Status (till last week)

- (very initial trial of) dE/dx from 2*MDC configuration

Next

in short (immediate) term

- Set the Gas mixture :
Helium base (He:iC4H10 = 90:10)

- Try to see dE/dx from the bethe-bloch formula

  -- with x-axis of unit in $\beta\gamma$

in middle (short) term

Since current way is just looking a possible chain with rough treatment at each procedure

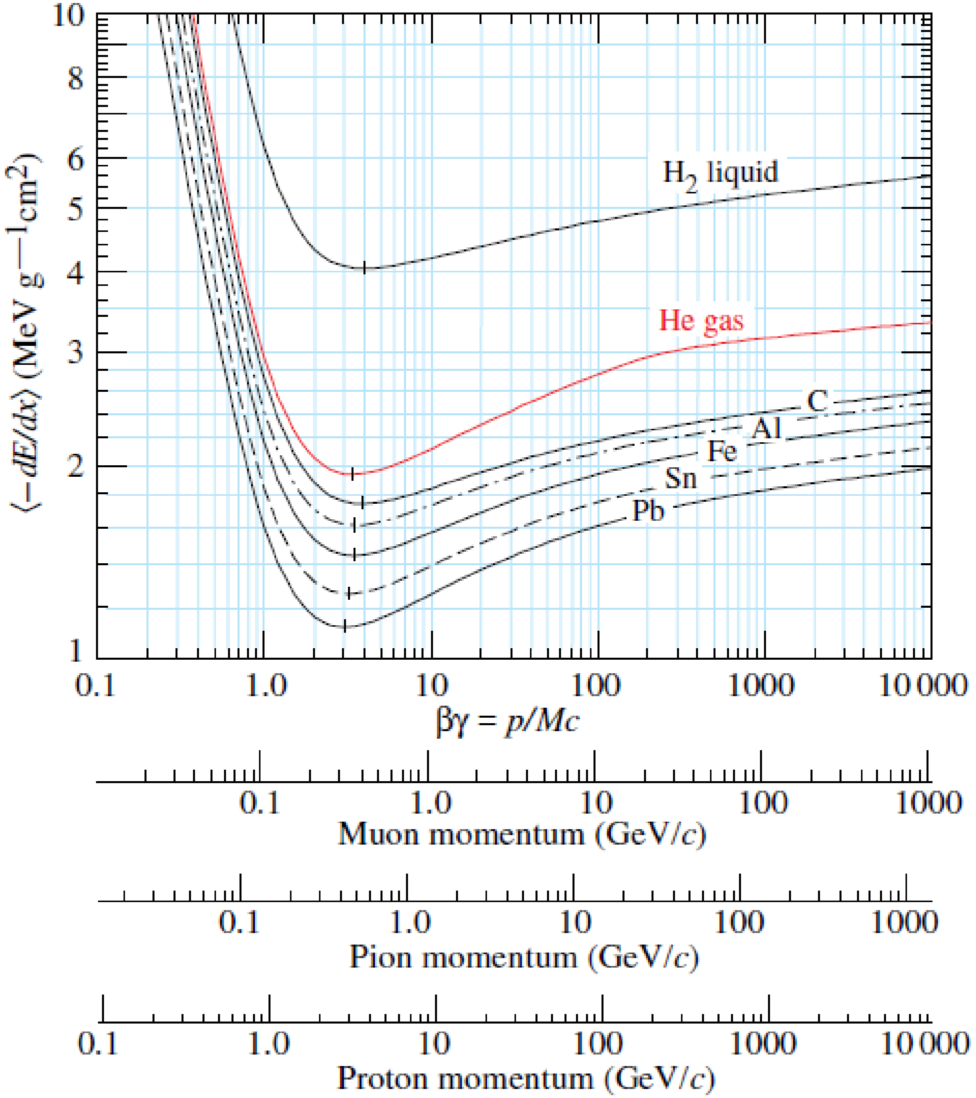
- Make more realistic detector ? Updating data analysis ?

- Digitization ? Garfield ? …

Energy loss (-dE/dx)

http://pdg.lbl.gov/2020/reviews/rpp2020-rev-passage-particles-matter.pdf

$$\left\langle -\frac{dE}{dx}\right\rangle = Kz^2\frac{Z}{A}\frac{1}{\beta^2}\left[\frac{1}{2}\ln\frac{2m_ec^2\beta^2\gamma^2W_{\max}}{I^2} - \beta^2 - \frac{\delta(\beta\gamma)}{2}\right].$$



For, $_{18}$Ar (gas), one of typical gas in chamber,
ρ(density) = 1.662e-3 g/cm^3

-dE/dx ~2 MeV・cm^2/g
➔ loss per unit length 1.3 KeV/cm

$$W_{\max} = \frac{2m_ec^2\,\beta^2\gamma^2}{1 + 2\gamma m_e/M + (m_e/M)^2} \sim 2m_ec^2\,\beta^2\gamma^2$$

