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RF module update

CompactLight "Glasgow Virtual" Meeting, 16-18 June 2020

M. Diomede, D. Alesini, M. Bellaveglia,

A. Gallo, L. Piersanti (INFN-LNF)

X-Band: COMPARISON BETWEEN TAPERINGS

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Wakefield optimization

Detuning by using Gaussian frequency distribution

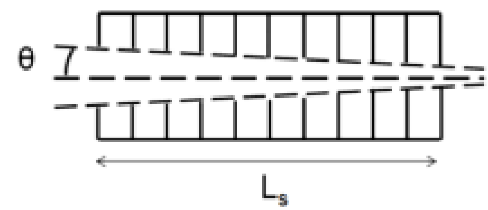
- Adjust the dipole mode frequency distribution by changing the coupling irises and the diameters of the cells

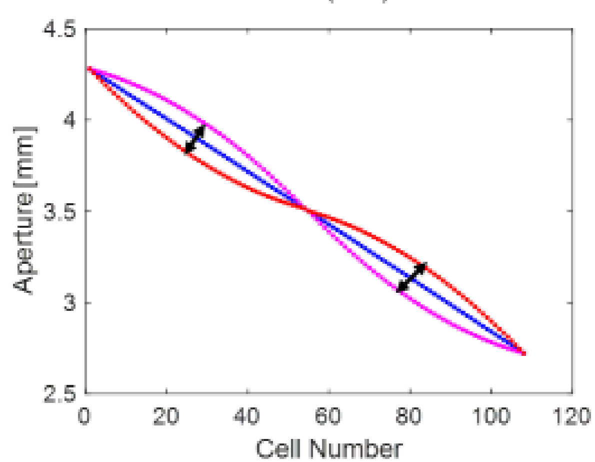
Optimize the wake by changing the curvature of the aperture distribution

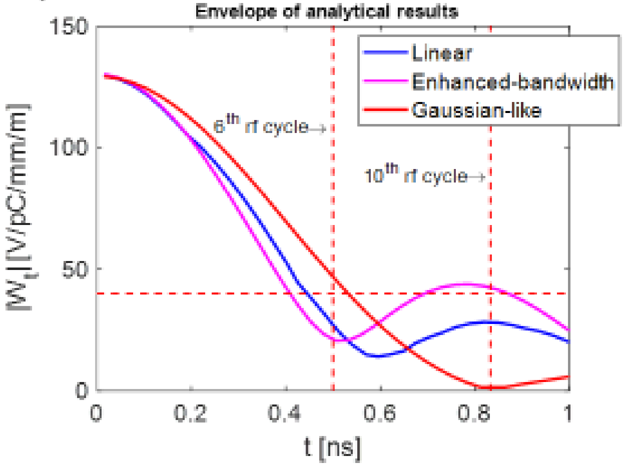
- Linear distribution (Blue) is the existing baseline design
- Enhanced-bandwidth distribution (Pink) reduces the wake at 6th rf cycle
- Gaussian-like distribution (Red) reduces the wake at 10th rf cycle

Baseline design's aperture:
from 4.278 mm to 2.722 mm

Structure with linear iris tapering







Xiaowei Wu, Long-range transverse wakefield optimization and preliminary bunch deflector system design, Jan 21-24, Athens, Greece 11

