Progress in Electrostatic Target Acceleration

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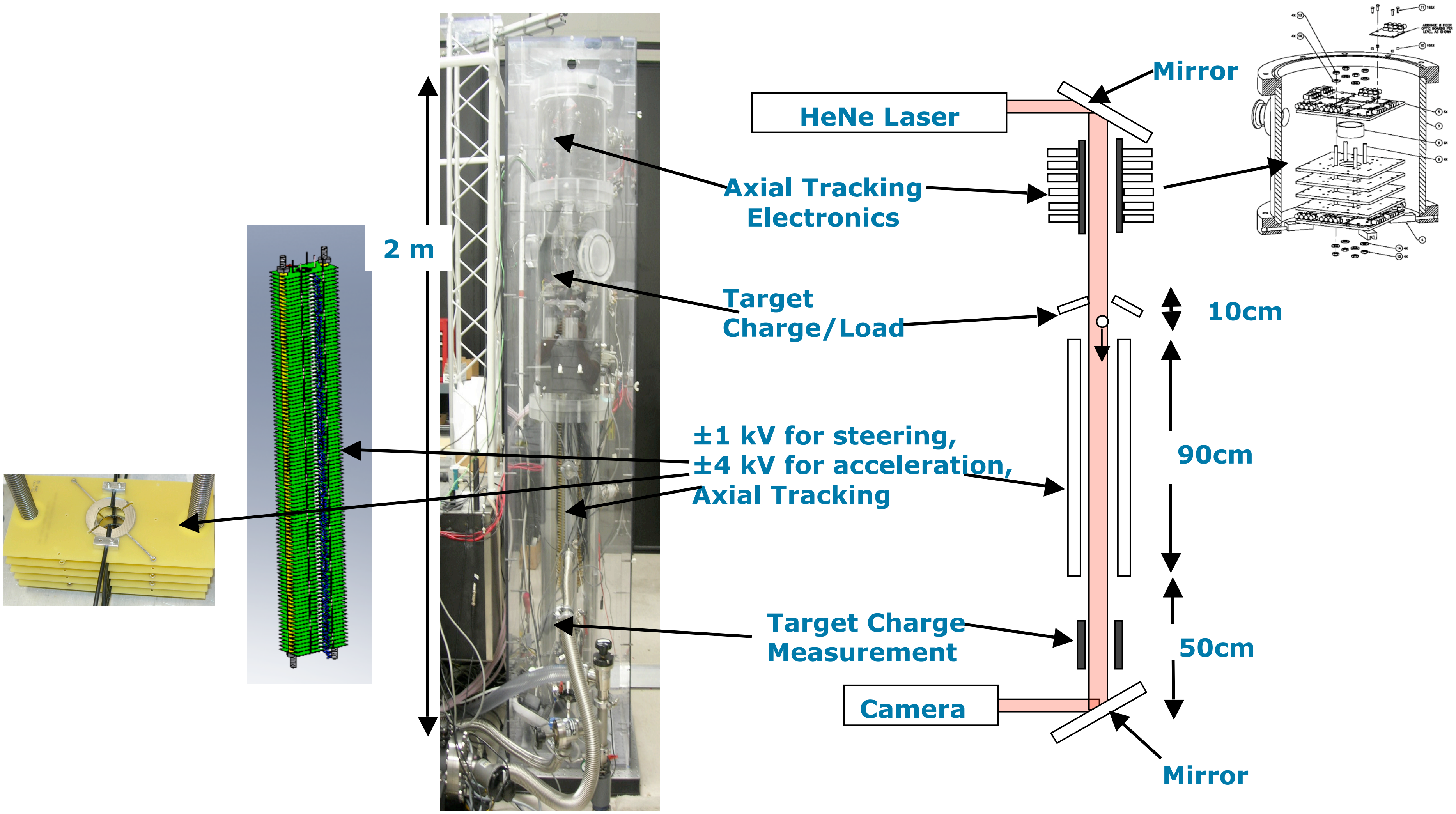
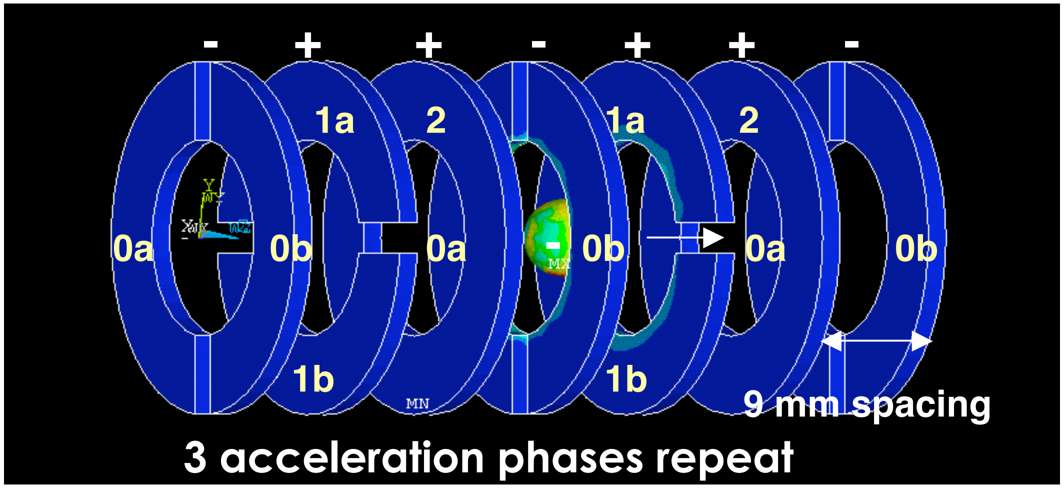
1. General Atomics
2. UCSD
3. Washington and Lee University
4. Kentech Instruments, UK

