Long-lived charged particles (non-colored); 10mm <~ $c\tau$ <~ 1m in collider context.

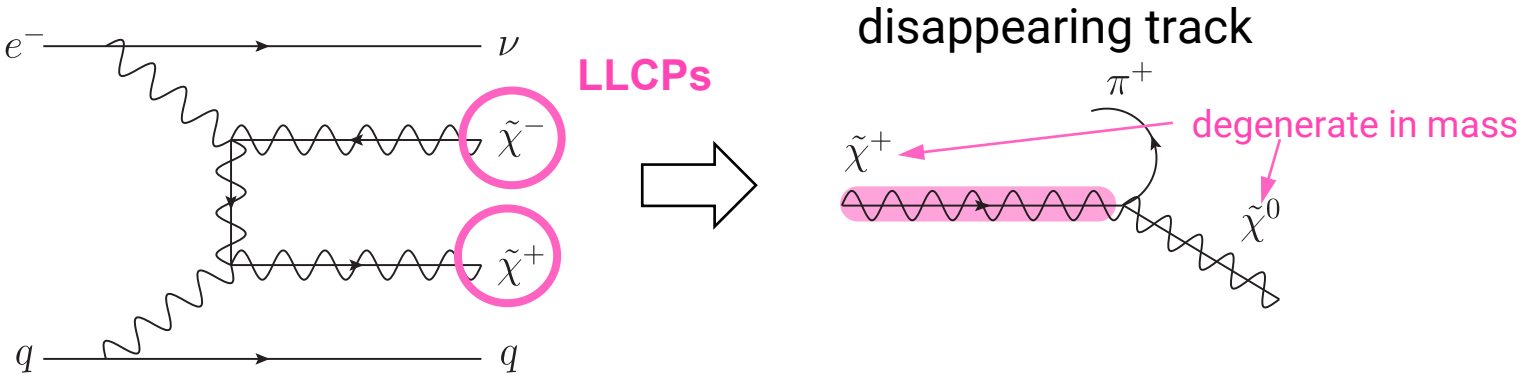
- Neutralino LSP (stable) degenerate with chargino
  - pure-Wino LSP: Δm ~ 160MeV, $c\tau$ ~ 60mm
  - pure-Higgsino LSP: Δm ~ 300MeV, $c\tau$ ~ 7mm

too short; smaller acceptance

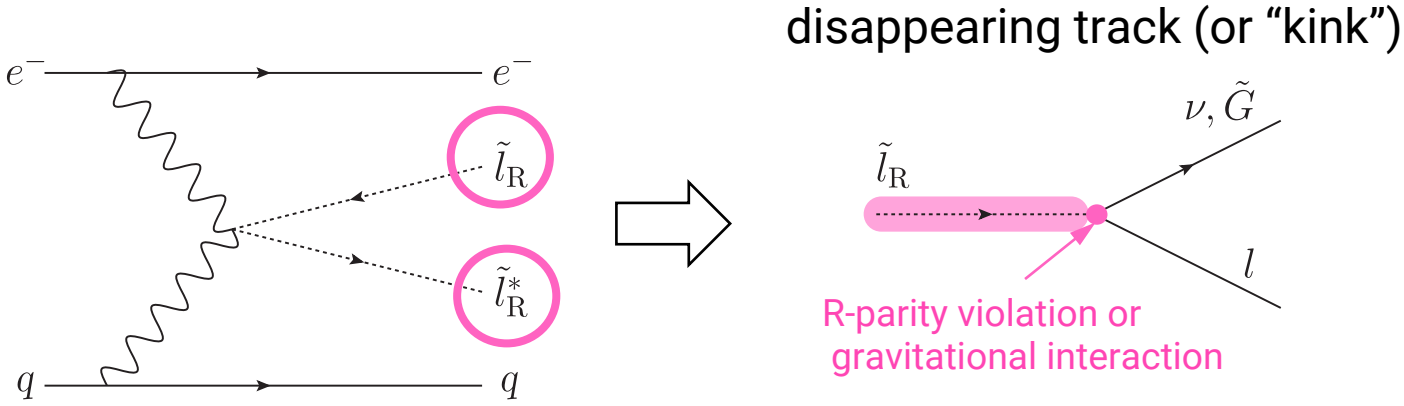
- Unstable slepton LSP
  - decaying to gravitino
  - decaying via tiny *R*-parity violation

Decay rates are determined by gravitino mass / the size of RpV.
Theoretically, any decay length is allowed; **set by hand**.

