Radboud University

# pqm4: Testing and Benchmarking NIST PQC on ARM Cortex-M4

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  - What is the overhead of masking?

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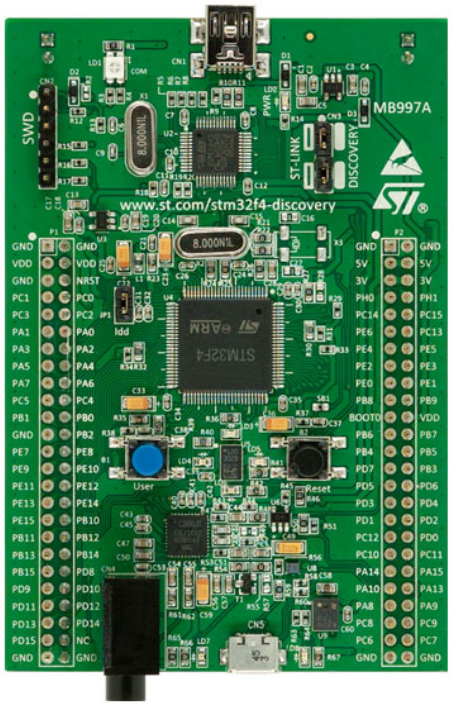
- STM32F4DISCOVERY
  - ARM Cortex-M4
  - 32-bit, ARMv7E-M
  - 192 KiB RAM, 168 MHz
- PQM4: test and optimize on the Cortex-M4
  - `github.com/mupq/pqm4`



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  - Our students know how to work with them

- **Goals**

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  - `m4`: Optimized using ARMv7E-M assembly

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# Schemes included in pqm4– KEMs

| | reference | optimized | |
|---|---|---|---|
| BIKE | ✗$_{Lib}$ | — | |
| Classic McEliece | ✗$_{Key}$ | — | |
| CRYSTALS-Kyber | ✓ | ✓ | [BKS19] |
| Frodo-KEM | ✓ | ✓ | [BFM+18] |
| HQC | ✗$_{Lib}$ | — | |
| LAC | ✓ | — | |
| LEDAcrypt | ✗$_{RAM}$ | WIP | |
| NewHope | ✓ | ✓ | [AJS16] |
| NTRU | ✓ | ✓ | [KRS19] |
| NTRU Prime | ✓ | — | |
| NTS-KEM | ✗$_{Key}$ | — | |
| ROLLO | ✗$_{Lib}$ | — | |
| Round5 | ✓ | ✓ | Round5 team |
| RQC | ✗$_{Lib}$ | — | |
| SABER | ✓ | ✓ | [KRS19] |
| SIKE | ✓ | — | |
| ThreeBears | ✓ | ✓ | ThreeBears team |

✗$_{Key}$: keys too large ✗$_{RAM}$: implementation uses too much RAM

✗$_{Lib}$: available implementations depend on external libraries

# Schemes included in pqm4– Signatures

| | reference | optimized | |
|---|---|---|---|
| CRYSTALS-Dilithium | ✓ | ✓ | [GKOS18, RSGCB19] |
| FALCON | ✗$_{RAM}$ | ✓ | Falcon team |
| GeMSS | ✗$_{Key}$ | — | |
| LUOV | ✓ | — | |
| MQDSS | ✗$_{RAM}$ | — | |
| Picnic | ✗$_{RAM}$ | — | |
| qTESLA | ✓ | — | |
| Rainbow | ✗$_{Key}$ | — | |
| SPHINCS+ | ✓ | — | |

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  - Most schemes only sample seed, so speed doesn't matter

# Benchmarking: Fast Hashing

- Submission packages often come with different implementations of SHA-2, SHA-3, or AES

