DARE180X

A 0.18UM MIXED-SIGNAL RADIATION-HARDENED LIBRARY FOR LOW-POWER APPLICATIONS

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OUTLINE

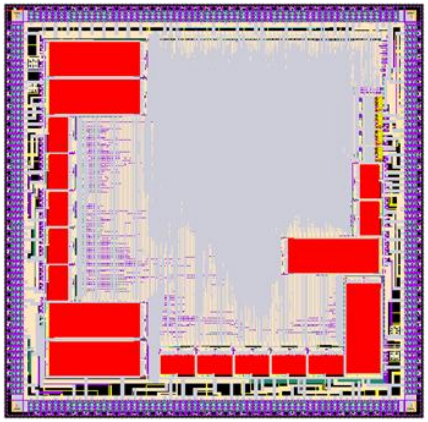
- Background
- The DARE solution
- **M**icro**E**lectronics **P**latform
- DARE180X libraries
- DARE180 vs. DARE180X
- Summary
- Future work

BACKGROUND

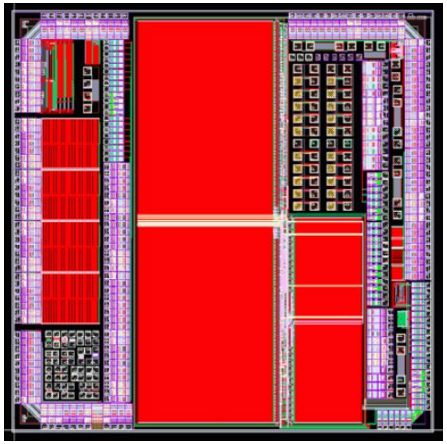
- Commercial IC technologies for radiation applications
  - Low cost / high yield
  - High speed
  - Low power
  - Thin-gate oxide => high TID tolerance

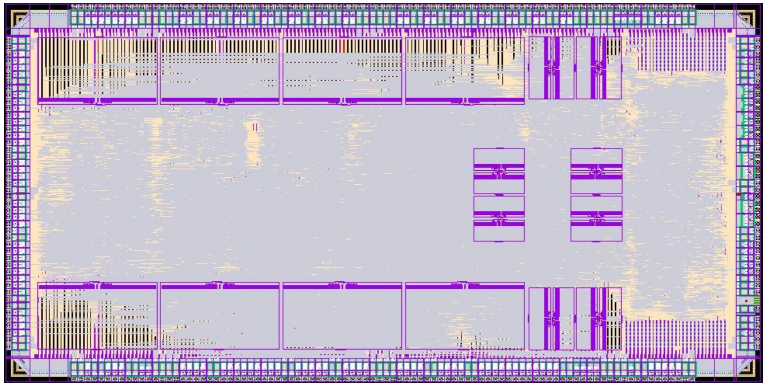
- Commercial libraries
  - Standard design flow
  - Designed for highest density
    - Highly sensitive to SEL & SEE
  - Solution tailored for radiation applications is needed

THE DARE SOLUTION



- **D**esign **A**gainst **R**adiation **E**ffects
  - DARE180 in UMC 0.18µm technology
    - Silicon-proven radiation-hardened library
    - General radiation applications (> 1Mrad)
      - ELT devices => high power consumption
    - No non-volatile memory
    - No high-voltage (BCD) devices



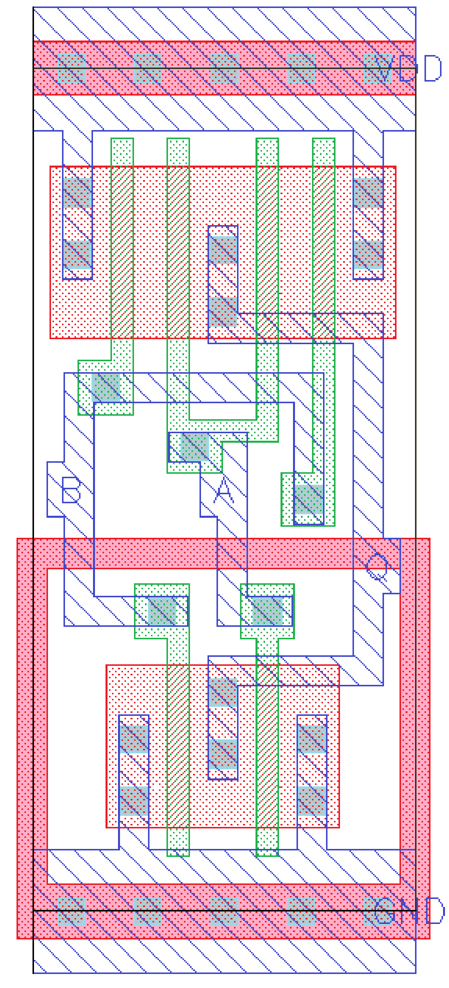


MICROELECTRONICS PLATFORM

- Libraries, back-end, manufacturing and test services for radiation applications
- DARE180X
  - New radiation-hardened mixed-signal library package
    - Low-power solution for space applications
  - XFAB 0.18µm (XH018)
    - Inherent TID tolerance >100 krad
    - Triple-well devices
    - High-Vt and low-Vt transistors
    - **High-voltage BCD devices**
    - **Non-volatile memory**
    - **European foundry**

