$Z \to \mu\mu$ and $W \to \mu\nu$ inclusive cross section measurements

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Standard Model

W,Z signatures sub-group

Cern

September 24, 2009

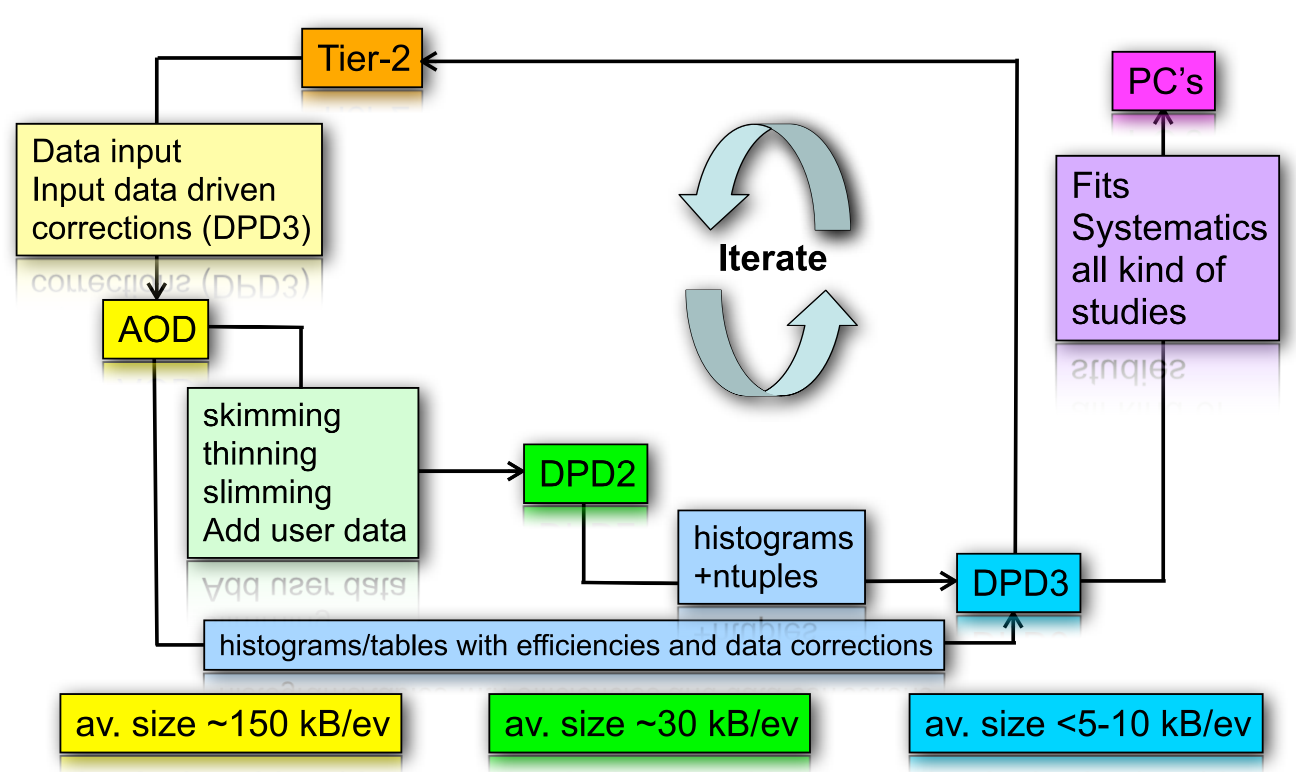
Outline

- Datasets and analysis model
- Theoretical uncertainties on acceptance
- Z and W selections on MC samples @ 10 TeV
  - ★ Results for 50 pb^{-1}
- Towards a measurement on real data
  - ★ Event selection from single particle efficiency
  - ★ Determination of efficiencies from data
  - ★ Event re-weighting procedure
- Signal and backgrounds yields extraction
  - ★ Data driven techniques and shapes fits
- Calibration effects
  - ★ Muon momentum scale and resolution
  - ★ Missing energy scale (not covered here)
- Conclusion & outlook

Datasets and analysis model

10 TeV Dataset	$\epsilon_g \cdot \sigma(nb)$
mc08.106051.PythiaZmumu_1Lepton.recon.AOD.e347_s462_r635/	1.098
mc08.106021.PythiaWmunu_1Lepton.recon.AOD.e352_s462_r635/	10.352
mc08.105200.T1_McAtNlo_Jimmy.recon.AOD.e357_s462_r635/	0.206
mc08.106052.PythiaZtautau.recon.AOD.e347_s462_r635/	1.128
mc08.106022.PythiaWtaunu_1Lepton.recon.AOD.e352_s462_r635/	4.184
mc08.105014.J5_pythia_jetjet.recon.AOD.e344_s479_r635/	5.18
mc08.108405.PythiaB_bbmu15X.recon.AOD.e388_a84_tid066711	90
mc08.106059.PythiaB_ccmu15X.recon.AOD.e401_a84	29
user09.*Salvucci.ganga.mc08.106051.Zmumu*ms100indcscDAY1_e347_s462_d154_task041200_r635*	1.098
user09.*Salvucci.ganga.mc08.106051.Zmumu*ms500_e347_s462_d154_task041200_r635*	1.098
user08.mariannatesta.ganga.datafiles.misal.106021.PythiaWmunu_1Lepton.recon.AOD	10.352

- Analysis runs in Athena 14.5.X based on EWPA framework (release 15-16 ready)
- Running in GRID at T-2 AODs
  - ★ heavy part of the analysis like track extrapolation, isolation studies, tag&probe selections
  - ★ AODs + derived data stored on D3PDs (flat ntuples of 5-10 kb/event*)
- Final analysis locally on "T-3"
  - ★ plot, tables and fits



* to be optimized further

Acceptance effects from NLO corrections

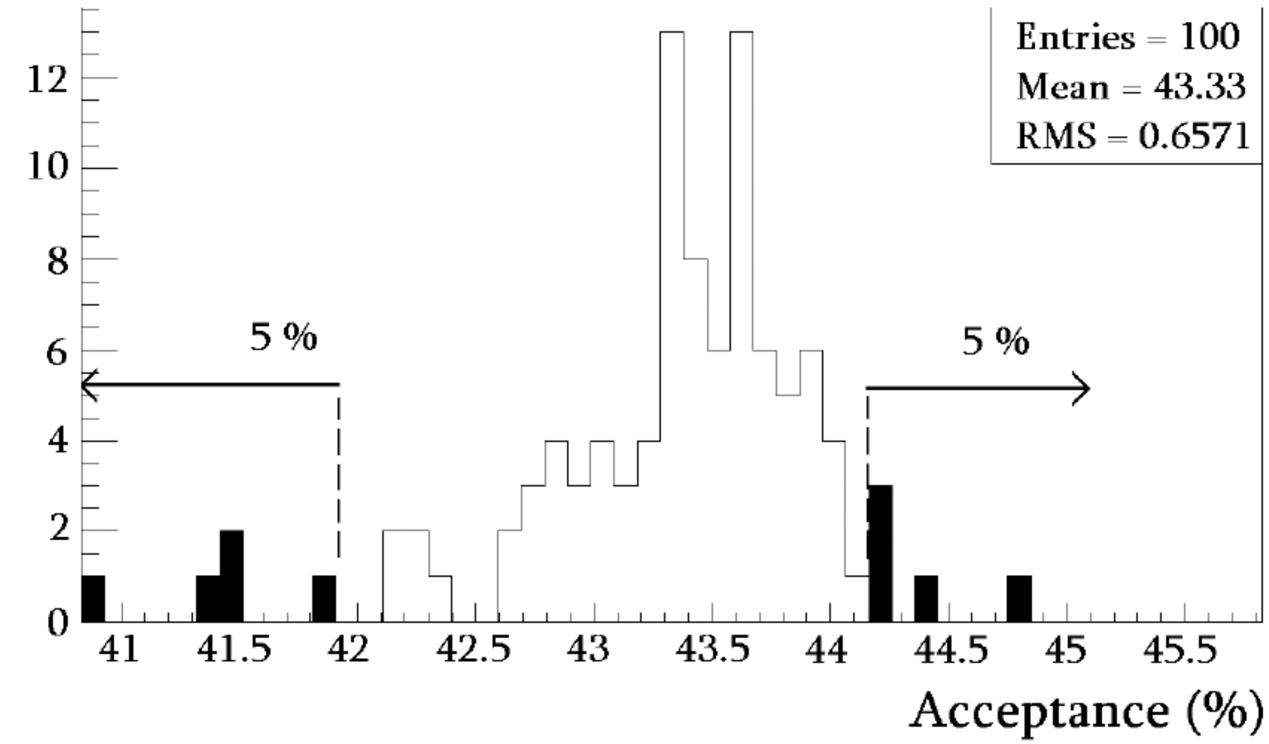
Frascati Physics Series Volume XLVIII First Young Researchers Workshop "*Physics Challenges in the LHC Era*" 2009 Ed. E. Nardi, Frascati (May 11th and May 14th, 2009) ISBN **978-88-86409-57-5**

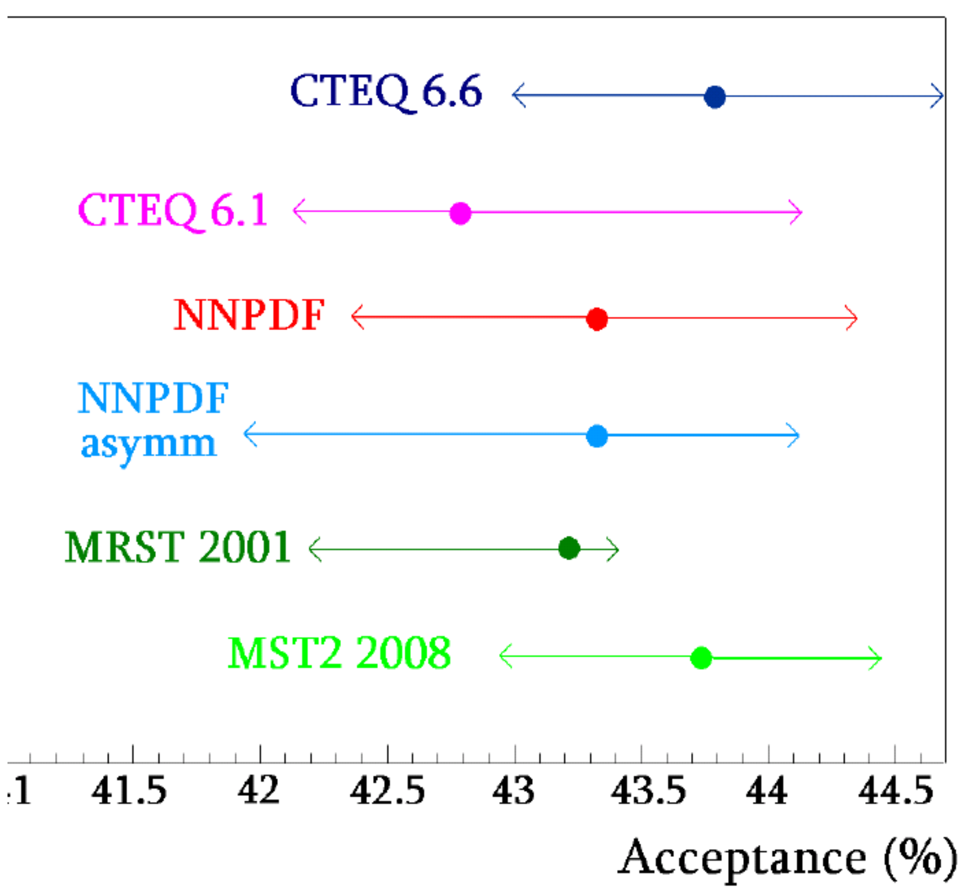
- Results for 14 TeV comparing different MC codes
  - ★ analysis for 10 TeV is ongoing
- Acceptances calculated with cuts
  - ★ $p_T > 20$ GeV and $|\eta| < 2.5$
  - ★ next results p_T cut will be lowered to 15 GeV to match analysis selections
- Both NLO calculations cause an upward shift wrt LO acceptance

Generator	order	$W^+ \to \mu^+ \nu_\mu$	$W^- \to \mu^- \bar{\nu}_\mu$	$Z \to \mu^+ \mu^-$
Herwig	LO	45.45 ± 0.30		39.98 ± 0.26
Pythia		45.99 ± 0.31		39.75 ± 0.26
Horace Born		45.82 ± 0.30	46.01 ± 0.31	38.93 ± 0.25
Horace NLO (EW)	NLO	47.87 ± 0.32	47.61 ± 0.32	42.01 ± 0.28
MC@NLO (QCD)		48.31 ± 0.34	48.28 ± 0.34	42.62 ± 0.29

Acceptance effects from PDFs

- Comparison of different PDFs using their error sets
  - ★ Confidence level is estimated with an asymmetric method
    - – low statistic limited
  - ★ All PDF sets used are NLO
  - ★ CTEQ 6.1 and MRST 2001 without quark mass effects





Central values of standard PDF sets are inside the **NN allowed range** (90 C.L.) which is a little **broader** than other (especially in the asymmetric case)

	A_0	$+\Delta A$	$-\Delta A$	$\left(\max \frac{\delta A}{A}\right) \times 100$
CTEQ 6.1	42.80	1.34	0.68	3.12
CTEQ 6.6	43.75	0.93	0.77	2.12
MSTW 2008	43.73	0.72	0.79	1.82
Symm NN	43.33	1.0		2.3
Asymm NN	**43.33**	**0.83**	**1.42**	**3.3**

W and Z event selections

- Starting with simple selections
  - ★ based as much as possible on well-know quantities
  - ★ user fewer cuts but tighter
    - – e.g. mu20 trigger instead of mu10 to reduce background instead of adding more isolation requirements (mu10 as support trigger)

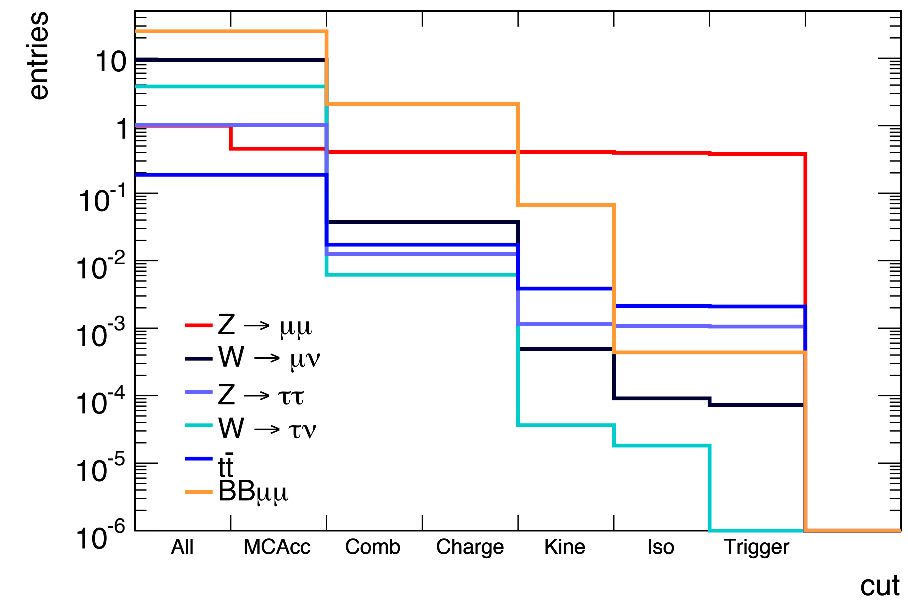
Z(W) selections		
Cut	Object	Value(s)
Acceptance	Truth Z(W) muons	$p_T > 15\ GeV$, $\|\eta\| < 2.5$
Kinematics	Combined track (Staco)	2(1), $p_T > 20\ GeV$, $\|eta\| < 2.5$
Isolation	ID cone (0.4) activity	$\sum p_T^{ID} < 5\ GeV$, $\sum N^{ID} < 6$
Trigger	event trigger EF trigger track	$\mu 20$ associated over threshold
MET (W-only)	MetRefFinal	$E_T^{miss} > 25\ GeV$

- Just a baseline selection to start with
  - ★ clearly all values need to be tuned on real data ...
- Work is ongoing to compare results with the benchmark analysis

$Z \to \mu\mu$ cut flow results for 50 pb^{-1}

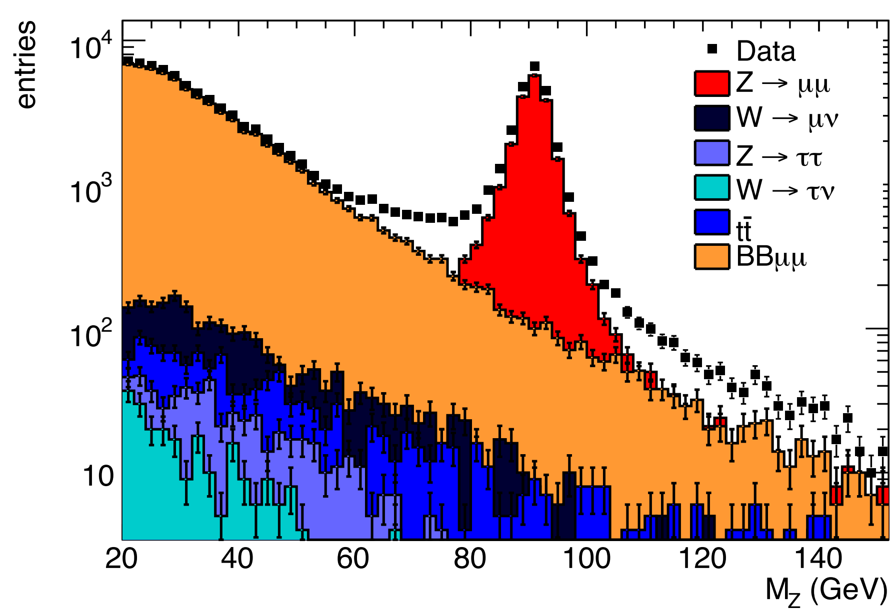
Cuts (%)	$Z \to \mu\mu$	$W \to \mu\nu$	$Z \to \tau\tau$	$W \to \tau\nu$	$t\bar{t}$	$BB\mu\mu$
Events	54900	517600	56400	209200	10300	1372868
MCAcc	45.62 ± 0.21	100.000 ± 0.000	100.000 ± 0.000	100.000 ± 0.000	100.000 ± 0.000	100.000 ± 0.000
Comb	40.82 ± 0.21	0.396 ± 0.009	1.220 ± 0.046	0.163 ± 0.009	9.214 ± 0.285	8.351 ± 0.024
Charge	40.82 ± 0.21	0.396 ± 0.009	1.220 ± 0.046	0.163 ± 0.009	9.214 ± 0.285	8.351 ± 0.024
Kine	40.59 ± 0.21	0.005 ± 0.001	0.112 ± 0.014	0.001 ± 0.001	2.058 ± 0.140	0.268 ± 0.004
Iso	39.67 ± 0.21	0.001 ± 0.000	0.105 ± 0.014	0.000 ± 0.000	1.136 ± 0.104	0.002 ± 0.000
Trigger	38.20 ± 0.21	0.001 ± 0.000	0.103 ± 0.013	0.000 ± 0.000	1.117 ± 0.104	0.002 ± 0.000

