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Fast Estimation for Electromigration Nucleation Time Based on Random Activation Energy Model

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Fast Estimation for Nucleation Time

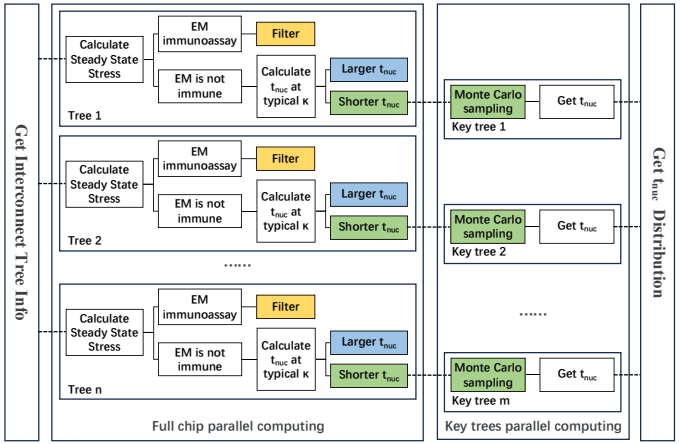
Introduction

- Electromigration is affected by the random annealing process during nanofabrication [1].
- It requires more reliable statistical models for EM analysis.
- Atomic activation energy(E_a^{eff}) follows a normal distribution:

$$f(E_a^{eff}) = \frac{1}{\bar{\sigma}\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{E_a^{eff} - \overline{E_a^{eff}}}{\bar{\sigma}}\right)^2\right]$$

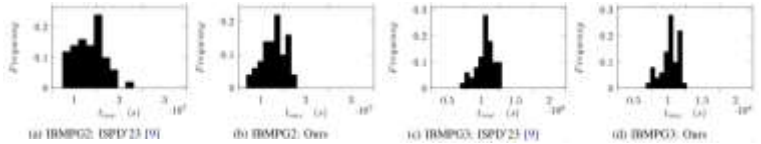
Proposed Method

- Filter out and select interconnect trees
- Monte Carlo sampling
- Parallel acceleration



Evaluation

- Dataset: IBMPG
- Baseline: ISPD'23 [2]
- 50 samplings using both two methods
- 10% key interconnect trees selected in our method
- The Kullback-Leibler (KL) divergence to measure the similarity of tnuc distributions



Benchmark	# Nodes	# Trees	ISPD'23 [5] (s)	Ours (s)	KL divergence
IBMPG2	127238	462	2868	1710	0.0310
IBMPG3	851584	8189	23245	4856	0.0118
IBMPG4	953583	9641	27496	24379	0.0072
IBMPG5	1079310	1982	9197	7329	0.0012
Avg.	-	-	15701.5	9568.5	0.0128

[1] V. Sukharev et al., "Experimental validation of a novel methodology for electromigration assessment in on-chip power grids," IEEE TCAD, vol. 41, no. 11, pp. 4837–4850, 2022 [2] A. Kteyan et al., "Electromigration assessment in power grids with account of redundancy and non-uniform temperature distribution," in Proc. ISPD, 2023, pp. 124–132.