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QUANTIFYING THE SPEED-UP OFFERED BY GENETIC ALGORITHMS DURING FAULT INJECTION CARTOGRAPHIES

Idris Raïs-Ali[1], Antoine Bouvet[1], Sylvain Guilley[1,2]

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[1] Secure-IC S.A.S., Cesson-Sévigné, France

[2] Télécom ParisTech, Palaiseau, France

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1. Fault Injection Analyses & Points of Interest
2. EMFI experiments
3. Spatial cartographies and Genetic Algorithms (GAs)
4. Quantifying a cartography method effectiveness
5. Conclusions

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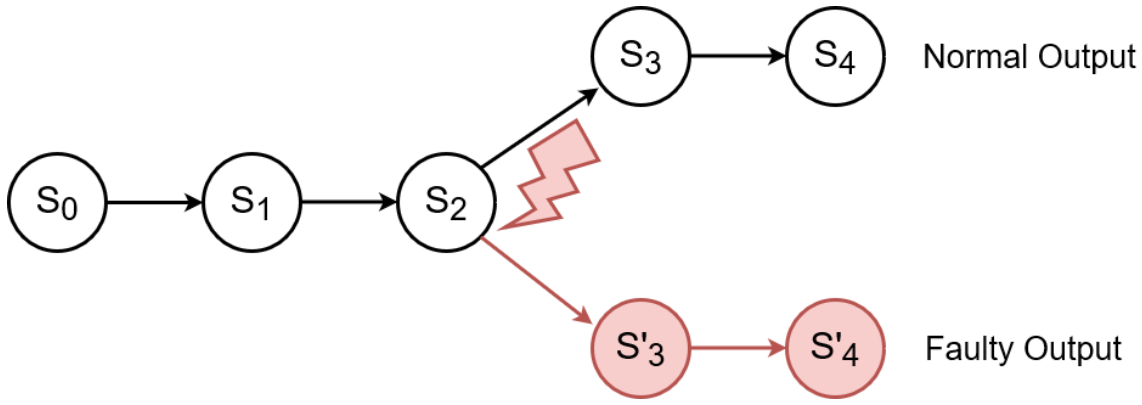
FIAS & POINTS OF INTEREST



Expected intern states S sequence,
disturbed by an external perturbation

Example of perturbation techniques:

- Electro-Magnetic Fault Injection (EMFI)
- Laser Fault Injection
- Power / Clock Glitch
- Body Biasing Injection (BBI)
- Temperature Variation

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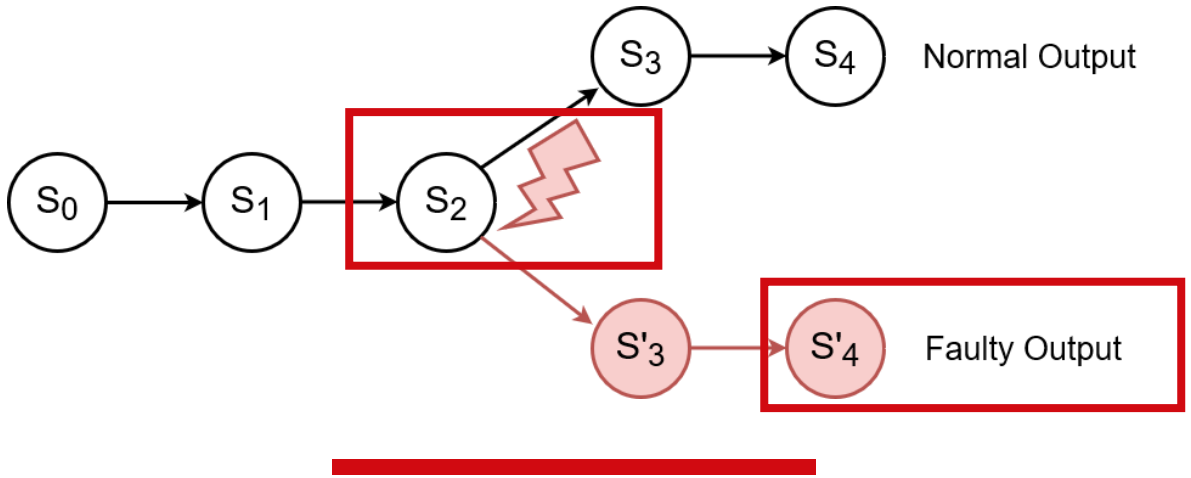

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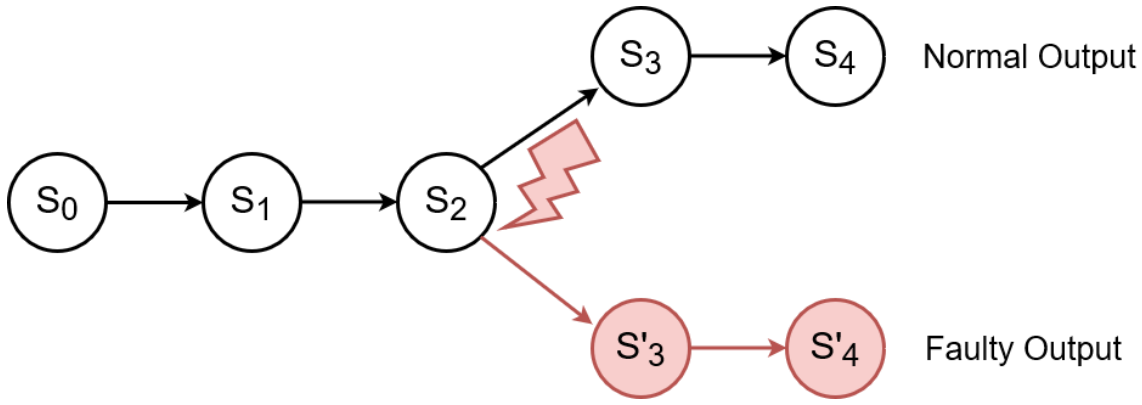

