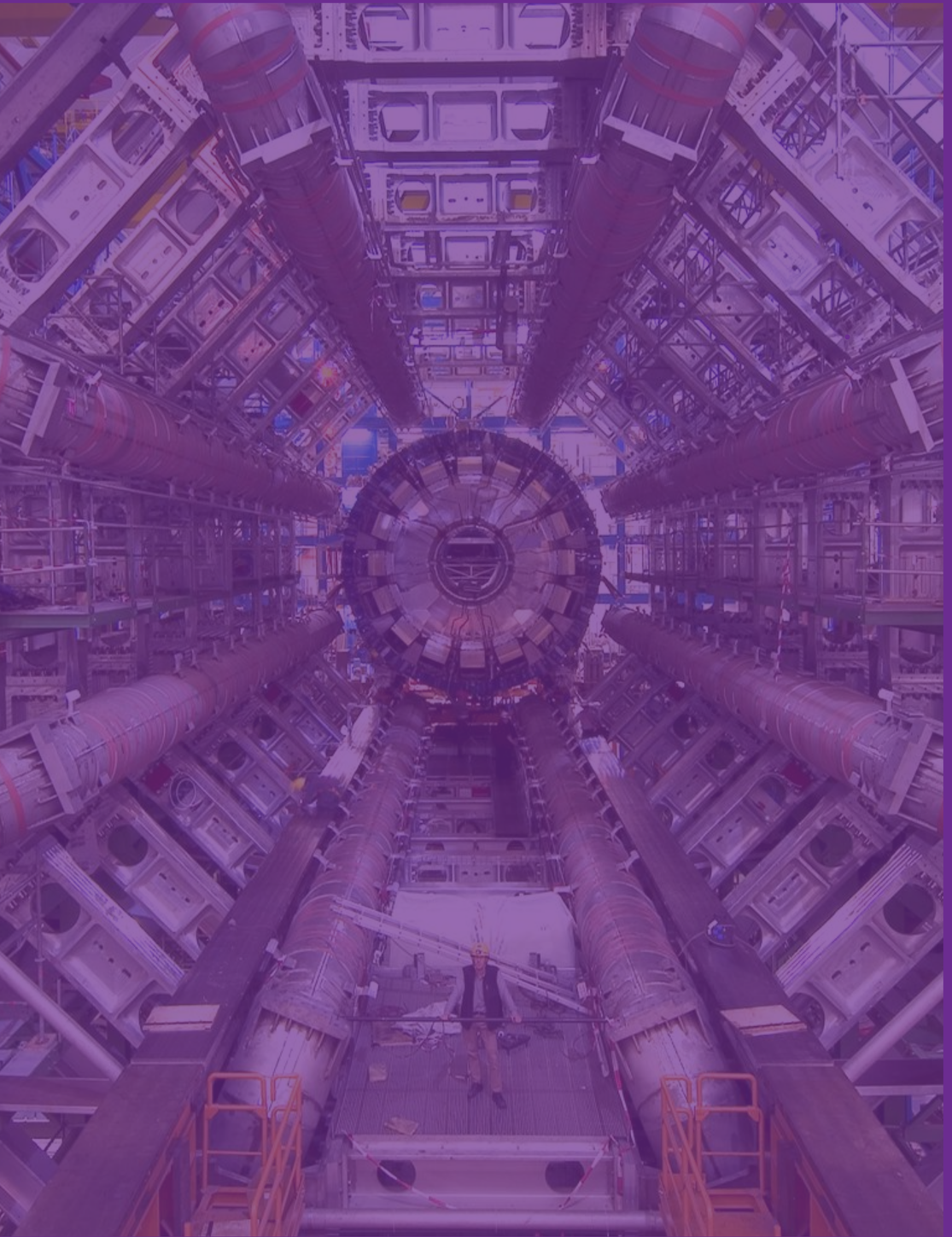


WORKSPACE EXPLORER

LHC Reinterpretation Forum

CERN

February 27th, 2025

Volker Austrup

MANCHESTER 1824

The University of Manchester

Historical Context

- Project started as part of combination effort for ATLAS analyses
- Combination SHOULD be straight-forward, as all analyses already scrutinised by ATLAS, BUT …
- Inputs to combination:
  - produced in various frameworks
  - converted into pyhf JSON format
  - need to be understood and validated

  → very time-consuming
- Idea: Streamline validation process to ensure correctness of workspace contents

Examples of issues we saw:


```
{
    "bounds": [
        [
            0.0,
            10.0
        ]
    ],
    "fixed": true,
    "inits": [
        1.0
    ],
    "name": "ATLAS_norm_Z"
},
{
    "bounds": [
        [
            0.0,
            10.0
        ]
    ],
    "fixed": true,
    "inits": [
        1.0
    ],
    "name": "ATLAS_norm_ttbar"
},
```


Fit parameters fixed when they should not be

But also cases of certain systematics missing completely!

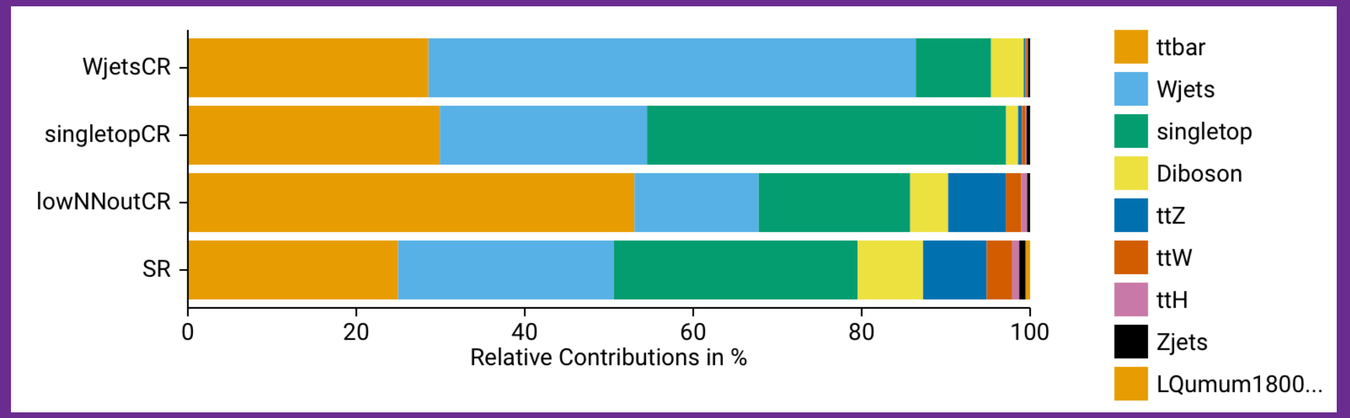

```
{
    "data": {
        "hi": 1.017,
        "lo": 0.983
    },
    "name": "luminosity",
    "type": "normsys"
},
```


