Summary

Identified point defects induced by irradiation

Defect	$E_{V,C} \pm E_t$ [eV]	$\sigma_{n,p}$ [cm^2]	T_{anneal} [°C]	g [cm^{-1}] N_t/Φ_{eq}	Material
IO_2(-/0)	–0.143	3.8×10^{-14}	≈100	≈ 0.21	MCz, EPI-DO
C_i(-/0)	–0.114	5.9×10^{-15}	≈80		FZ, EPI-ST
$C_iC_s^A$(-/0)	–0.171	1.4×10^{-14}	≈260		FZ, EPI-ST
VO_i(-/0)	–0.176	1.4×10^{-14}	≈300 / >300	0.73	MCz, EPI / FZ
X(=/-) V_2O(=/-)	–0.241	1.1×10^{-14}	≈260 in		MCz, EPI
V_2(=/-)	–0.224	7×10^{-16}	≈260 / 340	0.37	MCz,, EPI / Fz
L, V_3O(=/-)	–0.328	1.23×10^{-15}	≈240 in		MCz, EPI
E4, V_3(=/-)	–0.36	4×10^{-15}	≈240	0.19	MCz, EPI / FZ
E(205a)	–0.393	1.3×10^{-15}	≈180		MCz, EPI / FZ
V_2(-/0)	–0.424	2.1×10^{-15}	≈260 / 340	0.37	MCz, EPI / FZ
X(-/0), V_2O(-/0)	–0.467	1.1×10^{-14}	≈260 in		MCz, EPI
E5, V_3(-/0)	–0.456	5×10^{-15}	≈240	0.19	MCz,, EPI / FZ
C_iO_i(+/0)	+0.360	$2,45\times10^{-15}$	≈380	1.3	MCz, EPI / FZ

Summary

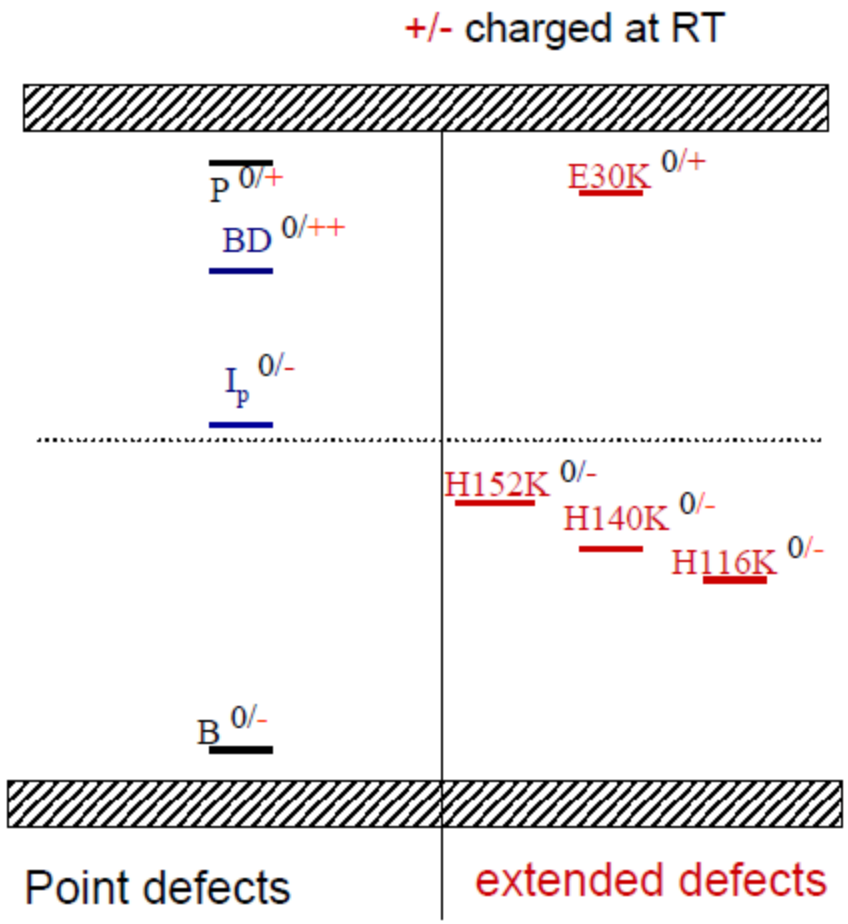
not identified defects but with strong impact on the device properties at operating temperature

