S-channel @ 100 TeV

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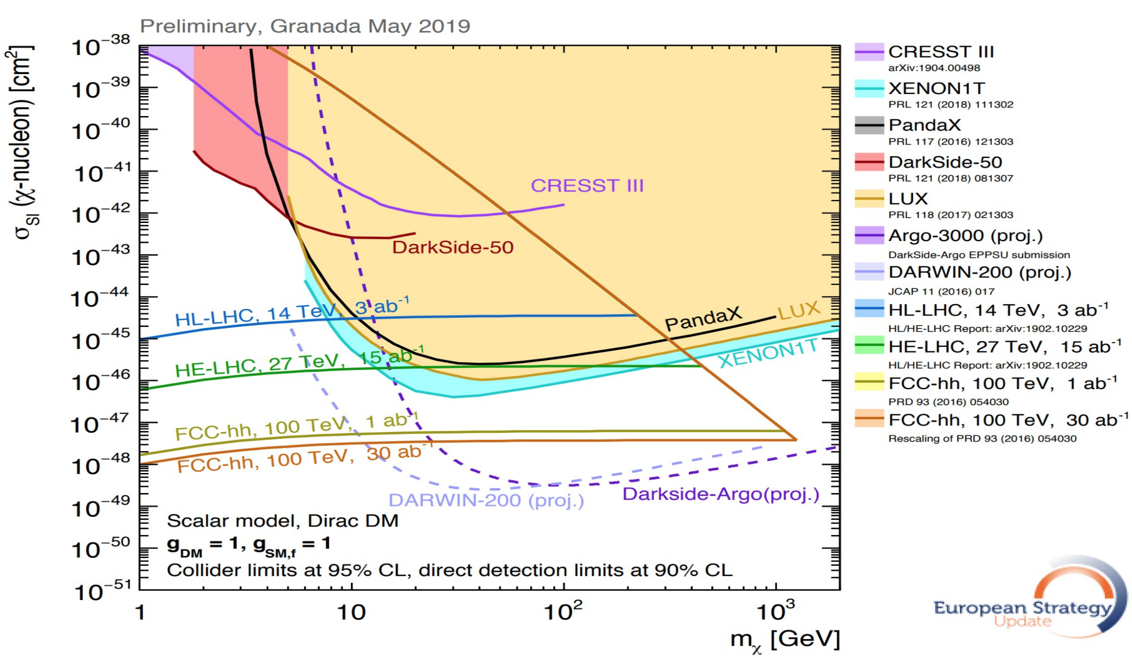
Point of this talk

- S-channel DM search discussion
  - An important consideration for future projections
  - Has been featured in various documents
  - Strategy has been to develop current analyses for :
    - 100 TeV pp collider with 30 ab-1
    - 14 TeV pp collider with 3ab-1



This talk :
Review analysis strategy

European Strategy Update

An Analysis for all ages

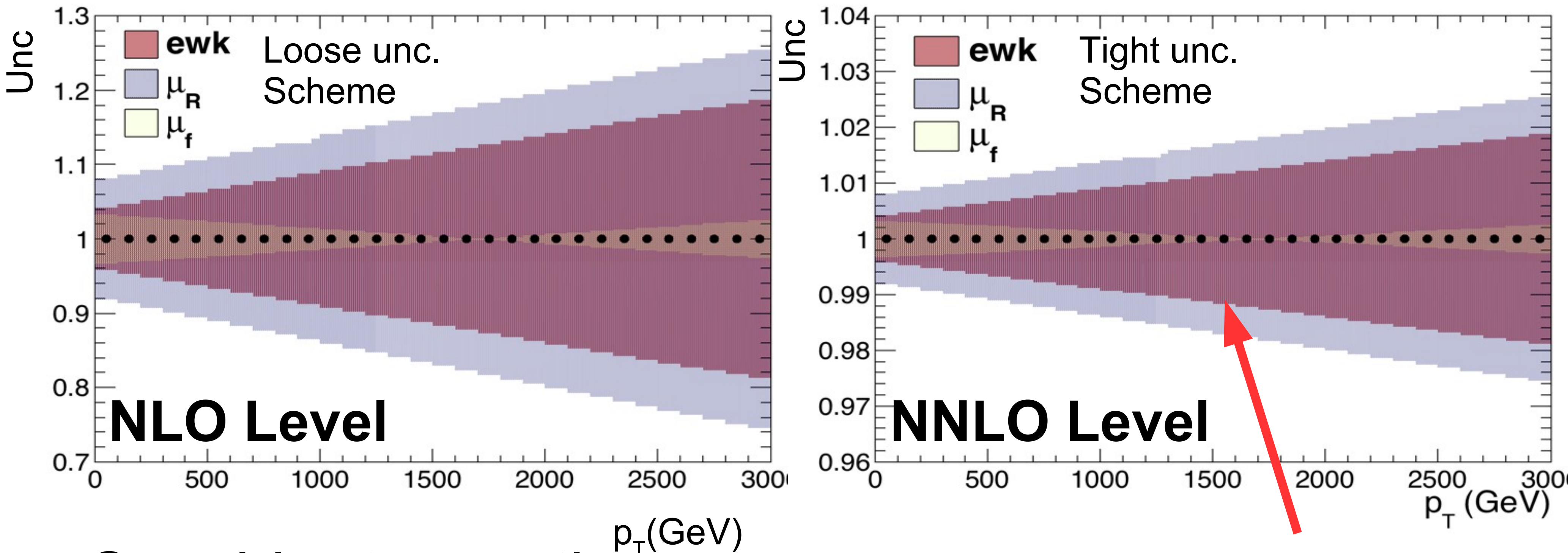
- In light of the LHC developments in monojet:
  - Big simultaneous fits
  - Improved theoretical constraints on EWK-corr
  - Fundamentally approach scales well with lumi
  - Goal should be to take advantage of this approach
- However 1st s-channel studies were done before
  - Studies were done before LHCDMWG recommends
  - Room for improvement
- Good news: mostly redone in Higgs to invisible

Experimental Approach in H→Inv

- Use full simultaneous fit approach
- Delphes for simulation
  - In s-channel studies used toy smearing
- Weighted MC generation (makes things fast)
  - This was not done s-channel studies
- Same experimental setup otherwise as s-channel
  - Define control regions with leptons out to $|\eta| < 4.0$
  - Apply vetos based on this detector range
  - Approximate same lepton veto rates as LHC
    - Following CMS numbers (ATLAS is similar)
  - Skipped QCD background (its small in the end)

