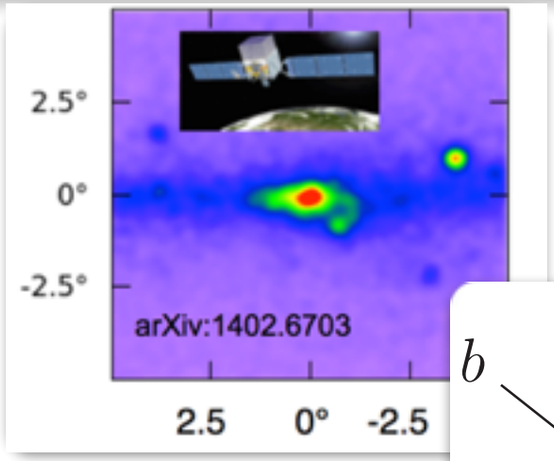
Imperial College London

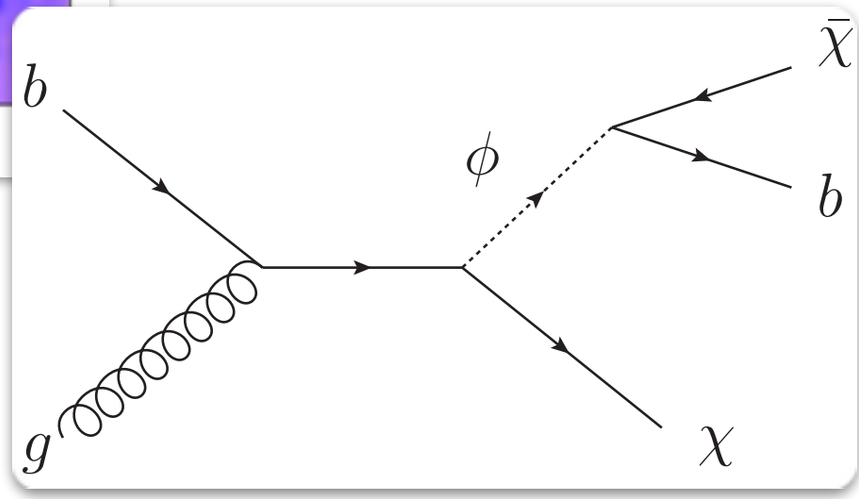
First look into b-FDM samples for 13 TeV

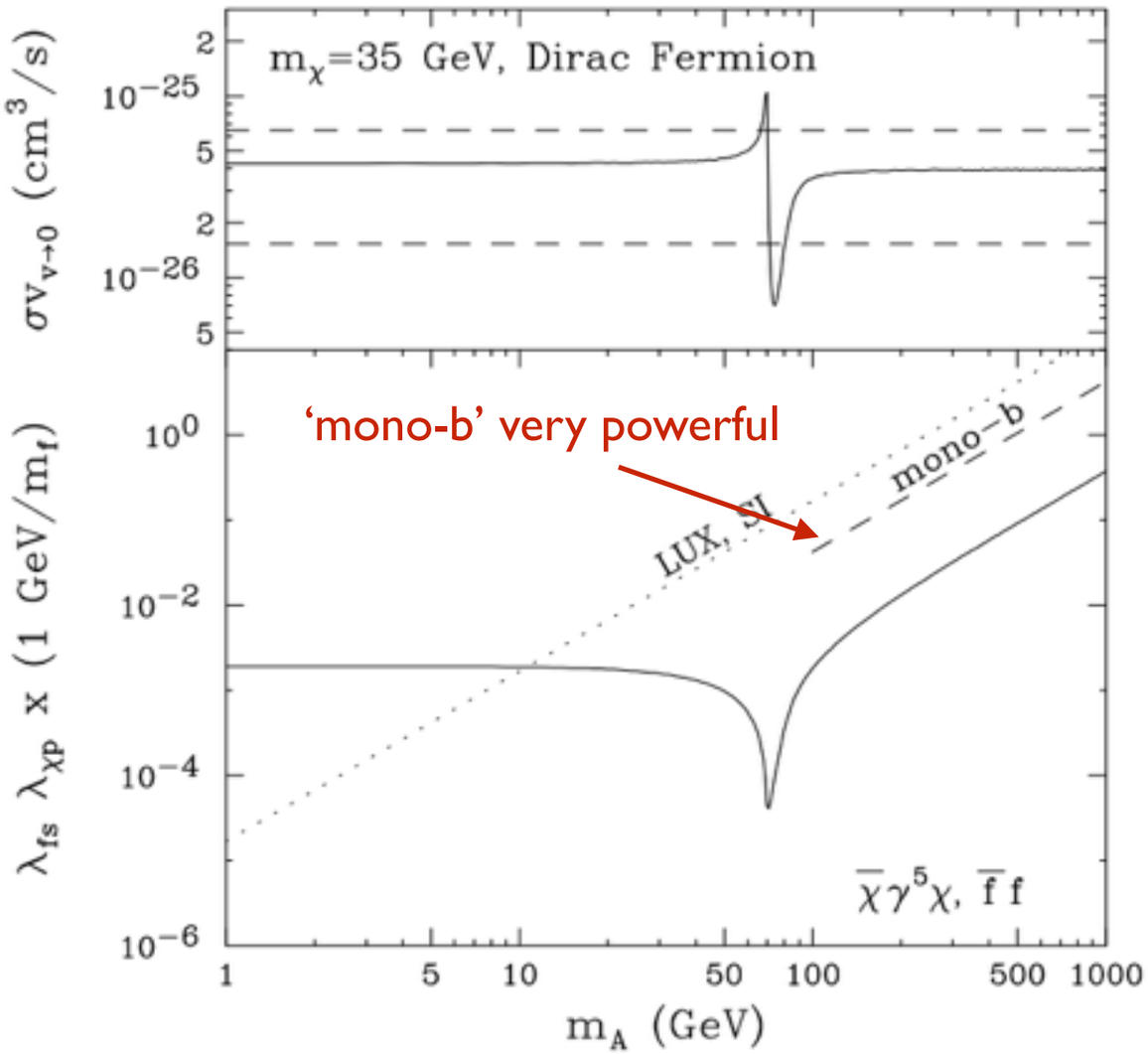
Björn Penning,
Deborah Pinah, Priscilla Pani

Introduction

- We consider a model from Lin et al. [1404.1373] where a colored scalar mediator couples to dark matter and a heavy quark (specifically a b-quark).
- Model inspired by the Fermi-LAT excess





