SIMULATION OF RECOMBINATION IN XE + TMA

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Simulation Objectives

- Quantify electron-ion recombination in xenon gas in Garfield++ in a parallel plate drift chamber
- Microphysics simulation
  - Multiple electrons tracked at once as a cloud
- Model how additives like TMA affect recombination
- Investigate possibility of directional detection via columnar recombination

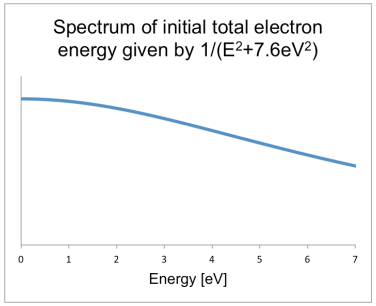
Modifications to Garfield++

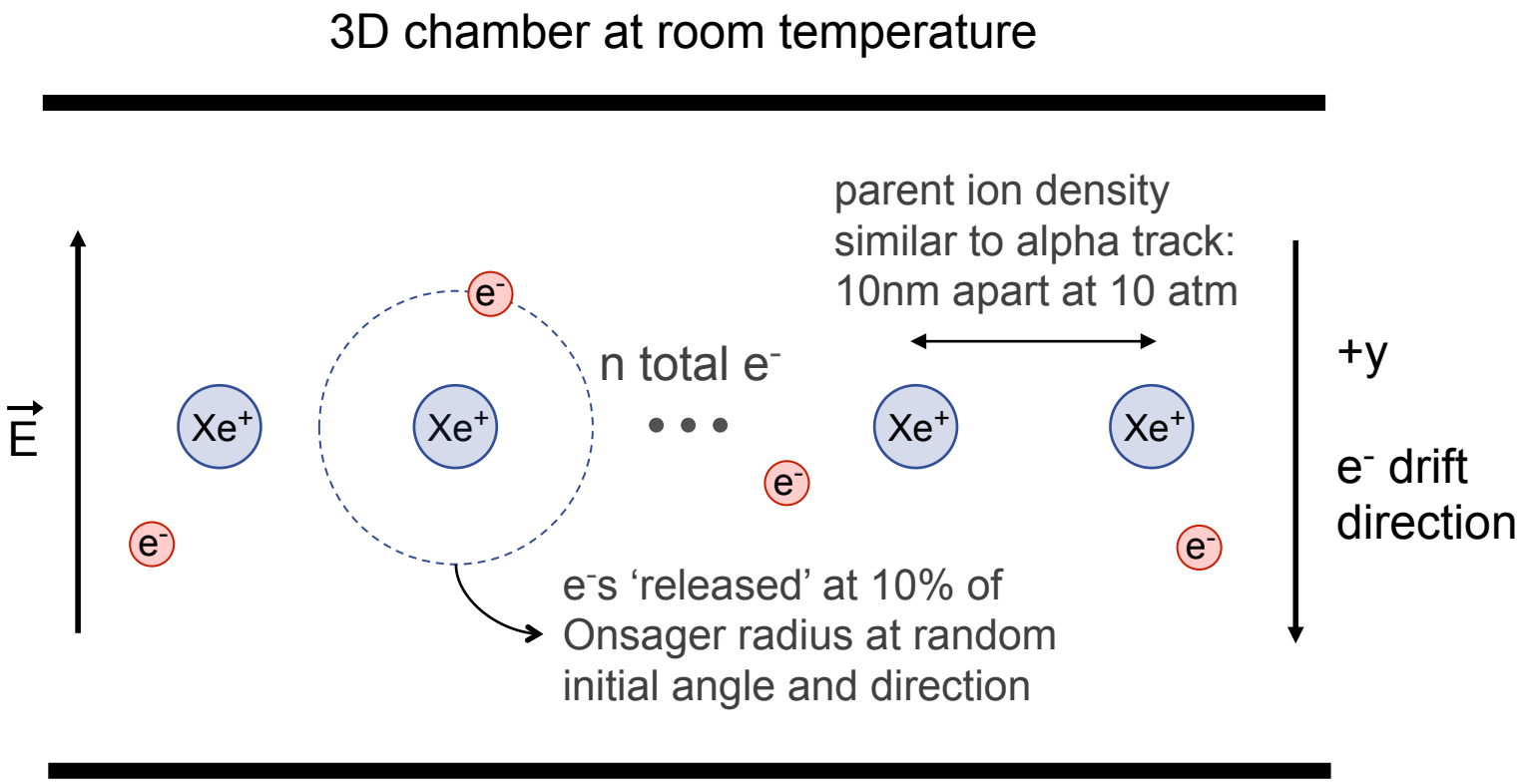
- Wrote AvalancheCloud() and TransportCloud(), based on AvalancheElectron() and TransportElectron(), to track multi-electron clouds
  - For each electron, calculates potential and electric field due to all other charges in addition to external field
  - At first step, adds energy equivalent to the initial potential energy to the kinetic energy to overcome initial potential well
- Increased frequency of null collisions by x10
- Fixed bug in code that prevented updating current direction when switching to tracking a different electron
- If an electron's kinetic energy > 8eV, reset to 7eV
- If electric field due to the cloud > 4.445e8 V/cm, perform calculations with only external field

