

EF08: BSM Model Specific Explorations

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Agenda/Outline

- The Snowmass process
- The goals of the this group
- Our thoughts on the the major questions
- Near-term planning of future meetings
- Review of SUSY in European Strategy Report
 - Talk by Monica D'Onofrio
- Open discussion



Your input
welcome, speak
up here or send
us input

Getting Information and Giving Input

Contact Info... on wiki https://snowmass21.org/energy/bsm_models

Conveners	Jim Hirschauer, Elliot Lipeles, Nausheen Shah (more contact info)
Mailing-list	SNOWMASS-EF-08-BSM_MODELS@FNAL.GOV (instructions)
Slack channel	ef08-bsm_models (instructions)
Next Event	May 28th 11am ET, general Energy Frontier Kick-off Meeting (and biweekly there after)
Contact Forms	In addition to direct emails, you can also use these forms to give us input (preferred method)
	If you'd like to add some input to the discussion in advance of the working group meetings, you can do so here https://forms.gle/FF55yn2aWHKQbgtc7
	To aid us in probing the interest of the community, steer future meetings, and facilitate connections between people interested in similar studies, we invite you to fill out a questionnaire at this link: https://forms.gle/1wSzdPNEqWVSeM1y9

Snowmass Process

U.S. Strategic Planning Process for Particle Physics

~year-long process

Snowmass Community-Wide “**Science**” Study

Organized by Division of Particles and Fields (DPF) of APS



Input to P5

~year-long process

P5 (Particle Physics Project **Prioritization** Panel)

formulate a 10-year plan (20 year vision) within funding constraints

Subpanel of HEPAP, High Energy Physics Advisory Panel for DOE/NSF funding agencies

