Reference = LEES 14M; PR D90 112010
Verifier code = BABAR

Normally we send all verifications for one experiment to one person, usually the spokesperson or data-analysis co-ordinator, who then distributes them to the appropriate people. Please tell us if we should send the verifications for your experiment to someone else.

PLEASE READ NOW

PLEASE REPLY WITHIN ONE WEEK

Fabio Anulli

EMAIL: anulli@slac.stanford.edu

March 20, 2017

Dear Colleague,

(1) Please check the results of your experiment carefully. They are marked.

(2) Please reply within one week.

(3) Please reply even if everything is correct.

(4) IMPORTANT!! Please tell WHICH papers you are verifying. We have lots of requests out.

(5) Feel free to make comments on our treatment of any of the results (not just yours) you see.

Thank you for helping us make the Review accurate and useful.

Sincerely,

Simon Eidelman
BINP, Budker Inst. of Nuclear Physics
Prospekt Lavrent'eva 11
RU-630090 Novosibirsk
Russian Federation

EMAIL: simon.eidelman@cern.ch

$b\bar{b}$ MESONS

NODE=MXXX030

$\chi_{b0}(1P)$

NODE=M076

$I^G(J^{PC}) = 0^+(0^{++})$
J needs confirmation.

Observed in radiative decay of the $\Upsilon(2S)$, therefore $C = +$. Branching ratio requires E1 transition, M1 is strongly disfavored, therefore $P = +$.

NODE=M076

$m_{\chi_{b1}(1P)} - m_{\chi_{b0}(1P)}$

NODE=M076M2

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
YOUR DATA **32.49±0.93**	LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$

NODE=M076M2

$\chi_{b0}(1P)$ BRANCHING RATIOS

NODE=M076220

$\Gamma(\gamma\Upsilon(1S))/\Gamma_{\text{total}}$ Γ_1/Γ

NODE=M076R1

VALUE (%)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
1.95±0.27 OUR AVERAGE						
YOUR DATA 2.08±0.24±0.21			[1,2] LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$
1.76±0.30±0.18		87	[2,3] KORNICER	11	CLEO	$e^+e^- \to \gamma\gamma\ell^+\ell^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •						
< 4.6	90		[4] LEES	11J	BABR	$\Upsilon(2S) \to X\gamma$
< 6	90		WALK	86	CBAL	$\Upsilon(2S) \to \gamma\gamma\ell^+\ell^-$
<11	90		PAUSS	83	CUSB	$\Upsilon(2S) \to \gamma\gamma\ell^+\ell^-$

NODE=M076R1

YOUR NOTE [1] LEES 14M quotes $\Gamma(\chi_{b0}(1P) \to \gamma\Upsilon(1S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(2S) \to \gamma\chi_{b0}(1P))/\Gamma_{\text{total}} = (7.8 \pm 0.9) \times 10^{-4}$ combining the results from samples of $\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$ with and without converted photons

NODE=M076R1;LINKAGE=A

YOUR NOTE [2] Assuming $B(\Upsilon(1S) \to \ell^+\ell^-) = (2.48 \pm 0.05)\%$.

NODE=M076R1;LINKAGE=KA

[3] KORNICER 11 reports $[\Gamma(\chi_{b0}(1P) \to \gamma\Upsilon(1S))/\Gamma_{\text{total}}] \times [B(\Upsilon(2S) \to \gamma\chi_{b0}(1P))] = (6.59 \pm 0.96 \pm 0.60) \times 10^{-4}$ which we divide by our best value $B(\Upsilon(2S) \to \gamma\chi_{b0}(1P)) = (3.8 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

NODE=M076R1;LINKAGE=KR

YOUR NOTE [4] LEES 11J quotes a central value of $\Gamma(\chi_{b0}(1P) \to \gamma\Upsilon(1S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(2S) \to \gamma\chi_{b0}(1P))/\Gamma_{\text{total}} = (8.3 \pm 5.6^{+3.7}_{-2.6}) \times 10^{-4}$.

NODE=M076R1;LINKAGE=LE

$\chi_{b0}(1P)$ CROSS-PARTICLE BRANCHING RATIOS

NODE=M076230

$B(\chi_{b0}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(2S) \to \gamma\chi_{b0}(1P)) \times B(\Upsilon(1S) \to \ell^+\ell^-)$

NODE=M076B01

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
1.67±0.28 OUR AVERAGE					
YOUR DATA $2.9\ ^{+1.7}_{-1.4}\ ^{+0.1}_{-0.8}$		[25] LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$
1.63±0.24±0.15	87	KORNICER	11	CLEO	$e^+e^- \to \gamma\gamma\ell^+\ell^-$

NODE=M076B01

YOUR NOTE [25] From a sample of $\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$ with one converted photon

NODE=M076B01;LINKAGE=A

$[B(\chi_{b0}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(2S) \to \gamma\chi_{b0}(1P))] / [B(\chi_{b1}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(2S) \to \gamma\chi_{b1}(1P))]$

NODE=M076A01

VALUE (%)	DOCUMENT ID		TECN	COMMENT
YOUR DATA **3.28±0.37**	[26] LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$

NODE=M076A01

YOUR NOTE [26] From a sample of $\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$ without converted photons

NODE=M076A01;LINKAGE=A

$\chi_{b0}(1P)$ REFERENCES

NODE=M076

YOUR PAPER	LEES	14M	PR D90 112010	J.P. Lees *et al.*	(BABAR Collab.)	REFID=56343
	KORNICER	11	PR D83 054003	M. Kornicer *et al.*	(CLEO Collab.)	REFID=16769
	LEES	11J	PR D84 072002	J.P. Lees *et al.*	(BABAR Collab.)	REFID=53936
	WALK	86	PR D34 2611	W.S. Walk *et al.*	(Crystal Ball Collab.)	REFID=22290
	PAUSS	83	PL 130B 439	F. Pauss *et al.*	(MPIM, COLU, CORN, LSU+)	REFID=22286

NODE=M077

$\chi_{b1}(1P)$

$I^G(J^{PC}) = 0^+(1^{++})$
J needs confirmation.

