# EMCM testing summary

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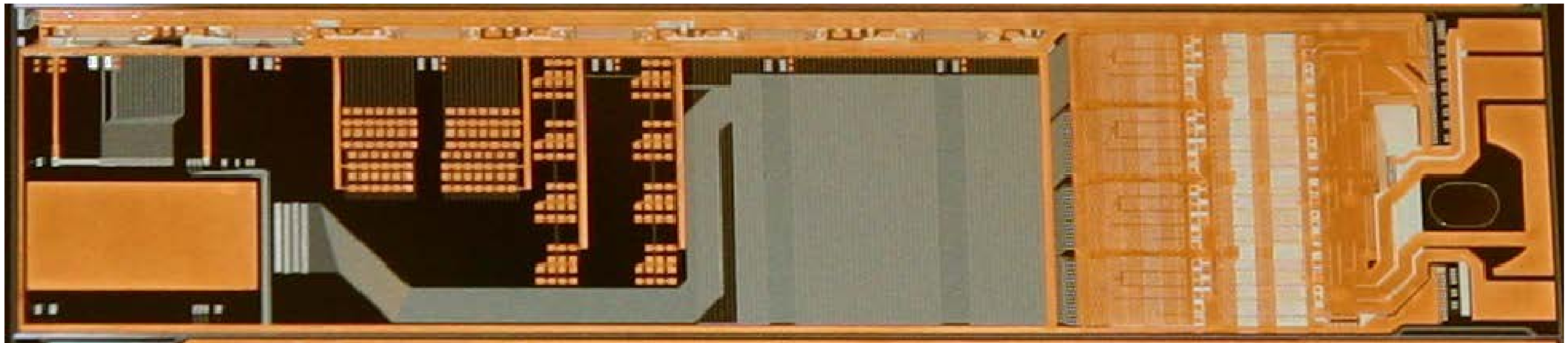
# Electrical Multi-Chip Module

- 3 metal layers on silicon substrate
- 4055 test pads (size down to 70µm x 70µm and 50µm x 100µm)
- 2149 different electrical nets
- Open and short test necessary



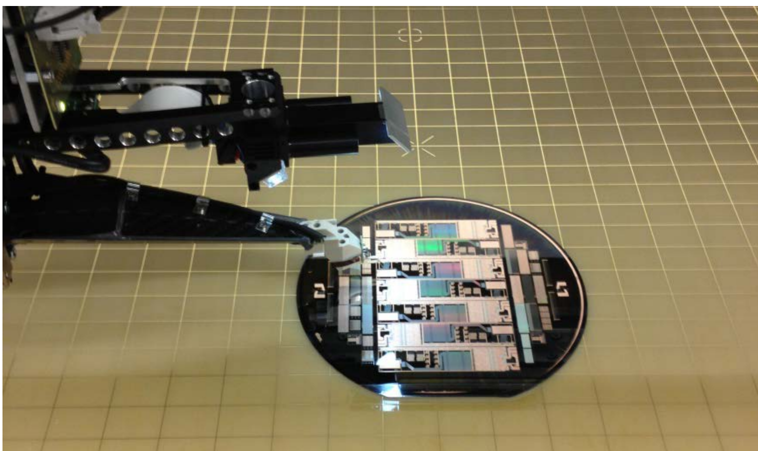
- Adjacency test contains >100k test per EMCM
- With up to 2k test for individual pads

# Test ZMI 5

- Wafers from Test ZMI5 – produced to optimize metal systems
- P1, P2, P3, P4, P5, P6
- P5 had problems in 2 metal layer system
- Other wafers had different variations but showed good performance in tests performed before Cu but EOS was not tested
- Change in the Cu layout to accommodate bigger caps required change in the test program

