

EF08 Collider Summary Plots

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European Strategy Report

- Using the [ES report](#) as starting point for summary plots
- Relevant searches in ES report:
 - Gluinos and squarks
 - Charginos, neutralinos
- Colliders considered by ES report:
 - HL-LHC, HE-LHC
 - FCC-hh 100, LE-FCC
 - CLIC 380, 1500, 3000
 - ILC 500, 1000
 - **Missing:** FCC-hh 75, 150; CEPC; Muon; LHeC; FCC-eh

Updates and Additions

- More recent studies have been published since January 2020
 - New mass reach projections can be directly included
 - Completed Run 2 searches can be extrapolated to future colliders
- Several colliders not considered in ES report
 - Some sources have been found to cover other colliders
- Currently considering: Gluinos, Light Squarks, Stops, Chargino Neutralino, Compressed Higgsino

If you want something included let us know! Extra dimensions, other non-SUSY things...

Example: Light Squarks

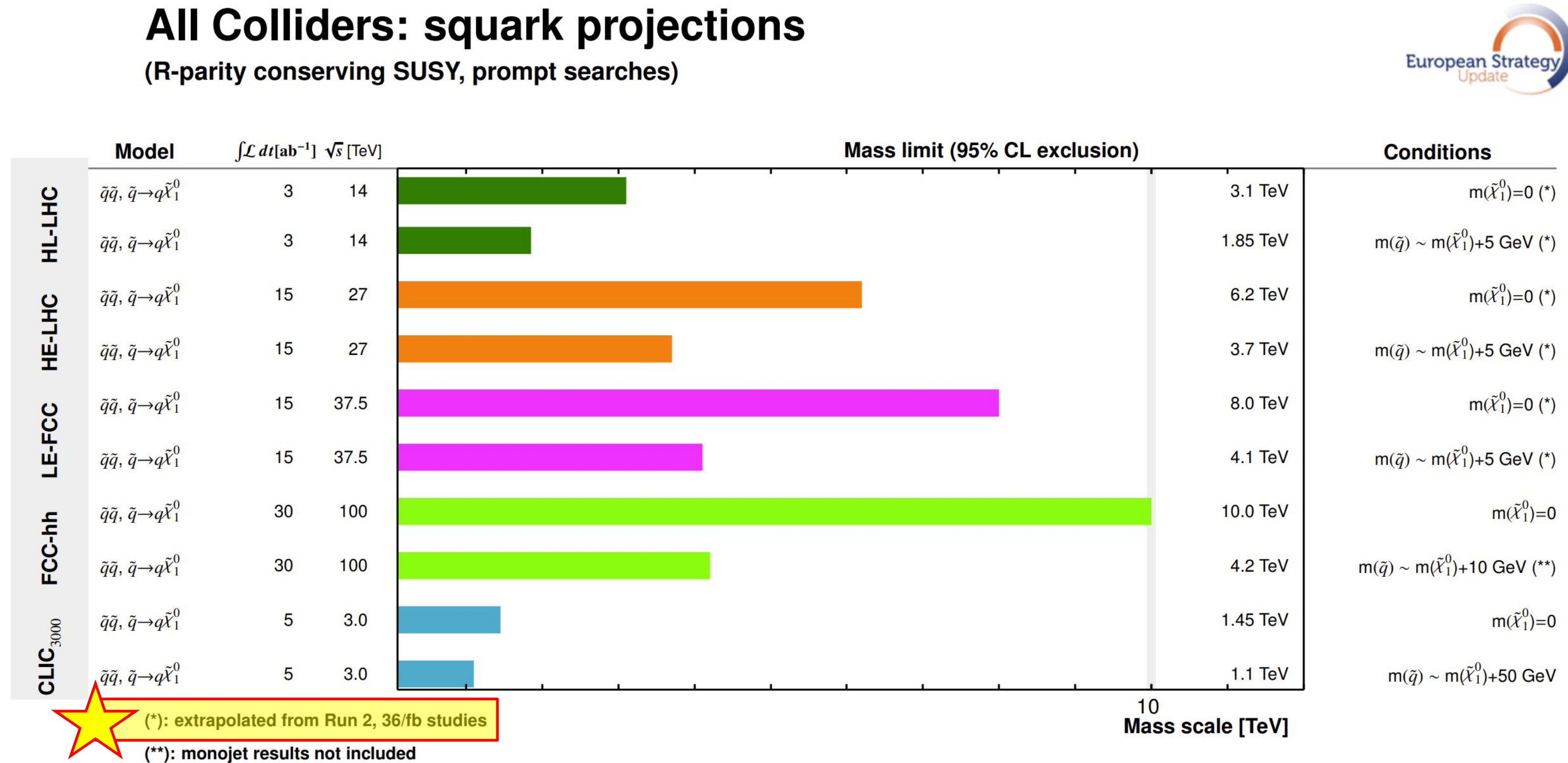


Fig. 8.7: Exclusion reach of different hadron and lepton colliders for first- and second-generation squarks.

Example: Light Squarks

- ES report cited partial CMS and ATLAS results (2.3 and 36 fb⁻¹) to approximate HL-LHC squark mass reach
- Since then, full Run 2 analysis (139 fb⁻¹) has been released and could be used to make better approximations
- **Let's make some updated HL-LHC mass reach estimates!**

