# Optimizing Storage Caching for Zoned Namespace Solid State Drives

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Background and Motivation

- ZNS interface allows for the offloading of GC and address mapping onto the host
- Zones are written sequentially and erased entirely during GC
- (WAF of 1)
- Limitations between two baselines:
  - *Flush*: Low HR.
  - *Relocate Everything:* High WAF

ZNS-SSD Cache
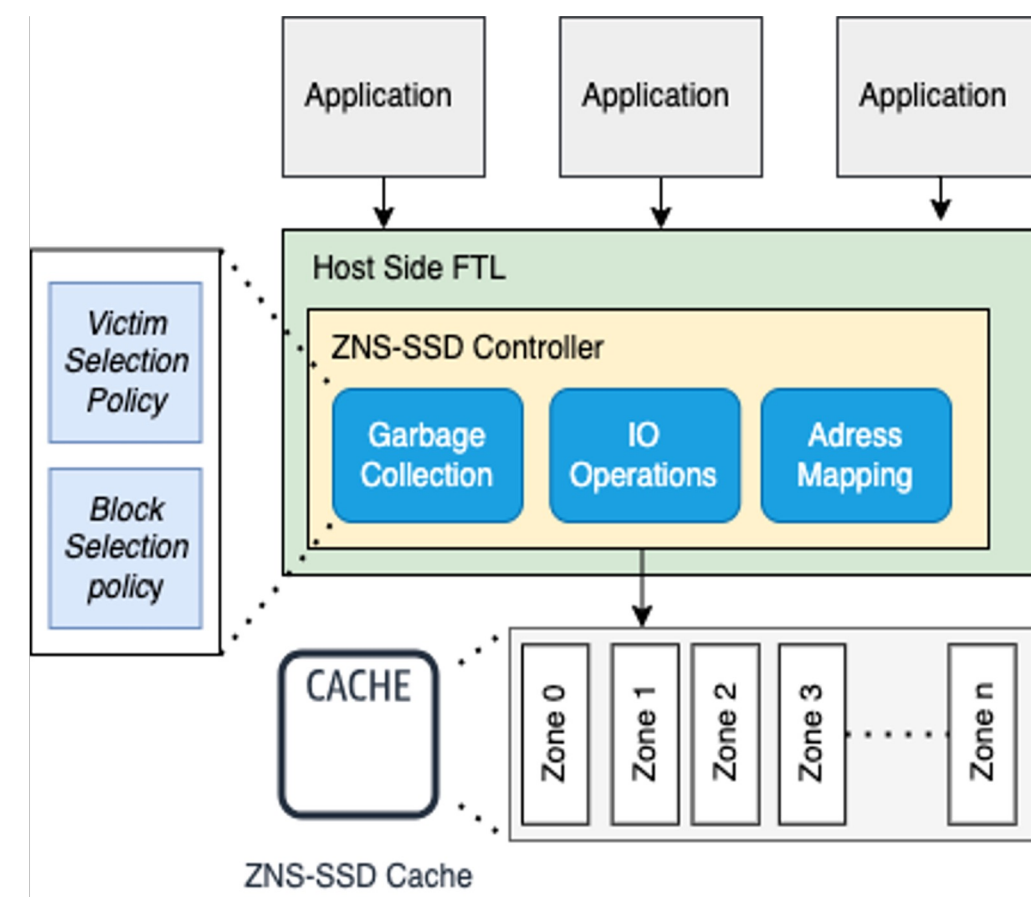
Research Challenges and Objectives

Objective: optimize ZNS caching to minimize write amplification while maintaining high HR

Challenges:
1. **Which zone should be cleaned? Victim Zone Selection**
2. **Which blocks in the victim zone should be reclaimed? Block Reclamation**

Cache Locality Aware Garbage Collection

Cache Locality Aware Victim Zone Selection (ts_score) :
Summation of timestamps in a zone can indicate low cache locality, i.e, old data.
*Cache Locality Aware Block Selection (DynamicRWSS_t):*
Capturing the RWS of each window interval predicts the

Trace Profiling/ Window Size Analysis

- Rwss_t uses a set data structure to track a block's memory access
- 23 Alibaba traces chosen for analysis on the window size to capture Rwss_t
- Average Rwss_t follows logarithmic fit as window size is increased
- Kneedle Algorithm used to programmatically determine knee point

