# APPROACHING CONFORMALITY

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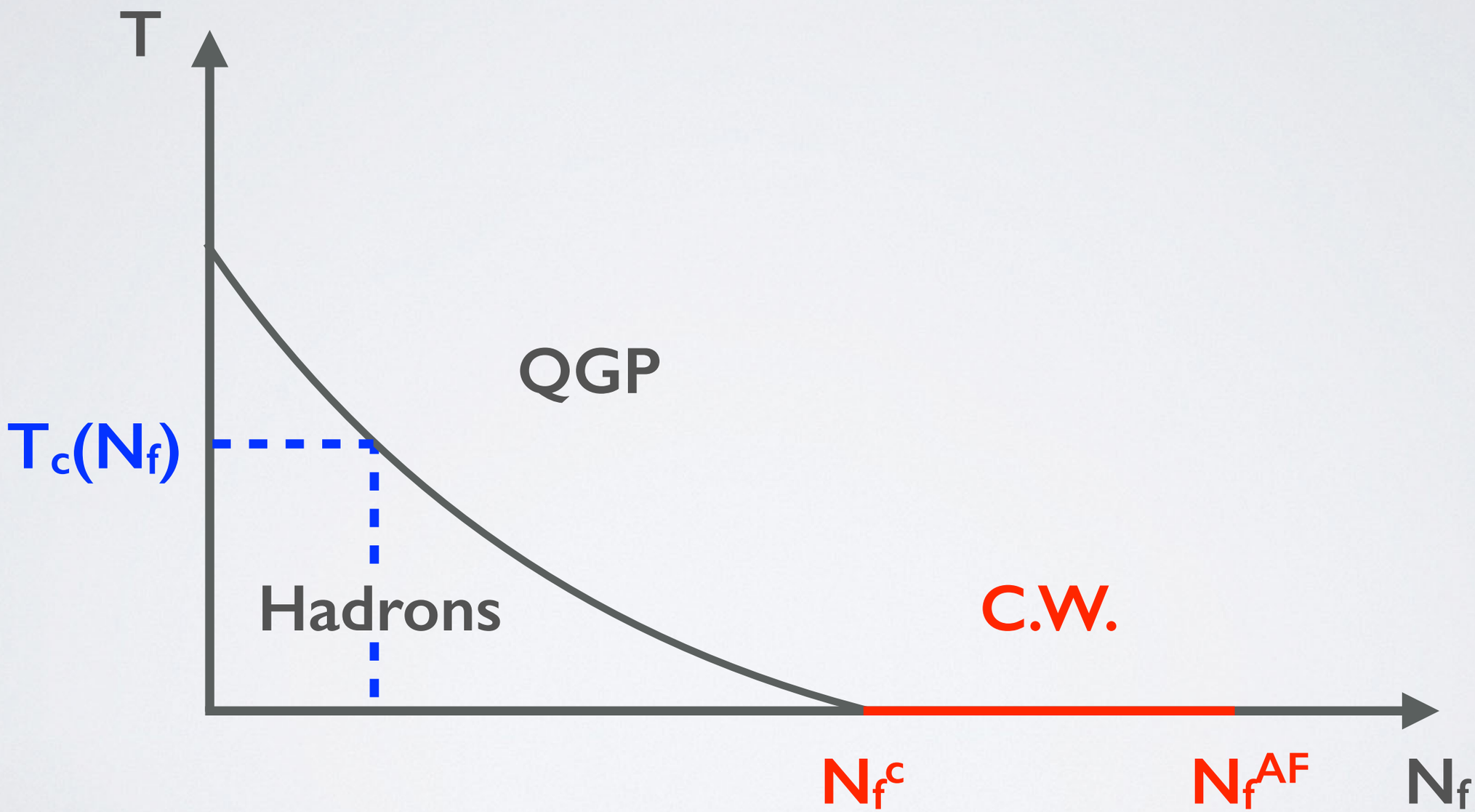
FOM

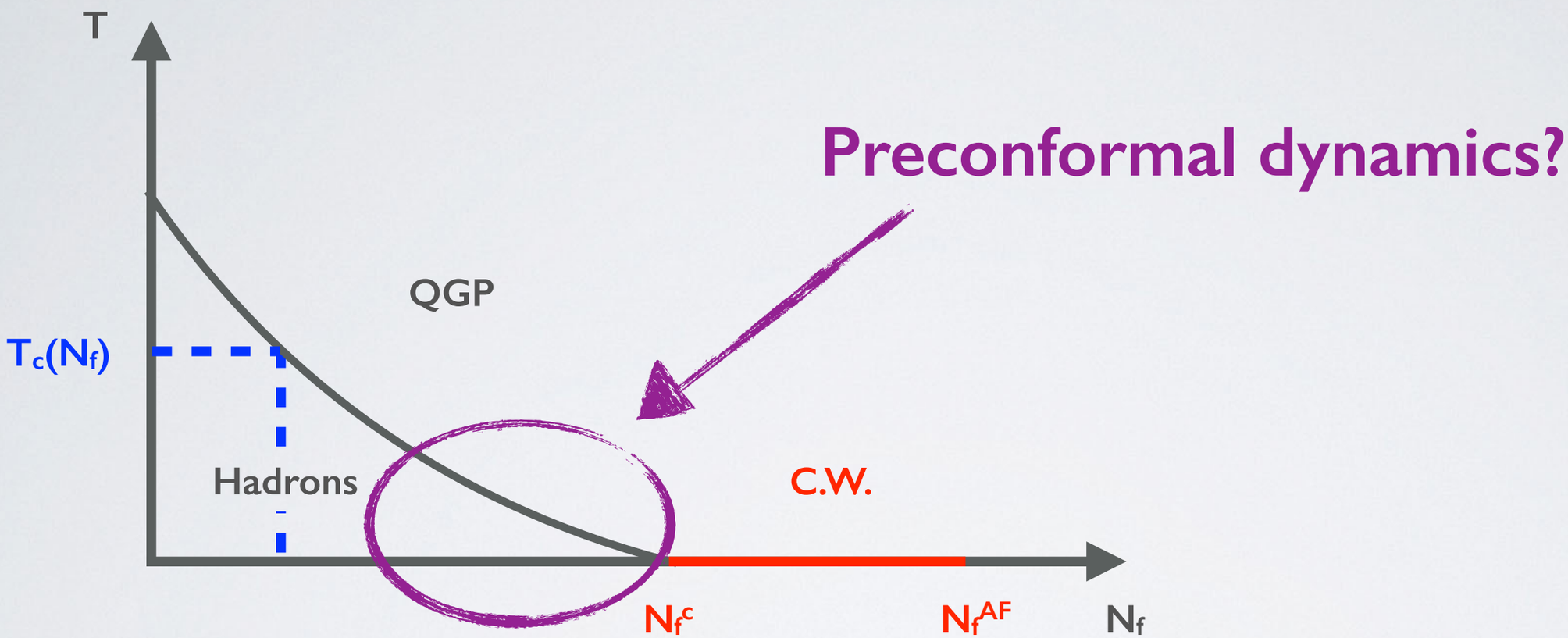
# SUMMARY

- Motivation and Setup
- The string tension and $\Lambda_L$
- The $w_0$ quantity
- Summary

