

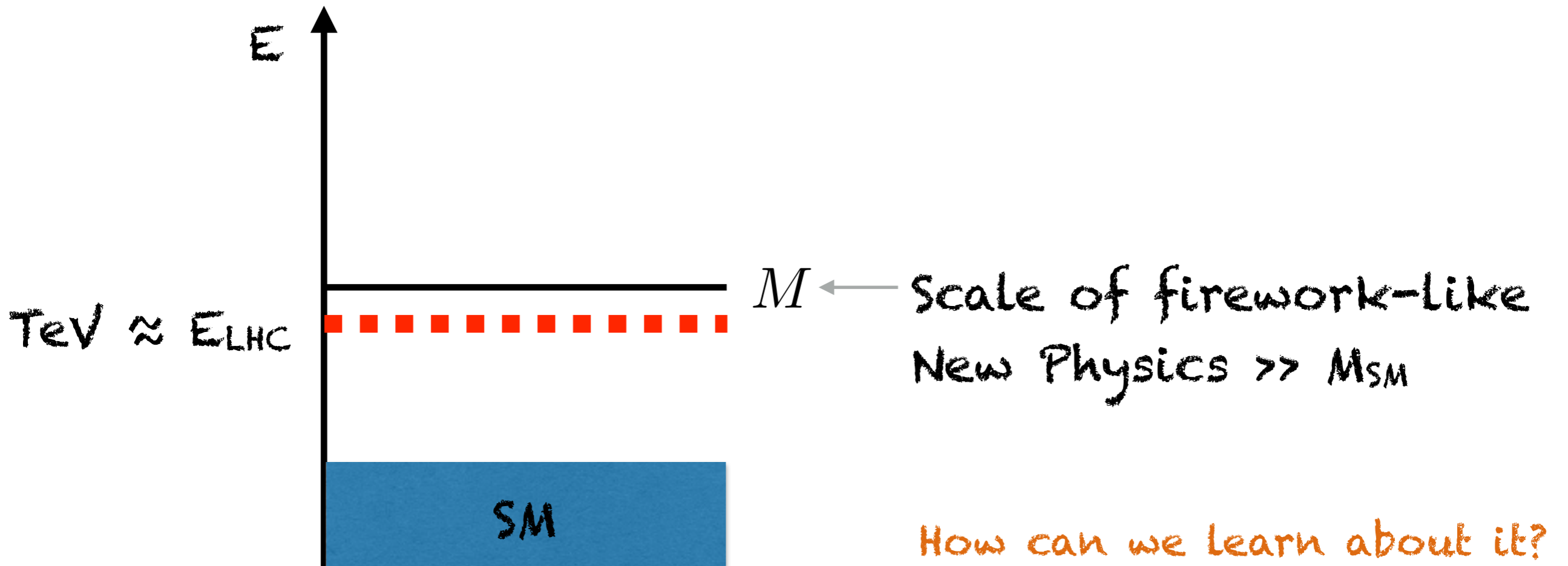
# Les Houches PhystEv 2017

Higgs Physics  
Theory introduction

Francesco Riva  
(Stefania Gori)

