ABBREVIATIONS

Abbreviation	Details
A	Ampere
BeO-SiC	Beryllium Oxide-silicon Carbide
BWOs	Backward Wave Oscillators
CARM	Cyclotron auto-resonsnce maser
CFAs	Crossed Field Amplifiers
CM	Cell Method
CPI	Communication and Power Industries
CRM	Cycloyron maser
CST	Computer Simulation Technology
CW	Continuous wave
DC	Direct current
DFT	Discrete Fourier Transform
DNP	Dynamic nuclear polarization
ECR	Electron Cyclotron Resonance
ECRM	Electron cyclotron resonance maser
EM	Electromagnetic
EPR	Electron paramagnetic resonance
FD	Finite Differences
FDTD	Finite-difference time-domain
FE	Finite Elements
FEL	Free Electron Laser

FEM	Finite Element Method
FFT	Fast Fourier Transform
FI	Finite Integration
FIT	Finite Integration Technique
FV	Finite Volumes
GHz	Gigahertz
GW	Gigawatts
Gyro-BWO	Gyrotron Backward Wave Oscillator
Gyro-TWT	Gyrotron Travelling Wave Tube
HPM	High Power Microwaves
IREB	Intense relativistic electron beam
keV	Kilo electron Volt
kV	kilovolts
kW	Kilowatts
LASER	Light Amplification by Stimulated emission of radiation
LSA	Large Signal Analysis
MHz	Megahertz
MIG	Magnetron Injection Gun
MIT	Massachusetts Institute of Technology
MMW	Millimeter wave
MoM	Method of Moments
MPM	Microwave Power Module
MW	Megawatt
NPU	National Penghu University

NRL	Novel Research Laboratory
NTHU	National Tsing Hua University
OFHC	Oxygen free High conductivity
PBA	Perfect boundary approximation
PBG	Photonic Band Gap
PIC	Particle-in-cell
PMS	Permanent magnetic systems
RF	Radio frequency
SSPA	Solid-state power amplifier
SWCA	Slow Wave Cyclotron Amplifier
TE	Transverse electric
THz	Terahertz
TM	Transverse magnetic
TWTs	Travelling Wave Tubes
VEDs	Vacuum Electronic Devices
VIRCATOR	Virtual cathode oscillators

LIST OF SYMBOLS

Symbol	Details
γ	Relativistic factor
α	Pitch factor
r_w	Radius of waveguide
r_b	Electron beam radius
r_L	Larmor radius
v_t	Perpendicular electron velocity
v_z	Axial electron velocity
ω_c	Cutoff frequency of the waveguide
Ω	Electron cyclotron frequency
Ω_r	Relativistic electron cyclotron frequency
c	Velocity of light in free space
e	Electron charge
m_e	Mass of electron
B_0	DC magnetic field
v_p	Phase velocity of RF wave
v_g	Group velocity of RF wave
ω	Angular frequency of the RF wave
s	Harmonic number
m, n	Azimuthal, and radial mode indices
k_t	Transverse propagation constant
k_z	Axial propagation constant
J_m	m^{th} order ordinary Bessel function of first kind
C_{mn}	Coupling coefficient
v_{mn}	The n^{th}zero of J (Bessel function)
θ , r, z	Azimuthal, radial, and axial cylindrical coordinates
k_0	Free-space propagation constant
ε_0	Free-space permittivity
μ_0	Free-space permeability
k_c	Cutoff wave number
I_0'	Normalized beam current parameter
I_b	Beam current

β_t	Normalized transverse electron velocity
β_z	Normalized axial electron velocity
J	AC current density
ε	Electron energy
w	Normalized energy of the electron beam
F	Normalized field amplitude
θ	Phase of electron
$\eta_\perp$	Transverse efficiency
η	Electronic efficiency
I_s	Start oscillation current for lossy gyro TWT
V_b	Beam voltage
L_{dB}	Total loss of the circuit in *dB*
λ	Wavelength
z'	Normalized axial position
t'	Normalized time
b	Recoil factor
T	Interaction time
$\mathcal{N}$	Number of electron orbits in the interaction region
P	Power propagating along the interaction circuit
$\mathcal{F}$	Normalized field amplitude
κ	Normalized transverse wave number
h	Normalized axial wave number
$\bar{\Delta}$	Detuning parameter
ε	Normalized electron energy
σ_0	The number of electrons per unit volume
N_s	Norm factor
F_s	Form factor
δ	Skin depth of the circuit wall
C_{mn}	Coupling coefficient
γ_n	Radial phase propagation constant
T_c	Time taken by an electron beam to complete its one gyration
E_t	Transverse Electric field
B_t	Transverse Magnetic field
B_z	Longitudinal Magnetic field
W_i	Normalized weighting factor
σ	Conductivity
$\Delta\omega_r$	Frequency width

$\Delta\omega_i$	Temporal growth rate
P_{in}	Power per unit length deposited into the RF field by the electron beam
P_{ohm}	Ohmic power per unit length dissipated on the wall
ε' and ε''	Real and imaginary part of complex dielectric constant
R_1 and R_2	Reflections at the ends of interaction region