南台科技大學
Southern Taiwan University of Technology

A Study of Operating Regimes of a Gyrotron Traveling-Wave Tube Driven by an External Signal

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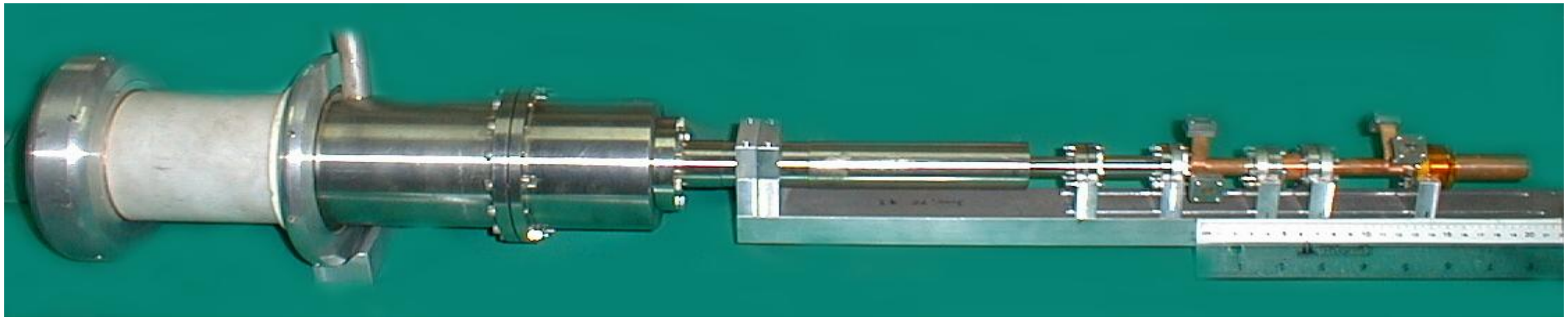

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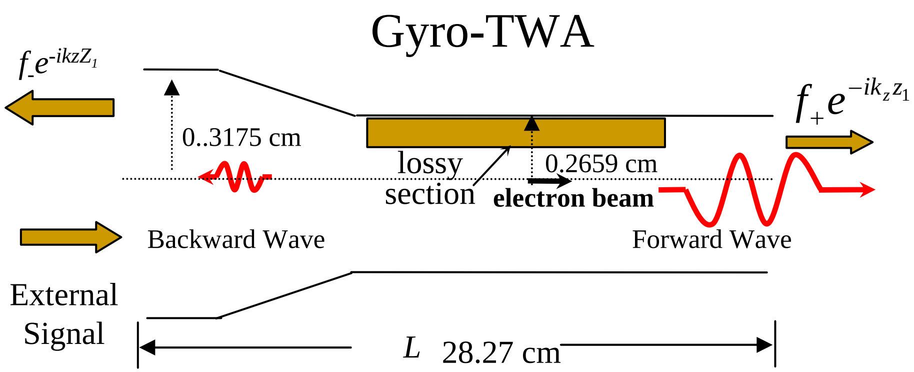
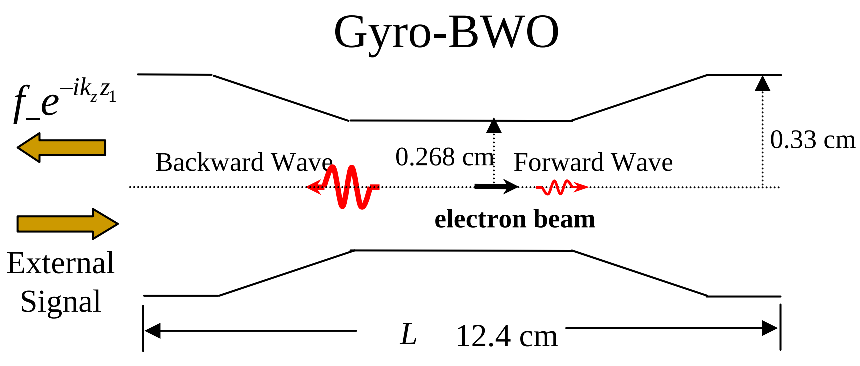
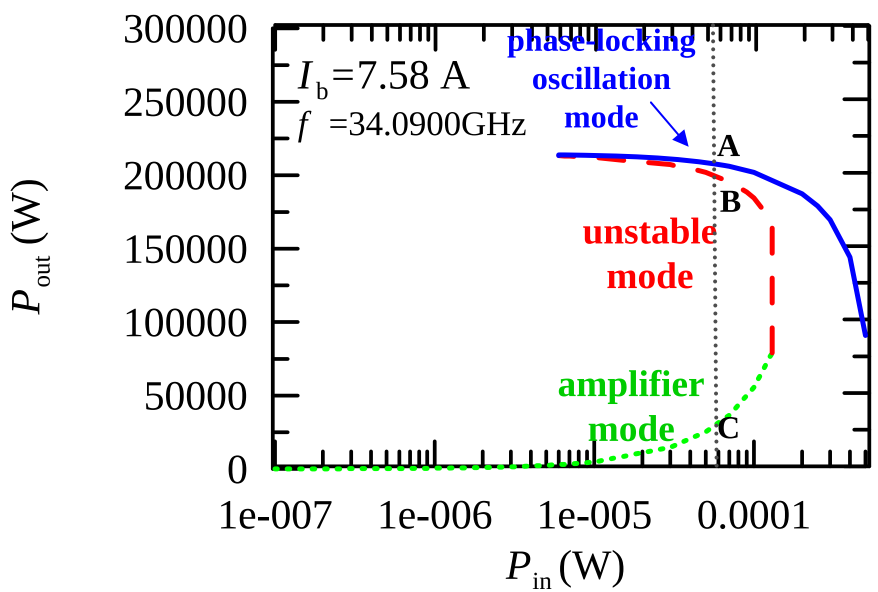
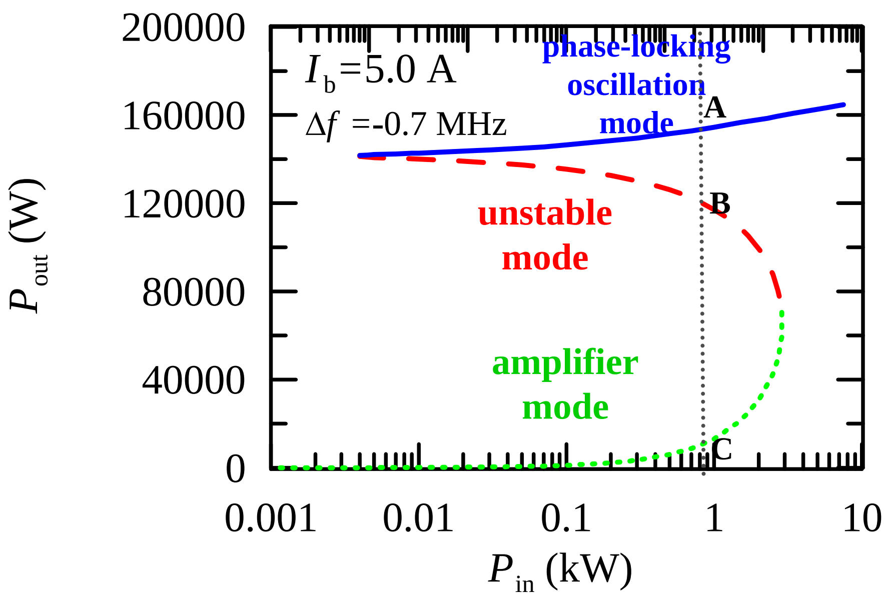
Operating Regimes of Gyro-BWOs Oscillator and Gyro-TWAs Driven by an External Signal









