Unquenched flavor physics with TeraFlop machines ?

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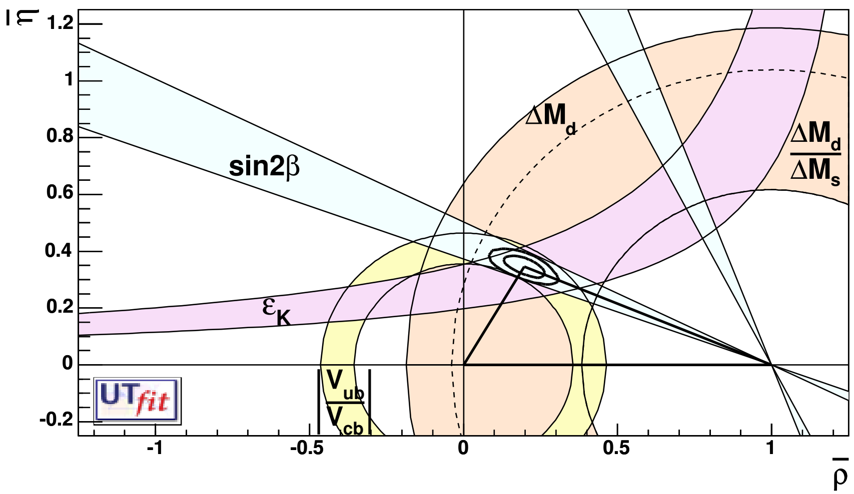
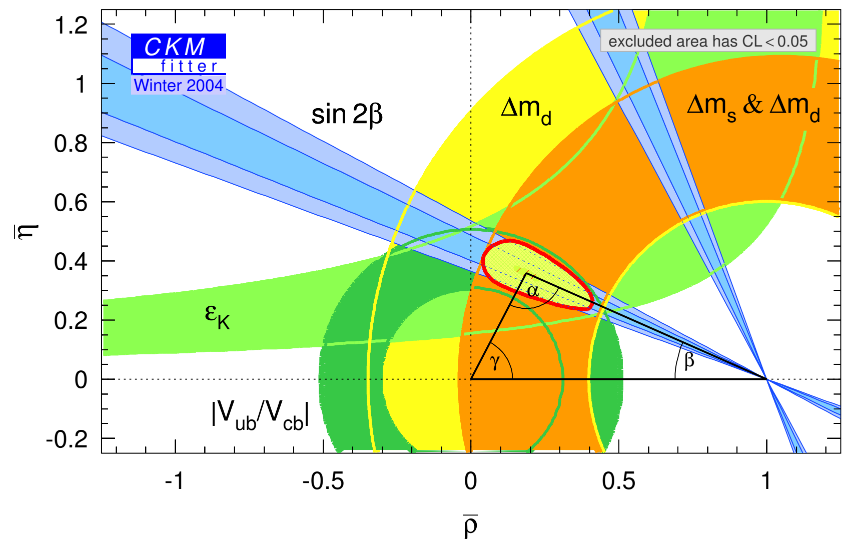
Outline

- Flavor physics with lattice QCD
- Introduction to LQCD
- The “wall” in unquenched simulations
- A new algorithm: SAP - first preliminary results
- Status and perspective of B-parameters and form factors
- Conclusions and outlook

Unitarity triangle fit in the Standard Model





- Indirect C$\!\!\!/$P in $K \to \pi\pi$

$$\varepsilon_K = \frac{\mathrm{T}[K_L \to (\pi\pi)_0]}{\mathrm{T}[K_S \to (\pi\pi)_0]}$$

- CP asymmetry in $B \to J/\psi\, K_S$

$$a = \frac{\Gamma[B_d^0 \to J/\psi\, \mathrm{K}_S] - \Gamma[\bar{B}_d^0 \to J/\psi\, K_S]}{\Gamma[B_d^0 \to J/\psi\, K_S] + \Gamma[\bar{B}_d^0 \to J/\psi\, K_S]}$$

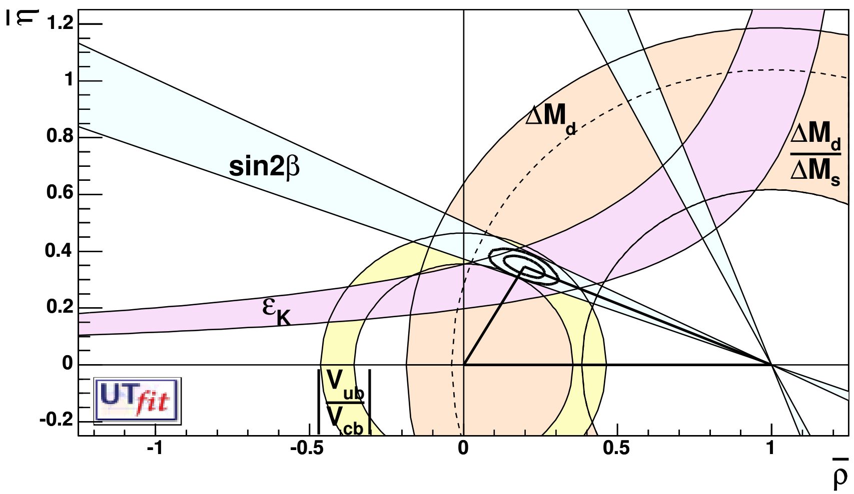
- Mass differences of neutral B

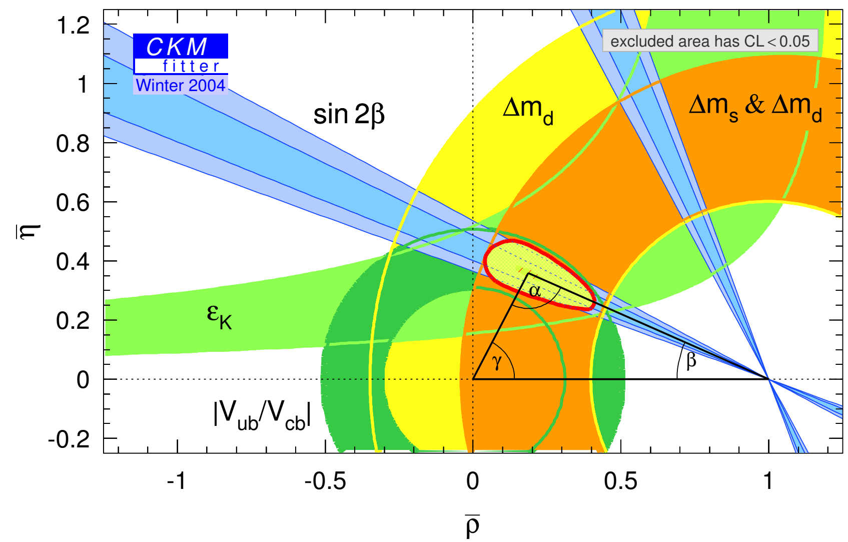
$$\Delta M_{B_q} = M_q^H - M_q^L \qquad q = d, s$$

