Statistics, recasting, global fits…

Belle II Physics week, October 17 2024

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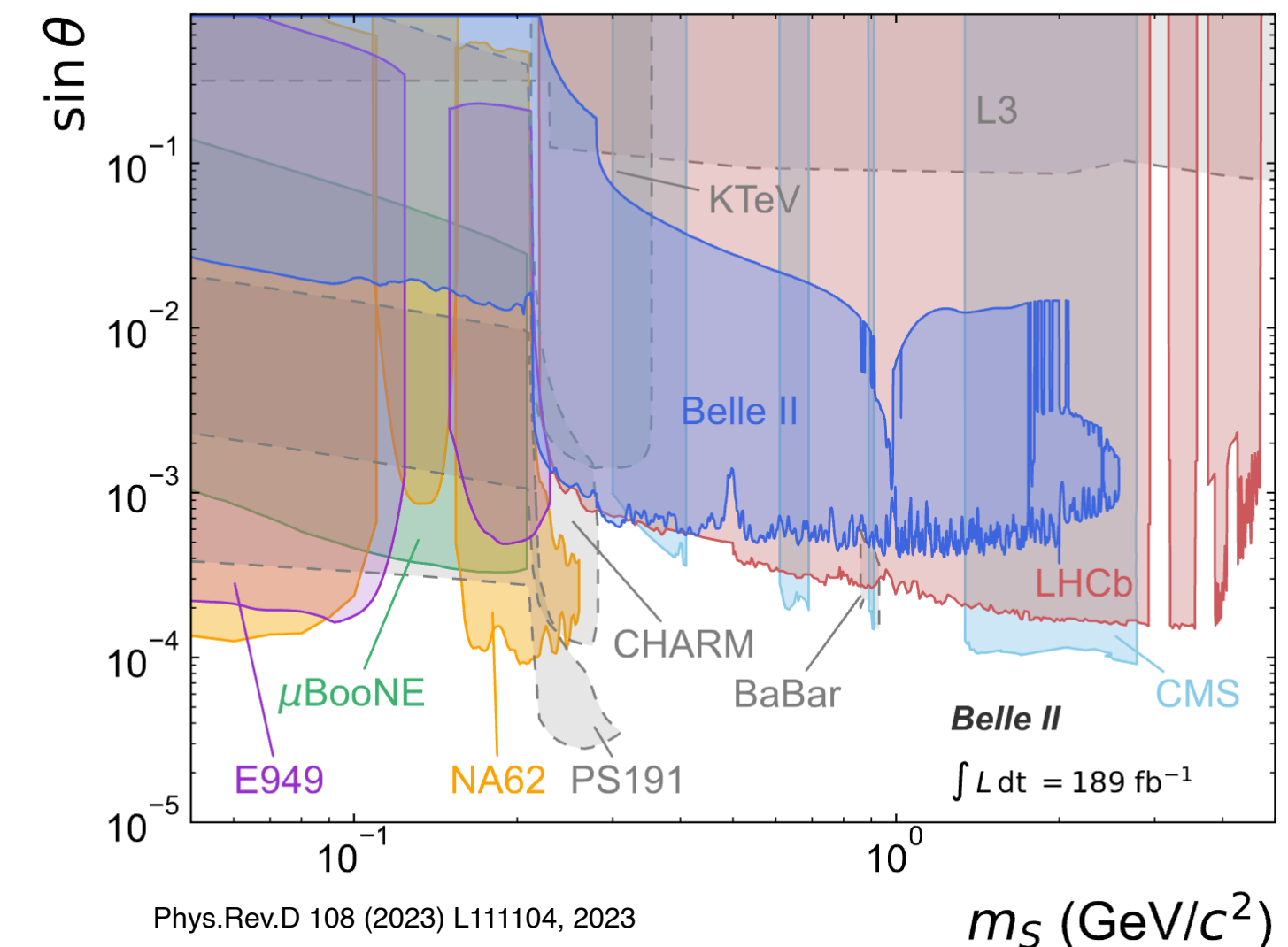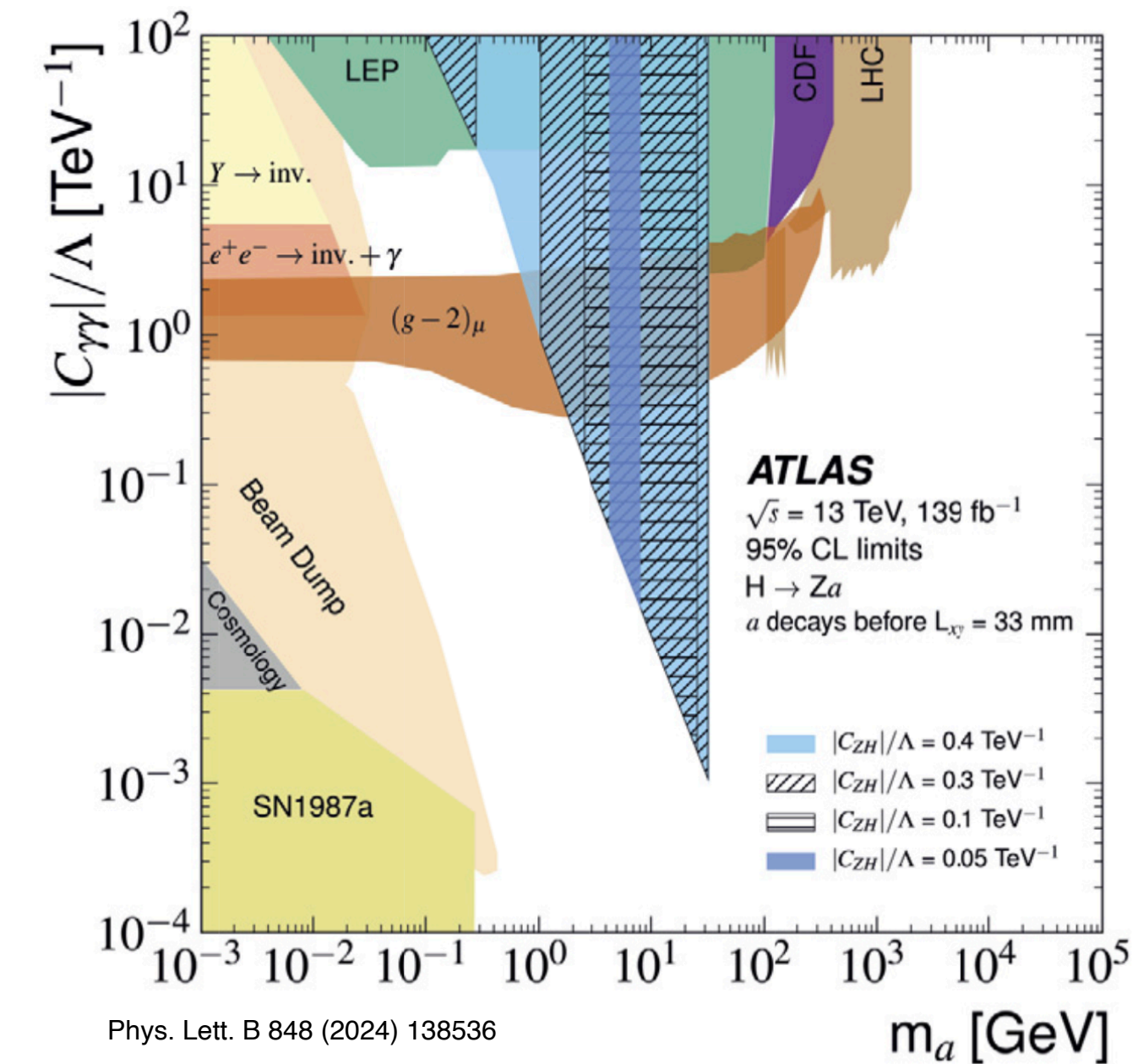**Anke Biekoetter, Nazila Mahmoudi**