# THE PHASE DIAGRAM



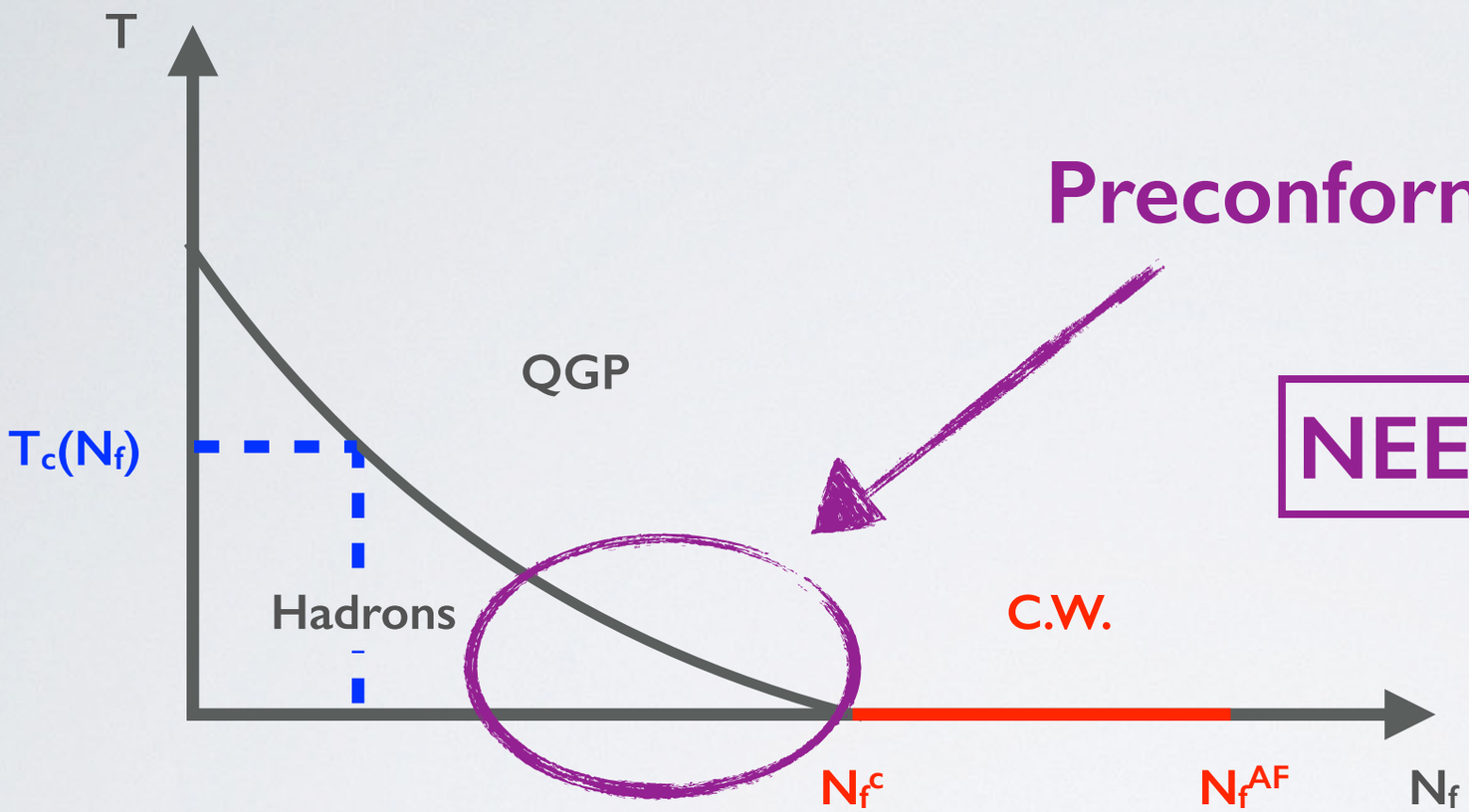
# MOTIVATION




Understand the shape of the chiral phase boundary $T_c(N_f)$

Search for precursory effects of conformality

# MOTIVATION




**Preconformal dynamics?**

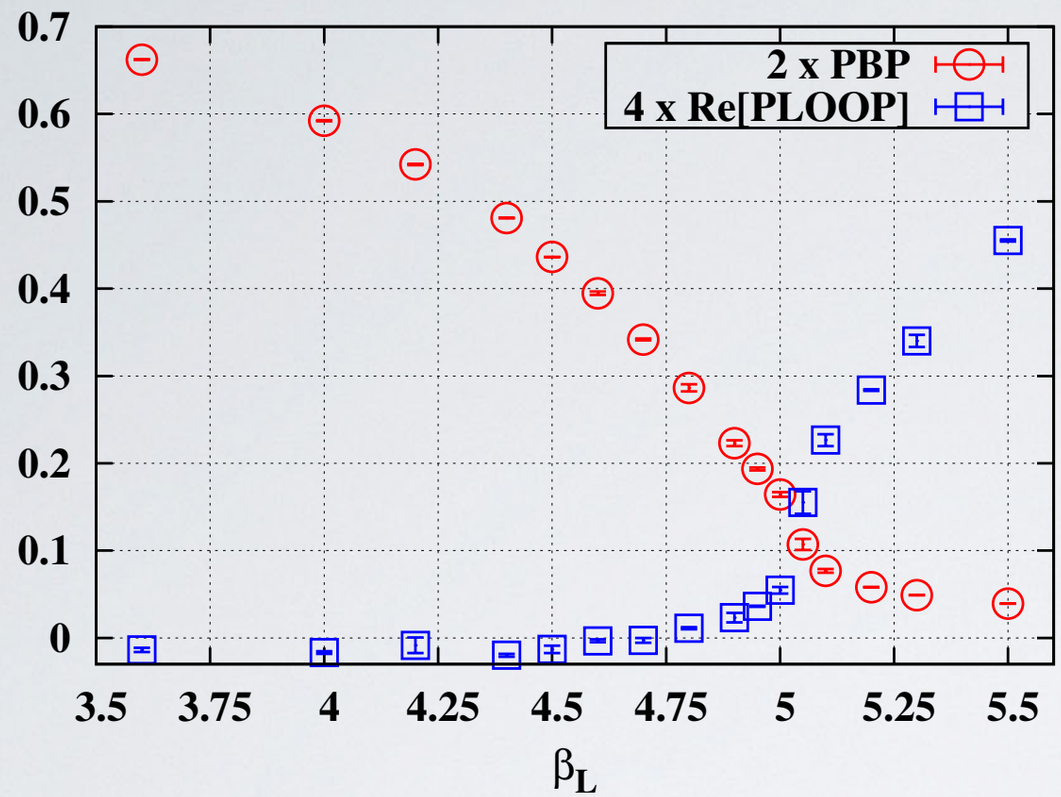
**NEED COMMON SCALE!**

**Understand the shape of the chiral phase boundary $T_c(N_f)$**

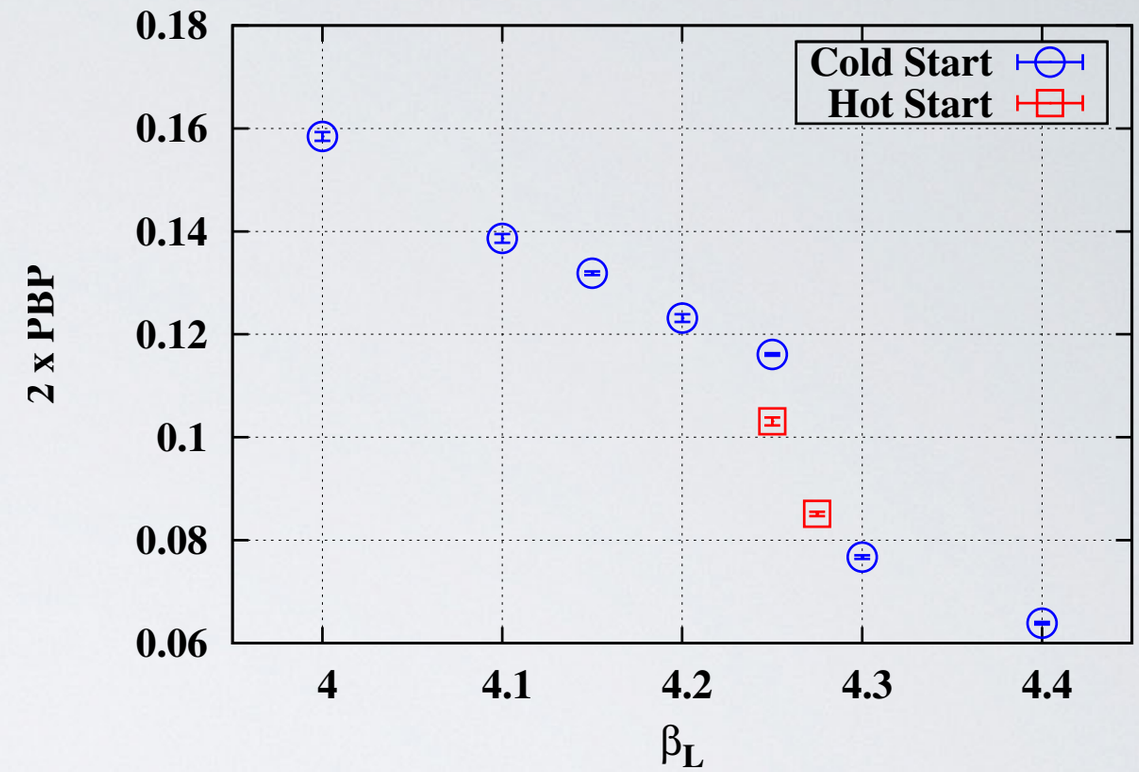
**Search for precursory effects of conformality**

# SETUP

- One loop Symanzik improved + Naik & Tadpole improved staggered fermions;
- Scan in range of $\beta$ values to locate transition at finite temperature for $N_f = 6,8$, $am = 0.02$;
- Zero temperature runs at critical $\beta$ values at volume 32x64.




