

# EIC Meson Structure Working Group

Meeting 02/22/2021

- History
- Where we are
- Next steps and goals for CY2021

# Pion and Kaon Structure at the EIC – History

- ❑ PIEIC Workshops hosted at [ANL \(2017\)](#) and [CUA \(2018\)](#)
- ❑ ECT\* Workshops: [Emergent Mass and its Consequences \(2018\)](#)

[Mapping Parton Distribution Amplitudes and Functions, \(2018\).](#)

**Pion and Kaon Structure at an Electron-Ion Collider**  
1–2 June 2017, Physics

**Jefferson Lab**  
EXPLORING THE NATURE OF MATTER

**PIEIC2018**  
Workshop on Pion and Kaon Structure at an Electron-Ion Collider  
May 24-25, 2018  
The Catholic University of America  
Washington, D.C.

**Links:**  
Circular  
Registration  
Program  
Transportation  
Lodging  
Participants List

**Introduction**  
This workshop at Argonne National Laboratory will explore opportunities provided by the Electron-Ion Collider (EIC) to study the quark and gluon structure of the pion and kaon and will stake stock of the progress since the earlier workshop at Argonne National Lab: <http://www.piec2018.org>

**Organizing Committee**  
Ian Cloet - ANL  
Tanja Horn - CUA  
Cynthia Keppel - Jlab  
Craig Roberts - ANL

**Sponsors:**  
CUA  
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**Pion and Kaon Structure at the Electron-Ion Collider**

**Eur. Phys. J. A 55 (2019) 10, 190**

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**Workshop on Pion and Kaon Structure Functions at the EIC**

Center for Frontiers in Nuclear Science  
Workshop series

2-5 June 2020  
Online  
US Eastern time zone

**Overview**  
Call for Abstracts  
Timetable  
Contribution List  
Registration  
Participant List  
Contact  
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The Lagrangian masses of the quarks deliver only ~1% of the proton mass, mp, and it is the emergence of the bulk of mp and the (very probably) related mechanism of confinement that are the key unresolved issues in hadron physics. In addressing these issues, the potential of the EIC is enormous. It promises to enable a quantitative understanding of the structure of hadrons, such as the nucleon, pion and kaon, in terms of quarks and gluons, thereby achieving key goals of modern physics. Recent synergistic advances in computation, experiment and theory reveal the prospects for a precise description of the one-dimensional structure of hadrons, exemplified by parton distribution functions (PDFs) and electromagnetic form factors, and of constructing three-dimensional images of hadrons, as expressed in generalized Parton Distributions (GPDs) and Transverse-Momentum Distributions (TMDs). Hence, today, there is an unprecedented opportunity to chart the in-hadron distributions of, *inter alia*, mass, charge, magnetization and angular momentum.

This workshop will canvass recent progress toward a coherent program of pion and kaon structure studies at the Electron-Ion Collider (EIC) that will deliver these maps. Their drawing demands an interplay between experiment and theory. Here, recent experimental developments have been matched by new theoretical insights and rapid computational advances. The progress trail is completed by high-level phenomenology in the form of global structure function fitting frameworks. Machine learning and exascale computing are both expected to play a material role in this march of progress.

This workshop aims to publicize on the success of two prior meetings (PIEIC2017, PIEIC2018), which led to a **White Paper**, published in *Eur. Phys. J. A 55 (2019) 10, 190*. Its near-term goals are to expand this documentation, driving toward a significant new element in the EIC User Group Physics and Detector Handbook, and develop contributions as part of the ongoing Yellow Report Initiative.

Starts Jun 2, 2020, 8:00 AM  
Ends Jun 5, 2020, 7:00 PM  
US Eastern  
Online  
Craig Roberts  
Tanja Horn  
There are no materials yet.

- ❑ [AMBER/CERN Workshop \(2020\)](#)
- ❑ [CFNS Workshop \(2020\)](#)
- ❑ [ECT\\* Workshops \(2021\): Mass in the Standard Model and Consequences of its Emergence](#)

# EIC Meson Structure WG – Where We Are

## Main progress over the last year:

- ❑ Synergy between Lattice QCD, QCD Phenomenology, and Global QCD Fits more refined
- ❑ Much theory progress – interplay emergent- and Higgs-mass mechanisms, gluon pdfs in lattice, global pion structure pdf fits, pressure distributions in pions and kaons, etc., etc.
- ❑ Tagged meson structure capabilities drove forward-detection definition at EIC. Community realization growing of importance and need to make beam line compatible with detection of  $n$ ,  $\Lambda$  (decay), etc.
- ❑ Projections of pion structure functions and pion form factor at EIC shows unique opportunities at EIC.
- ❑ Prominent appearance in EIC Yellow Report.
- ❑ Results documented and article submitted: “Revealing the structure of light pseudoscalar mesons at the Electron-Ion Collider”

# EIC Meson Structure WG – Next Steps

## Goals CY2021

- ❑ Make progress on defining mass sum rules for pion (and kaon) at physical-mass scale
- ❑ Similar, make progress on major parts of theory interface as written in 2.4: direct lattice calculation of contributions, inclusion of lattice in global data analysis, benchmarking calculations with QCD fits and phenomenology, relating Euclidean lattice QCD and continuum methods, mapping the pion light-front wave function.
- ❑ Similar, make progress on documenting gluon pdfs in pion and kaon from LQCD, pion and kaon pressure distributions, impact of emergent- and Higgs-mass interference on physical observables, and quantifying connections to understanding of the pion and kaon mass.
- ❑ Document  $\Lambda/\Sigma$  ratios from published and new L/T separated kaon electroproduction cross sections and make initial estimate if these can allow kaon form factor measurements at EIC.
- ❑ Drive the forward beam line design and detector choice and placement for an alternate second detector/IR optics, and document science gain – this can directly feed into the call for detector proposals.
- ❑ Project tagged kaon structure function data as possible at an EIC and their possible impact as determined from a global QCD fit.
- ❑ Study if tagged pion data at low  $-t$  can produce sufficient quality data for a pion pressure distribution measurement.
- ❑ Correlated, make theoretical progress on QCD backgrounds to ensure one can obtain clean physical pion data for tagged structure function measurements and beyond (pion pressure distribution, pion TMDs) at EIC.

# EIC Meson Structure WG – Next Steps

## Points to add from 2/21/2021 Meeting

- ❑ Impact of off-shellness on structure functions
- ❑ Investigate dependence of impact studies on, e.g. pion flux model
- ❑ Add background to analysis to validate event selection criteria

## Points to add 3/30/2021 – discussion with Garth

- ❑ Forward beamline design: investigate forward angle charged particle momentum resolution  
– how does it impact t-reconstruction