Standard communication of analysis data correlations

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- Primary data faithfully recorded, modulo format details. Issue is with *secondary data*
  - Correlation data
  - For searches: (MC) background estimates

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  LHC maturity and large integrated lumi $\Rightarrow$ a major issue for use of both measurement and search analysis data
- **All data needs to "automatically" flow from experiments $\rightarrow$ HepData $\rightarrow$ analysis tools**
  $\Rightarrow$ standardise formats and conventions for data & aux data
  $\Rightarrow$ *using* correlations in MC tuning, EFT fits, BSM scans = "easy"
  (formats like Rivet's YODA being extended to handle this: correlations via metadata & multiple named error bars)

Correlations in fits/limit setting

Many types of correlation:

- **SYST: between bins/SRs,** from experiment/theory systematics
- **STAT: between bins/analyses**, from event-sharing/normalisation
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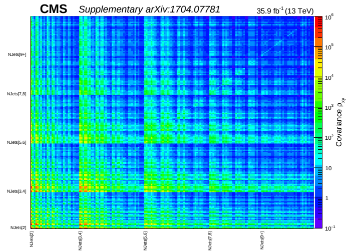
- **representation options:** independent error sources on data points; linked primary/secondary datasets; `pyhf`

Correlation formats: error sources vs. bin covariance

CMS 0ℓ cov matrix (log-scale!)



Error breakdown in a HepData record

NB. normal in *Standard Model* analyses

RE	P P --> JETS
COS PHI	**TEEC**
-1 - -0.96	10.5165 ±0.00779481 stat +0.0117651 -0.0113337 sys,jesNp1 +0.0034308 -0.00335944 sys,jesNp2 + 71 more errors Show all
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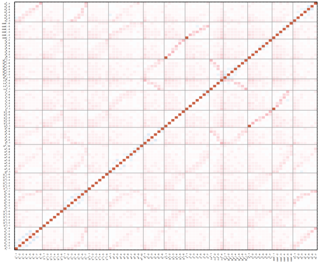

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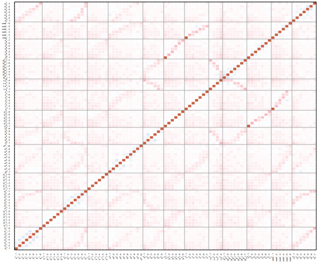

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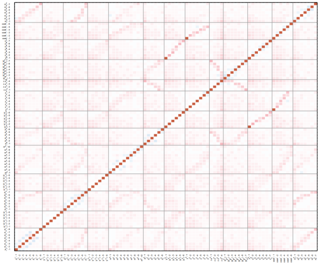

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Error-source representation more flexible: can construct cov matrix $C_{ij} = \sum_e \sigma_i \sigma_j$, or asymm by toy-sampling

Logistical issues & extensions

- Need standard names, esp. to distinguish uncorr stat errors
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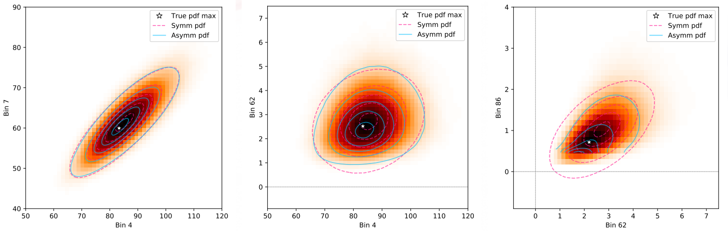

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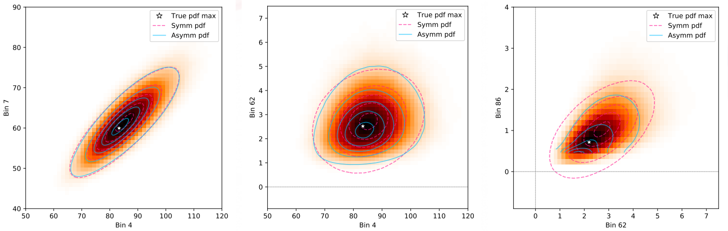

Extend HD for *semantic* correlation awareness? `pyhf` again...

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What's the best way to propagate this info in a ROOT workflow?

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- **Standardised reporting via HepData is key. Not all representations are equally good.**
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  - Integration of `pyhf` into HepData would allow for full semantic awareness of links between an analysis' primary & secondary datasets
- **If we can access correlation data in a standard form, downstream tools will definitely use it**

Backup

MC and background data

- Correlations are the most technically complex demand, since the data objects are semantically different from "normal" datasets
- Not the only requirement for scalable recasting, though: background estimates are also crucial
- Typical BSM reinterpretations only have the capacity to generate (maybe LO) signal events
- Backgrounds computed by experiments using vast MC datasets with very complex and CPU-intensive high-sophistication modelling: not reproducible, so needs to be published
- This has started, but – again – **how to make HD (and its API) *semantically* aware of what is data and what's the corresponding MC?**

  And background process breakdown? And pre-/post-fit? ...