The dark side of the photon.

Ongoing ATLAS search for dark matter through a dark photon.

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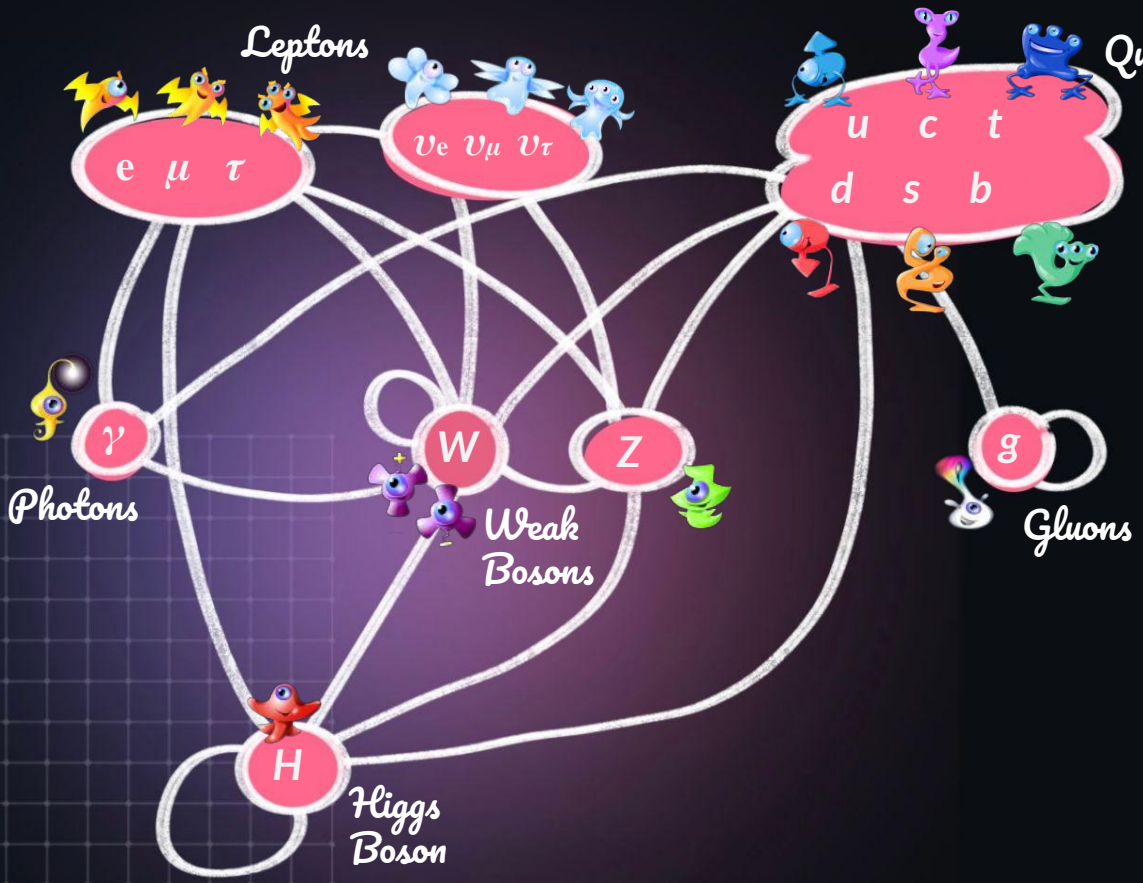
ATLAS EXPERIMENT

ASP

We know, what we don't know.

