

 *austriamicrosystems*

Processes & Runs

- **Process Presentation :**
 - **CMOS**
 - **CMOS-Opto**
 - **SiGe**
 - **HV-CMOS**
 - **HV-CMOS EEPROMIFlash**

- **Fabrication Activity in 2010**

- **100 μ TSV on 0.35 μ CMOS**

- **0.18 μ m HV-CMOS, and CMOS**

- **Conclusion**

Available Processes in 2010

No major changes between 2009 and 2010

0.35 μ CMOS : C35B4C3

0.35 μ SiGe : S35D4M5

0.35 μ CMOS-Opto : C35B4O1

0.35 μ CMOS-RF : C35B4M3

0.35 μ HV CMOS : H35B4D3

0.35 μ HV EEPROM : H35B4H3

0.8 μ BiCMOS : BYE / BYQ (Engineering runs available)

0.6 μ CMOS (Engineering runs available)



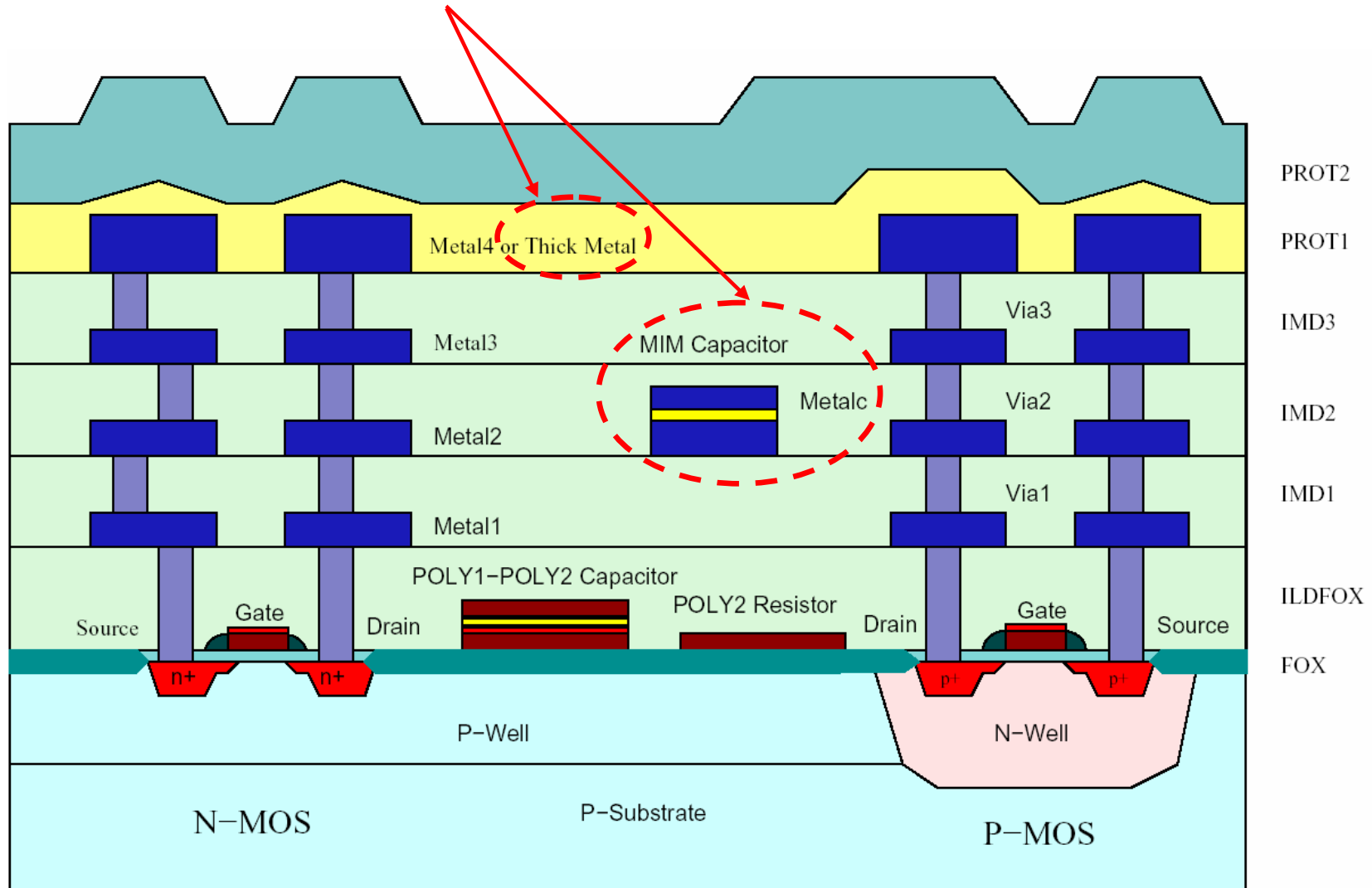
0.35 μ CMOS



CMOS 0.35 μ C35 (C35B4C3)

- 2 Levels Polysilicon, 4 Levels Metal, 3.3V / 5.0V, High Resistive Poly.
- 3.3V / 5.0V I/O pads.
- Peripheral cells with high driving capability (from 1mA to 24mA)
- Application : Analog, Digital, Mixed A/D, RF.
- Density : 18 kgates/mm²
- Gate Delay: 100ps (NAND2 typical)
- Libraries : Digital and Analog Standard Cells + Pads + SPIRAL Ind. + P-Cells.

