Muon Collider Physics: Status and Perspectives

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Introduction

arXiv:1901.06150

Lepton collider's competitive advantage:

- All the energy is stored in the colliding partons
- No energy "waste" due to parton distribution functions
- High-energy physics probed with much smaller collider energy

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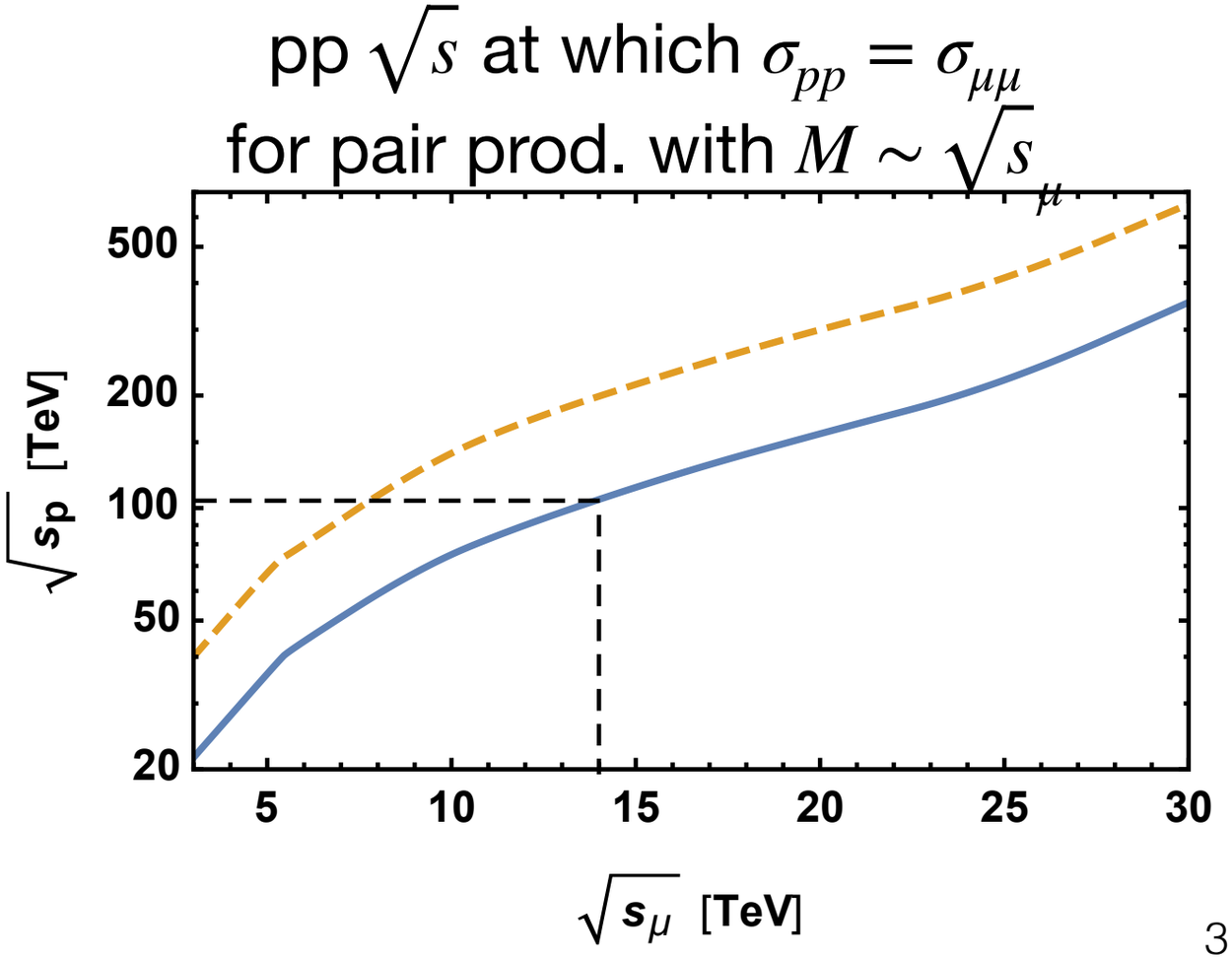

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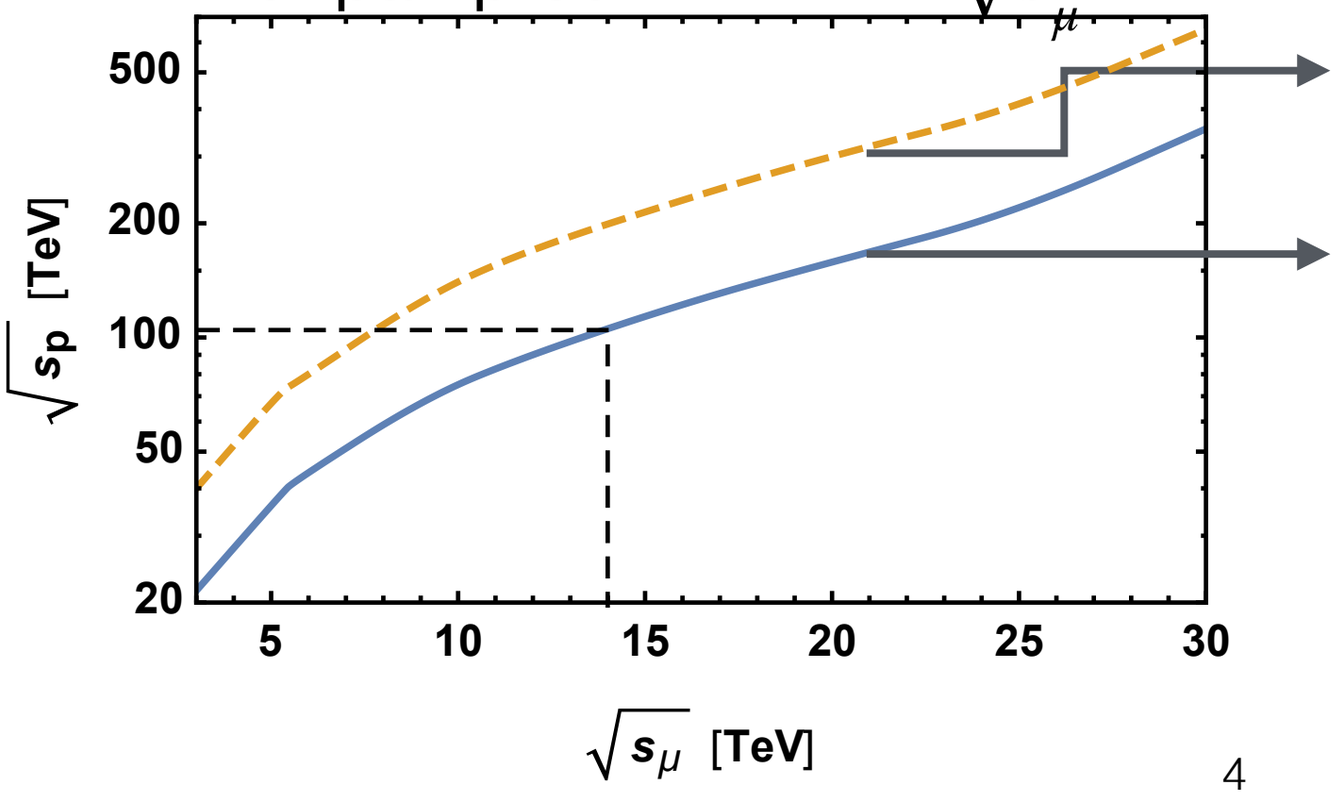
pp $\sqrt{s}$ at which $\sigma_{pp} = \sigma_{\mu\mu}$ for pair prod. with $M \sim \sqrt{s}_{\mu}$