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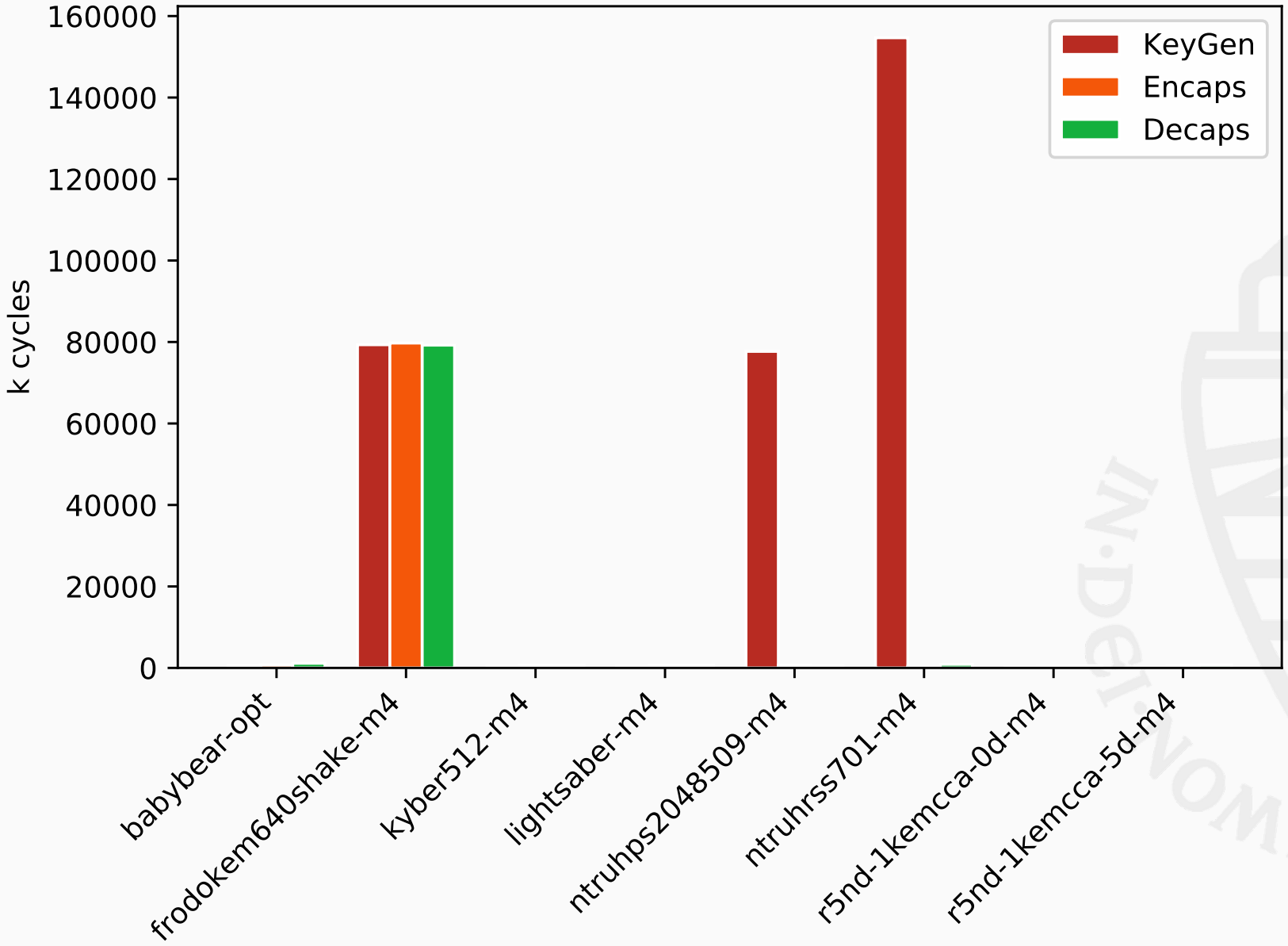
# KEM Speed


