

Physical Analysis Report on ERA16FA063

Prepared by Binghamton University
for the National Transportation
Safety Board, April 5, 2016

Summary of the Analyses

- Summary of Findings

- ✓ Configuration of the memory module

- Stacked chip – small chip mounted on a stack of larger chips
 - Larger chip stack is almost the size of the entire package
 - Wire bond connection of chips to a laminate substrate
 - Laminate is a thin card with multiple circuit layers (most likely two layers only, circuitry on the front and back of the card)
 - Package encasement – simple overmold

- ✓ Manufacturer's labels on the module

- Top: MicroSD HC, 16GB
 - Bottom: CDAAJ1137AO?

- ✓ Optical Inspection

- Package appeared substantially in tact, save for a crack traversing the entire body
 - No evidence of a thermal excursion
 - Foreign material on the bottom side of the package; likely transferred from the housing (not included with the specimen)

Summary of the Analyses, cont'd.

- Summary of Findings (cont'd.)

- ✓ X-ray analysis

- No evidence of short circuits or opens in the wire bond connections, nor were the wires deformed
 - Odd “wire sweep” in one location, but this is likely to have been from assembly rather than from the impact
 - Edge view showed wire bonds in a line, with no evidence of bowing away from the chip
 - Crack in the package could be discerned (albeit it barely)

- ✓ C-SAM analysis

- Surface of the chips clearly visible as is the shadow of the wire bonds
 - Stacked configuration is confirmed
 - Chips occupy almost all of the area of the package, including region through which the crack exists
 - Additional anomalies appearing to be crack lines suggest extensive damage to the chip stack
 - B-scan confirms additional cracking below the surface of the package

Summary of Analyses, cont'd.

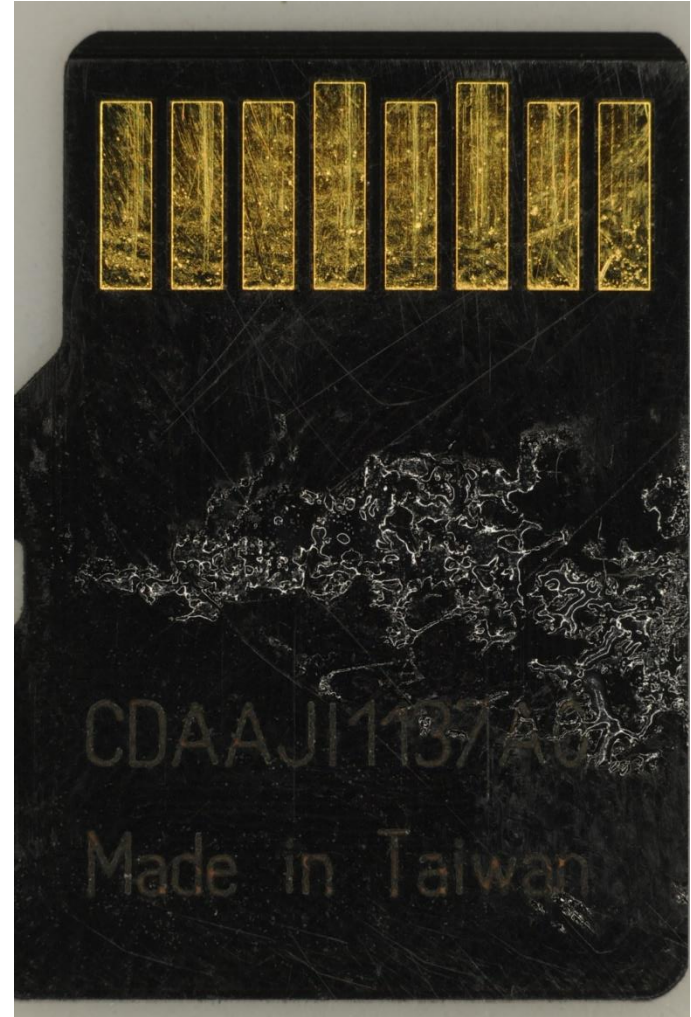
- Final Disposition
 - ✓ Optical and X-ray inspection of the module indicated that it was mechanically sound enough to attempt data recovery
 - At first glance, the damage observed optically may not have been sufficient to cause failure
 - In plane cracks are not readily observed with X-ray
 - ✓ Sonic imaging results suggested catastrophic damage to the chip
 - Image of the die stack showed a crack in the corner of the chip
 - Such a crack would likely render the chip inoperable
 - ✓ Recommend discontinuing attempted data recovery
- Details of the Analyses Are Given on the Following Pages