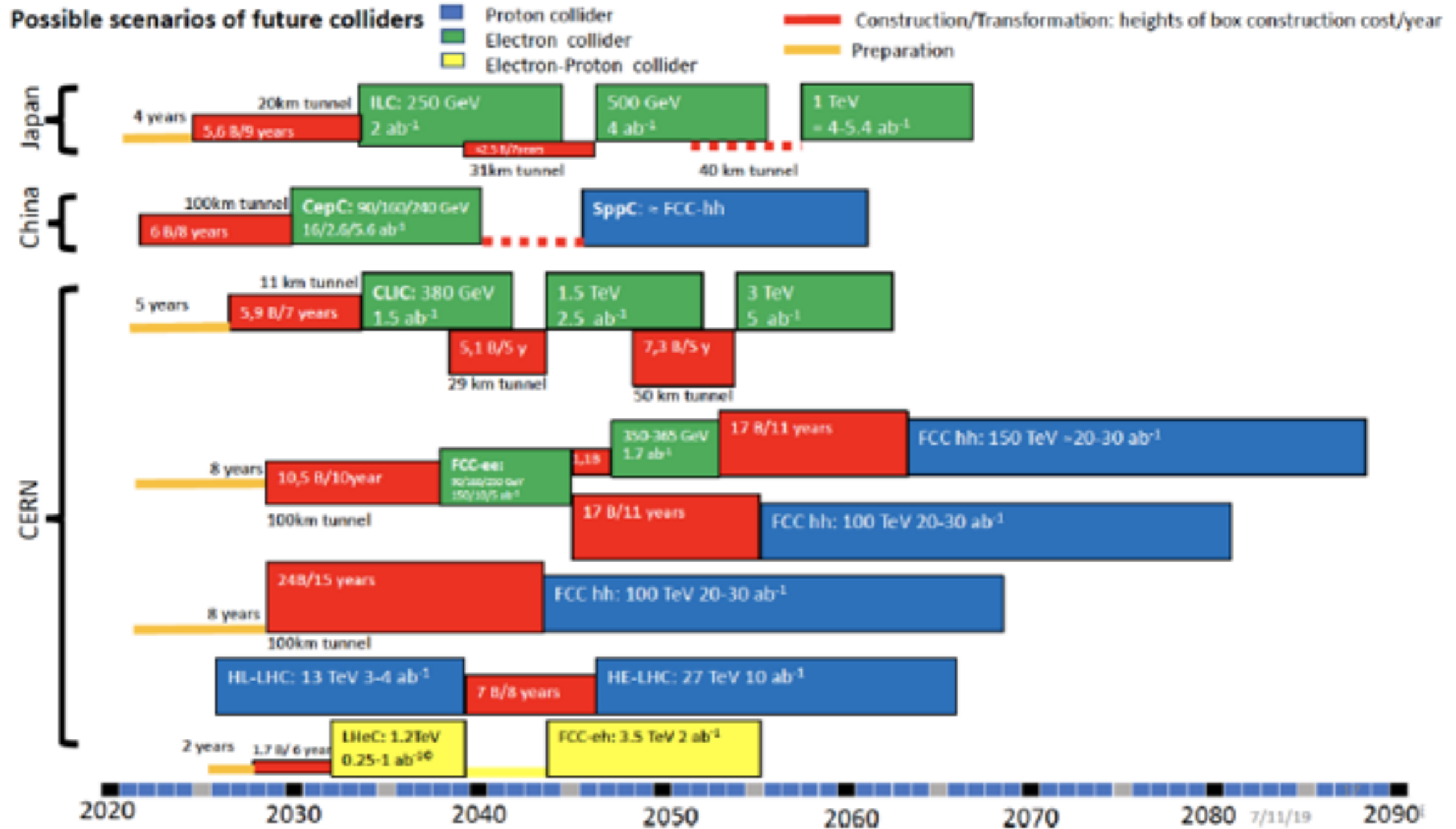
We are making a report on the Science

Snowmass Process

Our goal is to

- Focus on a “set of questions” and the “scientific merits” of the various collider options and proposals (colliders on next slide).
- Develop a global picture and a future roadmap.
- Compile existing studies
 - start from ESG briefing book and other sources
- Use machine parameters as used for ESG
 - EF will work with AF to identify a set of benchmark collider scenarios. Will deviate from the ESG scenarios only with good reason.
- Add new studies and information
 - What is needed to make the global picture

Snowmass Process



Ursula Bassler @ Granada meeting

- Will add EIC and Muon Collider to this chart.
- We will consider any new proposals which may come up during Snowmass 2021.

Your Inputs...

Letters of Interest (submission :April 1, 2020 – August 31, 2020)

- Allow conveners to see what proposals to expect and to encourage the community to begin studying them.
- Letters should give brief descriptions and cite the relevant papers to study. – Submission instructions: <https://snowmass21.org/loi>
- Authors are encouraged to submit a full writeup as a contributed paper

Contributed Papers (submission :April 1, 2020 – July 31, 2021)

- Part of the Snowmass proceedings.
- White papers on specific scientific areas, technical articles presenting new results on relevant physics topics, and reasoned expressions of physics priorities.
- These papers and discussions throughout the Snowmass process will help shape the long-term strategy of particle physics in the U.S.
- Contributed papers will remain part of the permanent record of Snowmass 2021. – Submission instructions: <https://snowmass21.org/submissions/>.

“Expression of Interest”:

- Informal message to conveners to aid us in probing the interest of the community, steer future meetings, and facilitate connections between people interested in similar studies and staffing of high-priority topics, we invite you to fill out a questionnaire at this link: <https://forms.gle/IwSzdPNEqWVSeMIy9>

Dates and Meetings

All Frontier Meetings

- Snowmass Planning Meeting: November 4-6, 2020 at Fermilab
- Snowmass Summer Study: July 11-19, 2021 at UW Seattle

Energy Frontier Meetings

- EF Workshop: July 9-10, 2020 (two full days, online)
- Future meetings will be scheduled in Fall....
 - Proposals: April 2021 (APS meeting),
 - EF meetings: Jan/Feb 2021 to check on progress since November
 - May/June 2021, finalizing the work for reports.
- Full set of EF meetings here: https://snowmass21.org/energy_meetings

Document Writing...

