Differential Study of Nuclear Effects in Hadronization by DIS

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(Parton propagation through strongly interacting matter)

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Overview:

Study hadronization in A$(e, e'[\pi, K])$X, on ^{2}H, ^{12}C, ^{64}Cu, and ^{184}W, by the attenuation of hadron yield

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

* Main objective-

Provide precise data for understanding hadronization mechanism, study propagation of quarks and hadrons *under specific kinematic conditions.*

$\longrightarrow$ small acceptance detectors;

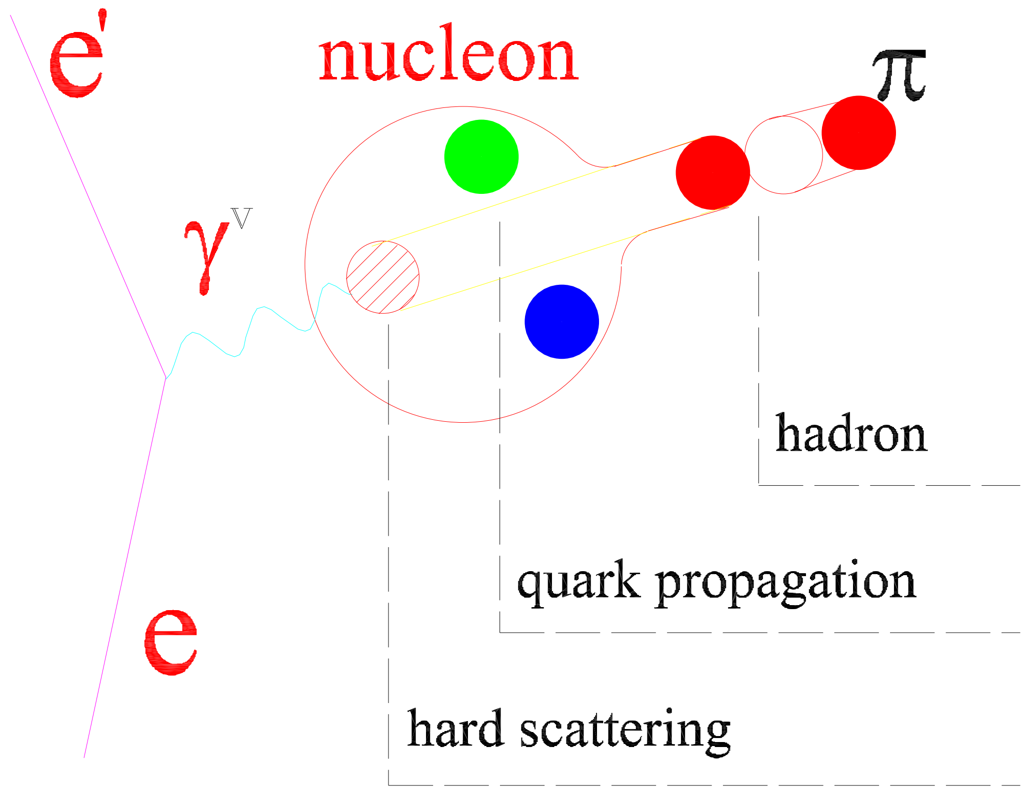
$\longrightarrow$ essential to QCD.

* Additional objective-

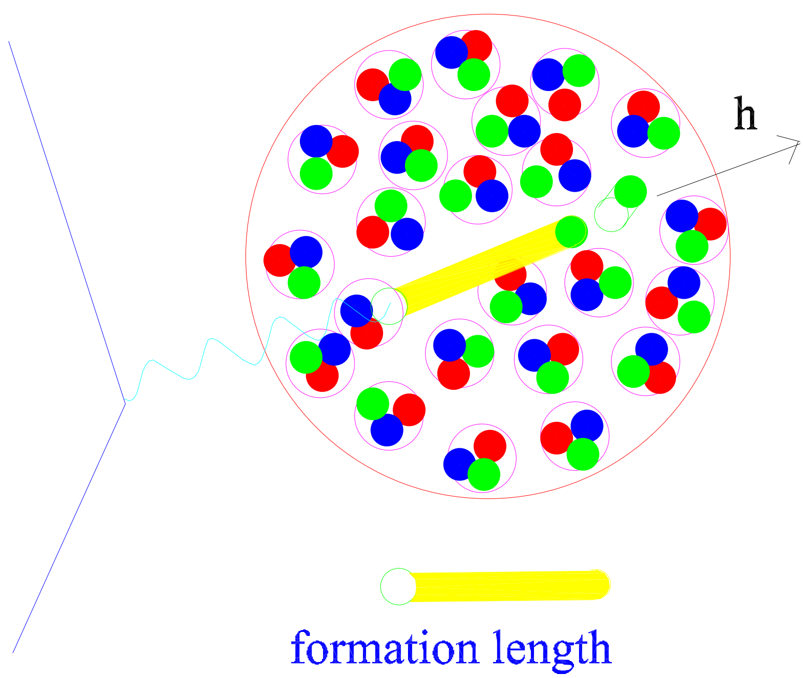
Input to RHIC data interpretation, jet quenching

$\longrightarrow$ Is QGP recreated at RHIC?

