### Quark Propagation and Hadron Formation

II spokespersons, 15 theory proponents

Microscopic understanding of the fundamental processes involved in QCD hadronization:

- parton propagation, gluon radiation, in medium and in vacuum
  - > production time, transport coefficient, quark energy loss, critical length
- hadron formation, with connections to confinement and hadron structure
  - ► formation times, formation mechanisms, in-medium cross sections
- more than 40 papers and reviews on these subjects since 2006 proposal

Measure:

- (i) broadening of the pT spectrum and (ii) attenuation/enhancement of mesons and baryons;
- correlations of leading hadrons with: photons, slow protons, sub-leading hadrons;
- vs. nuclear size, for five different nuclei, as a function of up to five kinematic variables





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hadron	сτ	mass	flavor content	limiting error
$\pi^0$	25 nm	0.13	uudd	5.7% (sys)
$\pi^{\scriptscriptstyle +}$ , $\pi^{\scriptscriptstyle -}$	7.8 m	0.14	ud, du	3.2% (sys)
η	170 pm	0.55	uuddss	6.2% (sys)
ω	23 fm	0.78	uuddss	6.7% (sys)
η'	0.98 pm	0.96	uuddss	8.5% (sys)
$\phi$	44 fm	1.0	uuddss	5.0% (stat)*
fl	8 fm	1.3	uuddss	_
<i>K</i> <sup>0</sup>	27 mm	0.50	ds	4.7% (sys)
<i>K</i> +, <i>K</i> -	3.7 m	0.49	us, us	4.4% (sys)
р	stable	0.94	ud	3.2% (sys)
$\bar{p}$	stable	0.94	ud	5.9% (stat)**
Λ	79 mm	1.1	uds	4.1% (sys)
A(1520)	13 fm	1.5	uds	8.8% (sys)
$\Sigma^+$	24 mm	1.2	us	6.6% (sys)
Σ-	44 mm	1.2	ds	7.9% (sys)
$\Sigma^0$	22 pm	1.2	uds	6.9% (sys)
$\Xi^0$	87 mm	1.3	us	16% (stat)*
<u></u> -	49 mm	1.3	ds	7.8% (stat)*

Dependency of observables (and thus derived quantities, such as production time, formation times, transport coefficent, in-medium cross section, etc.) on mass, flavor, and number of valence quarks



\*in a bin in z from 0.7-0.8, integrated over all V, pT,  $\phi_{
m pq}$ , and Q2>5 GeV2

\*\*in a bin in z from 0.6-0.7, integrated over all V, pT,  $\phi_{Pq}$ , and Q2>5 GeV2

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- This will be a definitive study: CLASI2 has the luminosity, acceptance, and particle ID to do the ultimate measurement in this energy range, where characteristic times ≈ nuclear dimensions
- A *complete* program of measurements that provides a path to understand hadronization on a microscopic, quantitative basis:
  - fundamental to QCD:
    - hadronization mechanisms
    - flavor, mass, baryon number dependence
  - <u>strong connections</u> to the rest of nuclear and high energy physics:
    - confinement and hadron structure
    - neutrino physics
    - Drell-Yan measurements in p-A collisions
    - heavy ion physics
- An *important* experiment with a wide range of impacts

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