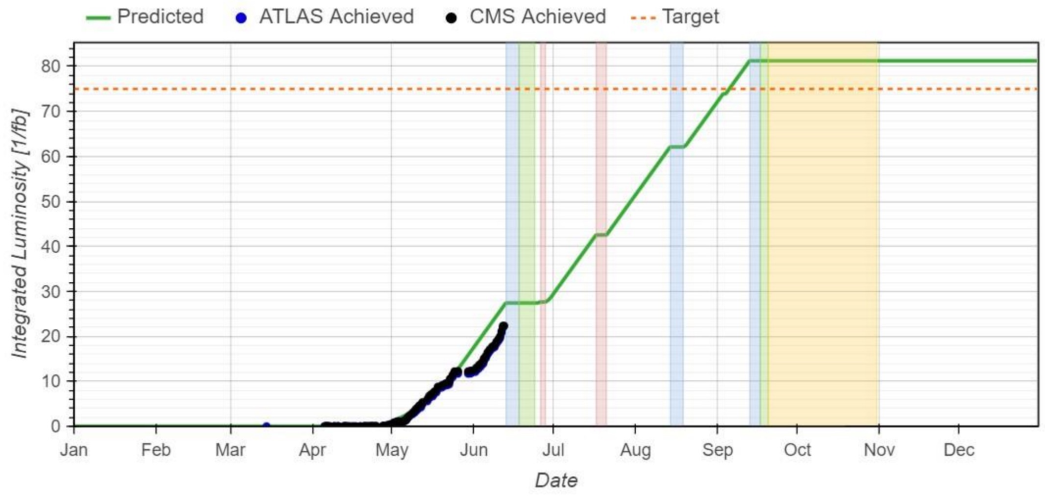
Highlight and closing remarks

Okumura + Masubuchi

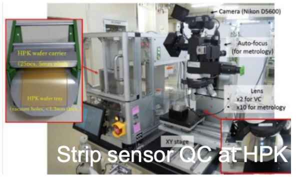
Run3 and HL-LHC

Run-3 operation in 2023



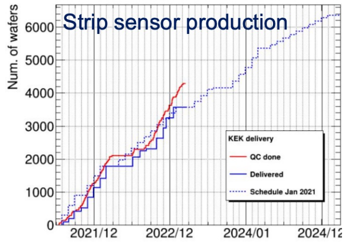
ITk production status

Japan has a big responsibility on ITk production.
A significant part of strip sensors and pixel modules are produced in Japan



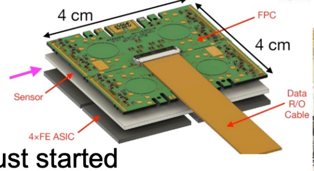
Strip sensor production

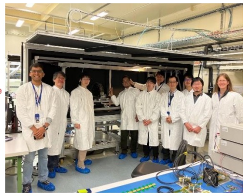
- 6350 sensors to be produced in Japan (out of 22,080)
- Production in progress (started from 2021)
  - Production at HPK going well
  - ~60% done as scheduled



Pixel module production

- 2800 modules to be produced in Japan (out of 8372)
- Pre-production in progress: important step to validate and optimize the long production process
  - Sensor production completed. Module assembly just started
- Production to be started in 2024



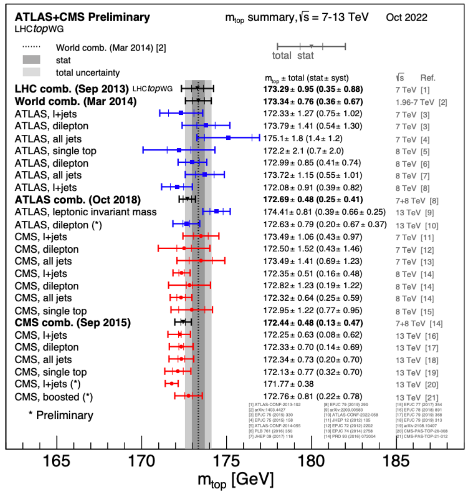


Top mass

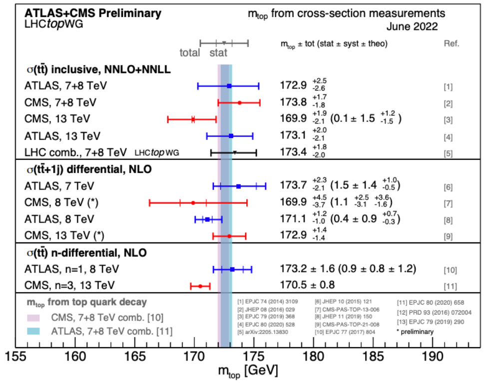
Top Quark Mass — Summary Plots <u>LHCtopWG</u>