- 2 reconstructed tracks and isolation requirements greatly suppress backgrounds in the signal window
  - ★ Signal selection efficiency **38.2 %**
    Backgrounds suppression >**99 %**

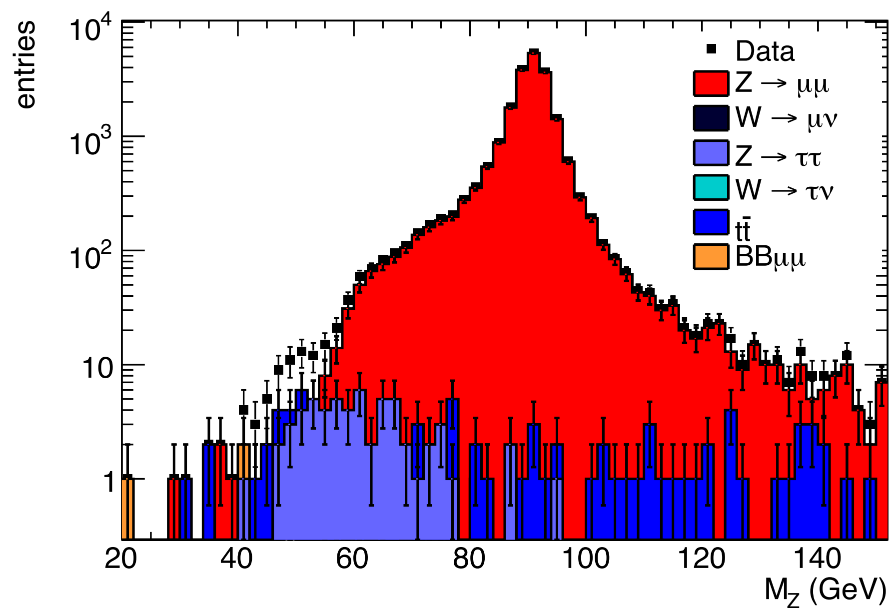


- That's very nice but
  - ★ efficiencies must be controlled with data
  - ★ backgrounds not known to the extent of trusting entirely in MC simulations
    - – techniques to study background shapes and normalizations from data

ALL EVENTS



AFTER TRIGGER CUT



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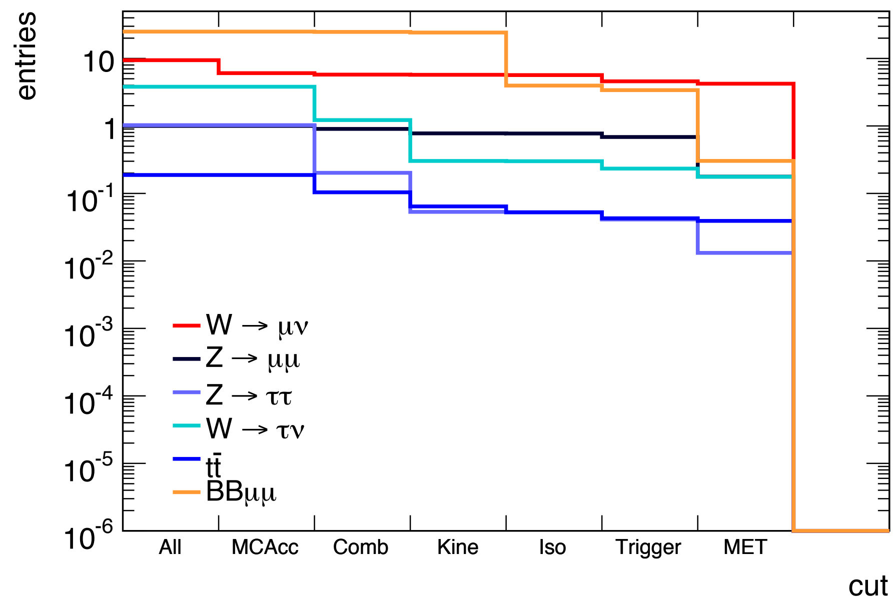
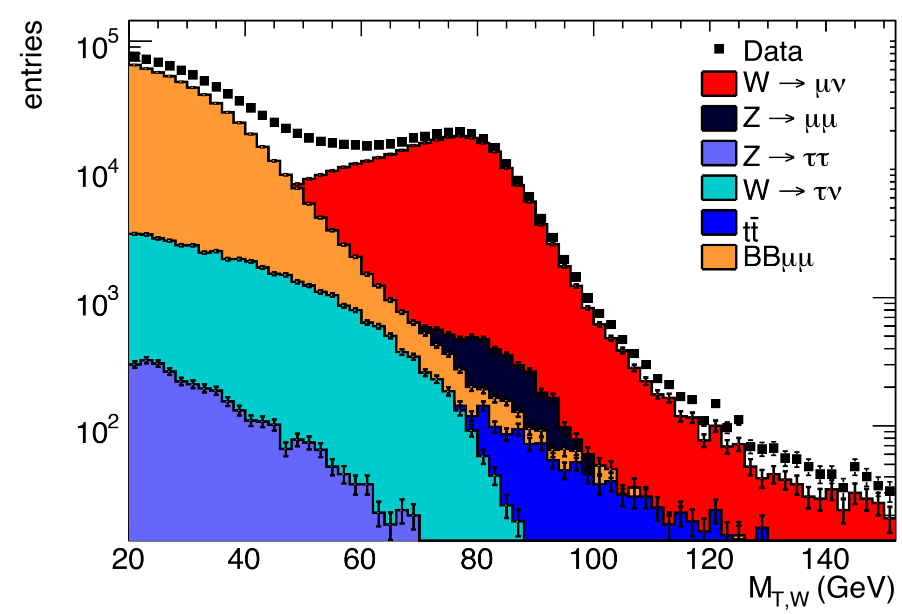
Events	517600	54900	56400	209200	10300	1372868
MCAcc	64.26 ± 0.07	100.000 ± 0.000	100.000 ± 0.000	100.000 ± 0.000	100.000 ± 0.000	100.000 ± 0.000
Comb	61.12 ± 0.07	90.348 ± 0.126	19.667 ± 0.167	32.065 ± 0.102	55.398 ± 0.490	98.945 ± 0.009
Kine	60.74 ± 0.07	77.645 ± 0.178	5.188 ± 0.093	7.946 ± 0.059	34.243 ± 0.468	96.869 ± 0.015
Iso	60.15 ± 0.07	77.293 ± 0.179	5.126 ± 0.093	7.882 ± 0.059	27.990 ± 0.442	15.853 ± 0.031
Trigger	48.63 ± 0.07	68.561 ± 0.198	4.005 ± 0.083	6.123 ± 0.052	22.845 ± 0.414	13.570 ± 0.029
MET	44.83 ± 0.07	17.738 ± 0.163	1.280 ± 0.047	4.627 ± 0.046	20.883 ± 0.401	1.213 ± 0.009

- Isolation requirements greatly suppress QCD background in the signal window
  - ★ Signal selection efficiency (w/ MET cut) **48.6 (44.8) %** Backgrounds suppression **QCD 13.6 (1.2)%**
  - ★ MET cut not so effective in EW backgrounds due to real or fake W topologies



- Same considerations on the need to extract information from data are applied here

ALL EVENTS



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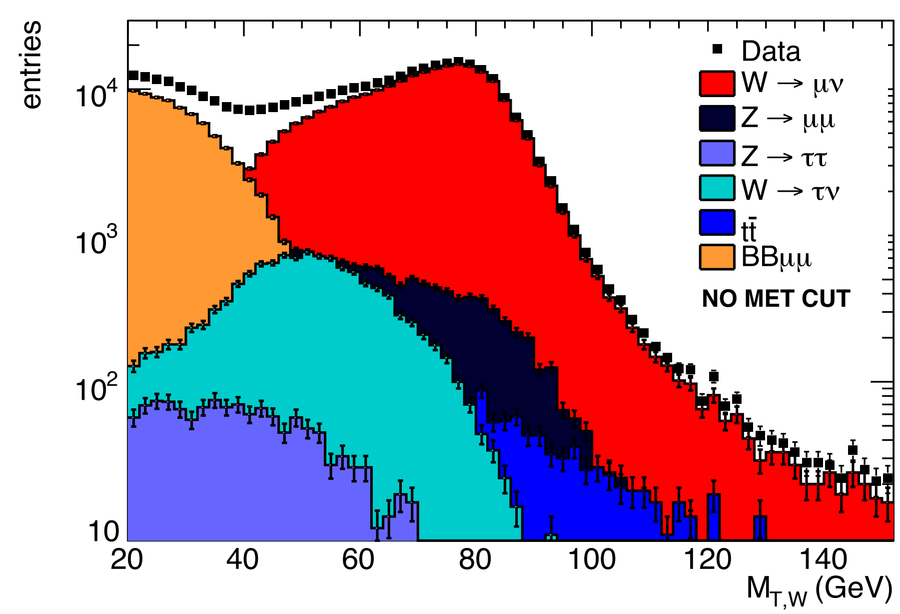

W → μυ cut flow results for 50 pb^{-1}

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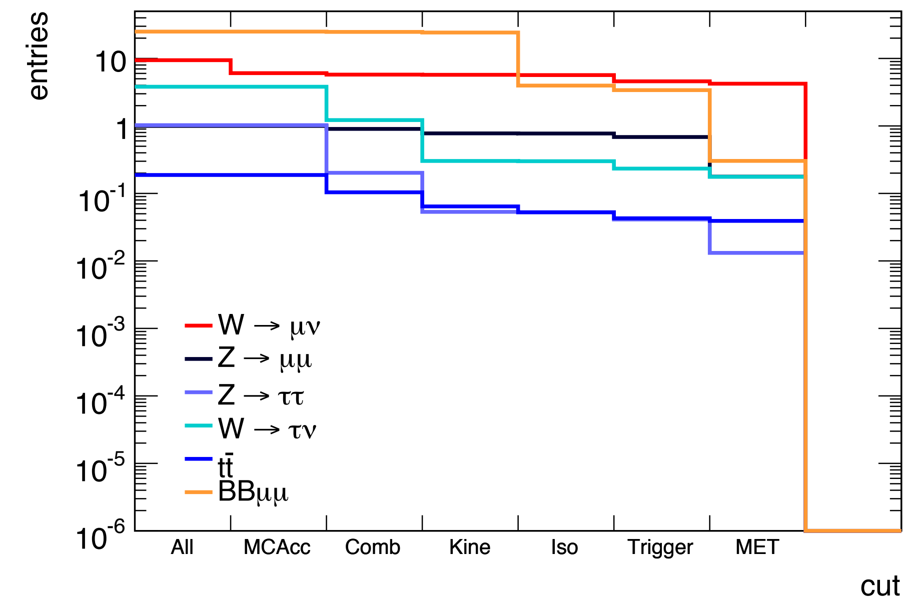
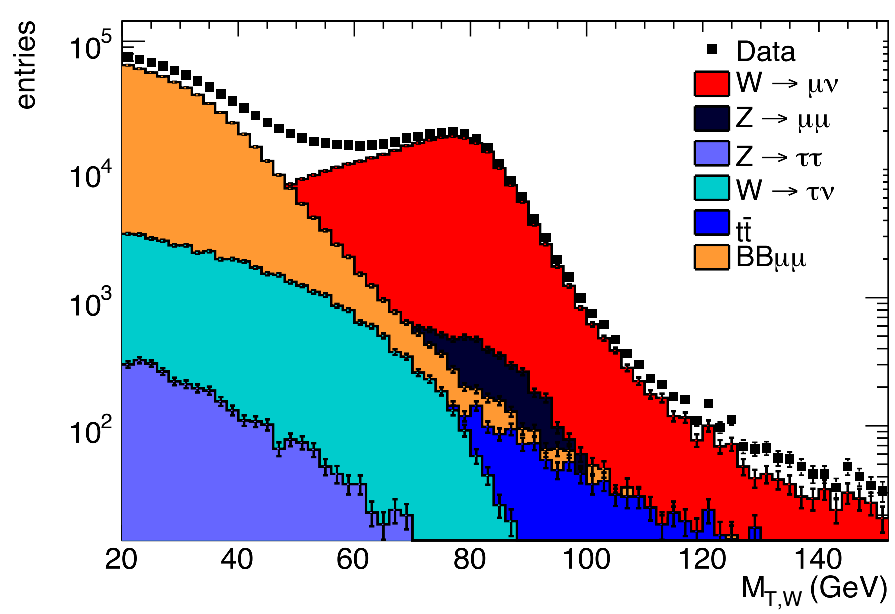
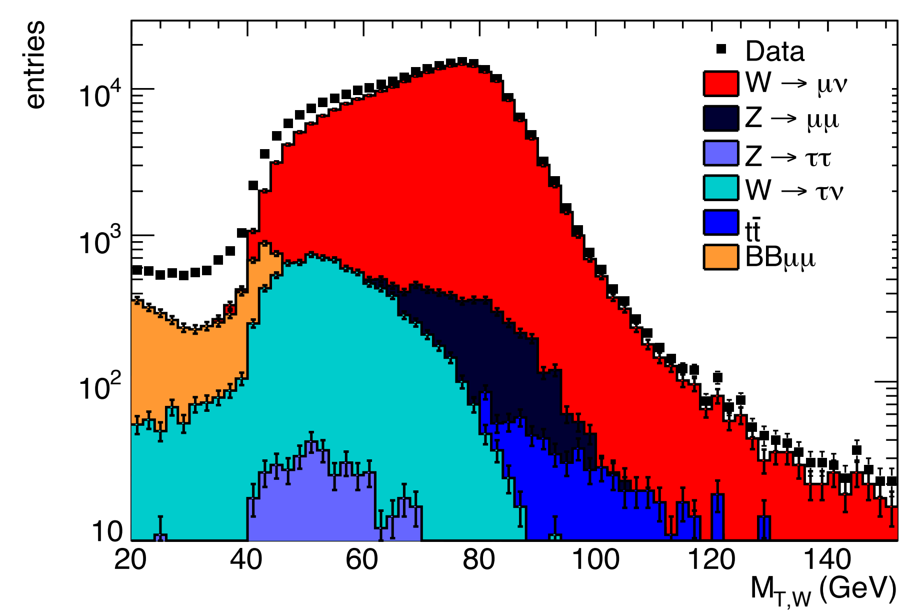


- Same data driven considerations can be applied here

ALL EVENTS

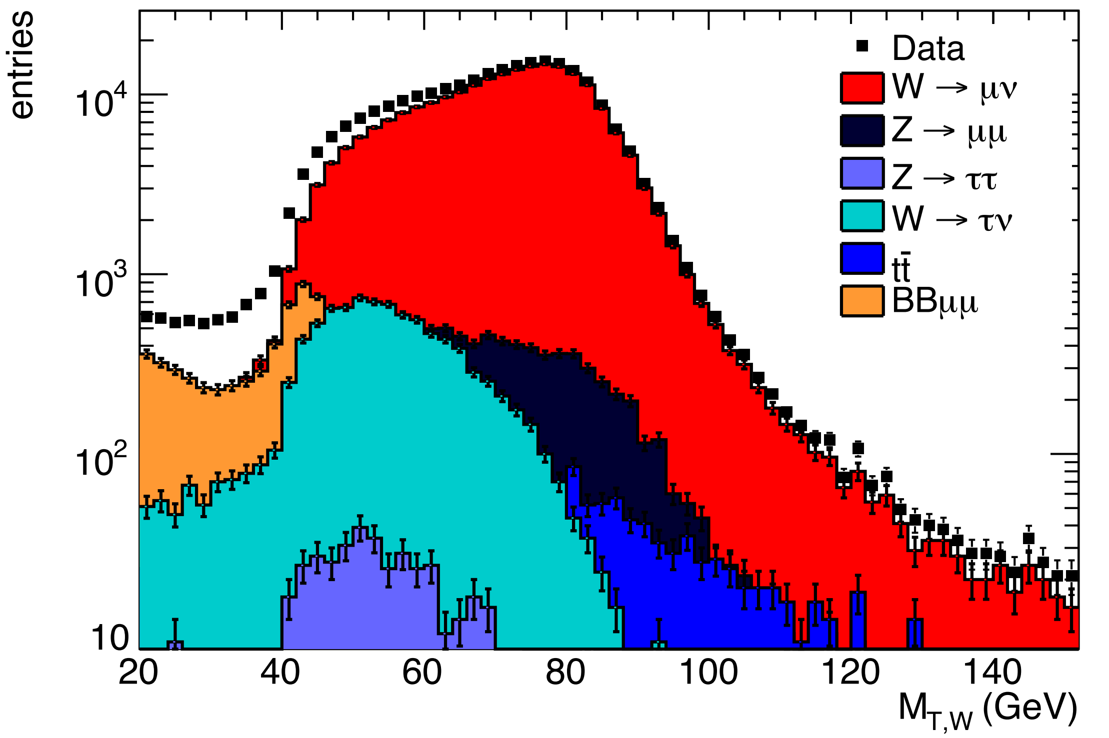


AFTER MET CUT



Towards a measurement on real data

- Extract from data the number of selected W or Z events
  - ★ lineshapes fit
  - ★ backgrounds subtraction using MC and data driven estimations



- Rescale this number for efficiencies and acceptance
  - ★ build MC cut flow efficiencies from single particle efficiencies

$$\begin{aligned}\epsilon_{evt} = \; & \epsilon^{+}_{MS/ID} \cdot \epsilon^{+}_{CB/MS} \cdot \epsilon^{+}_{CBISO/CB} \\ \cdot \; & \epsilon^{-}_{MS/ID} \cdot \epsilon^{-}_{CB/MS} \cdot \epsilon^{-}_{CBISO/CB} \\ \cdot \; & (1 - (1 - \epsilon^{+}_{TRIG/CBISO}) \cdot (1 - \epsilon^{-}_{TRIG/CBISO}))\end{aligned}$$

  - ★ re-weight with efficiencies extracted from data with Tag&Probe method
  - ★ apply momentum and missing energy scales corrections

