# On the status of flavor anomalies

Diego Guadagnoli
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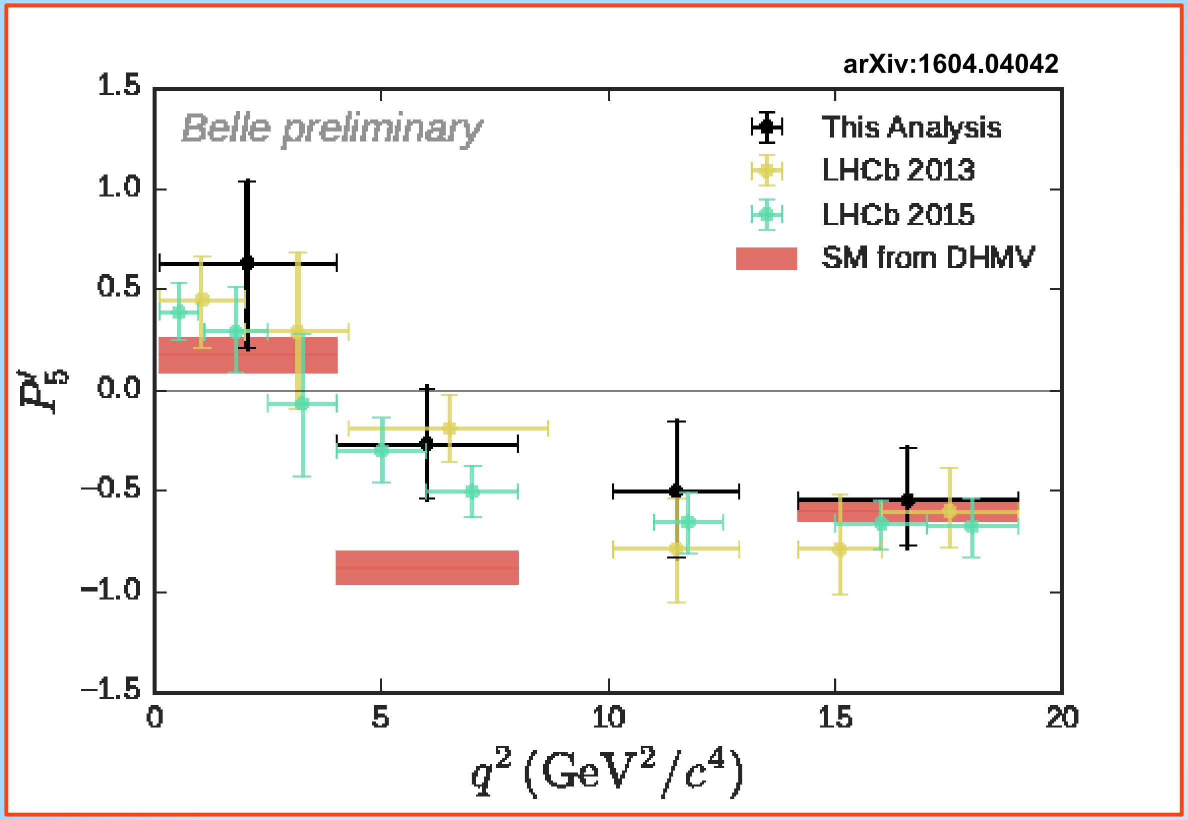

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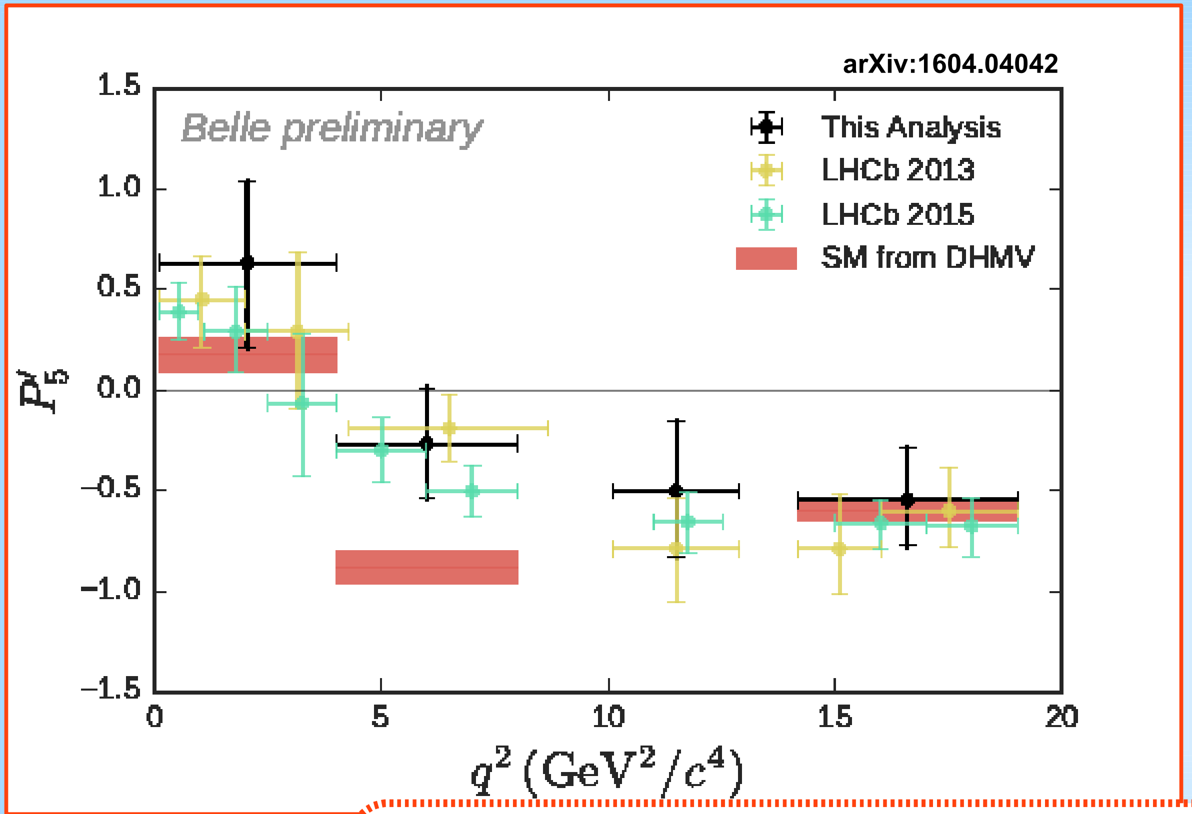


