



Structure of Physics WGs

ANALYSIS COORDINATORS Salvatore Fazio (Cosenza)

Rosi Reed (Lehigh)

INCLUSIVE PHYSICS

Tyler Kutz (MIT) Stephen Maple (Birmingham)

SEMI-INCLUSIVE PHYSICS

Ralf Seidl (Riken) Stefan Diehl (UConn)

JETS AND HEAVY FLAVOR

Rongrong Ma (BNL) Olga Evdokimov (UIC)

EXCLUSIVE, DIFFRACTION AND TAGGING

Raphael Dupre (Orsay) Zhoudunming Tu (BNL)

BSM AND PRECISION EW

Ciprian Gal (JLab) Juliette Mammei (Manitoba) Meeting time: Mondays (biweekly) at 12pm ET Mailing list: eic-projdet-Inclusive-I@lists.bnl.gov Indico: https://indico.bnl.gov/category/417/

Meeting time: Tuesdays (biweekly) at 8:30am ET Mailing list: eic-projdet-semiincl-l@lists.bnl.gov Indico: https://indico.bnl.gov/category/418/

Meeting time: Tuesday (biweekly) at 11:30pm ET Mailing list: <u>eic-projdet-jethf-l@lists.bnl.gov</u> Indico: https://indico.bnl.gov/category/420/

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INFN Interest and contribution

pre-TDR and Early Science

Main current efforts:

pre-TDR - Chapter 2: (~60 pages) focus on holistic detector performance, requirements from physics, and science reach

EIC Early Science: focus on the scientific impact of ePIC in its first five years of data taking Next E.S. workshop: April 24-25 @ Stony Book University [hybrid format] https://indico.cfnssbu.physics.sunysb.edu/event/410/

How can we help?

Italy has some potential to exploit (and help with the TDR cause): Leading experience with TMDs and SIDIS (3D imaging in momentum space) Leading experience with diffractive PDFs at HERA (onset of gluon saturation) Leading experience with exclusive processes and GPDs (partonic spatial tomography) Experience with Heavy Flavor tagging [e.g. flavor-tagged PDFs]

> we have an internal INFN milestone for September 2025 on "Performance studies of PID detectors in the extraction of TMDs"



Proposal for EIC Science Program in the First Years

Year - 1

Start with Phase 1 EIC ew Capability: Commission electron polarization in parallel Run: 10 GeV electrons on 115 GeV/u heavy ion beams (Ru or Cu)

Add your preferred science topic

Year - 2

Phase 1 EIC + electron polarization New Capability: Commission proton polarization in parallel Run: 10 GeV polarized electrons on 130 GeV/u Deuterium

Add your preferred science topic

Run:

Last weeks 10 GeV electrons and 130 GeV polarized protons Physics: Add your preferred science topic

Year - 3

Phase 1 EIC + electron polarization

+ proton polarization

New Capability: Commission running with hadron

spin rotators

Run:

10 GeV polarized electrons on 130 GeV transverse polarized protons

Physics:

Add your preferred science topic

Run:

Last weeks switch to longitudinal proton polarization Physics:

Add your preferred science topic

Year - 4

Phase 1 EIC

+ electron polarization

+ proton polarization

+ operation of hadron spin rotators **New Capability:**

Commission hadron accelerator to operate with not centered orbits Run:

10 GeV polarized electrons on 100 GeV Au

Physics:

Add your preferred science topic

Run:

10 GeV electrons on 250 GeV transverse and longitudinal polarized protons

Add your preferred science topic

Year - 5

Phase 1 EIC

- + electron polarization
- + proton polarization

centered orbits Run:

Au

Physics:

Run:

He-3

Physics:

Add your preferred science topic

+ operation of hadron spin rotators + operation of hadron beams with not

10 GeV polarized electrons on 100 GeV

Add your preferred science topic

10 GeV electrons on 166 GeV transverse and longitudinal polarized

Early science program

from the slides of Elke at the ePIC Collaboration Meeting in Frascati last week





Topics of interest

pions/kaons

Torino group using pseudo-data provided by Gregory Matousek (Duke)







Ferrara

Marco Contalbrigo, Staff Researcher

Lorenzo Polizzi, PhD

Pavia

Gianluigi Boca, Staff Researcher

Susanna Costanza, Associate Professor

Nicolò Valle, Postdoc

Theory group: Filippo Delcarro (Postdoc), Marco Radici (Staff Researcher)