III. Results and Discussion

Gyro-TWA

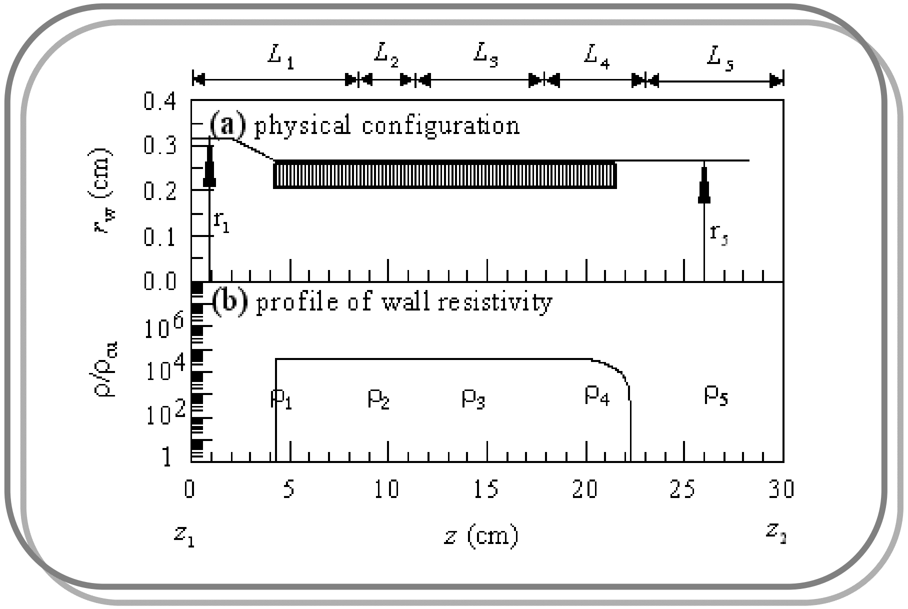


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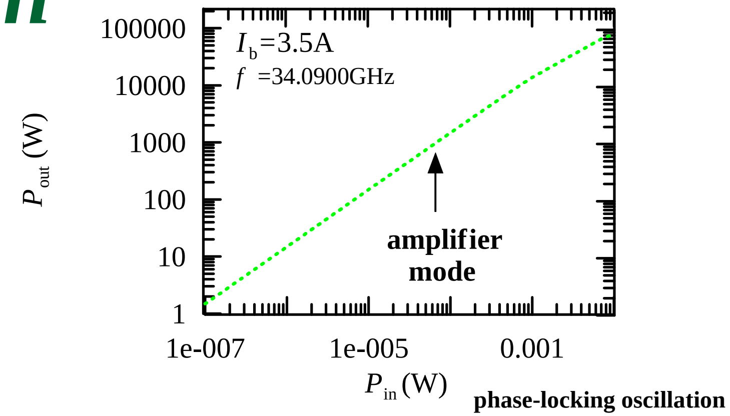
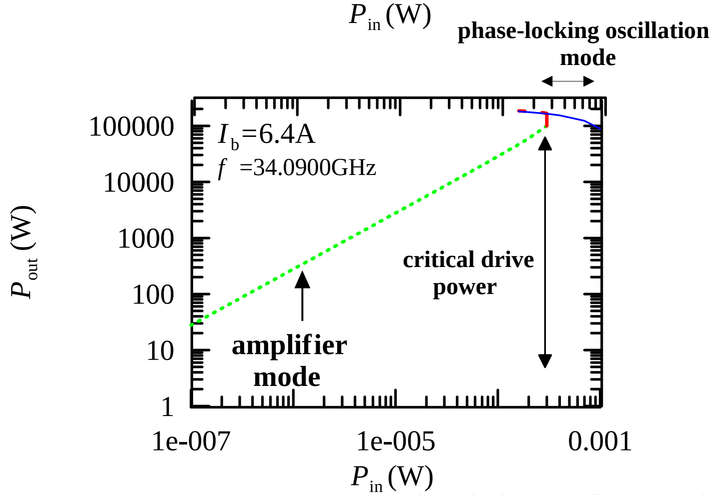
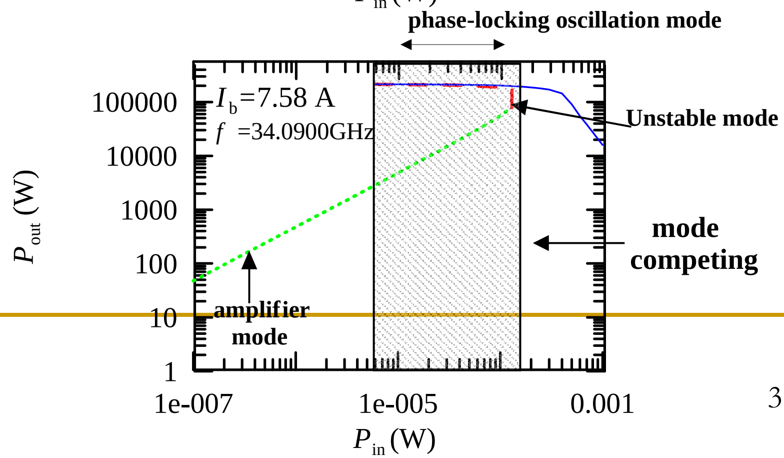
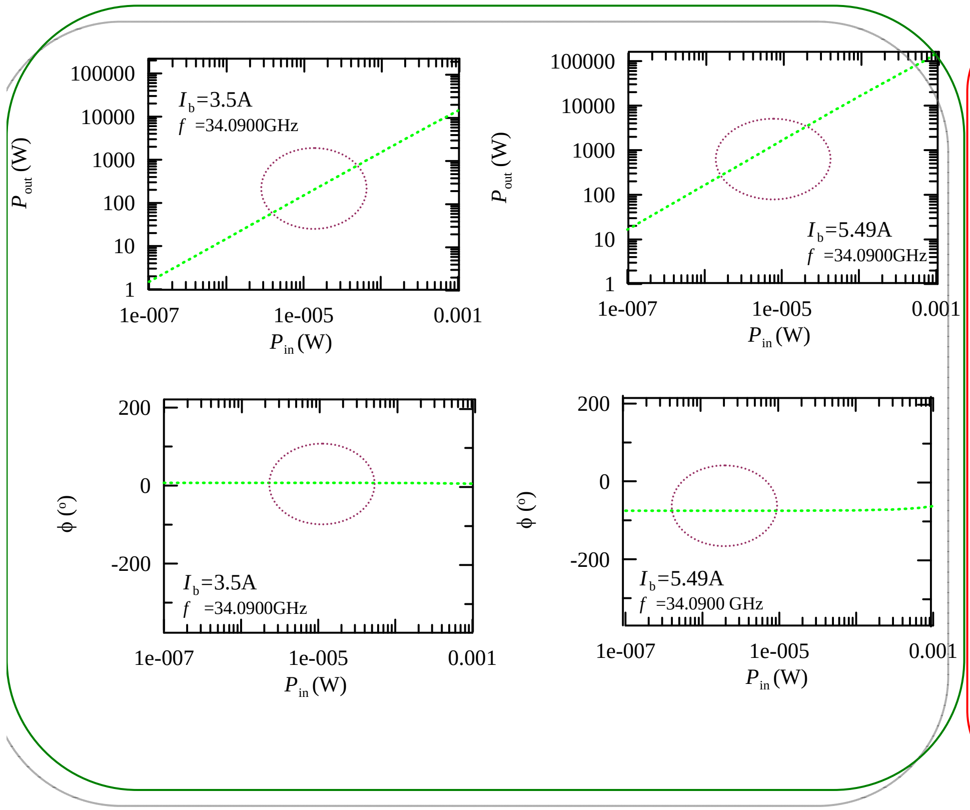