Details of the Analyses

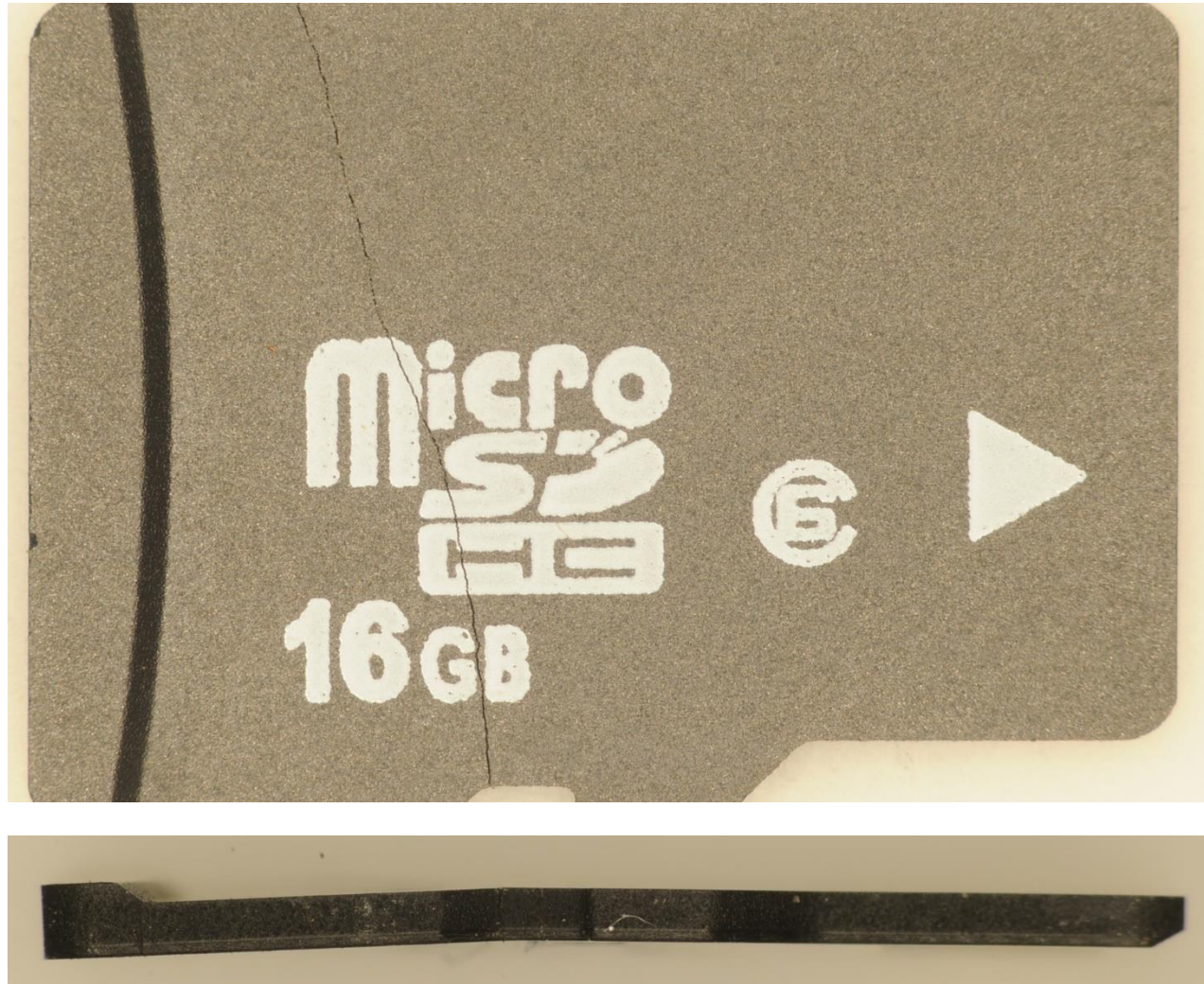
Approach Used in the Nondestructive Analyses

- Optical Microscopy
 - ✓ Wild 420 stereoscope
- X-ray Analyses
 - ✓ Initial characterization with Fein Focus Series FXS 100.23
 - 45 KV tube voltage
 - 255 integrations
 - X-rays hardened with Al foil (folded twice for additional thickness)
 - Contrast set manually to optimize the image
- Sonic Imaging
 - ✓ Sonix 550 HS acoustic microscope
 - ✓ 50 MHz transducer focused to approximately 15.5 usec time of flight
 - ✓ Pulse echo mode
 - ✓ Single gate set for wide sampling

Micrograph of the Top and Bottom Surfaces



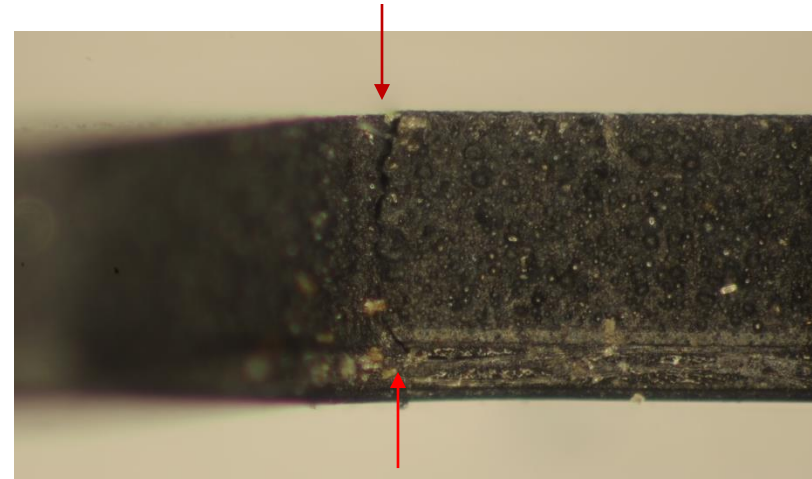
Crack in the Package and Bend on the Fracture line



