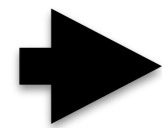# Searches for SUSY and Dark Matter at CMS, from early data to the future

Adam Elwood
DESY Fellow Day, Feb 2018

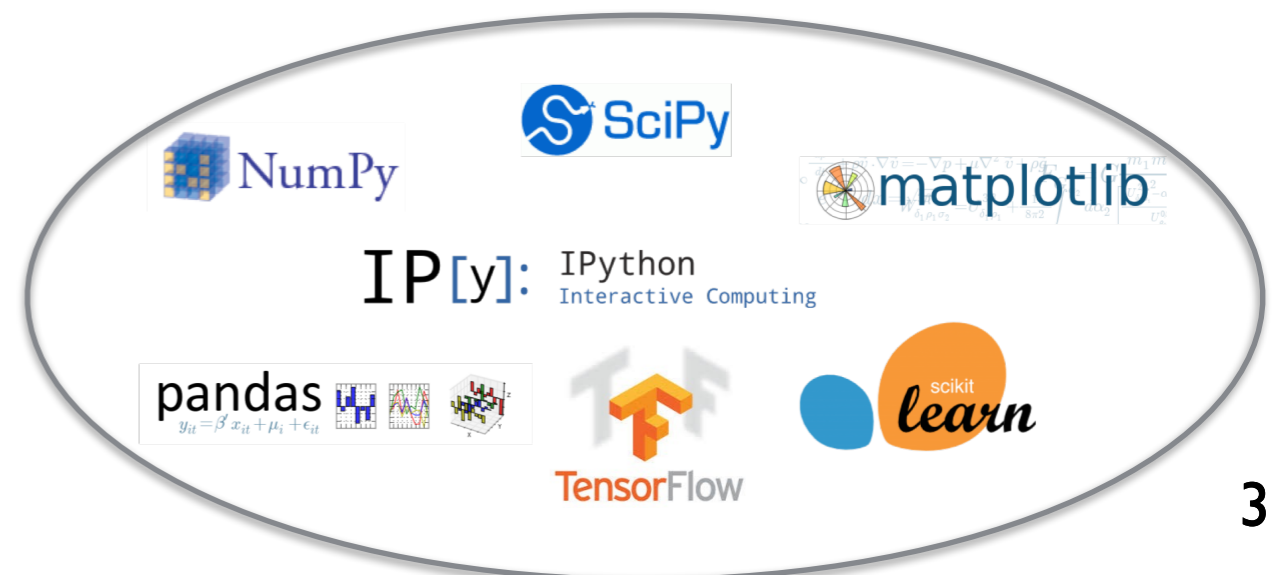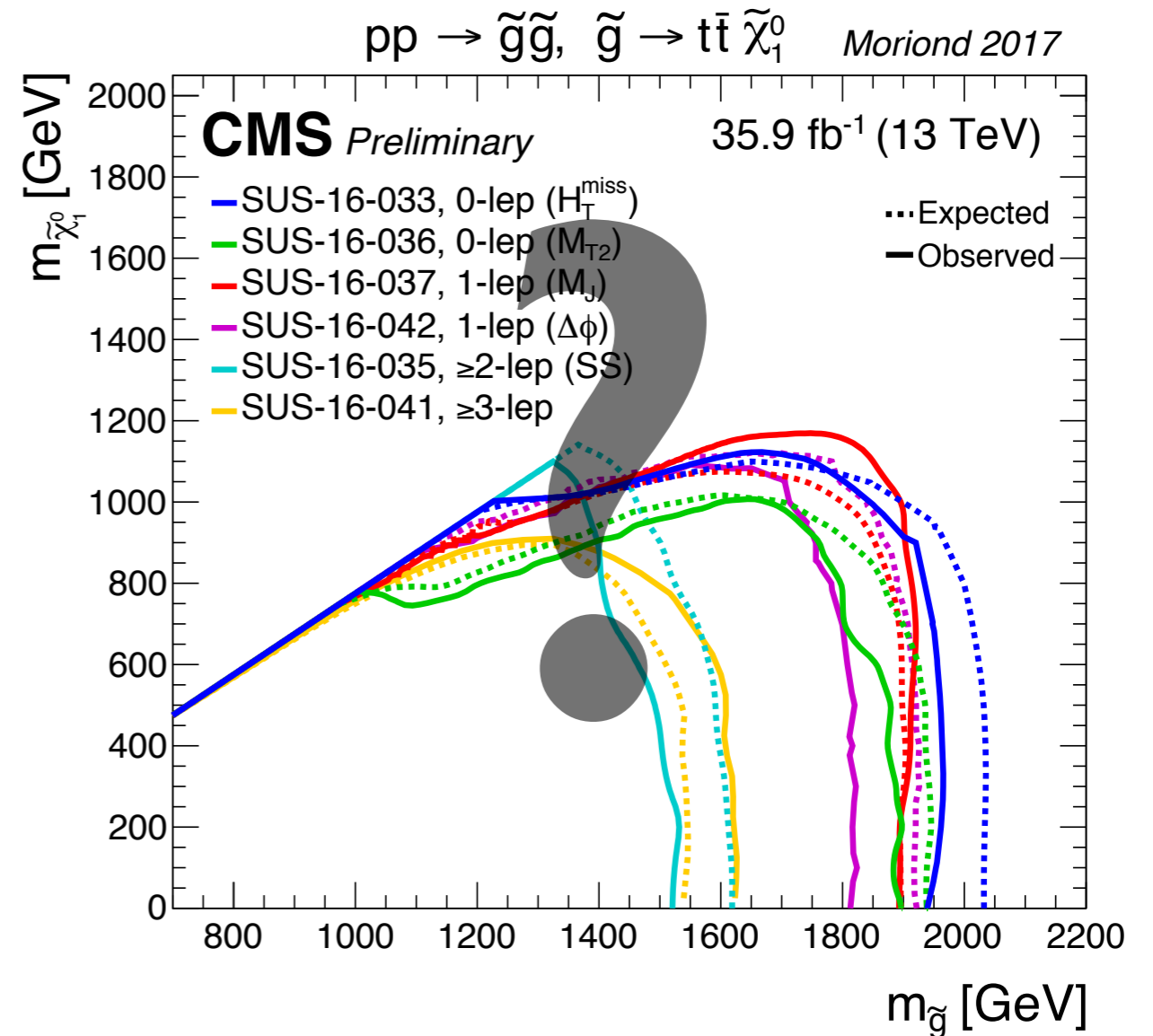adam.elwood@desy.de

