HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3rd Technical Presentations Day / ESTEC

Noordwijk, 3rd May 2006

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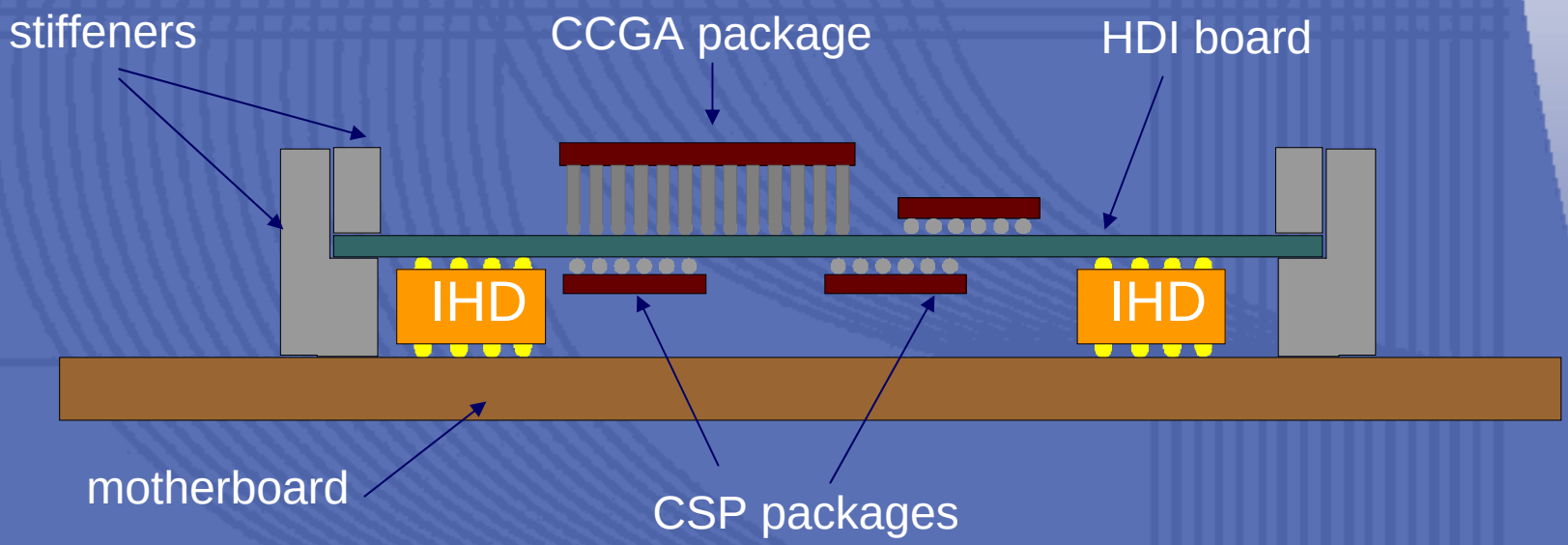
SUMMARY

1. Scope
2. WP1 Feasibility and definition of the demonstrator
3. WP2 Assembly of demonstrators
4. WP3 Characterization of demonstrators
5. Conclusion

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

1. Scope

development of a demonstrator module with high density interconnection taking into account results obtained from previous evaluation carried out on CCGA, CBGA and CSP.



HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

1. Scope
   - the demonstrator could be used as support for :
     - any kind of BGA package evaluation
     - BGA repair evaluation
     - new lead free alloy evaluation
   - the study was divided in 3 work packages :
     - WP1 : Feasibility and definition of demonstrator
     - WP2 : Assembly of demonstrators
     - WP3 : Characterization of demonstrators

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - Feasibility step led to list requirements for :
     - First level packaging
     - Second level packaging
   - First level packaging : Assembly of CCGA and CSP packages :
     - Considerations on the printed circuit board :
       - » Microvia technology was required for the routing of CSP packages
       - » The choice of the material should be compliant with reliability of CCGA and CSP packages
       - » In case of polyimid board : stiffening of the board is required for improved mechanical behaviour of CCGA packages

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - First level packaging : Assembly of CCGA and CSP packages :
     - Considerations on the printed circuit board :
       - » thermount material could be an alternative as assembly of CCGA packages was proved to be more reliable during thermal cycles and mechanical environments but manufacturing of thermount with microvias does not seem to be controlled
       - » Finition of boards should be compliant with CCGA and CSP packages but also with interposers
       - » Design of the board should include fixations (mechanical holes) for stiffening of CCGA packages but also for second level assembly

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - First level packaging : Assembly of CCGA and CSP packages :
     - Choice of CCGA package :
       - » review of existing CCGA packages used by ASIC and FPGA manufacturers
       - » Results from previous evaluations performed by EADS Astrium on the MCGA 472 from Atmel
     - Choice of CSP packages :
       - » Results from previous evaluations performed on ceramic CSP256 with eutectic solderballs (Kyocera)
       - » review of smaller ceramic CSP packages available for better thermal reliability
       - » Review of plastic CSP packages

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - Second level packaging : Interconnection on motherboard
     - Motherboard :
       - Simple routing was foreseen
       - Polyimid material could be used
       - Finitions should be compliant with the use of interposers and test connectors
     - Interconnection
       - Use of IHD 250 interposer for connecting HDI board to motherboard
     - Mechanical constraints
       - Stiffener on the motherboard to fix HDI board with interposers
       - A frame appeared necessary for the HDI board so as to limit warpage
       - Alignment and fixation of the different parts (HDI board, interposer, motherboard) had to be foreseen

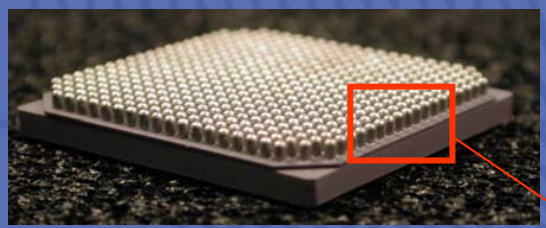
HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Choice and characteristics of packages for first level packaging
       - MCGA 472 from Atmel
       - CCGA 717 from Xilinx
       - New version of Kyocera's ceramic CSP 256 ⇒ with Sn10Pb90 solderballs / Use of ceramic interposers remaining from previous CSP evaluation (ESTEC study) and subcontracting Sn10Pb90 solderballs assembly
       - Ceramic CSP144 packages from Kyocera : two versions of packages
       - Plastic fBGA280 from Topline (plastic version of the CSP256)
     - All selected packages were daisy chained

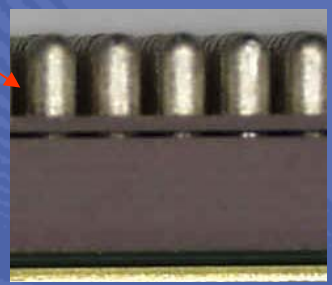
HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

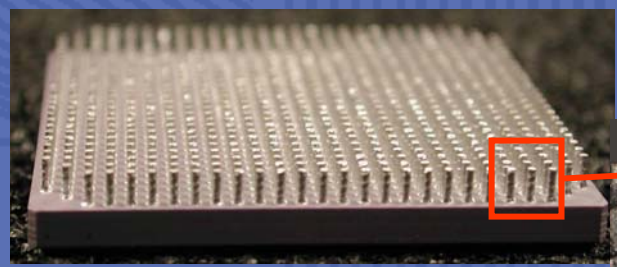
2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Choice and characteristics of packages for first level packaging

Type of package	dimensions	Total height	pitch	type of connections	Diameter of solder columns / solderballs
CCGA 717	35mm*35mm	5.2mm	1.27mm	Columns Sn10Pb90 with copper helix	540µm
MCGA 472	29mm*29mm	4 mm	1.27mm	Columns Sn10Pb90 in SCI	890µm

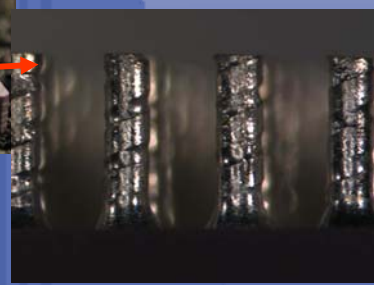


MCGA 472 (Atmel)





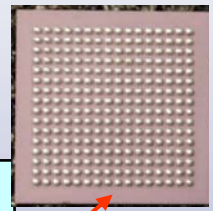
CCGA 717 (Xilinx)

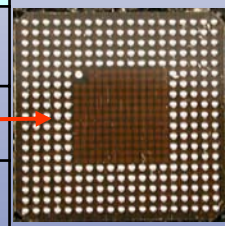


HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

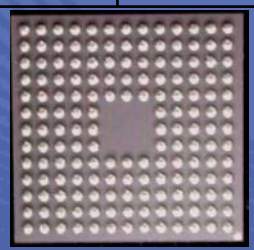
2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Choice and characteristics of packages for first level packaging

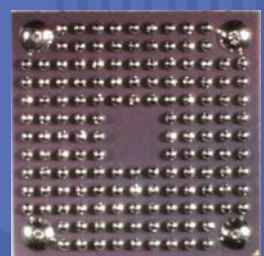
Type of package	dimensions	Total height	pitch	type of connections	Diameter of solder columns / solderballs
CSP 256	15.3mm*15.3mm	1 mm	0.8mm	Balls Sn10Pb90	500µm
fBGA 280	16mm*16mm	1.1 mm	0.8mm	Balls Sn63Pb37	460µm
CSP 144 a CSP 144 b	11mm*11mm	1.5 mm	0.8mm	Balls Sn63Pb37	500µm 124 solderballs with diameter of 500µm + 4 solderballs on each corner with diameter of 1.5mm





CSP 144a

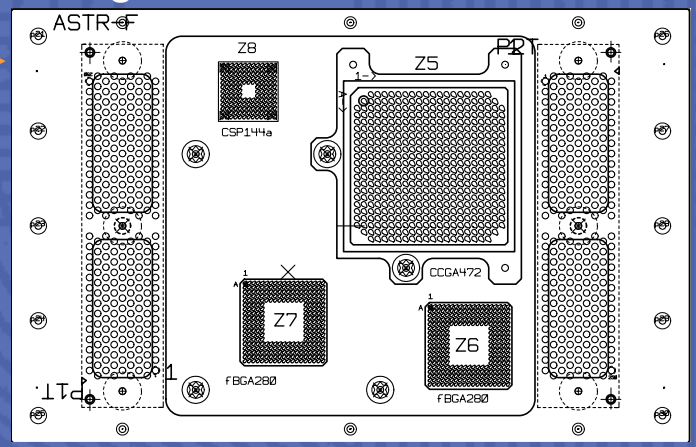


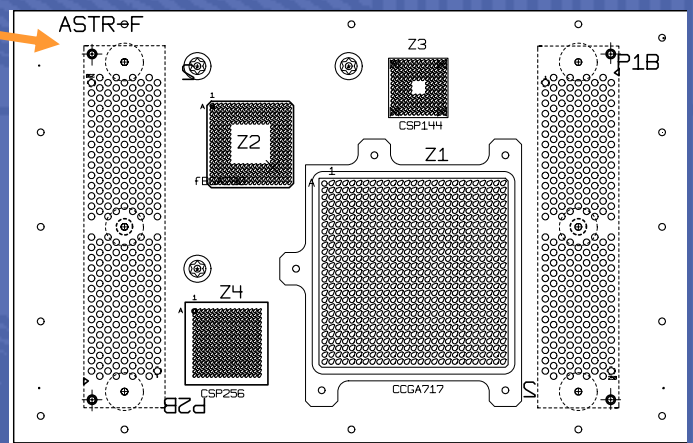


CSP 144b

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

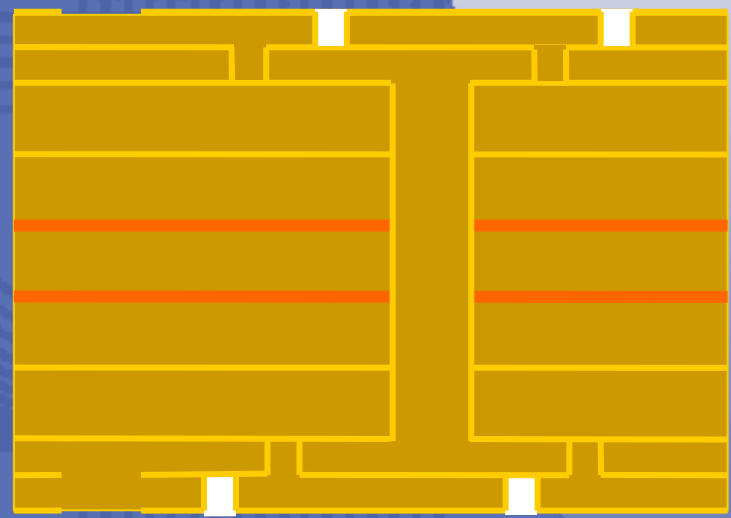
2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Distribution of daisy chained packages on HDI board :
       - Top side :
         - » 1 CCGA 472
         - » 1 CSP144
         - » 2 fBGA 280
       - Bottom side :
         - » 1 CCGA 717
         - » 1 CSP 144
         - » 1 fBGA 280
         - » 1 CSP 256





HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Description of the HDI board :
       - Dimensions of board : 125mm*80mm (= size of specimen used for assembly qualification)
       - Structure of the board : 2+6+2
         - 2 layers of microvias and a core of 6 layers
       - Glass polyimid material for all layers
       - Thickness : 2.4mm
       - 2 thick copper planes of 70µm within the core



Scheme of the construction of the HDI board

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Description of the HDI board :
       - Routing was achieved taking into account the possible need to use the HDI board “upside down” :
         - » IHD patterns routed on both sides of the board
         - » I/Os of daisy chains of each package connected to facing IHD patterns
       - Teardrop pads were designed for BGA and CSP packages
       - ACB, Belgium manufacturer, was chosen for the manufacturing of these boards

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

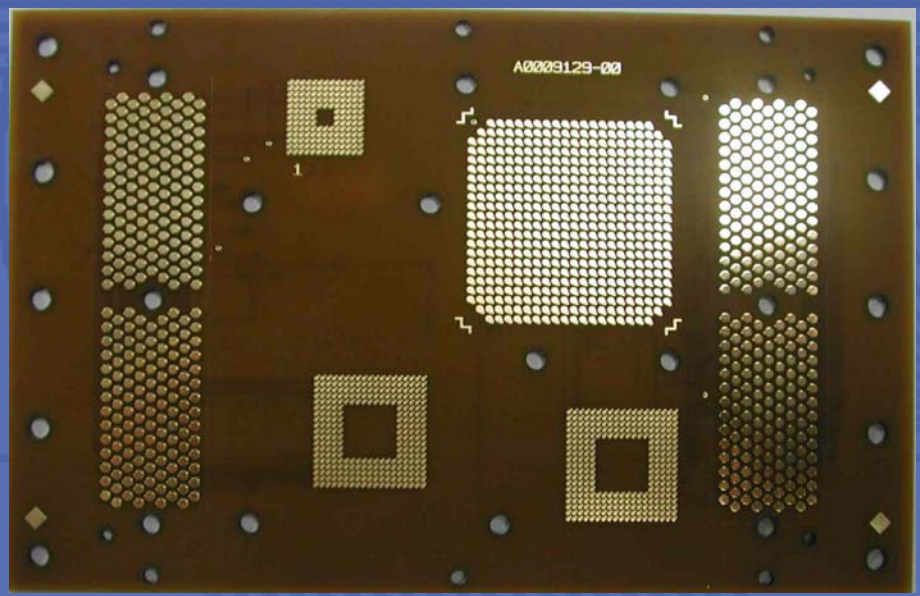
2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Description of the HDI board :
       - Recall of ACB's design rules

	∅via	∅pad on internal layers	∅pad on external layers
microvia	150µm	300µm	300µm
Buried via	300µm	600µm	550µm

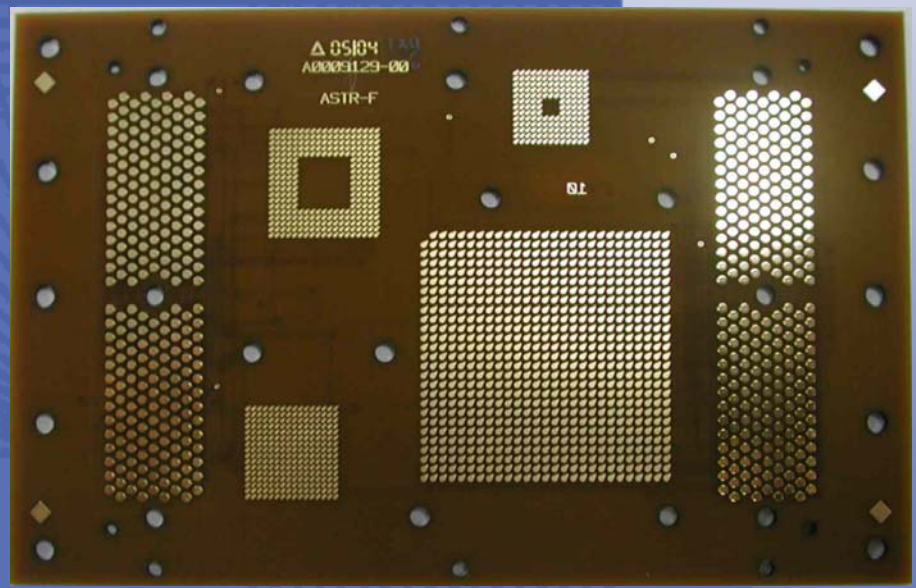
       - Width of track and space : 100µm on external and internal layers
       - Thickness of microvia layer : 60µm
       - Finition :
         - » Electroless Ni immersion Gold (ENIG) for BGA and CSP patterns
         - » Electrolytic NiAu for IHD patterns

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Description of the HDI board :



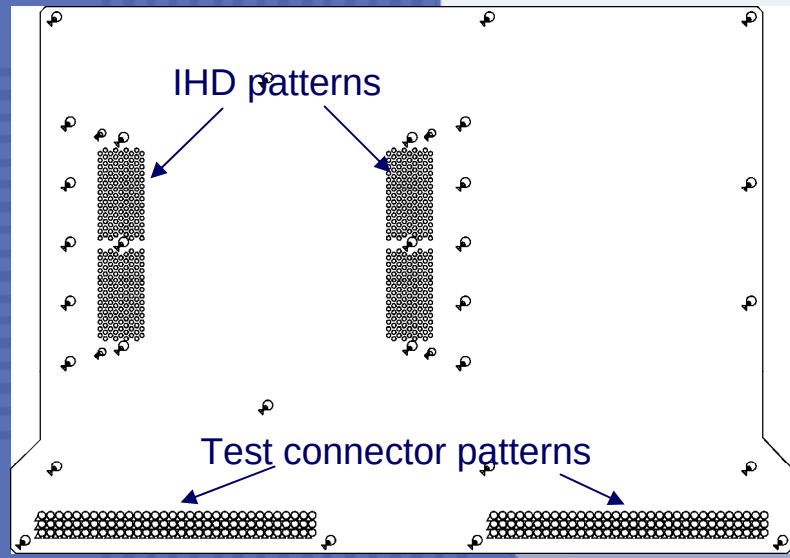
Top view of HDI board



Bottom view of HDI board

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

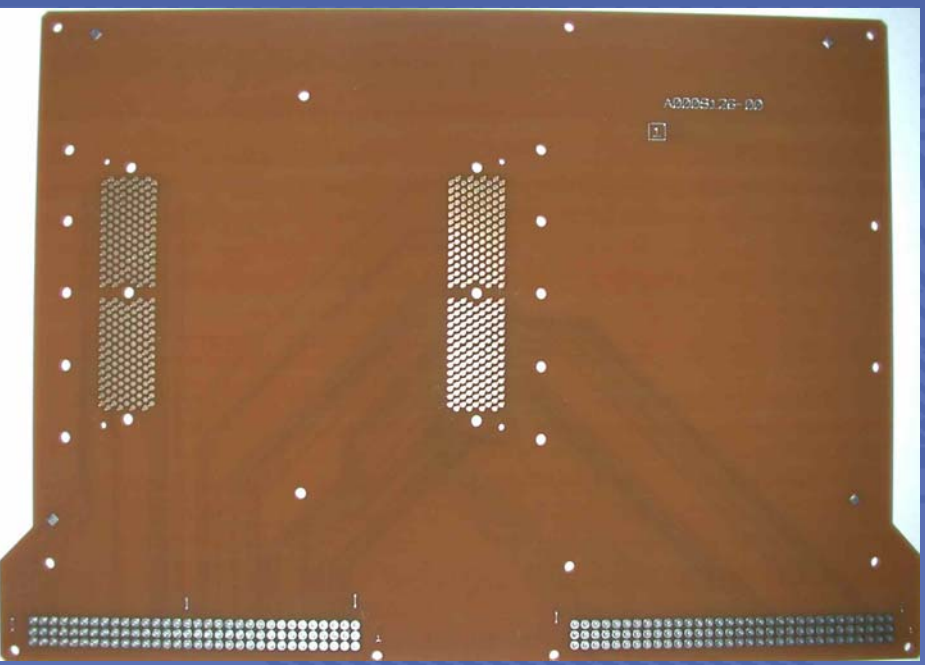
2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Characteristics of the motherboard :
       - Double Europe format
       - Material : polyimid glass
       - Number of layers : 6
       - Thickness : 2.6mm
       - Type of holes & characteristics :
         - » Plated Through Holes
         - » ∅ hole = 330µm and ∅ pad = 550µm
       - Width of track and space = 140µm
       - Finition : electrolytic NiAu (IHD patterns) and SnPb for test connectors pattern



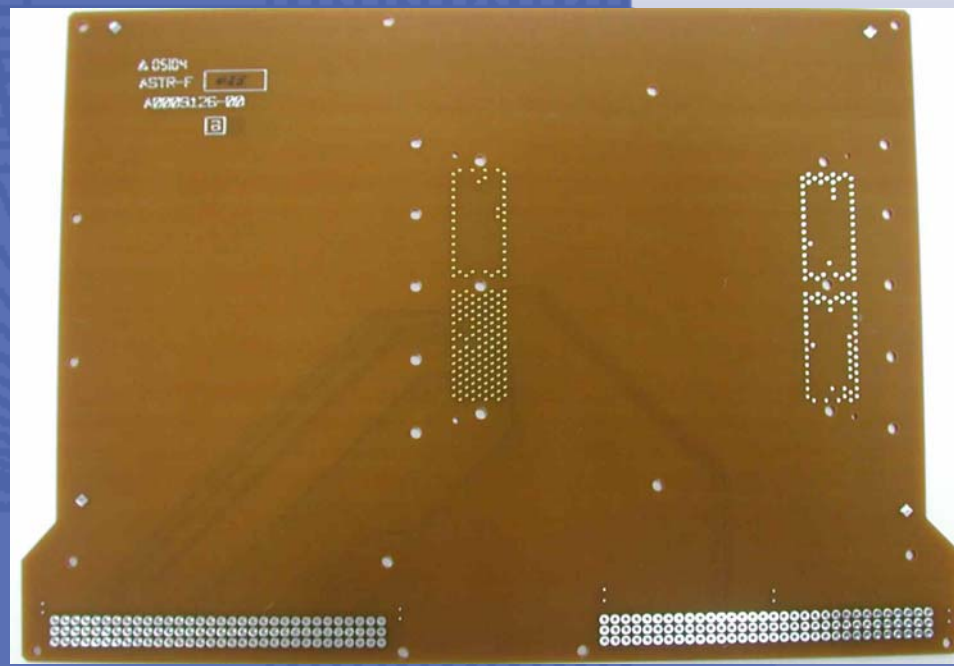
Manufacturing of motherboards was also subcontracted to ACB

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - Definition of the demonstrator
     - Characteristics of the motherboard :