Current Status

- Gets diffusion and drift velocities correct
- Aren’t seeing several effects that have been observed in experiment
- Run simulations on Carver cluster at the National Energy Research Scientific Computing Center (NERSC)
  - 100,000 hours used to date
  - ~200 electrons is maximum can currently simulate at once

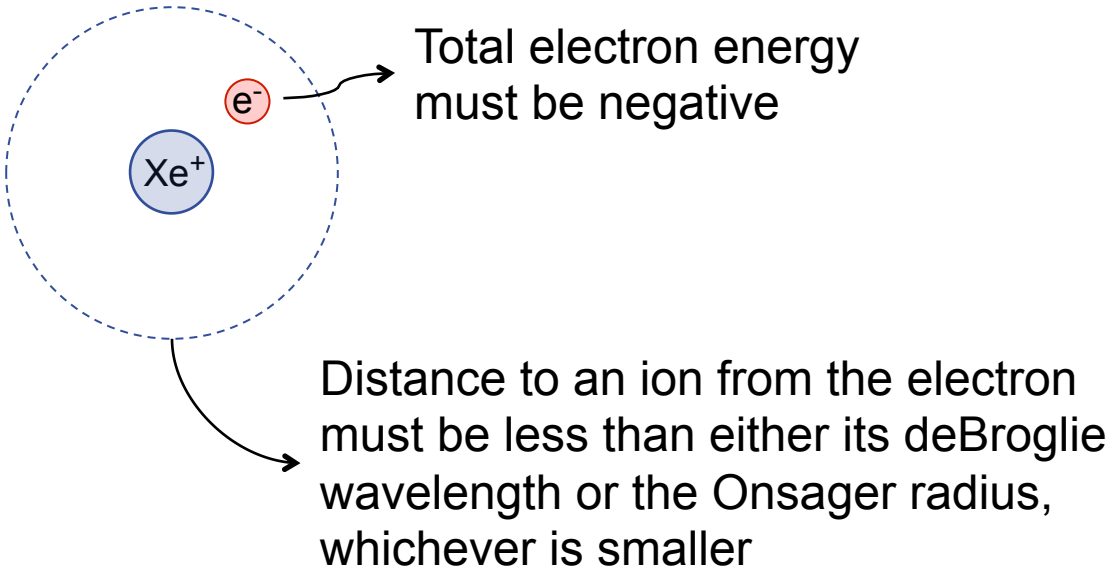
Physics of Simulation: Initial Conditions





