DE LA RECHERCHE À L'INDUSTRIE







# The PARTONS framework



Nucleon and resonance structure | Hervé MOUTARDE

May  $31^{\rm st}$ , 2017



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# Motivations.

3D imaging of nucleon's partonic content but also...



#### PARTONS

#### Introduction

#### Framework

Design Architecture

Examples

#### Features

Ergonomics EIC Fits

Modeling

#### Releases

First release Future releases Remarks

Conclusion

- Correlation of the longitudinal momentum and the transverse position of a parton in the nucleon.
  - Insights on:
    - **Spin** structure,
    - **Energy-momentum** structure.
- Probabilistic interpretation of Fourier transform of GPD(x, ξ = 0, t) in transverse plane.



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### Exclusive processes of current interest (1/2). Factorization and universality.



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Nucleon and resonance structure



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Remarks

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Nonperturbative

factorization

X +



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## Exclusive processes of present interest (2/2). Factorization and universality.



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# Bjorken regime : large $Q^2$ and fixed $xB \simeq 2\xi/(1+\xi)$

- Partonic interpretation relies on **factorization theorems**.
- All-order proofs for DVCS, TCS and some DVMP.
- GPDs depend on a (arbitrary) factorization scale  $\mu_F$ .
  - **Consistency** requires the study of **different channels**.

■ GPDs enter DVCS through **Compton Form Factors** :

$$\mathcal{F}(\xi, t, Q^2) = \int_{-1}^{1} dx C\left(x, \xi, \alpha_{\mathcal{S}}(\mu_F), \frac{Q}{\mu_F}\right) F(x, \xi, t, \mu_F)$$

for a given GPD F.

• CFF  $\mathcal{F}$  is a **complex function**.

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# Imaging the nucleon. How? Extracting GPDs is not enough...Need to extrapolate!



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**1** Extract  $H(x, \xi, t, \mu_F^{ref})$  from experimental data.

- **Extrapolate** to vanishing skewness  $H(x, 0, t, \mu_F^{ref})$ .
- **3** Extrapolate  $H(x, 0, t, \mu_F^{\text{ref}})$  up to infinite *t* and down to vanishing *t*.
- **Compute** 2D Fourier transform in transverse plane:

$$H(x, b_{\perp}) = \int_{0}^{+\infty} \frac{\mathrm{d}|\Delta_{\perp}|}{2\pi} |\Delta_{\perp}| J_0(|b_{\perp}||\Delta_{\perp}|) H(x, 0, -\Delta_{\perp}^2)$$

- 5 Propagate uncertainties.
- 6 **Control** extrapolations with an accuracy matching that of experimental data with **sound** GPD models.

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## Anatomy of the nucleon. A computing framework for the high precision era.



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- 1 The PARTONS framework.
- 2 Features and performances.

3 Releases.

# The PARTONS framework



PARtonic Tomography Of Nucleon Software

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## Computing chain design. Differential studies: physical models and numerical methods.



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Experimental data and phenomenology

Computation of amplitudes

principles and

fundamental parameters

First

Small distance contributions

Full processes

Large distance contributions

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FIC

Fits

# Computing chain design.

Differential studies: physical models and numerical methods.







Differential studies: physical models and numerical methods.





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Differential studies: physical models and numerical methods.





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# Many observables. Kinematic reach.

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Differential studies: physical models and numerical methods.



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Experimental data and phenomenology Need for modularity Computation

of amplitudes

First principles and fundamental parameters



- Many observables.
  - Kinematic reach.

# Perturbative approximations.

Physical models.

Fits.

- Numerical methods.
- Accuracy and speed.

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Differential studies: physical models and numerical methods.



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 Many observables.

Kinematic reach.

Perturbative approximations.

Physical models.

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Differential studies: physical models and numerical methods.



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 Many observables.

Kinematic reach.

- Perturbative approximations.
- Physical models.

Fits.

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- Numerical methods.
- Accuracy and speed.

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Differential studies: physical models and numerical methods.



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 Many observables.

Kinematic reach.

- Perturbative approximations.
- Physical models.

Fits.

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Differential studies: physical models and numerical methods.



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Many observables. Kinematic reach.

- Perturbative approximations.
  - Physical models.

Fits.

- Numerical methods.
- Accuracy and speed.

- E - N

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# Towards the first release.

