$$\delta = \Sigma D_{jkl} \theta^i_{fp} y^k_{fp} \phi^l_{fp}$$

$$D_{jkl} = \Sigma C_i^{D_{jkl}} x^i_{fp}$$

- Elas%c run -4%/-2%/0%/ 2%/4%

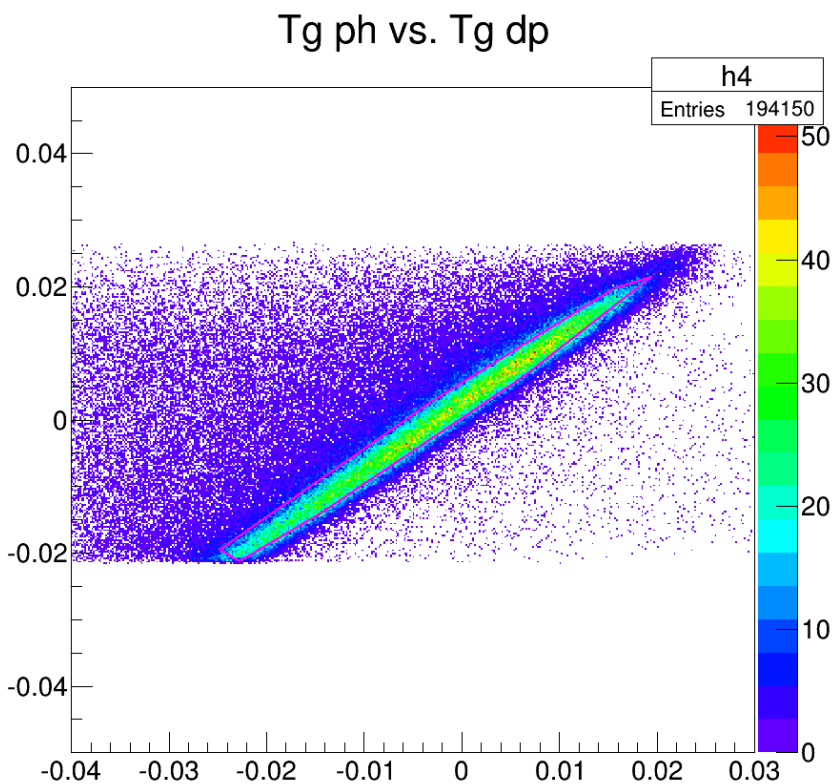
$$dpKin_{set} = \frac{p_{\theta_0} - p_{centeral}}{p_{central}}$$

- $$dpKin = dp - \frac{p_\theta - p_{\theta_0}}{p_{central}}$$

$$\chi^2 = \Sigma \left( dpKin_{set} - dpKin \right)^2$$

- Pass to Root^op%mize

by TMinuit



# Energy Loss

- BB stopping power: ionization energy loss+Density effect correction
- $$\frac{\mathrm{dE}}{dx} \propto ln\frac{m_e\gamma^2(\gamma-1)}{2I^2} - \frac{2\gamma-1}{\gamma^2}\ln 2 + \frac{1}{8}(1-\gamma)^2 + \delta$$
- Density effect correction $$\begin{cases} 2lgx - C & x > x_1 \\ 2lgx - C + a(x_1 - x)^k & x \in (x_0, x_1) \\ 0\ or\ \ \delta_0 10^{2(x-x_0)} & x < x_0 \end{cases}$$
- $x = lg\frac{p}{m}$
- R.M Sternheimer

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TABLE I. Density Effect Parameters for Elemental Substances

