Drift Chambers

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Particle Interactions

- Resonant (excitation only)
  - May participate in further ionization-causing reactions
  - Lower energy threshold; most common
- Ionization (release of X^+/e^-)
  - Higher energy threshold → less common
  - X^+/e^- produced are primary ionization
  - Molecular ions: $He^+ + He \rightarrow He_2^+$

Transport

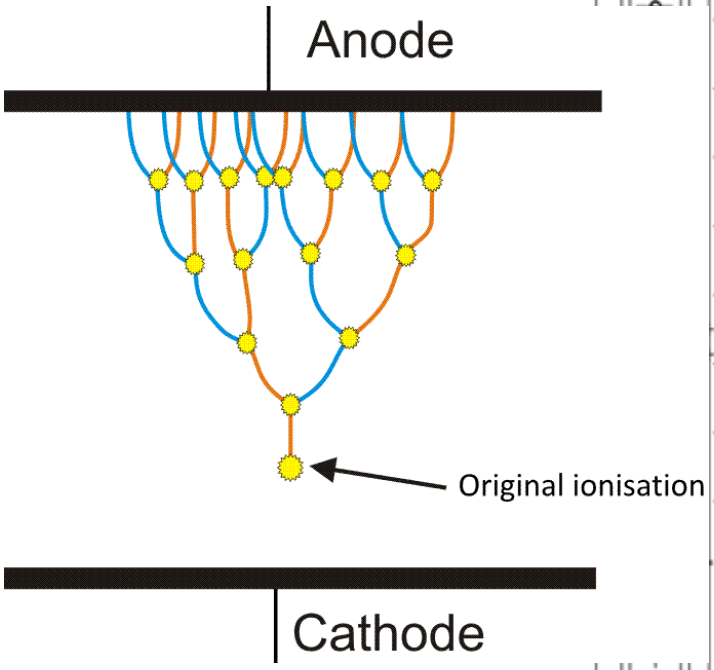
- Absence of E field:
  - Diffusion
  - $v = \mathrm{sqrt}(8kT/\pi m)$
    - Maxwell distrib.
  - Spherical spread:
    - $\sigma(r) = \mathrm{sqrt}(6\ D\ t)$
- Presence of E field:
  - Drift

Drift

- Mobility, $\mu = u/E$
  - Where drift velocity $u \propto E/p$
  - $\mu \propto 1/p$
- For ideal gases: Einstein relation
  - $D/\mu = kT/e$
- Electrons drift to anode wires, positive ions drift to cathodes

Avalanche Multiplication

- Occurs when primary ionized electrons cause further ionizations
  - Secondary, tertiary ionization, etc.
  - Electrons move much faster than their positive ion counterparts; this is the signal we detect
  - Rough avg: one X^+/e^- pair created for every 30 eV lost



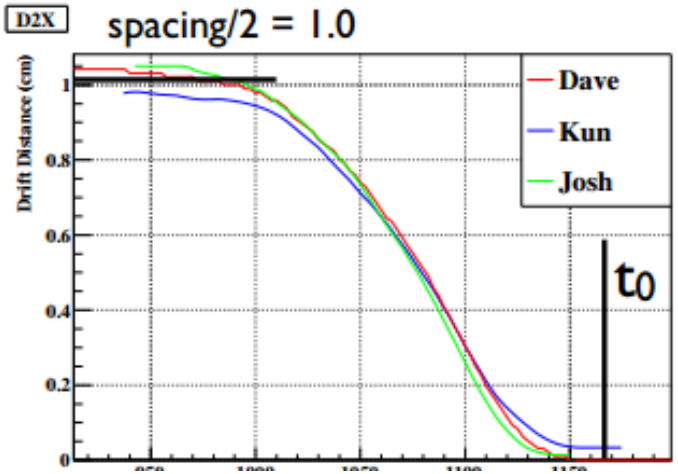
Choosing a Gas

- Must have ideal gas properties for the Einstein relation to hold
- High electron affinity (correlates with high electronegativity) causes electron attachment:
  - $X + e^- \rightarrow X^- + h\upsilon$
  - Gases to avoid: O_2, H_2O, CCl_4, SF_6
  - Noble gases have negative electron affinities
    - Result in much higher efficiency of electron collection
    - Test gas: 80/20 mix of Ar and CO_2
    - Run gas: P8

