Corrigendum: "A novel method of studying the core boron transport at ASDEX Upgrade" [(2018) Plasma Phys. and Control. Fusion 60 085011]

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1. Corrigendum

The shape of the experimental boron density profile that appears in our paper (Figs. 2, 3a, 12) is incorrect. As a result, the comparisons to the theoretical results presented in section 4 (Figs. 13 and 15) are also incorrect. The agreement between the experimentally measured and theoretically predicted impurity particle convection is significantly better than was reported in our publication.

There were two errors that contributed to the incorrect boron density profile. The first was an error in the absolute intensity calibration of the charge exchange recombination spectroscopy (CXRS) diagnostic used for the analysis [1]. This error was corrected by cross-calibrating to a second system [2] and by using the post-campaign (opposed to the pre-campaign) absolute-intensity calibration measurements. The second error was in the implementation of the 'COLRAD' package within the CHICA code [3] that was used to calculate the neutral density populations. The error resulted in incorrect distributions of halo neutrals, which lead to artificially hollow density profiles. This implementation error has since been corrected. Please note that these errors do not affect any other publication. In particular, the authors would like to stress that the impurity density profiles used in previous transport studies [4, 5, 6, 7] do not suffer from either of these errors as they were calculated using data from the NBI I CXRS system only [2] and using the 'FIDASIM' code rather than 'COLRAD' for the neutral distributions.

With these errors corrected, the boron density profiles in this discharge are flat, not hollow. The boron density profiles from both CXRS systems are shown in Fig. 1. The shapes of the profiles agree well within the error bars. Here, the boron density profile from the NBI Box II system has been scaled upward to match the NBI Box I system.

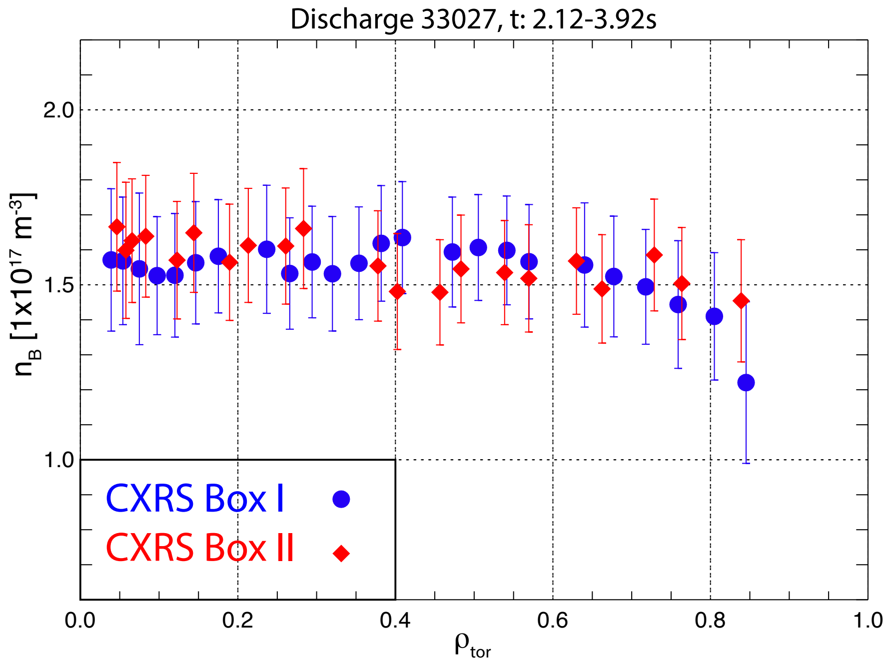

Figure 1. Steady-state boron density profiles from the two CXRS core diagnostics in discharge 33027. These profiles have been averaged over the time window 2.12-2.92s. The data from the NBI Box II system have been scaled upward by a factor of 1.6 to bring them into agreement with the profile from the NBI Box I diagnostic.

