Tommaso Diotalevi

Ph.D. in Physics

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Education

Nov 2018 – Jun 2022 **Ph.D. in Physics**, *Alma Mater Studiorum - University of Bologna*, Bologna
Field of research: Nuclear and Subnuclear Physics
"Application of Deep Learning techniques in the search for BSM Higgs bosons in the $\mu\mu$ final state in CMS" (*link*), Supervisor: Prof. Daniele Bonacorsi; Co-supervisors: by Dr. Federica Primavera, Stefano Marcellini and Gianni Masetti

Sep 2018 – Oct 2018 **Technological Student fellowship program**, *INFN-CNAF*
Bologna, Italy
2^{nd} classified in the national selection ranking
"Log parsing for a Machine Learning application on a predictive maintenance solution at the INFN-CNAF Tier-1 computing center (see Research Activities)"

Jul 2016 – Sep 2016 **CERN Summer Student Programme**
CERN, Switzerland
Supervisors: Nicolò Magini, Valentin Kuznetsov, Daniele Bonacorsi
"Analysing CMS transfers using Machine Learning techniques" (*link*)

Oct 2015 – Jul 2018 **Master Degree in Physics**, *University of Bologna*, Bologna
Curriculum: Nuclear and Subnuclear Physics
Final Mark: 110/110 cum laude
"CMS Level-1 Trigger Muon Momentum assignment with Machine Learning" (*link*), Supervisor: Prof. Daniele Bonacorsi; Co-supervisors: by Prof. Luigi Guiducci and Dr. Carlo Battilana

Oct 2012 – Oct 2015 **Bachelor Degree in Physics**, *University of Bologna*, Bologna
Final Mark: 110/110 cum laude
"Investigation of Petabyte-scale data transfer performances with PhEDEx for the CMS experiment" (*link*), Supervisor: Prof. Daniele Bonacorsi

Contracts for research and professional training

Feb 2023 – Today **Junior assistant professor (Ricercatore a tempo determinato tipo a))**
University of Bologna, Italy

Jul 2022 – Jan 2023 **INFN-CNAF Research Fellowship (assegno di ricerca) contract**
Bologna, Italy

Jul 2021 – Jun 2022 **CERN Doctoral Student fellowship programme**, *One year project based at CERN*,
Project title: *Application of Deep Learning techniques in the reconstruction of high energy muons and in the search for BSM Higgs bosons in the $\mu\mu$ final state in CMS*
INFN opening nb 1397
CERN, Switzerland

Jul 2021 – Sep 2021 **"Marco Polo" Scholarship for students mobility**, *Three months project based at CERN*,
Project title: *Machine and Deep Learning techniques in the search for physics Beyond the Standard Model of the Higgs Boson into the $\mu^+\mu^-$ final state, in proton-proton collisions at 13 TeV with the CMS experiment*
(Note: project was selected, I withdrew due to incompatibility with previous item)
University of Bologna, Italy

Nov 2019 – Feb 2020 **Corporate consultant for AlmaCube s.r.l. in the Oper CBI project**
Paid consultancy on Artificial Intelligence applications for industries - Initiative by Prof. S.Bertolucci
Bologna, Italy

Nov 2018 – Jun 2022 **Ph.D. Scholarship (funded by INFN)**
Ph.D. in Physics
University of Bologna, Italy

Sep 2018 – Oct 2018 **INFN-CNAF Technological Student fellowship**
Bologna, Italy

Jul 2016 – Sep 2016 **CERN Summer Student programme contract**
CERN, Switzerland

Participation in research groups

Memberships

2016 – Today **Member of the CMS Collaboration at LHC**

2020 – Today **Member of the "ML_INFN" (AI_INFN since January 2024) CSN5 project**
"End-to-end approach to the usage of Machine Learning for INFN research topics"
Bologna operational unit