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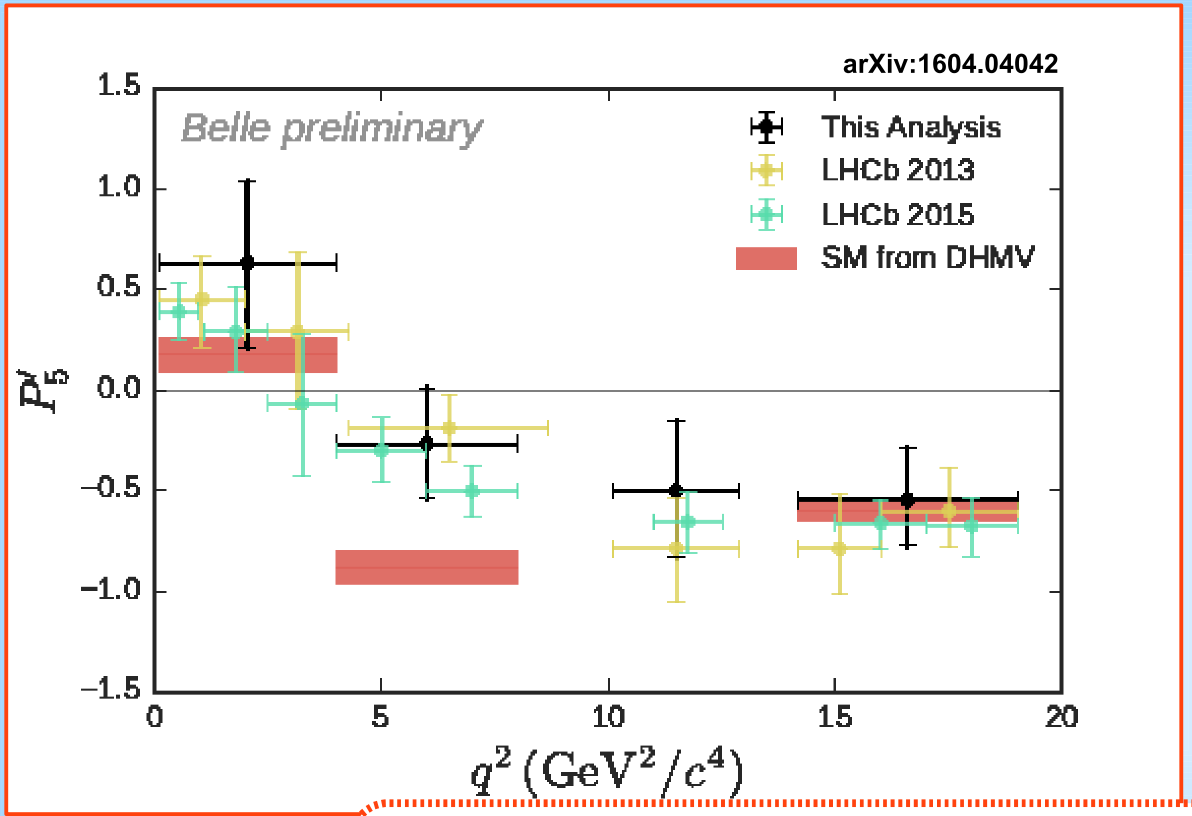


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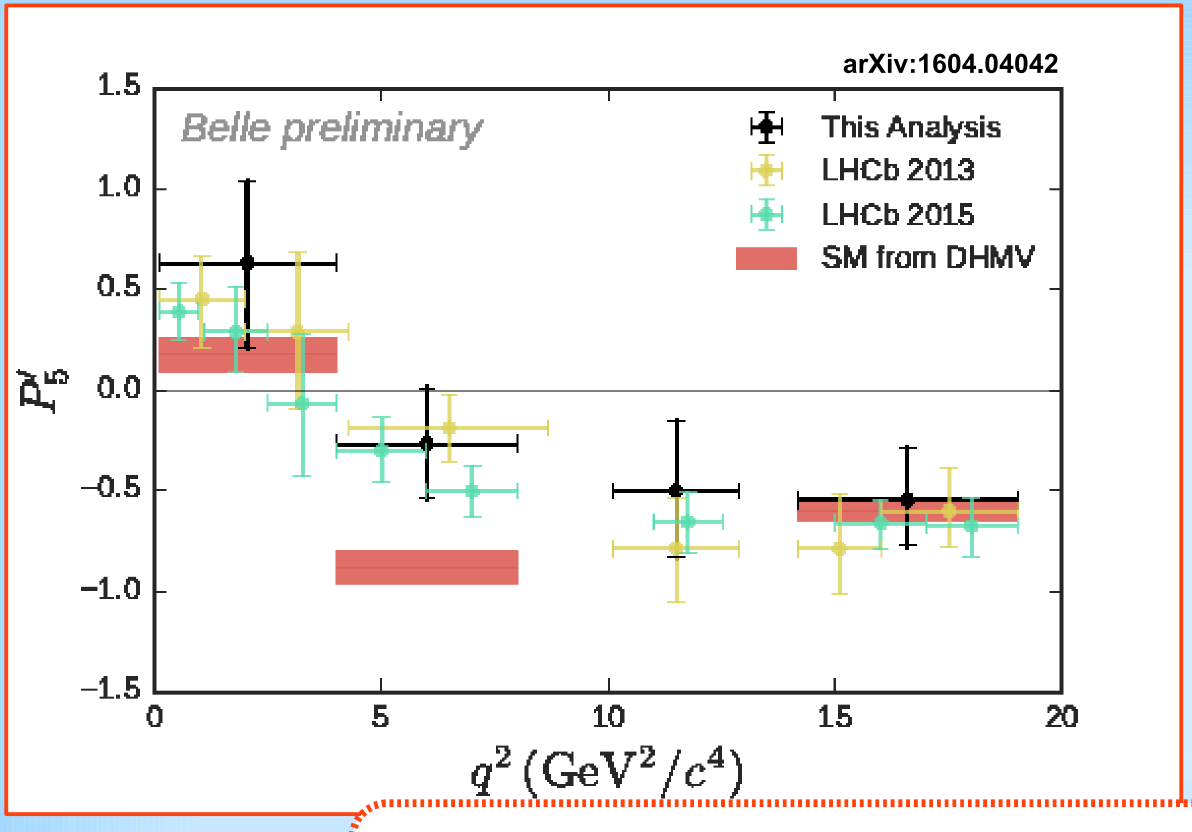


