



# Welcome to the 2009 Vxb Workshop

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Initiated by HFAG – Sponsored by SLAC

Vera Lüth, SLAC  
David Lopes Pegna, Princeton



# Workshop Purpose and Goals

- Promote the lively exchange of ideas among theorists and experimentalists working on semileptonic B decays and related topics.
- Focus on inclusive and exclusive semileptonic B decays and related processes, i.e. purely leptonic and radiative decays, paying particular attention
  - to current and improved strategies to analyse data from the B-Factories, BABAR, Belle, CLEO, as well as Tevtron, with benefit to LHCb and BESIII
  - to past and current non-perturbative QCD calculations required to extract  $V_{cb}$  and  $V_{ub}$
  - to the interpretation of the current and future data
- Interactive format, with short presentations and ample time for questions and discussions, focusing for theory and experiments
  - on essential ingredients
  - on principal challenges and problems
  - on the origin of the principal uncertainties and their impact on errors
  - on prospects for future improvements, employing improved techniques
- Some of the information presented here is unpublished and confidential
- HFAG: How can we combine results?



# Program

## Sessions

- Exclusive  $B \rightarrow D, D^*, D^{**} \ell \nu$  Decays  
Andreas Kronfeld  
Bob Kowalewski
  - Inclusive  $B \rightarrow X_c \ell \nu$  Decays  
Thomas Mannel  
Christoph Schwanda
  - Exclusive  $B \rightarrow \pi, \rho \ell \nu$  Decays  
Lawrence Gibbons  
Junko Shigemitsu
  - Inclusive  $B \rightarrow X_u \ell \nu$  Decays  
Michael Luke  
Vera Lüth
  - Summary/ Discussion  
Zoltan Ligeti
- Equal time for presentations and talks, plus more time at end of session and final conclusions on Saturday!  
This is your chance – please have your questions and comments ready!
- A few talks will be transmitted by phone, but for practical reasons we decided not to provide Phone Conference or EVO service in general .



# Principal Issues and Questions

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- Over the past decade to our knowledge of  $|V_{cb}|$  and  $|V_{ub}|$  has significantly improved, due to many contributions!
- Still, after the early BABAR and Belle publications, further improvements have been more difficult and slower than expected, both in theory as well as experiment!
- Likewise, we have seen QCD calculations develop, in particular HQE and lattice work – still there are miles to go.
- In the future, it may be difficult to sustain this effort, now that the full B Factory data are available.

“How do we convince physicists that some of these problems are more fundamental than others they are working on?”

May be this Workshop will help?!