Event selection efficiency

$$\epsilon_{evt} = \epsilon^{+}_{MS/ID} \cdot \epsilon^{+}_{CB/MS} \cdot \epsilon^{+}_{CBISO/CB} \cdot \epsilon^{-}_{MS/ID} \cdot \epsilon^{-}_{CB/MS} \cdot \epsilon^{-}_{CBISO/CB} \cdot (1 - (1 - \epsilon^{+}_{TRIG/CBISO}) \cdot (1 - \epsilon^{-}_{TRIG/CBISO}))$$

Muon Spectrometer efficiency wrt Inner Detector

Combined Muon efficiency wrt Muon Spectrometer

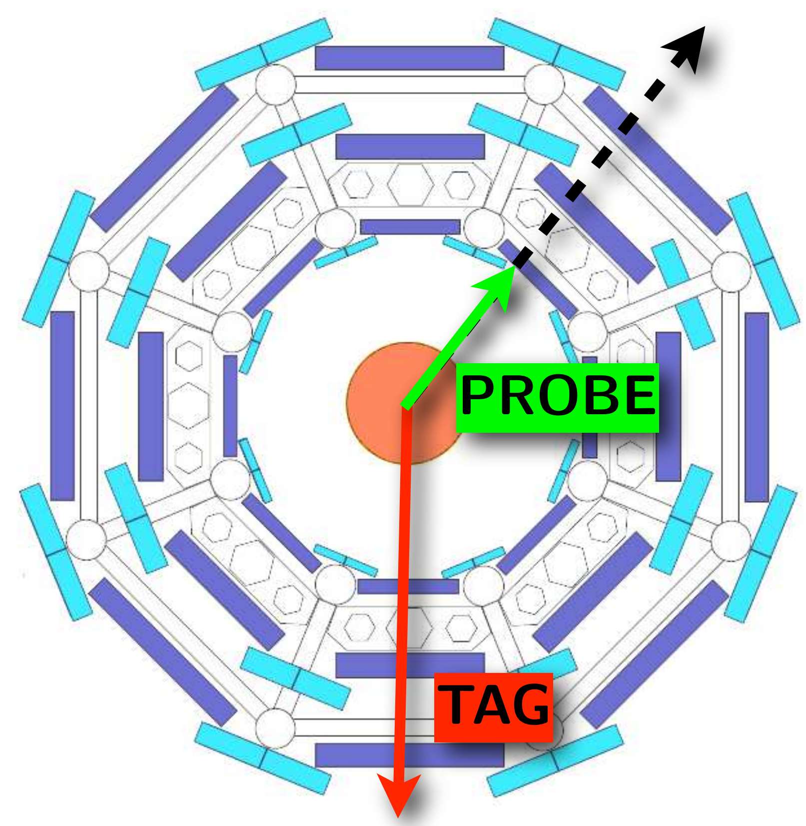
Isolation efficiency wrt Combined Muon

Muon Trigger efficiency wrt Isolated Combined Muon

- **Tag&Probe** to extract efficiencies from data
  - ★ trying to apply as few cuts as possible
  - ★ then, depending on background, selection will be tuned
  - ★ validation against true efficiency from Z muons

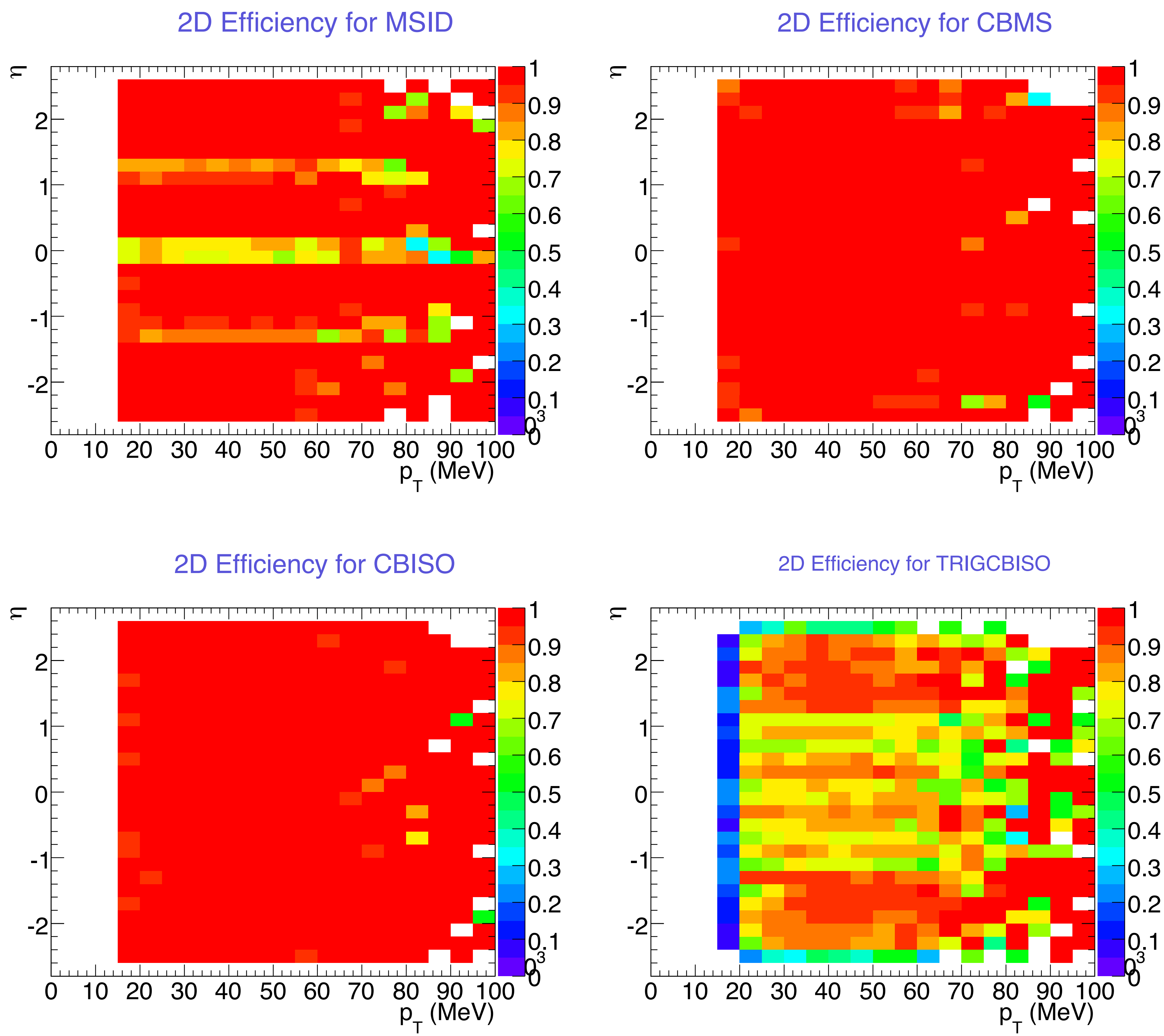
Tag selection	ID,MS Probes selection
combined track $p_T > 20$ GeV μ20 triggered event triggered track associated	ID track $p_T > 15, \lvert\eta\rvert < 2.5$ GeV opposite charge wrt tag $\lvert M_{\mu\mu} - M_Z \rvert < 15 \cdot \Gamma_Z$ calo muon associated ($dR < 0.001$)[1]

[1]only for ID probe selection



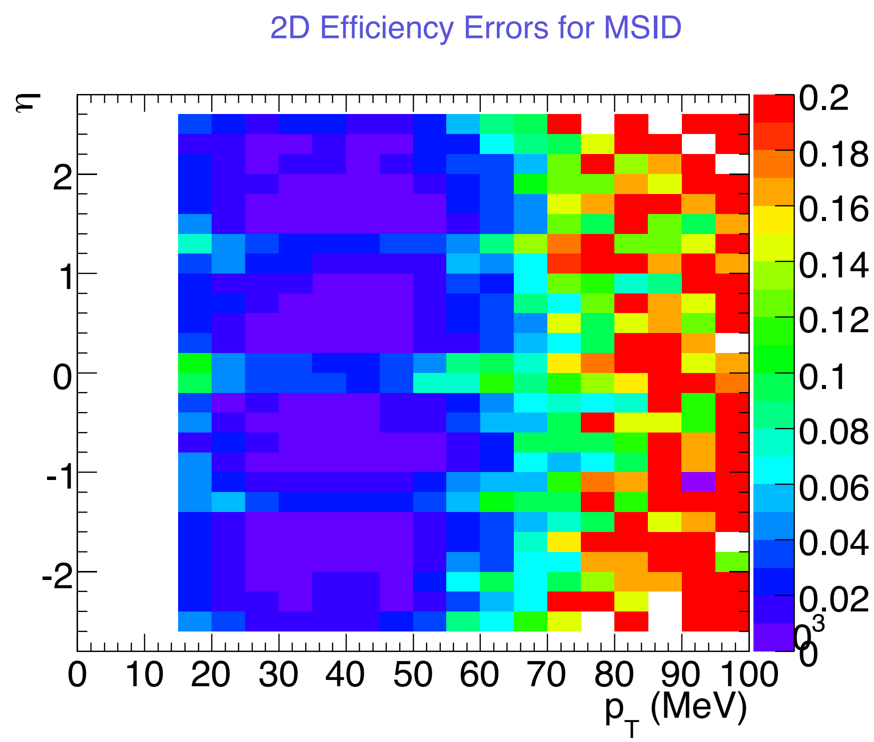
Efficiency results

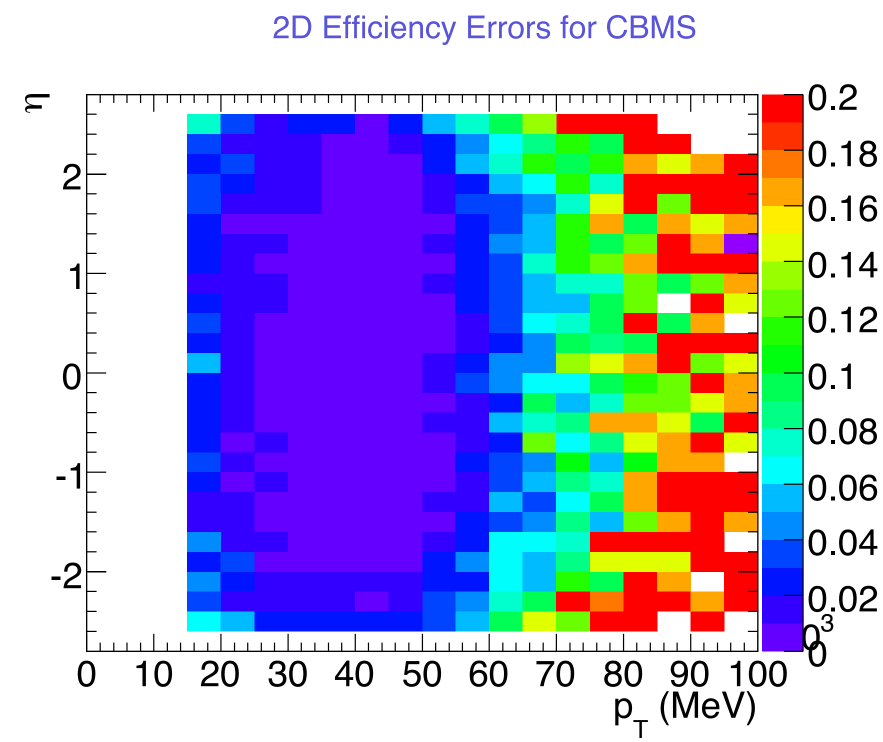
- η-p_T bins (0.2x5)
  - ★ good phase space coverage
  - ★ proper handling of empty bins taking average value of nearest ones

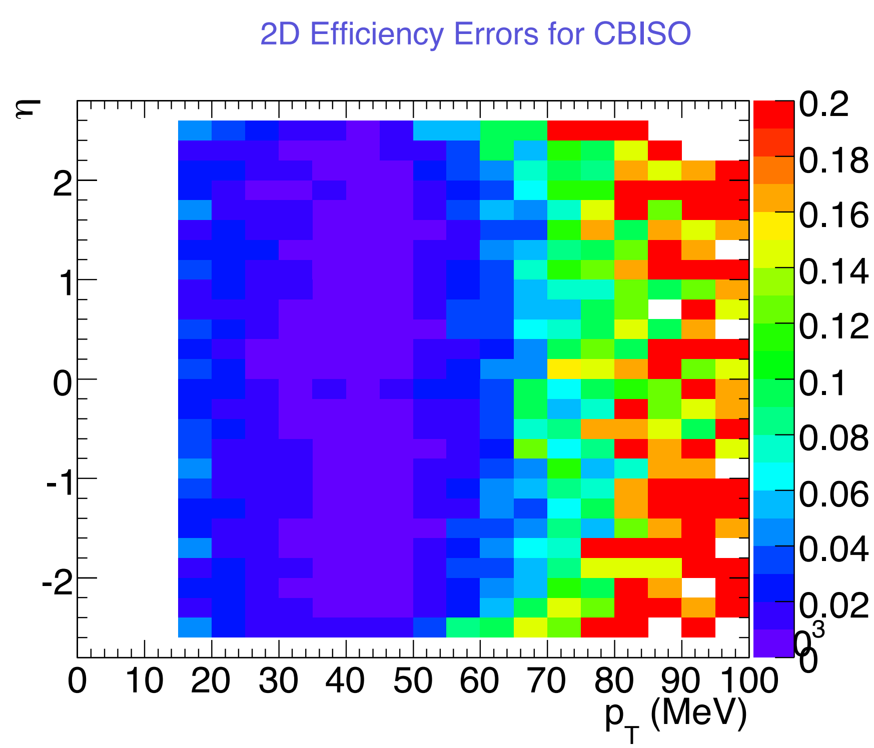


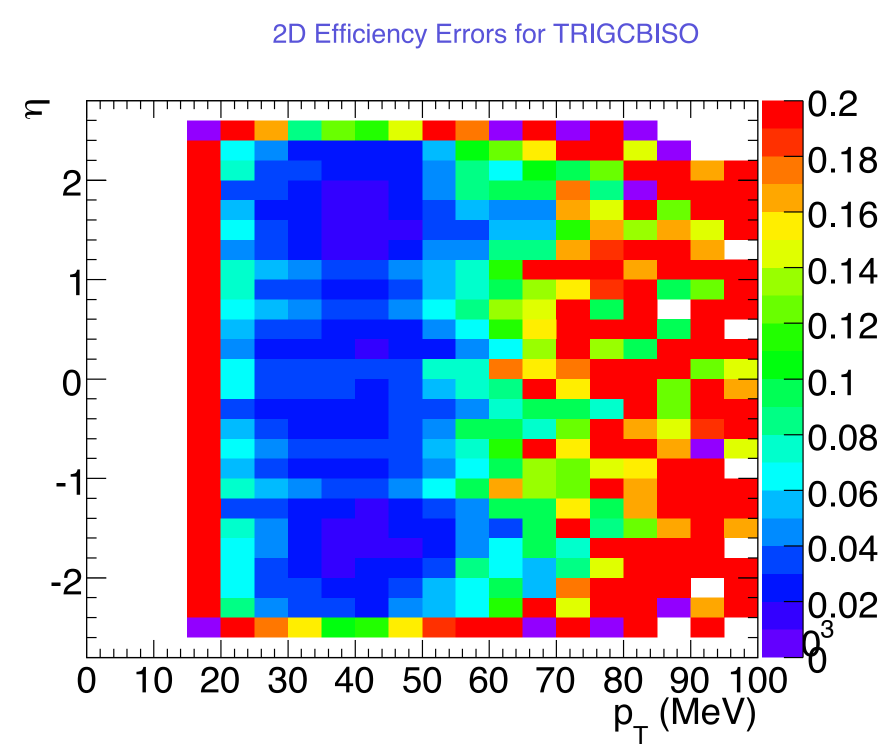
Efficiency results

- η-p_T bins (0.2x5)
  Statistical errors
  - ★ < 2% for p_T<60 GeV in all η space
  - ★ clearly growing at higher momentum







