

SPC Flavor Physics Summary

Scientific Program Committee:

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USQCD All Hands Meeting

Fermilab

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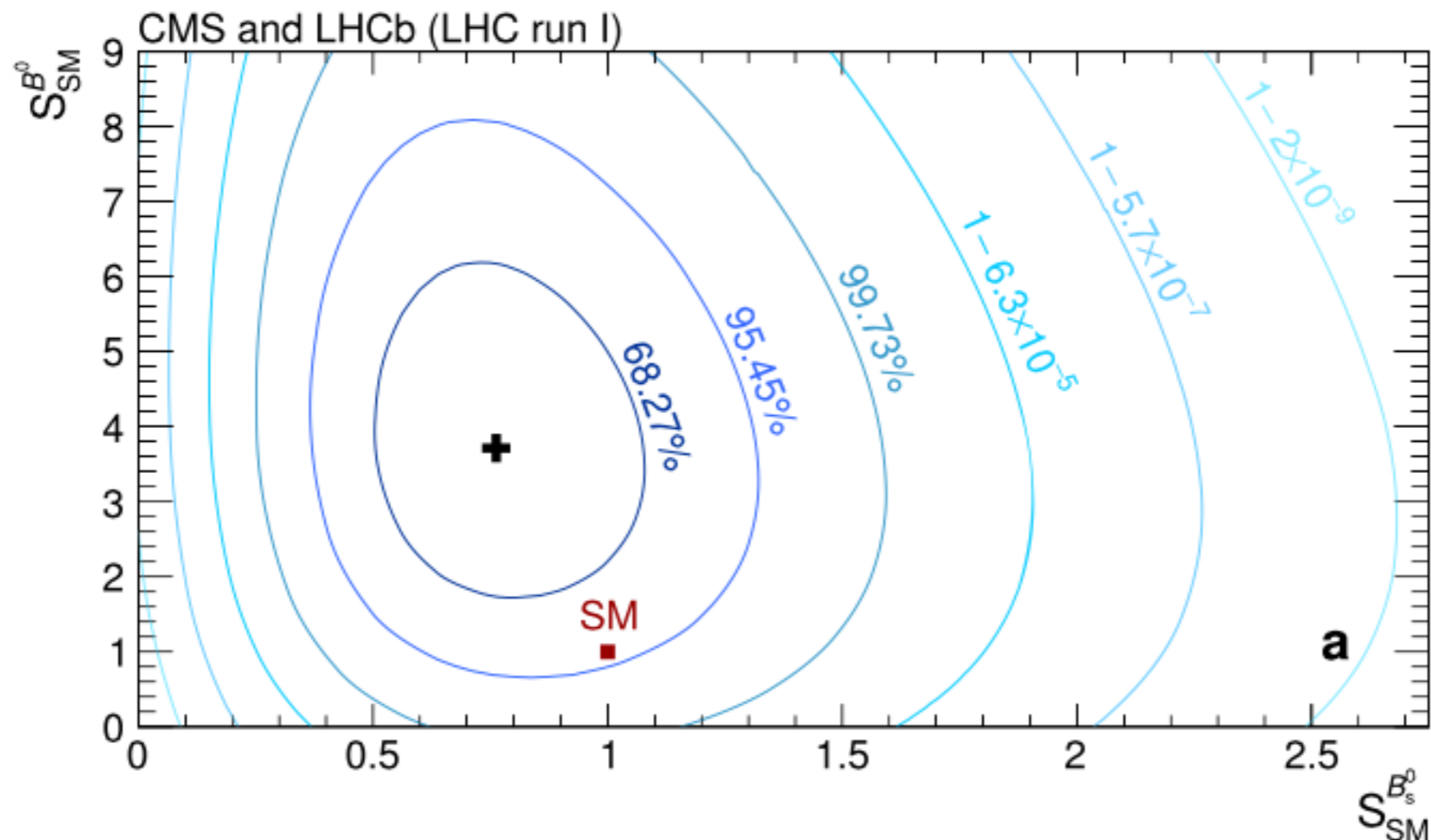
Introduction

- ◆ Last year gave a longer talk with details of CKM matrix determination and tensions between Standard Model predictions and experiment
- ◆ <http://www.usqcd.org/meetings/allHands2017/slides/Gottlieb.pdf>
- ◆ There have been a few changes, such as:
 - updated LHCb results that eliminate tension in $B_{(s)} \rightarrow \mu^+ \mu^-$,
 - new decay constant results for $D_{(s)}$ and $B_{(s)}$ from FNAL/MILC that greatly increase precision, (DeTar talk)
 - but, overall, picture has not changed that much.
- ◆ Overarching goal is still to produce decay constant and form factor results to a level comparable to that from experiment.

