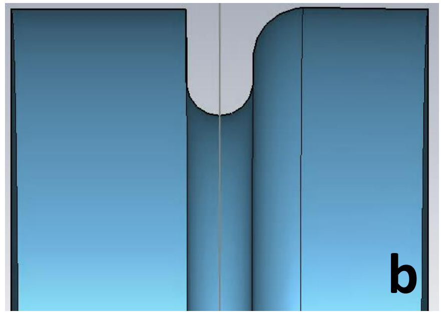
Single Cell Revisited: Candidates

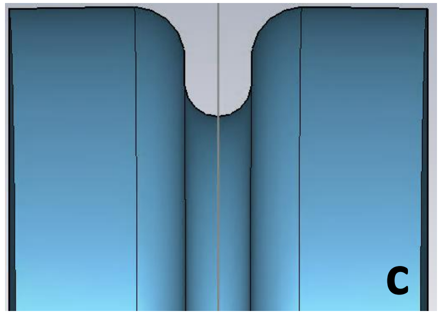
- 2 basic geometries studied:
  1. Simple.
  2. Reentrant.
- For each of this geometries, 3 variations were evaluated:
  a. No-blends at the equator (“Pillbox”).
  b. 1-blend at the equator (“CLARA-style”).
  c. 2-blends at equator (“Classic”).
- Each for 2 phase advances:
  - ${}^{2\pi}/_{3}$.
  - ${}^{5\pi}/_{6}$.





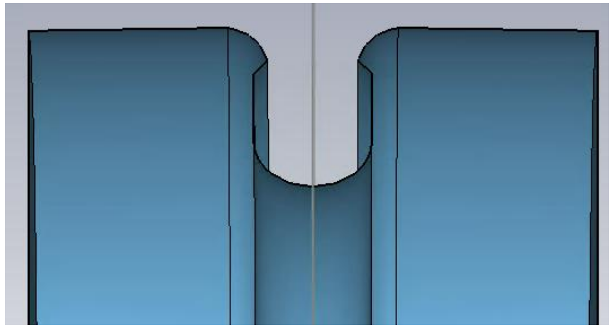


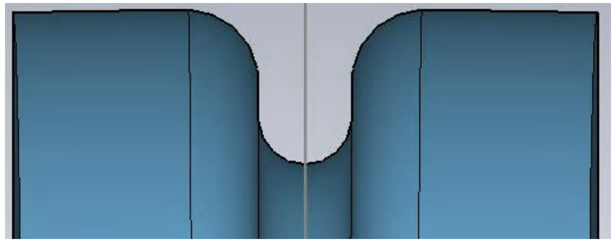




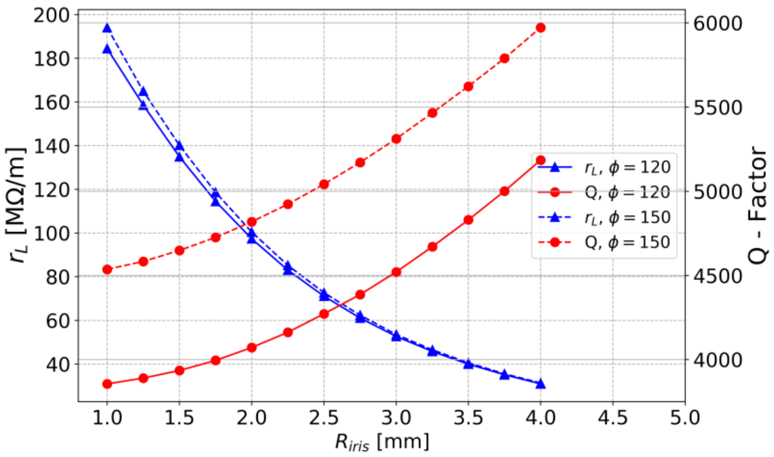
Single Cell Revisited: Comparison

- Shunt Impedance:
  - Higher for simple cells and low iris apertures.
- Intrinsic Q-Factor:
  - On average, higher for simple cells.