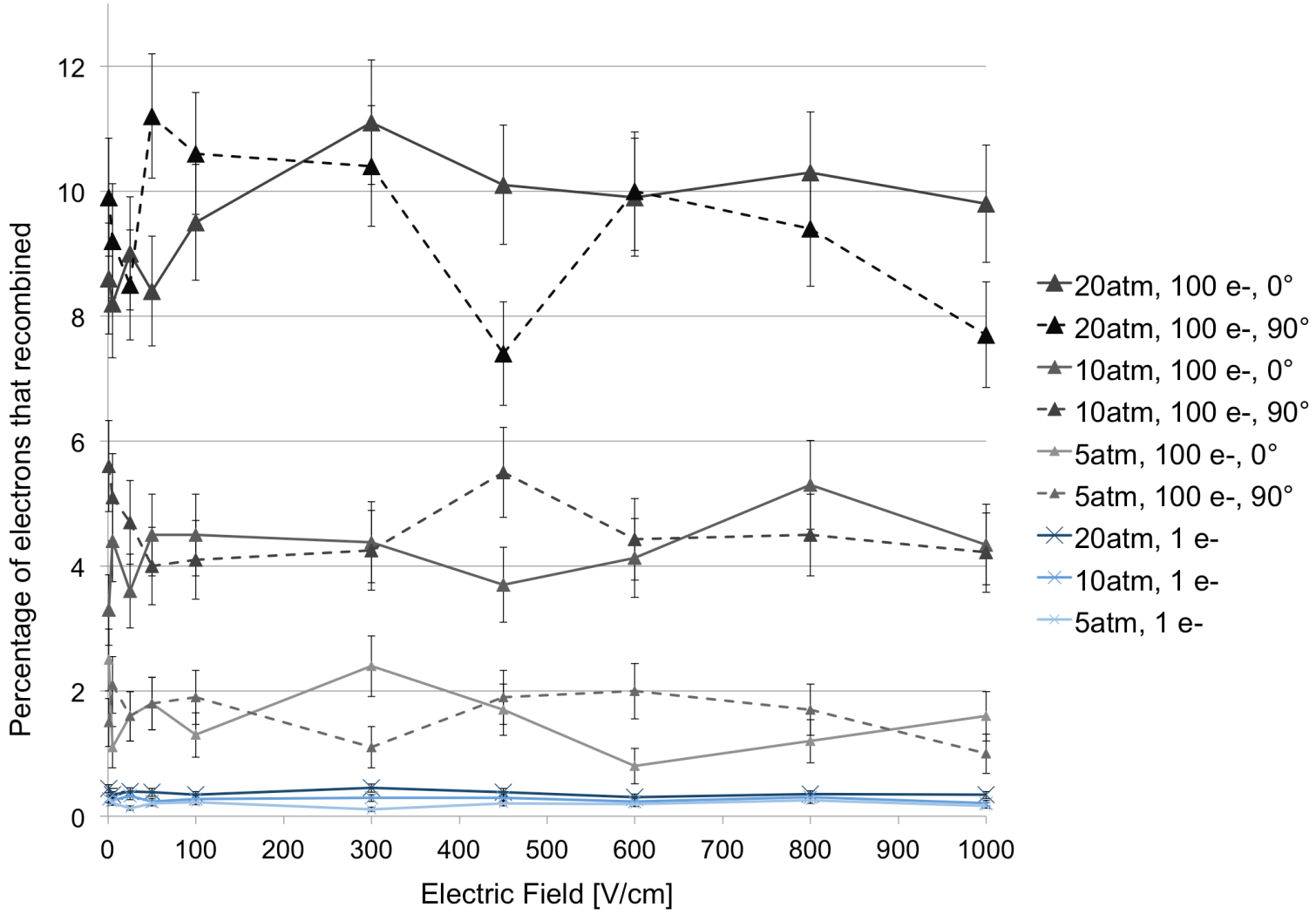
Specify: P, E, gas mix, number of e^-, angle of e^- line w.r.t. E, runtime