X. Wu

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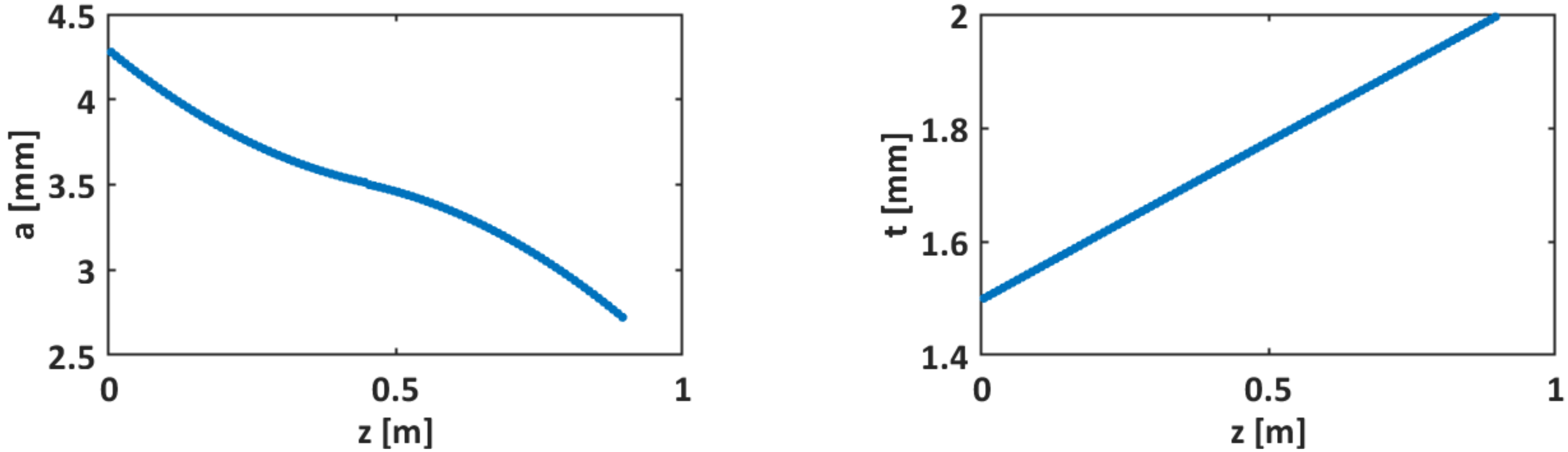
COMPARISON BETWEEN TAPERINGS

- New geometries from Xiaowei: gaussian distribution of iris radius and linear distribution of iris thickness