Tomasz Procter, Lorenz Gärtner, Giordon Stark

Summary: Global fits and combination

- C9 discrepancy in global fits of flavour anomalies has increased even more* with latest CMS and LHCb results that alone are not (very) significant

  - It appears that only significant progress on the theory side can lead to a robust prediction if this is new physics. Are the theory predictions and global fits published with the same statistical rigor and public information as the experimental ones?

    *Nazila's slide not public since results not published yet

- In dark sector searches we often do not yet actually combine different searches but just overlay limits

  - We need a quality control: The CERN PBC recommendatin is to outline recasts in gray dashed and show actual searches in solid colors. Belle II has adopted in the last $B \to KS$ search (and in the coming inelastic DM as well).

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Summary: Global fits and combination

- How do we best give complex model searches to theorists: Multiple final states, lifetimes and masses? (The upcoming inelastic DM analysis has seven free parameters and two different long-lived particles)
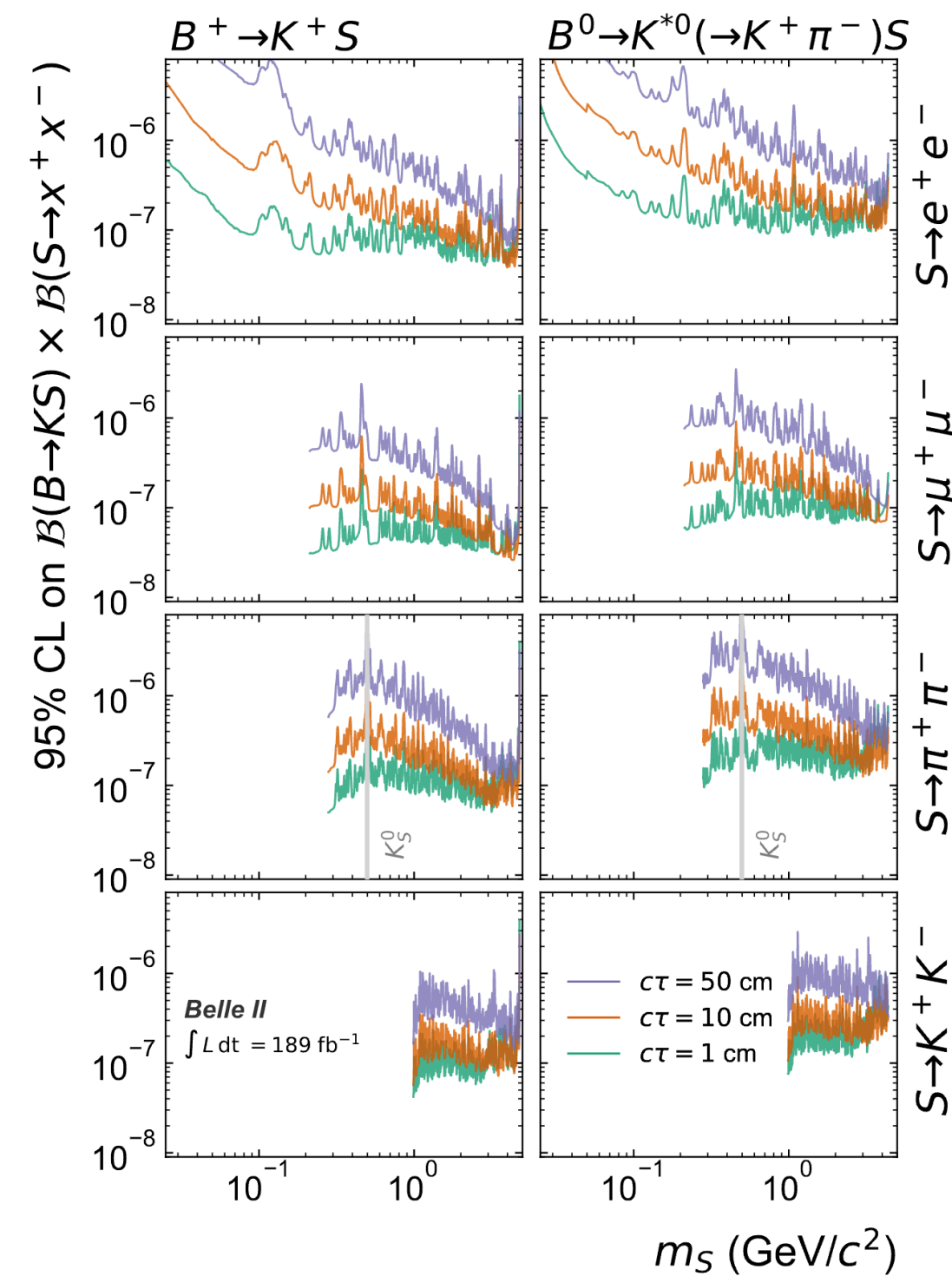
+ all event counts, background expectations and efficiencies