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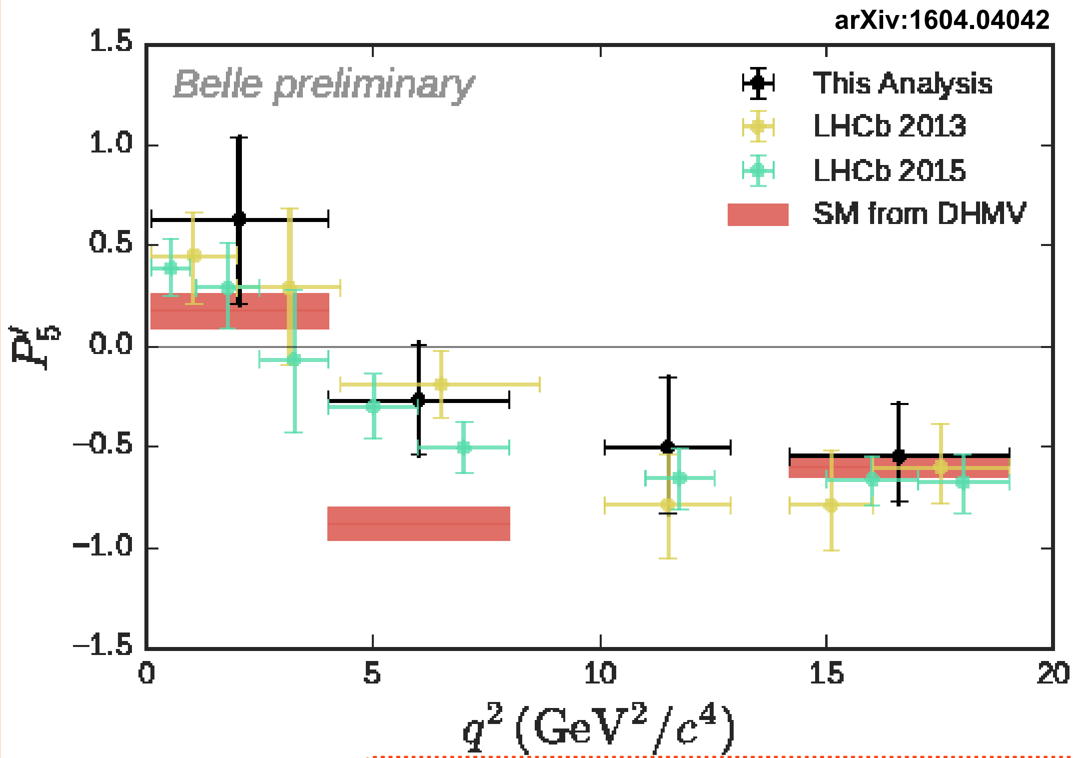


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❶ (+ ❷ + ❸) $\Rightarrow$ *There seems to be BSM LFNU and the effect is in μμ, not ee*

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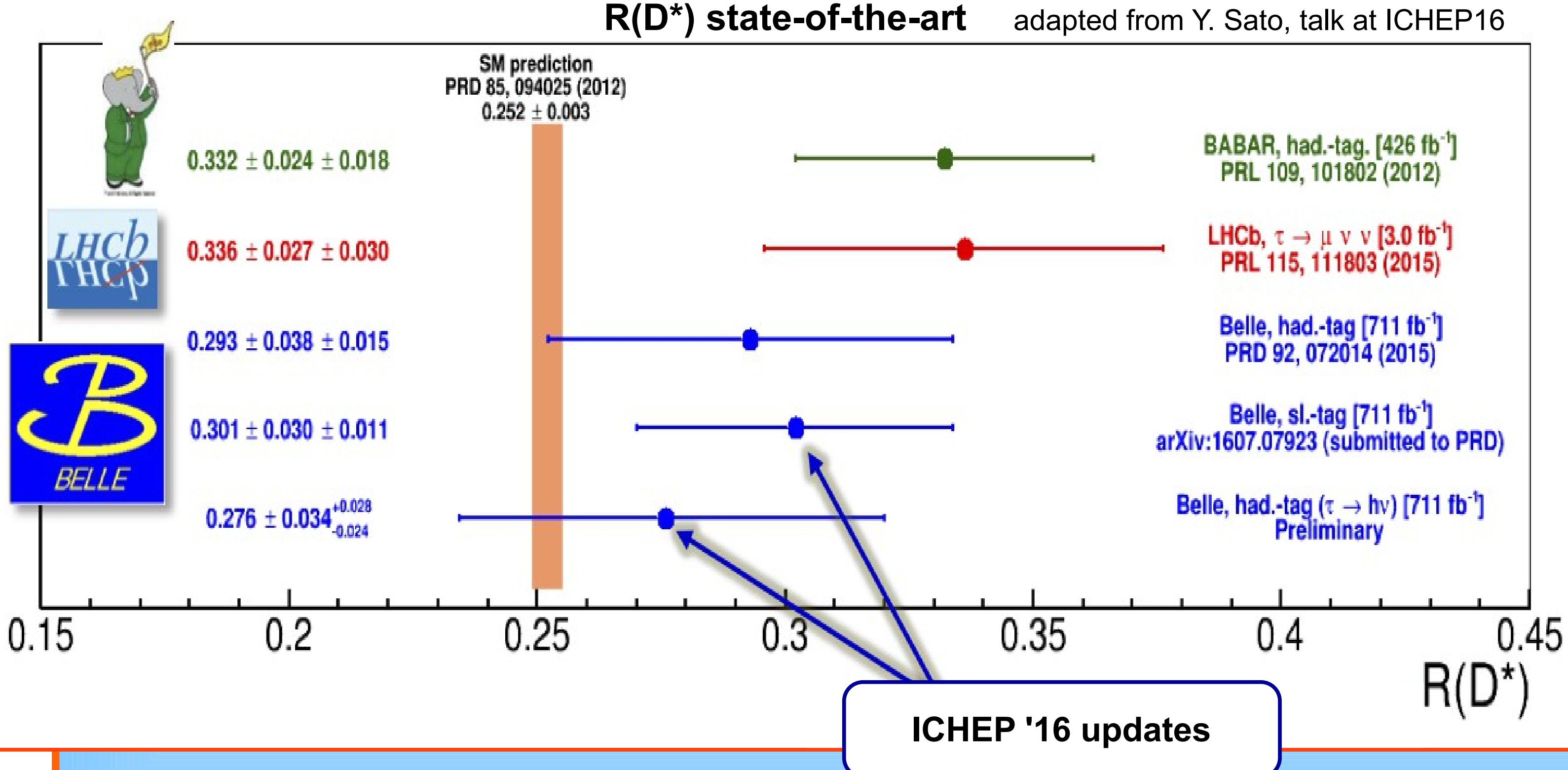

