

# EMRIC – Electromagnetic robustness of integrated circuits

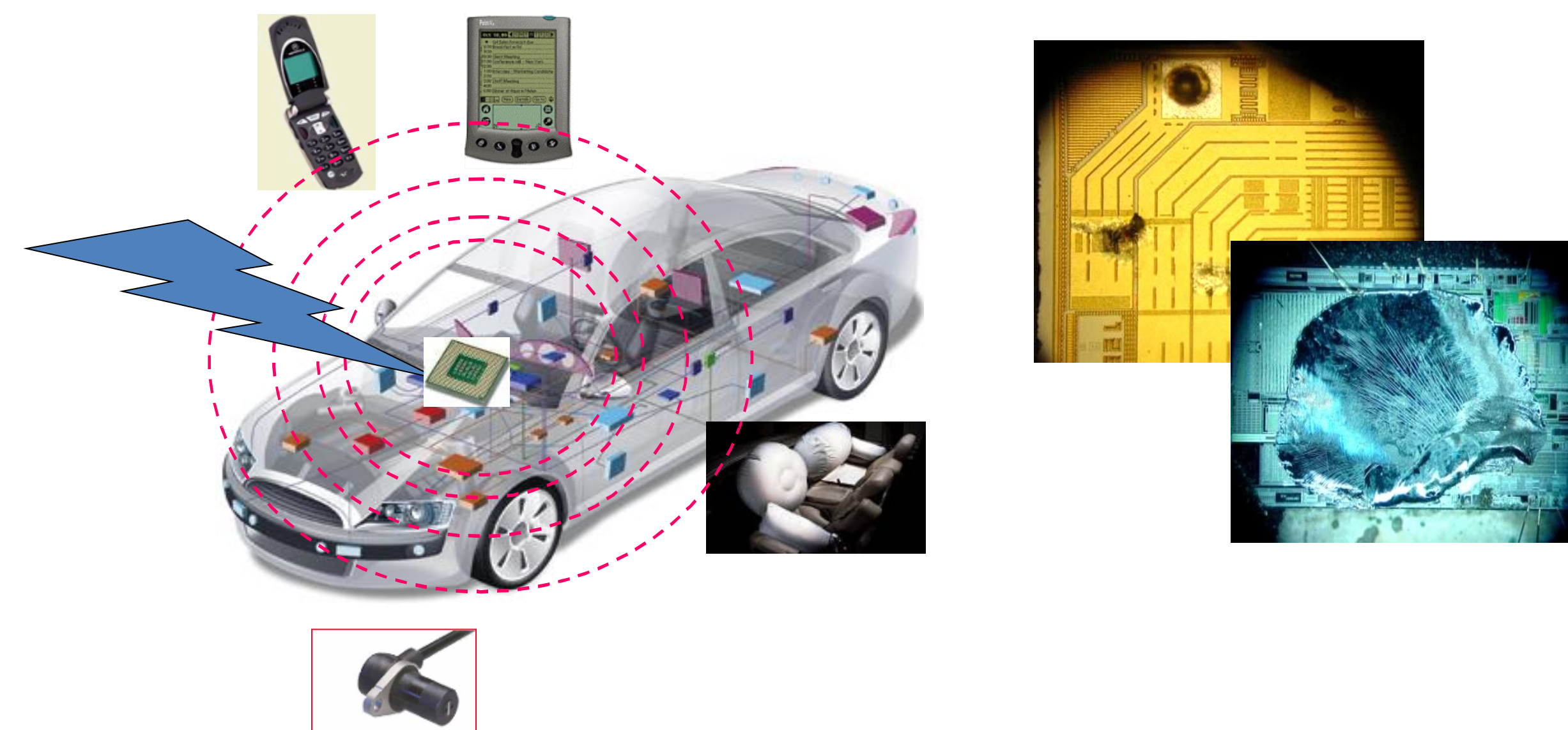
Projet ANR--09-JCJC-0008

Sonia Ben Dhia, Alexandre Boyer - LAAS CNRS - Toulouse



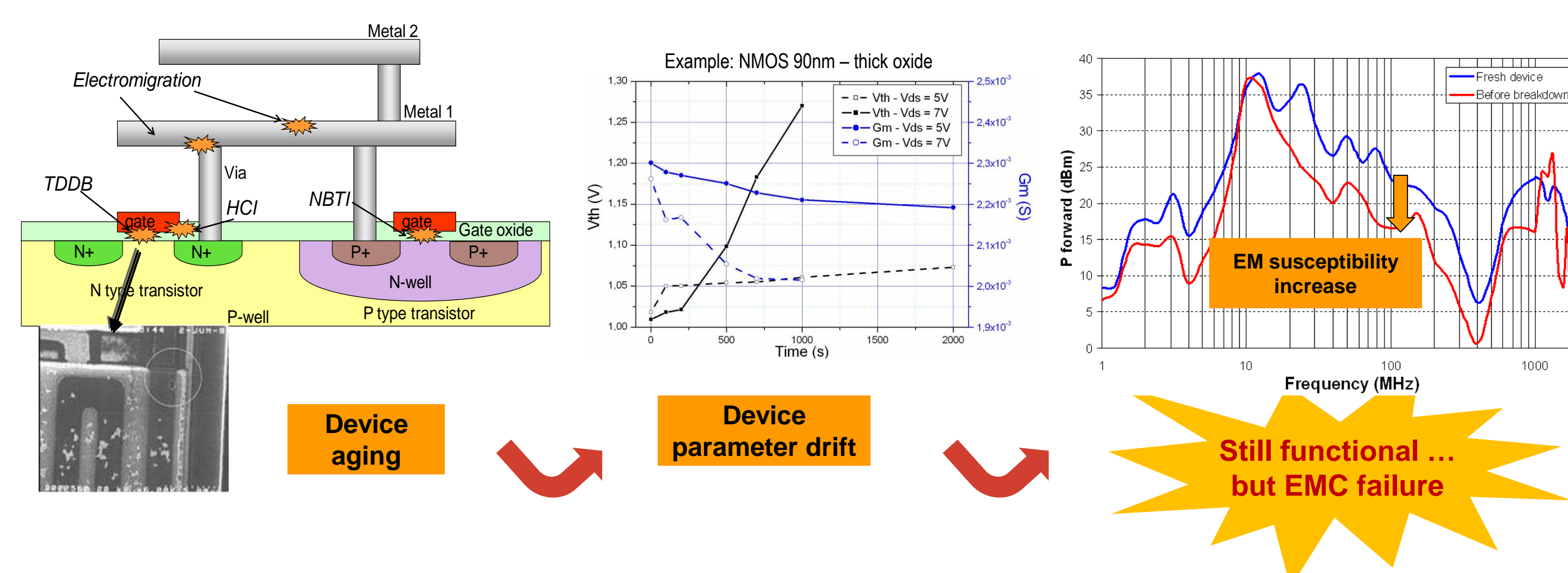
## Context: Electromagnetic Robustness:

- “Electromagnetic Robustness” is a new request from electronic equipment suppliers (for automotive, aerospace and consumer)
- Going further in electromagnetic behavior improvement and at the same time guarantee EMC behavior over the integrated circuit (IC) lifetime.



## Project Objectives

- Prove the aging effects on EMC of ICs (emission and immunity)
- Evaluate the effect of technology and design on long-term EMC
- Understand mechanisms that affect IC emission and susceptibility
- Model IC emission and susceptibility level drift after aging