**Hypothesis:**
Using the knee point as the window size allows for threshold calculations that accurately portray locality of the data within the cache. Each rwss_t within this given window can be used to calculate the best threshold value to determine the eviction status of a block within a zone.
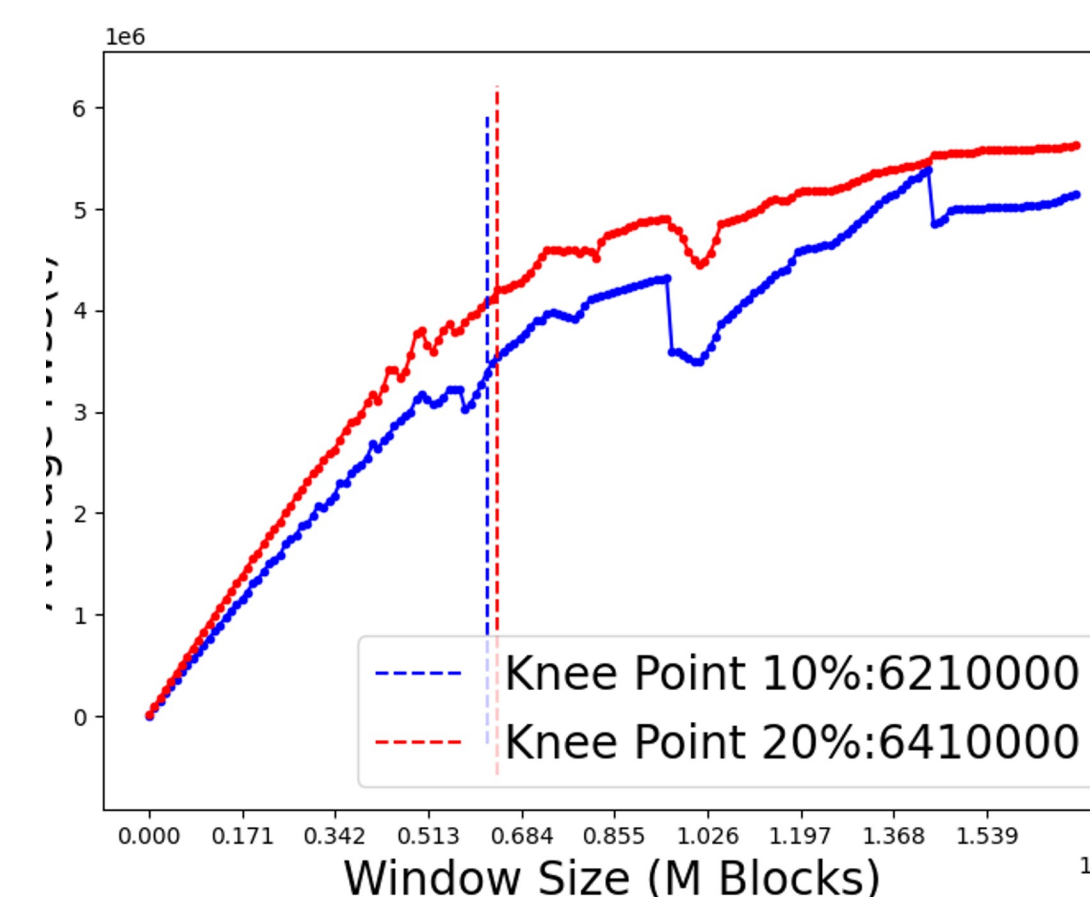

