ETMColl.: Discussion on ChPT

Open issues on ChPT fits (left from hep-lat/0701012):
- Lattice Artifacts
- Finite Size Effects
- NNLO
- in particular:
  effects on Chiral fit related to Flavor symm. breaking.

Other issues:
- error analysis
- $a=a(\beta)$
- ...

Finite Size Effects

[β=3.9, μ=0.004]

L	$M_\pi(L)$	$M_\pi(1)$	$M_\pi(2)$	$M_\pi(3)$
24	0.1359(7)	-0.9% 0.1347	0.1353	0.1350
32	-1.6% 0.1337(2)	0.1335	0.1336	0.1335

L	$F_\pi(L)$	$F_\pi(1)$	$F_\pi(2)$	$F_\pi(3)$
24	0.0653(4)	0.0669	0.0664	0.0669
32	0.0662(5)	0.0665	0.0664	0.0665

(1) CDH, expansion parameter for Finite Size effects: 1/F
(2) GL, 1/F
(3) GL, $1/F_0$

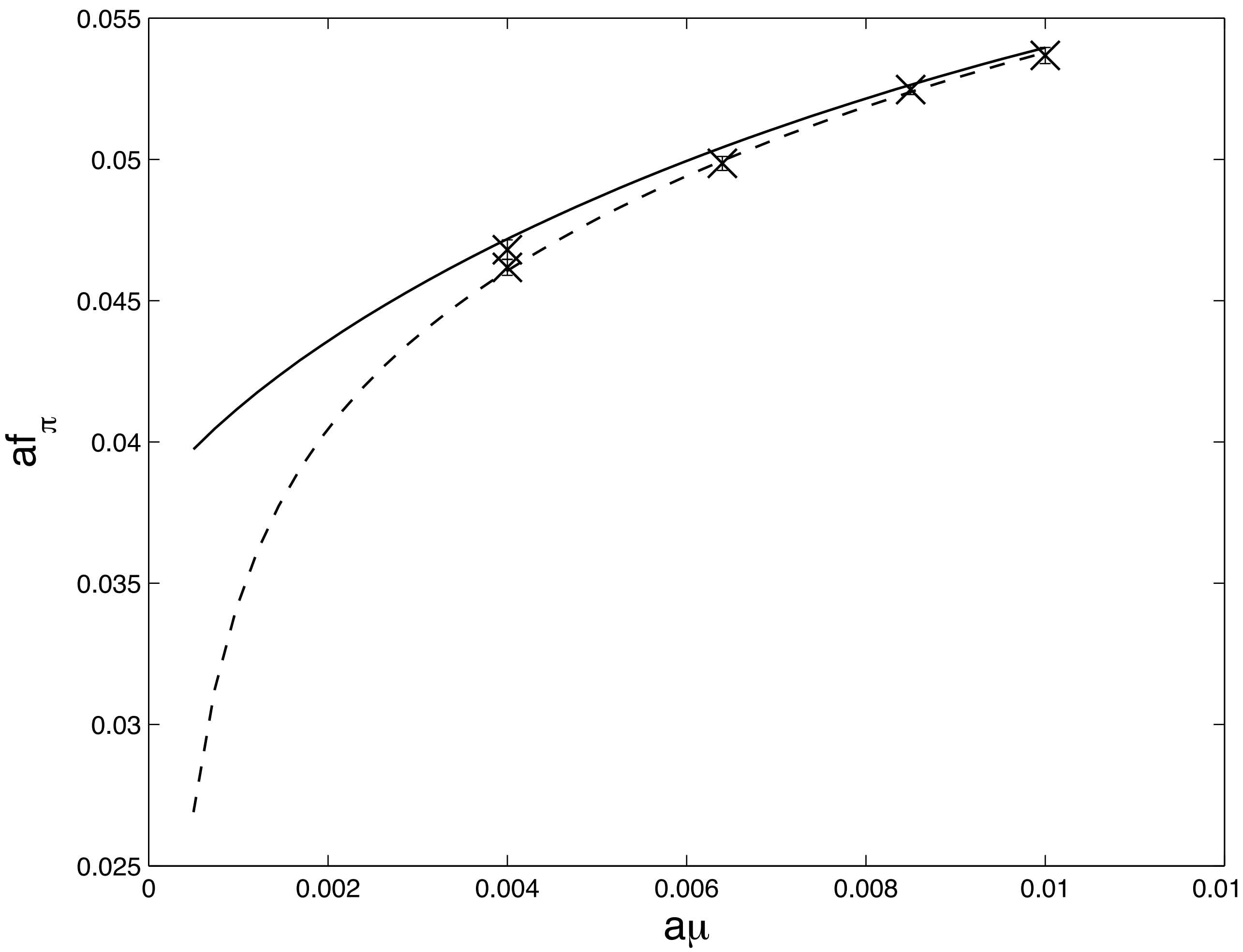
Update of the results

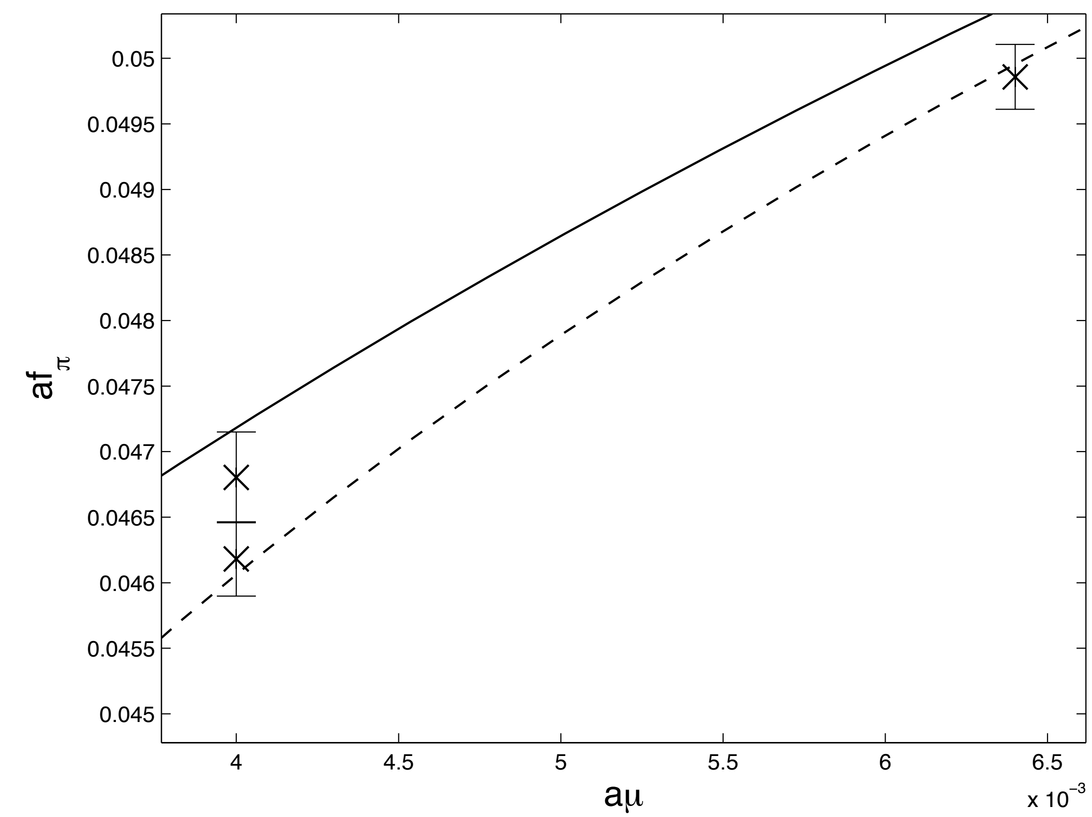
β=3.9 ONLY
old: only L=24
new: include L=32