- Neutralino LSP (stable) degenerate with chargino

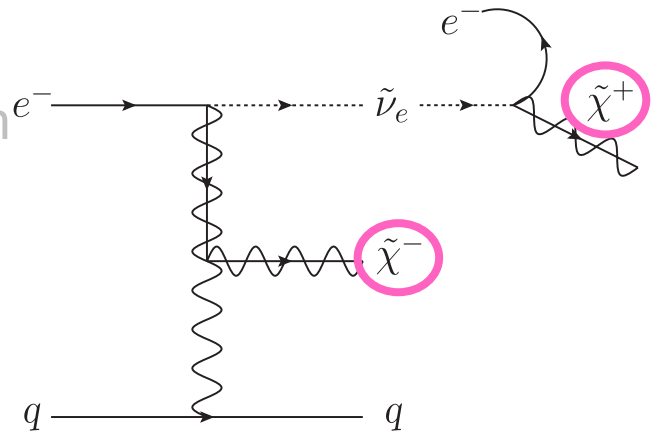


- Unstable slepton LSP



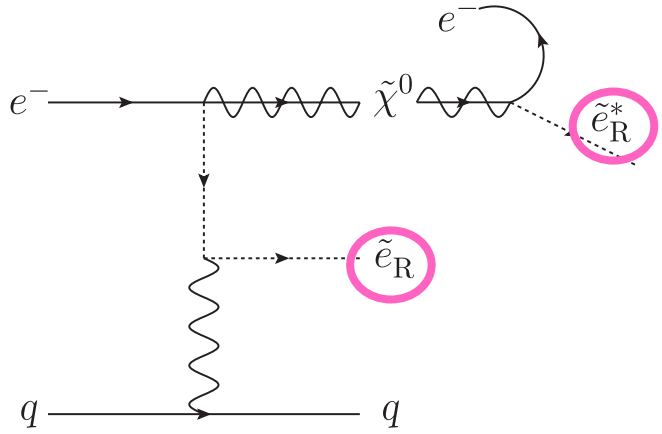
Four-body production = tiny production cross section

- Neutralino LSP (stable) degenerate with chargino
  - pure-Wino LSP + $(\tilde{e}_L, \tilde{\nu}_e)$ as the NLSP
  - pure-Higgsino LSP: $\Delta m \sim 300$MeV, $c\tau \sim 7$mm
    ← extension impossible



selectron $\tilde{e}_R$ (or wino, but Bino is simpler)

- Unstable ~~slepton~~ LSP + $\tilde{B}$ as the NLSP
  - decaying to gravitino
  - decaying via tiny *R*-parity violation



- Neutralino LSP (stable) degenerate with chargino
  - pure-Wino LSP (m_{LLCP})
  - **pure-Wino LSP + $(\tilde{e}_{\mathrm{L}}, \tilde{\nu}_e)$ NLSP** $(m_{\mathrm{LLCP}}, \Delta m, \tan\beta)$
  - pure-Higgsino LSP: $c\tau$ too short (m_{LLCP})

  ⋯ Hereafter, $m_{\tilde{e}_{\mathrm{L}}} - m_{\tilde{W}} = 9\,\mathrm{GeV}$, $\tan\beta = 3$.