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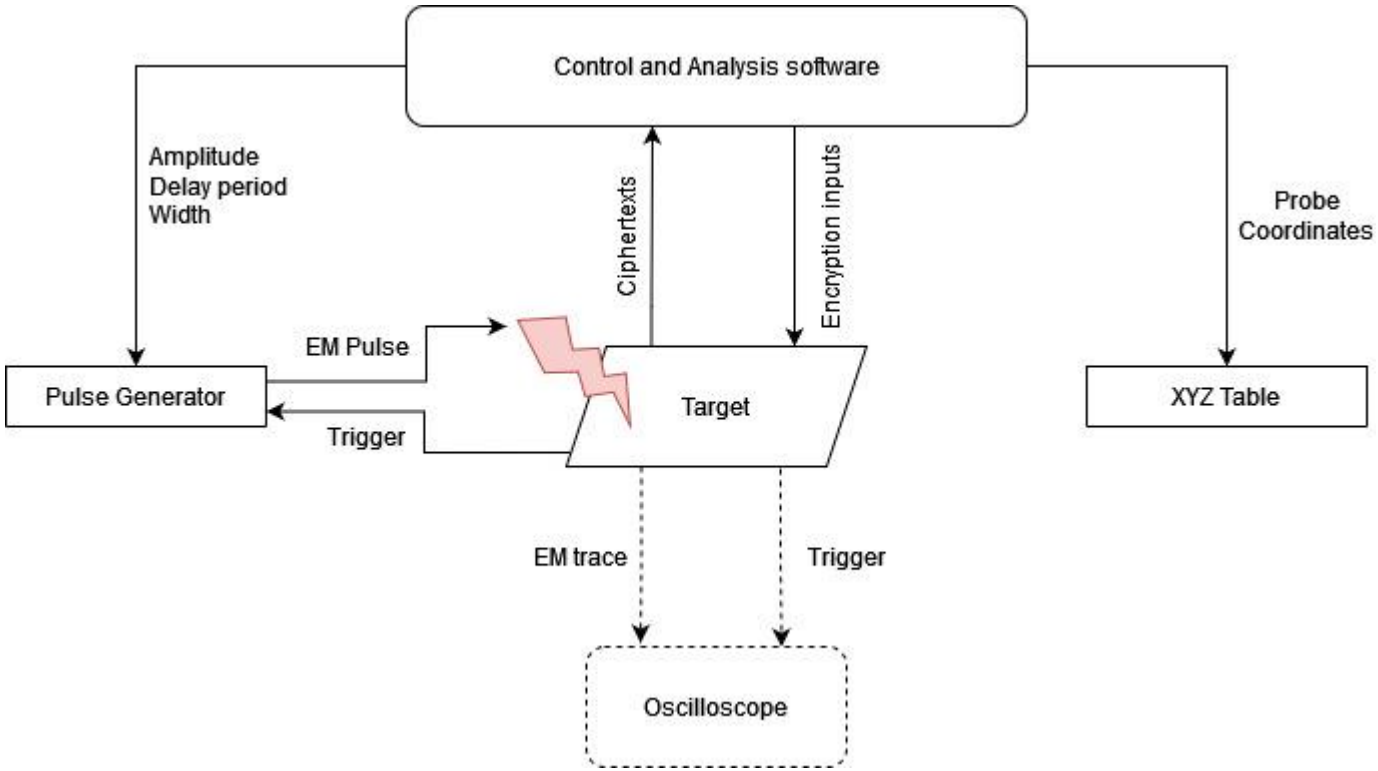
EMFI EXPERIMENTAL SETUP

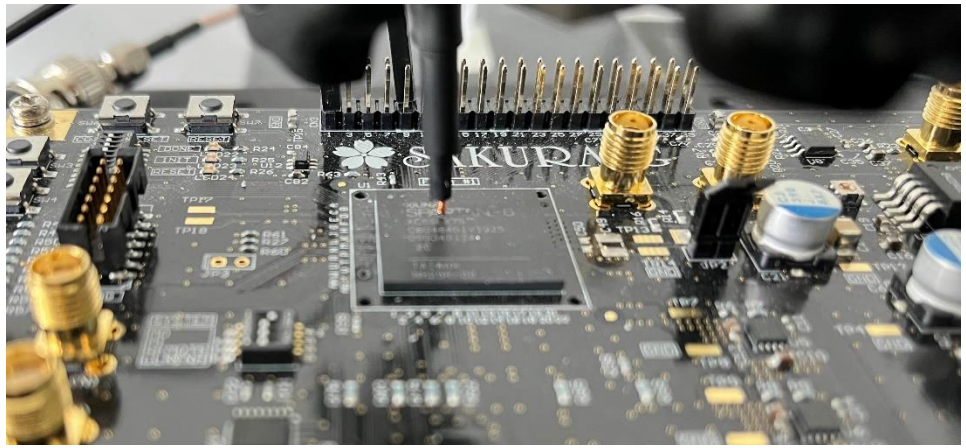


Electromagnetic Fault Injection setup

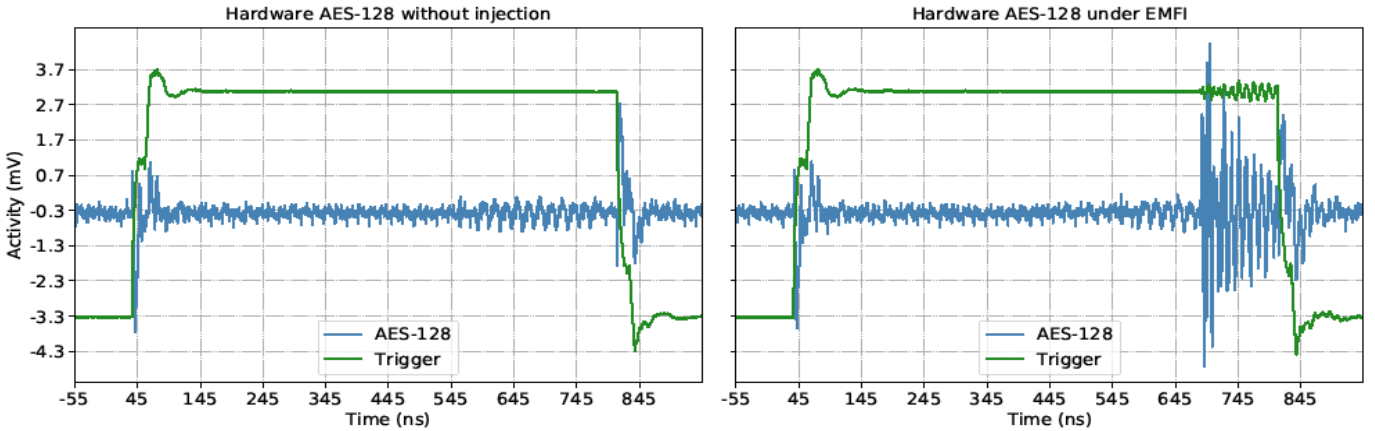
Parameters:

- Pulse amplitude
- Pulse width
- Delay period
- Probe position over the chip (spatial coordinates: X, Y, Z)

