Compressed chargino search at the LHeC (and beyond)

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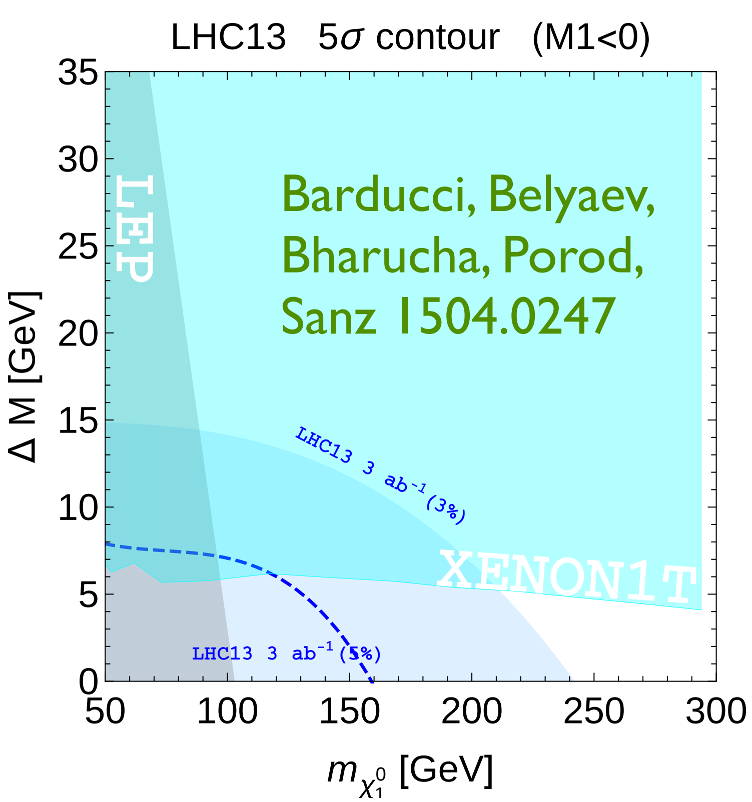
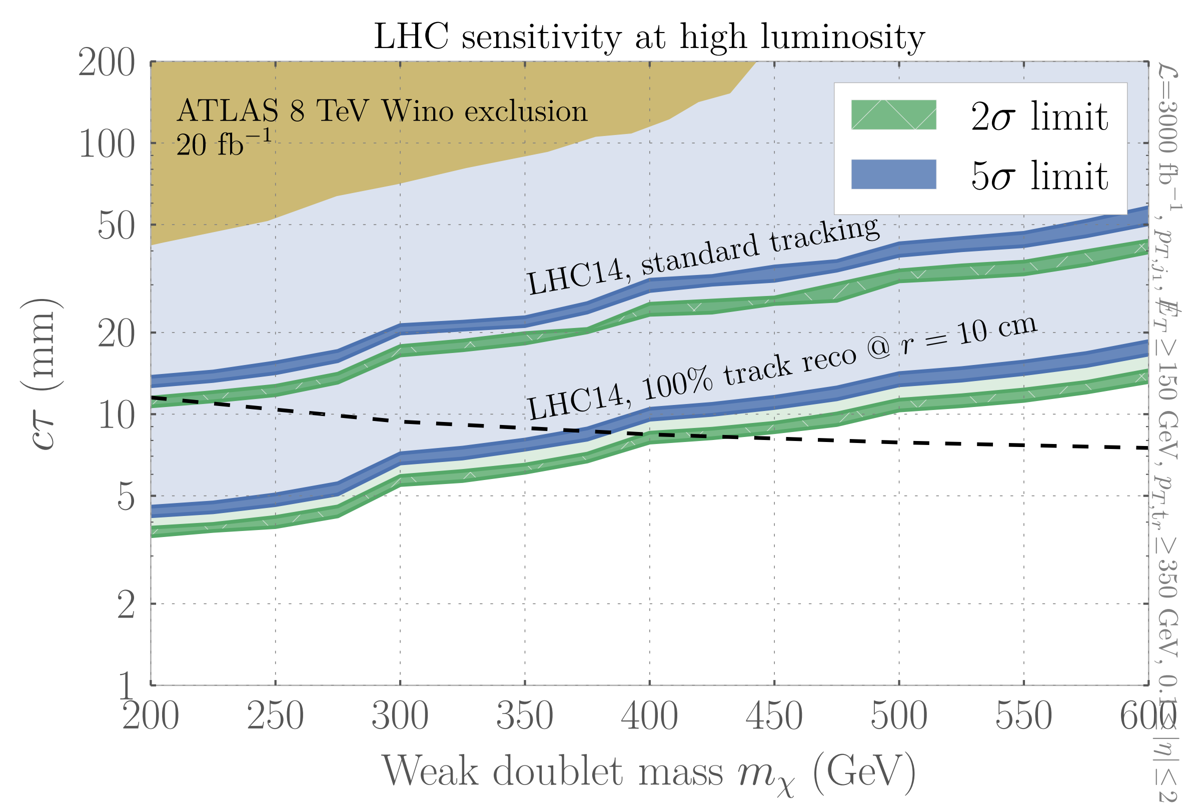
David Curtin, Kaustubh Deshpanse, Oliver Fischer, JZ, [arXiv 1709.abcde]

BSM physics studies at e-p colliders, CERN 11.08.2017

Why Higgsinos?

