Module Assembly and Measurements in Genova


University and INFN, Genova

Pixel week February 2003
Module Assembly: Flex Hybrid

- **MCC loading on the Flex Hybrid** (see Darbo’s talk later)
  - Low MCC yield definitively related to the automatic bonder machine.
  - We can load MCC using the manual machine (low speed).
- **Parametric and functional test of the MCC+Flex**
  - During the last PW, it was asked to verify the possibility to test the Flex+MCC with the pigtail already loaded.
  - In our probe station, using a single-handed probe card, it would be possible but the test procedure would be more complicated and test time would become longer. In fact, we would be forced to test one flex side, then take the flex out the station and bend the PT, rotate the Flex and test the other side.
  - We can fully test Flex with pigtail as exceptions; for the production we insist that it is desirable to make the full functional test before mounting the pigtail.
• We have completed a revised version of the main board for the test:
  – The new board is conceptually similar to the previous one with bugs fixed and some improvements. It is used to switch signals from/to FE and edge connector to the scanner for the parametric test or to/from the signal generator/analyser (MCCExe or to the HP16700 Pattern Generator & Logic State Analyser).
  – 3 boards were produced and they are already in our hands;
  – we are waiting for some components; loading is foreseen to be done in few weeks by a firm in Genova.
  – One board will be sent to UOK to be used to test the Flex with the HP16700.
Module Assembly: pigtail

- Pigtail is glued using the Pyralux foil suggested by Bonn.
- To cure the glue we have used the flip-chip machine.
The pigtail is manually aligned and fixed using tape. A glue rectangle (~17 x 4 mm$^2$) is placed under the pigtail pads.
• A small Al piece (21x6 mm²) is placed between the head and the pigtail. The head of the flip-chip machine is used to heat the adhesive strip.

• The head stays at 270 C for 1 hour thus providing 190 C on the adhesive. A force of 15 Kg is applied.

• After this process, the HV tail is fixed using few dots of Araldite.
• Can this high and localized temperature damage the Flex backside?
• An halo on the backside is visible by eye.
• A detailed inspection using the microscope shows a darkened region and some scratches.
• 5 HV tested Flexes arrived yesterday in Genova to have the pigtail attached. Then they will perform the HV test again.
Module Assembly: bare module

- To mount the Flex with the pigtail, we just add a hole in the plexiglass bridge.
- No problem when bonding the FEs under the pigtail (tape is used to take the pigtail bent).
Module Assembly: bonding

- 1 mil Al bonding wires are used both for the FEs and for the pigtails.
- At least 4 bondings are on the power lines so that we do not have any more limit on currents ($I \leq 1.2A$). In the past, using the edge connector pads, the limit on currents obliged us to detached FEs with high power consumption (the test pads are smaller and usually not perfectly clean after potting removal).
# Assembled devices

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<th>Bump</th>
<th>Vendor</th>
<th>Sensor</th>
<th>type</th>
<th>GKD</th>
<th>Bare probed</th>
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</table>

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General comments

• Starting from Ge_8, modules have the barrel pigtail since we attach the pigtail on the flex before assembling the module.
• Since the December, we have assembled 4 modules, mainly to feedback:
  – the assembly procedure (ok);
  – some AMS bumping problems with thin chips;
  – the yield of defective chips (cross-checking bare probing results);
  – reworkability of defective chips (Ge_11 on going).
• Moreover we have assembled 7 single chips for the testbeam telescope.
• 1 single chip was highly plasma cleaned (2 hours).
• Some results (sfits files, logbooks, noise&threshold plots) are accessible on web (www.ge.infn.it/~gemmec/laboratorio/modules/).
High Plasma cleaned FE

- This chip has been 2 hours plasma cleaned. It has the same threshold, noise and currents values of the other chips.

Threshold = 3600 e
Noise = 270 e
AMS bumping

- Merged bumps in the corner are not due just to a bad surface parallelism.
Merged defects at x-rays

Merged bumps on both corners
• In January Leonardo went to AMS to follow in detail every step of the flip-chip procedure. The effects of merged bumps was easily solved by lowering the pressure from 2.5kg to 2.0kg.

• Anyway, with the next mask production, bump diameter will be reduced from 20 to 18 mm both for sensor and electronics. This will reduce the probability of merging bumps.
GE_7: noise map

- Module with chips from two wafers differently thinned (0-7 210 ?m, 8-F 180 ?m).
- In this case the flip-chipping machine head pushes down the thickest chips. No way out, AMS must take more care…
Chip inefficiency in Genova

• Global AMS yield: out of 64 chips, 8 chips have problems:
  – 3 chips have shorts (avdd-dvdd,dvdd-dgnd,cck)
  – 1 chip has very high analog current
  – 1 chip has low analog current
  – 2 chips have very high digital current
  – 1 chip has lost working columns after some standard tests.

• Global IZM yield: out of 32 chips, 3 chips have problems:
  – 2 chips have shorts
  – 1 chip has low digital current

• Cross-check with bare module probing shows a high inefficiency after the bonding process:
  – AMS: bad before probing 1/16 become 3/16 after
  – IZM: bad before probing 1/16 become 2/16 after
• Some shorts are caused by the low precision of our bonder (visible Al shorts).

• Other damages can be caused by the bonder itself (see damages on the MCCs in Darbo’s talk later) that generates pulses on the first bonding.

• When the FEs are bonded, the starting point is on the flex.

• On the contrary when the MCC is bonded on the flex, the starting point is on the MCC to get the maximum precision on the chip pads (guard ring is 5\(\mu\)m from the pads).

• So it is expected that we have higher losses when bonding the MCC than the FE chips.

• Ge_10 has been manually bonded to have a cross check of this problem (we have a 100% efficiency on the MCC manually bonded).
Conclusions

• We have chip failures due to the bonder machine. This is now a fixed problem. Waiting for the new bonder (April), we can continue to bond modules accepting a ~10% loss. Anyway, some devices can be manually bonded.

• Next steps will be:
  – Assembling the reworked modules. The 3 chips reworked one will be bonded and measured next week.
  – Thermally cycle Dyconex modules: we use soft glue under the Fe pads, the pigtail, the MCC and the HV pads. We can check if the flex CTE is not low enough.
  – Dedicate more time in FE chip/module standard procedure characterization.
The Genova robot for gluing modules on the stave
(M.Dameri, C.Pizzorno and F.Vernocchi)

A global view of the robot
The head is approaching stave for measuring the position of gluing
Some measurements

- Y measurements along the stave of the jig that takes the cradle.

- Y measurements along the stave of the cradle: there is repeatability of the module position.
• Study on the planarity of the jig that hold the cradle:
The sets of measurements correspond to small adjustments (screws or thickness tape) in the setup. The actual setup (#1) should minimize arrows on the cradle present in the previous pictures.