Estimate for EWK-only charged particles

Estimate for EWK+QCD-charged particles

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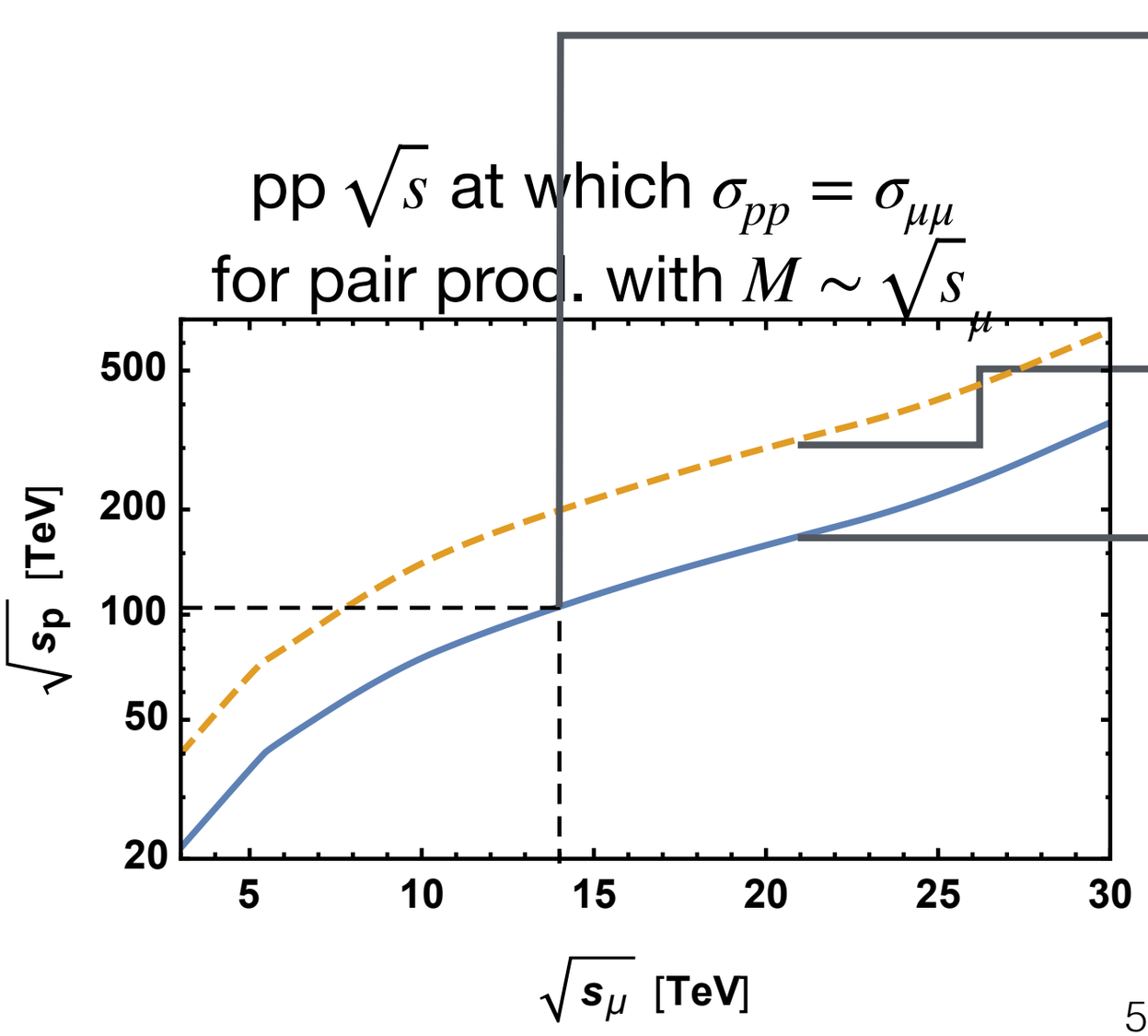

Reference Point:
14 TeV μ-collider ~ FCC@100 TeV

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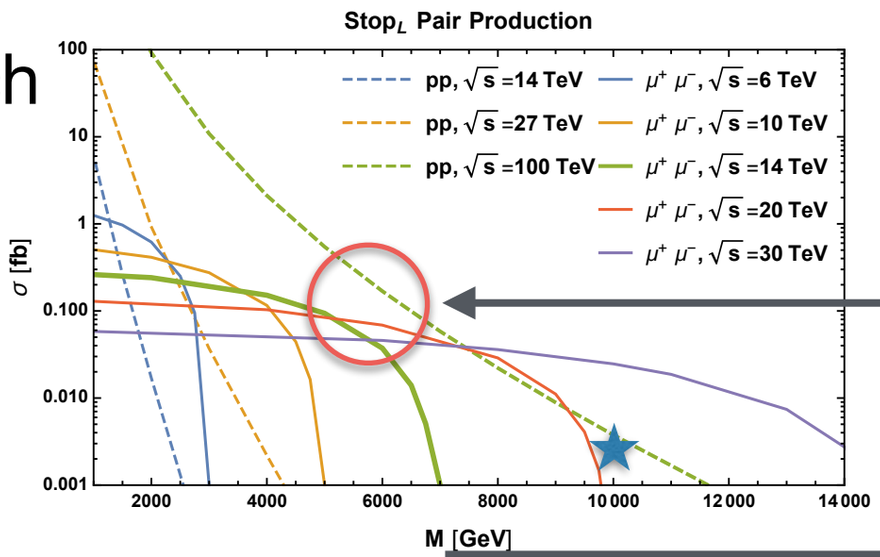
Examples:

★ = FCC reach

Stop



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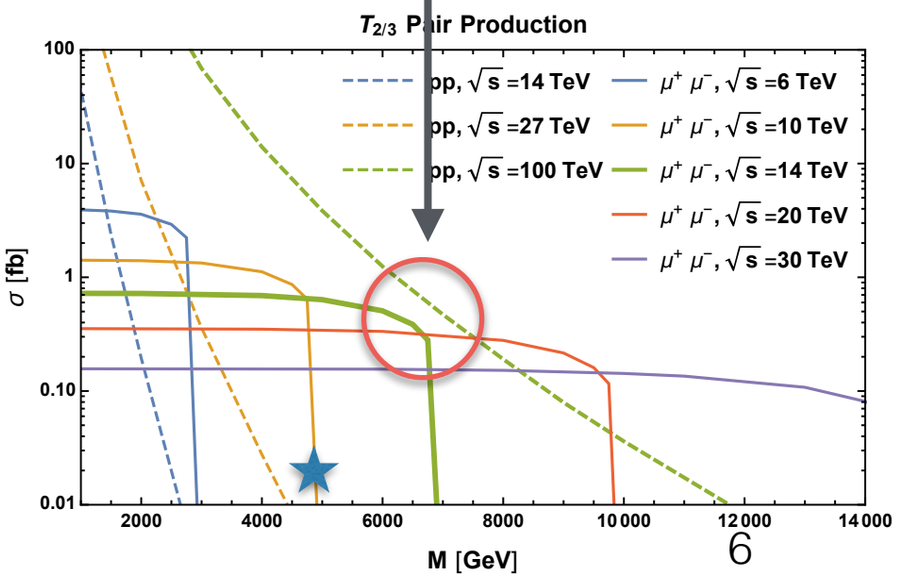
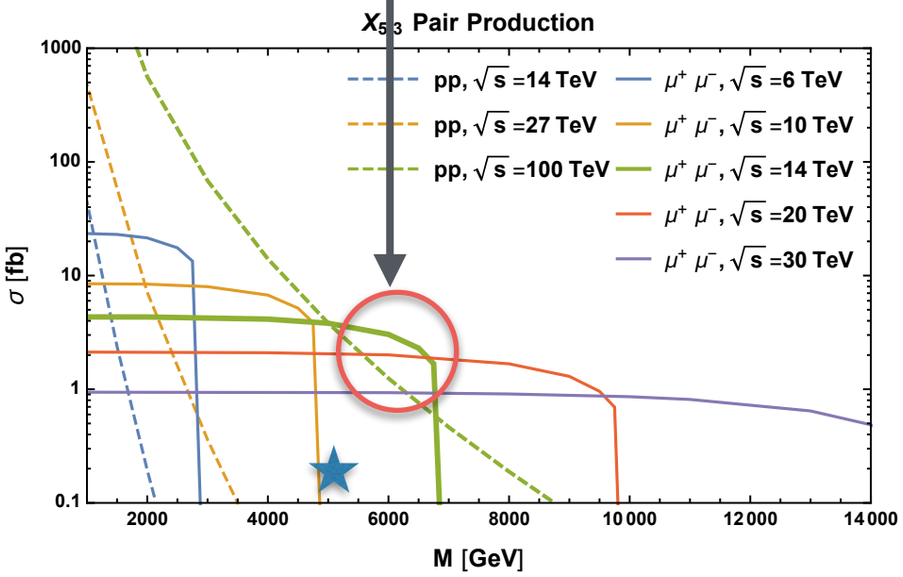
Top-Partners





