Overview:

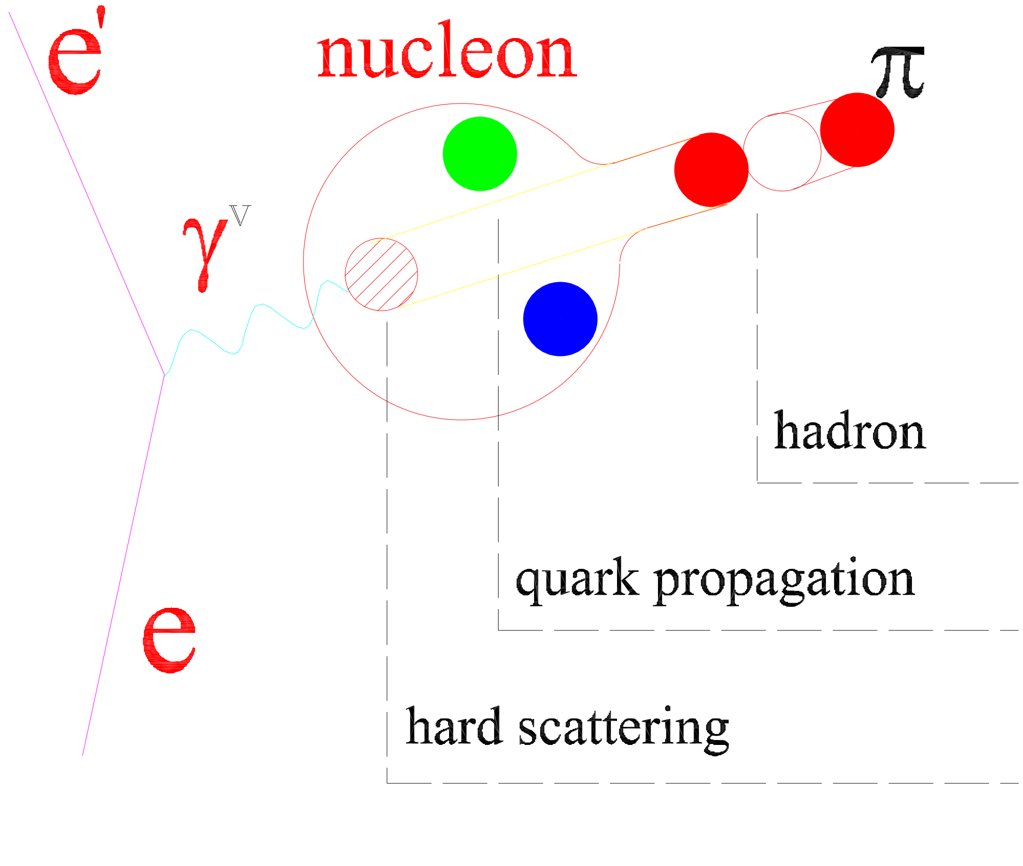
Studying hadronization by A$(e,e'[\pi,K])$X, on ^{2}D, ^{12}C, ^{64}Cu, and ^{184}W.

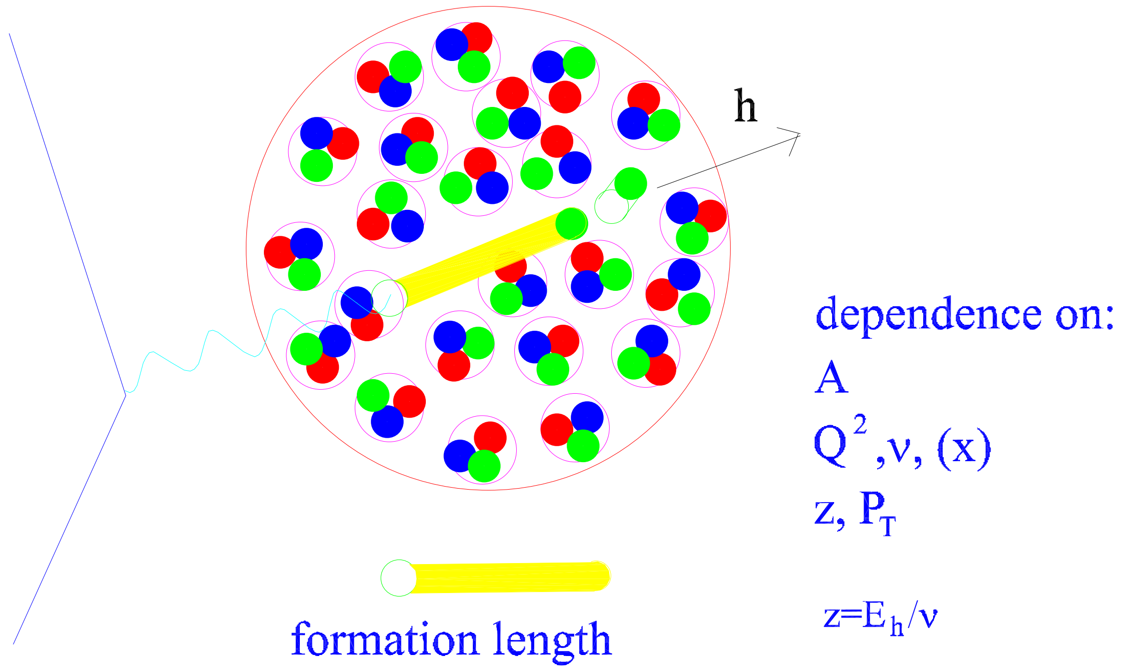
Quark/hadron propagation
$\longrightarrow$ hadronization $\longrightarrow$ confinement;

