Pushing the precision frontier at the LHC

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Z invisible decay

Rate of decay of the Z boson to particles that evade detection ('invisible')

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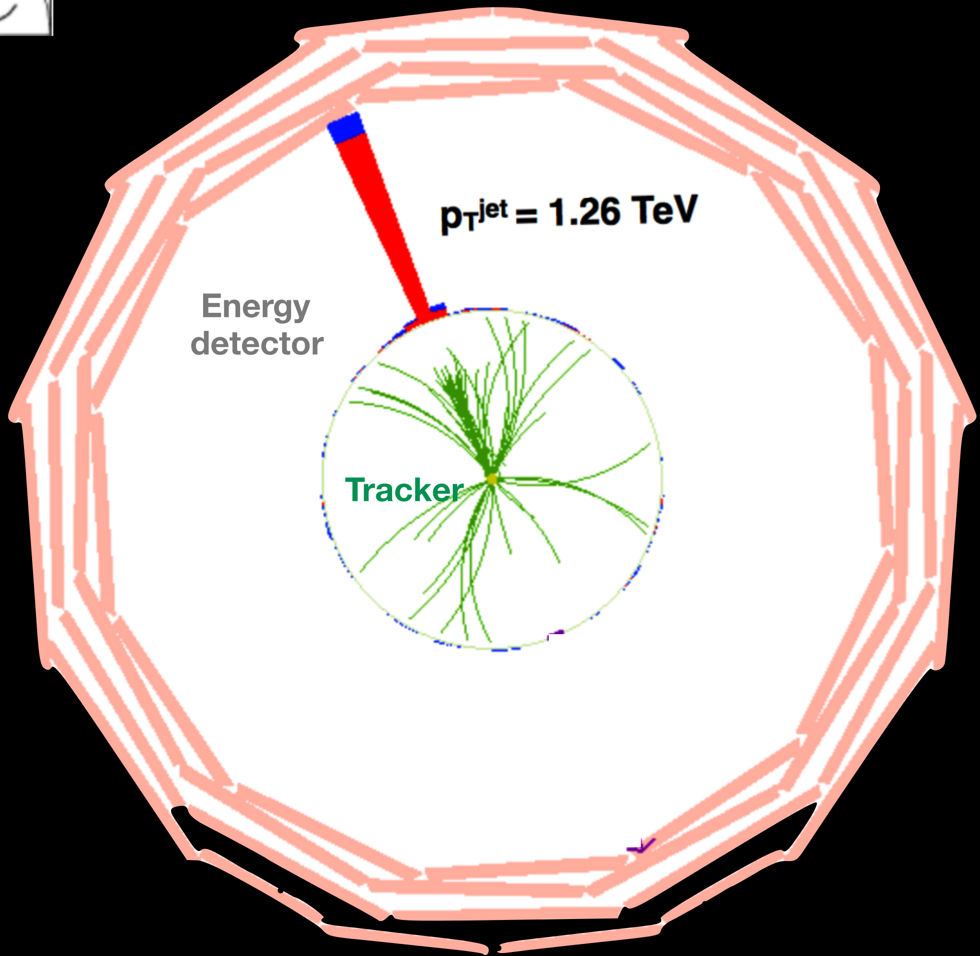
How do we detect invisible particles?



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Rate of decay of the Z boson to particles that evade detection (‘invisible’)