160000
140000
120000
100000
80000
60000
40000
20000
0
k cycles
KeyGen
Encaps
Decaps
babybear-opt
frodokem640shake-m4
kyber512-m4
lightsaber-m4
ntruhps2048509-m4
ntruhrss701-m4
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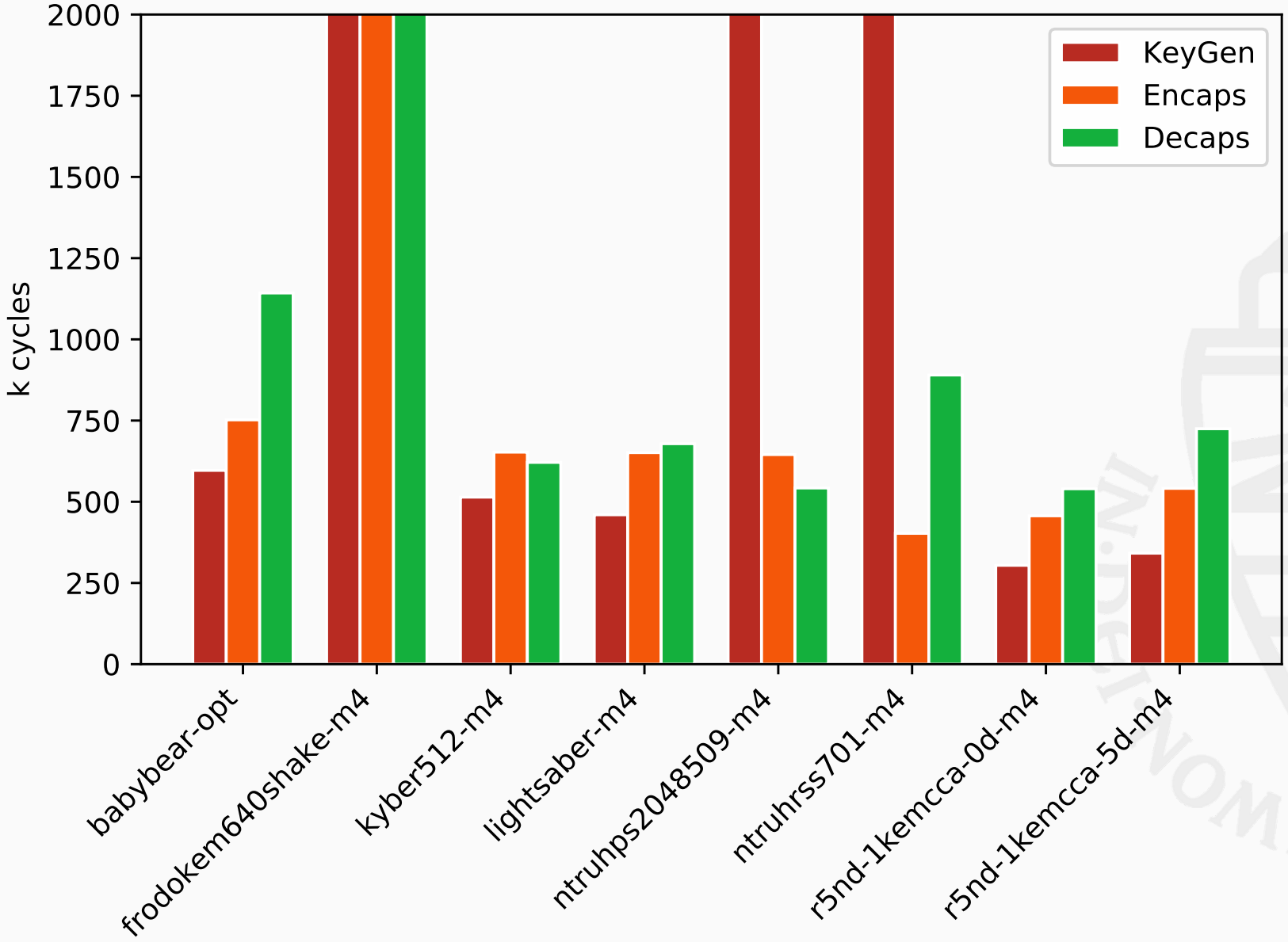
2000
1750
1500
1250
1000
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0
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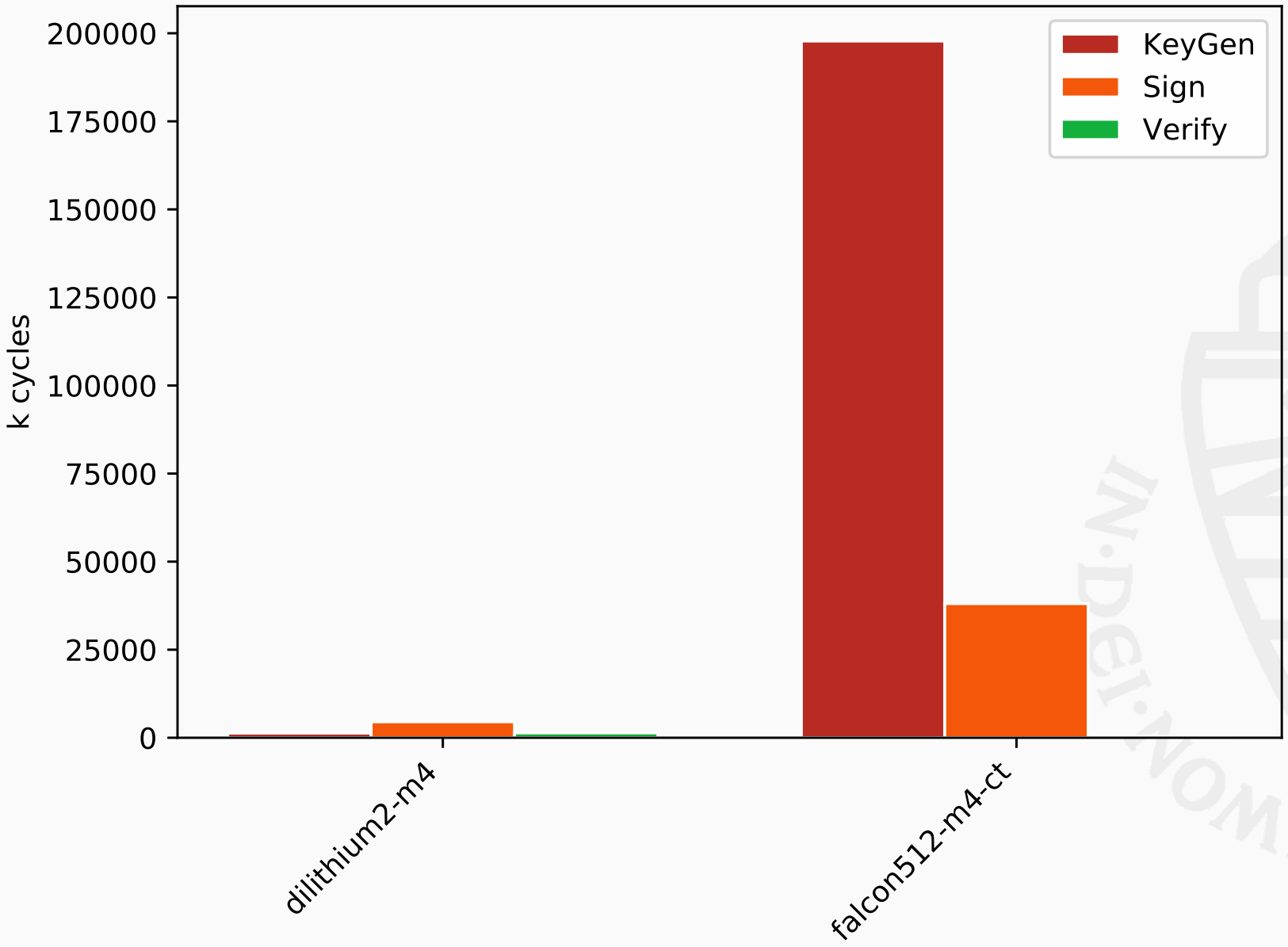
# Signature Speed