- Natural dark matter candidate (m < 1.1 TeV), with charged-neutral splitting of 300-340 MeV, and cτ ~ 6-19 mm. The mass reach (2-σ) at the LHC (FCC) is
  - Monojet: 250 (600) GeV
    Schwaller, JZ 1312.7350, Barducci, Belyaev, Bharucha, Porod, Sanz 1504.0247, Low, Wang 1404.0682.
  - Disappearing tracks: 200-370 (1100) GeV, depending on tracker improvements.
    Mahbubahni, Schwaller, JZ: 1703.05327.



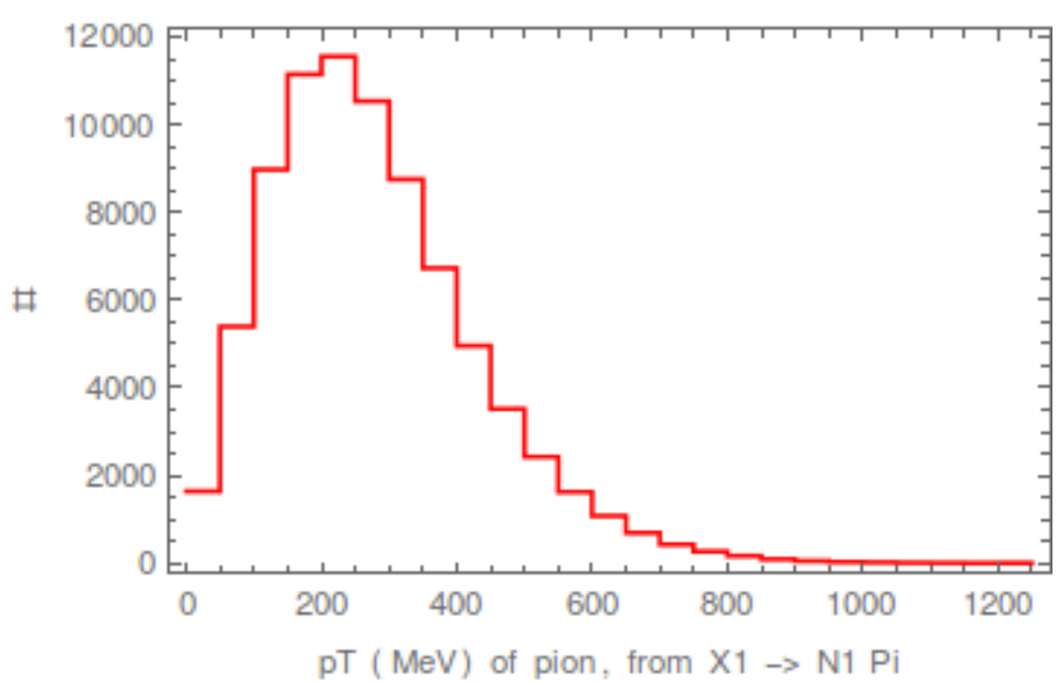


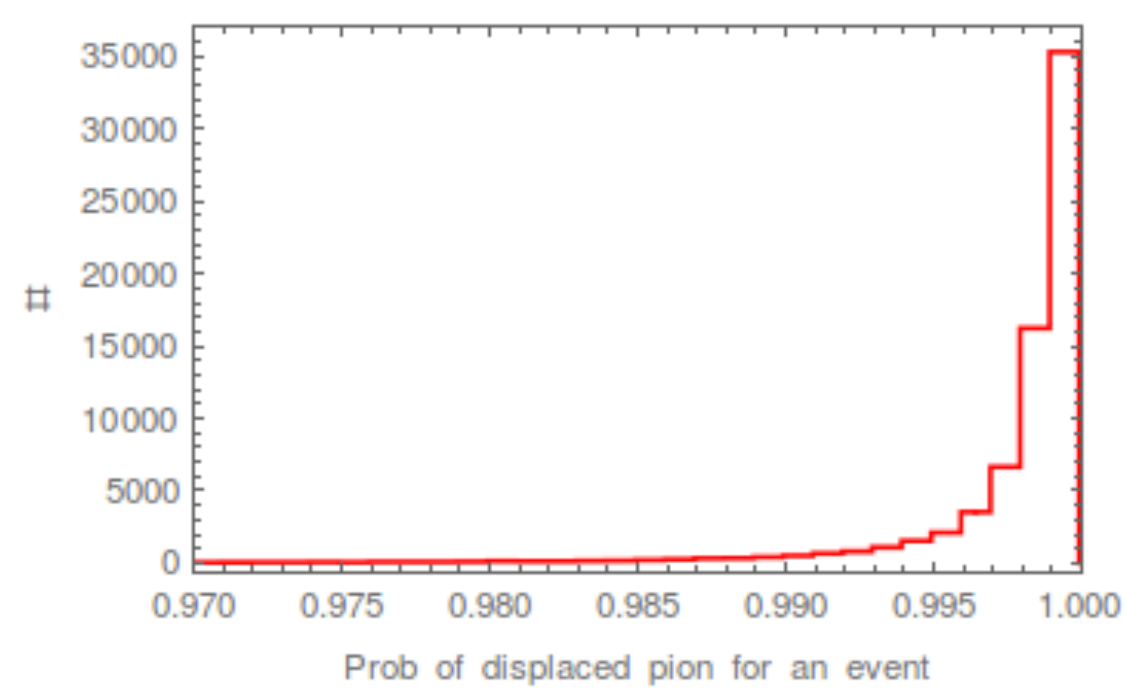
Mahbubahni, Schwaller, JZ: 1703.05327.

