Leptonic and rare decays

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Section Outline

Presented at KEK

	Initial page guestimates
1.1 B physics	
...	
K. Leptonic Decays and $B^+ \to D^{(*)} \tau^+ \nu$	
I. General theory overview and motivation	(short)
II. $B^+ \to l^+ \nu$ (l = e, μ, τ)	
II.i Theory	(2)
II.ii $B^+ \to \tau^+ \nu$ measurements	(3)
II.iii $B^+ \to l^+ \nu$ (l = e, μ) measurements	(2)
II.iv $B^+ \to l^+ \nu \gamma$ measurements	(1)
II.v Interpretation of results	(2)
III. $B \to D^{(*)} \tau^+ \nu$	
III.i Theory	(3)
III.ii Methodology and experimental results	(7)
IV. Discussion, interpretation and future prospects	(2)
← Radiative/EW section here?	
L. Rare, Exotic and Forbidden Decays	
I. Motivation and theory overview	(short)
II. Methodology	(short)
III. $B^0 \to l^+ l^-$ (also $\tau^+\tau^-$ and $l^+ l^- \gamma$)	(3)
IV. $B^0 \to \gamma\gamma$ (maybe in radiative/EW section?)	(1)
V. $B^0 \to$ invisible	(1)
VI. Lepton number/flavor violating modes	(2)

Status/plans

- No text yet, but (as of this morning...) working on tex outline
- In contact with Belle co-editors; anticipate beginning writing in coming month or so
- Some key analyses which are not yet finalized...

$B^+ \to \tau^+ \nu$

II.ii $B^+ \to \tau^+ \nu$ measurements

- There is a subsection under "Tools" which will present a description of the tag reconstruction method
  - focus of this section will be on issues specific to these analyses
- BABAR and Belle both perform separate “hadronic” and “semileptonic” tag analyses, so four independent measurements

BABAR refs:

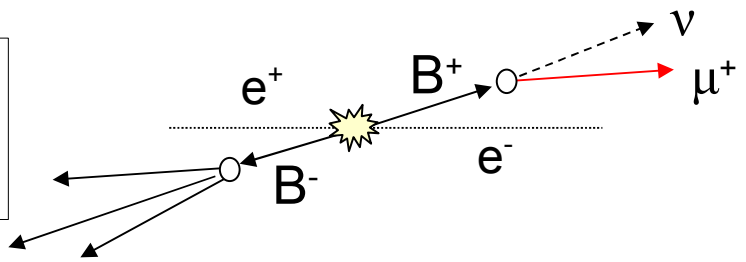
PRD-RC 77, 011107 (2008)	Hadronic tag (recently updated to full data set; to be submitted)
PRD-RC 81, 051101 (2010)	SL tag (final)

Belle refs:

PRL 97, 251802 (2006)	Hadronic tag (to be updated)
arXiv: 1006.4201 (2010) to be submitted)	SL tag 657M (update of arXiv:0809.3834 (2008)

$B^+ \to l^+ \nu$

II.iii $B^+ \to l^+ \nu$ (l = e, μ) measurements



- "Usual" method is an inclusive search based on the high-p lepton, however BABAR has published (and Belle is working on) "tagged" analyses using methodology similar to $B^+ \to \tau^+ \nu$

  ⇒ need a short explanation of what the conceptual difference is between the "inclusive" and "tagged" methods

  BABAR refs:

  PRD-RC 79, 091101 (2009) (full dataset, inclusive)

  PRD-RC 77, 091104 (2008) (hadronic tag)

  PRD-RC 81, 051101 (2010) (SL tag)

  Belle refs:

  PLB 647, 67 (2007) (inclusive; update in progress)

  Tagged analyses in progress, results expected in ~six months

$B^+ \to l^+ \nu\gamma$

II.iv $B^+ \to l^+ \nu\gamma$ measurements

- B factories seem to have had difficulties with this mode...

Will there be NO inclusive measurement in book??

BABAR refs:

PRD-RC 80, 111105 (2009) hadronic tag, full dataset

0704.1478 [hep-ex] inclusive search, likely will never be published

Belle ref:

arXiv:hep-ex/0408132 (2004) only a very old (2004) prelim

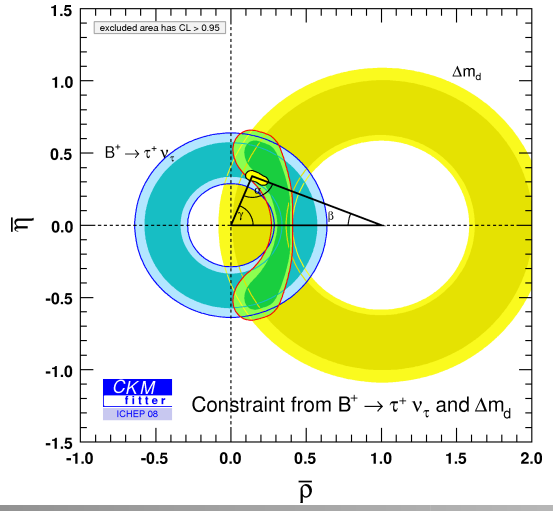
  - Experimental issue has been understanding of continuum (untagged) and exclusive semileptonic B background (tagged

