

ALLEGATO A

UNIVERSITÀ DEGLI STUDI DI MILANO

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CURRICULUM VITAE

INFORMAZIONI PERSONALI (NON INSERIRE INDIRIZZO PRIVATO E TELEFONO FISSO O CELLULARE)

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| COGNOME | RE |
| NOME | EMANUELE |
| DATA DI NASCITA | 26/09/1982 |

segue alla pagina successiva

EMANUELE RE: CURRICULUM VITAE

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|--------------------------------|--------------------------------------|
| Name | Emanuele Re |
| Date and place of birth | 26 September 1982, Vimercate (Italy) |
| Nationality | Italian |

Positions

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|---------------------------------|---|
| Oct 2015 - | CNRS chargé de recherche de Classe Normale CNRS researcher, permanent position, LAPTh, Annecy (hired in Spring 2015 as “Chargé de recherche de première classe (CR1)”, senior researcher) |
| Oct 2016 - Sept 2019 | Research Fellow (on leave from CNRS) Theoretical Physics Department, CERN, Geneve |
| Oct 2012 - Sept 2015 | Postdoc Research Associate Rudolf Peierls Centre for Theoretical Physics, Department of Physics, University of Oxford |
| Oct 2009 - Sept 2012 | Postdoc Research Associate Institute for Particle Physics Phenomenology, Department of Physics, University of Durham |

Qualifications

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|-------------|--|
| 2019 | Abilitazione Scientifica Nazionale , September 2019 “Abilitazione Scientifica Nazionale a Professore di prima e seconda fascia” Habilitation as Associate Professor and as Full Professor in Italy |
| 2009 | Ph.D. , 24 November 2009 Università degli Studi di Milano-Bicocca Thesis title: <i>Next-to-Leading-Order QCD corrections to Shower Monte Carlo event generators: single vector-boson and single-top hadroproduction</i> Tutor: Paolo Nason |
| 2006 | Laurea magistralis in Physics , <i>cum laude</i> , 29 September 2006 Università degli Studi di Milano-Bicocca Thesis title: <i>A study on high transverse momentum lepton production at the LHC</i> |
| 2004 | Laurea in Physics , <i>cum laude</i> , 15 October 2004 Università degli Studi di Milano-Bicocca Thesis title: <i>Asymptotical states for Coulomb scattering</i> |

Awards

BayFrance grant, 2019-2020

co-PI of an application for a grant for traveling and visiting LAPTh and MPI (Munich)
(4 weeks, financed by the “Centre de coopération franco-bavarois”).

Procope Mobility grant, 2019-2020

co-PI of an application for a grant to host at LAPTh a researcher from Germany
(4 weeks visit at LAPTh of W. Bizon, September 2020).

CNRS Prime d’encadrement doctoral et de recherche, 2015-2016

Fellowship in the CERN Theory group

Offered, to start in October 2015, subsequently converted to a 3rd year extension.

Two-years “Marie Skłodowska-Curie” Individual Fellowship

(Horizon 2020 Research and Innovation Framework Programme, 2014 call)
Offered in February 2015 after having already accepted the CERN fellowship.

Non-stipendiary Junior Research Fellowship

Wolfson College, Oxford, from January 2014 to September 2015
(awarded based on interview and scientific merit, it gives access to college facilities
and provides extra budget to attend conferences)

Premio Sergio Fubini, 14 October 2010

INFN national award for the 3 best italian Ph.D. thesis of the year in Theoretical
Physics

Organization of scientific meetings and Schools

More significant roles underlined.

- Convener of the “Standard Model Physics at the TeV Scale” session at “PANIC 2020”, Lisbon, September 2020 (postponed, COVID-19 pandemic)
- Member of the CERN-Fermilab HCPSS International Advisory Committee
- Organizer of the workshop “Taming the accuracy of event generators”, CERN, 29 June-10 July 2020
- Chair of the 14th CERN-Fermilab HCPSS (joint CERN-Fermilab “Hadron Collider Physics Summer School”), CERN, 28th August-6 September 2019

This is a major summer school for PhD students (TH and EXP) and young postdocs (EXP). There are about 80-100 participants, selected from a pool of about 200 applicants. The school was chaired by me and an experimental colleague (staff at CERN). I was in charge of all aspects of the organization and running of the school (composition of LOC, scientific program and selection of lecturers, social events, selection of students and of discussion leaders, chairing, etc...).

- Convener for the “QCD” session at “LHCP 2019”, Puebla, Mexico, May 2019

- Convener for the “Hadronic and Electroweak Observables” session at “DIS 2018”, Kobe, Japan, April 2018
- Organizer of the “Tools 2017” workshop, Corfu, September 2017
- Organizer and convener of the “PhysTeV” workshop, Les Houches:
June 2017 (organizer+convener), June 2019 (organizer+convener), June 2021 (organizer)

This is a 3-week long international workshop taking place every other year at the “École de Physique” in Les Houches, and gathering a total of about 160 participants experts in Particle Physics at colliders (mostly theoreticians, but with an important participation of experimentalists too). The rather unique format of the workshop is designed to encourage and facilitate very open and informal discussions on the most cutting-edge aspects of collider phenomenology, in particular those that are at the frontier of theory and experiments.

