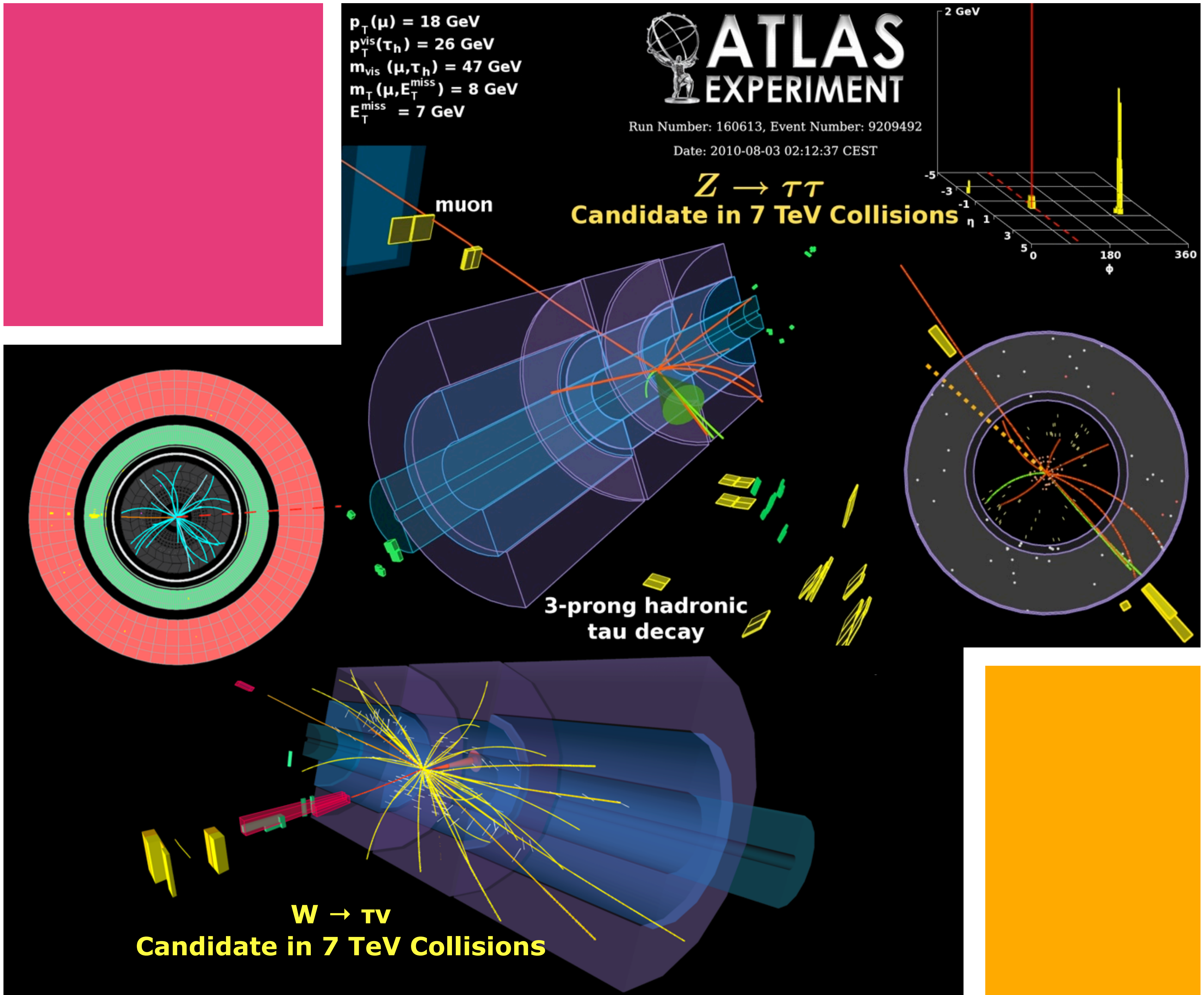
Status and plans of tau analyses



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ATLAS Italia Workshop, Napoli 18-19 Maggio 2011

Outline

- WZ analyses in tau channels
  - Status of the analyses in ATLAS and italian contribution
  - $W \rightarrow \tau\nu$ and $Z \rightarrow \tau\tau$ cross section measurement
- Performance studies within tau channels
- A/H $\rightarrow \tau\tau$: present ATLAS status, plans to re-enter the analysis
- Conclusion and future plans

WZ analyses in tau channels

- $W \to \tau\nu$ and $Z \to \tau\tau$ analyses are now in SM W/Z signatures group
- People involved in Italy (Milano group):
  - $W \to \tau\nu$: A. Andreazza, L. Dell'Asta, R. Cuozzo
  - $Z \to \tau\tau$: D. Cavalli, S. Consonni, C. Pizio.
- Main collaborations (mainly one/few persons groups)
  - $W \to \tau\nu$: Bonn, Desy, SFU
  - $Z \to \tau\tau$: Freiburg, Cracow, Oxford, Washington...
- Recent work in which we have been involved:

- $W \to \tau\nu$
  - observation (ATLAS-CONF-2010-097, ATL-COM-PHYS-2010-661, ATL-COM-PHYS-2010-520)
  - cross section measurement (going for paper STDM-2011-23)
- $Z \to \tau\tau \to$ lephad
  - observation (ATLAS-CONF-2011-010, ATL-COM-PHYS-2010-1033, ATL-COM-PHYS-2010-775)
  - cross section measurement (ATL-COM-PHYS-2011-416, ATL-COM-PHYS-2011-418, ATL-COM-PHYS-2011-419, going for paper STDM-2011-18, trying to be able to have open discussion before "Rencontres de Blois" conference) (contribution to the lep-lep channel too)

General methodology for cross sections

Total cross section:

$$\sigma_{tot} = \frac{N_{obs} - N_{bkg}}{A_Z C_Z \mathcal{L}}$$

$$C_Z = \frac{N^{reco\,pass}}{N^{gen\,kin}_{dressed}}$$

Efficiency correction factor: the denominator of Cz defines the fiducial phase space as close as possible to what we are looking at experimentally on truth level. The numerator is determined from full simulated MC. This factor encloses all the trigger, reconstruction and identification efficiencies for the various objects.

Fiducial cross section: defined only for the fiducial phase space. It does not include tentatively any extrapolation to other regions, and therefore it should be virtually model independent.

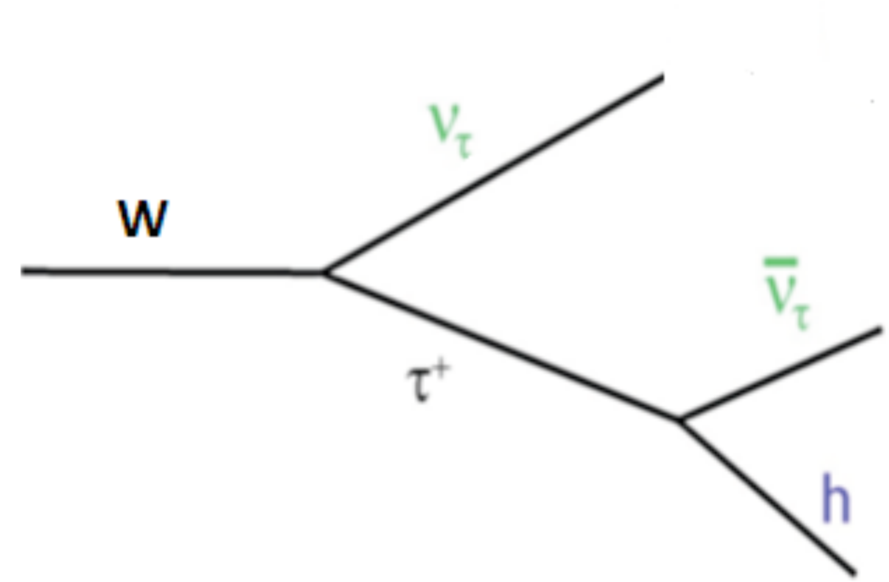
$$\sigma_{fid} = \frac{N_{obs} - N_{bkg}}{C_Z \mathcal{L}}$$

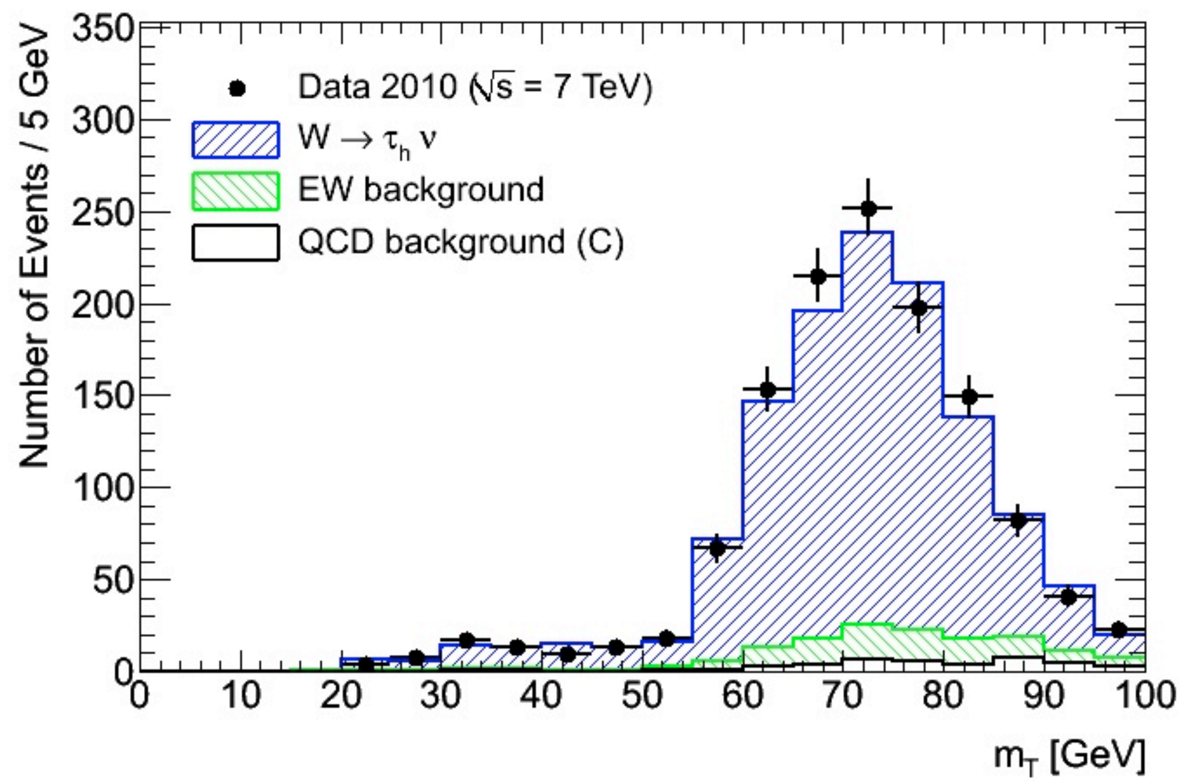
$$A_Z = \frac{N^{gen\,kin}_{dressed}}{N^{gen\,m_{inv}}_{born}}$$

Acceptance factor: it allows to correct the fiducial cross section back to other channels and theory.
Correction back to “Born” (pre FSR) level (as WZ inclusive analyses)

W→ τν analysis

- Study possible only up to 2010 data (luminosities < 10^{32} $cm^{-2}s^{-1}$ due to pileup and tau+met trigger rate)
- First hadronic tau candidate seen in ATLAS
- Most abundant source of τ in early running → used for tauID efficiencies studies (ATLAS-COM-CONF-2011-085)
- The measurement of the cross section allows to demonstrate the capability of ATLAS in tau channels
- General rehearsal for $H^{\pm} \rightarrow \tau\nu$ analyses: most striking signature of an extended Higgs sector