- Semileptonic B decays

$$\Gamma[B \to X_u\, l\, \nu_l] \qquad\qquad \Gamma[B \to X_c\, l\, \nu_l]$$

Unitarity triangle fit in the Standard Model

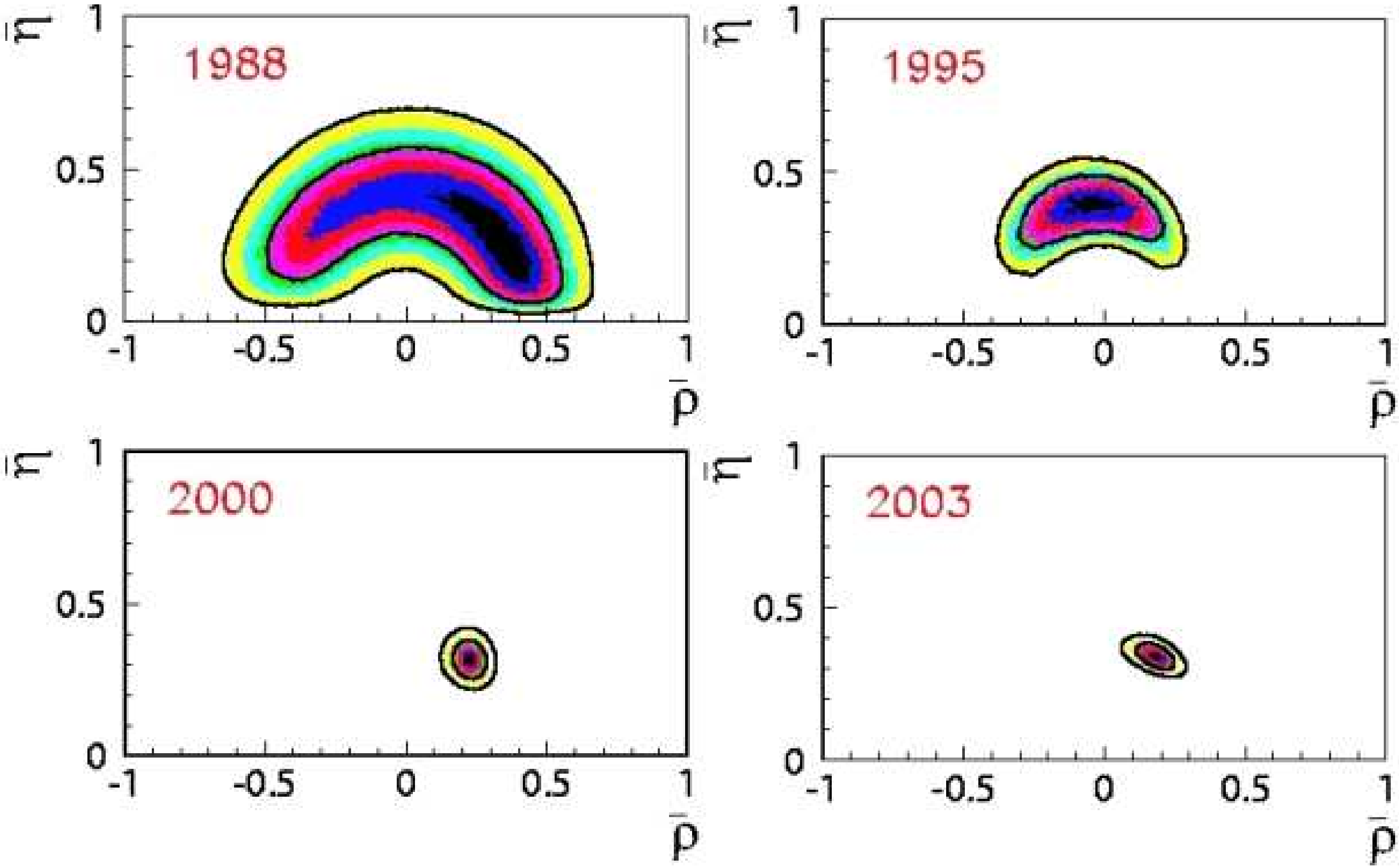




	$\lvert\epsilon_{\rm K}\rvert$	ΔM_{B_s}	$\dfrac{\Delta M_{B_s}}{\Delta M_{B_d}}$	$B \to \begin{pmatrix}\pi \\ \rho\end{pmatrix} l\nu$	$B \to \begin{pmatrix}D \\ D^*\end{pmatrix} l\nu$
CKM	$\text{Im}[V_{td}]$	$\lvert V_{ts}\rvert^2$	$\lvert V_{ts}\rvert^2/\lvert V_{td}\rvert^2$	$\lvert V_{ub}\rvert^2$	$\lvert V_{cb}\rvert^2$
Matrix Elements	$\hat{B}_{\rm K}$	$f^2_{B_s}\hat{B}_{B_s}$	$\dfrac{f^2_{B_s}\hat{B}_{B_s}}{f^2_{B_d}\hat{B}_{B_d}}$	$\lvert\langle {}^{\pi}_{\rho}\lvert J^{ub}_L\rvert B\rangle\rvert^2$	$\lvert\langle {}^{D}_{D^*}\lvert J^{cb}_L\rvert B\rangle\rvert^2$

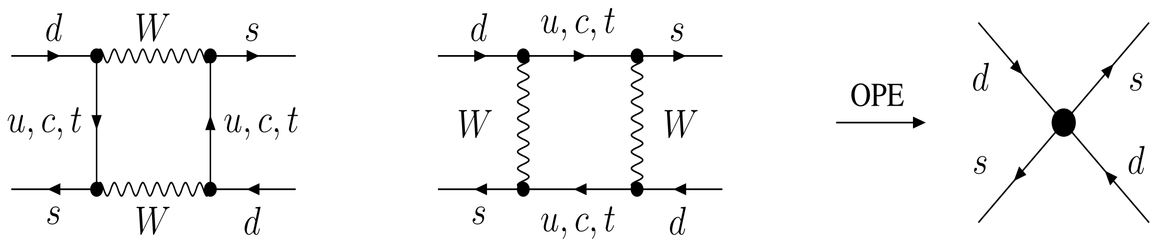
An impressive improvement thanks also to LQCD

M. Bona et al. [UTfit] 04



... but quenching systematics still not under control

Why we need LQCD ? The K^0-$\bar{K}^0$ mixing case



$$\varepsilon_K \simeq \frac{1}{\sqrt{2}}\, e^{i\frac{\pi}{4}}\, \frac{\mathrm{Im} M_{12}}{\Delta M_K} \qquad\qquad 2\, m_K M_{12}^* = \langle \bar{K}^0 | H_{\rm eff}^{\Delta \rm S=2} | K^0 \rangle$$

- In the Standard Model ($\lambda_i = V_{is}^* V_{id}$)

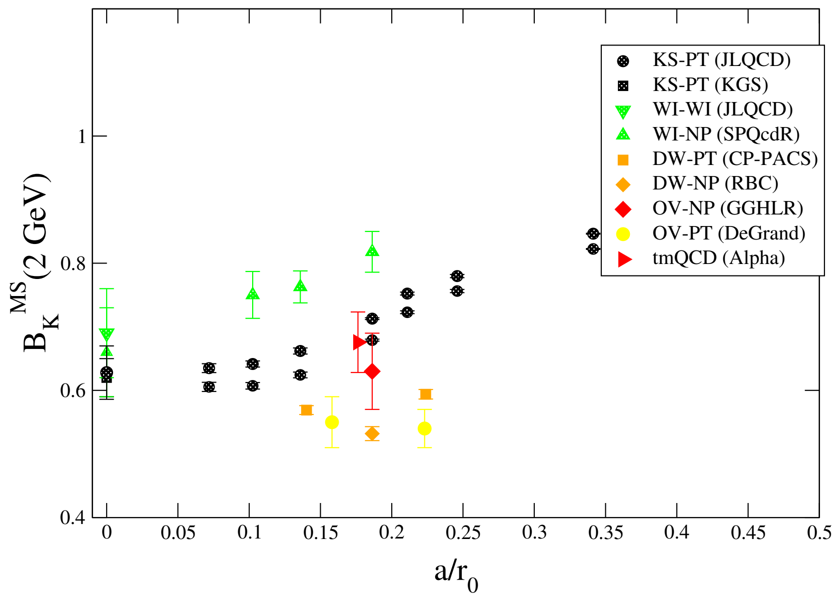
$$H_{\rm eff}^{\Delta \rm S=2} = \frac{G_F^2 M_W^2}{4\pi^2}\left[\lambda_c^2 \eta_1 S_0^c + \lambda_t^2 \eta_2 S_0^t + 2\lambda_c \lambda_t \eta_3 S_0^{ct}\right] \widehat{\mathcal{O}}^{\Delta S=2}$$

- Notice: $\mathrm{Im}[\lambda_t^2] \propto (A\lambda^2)^4 \lambda^2 \bar{\eta}(1-\bar{\rho})$

- The long-distance non-perturbative QCD effects are parameterized as

$$\langle \bar{K}^0 | \hat{\mathcal{O}}^{\Delta S=2} | K^0 \rangle = \hat{Z} \langle \bar{K}^0 | (\bar{s}\gamma_\mu P_- d)(\bar{s}\gamma_\mu P_- d) | K^0 \rangle = \tfrac{4}{3} F_K^2 m_K^2 \hat{B}_K$$

B_K from quenched QCD



- From JLQCD (S. Aoki et al. 98)

$$B_K^{\overline{\rm MS}}(2\text{GeV}) = 0.63 \pm 0.04$$
$$\hat{B}_K = 0.86 \pm 0.06$$

- Systematic uncertainties:

  - Statistical errors ✓
  - Finite volume effects ✓
  - Continuum limit ✓
  - Renormalization
  - Degenerate quarks ($m_s = m_d$) ?
  - Quenched Approximation ?