Dev:44 Rwss_t w/ Window Size of 100k
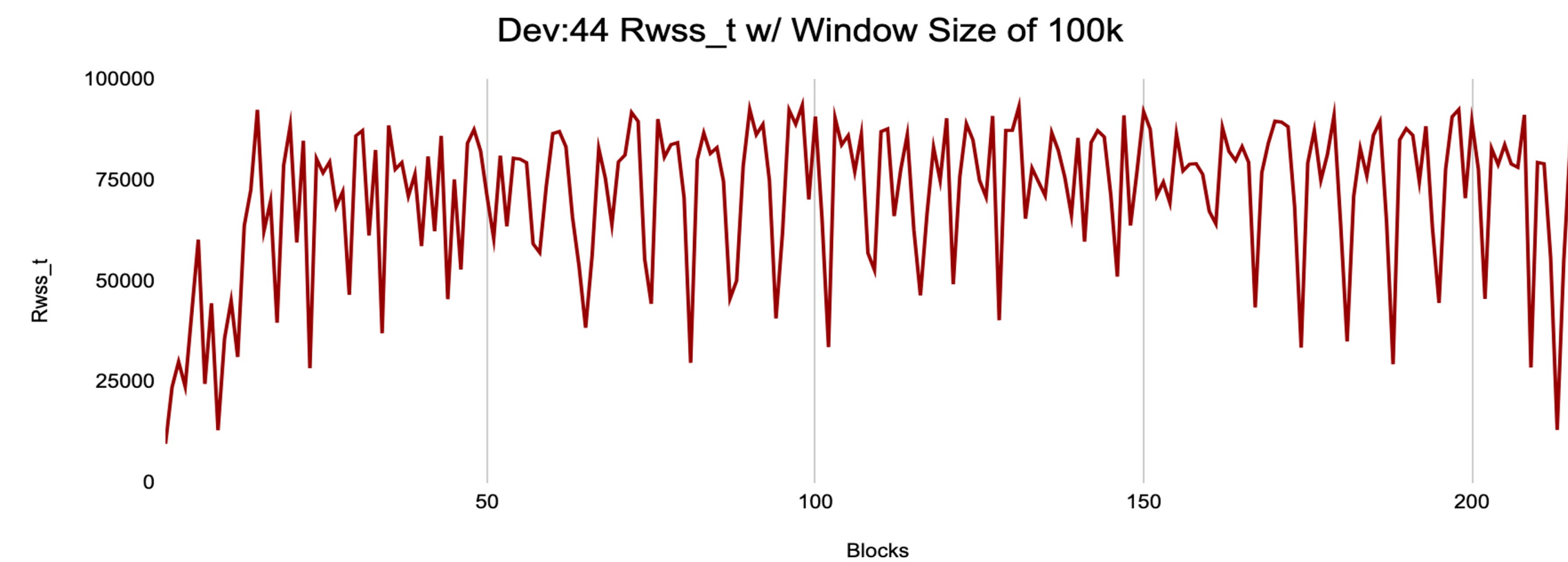
	100%	75%	50%	25%
RWSS	9104116	6828087	4552058	2276029

Device 26 Entire Trace Profile
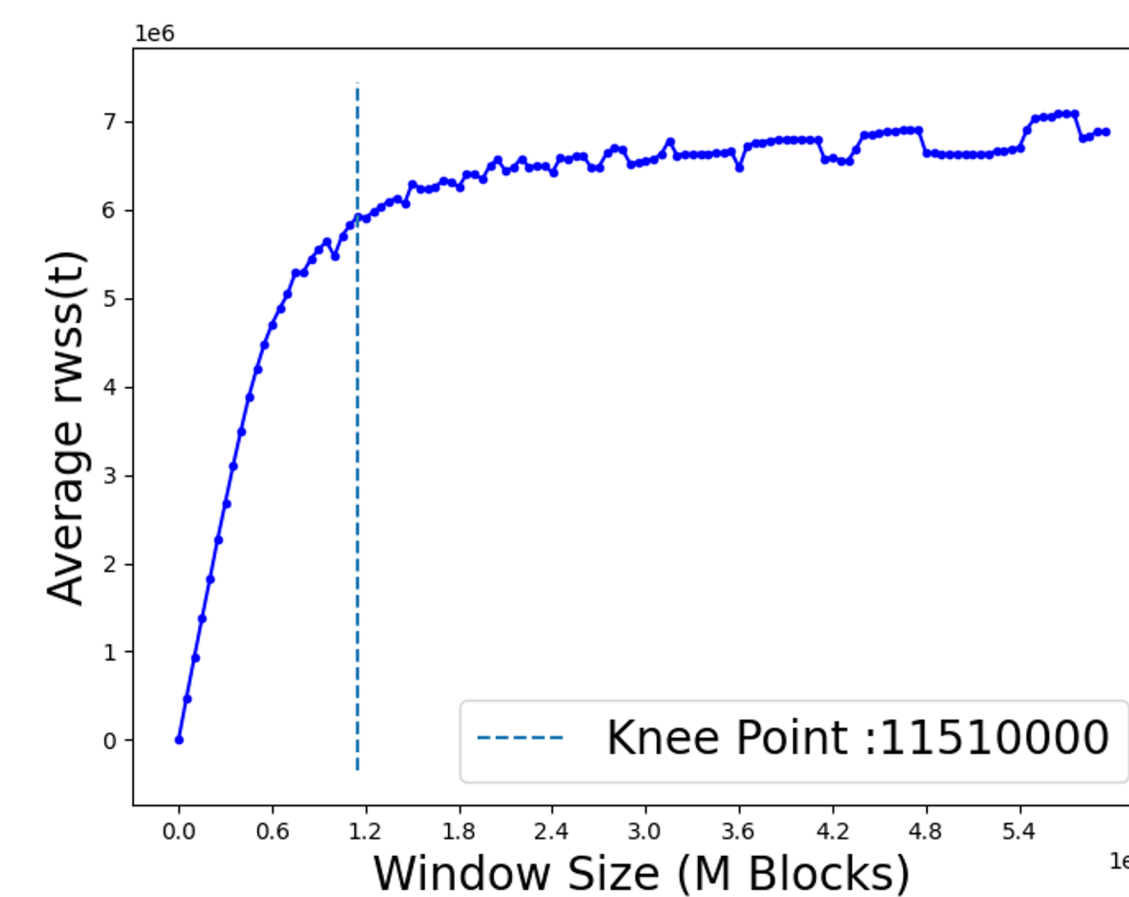
Device 26 10% and 20% Profile