Additional normalisation systematic for luminosity

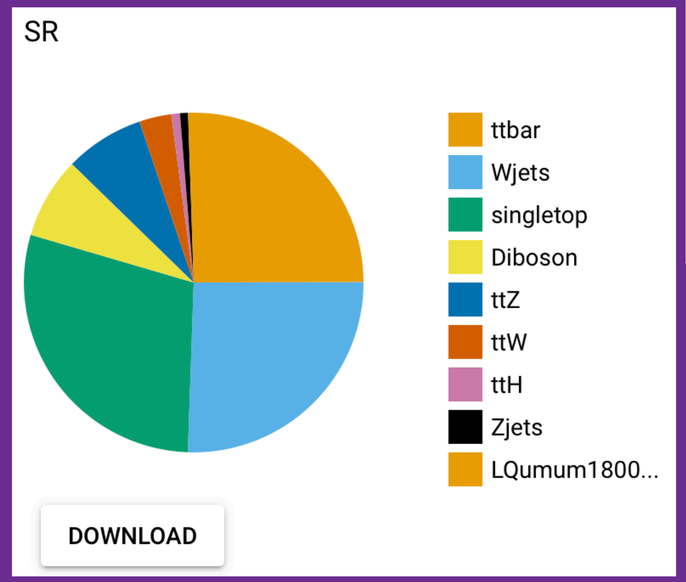
Issues hard to spot when not familiar with workspace

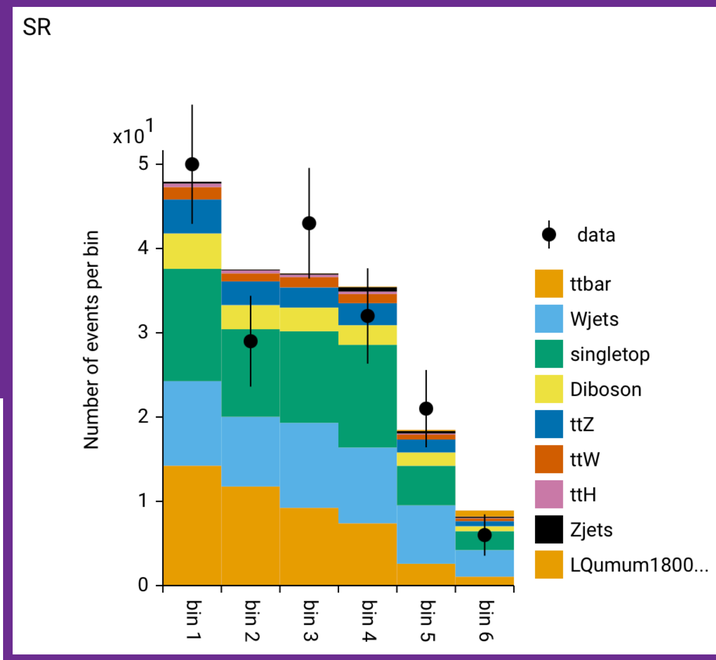
Overview

- Provide easy-to-use interface for analysers to validate their pyhf JSON workspaces → WorkspaceExplorer
- Runs in web browser, providing visualisations of workspace contents:
  - Bar charts, pie charts, data/MC comparisons, NP structure
- Connection to python-based backend allows retrieving fit results
- Load workspaces from local files or directly from HEPdata entries
- All plots can be downloaded as SVG



extend to HS3 in the future + may be useful for combine cards as well?





Overview

Summary

Processes

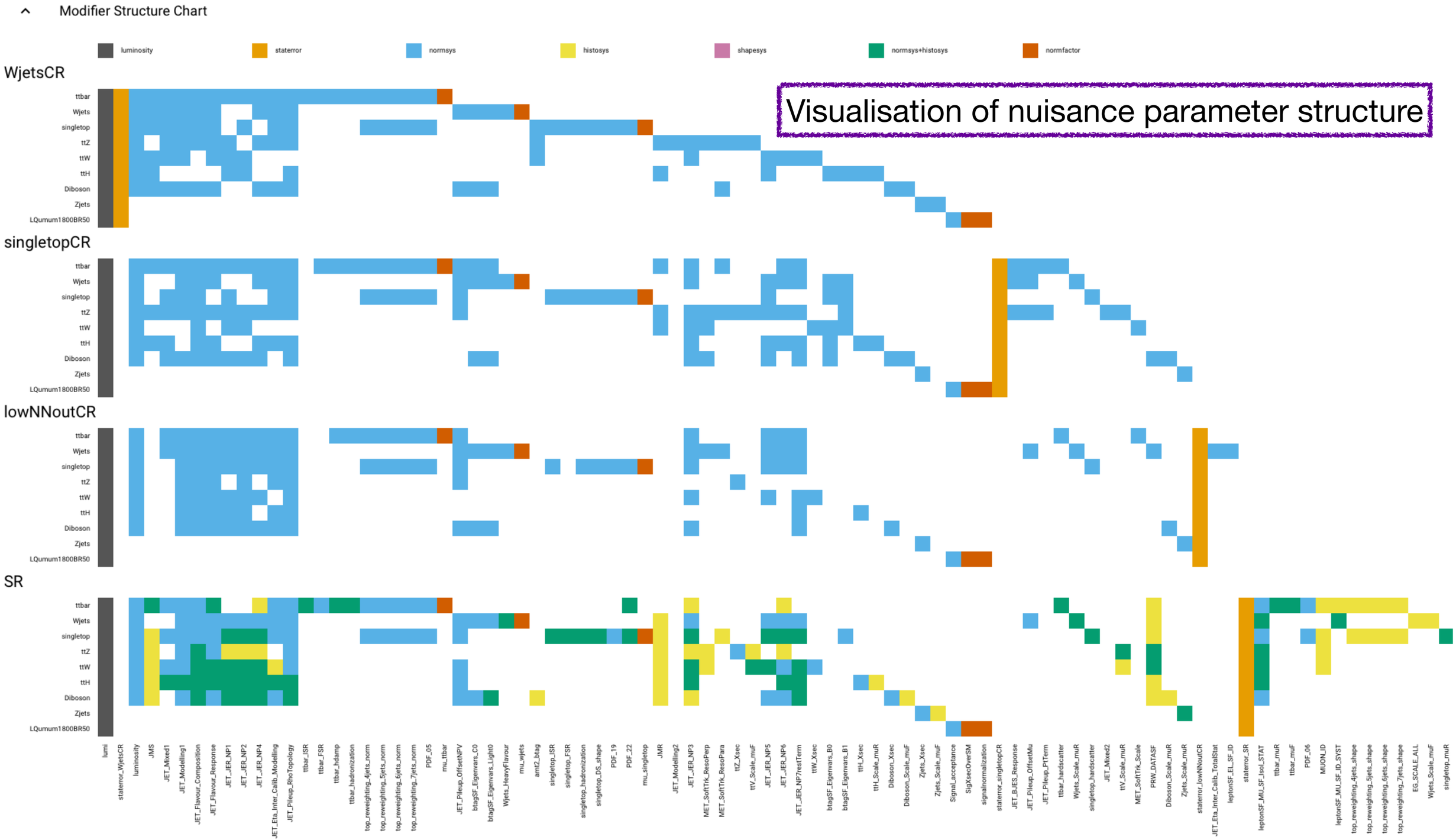
ttbar
Wjets
singletop
Diboson
ttZ
ttW
ttH
Zjets
LQumum1800BR50