CMS+LHCb II

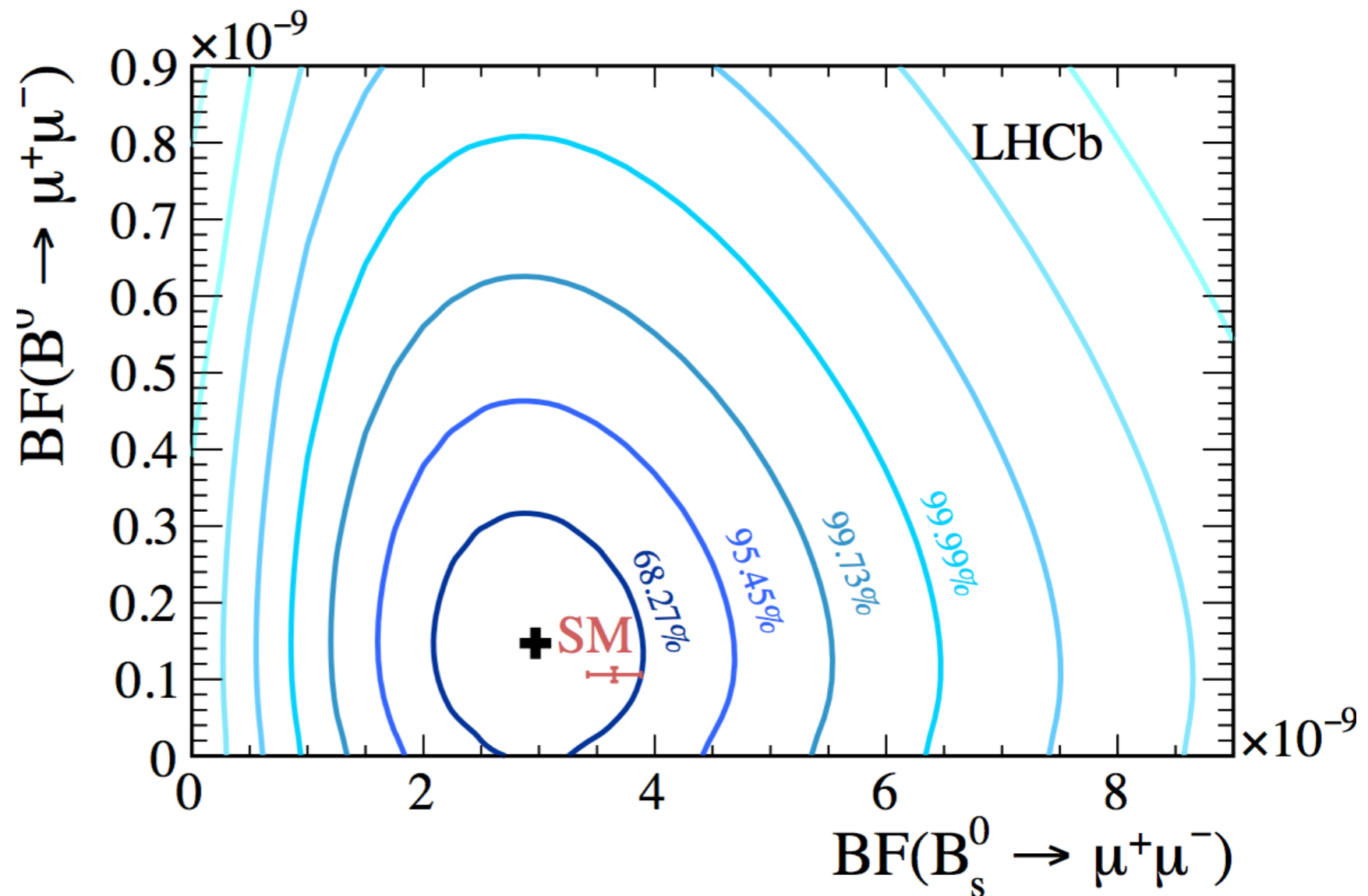
◆ 2D contour plot of branching ratios

- B_s too small by 1σ
- B too big by $\approx 2\sigma$, but *new results from LHCb in much better agreement with SM* arXiv:1703.05747; PRL 118, 191801 (2017)



