W-Band Harmonic Multiplying Gyrotron Traveling Wave Amplifier

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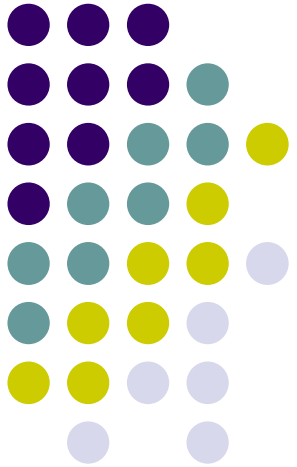
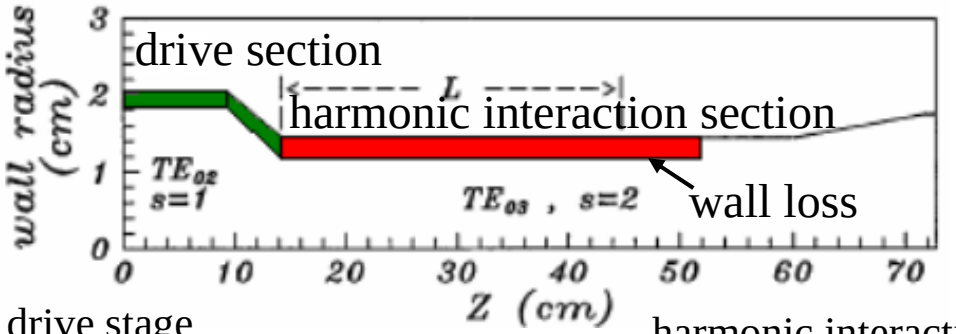
Advisor：Yi Sheng Yeh

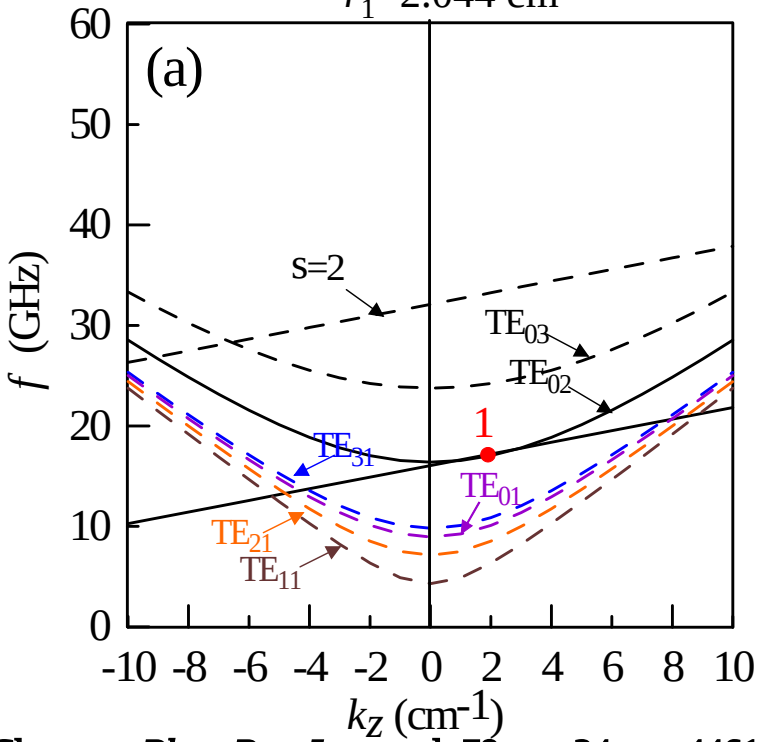


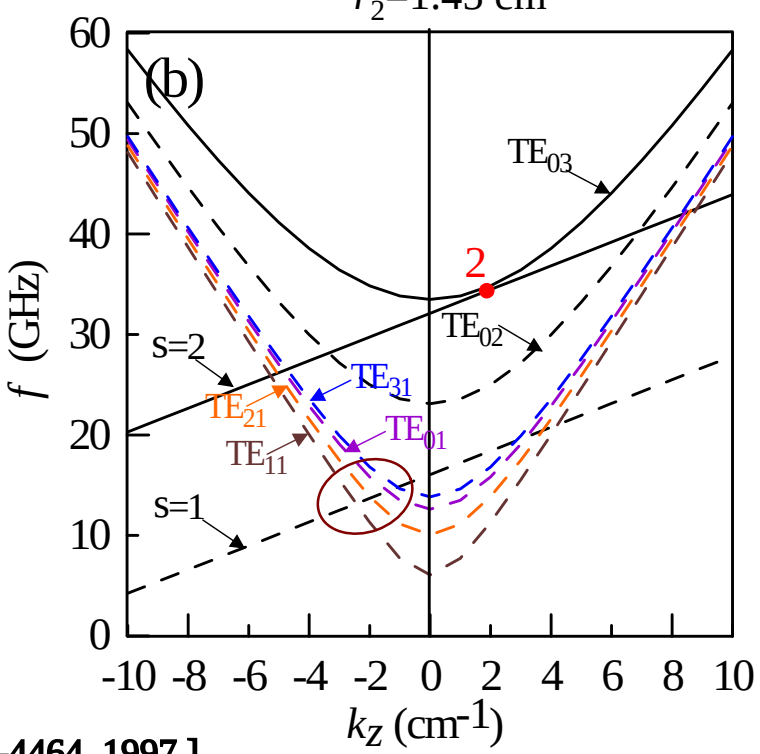
Harmonic Multiplying Gyro-TWA ($TE_{02}^{(1)} \rightarrow TE_{03}^{(2)}$)



