



How to Bring 3D IC to Maturity Example of a Pacemaker

DEVICE PACKAGING 2014
TP1 3D PACKAGING APPLICATIONS
TUESDAY, MARCH 11, 3:00 pm – 3:30 pm

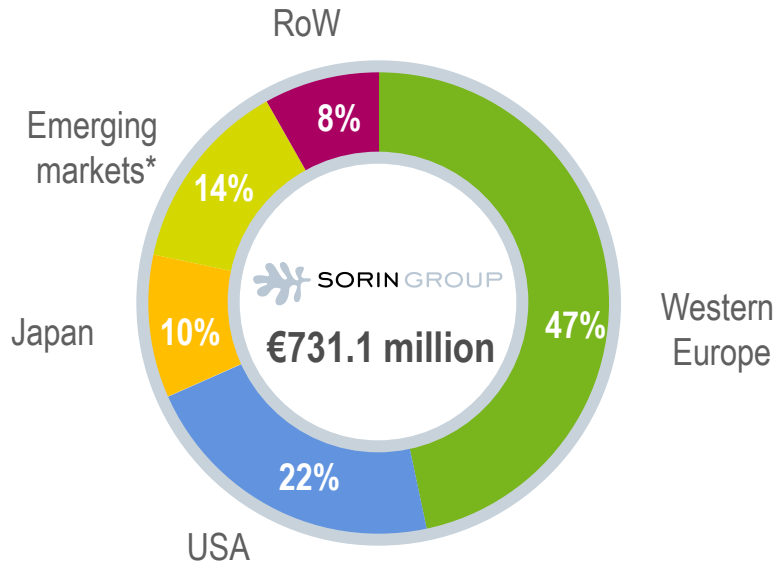
Renzo DAL MOLIN
Pascal COUDERC

SORIN GROUP
3D PLUS

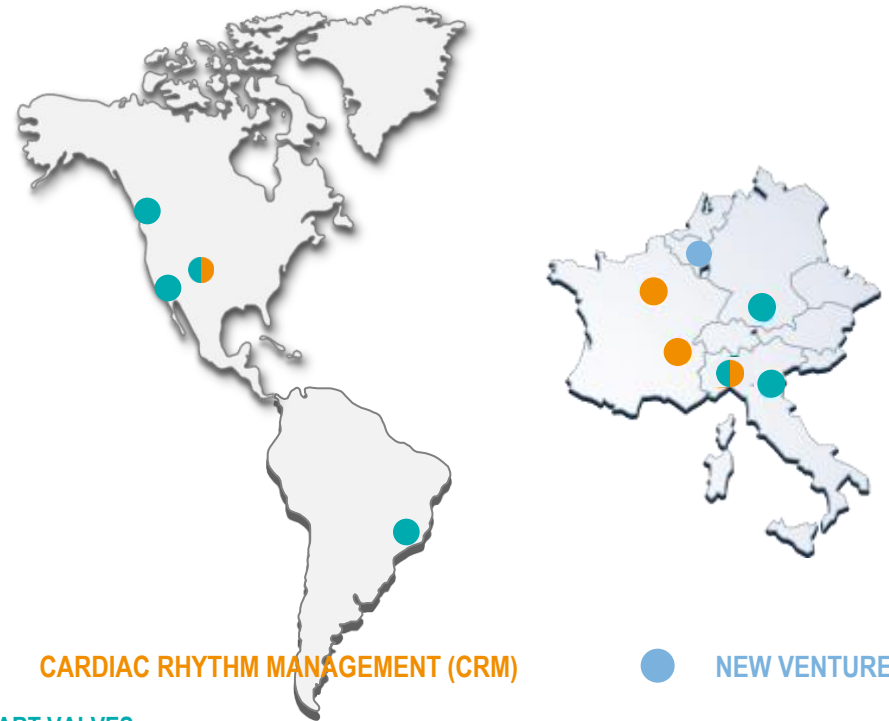
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A global presence

Sales By Geography



Current R&D and Manufacturing Locations



CARDIOPULMONARY PRODUCTS



Mirandola
(Italy)



Munich
(Germany)



Sao Paulo
(Brazil)



Costa Mesa
(USA)



Denver
(USA)



Vancouver
(Canada)



Saluggia
(Italy)



Clamart
(France)



