W,Z analysis

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April 1, 2008

Analysis areas

- **Measurements of W and Z inclusive cross sections in muon channels**

$$\sigma_{V\to ll} = \frac{(N_{obs} - N_{bgk})}{\int \mathcal{L}dt \cdot A \cdot \epsilon}$$

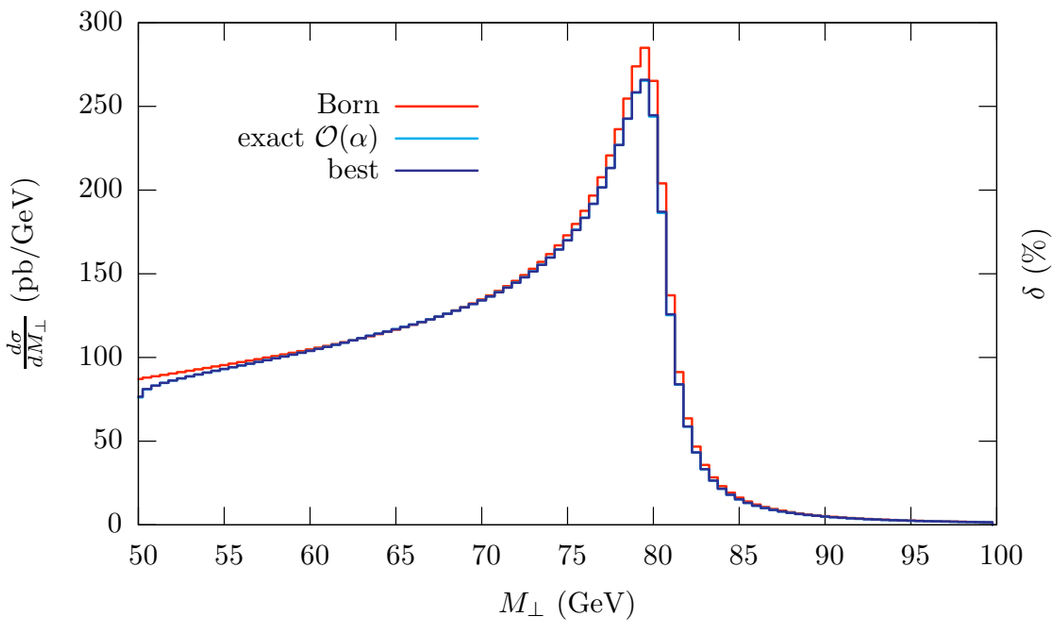
- **Acceptances for experimental selections (from MC)**
  - ★ Calculate using best EW and QCD NLO predictions from different generators
  - ★ Evaluate the uncertainty coming from PDF's
- **Trigger and offline efficiencies (from data)**
  - ★ Tool to measure efficiency from data: Tag&Probe normalized to ID, MS.
  - ★ Differential efficiency maps and impact of pile-up
- **Signal selection and background estimation**
  - ★ Signal selection and backgrounds estimation from MC and from data (e.g. QCD)
- **Integrated Luminosity**
  - ★ Considering an initial 10-20% uncertainty

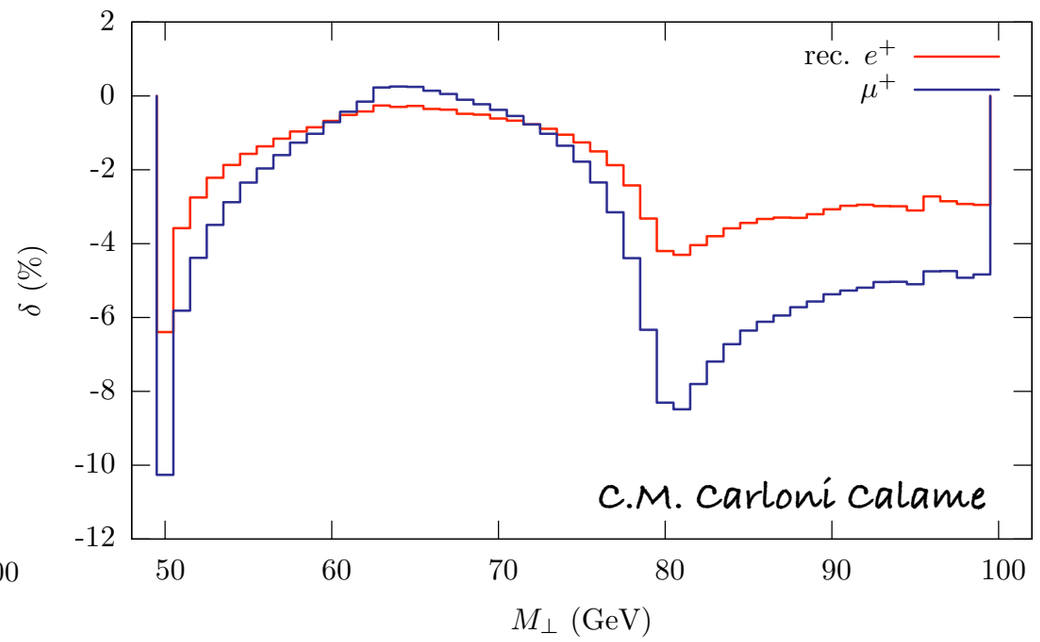
Acceptance studies in W→μν

- Using best theoretical description from NLO QCD and EW generators, as:
  - ★ MC@NLO S. Frixione, P. Nason and B.R. Webber [hep-ph/0204244] [hep-ph/0305252]
  - ★ HORACE C.M. Carloni Calame, G. Montagna, O. Nicrosini and A. Vicini [JHEP 0612:016,2006] [JHEP 0710:109,2007]
- In particular we are collaborating with HORACE authors in interfacing with ATLAS software for detailed EW studies
  - ★ `HORACE_i-00-00-01` is ready and tested (see last MC Generators meeting)

