



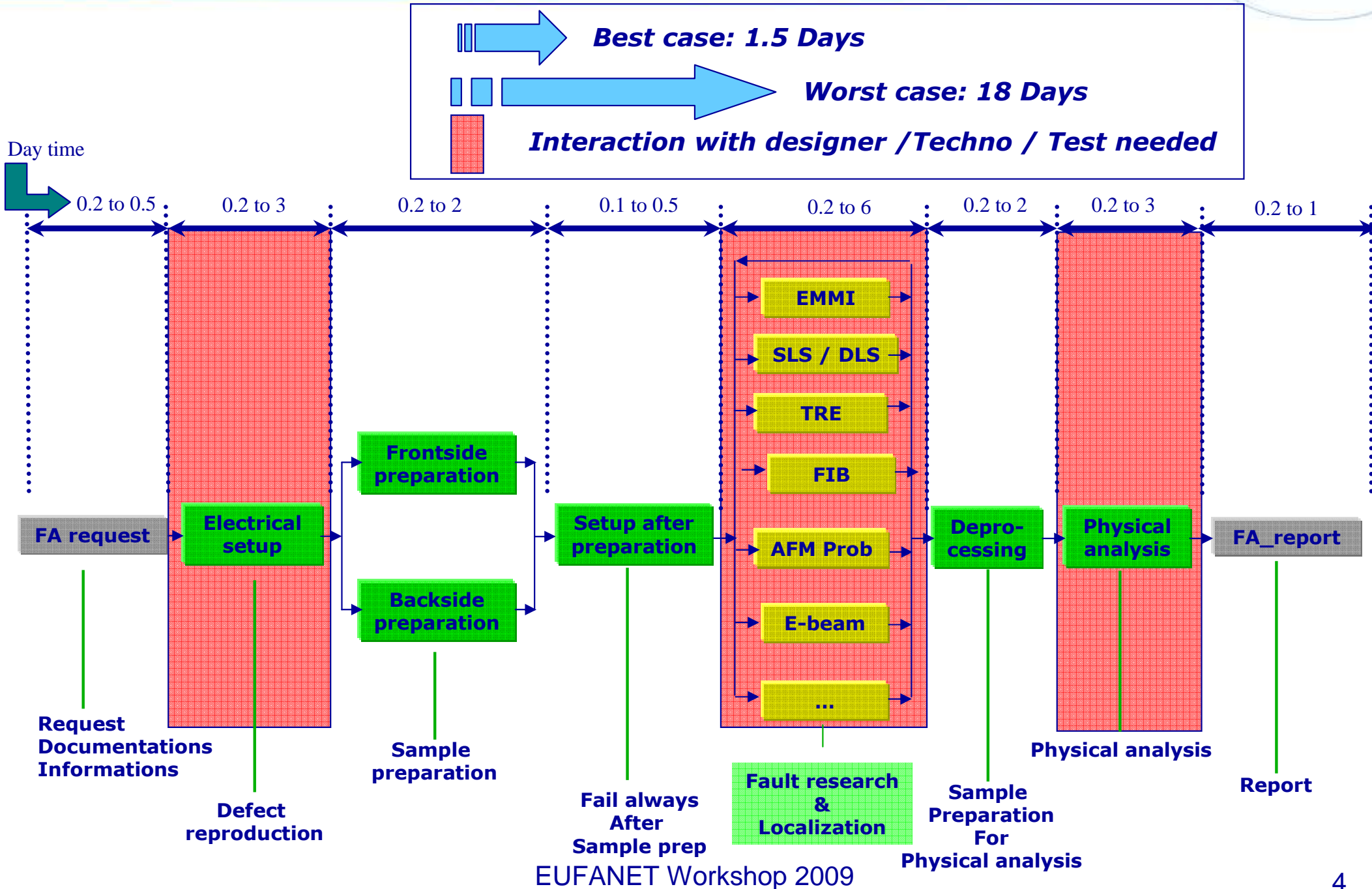
Cession 6 - Multiple FA techniques on advanced technologies

Sylvain DUDIT

- **Typical EFA flow**
- **Application on case of analysis**
- **Focus to put in place for a complex case of analysis**
 - **Optical techniques for fault research and localization**
 - **The FIB and AFM-P during the analysis**
 - **Knowledge for a failure analyst**

- **Typical EFA flow**
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Typical EFA flow