About me

- Born and grew up in Boston, Lincolnshire in the UK

  - 26 years old

- MSci in Physics with Theoretical Physics from Imperial College London

- PhD also from Imperial, including 2 years based in CERN to work on CMS

  - Development of new Level-1 trigger jet algorithm, including pileup subtraction

  - Search for SUSY in the all-hadronic final state with the α_T variable in 13 TeV CMS data

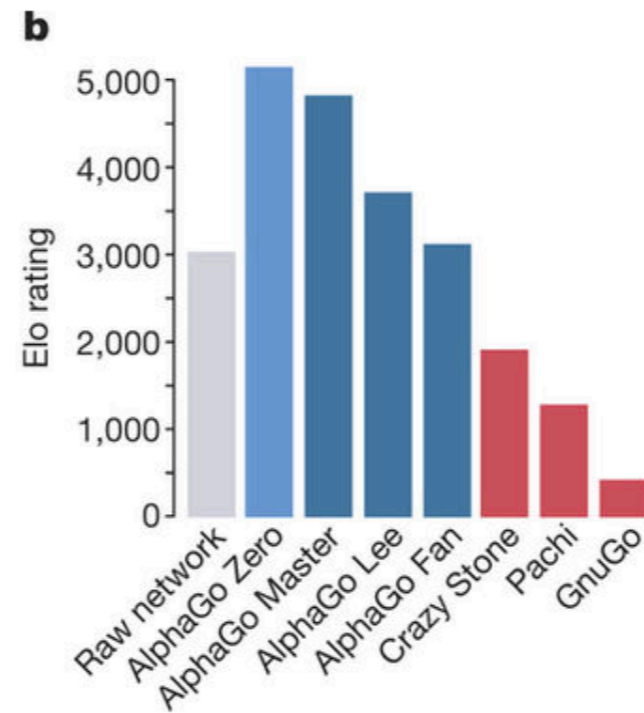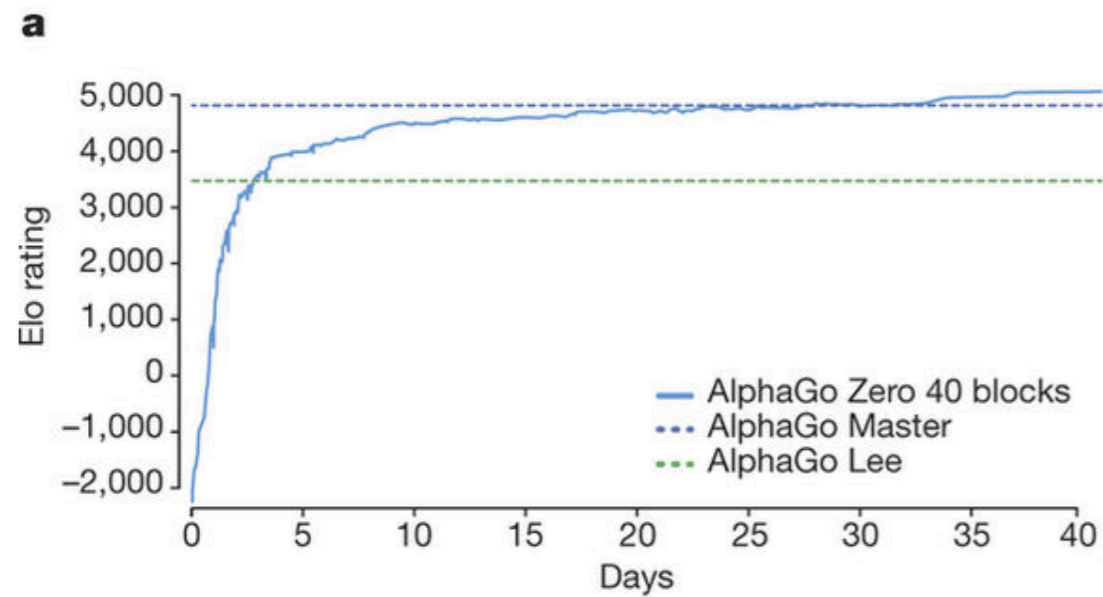- Began DESY fellowship in October 2017