See page 266 for Explanation of Tables

| Material | Z | Z/A | I (ev) | Density, $\rho_0$ (g/cm$^3$) | $h\nu_p$ (eV) | $\rho$ | $-C$ | $X_0$ | $X_1$ | a | m | $\delta_0$ | $\Delta_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HYDROGEN | 1 | 0.99216 | 19.2 | 8.3748E-05 | 0.263 | 1.412 | 9.5835 | 1.8639 | 3.2718 | 0.14092 | 5.7273 | 0.0 | 0.024 |
| HYDROGEN, LIQUID | 1 | 0.99216 | 21.8 | 6.0000E-02 | 7.031 | 1.546 | 3.2632 | 0.4759 | 1.9215 | 0.13483 | 5.6249 | 0.0 | 0.021 |
| HELIUM | 2 | 0.49967 | 41.8 | 1.6632E-04 | 0.263 | 1.700 | 11.1393 | 2.2017 | 3.6122 | 0.13443 | 5.8347 | 0.0 | 0.024 |
| LITHIUM | 3 | 0.43221 | 40.0 | 5.3400E-01 | 13.844 | 1.535 | 3.1221 | 0.1304 | 1.6397 | 0.95136 | 2.4993 | 0.14 | 0.062 |
| BERYLLIUM | 4 | 0.44384 | 63.7 | 1.8480E+00 | 26.098 | 1.908 | 2.7847 | 0.0592 | 1.6922 | 0.80392 | 2.4339 | 0.14 | 0.029 |
| BORON | 5 | 0.46254 | 76.0 | 2.3700E+00 | 30.170 | 2.320 | 2.8477 | 0.0305 | 1.9688 | 0.56224 | 2.4512 | 0.14 | 0.024 |
| CARBON (GRAPHITE, DENS 2.265) | 6 | 0.49954 | 78.0 | 2.2650E+00 | 30.652 | 2.290 | 2.8680 | -0.0178 | 2.3415 | 0.26142 | 2.8697 | 0.12 | 0.038 |
| CARBON (GRAPHITE, DENS 2.0) | 6 | 0.49954 | 78.0 | 2.0000E+00 | 28.803 | 2.376 | 2.9925 | -0.0351 | 2.4860 | 0.20240 | 3.0036 | 0.10 | 0.038 |
| CARBON (GRAPHITE, DENS 1.7) | 6 | 0.49954 | 78.0 | 1.7000E+00 | 26.555 | 2.490 | 3.1550 | 0.0480 | 2.5387 | 0.20762 | 2.9532 | 0.14 | 0.038 |
| NITROGEN | 7 | 0.49976 | 82.0 | 1.1653E-03 | 0.695 | 1.984 | 10.5400 | 1.7378 | 4.1323 | 0.15349 | 3.2125 | 0.0 | 0.086 |
| OXYGEN | 8 | 0.50002 | 95.0 | 1.3315E-03 | 0.744 | 2.314 | 10.7004 | 1.7541 | 4.3213 | 0.11778 | 3.2913 | 0.0 | 0.101 |
| FLUORINE | 9 | 0.47372 | 115.0 | 1.5803E-03 | 0.788 | 2.450 | 10.9653 | 1.8433 | 4.4096 | 0.11083 | 3.2962 | 0.0 | 0.121 |
| NEON | 10 | 0.49556 | 137.0 | 8.3851E-04 | 0.587 | 2.577 | 11.9041 | 2.0735 | 4.6421 | 0.08064 | 3.5771 | 0.0 | 0.110 |
| SODIUM | 11 | 0.47847 | 149.0 | 9.7100E-01 | 19.641 | 2.648 | 5.0526 | 0.2880 | 3.1962 | 0.07772 | 3.6452 | 0.08 | 0.098 |
| MAGNESIUM | 12 | 0.49373 | 156.0 | 1.7400E+00 | 26.708 | 2.331 | 4.5297 | 0.1499 | 3.0668 | 0.08163 | 3.6166 | 0.08 | 0.073 |
| ALUMINUM | 13 | 0.48181 | 166.0 | 2.6989E+00 | 32.860 | 2.180 | 4.2395 | 0.1708 | 3.0127 | 0.08024 | 3.6345 | 0.12 | 0.061 |
| SILICON | 14 | 0.49848 | 173.0 | 2.3300E+00 | 31.055 | 2.103 | 4.4351 | 0.2014 | 2.8715 | 0.14921 | 3.2546 | 0.14 | 0.059 |
| PHOSPHORUS | 15 | 0.48428 | 173.0 | 2.2000E+00 | 29.743 | 2.056 | 4.5214 | 0.1696 | 2.7815 | 0.23610 | 2.9158 | 0.14 | 0.057 |
| SULFUR | 16 | 0.49906 | 180.0 | 2.0000E+00 | 28.789 | 2.131 | 4.6659 | 0.1580 | 2.7159 | 0.33992 | 2.6456 | 0.14 | 0.059 |
| CHLORINE | 17 | 0.47951 | 174.0 | 2.9947E-03 | 1.092 | 1.734 | 11.1421 | 1.5555 | 4.2994 | 0.19849 | 2.9702 | 0.0 | 0.041 |
| ARGON | 18 | 0.45059 | 188.0 | 1.6620E-03 | 0.789 | 1.753 | 11.9480 | 1.7635 | 4.4855 | 0.19714 | 2.9618 | 0.0 | 0.037 |