drive stage
r_1=2.044 cm

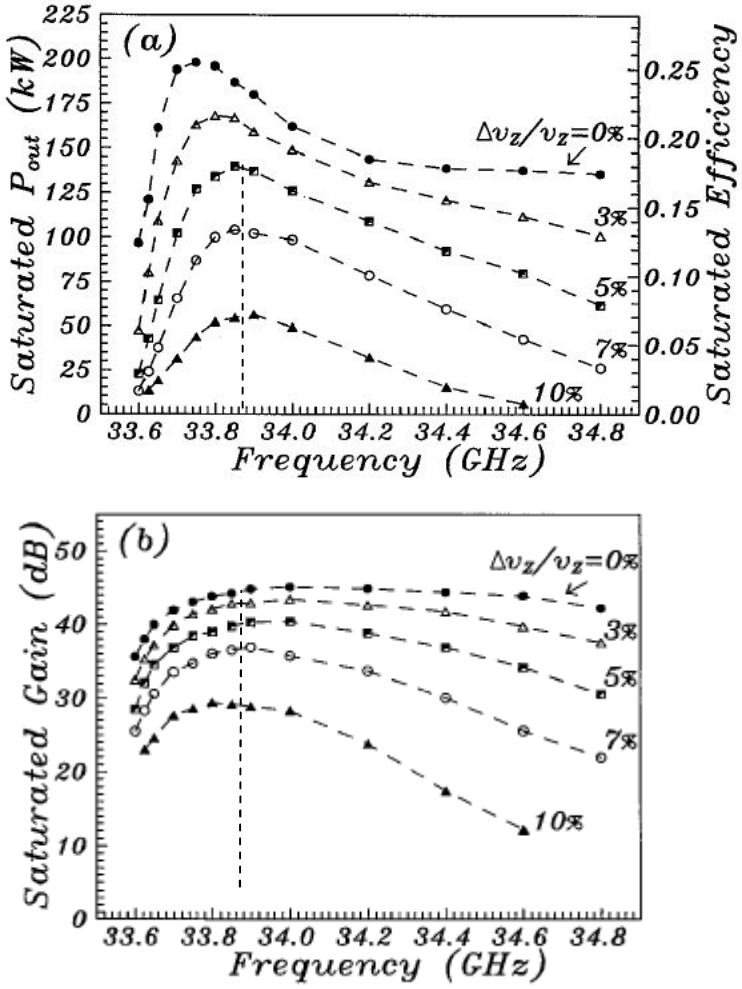
harmonic interaction stage
r_2=1.45 cm





[K. R. Chu, etc., *Phys. Rev. Lett.*, vol. 78, no. 24, pp. 4461-4464, 1997.]

Performance of Harmonic Multiplying Gyro-TWA

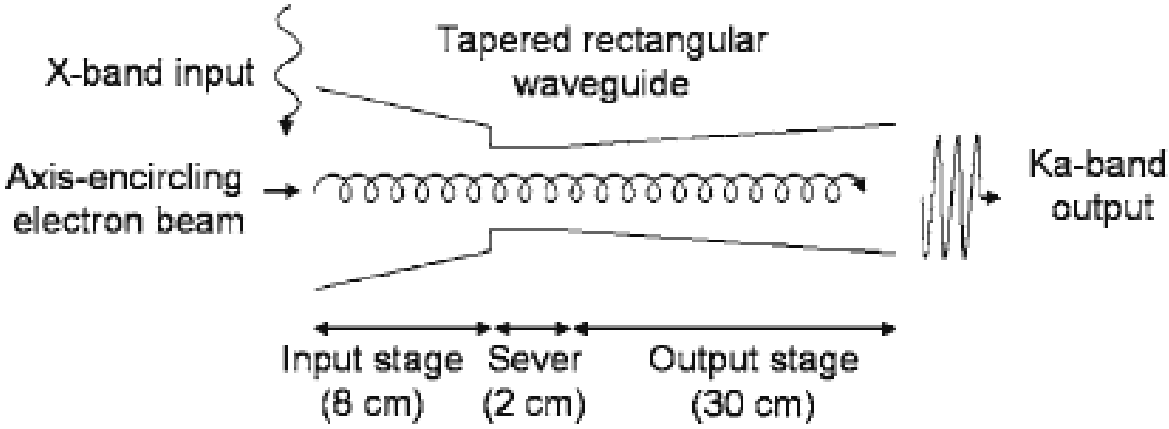


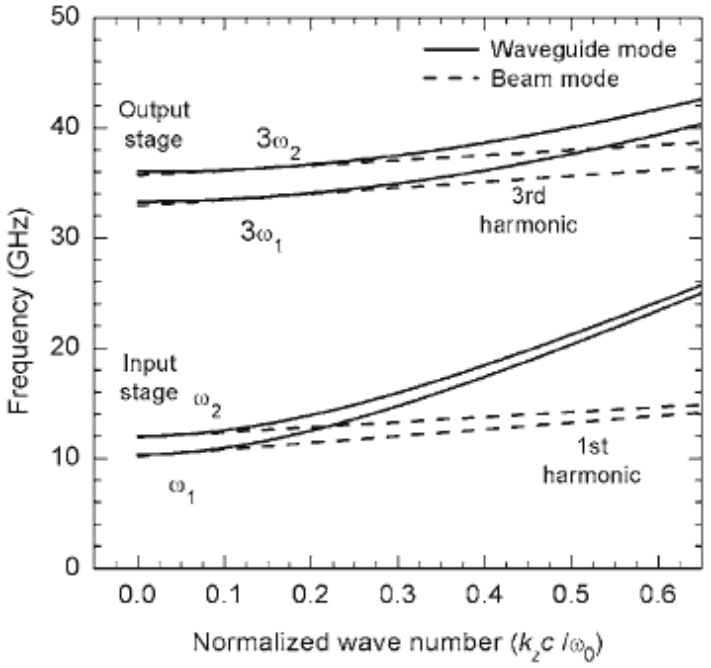
Operating current	: 13 A
Velocity spread	: 5 %
Drive frequency	: 16.925 GHz
Output frequency	: 33.85 GHz
Peak power	: 140 kW at 33.85 GHz
Saturated gain	: 40 dB
Saturated efficiency	: 18 %
Bandwidth	: 3.2 %

[K. R. Chu, etc., *Phys. Rev. Lett.*, vol. 78, no. 24, pp. 4461-4464, 1997.]

Third-Harmonic Frequency Multiplication of a Two-Stage Tapered Gyro-TWA

- By modulating an axis-encircling electron beam at the fundamental harmonic cyclotron frequency in the input stage, a frequency-tripled signal induced by the third-harmonic interaction in output stage.