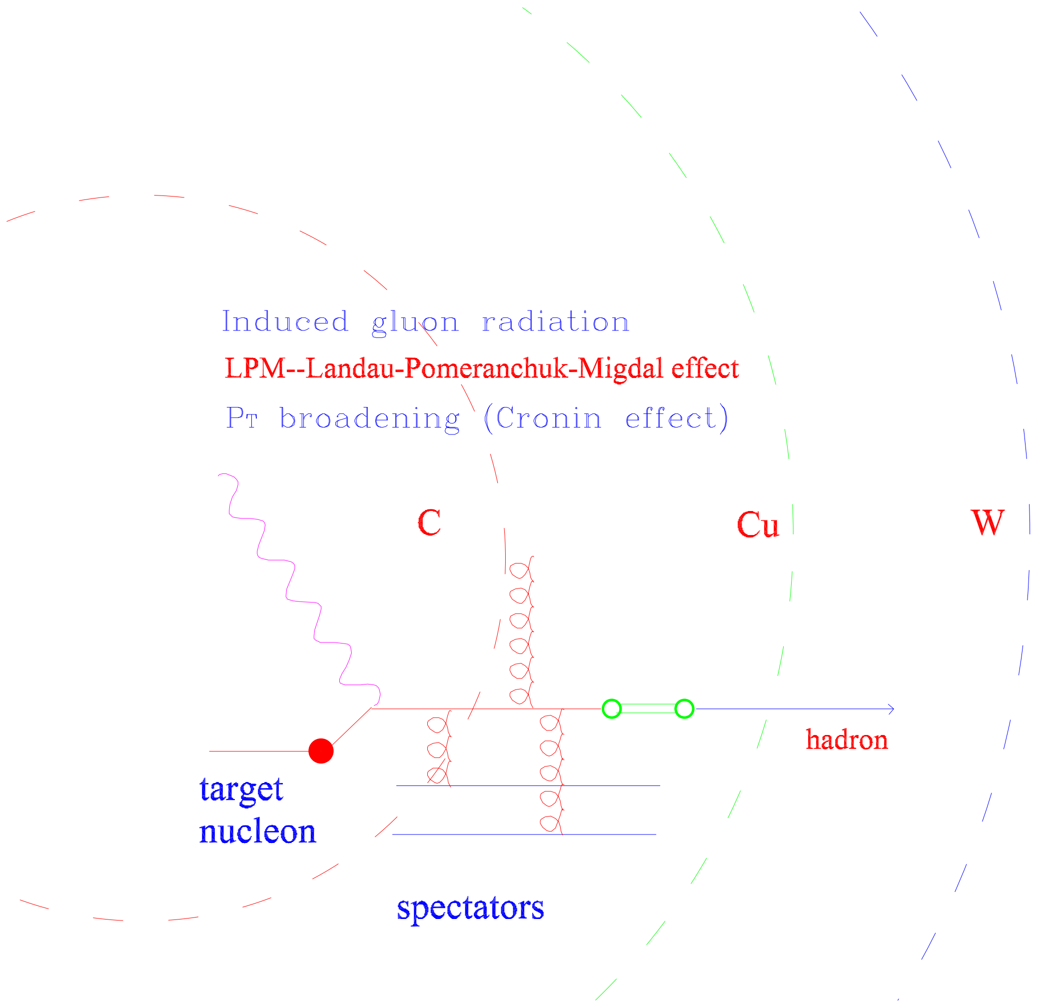
disentangle different mechanisms by
kinematic setting
different target nuclei;

input to RHIC data interpretation
jet quenching $\rightarrow$
one of the most promising candidates for
QGP.

Hadronization by DIS

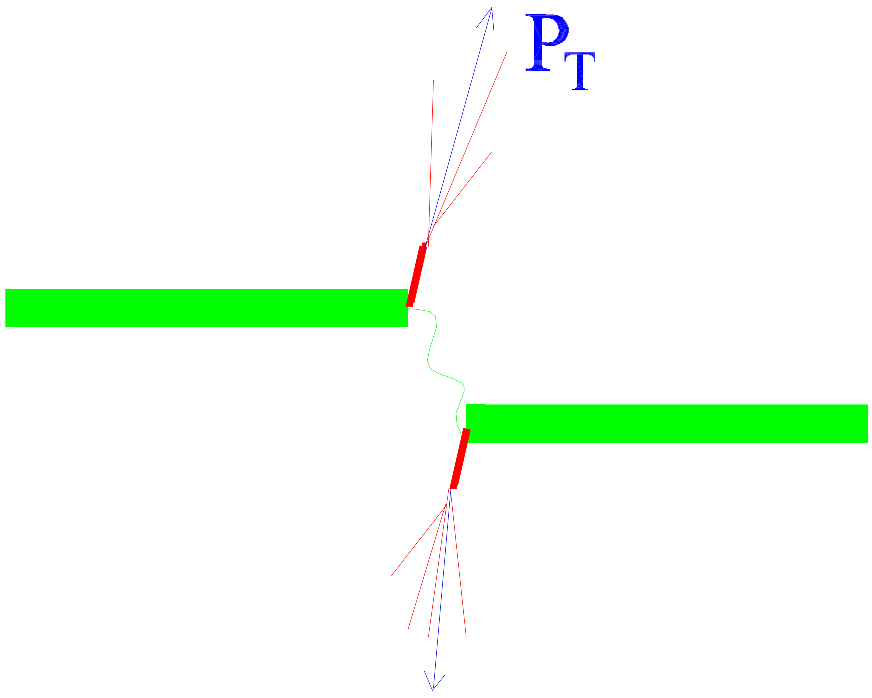



h
formation length
dependence on:
A
Q^2, ν, (x)
z, P_T
$z=E_h/\nu$



Induced gluon radiation
LPM--Landau-Pomeranchuk-Migdal effect
P_T broadening (Cronin effect)
C
Cu
W
hadron
target
nucleon
spectators

