
EXTREME QCD '06

Singlet Free Energies and Renormalized Polyakov Loops

Life After Deconfinement

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References

- Lattices generated by RBC-Bielefeld collaboration
- Simulations performed using CPS
  (product of RBC Corp., C.Jung)
- on QCDOC of RBC and apeNEXT @ Bielefeld
- Measurements performed using Chroma and CPS (crosscheck)

- **hep-lat**/0606020 C.Schmidt
- Phys.Rev.**D70:054503,2004 P.Petreczky, K.P.**

Static Approximation

Portrait of a Lattice

- Large Scale Simulation of improved staggered fermions
- P4 + Fat3 fermion action
- Exact, fast RHMC
- Along line of constant physics
- Previous studies - Asqtad, $N_t = 4, 6$, 3F and Bielefeld (2F, $N_t = 4$)
- Full QCD, *two* light and *one* strange dynamical quarks
- Physical strange quark mass
- Almost physical quark masses
- Scale setting via Sommer scale r_0 (for now)
- More details @ talks by M.Cheng, C.Schmidt, T. Umeda

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Free Energies

$$F_1(|x|,T)/T = -\ln\langle \mathrm{Tr} L(\vec{x}) L^\dagger(0)\rangle \quad (1)$$

- Not really gauge invariant
- However very physical in Coloumb Gauge [Philipsen]
- Renormalization required [Karsch et al]
- Assume that at very very short distances medium does not play any role
- Therefore everything is like at $T = 0$