How can the e-p colliders enhance the searches?

The e-p magic in action

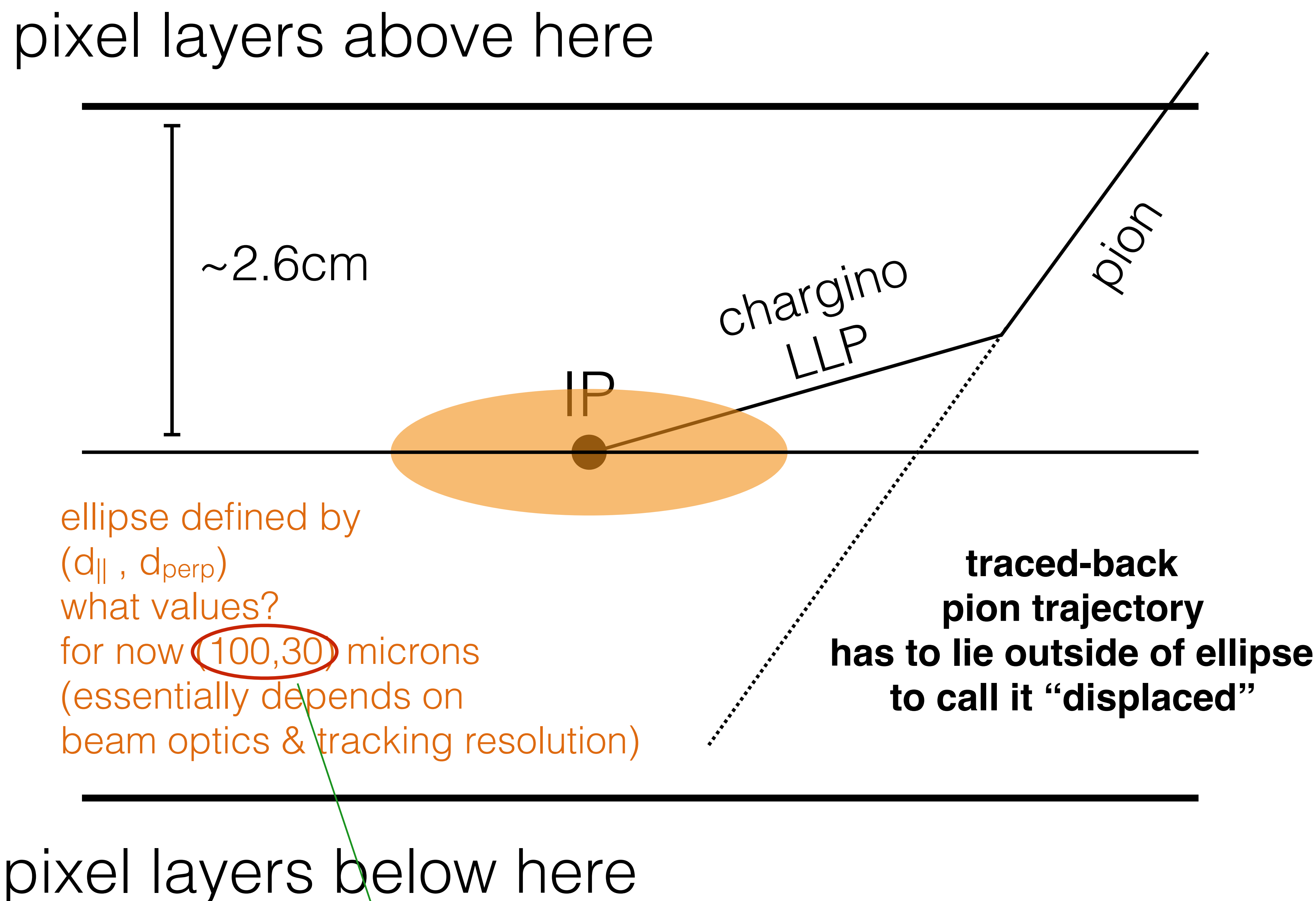
- Disappearing tracks at hadron colliders rely on $\chi^+ \longrightarrow \chi^0 \pi^+$ (the pion is lost).
- e-p provides a clean environment (1 bunch/crossing, event reconstruction, …)
- Our strategy is to have a displaced pion:
  - p_T > 100 MeV .
  - Live in a 40 microns sphere from the IP
    (displacement wrt PV is enough? Is this region BG free?
  - Highly likely to occur! (pion reconstruction efficiency set to 100%)





