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VRIJE UNIVERSITEIT AMSTERDAM

USENIX SECURITY 2018

SPYING ON YOUR NEIGHBOR: CPU CACHE ATTACKS AND BEYOND

TEASER

- We would like to protect against cache attacks generically
- You won’t believe this one thing that people forget

OVERVIEW

- Side channels
- Cache attacks
- TLBleed
- Evaluation

CACHE SIDE CHANNELS

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- The first combination safes in the 1950s

EXAMPLE: FLUSH+RELOAD

- Can attack AES implementation with T tables
- A table lookup happens $T_j\,[x_i = p_i \oplus k_i\,]$
- p_i is a plaintext byte, k_i a key byte
- We can detect lookups into the table using F+R

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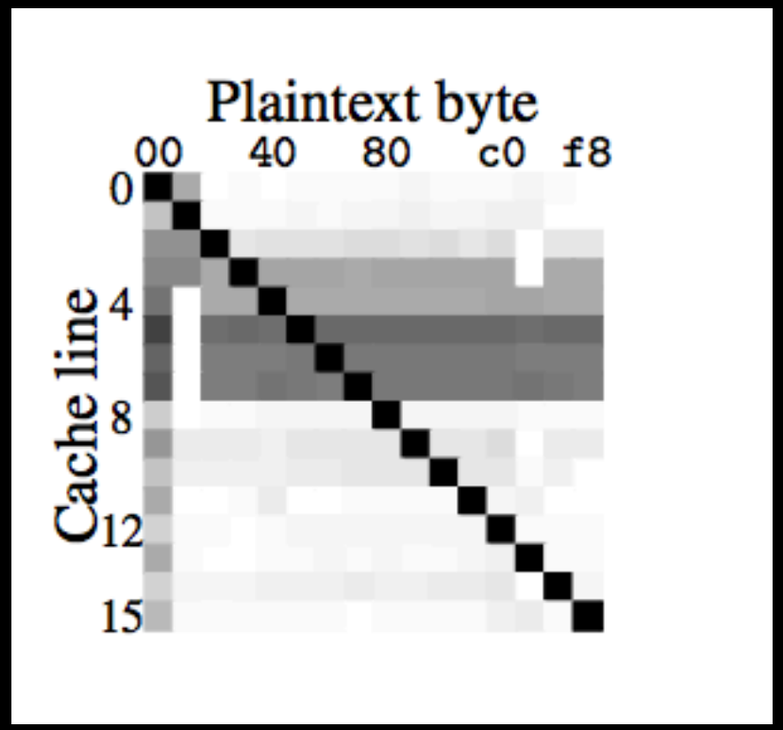

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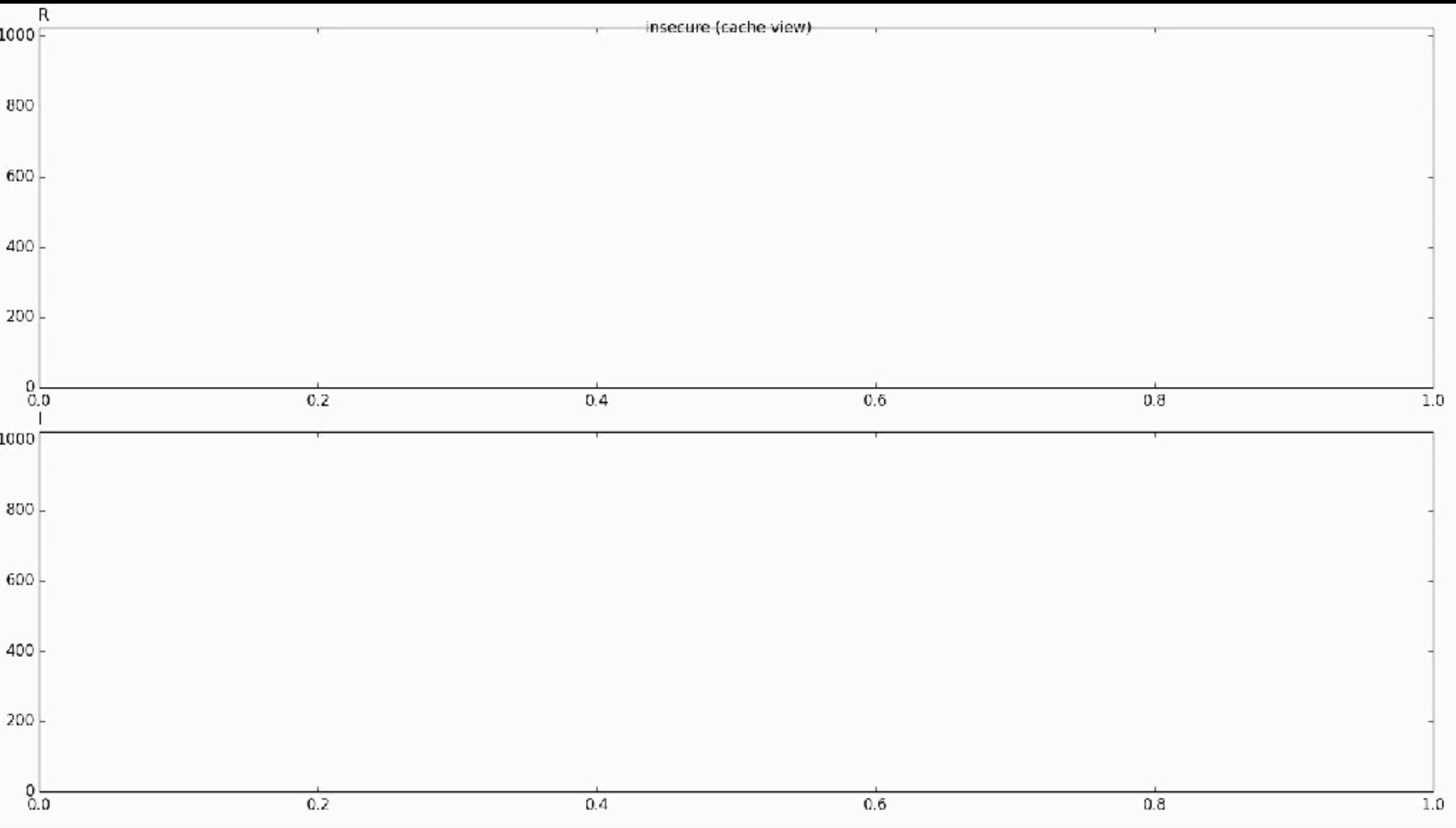

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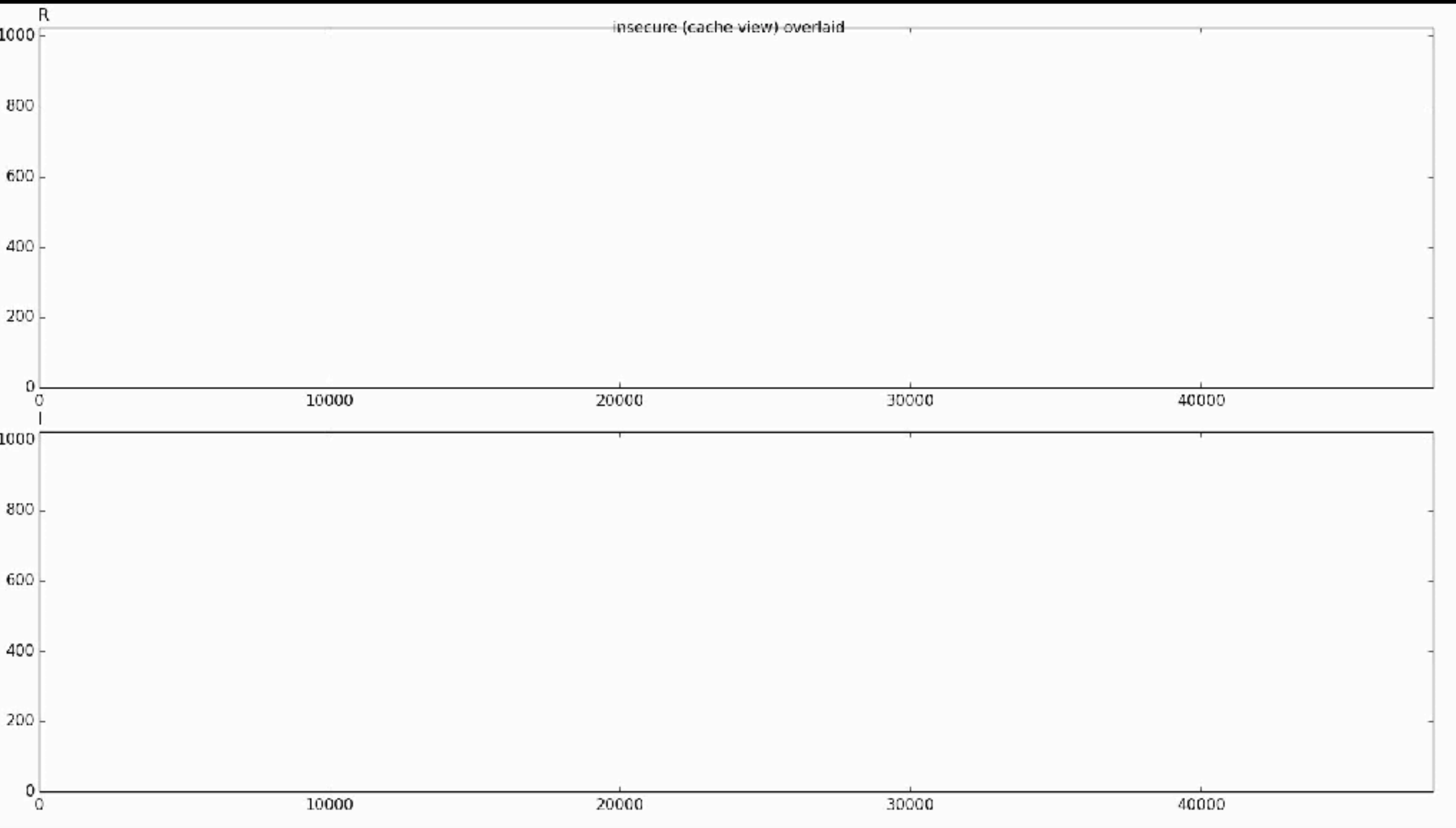

