Data re-interpretation tools

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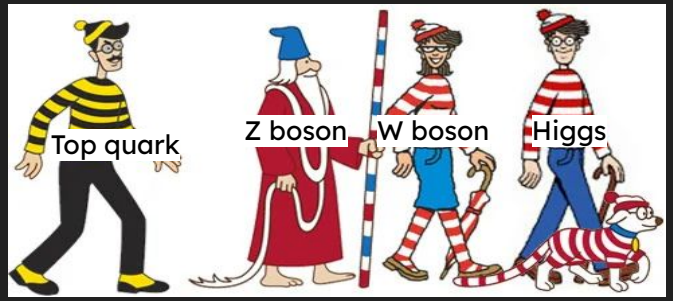
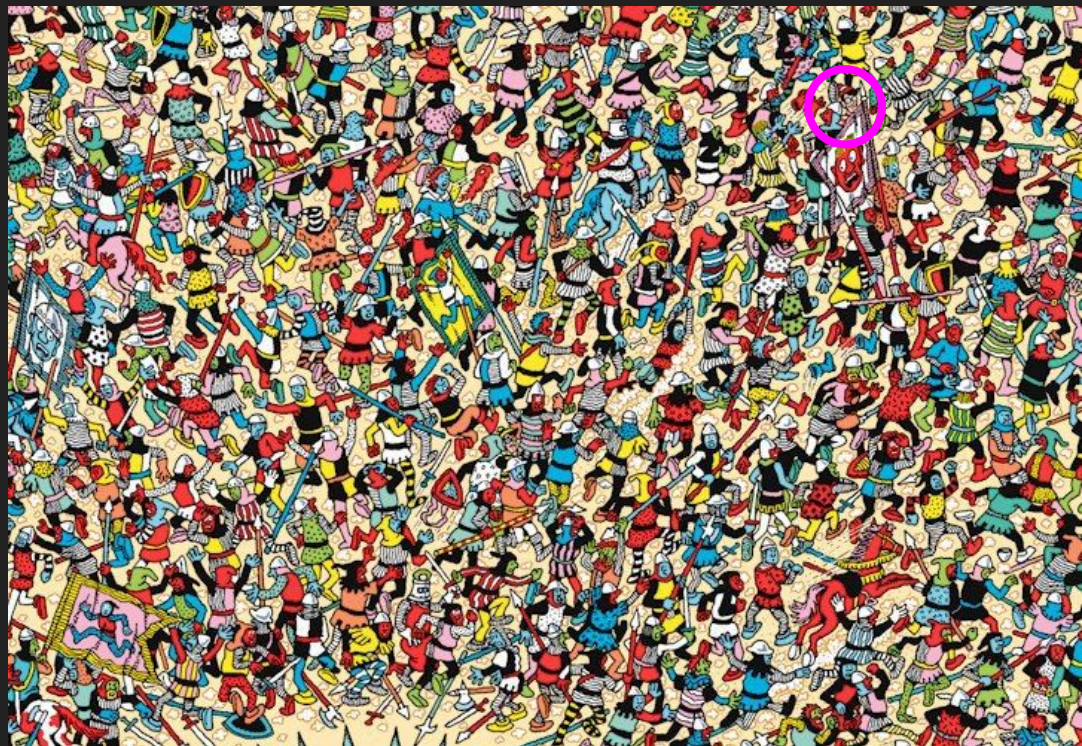
The “top down” Theory Approach