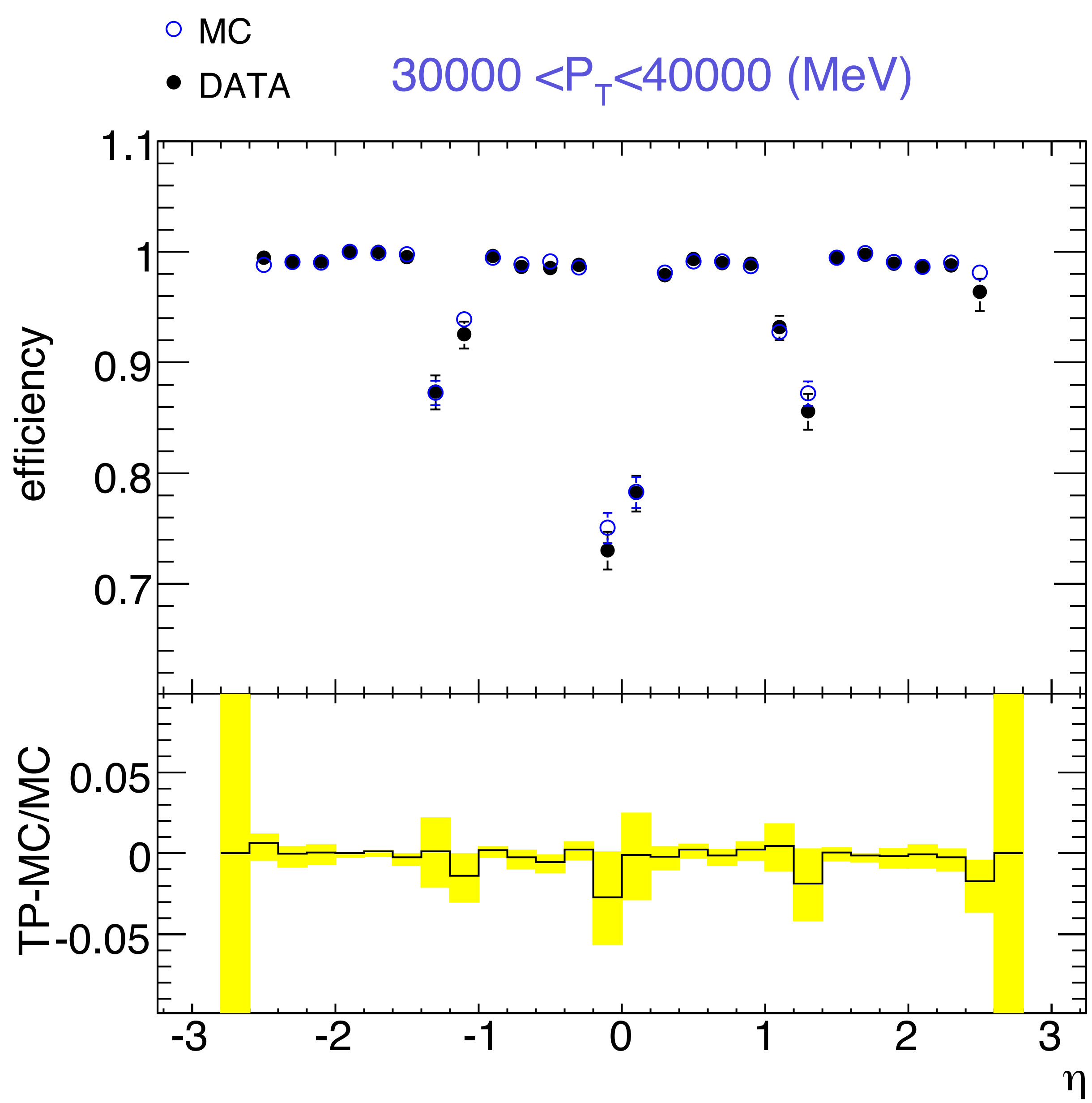


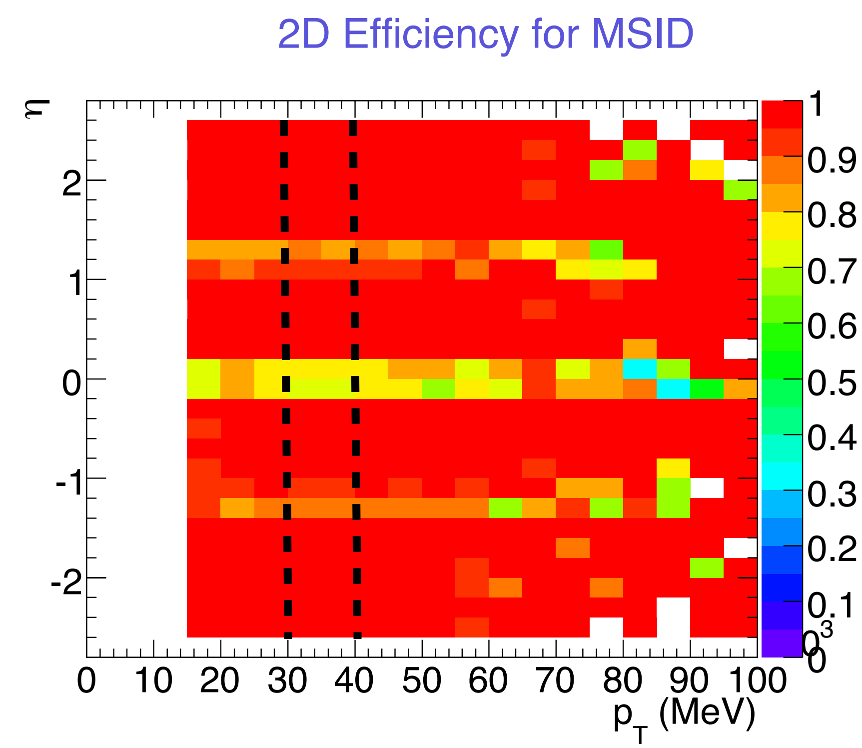
Efficiency results

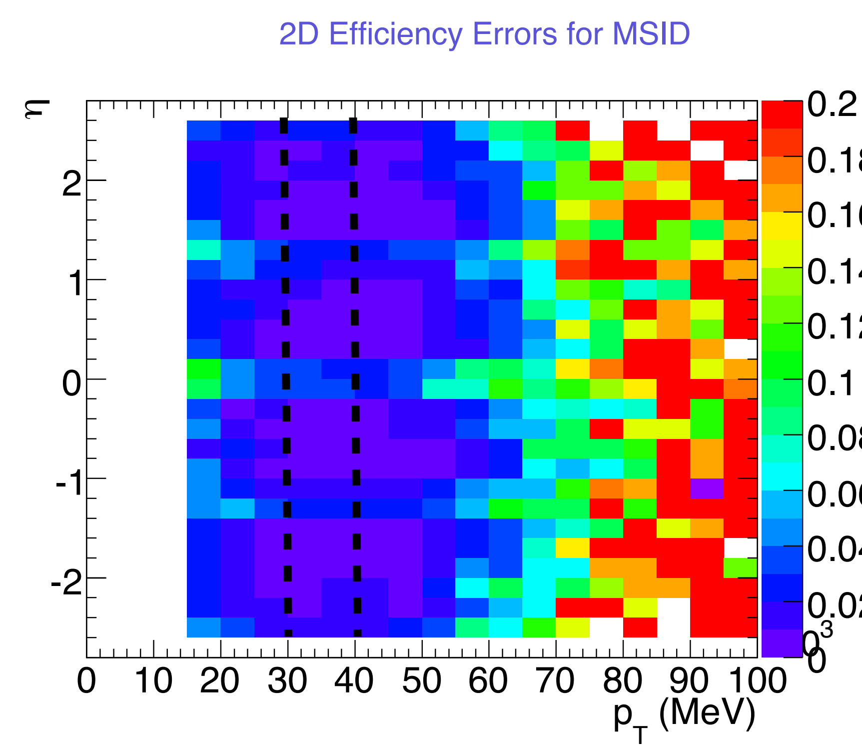
- η-p_T bins (0.2x5) - **MSID step**

  Systematic errors (deviation from truth efficiency)

  ★ generally below 1% and few % in critical regions





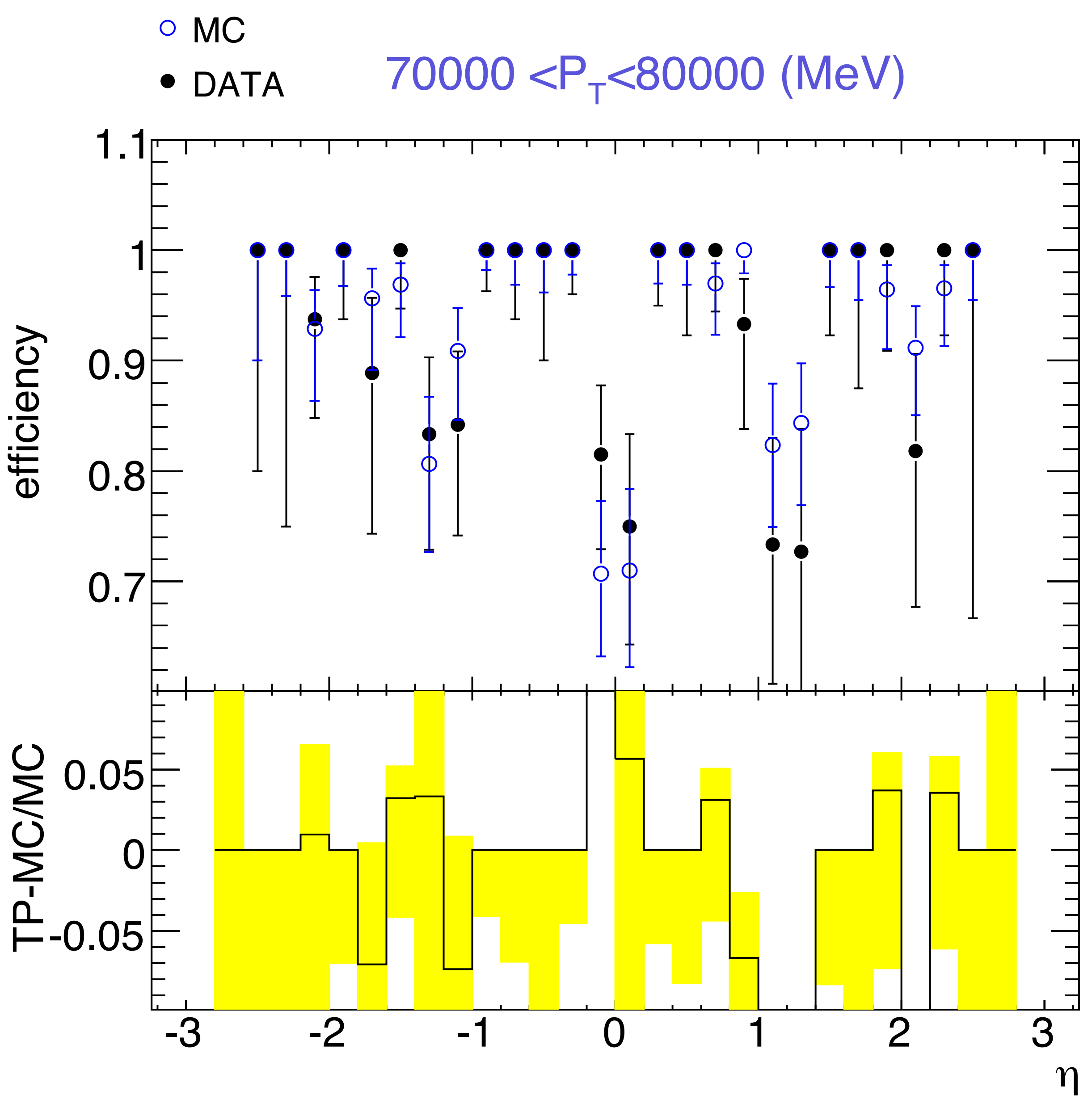


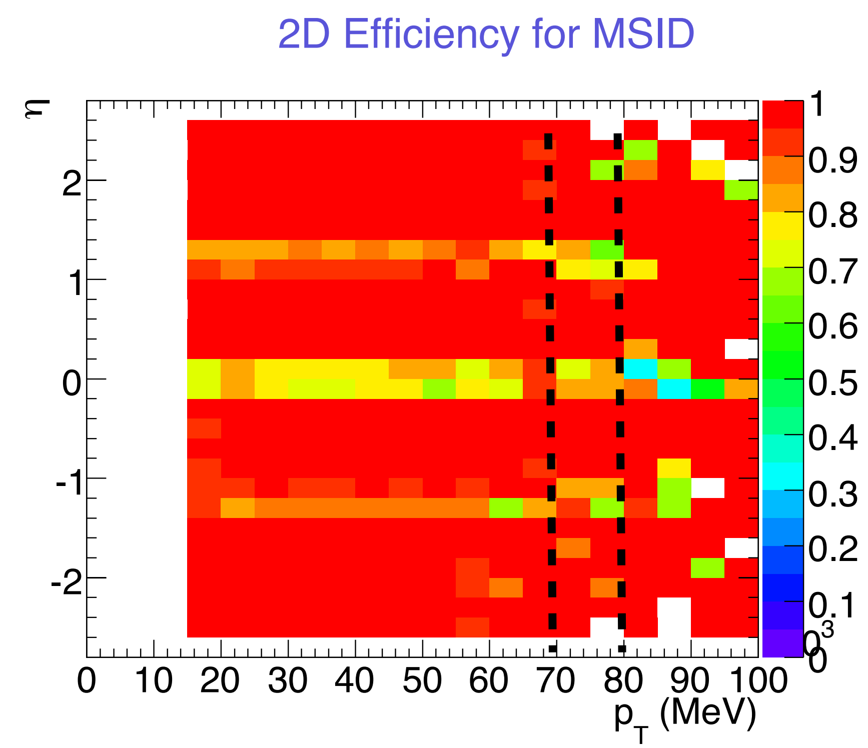
Efficiency results

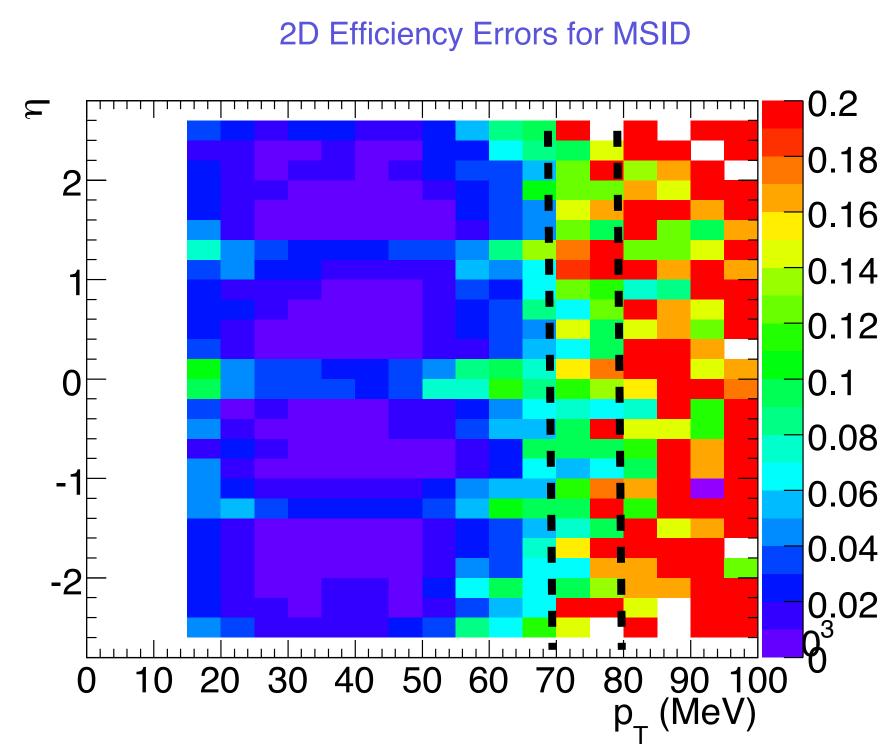
- η-p_T bins (0.2x5) - **MSID step**

  Systematic errors (deviation from truth efficiency)

  ★ clearly moving to higher p_T gives bigger errors



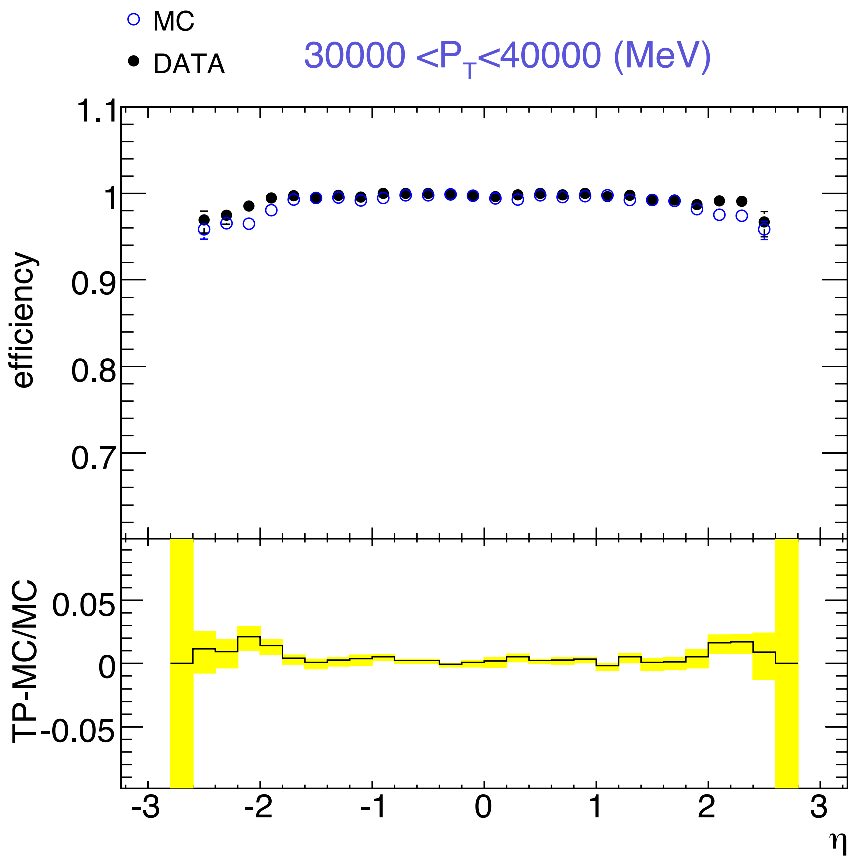


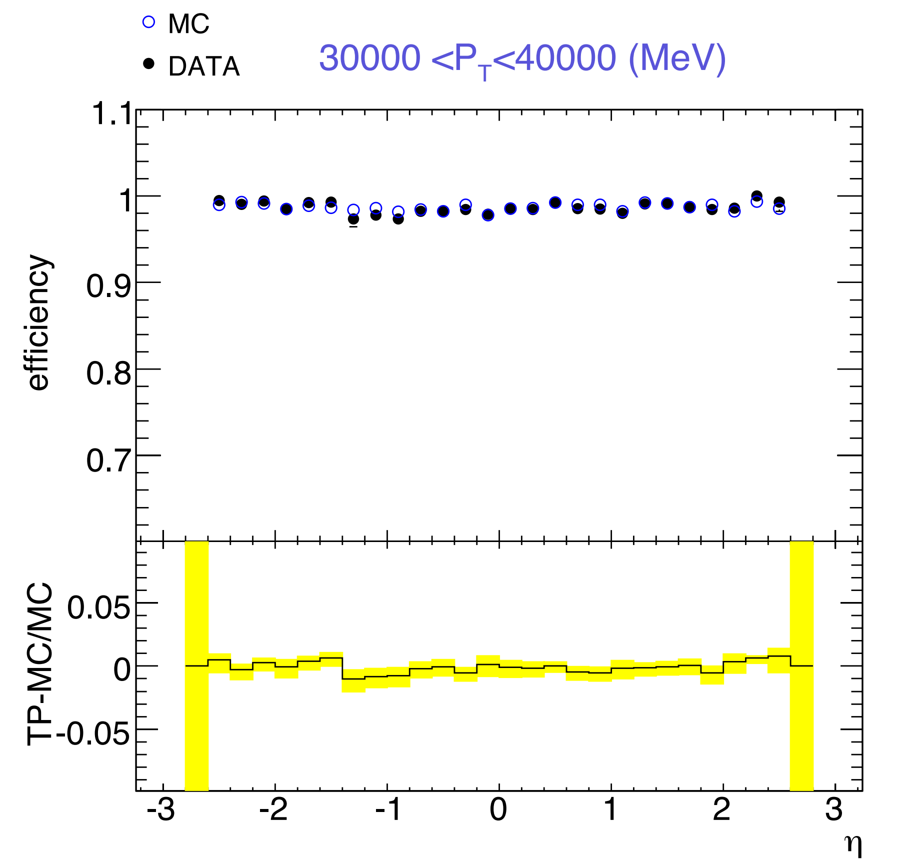


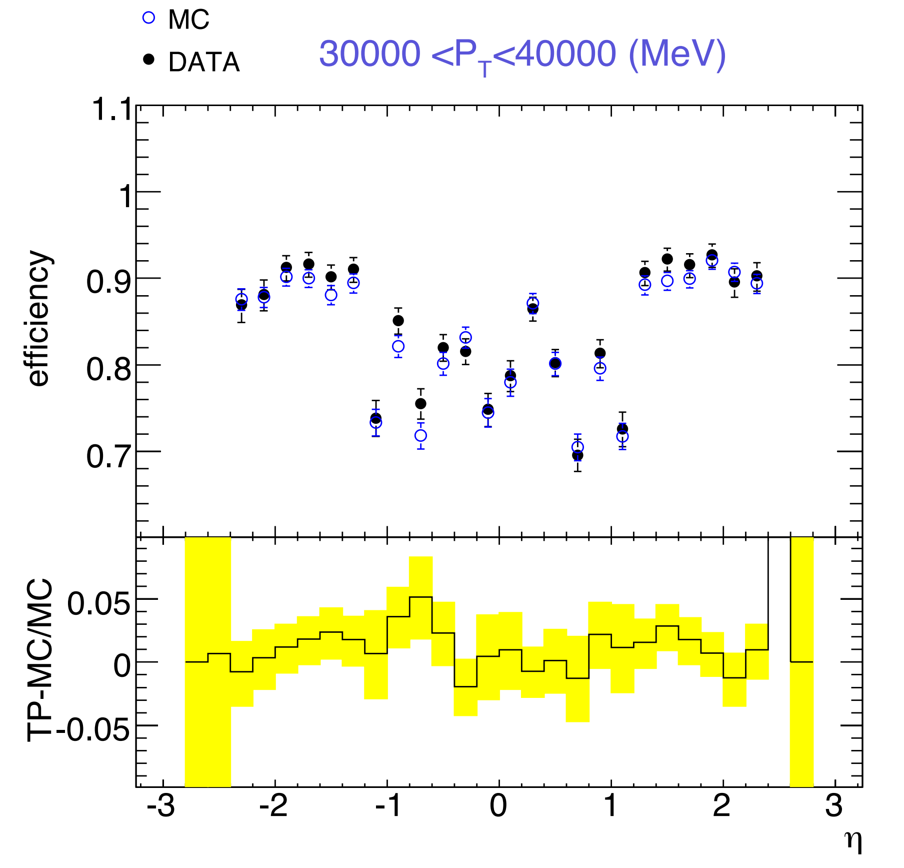
Efficiency results

- η-p_T bins (0.2x5) - **CBMS, CBISO, TRIGCBISO steps**

  Systematic errors
  (deviation from truth efficiency)







