

JRA4-WP22
3D structure of the nucleon in momentum space (TMD-neXt)
Alessandro Bacchetta

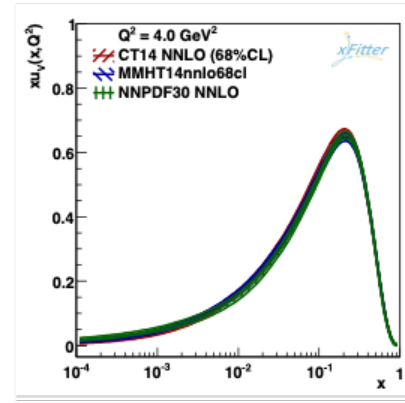
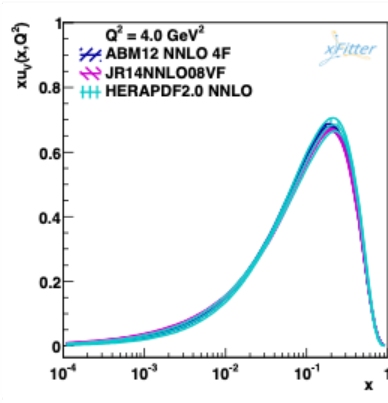


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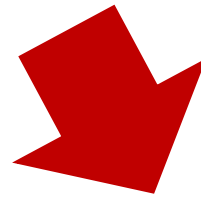
1. INFN
 1. Frascati
 2. Cagliari
 3. Ferrara
 4. Pavia
 5. Torino
 6. Trieste
2. CEA/IRFU Saclay
3. CNRS/CPHT Palaiseau
4. University of the Basque Country, Bilbao
5. LIP, Lisbon
6. Universidad Complutense, Madrid
7. Rijksuniversiteit Groningen
8. University of Montenegro





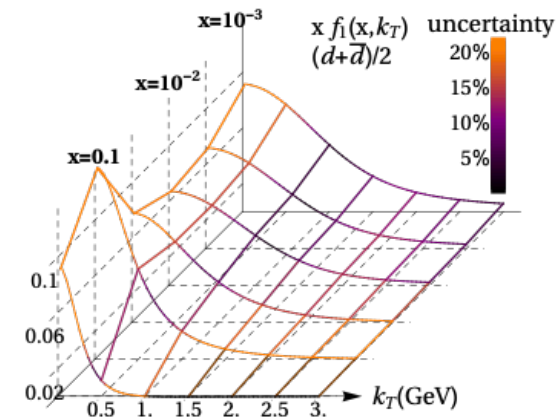
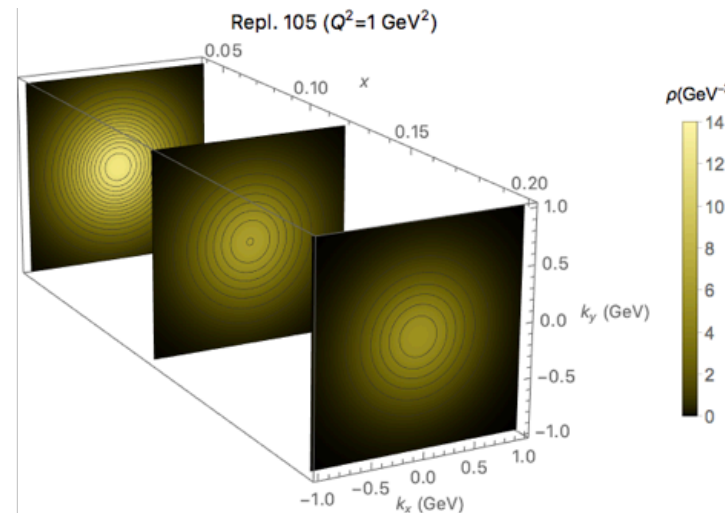
standard PDFs

