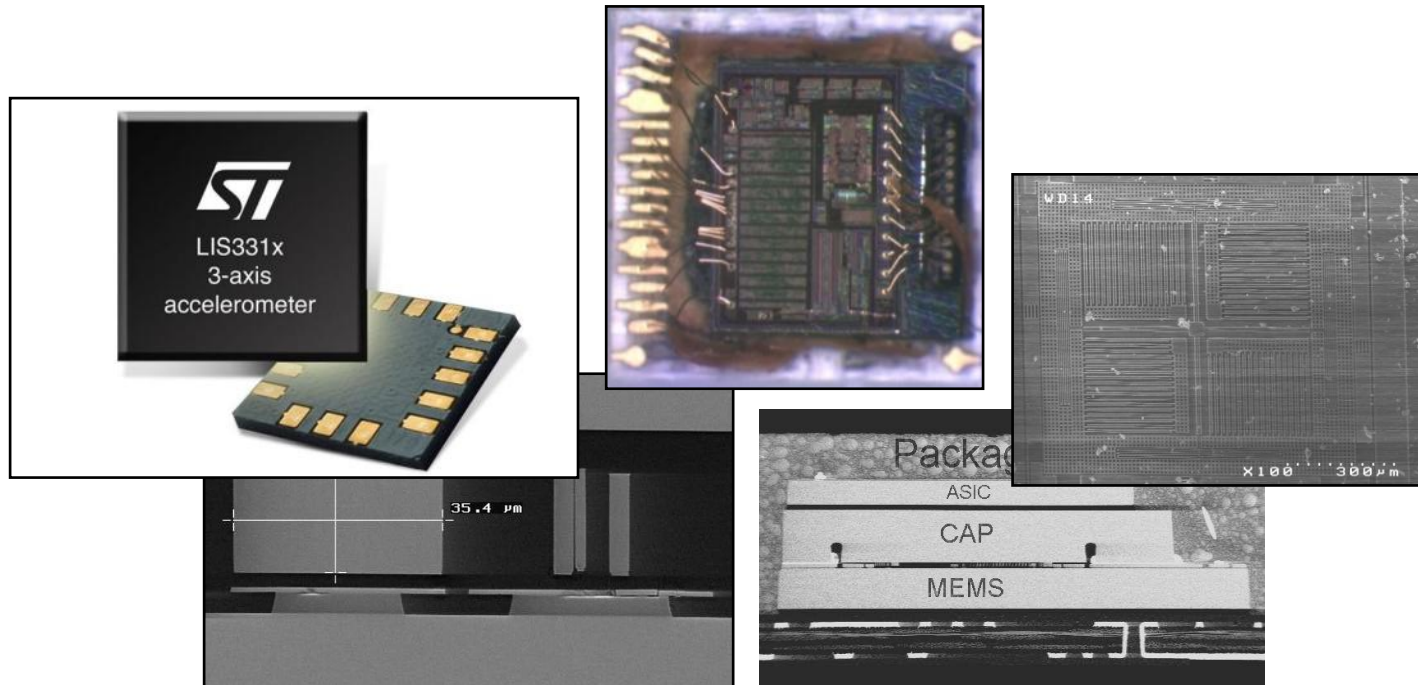


Reverse Costing analysis



STMicroelectronics LIS331DLH Triple-Axis MEMS Accelerometer

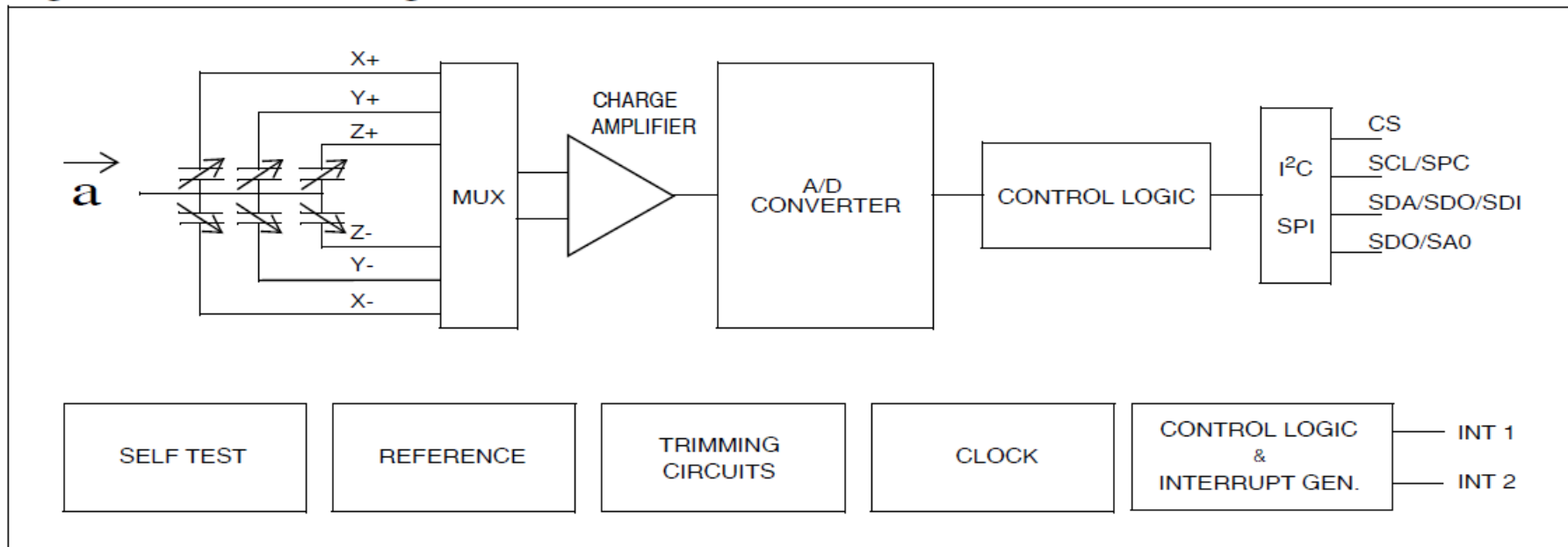
September 2010 - Version 1

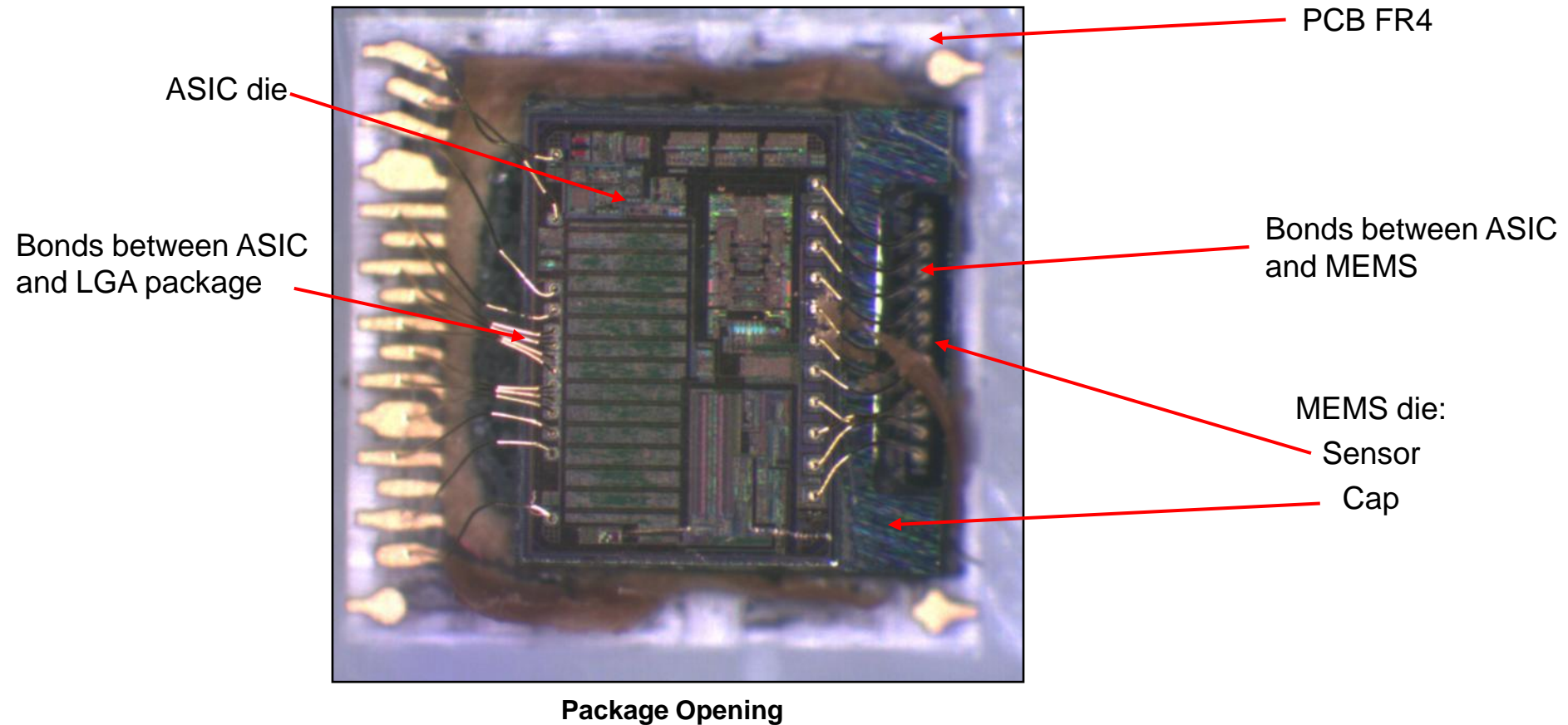
Written by: Sylvain HALLEREAU

DISCLAIMER : System Plus Consulting provides cost studies based on its knowledge of the manufacturing and selling prices of