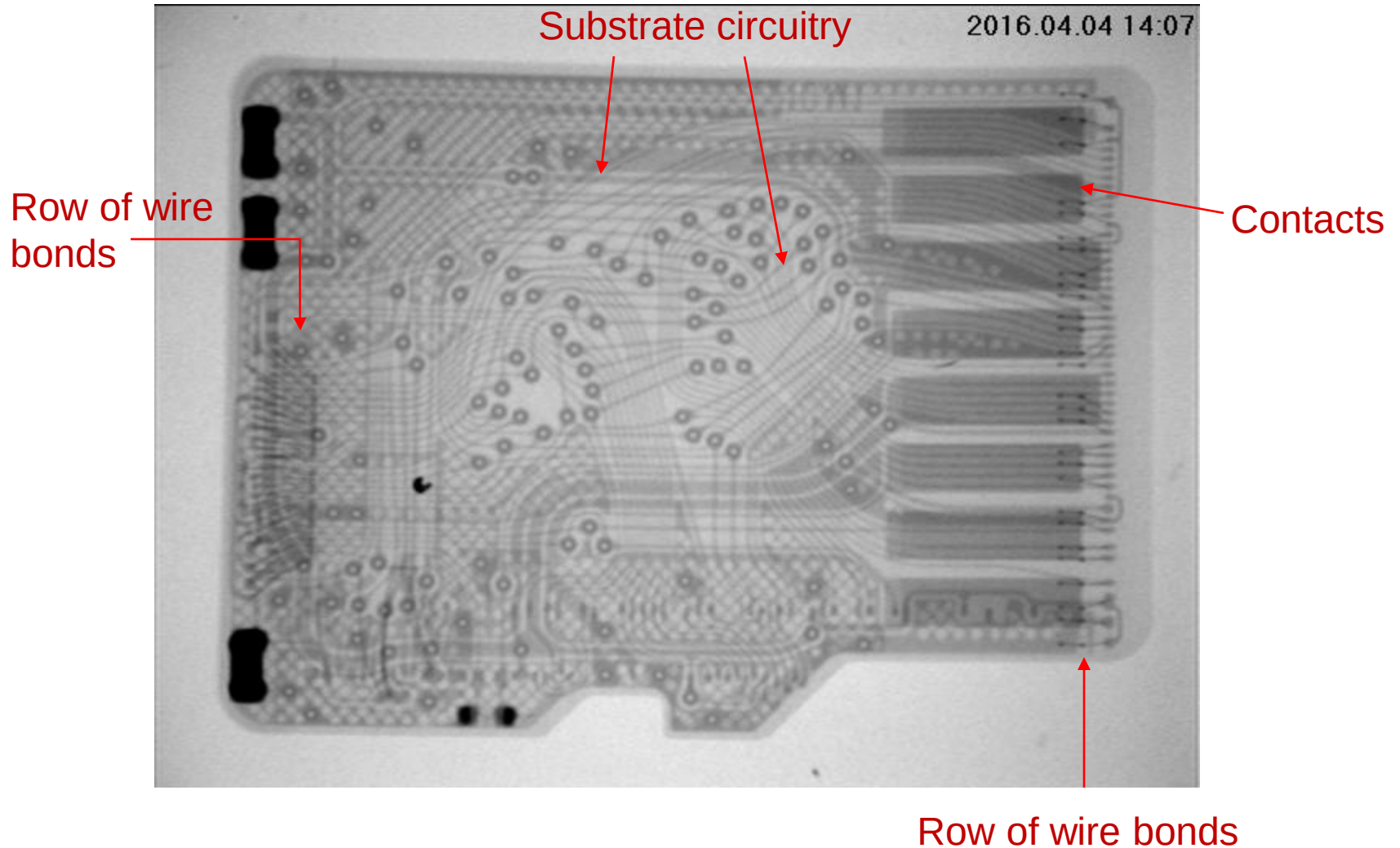
Higher Magnification of the Crack



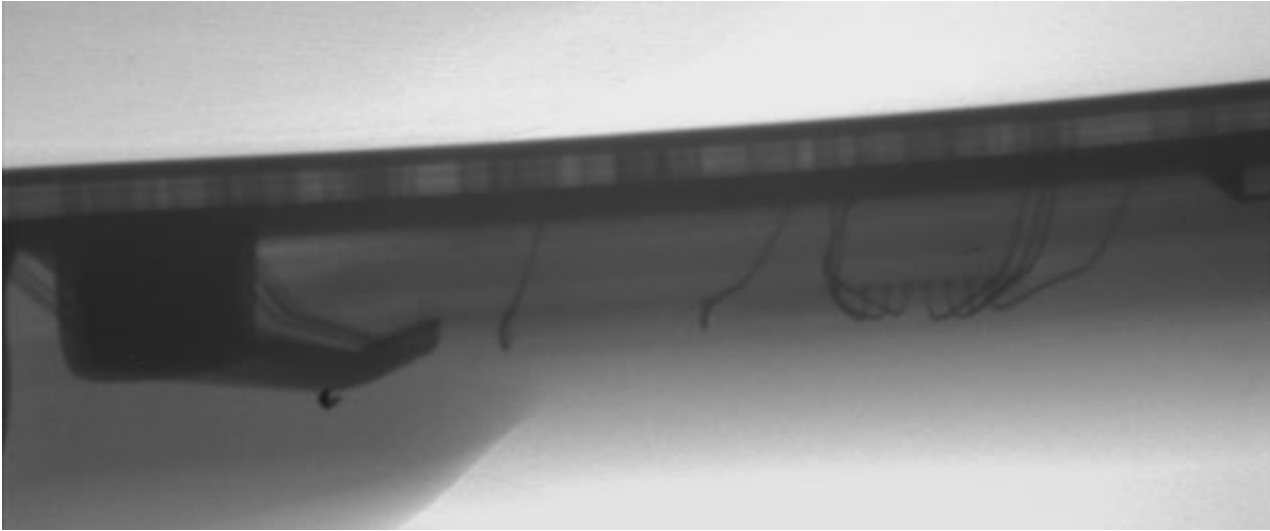
Crack Penetrates Through
the Overmold



