

iDM Search

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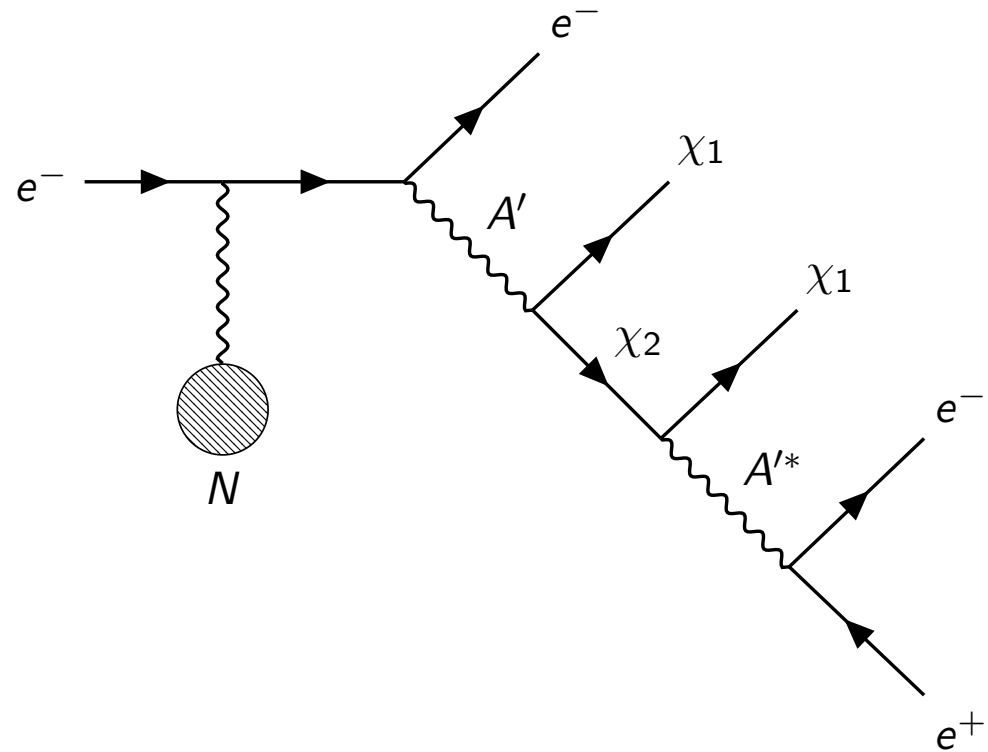
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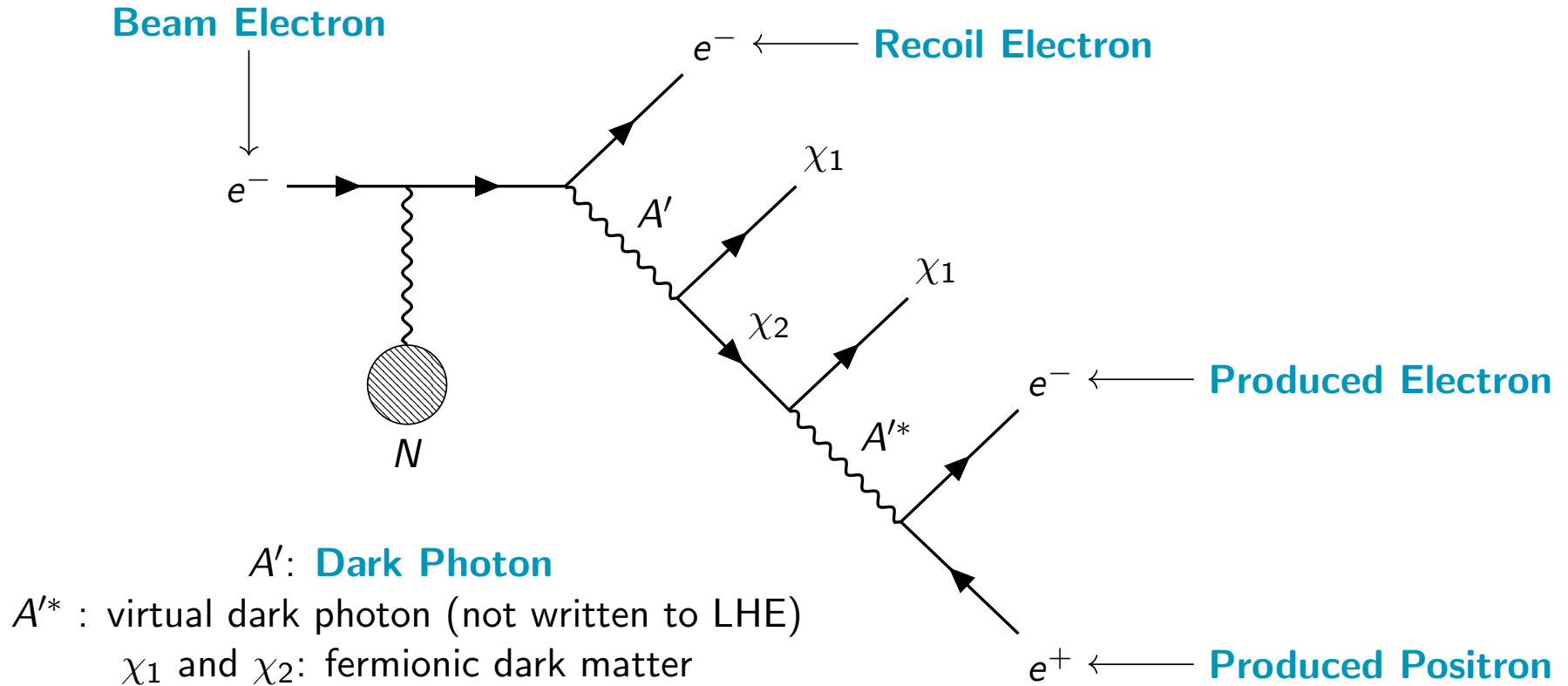
Good News