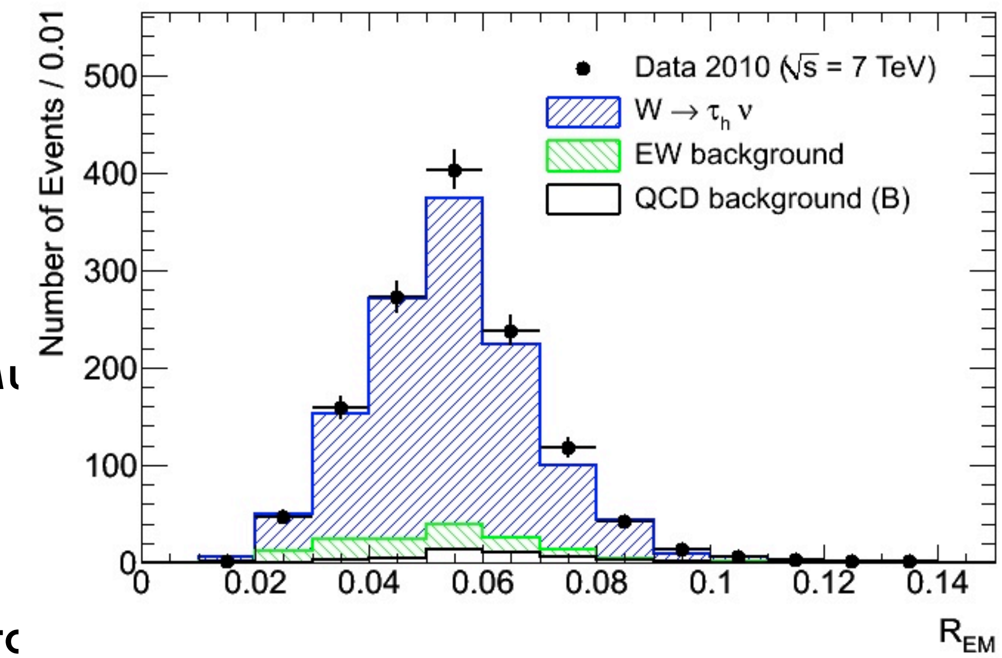


Selection

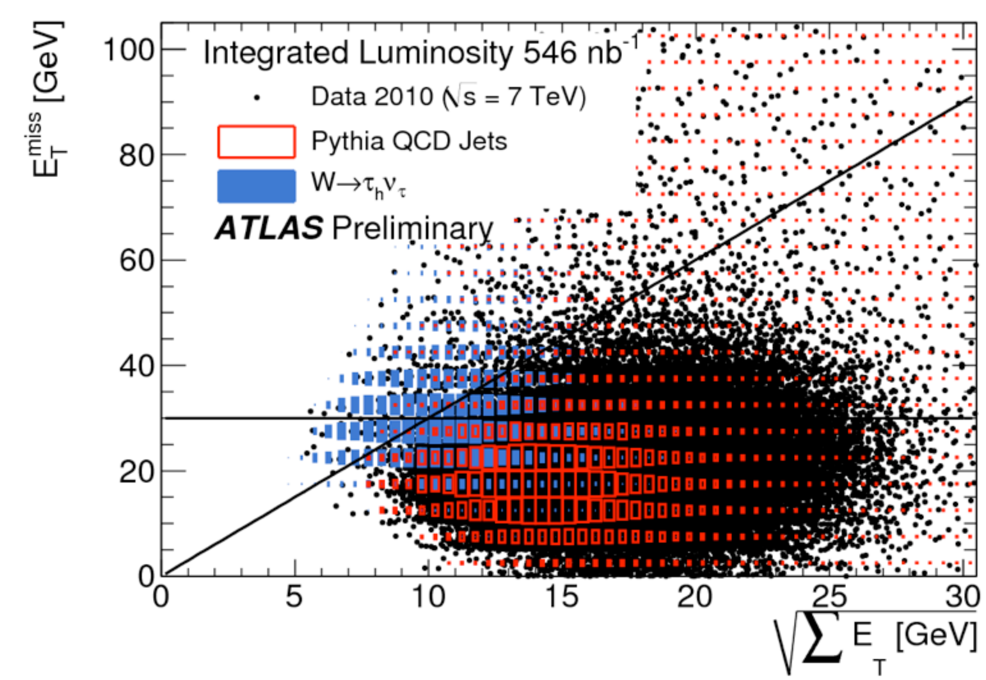
- Data quality: GRL WZ + cp_tau
- Trigger (34.3 pb-1):
  - First period (10.7 pb-1): EF_tau12_loose_xe20_noMu,
  - Second period (23.6 pb-1): EF_tau16_medium_xe22_noMu (EF_tau12_loose_xe20_noMu for inverted TauID QCD control region)
- Hard cleaning: collision candidates, event veto on loose bad jets, veto jets in the crack, Δphi(jet-met) > 0.5
- Signature:
  - Etmiss > 30 GeV
  - ID τ-jet (BDT medium 1-prong, tight multi-prong), pt in [20, 60] GeV, not in the crack
- WZ suppression: lepton vetoes (τ-jet object lepton vetoes and event level veto for electrons and muons with pt > 15 GeV)
- QCD rejection: Etmiss significance Etmiss/0.5√(ΣEt) > 6

Reweighted in-time pile-up was used

TauID: EM radius



Etmiss vs √ (ΣEt)

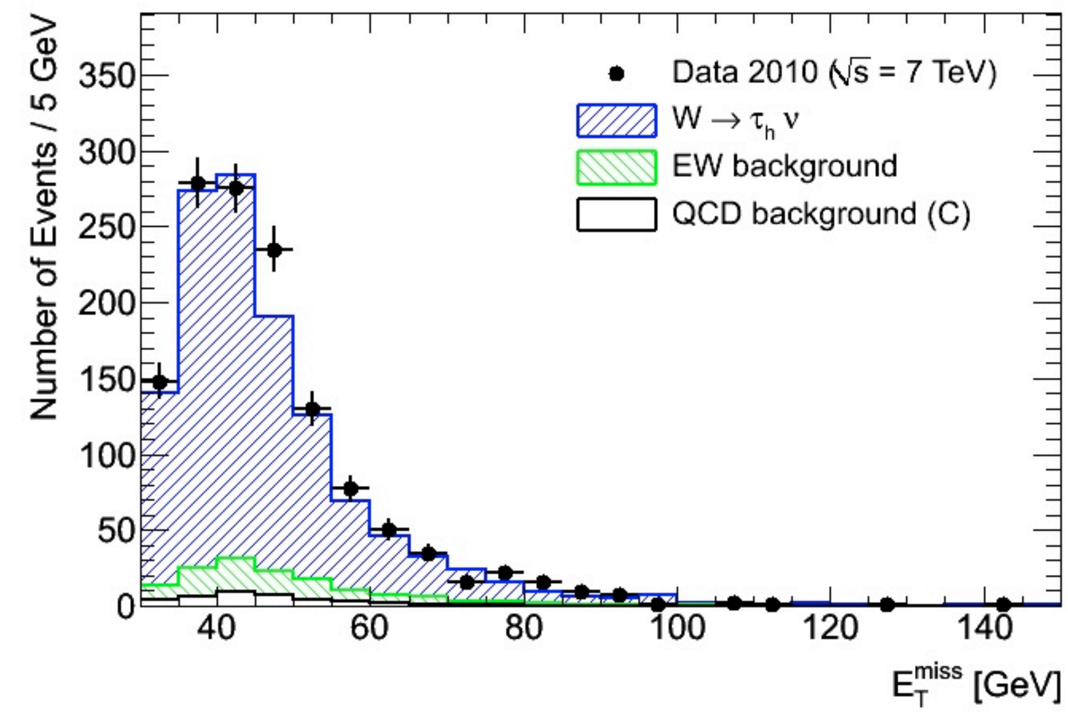


Background estimation

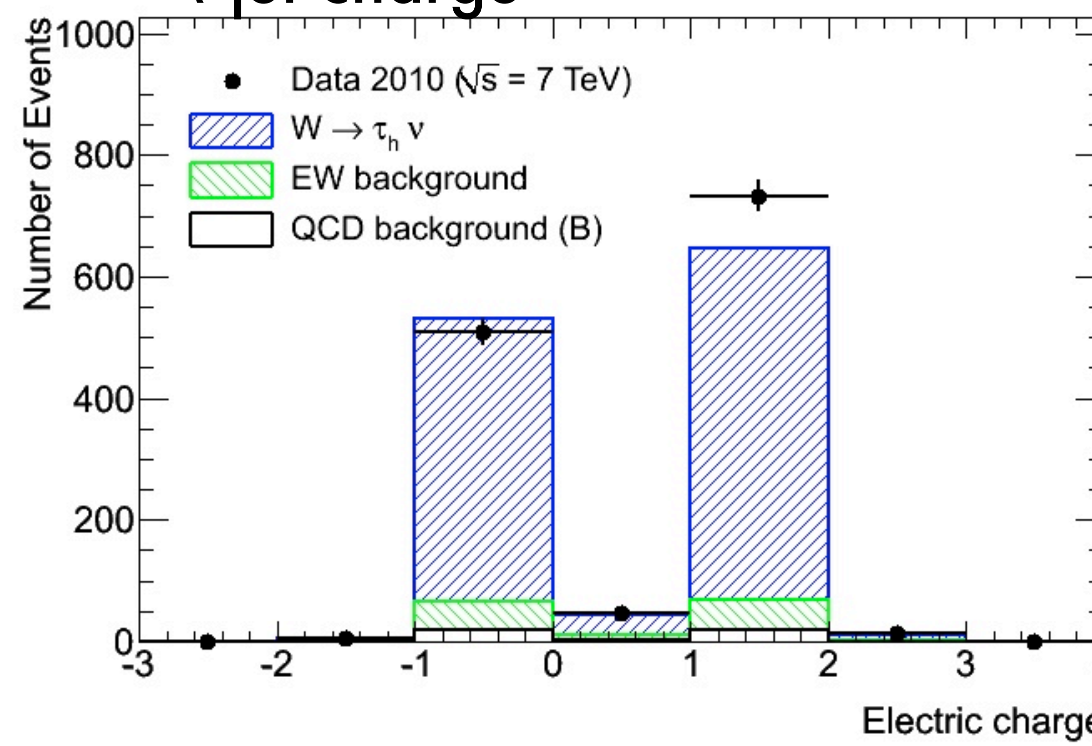
- Data driven estimate of the QCD background, with ABCD method (corrections for EW contamination in control regions from MC)
- Etmiss significance → event level, TauID → local to the τ-jet
- EW backgrounds: W→ lν , Z→ ll, ttbar are from Monte Carlo (normalized to NNLO cross section)

Primary	Etmiss Significance > 6	Etmiss Significance < 6
Tau Tight	A	B
Tau Loose but not Tight	C	D

Etmiss



τ-jet charge

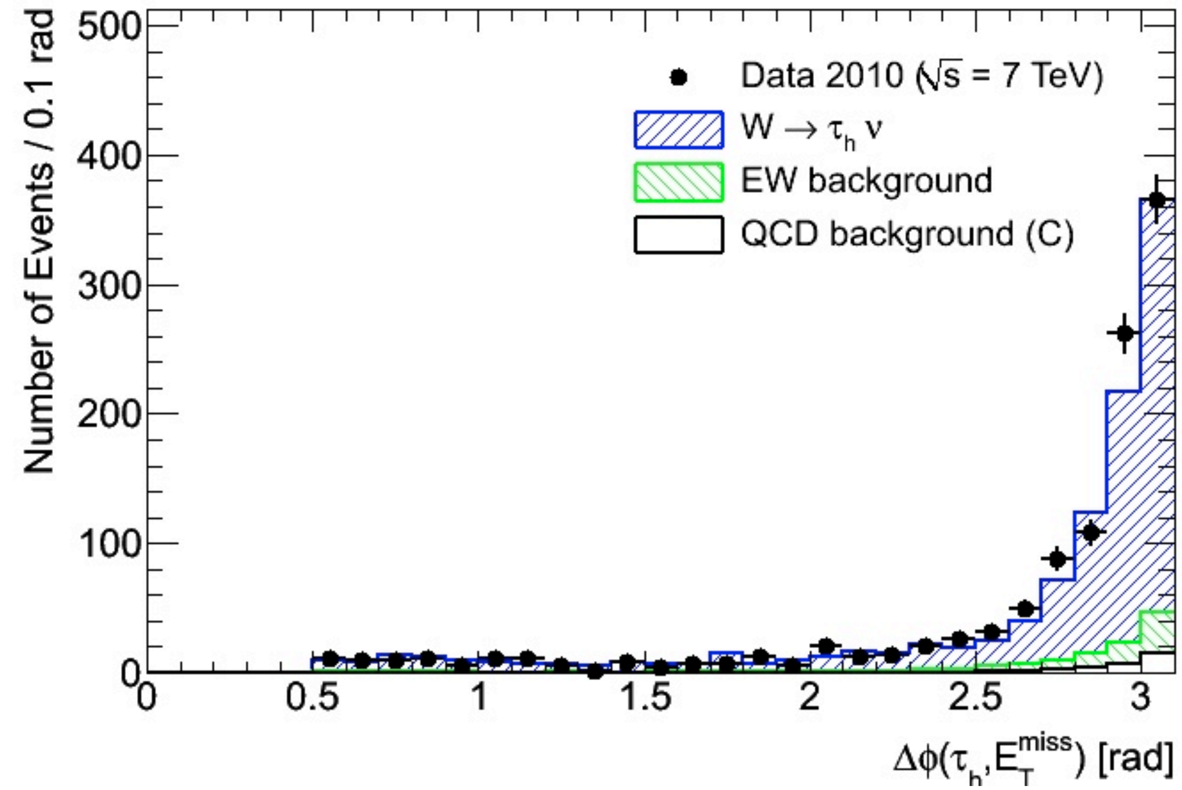


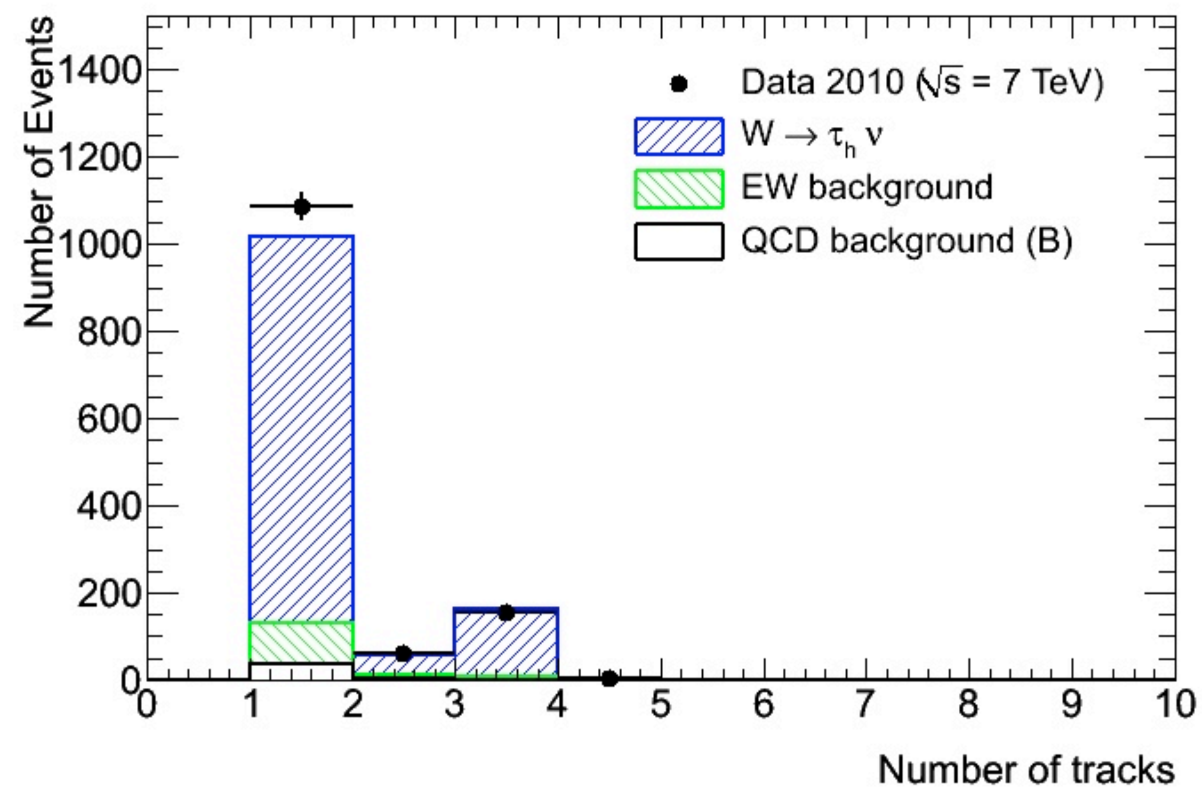
W→ τν cross-section measurements

Fiducial region defined by:
- τ-jet and Etmiss kinematics
- Angular cut Δphi(jet-met) > 0.5

