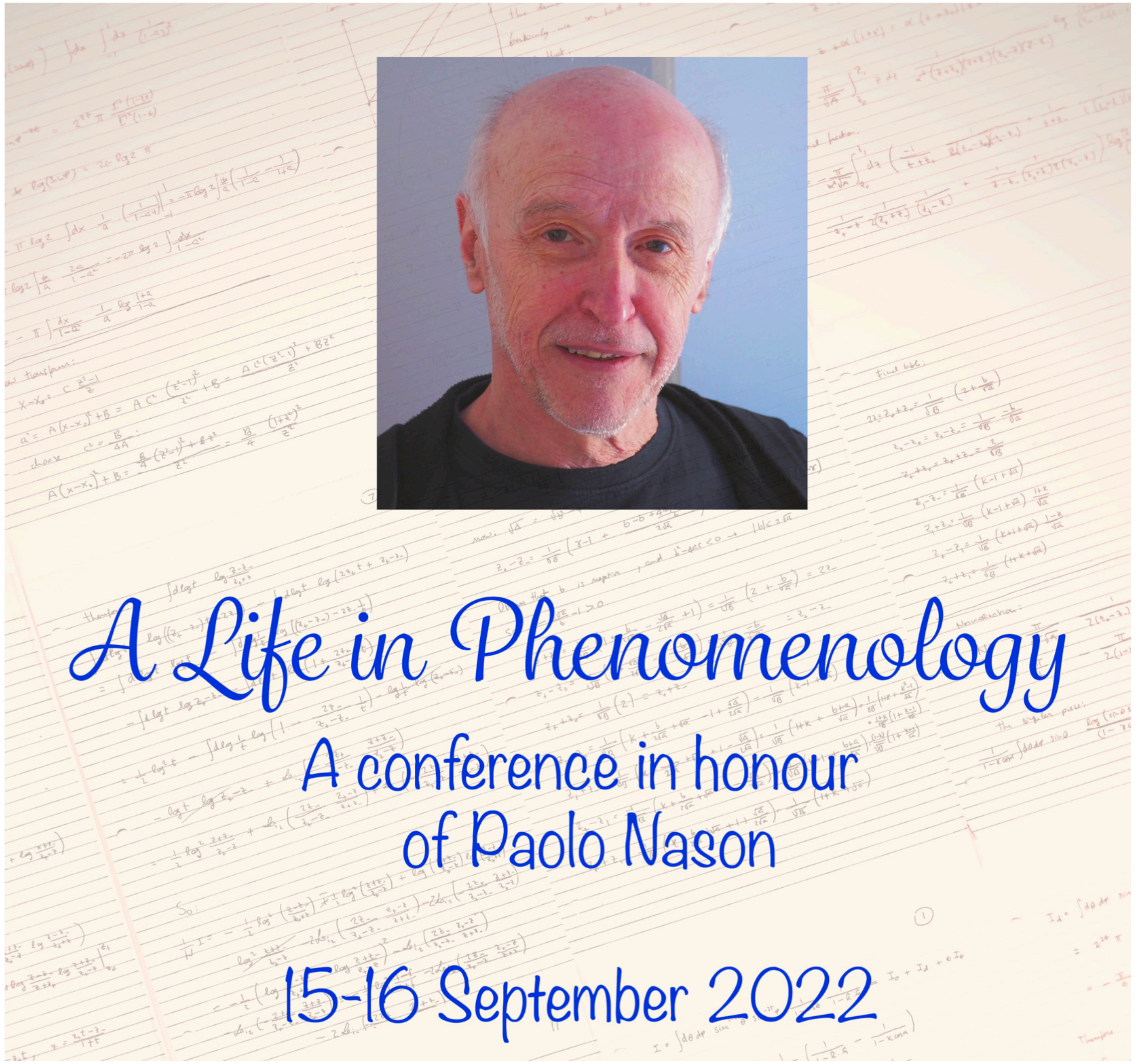
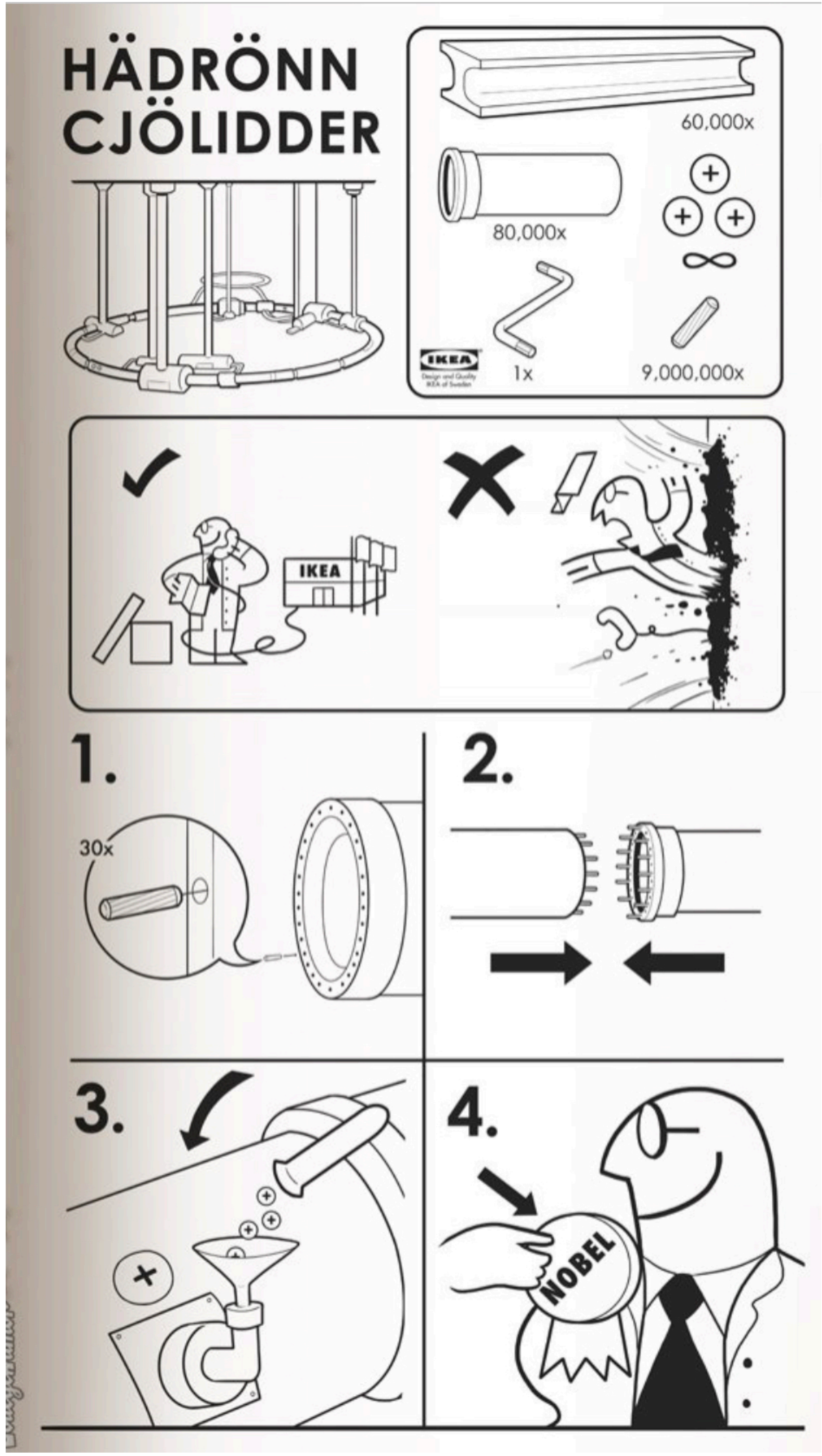
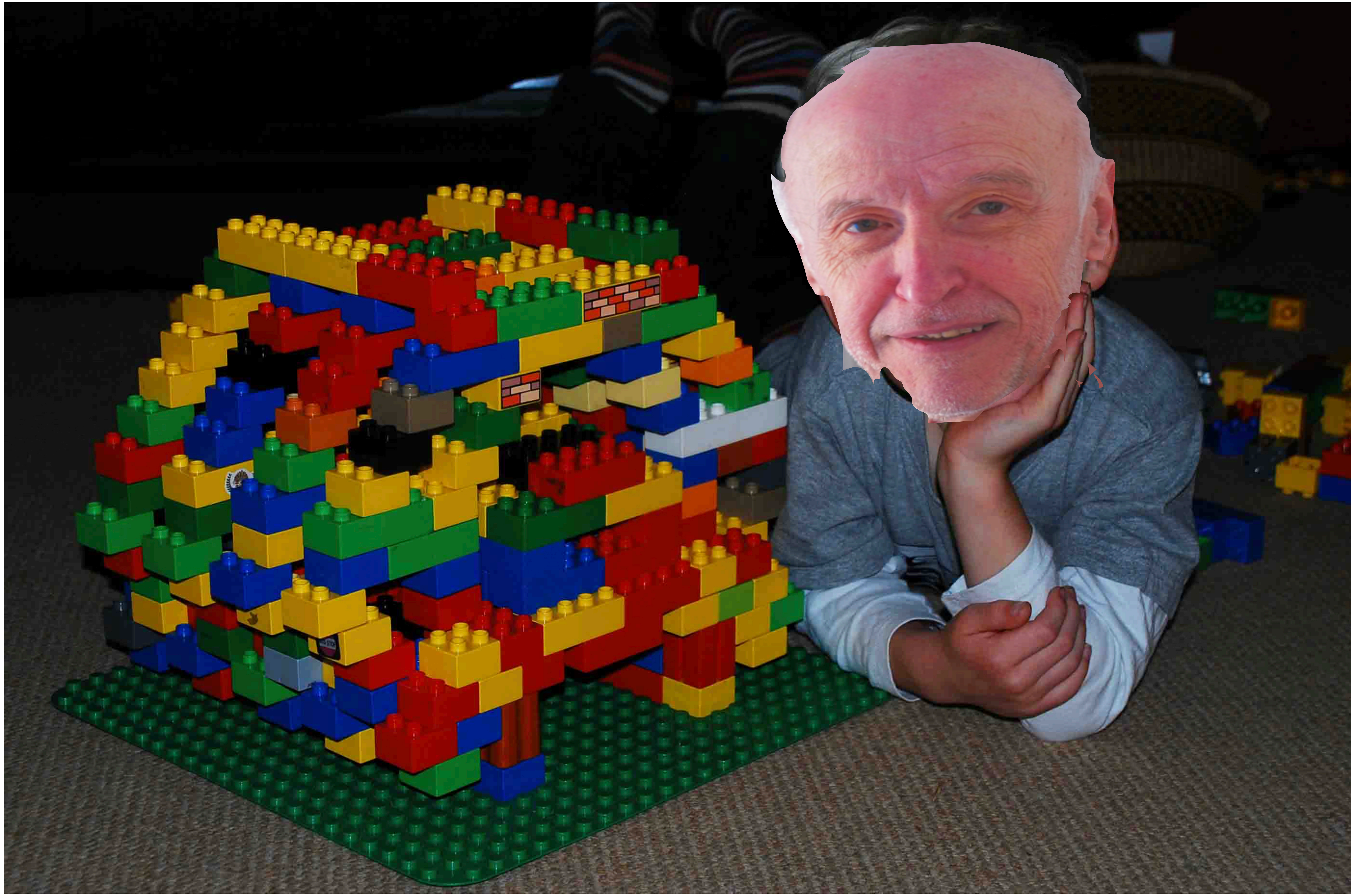