- (Full) QCD simulations required at this stage

Error milestones for B_K

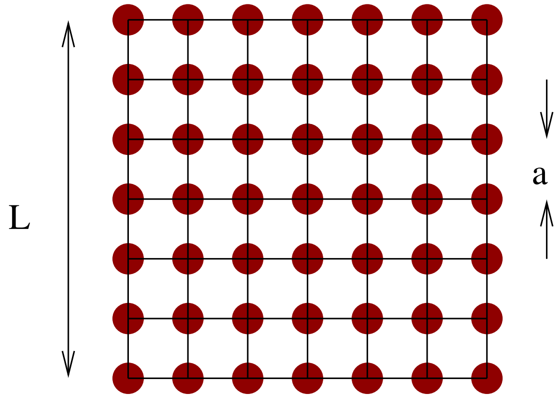
- Total non-B_K error in ε_K is 9.5%, mainly from 2.2% error in $A\lambda^2 = |V_{cb}|$

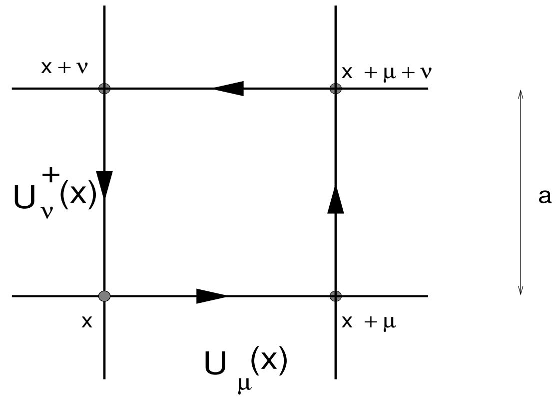
- Lattice $\hat{B}_K$ value used in CKM fits [CKM CERN Workshop 02]

$$\hat{B}_K = 0.86 \ \pm\ 0.06\ \text{[stat\&rin.]}\ \pm 0.14\ \text{[quench\&Chiral]} \qquad (18\%\ \text{error})$$

- Error milestones for lattice calculations of $\hat{B}_K$

  1. 10%: match the error from other sources
  2. 5%: $\sim$ half that of other sources





- The Wilson action for the $SU(3)$ Yang–Mills theory is

$$
\begin{aligned}
S_{\rm YM} &= \frac{6}{g^2} \sum_{x,\mu<\nu} \left\{ 1 - \frac{1}{6} \mathrm{Tr} \left[U_{\mu\nu}(x) + U^\dagger_{\mu\nu}(x) \right] \right\} \\
U_{\mu\nu}(x) &= U_\mu(x) U_\nu(x+\mu) U^\dagger_\mu(x+\nu) U^\dagger_\nu(x)
\end{aligned}
$$

- For small gauge fields (perturbation theory) $U_\mu(x) \simeq 1 - aA_\mu(x) + \ldots$
- Correlation functions computed non-perturbatively via Monte Carlo techniques

$$
\langle O_1(x) O_2(0) \rangle = \int \mathcal{D}U \, e^{-S_{\rm YM}(U)} O_1(U;x) O_2(U;0)
$$

Fermions on the lattice

- We know how to discretize fermions preserving the relevant symmetries

  1. Gauge invariance
  2. Flavor symmetry
  3. Chiral symmetry (recent! Kaplan 92, Neuberger 97, Hasenfratz 98, Lüscher 98 ...)

- Ginsparg–Wilson fermions numerically more expensive (typically 10-20 times): chiral symmetry to be used only when needed !

- Faster simulations if we renounce to some global symmetry: (Wilson, Staggered, tmQCD fermions), symmetry recovered for $a \to 0$

Extraction of matrix elements: the case of B_K

- Typically correlation functions of local operators

$$\langle J_L O^{\Delta \mathrm{S}=2} J_L \rangle = \int \mathcal{D}U e^{-S_{\mathrm{G}}} \, [\mathrm{DetD}]^{\mathrm{N_f}} \, [J_L O^{\Delta \mathrm{S}=2} J_L]_{\mathrm{contracted}}$$

  where $J_L(x) = \bar{d}_{\mathrm{L}}(x)\gamma_\mu s_{\mathrm{L}}(x)$.

- If we define

$$C_{JOJ}(t_x, t_y) = \sum_{\vec{x},\vec{y}} \langle J_L(x) O^{\Delta \mathrm{S}=2}(0) J_L(y) \rangle$$

  then for $t_x \to \infty$ and $t_y \to -\infty$

$$\frac{C_{JOJ}(t_x, t_y)}{C_{JJ}(t_x) C_{JJ}(t_y)} \propto B_K$$

- Euclidean correlation functions of bare operators at finite volume and finite cut-off computed non-perturbatively with Monte Carlo integration techniques

First-principle results from lattice simulations

- First-principle results when all systematic uncertainties quantified

- Main sources of errors:

  1. Statistical errors
  2. Finite volume
  3. Continuum limit: $a \to 0$, ($a^{-1} \simeq 2 - 6$ GeV, $a\Lambda_{QCD}$, am_q)
  4. Chiral extrapolation: $m \to m_u, m_d$

- On the lattice they can be estimated and (eventually) removed without extra free parameters or dynamical assumptions (QFT,V, Alg., CPU)

- The Witten–Veneziano formula is

$$\frac{F_\pi^2 m_{\eta'}^2}{2N_f}\Big|^{m=0}_{\frac{N_f}{N_c}=0} = \chi^{\rm YM}$$

where

$$\chi^{\rm YM} = \int d^4x \, \langle Q(x)Q(0)\rangle^{\rm YM}$$

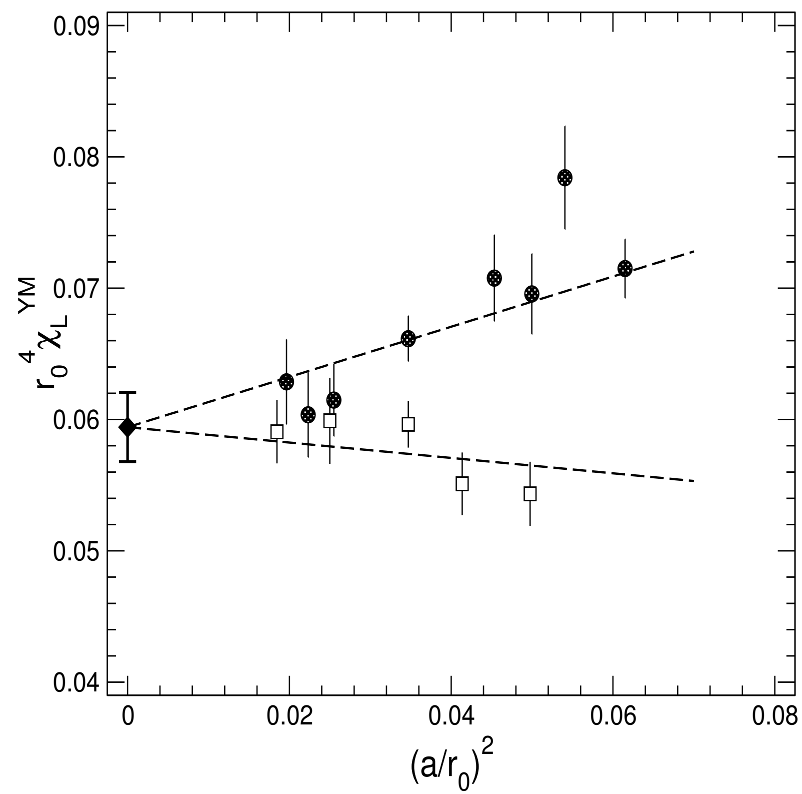
- By setting the scale $F_K = 113(1)$ MeV

$$\boxed{\chi^{\rm YM} = (191 \pm 5 \ {\rm MeV})^4}$$

to be compared with

$$\frac{F_\pi^2}{2N_f}(M_\eta^2 + M_{\eta'}^2 - 2M_K^2) \underset{\rm exp}{\approx} (180 \ {\rm MeV})^4$$