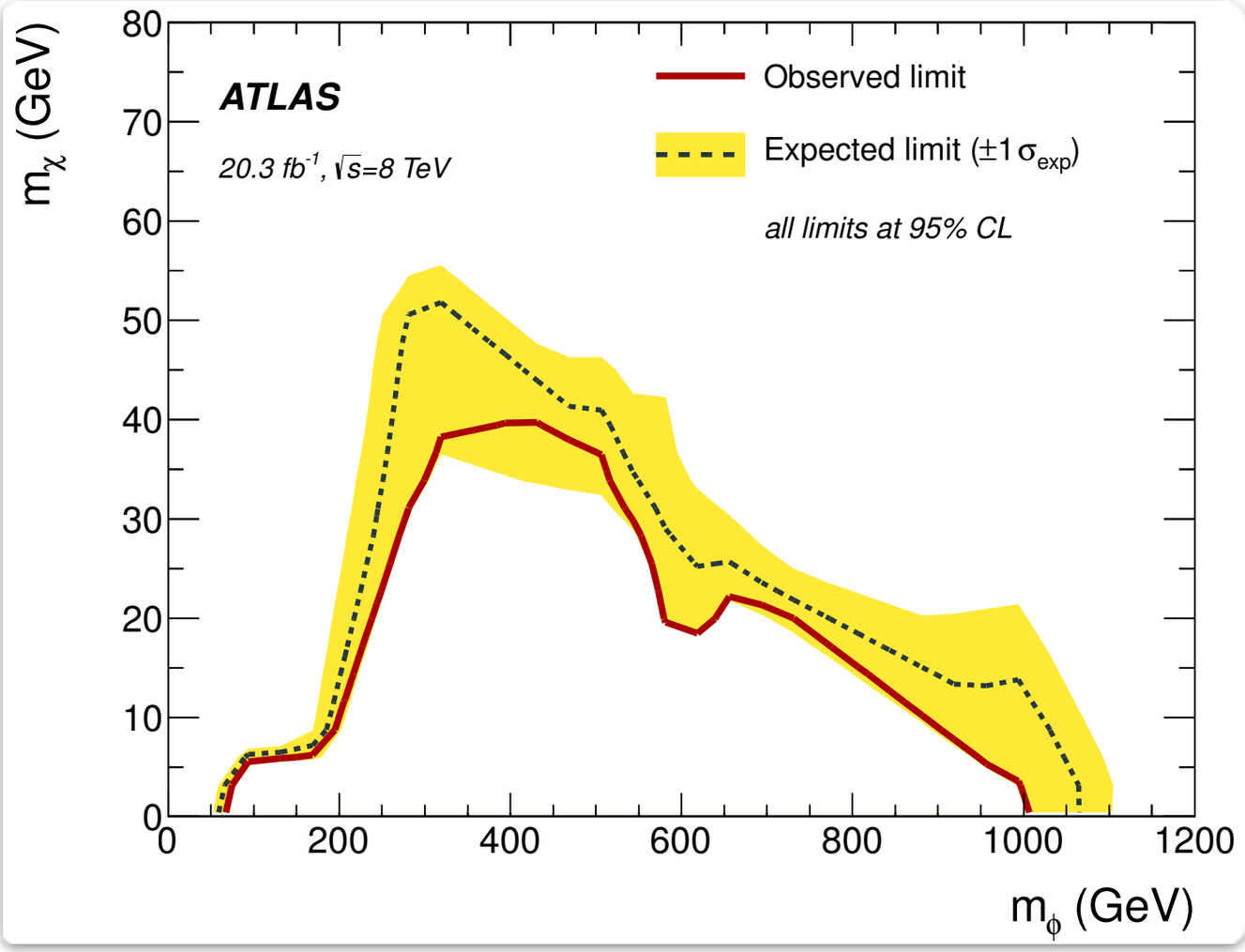


- First 'mono-b' Snowmass projections used by Hooper et al. [1404.0022] that 'mono-b' type searches constitute an important tool for low mass DM to probe the Fermi-LAT excess
- First search in ATLAS performed, laying out groundworks for 13 TeV
- Main interest Priscilla, Deborah & I

Introduction

	SR1
Trigger	$E_{\mathrm{T}}^{\mathrm{miss}}$
Jet multiplicity n_j	1–2
b-jet multiplicity n_b	>0 (60% eff.)
Lepton multiplicity n_ℓ	0
$E_{\mathrm{T}}^{\mathrm{miss}}$	>300 GeV
Jet kinematics	$p_{\mathrm{T}}^{b_1} > 100$ GeV
Three-jet invariant mass	
$\Delta\phi\left(j_i, E_{\mathrm{T}}^{\mathrm{miss}}\right)$	$> 1.0,\ i = 1, 2$
Angular selections	-
Event shape	-
am_{T2}	-
$m_{\mathrm{T}}^{\ell+E_{\mathrm{T}}^{\mathrm{miss}}}$	-
$E_{\mathrm{T}}^{\mathrm{miss}}/\sqrt{H_{\mathrm{T}}^{4j}}$	-

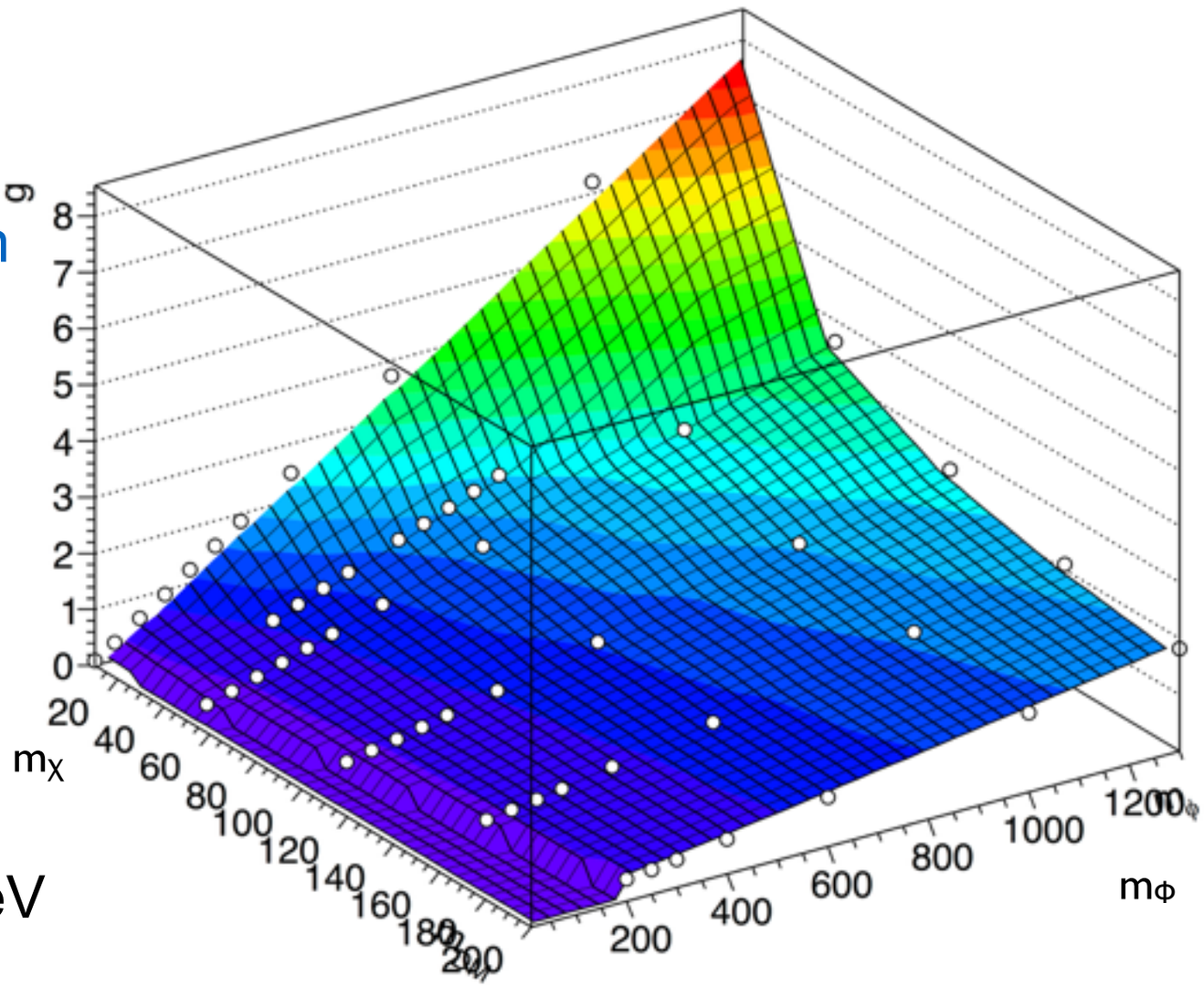
Eur. Phys. J. C (2015) 75:92; 1401.4031



- ATLAS published corresponding analysis in the hadronic & l+jets final state (http://arxiv.org/abs/1410.4031)
- ATLAS analysis weighted to relic density -> shapes exclusion region to some extend

