CMS and ATLAS
di-boson and aTGC(aQGC)
meeting

ZZ 7 TeV ATLAS+CMS
aTGC combination status

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aTGC combination status

<u>An effort to combine aTGC limits from ATLAS+CMS is ongoing.</u>

- First goal is to tune ATLAS and CMS tools to provide consistent results using ZZ 7TeV input
    - At the moment tuning tools with deltaNLL criteria (goal: limits within 1%)
- Identified many technical differences in the way how the aTGC limits were set between experiments

ATLAS publication
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/STDM-2012-02/

- Channels: ZZ->4l and ZZ->2l2nu
- Signal: Sherpa MC with ME weights
- Fit on Pt(Z) distribution
- F-C limits
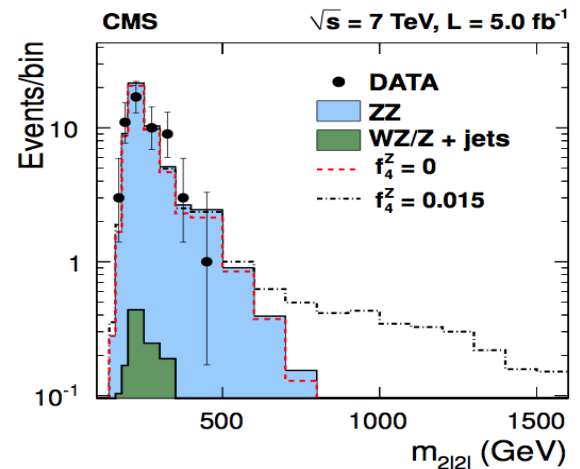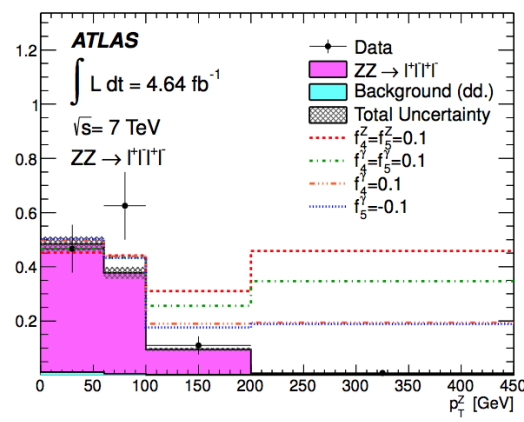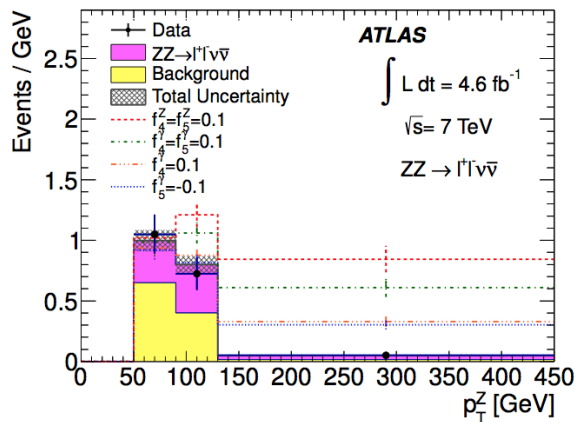- trG nuisance shape; nuisance summation:

$$N\_i = N\_i(S)(1 + \sum_k \sigma_k^i \tau_k)$$

CMS publication
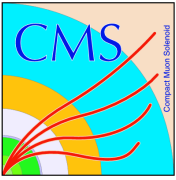http://link.springer.com/article/10.1007%2FJHEP01%282013%29063

- Channel: ZZ->4l
- Signal: Sherpa MC with pol2 fit on reco yields
- Fit on M(ZZ) distribution
- CLs limits; RooStats combine
- lnN nuisance shape; nuisance summation:

$$N\_i = N\_i(S)\prod_k (1 + \sigma_k^i \tau_k)$$

Exchange format: text file with yields, signal parameter fit values and uncertainties.