# BSM

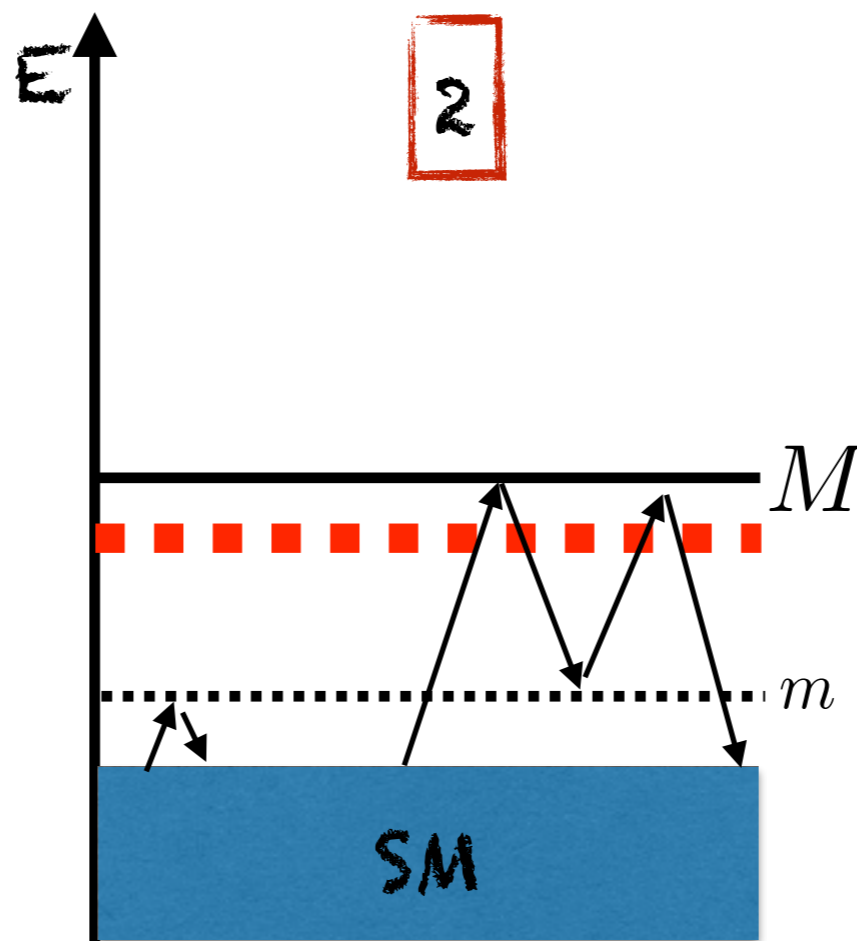
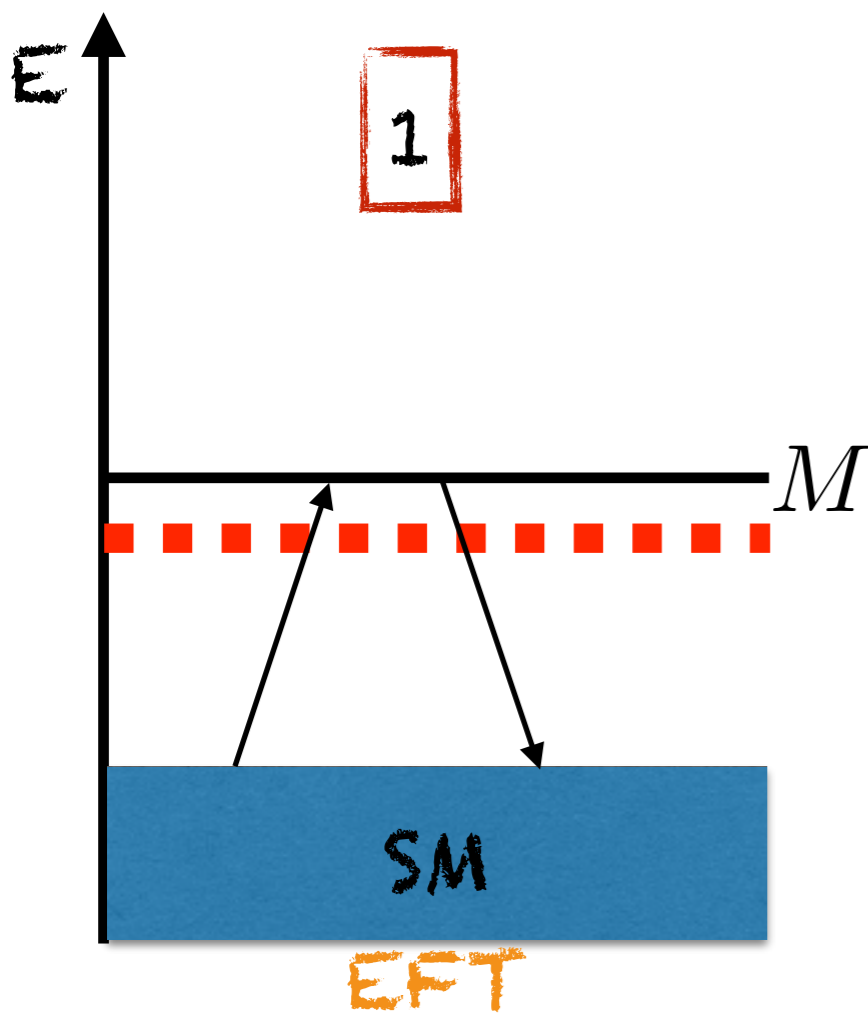
In what form can the SM emerge at low-energy from extended (completely different?) UV dynamics?