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Comparison even more favourable for EWK-only part. like **Higgsino** and **Wino** (potential **Dark Matter**)

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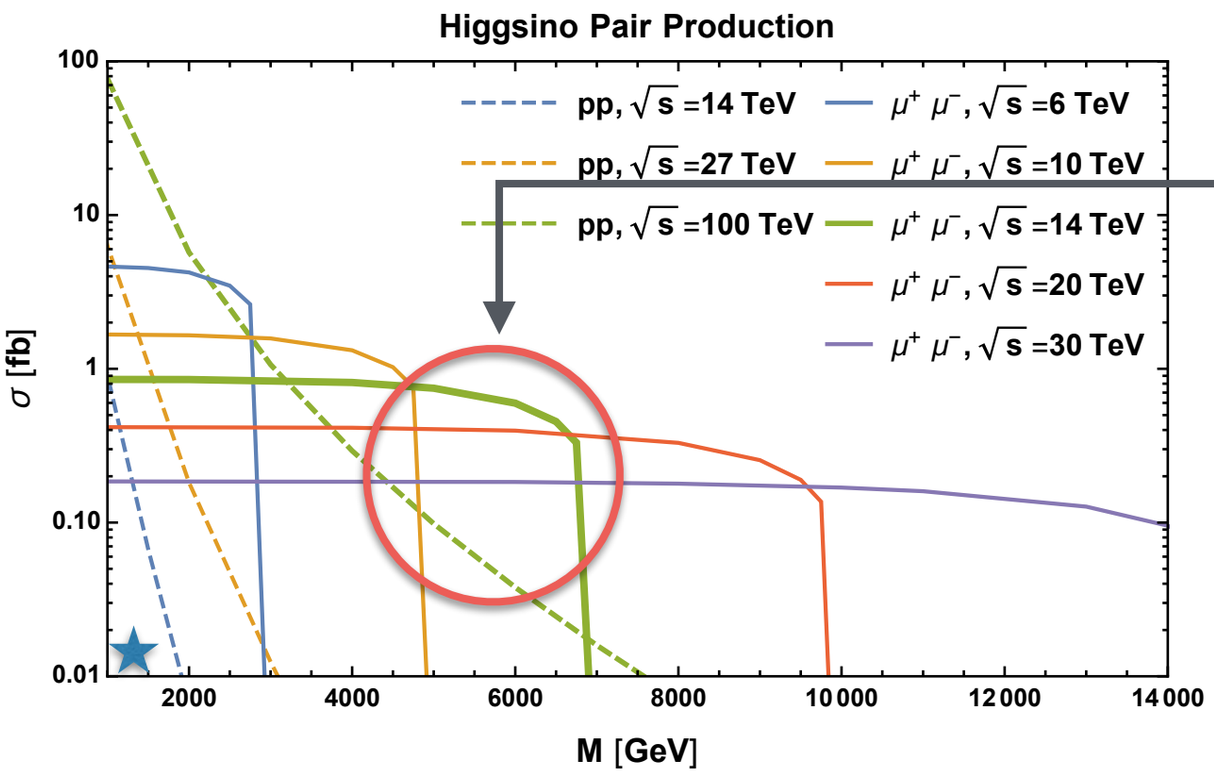

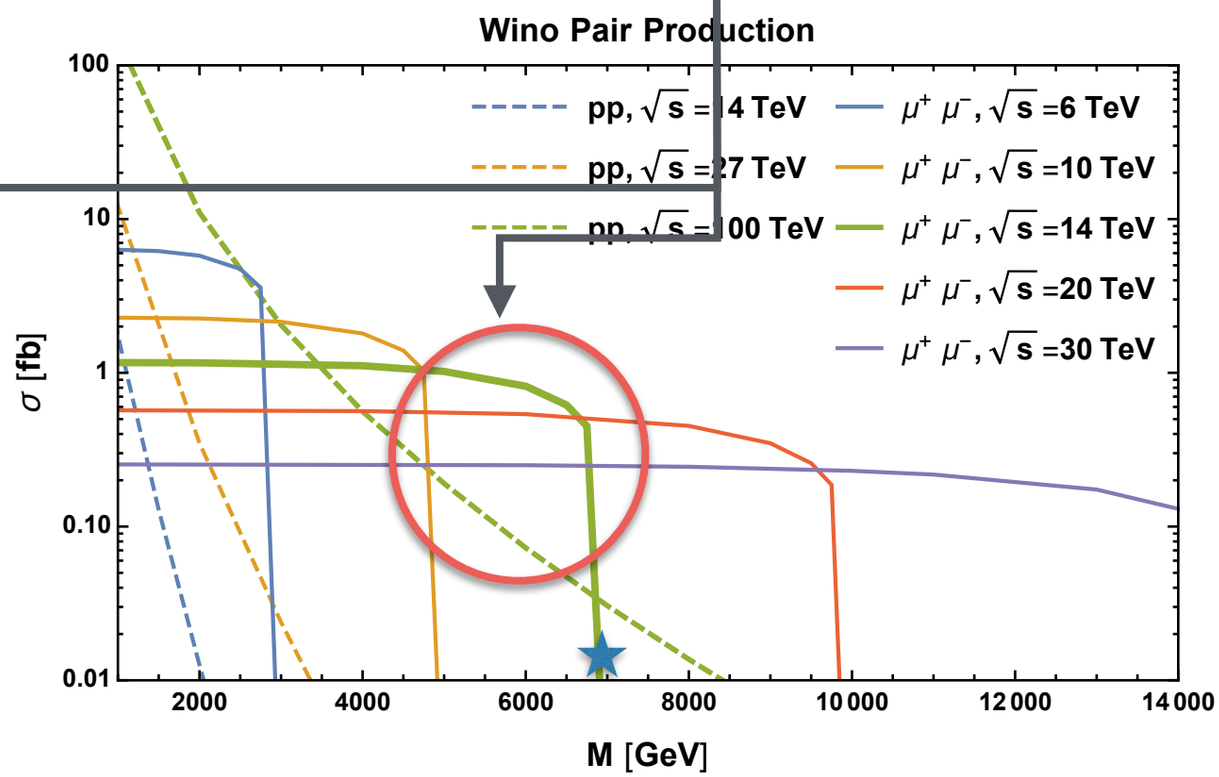

Target Energy and Luminosity

arXiv:1901.06150

Energy:

For a striking **Direct** Exploration program, after HL-LHC*, energy should be **close or above 10 TeV**

At **few TeV energy** one can still exploit high partonic energy for a striking **Indirect** Exploration program, by **High-Energy Precision**
We can borrow **CLIC** physics case (see below)

Luminosity:

$$L \gtrsim \frac{5\,\text{years}}{\text{time}} \left(\frac{\sqrt{s}_{\mu}}{10\,\text{TeV}} \right)^2 2 \cdot 10^{35} \text{cm}^{-2}\text{s}^{-1}$$

Set by asking for 100K SM “hard” SM pair-production events.
Compatible with other projects (e.g. CLIC = $(3\,\text{TeV}/10\,\text{TeV})^2\,\mathbf{6} \cdot 10^{35}$)
If much less, we could only bet on Direct Discoveries !
Could be reduced by running longer than 5yrs and > 1 I.P.