$N_f = 6$

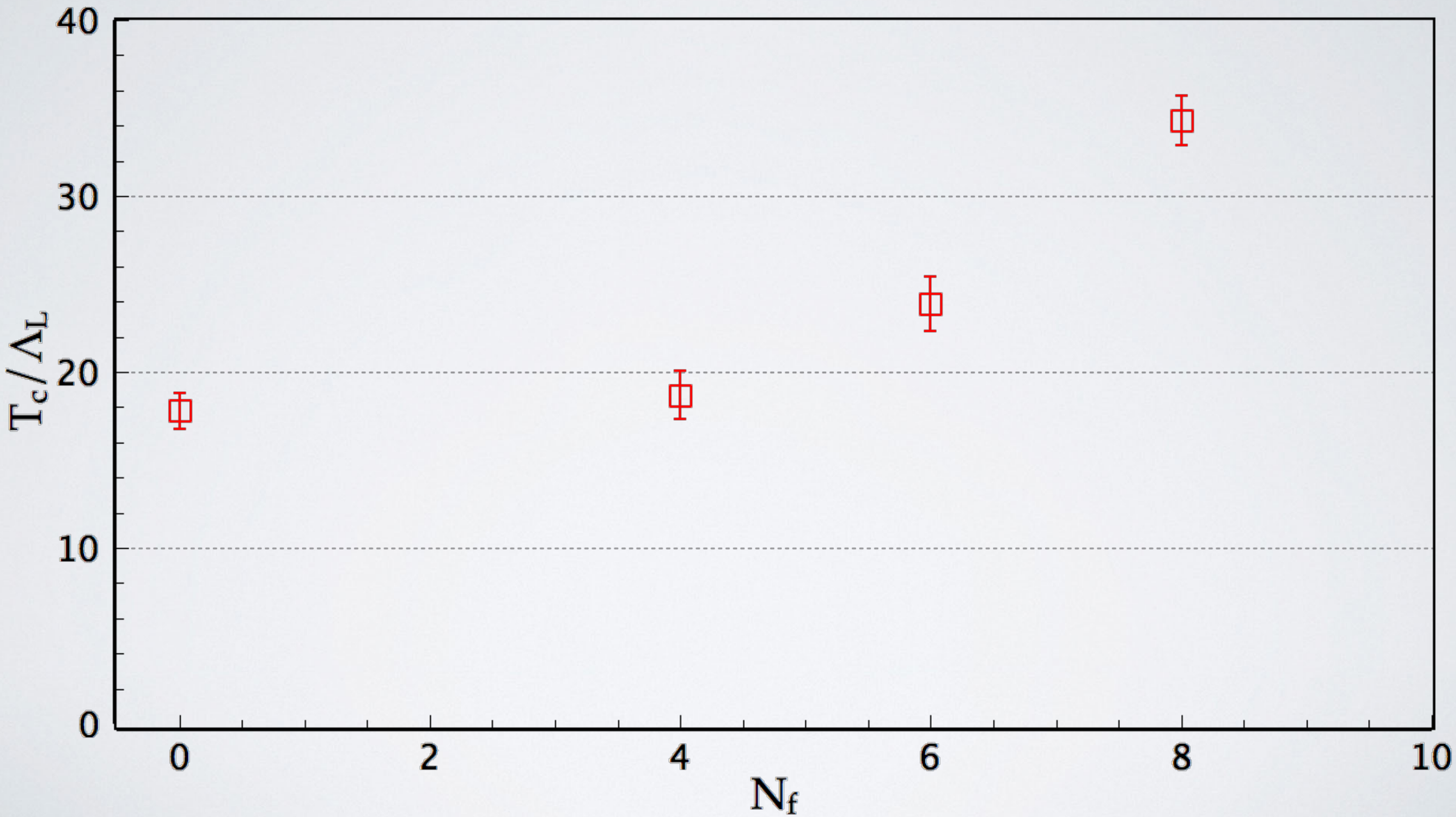



$N_f = 8$

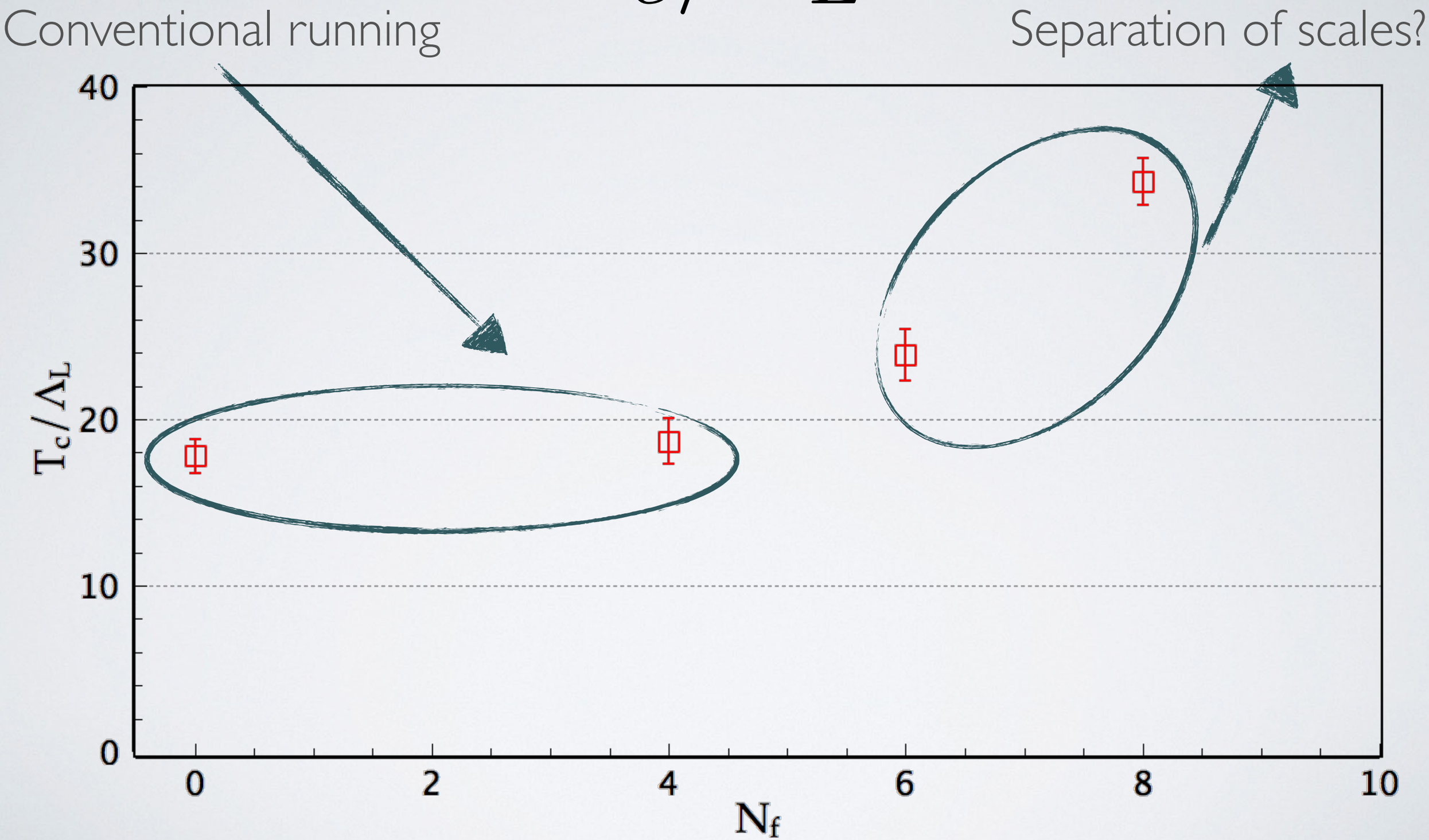
| Nf / Nt | Nt = 6 | Nt = 8 |
|---|---|---|
| Nf = 6 | 5.025 ± 0.05 | 5.20 ± 0.05 |
| Nf = 8 | 4.1125 ± 0.0125 | 4.275 ± 0.05 |

