

ϕ_{η}^* measurement in three mass regions in the
dimuon channel using 10.4 fb^{-1} data at the DØ
experiment

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Overview of the talk

- 1 The ϕ_η^* variable
- 2 Motivations
- 3 Previous results in the peak region
- 4 Data composition
- 5 Comparison with theoretical prediction
 - Comparison with ResBos
 - Comparison with a NLO+NNLL QCD prediction
- 6 Summary

The ϕ_η^* variable **Eur. Phys. J. C71 1600(2011)**

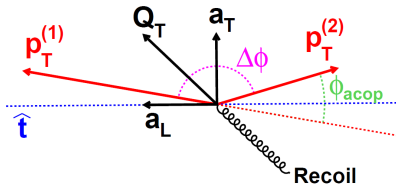


Figure: A schematic diagram of a_T , $\Delta\phi$ and ϕ_{acop} in the transverse plane with $Q_T = \vec{p}_T^{(1)} + \vec{p}_T^{(2)}$, $\phi_{acop} = \pi - \Delta\phi$, $\cos\theta^* = \tanh((\eta_- - \eta_+)/2)$ and $\phi^* = \tan(\phi_{acop}/2)\sin(\theta^*)$.

- Drell Yan process $q\bar{q} \rightarrow Z^0/\gamma^* \rightarrow l^+l^-$: colorless final state and low background.
- ϕ_η^* probes the same physics as Q_T , $\phi_\eta^* \sim a_T/M_{ll}$
- ϕ_η^* is less sensitive to effects of detector resolution and efficiency
- $\hat{t} = (\vec{p}_T^{(1)} - \vec{p}_T^{(2)})/|\vec{p}_T^{(1)} - \vec{p}_T^{(2)}|$

Motivations

- 1 Low mass region ($M_{\mu\mu} \in (30, 60)$ GeV): more sensitive to small- x effects and statistically more powerful than forward rapidity region ($|y| > 2$) in dielectron channel in the published peak region analysis. (**Most challenging!**) Note that $x_{1,2} = M/\sqrt{s}e^{\pm y}$
- 2 High mass region ($M_{\mu\mu} \in (160, 300) \cup (300, 500)$ GeV): constrain **ISR** uncertainty in top physics but with low statistics.
- 3 Peak region update ($M_{\mu\mu} \in (70, 110)$ GeV): more statistics.

Results in the peak region using 7.3 fb^{-1} data PRL 106, 122001 (2011)

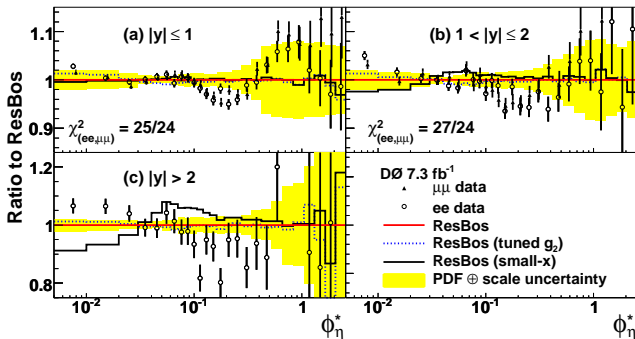
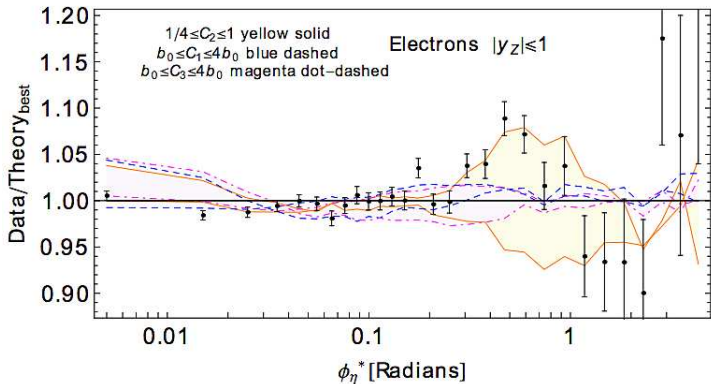


Figure: $M_{\mu\mu} \in (70, 110)$

Tuning ResBos **M. Guzzi et al. arXiv: 1309.1393**



Data composition after selections

1 Low mass region ($M_{\mu\mu} \in (30, 60)$ GeV)

- 74k events with 89.5% signal

2 High mass region

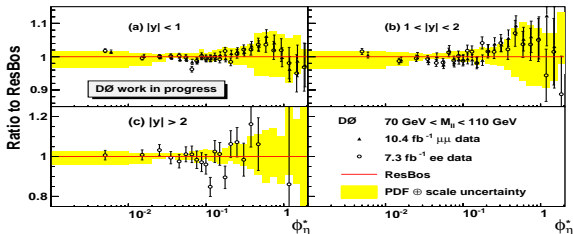
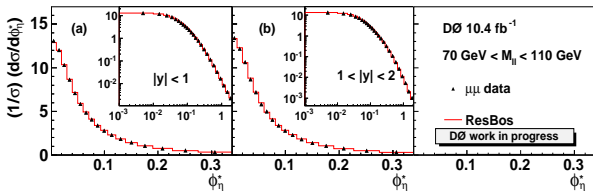
- $M_{\mu\mu} \in (160, 300)$ GeV: 1.7k events with 72.8% signal
- $M_{\mu\mu} \in (300, 500)$ GeV: 0.2k events with 56.6% signal

3 Peak region $M_{\mu\mu} \in (70, 110)$ GeV:

- 645k events with 99.84% signal

Note that most of the off-peak “background” arises from Drell Yan process due to the mismeasurement in $M_{\mu\mu}$.