11 /29

Direct measurements (MC mass)



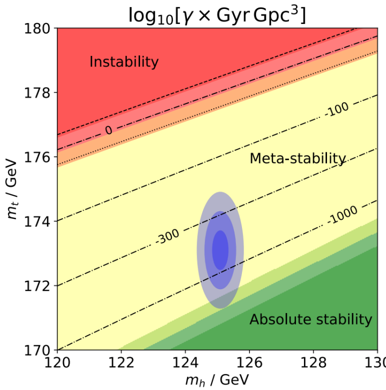
Indirect measurements (pole mass)



Recent results: relatively low m_t

Getting closer to the absolute stability?

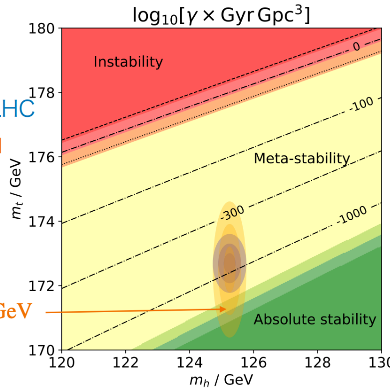
Top mass subtlety



cf.

- $\left|m_t^{\mathrm{MC}} - m_t^{\mathrm{pole}}\right| \lesssim 1\,\mathrm{GeV}$
- $\Delta m_t \sim 0.2\,\mathrm{GeV}$ @ HL-LHC

Hoang [2004.12915]



$M_t^{\mathrm{thresh}} \simeq 171.2\,\mathrm{GeV}$

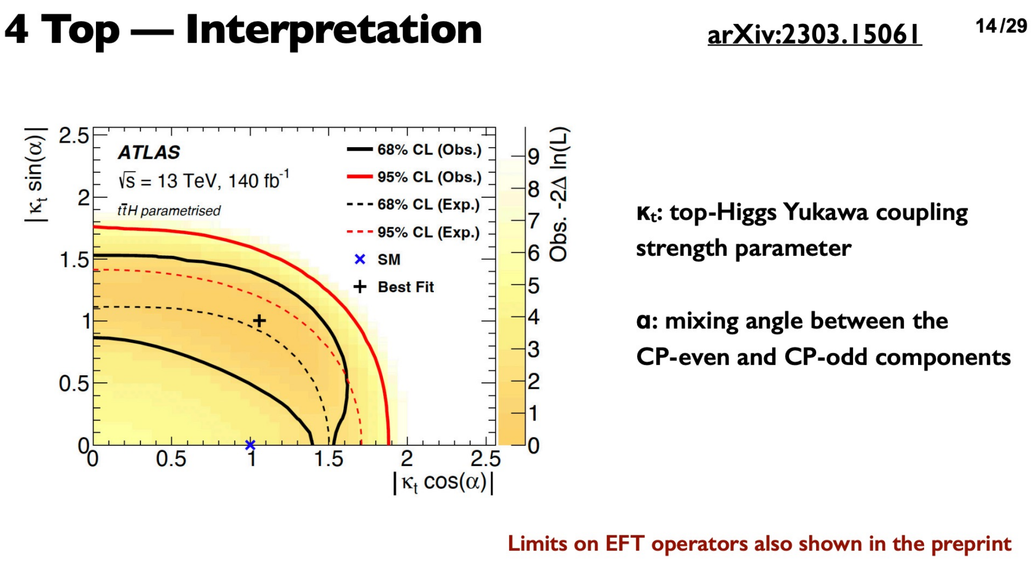
- $m_h = 125.09 \pm 0.24\,\mathrm{GeV}$
- $m_t = 173.1 \pm 0.6\,\mathrm{GeV}$ (MC mass)
- $\alpha_s = 0.1181 \pm 0.0011$