Hadronization by DIS



Multi-variable process



dependence on:

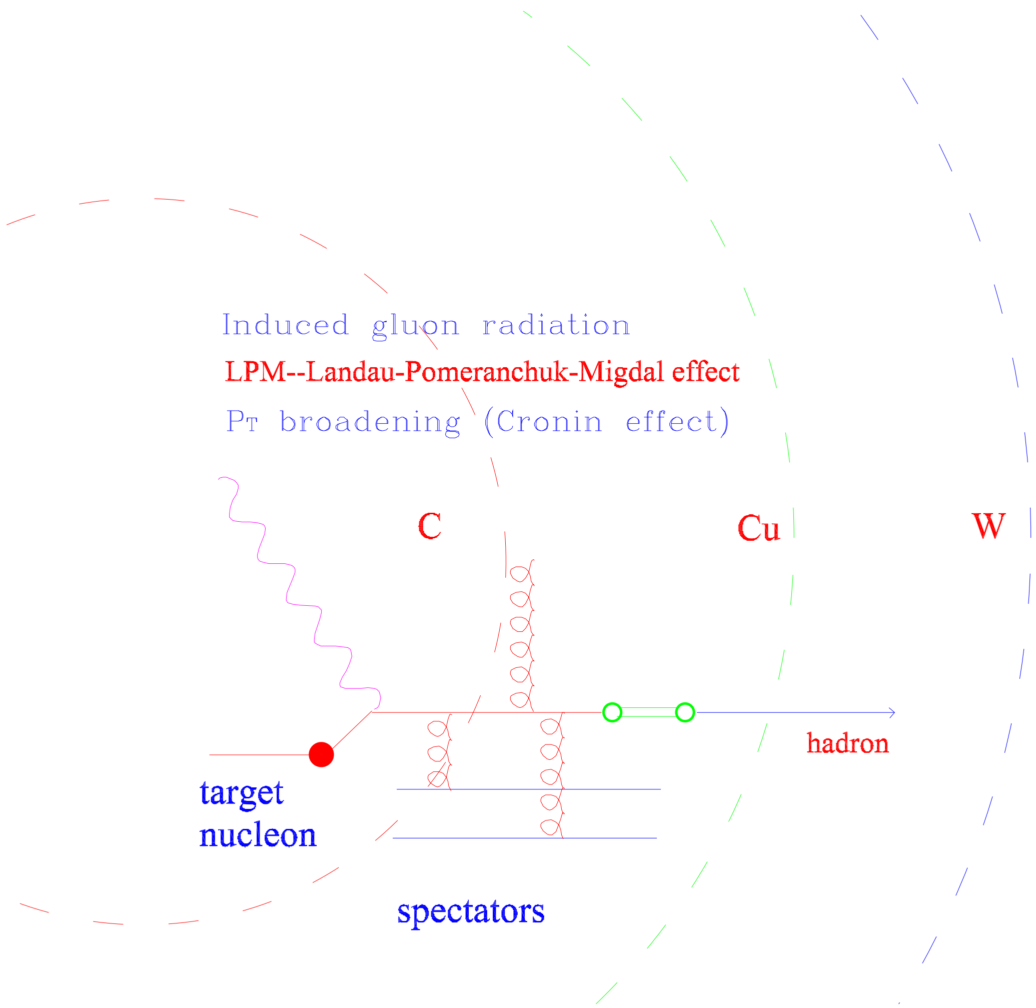
A

Q^2, ν, (x)