Curtin, Deshpande, Fischer, JZ (in preparation)

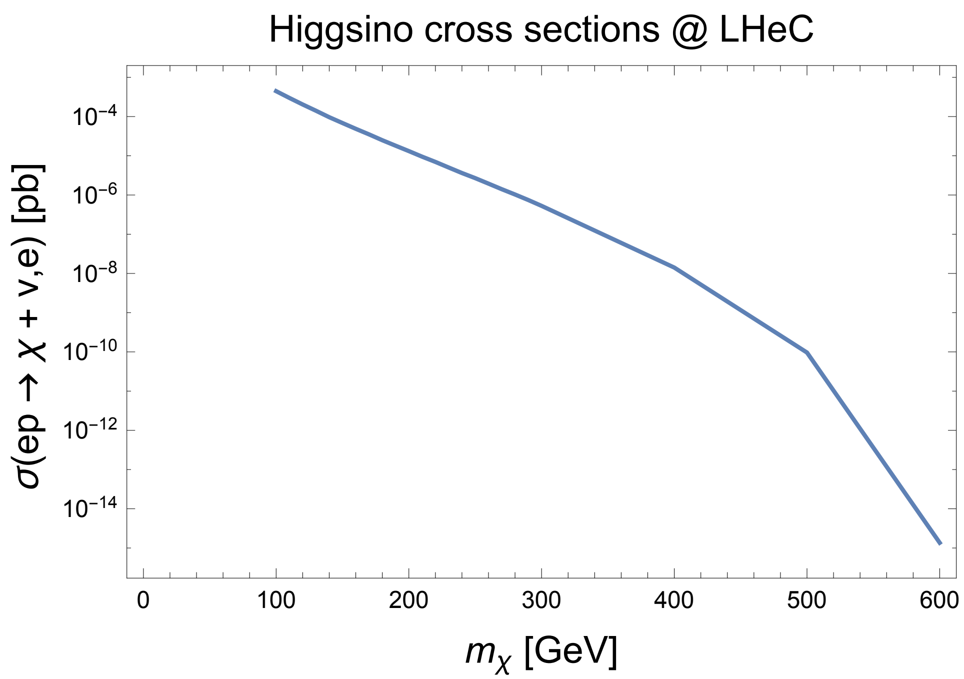
Zooming into displaced pions

