Why do we correct for temperature and pressure?

- How might pressure readings from a mercury barometer in the department differ from pressure reported by the local airport? What about Lima, Peru (Denver residents) or Caracas, Venezuela (UCLA)?
- Where should temperature be measured?
- Are there chambers where corrections aren’t needed?

- Temperature/pressure corrects for the mass of air in an unsealed chamber
- Pressure used in corrections should be local. Airports (or National Weather Service) typically report a corrected pressure at sea level
- Barometers are calibrated at a temperature and latitude (gravity correction). At Duke this was 0^o C and 45^o latitude.
  - $M_{TC} = \frac{[1+L(t-t_s)]}{[1+M(t-t_m)]}$ at 22^o C and 36^o latitude, correction is 3.5mmHg (small)

    Where L is the coefficient of linear thermal expansion of brass (0.0000184 m/m°C), M is the coefficient of volume thermal expansion of mercury (0.0001818 m^3/m^{3}°C), t is the variable temperature, t_m is the standard temperature for the density of mercury, and t_s is the calibration temperature of 0° C

- Some chambers (in linac) are sealed and don't require corrections.

$$P_{TP} = \frac{273.2+T}{273.2+22.0} \times \frac{101.33}{P},$$

What is P_{ion} and what does it correct for?

- What beam characteristics affect it?
- Is there an acceptable limit to the values of the correction factor?
- What can you do if it reaches the limit?
- Co^{60} beams have a different formula for calculation. Why?

- P_{ion} corrects for recombination inefficiencies in the ion chamber
- Dose rate and dose per pulse affect the recombination. It should be re-measured for different dose rates (FFF).
- The correction factor should be less than 1.05 (why can't it be less than 1?).
- Switch the chamber out if it is greater than 1.05. Do not change the voltage to get an acceptable correction factor!
- There are separate calculations for pulsed (linacs) and continuous (Co^{60}) beams.

$$P_{\text{ion}}(V_H) = \frac{1. - V_H/V_L}{M_{\text{raw}}^H/M_{\text{raw}}^L - V_H/V_L}.$$

Pulsed

$$P_{\text{ion}}(V_H) = \frac{1. - (V_H/V_L)^2}{M_{\text{raw}}^H/M_{\text{raw}}^L - (V_H/V_L)^2}.$$

Continuous

What is P_{pol} and what does it correct for?

- What is a typical value and is there a value beyond which you should be concerned?
- What additional correction is needed if P_{pol} is more than 0.3% from unity?

- P_{pol} corrects for polarity effects in the chamber reading.
- The value should be near unity.
- If it is more than 0.3% different, the P_{pol} of the calibration lab should be established and used to correct $N_{D,W}$

Polarity correction factor (P_{pol})

- = account for change in reading due to change in potential polarity
  - Typical range <1.005
  - Generally negligible in photon beam.
  - Can be significant in electron beam, especially with parallel plate chamber

$$P_{pol} = \left|\frac{M_{raw}^{+} - M_{raw}^{-}}{2M_{raw}}\right|$$

- Addendum says should be <= 0.4% for reference chamber, total variation across photon energies of interest < 0.5%
- Not all chambers follow expected behavior (Boag theory)
- Higher voltage can lead to higher uncertainty
  - Charge multiplication
- Recombination can be a function of the sign of the charge collected
  - These kind of chambers excluded from recommended reference chamber list
- **Max value = 300 V**
  - Maybe lower required for small volume chambers
- Measure P_{pol} for any new chamber and beam combination
  - Good, simple QA check of chamber/electrometer system
    - Collecting correct charge
    - Chamber-to-chamber variation small, can compare your value to published values
    - Change in P_{pol} over time may indicate change in chamber response