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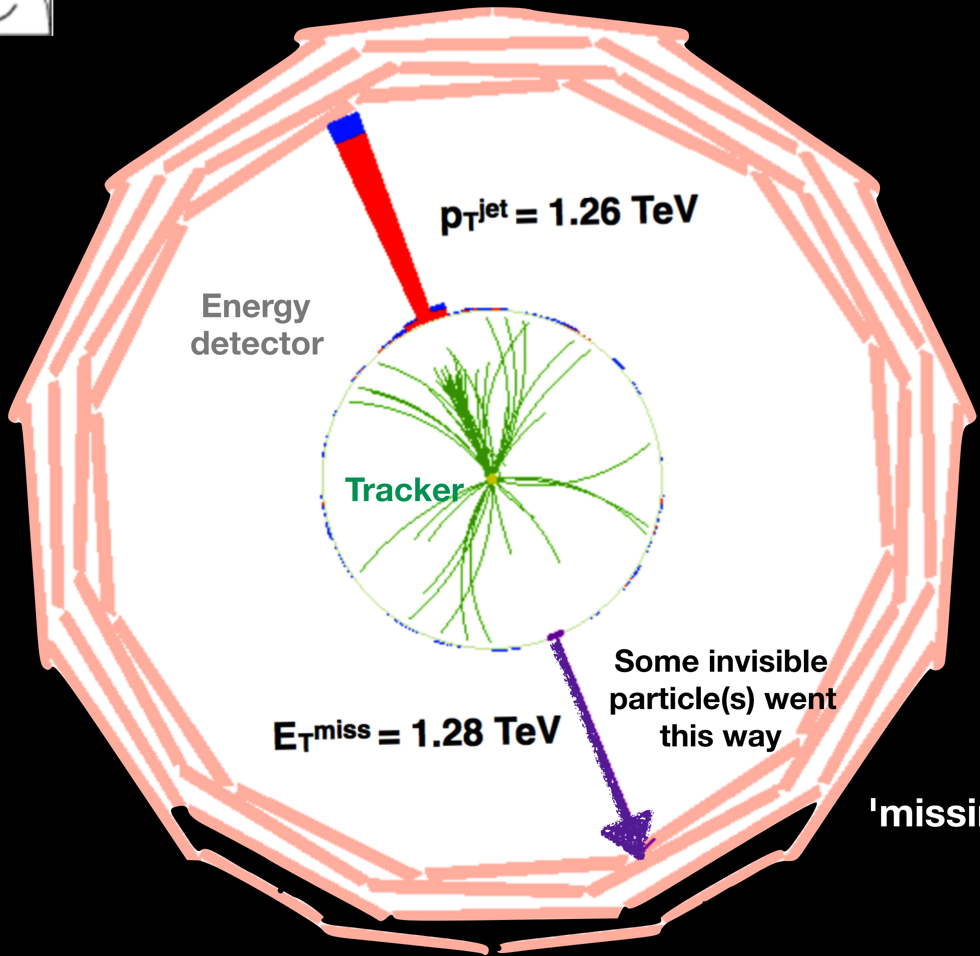
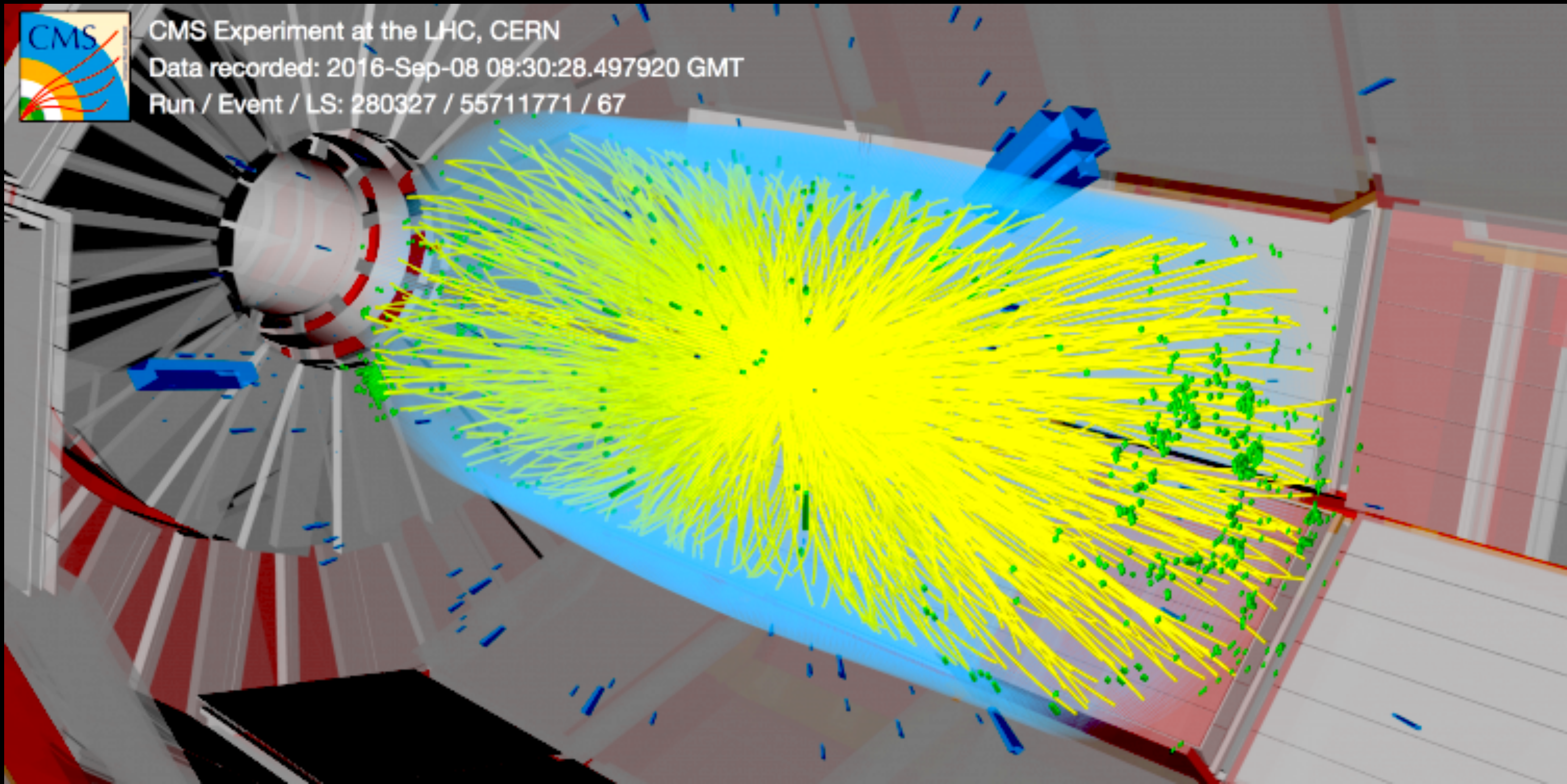


'missing momentum’

Z invisible decay

Rate of decay of the Z boson to particles that evade detection ('invisible')