JRA4



From standard PDFs to
Transverse-Momentum-Dependent PDFs

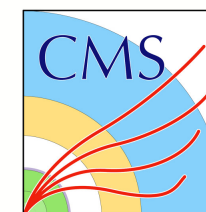
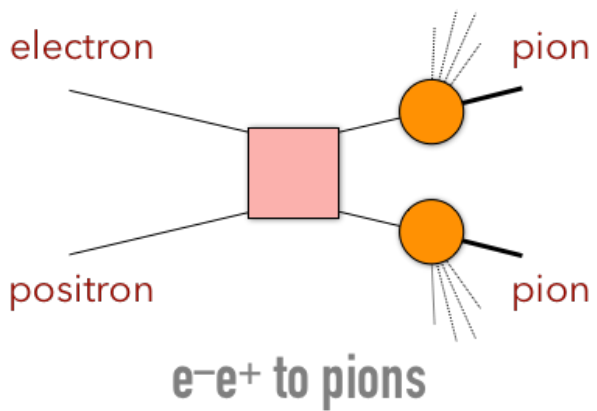
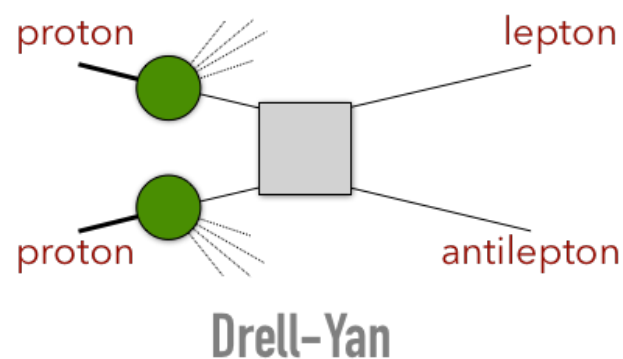
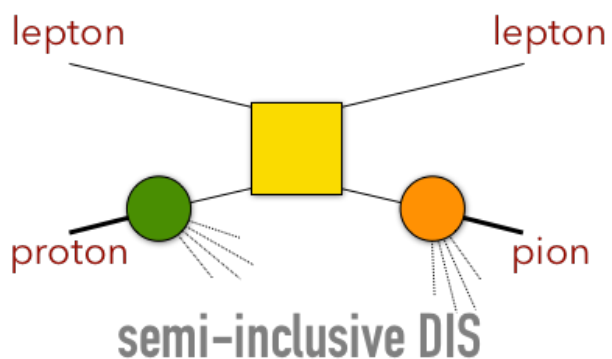
TMD PDFs



Bacchetta, Delcarro, Pisano, Radici, Signori, arXiv:1703.10157

Bertone, Scimemi, Vladimirov, arXiv:1902.08474

Where do you access TMDs?



Overall situation

- Progress taking place in each task
- Complex WP, with theory and several experiments together
- Already more than a dozen publications, mainly theory/phenomenology

(note: I will mention in the following only the publications that are more closely related to the tasks, but there are other publications)

- Not much money used so far

Costs

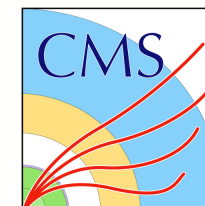
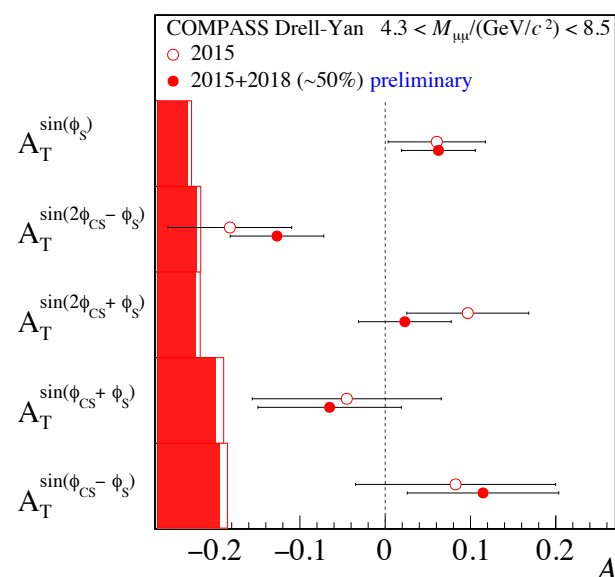
- Personnel: two researchers have been hired (at INFN Trieste and U. Montenegro). The goal is to hire 4-5 more researchers for two years, using matching funds. Most of the hiring should take place next year.
- Other costs: participation to a few conferences and workshops, but only about 3500€ have been spent, also due to Covid

WP Tasks

- Task 1. Analysis of Drell-Yan data.
- Task 2. Analysis of semi-inclusive DIS data
- Task 3. Analysis of electron-positron data
- Task 4. Quark TMD extractions
- Task 5. Gluon TMD studies