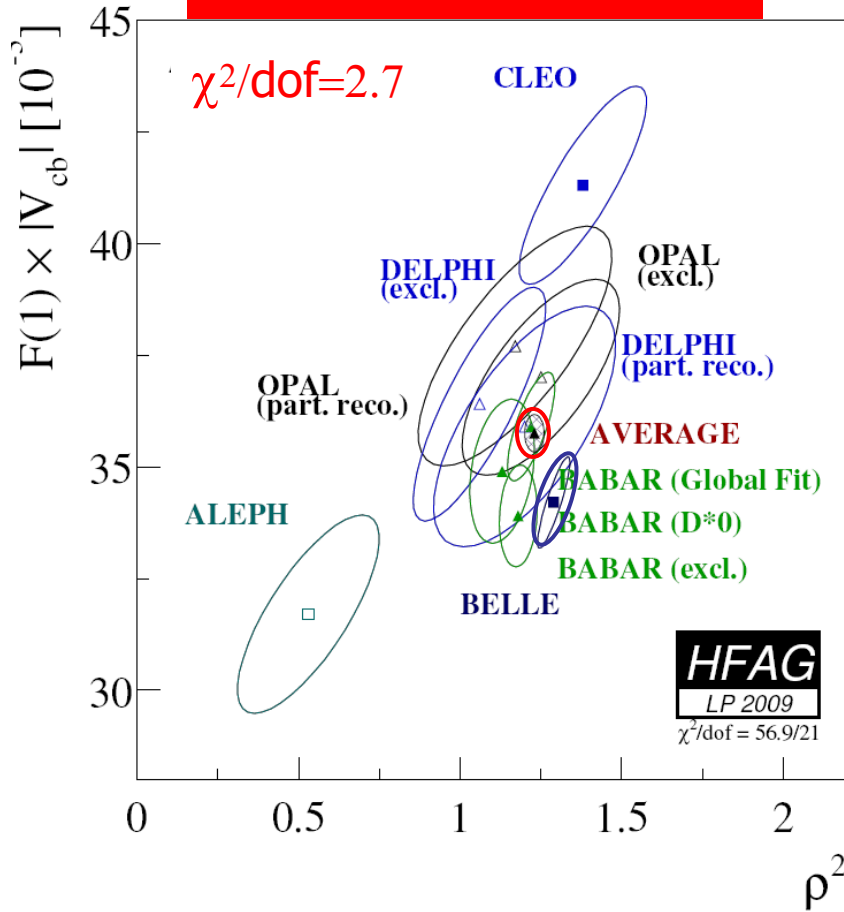
# Principal Issues and Questions

## Experimental errors remain sizable

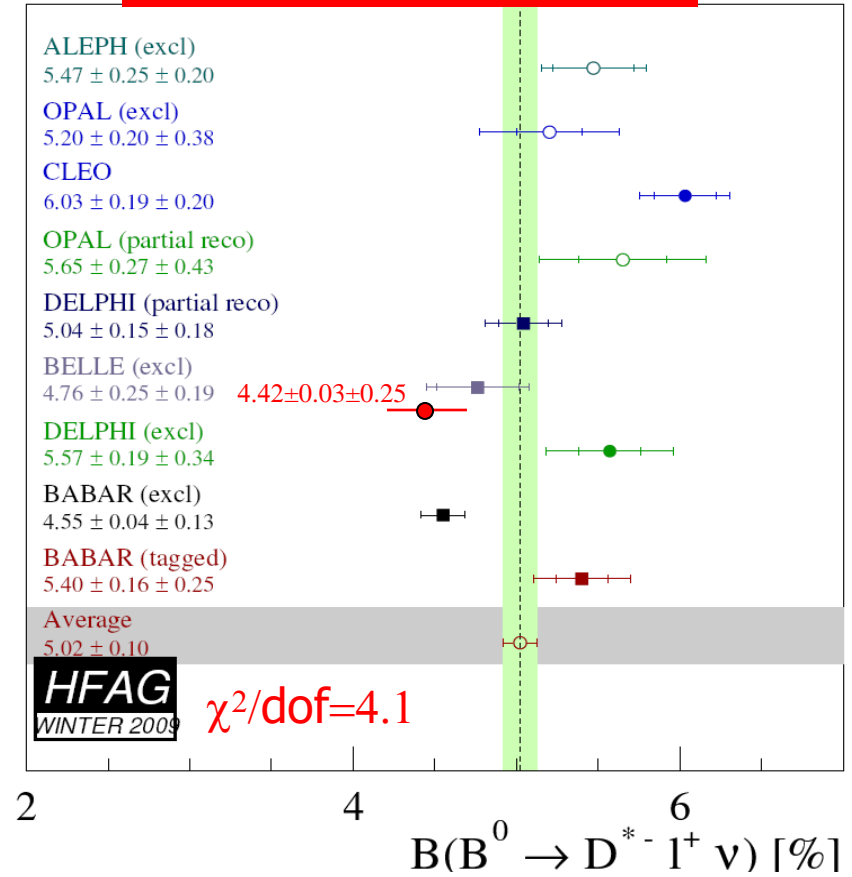
- Difficult  $\nu$  reconstruction – limited hermeticity of BABAR and Belle, KL,  $\nu$ ... lead to poorer resolution and high combinatorial backgrounds
- High backgrounds in  $X_u \ell \nu$  decays require tight selection criteria to isolate the signal, resulting in high reliance on signal and background simulation  
Can we enlarge the accepted phase space? What is the gain?
- Imperfect MC simulation of background processes affect signal extraction
  - Large uncertainties in branching fractions for exclusive background decays
  - Form factor measurements require large and pure event samples, especially for decays to non-scalar mesons, plus excellent understanding of efficiencies
- Limited off-resonance data samples to subtract continuum background
- Purer tagged event samples remain very small,  $1 \pi \ell \nu / 10^7$  BB events

HFAG: How do we combine measurements? Same experiment? Same technique?  
Use of different theoretical input? Errors, correlations?