Samples and weights

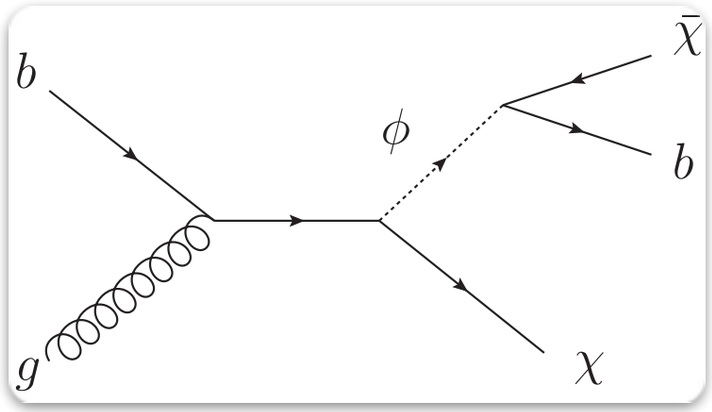
- Relic density weights are between O(0.1 - 2)
- Preferably want to simulate still ‘normalized grid’ and also perform scan in g
- Testing shape changes of various distributions for different couplings
  - If no shape change we may just renormalize
- Simulated
  - m_{DM}=10-200 GeV (step size ~50 GeV with smaller binning for m_{DM}<50)
  - m_{Phi} = 10-1300 GeV (step size ~100, also smaller at low masses)



weights to normalise to <σv>

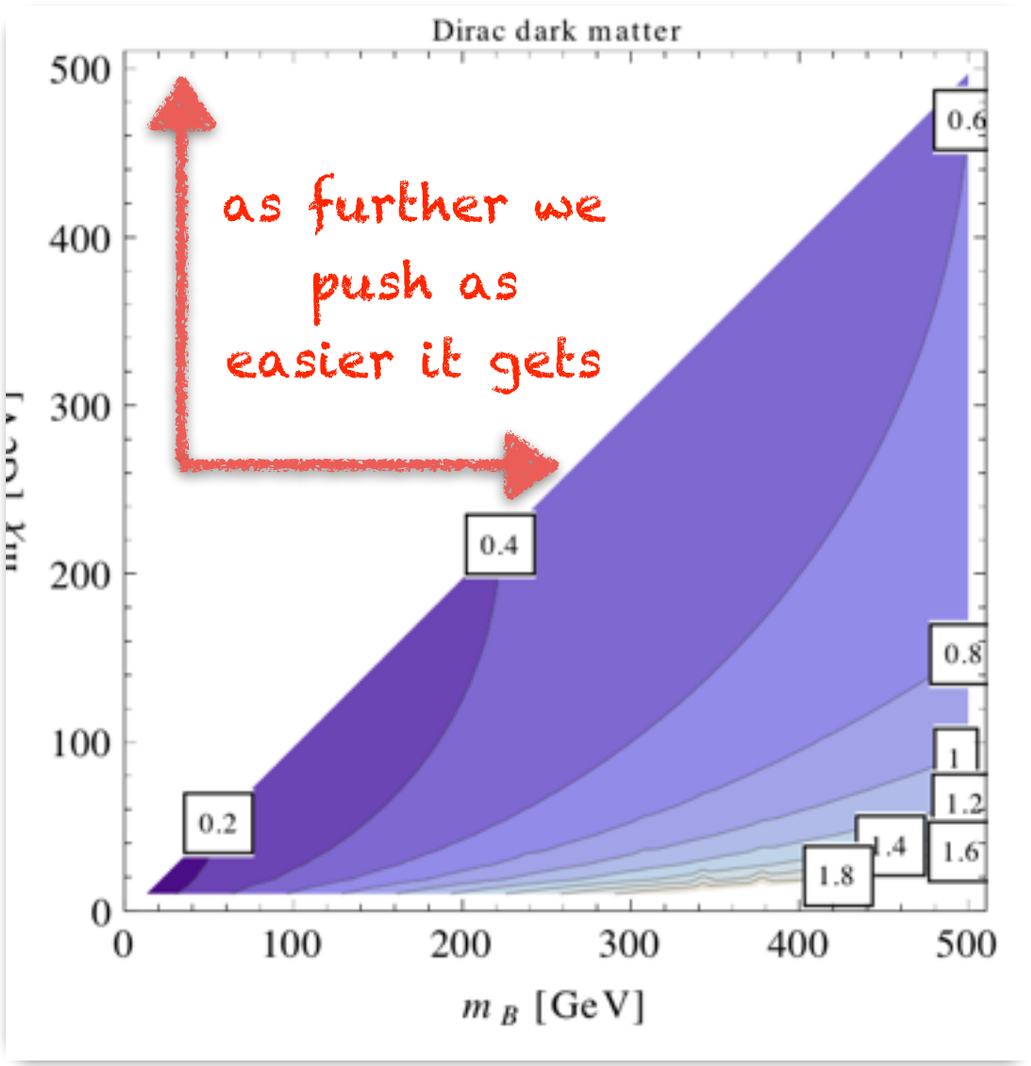
xsec improvements

- Rather large xsec increase, reasons:
  - b-quark in PDF



  - Relic density weights much less severe

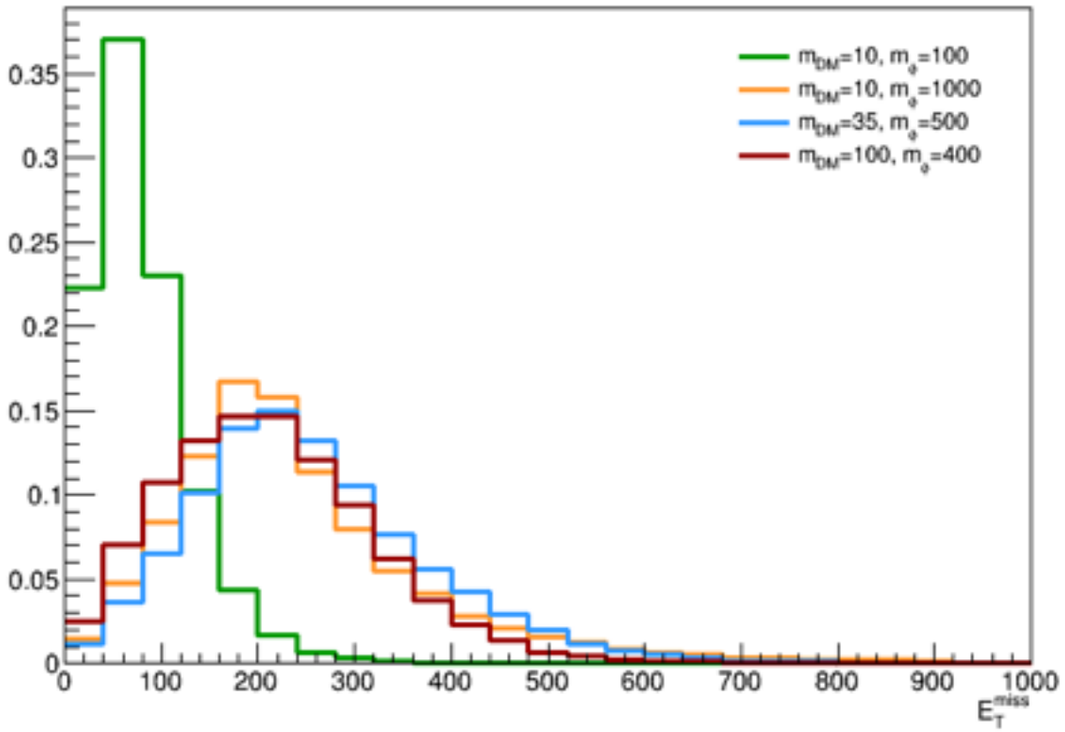
- Reproduce 8 TeV cross sections
- Studies ongoing to verify

