

# Rivet for BSM recasting

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# Rivet recap

Since Rivet isn't (yet!) a big thing in BSM-land...

- ▶ **Rivet is an MC analysis toolkit, originally developed for MC validation vs. SM data**
  - Designed for MC generator independence and close reproduction of expt methods
  - And low entry barriers – uncluttered “physicist-friendly” interface
- ▶ **Has become the LHC standard for archiving measurements in SM, top & Higgs**
  - **Important:** in ATLAS & CMS it's *standard for the analysis team to write a Rivet routine*
  - Along with paper preparation and HepData submissions – and Rivet is integrated with HD
  - After submission we quality-control, maintain, update, regression check, ...
  - Major “feedback” roles in MC generator development, tuning, comparison, ...

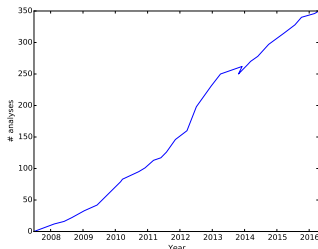


⇒ “central” source of LHC analyses for BSM recasting?

# Analysis coverage

Currently  $> 350$  analyses total &  $> 200$  LHC alone

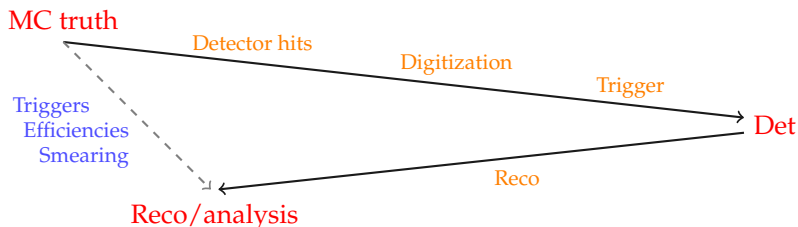
- ▶ But only 27 dedicated BSM searches, and not recent
- ▶ More BSM-sensitive measurements cf. e.g. Jon Butterworth talk  $\Rightarrow$  but BSM is currently niche
- ▶ Because of focus so far on *unfolded* observables? That's more emphasis than fundamental
- ▶ **Rivet 2.5 introduces detector smearing machinery!** BSM only!
- ▶ **Want to change this perception and extend the LHC Rivet programme for SM measurements  $\rightarrow$  BSM searches**



NB. glitch is Rivet 1.x  $\rightarrow$  2.x migration!

# BSM & detector effects

A problem with explicit fast detector simulation:

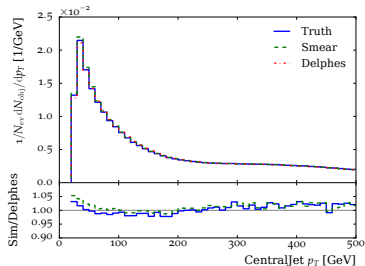


- ▶ **Reco already reverses most detector effects!**
- ▶ Calibration means that smearing is a few-percent effect. (Lepton) efficiency & mis-ID functions dominate, cf. GAMBIT talk – and are easily modelled.
- ▶ Much harder to fast-sim reco algorithms than detector geometry... and they change more frequently

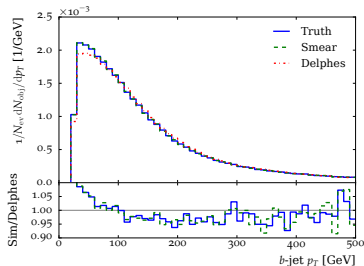
# Smearing vs. fast sim vs. MC truth

CMSSM eff/smearing effects from Rivet == GAMBIT smearing, in turn using some Delphes and paper/note calibration functions:

Central jet  $p_T$



$b$ -jet  $p_T$

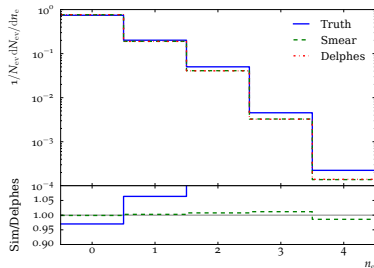


Note major lepton shifts from blue truth to green smeared: difference w.r.t red Delphes very small and not always rational.