- Convener for the “Monte Carlo” session at “QCD@LHC 2016”, Zurich, August 2016
- Organizer of GraSPA (“Graduate Summer School in Particle and Astroparticle Physics” of Annecy-le-Vieux), LAPTh/LAPP, Annecy:
July 2016, July 2017, July 2018, July 2019, July 2020 (canceled, COVID-19 pandemic)

This is an international summer school on Particle and Astroparticle Physics for 3rd year undergraduate students and 1st year master students, held in Annecy, and organized with colleagues from LAPP and LAPTh. The aim of the school is to introduce young students to the current research activities taking place in these topics, specifically on the aspects that are usually not discussed in normal lectures at University.

- Organizer of the 2016 edition of RPP (“Rencontre de Physique des Particules”), LAPTh, January 2016.
- Co-organizer of the Workshop “V + jets: Backgrounds for new physics and testing ground for QCD”, IPPP, Durham, 8-10 September 2010

Teaching and Mentoring

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|--------------------|---|
| Nov. 2019 - | Supervision of a postdoctoral researcher (2019-2021, LAPTh, Annecy) |
| June 2018 | Invited lecturer at the International Summer School of QCD (PhD level) (“Introduction to Monte Carlo event generators”, 6 hours) LPT Orsay, June 2018 |
| Sept. 2017 | Tutor (discussion leader) at the 2017 European School of High-Energy Physics (PhD level, several topics, ~ 10 hours) Evora, Portugal, September 2017 |
| 2014 - 2015 | College advisor of a PhD student in Particle Physics (Wolfson College, Oxford) |
| spring 2014 | Junior assessor for final-year projects in Theoretical Physics (MPhys level, Oxford) |

(Evaluation of ~ 10 final-year projects: reading of the reports, interview of students, final assessment. Done together with one senior faculty member)

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|--------------------|---|---------------------------|
| 2012 - 2015 | Taught graduate course in Theoretical Physics (PhD level) ("Introduction to Symmetries", 8+2 hours, Oxford) | [3 terms] |
| winter 2012 | Tutor ("Retained Lecturer") in Physics at Wadham College, Oxford ("Subatomic Physics", 3rd year, 15 hours, 8 students) | |
| Sept. 2012 | Tutor at the 42nd BUSSTEPP Summer School (PhD level) (Several topics in theoretical particle Physics - aimed at first-year PhD students from the UK, 10 hours) | |
| 2009 - 2012 | Tutor in the first-year courses in Physics (level 1) ("Foundations of Physics 1", 20 hours/group, 2 groups + problems marking, Durham) | [3 academic years] |
| fall 2008 | Teaching Assistant in the third-year courses in Physics ("Introduction to Quantum Mechanics", 20 hours, Milano-Bicocca) | |
| fall 2007 | Tutor in the third-year courses in Physics ("Introduction to Quantum Mechanics", 30 hours, Milano-Bicocca) | |

In 2017 I was the external examiner for a PhD thesis (details below). During and after my stay in Oxford, I've also informally co-supervised 2 PhD students.

Institutional responsibilities and community work

- Referee for: PRD, JHEP, PLB, EPJC, PRL
- Grant proposal reviewer for: NWO (Netherlands Organisation for Scientific Research), NCN (National Science Centre of Poland)
- External examiner for the PhD thesis of B. Hespel (June/September 2017, CP3, Université catholique de Louvain, Louvain-la-Neuve)

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- TH organizer of the "Collider Cross Talk" seminars at the CERN TH Department, from October 2017 to September 2019
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- Convener of the "ggH" subgroup within the "LHC Higgs Cross Section Working Group", from September 2019
 - Convener of the "VH" subgroup within the "LHC Higgs Cross Section Working Group", from January 2018 to September 2019
 - TH contact for the "single top" studies for the HL/HE LHC, from April 2018 to February 2019
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- Outreach activities in which I actively took part:

- organized visit of 50 people from Bernareggio (my hometown) to CERN, CERN, 2 November 2019
- given outreach talk for the general public: “L’infinitamente piccolo: dall’elettrone al bosone di Higgs”, Università del tempo libero, Bernareggio, 29 Ottobre 2018
- “Saturday Mornings of Theoretical Physics: Exploring the high energy frontier at the LHC”, outreach event for Oxford alumni, Oxford, 7 February 2015
- “Saturday Mornings of Theoretical Physics: Inner Space meets Outer Space”, outreach event for Oxford alumni, Oxford, 25 January 2014
- UK STEM ambassador in 2014
- “Ogden@10”, IPPP, September 2012
- outreach event during the “LHCphenonet annual meeting 2012”, Lumley Castle, UK, March 2012

List of publications

For the evaluation of my research activity in the context of the position “Professore Universitario di ruolo di II fascia presso il Dipartimento di Fisica Aldo Pontremoli” (Codice concorso: 4415), the publications to be considered are attached to the application submitted on-line, and are listed both in the dedicated numbered document, as well as in the document “dichiarazione sostitutiva di atto di notorietà (Allegato B)”.

At the end of the CV I add an exhaustive list of my publications in refereed journals and in other (non-refereed) reports.

Talks

- Invited Talks [last 6 years]

More significant talks underlined.