Systematics are in progress
Still under discussion:
- Etmiss and ΣEt systematics (entering etmiss significance)
- Systematic on combined trigger efficiency

- No preliminary results yet, discussion still ongoing on hot aspects of the analysis:
- MET_RefFinal vs MET_LocHadTopo
- Discovered inconsistencies in the trigger between data and MC

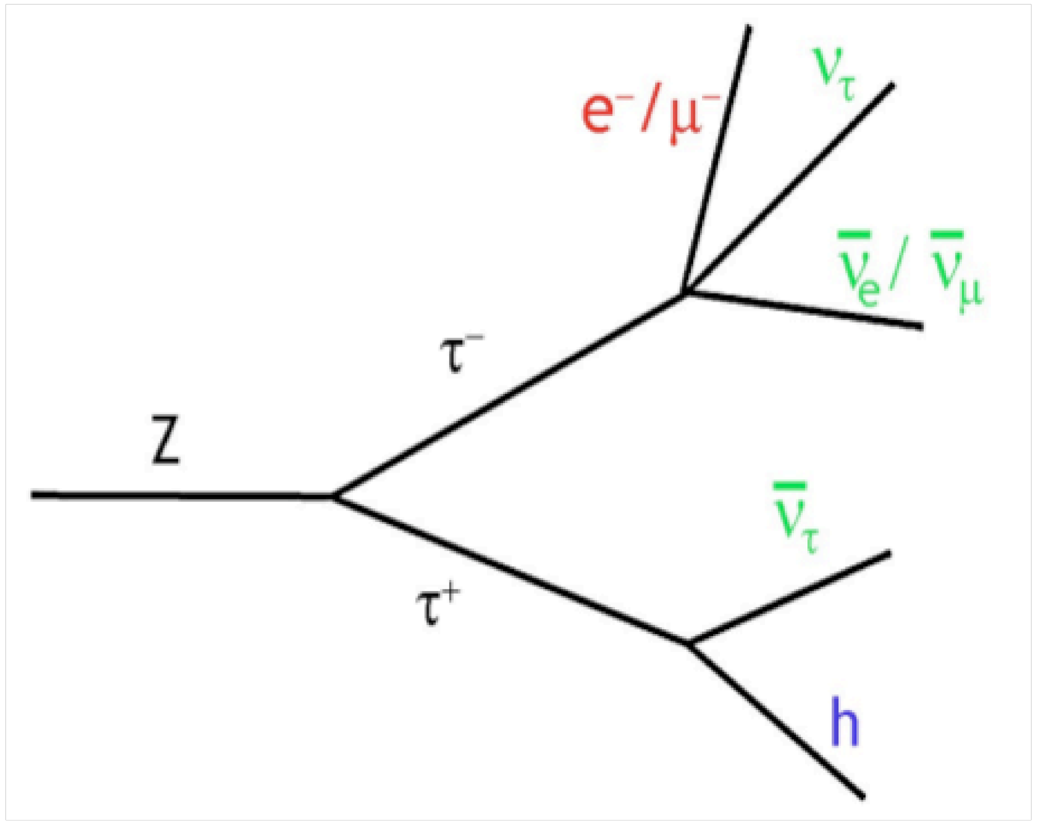


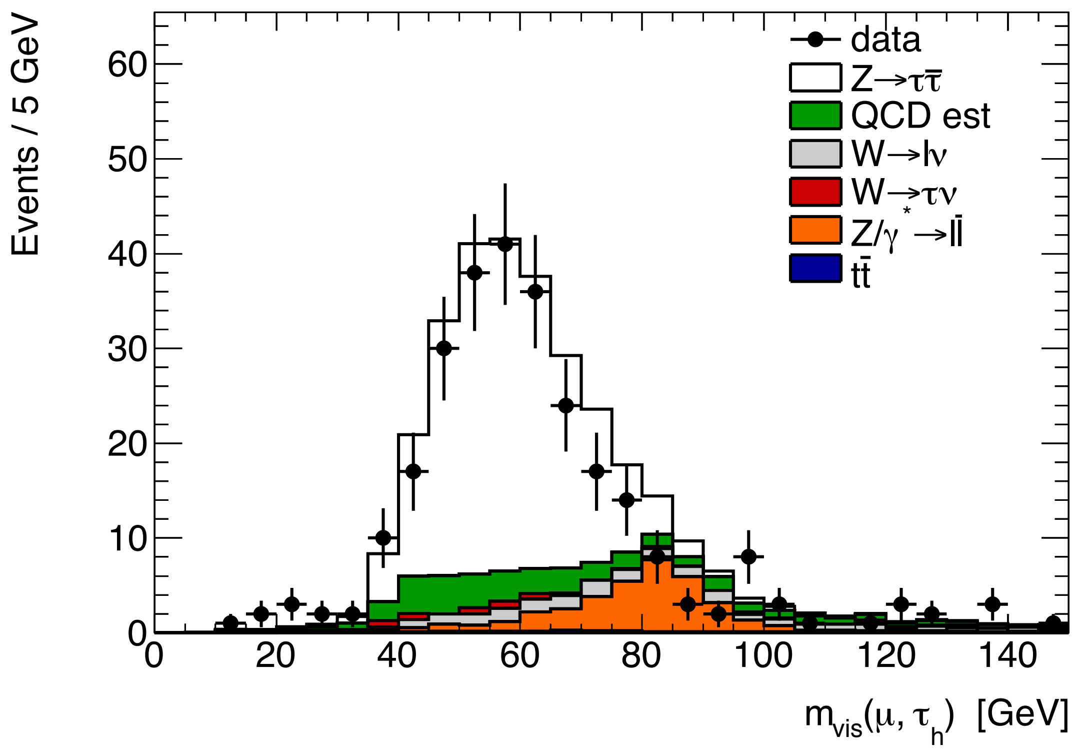


$Z \rightarrow \tau\tau$ production and decay

- Cross section factor 10 smaller than $W \rightarrow \tau\nu$
- Lepton-hadron channel: much cleaner, large BR (45%), possibility to use single lepton triggers
- First cross section measurement:
  - global check of the comprehension of analyses involving tau decay channels
  - complete electron and muon channels
  - eventually tests of universality if precision is sufficient
- Trigger unbiased control samples for tau performance studies
- Important background for many Higgs ($A/H \rightarrow \tau\tau$), SUSY, exotics, physics searches $\rightarrow$ needs to be well measured and understood

- Electron-muon and muon-muon channels were studied as well and the cross section measurements are now combined

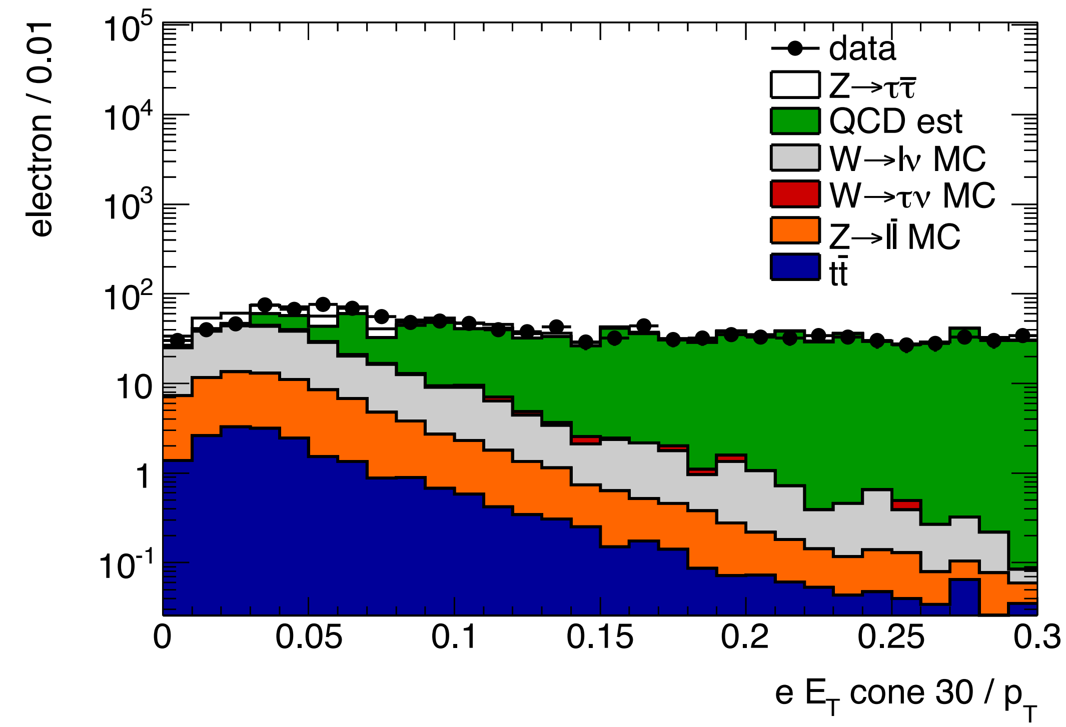


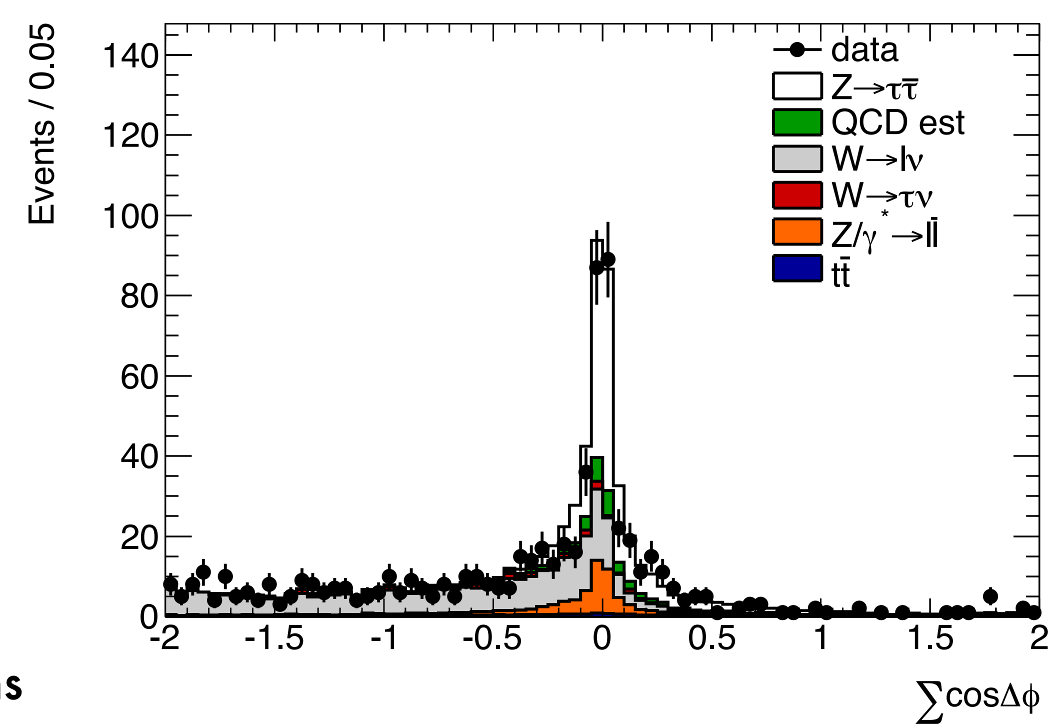


Selection

- Data quality: GRL WZ + cp_tau
- Trigger:
- Electron channel: EF_e15_medium,
- Muon channel (35.5 pb-1): EF_mu10_MG (E4-G1), EF_mu13_MG (G2-I1), EF_mu13_MG_tight (I1-I2)
- Cleaning: medium with tau modification
- Signature:
  - Electron channel: tight electron pt > 16 GeV not in the crack, isolated
  - Muon channel: combined muon pt > 15 GeV, isolated
  - ID τ-jet (medium 1-prong, tight multi-prong), pt 20 > GeV, not in the crack
- W suppression: angular correlations
  - cos(Δϕ(lep, Etmiss)) + cos(Δϕ(τ-jet, Etmiss)) > - 0.15,
  - mT < 50 GeV
- QCD rejection: τ-jet unitary charge and 1 or 3 associated tracks
- Z→ ll suppression: lepton vetoes (τ-jet object lepton vetoes and event level veto dilepton veto with loosely selected objects)
- Opposite charge of the lepton and τ-jet and invariant mass of the visible decay products in [35, 75] GeV