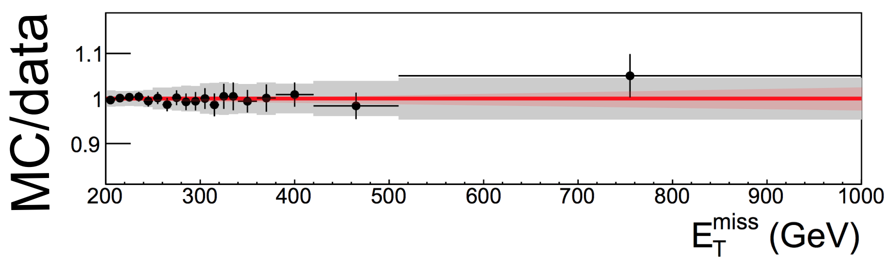
Uncertainties

- What are reasonable uncertainty choices

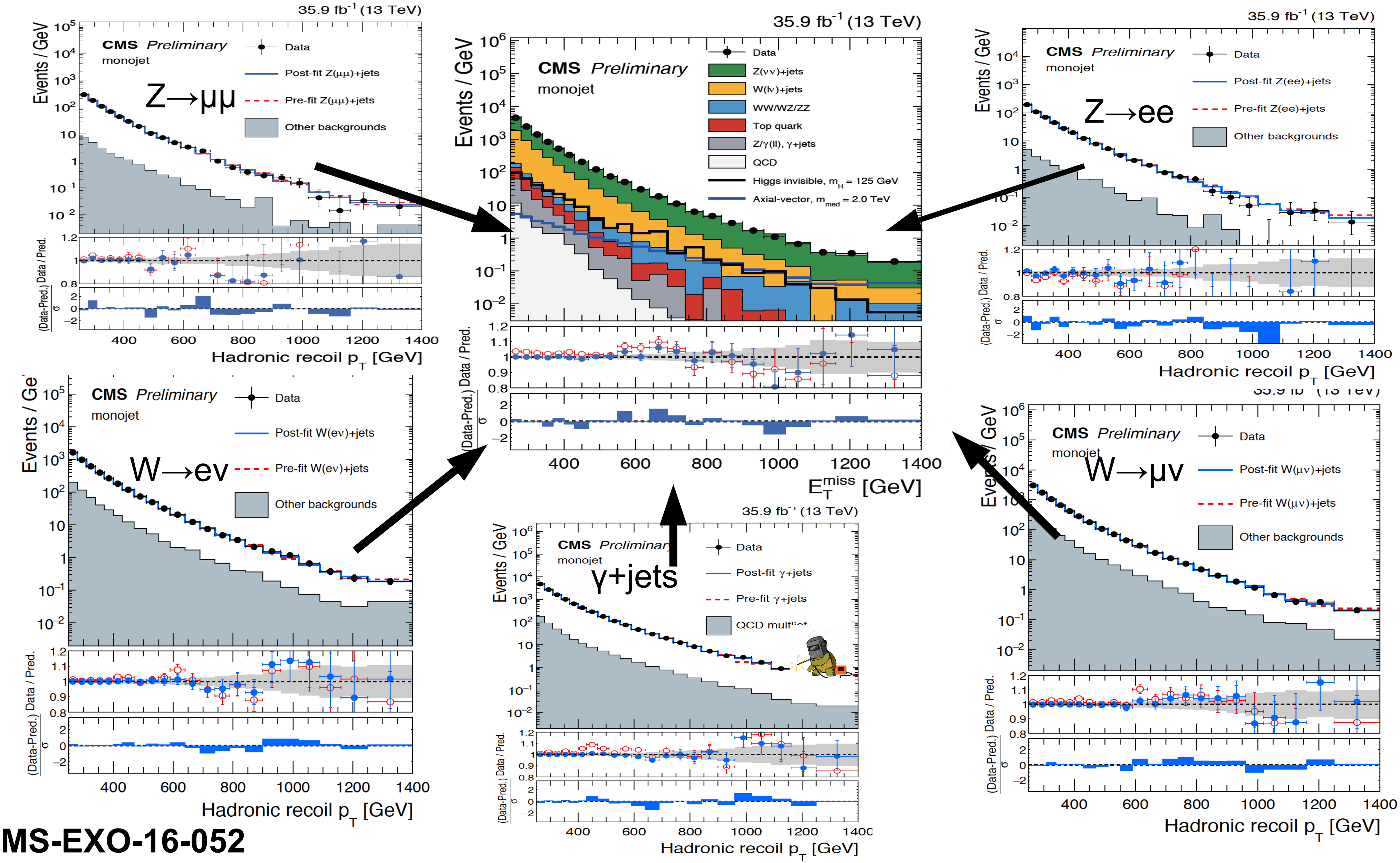


definitively there

- Consider two options :
  - A Loose uncertainty →Comparable to NLO
  - A Tight uncertainty →Comparable to NNLO
- Using : 0.5%/0.25%/5% e/μ/τ efficiency & 1% lumi



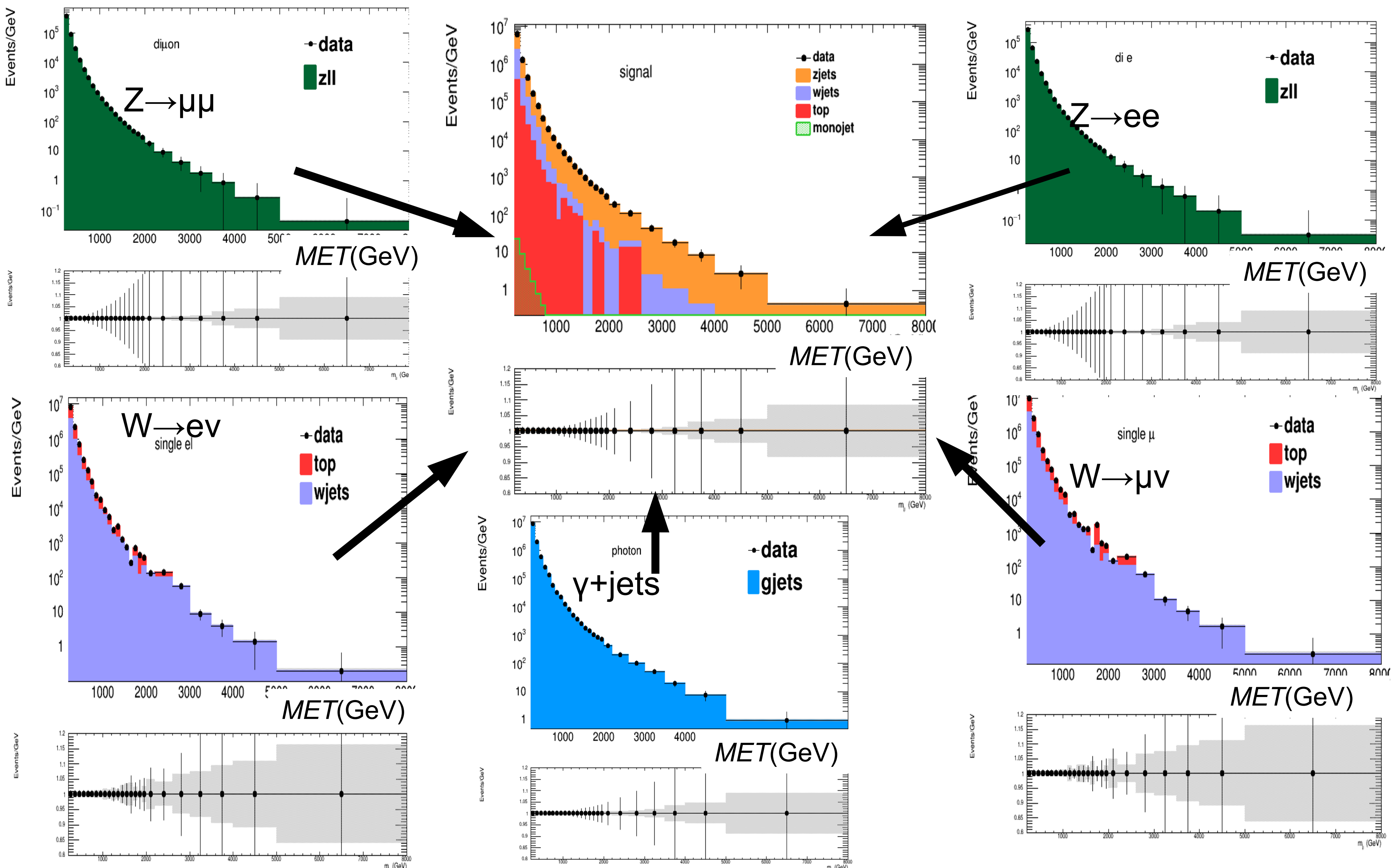
5 Control regions
15% uncertainty @ 1 TeV



CMS-EXO-16-052

Monojet analysis @ CMS

The same fitting scheme applies to 100 TeV (fits $1ab^{-1}$)