Observed in radiative decay of the $\Upsilon(2S)$, therefore $C = +$. Branching ratio requires E1 transition, M1 is strongly disfavored, therefore $P = +$. $J = 1$ from SKWARNICKI 87.

NODE=M077

$\chi_{b1}(1P)$ BRANCHING RATIOS

NODE=M077220

$\Gamma(\gamma\Upsilon(1S))/\Gamma_{total}$ Γ_1/Γ

NODE=M077R1
NODE=M077R1

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.350±0.021 OUR AVERAGE					
0.364±0.017±0.019		[1,2] LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$
0.331±0.018±0.017	3222	[2,3] KORNICER	11	CLEO	$e^+e^- \to \gamma\gamma\ell^+\ell^-$
0.350±0.023±0.018	13k	[4] LEES	11J	BABR	$\Upsilon(2S) \to X\gamma$
0.34 ±0.07 ±0.02	53	[2,5,6] WALK	86	CBAL	$\Upsilon(2S) \to \gamma\gamma\ell^+\ell^-$
0.47 ±0.18		KLOPFEN...	83	CUSB	$\Upsilon(2S) \to \gamma\gamma\ell^+\ell^-$

YOUR DATA

YOUR NOTE [1] LEES 14M quotes $\Gamma(\chi_{b1}(1P) \to \gamma\Upsilon(1S))/\Gamma_{total} \times \Gamma(\Upsilon(2S) \to \gamma\chi_{b1}(1P))/\Gamma_{total}$ = (2.51 ± 0.12) % combining the results from samples of $\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$ with and without converted photons — NODE=M077R1;LINKAGE=B

YOUR NOTE [2] Assuming $B(\Upsilon(1S) \to \ell^+\ell^-) = (2.48 \pm 0.05)\%$. — NODE=M077R1;LINKAGE=KA

[3] KORNICER 11 reports $[\Gamma(\chi_{b1}(1P) \to \gamma\Upsilon(1S))/\Gamma_{total}] \times [B(\Upsilon(2S) \to \gamma\chi_{b1}(1P))] = (22.8 \pm 0.4 \pm 1.2) \times 10^{-3}$ which we divide by our best value $B(\Upsilon(2S) \to \gamma\chi_{b1}(1P)) = (6.9 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. — NODE=M077R1;LINKAGE=KR

[4] LEES 11J reports $[\Gamma(\chi_{b1}(1P) \to \gamma\Upsilon(1S))/\Gamma_{total}] \times [B(\Upsilon(2S) \to \gamma\chi_{b1}(1P))] = (24.1 \pm 0.6 \pm 1.5) \times 10^{-3}$ which we divide by our best value $B(\Upsilon(2S) \to \gamma\chi_{b1}(1P)) = (6.9 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. — NODE=M077R1;LINKAGE=LE

[5] WALK 86 quotes $B(\Upsilon(2S) \to \gamma\chi_{b1}(1P)) \times B(\chi_{b1}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(1S) \to \ell^+\ell^-) = (5.8 \pm 0.9 \pm 0.7)$ %. — NODE=M077R1;LINKAGE=A

[6] WALK 86 reports $[\Gamma(\chi_{b1}(1P) \to \gamma\Upsilon(1S))/\Gamma_{total}] \times [B(\Upsilon(2S) \to \gamma\chi_{b1}(1P))] = (23.4 \pm 3.63 \pm 2.82) \times 10^{-3}$ which we divide by our best value $B(\Upsilon(2S) \to \gamma\chi_{b1}(1P)) = (6.9 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. — NODE=M077R1;LINKAGE=C

$\chi_{b1}(1P)$ Cross-Particle Branching Ratios

NODE=M077230

$B(\chi_{b1}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(2S) \to \gamma\chi_{b1}(1P)) \times B(\Upsilon(1S) \to \ell^+\ell^-)$

NODE=M077B01
NODE=M077B01

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
5.90±0.34 OUR AVERAGE Error includes scale factor of 1.3. See the ideogram below.					
$6.86^{+0.47}_{-0.45}{}^{+0.44}_{-0.35}$		[25] LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$
5.65±0.11±0.27	3222	KORNICER	11	CLEO	$e^+e^- \to \gamma\gamma\ell^+\ell^-$
5.8 ±0.9 ±0.7	53	WALK	86	CBAL	$\Upsilon(2S) \to \gamma\gamma\ell^+\ell^-$

YOUR DATA

YOUR NOTE [25] From a sample of $\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$ with one converted photon — NODE=M077B01;LINKAGE=A

$B(\chi_{b1}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(3S) \to \gamma\chi_{b1}(1P)) \times B(\Upsilon(1S) \to \ell^+\ell^-)$

NODE=M077B02
NODE=M077B02

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
1.30±0.34 OUR AVERAGE					
$1.16^{+0.78}_{-0.67}{}^{+0.14}_{-0.16}$		[26] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
1.33±0.30±0.23	50	KORNICER	11	CLEO	$e^+e^- \to \gamma\gamma\ell^+\ell^-$

YOUR DATA

YOUR NOTE [26] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with converted photons — NODE=M077B02;LINKAGE=A

$\chi_{b1}(1P)$ REFERENCES

NODE=M077

LEES	14M	PR D90 112010	J.P. Lees *et al.*	(BABAR Collab.)	REFID=56343
KORNICER	11	PR D83 054003	M. Kornicer *et al.*	(CLEO Collab.)	REFID=16769
LEES	11J	PR D84 072002	J.P. Lees *et al.*	(BABAR Collab.)	REFID=53936
SKWARNICKI	87	PRL 58 972	T. Skwarnicki *et al.*	(Crystal Ball Collab.) J	REFID=40019
WALK	86	PR D34 2611	W.S. Walk *et al.*	(Crystal Ball Collab.)	REFID=22290
KLOPFEN...	83	PRL 51 160	C. Klopfenstein *et al.*	(CUSB Collab.)	REFID=22285

YOUR PAPER

NODE=M078

$\chi_{b2}(1P)$

$I^G(J^{PC}) = 0^+(2^{++})$
J needs confirmation.