Z invisible decay at the LHC

CMS measurement : 523 ± 16 MeV

First precise measurement of invisible Z decays at a hadron collider

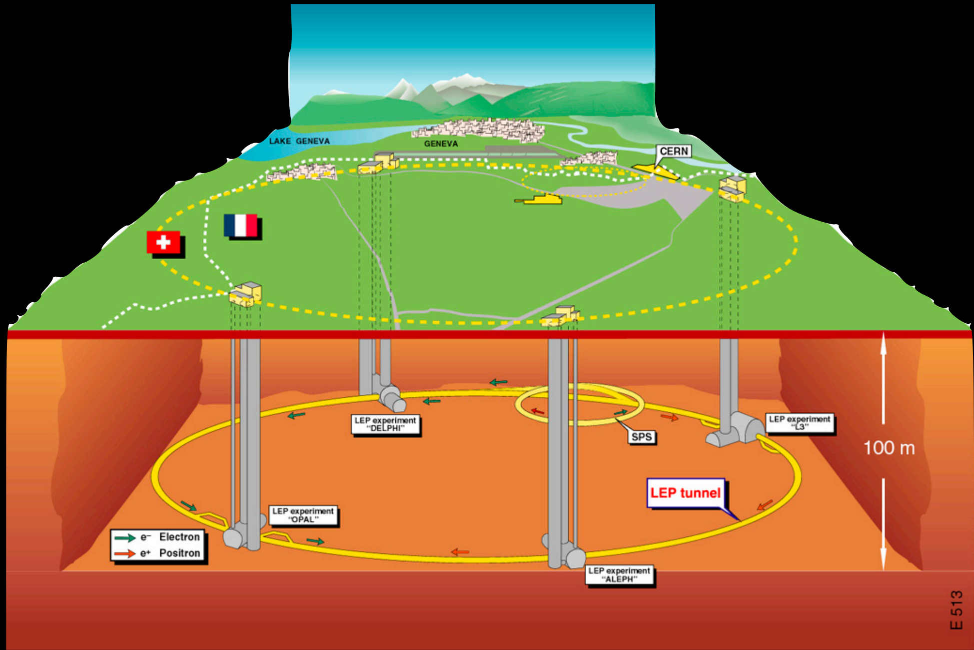
Z invisible decay at the LHC

CMS measurement : 523 ± 16 MeV

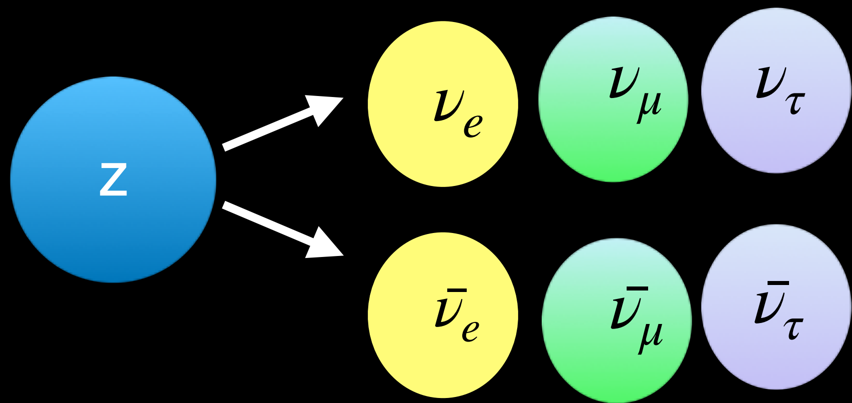
Source of systematic uncertainty	Uncertainty (%)
Muon identification efficiency (syst.)	2.1
Jet energy scale	1.8–1.9
Electron identification efficiency (syst.)	1.6
Electron identification efficiency (stat.)	1.0
Pileup	0.9–1.0
Electron trigger efficiency	0.7
τ_h veto efficiency	0.6–0.7
p_T^{miss} trigger efficiency (jets plus p_T^{miss} region)	0.7
p_T^{miss} trigger efficiency ($Z/\gamma^* \to \mu\mu$ region)	0.6
Boson p_T dependence of QCD corrections	0.5
Jet energy resolution	0.3–0.5
p_T^{miss} trigger efficiency (μ+jets region)	0.4
Muon identification efficiency (stat.)	0.3
Electron reconstruction efficiency (syst.)	0.3
Boson p_T dependence of EW corrections	0.3
PDFs	0.2
Renormalization/factorization scale	0.2
Electron reconstruction efficiency (stat.)	0.2
Overall	3.2

Z invisible decays at LEP collider

Large Electron Positron collider: Highest energy electron-positron collider ever built (1989 - 2000)



- LEP legacy: properties of the Z boson measured to <u>unprecedented</u> precision
- Direct and indirect measurement of Z boson invisible decays, indirect measurement used to deduce <u>three</u> species of light neutrinos



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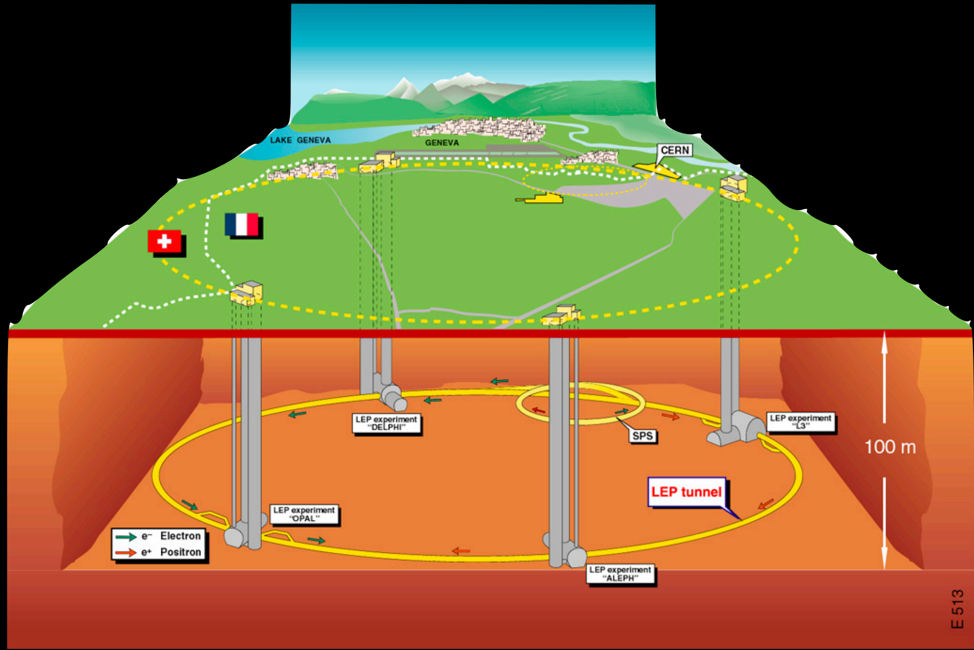

LEP combined direct measurement : 503 ± 16 MeV

Z invisible decay at the LHC

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Standard Model : 501.44 ± 0.04 MeV

