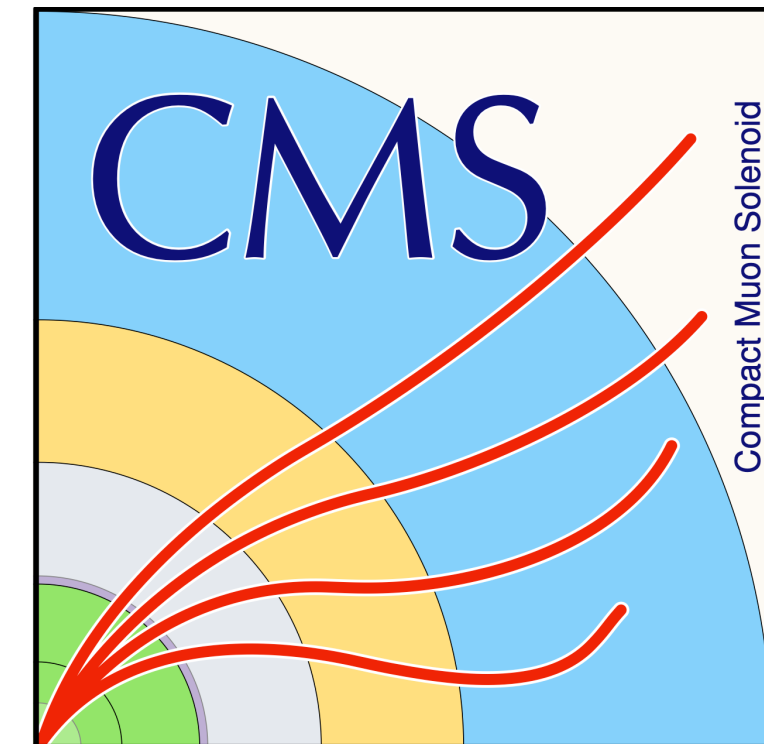




Alexander von
HUMBOLDT
STIFTUNG



(Non-) Perturbative computations

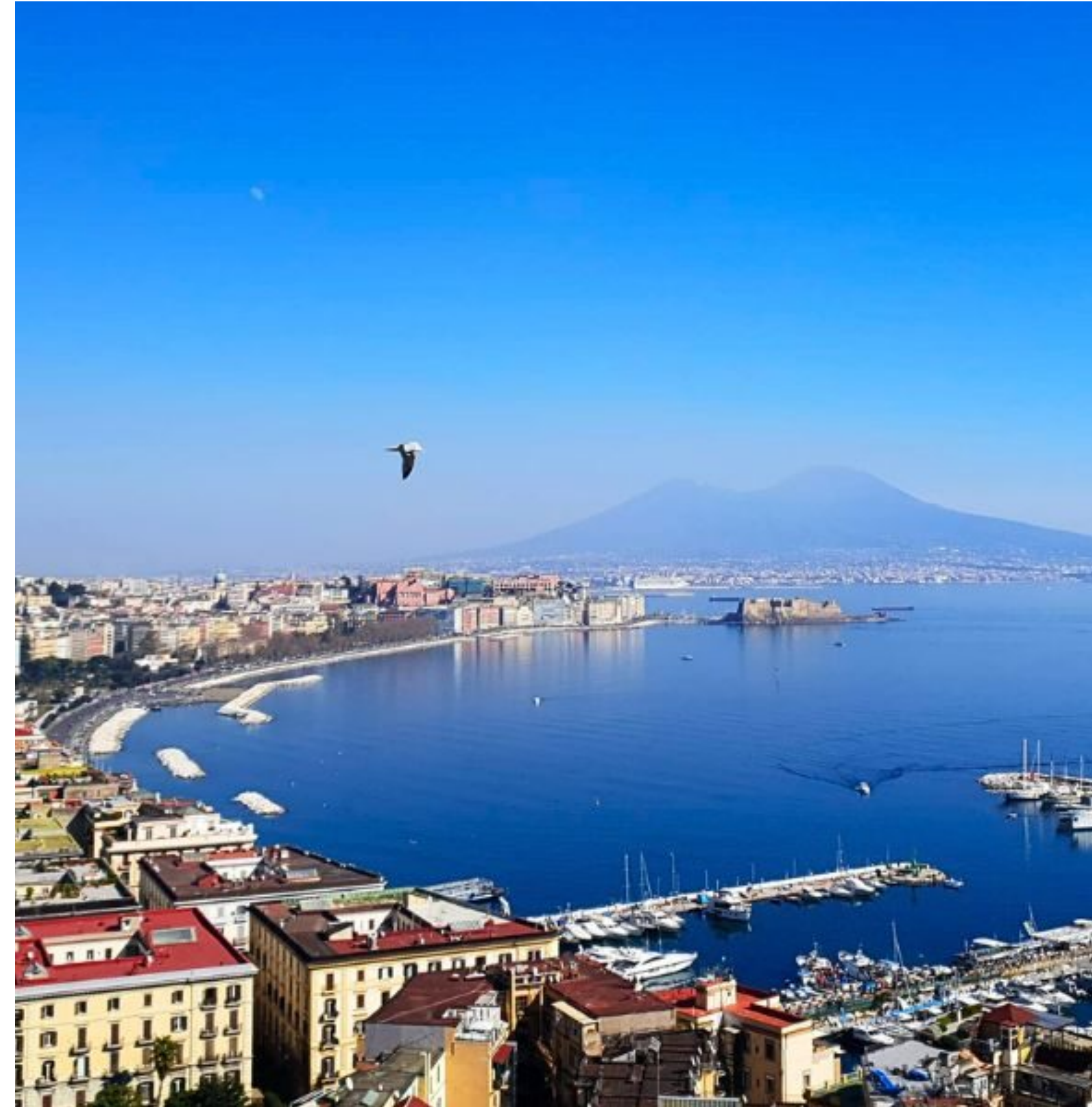
Theory Fellows Meeting
DESY
18 November 2024