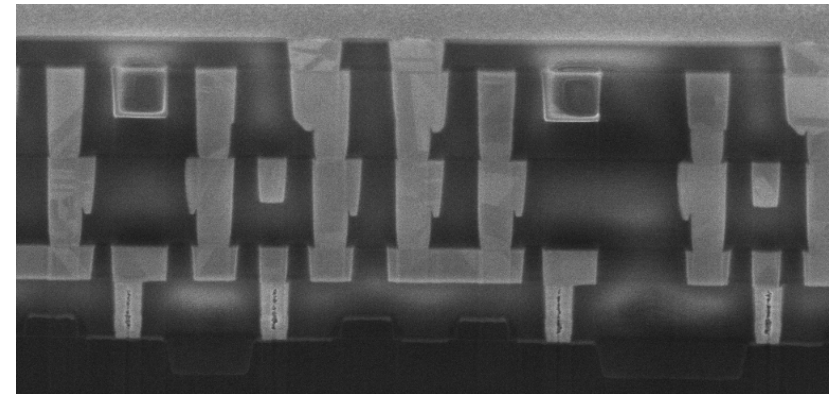
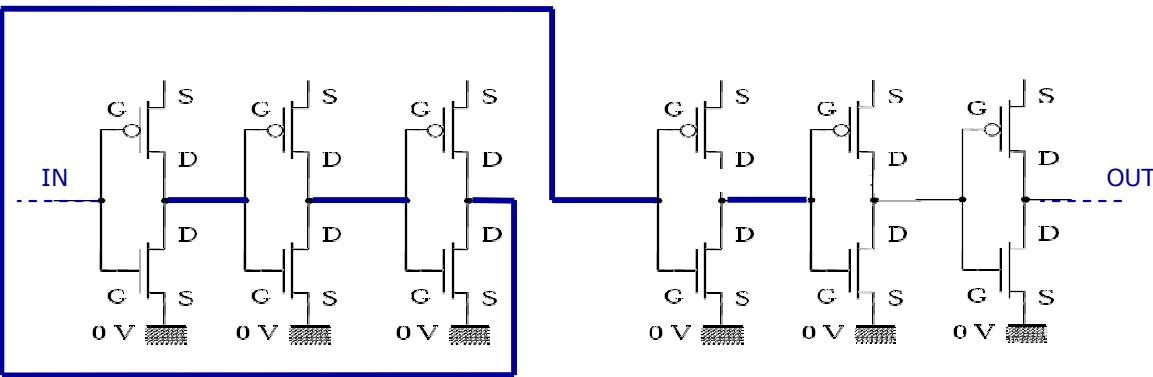
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Case of analysis (1/5)



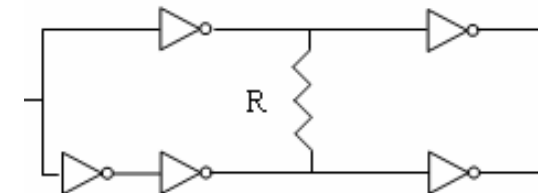
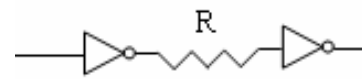
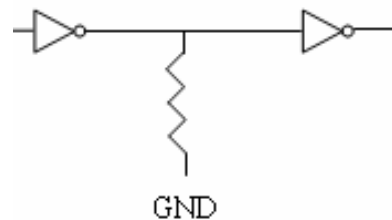
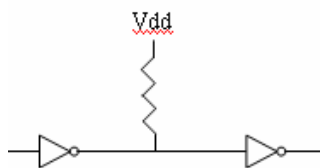
- Analysis

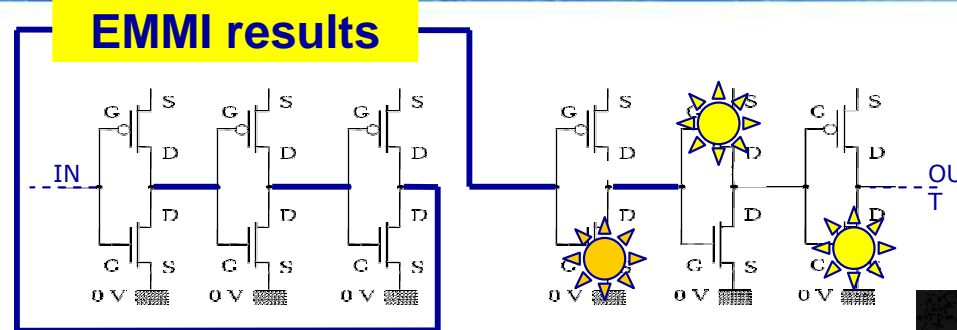
- Test chip analog and digital on 65nm technology
- Fail on specific structure to track the problem @ metallization level
- Output stuck @ - no evident over consumption observed