(M: incident particle mass)

$$K \quad 4\pi N_A r_e^2 m_e c^2 \qquad 0.307\,075\ \text{MeV mol}^{-1}\ \text{cm}^2$$

Backup

Average energy to produce one ion pair

$$W \langle N_{\mathrm{I}} \rangle = L \left\langle \frac{\mathrm{d}E}{\mathrm{d}x} \right\rangle$$

N_I : average number of ionization electrons created along a trajectory of Length **L**

dE/dx: average total energy loss per unit path length

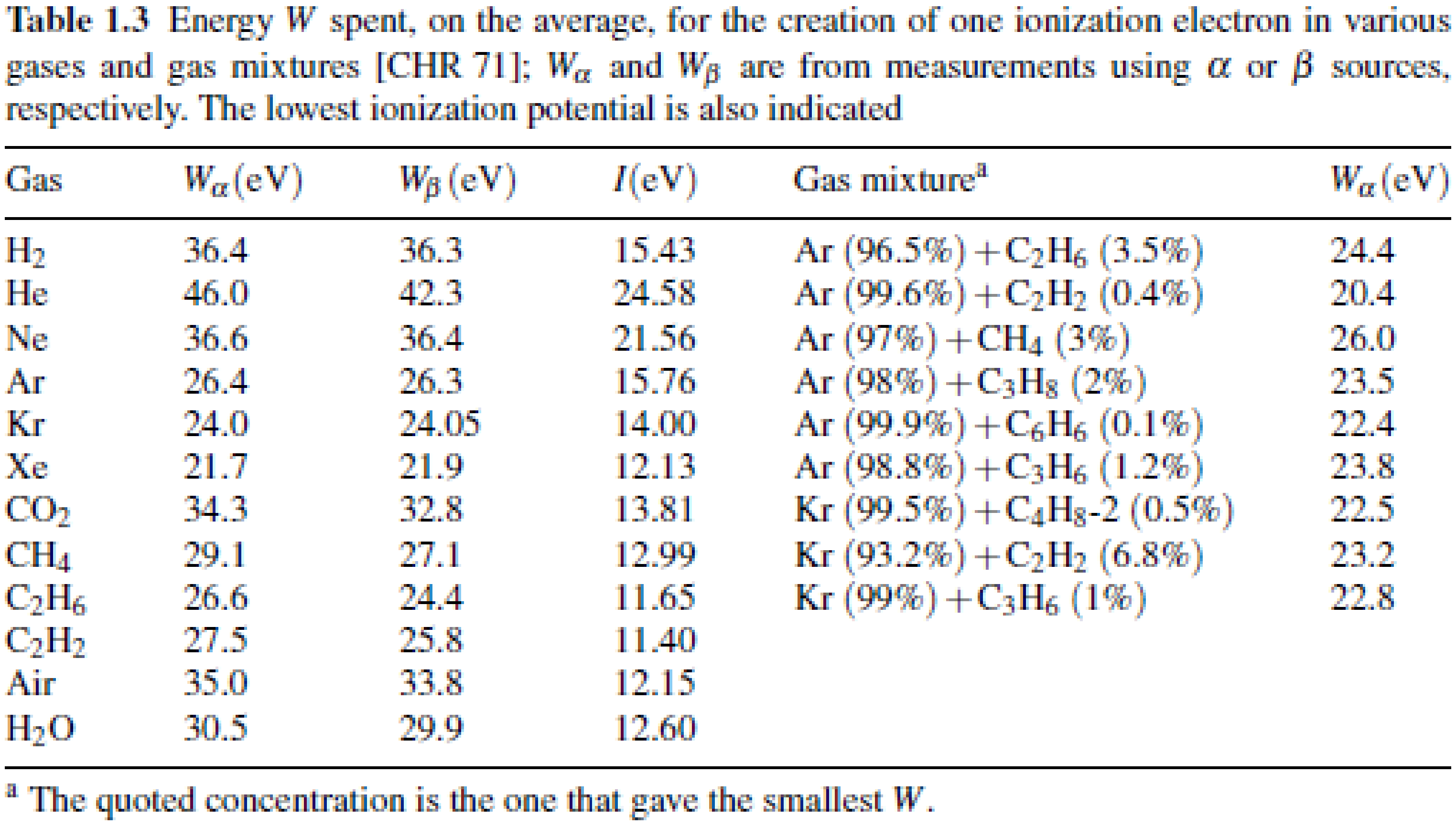


Table 1.3 Energy W spent, on the average, for the creation of one ionization electron in various gases and gas mixtures [CHR 71]; W_α and W_β are from measurements using α or β sources, respectively. The lowest ionization potential is also indicated