Comparison with the tuned ResBos prediction M. Guzzi *et al.* arXiv: 1309.1393

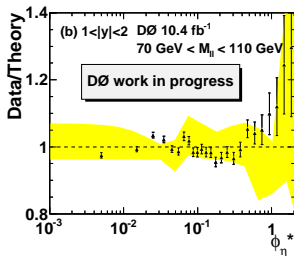
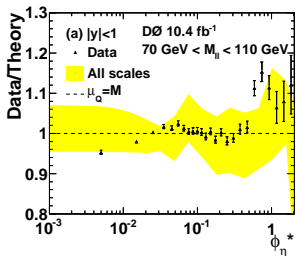


(a) $M_{\mu\mu} \in (70, 110)$



Comparison with a NLO+NNLL QCD prediction in the peak region

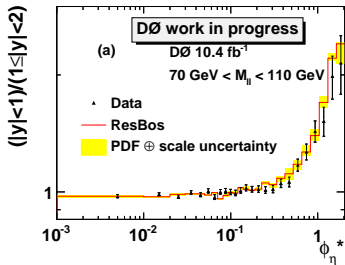
A. Banfi et al. JHEP01 (2012) 044



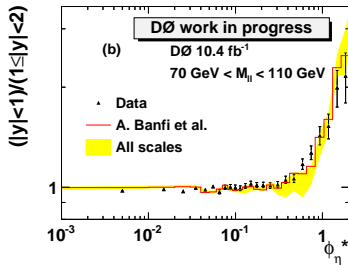
(b) $M_{\mu\mu} \in (70, 110)$

Ratio of $(1/\sigma)(d\sigma/d\phi_\eta^*)$ in rapidity bins in the peak region

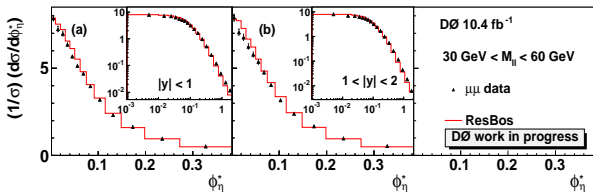
The motivation for this comparison is that the ratio in $(1/\sigma)(d\sigma/d\phi_\eta^*)$ of central rapidity region to that of forward rapidity region can reduce the uncertainty band from QCD scales to percent level due to cancellations. It suggests the possibility of a new variable that is less sensitive to theoretical uncertainty.



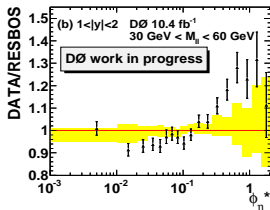
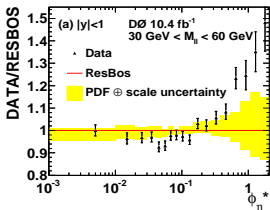
(c) RESBOS

(d) A. Banfi *et al.*

Comparison to theory in low-mass region



(e) $M_{\mu\mu} \in (30, 60)$



Comparison with a NLO+NNLL QCD prediction in the low-mass region **Lee Tomlinson, private communication**

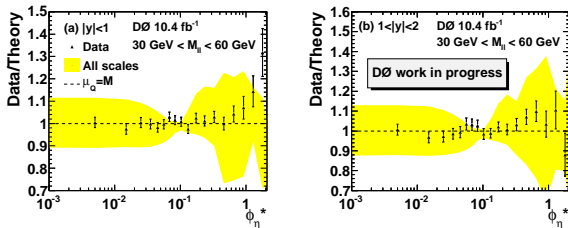
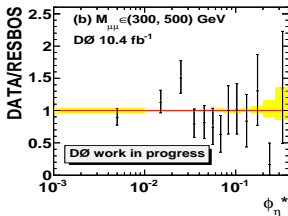
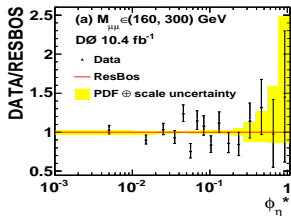
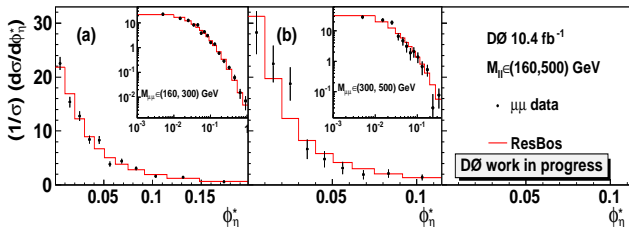


Figure: $M_{\mu\mu} \in (30, 60)$

Comparison with ResBos prediction in high mass region



Summary

- The transverse momentum can be determined with unprecedented precision in the peak region(645k events), the tuned ResBos is in excellent agreement in the peak region.
- The low-mass region results (74k events) agrees with ResBos prediction reasonably well.
- Data is in reasonable agreement with Resbos prediction in high-mass region (2k events) but no detailed comparison can be made due to limited statistics.
- A NLO+NNLL QCD prediction is in excellent agreement with data within assigned theoretical uncertainty.
- Measurement of the normalized differential cross section in terms of ϕ_η^* in the three mass regions is in D0 EB review and ready for collaboration review.