Giovanni Limatola
giovanni.limatola@desy.de
Office 02.213

HELMHOLTZ

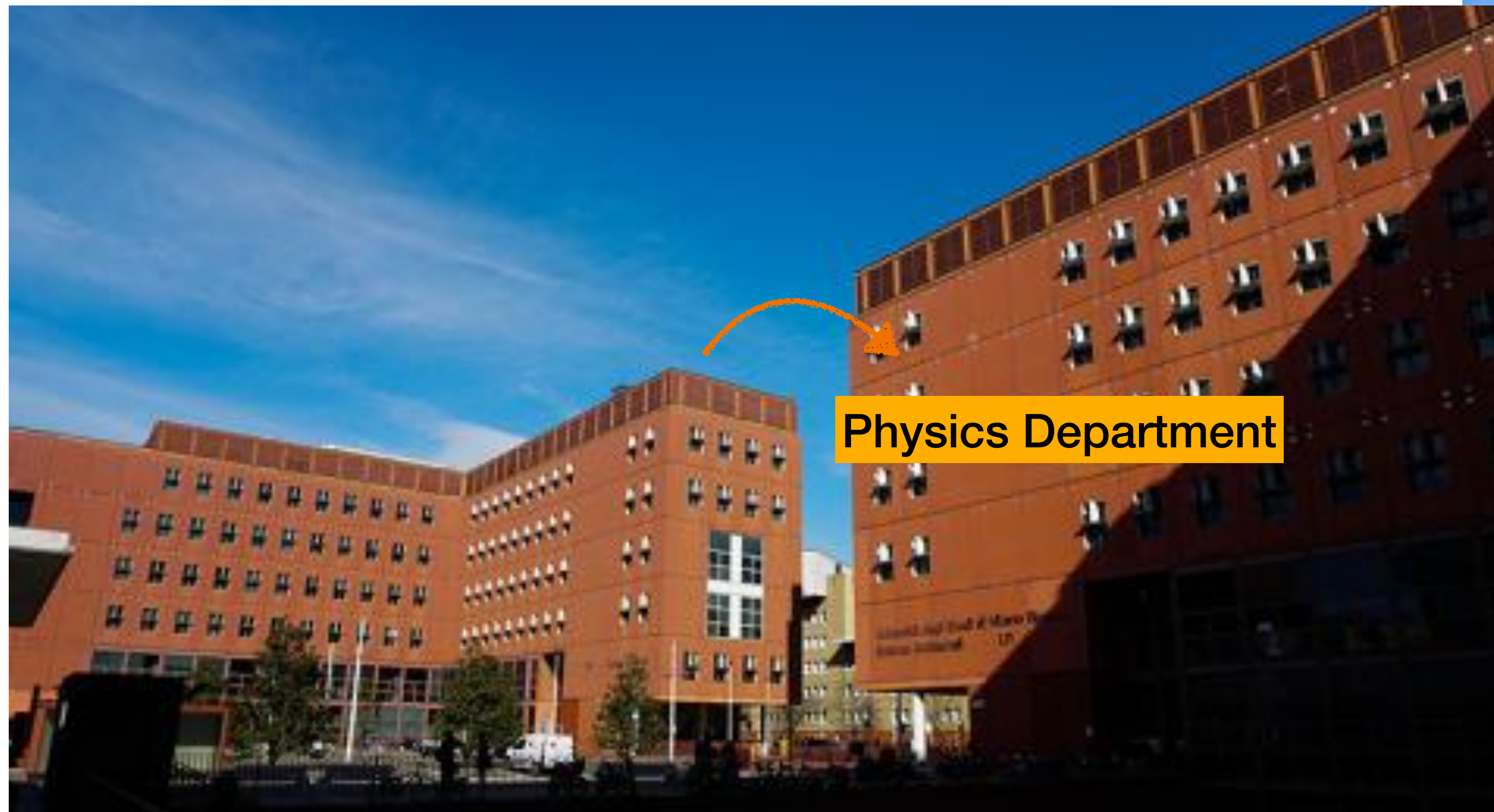
My Background

- Born and grown up in Naples
- Bachelor and Master at Università “Federico II” di Napoli (2019)



My Background

- Moved to Milan in 2019
- Ph.D. at Università di Milano Bicocca (2022)