Collider Reach

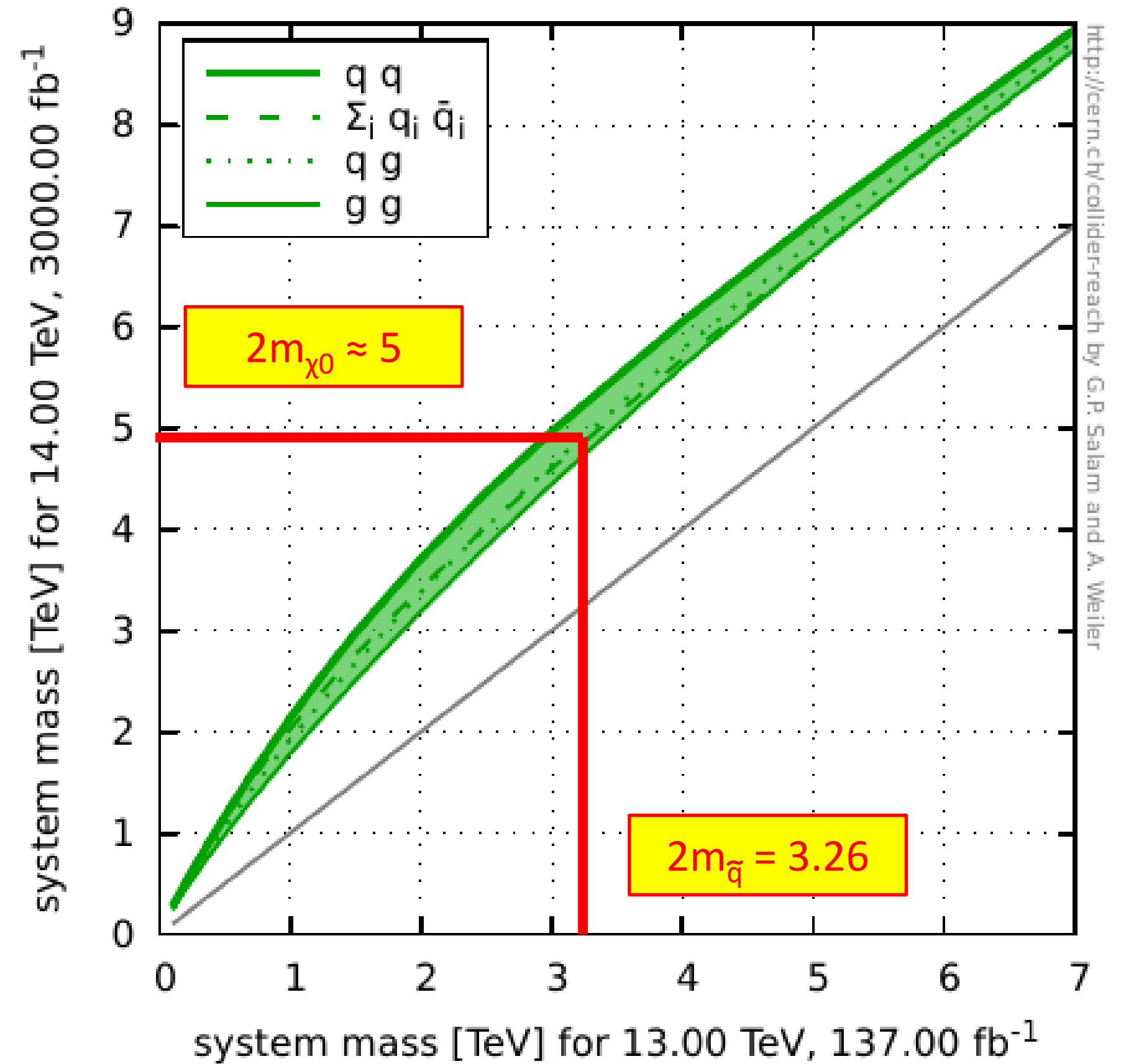
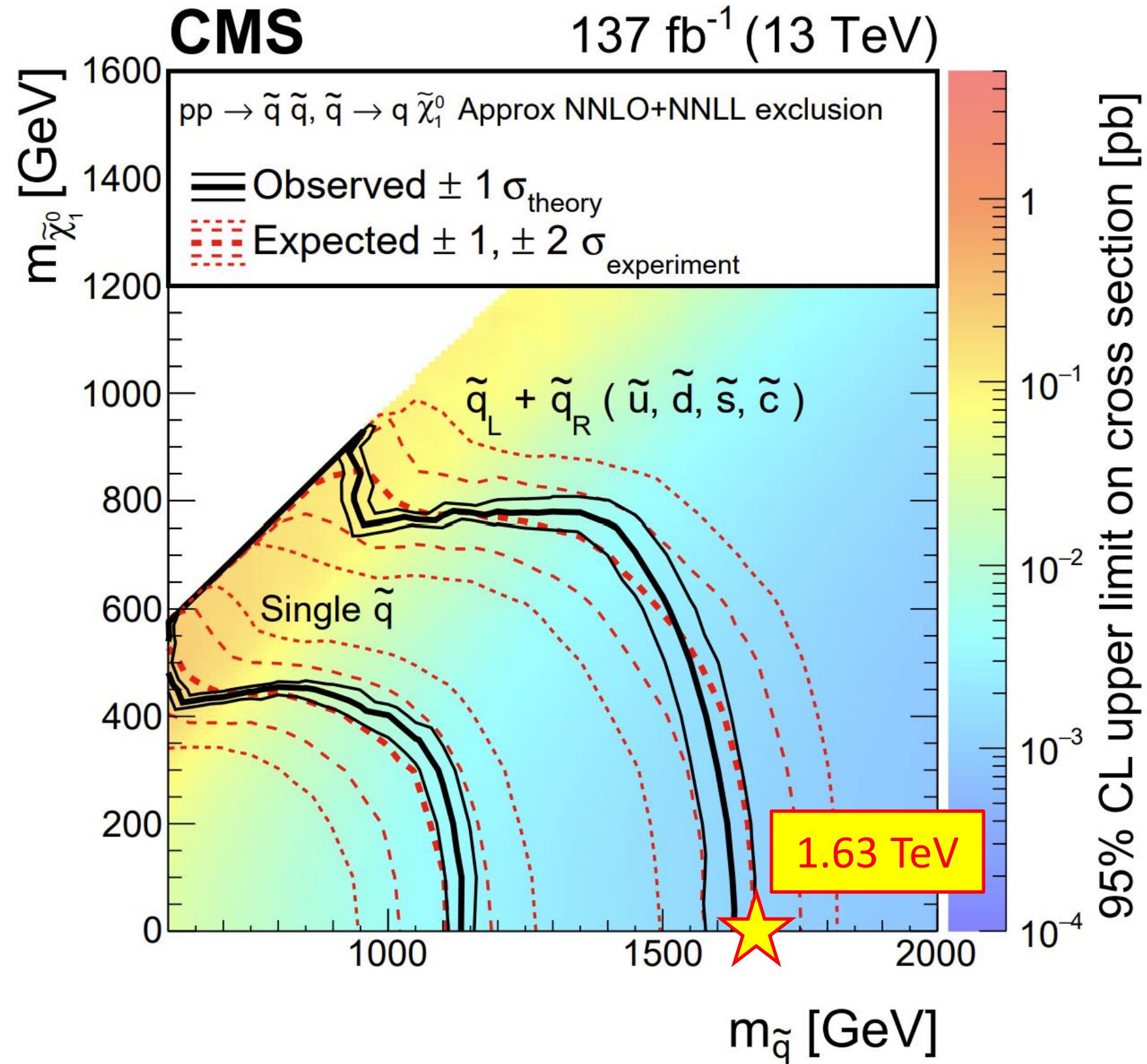
- Web-based [tool](#) developed by Gavin Salam and Andreas Weiler.

