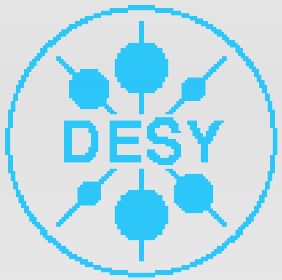
Björn Leder

Francesco Knechtli

Rainer Sommer

BERGISCHE
UNIVERSITÄT
WUPPERTAL



Scale r_0 and the static potential from CLS lattices

Lattice 2010

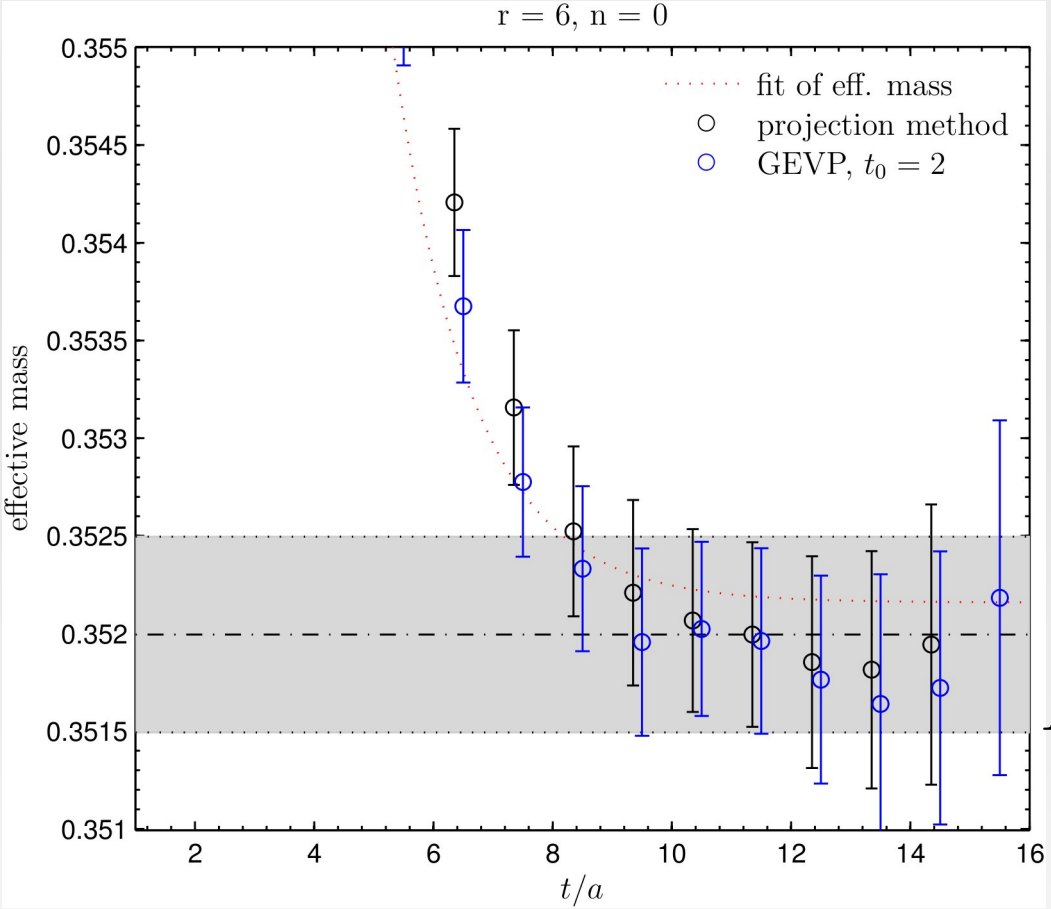
Villasimius, Sardinia, Italy

Motivation / Setup

- CLS lattices, scale determination through r_0
- Comparison with other run available sets
- Effects of sea quarks on the static potential

- Improved Wilson fermions, Wilson gauge action, DD-HMC
- Wilson loops on smeared configs: HYP, two parameter sets
- Operator basis from cubic smearing (like HYP, but only spatial links)

Effective mass



N=4: m,n = 0,1,2,3 levels of cubic smearing

[Blossier et al., 2009]