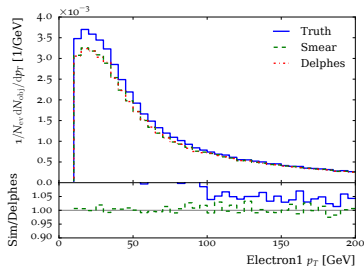
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## Electron multiplicity



## Leading electron $p_T$

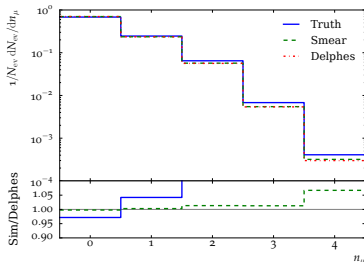


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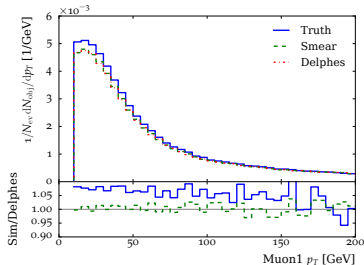
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## Leading muon $p_T$



Note major lepton shifts from blue truth to green smeared: difference w.r.t red Delphes very small and not always rational.

## BSM & detector effects (II) $\Rightarrow$ Rivet 2.5

In addition to last slides, *flexibility* of det-sim is important:

- ▶ “Global” fast-sims hence difficult for coverage of multiple experiments, multiple runs, multiple reco calibrations, etc.
- ▶ Analysis-specific efficiencies and smearings are both more precise and more politically likely than “official fast-sims”

$\Rightarrow$  Rivet det-sim as effs+smearing, localised per-analysis

Rivet internally caches results, so global effect sim still efficient

### Examples:

```
IdentifiedFinalState es1(Cuts::abseta < 5, {{PID::ELECTRON, PID::POSITRON}});
SmearredParticles es2(es, ELECTRON_EFF_ATLAS_RUN2, ELECTRON_SMEAR_ATLAS_RUN2);
declare(recoes, "Electrons");

FastJets js1(FastJets::ANTIKT, 0.6, JetAlg::DECAY_MUONS);
SmearredJets js2(fj, JET_SMEAR_PERFECT, JET_EFF_BTAG_ATLAS_RUN2); // or lambda
declare(recoj, "Jets");

...

Particles elems = apply<ParticleFinder>(event, "Electrons").particles(10*GeV);
Jets jets = apply<JetAlg>(event, "Jets").jetsByPt(30*GeV);
```

Note set of standard global functions. Inline also possible



# Plans and proposals

**Rivet 2.5 with smearing machinery very soon. Then...**

- ▶ Start coding up selected recent ATLAS & CMS search analyses – *seed* the collection with templates
- ▶ Include “local” eff function analyses e.g. [arXiv:1411.2921](https://arxiv.org/abs/1411.2921)
- ▶ CERN Rivet tutorials (next in July) to include focus on BSM features, advertised to ATLAS & CMS BSM
- ▶ Developing ecosystem of tools to streamline HepData integration for SR and limit data,  $p$ -value calculation, etc. – [hands-on mini-workshop planned for Sept, contact if interested](#)
- ▶ **Existing Rivet experience, integration & acceptance in the experiments is worth building on.** Also already integrated with RECAST, and GAMBIT planned: *working with, not against*
- ▶ **We all (incl. experiments!) would benefit from a global, expt-coded collection of quality collider analysis codes.**
- ▶ We are *very* happy to help support BSM users and help provide analysis routines for anyone to recast.