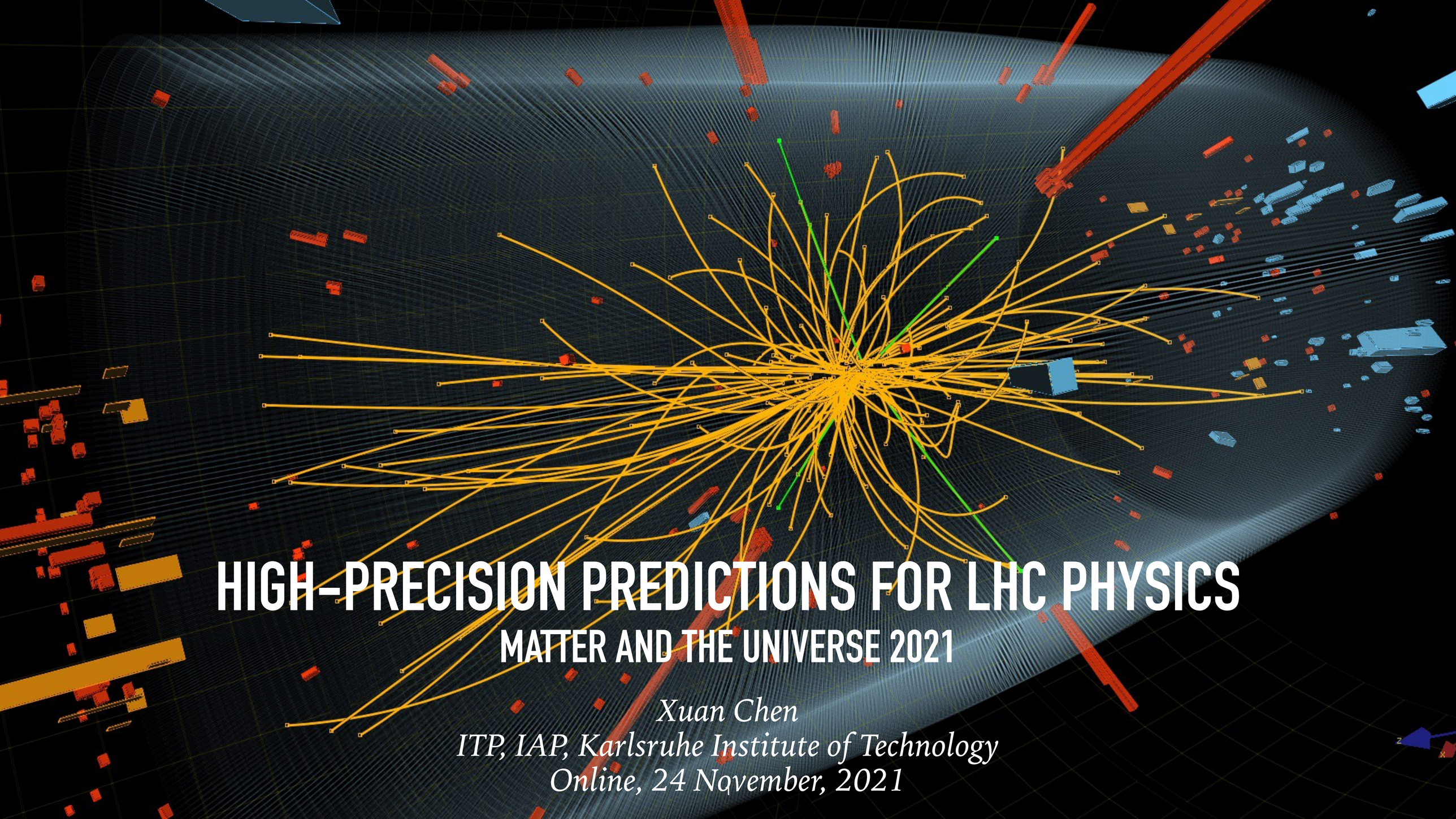


HIGH-PRECISION PREDICTIONS FOR LHC PHYSICS

MATTER AND THE UNIVERSE 2021

Xuan Chen
ITP, IAP, Karlsruhe Institute of Technology
Online, 24 November, 2021

TOM VAN BAAK'S GRE^{2}AT EXPERIMENT

Physics Today 2007 (16)

