Hadron Attenuation in Nuclei

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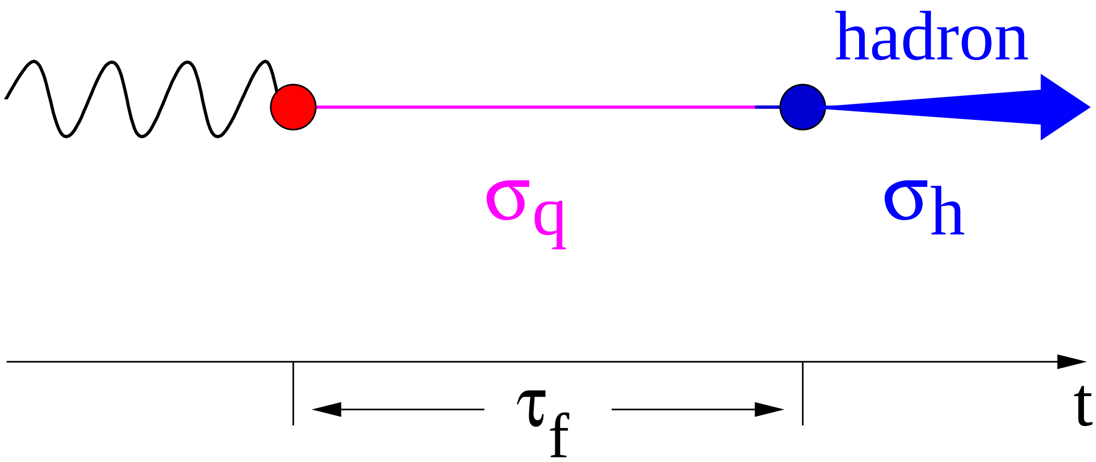
on behalf of the
hermes **Collaboration**

Models of Hadron Formation



Simple models argue -

- Formation time:

$$\tau_f \sim \tau_h\left(\frac{zv}{m_h}\right) \qquad \tau_f \sim \tau_q\left(\frac{v}{m_q}\right)$$

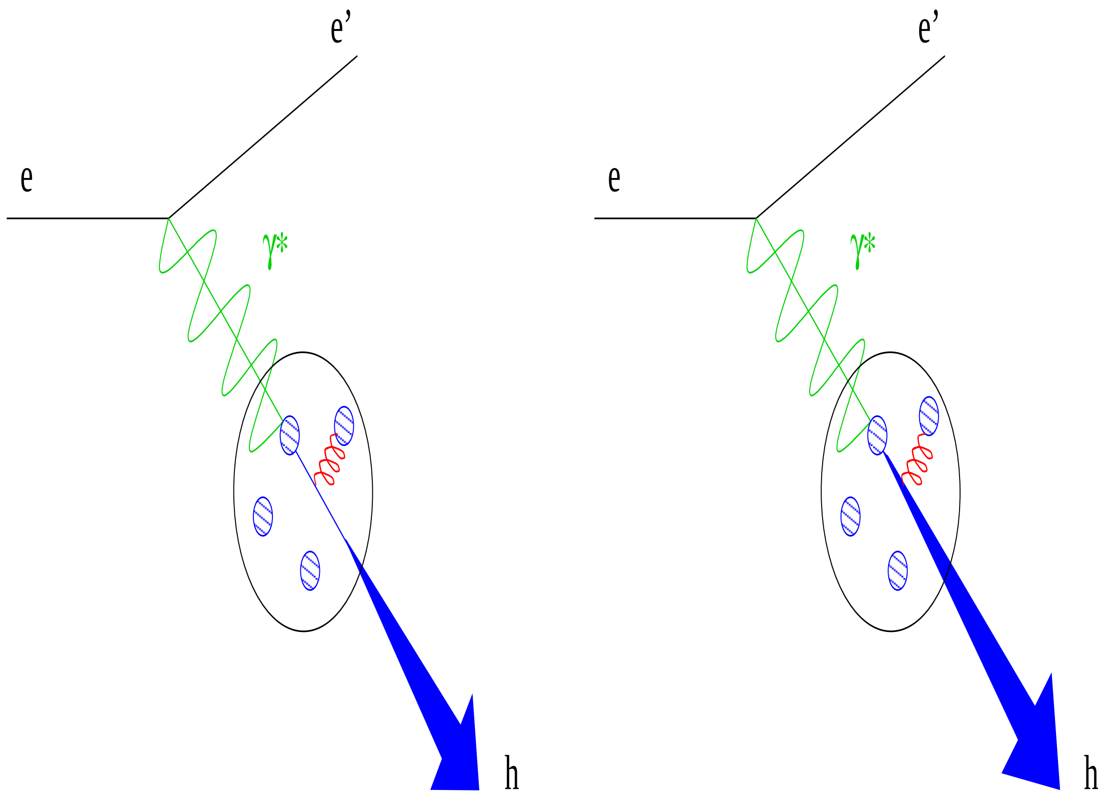
- Cross Sections:

$$\sigma_{q\mathrm{N}} << \sigma_{\mathrm{NN}}$$

$$\sigma_{\pi\mathrm{N}} \sim 10\mathrm{mb}$$

$$\sigma_{\mathrm{NN}} \sim 20\mathrm{mb}$$

How to study the hadron formation time

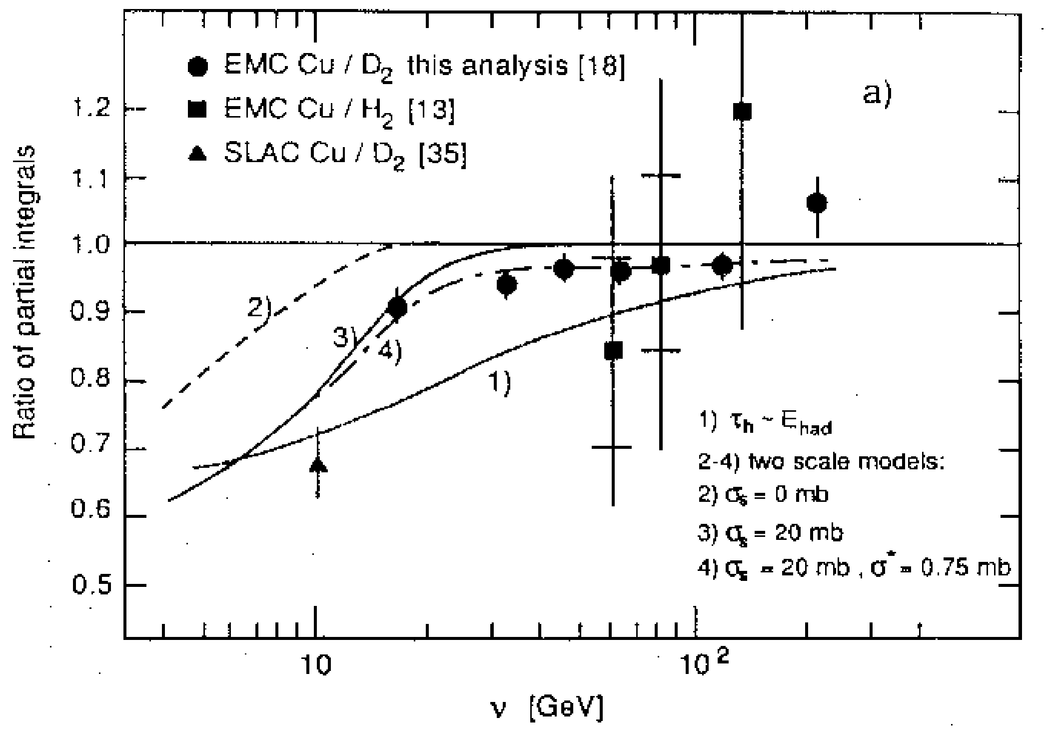


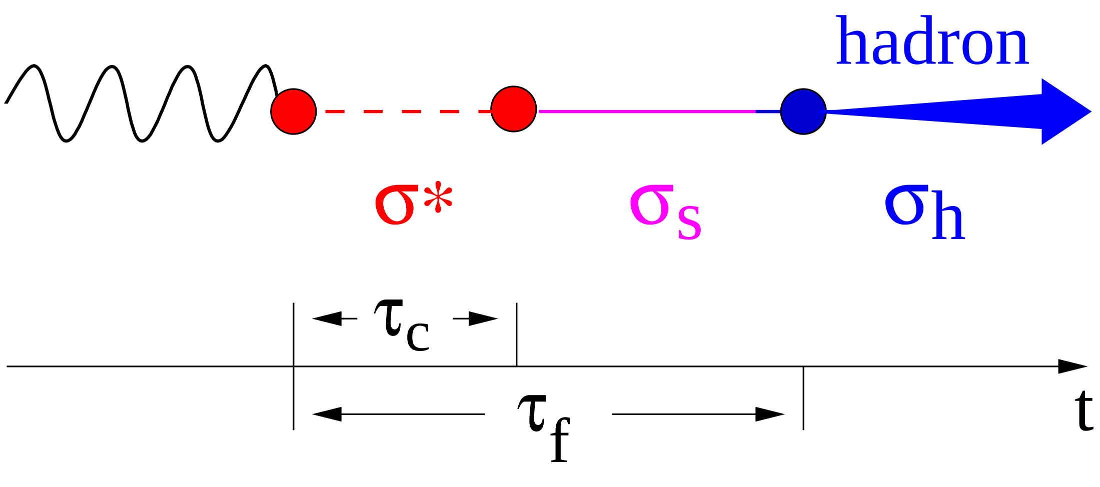
Study the formation time via nuclear dependence of attenuation ratio ...