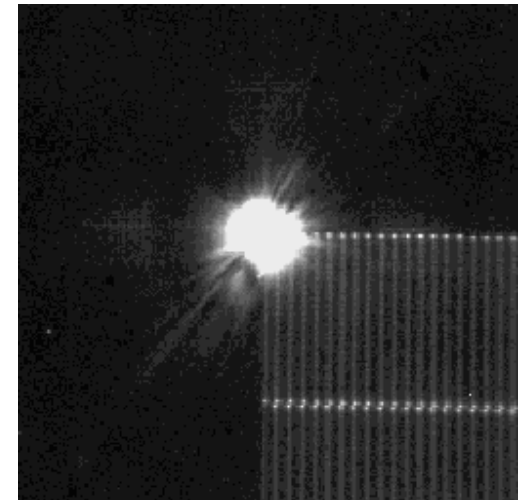
- For a failure analysis point of view

- Case with no over consumption : Open, bridge, serial defects
- Case with over consumption : short to GND, short to VDD,

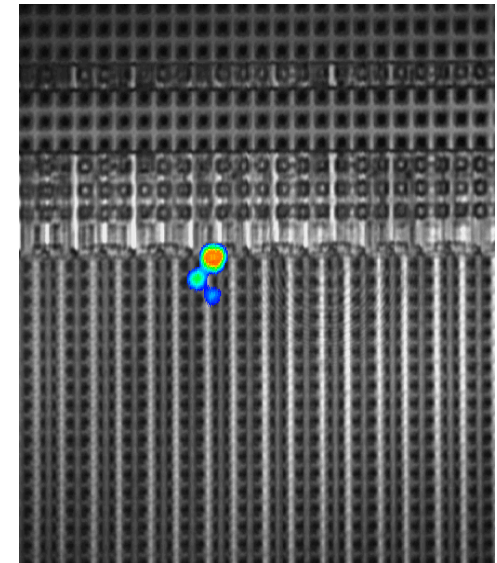


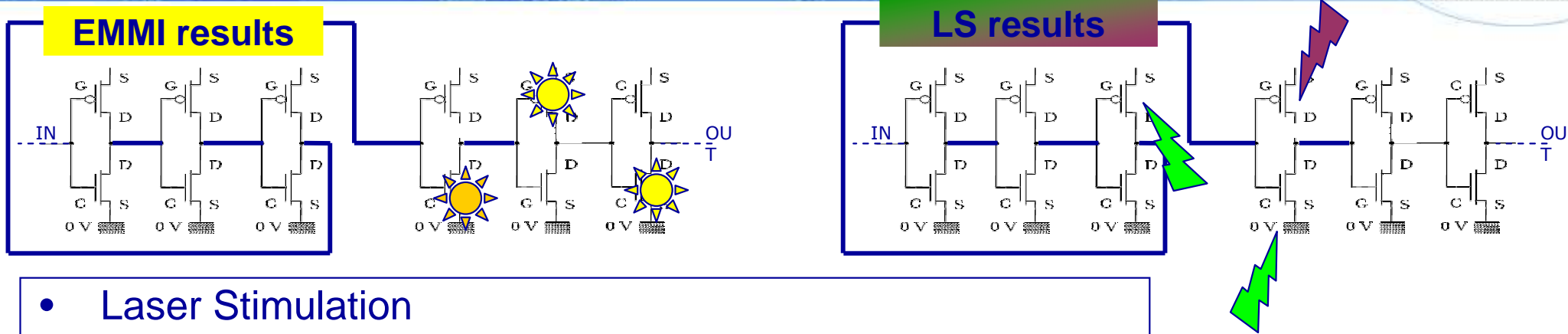


- **Dynamic EMMI :**
 - Transistor commutations
 - High EMMI spot (drawbacks for the low emitter)
 - No functionality after high EMMI spot
 - 3 IV impacted by the failure ?