- “NNLO+PS with MiNLO and POWHEG”, [invited]
Parton Showers and Resummation (Krakow), 27 May 2015
- “MC tools and NLO Monte Carlos”, [invited, plenary]
Higgs Hunting 2015 (Orsay), 30 July 2015
- “Latest theory developments for top pair production, generators and showering”, [invited, plenary]
TOP 2015 (Ischia), 15 September 2015
- “Standard Model: status & recent theory highlights”, [review, plenary]
Rencontre de Physique des Particules 2016 (LAPTh, Annecy), 25 January 2016
- “Jet multiplicity and higher order corrections”, [invited, plenary]
DM @ LHC 2016 (Amsterdam), 30 March 2016
- “Matching and Merging”, [invited]
MC4BSM (UCAS, Beijing), 20 July 2016
- “Latest developments in the simulation of final states involving top-pair and heavy bosons”, [invited, review]
ICHEP 2016 (Chicago), 4 August 2016
- “NNLO+PS with POWHEG + MiNLO”, [invited]
Future challenges for precision QCD (IPPP, Durham), 26 October 2016
- “Constraining light-quark Yukawa couplings using Higgs distributions”, [invited]
XXIII Krakow Epiphany Conference (IFJ PAN, Krakow), 9 January 2017
- “Predictions for exclusive Higgs cross sections”, [invited, review]
Large Hadron Collider Physics 2017 (Shanghai), 15 May 2017
- “NLO merging with MiNLO and NNLOPS: VV and VH”, [invited]
LoopFest XVI (Argonne National Laboratory), 31 May 2017
- “Resummation of transverse observables in momentum space: phenomenology”, [invited]
“Resummation, Evolution, Factorization” workshop (Madrid), 13 November 2017
- “Recent QCD results for Higgs and Drell-Yan production at the LHC”, [invited]
“Getting to grips with QCD” workshop (Paris), GDR QCD, 5 April 2018
- “Hadronic and electroweak observables: summary talk”, [invited, plenary]
DIS 2018 (Kobe, Japan), 20 April 2018
- “N3LL+NNLO resummation for color singlet production at the LHC”, [invited]
LoopFest XVII (Michigan State University), 19 July 2018
- “Progress in Monte Carlo tools for Higgs physics”, [invited, review]
LHCP 2019 (Puebla, Mexico), 21 May 2019

- Contributed Talks and Talks at Workshops [last 6 years]

- “spin-0 and spin-1 mediators with POWHEG (+ ideas for phenomenology)”,
ATLAS/CMS Dark Matter forum, 16 January 2015
- “Dark-matter at colliders, and QCD”,
Effective Theory and Dark Matter (Mainz), 25 March 2015
- “Recent developments in POWHEG”,, [invited]
GDR Terascale (LPSC, Grenoble), 25 November 2015
- “MC generators for final states including vector bosons”, [invited]
ATLAS-CMS Monte Carlo Generators Workshop (CERN), 11 January 2016
- “Higgs production: yields and kinematical distributions”, [invited]
Theorie LHC France (IPN, Orsay), 7 November 2016
- “Challenges for precision QCD at the LHC”, [invited]
GDR QCD (IPN, Orsay), 9 November 2016
- “Constraining light-quark Yukawa couplings using Higgs distributions”, [invited]
GDR Terascale (LPHE, Paris), 25 November 2016
- “Constraining light-quark Yukawa couplings using Higgs distributions”,
Milan Christmas meeting (Milan), 20 December 2016
- “NLO+PS merging of $pp \rightarrow WW$ and $pp \rightarrow WW+j$ using MiNLO”,
CMS Montecarlo meeting (CERN), 23 January 2017
- “Status of POWHEG and MiNLO”, [invited]
ATLAS-CMS Monte Carlo Generators Workshop (CERN), 2 May 2017
- “mini-review on resonance-aware NLO+PS tools”,
“PhysTeV 2017” workshop (Les Houches), 12 June 2017
- “Tools & Montecarlo summary”,
“PhysTeV 2017” workshop (Les Houches), 14 June 2017
- “MC & Tools at Les Houches 2017: summary of the summary”,
“LHC and the Standard Model: Physics and Tools” workshop (CERN), 19 June 2017
- “The Higgs transverse momentum distribution: a review”, [invited]
IRN Terascale (CPPM, Marseille), 14 December 2017
- “Resummation with RadISH”, [invited]
“ $p_{T,W}$ and $p_{T,Z}$ theory meeting” (CERN), 25 January 2018
- “VH subgroup: theory summary talk”
Higgs Cross Section Working Group Meeting (CERN), 26 March 2018
- “WW production at NNLO+PS”,
DIS 2018 (Kobe, Japan), 17 April 2018
- “POWHEG status report”,
ATLAS Physics Modelling Group Plenary (CERN), 26 June 2018

