



Muon isolation for Drell-Yan

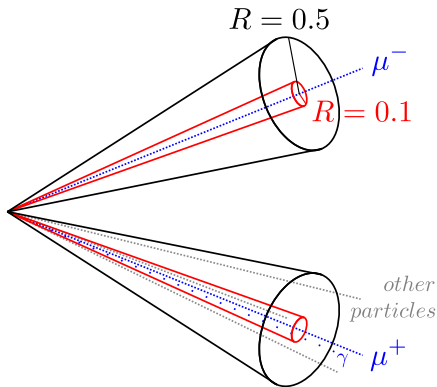
Inclusive $Z/\gamma^* \rightarrow \mu\mu$ production cross-section

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Isolation

Define minimum isolation as:

$$\max(p_T(\mu^+)_{R=0.5} - p_T(\mu^+)_{R=0.1}, p_T(\mu^-)_{R=0.5} - p_T(\mu^-)_{R=0.1})$$



Selection

Require one of the DY lines to fire:

- Z0_L0DiMuonDecision_TOS
- Z0_Hlt1DiMuonHighMassDecision_TOS
- Z0_Hlt1DiMuonLowMassDecision_TOS
- Z0_Hlt2DiMuonDY2Decision_TOS
- Z0_Hlt2DiMuonDY3Decision_TOS
- Z0_Hlt2DiMuonDY4Decision_TOS
- Z0_Hlt2DiMuonUnbiasedZmmDecision_TOS

Selection

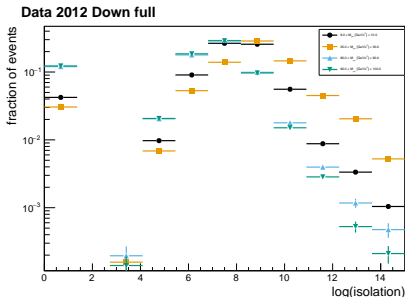
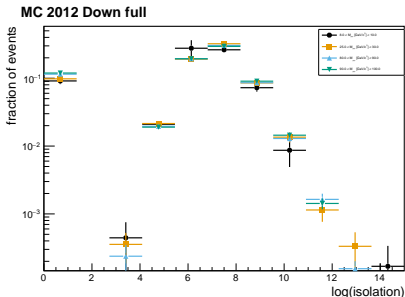
Additional selection cuts:

- $p_T(\mu^\pm) > 3 \text{ GeV}/c^2$
- $p(\mu^\pm) > 10 \text{ GeV}/c^2$
- $2 < \eta(\mu^\pm) < 4.5$
- $Prob(\chi_{track}^2) > 0.001$
- $\chi_{vertex}^2/ndf < 5$

Apply a 2D re-weighting of the MC, so it matches the 2012 data in $(nSPDHits, nTracks)$.

Isolation as a function of mass

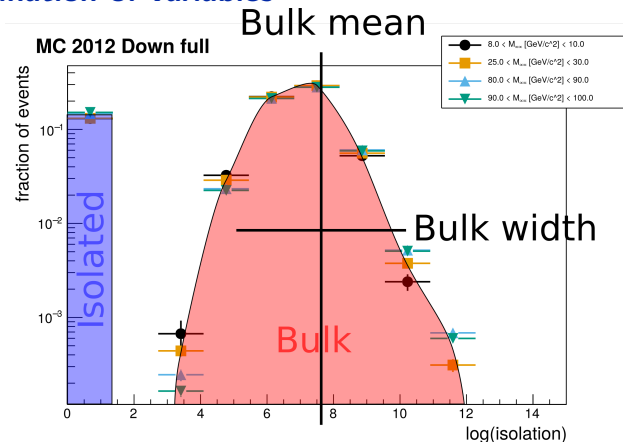
Normalized $\log(\text{isolation})$ in selected mass bins:



Backgrounds smear the isolation in data, especially away from resonances (orange). In MC very small mass-dependency, which we need to study.

Even at Z peak (blue and green), isolation bulk wider in data than in MC.

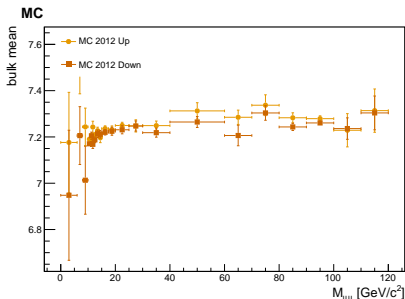
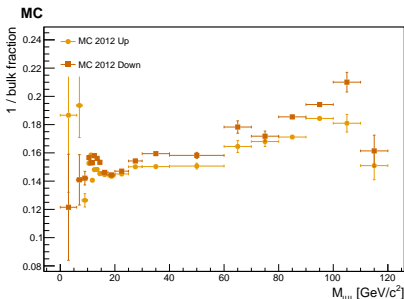
Explanation of variables