This was actually done like that with a lot of input from theorist Felix Kahlhoefer.

Phys.Rev.D 108 (2023) L111104, 2023, https://www.hepdata.net/record/ins2665757
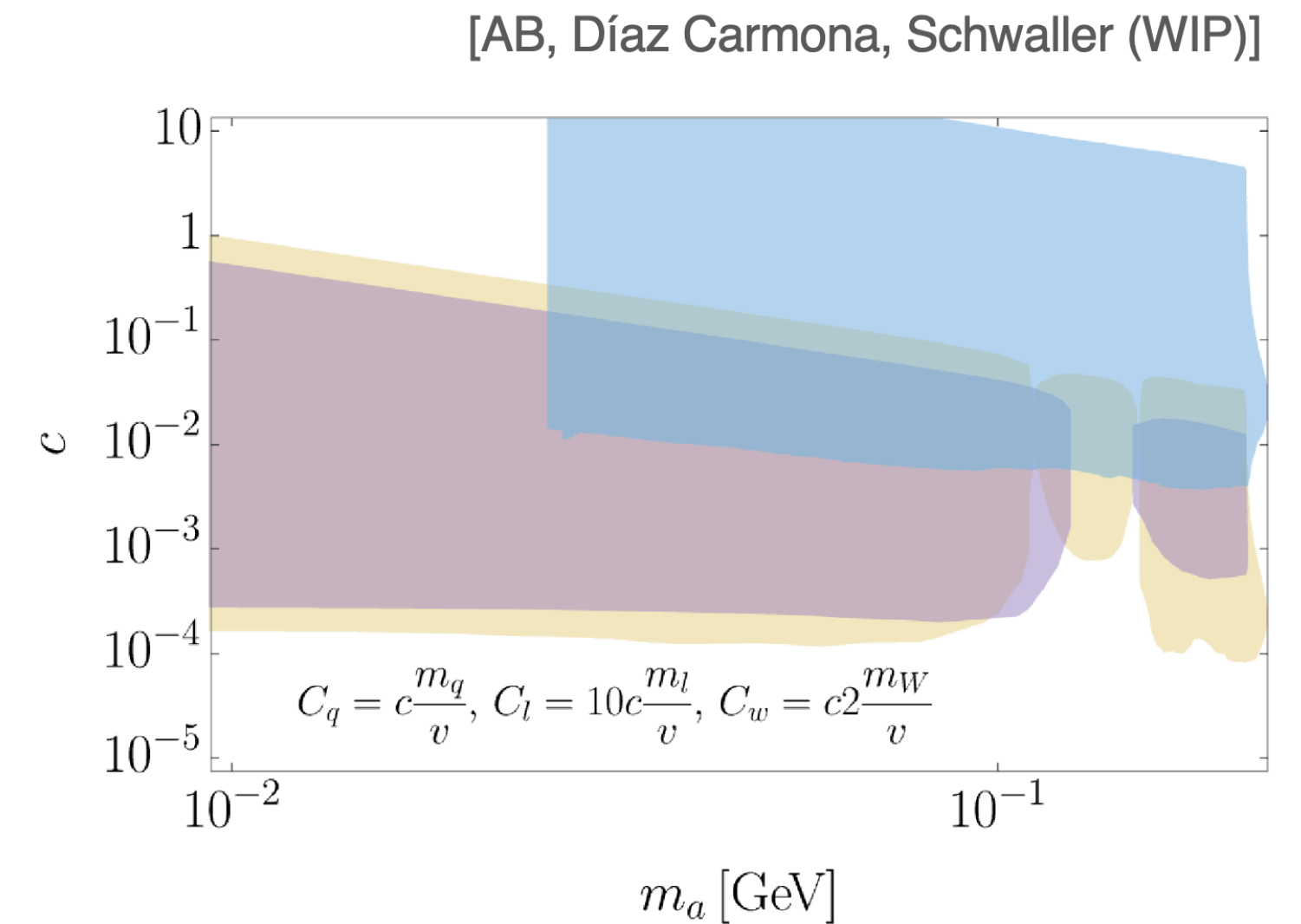