*see arXiv:1910.11775 for HL-LHC and F.C. projections summary

The CLIC-like Option

Few (~3) TeV is a reasonable “low” energy target

Radiation under control, acceleration relatively easy

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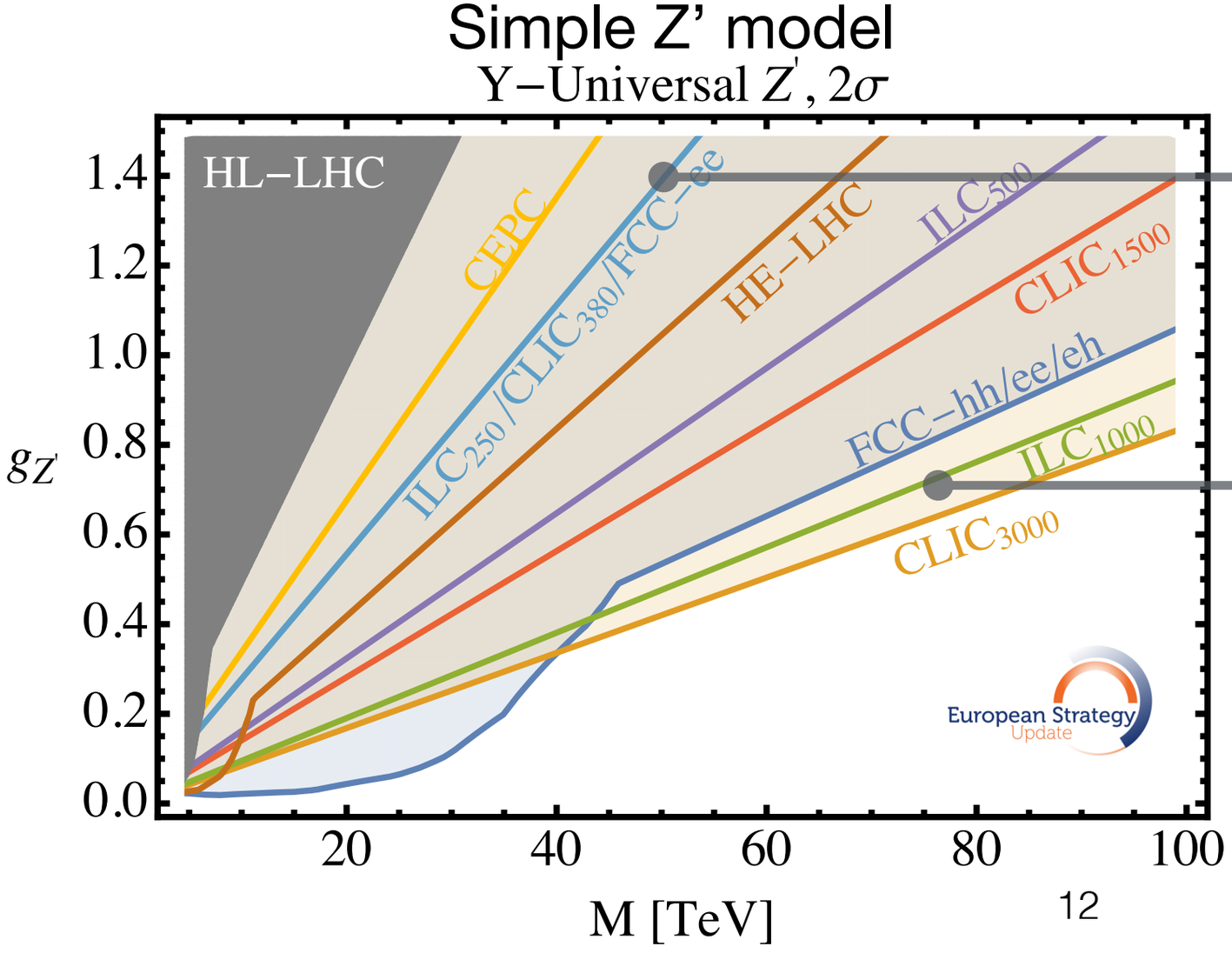

At some point, **Accuracy** reaches a floor.

We need **Energy** to go beyond.

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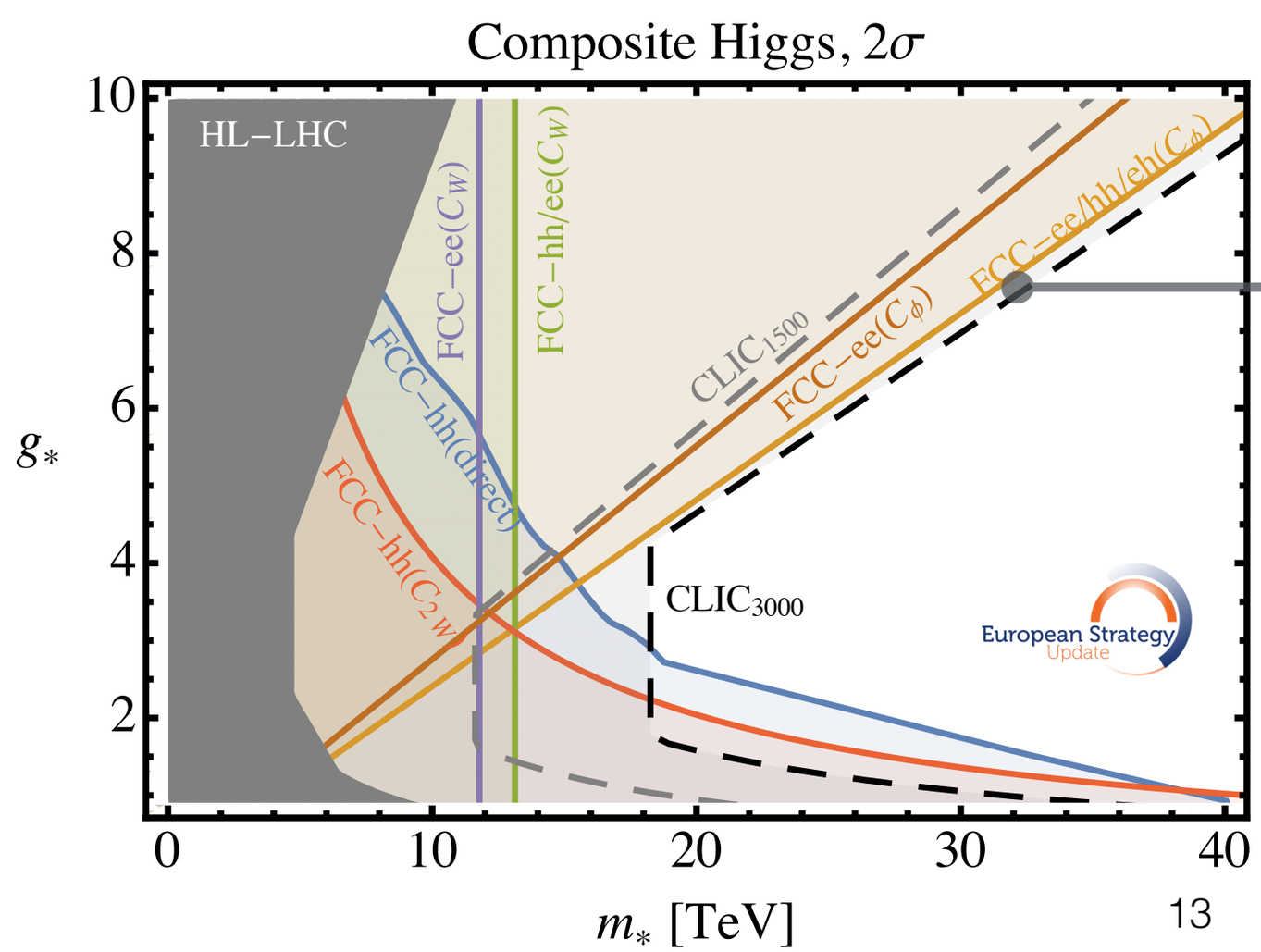