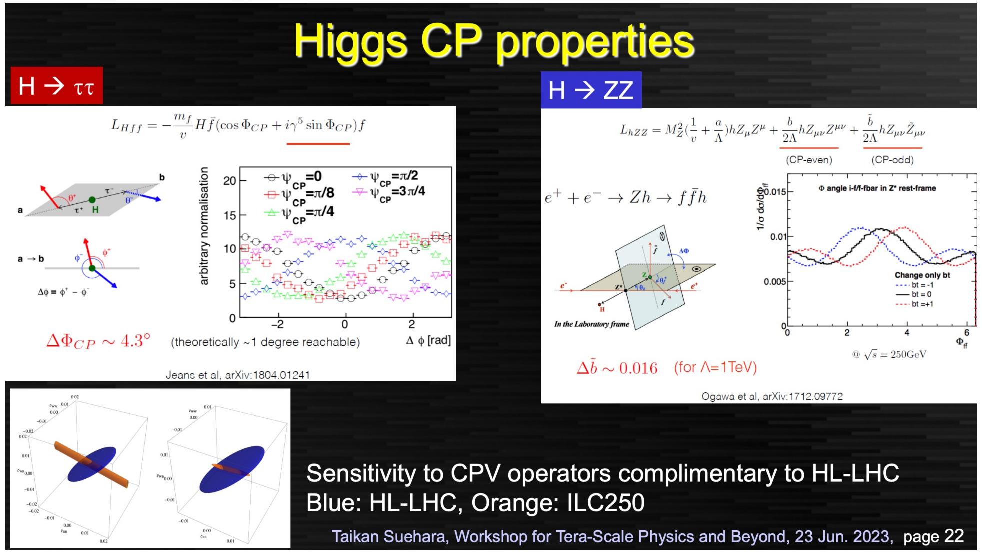
SC, Moroi & Shoji [1803.03902]

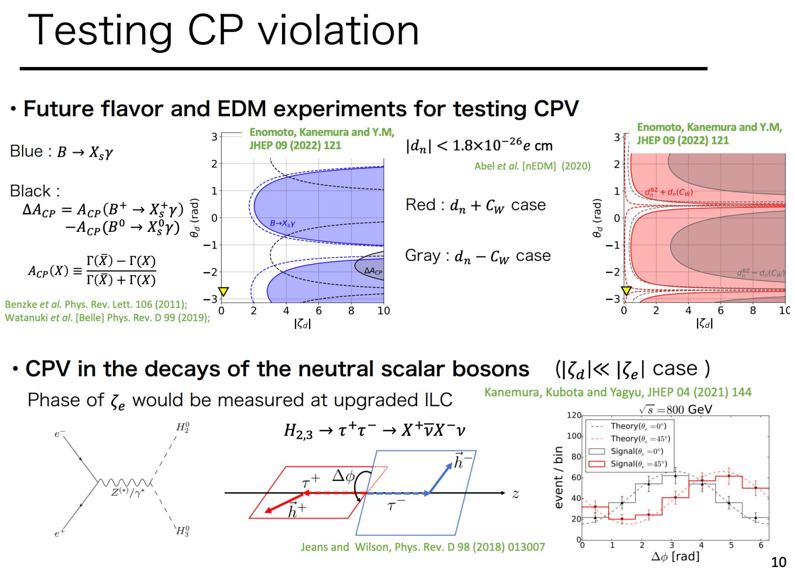
- $m_h = 125.25 \pm 0.17\,\mathrm{GeV}$
- $m_t = 172.5 \pm 0.7\,\mathrm{GeV}$ (Pole from cross-section)
- $\alpha_s = 0.1179 \pm 0.0009$