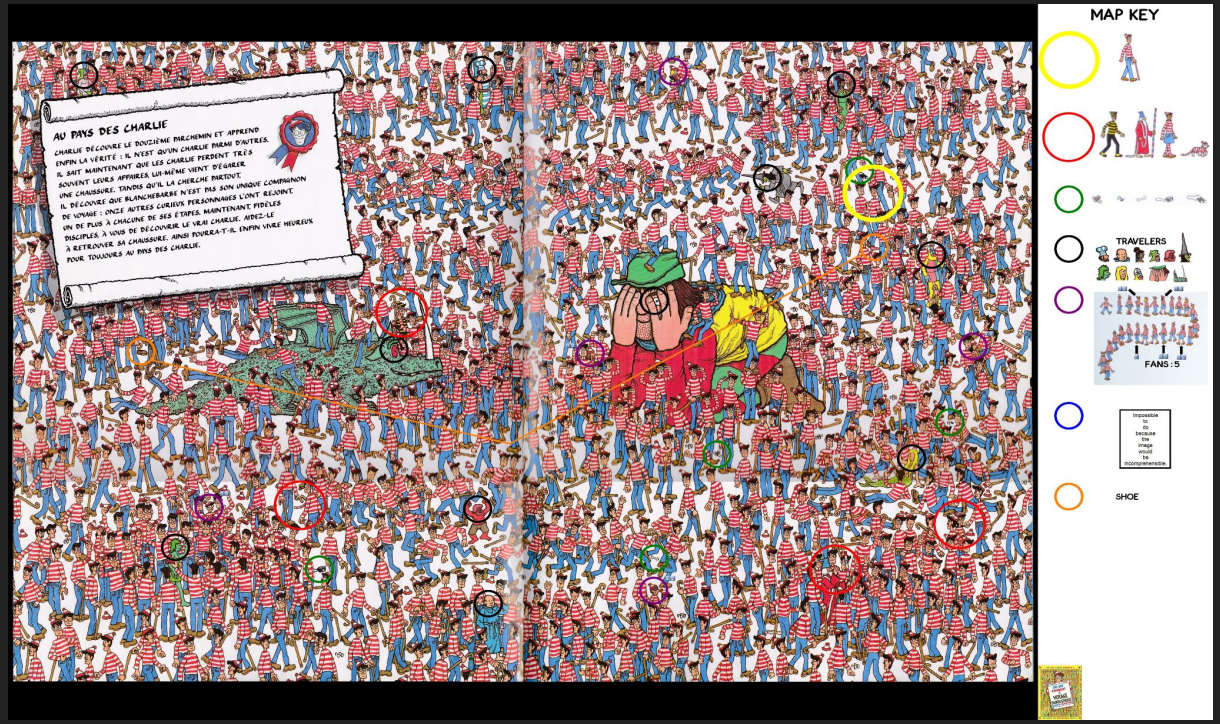
For the past +/- 50 years, particle physics has had a theoretical roadmap

- => we could design designated searches
- => a little bit of collider data went a long way :)