2016 – Today **Member of the CERN Operational Intelligence team**
CERN-based inter-experiment group on advanced CompOps techniques for current and next generation experiments

2021 – Today **Involvement in software&computing for Einstein Telescope (ETIC)**
Ramping up on AI applications in newly formed Bologna units in the ETIC project (BETIF for INFN, DIFAET for UniBO)

2022 – Today **Involvement in software&computing for SND@LHC**
Ramping up on ML-based track identification and reconstruction in the Bologna team

2022 – Today **Involvement in the EU project "Skills4EOSC"**
Ramping up on Open Science and Competence Centres, focus on WP1.2 and WP2.5 and work of the upskilling Task Force

Responsibilities

2020 – Today **Responsible of Monte Carlo simulations in the CMS HIG/HExtended and B2G groups**
Official L3 position in the CMS organigram

2018 – Today **Responsible of the parametric neural network implementation and support in the CMS HMuMu analysis group**

International committees

2020 **Member of Technical committee**
International Workshop on Predictive Maintenance (IWPM) of the 27^{th} FRUCT Conference

Contracts of association

2019 – Today **CERN**

2018 – Today **INFN (National Institution for Nuclear and Subnuclear Physics)**
Bologna, Italy

Research activities

PHYSICS ANALYSIS

- **Search for MSSM Higgs Boson decaying to $\mu^+\mu^-$ in pp collisions at $\sqrt{s}$= 13 TeV**
(Nov 2018 - Jun 2022)
I joined this group in November 2018. The CMS collaboration on this particular analysis, before my arrival, has published the following paper: CMS-HIG-18-010 (arXiv:1907.03152). My personal contribution is related to the evolution of such analysis, with the inclusion of the entire Run2 data at a center-of-mass energy of 13TeV. In particular, my involvement is focused on the production of Machine and Deep Learning algorithms for the improvement of the signal/background discrimination, using a novel approach called parametric Neural Network (pNN), comparing the performance with a "classical" cut-based approach. Such new architecture, including by design the Higgs unknown mass hypotheses among with the standard pNN input features, it is able to replace a whole set of single networks, each one trained at a specific mass value, with a single network able to interpolate masses where it is not specifically trained. As a MC contact for the HExtended Higgs subgroup, I am also responsible for the production of the analysis' Ultra-Legacy Monte Carlo samples, for the 2016-2018 data taking period.

SOFTWARE & COMPUTING

- **Development of a Tape REST API, for the WLCG storage managers**
(Jul 2022 - Jan 2023)
I joined the Software Development group at INFN-CNAF from July 2022. Currently, storage managers (e.g. StoRM, dCache, etc...) operating on the WorldWide LHC Computing GRID (WLCG) handle primarily disk related operations. However, compared to disk, tape storage is much cheaper and capable of storing much more data, but with a huge downside in terms of data recall and IO speed. The WLCG tape REST API offers a common HTTP interface allowing clients to manage disk residency of tape stored files and observe the progress of file transfer on disk. This API, as the name suggest, is RESTful and consists of a single endpoint handling different operations: the stage bulk-request of any requested tape-stored files, making them available on disk; the progress tracking of a previously staged bulk-request; the cancellation of previously staged file replicas from disk; the request information about the progress of file's staging. The API, when operational, will be accessed via authentication mechanisms like X509 + VOMS (proxy-based) or token based (JWT).

