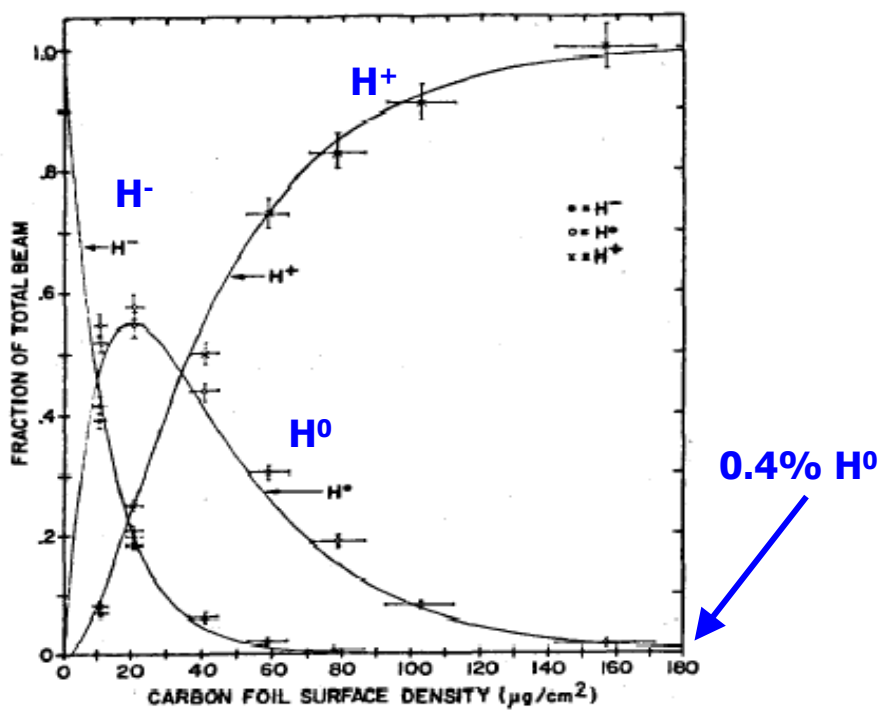
Website for this Mini-Workshop

All talks can be found on:

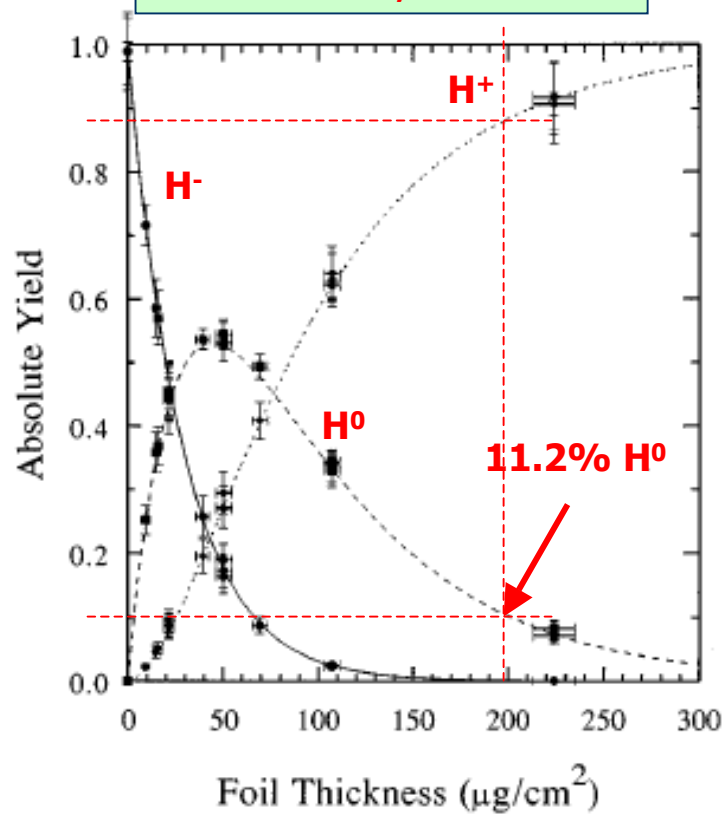
http://www-bd.fnal.gov/pdriver/H-workshop/hminus.html

