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UNIVERZITET CRNE GORE

SENATU

CENTAR ZA DOKTORSKE STUDIJE

U prilogu akta dostavljam Odluke sa LXXVI sjednice Vijeća Prirodno-matematičkog fakulteta održane 25.01.2022. godine.



Dekan,

Prof. dr. Predrag Miranović

## ISPUNJENOST USLOVA DOKTORANDA

OPŠTI PODACI O DOKTORANDU			
Titula, ime, ime roditelja, prezime	Mr Jelena Dragana Mijušković		
Fakultet	Prirodno-matematički fakultet		
Studijski program	Fizika		
Broj indeksa	1/2018		
NAZIV DOKTORSKE DISERTACIJE			
Na službenom jeziku	Mjerenje N-džetnost varijabli u događajima sa produkcijom Z bozona u CMS detektoru i performanse njegovog elektromagnetnog kalorimetra		
Na engleskom jeziku	Measurement of the N-jettiness variables in the production of Z boson events with the CMS detector and performance of its electromagnetic calorimeter		
Naučna oblast	Fizika elementarnih čestica		
MENTOR/MENTORI (u skladu sa Sporazumom o zajedničkom doktoratu UCG-Univerzitet Paris-Saclay)			
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Drugi mentor	Dr Federico Ferri Istraživač sa HDR (habilitation à diriger des recherches)	Institut CEA- IRFU, Saclay, Pariz, Francuska	Fizika elementarnih čestica
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	Dr Marco Delmastro, istraživač sa habilitacijom (habilitation à diriger des recherches) Eksterni evaluator	LAPP, Univerzitet Savoie Mont Blanc, LAPP, CNRS/IN2P3, Annecy ; Francuska	Fizika elementarnih čestica
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	Dr Philippe Gras, istraživač sa permanentnom pozicijom Supervizor disertacije	CEA-IRFU, Saclay, Pariz, Francuska	Fizika elementarnih čestica

<b>Datum značajni za ocjenu doktorske disertacije</b>	
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Dostavljanja doktorske disertacije organizacionoj jedinici i saglasnost mentora	19.1.2022.
Sjednica Vijeća organizacione jedinice na kojoj je dat prijedlog za imenovanje komisija za pregled i ocjenu doktorske disertacije	25.1.2022.
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<p>Jelena Mijuskovic on behalf of CMS collaboration            „The CMS electromagnetic calorimeter upgrade: high-rate readout with precise time and energy resolution“,            Journal of Instrumentation (JINST) 2022 17 C01004 (SCI, Q1)            DOI: <a href="https://doi.org/10.1088/1748-0221/17/01/C01004">https://doi.org/10.1088/1748-0221/17/01/C01004</a></p>	
Prezentacije rezultat doktorske disertacije na međunarodnim konferencijama i vorkšopovima	
<ol style="list-style-type: none"> <li>1. J. Mijuškovic, High-rate readout with precise time resolution of a high-granularity calorimeter: the case of the CMS Electromagnetic calorimeter upgrade, 22nd International Workshop on Radiation Imaging Detectors, Ghent, Belgium, 27 June 2021 to 1 July 2021. <a href="https://indico.cern.ch/event/820476/">https://indico.cern.ch/event/820476/</a></li> <li>2. J. Mijuskovic, The CMS Electromagnetic Calorimeter calibration and performance during LHC Run 2, Meeting of the Division of Particles and Fields of the American Physical Society (DPF21), Florida State University, USA, online, 12–14 Jul 2021. <a href="https://indico.cern.ch/event/1034469/">https://indico.cern.ch/event/1034469/</a></li> <li>3. J. Mijuskovic, Z + jets: N-jettiness, Journées CMS-France, Physique et Upgrades de Phase-2, 7–9 Oct 2020, online. <a href="https://indico.cern.ch/event/881933/">https://indico.cern.ch/event/881933/</a></li> <li>4. J. Mijuskovic, Measuring N-jettiness of DY+jets events, Workshop on DY + 0...N jets measurements with Run II data, 16 December 2021, online. <a href="https://indico.cern.ch/event/1101623/">https://indico.cern.ch/event/1101623/</a></li> <li>5. J. Mijuskovic, Status of N-jettiness analysis at CMS, Z(+jets) Run II analysis workshop II, DESY, 2-3 July 2020. <a href="https://indico.desy.de/event/26396/timetable/#all.detailed">https://indico.desy.de/event/26396/timetable/#all.detailed</a></li> <li>6. P. Gras, J. Mijuskovic et al., Prospects on N-jettiness measurement at CMS, CMS Z(+jets) Run II analysis workshop, 13–14 Jan 2020, IIHE Brussels, Belgium. <a href="https://indico.cern.ch/event/855439/">https://indico.cern.ch/event/855439/</a></li> </ol>	

Najvažnija izlaganja rezultata iz doktorske disertacije na zasjedanjima CMS kolaboracije u CERN-u

1. Update on N-jettiness measurement, SMP-VJ: Vector Boson Plus Jets meeting, 17 Dec 2021, <https://indico.cern.ch/event/1093689/>
2. Double-Muon trigger SF, Muon HLT+RECO meeting, 14 Dec 2021 <https://indico.cern.ch/event/1106050/>
3. Update on N-jettiness measurement, SMP-VJ: Vector Boson Plus Jets meeting, 1 Oct 2021, <https://indico.cern.ch/event/1071770/>
4. Update on N-jettiness in Z+jets, SMP-VJ: Vector Boson Plus Jets meeting, 23 Jul 2021, <https://indico.cern.ch/event/987960/>
5. Update on N-jettiness in Z+jets, SMP-VJ: Vector Boson Plus Jets meeting, 23 Jul 2021, <https://indico.cern.ch/event/987960/>
6. Tracking efficiency in Njettiness studies using UL2018 datase, Tracking Physics Object Group, 14 Jun 2021, <https://indico.cern.ch/event/1040448/>
7. Run2 resolution studies for Ecal paper, ECAL Detector Performance Group, 26 May 2021, <https://indico.cern.ch/event/991265/>
8. Update on N-jettiness studies, SMP-VJ: Vector Boson Plus Jets, meeting, 16 Apr 2021, <https://indico.cern.ch/event/987953/>
9. Dimuon SF for UL2018, 22 Feb 2021, Muon Physics Object Group, <https://indico.cern.ch/event/1005603/>
10. N-jettiness status report, SMP-VJ: Vector Boson Plus Jets meeting, 5 Feb 2021, <https://indico.cern.ch/event/987948/>
11. Status of the N-jettiness analysis, SMP-VJ: Vector Boson Plus Jets meeting, 18 Dec 2020, <https://indico.cern.ch/event/975614/>
12. SF for dimuon trigger with UL2018, Muon Physics Object Group, 14 Dec 2020, <https://indico.cern.ch/event/984867/>
13. ECAL Resolution studies, CMS Week: ECAL General, 2 Dec 2020, <https://indico.cern.ch/event/977830/>
14. Ecal developments for prompt calibration and time-dependent MC, CMS Week: Plenary on Run-3 preparation, 16 Sep 2020, <https://indico.cern.ch/event/952782/timetable/>
15. N-jettiness in Z+jets, SMP-VJ: Vector Boson Plus Jets meeting, 17 Jul 2020, <https://indico.cern.ch/event/920780/>
16. Update on N-jettiness, SMP-VJ: Vector Boson Plus Jets meeting, 22 May 2020, <https://indico.cern.ch/event/897915/>
17. N-jettiness in Z+jets, SMP-VJ: Vector Boson Plus Jets meeting, 27 Mar 2020, <https://indico.cern.ch/event/882833/>
18. UL legacy summary plots, ECAL Detector Performance Group, 12 Feb 2020, <https://indico.cern.ch/event/871238/>
19. UL2017 Ecal resolution tes, Joint ECAL/Egamma meeting, 17 Jan 2020, <https://indico.cern.ch/event/879915/>
20. N-jettiness measurement plans, SMP-VJ: Vector Boson Plus Jets meeting, 6 Dec, 2019. <https://indico.cern.ch/event/861704/>



**Obrazloženje mentora o korišćenju doktorske disertacije u publikovanim radovima**

Sadržaj publikovan u naučnom radu za ispunjenje uslova i pokretanje procedure za ocjenu i odbranu doktorske disertacije sadržan je i proširen u glavi 3 doktorske disertacije.

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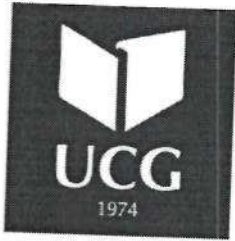


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*Mujerobh Mujepai*

**Prilog dokumenta sadrži:**

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  3. Kopiju rada publikovanog u časopisu sa odgovarajuće liste
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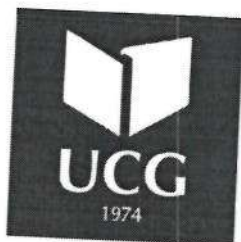
**POTVRDU**

MSc Jelena Mijušković, student doktorskih studija na Prirodno-matematičkom fakultetu u Podgorici, dana 19.01.2022.godine dostavila je ovom fakultetu doktorsku disertaciju pod nazivom "Mjerenje N-džetnosti varijabli u događajima sa produkcijom Z bozona u CMS detektoru i performance njegovog elektromagnetnog kalorimetra", na dalje postupanje.



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*[Signature]*  
Prof. dr Predrag Miranović



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**ODLUKA**

I

Utvrđuje se da su ispunjeni uslovi iz člana 38 Pravila doktorskih studija za doktoranda Mr Jelenu Mijušković.

II

Predlaže se Odboru za doktorske studije sastav komisije za ocjenu doktorske disertacije:

1. Prof. dr Nataša Raičević, redovni profesor PMF-a UCG, (naučna oblast: Fizika elementarnih čestica) prvi mentor;
2. Dr Federico Ferri, istraživač sa habilitacijom sa Instituta CEA-IRFU, Saclay, Pariz, Francuska (naučna oblast: Fizika elementarnih čestica) drugi mentor;
3. Dr Marco Delmastro, istraživač sa habilitacijom, LAPP; Univerzitet Savoie Mont Blanc, LAPP; CNRS/IN2P3; Annecy, Francuska;
4. Dr Ula Blumenschein, senior predavač, eksterni evaluator, School of Physics and Astronomy, Queen Mary University of London, Engleska (naučna oblast: Fizika elementarnih čestica), član i
5. Dr Philippe Gras, istraživač sa permanentnom pozicijom, supervisor disertacije, Institut CEA\_IRFU; Saclay, Pariz, Francuska (naučna oblast: Fizika elementarnih čestica) član.

III

Odluka se dostavlja Odboru za doktorske studije Univerziteta Crne Gore.



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*Prof. dr Predrag Miranović*  
Prof. dr Predrag Miranović

PAPER

# The CMS electromagnetic calorimeter upgrade: high-rate readout with precise time and energy resolution

Jelena Mijuskovic<sup>1,2</sup> and on behalf of CMS collaboration

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## Abstract

The electromagnetic calorimeter (ECAL) of the CMS detector has played an important role in the physics program of the experiment, delivering outstanding performance throughout data taking. The high-luminosity LHC will pose new challenges. The four to five-fold increase of the number of interactions per bunch crossing will require superior time resolution and noise rejection capabilities. For these reasons the electronics readout has been completely redesigned. A dual gain trans-impedance amplifier and an ASIC providing two 160 MHz ADC channels, gain selection, and data compression will be used in the new readout electronics. The trigger decision will be moved off-detector and will be performed by powerful and flexible FPGA processors, allowing for more sophisticated trigger algorithms to be applied. The upgraded ECAL will be capable of high-precision energy measurements throughout HL-LHC and will greatly improve the time resolution for photons and electrons above 10 GeV.





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22<sup>ND</sup> INTERNATIONAL WORKSHOP ON RADIATION IMAGING DETECTORS  
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## The CMS electromagnetic calorimeter upgrade: high-rate readout with precise time and energy resolution

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**ABSTRACT:** The electromagnetic calorimeter (ECAL) of the CMS detector has played an important role in the physics program of the experiment, delivering outstanding performance throughout data taking. The high-luminosity LHC will pose new challenges. The four to five-fold increase of the number of interactions per bunch crossing will require superior time resolution and noise rejection capabilities. For these reasons the electronics readout has been completely redesigned. A dual gain trans-impedance amplifier and an ASIC providing two 160 MHz ADC channels, gain selection, and data compression will be used in the new readout electronics. The trigger decision will be moved off-detector and will be performed by powerful and flexible FPGA processors, allowing for more sophisticated trigger algorithms to be applied. The upgraded ECAL will be capable of high-precision energy measurements throughout HL-LHC and will greatly improve the time resolution for photons and electrons above 10 GeV.

**KEYWORDS:** Calorimeters; Front-end electronics for detector readout

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## 1 Introduction

The Compact Muon Solenoid (CMS) is an experiment located at CERN at the Large Hadron Collider (LHC). The central part of the CMS detector is a superconducting magnet which provides a magnetic field of 3.8T. Inside the solenoid are placed the tracker, closest to the beam pipe, followed by the electromagnetic calorimeter (ECAL) and the hadronic calorimeter (HCAL). Muon chambers are placed outside of the solenoid and are embedded in the steel return yoke. The sketch of the CMS detector is shown in figure 1. A detailed description of CMS detector can be found in ref. [1]. During the run 1 and run 2 periods of data taking, an integrated luminosity of  $300 \text{ fb}^{-1}$  was accumulated. Excellent performance was obtained for these data taking periods with constant monitoring and calibration. The energy resolution during run 2 (2016, 2017 and 2018) for electrons from Z-boson decays was at the level of 1.7% in the low pseudorapidity region. In order to compare the run 2 and run 1 resolution, the samples are reweighted to match the pileup distribution from 2017. The performance from run 2 is very close to the one from run 1 despite much larger pileup and ageing of the detector (figure 2).

In order to extend the reach of new physics searches and the precision Higgs boson coupling measurements, the LHC will be upgraded to increase its luminosity by a factor of five to seven to reach  $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$  [2]. The center-of-mass energy for proton-proton collisions will be also raised from 13 TeV to 14 TeV. The average number of interaction will be 250–300 and the radiation levels will be much higher than in the previous data taking periods. To meet the challenges of HL-LHC, all LHC experiments, including CMS, will be upgraded.

In section 2 the ECAL barrel readout architecture used so far will be described. In section 3, the upgraded electronics for HL-LHC will be presented, including descriptions of the new very front-end (VFE) and front-end (FE) cards and the upgraded off-detector electronics.

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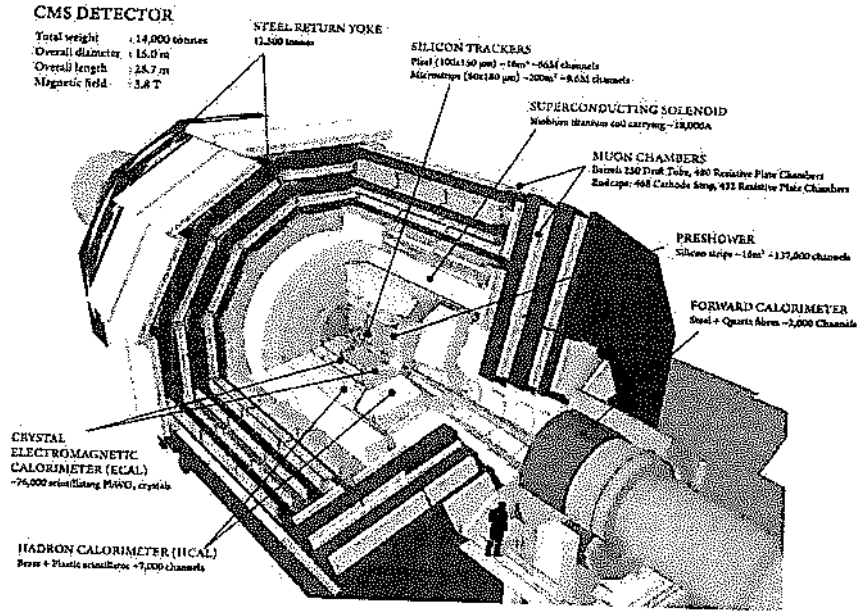


Figure 1. Schematic view of CMS detector.

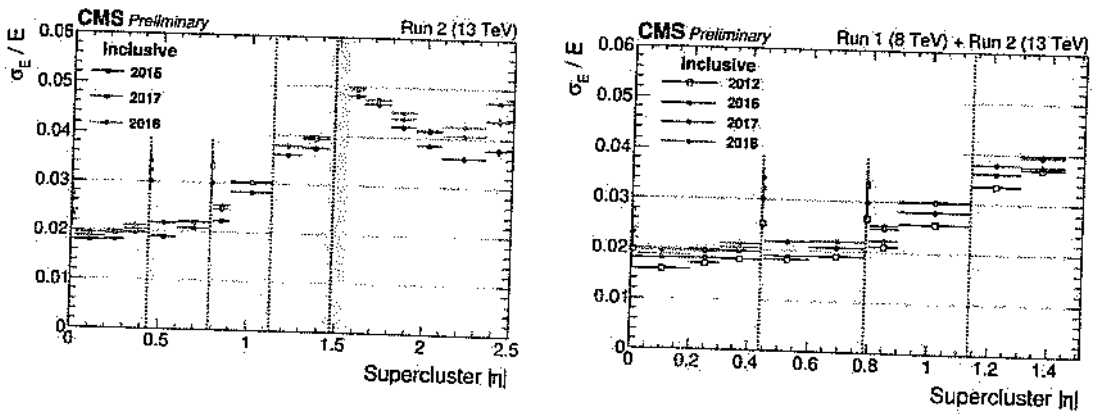


Figure 2. Energy resolution with the refined calibration as a function of the pseudorapidity comparing the 2016, 2017, and 2018 run 2 data-taking periods (left) and run 2 with 2012 run 1 data-taking period in the barrel region (right).

## 2 The CMS ECAL readout

ECAL is a high granularity lead tungstate crystal calorimeter, designed to achieve excellent energy resolution for electrons and photons. It is composed of a central, barrel region, which consists of 61200 crystals and covers the pseudorapidity region  $|\eta| < 1.48$ , and two endcaps with 14648 crystals covering the range  $1.48 < |\eta| < 3$ .

The CMS ECAL barrel is divided into 36 supermodules and 2448 readout units (figure 3). The photodetectors used are avalanche photodiodes (APDs) in the barrel and vacuum phototriodes (VPTs) in the endcaps. A sketch of the current ECAL readout system is shown in figure 4.