EMFI EXPERIMENTAL SETUP

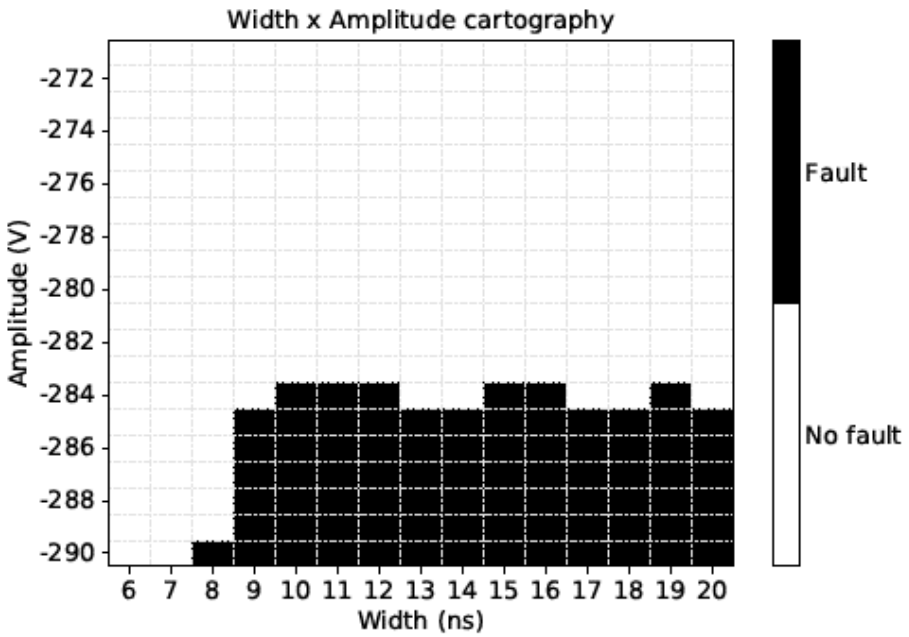


Picture of the target
with injection probe over the FPGA

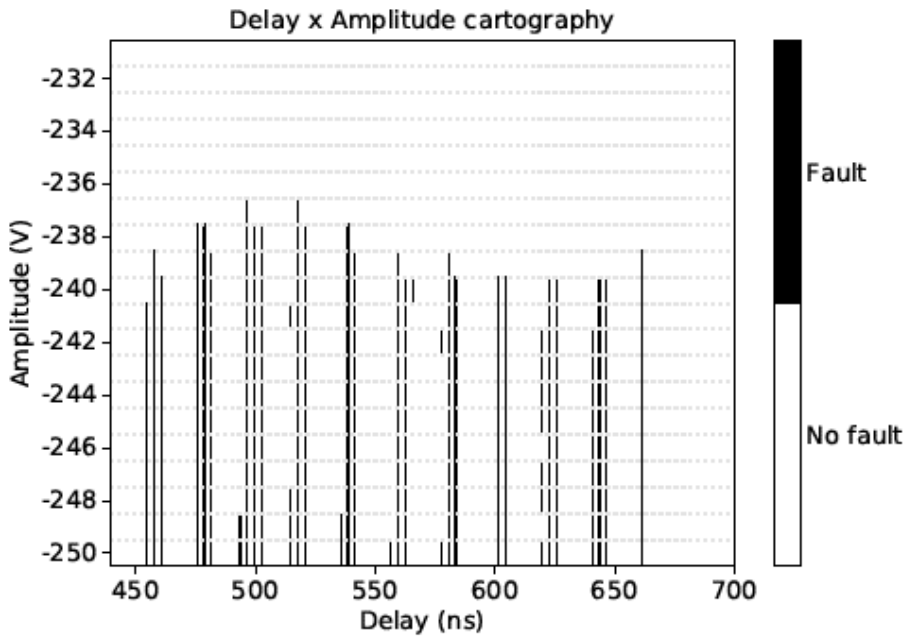


EM activity of the hardware AES-128,
without (left) and with (right) EMFI over the chip

EM PARAMETERS CARTOGRAPHIES



Width x Amplitude cartography



Delay x Amplitude cartography

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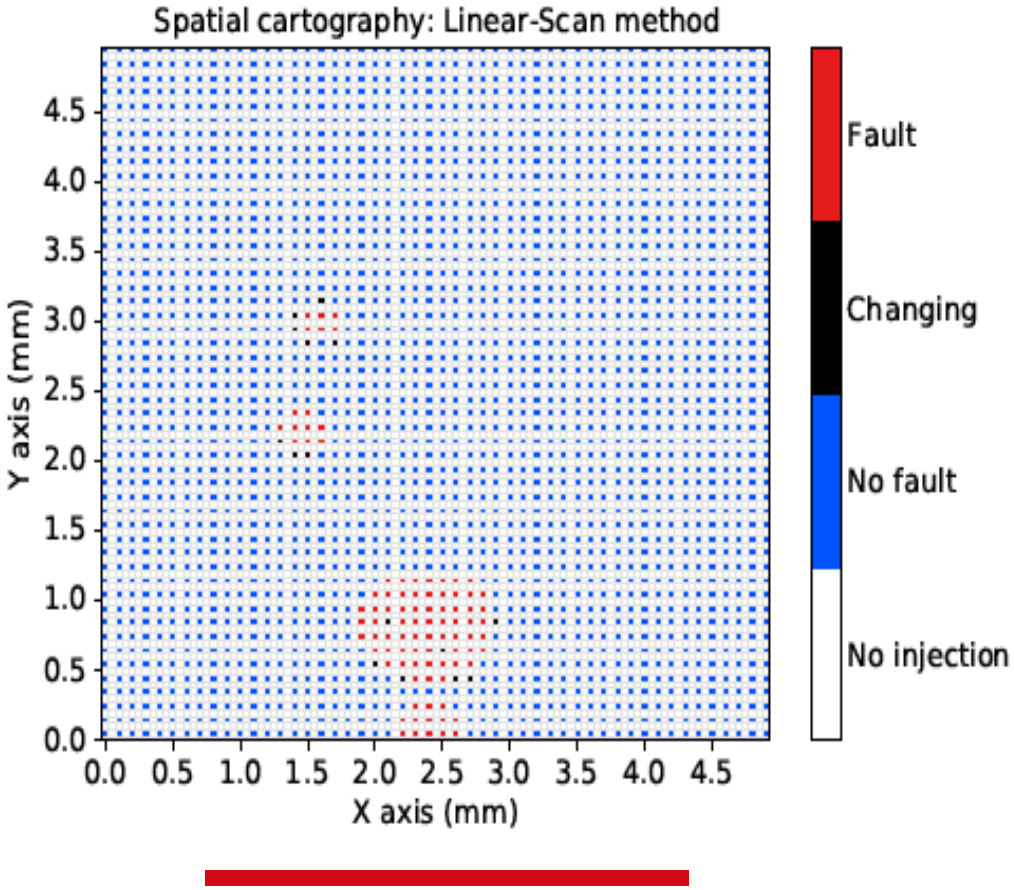
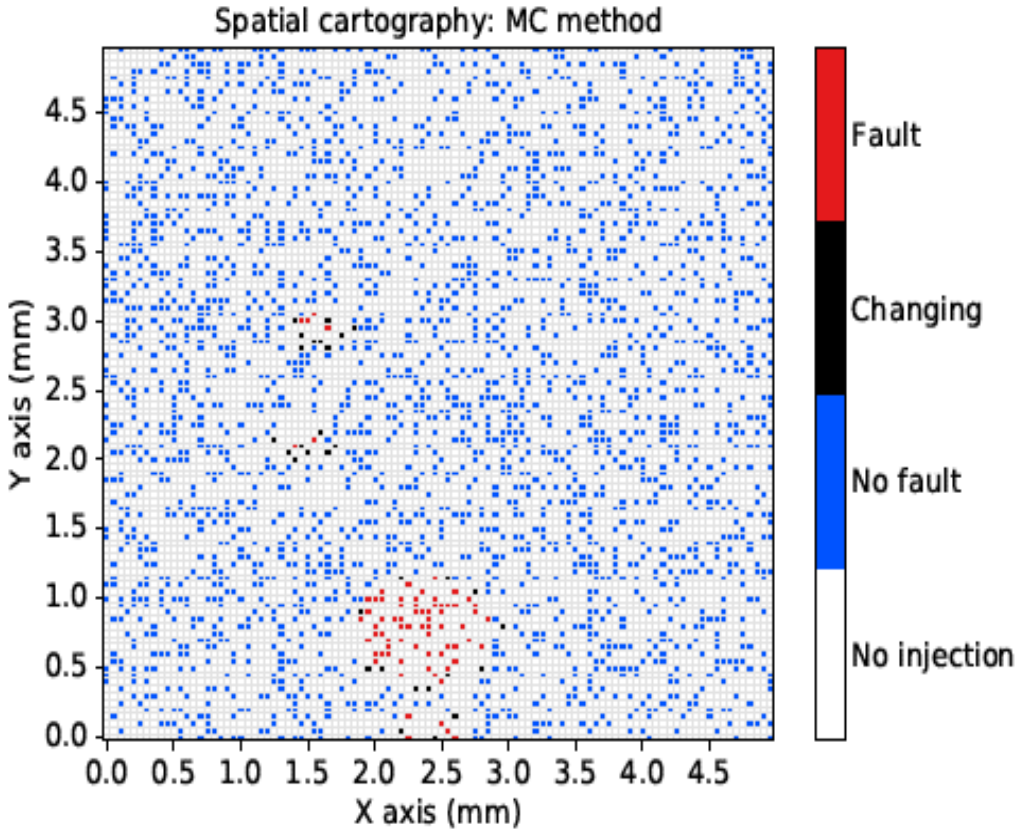
SPATIAL CARTOGRAPHIES: INTRODUCTION