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- More side channel proof version

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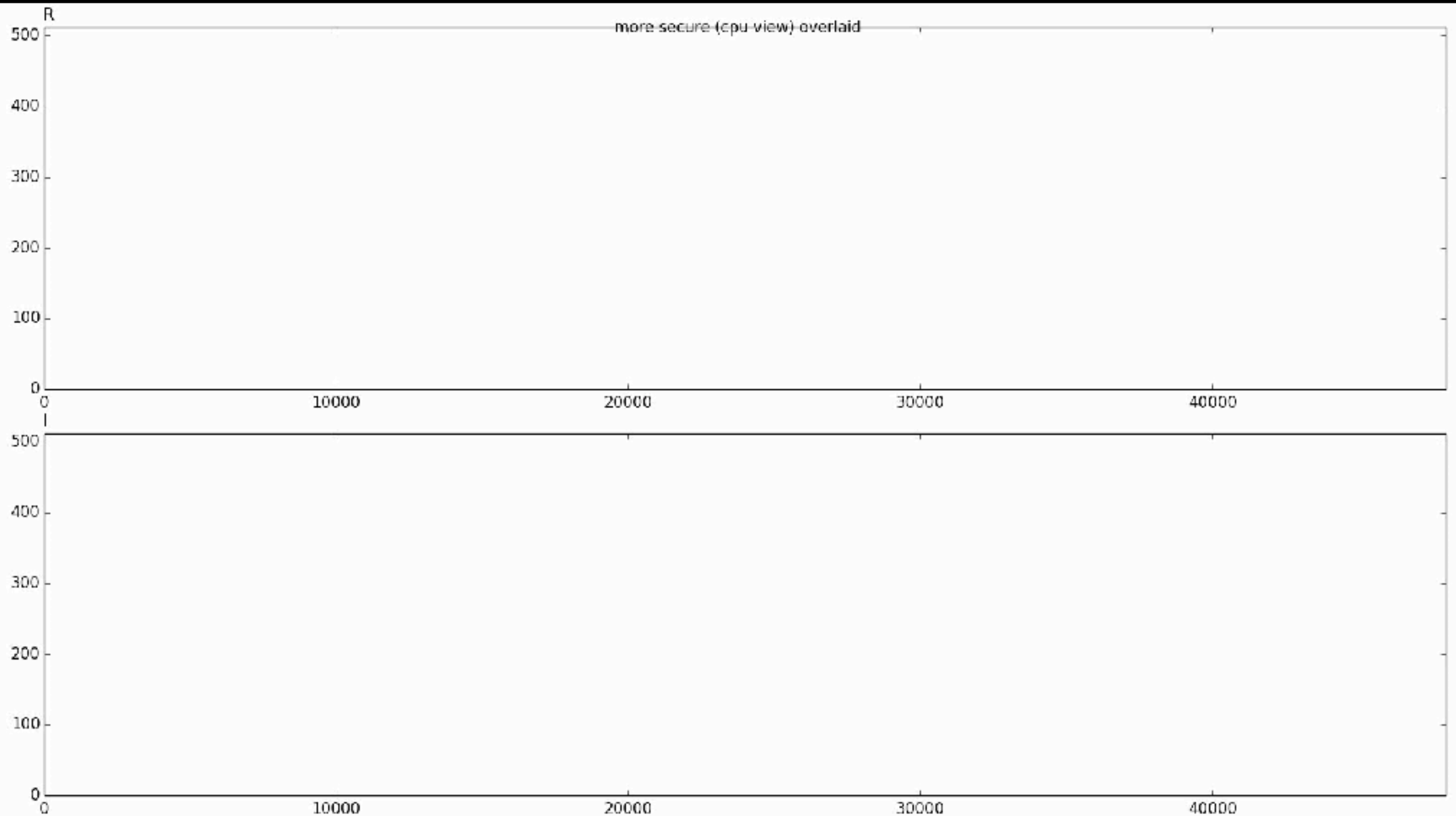

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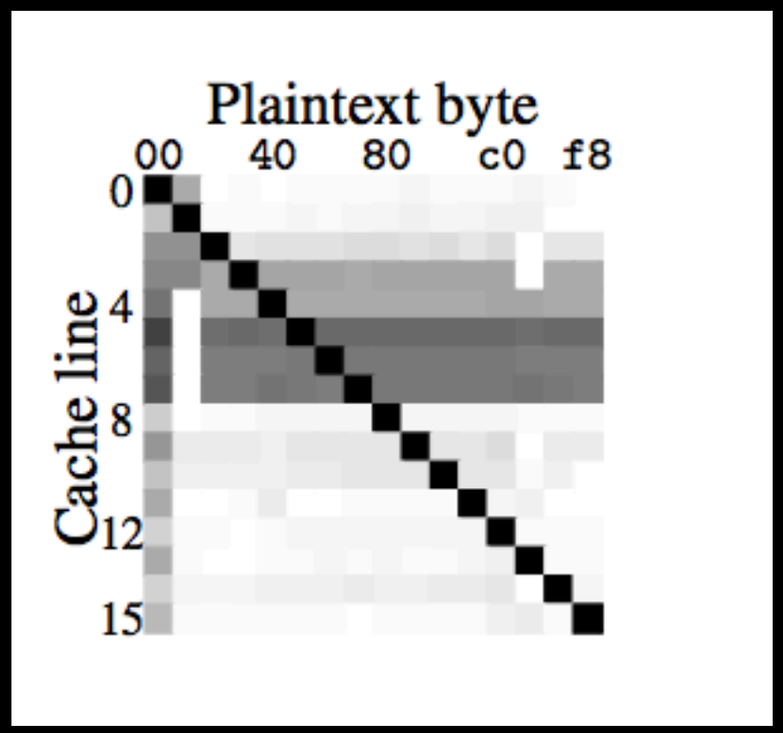

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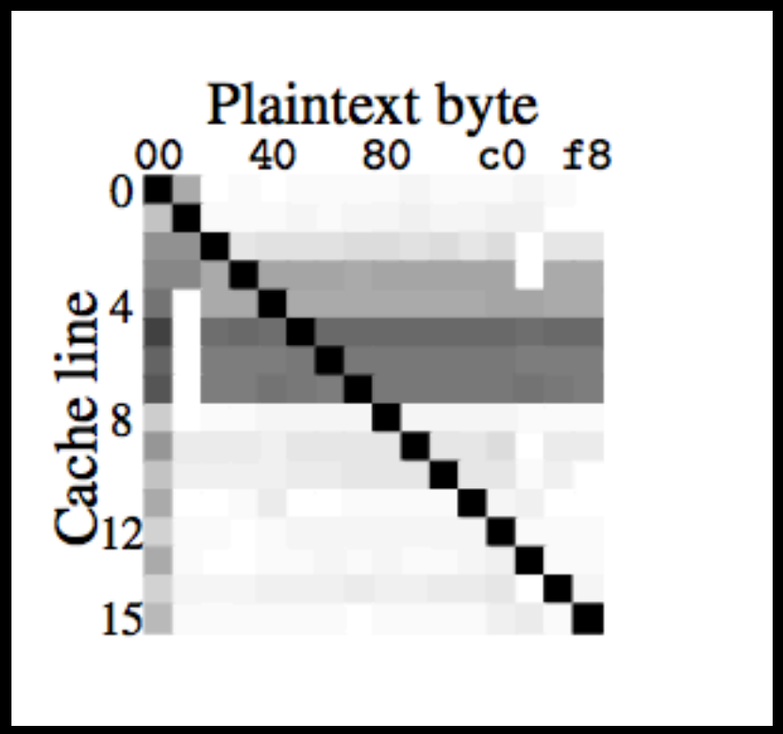