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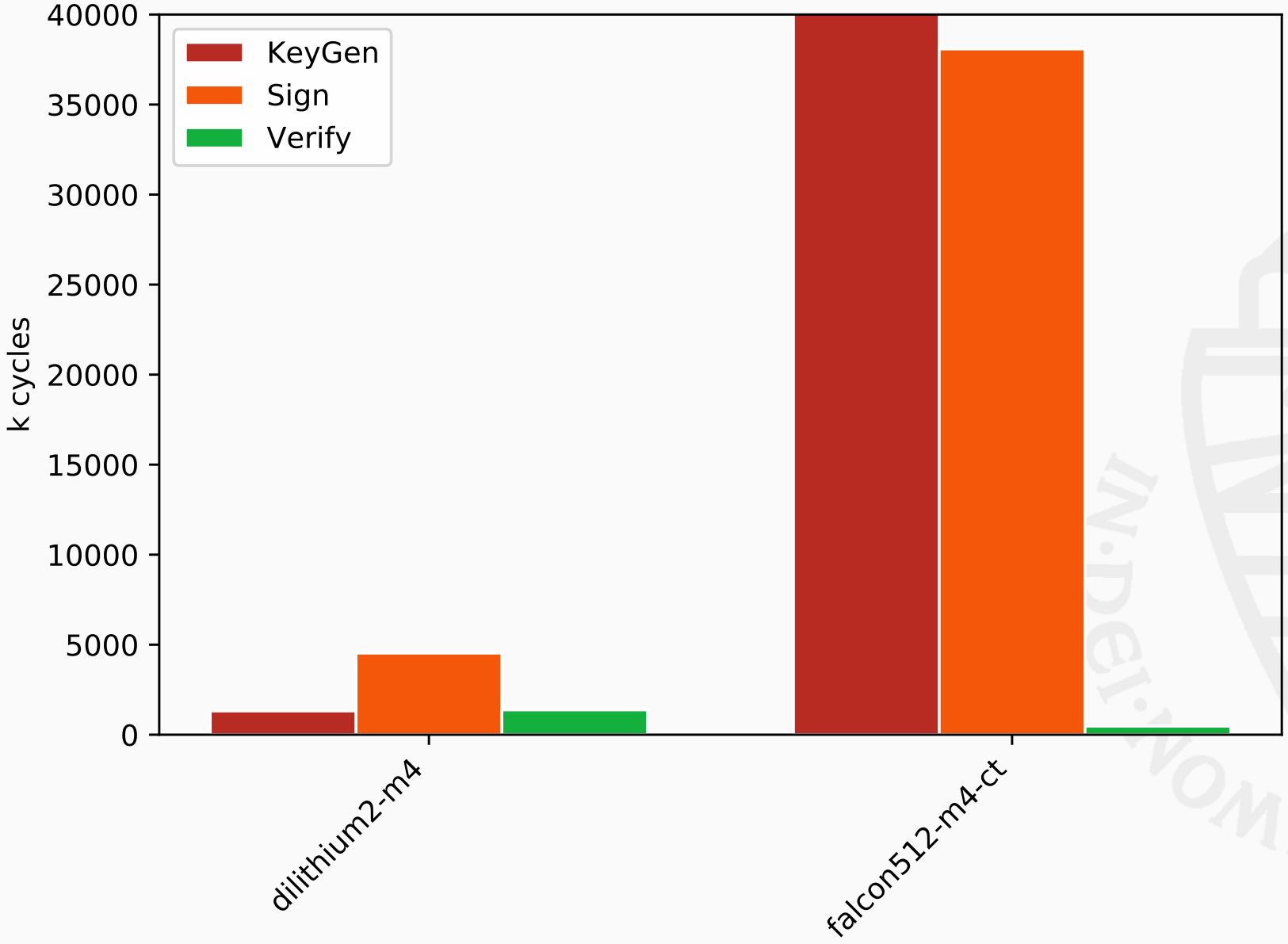