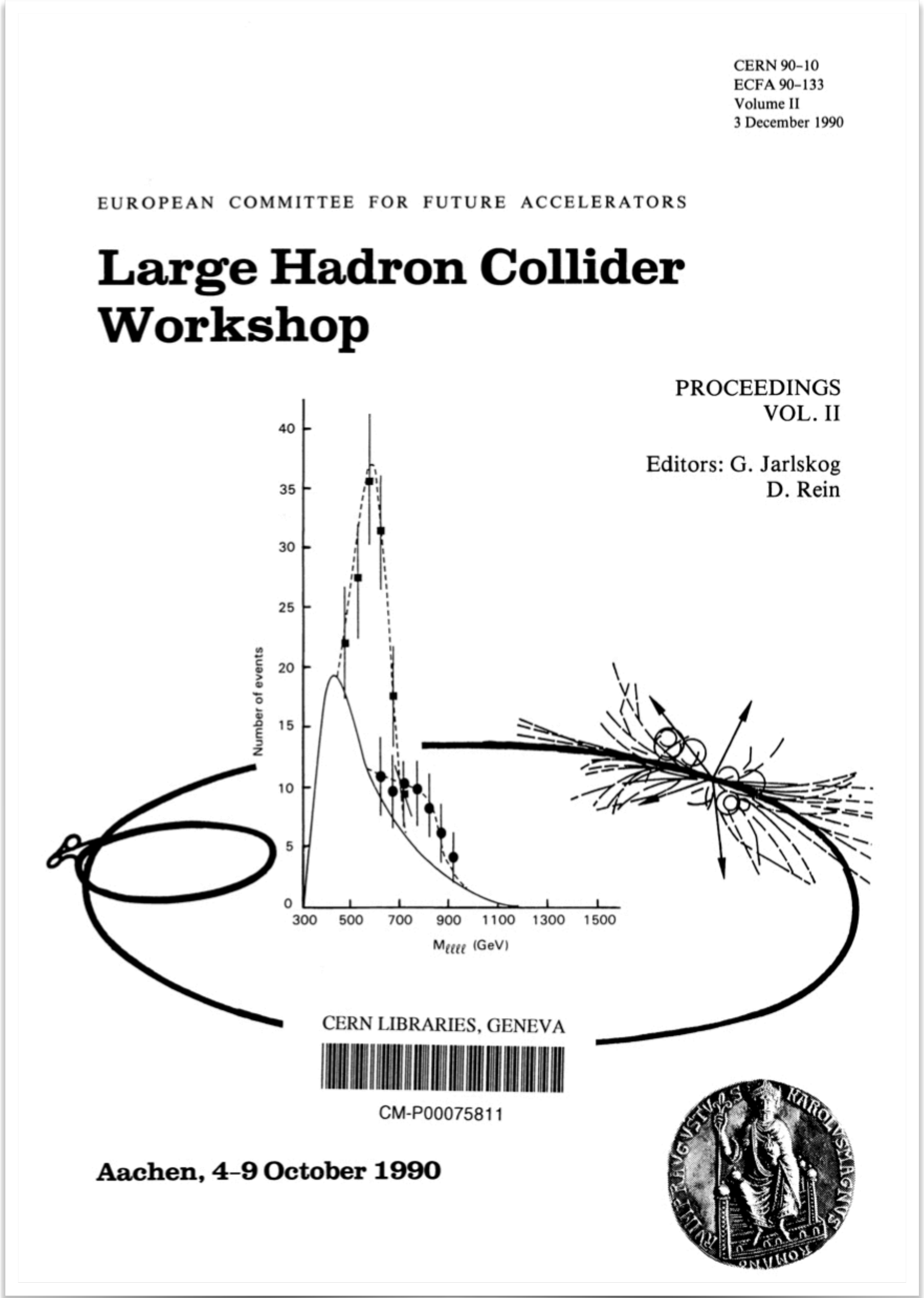
Paolo and the LHC

Michelangelo L. Mangano
TH Department
CERN


HÄDRÖNN
CJÖLIDDER
60,000x
80,000x
1x
9,000,000x
IKEA
1.
30x
2.
3.
4.
NOBEL



ECFA Large Hadron Collider Workshop,
Aachen, Germany, 4-9 Oct 1990,
SM Cross Sections & Hard Processes convener


CERN 90-10
ECFA 90-133
Volume II
3 December 1990

EUROPEAN COMMITTEE FOR FUTURE ACCELERATORS

Large Hadron Collider Workshop

PROCEEDINGS
VOL. II

Editors: G. Jarlskog
D. Rein

Aachen, 4-9 October 1990

Standard Model Cross Sections

P. Nason, convener

INFN, Gruppo Collegato di Parma

The working group on Standard Processes at the LHC was originally assigned the task of studying the cross sections for various standard processes of interest at the LHC. Two additional tasks were also assigned to this group: the measurement of the total and elastic cross section, and the study of the possibility for doing neutrino physics at the LHC. The group was therefore subdivided into a Total and Elastic cross section group, a Neutrino Physics group, and a Hard Processes group. The Hard Processes group was further subdivided into five subgroups, dealing with the structure functions, the physics of the intermediate vector bosons, the physics of direct photons, jets, and heavy quark production.

By its own nature, the group had to deal with all topics which where not considered central enough to require a single, dedicated working group, like the Higgs and Top searches, but on the other hand are very important in order to understand and model the physics at the LHC. Most of our work was the compilation of cross sections for everyday physics processes, with a considerable effort in trying to understand to what extent our present knowledge can be extrapolated to supercollider energies. Some processes that have impact on other areas of LHC physics have received particular attention. The $\gamma\gamma$ process, because of its importance as a background to an intermediate mass Higgs, was considered in detail. The cross sections for b and c production, which have an impact on the possibility of doing b physics and neutrino physics at the LHC, were also fully discussed, with much emphasis on the large amount of uncertainty that we have in their calculation. Some results of the working group are quite exciting, and stand by themselves as interesting physics topics. The limits on parton compositeness, arising both from jet and direct photon cross sections have considerable value, and certainly will be done at the LHC. A particularly interesting topic which was considered is the possibility of testing for anomalous couplings in the WWZ and $WW\gamma$ sectors, via WZ and $W\gamma$ detection. Both these topics have been fully discussed from an experimental point of view, at least at the level which is possible without a specific detector design. For the case of the $W\gamma$ process, the study of γ detection performed in the section on direct photons was quite essential.

We have tried to clarify in which areas our knowledge is sound, and in which areas improvement is needed. We hope therefore that the work done in this study group will be a useful starting point for future studies.

Summary of the studies

Total and Elastic Cross Sections.

Conveners: A. Martin and G. Matthiae

Theorists: C. Bourrely, P. Gauron, E. Leader, A. Martin, B. Nicolescu, E. Predazzi, J. Soffer and T. T. Wu;

Machine experts: B. Jeanneret and W. Scandale;

Experimentalists: G. Bellettini, D. Bernard, J. Bourotte, M. Bozzo, T. Camporesi, R. Castaldi, C. Da Via, R. De Salvo, M Haguenauer, R. M. Mondardini, G. Sanguinetti, J. Timmermans, G. Tonelli, O. Ullaland and S. Zucchelli.

List of contributions:

- C. Da Via, R. De Salvo, M. R. Mondardini and J. Orear,
  A new detector for small-p_t physics at LHC/SSC energies.
- D. Bernard,
  A fast and precise scintillating fiber tracking detector.
- G. Matthiae,
  Total and elastic cross section: the experimental method.
- E. Leader,
  Elastic scattering at the LHC: a chellenge to theory and experiment.

Neutrino Physics

Convener: K. Winter;

Theorists: A. De Rujula and A. B. Kaidalov;

Experimentalists: L. Camilleri, A. Capone, U. Dore, A. Ereditato, E. Fernandez, J. Gomez, P. F. Loverre, V. Palladino, F. Pietropaolo, L. Rolandi, R. Santacesaria, S. Schlenstedt and F. Vannucci.

List of contributions:

- K. Winter,
  Detection of the tau-neutrino at the LHC.

Hard processes

Convener: P. Nason;

Theorists: P. Aurenche, M. Fontannaz, J. P. Guillet, H. Kuijf, T. Matsuura, B. Mele, L. Trentadue and D. Zeppenfeld;

Experimentalists: M. Bonesini, L. Camilleri, T. Cox, M. Kienzle-Focacci, P. Lubrano, M. Nessi, F. Nessi-Tedaldi, F. Pastore, M. Pepe, H. Plothow-Besch, M. Werlen and D. Wood.

List of contributions:

- Jets at the Large Hadron Collider.
  P. T. Cox, J. P. Guillet, P. Lubrano, M. Nessi and F. Nessi-Tedaldi.
  Cross sections for jet production, limits on parton compositeness and multijets.
- Production of direct photon at LHC and SSC.
  P. Aurenche, M. Bonesini, L. Camilleri, P. Chiappetta, M. Fontannaz, J. P. Guillet, M. N. Kienzle-Focacci, M. Werlen.
  Cross section for production of photon, with and without isolation cuts. Probing the gluon structure function at small values of x. Detailed discussion of photon detectability and backgrounds to the photon signal.
- $\gamma\gamma$ production at LHC: a NLO order study of the "irreducible" background to $H^0 \to \gamma\gamma$.
  P. Aurenche, M. Bonesini, L. Camilleri, M. Fontannaz and M. Werlen.
  Study of experimental cuts needed for separating the intermediate Higgs signal from the $\gamma\gamma$ background.
- Parton luminosities, W and Z cross sections and gauge boson pair production.
  H. Kuif, G. Martinelli, T. Matsuura, B. Mele, P. Nason, F. Pastore, M. Pepe, H. Plothow-Besch, L. Trentadue, D. Wood, D. Zeppenfeld.
  Parton densities, W and Z cross sections and differential distributions, Drell-Yan pair production, Gauge boson pair production. Possibility of detecting deviations from the standard model three-vector-bosons couplings via WZ and $W\gamma$ production processes.
- QCD corrections to Z pair production at the LHC.
  B. Mele, P. Nason and G. Ridolfi.
  Results of a new calculation of strong radiative corrections to Z pair production processes.
- Heavy quark production at the LHC.
  J. P. Guillet, P. Nason, H. Plothow-Besch.
  Total and differential cross sections for the production of top, bottom and charmed hadron. Bottom and charm multiplicity in high $p_\perp$ jets. Production of heavy quark at high $p_\perp$: the fragmentation function of the b quark.

Mele, Nason, Ridolfi, QCD radiative corrections to Z boson pair production in hadronic collisions, https://inspirehep.net/literature/302613