The discrepancy in the absolute magnitudes is the result of significant damage to the optical heads that occurred during the experimental campaign.

Figure 3 from the original publication, which showed the temporal evolution of the measured modulation data and its simulated counterpart, is reproduced here (Fig. 2) using the correct boron density profiles. Here, the data from all CXRS diagnostics have been included while in the original publication only data from the NBI Box II system were used. The authors felt it important to include the data from NBI Box I system, as the profile shape measured on this system is more reliable.

The numerical scheme and methodology presented in the original publication are still valid. However, the results and comparisons presented in Section 4 that are connected to the shape of the density profile are not. The new modulation analysis for this discharge together with the results of the minimisation are shown in Fig. 3. The phase profile is the same as in the original data and the amplitude profile is quite similar within its uncertainties, see Fig. 12 (original publication) for comparison. Here, the amplitude profile is shown in units of density rather than in percent as was done in the original publication. The major change is the steady-state profile, which sets the ratio of diffusion to convection. The data in Fig. 3 appear noisier than in the original publication. The uncertainties, however, are extremely similar. The appearance of increased 'noisiness' results from significantly more data in closer radial proximity and the much flatter profile gradient. As in the original publication, the blue lines are the

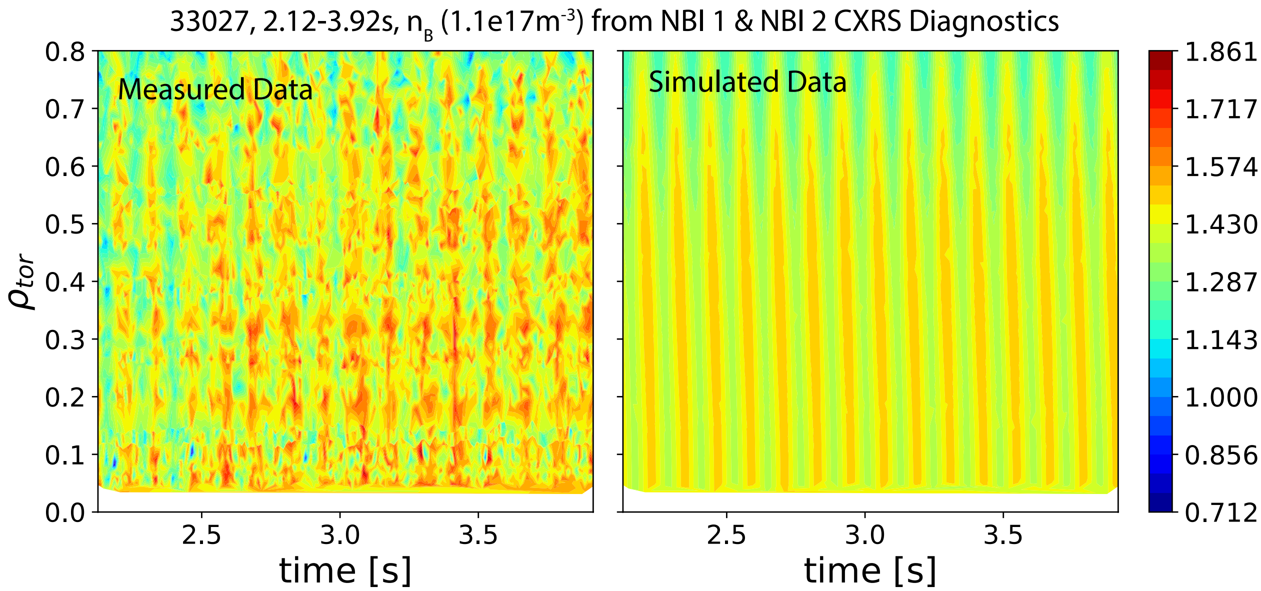

Figure 2. Fig. 3 from original publication using correct boron density profiles. Left: contour plot of the measured boron density. Right: contour plot of the reconstructed boron density. Note that the two plots have the same colorbar.

result of the best minimization to the dataset.