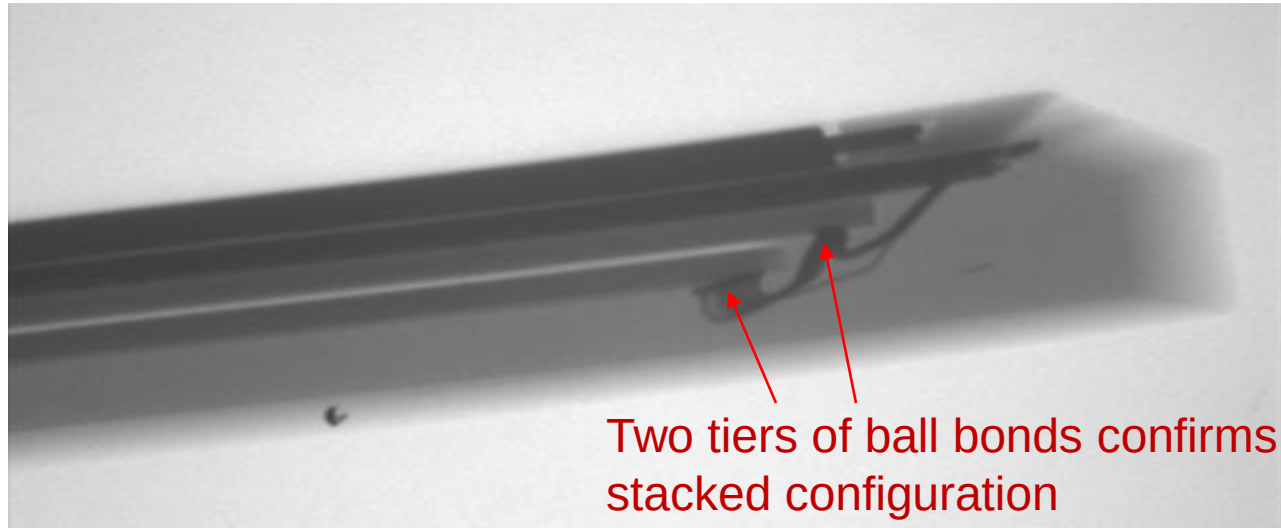
Initial X-ray Characterization



Side View of Wirebonds



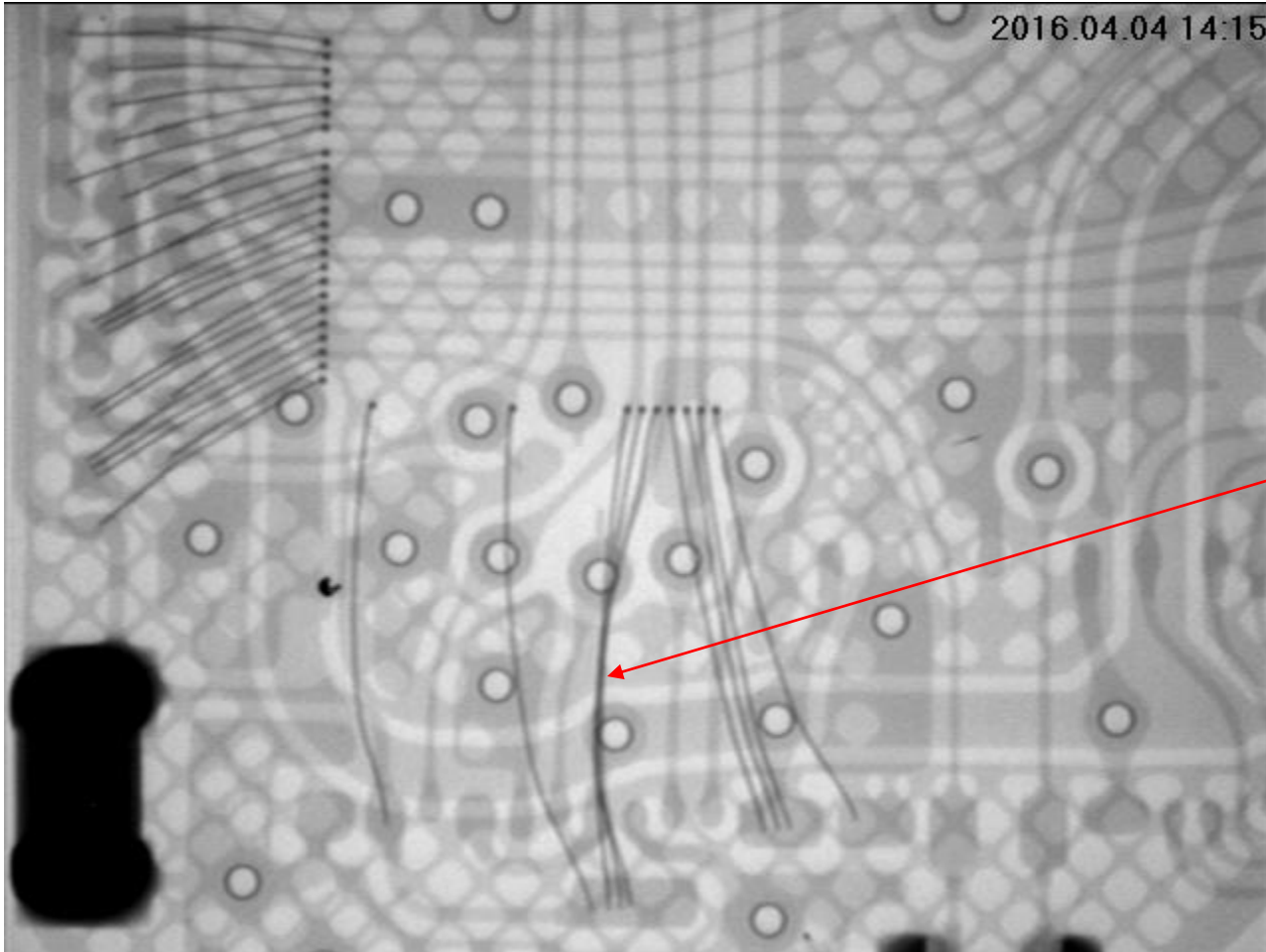
Two layers of circuitry
in the substrate