Top view of motherboard



Bottom view of motherboard

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

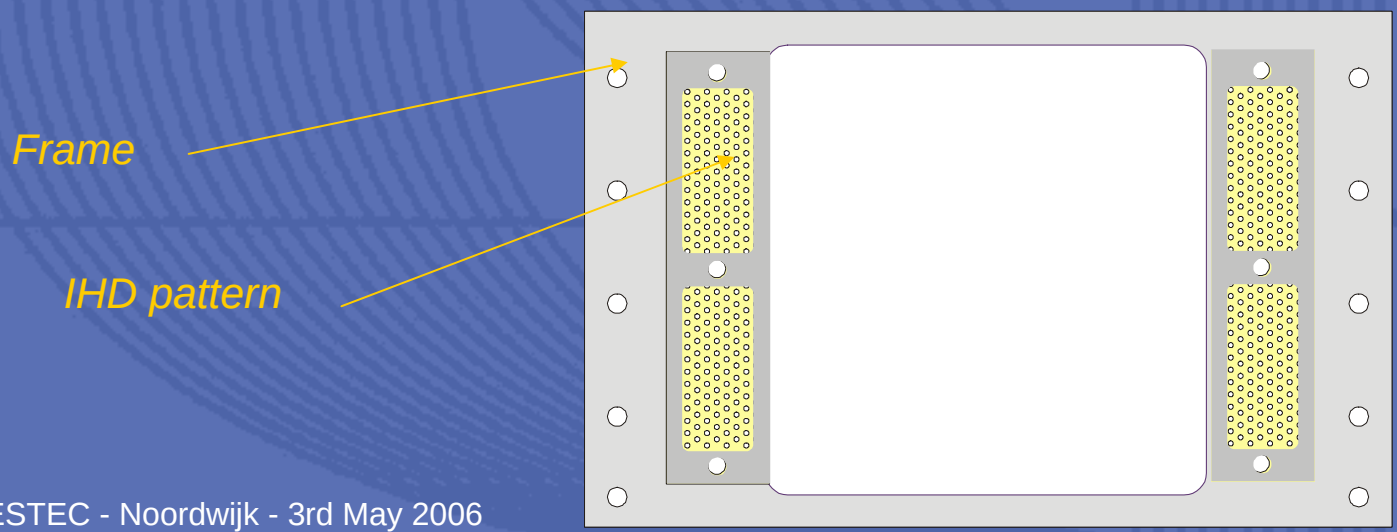
2. WP1 Feasibility and definition of demonstrator
   - Definition of demonstrators :
     - Assembly of HDI boards :

Three configurations of assembled HDI board were defined :

- Demonstrator 1 : Assembly of MCGA 472 and all CSP packages with tin lead process
- Demonstrator 2 : Assembly of CCGA 717 and all CSP packages with tin lead process
- Demonstrator 3 : Assembly of MCGA 472 and part of CSP packages with lead free process

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

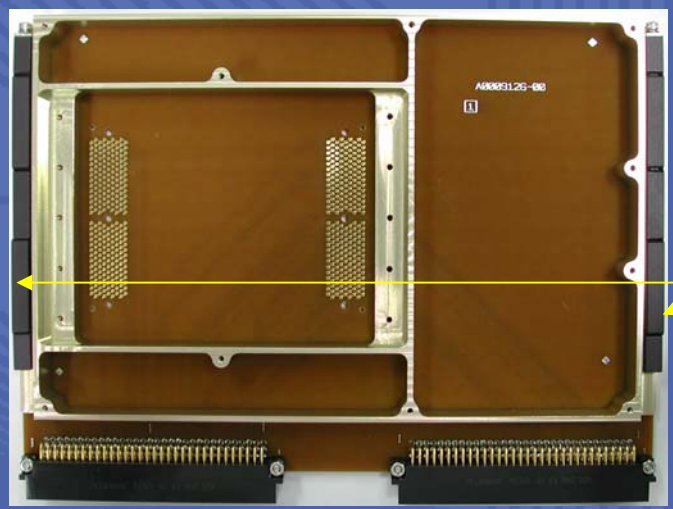
2. WP1 Feasibility and definition of demonstrator
   - Definition of demonstrators :
     - Second level packaging :
       - Design of mechanical tools for assembly of HDI boards on motherboard :
         - » A frame for the HDI board with openings over IHD patterns so as to allow test measurements directly on HDI board and holes for screwing on motherboard and for fixation of IHD interposers



HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

2. WP1 Feasibility and definition of demonstrator
   - Definition of demonstrators :
     - Second level packaging :
       - Design of mechanical tools for assembly of HDI boards on motherboard :
         - » A frame for the motherboard with an area dedicated for the interconnection of HDI board
         - » Holes were foreseen on this frame for fixation of mechanical slides

Motherboard assembled with its frame



HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3. WP2 Assembly of demonstrators
   - Incoming control of printed circuit boards

     HDI boards and motherboards were controlled by EADS Astrium : manufacturing defects were observed on both types of printed circuit boards such as SnPb residues on NiAu pads, blistering, inclusions, measling, scratches on NiAu pads…

     Surprisingly, major defects were found on motherboards, which are characterized by a simple structure (one lamination of 6 layers).

     After ACB's investigations, another batch of 7 motherboards was manufactured.

     The few defects observed on this new batch were considered as acceptable for this study.

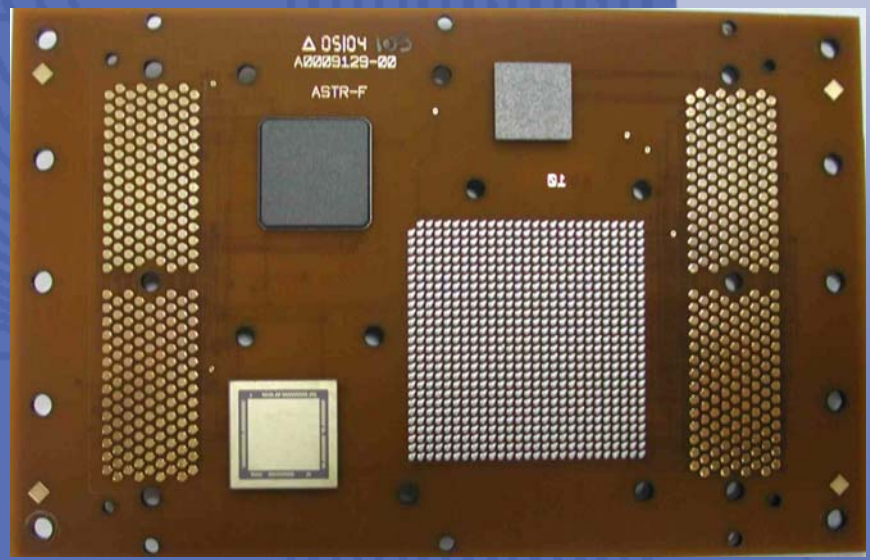
HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3. WP2 Assembly of demonstrators
   - Tin lead process assembly at EADS Astrium
     - Baking of boards and plastic packages
     - Printing of Sn63Pb37 solder paste with semi automatic Sigma Print
     - Pick and place with Mydata equipment
     - Reflow in vapor phase at 215°C
     - Cleaning with Branson machine

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3. WP2 Assembly of demonstrators
   - Assembly of HDI boards for demonstrator 1 :
     - Boards with MCGA 472 package / quantity : 9
       - All packages were assembled except the CCGA 717
       - Assembly was achieved with the standard tin lead process

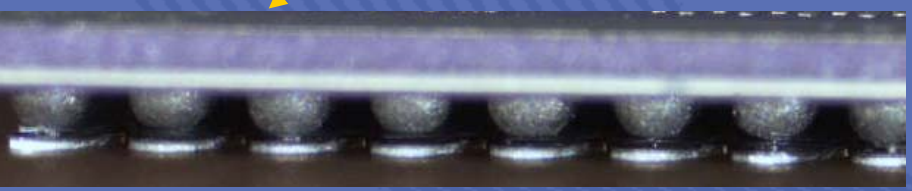
Top view

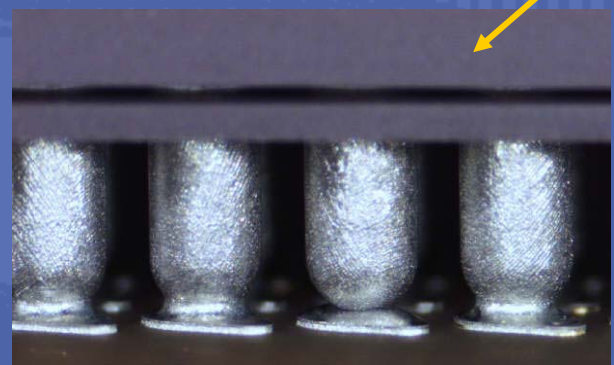


Bottom view

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3. WP2 Assembly of demonstrators
   - Assembly of HDI boards for demonstrator 1 :
     - Boards with MCGA 472 package / quantity : 9
       - Visual, X-ray and electrical test were performed on all boards
       - Visual inspection revealed two assembly defects :
         - » On MCGA package : on two boards, one column (on the same row) of the MCGA was not correctly soldered
         - » On CSP 256 package : on all boards, this package was not correctly sodered because of poor coplanarity of solderballs (reflow of solderballs during balling process ⇒ different height of balls)

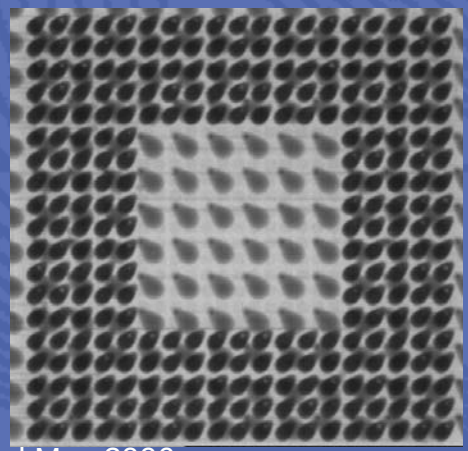


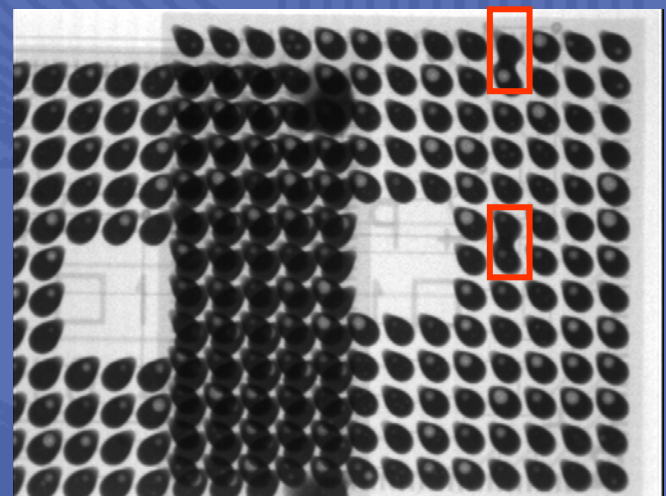


HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3. WP2 Assembly of demonstrators
   - Assembly of HDI boards for demonstrator 1 :
     - Boards with MCGA 472 package / quantity : 9
       - X-Ray inspection allowed to :
         - » Confirm assembly defects noticed by visual inspection
         - » Confirm the correct assembly of plastic fBGApackages : solderballs took the shape of the teardrop pads and presented voids upon microvias
         - » Detect bridges between eutectis solderballs on ceramic CSP 144