+ $N_f = 0$ quenched ensemble

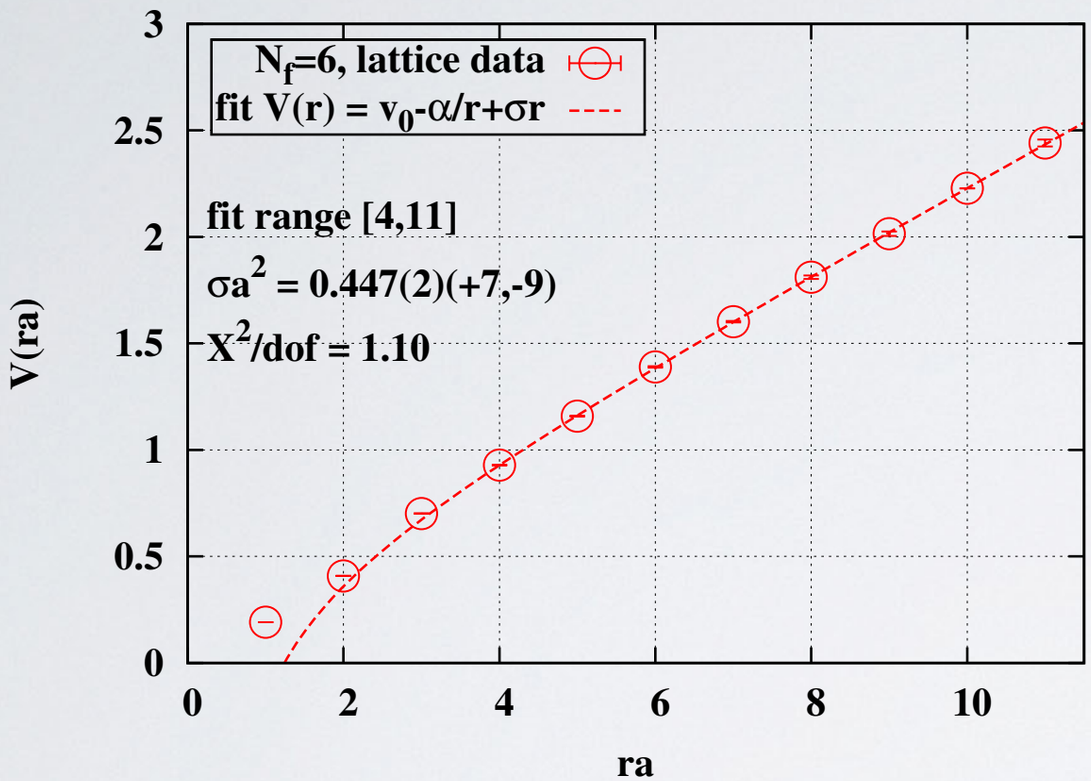
# $T_c/\Lambda_L$



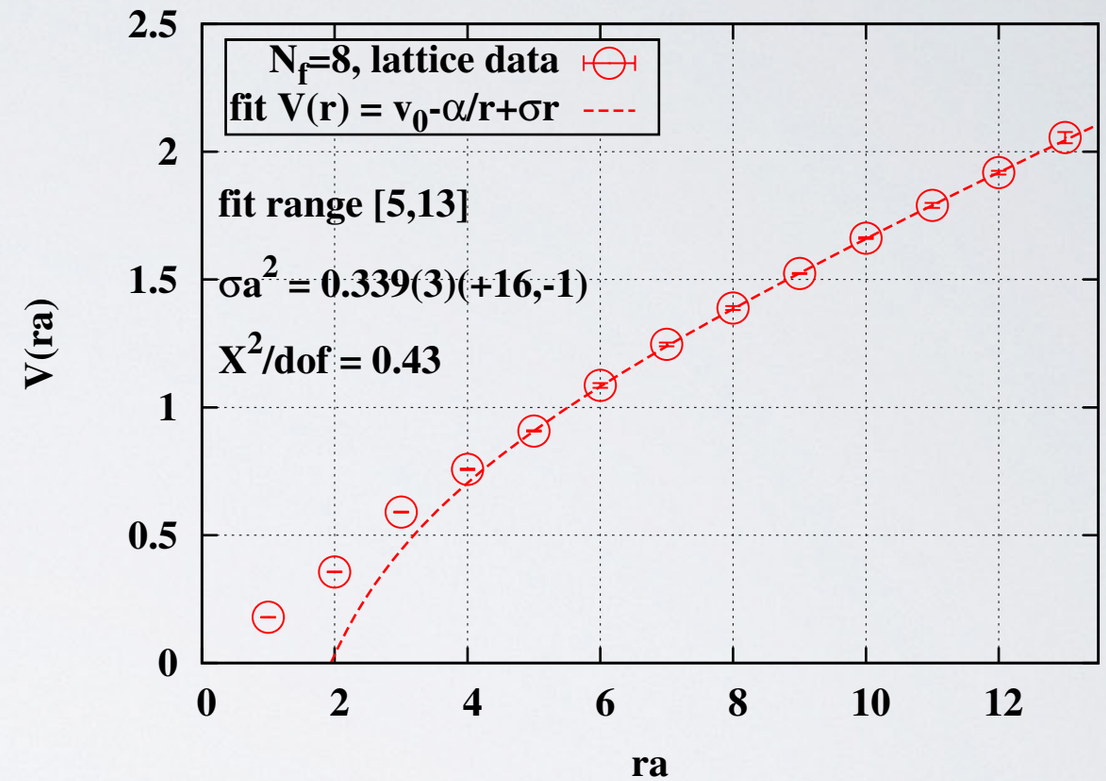
# $T_c/\Lambda_L$


Conventional running
Separation of scales?
40
30
20
10
0
$T_c/\Lambda_L$
0
2
4
6
8
10
$N_f$

# POTENTIAL



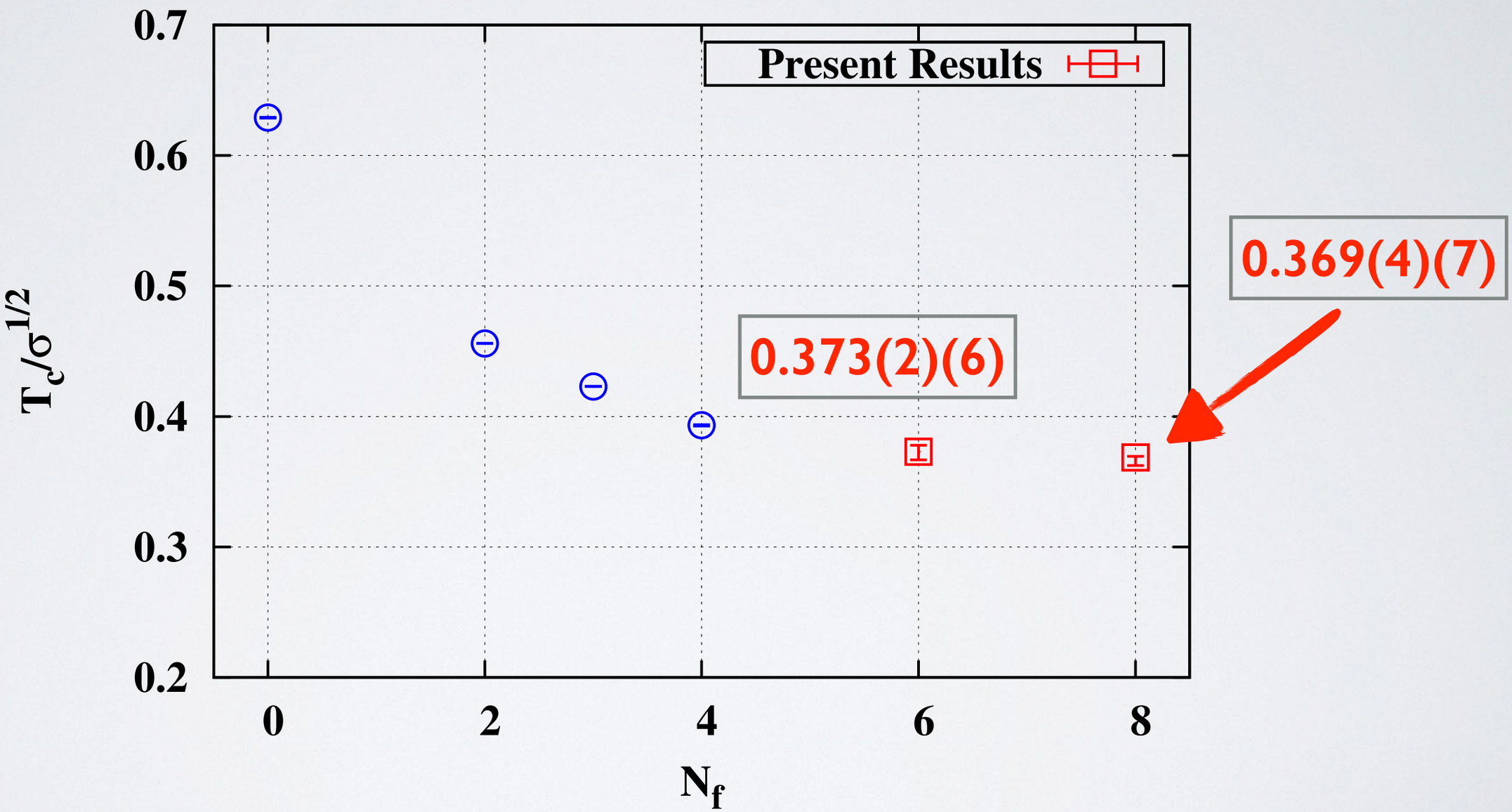

$N_f = 6$




$N_f = 8$

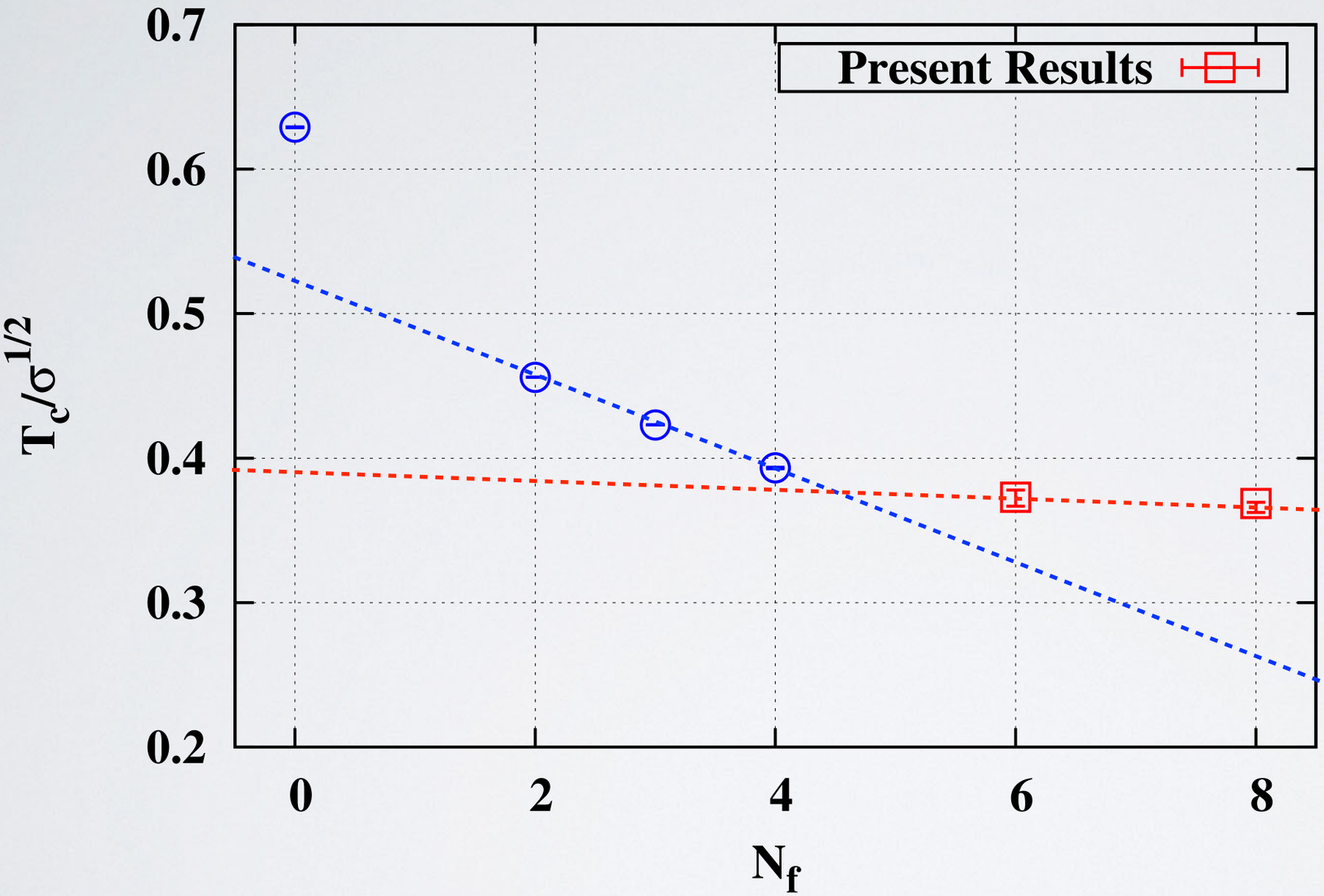
$$V(r) = V_0 - \frac{\alpha}{r} + \sigma r$$

