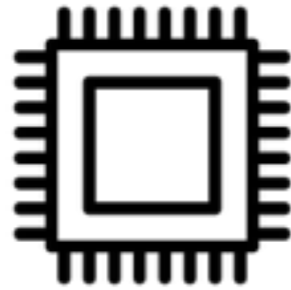


Approximate Flash Storage: A Feasibility Study

Amir Rahmati, Matthew Hicks, Atul Prakash

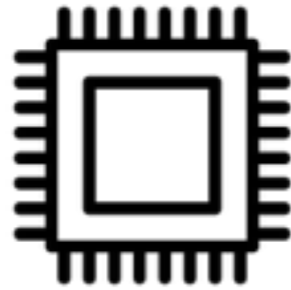


Introduction



Approximate computing

Introduction

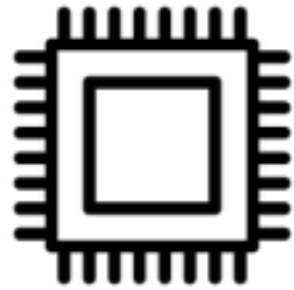


Approximate computing



Approximate memory & storage

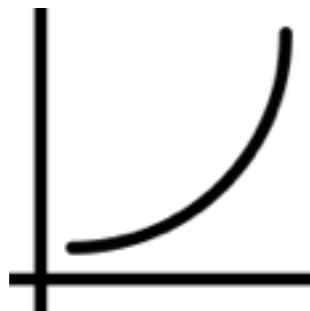
Introduction



Approximate computing

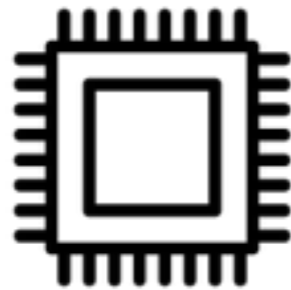


Approximate memory & storage



Rapid adoption of flash storage

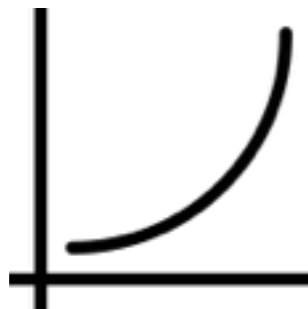
Introduction



Approximate computing



Approximate memory & storage



Rapid adoption of flash storage



Energy Saving / Performance Gain

Previous Work

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- **Approximate Memory:** SRAM, DRAM, PCM

Decreasing input voltage, refresh rate, number of writes

Previous Work

- **Approximate Memory:** SRAM, DRAM, PCM

Decreasing input voltage, refresh rate, number of writes

- **Under powering Flash:**

- Find minimum operable voltage (Tseng'13, Half-Wits'11)
- 34% - 45% Energy saving
- Repeat writes to correct error to low cases (Half-Wits'11)