Exclusive:  $D^* \ell \nu$



Exclusive:  $D^* \ell \nu$



Exp. errors are underestimated! more data awaiting to be analyzed, but...



# Principal Issues and Questions

- Theoretical uncertainties also remain sizable, in some cases dominant

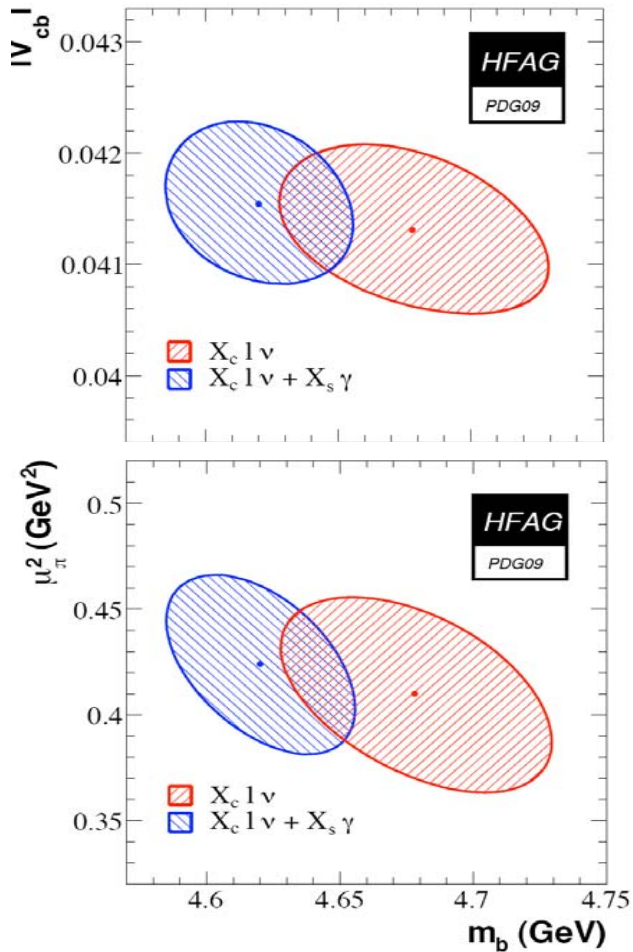
## Inclusive:

- Stringent kinematic event selection spoil the convergence of the HQE, thus requiring non-perturbative methods (shape functions or other)
- To leading order, non-perturbative parameters are measured in data
  - 0<sup>th</sup> to 2<sup>nd</sup> order constraints from moments,  $X_c \int v$  and  $s_\gamma$ , or ratio of spectra ??
  - What are the errors on these procedures ?? Impact of 2<sup>nd</sup> -3<sup>rd</sup> order?  
What are the approximations, assumptions?
- How do we treat non-leading effects (SF) ??
  - Different QCD calculations available – some with additional assumptions - models – HQE with missing terms? Progress ?!
- Global input parameters: b- and c- quark masses etc. have strong impact. Can we reduce the sensitivity of  $V_{xb}$ ?