- **Exploring Deep Learning fast inference on an ATCA processor board with Xilinx Virtex-7 FPGA**
  (Feb 2019 – Jun 2022)
  Both the University of Bologna and INFN-Bologna created this group with the idea of building and testing Machine and Deep Learning models into custom FPGA firmware. This kind of expertise is crucial in the future steps of High Energy Physics, in particular with low-latency hardware solutions like trigger and data acquisition that will cope with stricter requirements from the upcoming Run-3 as well as the new phase of operations with the High-Luminosity LHC. My work in this group is mainly focused with the application of the High-Level Synthesis toolkit - hls4ml - developed mainly at CERN, to convert simple neural networks into a series of logic operations and testing them on a high end ATC136 board with a Xilinx Virtex-7 FPGA.
- **Collection of system logs and prototypal analytics services with the Elastic (ELK) suite at the INFN-CNAF computing centre**
  (Nov 2018 – Apr 2019)
  The distributed Grid infrastructure for High Energy Physics experiments at the Large Hadron Collider (LHC) in Geneva comprises a set of computing centres, spread all over the world, as part of the Worldwide LHC Computing Grid (WLCG). In Italy, the Tier-1 functionalities are served by the INFN-CNAF data center, which provides also computing and storage resources to more than twenty non-LHC experiments. For this reason, a high amount of logs are collected each day from various sources, which are highly heterogeneous and difficult to harmonize. During my work at the INFN-CNAF, I started working on a centralised system that collects, parses and displays the log information from CNAF data sources, investigating them on a Machine Learning based predictive maintenance system.
- **Monitoring data transfer latency in CMS computing operations**
  (Jan 2015 – Oct 2015)
  I worked in the CMS PhEDEx (Physics Experiment Data Export) group, analysing several typical CMS transfer workflows, such as distribution of collision event data from CERN or upload of simulated event data from the Tier-2 centres to the archival Tier-1 centres. For each workflow, the typical patterns of transfer latencies that have been identified with the latency monitor, were identified; in particular the areas in PhEDEx where a development effort can reduce the latency, showing the ability to detect stuck transfers which need operator intervention. A set of metrics was created to alert about stuck subscriptions and prompt for manual intervention, with the aim of improving transfer completion times.

MUON POG

- **Run3 High p_T classifier with Machine Learning**
  (Mar 2020 – Today)
  I started collaborating with the CMS Muon POG L3 subgroups, studying possible refit techniques for high p_T muons, using Machine Learning techniques. If results will be promising, the algorithm developed will replace the actual algorithm for the choice of the best refit, TuneP, thus improving the overall muon high p_T assignment.

DETECTOR R&D

- **Development of a Machine Learning based muon trigger algorithm for the Phase2 upgrade of the CMS detector**
  (Jul 2017 – Jul 2018)
  After the high-luminosity upgrade of the LHC, the muon chambers of the CMS Barrel region must cope with an increase in the number of interactions per bunch crossing. Therefore, new algorithmic techniques for data acquisition and processing will be necessary in preparation for such a high pile-up environment. Using Machine Learning as a technique to tackle this problem, my work was mainly focused on the production of models - with data obtained through Monte Carlo simulations - capable of predicting the transverse momentum of muons crossing the CMS Barrel muon chambers, comparing them with the transverse momentum assigned by the current CMS Level-1 trigger system.

Conferences, workshops, schools and tutorials

In this section, I list all the attendances to events, as from the title. For my personal contributions, please refer to "Personal contribution at conferences".

Conferences

11-15 Mar 2024 **22nd International Workshop on Advanced Computing and Analysis Techniques in Physics Research (ACAT2024)**
Stony Brook, USA

6-13 Jul 2022 **International Conference on High Energy Physics (ICHEP 2022)**
Bologna, Italy

17-21 May 2021 **25th International Conference on Computing in High-Energy and Nuclear Physics (vCHEP2021)**
CERN, Switzerland (online)

22-26 Mar 2021 **International Symposium on Grids & Clouds 2021, ISGC2021**
Taipei, Taiwan (online)

31 Mar-5 Apr 2019 **International Symposium on Grids & Clouds 2019, ISGC2019**
Taipei, Taiwan

4-9 Jun 2018 **Sixth Annual Large Hadron Collider Physics conference, LHCP 2018**
Bologna, Italy

Workshops

13-16 Nov 2023 **Fifth ML-INFN Hackathon: Advanced Level**
Pisa, Italy

19-21 Jun 2023 **First course about the porting on GPUs of code and algorithms**
Italy (online)

