



pMSSM scan studies

Jennet Dickinson

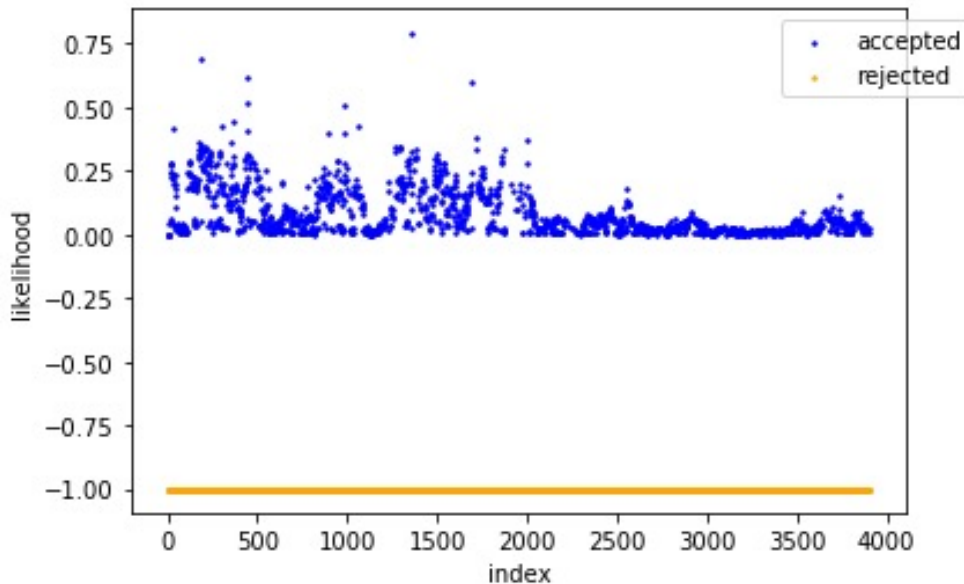
July 7, 2021

News

- Snowmass process for EF has re-started
 - Planning a short update on the pMSSM scan for the EF08 meeting on July 22
- Tag v1.4 of the scan code is now available [here](#)
 - Update FH and add patches from Sven applied. Docker image updated accordingly
 - Fixed HiggsBounds contribution to likelihood

Latest test scan

- Requested 5000 points, scanned 3899, accepted 1744
 - Scanned < requested due to crash in Spheno call
- Width of Gaussian used for stepping =
0.05 * (param_max - param_min)

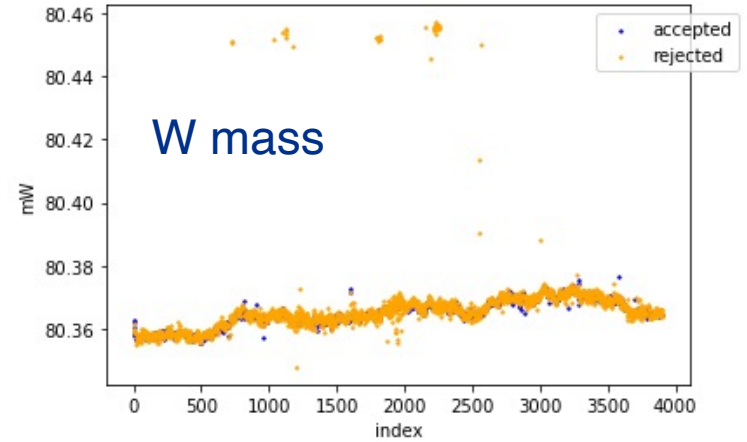
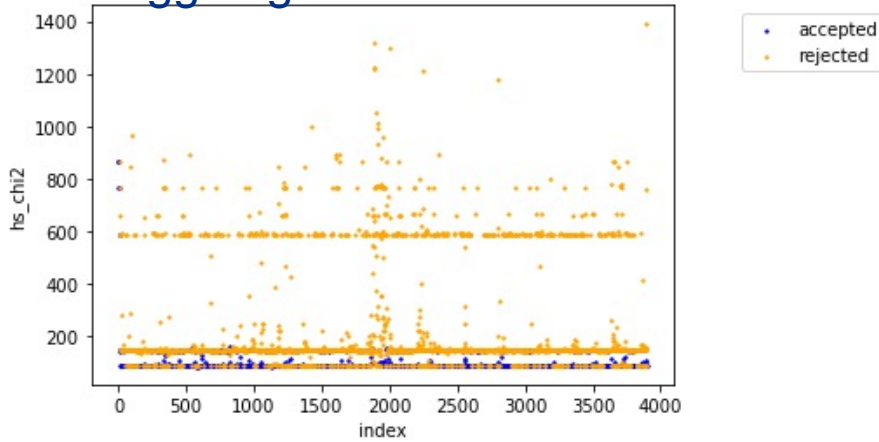


Well-behaved scan!