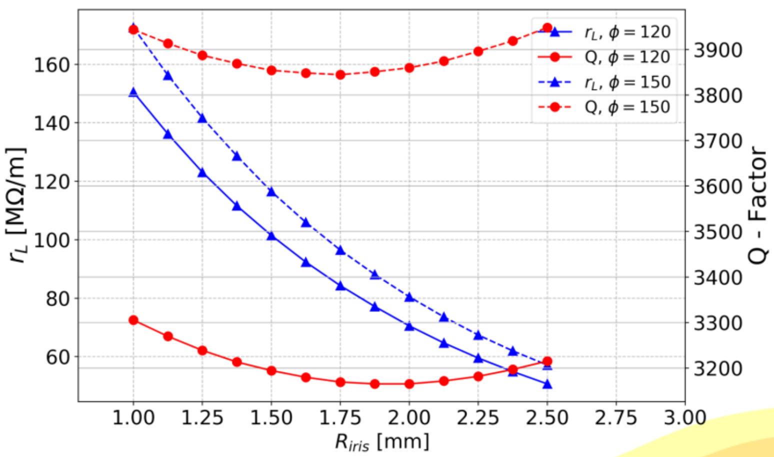




2-Blends Simple Cell

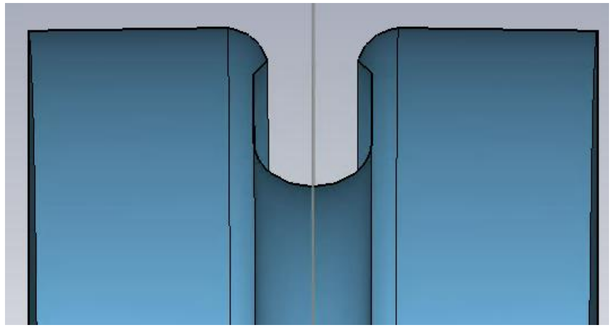


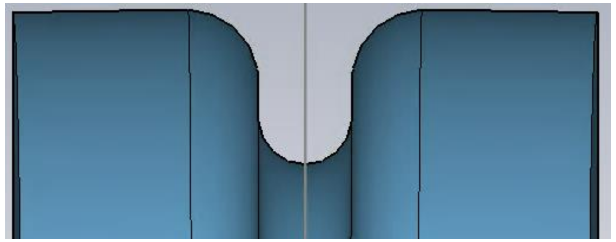
2-Blends Reentrant Cell



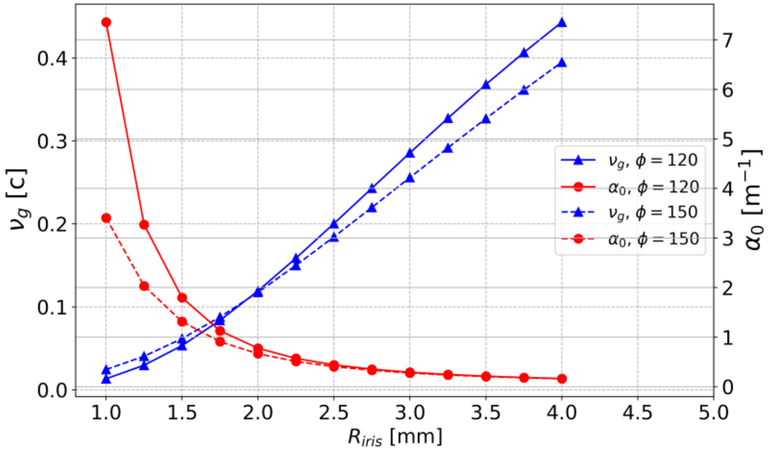
Single Cell Revisited: Comparison

- Group velocities:
  - Lower for the reentrant cell.
- Attenuation:
  - Higher for the reentrant cells.