Carbon Foil Stripping Efficiency – Measurements

Webber & Hojvat, 1979
Fermilab linac, 200 MeV



Gulley et al., 1996
LANL linac, 800 MeV



Measurements of Electron Loss Cross Section

	Webber & Hojvat 200 MeV	Gulley et al. 800 MeV	
$\sigma(-, 0)$	$(1.56 \pm 0.14) \times 10^{-18}$	$(0.676 \pm 0.009) \times 10^{-18}$	cm^2
$\sigma(0, +)$	$(0.60 \pm 0.10) \times 10^{-18}$	$(0.264 \pm 0.005) \times 10^{-18}$	cm^2
$\sigma(-, +)$	$(-0.08 \pm 0.13) \times 10^{-18}$	$(0.012 \pm 0.006) \times 10^{-18}$	cm^2

Scaling of Electron Loss Cross Section – Theories

- Born approximation for single- and double-electron detachment cross section:

$$\sigma(-, 0) + \sigma(-, +) = 8\pi\, a_0^2\, (\alpha^2/\beta^2) \sum_{n\neq 0} \sum_{m} [I_{nm} - J_{nm}(\beta^2) - K_{nm}(\beta^2)]$$

a_0 = Bohr radius
α = fine structure constant
$\beta = v/c$
I_{nm} = collision strength summed over all final states (ion+target atom)
$J_{nm}(\beta^2)$, $K_{nm}(\beta^2)$ = low energy corrections

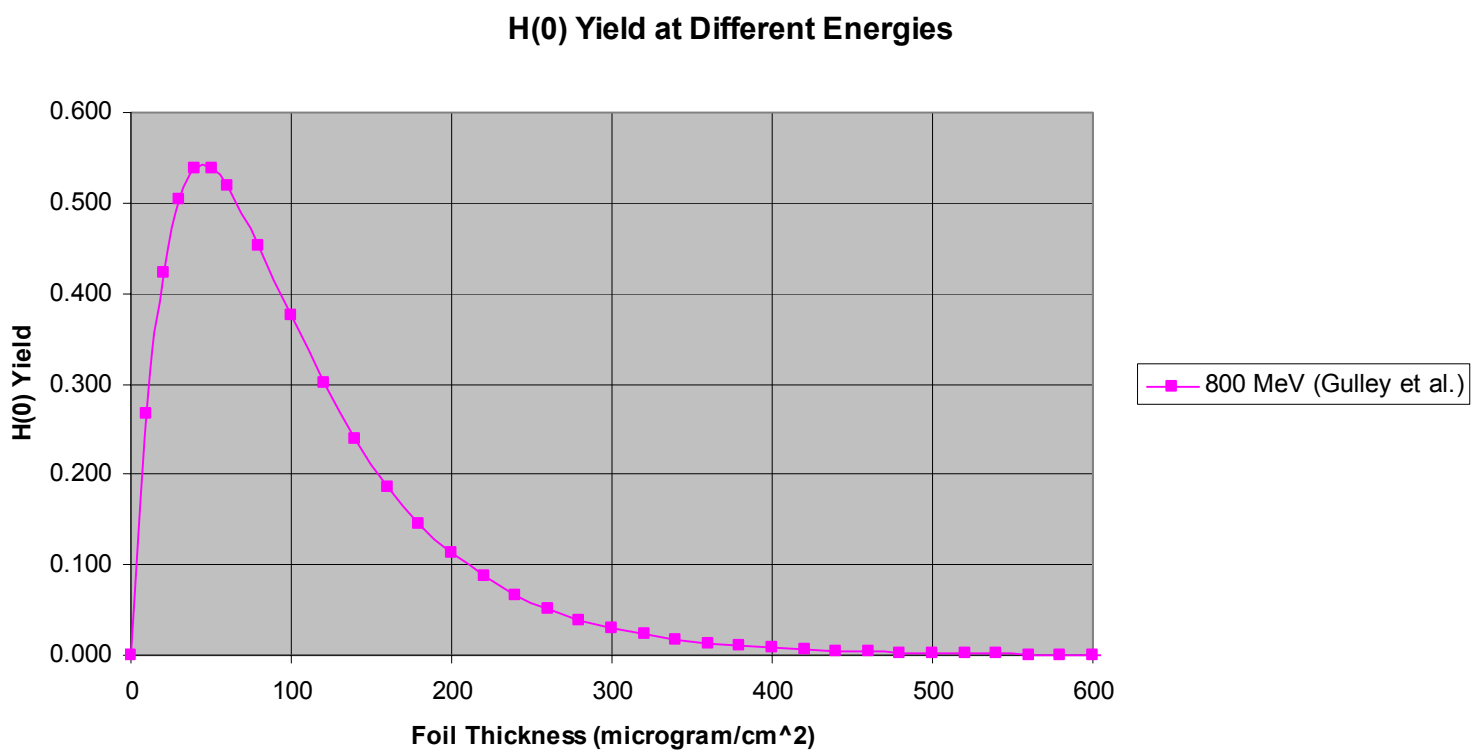
- Theoretical papers:
  - G.H. Gillespie (Feb 1977, Sept 1977, 1984) (use cross section σ)
  - B. Gervais et al. (1996) (use inverse mean free path λ^{-1}, which equals $N\sigma$)
  - P. Kurpick et al. (1998) (ditto)