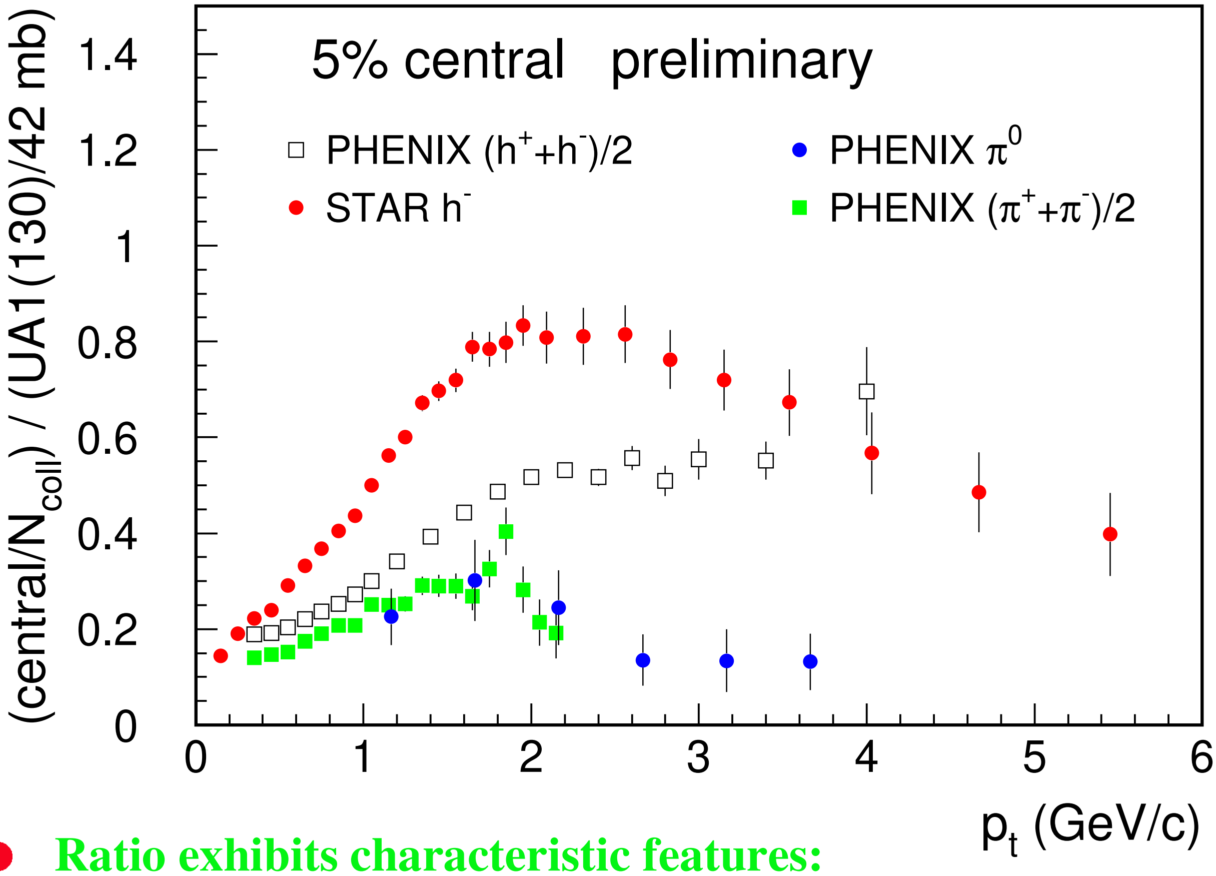
Jet production in RHIC



P_T (RHIC) $\longleftrightarrow$ ν (Jlab)

Comparison to central Au-Au to p-p

- **Use identical p-p parameterization for all data sets**
  - **normalize data to number of binary collisions**
  - **divide by p-p parameterization UA1(130)/42 mb**



- **Ratio exhibits characteristic features:**
  - **increases up to ~ 2 GeV**
  - **saturates at $R_{AA} < 1$**
  - **decrease at high p_t**

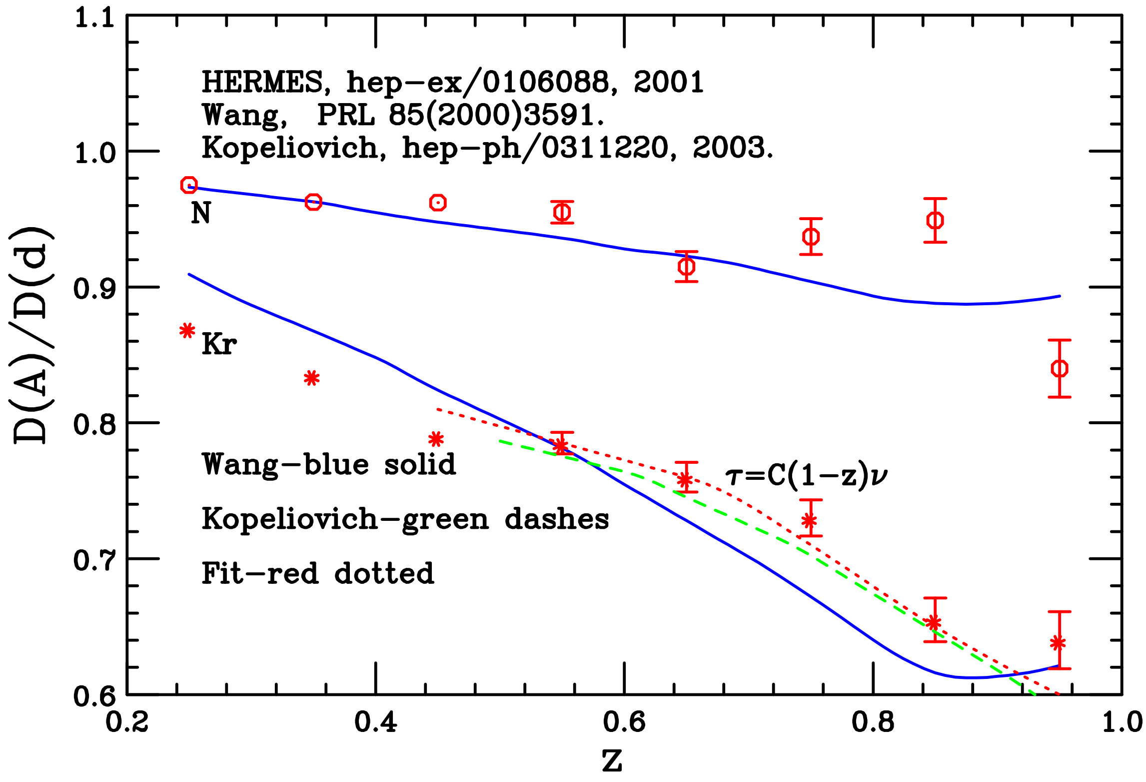
- **Issues: large systematic error ~ 30%**
  - **data: normalization, differences in shape, centrality selection, p/ p contribution ..**
  - **systematic uncertainty of p-p parameterization**

Previous data:

data	beam	E_0 (GeV)	ν (GeV)	Q^2 (GeV/c)^2
TMC	μ	490	>100	0.1-150
EMC	μ	175	>10	> 2
SLAC	e^-	20.5	>4	0.35-5
HERMES	e^+	27	7-23	$< 2.5 >$
HERMES	e^+	12	2.5-9	$< 0.9 >$

HERMES data up to ^{84}Kr.