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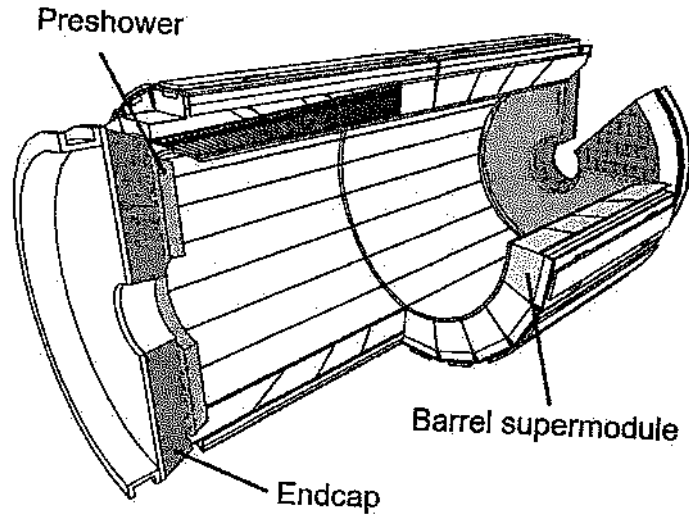


Figure 3. Structure of the ECAL.

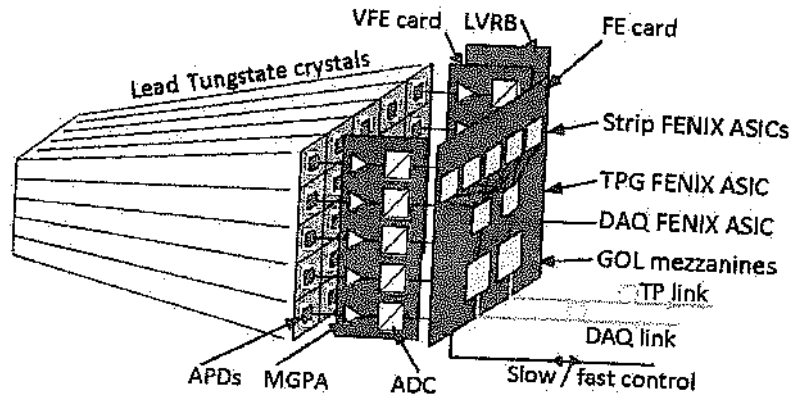


Figure 4. The CMS ECAL readout system.

In the barrel, two APDs are glued on one end of each crystal and connected through a Kapton cable to a VFE card. Each VFE card includes five readout channels consisting of a multi-gain pre-amplifiers (MGPA) and analog-to-digital converters (ADC). The MGPAs provide three different output gains ( $\times 1$ ,  $\times 6$ ,  $\times 12$ ) for each APD, and the outputs are converted by a 12-bit, 40 MS/s ADC chip. The signals from five VFE cards are passed to a single FE card. On the FE card the trigger generator circuit based on an ASIC and an optical transceiver is placed. The output is sent to the DAQ and trigger system through the optical transceiver called FENIX.

### 3 The ECAL barrel readout chain upgrade for HL-LHC

In order to cope with the larger trigger decision latency (12.5  $\mu\text{s}$  instead of current 4  $\mu\text{s}$ ) and larger L1 trigger rate (750 kHz compared to current 100 kHz) at HL-LHC, the ECAL barrel electronics

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need to be modified. In addition, the new electronics have been designed to adapt to the new conditions and to maintain performance [3].

In the VFE card, the MGPA will be replaced by a Trans Impedance Amplifier (TIA) named CATIA which will improve discrimination between the electromagnetic signals and the ones coming from direct ionization in the APDs (spikes). The multi-channel ADC will be replaced by the LiTE-DTU ASIC (Lisbon-Torino ECAL Data Transmission Unit) that samples the signal at 160 MS/s with 12-bit resolution. For the upgraded FE card, the trigger primitive generation will be moved from on-detector electronics to the off-detector system. Moreover, for the data transmission the FE card will use Low Power Gigabit Transceiver (lpGBT) optical transceiver [4] and Versatile Link plus [5]. The upgraded off-detector electronics, based on the Barrel Calorimeter Processor (BCP) card [9], will use powerful FPGAs for detector read-out and to generate trigger primitives. The schematic view of the ECAL barrel electronics upgrade is shown in figure 5.

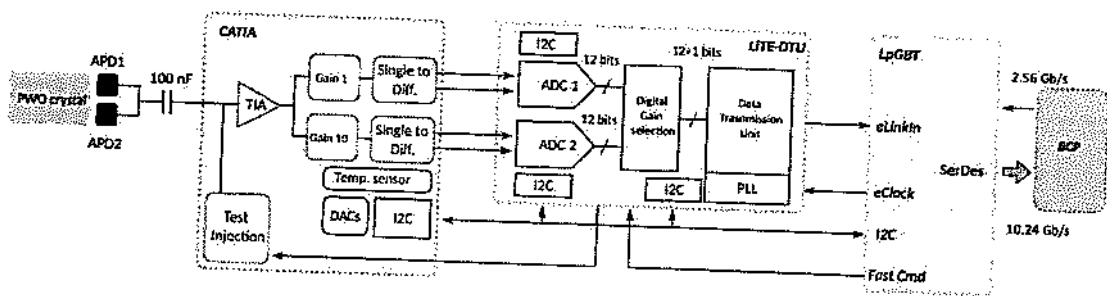


Figure 5. Schematic view of the new ECAL barrel electronics for HL-LHC.

### 3.1 CATIA ASIC

The CATIA (CAlorimeter TransImpedance Amplifier) is a fully analog ASIC designed in 130 nm CMOS technology. It features two output channels where one is for low energy signals (10 MeV–200 GeV) and the other is for high energy signals (10 MeV–2 TeV). The processing of signals from the APDs is done in three stages. The first stage converts the input current to a voltage using the high speed TIA. Following this step, the output is split into two channels with gains that differ by a factor of 10. The signals are routed to the LiTE DTU (described in the next section) by differential links.

The performance of the CATIA prototype has been tested in test beam campaigns at the H4/H2 beamline of the CERN SPS [6]. The test beam results have shown excellent performance of CATIA in terms of noise, linearity, and time resolution. The energy resolution matches with the resolution which has been obtained in beam tests with the legacy electronics [10], while a timing resolution of better than 30 ps is obtained for electrons with an energy greater than 50 GeV (figure 6) and complies with specifications.

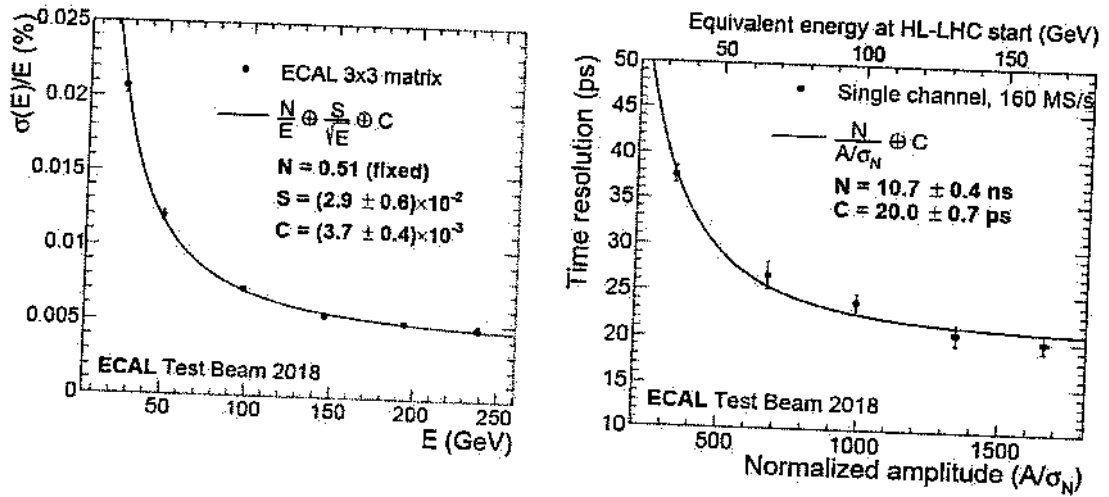


Figure 6. Energy resolution (left) and time resolution (right) obtained in the test beam campaign with the CATIA ASIC connected to a commercial ADC.

### 3.2 LiTE-DTU ASIC

The LiTE-DTU converts the analog output of CATIA to digital (ADC), selects one of the two gains for each time sample, compresses the data and transmits them to the FE card. This ASIC is built in 65 nm CMOS technology [7]. In order to convert, in parallel, the two outputs of the CATIA, the LiTE-DTU has two ADC IP blocks. The ADC, design by an external company, has 12-bit of resolution and a sampling frequency of 160 MHz. LiTE-DTU also includes a phase locked loop (PLL) for clock generation based on a design developed for the lpGBT chip. After conversion of the signal, the data transmission unit (DTU) selects between the two streams with different gains by looking for the highest non-saturated gain channel. In order to reduce the required bandwidth for the data transmission, the data are then compressed. Using a loss-less data compression mechanism, the reduction of the bandwidth is from 2.08 Gb/s to 1.08 Gb/s. Data packets from the LiTE-DTU are serialized to the FE board through differential electrical links at 1.28 Gb/s. LiTE-DTU is designed to sustain a total irradiation dose up to 20 kGy and it implements single-event upset (SEU) protection. The first prototype of the LiTE-DTU ASIC is tested was the late 2019.

### 3.3 Front-end board and back-end electronics upgrade

The FE card is designed for streaming the digitized data generated on the VFE to the back-end electronics system. The FE card contains four lpGBT ASICs. The new FE card will manage system initialization and control signals of the VFEs. In addition, it will provide the clock for the VFEs. The upgraded FE will no longer compute the trigger primitives as the data will now be streamed to the off-detector electronics at the full collision rate [8].

The off-detector system will be upgraded in order to handle the change in architecture and to deal with the higher transfer rates. On the BCP, implemented as an Advanced Telecommunications Computing Architecture (ATCA) blade, the FPGAs will be used to form the L1 trigger decision and

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read out the detector. The BCP will be common between ECAL and the CMS hadronic calorimeter. It will provide the clock distribution and control to the FE card. BCP will also interface with the CMS data acquisition.

#### 4 Conclusion

During LHC run 2, the CMS ECAL detector showed good performance despite increased pileup and radiation. Good energy resolution and good stability over time were maintained with constant calibration and monitoring. Nevertheless, for the pileup and radiation conditions that will be reached at HL-LHC, the replacement of the ECAL endcap with a new technology and an upgrade of the readout electronics of the barrel are needed. Replacing the readout electronics will ensure that ECAL complies with the new trigger requirements, has improved L1 capabilities, withstands the increased radiation, and mitigates pileup effects and APD noise. In addition, the upgrade will allow ECAL to maintain excellent energy resolution and have improved timing resolution. For the upgrade of the VFE two custom ASICs, CATIA and LiTE-DTU, have been designed. New FE and off-detector electronics have been developed. Prototypes have been tested and further tests are under way.

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**VIJEĆU PRIRODNO-MATEMATIČKOG FAKULTETA**

**CENTRU ZA DOKTORSKE STUDIJE**

**PREDMET:** Promjena konačnog naziva doktorske disertacije

Kao članovi Komisije za ocjenu pordobnosti teme (potpisnici obrasca D1), na incijativu mentora, prof. Nataše Raičević i doktoranda mr Jelene Mijušković, dajemo

**MIŠLJENJE**

o promjeni naslova doktorske disertacije doktoranda Jelene Mijušković

Jelena Mijušković radi dvojni doktorat definisan Sporazumom između Univerziteta Crne Gore i Univerziteta Paris Saclay.

Doktorand, mentor i komentor su nam detaljno predstavili konačne rezultate koji će biti sadržani u doktorskoj disertaciji i saglasni smo da se naslov doktorske disertacije:

„Mjerenja i aplikacije N-džetnost varijable pri produkcijama Z i Higs bozona u proton-proton sudarima na energiji od 13 TeV u CMS detektoru“

“Measurements and applications of the N-jettiness variable in the productions of Z and Higgs bosons in proton-proton collision at 13 TeV energy with the CMS detector”

promijeni u:

„Mjerenje N-džetnost varijabli u događajima sa produkcijom Z bozona u CMS detektoru i performanse njegovog elektromagnetnog kalorimetra“

„Measurement of the N-jettiness variables in the production of Z boson events with the CMS detector and performance of its electromagnetic calorimeter“

Ovim će se, prije svega, naslovom obuhvatiti veoma važna, dodatna istraživanja i rezultati koji nisu sadržani u prethodnom naslovu.

Doktorat sa ovakvim nazivom ne gubi na nivou naučnosti i naslov prirodno reflektuje konačne rezultate koji će biti sadržani u ovoj doktorskoj disertaciji.

U Podgorici, 19.01.2022.

*N. Raičević*

Prof. dr Nataša Raičević  
redovni profesor Prirodno-matematičkog fakulteta

*Ivana Pićurić*

Prof. dr Ivana Pićurić  
redovni profesor Prirodno-matematičkog fakulteta

*St. Backović*

Prof. dr Slobodan Backović  
redovni profesor i akademik CANU

Na osnovu člana 37 Pravila doktorskih studija Univerziteta Crne Gore dajemo

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### SAGLASNOST

da se doktorska teza pod nazivom „Mjerenje N-džetnost varijabli u događajima sa produkcijom Z bozona u CMS detektoru i performanse njegovog elektromagnetnog kalorimetra“ studenta doktorskih studija Prirodno-matematičkog fakulteta Univerziteta Crne Gore, mr Jelene Mijušković, uputi u proceduru za ocjenu. Smatramo da ista zadovoljava kriterijume doktorske disertacije propisane Statutom Univerziteta Crne Gore i Pravilima doktorskih studija Univerziteta Crne.

U Podgorici, 19.01.2022.

Mentori

*N. Raičević*

dr Nataša Raičević, redovni profesor

U Parizu, 19.01.2022.

*Federico Ferri*

dr Federico Ferri, habilitation à diriger des recherches

Pursuant to Article 37 of the Rules of Doctoral Studies of the University of Montenegro, we give

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Podgorica, 19. 01. 2022 god.

CONSENT

that the doctoral thesis of doctoral student at the Faculty of Natural Sciences and Mathematics, Jelena Mijuskovic, MSc, entitled " Measurement of the N-jettiness variables in the production of Z boson events with the CMS detector and performance of its electromagnetic calorimeter" should be sent for the evaluation procedure. We believe that it meets the criteria of a doctoral dissertation prescribed by the Statute of the University of Montenegro and the Rules of Doctoral Studies of the University of Montenegro.

In Podgorica, January 19th, 2022

Supervisors

*N. Raičević*

Dr. Natasa Raičević, full professor

*Federico Ferri*

In Paris, January 19th, 2022

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Подпис: М. Н. 2010 год.

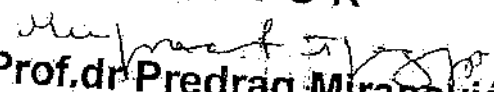
Ref: \_\_\_\_\_  
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Na osnovu člana 75 stav 2 Zakona o visokom obrazovanju (Sl.list RCG, br. 60/03 i Sl.list CG, br. 45/10) i člana 18 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore, na sjednici održanoj 28.10.2010. godine, donio je

## ODLUKU O IZBORU U ZVANJE

Dr NATAŠA RAIČEVIĆ bira se u akademsko zvanje redovni profesor Univerziteta Crne Gore za predmete: Elektromagnetizam i Fizika elementarnih čestica, na Prirodno-matematičkom fakultetu.

REKTOR

  
Prof. dr Predrag Miranović

# Curriculum Vitae

## Lični podaci

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**1993 Diplomirani fizičar**, Univerzitet Crne Gore, Prirodno-matematički fakultet  
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**1997 Magistar fizičkih nauka**, Univerzitet u Beogradu, Fizički fakultet  
(prosječna ocjena na studijama 10.0)

**2000 Doktor fizičkih nauka**, Univerzitet u Beogradu, Fizički fakultet

## Studentske nagrade i priznanja

**1990** Decembarska nagrada za najboljeg studenta Prirodno-matematičkog fakulteta

**1993** Nagrada Univerziteta Crne Gore za najboljeg studenta završne godine Prirodno-matematičkog fakulteta Univerziteta Crne Gore za školsku 1992/93. godinu

## Profesionalne pozicije

**1993–1997** Saradnik u nastavi na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici, Crna Gora

**1997–2000** Asistent na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici,

Crna Gora

2000–2005. **Docent** na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici, Crna Gora

2005–2010 **Vanredni profesor** na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici, Crna Gora

2010–danas **Redovni profesor** na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici, Crna Gora

## **Nastava**

**Vježbe na matičnom i nematičnim fakultetima** (u zvanju saradnika i asistenta)

Elektromagnetizam, Optika, Statistička fizika, Fizika čvrstog stanja, Nuklearna fizika (PMF), Eksperimentalne vježbe na nematičnim fakultetima

**Predavanja na predmetima** (u zvanju docenta, vanrednog i redovnog profesora)

Elektromagnetizam – osnovne studije na Prirodno-matematičkom fakultetu

Fizika elementarnih čestica – specijalističke studije na Prirodno-matematičkom fakultetu

Računari i programiranje – osnovne studije na Prirodno-matematičkom fakultetu

Teorijska elektrodinamika - osnovne studije na Prirodno-matematičkom fakultetu

Viši kurs fizike elementarnih čestica I - magistarske studije na Prirodno-matematičkom fakultetu

Eksperiment u savremenoj fizici čestica - magistarske studije na Prirodno-matematičkom fakultetu

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Biofizika na Medicinskom fakultetu

Poglavlja iz fizike u okviru predmeta Fiziologija na Medicinskom fakultetu

## **Oblast istraživanja**

**Eksperimentalna fizika elementarnih čestica**

**1995 – 1999 Član međunarodne istraživačke kolaboracije eksperimenta CERES u laboratoriji CERN u Ženevi (akcelerator SPS)**

1995–1996 Testiranje performansi trigera prvog nivoa na eksperimentu CERES Ujedinjeni institut za nuklearna istraživanja u Dubni, Rusija

1996–1997 Unapređenje softvera za analizu događaja sa eksperimenta CERES – rekonstrukcija verteksa za interakciju jezgara olova sa segmentisanom metom od zlata Ujedinjeni institut za nuklearna istraživanja u Dubni, Rusija

1996–1999 Proučavanje emisije  $e^+e^-$  parova u interakcijama teških jona  
Fizički institut Univerziteta u Hajdelbergu, Njemačka  
Univerzitet Crne Gore

2002– Član međunarodne istraživačke kolaboracije eksperimenta H1 u laboratoriji DESY u Hamburgu, Njemačka (akcelerator HERA)

Ova istraživanja realizovana su na Univerzitetu Crne Gore i kroz veći broj višemjesečnih boravaka godišnje na institutu DESY u Hamburgu i Berlinu.