Scaling of Electron Loss Cross Section – Calculations

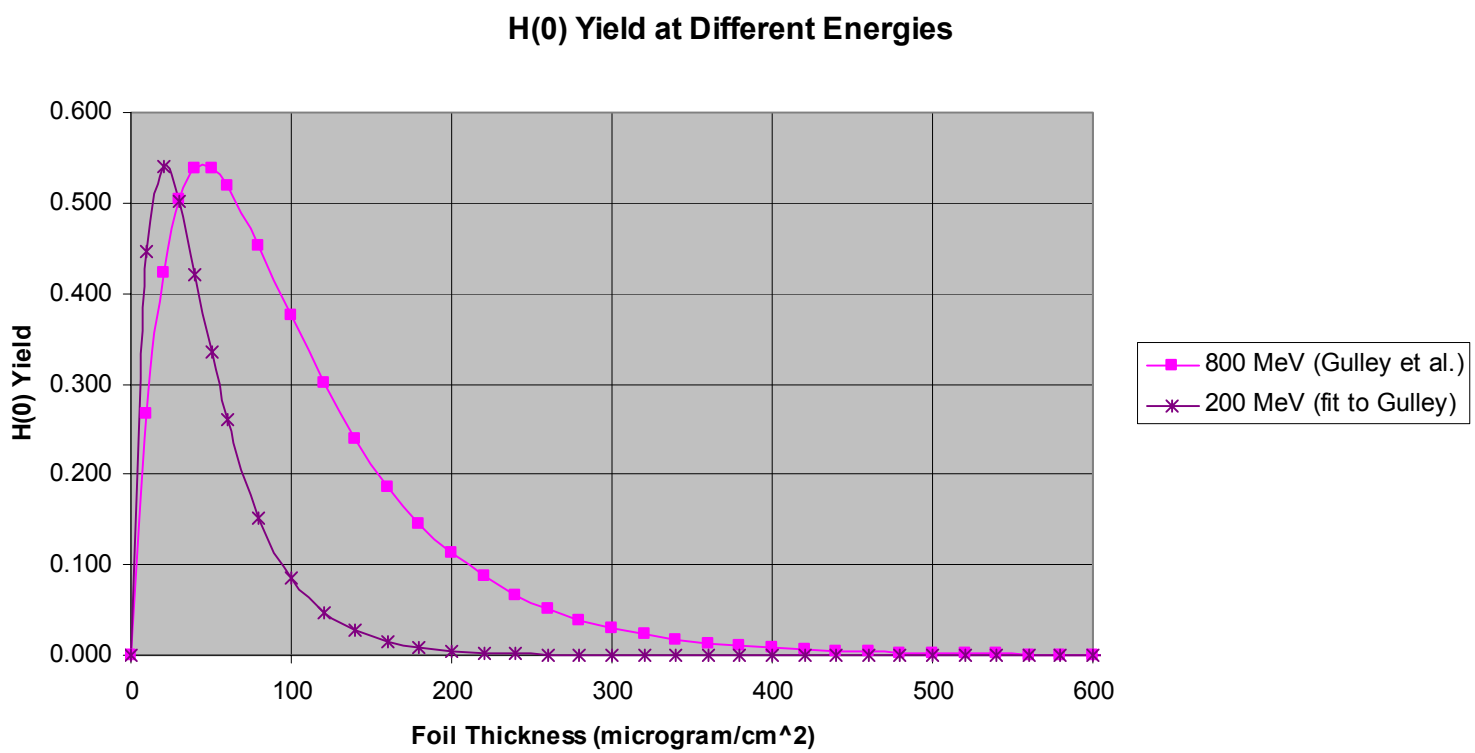
(unit 10^{-18} cm^2)