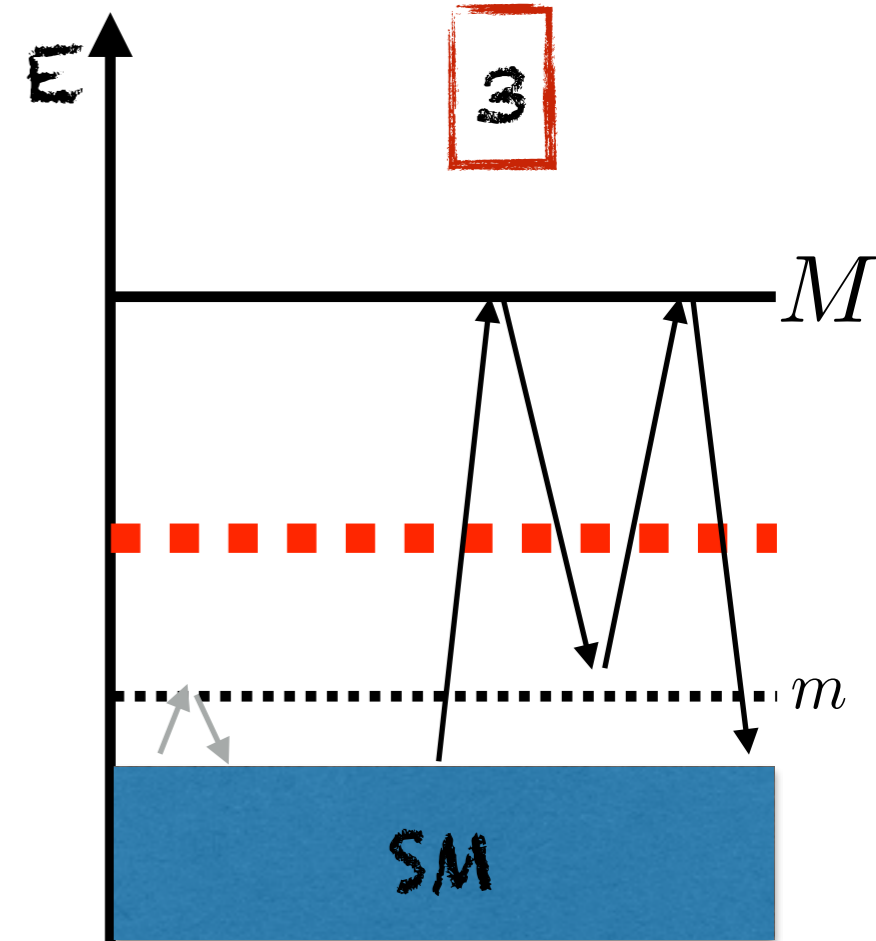
# BSM

In what form can the SM emerge at low-energy from extended (completely different?) UV dynamics?

How can we learn about  $M$ ?



On-shell  
(directly coupled to SM or through  $M$ )

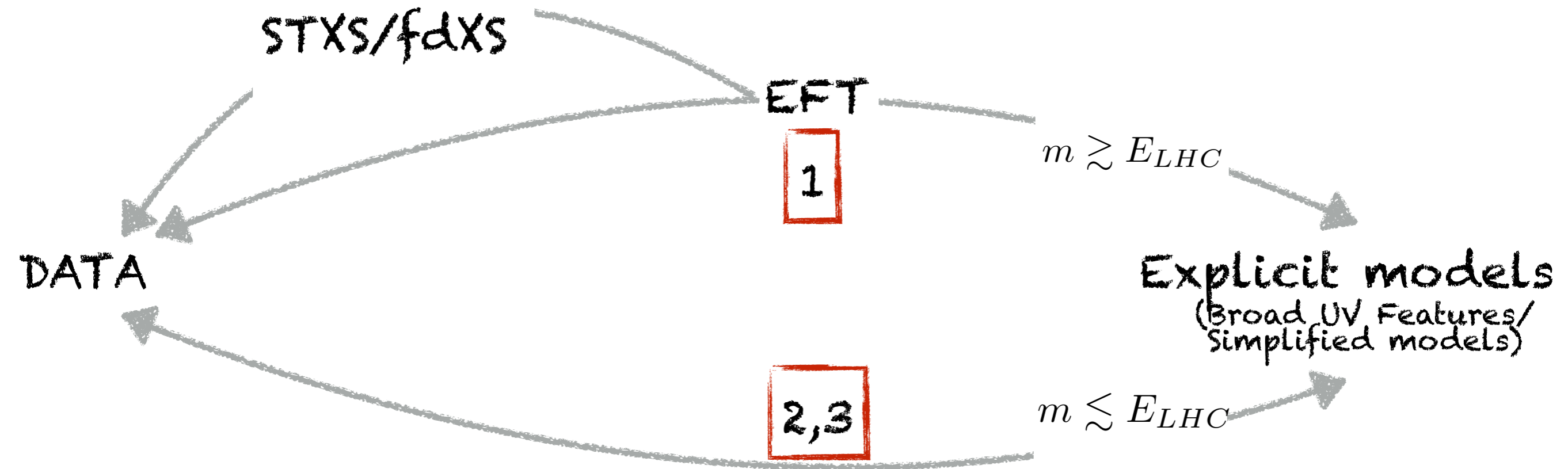


LLP (...DM)  
(small coupling or higher scale)