Fig. (a) Profile of the interaction structure. (b)profile of wall resistivity. The operating frequency is 34.0900 GHz in the gyro-TWA. Parameters are V_b=100 kV, B_0=12.7 kG, α =1, and r_c=0.09 cm.







Amplifier Mode (I)



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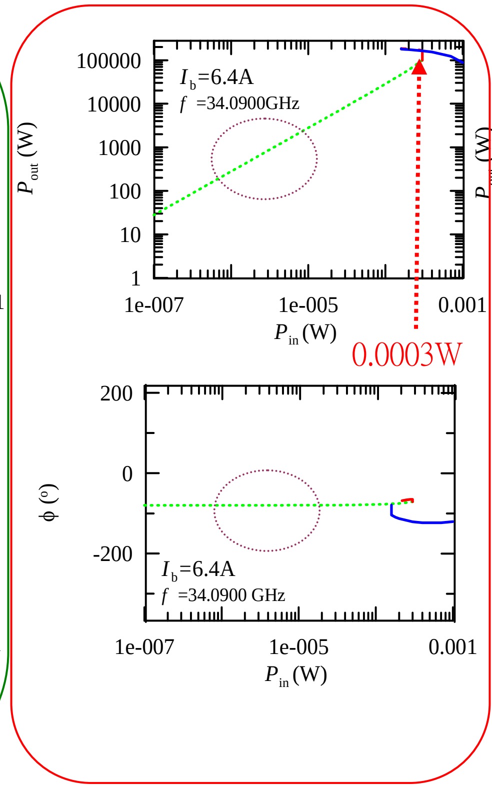