$$R_A^h = \frac{\left(\frac{1}{N_e} \cdot \frac{d\sigma(eN \rightarrow e'hX)}{d\nu dz}\right)_A}{\left(\frac{1}{N_e} \cdot \frac{d\sigma(eN \rightarrow e'hX)}{d\nu dz}\right)_D}$$

with $Q^2 > 1.0$ GeV/c and $x > 0.04$.

Existing data → two time-scale models

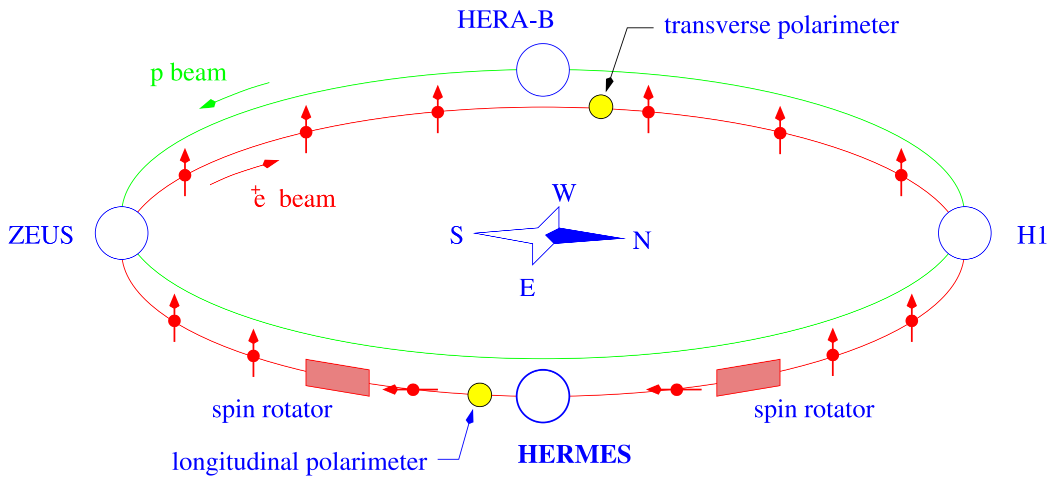




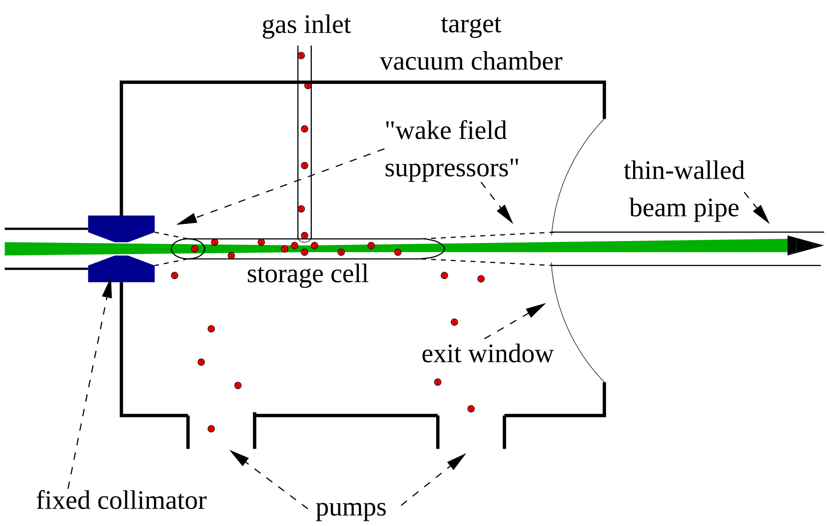
$$\tau_f - \tau_c = \frac{z\nu}{\kappa}$$