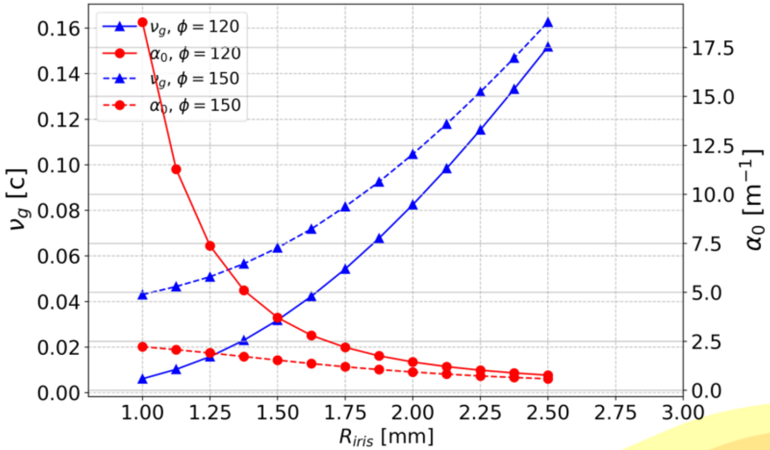




2-Blends Simple Cell

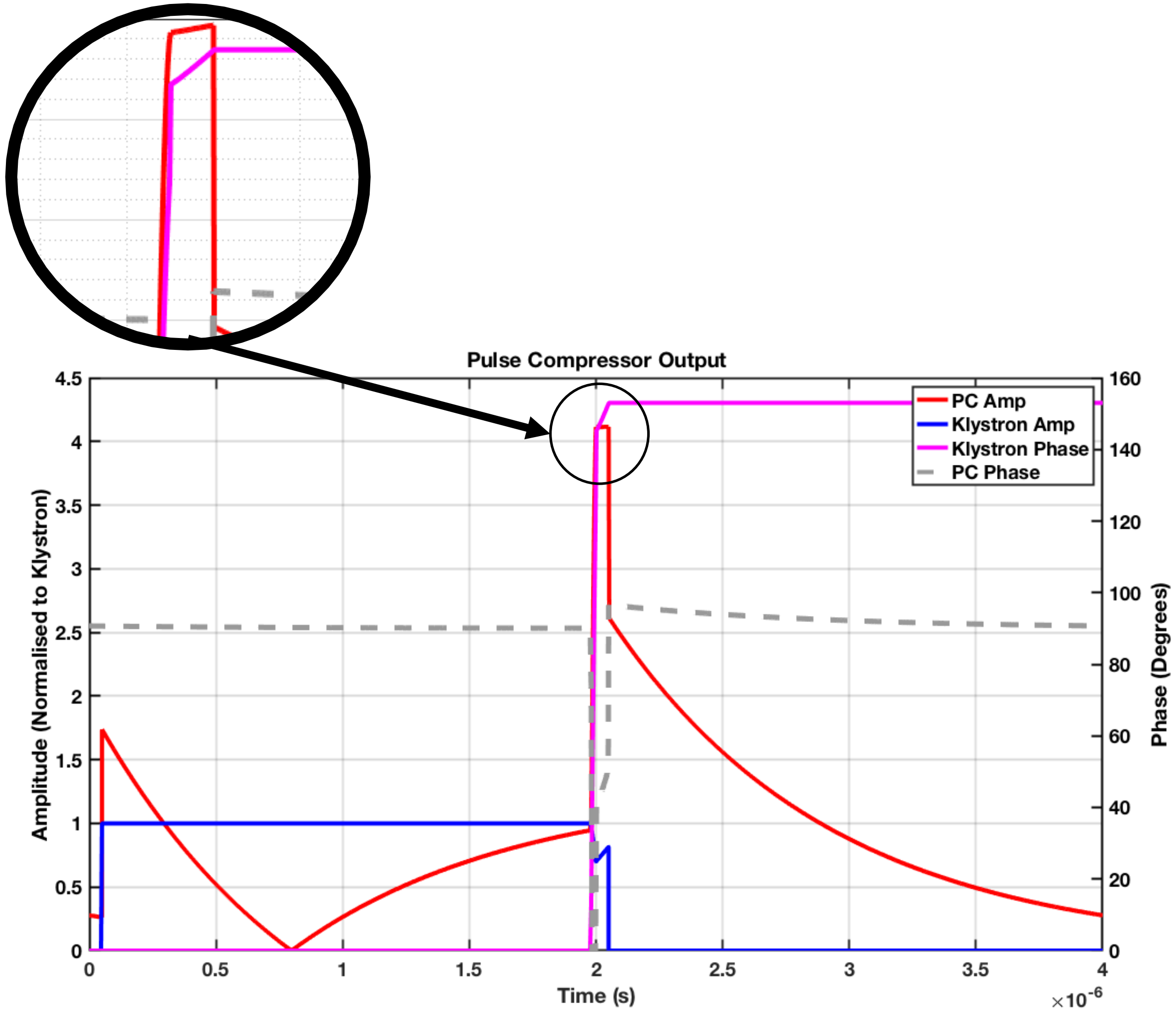


2-Blends Reentrant Cell



Power Considerations

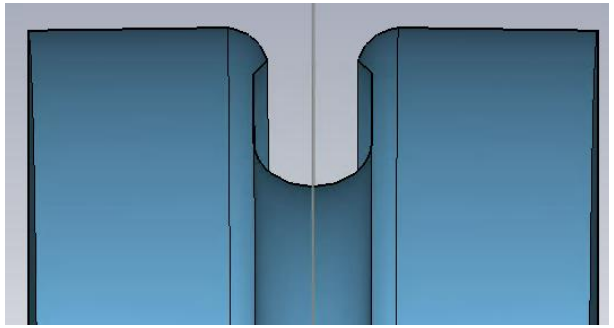
- 36GHz Gyro-klystron:
  - 2μs pulse length.
  - ≥2 MW amplitude.
- SLEDI Pulse Compressor:
  - 50ns flat top.
  - ~4× power gain.
    - Needs both Amp. & Phase ramps to have flat Amp. & Phase outputs.
    - Higher gains are possible w/o flat phase (not useful for beam operations).

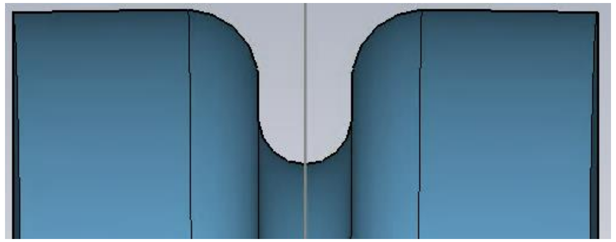


W.L. Millar - ULANC

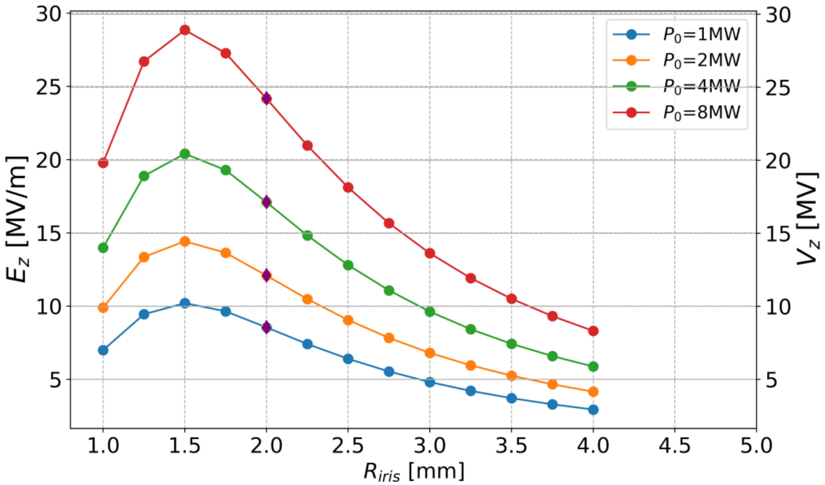
Single Cell: 1m Structure Performance

- For 2mm iris radius:
  1. Simple and reentrant cells have comparable performances.
  2. $^{2\pi}/_{3}$ and $^{5\pi}/_{6}$ also perform similarly.