★ generally below 1% with bigger deviations (2-3%) in the trigger step (to be opt)

Efficiency results - effect of backgrounds

- Num of probes/sample as % of total probes
  - ★ MC probes from Z→ττ to be removed
- Using a simple Tag&Probe selection not all selected probes comes from signal
  - ★ ≈ 5-6% from QCD bkg with 50% fake probability
  - ★ ≈ 3.6% of fakes introduces 4% bias in MSID efficiency
    - – fakes localized at low p_T
- QCD probes not isolated
  - ★ useless for CBISO step
- Need for a more robust Tag&Probe selection ...

Sample	MC probes (eff %)	TP probes (eff %)	Fakes tot % (rel %) (eff %)
MSID efficiency			
Data	77828.0 (95.85)	40518.0 (91.95)	3.57 (2.77)
$Z \to \mu\mu$	93.75 (95.84)	93.30 (95.31)	0.07 (0.08) (16.67)
$W \to \mu\nu$	-	0.58 (7.17)	0.55 (93.25) (1.36)
$Z \to \tau\tau$	6.25 (96.09)	0.27 (79.82)	0.05 (18.35) (0.00)
$W \to \tau\nu$	-	0.02 (10.00)	0.02 (90.00) (0.00)
$t\bar{t}$	-	0.38 (82.47)	0.04 (11.04) (11.76)
$BB\mu\mu$	-	5.44 (45.01)	2.83 (52.09) (2.61)
CBMS efficiency			
Data	74602.0 (98.94)	40176.0 (99.22)	0.01 (50.00)
$Z \to \mu\mu$	93.73 (98.93)	92.36 (99.25)	0.00 (0.00) (100.00)
$W \to \mu\nu$	-	0.07 (93.10)	0.01 (10.34) (33.33)
$Z \to \tau\tau$	6.27 (99.02)	0.22 (98.85)	0.00 (0.00) (-)
$W \to \tau\nu$	-	0.00 (100.00)	0.00 (0.00) (-)
$t\bar{t}$	-	0.41 (100.00)	0.00 (0.00) (-)
$BB\mu\mu$	-	6.93 (98.96)	0.00 (0.00) (-)
CBISO efficiency			
Data	73810.0 (98.92)	39864.0 (92.37)	0.01 (50.00)
$Z \to \mu\mu$	93.73 (98.90)	92.38 (98.77)	0.00 (0.00) (100.00)
$W \to \mu\nu$	-	0.07 (40.74)	0.01 (11.11) (33.33)
$Z \to \tau\tau$	6.27 (99.14)	0.22 (98.84)	0.00 (0.00) (-)
$W \to \tau\nu$	-	0.01 (50.00)	0.00 (0.00) (-)
$t\bar{t}$	-	0.41 (67.88)	0.00 (0.00) (-)
$BB\mu\mu$	-	6.91 (8.64)	0.00 (0.00) (-)
TRIGCBISO efficiency			
Data	73012.0 (74.53)	36822.0 (79.31)	0.01 (50.00)
$Z \to \mu\mu$	93.72 (76.06)	98.79 (79.36)	0.00 (0.00) (100.00)
$W \to \mu\nu$	-	0.03 (63.64)	0.01 (27.27) (33.33)
$Z \to \tau\tau$	6.28 (51.79)	0.23 (75.29)	0.00 (0.00) (-)
$W \to \tau\nu$	-	0.00 (0.00)	0.00 (0.00) (-)
$t\bar{t}$	-	0.30 (74.11)	0.00 (0.00) (-)
$BB\mu\mu$	-	0.65 (76.89)	0.00 (0.00) (-)

Efficiency results - effect of backgrounds *optimized*

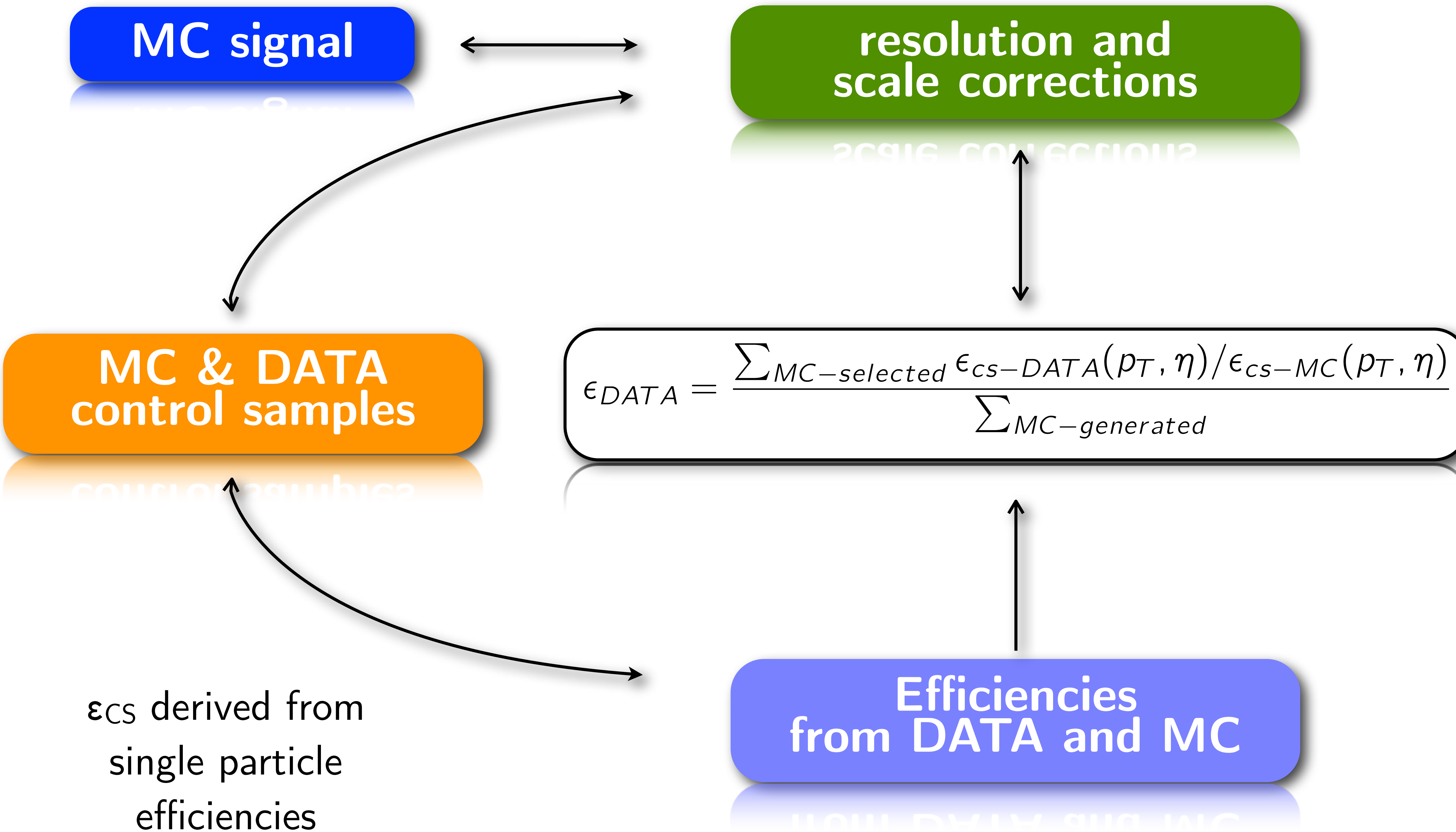
- Improved selections

Tag selection	Probes selection
$\|d_0\| < 0.2$ $\sum N^{ID} < 6$ $\sum p_T^{ID} < 5\ GeV$	$\|d_0\| < 0.2$

- High signal efficiency (>98%) and QCD background rejection
  - ★ ≈ 5-6% QCD probes reduced to 0.3-0.4%
  - ★ overall MSID fake reduced to 1%

Sample	MC probes (eff %)	TP probes (eff %)	Fakes tot % (rel %) (eff %)
MSID efficiency			
Data	77828.0 (95.85)	37974.0 (94.48)	0.94 (2.81)
$Z \to \mu\mu$	93.75 (95.84)	98.42 (95.32)	0.07 (0.07) (16.00)
$W \to \mu\nu$	-	0.55 (6.28)	0.52 (94.69) (1.53)
$Z \to \tau\tau$	6.25 (96.09)	0.28 (79.05)	0.05 (19.05) (0.00)
$W \to \tau\nu$	-	0.02 (12.50)	0.02 (87.50) (0.00)
$t\bar{t}$	-	0.32 (83.61)	0.03 (9.84) (16.67)
$BB\mu\mu$	-	0.41 (33.76)	0.25 (61.15) (1.04)
CBMS efficiency			
Data	74602.0 (98.94)	36948.0 (99.38)	0.01 (50.00)
$Z \to \mu\mu$	93.73 (98.93)	99.06 (99.39)	0.00 (0.00) (100.00)
$W \to \mu\nu$	-	0.06 (90.91)	0.01 (13.64) (33.33)
$Z \to \tau\tau$	6.27 (99.02)	0.22 (98.80)	0.00 (0.00) (-)
$W \to \tau\nu$	-	0.01 (100.00)	0.00 (0.00) (-)
$t\bar{t}$	-	0.35 (100.00)	0.00 (0.00) (-)
$BB\mu\mu$	-	0.31 (99.12)	0.00 (0.00) (-)
CBISO efficiency			
Data	73810.0 (98.92)	36720.0 (98.40)	0.01 (100.00)
$Z \to \mu\mu$	93.73 (98.90)	99.06 (98.80)	0.00 (0.00) (100.00)
$W \to \mu\nu$	-	0.05 (25.00)	0.00 (5.00) (100.00)
$Z \to \tau\tau$	6.27 (99.14)	0.22 (98.78)	0.00 (0.00) (-)
$W \to \tau\nu$	-	0.01 (50.00)	0.00 (0.00) (-)
$t\bar{t}$	-	0.35 (71.09)	0.00 (0.00) (-)
$BB\mu\mu$	-	0.31 (13.39)	0.00 (0.00) (-)
TRIGCBISO efficiency			
Data	73012.0 (74.53)	36131.0 (79.33)	-
$Z \to \mu\mu$	93.72 (76.06)	99.47 (79.36)	0.00 (0.00) (-)
$W \to \mu\nu$	-	0.01 (40.00)	0.00 (0.00) (-)
$Z \to \tau\tau$	6.28 (51.79)	0.22 (76.54)	0.00 (0.00) (-)
$W \to \tau\nu$	-	0.00 (0.00)	0.00 (0.00) (-)
$t\bar{t}$	-	0.25 (73.63)	0.00 (0.00) (-)
$BB\mu\mu$	-	0.04 (80.00)	0.00 (0.00) (-)

Event re-weighting formula



MC cut flow estimation

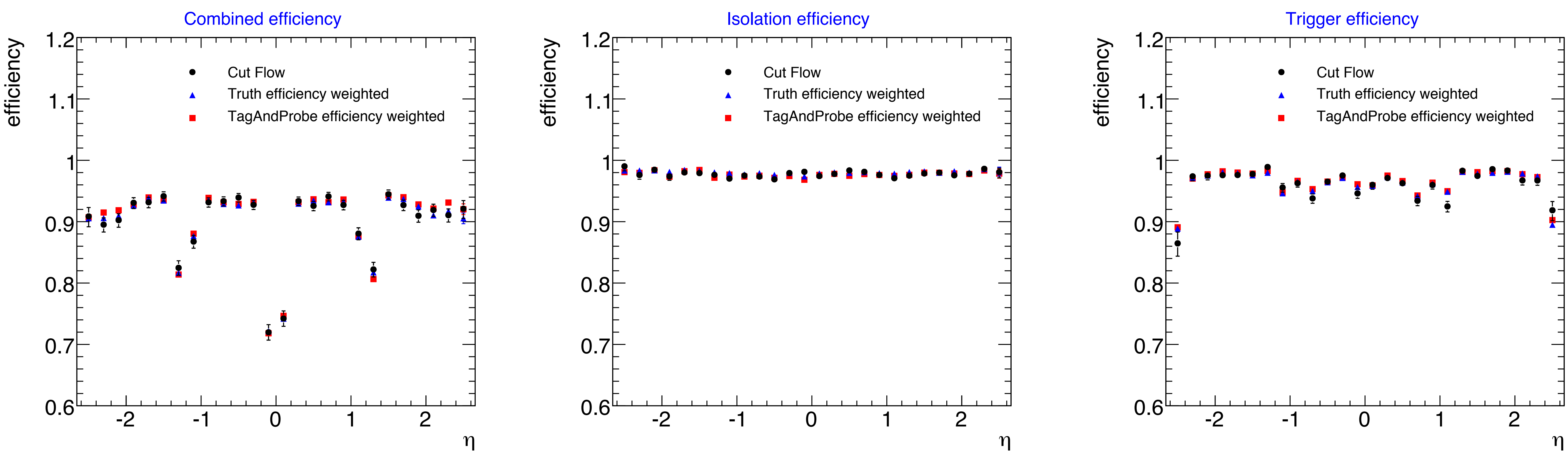
- Derive cut-flow values from single particle efficiencies extracted from data

Cuts (%)	$Z \rightarrow \mu\mu$	derived efficiency on (p_T, η) MC
MCAcc	45.62 ± 0.21	-
Comb	40.82 ± 0.21	$\epsilon^{+}_{MS/ID} \cdot \epsilon^{+}_{CB/MS} \cdot \epsilon^{-}_{MS/ID} \cdot \epsilon^{-}_{CB/MS}$
Charge	40.82 ± 0.21	-
Kine	40.59 ± 0.21	-
Iso	39.67 ± 0.21	$\epsilon^{+}_{CBISO/CB} \cdot \epsilon^{-}_{CBISO/CB}$
Trigger	38.20 ± 0.21	$1-(1-\epsilon^{+}_{TRIG/CBISO}) \cdot (1-\epsilon^{-}_{TRIG/CBISO})$

- Cross-check also with truth efficiency
  - ★ good agreement found

cut efficiency shown here wrt to previous cut in the flow

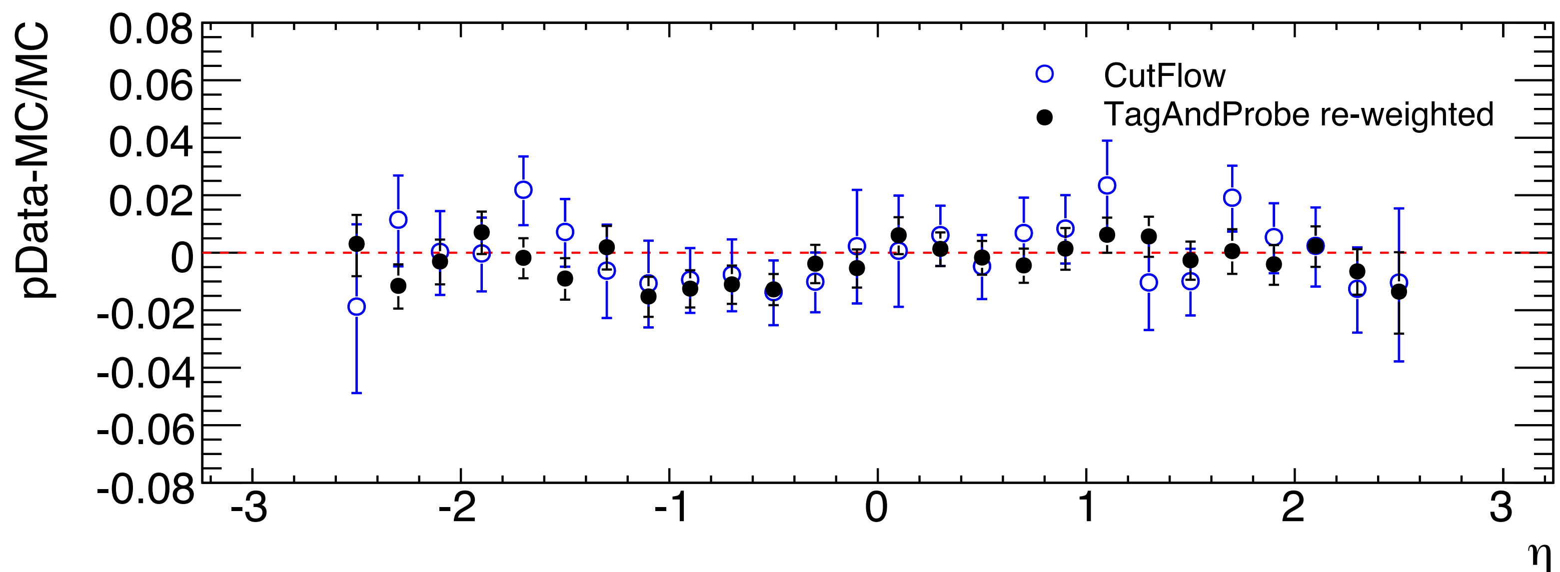
Cuts (%)	Cut Flow	MC-truth weighted	TagAndProbe weighted
Comb	89.48 ± 0.19	89.47 ± 0.19	89.71 ± 0.19
Iso	97.74 ± 0.10	98.01 ± 0.09	97.67 ± 0.10
Trigger	96.29 ± 0.13	96.50 ± 0.13	96.66 ± 0.12



Event re-weighting using pseudo-data (100 pb^{-1})

- Test event re-weighting using as pseudo-data a $Z \to \mu\mu$ sample simulated with a Muon Spectrometer 500µm misalignment and reconstructed with ideal geometry
  - ★ validating MC re-weighting using pDATA derived efficiency comparing differences from two samples using
    - CutFlow efficiency (that's truth, available only because data is pseudo one ...)
    - TagAndProbe re-weighted efficiency (unique test available in real data!)

