

# Theoretical Particle Physics group

IPARCOS Scientific Advisory Board: Bi-Annual Review 2026

Clara Peset



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# Group's Overview

## Group Snapshot

- **Group Name & Principal Investigator (PI):** Theoretical Particle Physics group  
**PI's:** Felipe J. Llanes-Estrada, José Ramón Peláez, Ignazio Scimemi
- **Current Size:** Total members: 5 Staff, 5 Tenure Track, 2 Postdoc, 14 PhD students.
- **Key Personnel Changes:** **Postdocs hired:** Alejandro Bris Cuerpo, Sergio Leal-Gomez (Europe Excellence project)  
**New PhD students:** Diego Voces, Eric García Hemon, Arturo Arroyo Castro

## Key Performance Indicators

- **High-Impact Publications:** 39 peer-reviewed papers (30 in Q1 journals / Letters) since March 2024  
Among them: 3 PRL, 12 JHEP, 1 JCAP, 9 PRD
- **Funding Secured:** Total new funding acquired in the last two years: 575211€
  - *HORIZON-INFRA-2025-01-SERV-03 (101292522)* - UCM node 71.875€, PI: Felipe Llanes-Estrada, European Commission
  - [COST Action 24159 SHARP](#), Vice Chair: Ignazio Scimemi, European Commission
  - [HEI, MCSA-Staff Exchange](#), 197.800€, IP Francesco Aprile
  - Europa Excelencia (EUR2023-143460) - 100 000 € - PI: Alexey Vladimirov, Ministry of Science and innovation
  - Research Consolidation Program, PI: Jacobo Ruiz de Elvira, 195.805,00 €, Ministry of Science and innovation
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# Senior Members



Francesco Aprile



Ángel Gómez Nicola



Felipe J.Llanes-Estrada



José Ramón Peláez

20% female members



Clara Peset



Jacobo Ruiz  
de Elvira



Juanjo Sanz  
Cillero



Ignazio Scimemi



Alexey Vladimirov



Pía Zurita

# Postdocs

- Alejandro de Bris
- Sergio Leal-Gomez

# PhD Students

- Alejandro Canoa Monsalve, (CAM)
- Juan J. Gálvez Viruet (FPU)
- Pablo Rabán Mondéjar (FPU)
- Alba Reyes Torrecilla (FPI)
- Óscar del Río (FPU)
- Sara Piloñeta (UCM)
- Arturo Arroyo-Castro (PID)
- Patricia Andrea Gutierrez Garcia (FPI)
- Daniel Díaz Fernandez (Talento)
- Javier Martínez (FPU)
- Diego Voces (UCM)
- Eric García Hemon

## External:

- Adriana Bariego Quintana (U. Valencia)
- Guillermo Portela (U. Salamanca)

30% female members  
among PhD students

Many of them have  
been temporarily  
fundend by **iparcos**



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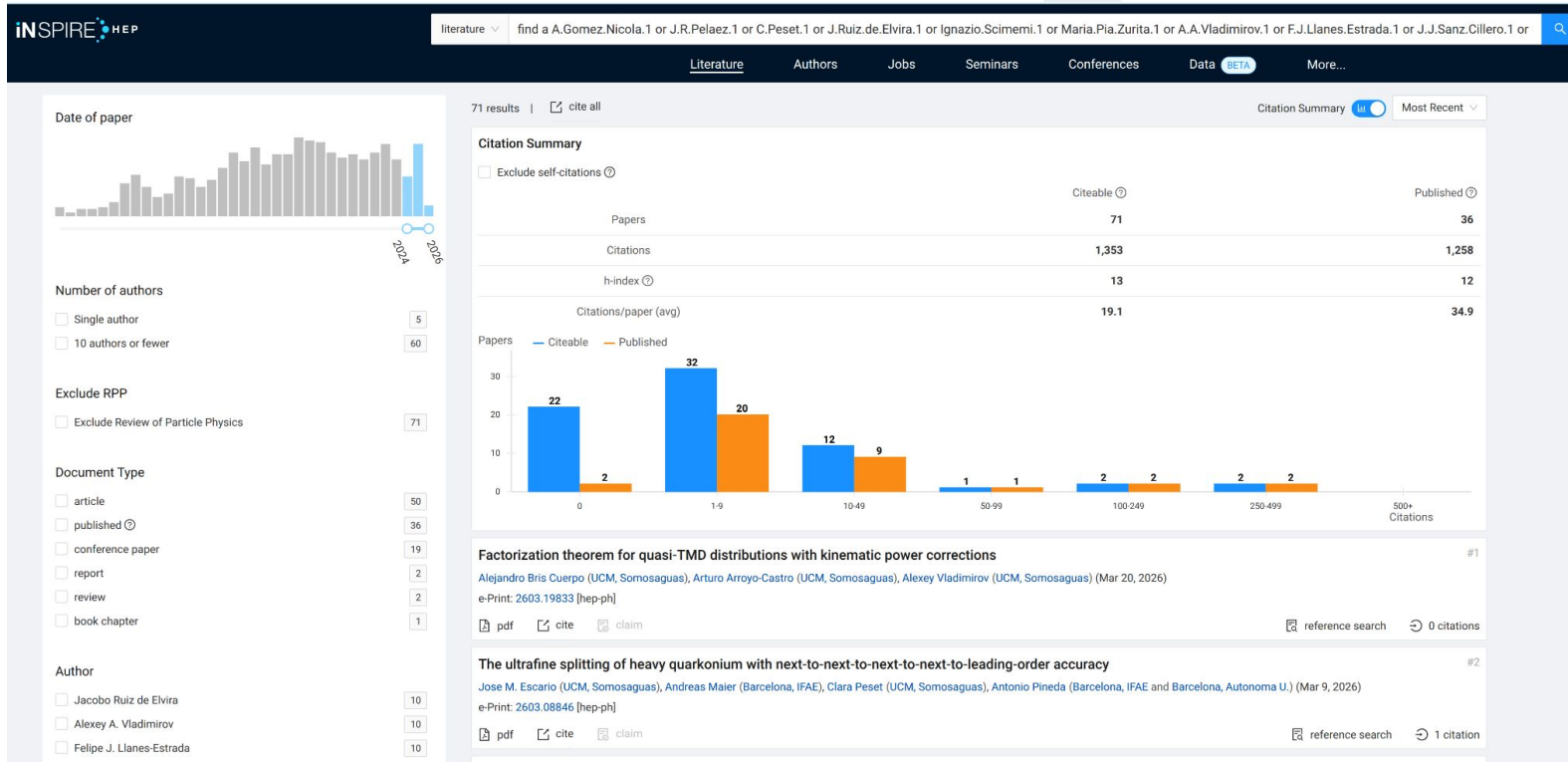
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# High impact publications