- At fixed r

$$C_{nm}(t) = \langle t \; \overset{r,\ m}{\square} \; t \rangle \qquad r,\ n$$

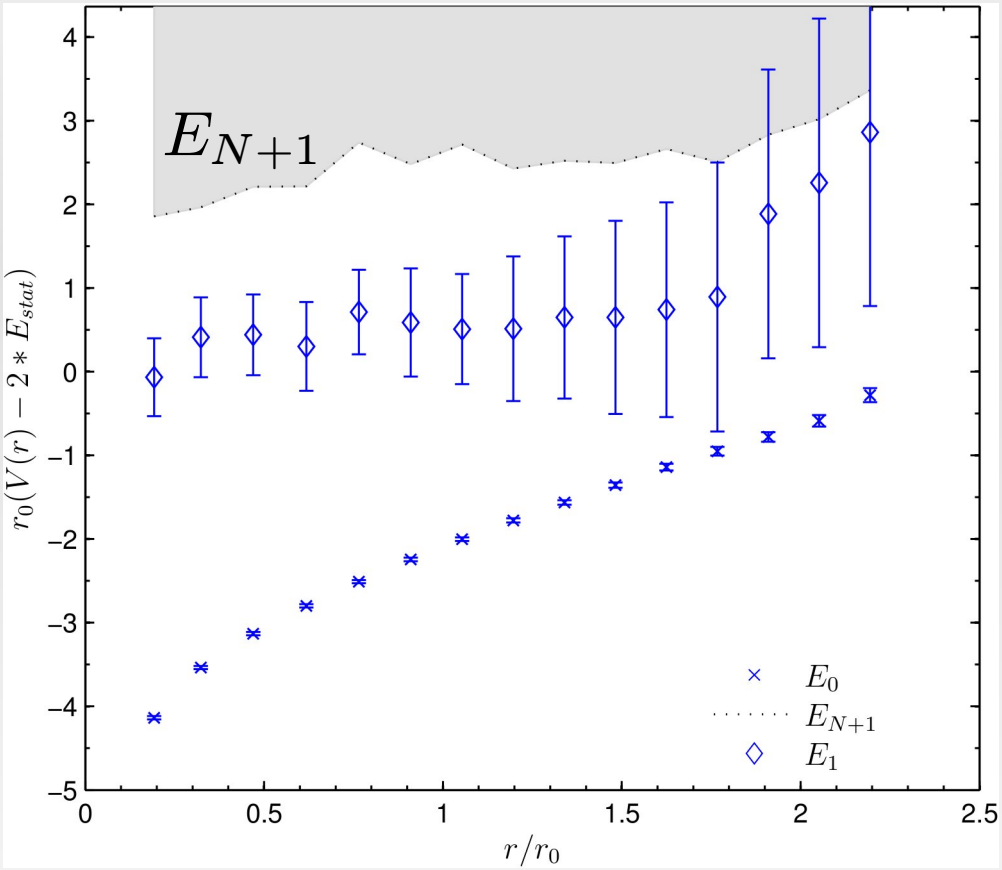
- Generalized EigenValue Prob.
- Fit (only to estimate sys. error)

$$E_n(t, t_0) = E_n + \beta_n(t_0) \mathrm{e}^{-(E_{N+1} - E_n)t}$$

$$t \leq 2t_0$$

- Projection with generalized EV
- Use value with min(stat + sys)

