Fermilab U.S. DEPARTMENT OF ENERGY Office of Science

Observables to include in the likelihood

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Snowmass pMSSM scan meeting

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Recap: plan for grand scan

- Perform a ***grand scan*** that populates all regions of parameter space relevant for Snowmass studies
- The scan will need to cover a very large region of parameter space
  - For 100 TeV pp collider, expect sensitivity up to ~20 TeV masses. Assume 50 TeV is sufficient for decoupling
  - Use log stepping to retain high granularity at low masses
- Today: what observables to include in the likelihood

Recap: plan for grand scan

- For 100 TeV pp collider, expect sensitivity up to ~20 TeV masses. Assume 50 TeV is sufficient for decoupling

Parameter	Minimum	Maximum	Stepping
tan β	1	60	Log
M_A	100 GeV	25 TeV	Log
$\lvert\mu\rvert$	80 GeV	25 TeV	Log
$\lvert M_1\rvert$	1 GeV	25 TeV	Log
$\lvert M_2\rvert$	70 GeV	25 TeV	Log
M_3	200 GeV	50 TeV	Log
m_L123~, m_e123~	90 GeV	25 TeV	Log
m_Q12~, m_u12~, m_d12~	200 GeV	50 TeV	Log
m_Q3~, m_u3~, m_d3~	100 GeV	50 TeV	Log
$\lvert A_b\rvert$, $\lvert A_\tau\rvert$	1 GeV	7 TeV	Log
$\lvert A_t\rvert$	1 GeV	3√(m_Q3~m_u3~)	Log

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Observables in the likelihood

- CMS McMC scan: (from Malte)
  - Include some parameters in likelihood as Gaussian centered on measured value:

Δ_0 (B →K γ)	BR(B0→K^{*0} γ)
BR(b →s γ)	BR(B^+→τ ν)
BR(B_s → μ μ)	BR(D_s→τ ν)
BR(B_d → μ μ)	BR(D_s→μ ν)
BR(b→ s μ μ)	Δ(ρ)
BR(b→s e e)	Higgs mass

  - Over-sample (ie. simulate more model points for higher statistics) in interesting regions
    - Near interesting values of a_μ
    - Near the Planck measurement of DM relic density
    - For ΔEW < 100

Observables in the likelihood

- ATLAS Run 1:
  – Randomly sample flat probability distribution, then apply cuts:

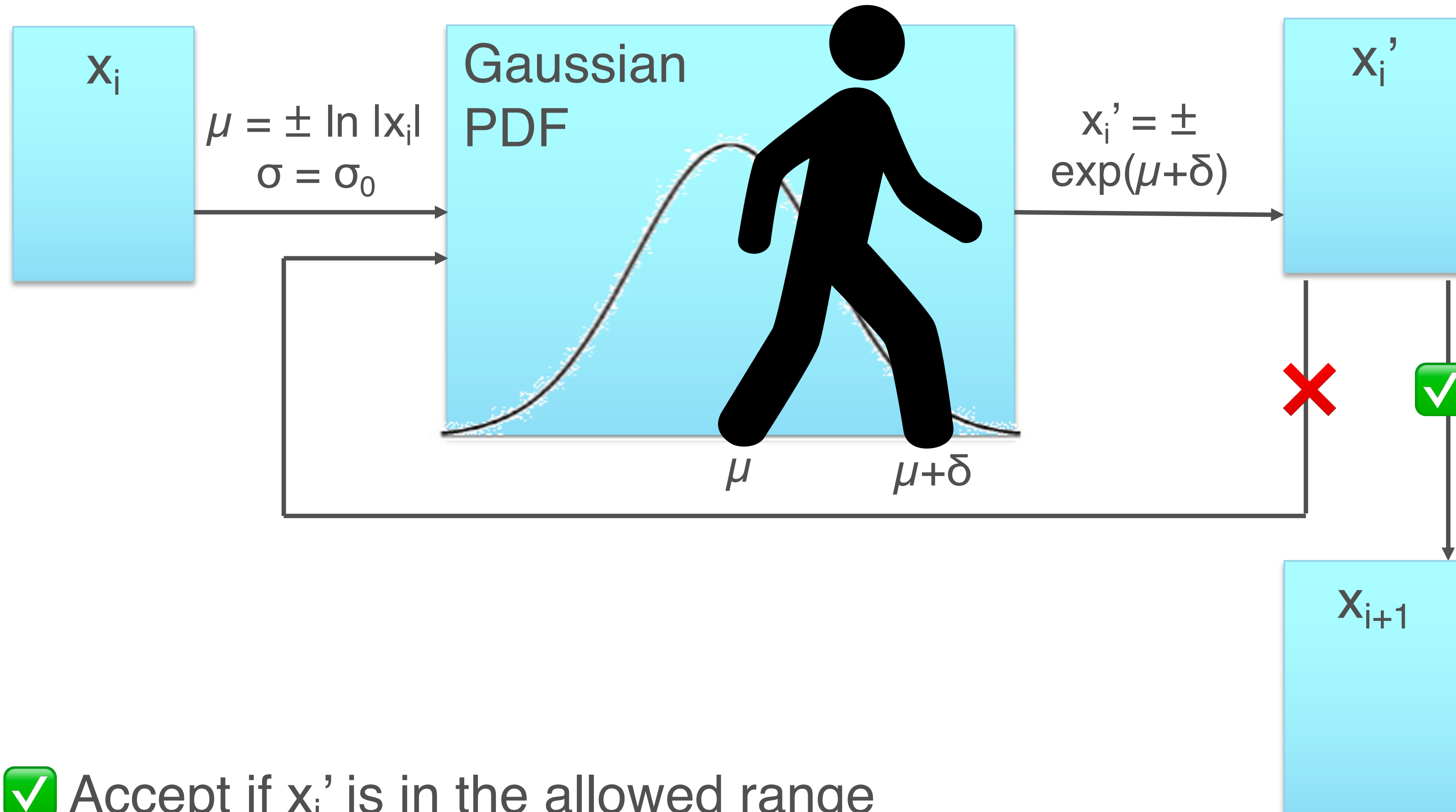
Parameter	Minimum value	Maximum value
$\Delta\rho$	-0.0005	0.0017
$\Delta(g-2)_\mu$	-17.7×10^{-10}	43.8×10^{-10}
$\mathrm{BR}(b \to s\gamma)$	2.69×10^{-4}	3.87×10^{-4}
$\mathrm{BR}(B_s \to \mu^+\mu^-)$	1.6×10^{-9}	4.2×10^{-9}
$\mathrm{BR}(B^+ \to \tau^+\nu_\tau)$	66×10^{-6}	161×10^{-6}
$\Omega_{\tilde{\chi}_1^0} h^2$	—	0.1208
$\Gamma_{\mathrm{invisible(SUSY)}}(Z)$	—	2 MeV
Masses of charged sparticles	100 GeV	—
$m(\tilde{\chi}_1^\pm)$	103 GeV	—
$m(\tilde{u}_{1,2}, \tilde{d}_{1,2}, \tilde{c}_{1,2}, \tilde{s}_{1,2})$	200 GeV	—
$m(h)$	124 GeV	128 GeV

Proposal

- Include B-physics measurements and Higgs mass in the McMC likelihood
- For all other observables, use oversampling when necessary
  - a_μ
  - DM relic abundance
  - ΔEW
  - Please share your additional suggestions!

Backup

Log stepping, fixed width gaussian



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

Log stepping

- This will efficiently populate parameter space
- Requires a nonzero lower bound on each parameter
- Need to tune:
  - Width of the gaussian
  - Base of the logarithm
- Cannot cross zero: a scan with initial point > 0 will only explore the parameter space > 0
  - For those parameters that can have negative values, rely on the distribution of initial points to populate $\pm$ space
- Requires us to abandon the fully Bayesian interpretation (á la CMS Run 1)