LHCb Results Updated

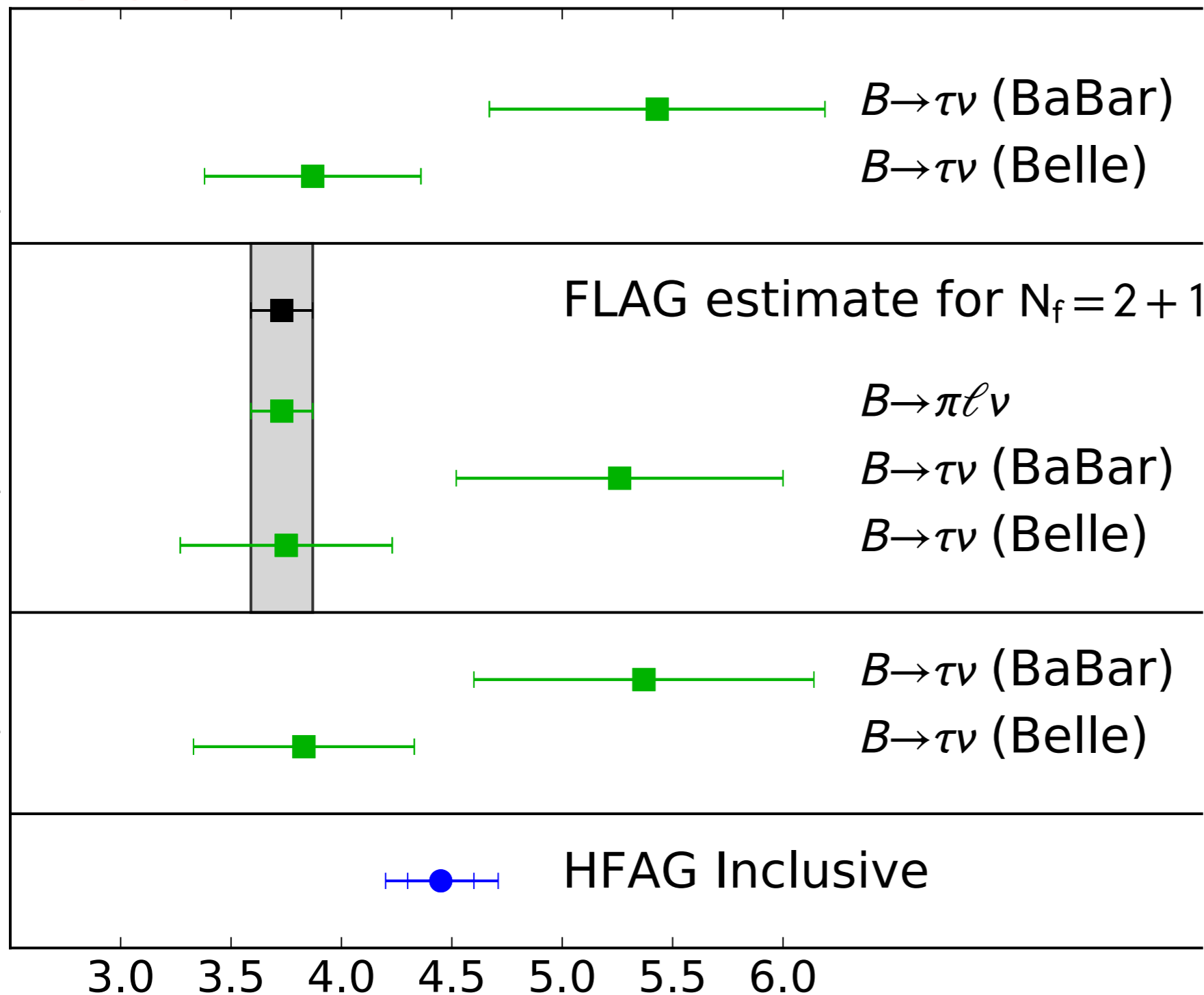
- From Kristof De Bruyn March, 2017 talk at La Thuile
- Updates prior CMS +LHCb graph with new data and analysis from LHCb
- There is no longer a tension with SM, but this does not preclude any new physics, just does not demand it.