1



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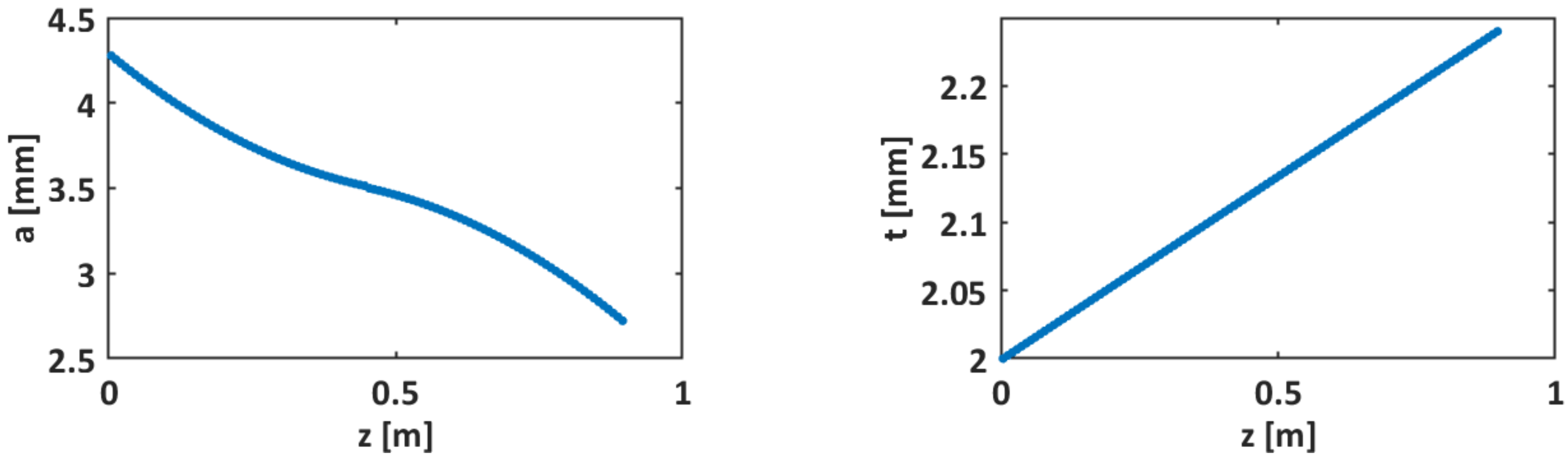
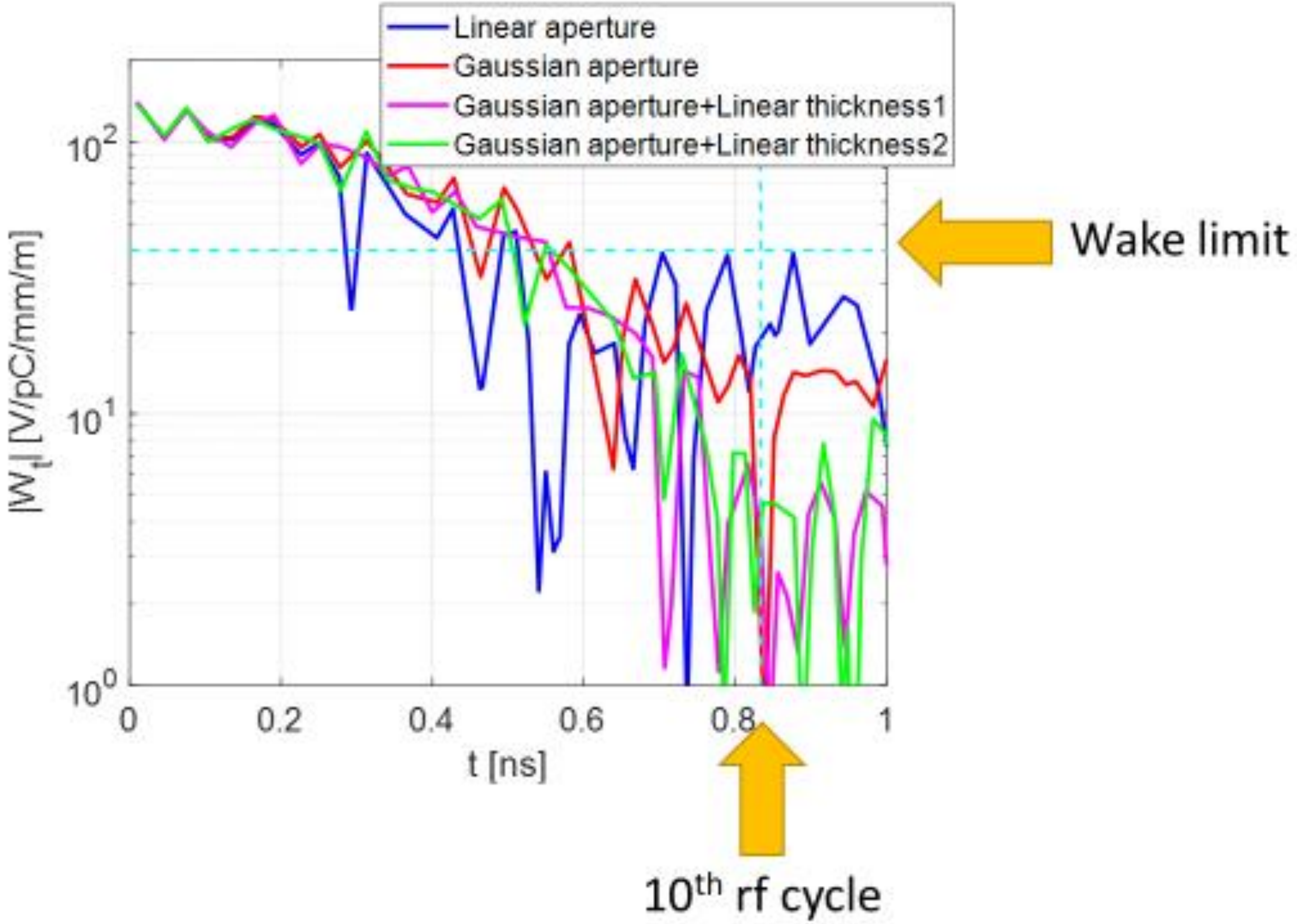


