EICUG 2nd detector meeting

CFNS, Stony Brook, Dec 6 – 8 2022

Exclusive vectormeson production at EIC

Simulations based on the CORE detector proposal

Stefan Diehl

JLU Giessen and UCONN

Physics Motivation



Physics Motivation





4 chiral even GPDs 4 chiral odd GPDs

Deeply virtual meson production



Sensitivity of DVMP to GPDs and their flavour



Sensitivity of DVMP to GPDs and their flavour

The COMPASS Collaboration, submitted to Eur. Phys. J. C (2022), arXiv:2210.16932

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$$\frac{d^3\sigma(ep \to e'p'V)}{dx_B dQ^2 dt} \propto \frac{d\sigma_T}{dt} + \epsilon \frac{d\sigma_L}{dt}$$

$$\frac{d\sigma_L}{dt} \propto |H|^2$$

$$\frac{d\sigma_T}{dt} \propto |H|^2 + |\widetilde{H}|^2$$

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10⁻¹

 $Q^2 ((\text{GeV}/c)^2)$

Kinematic coverage



EIC: $10^{-4} < x_{\rm B} < 0.01$

➔ Gluon and sea quark GPDs

→ So far only accessed with ZEUS and H1 at HERA (and early studies at CERN and Fermilab)

EIC: 1000 times more luminosity! → Fully multidimensional study

Expected cross sections

p(e-) x p(p):	18x275	10x275	5x275	10x100	5x100	5x41
L =	1.65×10^{33}	10.05×10^{33}	$5.29{\times}10^{33}$	4.35×10^{33}	3.16×10^{33}	0.44×10^{33}

		10 x 275 Q ² > 4 GeV ²			18	x 275	Q² > 1 G	² > 1 GeV ²		
σ ir	n pb: _{p⁺}	 р ⁰ → π+ π ⁻	ц Ц Щ Щ Ц	$\varphi \to K^+K^-$	J/Ψ → e⁺ e⁻	-μ+μ	$Y \rightarrow e^+ e^-$ Q ² > 1 GeV ²	Q² > 0 GeV²	$Y \rightarrow \mu^+ \mu^-$ Q ² > 1 GeV ²	Q² > 0 GeV²
18	275	930	1,7	72	10.3	10.4	0,057	0.39	0,060	0.40
10	275	817	1,5	63	7,9	8,1	0,040	0.27	0,042	0.28
5	275	691	1,3	52	5,7	5,8				
5	100	515	0,98	38	3,2	3,3				

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MC simulations

Simulations based on: estarlight generator

S. Klein M. Lomnitz, "Exclusive vector meson production at an electron-ion collider", Physical Review C 99, 015203 (2019), arXiv:1803.06420

Reconstruction based on: DELPHES Monte Carlo for the CORE detector proposal



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12/07/2022

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Required resolution

red: generated blue: reconstructed (CORE prop.)



→ Mass resolution should be sufficient to measure the natural width of ¢ to obtain an optimal signal / background separation





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Required resolution

red: generated blue: reconstructed (CORE prop.)



→ For J/ ψ ans Y an excellent resolution of the lepton pair reconstruction is required!

Measuring transition GPDs at the EIC

➔ From the Ground state nucleon to nucleon resonances



How does the exitation affect the **3D structure** of the Nucleon?

 \rightarrow Pressure distributions, tensor charge, ... of resonances?

→ Information encoded in transition GPDs

→ Measurement i.g. with non-diagonal processes (DVCS, DVMP)

Non-diagonal DVCS / DVMP

non-diagonal DVMP

non-diagonal DVCS



factorisation expected for: -t/Q² small, $Q^2 > M^2_{N^*}$ x_B fixed

Requirements of non-diagonal DVCS / DVMP

DVCS photon / DVMP meson (small |t|) → Same requirements as classical DVCS / DVMP

But: Instead of a ground state nucleon, the backward particle is now a N*

Simplest decay: $N^* \rightarrow N + meson$ (i.e. $p \pi^0$ or $n \pi^+$)

→ Deacy particles, especially the meson can have very low momenta

→ Low momentum threshold needed in the backward region!

→ For p π^0 a backward coverage for photons and for n π^+ a neutron detection is needed!

Workshop in 2023: https://www.ectstar.eu/workshops/ect-apctp-joint-workshop-exploring-resonance-structure-with-transition-gpds/

Conclusion and Outlook

- ➔ Exclusive VM production provides a powerfull tool for a flavour decomposition of GPDs and to access the gluon GPDs.
- ➔ The CORE proposal already showed very promissing characteristics for the reconstruction of exclusive VM channels.
- ➔ The measurement of non-diagonal processes allows the study of transition GPDs.
 - → Special requirements for the detection of the N* decay products.

Detector experience of the group in Giessen

group leader: K.-T. Brinkmann

➔ Several R&D projects in the field of basic development and characterisation of anorganic scintillators (light yield, radiation hardness,) i.e. PbWO₄, BaF₂, LYSO:Ce, anorganic fibers ...

- ➔ Leading role in the construction of the PbWO₄ based PANDA barrel EMC
- ➔ Experience with sampling calorimeters → PANDA Shashlyk EMC tests
 - → Prototype tests with LuAG:Ce and glass fibers in a lead matrix
- Development and characterisation of silicon detectors
 - ➔ PANDA MVD
 - ➔ All kinds of radiation hardness tests



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