HERMES: $4 < \nu < 24$ GeV ... $\tau_f \sim {}^{14}$N radius

The HERMES experiment

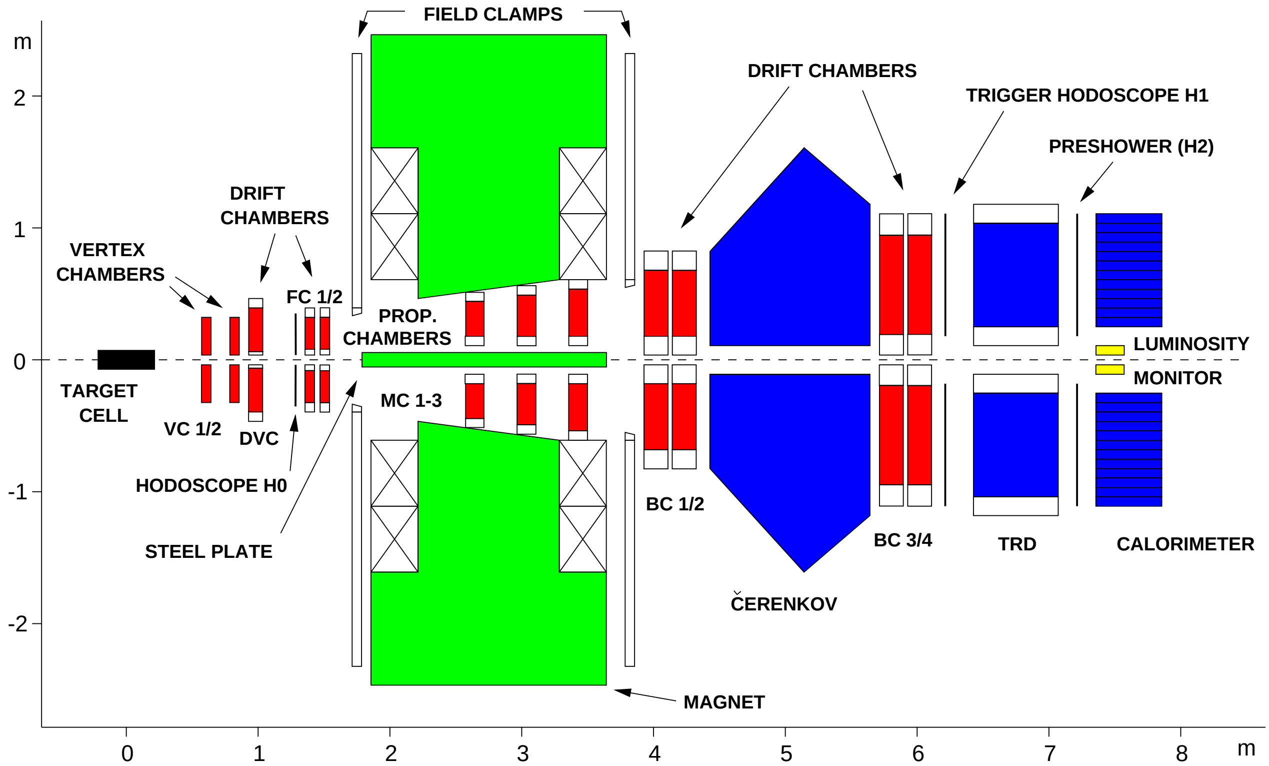


The HERMES experiment at HERA/DESY



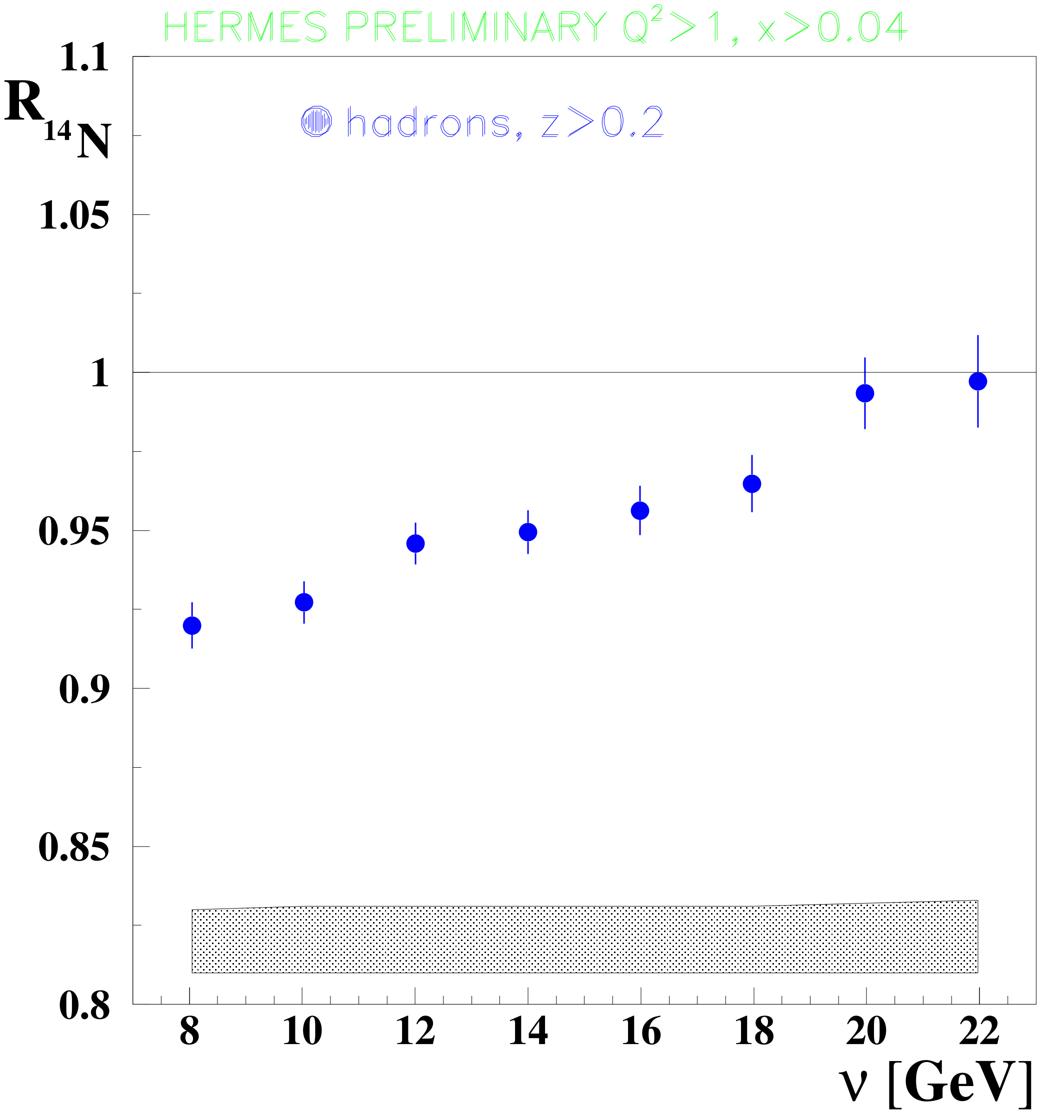
The HERMES target region

The HERMES spectrometer



- momentum resolution $\sim 1\%$ from 1 to 27 GeV
- hadron/lepton contamination $\ll 1\%$
- π id from 4 to 13.5 GeV by threshold Čerenkov