Thick Metal and MIM available in C35B4M3.





CMOS 0.35 μ C35 Features



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C35 C35-Opto S35 H35 H35-Flash Activity 2010

CMOS 0.35 μ C35 (C35B4C3)

2 Levels Polysilicon, 4 Levels Metal, 3.3V / 5.0V, High Resistive Poly.

CMP Option

Process Name	units	C35B3C0	C35B3C1	C35B4C3
Process Type		mixed signal CMOS	mixed signal CMOS	mixed signal CMOS
Drawn MOS Channel Length	μm	0.35	0.35	0.35
Operating Voltage	V	2.5 - 3.6	IO -5.5	IO -5.5
Number of Masks		14	17	20
Number of Masking layers		19	21	24
Number of Metal Layers		3	3	4
Number of Poly Layers		2	2	2
Substrate Type		p	p	p
Diffusion Pitch	μm	0.9	0.9	0.9
Metal1/2/3/4 Pitch	μm	0.95 / 1.1 / 1.1 / 1.2	0.95 / 1.1 / 1.1 / 1.2	0.95 / 1.1 / 1.1 / 1.2
Metal1/2/3/4 conacted Pitch	μm	1.05 / 1.2 / 1.2 / 1.3	1.05 / 1.2 / 1.2 / 1.3	1.05 / 1.2 / 1.2 / 1.3
Poly1 Pitch	μm	0.8	0.8	0.8
High Resistive Poly	kOhm/#	-	-	1,2
Poly1/Poly2 Precision Caps	fF/ μm^2	0,9	0,9	0,9
N/PMOS Channel Length	μm	0.30/0.30	0.30/0.30	0.30/0.30
N/PMOS Saturation Current	$\mu\text{A}/\mu\text{m}$	520 / 240	520 / 240	520 / 240
Flip-Flop Delay	ns	0.8	0.8	0.8
NAND2 Delay *)	ns	0.1	0.1	0.1
NAND2 Area	μm^2	54.6	54.6	54.6
NAND2 Power	$\mu\text{W}/\text{MHz}$	2	2	2



C35

C35-Opto

S35

H35

H35-Flash

Activity 2010

0.35 μ CMOS-Opto



CMOS-Opto 0.35 μ (C35B401)

(100% compatible with standard 4LM 0.35 μ CMOS)

Process features:

- 0.35 μ CMOS polycide-gate process
- 4 layers metal and 2 layers poly
- Peripheral Cells with high driving capabilities (1mA – 24mA)
- High performance digital and mixed signal capabilities
- N/PMOS saturation current : 520/240 μ A/ μ m

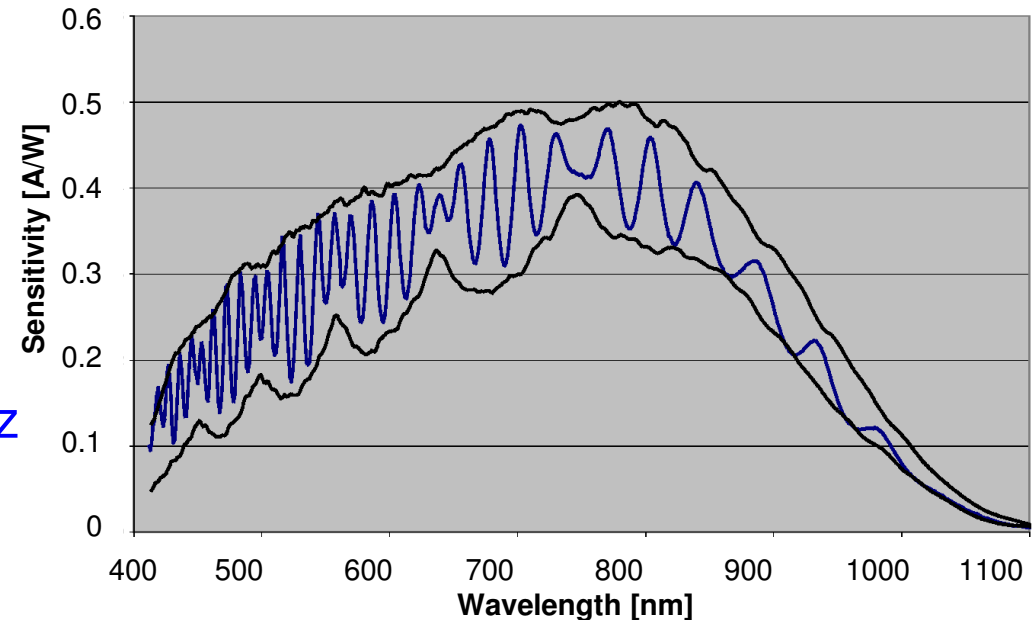
Opto features:

- Dark current < 45 pA/cm²
- Cut-off frequency > 20 MHz
- Responsivity @ 550 nm: 290 mA/W
- Responsivity @ 850 nm: 330 mA/W
- Cut-off frequency of photodiode: 20 MHz

Applications:

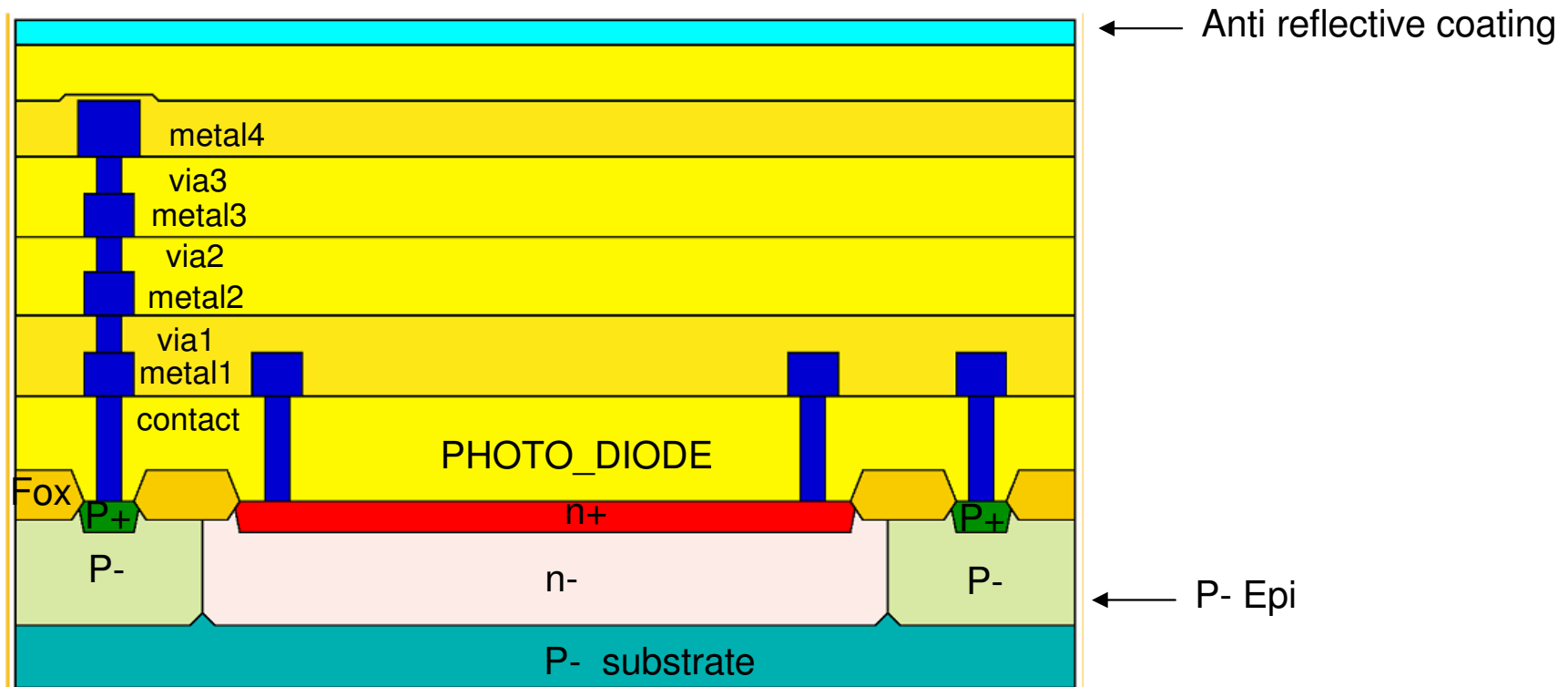
Photo sensors, APS, CMOS Camera ...

Responsivity Curve of Photodiode
(Courtesy austriamicrosystems AG)



CMOS-Opto 0.35 μ (C35B401)

- Planarization and anti-reflective coating allows much better optical properties than the standard CMOS.
- P-Epi wafers allow lower current leakage in the diode, then a lower dark current for a better sensitivity.



C35-Opto Process Cross-Section



CMOS-Opto 0.35 μ

- Design-rules and Electrical Parameters compatible with the C35 standard process. **HRES is available only in MPW runs**
- Design-kit compatible with the 4 layers metal process option C35B4.
- Every C35 MPW run planned by CMP includes the CMOS-Opto option.
- 6 MPW runs scheduled in 2009.
- MPW Price : 810 Euro/mm² (minimum price 3 mm²)