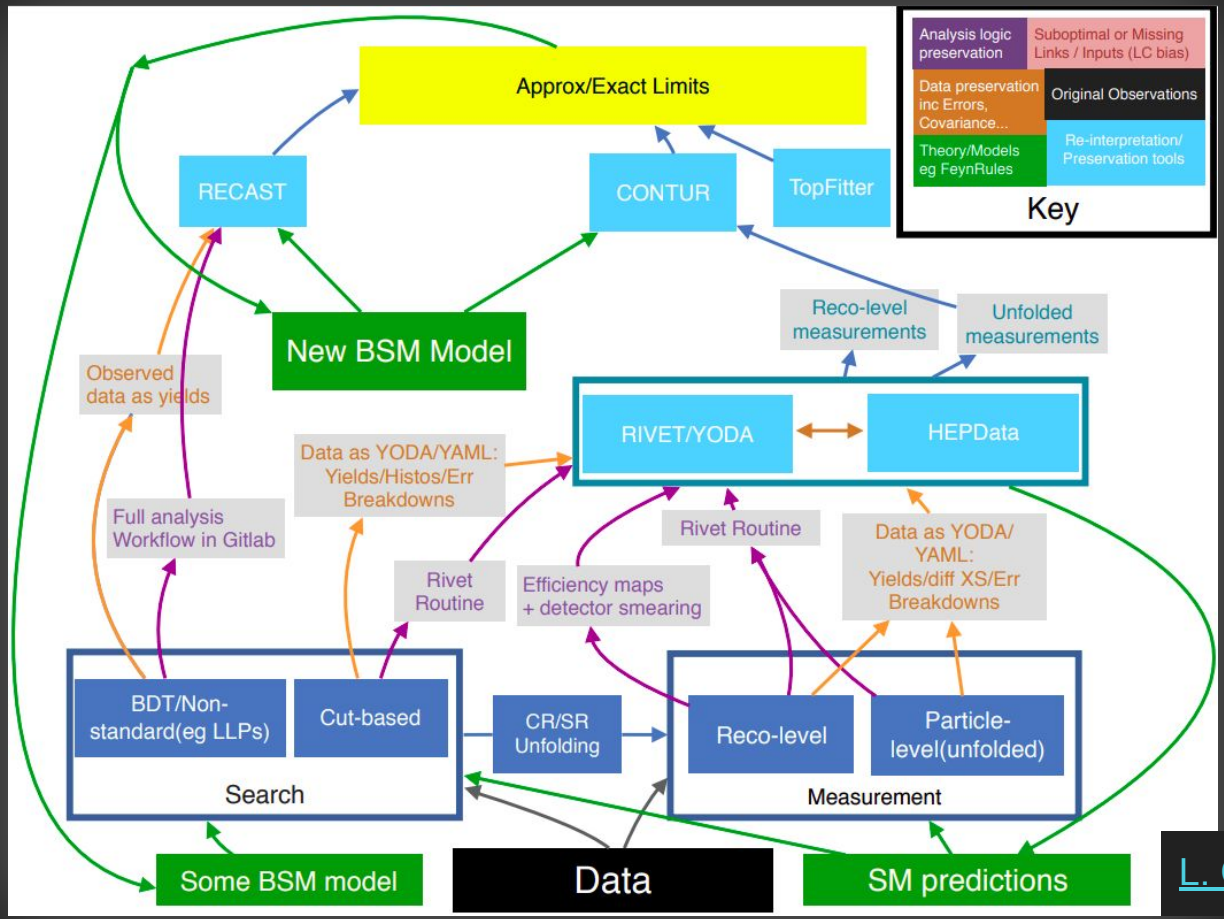


The “bottom up” Data Driven Approach

- No longer a preeminent theory guiding the field
  - Forced to transition to a new data driven era ?
  - But now …
    - More data which brings its own challenges [see Caterina’s talk]
    - => Need to make the most of the “person power” that goes into performing measurements + searches

