

# **Parton propagation and fragmentation**

## **- introduction -**

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Hampton U. & Jlab

Nuclear QCD @ EIC  
Argonne, 7-9 April, 2010



# Physics motivations

## ➤ Nuclei as space-time analyzers

- nucleons as femto-detectors
- medium rather well known
- low final-state multiplicity

## ➤ Non perturbative aspects of hadronization

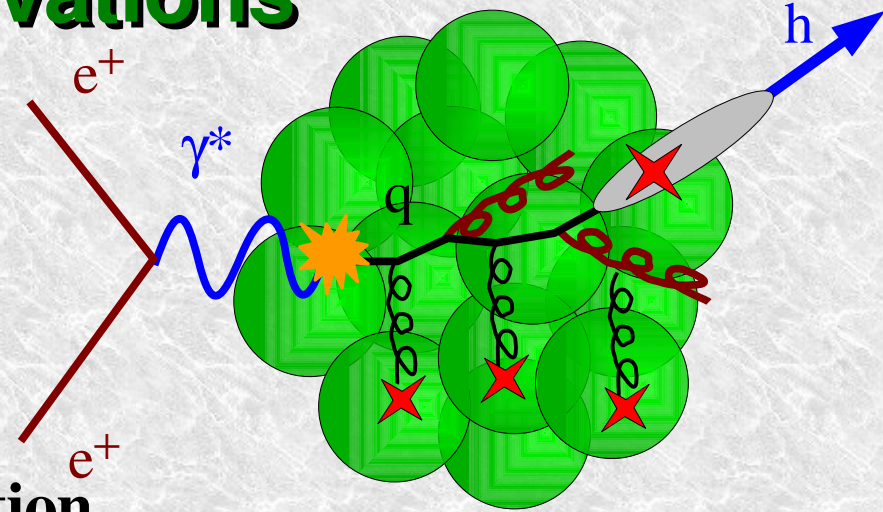
- approaching microscopic understanding of Fragmentation Functions
- how do partons dress up? Space-time evolution of hadronization
- color confinement dynamics

## ➤ Parton propagation in perturbative QCD

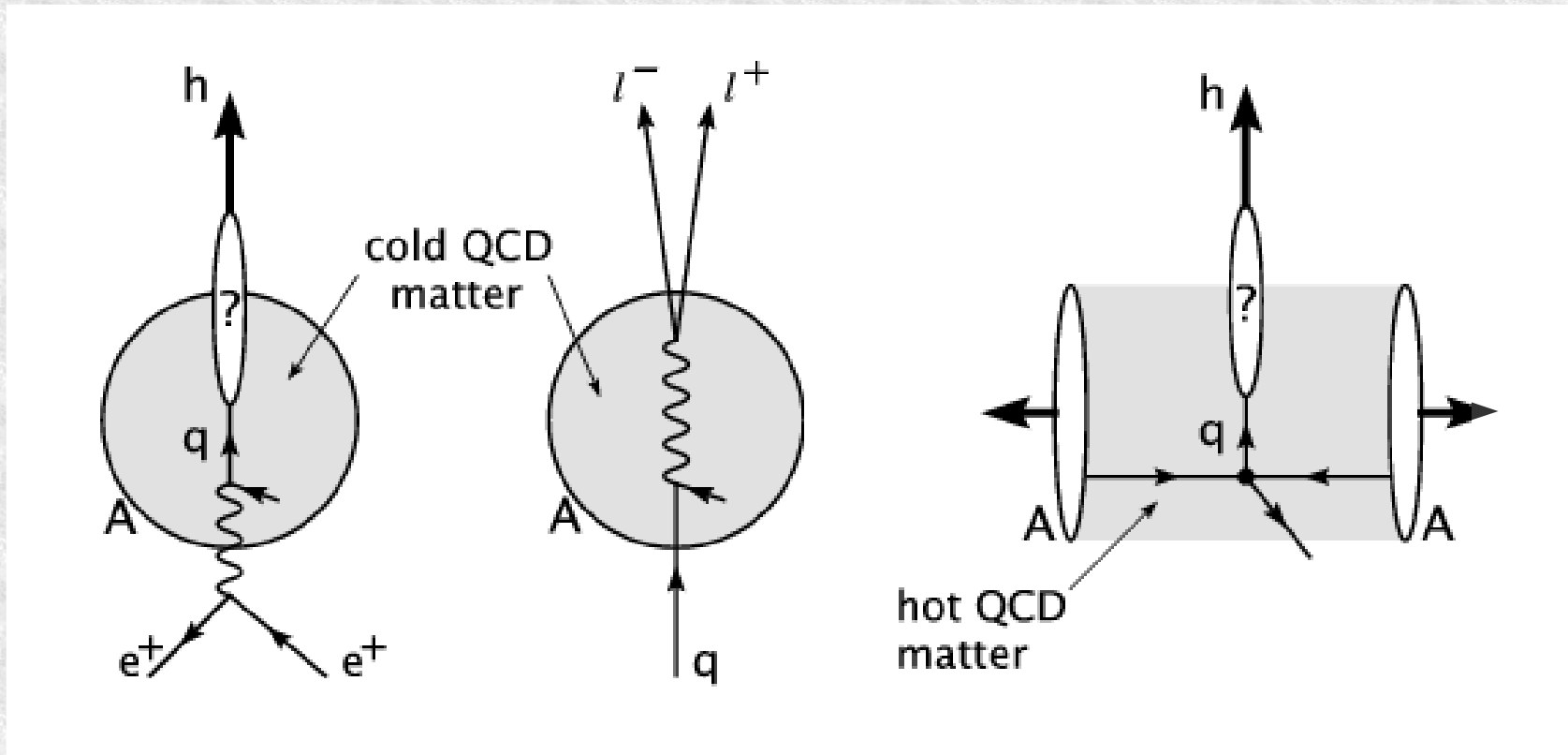
- QCD energy loss: basic pQCD, only indirectly tested so far
- DGLAP parton showers, jets