2002-2005 Analiza podataka za mjerenje efikasnog presjeka za duboko neelastično rasijanje elektrona (pozitrona) na protonu pri malim i srednjim vrijednostima kvadrata predatog kvadri-impulsa

2004-2005 Rad na unapređenju softverskog rješenja za simulaciju kaskada čestica u kalorimetru H1 eksperimenta koji detektuje elektrone sa malim uglom rasijanja.

2005-2007 Analiza podataka za mjerenje efikasnog presjeka za duboko neelastično rasijanje elektrona (pozitrona) na protonu pri velikim vrijednostima neelastičnosti interakcije

2006-2007 Učešće u priprema seansi za  $e^+p$  interakcije sa redukovanim energijama protona sa HERA akceleratora (kroz analizu tada postojećih eksperimentalnih podataka)

2007-2011 Mjerenje longitudinalne strukturne funkcije protona

2017- Član međunarodne istraživačke kolaboracije eksperimenta CMS u laboratoriji CERN u Ženevi, Švajcarska (akcelerator LHC)

2017 – Analiza produkcije Drell-Yan parova u proton-proton interakcijama.

### Projekti (sa rukovodećom ulogom)

2004–2007 Učesnik na međunarodnom projektu finansiranom od strane DFG-a (Deutsche Forschungsgemeinschaft): „Präzisionsmessungen und Analyse der Elektron-Quark-Wechselwirkung bei höchsten Energien sowie suche nach Phänomenen außerhalb des Standardmodels“, broj GZ:436JUG113/3/0-1, odobren 2007. godine (partnerske strane: Univerzitet Crne Gore, institut DESY u Hamburgu, institut DESY-Zeuthenu u Berlinu i institut Max Planck u Minhenu).

2007–2010 Produžetak prethodnog projekta od DFG, pod brojem GZ:436JUG113/3/0-2

2005–2007 Rukovodilac naučno-istraživačkog projekta odobrenog od Ministarstva prosvjete i nauke Crne Gore „H1 eksperiment na HERA akceleratoru“

2008–2011 - Rukovodilac naučno-istraživačkog projekta odobrenog od Ministarstva prosvjete i nauke Crne Gore „Duboko neelastično rasijanje elektrona (pozitrona) na protonu“

2012-2015 - Rukovodilac naučno-istraživačkog projekta odobrenog od Ministarstva nauke Crne Gore „Završna faza analiza H1 kolaboracije“.

**2019 – 2023** – Ključni partner u projektu odobrenog u program **HORIZONT2020** „The strong interaction at the frontier of knowledge: fundamental research and applications”.

### **Učešće u radu upravljačkih struktura velikih kolaboracija**

**2004–2012** učešće u radu Upravnog odbora H1 kolaboracije koji donosi najvažnije odluke za kolaboraciju

**2007–2009** član Izvršnog odbora H1 kolaboracije

**2012-2014** član Upravnog odbora H1 kolaboracije

**2017-** član Upravnog odbora CMS kolaboracije

### **Učešće u radu tijela/centara čiji je rad povezan sa obrazovanjem**

**2015-2017** – član Nacionalnog savjeta za obrazovnje Crne Gore

**2015-2017** – član Odbora za obrazovnje Crne Gore

**Od 2015** – član Centra za studije i kontrolu kvaliteta Univerziteta Crne Gore

**Od 2015** – član Odbora za monitoring magistarskih studija Univerziteta Crne Gore

**Od 2016** – član Vijeća za prirodne i tehničke nauke Univerziteta Crne Gore

### **Informatička pismenost**

Operativni sistemi: UNIX i WINDOWS

Programski jezici: fortran, C, python

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## **Bibliografija**

### **Odabrani radovi**

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6. N. Raičević, Measurement of the diffractive DIS cross section at the H1 experiment, Rom. Rep. Phys. 65 (2013) 427. \*\*
7. N. Raičević, Precision measurement of the proton structure at HERA, Rom.Rep. Phys. 65 (2013) 103. \*\*
8. H1 Collaboration (F. D. Aaron, N. Raičević *et al.*), Measurement of the Inclusive ep Scattering Cross Section at High Inelasticity  $y$  and of the Structure Function FL, Eur. Phys. J. C71 (2011) 1579.
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  16. N. Raičević, Measurement of the neutral current DIS cross section at H1, J. Phys. Con. Ser. 110 (2008) 022042. \*\*
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  19. N. Raičević, Measurement of the inclusive e p deep inelastic scattering cross section at low  $Q^2$  with the H1 detector at HERA, AIP Con. Proc. 899 (2007) 217. \*\*
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  21. CERES/NA45 Collaboration (G. Agakichiev, N. Saveljić *et al.*), Recent results from Pb - Au collisions at 158-GeV/c per nucleon obtained with the CERES spectrometer, Nucl. Phys. A 661 (1999) 23.
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  23. G. Agakishiev, N. Saveljić *et al.*, A New robust fitting algorithm for vertex reconstruction in the CERES experiment, Nucl. Instrum. Meth. A 394 (1997) 225.

## **Odabrani radovi u zbornicima međunarodnih konferencija**

24. N. Raičević, High  $y$  DIS cross section measurement with H1, Proceedings of 15<sup>th</sup> International Workshop on Deep-Inelastic Scattering and Related Subjects, Munich, Germany, April 2007, vol. 1, 293, editors: G. Grindhammer, K. Sachs. ISBN 978-3-935702-23-2. \*\*

25. N. Raičević, Structure functions and extractions of PDFs at HERA, Proceedings of 41<sup>st</sup> Rencontres de Moriond: QCD and Hadronic Interactions, La Thuile, Italy, 18-25 March 2006, 181, editors: Etienne Auge and Jean Tran Thanh. e-Print: hep-ex/0605050. \*\*

\*\* Radi se o publikacijama koje obuhvataju najzapaženije rezultate kolaboracija koji su predstavljani na međunarodnim konferencijama, a koje je N. Raičević predstavljala u ime jedne ili više kolaboracija.

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Ministère de l'enseignement supérieur, de la recherche et de l'innovation

SORBONNE UNIVERSITÉ

**HABILITATION À DIRIGER DES RECHERCHES**

Vu le code de l'éducation, et notamment son article L.613-1 ;

Vu les pièces justificatives produites par M. FEDERICO FERRI, né le 15 novembre 1978 à MILAN (ITALIE) en vue de son inscription pour le diplôme d'habilitation à diriger des recherches ;

Vu le procès-verbal du jury attestant que l'intéressé a présenté ses travaux le 4 octobre 2021 devant un jury présidé par BERTRAND LAFORGE et composé de FRANCO BEDESCHI, LOUIS FAYARD, MARCO PIERI, PARASKEVAS SPHICAS, ALESSANDRA TONAZZO ;

Vu la délibération du jury ;

Le diplôme d'**HABILITATION À DIRIGER DES RECHERCHES** en **PHYSIQUE** est délivré à **M. FEDERICO FERRI**

pour en jouir avec les droits et prérogatives qui y sont attachés.

Fait le 10 novembre 2021

*Le titulaire*

*L'administrateur provisoire*

*Le Recteur d'Académie,  
Chancelier des universités*

N°

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Dominique PATERON



Christophe KERRERO

# FEDERICO FERRI ~ CURRICULUM VITAE ET STUDIORUM

Personal details: born 15.11.1978 in Milano, Italy; italian nationality  
Contact: federico.ferri@cern.ch

## CAREER

- 2021 **Scientific Associate** at CERN
- 2008- **Staff** researcher at CEA Saclay, IRFU/DPhP
- 2007-2008 **Post-doctoral** researcher at CEA Saclay IRFU/DPhP
- 2005-2007 **Post-doctoral** researcher at Istituto Nazionale di Fisica Nucleare (INFN), Italy
- 2002-2005 **Ph.D.** in Physics and Astronomy, at the École Polytechnique Palaiseau and at the University of Milano-Bicocca. Thesis: "The CMS Electromagnetic Calorimeter for the Higgs Boson Search  $H \rightarrow ZZ^{(*)} \rightarrow 4e$  at the LHC" (supervisors: T. Tabarelli de Fatis, Y. Sirois)
- 2002 **Fellow** researcher at Istituto Nazionale di Fisica Nucleare (4th in national-ranked admission)
- 2002 **Laurea** in Physics at the University of Milano-Bicocca, mark of 110/110 *cum laude*

## RESEARCH HIGHLIGHTS

### PHYSICS ANALYSES

- **Discovery of the Higgs boson** with the CMS detector, in the diphoton decay channel
- Observation of **associated production of the Higgs boson with top quarks**
- Measurement of the **Higgs boson couplings, fiducial and differential production cross sections** with the diphoton decay channel - **Editor of JHEP 1901(2019)183**
- Measurement of the **Higgs boson mass** in the diphoton decay channel
- **Measurement** of the production cross section of pair of isolated photons in CMS
- **Study** and optimization of the electron and photon reconstruction in CMS

### DETECTOR PERFORMANCE

- **Construction, commissioning, calibration, and performance** optimization of the **CMS ECAL** (electromagnetic calorimeter), from the installation in CMS to physics with collisions
- Preparation of the **upgrade of the CMS ECAL** for the High-Luminosity LHC, consisting in the replacement of the front-end and back-end electronics
- Study of **radiation-induced effects in PbWO<sub>4</sub>** scintillating crystals
- Calibration and performance of the **HARP Time-of-Flight system**
- Development and characterization of **glass-made Resistive Plate Chambers**

## ROLES AND RESPONSIBILITIES WITHIN THE CMS EXPERIMENT

- 2019- *System Manager* of the CMS ECAL
- 2017-2019 *Deputy System Manager* of the CMS ECAL
- 2015-2016 *Convener* of the analysis group of the Higgs boson decaying into two photons
- 2013-2014 *Convener* of the Detector Performance Group of the CMS ECAL
- 2011-2012 *Responsible* of the CMS ECAL calibration
- 2011-2014 *Responsible* of the CMS ECAL laser monitoring system
- 2007-2010 *Responsible* of the CMS ECAL reconstruction software
- 2017- *Member* of the CMS Management Board
- 2013- *Member* of the CMS ECAL Editorial Board
- 2013- *Member* of the CMS ECAL Conference Committee

## PUBLICATIONS

More than 1000 publications in international peer-reviewed journals, of which more than 20 among the primary contributors. Full up-to-date list available online.

## PUBLICATIONS WITH MAIN CONTRIBUTIONS

- [1] CMS Collaboration, "Observation of a New Boson at a Mass of 125 GeV with the CMS Experiment at the LHC," *Phys. Lett. B*, vol. 716, pp. 30–61, 2012.
- [2] CMS Collaboration, "Observation of a New Boson with Mass Near 125 GeV in  $pp$  Collisions at  $\sqrt{s} = 7$  and 8 TeV," *JHEP*, vol. 06, p. 081, 2013.
- [3] CMS Collaboration, "Observation of the Diphoton Decay of the Higgs Boson and Measurement of Its Properties," *Eur. Phys. J. C*, vol. 74, no. 10, p. 3076, 2014.
- [4] CMS Collaboration, "Measurements of Higgs boson properties in the diphoton decay channel in proton-proton collisions at  $\sqrt{s} = 13$  TeV," *JHEP*, vol. 11, p. 185, 2018.
- [5] CMS Collaboration, "Measurement of inclusive and differential Higgs boson production cross sections in the diphoton decay channel in proton-proton collisions at  $\sqrt{s} = 13$  TeV," *JHEP*, vol. 01, p. 183, 2019.
- [6] CMS Collaboration, "Performance of Photon Reconstruction and Identification with the CMS Detector in Proton-Proton Collisions at  $\sqrt{s} = 8$  TeV," *JINST*, vol. 10, no. 08, p. P08010, 2015.
- [7] CMS Collaboration, "Performance of Electron Reconstruction and Selection with the CMS Detector in Proton-Proton Collisions at  $\sqrt{s} = 8$  TeV," *JINST*, vol. 10, no. 06, p. P06005, 2015.
- [8] CMS Collaboration, "Observation of  $t\bar{t}H$  production," *Phys. Rev. Lett.*, vol. 120, no. 23, p. 231801, 2018.
- [9] CMS Collaboration, "Measurement of the Production Cross Section for Pairs of Isolated Photons in  $pp$  collisions at  $\sqrt{s} = 7$  TeV," *JHEP*, vol. 01, p. 133, 2012.
- [10] CMS Collaboration, "Search for a standard model-like Higgs boson in the mass range between 70 and 110 GeV in the diphoton final state in proton-proton collisions at  $\sqrt{s} = 8$  and 13 TeV," *Phys. Lett. B*, vol. 793, pp. 320–347, 2019.
- [11] CMS Collaboration, "Time Reconstruction and Performance of the CMS Electromagnetic Calorimeter," *JINST*, vol. 5, p. T03011, 2010.
- [12] CMS Collaboration, "Radiation hardness qualification of  $PbWO_4$  scintillation crystals for the CMS Electromagnetic Calorimeter," *JINST*, vol. 5, p. P03010, 2010.
- [13] P. Adzic *et al.*, "Intercalibration of the barrel electromagnetic calorimeter of the CMS experiment at start-up," *JINST*, vol. 3, p. P10007, 2008.

- [14] CMS Collaboration, "The CMS Experiment at the CERN LHC," *JINST*, vol. 3, p. S08004, 2008.
- [15] CMS Collaboration, "CMS technical design report, volume II: Physics performance," *J. Phys. G*, vol. 34, no. 6, pp. 995–1579, 2007.
- [16] P. Adzic *et al.*, "Energy resolution of the barrel of the CMS electromagnetic calorimeter," *JINST*, vol. 2, p. P04004, 2007.
- [17] CMS Collaboration, "Results of the first performance tests of the CMS electromagnetic calorimeter," *Eur. Phys. J. C*, vol. 44S1, pp. 1–10, 2006.
- [18] P. Adzic *et al.*, "Reconstruction of the signal amplitude of the CMS electromagnetic calorimeter," *Eur. Phys. J. C*, vol. 46S1, pp. 23–35, 2006.
- [19] S. Baffioni, C. Charlot, F. Ferri, N. Godinovic, P. Meridiani, I. Puljak, R. Salerno, and Y. Sirois, "Discovery potential for the SM Higgs boson in the  $H \rightarrow ZZ^{(*)} \rightarrow e^+e^-e^+e^-$  decay channel," *J. Phys. G*, vol. 34, pp. N23–N46, 2007.
- [20] S. Baffioni, C. Charlot, F. Ferri, D. Futyan, P. Meridiani, I. Puljak, C. Rovelli, R. Salerno, and Y. Sirois, "Electron reconstruction in CMS," *Eur. Phys. J. C*, vol. 49, pp. 1099–1116, 2007.
- [21] A. Calcaterra *et al.*, "Analysis and interpretation of the performance degradation of glass Resistive Plate Chambers operated in streamer mode," *JINST*, vol. 2, p. P10003, 2007.
- [22] HARP Collaboration, "The HARP detector at the CERN PS," *Nucl. Instrum. Meth. A*, vol. 571, pp. 527–561, 2007.
- [23] HARP Collaboration, "Measurement of the production cross-section of positive pions in p-Al collisions at 12.9-GeV/c," *Nucl. Phys. B*, vol. 732, pp. 1–45, 2006.
- [24] M. Baldo-Ceolin *et al.*, "The time-of-flight TOFW detector of the HARP experiment: Construction and performance," *Nucl. Instrum. Meth. A*, vol. 532, pp. 548–561, 2004.
- [25] M. Bonesini *et al.*, "Laser-based calibration for the HARP time of flight system," *IEEE Trans. Nucl. Sci.*, vol. 50, pp. 1053–1058, 2003.



## CONFERENCES WITH PUBLISHED PROCEEDINGS

1. The CMS ECAL Phase-2 Upgrade for High Precision Timing and Energy Measurements, VCI2019: 15th Vienna Conference on Instrumentation, 18-22 Feb 2019, Vienna (Austria)
2. Role of the CMS electromagnetic calorimeter in the measurement of the Higgs boson properties and search for new physics, ICHEP 2014: 37th International Conference on High Energy Physics, 2-9 Jul 2014, Valencia (Spain)
3. Monitoring and Correcting for Response Changes in the CMS Lead-tungstate Electromagnetic Calorimeter, CALOR 2012: 15th International Conference on Calorimetry in High Energy Physics, 4-8 Jun 2012, Texas Tech University, Santa Fe, NM (United States)
4. Monitoring the stability of the CMS electromagnetic calorimeter, CALOR2010: 14th International Conference for Calorimetry in High Energy Physics, 10-14 May 2010, IHEP, Beijing (China)

## DIRECT SUPERVISION EXPERIENCE

1. Post-doctoral supervision of Chiara Amendola, for the work on timing reconstruction and calibration for the ECAL Phase2 upgrade, 2020-(2022)  
The work consists in the study of the timing reconstruction for electrons and photons for HL-LHC. This implies the improvement of the current performance, understanding of its limitations, and plans for the upgraded electronics for HL-LHC, in terms of reconstruction and calibration methods. Also, the timing information will be fully integrated in the simulation of the CMS detector.
2. Ph.D. supervision of Giulia Negro, "Search for heavy neutrinos with the CMS experiment and studies for the upgrade of its electromagnetic calorimeter", 2015-2018  
Heavy neutrinos, produced in the decay of a right-handed W boson, were searched in a fully reconstructed final state containing two same flavour leptons and two jets, with data from 2016 collisions ( $35.9 \text{ fb}^{-1}$ ). Limits were set, becoming the most stringent result at the time of the publication. The analysis work done for 50% in collaboration with another (small) group and for 50% completely alone. The thesis also comprised the supervision and participation of beam test studies for the Phase2 electronics prototypes.
3. Ph.D. supervision of Laurent Millisher, "Measurement of the inclusive production cross section of prompt photon pairs with the CMS detector at the LHC", 2008-2011  
Events with two isolated photons have been analyzed from the early collisions of the LHC (7 TeV,  $36 \text{ pb}^{-1}$ ). An important cross-section measurement preparatory to the search for the Higgs boson in its two photon decay. Comparison with several theoretical predictions have also been performed, providing useful input for theoreticians.
4. Supervision of the M2 stage of Francesco Bonacina, to work on the CMS ECAL laser monitoring system for channel alignment in time, 2017  
Three month of supervision, from teaching the basis of ROOT and C++ to the data analysis to determine the feasibility of using the ECAL laser monitoring system to align channels in time
5. Supervision of M2 student Stefano Marelli, for the final year thesis (about 10 month of work), 2006  
The work consisted in the feasibility study of the calibration of the CMS ECAL with minimum ionizing particles from collisions. This work was precursory for the ECAL calibration with cosmic rays prior installation in the detector, which has been done in the subsequent years.