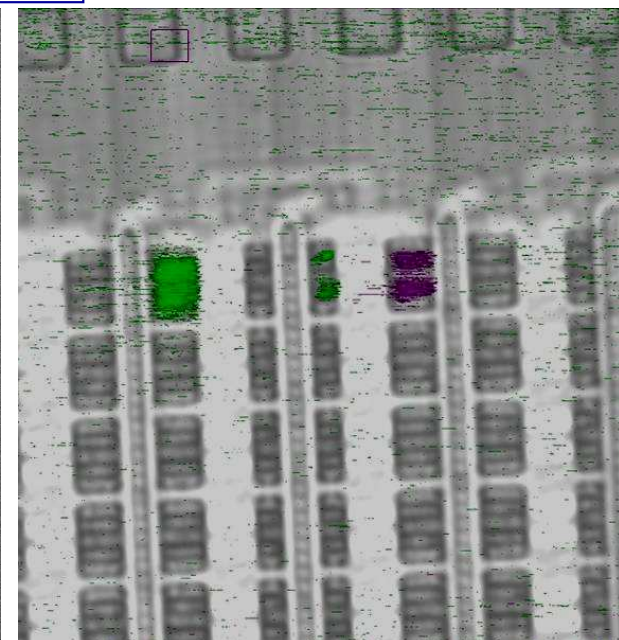
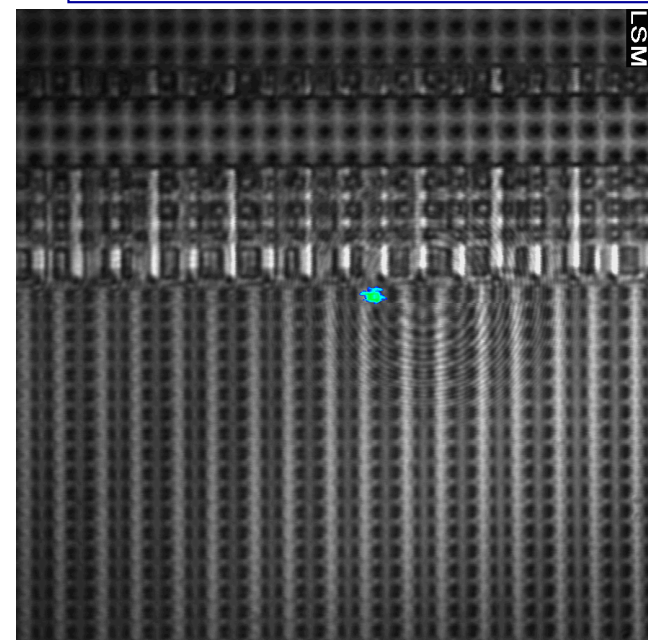
- **Next :**
 - Laser stimulation
 - Goal : best fail understanding





- **Laser Stimulation**

- SIL220X benefits versus a 100X lenses
 - Sensitivity, spatial resolution
 - Best fail understanding
 - 2 IV impacted by the failure ? (1 in accordance with EMMI result)