Currently: tests, benchmarking, documentation, tutorials.



#### PARTONS

3 stages:

- Introduction
- Framework
- Design
- Architecture
- Examples

#### Features

- Ergonomics FIC
- Fits
- Modeling

#### Releases

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- - Design.
  - Integration and validation.
  - Benchmarking and production.
- Flexible software architecture.
  - B. Berthou et al., PARTONS: a computing platform for the phenomenology of Generalized Parton Distributions arXiv:1512.06174, to appear in Eur. Phys. J. C.
- 1 new physical development = 1 new module.
- Aggregate knowledge and know-how:
  - Models .
  - Measurements
  - Numerical techniques
  - Validation
- What can be automated will be automated

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# Modularity.

Inheritance, standardized inputs and outputs.



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#### PARTONS



Conclusion

- Steps of logic sequence in parent class.
- Model description and related mathematical methods in daughter class.

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# Flexibility.

Example: implementation of new coefficient functions.



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- DVMP GPD at  $\mu \neq \mu_F^{\text{ref}}$ Evolution GPD at  $\mu_{F}^{ref}$
- A DVCS coefficient function module generically outputs a complex number when provided  $(\xi, t, Q^2, \mu_F^2, \mu_P^2)$ .
- ConvolCoeffFunctionModule.h virtual std::complex<double> compute( double xi, double t, double Q2, double MuF2, **double** MuR2, GPDType::Type gpdType) = 0;
- This module can be anything: Constant CFFs for local fits. CFFs for massless guarks. CFFs for heavy quarks. CFFs with TMC. イロト 不得 トイヨト イヨト H. Moutarde Nucleon and resonance structure 12 / 38



Design

EIC

Fits

Modeling

Remarks

# Modularity and layer structure. Modifying one layer does not affect the other layers.





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### Modularity and automation. Parse XML file, compute and store result in database.



#### PARTONS



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# Automation and nonregression. Mnemosyne, the PARTONS project database server.



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- Keep track of validated results.
- Systematic nonregression tests.
- Help preparing new releases.
- Store experimental data.
- Store grids of new models.
- Post processing?
- Time consuming fits?





# Handling experimental data. Using the power of SQL for data selections (1/2).



PARTONS	<ul> <li>All fixed-target DVCS data collected at Jefferson Lab are stored in the database used for fits.</li> </ul>
Framework Design Architecture Examples	<ul> <li>No data about TCS or DVMP so far.</li> <li>Including all existing DVCS data sets in a database is a matter of hours.</li> </ul>
Features Ergonomics EIC Fits Modeling	<ul> <li>Data selection from SQL requests for fits.</li> <li> insert_CLAS_asymmetries.sql</li> </ul>
Releases First release Future releases Remarks Conclusion	<ol> <li> Kinematics</li> <li>INSERT INTO observable_kinematic (bin_id, xB, t, Q2, E, phi) VALUES(0, 0.19400, -0.11000, 1.68000, 5.93200, 25.00000);</li> <li>SET @last_observable_kinematic_id = LAST_INSERT_ID();</li> <li> Value and uncertainties</li> <li>INSERT INTO observable_result (observable_name, observable_value, stat_error_lb, stat_error_ub, syst_error_lb, syst_error_ub, total_error, observable_kinematic_id) VALUES('Alu', 0.37000, 0.23000, 0.23000, 0.01000, 0.01000, 0.01000, @last_observable_kinematic_id);</li> </ol>



# Handling experimental data. Using the power of SQL for data selections (2/2).



#### PARTONS

Introduction	The database can be used for fits too!
Framework Design Architecture Examples	In fact, observable layer has been designed for fits: all observables correspond to the same kind of object from a software point of view.
Features Ergonomics	fit_scenario.xml
EIC Fits Modeling Releases First release Future releases Remarks Conclusion	<pre>1 2 <!-- 3th step : write your custom SQL query to select your observables--> 3 <task method="selectObservables" service="FitsService"> 4</task></pre>

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### GPD computing made simple. Each line of code corresponds to a physical hypothesis.



