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

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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].

## MCELIECE PKC

Encryption:

→ Encode message  $m$  using generator matrix  $G$ :  $\bar{c} = m \cdot SGP$

→ Add error vector  $e$  to produce ciphertext  $c$ :  $c = \bar{c} + e$

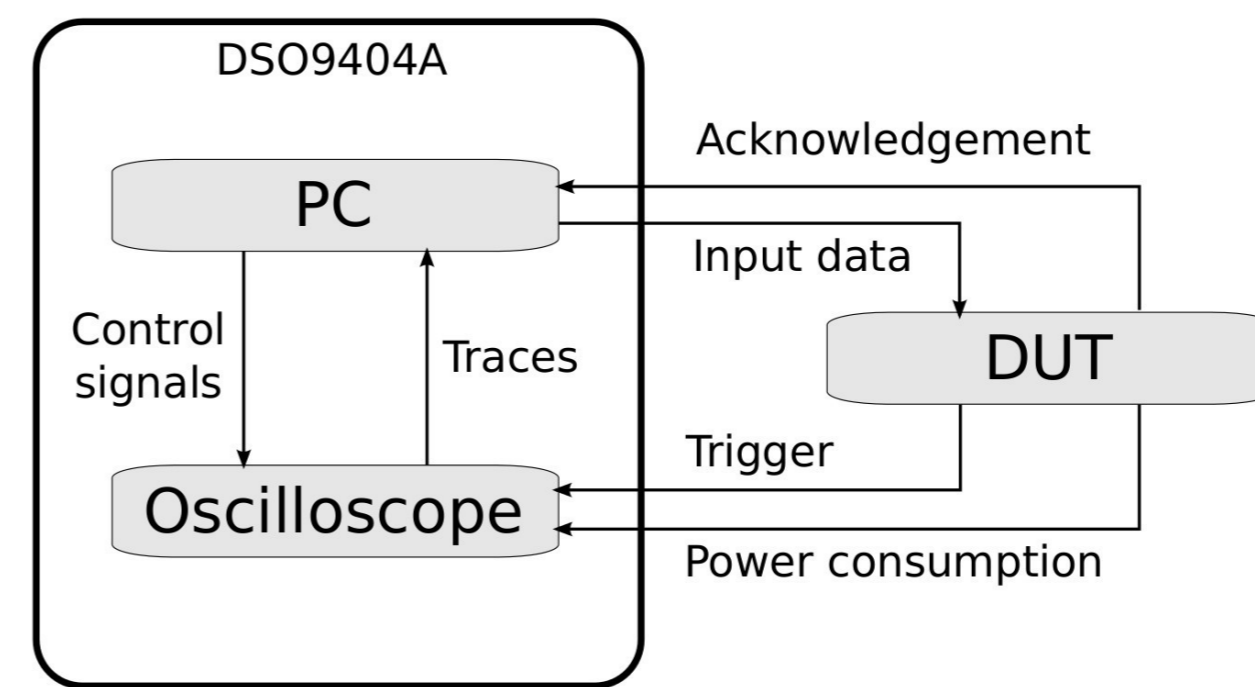
Decryption:

→ \*Permute ciphertext  $c$  using permutation matrix  $P^{-1}$ :  $\hat{c} = c \cdot P^{-1}$

→ \*Use decoding algorithm:  $\hat{m} = DEC(\hat{c})$

→ Unscramble message using scrambling matrix  $S^{-1}$ :  $m = \hat{m} \cdot S^{-1}$