22-26 May 2023 **Workshop sul calcolo nell'INFN (CCR)**
Loano, Italy

10-11 Mar 2022 **Workshop on data analysis @CMS Italia**
Florence, Italy

13-15 Dec 2021 **Second ML-INFN Hackathon: Starting Level**
Online only

11-13 Oct 2021 **Annual Workshop of the CMS experiment at LHC**
Naples, Italy

5-9 Jul 2021 **PyHEP 2021 (virtual) Workshop**

30 Nov-3 Dic 2020 **Fast Machine Learning for Science Workshop**
Southern Methodist University of Dallas, Texas (online)

19-23 Oct 2020 **4th Inter-experiment Machine Learning (IML) Workshop**
CERN, Switzerland (online)

22-23 Jan 2020 **CERN Openlab Technical Workshop**
CERN, Switzerland

15-18 Apr 2019 **3rd Inter-experiment Machine Learning (IML) Workshop**
CERN, Switzerland (online)

6 Feb 2019 **How to do ultrafast Deep Neural Network inference on FPGAs**
Zurich, Switzerland

Schools

2-8 Oct 2022 **Thirteenth INFN International School on: "EFFICIENT SCIENTIFIC COMPUTING" (ESC22)**
Bertinoro, Italy

7-18 Jun 2021 **ESCAPE Data Science Summer School 2021**
Annecy, France (online)

23-30 Sep 2020 **CMS Virtual Data Analysis School (CMSDAS)**
CERN, Switzerland (online)
Personal contribution: Physics analysis group presentation during plenary session.

20-24 Jul 2020 **Summer School on Physical Sensing and Processing**
Bologna, Italy (online)

27-28 Apr 2020 **Mathematical Methods and Models in Machine Learning**
Bologna, Italy (online)

16-20 Sep 2019 **Third International School on Open Science Cloud, SOSC2019**
Bologna, Italy

2-7 Jun 2019 **INFN School of Statistics 2019**
Paestum, Salerno

11-15 Apr 2016 **2nd BCD International School on High Energy Physics (ISHEP)**
Cargese, France

Tutorials

29 Apr 2022 **CMS Technical/DCS Shift Training**
CERN, Switzerland

7 Apr 2021 **Online CMS DQM Shift Tutorial**
CERN, Switzerland (online)

3-4 Feb 2021 **Quantum Machine Learning Tutorial**
CERN, Switzerland (online)

27-28 Feb 2020 **TensorFlow 2.0 Tutorial**
CERN, Switzerland (online)

Personal contributions at conferences

Oral contributions

- **Workshop sul calcolo nell'INFN, CCR2023**
  22 May - 26 May 2023, Loano (Italy)
  Title: *Esperienza di un'analisi dati CMS nell'INFN "Analysis Facility" framework* - **Speaker**