Notice, this is from Higgs Couplings

CLIC@380 important here

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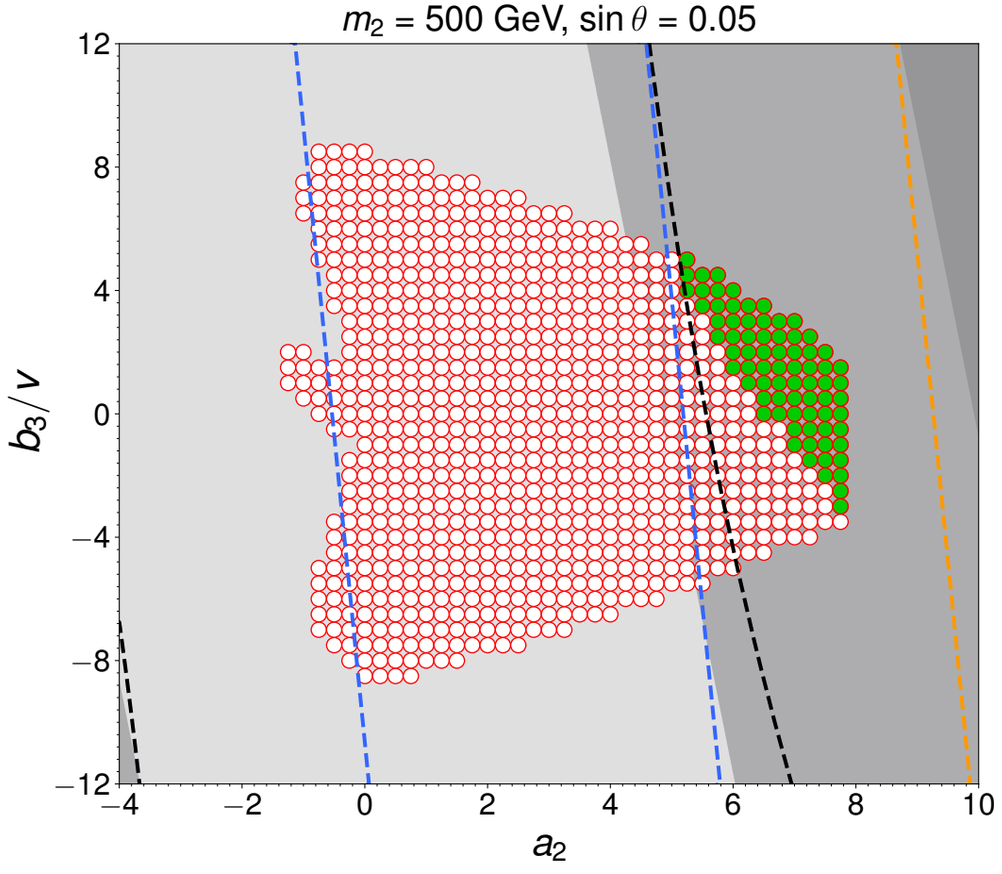

