

The Fourth MODE Workshop

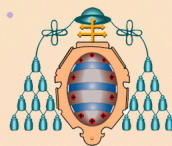
on Differentiable Programming
for Experiment Design

Closing session, Valencia

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UNIVERSIDAD DE OVIEDO



If you are reading this as a web page: have fun! If you are reading this as a PDF:
please visit

https://www.hep.uniovi.es/vischia/persistent/2024-09-25_MODEWorkshopClosing_vischia.html

to get the version with working animations

The MODE Goals

The goals of MODE

- *“We aim to create a versatile, scalable, customizable infrastructure, where a generic detector design task can be encoded, along with all the players (pattern reco, nuisances, cost constraints, a well constructed objective function). Then automatic scanning of the space of design solutions becomes possible!”*
- This doesn't replace the work of the physicist! We aim at **extending the physicist's abilities** by producing **design assistance tools**, focussing on **diagnostic tools and visualizations** for interpretability
- We don't propose *the one optimal solution* to a given problem, we aim at proposing a **distribution of solutions** in a region of optimality, to assist design choices!
- Optimization targets are not only strictly physics-related (e.g. significances): we consider also **financial cost** and other constraints in the optimization

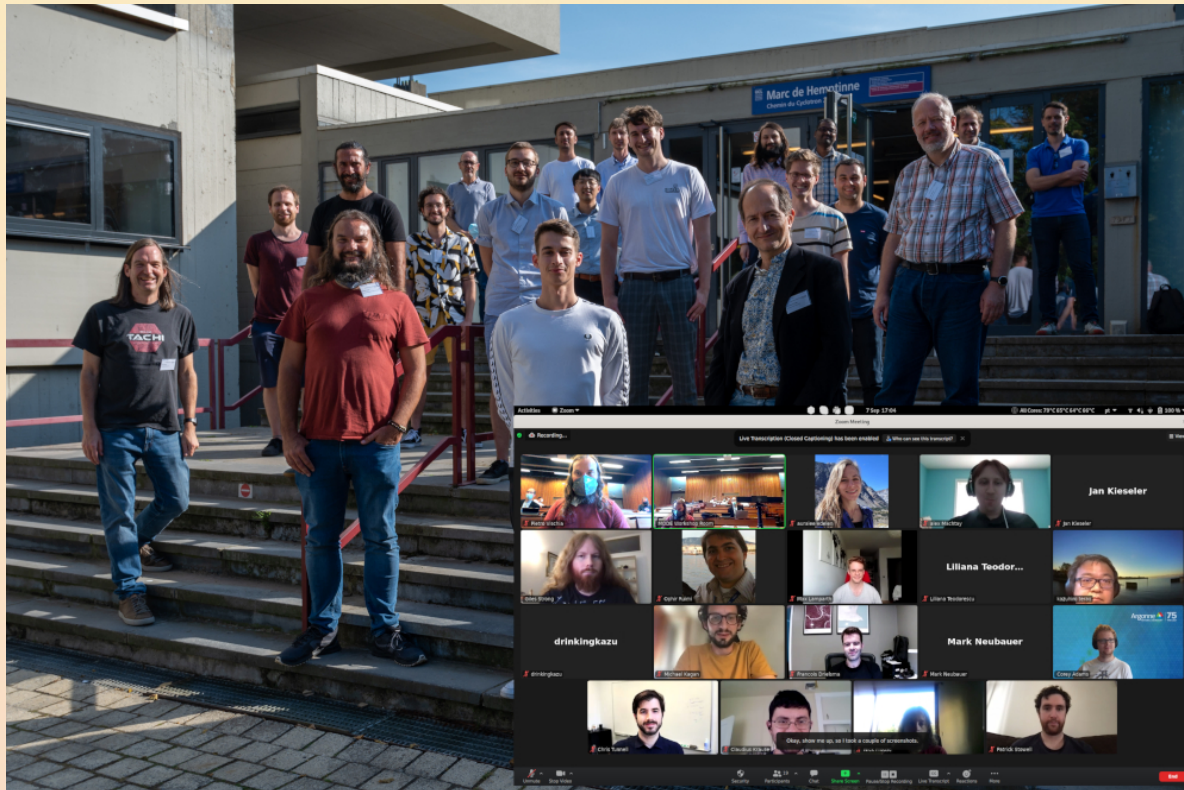
The MODE Goals

Begin simple, proceed towards complexity

- We identified and started studying some **relatively simple use cases**: muon tomography detector optimization, calorimeter optimization
- Plan to proceed to other simple use cases (e.g. small detectors for HL-LHC), providing **proofs of concept of increasing complexity**
- *“Every problem is difficult if you want to solve it well and make an impact”*
- In this workshop we aimed at starting to build a **community of interested peers** and identify **problems that we may tackle altogether**

First MODE Workshop (2021)

- In Louvain-la-Neuve (Belgium)
 - 34 talks
 - 22 in person participants



Outcome of the First Workshop!