$$T_c/\sqrt{\sigma}$$




[1]E. Laermann, Nucl. Phys. B, '96; [2] F. Karsch and E. Laermann, Nucl. Phys. B, '01; [3] Engels, Nucl. Phys. B, '97

$$T_c/\sqrt{\sigma}$$




$$T_c/\sigma^{1/2} \to const.$$

# THE QUANTITY $W_0$ [1]

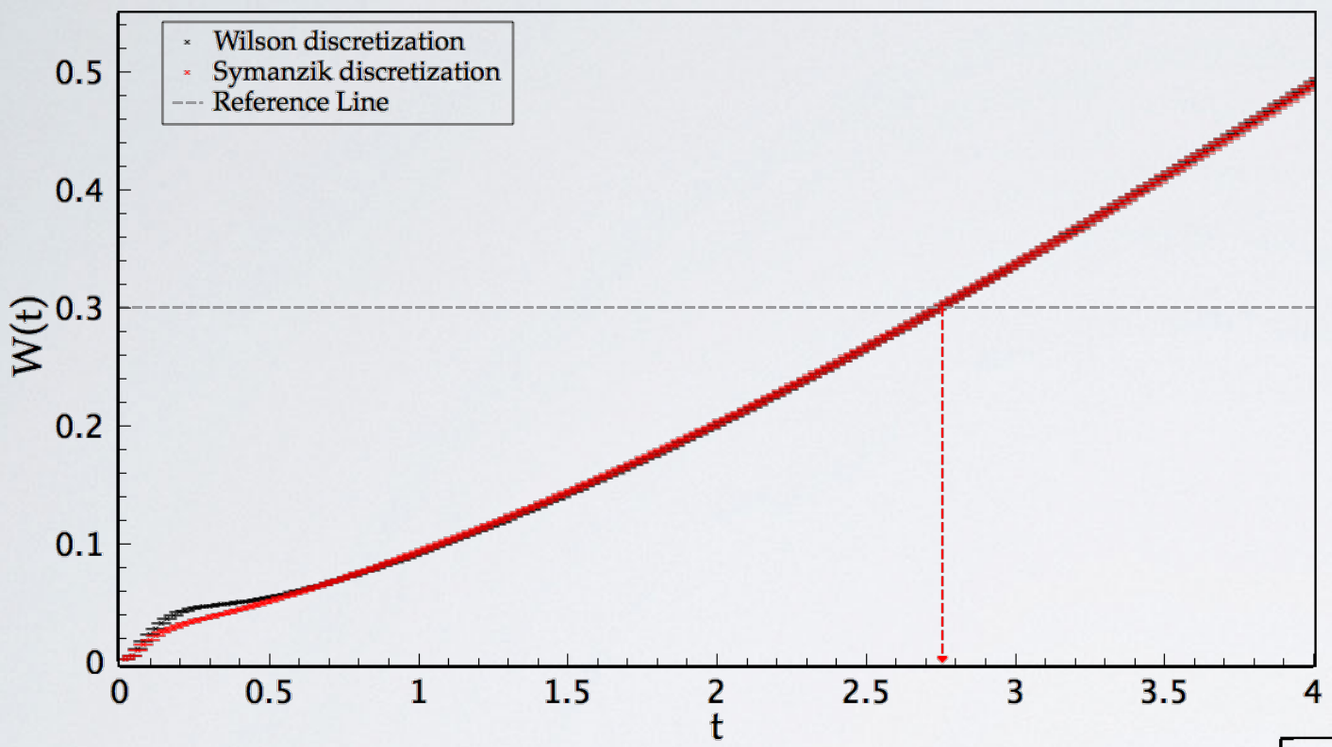
$$W(t) \equiv t\frac{d}{dt}\left\{t^2\langle E(t)\rangle\right\}$$ along the gradient flow.

Define $w_0 : W(t)|_{t=w_0^2} = 0.3$

- Cheap and easy to compute (no need to calculate quark propagators nor fitting correlation functions)
- Naturally smooth
- Provides a common UV scale

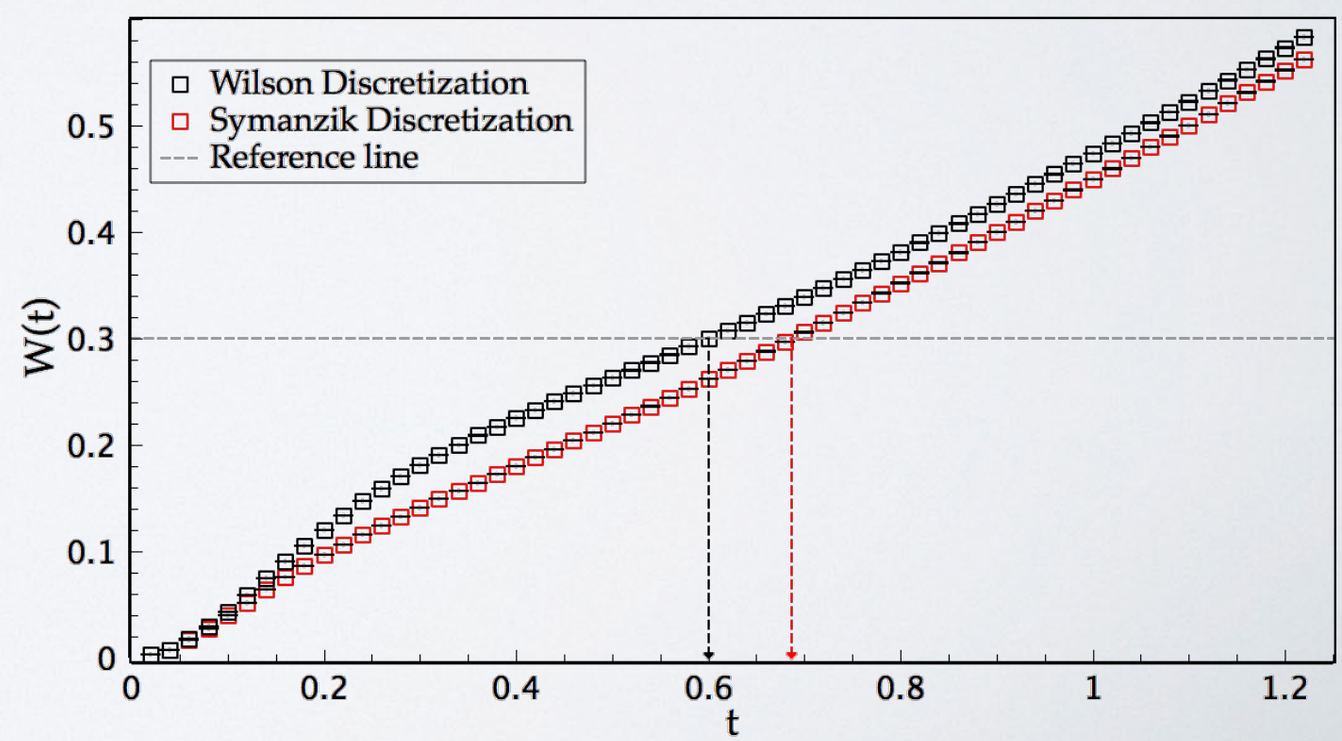
[1] Borsanyi et al., JHEP 1209 (2012)010