$$1/\text{bulk fraction} = \frac{\int \textit{isolated}}{\int \textit{bulk}}$$

Mass dependency of bulk

MC, 2012



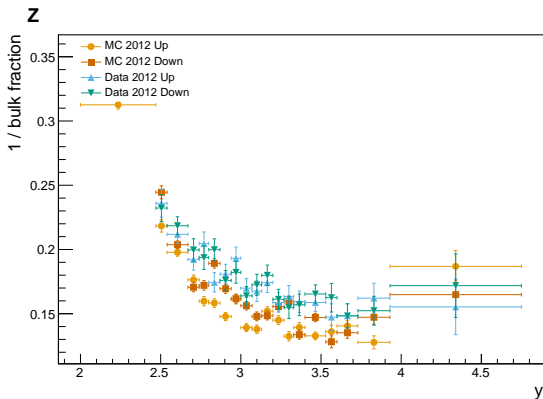
Large mass-dependence of bulk fraction, but smaller mass-dependence of bulk mean.

Difference between **MagUp** and **MagDown** to be investigated.

Effect of rapidity

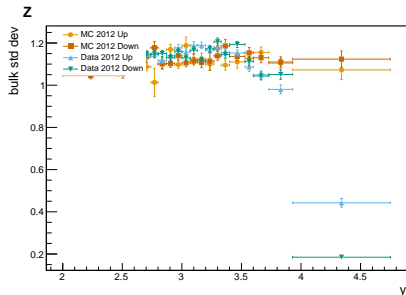
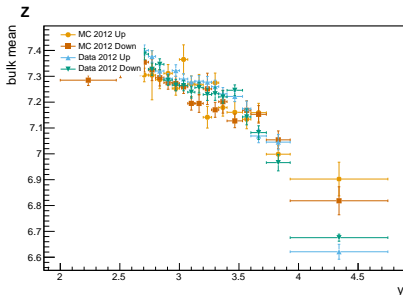
Z-peak

Strong dependency of bulk fraction of rapidity.



1 / bulk fraction under-estimated in MC.

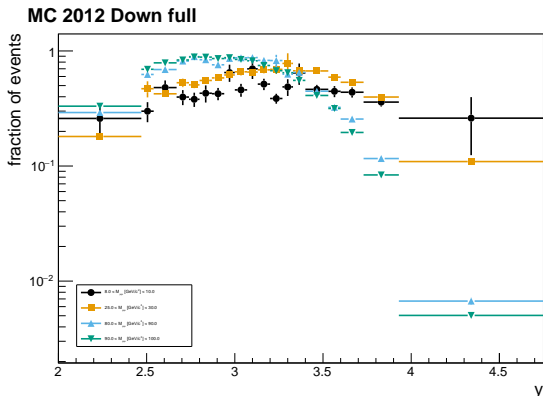
Effect of rapidity Z-peak



MC and data bulk mean and width agree at Z -peak. Data shows some dependency of bulk width for high y , MC not.

Effect of rapidity

Full mass-range



Rapidity distribution is not the same for different mass-bins (different regions in x). Working on finding out if mass dependence is given by this.

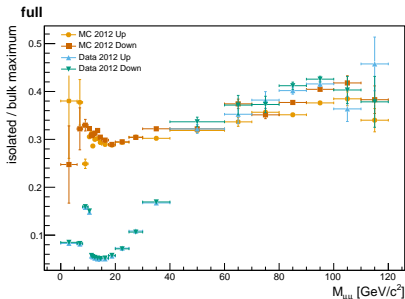
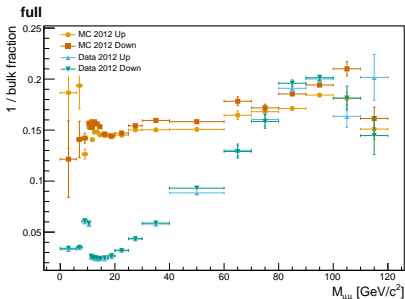


Conclusions

- MC isolation template describes data at Z -peak reasonably well
- But some differences exist, so have to take templates from data (MC can still serve as cross-check)
- Templates show a mass-dependence in MC (especially bulk fraction)
- Different mass-regions have different rapidity distributions
- Needs to be determined if mass-dependence is driven by rapidity-dependence

Mass dependency of bulk

MC vs data, 2012



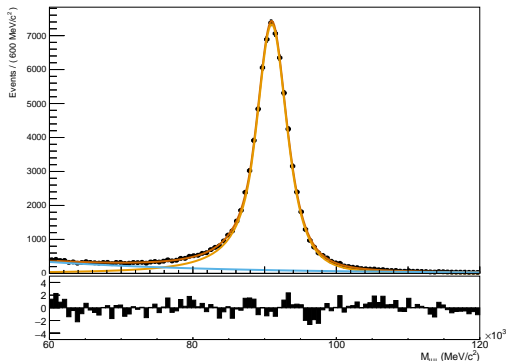
Near the Z-peak good agreement.



