TABLE 3 – Summary of Parameters and Performance [a)]

Case	σ^*_0 [b)]	IR Design	(ν_x, ν_y) [a)]	$N_\pm$	ε_0 [b)]	τ_+/τ_- [turns] [c)]	ξ_0 [a)]	$\mathcal{L}_0$ [d)]	$\mathcal{L}$ [d)]
6A	nom	APIARY 6.3D	(0.64, 0.57)	nom	nom	5014 / 5014	0.03	3	~ 2.6
6B	nom	APIARY 6.3D	(0.64, 0.57)	5/3 × nom	nom	5014 / 5014	0.05	8.33	~ 5.3
7A1	nom	APIARY 7.5	(0.64, 0.57)	nom	nom	5014 / 5014	0.03	3	~ 2.8
7B1	nom	APIARY 7.5	(0.64, 0.57)	5/3 × nom	nom	5014 / 5040	0.05	8.33	~ 5.9
9A4	nom	APIARY 7.5	(0.28, 0.18)	nom	nom	5014 / 5040	0.03	3	~ 1.1
9A5	nom	APIARY 7.5	(0.57, 0.64)	nom	nom	5014 / 5040	0.03	3	~ 2.4
11A4	nom	APIARY 6.3D	(0.28, 0.18)	nom	nom	5014 / 5014	0.03	3	~ 1.1
11A5	nom	APIARY 6.3D	(0.57, 0.64)	nom	nom	5014 / 5014	0.03	3	~ 2.4
12B	$\sqrt{3/5}$ × nom	APIARY 6.3D	(0.64, 0.57)	nom	3/5 × nom	5014 / 5014	0.05	5	~ 3.4
20B	$\sqrt{3/5}$ × nom	APIARY 7.5	(0.64, 0.57)	nom	3/5 × nom	5014 / 5014	0.05	5	~ 3.4
7A2 [e)]	nom	APIARY 7.5	(0.64, 0.57)	nom	nom	5014 / 5014	0.03	3	~ 2.9

Notes:

a) For all cases: the bunch spacing is $s_B = 2\lambda_{RF} = 1.2596$ m; the working point (ν_x, ν_y) is the same for both beams; all four nominal beam-beam parameters ξ_0 are equal; the simulations were run for 25,000 turns, 256 "superparticles" per bunch and 5 thick-lens slices.

b) σ^*_0 represents the four nominal rms beam sizes at the IP and ε_0 represents the four nominal emittances; "nom" means nominal, *i.e.*, the value specified in the CDR or DU (Table 1 or 2).

c) τ_+/τ_- are the damping times *actually used* in the simulations (horizontal assumed equal to vertical).

d) $\mathcal{L}_0$ and $\mathcal{L}$ are the nominal and dynamical luminosities, respectively, in units of 10^{33} cm^{-2} s^{-1}.

e) The synchrotron tune of the LEB is $\nu_{s+} = 0.05$; this is the only difference with case 7A1, for which $\nu_{s+} = 0.0403$.

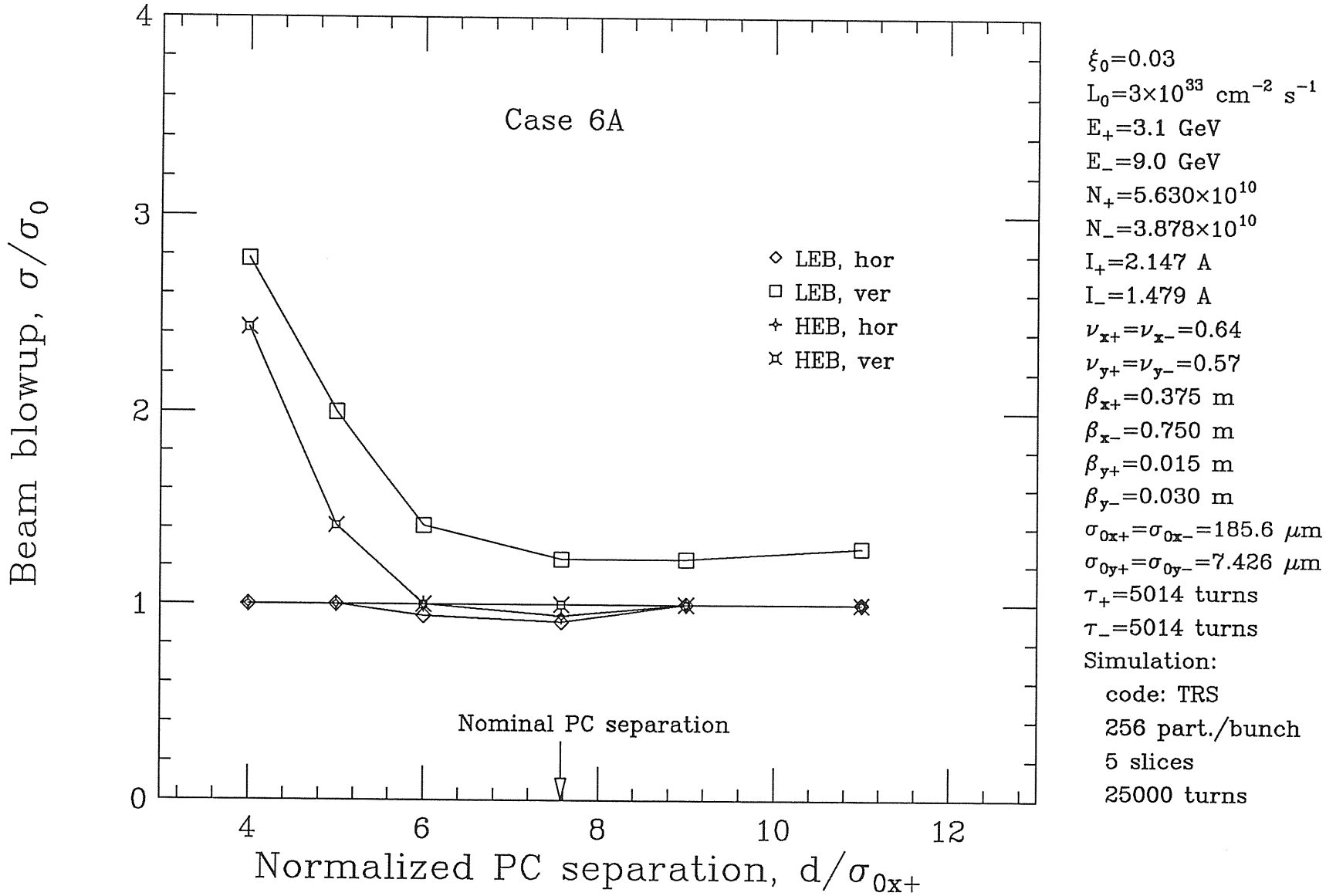

Fig. 2. Beam blowup for APIARY 6.3D for the nominal CDR case.

