Poster 2

April 30 (Tuesday) / 15:10 ~ 16:30 / Capri room

HPM and relativistic devices / Magnetrons

P2-2.1 / Design and Simulation of an X-Band RBWO using Non-uniform Bragg Structure

M.A. Ansari (Indian Institute of Technology, India), M. Thottappan (Indian Institute of Technology, India)

An X-band relativistic backward wave oscillator using a non-uniform Bragg structure as its slow wave structure and cut-off neck waveguide reflector is designed to increase its beam-wave interaction efficiency. The non-uniformity in Bragg introduces variable coupling impedance and velocity tapering in order to keep the synchronism between the RF wave and the electron beam. In the present work, a two-way helically corrugated single fold Bragg structure used that efficiently converts the backward propagating TM_{01} mode to forward propagating linearly polarized HE_{11} mode. The beam-wave interaction efficiency of the Bragg based RBWO is calculated as ~12%.

P2-2.2 / Design of MW-Class L-Band Magnetron with TE11 to TE10 Mode Converter

Jung-Hoon Han (The affiliated institute of Electronics and Telecommunications Research Institute, Korea), Taek-Heon Kim (The affiliated institute of Electronics and Telecommunications Research Institute, Korea), Seung-Kab Ryu (The affiliated institute of Electronics and Telecommunications Research Institute, Korea)

A magnetron is a representative signal source for vacuum electron devices. This paper describes the design of Lband magnetron for mega-watt (MW) power output. First, the radius and the length of the cathode are designed based on the required output current. The number of cavities in the anode is determined to be 12, and the length of the anode is designed to be approximately quarter wavelength. The remaining design dimensions of the anode are also presented in reasonable design way. We perform particle-in-cell (PIC) simulation using CST-particle studio (PS) tool and confirm that π-mode spokes are formed. We design and measure an antenna and a mode converter that deliver the amplified signal of the magnetron to the outside. The designed antenna is a type of the dipole, and the output mode is converted from TE11 to TE10 and deliver to the WR-650. The final output of the magnetron confirmed by simulation is 1.26 MW with 1.3 GHz oscillation. The anode output efficiency including the mode converter is about 34%. Based on the simulation and the cold test results, it is expected that the magnetron can be successfully manufactured.

P2-2.3 / Experimental Study on Axial Virtual Cathode Oscillator Operated Using 140J/170kV Pulsed Source

Se-Hoon Kim (Hanyang University, Korea), Chang-Jin Lee (Hanyang University, Korea), Kwang-Cheol Ko (Hanyang University, Korea)

An axial virtual cathode oscillator with stainless steel cathode and stainless steel anode is experimentally analyzed. A 140J/170kV Marx generator is used as an impulse generator to drive the axial virtual cathode oscillator. The gap distance between the anode and the cathode sets to 0.4 cm. The output power of the axial virtual cathode oscillator is analyzed for stainless steel cathode.

P2-2.4 / Circuit Design and Analysis of an External Coupled Magnetron at Ka Band for High Power Applications

Yong Yin (University of Electronic Science and Technology of China, China), Minsheng Song (University of Electronic Science and Technology of China, China), Tianqi Hu (University of Electronic Science and Technology of China, China), Yu Zhao (University of Electronic Science and Technology of China, China), Bin Wang (University of Electronic Science and Technology of China, China), Hailong Li (University of Electronic Science and Technology of China, China), Lin Meng (University of Electronic Science and Technology of China, China)

This paper describes the circuit of an Ka band high power magnetron with external couple structure. Main difference between the newly developed magnetron and the coaxial magnetron is that the coaxial cavity is replaced by a magnetron like circuit. To suppress the competition modes, the inner cavity operated in the π mode are connected to the external couple structure operated in the 2π mode. The dispersion relations of the external coupled magnetron are studied to verify the mode suppression properties of the newly circuit. The output circuit is also included.

P2-2.5 / The Characteristics Research on A6 Relativistic Magnetron with Diffraction Output Operating in the Negative First Harmonic of 2π/3 Mode

Chaoxiong He (University of Electronic Science and Technology of China, China), Tianming Li (University of Electronic Science and Technology of China, China), Biao Hu (University of Electronic Science and Technology of China, China), Haiyang Wang (University of Electronic Science and Technology of China , China), Keqiang Wang (University of Electronic Science and Technology of China, China), Xin Wang (University of Electronic Science and Technology of China, China), Jiayin Li (University of Electronic Science and Technology of China, China)

This paper presents that the A6 relativistic magnetron with diffraction output (MDO) operating in the negative first harmonic of 2π/3-mode can be feasible for the buildup of oscillations in the theory. Furthermore, the phase velocity of the negative first harmonic of 2π/3 mode is lower than that of the fundamental harmonic, which can be beneficial for the beam-wave interaction. A design for the MDO is presented numerically using the 3-D fully electromagnetic

and particle-in cell code CHIPIC. Compared with the fundamental harmonic of the conventional π mode, the PIC simulation demonstrates that the operation with the negative first harmonic of 2π/3 mode in the MDO can obtain higher total conversion efficiency. With a proper operating voltage and magnetic field, the results show that MDO synchronizing with the negative first harmonic of 2π/3 mode can get 61.2% total conversion efficiency, and the output power reaches 1.2 GW, respectively.