GENERAL ATOMICS

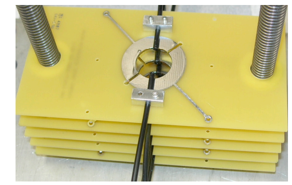
Targets are loaded, charged, released, tracked accelerated and steered in a vacuum chamber

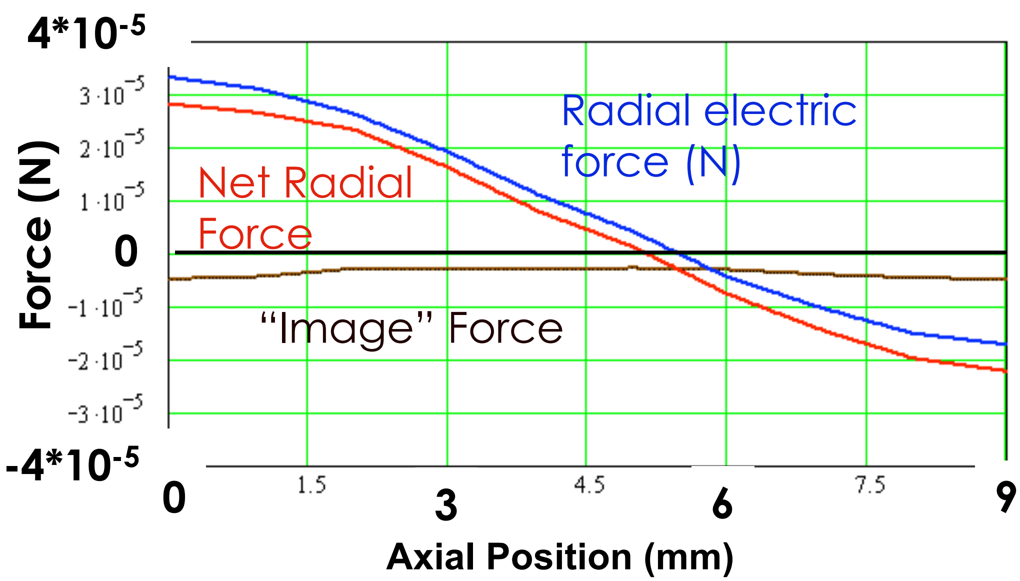


Our electrode configuration allows two-dimensional steering



- Optical position measurement sensors at each electrode are used to time the advance of electrode voltage