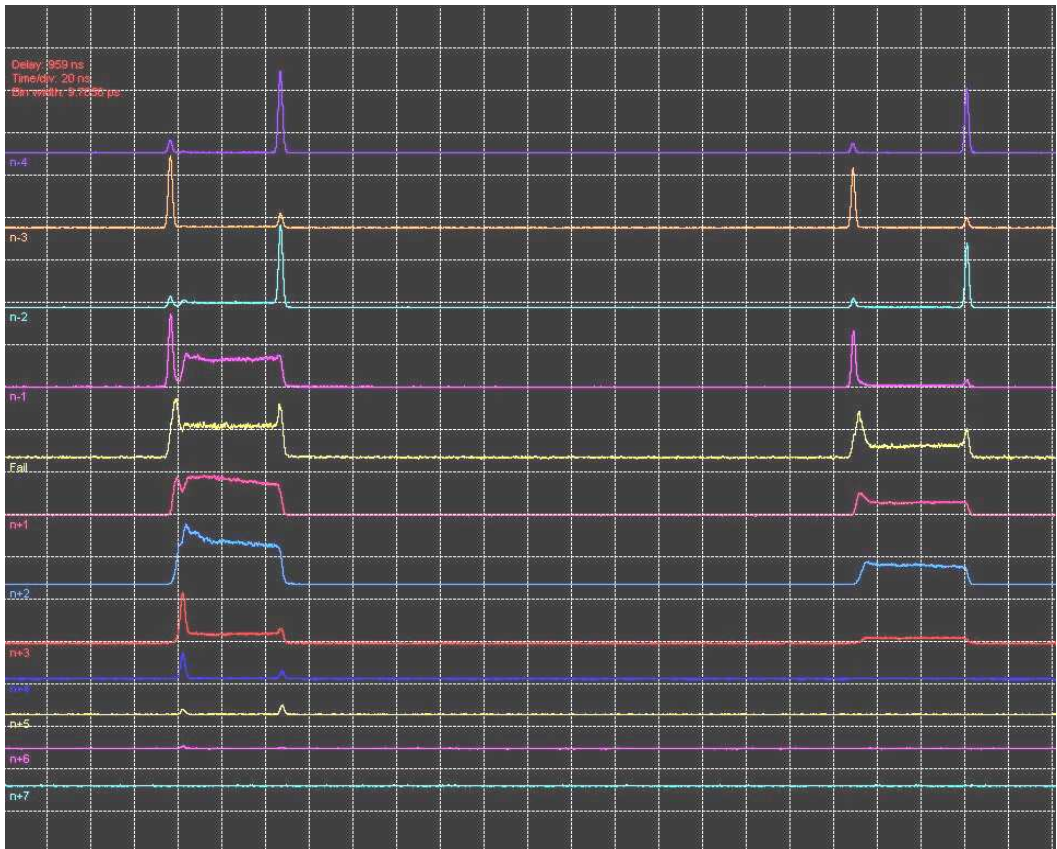
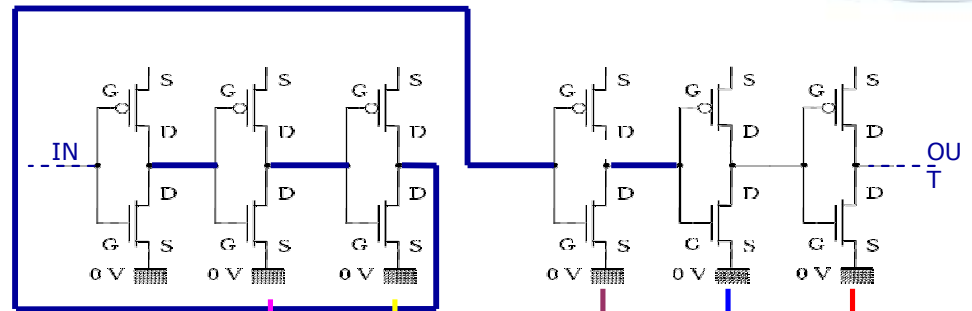


Case of analysis (4/5)