	800 MeV		200 MeV	400 MeV	8 GeV
		scaling			
σ(–, 0)	0.676±0.009	→	1.49 (1.56±0.14)	0.942	0.484
σ(0, +)	0.264±0.005	→	0.584 (0.60±0.10)	0.368	0.189
σ(–, +)	0.012±0.006	→	0.026 (–0.08 ±0.13)	0.0167	0.0086

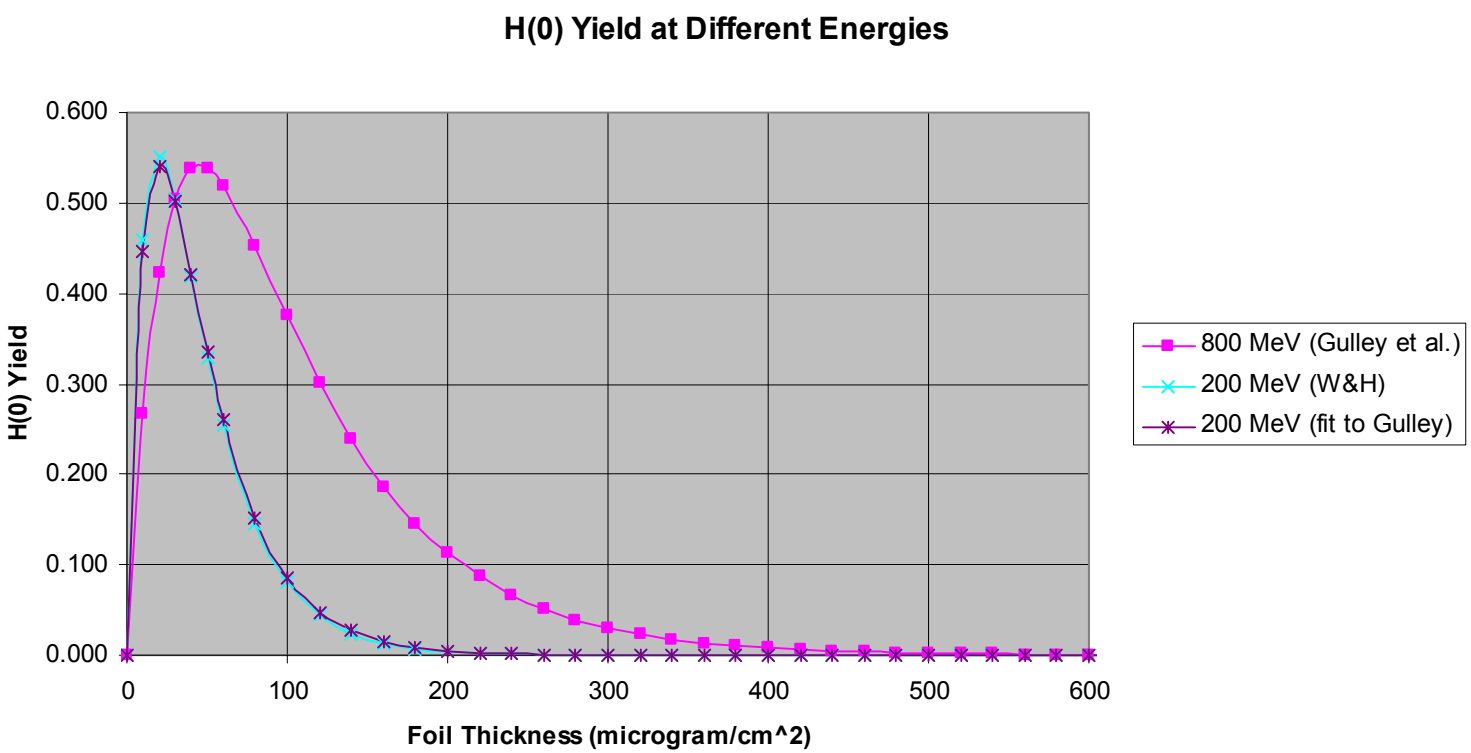
Energy Dependence of H(0) Yield



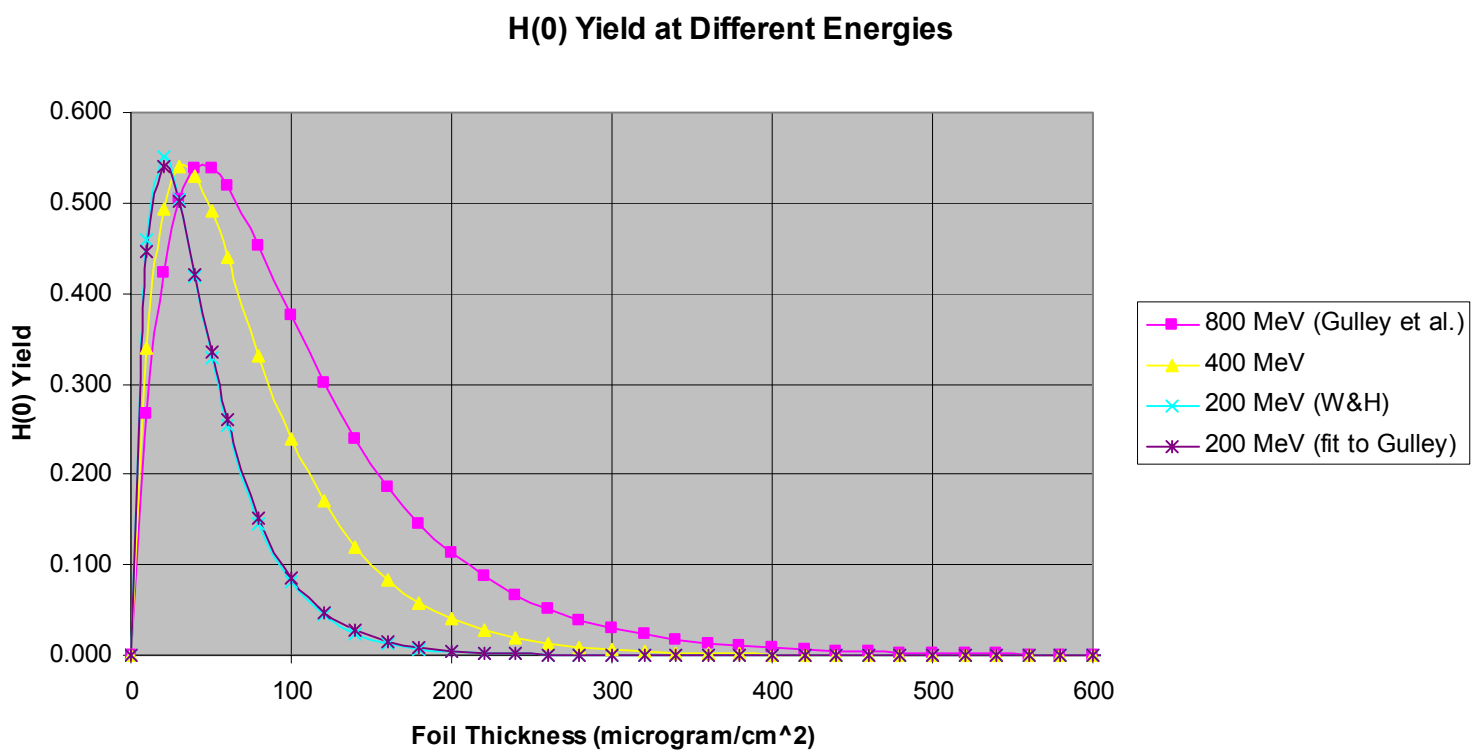
Energy Dependence of H(0) Yield