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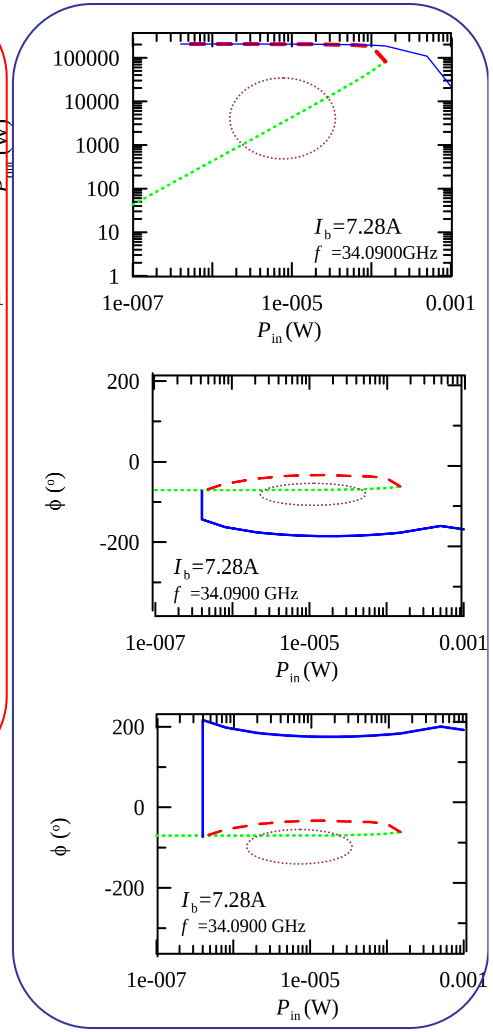

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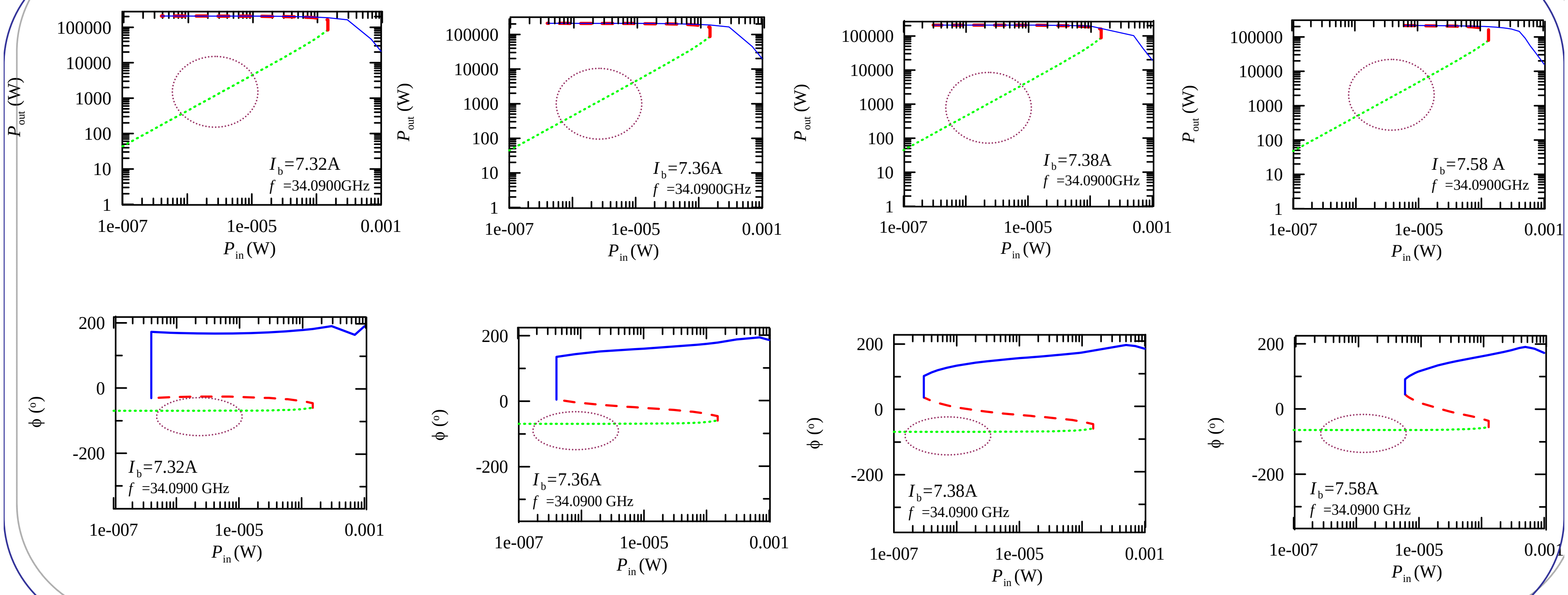
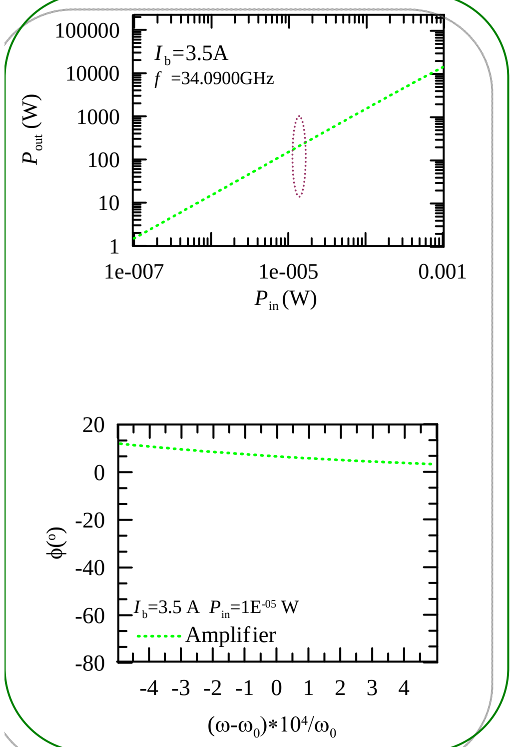
Amplifier Mode (II)



$I > I_{st}$

Amplifier Mode (III)