## WORKPLACE & MEASUREMENT



Attacked HW:  
ARM Cortex-M3 based  
STM32F103 MCU

Oscilloscope:  
Agilent Technologies  
DSO9404A

## PERMUTATION MATRIX REVELATION

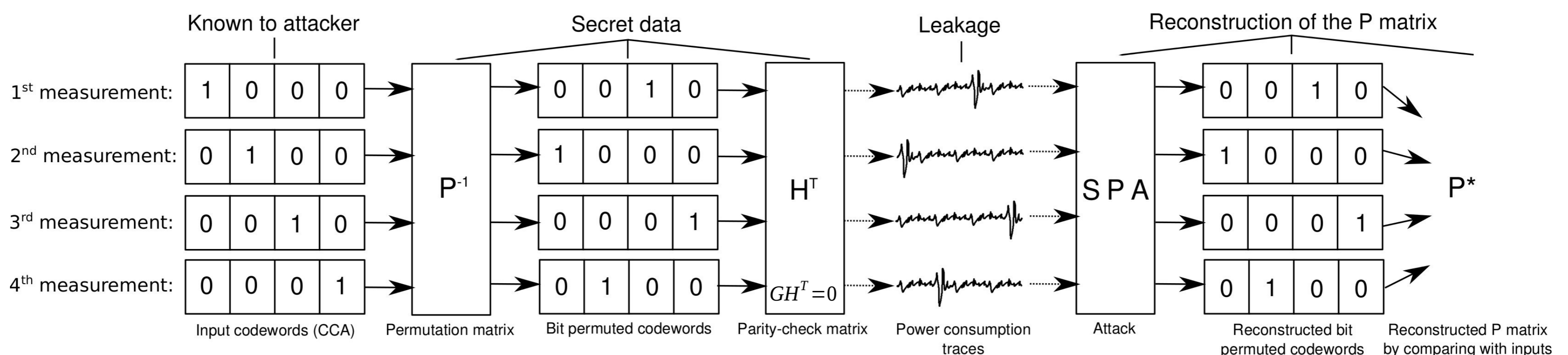
→ Quantification of a threat that poses revealed  $P$  matrix to an attacker – is it a complete breakdown of the encryption?