Meylan
(France)



Louvain La Neuve
(Belgium)

HEART VALVES



Vancouver
(Canada)



Saluggia
(Italy)



Clamart
(France)



Meylan
(France)



Louvain La Neuve
(Belgium)

Undisputed market leader



HEART-LUNG
MACHINE

70%



AUTOTRANSFUSION
SYSTEMS (ATS)

34%



OXYGENATORS

31%



 **SORIN** | CONNECT™



Provide integrated solutions
including cardiac surgery procedure
information



 **SORIN** | HEARTLINK™

CRM technologies

DISEASES

Heart Failure

Tachycardia /
Sudden Cardiac
Death

Bradycardia

Arrhythmia

DIAGNOSTICS & TREATMENTS

Cardiac
Resynchronization
Therapy
(CRT-D)

Implantable
Cardioverter
Defibrillator
(ICD)

Pacemaker

Non Invasive
Monitoring

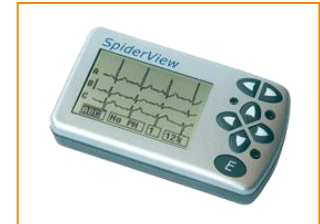
PRODUCTS

Heart failure
Management Systems

Tachyarrhythmia
Management Systems

Bradyarrhythmia
Management Systems

Arrhythmia
Assessment Systems



Bradycardia Pacemaker

IMAPS 10th International Conference on Device Packaging | March 10-13, 2013 | Fountain Hills, AZ, USA



Cardiac Rhythm Management Devices: Key Metrics in 10 Major Markets

Sick Sinus Syndrome Prevalence, 2012	2.38 million
Atrioventricular Block Prevalence, 2012	4.89 million
Ventricular Tachycardia Prevalence, 2012	20.23 million
Ventricular Fibrillation Prevalence, 2012	0.71 million

Tachycardia /Sudden Cardiac Death Implantable Cardioverter Defibrillator (ICD)



Global Cardiac Rhythm Management Market Revenue, 2012

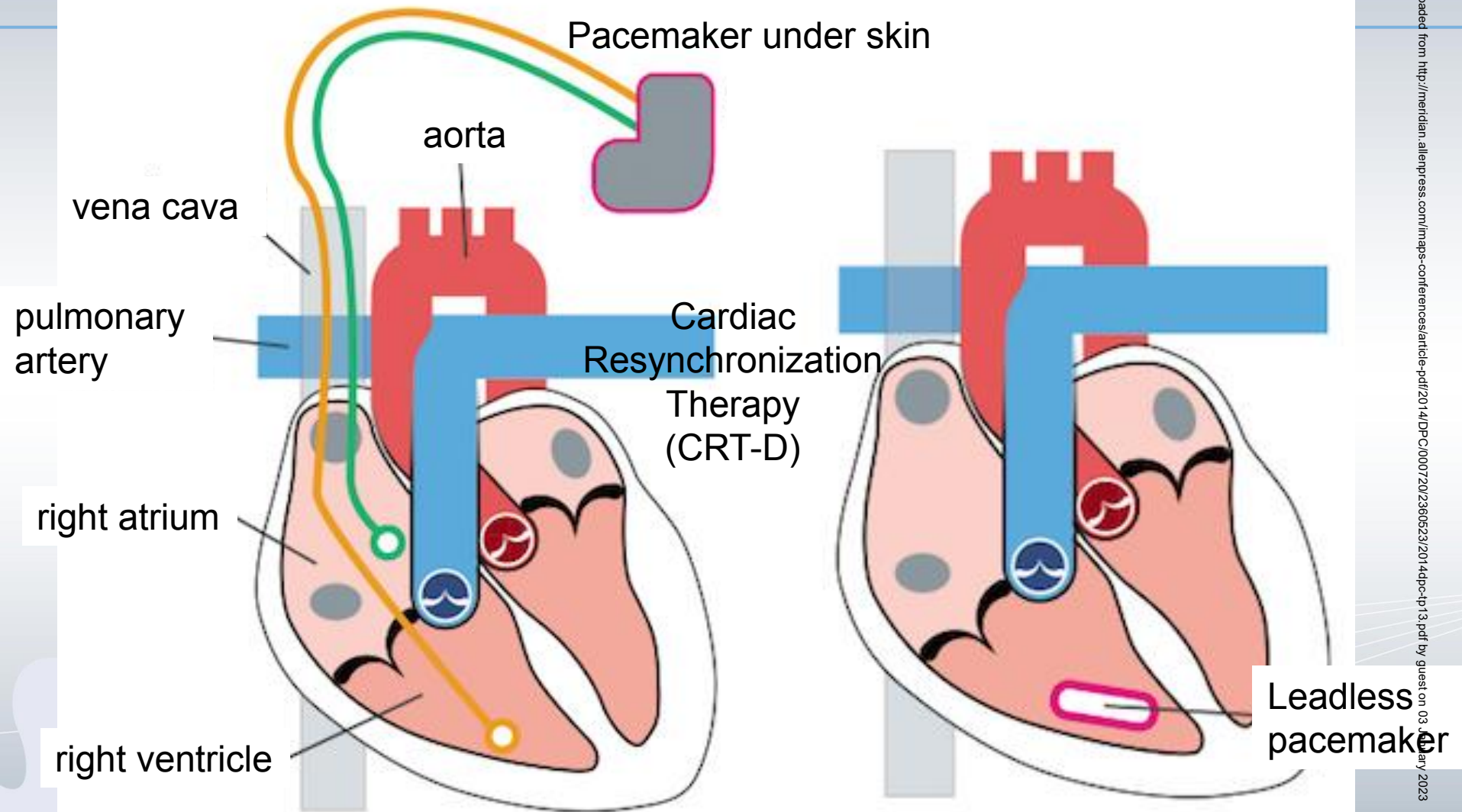
US	\$6.1bn
5EU	\$3.2bn
Japan	\$0.9bn
Emerging Markets (India, China, Brazil)	\$0.9bn
Total	\$11.1bn