$|V_{ub}|$ from FLAG

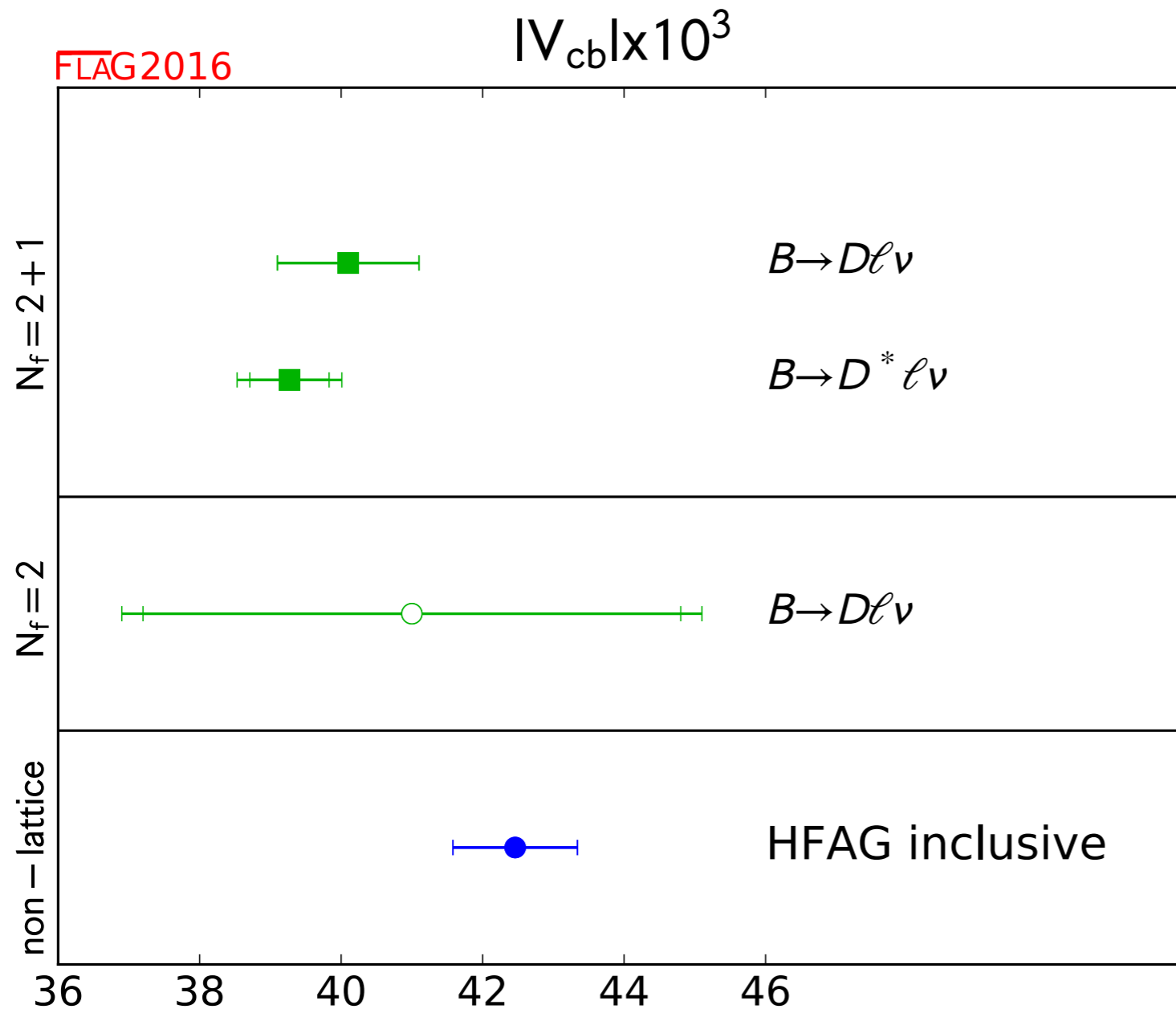
FLAG 2016

$|V_{ub}| \times 10^3$



- BaBar and Belle leptonic decays results don't agree very well.
- Semileptonic result is more precise.
- Tension between inclusive and exclusive determinations.