**3 members of the group** included in the [World's Top 2% Scientist](#):

J. R. Peláez, I. Scimemi and A. Vladimirov

more than **1300 citations** in publications 2024-2026

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# Additional Funding

- PRX22/00129 Visiting professorship grant, PI Jose Ramón Peláez, 9.731 €, Ministry of science and innovation

## Ongoing Projects 2024-2026:

- PID2022-136510NB-C31, 195.625€. PI's: Ignazio Scimemi and Jose Ramón Pelaez, 1/9/2023 to 31/08/2026, M. of Science
- PID2022-137003NB-I00, 66 300 €, PI: Felipe Llanes-Estrada and Antonio Dobado, 1/9/2023 to 31/08/2026, M. of Science
  - Both to be renewed this year.
- STRONG2020, 27K€, PI's: Ángel Gómez-Nicola and Jose Ramón Pelaez, ended 2025, European Commission
- [COST Action 22130 COMETA](#), PI: Ilaria Brivio, European Commission
- Effective field theories, particles and cosmology (GRFN24/24), 1.950,93 €, PI's: A.Dobado, A.Gómez Nicola, 01/24-12/24, UCM



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Portada / Grupos de Investigación / TEORÍAS EFECTIVAS, FÍSICA DE PARTÍCULAS Y COSMOLOGÍA

### Grupos de Investigación

910309 - TEORÍAS EFECTIVAS, FÍSICA DE PARTÍCULAS Y COSMOLOGÍA

Centro:	F. CIENCIAS FISICAS <a href="#">www</a>
Ámbito - Área AEI:	ÁREA DE EXPERIMENTALES - FÍSICA Y CIENCIAS DEL ESPACIO
Valoración :	EXCELENTE (91.00)
Acrónimo - E-Mail:	- dobado@fis.ucm.es
Director/es:	DOBADO GONZALEZ, ANTONIO ; GOMEZ NICOLA, ANGEL
Miembros:	ALVAREZ DOMINGUEZ, ALVARO ; ALVAREZ LUNA, CLARA ; APRILE , FRANCESCO ; ARRECHEA RODRIGUEZ, JULIO ; ASOREY BARREIRO, JACOBO ; BARCELO SERON, CARLOS ; BARCELOS NEVES, RITA ; BORISLAVOV VASSILEV, TEODOR ; BOYANOV SAVOV, VALENTIN ; BRIS CUERPO, ALEJANDRO ; CASADO TURRION, ADRIAN ;

910309  
Teorías efectivas  
Física de partículas y  
cosmología

**EXCELENTE (91.00)**

# Group's Overview

## Top 2-3 Scientific Highlights

- **Highlight 1:** *Understanding Large Localized CP Violation*, [PRL136\(2026\)111901](#), L. Heuser, A. Reyes-Torrecilla, et al.
- **Highlight 2:** *Extraction of unpolarized TMDs* [JHEP 05 \(2024\) 036](#) & [JHEP 11 \(2025\) 134](#), I. Scimemi, A. Vladimirov, P. Zurita et al.
- **Highlight 3:** *Quantum Computing Hadron Fragmentation Functions in Light-Front QCD*, [under revision in PRD](#), J.J.Gálvez-Viruet et al.