- All recommended SF, scales, smearings applied to MC. Since pt thresholds for e-mu are lower than recommendations by CP groups, some SF were recalculated according to prescriptions. SF for electrons faking taus.
- Reweighted bunch-train pile-up is used





Background estimation

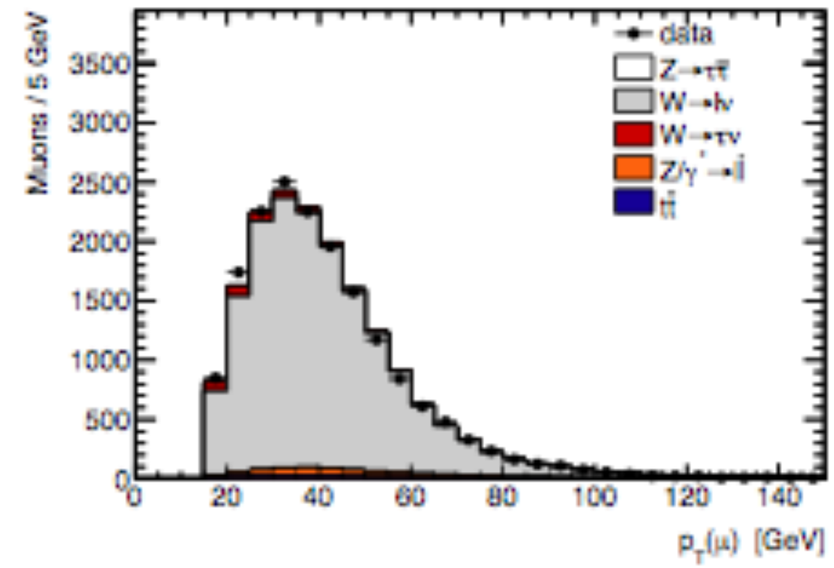
- Z → ll and ttbar from Monte Carlo normalized to NNLO
- W → lν and W → τν from Monte Carlo, with kW scale factor from data (W control region by reversing the W suppression cuts)

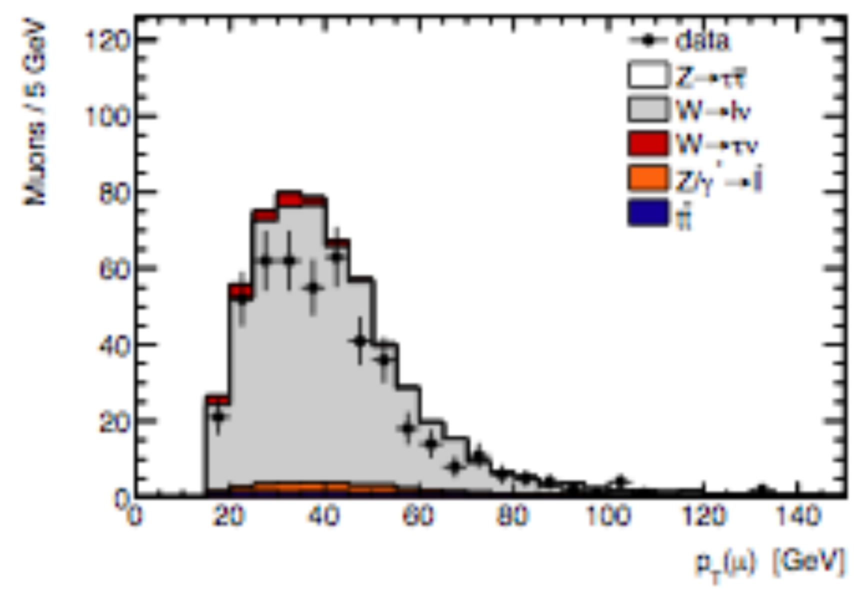
  Many studies were performed to understand cut dependencies of kW factors, consistent results applying fake rates from tauWG
- QCD from data driven estimate: ABCD
  - OS - SS method (OS-SS and isolation)

    Corrections for EW contamination in control regions from MC

    QCD shapes taken from B
  - TauID method (TauID and isolation)

    Correction for EW contamination (as for TauID method)





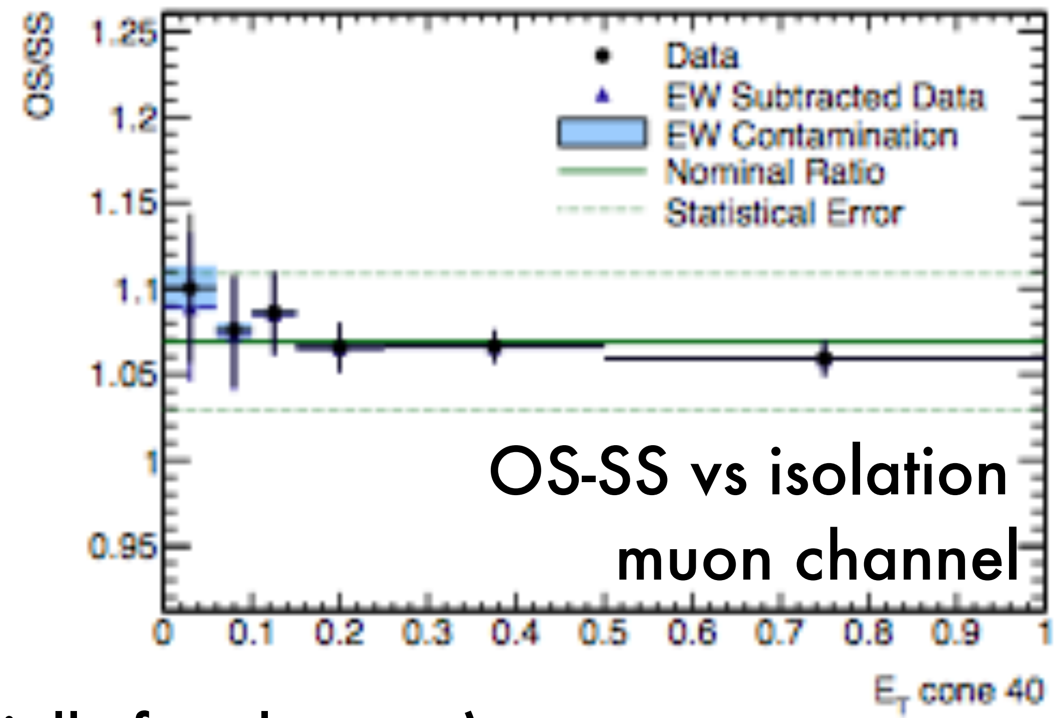
	Muon channel	Electron channel
OS-SS	24 ± 6 ± 3	23 ± 6± 4
TauID	23 ± 3 ± 4	25 ± 3 ± 3

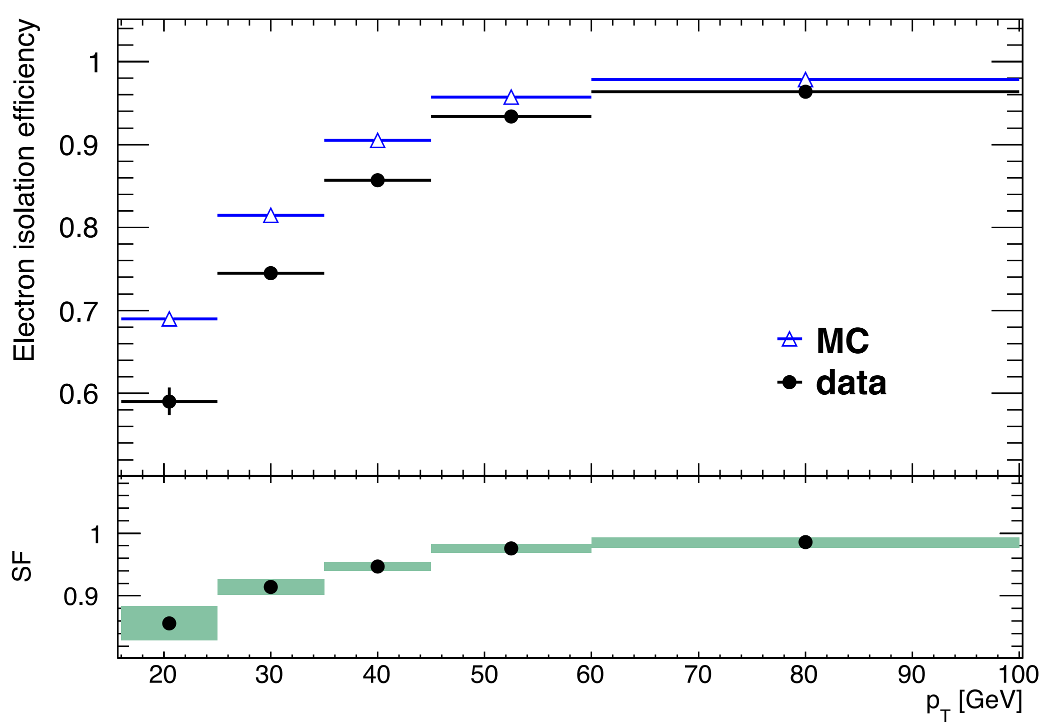
← Consistent results for QCD with the two methods

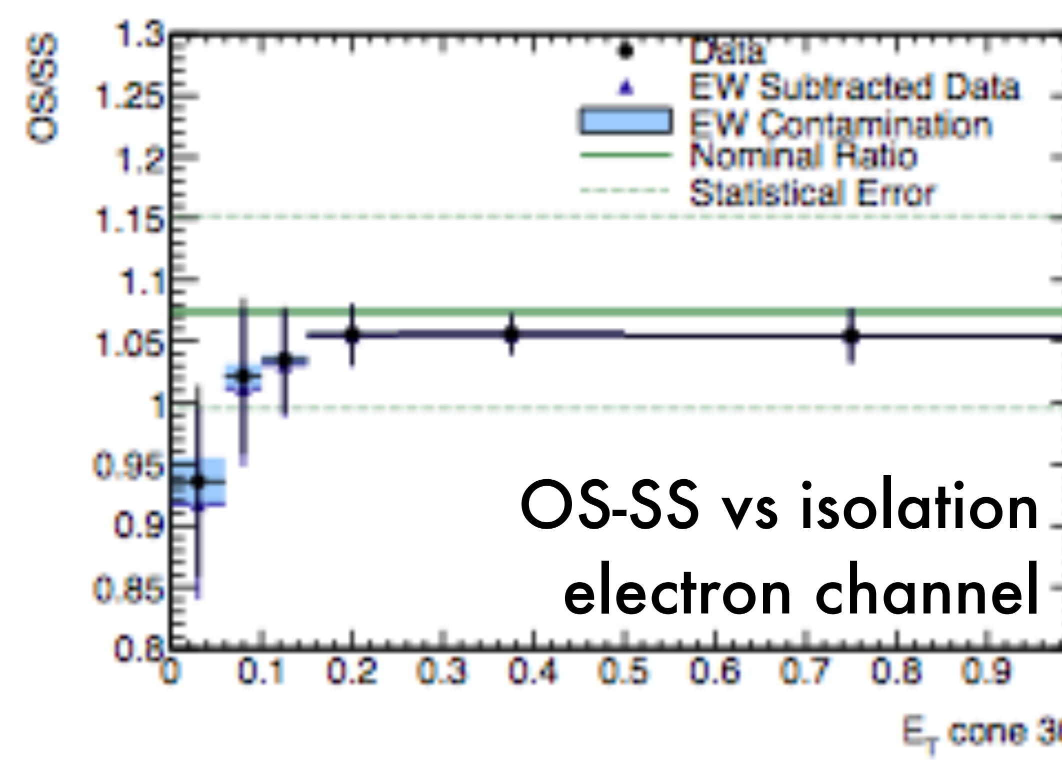
Considering all backgrounds
S/B = 3.7 muon channel
S/B = 2.6 electron channel

Systematics

- Systematics according to performance group recommendations (recalculated when necessary)
- Signal yield main systematics:
  - Tau energy scale
  - Tau fake rates
  - OS-SS method (ratio)
- Signal efficiency main systematics:
  - Tau energy scale
  - Tau identification efficiency
  - Lepton identification and isolation efficiency (especially for electrons)
- Acceptance main systematics: PDF sets