Heart Failure Cardiac Resynchronization Therapy (CRT-D)



Forecast Global Revenue by Device Type, 2020

Pacemakers	\$5.3bn
Implantable Cardioverter-Defibrillators	\$6.4bn
Cardiac Resynchronization Therapy Pacemakers	\$0.2bn
Cardiac Resynchronization Therapy Defibrillators	\$3.8bn



50 YEARS OF PACEMAKER TECHNOLOGY

1964

►SCI-4



55 cc
120 g

1977

►STILITH



36 cc
72 g

1988

►CHORUS



16 cc
41 g

2002

►SYMPHONY



10.5 cc
24 g

2007

►REPLY



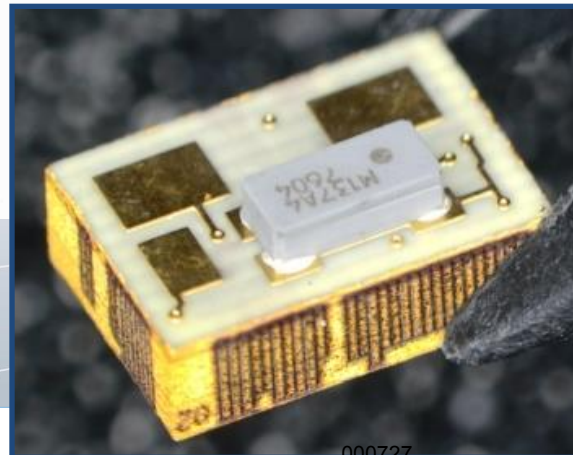
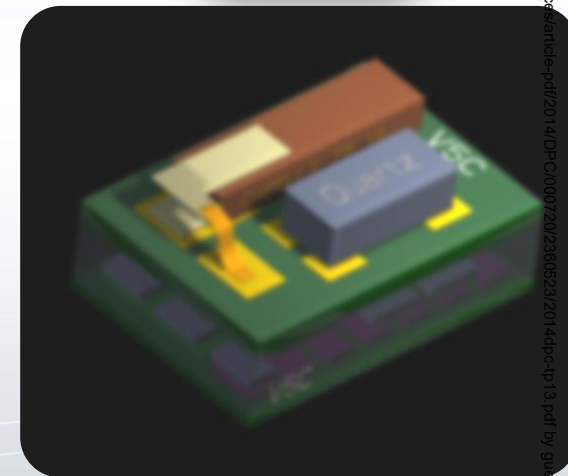
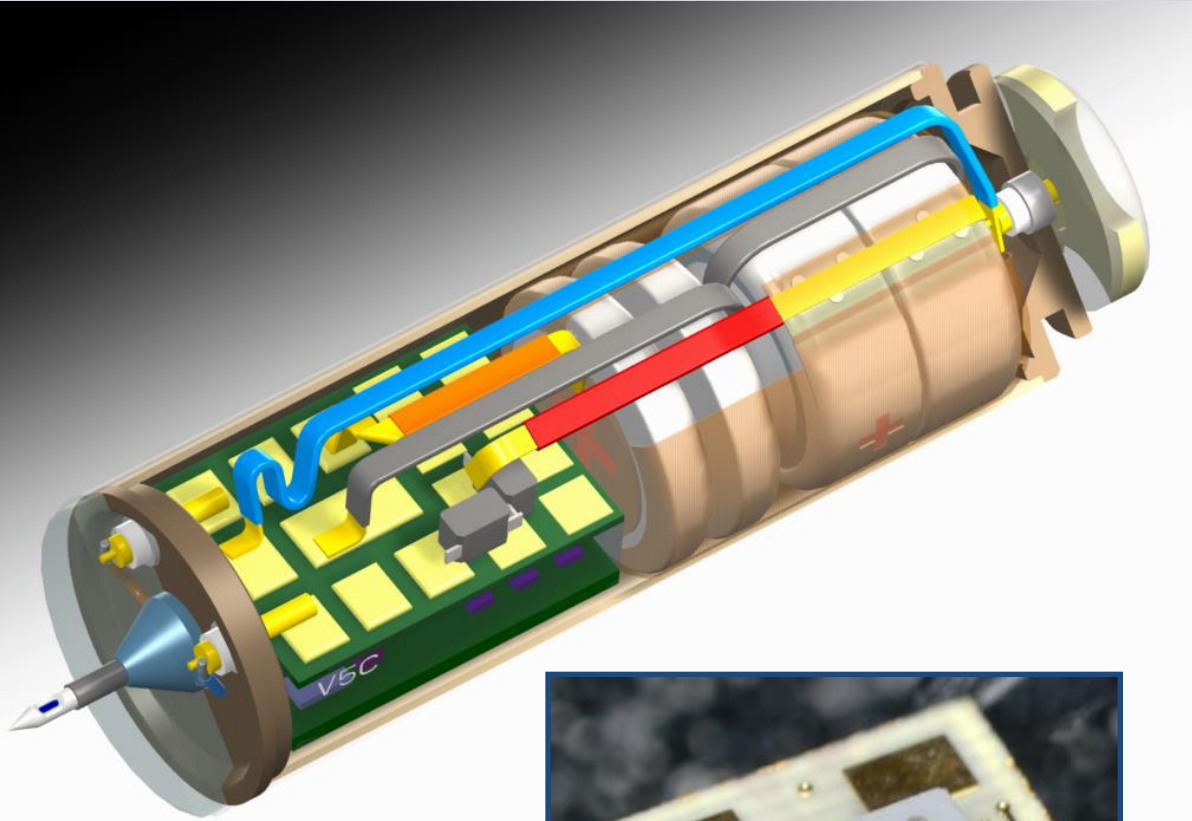
8 cc
20 g