Gas	W_α (eV)	W_β (eV)	I(eV)	Gas mixture[a]	W_α (eV)
H_2	36.4	36.3	15.43	Ar (96.5%) + C_2H_6 (3.5%)	24.4
He	46.0	42.3	24.58	Ar (99.6%) + C_2H_2 (0.4%)	20.4
Ne	36.6	36.4	21.56	Ar (97%) + CH_4 (3%)	26.0
Ar	26.4	26.3	15.76	Ar (98%) + C_3H_8 (2%)	23.5
Kr	24.0	24.05	14.00	Ar (99.9%) + C_6H_6 (0.1%)	22.4
Xe	21.7	21.9	12.13	Ar (98.8%) + C_3H_6 (1.2%)	23.8
CO_2	34.3	32.8	13.81	Kr (99.5%) + C_4H_8-2 (0.5%)	22.5
CH_4	29.1	27.1	12.99	Kr (93.2%) + C_2H_2 (6.8%)	23.2
C_2H_6	26.6	24.4	11.65	Kr (99%) + C_3H_6 (1%)	22.8
C_2H_2	27.5	25.8	11.40		
Air	35.0	33.8	12.15		
H_2O	30.5	29.9	12.60		

[a] The quoted concentration is the one that gave the smallest W.

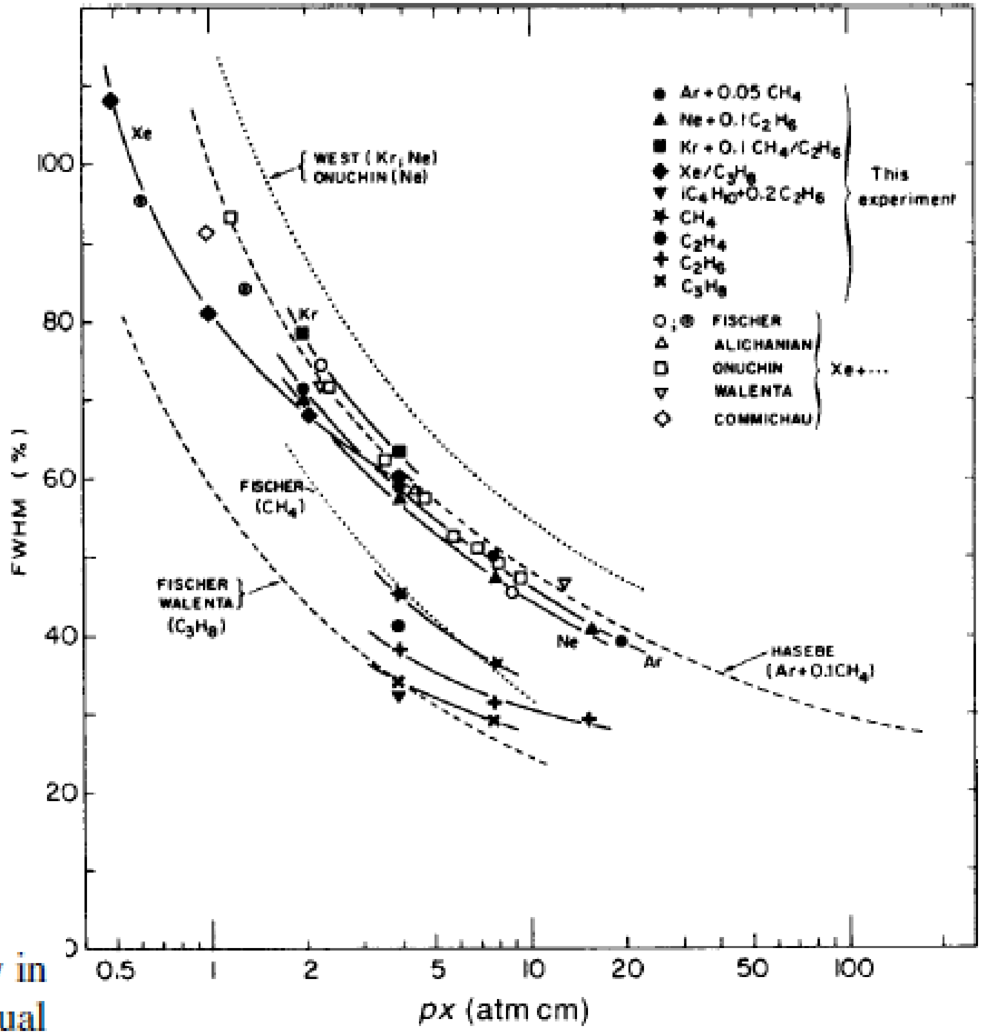
how we could know δI/I ?

The resolution is also depending on gas type and pressure.

$$\frac{\delta I_{\mathrm{mp}}}{I_{\mathrm{mp}}} = 0.115 \left(\frac{1\,\mathrm{mbar}}{Lp}\right)^{0.32} \left(\frac{Z_{\mathrm{Ar}} I}{Z I_{\mathrm{Ar}}}\right)^{0.32} \left(\frac{100}{n}\right)^{0.14} \quad (\mathrm{FWHM}), \qquad (10.12)$$

following remarks are put together …

It should be emphasized that this formula has not yet been tested experimentally in a systematic comparison between different gases. The value of the constant is equal to the value of $0.96(\xi/I)^{0.32}$ for 1 cm of argon.



10.9 Single-gap resolution measured for various gases and pressures [LEH 82b] as a function of the product of pressure p and sample length x