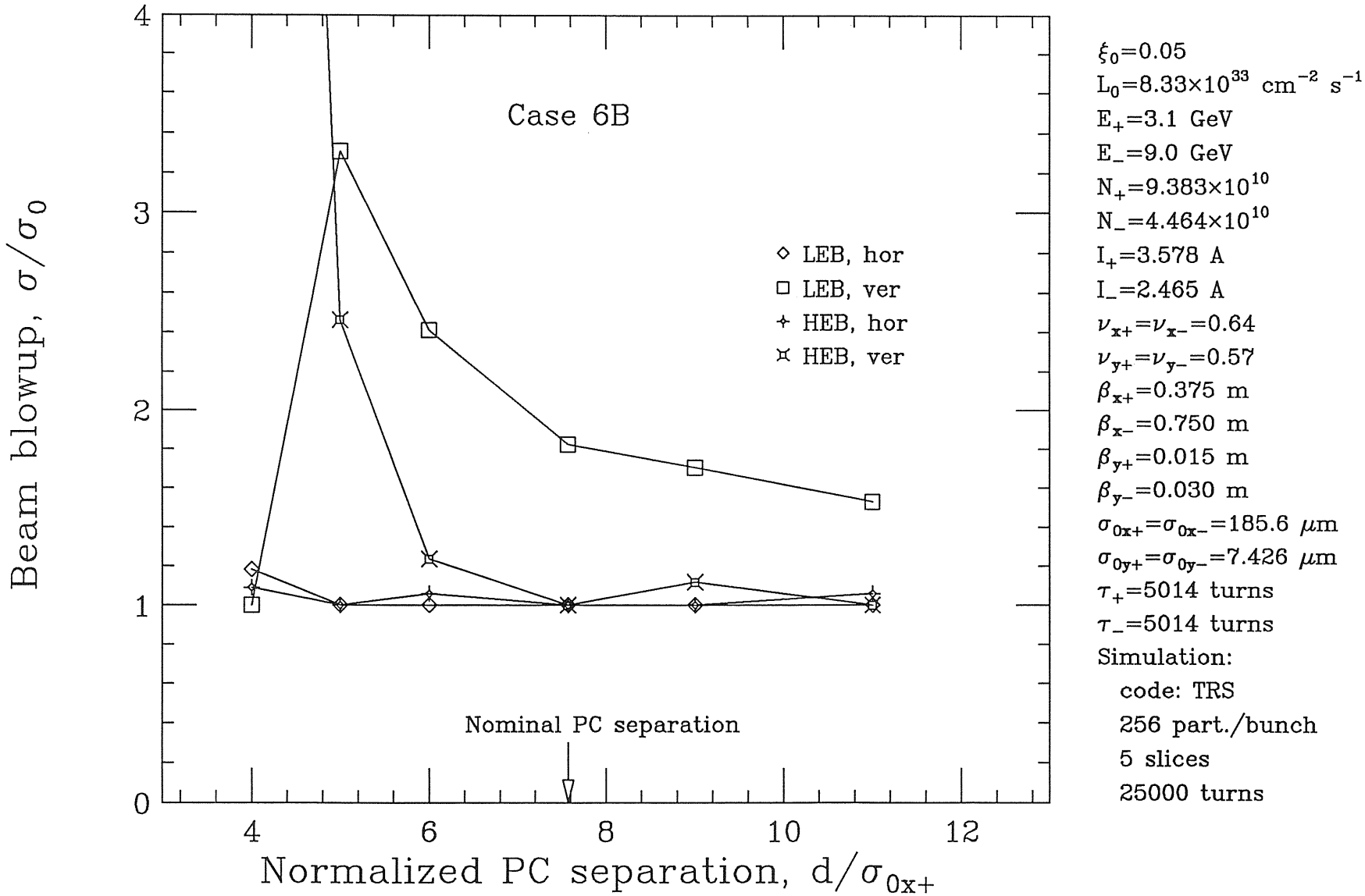

Fig. 3. Beam blowup for APIARY 6.3D for the high-current CDR case. Since the positron beam current exceeds 3 A, this particular choice of parameters is not compatible with other design constraints. For d/σ_{0x+}=4 the beams go into a flip-flop state, in which one beam is blown up vertically by a large factor while the other remains at its nominal size.

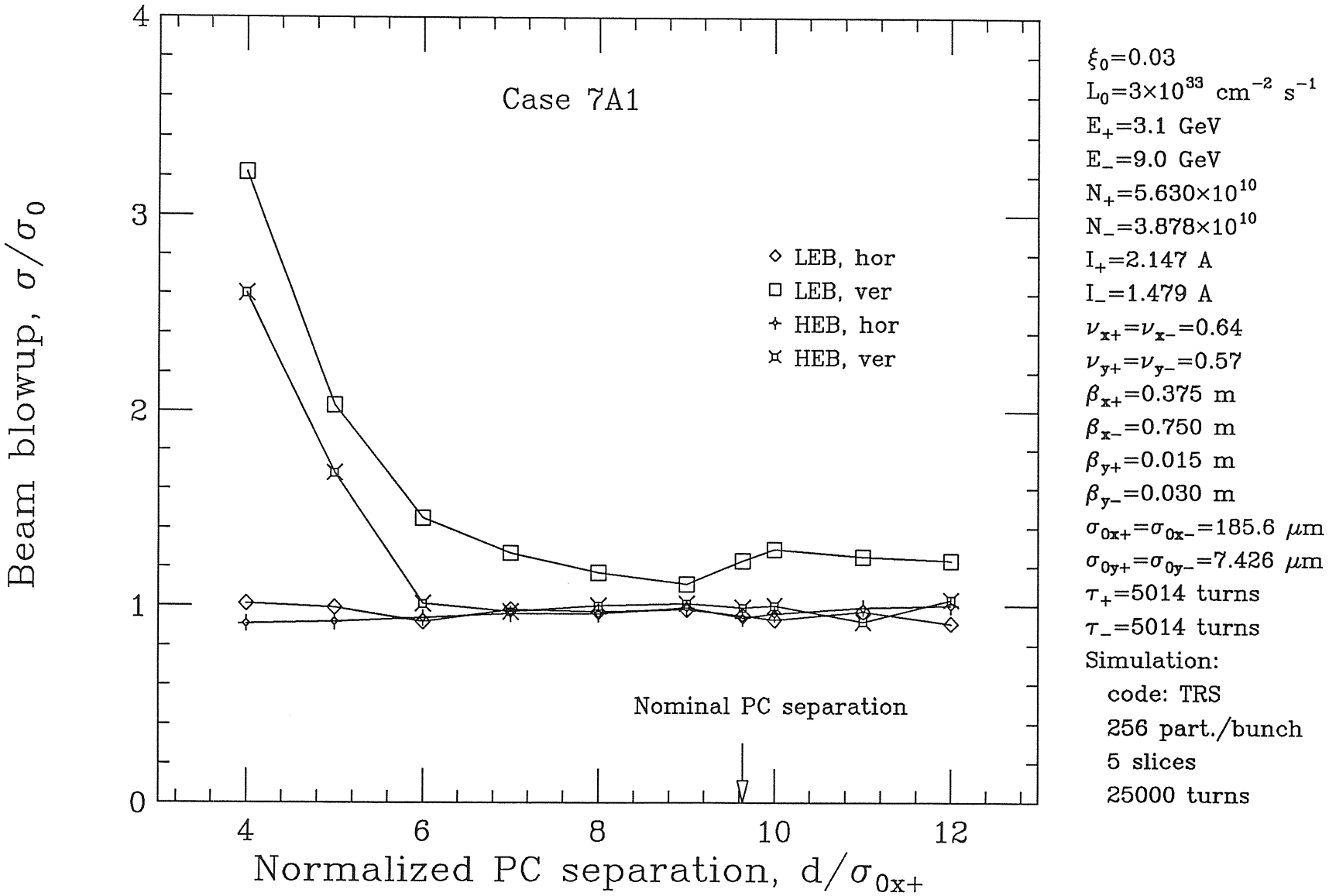

Fig. 4. Beam blowup for the nominal DU design APIARY 7.5 for the working point (0.64, 0.57).