Data required at ν=4 AND high Q^2 (3-5):
DIS domination and factorization.
Data required on larger A nuclei (^{184}W):
stronger attenuation and test of models.
Data required at different P_T's and Q^2's:
separate different effects.
PID required :
does hadronization occur inside the nucleus.



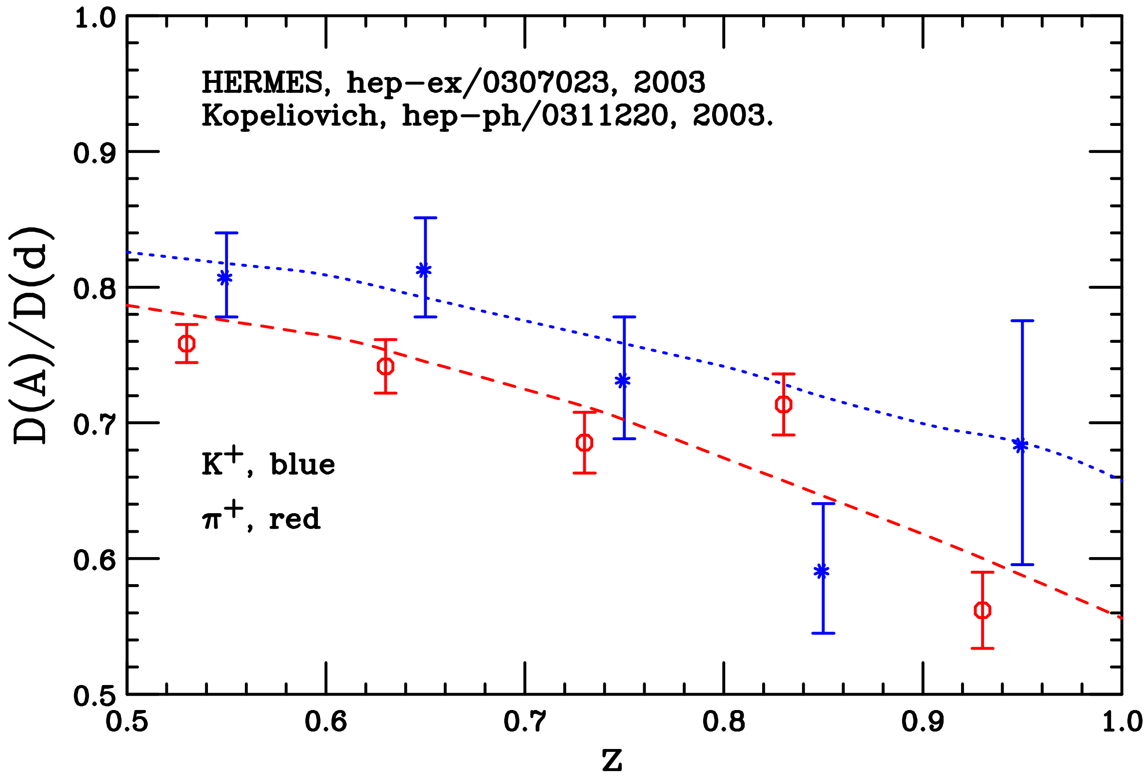
Sources of the attenuation?

HERMES hadronization inside nucleus;

Wang quark-medium interaction;

Kopeliovich pre-hadronic state interaction.

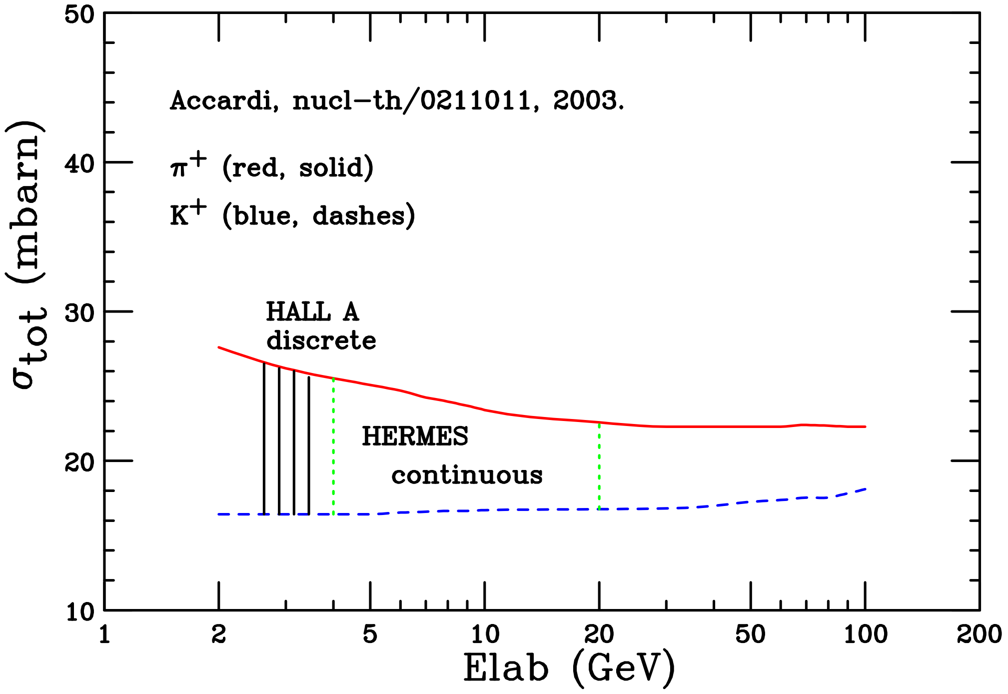
Lower ν, larger A, and PID are required.