Main assumptions:

- We don't worry about scaling of background vs. signal
- Reconstruction efficiencies, background rejection, etc. all stay reasonably constant
- Tool solves for M_{high} , given some upper and lower energies and luminosities

$$\frac{N_{\text{signal-events}}(M_{\text{high}}^2, 14 \text{ TeV}, \text{Lumi})}{N_{\text{signal-events}}(M_{\text{low}}^2, 8 \text{ TeV}, 19\text{fb}^{-1})} = 1$$

Run 2 + Collider Reach



Run 2 + Collider Reach vs. ES report

- Collider-Reach can be used to make a new estimate on the HL-LHC mass reach for light squarks using the full Run 2 dataset

	Process	LHC (full Run 2)	HL-LHC projection (CR with full Run 2)	HL-LHC projection (ES with early Run 2)
CMS (fig 14)	Squarks to qq X0, $m_X=0$	1.66 TeV	2.5 TeV	3.1 TeV
ATLAS (fig 13)	Squarks to qq X0, $m_X=0$	1.76 TeV	2.6 TeV	3.1 TeV

Run 2 + Collider Reach vs. ES report

- Collider-Reach can be used to make a new estimate on the HL-LHC mass reach for light squarks using the full Run 2 dataset
- Interesting to compare CR + Run 2 -> FCC-hh extrapolation, and compare with the dedicated FCC-hh study from 2019
 - Unclear how to compare dedicated studies with collider-reach projections

	Process	LHC (full Run 2)	HL-LHC projection (CR with full Run 2)	HL-LHC projection (ES with early Run 2)	FCC-hh projection (CR)	FCC-hh study (ES)
CMS (fig 14)	Squarks to qq X0, $m_X=0$	1.66 TeV	2.5 TeV	3.1 TeV	14 TeV	10 TeV
ATLAS (fig 13)	Squarks to qq X0, $m_X=0$	1.76 TeV	2.6 TeV	3.1 TeV	15 TeV	10 TeV

Conclusion

- We will create summary plots like those in the ES report
- Building on the ES estimates by adding proposed colliders and updating mass reaches using Collider-Reach
- Open Questions:
 - How do we weigh Collider-Reach vs dedicated studies?
 - Are there other existing scenarios with a significant number of colliders that we can make summary plots of?
 - Non-SUSY model-specific plots?

Would love some feedback from the community!