# ATG testing

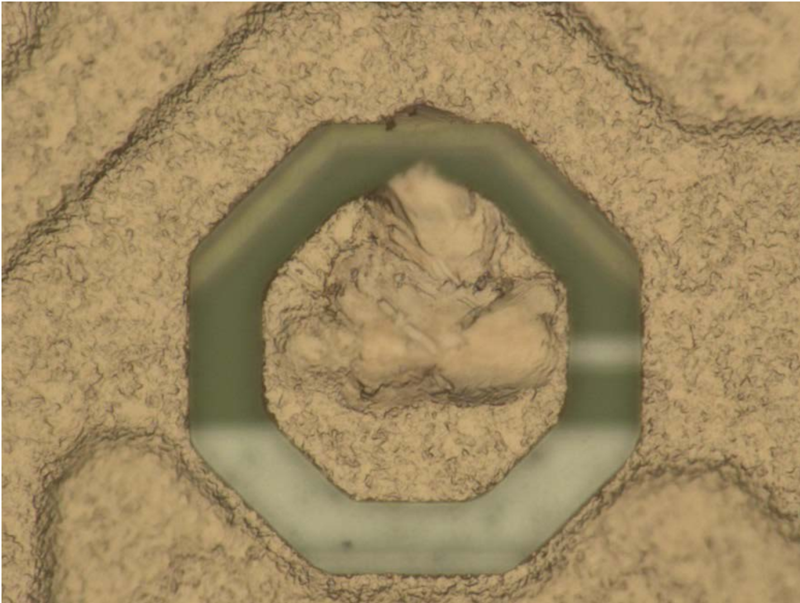
- A7 machine
- 4 flying needles
- Placed in not temperature controlled room and not in the clean room conditions.
- This brought some initial problems with alignment and some “not real” shorts due to the dirt falling on the wafers



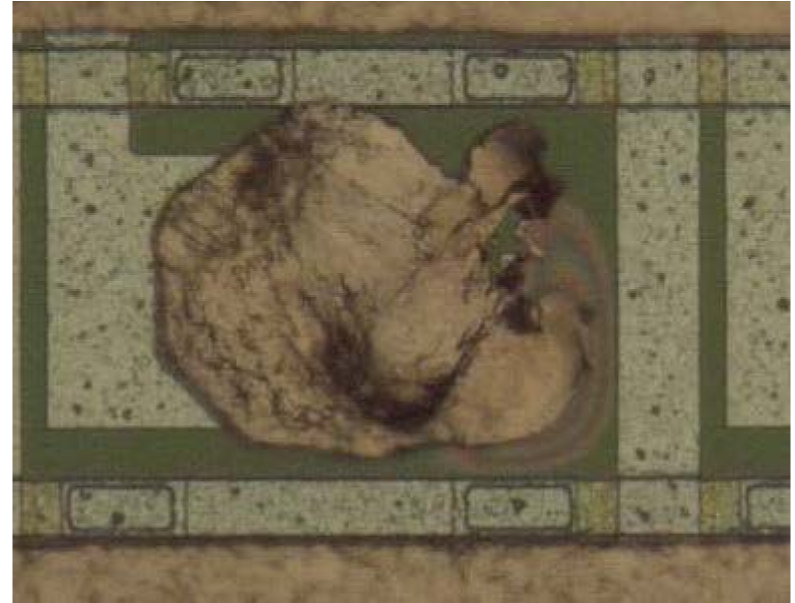
Measurements done by:
Christian K. (week 19 &20)
Paola A. (week 20)

# ATG testing - Wafers A1(dummy), P1

- Problems with alignment accuracy in time (week19)



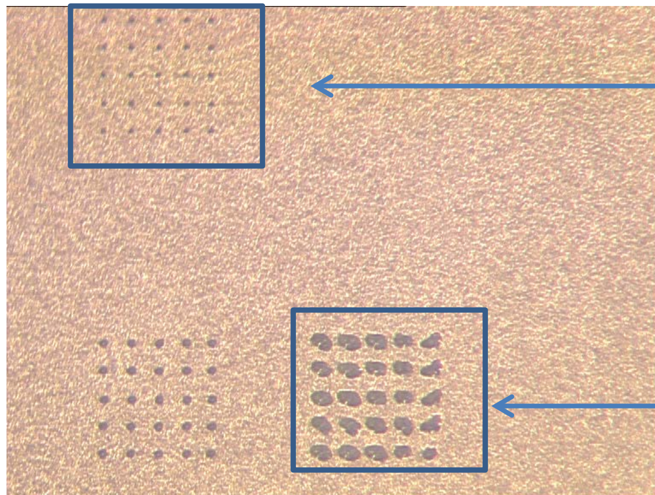
A7 machine has non optimal accuracy
Drifts due to the temperature changes



