Introduction

RF Cavities and Dark Currents MICE

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Particle Acceleration

RF Cavities are the work horse of High Energy Physics

We've come a long way from using a simple potential difference!





But it's not just accelerators...



Muon Ionisation Cooling Experiment



3D Rendered CAD drawing of MICE Step VI



Linear Acceleration





It started with Ising, built by Wideröe



and was improved by Alvarez



Single Cavity Structures

Solve Maxwell's Equations to find the field structure Exists in modes dependent on geometry



Example field structure for a TM_{010} mode cavity

Multiple Cavity Structures

The next step with a similar design is multicavity structure, either travelling wave or standing wave

Characterized by the field phase shift per cavity



A superconducting cavity CAD-Drawing

Field Emission Phenomena

Very strong electric fields perpendicular to cavity surfaces:

- Changes the work function potential barrier
- Permits higher rates of quantum tunnelling
- Amplified by local imperfections
- Builds to form dark currents



RF Cavities

Field Emissions

The Problem

The Solution

Fowler-Nordheim

Expected current density as a function of electric field Assumes a saw-toothed potential barrier



8,

Effects of Dark Currents

Dark currents produce X-Rays when	Harmful to sensitive equipment,
the impact the opposite wall of the	detectors and electronics
cavity	
Additional charge particles within	Can damage the cavity, wastes a lot
cavity increase liklihood of RF	of energy and inhibits the cavity's
breakdown	accelerating gradient
Slowly leak energy from the	Wastes energy, requires more stress
electromagnetic field	on the RF system, increases
	difficulty in construction



A MICE Tracker Module without outer casing

Simulating Dark Currents







Run through G4 Based Front End





X-Ray Detector

- Monitoring the dose received by the MICE tracker.
- Can compare with simulation.
- Predict X-Ray damage and Dark Current induced noise.



First Finish the simulation and obtain quantitative predictions

- Second Start work on designing the tracker shielding detectors
 - Then Consider the next part of my research: The RF phase control