Observed in radiative decay of the $\Upsilon(2S)$, therefore $C = +$. Branching ratio requires E1 transition, M1 is strongly disfavored, therefore $P = +$. $J = 2$ from SKWARNICKI 87.

NODE=M078

$m_{\chi_{b2}(1P)} - m_{\chi_{b1}(1P)}$

NODE=M078DM2

VALUE (MeV)		DOCUMENT ID		TECN	COMMENT
19.10±0.25 OUR AVERAGE	Error includes scale factor of 1.1.				
19.81±0.65±0.20	[1]	AAIJ	14BG	LHCB	$pp \to \gamma\mu^+\mu^- X$
YOUR DATA 19.01±0.24		LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$

[1] From the $\chi_{bj}(1P) \to \Upsilon(1S)\gamma$ transition.

NODE=M078DM2

NODE=M078DM2;LINKAGE=A

$\chi_{b2}(1P)$ BRANCHING RATIOS

NODE=M078220

$\Gamma(\gamma\Upsilon(1S))/\Gamma_{total}$ Γ_1/Γ

NODE=M078R1

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.188±0.011 OUR AVERAGE					
YOUR DATA 0.185±0.008±0.009		[2,3] LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$
0.186±0.011±0.009	1770	[3,4] KORNICER	11	CLEO	$e^+e^- \to \gamma\gamma\ell^+\ell^-$
$0.194^{+0.014}_{-0.017}\pm0.009$	8k	[5] LEES	11J	BABR	$\Upsilon(2S) \to X\gamma$
0.25 ±0.06 ±0.01	35	[3,6,7] WALK	86	CBAL	$\Upsilon(2S) \to \gamma\gamma\ell^+\ell^-$
0.20 ±0.05		KLOPFEN...	83	CUSB	$\Upsilon(2S) \to \gamma\gamma\ell^+\ell^-$

YOUR NOTE [2] LEES 14M quotes $\Gamma(\chi_{b2}(1P) \to \gamma\Upsilon(1S))/\Gamma_{total} \times \Gamma(\Upsilon(2S) \to \gamma\chi_{b2}(1P))/\Gamma_{total} = (1.32 \pm 0.06)\%$ combining the results from samples of $\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$ with and without converted photons

NODE=M078R1;LINKAGE=B

YOUR NOTE [3] Assuming $B(\Upsilon(1S) \to \ell^+\ell^-) = (2.48 \pm 0.05)\%$.

NODE=M078R1;LINKAGE=KA

[4] KORNICER 11 reports $[\Gamma(\chi_{b2}(1P) \to \gamma\Upsilon(1S))/\Gamma_{total}] \times [B(\Upsilon(2S) \to \gamma\chi_{b2}(1P))] = (1.33 \pm 0.04 \pm 0.07) \times 10^{-2}$ which we divide by our best value $B(\Upsilon(2S) \to \gamma\chi_{b2}(1P)) = (7.15 \pm 0.35) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

NODE=M078R1;LINKAGE=KR

[5] LEES 11J reports $[\Gamma(\chi_{b2}(1P) \to \gamma\Upsilon(1S))/\Gamma_{total}] \times [B(\Upsilon(2S) \to \gamma\chi_{b2}(1P))] = (13.9 \pm 0.5^{+0.9}_{-1.1}) \times 10^{-3}$ which we divide by our best value $B(\Upsilon(2S) \to \gamma\chi_{b2}(1P)) = (7.15 \pm 0.35) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

NODE=M078R1;LINKAGE=LE

[6] WALK 86 quotes $B(\Upsilon(2S) \to \gamma\chi_{b2}(1P)) \times B(\chi_{b2}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(1S) \to \ell^+\ell^-) = (4.4 \pm 0.9 \pm 0.5)$ %.

NODE=M078R1;LINKAGE=A

[7] WALK 86 reports $[\Gamma(\chi_{b2}(1P) \to \gamma\Upsilon(1S))/\Gamma_{total}] \times [B(\Upsilon(2S) \to \gamma\chi_{b2}(1P))] = (17.7 \pm 3.6 \pm 2.0) \times 10^{-3}$ which we divide by our best value $B(\Upsilon(2S) \to \gamma\chi_{b2}(1P)) = (7.15 \pm 0.35) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

NODE=M078R1;LINKAGE=E

$\chi_{b2}(1P)$ Cross-Particle Branching Ratios

NODE=M078230

$B(\chi_{b2}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(2S) \to \gamma\chi_{b2}(1P)) \times B(\Upsilon(1S) \to \ell^+\ell^-)$

NODE=M078B01

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
3.38±0.16 OUR AVERAGE					
YOUR DATA $3.63^{+0.36}_{-0.34}{}^{+0.18}_{-0.19}$		[27] LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$
3.29±0.09±0.16	1770	KORNICER	11	CLEO	$e^+e^- \to \gamma\gamma\ell^+\ell^-$
4.4 ±0.9 ±0.5	35	WALK	86	CBAL	$\Upsilon(2S) \to \gamma\gamma\ell^+\ell^-$

YOUR NOTE [27] From a sample of $\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$ with converted photons

NODE=M078B01;LINKAGE=A

$[B(\chi_{b2}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(2S) \to \gamma\chi_{b2}(1P))] / [B(\chi_{b1}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(2S) \to \gamma\chi_{b1}(1P))]$