Updates since our last meeting

1. Cross checked channels with disagreement >1% by comparing limits when adding uncertainties to the fit one-by-one
2. Fixed inconsistency in systematic uncertainty in ZZ->2l2nu channel
3. Fixed systematic disagreement in expected limit
   - Due to difference is definition of expected limit (toys-> Asimov dataset, post-fit->pre-fit nuisances)
4. Few bug fixes

Overall status:

Achieved 1% agreement in all (almost all) 1D observed (expected) limits
- for every channel individually and combined
- with and without uncertainty included in the fit
- with lnN and trG uncertainty shape
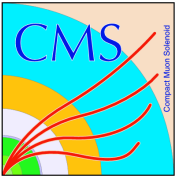
Expected limits (f5)
with full uncertainty
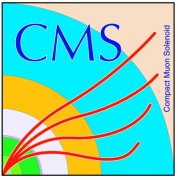
All within 1%!

1D deltaNLL limit			f_5^γ		f_5^Z	
ATLAS input:		**CMS code**	**ATLAS code**	**CMS code**	**ATLAS code**	
4l	lnN	[-0.0179, 0.0177]	[-0.0180, 0.0178]	[-0.0152, 0.0152]	[-0.0153, 0.0153]	
	trG	[-0.0180, 0.0178]	[-0.0181, 0.0180]	[-0.0153, 0.0153]	[-0.0154, 0.0154]	
2l2nu	lnN	[-0.0186, 0.0173]	[-0.0187, 0.0175]	[-0.0156, 0.0146]	[-0.0158, 0.0148]	
	trG	[-0.0192, 0.0180]	[-0.0192, 0.0180]	[-0.0162, 0.0151]	[-0.0162, 0.0151]	
4l +2l2nu	lnN	[-0.0149, 0.0143]	[-0.0151, 0.0143]	[-0.0126, 0.0121]	[-0.0128, 0.0121]	
	trG	[-0.0153, 0.0146]	[-0.0153, 0.0147]	[-0.0129, 0.0124]	[-0.0129, 0.0124]	

1D deltaNLL limit			f_5^Z		f_5^γ	
CMS input:		**CMS code**	**ATLAS code**	**CMS code**	**ATLAS code**	
4l	lnN	[-0.0169, 0.0167]	[-0.0170, 0.0167]	[-0.0141, 0.0144]	[-0.0143, 0.0145]	
	trG	[-0.0170, 0.0167]	[-0.0169, 0.0167]	[-0.0142, 0.0144]	[-0.0142, 0.0144]	

1D deltaNLL limit			f_5^Z		f_5^γ	
		CMS code	**ATLAS code**	**CMS code**	**ATLAS code**	
combined	lnN	[-0.0125, 0.0120]	[-0.0126, 0.0119]	[-0.0105, 0.0103]	[-0.0105, 0.0103]	
	trG	[-0.0126, 0.0122]	[-0.0127, 0.0121]	[-0.0106, 0.0104]	[-0.0106, 0.0104]	

Correlated uncertainties for ATLAS+CMS combination: luminosity and theoretical uncertainty on signal.
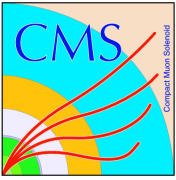
Observed limits (f5)
with full uncertainty

All within 1%!

1D deltaNLL limit			f_5^γ		f_5^Z	
ATLAS input:		**CMS code**	**ATLAS code**	**CMS code**	**ATLAS code**	
4l	**lnN**	-	-	-	-	
	trG	[-0.0182, 0.0182]	[-0.0183, 0.0182]	[-0.0155, 0.0156]	[-0.0155,0.0156]	
2l2nu	**lnN**	-	-	-	-	
	trG	[-0.0205, 0.0192]	[-0.0204, 0.0192]	[-0.0172, 0.0162]	[-0.0172, 0.0162]	
4l +2l2nu	**lnN**	[-0.0151, 0.0144]	[-0.0152, 0.0145]	[-0.0128, 0.0122]	[-0.0129, 0.0123]	
	trG	[-0.0153, 0.0146]	[-0.0154, 0.0147]	[-0.0129, 0.0124]	[-0.0130, 0.0124]	