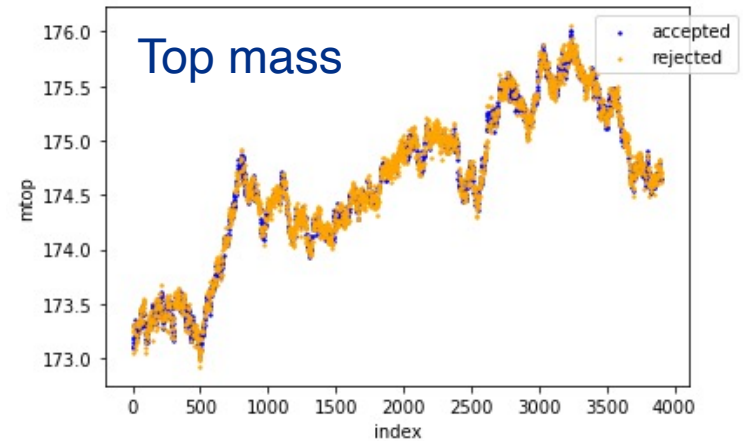
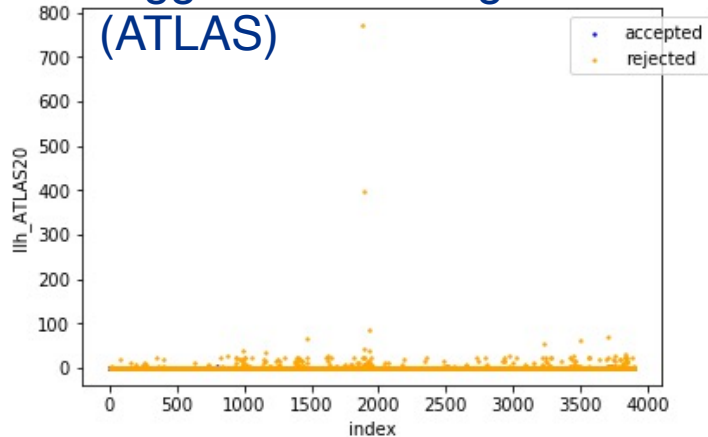
Contributions to the likelihood

- Full set of scatter plots [here](#)