C35

C35-Opto

S35

H35

H35-Flash

Activity 2010

0.35 μ SiGe



C35

C35-Opto

S35

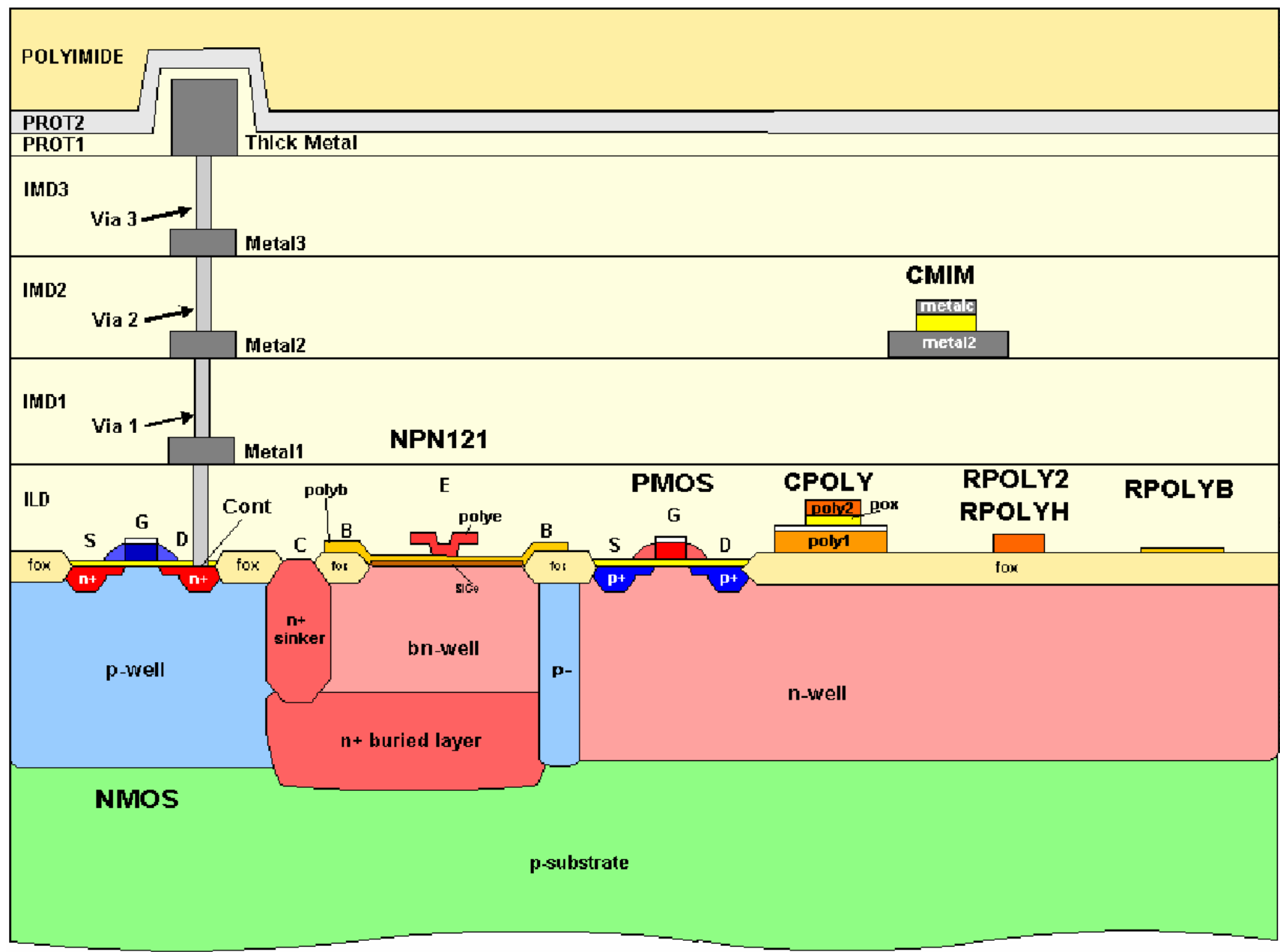
H35

H35-Flash

Activity 2010

SiGe HBT-BiCMOS 0.35 μ S35

- 4 Layers Polysilicon / 4 Layers Metal.
- Power supply voltage range (2.5V – 3.6V / 5.5V)
- Vertical SiGe-HBT NPN : $F_t = 70$ GHz
- High Resistive Polysilicon.
- High precision Poly1/Poly2 capacitors
- High precision MIM capacitors
- Thick Top Metal





C35

C35-Opto

S35

H35

H35-Flash

Activity 2010

SiGe HBT BiCMOS 0.35 μ S35 (S35D4M5)

- 4 Levels Polysilicon, 4 Levels Metal, 3.3V / 5.0V, High Resistive Poly, Thick Metal, MIM capacitors.

CMP Option

Process Name	units	S35D3M2	S35D4M2	S35D4M5
Process Type		SiGe-BiCMOS	SiGe-BiCMOS	SiGe-BiCMOS
Drawn MOS Channel Length, Drawn Emitter Width	μm μm	0.35 0.40	0.35 0.40	0.35 0.40
Operating Voltage CMOS	V V	2.5-3.6	2.5-3.6	2.5-3.6 / 5.5
Number of Metal Layers		3	4	4
Number of Poly Layers		4	4	4
Substrate Type		p	p	p
Diffusion Pitch	μm	0.9	0.9	0.9
Metal1/2/3 Pitch	μm	0.95/1.1/1.2	0.95/1.1/1.2	0.95/1.1/1.2
Poly1 Pitch	μm	0.8	0.8	0.8
Thick Metal 4 pitch	μm	-	4.5	4.5
High Resistive Poly	kOhm/#	-	-	1.2
Poly1 / Poly2 Precision Caps	fF/ μm^2	0.9	0.9	0.9
Metal 2 / Metal 3 Precision Caps	fF/ μm^2	1.25	1.25	1.25
N/PMOS Active Channel Length	μm	0.3/0.3	0.3/0.3	0.3/0.3
N/PMOS Saturation Current	$\mu\text{A}/\mu\text{m}$	540/240	540/240	540/240
Gain	-	160	160	160
Early Voltage VAF	V	100	100	100
HS-HBT: BVceo	V	2.7	2.7	2.7
ft / fmax	GHz	60 / 70	60 / 70	60 / 70
HV-HBT: BVceo	V	-	-	5.5
ft / fmax	GHz	-	-	35 / 50



0.35 μ HV-CMOS



HV CMOS 0.35 μ H35 (H35B4D3)

- 2 Layers Polysilicon, 4 Layers Metal, High Resistive Poly, Thick 4th Metal.
- 50 Volts Maximum operating voltage.
- 3.3V / 5.0V / 20V Maximum gate voltage.
- $R_{on} = 0.11 \text{ Ohm mm}^2$ for HV-NMOS
- $R_{on} = 0.29 \text{ Ohm mm}^2$ for HV-PMOS