- A lightweight pattern appears and is reproduced by method
  - ★ clearly small differences between pDATA and MC together with statistical errors make difficult to get reliable results
  - ★ need for worser data ...



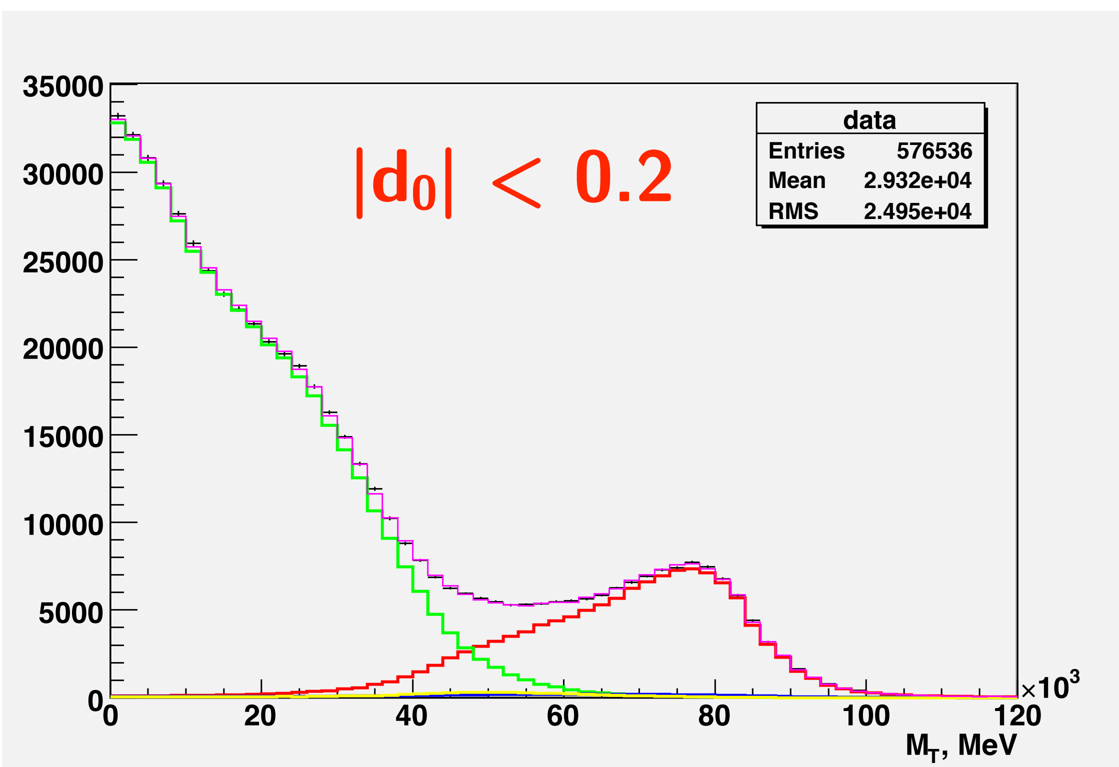
Efficiency on pData	38.459 ± 0.147
Efficiency on MC	38.535 ± 0.147
Weight	0.997 ± 0.003
Efficiency on MC weighted	38.437 ± 0.147 (stat) ± 0.098 (weight)
Effi MC-pData w/o weight	0.076 ± 0.208
Effi MC-pData w/ weight	-0.022 ± 0.230

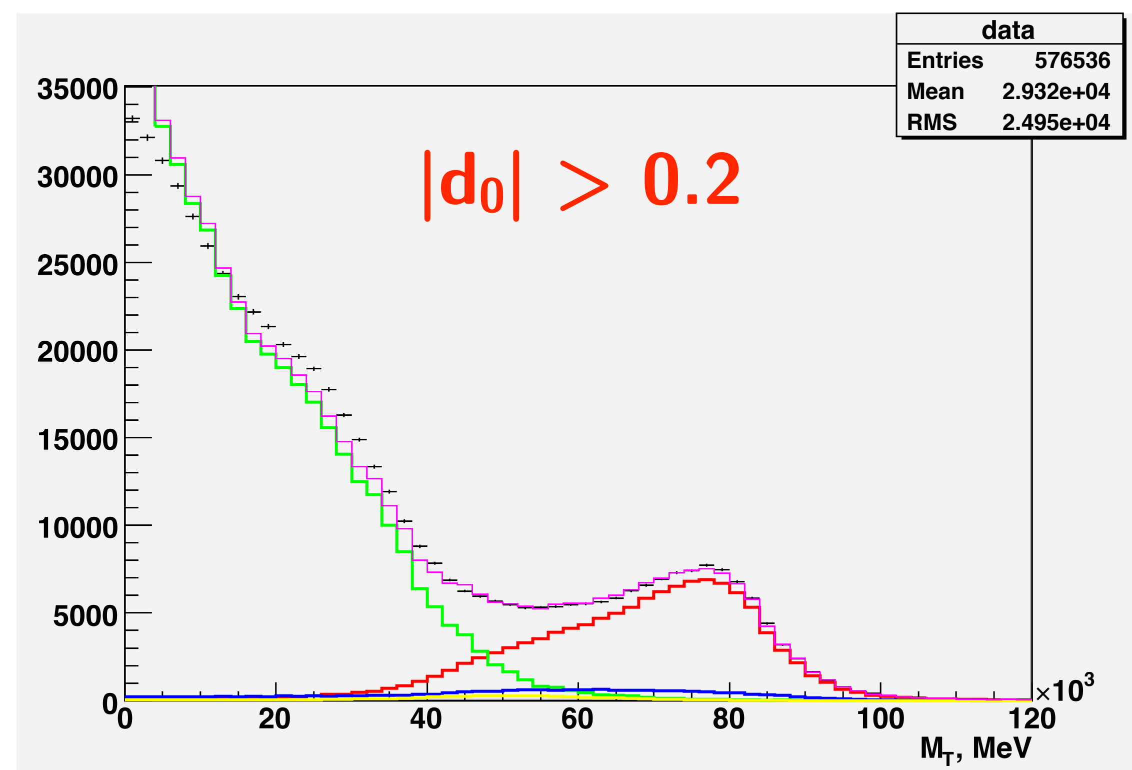
Yields extraction from data in W channel

- **Sidebands** technique (25+25 pb^{-1}, "Data=cross-section sum" and MC statistically independent)

★ two mostly uncorrelated variables: transverse mass (M_T) and impact parameter (d_0)

★ fit shapes from data in background region (d_0>0.2) and use them to get fractions in signal region (d_0<0.2)





Process	Fractions ($\|d_0\| < 0.2$)	Fractions ($\|d_0\| > 0.2$)	True Fractions
$W \to \mu\nu$	0.218 ± 0.003	0.205 ± 0.004	0.217775
$BB\mu\mu$	0.762 ± 0.002	0.754 ± 0.003	0.762176
$Z \to \mu\mu$	0.010 ± 0.006	0.032 ± 0.007	0.0104243
$W \to \tau\nu$	0.009 ± 0.002	0.009 ± 0.003	0.00962472

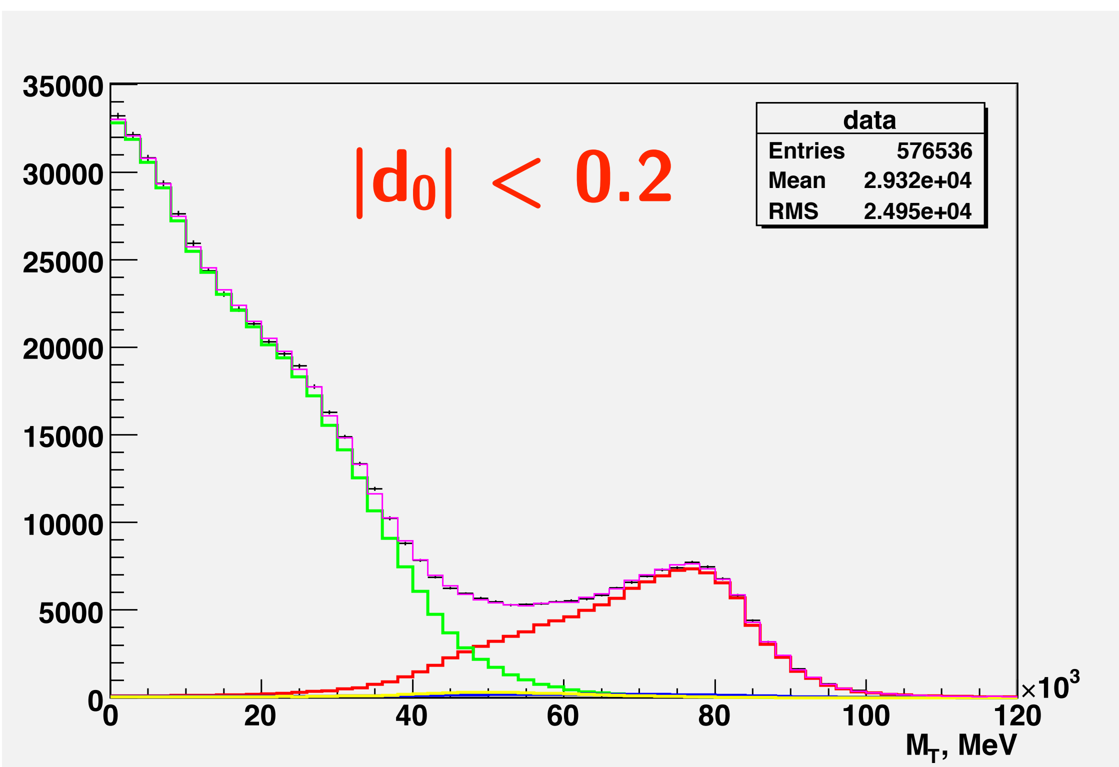
Yields extraction from data in W channel

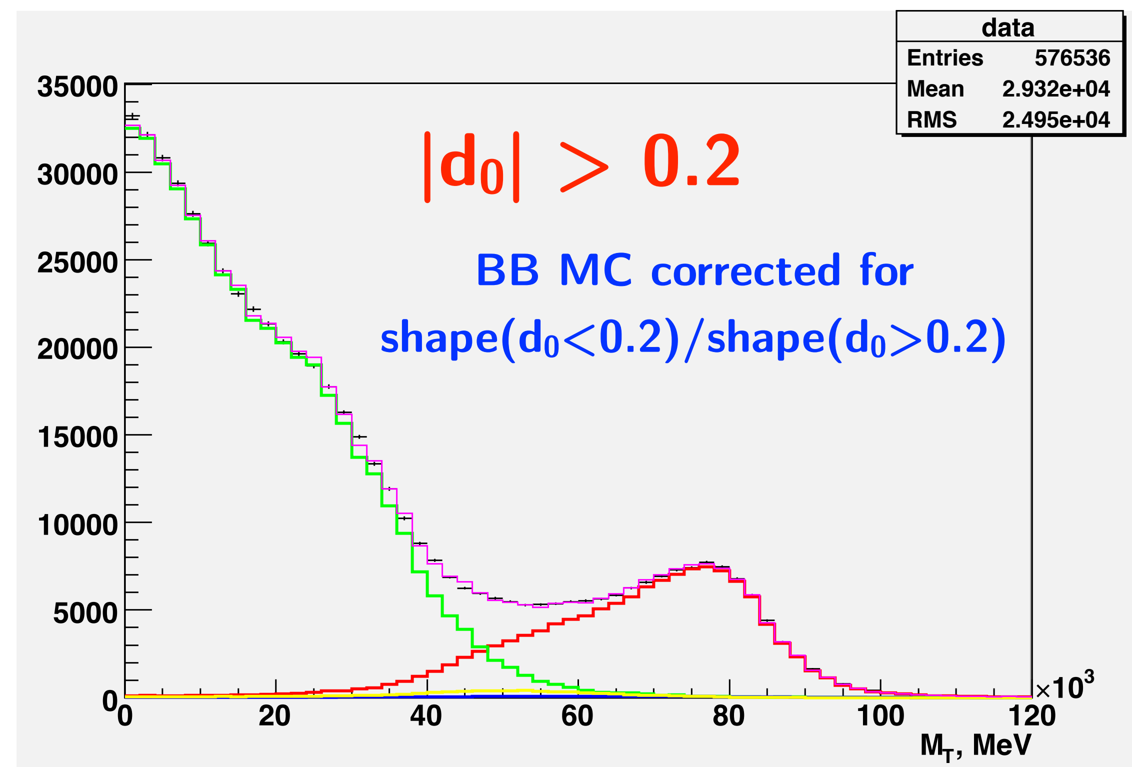
- **Sidebands** technique (25+25 pb^{-1}, "Data=cross-section sum" and MC statistically independent)

★ two mostly uncorrelated variables: transverse mass (M_T) and impact parameter (d_0)

★ fit shapes from data in background region (d_0>0.2) and use them to get fractions in signal region (d_0<0.2)

★ adding a MC corrections for effect of variable correlation





Process	Fractions ($\|d_0\| < 0.2$)	Fractions ($\|d_0\| > 0.2$) MC corrected	True Fractions
$W \to \mu\nu$	0.218 ± 0.003	0.2217 ± 0.0006	0.217775
$BB\mu\mu$	0.762 ± 0.002	0.763 ± 0.002	0.762176
$Z \to \mu\mu$	0.010 ± 0.006	0.003 ± 0.003	0.0104243
$W \to \tau\nu$	0.009 ± 0.002	0.012 ± 0.002	0.00962472

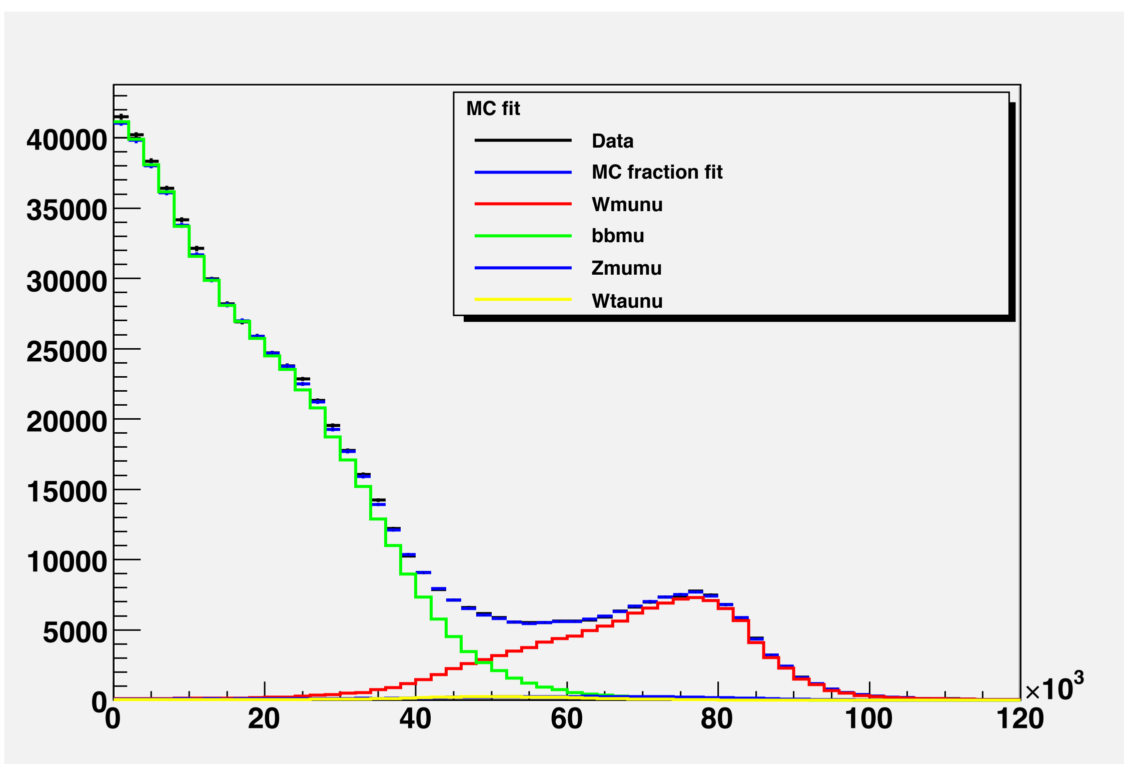
Yields extraction from data in W channel

