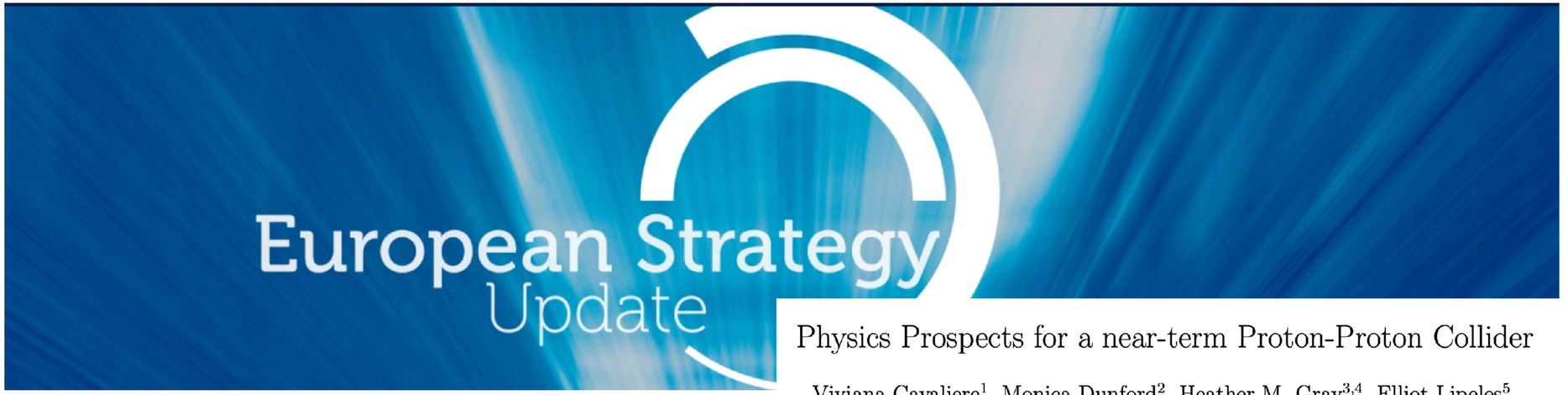
Physics Prospects of a near-term Proton-Proton Collider

2504.00951: Viviana Cavaliere, Monica Dunford, Heather M. Gray, Elliot Lipeles, Alison Lister, Clara Nellist



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Viviana Cavaliere[1], Monica Dunford[2], Heather M. Gray[3,4], Elliot Lipeles[5], Alison Lister[6], and Clara Nellist[7,8]

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[2]Kirchhoff-Institut für Physik, Universität Heidelberg
[3]Lawrence Berkeley National Laboratory
[4]University of California, Berkeley
[5]University of Pennsylvania
[6]University of British Columbia
[7]University of Amsterdam
[8]Nikhef

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Jürgen R. Reuter

Energy & luminosity parameters

- Limiting factors: cooling of synchrotron rad. ≤ 2 kW/beam, pile-up ≤ 1,000 (detector studies needed!)
- Luminosity can mostly compensate lower CM energies (for SM processes)

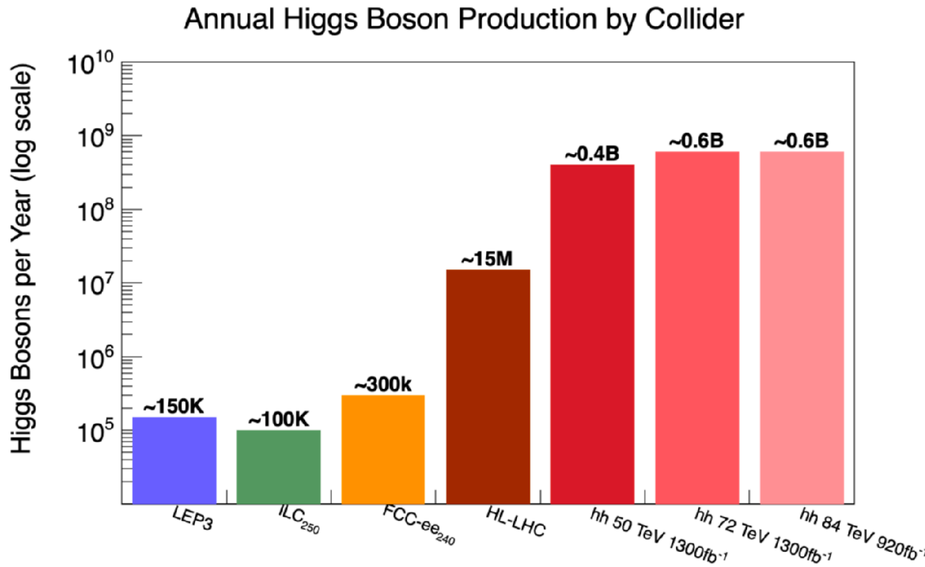
		HL-LHC [5]				
Parameter	Unit	initial (ultimate)	50 TeV	F12PU	F14	F17
Centre-of-mass energy	TeV	14	50	72	84	102
Peak arc dipole field	T	8.3	8.3	12	14	17
SR power / beam	kW	7.3		1450	1200	2670
Peak Collisions / crossing	-	135 (200)	1000	1000	920	975
Luminosity / yr	fb^{-1}	240 (350)	1300	1300	920	920