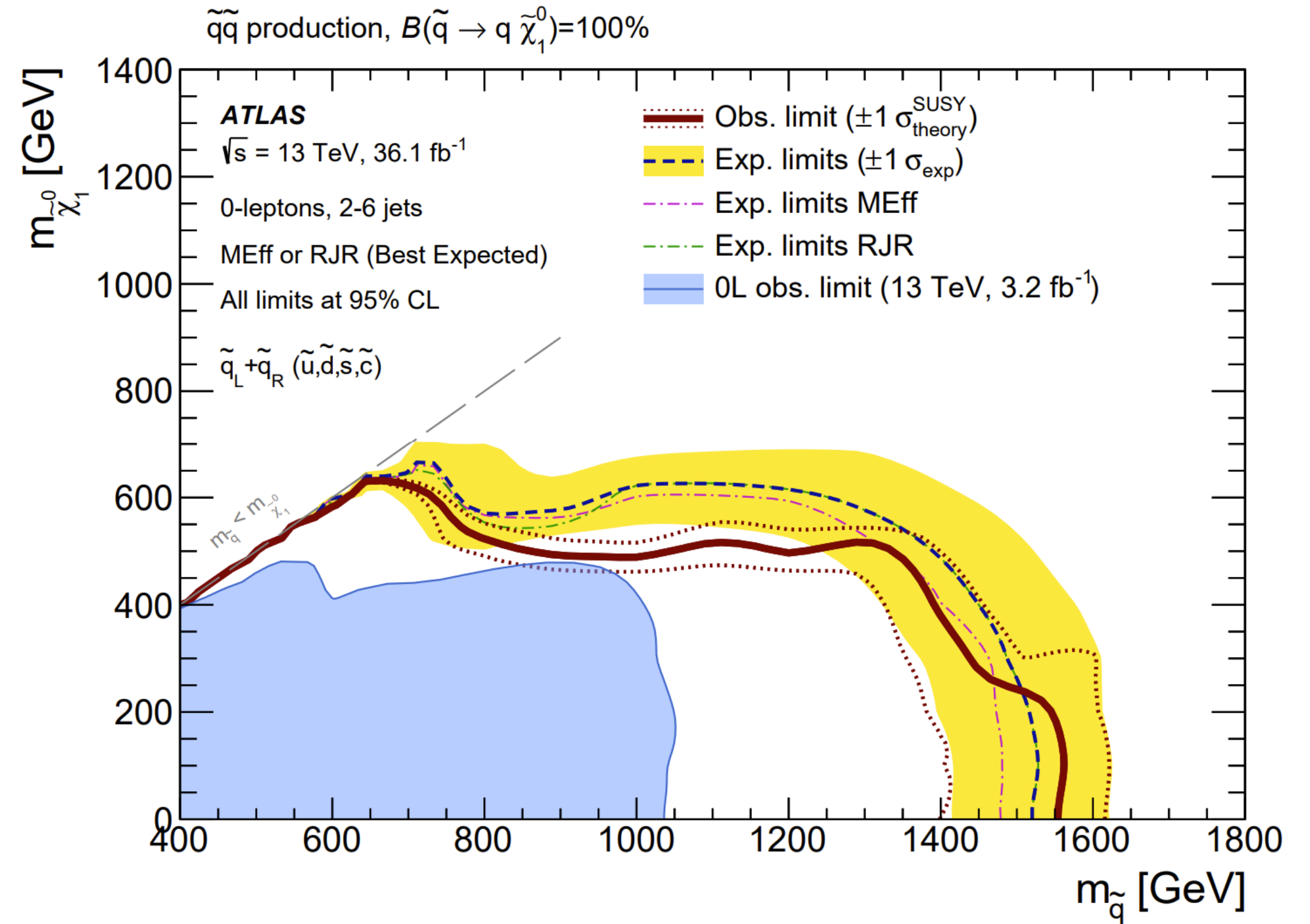