- “Understanding calculations: POWHEG”, [invited]
LHC EW Working Group Meeting - jets and EW bosons (CERN), 13 November 2018
- “POWHEG: status and plans”, [invited]
Physics Event Generator Computing Workshop (CERN), 26 November 2018
- “VH subgroup: theory summary talk”
Higgs Cross Section Working Group Meeting (CERN), 10 December 2018
- “Radish+NNLOJET predictions”,
LHC EW precision sub-group (CERN), 13 March 2019
- “top physics at HL-HE LHC”, [invited, canceled due to personal reasons]
TOP LHC France 2019 (LPSC, Grenoble), 26 April 2019
- “Tools & Montecarlo, opening talk”,
“PhysTeV 2019” workshop (Les Houches), 11 June 2019
- “LH 2019: “MC uncertainties” discussions”,
Higgs Cross Section Working Group Meeting (CERN), 27 June 2019
- “QCD and Monte Carlo at colliders”,
CPTGA “precision calculations” meeting (LAPTh, Annecy), 19 November 2019
- “The MiNNLOPS method”, [invited]
CMS generator meeting (CERN), 20 April 2020
- “The MiNNLOPS method”,
“Taming the accuracy of event generators” Workshop (CERN), 1 July 2020

- Seminars [last 6 years]

- “NNLO Event Generators for the LHC”,
Seminar (MPI Munich), 19 January 2015
- “Event generators for LHC Phenomenology”,
Particle Phenomenology forum (University of Oxford), 22 January 2015
- “Towards NNLO Event Generators for the LHC”,
Seminar (LAPTh, Annecy), 5 February 2015
- “Towards NNLO Event Generators for the LHC”,
Seminar (LPSC, Grenoble), 4 March 2015
- “Tools and ideas for LHC phenomenology”,
Seminar (Montpellier), 18 March 2015
- “Towards NNLO Event Generators for the LHC”,
Seminar (University of Milano), 16 April 2015
- “Event generators for LHC Phenomenology”,
Seminar (LPThE, Paris), 23 April 2015

- “Towards NNLO Event Generators for the LHC”,
Seminar (University of Edinburgh), 28 October 2015
- “Higher order QCD in Event Generators” + “DM searches at the LHC”,
Internal Seminar (LAPTh, Annecy), 14 January 2016
- “Towards NNLO event generators for the LHC”,
Seminar (IPhT, Saclay), 11 May 2016
- “Towards NNLO event generators for the LHC”,
Seminar (Louvain-la-Neuve), 8 June 2016
- “Event generators for the LHC: status and perspectives”,
Seminar (LAL, Orsay), 22 November 2016
- “Including higher order QCD corrections in Montecarlo event generators”
Particle and Astro-Particle Physics Seminars (CERN), 17 March 2017
- “NNLO+PS results for color-singlet production at the LHC”,
Seminar (Milano), 27 February 2019
- “MiNNLOps: a new method to match NNLO QCD and parton showers”,
Seminar (University of Zurich), 17 December 2019

- Talks in 2009 - 2014

In 2009-2014 I gave ~ 50 talks (plenary and parallel talks at conferences, workshops, invited seminars). The more important ones were the following:

- “Next-to-Leading-Order QCD corrections to Shower Monte Carlo event generators”,
Riunione nazionale INFN, piano triennale (Gran Sasso laboratories), 14 October 2010
[invited (“Premio Fubini”)]
- “Jet pair production with POWHEG”, [invited]
LoopFest X (Northwestern University), 13 May 2011
- “State-of-Art generators for top physics”, [invited, plenary]
TOP 2011 (Sant Feliu de Guixols), 26 September 2011
- “Z+2 jets at NLO in POWHEG”, [invited]
Working Group on Electroweak precision measurements at the LHC (CERN), 22 May 2012
- “Finding Higgs triplets in VBF searches”, [invited]
ATLAS VBF Workshop (Brookhaven), 9 July 2013
- “News in POWHEG and MINLO”, [invited, parallel]
QCD@LHC 2013 (DESY-Hamburg), 5 September 2013
- “NNLOPS with POWHEG & MINLO”, [invited, plenary]
ZP Workshop 2014: “Monte Carlo simulation” (Zurich), 9 January 2014
- “Tools and ideas for precision Physics at the LHC”,
Colloquium (University of Buffalo), 13 February 2014

- “QCD effects in mono-jet searches for dark matter”, [invited, parallel]
Astroparticle Physics 2014 (Amsterdam), 26 June 2014
- “NLO + Parton Showers merging: current status and future perspectives”, [invited, mini-review]
ICHEP 2014 (Valencia), 5 July 2014
- “Monte-Carlo overview”, [invited, plenary]
QCD@LHC 2014 (Suzdal), 25 August 2014
- “Mono-jet searches for dark matter: QCD effects and structure of dark-matter couplings”, [invited]
DM @ LHC 2014 (Oxford), 26 September 2014

Research Activity and Interests¹

My field of research is High-Energy Particle Physics. My main research interest is collider phenomenology and in particular the Physics of the Large Hadron Collider (LHC). My research expertise is mostly in Quantum Chromodynamics (QCD) and its role in collider Physics. Over the years, however, I've also broadened my interests toward several research areas related to aspects of LHC phenomenology in the Standard Model and Beyond. In the following, first I summarize the more significant results of my research activity, and then I list briefly my contributions to working groups (besides the convening roles I listed in the first part of the CV).

- *State-of-the-art Event Generators for LHC Physics:*

My PhD activity led to the development of a framework to match next-to-leading order (NLO) QCD computations with parton showers (NLOPS) according to the so-called POWHEG method. The software we have developed (named POWHEG BOX) is one of the state-of-the-art Monte Carlo event generators currently used by LHC collaborations for the majority of their analysis.