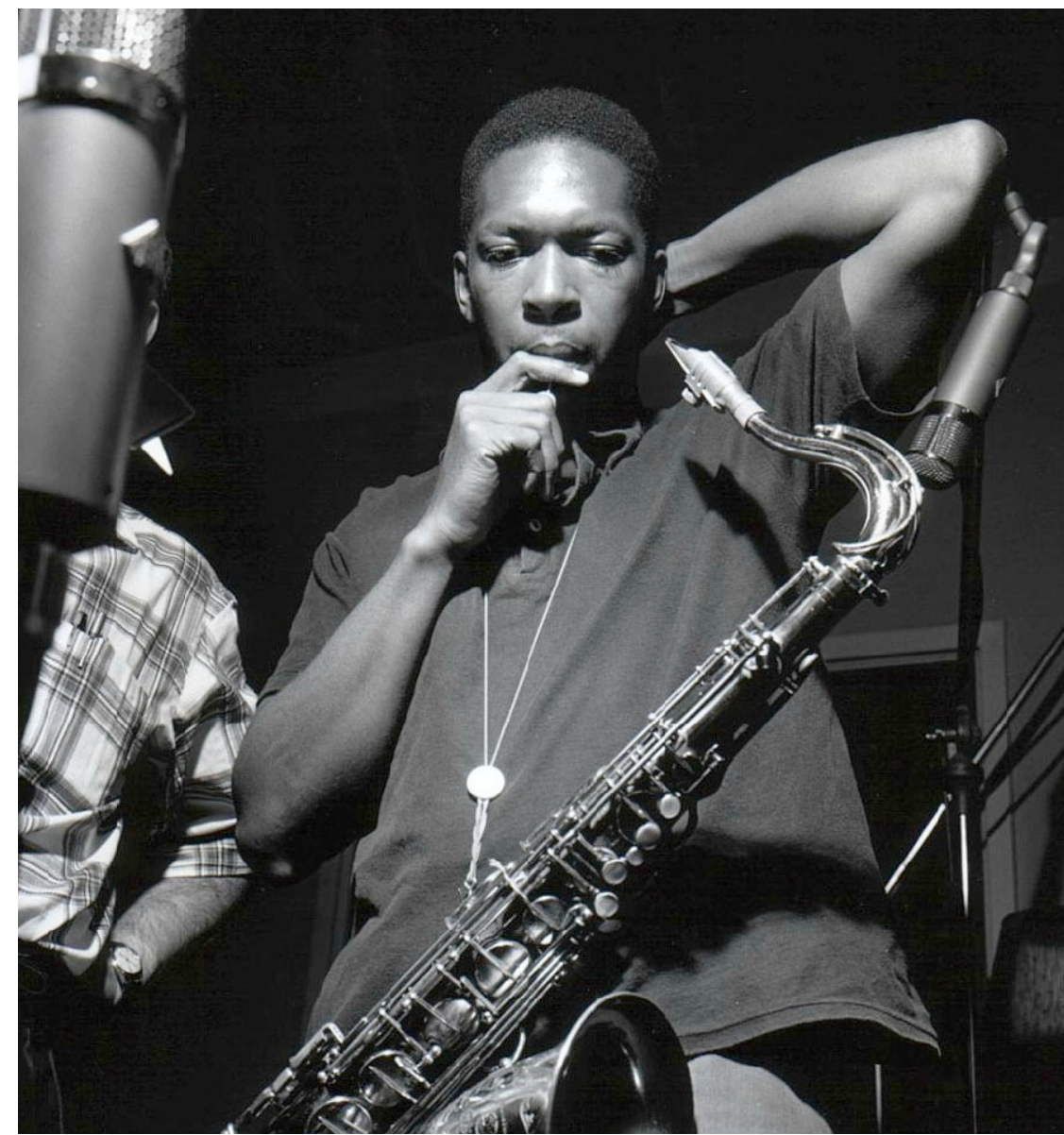
My Background

- Moved to Turin in 2022
- First Post Doc in Turin (2022-2024)
(San Salvario to be more precise!)



My Interests

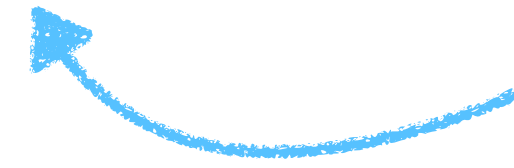
- Music: especially Jazz and Classical Music! (Also Rock, Folk, Country, Blues...)
- Playing Music! (**Clarinet Player**)



