# *Study of Thermionic Emission Microscope for Multi-Beam Cathode*

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***Abstract*— Thermionic emission microscope (THEM) is an important analytical research tool for studying the electron emission uniformity of a thermionic cathode. The criticality of its design and development stems from the need to characterize the inhomogeneous emission nature of the impregnated cathode surface. In this paper, a design of the lens and the deflection plates is presented for a multi-beam cathode (MBC). To understand the electron optics of THEM with lens and deflection plates system, simulations were carried out using the simulation tools CST Particle Studio software. The present MBC contains 19 protruding buttons-each acting as an independent emitter, whose image is projected onto the screen for study.**

*Keywords— Thermionic emission microscope (THEM), Multi-beam klystron (MBK), Multi-beam cathode (MBC), Single beam cathode (SBC), Electrostatic lens, Immersion lens, CST Particle Studio*

## *Introduction*

Klystrons are always in demand for the major source of high power RF in many applications such as particle accelerators, experimental reactors, radars, satellites and wideband high-power communication devices. The historical growth in klystron technology from past 70 years since WWII shows that the output power increases tremendously. Recent applications of high-energy such as super-conducting linear accelerators demand high power klystrons with high efficiency (> 70%) and long pulse duration (an order of 1ms). The peak power delivered by a long pulse Single-Beam Klystron (SBK) is limited by the high voltage that its gun can withstand. A lower cathode voltage is desirable to ensure reliable operation without gun arching or voltage breakdown.

However, in a SBK, the balance of output power, voltage and efficiency altogether is nearly impossible, since the perveance determines the relationship of all other operating parameters and even an achievable maximum efficiency of the tube. The concept of multiple-beam klystrons (MBKs) was proposed in 1950s in both the Russia and in France [1]–[3]. MBKs have many advantages such as low operating voltage, high perveance, small and light weight in design. Microwave tube researchers now a day have paid more attention to Multi-beam klystron (MBK) with growing need of high power and high frequency [4]-[7]. As the name implies, in MBK, multiple electron beamlets propagate in a separate, parallel beam tunnel, but interaction with electric fields takes place in common cavity. Due to this, the perveance of the individual beamlet would be low; and thus providing stable-beam propagation and efficient beam-wave interaction with negligible space-charge effects that could debunch the beam, while the total beam current would be high, thus having high-power and broad-bandwidth operation. Characterization of multi-beam cathode (MBC), becomes very necessary to check weather each beamlet has uniform emission distribution from the button of cathode. For this purpose THEM is used for MBC characterization.

THEM is a characterization tool to study the emission uniformity of a thermionic cathode [8]-[9]. The surface of a dispenser