

LHC EWWG meeting

Summary

Workshop summary: Precision EWK

Combinations between experiments:

Sin²θ_W

- Start with LHC combination, global fit to unfolded A₄/AFB by ATLAS/CMS/LHCb
- Longer term: wider range of fiducial cross sections
- Needed: NLO QCW+EW corrections, PDF uncertainties split into theory, modelling and data sources, assess impact of missing higher-order QCD effects

W mass

- Start with ATLAS+Tevatron combination
- Common uncertainties: PDF, EWK/QCD corrections, W width
- Problem: Published results use different PDFs, no unfolded p_T or m_T
- Rigorous approach: Tevatron reruns with updated PDF
- Alternate: emulate PDF effect using smeared predictions from common tool
- Provide fine grained unfolded cross sec vs p_T (and eta etc) in parallel

Timescale: aim for December 2018

Workshop summary: Precision EWK

New Benchmarking of state-of-the-art predictions with NLO EWK+(N)LO +PS

Predictions:

- ▶ Powheg EW
- ▶ Horace
- ▶ Winhac
- ▶ Sherpa
- ▶ SANC
- ▶ Herwig/Pythia
- ▶ KKMC
- ▶ DIZET form-factor approach
- ▶ PHOTOS as an afterburner

Switching on corrections step-by-step
(with and without reweighting to data
-> produce in bins of pT?)

Distributions:

- Lepton and photon definitions
 - ▶ Bare μ and "dressed" electrons
 - ▶ photons from hard scattering only
- CC DY
 - ▶ $M_{\ell\nu}$, 100 bins between 0 – 200 GeV
 - ▶ $p_{\perp,\ell}$, 100 bins between 0 – 100 GeV
 - ▶ leading γ in lab frame $\log_{10} p_{\perp,\gamma}$, 100 bins -7 – 3 GeV
 - ▶ leading γ relative to nearest ch. lepton $\log_{10} p_{\perp,\gamma}$, 100 bins -7 – 3 GeV
 - ▶ $\Delta R_{\gamma\ell}$ between hardest γ and nearest lepton
- NC DY
 - ▶ $M_{\ell\ell}$, 100 bins between 0 – 200 GeV
 - ▶ Collin Soper A_{FB} vs. $m_{\ell\ell}$, 100 bins between 0 – 100 GeV
 - ▶ Collin Soper A_{FB} vs. $|y_{\ell\ell}|$, 5 bins between 0 – 5
 - ▶ leading γ in lab frame $\log_{10} p_{\perp,\gamma}$, 100 bins -7 – 3 GeV
 - ▶ leading γ relative to nearest charged lepton $\log_{10} p_{\perp,\gamma}$, 100 bins -7 – 3 GeV
 - ▶ $\Delta R_{\gamma\ell}$ between hardest γ and nearest lepton

-> send proposal in the coming week and collect feedback, results beginning of 2019?

Workshop summary: Precision EWK

QCD aspects of precision measurements

pT(W)/pT(Z): Status Oct. 2017

	Uncertainty or size	Analytic resummation	Pythia	Leftover effect on W/Z
Leading-power resummation	5-10%	✓✓✓	✓	~ % ?
Power corrections	few %	(X)	(✓)?	?
Nonperturbative	few %	(✓)	(✓)	≲ % ?
Massive quarks	few %	X (✓)	(✓)	few % (?)
QED (ISR)	≲ %	X	✓ (?)	sub % (?)
PDFs	2%	✓	✓	✓
$\alpha_s(m_Z)$	up to 5%??	✓	✓	✓
$\alpha_s(m_Z)$	up to 5%	✓	✓	✓

Workshop summary: Precision EWK

QCD aspects of precision measurements

pT(W)/pT(Z): Status June 2018

	Uncertainty or size	Analytic resummation	Pythia	Leftover effect on W/Z
Leading-power resummation	3-5%	✓✓✓	✓	~ % ?
Power corrections	few %	(X)	(✓)?	?
Nonperturbative	few %	(✓)	(✓)	~ %
Massive quarks	few %	X (✓)	(✓)	few % (?)
QED (ISR)	≲ %	(✓)	✓ (?)	sub % (?)
PDFs	2%	✓	✓	✓
$\alpha_s(m_Z)$	up to 5%	✓	✓	✓

-> *Already lots of progress but developments will take longer to converge,
but should we at least discuss the current difference between resummation approaches?*

Workshop summary EWK bosons and jets

Direct combination of jet results

- Interpolation for jet radii if necessary
- ATLAS and CMS in agreement within stats when assuming an eta dependent relative JES shift of up to 2% between experiments, shift appears to be motivated given current understanding of JEC at ATLAS /CMS
- Use LHC Top WG prescriptions for first combination, later refine..

Indirect combination of jet results using reference prediction

- Independent of interpolations, fiducial phase space etc
- Can compare experiments, data sets, jet radii, etc.
- Would profit from correlated uncertainties in Rivet

-> Include 8TeV inclusive jets, do the same with W+jets (8TeV) and later Z+jets (13TeV)

Workshop summary EWK bosons and jets

Rivet and Hepdata:

- Agree on common format for detailed breakdown of uncertainties in hepdata
→ assess correlations between bins, experiments, data sets, sources etc
- Tool to extract this information into yoda for Rivet
- Agree on common naming convention
- Different approaches for
 - Simply unfolded cross sections: provided plain signed cross sec. shifts per NP?
 - Cross sections extracted from profiled LLH etc: (provide full/simplified likelihood or necessary inputs to construct it?)