# THE FLOWS : $N_F = 0, 6$

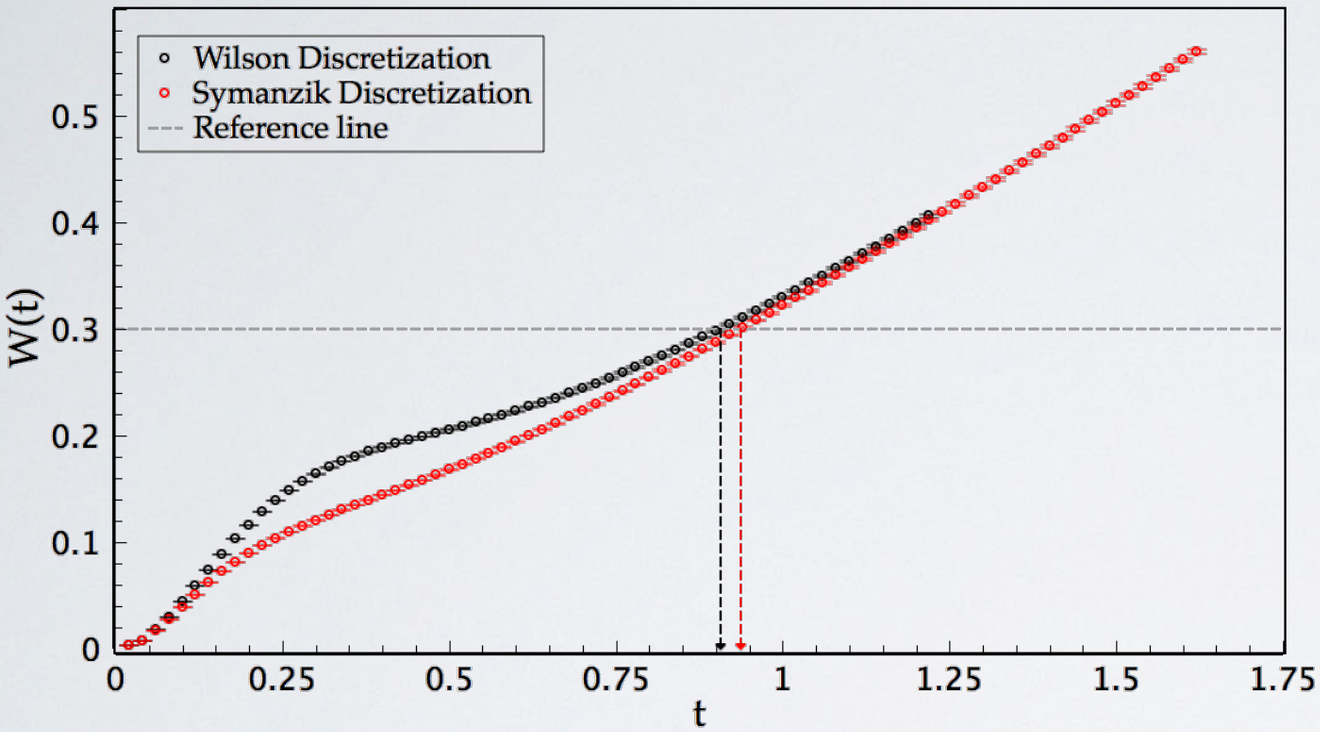



$N_f = 0, \beta = 7.970$

$N_f = 6, \beta = 5.025$

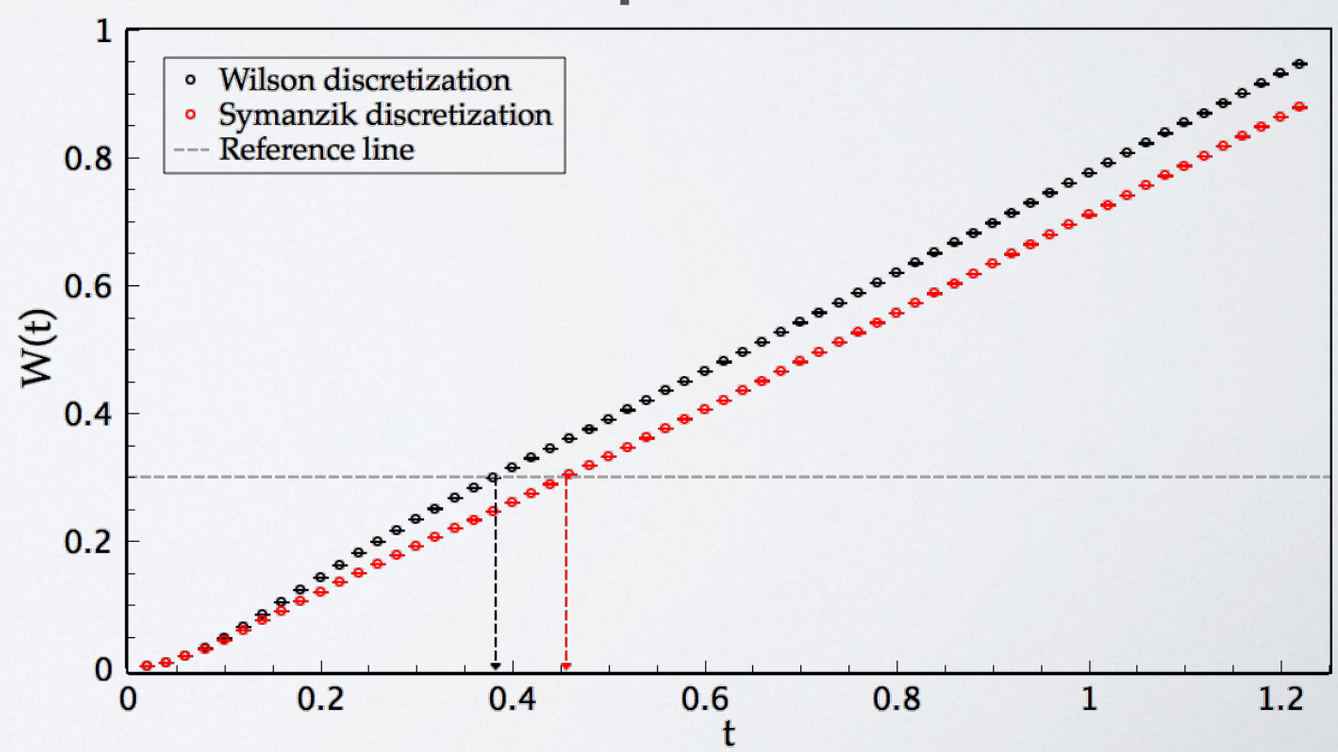


# THE FLOWS : $N_F = 8$

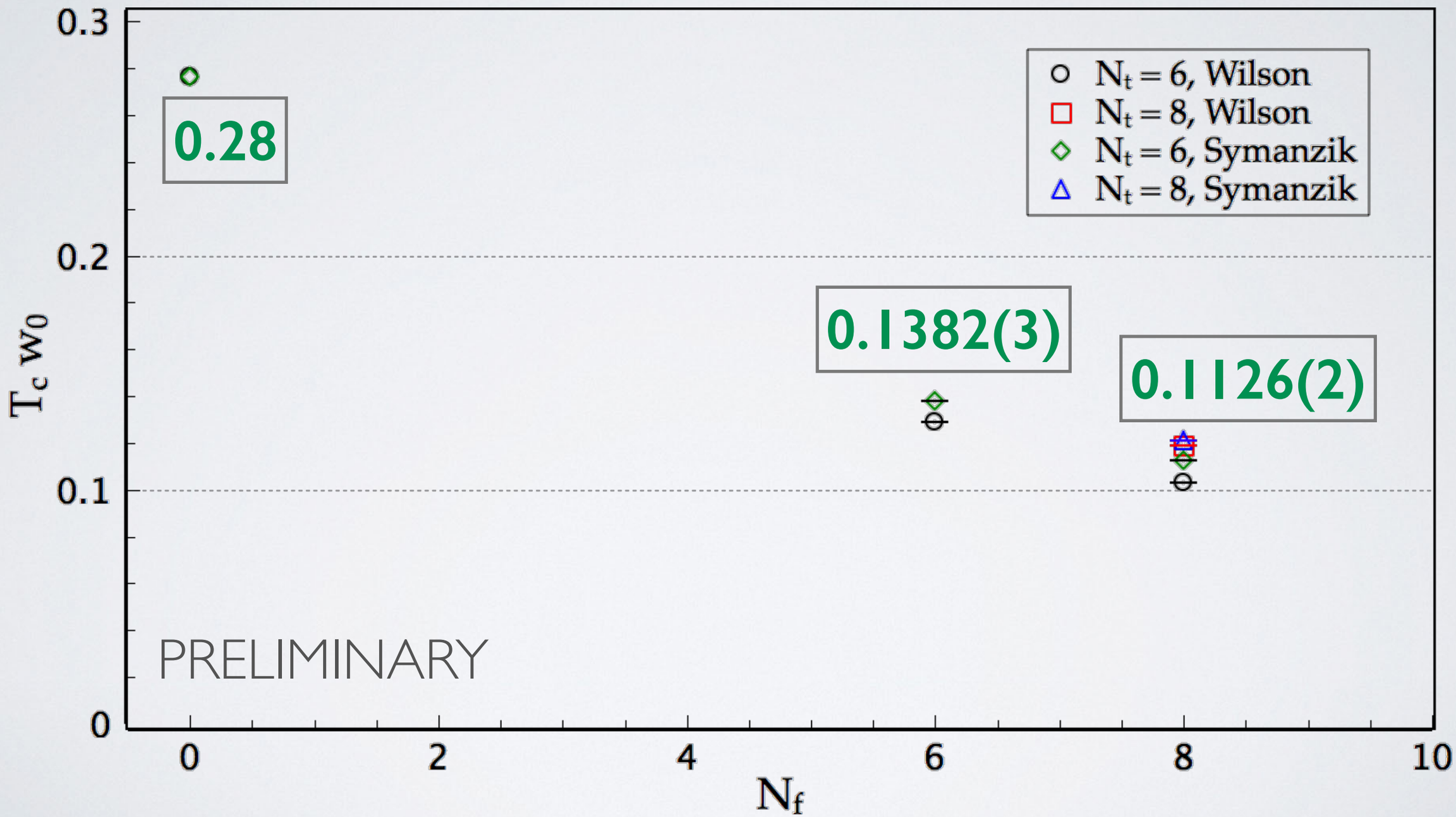



Nf = 8, β = 4.275

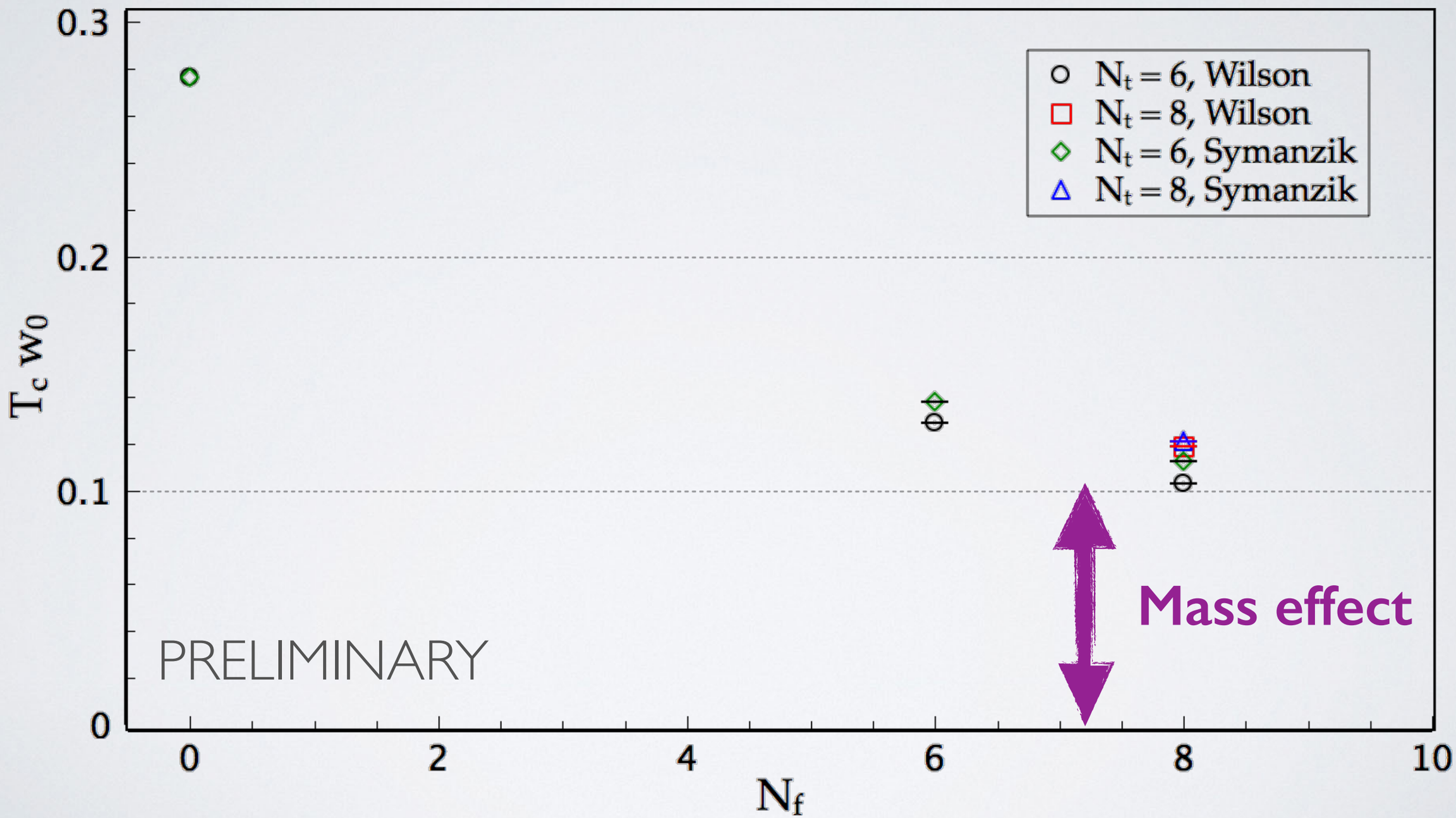
Nf = 8, β = 4.1125



# $T_c w_0$


0.3
0.2
0.1
0
$T_c w_0$
0
2
4
6
8
10
$N_f$
$N_t = 6$, Wilson
$N_t = 8$, Wilson
$N_t = 6$, Symanzik
$N_t = 8$, Symanzik
0.28
0.1382(3)
0.1126(2)
PRELIMINARY

# $T_c w_0$

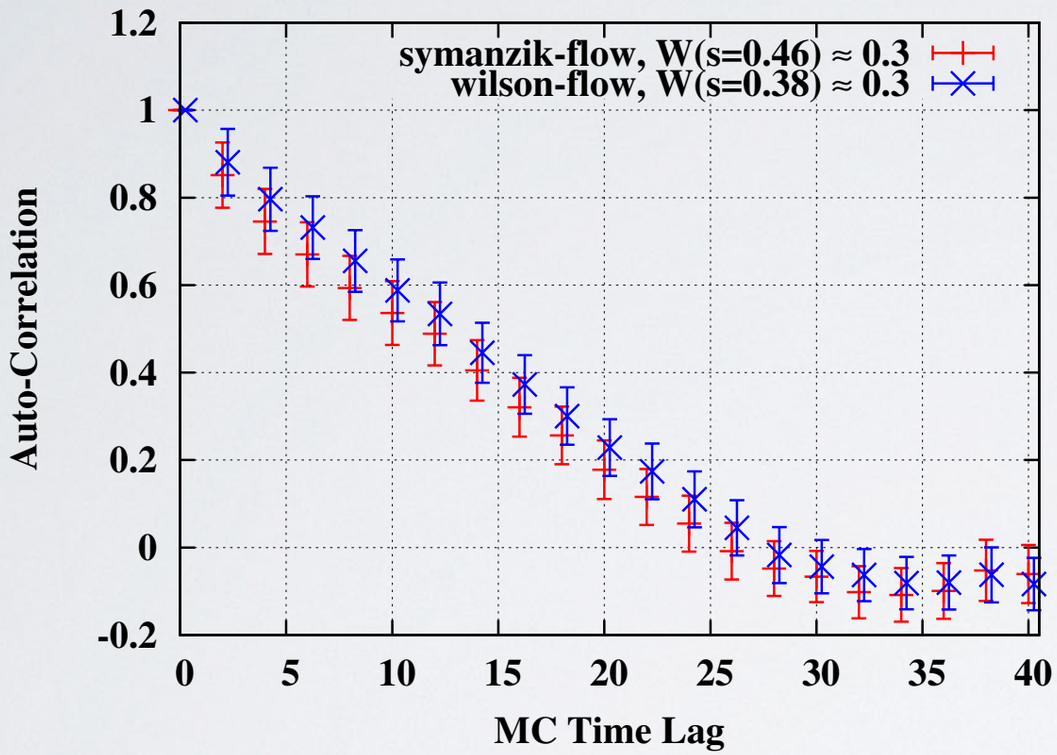

0.3
0.2
0.1
0
$T_c w_0$
0
2
4
6
8
10
$N_f$
