Weekly update

$4\ell + E_{\mathrm{T}}^{\mathrm{miss}}$ analysis

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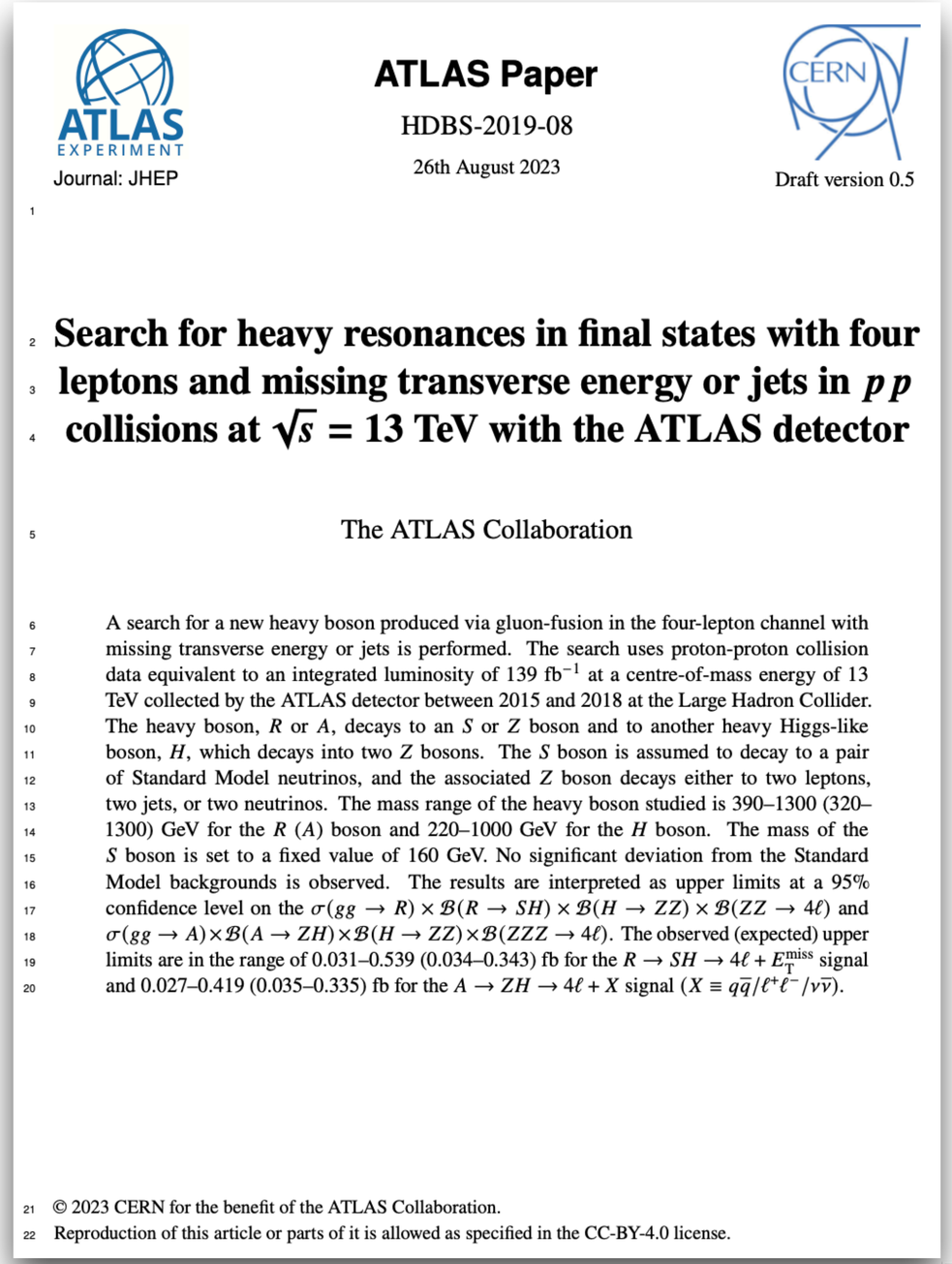
Introduction

- ☐ Finalised implementing all the comments received for the paper draft in the CDS.
- ☐ Two more comments need to be entered into the CDS.
- ☐ The discussion revolves around how the upper limit should be presented, especially for the $A \to ZH \to 4\ell + X$ search.
- ☐ I proposed cancelling out the $\mathscr{B}(Z \to jj/\ell^+\ell^-/\text{invisible})$ of the Z boson associated with the H boson.



ATLAS EXPERIMENT

Journal: JHEP

ATLAS Paper

HDBS-2019-08

26th August 2023

CERN

Draft version 0.5

Search for heavy resonances in final states with four leptons and missing transverse energy or jets in pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector

The ATLAS Collaboration

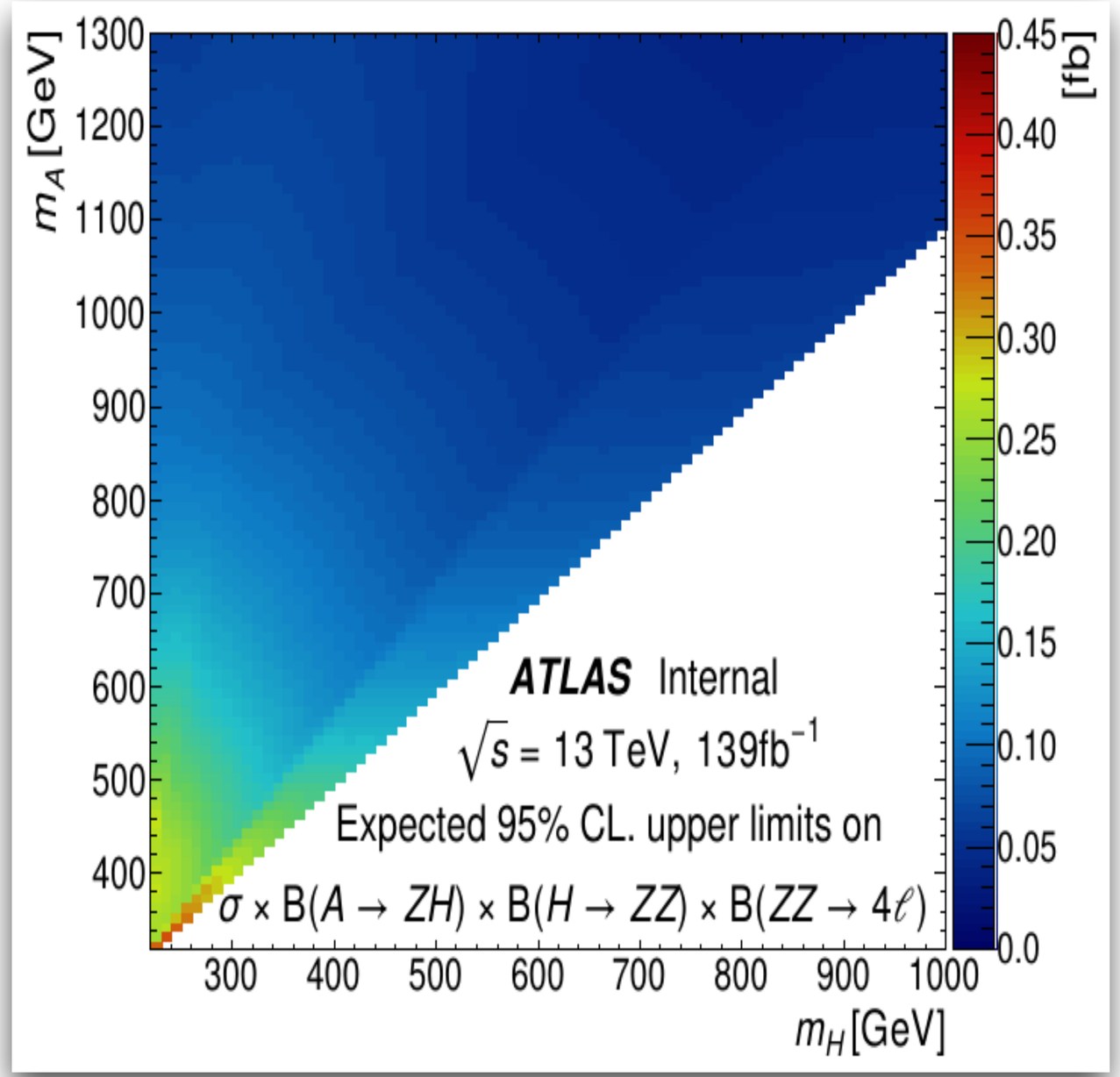
A search for a new heavy boson produced via gluon-fusion in the four-lepton channel with missing transverse energy or jets is performed. The search uses proton-proton collision data equivalent to an integrated luminosity of 139 fb^{-1} at a centre-of-mass energy of 13 TeV collected by the ATLAS detector between 2015 and 2018 at the Large Hadron Collider. The heavy boson, R or A, decays to an S or Z boson and to another heavy Higgs-like boson, H, which decays into two Z bosons. The S boson is assumed to decay to a pair of Standard Model neutrinos, and the associated Z boson decays either to two leptons, two jets, or two neutrinos. The mass range of the heavy boson studied is 390–1300 (320–1300) GeV for the R (A) boson and 220–1000 GeV for the H boson. The mass of the S boson is set to a fixed value of 160 GeV. No significant deviation from the Standard Model backgrounds is observed. The results are interpreted as upper limits at a 95% confidence level on the $\sigma(gg \to R) \times \mathcal{B}(R \to SH) \times \mathcal{B}(H \to ZZ) \times \mathcal{B}(ZZ \to 4\ell)$ and $\sigma(gg \to A) \times \mathcal{B}(A \to ZH) \times \mathcal{B}(H \to ZZ) \times \mathcal{B}(ZZZ \to 4\ell)$. The observed (expected) upper limits are in the range of 0.031–0.539 (0.034–0.343) fb for the $R \to SH \to 4\ell + E_{\mathrm{T}}^{\mathrm{miss}}$ signal and 0.027–0.419 (0.035–0.335) fb for the $A \to ZH \to 4\ell + X$ signal ($X \equiv q\bar{q}/\ell^+\ell^-/\nu\bar{\nu}$).

Dividing out the Z branching ratio

- The Z branching ratio:
  - $\mathscr{B}(Z \to e^+e^-) = 3.3632$
  - $\mathscr{B}(Z \to \mu^+\mu^-) = 3.3632$
  - $\mathscr{B}(Z \to$ invisible$) = 20.0$
  - $\mathscr{B}(Z \to$ hadrons$) = 69.911$

- For instance, for (320, 220) GeV, the upper limit is 0.325, which will become 0.336.

- So, the upper limit doesn't change by much.



$$A \to Z(\to jj/\ell\ell/\text{invisible})H(\to 4\ell)\ \&\ A \to Z(\to 2\ell)H(\to 2\ell + jj/\text{invisible})$$

Summary

- ☐ The discussion about removing the Z boson branching ratio is still going on.
- ☐ There's a suggestion from Klaus to remove all the Z boson branching ratios,
- ☐ which makes the results unambiguous.
- ☐ We will circulate the paper draft once this issue has been agreed upon.