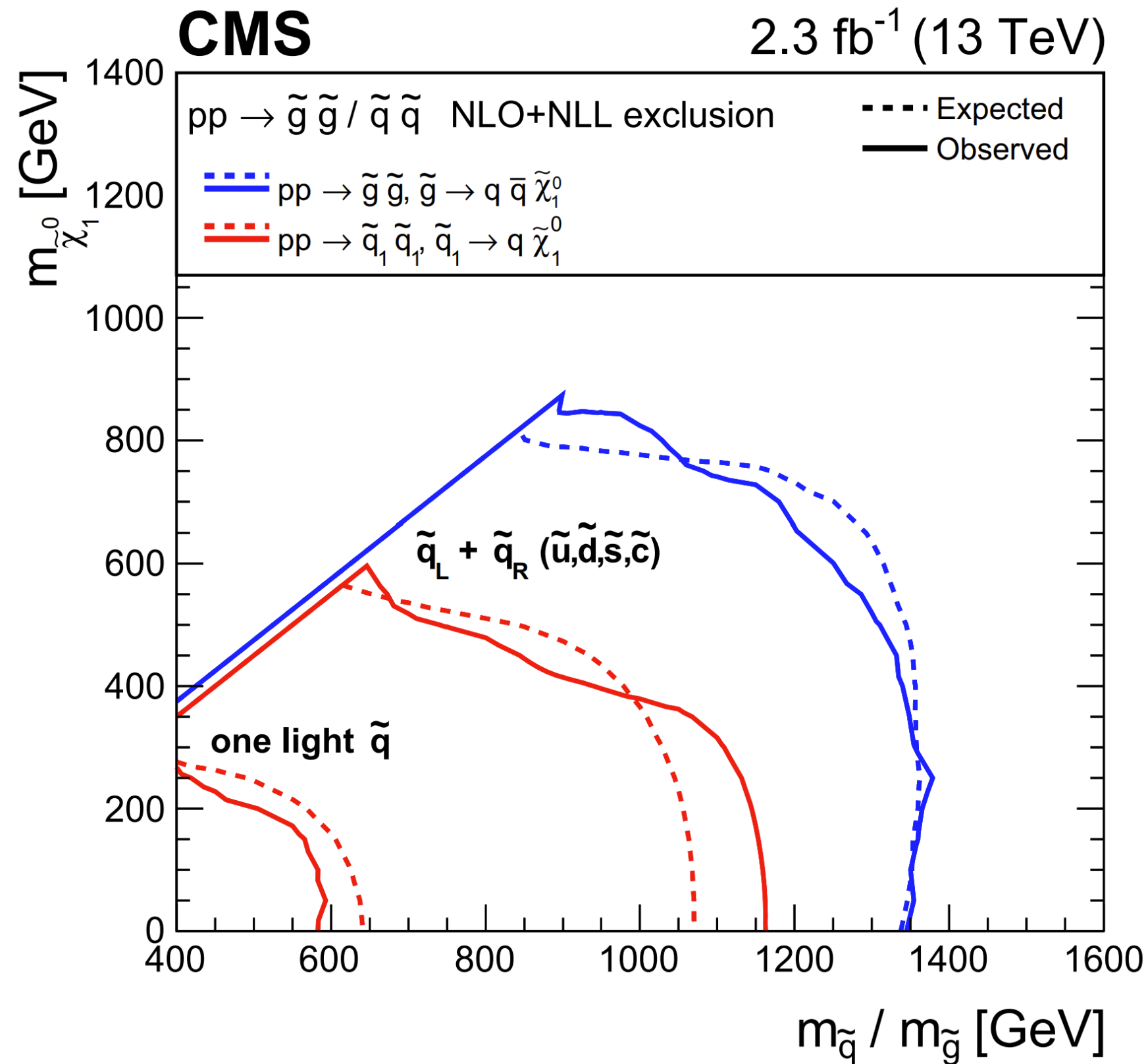
Backup