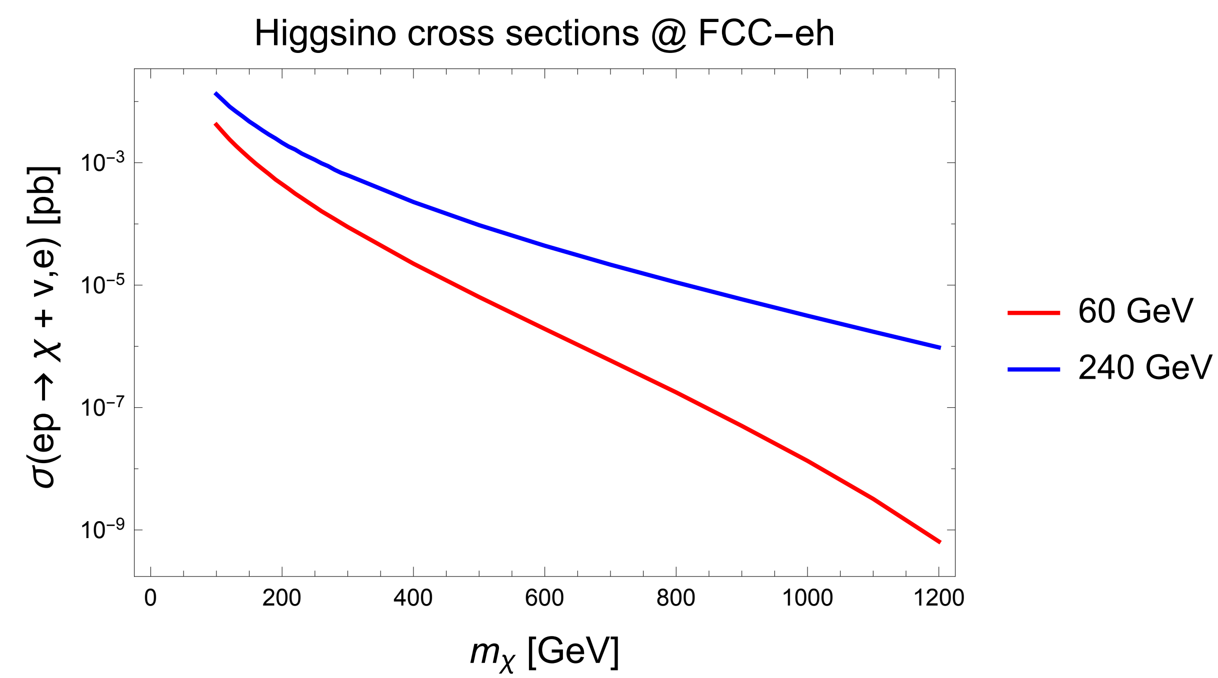


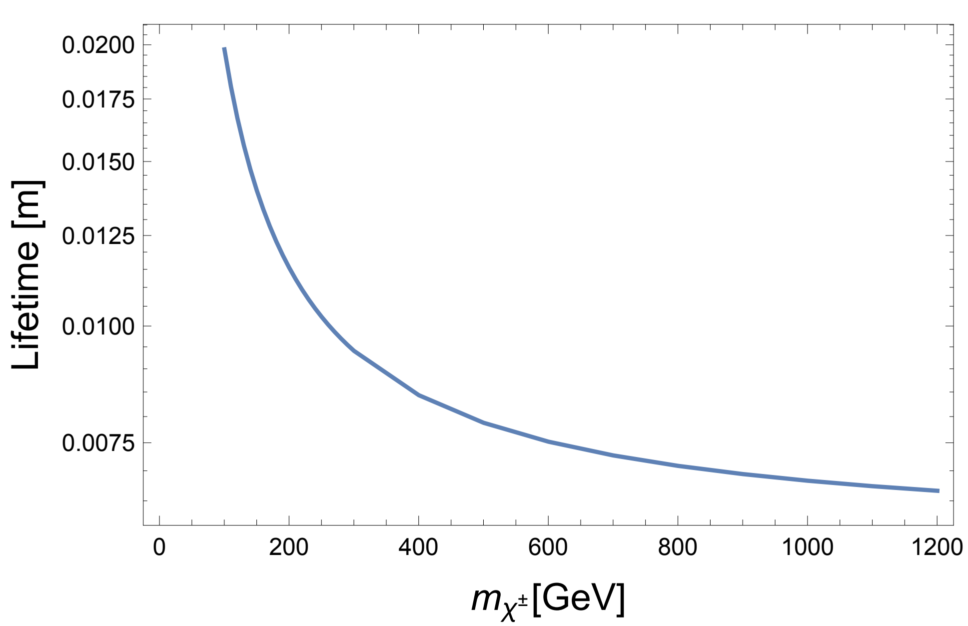
Latest: (40,40)