Have MADGRAPH model that calculates this diagram.

Bad News

Struggling to find phase space at HPS 2016 beam energy.





Parameter	Block	Default	Description
Mchi	dm	1.0	Average fermion dark matter mass in GeV
dMchi	dm	0.01	Difference between fermion DM masses in GeV
GAN	frblock	~ 0.3	SM photon-nucleon coupling
GZPN	frblock	~ 0.3	Dark photon-nucleon coupling
Anuc	frblock	184	atomic weight of nucleus in amu
Znuc	frblock	74	atomic number of nucleus
mZDinput	hidden	20	dark photon mass in GeV
MHSinput	hidden	200	dark higgs mass in GeV
epsilon	hidden	0.01	SM-dark photon mixing strength
kap	hidden	10^{-9}	???
aXM1	hidden	127.9	$1/\alpha_D$

Table: Relevant MADGRAPH/MADEvent parameters available in param_card.dat

Mixed-Up Notation $A' \equiv Z' \equiv Z_D$

Adaptation

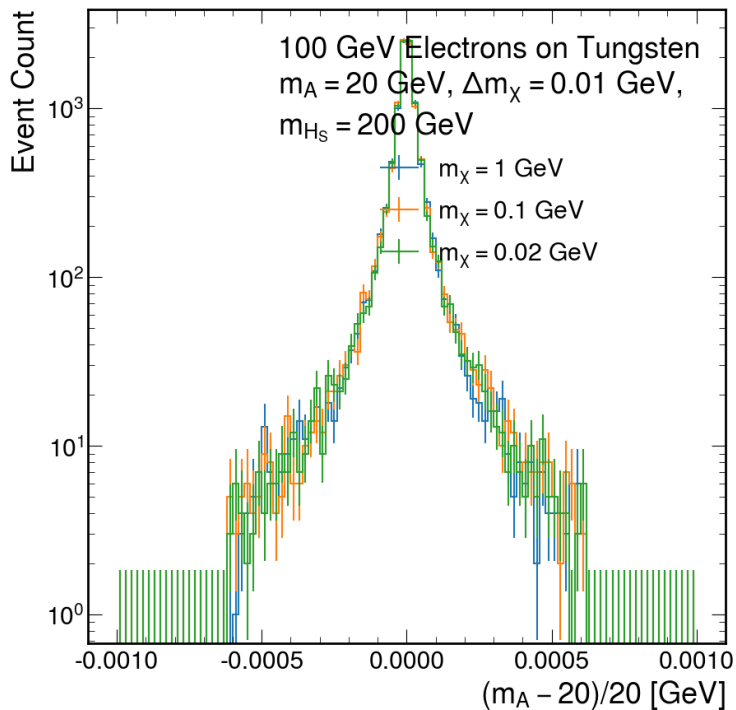
This model was adapted from an iDM model provided by Stefania for pp collisions (I think) and updated for eN fixed target by porting over the `frblock` parameters and couplings from the dark photon model in `hps-mc`.