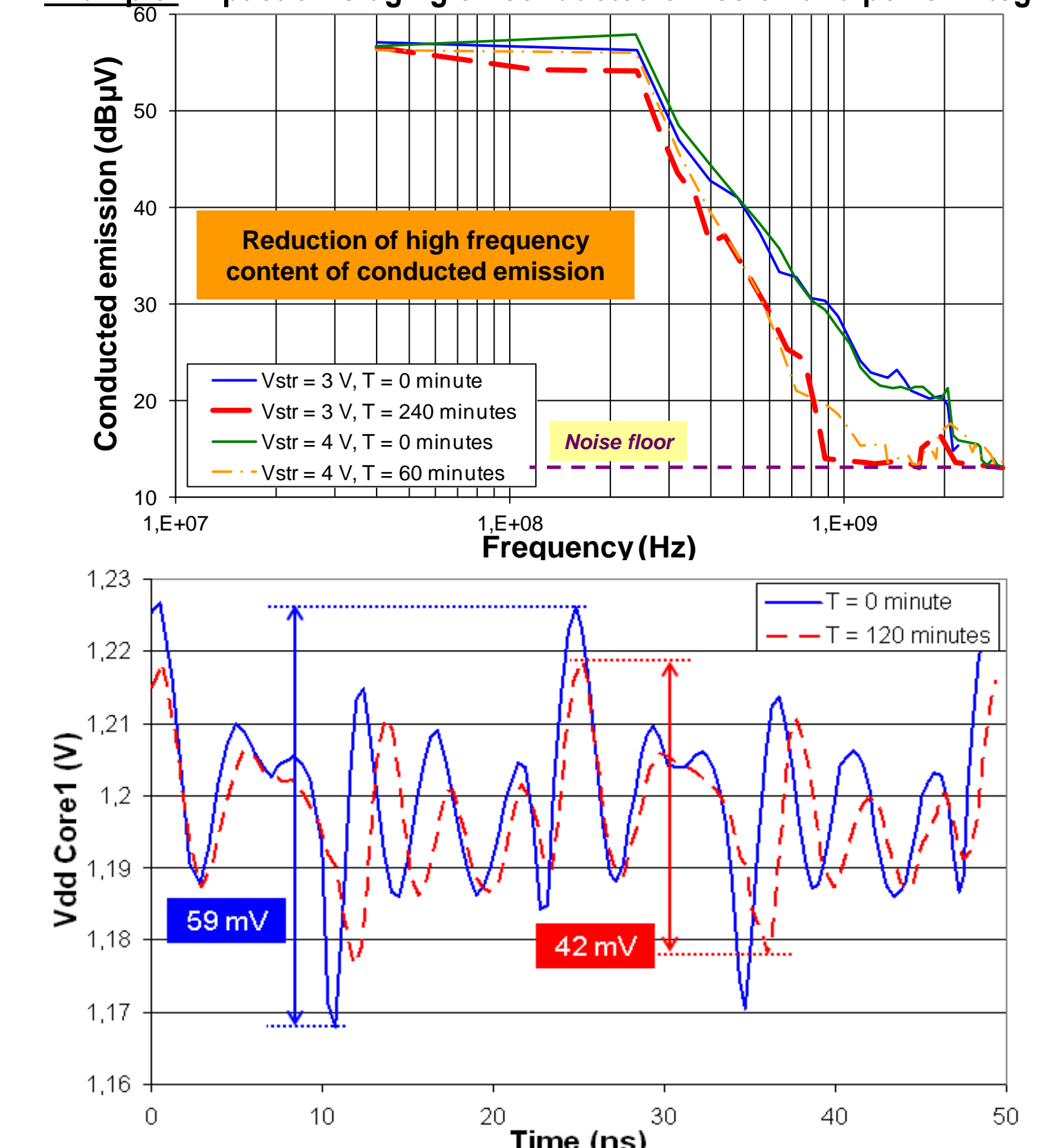


## Project results

### Effect of aging on IC emission

- General reduction of conducted and radiated emission and power integrity issues.
- The reduction of IC emission is linked to a spreading of IC transient current activated by intrinsic degradation mechanisms. The IC power distribution network is not affected.
- Modeling of aging impact on IC emission relies on a modeling of transient current change.
- At system level, the prediction of emission level evolution requires accurate models of IC emission change.
- The measurement of IC emission constitutes a side channel to detect IC aging (possible application for IC traceability, obsolescence management).