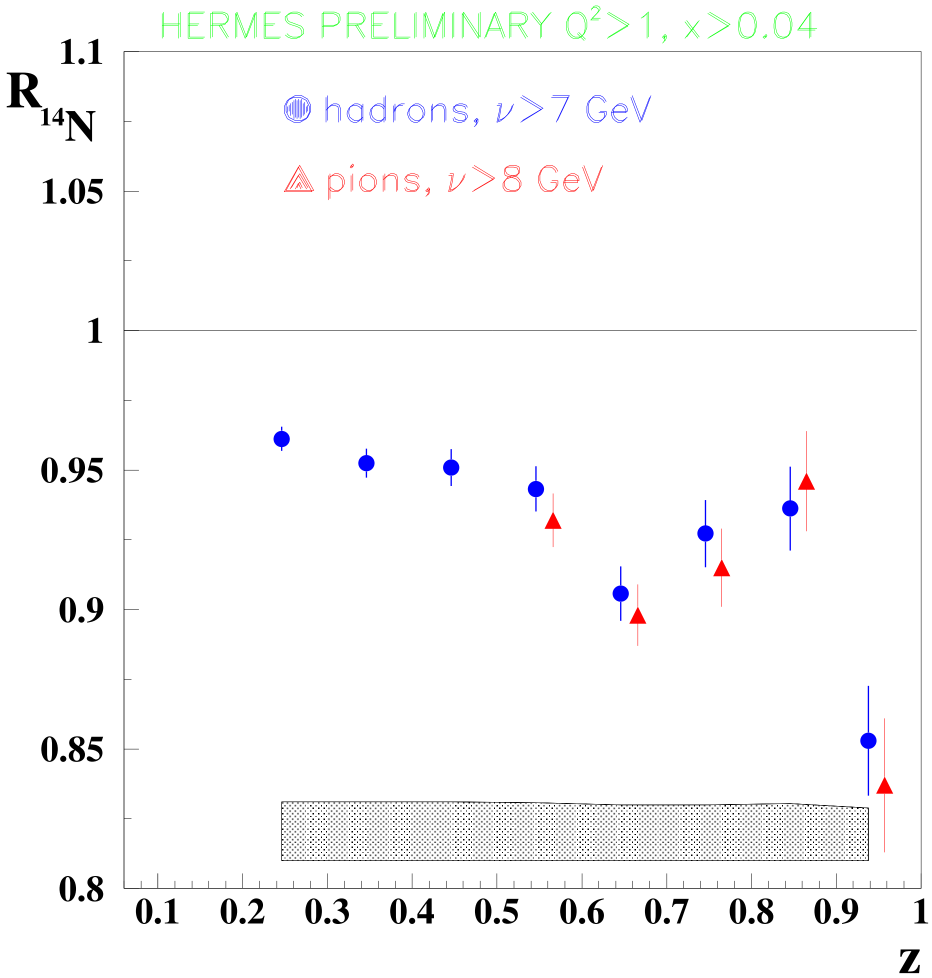
ν dependence of the hadron attenuation



$$\tau_f \sim \tau_h \frac{zv}{m_h} \quad \text{OR} \quad \tau_f \sim \tau_q \frac{v}{m_q}$$

- ν dependence consistent with expectation

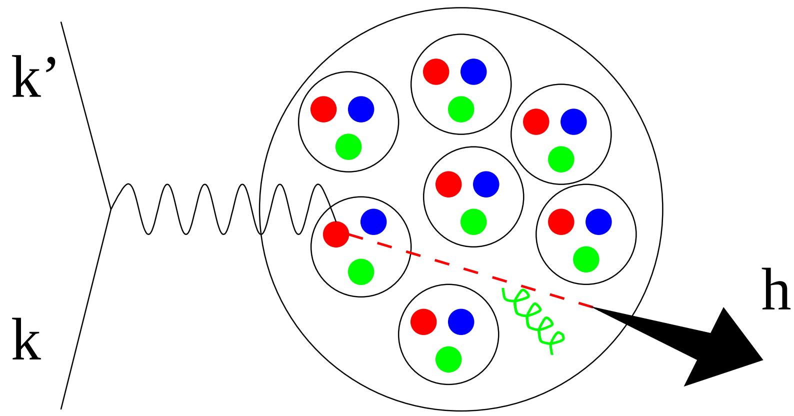
z dependence of the hadron attenuation



$$\tau_f \sim \tau_h \frac{zv}{m_h} \quad \text{OR} \quad \tau_f \sim \tau_q \frac{v}{m_q}$$