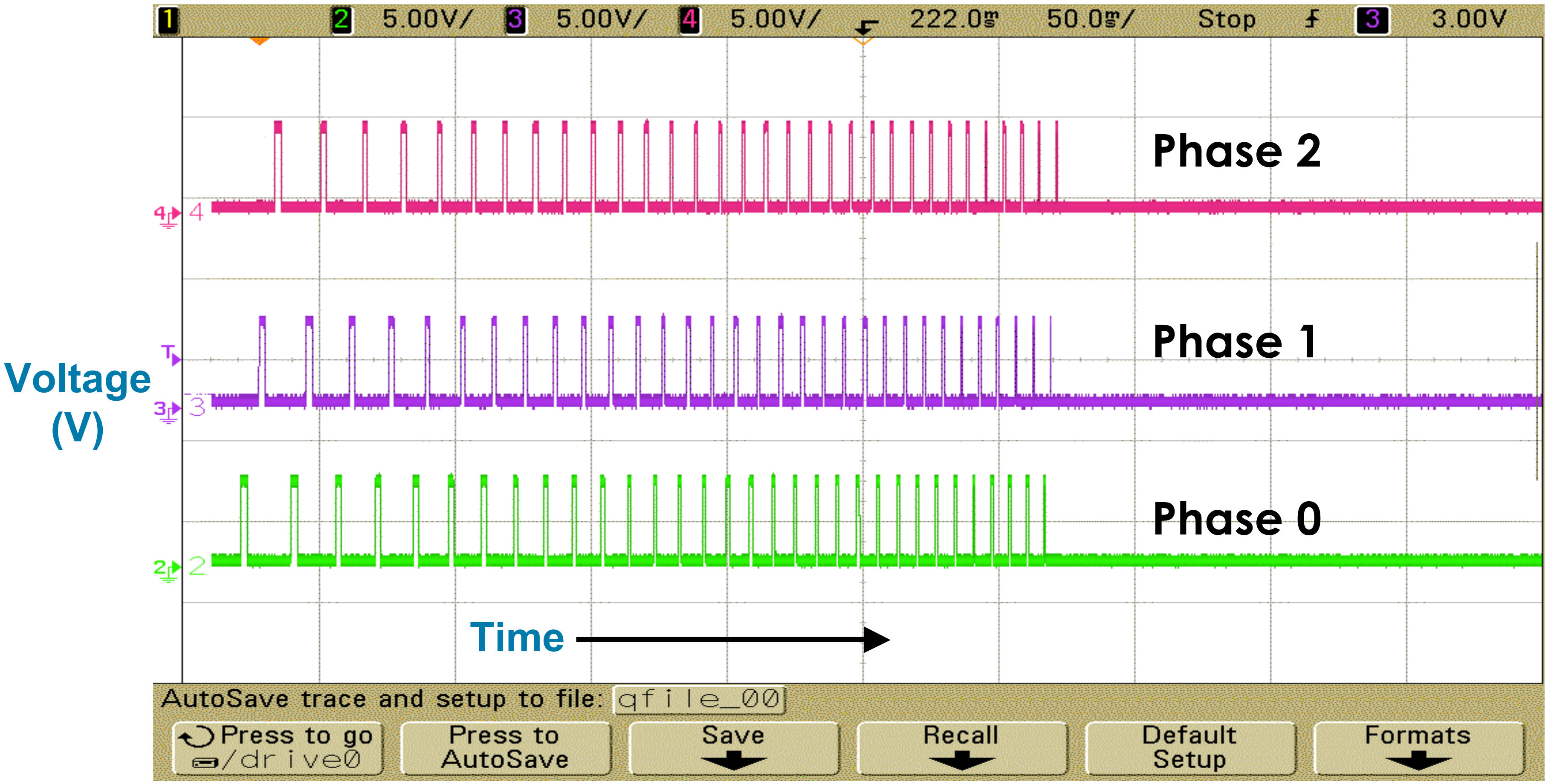
Electric Force created by the applied voltage