Monojet analysis @ CMS

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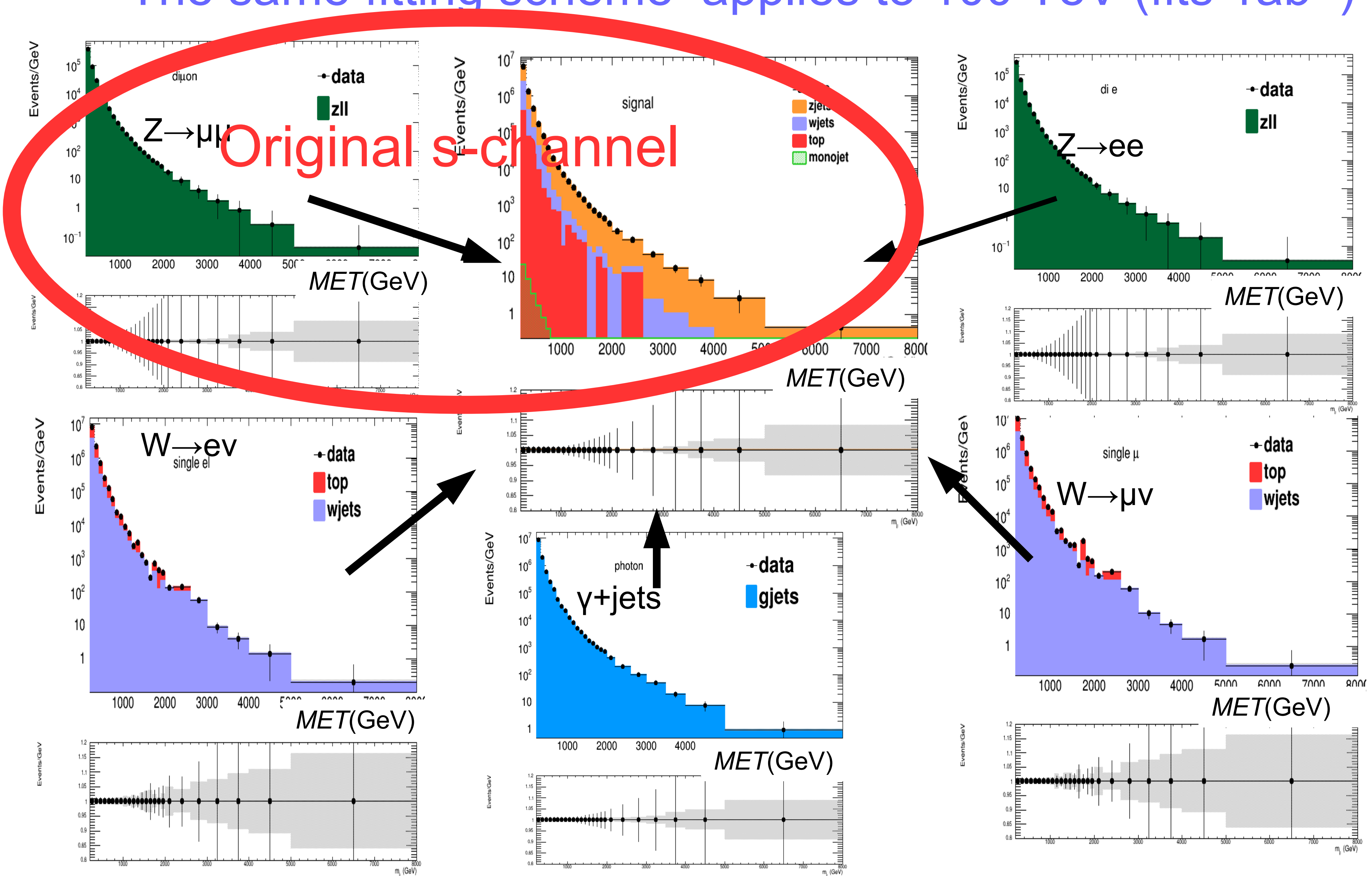
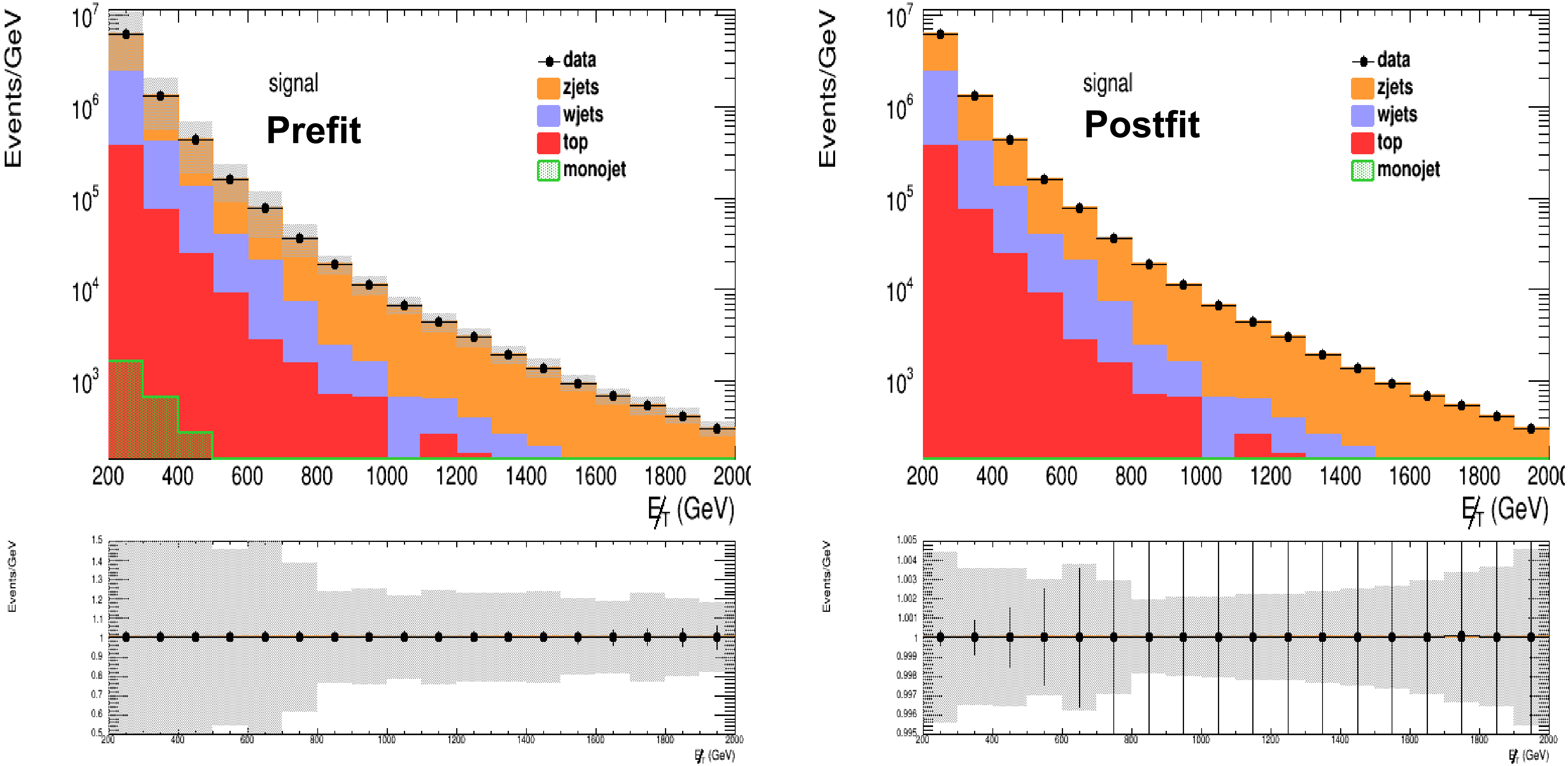


What is the precision?