electronic components and systems. The given values are realistic estimates which do not bind System Plus Consulting nor the manufacturers quoted in the report. System Plus Consulting is in no case responsible for the consequences related to the use which is made of the contents of this report. The quoted trademarks are property of their owners.

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– MEMS Front-End Cost per Process Steps	
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– MEMS Front-End : Material Cost per Family	
– MEMS Back-End 0 : Probe Test & dicing	
– MEMS Die Cost (Front End + Back End 0)	
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Figure 1. Block diagram





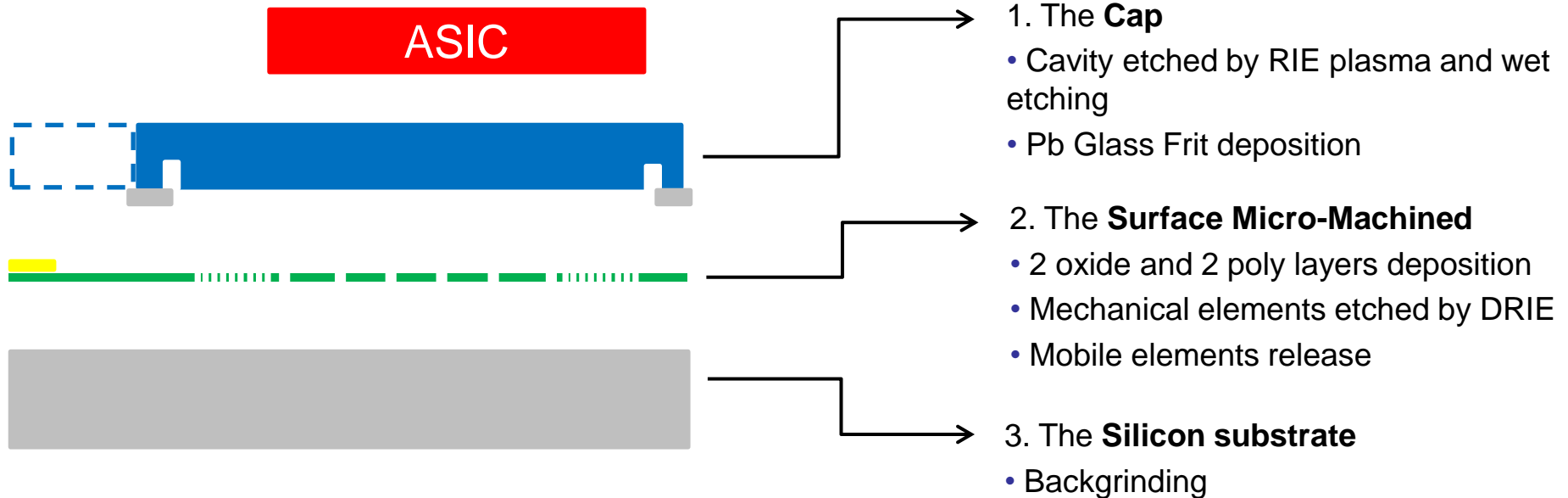
Bonding number : 25

Bonding material : Au (25µm diameter)