## Leadership, Internationalization & Impact

- **Major Roles:**
  - Iparcos **Director** (I. Scimemi) and **Dean** of the Faculty of Physics (A. Gómez-Nicola)
  - **Reviewer** of the Inclusive section of the ePIC Early Science Report (P. Zurita)
  - **International committee** member: Humboldt Foundation and Swiss national Foundation (I. Scimemi), Board Strong2020 (Llanes-Estrada)
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## The Horizon

- **Next Big Milestone:** Implementation of **Machine Learning algorithms in LHC** data analysis (J.J. Sanz-Cillero)
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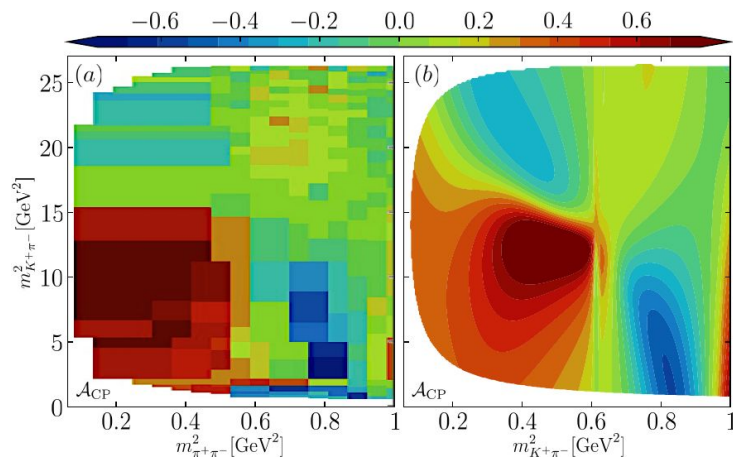
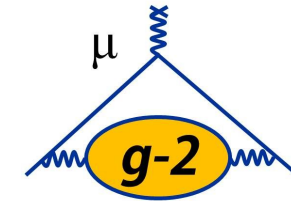
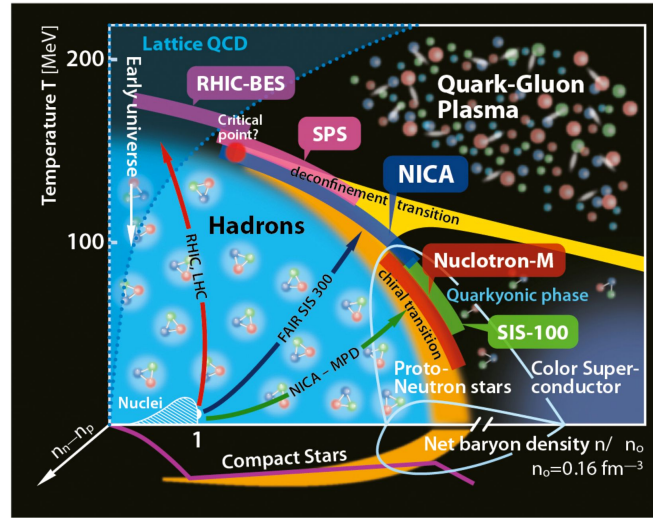
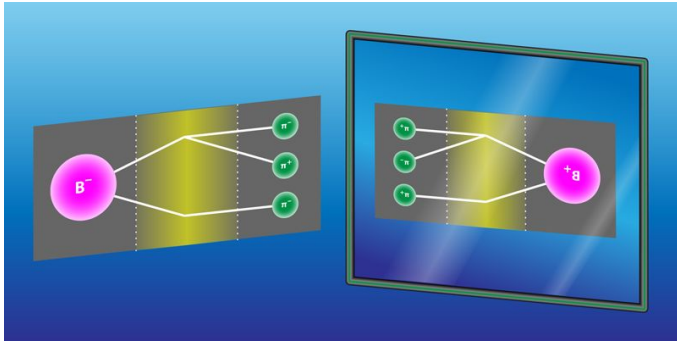
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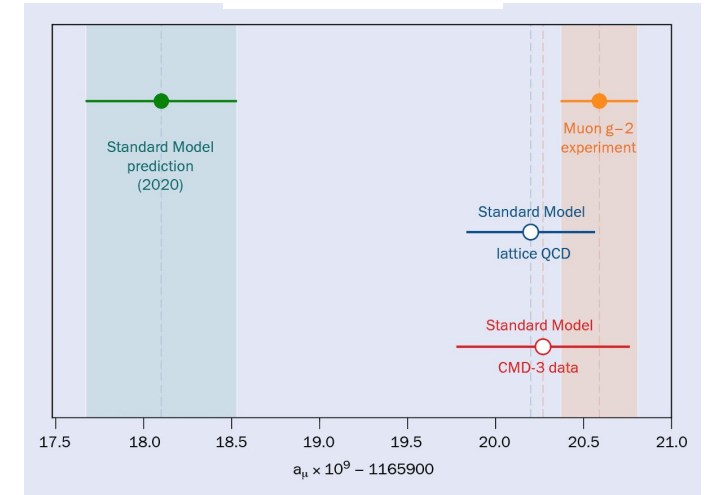
# Scientific Highlight 1: hadron physics



