ST Technologies Snapshot for Analog & Mixed

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STMicroelectronics

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- BCD6s/BCD6s SOI
- BICMOS9MW
- HCMOS9A
- C065 Space
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- Perspectives

Main technologies/applications

Technologie	Specificities	Applications
BCD	High voltage High current driving	Actuators driving Power stage driving …/…
BiCMOS SiGe	High Ft/Fmax Low RF losses	Gsps ADCs >10 Gbit/s links Multi GHz RF …/…
CMOS 0.25-0.13um	Analog features	AFEs + Dig Proc, ROICs …/…
DSM 65-22nm	High Digital density Mixed capabilities	Telecom ASICs FPGAs Processors …/…

BCD6s General Features

	BCD6s	BCD6s SOI
Manufacturing Plant	Agrate	**Agrate**
Wafer Size	8”	**8”**
Technology node	Bipolar + CMOS + DMOS 0.32 µm	**Bipolar + CMOS + DMOS** **0.32 µm**
Qualification Date	2008	**2009**
Automotive Qual.	Yes	
Perenity	Over 10 years	**Same**
Core Supply	3.3 Volt (MOS) 5/20 Volt (NLDMOS) 5 Volt (NPN) 20 Volt (LPNP) 100 Volt (MOM)	**Same**
Digital Density	**15 kgate/mm2**	**Same**
Substrate		**30 to 50 Ohm.cm**
Mask (Baseline)	20 (incl. 3 Metals) Several options	**23 Masks (Incl. 3 Metals)** **8 Options**
MPW / MLR	Yes / No	**Yes / No**

BCD6 Design Environment

	BCD6s	BCD6s SOI
OS	Linux Solaris	Same
Design Platform	Cadence (Composer & Virtuoso)	Same
Transistor models	Spice	Same
DRC – LVS	Calibre	Same
Parasitic extraction	Synopsys Star RCXT	Same

BCD6s Radiation Hardening
Status

- Several Components Tested
  - 10-30 rad/s and 0.05 rad/s
- Intrinsic Latch Up Robustness
- Design new Rad-Hard Cells with Higher TID Targets
  - Bipolar Transistors (NPN and VPNP)
  - NMOS and NLDMOS without Leakage
- Design of Digital Rad-Hard Library in ST Crolles
  - Using 65 nm DSM Rad-Hard Library Tools and Know How
- Dedicated Test Vehicle In Fab
  - Design & Methodology Validation
  - First Results : 4Q12

BCD6s Radiation Hardness
Evaluated Components

	BCD6s
CMOS Devices	3.3 V CMOS (Thin Gate Oxide)
DMOS Devices	20 Volt nlDMOS (Thin Gate Oxide) 30 Volt nlDMOS (Thin Gate Oxide) 45 Volt nlDMOS (Thin Gate Oxide) 90/100 Volt (Thin Gate Oxide)
PMOS Devices (drift & dext)	30 Volt pMOS Drift (Thin Gate Oxide) 100 Volt pMOS Dext (Thin Gate Oxide)
Bipolars	5 Volt NPN 20 Volt LPNP

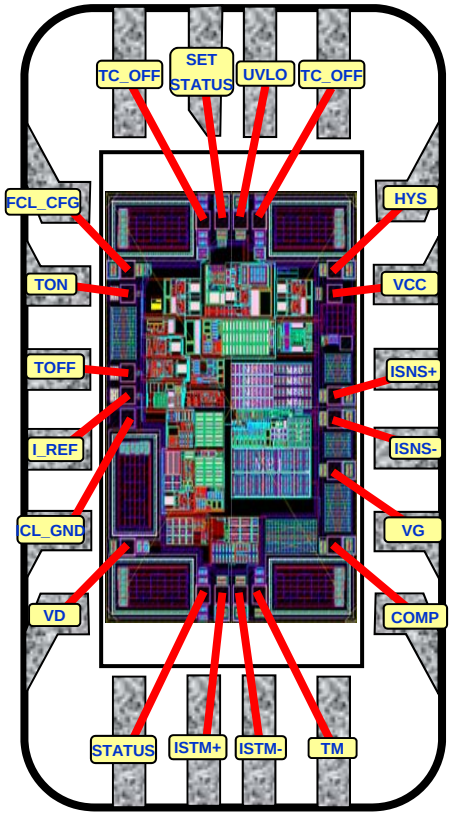
BCD6s SOI Radiation Hardnening
Status 2/2