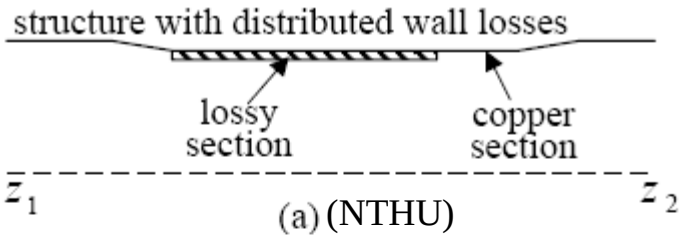




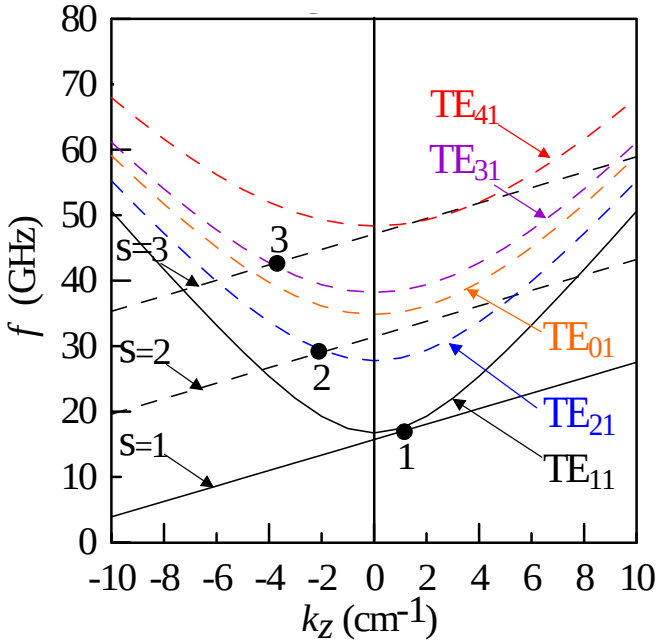
[C. W. Baik, etc, *IEEE Trans. Electron Devices*, 2005.]

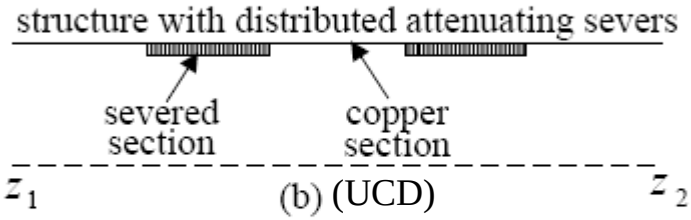
Harmonic Multiplying Gyro-TWA with Lossy Section and Serverd Section

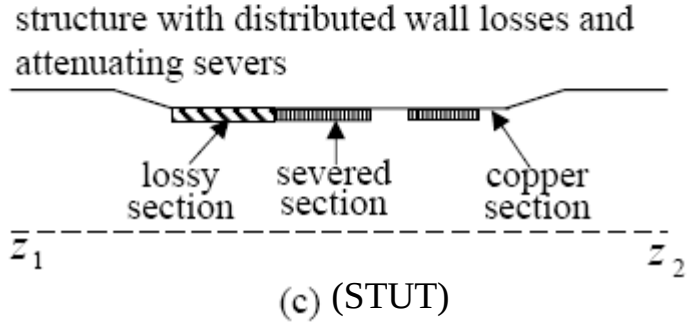
Suppressing the absolute instability (k_z>0)



Suppressing the absolute instability (k_z<0)

