Poster 1

April 29 (Monday) / 15:10 ~ 16:30 / Capri room

FELs / BWOs / Cherenkov devices

P1-7.1 / An S-Band Reversed Cherenkov Oscillator in a Novel All-Metal Metamaterial Miniaturized Slow-Wave Structure

Xiaoyi Li (University of Electronic Science and Technology of China, China), Xirui Zhan (University of Electronic Science and Technology of China, China), Zhaoyun Duan (University of Electronic Science and Technology of China), Xin Wang (University of Electronic Science and Technology of China), Daxi Ji (Nanjing Sanle Group Co., Ltd, China), Yubing Gong (University of Electronic Science and Technology of China, China), Baidyanath Basu (Supreme Knowledge Foundation Group of Institutions, India)

A novel metamaterial slow-wave structure was proposed for an S-band reversed Cherenkov oscillator based on CST simulation. In view of the sub-wavelength and strong resonance characteristics of metamaterial, the slow-wave structure enjoyed both miniaturization and high coupling impedance. Taking, typically, the beam radius, voltage and current as 4.2 mm, 25 kV and 3 A, respectively, and the longitudinal focusing field as 0.2 T, the output power of the reversed Cherenkov oscillator was predicted as 20 kW with 27% electronic efficiency at 2.2 GHz operating frequency in a miniaturized configuration with a typical structure radius of only 20 mm. The proposed device with low beam voltage, miniaturized configuration and high efficiency has wide application prospects in narrowband communication, radar and accelerator.

P1-7.2 / Demonstration on Ring FEL as EUV lithography tool

Jaeyu Lee (Pohang Accelerator Laboratory, Korea) G. Jang (POSTECH, Korea), J. Kim (POSTECH, Korea), J. Ko (Pohang Accelerator Laboratory / POSTECH, Korea), 2 B-H. Oh (Pohang Accelerator Laboratory, Korea), Y. Parc (Pohang Accelerator Laboratory, Korea) ,S-S. Lee (Pohang Accelerator Laboratory, Korea), S. Shin (Pohang Accelerator Laboratory, Korea)

Extreme ultraviolet radiation lithography (EUVL) is widely recognized as a strong candidate to succeed 193 nm immersion lithography for patterning the most critical layers in integrated circuit manufacturing. Therefore, the development of radiation sources for EUVL has lately received a considerable attention. One of the promising candidate sources for EUVL is a free-electron laser (FEL) as a high-power radiation source. By using extremely low emittance beam from the 4th generation storage ring (4GSR) by-pass beamline, which consists of the 1st undulator as energy modulator, chicane as dispersive section and the 2nd undulator as radiator, was designed as FEL source for EUVL. High-gain harmonic generation (HGHG) scheme with by-pass beamline in 4GSR allows average power at 13.5 nm wavelength to increase up to 500 W. In this paper, we describe stat-to-end simulation result for Ring FEL as EUV lithography tool.

P1-7.3 / Powerful W-band Surface-Wave Oscillator based on High-Current Relativistic Sheet Electron Beam: Design and Simulations

Nikolai Yu. Peskov (Russian Academy of Sciences, Russia), Andrey V. Arzhannikov (Russian Academy of Sciences, Russia), Naum S. Ginzburg (Institute of Applied Physics Russian Academy of Sciences), Petr V. Kalinin (Russian Academy of Sciences, Russia), Evgeny S. Sandalov (Russian Academy of Sciences, Russia), Alexander S. Sergeev (Russian Academy of Sciences, Russia), Stanislav L. Sinitsky (Russian Academy of Sciences, Russia), Vasily D. Stepanov (Russian Academy of Sciences, Russia), Vladislav Yu. Zaslavsky (Russian Academy of Sciences, Russia)

Project of powerful planar W-band surface-wave oscillator is under development in collaboration between IAP RAS (N.Novgorod) and BINP RAS (Novosibirsk) at the "ELMI" accelerator 1 MeV / 5 - 7 kA / 3 μs. Electrodynamic system of this oscillator is based on a two-dimensional doubly-periodical structure, which combines the properties of a slow-wave system that realizes conditions for an effective Cherenkov interaction with a high-current rectilinear sheet electron beam, and a high-Q resonator that implements the mechanism of two-dimensional distributed feedback and provides selective excitation of the operating mode in the strongly oversized interaction space. Design parameters of the project are discussed and results of the simulations are presented, which demonstrate the possibility to achieve in the considered scheme a stable narrow-band regime of oscillation with the output power of the gigawatt level.

