Supplementary Material

A. Calculation of the contribution of interstitials vs. vacancies

The following calculation demonstrated that the interstitial term on equation 16 of the main text can be considered of negligible influence respect the vacancy term, due to the difference of three orders of magnitude between them.

$$\frac{dV_{void}}{dt} = 4\pi R\Omega[D_v(C_v - C_v^V) - D_iC_i]$$

At t=0.0001, $C_v^V \approx 0$. For copper, we know that:

$D_v = 3.9e^{-7}\,\frac{cm^2}{s}$ [1]

$C_v \approx 2e^{-4}\,\frac{cm^2}{s}$ [2]

$D_i = 3.19e^{-5}\,\frac{cm^2}{s}$ [1]

$C_i \approx 6e^{-10}\,\frac{cm^2}{s}$ [2]

$D_vC_v \approx 7.8e^{-11}$ and $D_iC_i \approx 1.9e^{-14}$, therefore $D_vC_v \gg D_iC_i$

B. Thermal diffusivity and stopping powers

First table shows the calculation of the stopping powers heavy ion/proton ratio for each of the elements that compose the GRCop-84 alloy. At the end of the table, a composition-averaged ratio is shown.

	Ei (eV)	7000000								
		Z	M		E	Sn(E)	Sn(Ei)	Se(Ei)	Stot(Ei)	Ratio Stot (%)
Incoming	Cu	29	63.546		31201.4356	0.00016772	1.3754E-16	7.4921E-11	7.4921E-11	
Target	Cu	29	63.546							
	Ei (eV)	3000000								
		Z	M		E	Sn(E)	Sn(Ei)	Se(Ei)	Stot(Ei)	
Incoming	H	1	1.00794		1045171.56	6.691E-06	8.0889E-21	7.9373E-12	7.9373E-12	10.5941765
Target	Cu	29	63.546							
	Ei (eV)	7000000								
		Z	M		E	Sn(E)	Sn(Ei)	Se(Ei)	Stot(Ei)	
Incoming	Cu	29	63.546		34671.3284	0.00015246	1.1629E-16	7.4921E-11	7.4921E-11	
Target	Cr	24	51.9961							
	Ei (eV)	3000000								
		Z	M		E	Sn(E)	Sn(Ei)	Se(Ei)	Stot(Ei)	
Incoming	H	1	1.00794		1296343.87	5.4778E-06	6.8751E-21	7.9373E-12	7.9373E-12	10.5941795
Target	Cr	24	51.9961							
	Ei (eV)	7000000								
		Z	M		E	Sn(E)	Sn(Ei)	Se(Ei)	Stot(Ei)	
Incoming	Cu	29	63.546		25167.6954	0.00020364	1.8416E-16	7.4921E-11	7.4921E-11	
Target	Nb	41	92.90638							
	Ei (eV)	3000000								
		Z	M		E	Sn(E)	Sn(Ei)	Se(Ei)	Stot(Ei)	
Incoming	H	1	1.00794		703039.722	9.6648E-06	1.0745E-20	7.9373E-12	7.9373E-12	10.5941699
Target	Nb	41	92.90638							
									88/8/4 averaged composition	10.5941765

This second table shows the calculated drop in thermal diffusivity for Cu-ion irradiation and proton irradiation, and the calculated ratio.

Cu ions 3+ Low rate DPA		
Beam	SAWf	Th.diff
before	5.57E+08	6.77E-06
after	5.55E+08	6.60E-06
off/on	-0.40	-2.46
Protons at Low rate DPA		
Beam	SAWf	Th.diff
before	5.54E+08	6.59E-06
after	5.54E+08	6.60E-06
off/on	-0.01	0.22
		-11.155581

Both tables are available in an Excel file on the repository for this paper (https://github.com/shortlab/2025-ebotica-GRCop-Beam-Pulsing)