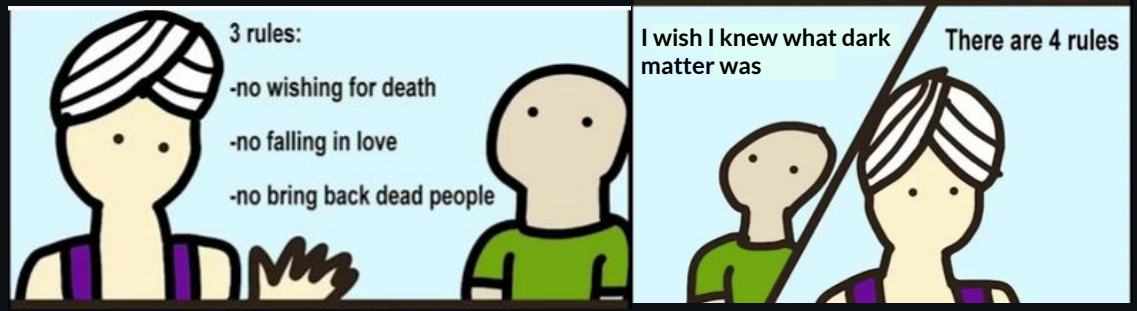


- The standard model of particle physics (SM) describes the fundamental particles and their interactions.
- However this model is incomplete, as it does not give a truly sufficient description of the universe.
- One enduring question we have long been faced with, is the existence of dark matter.

Dark matter, we know you're out there.

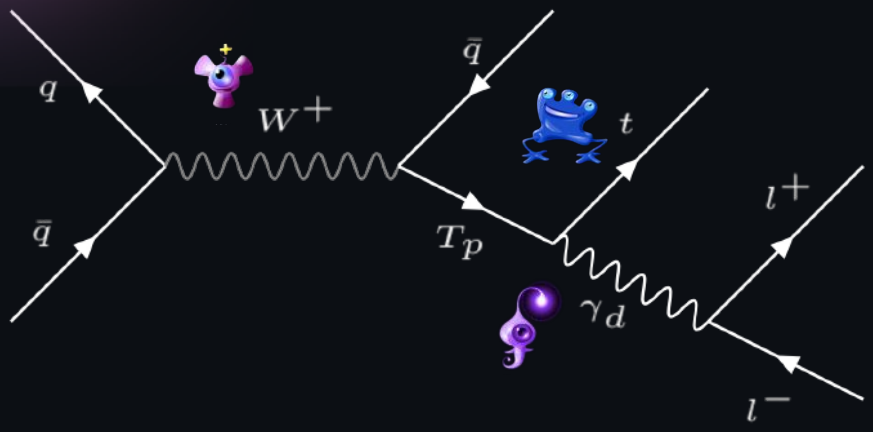
- Dark matter makes up about 27% of the universe
- Although, dark matter does not interact with ordinary matter, the evidence is undeniable.
- From gravitational lensing, to the very existence of galaxies.
- However as of yet, no promising results have come from previous searches.
- So now, new approaches are being investigated.

Figure by: Abagail Burrus , Harvard University



The dark side of the photon.

This search is for a hypothetical particle connected to dark matter, called a dark photon.



- We consider the Maverick top quark (Tp) , a hypothetical heavy fourth generation quark.
- Two collimated energetic leptons can give jet like signatures, which gives lepton jets.
- Dark photons can decay into such lepton jets.
- The MavTop will decay to a standard model top quark and a lepton jet.
- We only consider the top hadronic channel in this search.

The signal topology.

- The event contains a top quark, and at least one more jet coming from the initial quark.
- The dark photon has a mass of 100 MeV, so the decay is completely to an electron and positron pair.
- All decays shown are prompt.
- The large radius jet shows the hadronically decaying top quark.