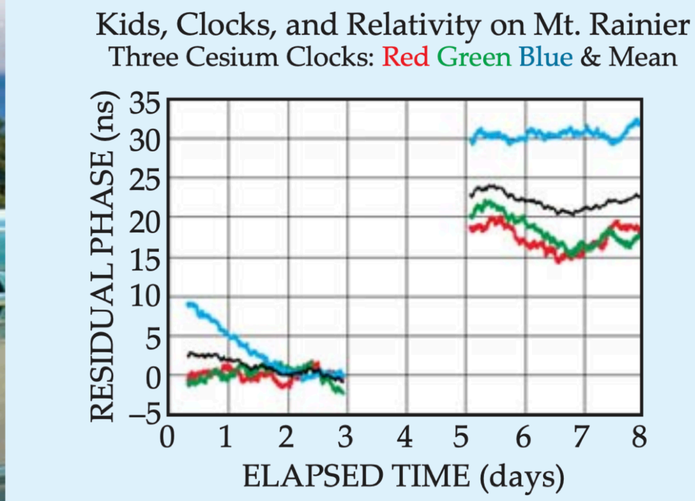
Four cesium clocks, three kids and a mountain

Day 0 to 3: Atomic clocks celebration

Day 3 to 5: Camping at Mount Rainier

Day 5 to 8: Compare time dilation of clocks

Altitude difference in day 3 to 5 is +1340 m



Terrestrial blueshift predicted by GR is $z = \frac{g}{c^2}\Delta h$

Two days at Mount Rainier converts to +22 ns

Experiment reveals +23 ns time dilation!

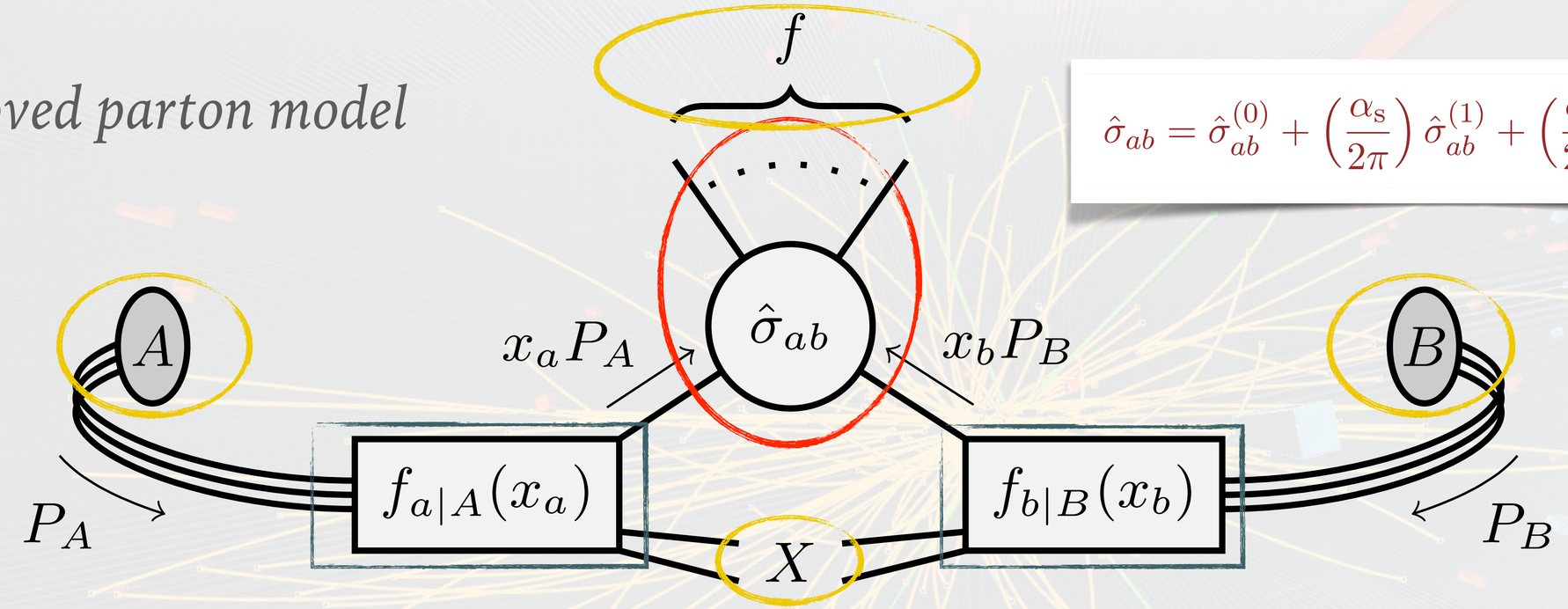
116 years after Einstein's first paper on relativity