Run 2 partial + Collider Reach vs. ES report

- Curious to compare ES report extrapolation to collider reach extrapolation
- Unclear where the compressed numbers came from

	Process	LHC partial	HL-LHC projection (collider-reach)	HL-LHC projection (ES)
ATLAS https://arxiv.org/pdf/1712.02332.pdf	Squarks to qq X0, mX=0	1.52 TeV (36 fb-1)	2.7	3.1
	Squarks to qq X0, mg=mX+5GeV	Unclear?		1.85
CMS https://link.springer.com/content/pdf/10.1140/epjc/s10052-017-4787-8.pdf	Squarks to qq X0, mX=0	1.06 (2.3 fb-1)	2.8	3.1
	Squarks to qq X0, mg=mX+5GeV	Unclear?		1.85

Run 2 partial light squarks



Collider Reach

Provide energy and luminosity of collider 1 and 2

Choose between 2 pdf options

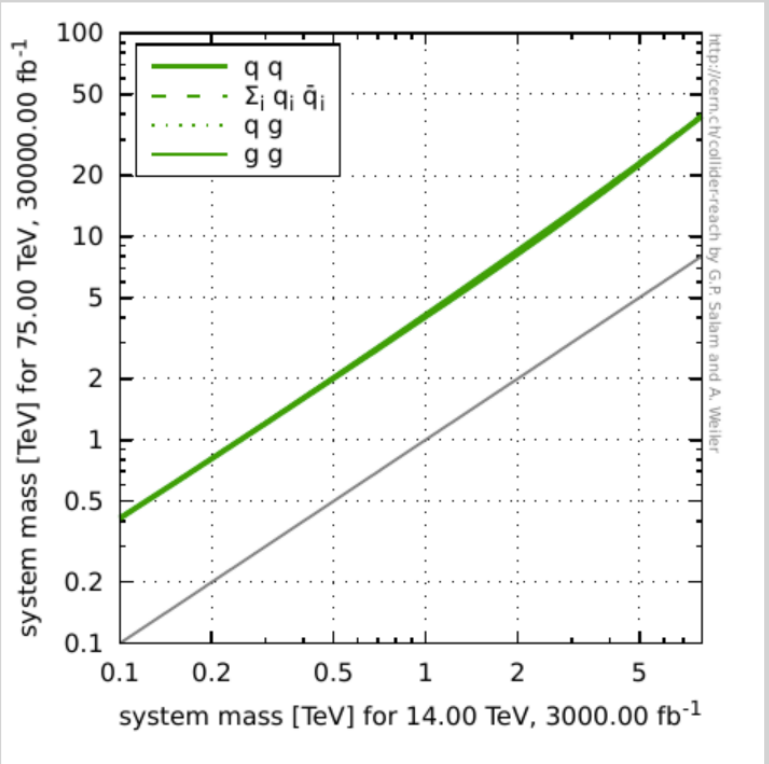
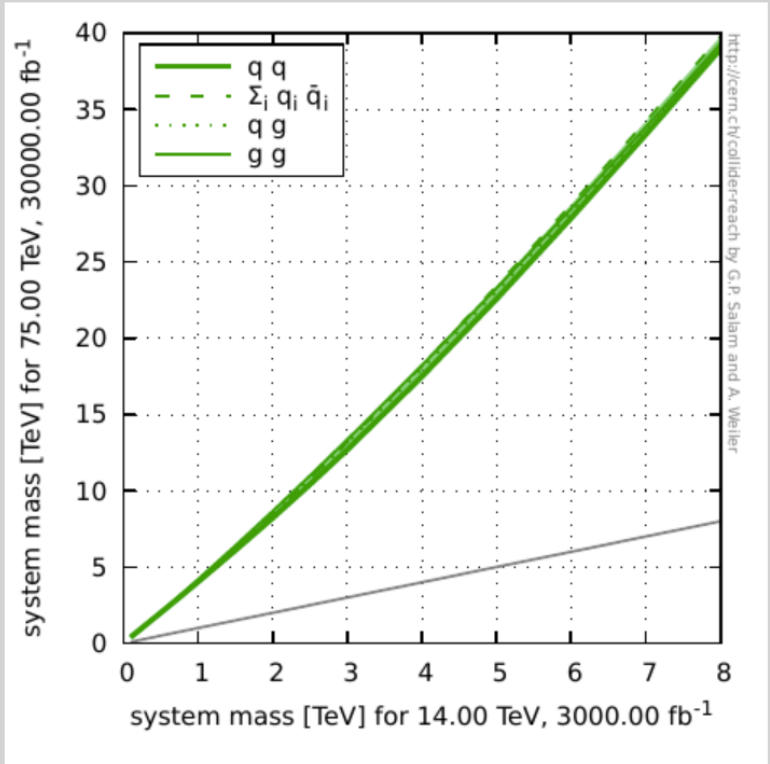
Provides plots that compare “system mass” ($2m$) reach for 2 colliders

Table of results by channel + interpolation tool

The Collider Reach tool gives you a quick (and dirty) estimate of the relation between the mass reaches of different proton-(anti)proton collider setups.

Collider 1: CoM energy TeV, integrated luminosity fb⁻¹
Collider 2: CoM energy TeV, integrated luminosity fb⁻¹
PDF:

Plots



Download: [collider.pdf](#), [colliderloglog.pdf](#), plot generation [log file](#)
The PDF choice was CT18NNLO

Table of results

Original mass [GeV]	gg	qg	allqq	qqbar
100.	413.	413.	412.	408.
125.	513.	513.	512.	506.

Interpolation

Input a baseline mass (e.g. Z' mass or $2m_{\tilde{q}}$) at collider 1 to get a specific reach estimate for collider 2:
 GeV → gg: 10990, qg: 10786, allqq: 10417, qqbar: 10785 GeV