High Energies

As you can see in the table, the masses of the DM seemingly require higher energies. I was able to generate iDM samples with this model at NA64's beam energy of 100 GeV.

General Plan

1. Modify parameters until masses are theoretically producible by HPS beam energy.
2. Lower beam energy.



double check that m_A aligns with the m_{ZD} parameter.

- ✓ Sharp distribution around $m_A = 20$ GeV
- ✓ Roughly reconstructing width of $\sim 10^{-4}$
- ✓ Neither changes as we change m_{χ_1}

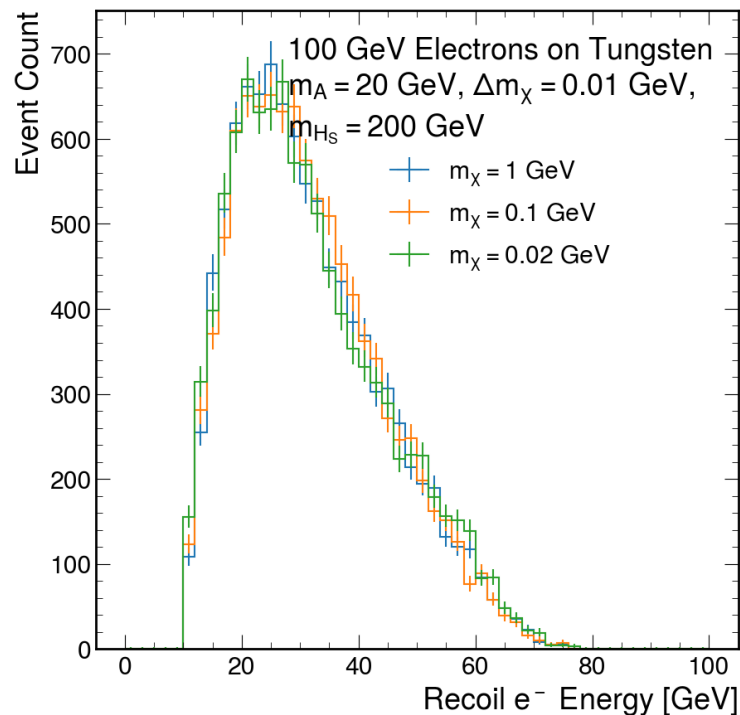
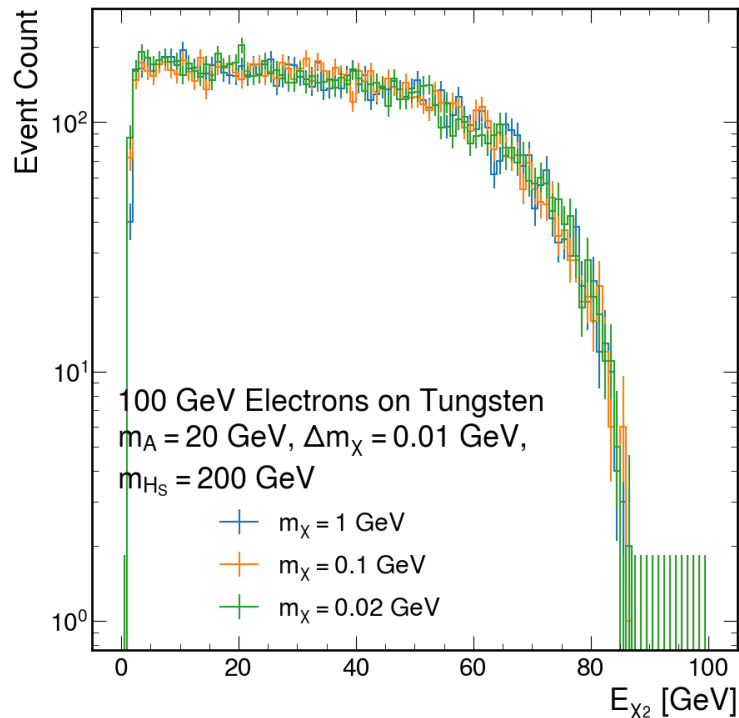


Figure: Energies of particles produced by dark photon decay.

