Explorations of the energy frontier

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- **Importance of the energy frontier**
- **Current plan**
- **Possible changes to the plan**

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High-energy collisions directly probe the laws of nature at the shortest accessible distances.

Each time the center-of-mass energy of the collisions has been substantially increased, a deeper understanding of the fundamental laws of physics has emerged:

SPS: $\bar{p}p$ collisions at 0.54 TeV - discovery of the W and Z bosons – 1983

Tevatron: $\bar{p}p$ collissions at 1.8 TeV - discovery of the top quark – 1995

LHC: pp collisions at 7 & 8 TeV - discovery of the Higgs boson – 2012

LHC: pp collisions at 13 TeV - ... ?

Current plan for pushing the energy frontier

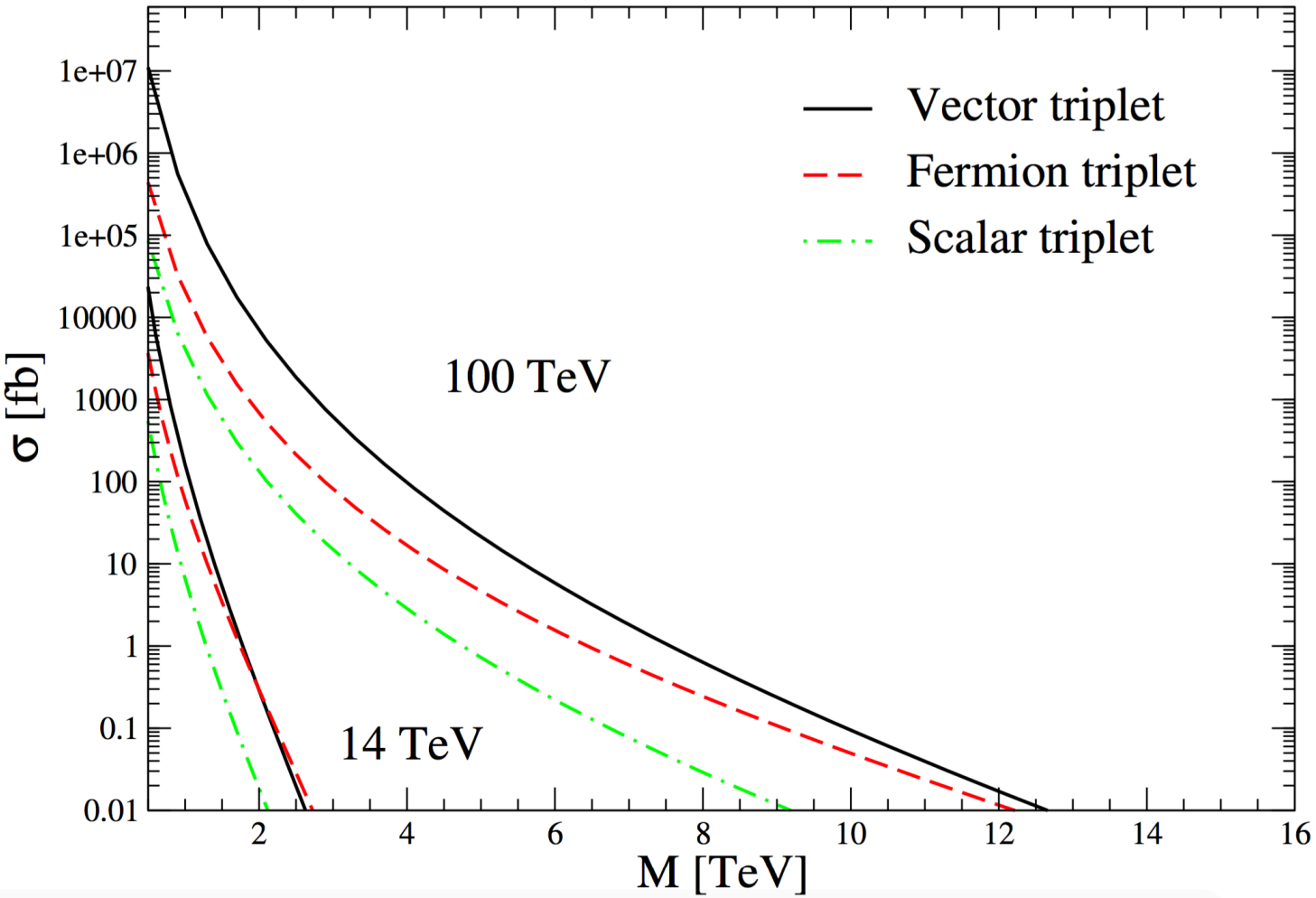
≤ 2023: LHC physics with 300 fb^{-1}

2024-2026: upgrade to High-Luminosity LHC