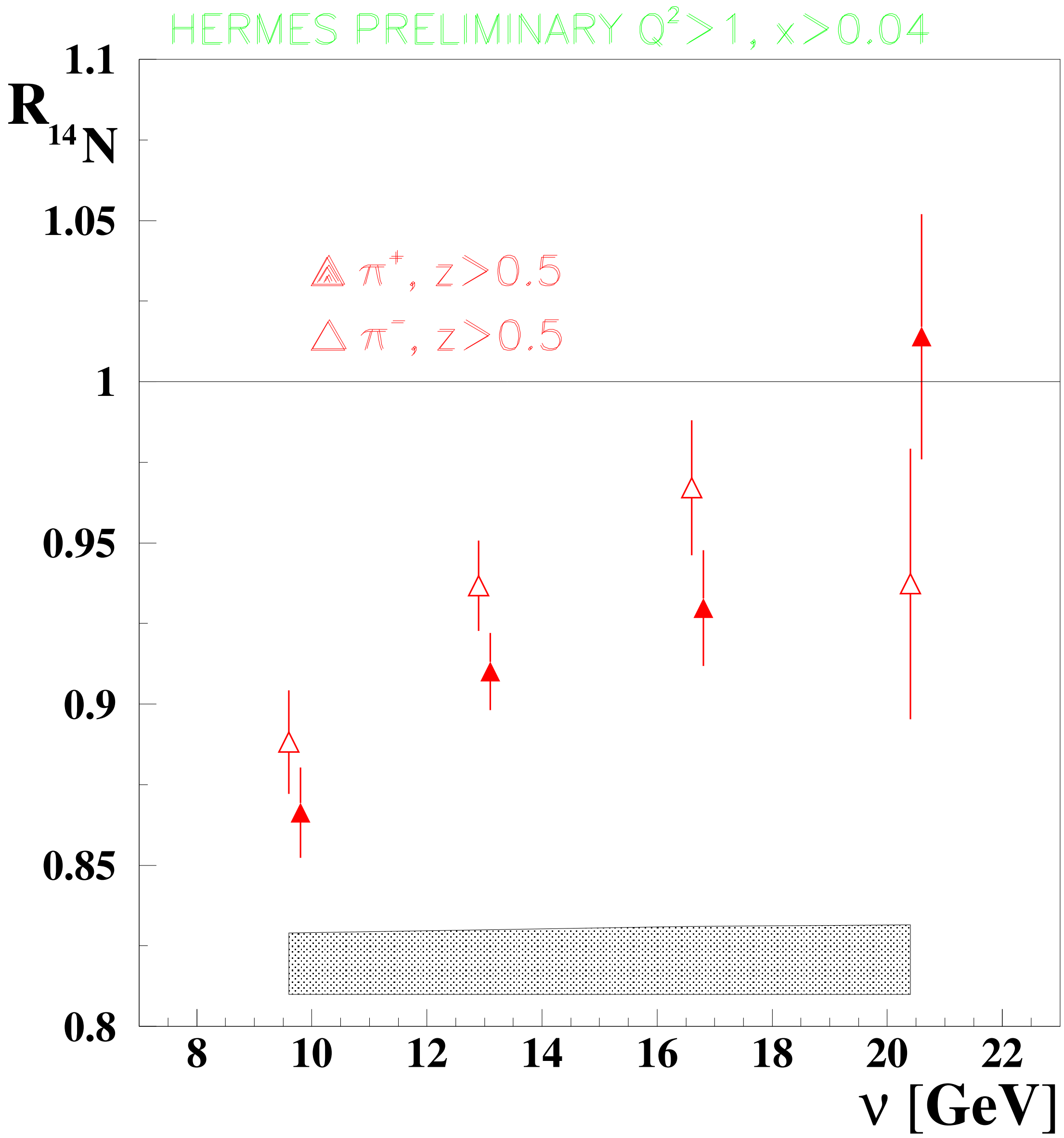
- z dependence is opposite of simple model
- but can be explained via gluon bremsstrahlung