pile-up lim. synchr. lim.

- Proposal of construction staging: half/“split”-magnet filling lowers initial cost, increases total cost

Physics motivation for 50+ TeV FCC-hh

- Main argument given: luminosity rules ⟹ highest number of Higgs bosons
- Trust into further development of analysis capabilities and ML algorithms
- HL-LHC (Higgs) measurements will remain theory-limited
- Advocating a large theory support (!!! .... all exp. authors)
- Focus on di-Higgs production and trilinear Higgs coupling



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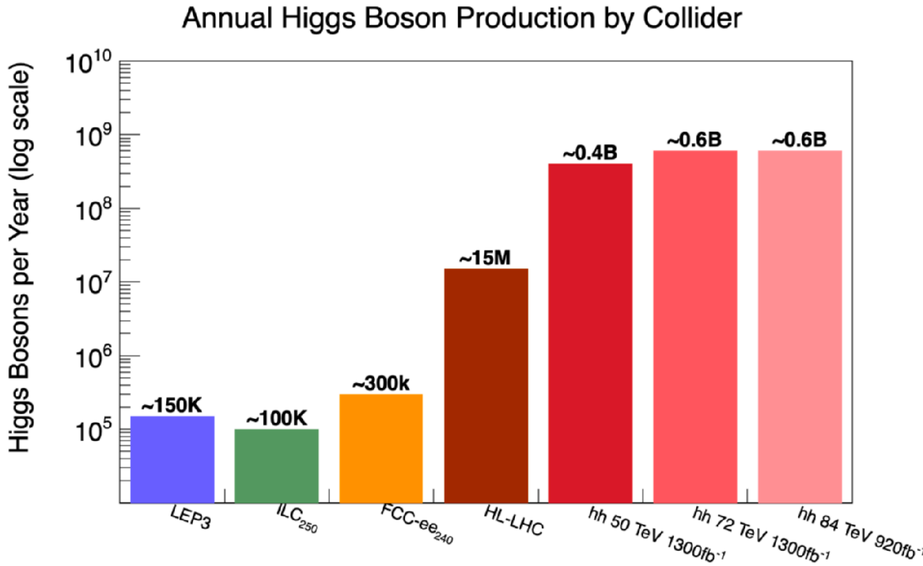