- BCD6s SOI :
  - Expectations : Better SEE – Lower TID
    - Intrinsic SEL Hardness : BOX + Lateral Trench Isolations
    - Correlation Trials In Progress : First Results 1Q13
- BCD8 0.25 µm Also Assessed
  - BCD6s SOI is a Better Tradeoff for Space
    - PROS : Radiation Hardness - Power capability
    - CONS : Digital Integration
- Next Steps :
  - Product Level TID and SEE Tests (First results : 4Q12)
  - Characterization of Elementary Components (MOS…)

BCD6s – BCD6s SOI

Rad-Hard Product Developments

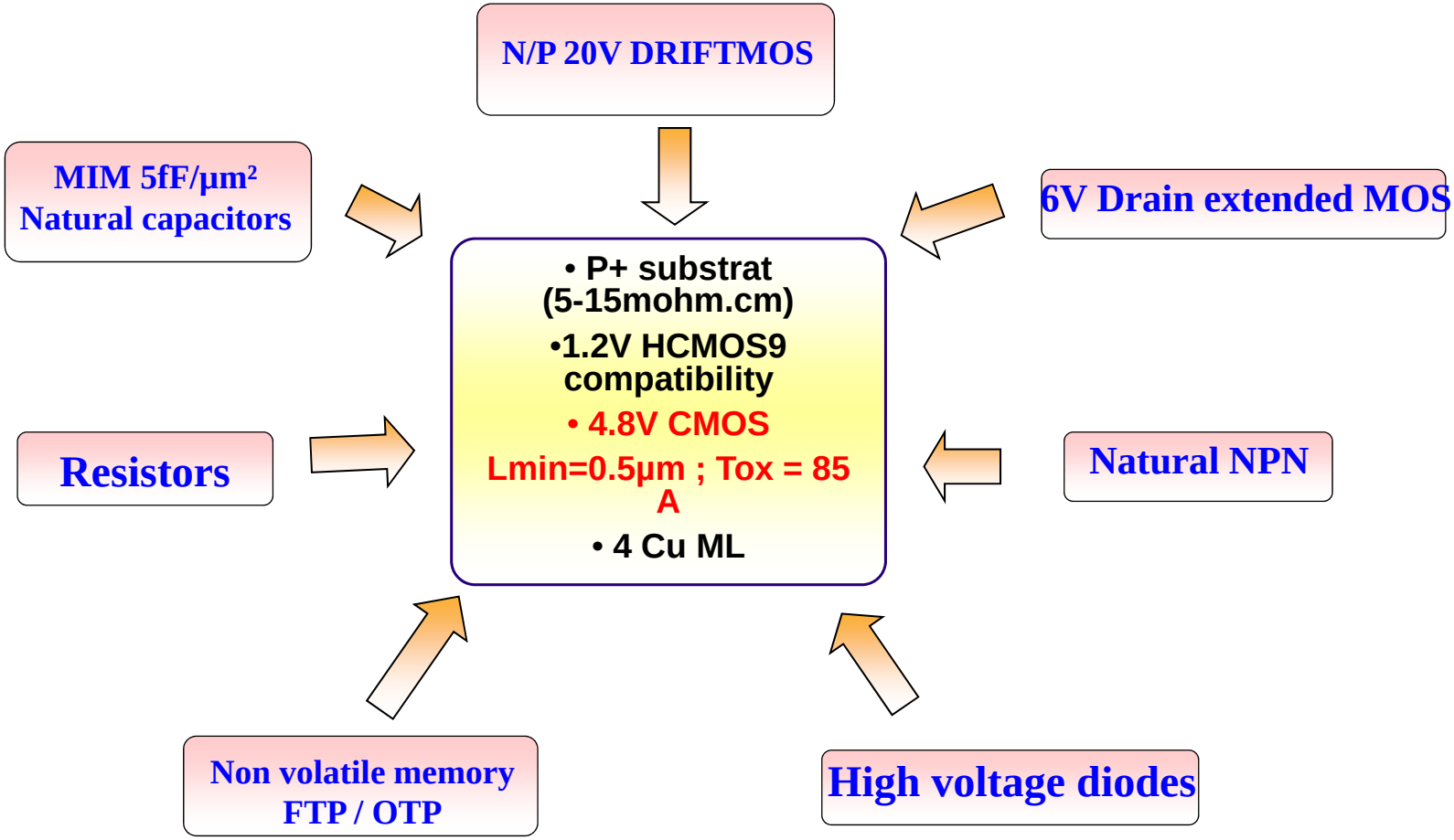
- 2 Rad-Hard Products Designed :
  - Using Conclusions of First Assesments
- Integrated Current Limiter : BCD6s
  - Silicon 2.0 Fully Validated
  - Product Level HDR and Heavy Ion : 4Q12
  - 100 krad LDR Results : Mid 2013
- Low Side Driver : BCD6s SOI
  - Silicon 1 Fully Validated
  - Product Level HDR and Heavy Ion : 4Q12
  - 100 krad LDR Results : Mid 2013