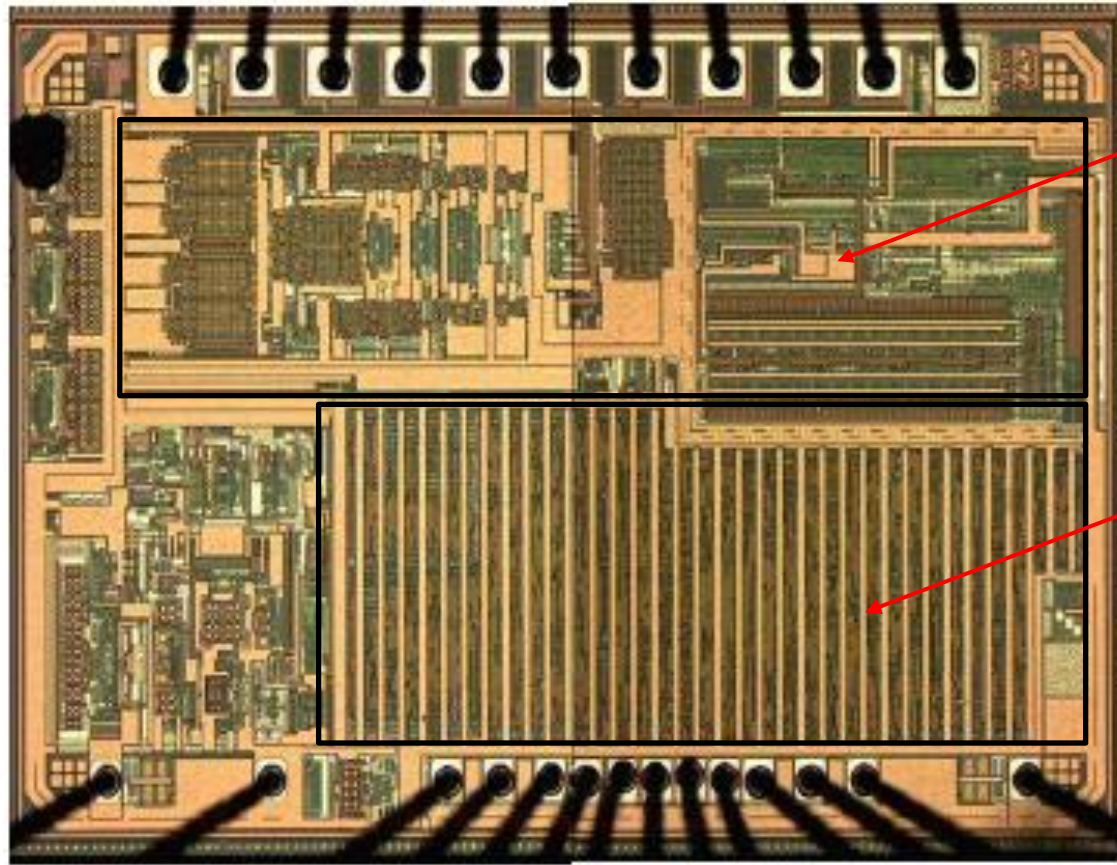
Bonding number between ASiC & Package : 14

Bonding number between MEMS & ASiC : 11

- 2 bonded wafers are used to build the LIS331DLH accelerometer MEMS.



- The sensing elements are made in thin poly and oxide layers and are protected by a silicon cap.
- The active layers are deposited and patterned.
- The sensor is protected and thus can be packaged using a standard assembly process.
- The ASIC is using a CMOS 0.Xµm process with SRAM, EEPROM and analog functions.
- The ASIC and MEMS are assembled in a LGA16 package stacked.

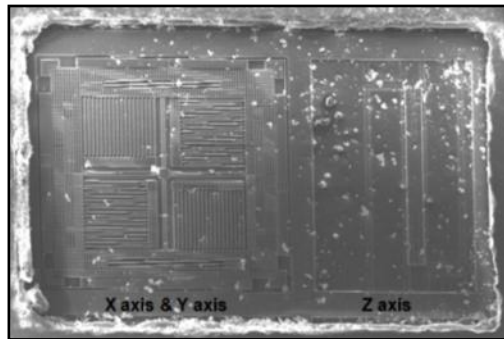


- Multiplexer
- ADC 16 bits.