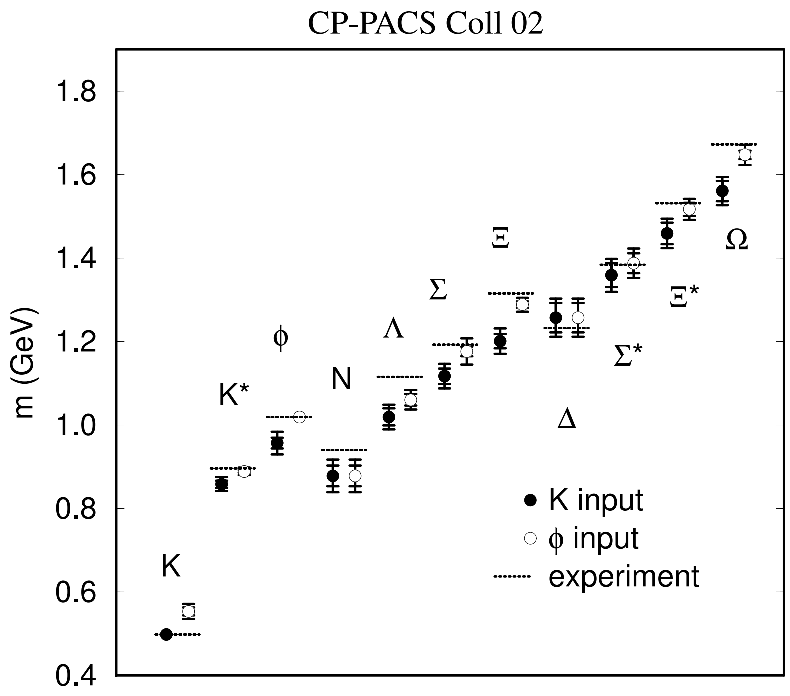
- In QCD the bulk of $m_{\eta'}$ is due to the quantum anomaly as conjectured by WV



[Del Debbio, L. G., Pica 04]

- Fermion determinant replaced by its average value

$$\langle O \rangle = \int \mathcal{D}U e^{-S_{\rm G}} \, [{\rm Det}\not{\rm D}]^{\rm N_f} \; O$$



- Quenched light hadron spectrum: $\sim 10\%$ discrepancy with experiment

- For some quantities quenching is the only systematics not quantified with confidence

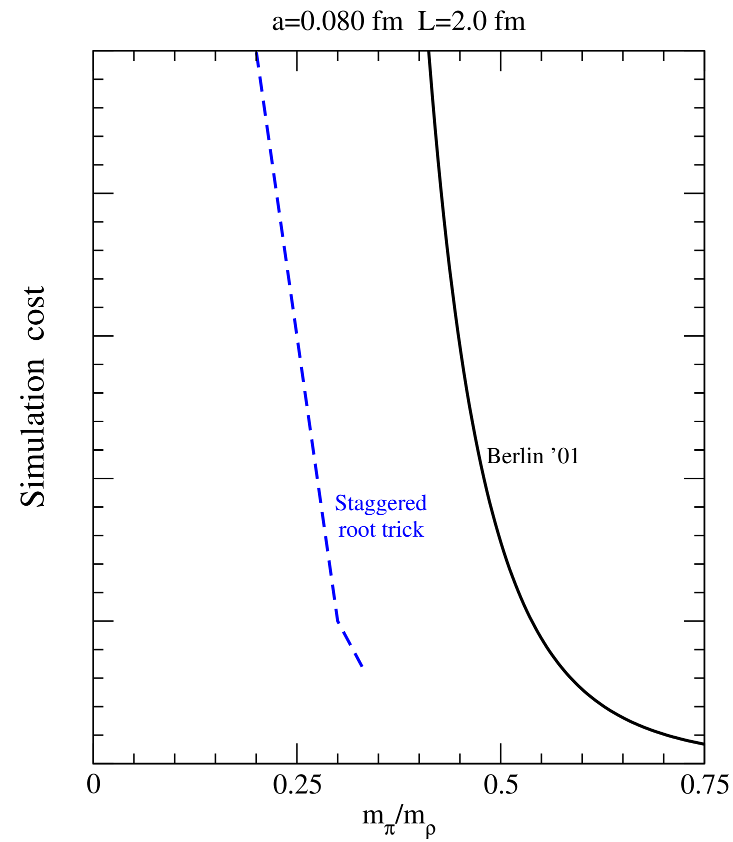
- For Wilson-type fermions [A. Ukawa Lattice 2001 - Berlin]

$$\mathrm{C_{ost}} \propto \mathrm{N_{conf}}\ m_q^{-3}\ L^5\ a^{-8}$$

- With a $\mathcal{O}(10)$ Tflops machine (example)

$$L = 2\,\mathrm{fm} \quad \frac{m_\pi}{m_\rho} = 0.55 - 0.7 \quad a^{-1} = 2.0 - 3.0\ \mathrm{GeV}$$

- With $O(1)$ Tflop machines some points feasible

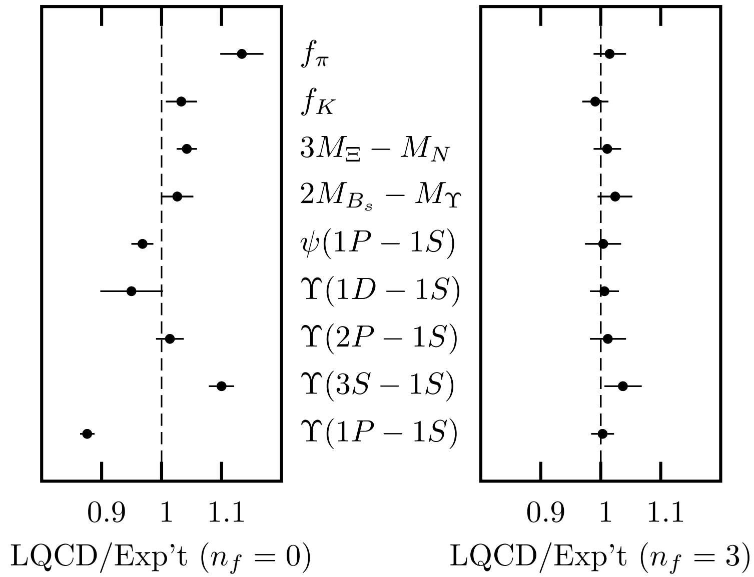


Improved staggered with the "root" trick

- Impressive effort: 2+1 flavor simulations with improved staggered fermions
- Detailed study of chiral extrapolation
- The formulation requires four deg. flavors (*tastes*)
- Dynamical simulations with the "root" trick

$$\det D = (\det D_{\text{stagg}})^{1/4}$$

Fermilab, HPQCD, MILC, UKQCD Coll. 04



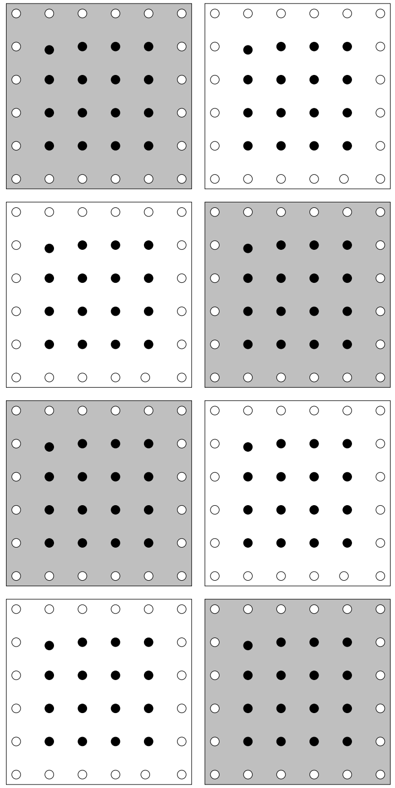
- No local action known with this determinant:

  $\Longrightarrow$ no first-principle computation

  $\Longrightarrow$ unitarity violations

  $\Longrightarrow$ unknown systematic errors

Schwarz-preconditioned Hybrid Monte Carlo (SAP) Lüscher 03-04



- Decomposition of the lattice into blocks with Dirichlet b.c. with $q \geq \pi/L > 1$ GeV