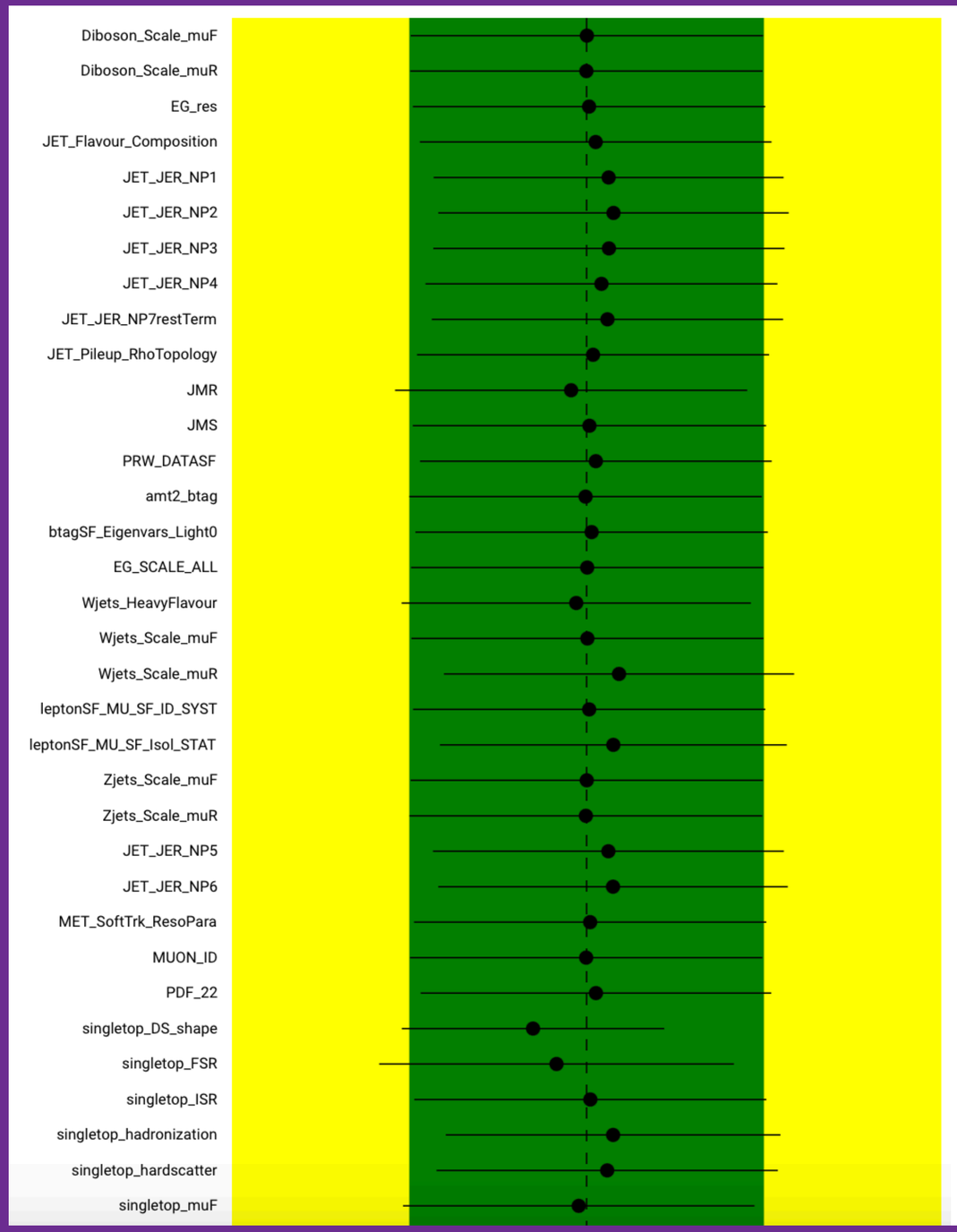
Regions

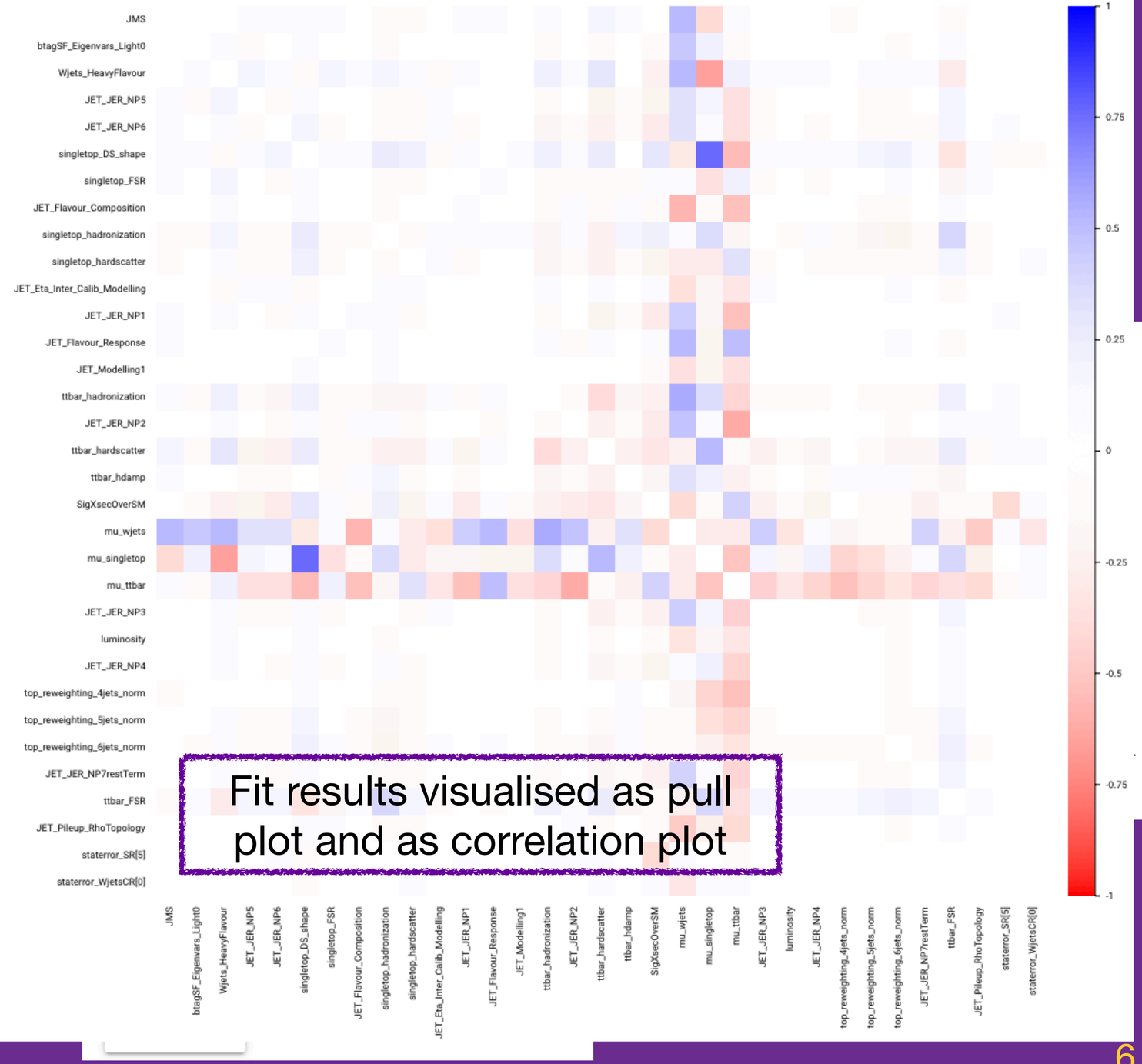
WjetsCR
singletopCR
lowNNoutCR
SR

Normalisation Factors

mu_ttbar (floating)
mu_wjets (floating)
mu_singletop (floating)
SigXsecOverSM (floating)
signalnormalization (fixed)


Modifier Structure Chart
luminosity
staterror
normsys
histosys
shapesys
normsys+histosys
normfactor
WjetsCR
singletopCR
lowNNoutCR
SR
ttbar
Wjets
singletop
ttZ
ttW
ttH
Diboson
Zjets
LQumum1800BR50
Visualisation of nuisance parameter structure
lumi
staterror_WjetsCR
luminosity
JMS
JET_Mixed1
JET_Modelling1
JET_Flavour_Composition
JET_Flavour_Response
JET_JER_NP1
JET_JER_NP2
JET_JER_NP4
JET_Eta_Inter_Calib_Modelling
JET_Pileup_RhoTopology
ttbar_ISR
ttbar_FSR
ttbar_hdamp
ttbar_hadronization
top_reweighting_4jets_norm
top_reweighting_5jets_norm
top_reweighting_6jets_norm
top_reweighting_7jets_norm
PDF_05
mu_ttbar
JET_Pileup_OffsetNPV
btagSF_Eigenvars_C0
btagSF_Eigenvars_Light0
Wjets_HeavyFlavour
mu_wjets
amt2_btag
singletop_ISR
singletop_FSR
singletop_hadronization
singletop_DS_shape
PDF_19
PDF_22
mu_singletop
JMR
JET_Modelling2
JET_JER_NP3
MET_SoftTrk_ResoPerp
MET_SoftTrk_ResoPara
ttZ_Xsec
ttV_Scale_muF
JET_JER_NP5
JET_JER_NP6
JET_JER_NP7restTerm
ttW_Xsec
btagSF_Eigenvars_B0
btagSF_Eigenvars_B1
ttH_Xsec