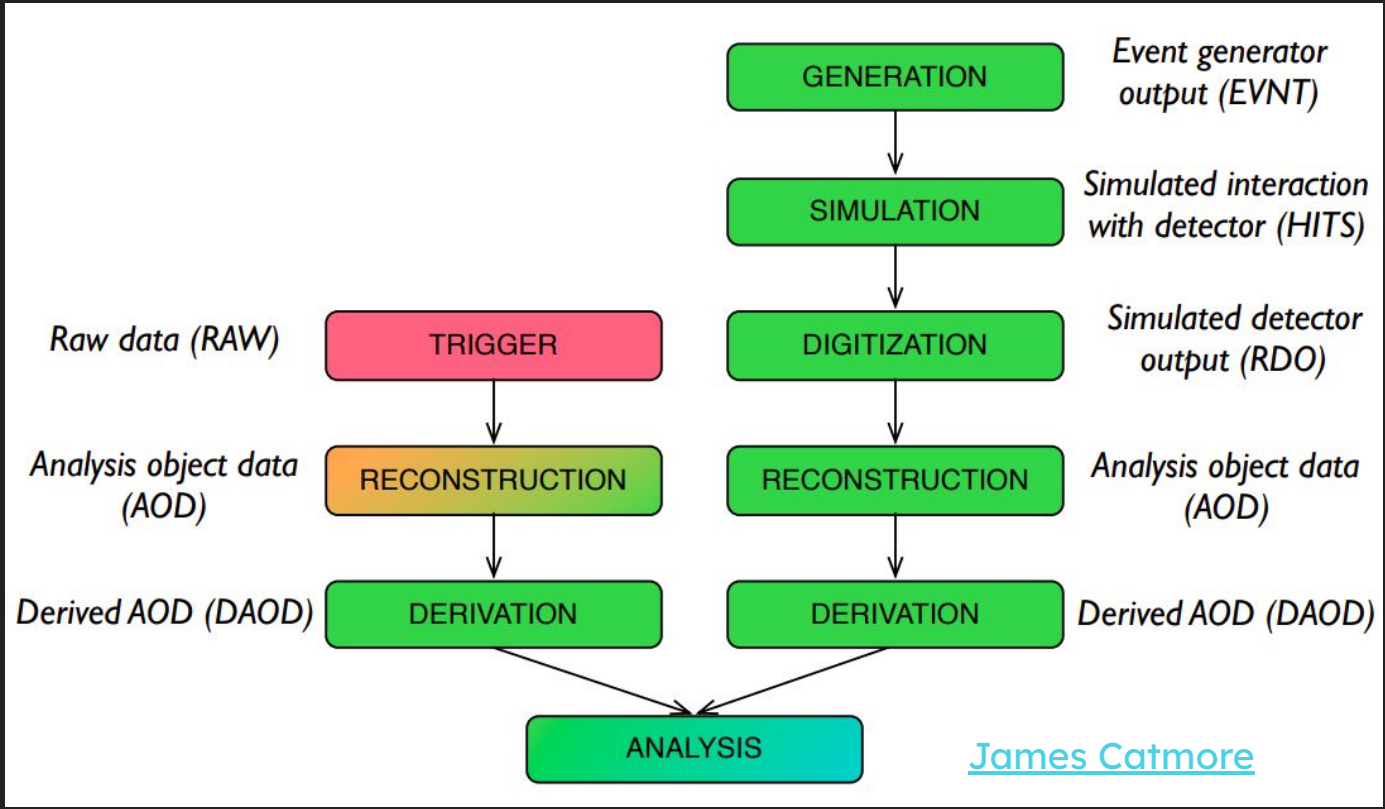


Current data re-interpretation landscape



L. Corpe (UCL)

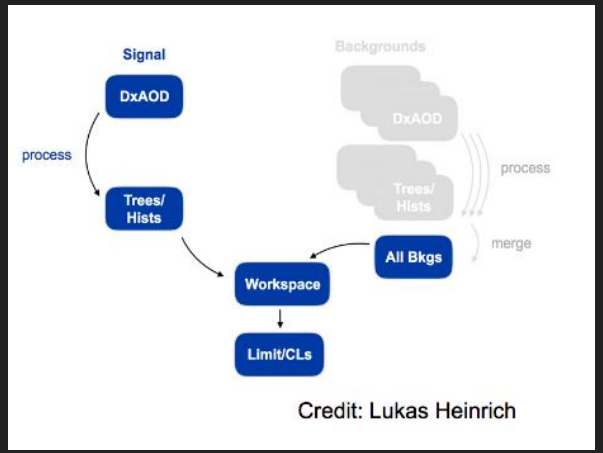
ATLAS Data Processing Chain

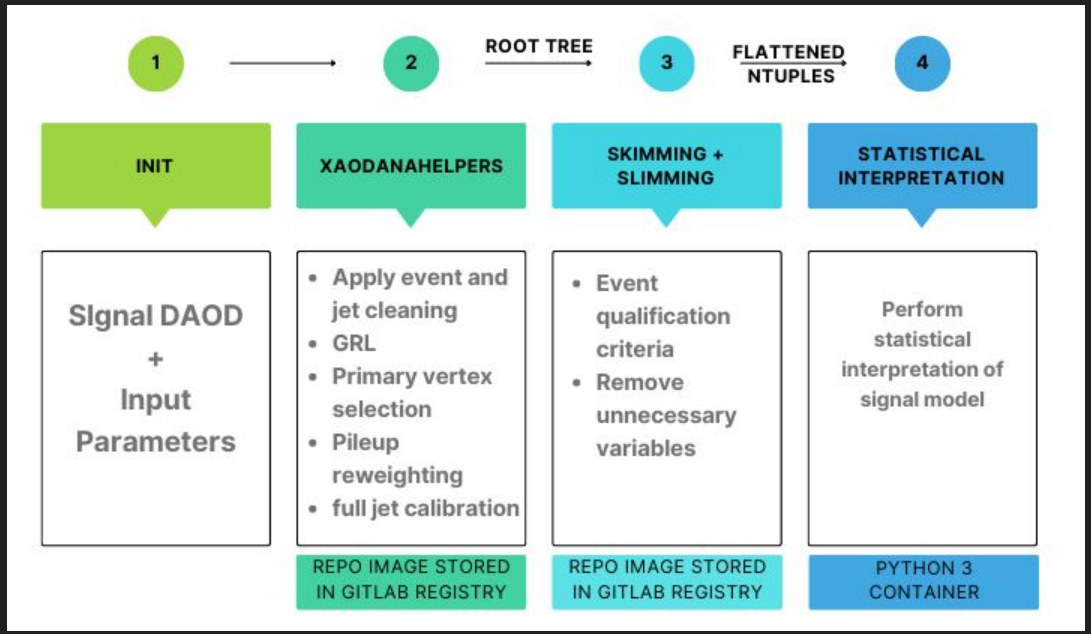


RECAST (Request Efficiency Computation for Alternative Signal Theories)

arXiv:1010.2506

Analysis code preserved for new theories manifesting in similar phase spaces to originally probed signal model





RECAST (Request Efficiency Computation for Alternative Signal Theories)

arXiv:1010.2506

- Internal to ATLAS
- Some publications have resulted from reinterpretation with the tool
  - Run 1 (pMSSM-19 Paper, DM pMSSM-5 EWKH, Gauge Mediated Models)
  - Run 2 (RPV-RPV, Exotics DM Summary)
- ATLAS requires analysis RECAST for publications in Exotics, Higgs and Diboson Searches and SUSY
- RECAST Software is open source

BUT …

- Is this process accessible to theorists?