My Interests

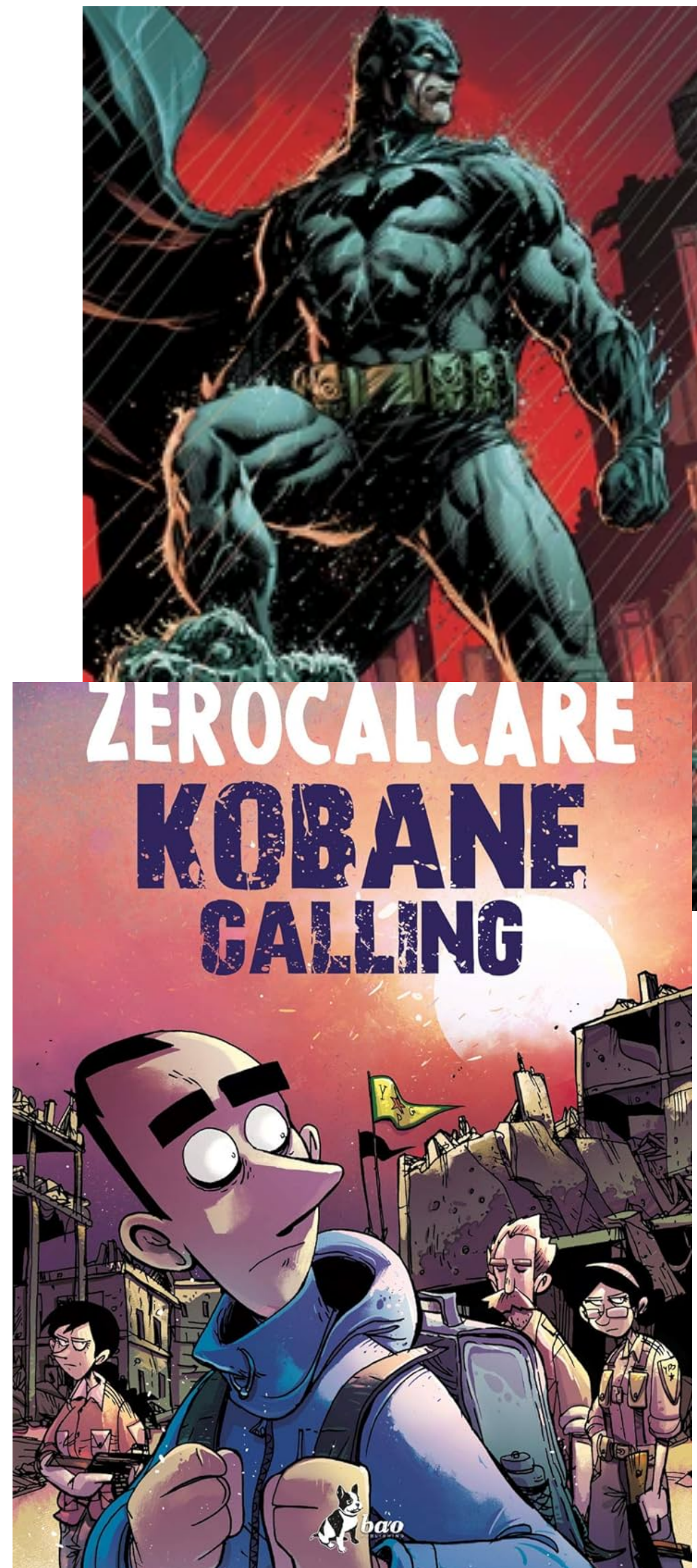
- Music: especially Jazz and Classical Music! (Also Rock, Folk, Country, Blues...)
- Playing Music! (**Clarinet Player**)
- Football: great **Napoli** supporter!

Maradona better than Pele!!!



My Interests

- Music: especially Jazz and Classical Music! (Also Rock, Folk, Country, Blues...)
- Playing Music! (**Clarinet Player**)
- Football: great **Napoli** supporter!
- Reading: books, comics (DC for life)



My previous work

Linear Power Corrections in Collider Observables associated with *Infrared Renormalons*

JHEP 06 (2021) 018, JHEP 01 (2022) 093, JHEP 12 (2022) 062

$$d\sigma = \sum_{i,j} \int dx_1 dx_2 f_{i,P_1}(x_1) f_{j,P_2}(x_2) (x_1 P_1, x_2 P_2) d\hat{\sigma}_{ij} \times \left[1 + \left(\frac{\Lambda_{\text{QCD}}}{Q} \right)^p \right]$$

$$d\hat{\sigma} = d\hat{\sigma}_{\text{LO}} + \underbrace{\left(\frac{\alpha_s}{\pi} \right) d\hat{\sigma}_{\text{NLO}}}_{\simeq 10\%} + \underbrace{\left(\frac{\alpha_s}{\pi} \right)^2 d\hat{\sigma}_{\text{NNLO}}}_{\simeq 1\%} + \left(\frac{\Lambda_{\text{QCD}}}{Q} \right)^p d\hat{\sigma}_{\text{NP}}$$

$$\begin{aligned} &\simeq 1 - 10\% \\ &Q = 100 \text{ GeV} \\ &p = 1 \end{aligned}$$

These Non-Perturbative corrections can be related to the factorial growth of perturbative expansion when increasing order and are dubbed *Infrared Renormalons*!