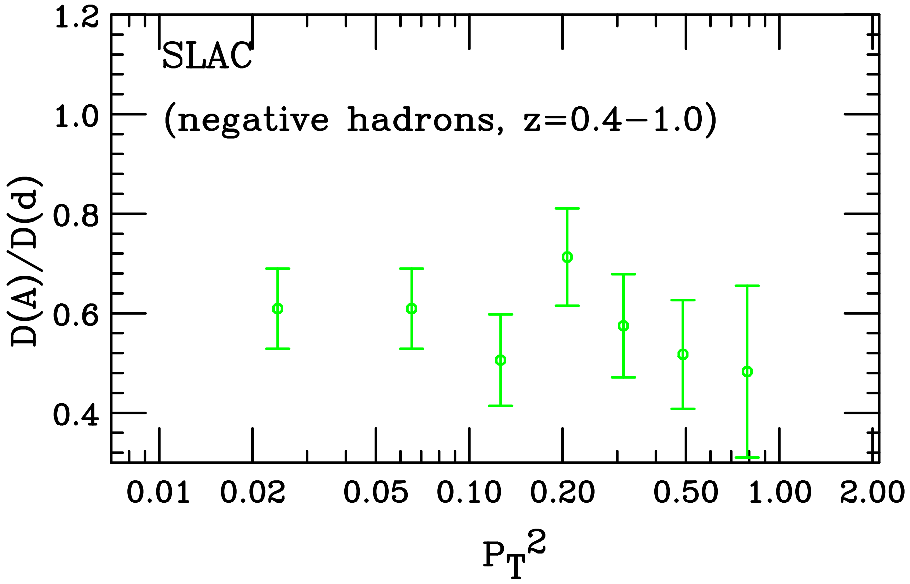
Data with higher precision are required.

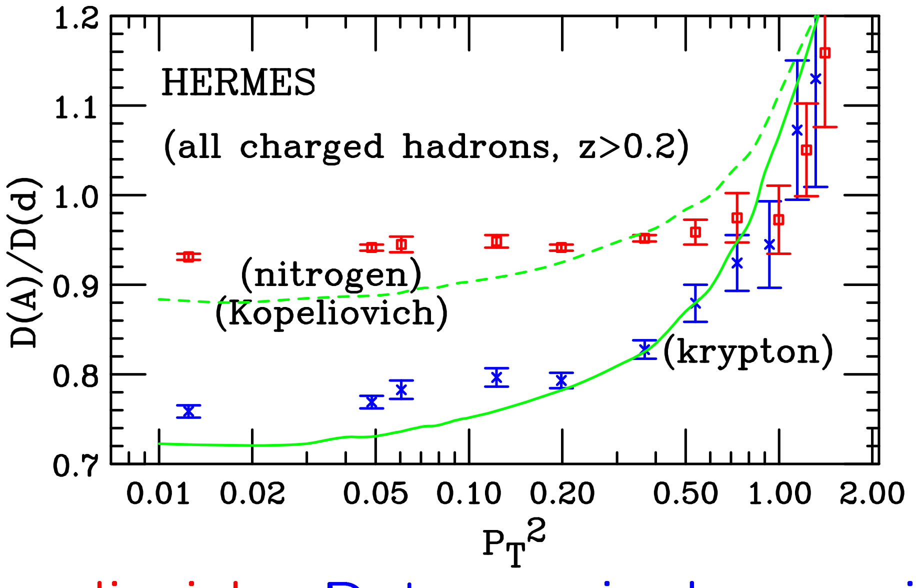
Data with lower ν and in small bins are required.

Hadron cross section in nuclear medium



Previous P_T data





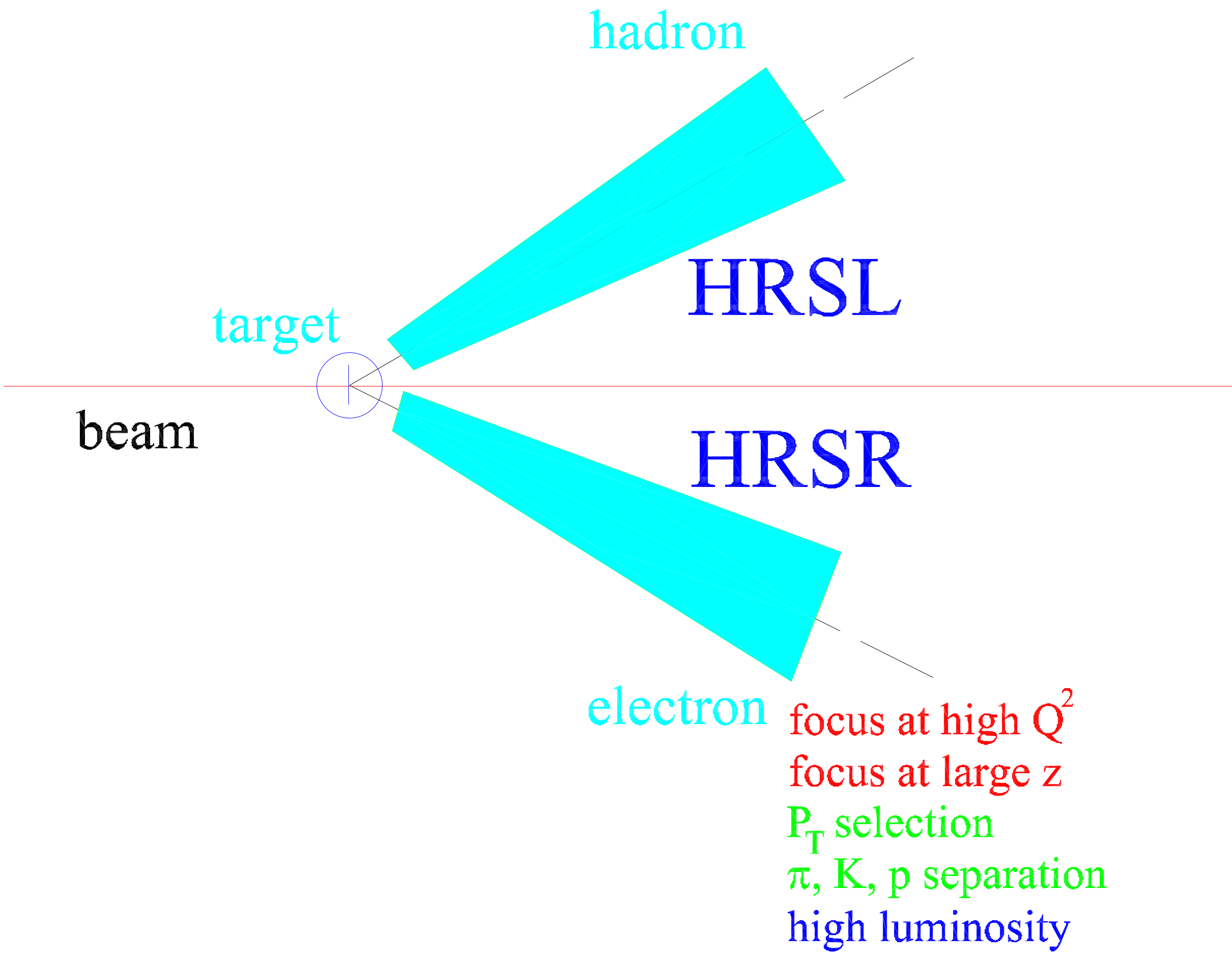
Kopeliovich: Data required on variation with z, direct measure of formation length.