Point defects

- $E_i^{BD} = E_c - 0.225$ eV
- $\sigma_n^{BD} = 2.3 \cdot 10^{-14}$ cm^2
- $E_i^{I} = E_c - 0.545$ eV
  - $\sigma_n^{I} = 1.7 \cdot 10^{-15}$ cm^2
  - $\sigma p^{I} = 9 \cdot 10^{-14}$ cm^2

Cluster related centers

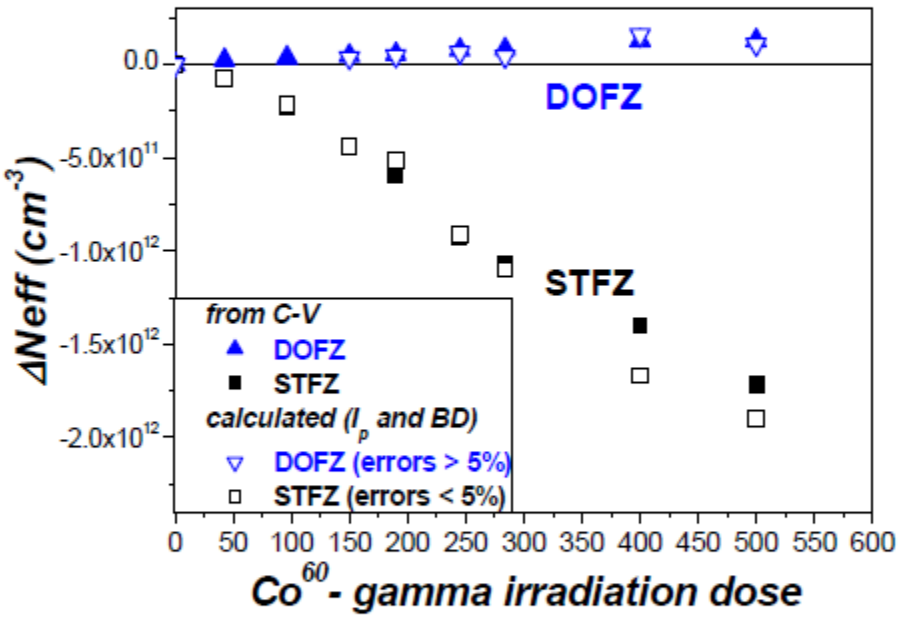
- $E_i^{116K} = E_v + 0.33$eV
- $\sigma_p^{116K} = 4 \cdot 10^{-14}$ cm^2
- $E_i^{140K} = E_v + 0.36$eV
- $\sigma_p^{140K} = 2.5 \cdot 10^{-15}$ cm^2
- $E_i^{152K} = E_v + 0.42$eV
- $\sigma_p^{152K} = 2.3 \cdot 10^{-14}$ cm^2
- $E_i^{30K} = E_c - 0.1$eV
- $\sigma_n^{30K} = 2.3 \cdot 10^{-14}$ cm^2