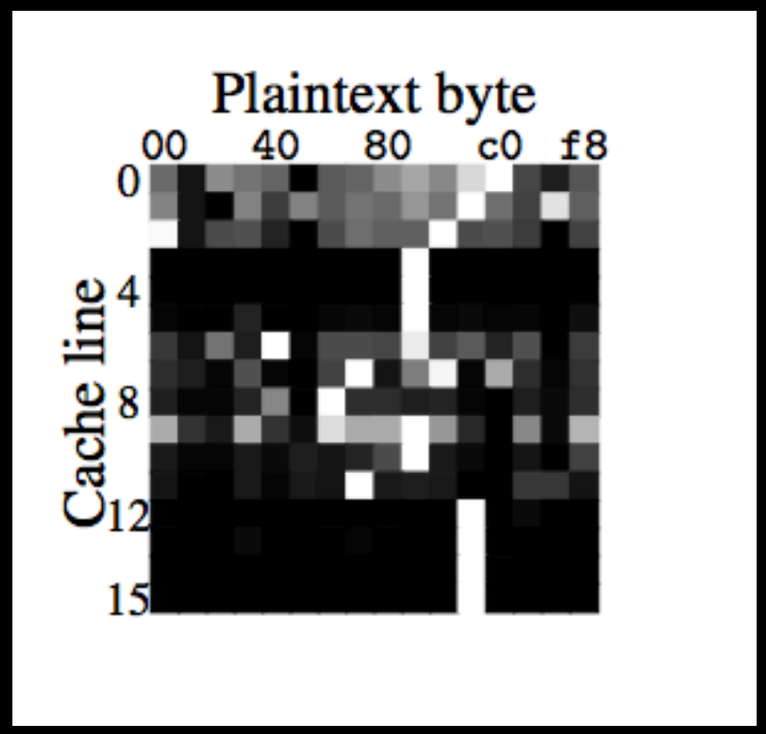

TLBLEED

TLBLEED: TLB AS SHARED STATE

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- Other structures than cache shared between threads?
- What about the TLB?
- Documented: TLB has L1iTLB, L1dTLB, and L2TLB
- Not documented: structure

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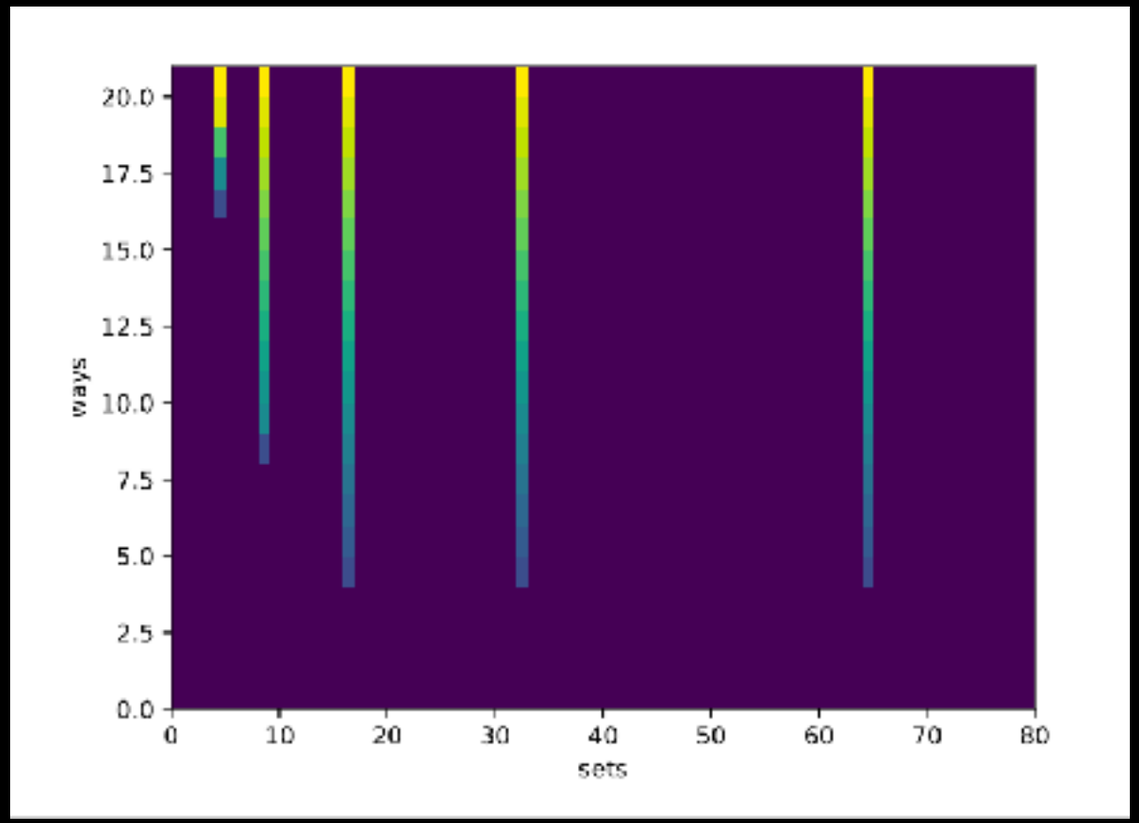

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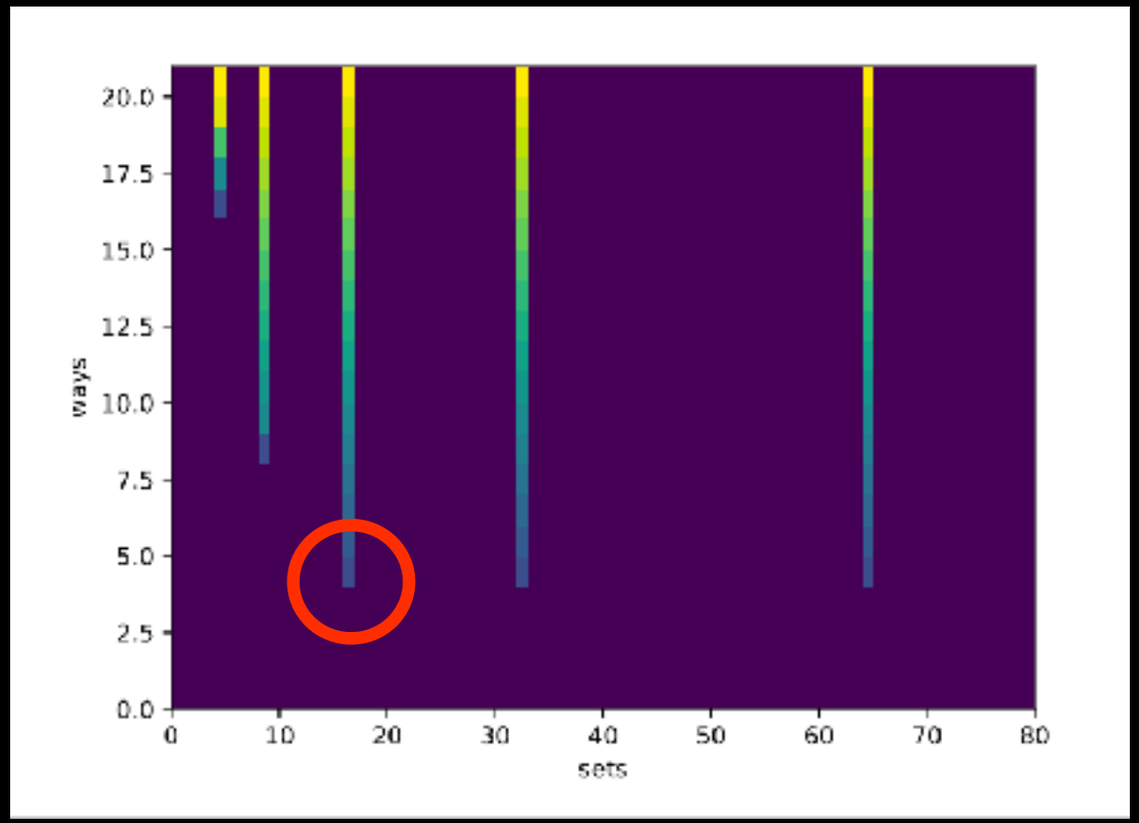

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$$H = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

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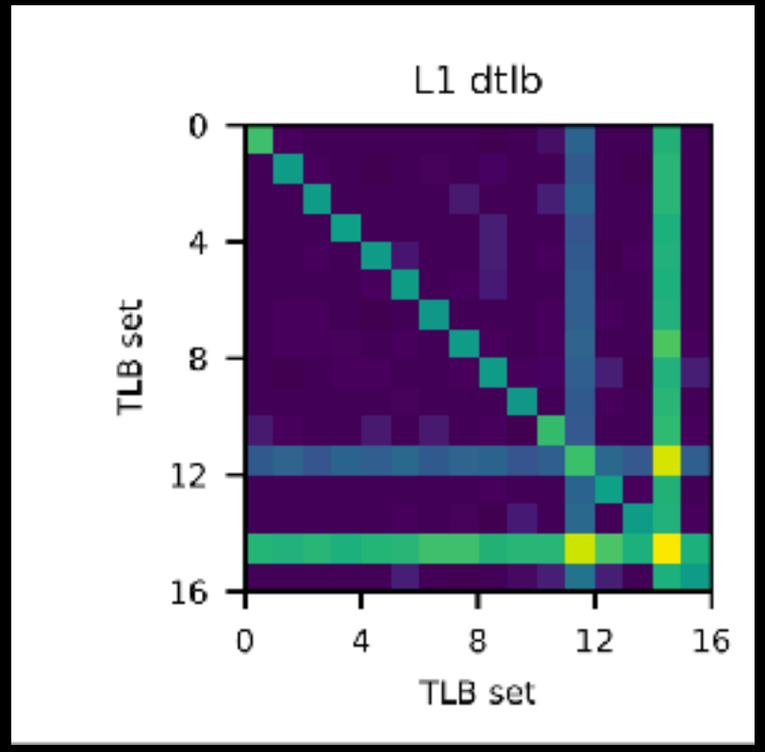