2026-2037: accumulate 3000 fb^{-1} of data at 14 TeV

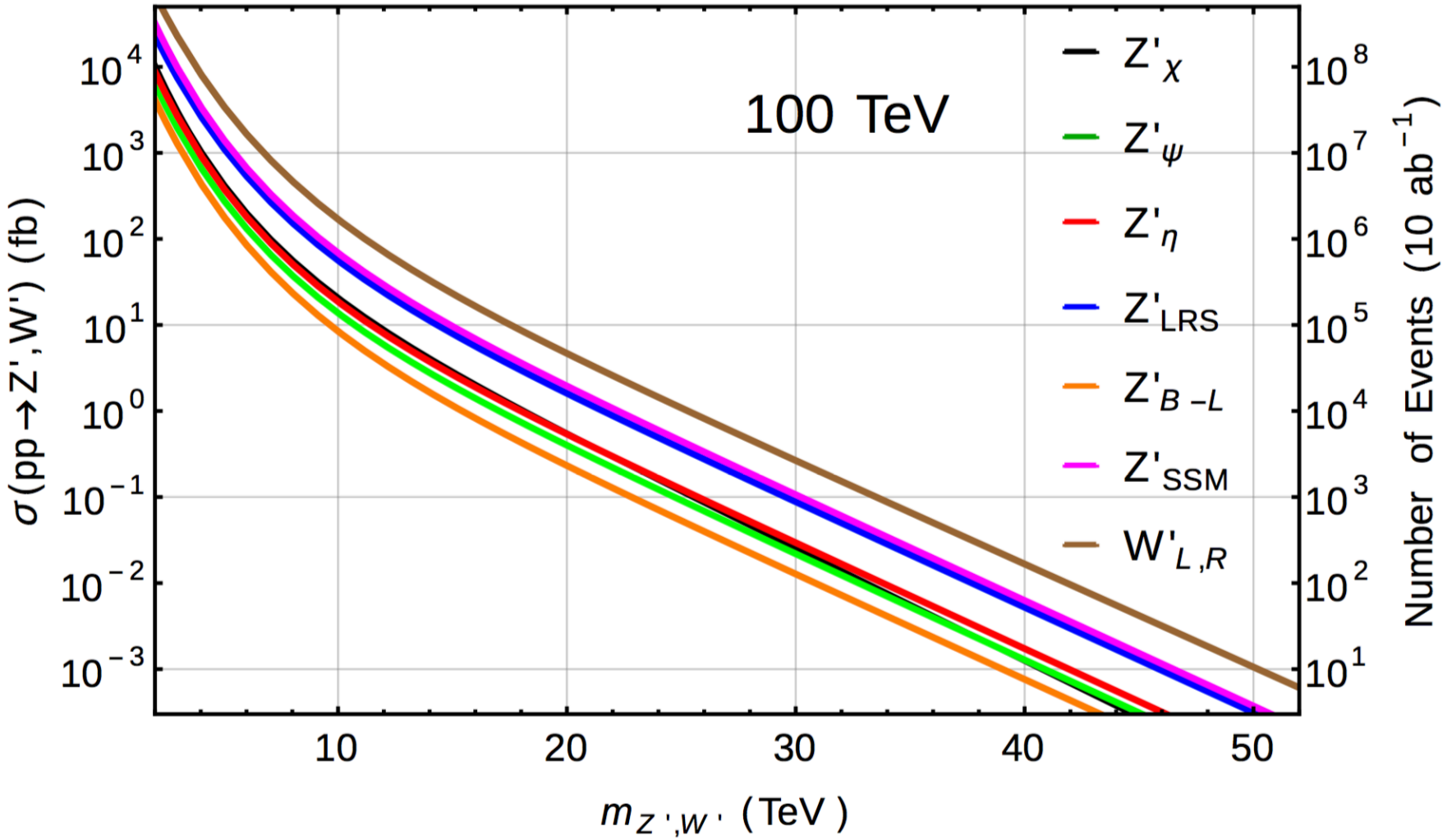
> 2037: pp collisions at 100 TeV (Future Circular Collider, ...)

Cross section for pair production of heavy quarks at $\sqrt{s} = 100$ TeV (1606.00947):



Quark masses will be probed even above 8 TeV.

Cross section for W' or Z' production at $\sqrt{s} = 100$ TeV (1606.00947):



Gauge boson masses will be probed even above 40 TeV.

Examples of possible changes to the current plan

- if an unexpected $\mu^+\mu^-$ resonance is discovered at the LHC, then a muon collider becomes compelling.

- if stronger magnets can be built, then a higher-energy pp collider in the LHC tunnel becomes a viable option.

- if discoveries will be made in neutrino physics or other low-energy experiments, a more precise target of exploration may become obvious.

- if new accelerator technologies will be developed, then various high-energy colliders may become possible.

- ...