2013



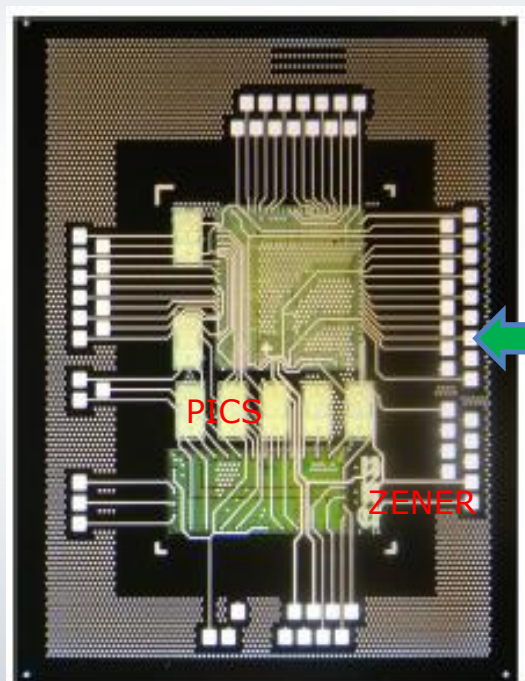
1.5 cc

Battery powered Pacemaker :Electronic Module

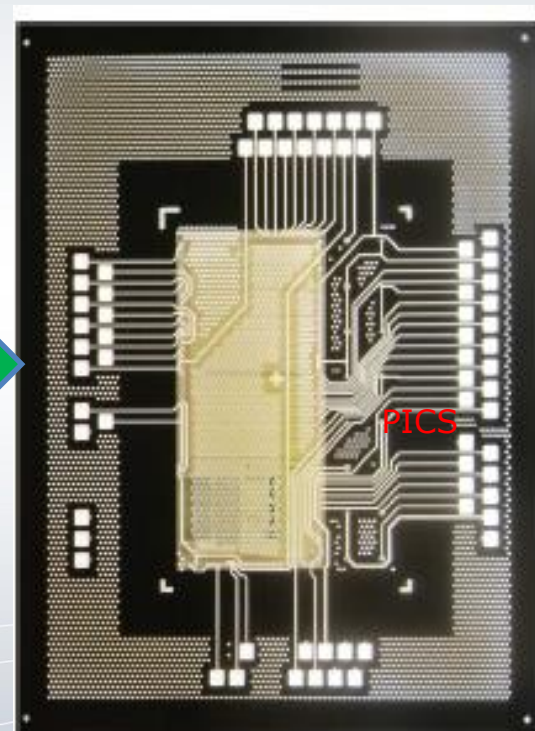


2.3 x 5.2 x 7.3 mm³

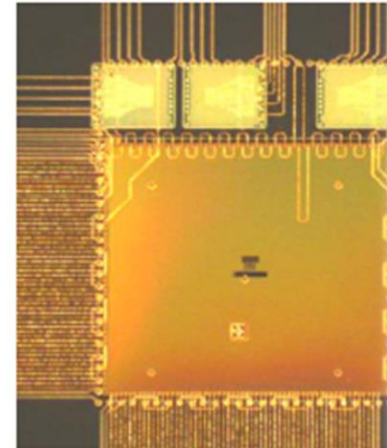
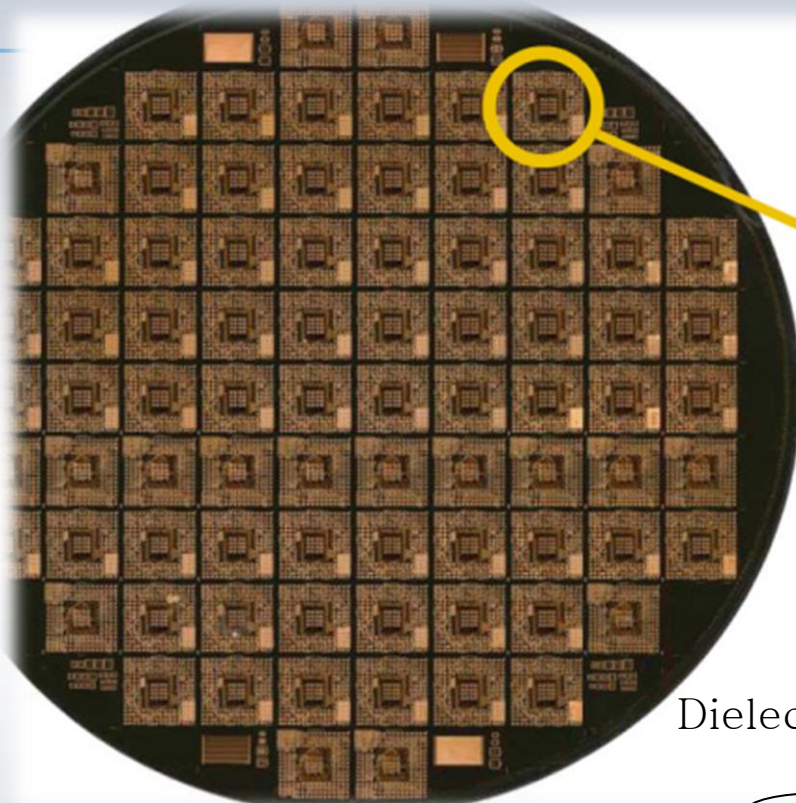
3D PLUS : Nanium RDL status