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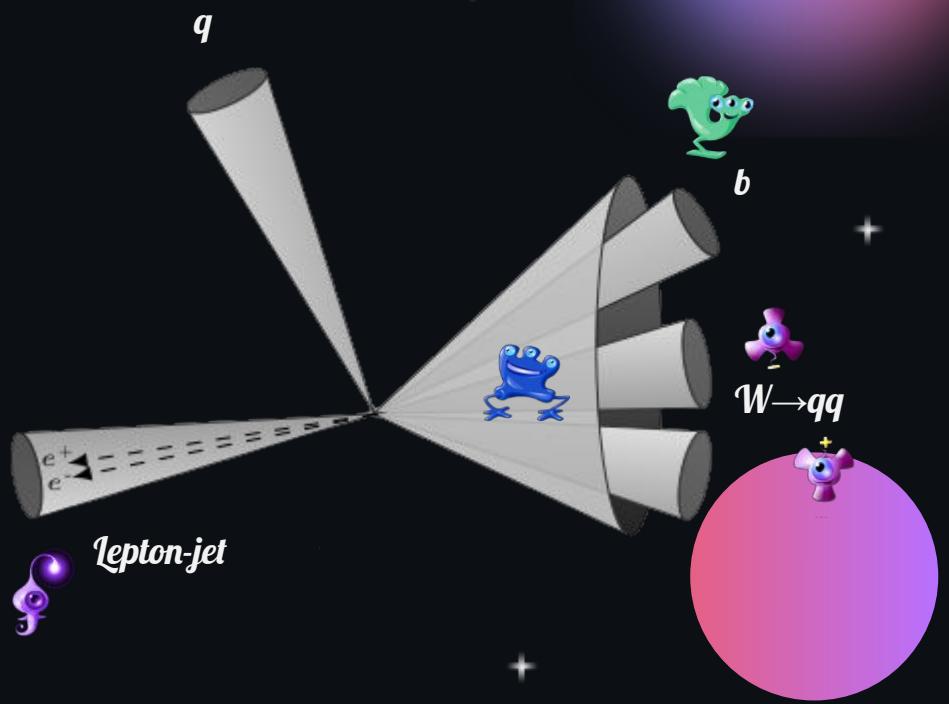


The search

- Initial studies used simulated samples from Madgraph5 interfaced with Pythia8 in Atlas framework Athena.
- Maverick top had masses of 1 to 5 TeV and dark photon had mass of 100 MeV.
- Event selection is at least one electron and at least one large jet.
- Top jet was chosen as a large jet in top mass window.
- Lepton jet is chosen as jet closest to the leading electron.