  - Many other tools: MadAnalysis, CheckMATE, SModelS…
    - LHC reinterpretation forum exists
- Full detection simulations = very computationally heavy

Enter the MCnet-ti-verse

- Rivet : Robust Independent Validation of Experiment and Theory
  - repository for analysis code
  - tools to construct physics objects from MC final state particles, using robust and standard definitions
  - direct comparisons with (unfolded) published data.
- Contur: Constraints On New Theories Using Rivet
  - Rapidly exclude BSM models based on existing measurements stored in Rivet

CONTUR - Constraints on new Theories using RIVET

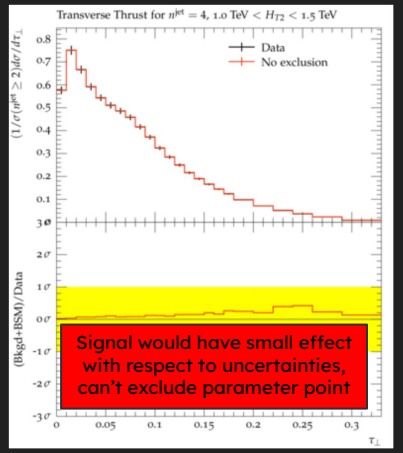
CONTUR webpage
arXiv:2102.04377
arXiv:1606.05296

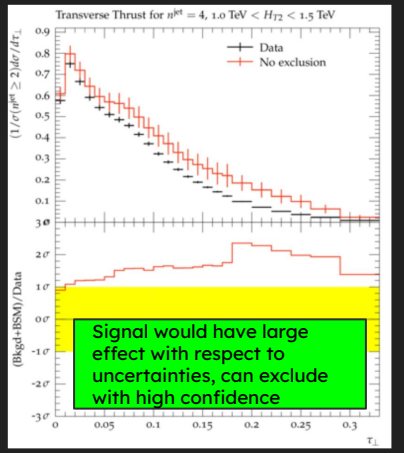
Useful to identify the model parameter space that is not viable from existing unfolded measurements