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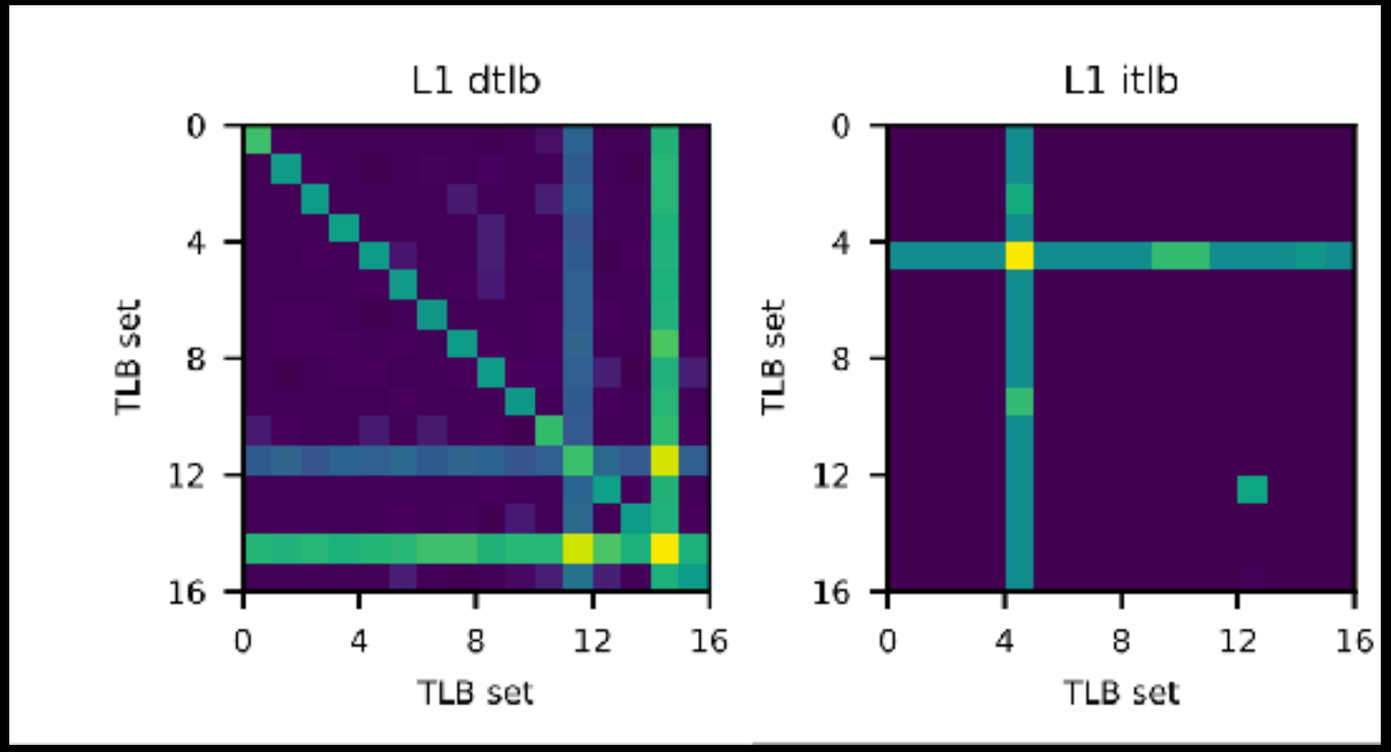

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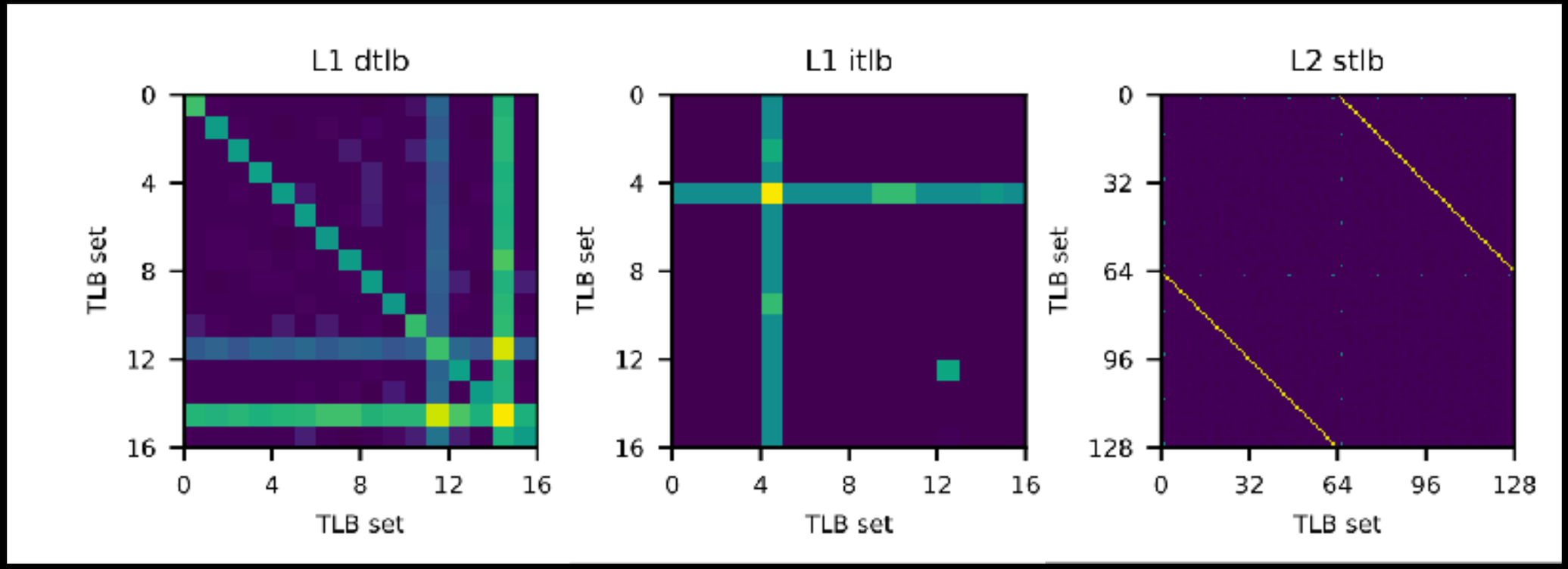

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		L1 dTLB					L1 iTLB					L2 sTLB				
Name	year	set	w	pn	hsh	shr	set	w	pn	hsh	shr	set	w	pn	hsh	shr
Sandybridge	2011	16	4	7.0	lin	✓	16	4	50.0	lin	✗	128	4	16.3	lin	✓
Ivybridge	2012	16	4	7.1	lin	✓	16	4	49.4	lin	✗	128	4	18.0	lin	✓
Haswell	2013	16	4	8.0	lin	✓	8	8	27.4	lin	✗	128	8	17.1	lin	✓
HaswellXeon	2014	16	4	7.9	lin	✓	8	8	28.5	lin	✗	128	8	16.8	lin	✓
Skylake	2015	16	4	9.0	lin	✓	8	8	2.0	lin	✗	128	12	212.0	XOR-7	✓
BroadwellXeon	2016	16	4	8.0	lin	✓	8	8	18.2	lin	✗	256	6	272.4	XOR-8	✓
Coffeelake	2017	16	4	9.1	lin	✓	8	8	26.3	lin	✗	128	12	230.3	XOR-7	✓

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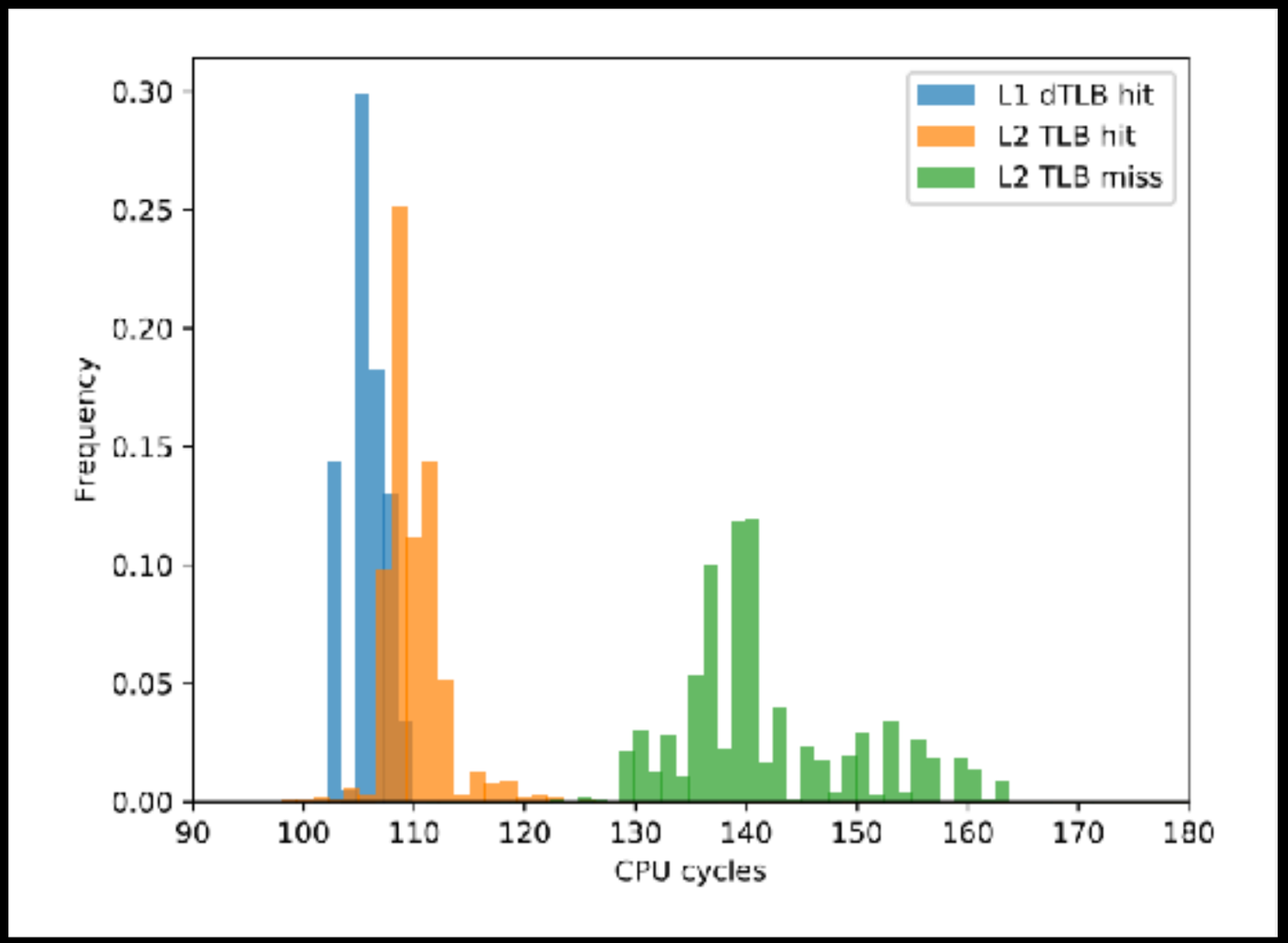