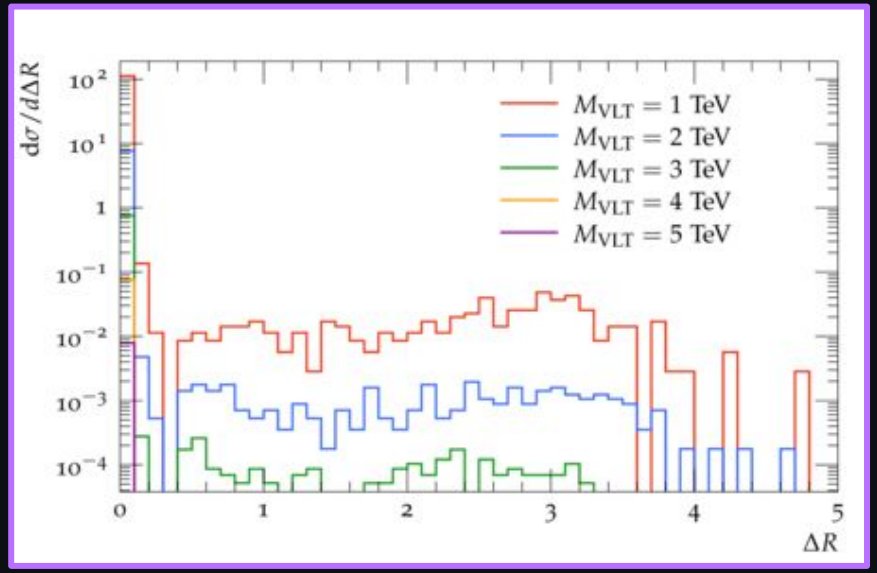


Figure 1: ΔR between leading electron and closest jet

Signal validation

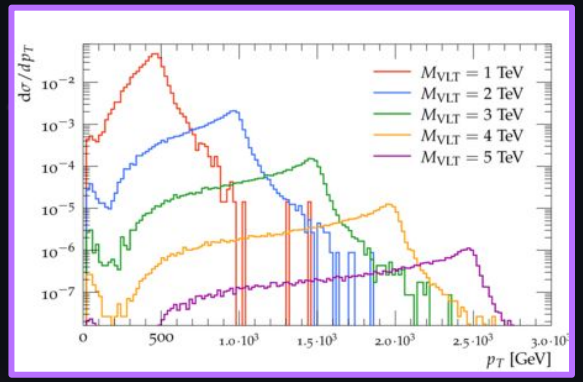


Figure 2: lepton jet pT

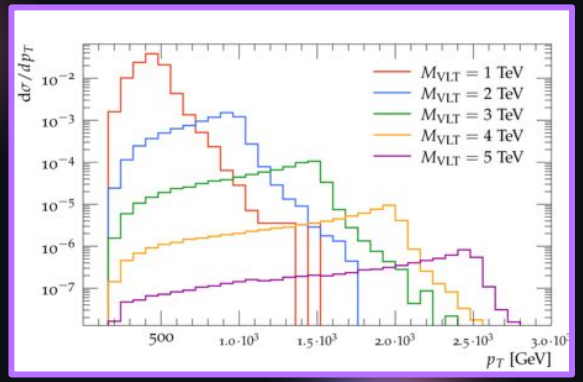


Figure 3: Top-jet pT

- Both lepton jet and top jet are boosted.
- The Maverick top is reconstructed as invariant mass of top and lepton jet.

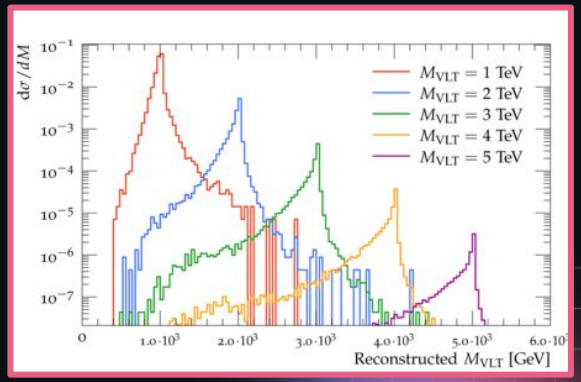


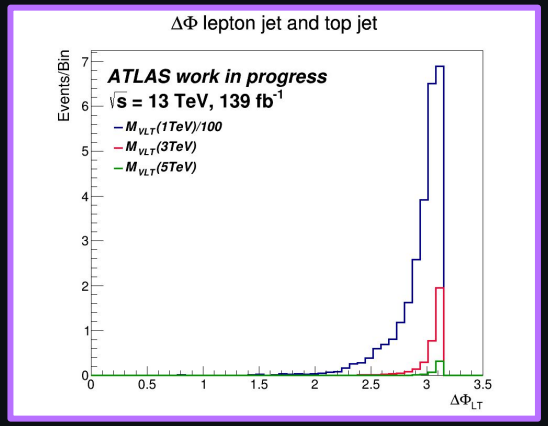
Figure 3: Reconstructed Maverick top mass

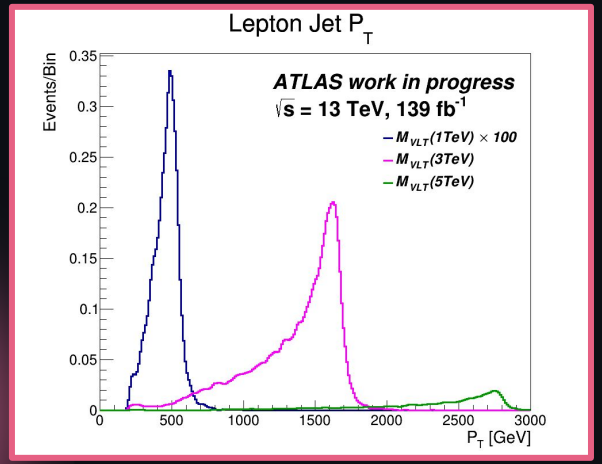
ATLAS signal events

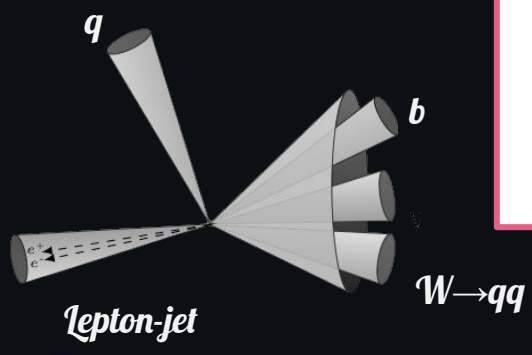
Using ATLAS detector level simulated samples and framework.