Common LHC tune:

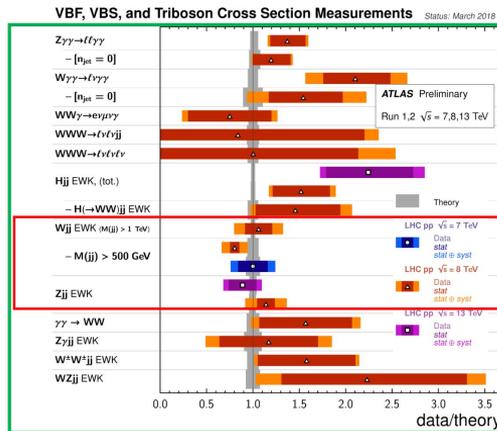
- Can develop common LHC tune.
- Not intended as “best” tune for any process, but as a benchmark reference tune that experiments can use in addition to other tunes.

Workshop summary: Multibosons

Prospect

Yusheng Wu

- ❑ For the measurements limited already by systematic uncertainties, a combination of ATLAS and CMS measurement might not help much, as systematic uncertainties are not expected to cancel much.
- ❑ For those with sizable statistical uncertainties, a combination will help to reach a better measurement precision which otherwise needs a new data-taking.
- ❑ For measurements of differential distributions and less-populated search phase spaces, which are currently limited by statistical uncertainties, a combination will be helpful



Statistical uncertainty dominating

Systematic uncertainties play critical roles

For some VBS and triboson channels, we are still seeking for individual observations, therefore not relevant for combination

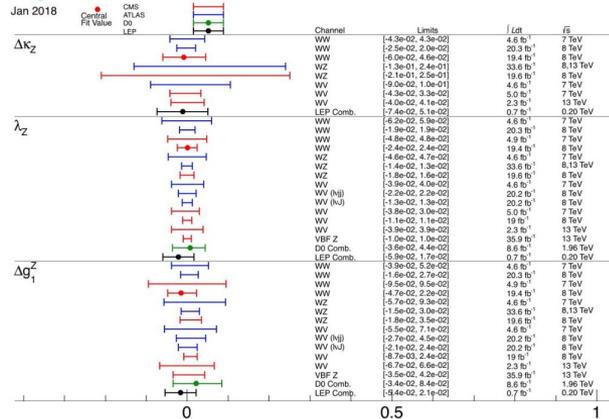
Yellow Report -> Aim for (recommendations towards) combinations

For channels not being combined in near future, yellow report should discuss sources of correlations between measurements and future measurements

Workshop summary: Multibosons

C. Degrande

Current status of Atlas/CMS EFT interpretations



- Many un(cor)related constraints
- can be compared
- Can often NOT be combined (missing information)
- Valid only for specific scenarios

$$a\text{TGC Limits @95\% C.L.}$$

$$\mathcal{O}_{WWW} = \text{Tr}[W_{\mu\nu}W^{\nu\rho}W_{\rho}^{\mu}]$$

$$\mathcal{O}_W = (D_{\mu}\Phi)^{\dagger}W^{\mu\nu}(D_{\nu}\Phi)$$

$$\mathcal{O}_B = (D_{\mu}\Phi)^{\dagger}B^{\mu\nu}(D_{\nu}\Phi),$$

	ZWW	AWW	HWW	HZZ	HZA	HAA	WWWW	ZZWW	ZAWW	AAWW
\mathcal{O}_{WWW}	X	X					X	X	X	X
\mathcal{O}_W	X	X	X	X	X		X	X	X	
\mathcal{O}_B	X	X		X	X					

Combined EFT Interpretations:
Challenging due to lack of unfolded data/measurements in BSM regime.
Different fiducial regions used.

Aim for Common Fiducial Region to aid interpretation & to publish unfolded cross sect.
Start with dibosons, aim to document in Yellow Report.

Encourage continued discussions with Higgs group to discuss interplay between processes, EFT interpretations, unfolding BSM sensitive phase spaces

Towards Yellow report: next steps

Three reports by 2019

Follow-up reports on topics which will not converge by the end of the year?

Precision EWK:

- W mass combination ATLAS-Tevatron
- $\sin^2\theta_W$ LHC combination
- Benchmarking of NLO EWK +(N)LO+PS approaches
- State-of-the-art of resummed predictions?

Jets & EWK bosons

- Direct comparisons of inclusive and di-jets measurements
- Indirect comparisons between experiments/jet radii etc using a reference prediction
- Comparisons of W+jets 8TeV (and Z+jets 13TeV?) measurements
- Common LHC tune
- State-of-the-art of Theory predictions

Towards Yellow report: next steps

Jonas M. Lindert

Three reports by 2019

Follow-up reports on topics which will not converge by the end of the year?

Multibosons:

- ▶ short experimental reviews of prior analyses, drafted per analysis channel
 - ▶ short theoretical overviews of state-of-the-art tools and predictions
 - ▶ short review for ETF interpretations
 - ▶ recommendations for combinations
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- ➡ Motivation for reviews: quick and clear references for analysis teams working with future data
 - ➡ Recommendations for measurements using LHC full Run-II data and early Run-III data:
MC event generation, definitions of common fiducial regions and BSM-sensitive variables/regions, EFT and anomalous coupling studies, measurement combinations, and possible other new ideas.

Conclusion

Aiming for:

- Defining scope of content for reports in the next Month
- Reasonably advanced report drafts and summary of content at December general meeting

Series of dedicated meetings:

- PDF4LHC & Precision EWK
- All subgroups: Common format for uncertainties in Hepdata and Rivet
- Higgs & Multibosons: unfolded cross sections in BSM sensitive regions
- ...
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Next general meeting: Thursday Dec. 13th & Friday Dec. 14th