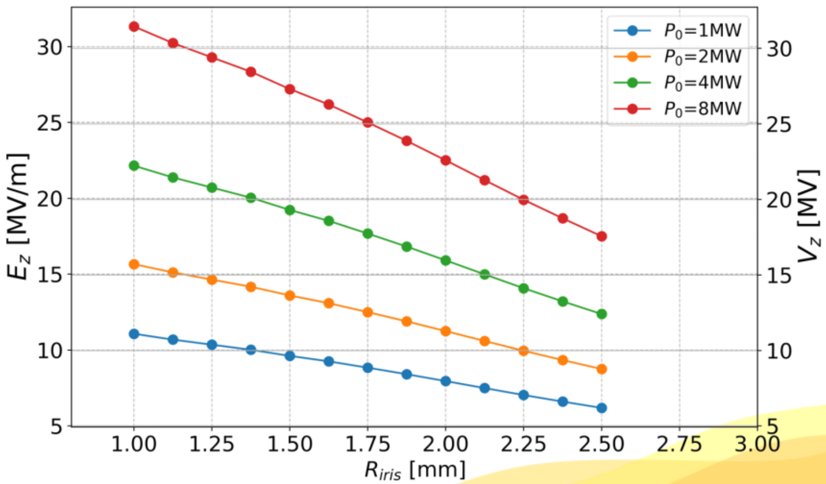




2-Blends Simple Cell @120deg

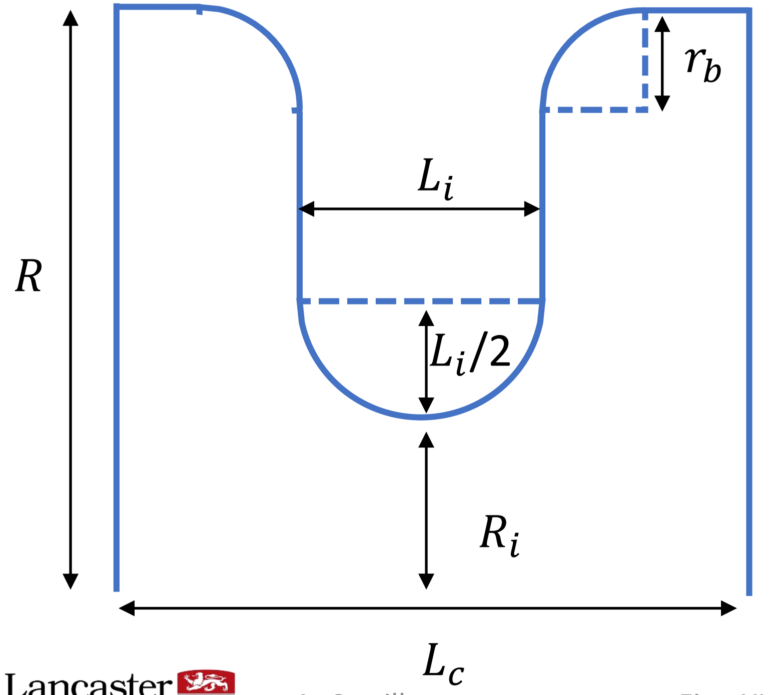


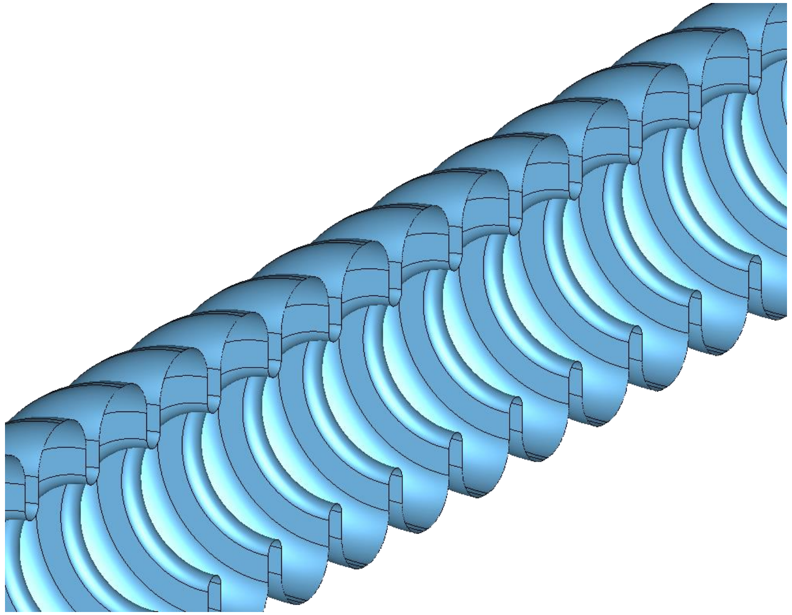
2-Blends Reentrant Cell @150deg



Cell Design

- Simple cell = less manufacturing constraints.
- A geometry is proposed.
- $H_p \approx$ 90kA/m and $E_p \approx$ 65MV/m @25MV/m





Parameter	Value	Units
Freq.	36	GHz
Q	4392	--
r_L	106	MΩ/m
v_g	0.12	c
α_0	0.7	m^{-1}
E_p^*	2.6	MV/m
R	3.96	mm
R_i	2.00	mm
L_c $(\varphi = {}^{2\pi}/_3)$	2.78	mm
L_i	0.60	mm
r_b	1.00	mm