Overview

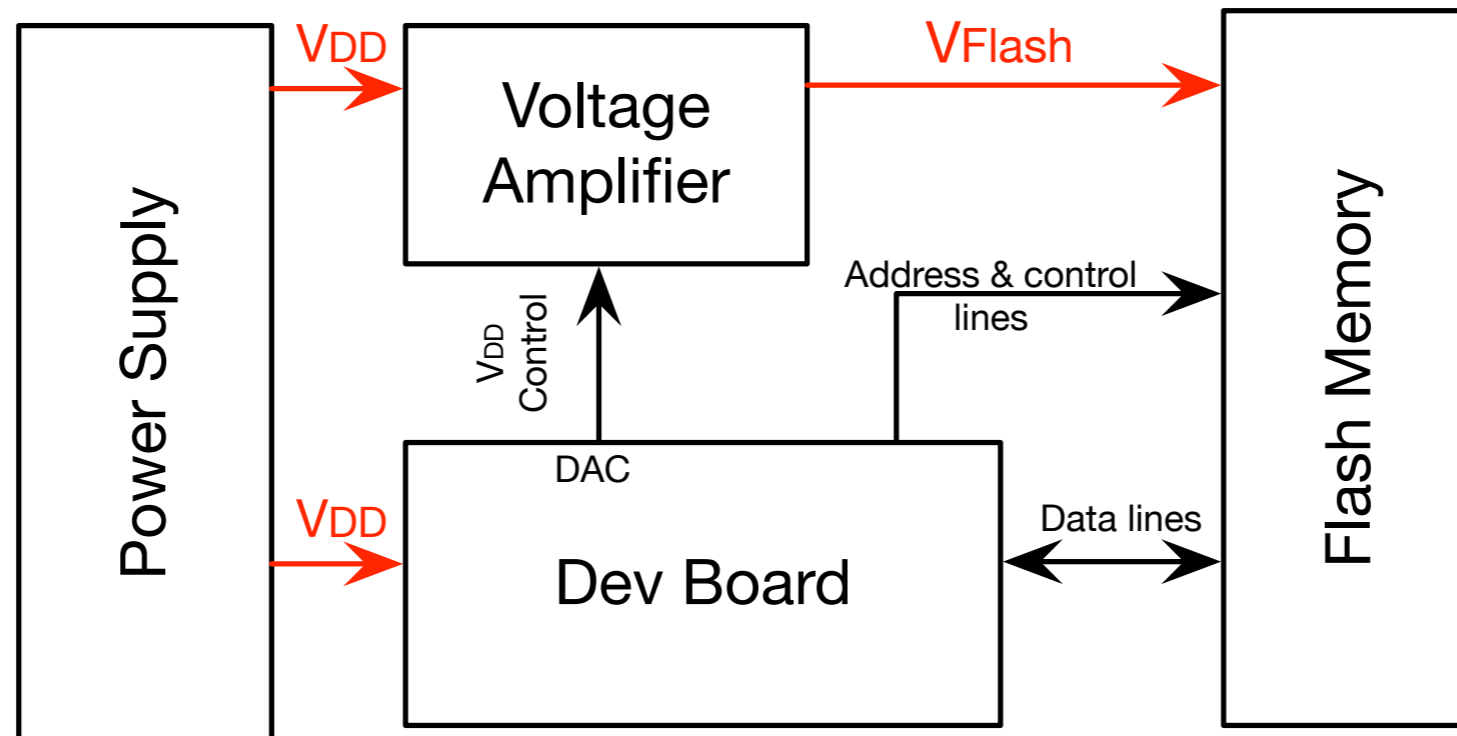
Overview

- **Hypothesis:** By allowing imprecision, it is possible to achieve **additional energy saving**.