★ EW corrections with lepton $|\eta|<2.5$ $p_T>25$ GeV @ **5-10 %**

★ EW corrections for high invariant mass regions (>1 TeV) @ **20-30%**

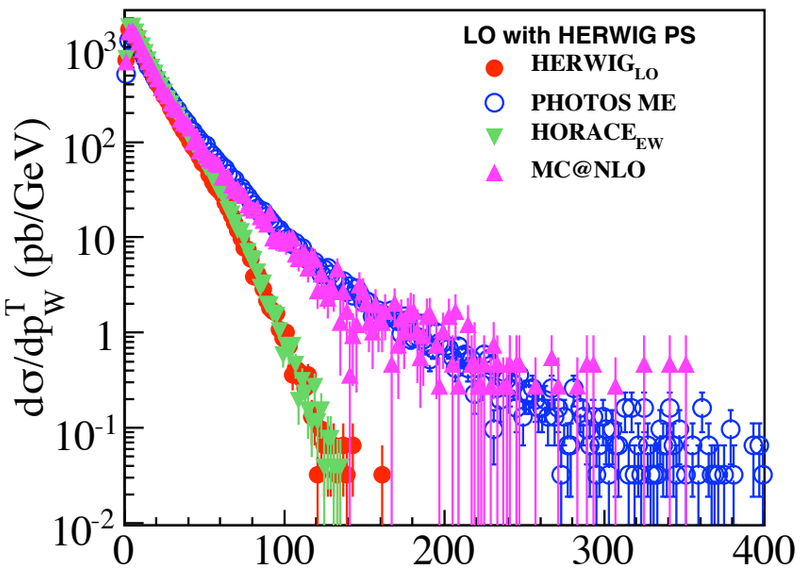


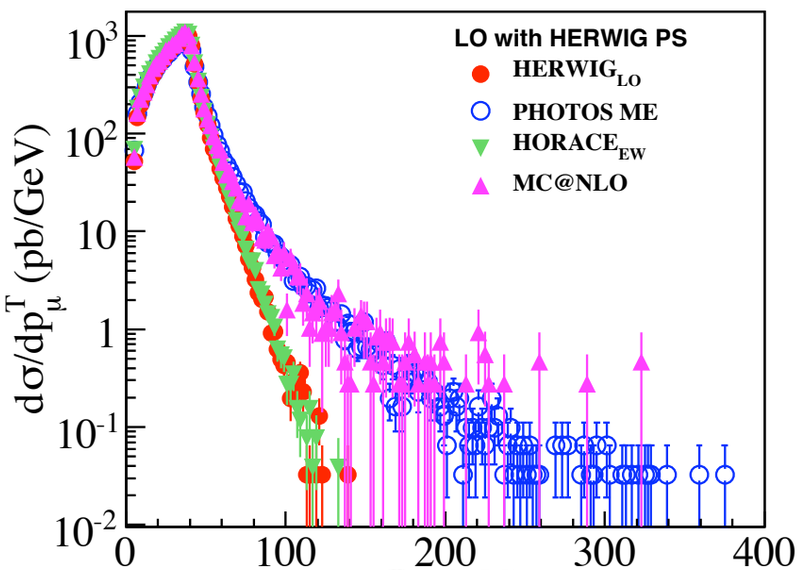


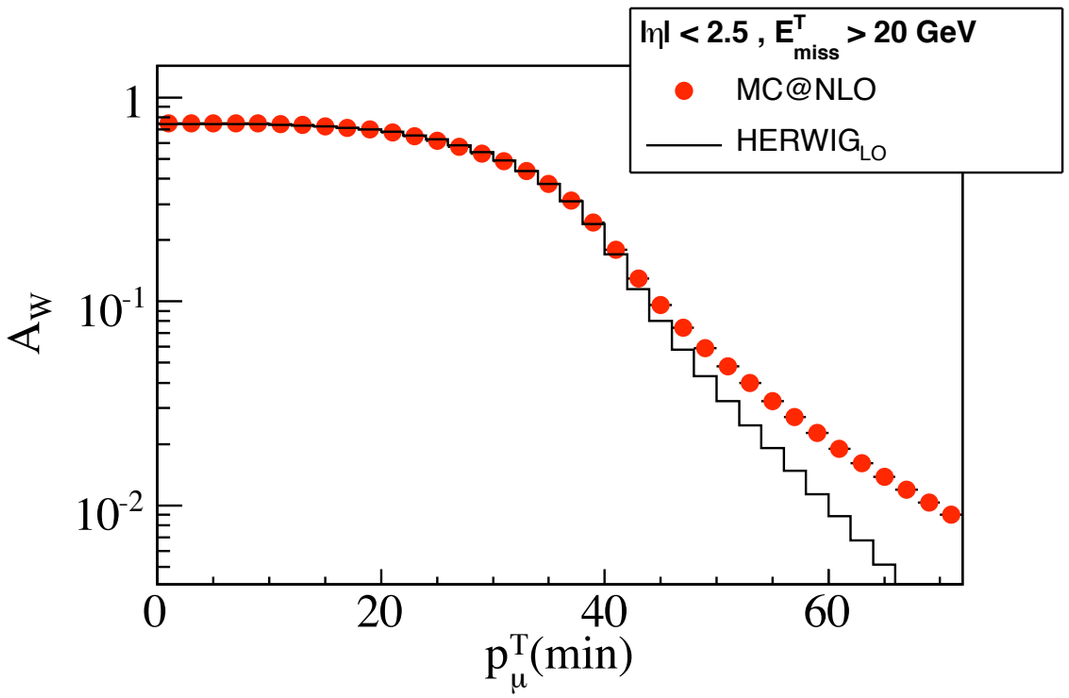
More details in "The theory side of W /Z Physics and PDFs", C.M. Carloni Calame"

Acceptance studies in W→μν

- Acceptance corrections due to geometrical coverage of detector and trigger system
  - ★ Comparisons of MC@NLO, Photos and Horace generators with Herwig parton shower
  - ★ A quantitative estimation is ongoing