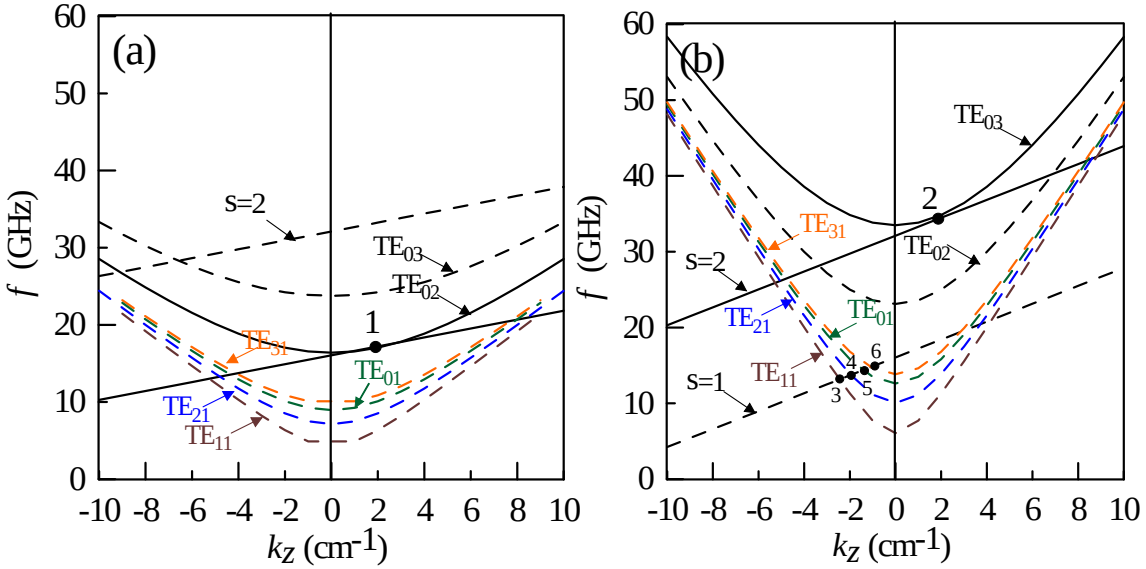


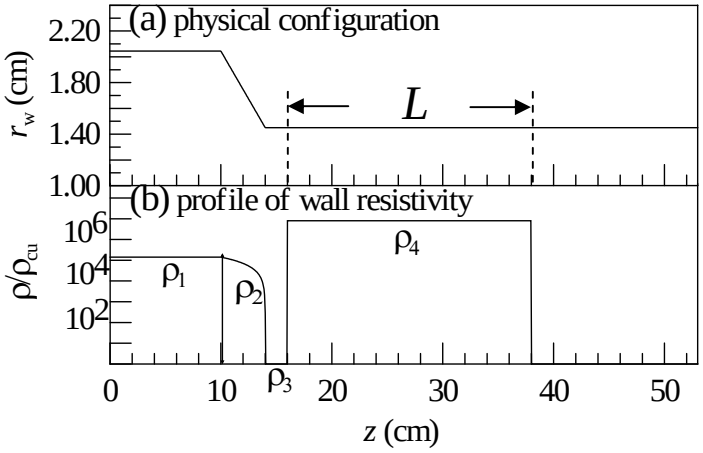


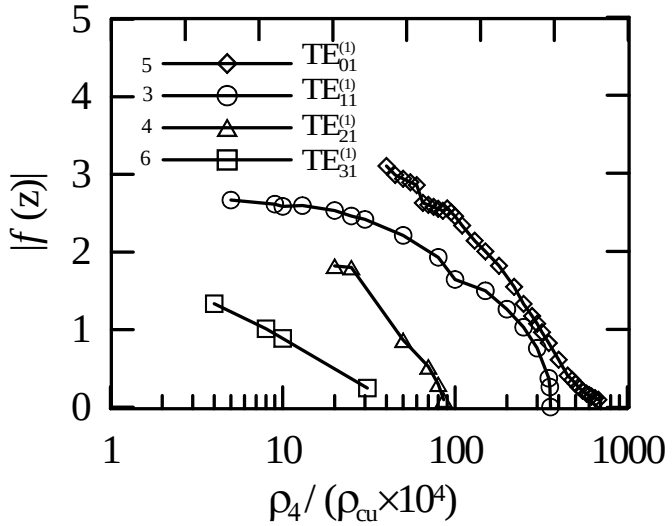


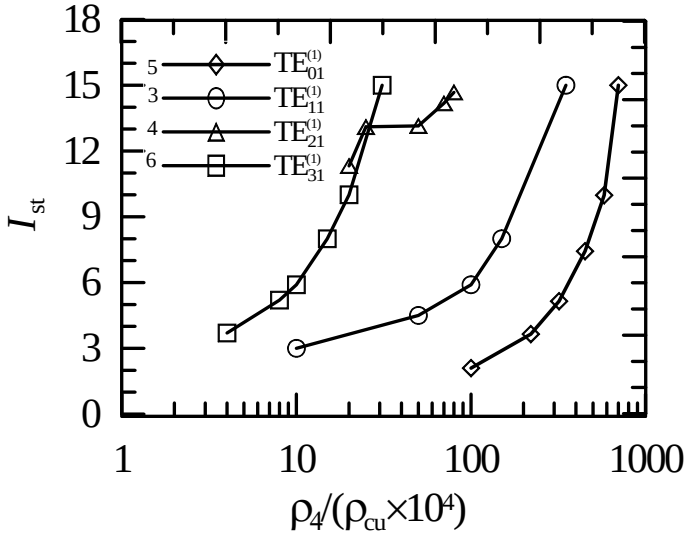
[Ref. Y. S. Yeh, Y. Y. Shin, Y. C. You, and L. K. Chen, *Phys. Plasmas*. Vol. 12, pp. 043108, 2005.]

• Harmonic Multiplying Gyro-TWA ($TE_{02}^{(1)} \rightarrow TE_{03}^{(2)}$)



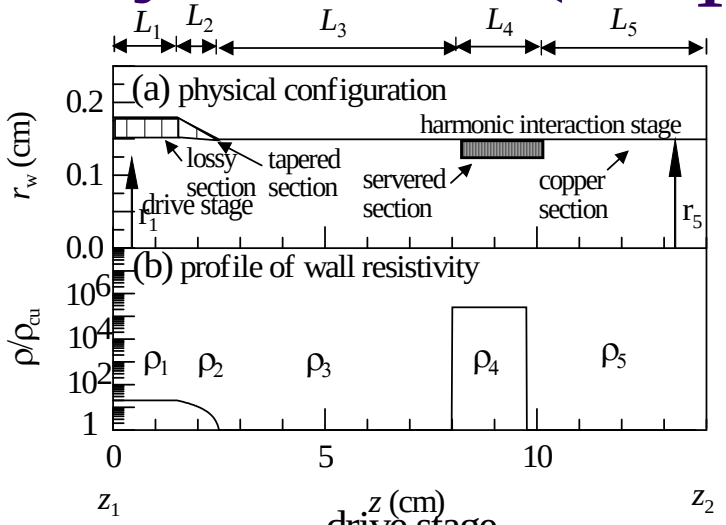






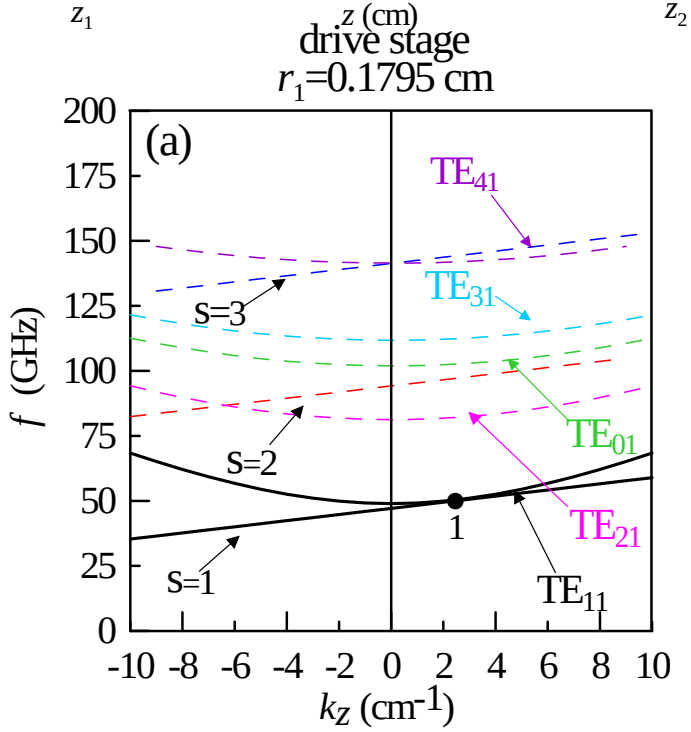
[Ref.陳良愷，”磁旋行波放大器“私立南台科技大學光電研究所碩士論文，(2006)6]