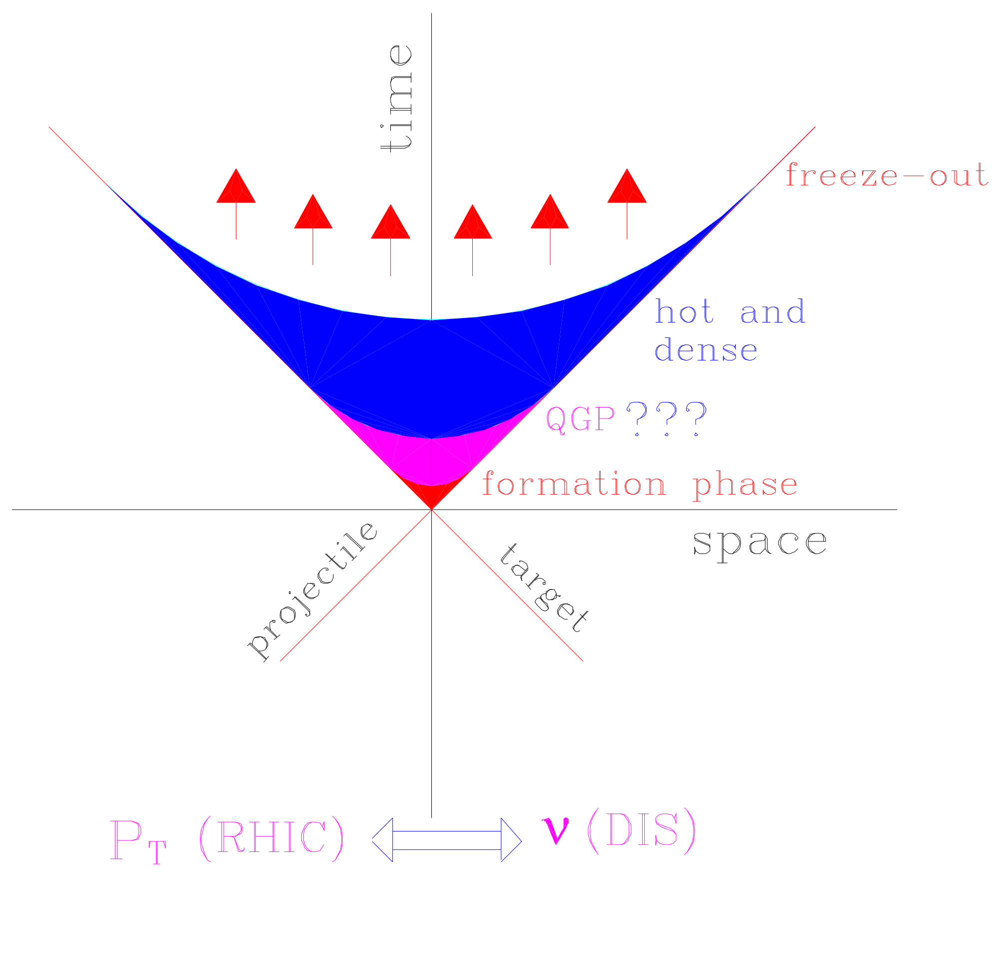
z, P_T

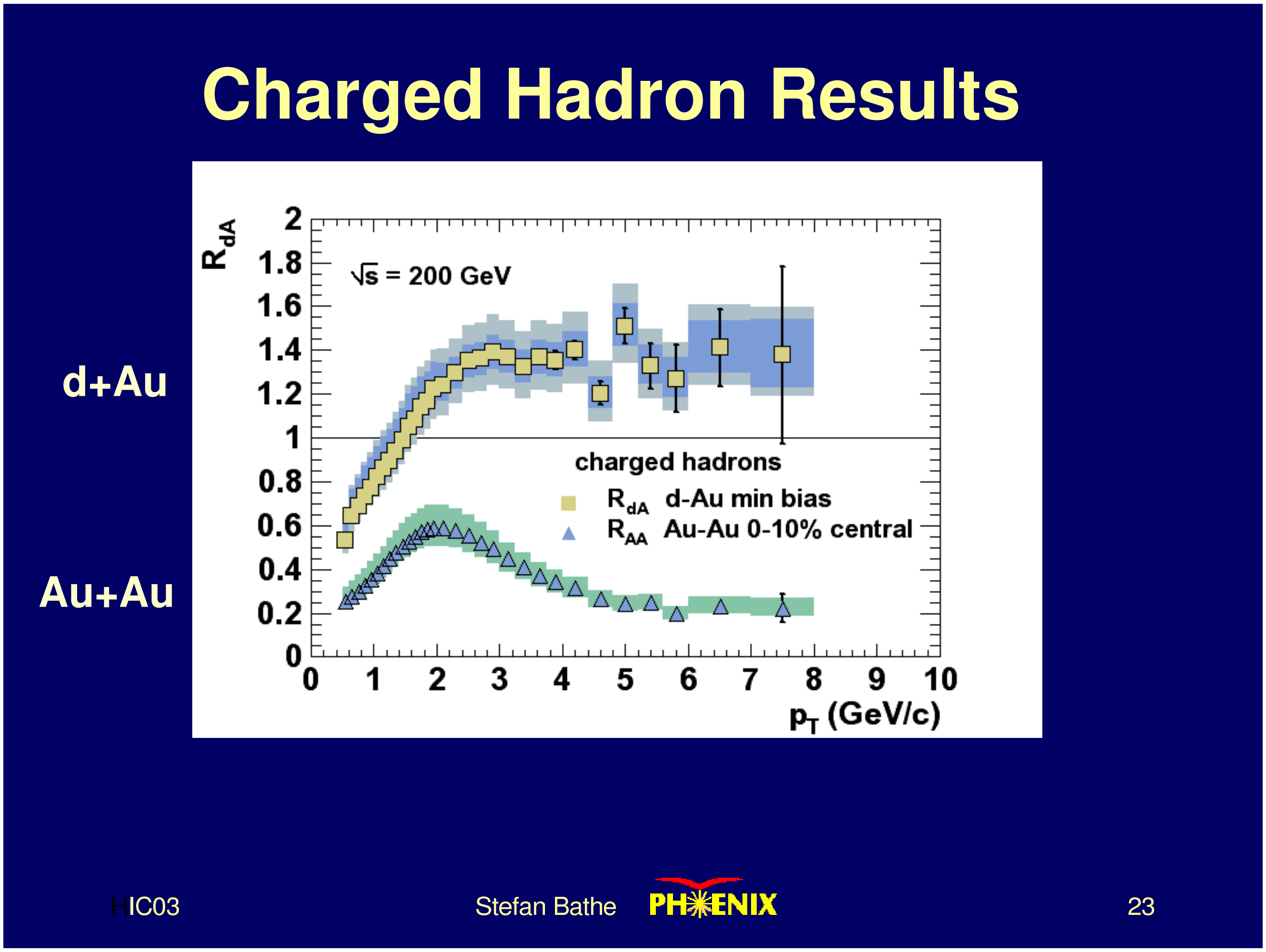
$z = E_h/\nu$

Multi-mechanism and multi-effect process



Space-time evolution of hot matter



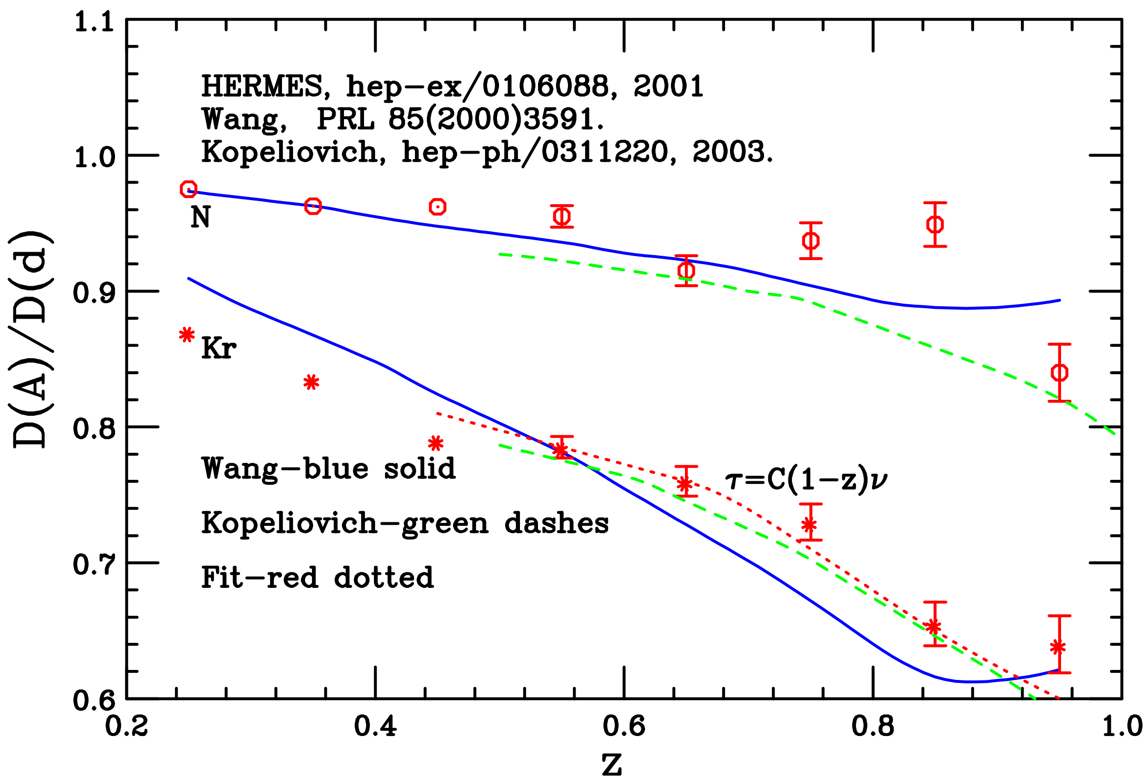


High P_T suppression in Au-Au collision, in comparison with dA data. Bathe (PHENIX).
PRL 91(2003)072303.

Previous data:

data	beam	E_0 (GeV)	ν (GeV)	Q^2 (GeV/c)^2
FNL	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	$< 0.9 >$
CLAS	e^-	5.7	3-5	1.5-5
HRS*	e^-	6	4	2.8, 4.2