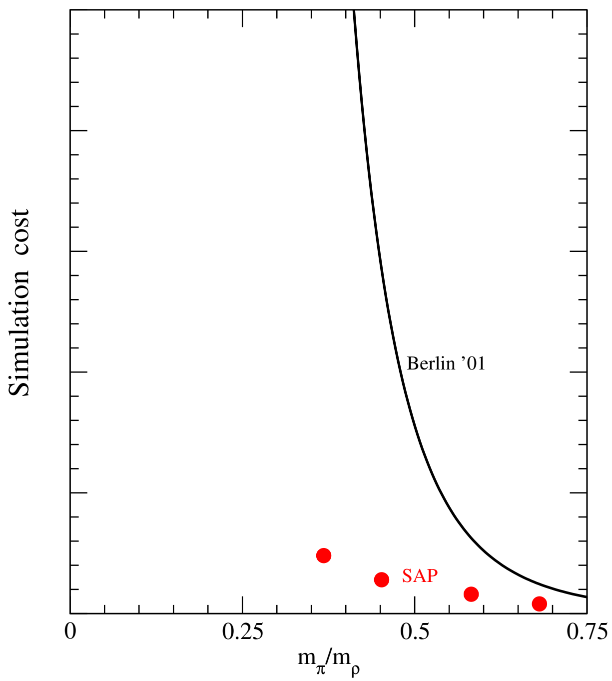
- Asymptotic freedom: quarks are weakly interacting in the blocks $\Longrightarrow$ QCD easy (*cheaper*) to simulate

- Block interactions are weak and are taken into account exactly

- Do not give up first-principles: teach Physics to exact algorithms for being smarter (*faster*)!

$$\mathrm{C_{ost}} \propto \mathrm{N_{conf}}\ m_q^{-1}\ L^5\ a^{-6}$$

First simulations with SAP Lüscher 04; Del Debbio, L.G., Lüscher, Petronzio, Tantalo 05



PC cluster with 80 Nodes (160 Xeon procs)

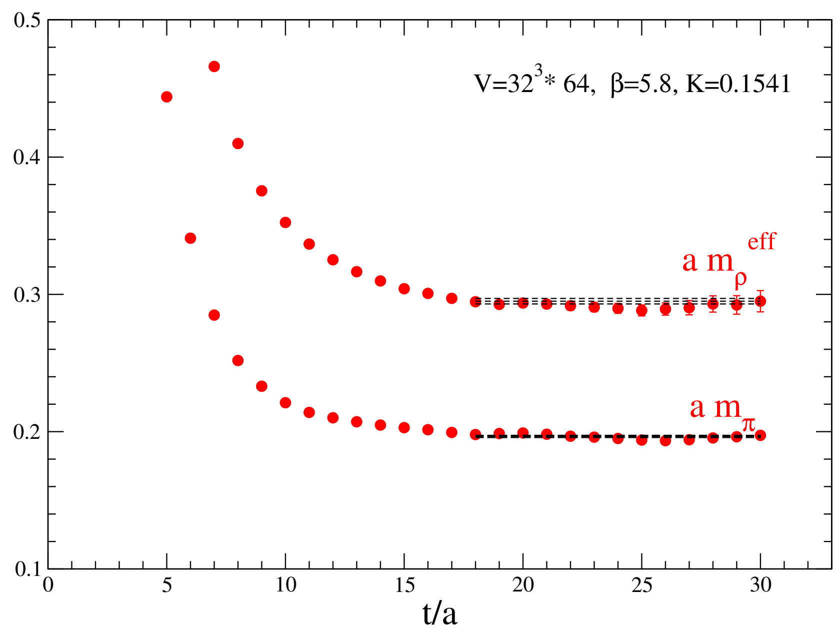
64 used for this project (∼200 Gflops sustained)

Volume	a[fm]	$\sim m/m_s$	$N_{\rm conf}$
$24^3 \times 32$	0.080	0.94	41 (100)
		0.47	40 (100)
		0.29	62 (100)
		0.15	34 (100)
$32^3 \times 64$	0.065	0.72	100 (100)
		0.50	75 (100)
		0.27	75 (100)
		TBD	

- Full statistics for small lattice:
  ∼45 days @ 64 nodes
- All confs archived @ CERN
- First goal: making contact w. ChPT

Correlation functions on the finer lattice

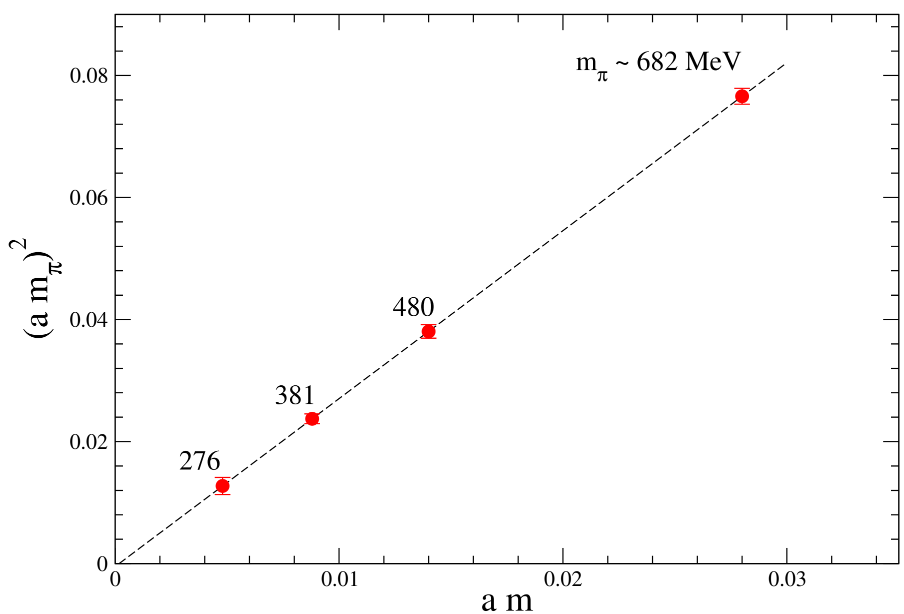
$$\sum_{\vec{x}} \langle O(x,t) O(0,0) \rangle \propto e^{-m_O(t)t}$$

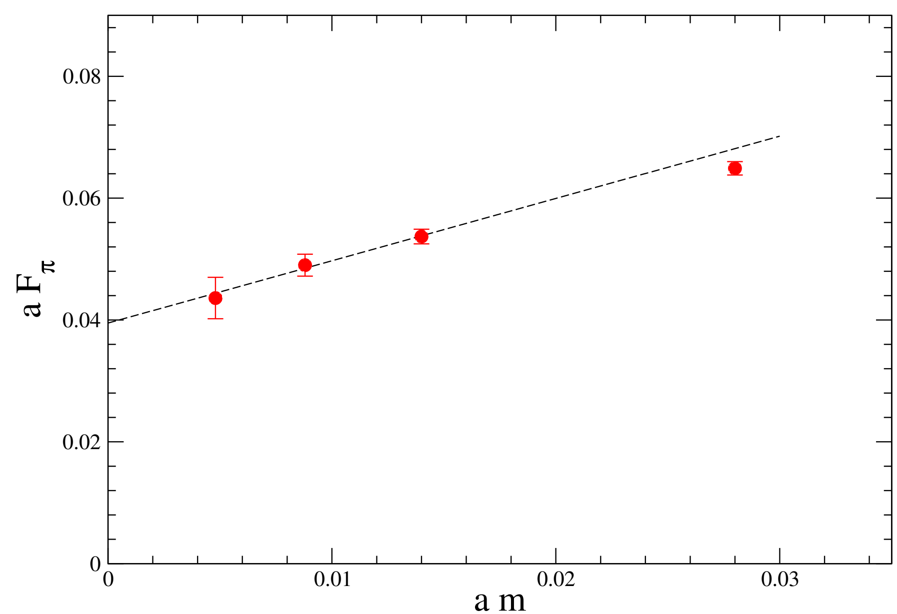


- Algorithm stable over the relevant parameter ranges:
  1. Quark mass: $m_s/6$ ✓
  2. Lattice spacing: $a^{-1} = 0.065$ fm ✓
  3. Volume: $L \sim 2$ fm ✓