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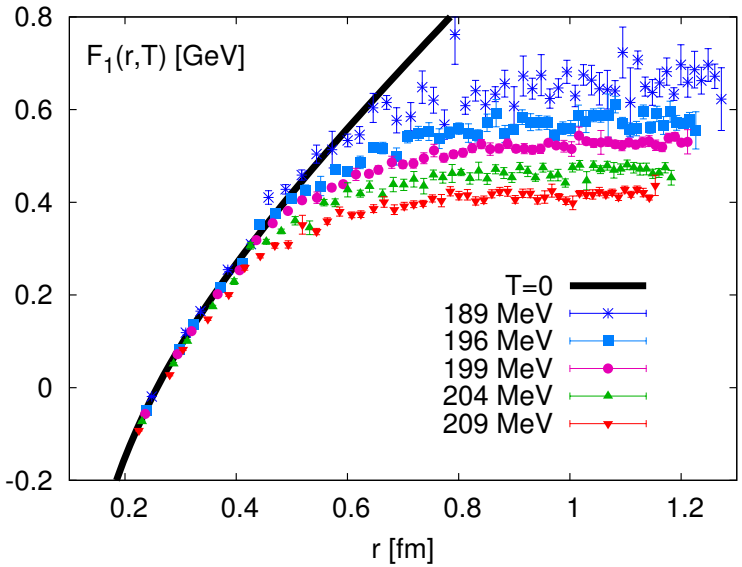