COMPARISON BETWEEN TAPERINGS

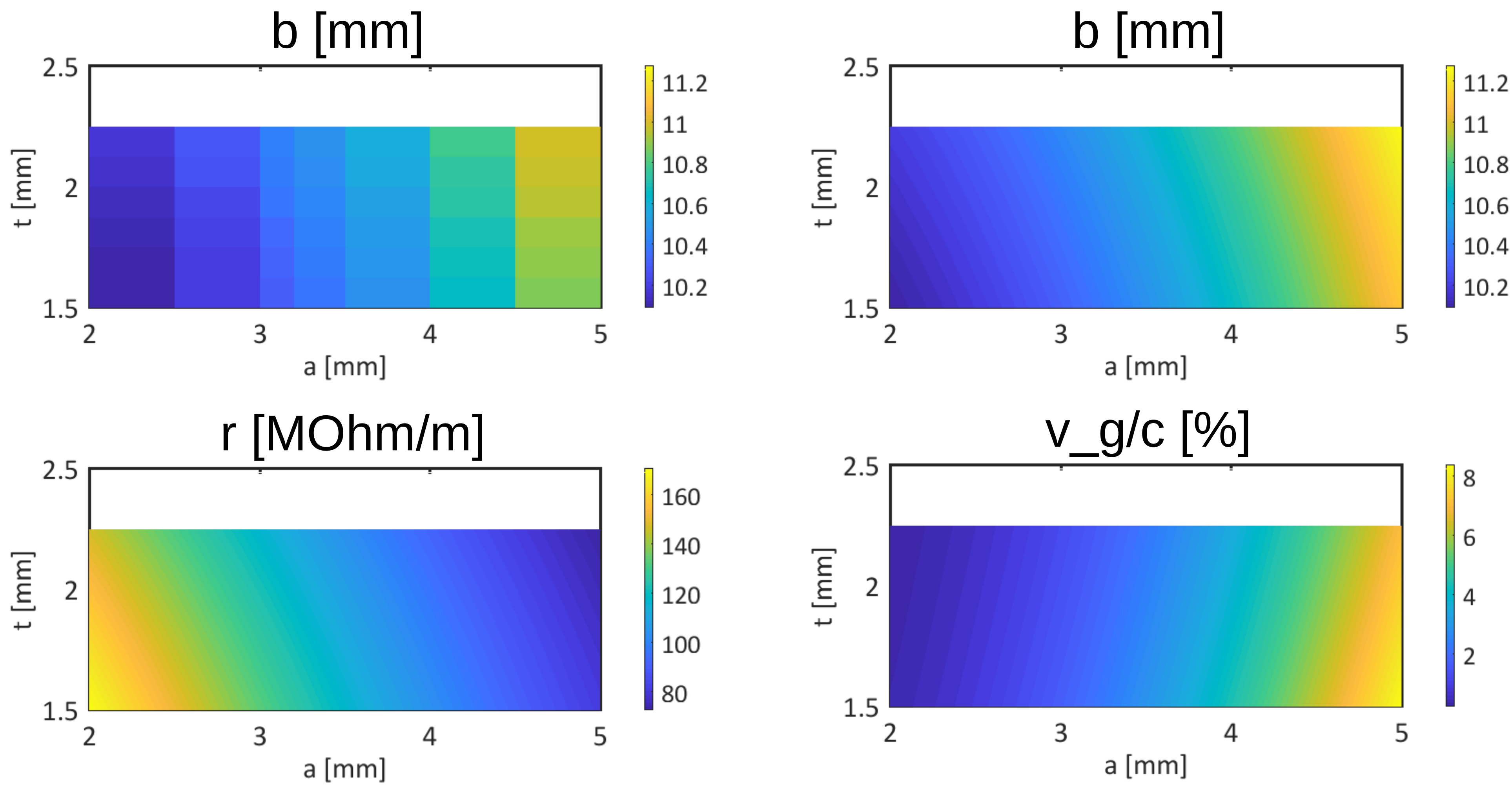
The wake around the 10th rf cycle was reduced by applying Gaussian distribution aperture and linear iris thickness



