Perturbative Calculations for Precision High-Energy Phenomenology

- Computational Frontier -

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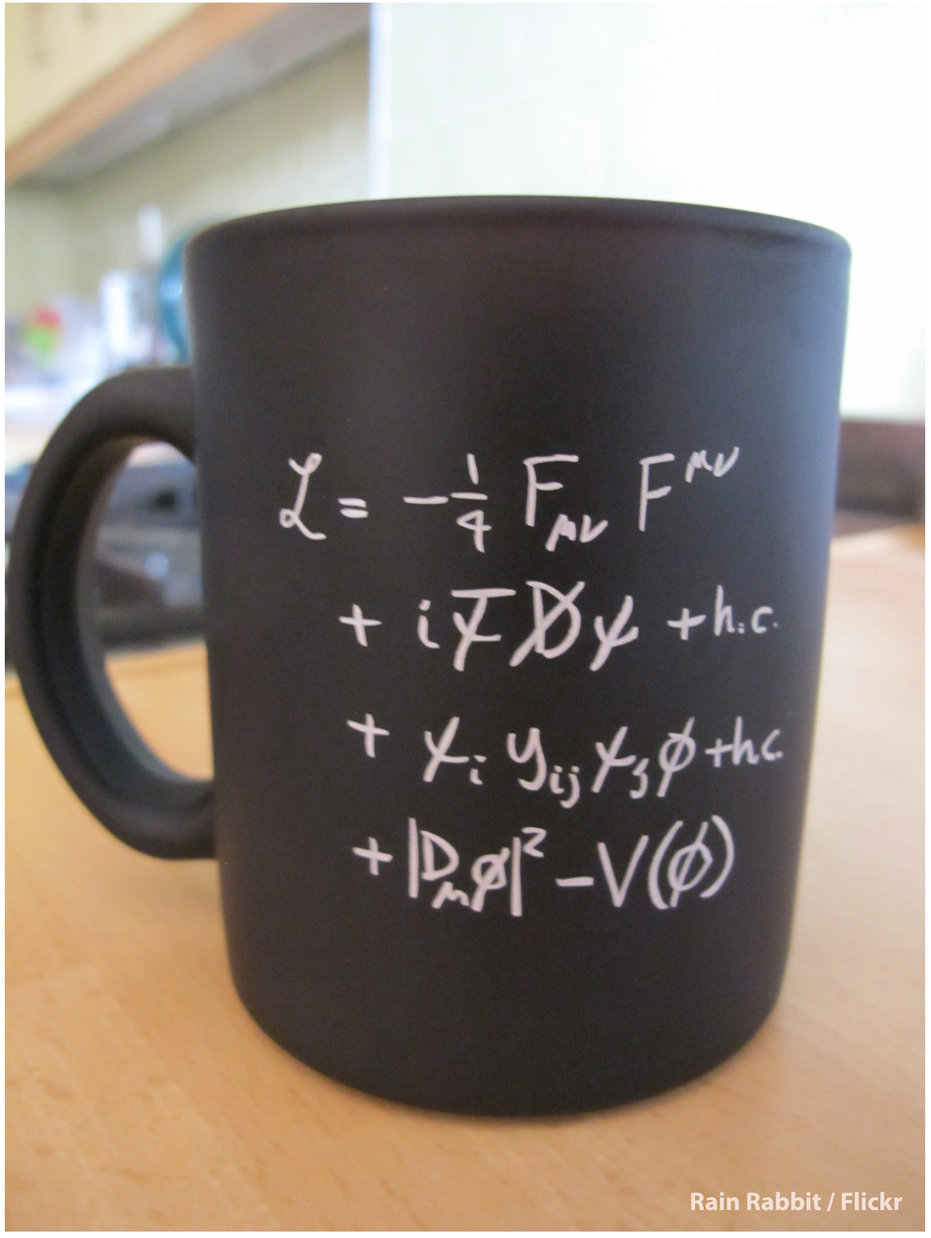
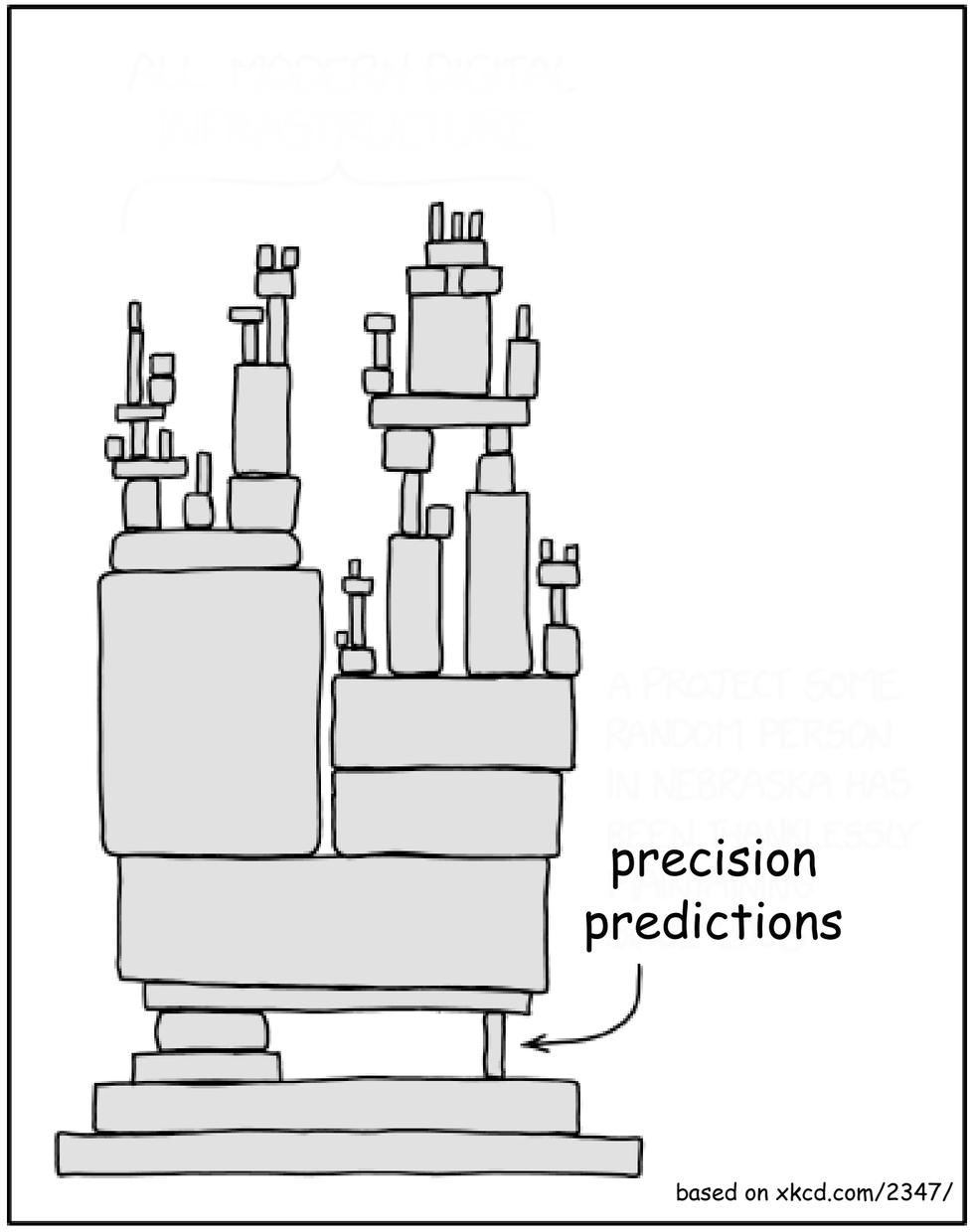