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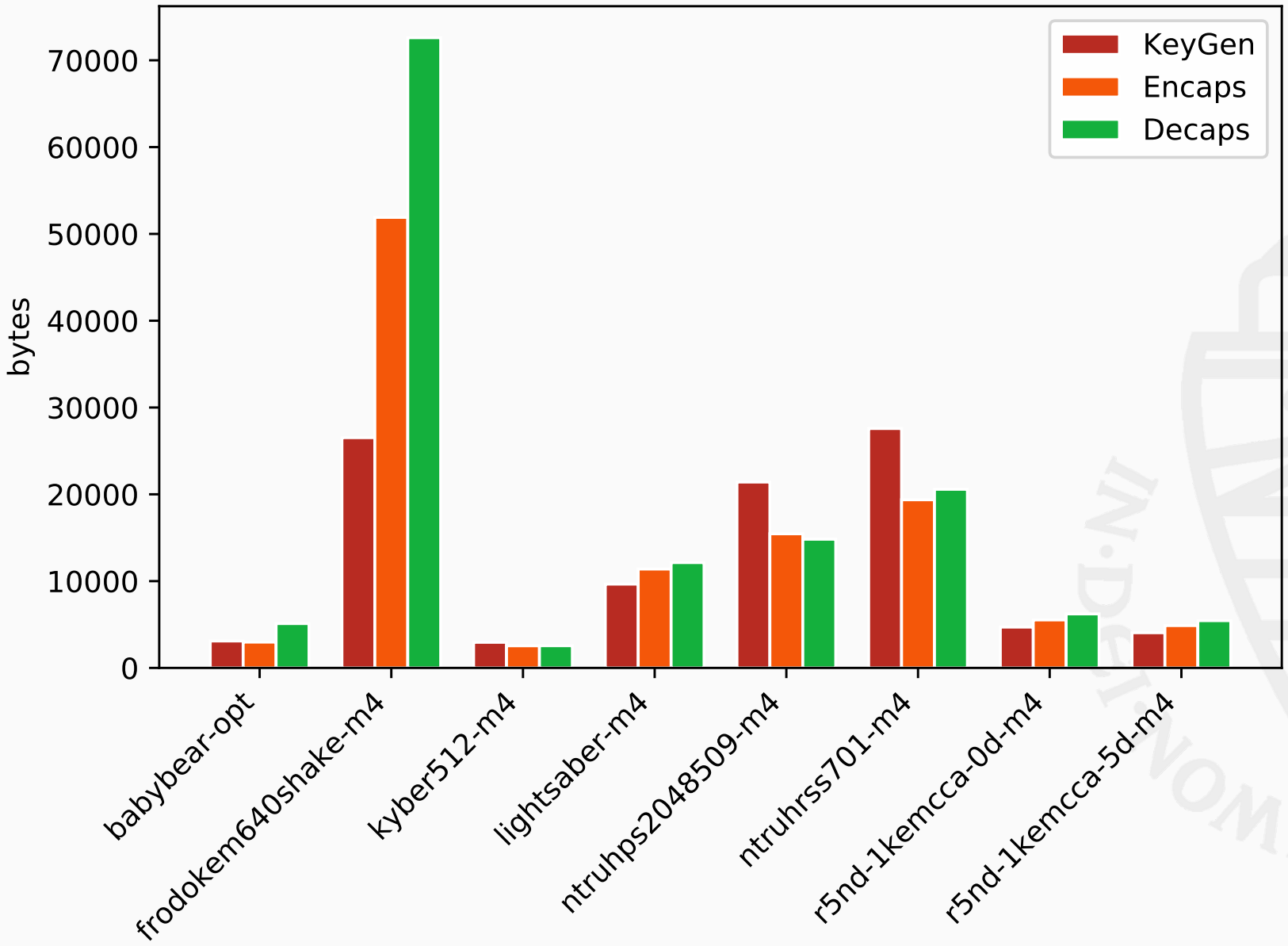