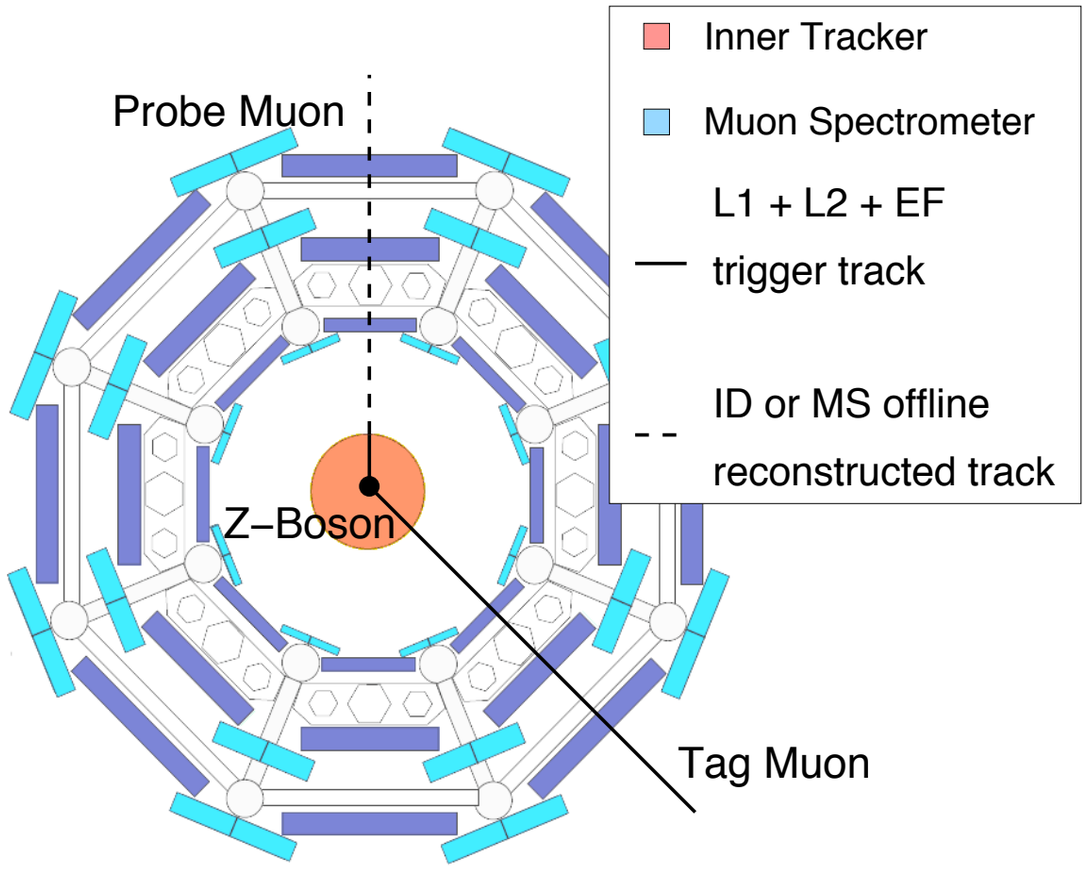


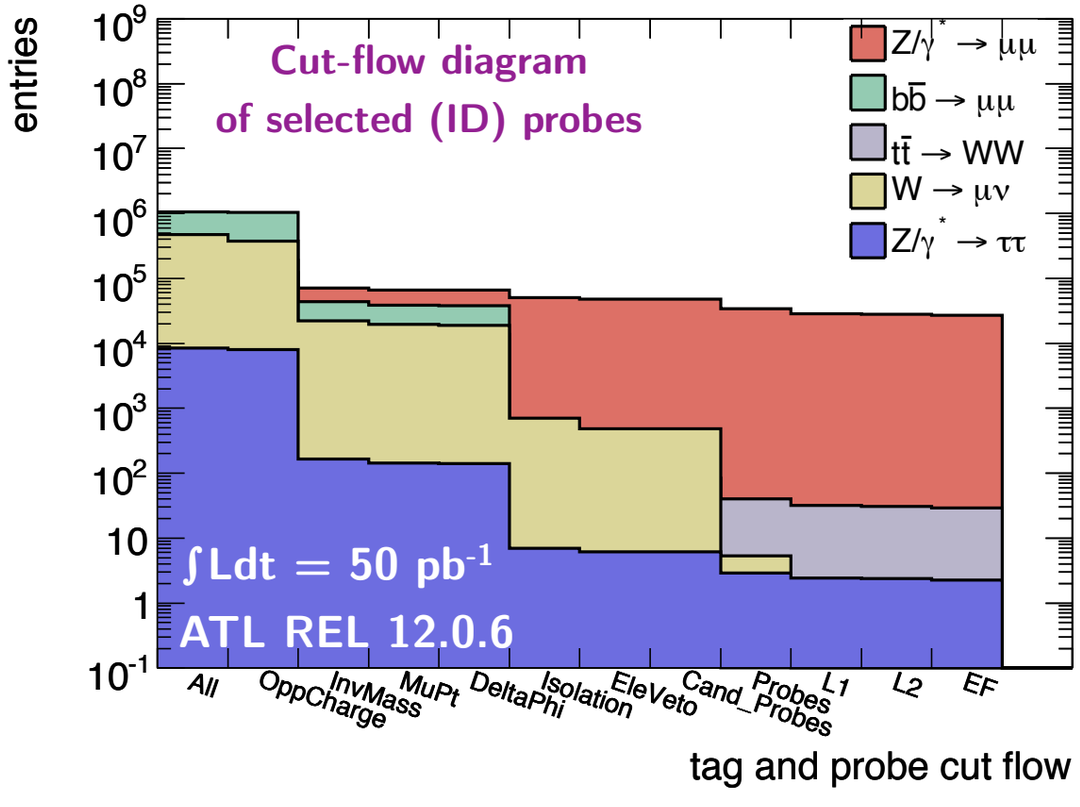


- Transverse momentum and pseudo-rapidity cumulative curves
  - ★ LO and NLO comparisons
  - ★ QCD corrections effect up to 2%
  - ★ lower impact from EW corrections (<1%)
  - ★ need to estimate impact of mixed EW-QCD NLO corrections

Trigger efficiency from $Z \rightarrow \mu^+\mu^-$

- Method is "Tag and Probe"
- Measurements wrt ID and wrt combined offline reconstruction:
  $c_1 * c_2 < 0$, $81 < M_{\mu\mu} < 101$ GeV, $pT > 20$ GeV
- Background rejection with kinematical and tight isolation cuts:
  - ★ **ID** ⇒ $\Sigma N^{ID} < 4$, $\Sigma p_T^{ID} < 8$GeV,
  - ★ **Calo** ⇒ $E_{jet} < 15$GeV, $\Sigma E_T^{EM} < 6$GeV





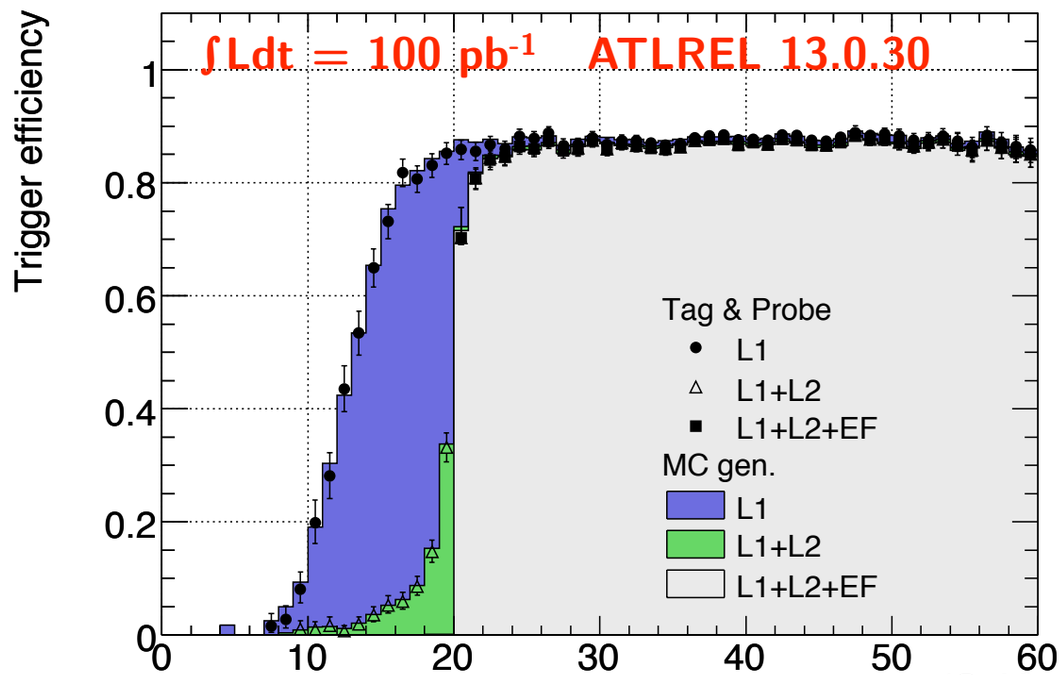
Statistical uncertainty for 50 pb^{-1} ≈ 0.3%