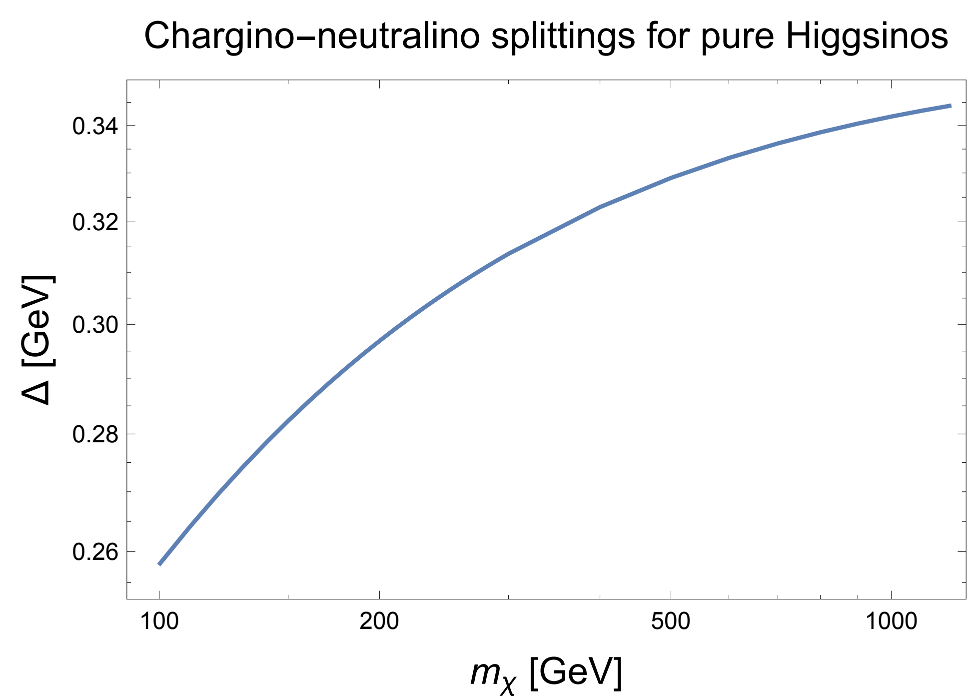
Artwork: David Curtin

Cross sections, cτ, splittings



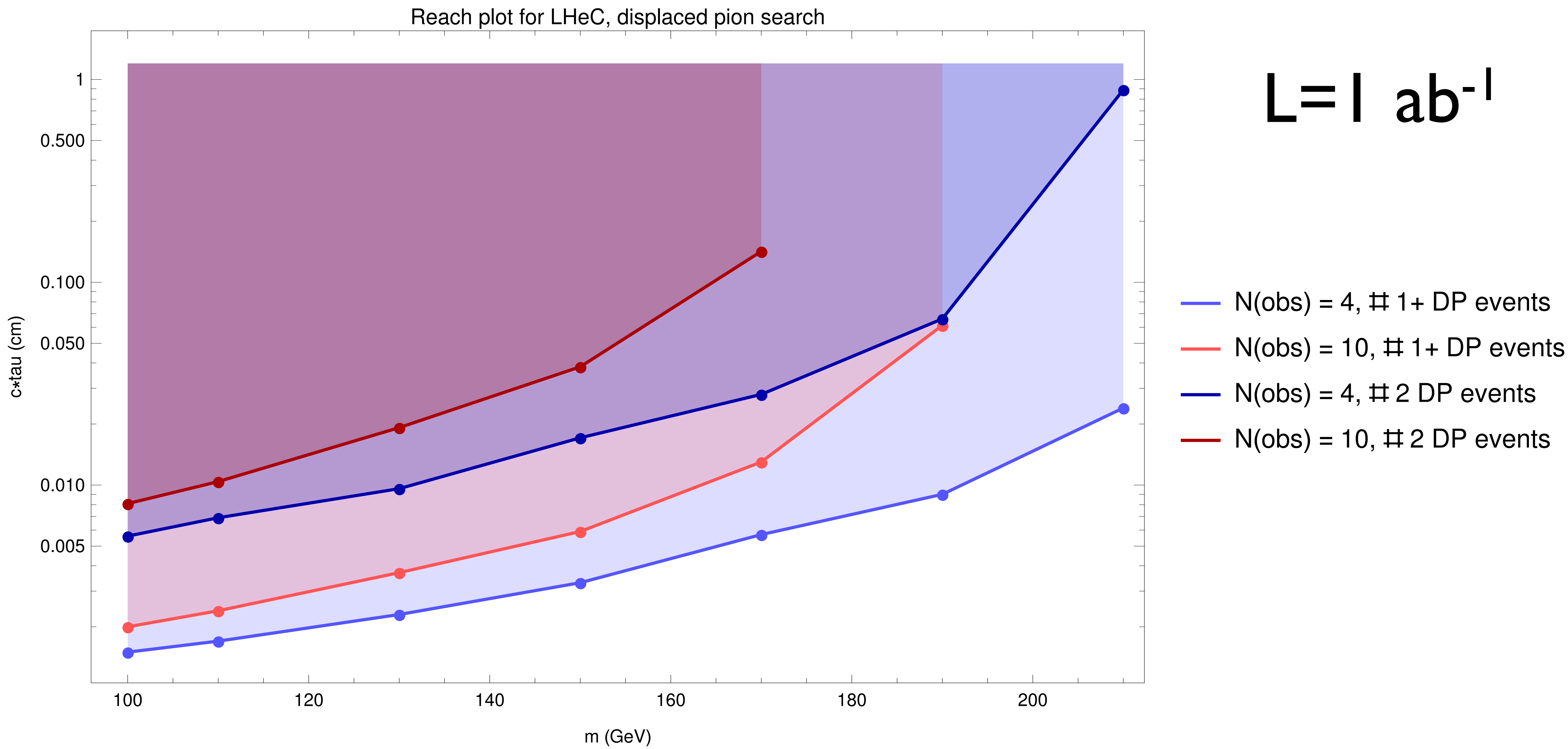






It is a fb, mm, 0.1 GeV world!