- **International Workshop on Advanced Computing and Analysis Techniques in Physics Research, ACAT2022**
  23 Oct - 28 Oct 2022, Bari (Italy)
  Title: *Affine Parametric Neural Networks for High-Energy Physics* - **Coauthor**
- **Workshop on data analysis @CMS Italia**
  10 Mar - 11 Mar 2022, Florence (Italy)
  Title: *BSM HMuMu analysis* - **Coauthor**
- **25th International Conference on Computing in High-Energy and Nuclear Physics, vCHEP2021**
  17 May - 21 May 2021, CERN (Switzerland) [online conference]
  Title: *Preparing distributed computing operations for the HL-LHC era with Operational Intelligence* - **Coauthor**
  Journal article published on Frontiers in Big Data: Frontiers in Big Data - Volume 4 (2022)
- **International Symposium on Grids & Clouds 2021, ISGC2021**
  22 March - 26 March 2021, Taipei (Taiwan) [online conference]
  Title: *Deep Learning fast inference on FPGA for CMS Muon Level-1 Trigger studies* - **Corresponding author and Speaker**
  Proceeding published on PoS: PoS(ISGC2021)005
- **International Symposium on Grids & Clouds 2020, ISGC2020**
  8 March - 13 March 2020, Taipei (Taiwan) - **Corresponding author and Speaker**
  [Cancelled due to Covid-19 pandemic, see ISGC2021]
- **24th International Conference on Computing in High-Energy and Nuclear Physics, CHEP2019**
  4 November - 8 November 2019, Adelaide (Australia)
  Title: *Operational Intelligence* - **Coauthor**
  Proceeding published on EPJ: EPJ Web of Conferences 245, 03017 (2020)
- **International Symposium on Grids & Clouds 2019, ISGC2019**
  31 March - 5 April 2019, Taipei (Taiwan)
  - Title: *Collection and harmonization of system logs and prototypal Analytics services with the Elastic (ELK) suite at the INFN-CNAF computing centre* - **Corresponding author and Speaker**
    Proceeding published on PoS: PoS(ISGC2019)027
  - Title: *Towards Predictive Maintenance with Machine Learning at the INFN-CNAF computing centre* - **Coauthor**
    Proceeding published on PoS: PoS(ISGC2019)003
- **International Symposium on Grids & Clouds 2018, ISGC2018**
  16 March - 23 March 2018, Taipei (Taiwan)
  Title: *Progress on Machine and Deep Learning applications in CMS Computing* - **Coauthor**
  Proceeding published on PoS: PoS(ISGC2018)022
- **International Symposium on Grids & Clouds 2017, ISGC2017**
  5 March - 10 March 2017, Taipei (Taiwan)
  Title: *Progress in Machine Learning Studies for the CMS Computing Infrastructure* - **Coauthor**
  Proceeding published on PoS: PoS(ISGC2017)023

Poster contributions

- **22nd International Workshop on Advanced Computing and Analysis Techniques in Physics Research (ACAT2024)**
  11-15 Mar 2024, Stony Brook (USA).
  Title: *Quasi interactive analysis of High Energy Physics big data with high throughput* - **Corresponding author**
  Proceedings TODO
- **26th International Conference on Computing in High Energy & Nuclear Physics (CHEP2023)**
  8-12 May 2023, Norfolk (USA).
  Title: *A RESTful approach to tape management in StoRM* - **Coauthor**
  Proceeding under peer-review
- **6th Annual Conference on Large Hadron Collider Physics (LHCP2018)**
  4-9 June 2018, Bologna (Italy).
  Title: *Development of Machine Learning based muon trigger algorithms for the Phase2 upgrade of the CMS* - **Corresponding author**
  Proceeding published on PoS: PoS(LHCP2018)092
- **21st International Conference on Computing in High Energy and Nuclear Physics, CHEP2015**, 13-17 April 2015 (Okinawa, Japan)
  Title: *Monitoring data transfer latency in CMS computing operations* - **Coauthor**
  Proceeding published on Journal of Physics: 664(3):032033, 2015

Teaching activities

Main professor

Feb 2024 – Today — **Professor**, *"Fenomeni Ondulatori (Wave-Motion Phenomena)" course* [cod. 15745]
Department of Physics and Astronomy, *University of Bologna*

Feb 2023 – Today — **Professor**, *"Fenomeni Termici (Thermodynamics)" course* [cod. 81783]
Department of Physics and Astronomy, *University of Bologna*

Tutoring

Jul 2021 – Jun 2022 — **Academic Tutor**, *"General Physics T-1" course, 60 hours* [cod. 27996] Prot. n. 186828 of 29/07/2021
Department of Electrical, Electronic, and Information Engineering, *University of Bologna*

Feb 2021 – May 2021 — **Academic Tutor**, *"Thermodynamics" course*, Contract waived [cod. 81783] Prot. n. 215838 of 05/10/2020
Department of Physics and Astronomy, *University of Bologna*