MICROELECTRONICS PLATFORM

- Radiation-hardening by design
  - TID tolerance > 100 krad
    - No ELT needed
  - SEL hardening > 70 MeV.cm^2/mg
    - Guard-rings
  - SEU/SET hardening > 60 MeV.cm^2/mg
    - Redundant architectures (DICE)
    - Hardening-by-drive-strength



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ICsense THE IC DESIGN COMPANY

imec

DARE180X LIBRARIES

- CORE standard cell library
  - Standard combinational cells (variable LETth)
  - SET-hardened combinational cells (LETth > 60 $MeV.cm^2/mg$)
    - Clock and set/reset trees
    - Hardening-by-drive-strength
  - SEU-hardened sequential cells (LETth > 60 $MeV.cm^2/mg$)
    - DICE architecture
  - P&R cells

- Two compatible implementations
  - Low-power core library (DARE180X)
  - High-speed core library (DARE180XL)

DARE180X LIBRARIES

- I/O library
  - 3.3V and 5V-tolerant digital I/Os
    - SET-hardened inputs
  - 3.3V and high-voltage analog I/Os

- SRAM blocks
  - 5 dual-port SRAM
  - MBU insensitive
    - SEU immune when used with an EDAC

DARE180X LIBRARIES

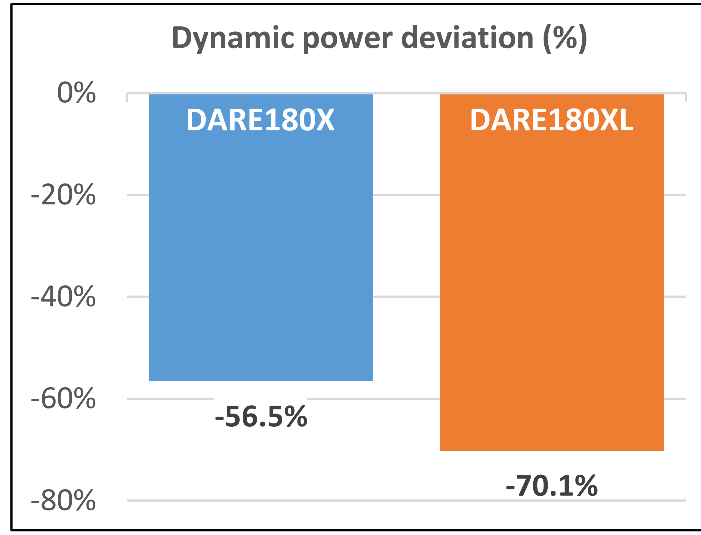
- SET-hardened analog blocks
  - PLLs
  - Bandgaps
  - Oscillators
  - ADC/DAC
  - Linear regulators
  - Other analog auxiliary blocks (comparators, PGAs, ...)

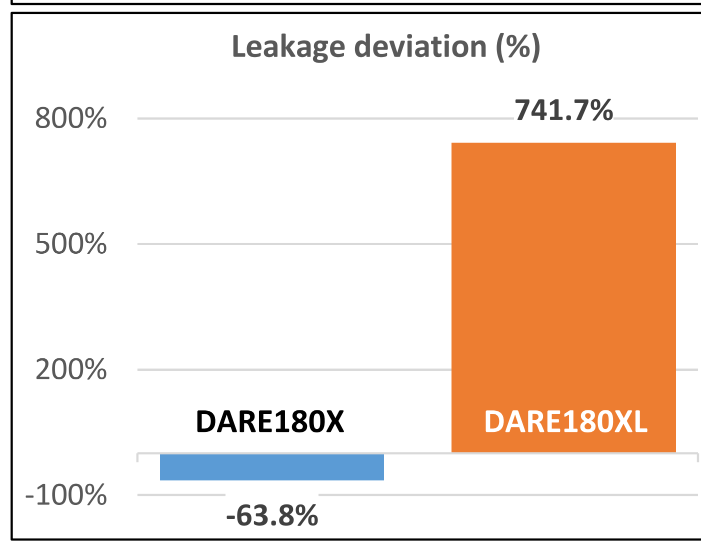
DARE180 VS. DARE180X

	DARE180	DARE180X
Technology	UMC 0.18µm	XFAB 0.18µm (HV)
Supply range	1.8V/3.3V ±10%	1.8V/3.3V ±10%
Temperature range	-55°C ~ 125°C	-55°C ~ 125°C
TID tolerance	**> 1 Mrad**	**> 100 krad**
Raw gate density	**25 kGates/mm^2**	**59 kGates/mm^2**
Core cells	130	86
I/O cells	83	48
SRAM	Single/dual-port SRAM compiler	5 dual-port blocks