Introduction	2 #include <src partons.h=""></src>
Framework Design Architecture	<ul> <li></li> <li>// Retrieve GPD service</li> <li>GPDService* pGPDService = Partons::getInstance()-&gt;getServiceObjectRegistry</li> <li>()-&gt;getGPDService():</li> </ul>
Features ( Ergonomics : EIC : Modeling & Releases [1] Future releases 11 Future releases 12 Conclusion 11 11 12 14 14 14 14	<pre>// Load GPD module with the BaseModuleFactory // GPDModule* pGK11Model = Partons::getInstance()-&gt;getModuleObjectFactory ()-&gt;newGPDModule(GK11Model::classId); // Create a GPDKinematic(x, xi, t, MuF, MuR) to compute GPDKinematic gpdKinematic(0.1, 0.00050025, -0.3, 8., 8.); // Compute data and store results GPDResult gpdResult = pGPDService-&gt; computeGPDModelRestrictedByGPDType(gpdKinematic, pGK11Model, GPDType::ALL); // Print results std :: cout &lt;&lt; gpdResult.toString() &lt;&lt; std::endl; delete pGK11Model; pGK11Model = 0;</pre>

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## GPD computing automated. Each line of code corresponds to a physical hypothesis.



PARTONS		computeOneGPD.xml				
	1	xml version="1.0" encoding="UTF-8" standalone="yes" ?				
Introduction	2	<pre><scenario date="" description="Example_:computation_of_one_GPD&lt;/pre&gt;&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;miloduction&lt;/td&gt;&lt;td&gt;&lt;/td&gt;&lt;td&gt;&lt;math&gt;\_model_{\sqcup}(GK11)_{\sqcup}without_{\sqcup}evolution" id="01"></scenario></pre>				
Framework	3	</math Select type of computation $>$				
Design	4	<task service="GPDService" method="computeGPDModel">				
Examples	5	</math Specify kinematic $>$				
Features	6	<kinematics type="GPDKinematic"></kinematics>				
Ergonomics	7	<param name="x" value="0.1"/>				
EIC	8	<param name="xi" value="0.00050025"/>				
Fits	9	<param name="t" value="-0.3"/>				
Modeling	10	<pre><param name="MuF2" value="8"/></pre>				
Releases	11	<pre><param name="MuR2" value="8"/></pre>				
First release	12					
Future releases Remarks	13	</math Select GPD model and set parameters $>$				
Conclusion	14	<computation_configuration></computation_configuration>				
Conclusion	15	<module type="GPDModule"></module>				
	16	<param name="className" value="GK11Model" $/>$				
	17					
	18					
	19					
	20					



## GPD computing automated. Each line of code corresponds to a physical hypothesis.



PARTONS		computeOneGPD.xml					
	1 2	<pre><?xml version="1.0" encoding="UTF-8" stand <scenario id="01" date="" description="Exam</pre></pre>	$H^{\mu} = 0.822557$				
Introduction Framework Design	3	<pre>umodel_(GK11)_uwithout_evolution"&gt;     <!-- Select type of computation-->     <task <="" method="computation" pre="" service="GPDService"></task></pre>	$H^{u(+)} = 0.165636$ $H^{u(-)} = 1.47948$				
Examples	5	Specify kinematic					
Features Ergonomics EIC Fits Modeling Releases First releases Remarks Conclusion	6 7 8 9 10 11 12 13 14 15 16	<pre><kinematics type="GPDKinematic">         <pre></pre></kinematics></pre>	$H^{d} = 0.421431$ $H^{d(+)} = 0.0805182$ $H^{d(-)} = 0.762344$ $H^{s} = 0.00883408$ $H^{s(+)} = 0.0176682$ $H^{s(-)} = 0$				
	17 18 19 20	   	$H^{g} = 0.385611$ and <i>E</i> , <i>H</i> , <i>E</i> ,				