1D deltaNLL limit			f_5^Z		f_5^γ	
CMS input:		**CMS code**	**ATLAS code**	**CMS code**	**ATLAS code**	
4l	**lnN**	[-0.0129,0.0126]	[-0.0128, 0.0125]	[-0.0107, 0.0109]	[-0.0107, 0.0109]	
	trG	[-0.0129, 0.0126]	[-0.0128, 0.0125]	[-0.0107, 0.0109]	[-0.0107, 0.0109]	

1D deltaNLL limit			f_5^Z		f_5^γ	
		CMS code	**ATLAS code**	**CMS code**	**ATLAS code**	
combined	**lnN**	[-0.0108, 0.0103]	[-0.0108, 0.0103]	[-0.00906, 0.00886]	[-0.00902, 0.00885]	
	trG	[-0.0108, 0.0104]	[-0.0108, 0.0103]	[-0.00908, 0.00890]	[-0.00907, 0.00891]	

Correlated uncertainties for ATLAS+CMS combination: luminosity and theoretical uncertainty on signal.

2% off all other within 1%

1D deltaNLL limit			f_4^γ		f_4^Z	
ATLAS input:		CMS code	ATLAS code	CMS code	ATLAS code
4l	lnN	[-0.0175, 0.0175]	[-0.0176, 0.0176]	[-0.0150, 0.0150]	[-0.0150, 0.0150]
	trG	[-0.0177, 0.0176]	[-0.0177, 0.0177]	[-0.0151, 0.0151]	[-0.0152,0.0153]
2l2nu	lnN	[-0.0177, 0.0176]	[-0.0177, 0.0176]	[-0.0149, 0.0149]	[-0.0149, 0.0149]
	trG	[-0.0183, 0.0182]	[-0.0184, 0.0183]	[-0.0154, 0.0154]	[-0.0155, 0.0155]
4l +2l2nu	lnN	[-0.0144, 0.0143]	[-0.0143, 0.0143]	[-0.0122, 0.0122]	[-0.0122, 0.0122]
	trG	[-0.0147, 0.0147]	[-0.0145, 0.0145]	[-0.0125, 0.0125]	[-0.0124, 0.0124]

1D deltaNLL limit			f_4^Z		f_4^γ	
CMS input:		CMS code	ATLAS code	CMS code	ATLAS code
4l	lnN	**[-0.0140,0.0145]**	**[-0.0138, 0.0148]**	[-0.0140,0.0145]	[-0.0137, 0.0148]
	trG	**[-0.0140, 0.0145]**	**[-0.0138, 0.0148]**	[-0.0140, 0.0145]	[-0.0138, 0.0148]

1D deltaNLL limit			f_4^Z		f_4^γ	
		CMS code	ATLAS code	CMS code	ATLAS code
combined	lnN	[-0.0119, 0.0123]	[-0.0120, 0.0123]	[-0.0102, 0.0104]	[-0.0102, 0.0104]
	trG	[-0.0120, 0.0125]	[-0.0121, 0.0125]	[-0.0103, 0.0105]	[-0.0103, 0.0105]

Correlated uncertainties for ATLAS+CMS combination: luminosity and theoretical uncertainty on signal.

Observed limits (f4)
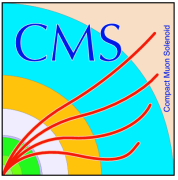## with full uncertainty

All within 1%!

1D deltaNLL limit		f_4^γ		f_4^Z	
ATLAS input:		**CMS code**	**ATLAS code**	**CMS code**	**ATLAS code**
4l	**lnN**	-	-	-	-
	trG	[-0.0180, 0.0180]	[-0.0180, 0.0180]	[-0.0154, 0.0154]	[-0.0154,0.0154]
2l2nu	**lnN**	-	-	-	-
	trG	-	[-0.0195, 0.0194]	-	[-0.0165, 0.0164]
4l +2l2nu	**lnN**	[-0.0146, 0.0146]	[-0.0147, 0.0146]	[-0.0124, 0.0124]	[-0.0125, 0.0125]
	trG	[-0.0148, 0.0148]	[-0.0148, 0.0148]	[-0.0126, 0.0126]	[-0.0126, 0.0126]