- Image force is proportional to charge squared and limits useful target charge

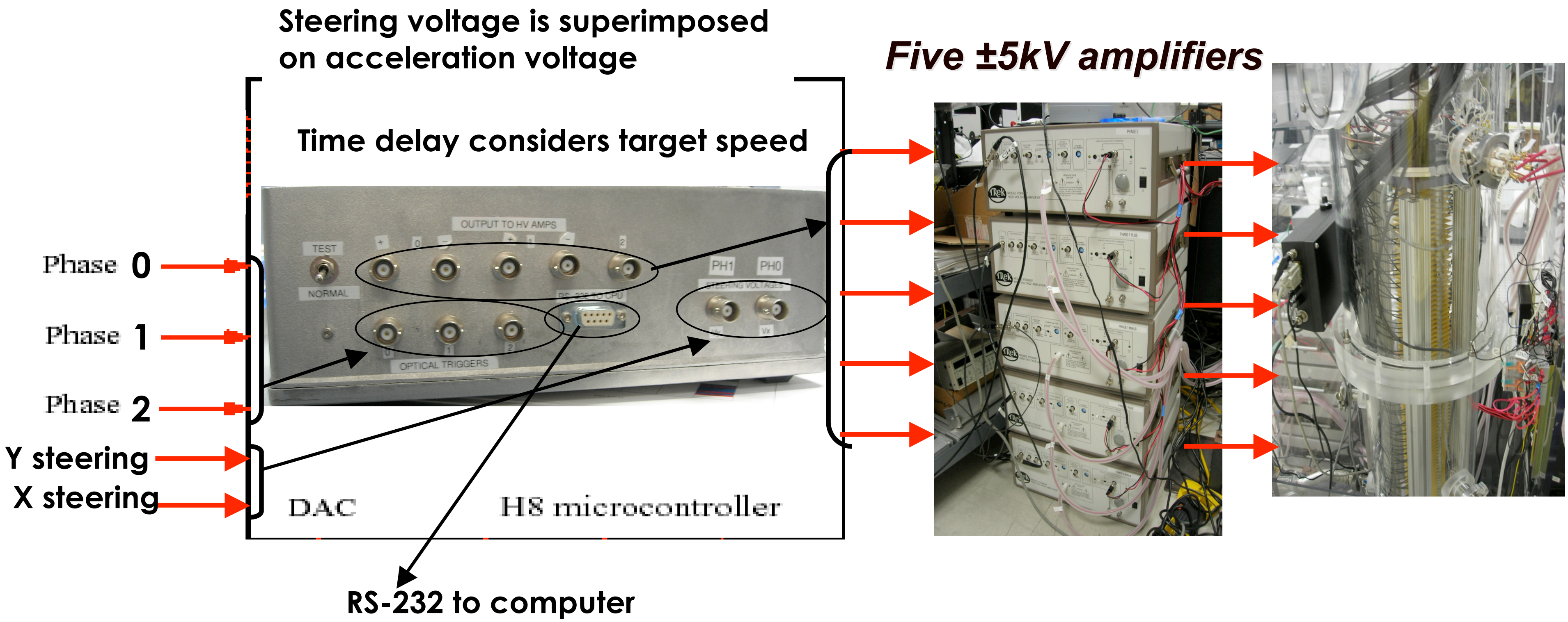
Q = -0.5 nC, V=±4 kV
Target 1 mm off axis

Triggering signals indicate when the target approaches each electrode

NAND and OR logic combines detector signals from each phase



The microcontroller provides acceleration and steering control voltage to five HV amplifiers