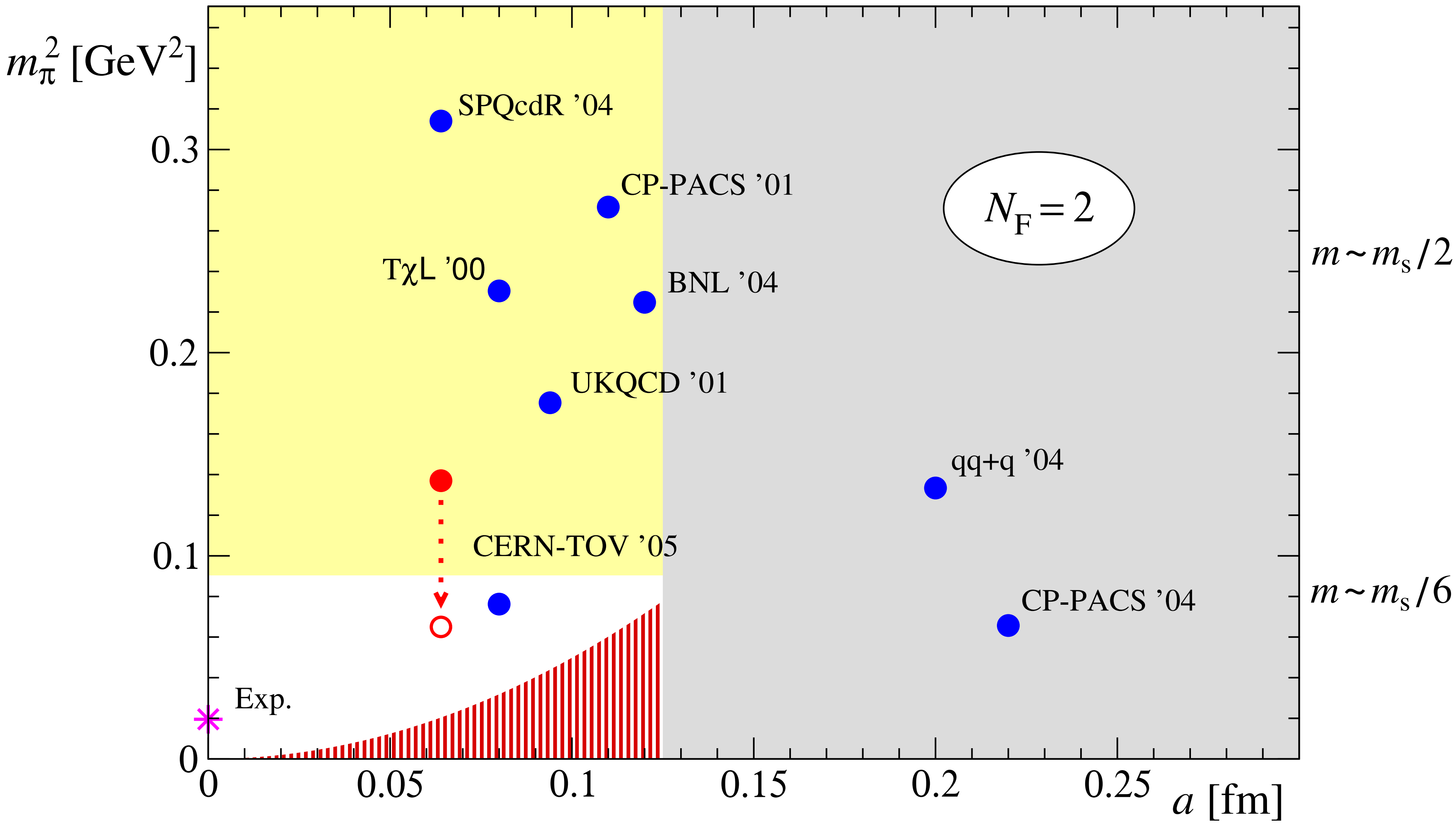
Some preliminary results

Volume	a[fm]	am	am_π	aF_π	$m_\pi/m_\rho^{\text{eff}}$
		0.0280(3)	0.277(2)	0.0649(11)	0.681(5)
$24^3 \times 32$	0.080	0.0140(2)	0.195(3)	0.0537(12)	0.582(13)
		0.0088(2)	0.155(3)	0.0490(18)	0.452(12)
		0.0048(3)	0.112(6)	0.0436(34)	0.368(27)





Where we are... Lüscher 04; Del Debbio, L.G., Lüscher, Petronzio, Tantalo 05



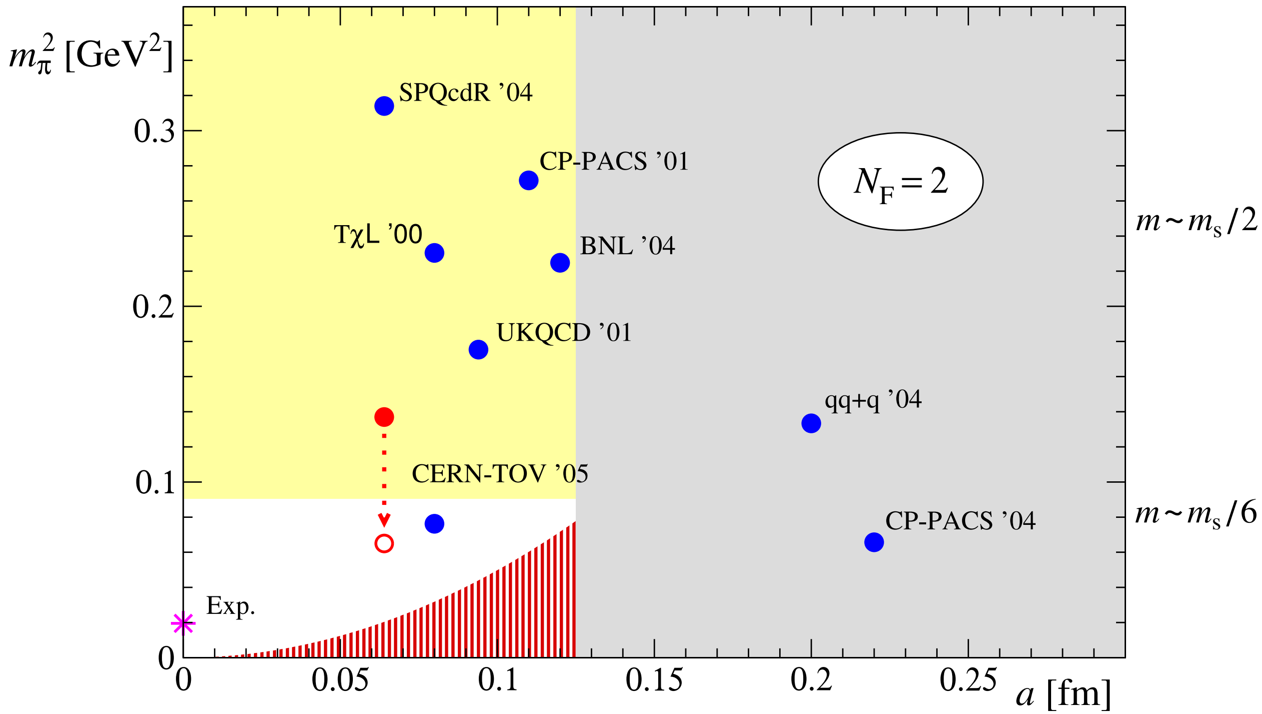
- If we are able to run full QCD simulations with machines $\mathcal{O}(1-10)$ Tflops

$$L = 2.0 - 2.5\,\text{fm} \qquad \frac{m_\pi}{m_\rho} = 0.25 - 0.5 \qquad a = 0.05 - 0.10\,\text{fm}$$