fBGA package

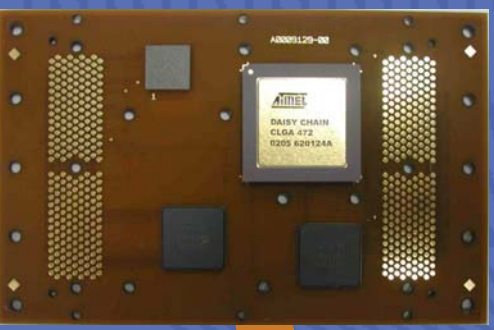


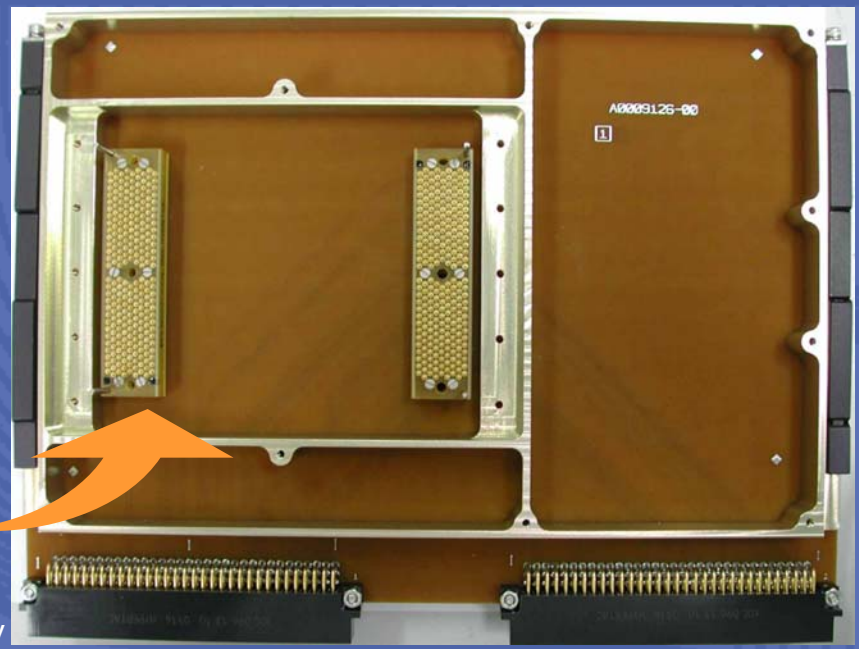


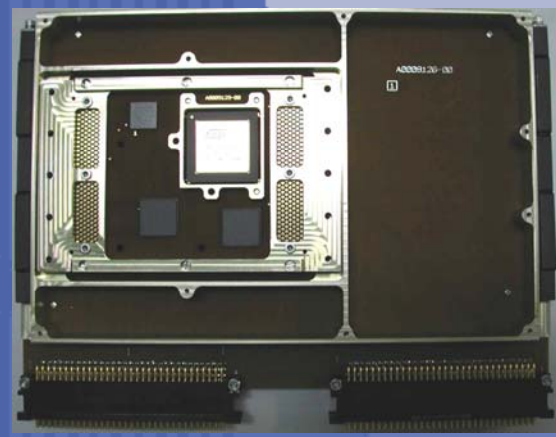
CSP144 package

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3. WP2 Assembly of demonstrators
   - Assembly of HDI boards for demonstrator 1 :
     - Boards with MCGA 472 package / quantity : 9
       - Electrical test :
         - » For testing daisy chains of each assembled package, assembled HDI boards were mounted on motherboards with IHD 250 interposers







Demonstrator 1

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

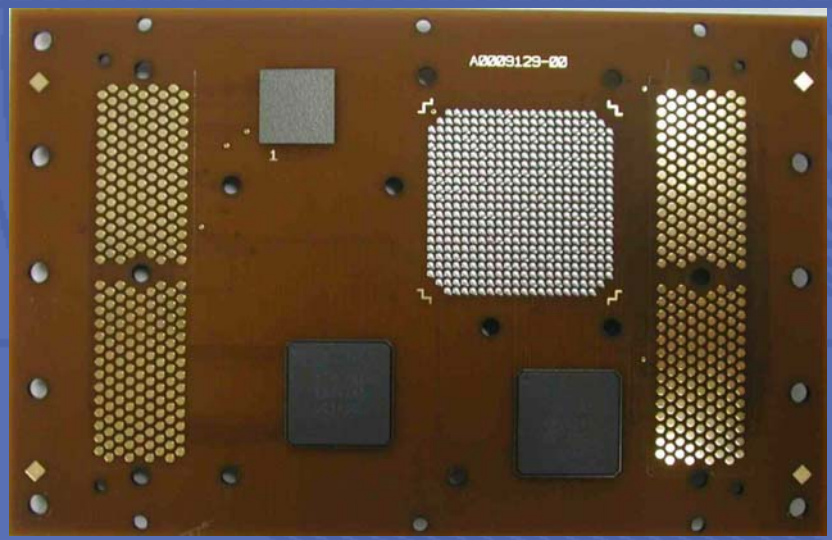
3. WP2 Assembly of demonstrators
   - Assembly of HDI boards for demonstrator 1 :
     - Boards with MCGA 472 package / quantity : 9
       - Electrical test :
         - » Among the nine boards :

           - one open circuit was detected on one of the MCGA 472 characterized by non soldered column

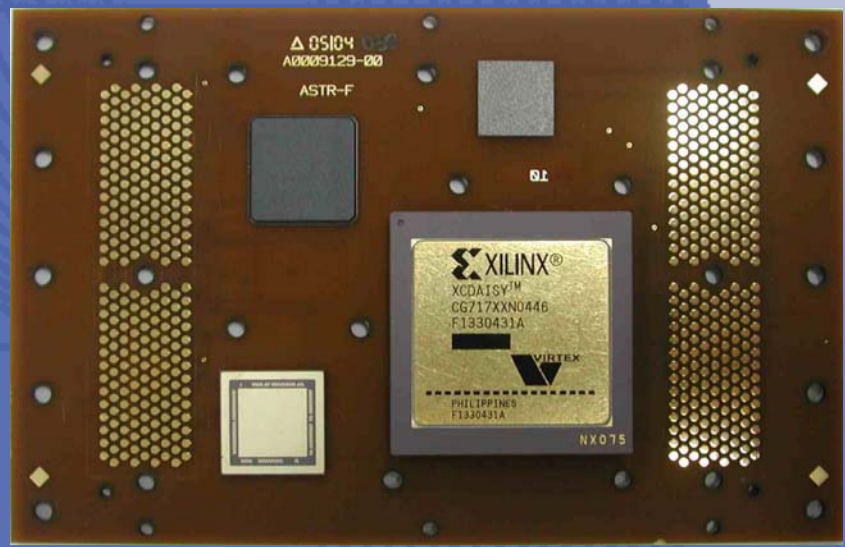
           - all CSP packages (except CSP 256) were characterized by electrical continuity despite bridges observed on CSP 144 on two boards (bridges coincide with daisy chains)

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3. WP2 Assembly of demonstrators
   - Assembly of HDI boards for demonstrator 2 :
     - Boards with CCGA 717 package / quantity : 5
       - All packages were assembled except the MCGA 472
       - Assembly was achieved with the standard tin lead process



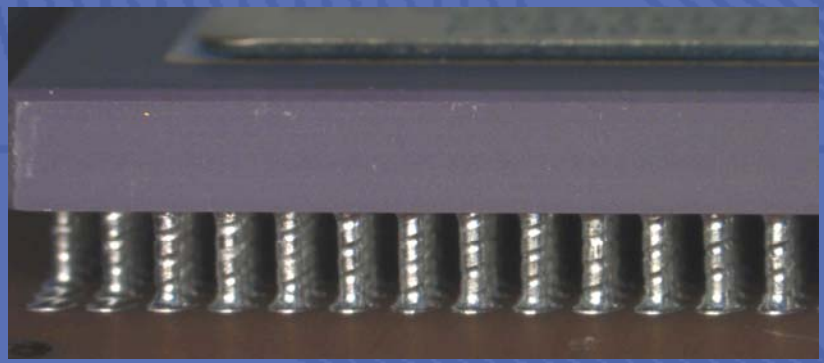
Top view



Bottom view

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3. WP2 Assembly of demonstrators
   - Assembly of HDI boards for demonstrator 2 :
     - Boards with CCGA 717 package / quantity : 5
       - Visual inspection
         - » No assembly defect was noticed on the CCGA 717 nor on the fBGA 280
         - » CSP 256 presented the same assembly defect due to poor coplanarity of Sn10Pb90 solderballs
         - » One of the CSP 144 presented one bridge between 2 solderballs



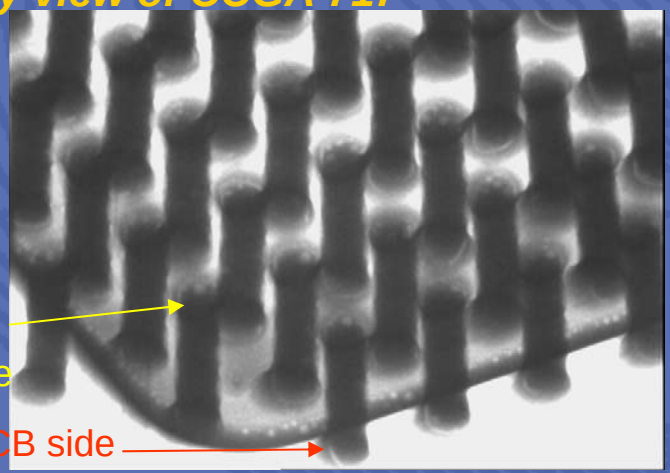
Side view of one asembled CCGA717

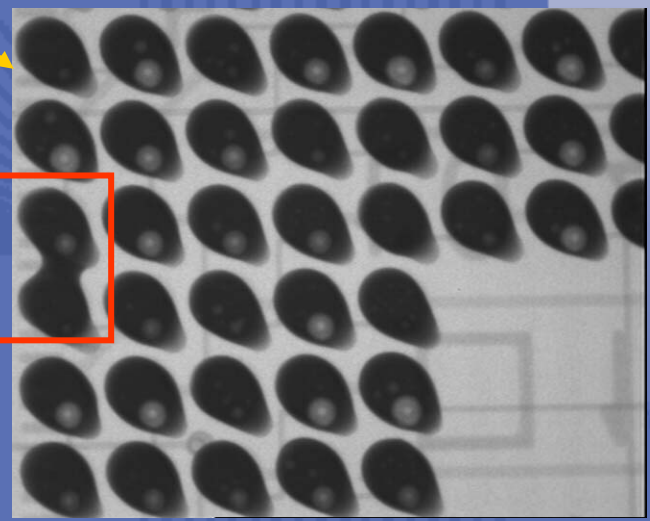
Side view of the bridge of one CSP144

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

3. WP2 Assembly of demonstrators
   - Assembly of HDI boards for demonstrator 2 :
     - Boards with CCGA 717 package / quantity : 5
       - On the five boards, X-Ray inspection allowed to :
         - » Confirm the correct assembly of CCGA 717 package
         - » Confirm the correct assembly of plastic fBGA packages
         - » Confirm the bridge on one CSP144 noticed by visual inspection