The minimization using the corrected boron density profile also yields new corrected diffusion and convection profiles. These can be seen in Fig. 4, which is a reproduction of Fig. 13 from the original publication with updated experimental data. The thick blue lines correspond to the minimization shown in Fig. 3. In addition, light blue uncertainty intervals are shown. These intervals correspond to the range of D and V values obtained from minimizations performed on variations of the original dataset altered to explore the maximum uncertainty ranges of the measurements. In particular, the gradients of the steady-state, phase, and amplitude profiles were varied by $\pm \sim 10\%$ to cover the steepest and shallowest profile gradients supported by the measurements. The minimizations corresponding to the variation of the steady-state profile are shown as dashed lines in Fig. 3. The blue shaded uncertainty interval can be thought of as a maximum error bar.

The new diffusion profile is similar to the original, but slightly larger giving even better agreement with the combined predictions from GKW and NEO. The most important difference is in the convective profile shown on the right hand side of Fig. 4. The boron density profiles in the original publication were hollow, leading to outward convection and poor agreement with the theoretical predictions. Here, the convection is found to be inward around mid-radius, leading to very good agreement with the predictions, even quantitatively so within the uncertainties of the measurements. For this plasma, the linear (and non-linear) predictions by GKW and NEO are able to accurately reproduce the experimental data.