## TEACHING RESPONSIBILITIES

1. Laboratory assistant for the M2 physics laboratory, Paris-Sud University, for the years 2009, 2010, 2011  
Particle physics laboratory (spectroscopy, muon life-time, etc.)
2. Laboratory assistant for the "Physics laboratory", Department of Physics, Milano-Bicocca University, 2006  
Mechanics and optics experiments of the first year physics students
3. Laboratory assistant for the "Computer science laboratory", Department of Physics, Milano-Bicocca University, 2004  
Linux, C, C++, ROOT
4. Laboratory assistant for the "Computer science for physics laboratory", Department of Physics, Milano-Bicocca University, 2004  
Linux, C, numerical analyses
5. Assistant professor for the lectures "Physics", Department of Geological Sciences and Technologies, Milano-Bicocca University, 2004  
Teaching and exercising for the first year physics course: motion, mechanics, stress tensors, fluids
6. Assistant professor for the lectures "Physics", Department of Geological Sciences and Technologies, Milano-Bicocca University, 2003  
Teaching and exercising for the first year physics course: motion, mechanics, stress tensors, fluids
7. CERN official guide since 2002 and CMS guide since 2018, with related activities during periods at CERN
8. Didactic collaboration for the exposition "Toys, experiments, ideas (GEI)", realized by the "Centro Laboratorio per la Didattica della Fisica del CIRD dell'Università degli Studi di Udine" for the setup in the municipality of Bresso (Milano, Italy), 2000  
Realization of toys and experiments for elementary school students and general public kids, with guided tours (isochronous pendula, shaped bubbles, water rockets, electrostatic experiments with Van-der-Graaf, etc.)
9. Didactic collaboration for the exposition "Toys and science", realized by the Physics Department of the Trento University, for the setup in the municipality of Bresso (Milano, Italy), 1999  
Realization of toys and experiments for elementary school students and general public kids, with guided tours (isochronous pendula, shaped bubbles, water rockets, electrostatic experiments with Van-der-Graaf, etc.)

## OTHER MAIN RESPONSIBILITIES

### i. System Manager of the CMS Electromagnetic Calorimeter

The work consists in managing the electromagnetic calorimeter of CMS (ECAL), a detector composed of  $\text{PbWO}_4$  crystals (75k channels) with two layers of a silicon/lead “preshower” (138k channels) in front of the two forward parts. The ECAL collaboration consists of approximately 150 physicists from 40 Institutes from 15 countries, with a total budget of about 600 kEUR/year. The responsibility includes the maintenance and operations of the existing detector, the optimization of its performance, from event triggering to particle reconstruction, the preparation of the new electronics for the High Luminosity LHC upgrade. It also includes the approval of results, whose publication is supervised with the help of an editorial board, and their submission to conferences.

### 2. Convener of the analysis group of the Higgs boson decay into two photons

This responsibility was taken during the first collision of the LHC at 13 TeV, a crucial moment of the machine. The Higgs boson was “rediscovered” at the new collider energy and the era of precision measurements started. The work consisted in participating to and supervising the analyses of the Higgs boson decaying into two photons: total and differential cross-sections, simplified template cross-sections, low mass analysis, Dalitz decays. About 40 people worked on these analyses.

### 3. Convener of the CMS ECAL Detector Performance group

The responsibility consisted in coordinating the work on the detector to reach the ultimate performance for electron and photon reconstruction. Calibration, pile-up and detector effect mitigation, amplitude and time reconstruction. This has been carried out after the laser monitoring and then calibration responsibilities, which were at the time of the Higgs boson discovery, when the calibration and resolution have been fundamental.

### 4. Evolution of computing tools at IRFU for the LHC experiments

This is a shared responsibility that has been given to myself, a physicist of the Department of Particle Physics (DPhP) and an computer engineer from the Detector Department (Dedip), by the head of the Irfu of CEA/Saclay, upon proposal from the head of the DPhP and Dedip. It mainly consists in establishing the status of the computing at Irfu; estimating the evolution of the needs, in term of computing and human resources; representing the LHC experiments within the Irfu and outside the institute, also in the context of CEA-IN2P3 collaborations. It is closely related to the computing Grid for LHC and the development of High Parallel Computing (HPC) and new technologies such as usage of Graphics Processor Units (GPUs).

COMMUNAUTE UNIVERSITE GRENOBLE ALPES

ATTESTATION DE REUSSITE AU DIPLOME

Le Président atteste que

l' HABILITATION A DIRIGER DES RECHERCHES Spécialité PHYSIQUE  
a été décernée à

**Monsieur DELMASTRO MARCO**

né le 26 août 1973 à TORINO (ITALIE)

au titre de l'année universitaire 2015/2016

Date de soutenance : 23 mars 2016  
Etablissement soutenance : COMMUNAUTE UNIVERSITE GRENOBLE ALPES  
Jury : M. GIOVANNI LAMANNA, Président du jury, DIRECTEUR DE RECHERCHE  
CNRS DELEGATION ALPES  
M. MATTEO CACCIARI, Rapporteur du jury, PROFESSEUR  
UNIVERSITE PARIS 7  
Mme LYDIA ICONOMIDOU-FAYARD, Rapporteur du jury, DIRECTRICE DE RECHERCHE  
CNRS DELEGATION ILE-DE-FRANCE SUD  
M. YVES SIROIS, Rapporteur du jury, DIRECTEUR DE RECHERCHE  
CNRS DELEGATION ILE-DE-FRANCE SUD  
Mme ISABELLE WINGERTER-SEEZ, Membre du jury, DIRECTRICE DE RECHERCHE  
CNRS DELEGATION ALPES  
Ecole doctorale : Physique (Grenoble)

Fait à Grenoble, le 1 avril 2016



N° étudiant : 21560762

Avis important : Il ne peut être délivré qu'un seul exemplaire de cette attestation. Aucun duplicata ne sera fourni.

Born on August 26, 1973 – Torino, Italy  
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### Areas of specialization and interests

Experimental high-energy physics, from detector prototyping, operations and performance optimization to large-scale data analysis and physics interpretation • Higgs physics • BSM searches with photon and jet final states • QCD precision measurements • Calorimetry • Readout electronics • Signal processing • Science education, communication and dissemination

### Appointments held

- 2020–present Scientific Associate, CERN, Switzerland.  
2017–present Directeur de Recherche, CNRS/IN2P3, LAPP, Annecy, France.  
2011–2017 Chargé de Recherche 1<sup>ère</sup> Classe, CNRS/IN2P3, LAPP, Annecy, France.  
2007–2011 Research Physicist Staff, CERN, Switzerland.  
2005–2007 Fellow, CERN, Switzerland.  
2003–2005 Post-doctoral Research Associate, University of Milano, Italy.  
1999–2003 Ph.D. Student, University of Milano, Italy.  
1998–1999 Post-graduate Research Associate, Microelectronics and Silicon Detector Group, CERN, Switzerland.

### Education

- 2016 Accreditation to Supervise Research (*Habilitation à Diriger des Recherches, HDR*), University of Grenoble-Alpes, France.  
THESIS *From ADC counts to the Higgs boson: photons for physics measurements with the ATLAS experiment at the LHC Run 1 (HAL tel-01312862)*  
REFEREES Prof. M. Cacciari (LPTHE, Paris, France)  
Dr. L. Iconomidou-Fayard (LAL, Orsay, France)  
Dr. Y. Sirois (LLR, Palaiseau, France)
- 2003 PHD in Nuclear and Subnuclear Physics, University of Milano, Italy (highest honours).  
THESIS *Energy reconstruction and calibration algorithms for the ATLAS electromagnetic calorimeter (CERN-THESIS-2003-033)*  
SUPERVISOR Prof. L. Mandelli (University of Milano, Italy)  
REFEREES Prof. W.E. Cleland (University of Pittsburgh, USA)  
Prof. S. Centro (University of Padova, Italy)
- 1998 MSc (“Laurea”) in Physics, University of Torino, Italy (110/110 cum laude, highest honours).  
THESIS *Measurement of the  $J/\psi$  production at the CERN SPS with the NA50 experiment*  
SUPERVISOR Prof. E. Chiavassa (University of Torino, Italy)  
CO-SUPERVISOR Dr. N. De Marco (INFN Torino, Italy)

### Awards

- 2014–2017 CNRS Scientific Excellence Prize (*Prime d'Excellence Scientifique*), rewarding the 2010–2014 period and awarded for the 2014–2017 period.  
2016 Award Italian Excellence on the Web, awarded by the Treccani Institute for the Italian Encyclopedia for the article *The particle that wasn't*.  
2014 Literary award *Le Due Culture (The Two Cultures)* “Maria Antonia Gervasio”, awarded to the best



popular-science book published in 2014 to *Particelle familiari* (Editori Laterza, Italy, 2014).

## Recent research grants

2016–2021 Principal investigator of the French ANR *PhotonPortal* Project (LAPP-LPNHE-LAL joint project, selected for funding in 2016 for 485'000 €).

## Services to the profession

### Responsibilities and coordination roles

- 2020–present Convener of the ATLAS Higgs Working Group.
- 2018–2020 Convener of the LHC Higgs Cross-Section Working Group 2 *Higgs Properties*.
- 2017–2020 ATLAS Analysis Contact for the  $H \rightarrow \gamma\gamma$  couplings analysis.
- 2017–2020 Member of the ATLAS Liquid Argon (LAr) Phase II Upgrade Steering Group.
- 2017–2020 Convener of the ATLAS LAr Phase II Calibration Upgrade Working Group.
- 2017–2020 Coordinator of the ATLAS LAr activities at LAPP Annecy.
- 2016–2017 Convener of the ATLAS Higgs  $H\Gamma$  Working Group ( $H \rightarrow \gamma\gamma$ ,  $H \rightarrow Z\gamma$ , low and high-mass  $\gamma\gamma$  resonances,  $HH \rightarrow \gamma\gamma b\bar{b}$ ,  $HH \rightarrow \gamma\gamma WW$ , mono-Higgs Dark Matter and heavy scalar searches with  $\gamma\gamma + E_{\text{T}}^{\text{miss}}$ )
- 2015–2016 ATLAS Analysis Contact for the *Search for Higgs-like  $\gamma\gamma$  resonances* analysis.
- 2012–2014 Member of the ATLAS Physics Coordination group.
- 2012–2014 Convener of the ATLAS  $e/\gamma$  (electron/photon) Combined Performance group.
- 2011–2012 Member of the ATLAS LAr Calorimeters Management and Steering Groups.
- 2011–2012 Convener of the ATLAS LAr Calorimeters Software and Data Preparation group.
- 2011–2012 Coordinator of the ATLAS Photon Identification working group.
- 2010–2011 Convener of the ATLAS Standard Model Direct Photons working group.
- 2009–2011 Coordinator of the photon analysis activities of the CERN ATLAS Team.
- 2005–2010 Convener of the ATLAS LAr Calorimeter Electronic Calibration working group.

### Conference and school organization

- 2019 Organizer of the parallel session *Quel avenir pour la physique des particules? (What future for particle physics?)* at the 25<sup>e</sup> Congrès Général de la Société Française de Physique, Nantes, France, July 8–12 2019.
- 2013–present Member of the organizing committee of Les Houches Workshop *Physics at the TeV Colliders*.
- 2017 Member of the organizing committee of the ENIGMASS Lectures *Neutrino physics*, LAPP Annecy, France.
- 2016 Member of the organizing committee of the ENIGMASS Lectures *Searching for Dark Matter at the LHC*, LSPC Grenoble, France.
- 2015 Member of the organizing committee of the ENIGMASS Lectures *Probing Naturalness and Electroweak Symmetry Breaking at LHC Run 2*, LAPP Annecy, France.
- 2014 Organizer and Chairman of the Higgs session, *Physique ATLAS France Workshop 2014*.
- 2012 Organizer of the *Workshop on Photon Physics and Simulation at Hadron Colliders*, Paris, March 2012.
- 2009 Organizer and chairman of the *Photon Reconstruction and Identification* session, ATLAS  $e/\gamma$  Workshop, Leysin, Switzerland.
- 2007 Organizer and chairman of the *Electronic Calibration* session, ATLAS Electromagnetic Calorimeter Calibration Workshop, Annecy, France.
- 2004, 2006 Reviewer of the procedures of prediction of the ionization signals of the ATLAS electromagnetic calorimeter for its electronic calibration, ATLAS Calorimetry Calibration Workshops (2004, Slovakia; 2006, Spain).

## Research management and evaluation

- 2020-present Member of the Plenary European Committee for Future Accelerator (ECFA).
- 2016-present Member of the Register of Expert Peer Reviewers for Italian Scientific Evaluation (REPRISE).
- 2012-present ATLAS Liquid Argon Group Representative for the LAPP Annecy group.
- 2015-2020 Member of the French CERN Fellowship Selection Committee.
- 2017-2018 Member of LHCC Panel in charge to review the Technical Design Report of the Phase-2 Upgrade of the CMS Barrel Calorimeters.
- 2011-2016 Organizer and chairman of ATLAS LAPP Weekly Group Meetings.

## Editorial activities

- 2015 Reviewer for *Journal of Instrumentation*.
- 2014 Reviewer for *The European Physical Journal C*.
- 2011 Reviewer for *Computer Physics Communications*.
- 2013 Editor of the Rapport d'Activité LAPP 2009-2012.
- 2009-present Chairman and member of Editorial Boards for internal review of ATLAS papers.
- 2009-2011 Member of the Publication Committee of the ATLAS Collaboration.
- 2009-2011 Responsible of the graphics and typesetting templates for the ATLAS Collaboration articles and plots.

## Management and communication training

- 2010 *Managing Teams program*, CERN training course, Divonne-les-Bains, France.
- 2006 *Introduction to communication and outreach*, CERN training course, CERN, Switzerland.

## Teaching

- 2014-present Faculty of the *Summer School in Particle and Astroparticle Physics of Annecy-le-Vieux (GraSPA)*, Annecy-le-Vieux (France). *LHC Experimental Physics* (2-hour lectures: 2014, 2015, 2016, 2017, 2018, 2019; no session in 2020 due to COVID sanitary conditions).
- 2014-present Faculty of the European School of Instrumentation in Particle and Astroparticle Physics (ESIPAP), Archamps (France). *Experimental Subatomic Physics* (15-hour lectures and tutorial: 2014, 2015, 2016, 2017, 2018, 2019, 2020).
- 2016 *Physics and Communication: science and the media* INFN Researcher Training Course. Case study: *scientific blogs* (1 hour).
- 2014 Accreditation as Associate Professor, Experimental Physics of Fundamental Interactions (*Abilitazione Scientifica Nazionale, Professore di Seconda Fascia, Settore 02/A1, tornata 2012*), Italy.
- 2014 CERN Italian Teacher Program 2014. CERN (Switzerland), October 12-17, 2014. *Introduction to Experimental Particle Physics* (4-hour lectures and tutorials).
- 2014 Summer School "Science Communication Society 2014". La Morra (Italy), September 7-12, 2014. *The visible researcher* (8-hour lectures and exercises on scientific blogging).
- 2012 XXIV Seminario Nazionale di Fisica Nucleare e Subnucleare. Otranto (Italy), September 21-27, 2012. Session on *Scientific communication and relationship with media, general public and industry* (2 hours)
- 2002-2005 Computational Physics Laboratory (lecturer). BSc in Physics, University of Milano, Italy. REFERENT: Prof. L. Perini (University of Milano, Italy).
- 2001-2011 Physics (secondary level professor; in leave of absence for research reasons), I.T.I.S. "Faccio", Vercelli, Italy.
- 2000 Mathematics (secondary level professor), I.T.I.S. "Bodoni", Torino, Italy, and Liceo Scientifico "Galilei", Ciriè, Italy.
- 2000 Qualification to teach Physics in all Italian secondary schools (*"Abilitazione"*, class 38/A).

## Student supervision

### Supervision and co-supervision of PhD theses

- 2018-present Luca Franco. *PhD at LAPP, France. Thesis Supervisor.*  
 PHD THESIS: *Precision Higgs Physics and search for Physics Beyond the Standard Model with the Higgs Boson decaying into two photons with the ATLAS experiment at LHC.*
- 2016-2019 Saskia Falke. *PhD au LAPP, France. Co-supervised with Dr. T. Guillemin.*  
 PHD THESIS: *Measurement of Higgs boson properties in the Higgs to diphoton channel with the ATLAS experiment, EFT interpretation of the Simplified Template Cross Section measurements and energy calibration of electrons and photons in ATLAS.* (defended on 17/9/2019. CERN-THESIS-2019-148).  
 Currently Research Fellow at CERN, Switzerland.
- 2014-2017 Kirill Grevtsov. *PhD at LAPP, France. Co-supervised with Dr. I. Wingerter-Seesz.*  
 PHD THESIS: *Exploring the diphoton final state at the LHC at  $\sqrt{s} = 13$  TeV: searches for new particles, and the Higgs boson mass measurement with the ATLAS detector.* (defended on 4/7/2017. CERN-THESIS-2017-138).  
 Currently Fellow at DESY, Hambourg, Germany.
- 2013-2017 Simone Mazza. *PhD at University of Milano, Italy. Co-supervised with Prof L. Carminati.*  
 PHD THESIS: *Search for new physics in the diphoton channel at the ATLAS experiment at the LHC.* (defended on 27/2/2017. CERN-THESIS-2017-010).  
 Currently PostDoc at SCIPP, University of California Santa Cruz, USA.
- 2012-2015 Zuzana Barnovska. *PhD at LAPP, France. Thesis Supervisor.*  
 PHD THESIS: *Diphoton measurements with the ATLAS detector at the LHC: search for new resonances and study of diphoton production in association with jets.* (defended on 29/09/2015. CERN-THESIS-2015-167).  
 Currently Post-doc at USTC Hefei, China, based at CERN, in maternity leave.
- 2010-2013 Maud Schwoerer. *PhD at LAPP, France. Co-supervised with Dr. I. Wingerter-Seesz.*  
 PHD THESIS: *Études des états finals diphoton dans l'expérience ATLAS au LHC: mesure de sections efficaces différentielles, découverte d'une nouvelle résonance dans la recherche du boson de Higgs et étude de ses propriétés* (defended on 27/09/2013. CERN-THESIS-2013-193).  
 Currently Data scientist at ProbaYes, Grenoble, France.