## ➤ Connection to other fields

- Calibration of jet-quenching in A+A  $\Rightarrow$  properties of QGP
- Hadron attenuation corrections for  $\nu$ -oscillation experiments
- TMD distributions in nucleons (?)



# Cold vs. hot



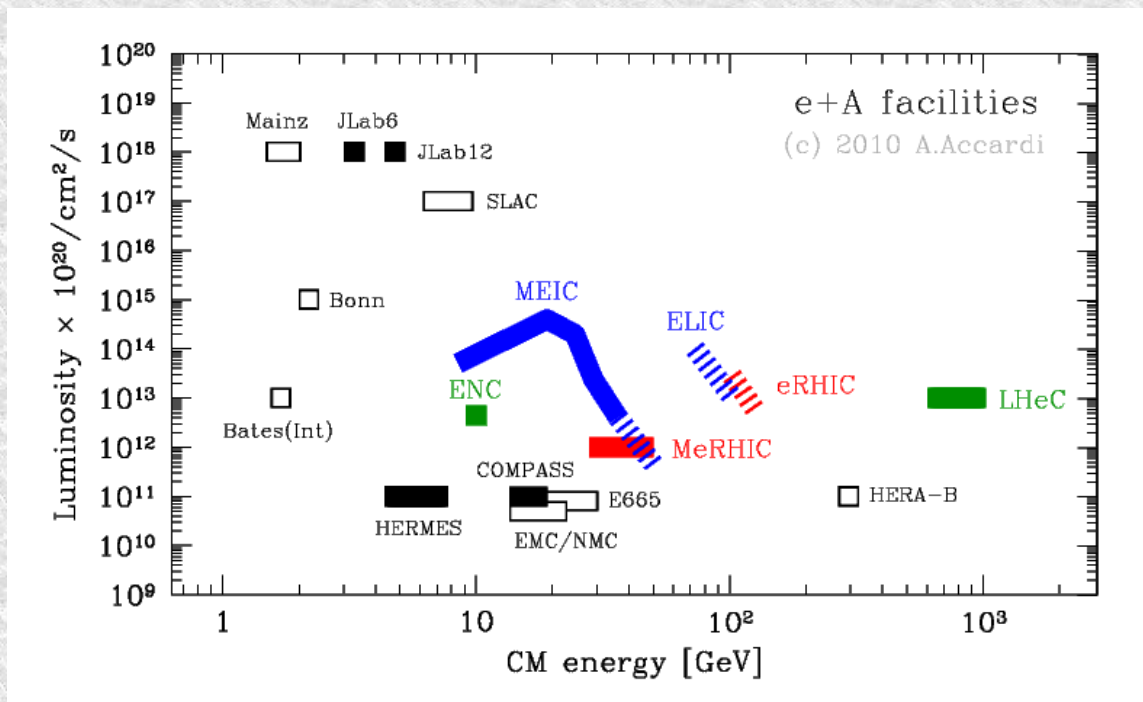
**DIS**  
FS energy loss  
+ hadronization

