

$P_{c\bar{c}}(4457)^+$  $I(J^P) = \frac{1}{2}(??)$  Status: \*

OMITTED FROM SUMMARY TABLE  
was  $P_c(4450)$

A resonance seen in  $\Lambda_b^0 \rightarrow P_c^+ K^-$ , then  $P_c \rightarrow J/\psi p$ , with a significance of 12 standard deviations. The  $J/\psi p$  quark content is  $uudc\bar{c}$ , a pentaquark. See also the  $P_{c\bar{c}}(4380)^+$ . In the best amplitude fit, the two states have opposite parity, one having  $J = 3/2$ , the other  $J = 5/2$ .

Extraction of the pentaquark signals requires some understanding of the dominant  $K^- p$  background. AAIJ 15P used a model-dependent approach. AAIJ 16AG reanalyzed the data making minimal assumptions about the  $K^- p$  background, and thus confirmed the strong significance of the pentaquark signals.

 **$P_{c\bar{c}}(4457)^+$  MASS**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
$4457.3 \pm 0.6^{+4.1}_{-1.7}$	AAIJ	19W	LHCB $p p$ at 7, 8, 13 TeV
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$4449.8 \pm 1.7 \pm 2.5$	<sup>1</sup> AAIJ	15P	LHCB Repl. by AAIJ 19W
<sup>1</sup> Considering $P_{c\bar{c}}(4440)$ and $P_{c\bar{c}}(4457)$ as a single resonance.			

 **$P_{c\bar{c}}(4457)^+$  WIDTH**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
$6.4 \pm 2.0^{+5.7}_{-1.9}$	AAIJ	19W	LHCB $p p$ at 7, 8, 13 TeV
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$39 \pm 5 \pm 19$	<sup>1</sup> AAIJ	15P	LHCB Repl. by AAIJ 19W
<sup>1</sup> Considering $P_{c\bar{c}}(4440)$ and $P_{c\bar{c}}(4457)$ as a single resonance.			

 **$P_{c\bar{c}}(4457)^+$  DECAY MODES**

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $J/\psi p$	seen
$\Gamma_2$ $\Lambda_c^+ \bar{D}^0$	not seen
$\Gamma_3$ $\Lambda_c^+ \pi^+ D^-$	not seen
$\Gamma_4$ $\Sigma_c(2455)^{++} D^-$	not seen
$\Gamma_5$ $\Sigma_c(2520)^{++} D^-$	not seen
$\Gamma_6$ $\bar{\Lambda}_c^- \pi^+ D^+$	[a] not seen
$\Gamma_7$ $\bar{\Sigma}_c(2455)^0 D^+$	[a] not seen
$\Gamma_8$ $\bar{\Sigma}_c(2520)^0 D^+$	[a] not seen

$\Gamma_9$	$\Lambda_c^+ \pi^+ D^{*-}$	not seen
$\Gamma_{10}$	$\bar{\Lambda}_c^- \pi^+ D^{*+}$	[a] not seen

[a] Searched for the charge conjugate mode from  $\bar{P}_{c\bar{c}}^-$  decays.

### $P_{c\bar{c}}(4457)^+$ BRANCHING RATIOS

$\Gamma(J/\psi p)/\Gamma_{\text{total}}$				$\Gamma_1/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
seen	<sup>1</sup> POPOV	21	D0	$p\bar{p}$ at 1.96 TeV
seen	AAIJ	19W	LHCB	$pp$ at 7, 8, 13 TeV
<b>seen</b>	AAIJ	15P	LHCB	$pp$ at 7, 8 TeV

<sup>1</sup> Search for  $J/\psi$  inclusive production in association with a charged particle, assumed to be a proton. POPOV 21 observes a resonant signal consistent with a superposition of the  $P_{c\bar{c}}(4440)^+$  and  $P_{c\bar{c}}(4457)^+$ , using masses and widths measured by AAIJ 19W, at significance of  $3\sigma$ .

$\Gamma(\Lambda_c^+ \bar{D}^0)/\Gamma_{\text{total}}$				$\Gamma_2/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
<b>not seen</b>	AAIJ	24Z	LHCB	$pp$ , $5.7 \text{ fb}^{-1}$ at 13 TeV

$\Gamma(\Lambda_c^+ \pi^+ D^-)/\Gamma_{\text{total}}$				$\Gamma_3/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
<b>not seen</b>	AAIJ	24Z	LHCB	$pp$ , $5.7 \text{ fb}^{-1}$ at 13 TeV

$\Gamma(\Sigma_c(2455)^{++} D^-)/\Gamma_{\text{total}}$				$\Gamma_4/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
<b>not seen</b>	AAIJ	24Z	LHCB	$pp$ , $5.7 \text{ fb}^{-1}$ at 13 TeV

$\Gamma(\Sigma_c(2520)^{++} D^-)/\Gamma_{\text{total}}$				$\Gamma_5/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
<b>not seen</b>	AAIJ	24Z	LHCB	$pp$ , $5.7 \text{ fb}^{-1}$ at 13 TeV

$\Gamma(\bar{\Lambda}_c^- \pi^+ D^+)/\Gamma_{\text{total}}$				$\Gamma_6/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
<b>not seen</b>	AAIJ	24Z	LHCB	$\bar{P}_{c\bar{c}}^- \rightarrow \Lambda_c^+ \pi^- D^-$

$\Gamma(\bar{\Sigma}_c(2455)^0 D^+)/\Gamma_{\text{total}}$				$\Gamma_7/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
<b>not seen</b>	AAIJ	24Z	LHCB	$\bar{P}_{c\bar{c}}^- \rightarrow \Sigma_c(2455)^0 D^-$

$\Gamma(\bar{\Sigma}_c(2520)^0 D^+)/\Gamma_{\text{total}}$				$\Gamma_8/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
<b>not seen</b>	AAIJ	24Z	LHCB	$\bar{P}_{c\bar{c}}^- \rightarrow \Sigma_c(2520)^0 D^-$

$\Gamma(\Lambda_c^+ \pi^+ D^{*-})/\Gamma_{\text{total}}$				$\Gamma_9/\Gamma$
VALUE	DOCUMENT ID	TECN	COMMENT	
<b>not seen</b>	AAIJ	24Z	LHCB	$pp$ , $5.7 \text{ fb}^{-1}$ at 13 TeV

$\Gamma(\bar{\Lambda}_c^- \pi^+ D^{*+})/\Gamma_{\text{total}}$				$\Gamma_{10}/\Gamma$
<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>	
not seen	AAIJ	24Z	LHCB	$\bar{P}_{c\bar{c}}^- \rightarrow \Lambda_c^+ \pi^- D^{*-}$

### $P_{c\bar{c}}(4457)^+$ REFERENCES

AAIJ	24Z	PR D110 032001	R. Aaij <i>et al.</i>	(LHCb Collab.)
POPOV	21	PAN 83 1383	A.V. Popov <i>et al.</i>	(D0 Collab.)
AAIJ	19W	PRL 122 222001	R. Aaij <i>et al.</i>	(LHCb Collab.)
AAIJ	16AG	PRL 117 082002	R. Aaij <i>et al.</i>	(LHCb Collab.)
AAIJ	15P	PRL 115 072001	R. Aaij <i>et al.</i>	(LHCb Collab.)