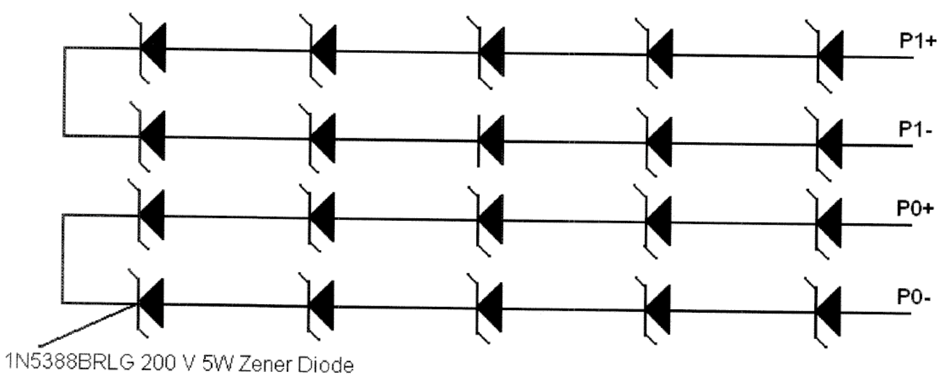


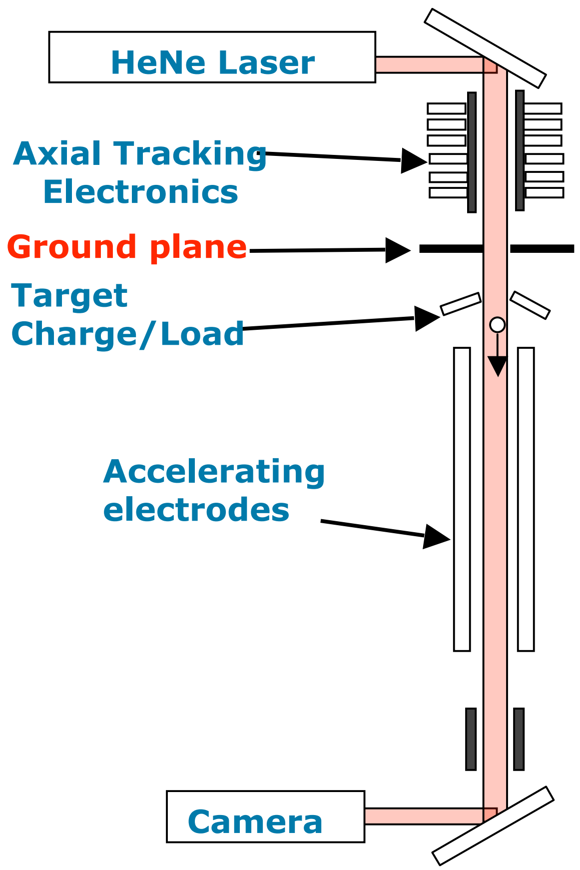
Each amplifier energizes 32 electrodes

Changes were implemented after HV breakdown damage to many components

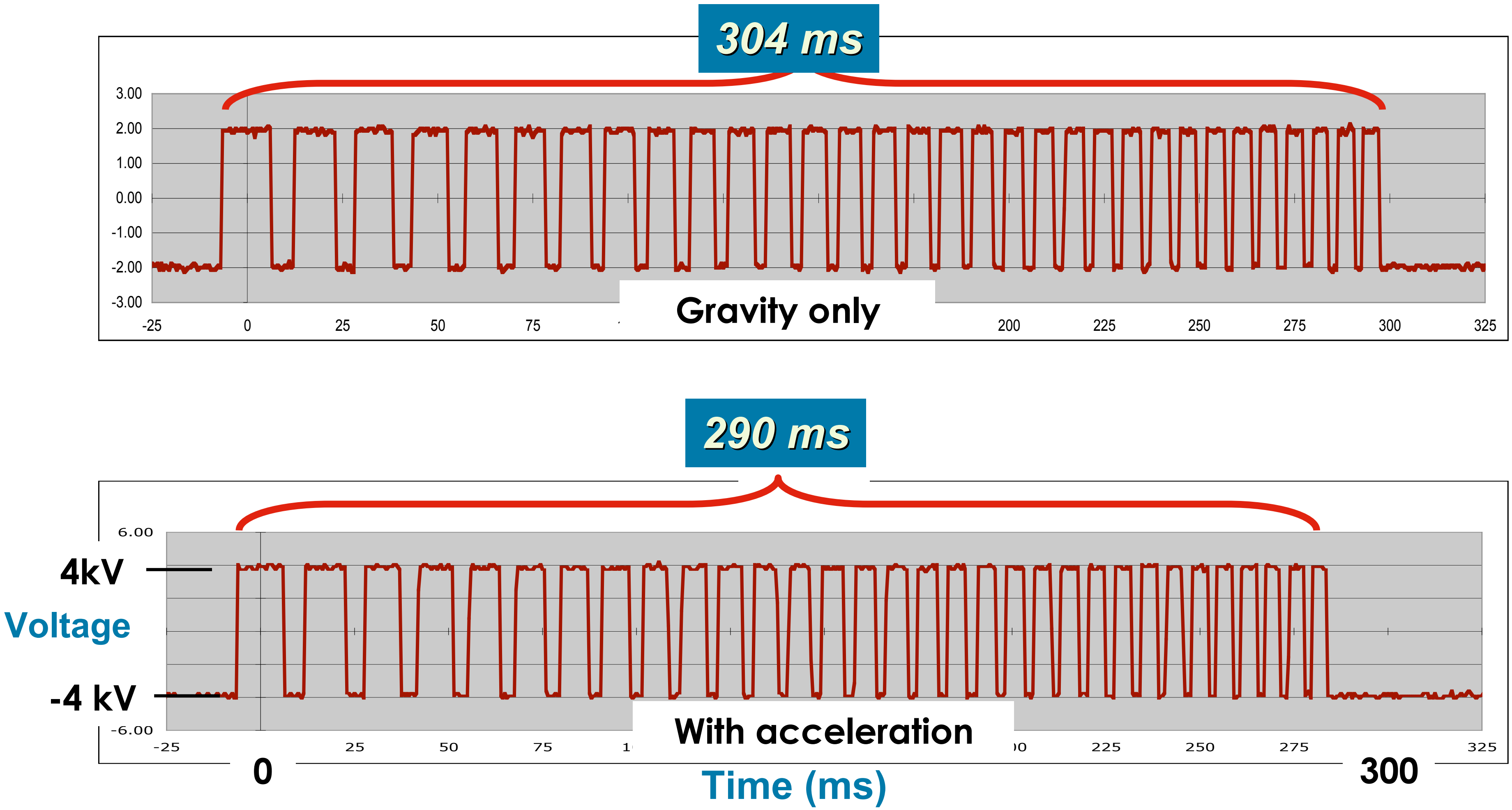
A ground plane between HV and axial tracking electronics attenuates electric fields