LS results

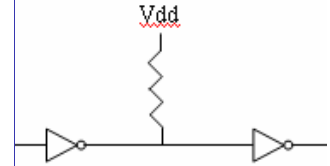
EMMI results



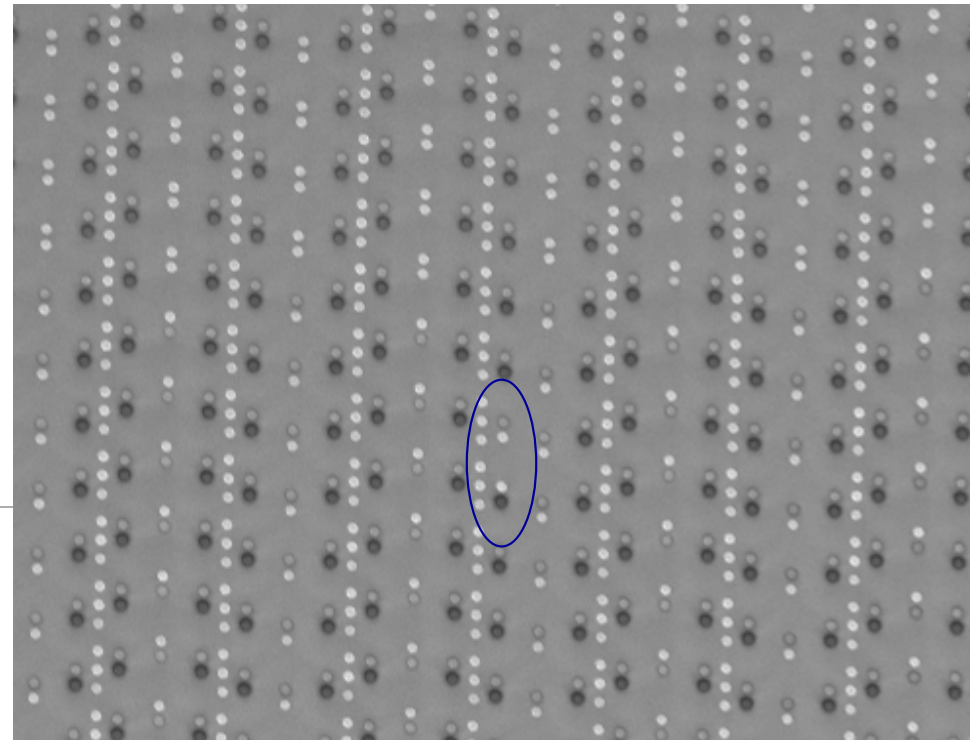
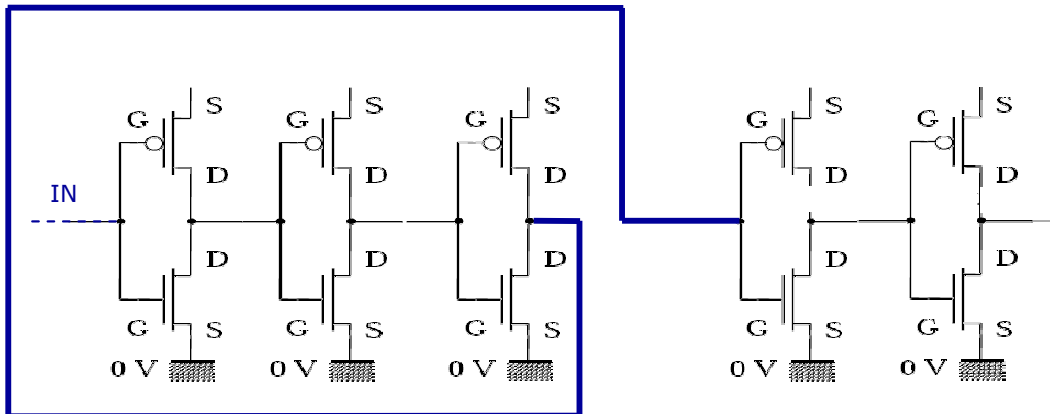
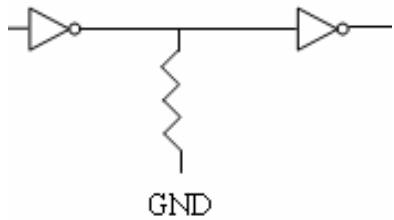
- TRE results
 - Not in total accordance with LS and EMMI
 - 5 IV impacted by the failure ?

- Conclusion about fail hypothesis :

- Short @ VDD or GND on a very long path
- 3 FA techniques of localization with results but without fine localization
- DLS technique : Fail (pseudo static fail)



!!! Charge contrast technique use to have the good localization !!!



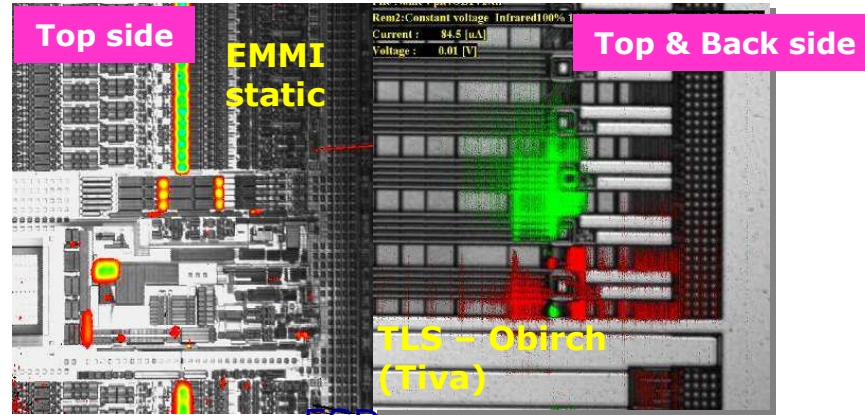
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Fault research & Localization