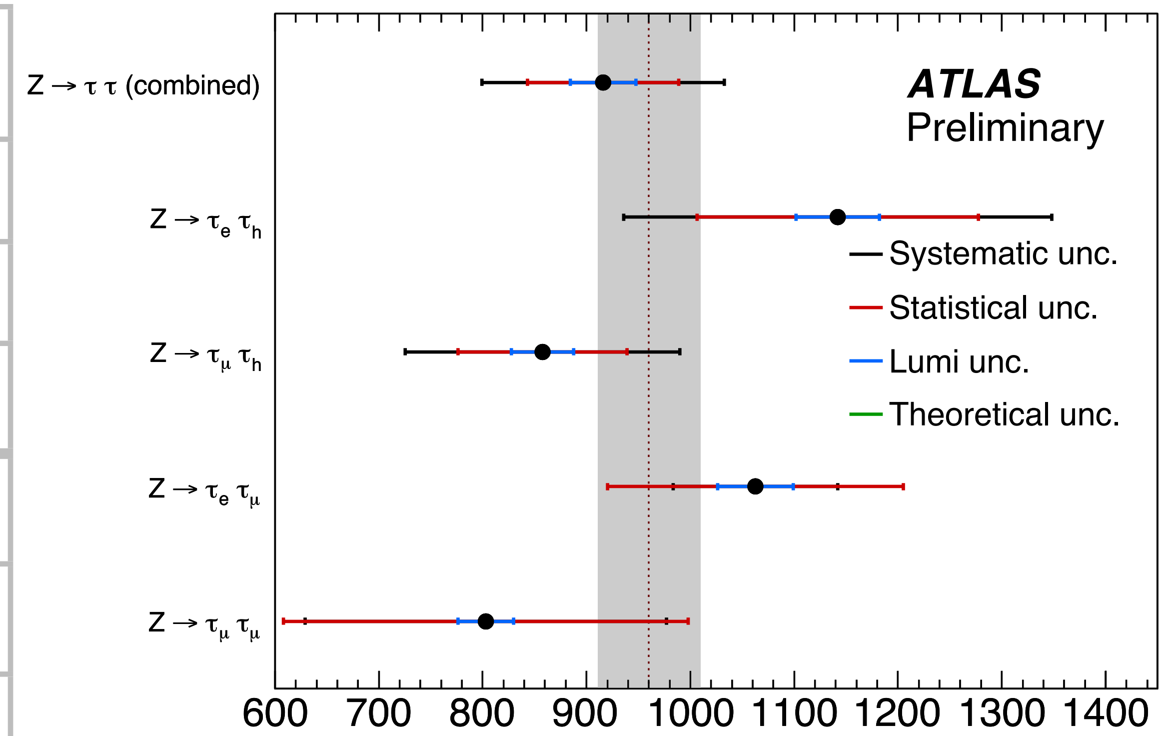


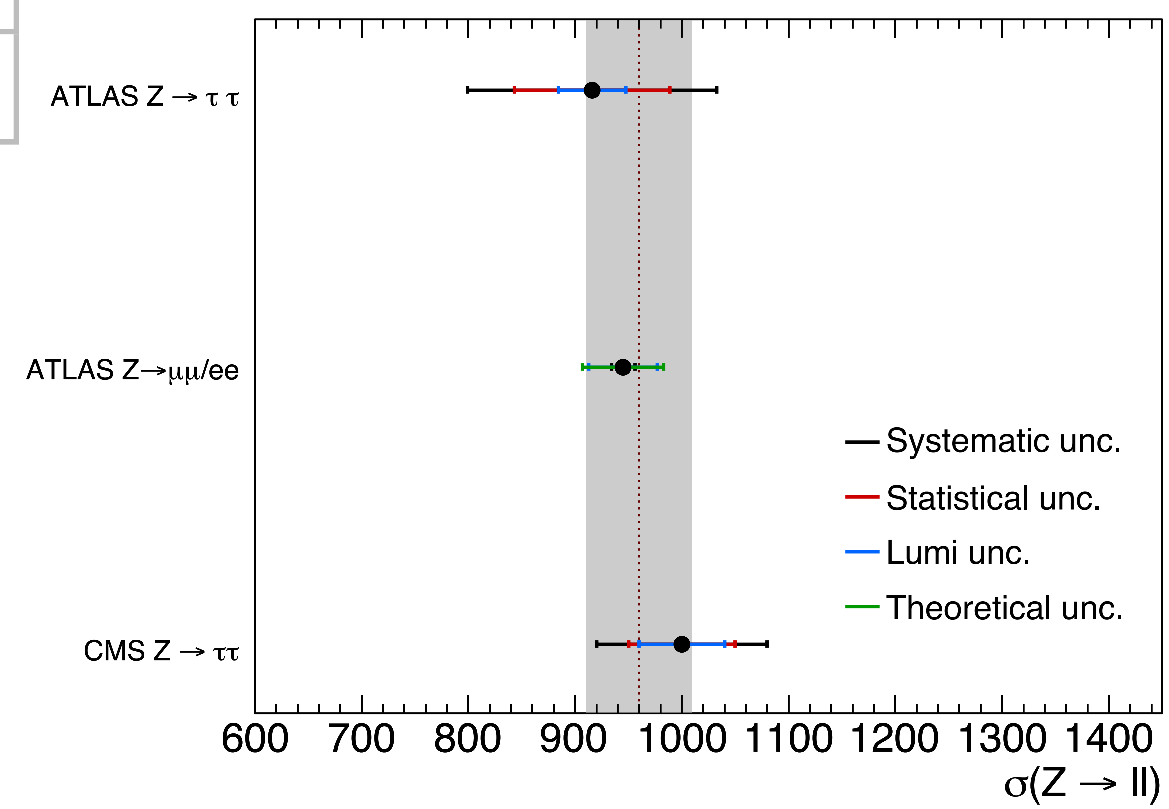




Z → ττ cross section measurement

	Muon channel
Nobs	213
σfid	22.6 ± 2.2 (stat) ± 3.2 (sys) ± 0.7 (lumi)
σtot	859 ± 84 (stat) ± 122 (syst) ± 28 (lumi) ± 3 (theo)
	Electron channel
Nobs	151
σfid	26.5 ± 3.2 (stat) ± 4.3 (sys) ± 0.9 (lumi)
σtot	1138 ± 137 (stat) ± 186 (syst) ± 37 (lumi) ± 4 (theo)





Fiducial region defined by:

- Full lepton and τ-jet kinematics
- Angular cuts, transverse mass and visible mass cuts

Total cross section in [66, 116] GeV invariant mass window

Agreement within errors with:

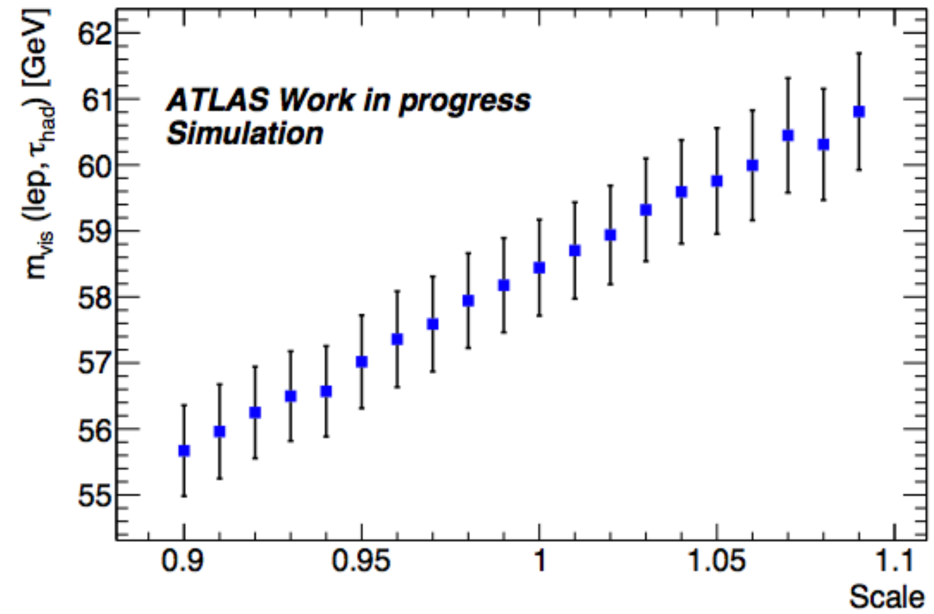
- other Z→ ττ channels
- Z→ ll channels
- CMS Z → ττ
- NNLO theory (960 ± 50 pb)

Performance using tau channels: scales

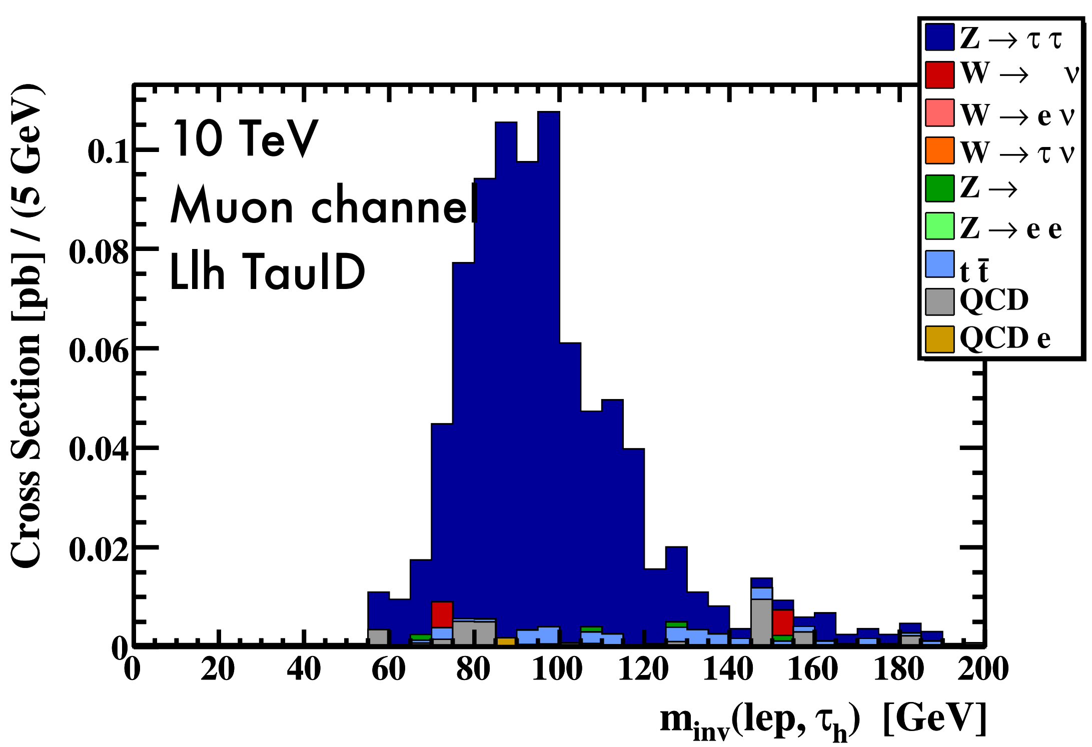
- Visible mass

$$m_{vis} = \sqrt{(p_{lep} + p_{\tau jet})^2}$$

shows a proportionality to the τ-jet scale
→ determine the scale from the visible mass peak position measured in data (comparing to MC templates)



- Last tried on MC with OS-SS subtraction of backgrounds → suffering from residual contaminations from Z→ ll especially (3.2% shift)
- To be reconsidered exploiting present knowledge
- Challenging (at Tevatron there was never a consistent result) but TauWG would like to have it



- Invariant mass (collinear approximation) shows a proportionality to the Etmiss scale
→ determine the scale from the invariant mass peak (pdg value!)
- Last tried on MC at 10 TeV, suffering from low statistics (hard cuts are needed to reconstruct the invariant mass well and with high efficiency), but very clean otherwise
- To be studied with present energy and data, high trigger pt threshold may be a problem

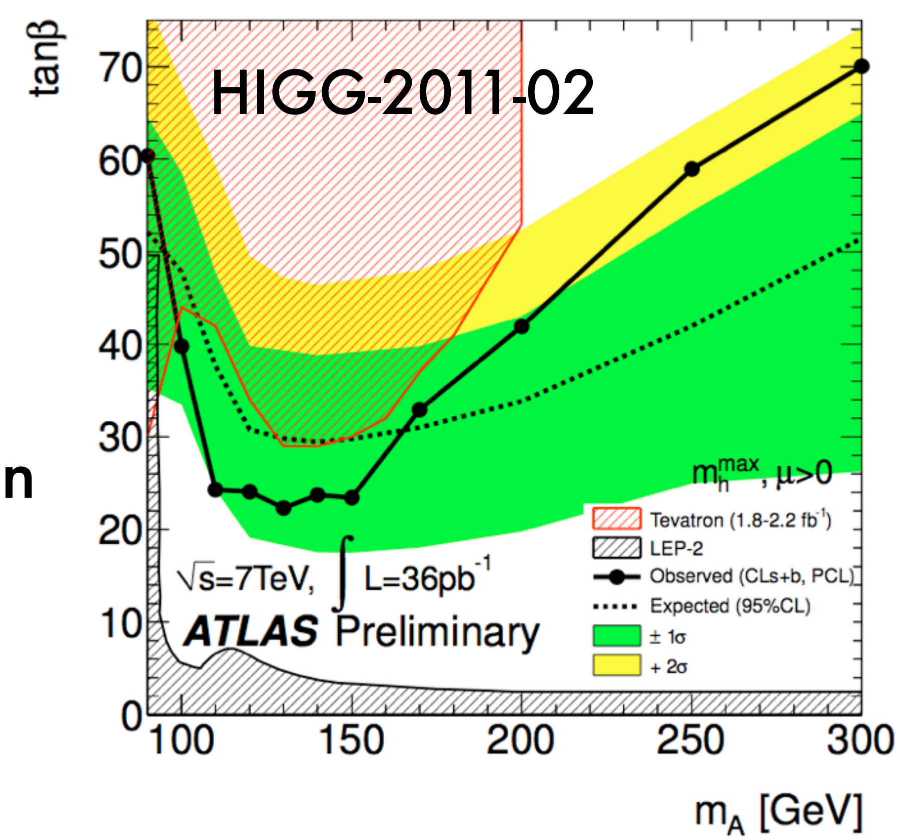
A/H → ττ: present status

Motivation:

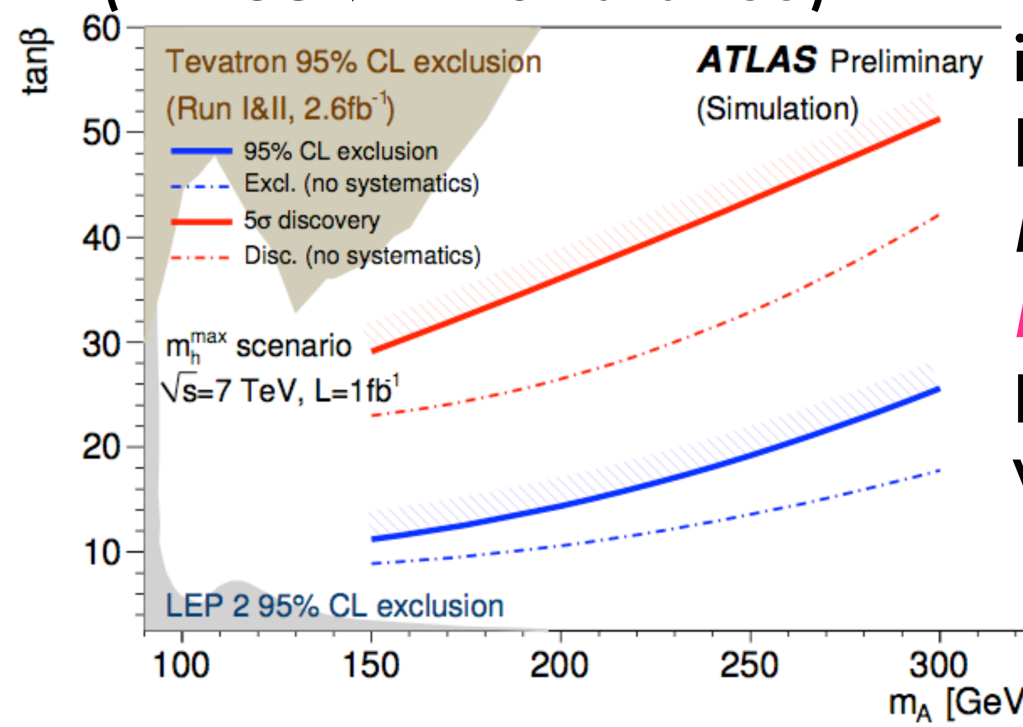
- In MSSM two Higgs doublets → 5 physical states, two charged ($H^{\pm}$) and three neutral (A, H, h)
- At tree level and no CP violating phases: just two parameters: m_A and tanβ
- A/H decays to third generation fermions are enhanced for large regions of the parameter space, where A/H masses are almost degenerate (m_A > 150 GeV)

- At the moment not involved, just starting to go back to this analysis
- At the moment loose connections with Z→ ττ analysis → more exchange is needed
- Present status in ATLAS: HIGG-2011-02 (going to PLB)

Groups involved: Freiburg, Wisconsin, Washington Tokyo...



Projection from last spring (ATL-COM-PHYS-2010-255)

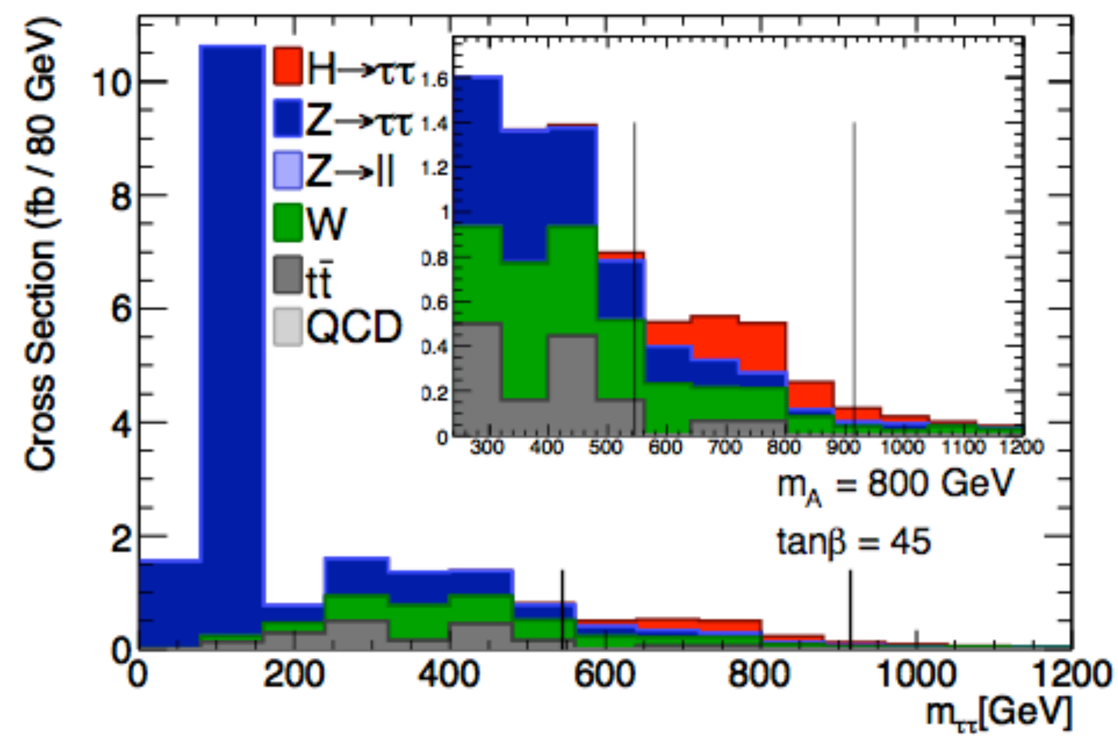


Groups involved: Dresden, Melbourne, Milano, Freiburg, Washington

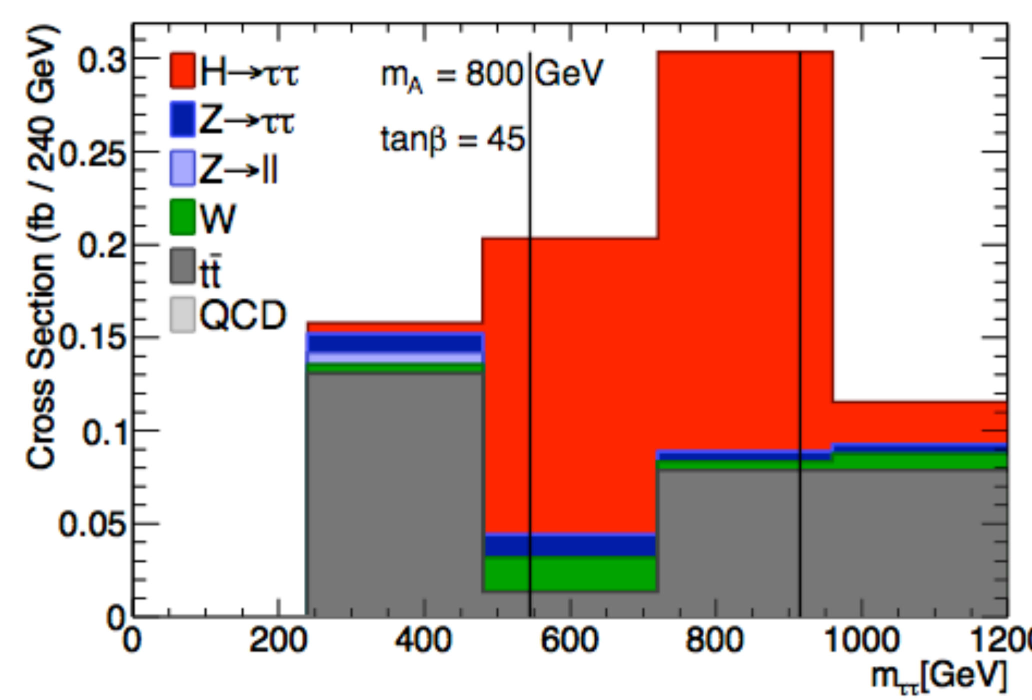
Plans to re-enter the analysis

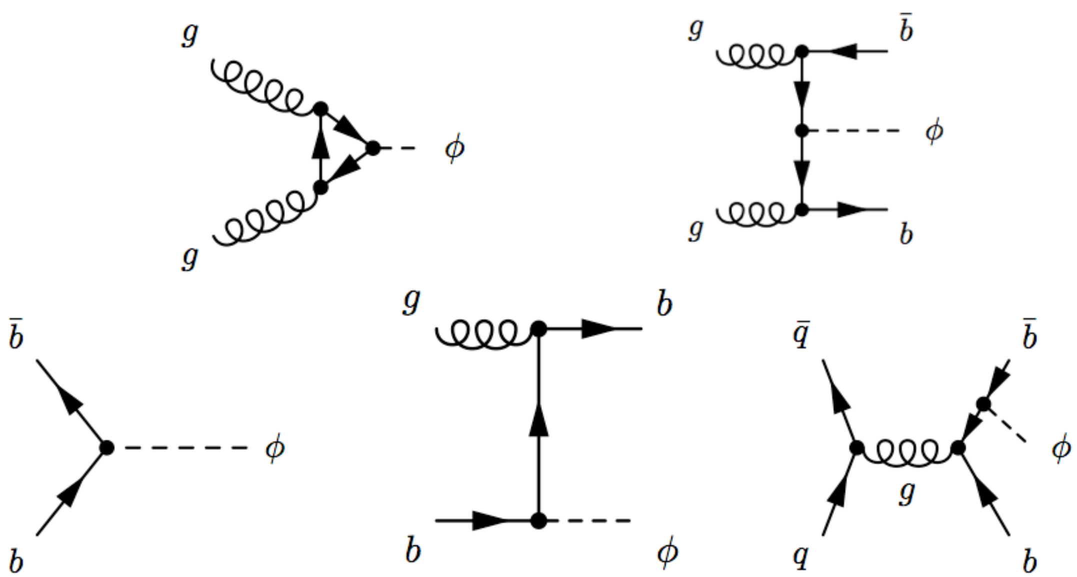
- Planning to re-enter the analysis
  - Historically first “ATLAS” analysis on this channel done in Milano
  - Contribution up to the 14 TeV and extrapolation to 7 TeV notes in 2009-2010
- Planning to re-enter now with a long-term perspective (no direct contribution to the EPS analysis but full 2011 dataset), exploiting the expertise on Etmiss and tracking performance
  - Invariant mass reconstruction using the collinear approximation
  - Splitting of the analysis by b-jet multiplicity to enhance the significance

ATL-PHYS-INT-2010-036, 14 TeV, no b-jets



ATL-PHYS-INT-2010-036, 14 TeV, b-jets





Conclusion and plans

- Presently active in the WZ to tau analyses
  - Observation of both $W\to \tau\nu$ and $Z\to \tau\tau$ channels
  - Cross-section measurements in both channels
- Possible to have a role besides the small number of persons involved.
- Leaving both now and moving the whole group to the $A/H \to \tau\tau$ analysis (end of this summer, modulo maintaing performance commitments in Etmiss and tracking groups).
- Scales determination to be done at the end of summer
- We would like to join $H^{\pm} \to \tau\nu$ analysis (searched for in ttbar events, for which there is expertise in Milano too), but lack of manpower

Backup

Selection

Preselection cuts:
- GRL (WZ + tau)
- Trigger: EF_tau16_medium_xe22_noMu (or EF_tau12_loose_xe20_noMu for the control region)

- Cleaning cuts:
  - Collision candidate: at least one vertex with N_trk >= 3
  - Jet/MET cleaning: reject the event if there is any loose bad jet (*see below for details!*)
  - Jet in crack rejection: reject the event if there is a jet with pT > 20 GeV and 1.3 < |eta| < 1.7 (*see below for more details!*)
  - DeltaPhi(jet,MET): reject event if min(DeltaPhi(jet,MET)) < 0.5 for jets with pT > 20 GeV

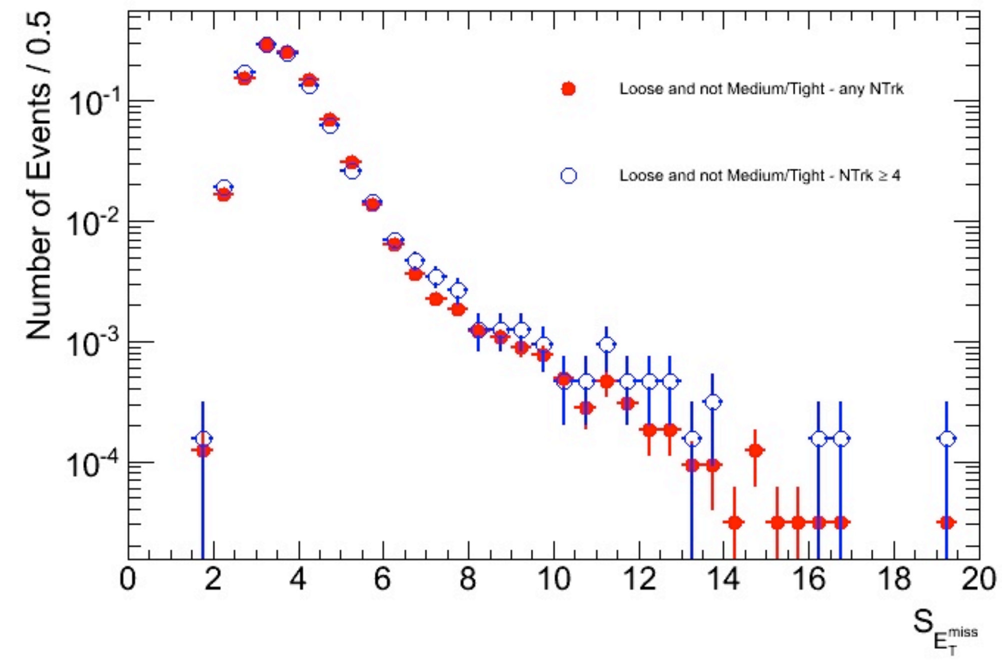
- Event signature cuts:
  - MET cut: **MET_RefFinal** > 30 GeV (was MET_LocaHadTopo)
  - Tau selection: select the leading of calo only or both seeded taus (author 1 or 3) passing:
    - BDT ID: 1 prong medium + multi prong tight
    - require this candidate to have 20 GeV < Et < 60 GeV
    - require the candidate not to have 1.3 < |eta| < 1.7