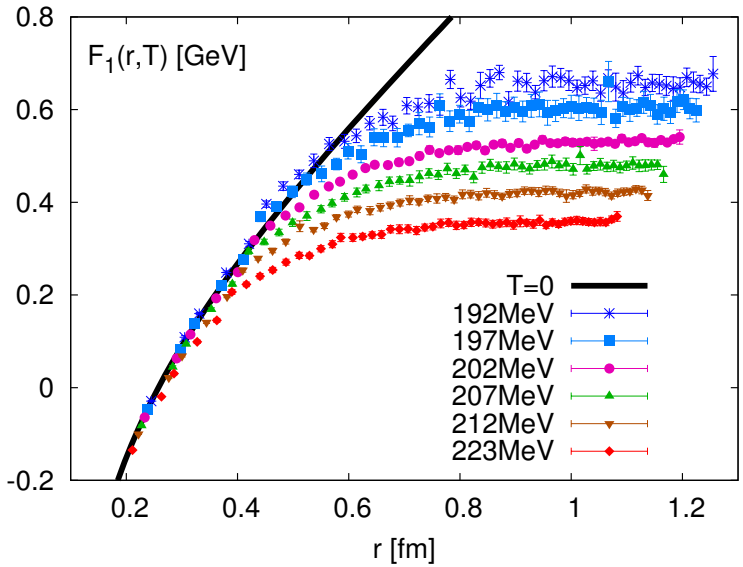
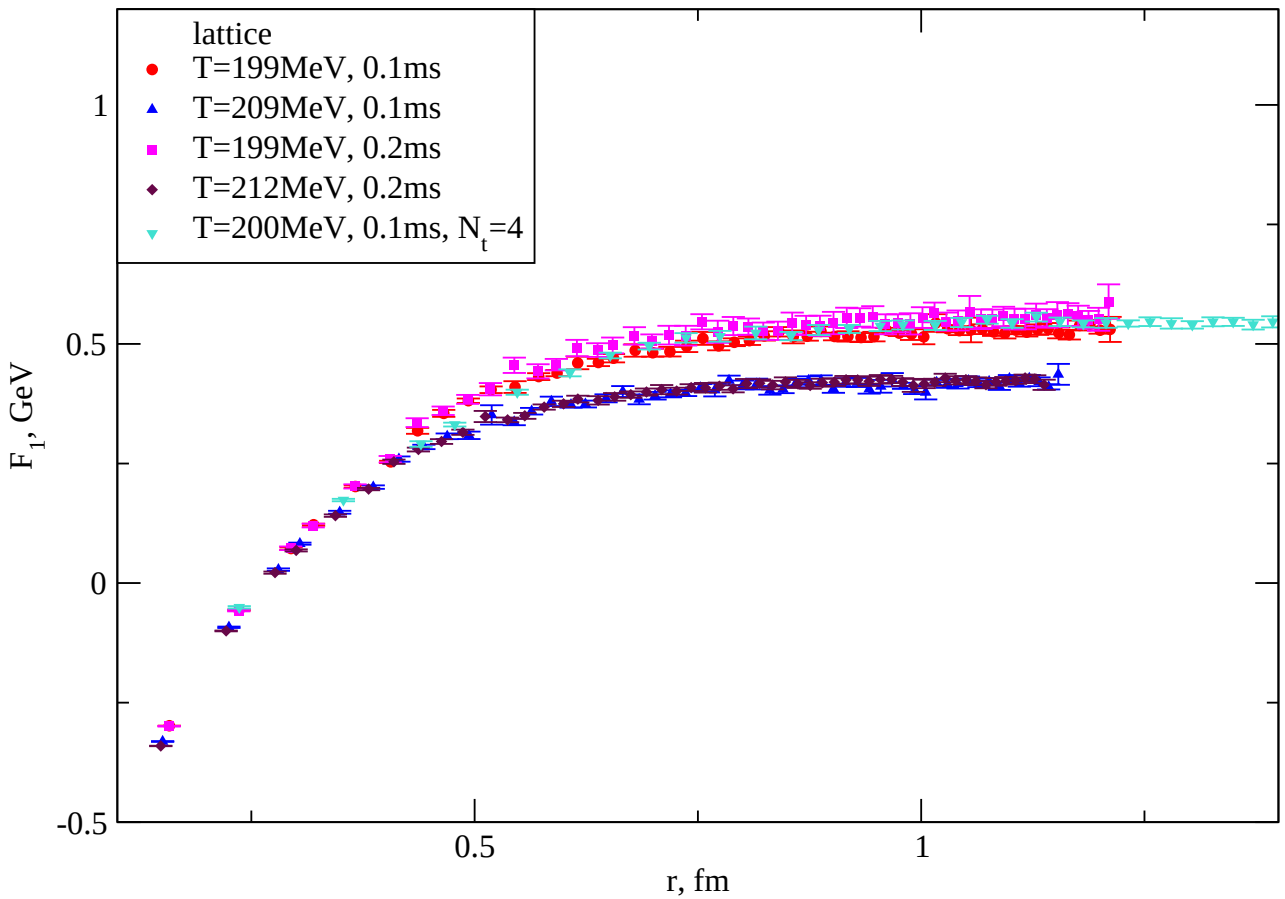
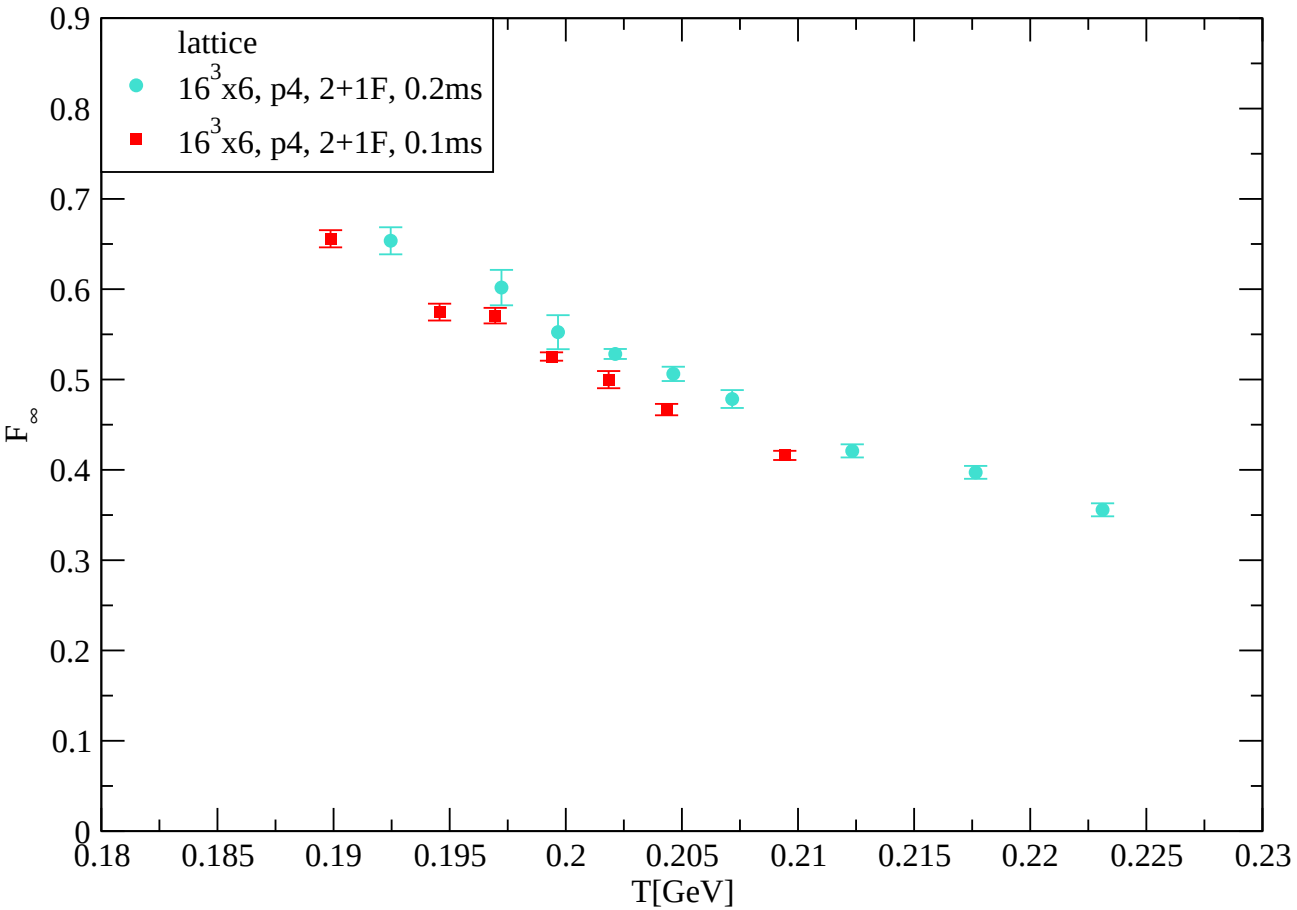