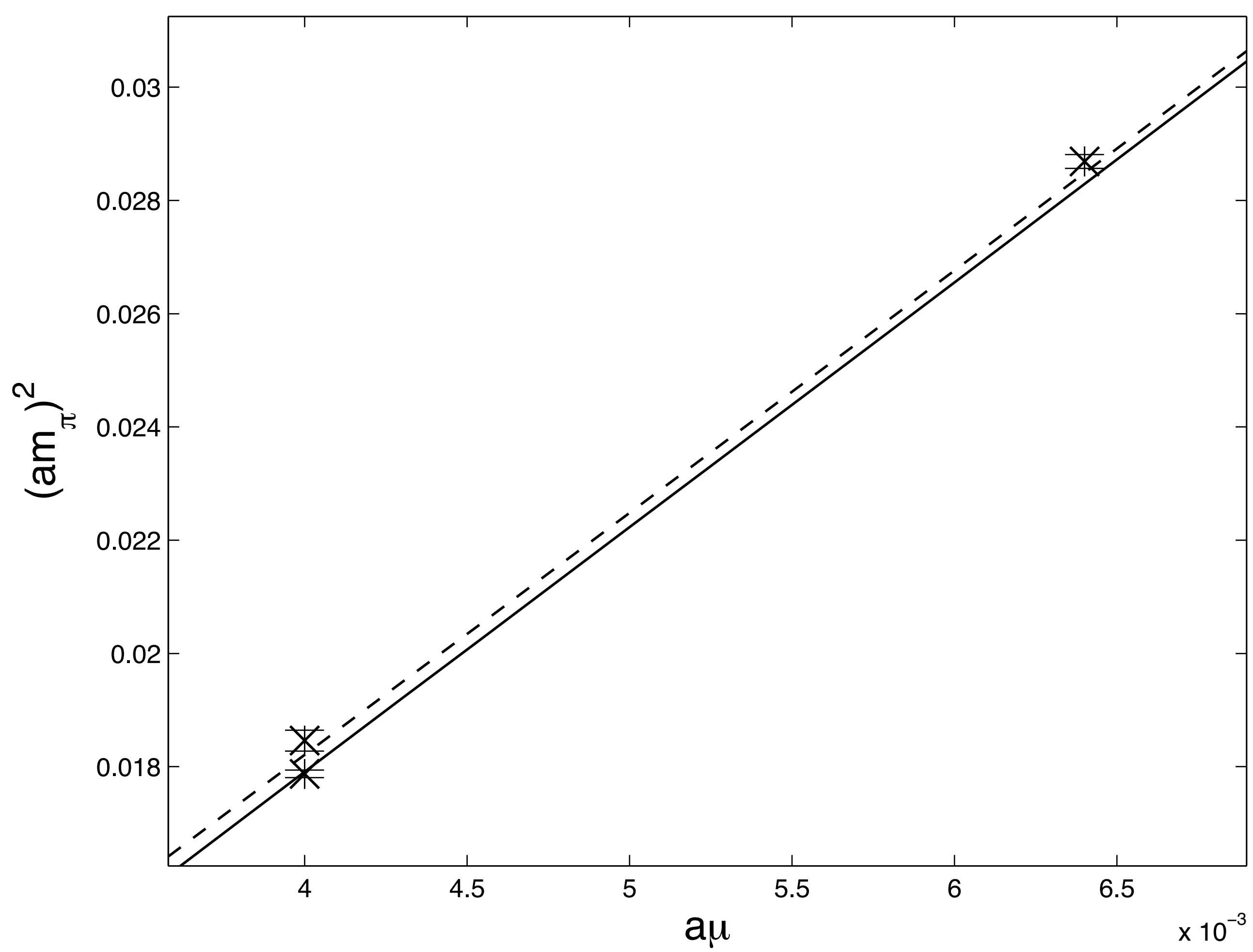
	(3) old	(2) old	(1) old	(3) new	(2) new	(1) new
$2aB_0$	4.99(7)	5.04(7)	4.98(7)	4.84(3)	4.86(3)	4.83(3)
aF_0	0.0534(7)	0.0523(8)	0.0532(8)	0.0535(6)	0.0528(6)	0.0533(6)
$2\log(a\Lambda_3)$	-1.92(12)	-1.90(11)	-1.96(12)	-2.22(8)	-2.23(8)	-2.23(8)
$2\log(a\Lambda_4)$	-1.06(5)	-1.03(5)	-1.05(5)	-1.03(4)	-1.01(4)	-1.03(4)
χ^2/n	0.15	0.14	0.15	1.65	2.05	1.35