X. Wu

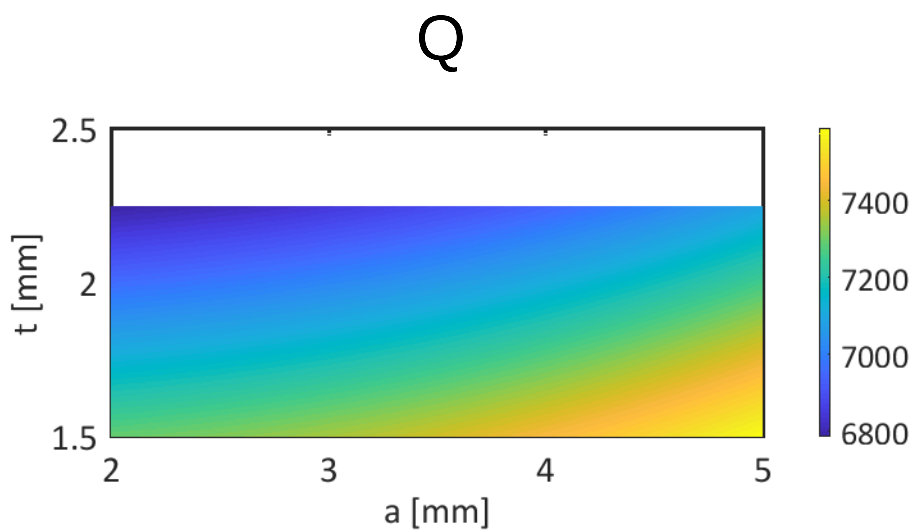
CELL PARAMETERS

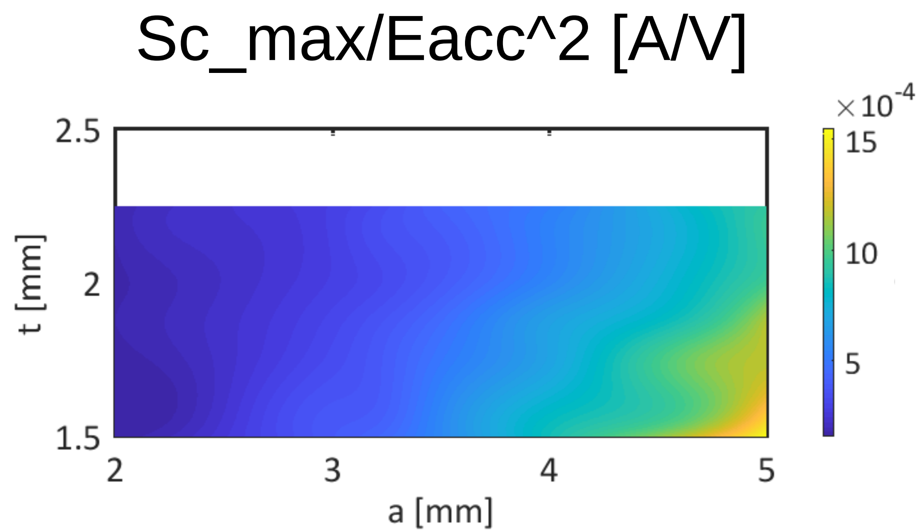
- As a function of iris radius a and iris thickness t