### Observable computing automated. Each line of code corresponds to a physical hypothesis.



		computeManyKinematicsOneModel.xml				
PARTONS	1	$<$ scenario date="2016-10-18" description="Use_kinematics_list">				
	2	<task <="" method="&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;Introduction&lt;/td&gt;&lt;td&gt;&lt;/td&gt;&lt;td&gt;computeManyKinematicOneModel" service="ObservableService" td=""></task>				
Framework	3	<pre><kinematics type="ObservableKinematic"></kinematics></pre>				
Design	4	$<$ param name="file" value="observable_kinematics.dat" $/>$				
Architecture	5					
Examples	6	<computation_configuration></computation_configuration>				
Features	7	<module type="Observable"></module>				
Ergonomics	8	<param name="className" value="Alu"/>				
EIC	9					
Modeling	10	<module type="DVCSModule"></module>				
Releases	11	<param name="className" value="BMJ2012Model" $/>$				
First release	12	<param name="beam_energy" value="1066"/>				
Future releases	13					
Remarks	14	<pre><module type="DVCSConvolCoeffFunctionModule"></module></pre>				
Conclusion	15	<param name="className" value="DVCSCFFModel"/>				
	16	<param name="qcd_order_type" value="LO"/>				
	17					
	18	<module type="GPDModule"></module>				
	19	<param name="className" value="GK11Model"/>				
	20					
	21					
		H. Moutarde Nucleon and resonance structure 20 / 38				

# Features and performances

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## Systematic studies made easy. A faster and safer way to GPD phenomenology.



#### PARTONS

Automation allows ...:

- to run numerous computations with various physical assumptions,
- to run **nonregression** tests.
- to perform **fits** with various models.
  - physicists to focus on physics!

# Without PARTONS



# With PARTONS



#### Introduction Framework

Design

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# GPD computations made fast.

Improved performances thanks to clever architecture design.



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### GPD computations with or without threads

<b>#general</b> 12 members   Company-wide annound
also I still have to "clean" if Bryan BERTHOU 1502 GRAND AND AND AND AND AND AND AND AND AND
<ul> <li>In my own computer with: kinematics -&gt; 500 results/ i i</li> <li>Cádric 16.33 Very good! I will have plen So your 500 results per sec ,t, Q*2) per second, is that or is it that you can compute Hi Cédric! With 2+1 threa E and Et foru, d, s and g on</li> </ul>





### Systematic studies made fast (1/2). What can be done from scratch in about 1 hour.



#### From D. Sokhan's talk, EIC User Group Meeting, ANL, 2016 PARTONS Luca Colaneri. **DVCS** beam-spin asymmetries at EIC Nabil Chouika Introduction (PARTONS) – GK11 Framework VGG 0.24 $Q^2 = 16 \text{ GeV}^2$ $x_B = 0.01$ 0.16 $E_e E_p = 500 \text{ GeV}^2$ Design Architecture 0.08 Examples -0.08 Features -0 16 -0.24 Ergonomics $Q^2 = 8 \text{ GeV}^2 \ x_B = 0.005$ 0.24 FIC PRELIMINARY 0.16 Fits 0.08 Modeling ALU 0 Releases -0.08 -0.16 First release 0.24 Euture releases 0.24 $O^2 = 4 \text{ GeV}^2$ $x_B = 0.003$ Remarks 0.16 0.08 Conclusion -0.08 See next talk on -0.16 PARTONS by C. Mezrag -0.24 0 40 80 120 160 200 160 200 240 280 320 360 200 $\phi(^{\circ})$ $\phi(^{\circ})$ $\phi(^{\circ})$ $-t = 0.1 \text{ GeV}^2$ $-t = 0.25 \text{ GeV}^2$ $-t = 1 \text{ GeV}^2$

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### Systematic studies made fast (2/2). EIC observables computed with different pQCD assumptions.



#### PARTONS

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#### (Preliminary) $A_{ m LU}(90^\circ)$ at LO with Goloskokov-Kroll model Introduction AluMap LO t -0.05 AluMap LO t -0.15 AluMap LO t -0.25 Framework 00<sup>1</sup>001 1.6 1.4 1.2 0.012 Architecture 1.2 Examples 0.000 0.8 0.8 Features o.eE 0.4E 0.4E 0.4E Ergonomics 0.2 92 AluMap LO t -0.35 AluMap LO 1 -0.45 AluMap LO t -0.55 Modeling Releases First release Euture releases 0.8 0.8 0.4E 0.4 Conclusion 0.2 Colaneri et al., Work in progress