A voltage limiting circuit now protects the steering electrodes





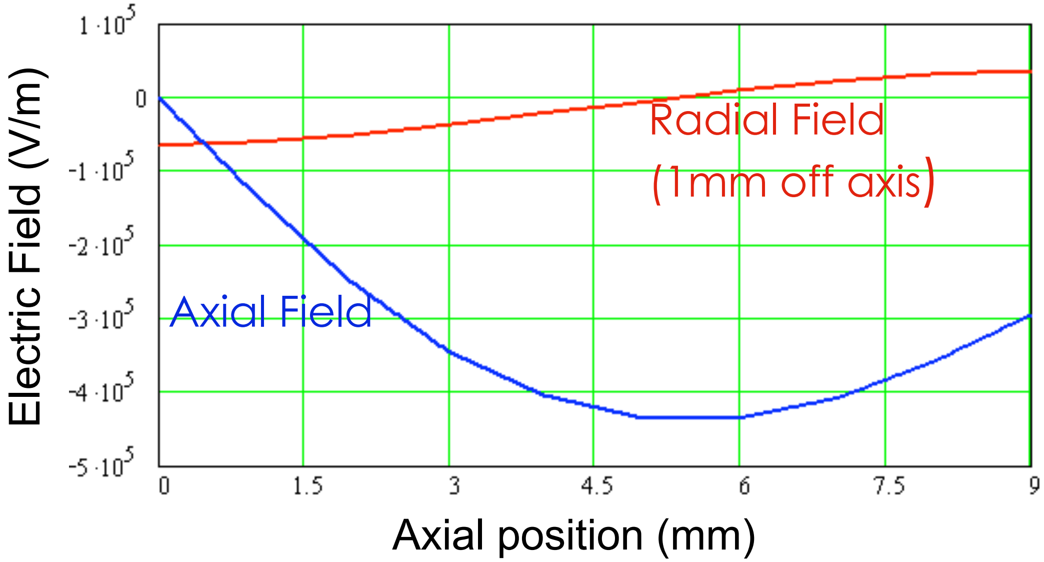
Acceleration was achieved with solid spheres



a - g = 1.4 m/s²

(-2.5kV charging ~-0.14 nC on 30mg target)

Greater acceleration may be achieved with lower mass and higher target charge



V=±4 kV
Electrode spacing = 9 mm
Average axial field = 307 kV/m
Surrogate target mass = 1.8 mg

$$a = \frac{qE}{m}$$

$$\sim \frac{5\times10^{-10}C\left(3.07\times10^{5}V/m\right)}{1.8\times10^{-6}kg} = 85m/s^{2}$$

Our 0.9 m demonstration unit could achieve ~12.5 m/s.
FTF targets require 50 m/s.
Higher voltage may be part of solution, but voltage breakdown is a problem.

Summary of injection/positioning progress

Electrostatic accelerator designed and built - now testing

- Corrective action taken for HV breakdown damage
  - Currently repairing one HV amplifier and the microcontroller

Modest electrostatic acceleration achieved

- Solid plastic spheres in air without steering

Next step is vacuum acceleration with steering