### Supervision of other PhD projects

- 2012-2013 Angel Campoverde. *PhD at Stonybrook University, USA. Co-supervised with Prof. R. McCarthy.*  
 PHD THESIS: *Search For Gravitons Decaying To Vector Bosons In Hadronic Final States in proton-proton Collisions at  $\sqrt{s} = 8$  TeV Collected With The ATLAS Detector* (defended on 12/08/2015. PDF).  
 PROJECT: *Study of the Calibration Constants of the Electromagnetic Calorimeter* (ATL-LARG-INT-2013-006).  
 Currently Post-doc at University of Siegen, Germany.
- 2012-2013 Guillaume Lefebvre. *PhD at LPNHE, France. Co-supervised with Prof. M. Ridel.*  
 PHD THESIS: *Étalonnage des jets et mesure de la section efficace de production de paires de quarks top dans le canal hadronique à  $\sqrt{s} = 8$  TeV avec l'expérience ATLAS auprès du LHC.* (defended on 26/09/2014. CERN-THESIS-2014-234).  
 PROJECT: *Impact of the LAr High Voltage corrections on the electromagnetic energy response resolution* (ATL-LARG-INT-2013-001).  
 Currently Consultant at InovenAltenor, Paris, France.
- 2009-2010 Stefania Bordoni. *PhD at LPNHE, France. Co-supervised with Prof. M. Ridel.*  
 PHD THESIS: *Mesure de la section efficace de production des quarks beaux et charmés à partir de leur désintégration semi-leptonique en électrons avec l'expérience ATLAS dans les collisions protons-protons à  $\sqrt{s} = 7$  TeV au LHC* (defended on 16/09/2011. CERN-THESIS-2011-246).  
 PROJECT: *Effect of electronic calibration constant variations on reconstructed cell energy in the ATLAS electromagnetic calorimeter* (ATL-LARG-INT-2011-001).  
 Currently Fellow at CERN, Switzerland.
- 2007-2009 Carolina Gabaldon Ruiz. *PhD at University of Madrid, Spain. Co-supervised with Prof. J. Del Peso.*  
 PHD THESIS: *Calibration of the ATLAS electromagnetic calorimeter and search of the  $W'$  exotic boson* (defended on 24/03/2010. PDF).

PROJECT: *Electronic calibration of the ATLAS electromagnetic calorimeter endcaps. Measurement of the drift time in the ATLAS electromagnetic calorimeter using cosmic pulses (ATL-LARG-INT-2009-010).*

Currently Area Performance Manager at Inmarsat, Nyon, Switzerland.

### Master student internships

- 2018 Luca Franco. *M2/Erasmus internship at LAPP, France. Co-supervised with Prof. E. Meoni, Università della Calabria, Italy.*  
MASTER THESIS ("LAUREA MAGISTRALE"): *Study of the Higgs boson production in Vector Boson Fusion through its decay into two photons with the ATLAS detector at LHC*
- 2017 Florian Eble. *M1 internship at LAPP, France. Co-supervised with Dr. N. Lorenzo Martinez.*  
PROJECT: *Study of LAr calibration from Run2 for phase II upgrade. (ATL-COM-LARG-2017-028).*

### Summer Student projects

- 2018 Dimitrios Sidiropoulos Kontos. *CERN Summer Student.*  
PROJECT: *Machine Learning techniques for precision Higgs physics, exploiting the Higgs Boson decays into two photons.*
- 2010 Maud Schwoerer. *CERN Summer Student.*  
PROJECT: *First evidence of  $\Upsilon \rightarrow e^+e^-$  events at  $\sqrt{s} = 7$  TeV in the ATLAS detector. (ATL-PHYS-INT-2011-054).*
- 2007 Kilian Mueller. *CERN Summer Student.*  
PROJECT: *Studies on longitudinal weight extraction for very low energy electrons.*
- 2006 Martin Skou Andersen. *CERN Summer Student.*  
PROJECT: *Optimization of clustering algorithms for very low energy electrons.*

## Brief overview of research activities

### Higgs physics at the LHC

2007–present *Search for the Higgs boson and measurement of its properties*

- Search and discovery of the Standard Model Higgs boson with the  $H \rightarrow \gamma\gamma$  decay with 7 TeV and 8 TeV  $pp$  data.
- Measurement of the Higgs boson couplings with the  $H \rightarrow \gamma\gamma$  with 7 TeV and 8 TeV  $pp$  data.
- Measurement of the Higgs boson mass with the  $H \rightarrow \gamma\gamma$  decay with 7 TeV and 8 TeV  $pp$  data; ATLAS Higgs mass Run 1 combination with  $H \rightarrow ZZ^* \rightarrow 4\ell$ ; ATLAS and CMS Run 1 mass combination.
- Measurements of the Higgs boson couplings, Simplified Template Cross Sections (STXS), mass and width with the  $H \rightarrow \gamma\gamma$  decay with 13 TeV  $pp$  data.
- Effective Field Theory (EFT) interpretation of Higgs properties, both in the  $H \rightarrow \gamma\gamma$  channel and in the global coupling combination. Global EFT fit (Higgs+EW+top).

2009–present *Prompt photons production at the LHC*

- Measurement of inclusive prompt photon cross sections in  $pp$  collisions at  $\sqrt{s} = 7$  TeV.
- Measurement of differential prompt diphoton cross sections in  $pp$  collisions at  $\sqrt{s} = 7$  TeV.
- Measurement of prompt diphoton production in association with jets in  $pp$  collisions at  $\sqrt{s} = 8$  TeV.
- Study of sensitivity potential of  $Z + j/\gamma + j$  8 TeV/13 TeV cross-section double ratio.

### ATLAS detector, performance optimization and upgrade

2000–present *Electron and photon energy calibration*

- Electron and photon response calibration, using *in-situ* techniques and MC-based calibration, at test-beam and with  $pp$  data.
- Data-driven correction to the electromagnetic calorimeter response; intercalibration of longitudinal layers of electromagnetic calorimeter with photons.
- Final Run 1 electron and photon calibration for the measurement of the Higgs boson mass.
- Run 2 improved electron and photon calibration exploiting lateral electromagnetic shower information.
- Development of an improved correction for the LAr Medium Gain electronic calibration using special  $Z \rightarrow e^+e^-$  data, to be used to improve the extrapolation of the electromagnetic calorimeter response between the  $Z$  and the  $H$  bosons' kinematical regimes.

2008–2012 *Photon identification*

- Optimization of photon identification criteria for 7 TeV and 8 TeV data taking.
- Data-driven measurement and correction of Data/MC discrepancies of electromagnetic shower shapes.
- Data-driven measurement of photon identification efficiencies.

2000–present *Liquid Argon calorimetry*

- ATLAS Liquid Argon (LAr) calorimeter detector prototyping, test-beam, assembly and installation.
- LAr electronic calibration development, from ADC count to cell energy.
- LAr reconstruction software, simulation and condition database development and maintenance.
- LAr data quality (software setup and maintenance, shifter training and coordination).
- Development of the new front-end calibration board for the LAr calorimeter Phase II HL-LHC upgrade.

### Other activities

2014–2017 *Search for physics beyond the Standard Model at the LHC*

- Search for low and high-mass spin-0 and spin-2 resonances decaying in photon pairs with 8 TeV and 13 TeV  $pp$  data.

2013–2015 *Study of physics potential of a Future Circular Collider (FCC)*

- Projection of Higgs property measurement sensitivity with  $H \rightarrow \gamma\gamma$  at FCC  $pp$  collider at  $\sqrt{s} = 100$  TeV

1997–1998 *Ultra-relativistic heavy ions at the SppS*

- Measurement of the  $J/\psi$  suppression in Pb-Pb collision at 158 GeV/c per nucleon with the  $\mu\mu$  decay

1998–2000 *Rad-hard microelectronics for the LHC detectors*

- Development and test of rad-hard *enclosed* transistors for the front-end electronics of the LHC detectors

## Summary of scientific production

### Publications

As of November 29, 2021, more than 900 publications on peer-reviewed scientific journals. All publications available on INSPIRE; citations and *h*-index available on SCOPUS, INSPIRE or Google Scholar.

#### Selected publications

15 publications selected among those representative of my research commitments and achievements, and counting major personal contributions.

- [1] ATLAS Collaboration, "Methodology for EFT interpretation of Higgs boson Simplified Template Cross-section results in ATLAS," <https://cds.cern.ch/record/2694284>.
- [2] ATLAS Collaboration, "Combined measurements of Higgs boson production and decay using up to  $80 \text{ fb}^{-1}$  of proton-proton collision data at  $\sqrt{s} = 13 \text{ TeV}$  collected with the ATLAS experiment," *Phys. Rev. D* 101 no. 1, (2020) 012002, arXiv:1909.02845 [hep-ex].
- [3] ATLAS Collaboration, "Observation of Higgs boson production in association with a top quark pair at the LHC with the ATLAS detector," *Phys. Lett. B* 784 (2018) 173–191, arXiv:1806.00425 [hep-ex].
- [4] ATLAS Collaboration, "Measurements of Higgs boson properties in the diphoton decay channel with  $36 \text{ fb}^{-1}$  of *pp* collision data at  $\sqrt{s} = 13 \text{ TeV}$  with the ATLAS detector," *Phys. Rev. D* 98 no. 5, (2018) 052005, arXiv:1802.04146 [hep-ex].
- [5] ATLAS Collaboration, "Search for resonances in diphoton events at  $\sqrt{s} = 13 \text{ TeV}$  with the ATLAS detector," *JHEP* 09 (2016) 001, arXiv:1606.03833 [hep-ex].
- [6] ATLAS Collaboration, "Measurement of Higgs boson production in the diphoton decay channel in *pp* collisions at center-of-mass energies of 7 and 8 TeV with the ATLAS detector," *Phys. Rev. D* 90 no. 11, (2014) 112015, arXiv:1408.7084 [hep-ex].
- [7] ATLAS and CMS Collaborations, "Combined Measurement of the Higgs Boson Mass in *pp* Collisions at  $\sqrt{s} = 7$  and 8 TeV with the ATLAS and CMS Experiments," *Phys. Rev. Lett.* 114 (2015) 191803, arXiv:1503.07589 [hep-ex].
- [8] ATLAS Collaboration, "Measurement of the Higgs boson mass from the  $H \rightarrow \gamma\gamma$  and  $H \rightarrow ZZ^* \rightarrow 4\ell$  channels with the ATLAS detector using  $25 \text{ fb}^{-1}$  of *pp* collision data," *Phys. Rev. D* 90 no. 5, (2014) 052004, arXiv:1406.3827 [hep-ex].
- [9] ATLAS Collaboration, "Electron and photon energy calibration with the ATLAS detector using LHC Run 1 data," *Eur. Phys. J. C* 74 no. 10, (2014) 3071, arXiv:1407.5063 [hep-ex].
- [10] ATLAS Collaboration, "Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC," *Phys. Lett. B* 716 (2012) 1–29, arXiv:1207.7214 [hep-ex].
- [11] ATLAS Collaboration, "Search for the Standard Model Higgs boson in the diphoton decay channel with  $4.9 \text{ fb}^{-1}$  of *pp* collisions at  $\sqrt{s} = 7 \text{ TeV}$  with ATLAS," *Phys. Rev. Lett.* 108 (2012) 111803, arXiv:1202.1414 [hep-ex].
- [12] ATLAS Collaboration, "Measurement of isolated-photon pair production in *pp* collisions at  $\sqrt{s} = 7 \text{ TeV}$  with the ATLAS detector," *JHEP* 01 (2013) 086, arXiv:1211.1913 [hep-ex].
- [13] ATLAS Collaboration, "Measurement of the inclusive isolated prompt photon cross-section in *pp* collisions at  $\sqrt{s} = 7 \text{ TeV}$  using  $35 \text{ pb}^{-1}$  of ATLAS data," *Phys. Lett. B* 706 (2011) 150–167, arXiv:1108.0253 [hep-ex].
- [14] ATLAS Collaboration, "Readiness of the ATLAS Liquid Argon Calorimeter for LHC Collisions," *Eur. Phys. J. C* 70 (2010) 723–753, arXiv:0912.2642 [physics.ins-det].
- [15] D. Banfi, M. Delmastro, and M. Fanti, "Cell response equalisation of the ATLAS electromagnetic calorimeter without the direct knowledge of the ionisation signals," *JINST* 1 (2006) P08001.

## Communications at international conferences

- [1] M. Delmastro, "Higgs couplings and properties measurements: recent results as well as full run-2 and HL-LHC prospects (invited talk)," in *31<sup>st</sup> Rencontres de Blois, Particle Physics and Cosmology*. 2-7 June, 2019.
- [2] M. Delmastro, "Diphoton searches in ATLAS," in *51<sup>st</sup> Rencontres de Moriond on Electroweak Interactions and Unified Theories*. 12-19 March 216, 2016. <https://cds.cern.ch/record/2150667>. ATL-PHYS-PROC-2016-046.
- [3] M. Delmastro, "Results of  $H \rightarrow \gamma\gamma$  and  $Z\gamma$  from ATLAS," in *Aspen 2013 "Higgs Quo Vadis" conference*. Aspen, CO, USA, 10-15 March, 2013.
- [4] M. Delmastro, "Photon and diphoton production at ATLAS," in *Proceedings of the 15<sup>th</sup> Lomonosov Conference, Moscow State University, 8-24 August, 2011*, pp. 57-60. Moscow, Russia, 2013. arXiv:1111.2223 [hep-ex]. ATL-PHYS-PROC-2011-236.
- [5] M. Delmastro, "Searches for the Higgs boson at the LHC," in *Proceedings of the XXI<sup>ème</sup> Rencontres de Blois*. Blois (France), 21-26 June, 2009. arXiv:0909.0493 [hep-ex]. ATL-PHYS-PROC-2009-077.
- [6] M. Delmastro, "Recent results of the ATLAS barrel combined test beam," *AIP Conf.Proc.* 867 (2006) 358-365. *Proceedings of the 12<sup>th</sup> International Conference on Calorimetry in High Energy Physics, CALOR 2006, Chicago, USA, June 5-9, 2006*.
- [7] M. Delmastro, "A stand-alone signal reconstruction and calibration algorithm for the ATLAS electromagnetic calorimeter," in *Proceedings of the IEEE Nuclear Science Symposium 2003*. Portland, Or, USA, 19-25 October, 2003.
- [8] M. Delmastro, "The ATLAS Liquid Argon calorimeters read-out system," in *Proceedings of the IEEE Nuclear Science Symposium 2003*. Portland, Or, USA, 19-25 October, 2003.
- [9] M. Delmastro, "The ATLAS liquid Argon electromagnetic calorimeter: main features, requested physics performances and test-beam results," in *Proc. 6<sup>th</sup> World Multiconference on Systemics, Cybernetics and Informatics (SCI2002)*. Orlando, FL, USA, 14-18 July, 2002.

## Recent communications at national conferences and workshops

- [1] M. Delmastro, "Higgs Review," in *Workshop Physics ATLAS France 2017*. Vogüé, France, 29-31 Mars, 2017. <https://indico.cern.ch/event/572873/>.
- [2] M. Delmastro, "ATLAS electromagnetic physics," in *2<sup>nd</sup> LPCC Workshop on LHC detector simulations: status, needs and prospects*. CERN, Switzerland, 18-19 March, 2014. <https://indico.cern.ch/conferenceDisplay.py?confId=279530>.
- [3] M. Delmastro, "Direct photons at ATLAS," in *1<sup>st</sup> Workshop on Photon Physics and Simulation at Hadron Colliders*. Paris, France, 30 March, 2012. <https://indico.in2p3.fr/event/5709/>.
- [4] M. Delmastro, "Four good reasons to be a visible researcher (invited talk)," in *102<sup>nd</sup> Congress of the Italian Physics Society (SIF)*. Padova, Italy, 26-30 September, 2016. <http://www.sif.it/attivita/congresso/102>.
- [5] M. Delmastro, "Communicate physics with the guise of daily experience (invited talk)," in *Comunicare Fisica 2012*. Torino, Italy, October 8-12, 2012. <http://agenda.infn.it/conferenceDisplay.py?confId=4955>.

## Recent technical reports

- [1] F. Bedeschi, M. Convery, H. Danielsson, M. Delmastro, G. Eigen, F. Forti, D. Glenzinski, A. Kluge, A. Kuzmin, F. Lanni, M. Morandin, F. Simon, and A. Smith, "UCG Report on the TDR for the Phase-II Upgrade of the CMS Barrel Calorimeter," <https://cds.cern.ch/record/2304338>. CERN-LHCC-2018-004. UCG-027.
- [2] A. Collaboration, "Technical Design Report for the Phase-II Upgrade of the ATLAS LAr Calorimeter," Tech. Rep. CERN-LHCC-2017-018. ATLAS-TDR-027, CERN, Geneva, Sep, 2017. <https://cds.cern.ch/record/2285582>.
- [3] ATLAS LAr Calorimeter Group, "Initial Design Review of the ATLAS Liquid Argon Calorimeter System Phase II Upgrade," <https://cds.cern.ch/record/2248382>. ATL-COM-LARG-2017-006.
- [4] ATLAS Collaboration, "ATLAS Liquid Argon Calorimeter Phase-I Upgrade Technical Design Report," Tech. Rep. CERN-LHCC-2013-017. ATLAS-TDR-022, Sep, 2013. <https://cds.cern.ch/record/1602230>.