Reviews in Physics

Volume 10, June 2023, 100085



Toward the end-to-end optimization of particle physics instruments with differentiable programming

Tommaso Dorigo^{a b x}  , Andrea Giammanco^{a c x}, Pietro Vischia^{a z c}, Max Aehle^d, Mateusz Bawaj^e, Alexey Boldyrev^{a f}, Pablo de Castro Manzano^{a b}, Denis Derkach^{a f}, Julien Donini^{a g x}, Auralee Edelen^h, Federica Fanzago^{a b}, Nicolas R. Gauger^d, Christian Glaser^{a i}, Atılım G. Baydin^{a j}, Lukas Heinrich^{a k}, Ralf Keidel^l, Jan Kieseler^{a m}, Claudius Krause^{a n}, Maxime Lagrange^{a c}, Max Lamparth^{a k} ... Haitham Zaraket^{a w}

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<https://doi.org/10.1016/j.revip.2023.100085> 

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Second MODE Workshop (2022)

- In Kolymbari (Crete)
 - 37 talks, 9 posters, one data challenge with prizes
 - 44 in person participants



Outcome of the Second Workshop!

Progress in End-to-End Optimization of Detectors for Fundamental Physics with Differentiable Programming

Max Ahle^d, Lorenzo Arsini^{r,s}, Anastasios Belias^a, Alexey Boldyrev^{a,e}, Konstantin Borozdin^o,
Susana Cebrian^l, Remco de Boer^p, Alexander Demin^e, Julien Donini^{a,f,v}, Tommaso Dorigo^{a,b,v},
Nicolas R. Gauger^d, Andrea Giammanco^{a,c,v}, Christian Glaser^{a,g}, Borja S. González^{p,q},
Lisa Kusch^d, Marcus Liwickiⁱ, Philipp Munkes^k, Federico Nardi^{a,f,j}, Alberto Ramos^h,
Fedor Ratnikov^{a,e}, Ryan Roussel^m, Roberto Ruiz de Austri^h, Fredrik Sandinⁱ, Bruno Scarpa^j,
Giles C. Strong^{a,b}, Andrey Ustyuzhanin^{a,t}, Pietro Vischia^{a,u}

^aMODE Collaboration, <https://mode-collaboration.github.io/>

- Submitted to Reviews in Physics

Third MODE Workshop (2023)

- At Princeton University (USA)
 - 37 talks
 - 26 in person participants



Outcome of the Third Workshop!

- Additions to:

Progress in End-to-End Optimization of Detectors for Fundamental Physics with Differentiable Programming

Max Ahle^d, Lorenzo Arsini^{r,s}, Anastasios Belias^a, Alexey Boldyrev^{a,e}, Konstantin Borozdin^o,
Susana Cebrian^l, Remco de Boer^p, Alexander Demin^e, Julien Donini^{a,f,v}, Tommaso Dorigo^{a,b,v},
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Giles C. Strong^{a,b}, Andrey Ustyuzhanin^{a,t}, Pietro Vischia^{a,u}

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Fourth MODE Workshop (2024)

- Here at IFIC/UV
 - 51 talks, 12 posters!!!
 - 76 in person participants!!!

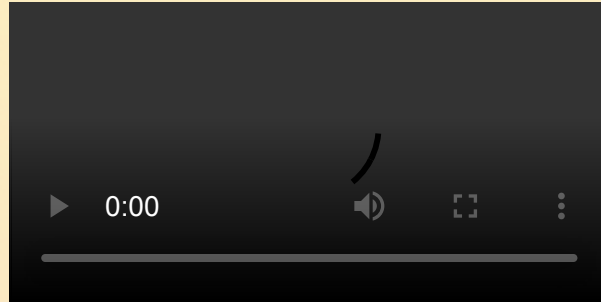


Fourth MODE Workshop on Differentiable Programming for Experiment Design

23–25 Sept 2024
Valencia (Spain)
Europe/Madrid timezone



Rich program, thanks to you!!!



Impossible without our funding agencies!

- In particular, we hugely appreciate the sustained support by NuPECC, APPEC, and IRIS-HEP across the years!!!