CELL PARAMETERS

- As a function of iris radius a and iris thickness t





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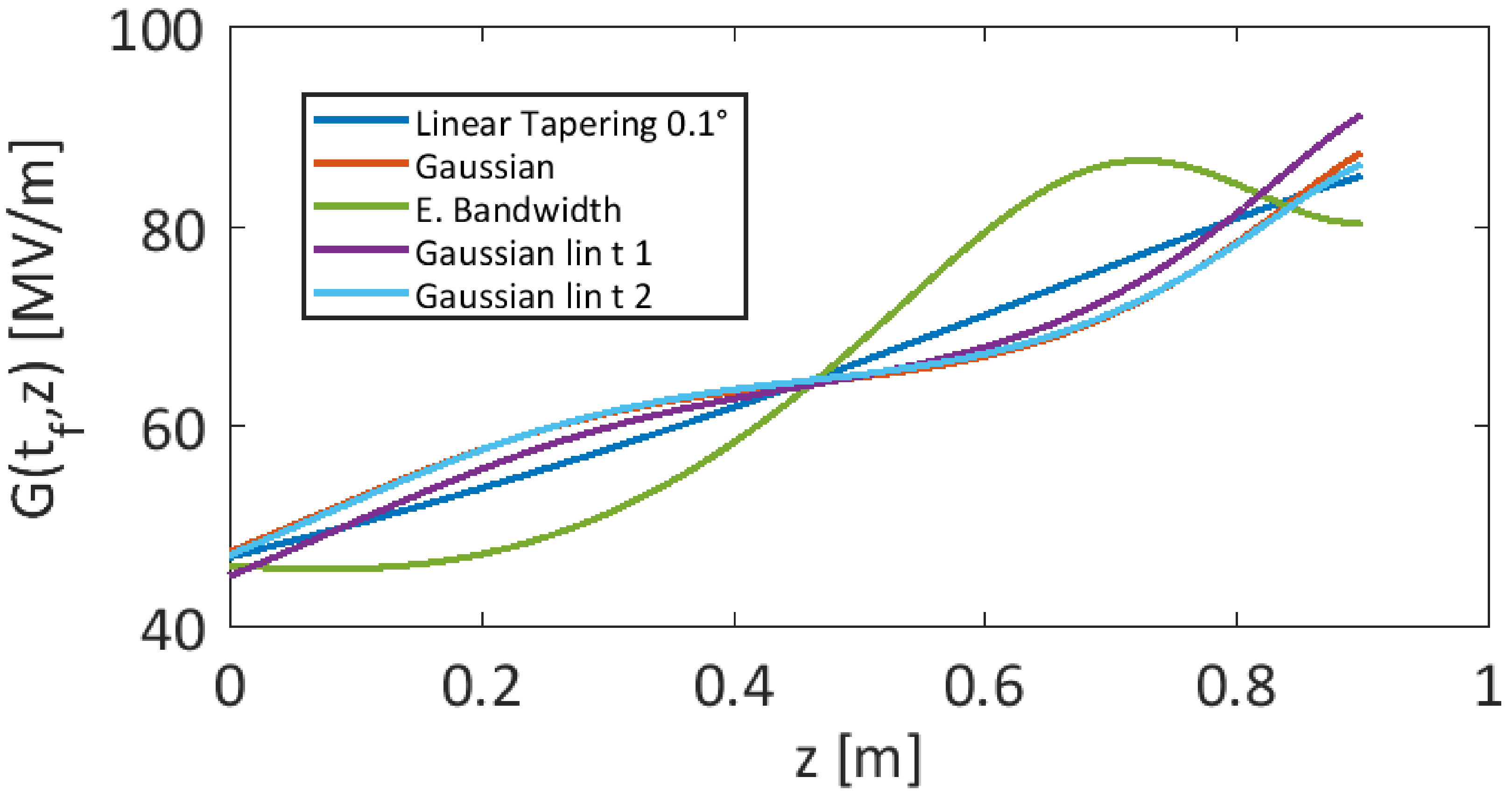
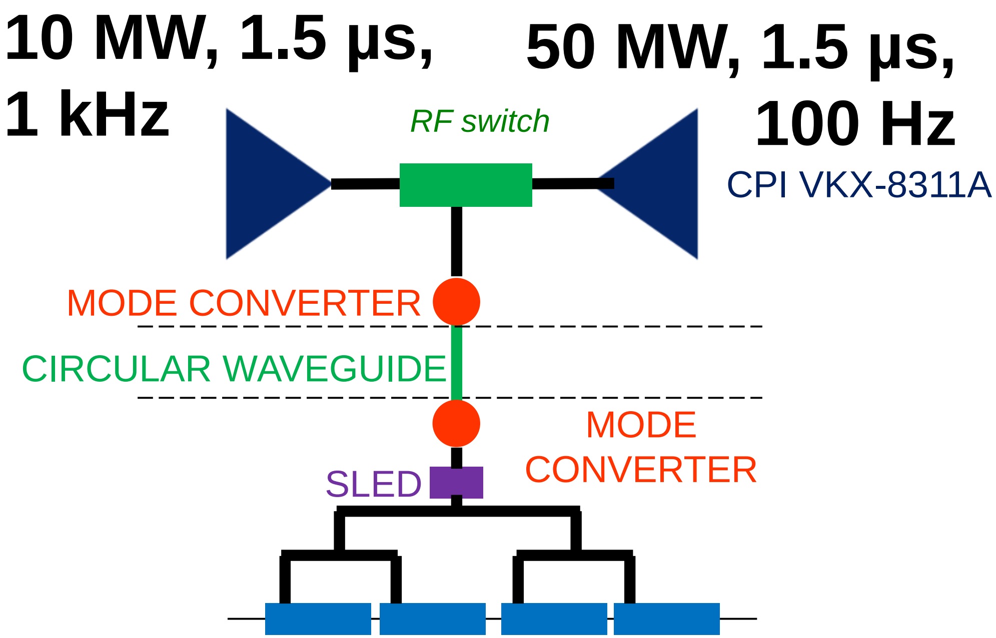
COMPARISON BETWEEN TAPERINGS