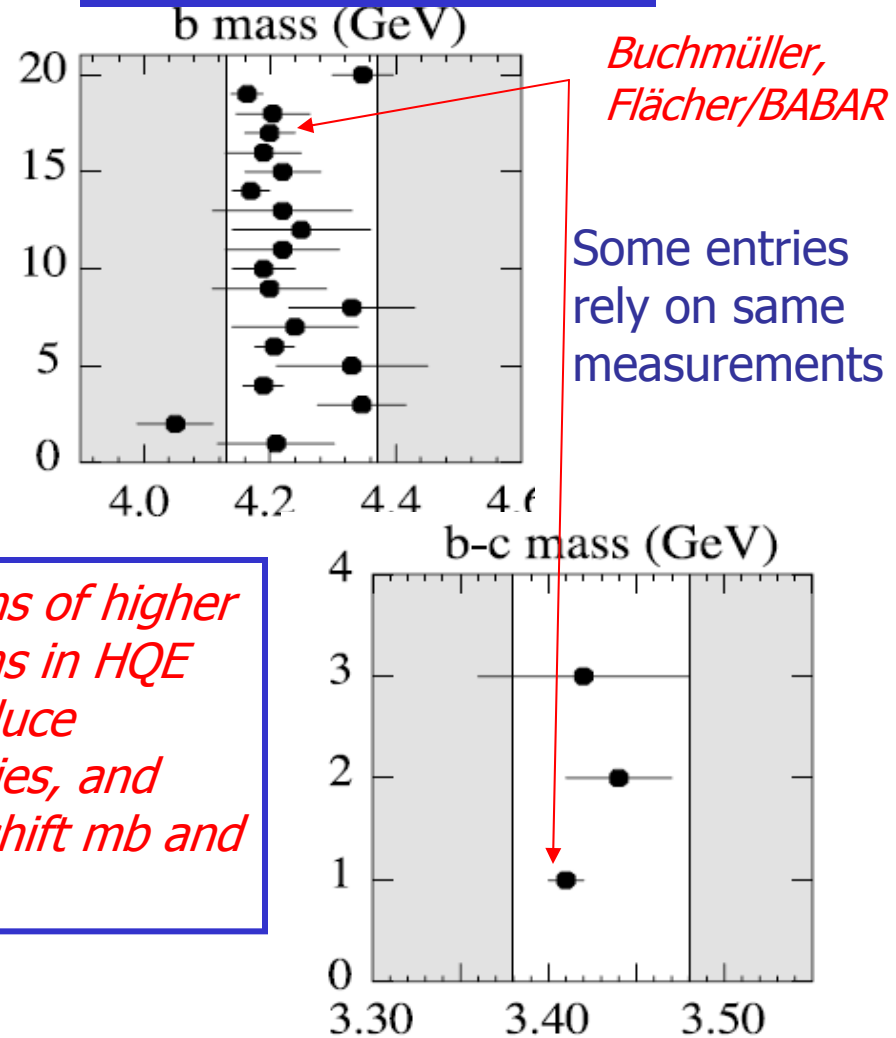
HFAG: How should we proceed in the future? How do we identify the best approach? Who is to judge? On what basis?

# Quark Masses and other Parameters

## HFAG 2009: Kinetic Scheme



## PDG 2009: $\overline{MS}$ Scheme



*Calculations of higher order terms in HQE should reduce uncertainties, and probably shift  $m_b$  and  $|V_{cb}|$  !*