Data required at lower ν AND higher Q^2's:
DIS is dominating and factorization is valid.
Data required on larger A nuclei (^{184}W):
stronger attenuation and test of models.
Data required at various P_T's and high z:
sensitive to different dynamics.



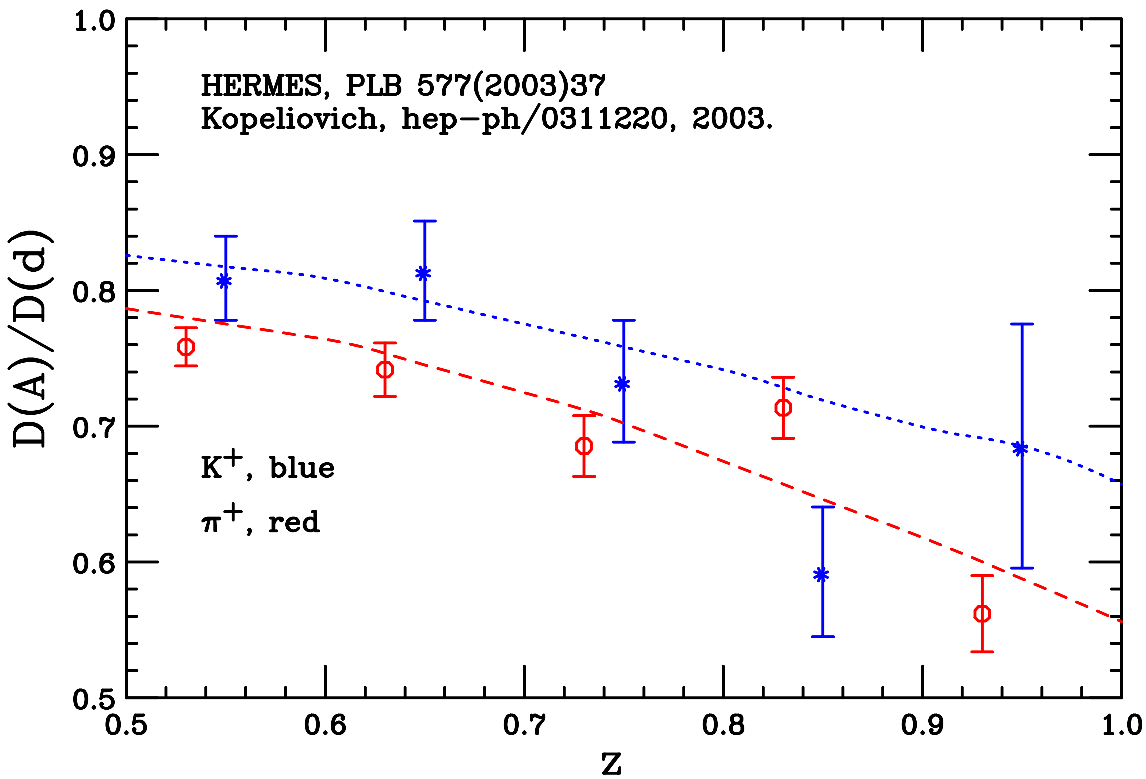
Sources of the attenuation?

HERMES hadronization inside nucleus;

Wang quark-medium interaction;

Kopeliovich colorless pre-hadronic state.

Flavor dependence is required.



Higher precision at large z is required.