HiggsSignals chi2

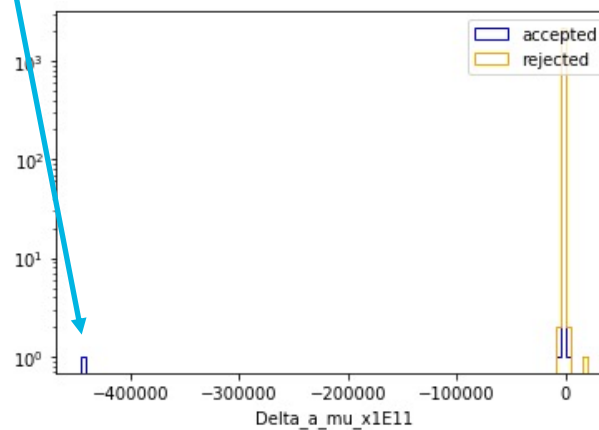
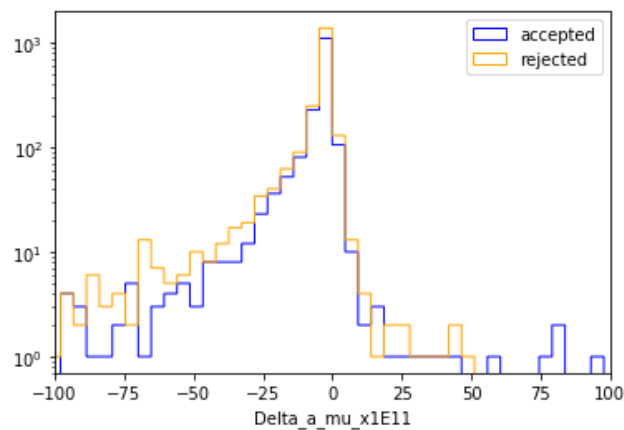
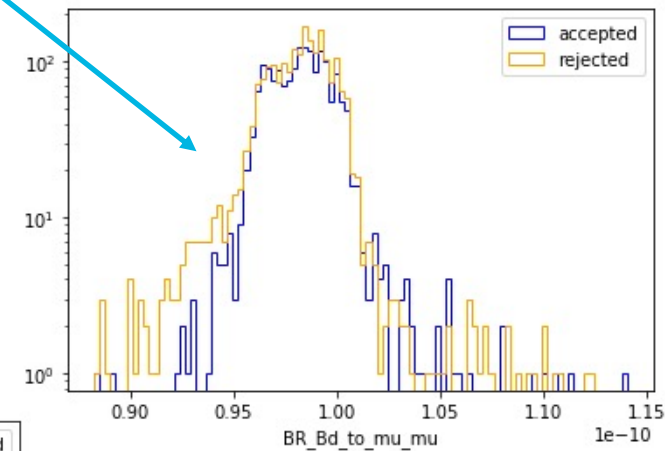
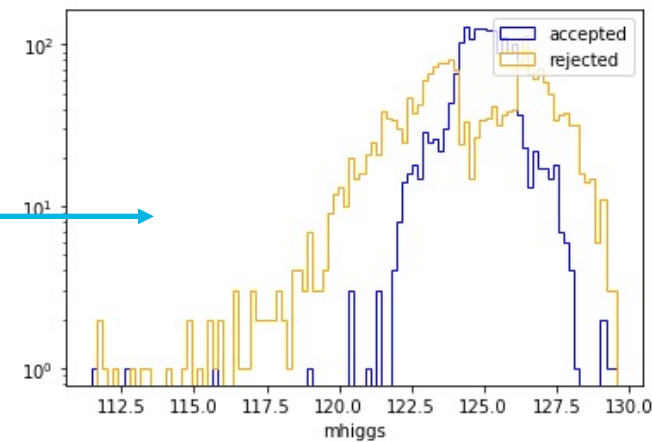


HiggsBounds -2logL (ATLAS)



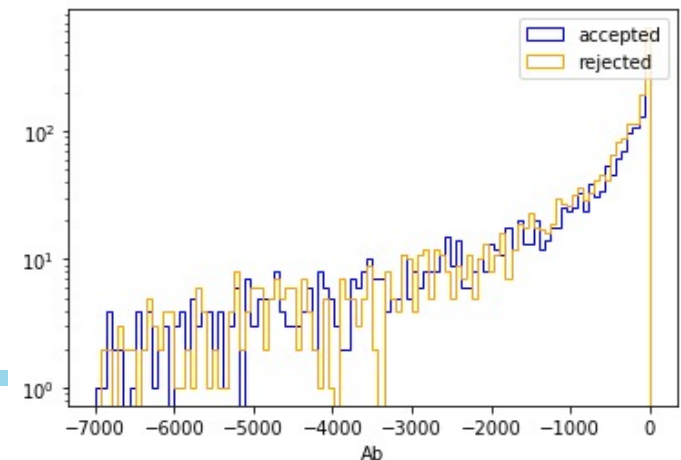
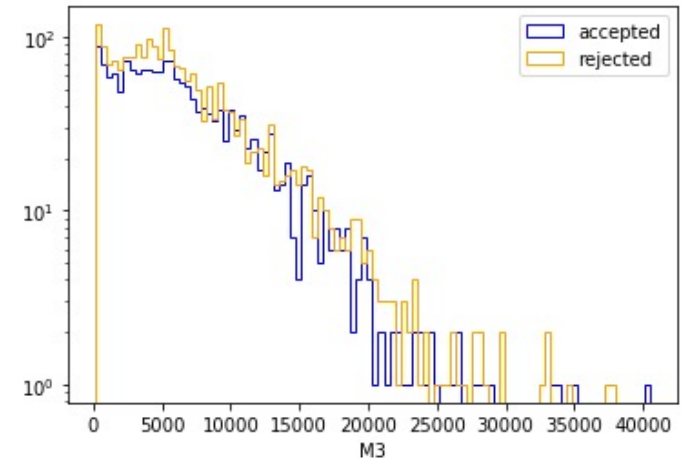
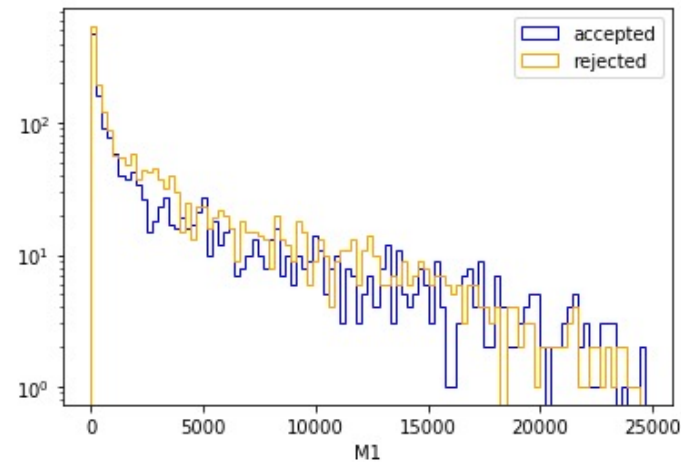
Interesting observables