- Can probe a few % effects (NNLO precision)

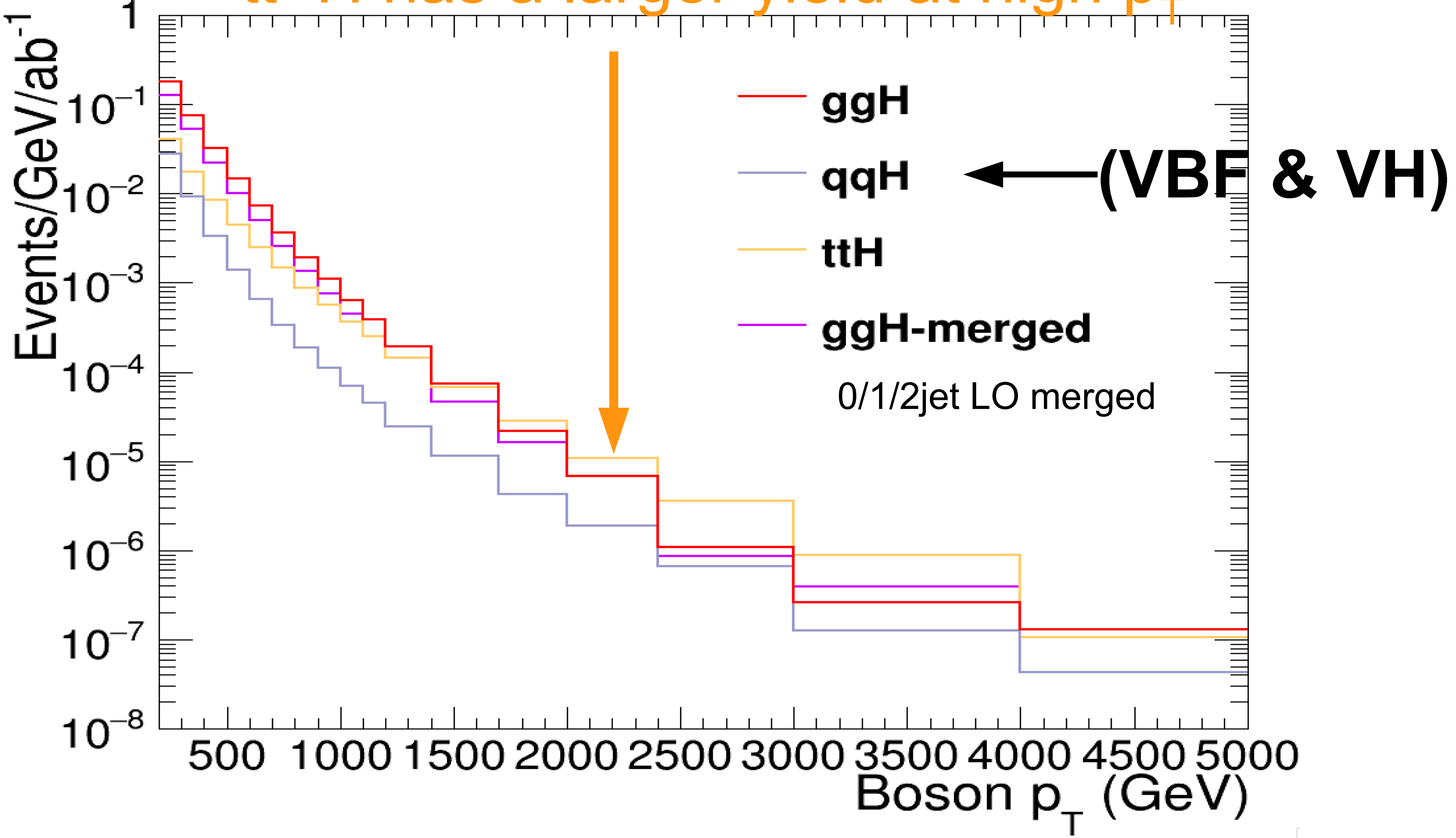


Through this scheme we can probe boson pT to 10^{-4} level

Higgs Invisible search

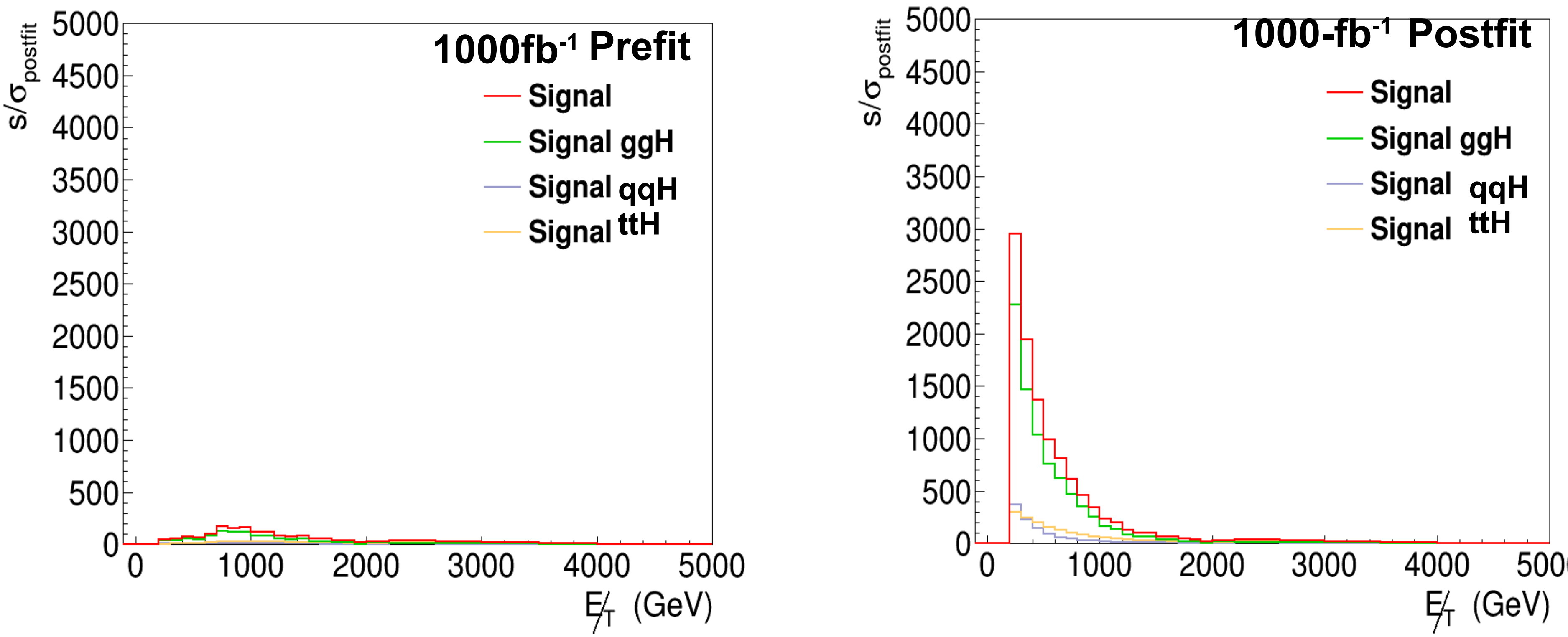
- A key feature at high p_T

tt+H has a larger yield at high p_T



At 100 TeV ttH is more important, ggH still leads

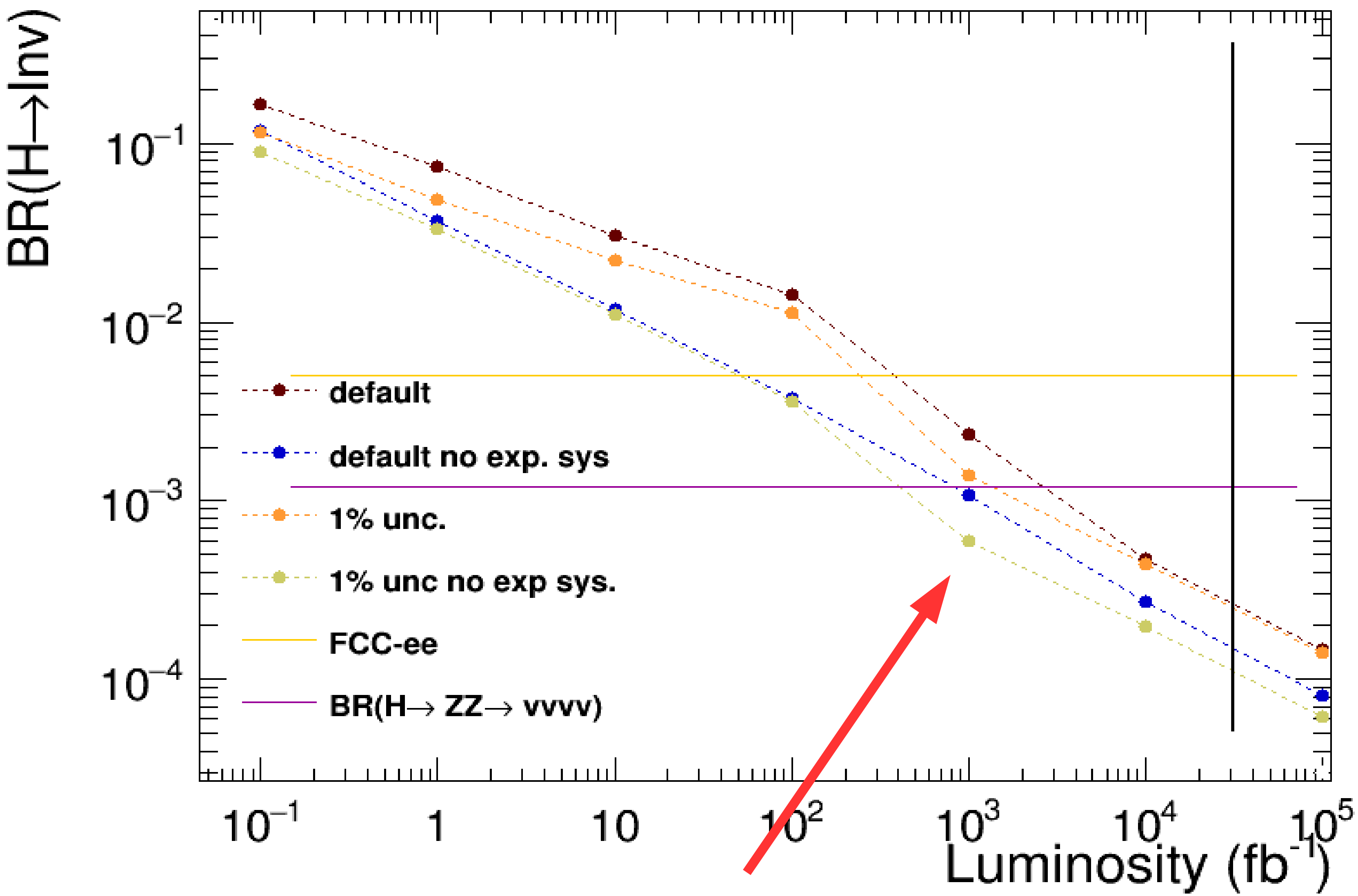
Understanding sensitivity