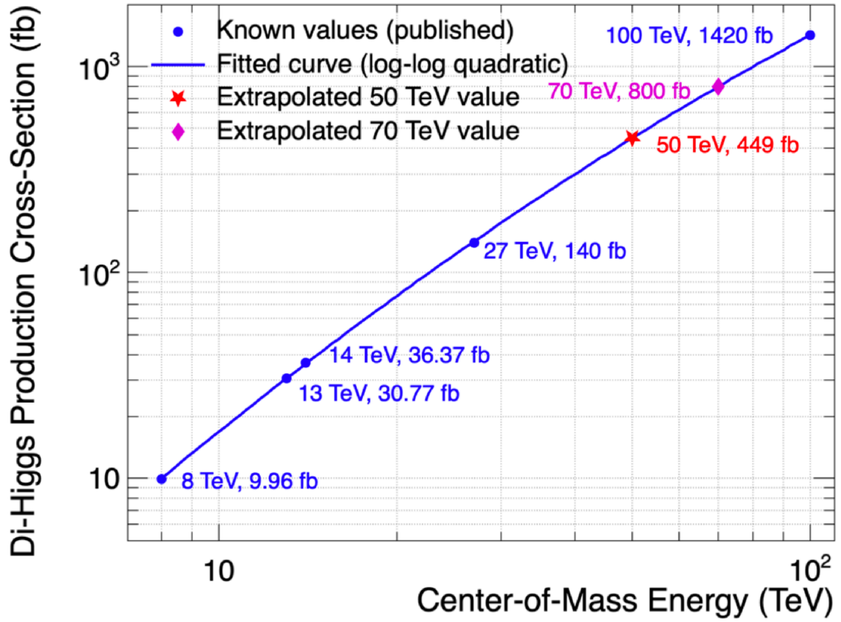

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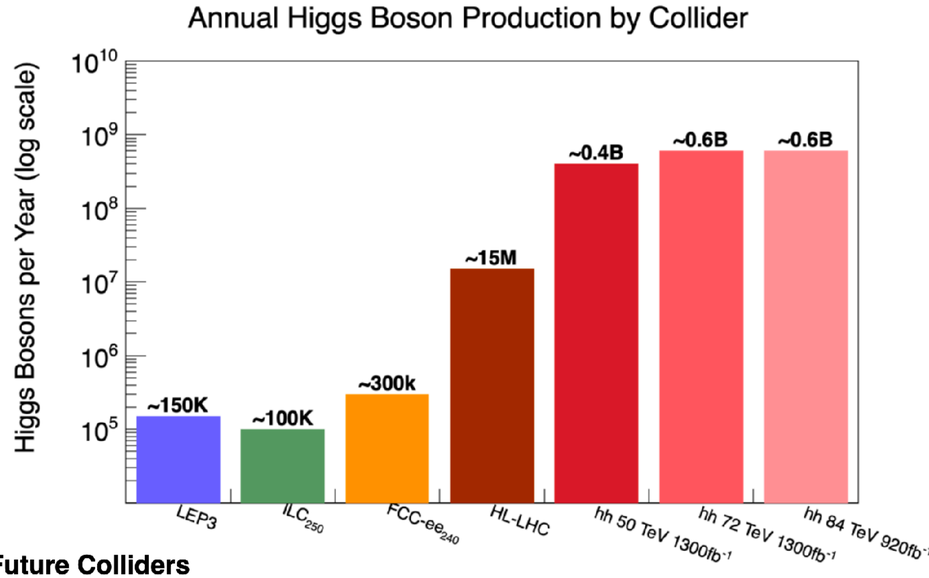