DARE180 VS. DARE180X

- Synthesis comparison
  - Real design case
  - Reference: DARE180
- Dynamic power
  - Switching power optimized
    - Smaller input capacitances
  - Internal power reduced
    - DICE flip-flops
- Leakage power
  - DICE flip-flops consume less
  - Device dependent

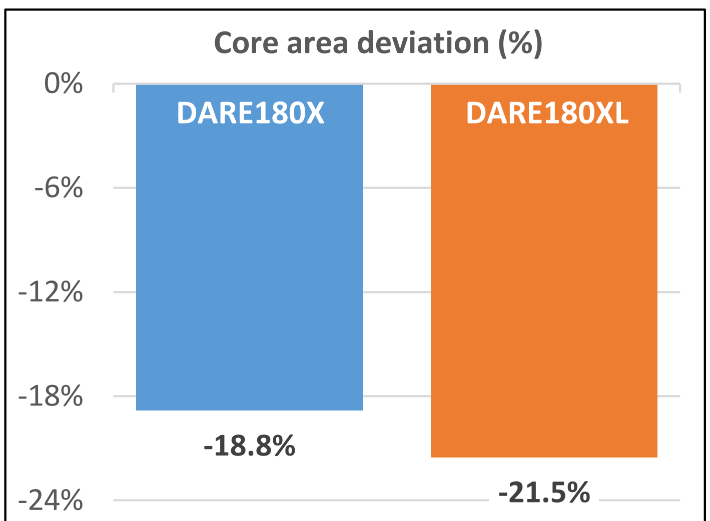


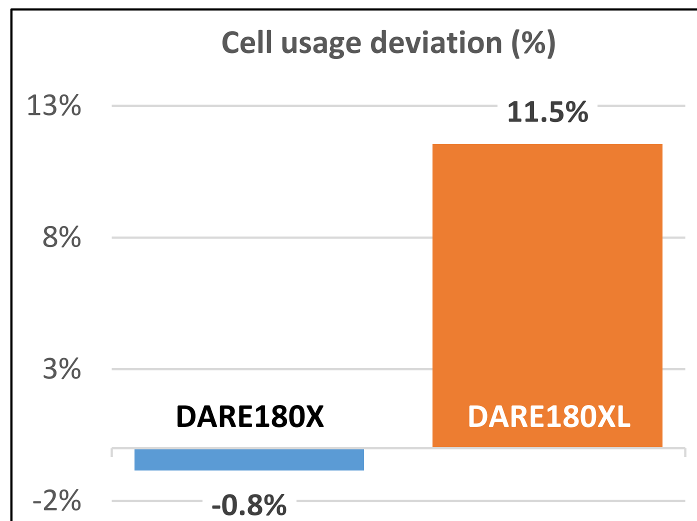


DARE180 VS. DARE180X

- Synthesis comparison
  - Real design case
  - Reference: DARE180

- Area reduction
  - Smaller cell footprint





DARE180 VS. DARE180X

	DARE180 (reference)	DARE180X	DARE180XL
Cell	NAND2	NA2JIX4	NA2JILVTX4
Rel. drive-strength	**X1**	**X4**	**X4**
LET threshold (SET)	35 MeV/cm^2.mg	-50%	0%
Sat. cross-section	3.45 cm^2	**-75%**	**-62%**
Area	39.5 µm^2	**-25%**	**-25%**
Rise FO4 delay	90 ps	+55%	**-10%**
Fall FO4 delay	66 ps	+43%	**-8%**
Avg. input cap.	15 fF	**0%**	**-7%**

- NAND2 = smallest/weakest NAND cell in DARE180
  - 4x stronger than NA2JI**X1** (the weakest NAND cell in DARE180X)

SUMMARY

- **M**icro**E**lectronics **P**latform
  - Radiation-hardened mixed-signal libraries and IP
  - Back-end, manufacturing and test services
  - Commercial IC technologies

- New DARE180X library
  - Low-power solution for space applications
  - Straight transistors (no ELTs)
    - Smaller area
    - Cell sizing not lower-bound limited
      - Better synthesis results => dynamic power optimized

FUTURE WORK

- DARE180X available in 2014' Q3
- Test vehicle chip in 2014' Q4
- Radiation tests in 2015

QUESTIONS?

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