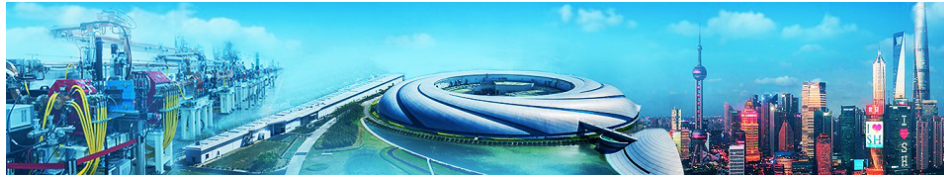


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High-power gyro-klystrons for acceleration applications

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High-power microwave sources play an important role in the applications of the radar system, controlled fusion plasma experiments, as well as particle accelerators. Currently, the conventional klystrons operating at S-, and X-band are the main driver in high-gradient accelerators. Klystrons with MW output power have been developed at CPI, SLAC, Thales, and so on. The most powerful klystron product is able to deliver higher than 50 MW at 11.424 GHz with us pulse length.

The future accelerators require higher acceleration gradient. One of the solutions is to operate the accelerating structures at a higher frequency. However, for conventional klystrons, operating at a higher frequency will significantly reduce the output power, with a factor of $1/f^2$. Gyro-klystrons not only have the bunching in the axial direction, which is the same as the klystrons. But also bunching at azimuthal direction due to the cyclotron resonance maser instability. It has the advantages of higher power capability as well as operating at higher frequency.

MW gyro-klystrons operating at Ka-and V-band for acceleration applications are currently being developed. It is a joint project between the University of Strathclyde, UK and University of Electronic Science and Technology of China (UESTC), China.

Two gyro-klystrons will be developed at the first stage. One is operating at 36 GHz for beam acceleration. From the simulation, a max output power of 1.9 MW, efficiency of 44%, gain of 39 dB and 3 dB bandwidth of 700 MHz were obtained. The other one is designed for the Compact Linear Accelerator for Research and Applications (CLARA), a Free-Electron Laser Test Facility at Daresbury Laboratory, UK. It will be used to drive the linearizer to correct the longitudinal phase space non-linearity from the RF acceleration. The operating frequency will be 48 GHz, which is 4th harmonic of the X-band linearizer. The output power of the gyro-klystron is predicted to be 1 MW if it is driven by a 100 kV, 50 A electron beam.

The long-term goal is to develop gyro-klystron at similar operating frequencies but with higher output power to 20 MW.

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