Session 19. EIKs / EIOs / Oscillators

May 1 (Wednesday) / 10:00 ~ 12:00 / Room 1

Session Chair: Young-Min Shin (Communications and Power Industries, USA)

10:00 ~ 10:20

19.1 / [Keynote] Development of a High Power Ka-Band Extended Interaction Klystron

Ding Zhao (Chinese Academy of Sciences, China), Gaofeng Liu (Chinese Academy of Sciences, China), Wei Gu (Chinese Academy of Sciences, China), Tongli Ma (Chinese Academy of Sciences, China), Qianzhong Xue (Chinese Academy of Sciences, China), Zhiqiang Zhang (Chinese Academy of Sciences, China)

After completing the designs of the electron gun with large compression ratio, the stable electron optics system with high transmission, and the efficient beam-wave interaction circuit, using a permanent magnetic uniform field focusing, we have successfully built a high power Ka-band extended interaction klystron with excellent performance. The working voltage and current are about 25.5 kV and 3.1 A, respectively. The measured DC beam transmission is over 97%, and in the most adverse state of high frequency operation, the transportation can still keep the value of over 90%. In the condition of non-equal excitation, the device demonstrates the bandwidth of 435 MHz corresponding to the output power of 10 kW or more. The duty cycle is over 3%. Near the optimal working point, the klystron clearly shows its potential, which means that the maximum output power exceeds 20 kW with the gain 44 dB and the efficiency 25% in the bandwidth of 60 MHz.

10:20 ~ 10:40

19.2 / Oversized W-band 2D Periodic Lattice Oscillator

A. W. Cross (University of Strathclyde, UK), A. J. MacLachlan (University of Strathclyde, UK), C. W. Robertson (University of Strathclyde, UK), L. Zhang (University of Strathclyde, UK), C. R. Donaldson (University of Strathclyde, UK), H. Yin (University of Strathclyde, UK), A.D.R Phelps (University of Strathclyde, UK), K. Ronald (University of Strathclyde, UK)

To mitigate the conventional scaling of slow-wave vacuum electronic oscillators, in which the maximum output power reduces as the frequency increases, an oversized cylindrical structure is driven by an annular electron beam. To enhance mode selectivity a two dimensional (2D) periodic lattice structure (PSL) is used. The 2D PSL consists of shallow periodic cosinusoidal perturbations in both the azimuthal and axial directions on the inner wall of a cylindrical waveguide. Analytical theory and numerical PIC simulations have been used to design the W-band oscillator that has been constructed. The ratio of the diameter of the cylindrical cross-section of the structure to the operating wavelength is ~5. The performance of this oscillator is being measured and compared with the predictions of the numerical simulations.

10:40 ~ 11:00

19.3 / Design and Fabrication of G-band Extended Interaction Klystron with Unequal-length Slots

Renjie Li (Beihang University, China), Shasha Li (Beihang University, China), Cunjun Ruan (Beihang University, China), Huafeng Zhang (Beihang University, China)

A G-band rectangular beam extended interaction klystron (EIK) with unequal-length slots structure is proposed. The unequal-length slots structure has great influence on the high-frequency features. The length ratio of long-slot with short slot will seriously affect the effective characteristic impedance and mode separation. Compromised length ratio is selected considering the mode competition and beam-wave interaction efficiency. Based on the design of high-frequency structure, we established a completed beam-wave interaction model. With PIC simulation, we obtained 400 W peak output power and 800 MHz bandwidth, with efficiency of 8.0%. We fabricated the high-frequency structure by CNC machining method, and the surface roughness and fabrication error are 0.40 μm and 10 μm, respectively. Measurement of S_{11} indicated that the amplitudes of measured and simulated are close, but the frequency is shift about 1 GHz. The frequency shift is resulted from the large fabrication error. Our design beam-wave interaction model preliminarily showed potential in performance improvement of terahertz EIK.

11:00 ~ 11:20

19.4 / Development of Ka-band Extended-Interaction Klystron

Haiping Feng (Beijing Vacuum Electronics Research Institute, China), Fujiang Sun (Beijing Vacuum Electronics Research Institute, China), Dongfeng Li (Beijing Vacuum Electronics Research Institute, China)

This paper presents the design and the results for a Ka-band Extended-Interaction Klystron working at 2π mode. The electron gun, the permanent magnetic focusing system, the extended-interaction technology performance are calculated by computer simulation. After testing Klystron, the peak output power is over 10KW, average power is over 500W ,gain is over 30dB and bandwidth is over 300MHz.

11:20 ~ 11:40

19.5 / The Primary Research of 140GHz EIO

Bo Wang (University of Electronic Science and Technology of China, China), Zhenhua Wu (University of Electronic Science and Technology of China, China) Chuanhong Xiao (University of Electronic Science and Technology of China, China), Jie Qing (University of Electronic Science and Technology of China, China), Jielong Li (University of Electronic Science and Technology of China, China), Min Hu (University of Electronic Science and Technology of China, China), Renbin Zhong (University of Electronic Science and Technology of China, China), Shenggang Liu (University of Electronic Science and Technology of China, China)

In this paper, a preliminary study of the structure of EIO is based on the EIO of the same aperture. The influence of the length of the coupling hole and the relative opening size on the EIO structure of the 2π operating point was studied by computer simulation. The dispersion curves and Q values of the 140 GHz EIO in TM_{11} and TM_{31} modes are analyzed. After obtaining the optimal aperture length, the aperture of the EIO interval is shortened to increase the bandwidth.

11:40 ~ 12:00

19.6 / Design of a Low Aspect Ratio Electron Gun for a 220 GHz Sheet Electron Beam EIK

Zhang Huafeng (Beihang University, China), Ruan Cunjun (Beihang University, China)

Taking the unit width electron beam based on the Pierce-type electron gun at the cathode surface as the object of study, we give the formula of designing the aspect ratio and the normalized range of the sheet beam electron gun. The main parameters of the electron gun is U = 16.5 kV, I = 0.30 A and the waist size is 0.30 mm × 0.13 mm, which can be used in the research of the 220 GHz extended interaction klystron (EIK). Through the modeling and analysis in the 3D software CST, it is found that the smaller the size of the anode hole, the higher the height of the electron beam waist and the larger the electron beam width ratio, and the smaller the distortion of the narrow side. Using the compression ratio formula and the range formula, it is convenient to calculate the key parameters of the electron gun. Therefore, our study provides an effective method for the design of the Pierce-type sheet beam gun.