1D deltaNLL limit		f_4^Z		f_4^γ	
CMS input:		**CMS code**	**ATLAS code**	**CMS code**	**ATLAS code**
4l	**lnN**	[-0.0122,0.0134]	[-0.0122, 0.0133]	[-0.0104,0.0111]	[-0.0104, 0.0111]
	trG	[-0.0122, 0.0133]	[-0.0121, 0.0133]	[-0.0104, 0.0111]	[-0.0104, 0.0111]

1D deltaNLL limit		f_4^Z		f_4^γ	
		CMS code	**ATLAS code**	**CMS code**	**ATLAS code**
combined	**lnN**	[-0.0102, 0.0108]	[-0.0102, 0.0108]	[-0.00871, 0.00909]	[-0.00870, 0.00907]
	trG	[-0.0103, 0.0109]	[-0.0103, 0.0108]	[-0.00874, 0.00913]	[-0.00875, 0.00912]

Correlated uncertainties for ATLAS+CMS combination: luminosity and theoretical uncertainty on signal.
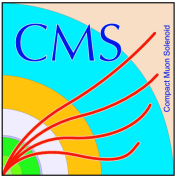
Problematic Expected limit (f4) in close

Comparison of limits while adding uncertainties one-by-one in the fit.

1D deltaNLL limit (trG)	f_4^Z		
CMS input:	CMS code	ATLAS code	Relative difference (%)
no uncertainty	[-0.013771, 0.014343]	[-0.013789, 0.014398]	[-0.13, -0.38]
ZZ other only	[-0.013967, 0.014531]	[-0.014054, 0.014561]	[-0.62, -0.21]
adding ZZ theory	[-0.013975, 0.014539]	[-0.014074, 0.014551]	[-0.71, -0.08]
adding bkg uncertainty	[-0.013975, 0.014539]	[-0.013976, 0.014536]	[-0.00, 0.02]
adding lumi (all uncertainties)	[-0.013979, 0.014539]	[-0.013841, 0.014794]	[0.99, -1.76]
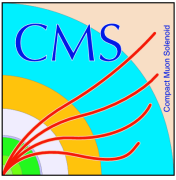
Open questions and todo list

Open questions

Statistical criteria for final combined measurement
- Both experiments agree that F-C is appropriate criteria?
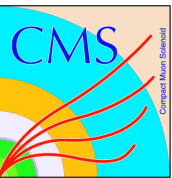
Uncertainty shape
- Both experiments agree with lnN shape?

Definition of expected limit
- Asimov dataset or toys?
- A posteriori (post-fit: with nuisance parameters set to best fit values from fit on data) vs a priori (pre-fit: all nuisance parameters set to 0) expected
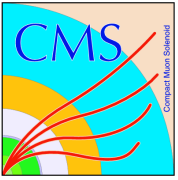
Todo list
- Understand and fix disagreement in expected f_4^z limit for CMS input
  - Run 2D limits
  - Run F-C limits

Backup

Uncertainty table for the combination

uncertainty	ATLAS: 4l [p_TZ]	ATLAS: 2l2nu [p_TZ]	CMS: 4l [MZZ]
N_bins	*4*	*3*	*5 (x3 channels)*
Luminosity	3.9%	3.9%	2.2%
Stat on signal	Shape (UNCORR bins)	-	-
	-	Shape (UNCORR bins)	-
Stat on bkg data-driven	Shape (UNCORR bins)	-	-
	-	Shape (UNCORR bins)	-
Stat on bkg MC	-	Shape (UNCORR bins)	-
Reco uncertainty	Shape (CORR bins)	Shape (CORR bins)	-
Syst on bkg data-driven	Shape (cross CORR bins)	Shape (cross CORR bins)	-
Syst on bkg MC	-	Shape (CORR bins)	-
Total bkg uncertainty	-	-	Per channel (CORR bins)
Signal other (stat+fit+reco)	-	-	13.42% (CORR bins, CORR channel)
Signal theory (PDF+scale)	Shape (CORR bins)	Shape (CORR bins)	4% (CORR bins)

Uncertainties in the same row are correlated!