P1-7.4 / Rigime of multi-stage trapping in a sectioned system of profiled rf undulators

Sergei Kuzikov (Russian Academy of Sciences, Russian), Andrei Savilov (Russian Academy of Sciences, Russian), Alexander Vikharev (Russian Academy of Sciences, Russian)

We propose a high-efficiency regime of a "multi-stage" trapping in FELs. This FEL scheme use strongly tapered flying RF undulator sections to be fed by short (nanosecond) high-power RF pulses produced by already existing BWOs. In this regime, phase locking of the RF sources is not necessary. Moreover, this regime provides an effective amplification of a multi-frequency wave signal in the SASE regime used in typical short-wavelength FELs. In this work, we describe the proposed multi-stage regime, as well as profiled microwave system designed for the realization of tapered rf undulators.

P1-7.5 / Compact free-electron lasers using laser driven cascaded dielectric nano-pillar arrays

Linbo Liang (University of Science and Technology of China, China), Weihao Liu (University of Science and Technology of China, China), Qika Jia (University of Science and Technology of China, China), Lin Wang (University of Science and Technology of China, China), Yalin Lu (University of Science and Technology of China, China)

We proposed a concept of very compact free-electron lasers (FELs) using infrared lasers to drive cascaded dielectric nano-pillar arrays (DNPAs). It employs a preset section of DNPA, driven by the longitudinal polarized laser, to prebunch the electron beam via the longitudinal

velocity bunching mechanism. After drifting a certain distance, these electron bunches then enter the downstream cascaded sections of DNPA, which are alternately driven by transverse polarized lasers with phase shift of π. The electron bunches will wiggle synchronously (due to the deflecting forces exerted by the transverse polarized electric fields) in these DNPAs, which act as effective undulator in conventional FELs. By changing the length of these sections, the undulator periodicity, together with the undulator strength K-value, can be adjusted effectively. It sets a prototype to develop the ultraviolet and soft X-ray FELs with tabletop sizes.

P1-7.6 / Design of a photocathode DC-gun for generating train of sheet-shaped electron bunches

Linbo Liang (University of Science and Technology of China, China), Weihao Liu (University of Science and Technology of China, China), Qika Jia (University of Science and Technology of China, China), Lin Wang (University of Science and Technology of China, China), Yalin Lu (University of Science and Technology of China, China), Yen-Chieh Huang (National Tsinghua University, Taiwan)

Using the superradiant Smith-Purcell radiation from a train of periodic electron-bunches interacting with a grating is an efficient way forgenerating terahertz radiation beyond the frequency region of traditional vacuum electron devices. The producing of a train of well-shaped electron bunches is essential for these radiation schemes. Here we design and simulate a photocathode DC-gun driven by train of laser pulses, aiming to generating train of sheet-shaped electron bunches for practices. The effects of main structural parameters and of laser properties on the performances of electron gun are investigated. It will set an important base for the development and improvement of practical electron guns in experiments.

P1-7.7 / Optimization of 0.1 THz Planar Interaction Structure for Higher Efficiency

Subhendu Chakraborty (The University of Burdwan, India), N. Purushothaman (CSIR-CEERI, India), Nikita Gurjar (CSIR-CEERI, India), Niraj Kumar (CSIR-CEERI, India), R. K Sharma (CSIR-CEERI, India)

In this paper, simulation studies on 0.1 THz planar slow wave interaction structure for Backward Wave Oscillators (BWOs) have been presented. The normalized phase velocity and dispersion variation profiles for different beam tunnel width to height ratios are analyzed using Eigen mode simulations in CST Microwave Studio. Axial electric field amplitude with interaction impedance profile for different aspect ratios, are also analyzed as a optimization study of effect of beam tunnel width to height ratio with the BWO operation and its frequency range.