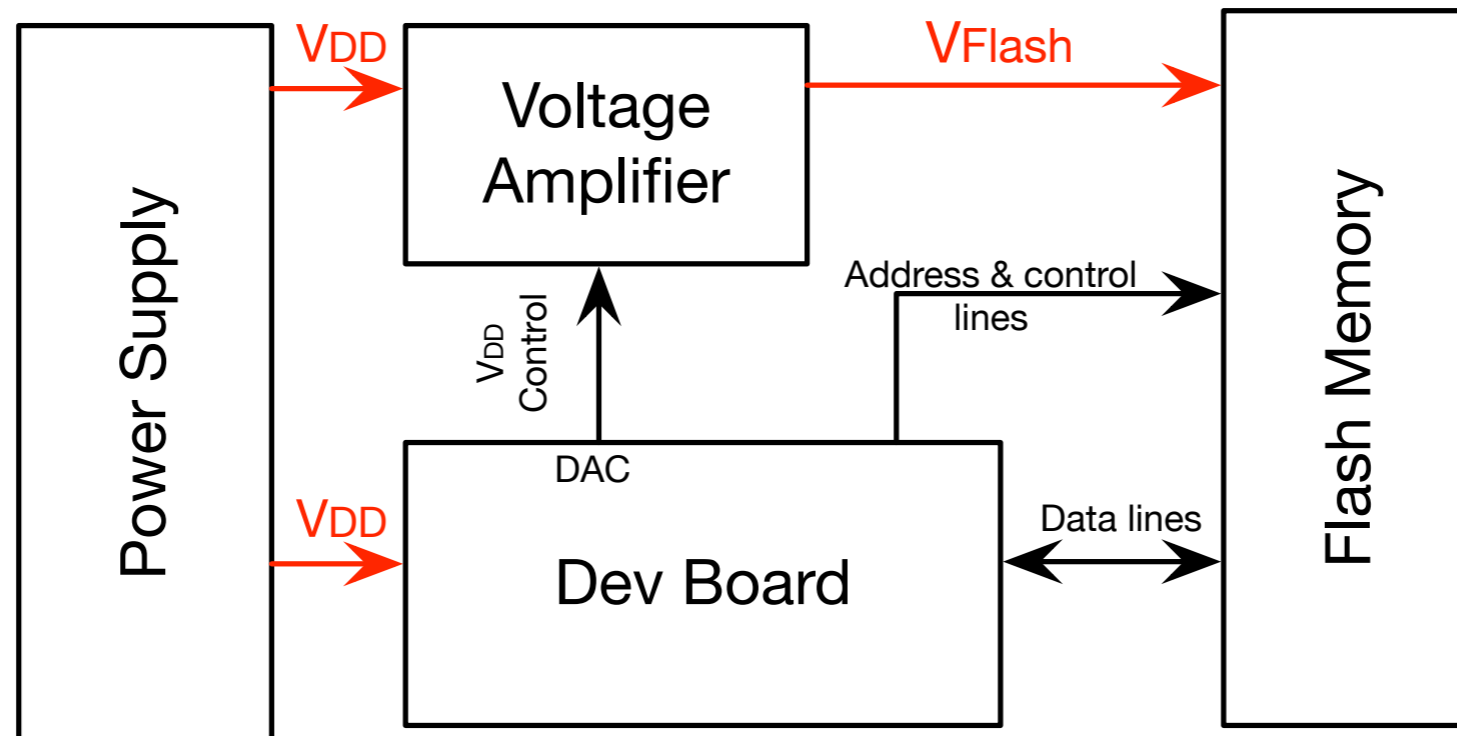
Overview

- **Hypothesis:** By allowing imprecision, it is possible to achieve **additional energy saving**.
- **Summery of Findings:**
 - Spatial locality in cell volatility
 - Large effect of temperature