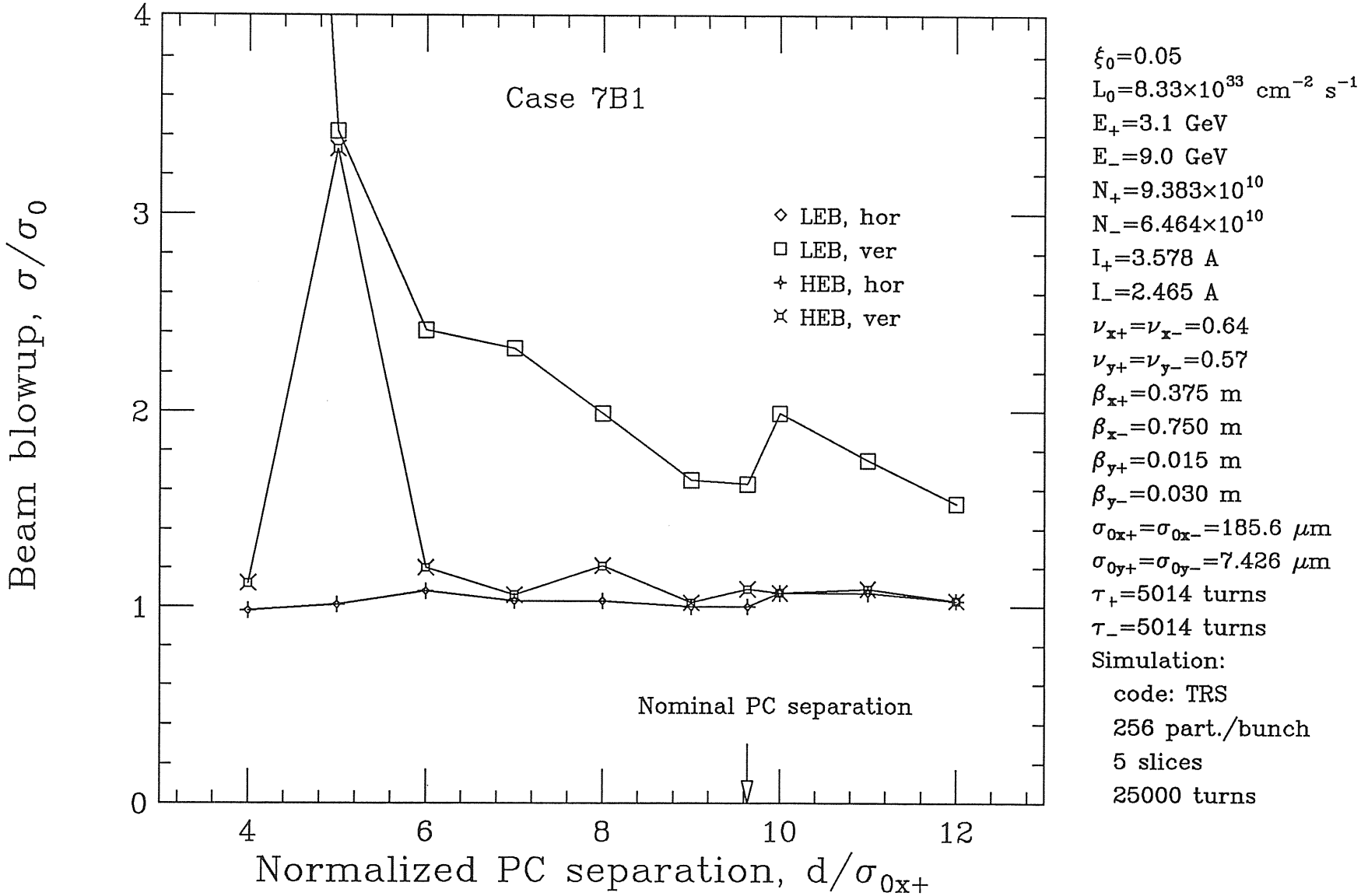

Fig. 5. Beam blowup for APIARY 7.5 for the high–current DU case. Since the positron beam current exceeds 3 A, this particular choice of parameters is not compatible with other design constraints. For d/σ_{0x+}=4 the beams go into a flip–flop state, in which one beam is blown up vertically by a large factor while the other remains at its nominal size.

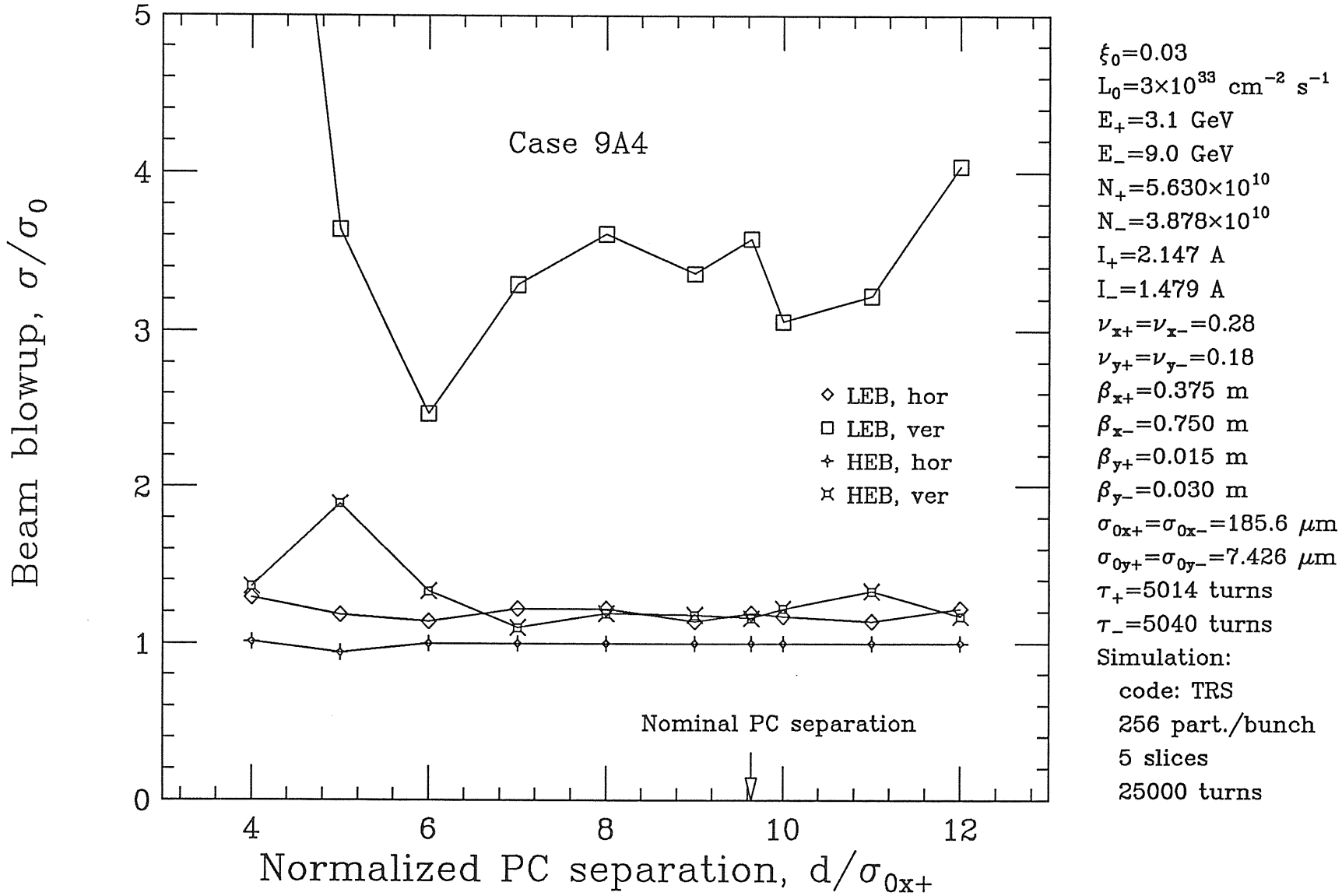

Fig. 6. Beam blowup for APIARY 7.5 for the working point (0.28, 0.18).

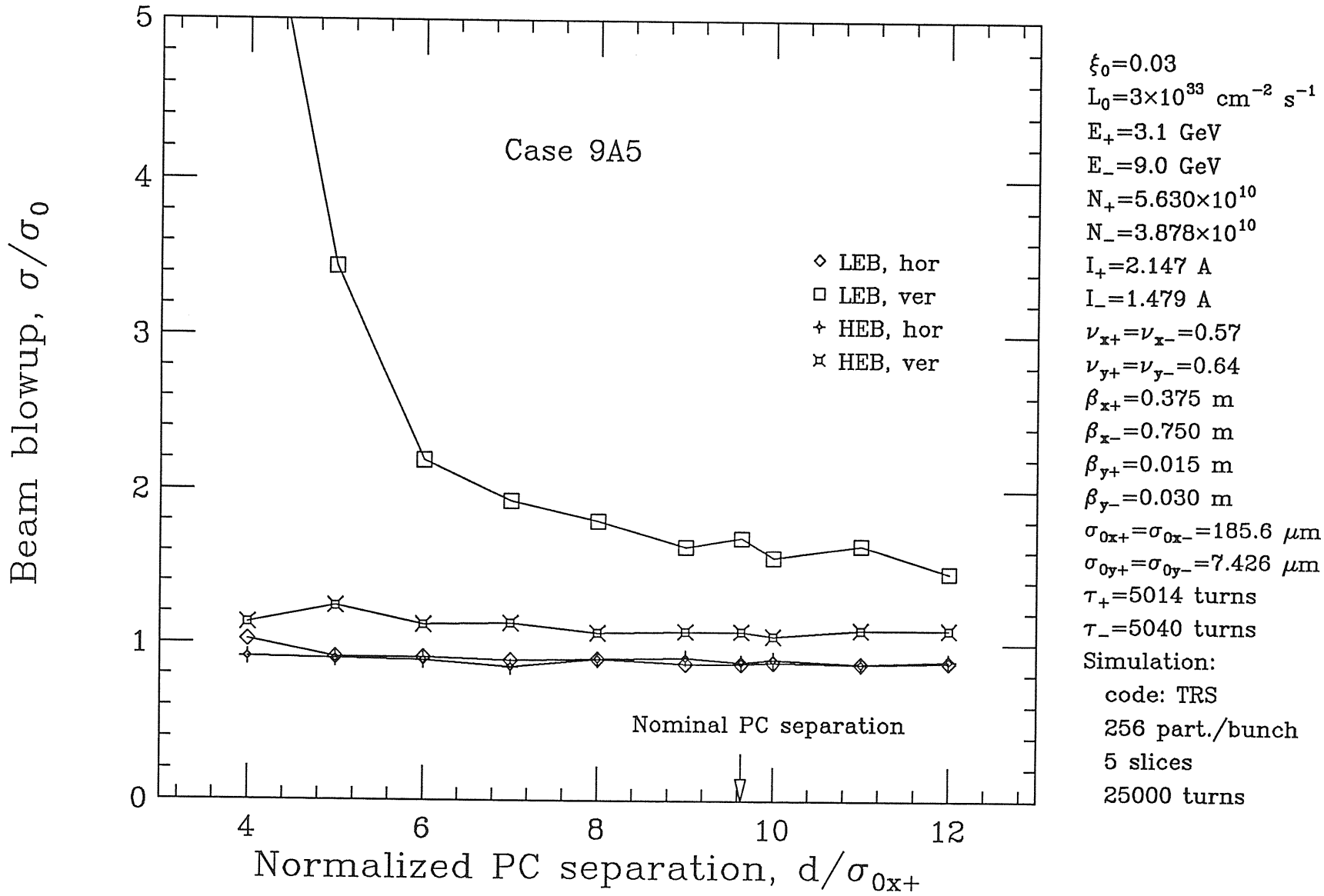

Fig. 7. Beam blowup for APIARY 7.5 for the working point (0.57, 0.64).

