Hamburg model [1]

$$\Delta N_{eff}(\Phi,t) = N_C(\Phi) + N_a(\Phi,t,T) + N_Y(\Phi,t,T)$$

Donor removal & Stable acceptor	$N_C(\Phi) = N_{C0}\left(1-e^{-c\Phi}\right) - g_C\Phi$	
Unstable acceptor	$N_a(\Phi,t,T) = -g_a\Phi\exp\left(-\Theta(T)_a t/\tau_a\right)$, $\Theta(T)_a = \exp\left(\frac{E_a}{k_B}\left[1/T_R - 1/T\right]\right)$	
Reverse annealing	$N_Y(\Phi,t,T) = -g_y\Phi\left(1-1/(1+\Theta(T)_y t/\tau_y)\right)$, $\Theta(T)_y = \exp\left(\frac{E_y}{k_B}\left[1/T_R - 1/T\right]\right)$	
Parameters	Standard Silicon $N_{C0} = 0.70 \times N_{eff,0}$ $c = 0.075\,\mathrm{cm}^{-1} / N_{C0}$ $g_a = 0.018\,\mathrm{cm}^{-1}$ $\tau_a = 2.29\,\mathrm{days}\,(20°\mathrm{C} \equiv \mathrm{T_R})$ $E_a = 1.09\,\mathrm{eV}$ $g_C = 0.017\,\mathrm{cm}^{-1}$ $g_y = 0.059\,\mathrm{cm}^{-1}$ $\tau_y = 480\,\mathrm{days}\,(20°\mathrm{C})$ $E_y = 1.33\,\mathrm{eV}$ $N_{eff,0} = 1.026\times10^{12}\ \mathrm{cm}^{-3}$	Oxygenated Silicon $N_{C0} = 0.45 \times N_{eff,0}$ $c = 0.075\,\mathrm{cm}^{-1} / N_{C0}$ (??) $g_a = 0.014\,\mathrm{cm}^{-1}$ $\tau_a = 2.917\,\mathrm{days}\,(20°\mathrm{C} \equiv \mathrm{T_R})$ $E_a = 1.09\,\mathrm{eV}$ $g_C = 0.020\,\mathrm{cm}^{-1}$ $g_y = 0.048\,\mathrm{cm}^{-1}$ $\tau_y = 800\,\mathrm{days}\,(20°\mathrm{C})$ $E_y = 1.33\,\mathrm{eV}$ $N_{eff,0} = 1.026\times10^{12}\ \mathrm{cm}^{-3}$

[1] G. Lindstrom et al., NIM A 466(2001) 308-326
M. Moll, Radiation Damage in Silicon Particle Detectors, Dissertation, Hamburg 1999.