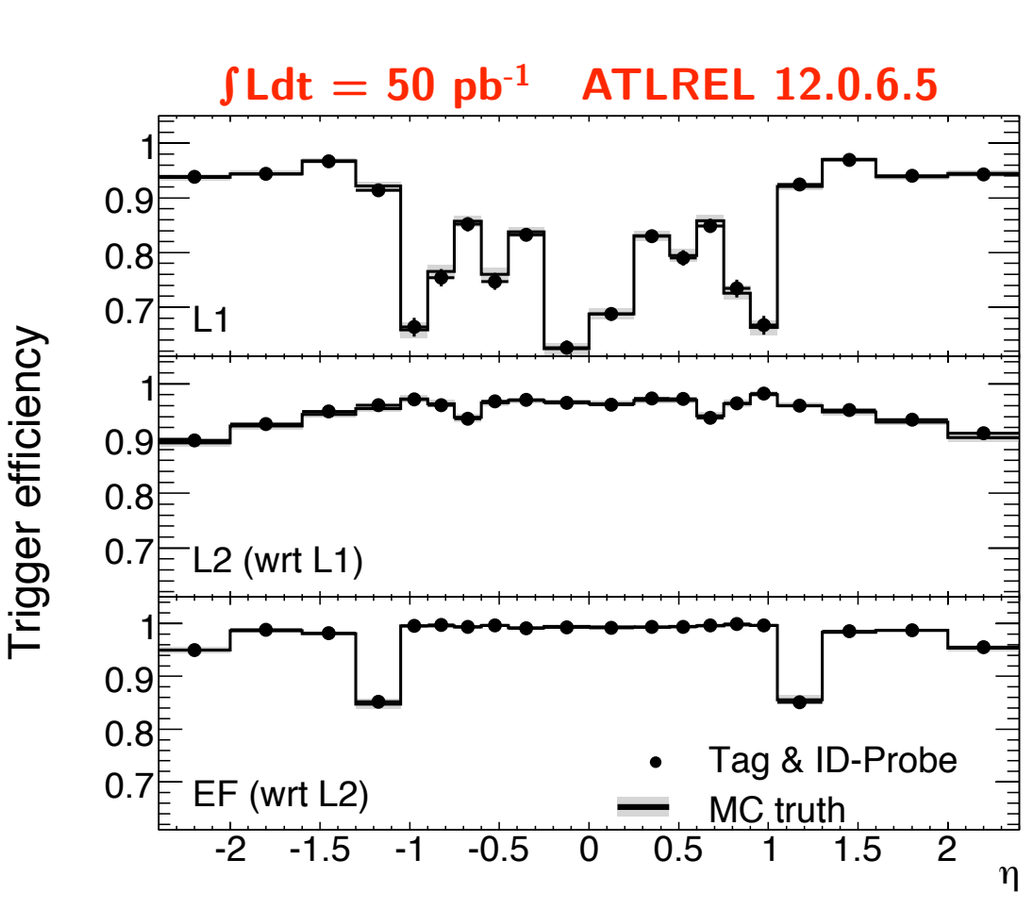
Systematic uncertainty ≈ 0.5%

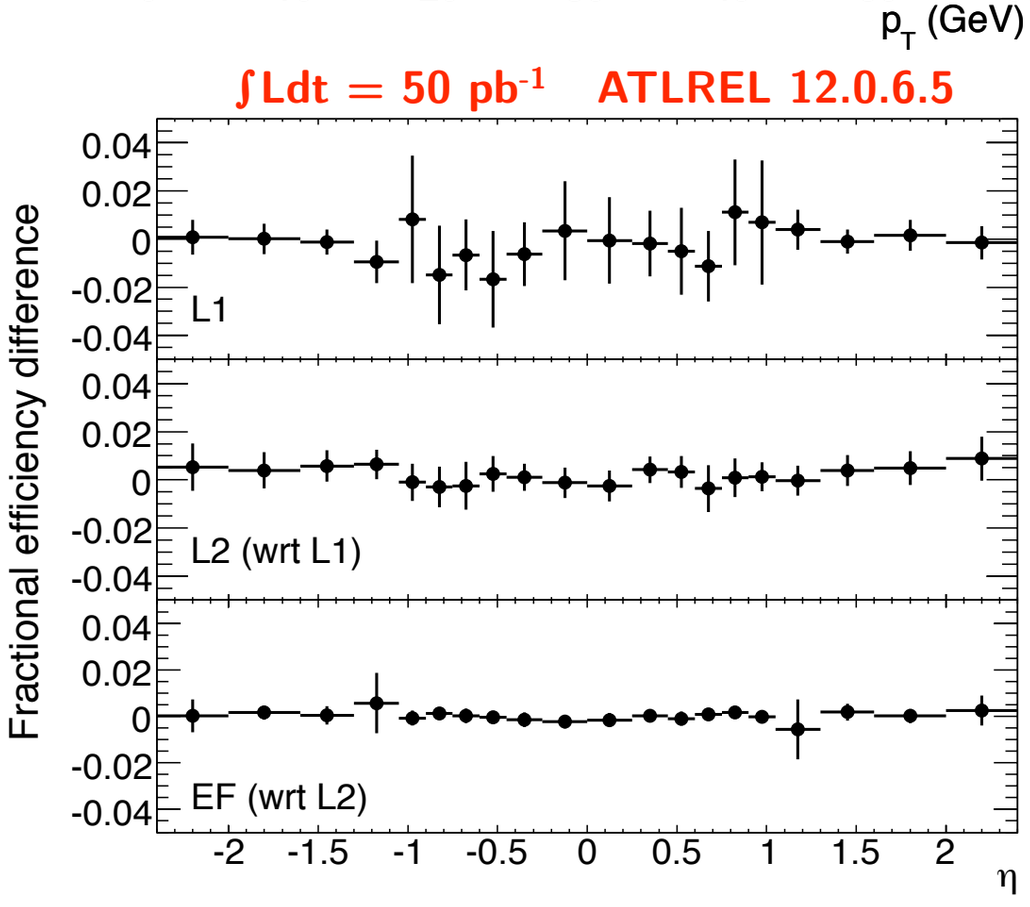
Background contribution negligible (<0.1%)

Trigger efficiency from $Z \to \mu^+\mu^-$

- Measurement of turn-on trigger curves and η, φ dependences
  - ★ Use standalone and combined reconstructions to cope with early data requirements
    - e.g. ID-MS alignment
  - ★ goal is to provide a detailed map of $\varepsilon(p_T,\eta,\varphi)$ for physics analysis