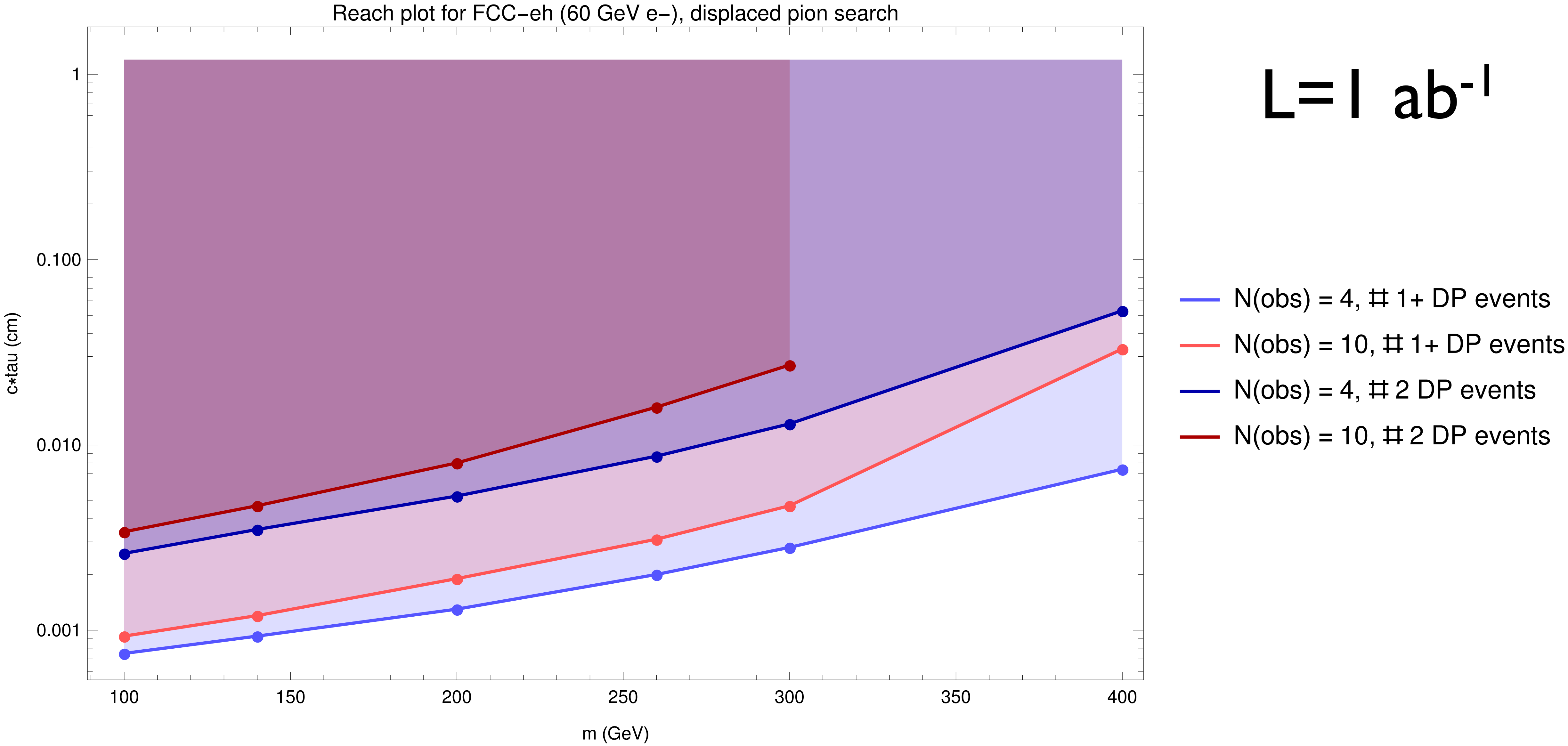
Reach (LHeC)



$L = 1\ ab^{-1}$

LHeC can compete with LHC monojet and disappearing tracks!