My current work

- Still no signs of new physics after a significant chunk (36/fb) of 13 TeV data have been analysed

- Need to get more creative in search for SUSY and dark matter

- New models:

  - 'Dark Higgs' and long lived SUSY

- New analysis techniques:

  - Deep learning offers a fast developing suite of new techniques to start exploring the phase space more deeply

  - Many powerful python-based tools and methods coming out of industry

- Lots of potential to apply this to HEP

  - Signal and background event classification (I'm looking at it in context of 1 lepton $\Delta\phi$(lepton, MET) SUSY search)

  - Improve the algorithms to a HEP specific use case (e.g. new loss functions)

 - Taking care of systematics! (this is the interesting problem)

$pp \rightarrow \tilde{g}\tilde{g}, \ \tilde{g} \rightarrow t\bar{t}\ \tilde{\chi}^0_1$ *Moriond 2017*

CMS *Preliminary* 35.9 fb^{-1} (13 TeV)

- SUS-16-033, 0-lep (H_T^{miss})
- SUS-16-036, 0-lep (M_{T2})
- SUS-16-037, 1-lep (M_J)
- SUS-16-042, 1-lep ($\Delta\phi$)
- SUS-16-035, ≥2-lep (SS)
- SUS-16-041, ≥3-lep

····Expected
— Observed

$m_{\tilde{\chi}^0_1}$ [GeV]

$m_{\tilde{g}}$ [GeV]

Potential and dangers…

Deep Neural Networks with the right architecture can do this…

But we need to make sure they aren't doing things like this…
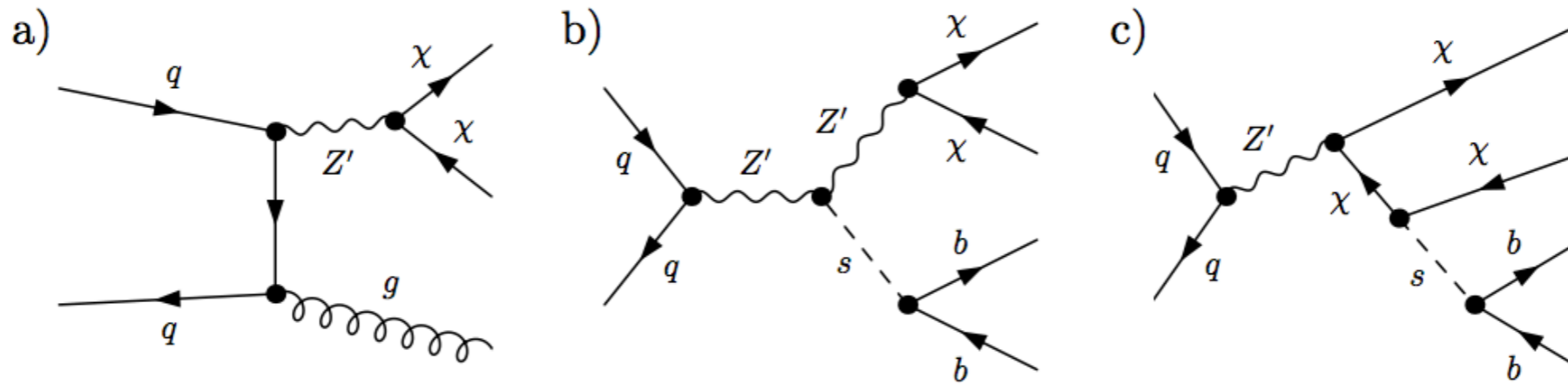
A. Elwood - DESY