# GPD or CFF fits (1/4). Local fit of CFFs.



#### PARTONS

## First local fit of pseudo DVCS data, Sep. 26th, 2016

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@herve PARTONS	partons_fits v 7 🎍 Search @
artons_fits	Mon, Sep 26, 2016
artons_tests	pawel 3:16 PM
ntrons_v0 artons_visualization dom-inverse nort_distance wm Square ello rtual_machine b TE GROUPS <b>+</b> tidab Ewille T MESSAGES T MESSAGES ryyan	FCN=1.001280=11         FROM MIGRAD         STATUS=CONVERGED         44         CALLS         45           TOTAL         EDM=2.00186e-11         STRATEGY=1         ERROR MATRIX ACCURATE           EXT PARAMETER         STEP         FIRST           NO. NAME         VALUE         ERROR         SIZE         DERIVATIVE           1         fit_CFF_H.Re         6.67247e-02         1.34241e-00         2.99231e-05         -7.02262e-07           2         fit_CFF_E.Re         -3.94780e-00         fixed         1.80608e-05         1.71071e-04           3         fit_CFF_E.TR         -1.64116e-01         fixed         6         fit_CFF_E.TR         1.93952e+01         fixed           6         fit_CFF_E.TR         2.59031-04         fixed         1         6         fit_CFF_E.TR         7.9952e+01         fixed           8         fit_CFF_E.TR         J.90952e+01         fixed         6         fit_CFF_E.TR         J.9952e+01         fixed           7.951c-03         J.5125e+00         Fixed         J.8008e+00         fixed         2           1.804s+00         7.951c-03         J.351e+00         J.8008e+00         J.8008e+00         J.8008e+00           PARAMETER         CORRELATION COFFICIENTS         J.80
cub ca houika	The true values of fit_CFF_H_Re and fit_CFF_H_Im are 0.06672466940113253 and 12.423114181138908
awel	Write a morrage
opora	write a message
	Help



# GPD or CFF fits (2/4). Global fit of CFFs using a analytic parameterization.



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#### RESULTS

<ul> <li>Kinematic cuts</li> </ul>	Q <sup>2</sup> > 1.5 GeV <sup>2</sup>	(where we can rely on LO approximation)
	-t / Q <sup>2</sup> < 0.25	(where we can rely on GPD factorization)

- x<sup>2</sup> / ndf 3272.6 / (3433 - 7) ≈ 0.96
- Free parameters a<sub>Hsea</sub>, a<sub>Ĥval</sub>, a<sub>Ĥsea</sub>, C<sub>sub</sub>, a<sub>sub</sub>, N<sub>E</sub>, N<sub>E</sub>
- x<sup>2</sup> / ndf per data set

[1] Phys. Rev. C 92, 055202 (2015) [2] Phys. Rev. Lett. 115, 212003 (2015) [3] Phys. Rev. D 91, 052014 (2015)

Experiment	Reference	Observables	N points all	N points selected		chi2 / ndf
Hall A	[1] KINX2	σUU	120	120	135.0	1.19
Hall A	[1] KINX2	ΔσLU	120	120	98.9	0.88
Hall A	[1] KINX3	σUU	108	108	274.8	2.72
Hall A	[1] KINX3	ΔσLU	108	108	107.3	1.06
CLAS	[2]	σUU	1933	1333	1089.2	0.82
CLAS	[2]	ΔσLU	1933	1333	1171.9	0.88
CLAS	[3]	AUL, ALU, ALL	498	305	338.1	1.13
Pawel Sznajder DIS 2017					12	
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# GPD or CFF fits (3/4). Global fit of CFFs using neural networks.



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# Neural network global fit of CLAS asymmetries, May $31^{\mathrm{st}}$ , 2017

#### NEURAL NETWORK

Paweł Sznajder



- $\hfill \label{eq:our verse}$  Our very first attempt to use NN technique  $\rightarrow$  proof of feasibility
- Genetic algorithm (GA) to learn NN
- NN and GA libraries by PARTONS group
- Very simple design of NN
- CLAS asymmetry data only
- x<sup>2</sup> / ndf = 273.9 / (305 68) ≈ 1.16

#### Nucleon and Resonance Structure Workshop 2017



# GPD or CFF fits (4/4). From local to global fits in 8 months!



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Conclusion

- PARTONS architecture allows focusing on parameterization and fitting engine.
- The same machinery is used for local and global fits.
- **Fast** and **constant** progress since the first fits.

See Pawel Sznajder's talk today!