- First draft of Topical Group summaries by March 2021.
- First draft of Frontier summaries by June 2021
- First draft of Snowmass Report by August 2021
- Final document by October 2021

Groups Focus

- Using models to quantify scenarios
- Models give concrete examples to compare scenarios
 - compare inclusivity of leptons colliders vs reach of hadron colliders
 - compare direct searches vs indirect constraints from precision measurements
- Limits on models are of intrinsic interest
 - What mass higgsino will still be allowed if we build XYZ
 - I.e. if we build experiment XYZ how will the field will be advanced?
- In some cases top down motivations suggest viable parameter ranges
 - How will the relative fine-tuning change before and after project XYZ

Other topical groups in Energy Frontier

Electroweak Physics

- EF01: Higgs Boson Properties and couplings: Mass, width, couplings, including limits on Higgs self-coupling.
- EF02: Higgs Boson as a portal to new physics: Broad spectrum of BSM Higgs (2HDM, extra singlets, ...)
- EF03: Heavy flavor and top-quark physics: Top properties, top/bottom/charm production.
- EF04: EW precision physics : Precision fits of EW+Higgs+top observables (EFT, models,

QCD and strong interactions

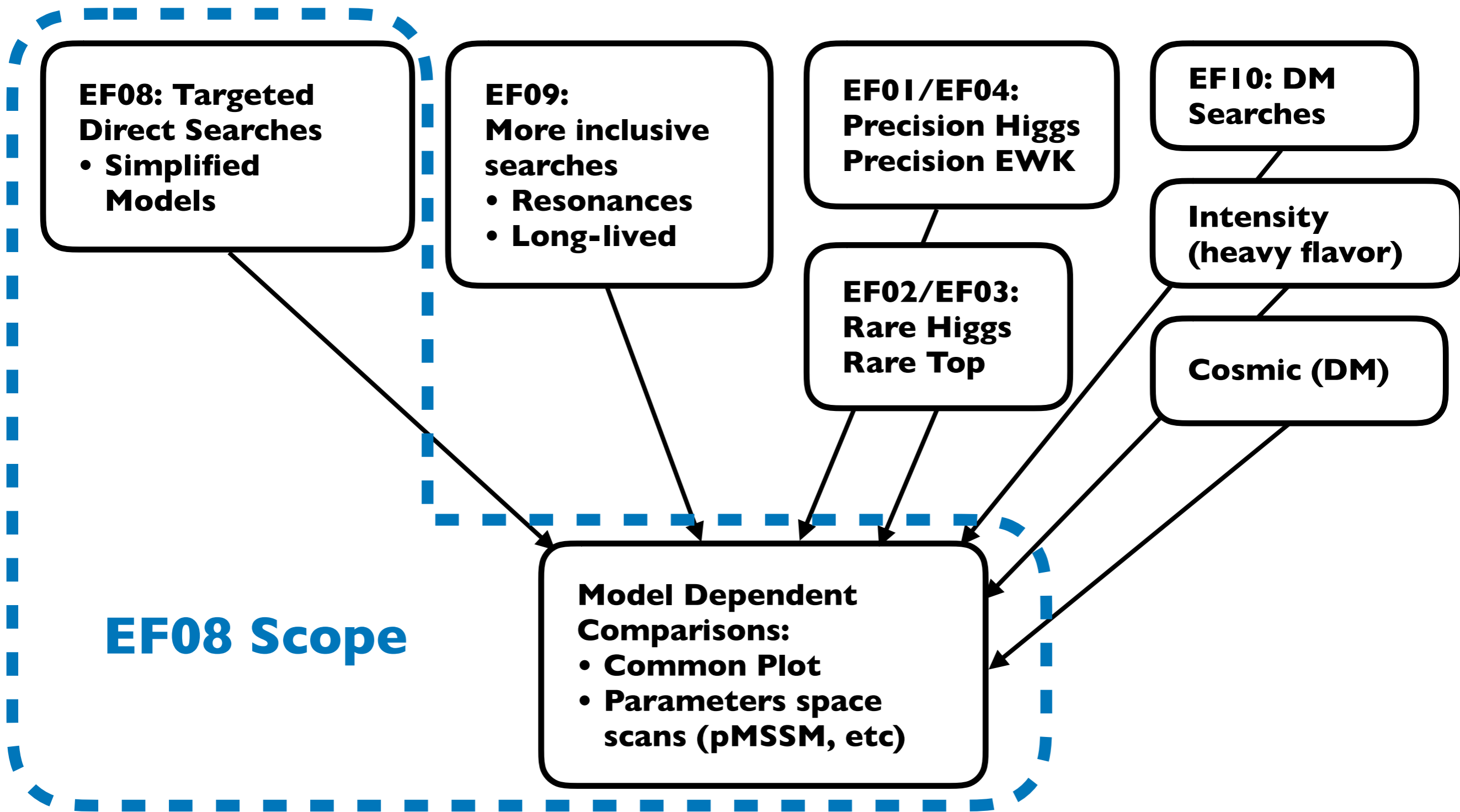
- EF05: Precision QCD
- EF06: Hadronic Structure and forward QCD
- EF07: Heavy Ions:

BSM Physics

- EF08: Model specific explorations: SUSY, composite models, ...
- EF09: More general explorations: New bosons, new fermions, MET signatures, long-lived particles, EFT, ...
- EF010: Dark matter at colliders

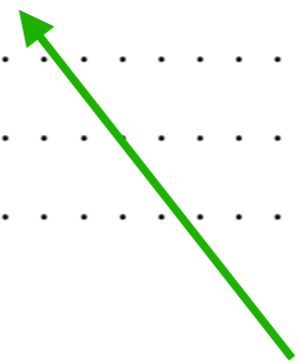
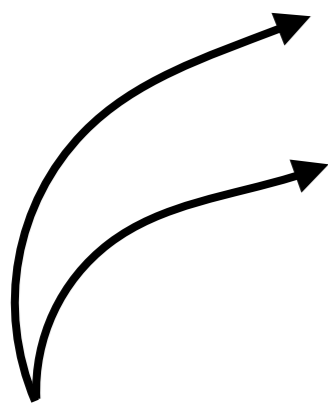
Energy Frontier Twiki: <https://snowmass21.org/energy/start>

Focus and Interaction with other groups...



European Strategy Report

8	Beyond the Standard Model	113
8.1	Introduction	113
8.2	Electroweak symmetry breaking and new resonances	114
8.3	Supersymmetry	118
8.4	Extended Higgs sectors and high-energy flavour dynamics	125
8.5	Dark Matter	129
8.6	Feebly-interacting particles	132
8.7	Summary and conclusions	137



Some Leptoquarks

- SUSY is main model considered
- Other models are more like EFT
 - Composite Higgs (EF02)
 - Contact interactions (EF09)
- Dark Matter Simplified Models (EF10)
- Need to think broadly about **which models** to consider based on our goals
 - Intrinsic interest in sensitivity
 - E.g. what scale SUSY (RPC/RPV) or RS/Composite Higgs is probed,
 - Will have different comparison of methods
 - e.g. different signatures...

Want a broad but achievable set of models

European Strategy Example: SUSY (I)



