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Pandit Madan Mohan Malaviya*

Ji,

My Parents

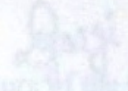
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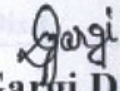
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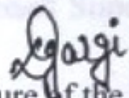
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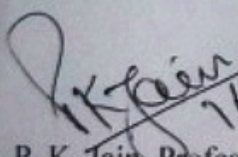

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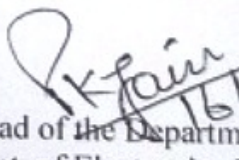
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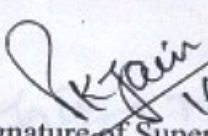

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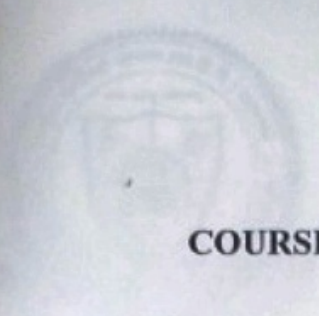

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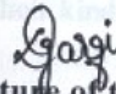
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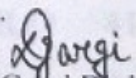
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Date: 16-7-16


(Gargi Dixit)

LIST OF FIGURES

Fig. 1.1	Primary components of HPM systems	6
Fig. 1.2	Origin and emergence of HPM microwave sources.	8
Fig. 1.3	Cross-sectional view of the A6 relativistic magnetron.	12
Fig. 1.4	Schematic of Virtual Cathode Oscillators	14
Fig. 1.5	Schematic of Load-Limited MILO	16
Fig. 1.6	Schematic of conventional MILO	25
Fig. 1.7	Schematic of improved MILO.	26
Fig. 1.8	Experimental view of Compact MILO [Cousin <i>et al.</i> (2007)]	27
Fig. 1.9	Schematic of X-Band MILO [Fan <i>et al.</i> (2008)].	28
Fig. 1.10	Schematic drawing of C-band MILO [Yang (2008)]	29
Fig. 1.11	Schematic of S-band tapered MILO [Fan <i>et al.</i> (2009)]	30
Fig. 1.12	Schematic of Ladder-cathode MILO	31
Fig. 2.1	Schematic of a typical MILO device	42
Fig. 2.2	Explosive emission from cathode surface. [Miller (1998)]	43
Fig. 2.3	Microscopic view of the local electric field enhancement at the tip of a whisker-like protrusion on the cathode surface [Miller (1998)]	44
Fig. 2.4	Variation of parapotential current I_p versus V_m	51
Fig. 2.5	Schematic represents RF interaction structure of MILO	53
Fig. 2.6	Variation of self azimuthal magnetic field with critical magnetic field	58
Fig. 2.7	Graph showing region of oscillation in MILO	63
Fig. 2.8	Operating voltage versus current	63
Fig. 2.9	Schematic of MILO representing flow of current	65
Fig. 2.10	(a) Variation of charge density profile from cathode radius to disc radius. (b) Variation of normalized RBF profile with radius.	69

Fig. 2.11	Exploration of sheath radius due to variation of self magnetic field	75
Fig. 2.12	Variation of critical magnetic field with critical current for coaxial waveguide.	76
Fig. 2.13	Exploration of sheath radius during magnetic insulation process.	77
Fig. 2.14	Determination of critical current due to variation of critical magnetic field	77
Fig. 2.15	Comparison plot of self magnetic field vs critical current for coaxial and disc-loaded coaxial waveguide	77
Fig. 3.1	Improved MILO structure modeled using simulation	90
Fig. 3.2	(a) 2D view of electric field variation along the SWS cavities (π mode operation), (b) Magnetic field variation along SWS cavities, (c) 3D contour plot conforming TM_{01} mode operation, (d) Arrow representation, (e) dispersion diagram for desired operating mode.	91
Fig. 3.3	Linear Phase of Operation	93
Fig. 3.4	Non-Linear Phase of Operation	94
Fig. 3.5	Temporal RF output power at TEM mode	96
Fig. 3.6	Frequency spectrum at TEM mode	96
Fig. 3.7	RF output power comparison	97
Fig. 3.8	(a) Improved MILO structure for extracting power in TM_{01} mode, (b) Temporal RF output power developed at TM_{01} mode	97
Fig. 3.9	Frequency Spectrum at TM_{01} mode	98
Fig. 3.10	Charging or critical current for magnetic insulation	98
Fig. 3.11	RF current developed during beam-wave interaction	99
Fig. 3.12	Beam Current developed during RF generation	99
Fig. 3.13	(a) Temporal electric field amplitude for TM_{01} mode	100
Fig. 3.14	(a) Self magnetic field amplitude developed for TM_{01} mode	100
Fig. 3.15	(a) Snapshot of bunching mechanisms, (b) energy transfer mechanism along interaction length	101