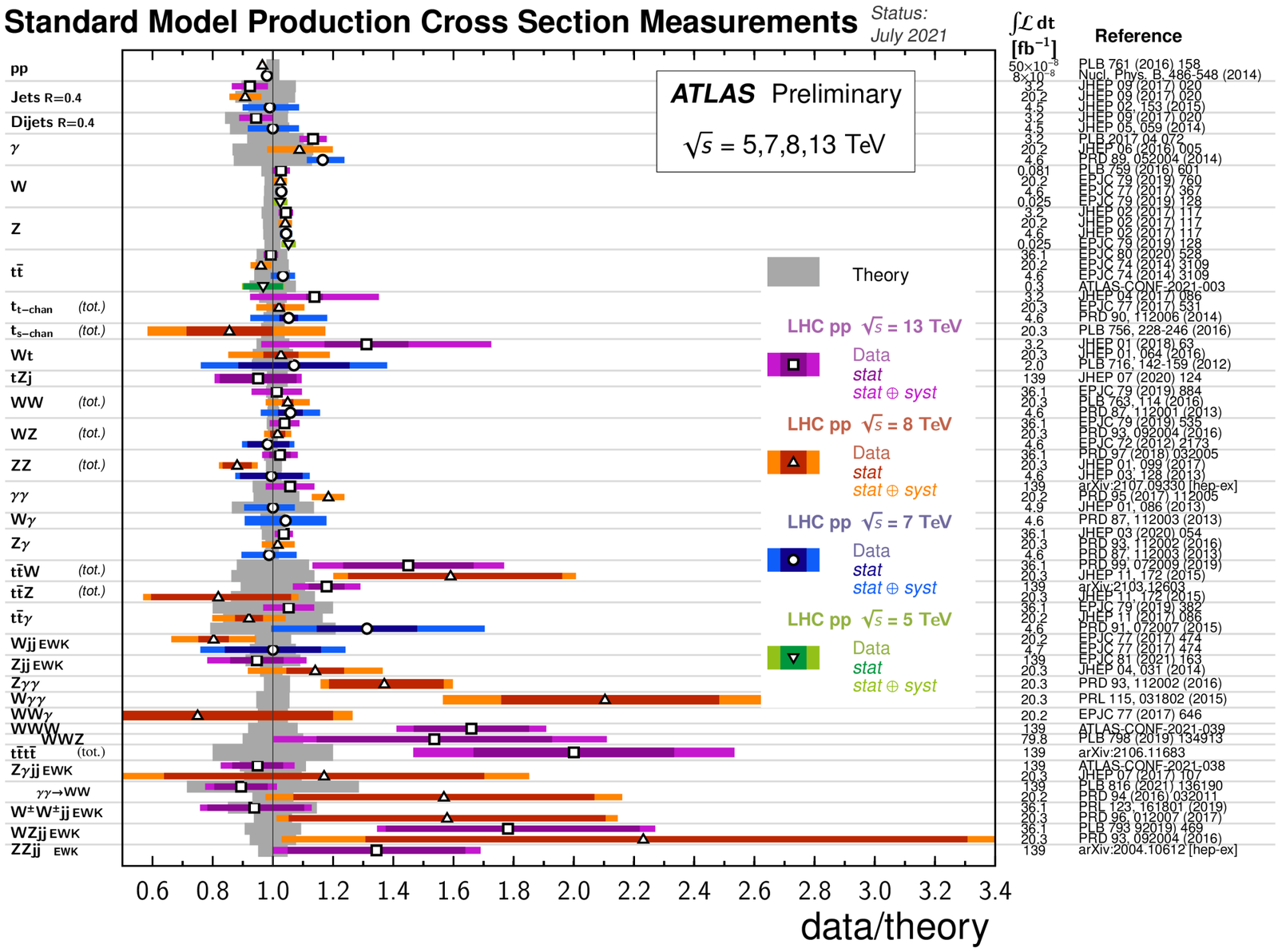
Rain Rabbit / Flickr

We measure 1.0 ± 0.01

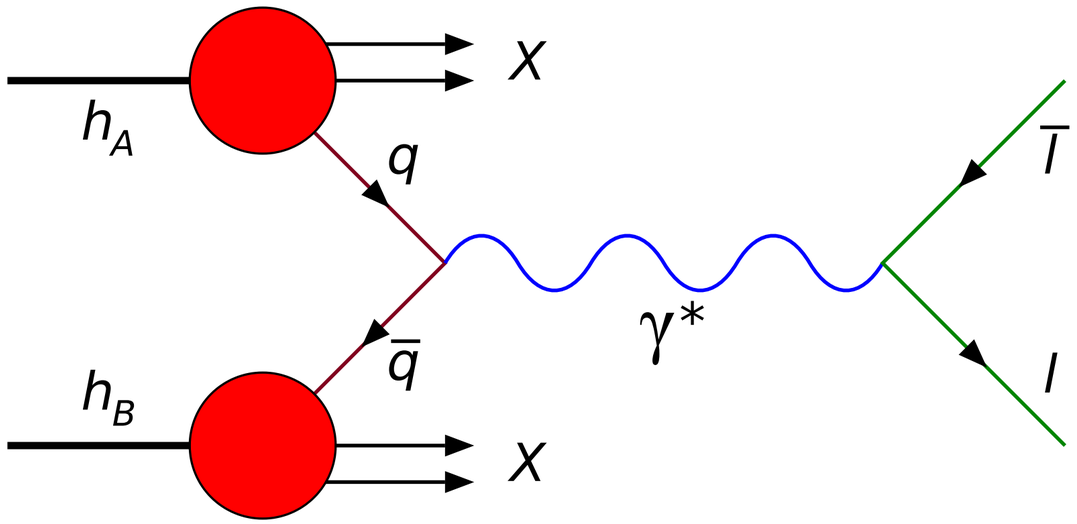
We measure 1.0 ± 0.01

But we predict (SM) 1.1 ± 0.1

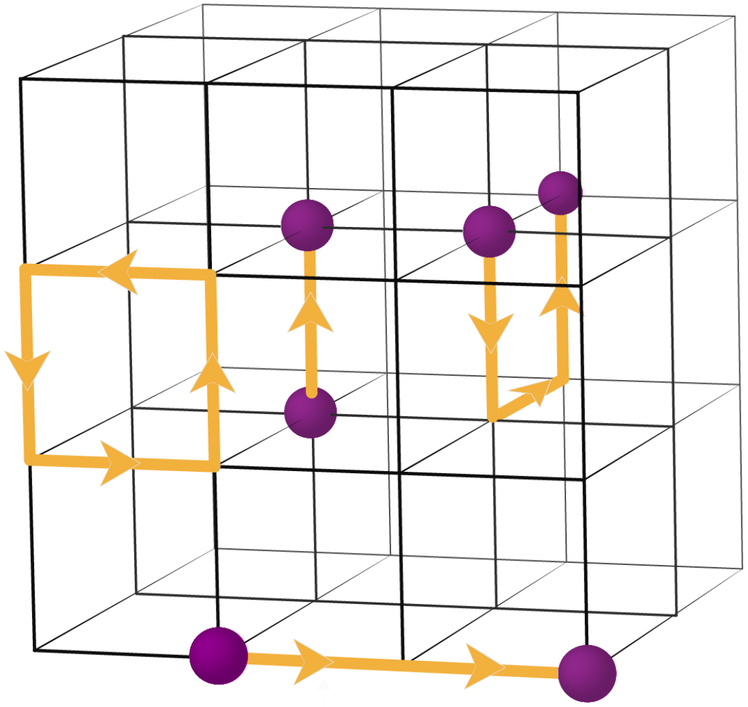

precision
predictions
based on xkcd.com/2347/


Standard Model Production Cross Section Measurements
Status: July 2021
ATLAS Preliminary
√s = 5,7,8,13 TeV
Theory
LHC pp √s = 13 TeV
Data
stat
stat ⊕ syst
LHC pp √s = 8 TeV
Data
stat
stat ⊕ syst
LHC pp √s = 7 TeV
Data
stat
stat ⊕ syst
LHC pp √s = 5 TeV
Data
stat
stat ⊕ syst
pp
Jets R=0.4
Dijets R=0.4
γ
W
Z
tt̄
t t−chan (tot.)
t s−chan (tot.)
Wt
tZj
WW (tot.)
WZ (tot.)
ZZ (tot.)
γγ
Wγ
Zγ
tt̄W (tot.)
tt̄Z (tot.)
tt̄γ
Wjj EWK
Zjj EWK
Zγγ
Wγγ
WWγ
WWW
WWZ
tt̄tt̄ (tot.)
Zγjj EWK
γγ→WW
W±W±jj EWK
WZjj EWK
ZZjj EWK
0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4
data/theory
∫L dt [fb−1]
Reference
50×10−3 PLB 761 (2016) 158
8×10−8 Nucl. Phys. B 486-548 (2014)
3.2 JHEP 09 (2017) 020
20.2 JHEP 09 (2017) 020
4.5 JHEP 02, 153 (2015)
3.2 JHEP 09 (2017) 020
4.5 JHEP 05, 059 (2014)
3.2 PLB 2017.04.072
20.2 JHEP 06 (2016) 005
4.6 PRD 89, 052004 (2014)
0.081 PLB 759 (2016) 601
20.2 EPJC 79 (2019) 760