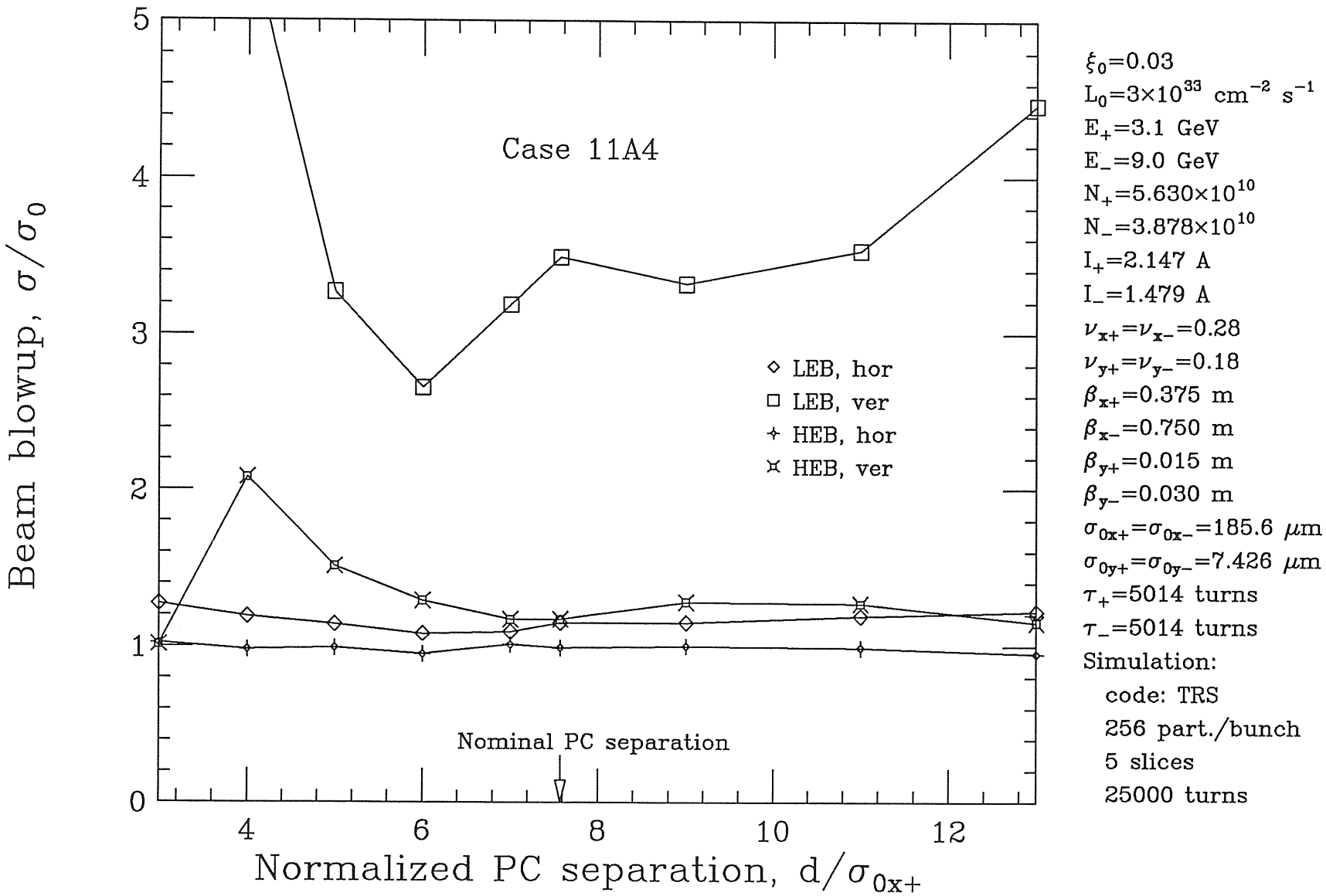

Fig. 8. Beam blowup for APIARY 6.3D for the working point (0.28, 0.18).

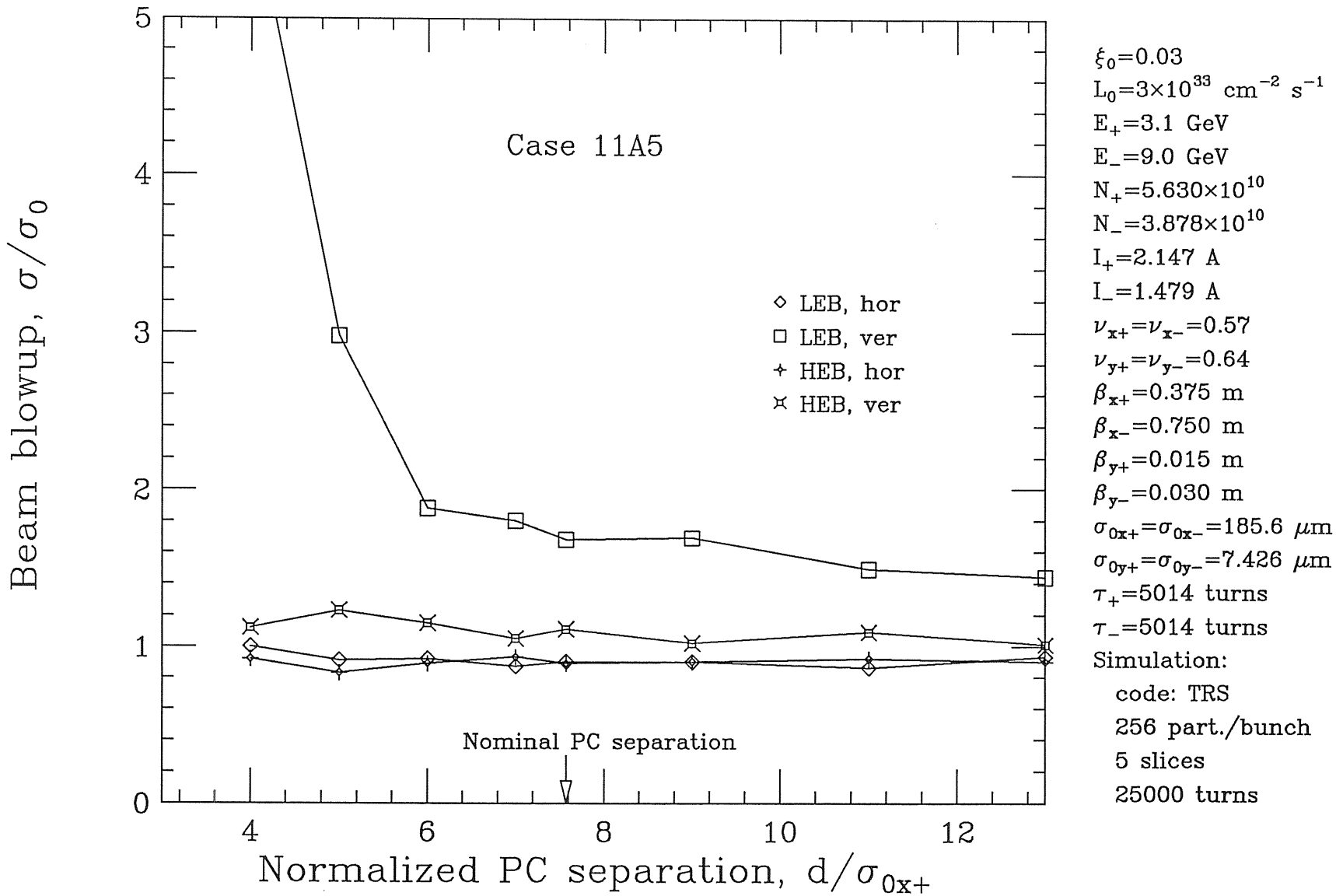

Fig. 9. Beam blowup for APIARY 6.3D for the working point (0.57, 0.64).