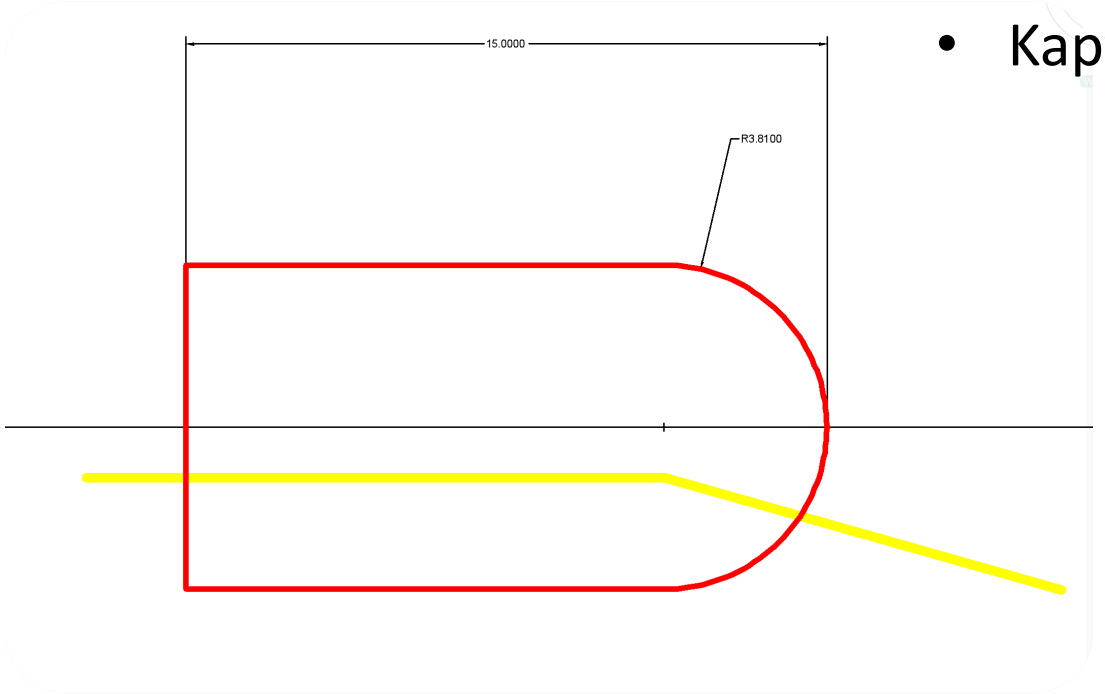
# Energy Loss

**Before Scattering**

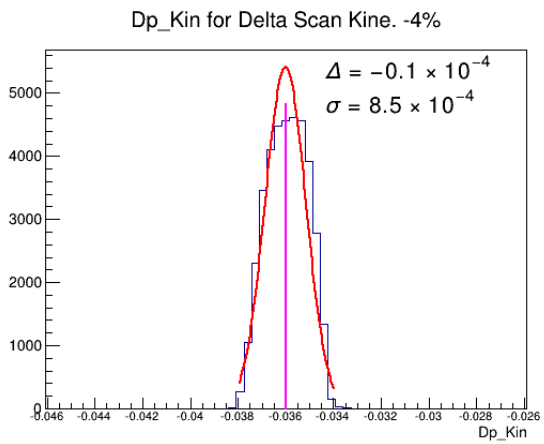
- Target entrance window
- LH2

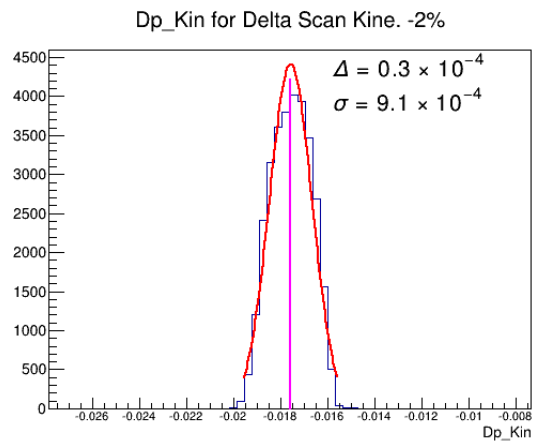
**After Scattering**

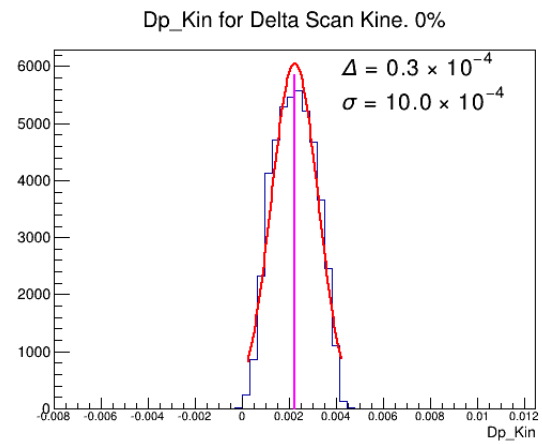
- LH2
- Target cell
- Air form target to HRS
- Kapton