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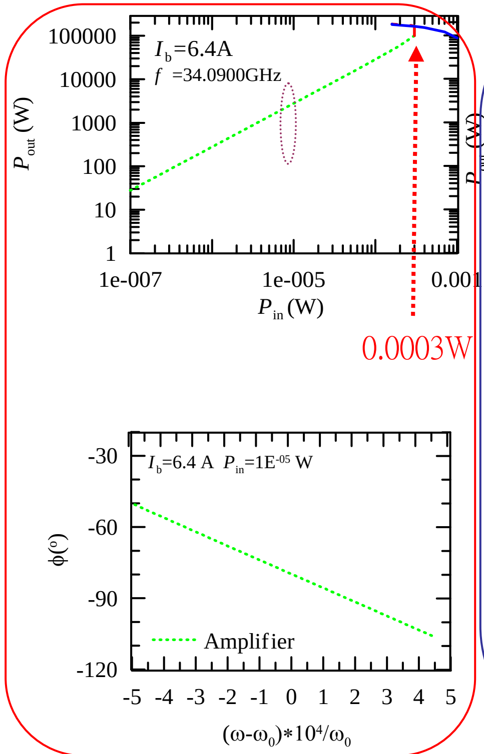

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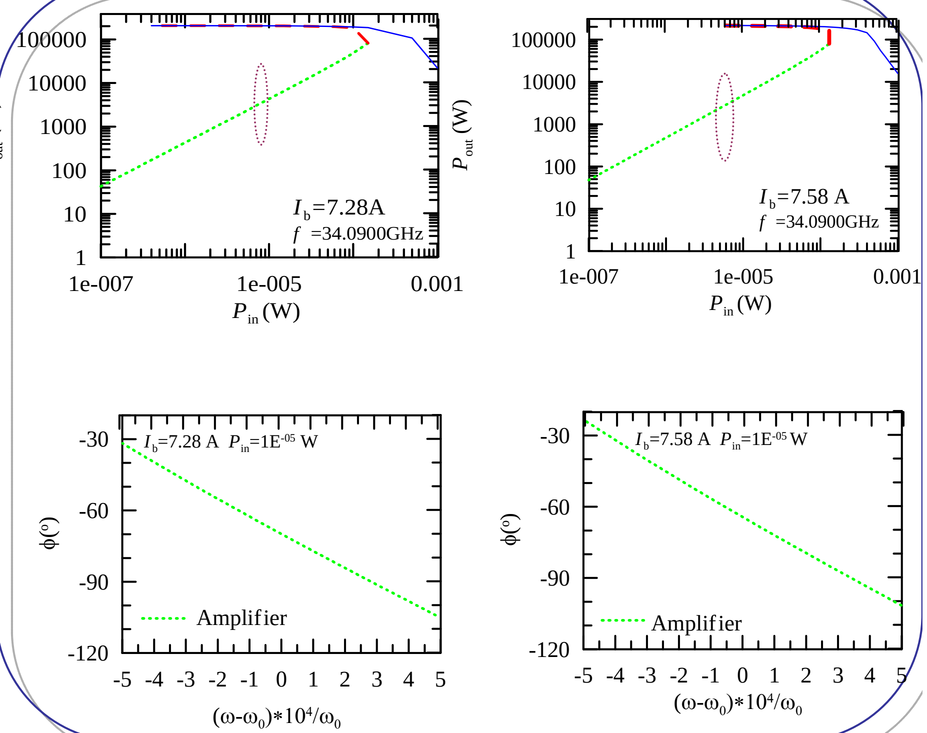

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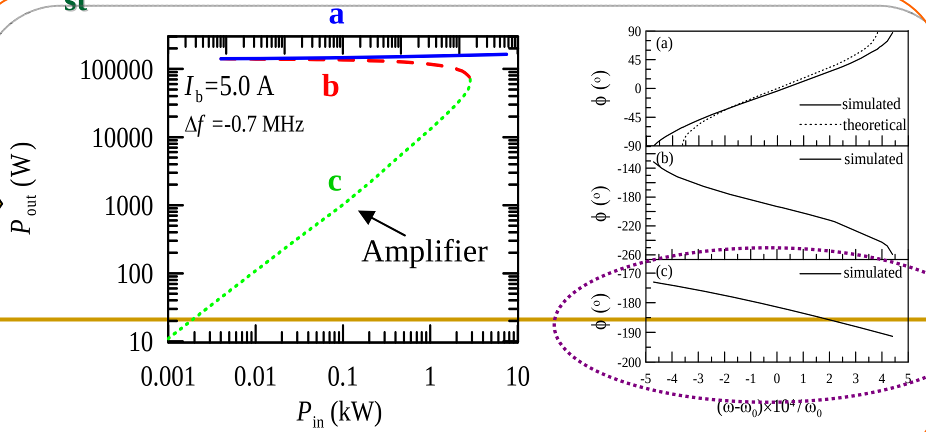
Gyro-BWO



Steady-state solution **[9,10,16, 17]**

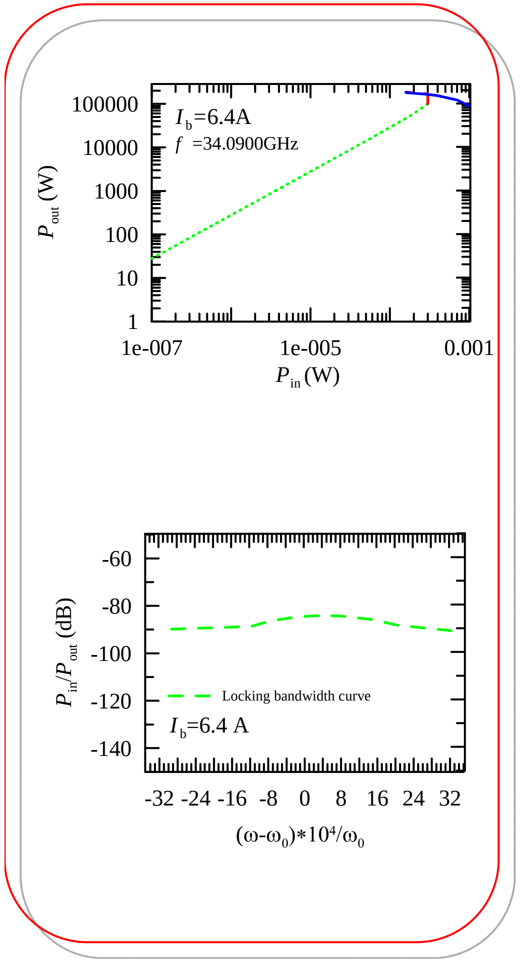
$$\frac{d\phi}{dt} = 0 \Rightarrow \phi = \sin^{-1}\left(\frac{\omega - \omega_0}{\Delta\omega_m}\right)$$