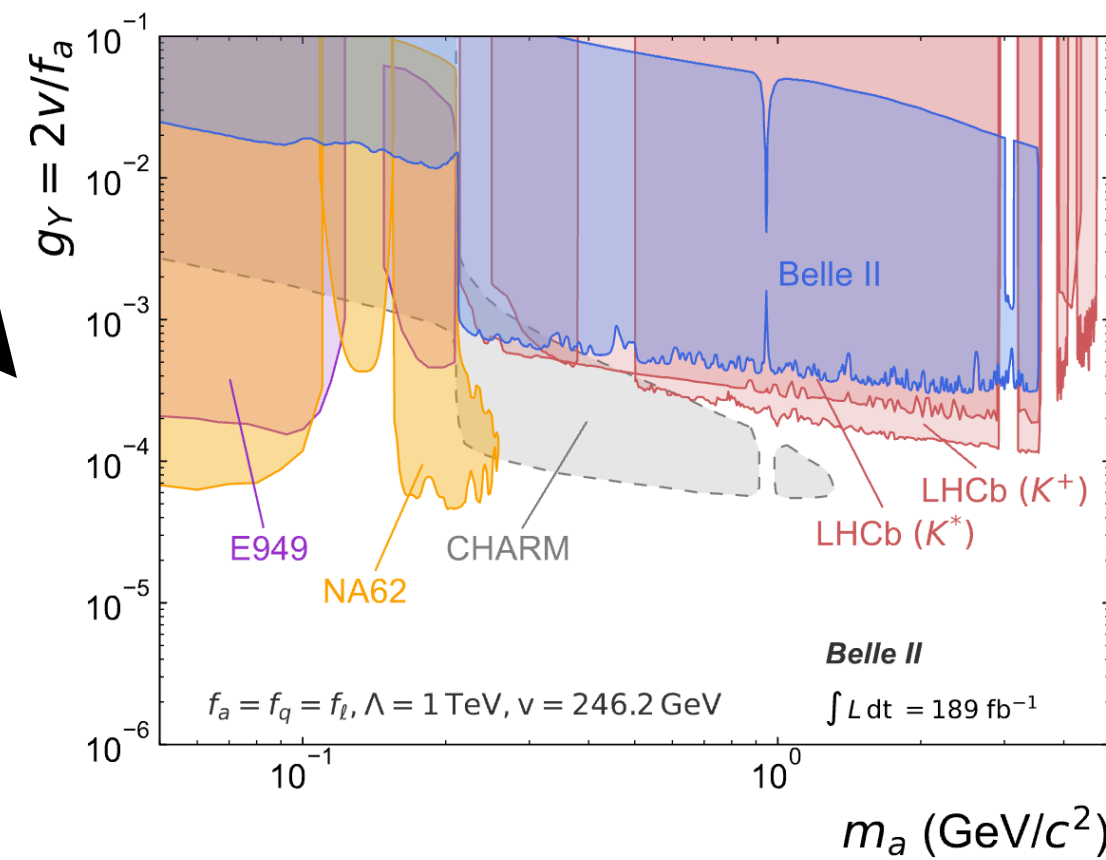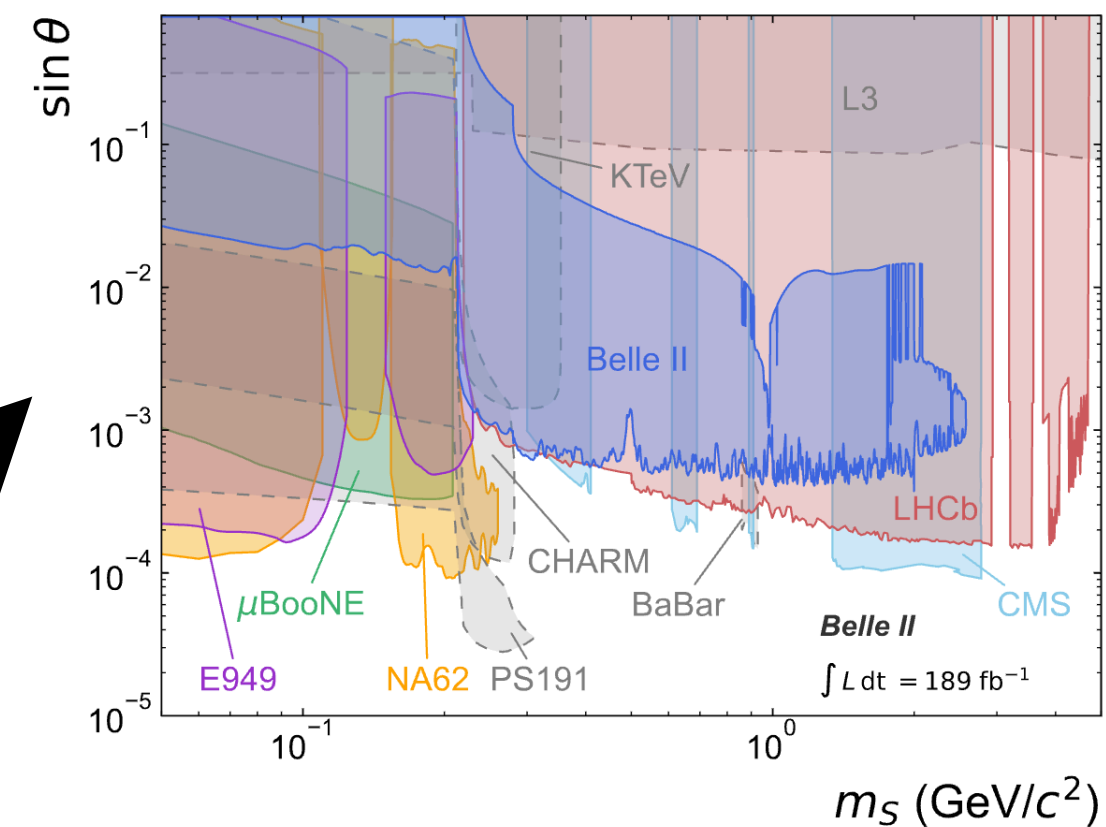
Summary: Tools and combinations

