Precise measurement of the branching ratio of $B^0 \rightarrow D^{*-}\pi^+\pi^-\pi^+$ at BaBar

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On behalf of **BaBar** Collaboration

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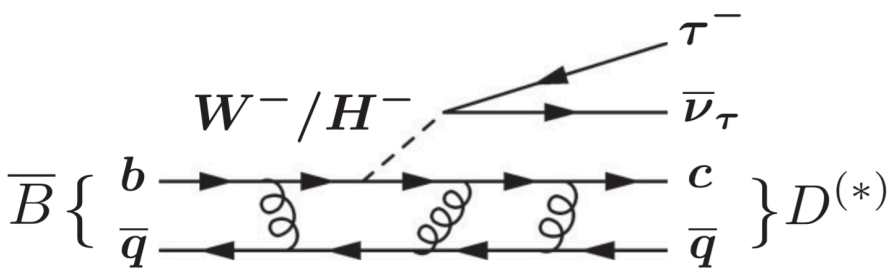
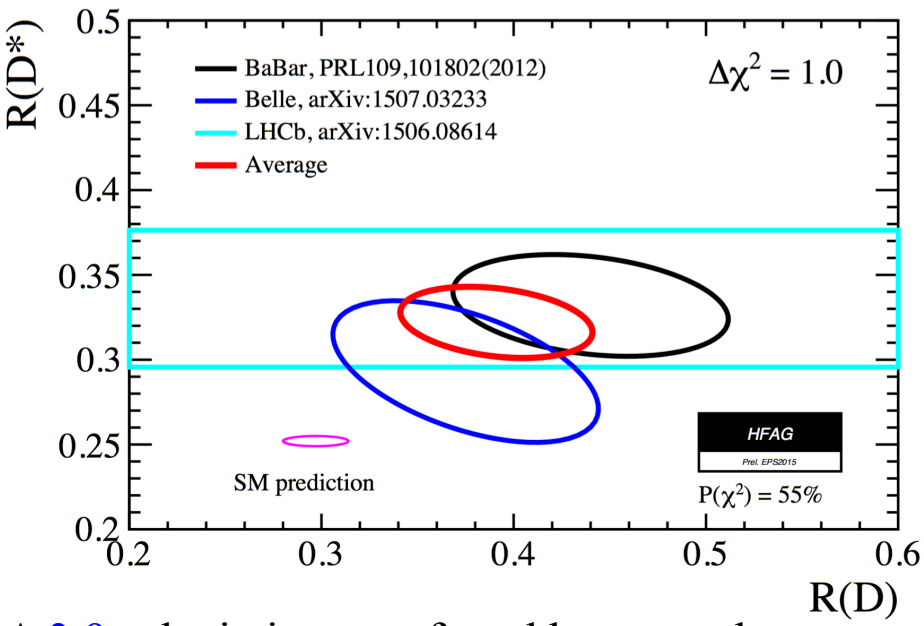
Semileptonic B decay





A 3.9σ deviation was found between the average of the measurements and the SM predictions

- $B^0 \to D^* \tau \nu$ is more sensitive to new physics than $B^0 \to D^* l \nu$ (l=e, μ) (e.g. charged Higgs)
- Relative ratios (independent of $|V_{cb}|$)

$$\mathcal{R}^{(*)} = \frac{\mathcal{B}(\overline{B} \to D^{(*)}\tau^-\overline{\nu}_\tau)}{\mathcal{B}(\overline{B} \to D^{(*)}\ell^-\overline{\nu})}$$

are measured by BaBar, Belle and LHCb

Phys. Rev. D.242 88, 072012 (2013)
Phys. Rev. D.244 92, 072014 (2015)
Phys. Rev. Lett.246 115, 111803 (2015)