$|V_{cb}|$ from FLAG



- Semileptonic results for 2+1 are in good agreement.
- For $B \rightarrow D^*$, theory and experiment have comparable error, but not based on full kinematic range.
- Tension between inclusive and exclusive determinations.

List of Proposals

- Blum: π - π and $K \rightarrow \pi\pi$ decay calculations at the physical point (91.2 M JPsi core-hr)
- DeTar: Semileptonic B- and D-meson form factors with high precision (3.2 M GPU-hr)
- Jang: Determination of V_{cb} from semileptonic decays $B \rightarrow D^{(*)} l \nu$ using the Oktay-Kronfeld action (42 M JPsi core-hr)
- Lehner: QCD+QED studies using twist-averaging (59 M Jpsi core-hr)
- Lepage: Pion electromagnetic form factor at large Q^2 (14.64 M JPsi core-hr)
- Soni: Semileptonic B and Bs decays with charming hadronic final states (25.95 M JPsi core-hr)
- Tomii: Nonperturbative renormalization of $\Delta S=1$ four-quark operators in position space (14.9 M JPsi core-hr)

Semileptonic Decay Proposals

- DeTar: Semileptonic B- and D-meson form factors with high precision
 - Multiple B and D meson tree level form factors to π or K using HISQ valence quarks on MILC's four flavor HISQ ensembles
 - 7 ensembles with $a=0.12-0.042$ fm (*talk to follow*)
- Jang: Determination of V_{cb} from semileptonic decays $B \rightarrow D^{(*)} l \nu$ using the Oktay-Kronfeld action
 - B meson decays to D and D^* using OK action for valence bottom and charm quarks
 - 9 MILC HISQ ensembles with $a=0.15-0.09$ fm (project 1% precision)
- Soni: Semileptonic B and Bs decays with charming hadronic final states
 - decays to both D and D^* using RHQ b-quark action and heavy Mobius domain wall c-quark action to test lepton flavor universality
 - analyze 28 configurations of $a=0.07$, 2+1 flavor DW ensemble (*Blum talk*)

Blum

- π - π and $K \rightarrow \pi\pi$ decay calculations at the physical point
- Goal is $l=0, 1,$ and 2 $\pi\pi$ scattering phase shifts and direct CP violation parameter ε'
- Using three ensembles of $2+1$ flavor DW quark configurations
 - $1/a = 1$ or 1.4 GeV
 - volumes $24^3 \times 64$ and $32^3 \times 64$
- More details in next talk...

Lehner



- QCD+QED studies using twist-averaging
- Will use physical mass $64^3 \times 128$, $1/a=2.36$ GeV Mobius domain wall 2+1 flavor ensemble
- Use improved quenched photon propagator QED $_{\infty}$
- Physics goals are electromagnetic effects on pion mass and decay constant, and muon $g-2$

Lepage

- Pion electromagnetic form factor at large Q^2
- Pion and kaon electromagnetic form factors will be measured at JLab. This is a priority project for 12 GeV upgrade.
- Goal is to see if the form factors approach the asymptotic form predicted by perturbative QCD
- Using MILC, $a=0.06$ fm, 2+1+1 flavor HISQ ensemble
 - Will be combined with results for $a \approx 0.15, 0.12,$ and 0.09 fm
- Will study five values of Q^2 up to 5 GeV^2

Tomii

- Nonperturbative renormalization of $\Delta S=1$ four-quark operators in position space
- These operators are used for the $K \rightarrow \pi\pi$ analysis (Blum).
- Position space method allows full gauge invariance and no mixing with gauge-non-invariant operators or those which vanish by equations of motion
- Uses three RBC/UKQCD ensembles generated with 2+1 flavors of domain wall quarks
 - $32^3 \times 64 \times (16, 12, 32)$, $1/a=(2.38, 3.15, 1, 37)$ GeV
 - pion masses are (370, 380, 250) MeV, respectively