Large Localized CP Violation

## Symmetry restoration in QCD at finite temperature

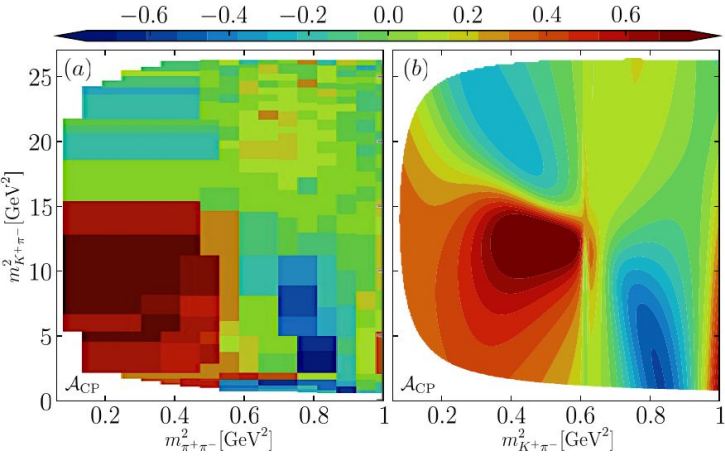
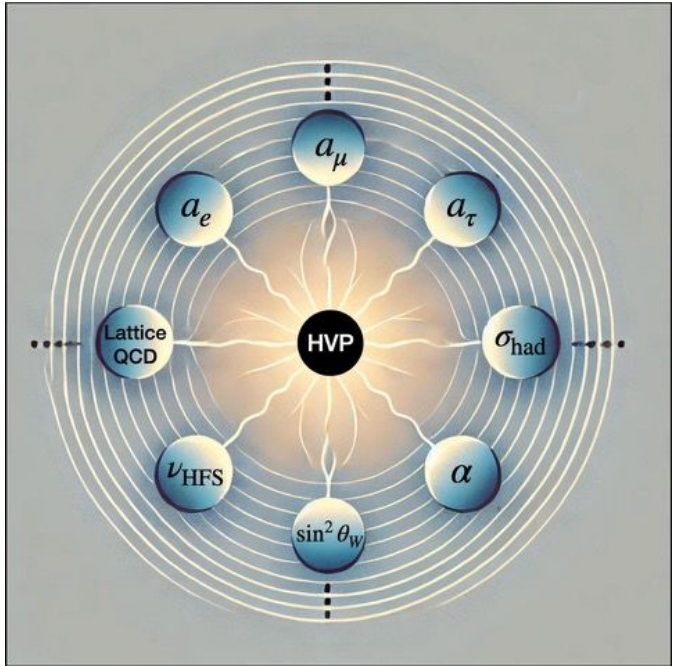
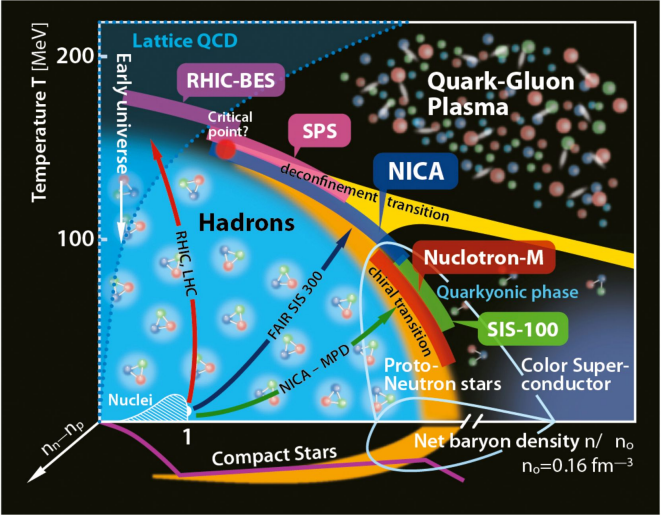
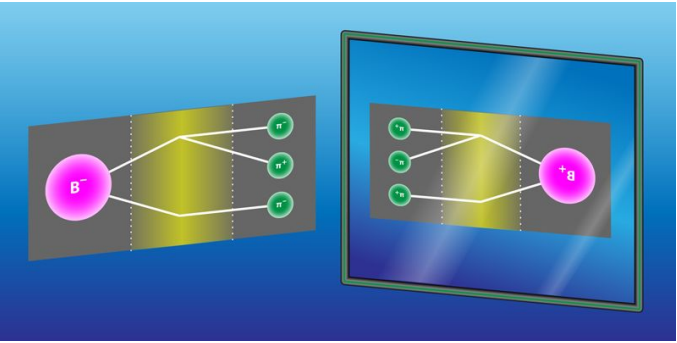
- non-zero chemical potential
- role of resonances



## Muon $g-2$ tension

- Role of the hadronic vacuum polarization
- [Muon  \$g-2\$  Theory initiative](#)