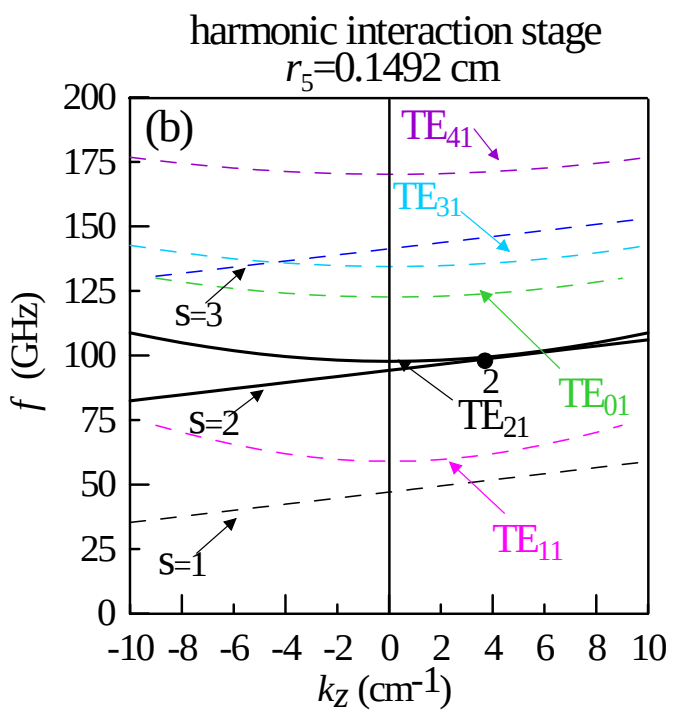
W-band Harmonic Multiplying Gyro-TWA($TE_{11}^{(1)} \rightarrow TE_{21}^{(2)}$)



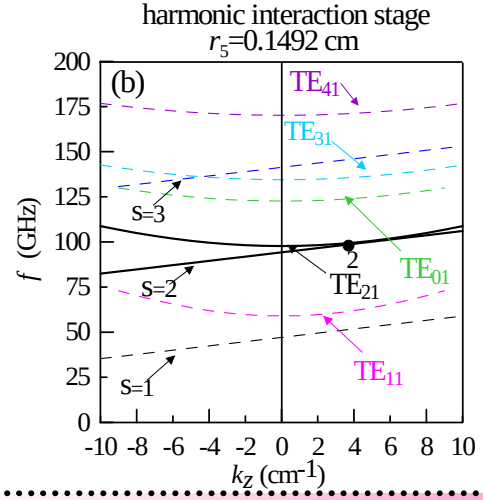
L_1=1.5cm
L_2=1 cm
L_3=5.5 cm
L_4=1.5 cm
L_5=4.0 cm

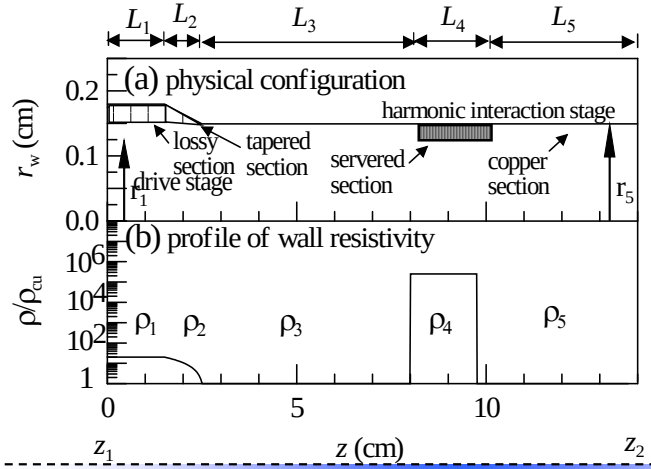
$\rho_1 = 2 \times 10^1 \rho_{cu}$
$\rho_4 = 1 \times 10^5 \rho_{cu}$
r_1 =0.1795 cm
r_4 =0.1792 cm