P2-2.6 / Influence of the Magnetic Field and Impedance of Pulsed Power System on the Resonance of Magnetron with Diffraction Output

Shen Shou Max Chung (Air Force Institute of Technology, National Penghu University of Science and Technology, Taiwan), Shih-Chung Tuan (Oriental Institute of Technology, Taiwan)

Particle-In-Cell (PIC) simulations were performed to study the resonance condition of A6 Magnetron with Diffraction Output (MDO) by conducting a magnetic field strength sweep and no resonance condition are found which results in lower than expectation output power. The cause of this is conjectured to be the impedance of the pulsed power system. Low pulsed power impedance results in more explosive field emission electrons, and they require higher than usual magnetic field to confine within the anode-cathode space to form resonance.

P2-2.7 / Investigation of X-Band Coaxial Magnetron using Three-dimensional Particle-In-Cell Simulation

Jeong-Hun Lee (Korea Electrotechnology Research Institute, Korea), Geun-Ju Kim (Korea Electrotechnology Research Institute, Korea), Sanghoon Kim (Korea Electrotechnology Research Institute, Korea), Yong-Seok Lee (Korea Electrotechnology Research Institute, Korea), Insoo S. Kim (Korea Electrotechnology Research Institute, Korea), Jung-Il Kim (Korea Electrotechnology Research Institute, Korea)

Medical magnetrons to operate the medical linear accelerator (LINAC) are widely used for the radiation therapy systems. The operation performances of medical LINAC generating the high energy X-ray to treat the cancers depends on the RF performances of medial magnetron. The medical 9.3 GHz coaxial magnetron is investigated by using three-dimensional particle-in-cell simulation to analyze the RF performances. The maximum output power of 1.88 MW with the efficiency of 53 % is measured at the stable π-mode resulted from the 20-electron spokes. And, the frequency bandwidth controlled by the frequency tuner shows the 1.5 MHz/μm with the bandwidth of 60 MHz.

P2-2.8 / Conceptual RF design of 3.7 GHz 20 kW CW Magnetron for LHCD system of Tokamaks

Aviraj R. Jadhav (IIT Bombay, India), Joseph John (IIT Bombay, India), Kushal Tuckley (IIT Bombay, India), Harish V. Dixit (BITS-Pilani, Inida), P. K. Sharma (Institute for plasma research, India)

This paper outlines the design steps for a 3.7 GHz 20 kW CW magnetron. Such magnetrons

may be used for current drive experiments in tokamak systems. The anode design is carried out using some empirical formulae and procedure. The design is simulated in CST Microwave Studio and the parameters are adjusted to obtain the π-mode field at the required frequency.

P2-2.9 / The Cause of Forward Leakage Current in Pulsed Magnetron with Diffraction Output

Shen Shou Max Chung (Air Force Institute of Technology / National Penghu University of Science and Technology, Taiwan), Shih-Chung Tuan (Oriental Institute of Technology, Taiwan)

Particle-In-Cell (PIC) simulations were performed to study the leakage current of the A6 Magnetron with Diffraction Output (MDO). Due to the time lag for the high voltage pulse to travel through the cathode, phase space diagrams show explosive field emission generated electrons have higher energy at the front end than the late end; the repelling force from the space charges pushes the late electrons towards to output and form the forward "leakage current", which is intrinsic in this type of device.

P2-2.10 / Electron Cloud Build-Up in a Cold Cathode Magnetron at the Front of Anode Impulse

Gennadiy Churyumov (Kharkiv National University of Radio Electronics, Ukraine / Harbin Institute of Technology, China), Wang Nannan (Harbin Institute of Technology, China), Alexander Gritsunov (Kharkiv National University of Radio Electronics, Ukraine)

A possible scenario of forming the re-entrant electron cloud in a cold cathode magnetron at the front of anode voltage impulse is considered. The role of the RF fields of the low-voltage modes is shown as well as their influence on the secondary emission mechanism of space charge accumulation at the front of the anode voltage impulse have been refined.

P2-2.11 / Noise Suppression of a 2.45GHz Magnetron for Wireless Power Transfer

Dokyun Kim (Korea Electrotechnology Research Institute / University of Science and Technology, Korea), Varun Pathania (Korea Electrotechnology Research Institute / University of Science and Technology, Korea), Suyeon Park (Kwangwoon University, Korea), Jinjoo Choi (Kwangwoon University, Korea), Jong-Soo Kim (Korea Electrotechnology Research Institute, Korea), Seong-Tae Han (Korea Electrotechnology Research Institute / University of Science and Technology, Korea)

We demonstrate a way to suppress noise of a commercial 2.45GHz magnetron for wireless power transfer application. The impurity of the microwave spectrum was identified being attributed to the switching frequency of 76kHz in the power supply. With the decoupling capacitor disposed to the output of the high-voltage power supply driving the magnetron, the spectral purity of the magnetron was significantly enhanced.

P2-2.12 / Frequency and Phase Locking Experiments on a 2.45 GHz magnetron

S. Y. Park (Kwangwoon university, Korea), Y. R. Heo (Kwangwoon university, Korea), J.Y. Kang (Kwangwoon university, Korea), D. G. Kim (Korea Electrotechnology Research Institute /

University of Science and Technology, Korea), S. T. Han (Korea Electrotechnology Research Institute / University of Science and Technology, Korea), J. J. Choi (Kwangwoon university, Korea)

This paper describes a study and experimental demonstration on a magnetron operating at 2.45 GHz. We checked the characteristics of the 1 kW magnetron. There were two noise sources of magnetron at frequencies of 0.5 Hz and 75 kHz. In order to suppress these noises, we used an external injection locking method. Measurement results showed that the frequency noise suppression was down up to 30 dBc and the phase fluctuation is reduced to 4 degrees when injection input power was 7 W. Power combining experiments were performed using two identical magnetrons. An initial result showed an output power of 2 kW, corresponding to combining efficiency > 93%.