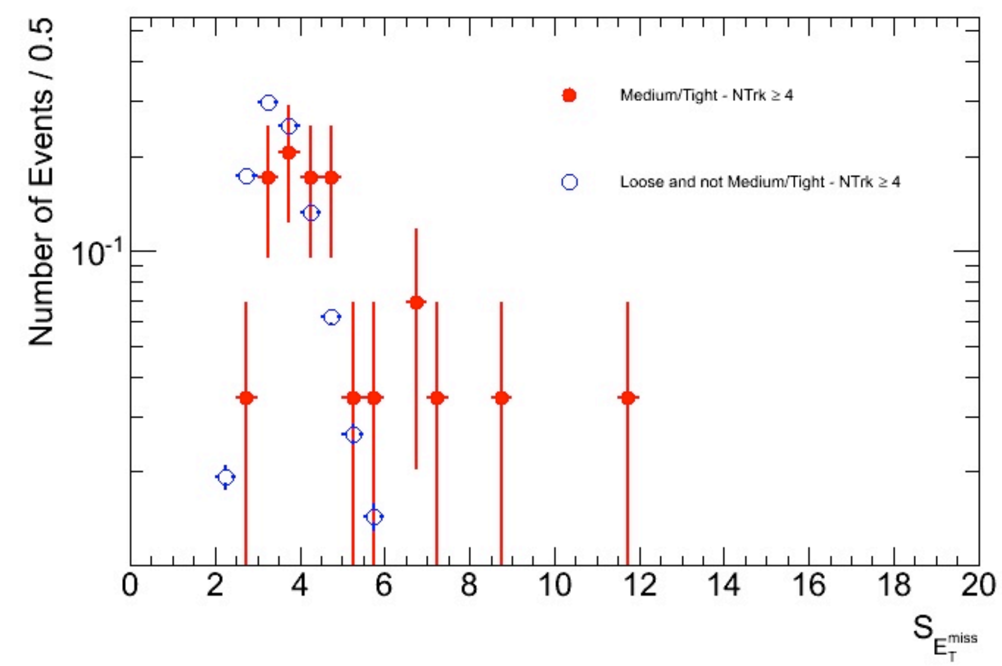
- Lepton vetoes:
  - require the tau candidate to pass the tau tight electron and muon vetoes
  - electron veto: reject the event if there is a loose electron with pT > 5 GeV
    - if(myele.pt > 5 && myele.loose = = 1 && myele.author ! = 8) return false;
  - muon veto: reject the event if there is a combined muon with pT > 5 GeV
    - if(mymu.pt > 5 && mymu.isCombinedMuon = = 1 && mymu.author = = 6) return false;

- MET significance: MET/0.5sqrt(SumET) >= 6

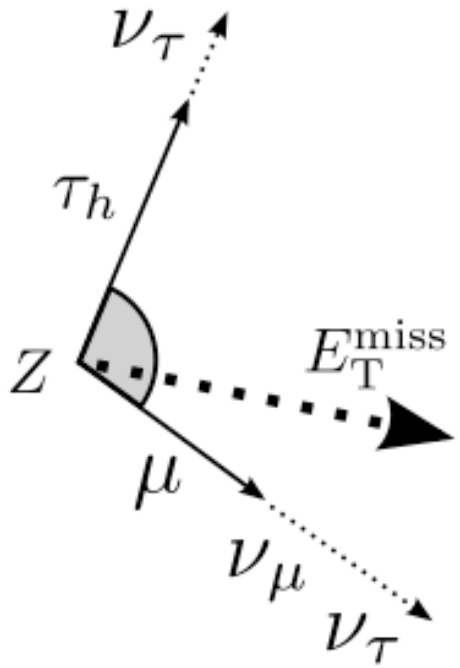
W→ τν systematics

- Systematics according to performance group recommendations
  - vertex reweighting
  - cleaning
  - Tau energy and ID
  - cross sections (EW subtraction)
  - tau fake rates and lepton vetoes efficiencies
  - underlying event modelling
  - luminosity
- Etmiss systematic (MET_RefFinal) still pending, in particular ΣEt systematics (entering etmiss significance)
- Combined trigger systematic: MC based (not enough statistics to measure in data), with data validation of the method
- Background estimation method systematics
- Theory systematics (as close as possible to WZ lepton analyses)

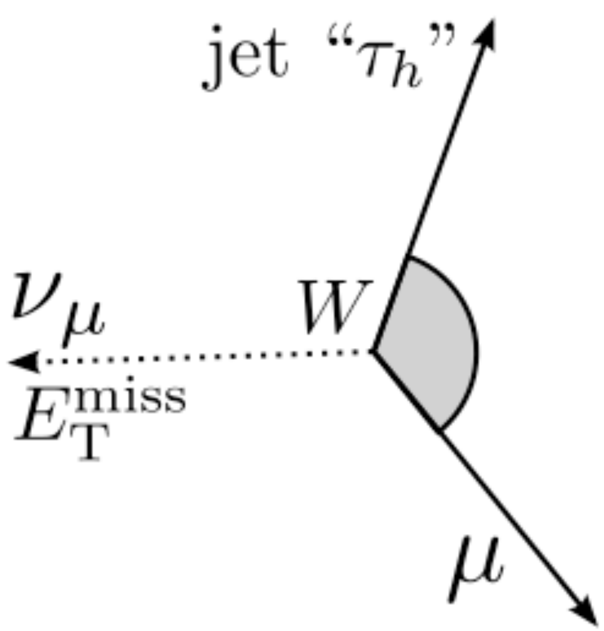




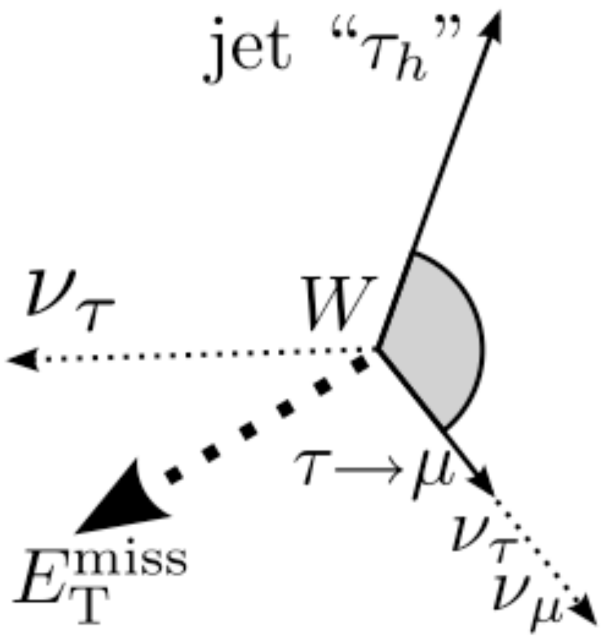
Angular correlations



(a) $Z \to \tau\tau \to \mu\tau_h$



(b) $W \to \mu\nu$



(c) $W \to \tau\nu \to \mu\nu\nu\nu$

Background estimation

$$N_A = N_B \left(\frac{N_C}{N_D} \right)$$

Primary	Isolated	Non Isolated
OS	A	C
SS	B	D

Cross check	Isolated	Non Isolated
Tau Tight	A	B
Tau Loose but not Tight	C	D

	Muon Channel (35.5 pb^{-1})	Electron Channel (35.7 pb^{-1})
Data (after all selections)	213	151
Total Estimated Background	50 ± 10	37 ± 9
Estimated Multijet Background OS/SS	*24 ± 6(stat.) ± 3(syst.)*	*23 ± 6(stat.) ± 4(syst.)*
Estimated Multijet Background isol. Lep.	*23 ± 3(stat.) ± 4 (syst.)*	*25 ± 3(stat.) ± 3 (syst.)*
Estimated W, Z, $t\bar{t}$, Diboson Background	*25 ± 2(stat.) ± 5(syst.)*	*14 ± 1(stat.) ± 3(syst.)*
Data (after background subtraction OS/SS)	164 ± 16(stat.)±4(syst.)	114 ± 14(stat.)±3(syst.)
Data (after background subtraction, isol. Lep.)	164 ± 15(stat.) ± 3(syst.)	110 ± 13(stat.) ± 11(syst.)
SM Signal Expectation	185.5 ± 2.1(stat.) ± 24.3(syst.)	97.3 ± 1.4(stat.) ± 15.4(syst.)

Criteria and definitions Cz

On Wednesday we had discussion with Jon Butterworth on the definition of Az and Cz in analyses with taus. These definitions are intended to superseed the previous ones.

- Cz serves to extract a fiducial cross section, defined as

$$\sigma_{fid} = \frac{N_{obs} - N_{bkg}}{C_Z \mathcal{L}}$$

  - this cross section must be as model independent as possible
  - therefore Cz must not include any extrapolation or correction to phase space regions we are not observing
  - the denominator of Cz should define the phase space as close as possible to what we are looking at experimentally
  - only stable particles should be considered in the determination of Cz
  - the fiducial cross section will be hardly comparable to theory and to other channels

- therefore the proposal for Cz definition is

$$C_Z = \frac{N^{reco\,pass}}{N^{gen\,kin}_{dressed}}$$

where

- $N^{reco\ pass}$ is the number of events that pass our analysis selection on full simulation (with full mc corrections etc).
- $N^{gen\ kin}_{dressed}$ is the number of events that pass the kinematic and geometric cuts.

These cuts include:
leptons pt and eta
taujet pt and eta (for lep-had)
$\Sigma \cos\Delta\phi$
mT (for lep-had)
visible mass
SumEt cut for LepLep IS NOT included here (see later)

- Both signal $Z\to\tau\tau$ and $\gamma^*\to\tau\tau$ must be included in both terms

Criteria and definitions Az

- Az serves to correct the fiducial cross section back to something that is comparable to theory
  - easiest way (and consistent with what WZ → e/μ people do) is to correct back to Born level
  - we must quote the cross section for a certain Z invariant mass range ([66, 116] as in Z→ ee and μμ analyses), because it is the only thing that makes sense
  - the numerator of Az must be the same as the denominator of Cz
- therefore the proposal for Az definition is

$$A_Z = \frac{N^{gen\,kin}_{dressed}}{N^{gen\,m_{inv}}_{born}}$$

where

- $N^{gen\ kin}_{dressed}$ is defined exactly as in the Cz case (and includes $\gamma^* \to \tau\tau$ as well)
- We excluded the SumEt for LepLep from the denominator of Cz because we do not want to have truth jet systematics in the extrapolation to theory (we are not doing $Z \to \tau\tau$ + jets)
- $N^{gen\ minv}_{born}$ is the number of events at generator level that are within the [66, 116] GeV invariant mass window, where the invariant mass is computed at Born level
- Both numerator and denominator are defined for LepHad or LepLep respectively only

Systematics

Systematic uncertainty	$\tau_\mu\tau_h$	$\tau_e\tau_h$	$\tau_e\tau_\mu$	$\tau_\mu\tau_\mu$
lepton efficiency	3.8%	9.6%	2.2/5.9% muon/electron	8.6%
lepton resolution(μ energy scale)	0.2%	0.2%	0.1%	1.0%
muon d_0 (d_0, shape, scale)	–	–	–	5.2%
Problematic calorimeter regions	–	0.4%	0.4%	–
e charge misidentification	–	0.1%	0.3%	–
τ id efficiency	8.6%	8.6%	–	–
lepton-jet τ fake rate	1.1%	0.7%	–	–
Energy scale lepton and τ	10%	11%	1.7%	0.1%
Pileup reweighting	0.4%	0.4%	0.5%	0.1%
Object quality cuts	1.9%	1.9%	0.4%	0.4%
k_W factor	0.1%	0.2%	–	–
Multijet estimate method	0.8%	2%	1.0%	1.7%
Theoret. cross section	0.2%	0.1%	0.3%	4.3%
A_Z systematics	2.9%	2.9%	2.9%	7.0%
Total Systematic uncertainty	15%	17%	7.3%	13%
Statistical uncertainty	9.8%	12%	13%	23%
Luminosity	3.4%	3.4%	3.4%	3.4%

Az systematics

Lepton-hadron channels

	Muon channel	Electron channel
A_Z	$0.11691 \pm 0.00023(stat.)$	$0.10073 \pm 0.00021(stat.)$
C_Z	$0.2045 \pm 0.0024(stat.)$	$0.1197 \pm 0.0017(stat.)$