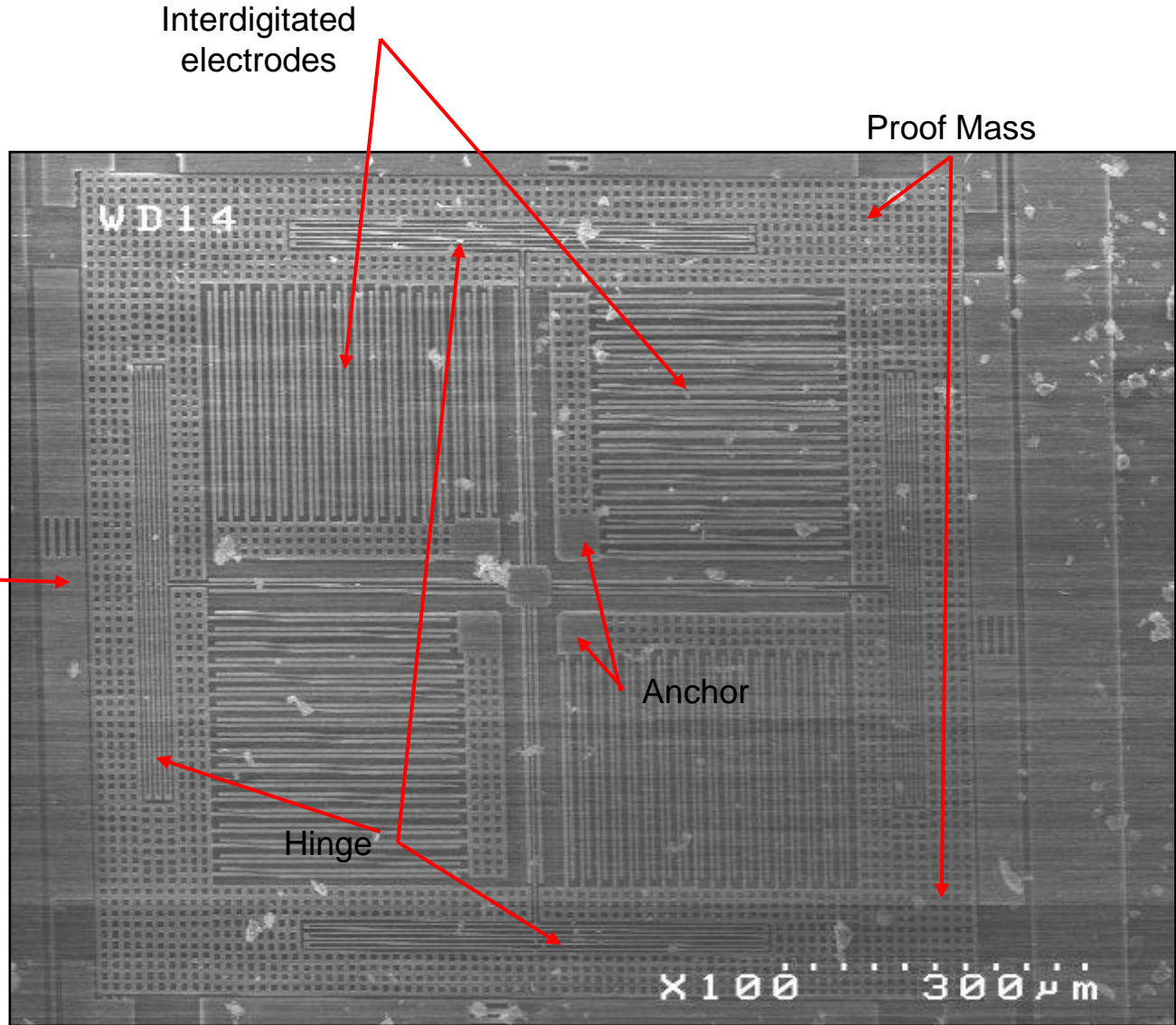
- Logic

ASIC Die (ST picture)

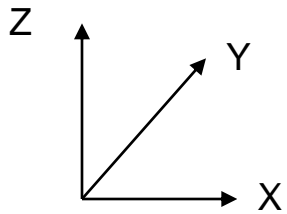
Memory : No memory block is visible on the picture. But the circuit integrates some registers and Non Volatile Memory (according to datasheet).