After my PhD, I continued my research improving in several directions the aforementioned program, in works done in collaboration with P. Nason, C. Oleari and S. Alioli as well as with other new collaborators. I have also independently chosen to undertake two projects on NLOPS simulations that were very relevant at the time. One of them was particularly urgent to fill a gap in the simulation tools publicly available for single-top searches, whereas the other (the implementation of the $Z + 2$ jets process) is important for current and future Higgs searches and its technical complexity is at the same level as other state-of-the-art results achieved at that time in the event generators community. I have carried out these projects alone and this led to two single-authored publications.

During my stay in Oxford I have started to work, with G. Zanderighi and other collaborators, on new techniques to match next-to-next-to-leading order (NNLO) QCD computations with parton showers (NNLOPS). We have used the so-called “MiNLO” method (“Multiscale-improved NLO”), and obtained for the very first time results with this accuracy for several LHC processes (gluon-fusion Higgs production, Drell-Yan, $pp \rightarrow W(\rightarrow \ell\nu)/Z(\rightarrow \ell\bar{\ell})H$, $pp \rightarrow W^+W^-$, $H \rightarrow b\bar{b}$). The most recent results are:

- In [32] (which, in turn, relies on earlier results [27]), with G. Zanderighi and M. Wiesemann, we have obtained NNLOPS-accurate results for the di-boson production process $pp \rightarrow W^+W^-$, with full leptonic decays. Due to the high multiplicity of the final state, this is the most challenging process computed with this accuracy.
- In [36] we have obtained NNLOPS-accurate results for the Higgs decay to b -quarks. We have achieved these results by refining the MiNLO technique, which was used so far only for processes with hadrons in the initial state. These results can be used to improve the accuracy of generators used for analysis where the $H \rightarrow b\bar{b}$ decay plays an important role.

Most recently, in [35], we have proposed a new and general method (called MiNNLOPS) to match NNLO computations with parton showers that relies on using only a NNLL+NNLO resummed result together with a NLOPS simulation, and have applied it, in a proof-of-concept study, to the Higgs and Drell-Yan processes. The core idea emerged by how we have obtained the “semi-analytic” resummed

¹In this section I use the full reference list at the end of the CV.

results described in the next section. The method simplifies enormously the procedure used so far to achieve NNLOPS accuracy, which, due to the computational complexity, is likely to have already reached its limits (the WW computation mentioned above demanded a major computational effort). This new method has the potential to be used for processes with higher-multiplicity final state, and with more complicated color structure (notably, for top-pair production).

During the last year, I have also started to work on the matching of NLO EW and NLO QCD corrections to parton showers. Results for di-boson production with full leptonic decays have been obtained recently, in [39]. The ultimate goal of this last research direction is to combine NNLO QCD and NLO EW corrections, thereby obtaining generators that are accurate at the few percent level in the hard matrix elements, and are consistently matched to parton showers.

- *All-order computations in QCD:*

In the last 5-6 years, I have started a new research direction with new collaborators (P. Monni, P. Torrielli and, subsequently, two former Oxford PhD students: W. Bizon and L. Rottoli). We introduced and developed a new formalism ([26], published in PRL) to resum to all orders large logarithms of soft-collinear origin for “transverse and inclusive” observables, for color-singlet production in hadronic collisions, directly in momentum space. It was the first time that such type of resummation was performed without using a formulation in a conjugate space. The proof-of-concept paper contained next-to-next-to-leading-logarithmic accurate (NNLL) results for the Higgs-boson transverse momentum spectrum matched to a NNLO differential result. In subsequent papers ([29], and then [31, 34]) we have

- given a more in-depth description of the method, discussed how it compares to other approaches, and spelled out all the technical details.
- used the formalism (and the **Radish** code based on it) to compute, for the very first time, the Higgs-boson and Z transverse momentum spectrum at N3LL, matching it to the QCD NNLO fixed order result, thereby obtaining for this observable the most accurate prediction available to date.
- performed broad phenomenological studies relevant for Higgs and, particularly, for Drell-Yan measurements, among which the state-of-the-art prediction of the ratio of the W and Z transverse momentum, which is the central observable needed for the measurement of the W -boson mass at the LHC.

Our results have been already included in public notes and papers of the ATLAS and CMS collaborations, and they are also having a significant impact in the groups involved in precision measurements at the LHC. In a more recent work [37], we have also automated the above formalism by interfacing the **Radish** code with **MATRIX**, obtaining state-of-the-art resummed results, matched to fixed order, for a large number of processes at the LHC.

As previously mentioned, the results obtained with this approach were also at the core of the new MiNNLOPS method that we proposed recently.

- *Phenomenology at the LHC:*

Over the years, I have broadened my research expertise also beyond subjects purely related to QCD, focusing on various aspects of phenomenology at the LHC. In the following I give a (non-exhaustive) list of the significant results obtained in this context, in chronological order.