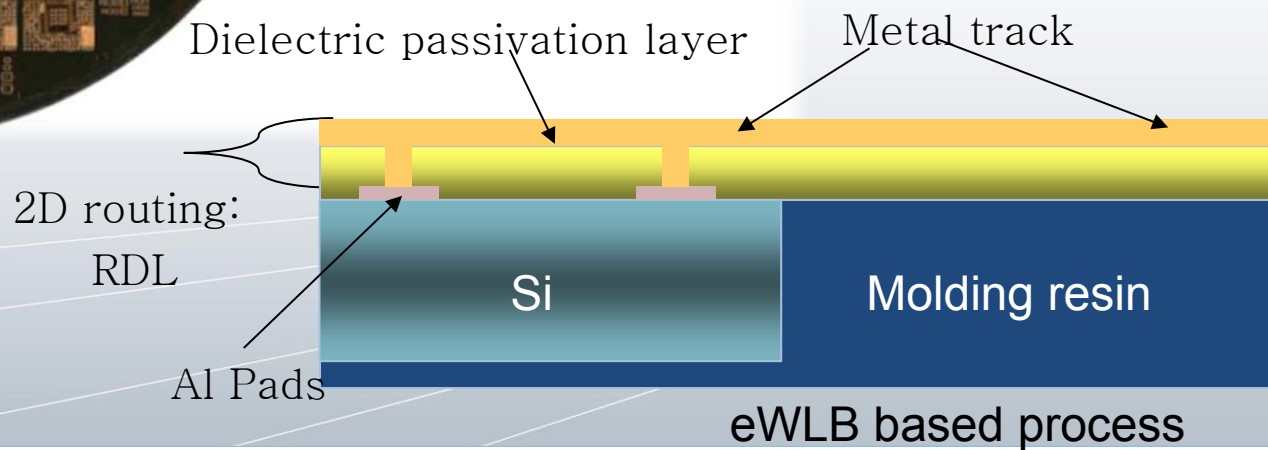
REBUILT
WAFERS
NANIUM
WITH RDL



Technology of the Stacking of Rebuilt Wafers

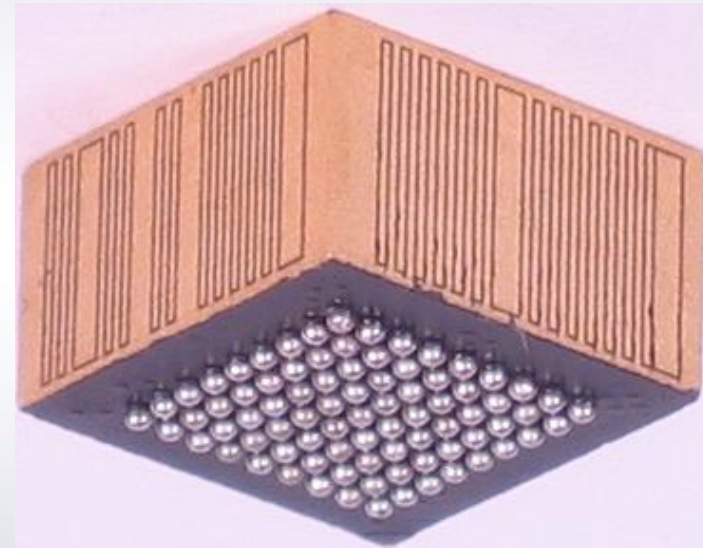
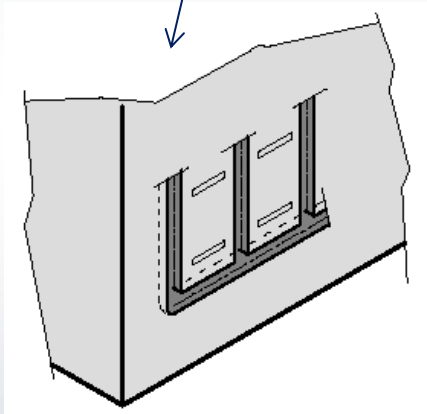