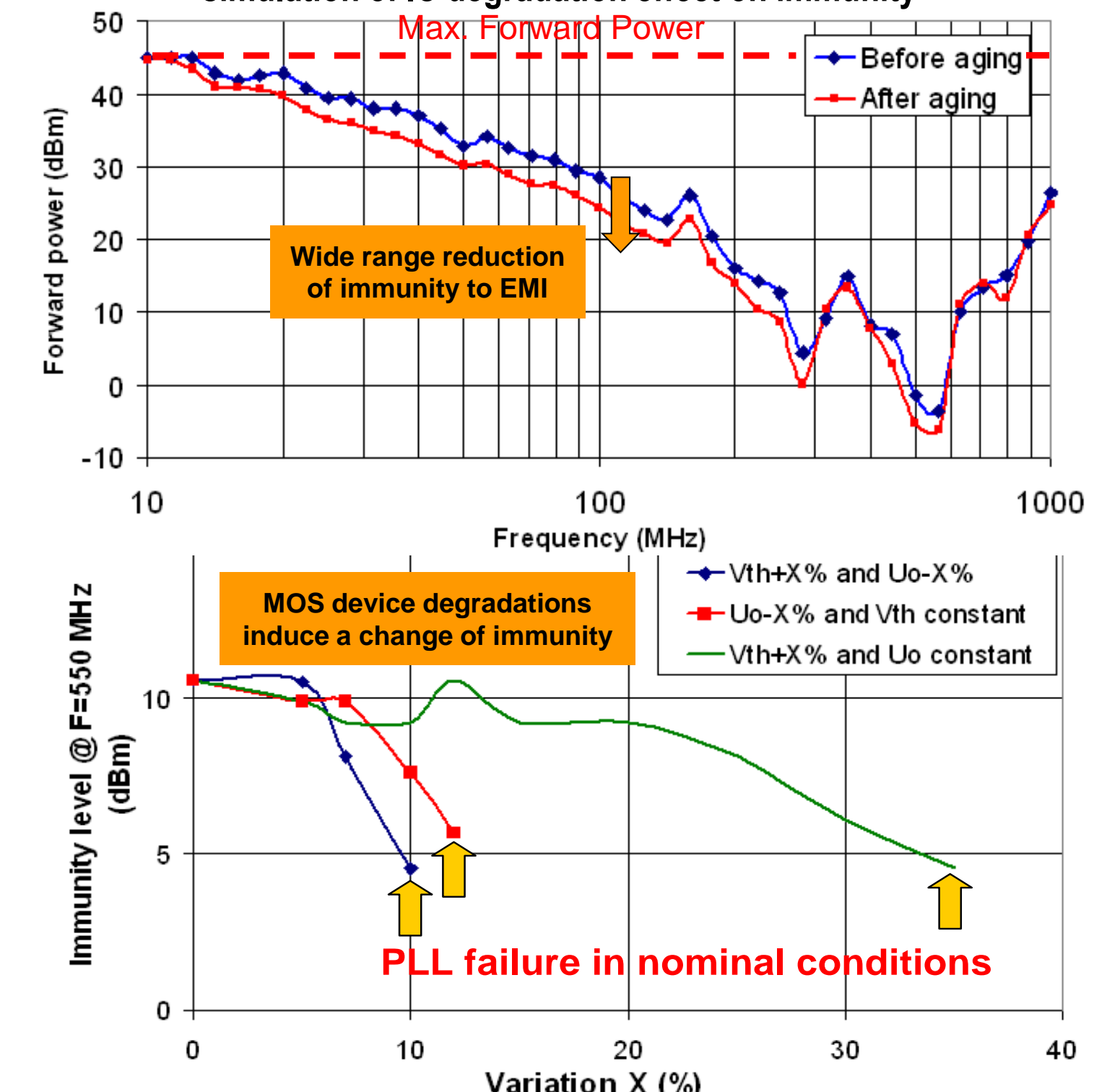
Example: impact of IC aging on conducted emission and power integrity



### Effect of aging on IC Immunity

- IC immunity varies after aging, causing a real problem to guarantee a high safety level of embedded electronic applications (reduction of EMI margin).
- The variation of IC susceptibility is linked to intrinsic degradation mechanisms (e.g. NBTI, HCI) but depends on circuit nature, technology or stress types.
- The modeling is essential to clarify the origin of IC susceptibility change (link between activated degradation mechanisms and sensitivity to electromagnetic interferences).
- The evaluation of risk of non-compliance at long-term for electronic systems requires accurate IC immunity drift model.

Example: impact of IC aging on conducted immunity of a PLL and simulation of IC degradation effect on immunity



## Scientific production

- A. Boyer, A. C. Ndoye, S. Ben Dhia, L. Guillot, B. Vrignon, “Characterization of the Evolution of IC Emissions after Accelerated Aging”, IEEE Transactions on EMC, Vol. 51, N°4, Nov. 2009, pp 892 – 900.
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- B. Li, A. Boyer, S. Ben Dhia, C. Lemoine, “Ageing effect on electromagnetic susceptibility of a phase locked loop”, Microelectronics Reliability, Vol. 50, Issues 9-11, September – Nov. 2010, pp. 1304-1308.
- B. Li, N. Berbel, A. Boyer, S. Ben Dhia, « Study of the impact of hot carrier injection to immunity of MOSFET to electromagnetic interferences », Microelectronics Reliability, Vol. 51, Issues 9-11, pp. 1557-1560,
- A. Boyer, S. Ben Dhia, B. Li, C. Lemoine, B. Vrignon, “Prediction of Long-Term Immunity of a Phase-Locked Loop”, Journal of Electronic Testing: Theory and Applications, Journal of Electrical Testing, 2012.

CONTACT : Sonia Ben Dhia

[Sonia.ben.dhia@laas.fr](mailto:Sonia.ben.dhia@laas.fr)

LAAS – CNRS - Toulouse