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- But: we can not use code information! Only data..!

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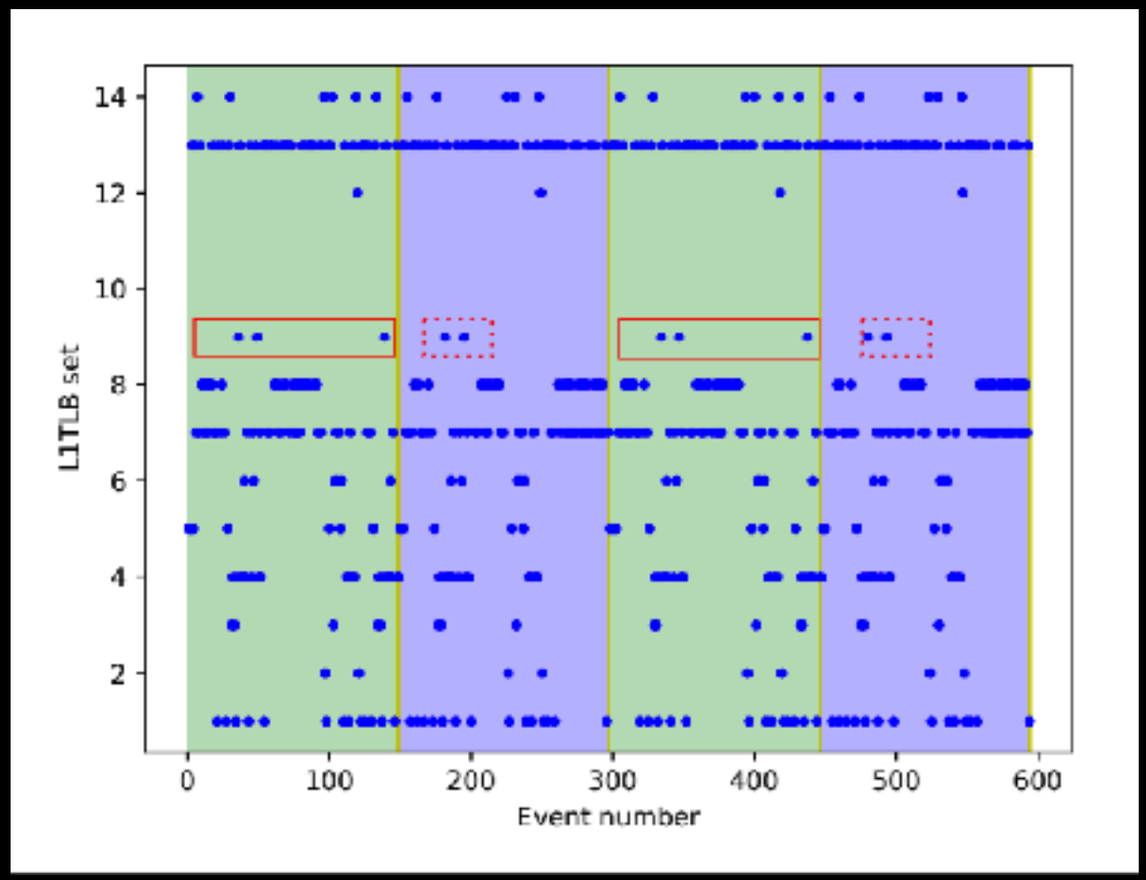

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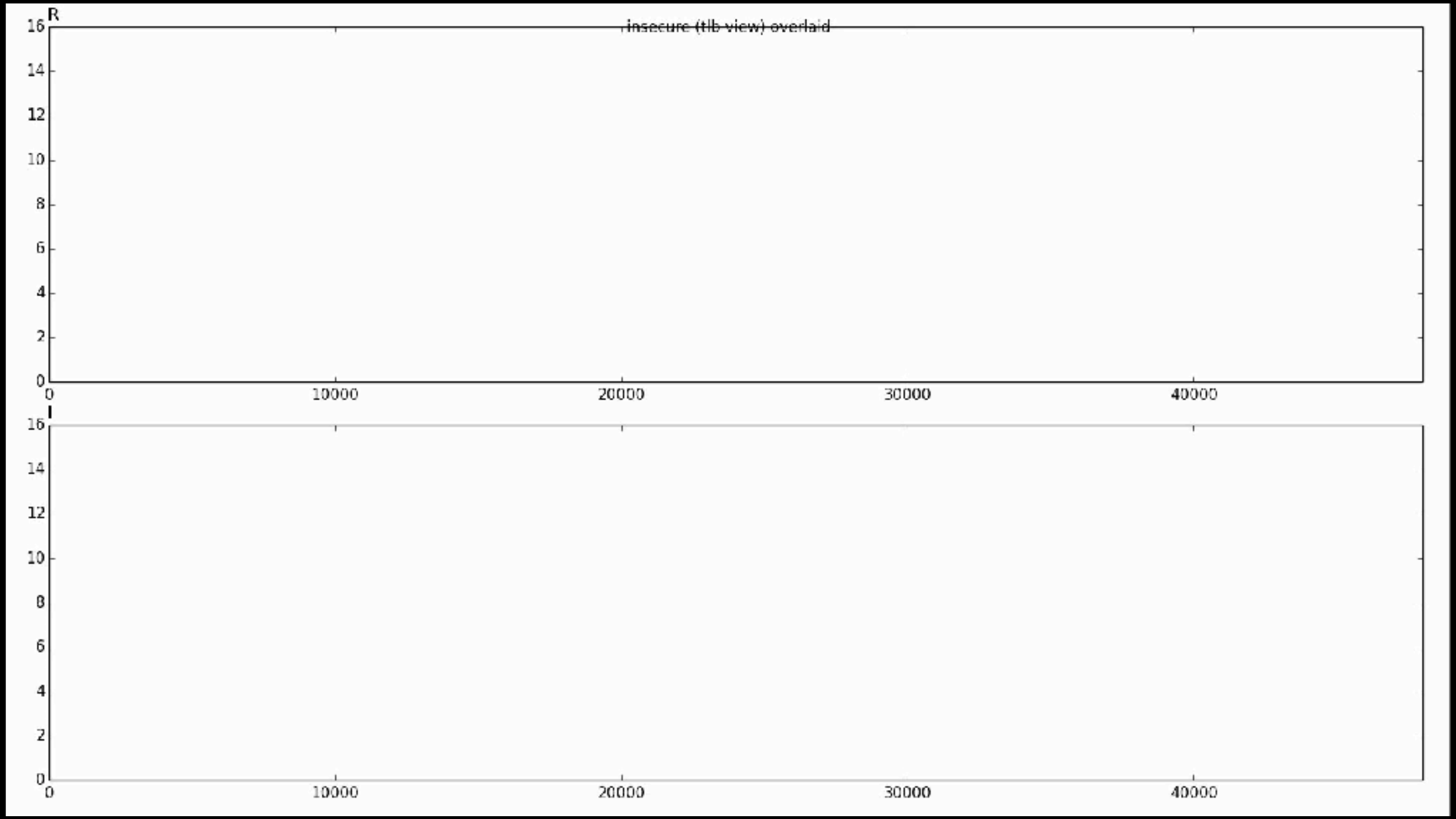