Important effect on Λ_3 (and B_0), while Λ_4 and F_0 are stable

The errorbars take into account non-linear implicit fitting procedure but:
-neglet cross correlation of basic parameters (easy to include)
-neglet autocorrelation (more work to adapt the Γ-method).







- X: data
- dashed lines: fit of Finite Volume formulae
- cont. lines: Infinite Volume extrapolation.

Does ChPT have an explanation?

- FSE Leading Order from Gasser Leutwyler   NO

- FSE NLO from Colangelo Dürr Haefli: tryed NO

- ChPT with non degenerate u, d quarks: very different

- compute Matrix element which enter CDH formulae with Wilson ChPT: maybe ?!?

- other reason: T not large enough ?!?

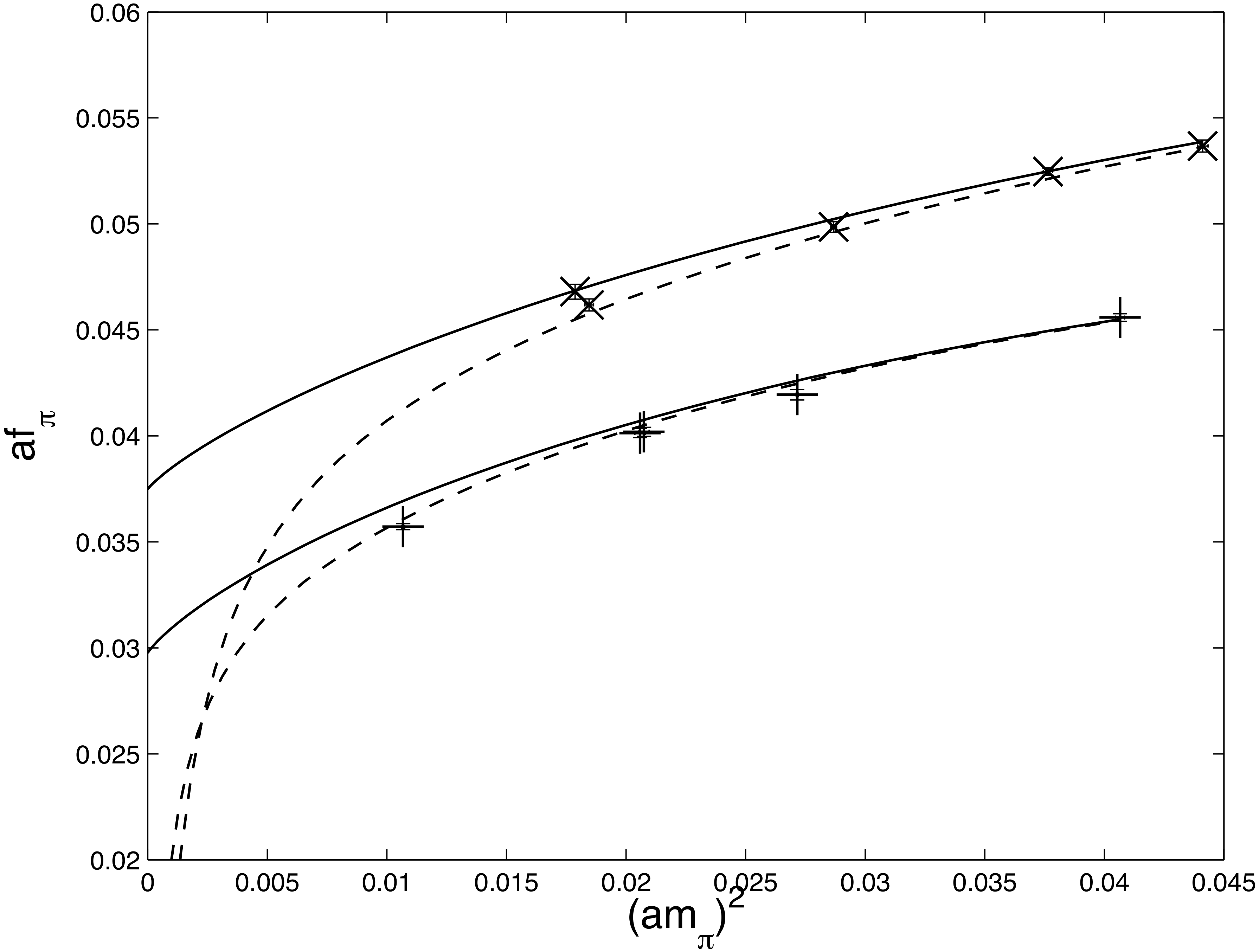
Lattice Artifacts

Plan:

- check the scaling.

- If fails, compelling to check WChPT.

- If the scaling is good, still might be helpful to check lattice artifacts with WChPT.



Scaling seems reasonable,
but only marginally within errorbars.

NNLO

A simple test: (inspired to the substitution $1/F_0$ --- $1/F_\pi$ as expansion parameter)

$$
\begin{aligned}
M_\pi^2 &= 2B_0\mu\left(1 - \frac{x}{2} l_3\right) \\
F_\pi &= F_0(1 + x l_4) \\
x &= \frac{2B_0\mu}{(4\pi F_0)^2} \quad \longrightarrow \quad x' = x(1 \pm 2x l_4) \\
l_{3,4} &= \log(\Lambda_{3,4}^2/(2B_0\mu))