- Prefer Higgs masses near 125 GeV
- B physics observables are peaked near the measured value
- Δa_μ peaked at zero (SM), with longer tail on the negative side ($< \text{SM}$)
 - One extreme outlier point is accepted



Width of Gaussian step

- In a 3899 point scan:
 - Mass parameters are explored up to 25 TeV, but not well up to 50 TeV
 - $\tan\beta$, A_1 , A_b , A_t are explored out to their limits
- 1D plots of explored points for all parameters are [here](#)
- Higher width coefficient would increase fraction of points that are explored in the high tails
 - Choosing the right width coefficient may be more art than science

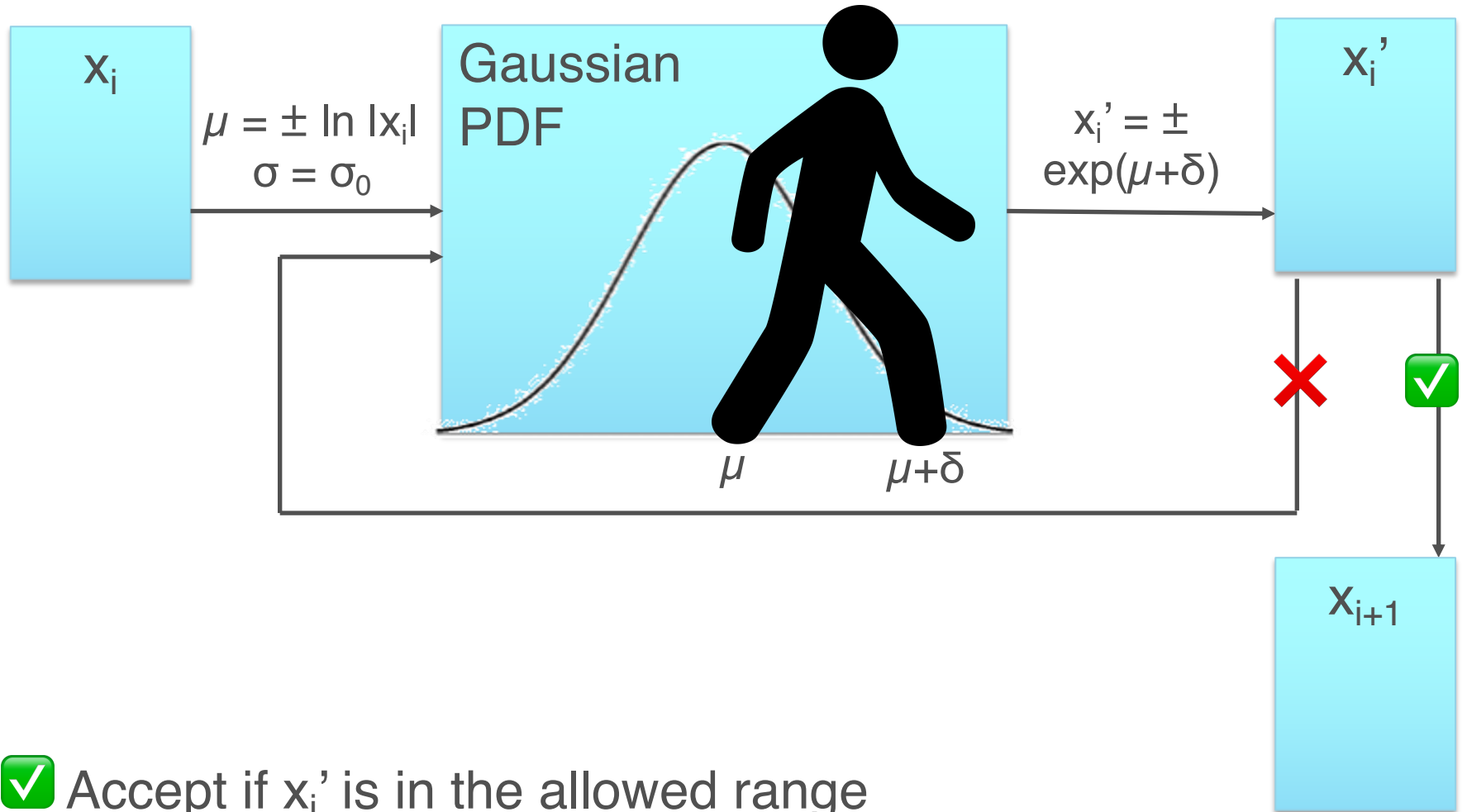


Remaining questions

- Sign choice: test all parameter sign combinations
 - So far, randomly assign signs for μ , $M1$, $M2$, $A1$, $A2$, $A3$
- Careful debugging run
 - Submit 100 x 5000 point scans and scour for errors, e.g. the crash in SPheno in latest scan
 - Make sure error handling is robust against all these cases
- Scale up
 - Longest Ixplus HTCondor queue is 1 week. Not long enough for 50,000 point scan
 - Options:
 - submit longer jobs somewhere else
 - Submit on Ixplus for small portion, re-submit with mode “resume” until complete

Backup

Log stepping, fixed width gaussian



✓ Accept if x_i' is in the allowed range and $L(x_i')$ satisfies criteria