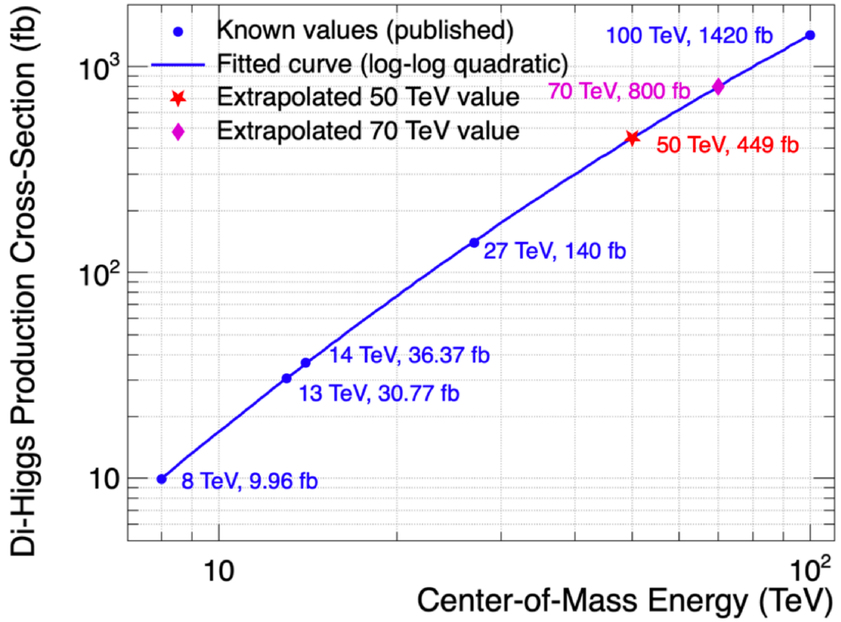

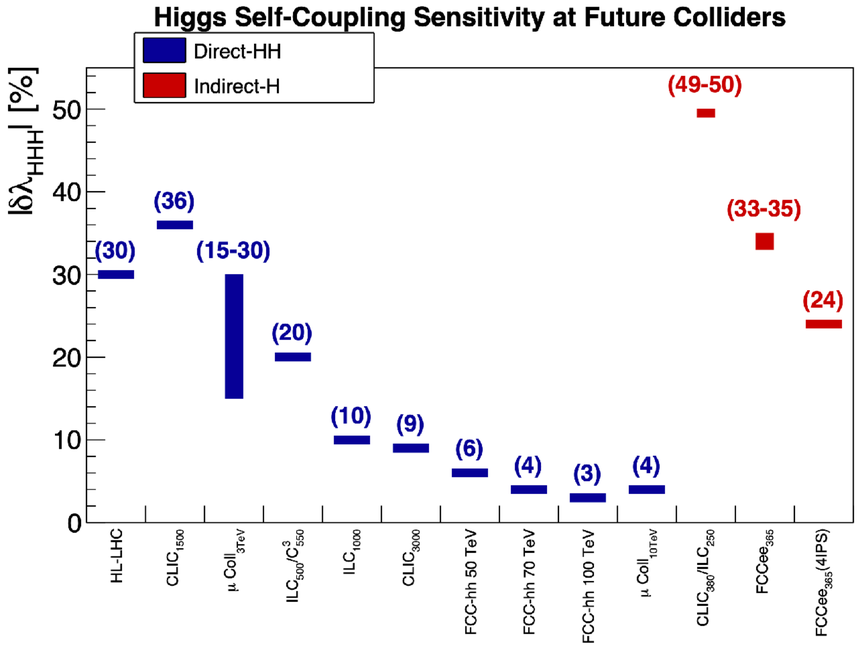

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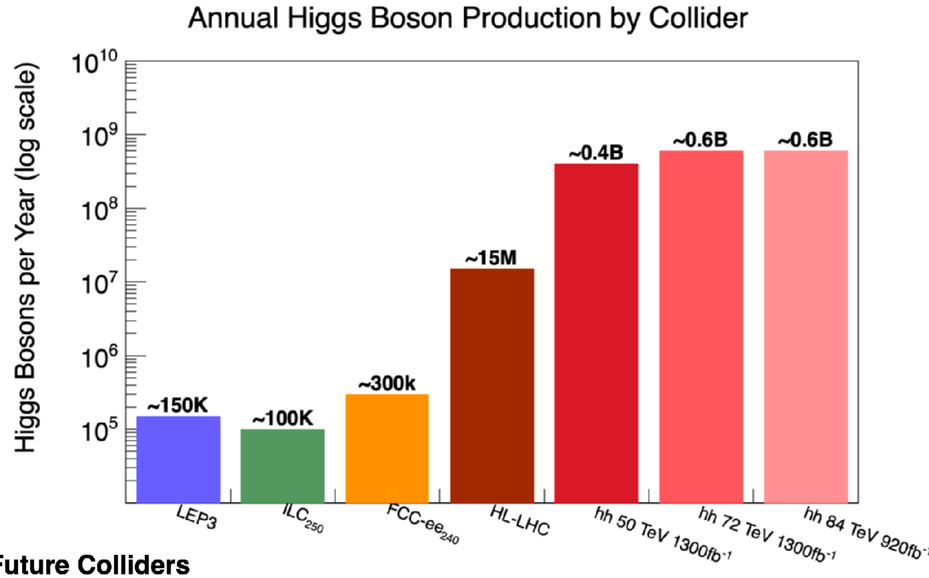