4.6 EPJC 77 (2017) 367
0.025 EPJC 79 (2019) 128
3.2 JHEP 02 (2017) 117
20.2 JHEP 02 (2017) 117
4.6 JHEP 02 (2017) 117
0.025 EPJC 79 (2019) 128
36.1 EPJC 80 (2020) 528
20.2 EPJC 74 (2014) 3109
4.6 EPJC 74 (2014) 3109
0.3 ATLAS-CONF-2021-003
3.2 JHEP 04 (2017) 086
20.3 EPJC 77 (2017) 531
4.6 PRD 90, 112006 (2014)
20.3 PLB 756, 228-246 (2016)
3.2 JHEP 01 (2018) 63
20.3 JHEP 01, 064 (2016)
2.0 PLB 716, 142-159 (2012)
139 JHEP 07 (2020) 124
36.1 EPJC 79 (2019) 884
20.3 PLB 763, 114 (2016)
4.6 PRD 87, 112001 (2013)
36.1 EPJC 79 (2019) 535
20.3 PRD 93, 092004 (2016)
4.6 EPJC 72 (2012) 2173
36.1 PRD 97 (2018) 032005
20.3 JHEP 01, 099 (2017)
4.6 JHEP 03, 128 (2013)
139 arXiv:2107.09330 [hep-ex]
20.2 PRD 95 (2017) 112005
4.9 JHEP 01, 086 (2013)
4.6 PRD 87, 112003 (2013)
36.1 JHEP 03 (2020) 054
20.3 PRD 93, 112002 (2016)
4.6 PRD 87, 112003 (2013)
36.1 PRD 99, 072009 (2019)
20.3 JHEP 11, 172 (2015)
139 arXiv:2103.12603
20.3 JHEP 11, 172 (2015)
36.1 EPJC 79 (2019) 382
20.2 JHEP 11 (2017) 086
4.6 PRD 91, 072007 (2015)
20.2 EPJC 77 (2017) 474
4.7 EPJC 77 (2017) 474
139 EPJC 81 (2021) 163
20.3 JHEP 04, 031 (2014)
20.3 PRD 93, 112002 (2016)