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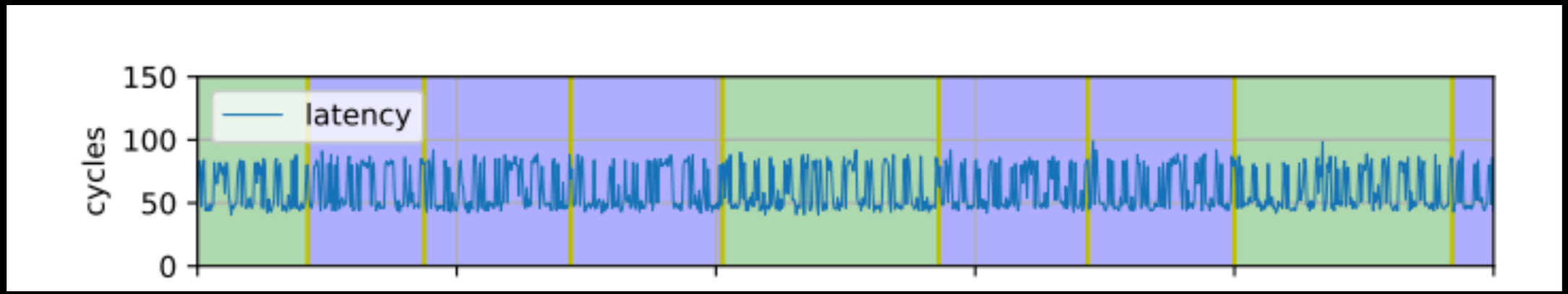

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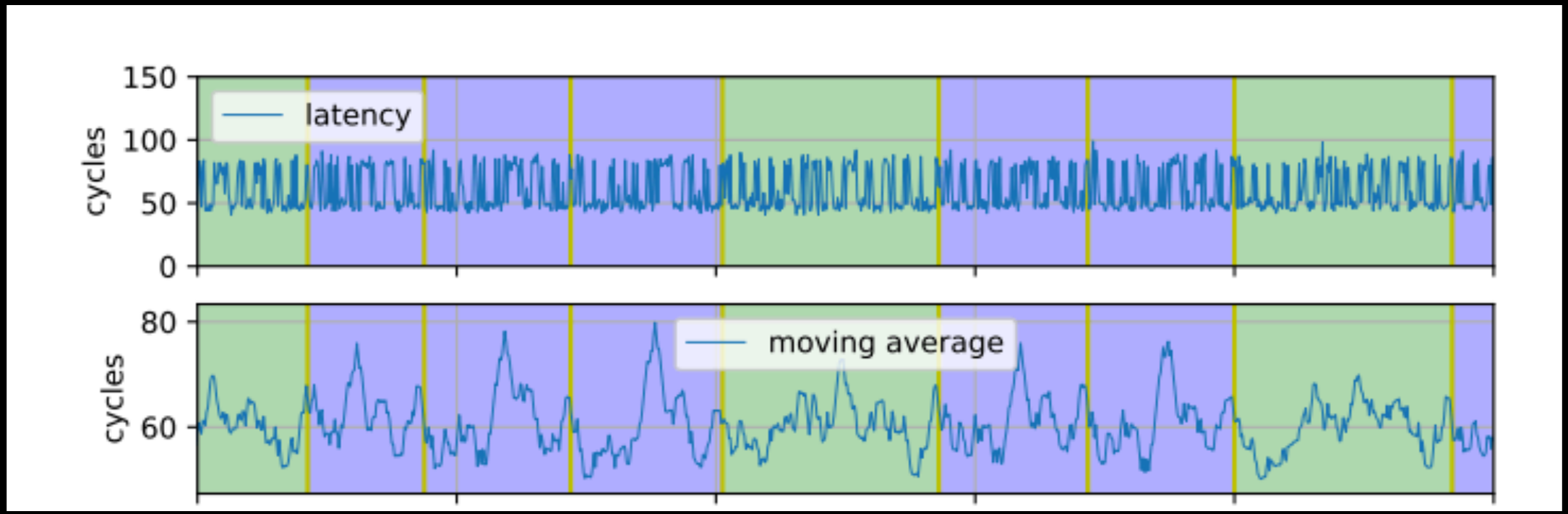

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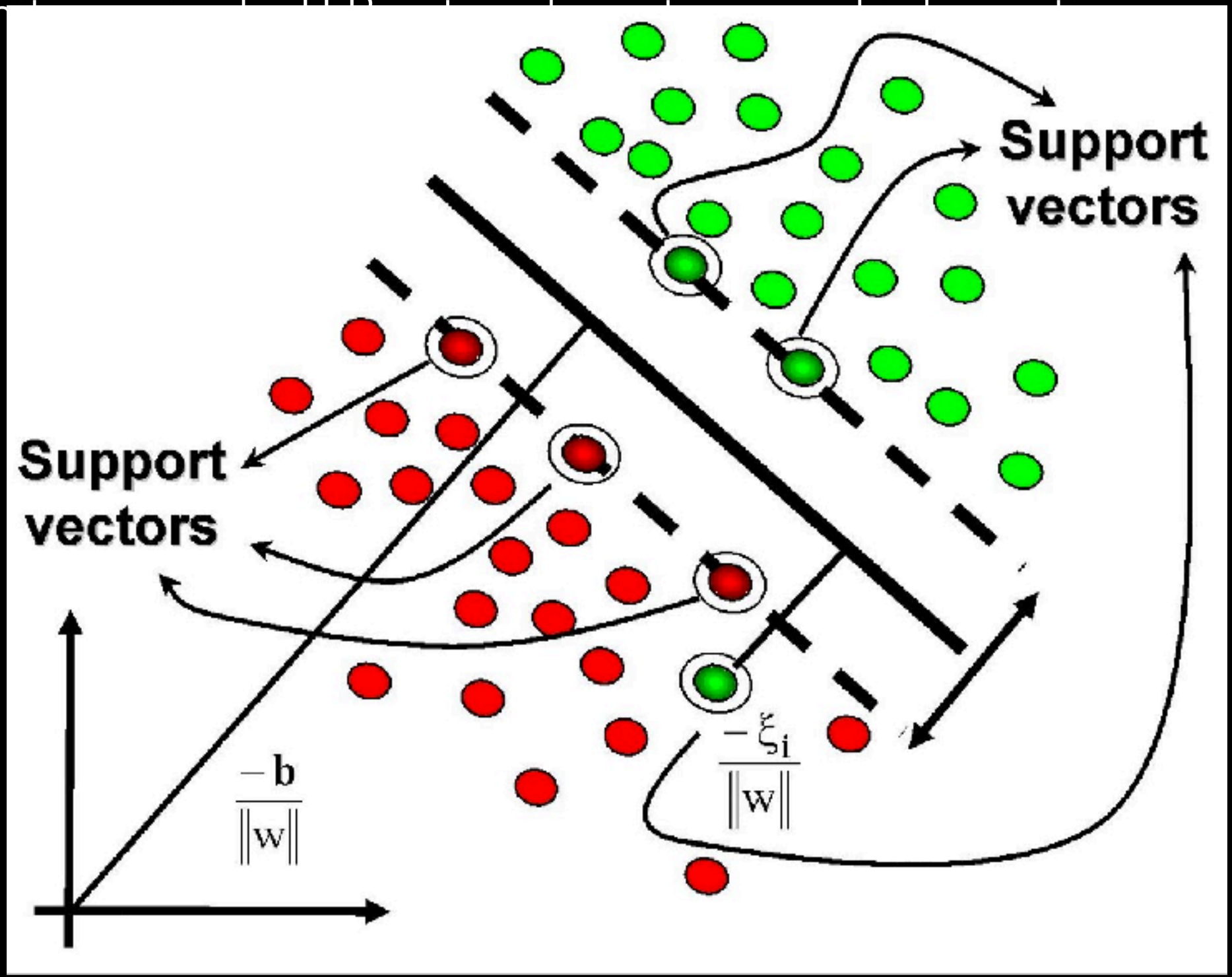