4
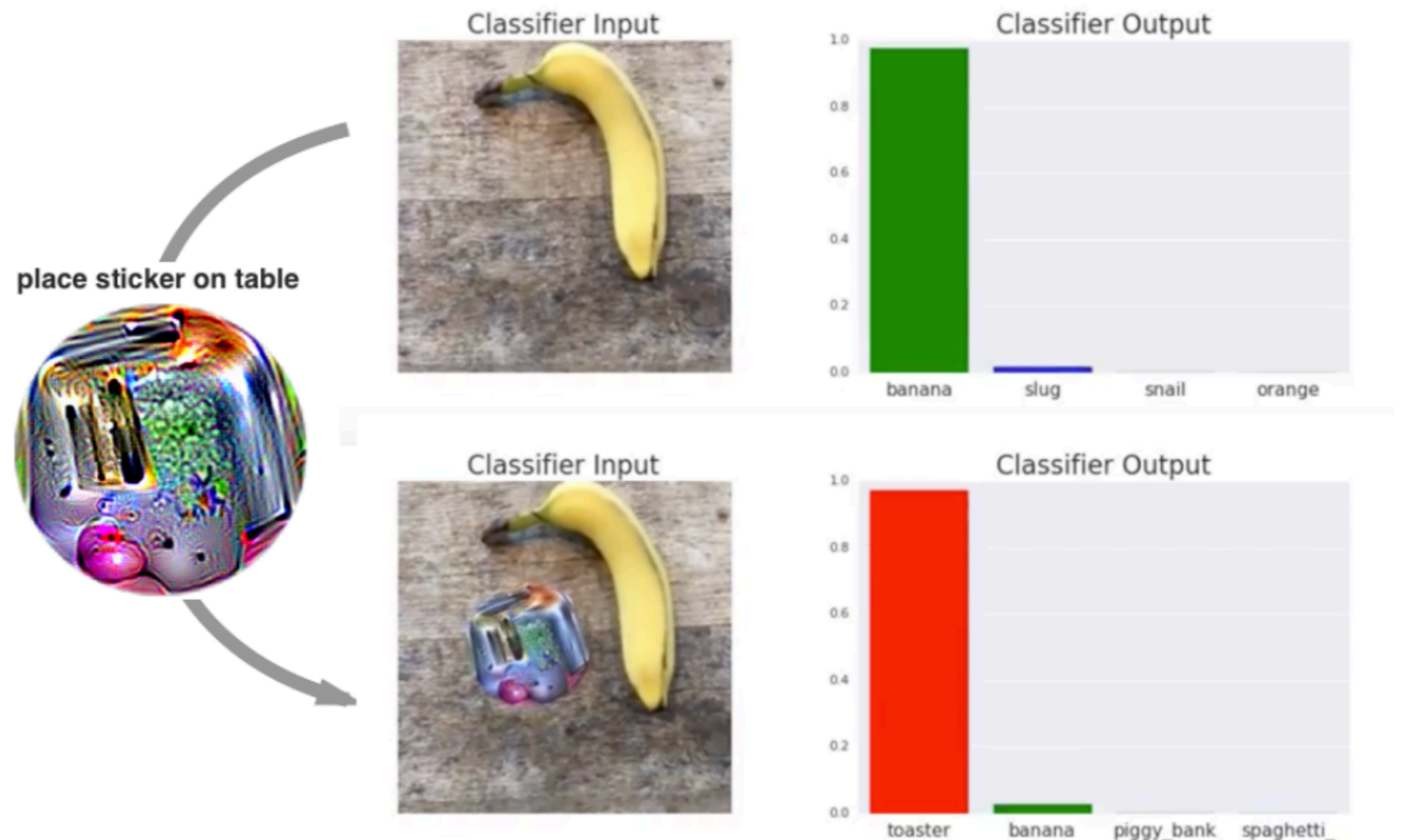
Backup

Dark Higgs diagrams

Figure 1. Processes leading to missing transverse momentum signatures at the LHC. Left: a typical mono-jet process. Centre and right: processes leading to a mono-dark-Higgs signal.