Salerno

Annalisa De Caro, Associate Professor

Cristina Ripoli, Postdoc

Laboratori Nazionali del Sud

Dario Lattuada, Tenure Track Researcher

one Postdoc

Trieste

Andrea Bres Professor

Torino

Michela Chiosso, Associate Professor

Davide Giordano, Post Doc

Theory group: Mariaelena Boglione (Full Professor), Emanuele Nocera (Associate Professor), Andrea Signori (Associate Professor)

Andrea Bressan, Associate

First steps

Become familiar with ePIC simulation and reconstruction software

Some useful link&material

https://wiki.bnl.gov/EPIC/index.php?title=SIDIS

https://eic.github.io/documentation/tutorials.html

Tutorial (Ralf Seidl February 2025)



Important for SIDIS analyzers

 DIS Kinematics, etc: // Inclusive kinematics: exist for methods "Electron","JB","DA","Sigma","eSigma" and "Truth" TTreeReaderArray<float> Kinematics x (tree reader, recox.data());





- TTreeReaderArray<float> KinematicsElectron x (tree reader, "InclusiveKinematicsElectron.x");
- std::string recox = "InclusiveKinematics"+reco+".x";
- std::string recoq2 = "InclusiveKinematics"+reco+".Q2";
- std::string recow = "InclusiveKinematics"+reco+".W";
- std::string recoy = "InclusiveKinematics"+reco+".y";
- std::string recoindex = " InclusiveKinematics"+reco+" scat.index";
- TTreeReaderArray<float> Kinematics Q2 (tree reader, recoq2.data());
- TTreeReaderArray<float> KinematicsE W (tree reader, recow.data());
- TTreeReaderArray<float> KinematicsElectron y (tree reader, recoy.data());

exclusive+diff+tag PWG

GPDs impact studies



- **INFN Institutes:** Cosenza (S. Fazio) Milestone y23
- Collaborators: BNL, Saclay, Warsaw, Mainz, Zagreb
- 0 S.F., K. Kumericki et al. - JHEP09(2013)093], now with:
 - ePIC full simulation and realistic event reconstruction
 - state of art models (GK and KM20) and radiative effects

✓ INFN Milestone y23 [100%]: Use the novel EpIC generator [Eur. Phys. J. C 82 (2022) 9, 819] to produce DVCS, TCS and mesons physics benchmarks

Paper about to be submitted to arXiv:

- GPDs impact studies. Quantify the impact of ePIC in constraining CFFs and GPDs, from DVCS and TCS measurements
- **Future Goal:** Add mesons and explore the possibility of disentangling flavor contribution to **GPDs**

Aim at performing impact studies for GPDs, similarly to [E.C. Aschenauer,

exclusive+diff+tag PWG

Diffractive PDFs

A Torino-Cosenza collaboration

M. Ruspa (TO), M. Capua, S. Fazio, H. Hashamipour, E. Tassi (CS)

• Proton DPDFs not yet exploited for the EIC

good constrain on the gluon densities though scaling violation

• Interesting to evaluate ePIC's capability to

Investigate the transition into saturation regime



Control Plots:





Use RAPGAP for event generation

- 42 million events as mock data
- 42 million events as MC data, total 84 million events
- Beam energies: 10 GeV e x 100 GeV p
- Q² and t distributions, rapidity of scattered proton

Jets and Heavy Flavor WG



INFN Institutes: Bari (S. Kumar, A. Mastroserio), Pavia (G. Boca)

Secondary vertex ID still under development at ePIC! One of the reconstruction priorities

PLAN: Quantify the impact for the tracker into heavy flavor physics

Heavy flavor D0 meson

Shyam Kumar (INFN, Bari), Connie Yang (UT Austin)

Fast simulation -> "reality": D0 topological reconstruction

- Machine learning to optimize topological cuts:
- Secondary vertexing: still under development
- ep 10x100 D0 enriched: official production is now available

For 5 fb-1 which corresponds to 6.5M ep collisions at 10x100 with Q2 > 100 GeV2, we expect significance ~ 30 in total with current study





How Boosted Decision Tree (BDT) classifier separates signal from background

Summary

INFN groups activities focused on three working groups:

Semi-inclusive physics Exclusive, diffractive and tagging Jets and Heavy Flavor

Works starting or ongoing

Focus on early science

Next E.S. workshop: April 24-25 @ Stony Book University [hybrid format] https://indico.cfnssbu.physics.sunysb.edu/event/410/

<u>News:</u> We are thinking to organize a 2-days SIDIS WG meeting in person in Pavia in May