NODE=M078A00

VALUE (%)	DOCUMENT ID		TECN	COMMENT
YOUR DATA **55.6±1.6**	[28] LEES	14M	BABR	$\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$

YOUR NOTE [28] From a sample of $\Upsilon(2S) \to \gamma\gamma\mu^+\mu^-$ events without converted photons

NODE=M078A00;LINKAGE=A

$B(\chi_{b2}(1P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(3S) \to \gamma\chi_{b2}(1P)) \times B(\Upsilon(1S) \to \ell^+\ell^-)$

NODE=M078B02
NODE=M078B02

VALUE (units 10^{-5})	EVTS	DOCUMENT ID		TECN	COMMENT
3.8 ±0.5 OUR AVERAGE					
YOUR DATA $4.68^{+0.99}_{-0.92}\pm0.37$		[29] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
$3.56\pm0.40\pm0.41$	126	KORNICER	11	CLEO	$e^+e^- \to \gamma\gamma\ell^+\ell^-$

YOUR NOTE [29] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with converted photons — NODE=M078B02;LINKAGE=A

$\chi_{b2}(1P)$ REFERENCES

NODE=M078

YOUR PAPER

AAIJ	14BG	JHEP 1410 088	R. Aaij *et al.*	(LHCb Collab.)	REFID=56199
LEES	14M	PR D90 112010	J.P. Lees *et al.*	(BABAR Collab.)	REFID=56343
KORNICER	11	PR D83 054003	M. Kornicer *et al.*	(CLEO Collab.)	REFID=16769
LEES	11J	PR D84 072002	J.P. Lees *et al.*	(BABAR Collab.)	REFID=53936
SKWARNICKI	87	PRL 58 972	T. Skwarnicki *et al.*	(Crystal Ball Collab.) J	REFID=40019
WALK	86	PR D34 2611	W.S. Walk *et al.*	(Crystal Ball Collab.)	REFID=22290
KLOPFEN...	83	PRL 51 160	C. Klopfenstein *et al.*	(CUSB Collab.)	REFID=22285

NODE=M079

$\chi_{b0}(2P)$

$I^G(J^{PC}) = 0^+(0^{++})$
J needs confirmation.

Observed in radiative decay of the $\Upsilon(3S)$, therefore $C = +$. Branching ratio requires E1 transition, M1 is strongly disfavored, therefore $P = +$. — NODE=M079

$m_{\chi_{b1}(2P)} - m_{\chi_{b0}(2P)}$

NODE=M079M2
NODE=M079M2

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
YOUR DATA **23.8±1.7**	LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$

NODE=M079M2

$\chi_{b0}(2P)$ BRANCHING RATIOS

NODE=M079220

$\Gamma(\gamma\Upsilon(2S))/\Gamma_{total}$ Γ_1/Γ

NODE=M079R2
NODE=M079R2

VALUE (%)	CL%	DOCUMENT ID		TECN	COMMENT
1.38±0.30 OUR AVERAGE					
YOUR DATA $1.31\pm0.27^{+0.13}_{-0.12}$		[3,4] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
$3.6 \pm1.6 \pm0.3$		[3,5] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<2.8	90	[6] LEES	11J	BABR	$\Upsilon(3S) \to X\gamma$
<8.9	90	[7] CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

YOUR NOTE [3] Assuming $B(\Upsilon(2S) \to \mu^+\mu^-) = (1.93 \pm 0.17)\%$ — NODE=M079R2;LINKAGE=D

YOUR NOTE [4] LEES 14M reports $[\Gamma(\chi_{b0}(2P) \to \gamma\Upsilon(2S))/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b0}(2P))] = (7.7 \pm 1.6) \times 10^{-4}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b0}(2P)) = (5.9 \pm 0.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. — NODE=M079R2;LINKAGE=E

[5] Recalculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b0}(2P)) \times B(\chi_{b0}(2P) \to \gamma\Upsilon(2S)) = (0.28 \pm 0.12 \pm 0.03)\%$ using $B(\Upsilon(2S) \to \mu^+\mu^-) = (1.44 \pm 0.10)\%$. Supersedes HEINTZ 91. — NODE=M079R2;LINKAGE=C

[6] LEES 11J quotes a central value of $\Gamma(\chi_{b0}(2P) \to \gamma\Upsilon(2S))/\Gamma_{total} \times \Gamma(\Upsilon(3S) \to \gamma\chi_{b0}(2P))/\Gamma_{total} = (-0.3 \pm 0.2^{+0.5}_{-0.4})\%$. — NODE=M079R2;LINKAGE=LE

[7] Using $B(\Upsilon(2S) \to \mu^+\mu^-) = (1.37\pm0.26)\%$, $B(\Upsilon(3S) \to \gamma\gamma\Upsilon(2S)) \times 2\, B(\Upsilon(2S) \to \mu^+\mu^-) < 1.19 \times 10^{-4}$, and $B(\Upsilon(3S) \to \chi_{b0}(2P)\gamma) = 0.049$. — NODE=M079R2;LINKAGE=B

$\Gamma(\gamma\Upsilon(1S))/\Gamma_{total}$ Γ_2/Γ

NODE=M079R1
NODE=M079R1

VALUE (%)	CL%	DOCUMENT ID		TECN	COMMENT
0.38±0.17 OUR AVERAGE					
YOUR DATA $0.36\pm0.17\pm0.03$		[8,9] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
$0.9 \pm0.7 \pm0.1$		[9,10] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<1.2	90	[11] LEES	11J	BABR	$\Upsilon(3S) \to X\gamma$
<2.5	90	[12] CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

YOUR NOTE [8] LEES 14M quotes $\Gamma(\chi_{b0}(2P) \to \gamma\Upsilon(1S))/\Gamma_{\rm total} \times \Gamma(\Upsilon(3S) \to \gamma\chi_{b0}(2P))/\Gamma_{\rm total} = (2.1 \pm 1.0) \times 10^{-4}$ combining the results from $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ samples with and without photon conversions NODE=M079R1;LINKAGE=D