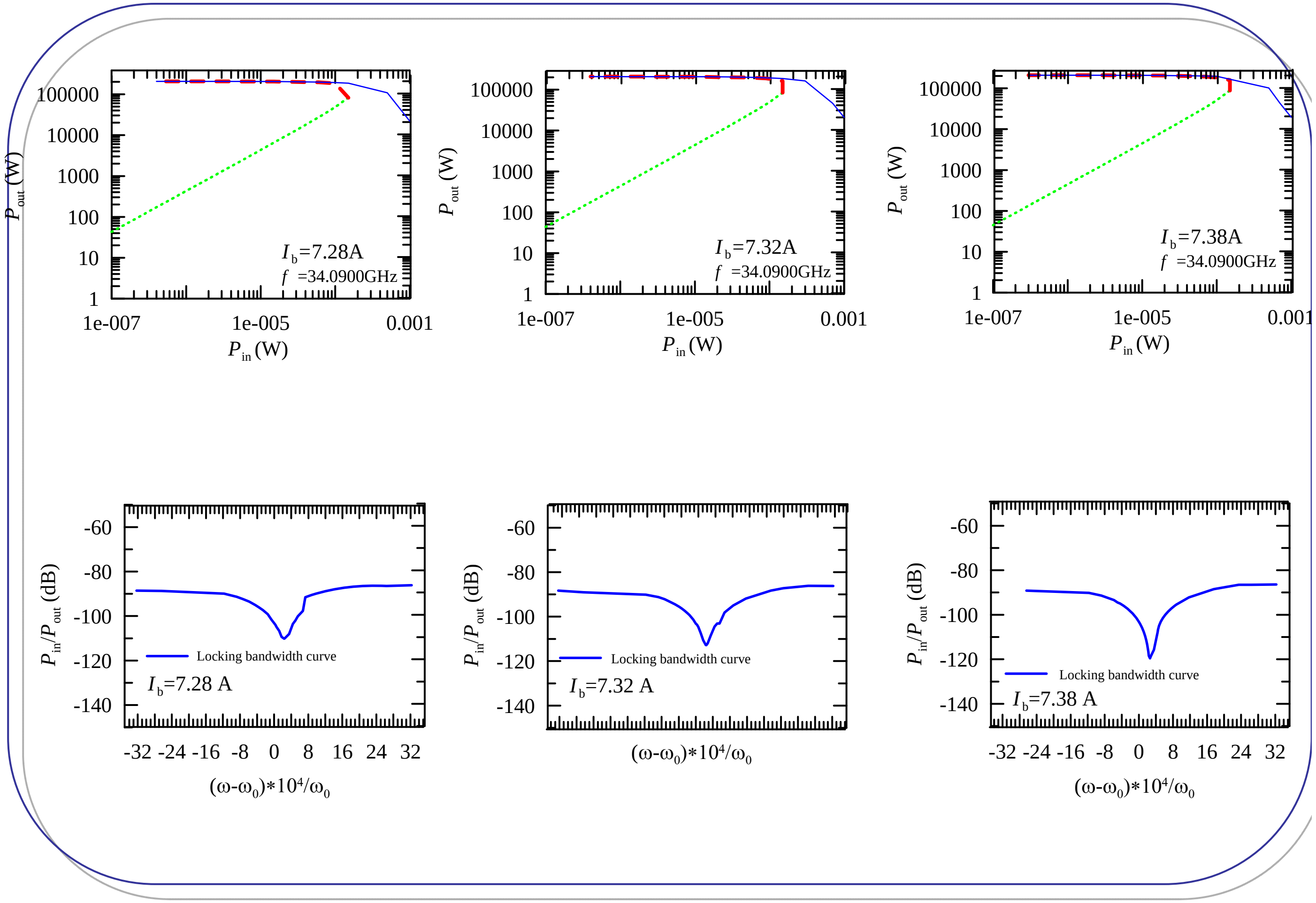
where $\Delta\omega_m = (\omega_{max} - \omega_{min})/2 = (\omega_0/2Q)\sqrt{P_{in}/P_{out}}$

Stable solution **[16]**

$$\frac{d\,\delta\phi}{dt} = -\delta\phi\,\Delta\omega_m\,\cos\phi < 0\,,\ -\frac{\pi}{2} < \phi < \frac{\pi}{2}$$

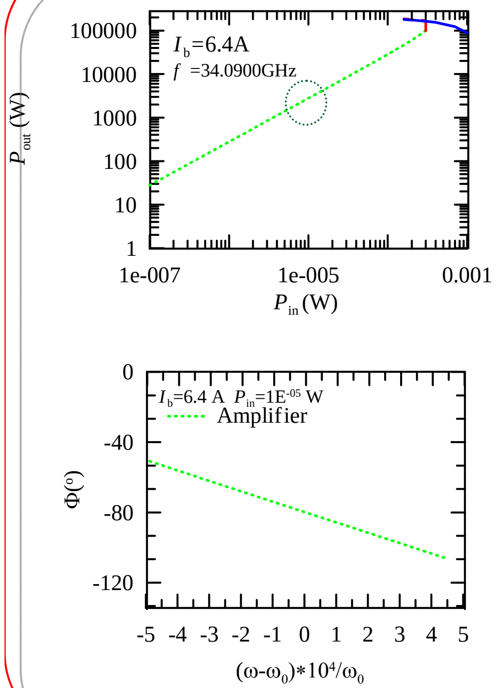
Phase-locking Oscillation Mode (I)