Physics of Simulation: Recombination

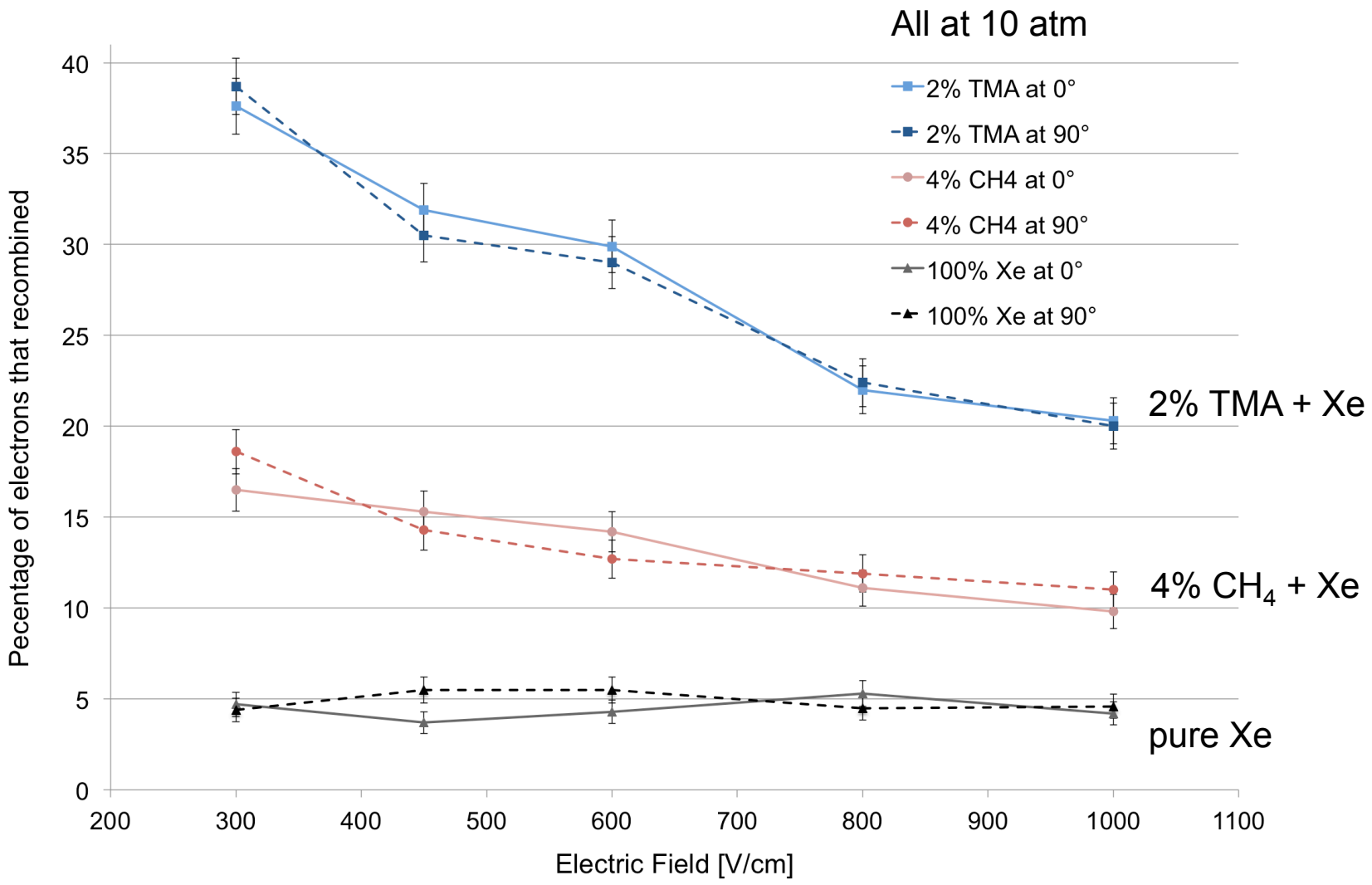


- After each step made while cycling through electrons and tracking them using their kinematics, the program checks to see if above recombination conditions have been met.