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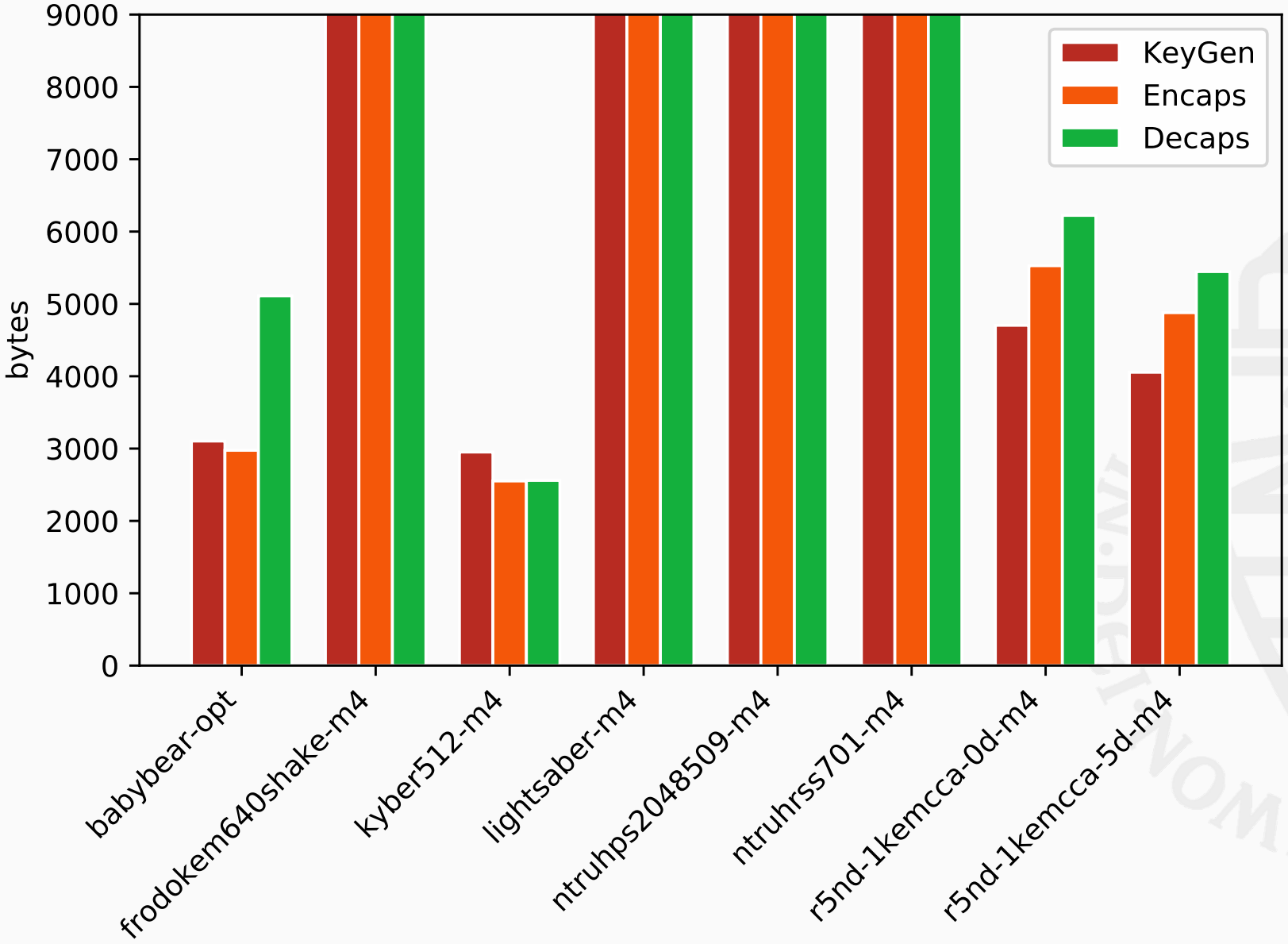