## Outreach

### Public events

- 2015–present *Il bosone di Higgs in un bicchiere d'acqua* (The Higgs Boson in a glass of water): a popular science conference targeting students, presented in numerous Italian high-schools and public events (and virtually held in 2020!).
- 2020 *Da dove viene il 99% della massa della materia ordinaria?* (Where does 99 % of ordinary matter come from?). Virtual conference for the Leeds EN-IT Interpreting Practice Sessions.
- 2020 *Misurare le proprietà del bosone di Higgs* (How to measure the Higgs boson properties): virtual conference for the “La Via delle Scienze” Spring 2020 cycle.
- 2020 *Mattoncini elementari* (Elementary Brick): virtual workshop at the 2020 INFN Kids Summer Camp.
- 2017 *Comunicare la fisica al tempo dei social?* (How to communicate physics in the social network era?). Public seminar at Università degli Studi di Milano, Milano (Italy), February 28, 2017.
- 2016 *Fête de la Science 2016*, LAPP Annecy, France. Presentation and projection of BBC documentary movie *Inside CERN*, and animation of following question-and-answers session.
- 2016 *Il compendio delle teorie squinternate* (The compendium of tattered theories), Conference at the *Festival della Comunicazione*, Camogli, Italy, September 10, 2016
- 2015 *Explaining the Higgs Boson with LEGO bricks*, Conference at the *Festival delle Scienze*, Rome, Italy, October 2, 2015.
- 2015 *The dance of science*, invited presentation and round-table discussion on LHC physics at *Orvieto Scienza 2015*, Orvieto, Italy, February 27-28, 2015. In collaboration with INFN.
- 2015 *Si può spiegare il bosone di Higgs?* (Can the Higgs boson be explained?), Conference at the *Festival della Comunicazione*, Camogli, Italy, September 12, 2015
- 2014 *FameLab 2014*. Communication trainer for the participants to the Geneva Regional Edition.
- 2013 Lecturer and volunteer for the CERN Open Days 2013.
- 2012 *Looking For the Immeasurably Small*. TED talk at TEDx Lake Como, November 19, 2012.
- 2005–present *ATLAS Guide*. Guided tours of the ATLAS underground experimental area and control room in English, French and Italian.

### Books

- 2014 *Particelle familiari (Familiar particles)*. A popular science book where the job of a particle physicist looking for the Higgs boson gets unveiled in the dialogues with his five-years old daughter, his wife and other members of the family. Published in Italy by Editori Laterza in July 2014. Second edition in 2015, paperback edition in 2016.

### Podcast

- 2020 *Tu che sei un fisico (You who are a physicist)*. A podcast where a particle physicist answer to any question sent from the audience. 8 episodes produced in 2020.

### Blogs

- 2006–present *Borborigmi di un fisico renitente (“Rumbles of a resistant physicist”)*. Popular-science blog in Italian, focused on particle physics vulgarization. About 2 millions unique visits since 2009.
- 2010 *Blogging ICHEP 2010*. Featured blogger of the collective forum about the 35<sup>th</sup> edition of the International Conference on High Energy Physics (Paris, July 2010).

### TV and radio

- 2016 Participation to the *Inside CERN* documentary movie by BBC 2 Horizon.
- 2015 Participation to the TV show *It's all Einstein's fault!* (“*Tutta colpa di Einstein*”), Italia 1, Italy.
- 2010–present Numerous interviews and interventions at panels on the Italian and Swiss public radios, addressing the state-of-the-art of particle-physics.



14/02/2019	<i>What happens during the LHC shutdown?</i>	Le Oche, Radio Popolare Milano
08/06/2017	<i>The practical value of science</i>	Millevoci, RSI
28/02/2017	Interview by <i>BreakingLab</i> podcast	Radio Statale
17/09/2016	Interview with <i>It's all Einstein's fault!</i> conductor	RSI
30/01/2016	<i>Einstein's garden: the electroweak force</i>	RSI
10/02/2015	<i>The history of the Higgs boson</i>	StoccolmaRoma podcast
11/11/2014	<i>The science of Interstellar</i>	Radio 3 Scienza, Radio 3
05/08/2014	Interview about <i>Familiar particles</i> book	Radio 3 Scienza, Radio 3
08/10/2014	<i>Seeing the invisible</i>	Memos, Radio Popolare Milano
16/10/2013	<i>A nearly-Nobel Prize for CERN</i>	Scintille, RSI
26/06/2013	<i>Particle physics and LEGO bricks</i>	Scintille, RSI
05/07/2012	<i>Emotions and reactions after the Higgs discovery</i>	Radio 3 Scienza, Radio 3
02/07/2012	<i>Rumours and scientific communication</i>	Radio 3 Scienza, Radio 3
25/10/2011	<i>Superluminal neutrinos?</i>	Scienza Speciale 42, RSI
05/10/2011	<i>What's behind superluminal neutrinos?</i>	Radio 3 Scienza, Radio 3
09/05/2011	<i>What else is there in the cosmos?</i>	Millevoci, RSI
05/04/2010	<i>The particle physics "commune"</i>	Radio 3 Scienza, Radio 3

## Press

2014	Comics & Science @ CERN. Organizer and co-author of the comic book "OraMai" ("NeverNow"), in collaboration with the CERN Internal Communication office.	
2012-present	Articles and interviews on various newspaper and magazines.	
	03/09/2016	<i>The crackpot index</i> Il Manifesto (Alias)
	19/12/2015	<i>Something new at the LHC? Only time will tell</i> Le Scienze (Italian edition of <i>Scientific American</i> )
	10/09/2015	<i>Little Einsteins</i> Style Piccoli (interview)
	09/10/2013	<i>A model Nobel</i> La Nazione Ticino
	04/02/2014	<i>Sixty years of CERN</i> La Nazione Ticino (interview)
	12/2013	<i>Imagine a night at CERN</i> Meridiani Svizzera (interview)
	10/2012	<i>scientists and navigators</i> D la Repubblica N. 813 (interview)
	09/2013	<i>Elementary physics of everyday time</i> Camminiamo Insieme (interview)
2012-2015	Author of the science section of DafDaf (Italian monthly magazine for children aged 6-11).	
	05/2015	<i>Why do metal boats float, and metal spoon sink?</i> DafDaf n. 56
	02/2015	<i>My name is Philae, and I ride a comet</i> DafDaf n. 53
	08/2014	<i>Measuring time</i> DafDaf n. 49
	06/2014	<i>Finding the way among the stars</i> DafDaf n. 46
	04/2014	<i>Why it is dark at night?</i> DafDaf n. 43
	12/2013	<i>Bits of cosmic honey</i> DafDaf n. 39
	07/2013	<i>Colors appearing, colors disappearing</i> DafDaf n. 34
	02/2013	<i>Mathematics and soap balls</i> DafDaf n. 29
	08/2012	<i>Water</i> DafDaf n. 23
	07/2012	<i>Air</i> DafDaf n. 22
	05/2012	<i>DIY spectroscopy</i> DafDaf n. 20
	04/2012	<i>It lives, it's yeast</i> DafDaf n. 19
	02/2012	<i>What do plants eat?</i> DafDaf n. 17

## Expositions

2016	Video presence in the renewed CERN Microcosm.
2016	Presence (audio interview, personal object locker) in the <i>Extreme</i> permanent exposition at the Science Museum in Milano, Italy, a joint project with CERN and INFN.
2014	<i>The daily life of a particle physicist</i> : activity during the Open Night 2014 at the Science and Technology Museum of Milano, Italy.

## Languages

Italian (native speaker). English (fluent). French (fluent).

Last updated: November 29, 2021

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Friday 23 August 2019

**Private & Confidential**  
Dr Ulla Blumenschein  
Physics and Astronomy  
Science and Engineering  
Mile End

Dear Dr Blumenschein,

**Re: Academic Promotions Round 2019**

I am writing to let you know the progress of the application that you submitted earlier this year for the Academic Promotions Round for Senior Lecturer.

I am pleased to inform you that the Academic Promotions Group is recommending that you should be promoted to Senior Lecturer. This decision was made after the Group read your application and CV.

Therefore, with effect from 1 October 2019, your salary will be paid at the rate of £45,000 per annum, Spinal Point 45, Grade 7 of the Queen Mary Pay and Grading Structure. All other terms and conditions remain unchanged.

I will implement this variation of contract on receipt of confirmation of your acceptance via email to me. Following this, you will receive an updated job profile for your new appointment.

Congratulations on your successful application, which is well deserved.

Yours sincerely,



**Rhianne Jones**  
Reward & Benefits Administrator

cc Head of School  
Personal File

# Dr Ulla Blumenschein

## Senior Lecturer in Particle Physics

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[Research](#)
[Publications](#)
[Supervision](#)
[Public Engagement](#)

## Profile

### Qualifications:

- Diploma in Biology (corresponds to an MSci), Mainz University
- PhD in Physics, Freiburg University
- Habilitation (higher education qualification), Goettingen University

### Research Expertise:

- Plant biology (physiological indicators of forest damage)
- Particle detectors, Calorimetry: Construction of a PbF2 calorimeter and commissioning and operation of a steel-scintillator sampling calorimeter, calibration and monitoring readout, DCS and monitoring software
- Particle detectors, Trigger: Monitoring, simulation, electron/photon trigger development, operation
- Particle physics data analysis: QCD and EWK physics: analysis management and review, associated Z/W+jets production; Higgs physics: Yukawa coupling to fermions; Beyond-Standard-Model physics: Search for Supersymmetry (gauginos, leptons), search for heavy charged and neutral Higgs bosons (2HDM and other models), search for heavy gauge bosons (Z')
- Big data, software: Fortran, C++, python, data skimming and slimming management, analysis software management

Starting from the academic year 2017/18, I have been **PhD progression tutor of the Particle Physics department (PPRC)** at the School of Physics and Astronomy. I am also the STFC contact at the School of Physics and Astronomy for matters related to PhD scholarships and the contact for the Graduate training network **GRADnet** of the South East Physics network **SEPnet**. I am also the contact for the **NExT** Institute.

Starting from the academic year 2020/21 I have been deputy exam board chair and acting **exam board chair of the School of Physics and Astronomy**. In this role, I have managed the exam paper review and the execution of the semester A and the semester B main exams and of the summer LSR exams, dealing with plagiarism cases, interacted with external examiners and chaired several UG SEB meetings.

I have also been a member of the task forces for the development and implementation of a **blended teaching** approach at the School of Physics and Astronomy in the academic years 2020/21 and 2021/22. In this functionality, I have worked on the implementation of new assessment strategies and a hybrid classroom approach.

I am deputy leader of the **PPRC ATLAS Level-1 calorimeter trigger group**.

#### **Brief research summary**

I have dedicated my physics research to High-energy physics at particle colliders.

During my **UG studies at Mainz university**, I participated in the construction of the A4 calorimeter at the MAMI accelerator at Mainz University, and in the construction of the Compass experiment at the SPS at CERN in Switzerland.

During my **MSc in Mainz**, I developed and performed a search for supersymmetric particles, sleptons, indirect production and through gaugino cascades, at the electron-positron collider at LEP. I managed to derive the first lower limit on the selectron mass which was independent of the mass difference to the lightest supersymmetric particle.

For my **PhD with Freiburg university**, I continued searching for supersymmetry: I established the first search for associated chargino-neutralino production in tri-lepton final states at the  $D0$  experiment at the proton-antiproton collider Tevatron in Illinois. I was also responsible for the calorimeter control system, developed new triggers for isolated electrons and photons and designed the electron/photon trigger suite.

After the PhD, I moved to the ATLAS experiment as a **postdoc with IFAE Barcelona**, where I managed the online and offline commissioning and the first operation of the ATLAS Tile calorimeter. I was also responsible for the analogue calibration and monitoring readout system. I developed the first feasibility study for in-situ jet calibration.

As a **research assistant with Goettingen University**, during LHC Run1, I developed the first measurement of associated  $Z$ +jets production and later managed all measurements with  $W$  and  $Z$  bosons. I also searched for Higgs bosons in decays to 2 tau-leptons. I have developed trigger monitoring software and participated in the operation of the ATLAS detector, as a calorimeter, trigger and monitoring expert and as a shift leader. I was

reorganized the software for Run-2.

In LHC Run2, I managed all ATLAS measurements of QCD and electroweak processes, a position where I reported directly to the Physics Coordination. I also published the first Z+jets cross-section measurement at cms energies of 13TeV and established the Higgs-Yukawa coupling to fermions, using Higgs decays to two tau-leptons. I also worked on tau identification and the reconstruction of di-tau final states. I participated in the operation of the ATLAS detector as ARC shift leader. During LHC Run2, I moved to PPRC at QMUL.

I am currently performing measurements of the production of Z bosons in association with high-energetic jets and in association with charm and bottom quarks, both key backgrounds to Higgs and BSM searches. I am also searching for charged and neutral heavy Higgs bosons arising from 2HDM models and for new heavy gauge bosons, in decays to Z or W boson and light Higgs boson.

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# Dr Ulla Blumenschein

## Senior Lecturer in Particle Physics

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## Teaching

### UG teaching:

#### 2008-2016:

- *Nuclear and Particle Physics* (BSc/MSc, module-assistant)
- *Physics of the Higgs boson* (BSc/MSc, module organizer)
- *Statistical data analysis* (BSc/MSc, module organizer)
- *Physics of the atom-shell* (BSc, module-assistant)
- *Physics laboratory* (BSc, module-assistant)
- *Electronics laboratory* (BSc/MSc, module-assistant)
- *Physics for chemists and engineers* (BSc, module organizer)

#### 2017/18:

- SPA4601 *Professional Skills for Scientists* (1st year, Semester A, module co-organizer)
- SPA4321 *Introduction to C++* (1st year, Semester B, module organizer)
- SPA7029U/P *Collider Physics* (4th year, Semester B, deputy module organizer)

#### 2018/19:

- SPA4601 *Professional Skills for Scientists* (1st year, Semester A, module co-organizer)
- SPA5201 *Physics Laboratory* (Semester B, module co-organizer)



organizer)

2019/20:

- SPA4601 *Professional Skills for Scientists* (1st year, Semester A, module organizer)
- SPA6306 *Elementary Particle Physics* (3rd year, Semester A, module organizer)
- SPA7029U/P *Collider Physics* (4th year, Semester B, deputy module organizer)

2020/21:

- SPA6306 *Elementary Particle Physics* (3rd year, Semester B, module organizer)
- SPA4122 *Mathematical techniques II* (1st year, Semester B, module-assistant)

2021/22:

- SPA6306 *Elementary Particle Physics* (3rd year, Semester B, module organizer)
- SPA4122 *Mathematical techniques II* (1st year, Semester B, module-assistant)

**Teaching development:**

From 2008-2016, I have developed the lecture *Physics of the Higgs boson* and introduced two new experiments in the advanced laboratory course. I have also developed the course work for the new course *Nuclear and Particle Physics*.

At QMUL, I have co-developed the course SPA4601 *Professional Skills for Scientists* and significantly upgraded the course SPA6306 *Elementary Particle Physics*.

**PG teaching:**

- Statistics course at the German Helmholtz-Allianz workshop, 2010
- Coordination of seminar presentations and Lecture *LHC results* at the German Autumn School of particle physics, 2011 and 2015
- The organisation of the NExT School 25-28 June 2018 at QMUL
- Lecture *Standard Model and Electroweak Physics* at the Hadron Collider Summer School 2019 in Goettingen
- Lecture series *Precision Tests of the Standard Model* at the Departamento de Fisica de CIVESTAV, Mexico, 2019 in Mexico City
- Lecture *LHC SM, top and B physics*, London Intercollegiate Particle Physics course, 2020
- *Texture Standard Model and electroweak Physics*, at the Hadron Collider Summer School 2021 in Goettingen.

**PhD Students:**



charm quarks at ATLAS

- **Tong Qiu:** Search for a massive Higgs boson with the ATLAS detector at the LHC experiment
- **Arran Freegard:** Higher-order QCD & EW corrections for high-energy V+jets production

**PhD examination:**

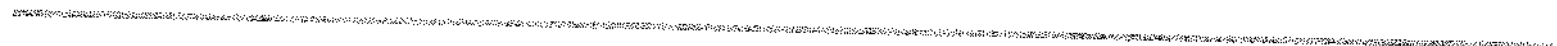
- 5 PhD vivas as an internal examiner at QMUL
- 5 PhD vivas as external examiner

**PhD Projects:**

- Production of a Z boson in association with b and c quarks
- Production of a Z boson in association with jets
- Search for a massive Higgs boson
- Associated Higgs and Z production in final states with b-quarks and leptons

**BSc and MSc Projects:**

- Regularized unfolding in hadron collider measurements
- Associated production of Z bosons with c or b quarks
- Using Machine Learning to improve the search for new heavy Higgs bosons
- Review of 2-Higgs-Doublet models and experimental tests at colliders
- ATLAS Level-1 calorimeter trigger upgrade: simulation and monitoring



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## Research

### Research Interests:

I am interested in the **Fundamental forces in nature**. By recreating conditions of the early universe in powerful synchrotrons like the **Large Hadron Collider (LHC)**, we aim to improve our understanding of the various forces with the hope to eventually be able to describe them in a unified theory.

The precision of the theoretical description of interactions in high-energy collisions has increased dramatically over the past years, prompting us to test them at a high precision level, with the option to find signs for new physics in deviations from the current models. In the ATLAS experiment, I have been investigating in particular the **Strong Force** by measuring processes where jets of hadrons are produced in association with the massive carriers of the weak force (JHEP 07 (2013) 032 Eur. Phys. J. C77 (2017) 361). Currently, I am focusing on two challenging classes of these interactions: Processes with a **Z boson and bottom or charm quarks** in the final state and processes where a **collinear Z boson** is radiated by a high-energetic quark in the final state. Both processes can mimic important new physics interactions, and must hence be modelled with high precision.

In our Standard Model, the breaking of Electroweak symmetry by the Higgs field leads to massive force carriers and at least one **Higgs boson**, which was

Models which go beyond that and predict two Higgs doublets (2HDM) with five massive Higgs bosons, could help understand why we have more matter than anti-matter in our universe. In such a model, a heavy new Higgs boson could be produced at the LHC and decay into the light Higgs and a Z boson. I am searching for such processes in final states with leptons and b-quarks.

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## Publications

### Selected publications:

#### ALEPH experiment:

- A. Heister et al., [ALEPH Collaboration], Absolute Lower Limits on the Masses of Selectrons and Sneutrinos in the MSSM, Phys. Lett. B 544 (2002) 73-88

#### D0 experiment:

- V. M. Abazov et al. [D0 Collaboration], Search for supersymmetry via associated production of charginos and neutralinos in final states with three leptons, Phys. Rev. Lett. 95 (2005) 151805.