My previous work

Linear Power Corrections in Collider Observables associated with *Infrared Renormalons*

[JHEP 06 \(2021\) 018](#), [JHEP 01 \(2022\) 093](#), [JHEP 12 \(2022\) 062](#)

- Such corrections arise from low momentum regions!
- Particular focus upon shape variables V in the three-jet region at NLO (Thrust, C-parameter)
- Show up as a shift in the observable

$$\tilde{\Sigma}^{\text{had}}(v) = \Sigma(v - \delta_{\text{NP}}(v))$$

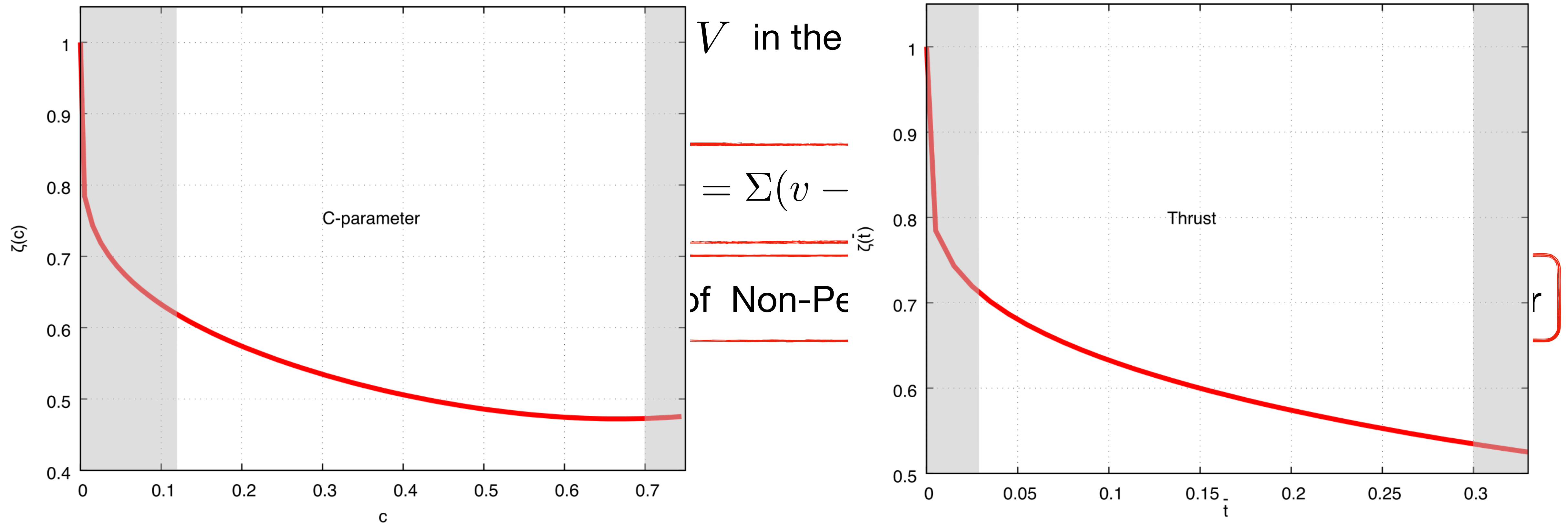
First estimate of the full functional form of Non-Perturbative shift for Thrust and C-Parameter

My previous work

Linear Power Corrections in Collider Observables associated with *Infrared Renormalons*

[*JHEP 06 \(2021\) 018*](#), [*JHEP 01 \(2022\) 093*](#), [*JHEP 12 \(2022\) 062*](#)

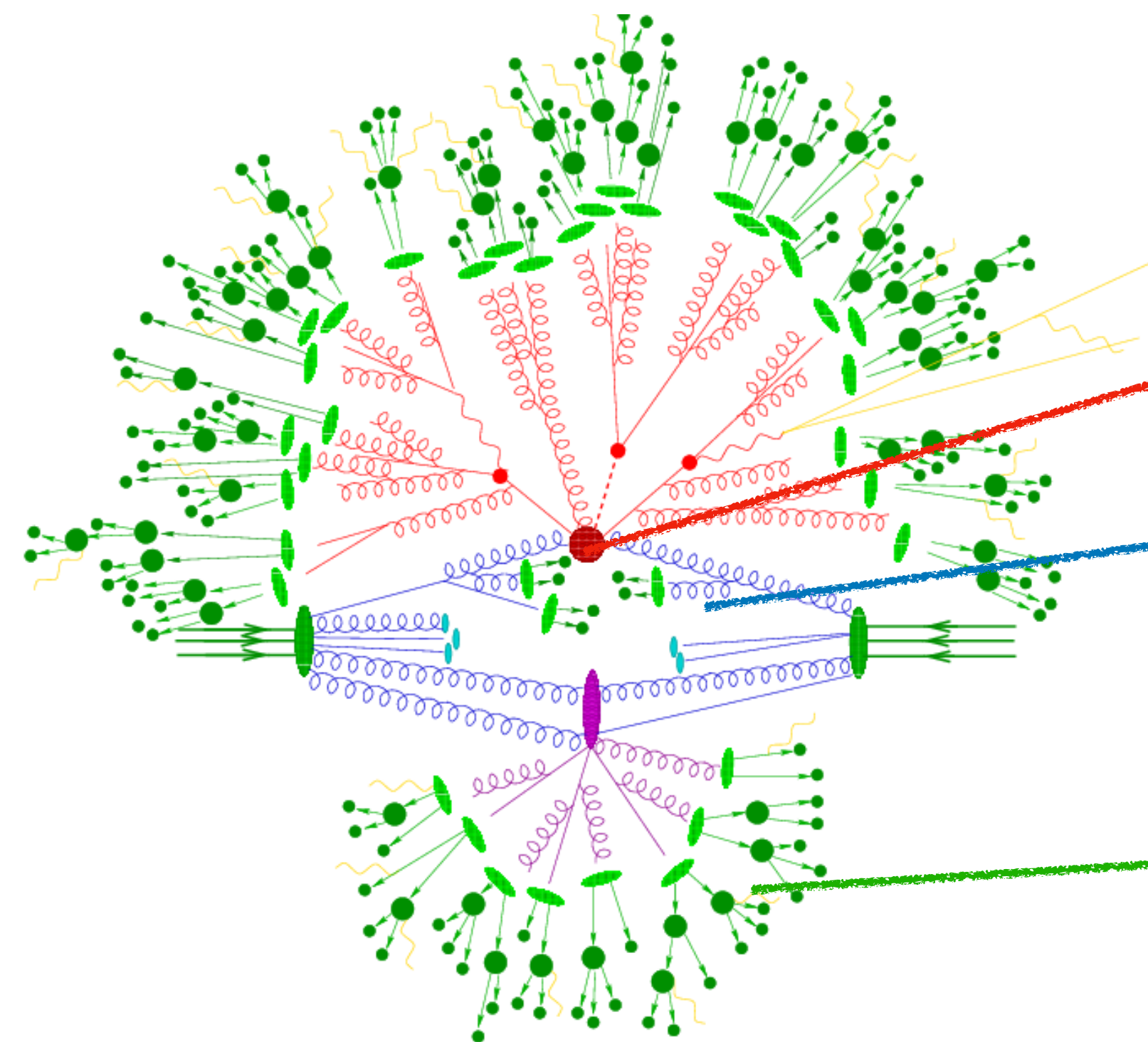
- Such corrections arise from low momentum regions!