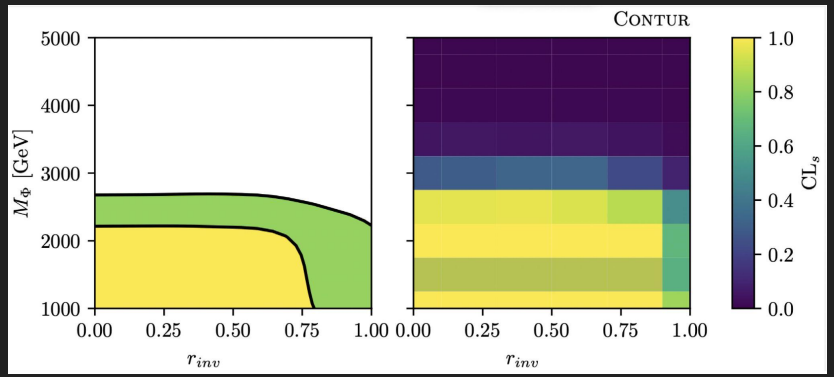
- => Focus on where there is still discovery potential

CONTUR + Dark sector jets (Master's thesis)

- Fully hadronic channels
  - SVJ s- and t-channel
  - DJR
- Used run 2 hadronic measurements
- Sensitivity to SVJ t-channel, with caveats
  - Identified some issues with the Hidden Valley event generations, no big change
  - Model generation not quite in line with most recent Snowmass theory recommendations