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FIC Fits

# Covariant and positive GPD models. First systematic procedure to build models satisfying all constraints.



#### PARTONS 2.4 1.6 Introduction 0.8 0.0 Framework Design -0.8 Architecture -0.5 Examples -1.6 -2.4 Features -1.0 Ergonomics Analytic result Modeling Releases First release Euture releases Remarks Conclusion GPD



### Numerical result

Algebraic Dyson Schwinger LFWF

## Chouika et al. Work in progress

H. Moutarde

1.0

(ロト (得) (手) (手) Nucleon and resonance structure



PARTONS

### Covariant and positive GPD models. First systematic procedure to build models satisfying all constraints.

(Preliminary) AdS/QCD LFWF

-0.50



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#### Introduction Framework Design Architecture H(x, ξ) Examples Features Ergonomics FIC Fits -3 Modeling -1.00 Releases First release Chouika et al., Work in progress Euture releases Remarks

See José Rodríguez-Quintero's talk today!

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Nucleon and resonance structure

Conclusion

Numerics under control for **smooth** LEWEs

0.00

x

Situation with Regge behavior currently studied.

0.50

1.00

Towards consistent modeling and fit of GPDs and TMDs? Wigner functions?

H. Moutarde

# Releases

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## First release content. DVCS channel only.



#### PARTONS

Introduction	GPD modules	CFF modules
Framework	GK	LO
Design Architecture	VGG	NLO
Features	<ul> <li>Vinnikov (evolution)</li> </ul>	NLO Noritzsch
Ergonomics	MPSSW13 (NLO study)	
Modeling	MMS13 (DD study)	Evolution modules
Releases		Vinnikov (LO)
Future releases Remarks	DVCS modules	
Conclusion	■ VGG	$lpha_{ m s}$ modules
	BMJ	4-loop perturbation
		constant value
	H. Moutard	・ロト・合ト・ミト・ヨト ヨー のへで de   Nucleon and resonance structure   32 / 38



# Open-source release.

Soon publicly available on CEA GitLab server.



#### PARTONS

#### Introduction

	Fra	me	work
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Design Architecture

Examples

#### Features

Ergonomics EIC

Fits

FILS

Modeling

#### Releases

First release

Future releases Remarks

Conclusion

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Partons Partons project a							
Partons-example Running version of PARTONS with examples (C++ code and XML computing scenarios)							
partons-exe Executable version of PARTONS							
NumA++: numerical analysis C++ routines							
elementary-utils Utility softwares (logger, parser, thr	reads, string and file ma	anipulation)					۵
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H. Moutarde

Nucleon and resonance structure | 33 / 38



# Future releases.

A lot remains to be integrated...Contributors welcome!



#### PARTONS

Introduction	Channel modules	Hadron structure modules
Framework	DVMP	DAs
Design Architecture Examples	TCS	DDs
Features	• ???	Form factors
Ergonomics EIC Fits		PDFs
Modeling	Other modules	LFWFs
Releases First release Future releases	<ul> <li>Mellin moments (EM tensor lattice QCD)</li> </ul>	■ ???
Remarks	■ ???	Nonperturbative QCD modules
		<ul> <li>Gap equation solver</li> <li>222</li> </ul>
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## A common framework for GPD studies? From a software development to a physics production phase.



35 / 38

#### PARTONS

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	accion

#### Framework

- Design Architecture
- Examples

#### Features

- Ergonomics EIC Fits
- Modeling

#### Releases

- First release
- Remarks

Conclusion

- Still room for improvement in first version but framework should become available to a wide community of users.
- User feedback much welcome! However the PARTONS team will not provide support for major modifications like *e.g.* translation into Java.
- It took years to design, write and validate PARTONS in C++. Time to produce physics with it; starting another software project would be much premature.
- PARTONS team will take responsibility only for main branch.
- Please make any new module available to the whole community through the main PARTONS branch.

H. Moutarde Nucleon and resonance structure

# Conclusion

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## Conclusions and prospects. Towards a unifying framework for GPD studies.



#### PARTONS

#### Introduction

- Framework
- Design Architecture
- Examples

#### Features

- Ergonomics EIC
- Fits
- Modeling

#### Releases

- First release Future releases Remarks
- Conclusion

- A lot has been achieved in the last few years!
- Initiated as an experimentalist companion, grown as a multidisciplinary project attracting theorists to the field.
- Challenging constraints expected from Jefferson Lab, COMPASS and EIC.
- Development of the PARTONS framework for phenomenology and theory purposes.
- Fitting engine ready for global and local fits. Original global CFF fits recently achieved, meeting initial aim!
- Forthcoming open-source release of PARTONS.

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