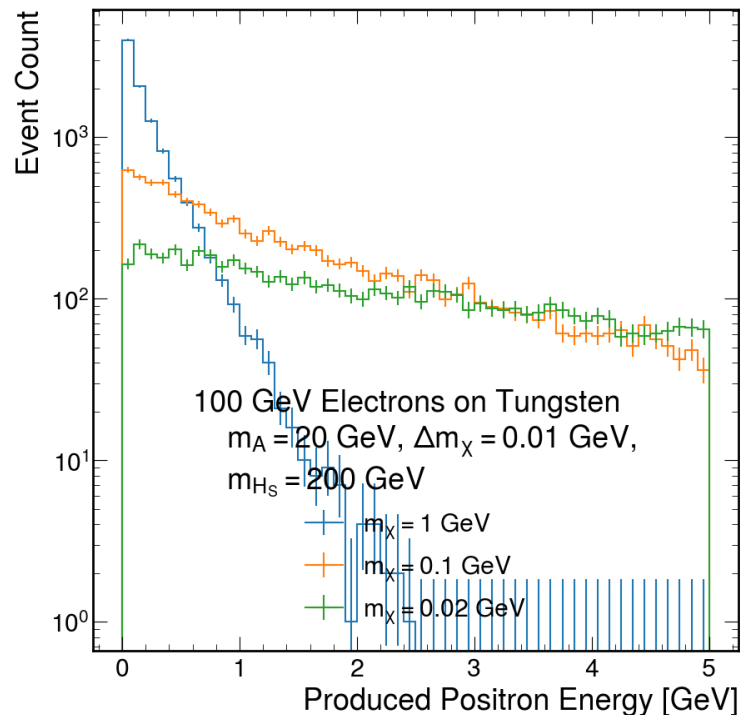
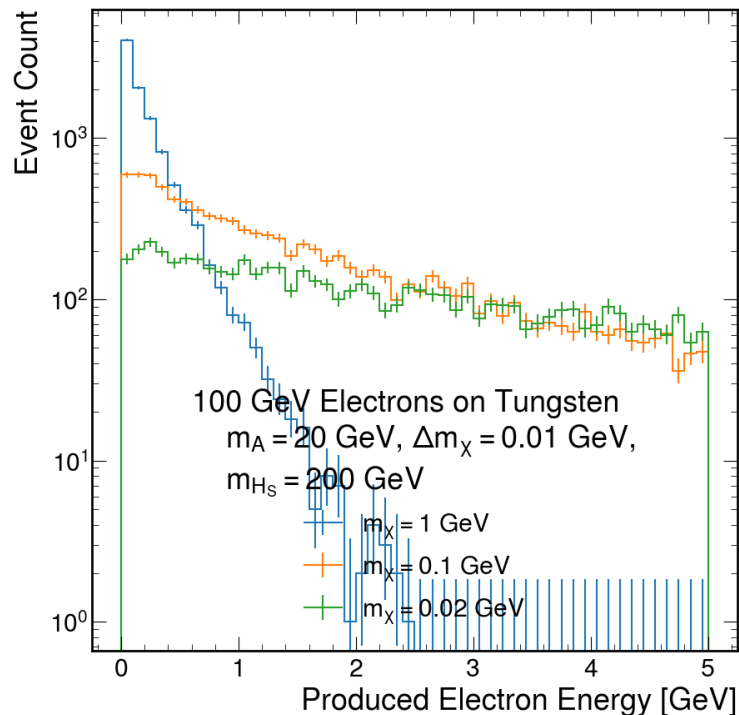
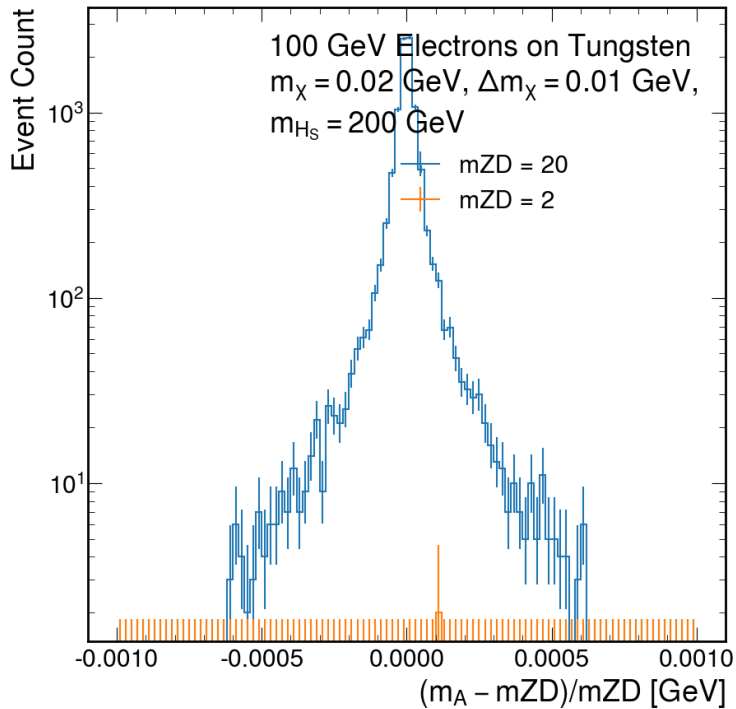
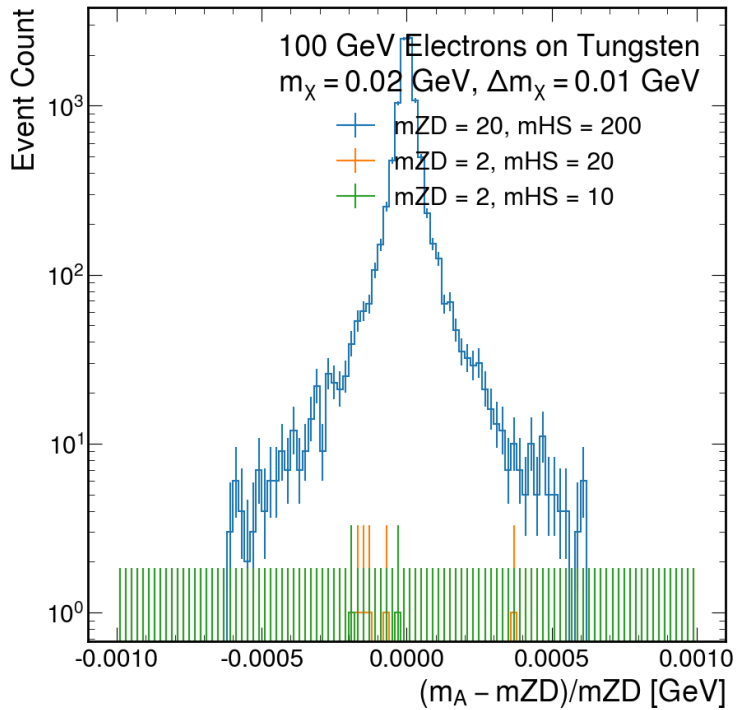