#### ATLAS experiment, LHC Run1

- K. J. Anderson et al., A Mobile Data Acquisition System, JINST 2, P07002 (2007).
- G. Aad et al. [ATLAS Collaboration], Measurement of the Z to tau cross-section with the ATLAS detector, Phys. Rev. D 84, 112006 (2011).
- G. Aad et al. [ATLAS Collaboration], Measurement of the production cross-section for Z/gamma\* in association with jets in pp collisions at  $\sqrt{s} = 7$  TeV with the ATLAS detector, Phys. Rev. D 85 (2012) 032009.

boson in the H to tau+ tau- decay mode in  $\sqrt{s} = 7$  TeV pp collisions with ATLAS, JHEP 09 (2012) 070.

- G. Aad et al. [ATLAS Collaboration], Measurement of the production cross-section of jets in association with a Z boson in pp collisions at  $\sqrt{s} = 7$  TeV with the ATLAS detector, JHEP 07(2013) 032.
- G. Aad et al. [ATLAS Collaboration], Evidence for the Higgs-boson Yukawa coupling to tau leptons with the ATLAS detector, JHEP 04 (2015) 117.
- G. Aad et al. [ATLAS Collaboration], Identification and energy calibration of hadronically decaying tau leptons with the ATLAS experiment in pp collisions at  $\sqrt{s} = 8$  TeV, Eur. Phys. J. C (2015).

#### ATLAS experiment, LHC Run2

- G. Aad et al. [ATLAS Collaboration], Measurement of W and Z-boson production cross-sections in pp collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector, Phys. Lett. B 759 (2016) 601.
- G. Aad et al. [ATLAS Collaboration], Measurements of the production cross-section of a Z boson in association with jets in pp collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector, Eur. Phys. J. C 77 (2017) 361.
- M. Aaboud et al. [ATLAS Collaboration], Cross-section measurements of the Higgs boson decaying into a pair of tau-leptons in proton-proton collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector, Phys. Rev. D 99 (2019) 072001
- M. Aaboud et al. [ATLAS Collaboration], Evidence for the production of three massive vector bosons with the ATLAS detector, Phys. Lett. B 798 (2019) 134913
- M. Aaboud et al. [ATLAS Collaboration], Measurements of the production cross-section for a Z boson in association with b-jets in proton-proton collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector, JHEP 07 (2020) 044
- ATLAS collaboration, Measurements of the production cross-section of a Z boson in association with high transverse momentum jets in pp collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector, ATLAS-CONF-2021-033
- ATLAS collaboration, Search for heavy resonances decaying into a Z boson and a Higgs boson in final states with leptons and b-jets in  $139 \text{ fb}^{-1}$  of pp collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector, ATLAS-CONF-2020-043

#### Reviews:

- U. Blumenschein et al., Pushing the precision frontier at the LHC with V+jets, hep-ex/1802.02100.
- U. Blumenschein, Jet production in association with vector bosons or top quarks, Int. J. Mod. Phys. A, 30, 1546007 (2015).

#### Complete list of publications with my involvement:

- Aad G, Abbott B, Abbott DC et al. (2020). Measurements of the production cross-section for a Z boson in association with b-jets in proton-proton collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector.

DOI: [10.1007/JHEP07\(2020\)044](https://doi.org/10.1007/JHEP07(2020)044)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/66059>

three massive vector bosons with the ATLAS detector.

DOI: [10.1016/j.physletb.2019.134913](https://doi.org/10.1016/j.physletb.2019.134913)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/61158>

• Aad G, Abbott B, Abbott DC et al. (2019). Measurement of the inclusive cross-section for the production of jets in association with a Z boson in proton-proton collisions at 8 TeV using the ATLAS detector.

DOI: [10.1140/epjc/s10052-019-7321-3](https://doi.org/10.1140/epjc/s10052-019-7321-3)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/65562>

• BLUMENSCHHEIN U (2019). Cross-section measurements of the Higgs boson decaying into a pair of tau-leptons in proton-proton collisions at  $\sqrt{s}=13$  TeV with the ATLAS detector.

DOI: [10.1103/PhysRevD.99.072001](https://doi.org/10.1103/PhysRevD.99.072001)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/59459>

• Aaboud M, Aad G, Abbott B et al. (2019). Measurement of the four-lepton invariant mass spectrum in 13 TeV proton-proton collisions with the ATLAS detector.

DOI: [10.1007/JHEP04\(2019\)048](https://doi.org/10.1007/JHEP04(2019)048)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/59499>

• The ATLAS collaboration (2018). Measurement of dijet azimuthal decorrelations in pp collisions at  $\sqrt{s}=8$  TeV with the ATLAS detector and determination of the strong coupling.

DOI: [10.1103/PhysRevD.98.092004](https://doi.org/10.1103/PhysRevD.98.092004)

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• Aaboud M, Aad G, Abbott B et al. (2018). Measurement of the Soft-Drop Jet Mass in pp Collisions at  $\sqrt{s}=13$  TeV with the ATLAS Detector.

DOI: [10.1103/PhysRevLett.121.092001](https://doi.org/10.1103/PhysRevLett.121.092001)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/54885>

• Aaboud M, Aad G, Abbott B et al. (2018). Measurement of inclusive jet and dijet cross-sections in proton-proton collisions at  $\sqrt{s}=13$  TeV with the ATLAS detector.

DOI: [10.1007/JHEP05\(2018\)195](https://doi.org/10.1007/JHEP05(2018)195)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/43505>

• Aaboud M, Aad G, Abbott B et al. (2018). Measurement of differential cross sections and  $W^+/W^-$  cross-section ratios for W boson production in association with jets at  $\sqrt{s}=8$  TeV with the ATLAS detector.

DOI: [10.1007/JHEP05\(2018\)077](https://doi.org/10.1007/JHEP05(2018)077)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/43506>

• Aaboud M, Aad G, Abbott B et al. (2018). Measurement of the cross section for isolated-photon plus jet production in pp collisions at  $\sqrt{s}=13$  TeV using the ATLAS detector.

DOI: [10.1016/j.physletb.2018.03.035](https://doi.org/10.1016/j.physletb.2018.03.035)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/43503>

• Aaboud M, Aad G, Abbott B et al. (2018). Measurement of the production cross section of three isolated photons in pp collisions at  $\sqrt{s}=8$  TeV using the ATLAS detector.

DOI: [10.1016/j.physletb.2018.03.057](https://doi.org/10.1016/j.physletb.2018.03.057)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/43486>

• Aaboud M, Aad G, Abbott B et al. (2018). Measurement of  $\tau$  polarisation in  $Z/\gamma^* \rightarrow \tau\tau$  decays in proton-proton collisions at  $\sqrt{s}=8$  TeV with the ATLAS detector.

DOI: [10.1140/epjc/s10052-018-5619-1](https://doi.org/10.1140/epjc/s10052-018-5619-1)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/36185>

mass in pp collisions at  $\sqrt{s}=7\text{TeV}$  with the ATLAS detector.

DOI: [10.1140/epjc/s10052-017-5475-4](https://doi.org/10.1140/epjc/s10052-017-5475-4)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/36154>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of the exclusive  $\gamma\gamma \rightarrow \mu^+\mu^-$  process in proton-proton collisions at  $\sqrt{s}=13\text{TeV}$  with the ATLAS detector.

DOI: [10.1016/j.physletb.2017.12.043](https://doi.org/10.1016/j.physletb.2017.12.043)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/36183>

• Aaboud M, Aad G, Abbott B et al. (2017). Determination of the strong coupling constant  $\alpha_s$  from transverse energy-energy correlations in multijet events at  $\sqrt{s}=8\text{TeV}$  using the ATLAS detector.

DOI: [10.1140/epjc/s10052-017-5442-0](https://doi.org/10.1140/epjc/s10052-017-5442-0)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/31344>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of the Drell-Yan triple-differential cross section in pp collisions at  $\sqrt{s}=8\text{TeV}$ .

DOI: [10.1007/JHEP12\(2017\)059](https://doi.org/10.1007/JHEP12(2017)059)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/32335>

• The ATLAS, Aad G, Abbott B et al. (2017). Measurement of the double-differential high-mass Drell-Yan cross section in pp collisions at  $\sqrt{s} = 8\text{TeV}$  with the ATLAS detector.

DOI: [10.1007/JHEP08\(2016\)009](https://doi.org/10.1007/JHEP08(2016)009)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/18505>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of differential cross sections of isolated-photon plus heavy-flavour jet production in pp collisions at  $\sqrt{s}=8\text{TeV}$  using the ATLAS detector.

DOI: [10.1016/j.physletb.2017.11.054](https://doi.org/10.1016/j.physletb.2017.11.054)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/33705>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of the cross-section for electroweak production of dijets in association with a Z boson in pp collisions at  $\sqrt{s}=13\text{TeV}$  with the ATLAS detector.

DOI: [10.1016/j.physletb.2017.10.040](https://doi.org/10.1016/j.physletb.2017.10.040)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/31287>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of inclusive and differential cross sections in the  $H \rightarrow ZZ^* \rightarrow 4\ell$  decay channel in pp collisions at  $\sqrt{s}=13\text{TeV}$  with the ATLAS detector.

DOI: [10.1007/JHEP10\(2017\)132](https://doi.org/10.1007/JHEP10(2017)132)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/28738>

• Aaboud M, Aad G, Abbott B et al. (2017). Study of  $WW\gamma$  and  $WZ\gamma$  production in pp collisions at  $\sqrt{s}=8\text{TeV}$  and search for anomalous quartic gauge couplings with the ATLAS experiment.

DOI: [10.1140/epjc/s10052-017-5180-3](https://doi.org/10.1140/epjc/s10052-017-5180-3)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/28555>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of the inclusive jet cross-sections in proton-proton collisions at  $\sqrt{s}=8\text{TeV}$  with the ATLAS detector.

DOI: [10.1007/JHEP09\(2017\)020](https://doi.org/10.1007/JHEP09(2017)020)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/28303>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of the  $W^+W^-$  production cross section in pp collisions at a centre-of-mass energy of  $\sqrt{s}=13\text{TeV}$  with the ATLAS experiment.

DOI: [10.1016/j.physletb.2017.08.047](https://doi.org/10.1016/j.physletb.2017.08.047)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/28773>



differential cross sections for isolated photon pair production in pp collisions at  $\sqrt{s} = 8$  TeV with the ATLAS detector.

DOI: [10.1103/PhysRevD.95.112005](https://doi.org/10.1103/PhysRevD.95.112005)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/25443>

• The ATLAS collaboration (2017). Measurement of WW/ WZ/ l $\gamma$ q' production with the hadronically decaying boson reconstructed as one or two jets in pp collisions at  $\sqrt{s}=8$ TeV with ATLAS, and constraints on anomalous gauge couplings.

DOI: [10.1140/epjc/s10052-017-5084-2](https://doi.org/10.1140/epjc/s10052-017-5084-2)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/25866>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of the kt splitting scales in Z  $\rightarrow$  ll events in pp collisions at  $\sqrt{s}=8$  TeV with the ATLAS detector.

DOI: [10.1007/JHEP08\(2017\)026](https://doi.org/10.1007/JHEP08(2017)026)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/25867>

• The ATLAS, Aaboud M, Aad G et al. (2017). Studies of Z $\gamma$  production in association with a high-mass dijet system in pp collisions at  $\sqrt{s}=8$  TeV with the ATLAS detector.

DOI: [10.1007/JHEP07\(2017\)107](https://doi.org/10.1007/JHEP07(2017)107)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/28536>

• Aaboud M, Aad G, Abbott B et al. (2017). Precision measurement and interpretation of inclusive W<sup>+</sup>, W<sup>-</sup> and Z/gamma\* production cross sections with the ATLAS detector.

DOI: [10.1140/epjc/s10052-017-4911-9](https://doi.org/10.1140/epjc/s10052-017-4911-9)

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• Aaboud M, Aad G, Abbott B et al. (2017). Measurements of the production cross section of a Z boson in association with jets in pp collisions at  $\sqrt{s}=13$  TeV with the ATLAS detector.

DOI: [10.1140/epjc/s10052-017-4900-z](https://doi.org/10.1140/epjc/s10052-017-4900-z)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/25056>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of the cross section for inclusive isolated-photon production in pp collisions at root s=13 TeV using the ATLAS detector.

DOI: [10.1016/j.physletb.2017.04.072](https://doi.org/10.1016/j.physletb.2017.04.072)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/25090>

• Aaboud M, Aad G, Abbott B et al. (2017). Measurement of charged-particle distributions sensitive to the underlying event in  $\sqrt{s}=13$  TeV proton-proton collisions with the ATLAS detector at the LHC.

DOI: [10.1007/JHEP03\(2017\)157](https://doi.org/10.1007/JHEP03(2017)157)

QMRO: <https://qmro.qmul.ac.uk/xmlui/handle/123456789/24490>

• Aaboud M, Aad G, Abbott B et al. (2017). High-ET isolated-photon plus jets production in pp collisions at  $\sqrt{s}=8$  TeV with the ATLAS detector.

DOI: [10.1016/j.nuclphysb.2017.03.006](https://doi.org/10.1016/j.nuclphysb.2017.03.006)

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## ATTESTATION

N/REF : IRFU/DIR/GRH/22-ED

I, the undersigned, Elise DOUET, Assistant of the Director of IRFU in charge of Human Resources at the Paris-Saclay Research Centre, certify that

Mr Philippe GRAS

benefits, since August 29, 2005, from a permanent position contract at the Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA). He is employed as a researcher in our institute and has supervised Jelena Mijuskovic during her thesis research work.

This certificate is provided for whatever purpose it may serve.

At Saclay, on January 20, 2022

Elise DOUET



Commissariat à l'énergie atomique et aux énergies alternatives  
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Direction de la Recherche Fondamentale  
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# Philippe Gras - Curiculam vitae

Born on May 22, 1974 in Montélimar, France  
Nationality: French

Contact: philippe.gras@cern.ch

## Work history

- 2015-now Staff researcher at the Institute of research in the fundamental laws of the Universe (Irfu) of the French Alternative Energies and Atomic Energy Commission (CEA).
- 2013-2015 Postdoctoral researcher at the Institute of research into the fundamental laws of the Universe (Irfu) of the French Alternative Energies and Atomic Energy Commission (CEA).
- 1998-1999 French civil service at CERN as engineer in the LHCb group.

## Education

- 2003 PhD in Science, University of Karlsruhe, Faculty of Physics. *A Front-End electronics configuration system for CMS subdetectors and Observability of an MSSM Higgs boson in the 4-b final state.*
- 1998 Graduated from Ecole Nationale Supérieure de Physique de Strasbourg (now Télécom Physique Strasbourg), option physics and modeling.  
D.É.A. (equivalent to Master II) Subatomic physics, instrumentation, and modeling from Louis Pasteur University of Strasbourg, IReS.
- 1996 Bachelor of Science degree in Physics from Louis Pasteur University of Strasbourg.
- 1992-1995 Classes de mathématiques supérieures (Lycée St-Joseph, Avignon). Classes de mathématiques spéciales P' (Lycée Champollion, Grenoble).

Languages French (native), English (fluent)

## Responsibilities in international collaborations

- 2021-now Chairperson of the CMS ECAL conference committee
- 2021-now Member of the CMS ECAL editorial board
- 2021-now Member of CMS Institution Board
- 2021-now Member of the CUPID collaboration Technical coordination board
- 2021-now Co-coordinator of the CUPID experiment computing and data storage
- 2019-2020 Physics event generator coordinator for the CMS Higgs-in-two-photons analysis group
- 2015-2016 Co-convenor of the CMS Physics analysis group "Vector boson-plus-jets"
- 2013-2014 Physics event generator coordinator for the CMS "Vector boson-plus-jets" analysis group
- 2006-now Responsible for the CMS ECAL selective readout system
- 2006-now Responsible for the data acquisition system and control system of the CMS ECAL laser monitoring system

## Editorial and conference organization activities

- 2021-now Member of the CMS ECAL editorial board
- 2020 Reviewer for *Physics Letter B*
- 2016-2021 Member of the Editorial Board of *Advances in High Energy Physics*
- 2013-now Member of the *Les Houches Physics at TeV* workshop organization committee.
- 2010-now Internal reviewer of CMS physics analyses

## Participation in PhD thesis juries

- 2022 Reviewer for Lorenzo Scavarda's PhD, *Design and development of the Calorimeter for the FOOT experiment*, directed by Prof. S. Argirò and Piergiorgio Cerello, PhD.
- 2020 Jury Member for Louis Moreaux's PhD, *Measurement of the transverse momentum of Drell-Yan lepton pairs over a wide mass range in proton-proton collisions at  $\sqrt{s} = 13$  TeV in CMS*, directed by Prof. L. Favart
- 2015 Jury member for Alexandre Leonard's PhD, *Measurement of Z boson production in association with jets at the LHC and study of a DAQ system for the Triple-GEM detector in view of the CMS upgrade*, directed by Prof. L. Favart

## Research activity highlights

Probing the effects of soft radiations on the production of boson at the LHC, measurement of Drell-Yan process over a wide range and comparison with predictions using transverse momentum parton distribution functions (TMD), measurement of n-jettiness; non-perturbative effect and Pythia8 generator tuning to CMS data.

Study of the production of a vector boson in association with light and heavy flavour jets at the LHC, validation of simulation used the standard model backgrounds to new physics searches, constraining parton distribution functions. Measurement of the production of two prompt photons at the LHC.

Search and discovery of the Higgs boson in the diphoton decay channel. Measurement of production differential cross-section and couplings. Prospect for Yukawa coupling measurement from triboson production involving an off-shell Higgs boson. Search at the LHC for Higgs bosons in the context of the minimal supersymmetry model.

Jet substructures and tagging.

Unveiling the nature of the neutrinos with neutrinoless double-beta decay and the CUPID experiment project.

Online monitoring of crystal response of the CMS electromagnetic calorimeter monitoring, from test beam to operation.

Reading a fine-grain calorimeter with a limited bandwidth and optimal energy measurement; design, realization and commissioning of the CMS electromagnetic calorimeter selective readout processor.