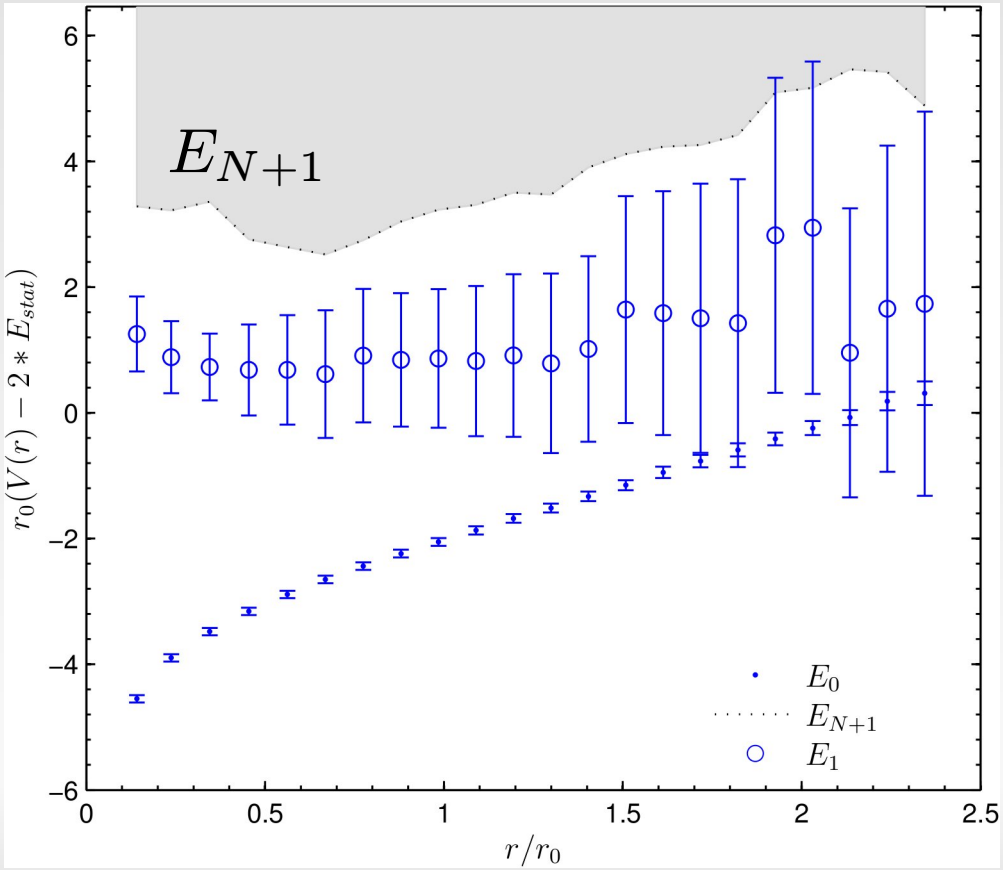
Potential and first excitation



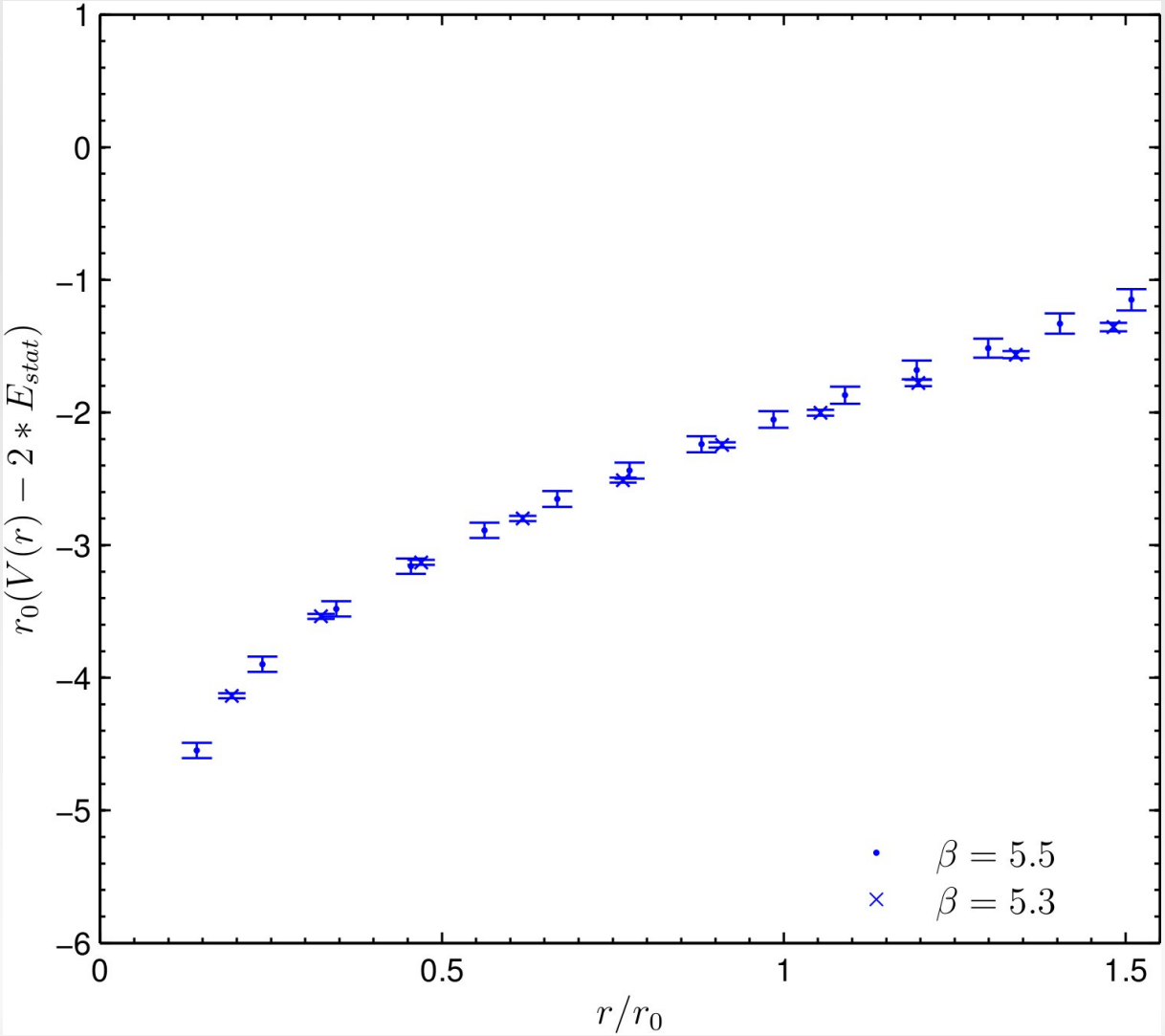
$\beta = 5.3 \qquad r_0/a = 7.05$

$$r_0\, M_{PS} \approx 1$$
$$L/r_0 \approx 4.5$$