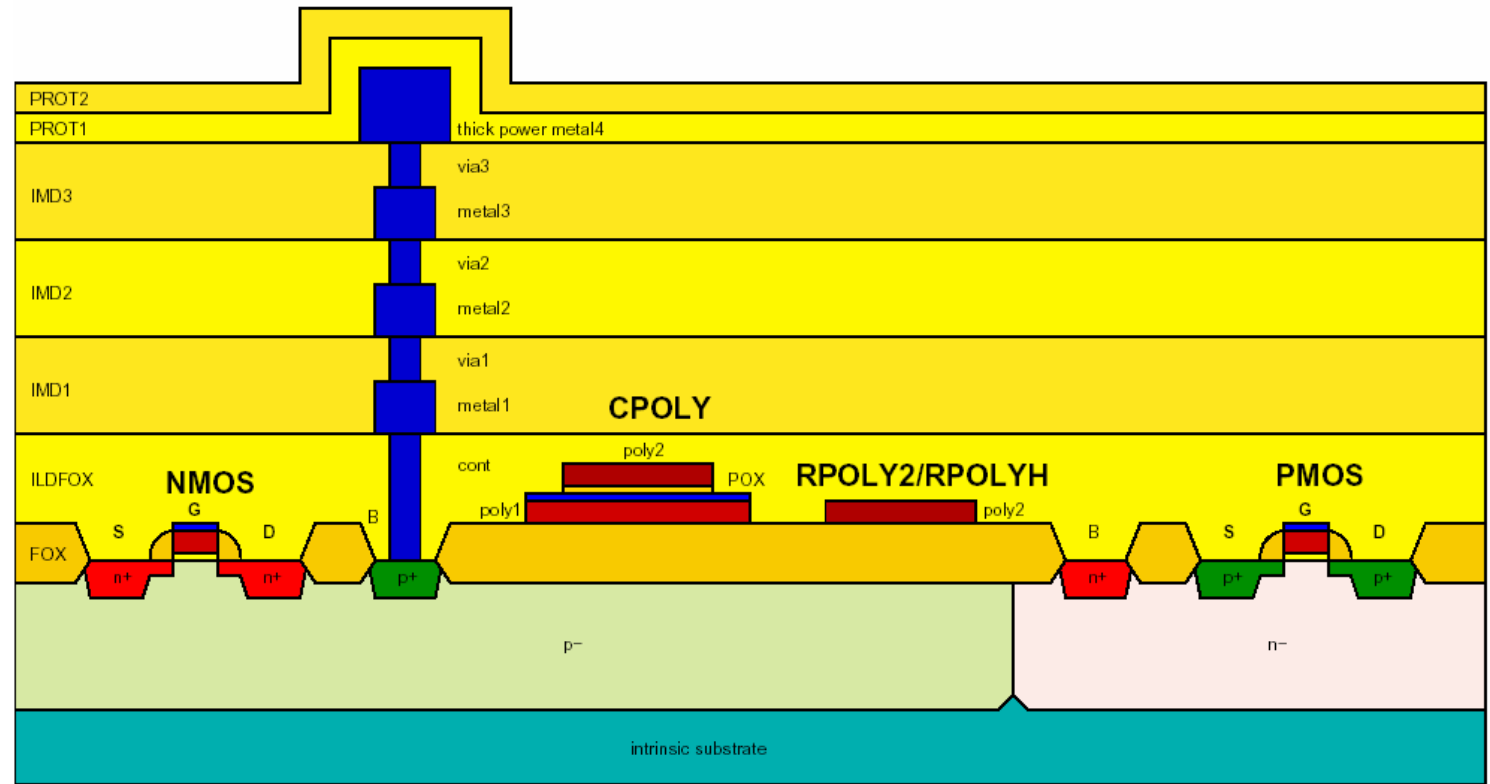
HV CMOS 0.35 μ Cross Section (H35)



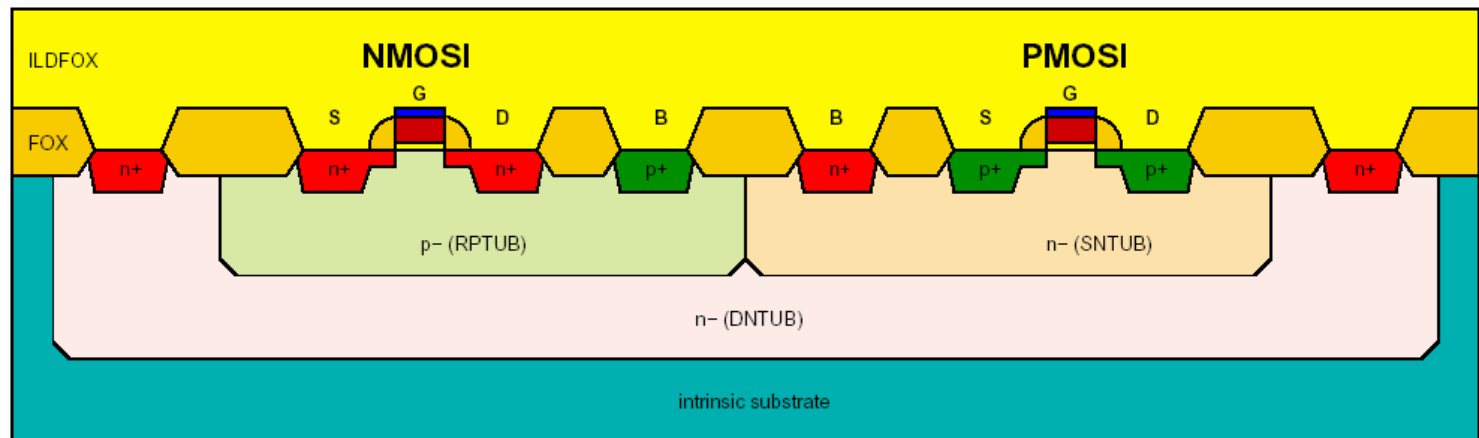
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C35 C35-Opto S35 **H35** H35-Flash Activity 2010