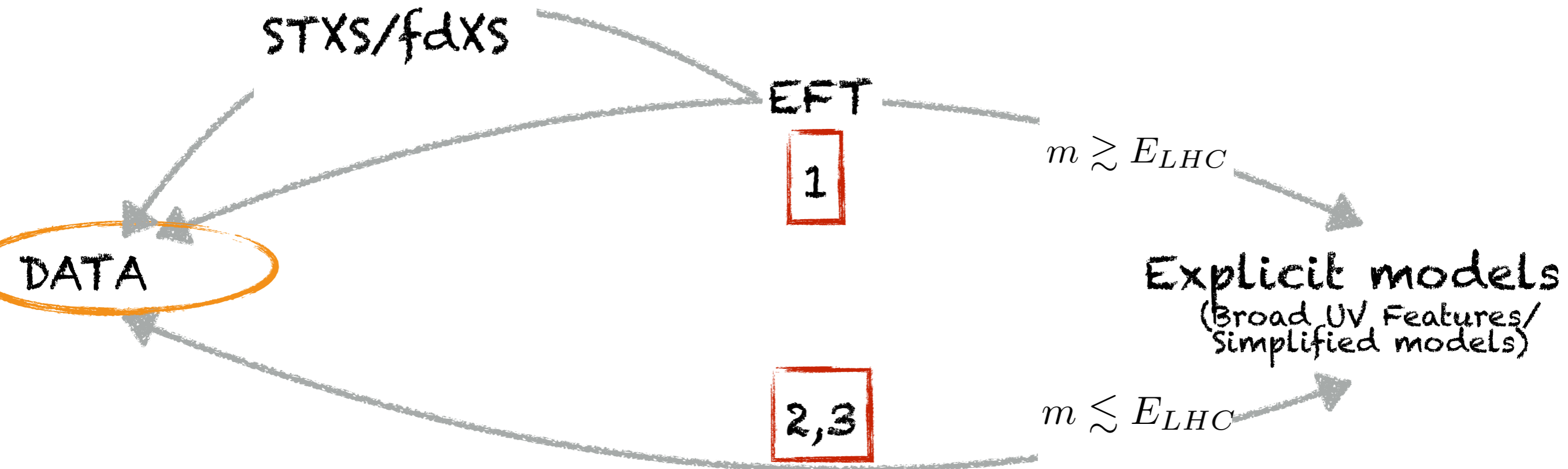
$g$  strong,  $M$  smallish

$g$  weak,  $M$  big

# In Practice



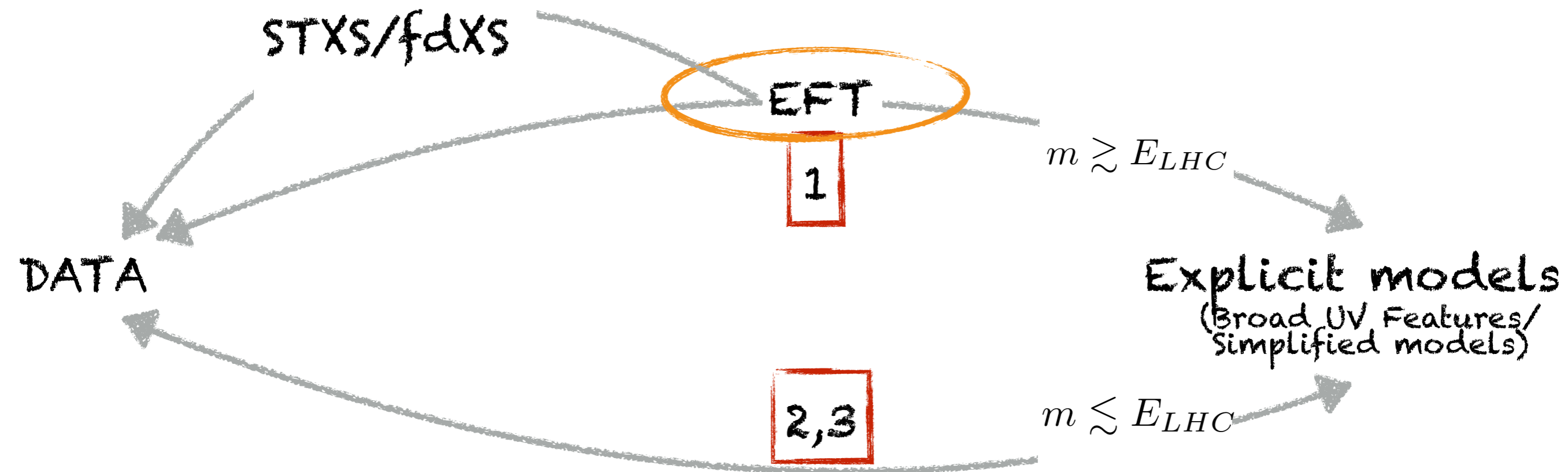
# In Practice



- Exotic decays of the 125 GeV Higgs: channels not covered?
- Exotic decays of heavier Higgses?  $H \rightarrow tt$ ?  $H \rightarrow tc$ ?...

See Pasquale's Talk

# In Practice



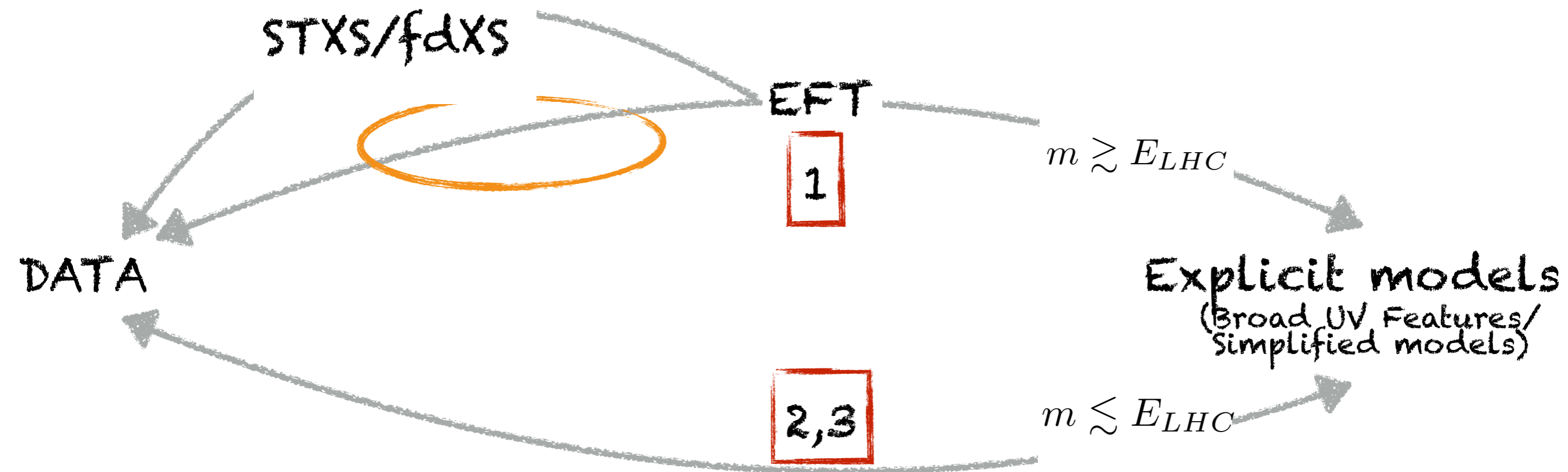
**EFT:** A way to capture the most relevant effects that survive at  $E \ll M$  and characterize **broad** hypotheses of BSM