Mar 2021 – Jun 2021 — **Academic Tutor**, *"Applied Machine Learning - Advanced" course, 20 hours* [cod. 93282] Prot. n. 5944 of 13/01/2021
Department of Pharmacy and Biotechnology, *University of Bologna*

Nov 2020 – Jun 2021 — **Academic Tutor**, *"General Physics T-1" course, 40 hours* [cod. 27996] Prot. n. 172928 of 27/08/2020
Department of Electrical, Electronic, and Information Engineering, *University of Bologna*

Mar 2020 – Sep 2020 — **Academic Tutor**, *"Applied Machine Learning - Advanced" course, 15 hours* [cod. 91934] Prot. n. 10170 of 17/01/2020
Department of Pharmacy and Biotechnology, *University of Bologna*

Mar 2020 – Sep 2020 — **Academic Tutor**, *"Applied Machine Learning - Basic" course*, Contract waived [cod. 88407] Prot. n. 10177 of 17/01/2020
Department of Pharmacy and Biotechnology, *University of Bologna*

Nov 2019 – June 2020 **Academic Tutor**, *"General Physics T-1" course, 30 hours*
[cod. 27996] Prot. n. 282321 of 12/11/2019
Department of Electrical, Electronic, and Information Engineering, *University of Bologna*

Mar 2019 – May 2019 **Academic Tutor**, *"Software and Computing for Nuclear and Subnuclear Physics" course, 16 hours*
[cod. 87945] Prot. n. 25559 of 13/02/2019
Department of Physics and Astronomy, *University of Bologna*

Theses co-supervisions

27 Mar 2024 **Co-supervisor**, *Master degree in Physics, University of Bologna*
Thesis topic: *A Machine Learning approach for Heavy Neutral Leptons search from D_s meson decays in the CMS experiment*

26 Mar 2021 **Co-supervisor**, *Master degree in Physics, University of Bologna*
Thesis topic: *FPGA implementation of muon momentum assignment with Machine Learning at the CMS Level-1 Trigger*

25 Sep 2020 **Co-supervisor**, *Master degree in Physics*
University of Bologna
Thesis topic: *Search for Beyond Standard Model neutral Higgs boson in the $\mu\mu$ channel with the CMS detector at LHC with a multivariate approach*

18 Oct 2019 **Co-supervisor**, *Bachelor degree in Physics*
University of Bologna
Thesis topic: *Search for neutral MSSM Higgs bosons with CMS at LHC: a comparison between a cut-based analysis and a Machine Learning approach*

Theses Opponent

23 Mar 2024 **Opponent**, *Master degree in Physics, University of Bologna*
Thesis topic: *Finding optimal targets in the off-shell Higgs width measurement using deep neural networks in the leptonic WW decay channel*

Honours and awards

- **Award** for scientific excellence in Physics (about 30 applications, ten awards assigned, my rank: 1^{st}), by "*Fondazione G.Occhialini*", achieved on 07/06/2013
- **Award** for the best solution on the Machine Learning Kaggle challenge organised by the Third International School on Open Science Cloud 2019 (about 50 applications, my rank: 2^{nd}).
- **Award** for the best solution on the Machine Learning Kaggle challenge organised by the INFN School of Statistics 2019 (about 100 applications, my rank: 1^{st}).