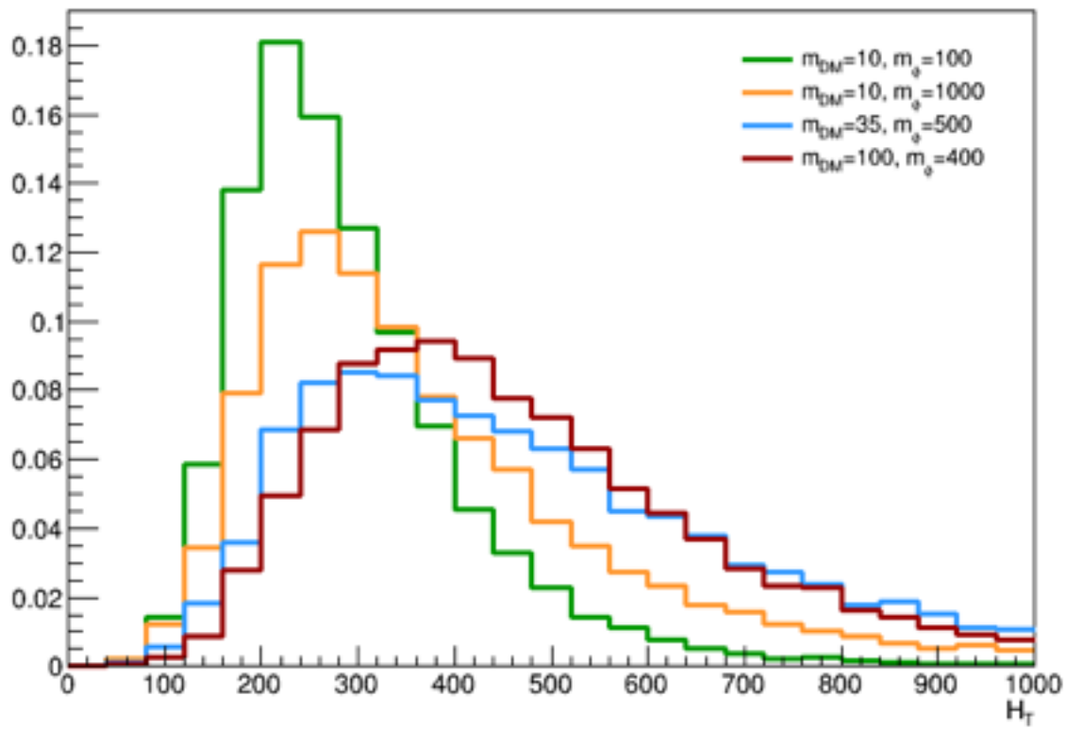


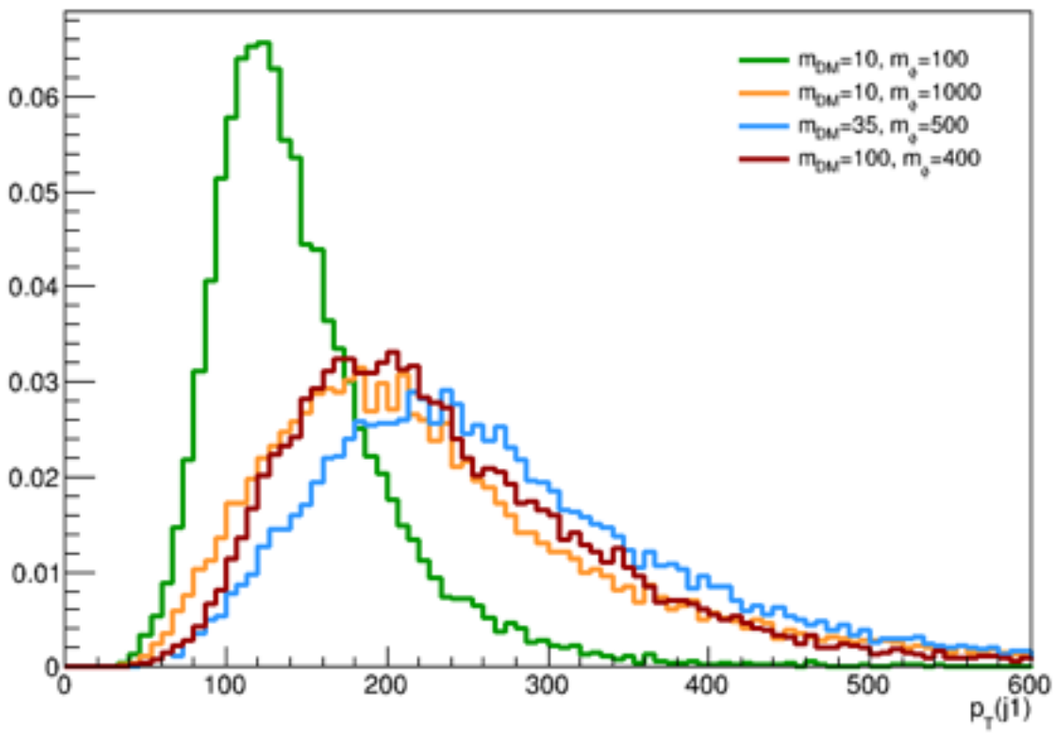
weight for normalizing to <σv>

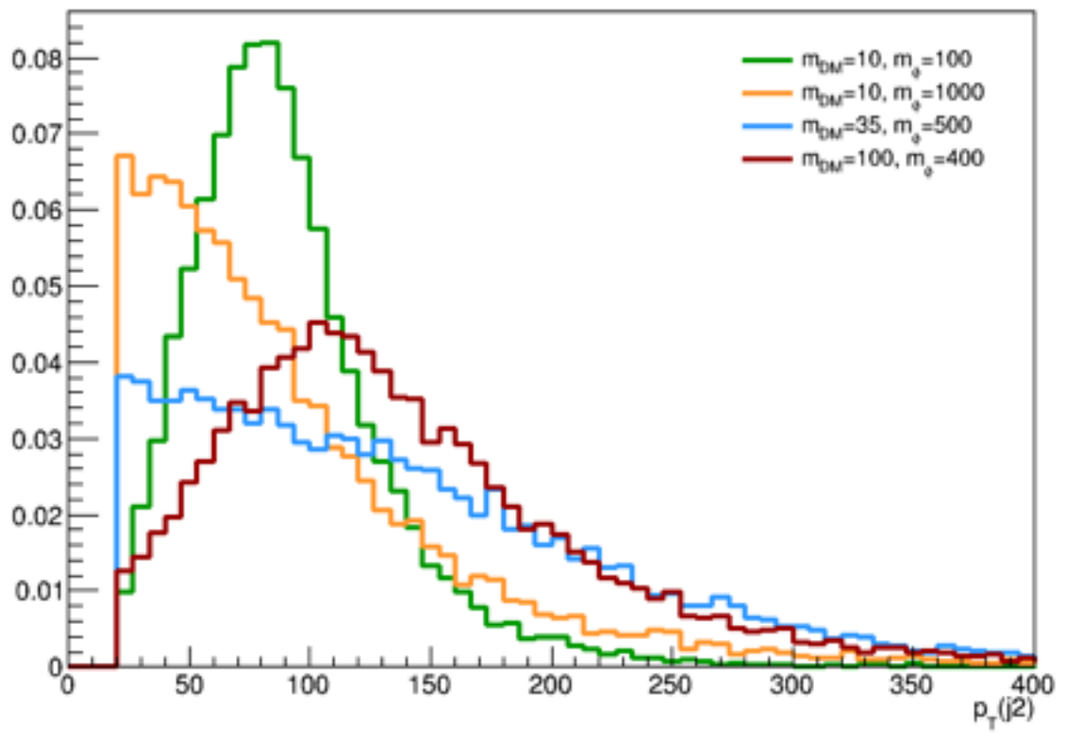
$$\langle \sigma v \rangle \approx \frac{3\lambda^4}{32\pi} \frac{m_\chi^2 \sqrt{1-(m_b/m_\chi)^2}}{(m_B^2+m_\chi^2-m_b^2)^2} \approx \frac{3\lambda^4 m_\chi^2}{32\pi(m_B^2+m_\chi^2)^2}$$