$$\mathcal{L}_{\text{eff}} = \mathcal{L} \left( \frac{D_\mu}{M}, \frac{g_H H}{M}, \frac{g_\Psi \Psi_{L,R}}{M^{3/2}}, \frac{g_V F_{\mu\nu}}{M^2} \right) \simeq \mathcal{L}_4 + \mathcal{L}_6 + \dots$$

$\sum_i c_i \frac{O_i}{M^2}$

- scenarios with dim-6=0, leading by dim-8, pheno? MonteCarlo?
- Non-decoupling theories? (e.g. Luty, Galloway, Tsai, Zhao'13)

# In Practice



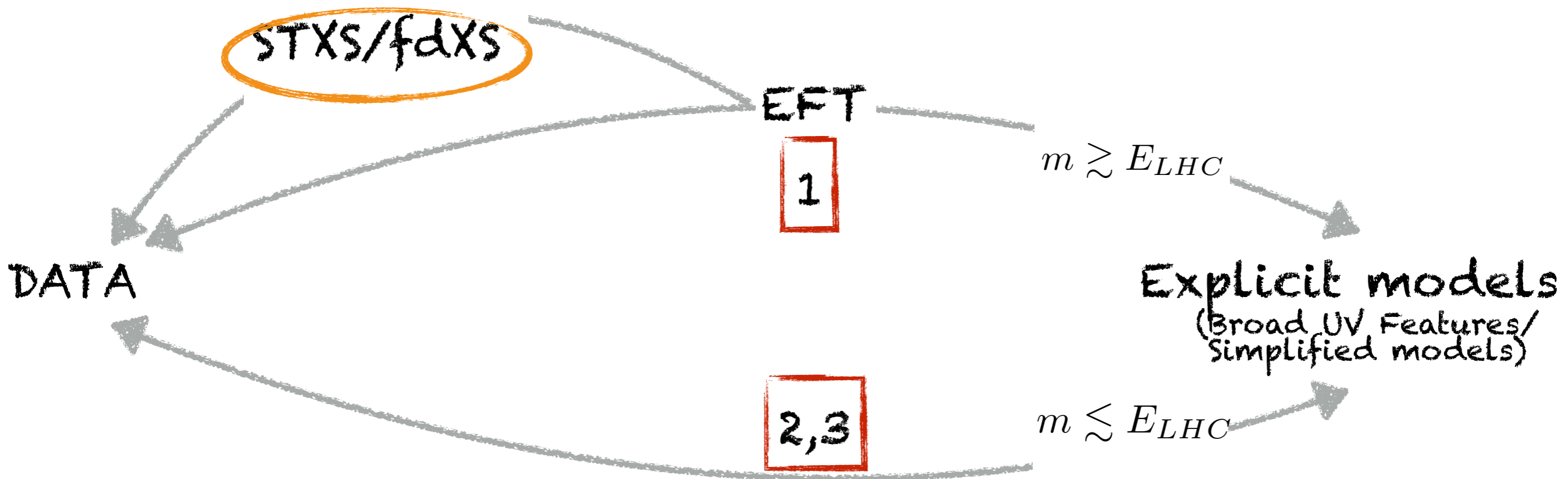
**EFT:** A way to capture the most relevant effects that survive at  $E \ll M$  and characterize **broad** hypotheses of BSM

$$\mathcal{L}_{\text{eff}} = \mathcal{L} \left( \frac{D_\mu}{M}, \frac{g_H H}{M}, \frac{g_\Psi \Psi_{L,R}}{M^{3/2}}, \frac{g_V F_{\mu\nu}}{M^2} \right) \simeq \mathcal{L}_4 + \mathcal{L}_6 + \dots$$