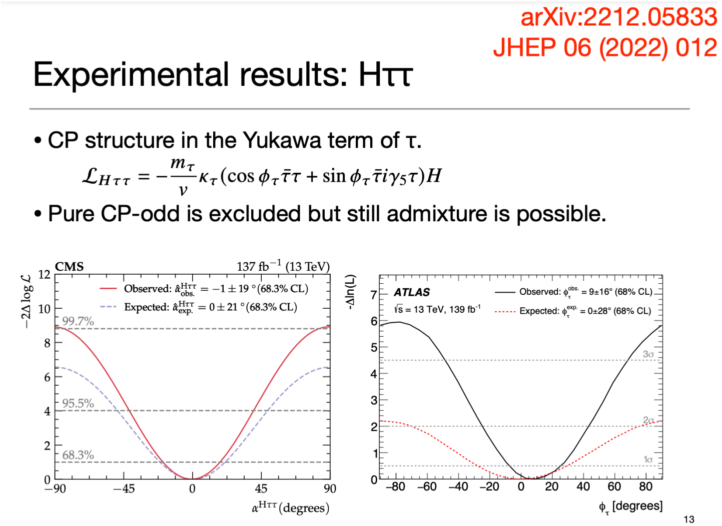
PDG 2023

CP structure of Higgs







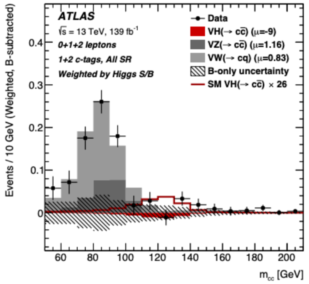


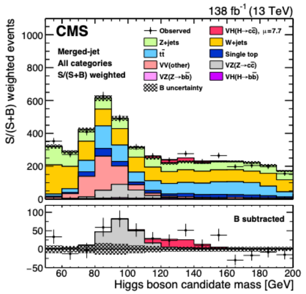
Rare decay modes of Higgs

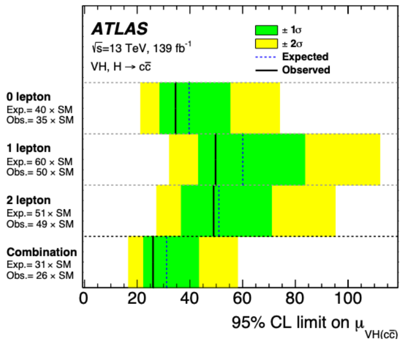
Eur. Phys. J. C 82 (2022) 717
arXiv:2205.05550

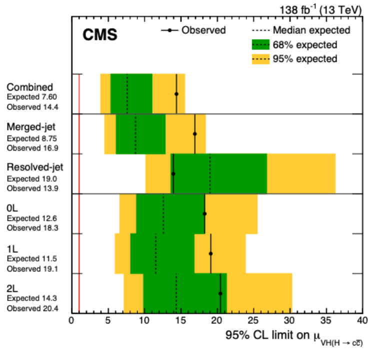
H→2nd gen. particles: H→cc

- Upper limit on $\mu=(\sigma_{obs}/\sigma_{SM})$: 26 by ATLAS, 14.4 by CMS.





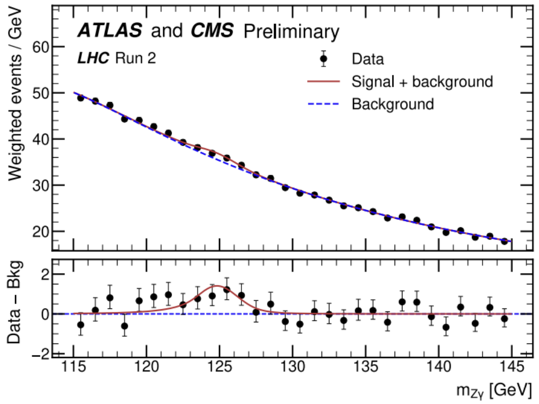




ATLAS-CONF-2023-025
CMS-PAS-HIG-23-002

H→Zγ

- Combination effort between ATLAS and CMS
  - ➡ Studied uncertainty treatment, m_H assumption...
- The first evidence of the Higgs boson decay to Z and a photon.
  - ➡ Agrees with the theoretical expectation within 1.9σ.



μ = 2.2 ± 0.7
Signi. : 3.7σ

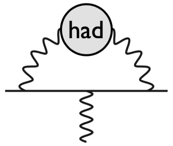
g-2/SUSY

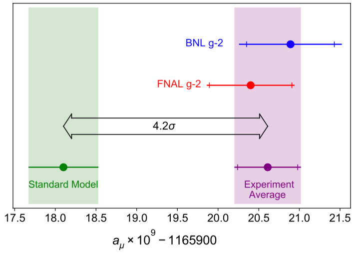
Muon anomalous magnetic moment: g-2

Tension btw FNAL (+BNL) vs SM (white paper) $a_\ell = \frac{g_\ell - 2}{2}$

$$a_\mu^{\rm BNL+FNAL} - a_\mu^{\rm SM} = (25.1 \pm 5.9) \times 10^{-10} \quad 4.2\sigma$$

Issues on hadronic contribution





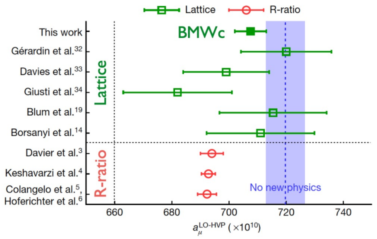
* FNAL Run2+3 planned in Aug/Sep 2023

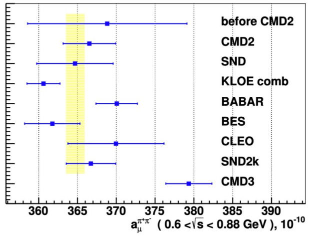
Hadronic contribution to photon vac polarization

Traditionally determined by R-ratio (dispersive approach).