$F_1(r,T)$ [GeV]
r [fm]
T=0
189 MeV
196 MeV
199 MeV
204 MeV
209 MeV


$F_1(r,T)$ [GeV]
r [fm]
T=0
192MeV
197MeV
202MeV
207MeV
212MeV
223MeV

Checks and Balances: Scaling with m_q and N_t



Free energy at infinite separation



Renormalized Polyakov Loop

- Very nice oder parameter in pure glue
- Still interesting in full QCD
- Hated by experimentalists
- Loved by model-builders
- Needs renormalization [also see Pisarski way]
- But we define it through already renormalized F_1 [Karsch et al]

$$L_{ren} = exp(-F_\infty/2T) \tag{2}$$

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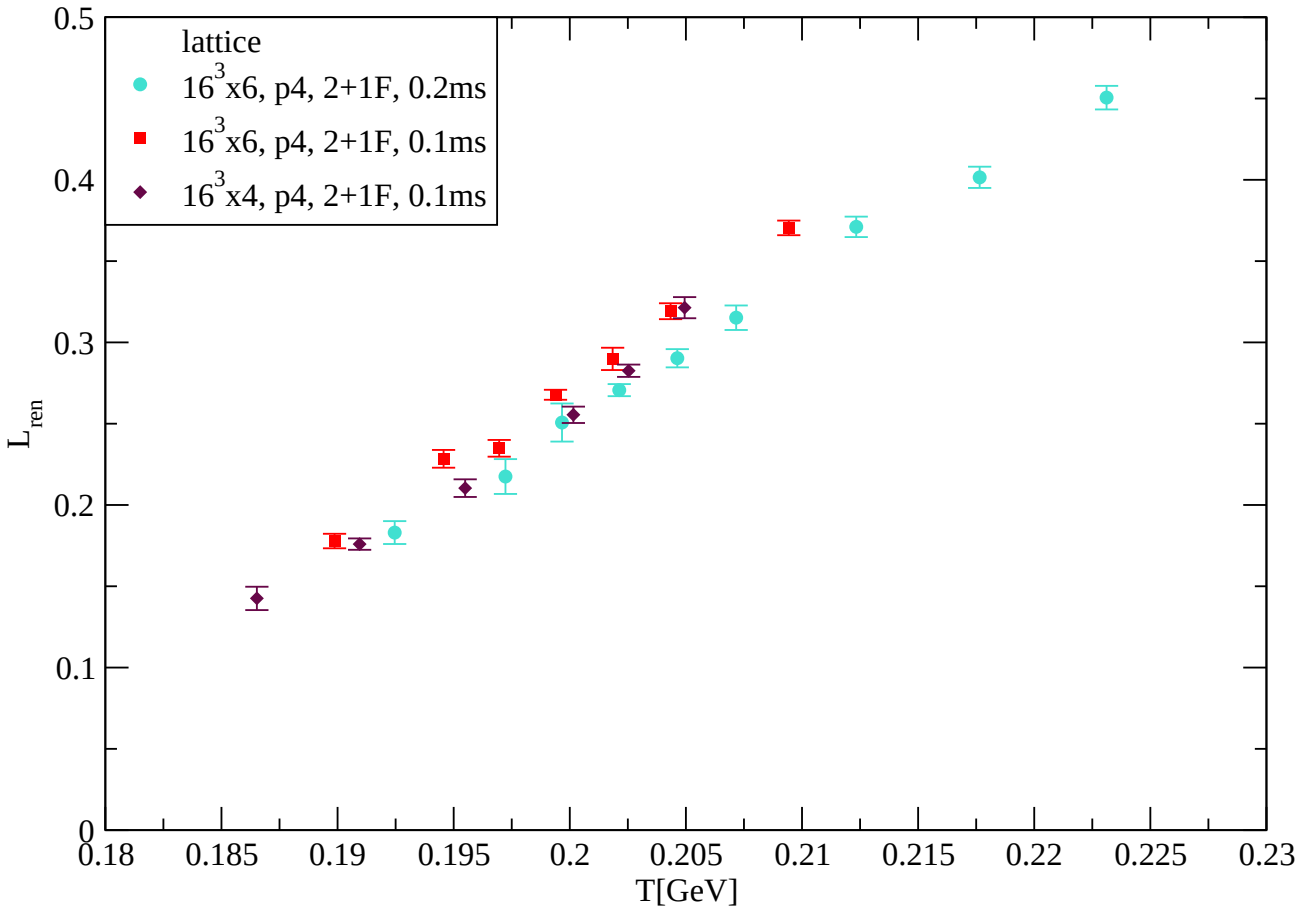
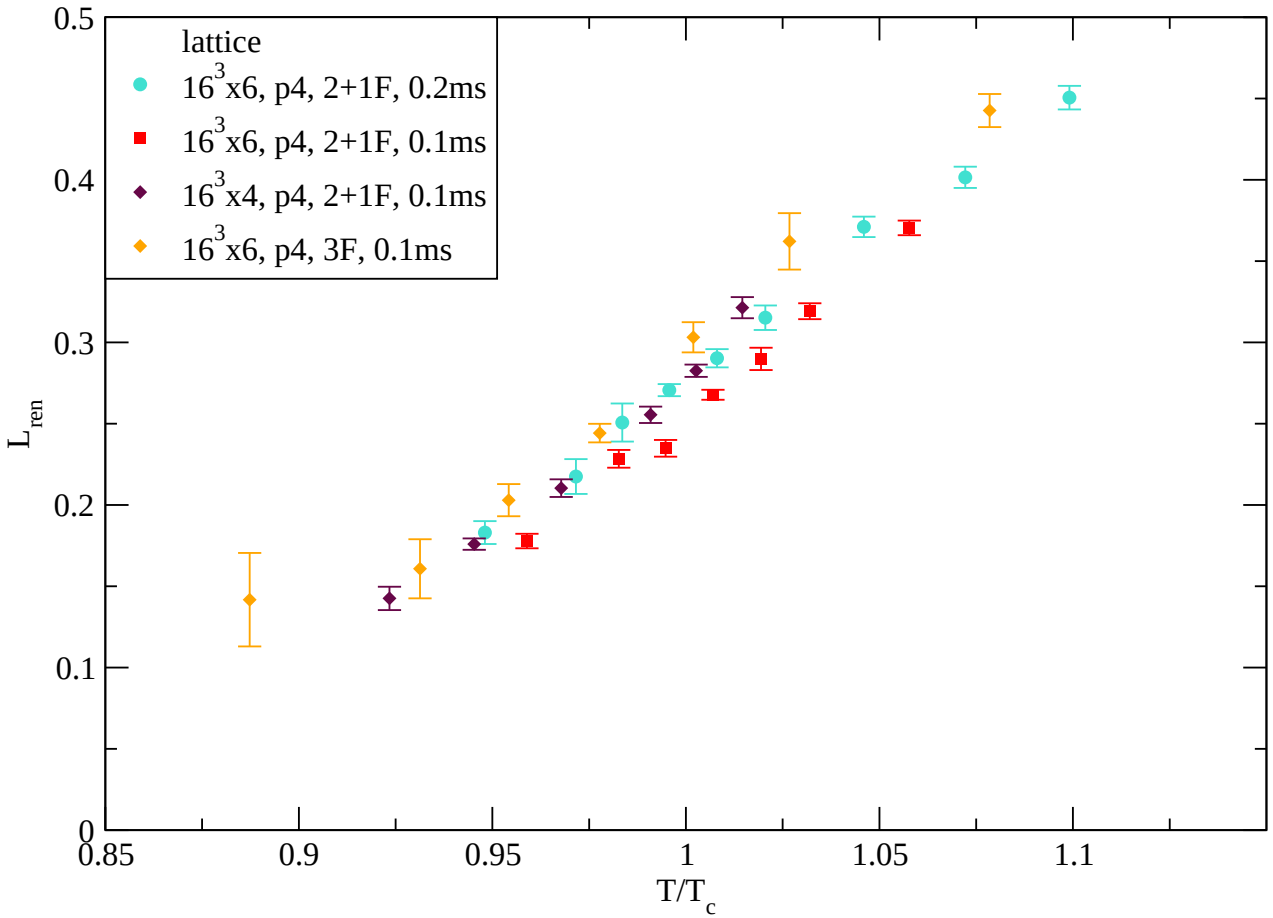
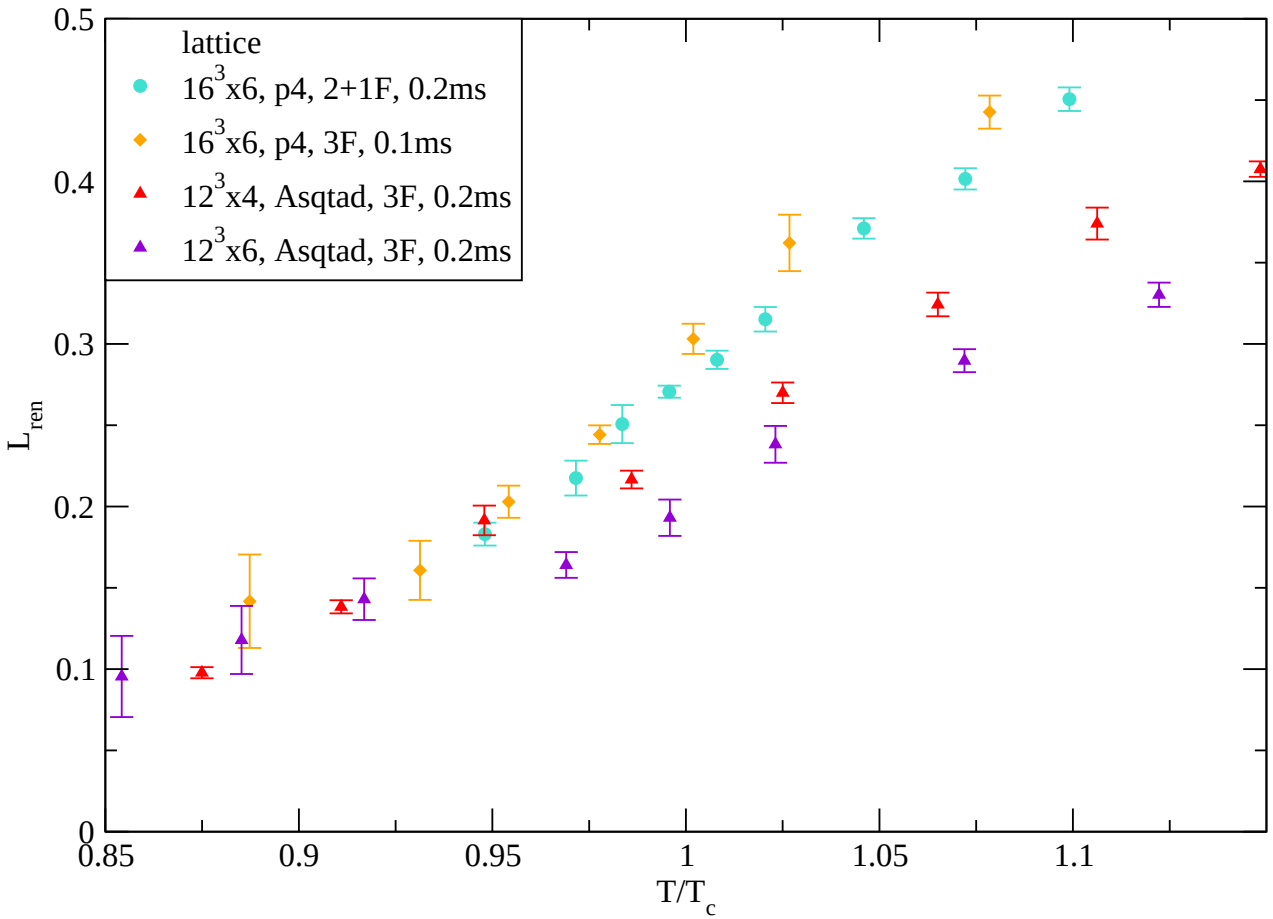
Renormalized Polyakov Loop in physical units



T_c dependence



Asqtad comparison



[Asqtad points K.P., P.Petreczky 2005, lattices by MILC and RBC]

Summary

- Interaction in hot medium gets screened at increasingly short distances
- Can define and calculate Renormalized Polyakov Loop
- Small finite size effects
- Lattice spacing / quark mass scaling is at threat level: Orange
- Go to higher representation (in progress)
- Diquark correlators (in progress)

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