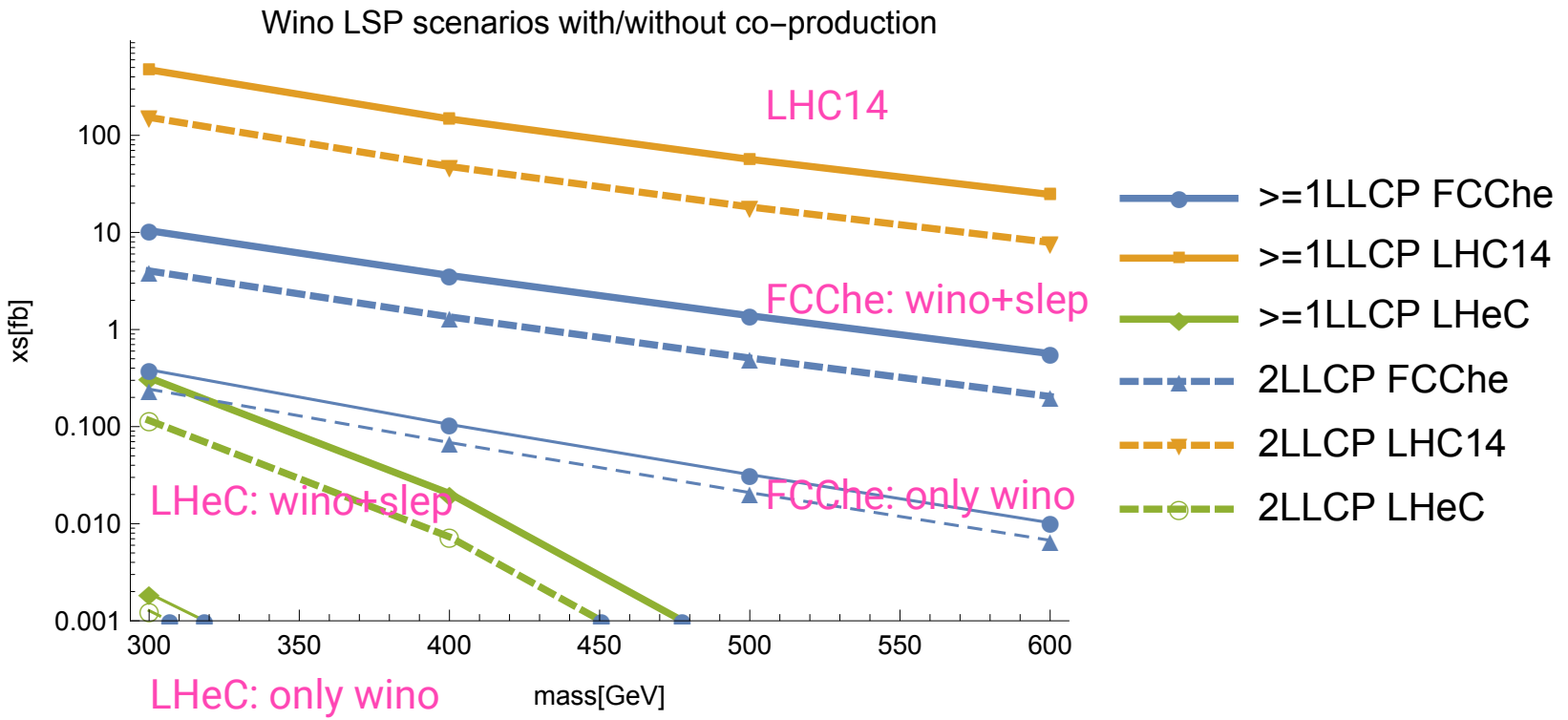
  so that $m_{\tilde{\nu}_e} \simeq m_{\tilde{e}_{\mathrm{L}}} - 9\,\mathrm{GeV} > m_{\tilde{W}}$.

- Unstable slepton LSP
  - slepton LSP $(m_{\mathrm{LLCP}}, c\tau)$
  - **slepton LSP + $\tilde{B}$ NLSP** $(m_{\mathrm{LLCP}}, c\tau, \Delta m)$

  ⋯ Hereafter, $\Delta m = 1\,\mathrm{GeV}$.