ttH_Scale_muR
Diboson_Xsec
Diboson_Scale_muF
Zjets_Xsec
Zjets_Scale_muF
Signal_acceptance
SigXsecOverSM
signalnormalization
staterror_singletopCR
JET_BJES_Response
JET_Pileup_OffsetMu
JET_Pileup_PtTerm
ttbar_hardscatter
Wjets_Scale_muR
singletop_hardscatter
JET_Mixed2
ttV_Scale_muR
MET_SoftTrk_Scale
PRW_DATASF
Diboson_Scale_muR
Zjets_Scale_muR
staterror_lowNNoutCR
JET_Eta_Inter_Calib_TotalStat
leptonSF_EL_SF_ID
staterror_SR
leptonSF_MU_SF_Isol_STAT
ttbar_muR
ttbar_muF
PDF_06
MUON_ID
leptonSF_MU_SF_ID_SYST
top_reweighting_4jets_shape
top_reweighting_5jets_shape
top_reweighting_6jets_shape
top_reweighting_7jets_shape
EG_SCALE_ALL
Wjets_Scale_muF
singletop_muR





Fit results visualised as pull plot and as correlation plot

Application Structure

Code publicly available on Github
WorkspaceExplorerFrontend
WorkspaceExplorerBackend

Frontend written in Typescript
Accessible at
workspaceexplorer.app.cern.ch

"Business logic":
VueJS framework

Pinia for state management

Quasar framework for UI elements

Plots created from native SVG elements

Send workspaces to RESTful API

Retrieve fit results from RESTful API

Python-based backend
Hosted on CERN Openshift instance

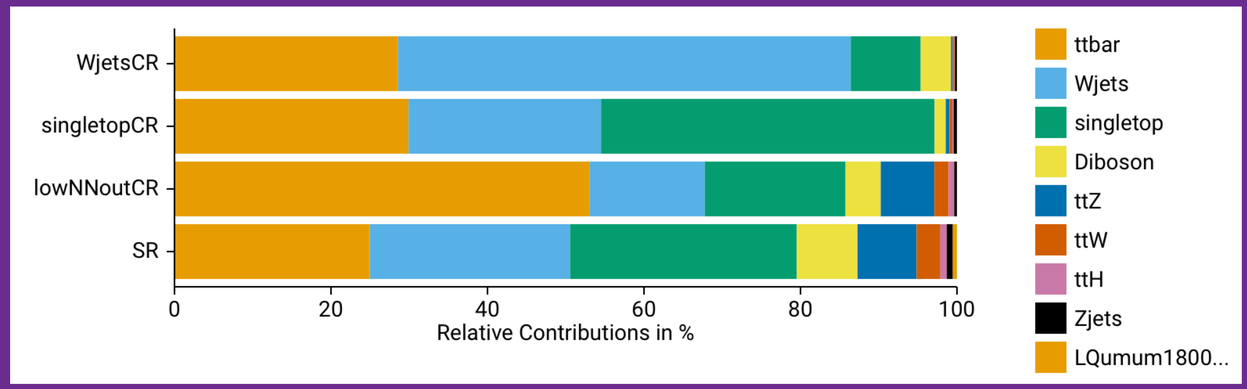
Simple RESTful API using Flask:
- POST workspace
- GET fit results