Spatial cartography with Linear-Scan method

- Two-dimensional cartographies
- Injection probe moves above the targeted FPGA
- Linear-Scan: fixed step

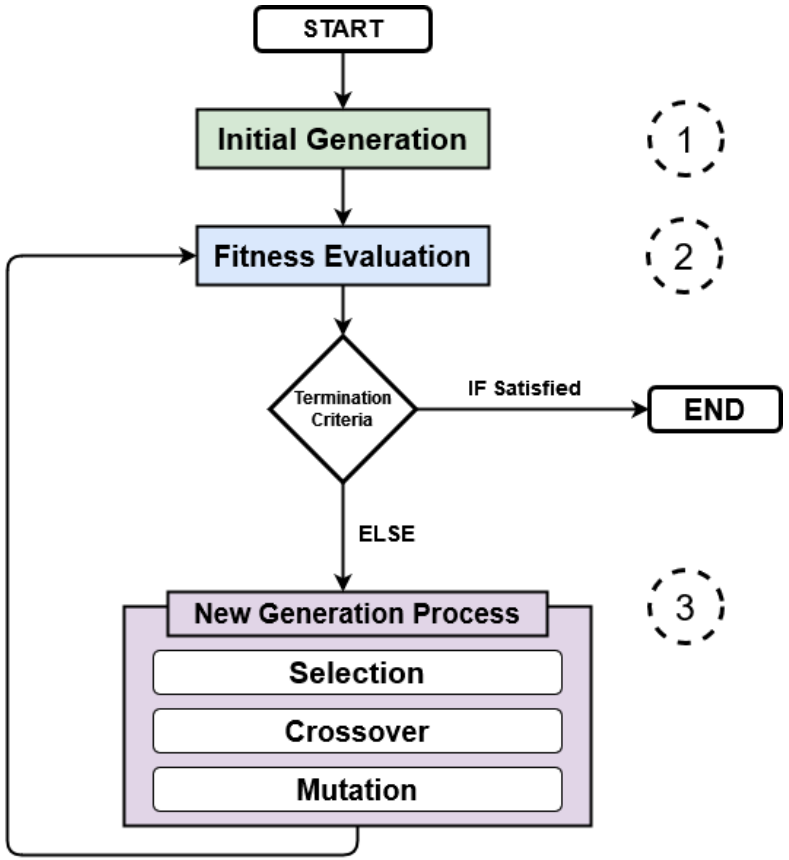
SPATIAL CARTOGRAPHIES: MONTE-CARLO



Random selection
(Monte-Carlo)

- Monte-Carlo: randomly selected points
- Allow to make an estimation of the proportion / number of PoIs above the scanned surface.

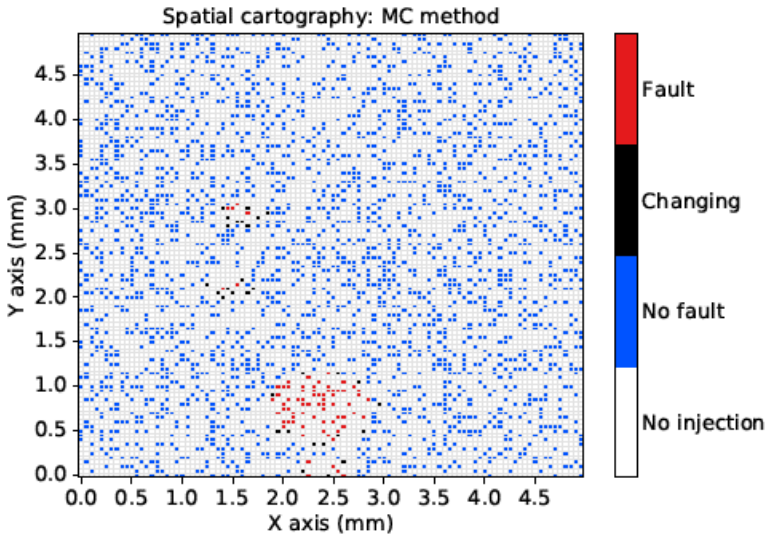
SPATIAL CARTOGRAPHIES: GENETIC ALGORITHMS



Genetic Algorithms scheme

- Analyze injection results though the process
- Main steps:
  1) Initial Generation
  2) Fitness Evaluation
  3) New Generation Process
- Pros:
  - Leave areas without interest
  - Focus on Areas of Interest (AoIs)

SPATIAL CARTOGRAPHY BASED ON RANDOM PROCESS



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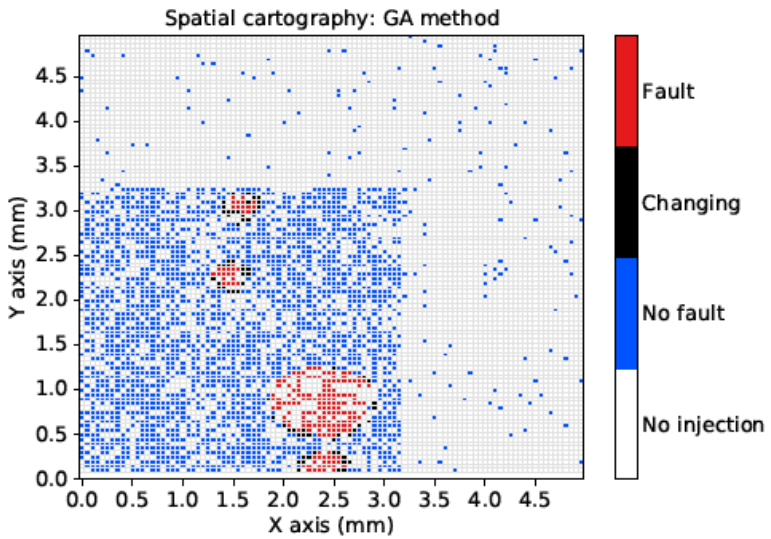
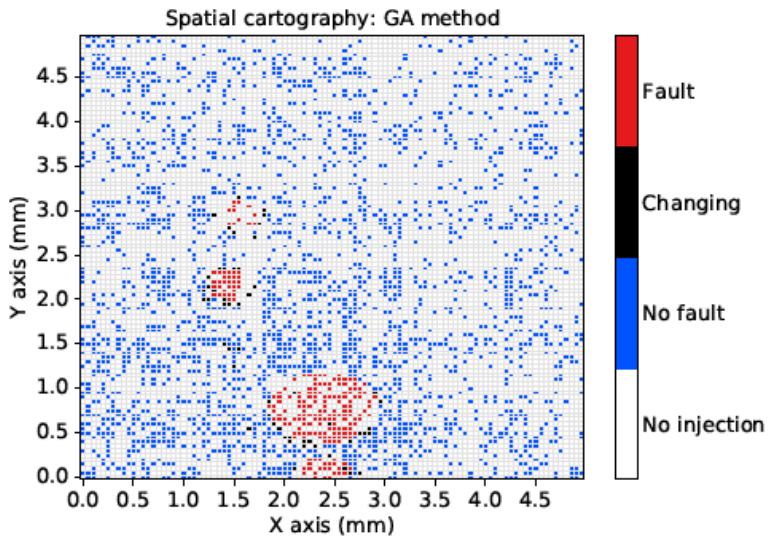