- Neutralino LSP (stable) degenerate with chargino
  - pure-Wino LSP (m_{LLCP})
  - **pure-Wino LSP + $(\tilde{e}_L, \tilde{\nu}_e)$ NLSP** ($m_{\mathrm{LLCP}}, \Delta m, \tan\beta$)

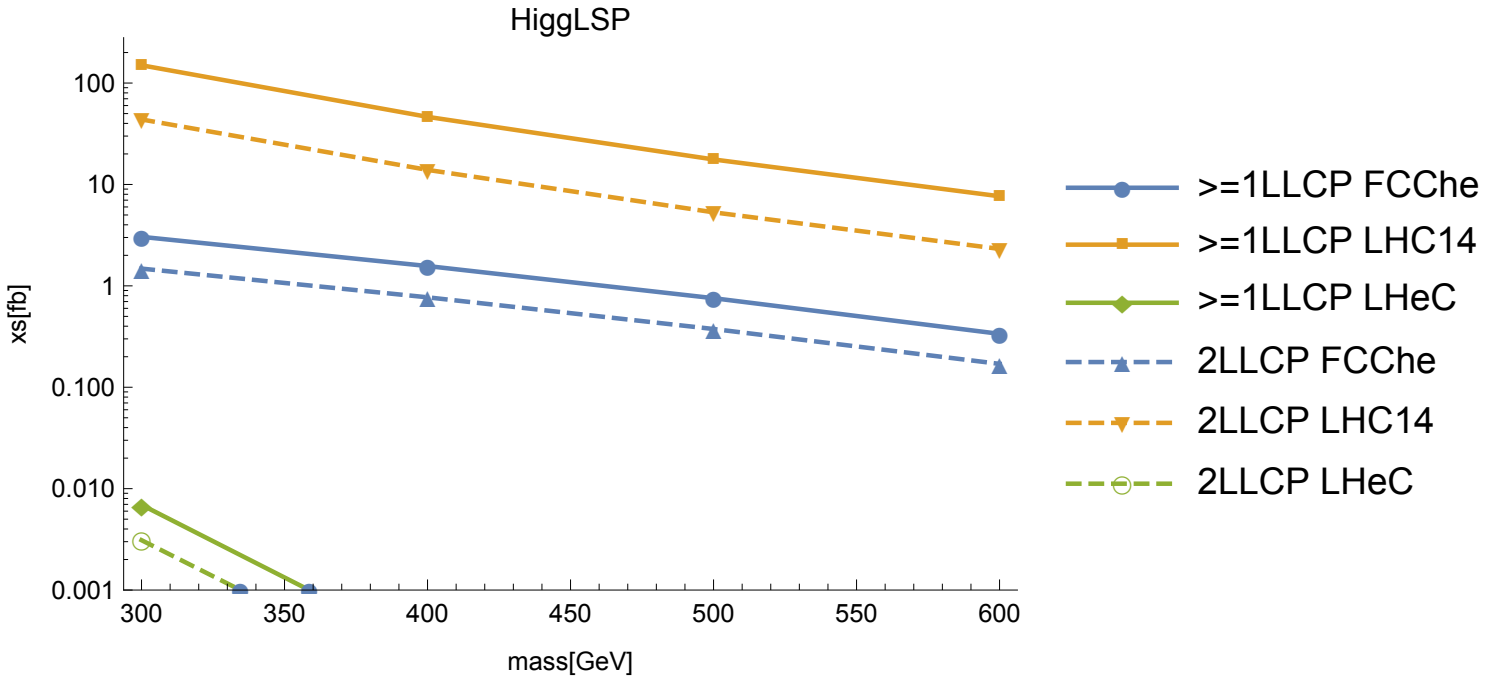
··· Hereafter, $m_{\tilde{e}_L} - m_{\tilde{W}} = 9$ GeV, $\tan\beta = 3$.