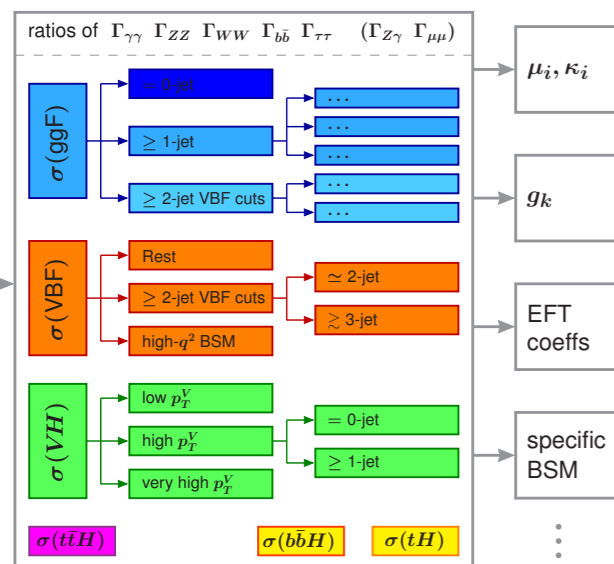
$\sum_i c_i \frac{O_i}{M^2}$

- scenarios with dim-6=0, leading by dim-8, pheno? MonteCarlo?
- Non-decoupling theories? (e.g. Luty, Galloway, Tsai, Zhao'13)
- Are all tools available for Experiments to use EFT? (e.g high-pt effects in VH or VBF?)

# In Practice



**STXS/fdXS:** exclusive bins with simple acceptance cuts divided in categories with different sensitivity to production modes (stage 1).



- Optimized for Data AND EFT (signal)?
- How much info is lost?
- Ready for, e.g., CPV effects in Higgs couplings?
- (Development towards a more concrete proposal of stage 2)



# In Practice

STXS/fdXS

EFT

$$m \gtrsim E_{LHC}$$

Explicit models  
(Broad UV Features/  
Simplified models)

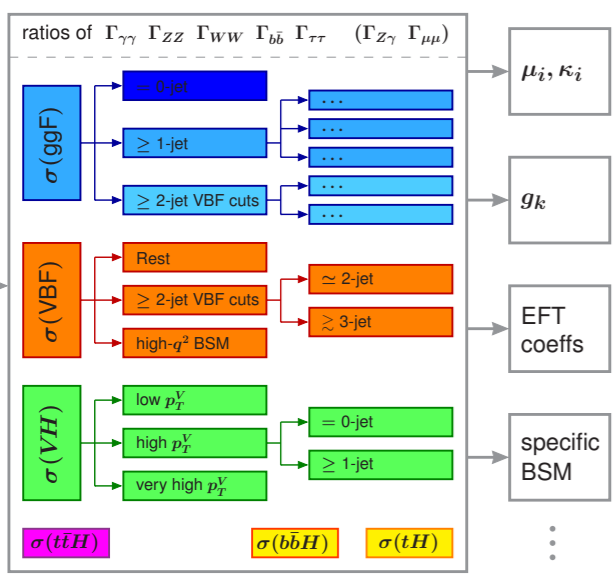
$$m \lesssim E_{LHC}$$

1

2,3

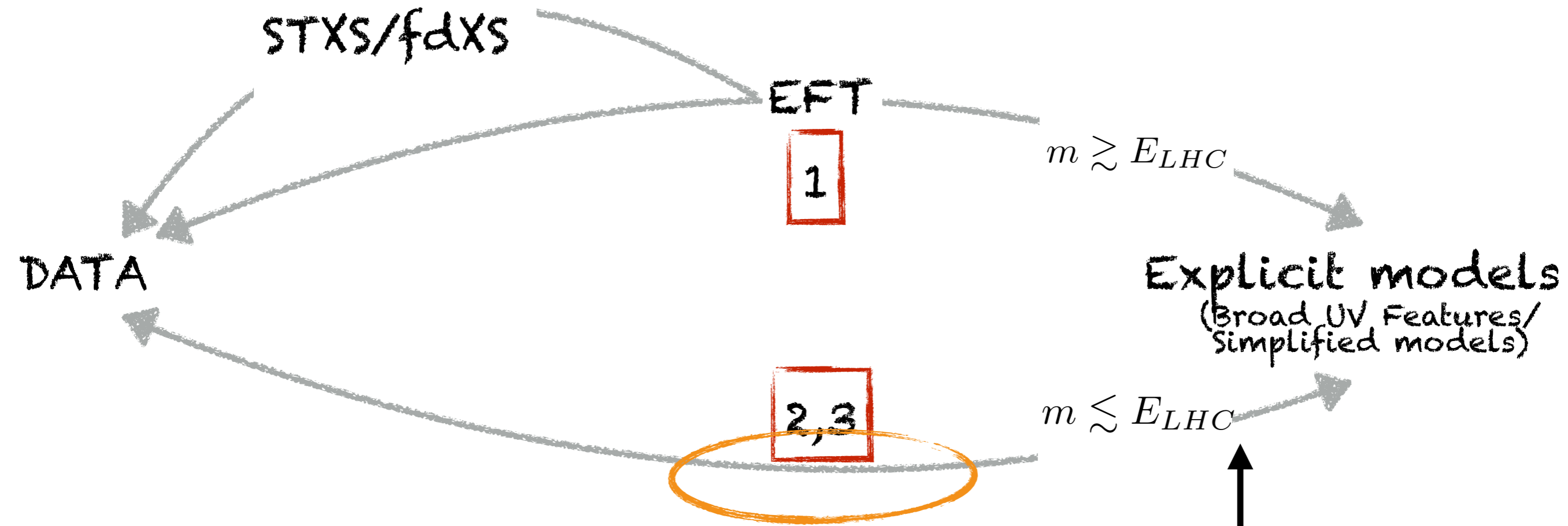
DATA

STXS/fdXS: exclusive bins with simple acceptance cuts divided in categories with different sensitivity to production modes (stage 1).