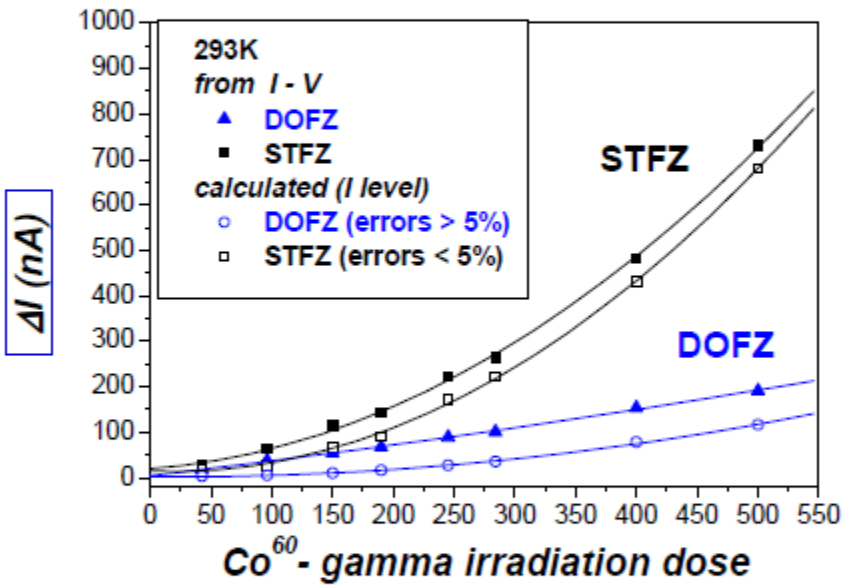


Impact of I_p and BD defects on detector properties

$$\Delta N_{eff}(T) = -n_T(T)$$

$$\Delta I(T) = q_0 \cdot e_n(T) \cdot n_T(T) \cdot Vol$$



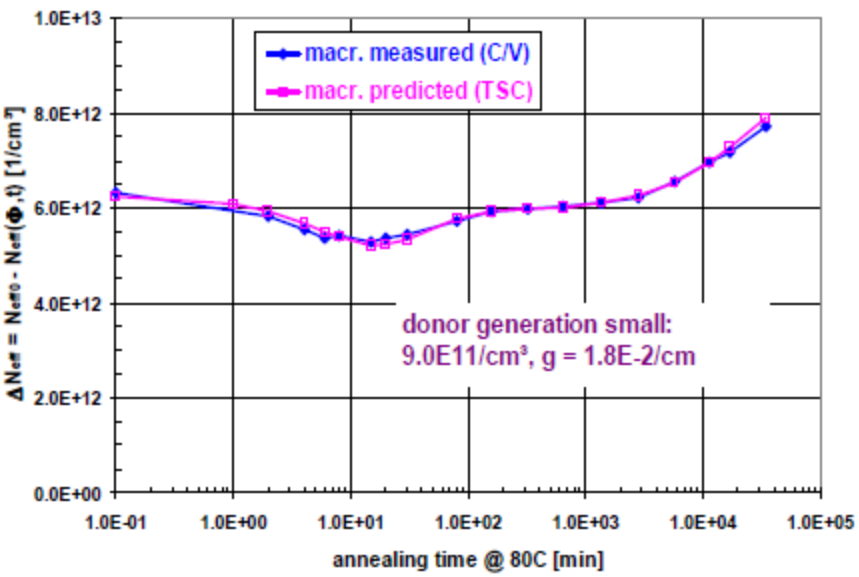


change of N_{eff} and leakage current well described

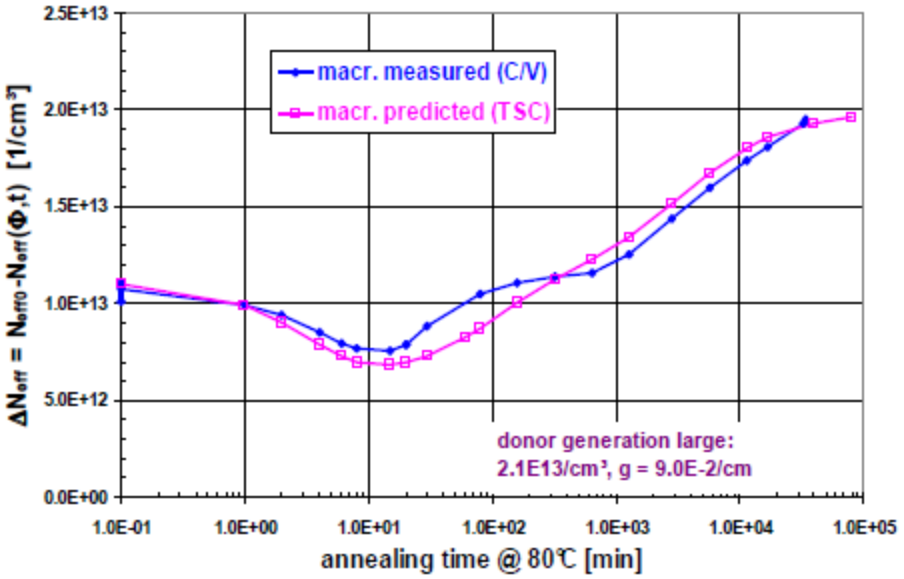
⇒ first breakthrough in understanding the damage effects

EPI-DO 75 μm: $N_d = 2.48 \times 10^{13}$ cm^{-3}

1 MeV neutrons, $\Phi = 5 \times 10^{13}$ cm^{-2}



23GeV protons, $\Phi_{eq} = 2.33 \times 10^{14}$ cm^{-2}



Larger donor generation (E(30K) and BD) after 23GeV protons than after 1 MeV neutrons (~4.5 times) !