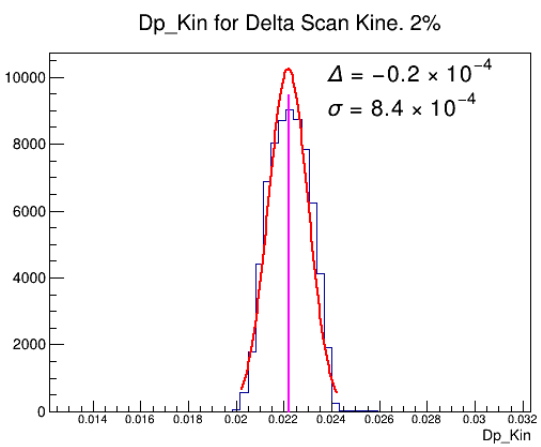


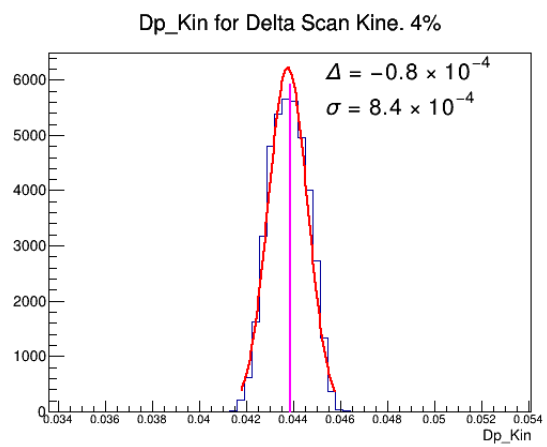

$$E_{loss} = \frac{E_{before}}{\eta} + E_{after}$$



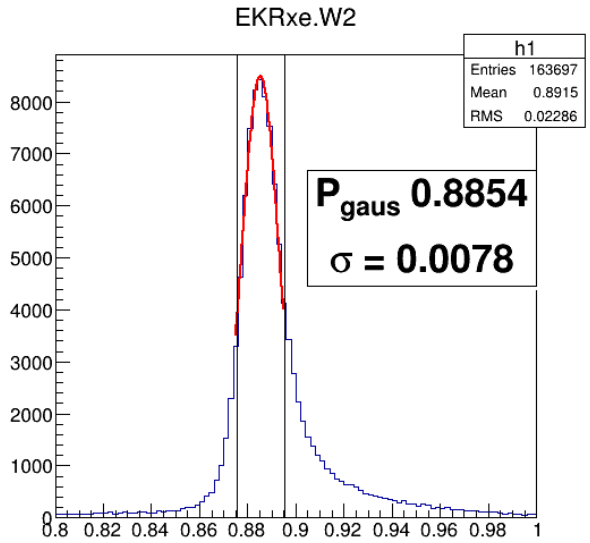




$$\mathbf{DpKin_{Real}} = \frac{\mathbf{P_{\theta_{HRS}} - P_{Central}}}{\mathbf{P_{Central}}}$$

$$\mathbf{DpKin = dp - \frac{(P_{\theta} - P_{Loss}) - P_{\theta_{HRS}}}{P_{Central}}}$$