Fig. 3.16	Effect of repetitive pulse on device operation	102
Fig. 4.1	Schematic of a disc loaded coaxial cylindrical waveguide structure	109
Fig. 4.2	Dispersion versus frequency plot for (a) TM_{0l} mode, (b) TM_{00} mode of the disc-loaded coaxial cylindrical waveguide structure	120
Fig. 4.3	Pass and stop band characteristics of a disc loaded coaxial waveguide structure showing the effect of lower order harmonics ($n=0, \pm 1, \pm 2$)	120
Fig. 4.4	Variation of (a) shunt capacitance and (b) series inductance per unit length of the equivalent transmission line of the disc loaded coaxial structure versus operating frequency	122
Fig. 4.5	Variation of (a) shunt capacitance and (b) series inductance per unit length versus frequency plot taking the disc radius (r_d) as the parameter, (c) shunt capacitance and (d) series inductance per unit length versus frequency plot taking the disc periodicity (L) as the parameter, for a disc loaded coaxial waveguide structure	122
Fig. 4.6	Variation of phase velocity (v_p/c) versus frequency plot of a disc loaded coaxial waveguide structure with (a) the disc hole radius r_d and (b) disc periodicity L as the parameter	123
Fig. 4.7	Dispersion: phase velocity ($\beta_0 L$) versus frequency plot of a metal disc loaded coaxial waveguide structure with (a) waveguide radius r_w , (b) cathode radius r_c , (c) disc periodicity L and (d) disc hole radius r_d as the parameters, for the typically selected structure parameters $r_w = 73\text{mm}$, $r_c = 25\text{mm}$, $L = 15\text{mm}$, $r_d = 48\text{mm}$, $T = 3\text{mm}$.	124
Fig. 5.1	Schematic diagram of a disc-loaded coaxial waveguide structure.	132
Fig. 5.2	Variation of (a) shunt capacitance and (b) series inductance per unit length versus frequency plot.	146
Fig. 5.3	Variation of series inductance per unit length versus frequency for beam absent and beam present case.	146
Fig. 5.4	Variation of phase velocity versus frequency plot of disc loaded coaxial waveguide.	147

Fig. 6.18	Schematic of conventional MILO structure	179
Fig. 6.19	Arrow representation of TM_{01} mode at output port	180
Fig. 6.20	Temporal RF output power developed at desired mode	181
Fig. 6.21	Schematic of disk-type MILO structure	181
Fig. 6.22	Temporal RF output power at TM_{01} mode	182

Table 6.1	Design specifications for tapered MILO	179
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Table 6.2	Variation of extractor radius with quality factor and coupling coefficient of the cavity	177
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Table 6.3	Design specifications for S-Band tapered cathode MILO	171
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Table 6.4	Design specifications of constant radius cathode MILO	178
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LIST OF TABLES

Table 3.1	Design specifications for Improved MILO	89
Table 6.1	Variation of extractor radius with quality factor and coupling coefficient of the cavity	157
Table 6.2	Design specifications for S-Band tapered cathode MILO	171
Table 6.3	Design specifications of constant radius cathode MILO	179

LIST OF SYMBOLS

γ	Relativistic factor
α	Coupling coefficient of cavity
r_w	Waveguide Radius
r_b	Beam radius
r_c	Cathode radius
v_d	Drift velocity of electrons
v_p	Phase velocity of RF wave
ω_p	Plasma frequency
ω_c	Cyclotron frequency
c	Velocity of light in free space
e	Electron charge
m_e	Mass of electron
B_{cr}	Critical magnetic field
B_θ	Azimuthal self magnetic field
I_{cr}	Critical current
I_0	Start-oscillation current
ω	Angular frequency of the RF wave
s	Strength of EM wave
n	Space harmonic of travelling wave
m	Modal harmonic
J_{m_0}	m^{th} order ordinary Bessel function of first kind
L	Periodicity between discs
T	Thickness of discs
θ, r, z	Azimuthal, radial, and axial cylindrical coordinates
k_0	Free-space propagation constant
ψ	Perturbation parameter
h_0	Mode wave number