Two tiers of ball bonds confirms
stacked configuration

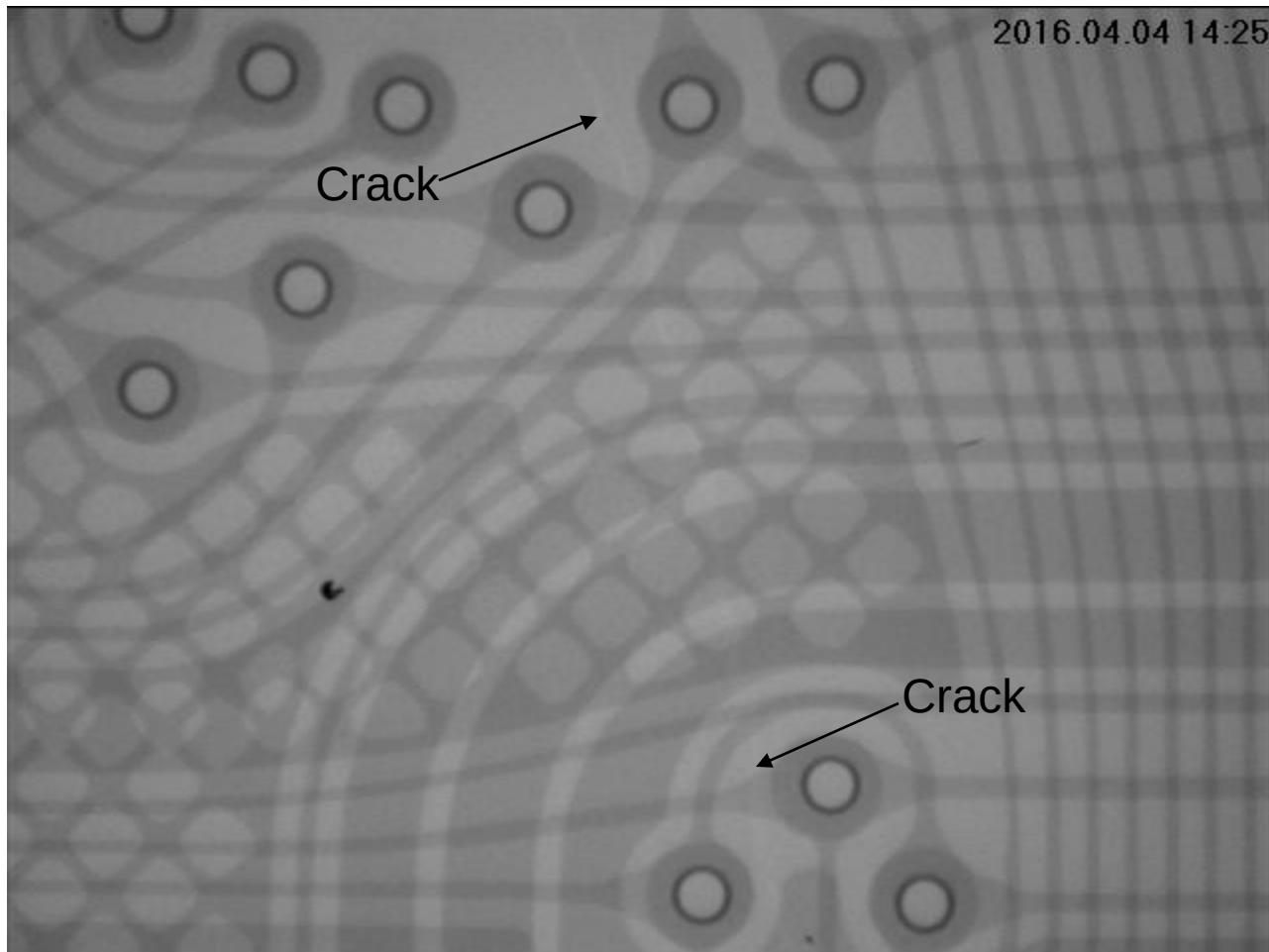
X-ray Inspection of the Module; Wirebonds on the Grip Side