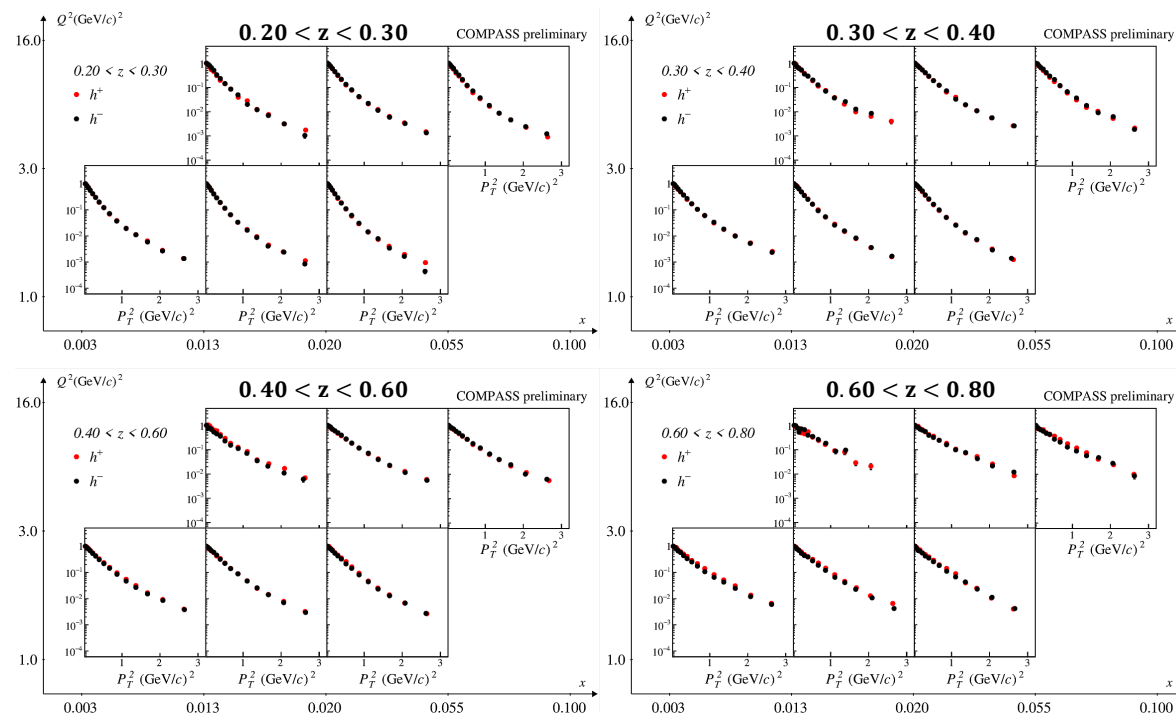
Analysis of Drell-Yan (DY) data

The analysis of COMPASS (2018 data taking) and CMS (2016 data taking) are in an advanced stage.
Publications expected in 2021.



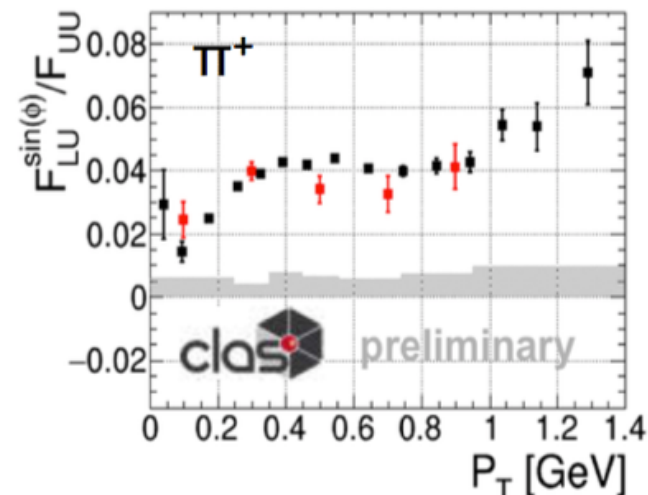
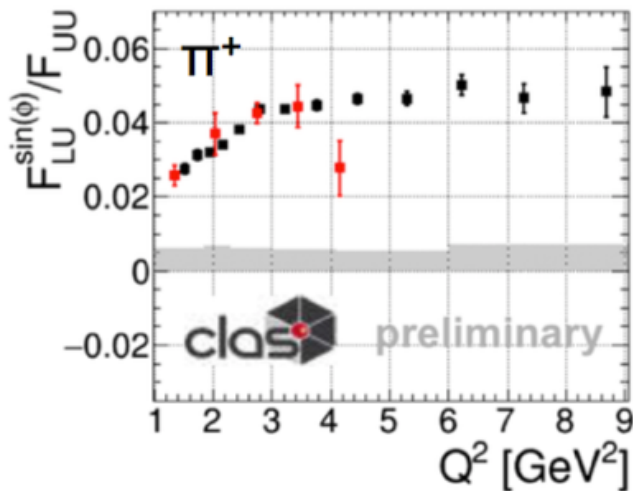
Analysis of semi-inclusive DIS data

