



# Snowmass 2021: pMSSM studies

**Jennet Dickinson**, Jim Hirschauer

EF08 pMSSM Kick off

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# Intro to pMSSM

- Most experimental SUSY searches are optimized in terms of simplified models containing 2-3 free parameters
- However, the full MSSM contains 120 free parameters
- The pMSSM goes beyond simplified models, but uses motivated assumptions to reduce the total number of parameters to a more tenable 19:

$\tan \beta$ : the ratio of the vev of the two-Higgs doublet fields.

$M_A$ : the mass of the pseudoscalar Higgs boson

$\mu$ : the Higgs-higgsino mass parameter

$M_1, M_2, M_3$ : the bino, wino and gluino mass parameters.

$m_{\tilde{q}}, m_{\tilde{u}_R}, m_{\tilde{d}_R}, m_{\tilde{l}}, m_{\tilde{e}_R}$ : first/second generation sfermion masses

$m_{\tilde{Q}}, m_{\tilde{t}_R}, m_{\tilde{b}_R}, m_{\tilde{L}}, m_{\tilde{\tau}_R}$ : third generation sfermion masses

$A_t, A_b, A_\tau$ : third generation trilinear couplings.

arXiv 9901246

# Goal of Snowmass 2021 pMSSM scan

- Explore future sensitivity in a framework that goes beyond simplified SUSY models
- Understand the physics potential of different future collider scenarios in the context of the pMSSM
  - How will SUSY sensitivity from various collider scenarios overlap/complement each other?
  - What interesting pMSSM models have limited coverage, and how can we expand this coverage?
- Complementarity across Snowmass Frontiers: input from dark matter, rare frontier, etc.

# Overview of pMSSM scan strategy

- **Sample points** in the pMSSM
  - Can build in well-established physics knowledge
  - e.g. with a Markov chain Monte Carlo (see Malte's talk)
- **Focus in** on interesting regions of phase space
  - Accessible to different experiments
  - Well-motivated by existing measurements
  - Well-motivated by theoretical considerations
- **Generate** signal points
  - SM backgrounds can mostly be generated centrally
- **Get event counts** for various signal regions
  - Based on selections chosen by different collider groups
- **Do statistics**

# Collider scenarios

- SM backgrounds to be provided for the colliders and center of mass energies listed below ([link to slides](#))
  - Should choose a subset to focus on
- Regions of pMSSM sensitivity vary widely...
  - One big scan for all scenarios?
  - Multiple scans, with one targeting each scenario?

Machine	Energy							
CEPC	$m_Z$	$2m_W$	240					GeV
FCC-ee	$m_Z$	$2m_W$	240	$2m_t$				
ILC	250	350		500	1000			
CLIC			380			1500	3000	
HL-LHC/FCC-hh	14	75	100	150				TeV
LHeC/FCC-eh	1.3	3.5						
$\mu\mu$	3	10	14	30				

John Stupak - University of Oklahoma

# Today's meeting

- We will hear from experts working on pMSSM studies from CMS, ATLAS, and theory perspectives
- Followed by discussion of how to adapt existing tools for Snowmass studies

<b>2:00 PM</b>	→ 2:10 PM	<b>Introduction</b>	🕒 10m
		<b>Speaker:</b> Jennet Dickinson (UC Berkeley/LBNL)	
<b>2:10 PM</b>	→ 2:22 PM	<b>CMS pMSSM scan workflow</b>	🕒 12m
		<b>Speaker:</b> Malte Mrowietz (University of Hamburg)	
<b>2:22 PM</b>	→ 2:34 PM	<b>ATLAS pMSSM workflow</b>	🕒 12m
		<b>Speaker:</b> Giordon Stark	
<b>2:34 PM</b>	→ 2:46 PM	<b>Theory considerations for pMSSM scans</b>	🕒 12m
		<b>Speaker:</b> Sven Heinemeyer (IFT (CSIC, Madrid))	
<b>2:46 PM</b>	→ 3:02 PM	<b>Discussion</b>	🕒 16m