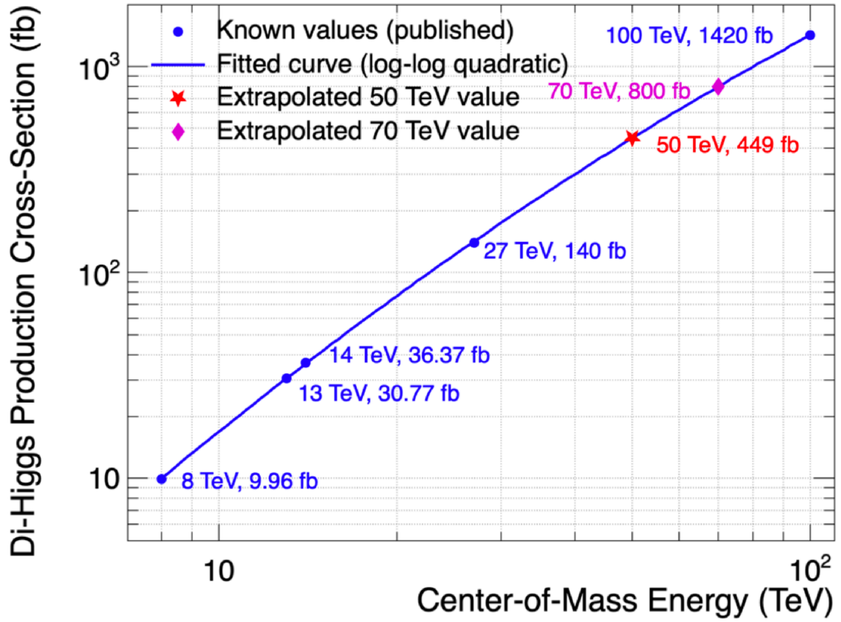

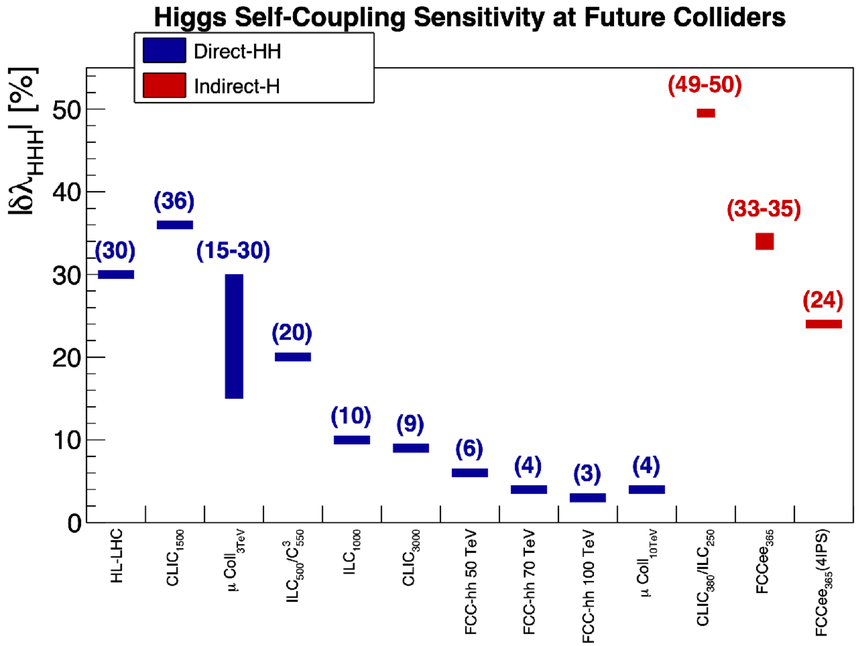

Some numbers with recent updates, some not; be careful with EVERY single plot in EPPSU documents!

Measurements & Searches

- Precision measurements: Advocating ratio measurements to cancel both theory & detector uncertainties
- BSM searches: very simple rescaling from 84 TeV scenarios downwards or HL-LHC projections upwards

  New resonance searches: benefit from lower energy/higher lum. for $M \lesssim 3$ TeV, degradation above $M \sim 3$ TeV
- Extended range compared to HL-LHC: SUSY stop 2 TeV $\Longrightarrow$ 8-10 TeV, (SSM) Z' 5 TeV $\Longrightarrow$ 33–46 TeV