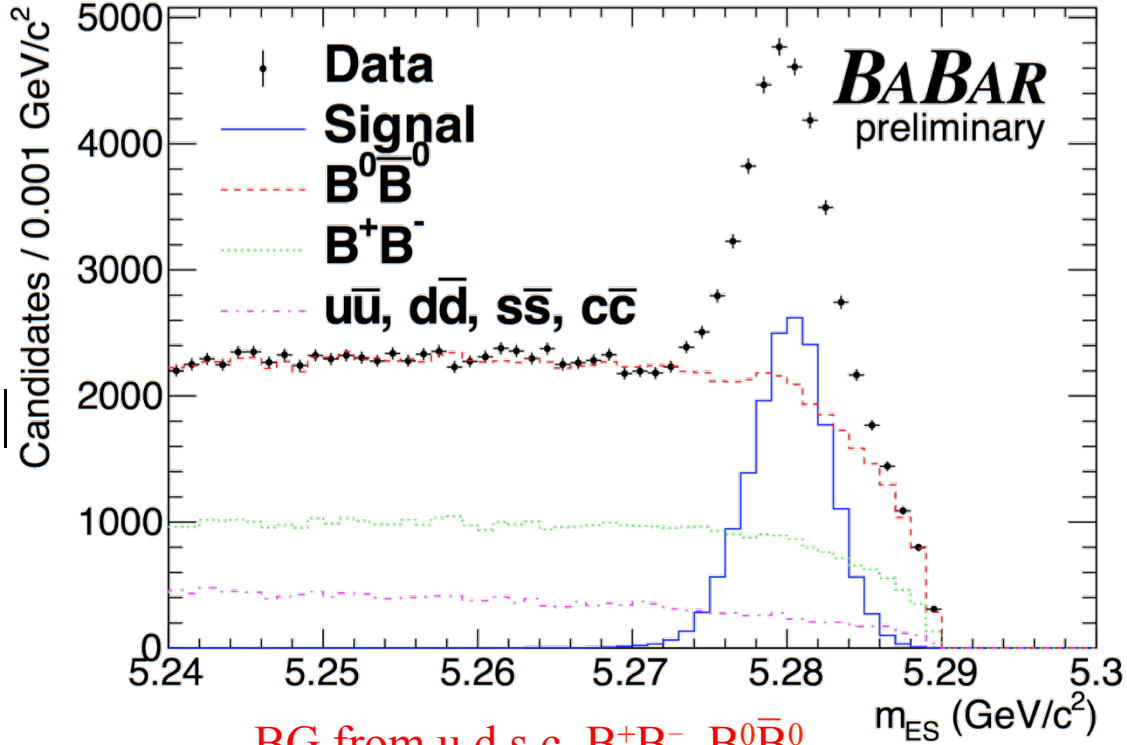
(New result from Belle with the semileptonic-tag method [hep-ex: 1603.06711] is not included in the average yet.)

- A measurement of a ratio $Br(B^0 \to D^* \tau \nu)$/ $Br(B^0 \to D^* 3\pi)$ using $\tau \to 3\pi\nu$ at a hadronic collider can further improve the R^* precision while it relies on a precise measurement of $Br(B^0 \to D^* 3\pi)$ (this talk)

(charge conjugate is implied)

Selection of $B^0 \rightarrow D^{*-}\pi^+\pi^-\pi^+$ candidates

- Full reconstruction of $B^0 \rightarrow D^{*-}\pi^+\pi^-\pi^+$ with $D^{*-} \rightarrow \bar{D}^0\pi^-$, $\bar{D}^0 \rightarrow K^+\pi^-$
- The reconstructed masses of $\bar{D}^0$ and D^{*-} are required to be consistent with the nominal ones
- A multilayer perceptron (MLP) classifier used to suppress non-$B\bar{B}$ backgrounds
- Finally a kinematic criterion $|\Delta E|=|E_B^{cm}-E_{ee}^{cm}/2|$ <90MeV is applied on the candidates
- Mass of B^0 candidates $m_{ES}=(s/4-(p_B^{cm})^2)^{1/2}$

