Contribution ID: **39** Type: 海报展示

Toward a multipactor-free cavity design for a very-high-frequency continuous-wave electron gun

摘要

甚高频（VHF）光阴极电子枪可产生高重复频率、高亮度电子束，并工作于连续波模式。二次电子倍增（Multipactor）是制约其应用的关键问题，会导致功率损耗、腔体损伤、束流品质下降及寿命缩短。本文证实腔体内为非谐振二次电子倍增并确定其易发区域，通过系统优化腔体几何结构实现倍增抑制；基于电子轨迹统计分析阐明抑制机理，研究铜材料二次电子产额（SEY）的影响，最终提出一种具有极低二次电子倍增效应与优异射频性能的优化腔体方案，为 VHF 电子枪稳定运行提供支撑。

关键词

二次电子倍增，二次电子，甚高频电子枪，腔形

Abstract

A VHF photocathode electron gun generates high-repetition-rate, high-brightness electron bunches in continuous-wave mode. Multipactor is a critical issue that causes power loss, cavity damage, beam quality degradation, and shortened lifetime. This work confirms non-resonant multipactor in the cavity, identifies its dominant region, and systematically optimizes cavity geometry to suppress multipactor. The suppression mechanism is clarified via statistical analysis of electron trajectories. The influence of copper secondary electron yield (SEY) is investigated, and an optimized cavity with ultra-low multipactor and excellent RF performance is proposed for stable VHF gun operation.

Keywords

multipactor, secondary electron, VHF electrongun, cavity shape

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Session Classification: 海报展示

Track Classification: 海报展示: 海报展示