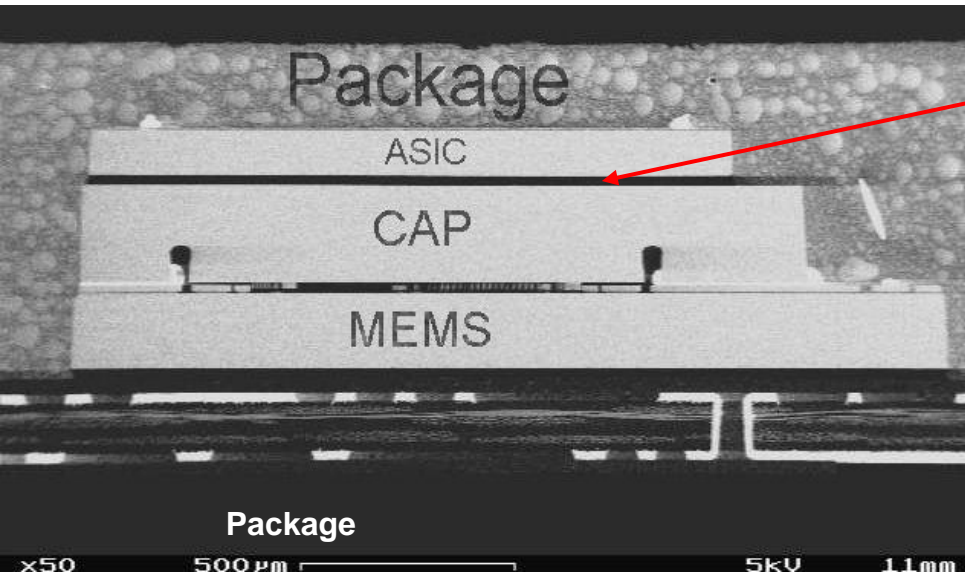


MEMS Sensor Overview



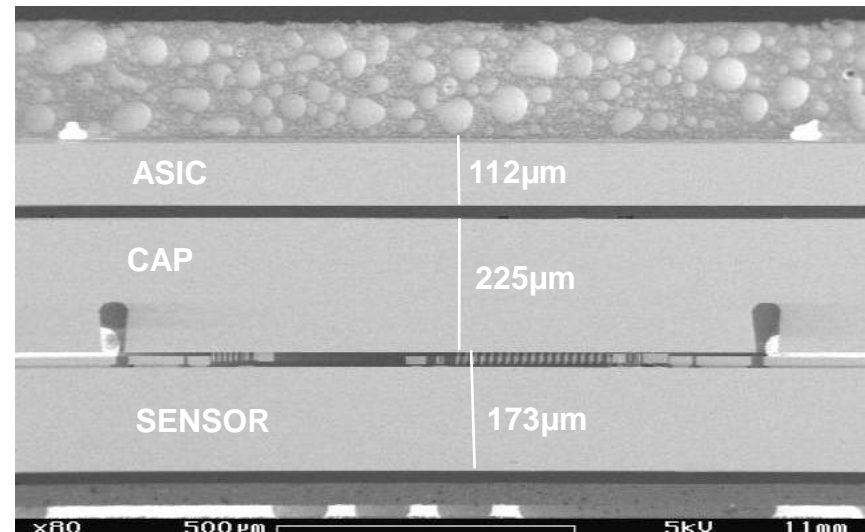
MEMS Sensor SEM View - X-Axis



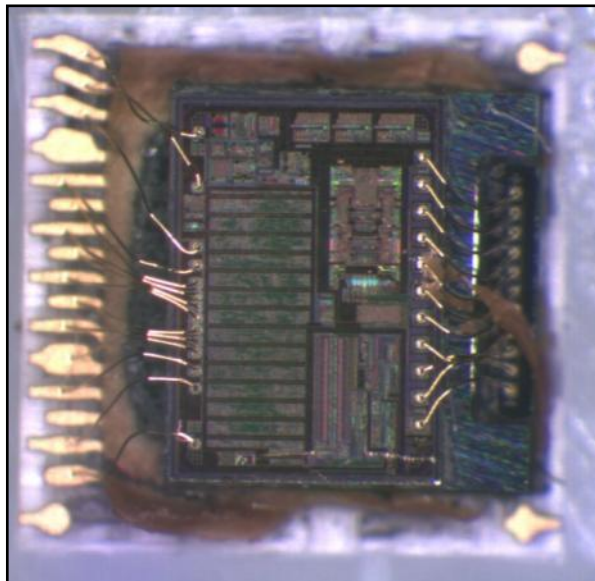


Component Cross Section

The ASIC is glued with epoxy glue on the top of the cap. This configuration reduces the area but increases the thickness of the MEMS. The 3 wafers are backgrounded in order to decrease the final thickness of the component. The backgrounding step increases the wafer cost and decreases the yield.