**DY**  
IS energy loss  
+ nuclear PDFs

**properties of  
the QGP**

DY vs. EMC effect

# The EIC



➡ high  $L \approx 10^2\text{-}10^4 \times \text{HERMES}$  – large  $\nu$ , large  $Q^2$  reach

➡ Test /extend HERMES

➡ cross-check results

➡ multi-differential observables

➡ 2-particle correlation (h-h,  $\gamma$ -h, ...)

➡ Unique:

➡ tests of parton dynamics

➡ heavy flavors

➡ jets

# The 'ppf' working group

- Wiki:

[https://eic.jlab.org/wiki/index.php/EA\\_Parton\\_propagation\\_and\\_fragmentation](https://eic.jlab.org/wiki/index.php/EA_Parton_propagation_and_fragmentation)

- Weekly phone meetings

- Please join us!

## Review papers

- Accardi, Arleo, Brooks, d'Enterria, Muccifora,  
Riv.Nuovo Cim.032:439-553,2010 [arXiv:0907.3534]

- Majumder, van Leeuwen, arXiv:1002.2206

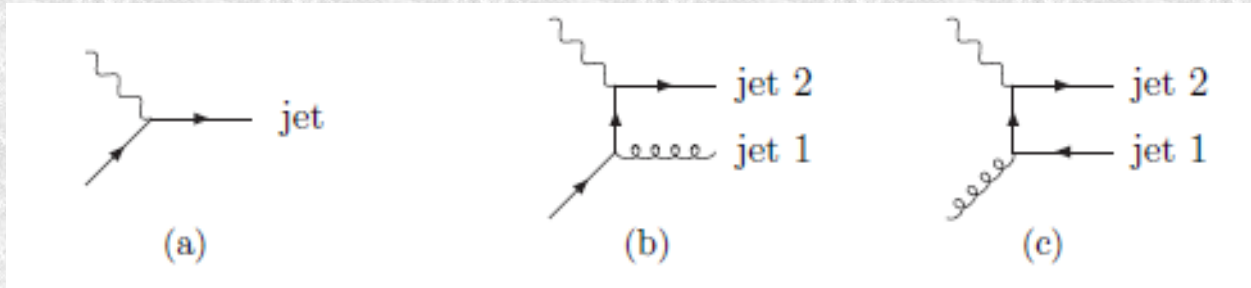
## Title: Propagation in nuclei

Chair: Alberto Accardi

13:30 - 13:35	A. Accardi	Introduction
13:35 - 13:55	P. Di Nezza	HERMES data overview
13:55 - 14:15	T. Mineeva	JLab data overview
14:15 - 14:45	I. Vitev	Cold energy loss and photons
15:45 - 15:05	W. Bentz	The NJL jet-model for quark fragmentation functions
<b>15:05 - 15:35</b>	<b>Coffee break</b>	
15:35 - 15:55	R. Dupre	Monte Carlo tools and simulations
15:55 - 16:15	K. Gallmeister	Hadron Attenuation and pT-Broadening within GiBUU
16:15 - 16:35	A. Majumder	Higher-Twist energy loss and in medium evolution
16:35 - 16:55	H. Avakian	Modification of transverse momentum distributions in nuclei
16:55 - 18:00	Discussion	
<b>18:30</b>	<b>Workshop Dinner</b>	

**William Brooks**, Universidad Tecnica Federico Santa Maria  
*Coming Unglued: the Life and Times of Quasi-Free Quarks*  
Argonne Physics Division Colloquium - 9 Apr 2010  
11:00 AM, Building 203 auditorium