BMWc (lattice) reported 2.1σ tension w/ traditional value.

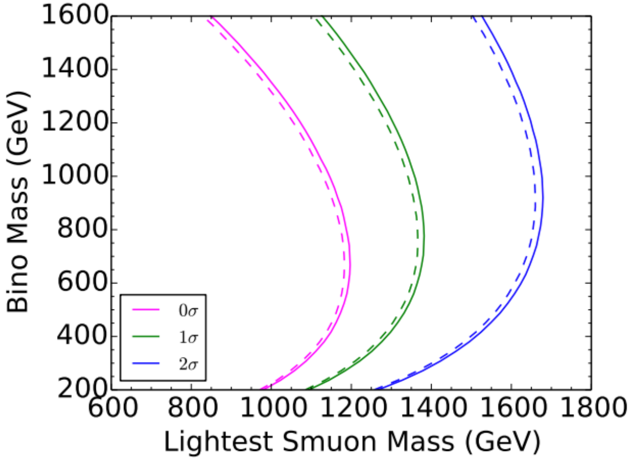
CMD-3 supports BMWc, conflicting w/ other R-ratio data.





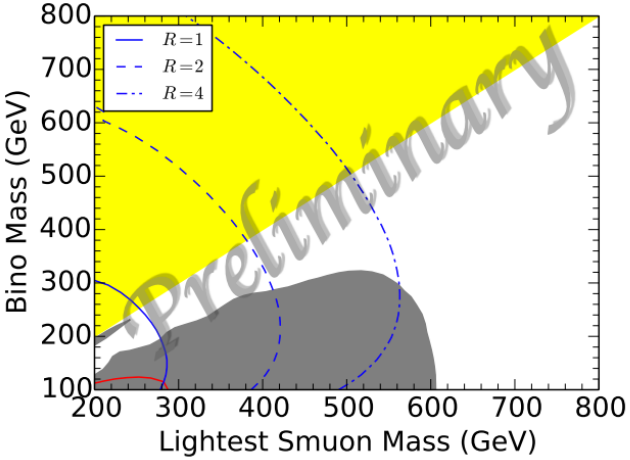
Constraints on $(g-2)_\mu$ MSSM explanation

- light $\tilde{B}$, $\tilde{\mu}$
  - CB minimum with $\langle \tilde{\mu} \rangle \neq 0$



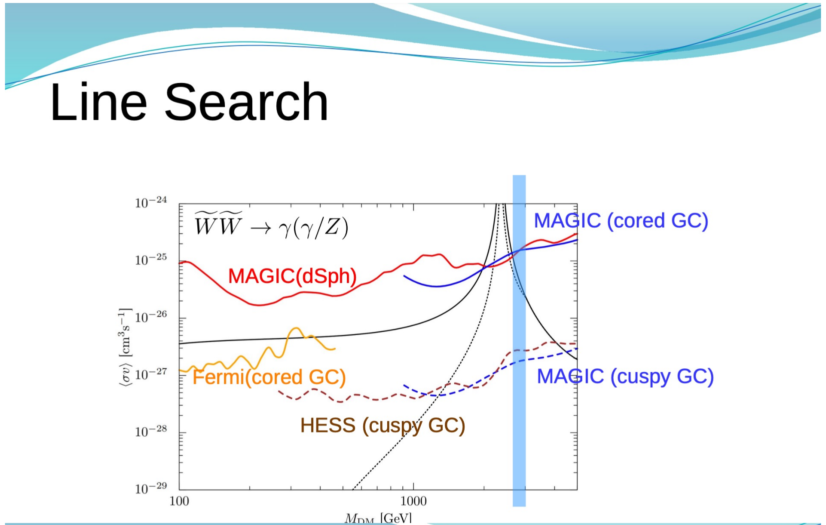
SC, Moroi & Shoji [2203.08062]

- light $\tilde{B}$, sleptons $m_{\tilde{\tau}} = R(m_{\tilde{\mu}} = m_{\tilde{e}})$
  - CB minimum with $\langle \tilde{\tau} \rangle \neq 0$