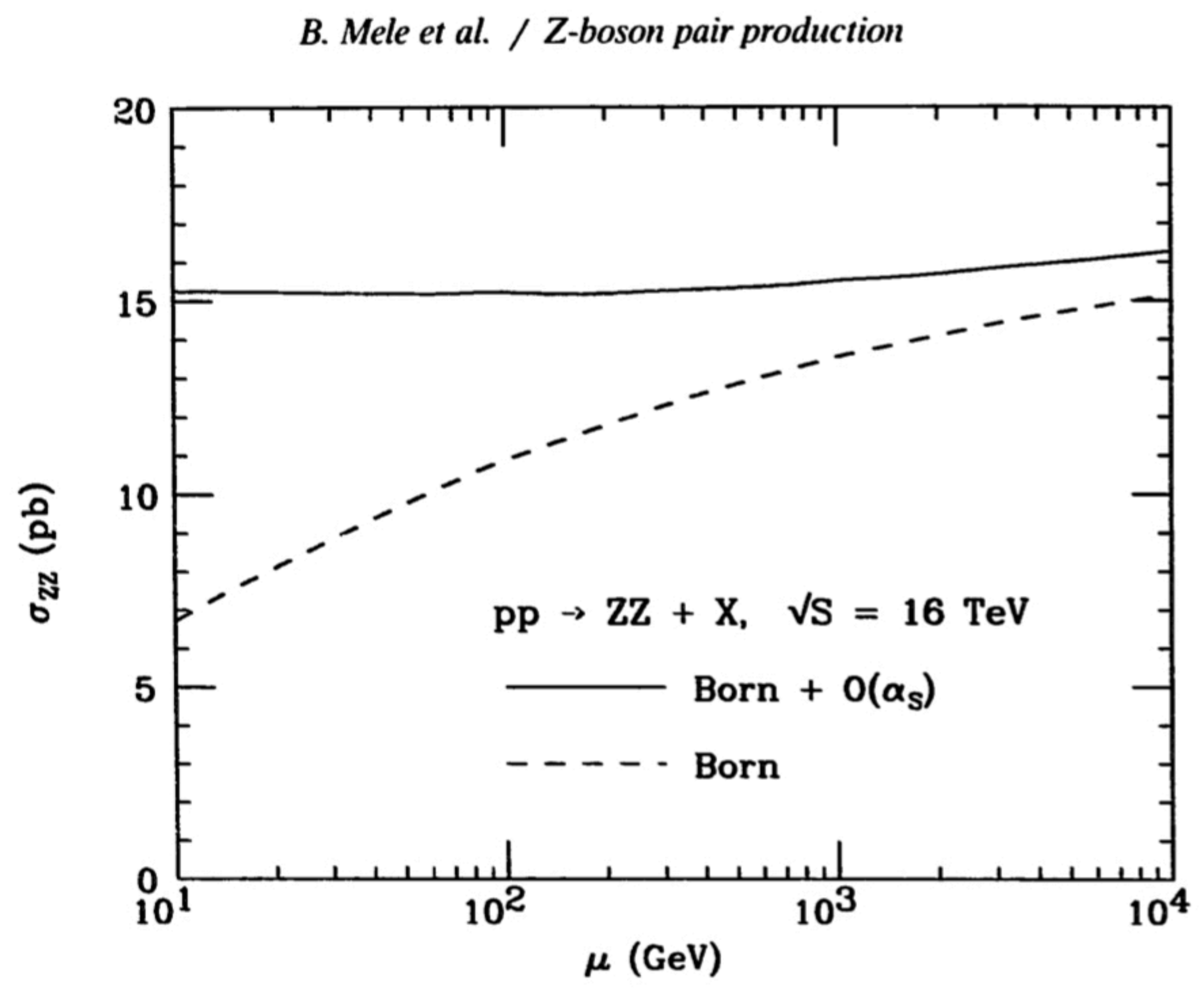


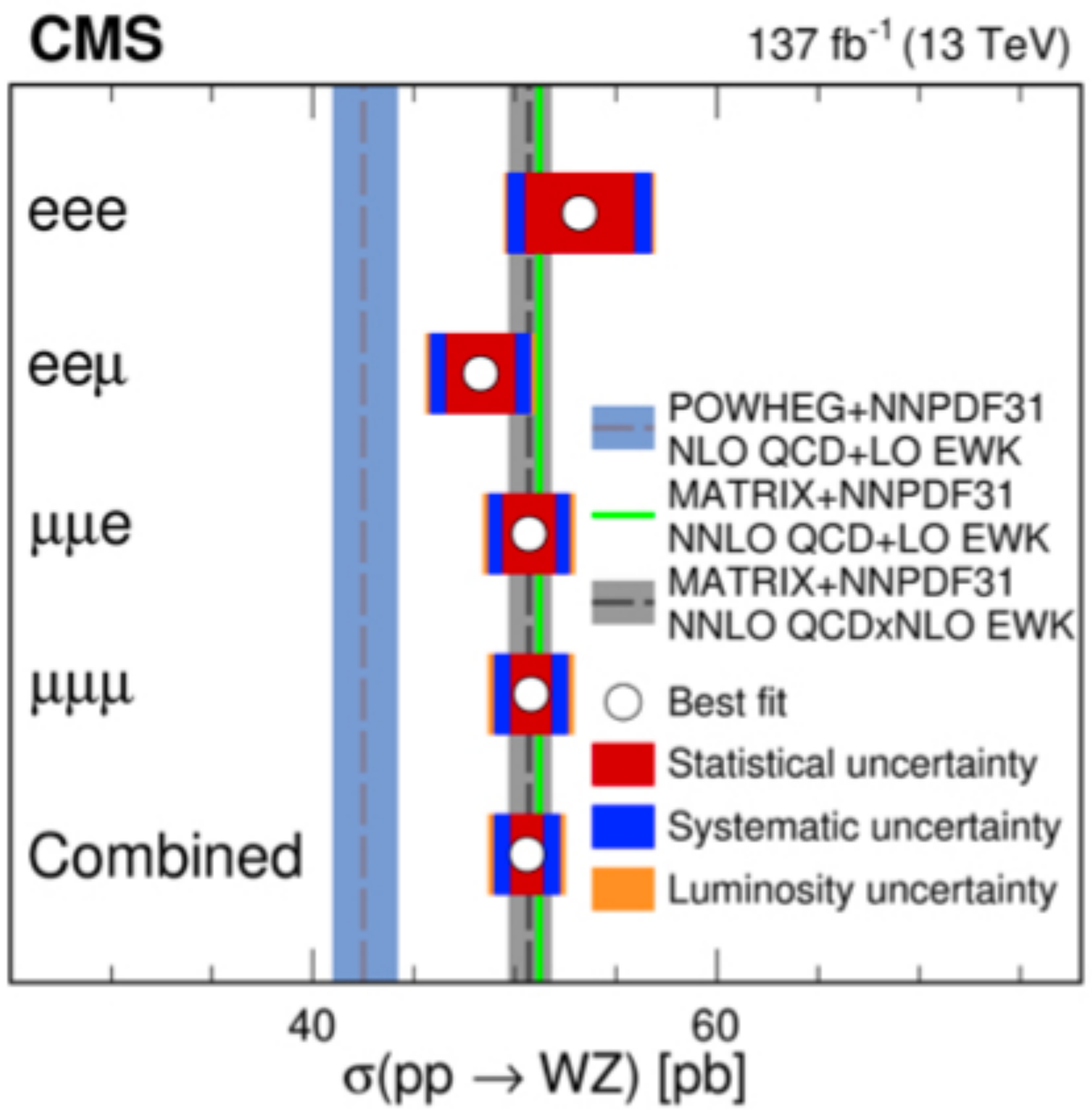
Fig. 9. Same as in fig. 8, for $\sqrt{s}$ = 16 TeV.

- Emphasis on exclusive representation of HO corrections, leads directly to parton-level event generator
- First example of a series of NLO results adopting the same techniques: WZ, QQbar
- First process to be included in POWHEG

30 yrs later: ZZ at LHC

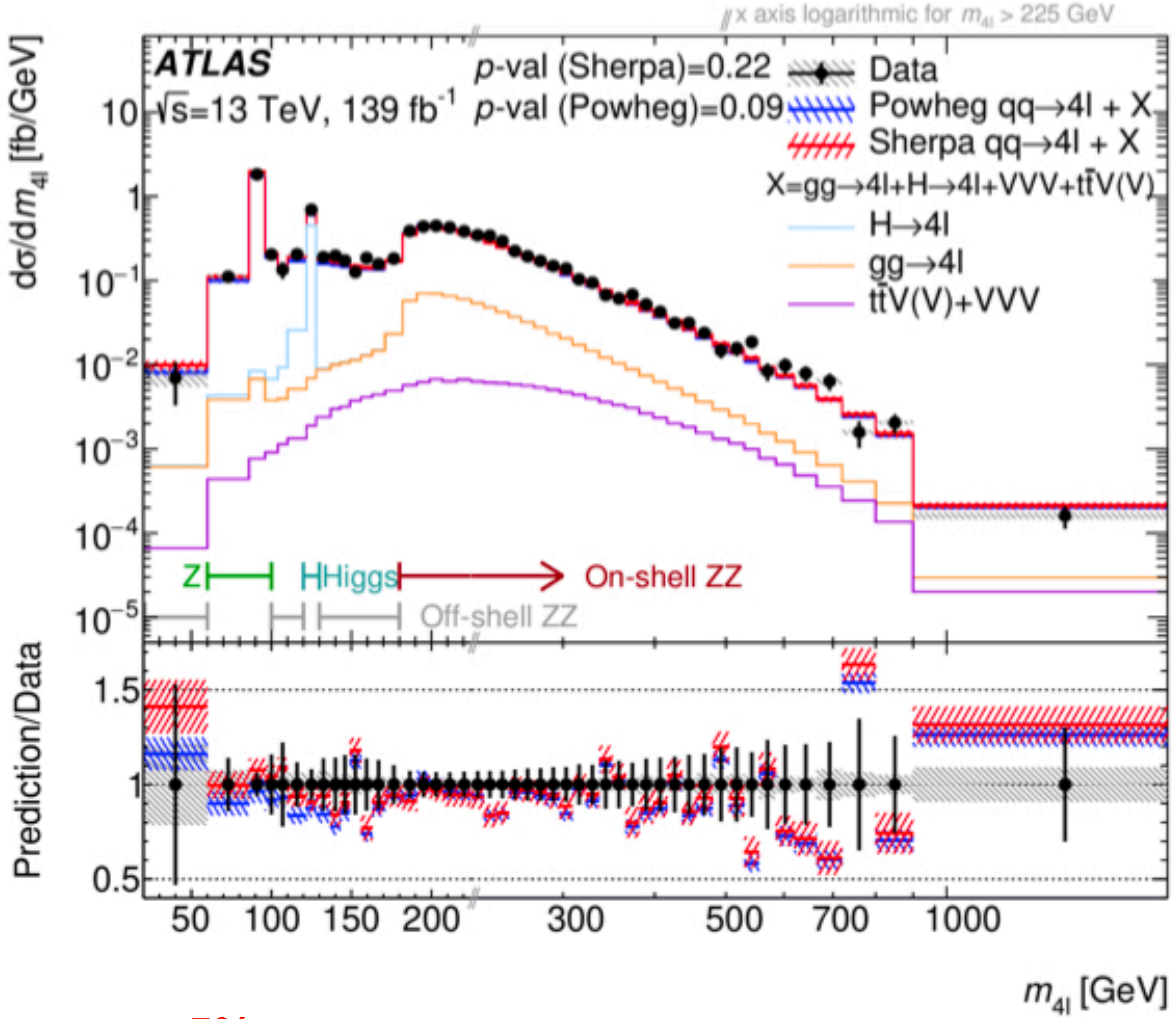
$\sigma_{tot}(pp \to ZZ) = 17.4 \pm 0.3_{stat} \pm 0.5_{syst} \pm 0.3_{lumi} \pm 0.4_{TH}$ pb ~ ± 5% EPJC 81 (2021) 200

$\sigma_{tot}(pp \to WZ) = 50.6 \pm 0.8_{stat} \pm 1.5_{syst} \pm 1.1_{lumi} \pm 0.5_{TH}$ pb ~ ± 4% JHEP 07 (2022) 032



Total rates:
- **importance of QCD NNLO**
- **minor impact of EW NLO**

ATLAS pp→4l JHEP 07 (2021) 005

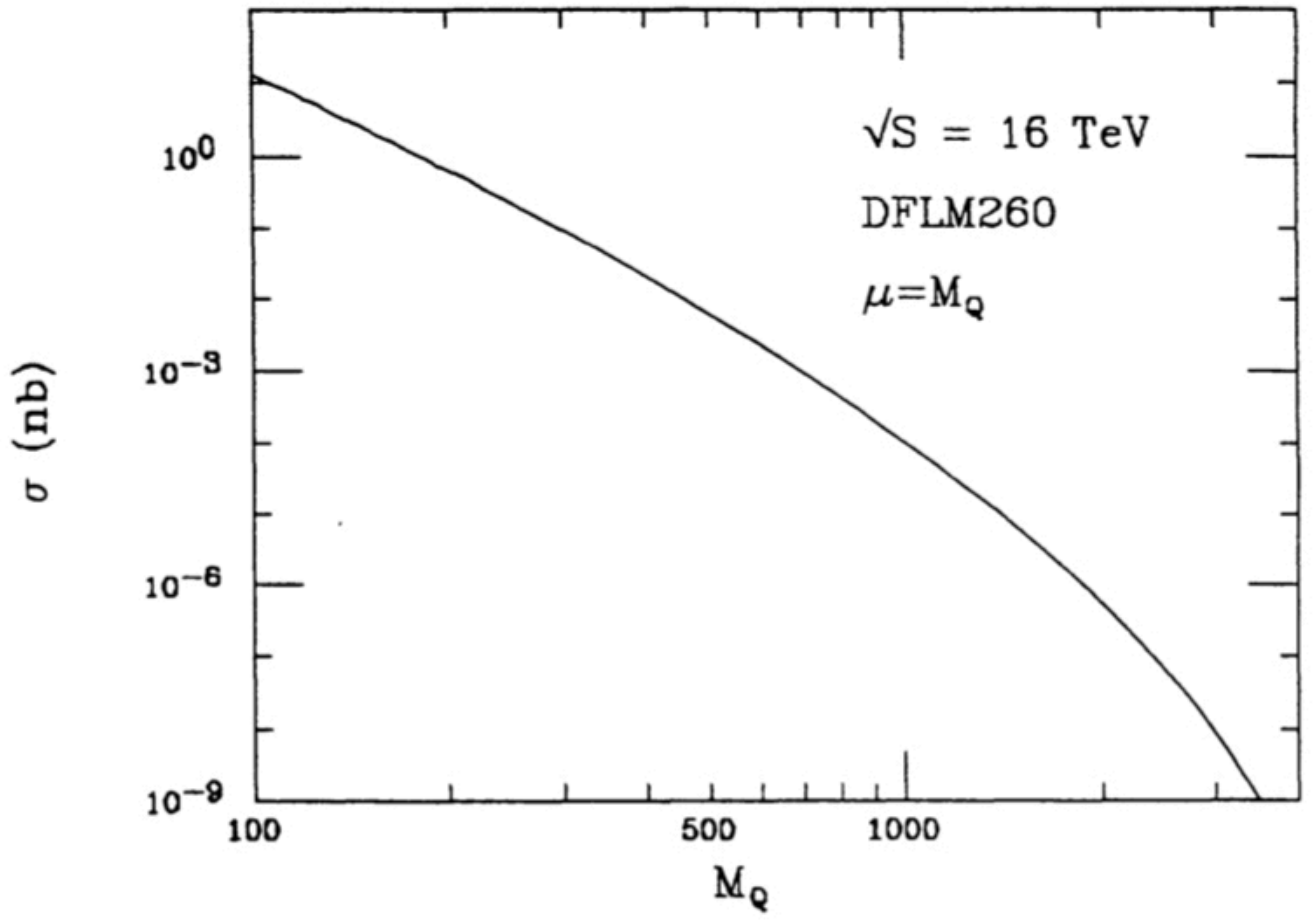


± 5%

	Region				
	Full	$Z \to 4\ell$	$H \to 4\ell$	Off-shell ZZ	On-shell ZZ
Measured fiducial cross-section [fb]	88.9 ±1.1 (stat.) ±2.3 (syst.) ±1.5 (lumi.) ±3.0 (total)	22.1 ±0.7 (stat.) ±1.1 (syst.) ±0.4 (lumi.) ±1.3 (total)	4.76 ±0.29 (stat.) ±0.18 (syst.) ±0.08 (lumi.) ±0.35 (total)	12.4 ±0.5 (stat.) ±0.6 (syst.) ±0.2 (lumi.) ±0.8 (total)	49.3 ±0.8 (stat.) ±0.8 (syst.) ±0.8 (lumi.) ±1.3 (total)
Sherpa	86±5	23.6±1.5	4.57±0.21	11.5±0.7	46.0±2.9
Powheg + Pythia8	83±5	21.2±1.3	4.38±0.20	10.7±0.7	46.4±3.0

Heavy quark production at the LHC.
J. P. Guillet, P. Nason, H. Plothow-Besch.

First NLO predictions for tt production at LHC



Total $\sigma_{t\bar{t}}$ in nb, $m_{top} = 130\,\mathrm{GeV}$			
	DFLM260	HMRSB	GRV
$p\bar{p}$, 0.63 TeV	$2.5\ 10^{-4}$	$2.7\ 10^{-4}$	$2.7\ 10^{-4}$
$p\bar{p}$, 1.8 TeV	$2.23\ 10^{-2}$	$2.33\ 10^{-2}$	$1.95\ 10^{-2}$
pp, 16 TeV	4.35	3.96	3.38
pp, 40 TeV	21.85	18.34	18.35
$m_{top} = 200\,\mathrm{GeV}$			
$p\bar{p}$, 0.63 TeV	$7.3\ 10^{-6}$	$4.34\ 10^{-6}$	$1.0\ 10^{-5}$
$p\bar{p}$, 1.8 TeV	$1.9\ 10^{-3}$	$2.2\ 10^{-3}$	$1.9\ 10^{-3}$
pp, 16 TeV	.636	.621	.489
pp, 40 TeV	3.89	3.50	3.17

Event Generators for LHC

F. Anselmo[1], P.T. Cox[2], J.R. Cudell[3], M. Della Negra[3], A. Di Ciaccio[4], O. Di Rosa[1], B. van Eijk[1], D. Froidevaux[3], W.T. Giele[5], R. Kleiss[3], P. Lubrano[3], R. Odorico[6], H. Plothow-Besch[3], G. Polesello[3], T. Sjöstrand[3], G. Unal[7]

Table 1: Standard model physics processes included in the event generators studied. See text for program notation. 'f' stands for fermion, 'V' for W or Z, and 'Q' for heavy quark.