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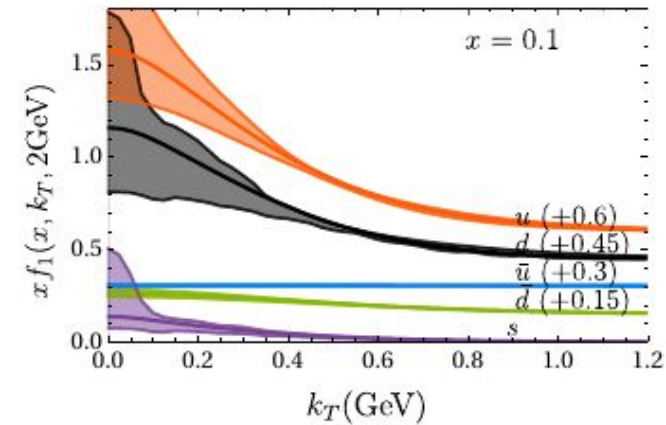
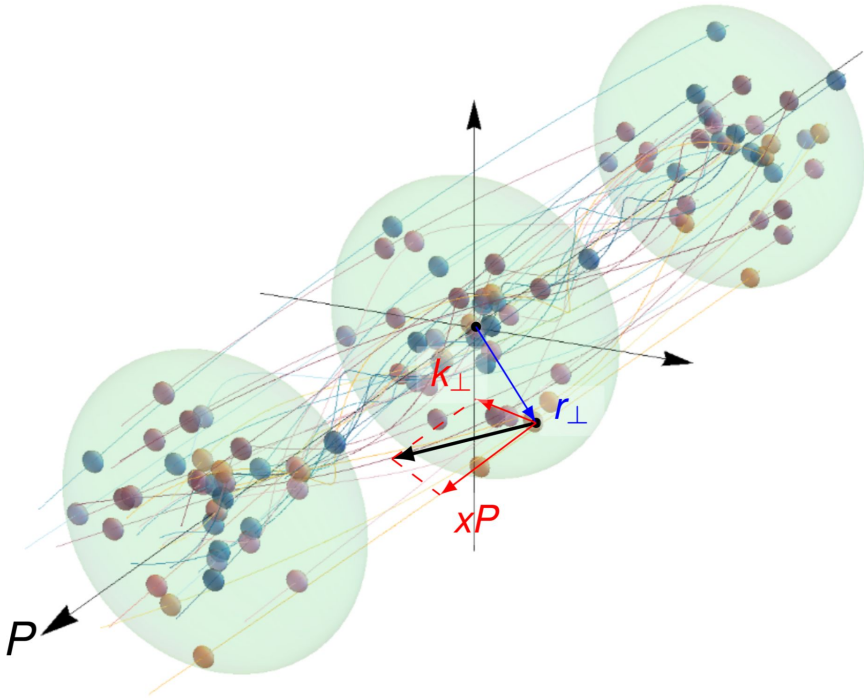
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# Scientific Highlight 2: Unpolarized TMDs

## 3-dimensional structure of hadrons



Example:  
Proton structure  
functions

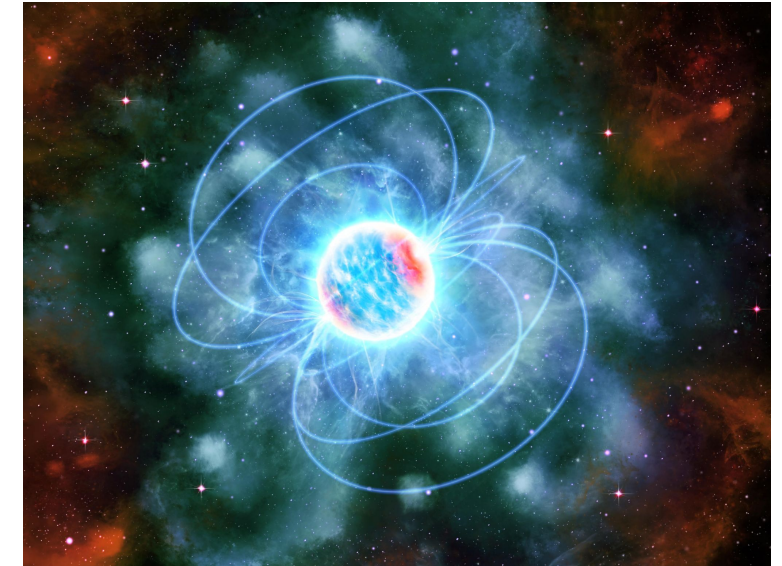
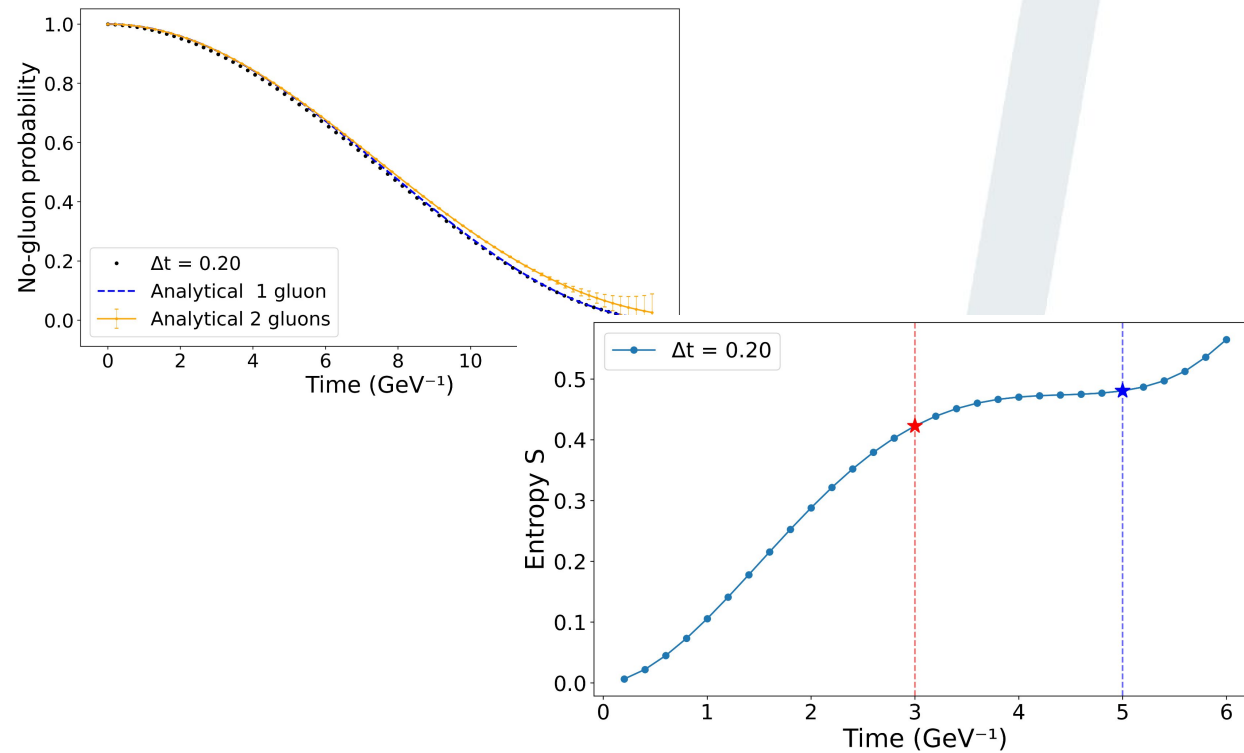
- Extremely accurate results N4LL
- first joined extraction of PDF and TMD from global data (junto con JLab collaboration, enviada a PRL)

