

#### Countermeasure against the SPA attack on an embedded mceliece cryptosystem

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# COUNTERMEASURE AGAINST THE SPA ATTACK ON AN EMBEDDED MCELIECE CRYPTOSYSTEM



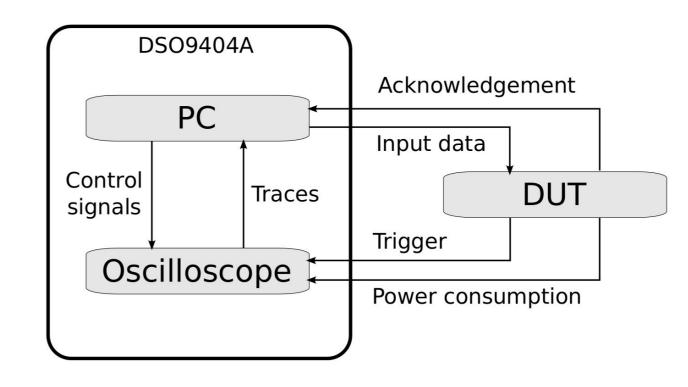
### Martin Petrvalský<sup>1</sup>, Tania Richmond<sup>2</sup>, Miloš Drutarovský<sup>1</sup>, Pierre-Louis Cayrel<sup>2</sup> and Viktor Fischer<sup>2</sup>

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### INTRODUCTION

The code-based cryptosystems are very attractive because of their robustness regarding attacks based on the use of quantum computers. The first code-based cryptosystem was proposed by R. McEliece in 1978 [1]. However, it appeared that the code-based cryptosystems are as vulnerable to side channel attacks (SCA) proposed by Kocher in 1996 [2] as other cryptosystems. The first known SCA against the McEliece public key cryptosystem (PKC) appeared in 2008 [3].

# WORKPLACE & MEASUREMENT



Attacked HW: ARM Cortex-M3 based STM32F103 MCU

Oscilloscope: Agilent Technologies DSO9404A

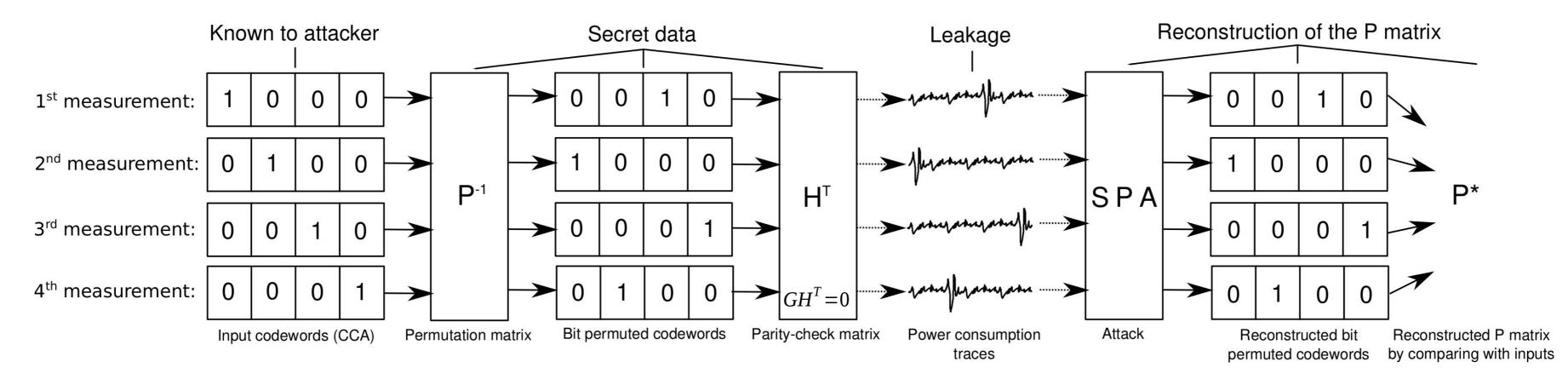
# MCELIECE PKC

#### Encryption:

#### PERMUTATION MATRIX REVELATION

- Encode message m using generator matrix G:  $\overline{c} = m.SGP$
- → Add error vector e to produce ciphertext c:  $c = \overline{c} + e$ Decryption:
- → \*Permute ciphertext c using permutation matrix P<sup>-1</sup>:  $\hat{c} = c \cdot P^{-1}$
- → \*Use decoding algorithm:  $\hat{m} = DEC(\hat{c})$
- → Unscramble message using scrambling matrix S<sup>-1</sup>:  $m = \hat{m} \cdot S^{-1}$
- → Quantification of a threat that poses revealed P matrix to an attacker – is it a complete breakdown of the encryption?
- Using parameters: n=1024 m=10
- → Complexity of the attack:  $m^2(n^3 + n^2)$
- → Complexity decreases from 2<sup>62</sup> to 2<sup>37</sup> binary operations

### HOW DOES SIMPLE POWER ANALYSIS USING CHOSEN CIPHERTEXT ATTACK WORK?

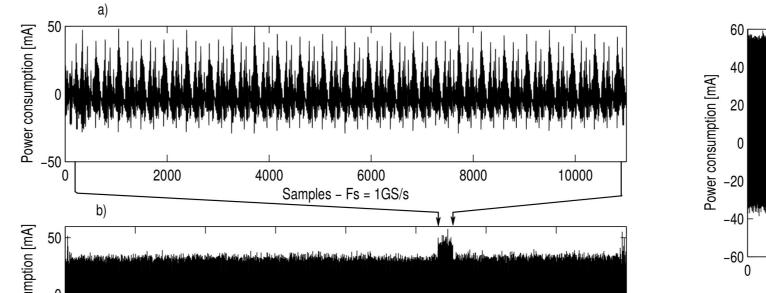


1.5

1.5

# **RESULTS & CONLCUSION**

- Recreation of the SPA attack
- Quantification of the threat:  $2^{62} \rightarrow 2^{37}$  operations
- Application of the software countermeasure based on avoiding conditional statements and creating time and instruction constant software
- Countermeasure 3x slower on average
- Advantage of the linear complexity



2.5

2.5

5 2 2 Samples - Fs = 1GS/s

2

Samples - Fs = 1GS/s

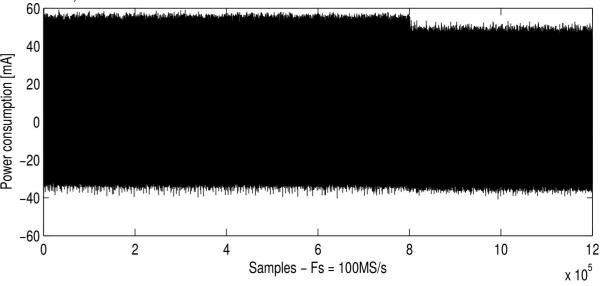
3.5

3.5

x 10<sup>5</sup>

x 10<sup>5</sup>

[mA]



Samples - Fs = 100MS/s

10

12

x 10<sup>5</sup>

• Problem with initialization of variables

• Test of the SPA resistant implementation

Future steps:
a) DPA attack on the secure implementation
b) Attack on an FPGA implementation

# ACKNOWLEDGEMENT





S

Power

coefficie

-0.5

0.5

0.5

C)



The authors would also like to thank Alain Couvreur for his helpful advices.

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