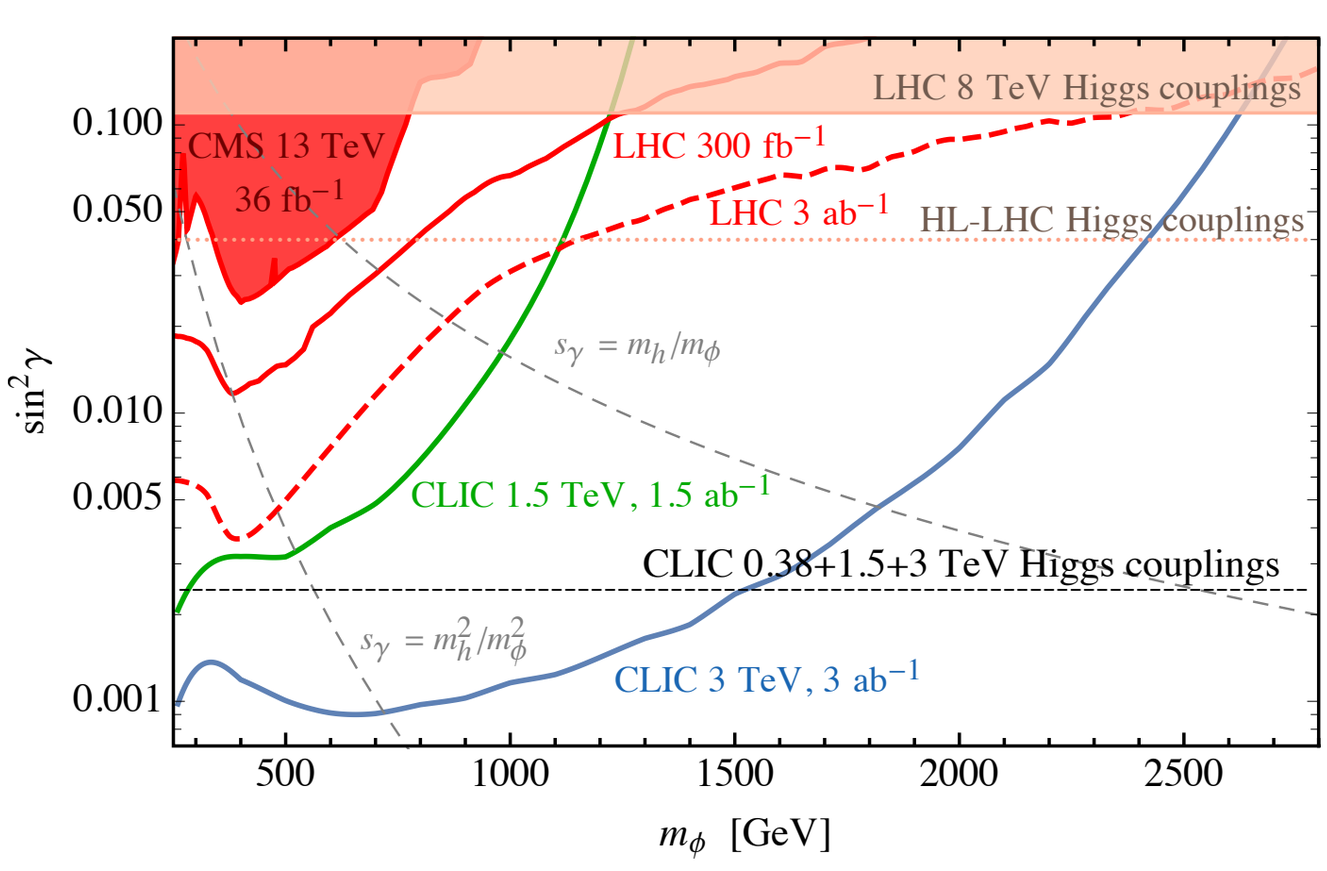

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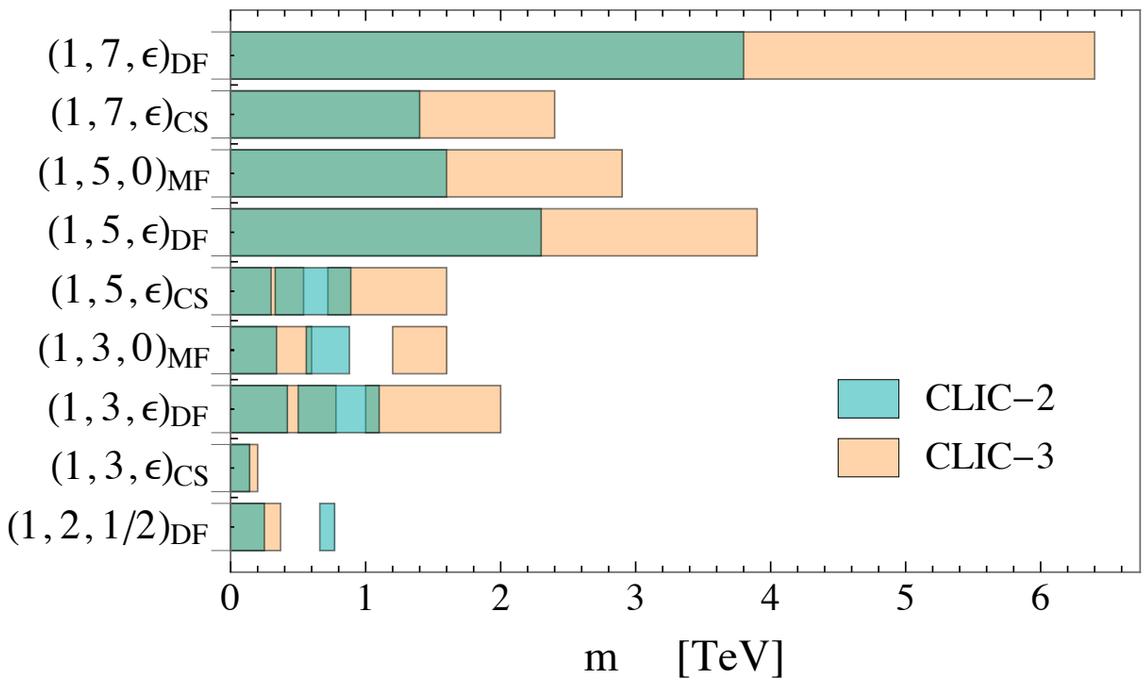

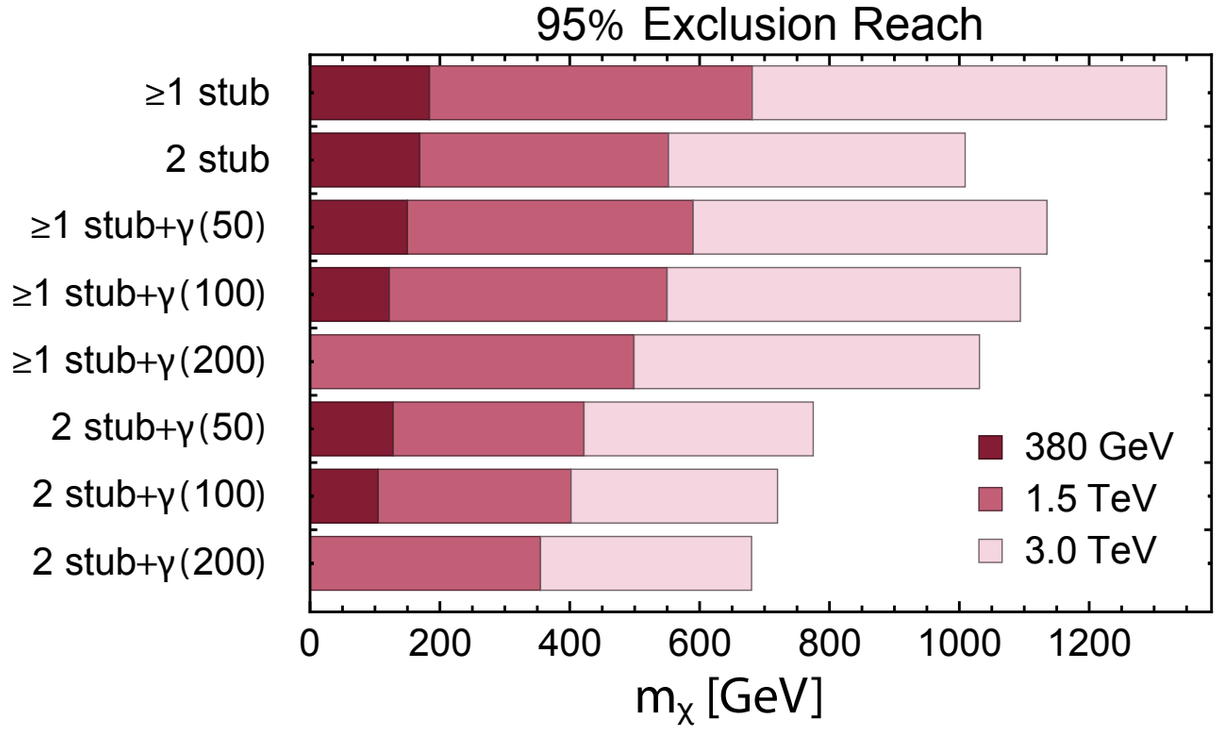

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THE CLIC POTENTIAL FOR NEW PHYSICS

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Towards the μ@3TeV Physics Potential

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We loose much for BSM potential? Rely on near-future Higgs-factory?

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Much More in Marc's and Marcel’s talks

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The Dream Machine

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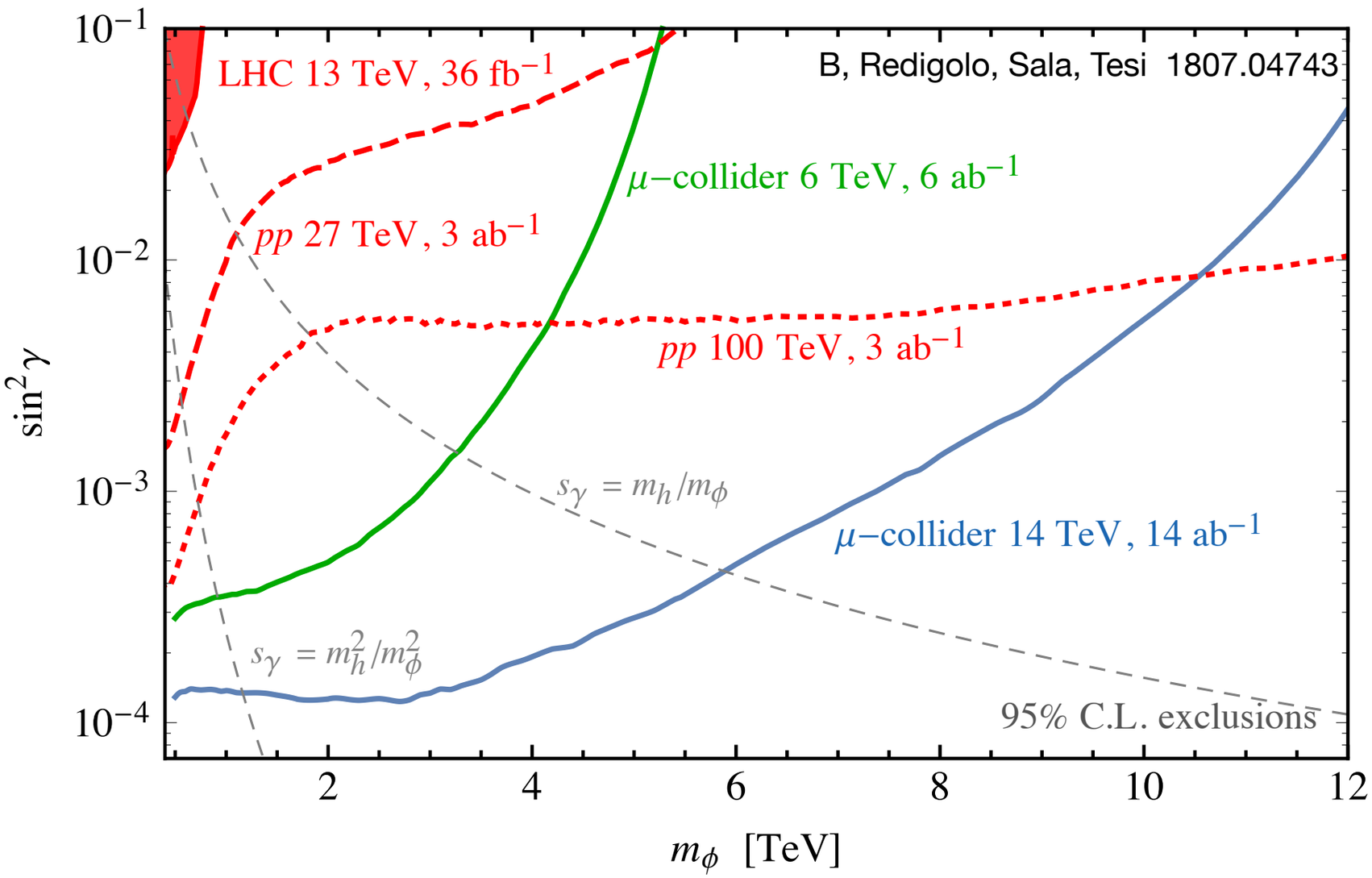
Direct reach **comparable with FCC-hh**