Build an Open Platform



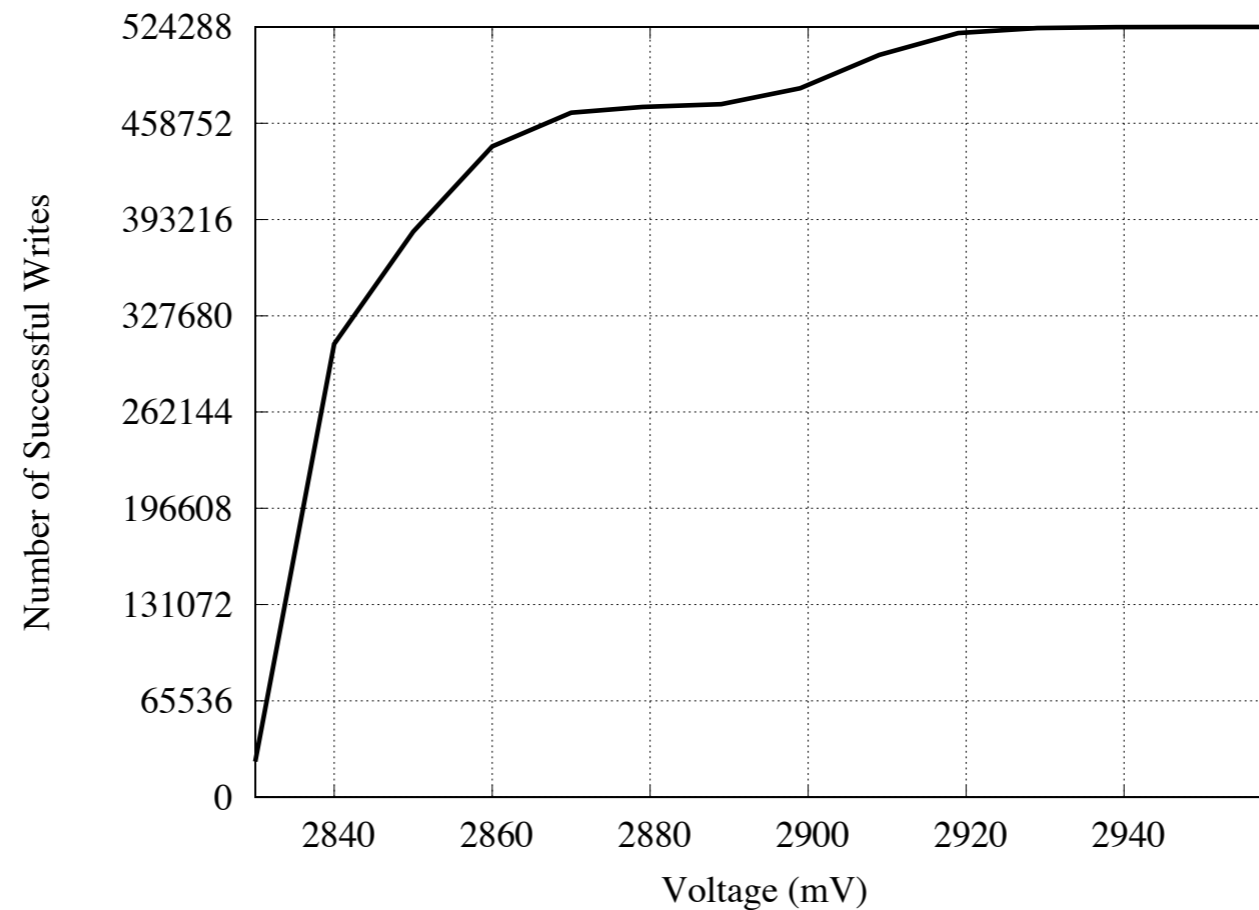
Build an Open Platform



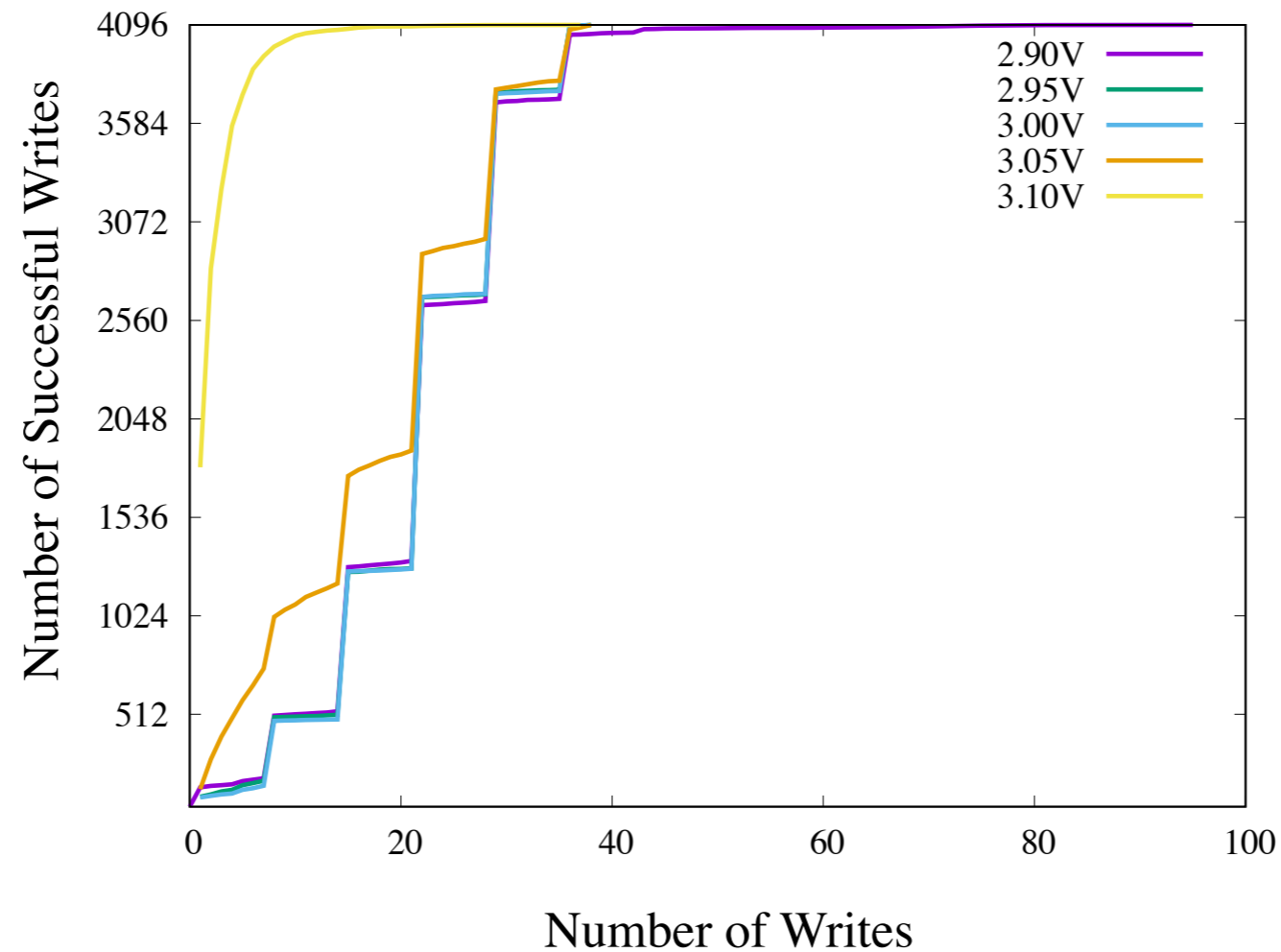
Part #, codes, and blueprints are available at

