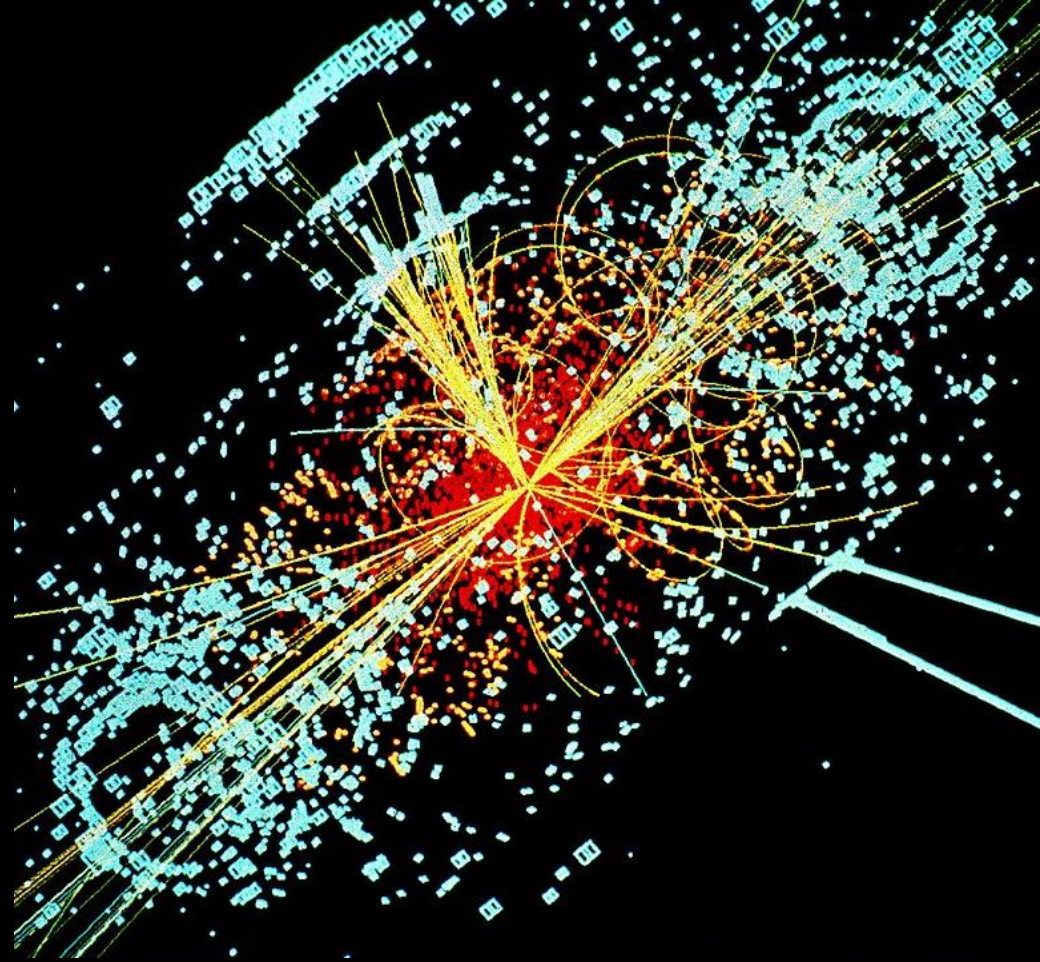
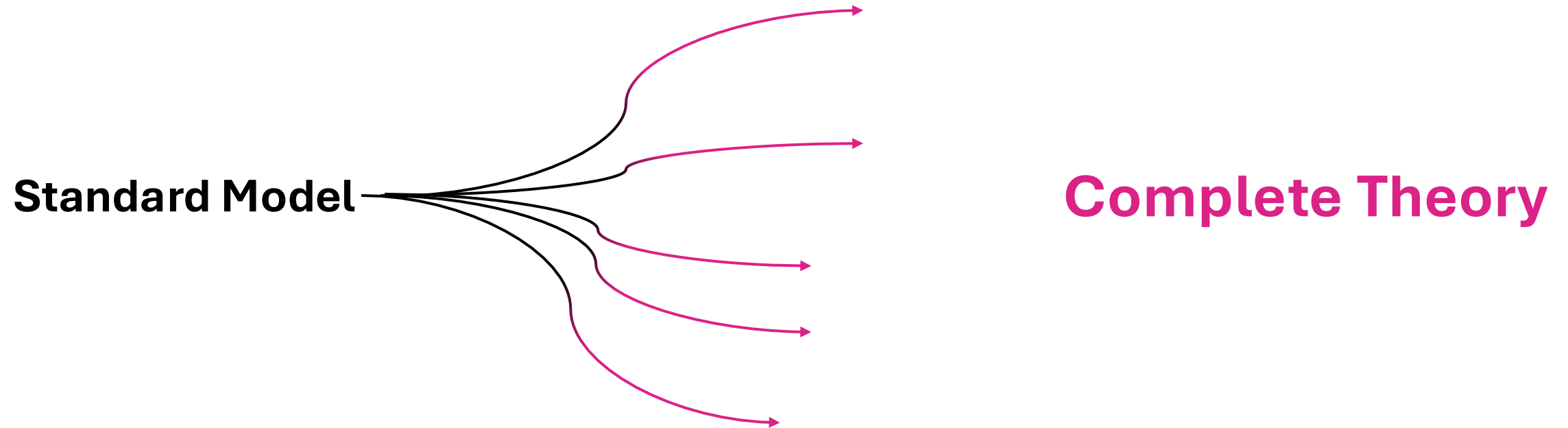