Observable	$\lvert\varepsilon\rvert$	ΔM_{B_s}	$\frac{\Delta M_{B_s}}{\Delta M_{B_d}}$	$B \to \binom{\pi}{\rho} l\nu$	$B \to \binom{D}{D^*} l\nu$
CKM	Im$[V_{td}]$	$\lvert V_{ts}\rvert^2$	$\lvert V_{ts}\rvert^2/\lvert V_{td}\rvert^2$	$\lvert V_{ub}\rvert^2$	$\lvert V_{cb}\rvert^2$
Matr. Elem.	$\hat{B}_K$	$f^2_{B_s}\hat{B}_{B_s}$	$\frac{f^2_{B_s}\hat{B}_{B_s}}{f^2_{B_d}\hat{B}_{B_d}}$	$\lvert\langle \binom{\pi}{\rho} \lvert J_L^{ub}\rvert B\rangle\rvert^2$	$\lvert\langle \binom{D}{D^*} \lvert J_L^{cb}\rvert B\rangle\rvert^2$
Err. in Quen.	7%	10%	6%	30%	8%
Quen+χ Err.	15%	20%	10%	-	3%
Proj. error	5%	10%	5%	20%	6%

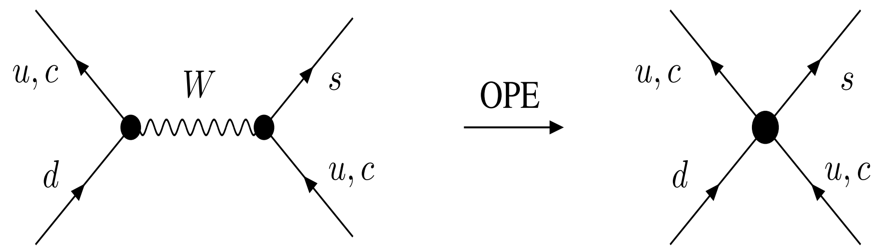
...it is timely to attack these computations in full QCD

Conclusions and Outlook



- First results with SAP: a breakthrough in full QCD simulations
- First goal: establish contact with ChPT
- If successful, it will be worth to attack computations of weak MEs and form factors in full QCD with $O(1-10)$ Tflops computer (but do not expect results by tomorrow !)
- It is getting interesting for flavor physics, stay tuned !

The $H_{\rm eff}^{\Delta S=1}$ with an active charm



$$iA_{\rm I}e^{i\delta_{\rm I}} = \langle (\pi\pi)_{\rm I} \mid H_{\rm eff}^{\Delta S=1} \mid K^0\rangle$$

- The CP-conserving $\Delta S = 1$ effective Hamiltonian is [Gaillard, Lee 74; Altarelli, Maiani 74]

$$H_{\rm eff}^{\Delta S=1} = \sqrt{2} G_F V_{ud} V_{us}^* \sum_{\sigma=\pm} \left\{ k_1^\sigma \mathcal{Q}_1^\sigma + k_2^\sigma \mathcal{Q}_2^\sigma \right\}$$

where

$$\mathcal{Q}_1^\pm = \Big[(\bar{s}\gamma_\mu P_- u)(\bar{u}\gamma_\mu P_- d) \pm (\bar{s}\gamma_\mu P_- d)(\bar{u}\gamma_\mu P_- u)\Big] - \Big[u \to c\Big]$$

$$\mathcal{Q}_2^\pm = (m_u^2 - m_c^2)\Big[m_d(\bar{s}P_+ d) + m_s(\bar{s}P_- d)\Big]$$

- For $m_s \pm m_d \neq 0$

$$\bar{s}P_{\pm}d = \partial_\mu \Big[\frac{1}{m_s - m_d}\bar{s}\gamma_\mu d \pm \frac{1}{m_s + m_d}\bar{s}\gamma_\mu\gamma_5 d\Big]$$

and it does not contribute in MEs which preserve four-momentum

- In physical matrix elements

$$H_{\rm eff}^{\Delta S=1} = \sqrt{2} G_F V_{ud} V_{us}^* \sum_{\sigma=\pm} k_1^\sigma \mathcal{Q}_1^\sigma$$

- The Wilson coefficients are known at NLO in α_s [A.J. Buras et al. 92; M. Ciuchini et al. 94]

- A non-perturbative determination of the matrix elements $\langle(\pi\pi)_{\rm I}|\widehat{\mathcal{Q}}_1^{\pm}|K^0\rangle$ of the properly renormalized operators is needed

Renormalization pattern for $\mathcal{Q}_1^\pm$

- To select operators with $d \leq 6$:
  - Flavour symmetry
  - P, C symmetries
  - Chiral symmetry

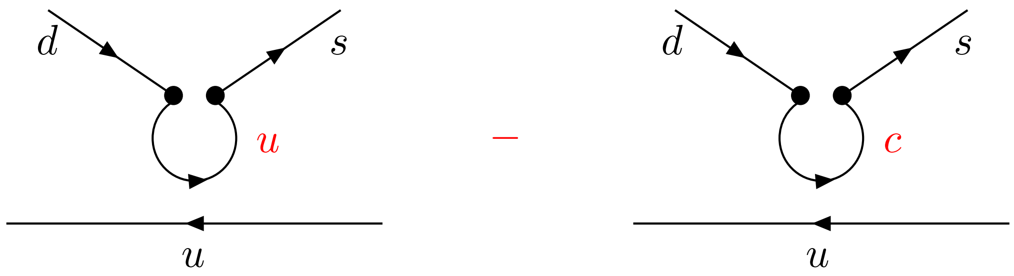
- At a non-zero physical distance (on-shell) one operator is left

$$\mathcal{Q}_2^\pm = (m_u^2 - m_c^2)\Big[m_d(\bar{s}P_+\tilde{d}) + m_s(\bar{s}P_-\tilde{d})\Big]$$

- No power divergent subtractions are needed with GW fermions [S. Capitani, L. G. 00]

$$\widehat{\mathcal{Q}}_1^\pm = Z_1^\pm\Big\{\mathcal{Q}_1^\pm + z^\pm \mathcal{Q}_2^\pm\Big\}$$

- Note the quadratic GIM mechanism



- For parity conserving sector, flavour and CPS symmetries [Maiani et al. 87; Dawson et al.97]

$$
\begin{aligned}
[\widehat{\mathcal{Q}}_1^{\pm}]^{\mathrm{PC}} &= \mathcal{Z}_1^{\pm}[\widetilde{\mathcal{Q}}_1^{\pm}]^{\mathrm{PC}} \\
[\widetilde{\mathcal{Q}}_1^{\pm}]^{\mathrm{PC}} &= [\mathcal{Q}_1^{\pm}]^{\mathrm{PC}} + \sum_j b_j^{\pm}\mathcal{O}_j^{\pm} + z_\tau^{\pm}\mathcal{Q}_\tau + \frac{z_s^{\pm}}{a^2}\mathcal{Q}_s
\end{aligned}
$$

where

$$
\begin{aligned}
\mathcal{Q}_\tau &= (m_u - m_c)\bar{s}\sigma_{\mu\nu}F_{\mu\nu}d \\
\mathcal{Q}_s &= (m_u - m_c)\bar{s}d
\end{aligned}
$$

and $\mathcal{O}_j^{\pm}$ are 4-fermion operators with wrong chirality

The $H_{\rm eff}^{\Delta S=1}$ with charm integrated out

- The effective Hamiltonian reads

$$H_{\rm eff}^{\Delta S=1} = \sqrt{2} G_F V_{ud} V_{us}^* \sum_{i=1}^{10} h^i \widehat{\mathcal{Q}}^i$$

where a basis for QCD-penguin operators is

$$\mathcal{Q}^{3,5} = (\bar{s}\gamma_\mu P_- \tilde{d}) \sum_q (\bar{q}\gamma_\mu P_\mp \tilde{q}) \qquad \mathcal{Q}^{4,6} = (\bar{s}^\alpha \gamma_\mu P_- \tilde{d}^\beta) \sum_q (\bar{q}^\beta \gamma_\mu P_\mp \tilde{q}^\alpha)$$

- At a non-zero physical distance two more operators can mix

$$\mathcal{Q}_\sigma = m_d(\bar{s} F_{\mu\nu}\sigma_{\mu\nu} P_+ \tilde{d}) + m_s(\bar{s} F_{\mu\nu}\sigma_{\mu\nu} P_- \tilde{d}) \qquad \mathcal{Q}_m = m_d(\bar{s} P_+ \tilde{d}) + m_s(\bar{s} P_- \tilde{d})$$

- Power-divergences even with chiral symmetry

$$\widehat{\mathcal{Q}}^i = Z^{ij}\left[\mathcal{Q}^j + z_\sigma^j \mathcal{Q}_\sigma + \frac{z_m^j}{a^2}\mathcal{Q}_m\right]$$