Rebuilt wafer from KGD

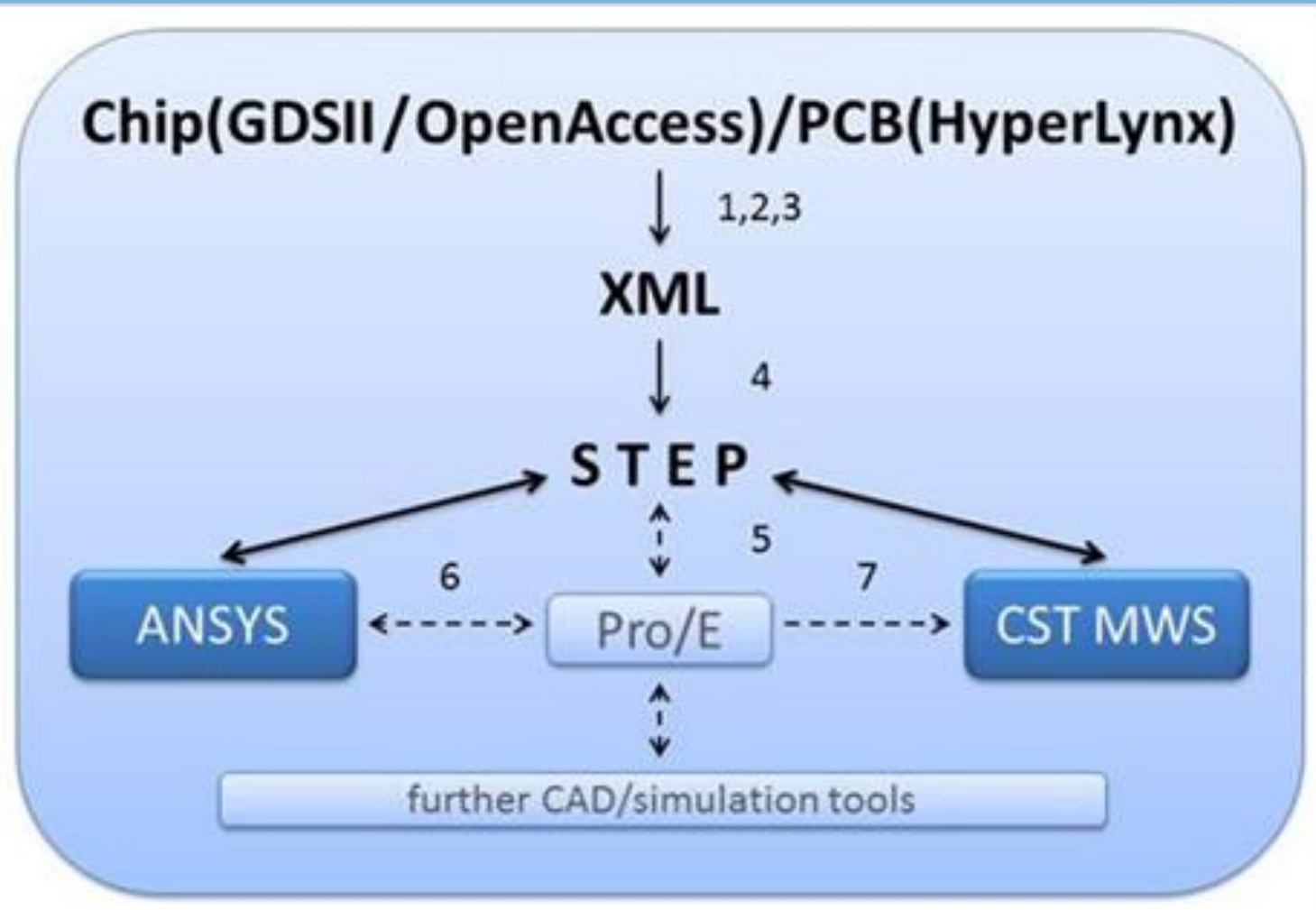


Technology of the Stacking of Rebuilt Wafers

Laser patterning

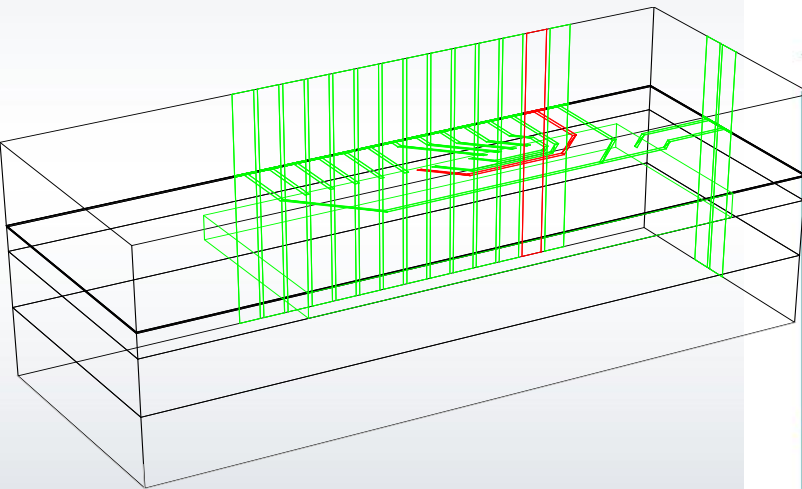


- **Stacking of Known Good Rebuilt Wafer (KGRW)**



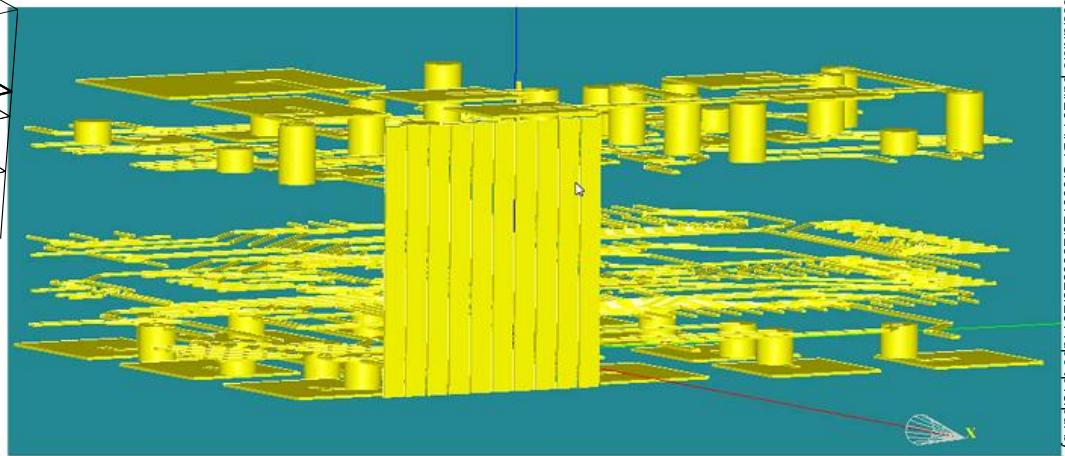
Routing constraints on 3D module

- ▶ Total capacitance max value 5pF
 - Few signals at 2 MHz, μ P bus



SORIN simulations

All Levels



© Fraunhofer

Fraunhofer simulations

Fraunhofer



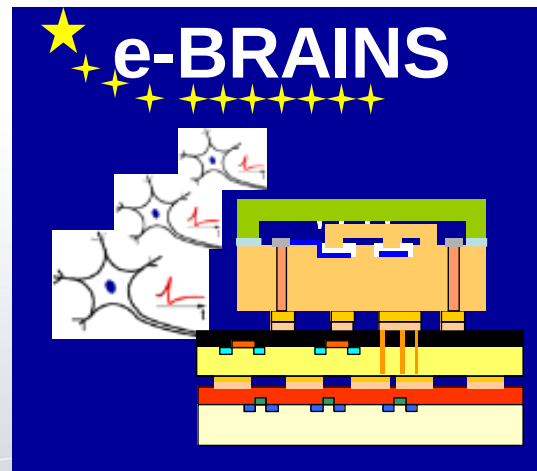
- The yield Y1 of one rebuilt wafer could be from 80 to 99 %
- The yield of “4” stacked rebuilt wafers could be from 41% to 96%
- Interconnections yield Y2 between stacked wafers can induce another 1 to 20 % losses
- Global yield : $(Y1)^n * Y2$ can be in the range 33% and 95%



Conclusion

- In the e-Brains project we proved the feasibility of realizing prototypes of 3D IC heterogeneous integrated modules for all the electronics of a leadless pacemaker in a very small volume
- We need to work on the process yield

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