Wire bonds
all appear
to be in tact



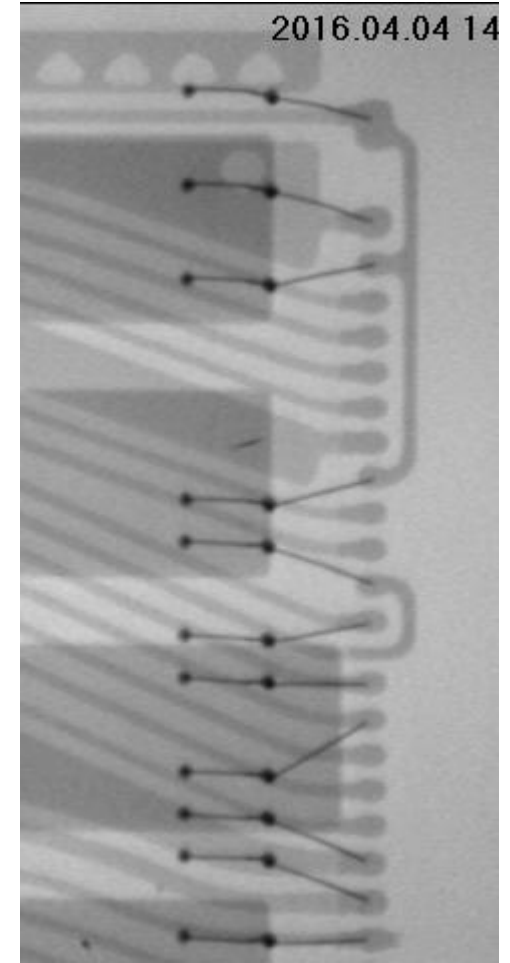
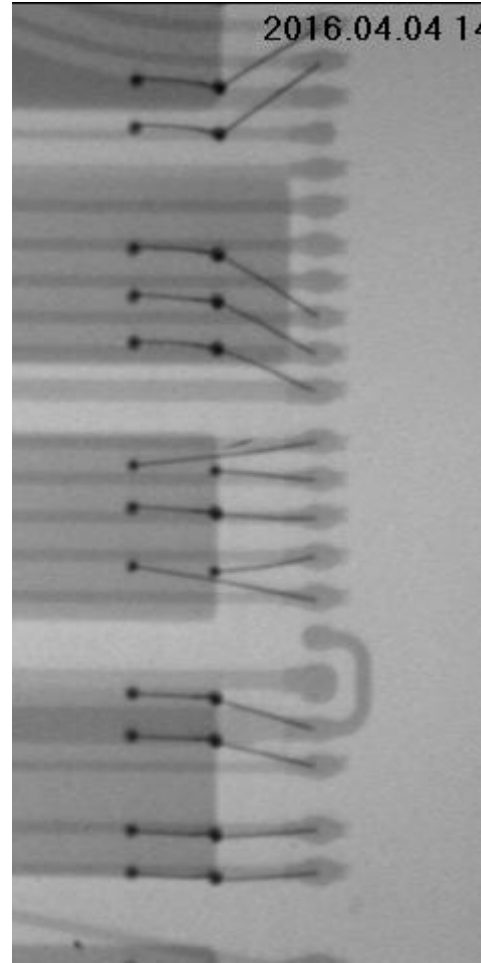
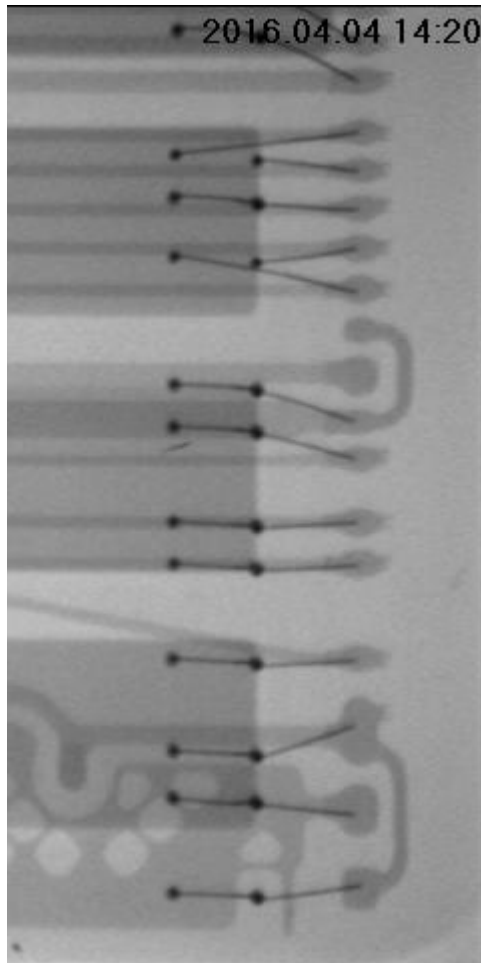
Wire sweep
(likely from
assembly)