Evaluation Results

Baseline vs Solution HR Results

Baseline vs Solution WAF
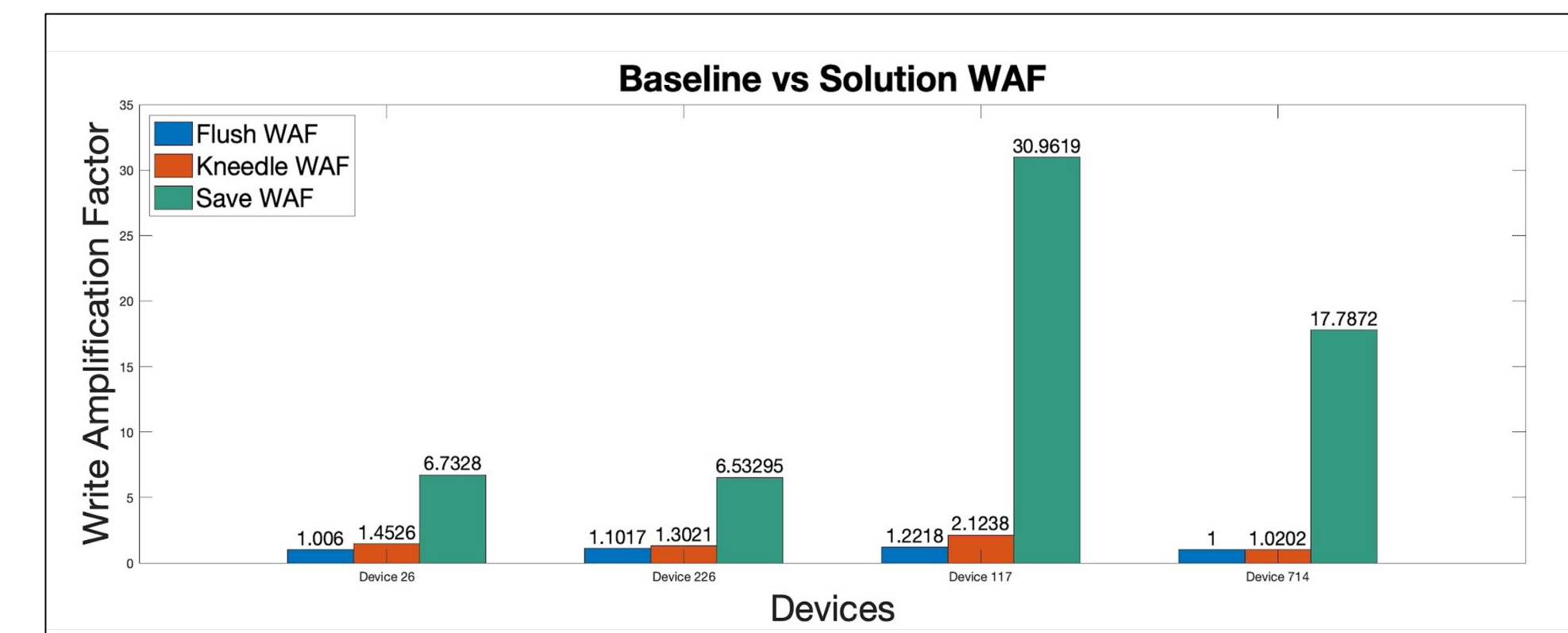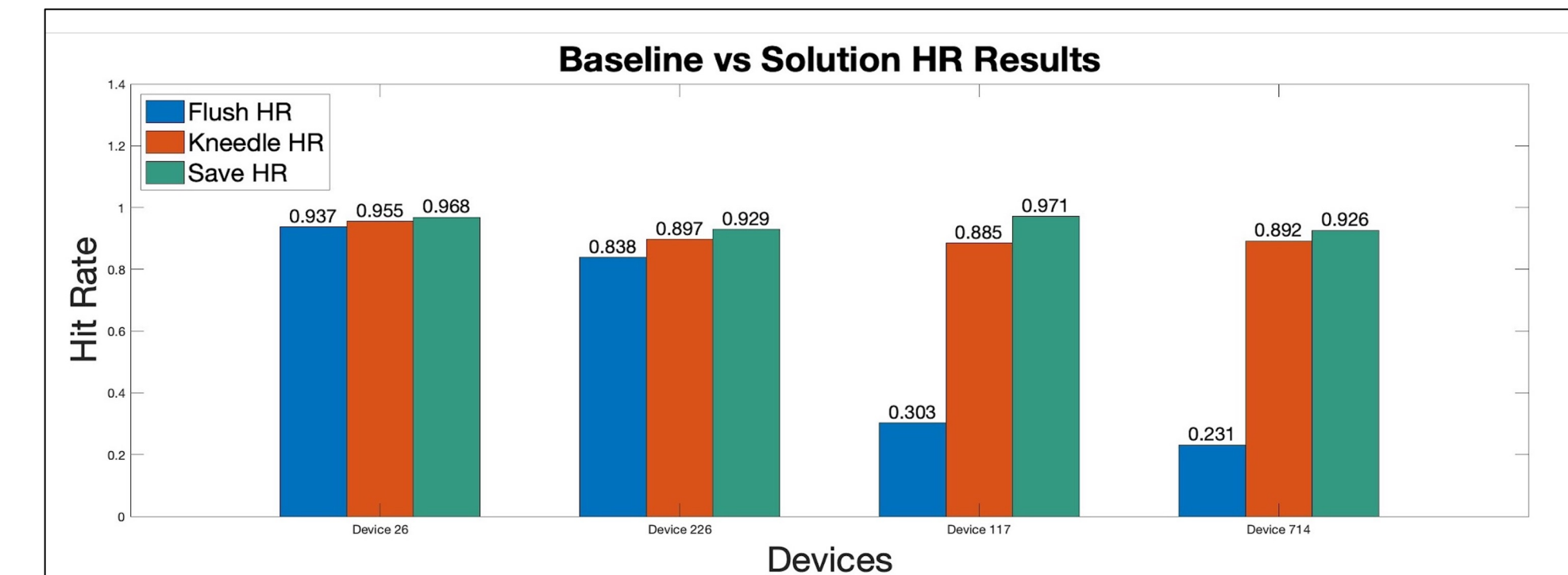
- Comparable HR and significant decrease in WAF from baseline
- Device 714: 94% drop in WAF with only 3.7% drop in HR
- Effectiveness of the Cache Locality Aware Block Selection

Acknowledgements

- **ZNSCache project team**: Kritshekhar Jha (Student lead), Alexander Sutila, Yongfeng Wang, Prof. Zhichao Cao, Prof. Ming Zhao (FURI mentor)
  - **My contributions**: Trace profiling, RWS window analysis, participation in overall solution designs and evaluations
- **Sponsors**: FURI, National Science Foundation Awards CNS-1955593, SES-2231874

References

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- Han, K., Gwak, H., Shin, D., & Hwang, J.-Y. (n.d.). ZNS+: Advanced Zoned Namespace Interface for Supporting In-Storage Zone Compaction.

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