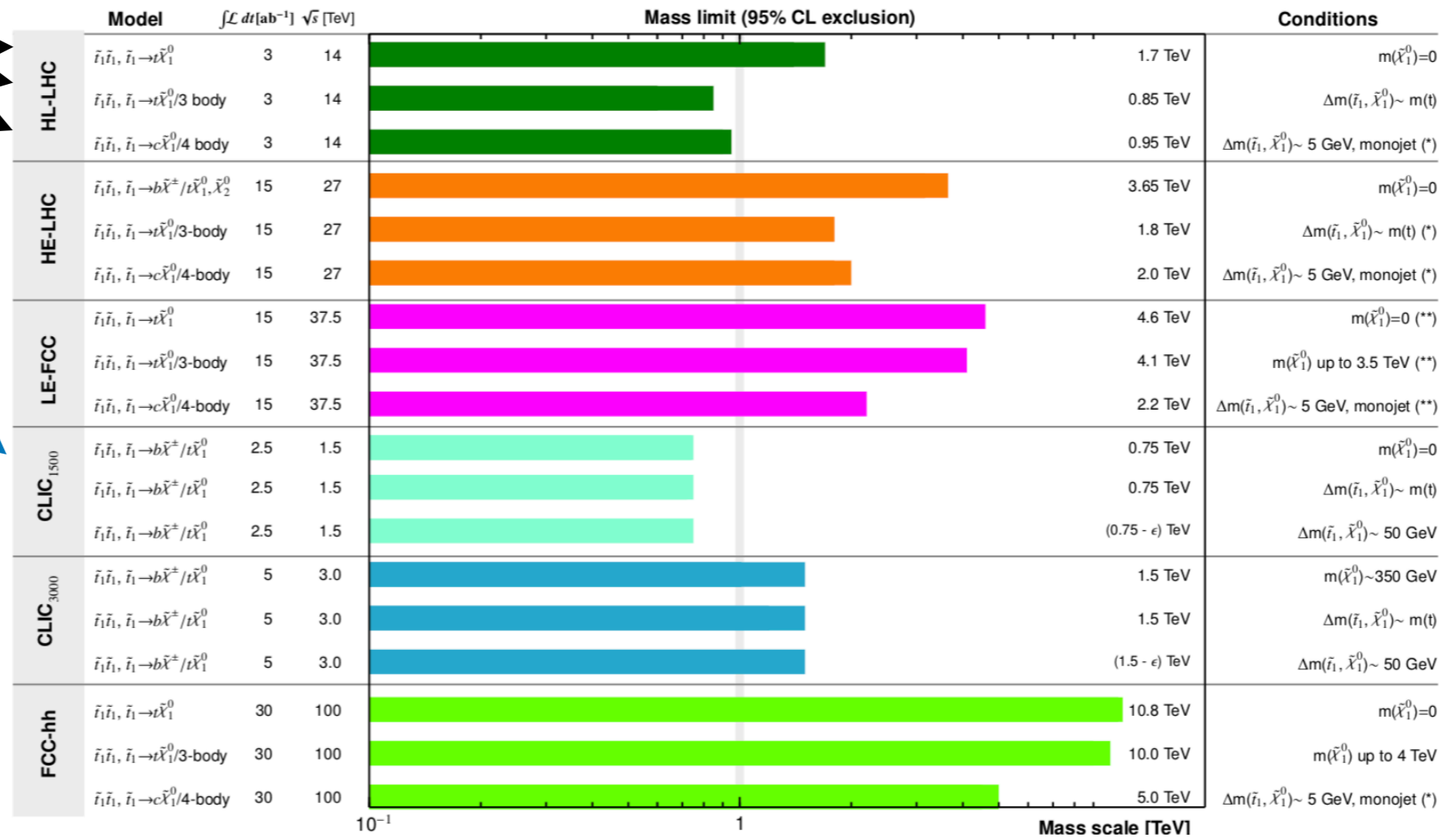
Consider several corners of stop phase space

Leptons less sensitive to corners

Measure of fine-tuning: Is it meaningful/interesting?