Z invisible decay at the LHC

CMS measurement : 523 ± 16 MeV

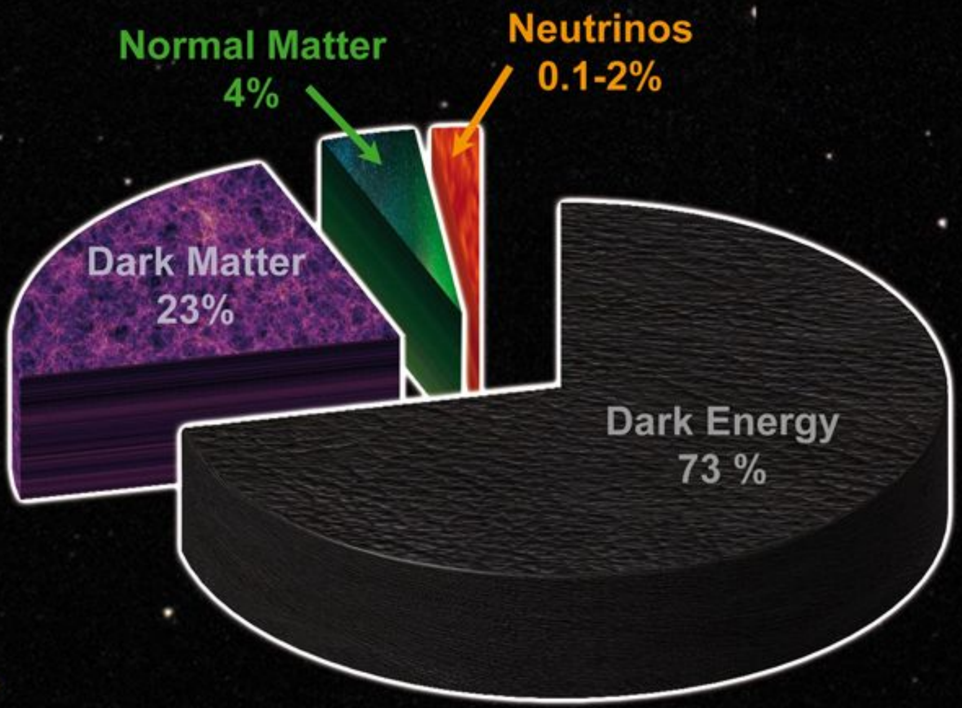
LEP combined measurement : 503 ± 16 MeV

Standard Model : 501.44 ± 0.04 MeV

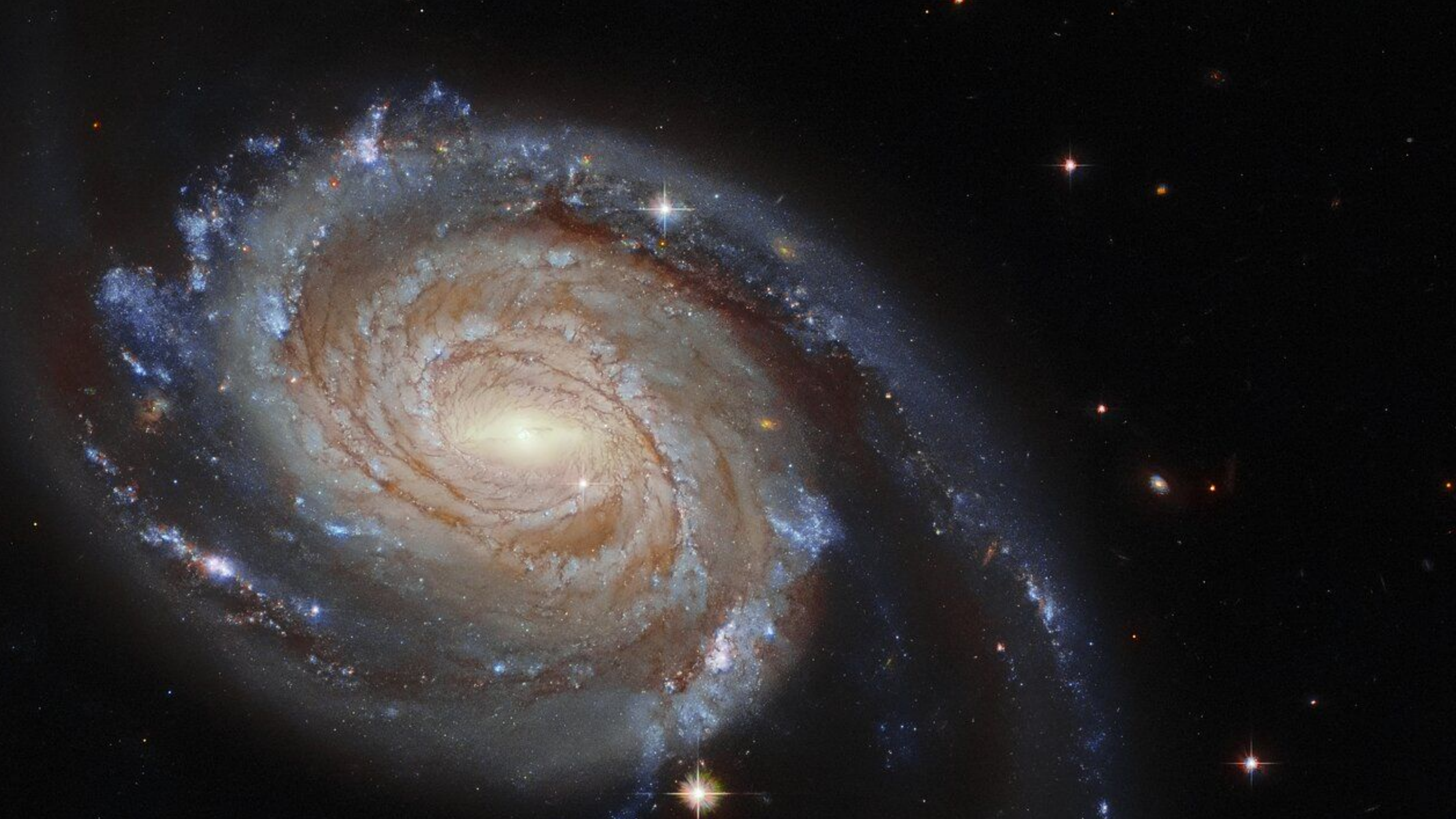
CMS result : Single most precise direct measurement in the world

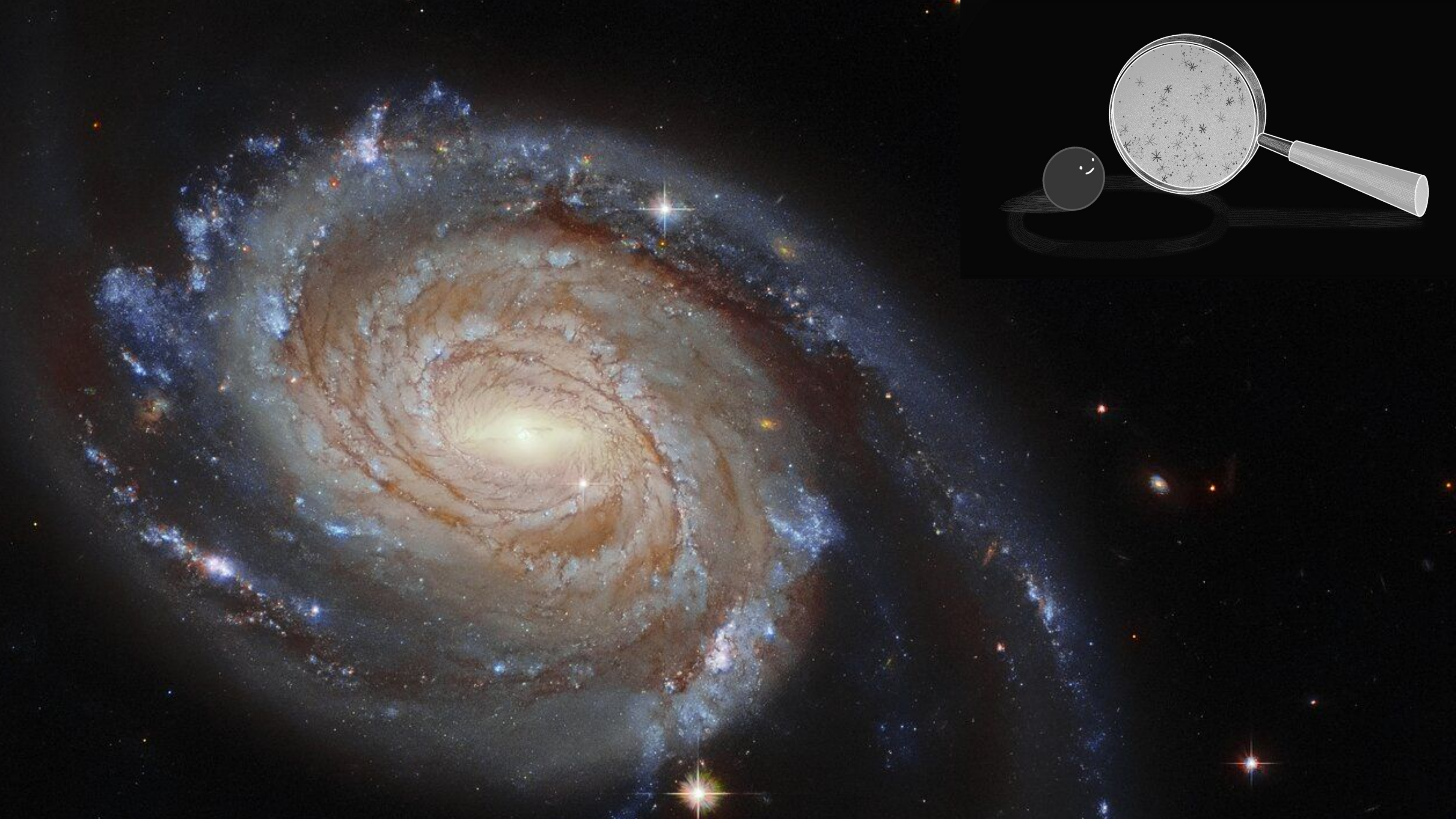
Dark matter and dark energy at the LHC: from the very big to the very small