- In two papers written in collaboration with C. Englert and M. Spannowsky ([13, 14]) we have comprehensively studied the phenomenology of an extension (originally proposed by Georgi-Machacek) of the SM Higgs sector containing triplets. A thorough comparison of theoretical predictions and data available at that time (ranging from LHC results to direct and indirect constraints from e^+e^- collisions at LEP) was carried out, and we have also shown that already existing searches for Supersymmetry at the LHC, with minor modifications, have the potential to lead to conclusive results for a complete exclusion (or a discovery) of this model. We have also proposed and shown the potential of a new, dedicated experimental analysis that the LHC collaborations have carried out.
- In [18] we have shown that complementary information to bound the top-quark Yukawa coupling y_t can be obtained by looking into Higgs-associated single-top production ($pp \rightarrow tHj$). Despite cross-sections are quite small, we have shown that in the long run it is possible to set bounds using this channel too, by exploiting the fact that for non standard values of y_t the typical interference pattern present at tree-level for this process allows to have non-trivial angular correlations in the final state, correlated to the value of y_t .
- A very active domain of research during the last few years has been the one of Dark Matter searches at colliders, since in some cases, and under certain assumptions, these searches can place strong constraints on properties of DM that are complementary to those from direct detection experiments. I have written 3 papers on this subject:
 - In [16] we performed a detailed study of QCD effects in DM production at the LHC in the mono-jet search with an s-channel mediator, developed a state-of-the-art public tool to simulate these processes, and pointed out the importance of the multijet component of these signals.
 - We have also exhibited for the first time [17] an example on how to disentangle whether dark matter pair production proceeds dominantly through tree or loop diagrams, which is not possible to establish by just looking into the classical mono-jet signature. Moreover, for models where dark matter interacts predominantly with the top quark, this technique allows to test the CP nature of the particle mediating these interactions, which is in general quite difficult to understand in direct-detection experiments.
 - Models with spin-0 s-channel mediators gained attention because of their simplicity and as they are possible candidates to account for the excess of gamma-ray emission from the Galactic Centre observed with the Fermi-LAT instrument. In [21] we have thoroughly compared direct, indirect and collider bounds for these models in the assumption of Minimal Flavour Violation. Under this assumption, the dominant interaction of the DM sector is with top-quarks: we studied the complementarity between the mono-jet signal (where the mediator that pair-produces DM is radiated from top-quark loops) and the tree-level $t\bar{t} + \cancel{E}_T$ signature, which has very different SM backgrounds.
- In [28] (published in PRL) we have proposed a completely new strategy to constrain the Yukawa couplings of the bottom and charm quark. This is extremely relevant because measuring the Higgs couplings to light quarks (notably the 2nd generation) is currently a major challenge: these couplings are essentially unknown experimentally, due to their small values in the SM, but their extraction is crucial to establish whether or not the 2nd generation fermions acquire a mass through the Higgs mechanism.

The key observation is that differential distributions of the Higgs boson in different production channels have different properties (dictated also by subleading QCD effects), which can be exploited to extract information on Yukawa couplings that would be very difficult to access otherwise. The idea is at least as powerful as other approaches, and another novelty is that

its full reach is only limited by theoretical accuracy, but not by statistical and systematical experimental uncertainties. Our proposal already had a significant impact in the community: results based on our idea have been presented at conferences, and have also been published in journal papers as well as in public notes by ATLAS and CMS.

I contributed to several “collective” studies of the theoretical and experimental communities active in collider Physics:

- I have participated to the discussions and activities related to the searches for Dark Matter at the LHC, initially within the “ATLAS/CMS Dark Matter forum”. I contributed to the report [46] and the publication [23].
 - I have contributed to the report “Precision Studies of Observables in Drell-Yan processes at the LHC”, that was eventually published on a peer-reviewed journal [24].
 - I have participated to the collective studies aiming at highlighting the Physics opportunities of a 100 TeV hadron collider, with a contribution to the chapter dedicated to SM top-quark production, in the report “Physics at a 100 TeV pp collider: Standard Model processes”[48].
 - I contributed to the sections on the “ $gg \rightarrow H$ ” “ $pp \rightarrow HV$ ” processes of the CERN Yellow Report “Handbook of LHC Higgs Cross Sections, volume 4: Deciphering the Nature of the Higgs Sector”[49].
 - In the context of the studies related to the future of the LHC Physics program (“HL/HE” LHC), I contributed to two CERN Yellow Reports [54, 55]. I was in charge of the chapter on “single-top studies within and beyond the SM”, and of the chapter on the “ $pp \rightarrow VH$ ” process.
 - I have edited, and actively contributed to, the proceedings of two editions of the “PhysTeV” workshop [52, 57], and also contributed as an author to a third one [43].
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Journal articles [[1]–[40]] and Conference proceedings & Working Group reports [[41]–[57]] ²

- [1] S. Alioli, P. Nason, C. Oleari, and E. Re, *NLO vector-boson production matched with shower in POWHEG*, *JHEP* **07** (2008) 060, [0805.4802].
- [2] S. Alioli, P. Nason, C. Oleari, and E. Re, *NLO Higgs boson production via gluon fusion matched with shower in POWHEG*, *JHEP* **04** (2009) 002, [0812.0578].
- [3] S. Alioli, P. Nason, C. Oleari, and E. Re, *NLO single-top production matched with shower in POWHEG: s- and t-channel contributions*, *JHEP* **09** (2009) 111, [0907.4076].
- [4] S. Alioli, P. Nason, C. Oleari, and E. Re, *A general framework for implementing NLO calculations in shower Monte Carlo programs: the POWHEG BOX*, *JHEP* **06** (2010) 043, [1002.2581].
- [5] E. Re, *Single-top Wt-channel production matched with parton showers using the POWHEG method*, *Eur. Phys. J.* **C71** (2011) 1547, [1009.2450].
- [6] S. Alioli, P. Nason, C. Oleari, and E. Re, *Vector boson plus one jet production in POWHEG*, *JHEP* **01** (2011) 095, [1009.5594].