# Principal Issues and Questions

- Theoretical uncertainties also remain sizable, in some cases dominant

## Exclusive

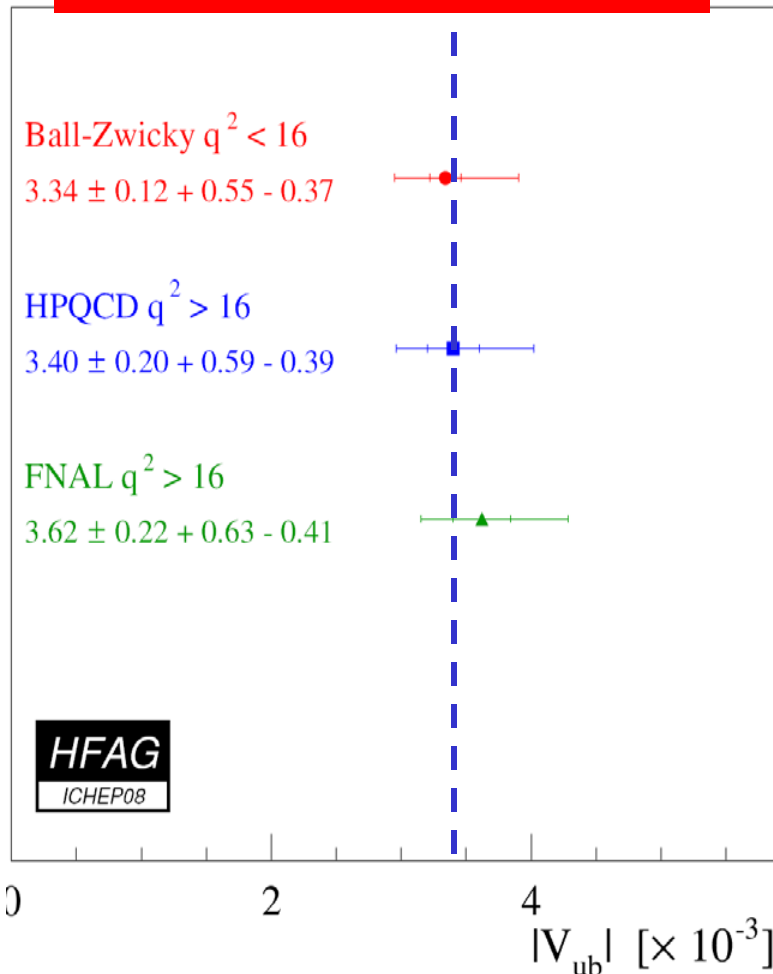
- Reliance on predictions for FF ansatz and normalization by LQCD and LCSR
  - Progress in precision of QCD calculations is slower than hoped
    - Can we extend the range of QCD predictions to smaller  $q^2$ ? i.e. for  $D \ell \nu$
  - Multiple efforts are welcome, but again, how do we determine the uncertainties?
    - Can we choose a standard?

## Simulations

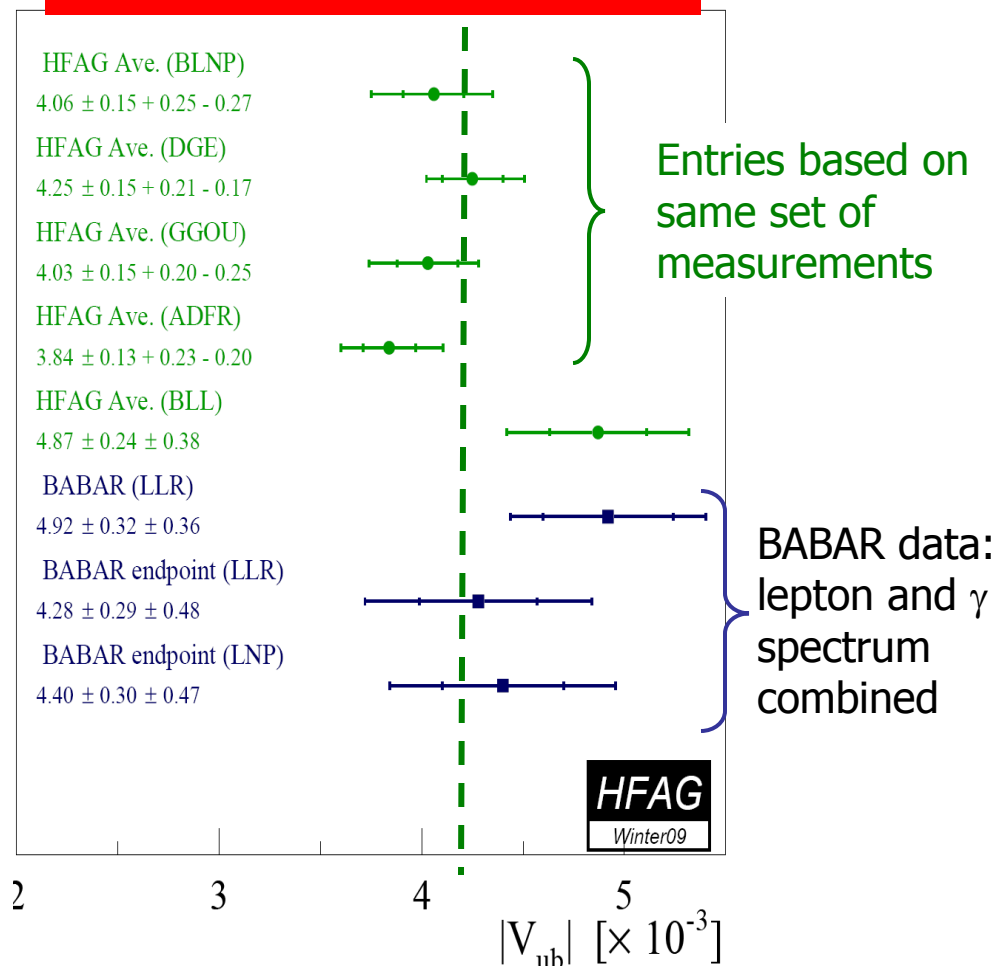
- Experimenters need improved physics simulations for signal and backgrounds
  - theory and exp. input/tests required
- Weak annihilation
  - can we estimate the size of the contributions using data or should we limit phase space?
- Parton-hadron duality
  - can we assess the potential impact ?