Michaela Queitsch-Maitland
University of Manchester

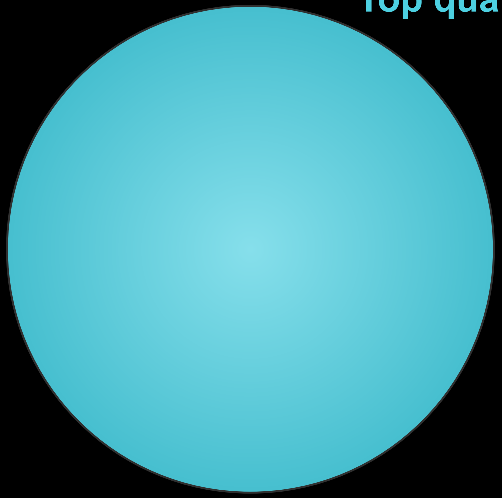


Content of the Universe

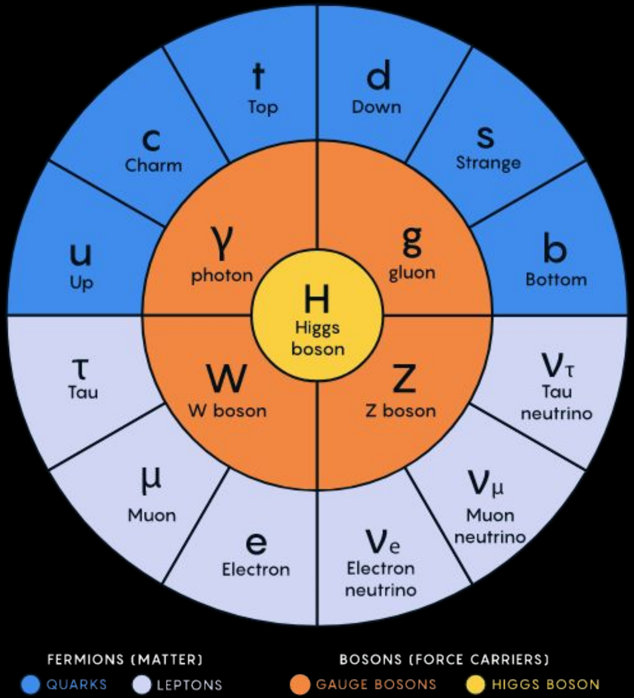


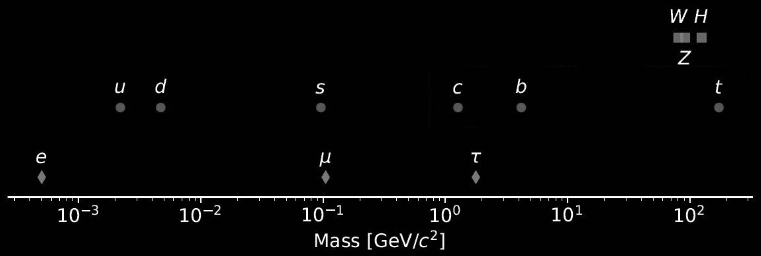