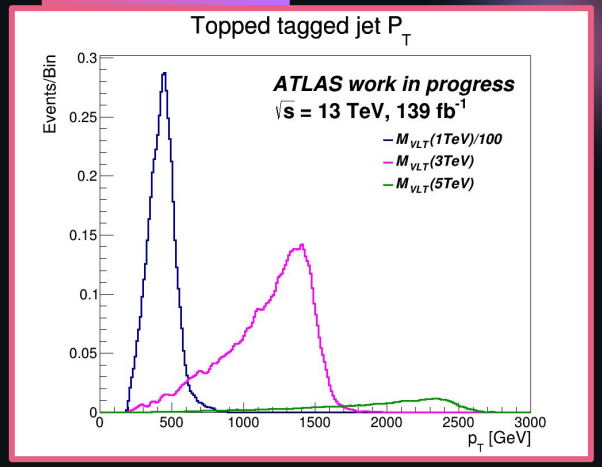
- Samples are generated with MadGraph5 and interfaced with Pythia8.
- Lepton jet is chosen as jet closest to leading electron.
- Lepton jet has mass of 100 MeV.
- Decay completely to electron and positron pair.
- Top quark is chosen as leading mass jet.
- Consider MavTop mass of 1,3 and 5 TeV.

Signal kinematics



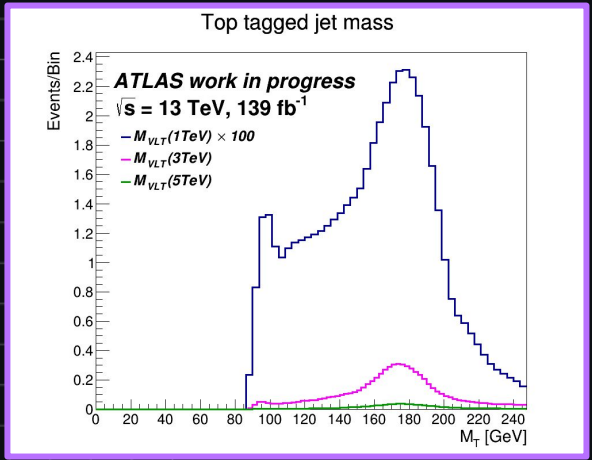


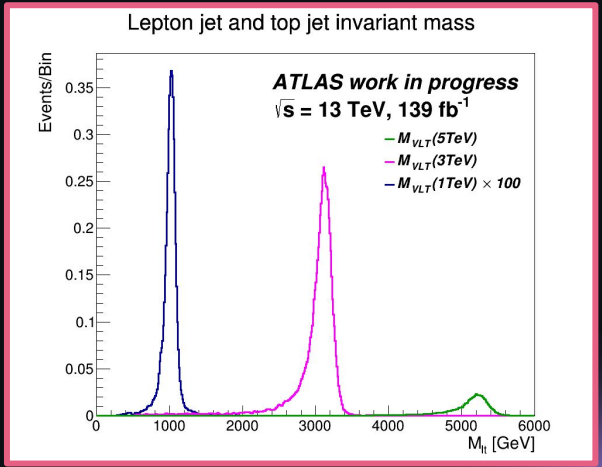




Further important kinematics

- Top jet was chosen as leading mass jet.
- Plots give us what we would expect.





Summary and next steps

Truth validations	From truth level simulation, we found that our signal is viable
Detector level	Looked at our signal for detector level simulations
Background	Background contributions are from ttbar and mulitjet
Optimisation	Determine best approach for efficient signal selection and background optimisation

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Thank You