Nikhef Strategy Day Pitch:
BSM Searches with
Future Colliders



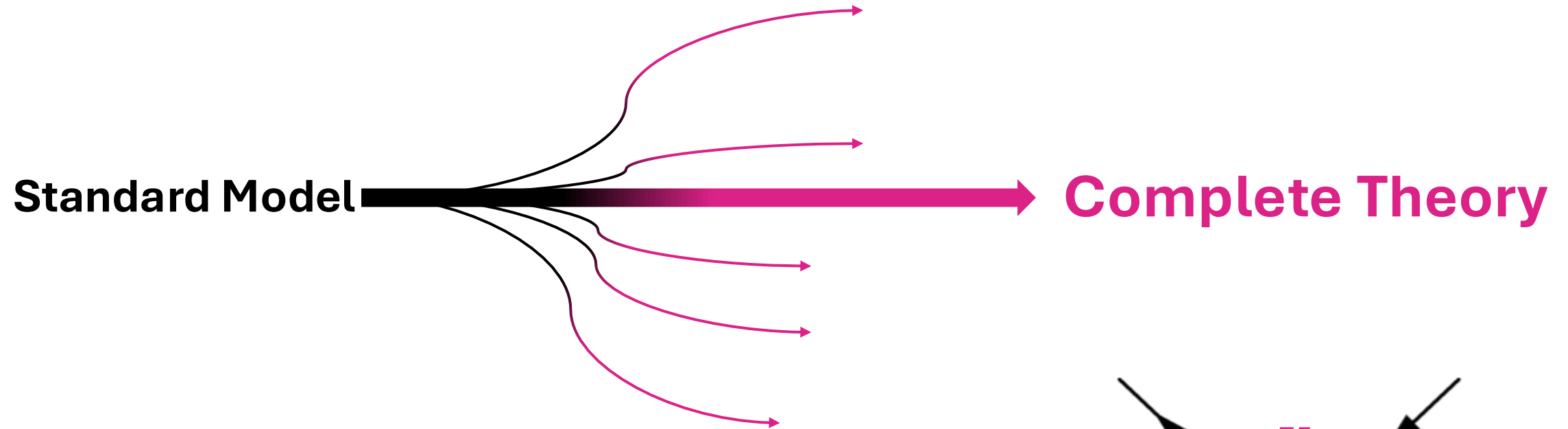
Robin Hayes
Nikhef Strategy Day
Oct 15, 2024

Searches

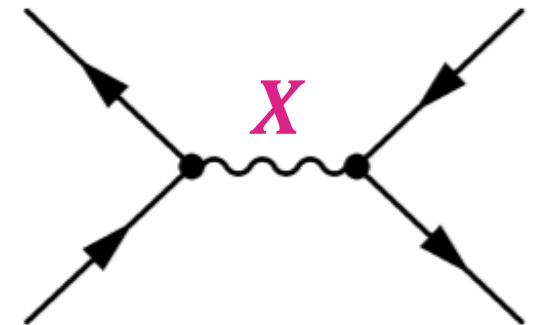


- Lots of possible paths toward a new theory.