The first major goal:

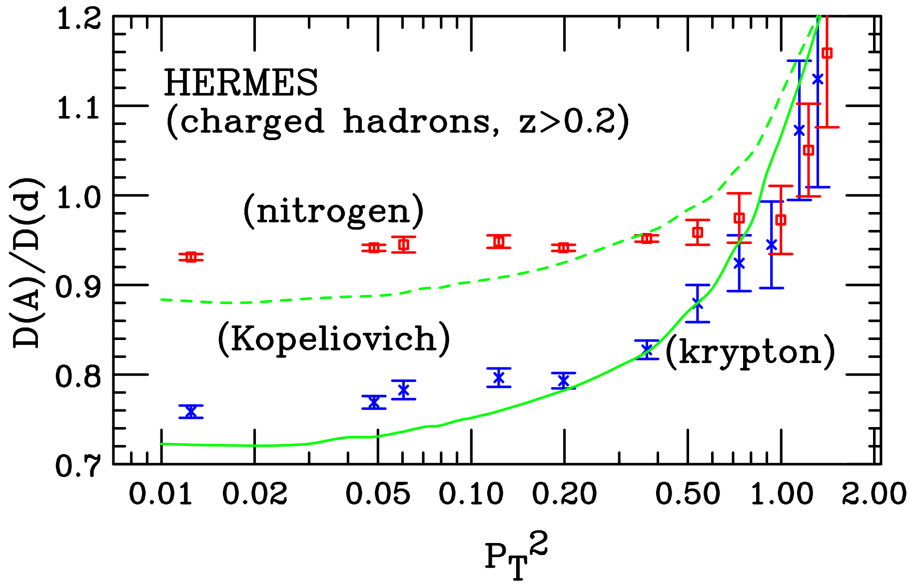
Determine

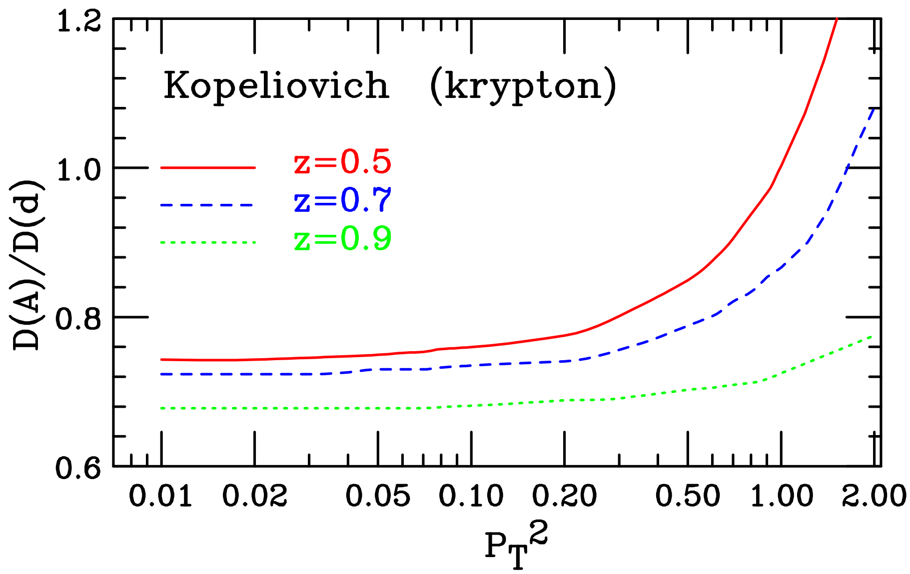
Whether the hadron is produced inside the nucleus.

Lower $\nu-$ shorter formation length; larger difference in σ_π and σ_K.

Larger A$-$ longer traversing path.

PID$-$ Different attenuation for π^+ and K^+ if they are formed inside the medium.





The second major goal:

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

Large A - stronger effect.

Dynamic features

Multi-variable (Q^2, ν, z, P_T, A);
Multi-mechanism (quark, color-dipole, and hadron propagation);
Multi-effects (gluon radiation, LPM, P_T broadening).

Requirements:

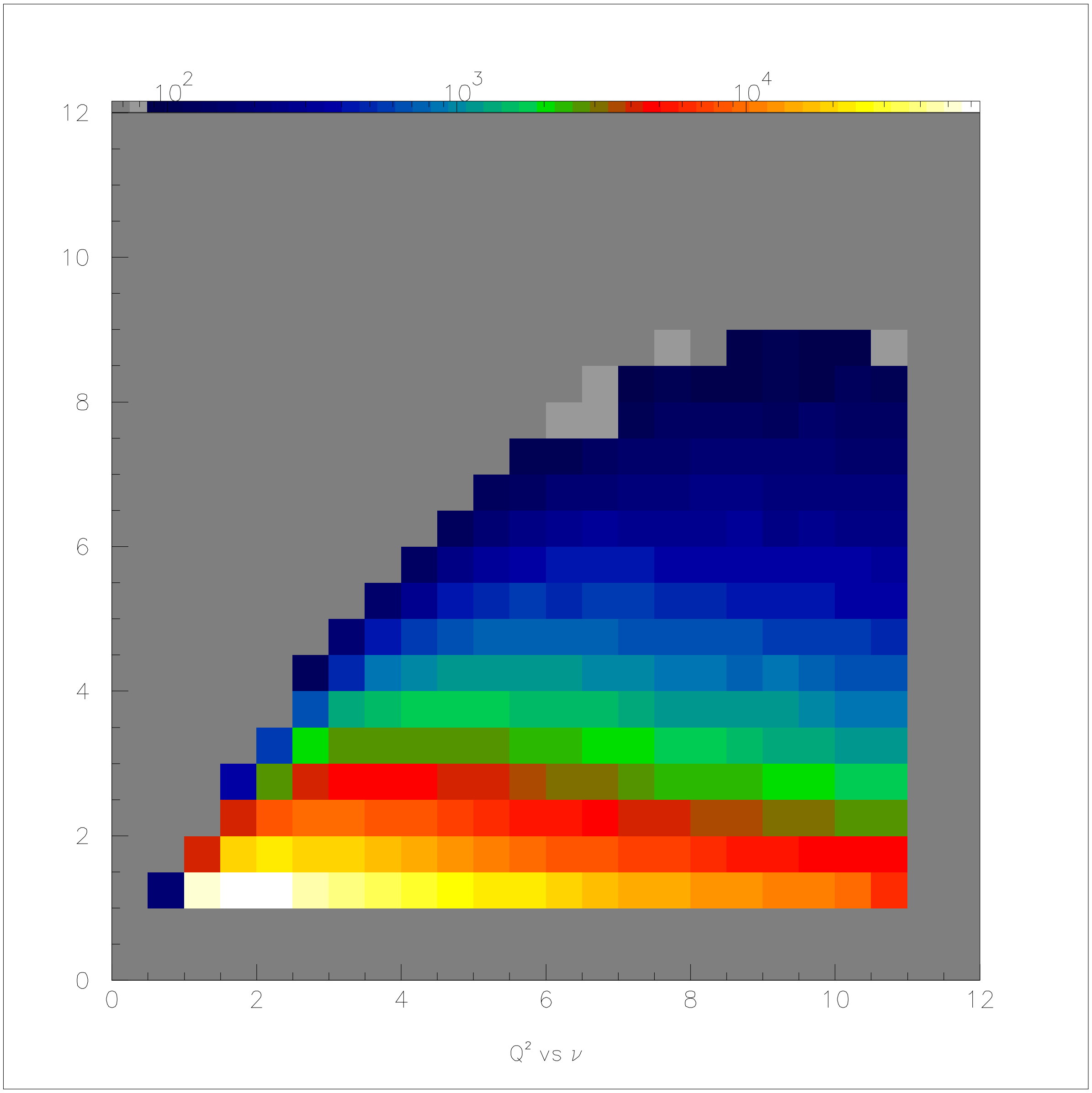
Higher Q^2 and larger Q^2 range;
Large $z = E_h/\nu$;
Data at smaller bins;
Particle ID.

Kinematic selectivity

In order to -

disentangle the dependence on each varible,
distinguish one effect from the other,
identify one mechanism from the other,

Specific data sets are required concentrated at a fixed selective kinematic region with small bins. These data will be complementary to that from large acceptance detector.



10^2
10^3
10^4
12
10
8
6
4
2
0
0
2
4
6
8
10
12
Q^2 vs ν

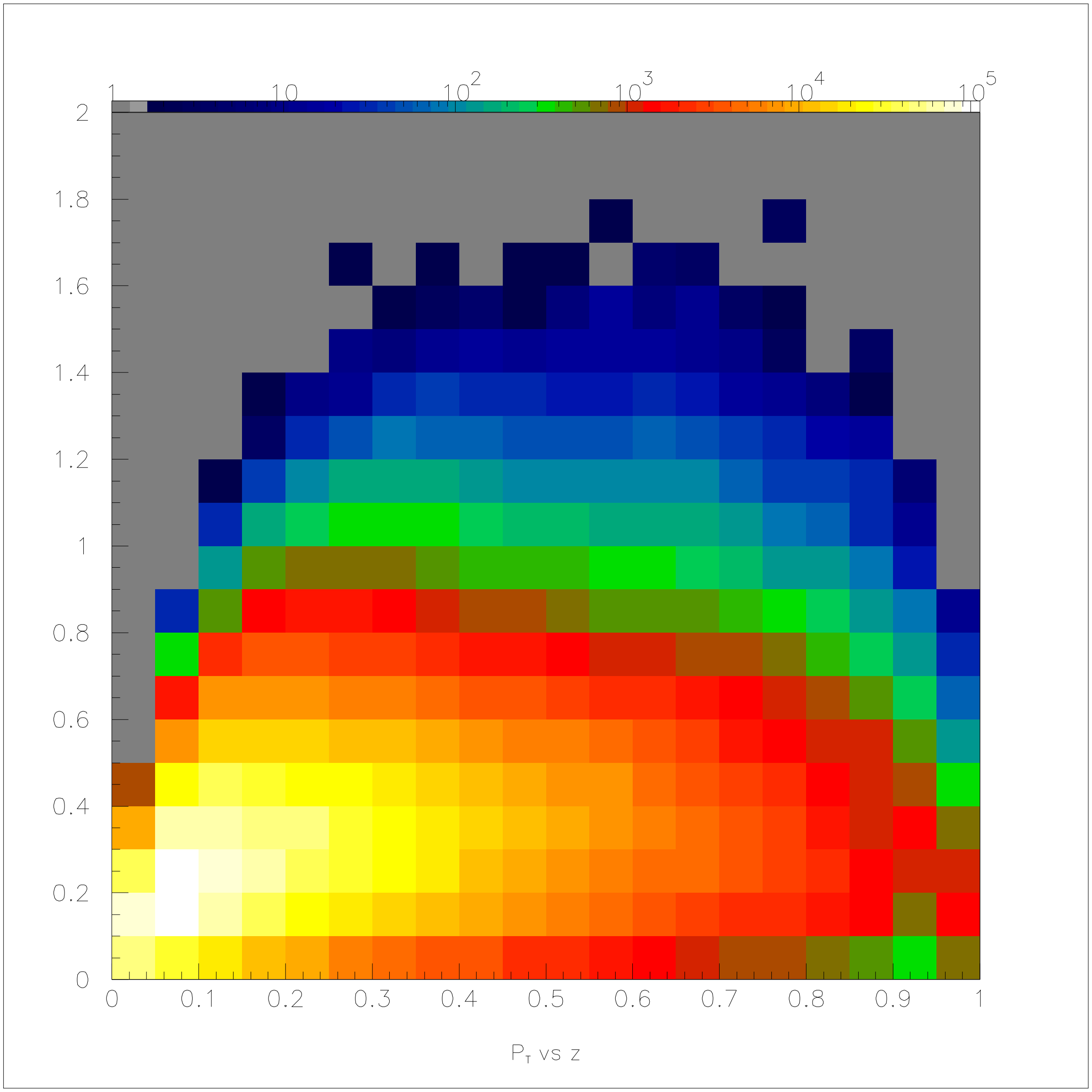
Dilema

On one hand, we like to selectively take data at higher Q^2, this will require to measure electrons at larger angle;