MEMS Cross Section



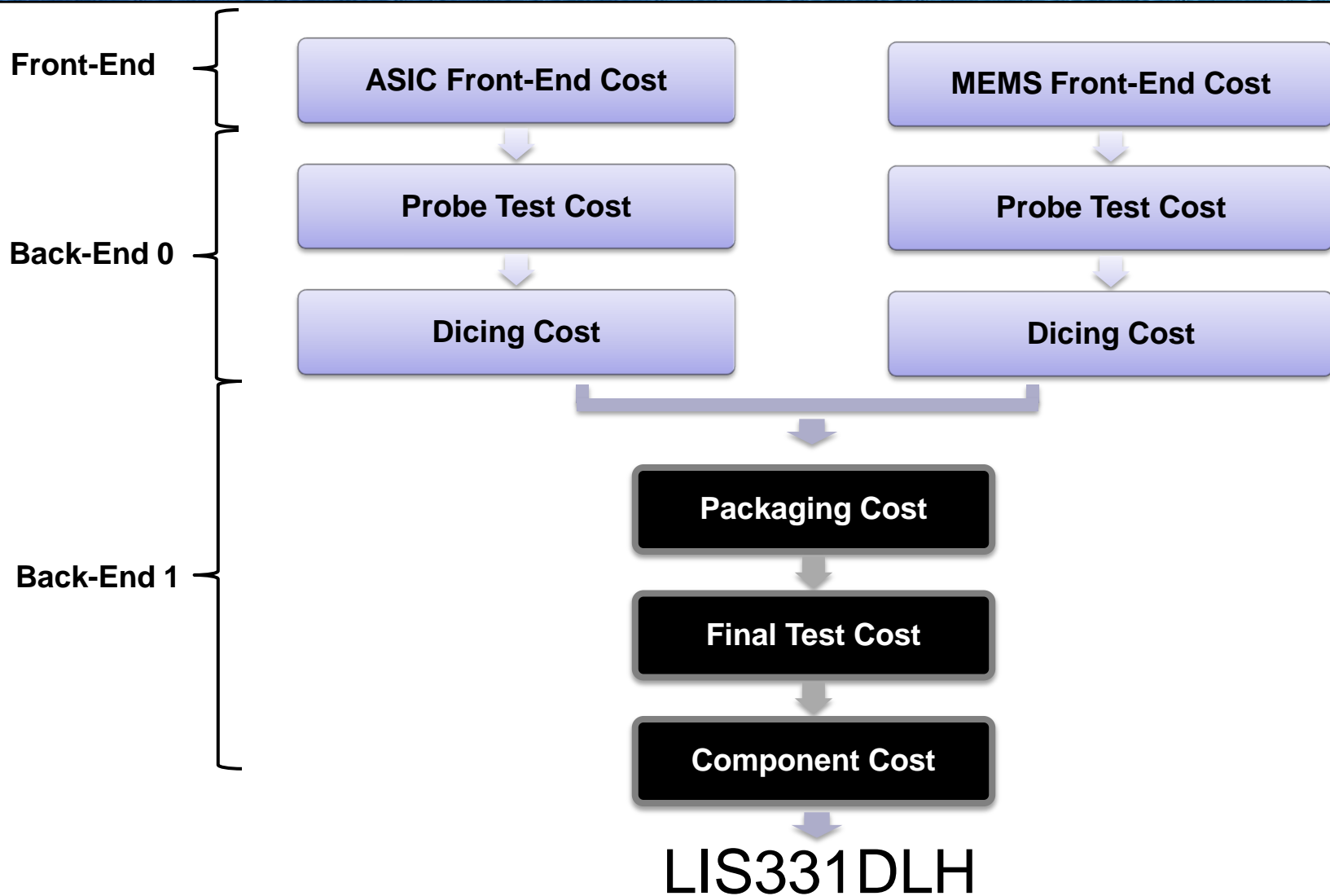
Sensor Wafer Process:

•The sensors are manufactured on a standard 200mm wafer. The xx μ m of poly-silicon is used for the mechanical elements.

•The manufacturing of the sensor begins with a deposition of the isolation oxide 1 (x.xx μ m). A first polysilicon layer (x.xx μ m) is then deposited and patterned and used for electrical interconnects. The sacrificial oxide 2 (x.xx μ m) is then deposited, patterned and the anchor and contact holes are etched.

Sensor Wafer

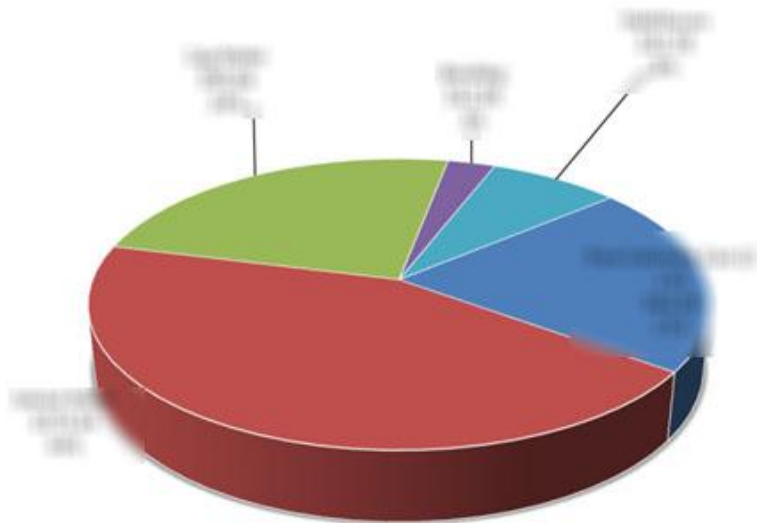
- ◆ Isolation - Inspection
- ◆ Isolation - Clearing
- ◆ Isolation - Thermal Oxide 1 - 2.8 μ m
- ◆ Isolation - Measurement
- ◆ Interconnection - Deposit Polysilicon 1 - 0.4 μ m
- ◆ Interconnection - Ion Implant
- ◆ Interconnection - Thermal activation
- ◆ Interconnection - Measurement
- ◆ Interconnection - Clearing
- ◆ Interconnection - Pattern Poly 1
- ◆ Interconnection - Measurement
- ◆ Interconnection - Etching Poly 1
- ◆ Interconnection - PR Removal
- ◆ Interconnection - Clearing
- ◆ Sacrificial Layer - Deposit Oxide 2 - 1.8 μ m
- ◆ Sacrificial Layer - Clearing
- ◆ Sacrificial Layer - Pattern Oxide 2
- ◆ Sacrificial Layer - Etching Oxide 2
- ◆ Sacrificial Layer - PR Removal
- ◆ Sacrificial Layer - Clearing
- ◆ Sacrificial Layer - Measurement