- Examples of actual combinations of searches (same model, different final states) are significantly stronger than individual limits: Do we have Belle II cases for this?
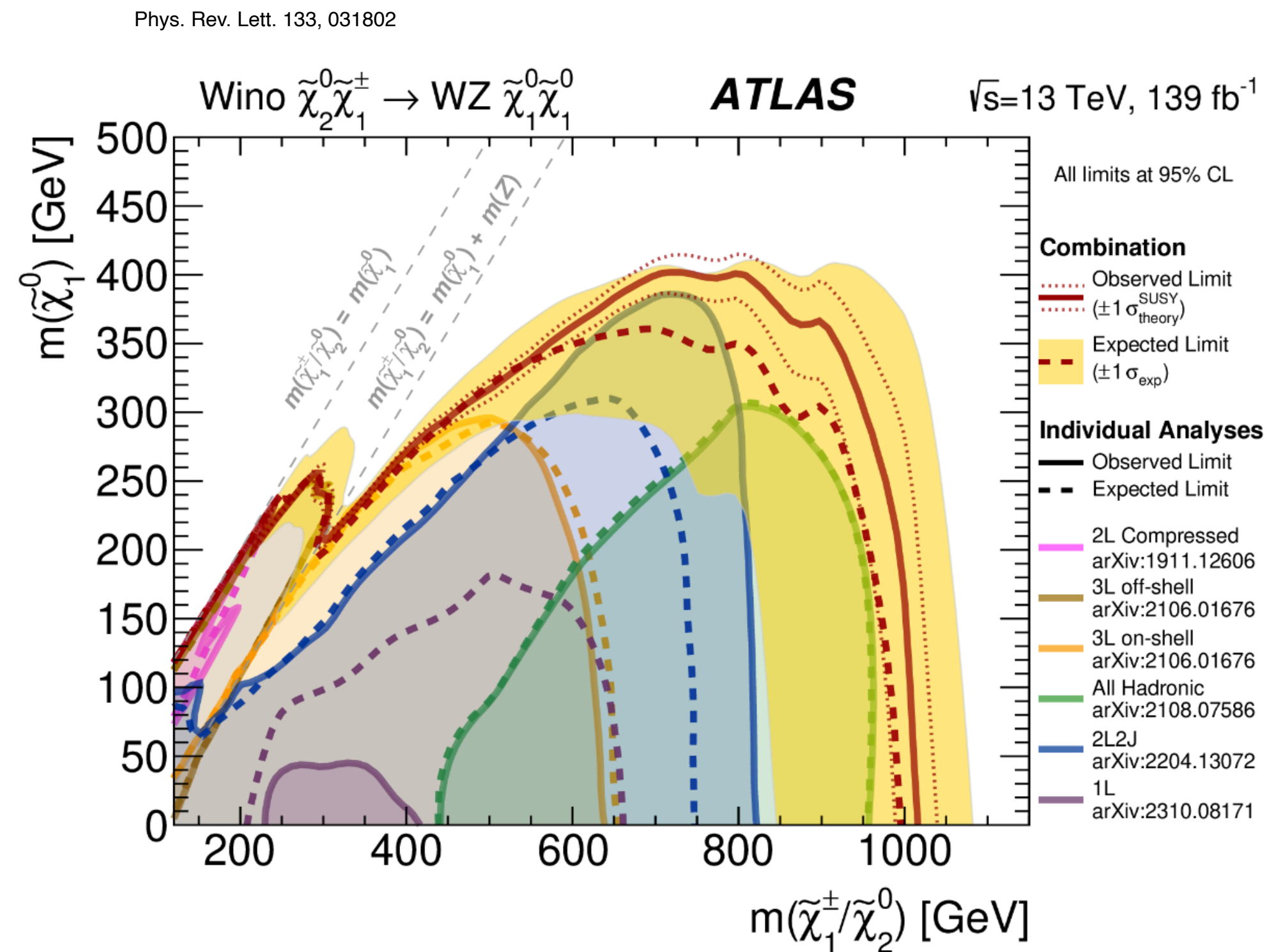
- Reinterpretation of published analyses was historically time-consuming and complicated. It can be made fast(er) and easy(er) with the right tools and preparation by the experiments

- Reproducibility (and even more so recasting) of analyses particularly challenging if ML methods are involved. Are Belle II analyses reproducible (by us)?

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Questions

- What do we mean if we say "recasting" or "reinterpretation"?

  - Theorists using our results? Internal re-use of analyses to speed up publications? Internal combinations?

- Should Belle II publish "combined analysis" papers or are we leaving this to theorists?

- Does Belle II need a fast-simulation?

  - After all, our full sim+rec takes less than 1s per event (including low-ish beam background) and our framework is open source

- Does Belle II need a Delphes version?

  - Probably mostly for studying new ideas fast?

- How much effort/time should we spend on making an analysis "recastable"?

  - At the end, (PhD) time is limited. Do we have any metric of "usefulness" (e.g. more citations if HepData is available)?

- Is publishing useful information only a challenge to experimentalists, or also to theorists?

- Are there certain models that should be prioritized in Belle II searches to be useful in global analysis?

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