Outreach activities

13 Feb 2024 **Training course**, *Using Leonardo Supercomputer: computing HPC contest*
Bologna, Italy

Oct 2023 - Feb 2024 **Fisica e Scuola (social promotion course)**, *Artificial Intelligence: present and future of a pervasive technology*
Bologna, Italy

29 Sep 2023 **European Night of Researchers**, *Artificial Intelligence for High Energy Physics*
Bologna, Italy

30 Sep 2022 **European Night of Researchers**, *Artificial Intelligence for High Energy Physics*
Bologna, Italy

24 Sep 2021 **European Night of Researchers**, *Artificial Intelligence for High Energy Physics*, (online stand)
Bologna, Italy

27 Nov 2020 **European Night of Researchers**, *Artificial Intelligence for High Energy Physics*, (online stand)
Bologna, Italy

27 Sep 2019 **European Night of Researchers**, *Artificial Intelligence for High Energy Physics*
Bologna, Italy

Jul 2019 **Outreach Tutor**, *High school study/work experience*
Bologna, Italy
Project developed by the "*Comitato di Coordinamento III missione (cc3m)*" of the INFN, focused on outreach for general audience and young students from High Schools

28 Sep 2018 **European Night of Researchers**, *Artificial Intelligence for High Energy Physics*
Bologna, Italy

Personal skills

Linguistic skills

Italian Mother tongue

English TOEFL iBT

- Understanding (listening): C1
- Understanding (reading): C1
- Speaking (Spoken interaction): C1
- Speaking (Spoken production): B2
- Writing: B2

IT skills

Op. Systems	Microsoft Windows, MacOS, Linux	Languages	C++ (advanced), Python (advanced), Bash (advanced), R (basic), LabVIEW (basic), CUDA (basic)
Data Analysis	ROOT, TMVA, RooFit	Data Simulation	MadGraph5, Pythia8, PowhegV2
Libraries and Tools	Tensorflow, Keras, Pytorch, Jupyter, Scikit-learn, Git, Numpy, Pandas	Protocols	GridFTP, xRootd, WebDAV
Automation Tools	Docker containers (advanced), Puppet deployment on server (basic)	Container Orchestration	Kubernetes (medium), Helm (basic)
Monitoring	Elasticsearch tools (basic), Graphana (basic)	Document editing	Microsoft Office package, LaTeX and Beamer, Overleaf
Distributed computing	HTCondor (medium), Dask (basic)		

Peer reviewer

- Journal of Instrumentation (JINST) - Institute of Physics (IOP)

Scientific Publications

RELEVANT PUBLICATIONS IN TERMS OF PERSONAL CONTRIBUTION

[1] Luca Anzalone, Tommaso Diotalevi, and Daniele Bonacorsi. **"Improving parametric neural networks for high-energy physics (and beyond)"**. In: *Machine Learning: Science and Technology* 3.3 (Sept. 2022), p. 035017. DOI: 10.1088/2632-2153/ac917c. URL: https://doi.org/10.1088/2632-2153/ac917c.

[2] Tommaso Diotalevi. **"Application of Deep Learning techniques in the search for BSM Higgs bosons in the $\mu\mu$ final state in CMS"**. PhD thesis. Bologna U., 2022. DOI: 10.48676/unibo/amsdottorato/10356.

[3] Alessandro Di Girolamo et al. **"Preparing Distributed Computing Operations for the HL-LHC Era With Operational Intelligence"**. In: *Frontiers in Big Data* 4 (2022). ISSN: 2624-909X. DOI: 10.3389/fdata.2021.753409. URL: https://www.frontiersin.org/article/10.3389/fdata.2021.753409.

[4] Tommaso Diotalevi et al. [CMS Collaboration]. **"Deep Learning fast inference on FPGA for CMS Muon Level-1 Trigger studies"**. In: *PoS* ISGC2021 (2021), p. 005. DOI: 10.22323/1.378.0005.

[5] Alessandro Di Girolamo et al. **"Operational Intelligence for Distributed Computing Systems for Exascale Science"**. In: *EPJ Web Conf.* 245 (2020). Ed. by C. Doglioni et al., p. 03017. DOI: 10.1051/epjconf/202024503017.

[6] Tommaso Diotalevi et al. **"Collection and harmonization of system logs and prototypal Analytics services with the Elastic (ELK) suite at the INFN-CNAF computing centre"**. In: *PoS* ISGC2019 (2019), p. 027. DOI: 10.22323/1.351.0027.