In both cases monojet dominates tt+H signal for sensitivity
Transition to ttH happens at 1-2 TeV (note no top selection)

Postfit brings an improvement in sensitivity
Especially at low *MET* : still critical for search

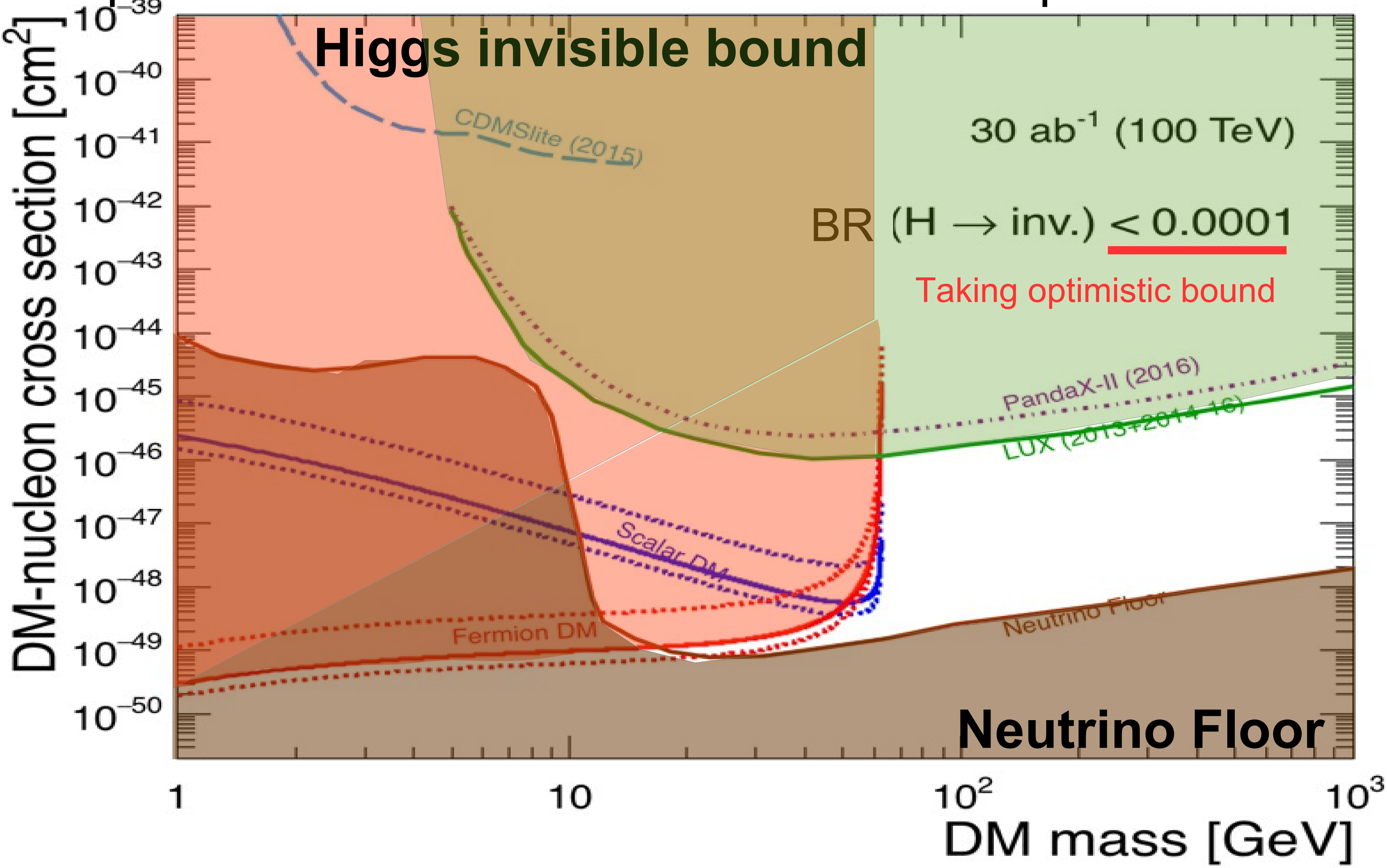
How do things scale?



There is no systematics wall

Future Bounds

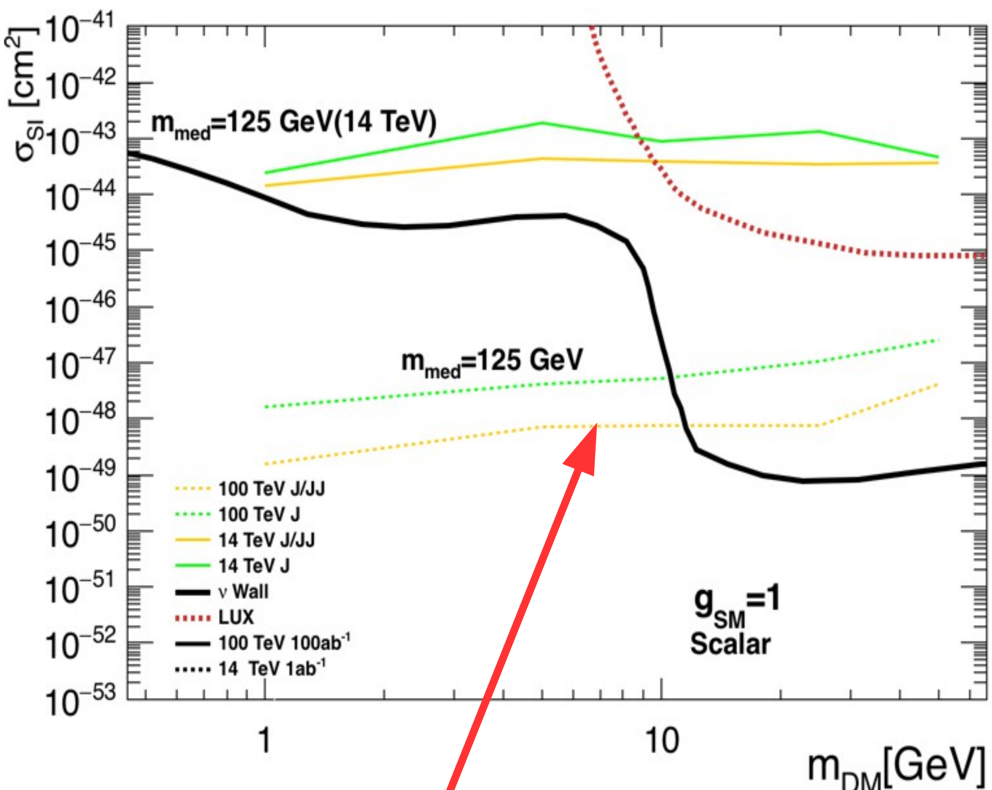
Competitive with the best direct detection experiments