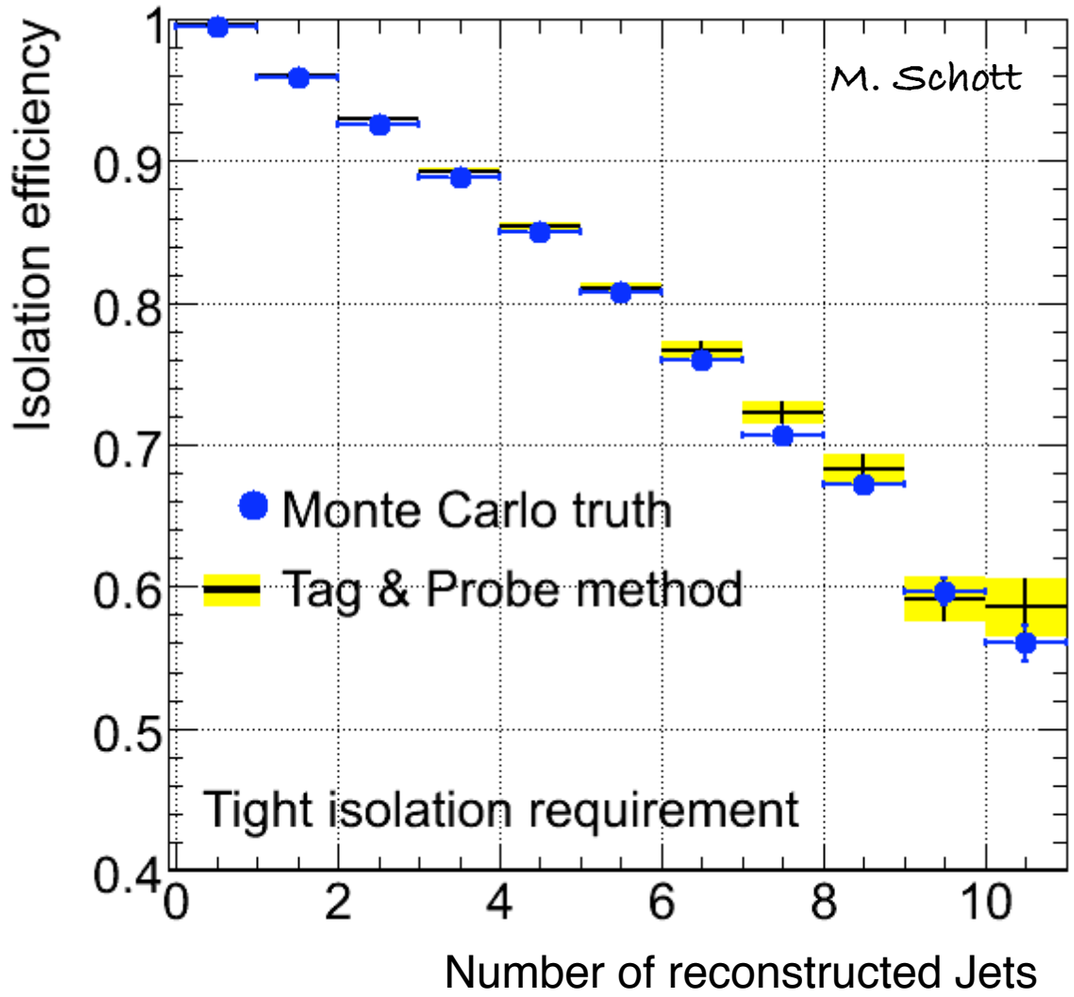






Further Systematic Uncertainties

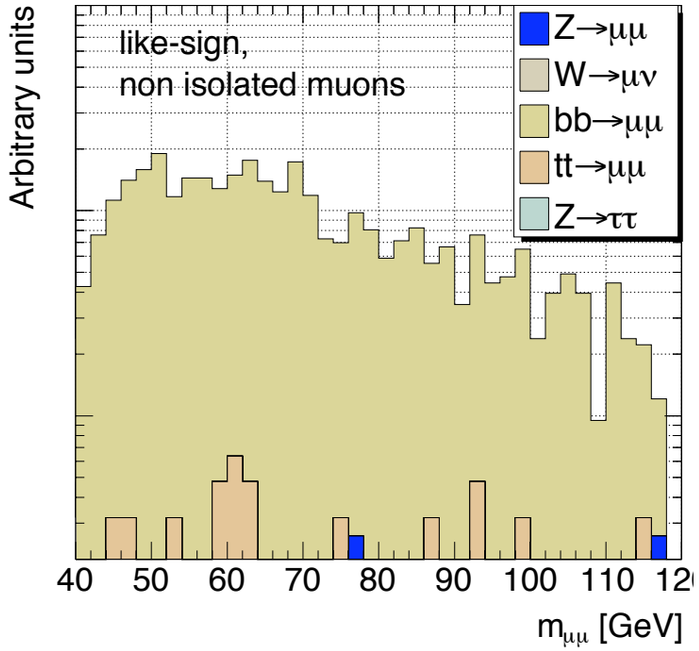
- Efficiency of isolation requirement also determined via Tag and Probe
  - ★ Avoid correlations by determination versus number of reconstructed jets
  - ★ Early Data:
    - $\Delta\varepsilon_{iso}/\varepsilon_{iso}=0.002(stat)\pm0.003(sys)$
  - ★ High Luminosity Measurement:
    - $\Delta\varepsilon_{iso}/\varepsilon_{iso}=0.000(stat)\pm0.001(sys)$
- Main systematic from background
- **Efficiency of kinematic cuts**
  Uncertainty arises from uncertainty on momentum scale measurement
  - ★ $\varepsilon_{kinematic}=0.906\pm0.003(sys)$
- Uncertainty on **impact-parameter** and **misalignments** should be negligible

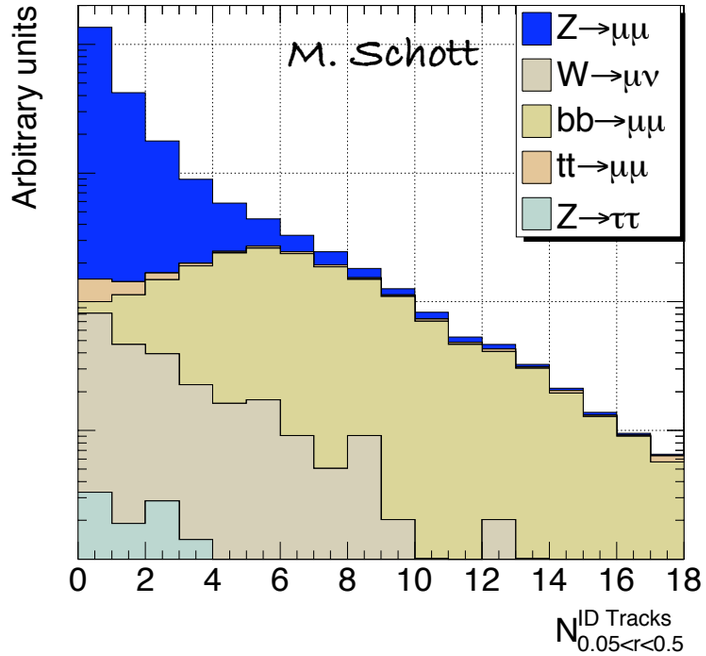


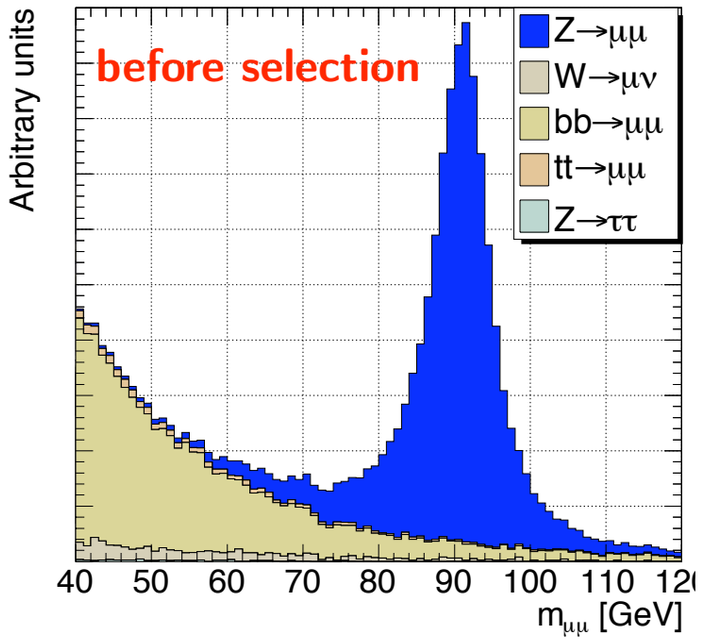
Impacts of **PDFs** on the acceptance must be studied! (few % uncertainty)

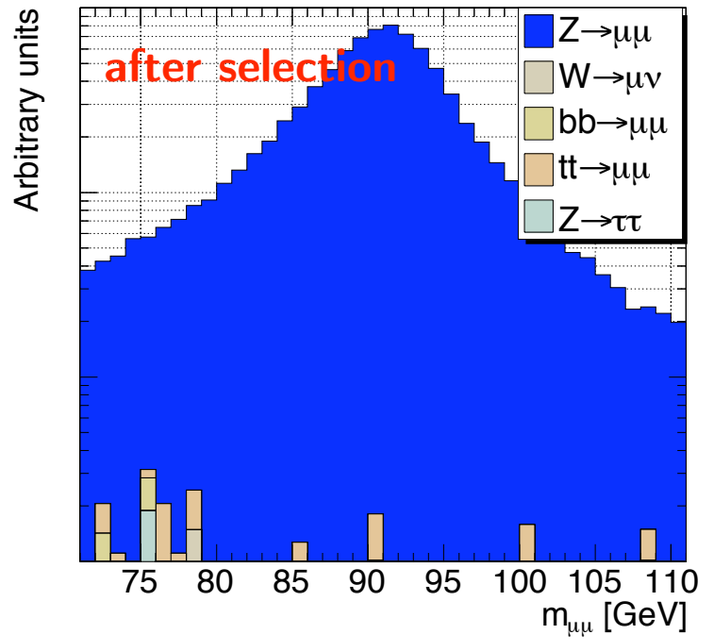
$Z \to \mu^+\mu^-$ event selection

- Selection based on Muon Spectrometer tracks in $|\eta < 2.5|$
  - ★ Isolation via Inner Detector only or with also Calorimeter-based cuts
- Different scenarios for muon spectrometer standalone (first data) and combined measurement
- QCD background need to be estimated from data
  - ★ QCD enriched sample (like-sign) and normalization to signal selection from MC
- Background uncertainty expected ≈ 0.2%