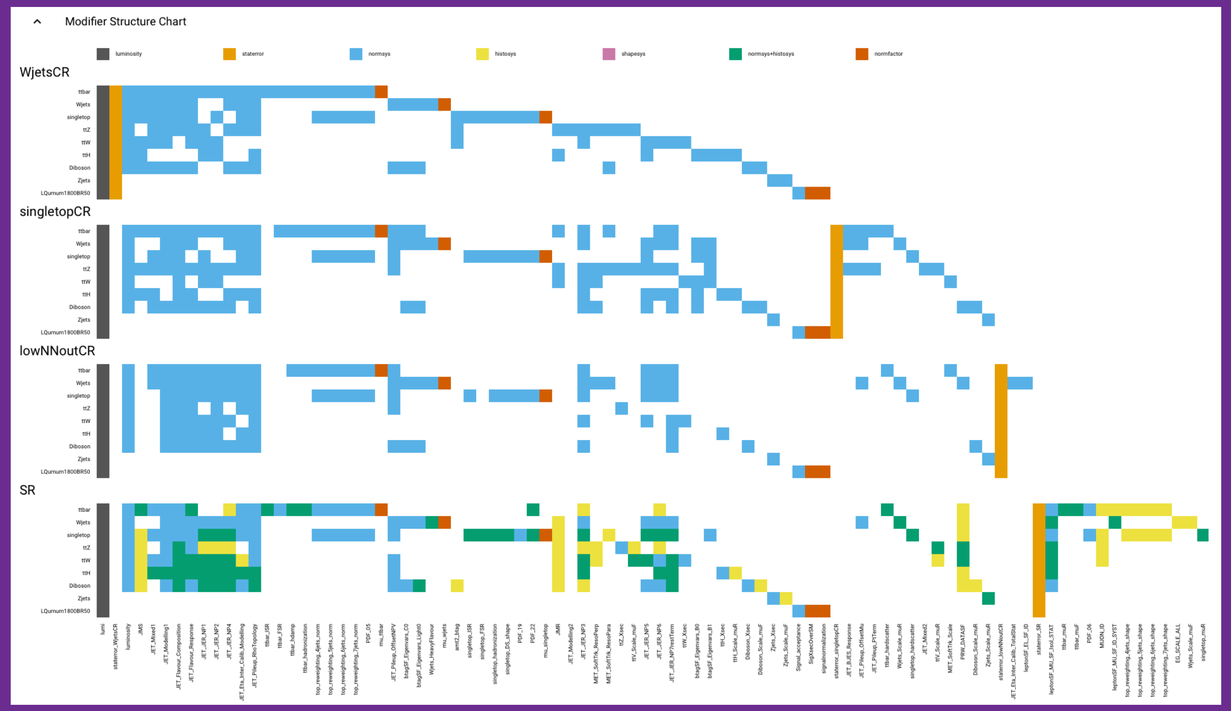
Celery + Redis for asynchronous task handling

Profile likelihood fits using pyhf + cabinetry

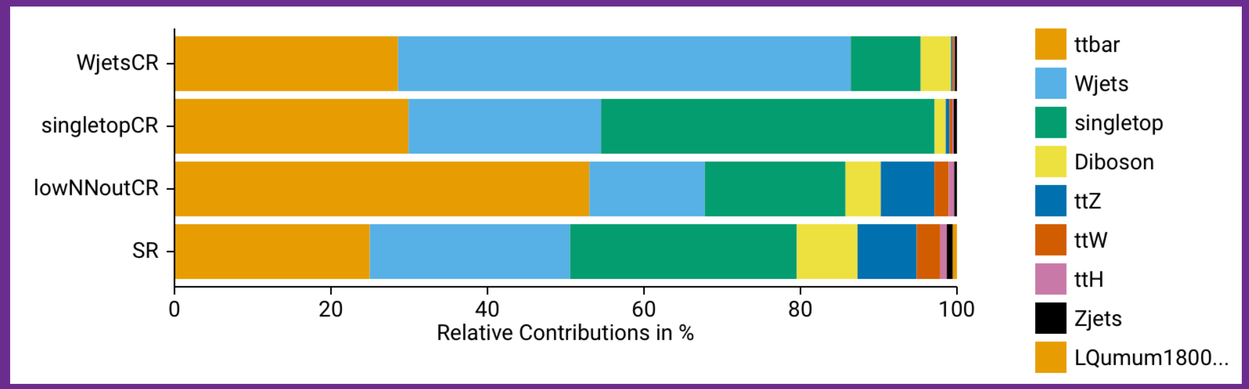
Usage Scenarios

- Validation of workspaces:
  - easy way for analysers to confirm contents of workspaces
  - avoid mistakes due to conversion between different statistical frameworks
  - confirm all necessary information is available
- Exploration of unfamiliar workspaces:
  - aid understanding of analyses from outsider's perspective
- Education:
  - introduce newcomers to key concepts