Gluon bremsstrahlung model



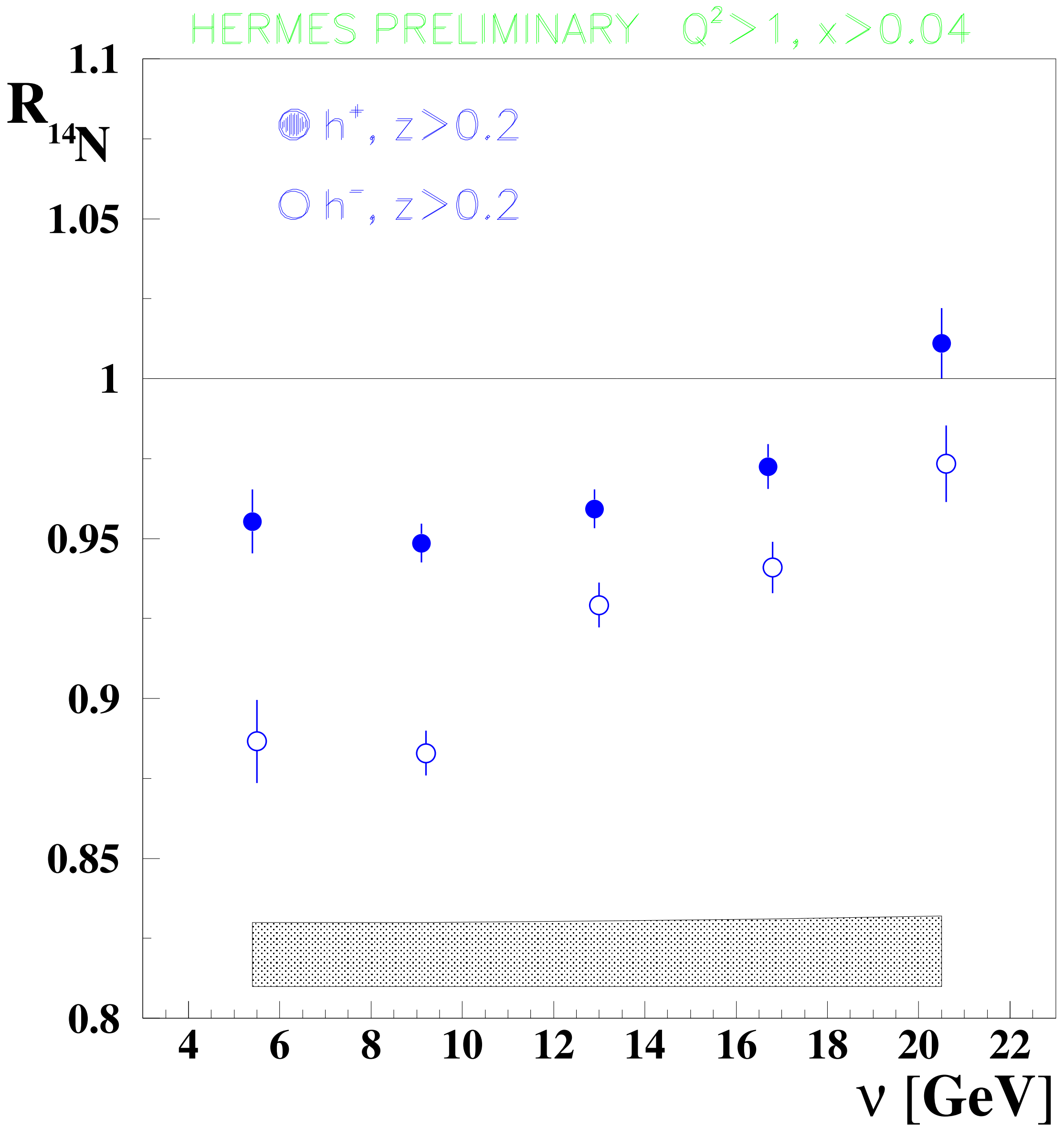
- at $z \sim 1$, hadron must retain energy of the quark
- the greater number of nucleons increases probability of gluon radiation
- so, high z hadron are more attenuated in larger nuclei

ν dependence of the $\pi+/\pi-$ attenuation



- no charge dependence observed
- ν dependence consistent with expectation

ν dependence of the h+/h- attenuation



- h+ sample has many more p than the h- has $\bar{\mathrm{p}}$
- dependence on mass is opposite to expected $\frac{1}{m_h}$

Conclusion/Outlook

- Observed non-trivial z dependence
- Observed "baryon/meson" dependence of τ_f
- Study nuclear (^{84}Kr,^{20}Ne,^{4}He) dependence
- Isolate different particles with RICH