On the other hand, at high $Q2$, the leading hadron will favor smaller forward angles.

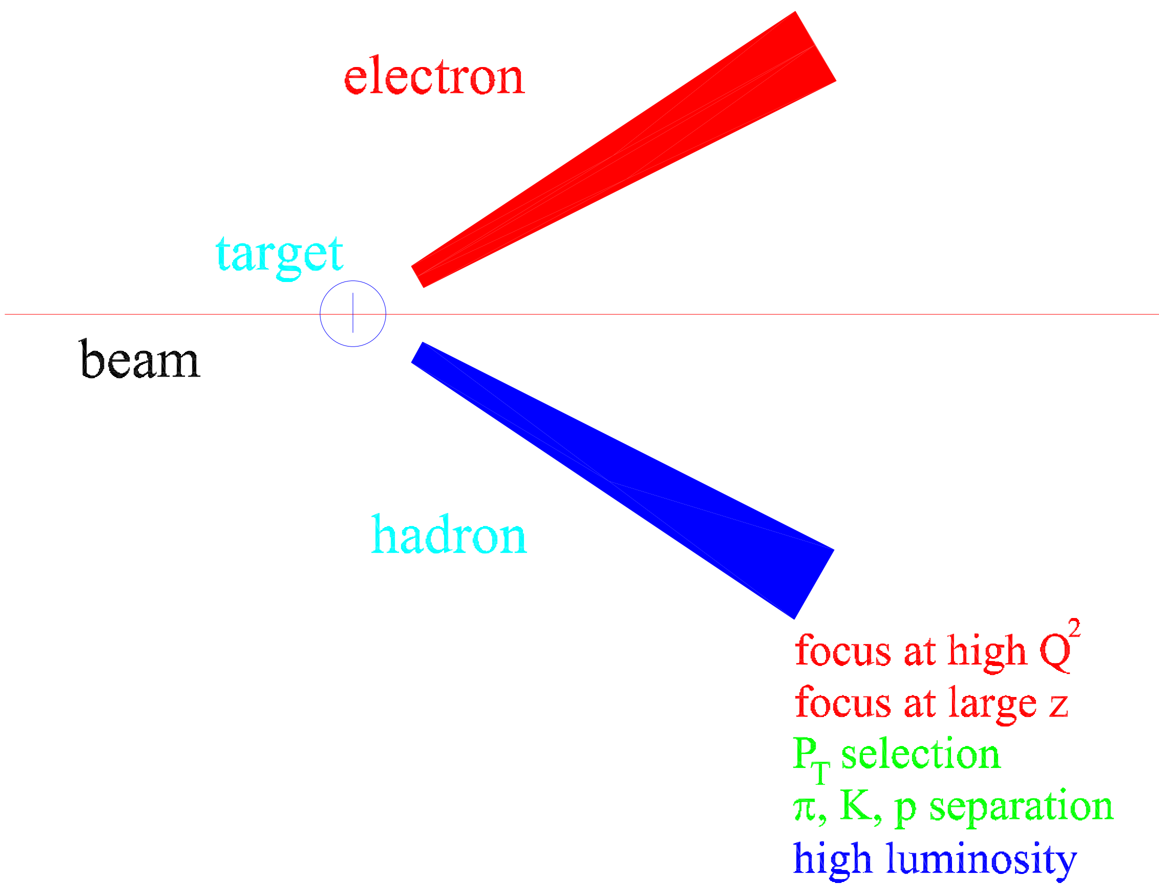
Solution:

Using separate detectors for electrons and hadrons. While setting the electron arm at larger angle, leaving the hadron arm more toward forward diection.



1
10
10^2
10^3
10^4
10^5
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
P_T vs z