YOUR NOTE [9] Assuming $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.48 \pm 0.05)$ NODE=M079R1;LINKAGE=E

[10] Recalculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b0}(2P)) \times B(\chi_{b0}(2P) \to \gamma\Upsilon(1S)) = (0.05 \pm 0.04 \pm 0.01)\%$ using $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.57 \pm 0.05)\%$. Supersedes HEINTZ 91. NODE=M079R1;LINKAGE=C

[11] LEES 11J quotes a central value of $\Gamma(\chi_{b0}(2P) \to \gamma\Upsilon(1S))/\Gamma_{\rm total} \times \Gamma(\Upsilon(3S) \to \gamma\chi_{b0}(2P))/\Gamma_{\rm total} = (3.9 \pm 2.2^{+1.2}_{-0.6}) \times 10^{-4}$. NODE=M079R1;LINKAGE=LE

[12] Using $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.57 \pm 0.07)\%$, $B(\Upsilon(3S) \to \gamma\gamma\Upsilon(1S)) \times 2\ B(\Upsilon(1S) \to \mu^+\mu^-) < 0.63 \times 10^{-4}$, and $B(\Upsilon(3S) \to \chi_{b0}(2P)\gamma) = 0.049$. NODE=M079R1;LINKAGE=B

$B(\chi_{b0}(2P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(3S) \to \gamma\chi_{b0}(2P)) \times B(\Upsilon(1S) \to \ell^+\ell^-)$

NODE=M079A02
NODE=M079A02

VALUE (units 10^{-5})		DOCUMENT ID		TECN	COMMENT
1.4±0.9 OUR AVERAGE					
YOUR DATA $1.7^{+1.5+0.1}_{-1.4-1.2}$	[30]	LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
$1.3 \pm 1.0 \pm 0.3$	[31]	HEINTZ	92	CSB2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$

YOUR NOTE [30] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with one converted photon NODE=M079A02;LINKAGE=A

[31] Calculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b0}(2P)) \times B(\chi_{b0}(2P) \to \gamma\Upsilon(1S)) = (0.05 \pm 0.04 \pm 0.01)\%$ using $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.57 \pm 0.05)\%$. NODE=M079A02;LINKAGE=K

$[B(\chi_{b0}(2P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(3S) \to \gamma\chi_{b0}(2P))] / [B(\chi_{b1}(2P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(3S) \to \gamma\chi_{b1}(2P))]$

NODE=M079A00
NODE=M079A00

VALUE (%)		DOCUMENT ID		TECN	COMMENT
YOUR DATA **1.71±0.80**	[32]	LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$

YOUR NOTE [32] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ without converted photons NODE=M079A00;LINKAGE=A

$B(\chi_{b0}(2P) \to \gamma\Upsilon(2S)) \times B(\Upsilon(3S) \to \gamma\chi_{b0}(2P)) \times B(\Upsilon(2S) \to \ell^+\ell^-)$

NODE=M079A03
NODE=M079A03

VALUE (units 10^{-5})		DOCUMENT ID		TECN	COMMENT
4.4±1.6 OUR AVERAGE					
YOUR DATA $6.6^{+4.9+2.0}_{-4.0-0.3}$	[34]	LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
$4.0 \pm 1.7 \pm 0.3$	[35]	HEINTZ	92	CSB2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$

YOUR NOTE [34] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with one converted photon NODE=M079A03;LINKAGE=A

[35] Calculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b0}(2P)) \times B(\chi_{b0}(2P) \to \gamma\Upsilon(2S)) = (0.28 \pm 0.12 \pm 0.03)\%$ using $B(\Upsilon(2S) \to \mu^+\mu^-) = (1.44 \pm 0.10)\%$. NODE=M079A03;LINKAGE=B

$[B(\chi_{b0}(2P) \to \gamma\Upsilon(2S)) \times B(\Upsilon(3S) \to \gamma\chi_{b0}(2P))] / [B(\chi_{b1}(2P) \to \gamma\Upsilon(2S)) \times B(\Upsilon(3S) \to \gamma\chi_{b1}(2P))]$

NODE=M079A01
NODE=M079A01

VALUE (%)		DOCUMENT ID		TECN	COMMENT
YOUR DATA **3.31±0.56**	[36]	LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$

YOUR NOTE [36] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ without converted photons NODE=M079A01;LINKAGE=A

$\chi_{b0}(2P)$ REFERENCES

NODE=M079

YOUR PAPER LEES	14M	PR D90 112010	J.P. Lees *et al.*	(BABAR Collab.)	REFID=56343
LEES	11J	PR D84 072002	J.P. Lees *et al.*	(BABAR Collab.)	REFID=53936
CRAWFORD	92B	PL B294 139	G. Crawford *et al.*	(CLEO Collab.)	REFID=43177
HEINTZ	92	PR D46 1928	U. Heintz *et al.*	(CUSB II Collab.)	REFID=43604
HEINTZ	91	PRL 66 1563	U. Heintz *et al.*	(CUSB Collab.)	REFID=41580

NODE=M080

$\chi_{b1}(2P)$

$I^G(J^{PC}) = 0^+(1^{++})$
J needs confirmation.