Non optimal stopping speed of the probe heads

# ATG testing – Wafers P2, P4, P6

- Optimized speed of the probe heads (week20)
- Calibration of the A7 before each run
- Best results in terms of accuracy of the needle position during the night run (wafer P4)



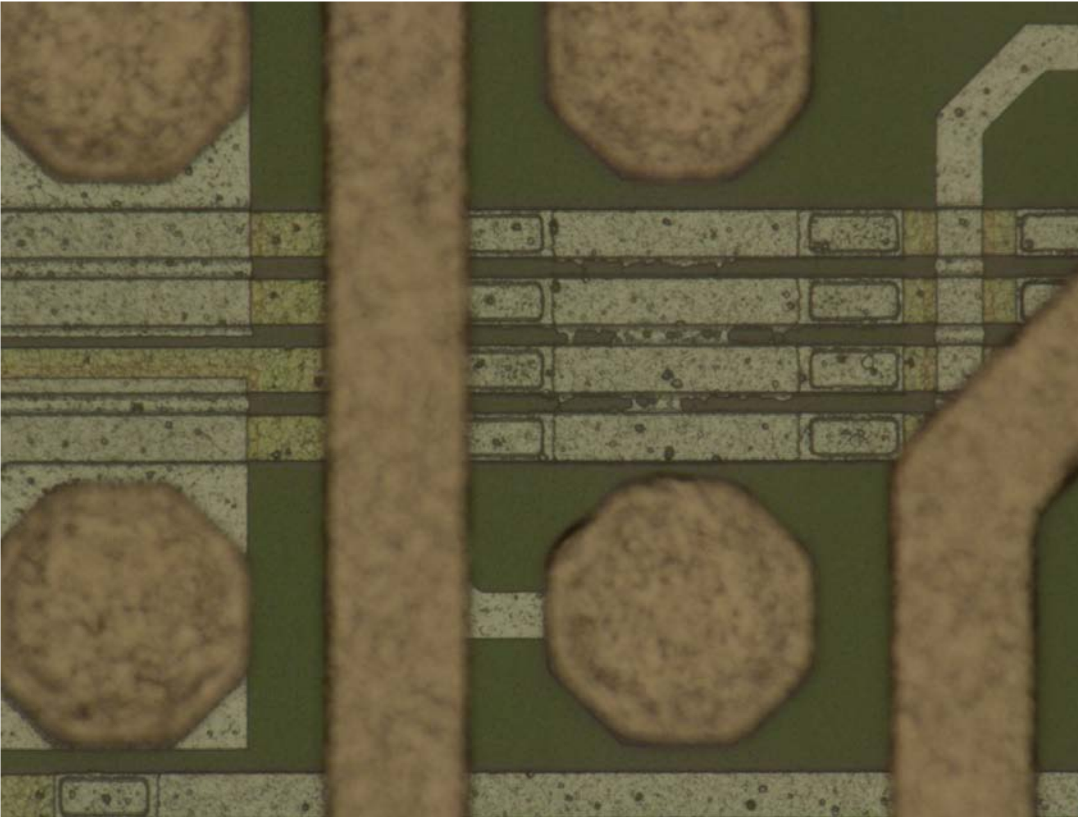
100 x touch down with optimized settings (week 20)
(stroke, pressure and accuracy set to 5)

100 x touch down with non-optimized settings from the first week (week19)

# ATG results – P1

- Showed :
  - order of 20 low ohmic shorts on a DUT1 (<20 Ω)
  - order of 600 high ohmic shorts on a DUT 1 (few MΩ)