### NEXT:

- systematic treatment of power correction and pt-dependent processes in complete kinematic range
- Simultaneous determination of collinear and TMD PDFs at NNLO

# Scientific Highlight 3: Quantum computing

## Hadron Fragmentation Functions in Light-Front QCD



**NEXT:** An algorithm to compute the equation of state of neutron stars on a quantum computer from QCD's Weyl gauge.

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# Internationalization and transfer

## International collaborations:

- EIC user group (I. Scimemi, A.Vladimirov, P. Zurita)
- pt/W working group at CERN (I. Scimemi, A.Vladimirov)
- Higgs working group at CERN (J.J. Sanz-Cillero)
- DFG research unit 2026 (DESY, Regensburg, Tübingen) (I. Scimemi, A. Vladimirov, P. Zurita)
- JAM collaboration at JLab (A.Vladimirov)
- EINSTEIN Telescope (Llanes-Estrada)
- MuAsti Initiative (C. Peset)

**External collaborators:** regular collaborations with Europe, North America, Asia and South America

## Open software:

[ARTEMIDE](#) Multi-purpose code for phenomenology of transverse momentum(predictions, extractions, impact studies, analysis)



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# Outreach activities



## Search for the Muon Electric Dipole Moment with RF-Phase Coherent Spin Analysis in SPS Secondary Muon Beams at CERN

- Maestro Matías Bravo Highschool (Madrid)
- Tutor: J.J. Sanz-Cillero

### 2nd European School on the Physics of the EIC and Related Topics

22 June 2025 to 2 July 2025  
Europe/Madrid timezone

- Overview
- Committees
- Timetable
- List of lectures
- Venue
- Registration
- Participant List
- Code of conduct
- Wifi in the hostel
- School Survey
- Instructions for the social dinner

The Second European School on the Physics of the EIC and Related Topics will take place at the [Albergue juvenil Argentina](#) of Benicàssim, located right at the beach, in the small town of Benicàssim (Castellón), Spain.

The arrival date for the participants is June 22, 2025 and the departure date is July 2, 2025. Lectures will take place from 23rd of June until 1st of July, with an excursion day on Sunday (June 29), to Peñíscola. The course includes lectures about physics and experimental parts of the EIC experiment. The target audience are Ph.D. students.

We encourage participants to submit an abstract in order to organise the student lectures.

**Participation fee: 300 euro** (it includes lodging, all meals and the excursion). For late payment (after may 1st) the fee is 500€.

Lodging and meals are all provided at the Albergue juvenil Argentina (number of places is limited). Note that rooms will be shared. We invite participants to indicate their preference for room sharing at the time of registration.

**Registration is closed.**

- #### Contacts
- ✉ [ignazios@ucm.es](mailto:ignazios@ucm.es)
  - ✉ [alexeyvi@ucm.es](mailto:alexeyvi@ucm.es)
  - ✉ [charlotte.van@uah.es](mailto:charlotte.van@uah.es)
  - ✉ [marzurit@ucm.es](mailto:marzurit@ucm.es)
  - ✉ [francesco.celiberto@ua...](mailto:francesco.celiberto@ua...)