Distributions normalized to relic density

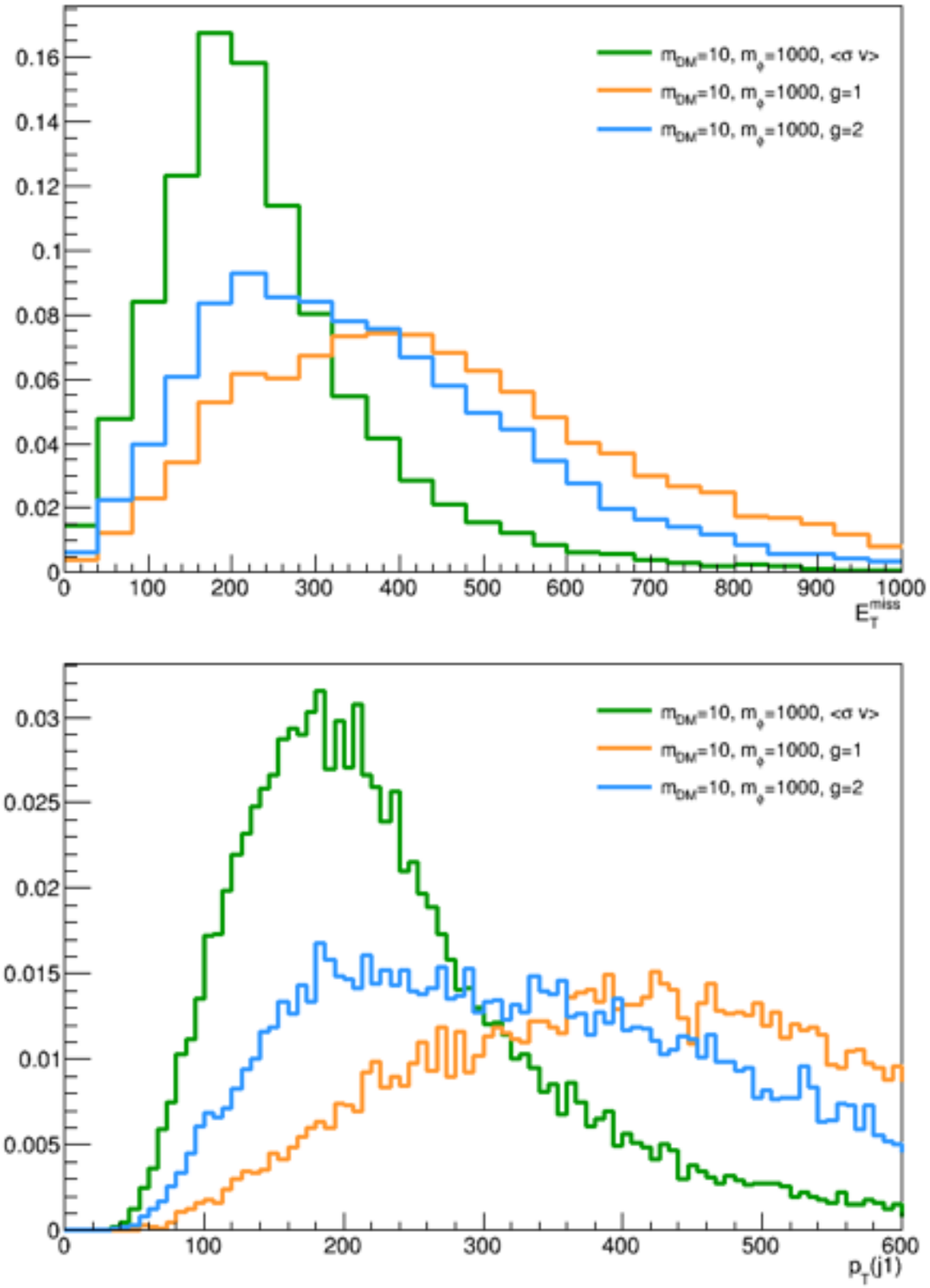


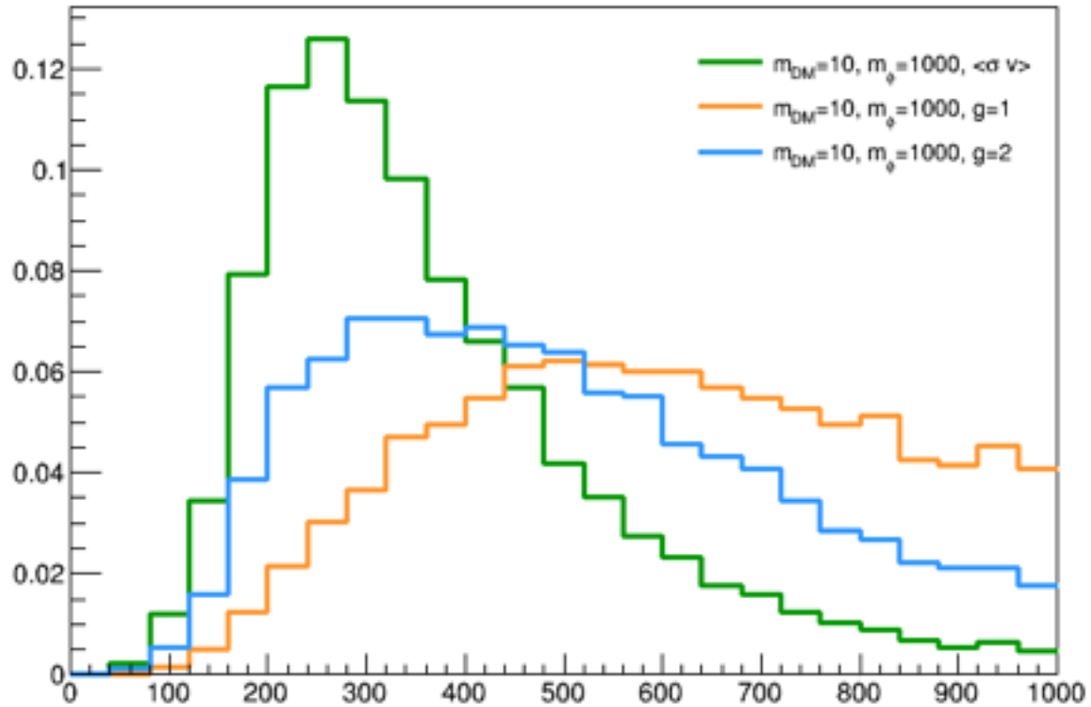


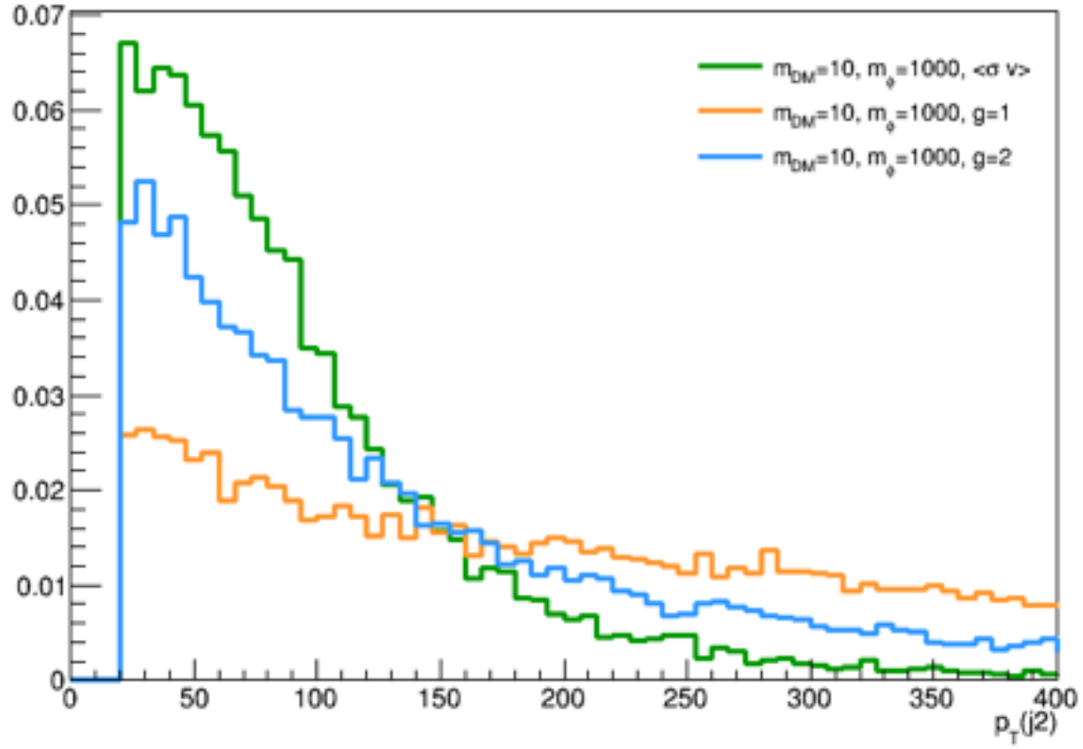


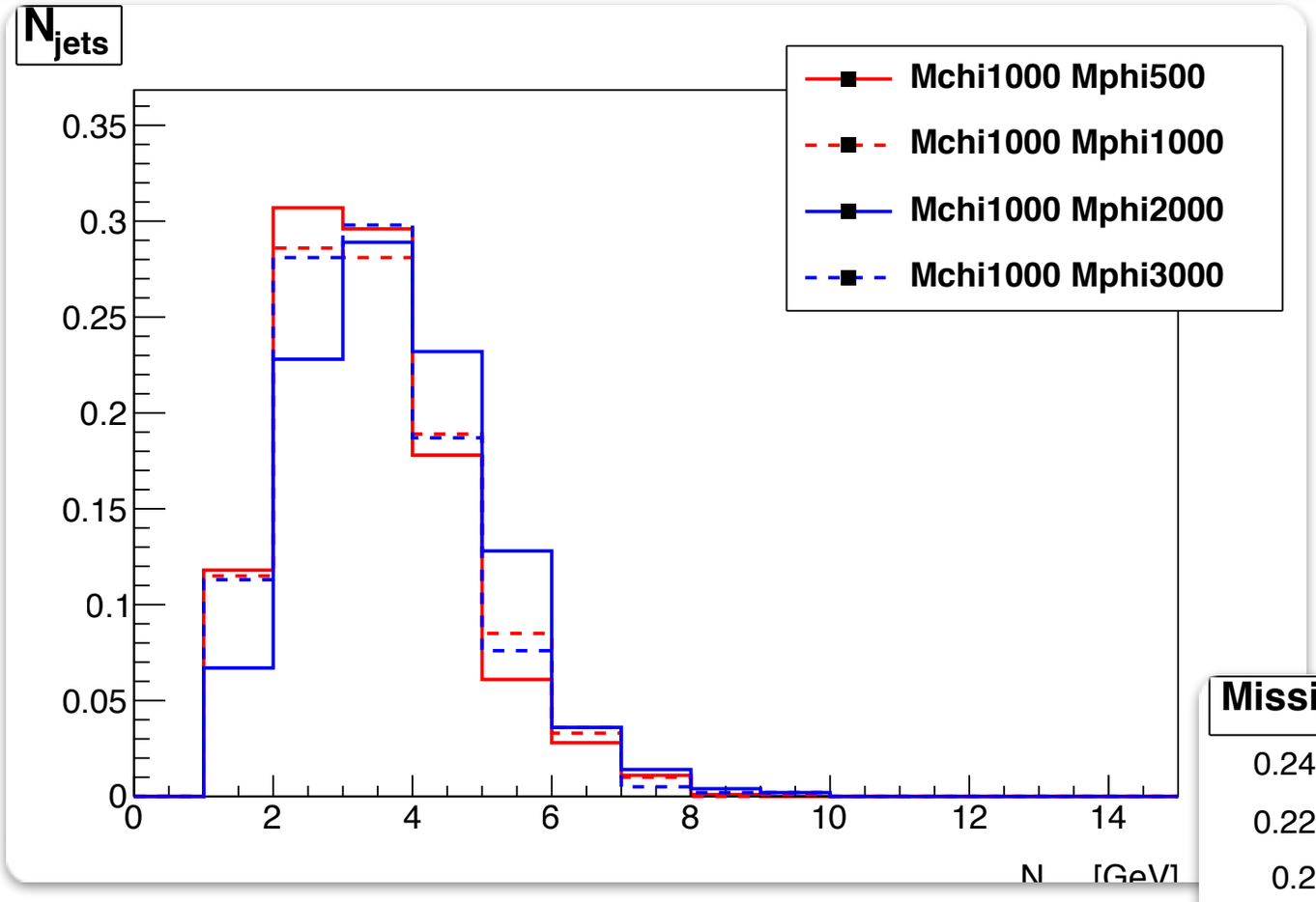


Var. coupling strengths: m_{DM}=10, m_{Phi}=1000