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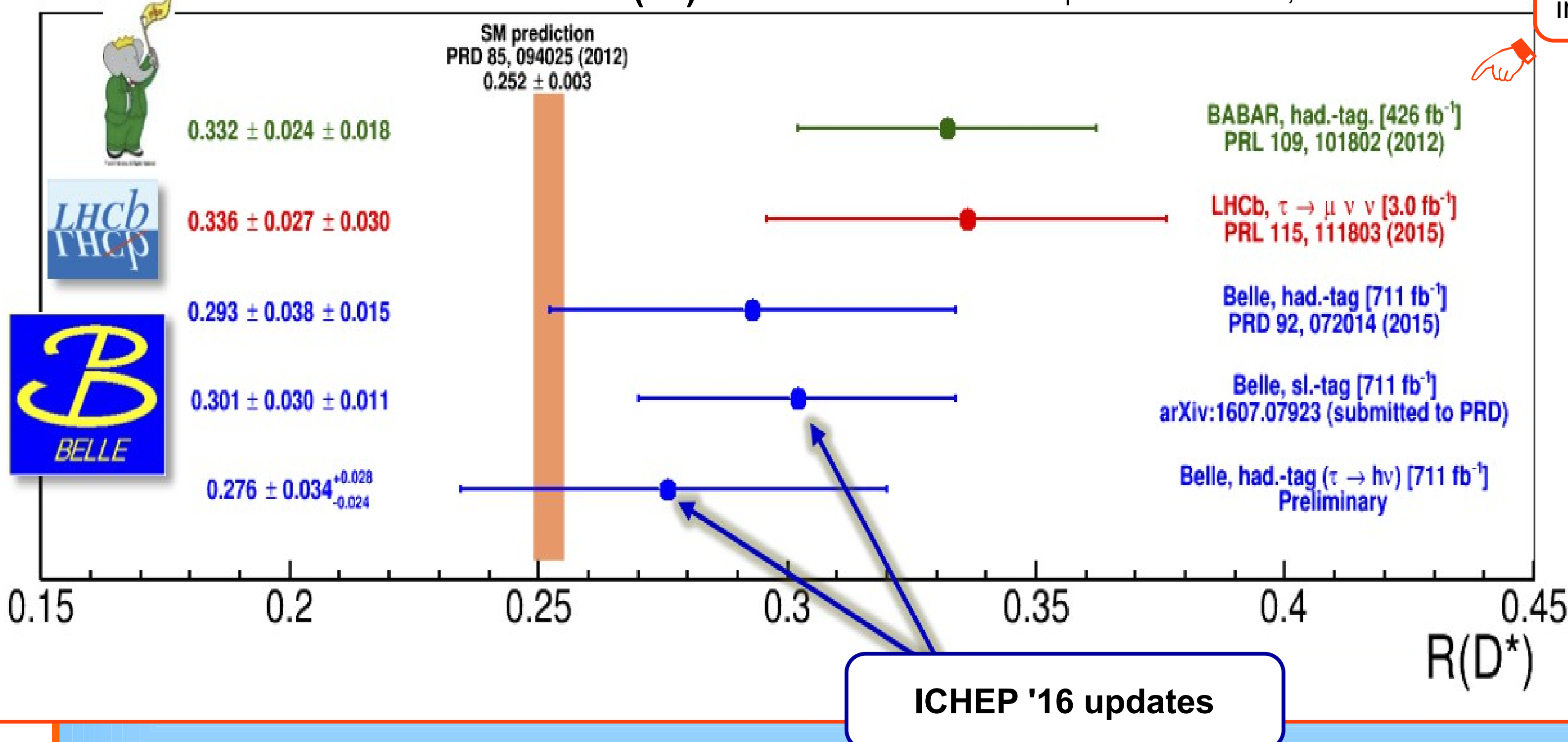