But much better for EW-only (see e.g. here)



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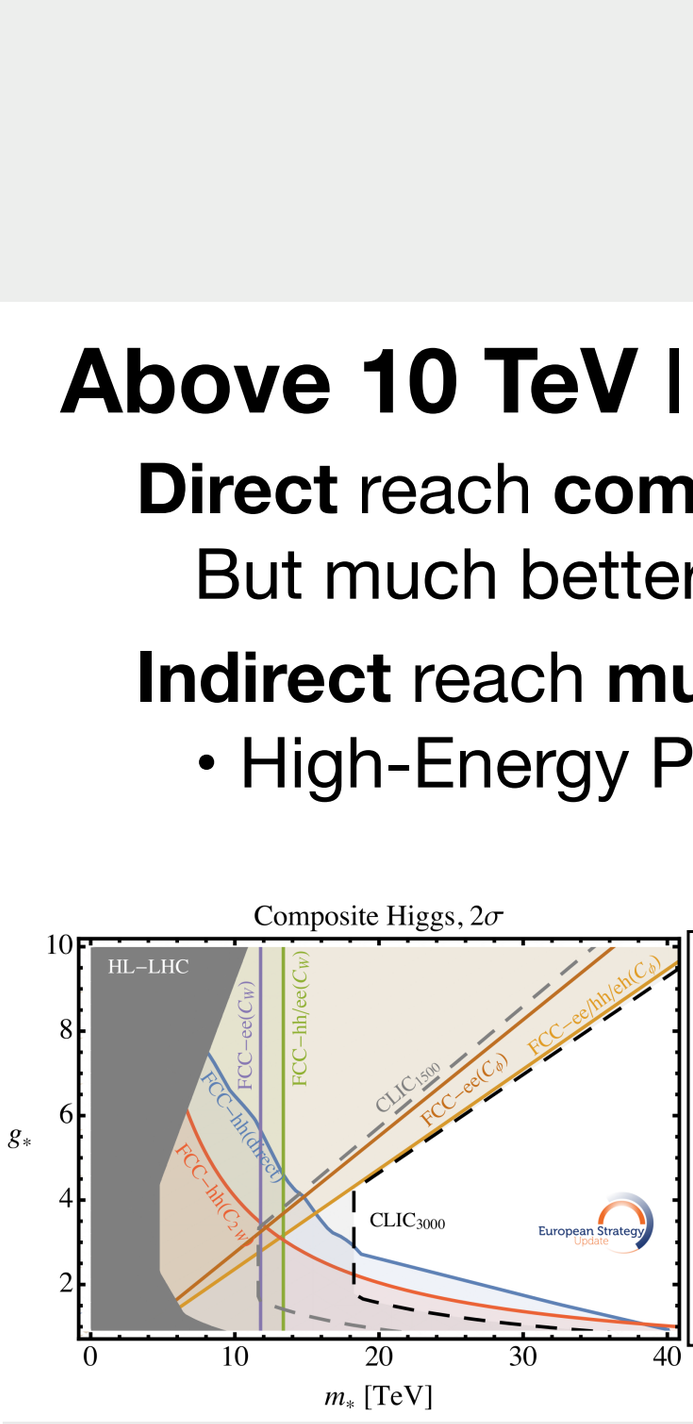
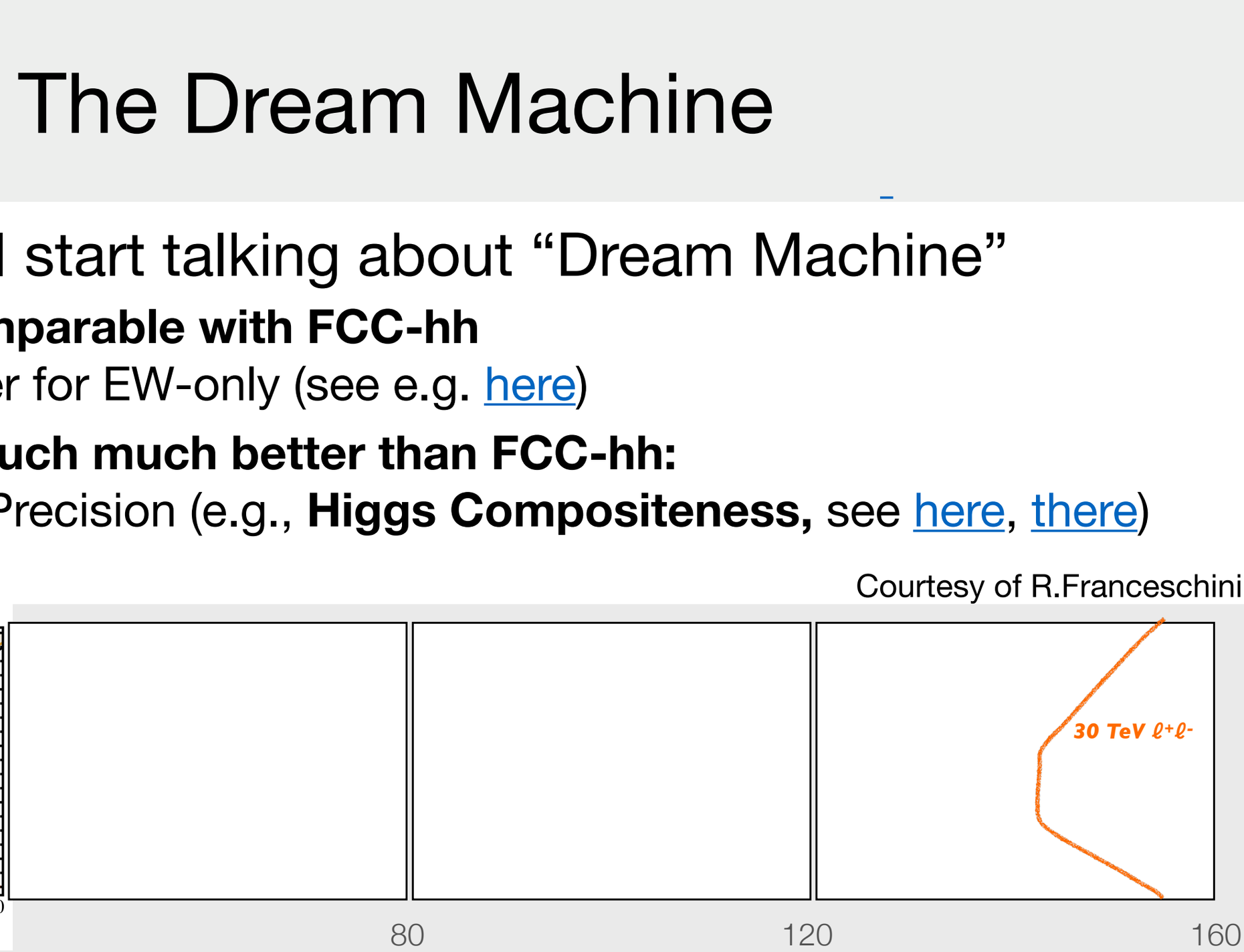
Courtesy of R.Franceschini