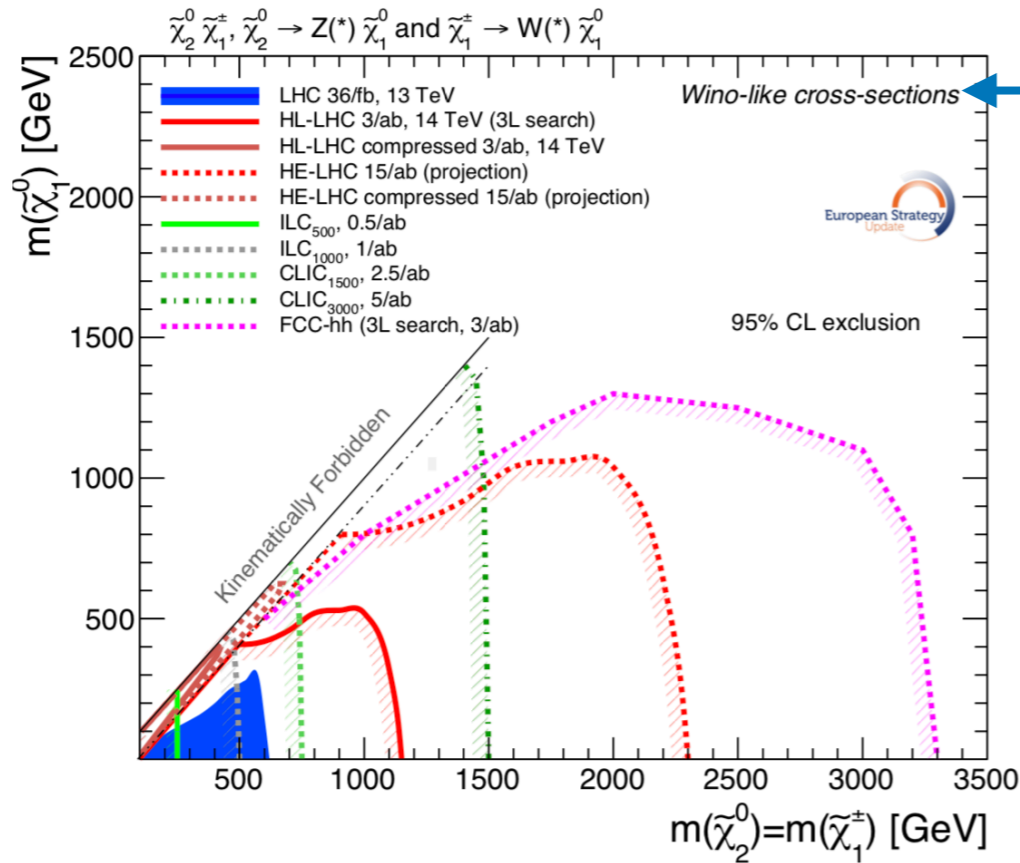
Will plan dedicated session to discuss this

All Colliders: Top squark projections
(R-parity conserving SUSY, prompt searches)



ϵ	High-scale mediation	Low-scale mediation
stop	$5 \times 10^{-5} \left(\frac{10 \text{ TeV}}{m_{\tilde{t}}} \right)^2$	$2 \times 10^{-3} \left(\frac{10 \text{ TeV}}{m_{\tilde{t}}} \right)^2$
gluino	$7 \times 10^{-6} \left(\frac{17 \text{ TeV}}{m_{\tilde{g}}} \right)^2$	$6 \times 10^{-3} \left(\frac{17 \text{ TeV}}{m_{\tilde{g}}} \right)^2$