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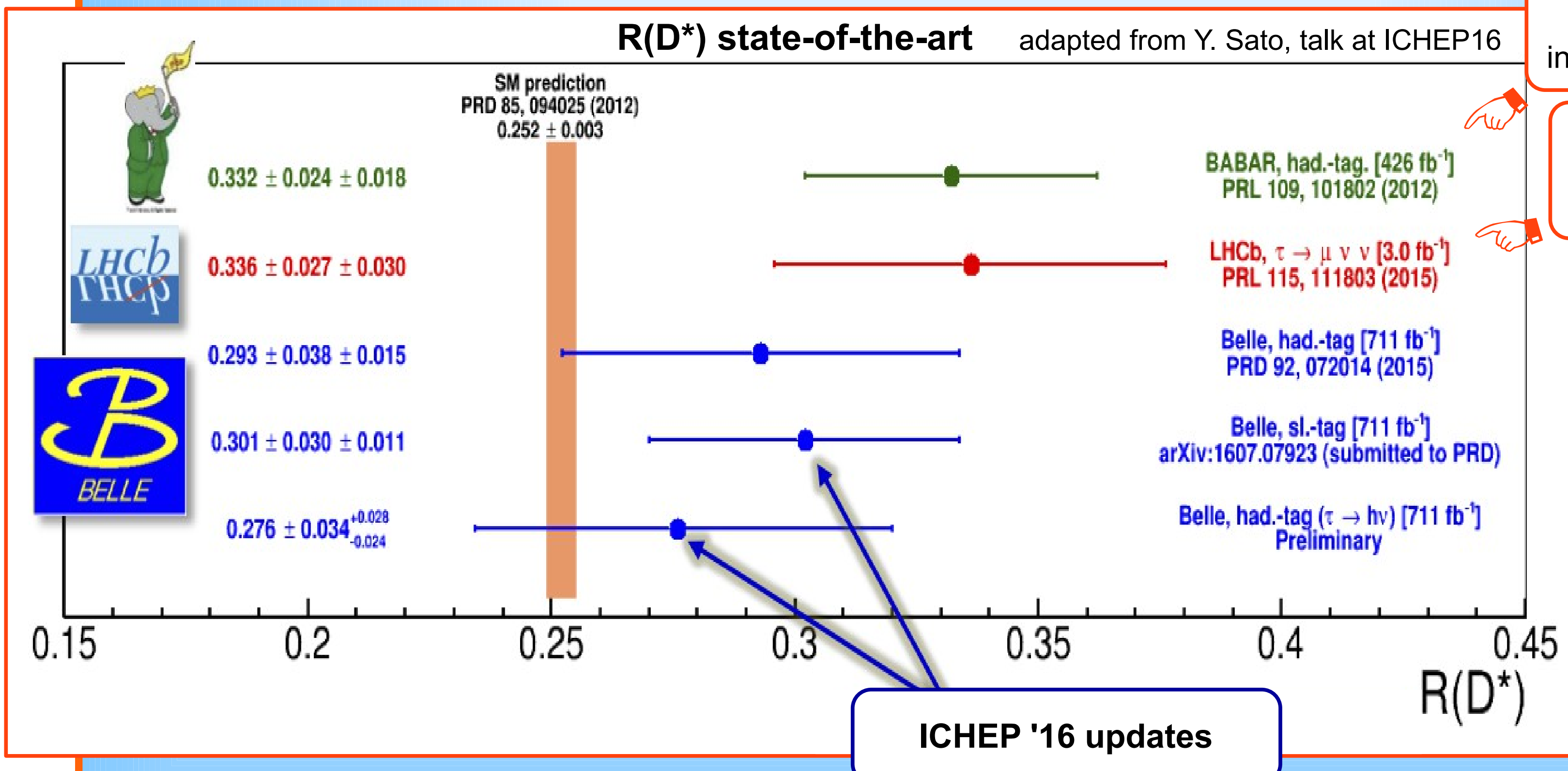


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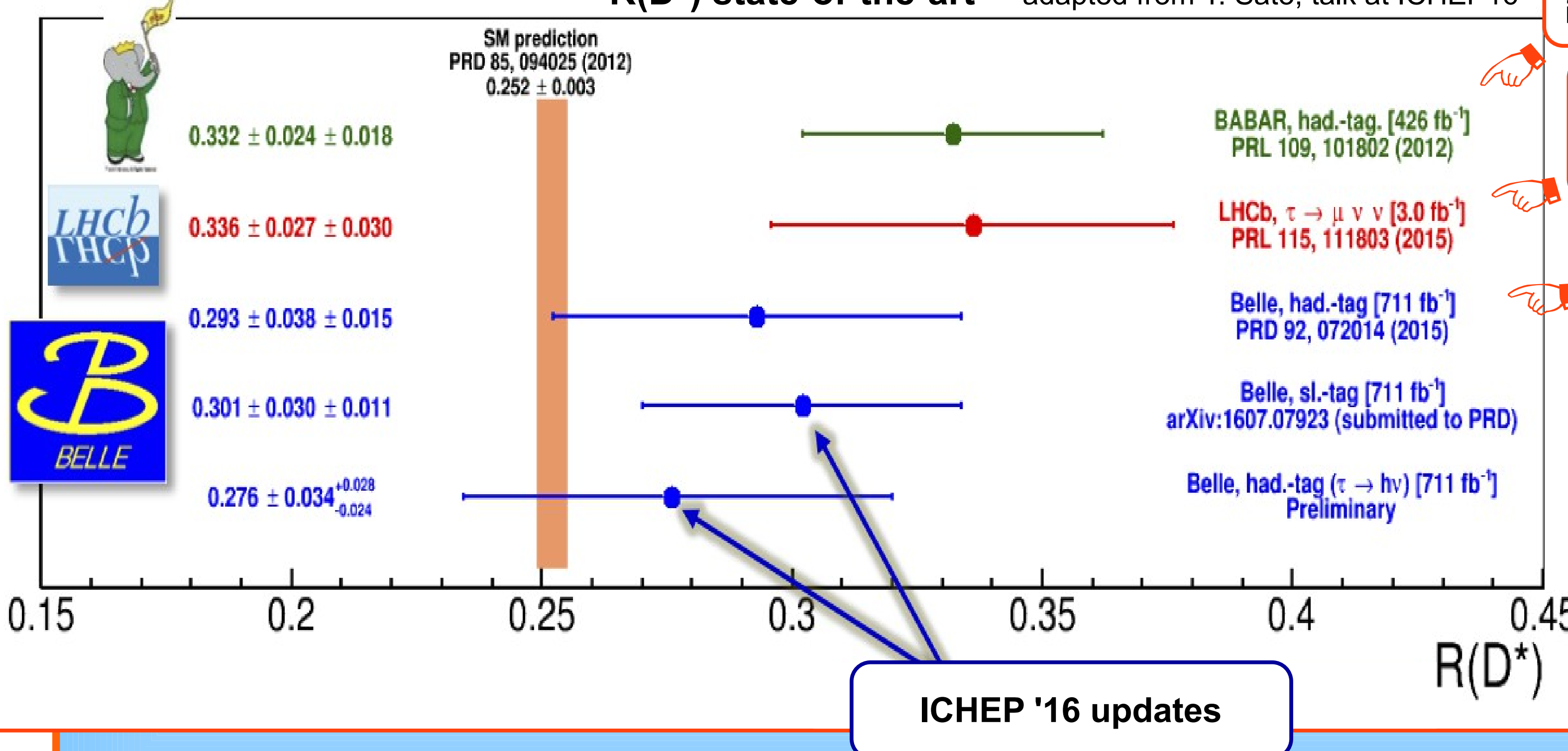