X-ray in the Visinity of the Overmold Crack



X-ray Inspection of the Module; Wirebonds on the Connector Side

Wire bonds
all appear
to be in tact

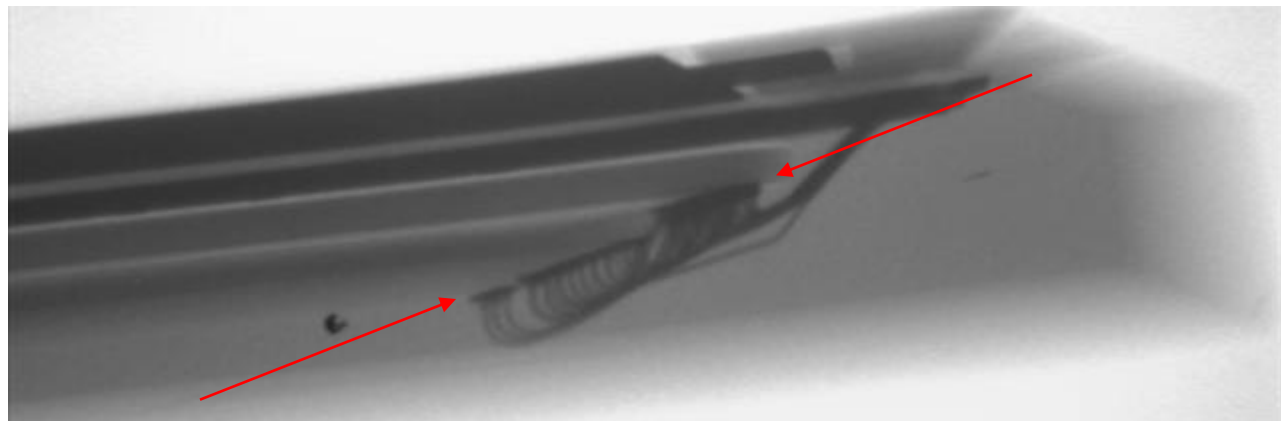


X-ray Inspection; Edge View of the Wire Bond Arrays

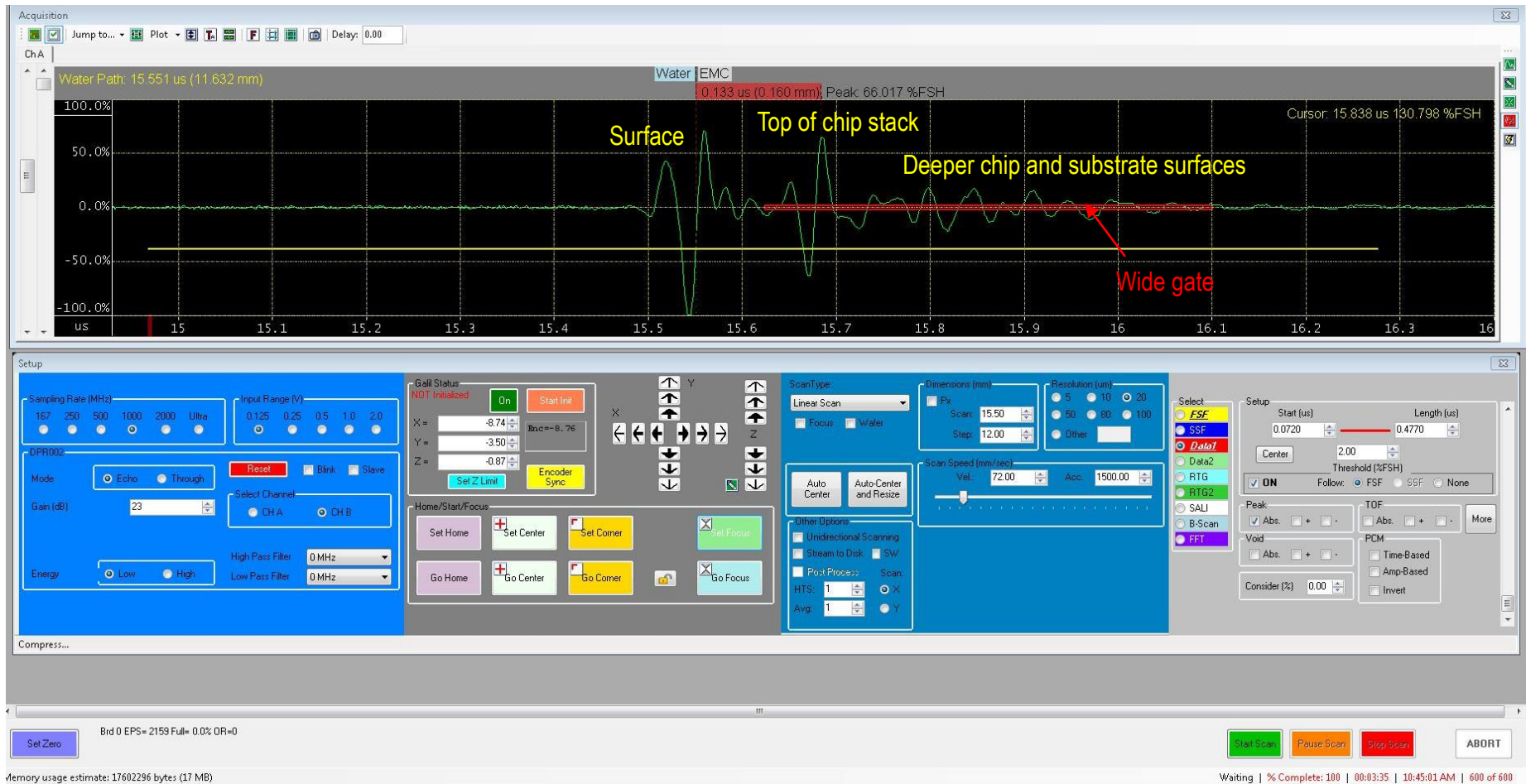


Wire bonds in a level plane; no evidence of “bowing” from the chip

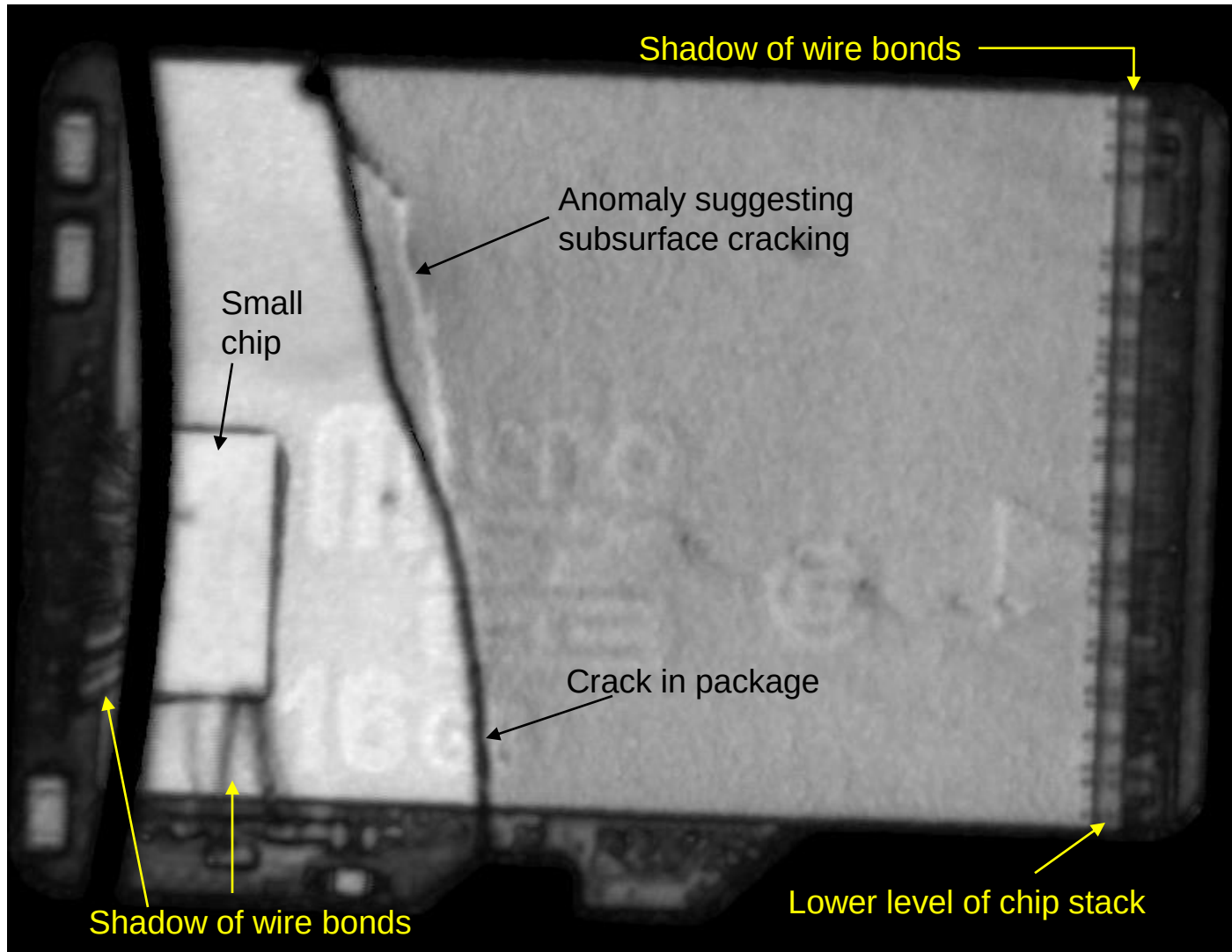
Wire bonds in a level plane; no evidence of “bowing” from the chip