Genetic Algorithm

(GA 100%)



Genetic Algorithm mixed with random selection at 2%
(GA 98%)

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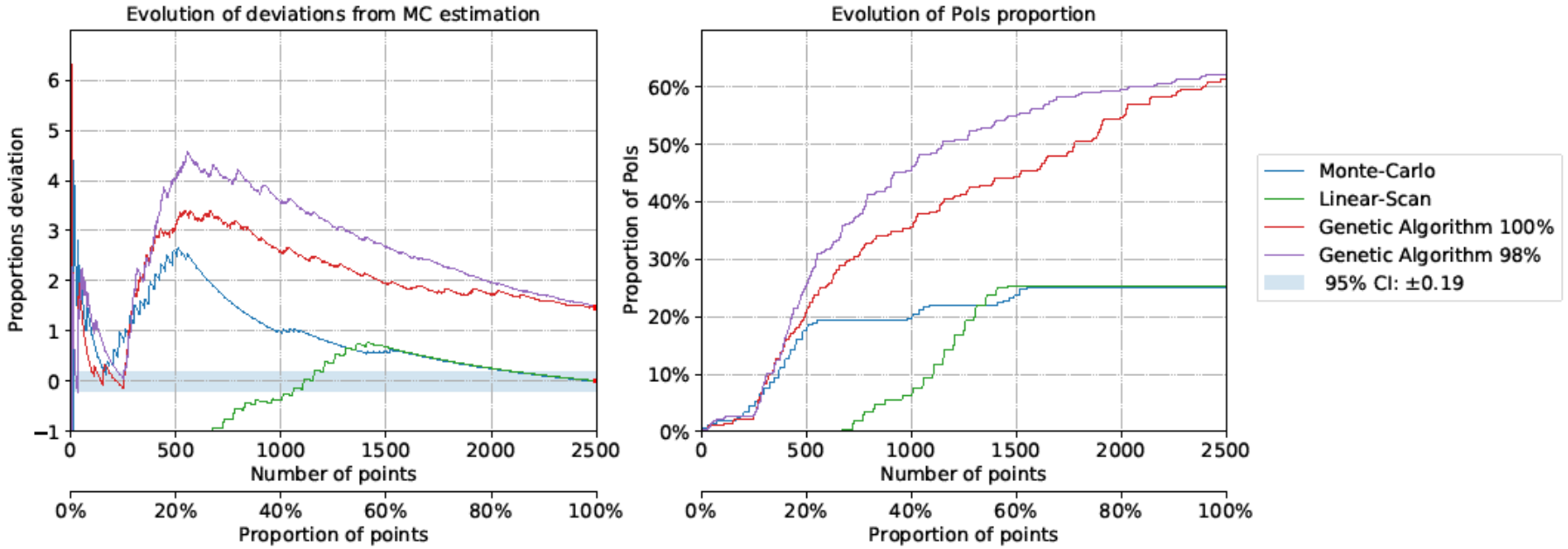
COMPARISON OF CARTOGRAPHY STRATEGIES



- Using Monte-Carlo, we estimate the proportion of PoIs in the set of selectable points over the scanned surface, and its total number.
- These reference values are compared with the proportion/number of PoIs in the samples from the different scan methods.

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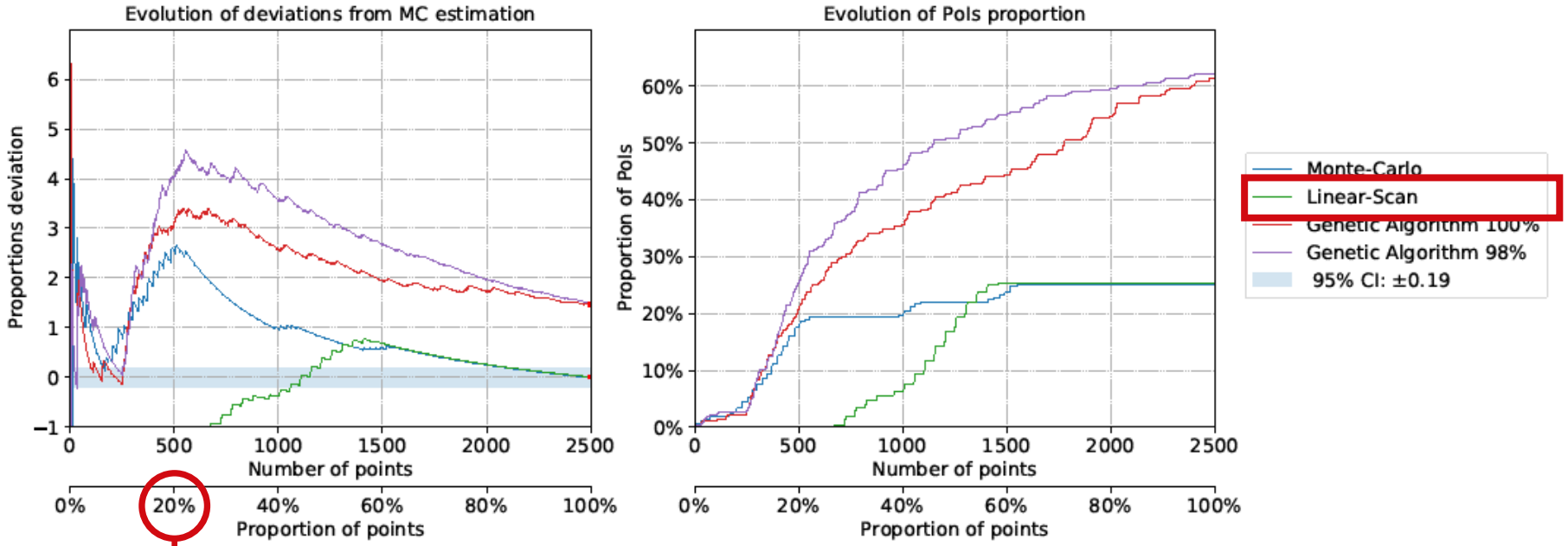