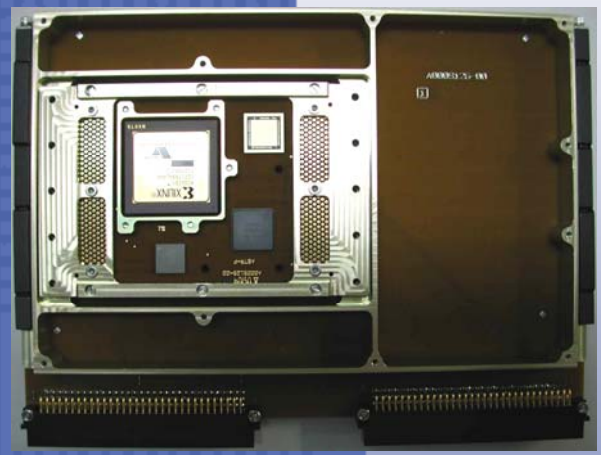
Tilted X-Ray view of CCGA 717





HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

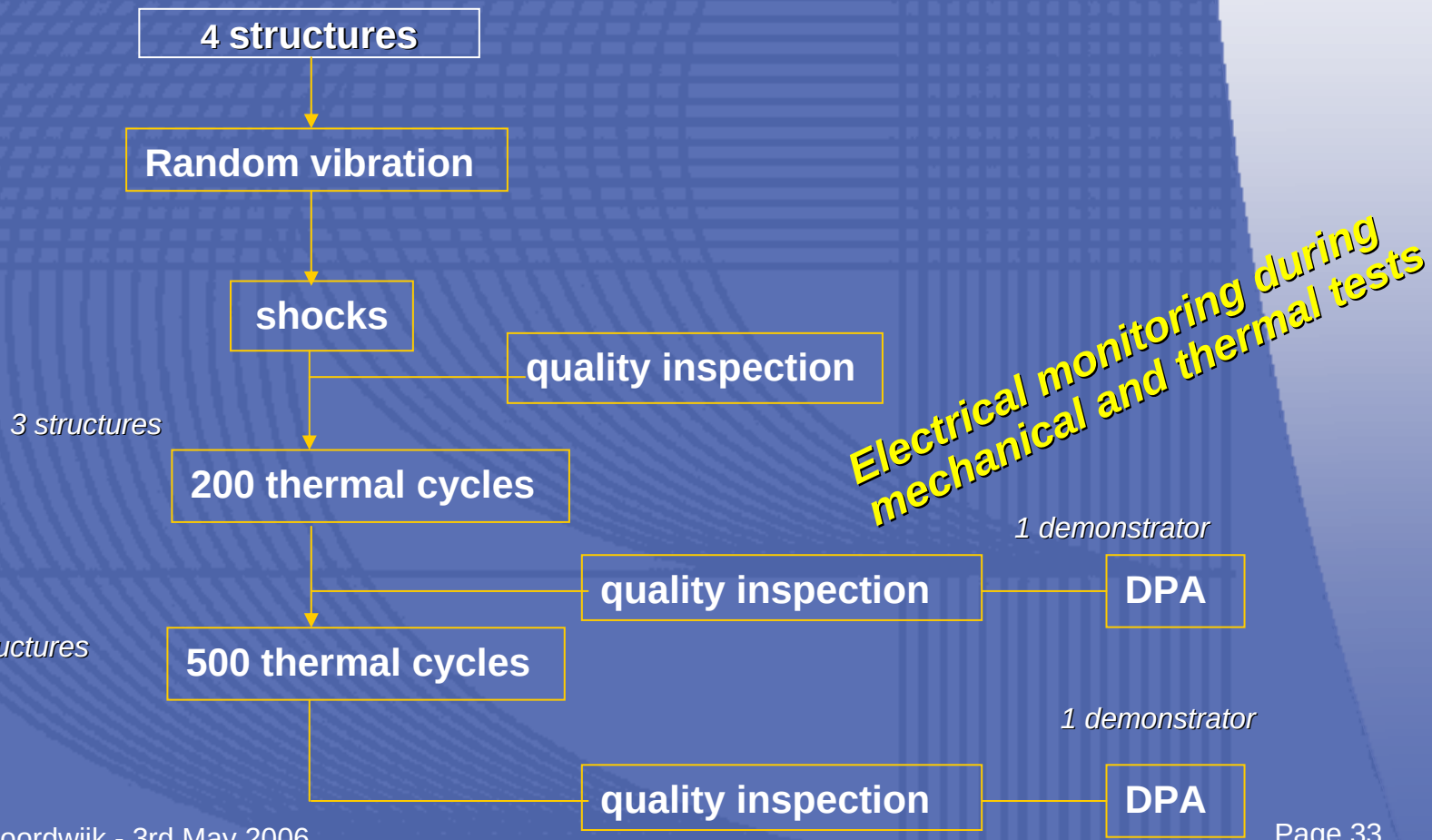
3. WP2 Assembly of demonstrators
   - Assembly of HDI boards for demonstrator 2 :
     - Boards with CCGA 717 package / quantity : 5
       - Electrical test of the five assembled boards
         - » Each assembled HDI board was mounted on motherboard to test daisy chains
         - » All assembled packages were characterized by electrical daisy chains (except CSP 256)
         - » The bridge detected on one CSP 144 was not detected by electrical test as this defect is coincide with the daisy chains



Demonstrator 2

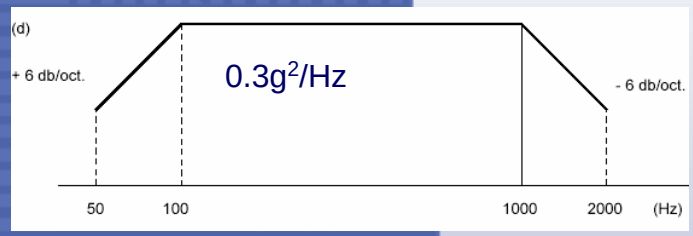
HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

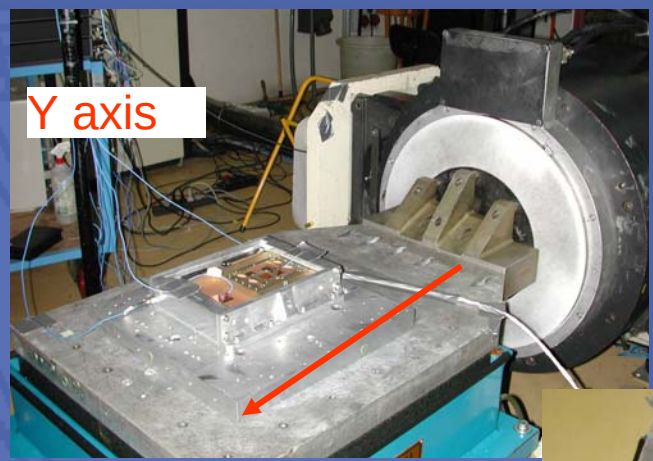
4. WP3 Characterization of demonstrators
   - Test plan for each type of demonstrators

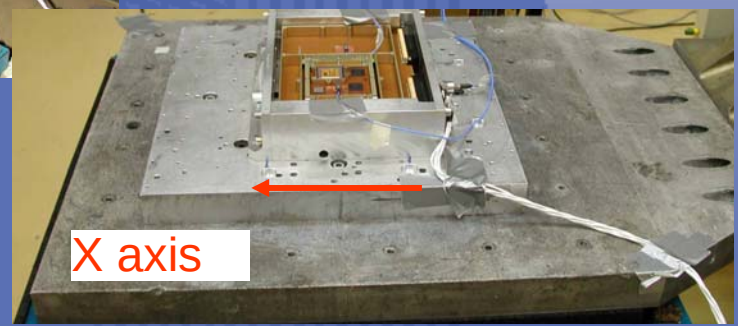


HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of random vibration :
     - Test condition : RNC-CNES-Q-70-508
     - Duration of random vibration : 10mn/axis

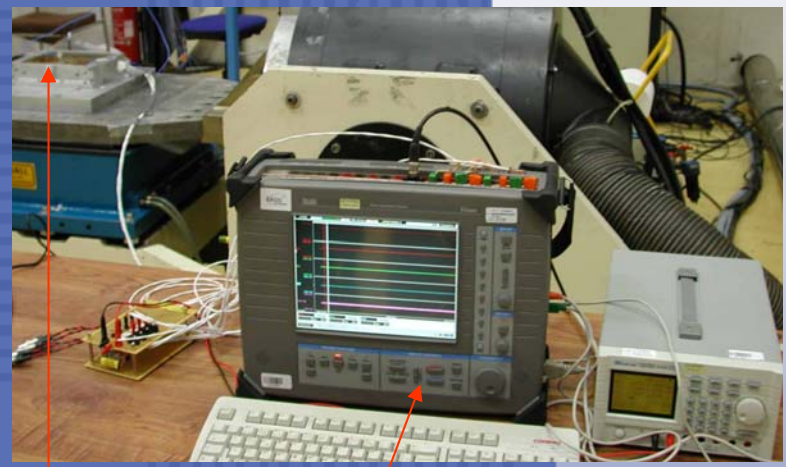


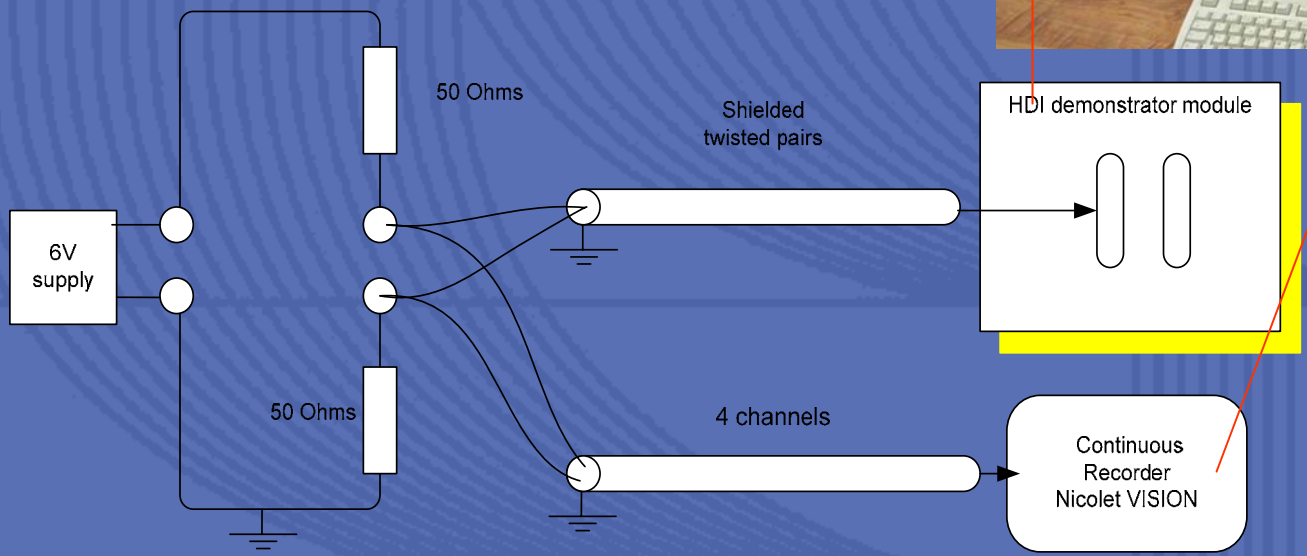




HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of random vibration :
     - Electrical monitoring test bench
       - Sampling : 100kS/sec
       - Resolution : 10µsec on 4 channels



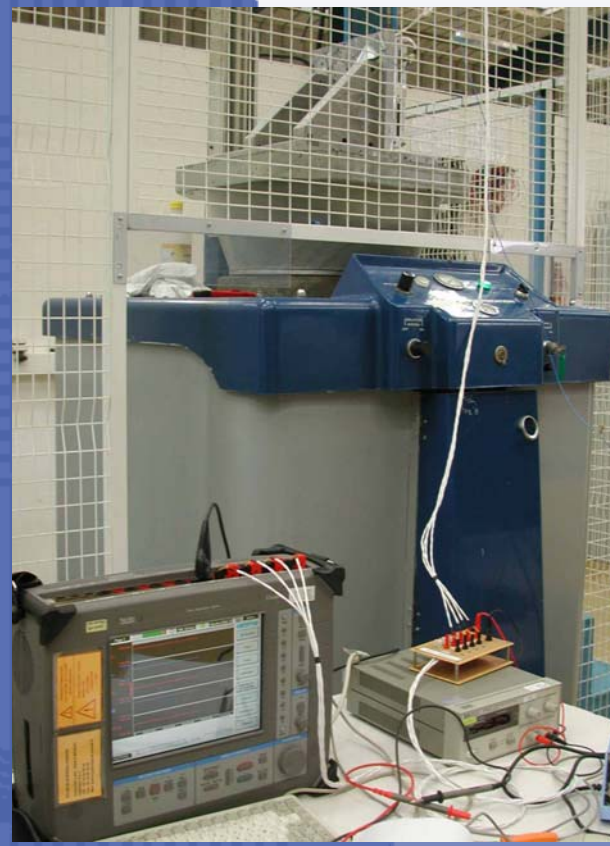


HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of random vibration :
     - Demonstrator 1 : Configuration MCGA472 + CSP
       - During random vibration :
         - » no event was detected related to MCGA package and CSP packages
         - » Few microcuts were detected on daisy chains including only IHD contacts ; largest microcut was about 90 µsec
       - After vibrations, resistance of daisy chains was measured and no variation was noticed
     - Demonstrator 2 :Configuration CCGA717 + CSP :
       - During vibration : no event was detected on all assembled packages
       - After vibrations, resistance of daisy chains was measured and no variation was noticed