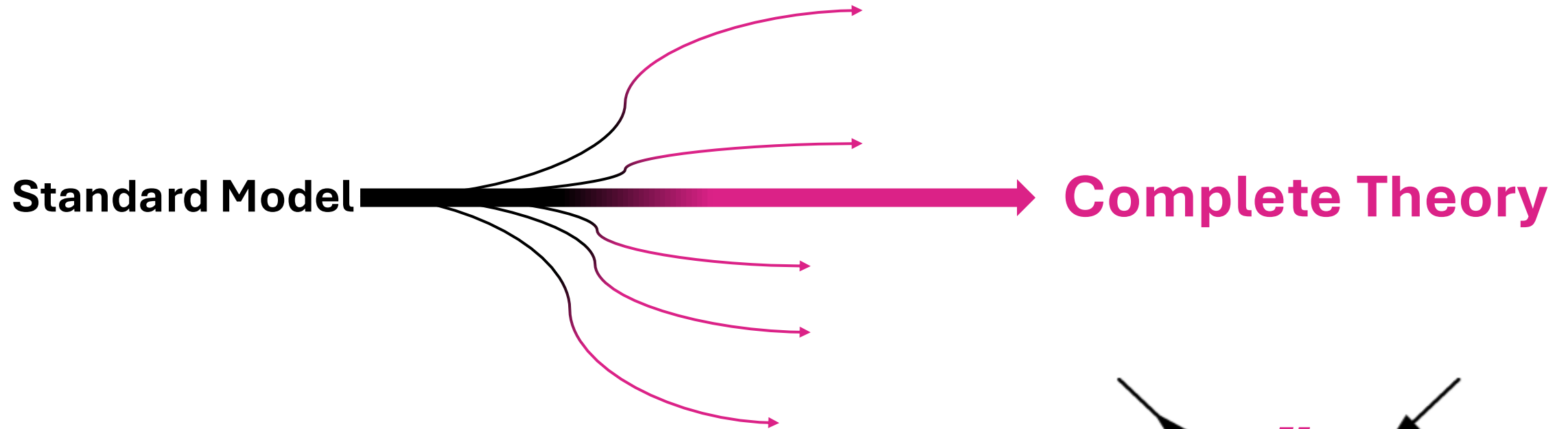
Searches



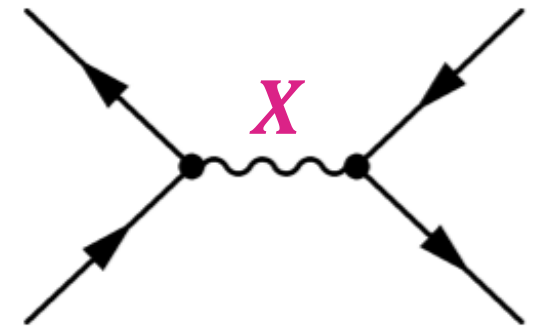
- Lots of possible paths toward a new theory.
- Very straightforward: discover new particle **X!**



Searches



- Lots of possible paths toward a new theory.
- Very straightforward: discover new particle **X**!
- This talk: prospects for BSM searches at future colliders.



Prospects on One Slide

High-energy $\mu^+\mu^-$ or pp collider

- **Probe direct production of new particles** for masses up to 10s of TeV
 - SUSY, extended Higgs sectors, sterile neutrinos, and more....