	Muon channel	Electron channel
CTEQ 6.6 eigenvector set	1.2%	1.2%
Different PDF sets	1.9%	1.9%
Model dependence	1.8%	1.6%
Total uncertainty	2.9%	2.8%

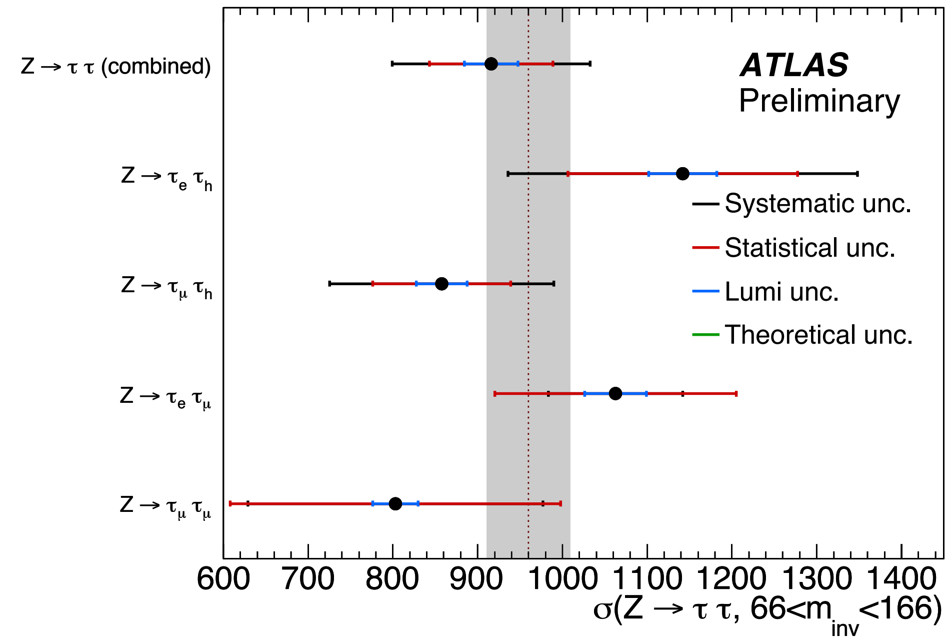
Lepton-lepton channels

	Electron-Muon channel	Muon-Muon channel (Standard)	Muon-Muon channel (BDT)
A_Z	0.1139	0.0488	0.1557
C_Z	0.2857	0.4022	0.2953

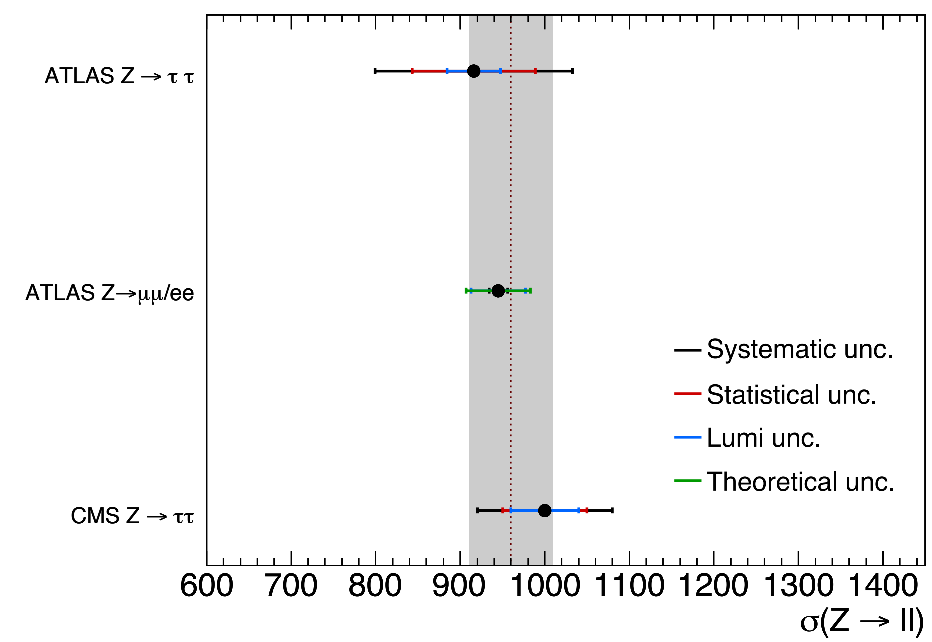
$Z \to \tau\tau$ cross section measurement

	Muon channel
N_{obs}	213 ± 15
$N_{obs} - N_{bkg}$	$164 \pm 16 \pm 4$
A_Z	$0.11691 \pm 0.00023 \pm 0.00351$
C_Z	$0.2045 \pm 0.0022 \pm 0.0268$
$\mathcal{L}$	35.51 ± 1.21
σ_{fid}	$22.60 \pm 2.21(\text{stat}) \pm 3.22(\text{syst}) \pm 0.74(\text{lumi})$ pb
$\sigma_{incl} \times BR(\tau \to e/\mu, \tau \to \tau_{had})$	$193.3 \pm 18.9(\text{stat}) \pm 27.5(\text{syst}) \pm 6.4(\text{lumi})$ pb
$\sigma_{incl\,tot}$	$859.4 \pm 84.0(\text{stat}) \pm 122.4(\text{syst}) \pm 28.3(\text{lumi}) \pm 2.8(\text{theo})$ p

	Electron channel
N_{obs}	151 ± 12
$N_{obs} - N_{bkg}$	$114 \pm 14 \pm 3$
A_Z	$0.10073 \pm 0.00021 \pm 0.00302$
C_Z	$0.1197 \pm 0.0017 \pm 0.0189$
$\mathcal{L}$	35.75 ± 1.22
σ_{fid}	$26.52 \pm 3.20(\text{stat}) \pm 4.32(\text{syst}) \pm 0.87(\text{lumi})$ pb
$\sigma_{incl} \times BR(\tau \to e/\mu, \tau \to \tau_{had})$	$263.3 \pm 31.8(\text{stat}) \pm 42.9(\text{syst}) \pm 8.7(\text{lumi})$ pb
$\sigma_{incl\,tot}$	$1138 \pm 137.5(\text{stat}) \pm 185.6(\text{syst}) \pm 37.4(\text{lumi}) \pm 3.6(\text{theo})$ p



Final State	Measured Fiducial Cross-section
$Z \to \tau_\mu\tau_h$	22.6 ± 2.1(stat) ± 3.4(syst) ± 0.8(lumi) pb
$Z \to \tau_e\tau_h$	26.6 ± 3.2(stat) ± 4.7(syst) ± 0.9(lumi) pb
$Z \to \tau_e\tau_\mu$	7.5 ± 1.0(stat) ± 0.6(syst) ± 0.3(lumi) pb
$Z \to \tau_\mu\tau_\mu$	125.1 ± 30.4(stat) ± 38.9(syst) ± 4.3(lumi) pb
Final State	**Measured Total Cross-section (66 < m_{inv} < 116 GeV)**
$Z \to \tau_\mu\tau_h$	857.6 ± 81.4(stat) ± 132.5(syst) ± 30.2(lumi) ± 2.8(theo) pb
$Z \to \tau_e\tau_h$	1142 ± 135.5(stat) ± 206.2(syst) ± 40.2(lumi) ± 3.6(theo) pb
$Z \to \tau_e\tau_\mu$	1062.6 ± 142.3(stat) ± 77.7(syst) ± 36.1(lumi) ± 4.3(theo) pb
$Z \to \tau_\mu\tau_\mu$	803 ± 195(stat) ± 141(syst) ± 27(lumi) ± 2(theo) pb



Combined cross section times BR($Z \to \tau\tau$)
σ = 0.97nb±0.07nb(stat)±0.07nb(syst)±0.03nb(lumi)

$Z \rightarrow \tau\tau$ cross section combination

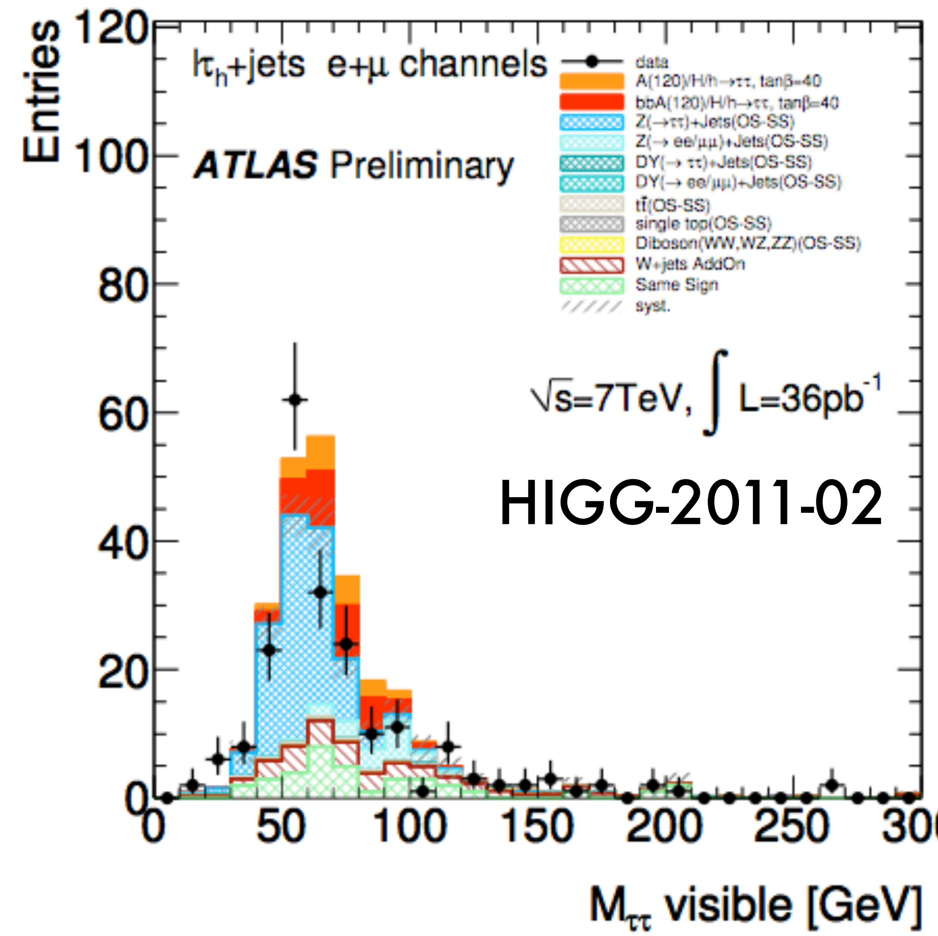
$$\hat{\sigma} = \sum_i \alpha_i \sigma_i,$$

$$\vec{\alpha} = \frac{\mathcal{E}^{-1}\mathcal{U}}{\mathcal{U}^{\mathsf{T}}\mathcal{E}^{-1}\mathcal{U}}$$

$$\Delta\hat{\sigma}^2 = \vec{\alpha}^{\mathsf{T}}\mathcal{E}\vec{\alpha}$$

Systematic	$\tau_e\tau_h/\tau_\mu\tau_h$	$\tau_e\tau_h/\tau_e\tau_\mu$	$\tau_e\tau_h/\tau_\mu\tau_\mu$	$\tau_\mu\tau_h/\tau_e\tau_\mu$	$\tau_\mu\tau_h/\tau_\mu\tau_\mu$	$\tau_e\tau_\mu/\tau_\mu\tau_\mu$
τ id efficiency	100%	0%	0%	0%	0%	0%
e charge misidentification	0%	100%	0%	0%	0%	0%
k_W factor	0%	0%	0%	0%	0%	0%
Energy scale lepton and τ	100%	100%	100%	100%	100%	100%
Jet Cleaning	100%	100%	100%	100%	100%	100%
OSSSRatio	100%	100%	0%	100%	0%	0%
Pileup reweighting	100%	100%	100%	100%	100%	100%
Problematic calorimeter regions	0%	100%	0%	0%	0%	0%
Theoret. cross section	100%	100%	100%	100%	100%	100%
electron efficiency	0%	100%	0%	0%	0%	0%
lepton resolution(μ energy scale)	0%	100%	0%	100%	100%	100%
lepton-jet τ fake rate	100%	0%	0%	0%	0%	0%
az_sys_err	100%	100%	100%	100%	100%	100%
muon efficiency	0%	0%	0%	100%	100%	100%
muon D0	0%	0%	0%	0%	0%	0%

A/H → ττ present analysis



- Present analysis
  - Single lepton triggers (as Z→ ττ)
  - Exactly one lepton pT > 20 GeV (electron channel) pt > 15 GeV (muon channel)
  - τ-jet ID (cut-based) and with opposite charge with respect to the lepton
  - Etmiss > 20 GeV
  - mT ≤ 30 GeV
  - only visible mass is reconstructed
  - 74 events selected in the electron channel, 132 in the muon channel
  - background estimation based on OS-SS refined method and ABCD (OS-SS and isolation)
  - embedding method to estimate Z→ ττ contribution in the sample (dominant irreducible background)
  - limit setting with profile likelihood method

W→ τν cross-section measurements

Fiducial region defined by:

- τ-jet and etmiss kinematics
- Angular cut Δphi(jet-met) > 0.5

Preliminary results (statistical errors only):

Nobs =

σfid =

σ tot X BR(τ → had ν) =

Theory NNLO cross-section: ... pb

Systematics are in progress

Still under discussion:

Etmiss and ΣEt systematics (entering etmiss significance)

Systematic on combined trigger efficiency