More plots

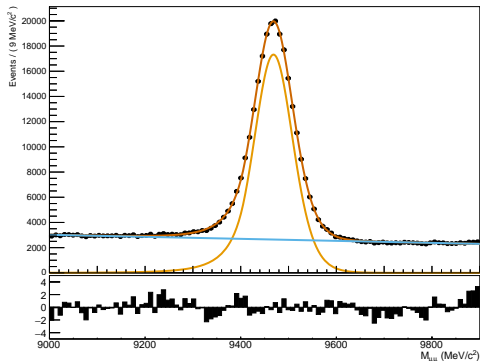
Signal purity

Around the Z -peak, the purity reaches close to 100%.
Nevertheless, there can be some background left. Do an *sPlot* fit to get purely Z -contribution.



Hypatia function as signal and an exponential as background.

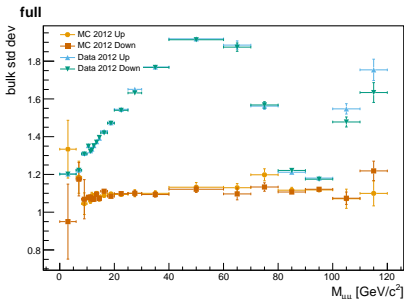
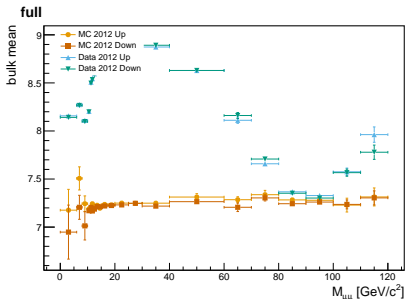
Signal purity



The Υ -peak is not as pure, using a *Hypatia* function as signal and a first-order Chebychev-polynomial as background.

Mass dependency of bulk

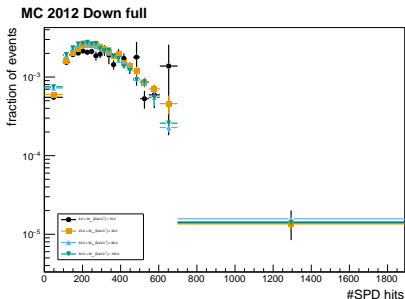
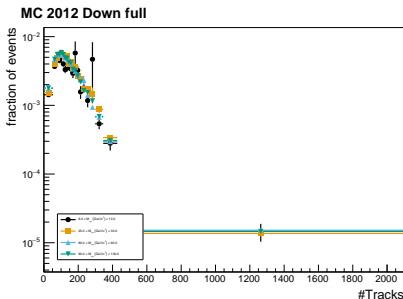
MC vs data, 2012



Near the Z -peak and the Υ -peak good agreement.
 Small mass-dependency even in MC (*value*⁰%).

Effect of multiplicity

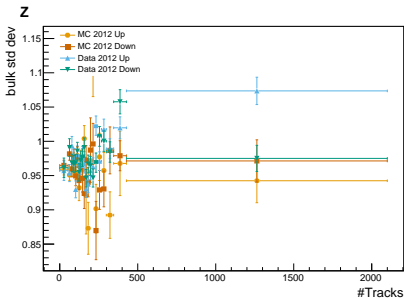
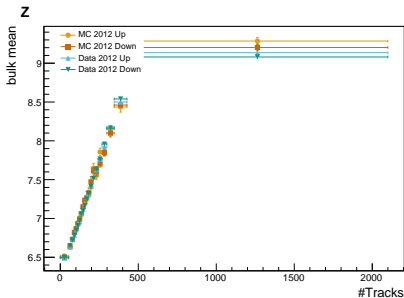
Isolation should, in general, be dependent on multiplicity. First, check if multiplicity is mass dependent.



No mass dependency of multiplicity (n_{Tracks} and n_{SPD}) in MC

Effect of multiplicity

At Z -peak ($60 < M_{\mu\mu} < 120 \text{ GeV}/c^2$)
Isolation not independent of $n\text{Tracks}$:

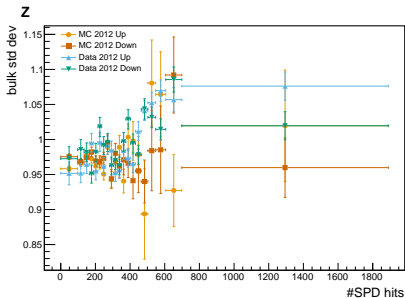
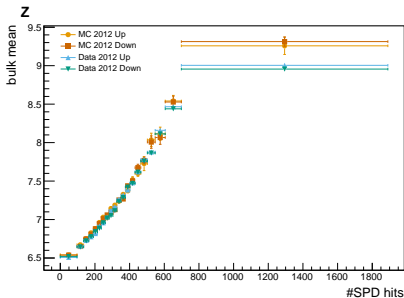


In data, width and mean of bulk dependent on $n\text{Tracks}$, in MC only mean.

Effect of multiplicity

At Z -peak ($60 < M_{\mu\mu} < 120 \text{ GeV}/c^2$).

Bulk width not independent of $nSPD$:



Mean of bulk agrees in data and MC.

Multiplicity reweighting

Data, MC before reweighting, MC after reweighting