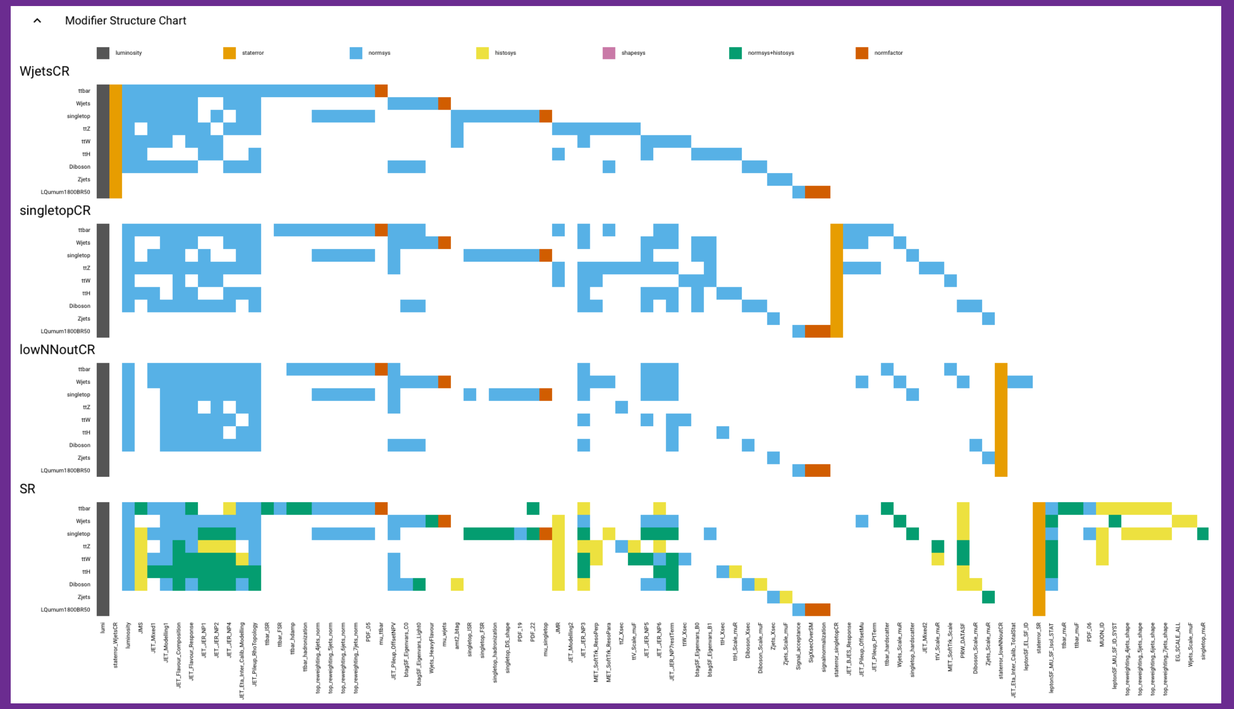


Advantages



- Parallels to RooBrowser, but:
  - focus on HistFactory schema
  - no need to setup ROOT
  - runs natively in web browser

  → low barrier to entry



- Can tie in directly with HEPdata:
  - load via ID of HEPdata entry
  - share via URL parameter, e.g.

    https://workspaceexplorer.app.cern.ch/?id=2077557

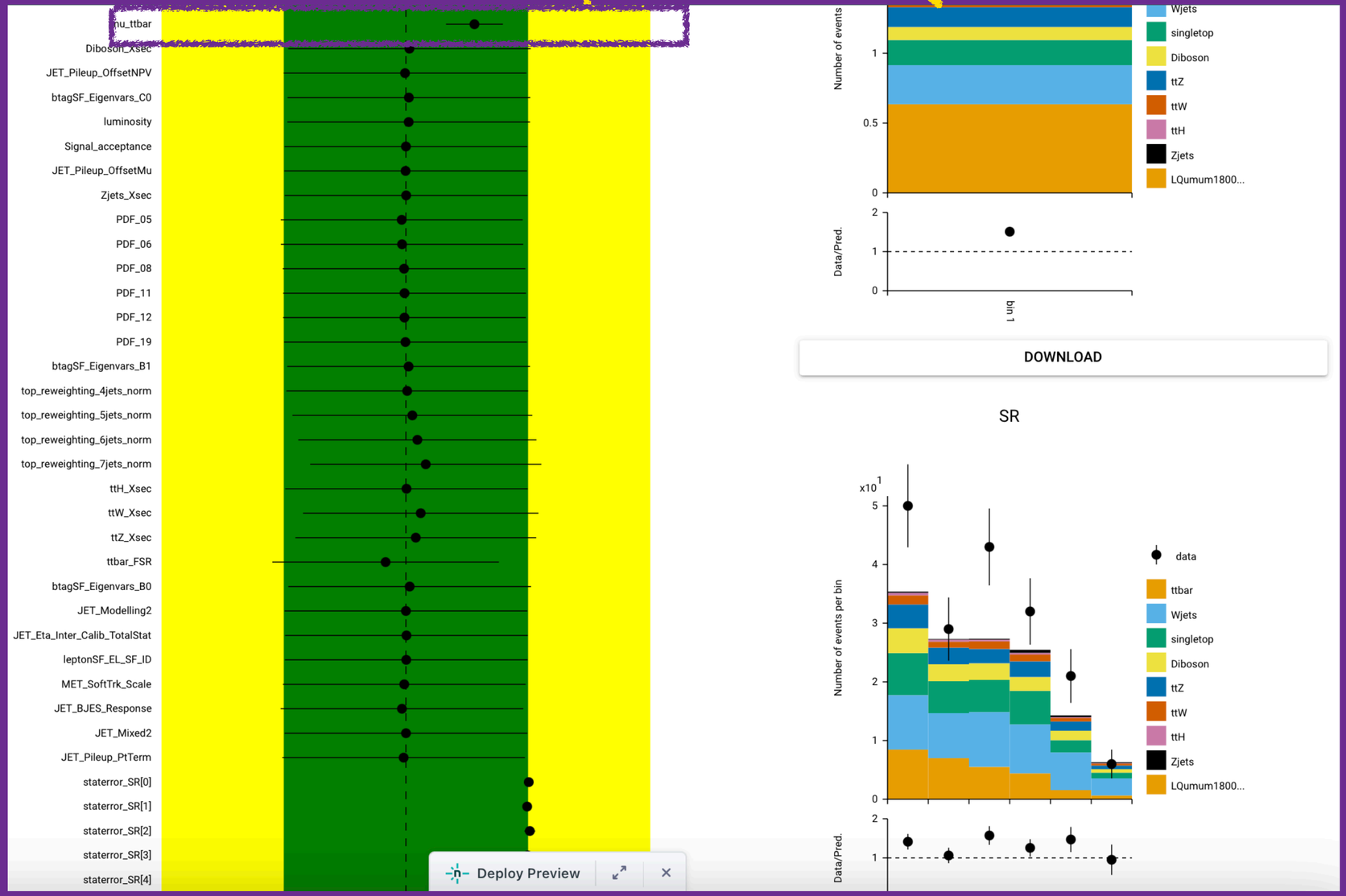
(only works if the raw workspace is directly attached to the HEPdata entry, but I will try to find time to implement unpacking of tarballs & applying signal patches soon)

Interactive Pulls

- New, experimental feature: “pulling the pulls"
- Change pulls directly in the UI
- Work in progress, but preview to play around with here
- Investigate impact of nuisance parameters

  → “Fitting by hand”