$\beta = 5.5 \qquad r_0/a = 9.59$



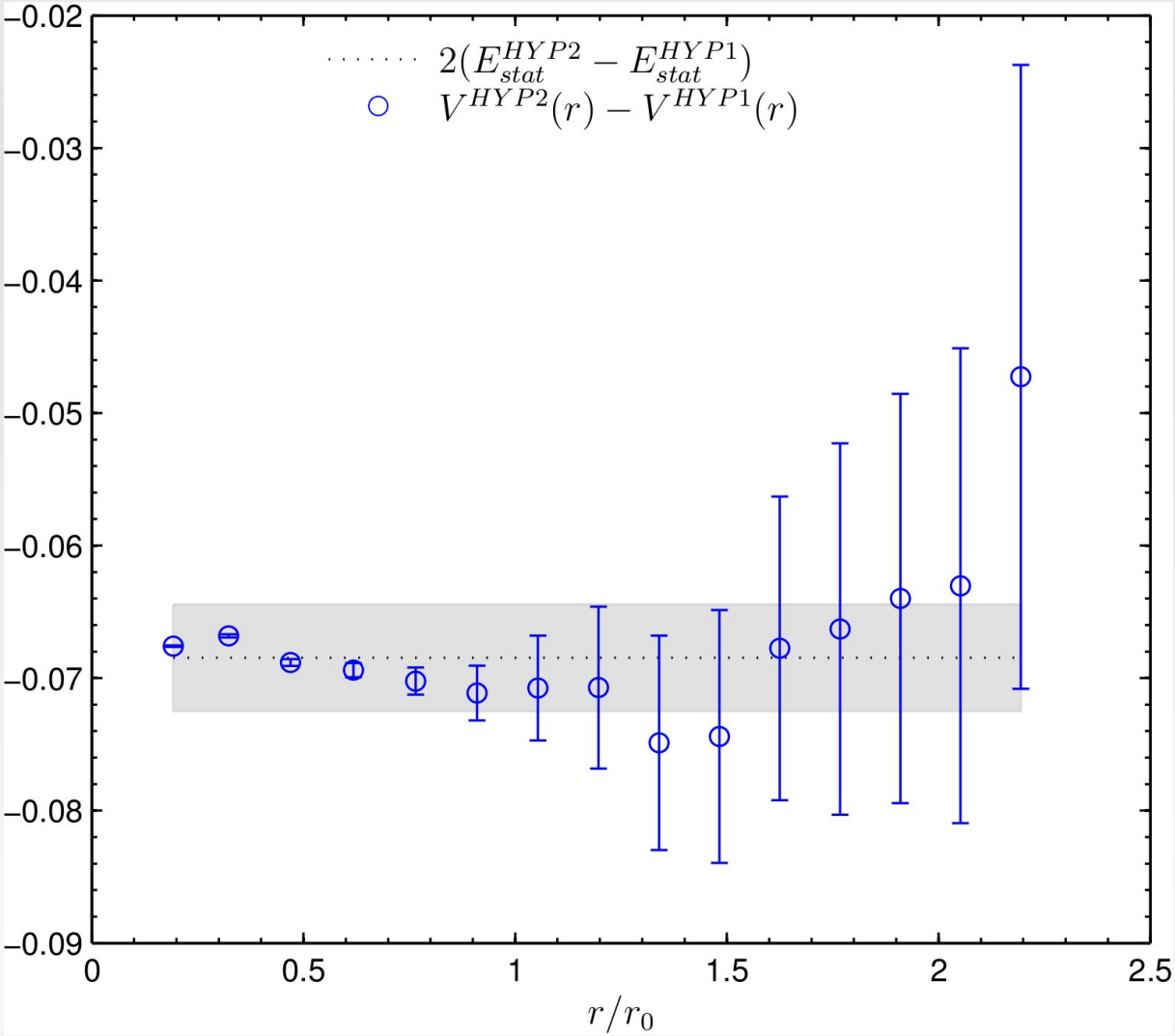
Cutoff effects



For determination of E_{stat}

see talk by B. Blossier

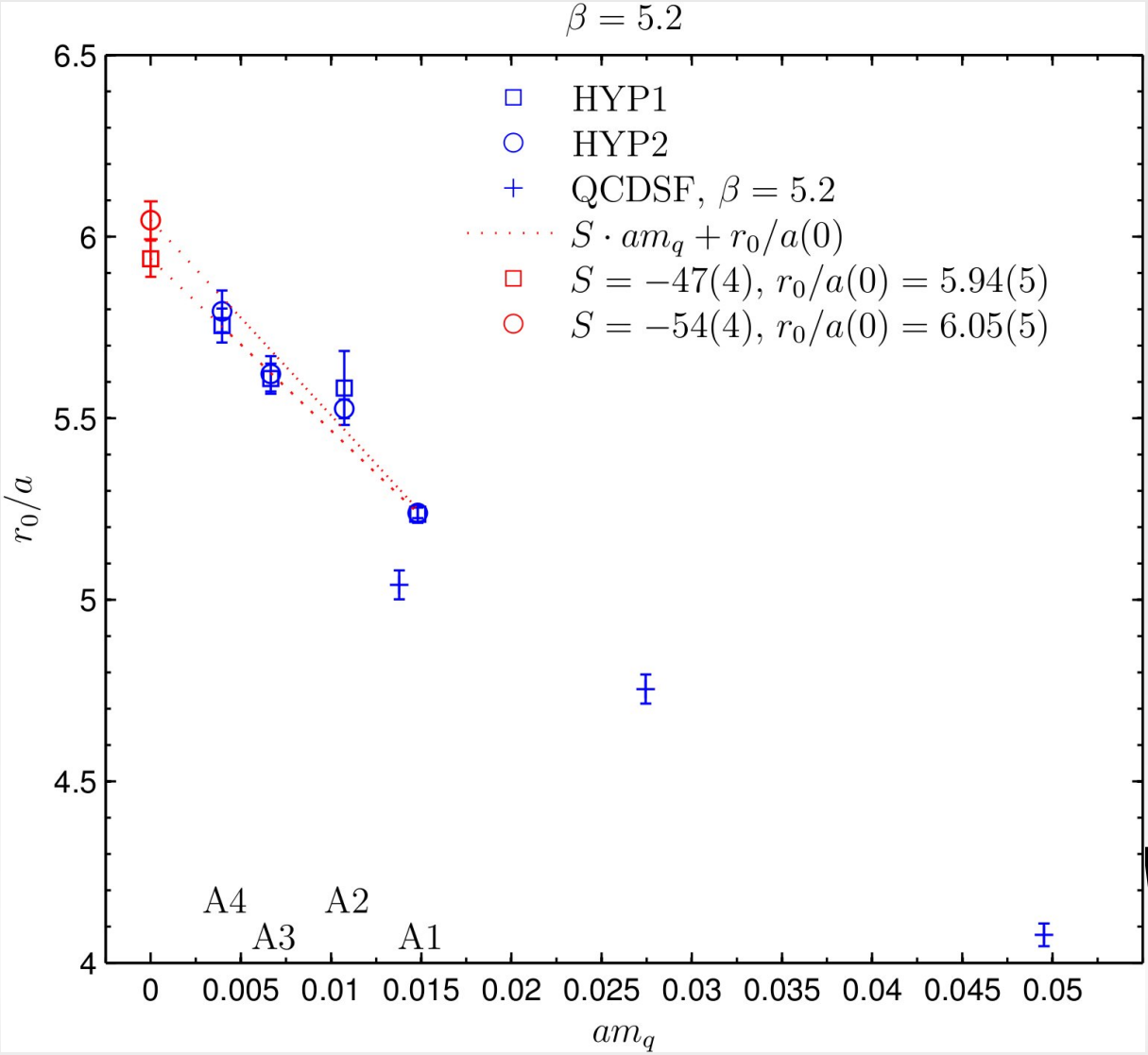
Systematic errors due to smearing



- HYP1: 0.75, 0.6, 0.3
- HYP2: 1.0, 1.0, 0.5
- Difference is flat at $r=r_0$
- Agreement with difference of E_{stat}
- Confidence about absence of systematic errors due to smearing