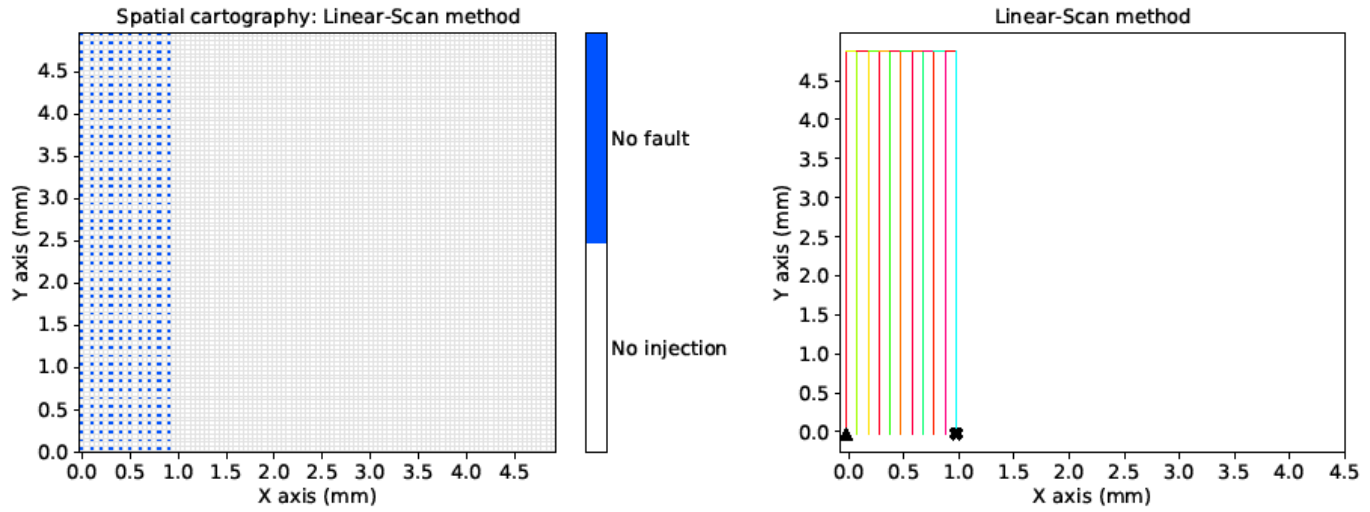

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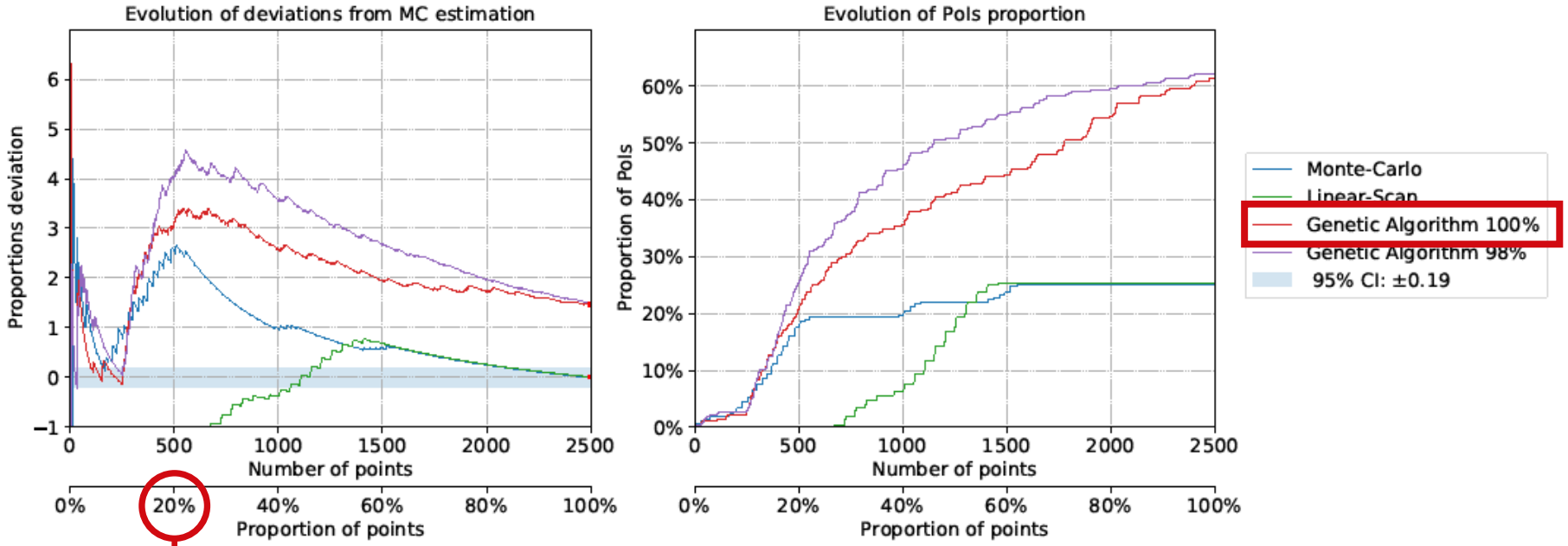