Changing pulls in pull plot instantly reflected in post-fit plots



Interactive Pulls

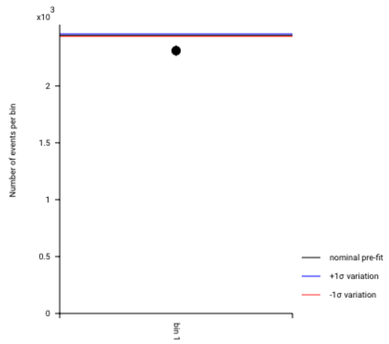
Systematic Uncertainty Chart

Filter by name
JER

1 / 2

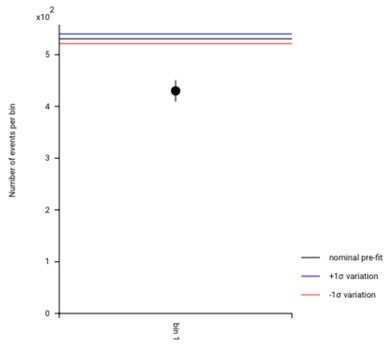
JET_JER_NP1

WjetsCR



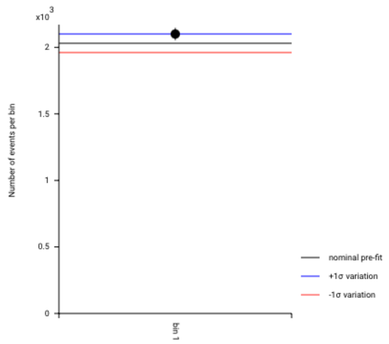
DOWNLOAD

singletopCR



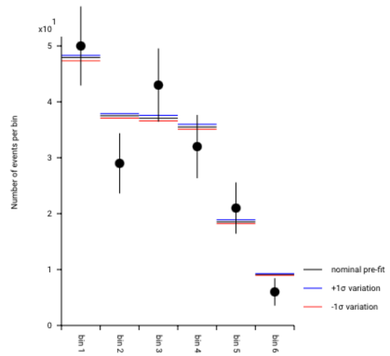
DOWNLOAD

lowNNoutCR



DOWNLOAD

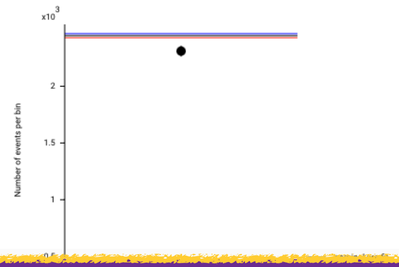
Signal Region



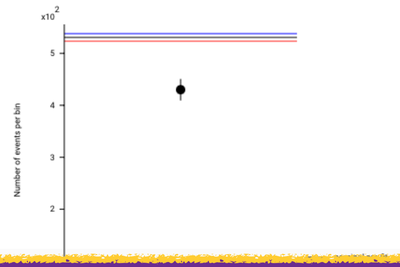
DOWNLOAD

JET_JER_NP2

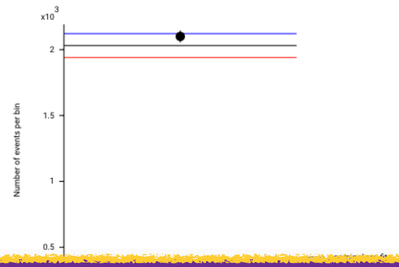
WjetsCR



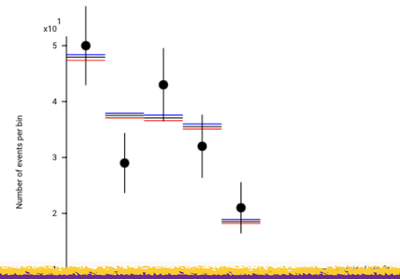
singletopCR



lowNNoutCR

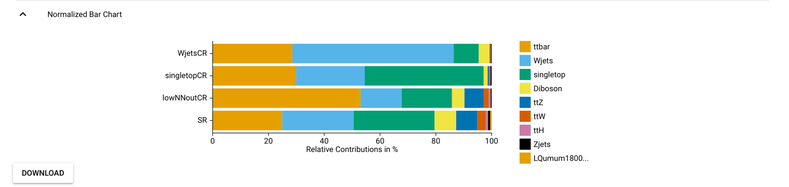


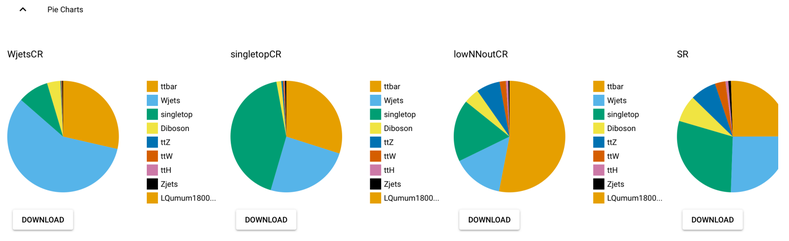
Signal Region

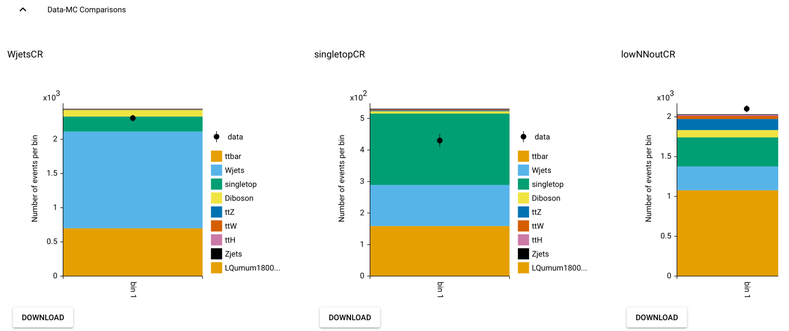


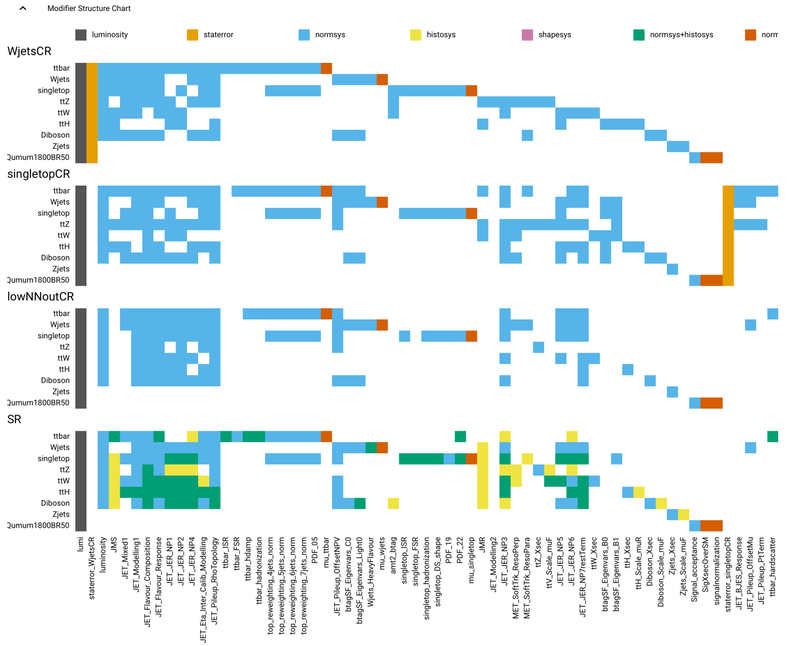
Conclusions & Outlook (I)