Scale setting with r_0 , $\beta = 5.2$

64×32^3



- Definition of r_0

$$r^2 F(r_I)\big|_{r_0} = 1.65$$

- Local interpolation of $F(r)$
- At $am_q = 0$, HYP2

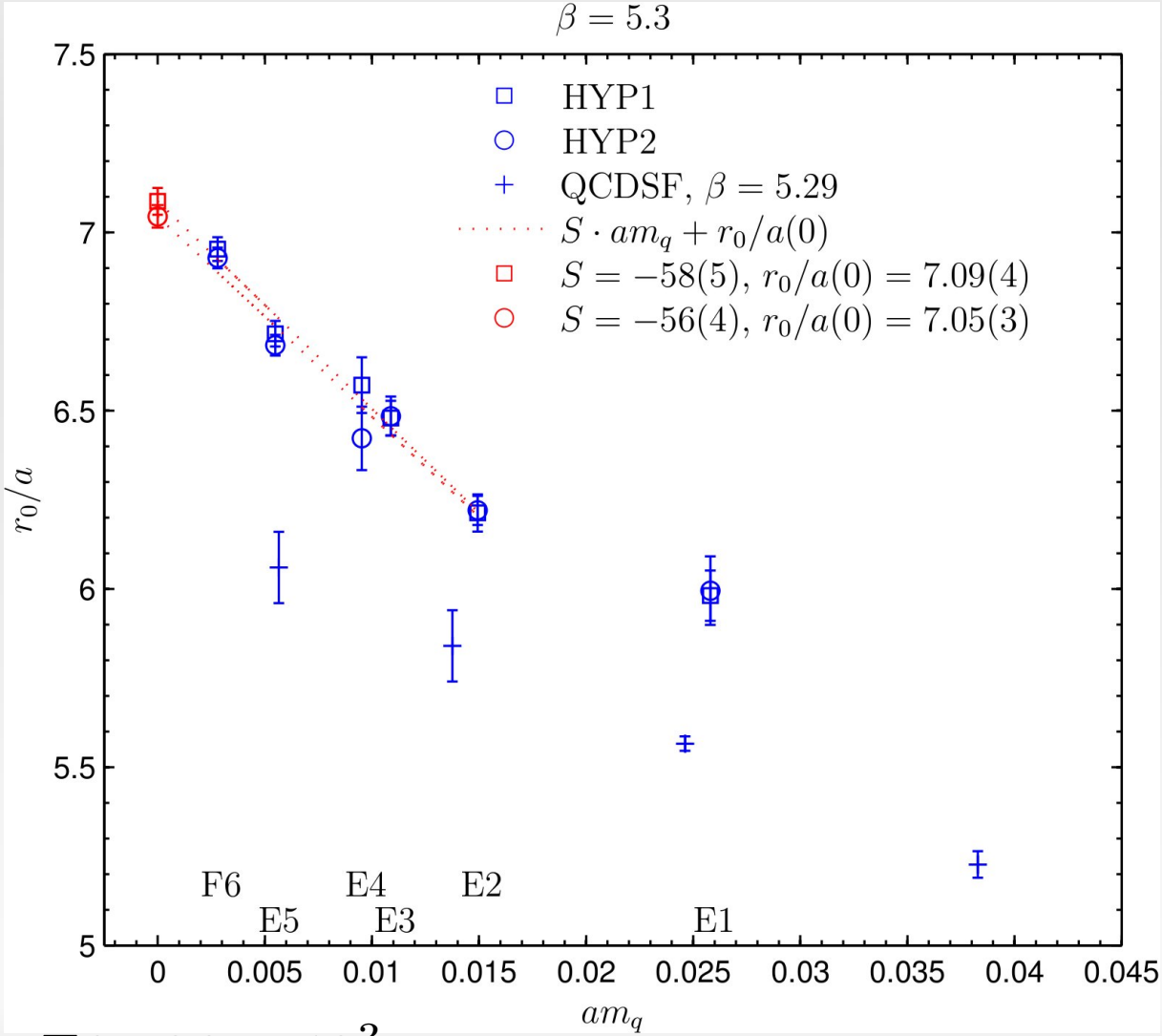
$$r_0/a = 6.05(5)$$

- QCDSF values from fit

$$V(r) = \mu + \sigma\, r + \frac{c}{r} + \Delta V_{Lat}(r)$$

Scale setting with r_0 , $\beta = 5.3$

64×32^3



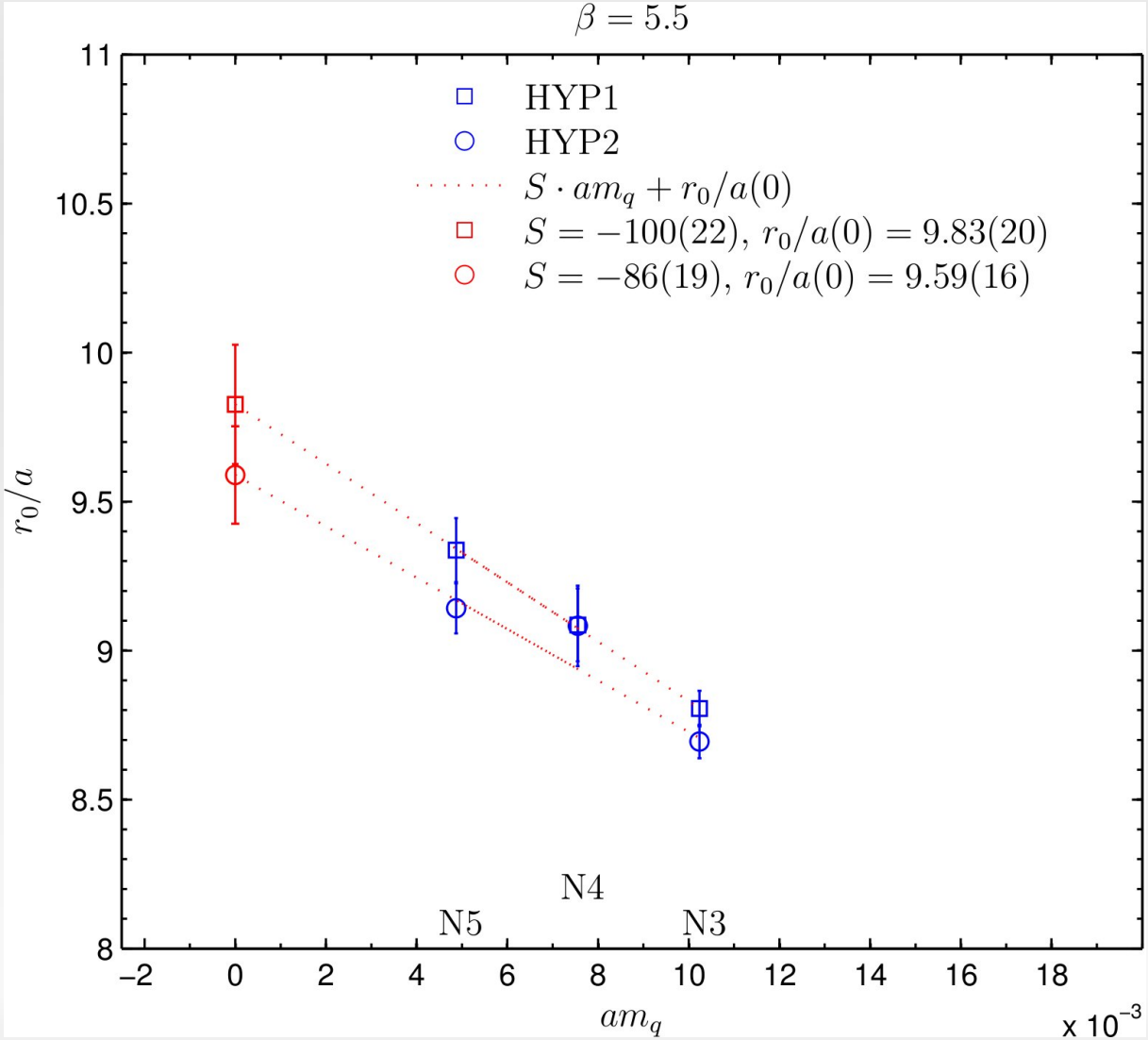