66 years since Essen's first cesium clock

PRECISION PREDICTIONS AT THE LHC

QCD improved parton model

$$\hat{\sigma}_{ab} = \hat{\sigma}^{(0)}_{ab} + \left(\frac{\alpha_s}{2\pi}\right)\hat{\sigma}^{(1)}_{ab} + \left(\frac{\alpha_s}{2\pi}\right)^2 \hat{\sigma}^{(2)}_{ab} + \dots$$



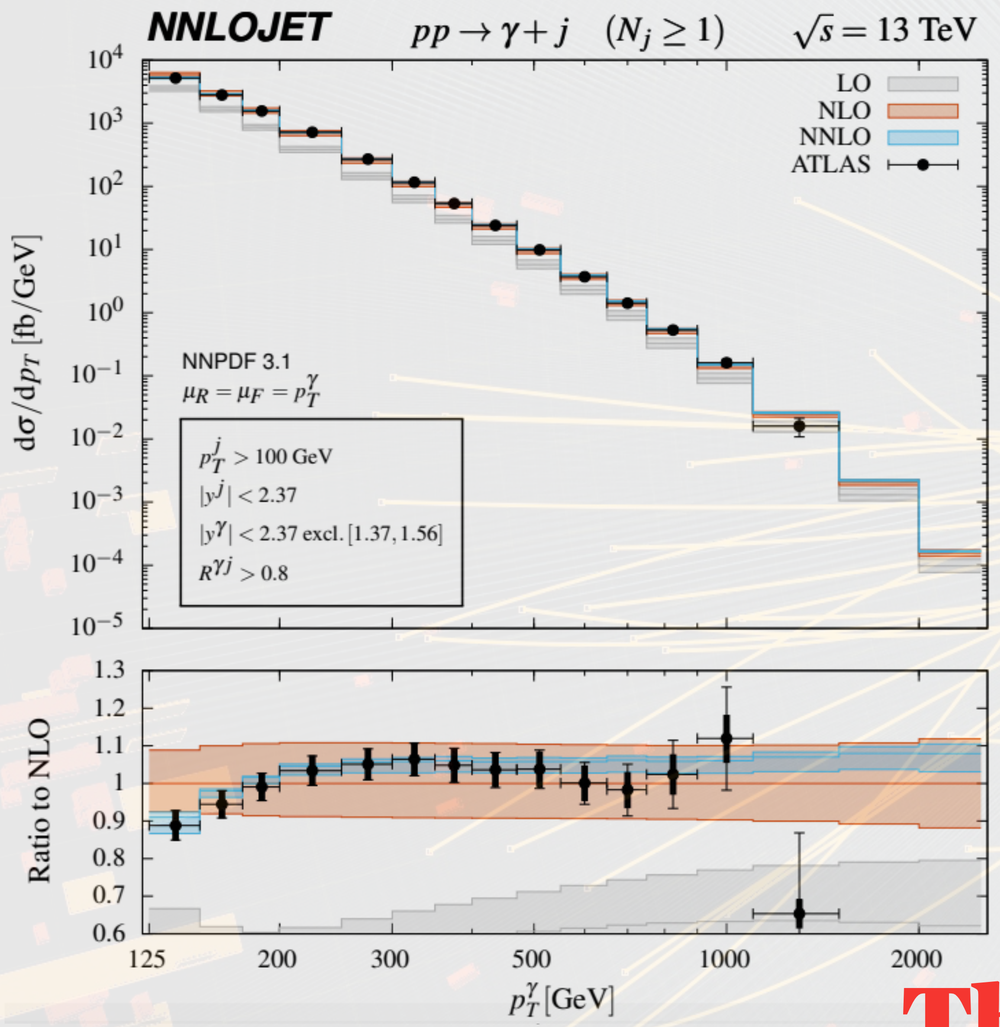
$$\sigma_{AB} = \sum_{ab} \int_0^1 \mathrm{d}x_a \int_0^1 \mathrm{d}x_b \; f_{a|A}(x_a)\; f_{b|B}(x_b)\; \hat{\sigma}_{ab}(x_a, x_b)\; \left(1 + \mathcal{O}(\Lambda_{\mathrm{QCD}}/Q)\right)$$