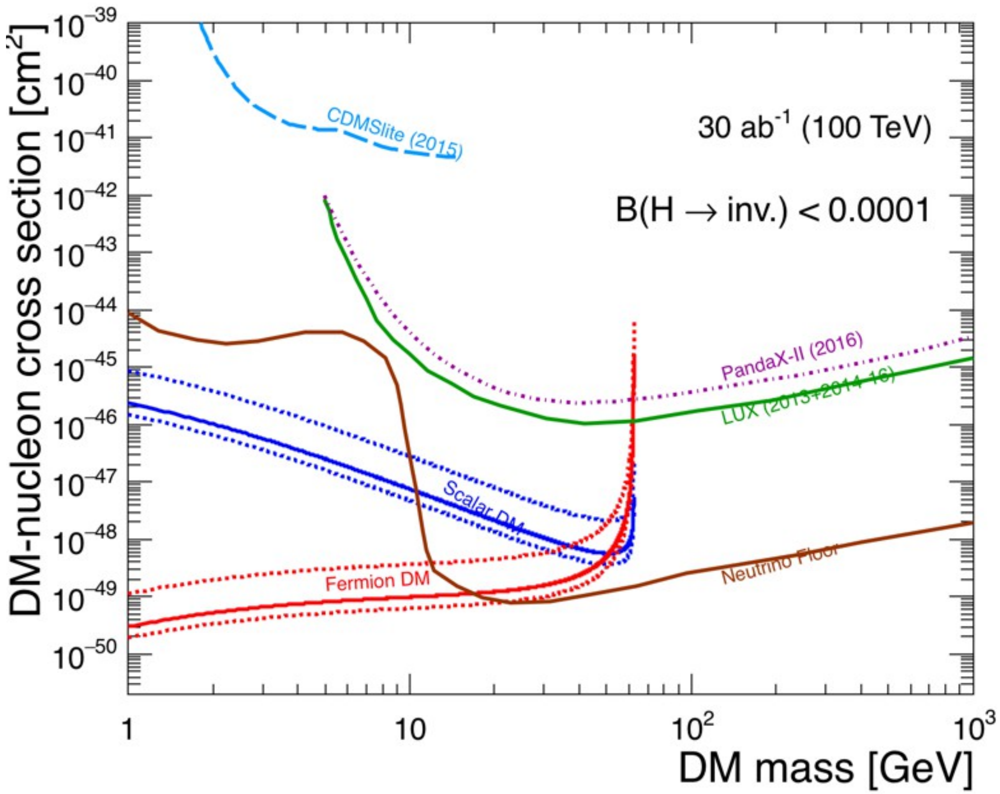


Higgs invisible of 10^{-4} corresponds to g_{SM} from 10^{-3} to 10^{-2}

Back to s-channel

- Original studies used a worse uncertainty scheme
  - Fit strategy and setup was not as sophisticaed
  - Updating with the full procedure is a good idea



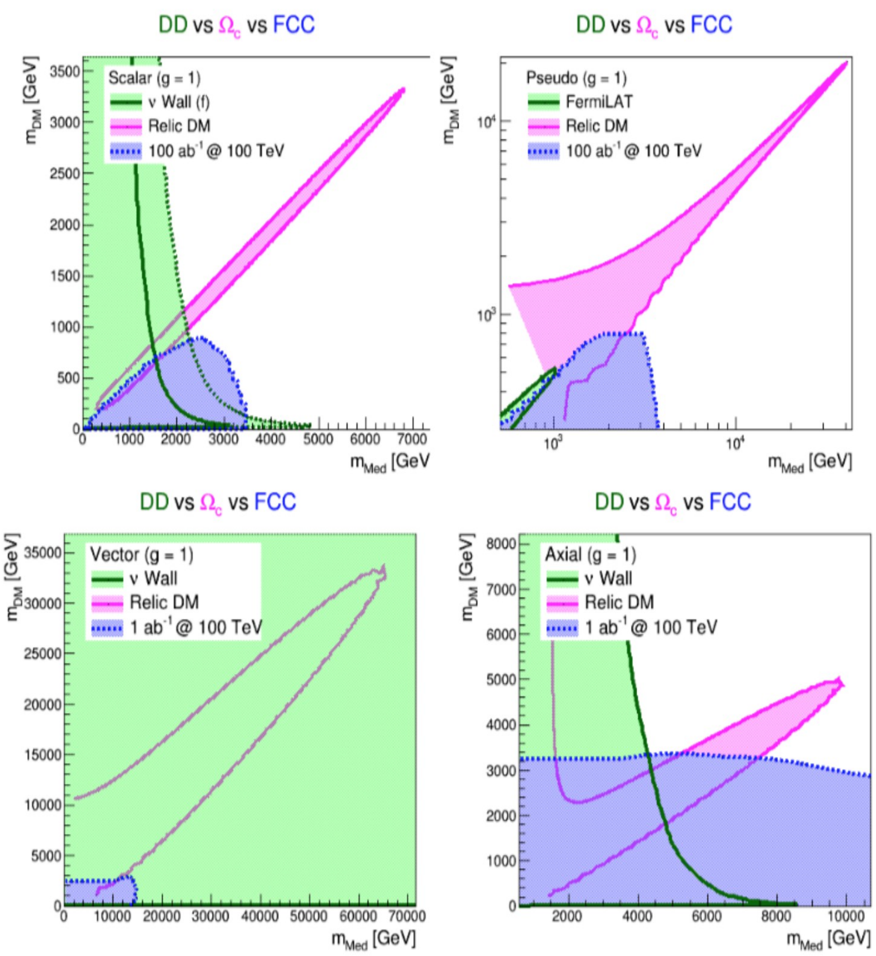


Original studies are worse

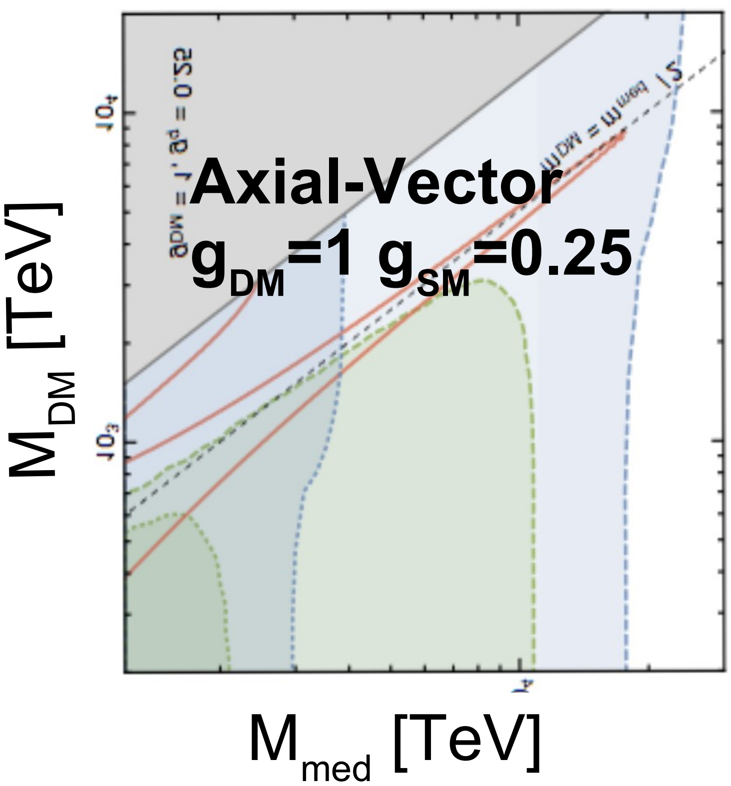
Back to s-channel

- Note the original Spin-1 used wrong coupling
  - Other groups have done this with DMWG recommends