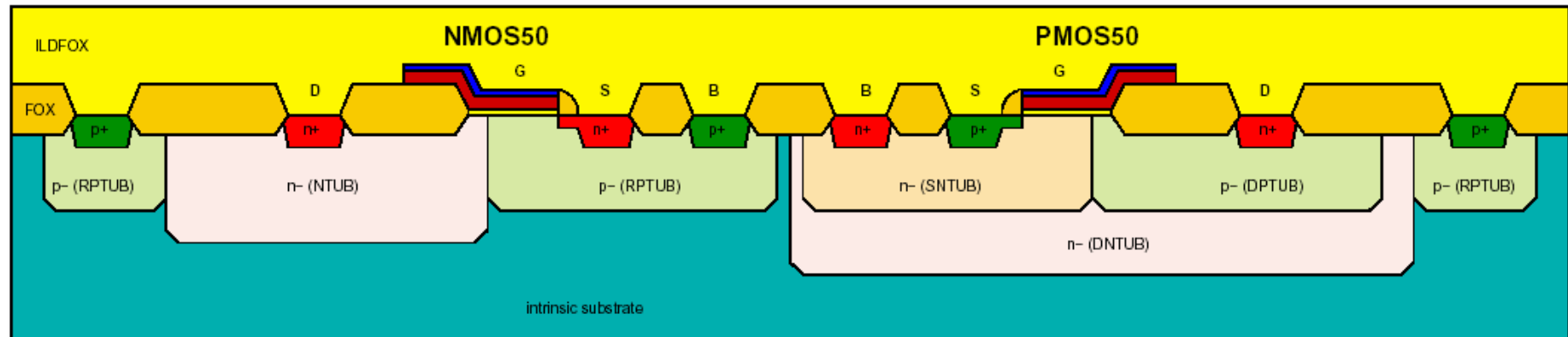
Standard 3.3V / 5V



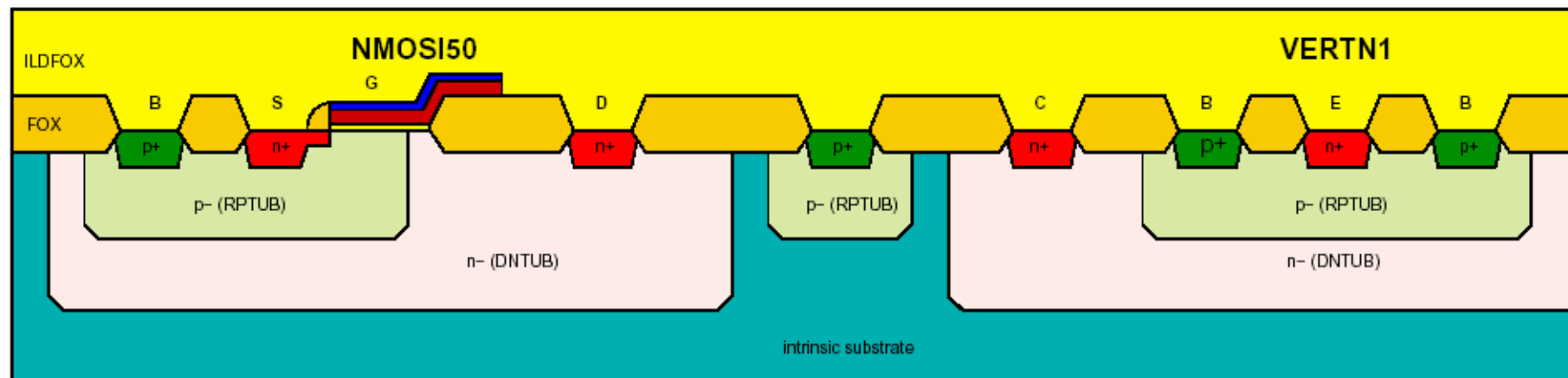
Isolated 3.3V / 5V



NMOS50 and PMOS50 transistors



NMOSI50 and VERTN1 transistors





High Voltage CMOS 0.35 μ H35 Features



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C35 C35-Opto S35 **H35** H35-Flash Activity 2010

CMP Option

Process Name	H35B3KC	H35B3LC***	H35B4KD***	H35B4LD***	H35B4D3
Process features	2P, 3M, HP, 20V	2P, 3M, HP, 5V, 20V	2P, 4M, HP, TM, 20V	2P, 4M, HP, TM, 5V, 20V	2P, 4M, HP, TM, S, 5V, 20V
Number of masks	18	16	19	22	25
Max. operating voltage HV-NMOS [V]	50	50	50	50	50
Max. operating voltage HV-PMOS [V]	50	50	50	50	50
specific R _{on} * HV-NMOS [Ohm mm ²]	0.11	0.11	0.11	0.11	0.11
specific R _{on} * HV-PMOS [Ohm mm ²]	0.29	0.29	0.29	0.29	0.29
Drawn LVMOS Channel Length [μm]	0.35	0.35	0.35	0.35	0.35
Operating voltage LV-MOS [V] **	3.3V	3.3V, 5V	3.3V, 5V	3.3V, 5V	3.3V, 5V
Max. gate voltage [V]	3.3V, 20V	3.3V, 5 V, 20V	3.3V, 5 V, 20V	3.3V, 5V, 20V	3.3V, 5V, 20V