Figure: Energies of SM particles produced by χ_2 decay.

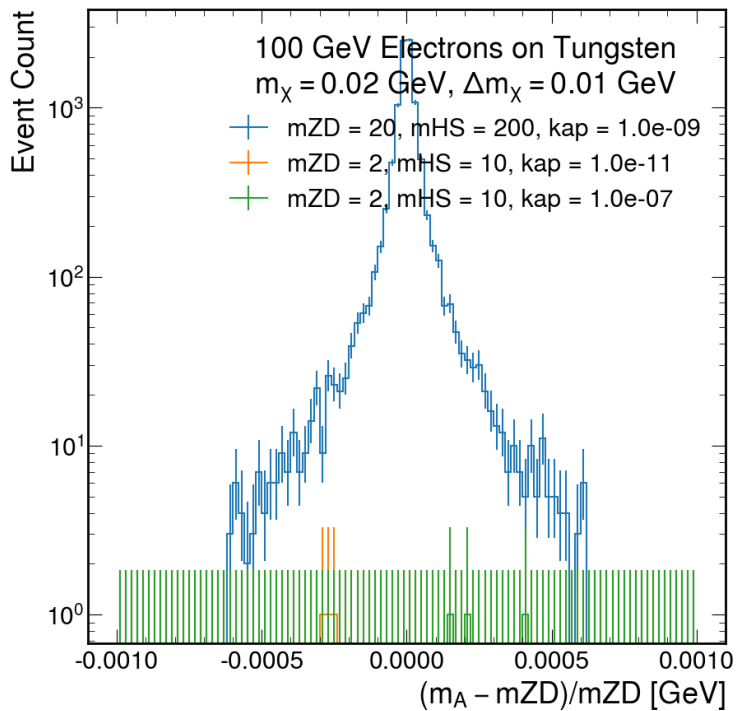


Bad News

Lowering m_A squeezes phase space \rightarrow little space available even at 100GeV beam



Trying to re-open the phase space.
No luck.



Trying to re-open the phase space.
No luck.

- Continue exploring iDM phase space, lots of parameters to “tune”
 - ▶ Try to make contact with theorists to help debug model
- Put model into HPS and see how this signal behaves differently than SIMPs
 - ▶ Work with Alic to share code and tooling to make both our analyses easier and more robust
- Cut-n-count analysis of 2016 physics data — derivative of previous displaced vertex searches