My previous work

"An Event Generator for Lepton-Hadron Deep Inelastic Scattering at NLO+PS with POWHEG including mass effects"

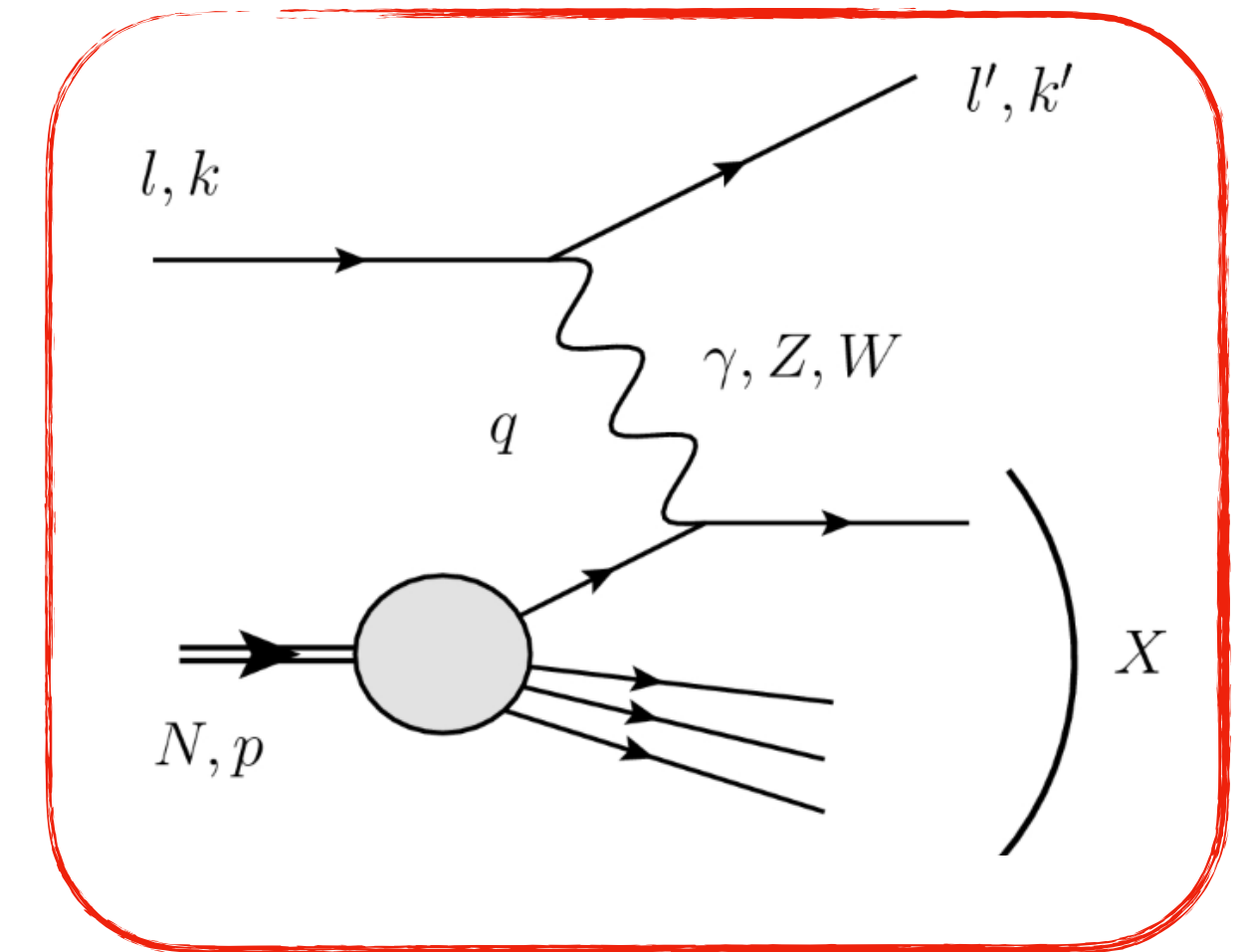
JHEP 08 (2024) 083



Hard Scattering
Perturbative QCD

Parton Shower

Hadronization



Shower Monte Carlo program

Fully differential distributions at NLO+PS accuracy for both charged and neutral current neutrino scattering
also including charm quarks

My previous work

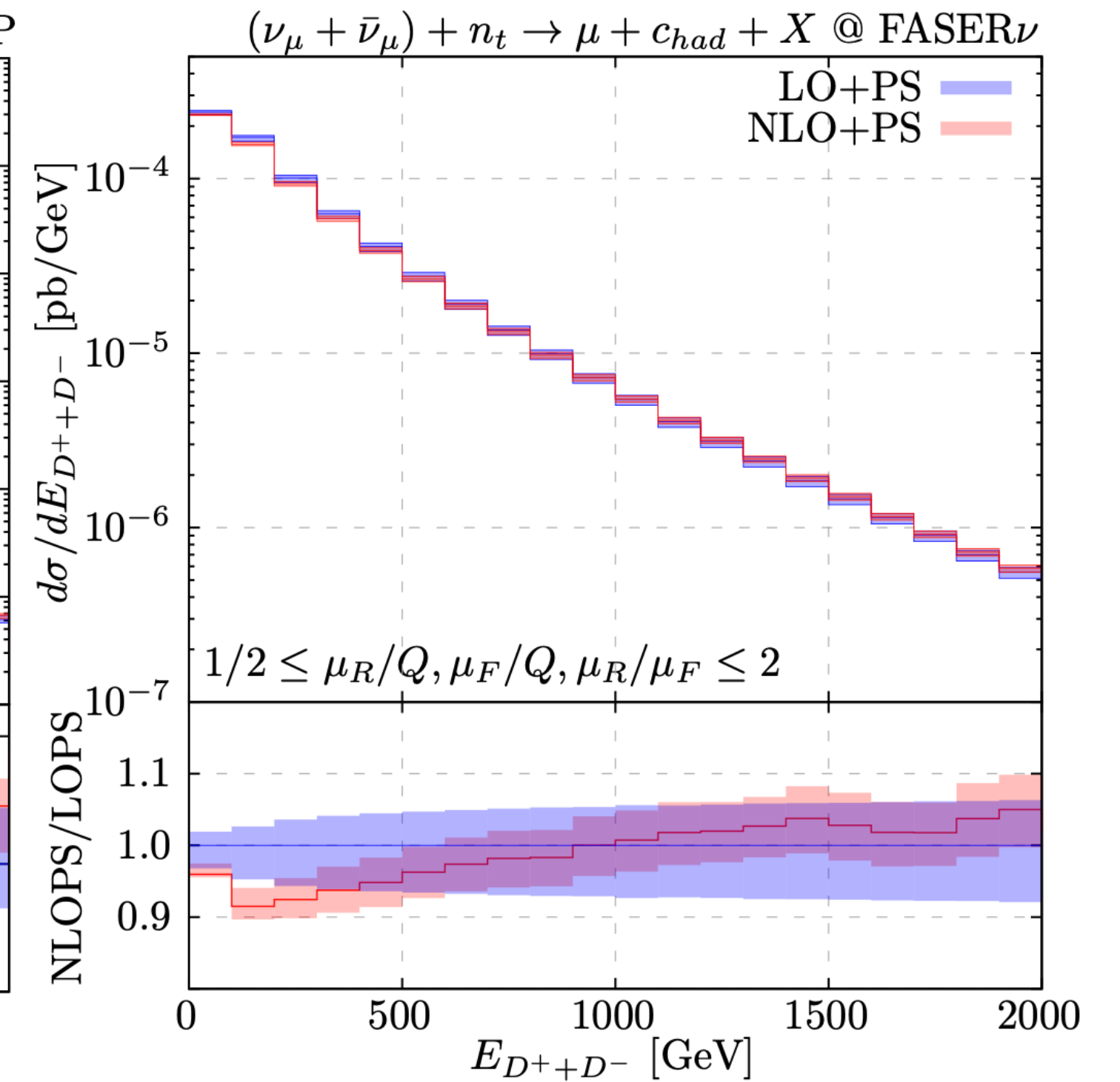
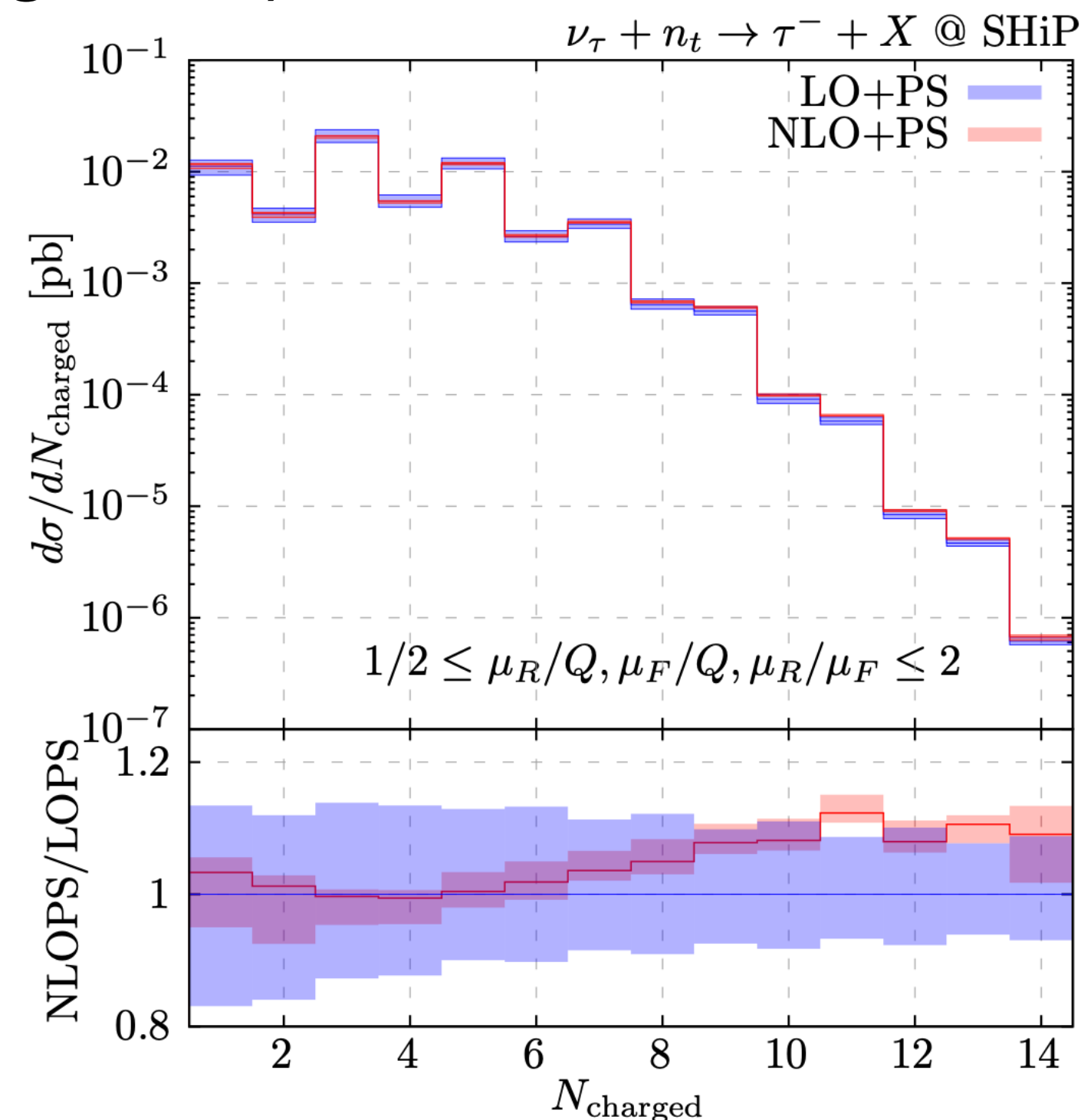