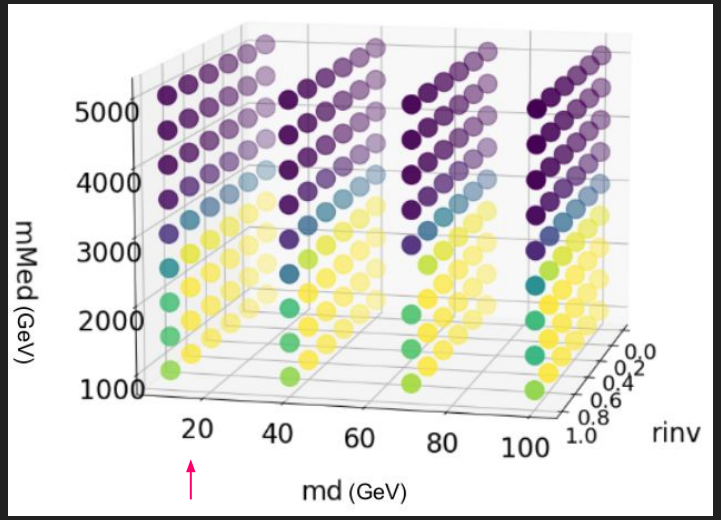




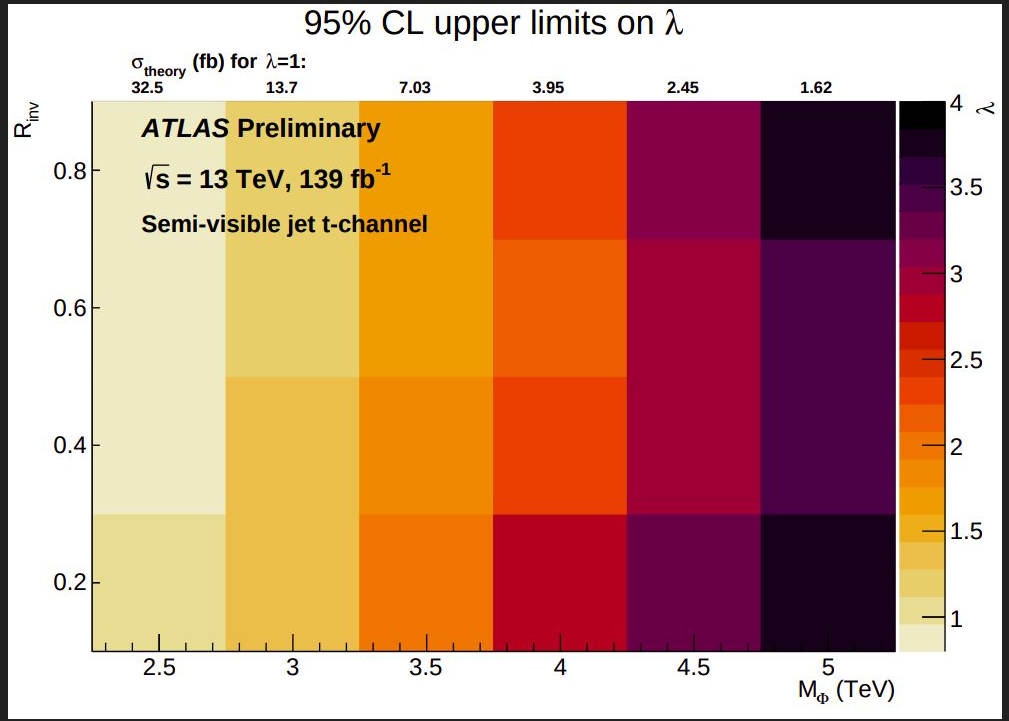
Search for non-resonant production of semi-visible jets using Run 2 data in ATLAS

CONTUR

* Not all other parameters are the same



Main sensitivity: Measurement of hadronic event shapes in high-pT multijet final states with the ATLAS detector



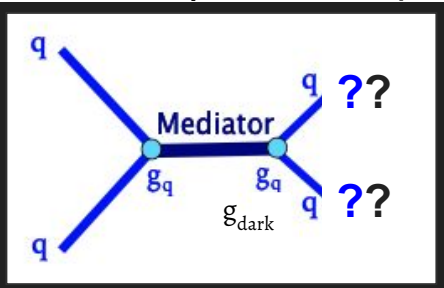
Conclusion

- With no clear guiding theory, and with increasingly large data sets
  - We need to make the most of our data, and the effort put into performing searches and measurements
- RECAST and RIVET + CONTUR can be helpful when combing through the vast BSM model space
- Important to consider how our analyses can be preserved for reuse for other theories

Back Up

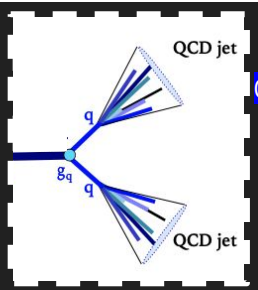
Run-3 plans: dark jets with Partial Event Building

Dark Z' decays in (dark) quarks



Trigger-Level Analysis (TLA)

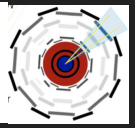
store **only HLT objects** (jets, photons, etc) for analysis



0.5% the size of the full event!

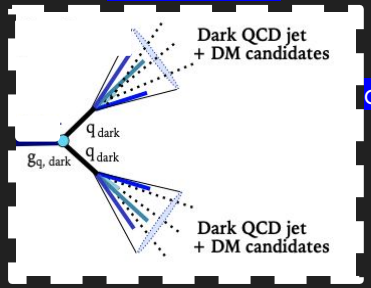
Partial event building (PEB)

(+ TLA)



store raw detector information in regions of interest

(+ HLT objects)



approx. ⅛ of the size of the full event

- TLA: use HLT objects to reach lower mediator masses
- PEB: use HLT objects + more information to search for unusual jets for dark sector physics cases
  - E.g. jets with weird things inside (displaced vertices, leptons, missing energy etc)
- Dark sector searches usually look for high mass/high-pT jets first
  - Semivisible jet s-channel search ongoing (see e.g. Tobias Fitschen's talk)
  - we want to target lower mass dark sector mediator with PEB
    …stay tuned!