**Multidimensional hadron attenuation**

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- **Protons behave very differently from the other hadrons**
- **Semiconductor hadron electroproduction process**
  \[ e + N \rightarrow e' + h + X \]
- **Nuclear targets** $^2$D$_{10}$ Ne, $^{84}$Kr
- **Good momentum resolution** ($\Delta p/p < 2\%$)
- **Excellent particle identification capabilities**

### Figure 1: HERMES spectrometer

- **Particle Tracking System**
- **Particle Identification System**

### Figure 2: Momentum dependence of the Cherenkov angle for different hadron types and radiators.**

- **Charge separated** for $\pi$, $K$, and $p$
- **Separation of $\pi$, $K$, and $p$ in momentum range of $2 - 15$ GeV**

### Figure 3: Diagram of semi-inclusive deep inelastic scattering.

\[ R^h(x, Q^2, \nu, \nu') \rightarrow \frac{N^h(x, Q^2, \nu, \nu')}{N^h(x, Q^2, \nu, \nu')} \]  \hspace{1cm} (1)

- **$N^h(x, Q^2, \nu, \nu')$** - number of semi-inclusive hadrons in a given $(\nu, Q^2, \nu, \nu')$ bin
- **$N^h(x, Q^2, \nu, \nu')$** - number of inclusive deep inelastic scattered leptons in the same $(\nu, Q^2)$ bin
- **$\nu = E - E'$** - energy of a virtual photon
- **$Q^2 = -q^2 = -(k - k')^2$** - negative squared four momentum transfer
- **$p_T^2$** - transverse momentum square of a hadron
- **$x = \frac{Q^2}{2E\nu}$** - energy fraction of a hadron

### Figure 4: Dependence of $R^h$ on $\nu$ for positively charged hadrons for three slices in $z$.

### Figure 5: Dependence of $R^h$ on $\nu$ for negatively charged hadrons for three slices in $z$.

### Figure 6: Dependence of $R^h$ on $p_T$ for positively charged hadrons for three slices in $z$.

- **Cronin effect suppressed for large $z$**
- **Less attenuation with larger $\nu$ and small $z$**

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* arXiv:1107.3496