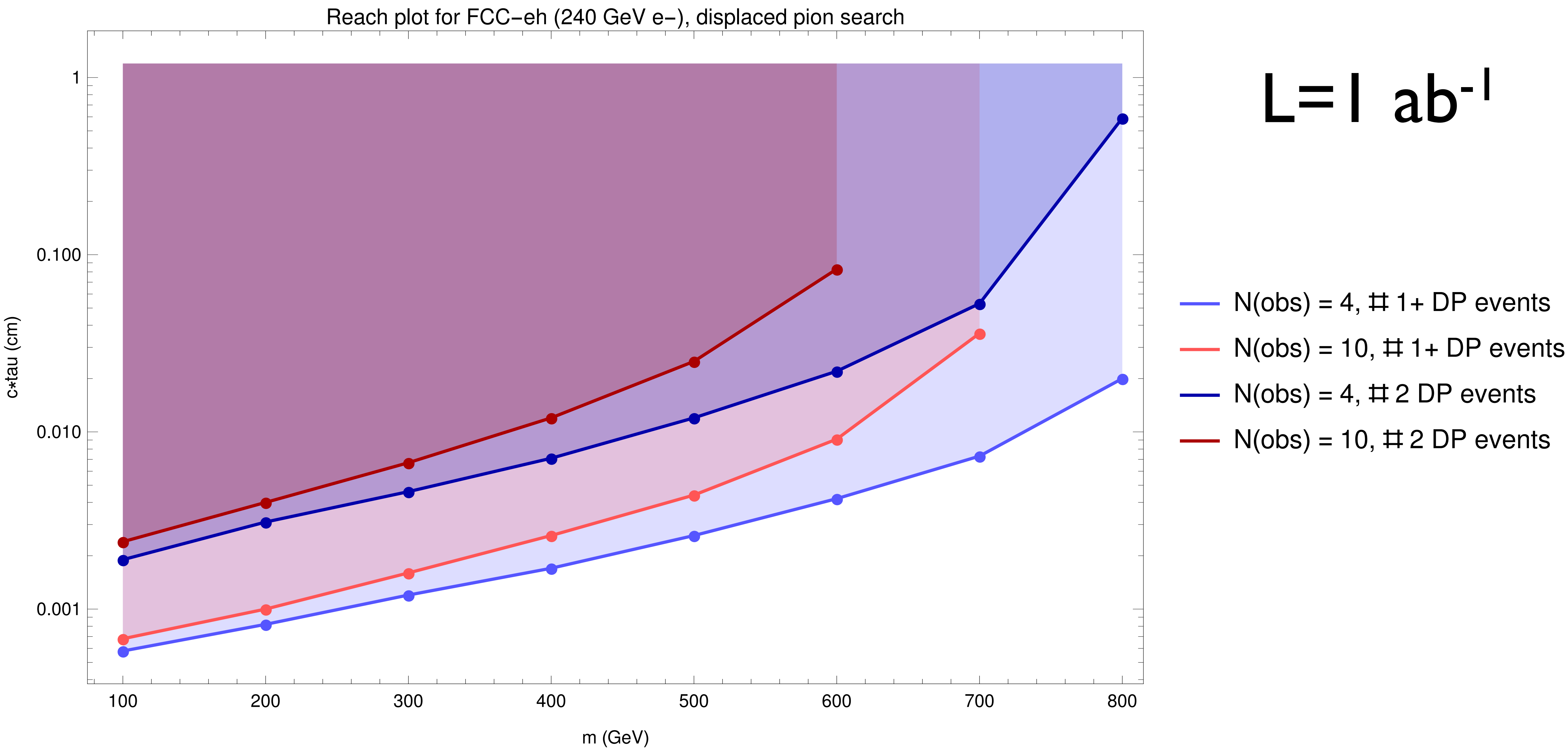
Reach (FCC-eh)



L=1 ab^{-1}

Reach extended to ~ 600 GeV (not shown): comparable with FCC mono jet

Reach (Maximizing E_e)



$L=1\ ab^{-1}$

Even larger E_e or more lumi required to probe relic preferred 1.1 TeV mass

Conclusions

• Compressed spectra is “natural”: O(100 MeV) splittings among components of the same EW-multiplet. Hardest case: pure Higgsino, lifetime 6-19 cm.

• In an e-p collider the advantages (less (and less complicated) backgrounds, no pile-up, excellent reconstruction efficiency, etc) can overcome the low rates.

• We studied the *displaced pion* signature, which is exclusive of e-p colliders (I can not imagine doing it at a hadron collider!).

•Mass reach are comparable for LHC vs LHeC and FCC vs FCC-eh.

•Moreover, an e-p collider could measure $c\tau$, Δ (not possible @ pp colliders!)

•1.1 TeV “golden” spot would require more powerful electron beams and/or more luminosity. Can we go there?

• Input is most welcome!