This workshop is partially supported by:

- the joint ECFA-NuPECC-APPEC Activities ([JENAA](#));
- the National Science Foundation cooperative agreement PHY-2323298 ([IRIS-HEP](#));
- the Ministerio de Ciencia y Innovación, under the network RED2022-134769-T ([COMCHA](#));
- the projects PROMETEO/2022/69 and PROMETEO/2022/70 from the Generalitat Valenciana;
- the Ministerio de Ciencia y Innovación and by the European Union NextGenerationEU/PRTR under the grant RYC2021-033305-I ([NeuroModelling](#));
- the [Particles](#) journal.

We had a wonderful time in Valencia!

...huge thanks to the local organizers!!!

- Cesar Domingo (IFIC, CSIC-UV)
- Gabriela Llosá (IFIC, CSIC-UV)
- Roberto Ruiz de Austri (IFIC, CSIC-UV)
- José Salt (IFIC, CSIC-UV)
- Michel Sorel (IFIC, CSIC-UV)
- Emma Torró (IFIC, CSIC-UV)
- Miguel Villaplana (IFIC, CSIC-UV)

- María José García Fortea (ADEIT)
- José Martínez Sáez (ADEIT)

Outcome of the Fourth Workshop

- We plan to publish all contributions to this workshop (talks and posters) in a special issue of MDPI Particles
 - Deadline 31/12/2024 (not negotiable)

The screenshot displays the MDPI website interface. At the top, the MDPI logo is on the left, and navigation links for Journals, Topics, Information, Author Services, Initiatives, and About are in the center. On the right, there are buttons for 'Sign In / Sign Up' and 'Submit'. Below the navigation is a search bar with the text 'Search for Articles:' and input fields for 'Title / Keyword', 'Author / Affiliation / Email', 'Particles' (a dropdown menu), and 'All Article Types' (another dropdown menu). A 'Search' button and an 'Advanced' link are also present.

The main content area shows a breadcrumb trail: 'Journals / Particles / Special Issues / Selected Papers from the 4th MODE Workshop on Differentiable Programming...'. On the right side of the page, there are two circular metrics: 'IMPACT FACTOR 1.7' in a yellow circle and 'CITESCORE 3.2' in a dark blue circle. Below these are social sharing icons for a share symbol and a notification icon.

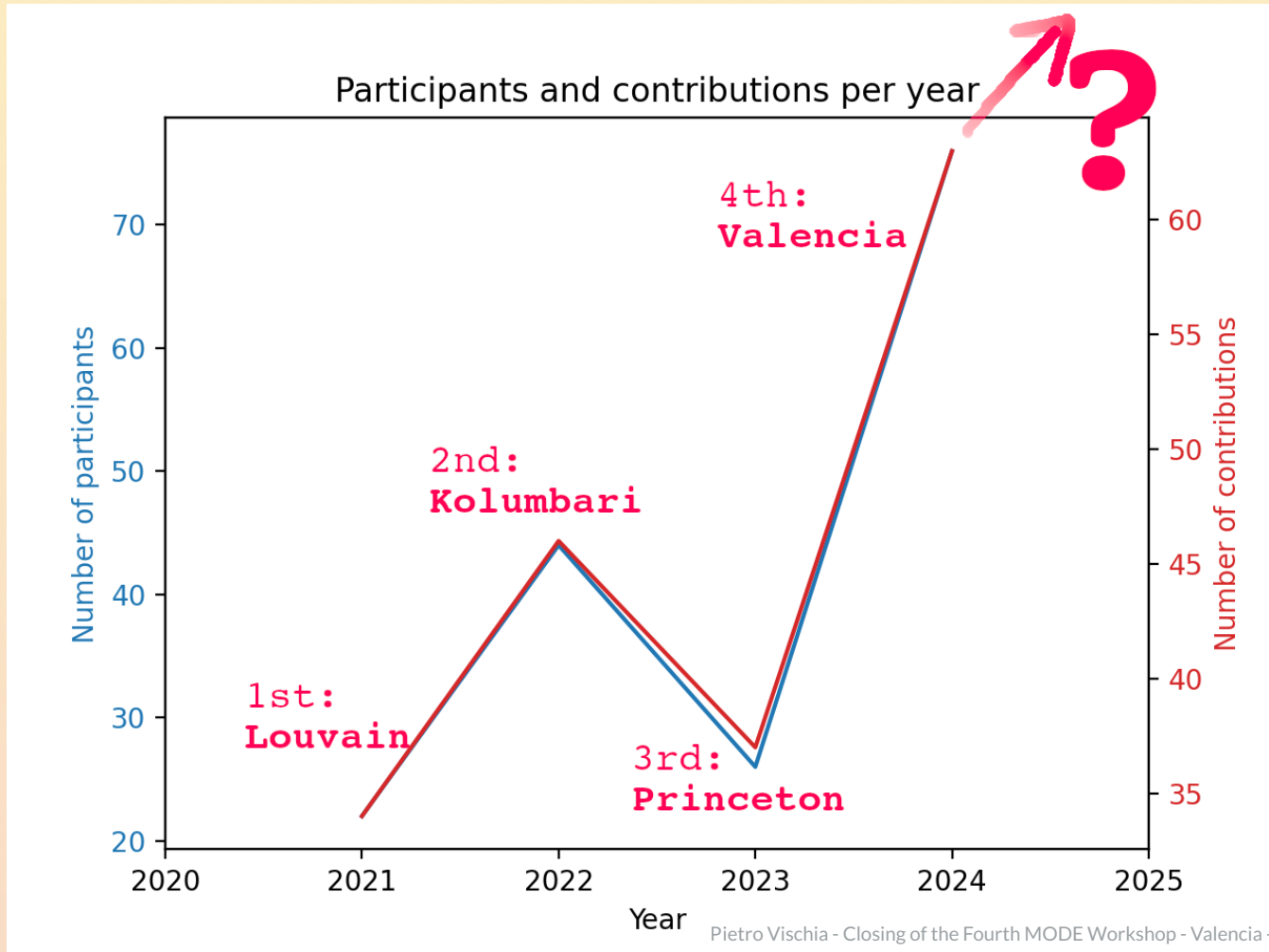
The central focus is the special issue page for 'Selected Papers from the 4th MODE Workshop on Differentiable Programming for Experiment Design'. On the left side of this page, there is a sidebar with the 'particles' logo and four buttons: 'Submit to Special Issue', 'Submit Abstract to Special Issue', 'Review for Particles', and 'Propose a Special Issue...'. Below this is a 'Journal Menu' with a list of links: Particles Home, Aims & Scope, Editorial Board, Reviewer Board, Instructions for Authors, Special Issues, Topical Collections, Article Processing Charge, Indexing & Archiving, Editor's Choice Articles, and Most Cited & Viewed.