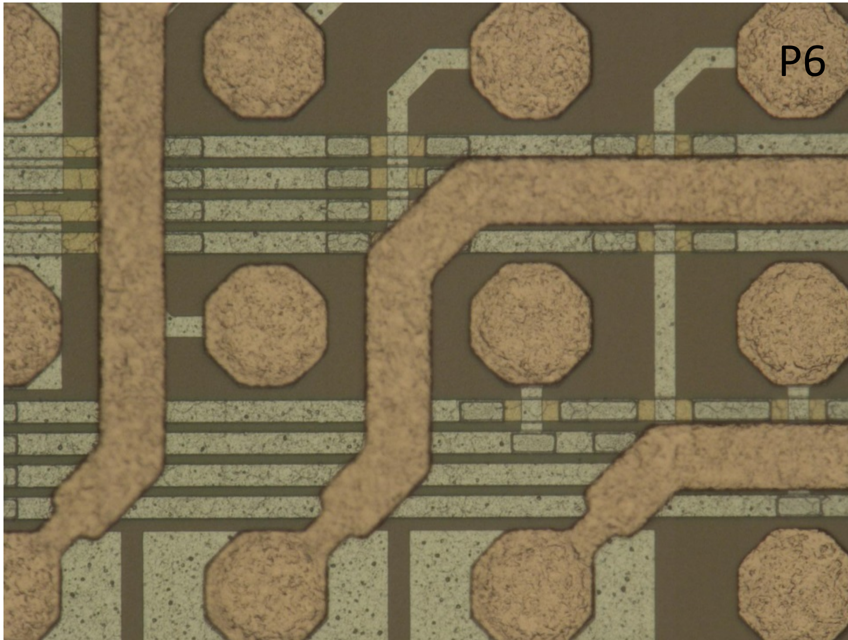
# Low ohmic shorts

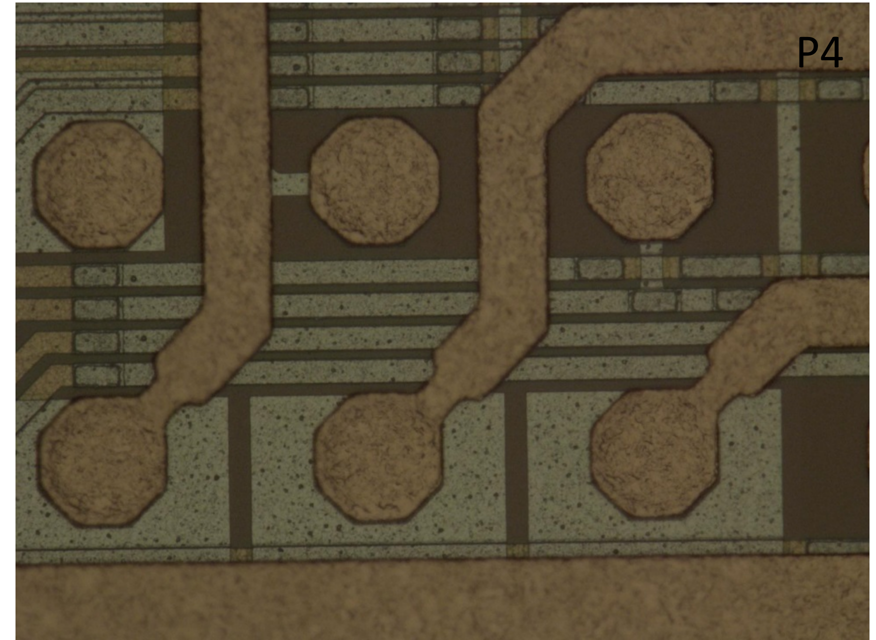


Stack of Al1 +Al2 used to
decrease resistance of the
control lines of switchers
had problems in production
Differs from wafer to wafer

# Low ohmic shorts – Wafers P4 &P6

- Optical inspection done on all wafers - this problem could not be identified of wafers P4 and P6 - still significant area under Cu



**EMCM (ZMI-5) WaferP6**

DUT 1: 1 low ohmic short (??)