\end{aligned}
$$

	usual x	x'(+)	x'(-)
$2aB_0$	4.99(7)	5.20(8)	No convergence
aF_0	0.0534(7)	0.0516(9)	
$2\log(a\Lambda_3)$	-1.92(12)	-2.19(7)	
$2\log(a\Lambda_4)$	-1.06(5)	-1.76(1)	
χ^2/n	0.15	1.5	

Definition of fixed *lattice spacing* at different masses

- Pion mass splitting is mass independent up to NNLO: $m_{\pi\pm}^2 - m_{\pi 3}^2 = c\, a^2 \sin(\omega)^2$

-This offers a probably impractical but theoretically clear definition of *lattice spacing a*, which is compatible whit ChPT:
If I use such definition of a, I am sure that I will get the continuum limit LEC's from ChPT fits.

- In the physical point all definition of a' are ok, even if: $a' = a(1 + \lambda\, m/\Lambda_{\rm QCD})$
  (even $a=aF_\pi/(92\text{MeV})$)

- However, to compare with ChPT, only those are good such that at least. Otherwise LEC's would be wrong in the continuum limit $a' = a(1 + \lambda\, a\, m)$

- No problems for ratios of quantities which have ChPT predictions (for example: F_π/M_π)
- But it is a problem when fitting for example: aF_π

Is it possible to prove that the usual definition $a=a(\beta)$ has a good relation with the natural one in ChPT ?

- The relation between the two definitions $a=a(\beta)$ and $a=a(r_0)$ has been discussed in [Aoki at Lattice2000, Sommer at Lattice 2003].