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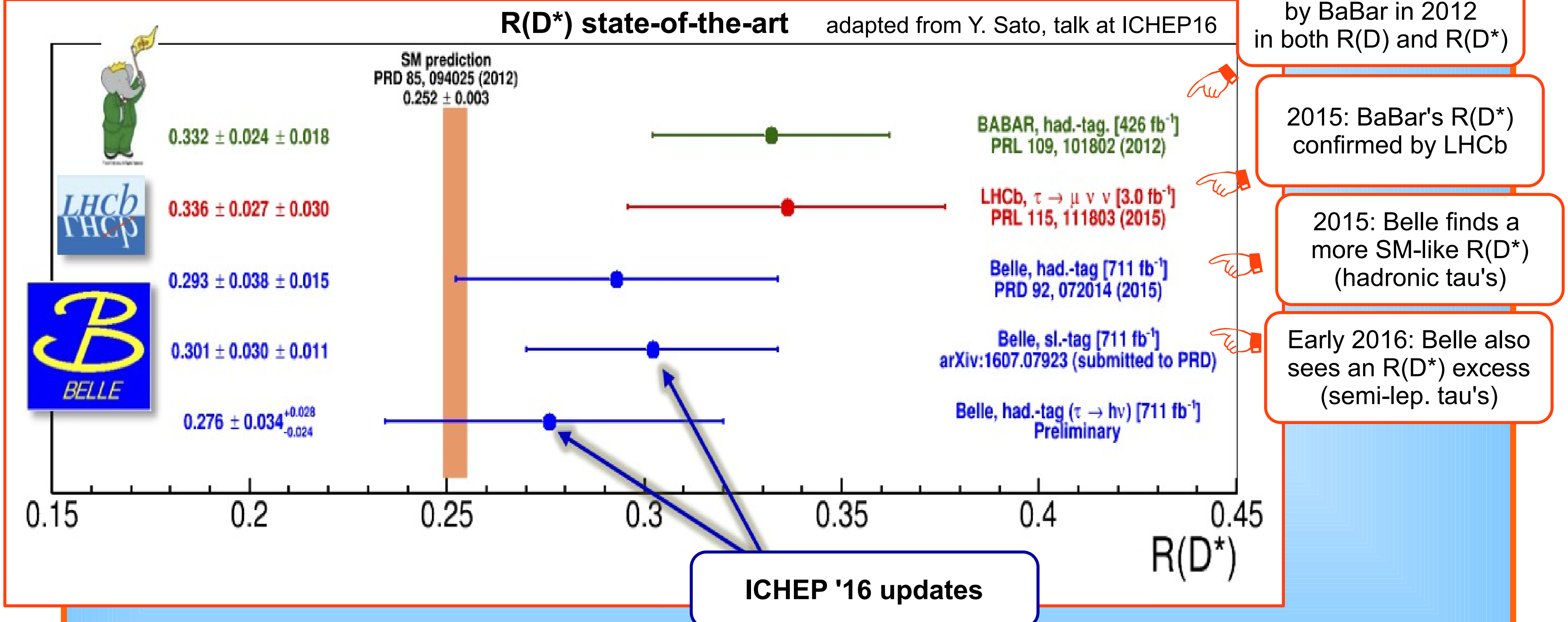