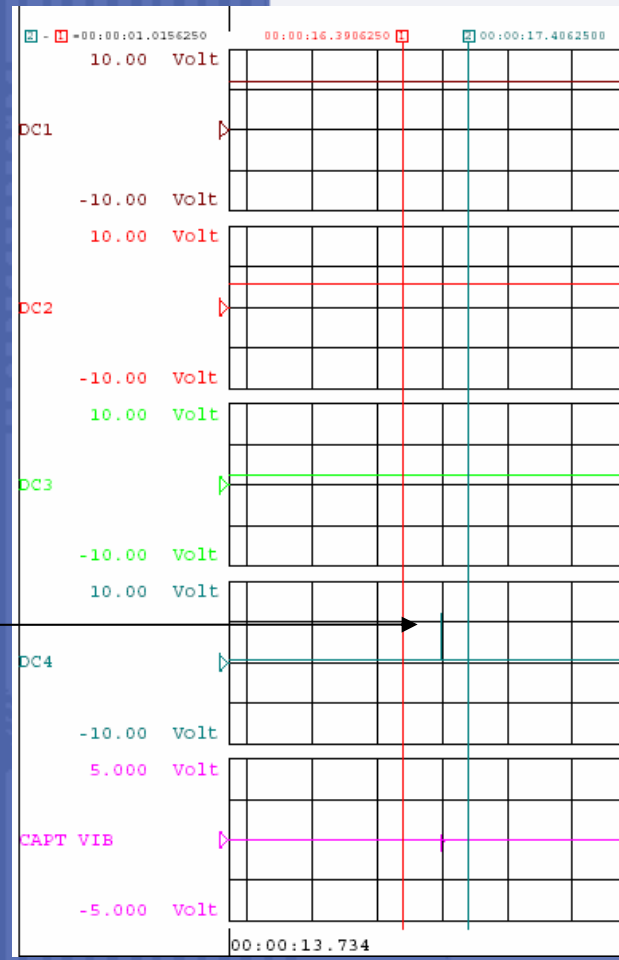
HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of shocks
     - Test conditions :
       - RNC-CNES-Q-70-508 : 600g, 0.5ms, ½ sine along 3 axis
     - Electrical monitoring during mechanical shocks, with the same test bench used for vibration.



HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of shocks
     - Demonstrator 1 : Configuration MCGA472 + CSP
       - No event was recorded on daisy chains of MCGA 472 and on daisy chains of CSP packages, for both levels of shocks
       - Microcuts were recorded on all axes on daisy chain including only IHD contacts (channel 4) :
         - » largest microcut ~ 70µsec
       - After shocks, no variation of resistance of daisy chains was noticed

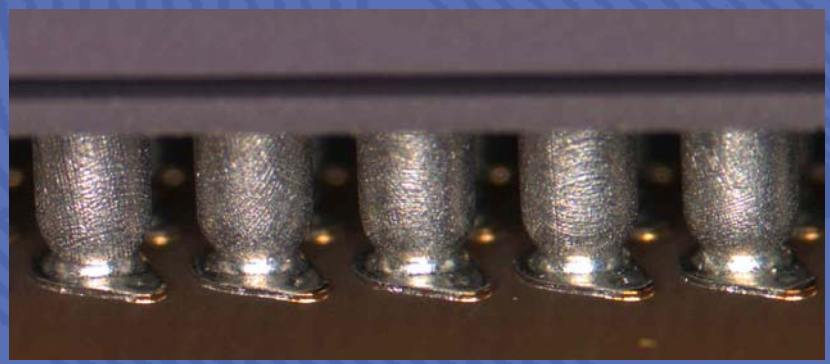


HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

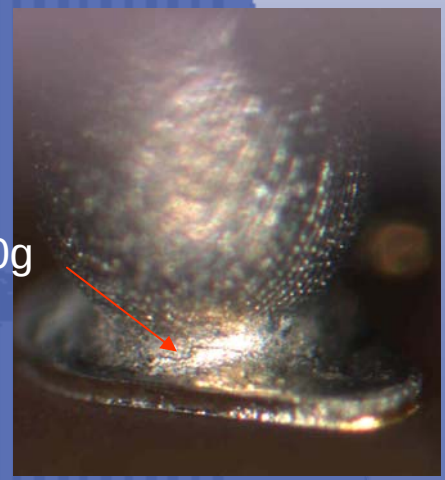
4. WP3 Characterization of demonstrators
   - Results of shocks
     - Demonstrator 2 : Configuration CCGA 717 + CSP :
       - No event was recorded on all assembld packages
       - Microcuts were recorded on daisy chain including only IHD contacts (channel 4) :
         - » along Z axis on two boards : duration of microcuts ~ 50µsec
         - » along Y axis on two other boards : duration of microcuts ~ 40µsec and 170µsec
       - After shocks, no variation of resistance of daisy chains was noticed

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Visual inspection after random vibration + shocks
     - Demonstrator 1 : Configuration MCGA472 + CSP
       - Solderballs of CSP packages remained intact after mechanical tests : no initiation crack was detected
       - On MCGA 472 package, initiation cracks were noticed on corner solder joints



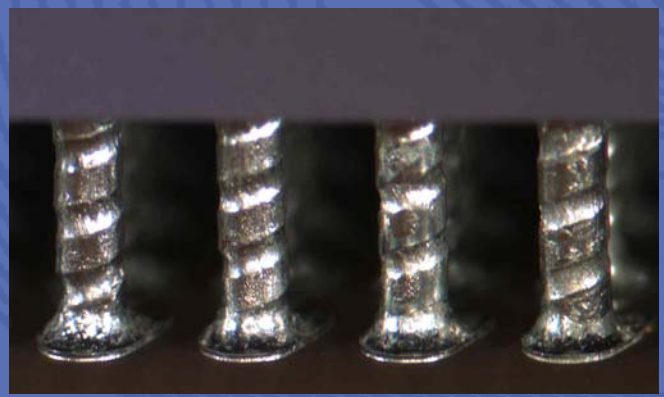
View of solder joints after random vibration + shocks



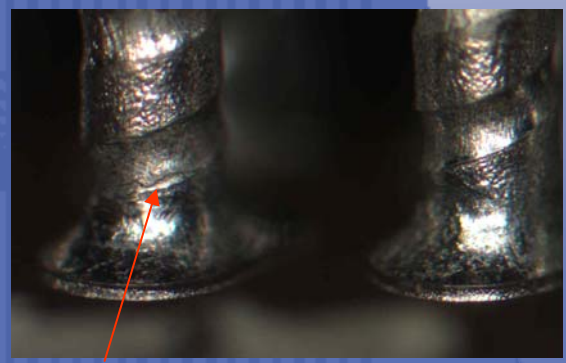
Corner solder columns

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Visual inspection after random vibration + shocks
     - Demonstrator 2 :Configuration CCGA 717 + CSP
       - All CSP packages remained intact after vibrations and shocks
       - On two boards, initiation crack was noticed on the same column of CCGA 717 (column located at one corner)
       - On two other boards : no initiation crack was detected on columns of CCGA 717



View of solder joints after random vibration + shocks



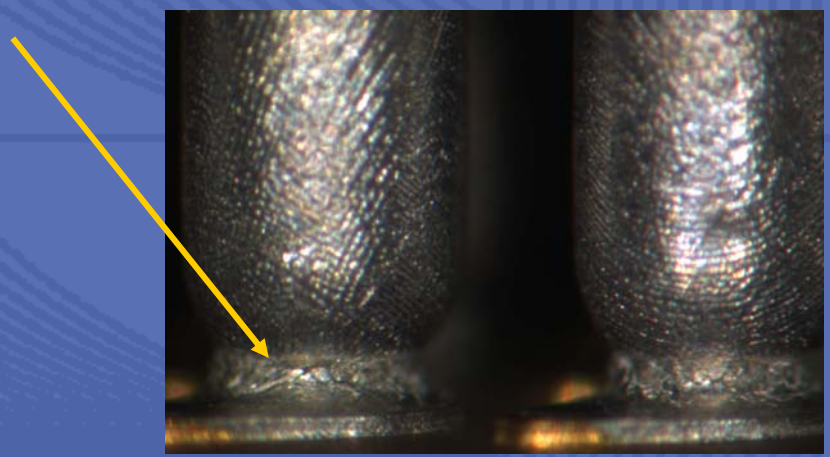
Corner solder column

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Test condition :
       - 500 cycles in the range [-55°C ; 100°C] with 20mn dwell time and 10°C/mn slope
     - Electrical monitoring of resistance of daisy chains
       - Use of HP data acquisition system combined with Benchlink software ⇒ possibility to monitore 120 channels every minute

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

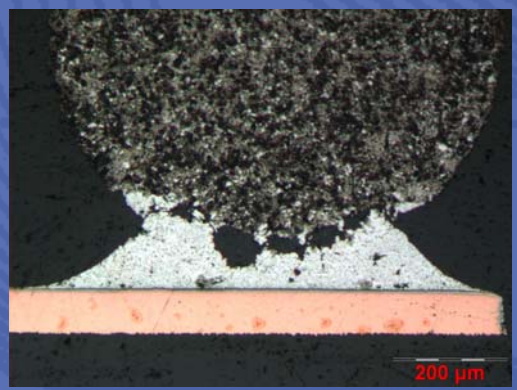
4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 1 : Configuration MCGA472 + CSP :
       - During 200 thermal cycles, no electrical failure was detected on the 4 structures :
         - » Solderballs of CSP packages remained intact
         - » On MCGA 472, ageing of solder joints was observed on all boards and initiation cracks were noticed in the middle of external rows of solder joints

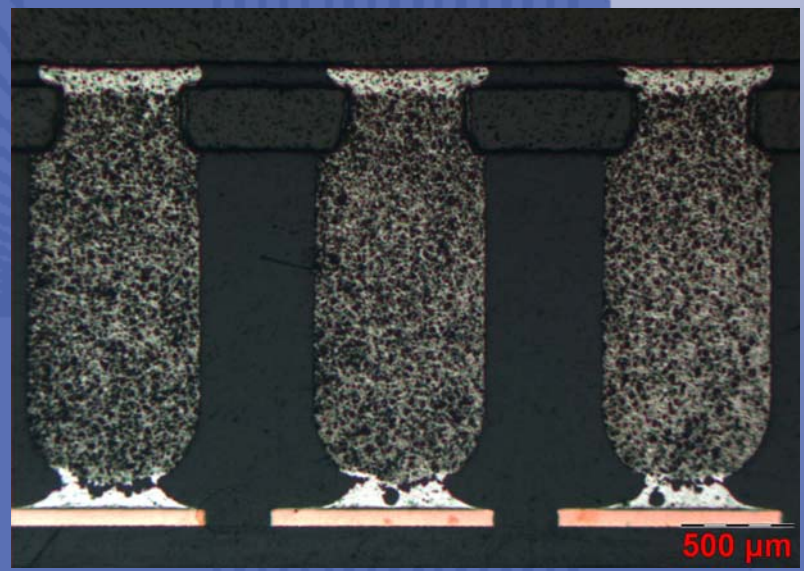


HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 1 : Configuration MCGA472 + CSP :
     - Microsection after 200 thermal cycles
       - On board which underwent 600g / MCGA 472 package
         - » Poor solder joints were noticed (new stencil manufacturer)