[7] Luca Giommi et al. **"Towards Predictive Maintenance with Machine Learning at the INFN-CNAF computing centre"**. In: *PoS* ISGC2019 (2019), p. 003. DOI: 10.22323/1.351.0003.

[8] Tommaso Diotalevi et al. **"Development of Machine Learning based muon trigger algorithms for the Phase2 upgrade of the CMS detector"**. In: *PoS* LHCP2018 (2018), p. 092. DOI: 10.22323/1.321.0092.

[9] Daniele Bonacorsi et al. **"Progress on Machine and Deep Learning applications in CMS Computing"**. In: *PoS* ISGC2018 & FCDD (2018), p. 022. DOI: 10.22323/1.327.0022.

[10] Daniele Bonacorsi et al. **"Progress in Machine Learning Studies for the CMS Computing Infrastructure"**. In: *PoS* ISGC2017 (2017), p. 023. DOI: 10.22323/1.293.0023 , FERMILAB-CONF-17-649.

[11] D. Bonacorsi et al. **"Monitoring data transfer latency in CMS computing operations"**. In: *J. Phys. Conf. Ser.* 664.3 (2015), p. 032033. DOI: 10.1088/1742-6596/664/3/032033 , FERMILAB-CONF-15-659-CMS.

LIST OF ALL PUBLICATIONS SUBMITTED TO OR PUBLISHED ON INTERNATIONAL PEER REVIEW JOURNALS

[1] Aram Hayrapetyan et al. [CMS Collaboration]. **"Search for production of a single vector-like quark decaying to tH or tZ in the all-hadronic final state in pp collisions at $\sqrt{s} = 13$ TeV"**. In: (May 2024). arXiv: 2405.05071 (hep-ex), CMS-B2G-19-001, CERN-EP-2024-067.

[2] Aram Hayrapetyan et al. [CMS Collaboration]. **"Girth and groomed radius of jets recoiling against isolated photons in lead-lead and proton-proton collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV"**. In: (May 2024). arXiv: 2405.02737 (nucl-ex), CMS-HIN-23-001, CERN-EP-2024-073.

[3] Aram Hayrapetyan et al. [CMS Collaboration]. **"Search for new resonances decaying to pairs of merged diphotons in proton-proton collisions at $\sqrt{s} = 13$ TeV"**. In: (May 2024). arXiv: 2405.00834 (hep-ex), CMS-EXO-22-022, CERN-EP-2024-101.

[4] Aram Hayrapetyan et al. [CMS Collaboration]. **"Search for the Z boson decay to $\tau\tau\mu\mu$ in proton-proton collisions at $\sqrt{s} = 13$ TeV"**. In: (Apr. 2024). arXiv: 2404.18298 (hep-ex), CMS-SMP-22-016, CERN-EP-2024-107.

[5] Aram Hayrapetyan et al. [CMS Collaboration]. **"Performance of CMS muon reconstruction from proton-proton to heavy ion collisions"**. In: (Apr. 2024). arXiv: 2404.17377 (hep-ex), CMS-MUO-21-001, CERN-EP-2024-040.

[6] Aram Hayrapetyan et al. [CMS Collaboration]. **"Measurement of multijet azimuthal correlations and determination of the strong coupling in proton-proton collisions at $\sqrt{s} = 13$ TeV"**. In: (Apr. 2024). arXiv: 2404.16082 (hep-ex), CMS-SMP-22-005, CERN-EP-2024-066.

[7] Aram Hayrapetyan et al. [CMS Collaboration]. **"Search for Higgs Boson Pair Production with One Associated Vector Boson in Proton-Proton Collisions at $\sqrt{s} = 13$ TeV"**. In: (Apr. 2024). arXiv: 2404.08462 (hep-ex), CMS-HIG-22-006, CERN-EP-2024-064.

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