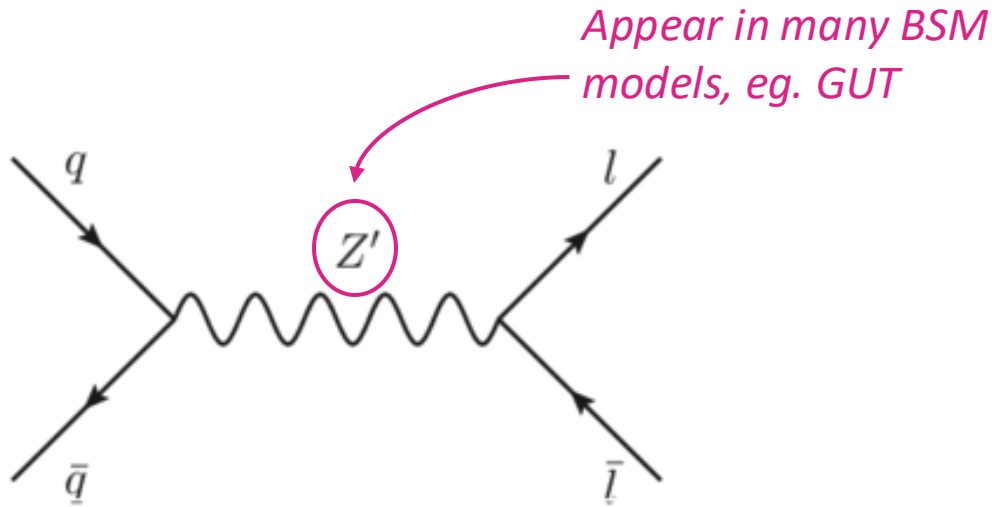
Low-energy e^+e^- Higgs factory

- **Probe direct production of new particles** for sufficiently low masses.
- **Fill in some gaps:**
 - Low-xsec processes with sizeable hadronic BRs
 - Models presenting reconstruction/identification difficulties.
 - Indirect constraints via precision measurements and EFT.

Next slides: some concrete examples.

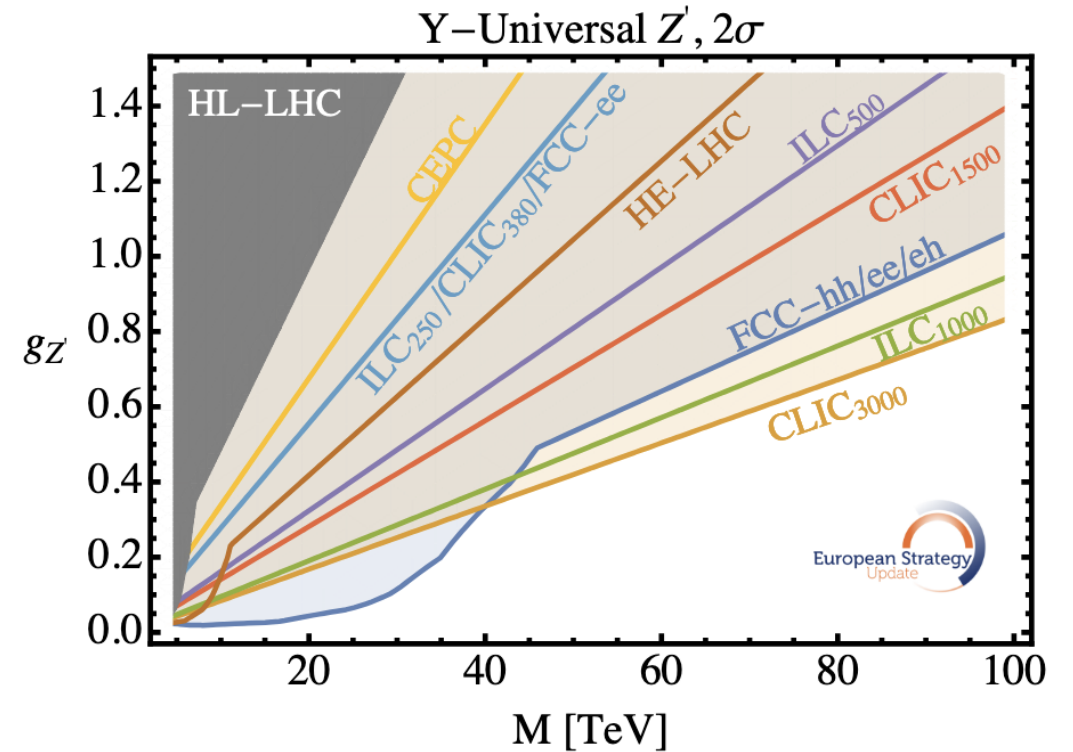
New Vector Bosons

Search for Z'



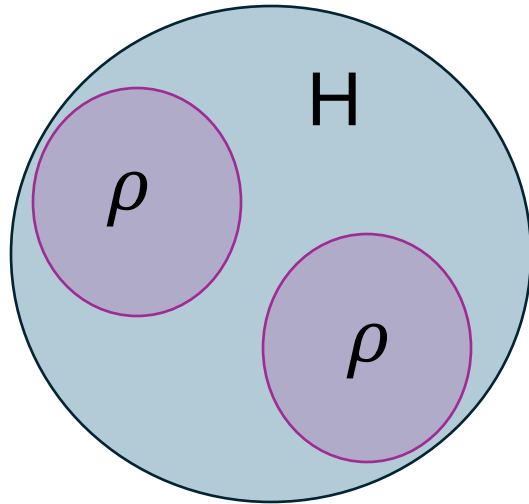
High-energy (eg. FCC-hh): direct searches can exclude masses up to ~ 43 TeV (30 ab^{-1}).