*normalized to $E_z = 1\ MV/m$

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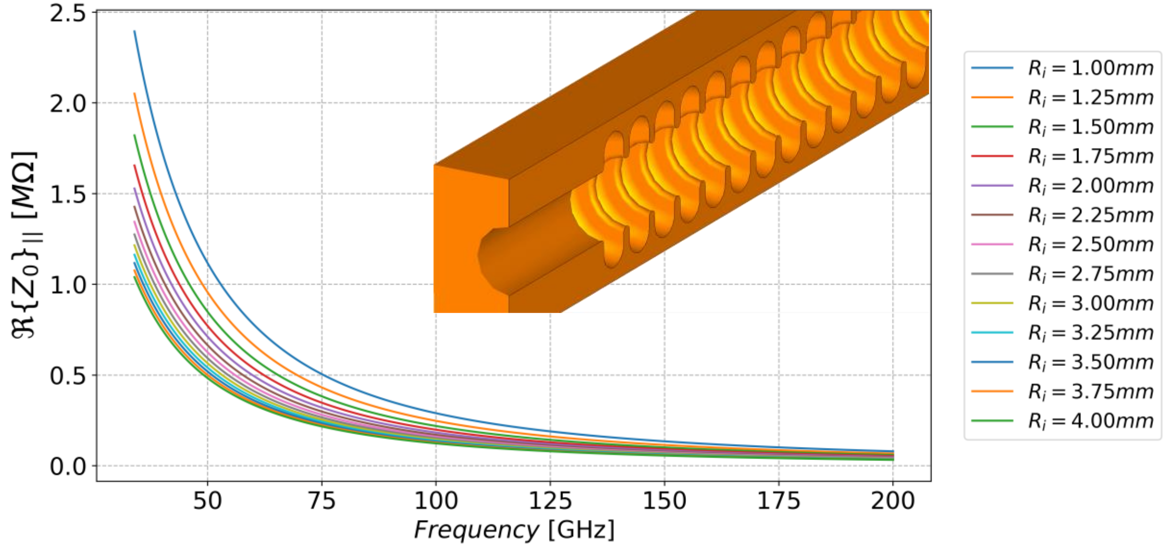
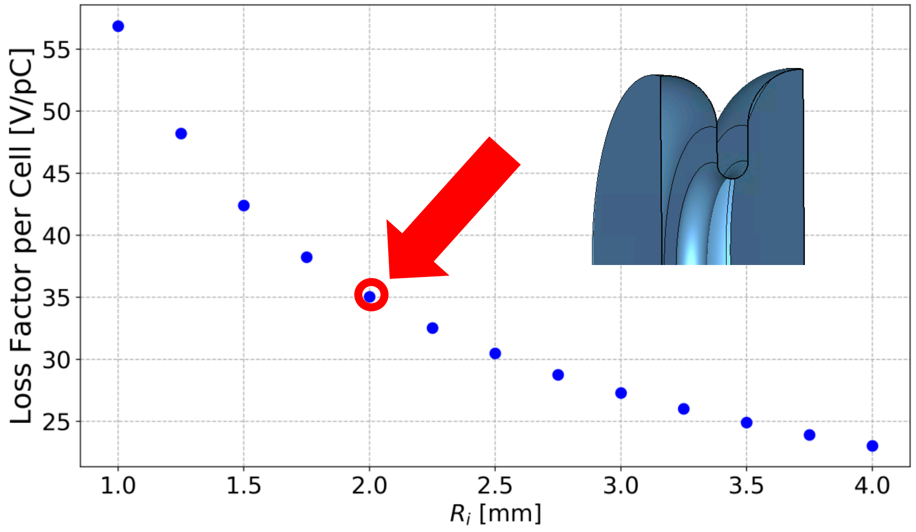
A Quick Look Into The Wakes

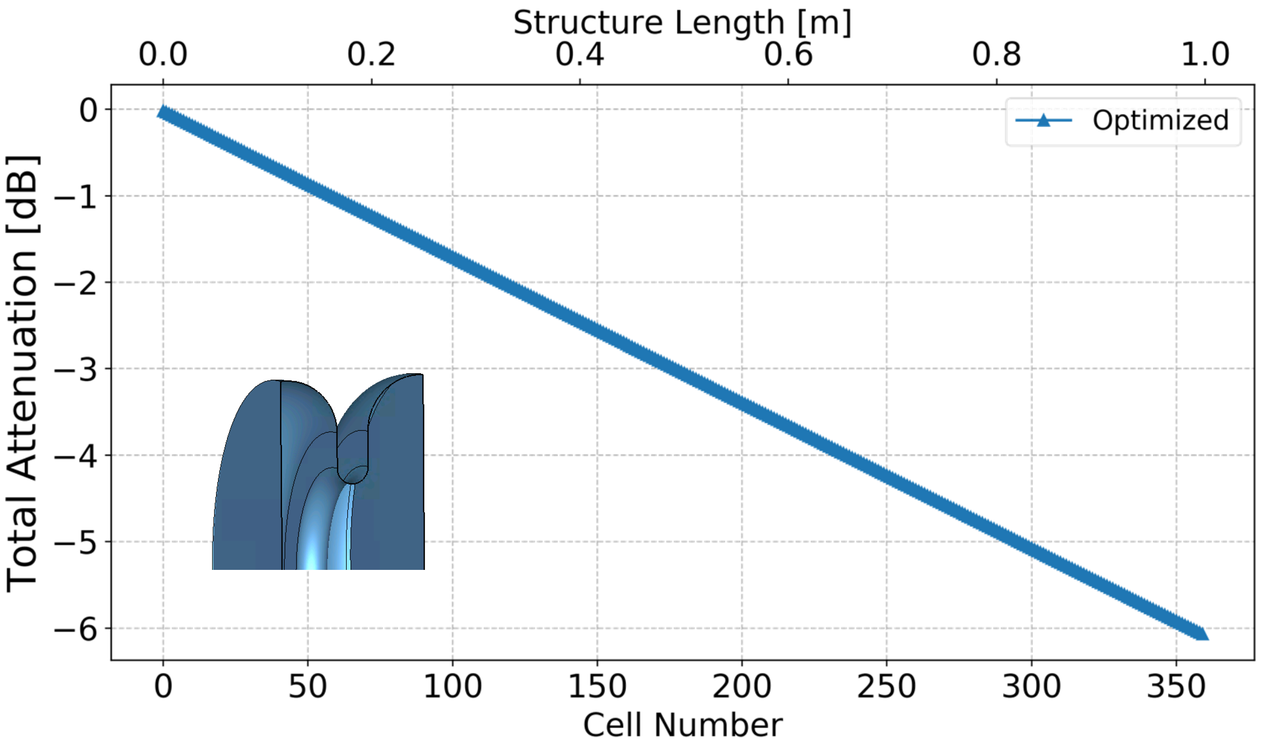
- Considering a 1 meter structure for ${}^{2\pi}/_{3}$ mode (i.e. 360 cells).
- The longitudinal loss factor per cell decreases with the iris aperture.
- Effect of the transverse wakes even more significant.