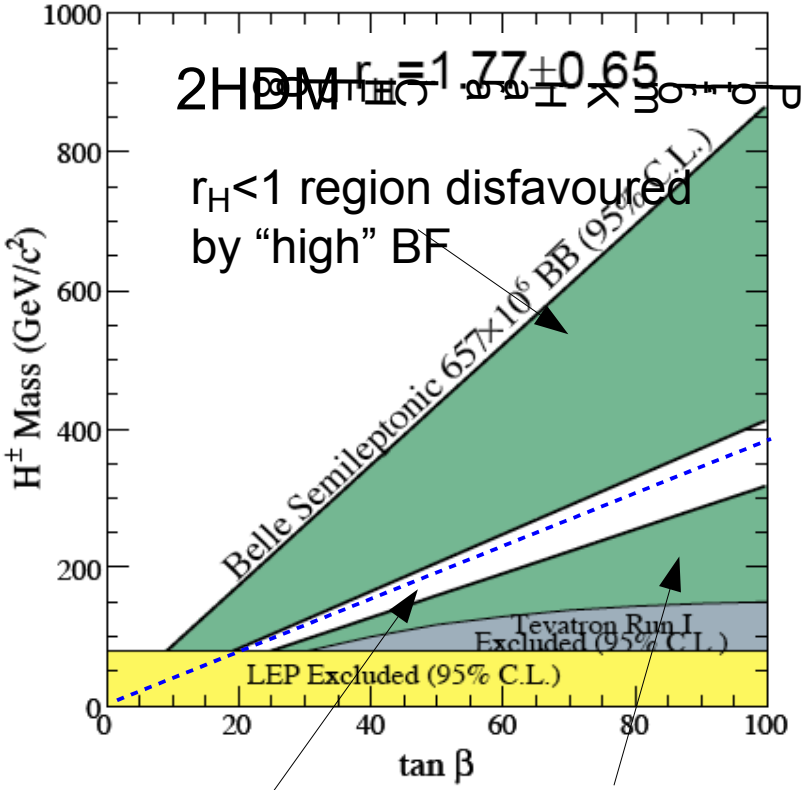
- discussion should include some comparison of consistency with respect to $B^+ \to l^+ \nu$, comments on extraction of QCD parameters and (maybe) discussion of effect of $B^+ \to \pi^0 l^+ \nu$ form factors on background determination

New Physics Constraints

II.v Interpretation of results

- Interesting to compare with $B^+ \to \tau^+ \nu$; current limits on $B^+ \to \mu^+ \nu$ are approaching SM sensitivity, hence might be some tension with "high" value of $B^+ \to \tau^+ \nu$
- Important to clearly present new physics context, interpretation of inclusive/exclusive $|V_{ub}|$ etc.





"Pathological" case where Higgs contribution is exactly double the SM contribution

Large - r_H region (ruled out by BF upper limits)

$B \to D^{(*)} \tau^+ \nu$

III. $B \to D^{(*)} \tau^+ \nu$
- III.i Theory
- III.ii Methodology and experimental results

- Hadronic tag analyses

BABAR refs:

PRD 79, 092002 (2009)

PRL 100, 021801 (2008) first BABAR result

Update in progress, but timescale unclear

Belle refs:

PRL 99, 191807 (2007)

arXiv:0910.4301 preliminary

- $B \to D^{(*)} \tau^+ \nu$ results have only become available in the past few years and are still an active topic of study; would be desirable to have "final" results available on time scale of book

$B^0 \to l^+ l^-$ and related modes

III. $B^0 \to l^+ l^-$ (also $\tau^+\tau^-$ and $l^+ l^- \gamma$)
IV. $B^0 \to \gamma\gamma$
V. $B^0 \to$ invisible
VI. Lepton number/flavor violating modes

BABAR refs:

PRD 77, 032007 (2008)	$B^0 \to l^+ l^-$	full dataset
PRD-RC 77, 011104 (2008)	$B^0 \to l^+ l^- \gamma$	full dataset
PRL 96, 241802 (2006)	$B^0 \to \tau^+ \tau^-$	old result, but will not be updated

Belle refs:

PRD 68, 111101(R) (2003)	$B^0 \to l^+ l^-$	very old!

- $B^0 \to l^+ l^-$ is most stringent constraint, but new physics reach superseded by Tevatron $B_s^0 \to l^+ l^-$

Other rare modes

- $B^0 \to \gamma\gamma$ and $B^0 \to$ invisible sections will be short

BABAR refs:

PRL 87, 241803 (2001) NEW $B^0 \to \gamma\gamma$ prelim to be submitted shortly

PRL 93, 091802 (2004) $B^0 \to$ invisible with SL tag (update?)

Belle refs:

PRD 73, 051107 (2006) $B^0 \to \gamma\gamma$

$B^0 \to$ invisible study in progress; result expect in time for book

- LFV modes mostly published with related modes, with some exceptions:

BABAR refs:

PRD-RC 77, 091104 (2008) $B^0 \to l^+\tau^-$ (essentially full dataset)

PRL 99, 201801 (2007) $B^+ \to K^+\tau^+\mu^-$ update in progress

Lepton/baryon # violating $B^+ \to \Lambda_{(c)}\, l^-$ result anticipated soon!

$B^+ \to D^- l^+ l^+$ recent preliminary result from Belle

NEW!

Conclusions

- Basic section(s) outline is available and notional content sketched out before KEK meeting.
- No draft text yet, but plan for initial work over next couple of months
- Several key analysis topics are still lacking “final” BABAR and/or Belle results; some new rare decays results and prelim leptonic results becoming available