Observed in radiative decay of the $\Upsilon(3S)$, therefore $C = +$. Branching ratio requires E1 transition, M1 is strongly disfavored, therefore $P = +$. NODE=M080

$\chi_{b1}(2P)$ BRANCHING RATIOS

NODE=M080220

$\Gamma(\gamma\Upsilon(2S))/\Gamma_{\rm total}$ Γ_2/Γ

NODE=M080R2
NODE=M080R2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.181±0.019 OUR AVERAGE					
YOUR DATA $0.211 \pm 0.017 \pm 0.019$		[5,6] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
$0.190 \pm 0.018 \pm 0.017$	4.3k	[7] LEES	11J	BABR	$\Upsilon(3S) \to X\gamma$
$0.206 \pm 0.035 \pm 0.019$		[5,8] CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
$0.132 \pm 0.018 \pm 0.012$		[5,9] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

YOUR NOTE [5] Assuming B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.97 ± 0.17)% NODE=M080R2;LINKAGE=D

YOUR NOTE [6] LEES 14M quotes $\Gamma(\chi_{b1}(2P) \to \gamma\Upsilon(2S))/\Gamma_{total} \times \Gamma(\Upsilon(3S) \to \gamma\chi_{b1}(2P))/\Gamma_{total}$ = (2.66 ± 0.22)% combining the results from $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ samples with and without photon conversions NODE=M080R2;LINKAGE=E

[7] LEES 11J reports $[\Gamma(\chi_{b1}(2P) \to \gamma\Upsilon(2S))/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b1}(2P))] = (2.4 \pm 0.1 \pm 0.2) \times 10^{-2}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) = (12.6 \pm 1.2) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. NODE=M080R2;LINKAGE=LE

[8] CRAWFORD 92B quotes $B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) \times B(\chi_{b1}(2P) \to \gamma\Upsilon(2S)) \times 2\ B(\Upsilon(2S) \to \ell^+\ell^-) = (10.23 \pm 1.20 \pm 1.26)\ 10^{-4}$. NODE=M080R2;LINKAGE=B

[9] Recalculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) \times B(\chi_{b1}(2P) \to \gamma\Upsilon(2S))$ = (2.29 ± 0.23 ± 0.21) % using $B(\Upsilon(2S) \to \mu^+\mu^-)$ = (1.44 ± 0.10)%. Supersedes HEINTZ 91. NODE=M080R2;LINKAGE=C

$\Gamma(\gamma\Upsilon(1S))/\Gamma_{total}$ Γ_3/Γ

NODE=M080R1
NODE=M080R1

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.099±0.010 OUR AVERAGE					
0.107±0.006±0.010		[10,11] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
0.098±0.005±0.009	15k	[12] LEES	11J	BABR	$\Upsilon(3S) \to X\gamma$
0.103±0.023±0.009		[10,13] CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
0.075±0.010±0.007		[10,14] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

YOUR NOTE [10] Assuming B($\Upsilon(1S) \to \ell^+\ell^-$) = (2.48 ± 0.05)% NODE=M080R1;LINKAGE=D

YOUR NOTE [11] LEES 14M quotes $\Gamma(\chi_{b1}(2P) \to \gamma\Upsilon(1S))/\Gamma_{total} \times \Gamma(\Upsilon(3S) \to \gamma\chi_{b1}(2P))/\Gamma_{total}$ = (13.48 ± 0.72) × 10^{-3} combining the results from samples of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with and without converted photons NODE=M080R1;LINKAGE=E

[12] LEES 11J reports $[\Gamma(\chi_{b1}(2P) \to \gamma\Upsilon(1S))/\Gamma_{total}] \times [B(\Upsilon(3S) \to \gamma\chi_{b1}(2P))] = (12.4 \pm 0.3 \pm 0.6) \times 10^{-3}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) = (12.6 \pm 1.2) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. NODE=M080R1;LINKAGE=LE

[13] CRAWFORD 92B quotes $B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) \times B(\chi_{b1}(2P) \to \gamma\Upsilon(1S)) \times 2\ B(\Upsilon(1S) \to \ell^+\ell^-) = (6.47 \pm 1.12 \pm 0.82)\ 10^{-4}$. NODE=M080R1;LINKAGE=B

[14] Recalculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) \times B(\chi_{b1}(2P) \to \gamma\Upsilon(1S))$ = (0.91 ± 0.11 ± 0.06)% using $B(\Upsilon(1S) \to \mu^+\mu^-)$ = (2.57 ± 0.05)%. Supersedes HEINTZ 91. NODE=M080R1;LINKAGE=F

$\chi_{b1}(2P)$ Cross-Particle Branching Ratios

NODE=M080230

$B(\chi_{b1}(2P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) \times B(\Upsilon(1S) \to \ell^+\ell^-)$

NODE=M080A00
NODE=M080A00

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.9 ±0.4 OUR AVERAGE Error includes scale factor of 1.9. See the ideogram below.					
$3.52^{+0.28}_{-0.27}{}^{+0.17}_{-0.18}$		[32] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
3.24±0.56±0.41	58	[33] CRAWFORD	92B	CLE2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$
2.34±0.28±0.15		[34] HEINTZ	92	CSB2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$

YOUR NOTE [32] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with one converted photon NODE=M080A00;LINKAGE=A

[33] CRAWFORD 92B quotes $2\times B(\Upsilon(3S) \to \gamma\chi_{bJ}(2P))\ B(\chi_{bJ}(2P) \to \gamma\Upsilon(nS))\ B(\Upsilon(nS) \to \ell^+\ell^-)$. NODE=M080A00;LINKAGE=C

[34] Calculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) \times B(\chi_{b1}(2P) \to \gamma\Upsilon(1S))$ = (0.91 ± 0.11 ± 0.06)% using $B(\Upsilon(1S) \to \mu^+\mu^-)$ =(2.57 ± 0.05)%. NODE=M080A00;LINKAGE=B

$B(\chi_{b1}(2P) \to \gamma\Upsilon(2S)) \times B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) \times B(\Upsilon(2S) \to \ell^+\ell^-)$

NODE=M080A01
NODE=M080A01

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
3.8 ±0.6 OUR AVERAGE Error includes scale factor of 1.8. See the ideogram below.					
$4.95^{+0.75}_{-0.70}{}^{+1.01}_{-0.24}$		[35] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
5.12±0.60±0.63	111	[36] CRAWFORD	92B	CLE2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$
3.30±0.33±0.20		[37] HEINTZ	92	CSB2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$