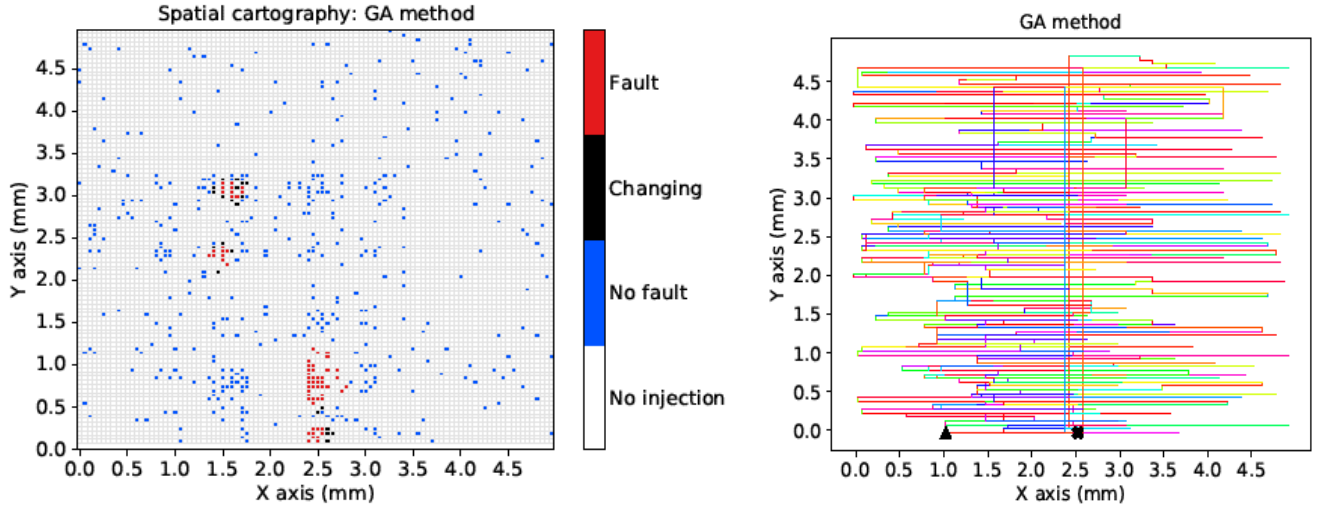

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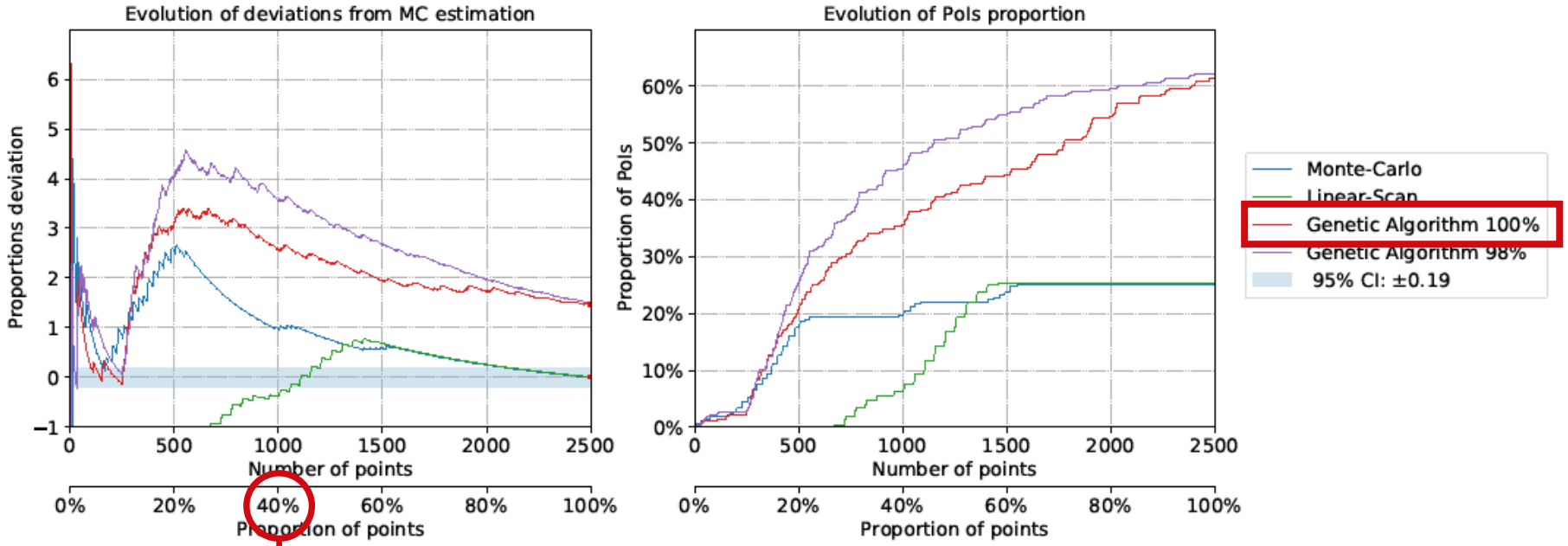

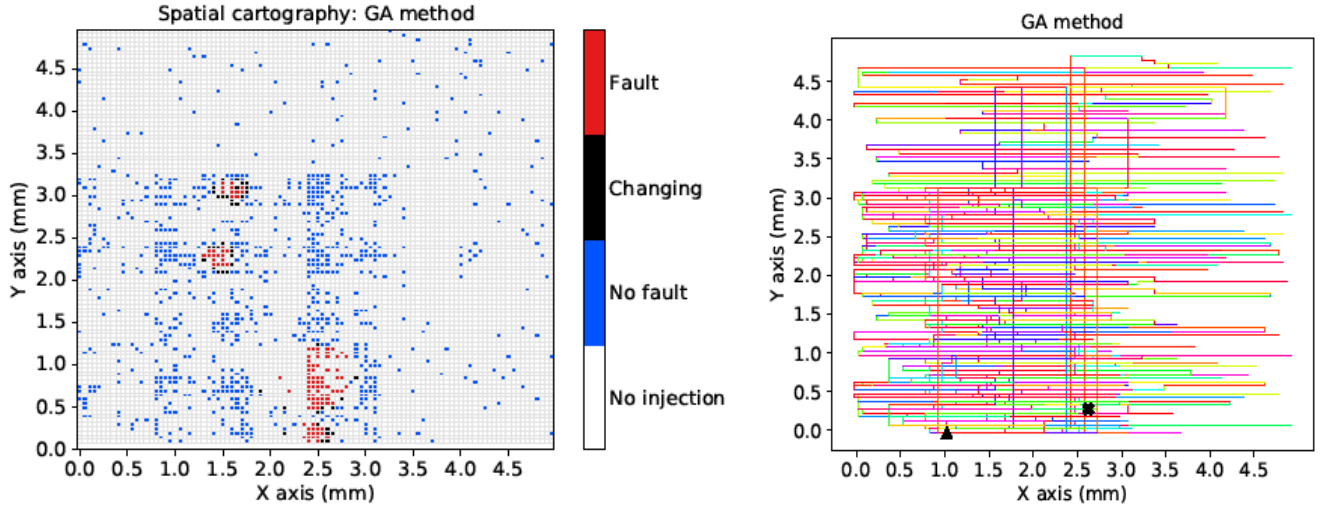

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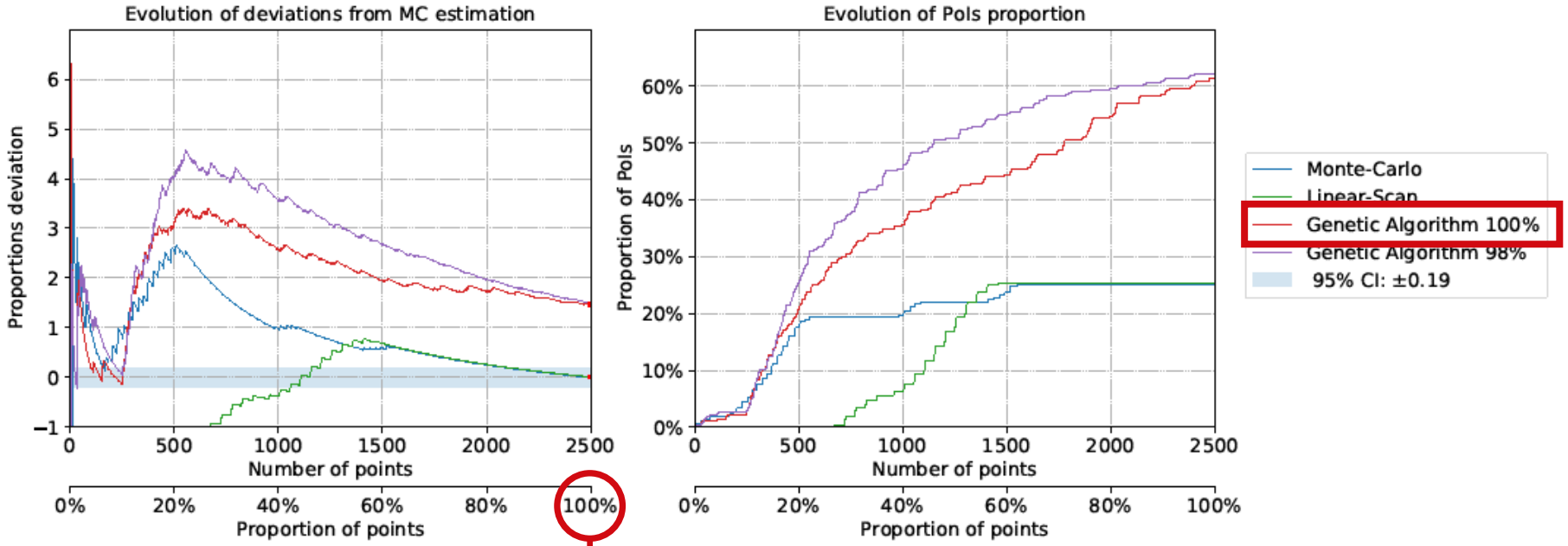