ω	Angular frequency
ζ_n	Velocity shifted frequency
γ_n	Perturbed relativistic momentum
$x_{m,n}$	Eigen value (root of Bessel function)
r_{a1}	Choke cavity radius
r_{a3}	Extractor cavity radius
Z_f	Flow impedance parameter
Z_o	Load impedance
Z_p	Impedance at magnetically insulated sheath
θ	Transit angle
η_{elec}	Conversion efficiency
d	Axial depth of collector cavity
L_c	Length of collector
C_e	Shunt capacitance per unit length
L_e	Series inductance per unit length
β_n^I	Axial propagation constant in region I
γ_n^I	Radial propagation parameter
k	Free space propagation constant
H_θ	Azimuthal component of magnetic field intensity
ρ_s	Surface charge density
V	Scalar Potential
A_z	Vector potential
m	Modal Harmonic
β_m^{II}	Axial propagation constant in region II
J_{z1}	perturbed (RF) axial current density
$f_1(x, p, t)$	RF distribution function
E_z^I	Axial electric field intensity in region I
E_r^I	Radial electric field intensity in region I

H'_0	Azimuthal magnetic field intensity in region <i>I</i>
j	Square root of -1 (that is, $\sqrt{-1}$)
J_0	Zero th -order Bessel function of the first kind
J'_0	Derivative of the zero th -order Bessel function of the first kind with respect to argument
A_0^I	Fundamental space-harmonic field constant in region <i>I</i>
A_0^{II}	Fundamental space-harmonic field constant in region <i>II</i>
A_n^I	n^{th} space-harmonic field constant in region <i>I</i>
A_n^{II}	m^{th} stationary-wave modal harmonic field constant in region <i>II</i>
A_n^{III}	m^{th} stationary-wave modal harmonic field constant in region <i>III</i>
$A_{m,b}^{II}$	m^{th} stationary-wave modal harmonic field constant referring to the backward wave component in region <i>II</i>
$A_{m,b}^{III}$	m^{th} stationary-wave modal harmonic field constant referring to the backward wave component in region <i>III</i>
$A_{m,f}^{II}$	m^{th} stationary-wave modal harmonic field constant referring to the forward wave component in region <i>II</i>
$A_{m,f}^{III}$	m^{th} stationary-wave modal harmonic field constant referring to the forward wave component in region <i>III</i>
$B_{m,f}^{II}$	m^{th} stationary-wave modal harmonic field constant referring to the forward wave component in region <i>II</i>
$B_{m,b}^{II}$	m^{th} stationary-wave modal harmonic field constant referring to the forward wave component in region <i>II</i>
$M_{n,m}$	Dimensionless function involving propagation constant and structure parameters
$N_{n,m}$	Dimensionless function involving propagation constant and structure parameters
$\det M_{n,m} - N_{n,m} $	Dispersion relation

PREFACE

High Power Microwaves (HPM) has drawn considerable attention in recent years as a new technology, allowing new strategic applications and offering innovative approaches to existing applications. Many of the HPM sources are being developed are derivatives of sources that are well known to the vacuum electronics community. HPM sources are being developed that provide peak powers that exceed 1GW at frequencies on the order of 1GHz in short pulses, typically on the order of 100ns. The technology that is used to drive such sources has its root in pulsed power and a comprehensive understanding of their behavior requires the use of tools that have been developed in the plasma physics community. Magnetically Insulated Line Oscillator (MILO) is one of the most stimulating device among all the cross field device family and has been now extrapolated to the high pulsed power microwave regime in the range of gigawatts. MILO is a compact, robust, and simple device which does not require external DC magnetic field for its operation.

MILO is basically a linear variant of the magnetron invented by M. Collins Clark during 1988 at Sandia National Laboratory, USA. It is a high power microwave source capable of delivering output power greater than 1GW at a frequency of 1-10GHz. Because high power microwave sources operating in gigawatt range of pulse length of ~ 100 ns to 1 μ sec has applications in defense and plasma systems, there are continued interest in improving the output performance of the MILO which includes RF output power, pulse length, efficiency, cathode performance, and power extraction.

Initial research and development work on the magnetron was mainly concentrated at France, China and US, but with growing applications of this device, several other groups around the globe have also emerged out. In India, DRDO, Bangalore is indigenously putting its effort in the research and development of the MILO.

In the present thesis, studies have been made to improve and optimize RF interaction structure of MILO using equivalent circuit approach. This analysis is carried out both for the beam absent and present case for the disc-loaded coaxial waveguide structure. MILO structure has also been simulated using CST-PIC simulation technique. The results have been validated with the experimental data available in different literatures. Further, in order to improve the device power conversion efficiency different improvement techniques have been proposed and validated through the PIC simulation.