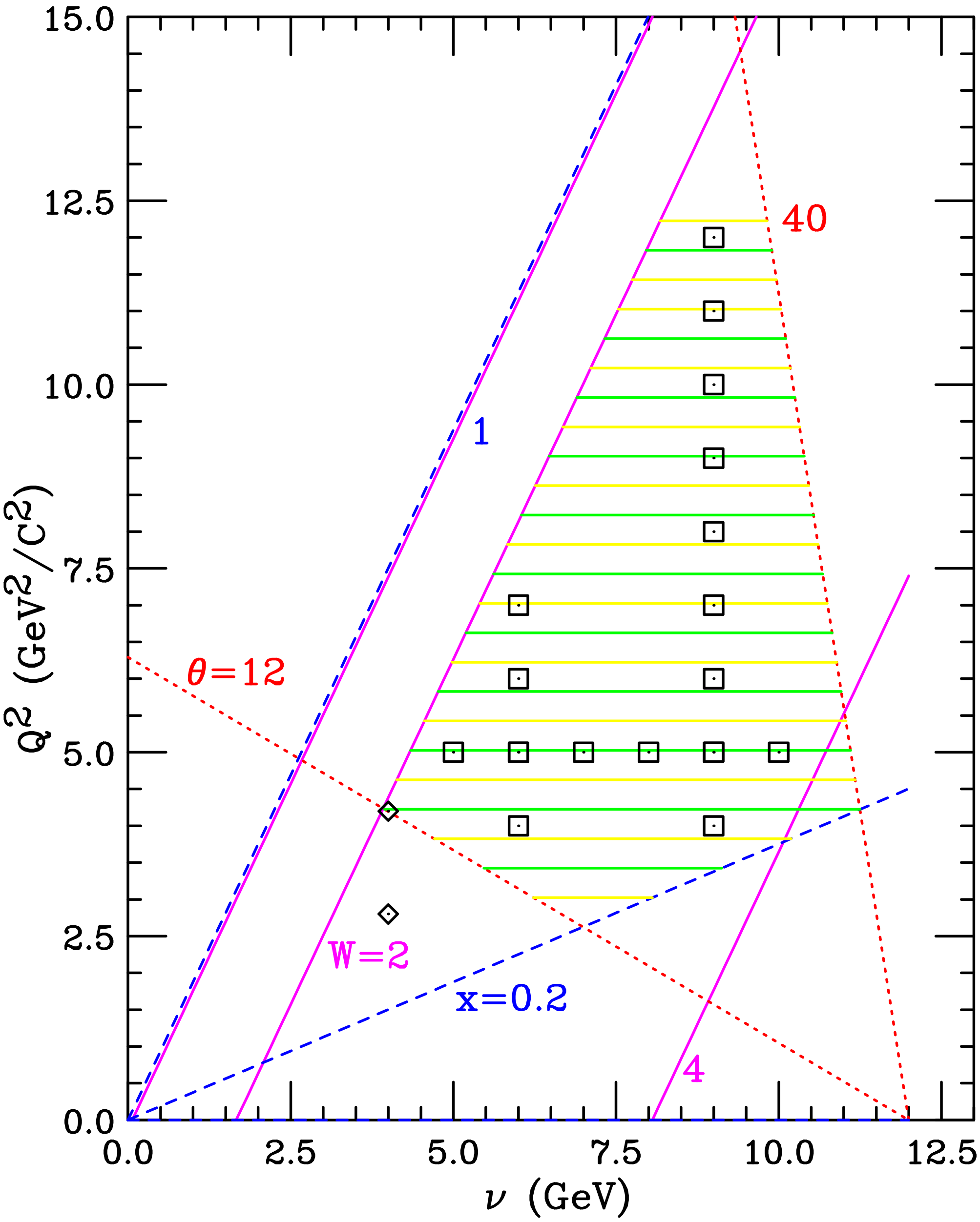
Detector setup

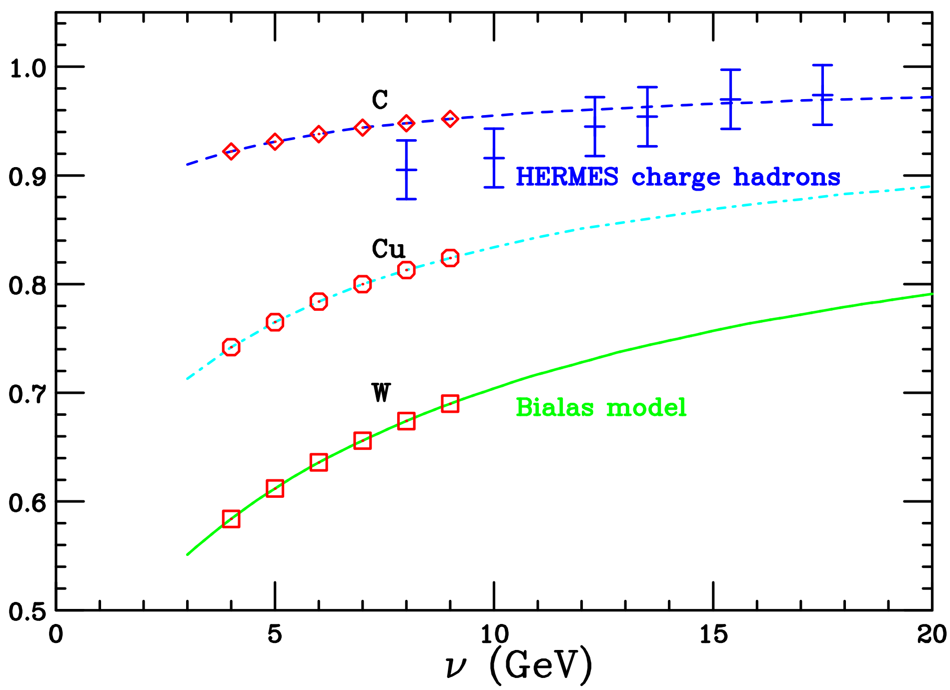


Detector Description

	Hall A		Hall C	
	HRS	MAD	HMS	SHMS
P_c (GeV/c)	4.3	7.5	7.3	11
ΔP (%)	$\pm$5	$\pm$15	$\pm$10	-15 to 25
δ P (%)	0.02	0.1	0.1	0.2
$\Delta\Omega$ (msr)	12	28	8.1	4

$Q^2 - \nu$ Phase at 12 GeV





Projected attenuation ratio $R(\nu)$ with 12 GeV beam, at different Q^2, z and PID;
HERMES data: $z > 0.5$, all Q^2 and P_T (blue).

Summary:

Hadronization can be studied with small acceptance detectors by SIDIS from light to heavy nuclei at high Q^2, large z.

Select data at isolated high Q^2;
Select data at large z;
Select data at large P_T;

More sensitive to different effects;
More sensitive to the response of variable change.