"wino+slep" model gives enough events in FCC-he. (even competitive to LHC14)

■ Neutralino LSP (stable) degenerate with chargino

➢ pure-Higgsino LSP: $c\tau$ too short (m_{LLCP})

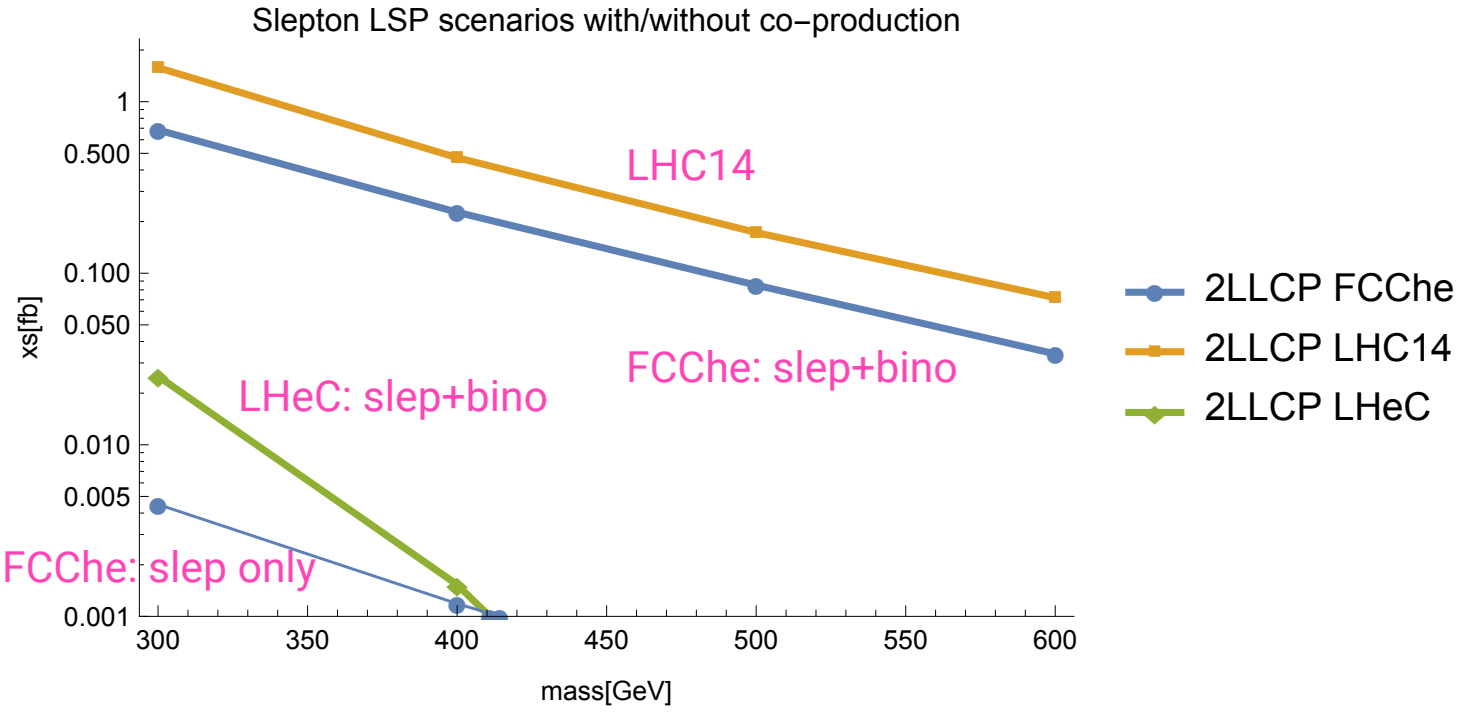


Looks enough events in FCC-he,
but later deteriorated because of small cτ.
(but LHC14 will also be deteriorated; any method to improve FCC-he sensitivity?)

Unstable slepton LSP

- slepton LSP $(m_{\mathrm{LLCP}}, c\tau)$
- **slepton LSP + $\tilde{B}$ NLSP** $(m_{\mathrm{LLCP}}, c\tau, \Delta m)$