²List with updated citations is available online from the SPIRESdatabase.

- [7] S. Alioli, K. Hamilton, P. Nason, C. Oleari, and E. Re, *Jet pair production in POWHEG*, *JHEP* **04** (2011) 081, [1012.3380].
- [8] S. Alioli, K. Hamilton, and E. Re, *Practical improvements and merging of POWHEG simulations for vector boson production*, *JHEP* **09** (2011) 104, [1108.0909].
- [9] C. Englert, J. Jaeckel, E. Re, and M. Spannowsky, *Evasive Higgs Maneuvers at the LHC*, *Phys.Rev.* **D85** (2012) 035008, [1111.1719].
- [10] S. Alioli, J. R. Andersen, C. Oleari, E. Re, and J. M. Smillie, *Probing higher-order corrections in dijet production at the LHC*, *Phys.Rev.* **D85** (2012) 114034, [1202.1475].
- [11] E. Re, *NLO corrections merged with parton showers for Z+2 jets production using the POWHEG method*, *JHEP* **1210** (2012) 031, [1204.5433].
- [12] R. Frederix, E. Re, and P. Torrielli, *Single-top t-channel hadroproduction in the four-flavour scheme with POWHEG and aMC@NLO*, *JHEP* **1209** (2012) 130, [1207.5391].
- [13] C. Englert, E. Re, and M. Spannowsky, *Triplet Higgs Collider Phenomenology after LHC*, *Phys.Rev.* **D87** (2013) 095014, [1302.6505].
- [14] C. Englert, E. Re, and M. Spannowsky, *Pinning down Higgs triplets at the LHC*, *Phys.Rev.* **D88** (2013) 035024, [1306.6228].
- [15] K. Hamilton, P. Nason, E. Re, and G. Zanderighi, *NNLOPS simulation of Higgs boson production*, *JHEP* **1310** (2013) 222, [1309.0017].
- [16] U. Haisch, F. Kahlhoefer, and E. Re, *QCD effects in mono-jet searches for dark matter*, *JHEP* **1312** (2013) 007, [1310.4491].
- [17] U. Haisch, A. Hibbs, and E. Re, *Determining the structure of dark-matter couplings at the LHC*, *Phys.Rev.* **D89** (2014) 034009, [1311.7131].
- [18] C. Englert and E. Re, *Bounding the top Yukawa with Higgs-associated single-top production*, *Phys.Rev.* **D89** (2014) 073020, [1402.0445].
- [19] A. Karlberg, E. Re, and G. Zanderighi, *NNLOPS accurate Drell-Yan production*, *JHEP* **1409** (2014) 134, [1407.2940].
- [20] J. M. Campbell, R. K. Ellis, P. Nason, and E. Re, *Top-pair production and decay at NLO matched with parton showers*, *JHEP* **1504** (2015) 114, [1412.1828].
- [21] U. Haisch and E. Re, *Simplified dark matter top-quark interactions at the LHC*, *JHEP* **1506** (2015) 078, [1503.00691].
- [22] R. Gauld, U. Haisch, B. D. Pecjak, and E. Re, *Beauty-quark and charm-quark pair production asymmetries at LHCb*, *Phys. Rev.* **D92** (2015) 034007, [1505.02429].
- [23] J. Abdallah *et al.*, *Simplified Models for Dark Matter Searches at the LHC*, *Phys. Dark Univ.* **9-10** (2015) 8–23, [1506.03116].
- [24] S. Alioli *et al.*, *Precision studies of observables in $pp \rightarrow W \rightarrow l\nu_l$ and $pp \rightarrow \gamma, Z \rightarrow l^+l^-$ processes at the LHC*, *Eur. Phys. J.* **C77** (2017), no. 5 280, [1606.02330].