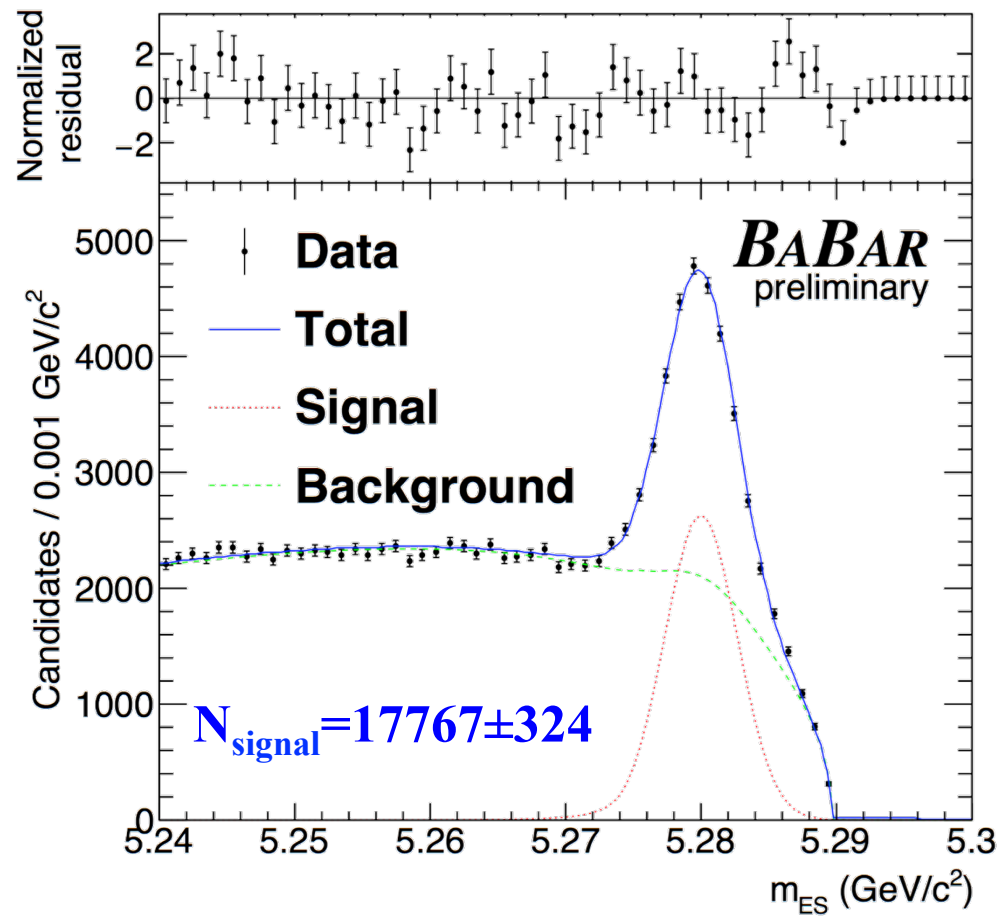


BG from u,d,s,c, B^+B^-, $B^0\bar{B}^0$ are stacked one by one

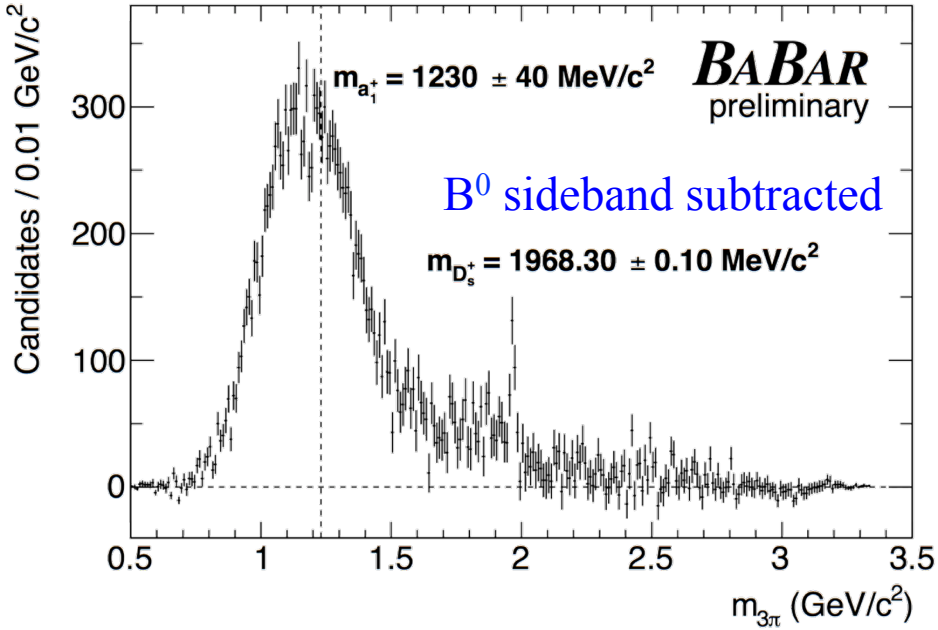
Extraction of $B^0 \rightarrow D^{*-}\pi^+\pi^-\pi^+$ events

An unbinned extended-maximum-likelihood fit:

- Signal: **Crystal ball** function
- Peaking background: **Gaussian** functions predicted by simulation
- Non-peaking background: **Argus** function



The 3π mass and preliminary results



Source	Uncertainty
fit algorithm and peaking background	2.4%
track-finding	2.0%
$\pi^+\pi^-\pi^+$ invariant mass modeling	1.7%
D^{*-} and $\overline{D}^0$ decay branching fractions	1.3%
$\Upsilon(4S) \to B^0\overline{B}^0$ decay branching fraction	1.2%
K^+ identification	1.1%
MC statistics	0.9%
$B\overline{B}$ counting	0.6%
Total	4.3%

- **a_1^+ dominates the $m_{3\pi}$ spectrum (peak is lower than PDG)**
- **Hint of π(1800) between 1.7 & 1.9GeV/c²**
- **Clear D_s^+ peak**
- ➢ **Efficiency is corrected as a function of $m_{3\pi}$** (=> produced n_{sig})

$Br(B^0 \to D^{*-}\pi^+\pi^-\pi^+)$=
$(7.26 \pm 0.11 \pm 0.31) \times 10^{-3}$
(without $B^0 \to D^{*-}D_s^+$)

$(7.37 \pm 0.11 \pm 0.31) \times 10^{-3}$ (with $B^0 \to D^{*-}D_s^+$)

Consistent with and 2.4 times more precise than the average of the previous measurements $(7.0 \pm 0.8)\times10^{-3}$ (PDG)

Summary

- ✧ A new measurement of $B(B^0 \rightarrow D^{*-}\pi^+\pi^-\pi^+)$ is performed at BaBar with a precision which is improved by a factor of 2.4 comparing to the current world average (PDG).

- ✧ The precise measurement of $B(B^0 \rightarrow D^{*-}\pi^+\pi^-\pi^+)$ at BaBar will be published in the near future.

- ✧ This result can significantly reduce the systematic uncertainty of extracting $Br(B^0 \rightarrow D^*\tau\nu)$ in a measurement of $Br(B^0 \rightarrow D^*\tau\nu)/Br(B^0 \rightarrow D^*3\pi)$ with $\tau \rightarrow 3\pi\nu$ at a hadronic collider.

THANK YOU FOR YOUR ATTENTION!