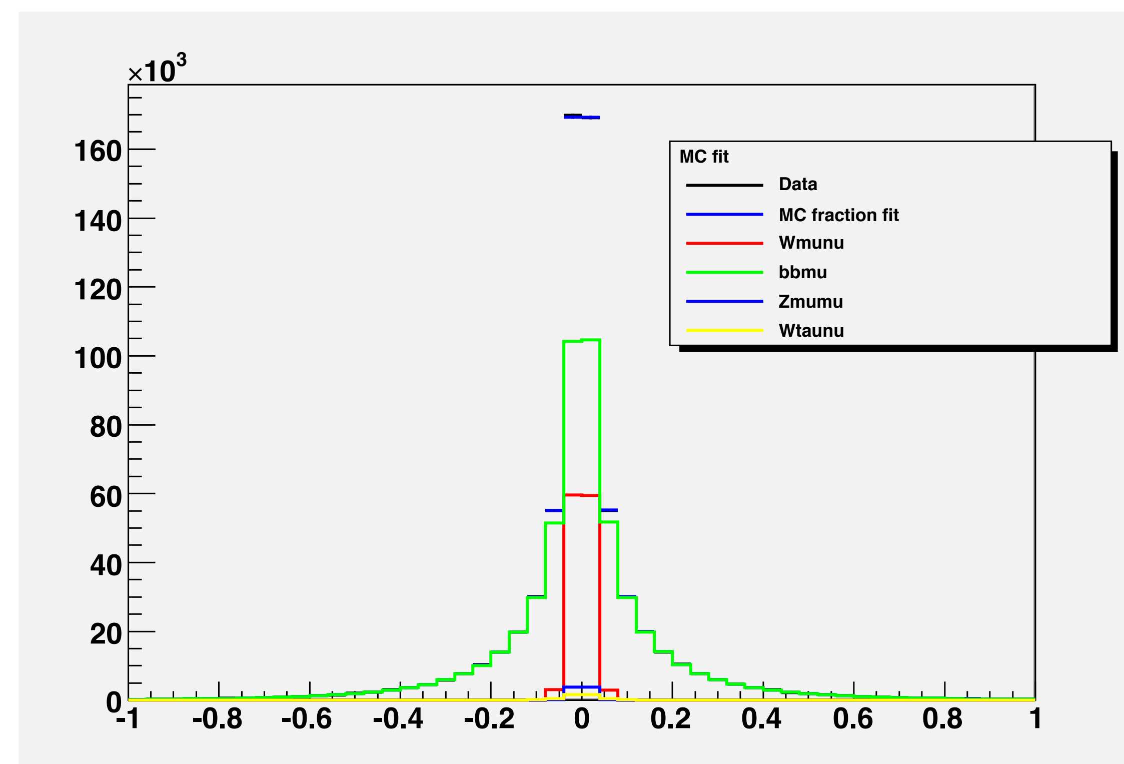
- **2-D shapes fit** technique

  (25+25 pb^{-1}, "Data=cross-section sum" and MC statistically independent)

  ★ fitting two uncorrelated variables simultaneously

  ★ better solution but need a good knowledge of process shapes



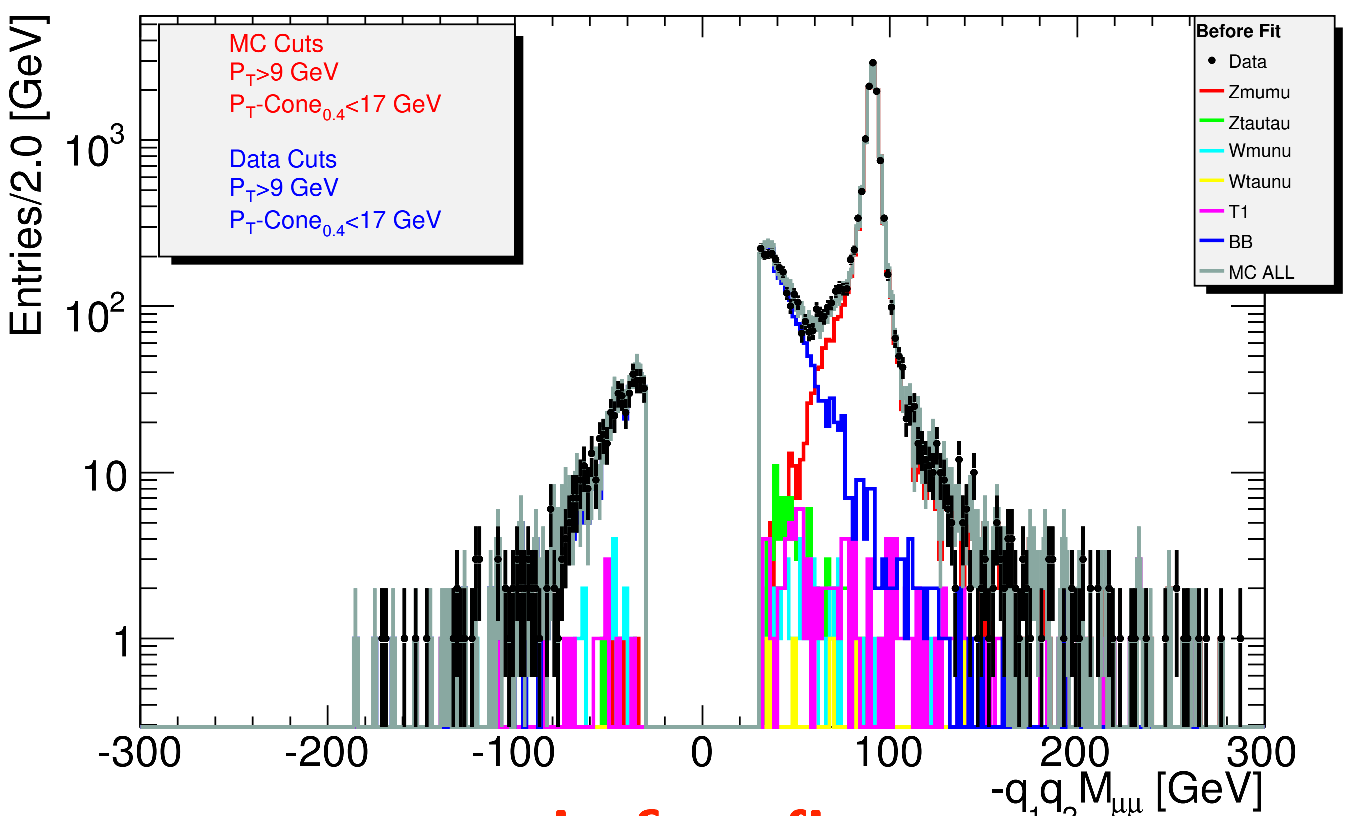


Process	Fractions 2-D Fit	True Fractions
$W \to \mu\nu$	0.186 ± 0.002	0.1867
$BB\mu\mu$	0.796 ± 0.001	0.7961
$Z \to \mu\mu$	0.012 ± 0.003	0.0089
$W \to \tau\nu$	0.007 ± 0.001	0.0083

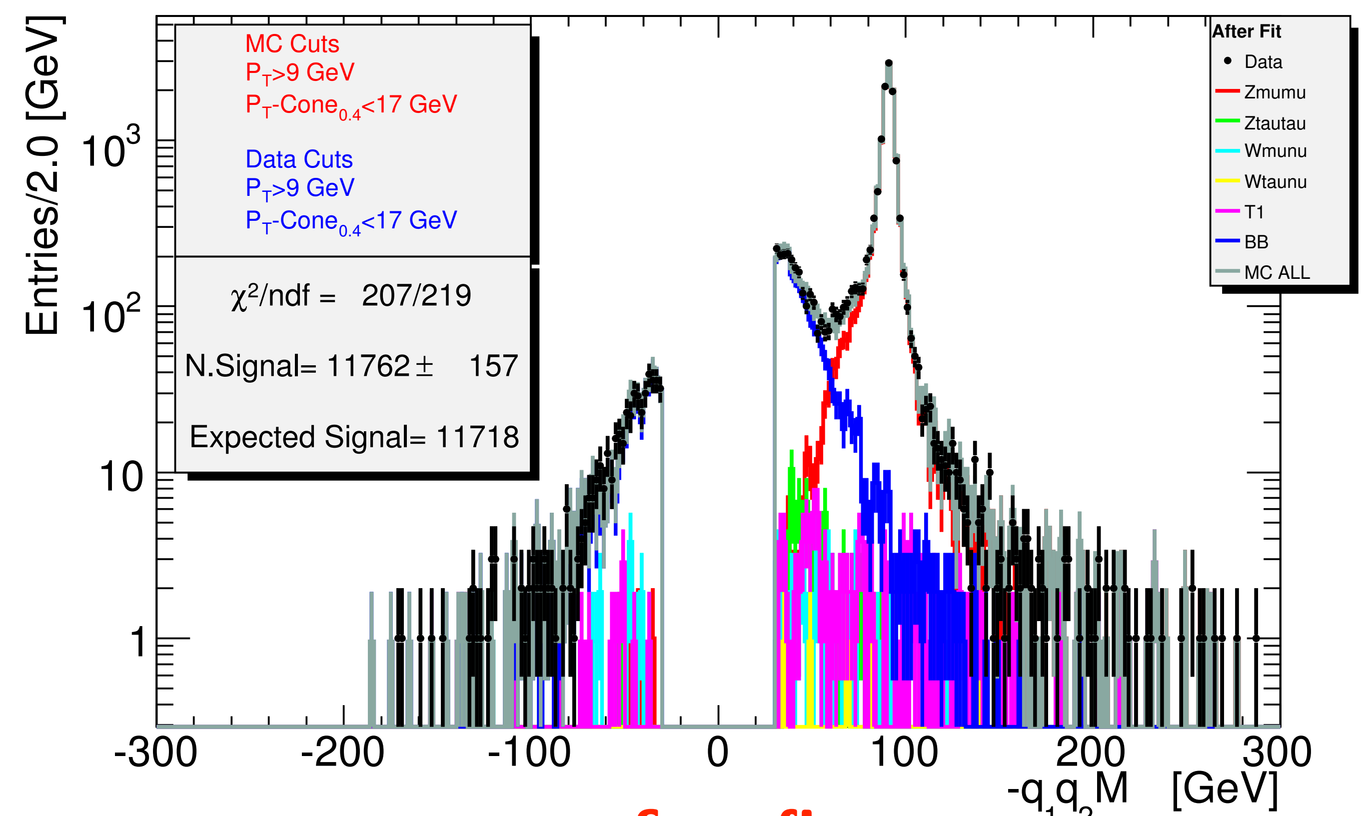
Yields extraction from data in Z channel

- Fitting invariant mass distribution for **same sign** and **opposite sign** muon pairs
  (25+25 pb^{-1}, "Data=cross-section sum" and MC statistically independent)
  - ★ positive values are opposite signs
  - ★ varying MC sample momentum and isolation (Σp_T^{ID} in cone) cuts in range (9-5) and (17-5) GeV to change normalization and shapes used to fit "Data"
    - – testing systematics coming from shapes differences

same cuts between MC and "Data"



before fit

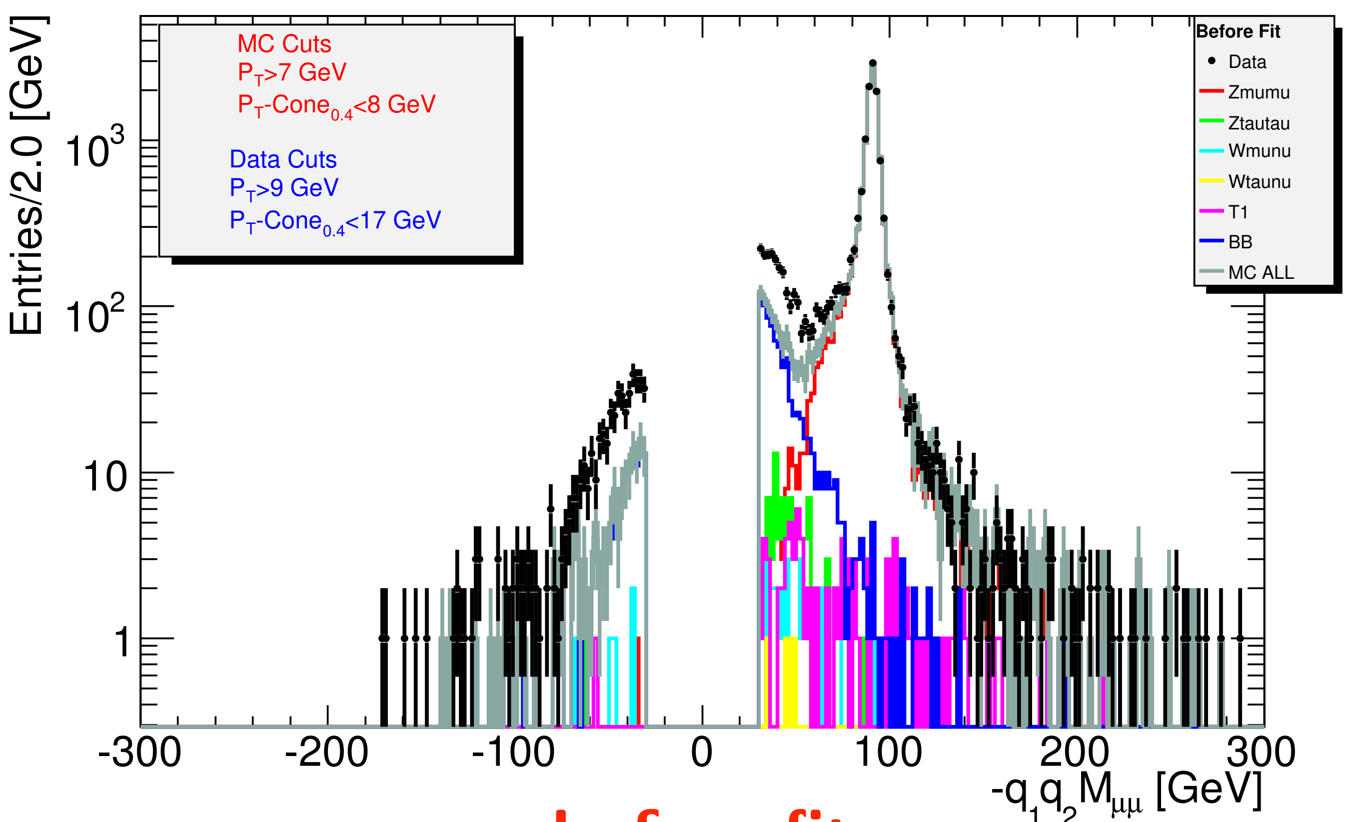


after fit

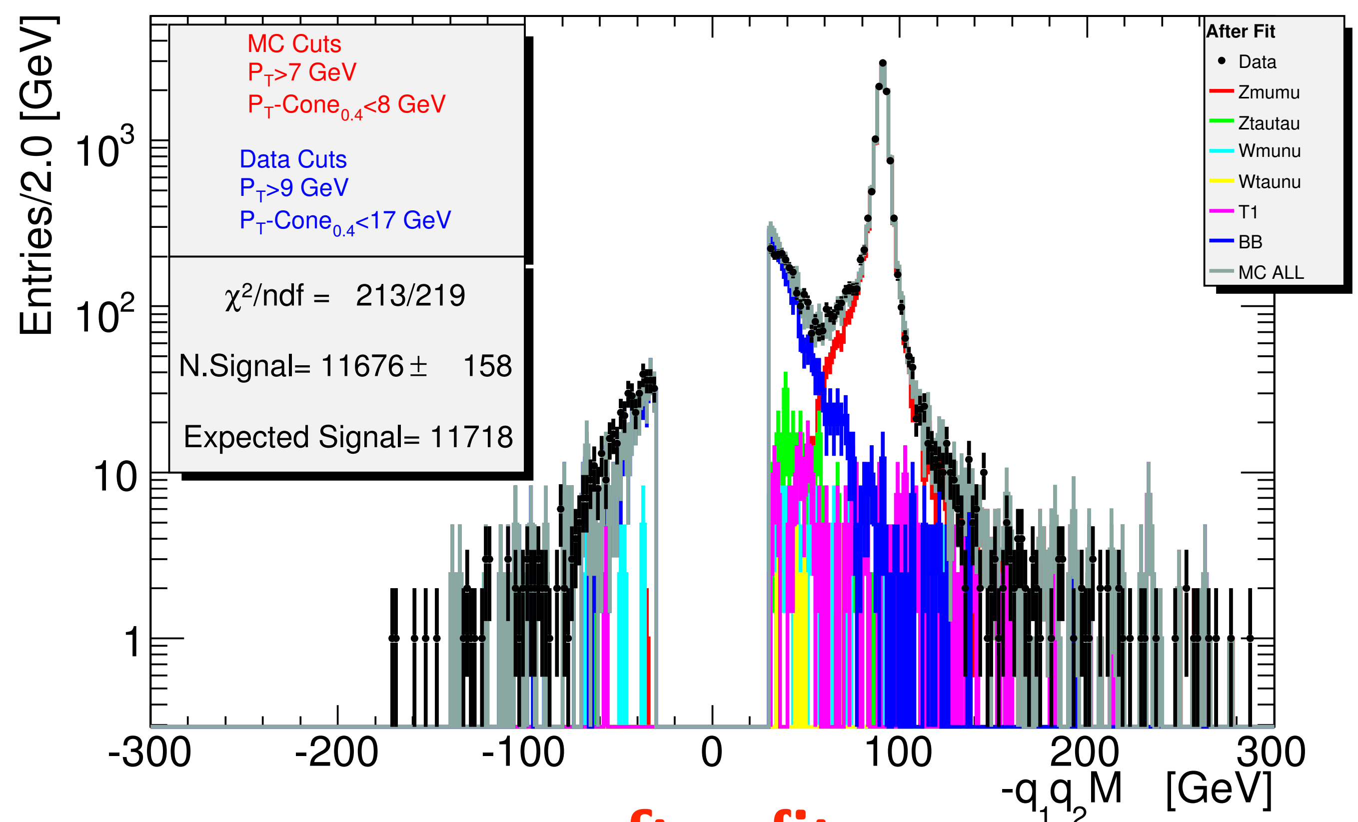
Yields extraction from data in Z channel

- Fitting invariant mass distribution for **same sign** and **opposite sign** muon pairs
  (25+25 pb^{-1}, "Data=cross-section sum" and MC statistically independent)
  - ★ positive values are opposite signs
  - ★ varying MC sample momentum and isolation (Σp_T^{ID} in cone) cuts in range (9-5) and (17-5) GeV to change normalization and shapes used to fit "Data"
    - – testing systematics coming from shapes differences