- [25] W. Astill, W. Bizon, E. Re, and G. Zanderighi, *NNLOPS accurate associated HW production*, *JHEP* **06** (2016) 154, [1603.01620].
- [26] P. F. Monni, E. Re, and P. Torrielli, *Higgs Transverse-Momentum Resummation in Direct Space*, *Phys. Rev. Lett.* **116** (2016), no. 24 242001, [1604.02191].
- [27] K. Hamilton, T. Melia, P. F. Monni, E. Re, and G. Zanderighi, *Merging WW and WW+jet with MINLO*, *JHEP* **09** (2016) 057, [1606.07062].
- [28] F. Bishara, U. Haisch, P. F. Monni, and E. Re, *Constraining Light-Quark Yukawa Couplings from Higgs Distributions*, *Phys. Rev. Lett.* **118** (2017), no. 12 121801, [1606.09253].
- [29] W. Bizon, P. F. Monni, E. Re, L. Rottoli, and P. Torrielli, *Momentum-space resummation for transverse observables and the Higgs p_\perp at $N^3LL+NNLO$* , *JHEP* **02** (2018) 108, [1705.09127].
- [30] W. Astill, W. Bizon, E. Re, and G. Zanderighi, *NNLOPS accurate associated HZ production with $H \rightarrow b\bar{b}$ decay at NLO*, *JHEP* **11** (2018) 157, [1804.08141].
- [31] W. Bizoń, X. Chen, A. Gehrmann-De Ridder, T. Gehrmann, N. Glover, A. Huss, P. F. Monni, E. Re, L. Rottoli, and P. Torrielli, *Fiducial distributions in Higgs and Drell-Yan production at $N^3LL+NNLO$* , *JHEP* **12** (2018) 132, [1805.05916].
- [32] E. Re, M. Wiesemann, and G. Zanderighi, *NNLOPS accurate predictions for W^+W^- production*, *JHEP* **12** (2018) 121, [1805.09857].
- [33] J. Bellm *et al.*, *Jet Cross Sections at the LHC and the Quest for Higher Precision*, *Eur. Phys. J.* **C80** (2020), no. 2 93, [1903.12563].
- [34] W. Bizon, A. Gehrmann-De Ridder, T. Gehrmann, N. Glover, A. Huss, P. F. Monni, E. Re, L. Rottoli, and D. M. Walker, *The transverse momentum spectrum of weak gauge bosons at $N^3LL + NNLO$* , *Eur. Phys. J.* **C79** (2019), no. 10 868, [1905.05171].
- [35] P. F. Monni, P. Nason, E. Re, M. Wiesemann, and G. Zanderighi, *MiNNLOPS: A new method to match NNLO QCD to parton showers*, *JHEP* **05** (2020) 143, [1908.06987].
- [36] W. Bizoń, E. Re, and G. Zanderighi, *NNLOPS description of the $H \rightarrow b\bar{b}$ decay with MINLO*, *JHEP* **06** (2020) 006, [1912.09982].
- [37] S. Kallweit, E. Re, L. Rottoli, and M. Wiesemann, *Accurate single- and double-differential resummation of colour-singlet processes with MATRIX+RadISH: W^+W^- production at the LHC*, 2004.07720.
- [38] K. Becker *et al.*, *Precise predictions for boosted Higgs production*, 2005.07762.
- [39] M. Chiesa, C. Oleari, and E. Re, *NLO QCD+NLO EW corrections to diboson production matched to parton shower*, [Accepted for publication in EPJC] [2005.12146].
- [40] P. F. Monni, E. Re, and M. Wiesemann, *MiNNLOPS: Optimizing $2 \rightarrow 1$ hadronic processes*, 2006.04133.
- [41] E. Re, *Single-top production with the POWHEG method*, *PoS DIS2010* (2010) 172, [1007.0498].
- [42] E. Re, *State-of-the-art generators for top physics*, *Nuovo Cim.* **C035N3** (2012) 13–18.

- [43] J. A. Maestre, S. Alioli, J. Andersen, R. Ball, A. Buckley, *et al.*, *The SM and NLO Multileg and SM MC Working Groups: Summary Report*, 1203.6803.
- [44] E. Re, *Reaching NNLOPS accuracy with POWHEG and MiNLO*, *Nuovo Cim.* **C037N2** (2014) 137–142, [1401.2944].
- [45] E. Re, *Higgs production at NNLOPS*, 1405.7079.
- [46] D. Abercrombie *et al.*, *Dark Matter Benchmark Models for Early LHC Run-2 Searches: Report of the ATLAS/CMS Dark Matter Forum*, 1507.00966.
- [47] E. Re, *Latest theory developments for top pair production, generators and showering*, *PoS TOP2015* (2016) 012, [1601.03647].
- [48] M. L. Mangano *et al.*, *Physics at a 100 TeV pp collider: Standard Model processes*, *CERN Yellow Report* (2017), no. 3 1–254, [1607.01831].
- [49] **LHC Higgs Cross Section Working Group** Collaboration, D. de Florian *et al.*, *Handbook of LHC Higgs Cross Sections: 4. Deciphering the Nature of the Higgs Sector*, 1610.07922.
- [50] E. Re, *Latest developments in the simulation of final states involving top-pair and heavy bosons*, *PoS ICHEP2016* (2017) 657.
- [51] E. Re, *Predictions for exclusive Higgs cross sections*, 1710.08869.
- [52] J. R. Andersen *et al.*, *Les Houches 2017: Physics at TeV Colliders Standard Model Working Group Report*, 1803.07977.
- [53] E. Re, *W^+W^- production at NNLO+PS*, *PoS DIS2018* (2018) 115, [1808.09103].
- [54] M. Cepeda *et al.*, *Report from Working Group 2*, *CERN Yellow Rep. Monogr.* **7** (2019) 221–584, [1902.00134].
- [55] P. Azzi *et al.*, *Report from Working Group 1*, *CERN Yellow Rep. Monogr.* **7** (2019) 1–220, [1902.04070].
- [56] S. Alioli *et al.*, *Monte Carlo event generators for high energy particle physics event simulation*, 1902.01674.
- [57] S. Amoroso *et al.*, *Les Houches 2019: Physics at TeV Colliders: Standard Model Working Group Report*, in *11th Les Houches Workshop on Physics at TeV Colliders: PhysTeV Les Houches*, 3, 2020. 2003.01700.

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