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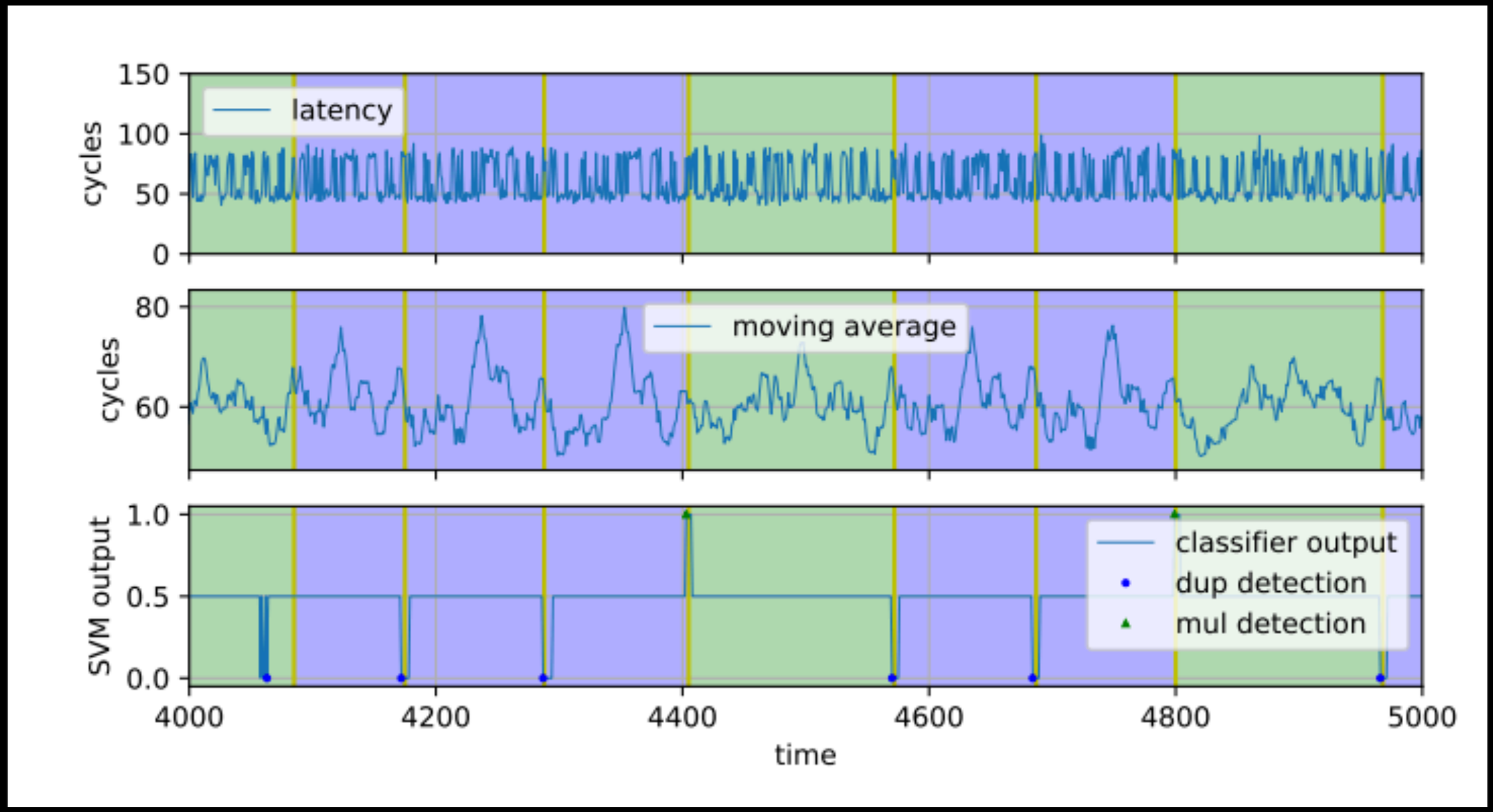

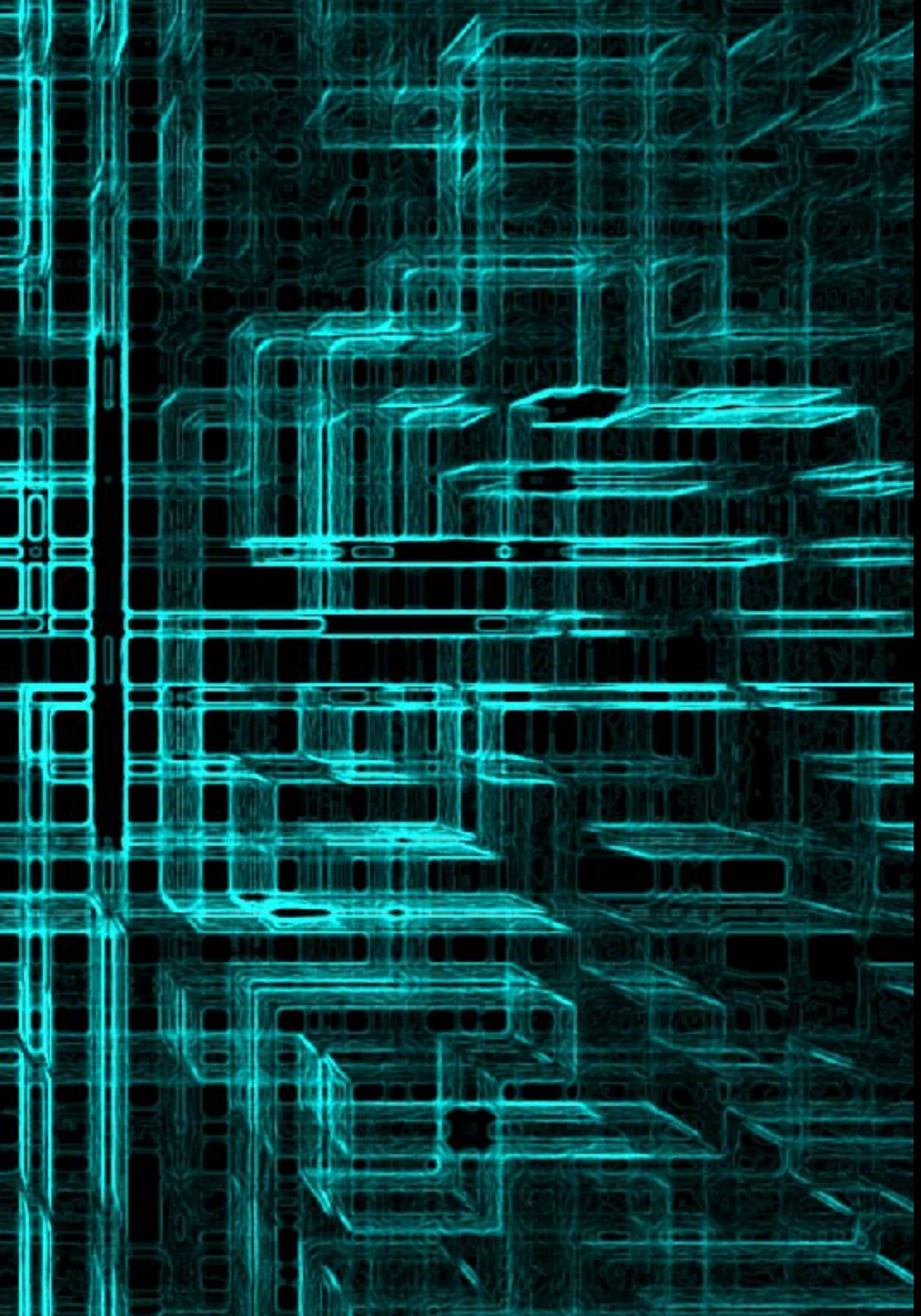

EVALUATION

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Microarchitecture	Trials	Success	Median BF
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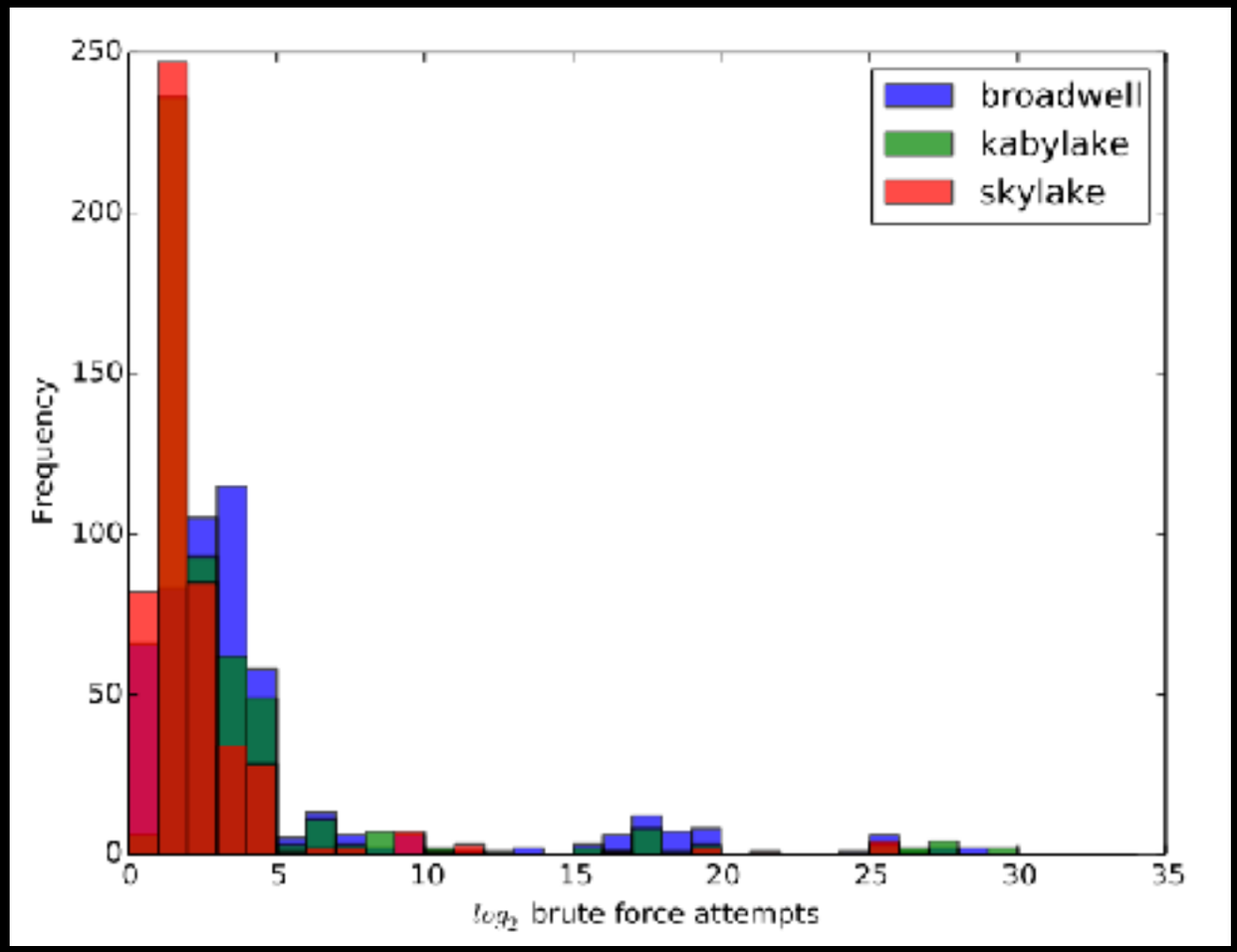