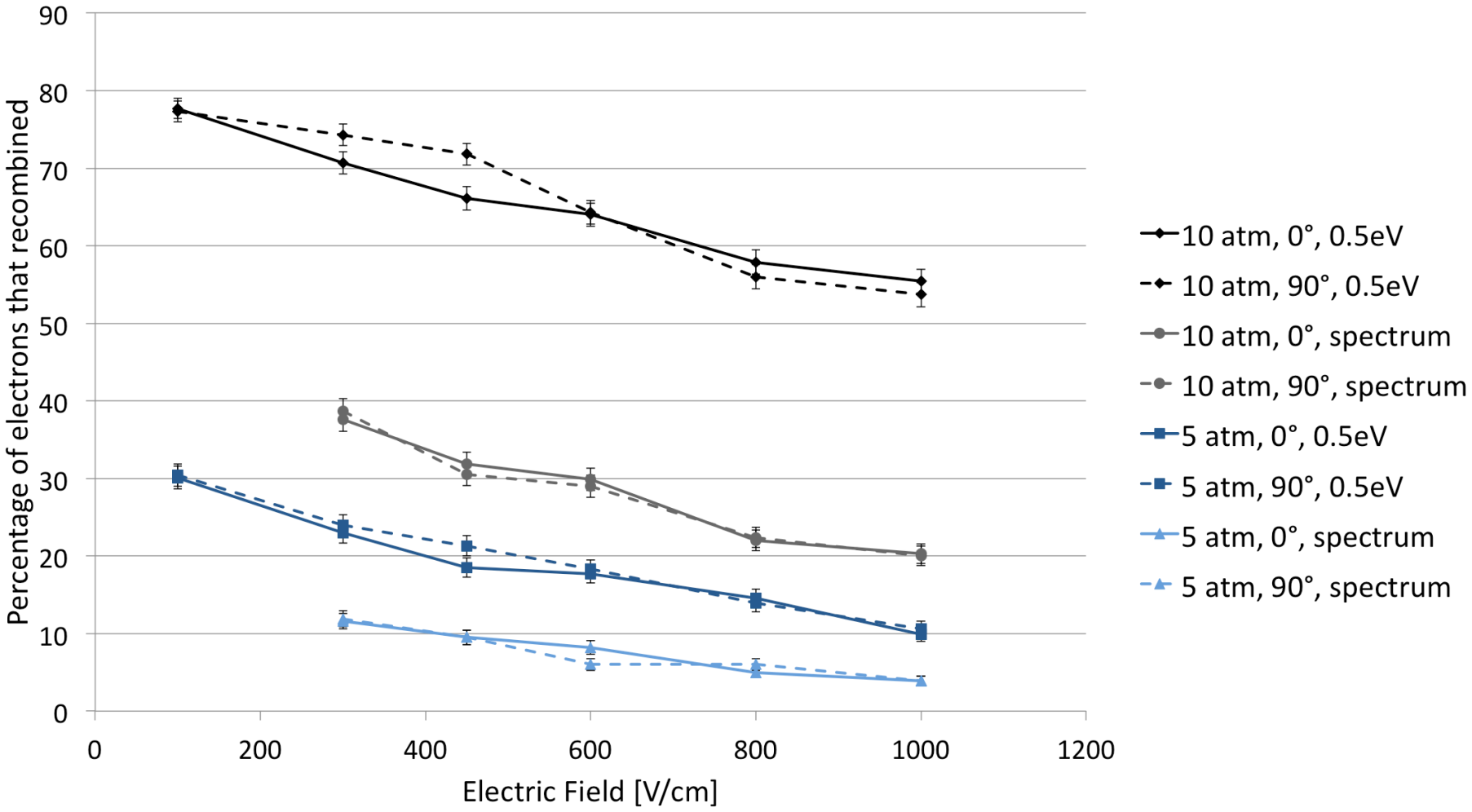
Current Results: Pure Xenon



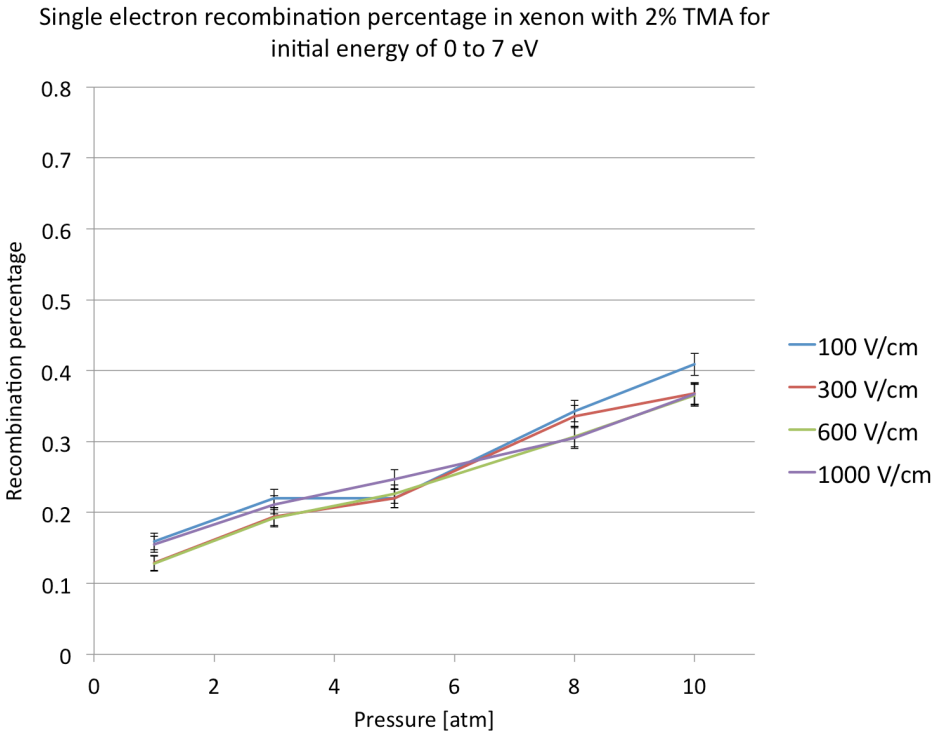
Current Results: Additives

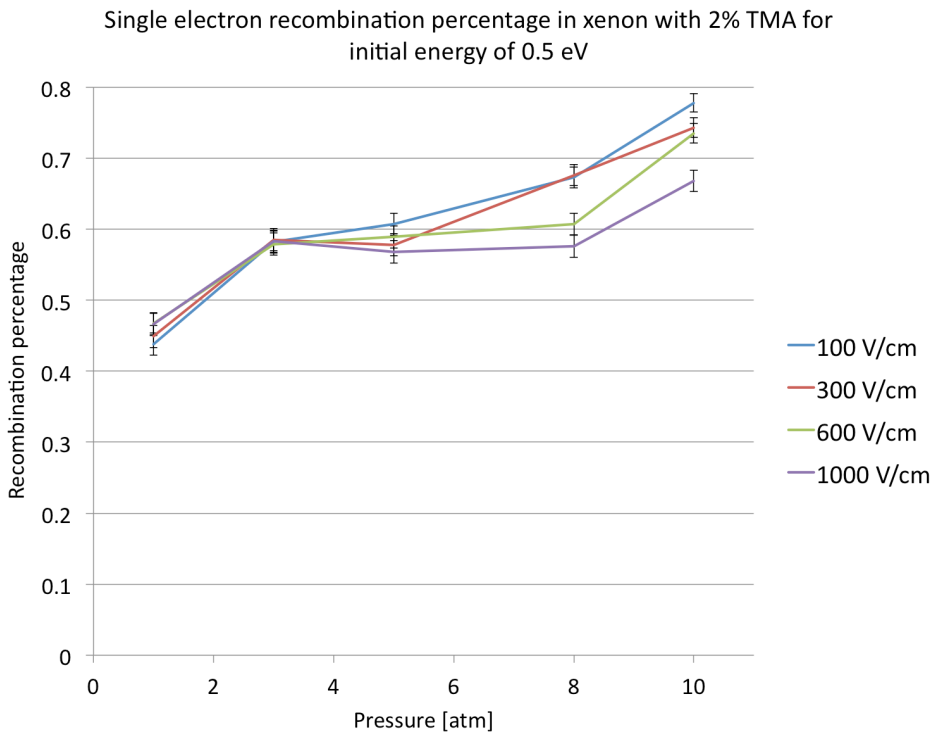


Current Results:
TMA with Monoenergetic Electrons in Clouds



Current Results: Single Electrons in TMA





Next Steps

- Benchmarking the simulation
  - Angular dependence
  - In pure xenon, should see increase in recombination at low fields based on Bolotnikov
  - Zaragoza's results with gammas & alphas in Xe + TMA
- Possible explanations:
  - Need to extend the simulated track to compare with actual length of alpha track
  - Clusters in gamma tracks, possibly also in alpha tracks, affecting recombination more (simulating this now for gammas)
  - TMA energy levels affect recombination near an ion