The main content area of the special issue page features a list of links: 'Print Special Issue Flyer', 'Special Issue Editors', 'Special Issue Information', 'Keywords', 'Benefits of Publishing in a Special Issue', and 'Published Papers'. Below this list, it states 'A special issue of *Particles* (ISSN 2571-712X).'. The deadline for manuscript submissions is '31 December 2024' and it has been 'Viewed by 68'.

At the bottom of the page, there is a 'Share This Special Issue' section with icons for email, a social media icon, LinkedIn, Facebook, and a social media icon.

Growth

- This year, 19 early career researchers!!! Almost 1/4th of the participants!



The MODE Collaboration

COLLABORATION

At INFN and Università of Padova Dr. **Tommaso Dorigo**, Dr. **Pablo De Castro Manzano**, Dr. **Federica Fanzago**, Dr. **Lukas Layer**, Dr. **Giles Strong**, Dr. **Mia Tosi**, and Dr. **Hevjin Yarar**

At Université catholique de Louvain Dr. **Andrea Giammanco**, Prof. **Christophe Delaere**, and Mr. **Maxime Lagrange**

At Universidad de Oviedo and ICTEA Dr. **Pietro Vischia**

At Université Clermont Auvergne, Prof. **Julien Donini**, and Mr. **Federico Nardi** (joint with Università di Padova)

At the Higher School of Economics of Moscow, Prof. **Andrey Ustyuzhanin**, Dr. **Alexey Boldyrev**, Dr. **Denis Derkach**, and Dr. **Fedor Ratnikov**

At the Instituto de Física de Cantabria, Dr. **Pablo Martínez Ruiz del Árbol**

At CERN, Dr. **Sofia Vallecorsa**

At Karlsruher Institut für Technologie, Dr. **Jan Kieseler**

At University of Oxford Dr. **Atilim Gunes Baydin**

At New York University Prof. **Kyle Cranmer**

At Université de Liège Prof. **Gilles Louppe**

At GSI/FAIR Dr. **Anastasios Belias**

At HEPHY Vienna (OeAW) Dr. **Claudius Krause**

At Uppsala Universitet Prof. **Christian Glaser**

At TU-München, Prof. **Lukas Heinrich** and Mr. **Max Lamparth**

At Durham University Dr. **Patrick Stowell**

At Lebanese University Prof. **Haitham Zaraket**

At University of Kaiserslautern-Landau Mr. **Max Aehle**, Prof. **Nicolas Gauger**, Dr. **Lisa Kusch**