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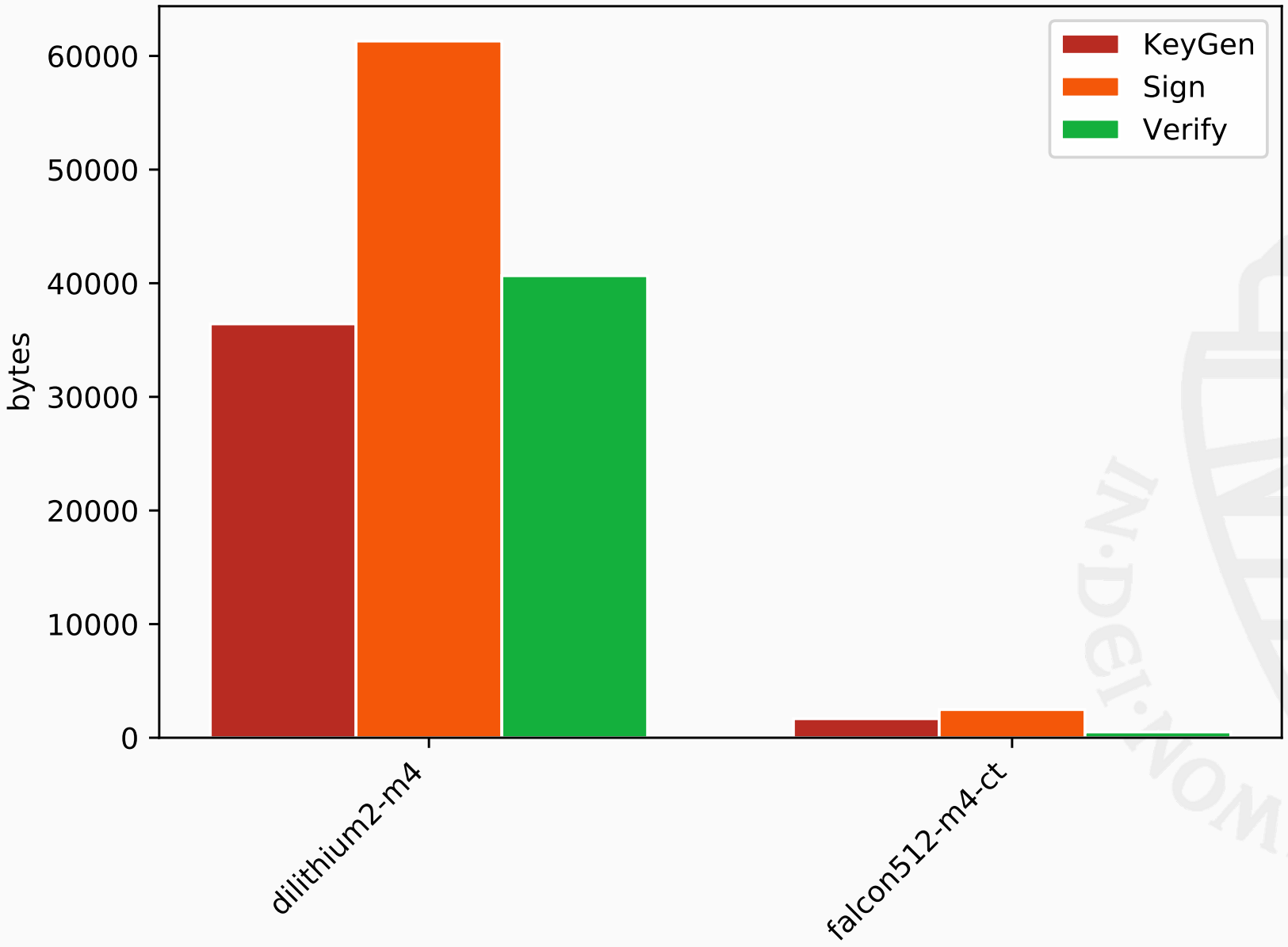