YOUR NOTE [35] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with one converted photon NODE=M080A01;LINKAGE=A

[36] CRAWFORD 92B quotes $2\times B(\Upsilon(3S) \to \gamma\chi_{bJ}(2P))\ B(\chi_{bJ}(2P) \to \gamma\Upsilon(nS))\ B(\Upsilon(nS) \to \ell^+\ell^-)$. NODE=M080A01;LINKAGE=C

[37] Calculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) \times B(\chi_{b1}(2P) \to \gamma\Upsilon(2S))$ = (2.29 ± 0.23 ± 0.21) % using$B(\Upsilon(2S) \to \mu^+\mu^-)$ = (1.44 ± 0.10)%. NODE=M080A01;LINKAGE=B

$\chi_{b1}(2P)$ REFERENCES

NODE=M080

YOUR PAPER	LEES	14M	PR D90 112010	J.P. Lees *et al.*	(BABAR Collab.)	REFID=56343
	LEES	11J	PR D84 072002	J.P. Lees *et al.*	(BABAR Collab.)	REFID=53936
	CRAWFORD	92B	PL B294 139	G. Crawford *et al.*	(CLEO Collab.)	REFID=43177
	HEINTZ	92	PR D46 1928	U. Heintz *et al.*	(CUSB II Collab.)	REFID=43604
	HEINTZ	91	PRL 66 1563	U. Heintz *et al.*	(CUSB Collab.)	REFID=41580

NODE=M081

$\chi_{b2}(2P)$

$I^G(J^{PC}) = 0^+(2^{++})$
J needs confirmation.

Observed in radiative decay of the $\Upsilon(3S)$, therefore $C = +$. Branching ratio requires E1 transition, M1 is strongly disfavored, therefore $P = +$.

NODE=M081

$m_{\chi_{b2}(2P)} - m_{\chi_{b1}(2P)}$

NODE=M081M2

NODE=M081M2

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
13.10±0.24 OUR AVERAGE				
12.3 ±2.6 ±0.6	[1] AAIJ	14BG	LHCB	$pp \to \gamma\mu^+\mu^- X$
YOUR DATA 13.04±0.26	LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
13.5 ±0.4 ±0.5	[2] HEINTZ	92	CSB2	$e^+e^- \to \gamma X, \ell^+\ell^-\gamma\gamma$

[1] From the $\chi_{bJ}(2P) \to \Upsilon(1S)\gamma$ transition. NODE=M081M2;LINKAGE=B

[2] From the average photon energy for inclusive and exclusive events. Supersedes NARAIN 91. NODE=M081M2;LINKAGE=A

$\chi_{b2}(2P)$ BRANCHING RATIOS

NODE=M081220

$\Gamma(\gamma\Upsilon(2S))/\Gamma_{\text{total}}$ Γ_2/Γ

NODE=M081R2

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.089±0.012 OUR AVERAGE					
YOUR DATA 0.085±0.010±0.010		[6,7] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
0.084±0.011±0.010	2.5k	[8] LEES	11J	BABR	$\Upsilon(3S) \to X\gamma$
0.096±0.022±0.012		[7,9] CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
0.106±0.016±0.013		[7,10] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

NODE=M081R2

YOUR NOTE [6] LEES 14M quotes $\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(2S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \to \gamma\chi_{b2}(2P))/\Gamma_{\text{total}} = (1.12 \pm 0.13)\%$ combining the results from samples of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with and without converted photons NODE=M081R2;LINKAGE=D

YOUR NOTE [7] Assuming $B(\Upsilon(2S) \to \ell^+\ell^-) = (1.97 \pm 0.17)\%$. NODE=M081R2;LINKAGE=E

[8] LEES 11J reports $[\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(2S))/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (1.1 \pm 0.1 \pm 0.1) \times 10^{-2}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. NODE=M081R2;LINKAGE=LE

[9] CRAWFORD 92B quotes $B(\Upsilon(3S) \to \gamma\chi_{b1}(2P)) \times B(\chi_{b2}(2P) \to \gamma\Upsilon(2S)) \times 2\, B(\Upsilon(2S) \to \ell^+\ell^-) = (4.98 \pm 0.94 \pm 0.62)\ 10^{-4}$. NODE=M081R2;LINKAGE=B

[10] Recalculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) \times B(\chi_{b2}(2P) \to \gamma\Upsilon(2S)) = (1.90 \pm 0.23 \pm 0.18)$ % using $B(\Upsilon(2S) \to \mu^+\mu^-) = (1.44 \pm 0.10)\%$. Supersedes HEINTZ 91. NODE=M081R2;LINKAGE=C

$\Gamma(\gamma\Upsilon(1S))/\Gamma_{\text{total}}$ Γ_3/Γ

NODE=M081R1

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.066±0.008 OUR AVERAGE					
YOUR DATA 0.061±0.004±0.007		[11,12] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
0.070±0.004±0.008	11k	[13] LEES	11J	BABR	$\Upsilon(3S) \to X\gamma$
0.077±0.018±0.009		[12,14] CRAWFORD	92B	CLE2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$
0.061±0.009±0.007		[12,15] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\gamma\gamma$

NODE=M081R1

YOUR NOTE [11] LEES 14M quotes $\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(1S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \to \gamma\chi_{b2}(2P))/\Gamma_{\text{total}} = (8.03 \pm 0.50) \times 10^{-3}$ combining the results from samples of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with and without converted photons NODE=M081R1;LINKAGE=D

YOUR NOTE [12] Assuming $B(\Upsilon(1S) \to \ell^+\ell^-) = (2.48 \pm 0.05)\%$. NODE=M081R1;LINKAGE=E