Low-energy e^+e^- : direct searches up to $m \sim \frac{\sqrt{s}}{2}$ (too low to compete with HL-LHC), indirect constraints (EFT) strong above FCC limit.

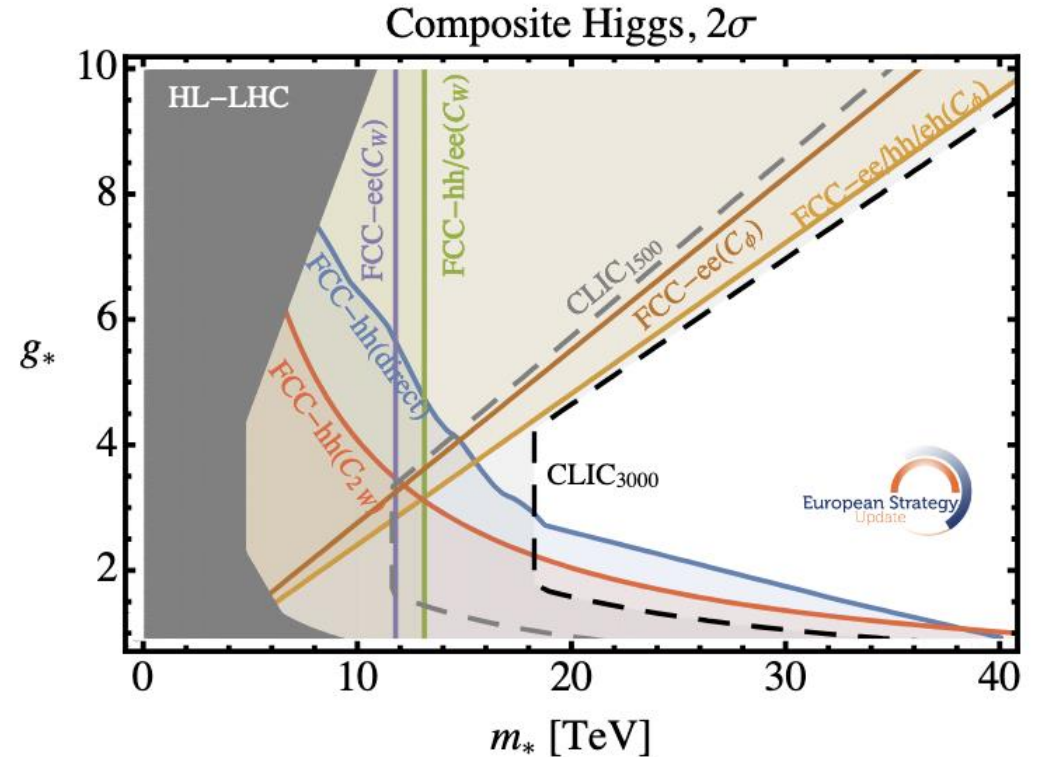


Composite Higgs

Search for ρ Resonance



ρ = spin-1 resonance
 m_* = confinement scale
 g_* = coupling strength of H to ρ



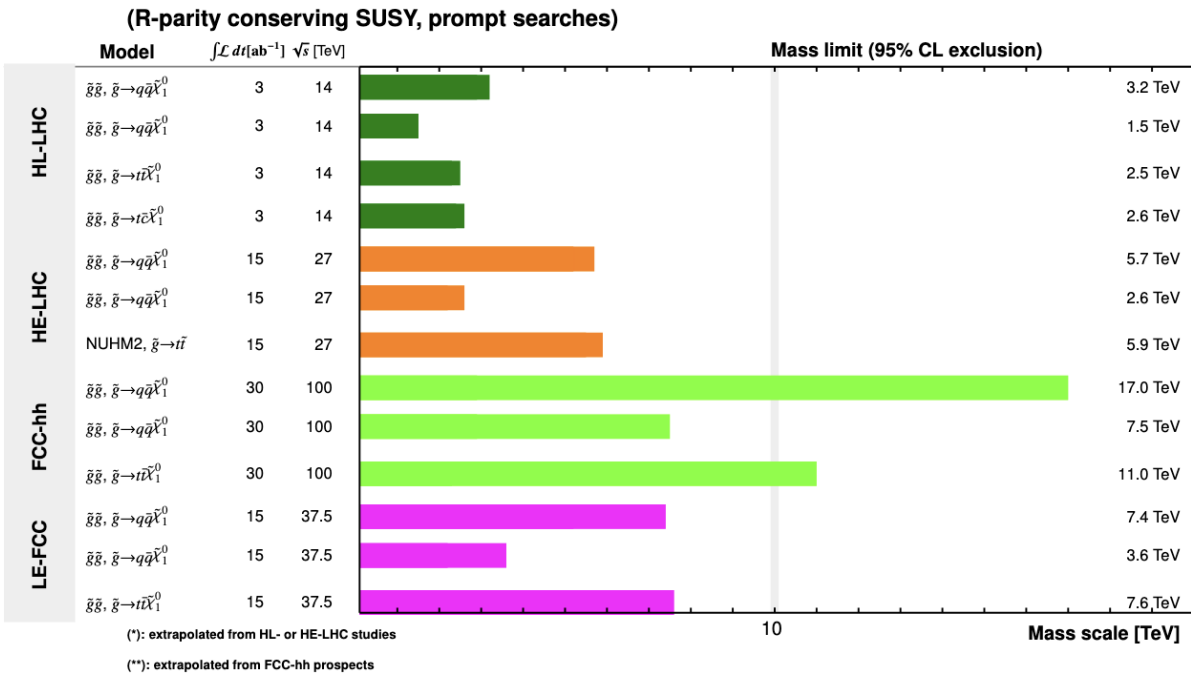
1910.11775

High-energy (eg. FCC-hh): direct searches can exclude m up to 40 TeV for low values of g^*

- Further info on fine-tuning from mass of top partner: limits of 1.5 TeV (HL-LHC) \rightarrow 4.7 TeV (FCC-hh).