The analysis of COMPASS (2016 data taking) is in an advanced stage.



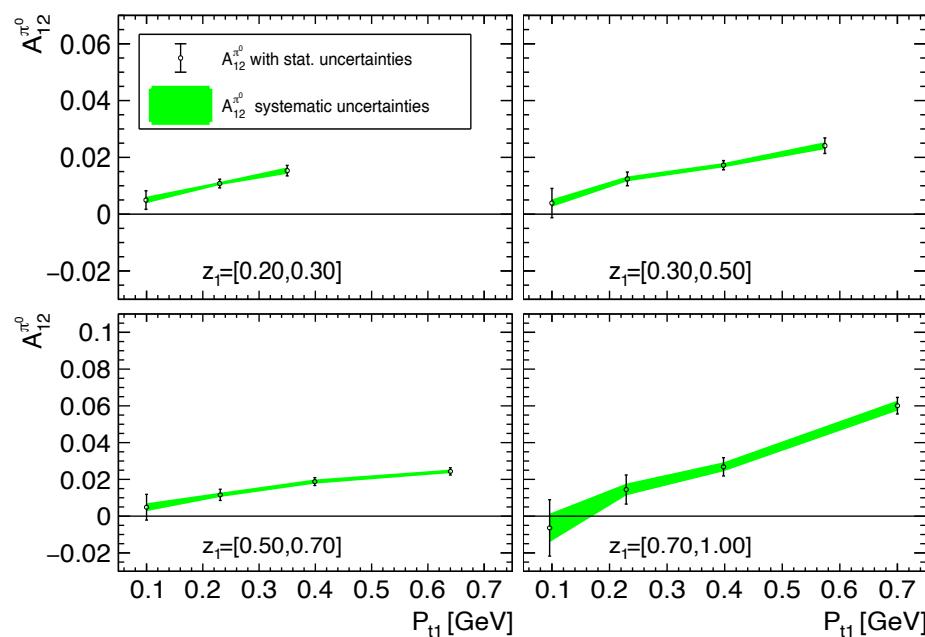
Analysis of semi-inclusive DIS data

CLAS: the original plan was to do measurements with polarized target. However, it is not clear when data taking will happen (see also discussion of milestones). Nevertheless, data with polarized beam have been analyzed and publications are expected in 2021.



Analysis of e^+e^- annihilation

Azimuthal asymmetries at BELLE have been published ([arXiv:1909.01857](https://arxiv.org/abs/1909.01857)).
Analysis of hadron multiplicities in progress.



Task 4

Quark TMD extractions

Extraction of unpolarized TMD PDFs and FFs from Drell-Yan-like and SIDIS processes (**arXiv:1912.06532**).

A theoretical study of the PT-dependent cross sections in e^+e^- single hadron production was presented (**arXiv:2007.13674**).

Extraction of the quark polarizing fragmentation function for a Λ hyperon (**arXiv:2003.01128**).

Phenomenological study of the quark Boer-Mulders TMD (**arXiv:2004.02117**).

Task 5

Gluon TMD studies

Theoretical studies of gluon TMDs in quarkonia production were published (**arXiv:1909.05769**, **arXiv:2004.06740**).

Access to gluon TMDs through unpolarized observables and transverse single-spin asymmetries for quarkonium production in hadronic collisions was studied (**arXiv:1909.05769**, **arXiv:1910.09640**)

Studies were conducted on quarkonia production in SIDIS (**arXiv:2004.06740**, **arXiv:2007.05547**, **arXiv:2008.07531**). A model for gluon TMD was developed, which can be used for estimates of observables (**arXiv: 2005.02288**).