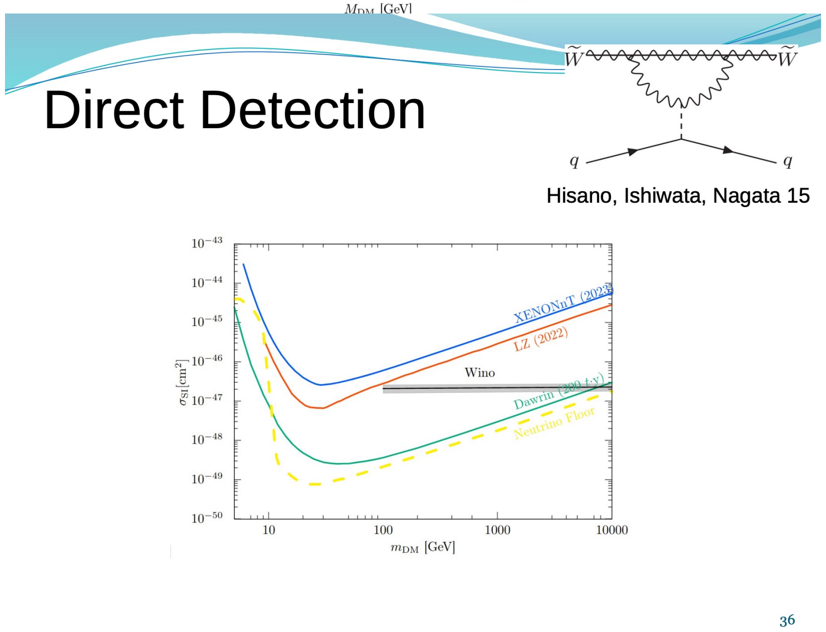


SC, Moroi & Shoji [2306.xxxxx]

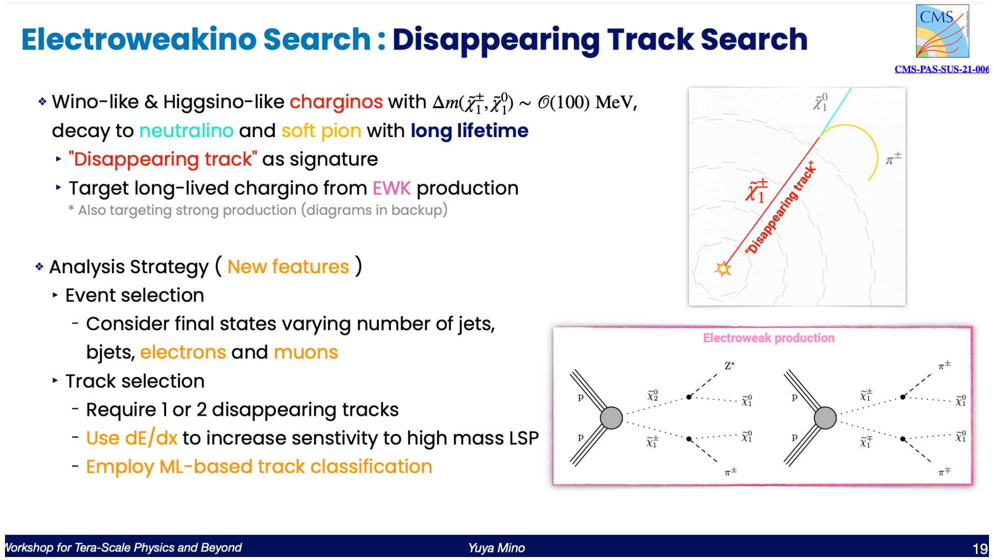
WIMP/SUSY



Line Search
$\widetilde{W}\widetilde{W} \to \gamma(\gamma/Z)$
MAGIC (cored GC)
MAGIC(dSph)
Fermi(cored GC)
MAGIC (cuspy GC)
HESS (cuspy GC)
$\langle\sigma v\rangle$ [cm^{3}s^{-1}]
M_{DM} [GeV]



Direct Detection
Hisano, Ishiwata, Nagata 15
XENONnT (2023)
LZ (2022)
Wino
Darwin (200 t·y)
Neutrino Floor
σ_{SI} [cm^2]
m_{DM} [GeV]
36