→ Using parameters:  $n = 1024$   $m = 10$

→ Complexity of the attack:  $m^2(n^3 + n^2)$

→ Complexity decreases from  $2^{62}$  to  $2^{37}$  binary operations

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

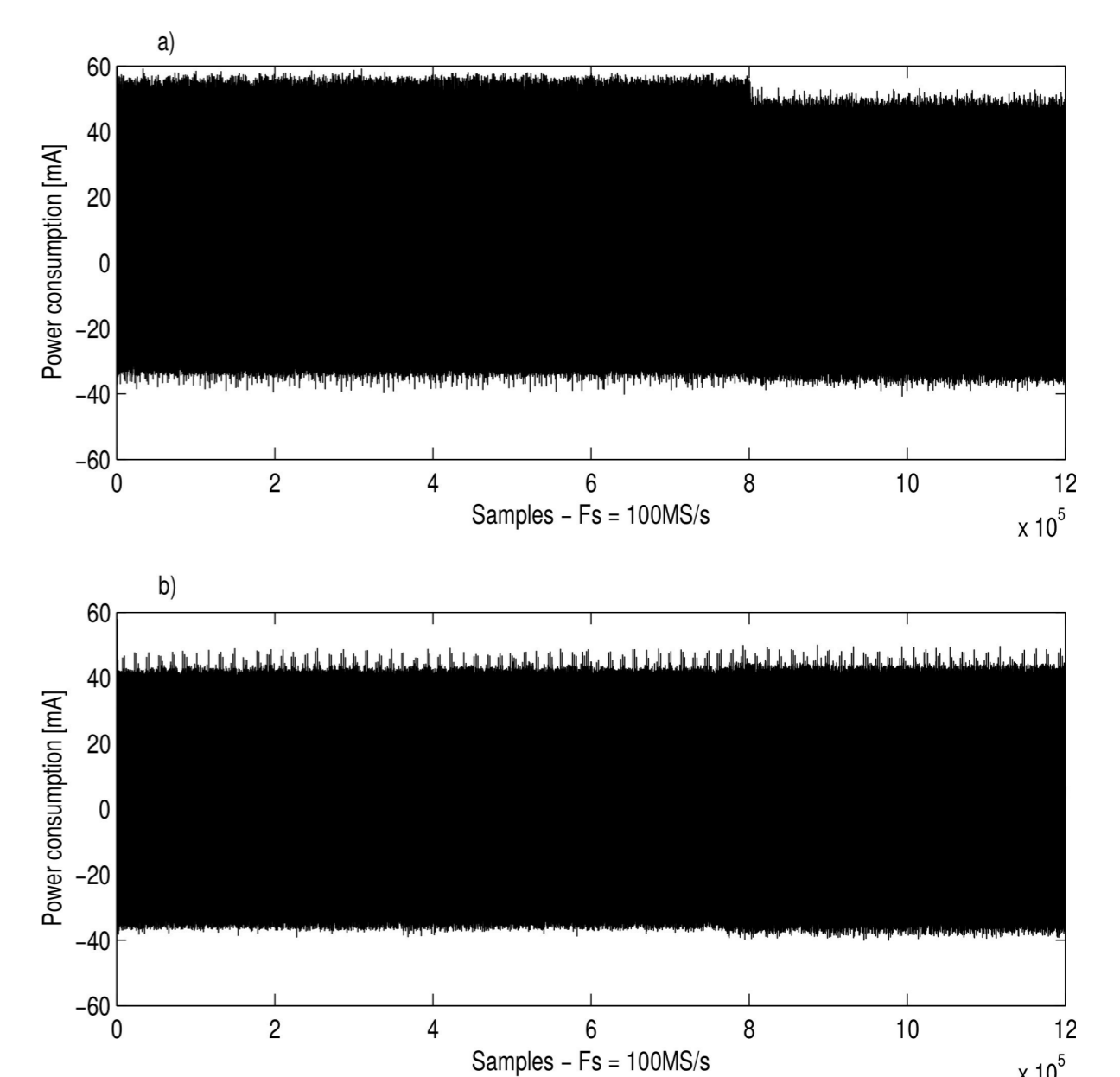
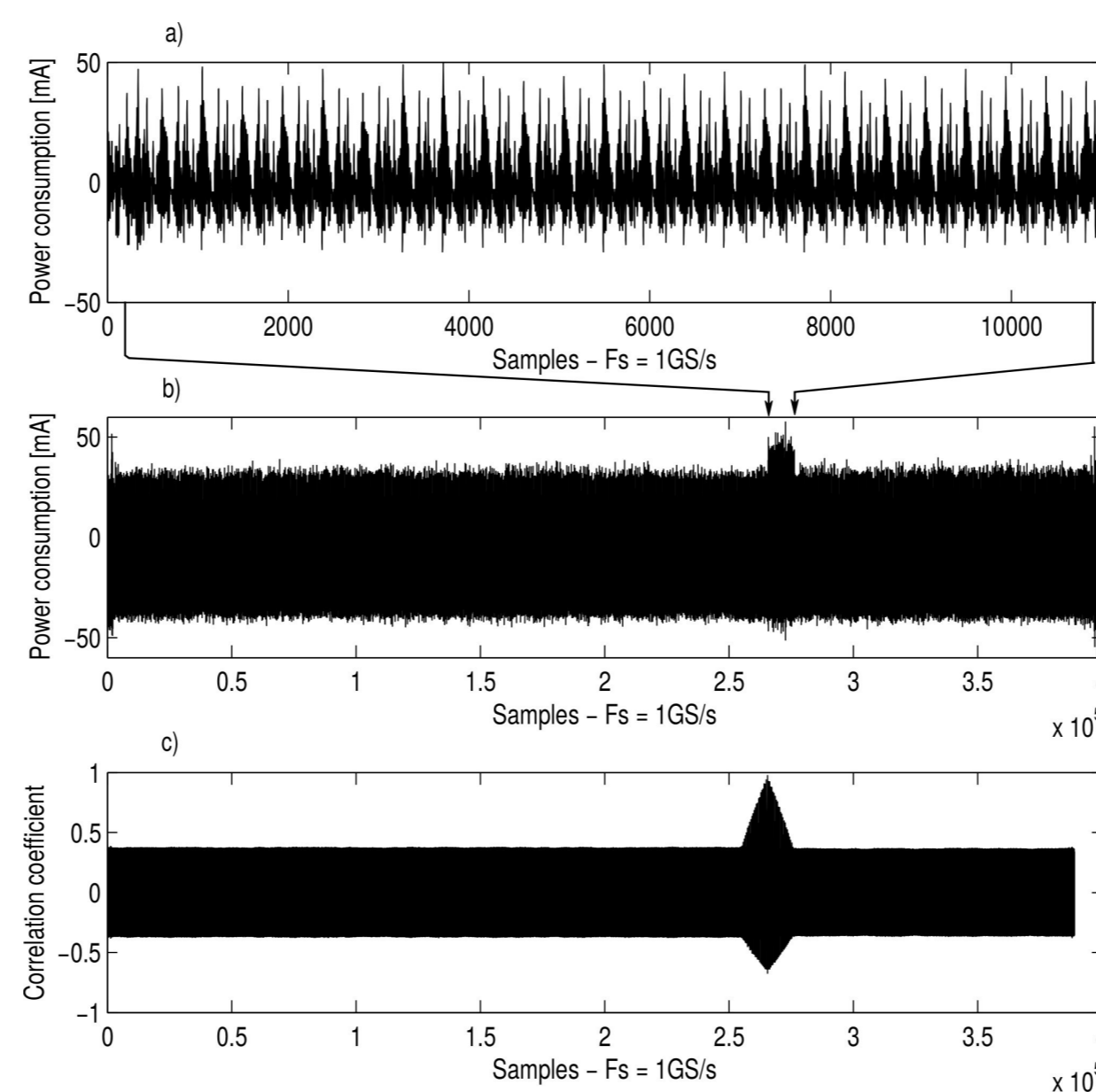


## RESULTS & CONCLUSION

- 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
- 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



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