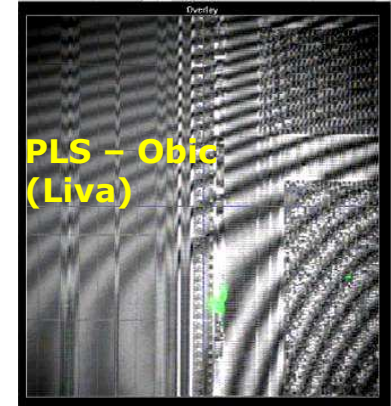


EMMI + SLS

Static



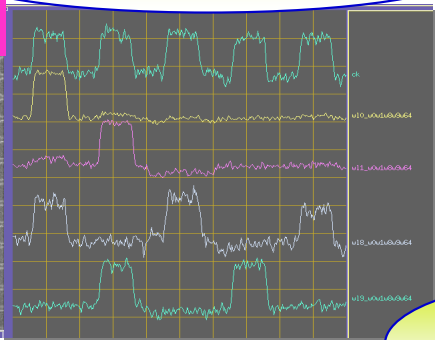
- ESD
- Hot carriers
- Latch-up



- Floating node
- Non bias junction
- Resistive path

EBT-Ebeam Tester

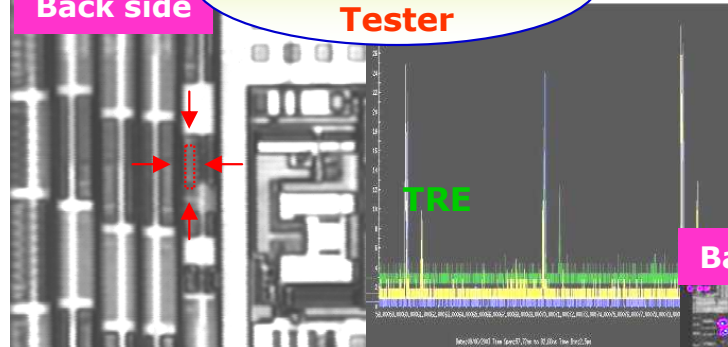
Top & Back side



Measurement :
 - Delay
 - Rise/fall time
 @ebeam probe point

Timing analysis Tester

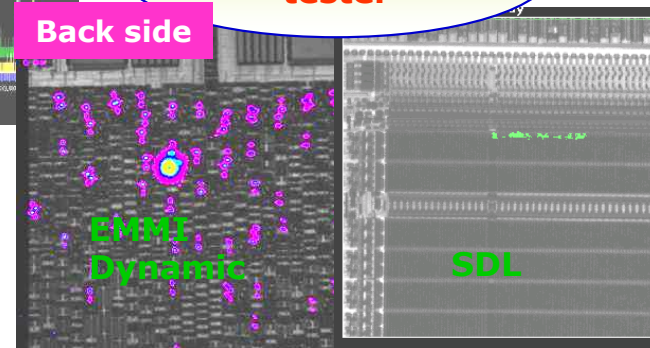
Back side



Measurement :
 - Delay
 @transistor level

EMMI + Laser tester

Back side



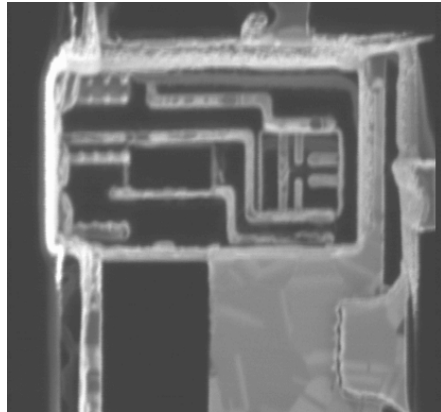
Dynamic fault tracking:
 - cross talk
 - Latch-up