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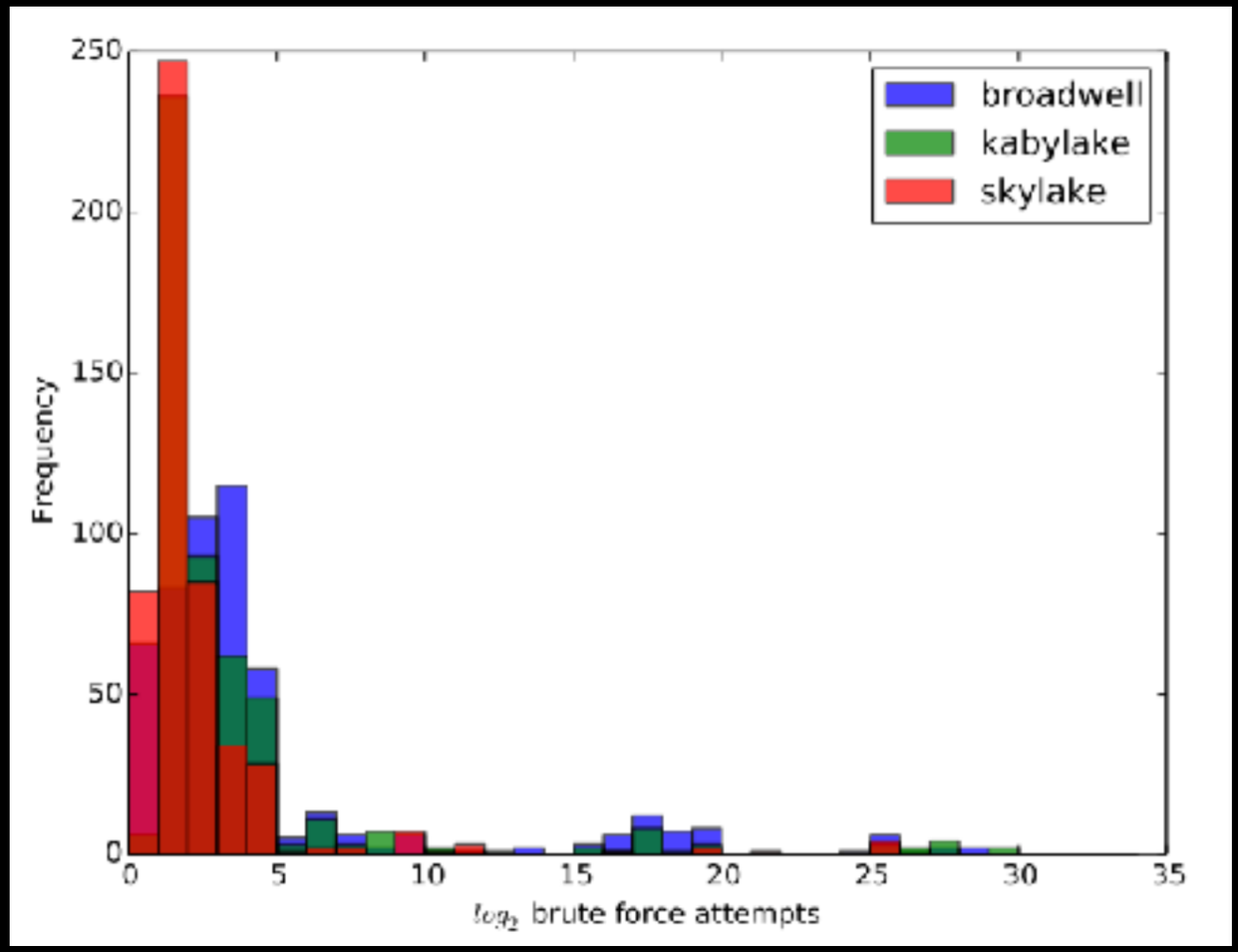

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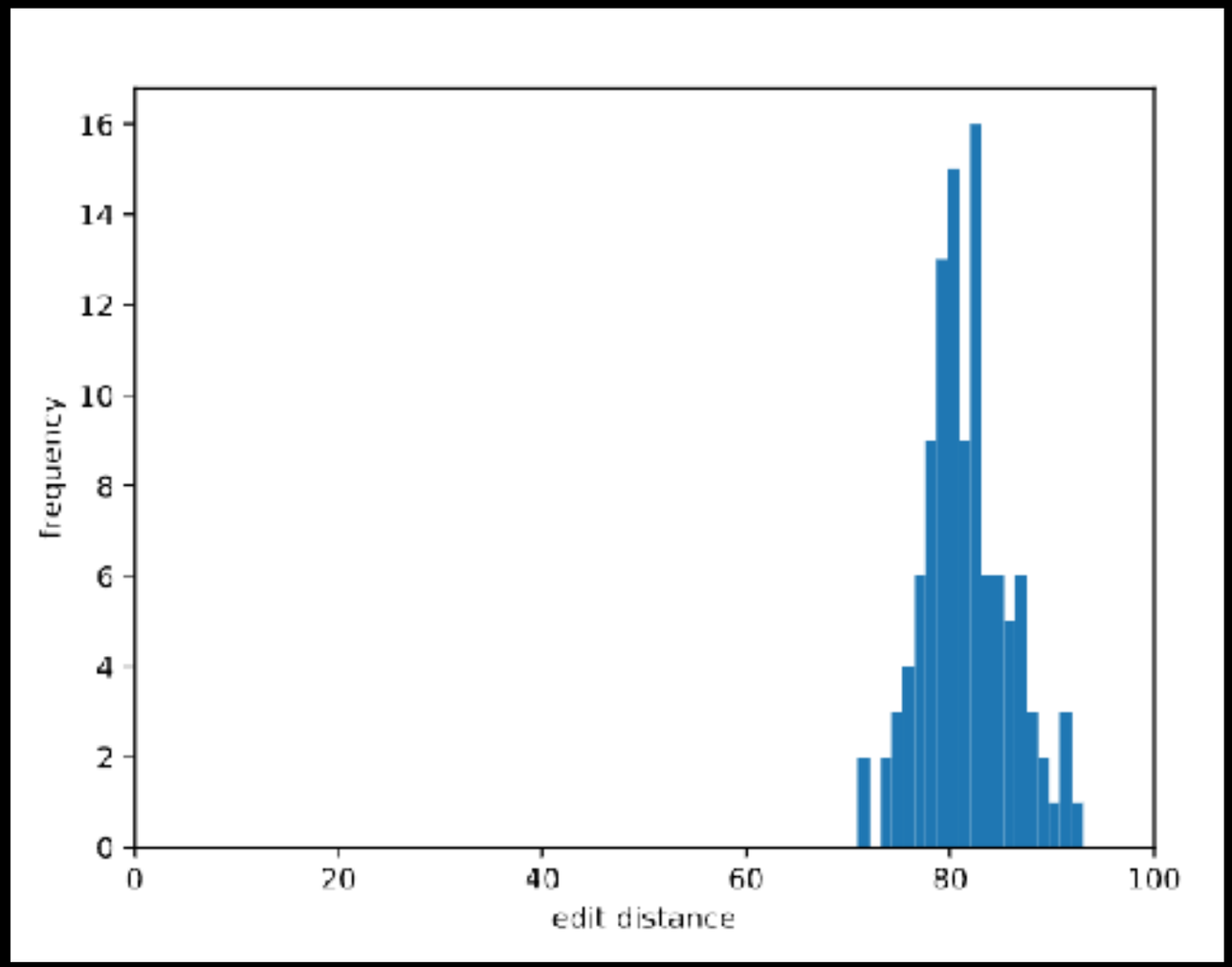

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- Widespread media coverage, logo thanks to TheRegister

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Mani Kotteris Tue, 19 Jun 2018 12:30:10 -0700

CVSROOT: /cvs
Module name: src
Changes by: kettle...@cvs.openbsd.org 2018/06/19 11:27:52

Modified files:
sys/arch/amd64/amd64: cpu.c
sys/arch/amd64/include: cpu.h
sys/kern : kern_sched.c kern_sysctl.c
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Log message:
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TLBleed

From Wikipedia, the free encyclopedia

TLBleed is a cryptographic side-channel attack that uses machine lea
simultaneous multithreading.[1][2] As of June 2018, the attack has only
vulnerable to a variant of the attack, but no proof of concept has been

The attack led to the OpenBSD project disabling simultaneous multithr
theoretically be prevented by preventing tasks with different security c

References [edit]

1. ^ Williams, Chris (2018-06-22). "Meet TLBleed: A crypto-key-leaking C
2. ^ a b c Vaughan-Nichols, Steven J. (25 June 2018). "OpenBSD chief do Raadt says

CREDIT

- Work also by Kaveh Razavi, Cristiano Giuffrida, Herbert Bos
- Some diagrams in these slides were taken from other work: FLUSH+RELOAD, Cloak
- Yuval Yarom, Katrina Falkner, Peter Peßl, Daniel Gruss

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- Thank you for listening