Deliverables

	Deliverable name	Date
D22.1	TMD data from DY, SIDIS, e^+e^-	24, 36, 48
D22.2	Parametrizations of TMD PDFs and FFs	48
D22.3	Estimates of quarkonium production in electron-proton collisions	48

No deliverable was foreseen in the first periodic report, however something has already been achieved.

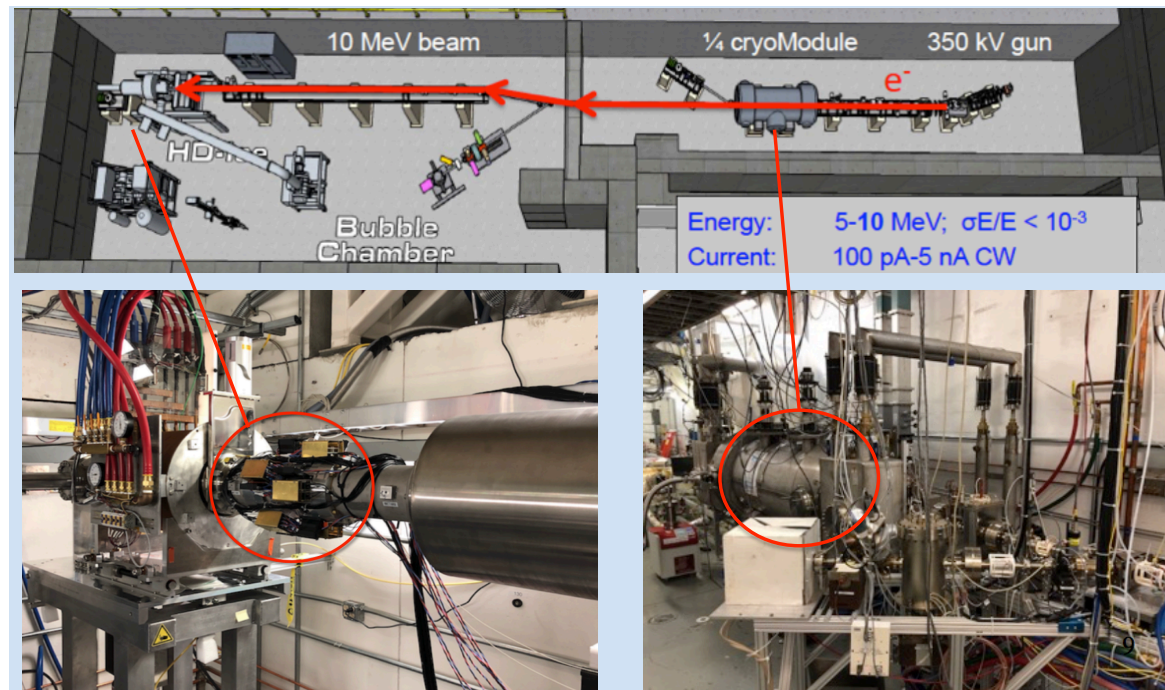
- Azimuthal asymmetries in e^+e^- were published.
- Parametrizations of TMD PDFs and FFs have been obtained and will also be made available to public through VA2- 3D partons.
- One article with estimates of quarkonium production in SIDIS published.

Milestone number ¹⁸	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS42	Implementation of polarized target at CLAS12	30 - INFN	15	Polarized target up and running

Advancement: the longitudinal NH_3/ND_3 target is under construction, the transverse HD-ice target is ready for the performance validation with the JLab UITF test beam.

Expected delivery date: the (transverse) target is ready and should be tested in the next months, with some delay compared to plans due to Covid-19. However, it is not clear when it will be installed in the beamline to take data. This depends on JLab scheduling.

MS42 was supposed to be achieved by August 2020



Expected results and impact

The amount of TMD data will be significantly increased.

At least two sets of unpolarized TMD PDFs and FFs will be completed and made available to public, not only through publications, but also through VA2 - 3D partons.

We expect also to obtain other extractions of polarized TMDs, with less data and accuracy compared to the unpolarized ones.

Results are already being used for studies related to Electron Ion Collider.

Impact expected also in comparison with LHC measurements and search for new physics.