BCD6s SOI Perspectives

- BCD6s SOI Standard Design Kit : Available
- Mixed Signal Power Rad-Hard ASIC :
  - Basic ASIC Offer : Under Investigation
    - Design Kit Delivery : ST
    - Design up to GDS2 File & test patterns : Customer
    - Mask making, Diffusion, Test, Assembly, Qualification : ST
    - Case by Case Basis for the Time Being
  - ST Candidate to Build a Generic Rad-Hard ASIC Offer
    - Digital & Analog Library Extension
    - IP Blocks Developments
    - ….

HCMOS9A Definition



Extra mask needed

HCMOS9A Device offer

MOS Transistors

1.2 V NMOS Low Power (LP)
1.2 V PMOS Low Power (LP)
4.8 V NMOS ANALOG
4.8 V PMOS ANALOG
6.0 V Isolated Drain Extended NMOS
6.0 V Drain Extended PMOS

HVMOS Transistors

P DRIFT MOS HV GO2 85
N DRIFT MOS HV GO2 85
Native N DRIFT MOS MV GO2 85
Native P DRIFT MOS MV GO2 85

Capacitor

N+ Poly/ 8.5 nm oxide/ NWELL GO2 85
MOM
5 fF/ μm^2 MIM

Resistor

Unsilicided P+ Poly
Unsilicided N+ Active
NWELL GO2 85 under STI
RHIPO Poly in NWELL GO2 85
Unsilicided RPLDD P Active

Bipolar Transistor

NPN GO2 85

Diode

N+/ PWELL Junction Diode, GO1 Device
P+/ NWELL Junction Diode, GO1 Device
HV N Junction Diode, NDRIFT/ PSUBSTRAT
HV P Junction Diode, PDRIFT/ NISO
P+/ NWELL GO2 85 Junction Diode
N+/ PWELL GO2 85 Junction Diode
Schottky Diode

8.5 nm MOS transistors @ 4.8V

- PMOS

Param description	Name	Unit	LSL	SPEC	USL
PMOS 4.8V Ioff 10/0.5	PIL1005DH	log(A/um)	-13.36	-11.8	-10.16
PMOS 4.8V Ion 10/0.5	PIS1005DH	uA/um	-399	-340	-287
PMOS 4.8V Vth 10/0.5	PVT1005DH	V	-0.696	-0.644	-0.593
PMOS 4.8V Vth 10/10	PVT1010DH	V	-0.712	-0.666	-0.620