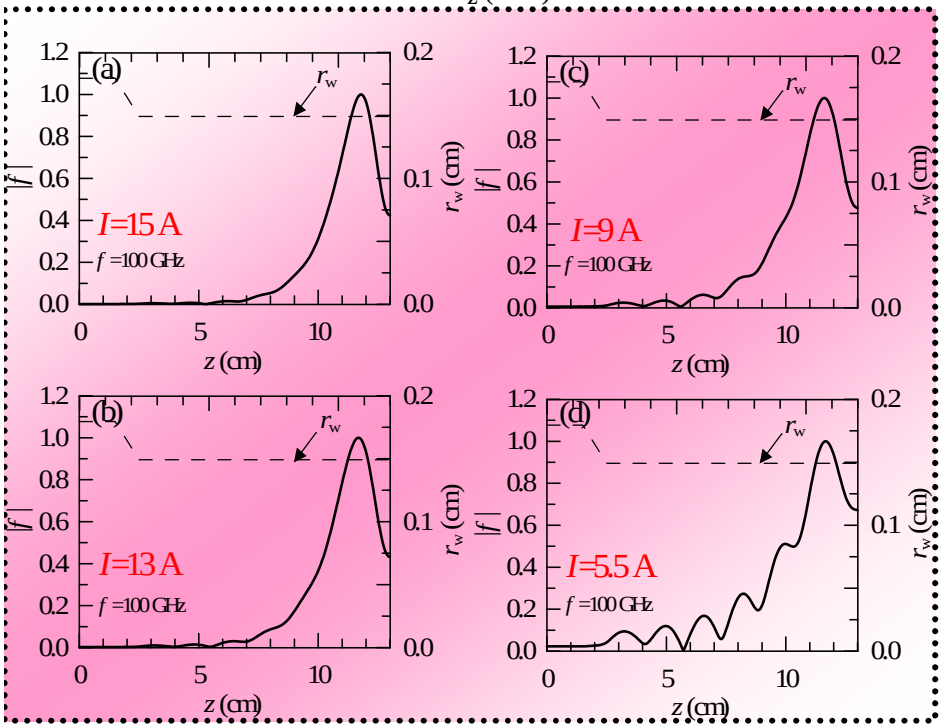


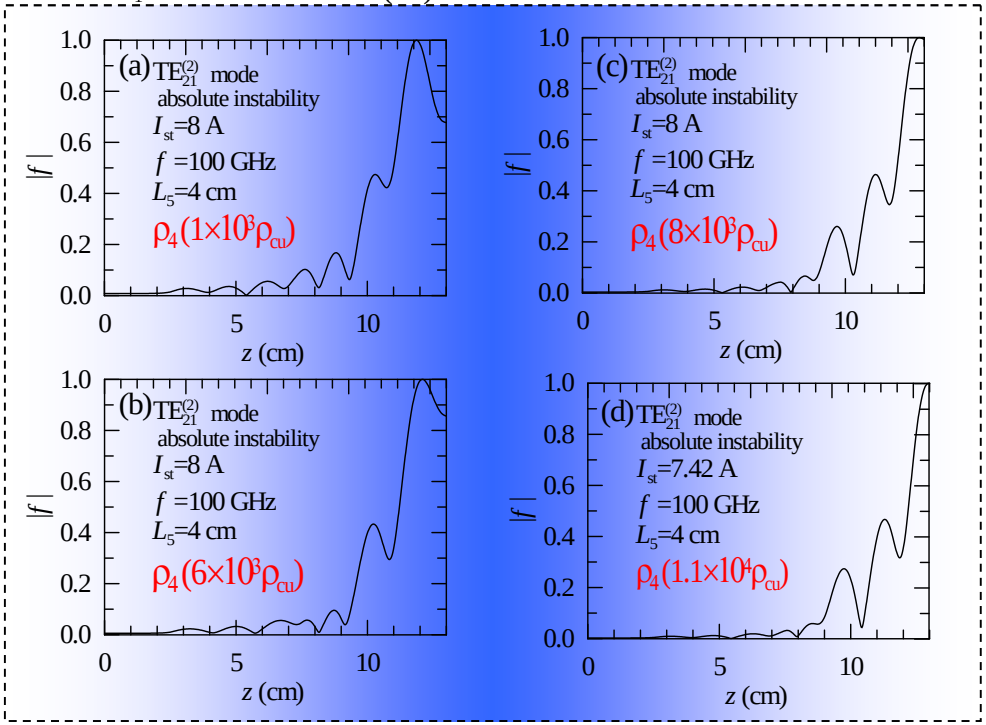


Analysis of Absolute Instability in the Harmonic Interaction Stage (Ⅰ)