Process	ISAJET	PYTHIA	other PS	PAPA-GENO	other ME
QCD					
QCD jets	•	•	•	•	E, NJ
$q\bar{q}, gg \to t\bar{t}$	•	•	•	•	E
$qb \to q't$	-	•	H	-	
minimum bias	•	•	•	-	E
diffractive	•	•		-	
elastic	-	•		-	
Prompt photons					
$qg \to q\gamma, q\bar{q} \to g\gamma$	•	•	H	•	
$q\bar{q} \to \gamma\gamma$	•	•		•	
$gg \to \gamma\gamma$	-	•		•	
W/Z production					
$q\bar{q} \to V$	•	•	•	•	LD
$qg, q\bar{q} \to V(q, g)$	•	•	H	•	LD
$q\bar{q} \to VV, V\gamma$	•	•		•	BZ, BH
$q\bar{q}, qg \to VV(q, g)$	-	-		-	VV, BH
$gg \to VV, V\gamma$	-	-		-	GG
$q\bar{q} \to V^* V^*$	-	•		-	
$gg \to ZQ\overline{Q}$	-	•		•	LD
Standard model H^0 ($m_H \leq 800$ GeV)					
$q\bar{q} \to H^0$	•	•		-	
$gg \to H^0$	•	•	H	•	GG
$VV \to H^0$	•	•	H	•	BG
$q\bar{q} \to VH^0$	-	•		-	
$gg, qg, q\bar{q} \to H^0(q, g)$	-	•		-	HV
$H^0 \to VV$	•	•	H	•	BG, HV
$H^0 \to V^* V^*$	•	•	H	-	
$H^0 \to f\bar{f}$	•	•	H	-	
$H^0 \to gg$	•	•		-	
$H^0 \to \gamma\gamma$	•	•	H	-	
$H^0 \to \gamma Z^0$	-	•		-	
Standard model H^0 ($m_H \geq 700$ GeV)					
$VV \to VV$	•	•	H	-	BG
$gg \to VV$	-	-		-	GG

Table 2: Non-standard model physics processes included in the event generators studied. See text for program notation. In addition to notation for Table 1, 'V'' stands for W' or Z', 'R' for a horizontal boson, and 'L' for heavy lepton.

Process	ISAJET	PYTHIA	other PS	PAPA-GENO	other ME
Non-standard Higgs particles					
$q\bar{q}' \to H^+$	-	•		-	
$gb \to H^- t$	-	•		-	
$\gamma^*/Z^* \to H^+ H^-$	-	•		-	
$t \to H^+ b$	-	•		-	
$H^+ \to f\bar{f}'$	-	•		-	
Supersymmetry					
$q\bar{q}, gg \to \tilde{q}\bar{\tilde{q}}$	•	-		•	UA, BT
$q\bar{q}, gg \to \tilde{g}\tilde{g}$	•	-		•	UA, BT
$qg \to \tilde{q}\tilde{g}$	•	-		•	UA, BT
$q\bar{q} \to \tilde{g}\tilde{V}$	•	-		-	UA
$qg \to \tilde{q}\tilde{V}$	•	-		-	UA
$\tilde{q}, \tilde{g}, \tilde{V}$ decays	-	-		•	UA, BT
New Gauge Groups					
$q\bar{q} \to V'$	-	•		-	
$VV \to V'$	-	-		-	
$V' \to f\bar{f}$	-	•		-	
$V' \to VV$	-	•		-	
$q\bar{q}' \to R \to q''\bar{q}'''$	-	•		-	
Fourth Generation					
$q\bar{q}, gg \to Q\overline{Q}$	•	•		•	
$V/V' \to Q\overline{Q}, L\overline{L}$	-	•		-	
$qq' \to q''Q$	-	•		-	
Other Topics					
contact interactions	-	-		•	
axigluons	-	-		•	
leptoquarks	-	-		-	E
strongly interacting V	-	•		-	

2.1.1 QCD

Exact Born term cross-sections, for up to five jets in the final state, are available in the NJETS program of Kuijf and Berends ('NJ' of Table 1), see [9], which is the most advanced in this category. This program also contains approximate expressions for up to eight jets.

Few years went by, covering Paolo’s staff position at CERN, mostly focused, among many other things, on precision QCD physics at LEP, on heavy quark and top production at the Tevatron, …

Few years went by, covering Paolo's staff position at CERN, mostly focused, among many other things, on precision QCD physics at LEP, on heavy quark and top production at the Tevatron, …

… and on mandatory TH staff-duty responsibilities

Focus on LHC returned in 1999, as LEP2 was wrapping up and planning for LHC physics readiness started building up …

1999 CERN Workshop on Standard Model Physics (and more) at the LHC

, "Bottom production" WG convener

BOTTOM PRODUCTION

Convenors: *P. Nason, G. Ridolfi, O. Schneider G.F. Tartarelli and P. Vikas*
Contributing authors: *J. Baines, S.P. Baranov, P. Bartalini, A. Bay, E. Bouhova, M. Cacciari, A. Caner, Y. Coadou, G. Corti, J. Damet, R. Dell'Orso, J.R.T. De Mello Neto, J.L. Domenech, V. Drollinger, P. Eerola, N. Ellis, B. Epp, S. Frixione, S. Gadomski, I. Gavrilenko, S. Gennai, S. George, V.M. Ghete, L. Guy, Y. Hasegawa, P. Iengo, A. Jacholkowska, R. Jones, A. Kharchilava, E. Kneringer, P. Koppenburg, H. Korsmo, M. Krämer, N. Labanca, M. Lehto, F. Maltoni, M.L. Mangano, S. Mele, A.M. Nairz, T. Nakada, N. Nikitin, A. Nisati, E. Norrbin, F. Palla, F. Rizatdinova, S. Robins, D. Rousseau, M.A. Sanchis-Lozano, M. Shapiro, P. Sherwood, L. Smirnova, M. Smizanska, A. Starodumov, N. Stepanov, R. Vogt*

QCD Group:

S. Catani
M. Dittmaier
D. Soper
J. Stirling
S. Tapprogge

Top Group:

M. Beneke
I. Efthymiopoulos
M. Mangano
J. Womersley

Beauty Decays Group:

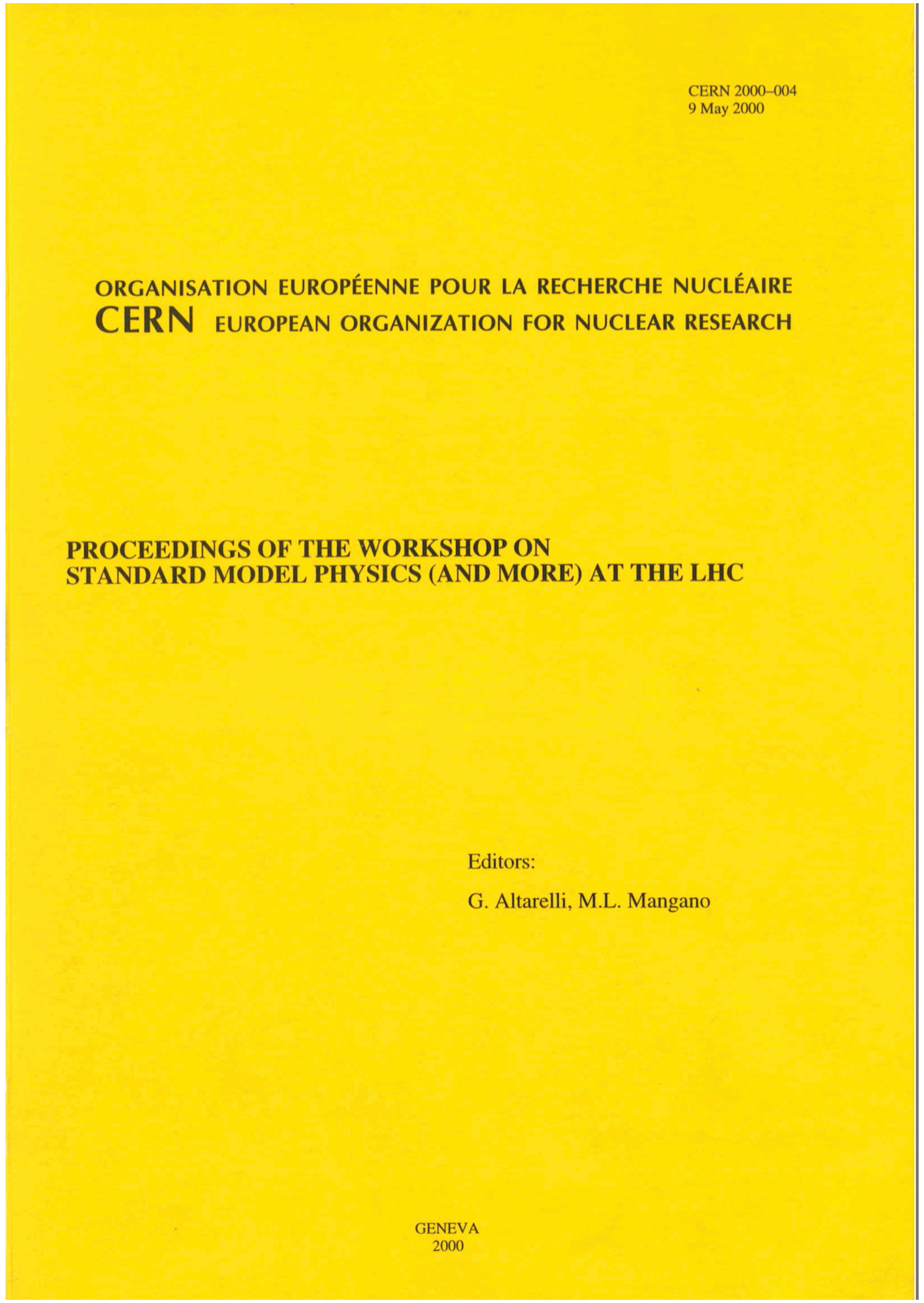
P. Ball
R. Fleischer
G. Tartarelli
P. Vikas
G. Wilkinson

Electroweak Group:

S. Haywood
P. Hobson
W. Hollik
Z. Kunszt

Beauty Production Group:

P. Nason
G. Ridolfi
O. Schneider
G. Tartarelli
P. Vikas


CERN 2000–004
9 May 2000

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

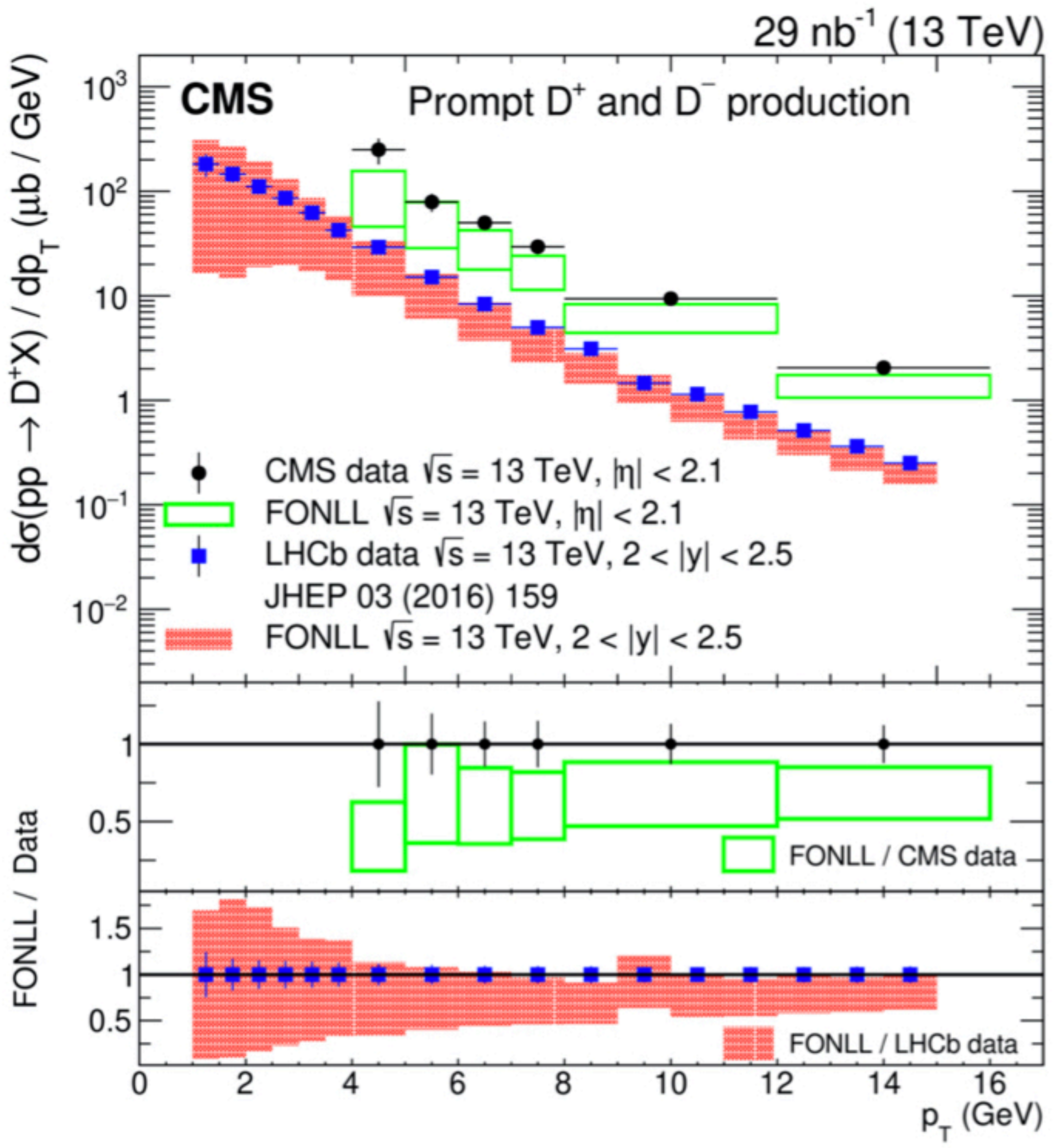
PROCEEDINGS OF THE WORKSHOP ON
STANDARD MODEL PHYSICS (AND MORE) AT THE LHC

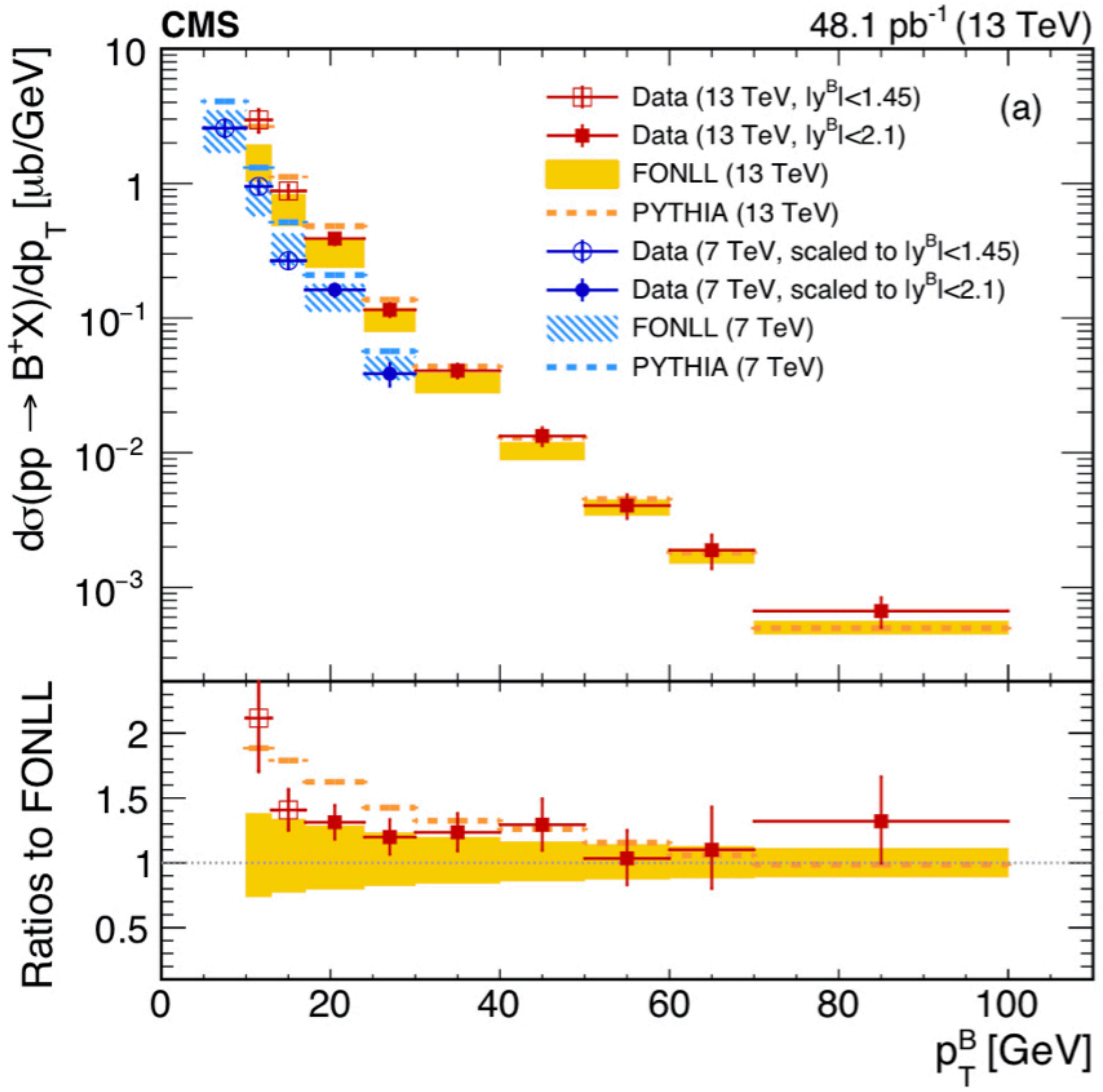
Editors:
G. Altarelli, M.L. Mangano

GENEVA
2000

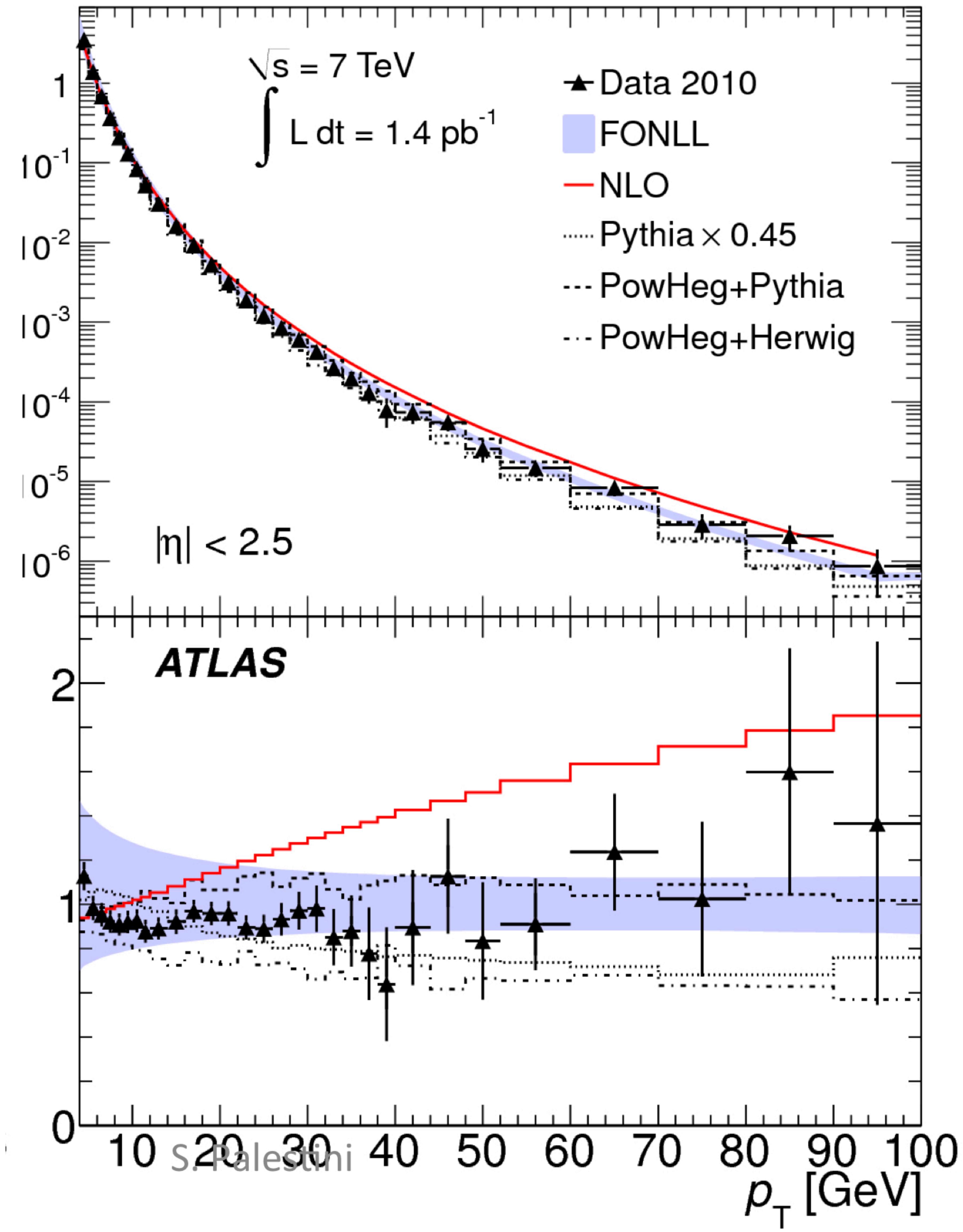
20 yrs later

CMS, https://arxiv.org/abs/2107.01476



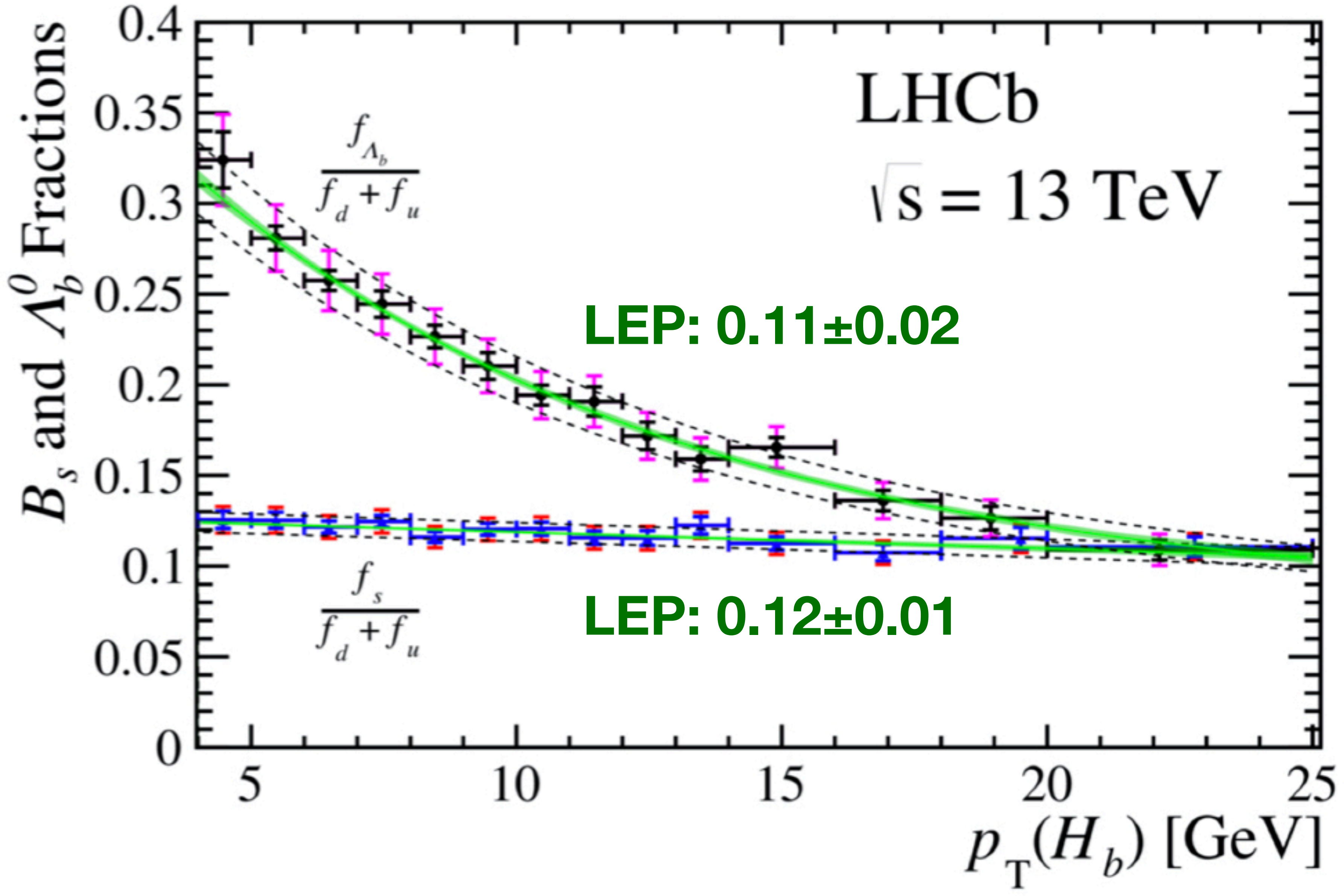


ATLAS, http://arxiv.org/abs/1109.0525

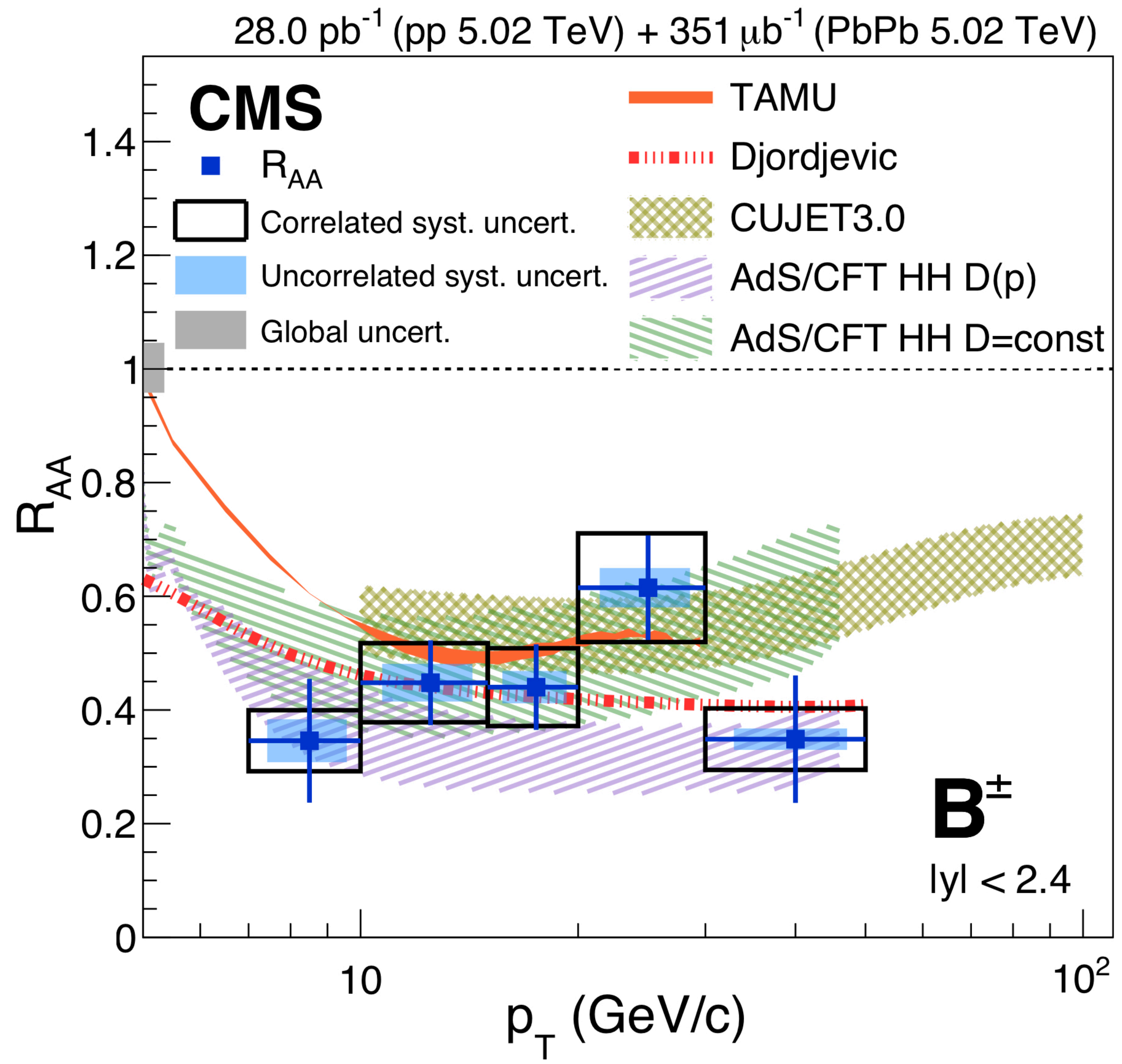


M. Cacciari, S. Frixione, N. Houdeau, M.L. Mangano, P. Nason and G. Ridolfi, Theoretical predictions for charm and bottom production at the LHC, [1205.6344]

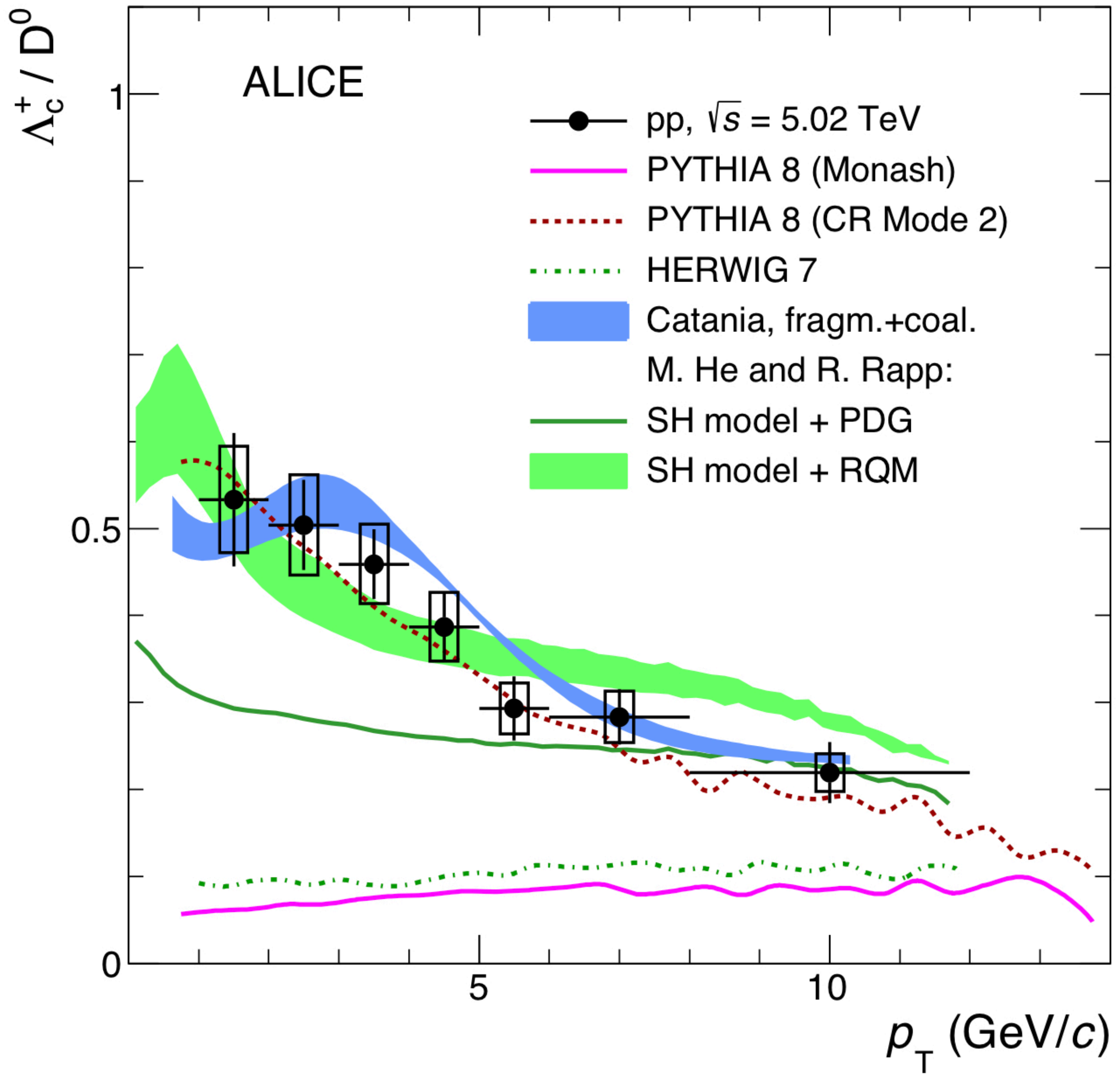
LHCb, https://arxiv.org/abs/1902.06794

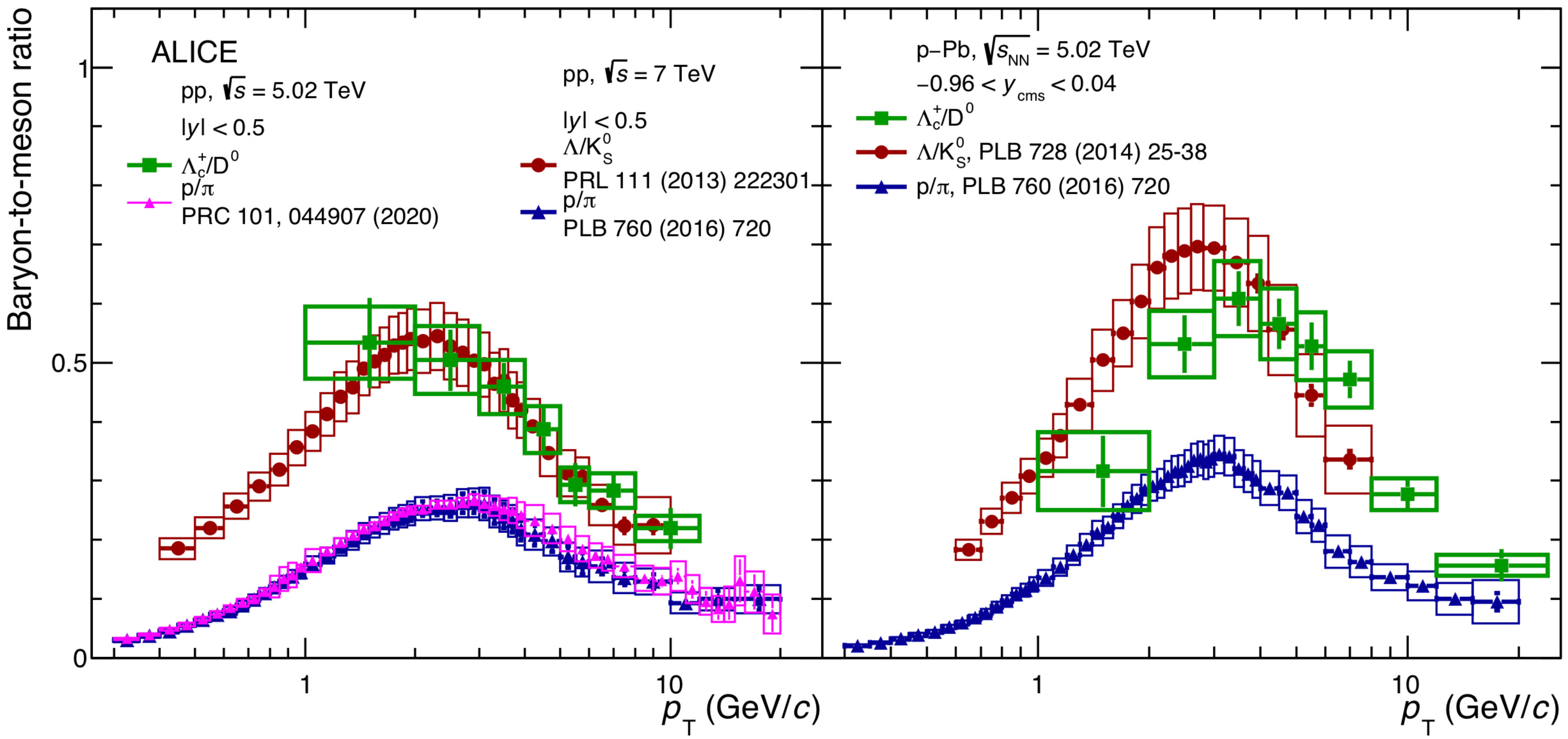


CMS, arxiv:1705.04727



ALICE, arxiv:2011.06078





INFN Workshop on Monte Carlo's, Physics and Simulations at the LHC , LNF, Febr - Oct 2006.
Organizer and Proceedings editor, https://arxiv.org/pdf/0902.0293.pdf

Preface

These proceedings collect the presentations given at the first three meetings of the "Workshop on Monte Carlo's, Physics and Simulations at the LHC", held on February 27-28, May 22-24 and October 23-25 2006 in Frascati (Italy). The purpose of the workshop, sponsored by the INFN, was to bring together all the complementary Italian scientific communities interested into high p_T physics at the LHC. The workshop was thus attended by LHC experimental physicists, theoretical physicists dedicated to the calculation of matrix elements for collider processes and to the implementation of Monte Carlo programs, and theoretical physicists interested into model building and physics beyond the Standard Model. Theoretical Standard Model prediction, as well as physics signals from new models, are made available to the experimental community as Monte Carlo generators, that thus constitute the meeting points of the three communities mentioned above. The aim of the workshop was essentially to start to talk to each other, and to begin to understand the methods, the problems, and the language of the complementary communities.

Many of the presentations held at the first three workshop meetings were basic introductions to important theoretical and experimental topics relevant to LHC physics, and the speakers were requested to use a language suitable for people with no expertise in their field. The collection of these presentations constitutes thus an introduction to a few basic aspects of high p_T LHC physics. It was decided to put them in the form of proceedings, maintaining the requirements of a language suitable for the complementary physics communities. In order to achieve this goal, the contributions were refereed internally, and have gone through several revisions. The second part of these proceedings collects more specialised presentations held at the workshop.