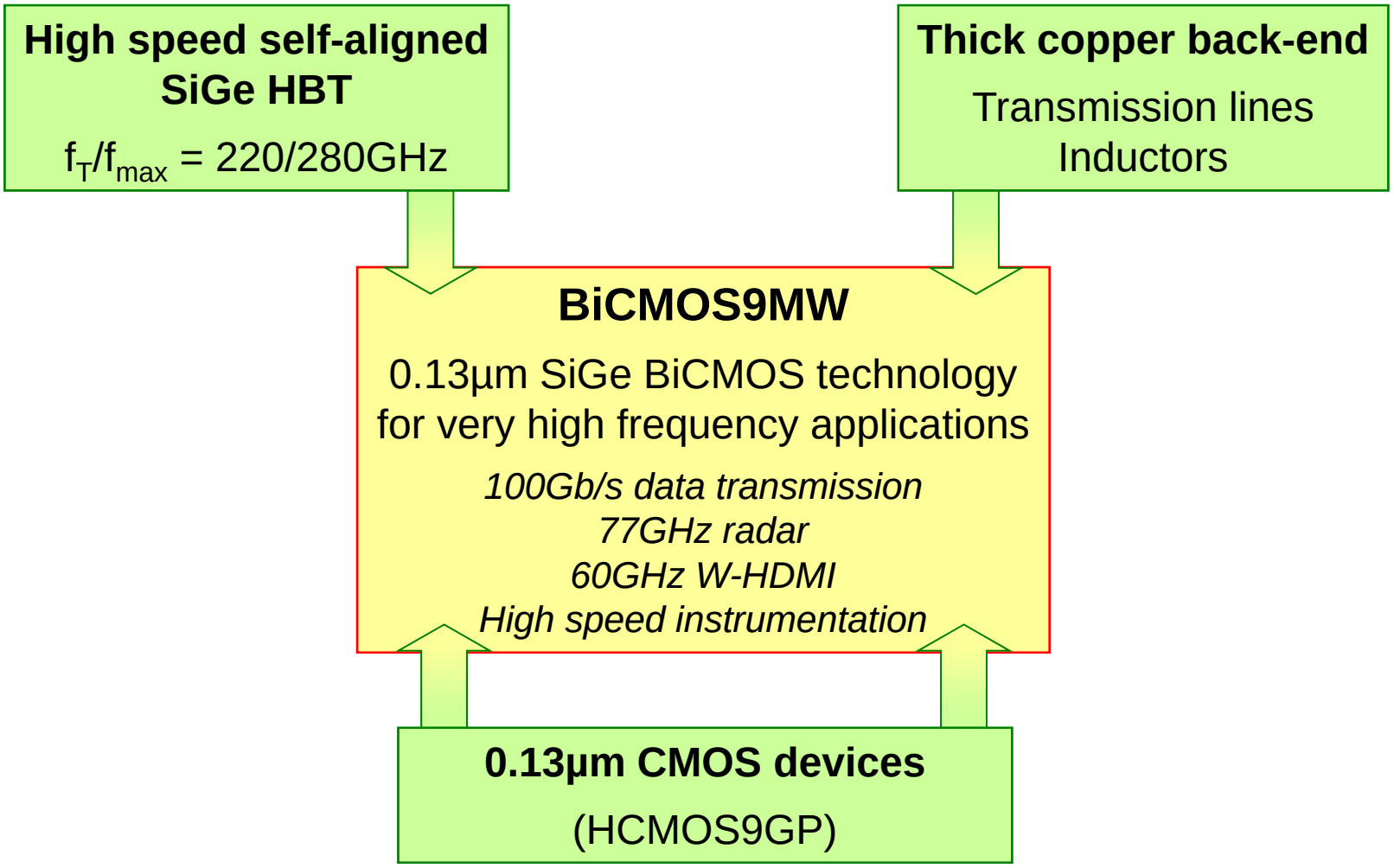
- NMOS

Param description	Name	Unit	LSL	SPEC	USL
NMOS 4.8V Ioff 10/0.5	NIL1005DH	log(A/um)	-14	-12.8	-11.9
NMOS 4.8V Ion 10/0.5	NIS1005DH	uA/um	604	682	767
NMOS 4.8V Vth 10/0.5	NVT1005DH	V	0.618	0.692	0.763
NMOS 4.8V Vth 10/10	NVT1010DH	V	0.534	0.580	0.626