Electroweakino Search : Disappearing Track Search
CMS-PAS-SUS-21-006
Wino-like & Higgsino-like charginos with $\Delta m(\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0) \sim \mathcal{O}(100)$ MeV, decay to neutralino and soft pion with long lifetime
"Disappearing track" as signature
Target long-lived chargino from EWK production
* Also targeting strong production (diagrams in backup)
Analysis Strategy (New features)
Event selection
Consider final states varying number of jets, bjets, electrons and muons
Track selection
Require 1 or 2 disappearing tracks
Use dE/dx to increase senstivity to high mass LSP
Employ ML-based track classification
"Disappearing track"
Electroweak production
Workshop for Tera-Scale Physics and Beyond
Yuya Mino
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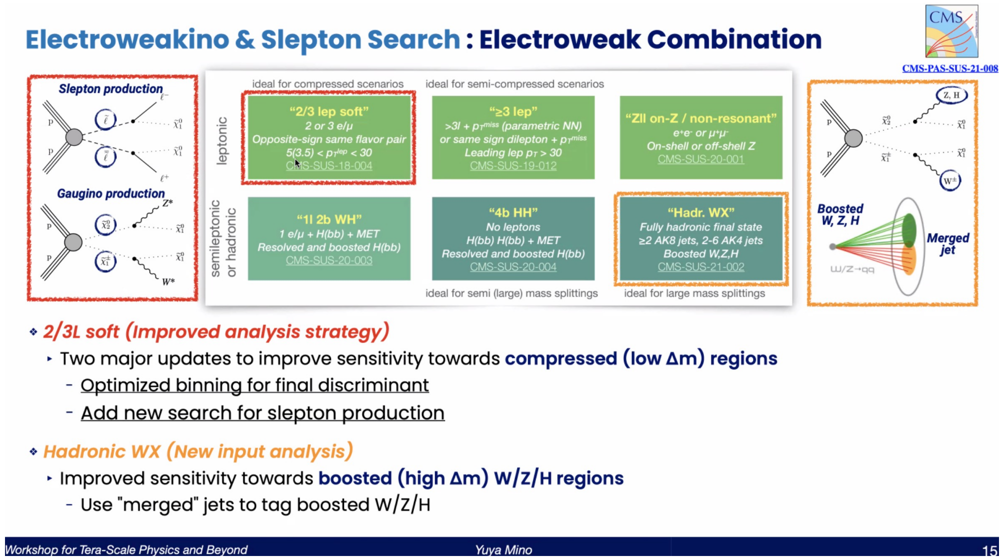

Electroweakino & Slepton Search : Electroweak Combination
CMS-PAS-SUS-21-008
Slepton production
Gaugino production
ideal for compressed scenarios
ideal for semi-compressed scenarios
leptonic
semileptonic or hadronic
"2/3 lep soft"
"≥3 lep"
"Zll on-Z / non-resonant"
"1l 2b WH"
"4b HH"
"Hadr. WX"
ideal for semi (large) mass splittings
ideal for large mass splittings
Boosted W, Z, H
Merged jet
2/3L soft (Improved analysis strategy)
Two major updates to improve sensitivity towards compressed (low Δm) regions
Optimized binning for final discriminant
Add new search for slepton production
Hadronic WX (New input analysis)
Improved sensitivity towards boosted (high Δm) W/Z/H regions
Use "merged" jets to tag boosted W/Z/H
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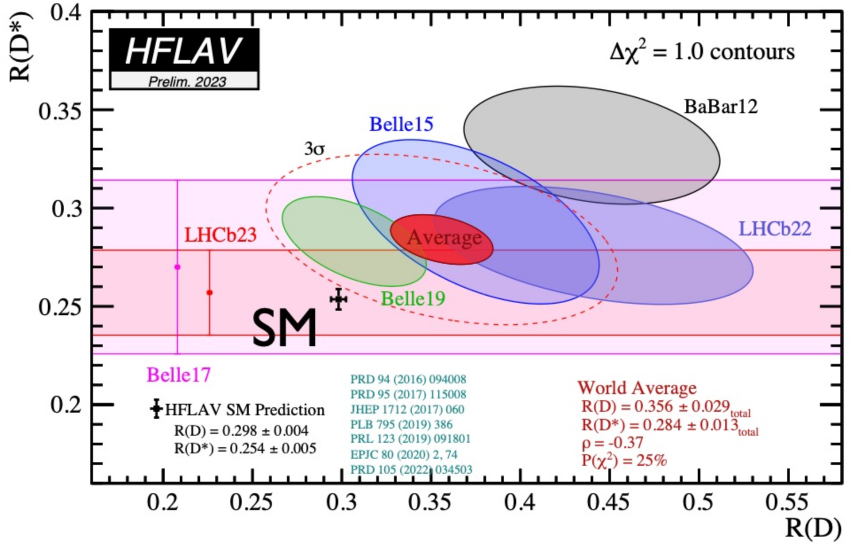
Charged current flavor anomaly