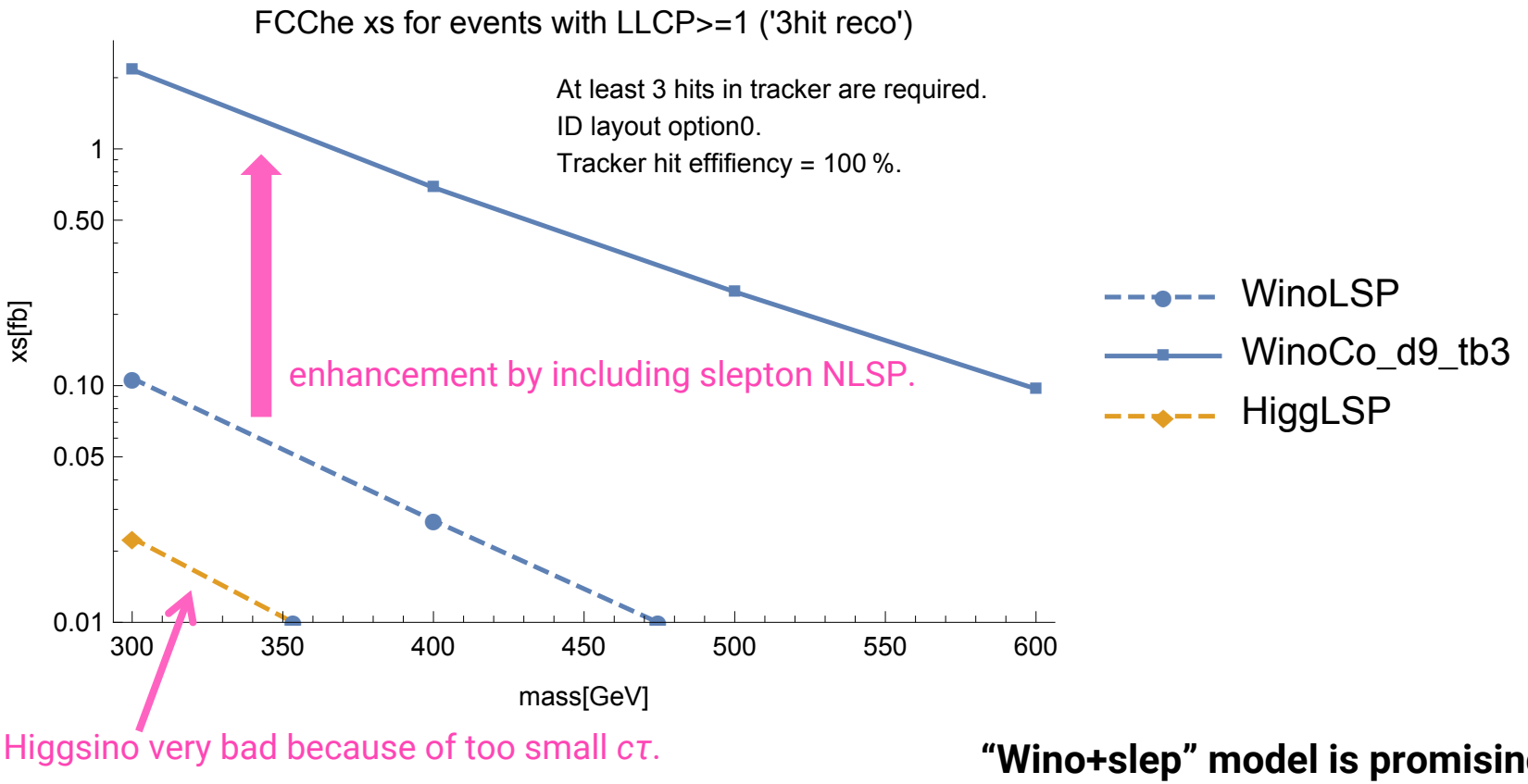
··· Hereafter, Δm = 1 GeV.



"slep+bino" model gives enough events in FCC-he and expected to exceeds LHC14 limits.

