the pre-injection $\bar{n}_e$. Because the density rise with beam injection was larger at higher beam power, $\bar{n}_e$ before beam injection was lower in the higher beam power discharges. The pre-injection $\bar{n}_e$ in the discharges with beam injection ranged from 4.2×10^{13} cm^{-3} at 1.2 MW beam power to 3.1×10^{13} cm^{-3} at 5.6 MW. A discharge with ohmic heating only was also included in the scan.

Figure 16 shows Z_{eff} before and during beam injection in these discharges. Z_{eff} before beam injection ranged from 2.0 to 3.6 and was larger in the discharges with higher beam power due to their lower pre-injection $\bar{n}_e$. As previously discussed, the Z_{eff} drop with beam injection was primarily due to the $\bar{n}_e$ rise. Z_{eff} during the beam pulse rose from 2.0 to 2.8 as the beam power increased from zero to 5.6 MW: because $\bar{n}_e$ was constant, the average impurity density increased with beam power.

Central nickel and chromium densities before and during beam heating are shown in Figs. 17a and 17b. Again, metallic impurity concentrations were small in all of these discharges, less than 0.01% of $n_e(0)$. Metallic impurity densities were larger during beam injection than before it, and increased with beam power. Because the pre-injection $\bar{n}_e$ was lower in the higher beam power discharges, metallic impurity densities before beam injection were somewhat higher in the higher power discharges.

Figure 18 shows the carbon-to-oxygen density ratio before and during beam injection. Carbon was the major impurity contributor to Z_{eff}, both before and during beam injection, in almost all of these discharges. The carbon-to-oxygen density ratio before beam injection was larger in the plasmas with greater beam power; because the pre-injection $\bar{n}_e$ decreased with beam power, this is consistent with the $\bar{n}_e$ scaling of the previous section. With one exception, the carbon-to-oxygen density ratio in a given discharge was larger during beam injection than before it; the difference was always a factor of two or less, and did not vary systematically with beam power. The carbon-to-oxygen density ratio during beam injection increased with beam power.

Figures 19a and 19b show the central carbon and oxygen densities before and during beam injection. During a particular discharge, the central carbon density was not different before and during beam injection. The pre-injection carbon density was larger in the lower initial density, higher beam power discharges, consistent with the $\bar{n}_e$ scaling discussed in the previous section. The carbon density during beam heating increased with beam power.