<table>
<tr><th>CompactLight</th><th>Linear tapering</th><th>Gaussian</th><th>E. Bandwidth</th><th>Gaussian w lin. iris thickness 1</th><th>Gaussian w lin. iris thickness 2</th></tr>
<tr><td>Frequency [GHz]</td><td colspan="5">11.9942</td></tr>
<tr><td>RF pulse [μs]</td><td colspan="5">1.5</td></tr>
<tr><td>Net kly. power (@ 1 kHz) [MW]</td><td colspan="5">≈40 (8)</td></tr>
<tr><td>Average iris radius <a></td><td colspan="5">3.5</td></tr>
<tr><td>Iris radius a [mm]</td><td colspan="5">4.3-2.7</td></tr>
<tr><td>Iris thickness t [mm]</td><td colspan="3">2.0</td><td>1.5-2.0</td><td>2.0-2.24</td></tr>
<tr><td>Average gradient <G> (@1 kHz) [MV/m]</td><td>65 (30)
(w/ margin)</td><td>65 (30)
(w/ margin)</td><td>65 (30)
(no margin)</td><td>65 (30)
(w/ margin)</td><td>65 (30)
(no margin)</td></tr>
<tr><td>Structure length L_s [m]</td><td colspan="5">0.9</td></tr>
<tr><td>Unloaded SLED Q-factor Q_0</td><td colspan="5">180000</td></tr>
<tr><td>External SLED Q-factor Q_E</td><td>23000</td><td>22500</td><td>24300</td><td>21900</td><td>23200</td></tr>
<tr><td>Shunt impedance R [MΩ/m]</td><td colspan="3">90-131</td><td>97-131</td><td>90-125</td></tr>
<tr><td>Effective shunt Imp. R_s [MΩ/m]</td><td>387</td><td>388</td><td>380</td><td>400</td><td>378</td></tr>
<tr><td>Group velocity v_g/c [%]</td><td colspan="3">4.7-1</td><td>5.4-1</td><td>4.7-0.9</td></tr>
<tr><td>Filling time [ns]</td><td>144</td><td>138</td><td>157</td><td>129</td><td>146</td></tr>
<tr><td>Max. Mod. Poy. Vec. - 10^{-6} bpp/m limit [%]</td><td>-32.7</td><td>-31.3</td><td>-30.5</td><td>-12.3</td><td>-29.7</td></tr>
<tr><td>Max. Mod. Poy. Vec. [W/um^2]</td><td>2.85</td><td>3.1</td><td>3.0</td><td>4.1</td><td>3.1</td></tr>
</table>

COMPARISON BETWEEN TAPERINGS



X-BAND MODULE



Module (linear t No. 2)			
Frequency [GHz]	11.994		
RF pulse (250 Hz) [µs]	1.5 (0.15)		
Average iris radius <a> [mm]	3.5		
Iris radius a [mm]	4.3-2.7		
Iris thickness t [mm]	2.0-2.24		
Structure length L_s [m]	0.9		
Unloaded SLED Q-factor Q_0	180000		
External SLED Q-factor Q_E	23200		
Shunt impedance R [MΩ/m]	90-125		
Effective shunt Imp. R_s [MΩ/m]	378		
Group velocity v_g/c [%]	4.7-0.9		
Filling time [ns]	146		
Repetition rate [Hz]	100	250	1000
SLED	ON	OFF	ON
Net kly. power (w/ loss) [MW]	40	40	8
Avg. acc. gradient [MV/m]	65	30	30