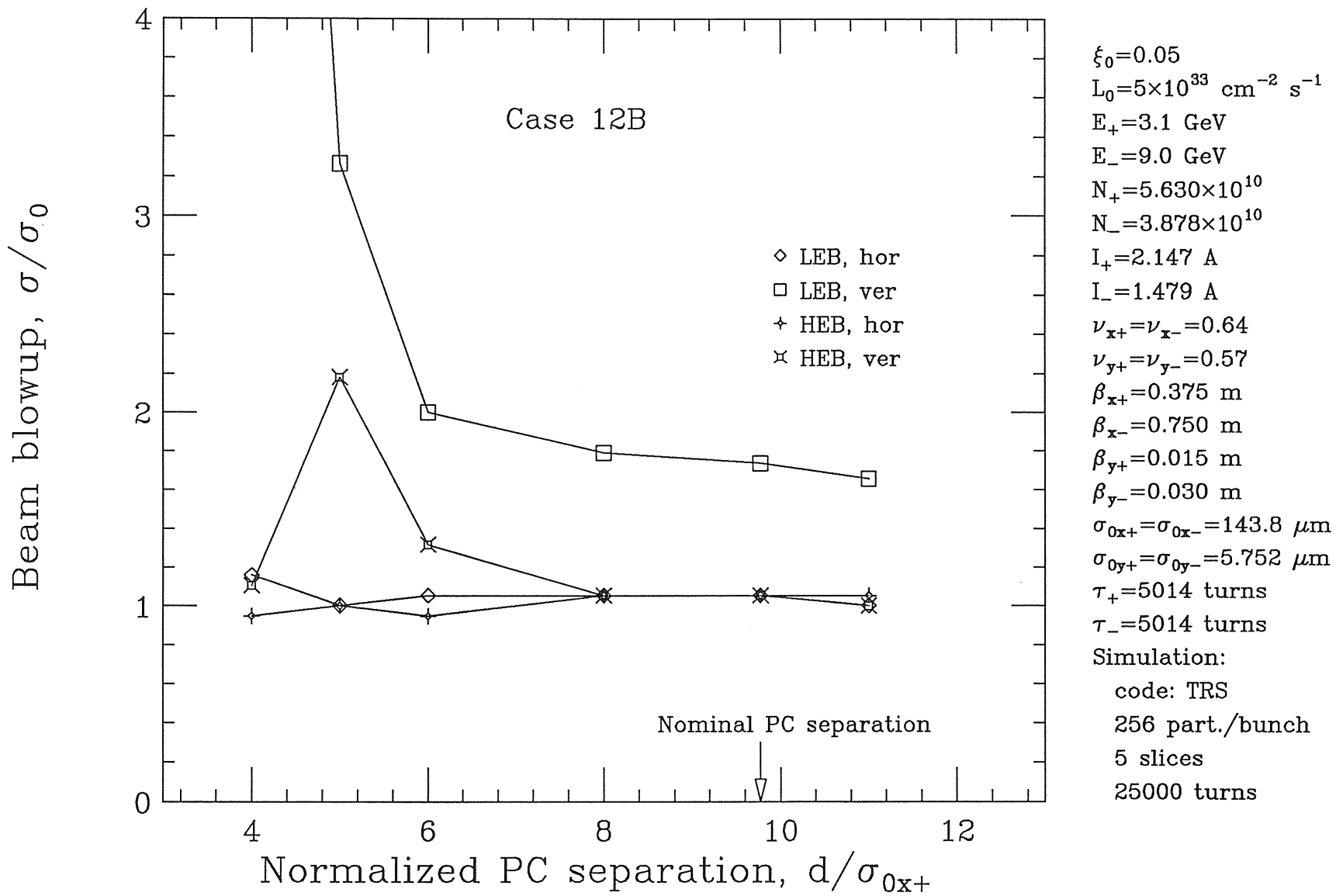

Fig. 10. Beam blowup for APIARY 6.3D for the nominal–current small–emittance case. In this case the emittances are 3/5 times nominal, corresponding to ξ_0=0.05 and $L_0=5\times10^{33}$ cm^{-2} s^{-1}.

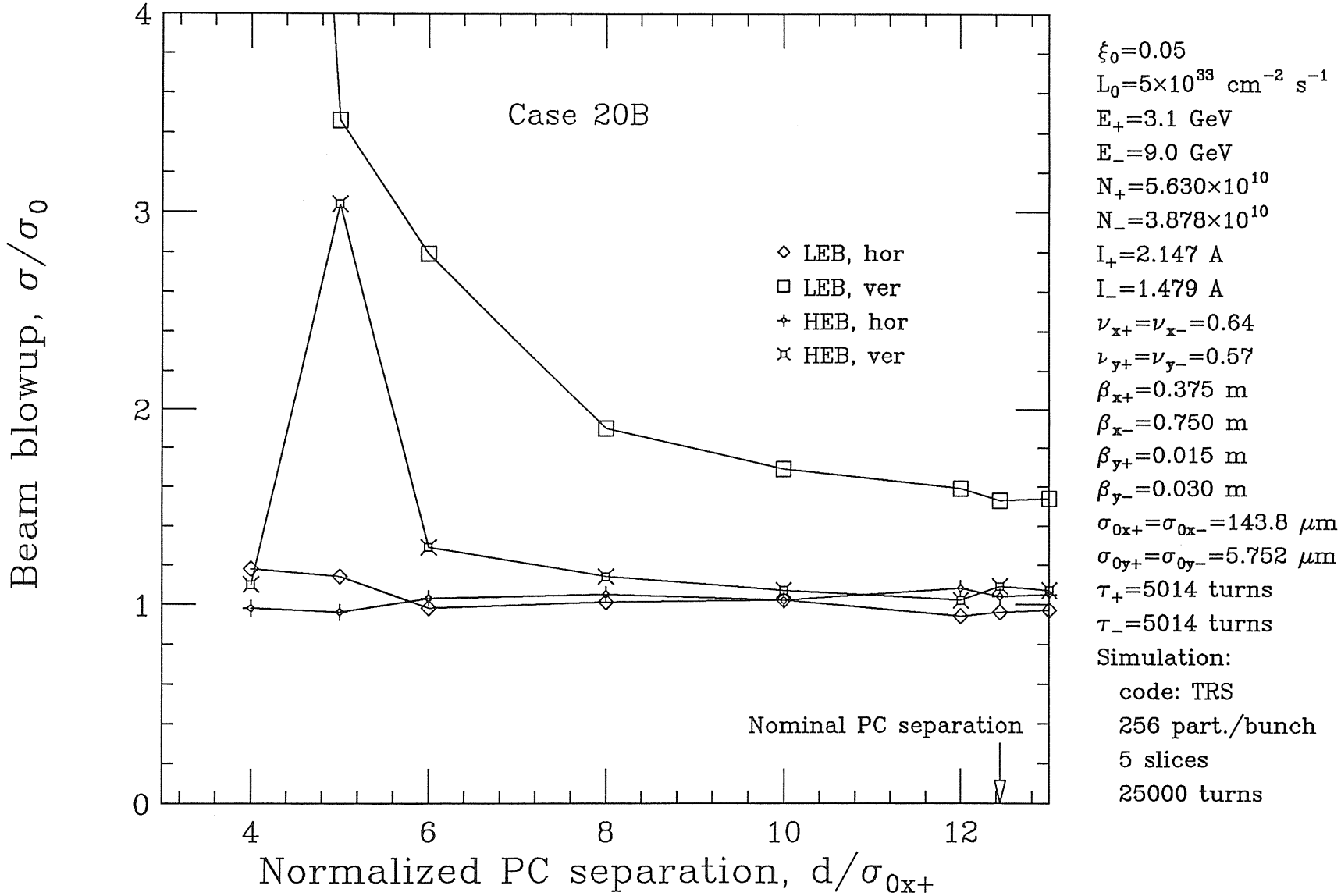

Fig. 11. Beam blowup for APIARY 7.5 for the nominal–current small–emittance case. In this case the emittances are 3/5 times nominal, corresponding to ξ_0=0.05 and $L_0=5\times10^{33}$ cm^{-2} s^{-1}.