20.3 PRL 115, 031802 (2015)
20.2 EPJC 77 (2017) 646
139 ATLAS-CONF-2021-039
79.8 PLB 798 (2019) 134913
139 arXiv:2106.11683
139 ATLAS-CONF-2021-038
20.3 JHEP 07 (2017) 107
139 PLB 816 (2021) 136190
20.2 PRD 94 (2016) 032011
36.1 PRL 123, 161801 (2019)
20.3 PRD 96, 012007 (2017)
36.1 PLB 793 92019) 469
20.3 PRD 93, 092004 (2016)
139 arXiv:2004.10612 [hep-ex]

Perturbative



Non-perturbative



- Construction of amplitudes
- Calculation of loop integrals
- Phase space integration

The worker nodes detail:

- HPE ProLiant XL270d Gen10
- Intel(R) Xeon(R) Gold 6248 CPU @ 2.50GHz
- NUMA node0 CPU(s): 0-19
- NUMA node1 CPU(s): 20-39
- Thread(s) per core: 1
- Core(s) per socket: 20
- Socket(s): 2
- NUMA node(s): 2
- 8x Nvidia V100-SXM2-32GB with NV-Link
- 768 GB Memory
- InfiniBand EDR connectivity

Perturbative Calculations for Precision High-Energy Phenomenology

a whitepaper with Andreas von Manteuffel (MSU) and Fernando Febres Cordero (FSU)

- Survey advances in perturbative methods for precision phenomenology
- Characterize methods and complexity of existing calculations
- Assess computational demands which deliver the required precision for LHC, EIC, HL-LHC