- We perform the economic analysis of the ASIC with the [IC Purchaser](#) software.
- We perform the economic analysis of the MEMS and the packaging with the [MEMS CoSim+](#) software.

MEMS Manufacturing	Low Yield		Medium Yield		High Yield	
	Cost	Breakdown	Cost	Breakdown	Cost	Breakdown
Raw Substrate Cost (2 x Si)	1000000	25.00%	1000000	25.00%	1000000	25.00%
Sensor Wafer	6750000	80.00%	6750000	80.00%	6750000	80.00%
Cap Wafer	1000000	25.00%	1000000	25.00%	1000000	25.00%
Bonding	1000000	2.00%	1000000	2.00%	1000000	2.00%
Yield losses	1000000	10.00%	1000000	10.00%	1000000	10.00%
MEMS Manufacturing Cost	4000000	100%	4000000	100%	4000000	100%

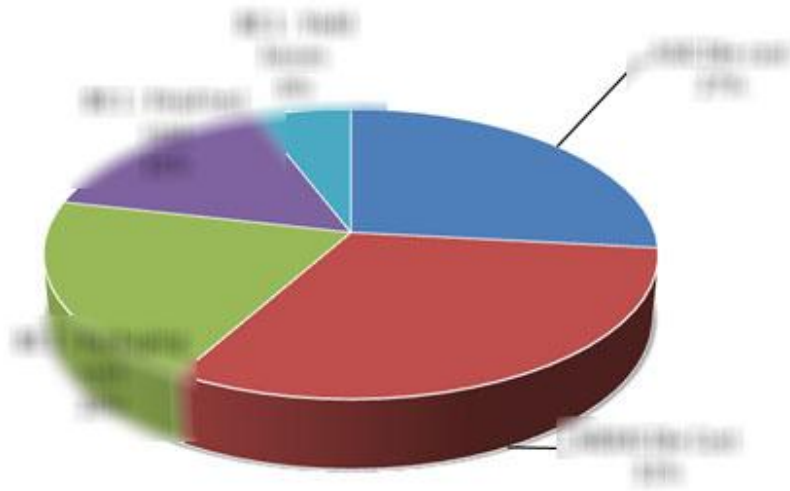
MEMS Manufacturing Cost Breakdown (Middle Yield)



•The **Sensor** represents the main part of the manufacturing cost with **XX%**.

LIS331DLH component cost	Low Yield		Medium Yield		High Yield	
	Cost	Breakdown	Cost	Breakdown	Cost	Breakdown
ASIC Die cost	\$0.110	25.0%	\$0.107	25.7%	\$0.100	25.0%
MEMS Die Cost	\$0.140	32.0%	\$0.130	31.0%	\$0.110	27.5%
BE 1 : Packaging cost	\$0.080	18.0%	\$0.080	19.0%	\$0.080	20.0%
BE 1 : Final test cost	\$0.080	18.0%	\$0.080	19.0%	\$0.080	20.0%
BE 1 : Yield losses	\$0.033	7.2%	\$0.033	8.0%	\$0.037	9.5%
component cost	\$0.433	100%	\$0.410	100%	\$0.397	100%

LIS331DLH Component Cost Breakdown (Medium Yields)



- The component cost is between **\$x.xxx** and **\$x.xxx** according to yield variations.
- The die (ASIC + MEMS) represents **XX%** of the total manufacturing cost.
- The packaging cost represents **XX%** of the total manufacturing cost.
- Final test cost and yield losses (due to packaging and final test) represent **XX%** of the total manufacturing cost.