- » Cracks were noticed on board side





HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

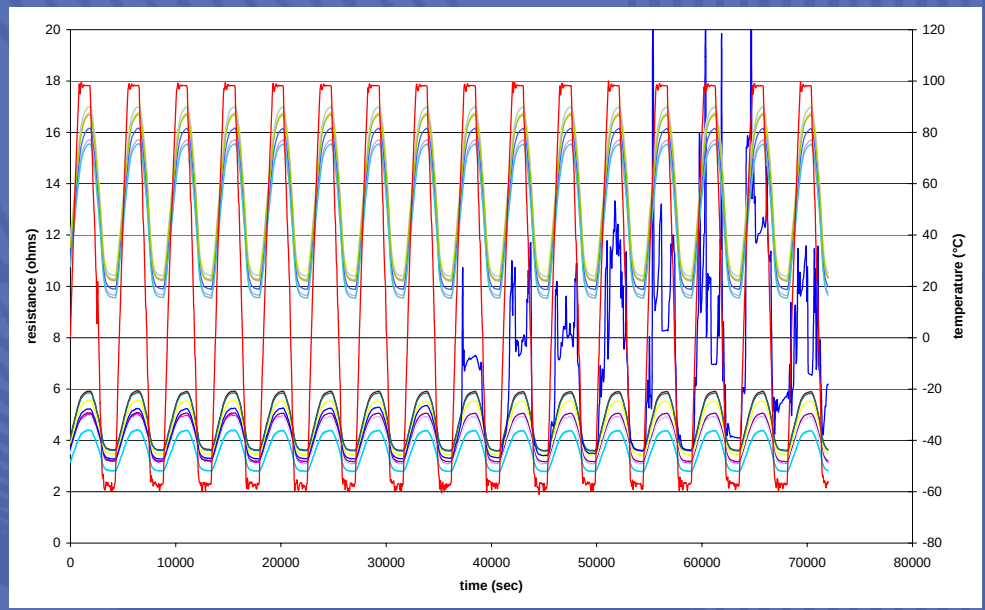
4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 1 : Configuration MCGA472 + CSP :
     - Microsection after 200 thermal cycles
       - On board which underwent 600g / CSP packages :
         - » No crack was noticed on fBGA280

         - » No crack was noticed on CSP144 package

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

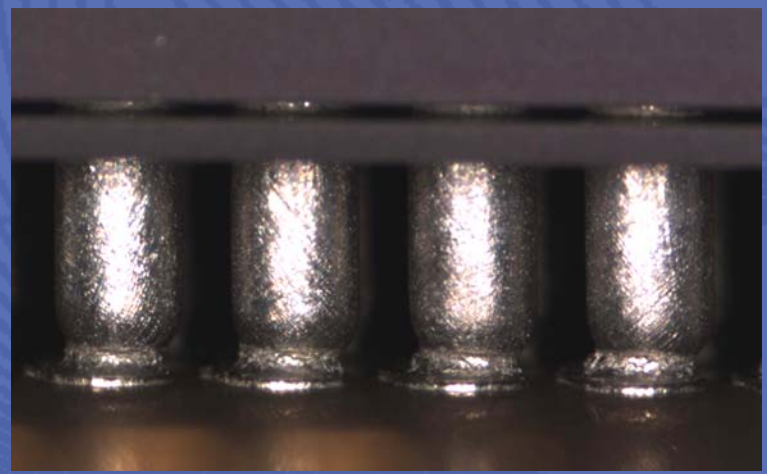
4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 1 : Configuration MCGA472 + CSP :
       - Between 201 and 500 cycles
         - » electrical failures were detected on external solderballs of ceramic CSP packages between 280 and 370 cycles
         - » electrical failures were detected on plastic CSP, between 350 and 500 cycles

Increase of resistance on external solder joints of one CSP144 after 282 cycles



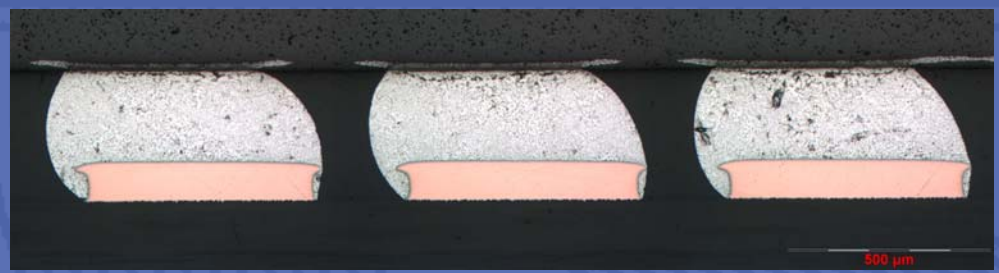
HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

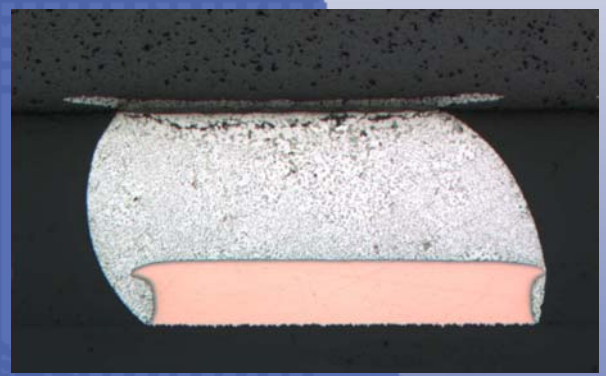
4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 1 : Configuration MCGA472 + CSP :
     - Visual inspection after 500 cycles
       - » Failures could not be observed on CSP package because of the low gap between package and board (~ 300µm)
       - » Cracks were observed on almost all solder joints of MCGA 472 package while no electrical failure was detected



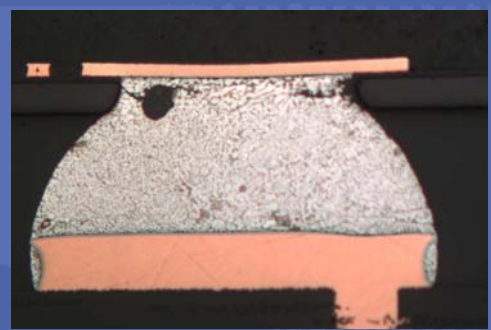
HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 1 : Configuration MCGA472 + CSP :
     - Microsection after 500 cycles :
       - » On CSP 144 : cracks were noticed on the external row of the solderballs on the package side



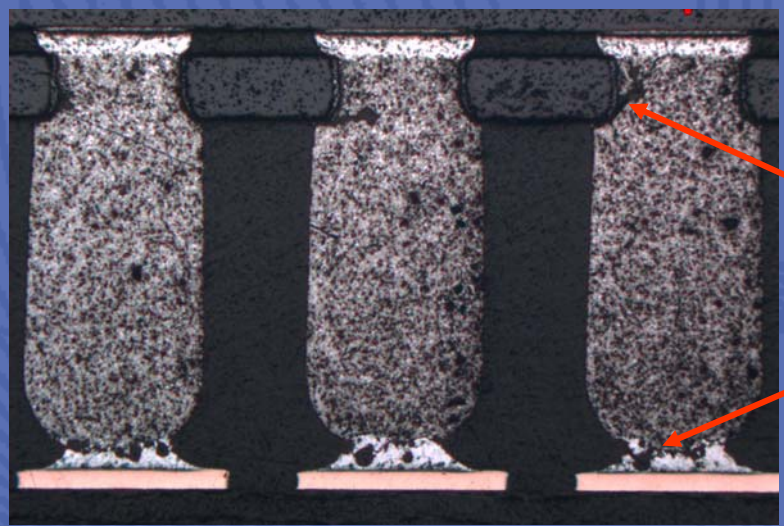


       - » On fBGA 280 : cracks were also observed on package side



HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

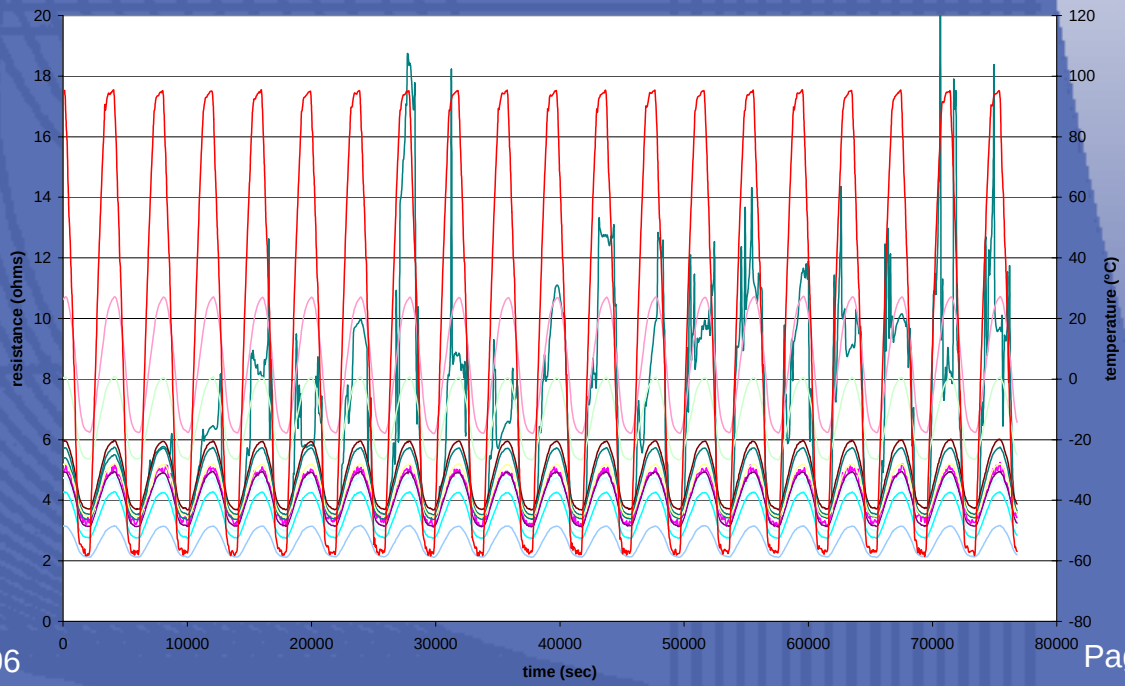
4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 1 : Configuration MCGA472 + CSP :
     - Microsection after 500 cycles :
       - » On MCGA 472 : two sites location for cracks : at interposer level and on the PCB side (poor solder joints)



HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

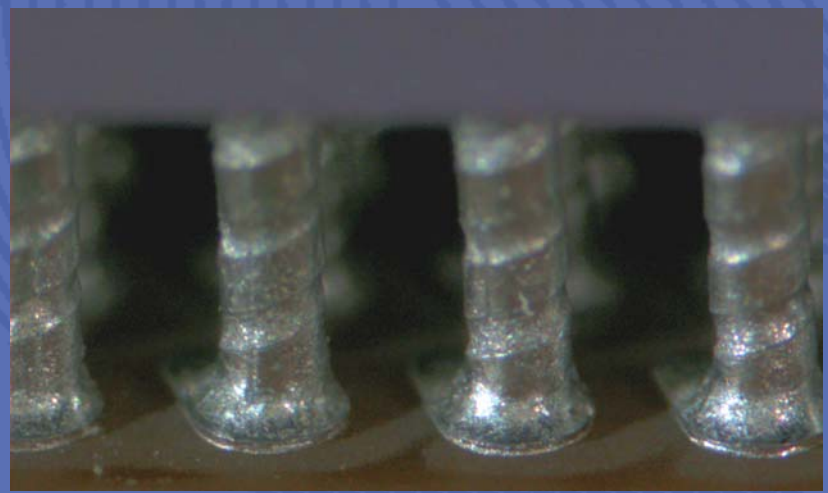
4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 2 :Configuration CCGA 717 + CSP
       - During the 200 cycles, one electrical failure was noticed on one CSP 144 of one structure
       - No other defect was noticed on other packages