DUT 2: no low ohmic shorts

DUT 1 open: 2 x DCD to DHP interconnection in 2nd and 4th pair

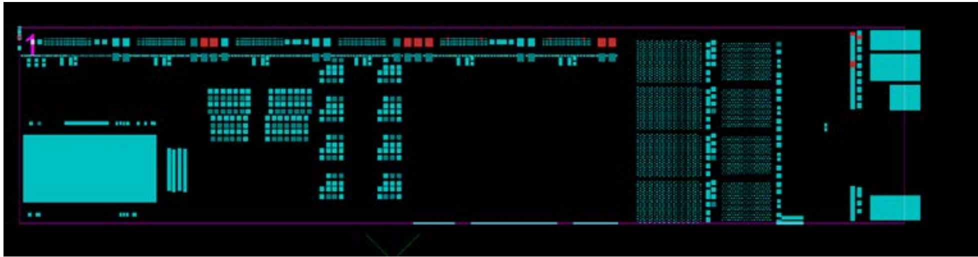
DUT 2 open: 1 connection to test switcher pad (2nd SW)
1 drain pad to DCD input

EMCM (ZMI-5) WaferP6

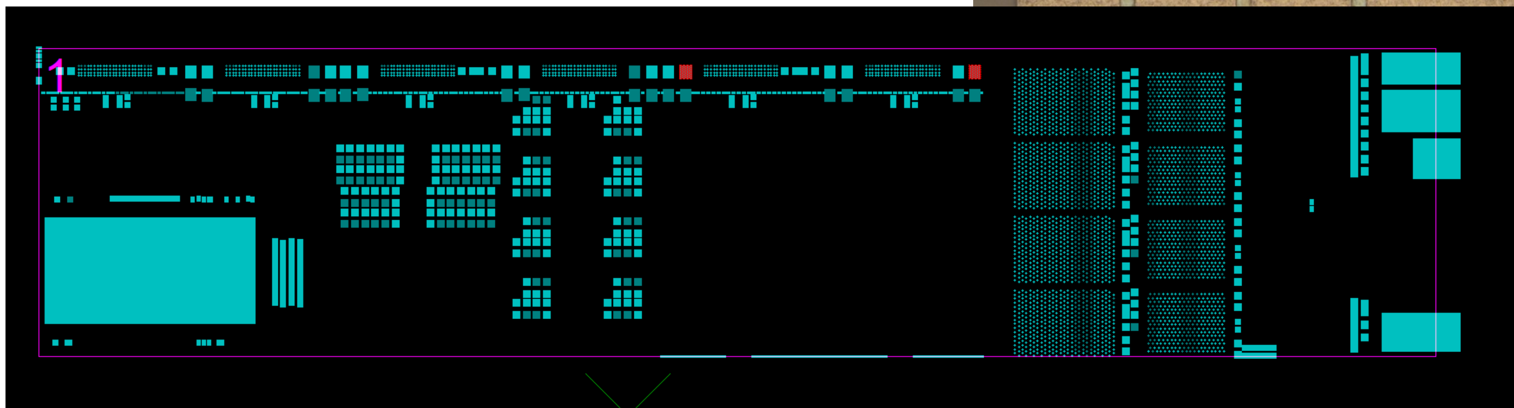
**DUT1 – short GATE ON –GATE OFF**

Particle or below Cu?