Top quark

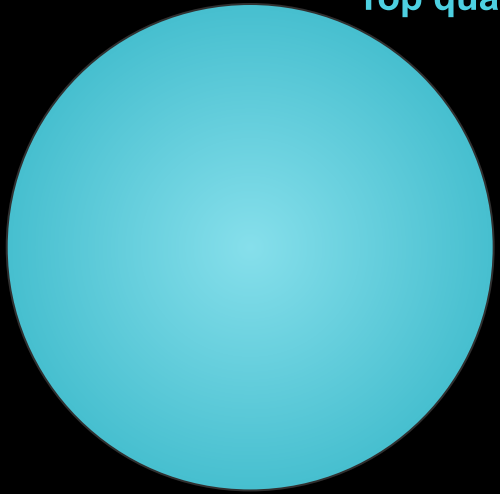


The Standard Model





Top quark



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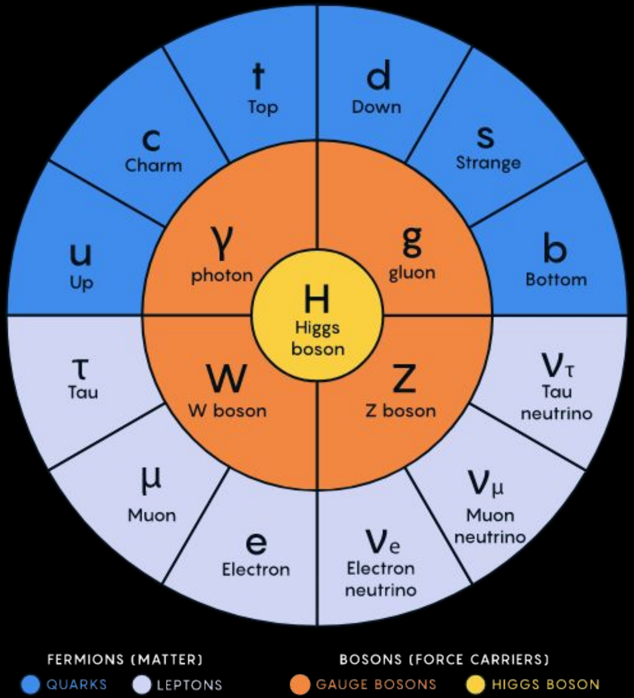