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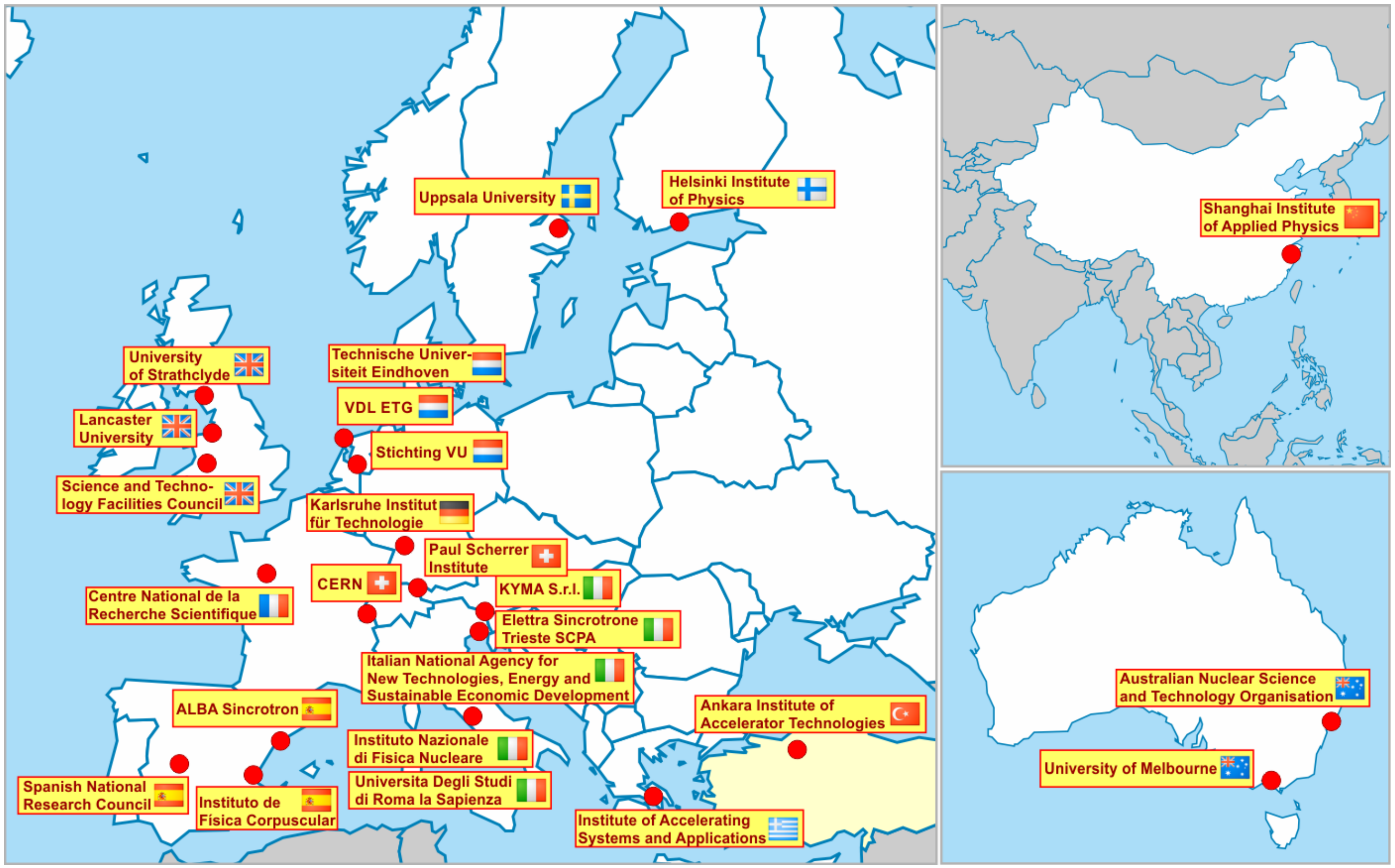
Conclusions

- RF performances of TW structures with 2 new iris tapering profiles have been calculated
- Both cases allow to minimize transverse wakefields
- Case No. 1 has the highest efficiency but a breakdown rate close to 10^{-6} bpp/m
- Case No. 2 has a better expected breakdown rate but a lower efficiency, still able to guarantee the reference acc. gradients but with no margin
- Next: EM simulations of the whole structure + tuning

Thank you!

CompactLight@elettra.eu

www.CompactLight.eu



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