Nets 1721,1749



Short measured on pads 3762-3846



# EMCM (ZMI-5) WaferP4

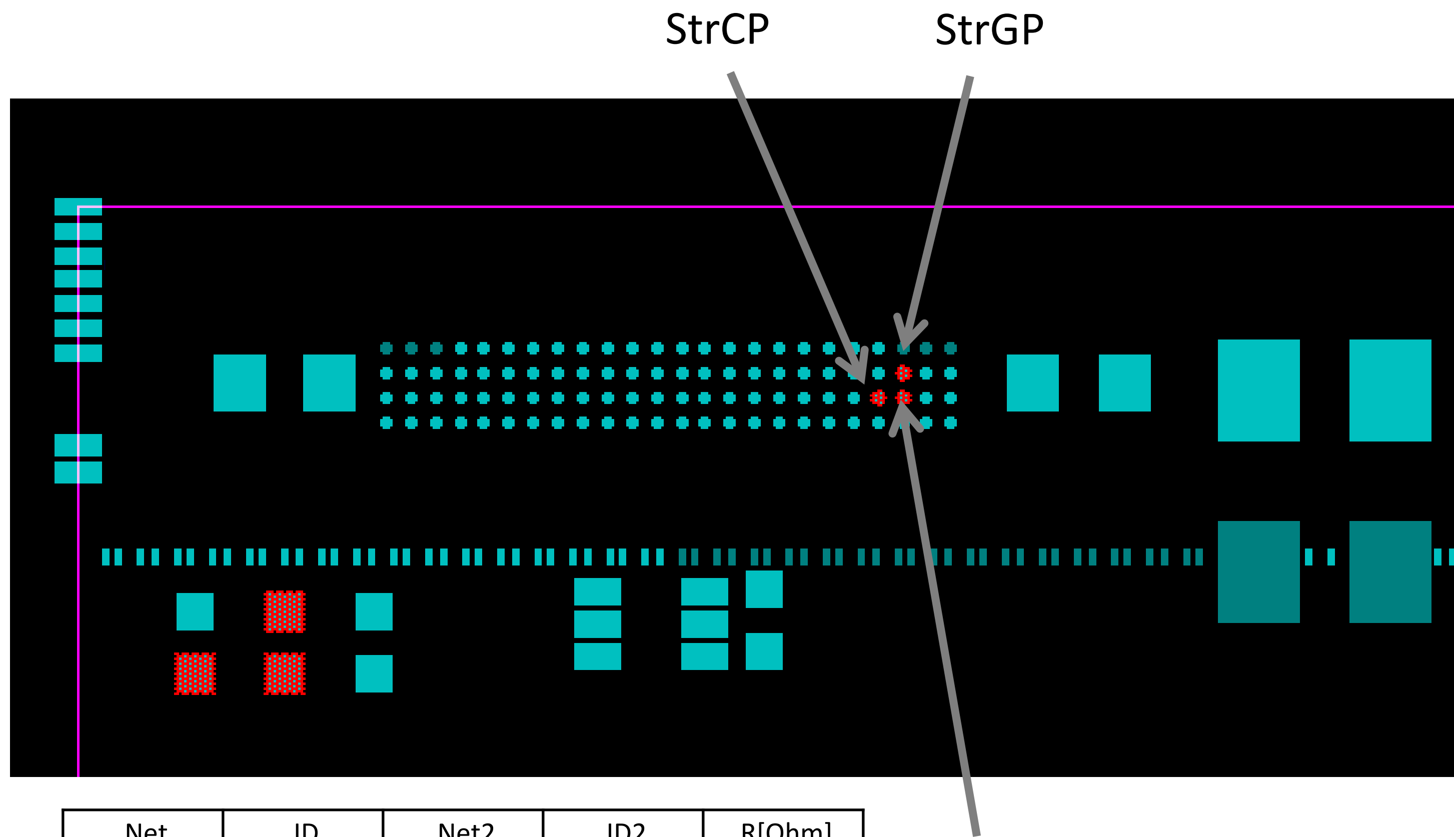
**DUT1 – 400kΩ shorts - to be remeasured … on wafer P1 such measurement results were caused by dirt**