***different** cuts between MC and "Data"*



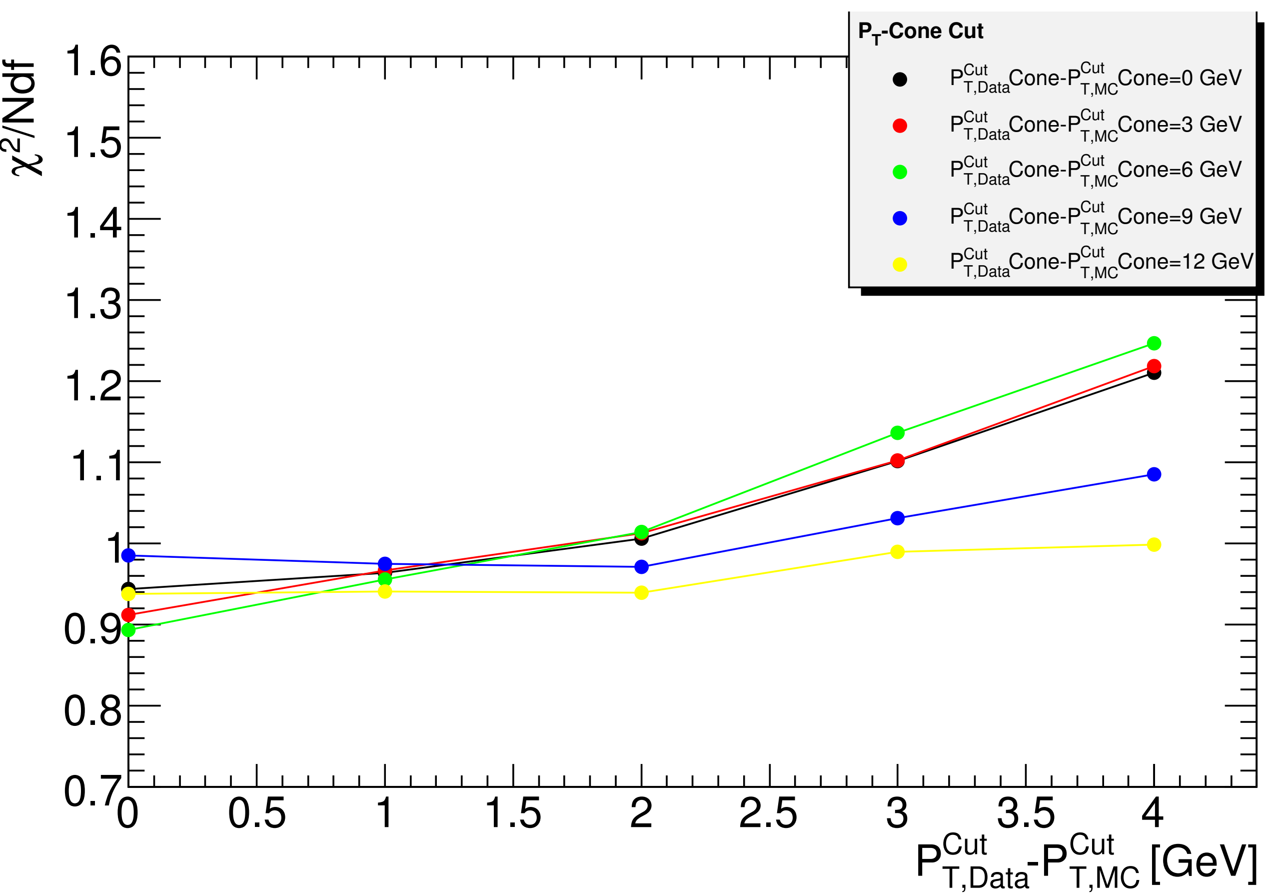
before fit

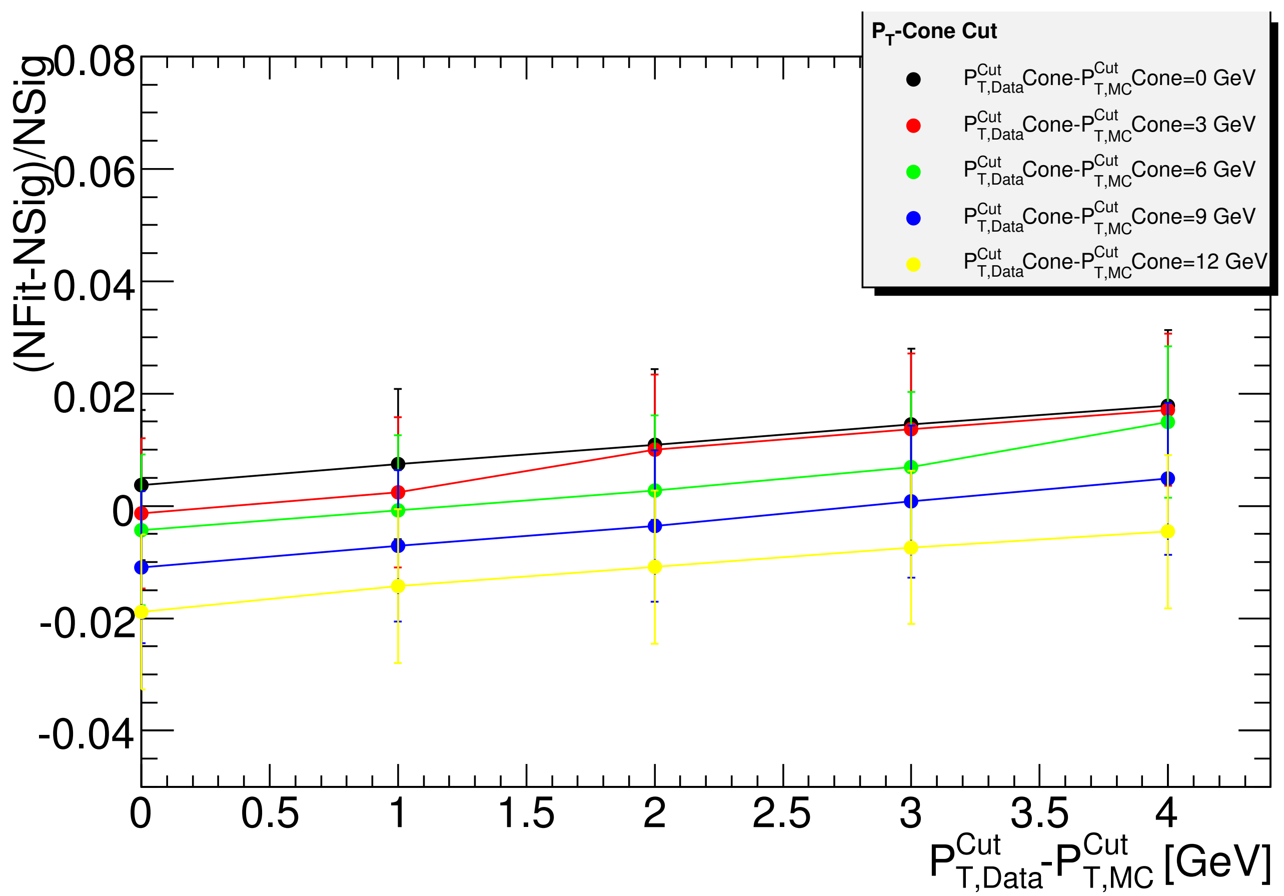


after fit

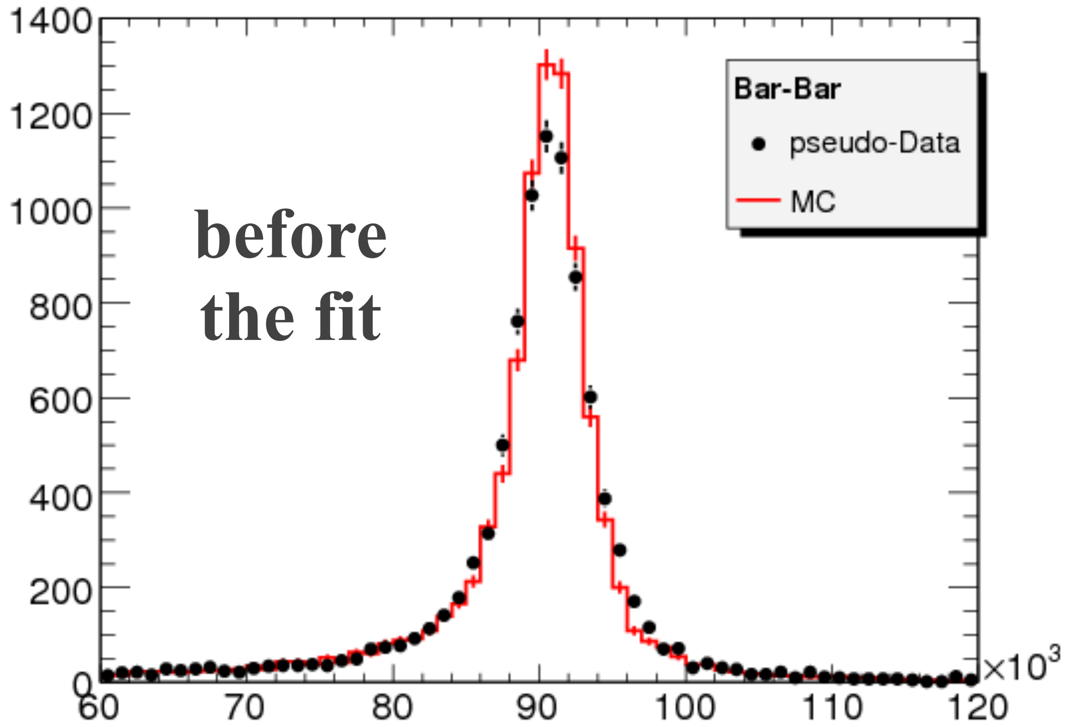
Yields extraction from data in Z channel

- Fitting invariant mass distribution for **same sign** and **opposite sign** muon pairs (25+25 pb^{-1}, "Data=cross-section sum" and MC statistically independent)
  - ★ positive values are opposite signs
  - ★ varying MC sample momentum and isolation (Σp_T^{ID} in cone) cuts in range (9-5) and (17-5) GeV to change normalization and shapes used to fit "Data"
    - – testing systematics coming from shapes differences
- Results for reduced χ^2 and signal yield deviations
  - ★ yield stable within 2%

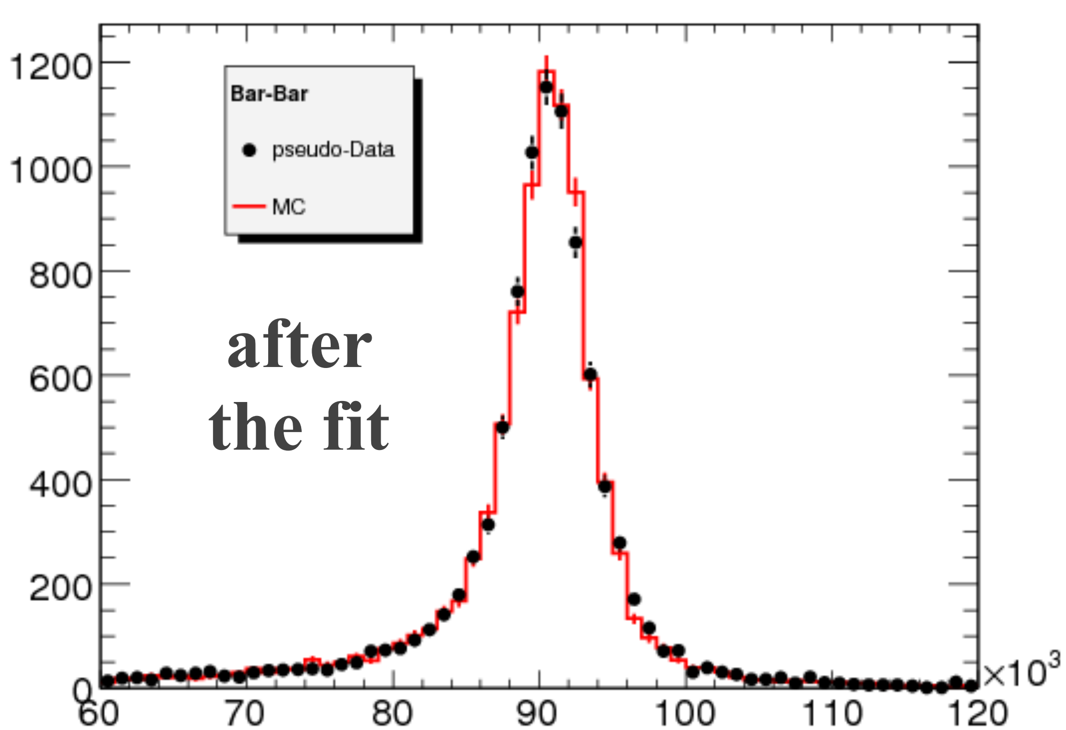




Determination of the momentum resolution



MZ(MeV)



- Determination of the momentum resolution using the Z peak constraint
  - ★ Continuing activities in collab. with Perf Group http://indico.cern.ch/getFile.py/access?contribId=4&sessionId=2&resId=0&materialId=slides&confId=48120
  - ★ Fit to the Z lineshape for the selected events
    - Combined fit for events in the Barrel-Barrel, Barrel-EndCap and EndCap-EndCap configurations
    - pFit=pRecS×(1+g×R) g is a random gaussian number

Parameter	Fit value
S_B	1.0005 ± 0.0014
S_E	1.0003 ± 0.0013
R_B	0.0165 ± 0.0089
R_E	0.0146 ± 0.0084

- Next step: insert the momentum smearing in the MC simulation

Conclusion & outlook

- Analysis model continuously stressed and optimized
  - ★ statistics of 50-100 pb^{-1} (2-3 millions of events) processed in a few days
  - ★ there is still space for optimization (D3PD size)
- New steps towards real data measurement are under study
  - ★ acceptance uncertainties at 10 TeV from NLO corrections, PDFs, ...
  - ★ single particle efficiencies from data (with backgrounds) and derivation of cut flow probabilities
  - ★ event re-weighting using data-driven efficiencies
  - ★ yields extraction from data (sidebands, 2-D fits, systematics studies ...)
  - ★ effects of initial layout geometries, of muon and MET scale calibrations
- Near future developments
  - ★ mis-aligned samples from QCD backgrounds, effects of mis-measured B-field, ...
  - ★ access and use of metadata information in Athena (luminosity blocks, run quality flags, etc.)
  - ★ and obviously more on previous items ...
  - ★ **ATLAS note in preparation**

Back-up slides

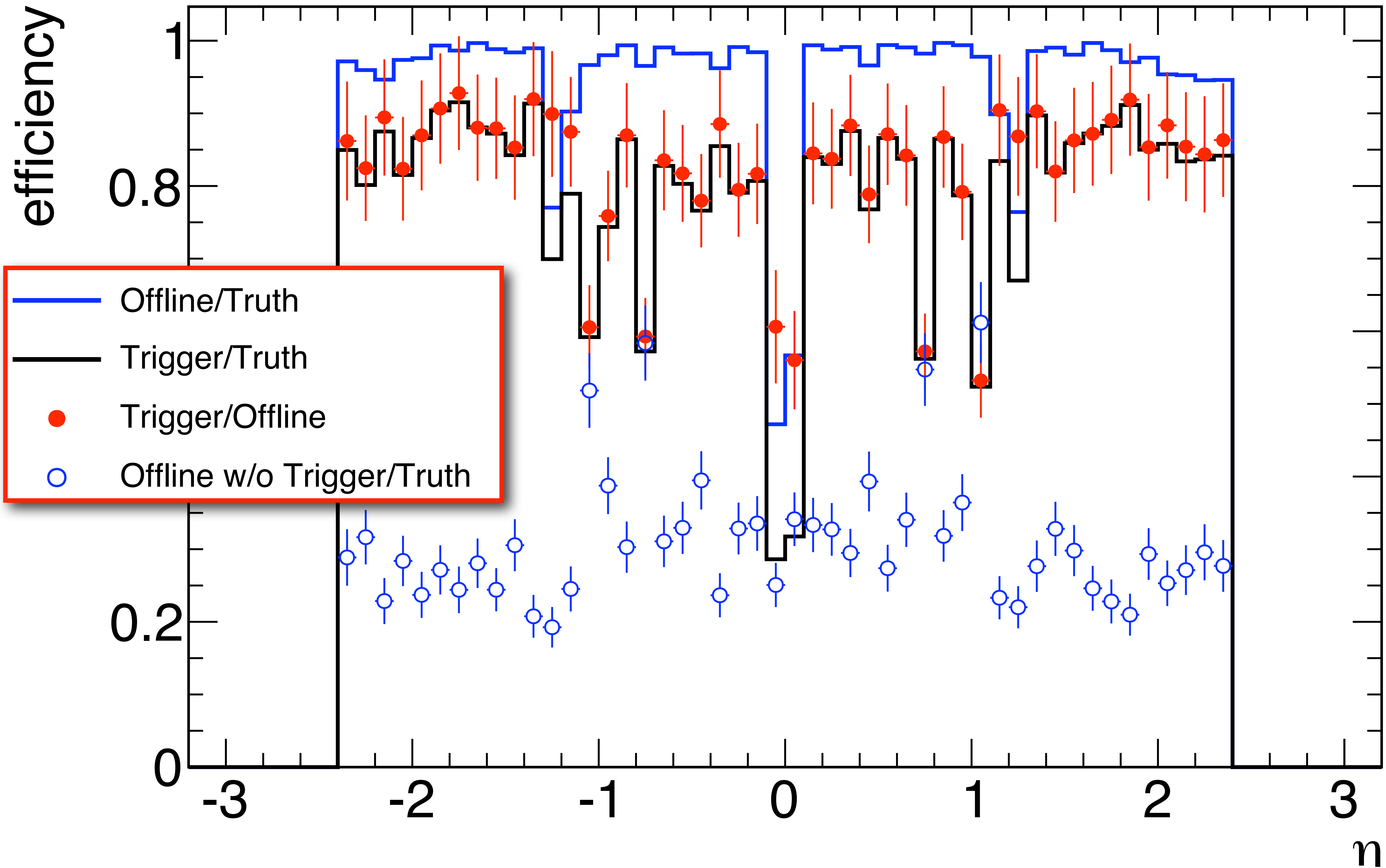
W re-weighting (200k events)

- W MC re-weighting using efficiencies derived from Z decay
  - ★ derivation of cut flow efficiencies
- Re-weighting of misaligned W sample (MS 500um)
  - ★ weight correction with efficiencies derived from MS 500um Z sample

Cuts (%)	Cut Flow	TagAndProbe weighted	ratio
Comb	95.152 ± 0.057	94.843 ± 0.059	-0.003 ± 0.001
Isol	99.013 ± 0.028	98.609 ± 0.033	-0.004 ± 0.000
Trig	80.718 ± 0.113	80.600 ± 0.114	-0.001 ± 0.002

Efficiency on pData	0.446 ± 0.002
Efficiency on MC	0.451 ± 0.001
Weight	0.995 ± 0.003
Efficiency on MC weighted	0.449 ± 0.001 (stat) ± 0.001 (weight)
Effi MC-pData w/o weight	0.005 ± 0.002
Effi MC-pData w/ weight	0.003 ± 0.002

Trigger efficiency wrt offline standard track



Offline tracks must be defined requiring trigger hits to factorize triggeracceptance !