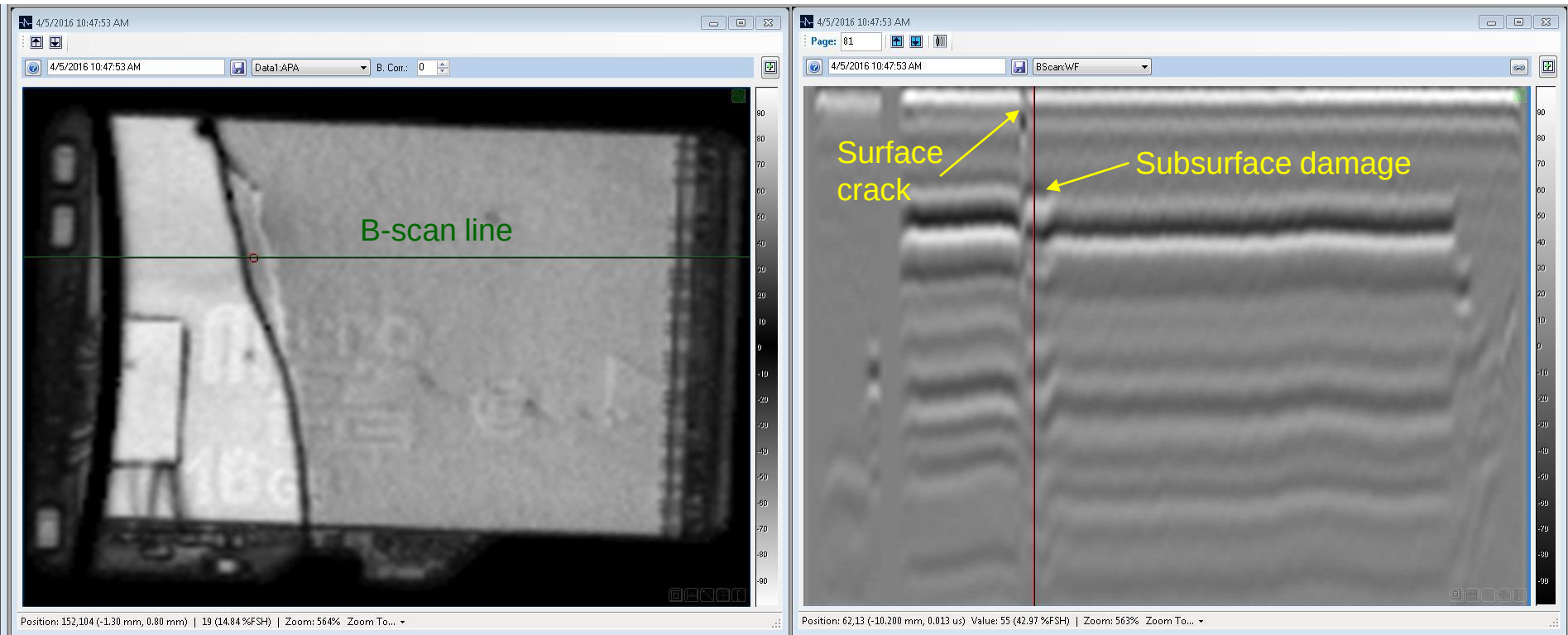
C-SAMs of the Module



C-SAM of the Module



B- and C-Scans



Summary of Non-Destructive Tests

- Optical Inspection
 - ✓ Crack in the overmold
 - ✓ No evident damage other than the crack
- X-ray Analysis
 - ✓ Stacked chip configuration connected to a laminate substrate with wirebonds
 - ✓ Wirebonds exhibit good integrity
 - ✓ Laminate circuitry appears to be in tact
- Sonic Imaging
 - ✓ Stacked die configuration confirmed
 - ✓ Crack in die stack observed; die likely inoperable
- Likelihood of Successful Data Recovery: LOW