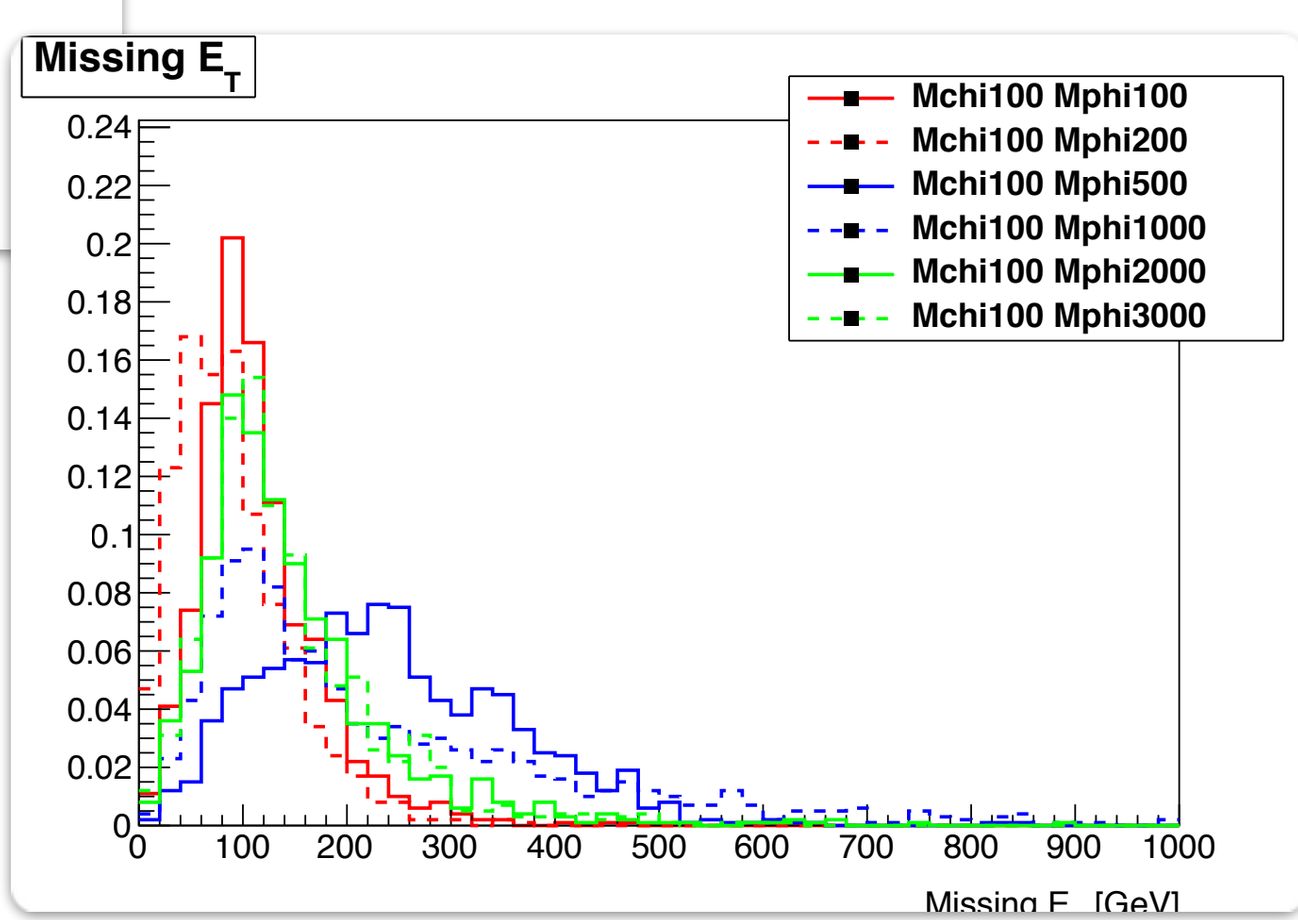






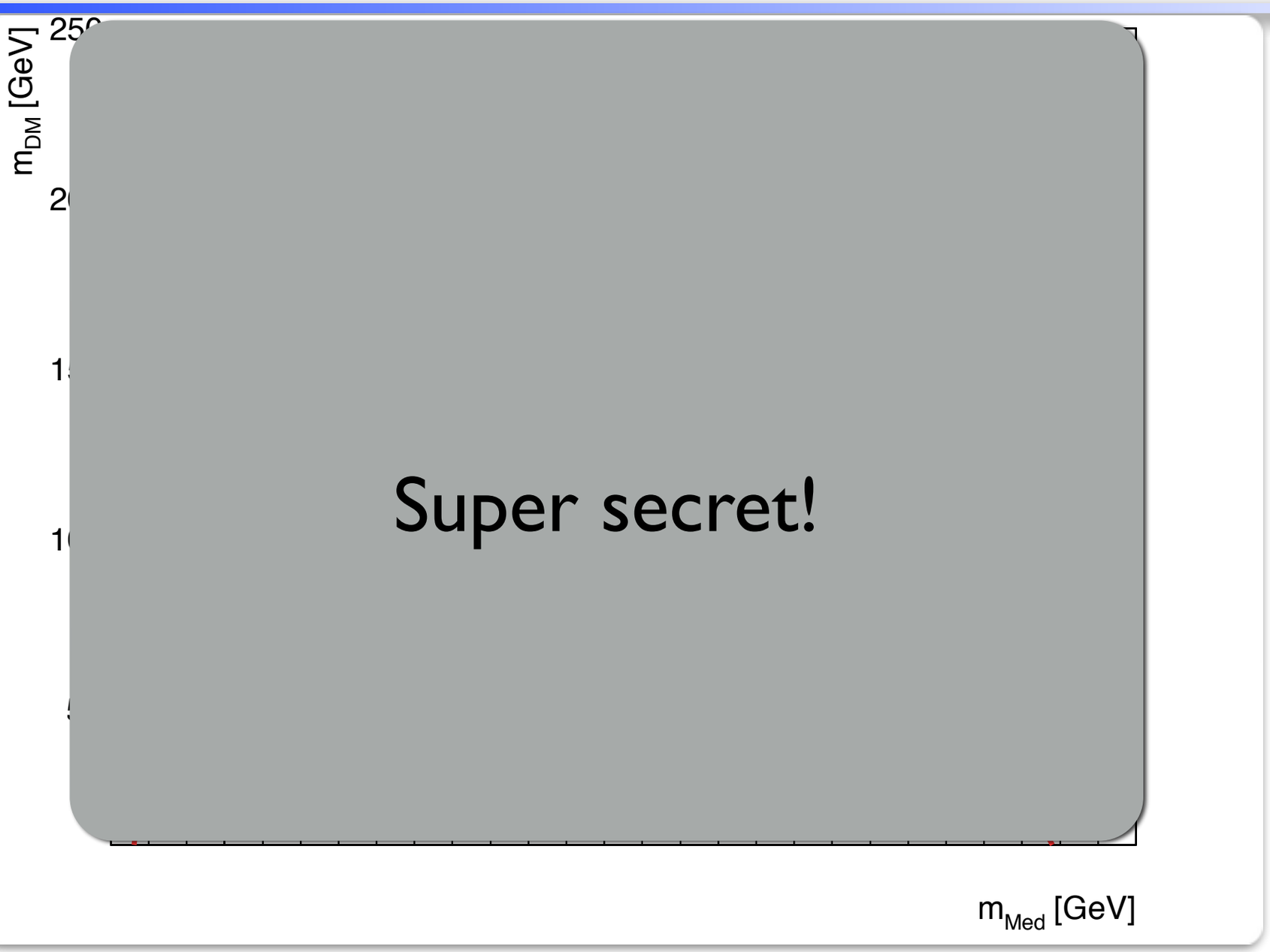


- Also Deborah produced distributions and her plots support prelim. conclusions



- Ongoing studies to compare setups with Priscilla
- We've been busy with DM+tt, DM +b and related responsibilities in individual collaborations

Results



- Super secret (unfortunately an internal tool) indicates that we should generate DM masses up to ~300 GeV
- Remaining mass grid looks good and smooth

