Report from the muon g-2 theory initiative

Christoph Lehner (BNL)

September 8, 2017 – FCCP2017

Muon g-2 Theory Initiative: Goals

- theory support to the Fermilab and J-PARC experiments to maximize their impact
  ➟ need theoretical predictions of the hadronic corrections with reduced and reliably estimated uncertainties
- summarize the theoretical calculations of the hadronic corrections to the muon g-2
  ➟ comparisons of intermediate quantities between the different approaches. For example, lattice vs experiment
  ➟ assess reliability of uncertainty estimates

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- combine to provide theory predictions for $a_\mu^{\rm HVP}$ and $a_\mu^{\rm HLbL}$ and write a report **before** the Fermilab and J-PARC experiments announce their first results.

Muon g-2 Theory Initiative

Steering Committee:

- Gilberto Colangelo (Bern) gilberto@itp.unibe.ch
- Michel Davier (Orsay) davier@lal.in2p3.fr
- Simon Eidelman (Novosibirsk) eidelman@cern.ch
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- Tsutomu Mibe (KEK): mibe@post.kek.jp
  J-PARC E34 experiment
- Andreas Nyffeler (Mainz) nyffeler@uni-mainz.de
- Lee Roberts (Boston): roberts@bu.edu
  Fermilab E989 experiment
- Thomas Teubner (Liverpool) thomas.teubner@liverpool.ac.uk

Muon g-2 Theory Initiative: Plan

- Organize ``plenary" workshops to bring the different communities together
  - First workshop: held near Fermilab, June 2017: kick-off

First Workshop of the Muon g-2 Theory Initiative

3-6 June 2017 *Q Center*
US/Central timezone

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- Sponsors
- Committees
- Timetable
- Registration
  - Registration Form
- List of registrants
- List of confirmed speakers
- workshop photos
- Accommodations
- Wilson Hall
- Visa Information

In the coming years, experiments at Fermilab and at J-PARC plan to reduce the uncertainties on the already very precisely measured anomalous magnetic moment of the muon by a factor of four. The goal is to resolve the current tantalizing tension between theory and experiment of three to four standard deviations. On the theory side the hadronic corrections to the anomalous magnetic moment are the dominant sources of uncertainty. They must be determined with better precision in order to unambiguously discover whether or not new physics effects contribute to this quantity.

There are a number of complementary theoretical efforts underway to better understand and quantify the hadronic corrections, including dispersive methods, lattice QCD, effective field theories, and QCD models. We have formed a new theory initiative to facilitate interactions between the different groups through organizing a series of workshops. The goal of this first workshop is to bring together theorists from the different communities to discuss, assess, and compare the status of the various efforts, and to map out strategies for obtaining the best theoretical predictions for these hadronic corrections in advance of the experimental results.

All sessions in this workshop will be plenary, featuring a mix of talks and discussions.

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66 registered participants, 40 talks, 15 discussion sessions (525 minutes)

- Goal: finalize first report around September 2018 before BNL-level statistics result is available from Fermilab E989.

- We are planning to have three workshops in 2018, one each for the HVP and HLbL working groups, and a plenary workshop in June:

  - The 2018 HVP WG workshop will be held at KEK on 12-14 February 2018 (see talk by Daisuke): `http://www-conf.kek.jp/muonHVPws/index.html`

  - The 2018 HLbL WG workshop will be held at University of Connecticut on 12-13 March 2018

  - The 2018 plenary meeting of the muon g-2 theory initiative will be held in Mainz on 18-22 June 2018

Muon g-2 Theory Initiative: WGs

`http://goo.gl/YjKVkS`

- sign-up for the HVP or HLbL WG in the google sheet
  or send email to one of the WG coordinators
- HVP WG coordinators:
  - Michel Davier davier@lal.in2p3.fr
  - Simon Eidelman eidelman@cern.ch
  - Aida El-Khadra axk@illinois.edu
  - Thomas Teubner thomas.teubner@liverpool.ac.uk
- HLbL WG coordinators:
  - Gilberto Colangelo gilberto@itp.unibe.ch
  - Christoph Lehner clehner@bnl.gov
  - Andreas Nyffeler nyffeler@uni-mainz.de

Currently 42 signed up for HVP and 19 for HLbL

A selection of topics that may require discussion before we can reach a community consensus:

Good agreement for sum but not individual channels in R-ratio HVP analysis:

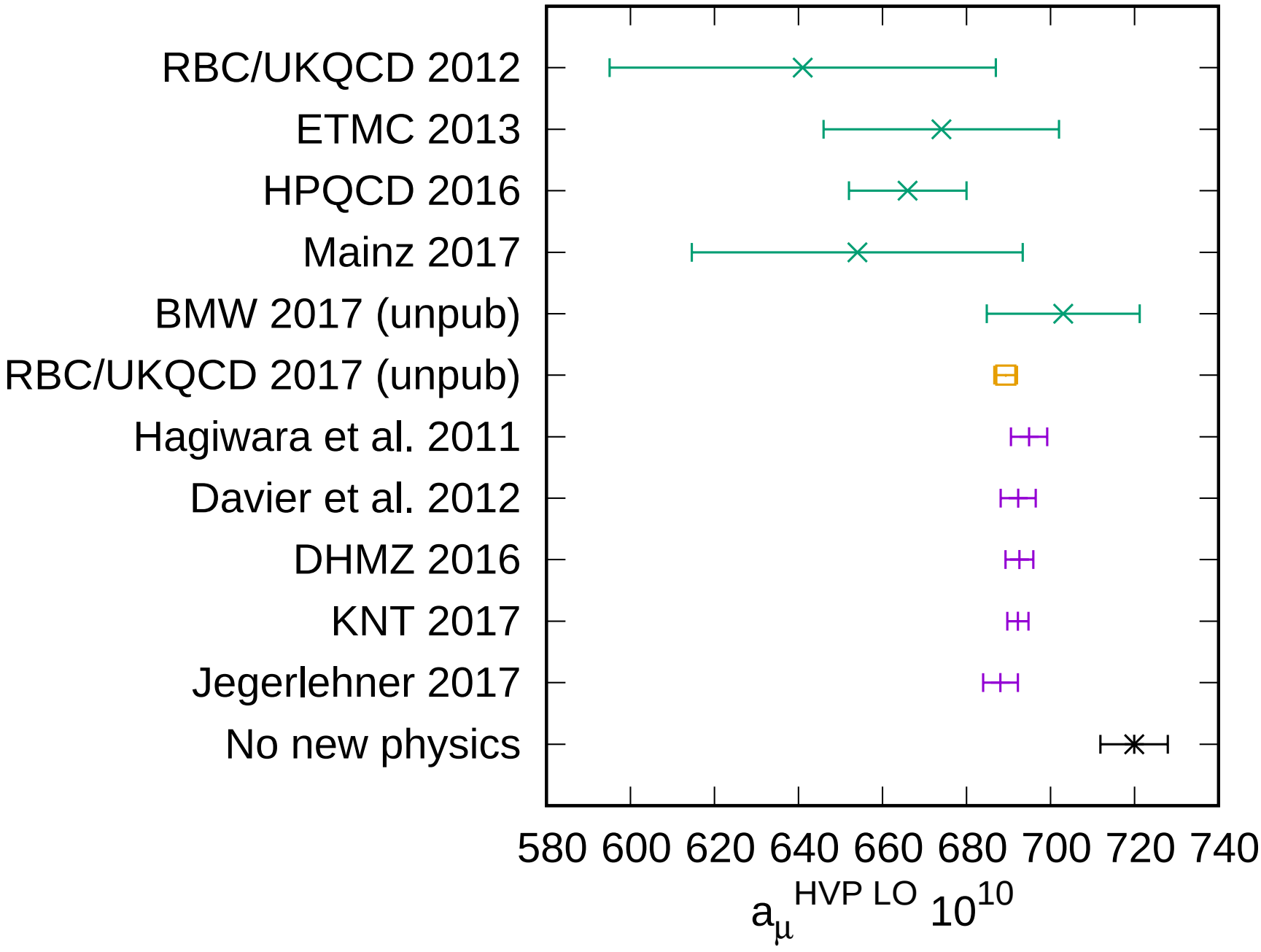
Channel	KNT17	DHMZ16	FJ17
$\pi^+\pi^-$	502.73 ± 1.94	506.9 ± 2.55	
$\pi^+\pi^- 2\pi^0$	17.80 ± 0.99	18.03 ± 0.56	
$2\pi^+ 2\pi^-$	14.00 ± 0.19	13.70 ± 0.31	
K^+K^-	22.70 ± 0.25	22.67 ± 0.43	
$K^0_S K^0_L$	13.08 ± 0.14	12.81 ± 0.24	
Total HVP	692.23 ± 2.54	692.6 ± 3.3	688.07 ± 4.14