K$\rightarrow \pi\pi$ at LO in ChPT

- At leading order in ChPT

$$\left|\frac{A_0}{A_2}\right| = \frac{1}{2\sqrt{2}}\left\{1 + 3\frac{g_1^-}{g_1^+}\right\}$$

and if compared with experimental results $g_1^- / g_1^+ \approx 20.5$

- At this order the low energy constants can be extracted from

$$\langle\pi^+|k_1^\pm \widehat{\mathcal{Q}}_1^\pm|K^+\rangle = \frac{F^2 M^2}{2} g_1^\pm$$

where $M^2 = 2\, m\, \Sigma / F^2$

- The complications of the direct computation of K$\rightarrow \pi\pi$ amplitudes in finite volume can thus be avoided at this order [Bernard et al. 85]

K$\rightarrow$ $\pi\pi$ from finite-volume correlators Lellouch, Lüscher 00

- Finite volume correlators ($t_1 \ll 0, t_2 \gg 0$)

$$\langle O_n(t_2) H_{\rm eff}(0) O_K(t_1)\rangle \rightarrow$$

$$\sum_l \langle 0|O_n|l\rangle\langle l|H_{\rm eff}|K^0\rangle\langle K^0|O_{K^0}|0\rangle\, {\rm e}^{(-W_l t_2 + m_K t_1)}$$

dominated by the exponential of two pions at rest ($l = 0$)

- MEs for higher l obtained by extracting the proper exponential

- If L tuned so that $W_l = m_K$ ($L \sim 5$ fm), physical amplitude obtained by matching first order weak contributions on both sides of the eq.

$$|A|^2 = \frac{8\pi m_K^3}{k^2}\left[\frac{\partial\phi}{\partial k} + \frac{\partial\delta}{\partial k}\right] |\langle l|H_{\rm eff}|K^0\rangle|^2$$

Status and perspective for $f_{B_d}\sqrt{\hat{B}_{B_d}}$ and $f_{B_s}\sqrt{\hat{B}_{B_s}}$

- ΔM_{B_s} not measured yet! Probably soon at Tevatron

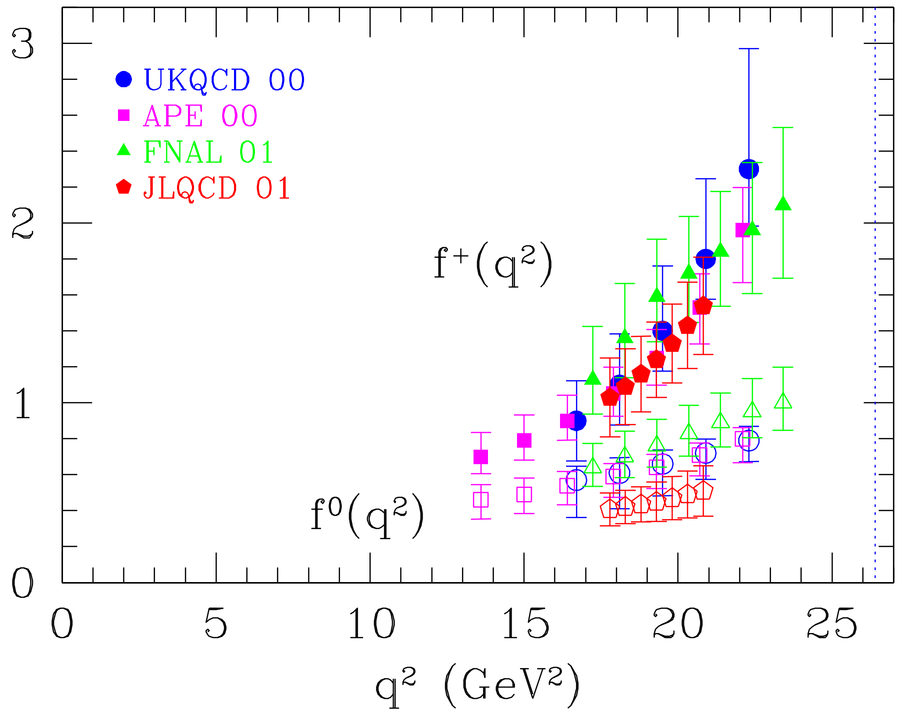
- Lattice values used in CKM fits [CKM CERN Workshop 02]

$$f_{B_s}\sqrt{\hat{B}_{B_s}} = 276 \pm 38 \text{ [stat + syst]} \qquad (14\% \text{ error})$$

$$\xi = \frac{f_{B_s}\sqrt{\hat{B}_{B_s}}}{f_{B_d}\sqrt{\hat{B}_{B_d}}} = 1.24 \pm 0.04 \text{ [stat]} \pm 0.06 \text{ [syst\&Chiral]} \qquad (6\% \text{ error})$$

- Error milestones for lattice calculations:
  1. 5% for $f_{B_s}\sqrt{\hat{B}_{B_s}}$
  2. 2.5% for ξ

$B \to \pi l \nu_l$ from quenched QCD

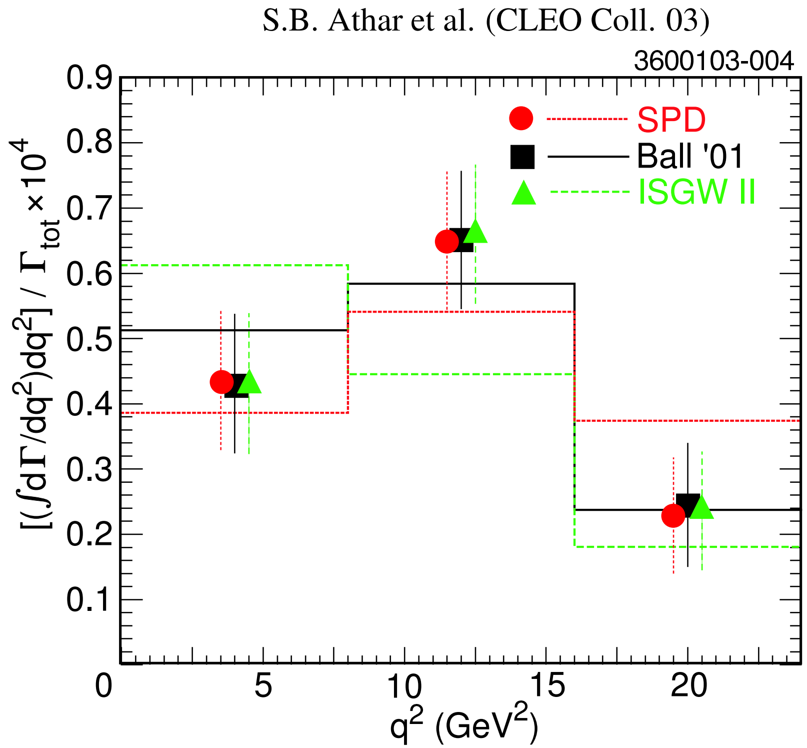


$$\langle \pi | \bar{u} \gamma_\mu b | \bar{B} \rangle = f_+(q^2)(p_B + p_\pi - \frac{m_B^2 - m_\pi^2}{q^2} q_\mu) + f_0(q^2) \frac{m_B^2 - m_\pi^2}{q^2} q_\mu$$

- Systematic uncertainties:
  - Statistical errors ✓
  - Finite volume effects ✓
  - Continuum limit
  - Renormalization ✓
  - Quenched Approximation ?

- Full QCD simulations required
- q^2 can be reduced by imposing θ-boundary conditions [de Devitis et al. 04]
- $\sim 10\%$ as an error milestone in lattice calculations of these form factors

More information from experiments CLEO, Babar, Belle



- q^2 dependence of the physical rate for $B \to (\pi, \rho) l \nu_l$

- First analyses presented also by Babar and Belle

- Leptonic decays of charged B-mesons

$$\mathcal{B}[B^- \to \tau^- \nu_\tau] = \frac{G_F^2 |V_{ub}|^2}{8\pi} f_B^2 \tau_B\, m_B\, m_\tau^2 \left(1 - \frac{m_\tau^2}{m_B^2}\right)^2$$

- A measurement by the end of the B-factories ?

- Competitive to extract V_{ub} once f_B known at $5 - 10\%$

UT fit with same observables but extr. exp+theo err.

- Conservative! More observables may be relevant for the fit in future