$N_t = 6$, Wilson
$N_t = 8$, Wilson
$N_t = 6$, Symanzik
$N_t = 8$, Symanzik
Mass effect
PRELIMINARY

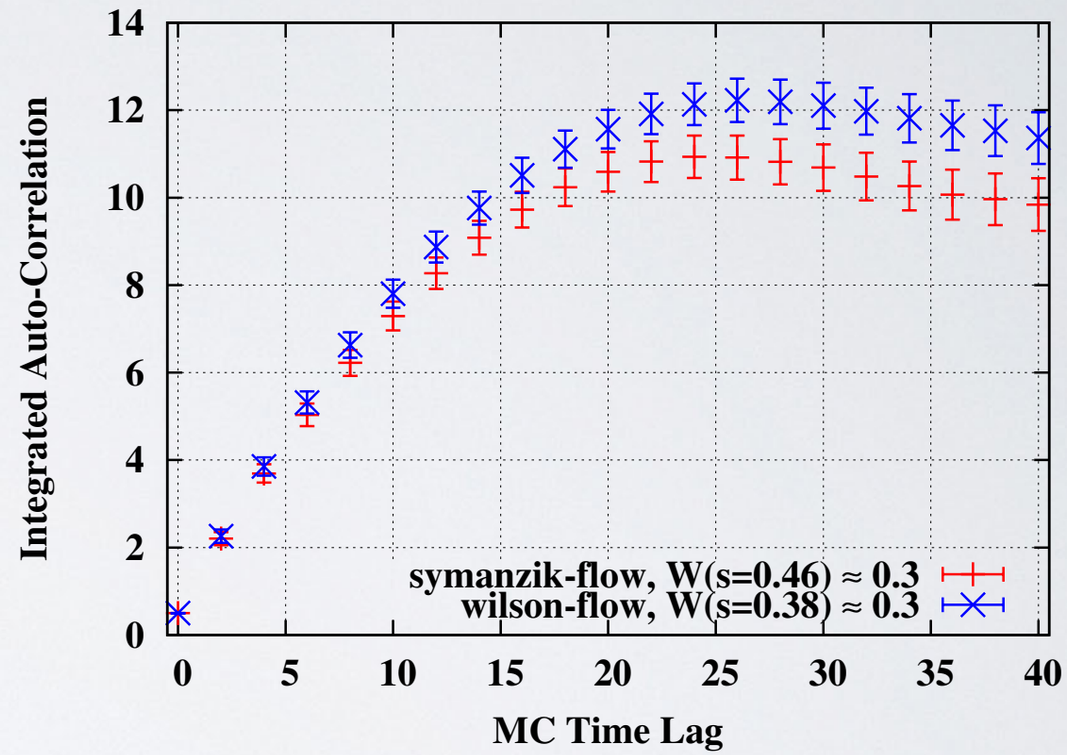
# CONCLUSIONS AND OUTLOOK

- Last ensemble Nf = 6, Nt = 8 finishing production.
- The ratio $T_c/\Lambda_L$ exhibits signs of scale separation ⇒ indication of preconformality
- $T_c$ and the string tension exhibit a similar sensitivity to the IRFP and their ratio is weakly dependent on Nf
- The product $T_c w_0$ decreases with $N_f$ as expected. A better understanding of finite mass effects is required for a proper estimation of $N_f^c$. (Work in Progress)