Large A stronger effect.

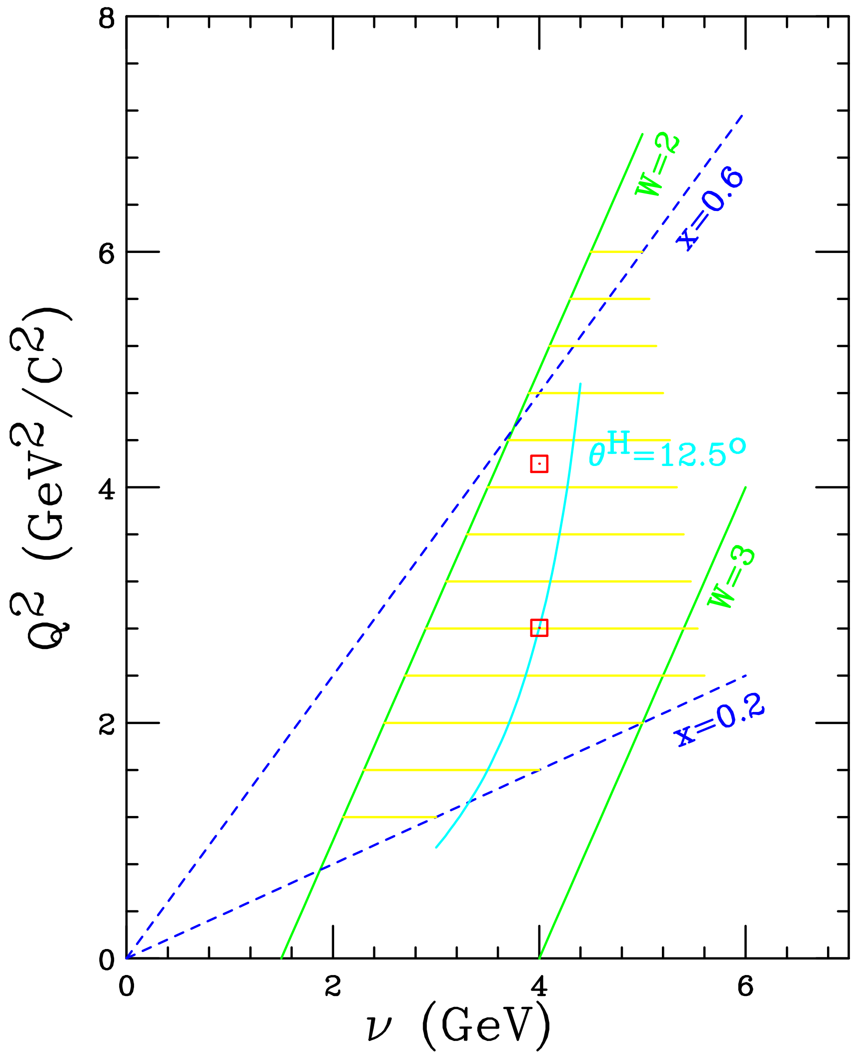
Approaches:

$$R(\nu, z, P_T, Q^2) = \frac{\frac{dN^h(A)}{N_e(A)dz}}{\frac{dN^h(D)}{N_e(D)dz}}$$

$R(\nu, z)$ for formation length;
$R(x, z)$ for factorization;
$R(z, P_T)$ for LPM effect;
$R(P_T, z)$ for P_T broadening.


hadron
HRSL
target
beam
HRSR
electron
focus at high Q2
focus at large z
PT selection
π, K, p separation
high luminosity