$F6 : 96 \times 48^3$

- At $am_q = 0$, HYP2

$$r_0/a = 7.05(3)$$

Scale setting with r_0 , $\beta = 5.5$

96×48^3



- At $am_q = 0$, HYP2

$$r_0/a = 9.59(16)$$

Physics results I: update of $r_0 \Lambda_{\overline{MS}}$

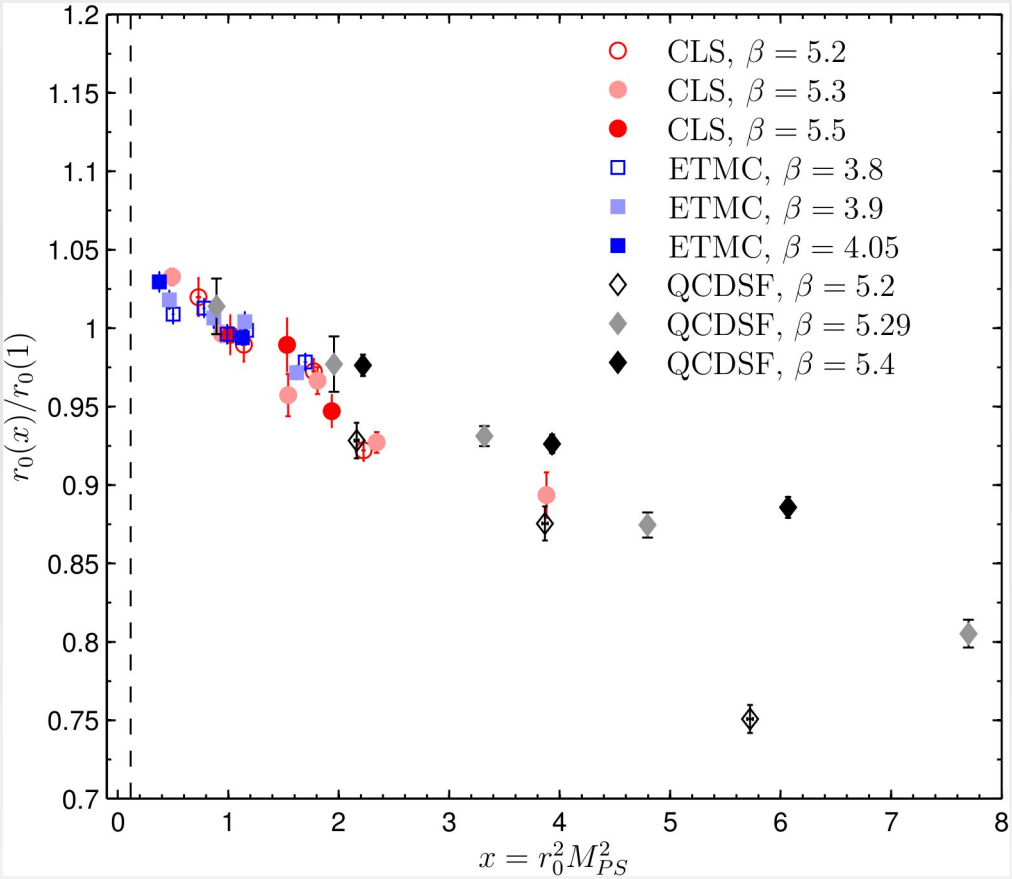
- Preliminary! update of the Nf=2 value due to new r_0

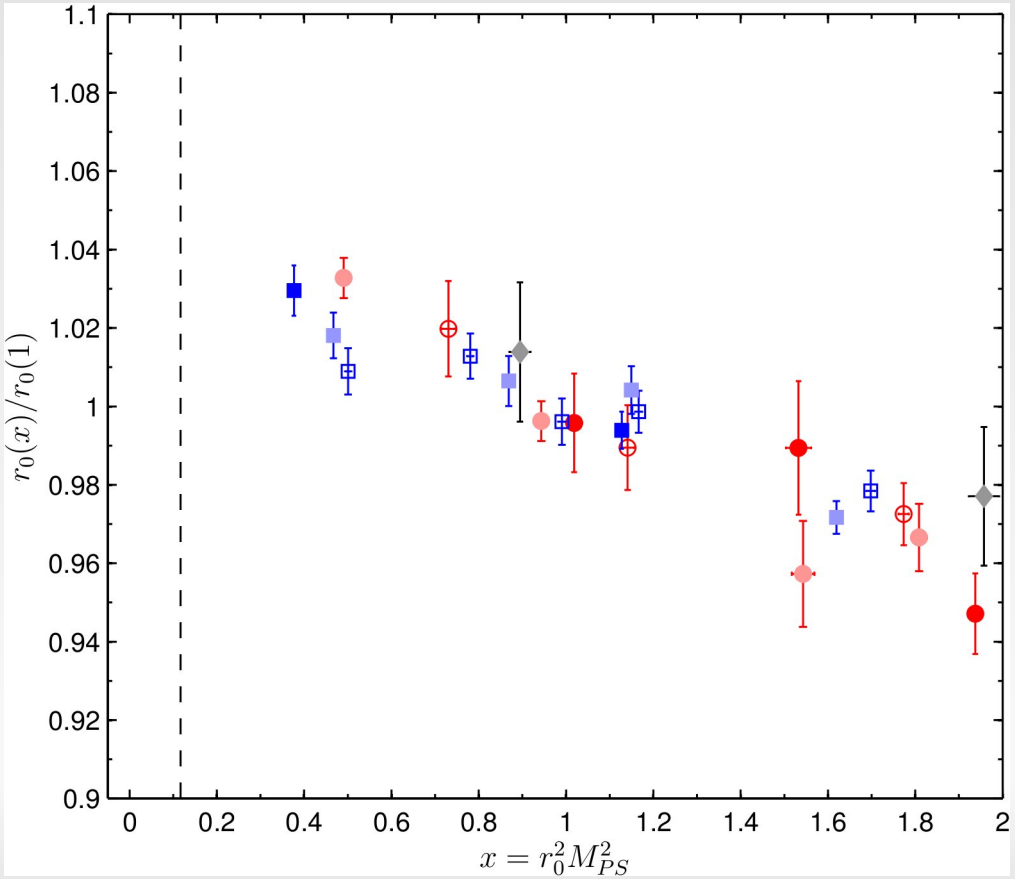
[Della Morte et al., 2004]