- Optimized for Data AND EFT (signal)?
- How much info is lost?
- Ready for, e.g., CPV effects in Higgs couplings?
- (Development towards a more concrete proposal of stage 2)
- scaling of EFT in each STXS bin as universal fitter?
- Comparison with direct EFT fit can show how much lost?

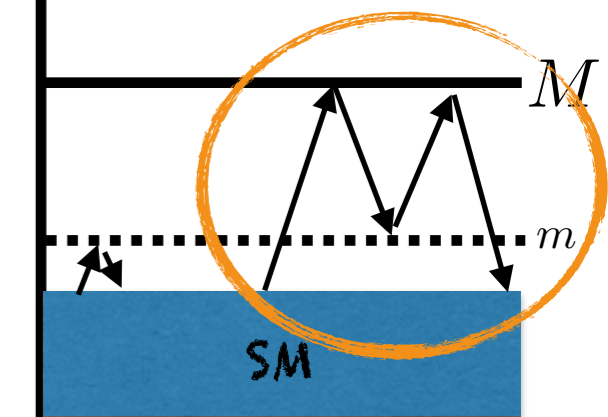
# In Practice



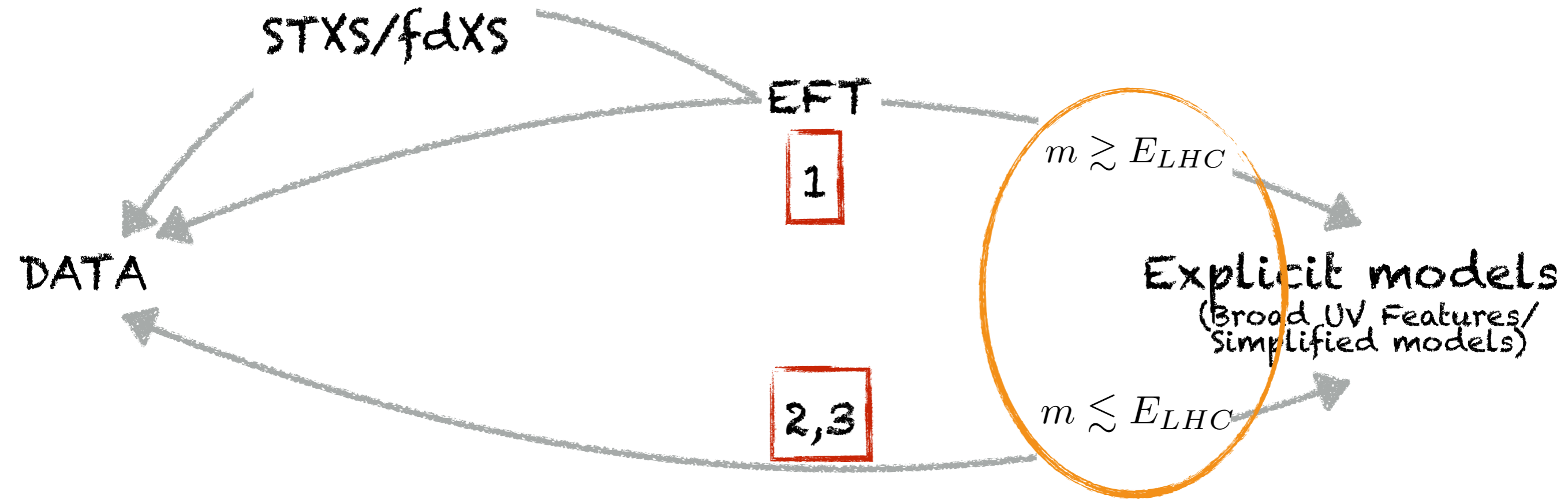
## Direct Searches/LLP:

- (simplified) modeling: heavy mediator effects?