2M.....2 metal layers	HP.....high resistive poly
3M.....3 metal layers	S.....substrate related LV devices
4M.....4 metal layers	TM.....thick metal layer
1P.....1 poly layer	5V.....5V gate oxide
2P.....2 poly layers	20V.....20V gate oxide



HV-CMOS 0.35 μ (H35)



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C35

C35-Opto

S35

H35

H35-Flash

Activity 2010

HV-CMOS 0.35 μ

- LV CMOS fully compatible with C35.
- Design-kits available for Cadence and Mentor Graphics.
- 4 MPW runs scheduled in 2010.
- MPW Price : 1000 Euro/mm² (minimum price 7 mm²)



0.35 μ HV-CMOS EEPROMIFlash



HV-CMOS 0.35 μ with Embedded EEPROM / Flash

- HV-CMOS fully compatible with H35.
- EEPROM or Flash available on request.
- Simulation files and abstract view for P&R are accessible.
(layout block replacement done at austriamicrosystems).
- License fees (contact CMP)
- Prototyping price : Contact CMP



HV-CMOS 0.35 μ EEPROM (H35B4D3)



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C35 C35-Opto S35 H35 **H35-Flash** Activity 2010

Available EEPROM Blocks

Process	Block Size	Organization	Read Supply	Write Supply	Endurance	Data Retention	Size
H35	64x8 bit	EEPROM	1.8 – 3,6V	1.8 – 3,6 V	80k @ 125°C	>20 years @ 125°C	0.36mm ²
H35 (mid-ox only)	128x8 bit	EEPROM	2.3 – 5.5V	2.3 – 5.5 V	80k @ 125°C	>20 years @ 125°C	0.54mm ²
H35	1Kx8 bit	EEPROM	2.7 – 3.6 V	2.7 – 3.6 V	80k @ 125°C	>20 years @ 125°C	0.73mm ²
H35, high-temp	1Kx8 bit	EEPROM	2.7 – 3.6 V	2.7 – 3.6 V	40k @ 150°C	10 years @ 150°C	0.94mm ²
H35, high-temp	2Kx8 bit	EEPROM	1.8 – 3.6V	1.8 – 3.6V	40k @ 150°C	10 years @ 150°C	1.20mm ²
H35	4Kx16 bit	EEPROM	2.7 – 3.6 V	2.7 – 3.6 V	80k @ 125°C	>20 years @ 125°C	1.55mm ²

- Black box delivery: abstract and a Verilog simulation model of the memory
- Mandatory 3 days design review with specialized *austriamicrosystems* design engineers



Activity in 2010



austriamicrosystems Runs in 2010



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C35 C35-Opto S35 H35 H35-Flash **Activity 2010**

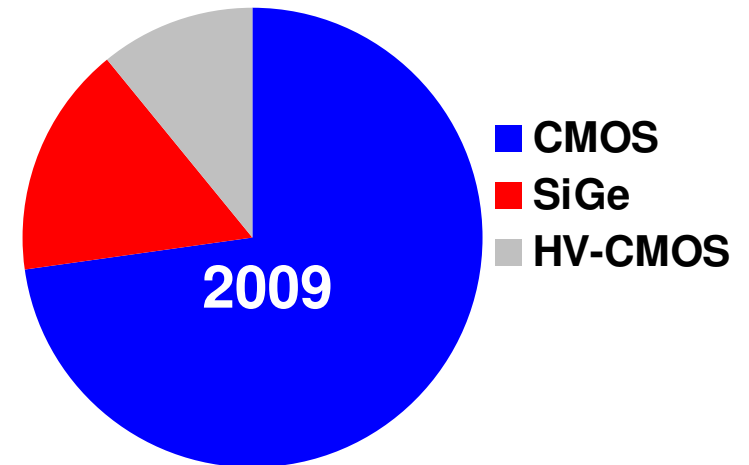
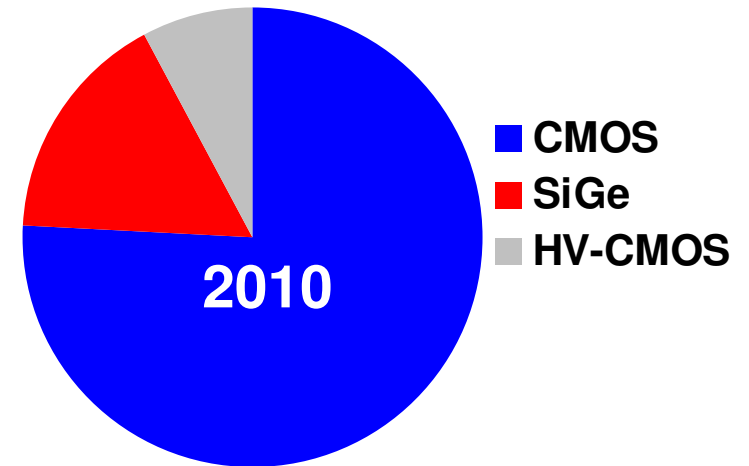
Number of prototypes in 2010 : **165** (155 in 2009)
 Number of Low volume prod. in 2010 : **54** (38 in 2009)