Observables in likelihood

Superiso	SPheno	FeynHiggs	Higgs Signals	Higgs Bounds
$\Delta_0(B \rightarrow K\gamma)$	$BR(B^+ \rightarrow \tau\nu)^*$	m_W	LHC Higgs meas. (includes m_H)	LHC Higgs Heavy H($\tau\tau$)
$BR(b \rightarrow s\gamma)$	$BR(D_s \rightarrow \tau\nu)^*$			
$BR(B_s \rightarrow \mu\mu)$	$BR(D_s \rightarrow \mu\nu)^*$			
$BR(B_d \rightarrow \mu\mu)$	$\Delta(\rho)^*$			
$BR(b \rightarrow s\mu\mu)$	m_{top}			
$BR(b \rightarrow see)$	α_S			
$BR(B_0 \rightarrow K^{*0}\gamma)$	m_{bottom}			

* Missing for v1.3

Parameter ranges

Parameter	Minimum	Maximum	Stepping
$\tan \beta$	1	60	Log
M_A	100 GeV	25 TeV	Log
$ \mu $	80 GeV	25 TeV	Log
$ M_1 $	1 GeV	25 TeV	Log
$ M_2 $	70 GeV	25 TeV	Log
M_3	200 GeV	50 TeV	Log
$m_{L123\sim}, m_{e123\sim}$	90 GeV	25 TeV	Log
$m_{Q12\sim}, m_{u12\sim}, m_{d12\sim}$	200 GeV	50 TeV	Log
$m_{Q3\sim}, m_{u3\sim}, m_{d3\sim}$	100 GeV	50 TeV	Log
$ A_b , A_\tau $	1 GeV	7 TeV	Log
$ A_t $	1 GeV	$3\sqrt{(m_{Q3\sim}m_{u3\sim})}$	Log

Scan code

- Python 2.7.12 and ROOT 6.12.06
- Scan code and instructions:
https://github.com/jennetd/pMSSM_McMC
- External packages:

Package	Version	McMC interface?
FeynHiggs	2.18.0	Yes
SPheno	4.0.4	Yes
HiggsBounds	5.9.1	Yes
HiggsSignals	2.6.0	Yes
Micromegas	5.2.4	Yes, but won't use
GM2Calc	1.7.3	Yes
superiso	4.0	Yes