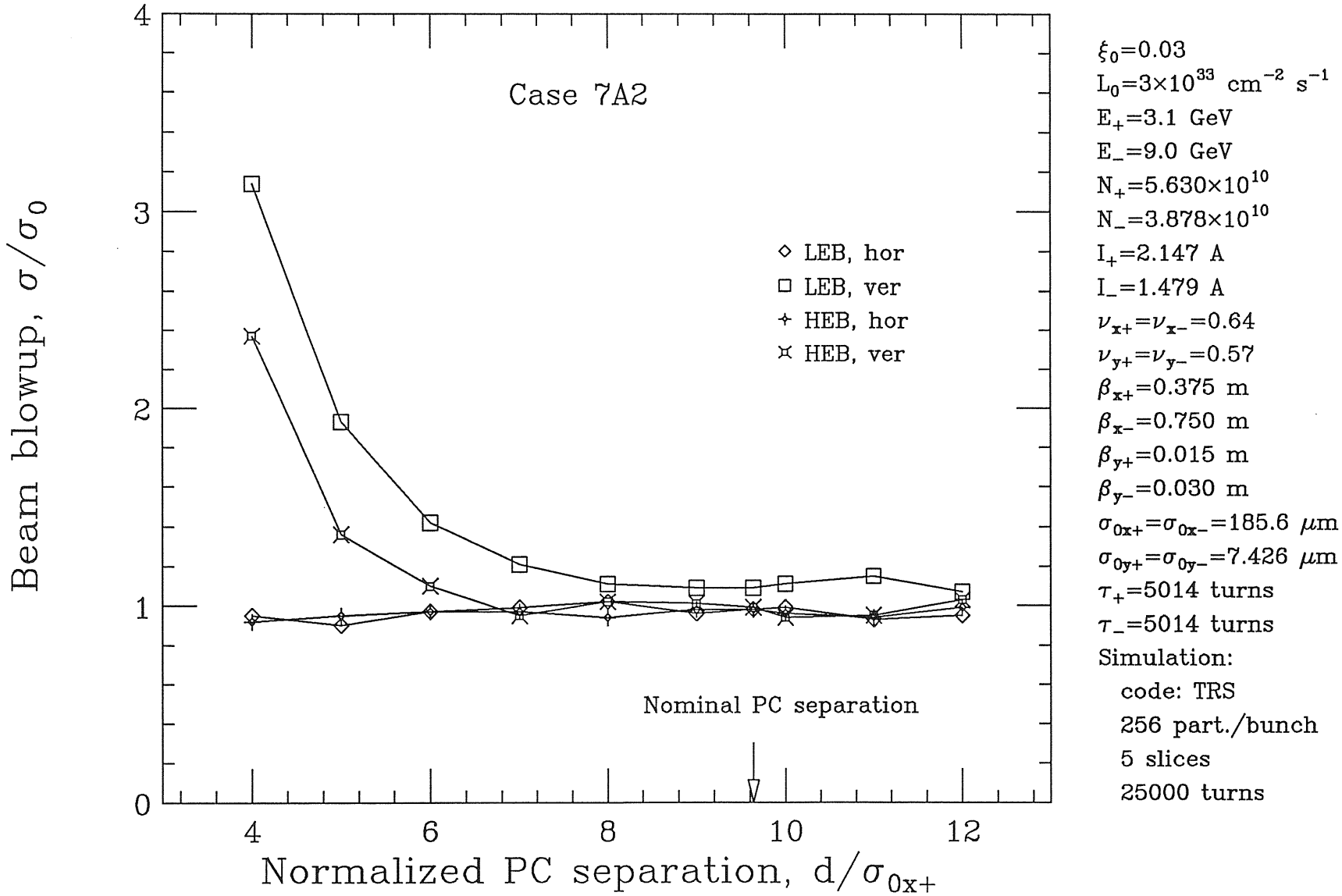

Fig. 12. Beam blowup for the nominal DU design APIARY 7.5 for the working point (0.64, 0.57). The only difference with case 7A1 is that here the synchrotron tune of the LEB is ν_{s+}=0.05 instead of 0.0403.

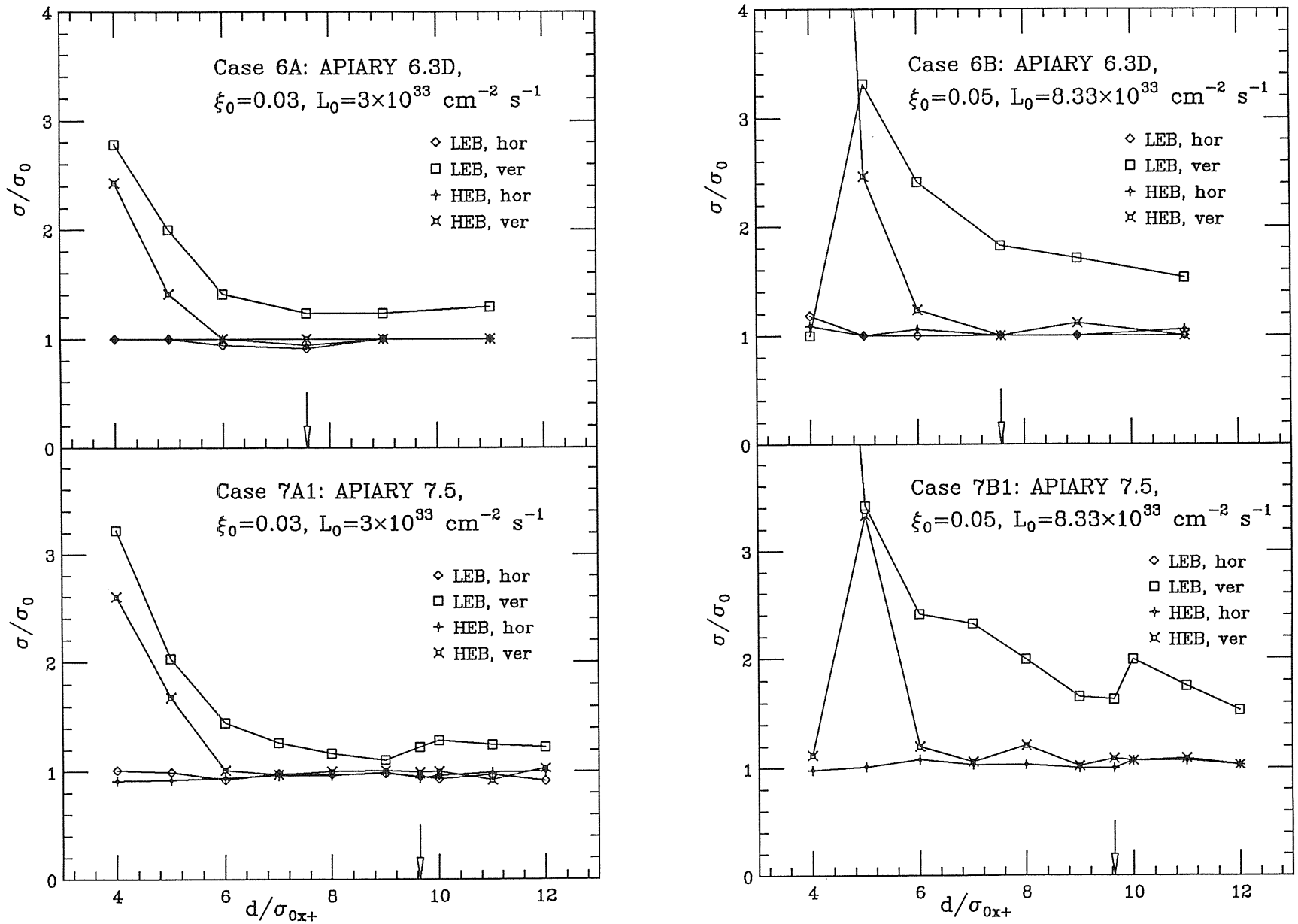

Fig. 13. Comparison of beam blowup between APIARY 6.3D and APIARY 7.5 for the nominal (ξ_0=0.03) and high−current (ξ_0=0.05) cases. The working point is the same in all cases, namely (ν_x, ν_y)= (0.64, 0.57) for both beams. The arrow shows the nominal PC separation in each case.