# HFAG Dilemma: How do we evaluate QCD calculations?

## Exclusive: $B \rightarrow \pi l \nu$



## Inclusive: $B \rightarrow Xu l \nu$



# Why are we doing this? How does it all fit together?

- Tests of validity of the CKM Prediction via tree level processes, free of new physics!?  $|V_{ub}|$  vs  $\sin 2\beta$
- Difference between results from inclusive and exclusive s.l. B!  
**A problem, but a chance to improve our understanding.**
- How do we combine measurements of different CKM parameters, based on different theoretical calculations, errors and correlations?
- Purely leptonic B (D) decays: clean test of quark coupling and decay constant: LQCD vs measurements, any difference?  
**Need more B data! Recent excitement and progress in LQCD for Ds!**
- Relations to hadronic B, D decays: Form factors?
- Decays  $B \rightarrow D^{(*)} \tau \nu$ , mostly test of non-SM physics! **Need more data!**
- What can we/have we learned from D, K,  $\tau$  decays?

**A very long, though incomplete list of issues!**



## Web Page – Upload Talks

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- The program is set up in INDICO accessible from the Workshop Website, enabling
  - Upload of presentations
  - Upload of questions and issues
- All conveners who are registered INDICO users will be able to upload talks and questions/comments.

Any technical questions? please ask David Lopes Pegna!

- Some of the presentations may contain **information that is unpublished**. Workshop participants are asked to **treat this information as confidential**. It will be up to the speaker to decide what may be posted on the web.



# Logistics

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## ■ Vxb Workshop Venue

- Thursday      Kavli Auditorium      14:00 – 18:00
- Friday        Kavli Auditorium      8:30 – 18:00
- Saturday      ROB – Building 48      8:30 – 17:30

## ■ Dinner at Hunan Gardens, Friday 19:00    Fee \$35.--

- Sign up by break this afternoon with Natasha Haulman
- Sign up for car pool, departing from Guest House at 18:40

## ■ Saturday Lunch – included in registration Fee \$40.--

- Please register with Judy Meo

## ■ Travel Reimbursement

- See Natasha Haulman



# Vxb Workshop

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- The program of the Workshop was arranged by the session conveners, a joint effort by experimentalists and theorists.
- In spite of the narrow focus, not an easy task to meet everybody's expectation.
  - talks should be **concise**, with focus on problems and ideas to overcome them,
  - **lots of time for critical assessment and questions**. This is how we hope to learn what is important!
- It will be up to all of you as participants to make this meeting a productive experience and fun!

**Many thanks to the SLAC support and staff who make all this possible!**

**Many thanks to the conveners.**