P1-7.8 / 220GHz Sine Waveguide BWO with large Beam Tunnel

P. C. Yin (University of Electronic Science and Technology of China, China), H. R. Yin (University of Electronic Science and Technology of China, China), J. Xu (University of Electronic Science and Technology of China, China), S. Z. Fang (University of Electronic Science and Technology of China, China), X. Lei (University of Electronic Science and Technology of China,

China), G. X. Wu (University of Electronic Science and Technology of China, China), L. N. Yue (University of Electronic Science and Technology of China, China), G. Q. Zhao (University of Electronic Science and Technology of China, China), W. X. Wang (University of Electronic Science and Technology of China, China), Y. Y. Wei (University of Electronic Science and Technology of China, China), Luqi Zhang (Huawei Technology Co., Ltd. China), Dazhi Li (Institute for Laser Technology, Japan)

The development of 220GHz sine waveguide BWO with cylindrical beam tunnel is presented here. The particle-in-cell (PIC) simulation result predicts that this device can product the output power over 6.5W in frequency range of 214.07GHz to 224.99GHz. The radius of beam tunnel is 0.2 mm. The beam current is chosen as 70mA which has a current density of 99A/cm^2. The uniform magnetic is 0.25T.

P1-7.9 / O-Type Millimeter-Wave Band Devices on the Spiral Bent Rectangular Waveguide

Alexander Kurayev (Belarusian State University of Informatics and Radioelectronics, Belarus), Alexey Rak (Belarusian State University of Informatics and Radioelectronics, Belarus), Artem Badarin (Innopolis University, Russia), Semen Kurkin (Innopolis University, Russia), Alexey Koronovskii (Saratov State University, Russia)

The designs of O-type millimeter-wave band devices with two wide tape electron beams are proposed and investigated. It is proposed to use a spirally bent rectangular waveguide on fundamental H10 mode as an electrodynamic structure of the tubes. Analytical estimates have shown the possibility of effective interaction of the electron beam with both direct and backward electromagnetic waves for the certain values of control parameters of the systems.

P1-7.10 / Optimization of Volume Free-Electron Laser with Photonic Crystal Foil Grid Structure for Operation in Sub-Terahertz Range

Artem Badarin (Innopolis University, Russia), Nikita Frolov (Innopolis University, Russia), Semen Kurkin (Innopolis University, Russia), Alexey Rak (Belarusian State University of Informatics and Radioelectronics, Belarus)

In this work we present the results of numerical optimization of volume free-electron laser based on the interaction between electron beam and periodic structure of microwave photonic crystal. The optimization aims at advancement of such device to sub-terahertz frequency range. We show that reduction of characteristic geometric dimensions allows to increase the oscillation frequency of photonic crystal fundamental mode f_0 up to 12.5 GHz. Moreover, we observe the possibility to generatemicrowaves at higher harmonics of fundamental frequency, namely at $f_5 = 5 \times f_0 = 62.5$ GHz, and obtain output power level of about 3.6 kW.

P1-7.11 / Hybrid Microwave Device Based on the Vircator with Additional Electrodynamic Section

Andrey Starodubov (Saratov State University, Russia), Nikolay Kuznetzov (Saratov State

University, Russia), Alexey Koronovskii (Saratov State University, Russia), Yurii Kalinin (Saratov State University, Russia)

The results of the study of a microwave generator based on a nonrelativistic low-voltage vircator with a non-laminar electron beam and with an additional extended electrodynamics section are presented. An additional extended electrodynamics section based on the slow wave structure of helix type. It is shown that the proposed device has the efficiency of 20% with a frequency band of 1-3 GHz.

P1-7.12 / Low Starting Current Oscillator Based on the Degenerate Band Edge in a Double Helix Slow Wave Structure

Ahmed F. Abdelshafy (University of California Irvine, USA), Tarek Mealy (University of California Irvine, USA), Alexander Figotin (University of California Irvine, USA), Filippo Capolino (University of California Irvine, USA)

We present a new slow wave structure (SWS) for high-power electron-beam-driven oscillators based on the degenerate band edge (DBE). The proposed DBE operational regime is based on four degenerate eigenmodes all synchronized with the electron beam, and leads to an effective energy transfer from the electron beam to the four degenerate eigenmodes. This paves the way for a new class of high-power oscillators, which we have called degenerate band edge oscillators (DBEOs) that show an unconventional trend of the starting current and feature single frequency of oscillation with high spectral purity.