# Group's Overview

## Top 2-3 Scientific Highlights

- **Highlight 1:** *Understanding Large Localized CP Violation*, [PRL136\(2026\)111901](#), L. Heuser, A. Reyes-Torrecilla, et al.
- **Highlight 2:** *Extraction of unpolarized TMDs* [JHEP 05 \(2024\) 036](#) & [JHEP 11 \(2025\) 134](#), I. Scimemi, A. Vladimirov, P. Zurita et al.
- **Highlight 3:** *Quantum Computing Hadron Fragmentation Functions in Light-Front QCD*, under revision in PRD, J.J.Gálvez-Viruet et al.

## Leadership, Internationalization & Impact

- **Major Roles:**
  - Iparcos **Director** (I. Scimemi) and **Dean** of the Faculty of Physics (A. Gómez-Nicola)
  - **Reviewer** of the Inclusive section of the ePIC Early Science Report (P. Zurita)
  - **International committee** member: Humboldt Foundation and Swiss national Foundation (I. Scimemi), Board Strong2020 (Llanes-Estrada)
  - **Honorific member** of the official Spanish Physical Association (A. Gómez-Nicola)
- **Recognitions:**
  - Invited **plenary talks:** [ICHEP2026](#) (J.R. Peláez), [11th Int.Workshop of Chiral Dynamics](#) (J. Ruiz de Elvira), [QNP2024](#) (Vladimirov), [ePIC 2025](#) (Zurita)
- **Tech Transfer / Outreach:**
  - **Conference and workshop organization:** [QCD evolution 2026](#), [SCET2024](#), [Bridging TMD frameworks \(ECT\\*\)](#), [Perturbative QCD for EIC \(MITP\)](#), [Neutron Star workshop \(UAH\)](#), [QICPP \(UCM\)](#), [Excited QCD 2026 \(UGR\)](#), [QNP2024](#) (UB)
  - **Organization** of [The Second European School on the Physics of the EIC and Related Topics](#) (2025)

## The Horizon

- **Next Big Milestone:** Implementation of **Machine Learning algorithms in LHC** data analysis (J.J. Sanz-Cillero)
- **Next Big Milestone:** Inclusion of **heavy quarks and quarkonia in the TMD** formalism (I. Scimemi, C. Peset)

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## Leadership, Internationalization & Impact

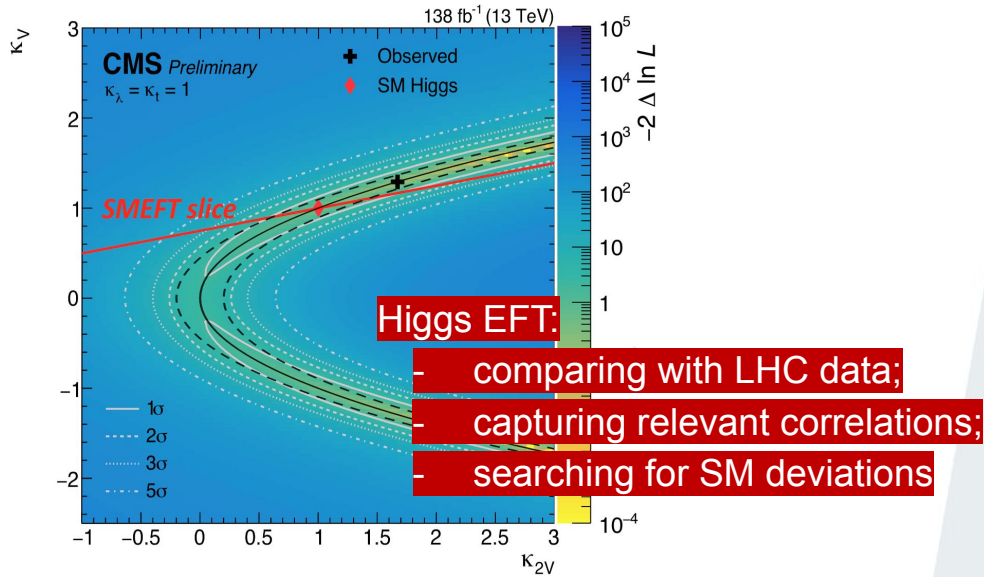
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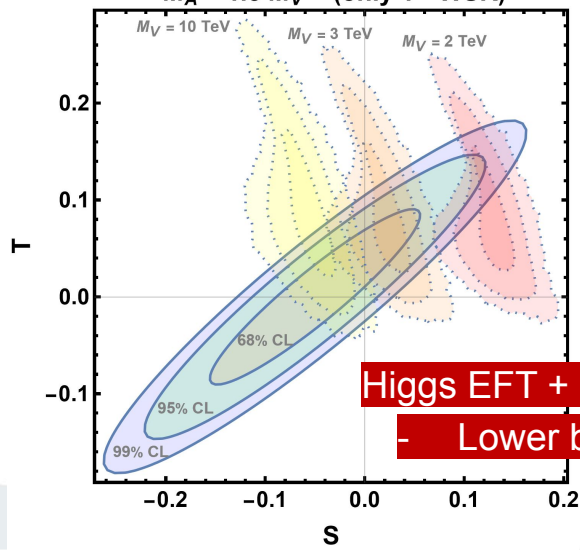
# Next big milestone: ML algorithms @ LHC