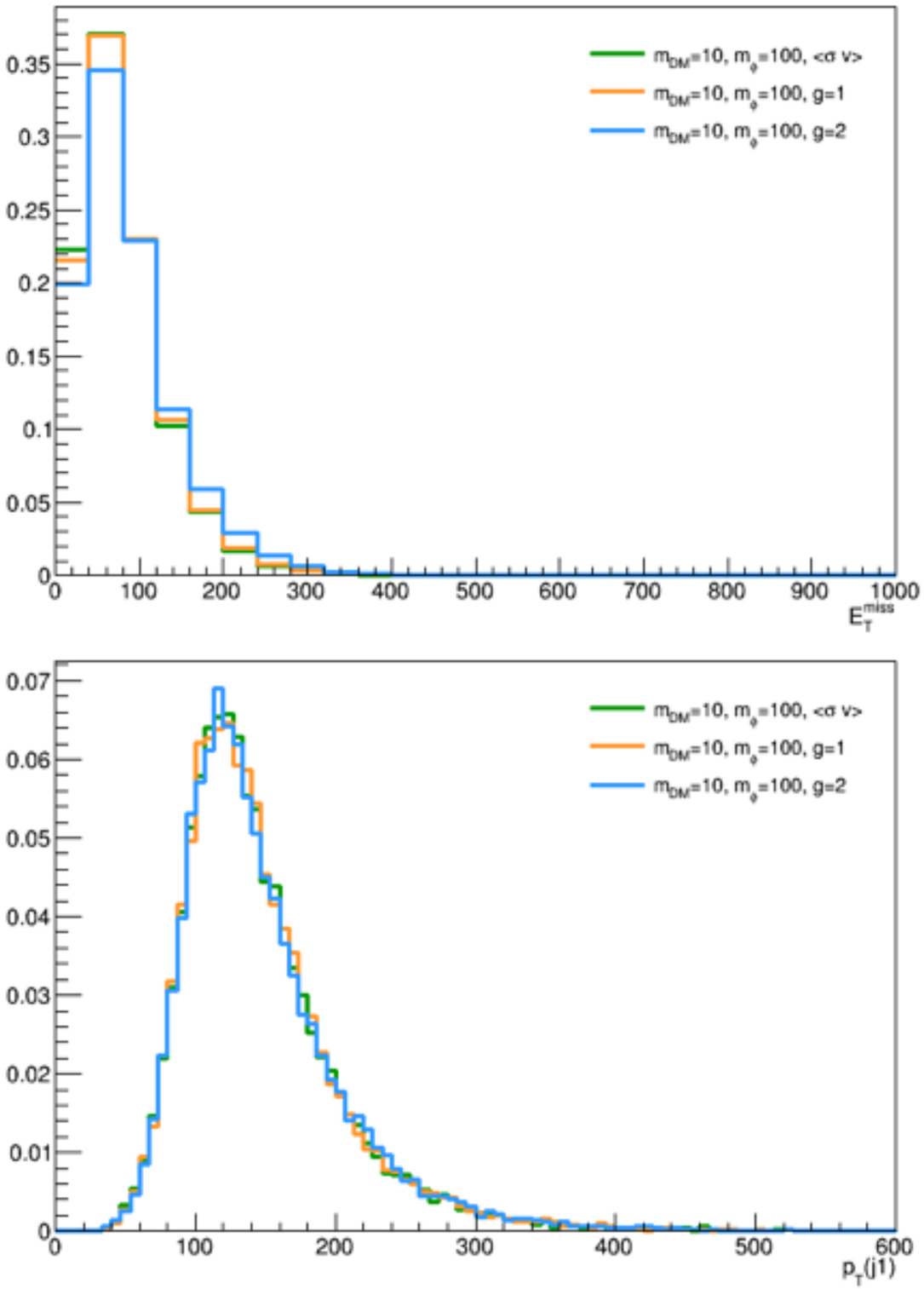
Conclusion

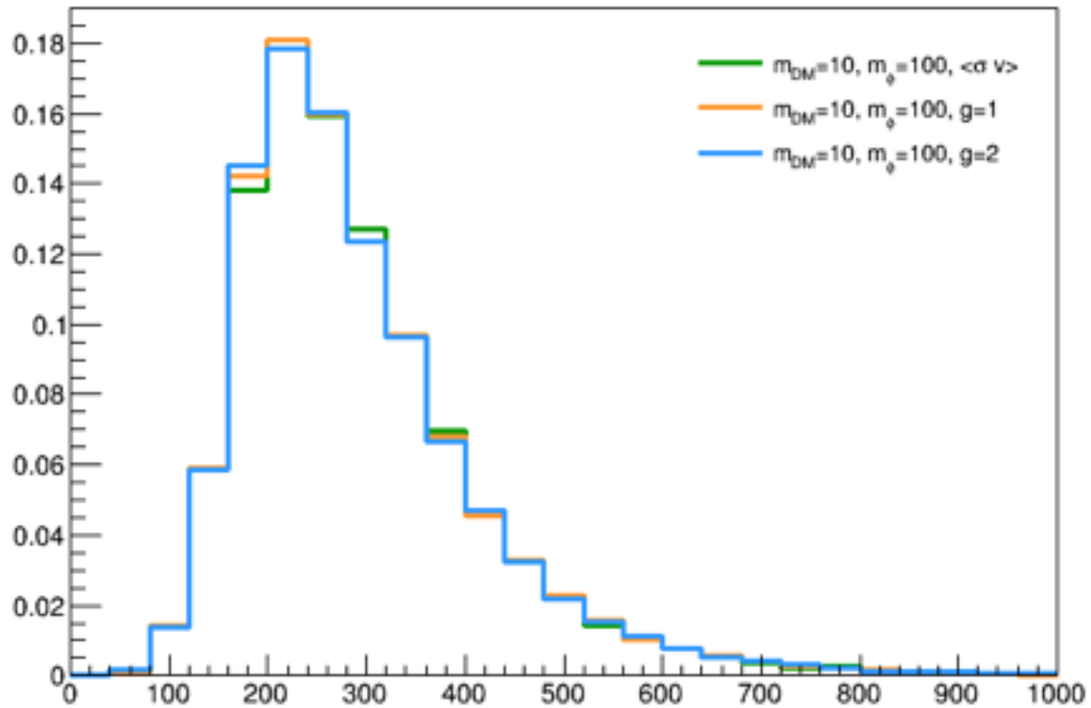
- Interesting model to probe unique phase space
- Large cross section increase makes such models attractive for early data
- Shapes dependent on g in m_{DM} and m_{Phi} observed
  - Need to generate all couplings to be probed individually
- Sensible to produce samples for coarse grid in g=1,2.. and one set normalised to relic density
- In some sense more constrained model, easier to define parameter space

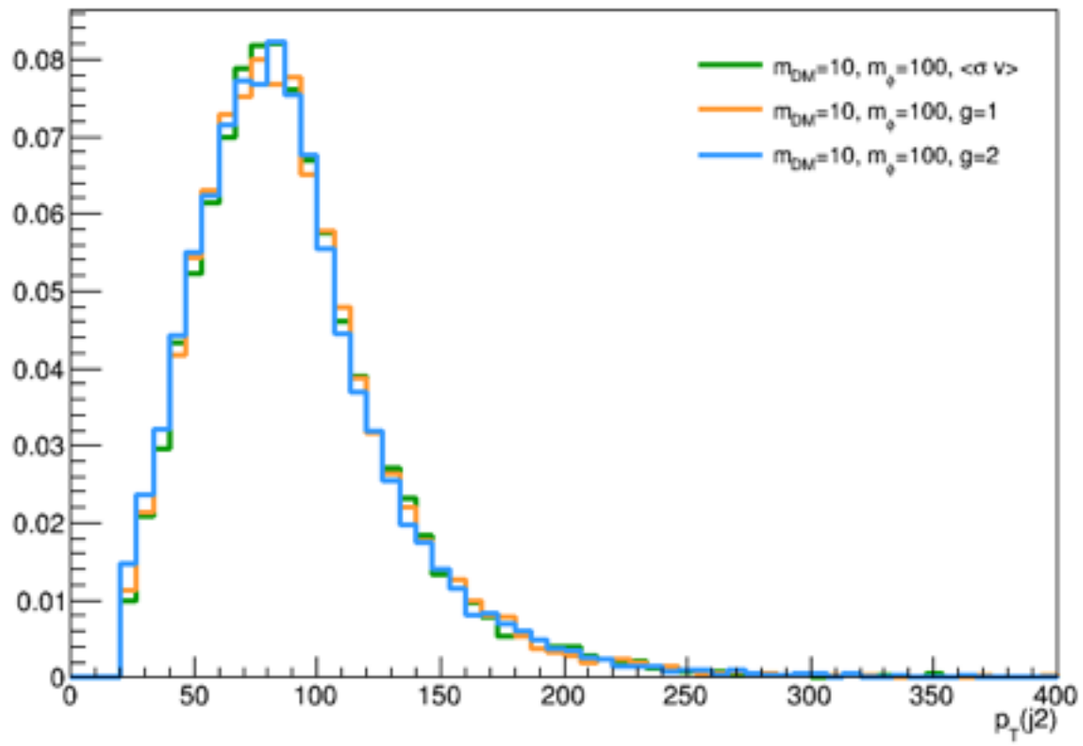
Backup

Just some more distributions

Var. coupling strengths: m_{DM}=10, m_{Phi}=100 G







Var. coupling strengths: m_{DM}=35, m_{Phi}=500