High mass bounds: have a good feel for the range of performance

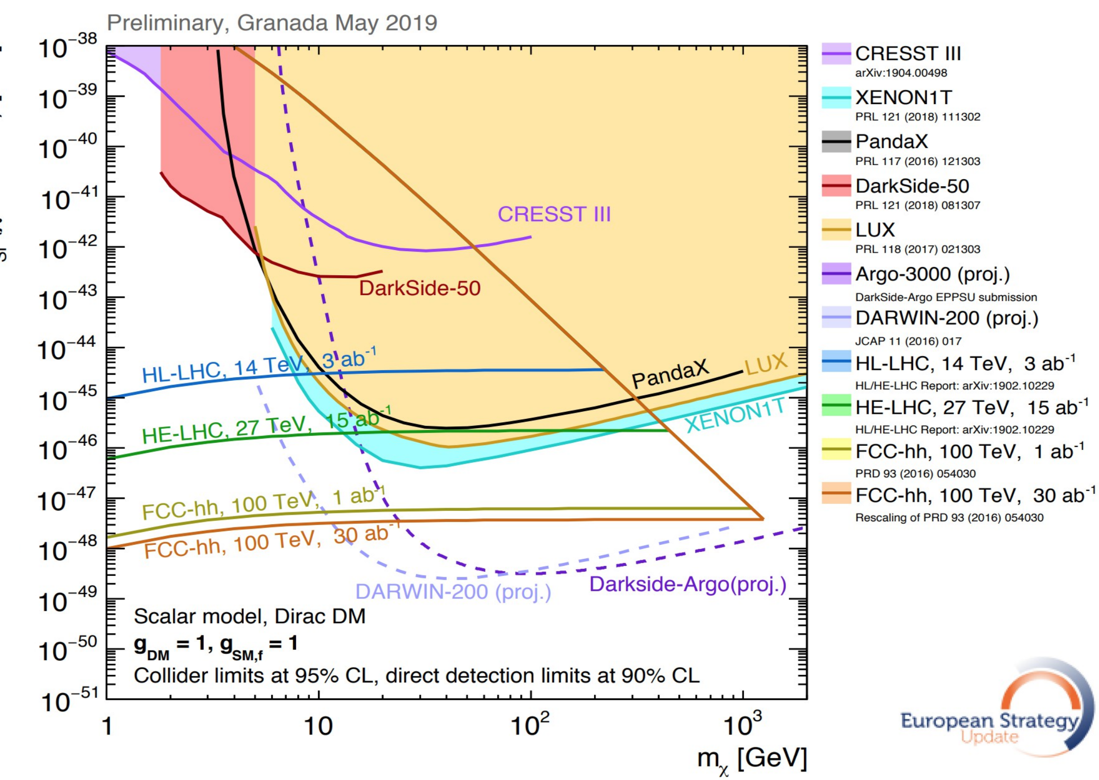


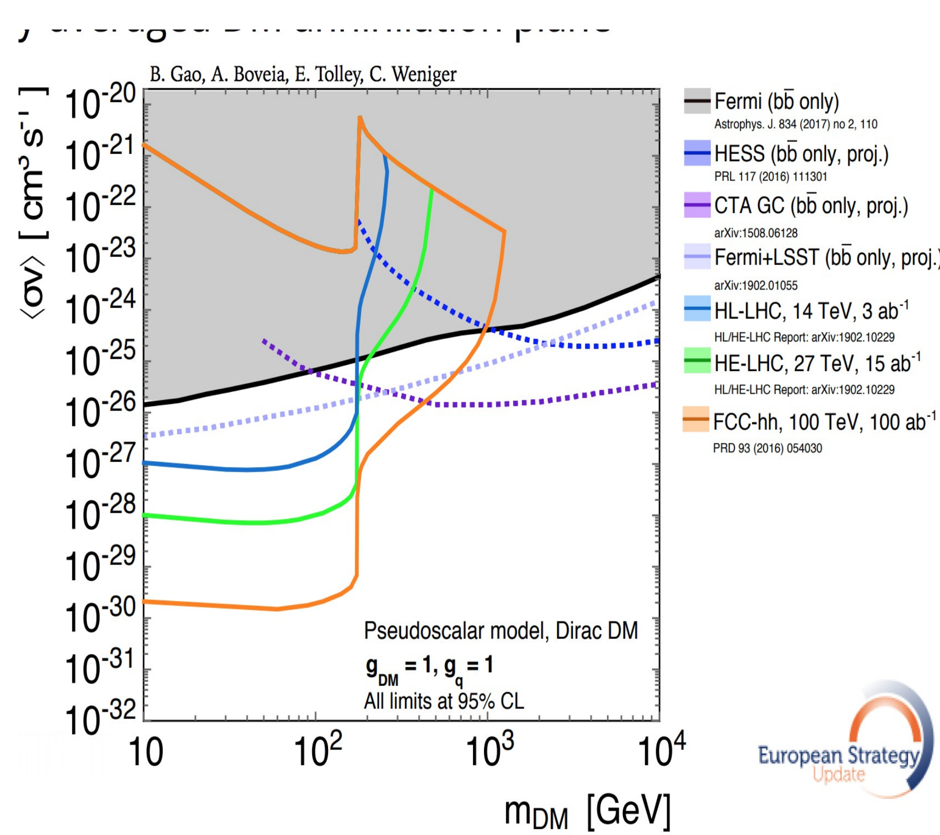
https://arxiv.org/pdf/1503.05916.pdf



Updated Now

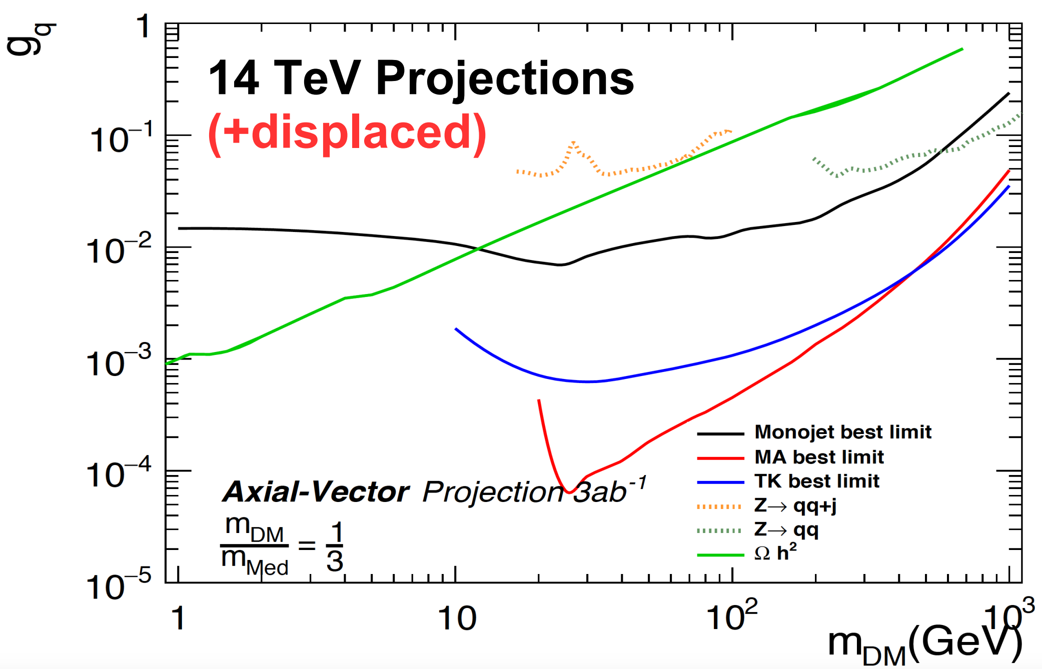
- Thanks to Caterina and Co for updated plots
  - Original ones used non-standard scheme
  - More on these plots in Antonio's talk