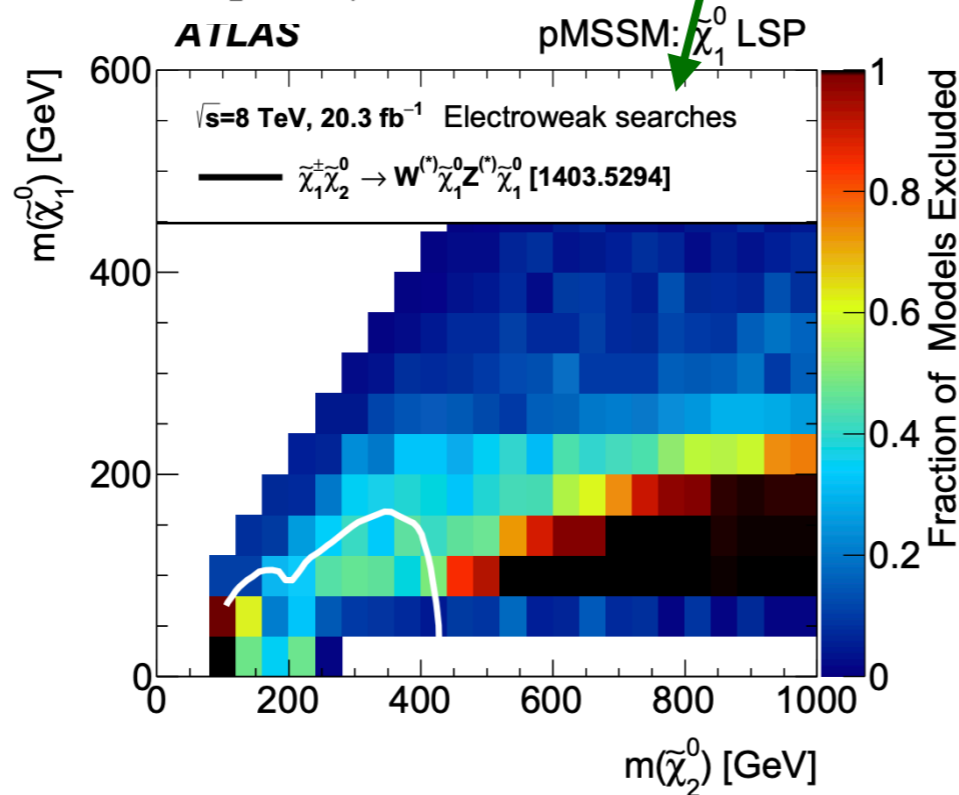
European Strategy Example: SUSY (II)



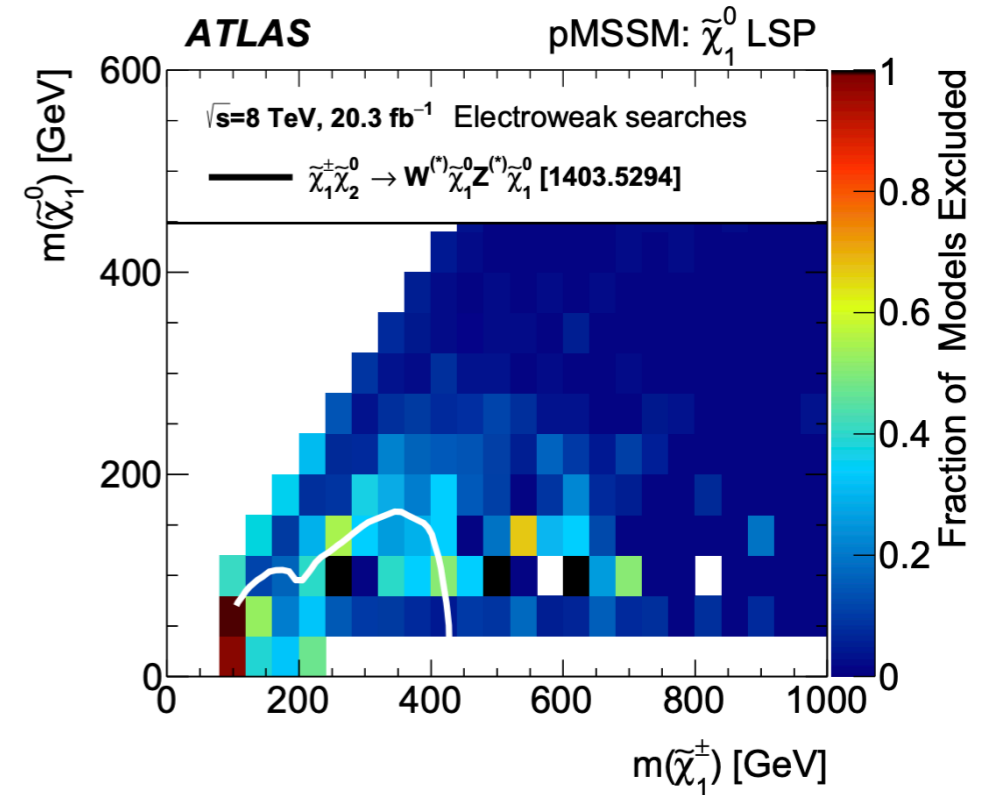
Assumptions are important. Simplified models plots have limitations

pMSSM scan → Very little of simplified model region actually excluded. How far should we go?