$I \sim I_{st}$ $I > I_{st}$

Phase-locking Oscillation mode (II)



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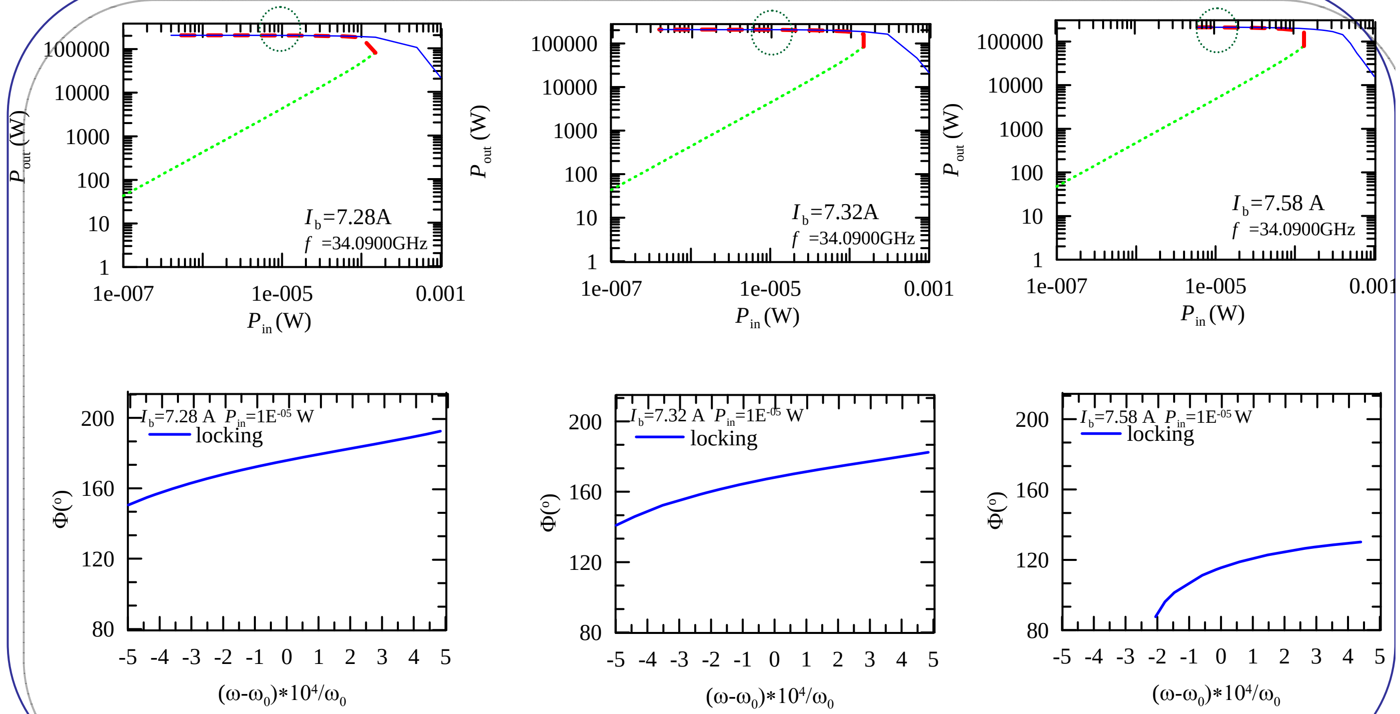
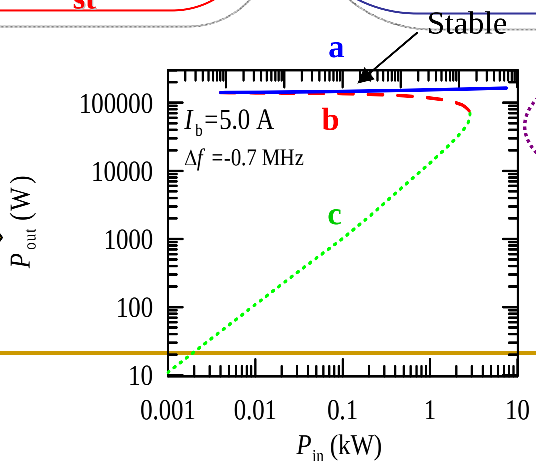
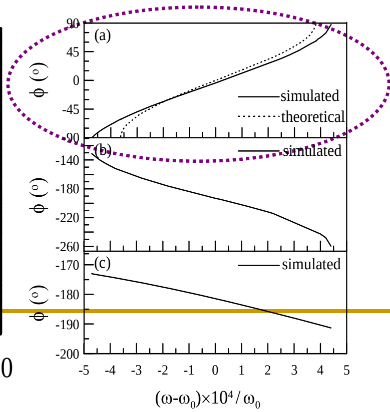