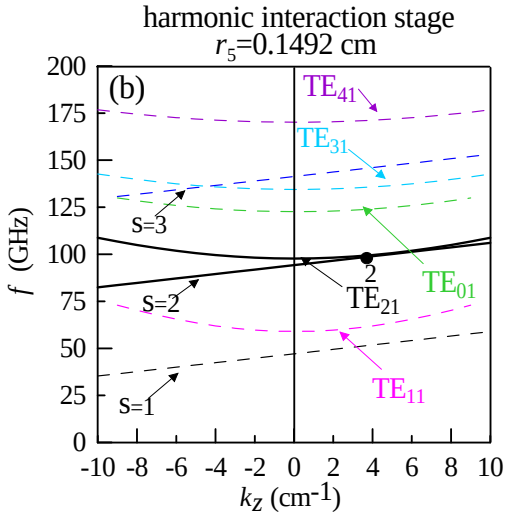


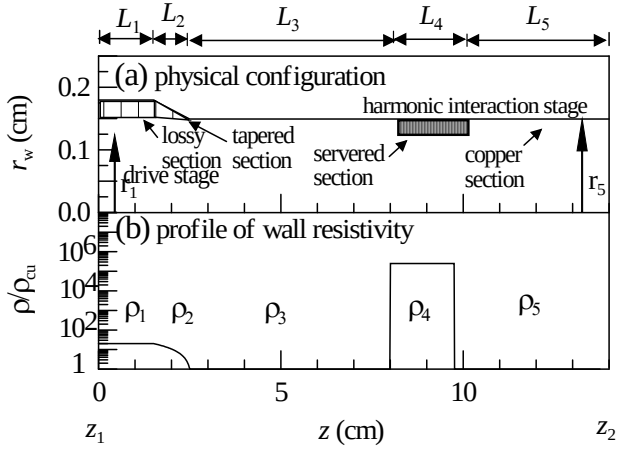


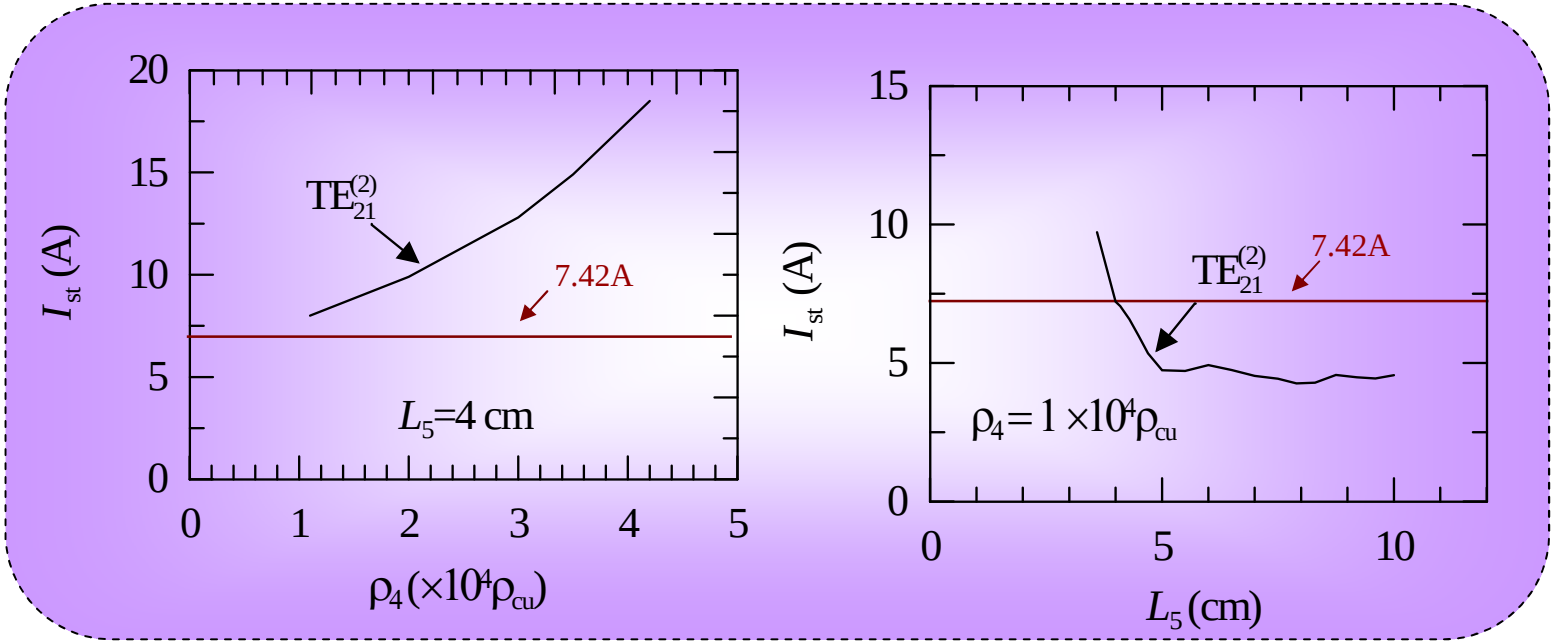




Analysis of Absolute Instability in the Harmonic Interaction Stage (Ⅱ)

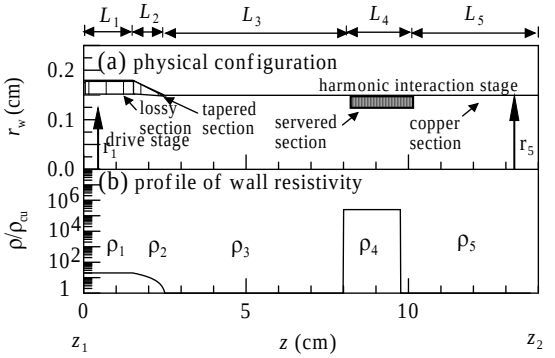


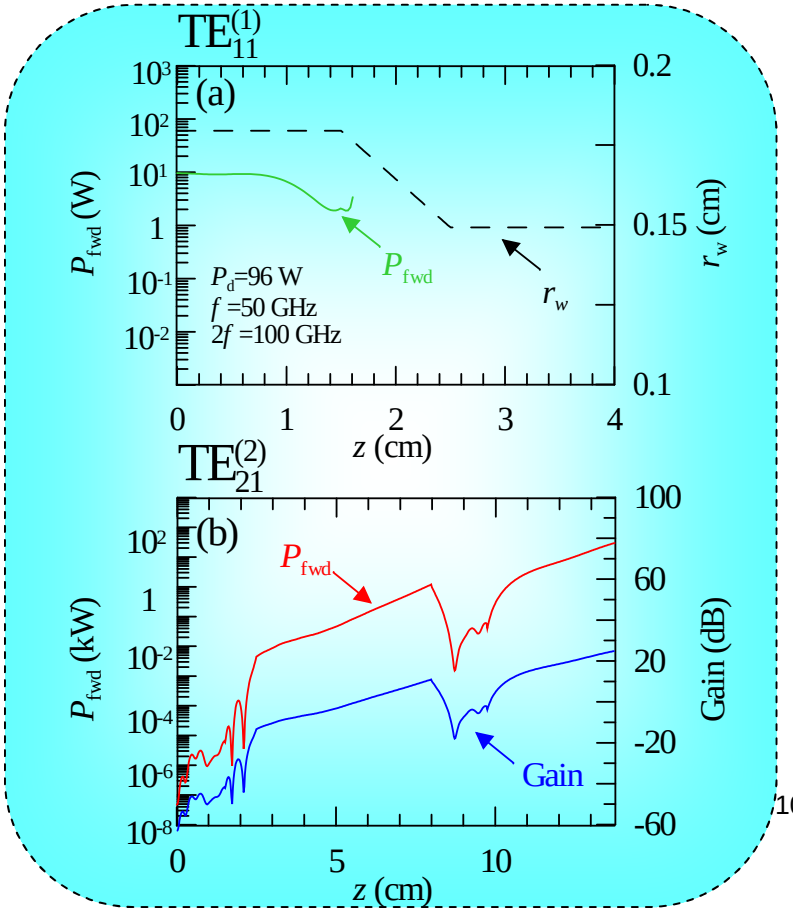




Performance of W-band Harmonic Multiplying Gyro-TWA

- Operating current : 7.42A
- Velocity spread : 8 %
- Operating voltage : 60 kV
- Drive frequency : 50 GHz
- Input power : 96 W
- Output frequency : 100 GHz
- Peak power : 30 kW
- Efficiency : 7%
- Saturated gain : 20 dB