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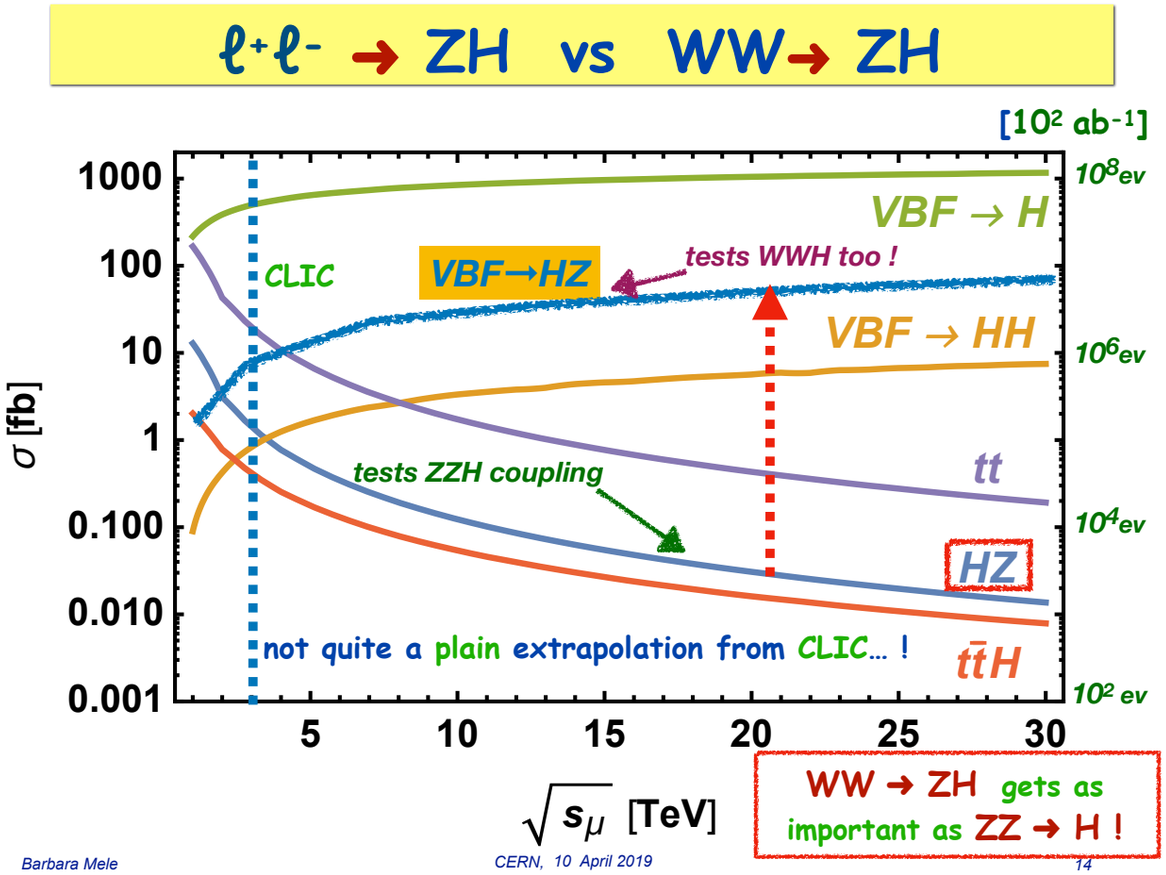

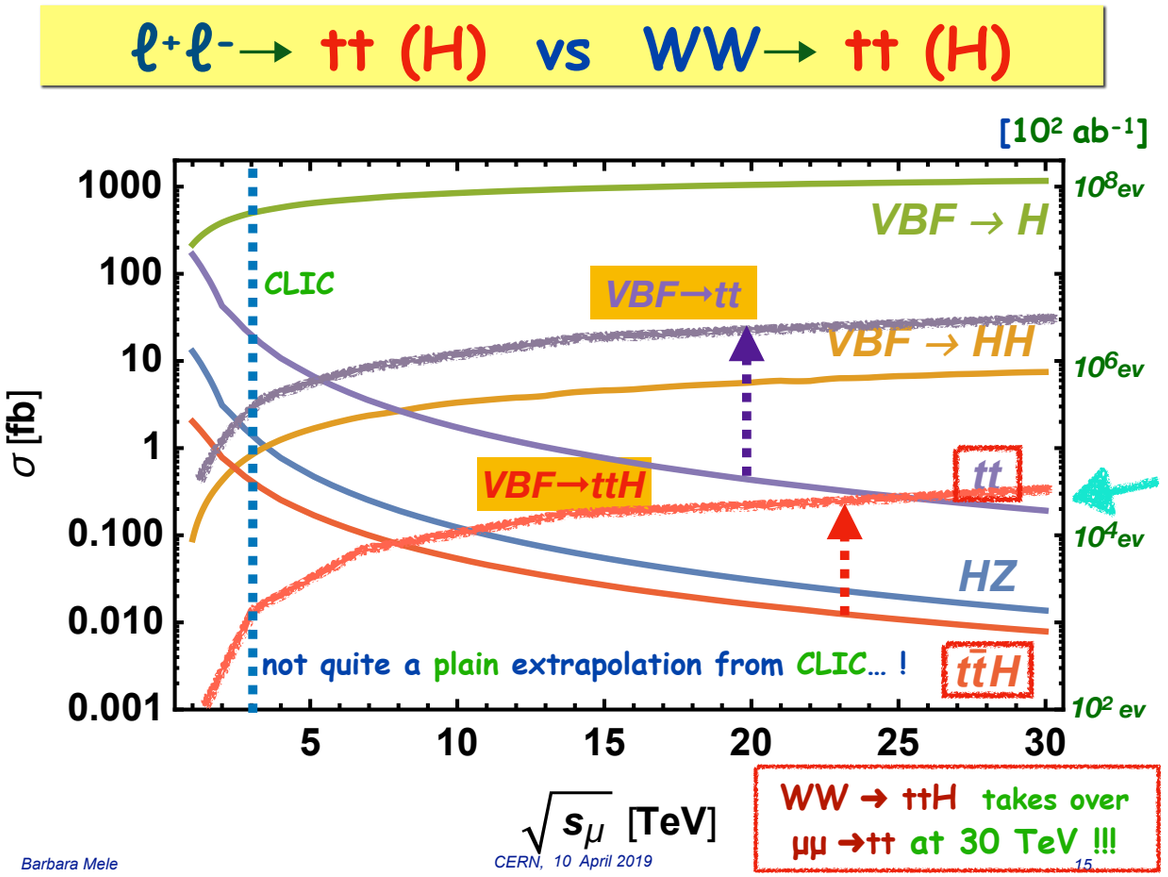

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And, often, Dreams DO become Reality!

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Thank You !