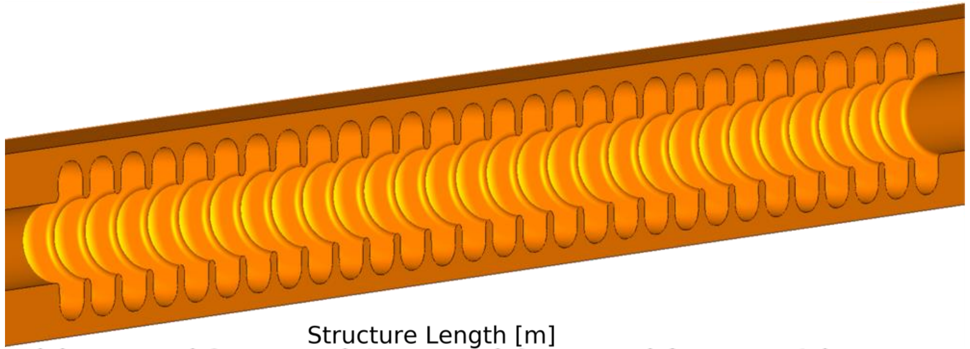


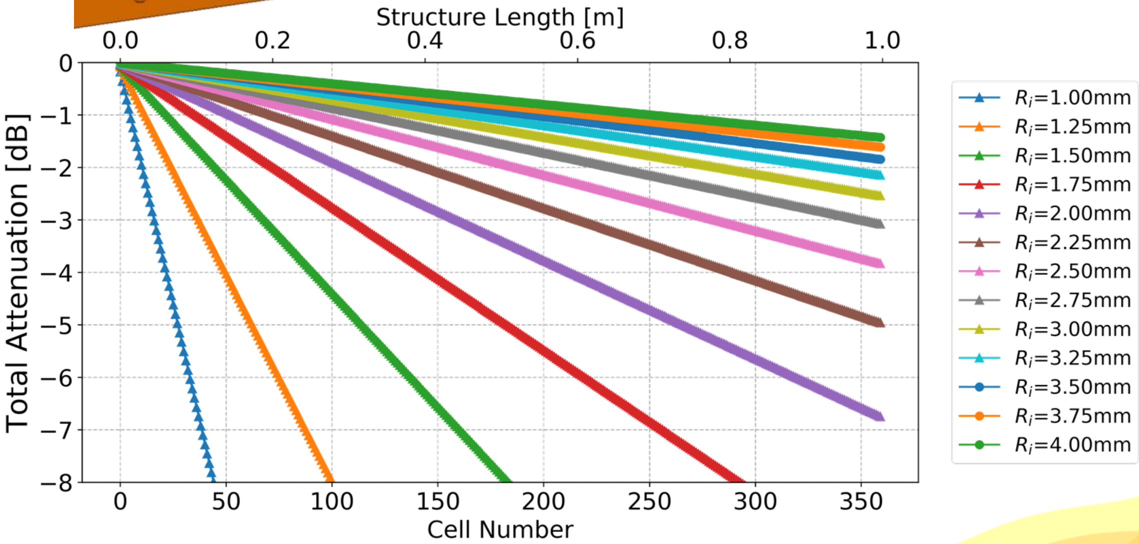


Other Options

- Power recirculation advantages bounded by the total structure attenuation:
  - It may be challenging for this aperture.