Data and software tools

- Next analyses will be based on release **13.0.X AOD**
  - ★ samples are produced in the SM quota with backgrounds from other groups
  - ★ see https://twiki.cern.ch/twiki/bin/view/Atlas/StandardModelCSCDatasets

- Analysis on **FDR 1-2** data:
  - ★ unique opportunity before start to use real-like data
  - ★ FDR2: 7h of 10^{32} data (2.5 pb^{-1}) and 3h of 10^{33} data (10.8 pb^{-1})
  - ★ see https://twiki.cern.ch/twiki/bin/view/Atlas/FullDressRehearsal

- **EWPA analysis framework** (Atlas cvs link for EWPA-00-00-01 version)
  - ★ Main new features foreseen for EWPA-00-01-00 (ready/indev)
    - Factorized input (ESD, AOD, DnPD) and analysis environment to the analysis code
    - User Data handling (like associations, extrapolated parameters, fit, ...)
    - Transient/Persistent (TP) separation of data classes
    - POOL persistification of analysis results with Atlas compliant TP converters
    - AthenaROOTAccess (ARA) support to perform analysis outside Athena (same analysis classes)
    - ARA/Athena Dual Tools support for common python-based configuration

Analysis areas

$$\sigma_{V \to ll} = \frac{(N_{obs} - N_{bgk})}{\int \mathcal{L} dt \cdot A \cdot \epsilon}$$

- **Acceptances for experimental selections (from MC)**
- **Trigger and offline efficiencies (from data)**
- **Signal selection and background estimation**
- **Integrated Luminosity**

- **We are also responsible for SM muon validation (bi-weekly meeting reports)**
- **SM Pavia analysis group is:**
  M.B., S. Franchino, G. Gaudio, A. Negri, G. Polesello, A. Rimoldi,
  D.Scannicchio, V.Vercesi

back-up

LHC early data

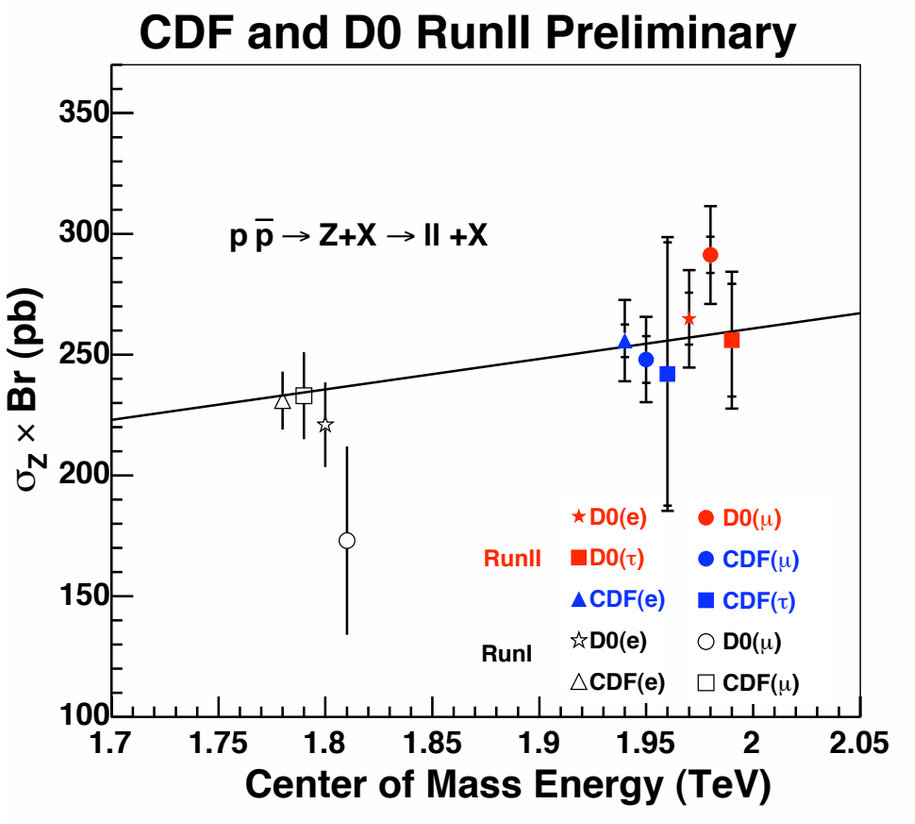
- During last SM meeting T.Le Compte reported recent news for first collisions
- This scenario assumes first collisions in August with 5 - 5.5 GeV beam energy and a running period of 2-3 months
  - ★ given N_p constant 10^{31} $cm^{-2}s^{-1}$ will become about 7.5 10^{30} $cm^{-2}s^{-1}$ (7.5 10^{-3} $nb^{-1}s^{-1}$)
- In the hypothesis of a 3 months (7.8 10^6 s) data recording
  - ★ an integrated luminosity of about 50-60 pb^{-1}

Process	σ x Br [pb]	ε(estimate)	Events in 10 pb^{-1}
$Z \to ll$	2000	20%	4000
$W \to l\nu$	20000	20%	40000
ttbar $\to l\nu$ +X	370	1.5%	< 100
Jet $E_T > 25$ GeV	$3 \cdot 10^9$	100%	$3 \cdot 10^{10}$ x p.f.
Minimum bias	10^{11}	100%	10^{12} x p.f.

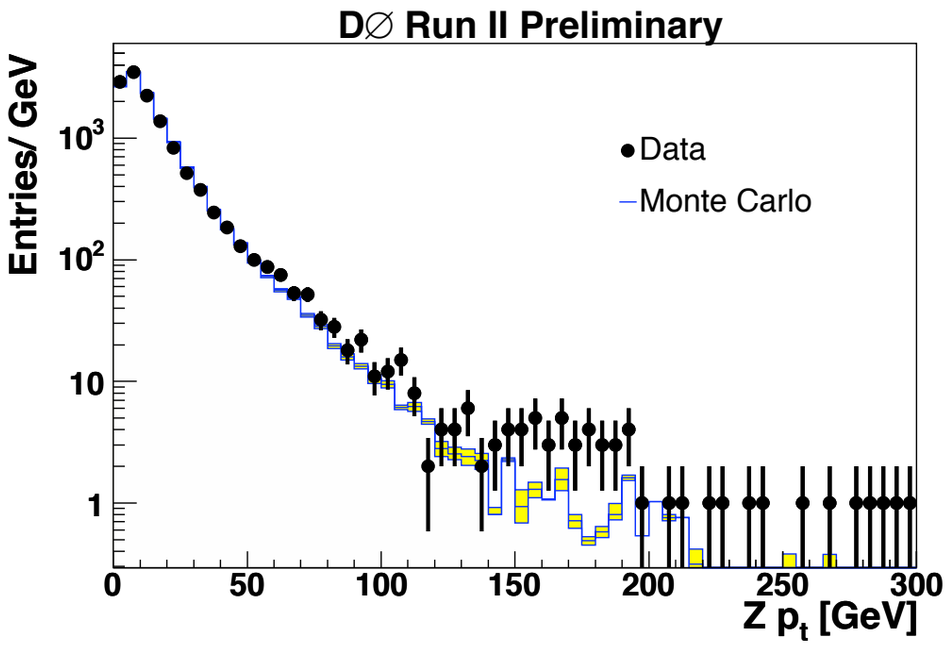
- **Aim of first data:**
  - ★ detector understanding/calibration and first physics measurements

W,Z physics

- Measurements of Electroweak observables
  - ★ **W,Z cross sections**
  - ★ W mass and width, $\sin^2 \theta_{eff}$, A_{FB}
  - ★ W charge asymmetry $A(\eta_l)$ and differential cross sections
  - ★ Di-Boson productions
  - ★ to search for new physics looking at invariant mass high tail, ...

