Introducing Myself

Who am I and what did I do before coming to DESY?

Daniel Werner

ATLAS-SM Meeting, 18.11.2024

HELMHOLTZ

DESY.

Introduction

Who am I

- Daniel Werner
- 24 years (delayed cake soon)
- Office O1.348

Previous topics

- B.Sc.: top quark polarisation in trileptonic tZq
- Summer Student: Benchmarking stat. analysis in RooFit
- M.Sc.: Effetive Field Theory in ttZ and tZq

PhD topic

Measurement of $\gamma\gamma \to \tau^+\tau^-$ in the electron-muon decay mode in proton-proton collisions

SMEFT Search in $t\bar{t}X$

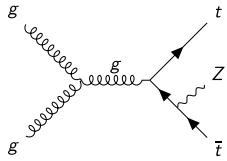
SMEFT-search in $t\bar{t}X$

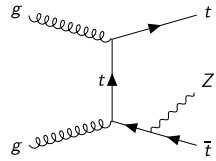
ttZ

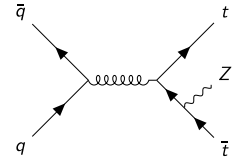
- LO QCD process
- Final state:

  3ℓ, $E_{\mathrm{T}}^{\mathrm{miss}}$, 4 jets, 2$b$-tags

$\sigma_{t\bar{t}Z} = 860 \pm 40 \pm 40\,\mathrm{fb}$ [1]





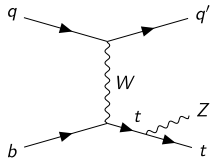


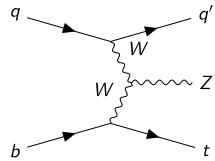
tZq

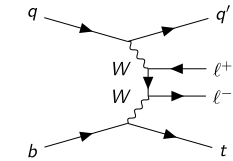
- NLO EW process
- Final state:

  3ℓ, $E_{\mathrm{T}}^{\mathrm{miss}}$, 3 jets, 2$b$-tags

$\sigma_{tZq} = 97 \pm 13 \pm 7\,\mathrm{fb}$ [2]

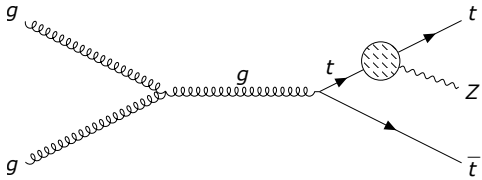






Effective Field Theory

$$\mathcal{L}_{\text{SMEFT}} = \mathcal{L}_{\text{SM}} + \sum_i \frac{c_i \mathcal{O}_i}{\Lambda^2}$$



Coefficients modifying the ttZ-vertex [3]:

$$\underbrace{c_{Ht}\ ,\ c_{HQ}^{(1)}\ ,\ c_{HQ}^{(3)}}_{\text{V-A-structure}}\ ,\quad \underbrace{c_{tB}\ ,\ c_{tW}}_{\text{Dipole moments}}$$

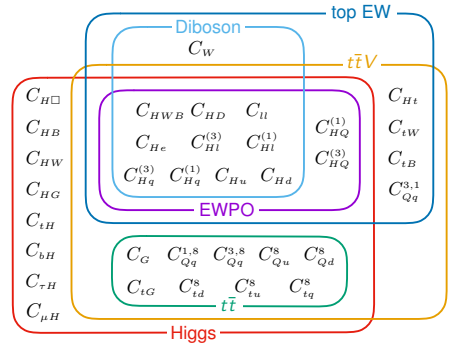


Figure: Dependency of different processes on Wilson coefficients [4].

Obtaining ntuples

TopCPToolkit

A **Toolkit** that uses common algorithms from the **C**ombined **P**erformance groups.
(Developed by the **Top**WG including top-specific algorithms)

Usage:

> Write a config file (`.yaml`)

```yaml
Jets:
  - containerName: 'AnaJets'
    jetCollection: 'AntiKt4EMPFlowJets'
    runNNJvtUpdate: True
    systematicsModelJES: 'Category'
    systematicsModelJER: 'Full'
    PtEtaSelection:
        minPt: 25000.0
        maxEta: 2.5
    FlavourTagging:
      - btagger: 'DL1dv01'
        btagWP: 'FixedCutBEff_85'
        generator: 'autoconfig'
    FlavourTaggingEventSF:
      - containerName: 'AnaJets.baselineJvt'
        btagger: 'DL1dv01'
        btagWP: 'FixedCutBEff_85'
```

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Usage:

> Write a config file (`.yaml`)

```yaml
EventSelection:
  - electrons: 'AnaElectrons.tight'
    muons: 'AnaMuons.tight'
    jets: 'AnaJets.baselineJvt'
    met: 'AnaMET'
    btagDecoration: 'ftag_select_DL1dv01_85'
    noFilter: False
    cutFlowHistograms: True
    selectionCutsDict:
      'SUBcommon': |
        JET_N_BTAG >= 1
        JET_N 25000 >= 2
        SAVE
      'ejets_mumu': |
        IMPORT SUBcommon
        EL_N tight 7000 == 1
        MU_N tight 7000 == 2
        MLL_OSSF 80000 100000
        SAVE
```

Obtaining ntuples

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Usage:

- Write a config file (`.yaml`)
- Add custom algorithms (Advanced)
  - Adapt `TutorialAlg.cxx` and `TutorialAlg.h`
  - Add algorithm in config

```
44  TTZLeptonAssignment:
45    electrons: 'AnaElectrons.tight'
46    muons: 'AnaMuons.tight'

96  AddConfigBlocks:
97      - modulePath: 'TopCPToolkit.TTZLeptonAssignmentConfig'
98        functionName: 'TTZLeptonAssignmentConfig'
99        algName: 'TTZLeptonAssignment'
100       pos: 'SpaNet'
```

Obtaining ntuples

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- Write a config file (`.yaml`)
- Add custom algorithms (Advanced)
  - Adapt `TutorialAlg.cxx` and `TutorialAlg.h`
  - Add algorithm in config
- Run with options `runTop_el.py`

`-i` input filelist
`-o` output name
`-t` config name

Obtaining ntuples

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  - Adapt `TutorialAlg.cxx` and `TutorialAlg.h`
  - Add algorithm in config
- Run with options `runTop_el.py`

`-i` input filelist
`-o` output name
`-t` config name

`-e` max-events
`--parton` Activate parton level
`--particle` Activate particle level
`--no-systematics` Only run nominal
`-d` Use `gdb` debugger

Event Selection

	$e+$jets, ee	$e+$jets, $\mu\mu$	$\mu+$jets, ee	$\mu+$jets, $\mu\mu$
N_{jet}	≥ 3			
N_{bjet}	≥ 1 at 85% Efficiency			
N_e	3	1	2	0
N_μ	0	2	1	3
N_{OSSF}	≥ 1 with $\lvert m_{\ell\ell} - m_Z \rvert < 10$ GeV			

	SR ttZ	SR $t\ell\ell q$	CR Diboson	CR Fakes e	CR Fakes μ
N_{bjet}	> 1	$= 1$	$= 1$		
N_{fjet}		> 0	$= 0$		
$p_{\text{T}}(\ell_t)$	> 20	> 20	> 20	≤ 20	≤ 20
non-prompt PDG-Id				$== 11$	$== 13$

FastFrames

Framework based on RDataFrames:

- New columns calculated from existing ones
- Lazy evaluation of columns
- Use systematic variations if necessary

Usage:

- Histogramming
- Unfolding
- Custom reconstruction

event	el_pt_NOSYS	el_phi_NOSYS		
1	$42\,000$ MeV	0		
2	$27\,500$ MeV	$\pi/2$		
3	$31\,000$ MeV	0.455		
4	.	.		
⋮	⋮	⋮		

Table: Example information depicted in the columnar format of RDataFrames.

FastFrames

Framework based on RDataFrames:

- New columns calculated from existing ones
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- Use systematic variations if necessary

Usage:

- Histogramming
- Unfolding
- Custom reconstruction

event	el_pt_NOSYS	el_phi_NOSYS	'el_pt_NOSYS/1e3'	'el_pt_NOSYS*cos(el_phi_NOSYS)'
1	42 000 MeV	0		
2	27 500 MeV	$\pi/2$		
3	31 000 MeV	0.455		
4	.	.		
⋮	⋮	⋮		

Table: Example information depicted in the columnar format of RDataFrames.

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Usage:

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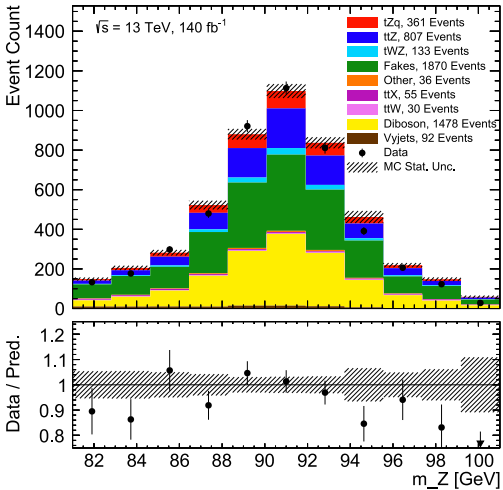
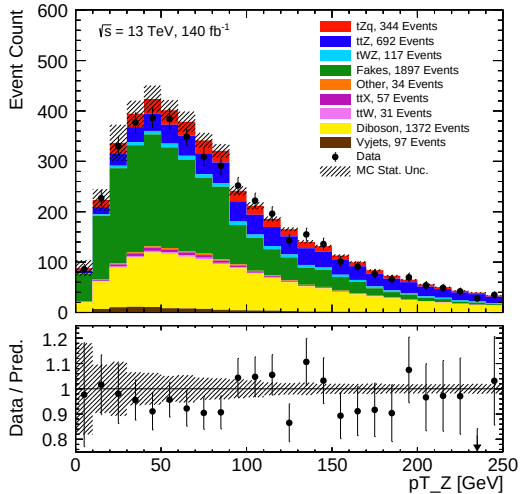
event	el_pt_NOSYS	el_phi_NOSYS	'el_pt_NOSYS/1e3'	'el_pt_NOSYS*cos(el_phi_NOSYS)'
1	42 000 MeV	0	42 GeV	42 000 MeV
2	27 500 MeV	$\pi/2$	27.5 GeV	0 MeV
3	31 000 MeV	0.455	31 GeV	27 846 MeV
4	.	.	.	.
⋮	⋮	⋮	⋮	⋮

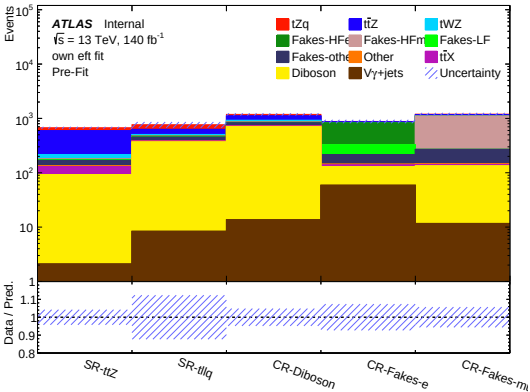
Table: Example information depicted in the columnar format of RDataFrames.

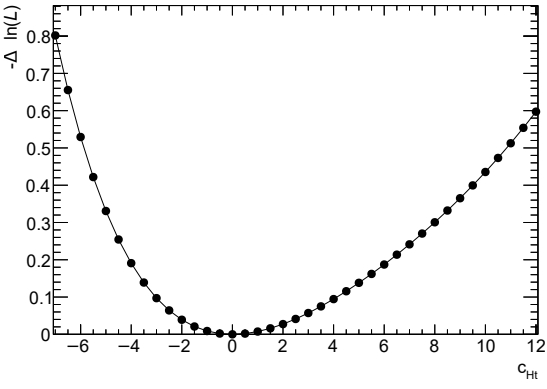
Data - MC comparison





EFTRExFitter





Thank you for your attention!

Contact

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Synchrotron DESY

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References I

[1] Atlas Collaboration. “Inclusive and differential cross-section measurements of $t\bar{t}Z$ production in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector, including EFT and spin-correlation interpretations”. In: JHEP 07 (2024), p. 163. doi: 10.1007/JHEP07(2024)163.

[2] Atlas Collaboration. “Observation of the associated production of a top quark and a Z boson in pp collisions at $\sqrt{s} = 13$ TeV with the Atlas detector”. In: JHEP 07 (2020), p. 124. doi: 10.1007/JHEP07(2020)124.

[3] J. A. Aguilar-Saavedra. “A Minimal set of top anomalous couplings”. In: Nucl. Phys. B 812 (2009), pp. 181–204. doi: 10.1016/j.nuclphysb.2008.12.012.

[4] John Ellis et al. “Top, Higgs, Diboson and Electroweak Fit to the Standard Model Effective Field Theory”. In: JHEP 04 (2021), p. 279. doi: 10.1007/JHEP04(2021)279.