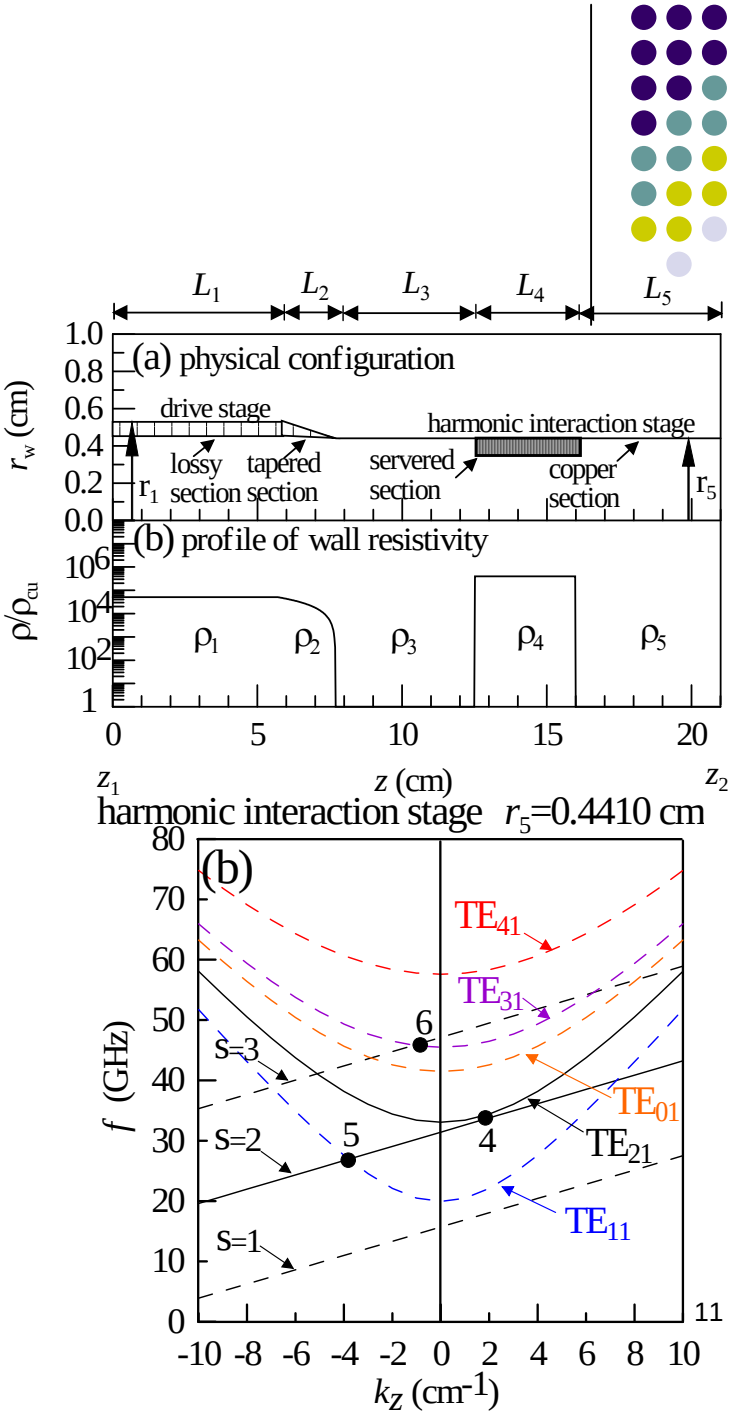




• Conclusions(Ⅰ)

■ A Ka-band and W-band harmonic multiplying gyro-TWTs with distributed wall losses and attenuating severs are proposed to improve the stability of the amplification and the performance of an amplifier.

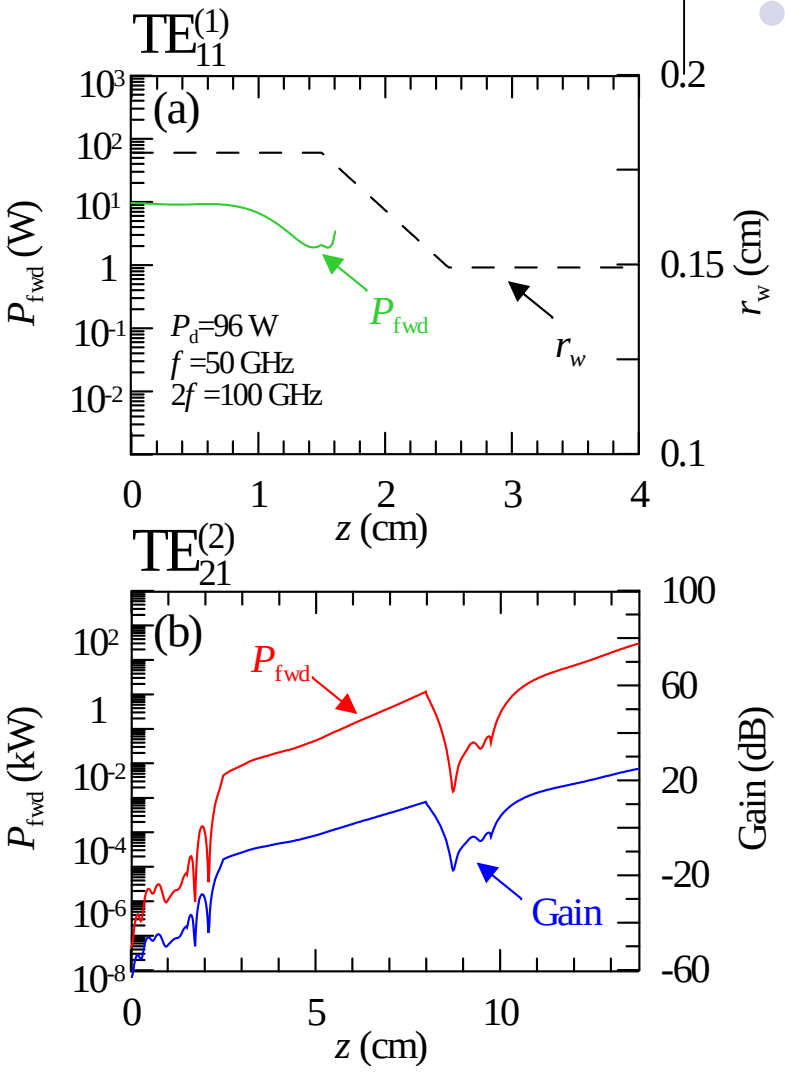
■ Due to absolute instabilities in the harmonic multiplying gyro-TWA ($TE_{02}^{(1)} \rightarrow TE_{03}^{(2)}$) , the harmonic multiplying gyro-TWA operates at $TE_{11}^{(1)} \rightarrow TE_{21}^{(2)}$ modes.



● Conclusions(Ⅱ)

■ Ka-band harmonic multiplying gyro-TWT is predicted to yield a peakpower of 230 kW, corresponding to a saturated gain of 40 dB at an interaction efficiency of 30% where I_b=13 A and $\Delta v_z / v_z$=8%.

■ W-band harmonic multiplying gyro-TWT is predicted to yield a power of 30 kW, corresponding to a saturated gain of 20 dB at an interaction efficiency of 7% where Ib= 7.42 A and Δvz /vz=8%.



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12. 陳良愷，"磁旋行波放大器"私立南台科技大學光電研究所碩士論文，(2006)6.