[13] LEES 11J reports $[\Gamma(\chi_{b2}(2P) \to \gamma\Upsilon(1S))/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] = (9.2 \pm 0.3 \pm 0.4) \times 10^{-3}$ which we divide by our best value $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) = (13.1 \pm 1.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. NODE=M081R1;LINKAGE=LE

[14] CRAWFORD 92B quotes $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) \times B(\chi_{b2}(2P) \to \gamma\Upsilon(1S)) \times 2\, B(\Upsilon(1S) \to \ell^+\ell^-) = (5.03 \pm 0.94 \pm 0.63)\ 10^{-4}$. NODE=M081R1;LINKAGE=B

[15] Recalculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) \times B(\chi_{b2}(2P) \to \gamma\Upsilon(1S)) = (0.77 \pm 0.11 \pm 0.05)\%$ using $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.57 \pm 0.05)\%$. Supersedes HEINTZ 91. NODE=M081R1;LINKAGE=C

$\chi_{b2}(2P)$ Cross-Particle Branching Ratios

NODE=M081230

$B(\chi_{b2}(2P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) \times B(\Upsilon(1S) \to \ell^+\ell^-)$

NODE=M081A01
NODE=M081A01

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.02±0.18 OUR AVERAGE					
YOUR DATA $1.95^{+0.22}_{-0.21}{}^{+0.10}_{-0.16}$		[34] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
2.52±0.47±0.32	48	[35] CRAWFORD	92B	CLE2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$
1.98±0.28±0.12		[36] HEINTZ	92	CSB2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$

YOUR NOTE
[34] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with converted photons. NODE=M081A01;LINKAGE=A

[35] CRAWFORD 92B quotes $2\times B(\Upsilon(3S) \to \gamma\chi_{bJ}(2P))\ B(\chi_{bJ}(2P) \to \gamma\Upsilon(\text{nS}))\ B(\Upsilon(\text{nS}) \to \ell^+\ell^-)$. NODE=M081A01;LINKAGE=C

[36] Calculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) \times B(\chi_{b2}(2P) \to \gamma\Upsilon(1S)) = (0.77 \pm 0.11 \pm 0.05)\%$ using $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.57 \pm 0.05)\%$. NODE=M081A01;LINKAGE=B

$[B(\chi_{b2}(2P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] / [B(\chi_{b1}(2P) \to \gamma\Upsilon(1S)) \times B(\Upsilon(3S) \to \gamma\chi_{b1}(2P))]$

NODE=M081A00
NODE=M081A00

VALUE (%)	DOCUMENT ID		TECN	COMMENT
YOUR DATA **66.6±3.0**	[37] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$

NODE=M081A00

YOUR NOTE
[37] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ events without converted photons. NODE=M081A00;LINKAGE=A

$B(\chi_{b2}(2P) \to \gamma\Upsilon(2S)) \times B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) \times B(\Upsilon(2S) \to \ell^+\ell^-)$

NODE=M081A02
NODE=M081A02

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
2.74±0.29 OUR AVERAGE					
YOUR DATA $3.22^{+0.58}_{-0.53}{}^{+0.16}_{-0.71}$		[38] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$
2.49±0.47±0.31	53	[39] CRAWFORD	92B	CLE2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$
2.74±0.33±0.18		[40] HEINTZ	92	CSB2	$\Upsilon(3S) \to \gamma\gamma\ell^+\ell^-$

YOUR NOTE
[38] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ with converted photons. NODE=M081A02;LINKAGE=A

[39] CRAWFORD 92B quotes $2\times B(\Upsilon(3S) \to \gamma\chi_{bJ}(2P))\ B(\chi_{bJ}(2P) \to \gamma\Upsilon(\text{nS}))\ B(\Upsilon(\text{nS}) \to \ell^+\ell^-)$. NODE=M081A02;LINKAGE=C

[40] Calculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \to \gamma\chi_{b2}(2P)) \times B(\chi_{b2}(2P) \to \gamma\Upsilon(2S)) = (1.90 \pm 0.23 \pm 0.18)\%$ using $B(\Upsilon(2S) \to \mu^+\mu^-) = (1.44 \pm 0.10)\%$. NODE=M081A02;LINKAGE=B

$[B(\chi_{b2}(2P) \to \gamma\Upsilon(2S)) \times B(\Upsilon(3S) \to \gamma\chi_{b2}(2P))] / [B(\chi_{b1}(2P) \to \gamma\Upsilon(2S)) \times B(\Upsilon(3S) \to \gamma\chi_{b1}(2P))]$

NODE=M081A03
NODE=M081A03

VALUE (%)	DOCUMENT ID		TECN	COMMENT
YOUR DATA **46.9±2.0**	[41] LEES	14M	BABR	$\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$

YOUR NOTE
[41] From a sample of $\Upsilon(3S) \to \gamma\gamma\mu^+\mu^-$ without converted photons. NODE=M081A03;LINKAGE=A

$\chi_{b2}(2P)$ REFERENCES

NODE=M081

AAIJ	14BG	JHEP 1410 088	R. Aaij *et al.*	(LHCb Collab.)	REFID=56199
YOUR PAPER LEES	14M	PR D90 112010	J.P. Lees *et al.*	(BABAR Collab.)	REFID=56343
LEES	11J	PR D84 072002	J.P. Lees *et al.*	(BABAR Collab.)	REFID=53936
CRAWFORD	92B	PL B294 139	G. Crawford *et al.*	(CLEO Collab.)	REFID=43177
HEINTZ	92	PR D46 1928	U. Heintz *et al.*	(CUSB II Collab.)	REFID=43604
HEINTZ	91	PRL 66 1563	U. Heintz *et al.*	(CUSB Collab.)	REFID=41580
NARAIN	91	PRL 66 3113	M. Narain *et al.*	(CUSB Collab.)	REFID=41586