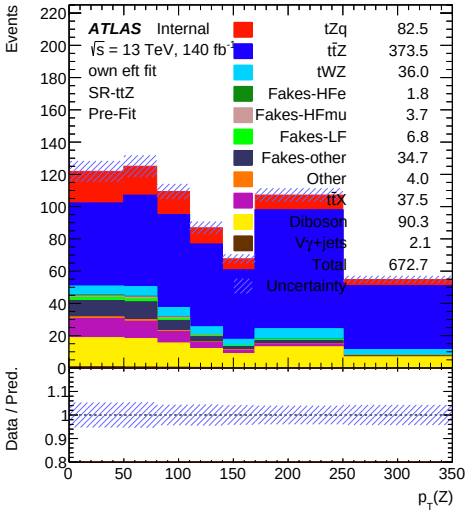
Backup

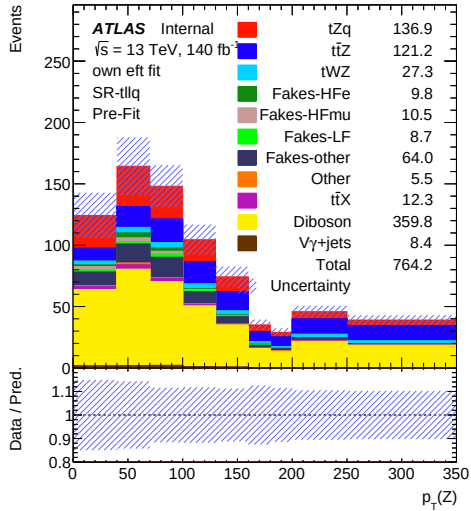
Object definitions

Object	p_{T}	$\lvert\eta\rvert$	Working Points
Electron	≥ 7 GeV	≤ 2.47	MediumLH ID, Tight−VarRad Isolation
Muon	≥ 7 GeV	≤ 2.5	Medium Reco, Tight−VarRad Isolation
Jet	≥ 25 GeV	≤ 4.5	AntiKt Algorithm, NNJVT , DL1r btagger

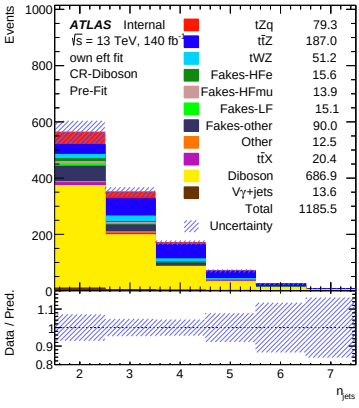
Table: Object definitions used to create ntuples.

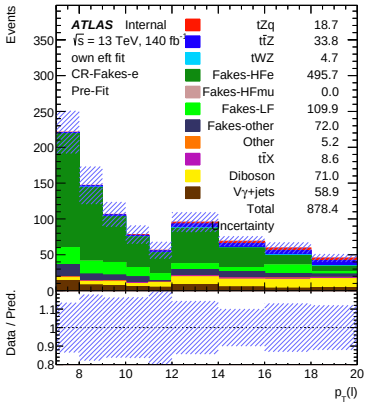
Signal Regions

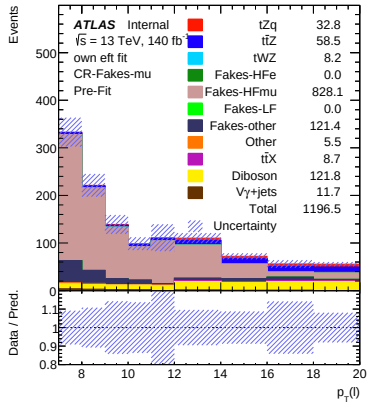




Signal Regions







EFT Fits

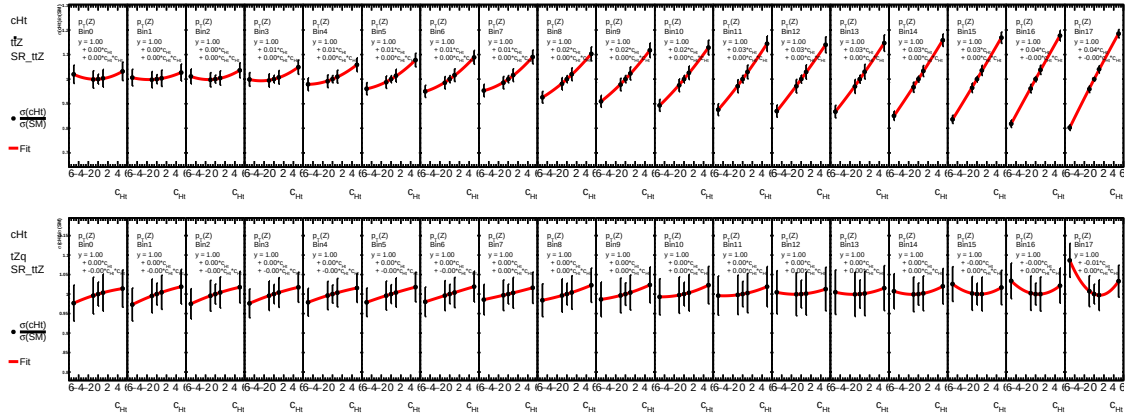


Figure: EFT effects per bin for ttZ (top) and tZQ (bottom).