# BACKUP

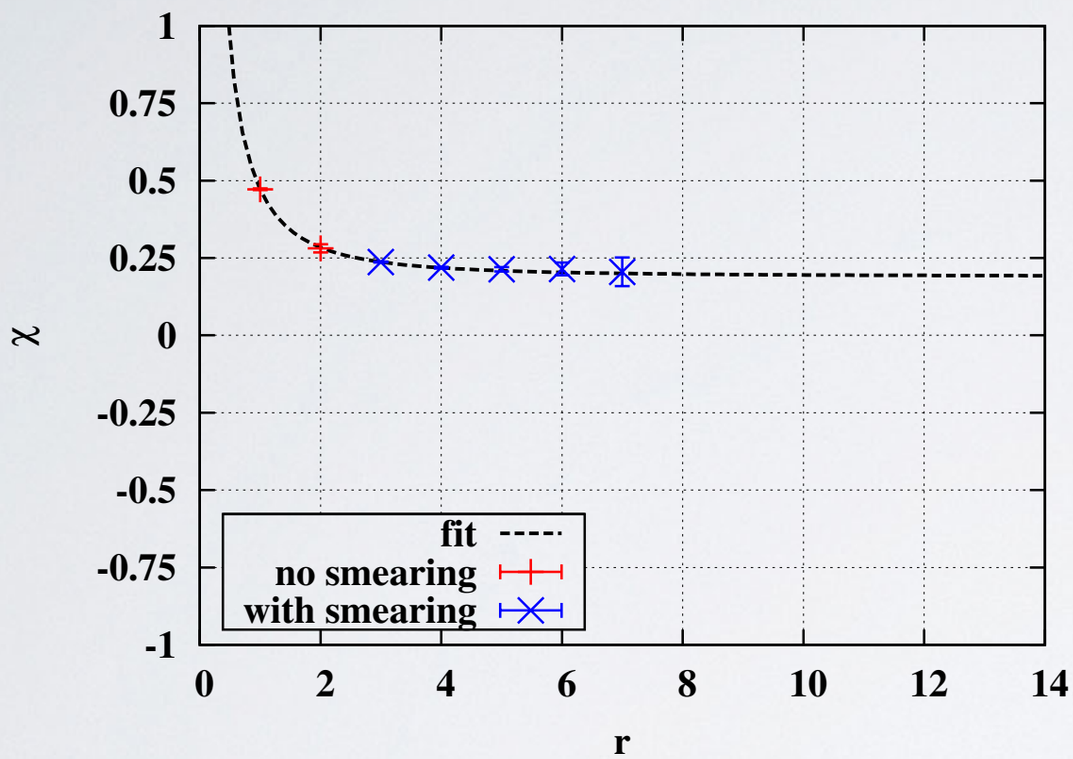
# AUTOCORRELATION



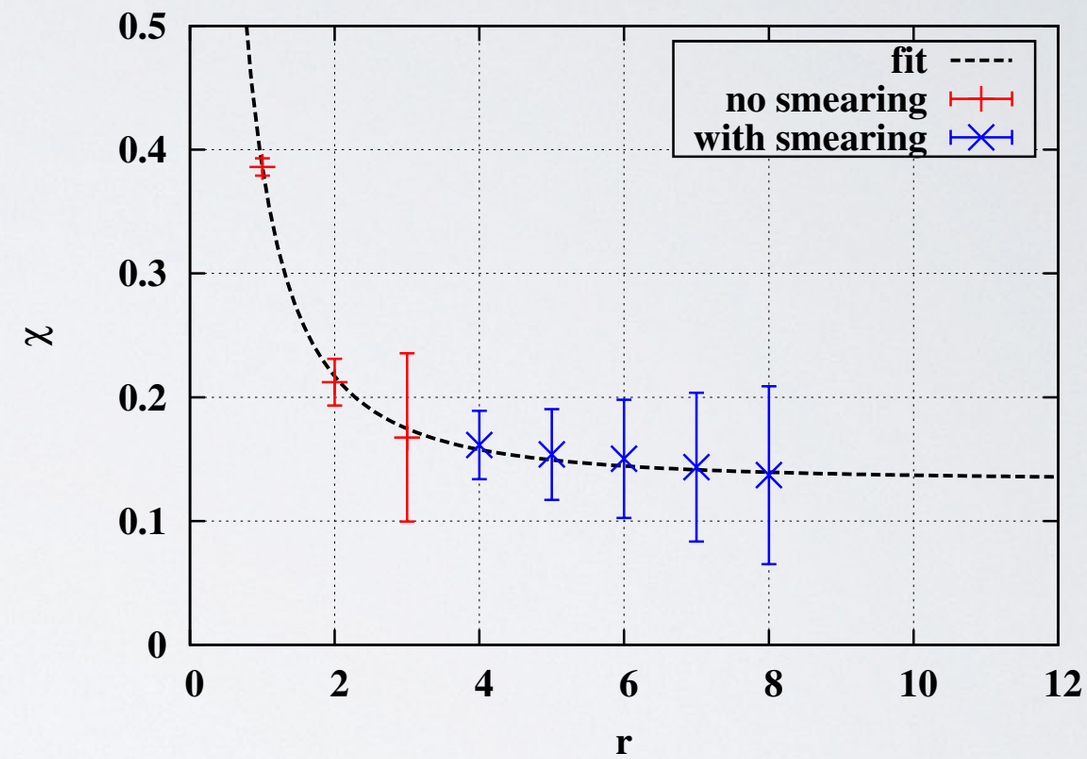




$Nf = 8, \beta = 4.1125$

# CREUTZ RATIOS



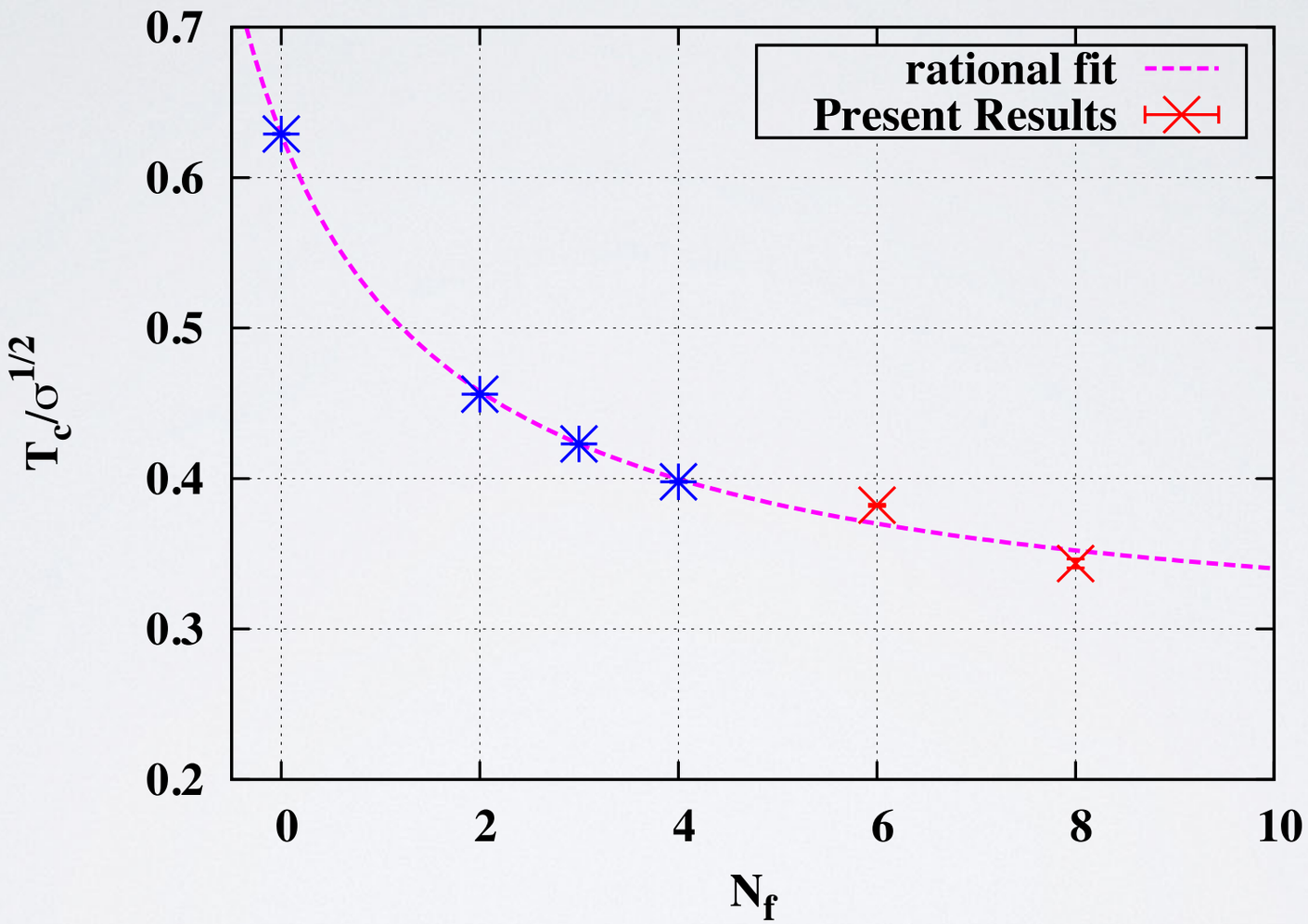

$N_f = 6$




$N_f = 8$

$$\chi_{r,t} = -\log \frac{W_{r,t} W_{r+1,t+1}}{W_{r,t+1} W_{r+1,t}} = \frac{\alpha}{r(r+1)} + \sigma$$

# $T_c/\sqrt{\sigma}$




$$\frac{T_c}{\sqrt{\sigma}}(N_f) = A \cdot \left[\frac{1 + B \cdot N_f}{1 + E \cdot N_f}\right]$$