Will plan dedicated session to discuss this



(a) Neutralinos



(b) Chargino-neutralino

Near Term Activities

Review Literature (especially European Strategy)

- Are limits produced in a consistent manner and robust?
- What is missing?
 - e.g. diagnostic capabilities
 - Additional models: Composite resonance? RPV susy? RS summary plots?

Planned dedicated meetings (Volunteers/recommendations for talks?)

- Composite Higgs (in two weeks)
- Extra dimensions
- Naturalness/fine-tuning
- More SUSY: pMSSM scans, RPV,
- Other suggestions?

To think about for all topics

- What are good benchmarks
- What are good summary plots

Bibliography...

Need to build a bibliography for participants to review what has been done

Here is a very partial quick list (nothing has been excluded intentionally).

Please send us suggestions.

- European Strategy Briefing Book: <http://cds.cern.ch/record/2691414>
- Snowmass 2013 EF reports: <https://www.slac.stanford.edu/econf/C1307292/docs/EnergyFrontier.html>
- FCC physics opportunities: <https://inspirehep.net/literature/1713706>
- ILC physics report: <https://arxiv.org/pdf/1306.6352.pdf>
- CERN yellow book on HL-LHC and HE-LHC: <https://cds.cern.ch/record/2703572?ln=en>
- The CLIC Potential for New Physics: <http://dx.doi.org/10.23731/CYRM-2018-003>

- **Two-step strategy** to address MC production for Snowmass 2021:
 - **Assess the MC needs** for EF (exp+th) and formulate a plan. We have formed a “**Task force**” for this purpose.
 - **Produce the “needed” MC samples** by the community to carry of the necessary studies for EF.
- **Members of the EF MC task force:** **John Stupak** (Chair)
 - EF TG conveners: **Isobel Ojalvo**, **Michael Schmitt**, **Simon Pagan Griso**.
 - MC authors: **Fabio Maltoni**, **Stefan Hoeche**.
 - OSG representative: **Robert Gardner**.
- In assessing the needs, the MC Task Force will:
 - Consider the process, the MC generators, the accelerator configurations, detector configurations, number of events.
 - Survey existing frameworks for MC generation and analysis for future colliders (FCC-ee, FCC-hh, CepC, SppC, LHeC, ILC, CLIC, Muon colliders, etc.)
 - Are they sufficient, are we permitted to use them?
 - Check if collaborations prefer users to use specific frameworks or a common one is agreeable
- The OSG has kindly agreed to support the MC generation for EF, and will provide both compute resources and storage on the OSG Data Federation
- **Input to the MC Task Force will be facilitated by the TG conveners.**

Conclusions

- EF08 should focus on model specific signatures not covered in other groups and on model specific comparisons
- Should review European Strategy and other inputs
 - What can be used directly, what should be looked at in more depth
- Questions to address about our scope:
 - **Which Models**
 - Inclusive, but limited, adding models should motivate different signatures or sensitivity comparisons
 - Sensitivity to externally motivations: anomalies, fine-tuning, ...
 - Need to consider how to approach **naturalness/fine-tuning**
 - Need to consider **applicability of simplified models**
 - Need to consider **detector constraints**, but also what might motivate detector choices
- Use forms to suggest more discussion questions or express interest in working on topics
 - Volunteer/suggest talks
 - Indicate interest in working even if you don't know the topic yet
 - Also can use for to suggest documents for a bibliography
 - Email is also always welcome