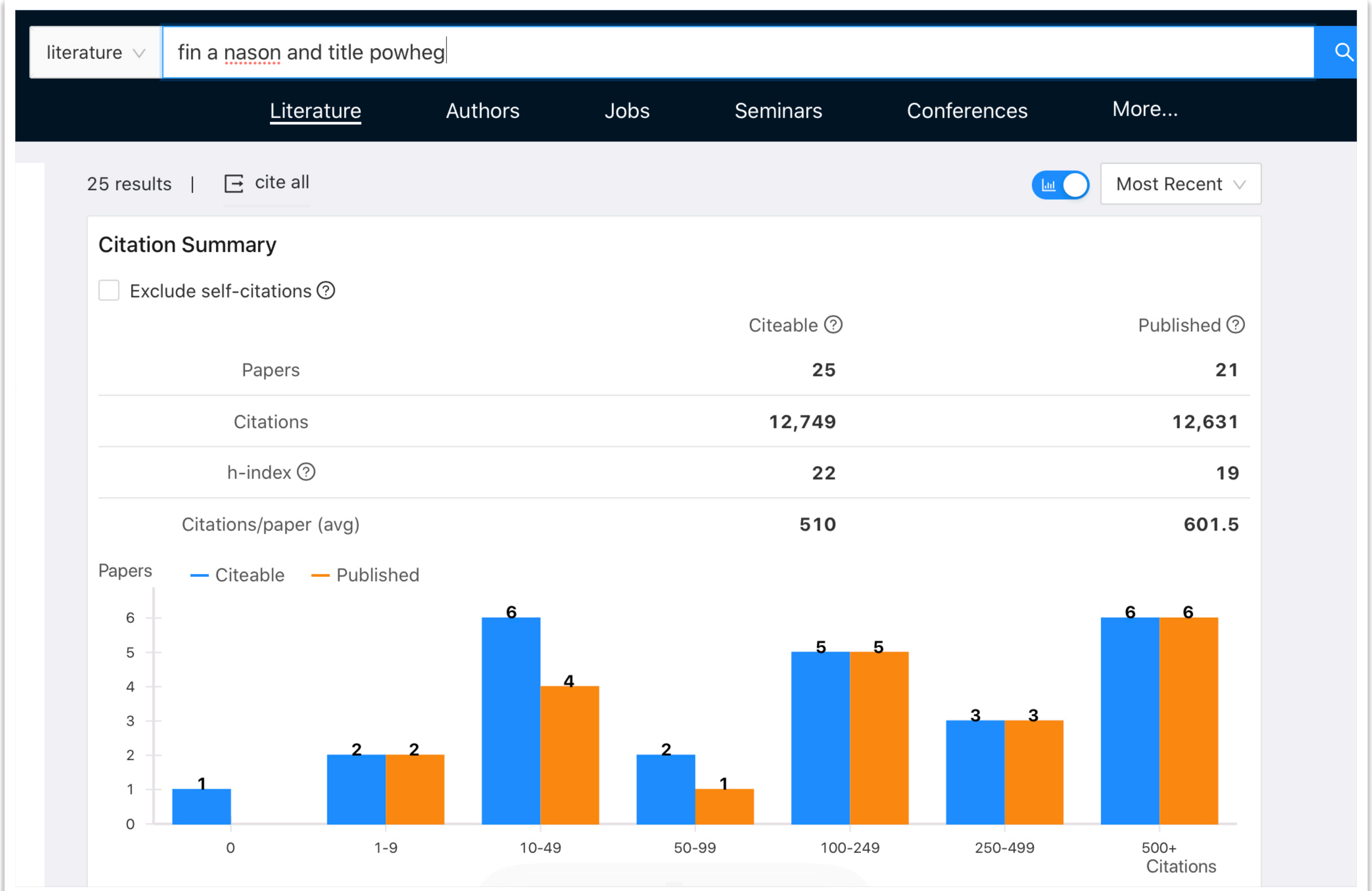
Although the very ambitious plan for these proceedings was not totally fulfilled (for instance, a few chapters were never completed), we feel that, at least for some of the chapters, we have met our goal. In particular, the first chapter constitute a very condensed presentation of the basics about LHC high p_T physics, that can be used as a first introductory reading for the subject. The last chapter summarizes the basic features of the most important component of the ATLAS and CMS experiments, written in a way that should be easily understandable also by theorists. Many chapters of these proceedings[1] can be used for an introductory class on LHC high p_T physics for graduate students in experimental and theoretical physics.

Although LHC physics is evolving rapidly, we believe that the basic argument treated in this volume will remain valid for an introduction, and that this effort will remain useful for the years to come.

Paolo Nason

Workshop's Organizing Committee:
V. Del Duca, B. Mele, P. Nason, G. Polesello (ATLAS), R. Tenchini (CMS).
Workshop's Conveners:
Shower Monte Carlo: *S. Frixione, L. Fanó (CMS) S. Rolli (ATLAS);*
Exact calculations at fixed order: *F. Piccinini, P. Azzi (CMS);*
SM and BSM Physics at LHC: *B. Mele, M. Cobal (ATLAS), F. Fabbri (CMS);*
Experimental Studies: *F. Tartarelli (ATLAS), C. Mariotti, E. Migliore (CMS).*

2003-2004: POWHEG enters the scene



LHC TOP WG meeting

28 May 2019, 09:00 → 29 May 2019, 13:00 Europe/Zurich

4/3-006 - TH Conference Room (CERN)

Martijn Mulders (CERN), Michelangelo Mangano (CERN), Reinhard Schwienhorst (Michigan State University (US))

17:15 **A discussion of precision top quark mass extraction** 25m

Speaker: Paolo Nason (Universita & INFN, Milano-Bicocca (IT))

TOPWG-19-5-2019....

Renormalons and the Top Quark Mass Measurement #1

Paolo Nason (INFN, Milan Bicocca and Milan Bicocca U.) (Jan 15, 2019)

Contribution to: TOP2018 • e-Print: 1901.04737 [hep-ph]

pdf cite 3 citations

All-orders behaviour and renormalons in top-mass observables #2

Silvia Ferrario Ravasio (Milan Bicocca U. and INFN, Milan Bicocca), Paolo Nason (CERN and INFN, Milan Bicocca), Carlo Oleari (INFN, Milan Bicocca and Milan Bicocca U.) (Oct 25, 2018)

Published in: *JHEP* 01 (2019) 203 • e-Print: 1810.10931 [hep-ph]

pdf DOI cite 24 citations

A theoretical study of top-mass measurements at the LHC using NLO+PS generators of increasing accuracy #3

Silvia Ferrario Ravasio (INFN, Milan Bicocca and Milan Bicocca U.), Tomáš Ježo (Zurich U.), Paolo Nason (CERN and INFN, Milan Bicocca), Carlo Oleari (INFN, Milan Bicocca and Milan Bicocca U.) (Jan 11, 2018)

Published in: *Eur.Phys.J.C* 78 (2018) 6, 458, *Eur.Phys.J.C* 79 (2019) 10, 859 (addendum) • e-Print: 1906.09166 [hep-ph], 1801.03944 [hep-ph]

pdf DOI cite 56 citations

The Top Mass in Hadronic Collisions #4

Paolo Nason (CERN and INFN, Milan Bicocca) (Dec 7, 2017)

e-Print: 1712.02796 [hep-ph]

pdf DOI cite 46 citations

The Top Quark Mass at the LHC #5

Paolo Nason (CERN and INFN, Milan Bicocca) (2017)

Published in: *Frascati Phys.Ser.* (2017) 65-70 • Contribution to: LFC17, 65-70 • e-Print: 1801.04826 [hep-ph]

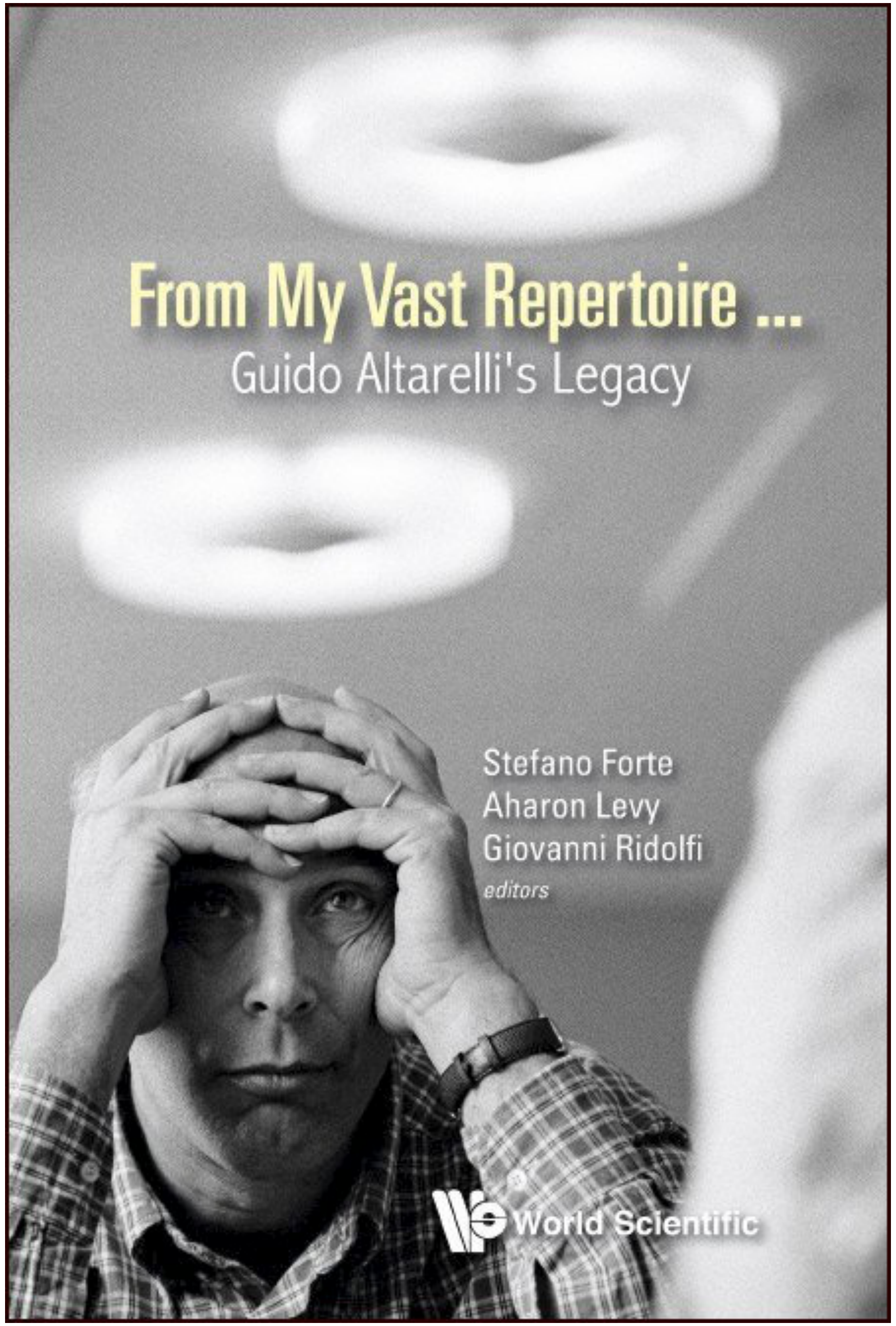
pdf cite 6 citations

On the ultimate uncertainty of the top quark pole mass #6

M. Beneke (Munich, Tech. U.), P. Marquard (DESY, Zeuthen), P. Nason (INFN, Milan Bicocca), M. Steinhauser (KIT, Karlsruhe, TTP) (May 11, 2016)

Published in: *Phys.Lett.B* 775 (2017) 63-70 • e-Print: 1605.03609 [hep-ph]

pdf DOI cite 89 citations



arxiv:1712.02796

CERN-TH-2017-266
January 22, 2018

The Top Mass in Hadronic Collisions

P. Nason

Theoretical Physics Department, CERN, Geneva, Switzerland, and
INFN, Sezione di Milano Bicocca, Milano, Italy.

Abstract

I discuss theoretical issues related to the top mass measurements in hadronic collisions.

Contribution to the volume

From My Vast Repertoire – The Legacy of Guido Altarelli.


TOP2015, Braga (PT)

Physics of the HL-LHC, and perspectives at the HE-LHC, CERN Workshop, 2017-2018

Working Group 1 Convener:

Standard Model Physics at the HL-LHC and HE-LHC, 1902.04070

CERN-LPCC-2018-03
December 23, 2019

Standard Model Physics at the HL-LHC and HE-LHC

Report from Working Group 1 on the Physics of the HL-LHC, and Perspectives at the HE-LHC

Editors:
P. Azzi[1], *S. Farry*[2], *P. Nason*[3,4], *A. Tricoli*[5], *D. Zeppenfeld*[6]