Charged current

$$R_{D^{(*)}} = \frac{\mathcal{B}(\bar{B} \to D^{(*)}\tau^-\bar{\nu}_\tau)}{\mathcal{B}(\bar{B} \to D^{(*)}\ell^-\bar{\nu}_\ell)}$$



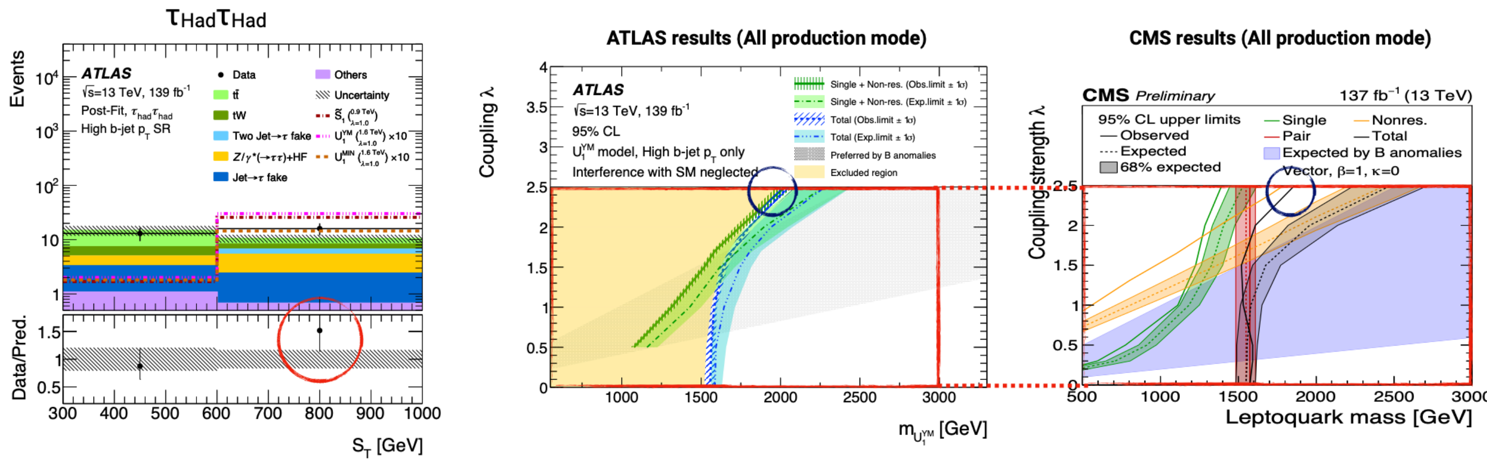
3.2σ tension b/w exp and SM

Need further experiments

Leptoquark (b-τ) : All Production Mode

arXiv:2305.15962

- CMS observed ~3σ excess above m > 1.8 TeV driven by non-resonant mode
  - ATLAS results not excluding CMS excess



Backup

Exotic theory for new signatures

No Global Symmetry

Statement: No Global Symmetry in QG.

[…, Banks-Dixon ’88, …, Banks-Seiberg ’10, …, Harlow-Ooguri ’18, …]

Perturbative string BH Holography

There are no discrete and continuous global symmetries.

For example, there are no $\mathbb{Z}_N$ and $SU(2)$ global symmetries.

The Conjecture also applies to new notion of symmetry such as higher form symmetry and non-invertible symmetry.

The global symmetry at the boundary of the spacetime is OK. (e.g. AdS/CFT)

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Example

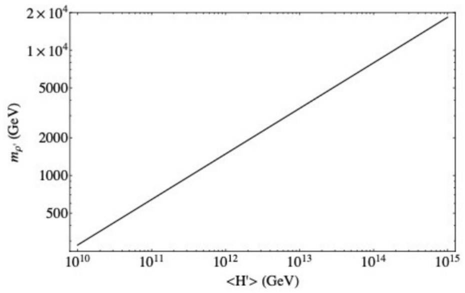
A model [Hook ‘14] solving the strong CP problem utilizes $\mathbb{Z}_2$ symmetry.

Standard Model ⟺ Mirror Standard Model

$\mathbb{Z}_2$

Prediction: Colored particle at TeV scale.

Chance to test at LHC.



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Thank you!

We are happy to resume in-person version of Tera-scale workshop again with you

- Thanks to all participants
- Thanks to all speakers and chairs
- Special thanks to Kyushu University colleagues! (Tojo-san!)

Take care of the way back, and see you
at the next workshop of this series