Purpose: To quantify the impact of loss in functional imaging sensitivity and specificity on tumor control and normal tissue toxicity for selective boosting IMRT.

Methods and materials: Four selective boosting scenarios were designed: SB91-81 (EUD=91Gy for the high risk tumor subvolume (node) and EUD=81Gy for a remaining low risk PTV (rPTV)), SB80-74, SB90-70, and risk-adaptive optimization. For each sensitivity loss level, the loss in tumor control probability (ΔTCP) was calculated. For each specificity loss level, the increase in rectal and the bladder toxicity was quantified using the radiobiological indices (equivalent uniform dose (EUD) and normal tissue complication probability (NTCP)) and physical indices (%-volumes).

Results: The impact of loss in sensitivity on local tumor control was maximized as the dose level for rPTV had a lower value. The SB90-70 plan had a ΔTCP= 93.8 %, for the SB91-81 plan ΔTCP = 26.8 %, while for risk-adaptive optimization ΔTCP= 8.0 %. Independent of planning technique, loss in functional imaging specificity appears to have a minimal impact on the expected normal tissue toxicity since an increase in rectal or bladder toxicity as a function of loss in specificity was not observed. Additionally, all plans fulfilled the rectum and the bladder sparing criteria found in the literature for late rectal bleeding and genitourinary complications.

Conclusions: Our study shows that the choice of a low-risk classification for the rPTV in selective boosting IMRT may lead to a significant loss in TCP. Furthermore, it appears that in order to improve the therapeutic ratio a functional imaging technique with a high sensitivity, rather than specificity, is needed.