Signal

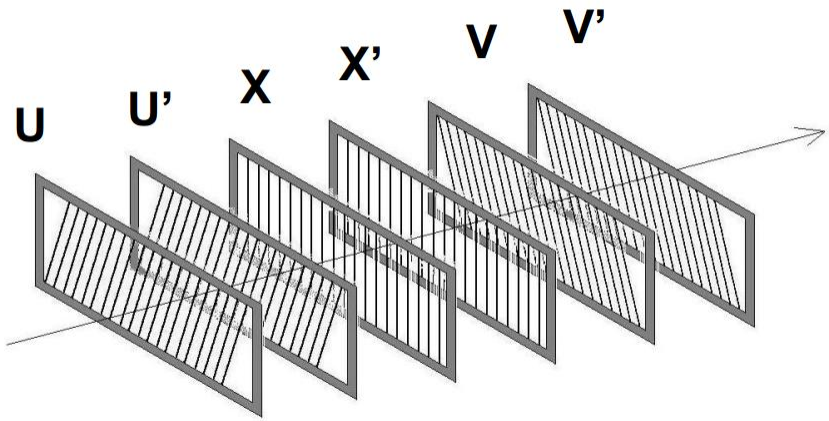
- Find the drift time between detection of particle by trigger mechanism (e.g. hodoscopes or prop tubes) and detection by drift chamber.
  - Drift chamber detects small current from avalanche of electrons hitting anode (sense) wire
- This drift time is related to the distance from the wires (non-linear)

$$x = \int_{t_0}^{t_1} u \, dt$$



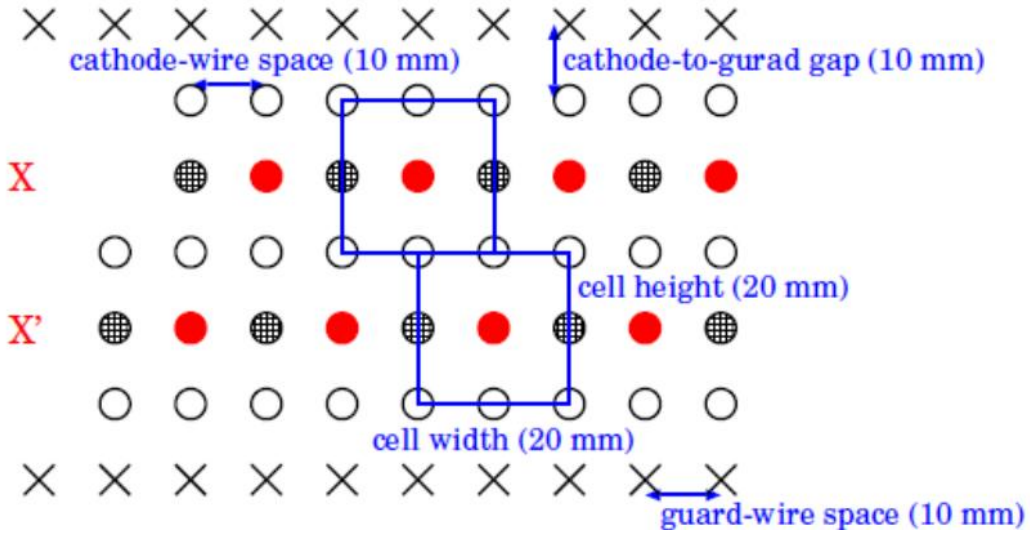
Specs

- Station 1 has X/X’ plane
  - Prime planes are ½ wire spacing offset from unprime planes
- Stations 2 and 3 have U/U’/X/X’/V/V’
  - U and V are 14 degrees from X



Specs

- Station 1 has a thin film cathode
- Stations 3p/3m have wire cathodes:



Thanks

- Shou – guidance fixing St. 1
- Florian – relevant diagrams of St. 3
- Kenichi – RT curve