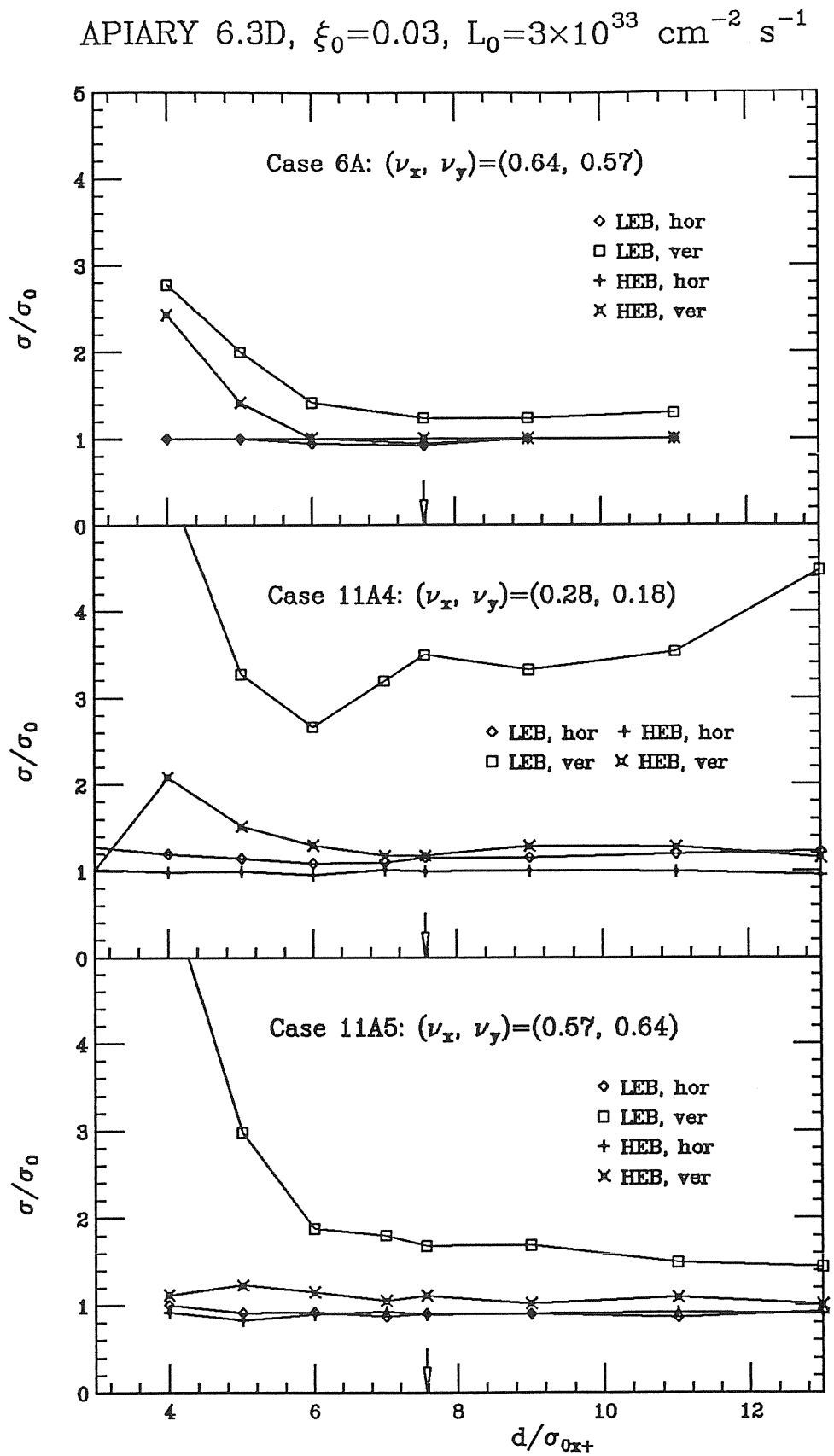

Fig. 14. Comparison of beam blowup for the CDR design APIARY 6.3D for three different working points.

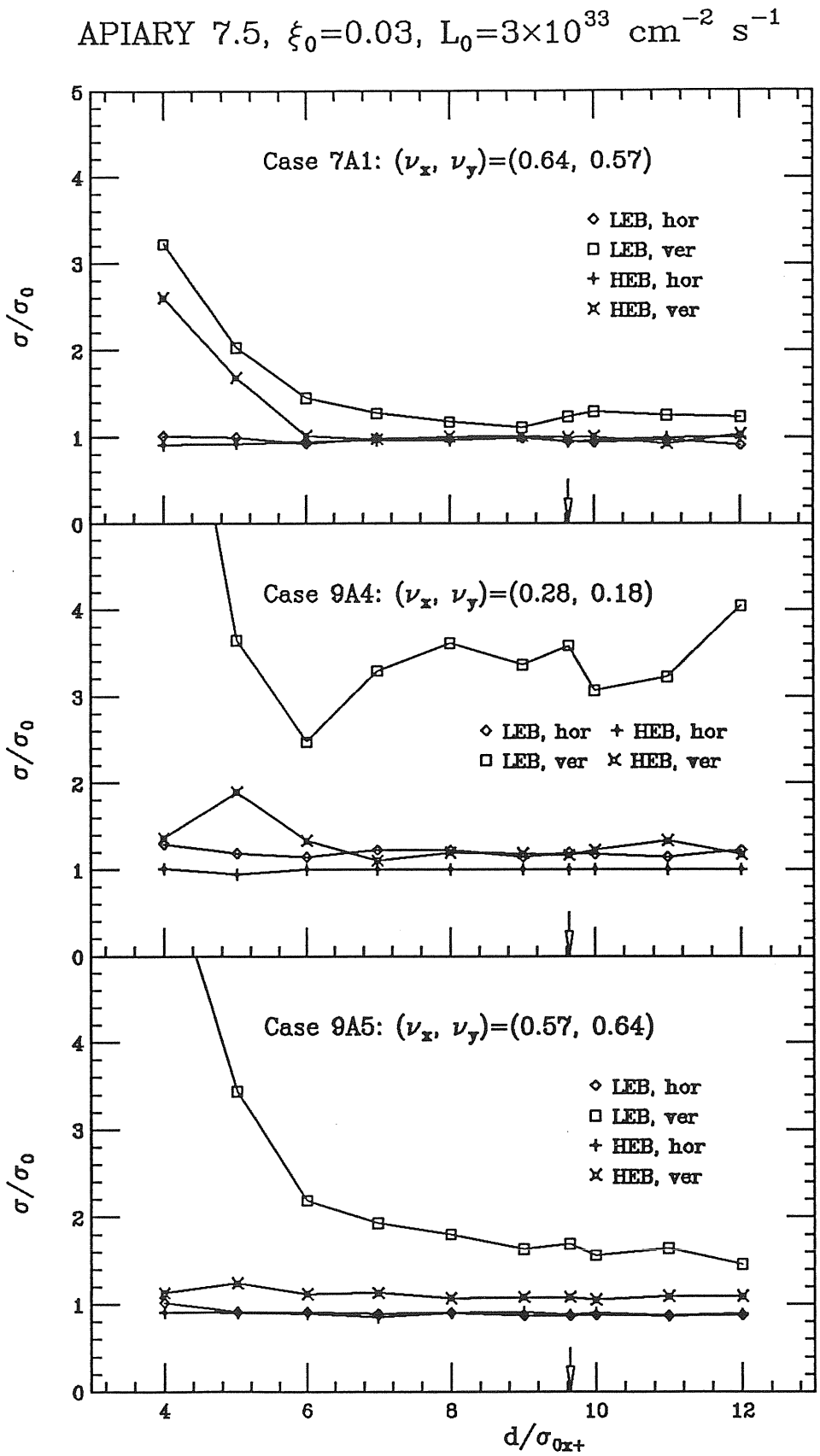

Fig. 15. Comparison of beam blowup for the DU design APIARY 7.5 for three different working points.

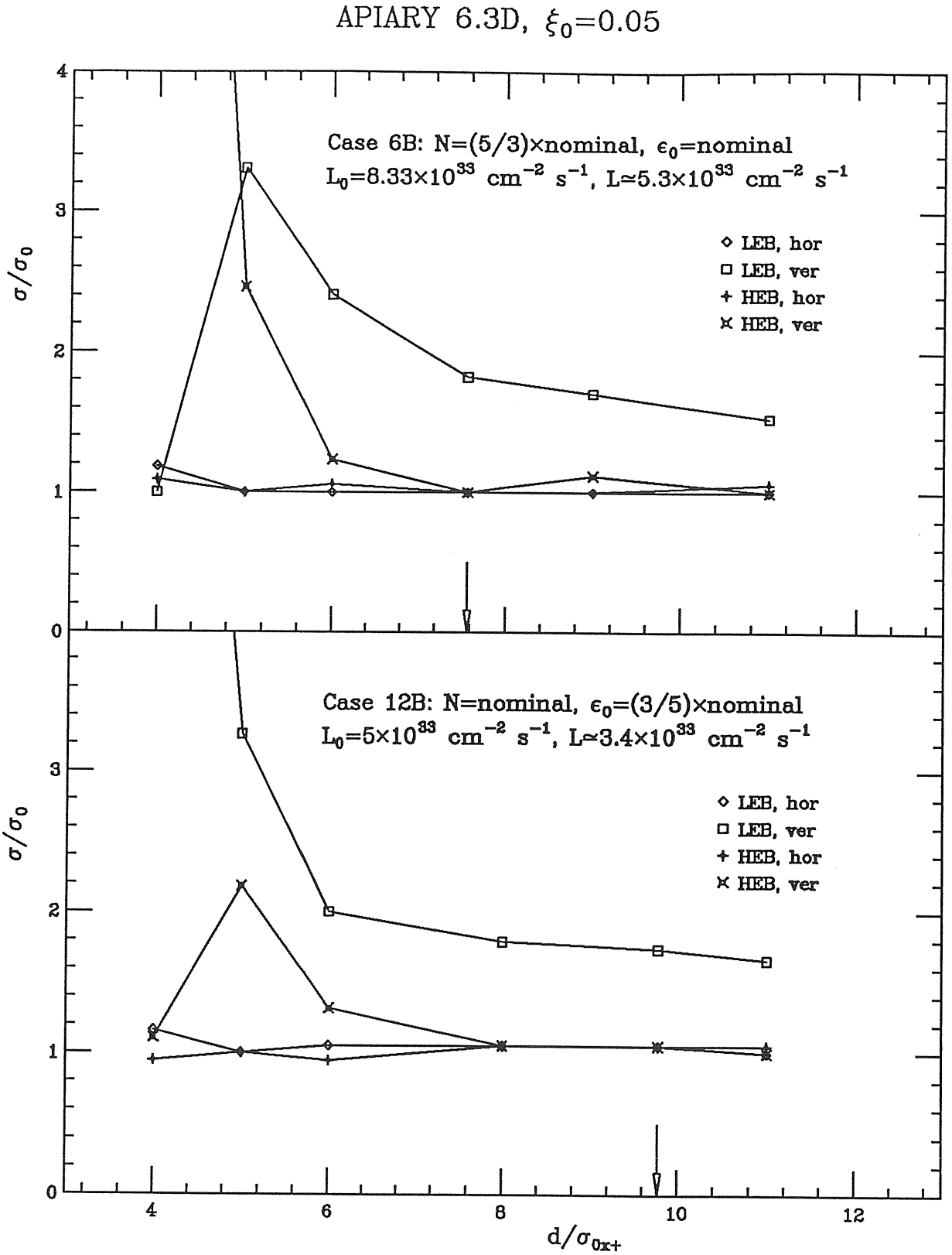

Fig. 16. Comparison of beam blowup for the CDR design APIARY 6.3D for two cases with ξ_0=0.05. This value for ξ_0 is obtained in two different ways. Note that the nominal luminosity is different in the two cases. For d/σ_{0x+}<5 the beams spontaneously choose the opposite states of a flip–flop instability.