$$r_0 \, \Lambda_{\overline{MS}}^{N_f=2} = 0.73(3)$$

$$r_0 \, \Lambda_{\overline{MS}}^{N_f=0} = 0.60(5)$$

Physics results II: mass dependence of r_0

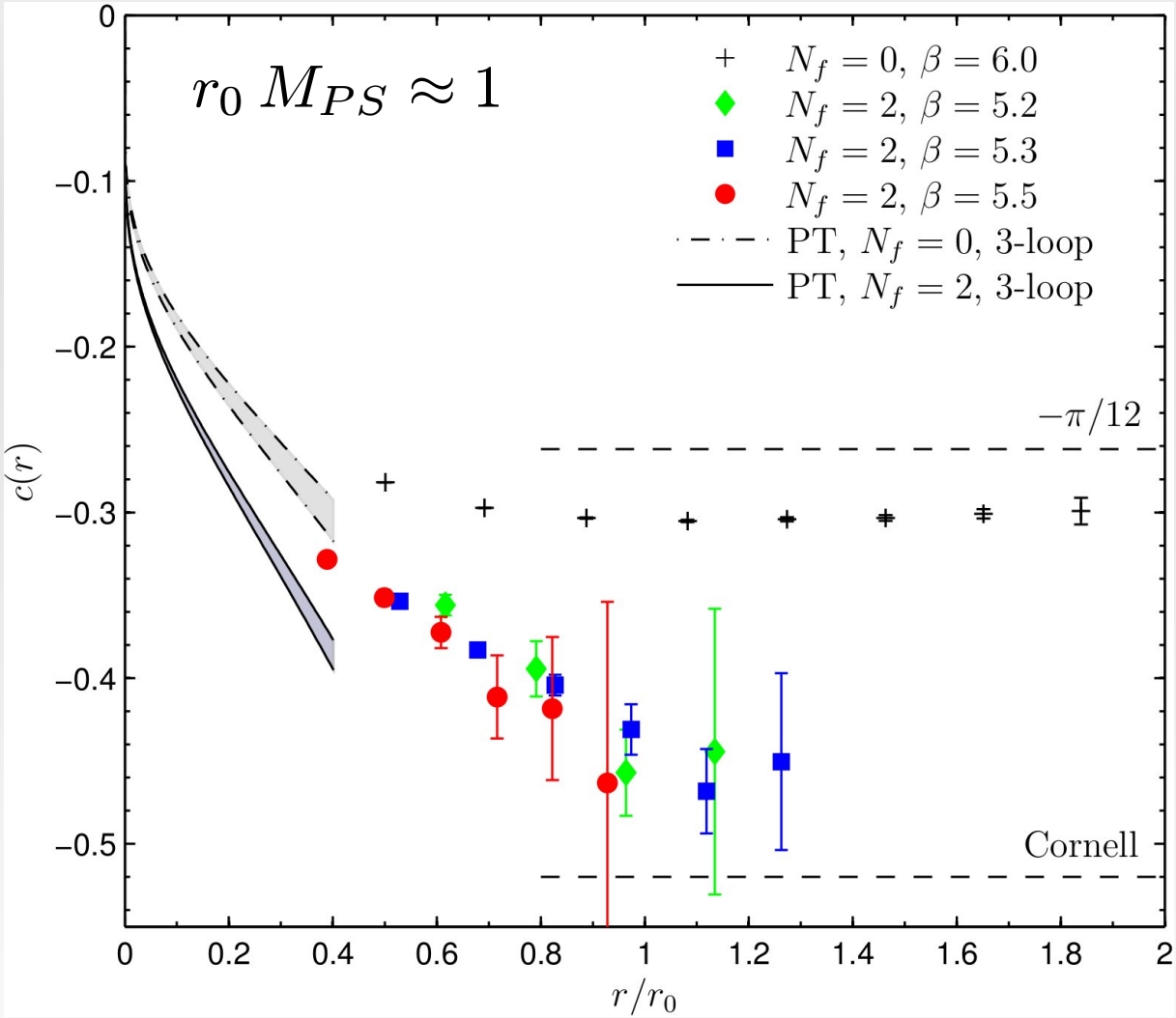




[ETMC, 2009]

[QCDSF, 2006]

Physics results III: static force



- Definition

$$c(\tilde{r}) = \tfrac{1}{2} r^3 F'(\tilde{r})$$

$$-c/C_F = g_0^2 + O(g_0^4)$$

- Cornell – Potential

$$V(r) = \mu + \sigma\, r + \frac{-0.52}{r}$$

param. fixed with fit of Charm./Bottom. spectrum

$N_f = 0$: Data: [Lüscher, Weisz, 2002] PT: [Necco, Sommer 2001], [Necco, PhD thesis]

Summary / Outlook

- Scale setting with r_0 : O(100) configs → 1% error (sys. + stat.)
- New r_0 leads to new Nf=2 value of $r_0 \Lambda_{\overline{MS}}$
- Assuring agreement with other efforts
- Large effects of sea quarks on the shape of the static force
- Signal for plateau of c(r) and string tension around r_0
- More detailed analysis of mass dependence at small r
- String breaking, (need off-axis Wilson loops)

String tension