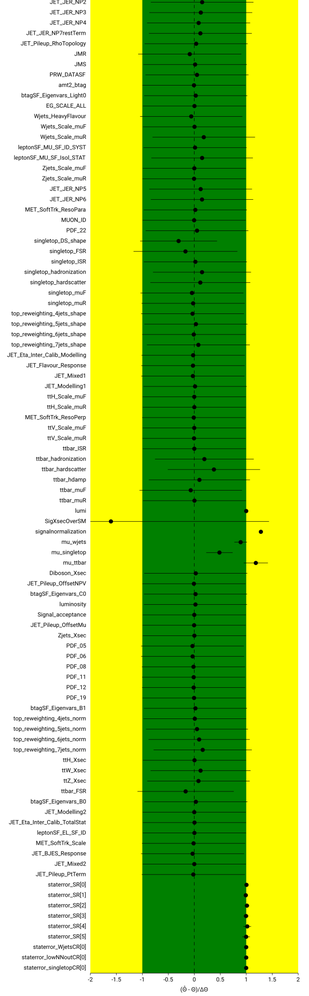
- Interactive visualisation of pyhf workspaces in the web browser
- Read in local files or load directly from HEPdata (maybe even link directly?)
- Connection to backend running pyhf + cabinetry for profile-likelihood fits
- Useful for understanding and validating statistical models, but also for sharing them

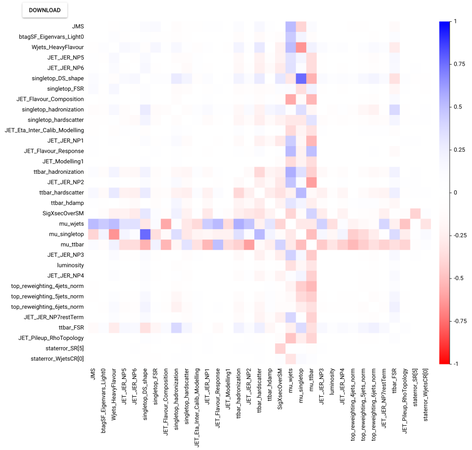






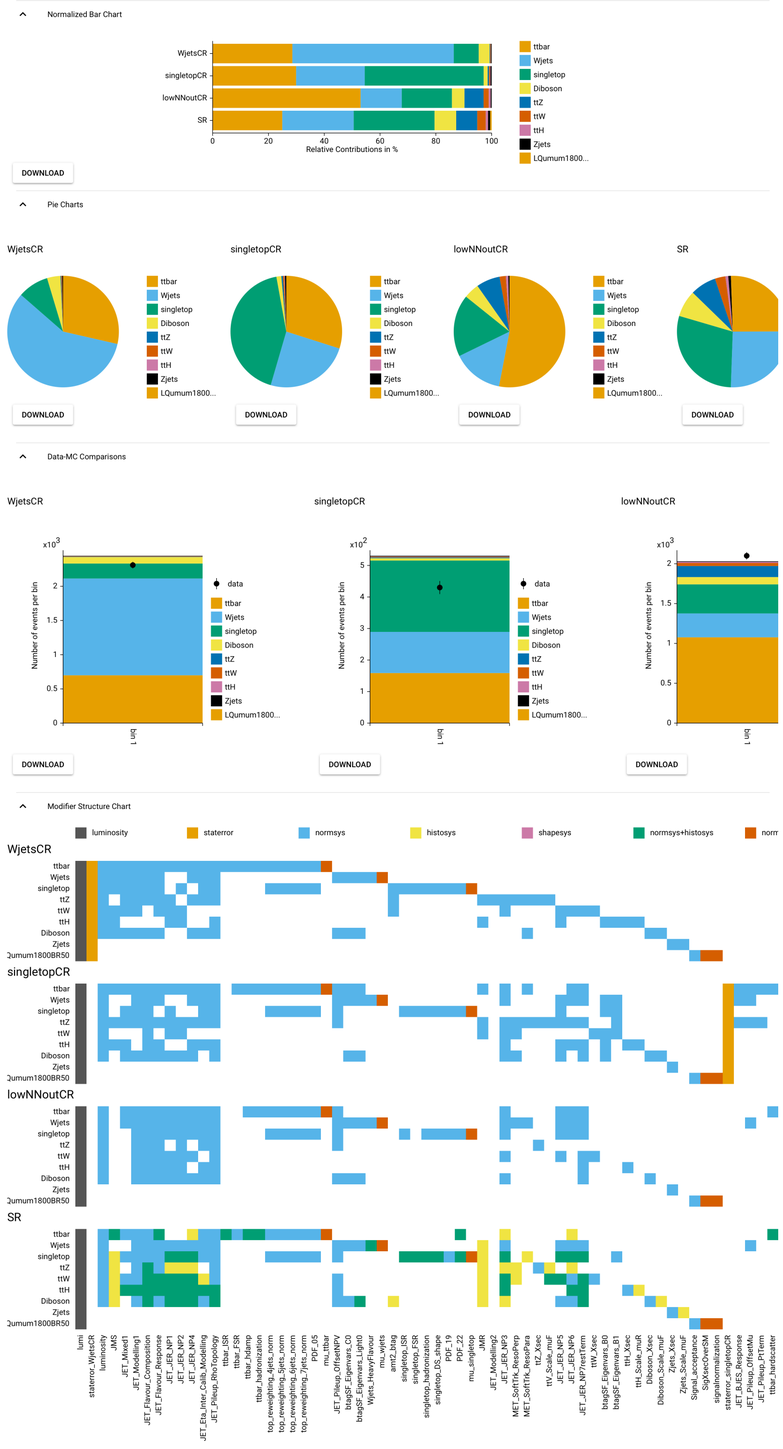






Conclusions & Outlook (II)

- In Progress:
  - interactive pulls
  - plots of systematic variations
- Ideas for the future:
  - Interfaces for HS3, combine
  - Cache workspaces and fit results on server to allow sharing via permalink
  - Customisable fit parameters (e.g. exclude certain NPs)
  - …



Thank you!