$Q^2 - \nu$ phase space

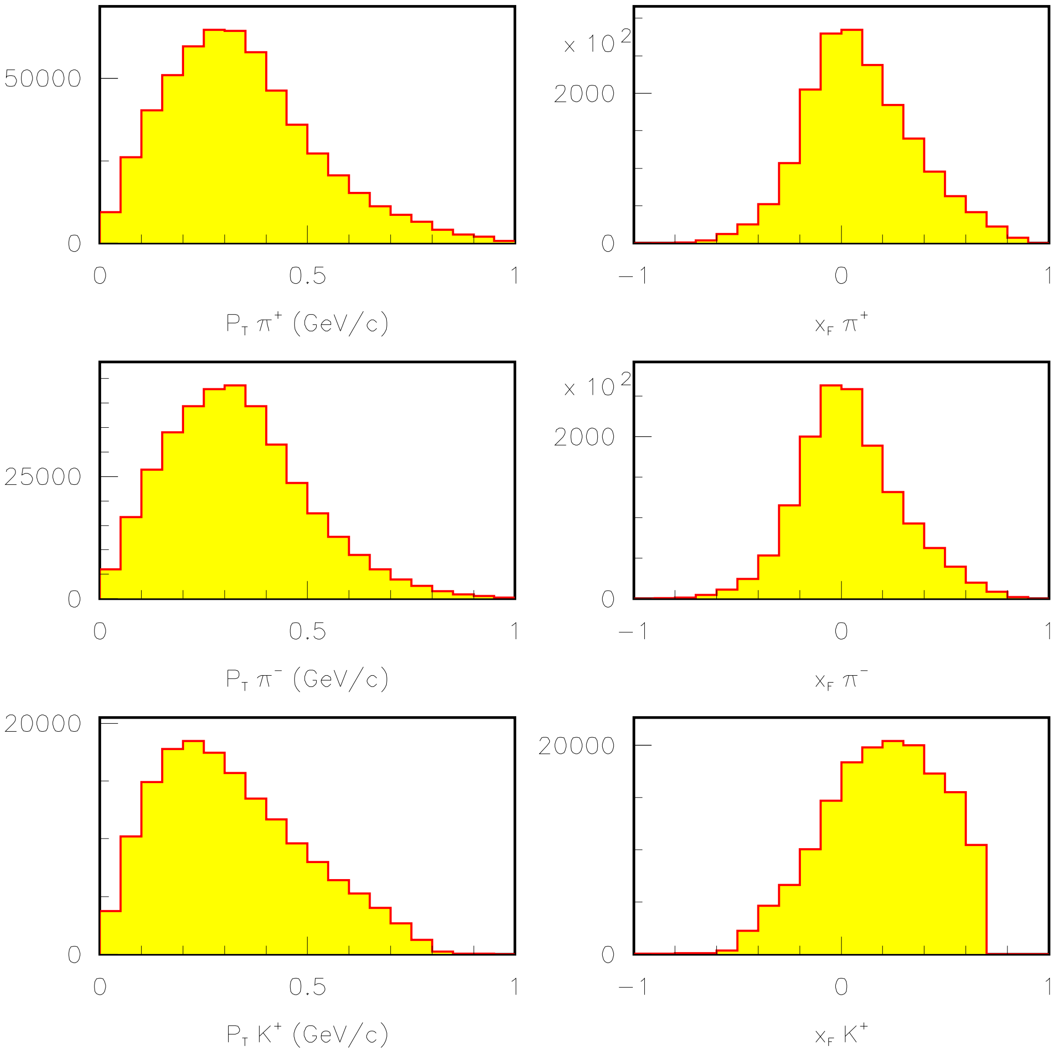


Kinematic setting

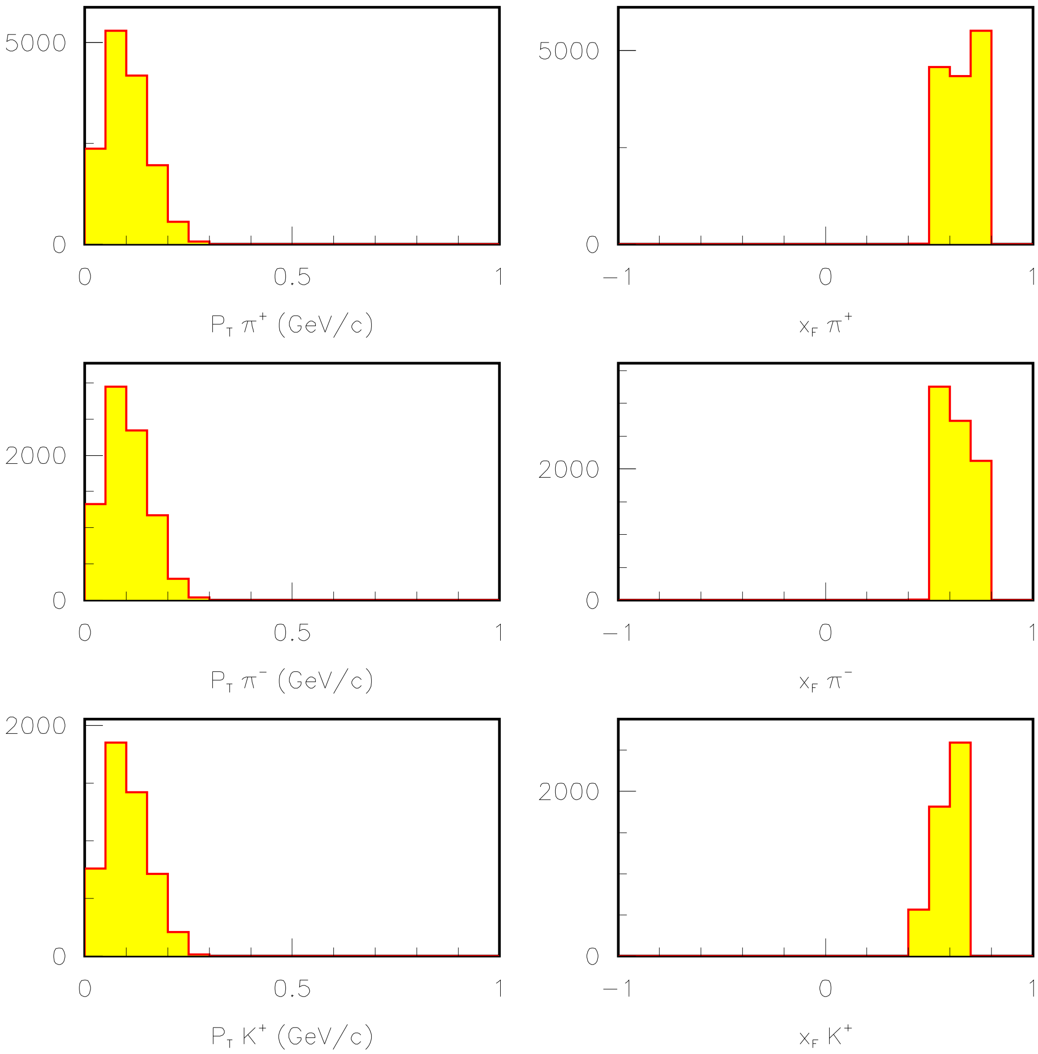
Beam energy 6 GeV
Beam current 100 μA

θ_e (deg.)	ν (GeV)	Q^2 $(GeV/c)^2$	θ_R (deg.)	θ_h (deg.)
27.99	4.0	2.81	12.5	12.5(+)
27.99	4.0	2.81	12.5	12.5(-)
27.99	4.0	2.81	12.5	20.5(+)
27.99	4.0	2.81	12.5	24(+)
34.50	4.0	4.20	14.5	14.5(+)

Kopeliovich: R(Q^2) is decreasing with Q^2;
HERMES: R(Q^2) is increasing with Q^2.



Hadrons tagged by electron arm.



Hadrons tagged by electron arm, accepted by hadron arm.