FCC-he analysis with reconstruction

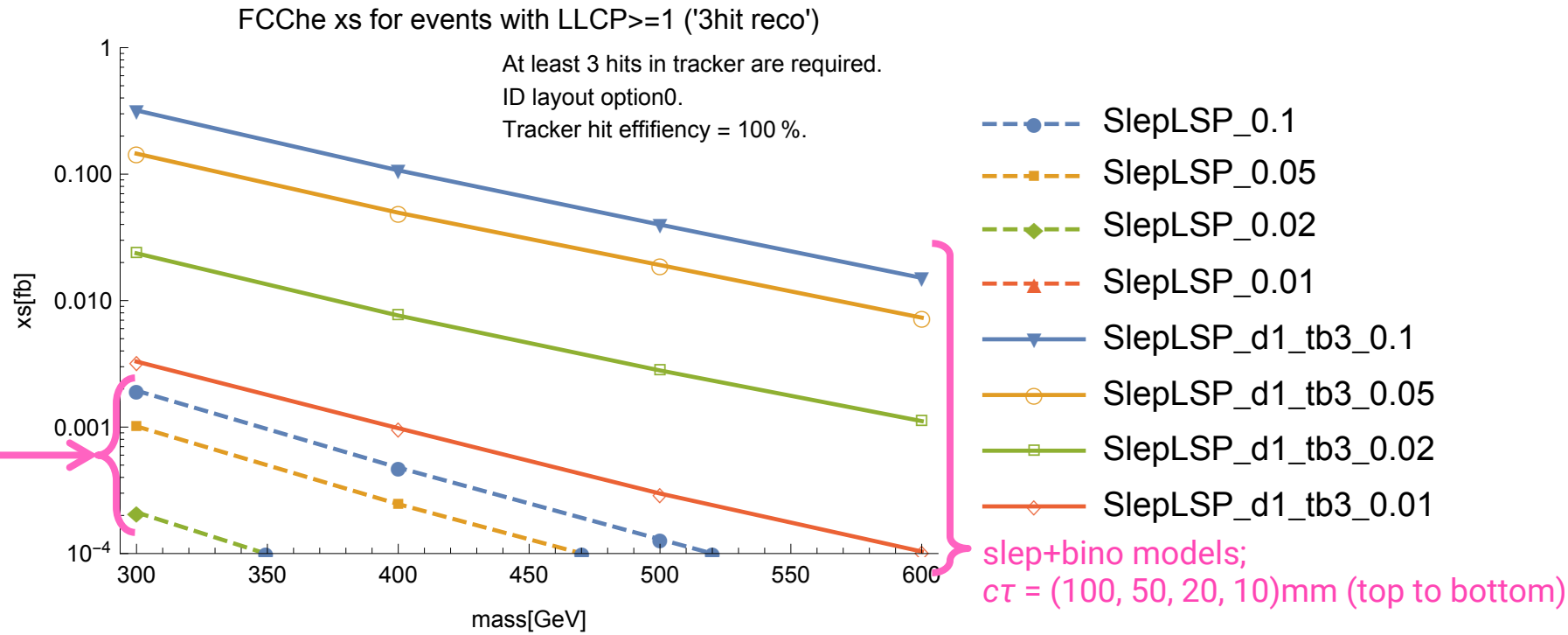
- $p_T > 50$ GeV
- $-5.0 < \eta < 5.2$
- decays after three layers of inner detectors (≡ at least three hits in ID)



"Wino+slep" model is promising.

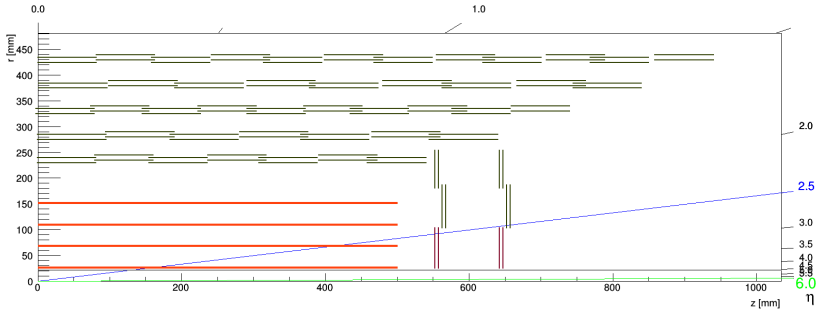
FCC-he analysis with reconstruction

- $p_T > 50\,\text{GeV}$
- $-5.0 < \eta < 5.2$
- decays after three layers of inner detectors (≡ at least three hits in ID)