<http://amir.rahmati.com>

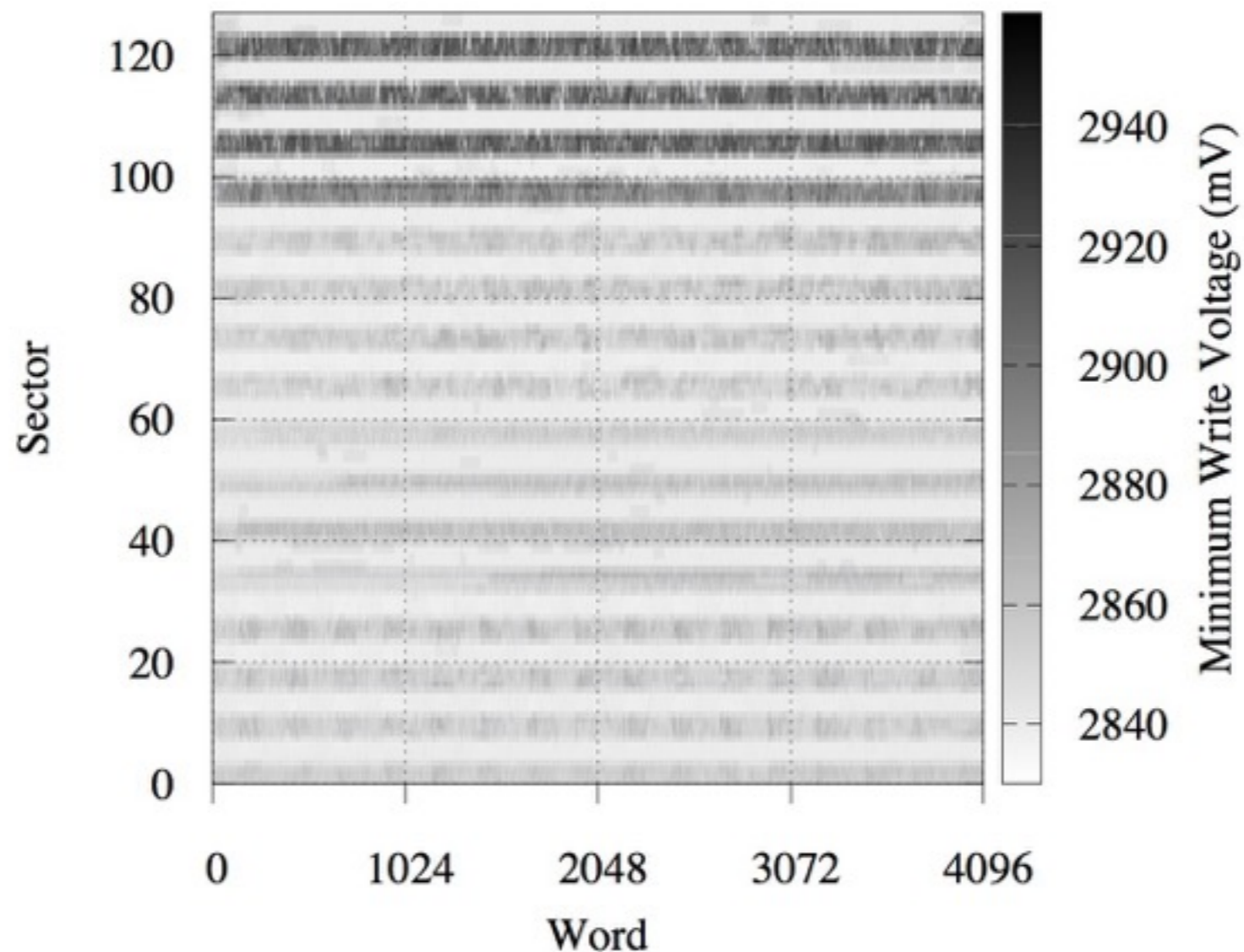
Memory cells are successfully written at a voltage **well below their minimum** recommended of 4.5V