At University of Applied Sciences Worms Prof. **Ralf Keidel**

At Princeton University Prof. **Peter Elmer**

At University of Washington Prof. **Gordon Watts**

At SLAC Dr. **Ryan Roussel**

At Lulea University of Technology Prof. **Fredrik Sandin** and Prof. **Marcus Liwicki**

At IGFAE and Universidad de Santiago de Compostela Prof. **Xabier Cid Vidal**

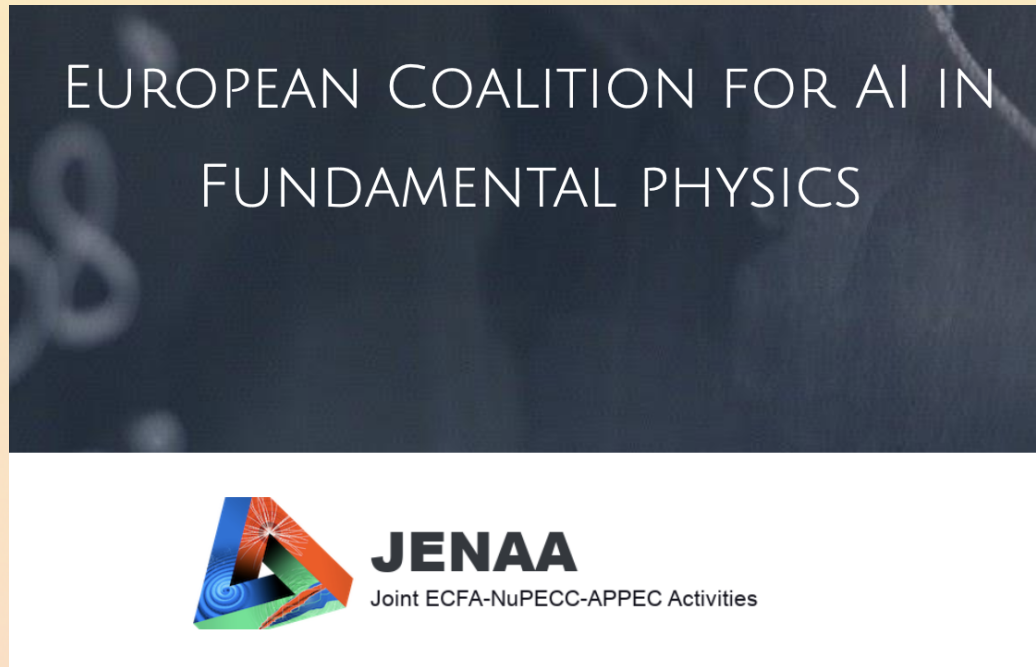
The Scientific Coordinator of the MODE Collaboration is Dr. **Tommaso Dorigo**, INFN-Sezione di Padova

The Steering Board of the MODE Collaboration includes:

- Prof. **Julien Donini**, UCA
- Dr. **Tommaso Dorigo**, INFN-PD
- Dr. **Andrea Giammanco**, UCLouvain
- Dr. **Fedor Ratnikov**, HSE
- Dr. **Pietro Vischia**, UniOvi

Broader efforts

- European initiative for advancing the use of AI in Fundamental Physics
 - The [First EuCaif conference](#) took place in Amsterdam beginning of May
 - **Work Package 2: Experiment Design**



Ultimately, thank YOU!!!



- Additional photos will be downloadable from the [Workshop Page](#) in the next few days

Want to join us?

- According to our Statute, you need to:
 - [be interested](#) in our research plan, and to [produce research](#) in that area
 - [bring competence](#) of relevance, or vow to [acquire](#) it
 - aim to contribute to it within your (time and resource) possibilities
- If you are interested, send the [MODE Steering board](#) (Dorigo, Donini, Giammanco, Ratnikov, Vischia) an email with confirmation of the above and a short bio/CV: chances are we'll get you in!

<https://mode-collaboration.github.io/>

Fifth MODE Workshop (2025)

At 95% confidence level...

Fifth MODE Workshop (2025)

~~At 95% confidence level...~~ With a prior probability of 95%...

Fifth MODE Workshop (2025)

~~At 95% confidence level...~~ With a prior probability of 95%...

Back to Kolumbari!!!



Maximum extraction
of scientific value

Challenge current
design concepts

Assist with a
landscape of
solutions



MODE

Modular pipelines
powered by autodiff

Make generators
differentiable where
possible

Create and guide a
multidisciplinary
community