Contributors:
R. Abdul Khalek[7,8], *J. Alimena*[9], *N. Andari*[10], *L. Aperio Bella*[11], *A.J. Armbruster*[11], *J. Baglio*[12], *S. Bailey*[13], *E. Bakos*[14], *A. Bakshi*[15], *C. Baldenegro*[16], *F. Balli*[10], *A. Barker*[15], *W. Barter*[17], *J. de Blas*[18,1], *F. Blekman*[19], *D. Bloch*[20], *A. Bodek*[21], *M. Boonekamp*[10], *E. Boos*[22], *J.D. Bossio Sola*[23], *L. Cadamuro*[24], *S. Camarda*[11], *F. Campanario*[25], *M. Campanelli*[26], *J.M. Campbell*[27], *Q.-H. Cao*[28,29,30], *V. Cavaliere*[5], *A. Cerri*[31], *G.S. Chahal*[17,32], *B. Chargeishvili*[33], *C. Charlot*[34], *S.-L. Chen*[35], *T. Chen*[36], *L. Cieri*[3], *M. Ciuchini*[37], *G. Corcella*[38], *S. Cotogno*[34], *R. Covarelli*[39,40], *J.M. Cruz-Martinez*[41], *M. Czakon*[42], *A. Dainese*[1], *N.P. Dang*[43], *L. Darmé*[44], *S. Dawson*[5], *H. De la Torre*[45], *M. Deile*[11], *F. Deliot*[10], *S. Demers*[46], *A. Denner*[47], *F. Derue*[48], *L. Di Ciaccio*[49], *W.K. Di Clemente*[50], *D. Dominguez Damiani*[51], *L. Dudko*[22], *A. Durglishvili*[33], *M. Dünser*[11], *J. Ebadi*[52], *R.B. Ferreira De Faria*[53], *G. Ferrera*[41,54], *A. Ferroglia*[55], *T.M. Figy*[36], *K.D. Finelli*[56], *M.C.N. Fiolhais*[57,53], *E. Franco*[58], *R. Frederix*[59], *B. Fuks*[60,61], *B. Galhardo*[53,62], *J. Gao*[63], *J.R. Gaunt*[11], *T. Gehrmann*[64], *A. Gehrmann-De Ridder*[65], *D. Giljanovic*[66,34], *F. Giuli*[67], *E.W.N. Glover*[32], *M.D. Goodsell*[68], *E. Gouveia*[53], *P. Govoni*[3,4], *C. Goy*[49], *M. Grazzini*[64], *A. Grohsjean*[51], *J.F. Grosse-Oetringhaus*[11], *P. Gunnellini*[69], *C. Gwenlan*[70], *L.A. Harland-Lang*[13], *P.F. Harrison*[71], *G. Heinrich*[72], *C. Helsens*[11], *M. Herndon*[73], *O. Hindrichs*[21], *V. Hirschi*[65], *A. Hoang*[74], *K. Hoepfner*[42], *J.M. Hogan*[75,76], *A. Huss*[11], *S. Jahn*[72], *Sa. Jain*[77], *S.P. Jones*[11], *A.W. Jung*[15], *H. Jung*[51], *S. Kallweit*[4], *D. Kar*[78], *A. Karlberg*[64], *T. Kasemets*[79], *M. Kerner*[64], *M.K. Khandoga*[10], *H. Khanpour*[80], *S. Khatibi*[81], *A. Khukhunaishvili*[82], *J. Kieseler*[11], *J. Kretzschmar*[2], *J. Kroll*[50], *E. Kryshen*[83], *V.S. Lang*[51], *L. Lechner*[84], *C.A. Lee*[5], *M. Leigh*[85], *D. Lelas*[58], *R. Les*[86], *I.M. Lewis*[16], *B. Li*[87], *Q. Li*[28], *Y. Li*[88], *J. Lidrych*[51], *Z. Ligeti*[89], *J.M. Lindert*[90,32], *Y. Liu*[91], *K. Lohwasser*[92], *K. Long*[73], *D. Lontkovskyi*[19], *G. Majumder*[77], *M. Mancini*[19], *P. Mandrik*[93], *M.L. Mangano*[11], *I. Marchesini*[19], *C. Mayer*[94], *K. Mazumdar*[77], *J.A. McFayden*[11], *P.M. Mendes Amaral Torres Lagarelhos*[53], *A.B. Meyer*[51], *S. Mikhalcov*[95], *S. Mishima*[96], *A. Mitov*[97], *M. Mohammadi Najafabadi*[52], *M. Moreno Llácer*[11], *M. Mulders*[11], *M. Myska*[98], *M. Narain*[76], *A. Nisati*[58,99], *T. Nitta*[100], *A. Onofre*[101], *S. Pagan Griso*[89,102], *D. Pagani*[59], *E. Palencia Cortezon*[103], *A. Papanastasiou*[97], *K. Pedro*[27], *M. Pellen*[97], *M. Perfilov*[22], *L. Perrozzi*[65], *B.A. Petersen*[11], *M. Pierini*[11], *J. Pires*[104], *M.-A. Pleier*[5], *S. Plätzer*[74], *K. Potamianos*[88], *S. Pozzorini*[64], *A.C. Price*[90], *M. Rauch*[6], *E. Re*[11,105], *L. Reina*[106], *J. Reuter*[51], *T. Robens*[107], *J. Rojo*[8], *C. Royon*[16], *S. Saito*[77], *A. Savin*[73], *S. Sawant*[77], *B. Schneider*[27], *R. Schoefbeck*[84], *M. Schoenherr*[32,11], *H. Schäfer-Siebert*[6], *M. Seidel*[11], *M. Selvaggi*[11], *T. Shears*[2], *L. Silvestrini*[58,11], *M. Sjodahl*[108], *K. Skovpen*[19], *N. Smith*[27], *D. Spitzbart*[84], *P. Starovoitov*[109], *C.J.E. Suster*[110], *P. Tan*[27], *R. Taus*[21], *D. Teague*[73], *K. Terashi*[111], *J. Terron*[112], *S. Uplap*[77], *F. Veloso*[53], *M. Verzetti*[64], *M.A. Vesterinen*[71], *V.E. Vladimirov*[71], *P. Volkov*[22], *G. Vorotnikov*[22], *M. Vranjes Milosavljevic*[14], *N. Vranjes*[14], *E. Vryonidou*[11], *D. Walker*[90], *M. Wiesemann*[11], *Y. Wu*[113], *T. Xu*[10], *S. Yacoob*[85], *E. Yazgan*[114], *J. Zahreddine*[48], *G. Zanderighi*[11,72], *M. Zaro*[8], *O. Zenaiev*[51], *G. Zevi Della*

… followed by a 2-year term as Higgs Working Group convener 2019-20

Paolo & I

Preprint typeset in JHEP style - PAPER VERSION

CERN-TH/2002-129
FTN/T-2002/06
hep-ph/0206293

ALPGEN, a generator for hard multiparton processes in hadronic collisions *

Michelangelo L. MANGANO, Fulvio PICCININI† and Antonio D. POLOSA
CERN, Theoretical Physics Division, CH 1211 Geneva 23, Switzerland
E-mail: michelangelo.mangano@cern.ch, fulvio.piccinini@cern.ch, antonio.polosa@cern.ch

Mauro MORETTI
Dipartimento di Fisica, Università di Ferrara, and INFN, Ferrara, Italy
E-mail: mauro.moretti@fe.infn.it

Roberto PITTAU
Dipartimento di Fisica, Università di Torino, and INFN, Torino, Italy
E-mail: roberto.pittau@to.infn.it

Abstract: This paper presents a new event generator, ALPGEN, dedicated to the study of multiparton hard processes in hadronic collisions. The code performs, at the leading order in QCD and EW interactions, the calculation of the exact matrix elements for a large set of parton-level processes of interest in the study of the Tevatron and LHC data. The current version of the code describes the following final states: $(W \to f\bar{f}')Q\overline{Q} + N$ jets (Q being a heavy quark, and $f = \ell, q$), with $N \leq 4$; $(Z/\gamma^* \to f\bar{f})\,Q\overline{Q} + N$ jets ($f = \ell, \nu$), with $N \leq 4$; $(W \to f\bar{f}')$ + charm + N jets ($f = \ell, q$, $N \leq 5$); $(W \to f\bar{f}') + N$ jets ($f = \ell, q$) and $(Z/\gamma^* \to f\bar{f}) + N$ jets ($f = \ell, \nu$), with $N \leq 6$; $nW + mZ + lH + N$ jets, with $n + m + l + N \leq 8$, $N \leq 3$, including all 2-fermion decay modes of W and Z bosons, with spin correlations; $Q\overline{Q} + N$ jets, with $t \to bf\bar{f}'$ decays and relative spin correlations included if $Q = t$, and $N \leq 6$; $Q\overline{Q}Q'\overline{Q}' + N$ jets, with Q and Q' heavy quarks (possibly equal) and $N \leq 4$; $HQ\overline{Q} + N$ jets, with $t \to bf\bar{f}'$ decays and relative spin correlations included if $Q = t$ and $N \leq 4$; N jets, with $N \leq 6$. Parton-level events are generated, providing full information on their colour and flavour structure, enabling the evolution of the partons into fully hadronised final states.

*The work of MLM and FP is supported in part by the EU Fourth Framework Programme “Training and Mobility of Researchers”, Network “Quantum Chromodynamics and the Deep Structure of Elementary Particles”, contract FMRX–CT98–0194 (DG 12 – MIHT). MM and RP acknowledge the financial support of the European Union under contract HPRN-CT-2000-00149. ADP is supported by a M.Curie fellowship, contract HPMF-CT-2001-01178.

†On leave of absence from INFN Sezione di Pavia, Italy.

Preprint typeset in JHEP style - PAPER VERSION

Bicocca-FT-07-9
GEF–TH–21/2007

Matching NLO QCD computations with Parton Shower simulations: the POWHEG method

Stefano Frixione
INFN, Sezione di Genova, Via Dodecaneso 33, 16146 Genova, Italy
E-mail: Stefano.Frixione@cern.ch

Paolo Nason
INFN, Sezione di Milano-Bicocca, Piazza della Scienza 3, 20126 Milan, Italy
E-mail: Paolo.Nason@mib.infn.it

Carlo Oleari
Università di Milano-Bicocca and INFN, Sezione di Milano-Bicocca
Piazza della Scienza 3, 20126 Milan, Italy
E-mail: Carlo.Oleari@mib.infn.it

Abstract: The aim of this work is to describe in detail the POWHEG method, first suggested by one of the authors, for interfacing parton-shower generators with NLO QCD computations. We describe the method in its full generality, and then specify its features in two subtraction frameworks for NLO calculations: the Catani-Seymour and the Frixione-Kunszt-Signer approach. Two examples are discussed in detail in both approaches: the production of hadrons in e^+e^- collisions, and the Drell-Yan vector-boson production in hadronic collisions.

Keywords: QCD, Monte Carlo, NLO Computations, Resummation, Collider Physics.

Preprint typeset in JHEP style - PAPER VERSION

CERN-TH/2002-129
FTN/T-2002/06
hep-ph/0206293

ALPGEN, a generator for hard multiparton processes in hadronic collisions *

Michelangelo L. MANGANO, Fulvio PICCININI† and Antonio D. POLOSA

CERN, Theoretical Physics Division, CH 1211 Geneva 23, Switzerland
E-mail: michelangelo.mangano@cern.ch, fulvio.piccinini@cern.ch, antonio.polosa@cern.ch

Mauro MORETTI

Dipartimento di Fisica, Università di Ferrara, and INFN, Ferrara, Italy
E-mail: mauro.moretti@fe.infn.it

Roberto PITTAU

Dipartimento di Fisica, Università di Torino, and INFN, Torino, Italy
E-mail: roberto.pittau@to.infn.it

ABSTRACT: This paper presents a new event generator, ALPGEN, dedicated to the study of multiparton hard processes in hadronic collisions. The code performs, at the leading order in QCD and EW interactions, the calculation of the exact matrix elements for a large set of parton-level processes of interest in the study of the Tevatron and LHC data. The current version of the code describes the following final states: $(W \to f\bar{f}')Q\overline{Q}+N$ jets (Q being a heavy quark, and $f = \ell, q$), with $N \leq 4$; $(Z/\gamma^* \to f\bar{f})Q\overline{Q}+N$ jets ($f = \ell, \nu$), with $N \leq 4$; $(W \to f\bar{f}')$ + charm + N jets ($f = \ell, q$, $N \leq 5$); $(W \to f\bar{f}') + N$ jets ($f = \ell, q$) and $(Z/\gamma^* \to f\bar{f}) + N$ jets ($f = \ell, \nu$), with $N \leq 6$; $nW + mZ + lH + N$ jets, with $n+m+l+N \leq 8$, $N \leq 3$, including all 2-fermion decay modes of W and Z bosons, with spin correlations; $Q\overline{Q}+N$ jets, with $t \to bf\bar{f}'$ decays and relative spin correlations included if $Q = t$, and $N \leq 6$; $Q\overline{Q}Q'\overline{Q}'+N$ jets, with Q and Q' heavy quarks (possibly equal) and $N \leq 4$; $HQ\overline{Q}+N$ jets, with $t \to bf\bar{f}'$ decays and relative spin correlations included if $Q = t$ and $N \leq 4$; N jets, with $N \leq 6$. Parton-level events are generated, providing full information on their colour and flavour structure, enabling the evolution of the partons into fully hadronised final states.

*The work of MLM and FP is supported in part by the EU Fourth Framework Programme "Training and Mobility of Researchers", Network "Quantum Chromodynamics and the Deep Structure of Elementary Particles", contract FMRX–CT98–0194 (DG 12 – MIHT). MM and RP acknowledge the financial support of the European Union under contract HPRN-CT-2000-00149. ADP is supported by a M.Curie fellowship, contract HPMF-CT-2001-01178.

†On leave of absence from INFN Sezione di Pavia, Italy.

Preprint typeset in JHEP style - PAPER VERSION

Bicocca-FT-07-9
GEF–TH–21/2007

Matching NLO QCD computations with Parton Shower simulations: the POWHEG method

Stefano Frixione

INFN, Sezione di Genova, Via Dodecaneso 33, 16146 Genova, Italy
E-mail: Stefano.Frixione@cern.ch

Paolo Nason

INFN, Sezione di Milano-Bicocca, Piazza della Scienza 3, 20126 Milan, Italy
E-mail: Paolo.Nason@mib.infn.it

Carlo Oleari

Università di Milano-Bicocca and INFN, Sezione di Milano-Bicocca
Piazza della Scienza 3, 20126 Milan, Italy
E-mail: Carlo.Oleari@mib.infn.it

ABSTRACT: The aim of this work is to describe in detail the POWHEG method, first suggested by one of the authors, for interfacing parton-shower generators with NLO QCD computations. We describe the method in its full generality, and then specify its features in two subtraction frameworks for NLO calculations: the Catani-Seymour and the Frixione-Kunszt-Signer approach. Two examples are discussed in detail in both approaches: the production of hadrons in e^+e^- collisions, and the Drell-Yan vector-boson production in hadronic collisions.

KEYWORDS: QCD, Monte Carlo, NLO Computations, Resummation, Collider Physics.

TOP2017, Ischia (IT)

TOP2017, Ischia (IT)


6