HCMOS9A for Space

- Internally used : 5 products in Development
  - Radiation Test : 4Q12
  - QMLV : 2013
- On-going thesis (ST-CNES-IXL) :
  - rad-hard design rules

BiCMOS9MW


High speed self-aligned SiGe HBT
f_T/f_{max} = 220/280GHz
Thick copper back-end
Transmission lines
Inductors
BiCMOS9MW
0.13µm SiGe BiCMOS technology for very high frequency applications
100Gb/s data transmission
77GHz radar
60GHz W-HDMI
High speed instrumentation
0.13µm CMOS devices
(HCMOS9GP)

Device list (1)

- Core process devices
  - 1.2V GO1 (2nm) devices
    - NMOS & PMOS LL transistors
    - *NMOS & PMOS HS transistors (option)*
  - 2.5V GO2 (5nm) devices
    - NMOS & PMOS transistors
    - *NMOS & PMOS HS transistors (option)*
    - Natural drift NMOS & PMOS transistors
    - PolyN/Nwell MOS varactor
    - PolyN/Nwell & PolyP/Pwell MOS capacitors
  - Diodes
    - N+/Pwell & P+/Nwell
    - N+/Pwell GO2 2.5V & P+/Nwell GO2 2.5V
    - Nwell/Psub & Pwell/Niso
    - Varactor diode
  - Resistors
    - N+ silicided Poly (10Ω/sq)
    - N+ (120Ω/sq) and P+ (320Ω/sq) unsilicided Poly
    - P+ unsilicided Active (135Ω/sq)
    - *Highly resistive Poly (1000Ω/sq) (option)*

Device list (2)

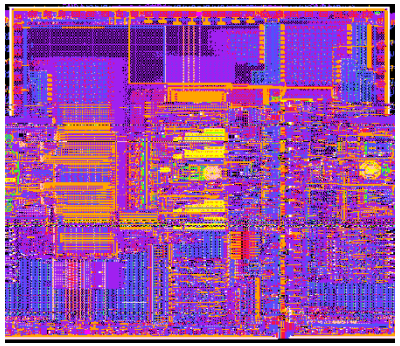
- Core process devices (cont.)
  - Bipolar devices
    - P+/Nwell/Psub transistor
    - N+/Pwell/Niso transistor
- Specific devices
  - Bipolar devices
    - High Speed (HS) NPN SiGe HBT (f_T/f_{max} = 220/280GHz, BV_{CEO} = 1.6V)
    - Medium Voltage (MV) NPN SiGe HBT (f_T/f_{max} = 145/300GHz, BV_{CEO} = 2.0V)
  - Inductors
    - Low Value High Q inductor (symmetrical and differential)
    - High Current inductor (symmetrical and differential)
  - Capacitors
    - *MIM 2 fF/µm^2 (option)*
  - Transmission lines
    - Microstrip line
- *Mask count*
  - *Core process: 39 (HBT=8, including SIC mask enabling free MV HBT)*
  - *Options: 2 (HS G01) + 2 (HS G02) + 1 (HIPO) + 2 (MIM)*