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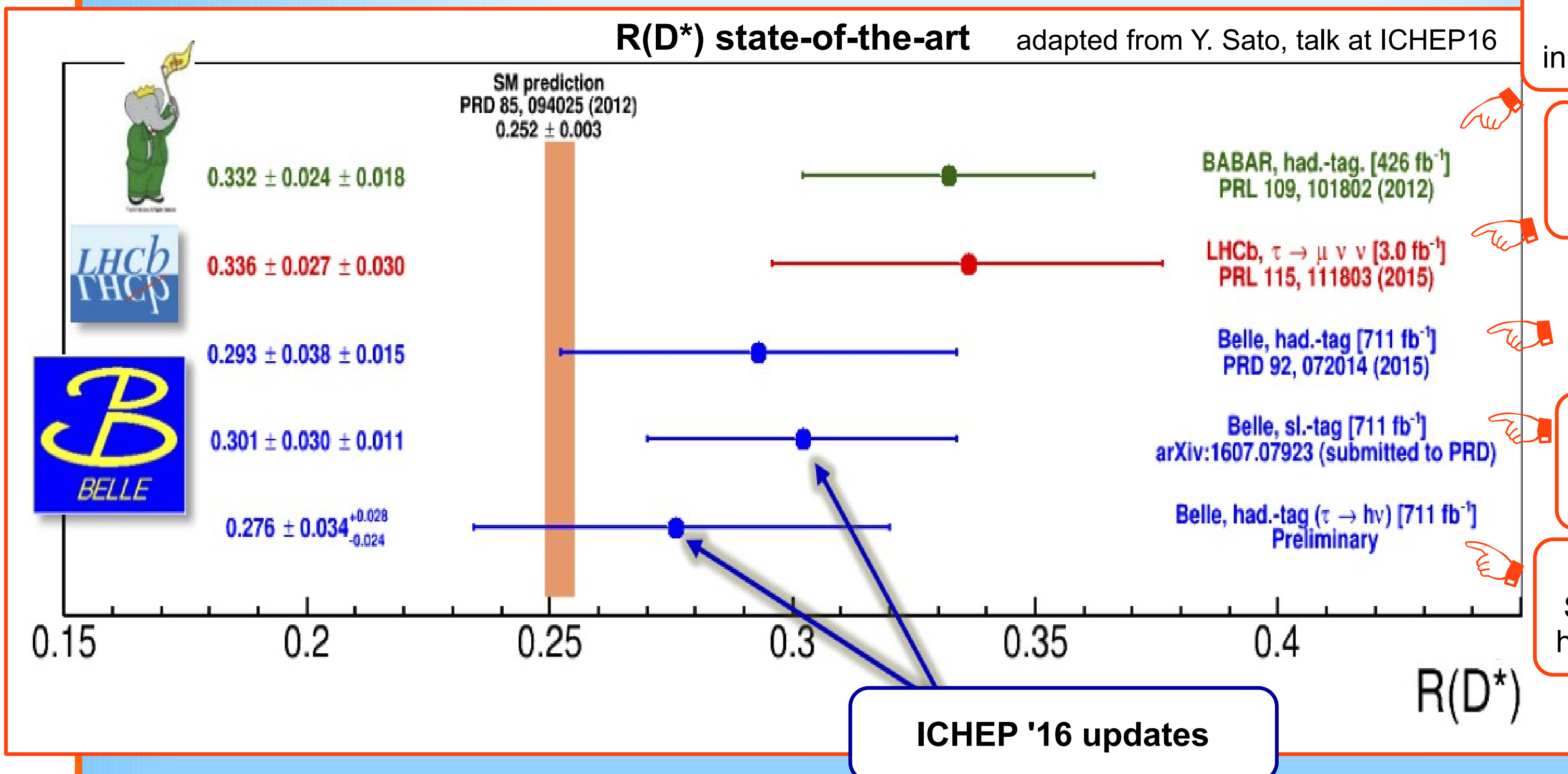


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2015: Belle finds a more SM-like R(D*) (hadronic tau's)

Early 2016: Belle also sees an R(D*) excess (semi-lep. tau's)

Summer '16: SM-like R(D*) in new had.-tag Belle analysis

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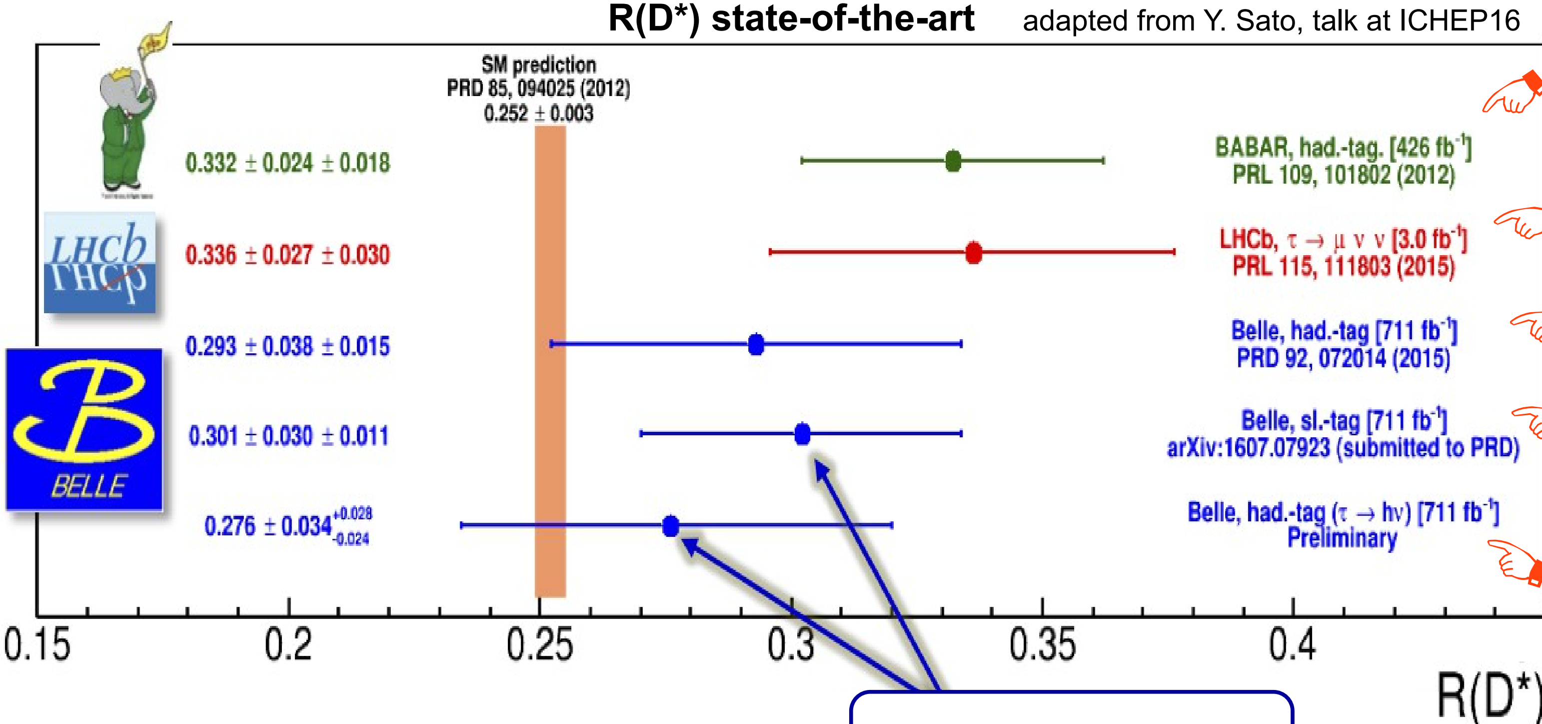