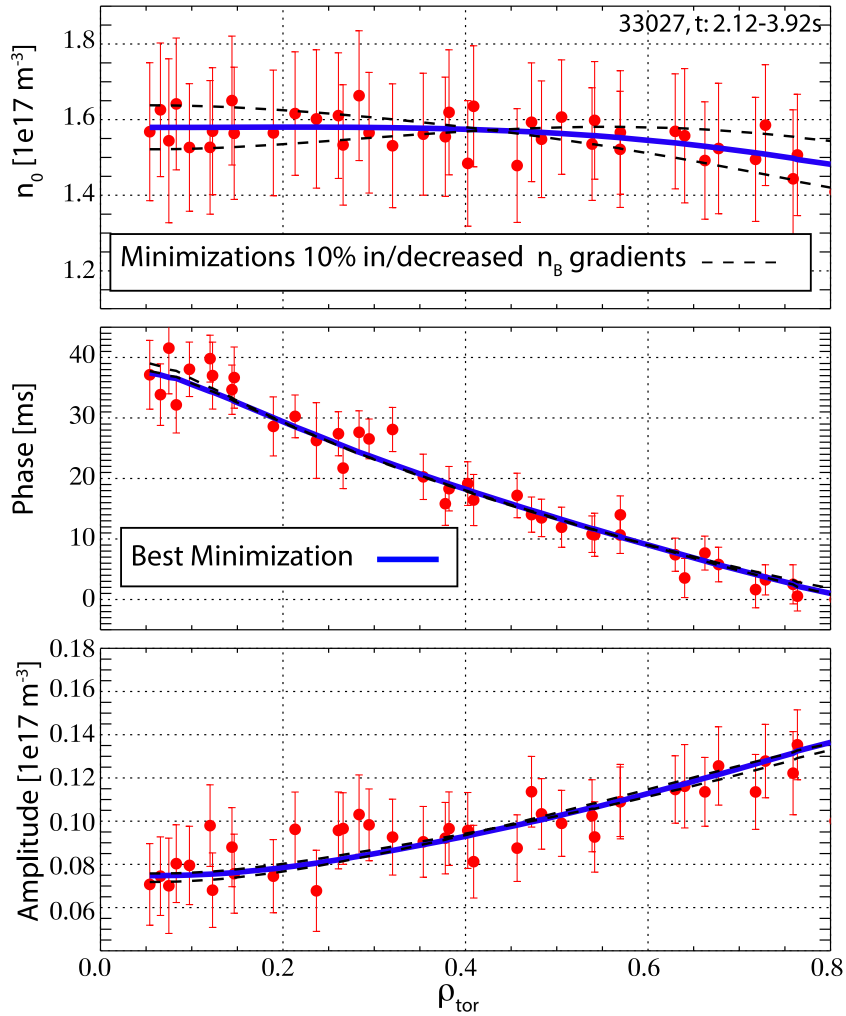

Figure 3. Fig. 12 from original publication using correct boron density profiles. Steady-state, phase, and amplitude of the measured data (red) and the simulation (blue). The blue lines are not fits to the red data points, but rather the results of the minimization. The black dashed lines correspond to minimizations performed on datasets that were altered to have 10% increased and decreased gradients of the steady-state profile.

Acknowledgments

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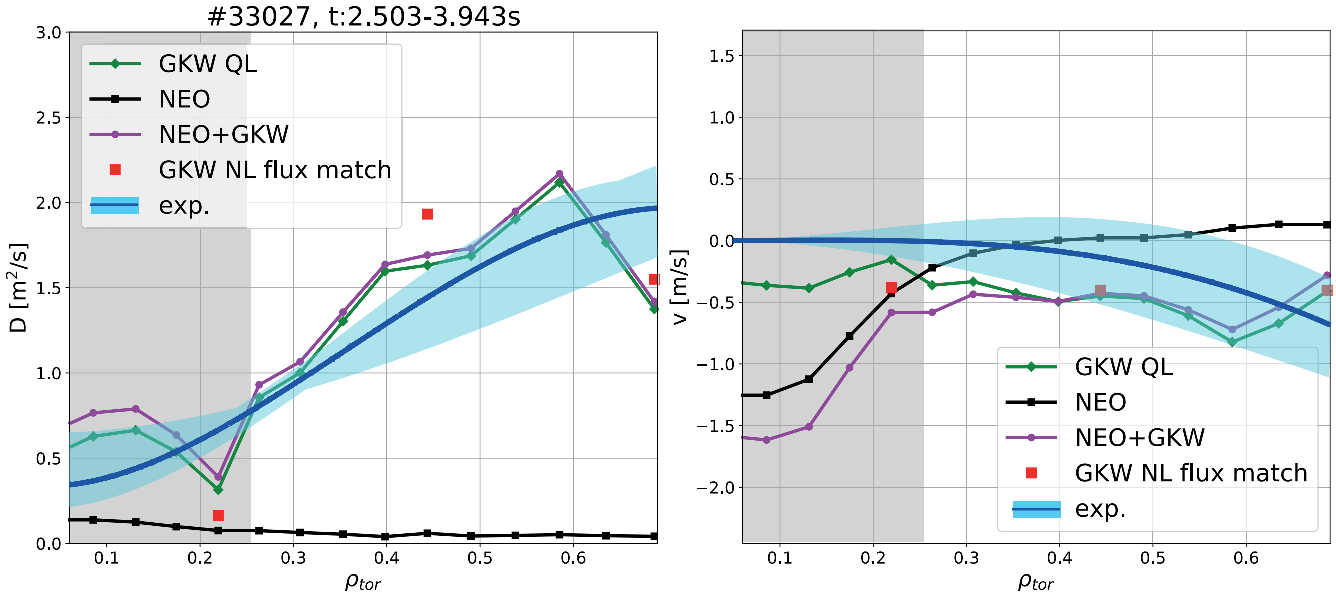

Figure 4. Reproduction of Fig. 13 from the original publication using new corrected boron density profiles. Experimental and theoretical D (left) and v (right) profiles. The experimental profiles with their uncertainty bands are depicted in blue, the ones from the quasi-linear GKW run in green diamonds, from NEO in black squares, and the total theoretical profiles in magenta circles. The red squares represent the result of the nonlinear GKW run performed with matching of the heat fluxes. Our region of interest starts at ρ_{tor} =0.25, hence, where the gray region ends.

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