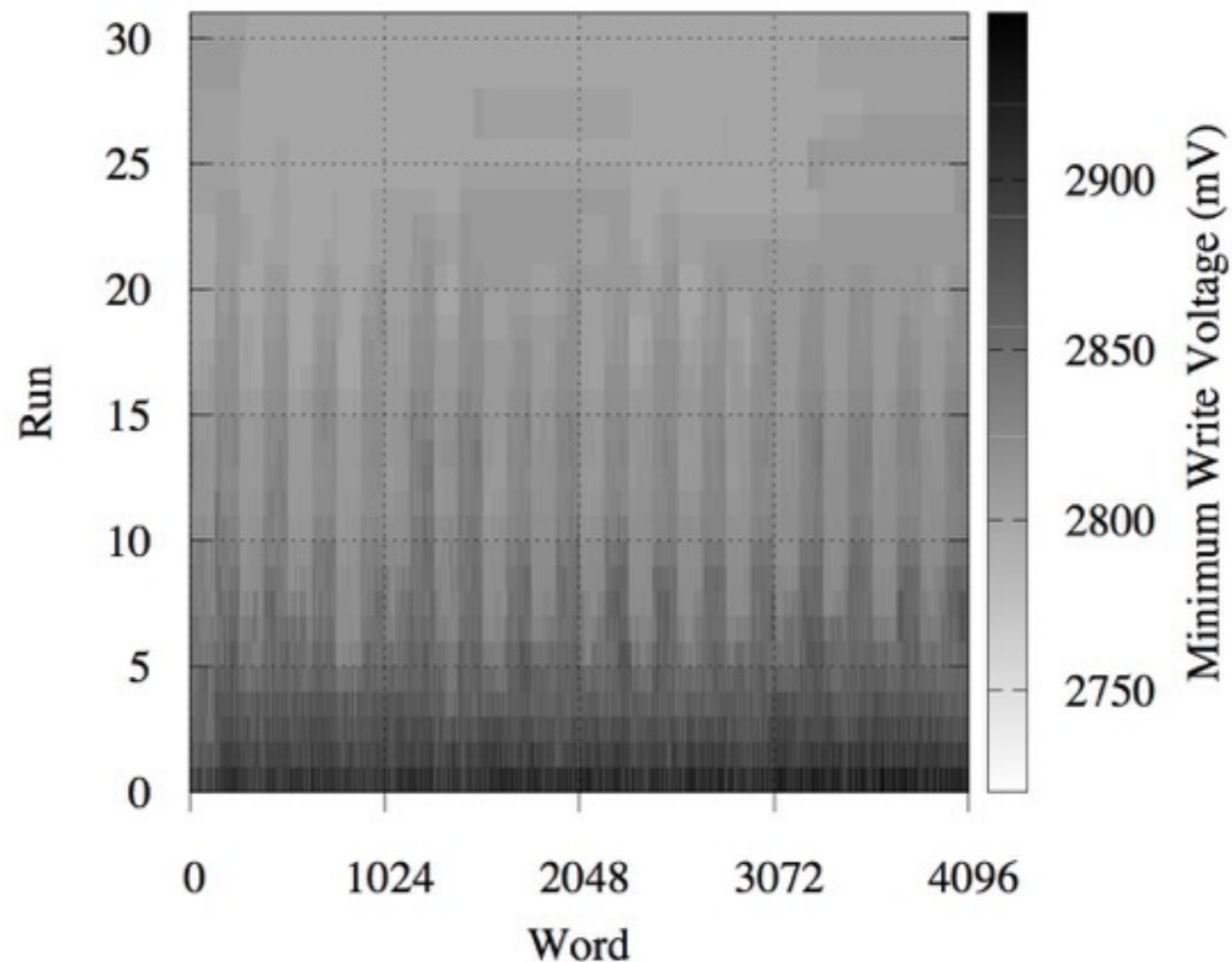
Groups of cells in a sector behave similarly to write iterations



Minimum write voltage of
cells in a sector are closely related



Temperature increase caused by continuous experiments **reduce** minimum write voltage variations



Approximate Flash Storage

Approximate Flash Storage

- **Partition memory** into sectors with different volatility level.

Approximate Flash Storage

- **Partition memory** into sectors with different volatility level.
- Adjust input voltage based on **partition volatility, temperature, and precision requirement.**

Approximate Flash Storage

- **Partition memory** into sectors with different volatility level.
- Adjust input voltage based on **partition volatility, temperature, and precision requirement.**
- Choose write location based on **energy and storage availability.**

Conclusion

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- Is approximate storage feasible? - Yes

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