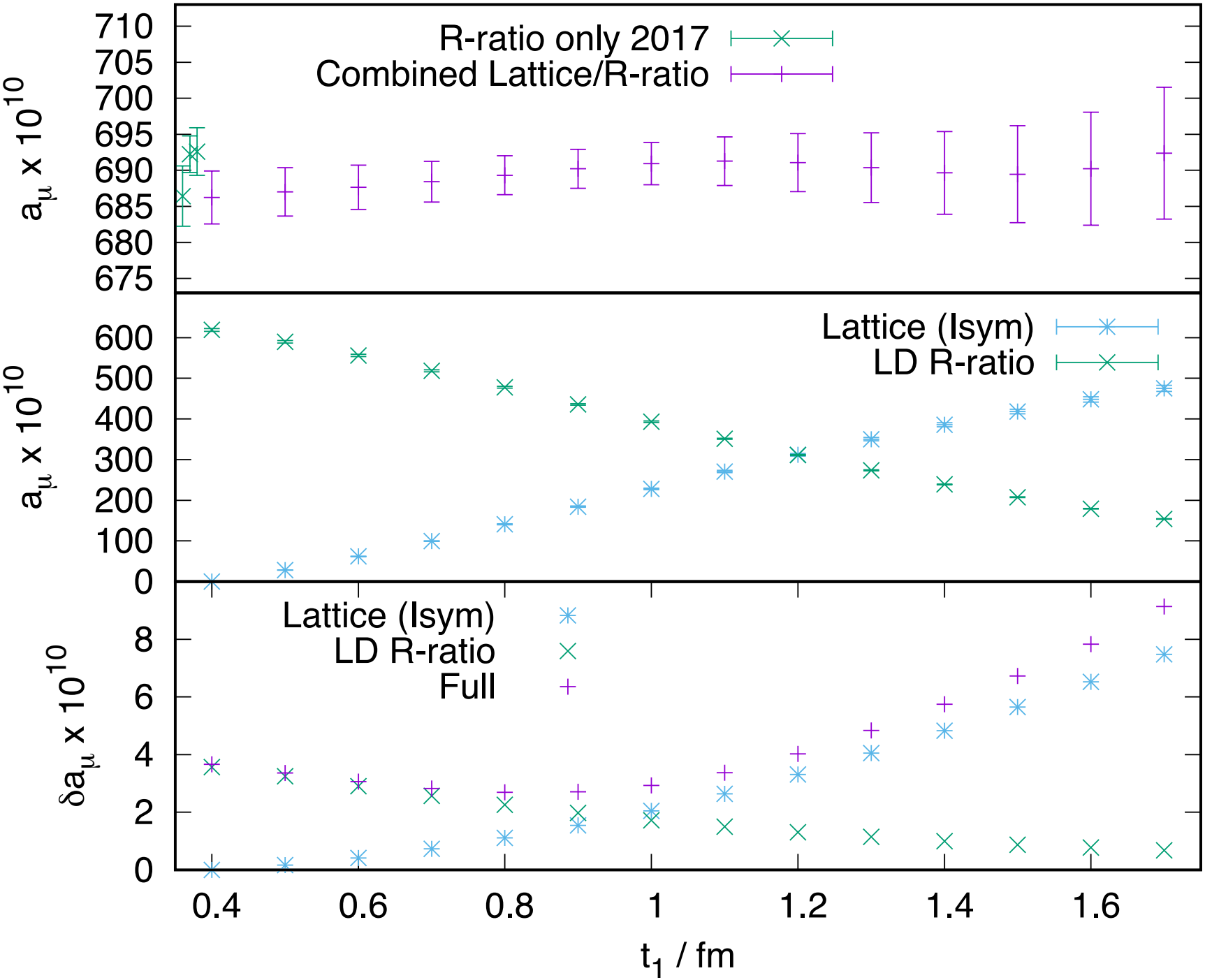
(Table by Alex Keshavarzi)

HLbL:

- How can dispersive and lattice approaches work together more closely
- Which lattice inputs could benefit precision of dispersive analysis (which lattic precision yields which dispersive overall precision)?
- Can we cross-check individual contributions, form factors?

Combine lattice and R-ratio to further reduce HVP uncertainty:

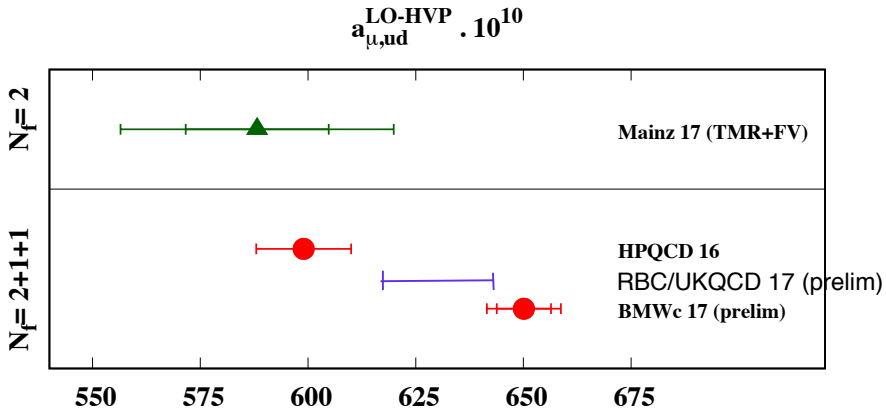


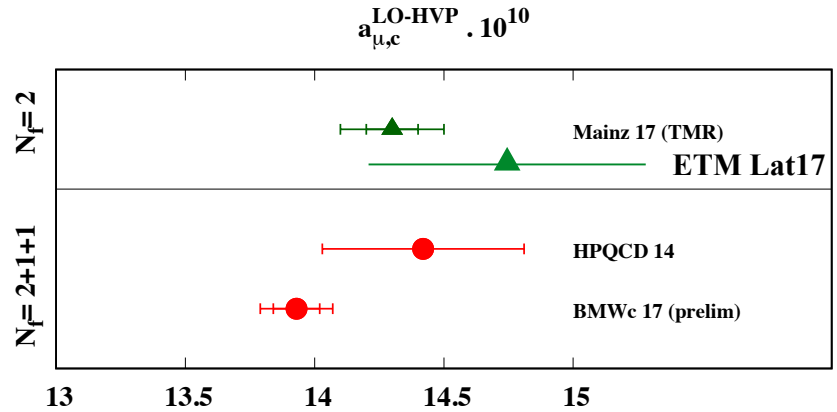


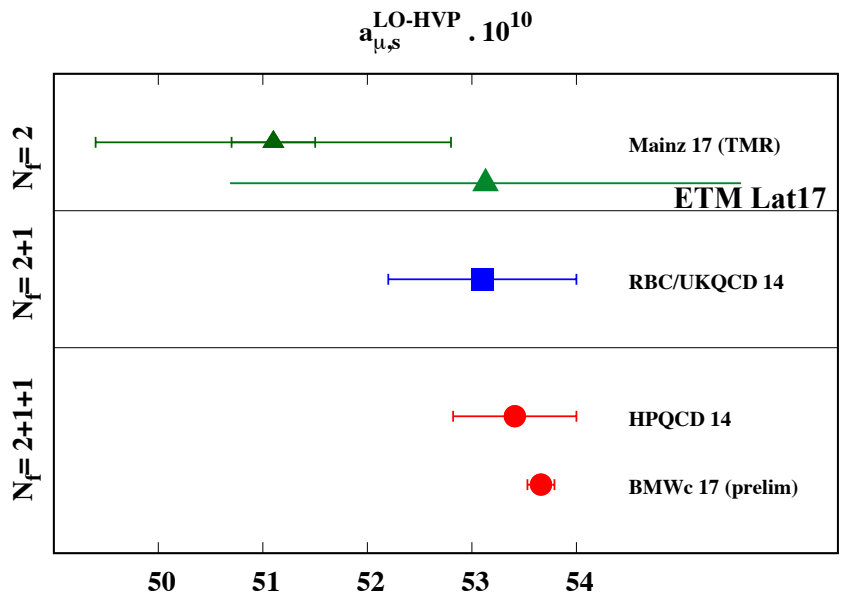
New result by RBC/UKQCD, to be published next month

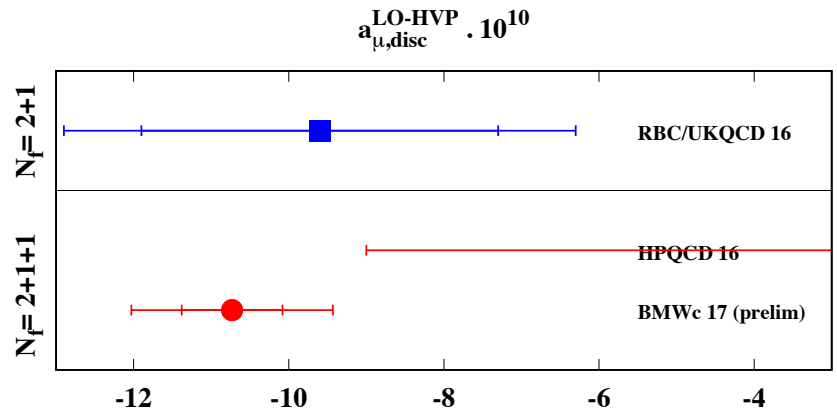
Need consistency check for lattice HVP channel-by-channel (or other target quantities):

L. Lellouch, K. Miura (for BMWc @ Fermilab workshop & Lattice 2017)









Summary

- First workshop at Fermilab started the efforts
- We are just forming the working groups, please sign up if you are interested at `http://goo.gl/YjKVkS`
- Three upcoming workshops
  - The 2018 HVP WG workshop will be held at KEK on 12-14 February 2018 (see talk by Daisuke): `http://www-conf.kek.jp/muonHVPws/index.html`
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- Webpage is under construction
- Plan to coordinate with other working groups/efforts, e.g., Radio MonteCarLow and FLAG