I>I$_{st}$

Gyro-BWO





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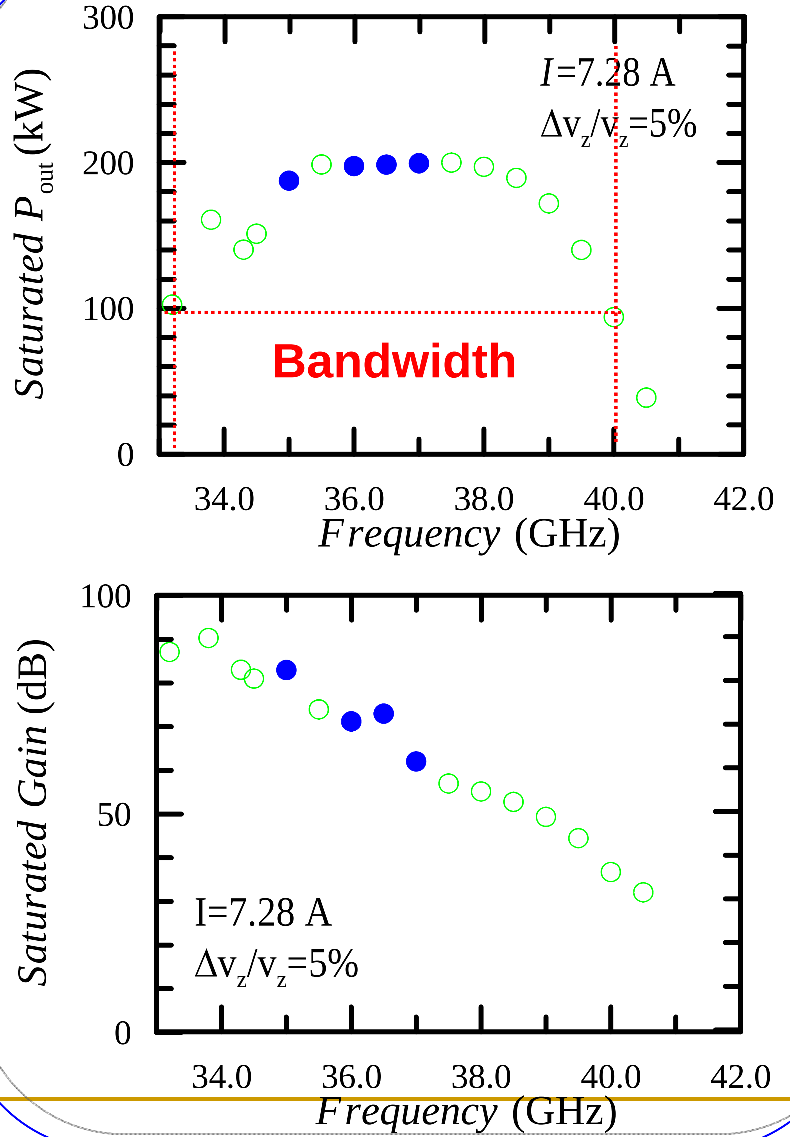
where $\Delta\omega_m = (\omega_{max}-\omega_{min})/2 = (\omega_0/2Q)\sqrt{P_{in}/P_{out}}$

Stable solution **[16]**

$$\frac{d\delta\phi}{dt} = -\delta\phi\,\Delta\omega_m \cos\phi < 0\,,\ -\frac{\pi}{2} < \phi < \frac{\pi}{2}$$

Performance of Gyro-TWA

- **Operating current : 7.28 A**
- **Operating voltage : 100 kV**
- **Peak power : 200 kW**
- **Velocity spread : 5 %**
- **Saturated gain : 90 dB**
- **Bandwidth : 7 GHz**
- **Efficiency : 27.47%**



IV. Summary

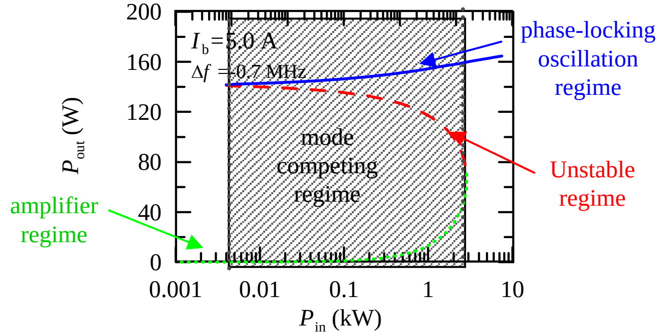
- Gyro-TWT have very high output power(200kW) and gain.

- There are three different operating regimes, amplifier regime , mode competing regime and phase-locking oscillation regime in gyro-BWO and gyro-TWA driven by an external signal.

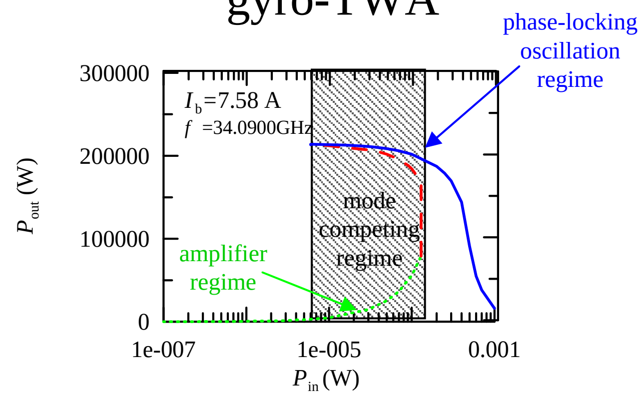
- Only amplifier mode occur where the beam currents are below the free-running currents.

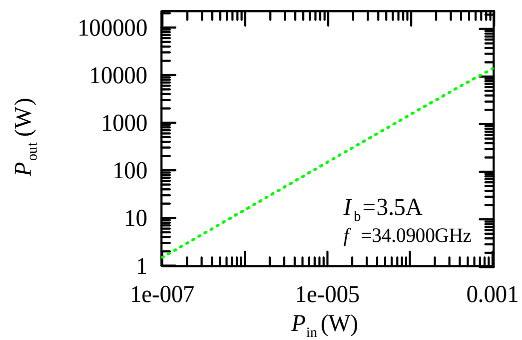
- There are three possible mode , amplifier mode , unstable mode and phase-locking oscillation mode in the mode competing regime.

gyro-BWO



gyro-TWA





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