22 scheduled MPW runs (24 in 2009)
 5 extra runs (Production) (4 in 2009)

125 circuits CMOS **76%** (73% in 2009)
 (113 in 2009)

27 circuits SiGe **16%** (16% in 2009)
 (25 in 2009)

13 circuits HV-CMOS **8%** (11% in 2009)
 (17 in 2009)



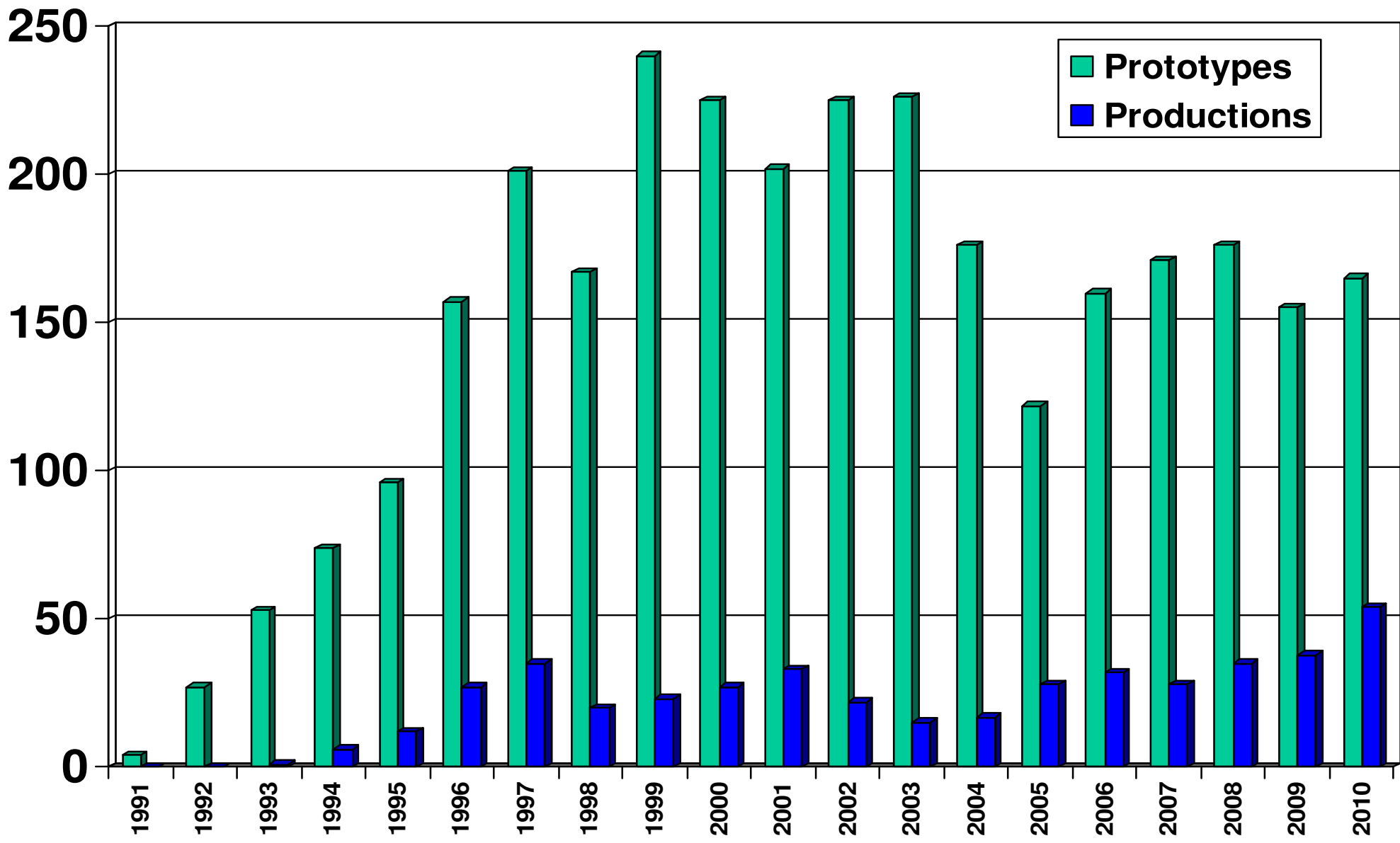


austriamicrosystems Runs Histogram



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C35
C35-Opto
S35
H35
H35-Flash
Activity 2010





- Low volume productions available in MPW runs when possible.
- Otherwise, organized with engineering runs, or production runs.

Dedicated production runs :

LAL Orsay	25 wafers 8" (0.35um SiGe)
CEA Saclay / IPHC	9 wafers 8" (0.35um CMOS)
LETI-CEA Grenoble	6 wafers 8" (0.35um CMOS-RF)
LETI-CEA Grenoble	6 wafers 8" (0.35um CMOS)
ANR-SPIN Consortium	12 wafers 8" (0.35um CMOS)

Conclusion

- **2010 : More Prototypes than 2009.**

- **Much more Low Volume Productions.**

- **New processes :**
 - ❖ **180nm CMOS & HV-CMOS**
 - ❖ **100 μ TSV on the 0.35 μ CMOS**

- **Excellent Partnership CMP / Autriamicrosystems**