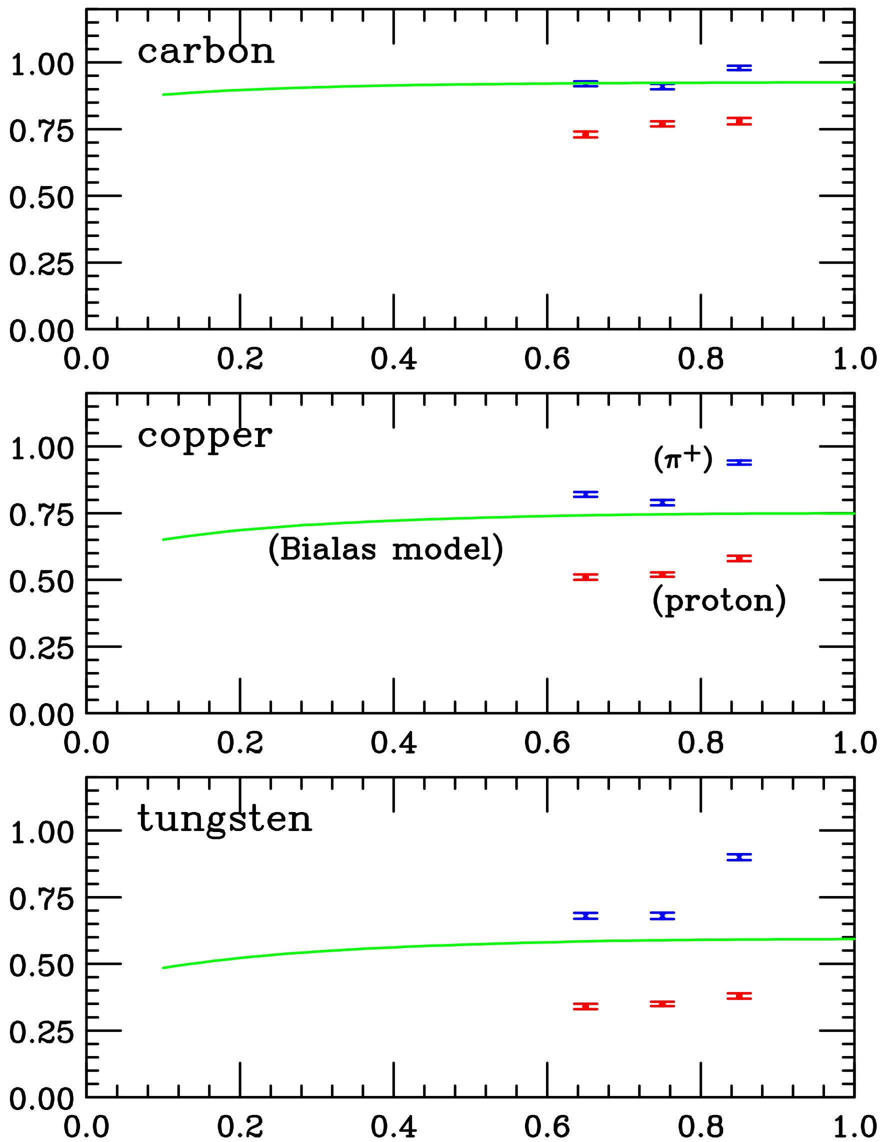
Beam time distribution

Kin	data (hour)	Aux (hour)
1	40	4
2	40	8
3	80	9
4	80	5
5	54	4
total	294	30

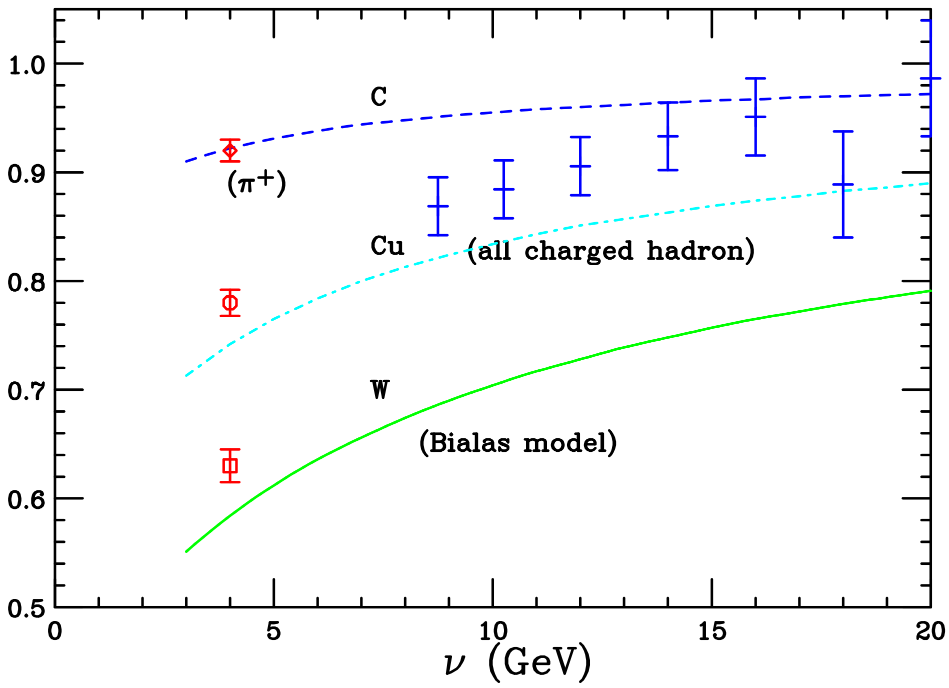
15 days in total.

13.5 days for data taking, target change etc,

plus 1.5 days for calibration.



Attenuation ratio $R(z)$ for $\nu = 4GeV$, $Q^2 =$ 2.81 (GeV/c)^2 and P_T <0.2 GeV/c.



Attenuation ratio $R(\nu)$ for $\nu = 4$ GeV, $Q^2 = 2.81$ (GeV/c)^2, z=0.65, P_T <0.2 GeV/c (red); HERMES data: z >0.5, all Q^2 and P_T (blue).

Summary:

Space-time evolution can be studied with HRS-HRS by SIDIS from light to heavy nuclei at high Q^2, large z, and ν=4 GeV, with high precision in small bins.

- attenuation(ν,z) $\Rightarrow$ formation length;
- PID $\Rightarrow$ where the hadron is formed;
- LPM effect at different z and P_T;
- P_T broadening;
- interpretation of RHIC data;