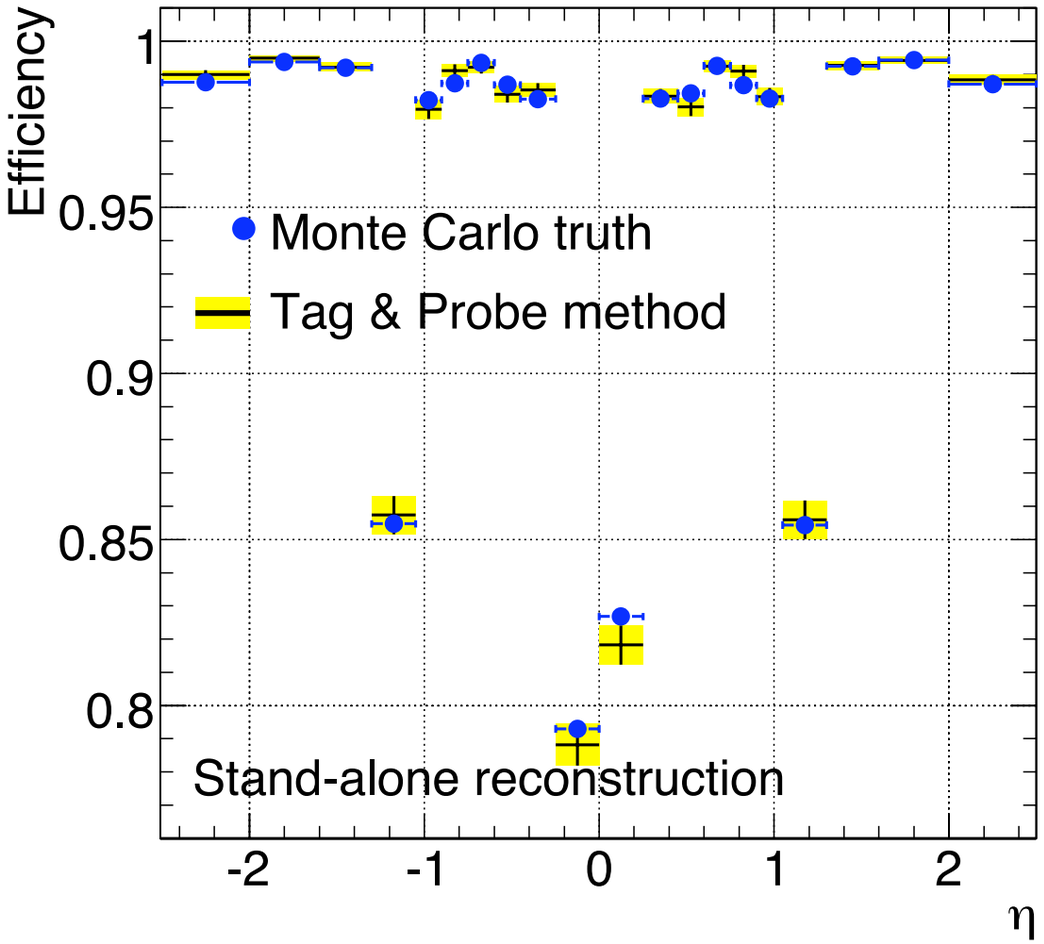


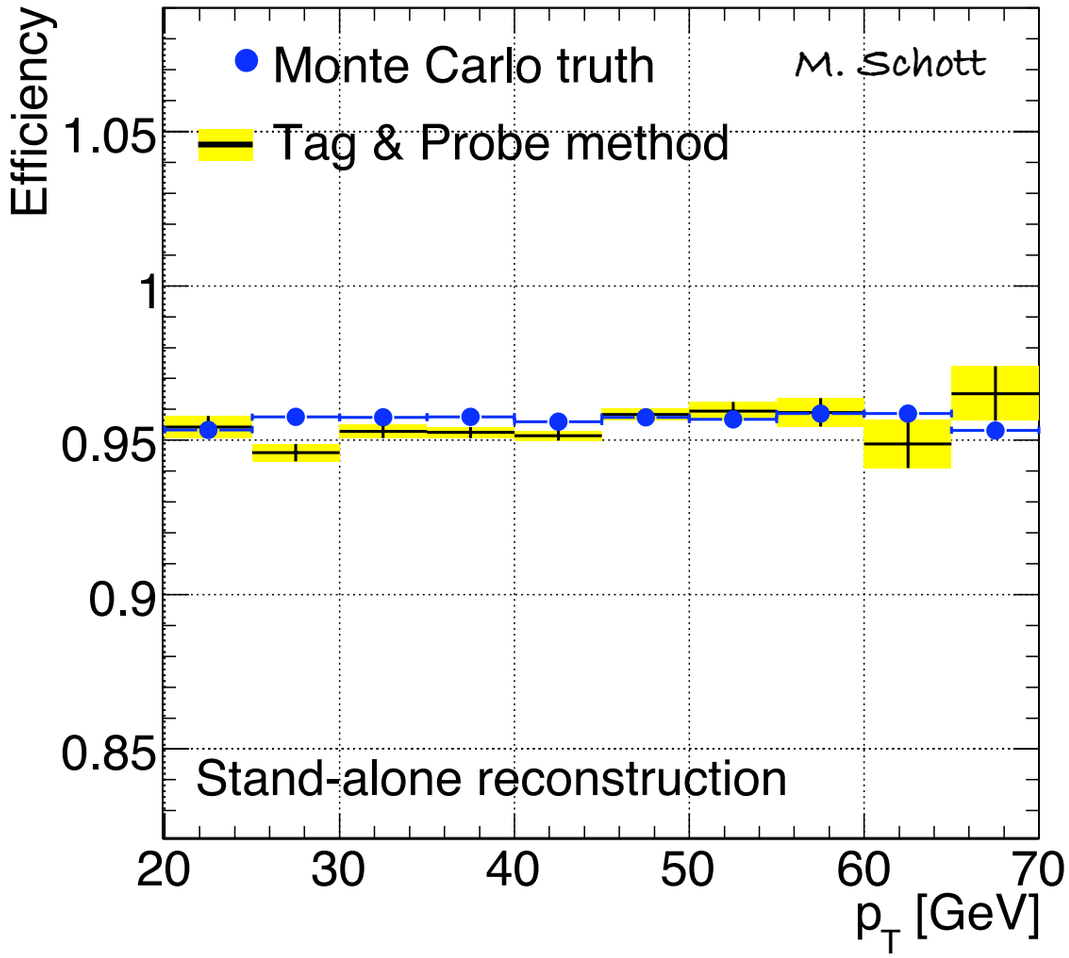
- Single W/Z boson production is a clean processes with large cross section useful also for :
  - ★ **"Standard candles" for detector calibration/understanding**
  - ★ constrain PDFs looking at σ_{TOT}, W rapidity, ...
  - ★ monitor collider luminosity