## Work experience prior PhD studies

- 1998-1999. Evaluation of the OPC interface in view of its usage for LHC experiment control system, CERN
- 1998. Measurement of the absolute gain of gas mixtures and effect of temperature and pressure for the BaBar experiment drift chamber, CNRS/LAPP, Annecy
- 1997. Design of a new UV calibration system for the RICH detector of the DELPHI experiment, CERN
- 1996. Commissioning of a curved elastic analyser for the three-axes neutronic spectrometer IN20 and study of porous silicon with neutronic spectrometry, Laue-Langevin Institute, Grenoble

## Publications

More than 1000 publications in international peer-reviewed journals, the full list can be consulted at <http://cern.ch/go/VbW9>

### Selection of publications with a major personal contribution

1. "Observation of a New Boson at a Mass of 125 GeV with the CMS Experiment at the LHC", *Phys.Lett.B* 716 (2012) 30-61, S. Chatrchyan et al.
2. "Observation of a new boson with mass near 125 GeV in pp collisions at  $\sqrt{s}=7$  and 8 TeV", *JHEP* 81 (2013), doi:10.1007/JHEP06(2013)081
3. "Light quark Yukawas in triboson final states", A. Falkowski, S. Ganguly, P. Gras, J. Miguël, K. Tobioka, N. Vignaroli, T. You, *JHEP* 04 (2021) 023, doi:10.1007/JHEP04(2021)023
4. "Systematics of quark/gluon tagging", P. Gras, S. Höche, D. Kar, A. Larkoski, L. Lönnblad, S. Plätzer, A. Siódmok, P. Skands, G. Soyez, and J. Thaler, *JHEP* 07 (2017) 091, doi:10.1007/JHEP07(2017)091
5. "Measurements of Higgs boson production cross sections and couplings in the diphoton decay channel at  $\sqrt{s}=13$  TeV", A. M. Sirunyan et al., *JHEP* 07 (2021), doi:10.1007/JHEP07(2021)027
6. "Measurements of differential production cross sections for a Z boson in association with jets in pp collisions at  $\sqrt{s}=8$  TeV", V. Khachatryan et al., *JHEP* 04 (2017) 022, doi:10.1007/JHEP04(2017)022
7. "Measurements of differential cross sections for associated production of a W boson and jets in proton-proton collisions at  $\sqrt{s}=8$  TeV", V. Khachatryan et al., doi:10.1103/PhysRevD.95.052002
8. "Measurement of associated Z + charm production in proton-proton collisions at  $\sqrt{s}=8$  TeV", A.M. Sirunyan et al., *Eur.Phys.J.C* 78 (2018) 4, 287, doi:10.1140/epjc/s10052-018-5752-x
9. "Measurement of differential cross sections for inclusive isolated-photon and photon+jets production in proton-proton collisions at  $\sqrt{s}=13$  TeV", A.M. Sirunyan et al., *Eur.Phys.J.C* 79 (2019) 1, doi:10.1140/epjc/s10052-018-6482-9
10. "Measurement of the differential cross sections for the associated production of a W boson and jets in proton-proton collisions at  $\sqrt{s}=13$  TeV", A.M. Sirunyan et al., *Phys.Rev.D* 96 (2017) 7, 072005, doi:10.1103/PhysRevD.96.072005

11. "Measurement of differential cross sections for Z boson production in association with jets in proton-proton collisions at  $\sqrt{s}=13$  TeV", A.M. Sirunyan et al., *Eur.Phys.J.C* 78 (2018) 11, doi:10.1140/epjc/s10052-018-6373-0
12. "Energy resolution of the barrel of the CMS electromagnetic calorimeter", P. Adzic et al., *JINST* 2 (2007) P04004, doi:10.1088/1748-0221/2/04/P04004
13. "Laser monitoring system for the CMS lead tungstate crystal calorimeter", M. Anfreville et al., *Nucl.Instrum.Meth.A* 594 (2008) 292-320, doi:10.1016/j.nima.2008.01.104
14. "Measurements of differential Z boson production cross sections in proton-proton collisions at  $\sqrt{s}=13$  TeV", A.M. Sirunyan et al., *JHEP* 12 (2019) 061, doi:10.1007/JHEP12(2019)061
15. "Measurements of triple-differential cross sections for inclusive isolated-photon+jet events in pp collisions at  $\sqrt{s}=8$ TeV, A.M. Sirunyan et al., *Eur.Phys.J.C* 79 (2019) 11, 969, doi:10.1140/epjc/s10052-019-7451-7
16. "Measurement of the Production Cross Section for Pairs of Isolated Photons in pp collisions at  $\sqrt{s}=7$  TeV", *JHEP* 01 (2012) 133, doi:10.1007/JHEP01(2012)133
17. "Extraction and validation of a new set of CMS PYTHIA8 tunes from underlying-event measurements", A. M. Sirunyan, *Eur.Phys.J.C* 80 (2020), doi:10.1140/epjc/s10052-019-7499-4
18. "Phonon-mediated crystal detectors with metallic film coating capable of rejecting  $\alpha$  and  $\beta$  events induced by surface radioactivity", I. C. Bandac et al., *Appl.Phys.Lett.* 118 (2021) 18, doi.org:10.1063/5.0050124
19. "Commissioning and performance of the CMS calorimeter system with proton-proton collisions at the LHC", P. Gras for the CMS collaboration, doi.org:10.22323/1.120.0012
20. "The Selective Read-out Processor for the CMS electromagnetic calorimeter", N. Almeida, J. Varela, P. Buisson, J. L. Faure, O. Gachelin, P. Gras, I. Mandzhavidze, M. Mur, *IEEE Trans.Nucl.Sci.* 52 (2005) 772-777, doi:10.1109/TNS.2005.850946
21. "The control system for the CMS tracker front end", F. Drouhin, P. Figueiredo, P. Gras, C. Ljuslin, C. Maazouzi, A. Marchioro, N. Marinelli, C. Paillard, P. Placidi, P. Siegrist, A. Tsirou, P. G. Verdini, *IEEE Trans.Nucl.Sci.* 49 (2002) 846-850, doi:10.1109/TNS.2002.1039576
22. "Results of the OPC evaluation done within JCOP for the control of the LHC experiments", *Conf.Proc.C* 991004 (1999), R. Barillere, V. Baggiolini, M. Beharell, D. Chmielewski, P. Gras, H. Milcent, K. Kostro, A. Liou, V. Khomutnikov
23. "The CMS electromagnetic calorimeter barrel upgrade for High-Luminosity LHC", P. Gras for the CMS collaboration, *J.Phys.Conf.Ser.* 587 (2015), doi:10.1088/1742-6596/587/1/012016
24. "The CMS Experiment at the CERN LHC", S. Chatrchyan et al., *JINST* 3 (2008) S08004, doi:10.1088/1748-0221/3/08/S08004

# Jelena Mijušković

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✉ **Email address:** [jelenamijuskovic@yahoo.com](mailto:jelenamijuskovic@yahoo.com) 📞 **Phone number:** (+382) 68660343

**Date of birth:** 14/12/1993 **Nationality:** Montenegrin

## WORK EXPERIENCE

[ 07/2017 – Current ] **Trainee researcher**

**CERN - European Organization for Nuclear Research**

**Address:** Geneva, Switzerland

**Main activities and responsibilities:**

Included in projects as a member of CMS group of University of Montenegro and University Paris-Saclay

[ 03/2018 ] **International Master Classes 2018 - hands on particle physics**

**Main activities and responsibilities:**

- teaching basic concepts in particle physics experimental techniques
- teaching students to perform measurements on real data from particle physics experiments themselves (ATLAS data)

<http://www.mna.gov.me/vijesti/183126/Odrzan-drugi-medunarodni-Masterclass-Hands-on-Particle-Physics.html>

[ 10/2017 ] **Assistant at Open Science Days 2017**

**Main activities and responsibilities:**

- Promoting CMS experiment
- Assisting in the project Art@CMS

<http://www.mna.gov.me/vijesti/177089/Izlozborn-ART-CMS-svecano-otvoreni-sedmi-Otvoreni-dani-nauke.html>

[ 01/2017 – 10/2017 ] **Physics teacher**

**Grammar school "Stojan Cerovic"**

**Address:** Nikšić, Montenegro

[ 03/2017 ] **Assistant at Winter Science School Ivanova Korita, Montenegro**

**Montenegrin Science Promotion Foundation PRONA**

**Main activities and responsibilities:**

- supervision of high school students working on different physics projects

[ 03/2017 ] **International Master Classes 2017 - hands on particle physics**

**Main activities and responsibilities:**

- teaching basic concepts in particle physics theory
- teaching students to perform measurements on real data from particle physics experiments themselves (CMS data)

<http://www.mna.gov.me/vijesti/170365/Odrzan-prvi-medunarodni-Masterclass-Hands-on-Particle-Physics.html>

27/06/2016 – 19/08/2016 ] **Student at CERN Summer Student Programme**

***CERN - European Organization for Nuclear Research***

**Address:** Geneva, Switzerland

**Main activities and responsibilities:**

- work on a project (4 - 8 hours per day), the report on which you can find at: [http://cds.cern.ch/record/2209186/files/Report\\_JM.pdf](http://cds.cern.ch/record/2209186/files/Report_JM.pdf)
- attending lectures on different topics
- visits to experimental facilities, data and control centers

21/09/2015 – 25/09/2015 ] **Assistant at CERN's exhibition at Open Science Days 2015**

***Ministry of Science***

**Address:** Montenegro

**Main activities and responsibilities:**

- demonstrating interactive experiments
- teaching about basic concepts of particle physics

**EDUCATION AND TRAINING**

[ 11/2018 – Current ] **PhD in Physics**

***University of Montenegro and University Paris-Saclay***

[ 10/2017 – 10/2018 ] **Master Degree in Physics**

***Faculty of Natural Sciences and Mathematics, University of Montenegro***

**Address:** Podgorica, Montenegro

**Thesis:** Emission of  $\mu^+ \mu^-$  pairs in pp interactions at the energy of 5 TeV at CMS experiment

[ 09/2015 – 10/2016 ] **Specialist Degree in Physics**

***Faculty of Natural Sciences and Mathematics, University of Montenegro***

**Address:** Podgorica, Montenegro

**Thesis:** Efficiency of detection  $^{134}\text{Cs}$  by gamma detector pairs at the angles of  $90^\circ$  and  $180^\circ$

[ 09/2012 – 09/2015 ] **BSc Physics**

***Faculty of Natural Sciences and Mathematics, University of Montenegro***

**Address:** Podgorica, Montenegro

## LANGUAGE SKILLS

**Mother tongue(s):** Montenegrin

**Other language(s):**

**English**

**LISTENING C1 READING C1 WRITING C1**

**SPOKEN PRODUCTION C1 SPOKEN INTERACTION C1**

**Italian**

**LISTENING A2 READING A2 WRITING A2**

**SPOKEN PRODUCTION A2 SPOKEN INTERACTION A2**

## DIGITAL SKILLS

python | C++ | Root CERN | Linux | GIT Hub | Working with CMS Offline Software (CMSSW)

## CONFERENCES AND SEMINARS

- [ 15/11/2021 – 19/11/2021 ] **Resummation, Evolution, Factorization Workshop 2021**  
<https://indico.desy.de/event/28334/>
- [ 12/07/2021 – 14/07/2021 ] **Division of Particles and Fields of the American Physics Society (DPF2021)**  
The CMS Electromagnetic Calorimeter calibration and performance during LHC Run 2  
<https://indico.cern.ch/event/1034469/contributions/4431722/>
- [ 27/06/2021 – 01/07/2021 ]  
**22nd International Workshop on Radiation Imaging Detectors (iWoRiD 2021)**  
High-rate readout with precise time resolution of a high-granularity calorimeter: the case of the CMS Electromagnetic calorimeter upgrade  
<https://indico.cern.ch/event/820476/contributions/4372898/>
- [ 13/07/2020 – 17/07/2020 ] **PyHEP 2020 Workshop**  
<https://indico.cern.ch/event/882824/>
- [ 02/07/2020 – 03/07/2020 ] **CMS Z(+jets) Run II analysis workshop (II)**  
<https://indico.desy.de/event/26396/timetable/#all.detailed>
- [ 13/01/2020 – 14/01/2020 ] **CMS Z (+jets) Run II analysis workshop** Brussels  
<https://indico.cern.ch/event/855439/>
- [ 12/05/2019 – 18/05/2019 ] **New Trends in High-Energy Physics** Odessa, Ukraine
- [ 28/01/2019 – 01/02/2019 ] **CMS Data Analysis School Pisa 2019** INFN Pisa

[11/06/2017 - 16/06/2017 ]

## **Fifth International Conference on Radiation and Applications in Various Fields of Research (RAD 2017)**

Budva, Montenegro

- THE REGISTRATION OF Cs-134 BY GAMMA DETECTOR PAIRS AT AN ANGLE OF 90°  
Nikola Svrkota, Jelena Mijušković and Nevenka M. Antović

10.21175/RadJ.2018.01.004

### **ORGANISATIONAL SKILLS**

#### **Organisational skills**

- experience in organising the events for science promotion

### **COMMUNICATION AND INTERPERSONAL SKILLS**

#### **Communication and interpersonal skills**

- good communication skills gained through my work with students teaching physics and science promotions
- experience in intensive collaboration and interaction with many people researching within CMS collaboration
- experienced at giving presentation to large audience

### **AWARDS**

#### **Awards and scholarships**

- International Doctoral Action Program (ADI 2018) of the IDEX Université Paris-Saclay
- Scholarship for doctoral research in Montenegro from Ministry of Science Montenegro
- City of Nikšić scholarship for academic achievement

## Bibliografija:

- Jelena Mijuskovic on behalf of CMS collaboration „The CMS electromagnetic calorimeter upgrade: high-rate readout with precise time and energy resolution“, Journal of Instrumentation (JINST) 2022 17 C01004

DOI: <https://doi.org/10.1088/1748-0221/17/01/C01004>

- Koautor na 29 publikovanih radova CMS kolaboracije. Publikacije dostupne na sajtu publikacija iz oblasti fizike čestica:

<https://inspirehep.net/authors/1712994>

- Prezentacije rezultat doktorske disertacije na međunarodnim konferencijama i workšopovima:
  1. J. Mijušković, High-rate readout with precise time resolution of a high-granularity calorimeter: the case of the CMS Electromagnetic calorimeter upgrade, 22<sup>nd</sup> International Workshop on Radiation Imaging Detectors, Ghent, Belgium, 27 June 2021 to 1 July 2021, <https://indico.cern.ch/event/820476/>
  2. J. Mijuskovic, The CMS Electromagnetic Calorimeter calibration and performance during LHC Run 2, Meeting of the Division of Particles and Fields of the American Physical Society (DPF21), Florida State University, USA, online, 12–14 Jul 2021. <https://indico.cern.ch/event/1034469/>
  3. J. Mijuskovic, Z + jets: N-jettiness, Journées CMS-France, Physique et Upgrades de Phase-2, 7–9 Oct 2020, online. <https://indico.cern.ch/event/881933/>
  4. J. Mijuskovic, Measuring N-jetiness of DY+jets events, Workshop on DY + 0...N jets measurements with Run II data, 16 December 2021, online. <https://indico.cern.ch/event/1101623/>
  5. J. Mijuskovic, Status of N-jettiness analysis at CMS, Z(+jets) Run II analysis workshop II, DESY, 2-3 July 2020. <https://indico.desy.de/event/26396/timetable/#all.detailed>
  6. P. Gras, J. Mijuskovic et al., Prospects on N-jettiness measurement at CMS, CMS Z(+jets) Run II analysis workshop, 13–14 Jan 2020, IIHE Brussels, Belgium. <https://indico.cern.ch/event/855439/>

- Najvažnija izlaganja rezultata iz doktorske disertacije na zasjedanjima CMS kolaboracije u CERN-u:



1. Update on N-jettiness measurement, SMP-VJ: Vector Boson Plus Jets meeting, 17 Dec 2021, <https://indico.cern.ch/event/1093689/>
2. Double-Muon trigger SF, Muon HLT+RECO meeting, 14 Dec 2021  
<https://indico.cern.ch/event/1106050/>
3. Update on N-jettiness measurement, SMP-VJ: Vector Boson Plus Jets meeting, 1 Oct 2021, <https://indico.cern.ch/event/1071770/>
4. Update on N-jettiness in Z+jets, SMP-VJ: Vector Boson Plus Jets meeting, 23 Jul 2021, <https://indico.cern.ch/event/987960/>
5. Update on N-jettiness in Z+jets, SMP-VJ: Vector Boson Plus Jets meeting, 23 Jul 2021, <https://indico.cern.ch/event/987960/>
6. Tracking efficiency in Njettiness studies using UL2018 dataset, Tracking Physics Object Group, 14 Jun 2021, <https://indico.cern.ch/event/1040448/>
7. Run2 resolution studies for Ecal paper, ECAL Detector Performance Group, 26 May 2021, <https://indico.cern.ch/event/991265/>
8. Update on N-jettiness studies, SMP-VJ: Vector Boson Plus Jets, meeting, 16 Apr 2021, <https://indico.cern.ch/event/987953/>
9. Dimuon SF for UL2018, 22 Feb 2021, Muon Physics Object Group, <https://indico.cern.ch/event/1005603/>
10. Njettiness status report, SMP-VJ: Vector Boson Plus Jets meeting, 5 Feb 2021, <https://indico.cern.ch/event/987948/>
11. Status of the N-jettiness analysis, SMP-VJ: Vector Boson Plus Jets meeting, 18 Dec 2020, <https://indico.cern.ch/event/975614/>
12. SF for dimuon trigger with UL2018, Muon Physics Object Group, 14 Dec 2020, <https://indico.cern.ch/event/984867/>
13. ECAL Resolution studies, CMS Week: ECAL General, 2 Dec 2020, <https://indico.cern.ch/event/977830/>
14. Ecal developments for prompt calibration and time-dependent MC, CMS Week: Plenary on Run-3 preparation, 16 Sep 2020, <https://indico.cern.ch/event/952782/timetable/>
15. N-jettiness in Z+jets, SMP-VJ: Vector Boson Plus Jets meeting, 17 Jul 2020, <https://indico.cern.ch/event/920780/>
16. Update on N-jettiness, SMP-VJ: Vector Boson Plus Jets meeting, 22 May 2020, <https://indico.cern.ch/event/897915/>
17. N-jettiness in Z+jets, SMP-VJ: Vector Boson Plus Jets meeting, 27 Mar 2020, <https://indico.cern.ch/event/882833/>
18. UL legacy summary plots, ECAL Detector Performance Group, 12 Feb 2020, <https://indico.cern.ch/event/871238/>
19. UL2017 Ecal resolution test, Joint ECAL/Egamma meeting, 17 Jan 2020, <https://indico.cern.ch/event/879915/>
20. N-jettiness measurement plans, SMP-VJ: Vector Boson Plus Jets meeting, (6 Dec 2019, <https://indico.cern.ch/event/861704/>