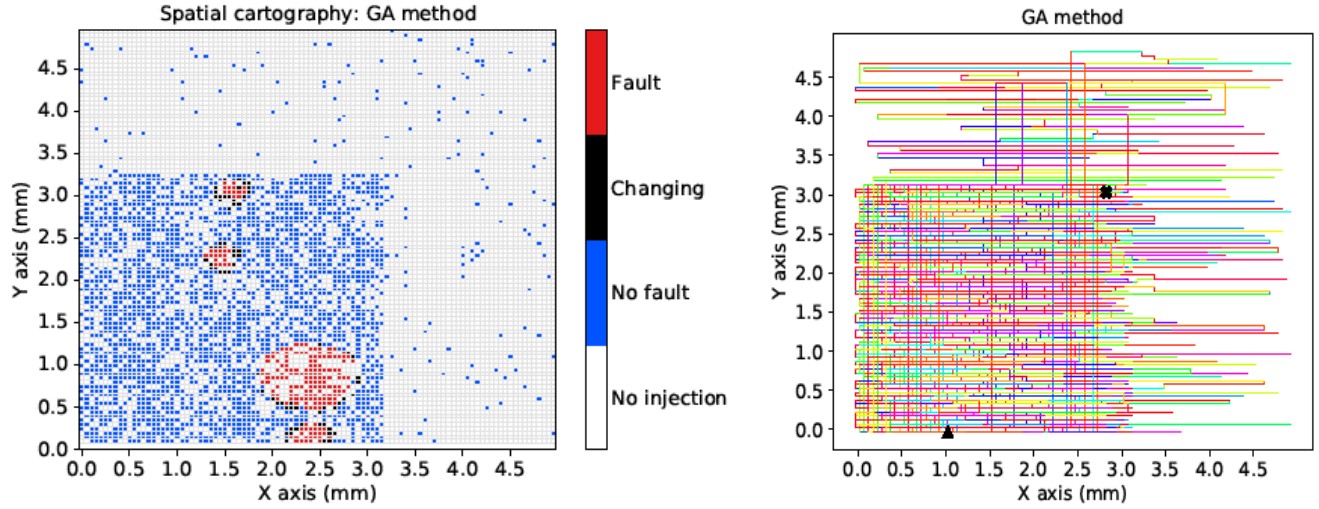

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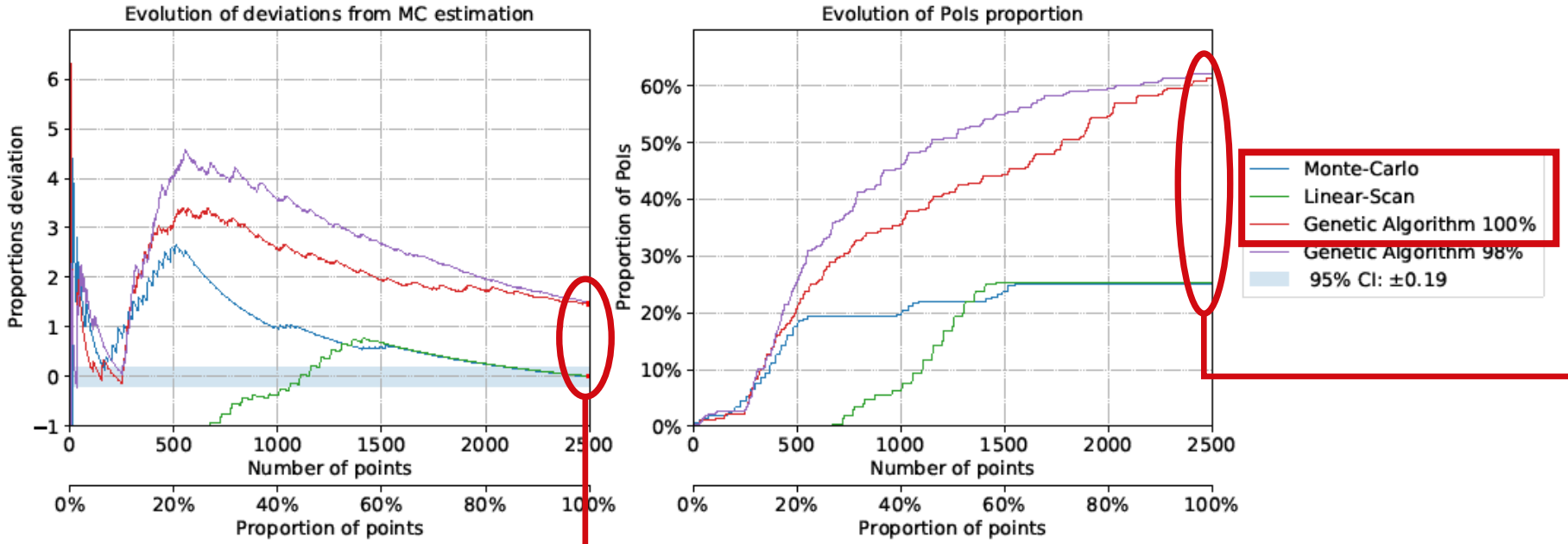

Cartography method	Proportion of PoIs in the sample	Deviation from estimation	Proportion of recovered PoIs
Linear-Scan	4.2%	1.0%	25.2%
Monte-Carlo	4.2%	0% *(reference)*	25.0%
Genetic Algorithm (98%)	10.4%	148.6%	62.1%
Genetic Algorithm (100%)	10.3%	145.7%	61.4%

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CONCLUSION

- We introduced a way to evaluate and compare the efficiency of different cartography methods.
- For spatial cartographies, the use of Genetic Algorithm has a significant benefit to identify Area of Interests and obtain a qualitative sample.
- Outlooks:
  - Comparison with Memetic Algorithms (GA + local search).
  - Adaptation for cartographies in higher dimensions.
  - Study of the impact of the intern functions of the GA (initial generation selection, fitness evaluation, selection, crossover and mutation).

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THANK YOU FOR YOUR ATTENTION

CONTACTS

EMEA	sales-EMEA@secure-IC.com
APAC	sales-APAC@secure-IC.com
CHINA	sales-CHINA@secure-IC.com
JAPAN	sales-JAPAN@secure-IC.com
AMERICAS	sales-US@secure-IC.com

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APPENDIXES: GREAT AOI