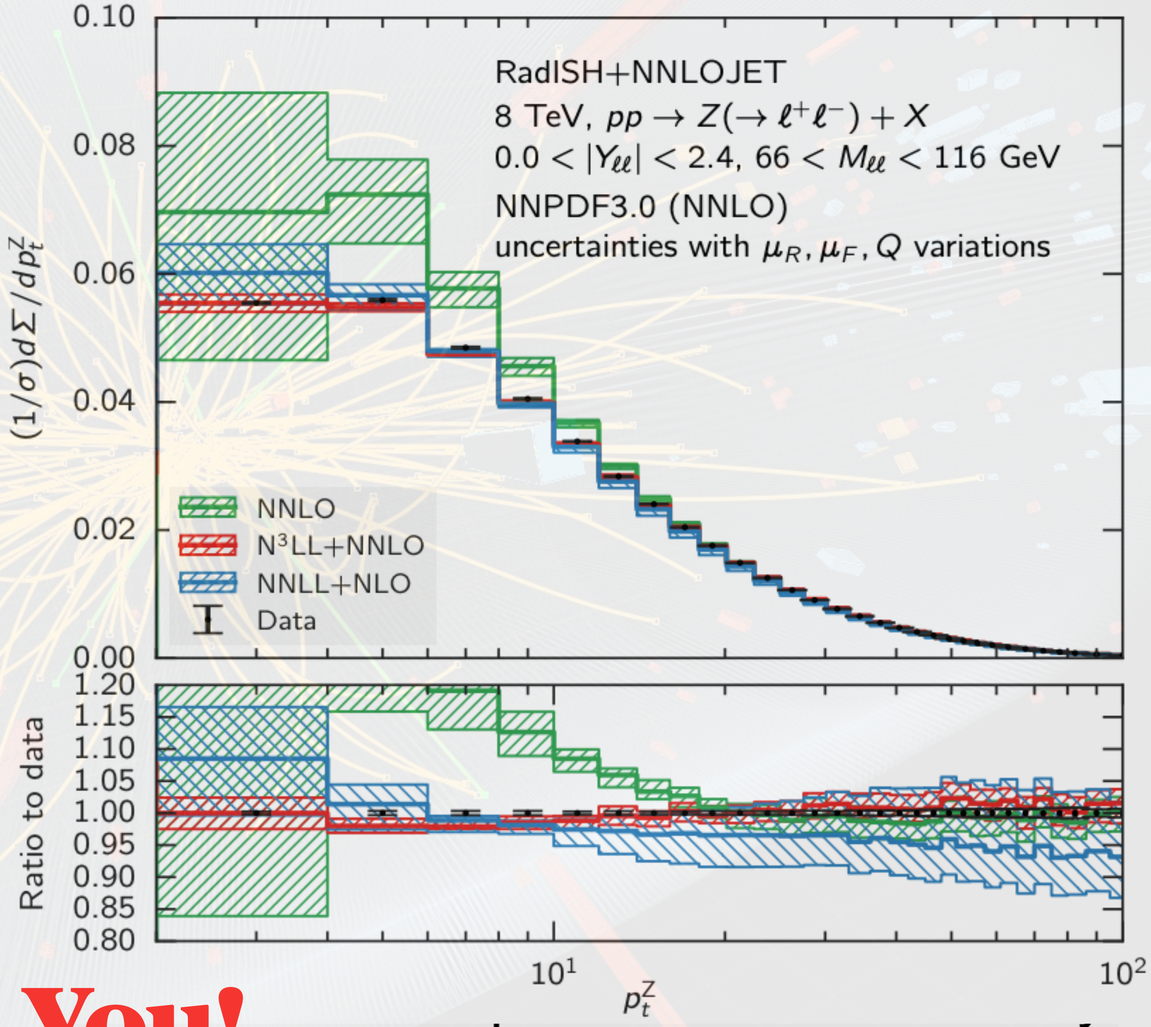
Parton distribution functions
(Energy evolution from all exp.)
± 1 % at the LHC

Hard scattering
(Perturbative quantum field theory)
± 10 % level!

non-perturbative effects
(Fragmentation, lattice QCD)
± 1.2 GeV/13 TeV

PRECISION PREDICTIONS AT THE LHC





Thank You!

XC, T. Gehrmann, N. Glover, M. Hofer, A. Huss
XC, T. Gehrmann N. Glover, A. Huss, B. Mistlberger, A. Pelloni
JHEP 04 (2020) 166
Phys. Rev. Lett. 127 (2021) 7, 072002

W. Bizon, XC, A. Gehrmann-De Ridder, T. Gehrmann
N. Glover, A. Huss, P. Monni, E. Re, L. Rottoli, P Torrielli
CERN Yellow Rep. Monogr. 7 (2019) 221-584
JHEP 12 (2018) 132