# Jets and gluon distribution

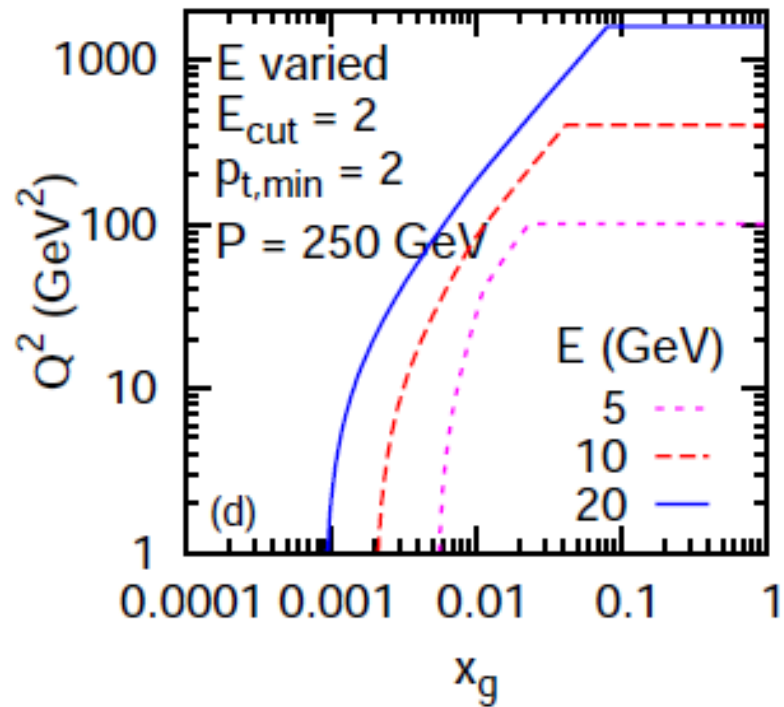
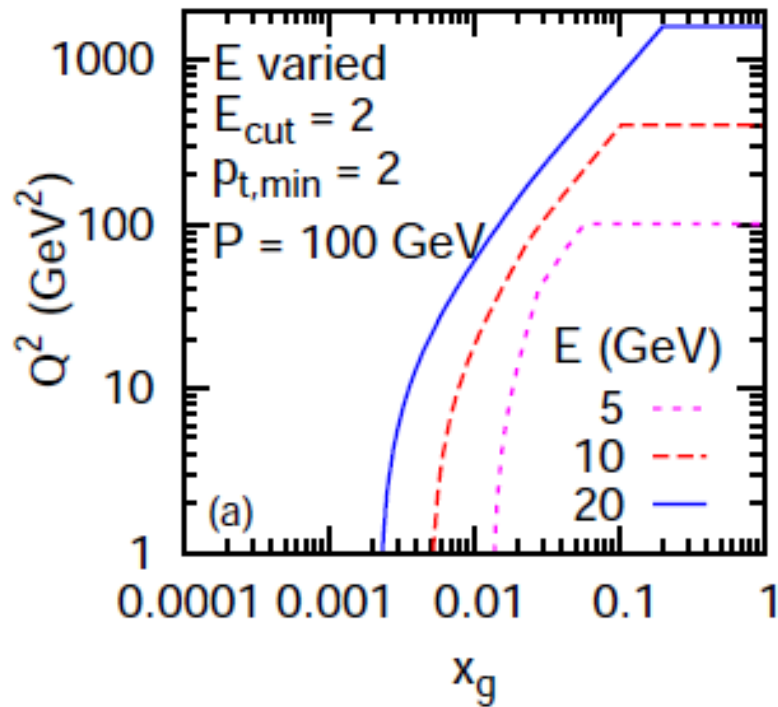


known from inclusive DIS

$$\frac{d^2\sigma_{2+1}}{dx_p dQ^2} = A_q(x_p, Q^2) q(x_p, Q^2) + A_g(x_p, Q^2) g(x_p, Q^2),$$

calculable in pQCD

# Jets and gluon distribution



A final note concerns the medium effects in  $e+A$  collisions. Since the outgoing jets have to travel in the medium, the coefficients  $A_a$  and  $A_g$  will be affected by in-medium propagation. We shall assume here that the measurements of 1+1-jet cross-sections allow to control how jets propagate in the medium and hence to know the corrections to  $A_q$  and  $A_g$ . This is not completely trivial as 1+1-jet events will be highly dominated by quark-initiated jets, while in the 2+1-jet case, we can have both quarks and gluons. As a consequence, the medium effects on  $A_q$  and  $A_g$  will probably introduce an additional systematic error coming from the uncertainty on the gluon-jet propagation<sup>3</sup>.



## What can we learn from jet physics at EIC

- gluon PDF
  - from 2+1 jets
  - $ep$  vs.  $eA$ : shadowing, multiple interactions
- BFKL (and saturation) tests from forward jets
- ...

New tests of parton energy loss, parton showers, jet structure