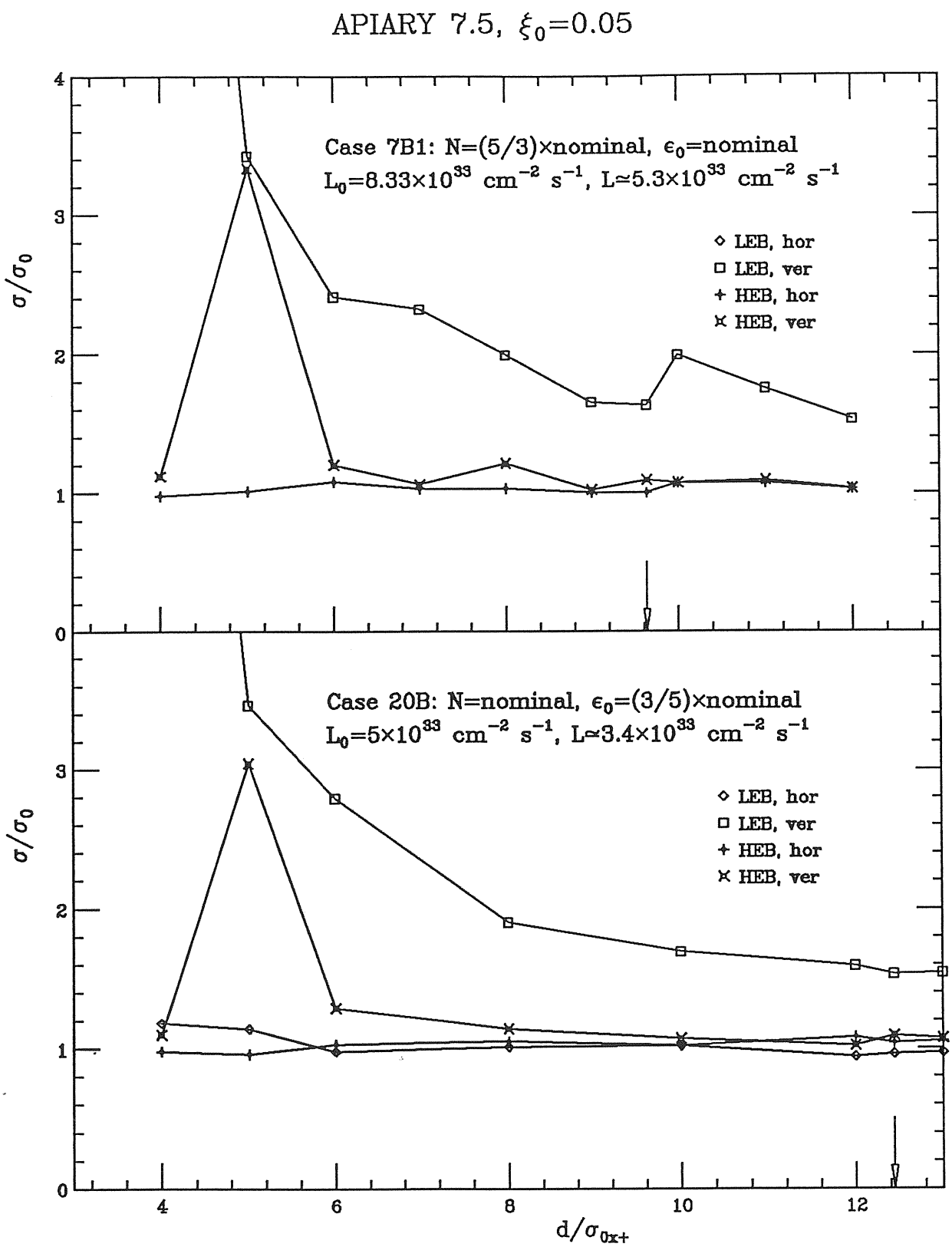

Fig. 17. Comparison of beam blowup for the DU design APIARY 7.5 for two cases with ξ_0=0.05. This value for ξ_0 is obtained in two different ways. Note that the nominal luminosity is different in the two cases. For d/σ_{0x+}<5 the beams spontaneously choose the same state of a flip–flop instability.

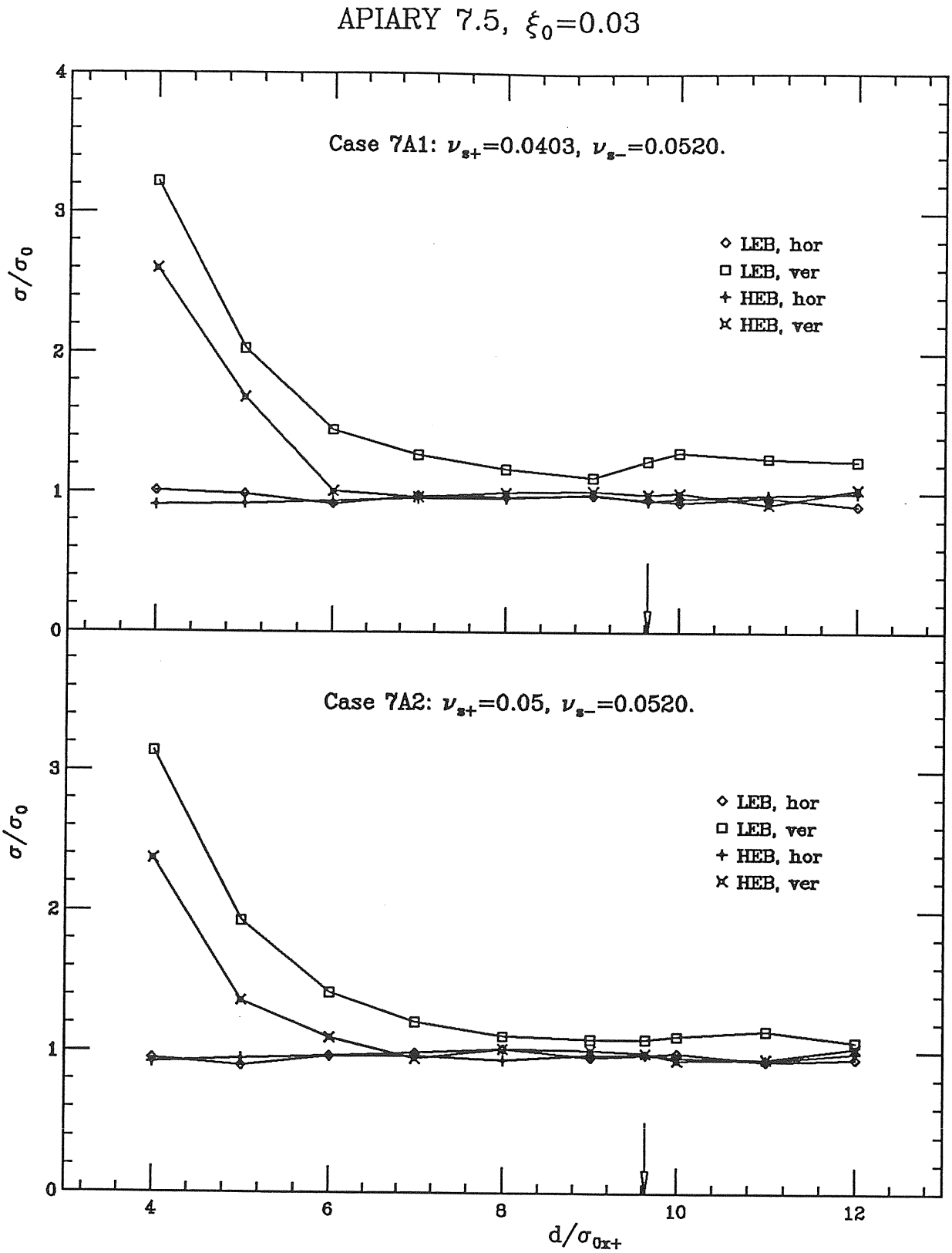

Fig. 18. Comparison of beam blowup for the DU design APIARY 7.5 for ν_{s+}=0.0403 and ν_{s+}=0.05.