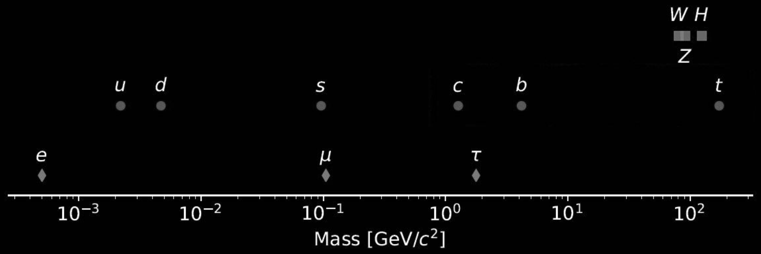
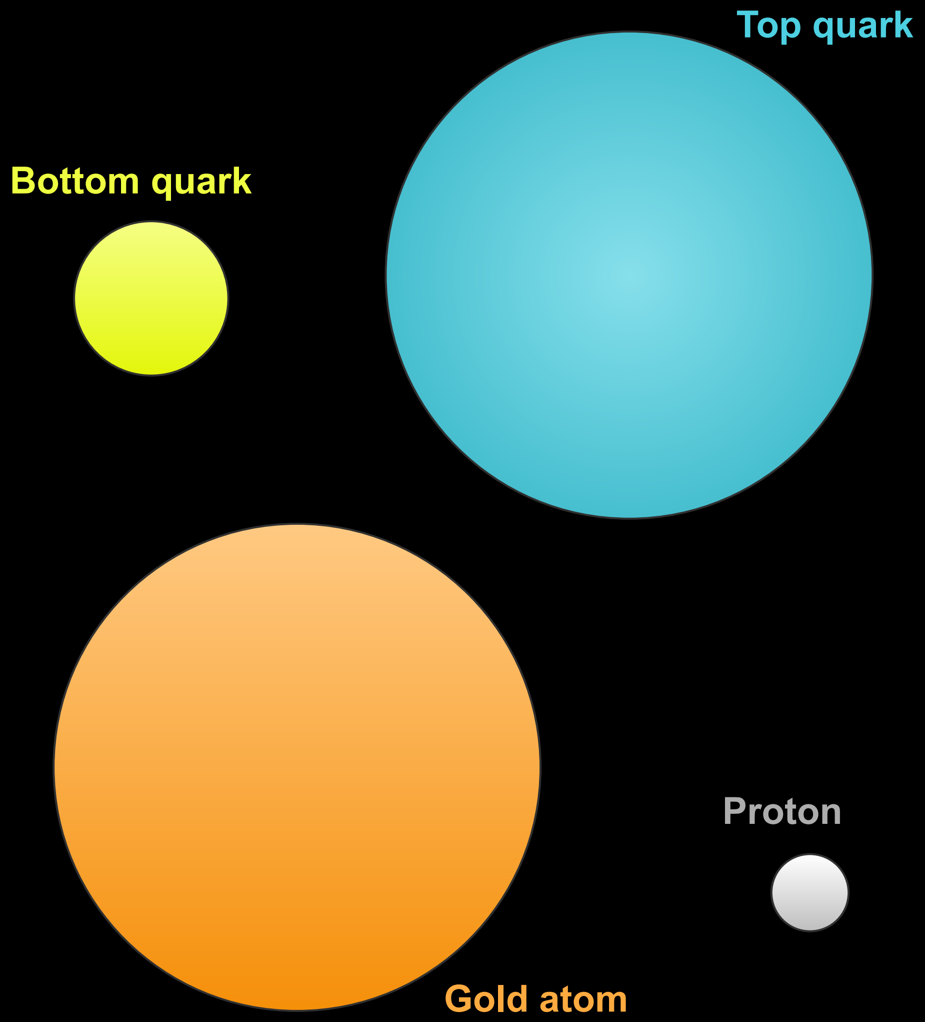
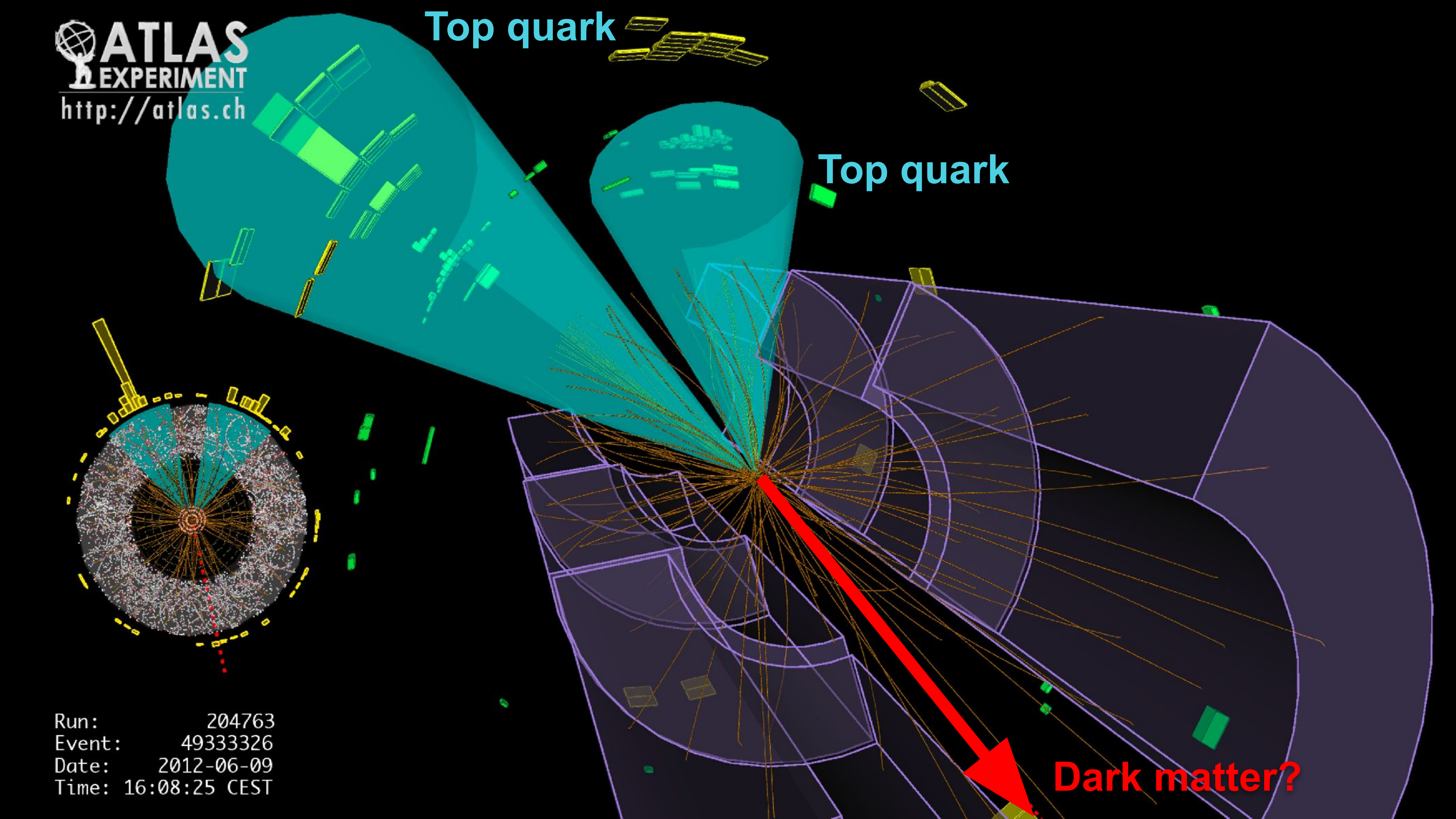
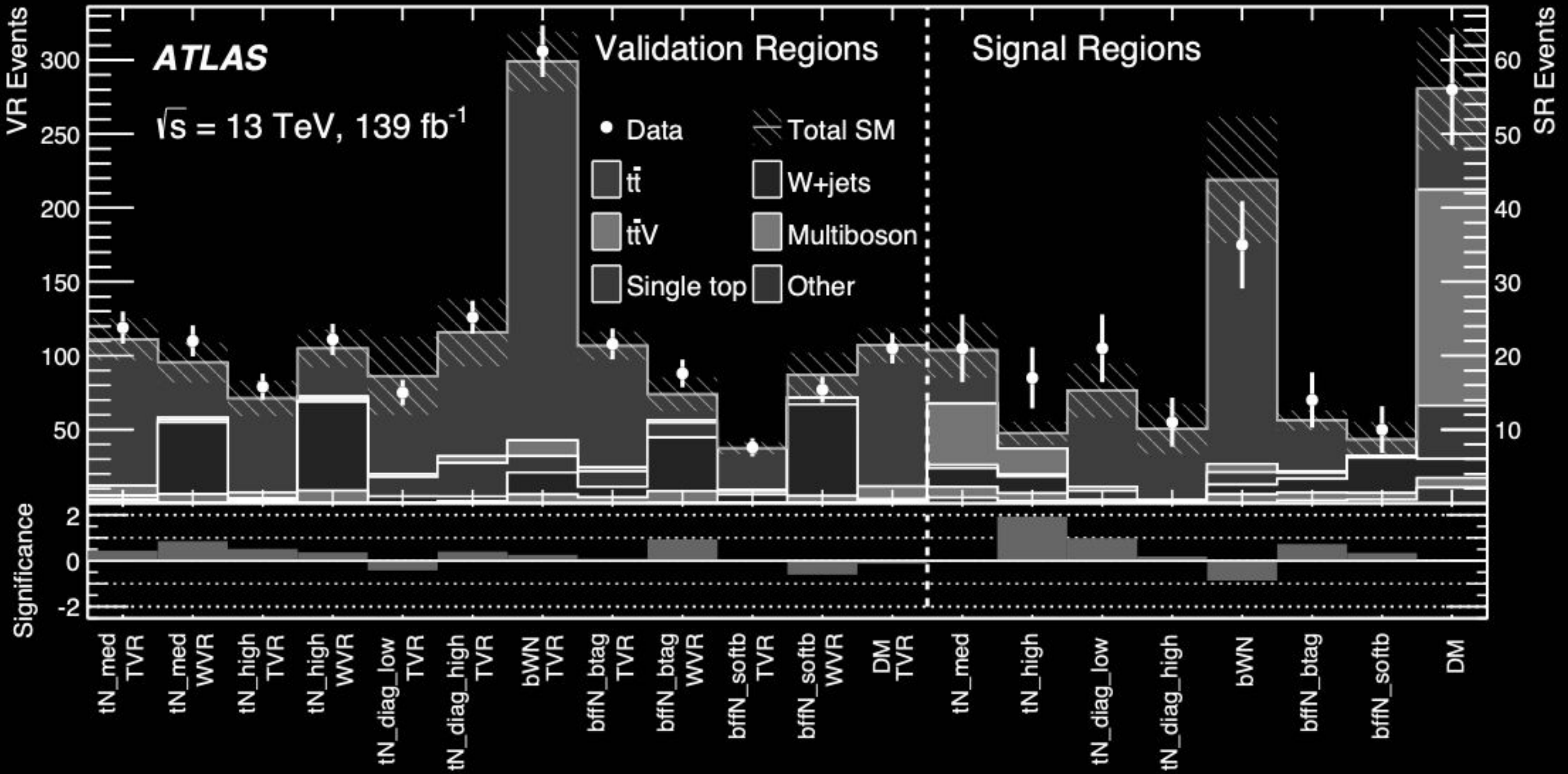