"An Event Generator for Lepton-Hadron Deep Inelastic Scattering at NLO+PS with POWHEG including mass effects"

JHEP 08 (2024) 083

Predictions for fixed energy incoming neutrinos and for neutrino fluxes as well!

Three experimental setups (tungsten target n_t)

- $\nu_\tau + n_t \rightarrow \tau^- + X$ at SND@LHC
- $\nu_\tau + n_t \rightarrow \tau^- + X$ at SHiP
- $(\nu_\mu + \bar{\nu}_\mu) + n_t \rightarrow \mu + c_{had} + X$ at FASER ν



My previous work

Based on:

- Local Analytic Sector Subtraction (LASS) ([Magnea et al... \[1806.09570\]](#), [\[1809.05444\]](#), [\[2010.14493\]](#))
- Completely developed at NLO for QCD@LHC processes (massless final state) ([Bertolotti et al... \[2209.09123\]](#))
- Extended at NNLO for final state IR singularities! ([Bertolotti et al... \[2212.11190\]](#))

Stay Tuned...



- Numerical implementation of LASS within a process independent framework at NLO + mass effects ([Bertolotti, GL, Torrielli, Uccirati \[to appear soon...\]](#))
- Numerical implementation of NNLO formulas for final state regions ([Bertolotti, GL, Torrielli, Uccirati \[to appear soon...\]](#))

**Thank you for the attention and
nice to meet you!!!**