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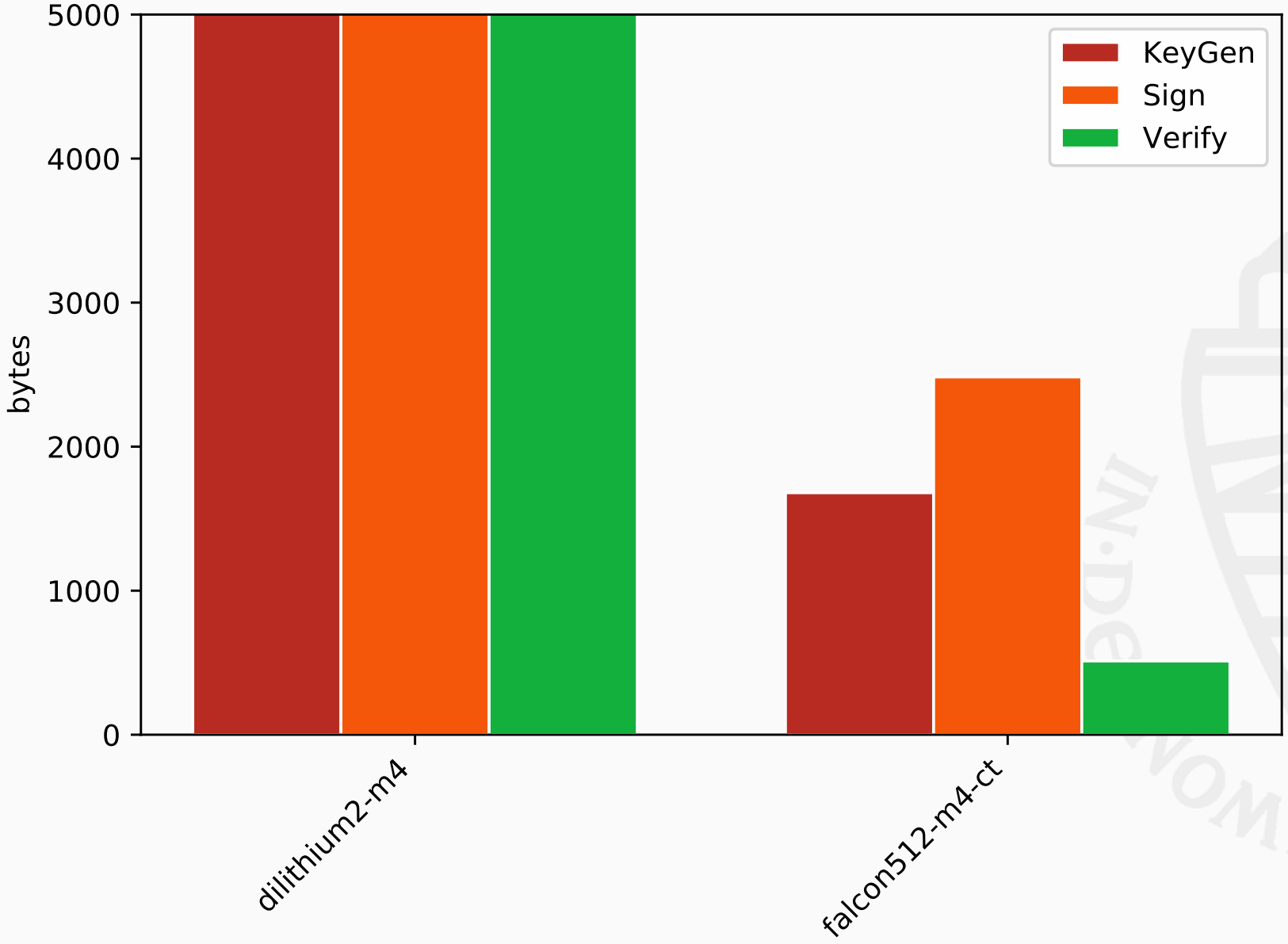

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- BIKE, HQC, ROLLO, RQC use OpenSSL/NTL/GMP
  $\rightarrow$ needs to be replaced to make it work

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  - But Kyber, NTRU, Saber, ThreeBears very close

https://github.com/mupq/pqm4

**slides and paper available at** kannwischer.eu

**Thank you!**

# References i


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