**All in all:**
Simultaneous fit to R(D) & R(D*) about 4σ away from SM

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- *Yet, focusing for the moment on the $b \to s$ discrepancies*

    - ***Q1:*** *Can we (easily) make theoretical sense of data?*
    - ***Q2:*** *What are the most immediate signatures to expect ?*

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- *Rotating q and $\ell$ to the mass eigenbasis generates LFV interactions.*

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*So, BSM LFNU* $\Rightarrow$ *BSM LFV (i.e. not suppressed by $m_\nu$)*

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- *Advocating the same (V – A) x (V – A) structure also for the corrections to $C_{9,10}^{SM}$ (in the μμ-channel only!) would account for:*
  - *$R_K$ lower than 1*
  - *$B \to K\mu\mu$ & $B_s \to \mu\mu$ BR data below predictions*
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- *A fully quantitative test requires a global fit.*

new physics contributions to the Wilson coefficients. We find that the by far largest decrease in the $\chi^2$ can be obtained either by a negative new physics contribution to $C_9$ (with $C_9^{\rm NP} \sim -30\% \times C_9^{\rm SM}$), or by new physics in the $SU(2)_L$ invariant direction $C_9^{\rm NP} = -C_{10}^{\rm NP}$, (with $C_9^{\rm NP} \sim -12\% \times C_9^{\rm SM}$). A positive NP contribution to $C_{10}$ alone would also improve the fit, although to a lesser extent. [Altmannshofer, Straub, EPJC '15]

*For analogous conclusions, see also* [Ghosh, Nardecchia, Renner, JHEP '14]

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Glashow et al., PRL 2015

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  - *This rotation induces* *<u>LFNU and LFV</u>* *effects*

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*implying (within our model) the correlations*

$$\frac{BR(B_s \to \mu\mu)_{exp}}{BR(B_s \to \mu\mu)_{SM}} \simeq R_K \simeq \frac{BR(B^+ \to K^+ \mu\mu)_{exp}}{BR(B^+ \to K^+ \mu\mu)_{SM}}$$

Another good reason to pursue accuracy in the $B_s \to \mu\mu$ measurement

See also Hiller, Schmaltz, PRD 14

## LFV model signatures

*As mentioned: if $R_K$ is signaling BSM LFNU, then expect BSM LFV as well*

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- ☑ *An analogous argument holds for purely leptonic modes*

## More on LFV model signatures

DG, Melikhov, Reboud, PLB 16

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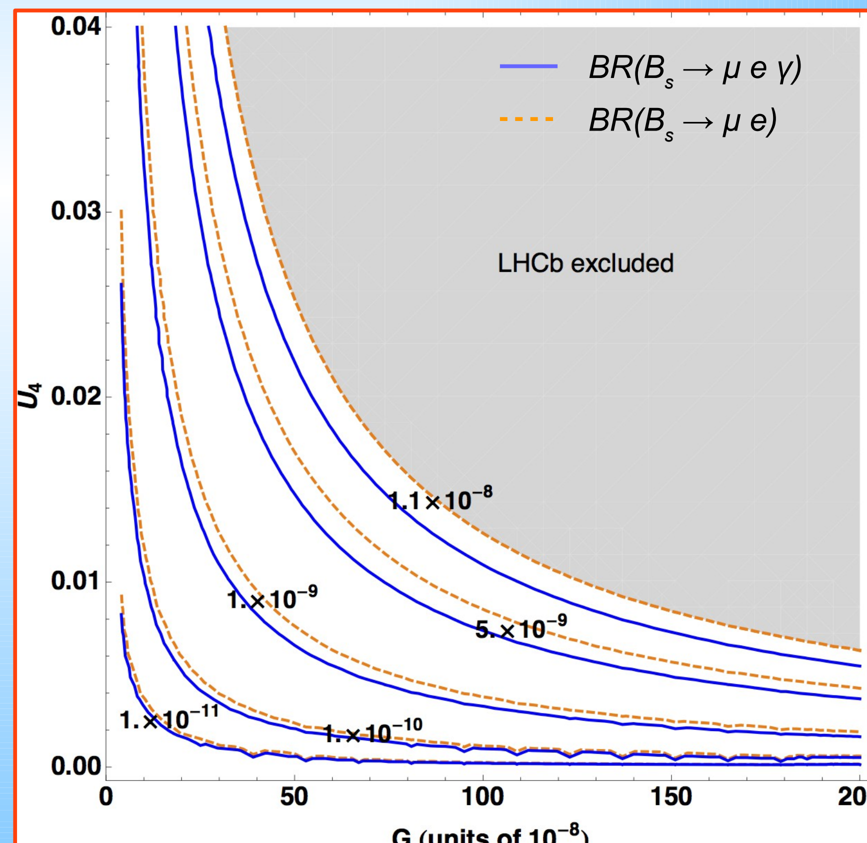


*Enhancement by ~ 30%*

*Inclusion of the radiative mode more-than-doubles statistics of the non-radiative*

See:
**Bhattacharya, Datta, London, Shivashankara,** PLB 15

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- *But this coin has a flip side.*

*Through RGE running, one gets also LFU-breaking effects in $\tau \to \ell\, \nu\, \nu$ (tested at per mil accuracy)*

*Such effects "strongly disfavour an explanation of the R(D(*)) anomaly model-independently"*

Feruglio, Paradisi, Pattori, 2016

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- *Early to draw conclusions. But Run II will provide a definite answer*

- *Timely to propose further tests. One promising direction is that of LFV.*
  *Plenty of channels, many of which largely untested.*