Higgs EFT:

- comparing with LHC data;
- capturing relevant correlations;
- searching for SM deviations

Approach B [P-odd/even]:  
 $M_A = 1.5 M_V$  (only 1<sup>st</sup> WSR)



Higgs EFT + spin-1 + EWPO:

- Lower bounds on new BSM vectors

Home > Collection

## Chiral dynamics for the Standard Model and beyond

Participating journal: The European Physical Journal Special Topics

Closed for submissions

This issue aims to bring together original research and review articles that highlight recent progress in understanding chiral dynamics within the Standard Model and its possible extensions.

Chiral dynamics remains a cornerstone of particle and nuclear physics. It provides essential insights into the non-perturbative aspects of quantum chromodynamics, the dynamics of chiral symmetry breaking and restoration, the appearance of Nambu-Goldstone bosons, and their phenomenological consequences across multiple physical domains. For decades, it has been an indispensable tool for systematically studying the interactions of pions, kaons, and nucleons. Its applications are vast, ranging from hadron spectroscopy and scattering processes to nuclear forces and the properties of hadronic matter under extreme conditions....

Participating journal

Journal: The European Physical Journal Special Topics

Publishing model: Hybrid

Journal Impact Factor: 2.3 (2024)

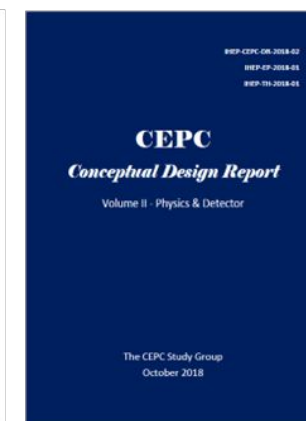
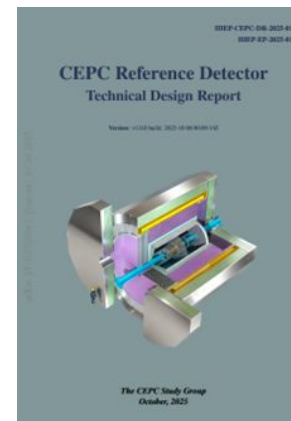
Downloads: 782.5k (2025)

Submission to first decision: 9 days (median)

Editors

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EPJ ST Volume: Chiral Dynamics for SM and Beyond



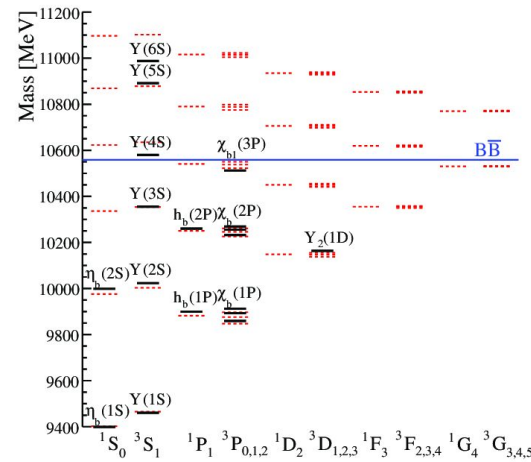
CEPCreports: Chinese Higgs e+e- Factory



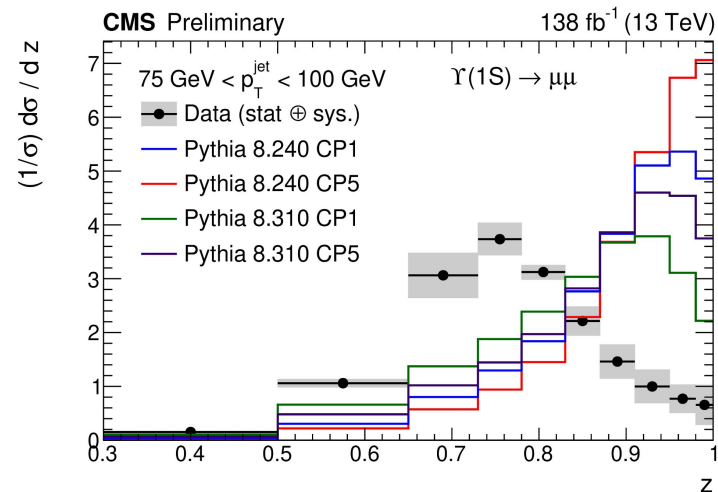
# Next big milestone: TMDs and heavy quarks

**THE CURIOUS CASE OF QUARKONIA INSIDE JETS**  
 The curious case of quarkonia inside jets. In a first study by CMS, Y mesons – bound states of a bottom quark and antiquark – produced inside jets are defying expectations, revealing cracks in our theoretical models.

CMS  
 For all the latest news → [cms.cern](https://cms.cern)



- Understand **polarization** in **heavy quarkonium**
- Phenomenology of **hadron in jet** at higher perturbative order in polarized processes





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MADRID

**Thank you!**