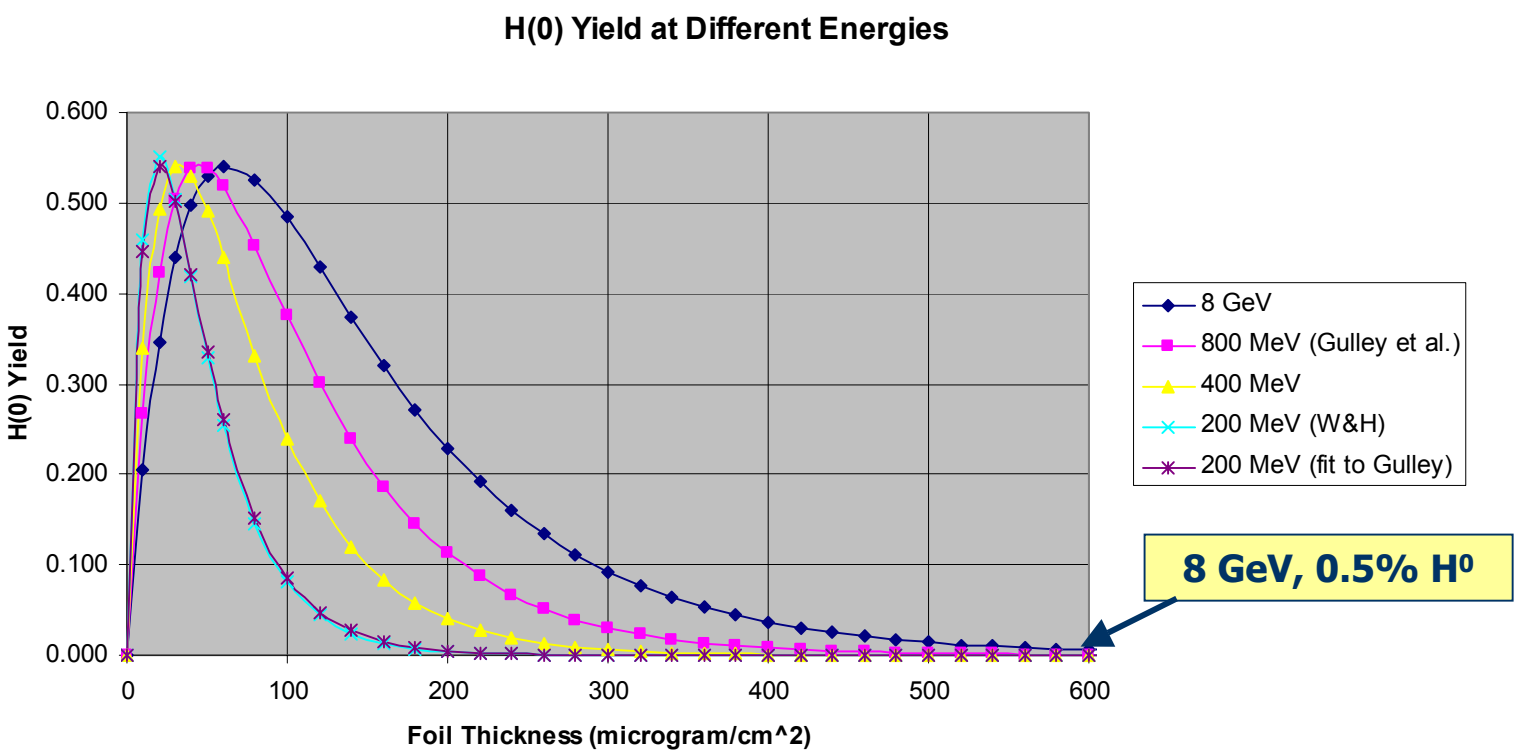
Energy Dependence of H(0) Yield



Energy Dependence of H(0) Yield



Energy Dependence of H(0) Yield



Multiple Coulomb Scattering

Emittance dilution from multiple Coulomb scattering (per hit):

$$\Delta\varepsilon_{\mathrm{rms}} = \frac{1}{2}\hat{\beta}\,\theta_{\mathrm{rms}}^2$$

$$\theta_{\mathrm{rms}} = \frac{15}{\beta\, p(\mathrm{MeV/c})}\sqrt{L/L_{\mathrm{rad}}}$$

p = 8.89 GeV/c

$\hat{\beta}$ = 58 m

L = 600 μg/cm^2

L_{rad} = 42.7 g/cm^2

No. hits = 6

$\Delta\varepsilon_{\mathrm{rms}} = 7 \times 10^{-3}$ mm-mrad

Foil Issues

- Stripping efficiency
- Multiple Coulomb scattering
- Large angle Coulomb scattering
- Energy straggling
- Heating
- Stress and buckling
- Lifetime
- Radiation
- Diamond foil