Bicmos9MW D.K. 9.2 Tools version

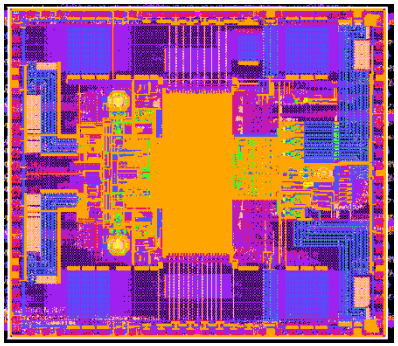
Front-end/Schematic capture	EDA tools	EDA Vendors	Tool versions (or newest)
Schematic Capture (Composer)	IC	Cadence	5.1.41_usr5
Design environment	ArtistKit	ST	5.4.1 or 5.6 TBC
Simulation model libraries	Eldo	Mentor	2009.2c
	Spectre + AMSDesigner	Cadence	MMSIM 7.2 IUS_8.1
	Hspice	Synopsys	c-2009.09
	Nanosim		b-2008.09
RF Simulation	ADS	Agilenteesof	2009 U1
	GoldenGate	Agilenteesof	4.4.2
Fast spice simulators	Hsimplus	Synopsys	b-2008.09
Layout Entry & Finishing	**EDA tools**	**EDA Vendors**	**Tool versions (or newest)**
Layout Placement	Virtuoso LE	Cadence	5.1.41_usr5
Layout Verification : DRC/LVS	Calibre	Mentor	2008.4_19.14
Parasitic Extraction : interconnect RC	StarRCXT Jivaro A&D	Synopsys Edxact	b.2008.06-sp2-1 (new) 3.2 (D) & 4.0.08 (A)
Post Layout Simulation flow	PLSKit	ST	2.2.3 or 2.4
	DK	ST	

BICMOS9MW : Terrestrial examples

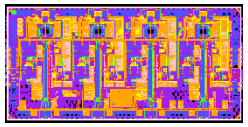
100Gb/s Ethernet



Area : 27mm²

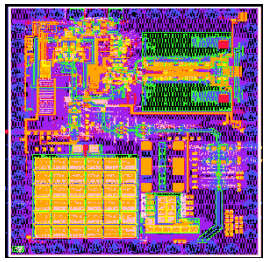


Area:27mm²



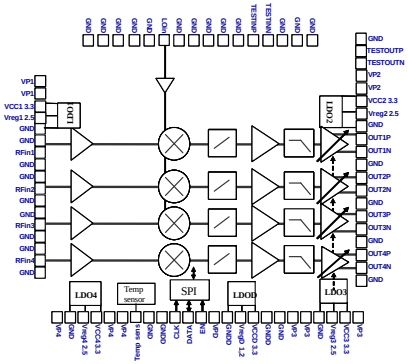
Area :5.14 mm²

60Ghz Fast Downloading

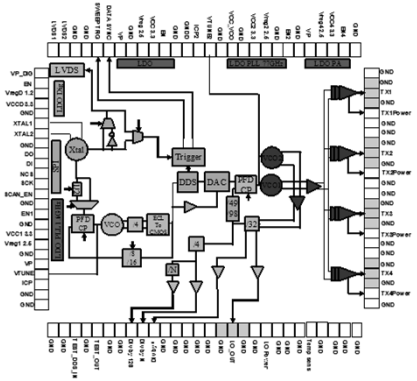


Area :~9 mm²

77 Ghz Automotive Radar Chipset



RX



TX

-Fiber optics Communications (100Gb/s)
-Test & Measurements Equipment
-77 Ghz Automotive radar
-60Ghz LAN

C065 Space

- European High Density Technology
  - CNES + ESA Support
  - Library : 140 Rad-Hard Cells
    - 1st Test Chip : Radiation Tested
    - 2nd Test Chip : Radiation Test Result : 4Q12
      - Rad-hard PLL (400MHz-1.2GHz)
      - SRAMs generators with ECC
  - First Space Plateform : 3Q12
  - Design hardening of 6.25Gbit/s HSSL on going
- Space platform deployment to start in Q4-12
  - Partnership with Atmel

Summary

Technologie	Space subset	Status
BCD	BCD6s (0.32um) BCD6s SOI	On going ST products ASICs considered
BiCMOS SiGe:C	BICMOS9MW 130nm BICMOS9	On going e2v product
CMOS 0.25-0.13um	HCMOS9 130nm	On going ST products
DSM 65-22nm	C065LP (65nm)	On going ASIC offer devt & deployment

www.cmp.imag.fr

Thanks for your attention!

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