Dynamic

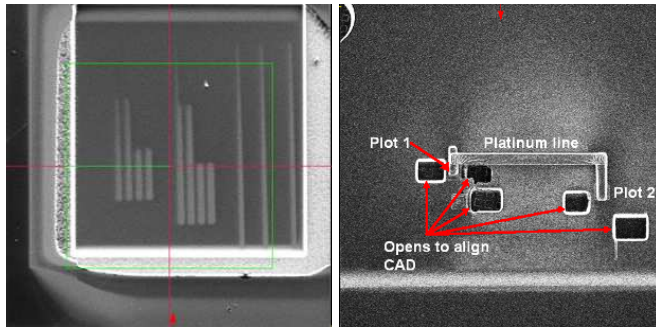
Fault research & Localization



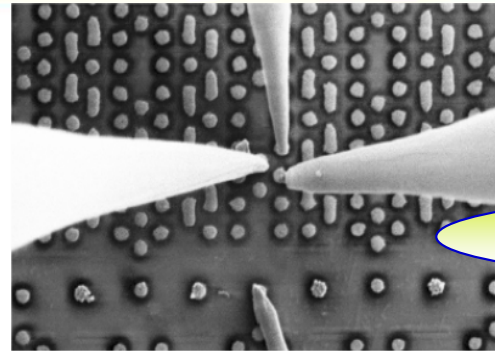
FIB



Front side modification



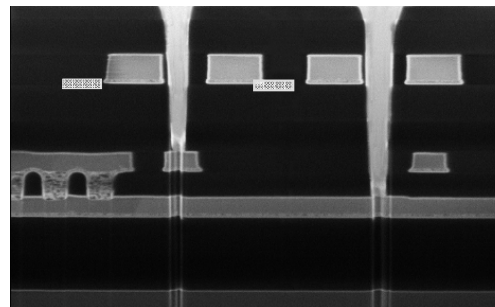
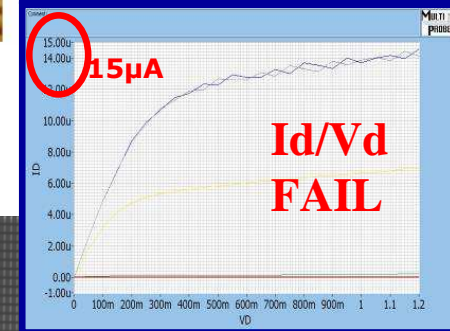
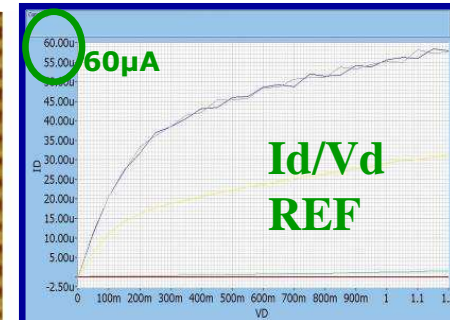
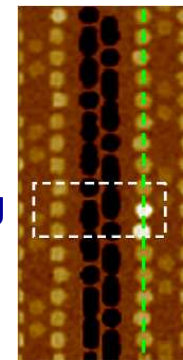
Backside modification



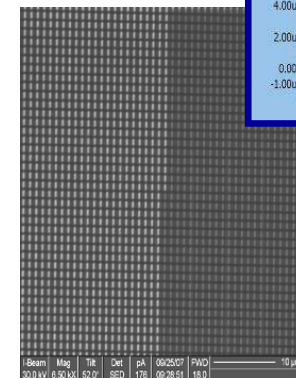
AFM Probing

Electrical characterization by "in situ" contact

Current leakage mapping



Ebeam Probe Pad Generation



Charge contrast

Static

Knowledge needed :

- *Sample Preparation (// polishing, chemical, micro drill ...)*
- *Electrical setup (Power supplies , DC)*
- *CAD navigation setup – Layout view*
- *Optic Tester (EMMI+SLS)*
(collaboration with the designers)
- *Mechanical deprocessing*
- *Chemical deprocessing*
- *SEM Imaging*
- *Fib editing (F / B) and X-sectioning*

Dynamic

Knowledge needed :

- *Sample Preparation (// polishing, chemical, micro drill ...)*
- *Electrical setup (Power supplies , DC)*
- *Electrical setup AC :*
 - *Pattern conversion & Optimization*
- *CAD navigation setup*
 - *Layout view*
 - *Netlist view*
 - *Schematic view*
- *Optic Tester 5 (EMMI+ SLS + TRE + DLS)*
- *E-beam*
- *Comparison with simulation results*
(close collaboration with the designers)
- *AFM probing*
- *Mechanical deprocessing*
- *Chemical deprocessing*
- *SEM Imaging*
- *Fib editing (F / B) and X-sectioning*