ATLAS EXPERIMENT
http://atlas.ch
Top quark
Top quark
Dark matter?
Run: 204763
Event: 49333326
Date: 2012-06-09
Time: 16:08:25 CEST


ATLAS
$\sqrt{s}$ = 13 TeV, 139 fb^{-1}
Validation Regions
Signal Regions
Data
Total SM
$t\bar{t}$
W+jets
$t\bar{t}V$
Multiboson
Single top
Other
VR Events
SR Events
Significance
300
250
200
150
100
50
60
50
40
30
20
10
2
0
-2
tN_med TVR
tN_med WVR
tN_high TVR
tN_high WVR
tN_diag_low TVR
tN_diag_high TVR
bWN TVR
bffN_btag TVR
bffN_btag WVR
bffN_softb TVR
bffN_softb WVR
DM TVR
tN_med
tN_high
tN_diag_low
tN_diag_high
bWN
bffN_btag
bffN_softb
DM

Published for SISSA by Springer

Received: *March 6, 2019*
Accepted: *May 9, 2019*
Published: *May 23, 2019*

Constraints on mediator-based dark matter and scalar dark energy models using $\sqrt{s} = 13$ TeV pp collision data collected by the ATLAS detector

The ATLAS collaboration

E-mail: atlas.publications@cern.ch

Abstract: Constraints on selected mediator-based dark matter models and a scalar dark energy model using up to 37 fb^{-1} $\sqrt{s} = 13$ TeV pp collision data collected by the ATLAS detector at the LHC during 2015–2016 are summarised in this paper. The results of experimental searches in a variety of final states are interpreted in terms of a set of spin-1 and spin-0 single-mediator dark matter simplified models and a second set of models involving an extended Higgs sector plus an additional vector or pseudo-scalar mediator. The searches considered in this paper constrain spin-1 leptophobic and leptophilic mediators, spin-0 colour-neutral and colour-charged mediators and vector or pseudo-scalar mediators embedded in extended Higgs sector models. In this case, also $\sqrt{s} = 8$ TeV pp collision data are used for the interpretation of the results. The results are also interpreted for the first time in terms of light scalar particles that could contribute to the accelerating expansion of the universe (dark energy).

Keywords: Dark matter, Hadron-Hadron scattering (experiments)

ArXiv ePrint: 1903.01400

https://doi.org/10.1007/JHEP05(2019)142

JHEP

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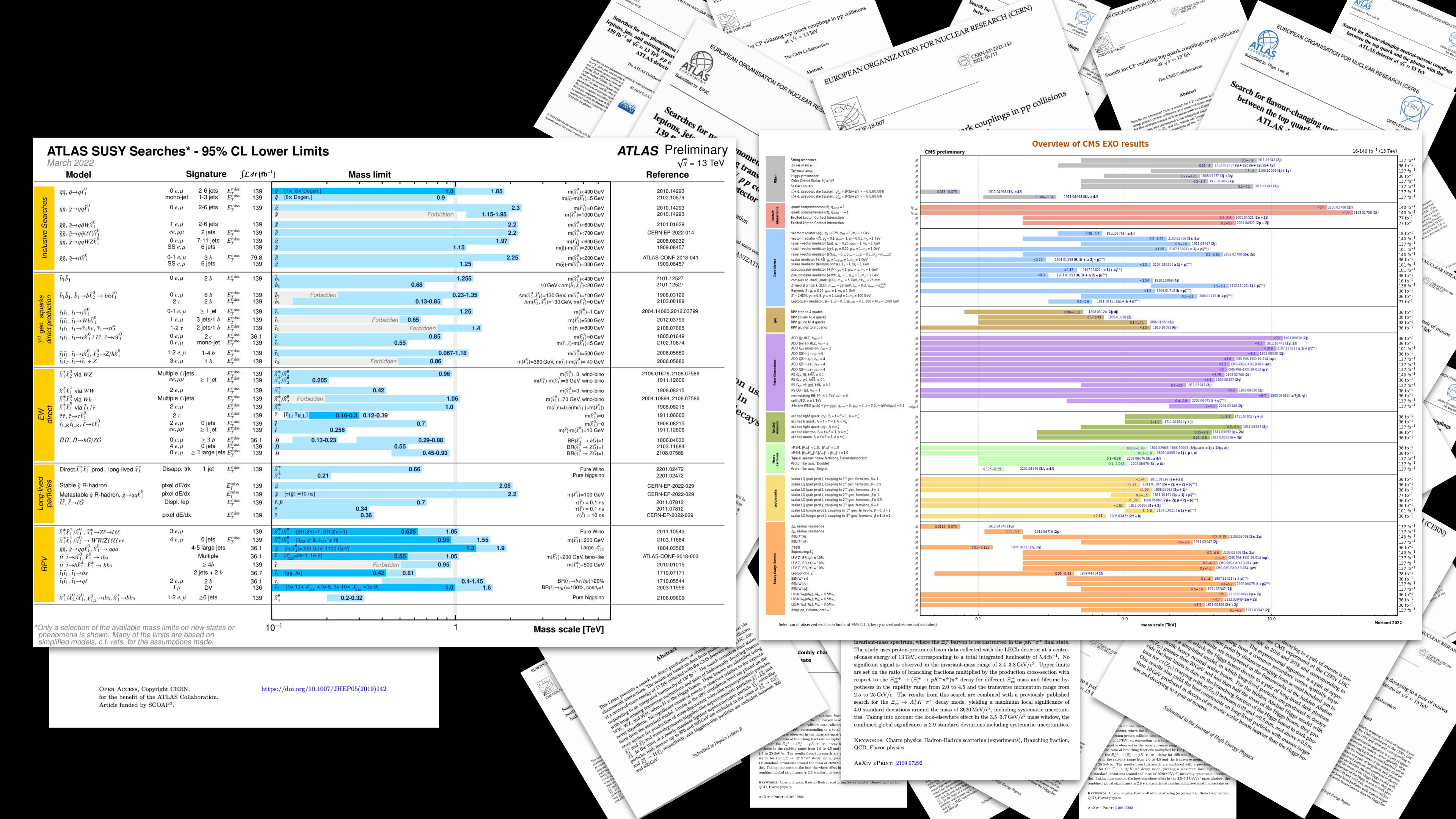
ATLAS SUSY Searches* - 95% CL Lower Limits
March 2022
ATLAS Preliminary
√s = 13 TeV
Model
Signature
Mass limit
Reference
Inclusive Searches
EW direct
Long-lived particles
RPV
Mass scale [TeV]
*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.
Overview of CMS EXO results
CMS preliminary
16-140 fb⁻¹ (13 TeV)
Selection of observed exclusion limits at 95% C.L. (theory uncertainties are not included).
mass scale [TeV]
Moriond 2022
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KEYWORDS: Charm physics, Hadron-Hadron scattering (experiments), Branching fraction, QCD, Flavor physics
ARXIV EPRINT: 2109.07292