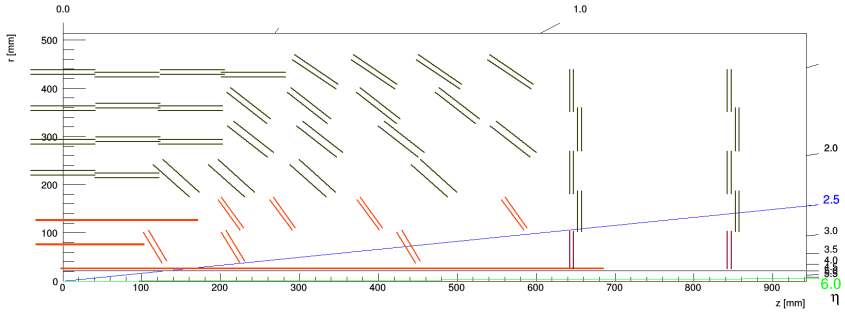


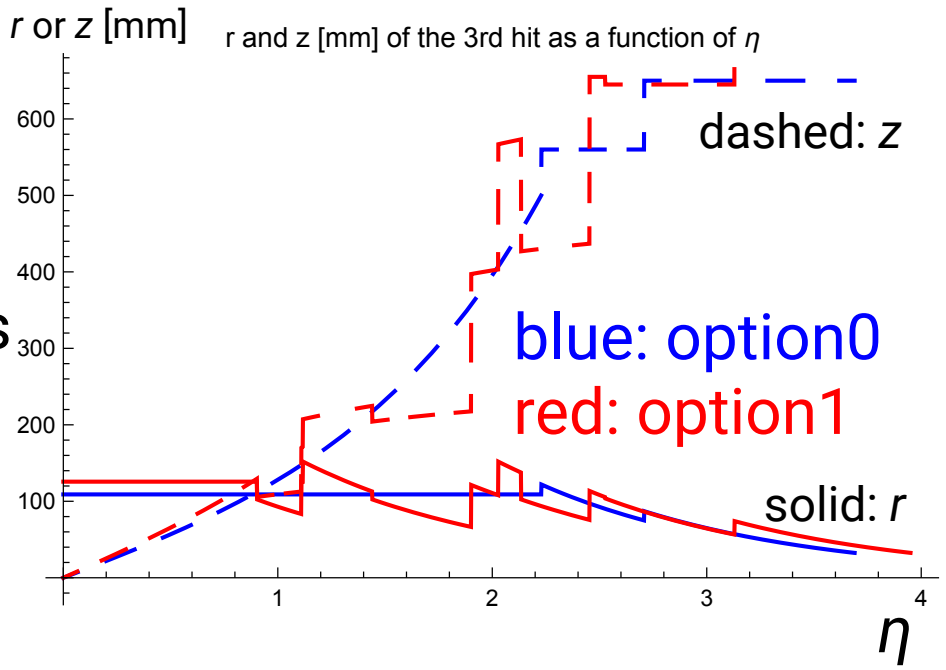
"slep+bino" model is promising if lifetime is more than 10mm.

- Option 0 – FCC-Berlin



- Option 1 - tilted endcap-rings





The position of "3rd layer" is not very different.
Acceptance will be similar for both options.

- More realistic tracker design (using the design provided by Peter Kostka)
  - the results won't be very different. DONE
  - anyway **Sho will do this.**

- SM/detector background?
  - … not easy because
    - the BKGD will mainly from detector effect. NOT TO DO
    - no running EP-collider to rescale.
  - → **not to do**

- **Any other improvements?**
  - maybe with Ee=100/240GeV as well? 5: (firstly 60 GeV should be done)
  - **POLARIZATION!!! what values should I use?** 4: (the result will be similar)
  - **ctau & delta measurements? [Jose]** 2: (umm….)
  - **<10GeV charged particles reconstruction?** 1: to plot the properties of reconstructed LLCPS
  - **Triggering……** 2: (umm….)