$$\mathbf{DpKin - DpKin_{Real} = dp - \frac{(P_{\theta} - P_{Loss}) - P_{Central}}{P_{Central}}}$$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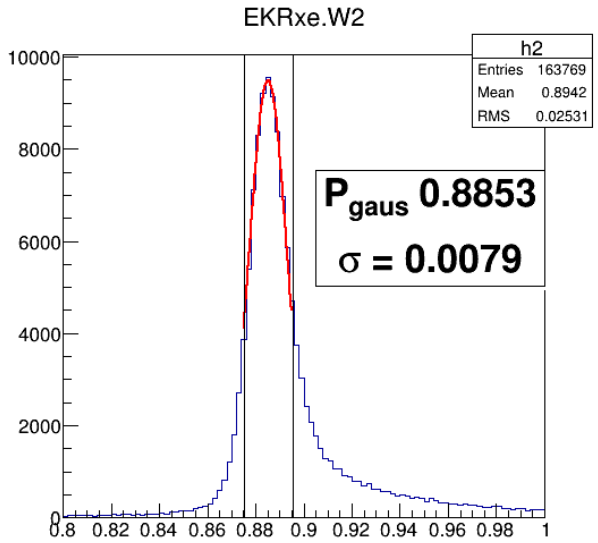
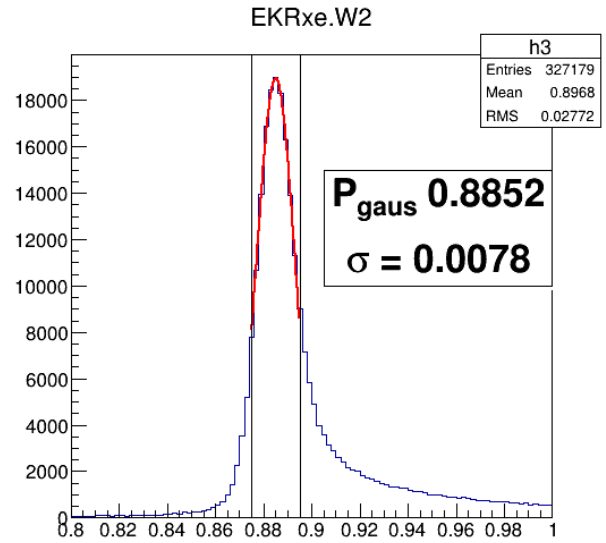
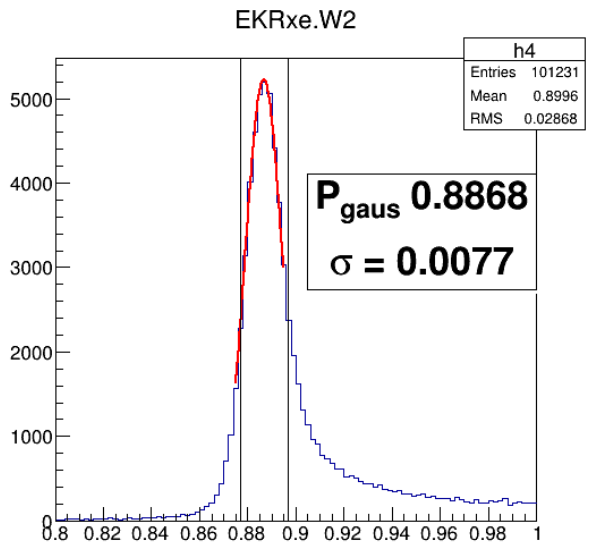
h1
Entries 163697
Mean 0.8915
RMS 0.02286
$P_{gaus}$ 0.8854
$\sigma$ = 0.0078


EKRxe.W2
h2
Entries 163769
Mean 0.8942
RMS 0.02531
$P_{gaus}$ 0.8853
$\sigma$ = 0.0079


EKRxe.W2
h3
Entries 327179
Mean 0.8968
RMS 0.02772
$P_{gaus}$ 0.8852
$\sigma$ = 0.0078


EKRxe.W2
h4
Entries 101231
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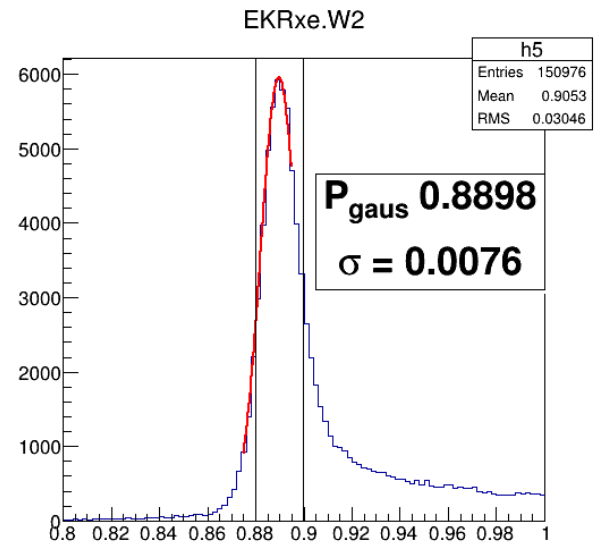
RMS 0.02868
$P_{gaus}$ 0.8868
$\sigma$ = 0.0077


EKRxe.W2
h5
Entries 150976
Mean 0.9053
RMS 0.03046
$P_{gaus}$ 0.8898
$\sigma$ = 0.0076