Low-energy e^+e^- : indirect constraints (EFT) stronger than HL-LHC.

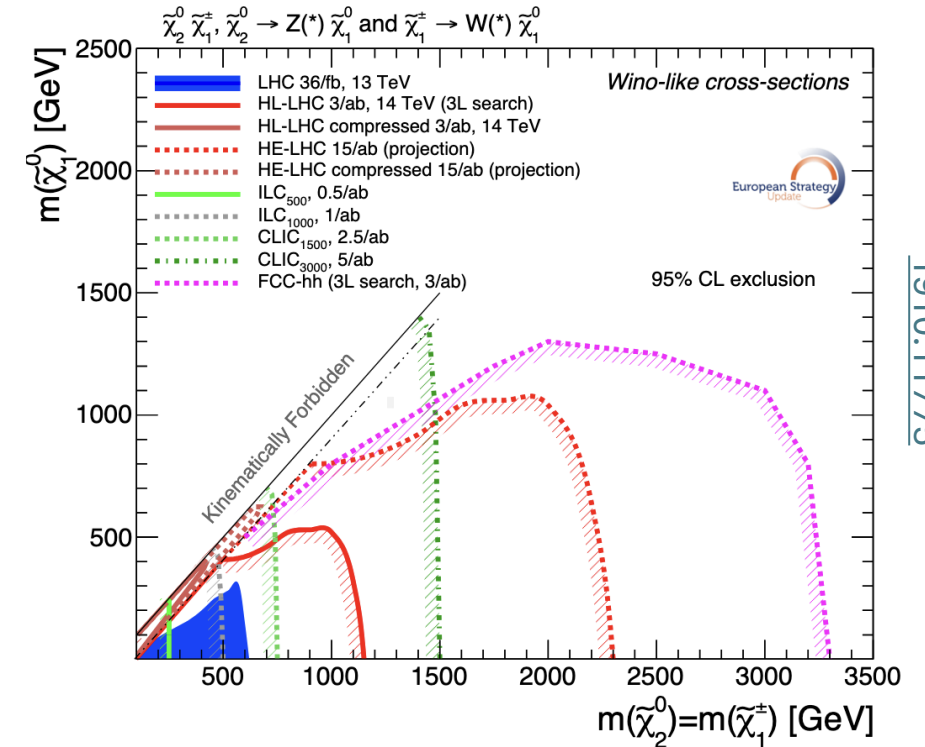
Gluinos



High-energy (eg. FCC-hh): exclusion limits reach 7.5-17 TeV (1.5-3.2 TeV for HL-LHC)

Low-energy e^+e^- : Not possible

EWKinos



Low-energy e^+e^- : at low masses, provide strongest limits for small mass splitting (low MET) – reach 1.5 TeV.

Conclusions

- Energy-frontier machines bring predictably better constraints and opportunity for direct study.
- Low-energy options provide good complementarity and a reach that still extends the HL-LHC's.
- Complete programme (eventually) could include both.