Offline efficiencies from $Z \to \mu^+\mu^-$

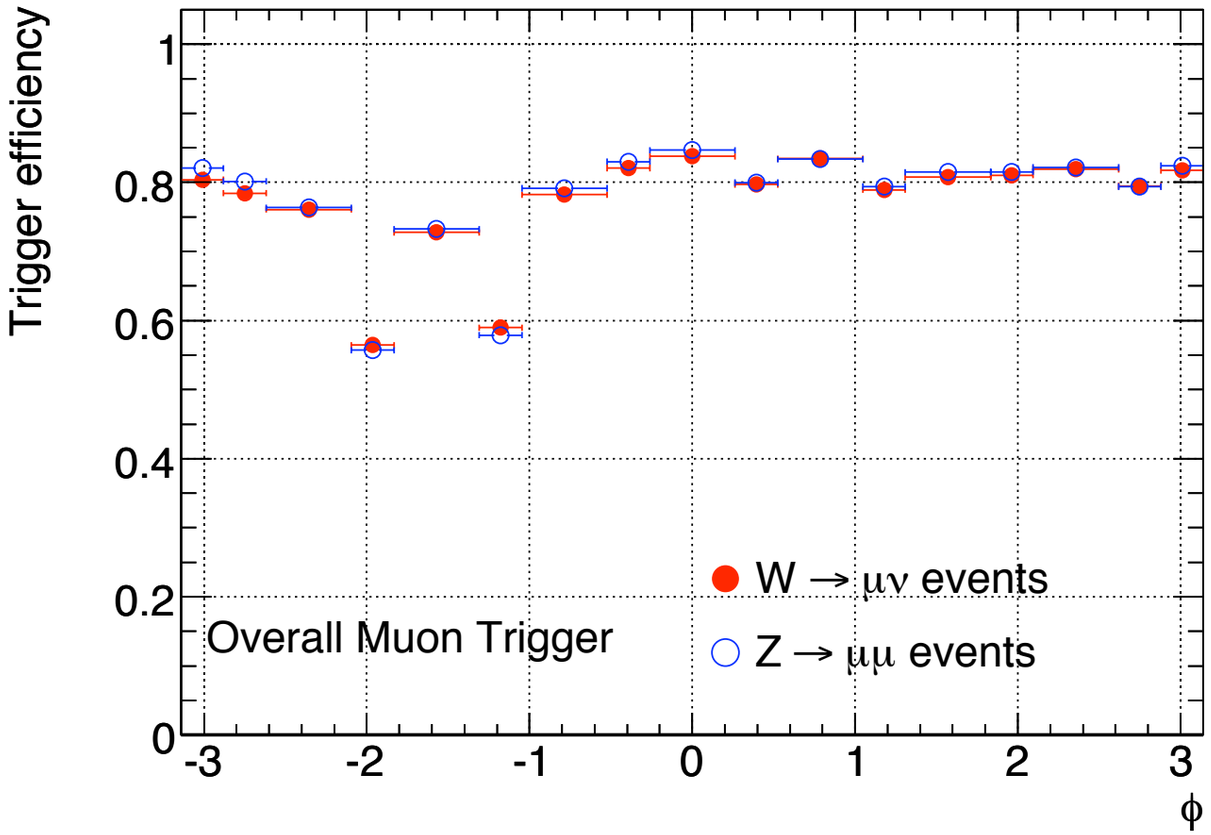
- Offline efficiency measured from data with Tag and Probe:
  - ★ same approach as for trigger measurements
  - ★ systematics at 0.2%

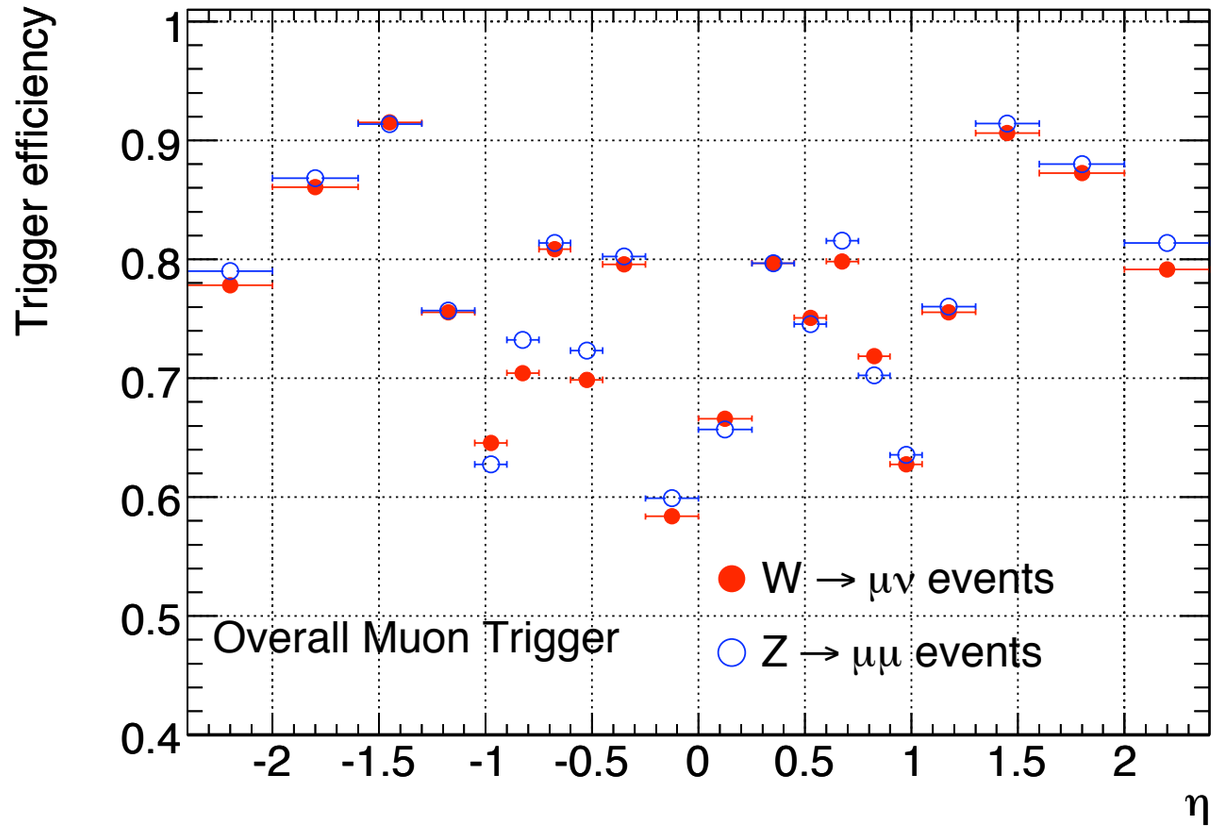




W vs Z muon trigger efficiency

- Comparisons of muon trigger efficiency from W and Z events from MC truth (wrt to all events with at least 1 muon in trigger coverage, no off. cuts)





High luminosity ($\int \mathcal{L}dt = 1000\ pb{-}1$)			
Detector region	**Barrel** ($\lvert\eta < 1.05\rvert$)	**Endcap** ($1.05 < \lvert\eta\rvert < 2.4$)	**Overall** ($0 < \lvert\eta\rvert < 2.4$)
$\lvert\epsilon_{mu20i}^{W\to\mu\nu} - \epsilon_{mu20i}^{Z\to\mu\mu}\rvert$	0.005 ± 0.001	0.004 ± 0.001	0.008 ± 0.001