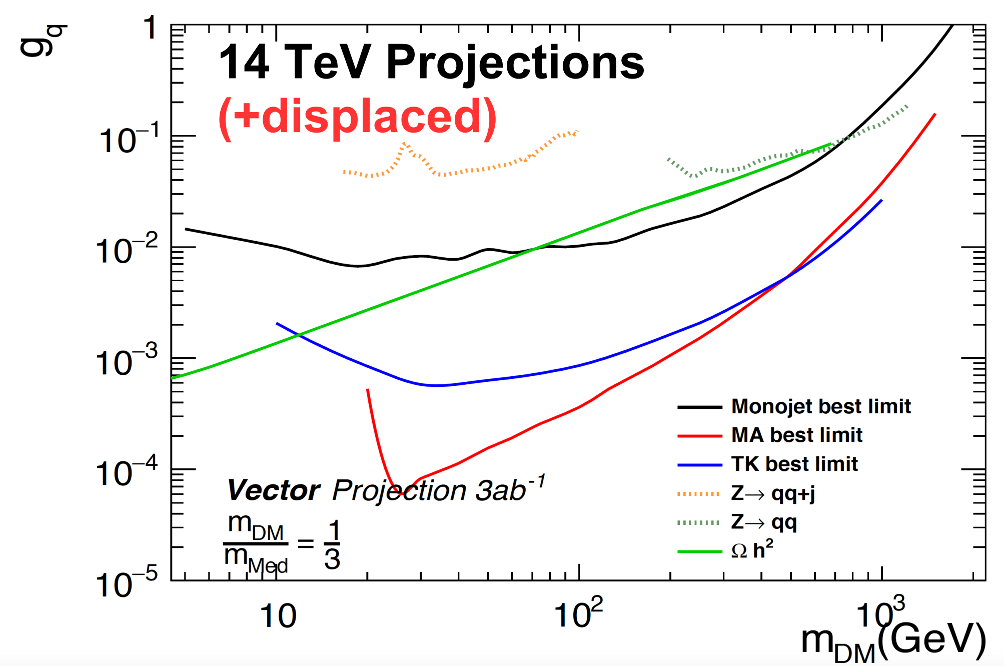




Going Forward

- Original study focused on mass reach
  - Coupling reach (like H→Invisible) more interesting now
- Still have Delphes samples and fit framwork
  - Can extend this to broad range of models
  - Would be happy to involve/pass on to others





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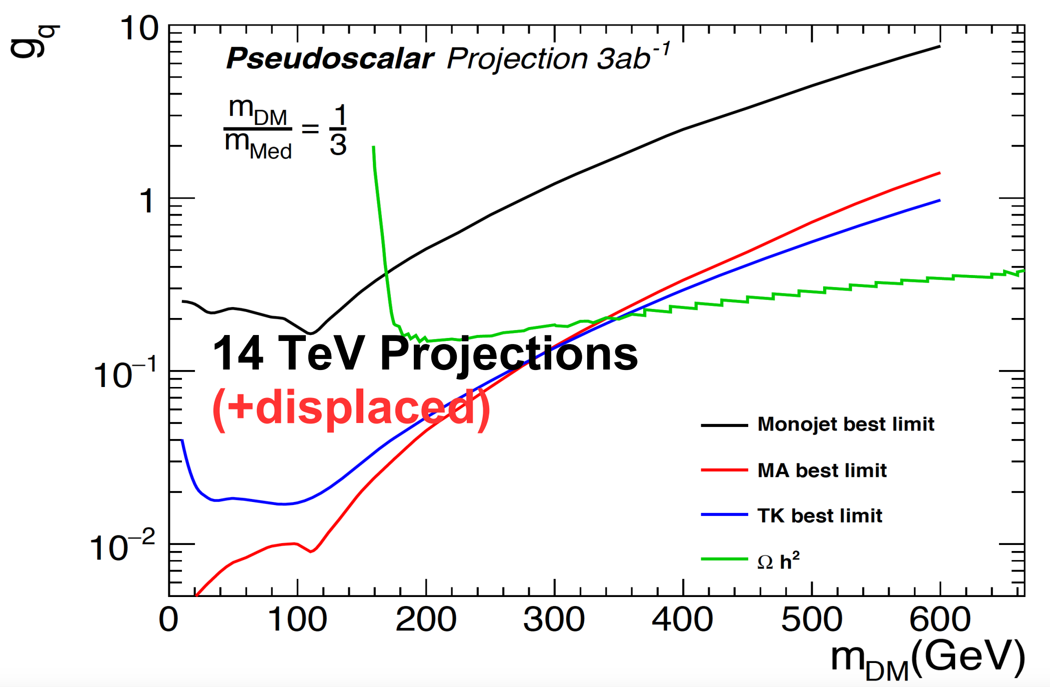

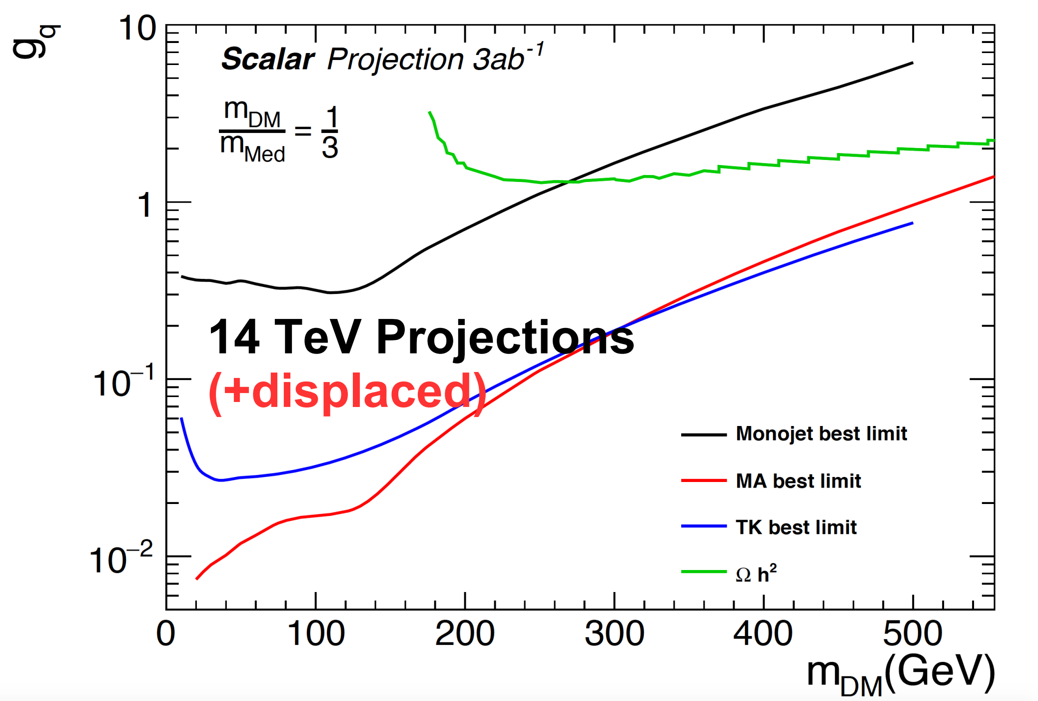

Conclusion

- Some old studies on 100 TeV
  - There were some limitations
  - There has been active work since then
    - Has not been extended to s-channel
    - But it could be good

- We should think about how we want to present?
  - Can we focus more on coupling and low masses?
  - Are there other regions critical to the cosmic frontier