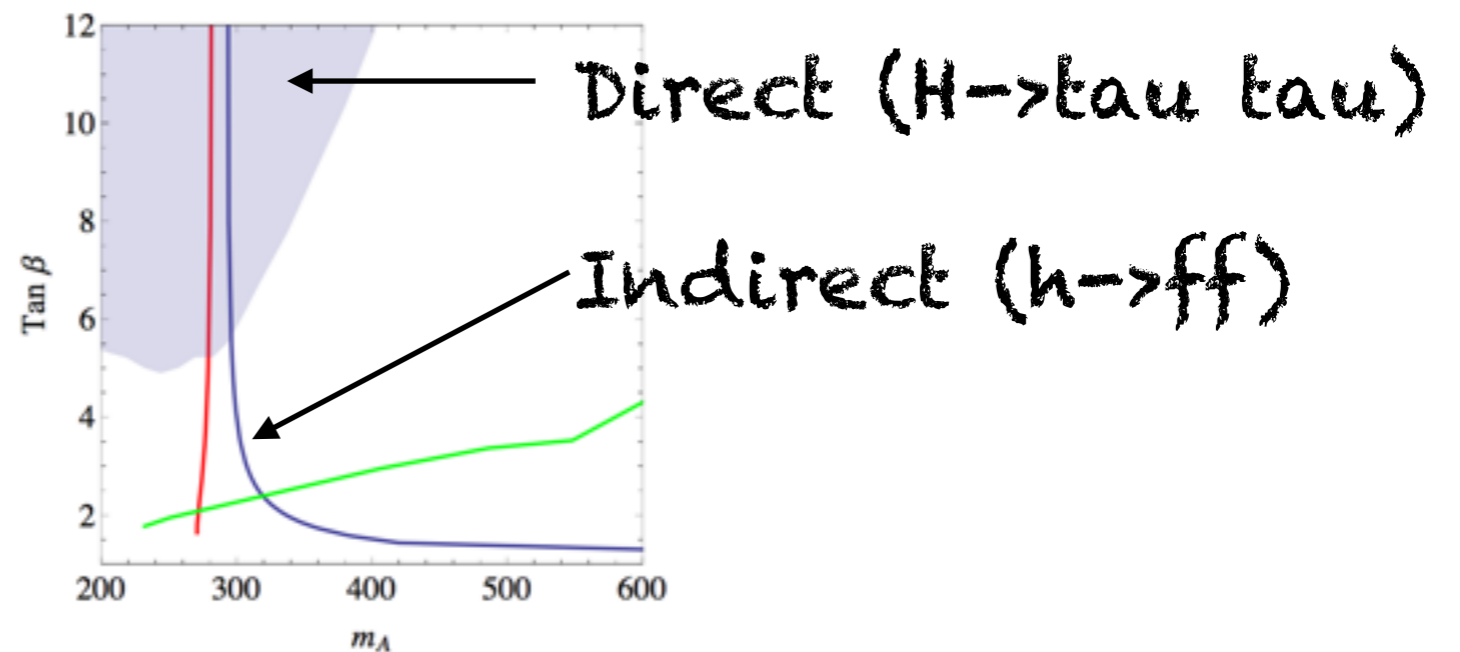
- Holes in searches? Very light scalars/others  $m \ll m_h$ ?



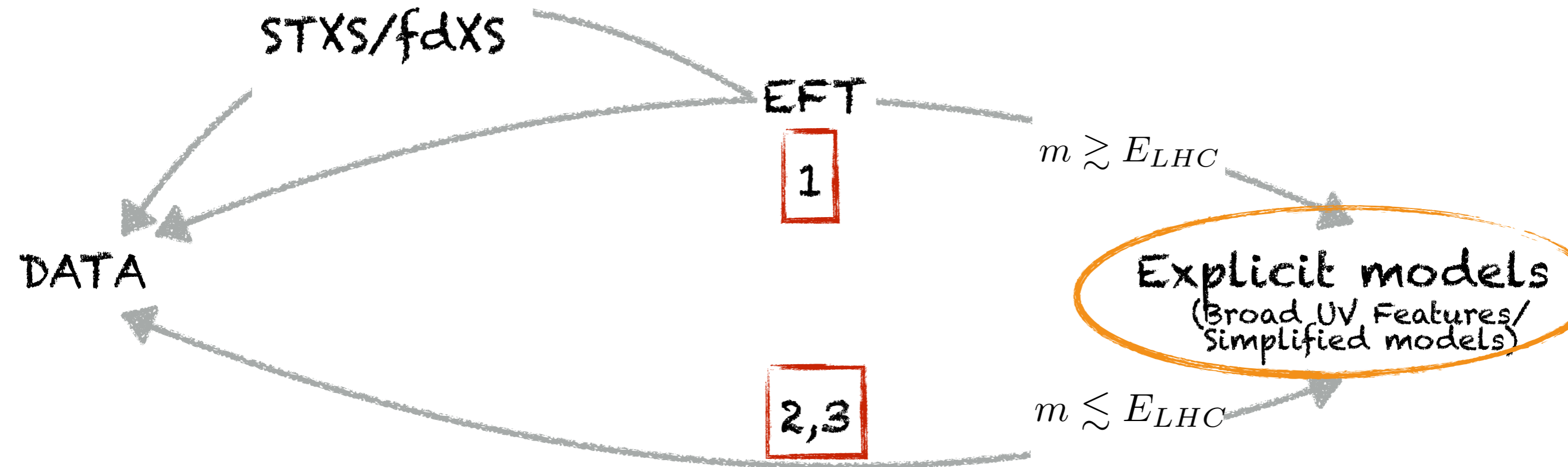
# In Practice



- Complementarity direct/indirect searches? (e.g.  $\tan\beta/m_H$  plane in 2HDMs... others?)



# In Practice



- What features of Naturalness can/must be tested? What is the status?
- New scenarios that stimulate new searches/signals?  
( $\rightarrow$ dedicated discussion "crazy" signatures)