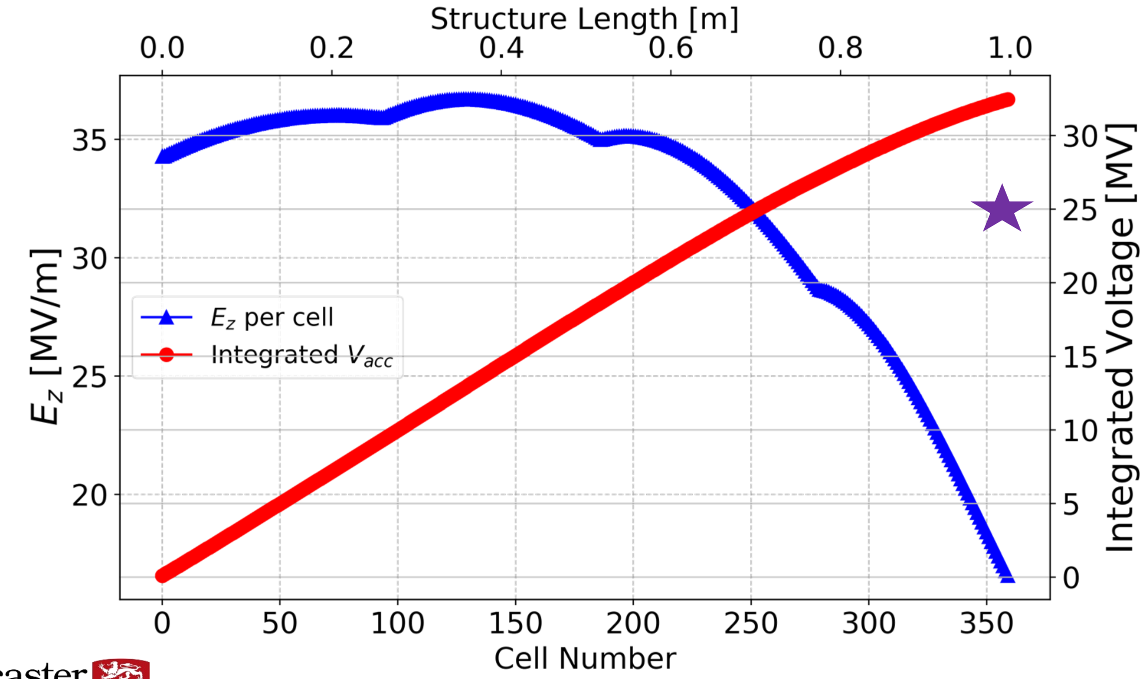


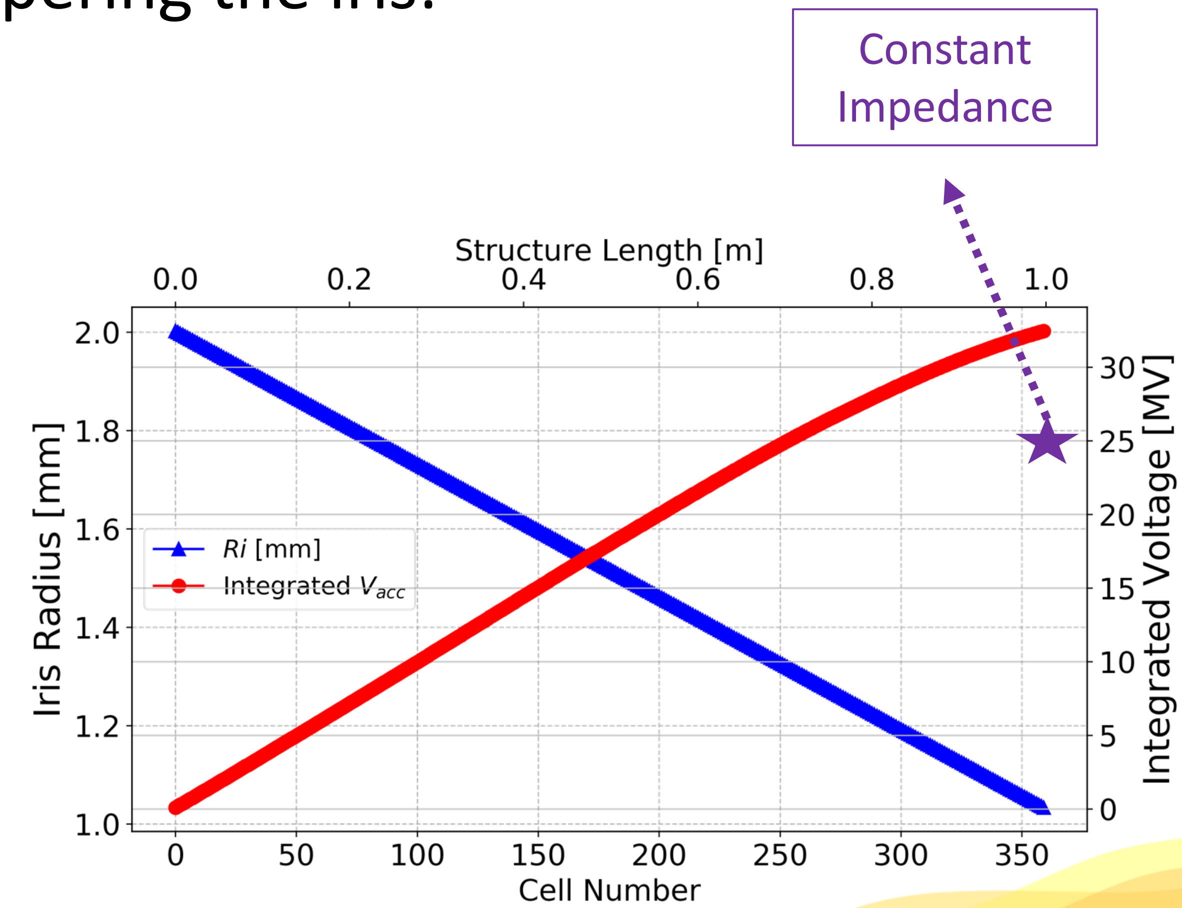




Simple Cell: ‘Constant Gradient’ (@8MW)