Increase of resistance on external solder joints of one CSP144 after 170 cycles



HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

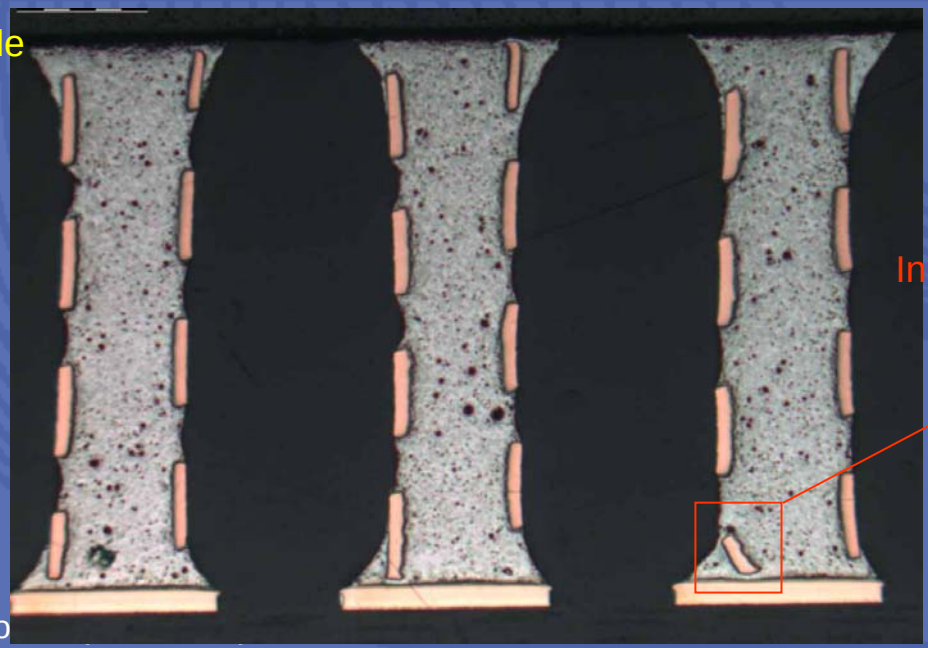
4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 2 :Configuration CCGA 717 + CSP :
       - Visual inspection after 200 cycles
         - » Ageing of solder joints of the CCGA 717 was noticed
         - » Initiation cracks were observed on a few columns
         - » Limited visual inspection on CSP packages



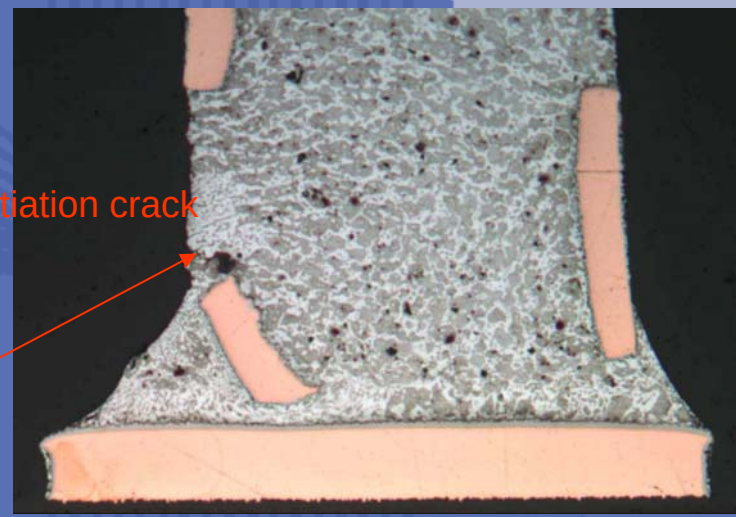
HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 2 :Configuration CCGA 717 + CSP :
       - Microsection after 200 cycles performed on CCGA 717 package
         - » initiation crack noticed by visual inspection remained short and thin
         - » Solder columns were not altered by 200 cycles

Package side



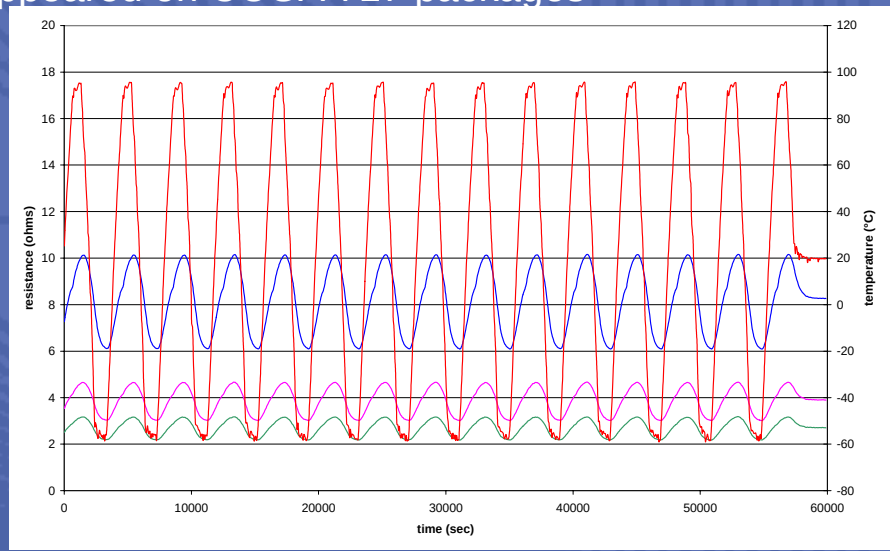
Board side



HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

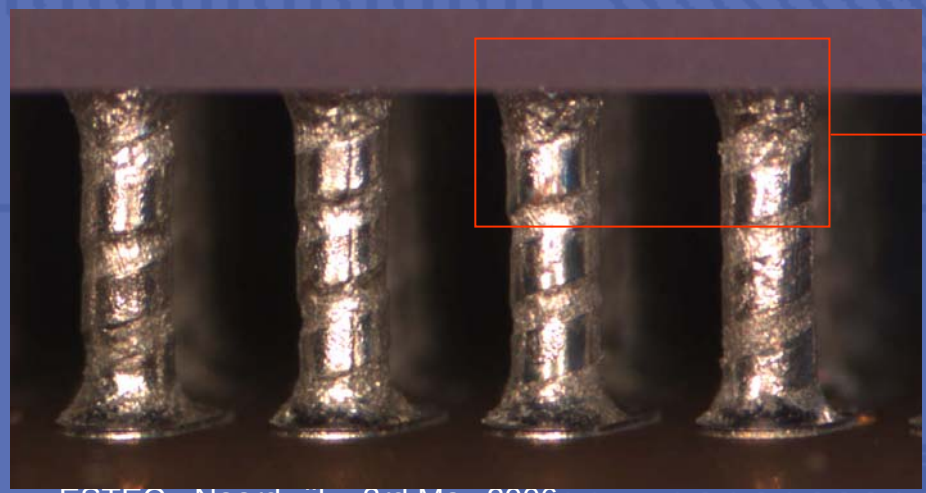
4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 2 :Configuration CCGA 717 + CSP :
       - Between 201 to 500 cycles : electrical failures appeared on
         - » External solder joints of ceramic CSP144 between 205 and 350 cycles
         - » Internal solder joints of ceramic CSP 144 around 350 cycles
         - » Plastic CSP 280 between 300 and 500 cycles
         - » No electrical failures appeared on CCGA 717 packages

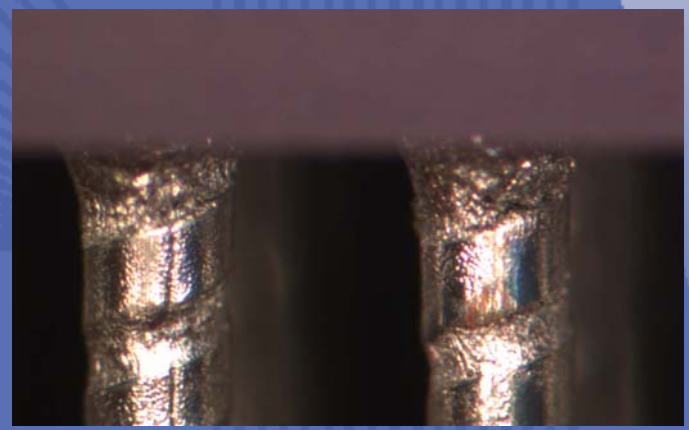
Electrical monitoring of daisy chains of CCGA 717 between 486 and 500 cycles



HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

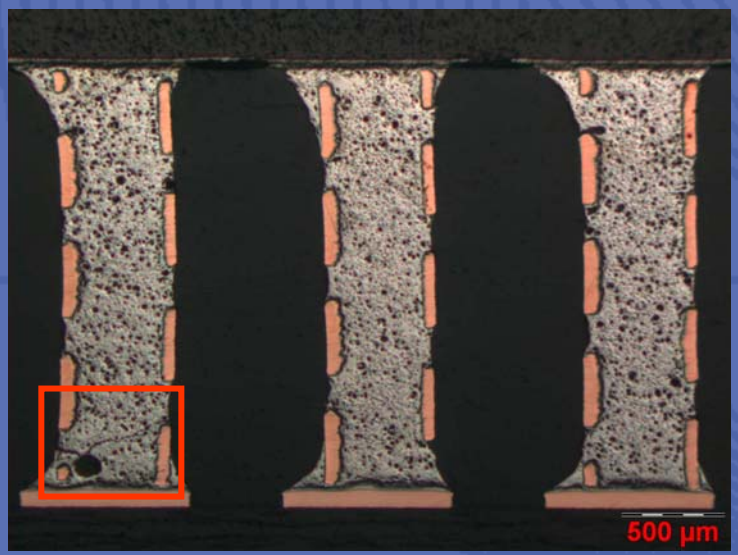
4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 2 :Configuration CCGA 717 + CSP :
       - Visual inspection after 500 cycles
         - » Ageing of solder joints was noticed on the whole external rows
         - » Some cracks were observed in the columns on the package side
         - » Initiation cracks observed on board side after 200 cycles did not evolve that much

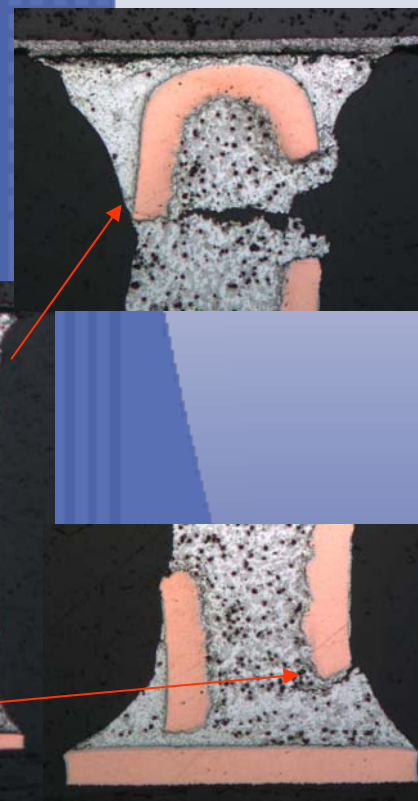




HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

4. WP3 Characterization of demonstrators
   - Results of thermal cycles :
     - Demonstrator 2 :Configuration CCGA 717 + CSP :
       - Microsection after 500 cycles on CCGA 717
         - » two site locations for cracks were identified on corner columns :
           - in the column near the package
           - in the column near the PCB





HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

5. Conclusion

A demonstrator module was defined and developed by EADS Astrium. This demonstrator consists in interconnecting HDI board with assembled BGA and CSP packages on a motherboard, interconnection being provided by IHD interposers.

Two configurations of HDI boards were characterized :

- one configuration with MCGA 472, ceramic and plastic CSP packages
- one configuration with CCGA 717, ceramic and plastic CSP packages

Demonstrators interconnected with these boards were submitted to mechanical and thermal environments.

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

5. Conclusion

All configurations of HDI boards passed random vibrations and shocks (CNES level).

Electrical failures were detected during thermal cycles on ceramic and plastic CSP packages around 300 cycles. Microsections peformed on these pakages highlighted the presence of cracks on external solderballs, on the package side.

No electrical failure was detected on MCGA 472 nor on the CCGA 717, despite the ageing of solder joints noticed through thermal cycles and the cracks revealed by microsection after 500 cycles.

Taking into account the failure criteria upon the ECSS-Q-70-38A, which defines that « internal cracks shall penetrate less than 25% of the solder fillet, ball or column » : no package passed thermal cycles when tested in this type of demonstrator.

HDI DEMONSTRATOR MODULE WITH CSP AND BGA PACKAGES

5. Conclusion

Screen printing is one of the root cause of this poor reliability through thermal cycles.

But one can also think that the frame on the HDI board, foreseen to limit warpage, may have impacted the expansion of the board and then decreased the number of cycles to failure of assembled packages.

Optimisation of this frame (change material and or design) would help to define a new demonstrator which could provide improved thermo-mechanical reliability on HDI board.