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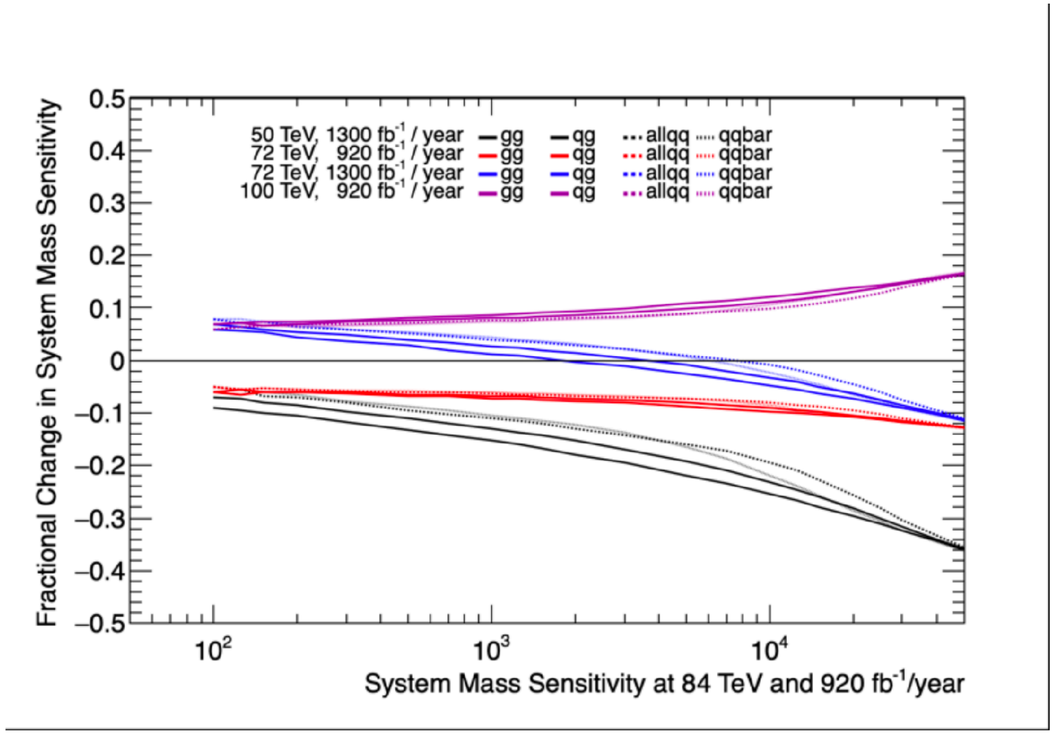

- Very strong statements:
  e.g. SUSY compressed spectra are considered unlikely
- or: "clear case for the uniqueness of the e^+e^- machine needs to be made"
  (example aTGCs projections vs. LHC measurements)

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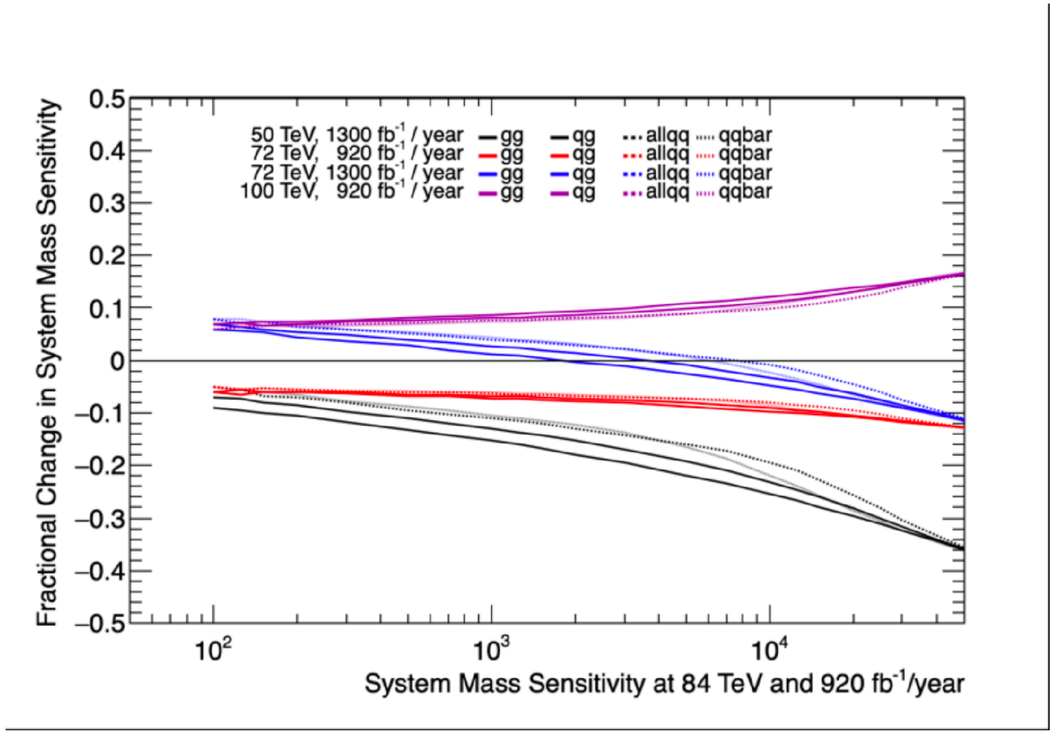

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  e.g. SUSY compressed spectra are considered unlikely
- or: "clear case for the uniqueness of the e^+e^- machine needs to be made"
  (example aTGCs projections vs. LHC measurements)
- Main conclusions: a fast FCC-hh can (only?) "energize" the community (without an e^+e^- machine)