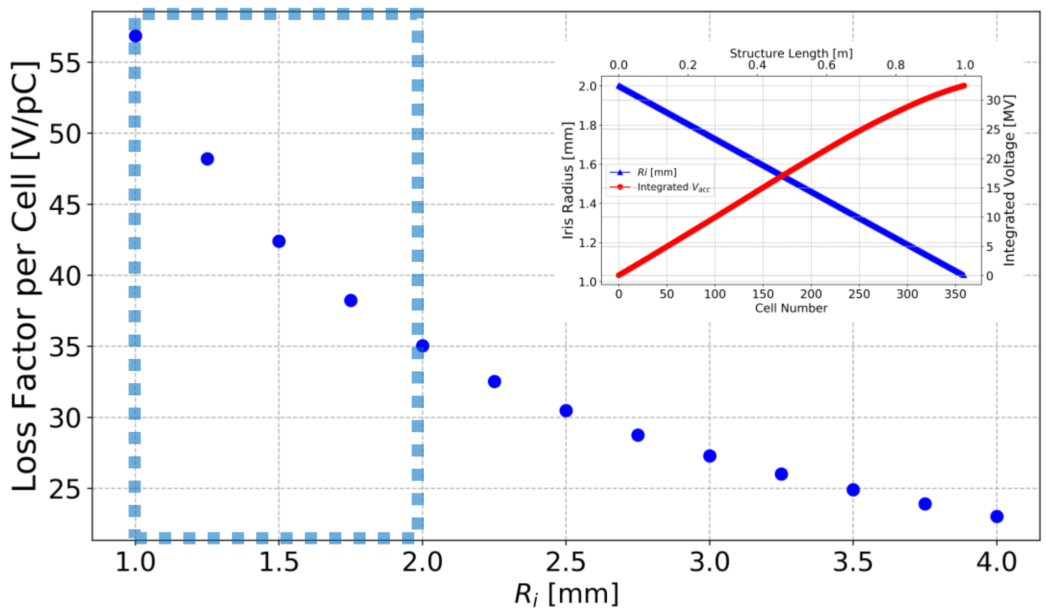
- Improved gains at the expense of tapering the iris:
  - Higher loss factor.
  - ~32MV integrated voltage.

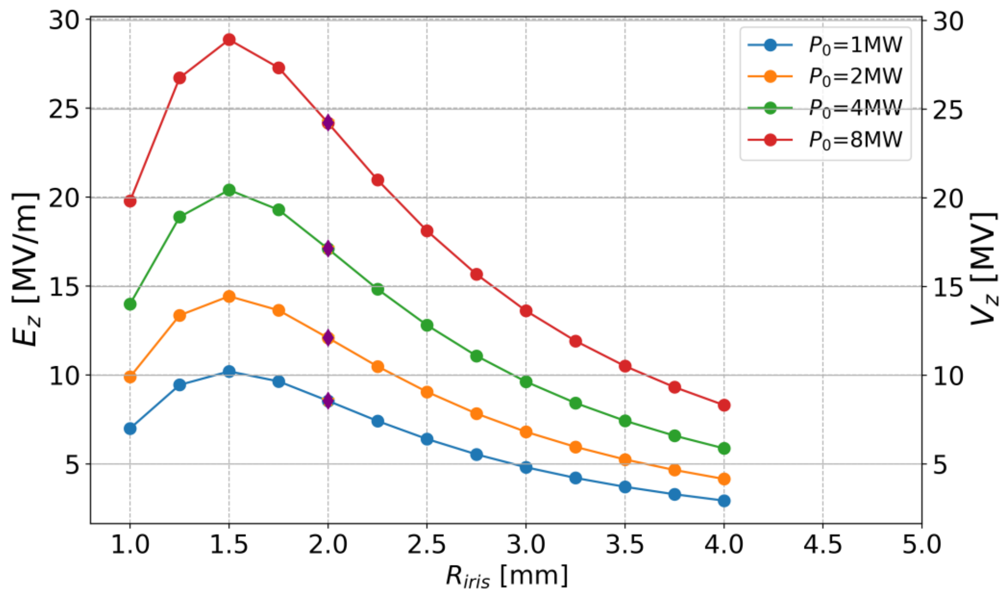




Simple Cell: ‘Constant Gradient’ (@8MW)

- Improved gains at the expense of tapering the iris:
  - Higher loss factor: Sweeping between 2 and 1mm.
  - Slightly higher integrated voltage (~32MV).





Summary

- **Detailed exploration of the parameter space revisited:**
  - Wakes constrain the minimum iris aperture.
  - RF performance constrains the maximum iris aperture.
  - **A simple cell geometry is proposed with 2mm iris radius.**
- **Performance of a 1m structure:**
  - ~25MV achievable with reasonable power considerations.
- **Power recirculation option:**
  - More efficient for higher iris apertures (i.e. lower attenuation factors).
- **Constant gradient structure option:**
  - Higher integrated voltages than the constant impedance option.
  - Higher loss factors from wakes due to reduction on the iris aperture.

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Thanks!