Problem Statement and Goals
Charged Particle Trajectory Simulator

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Table 1: Revision History

Date	Developer(s)	Change
2026-01-16	Zhuo Zhang	Initial draft

1 Problem Statement

1.1 Problem

In electromagnetism, charged particles undergo deflection circular motion and velocity selection under electric and magnetic fields. Analyzing these behaviors can help understanding phenomena such as velocity selectors, Cathode Ray Tube deflection and other basic principles of mass separation. The problem is to provide a computational tool that predicts trajectories and deflection of charged particle when it passes through uniform electric or magnetic field regions under different sets of configuration and parameter. The importance of this problem is from that the motion is described by a system of ordinary differential equations (ODEs).

1.2 Inputs and Outputs

The inputs are particle properties, field specification, geometry of the experiment, and termination condition of the experiment. The outputs are representation of particles' trajectory and deflection.

1.3 Stakeholders

- Primary use stakeholders: instructors or students who want to confirm or analyze motions of charged-particle in different conditions of fields.

- Project stakeholders: the Drasil maintainers and course instructors who will check the artifacts, traceability and quality of the document.
- Secondary stakeholders: future CAS741 students who wish to reuse, refer or extend the case study.

1.4 Environment

This software runs on personal computer with Ubuntu 22.04 LTS. User interacts via command line. Inputs are provided through a text-based configuration and outputs are given by portable and standard formats in CSV. The documentation and generated artifacts are under Drasil workflow.

2 Goals

- This software will compute motion of charged-particle by modeling dynamics.
- This software will support electric-field-only, magnetic-field-only, and crossed-field configuration regions.
- This software will produce impact point, flight time, trajectory and deflection in a readable format.

3 Stretch Goals

- This software will solve for unknown parameter given a target detector location.
- This software will add error estimation to improve accuracy across different parameters.