**(**DHP_CORE -DCD AmpLow**) – should be functional even with this short**

**and in addition several hundred Mohm shorts, no open**

# EMCM (ZMI-5) WaferP4

## DUT2 – low ohmic shorts



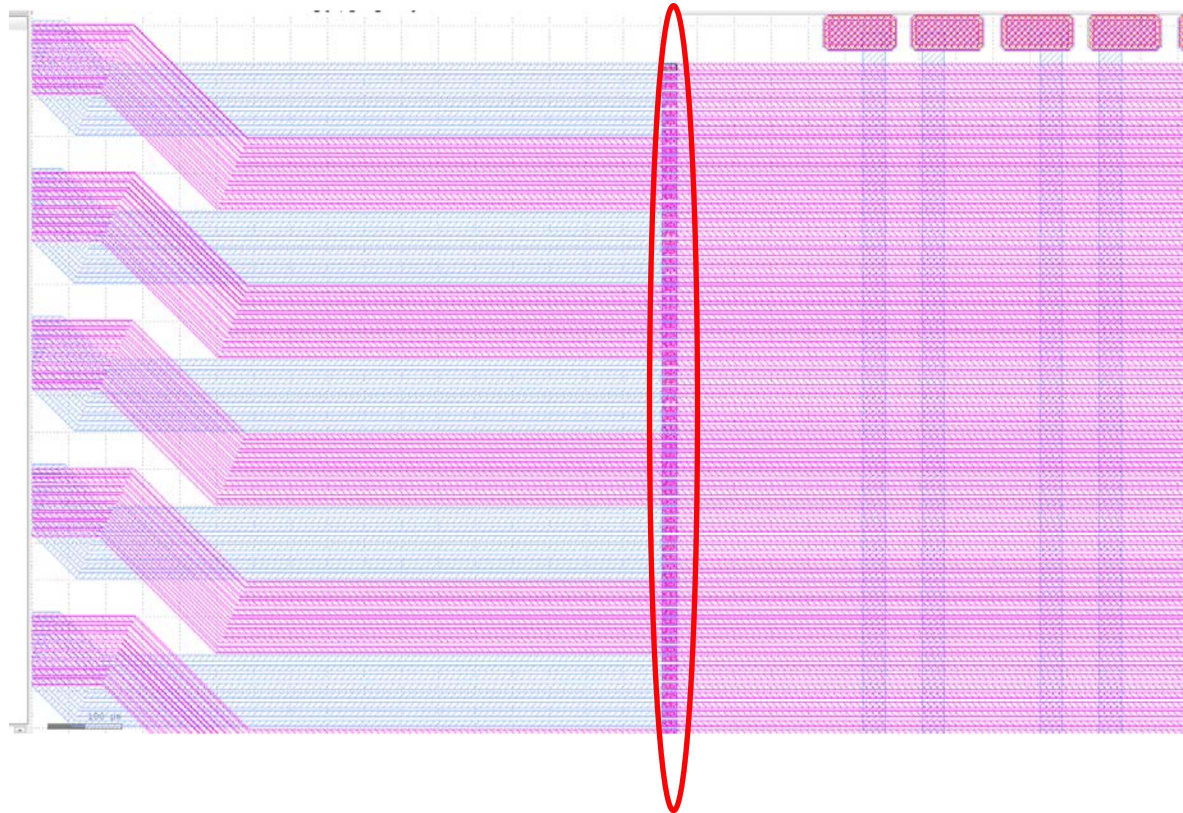

| Net | ID | Net2 | ID2 | R[Ohm] |
|---|---|---|---|---|
| 1731 | 3786 | 1780 | 3928 | 31.07 |
| 1731 | 3786 | 1780 | 3928 | 36.18 |
| 1732 | 3793 | 1780 | 3928 | 75.53 |
| 1732 | 3793 | 1731 | 3786 | 80.36 |
| 1731 | 3786 | 1732 | 3793 | 81.49 |

**And in addition several hundred Mohm shorts**

# High Ohmic shorts

- Present on all tested wafers
- Test ZMI5 project had additional Polysilicon layer  and Contact 1 mask to increase topology
- Reason for high ohmic shorts understood.
- During the conversion process to produce mask for photolithography some of the contact 2 openings were transferred into contact1 mask – not really understood how this happened
- Result – all drain lines  are connected once to the bulk

# Position of problematic contacts to the bulk



Due to the fact that high ohmic material was used one can use those EMCM
(in dark dynamic resistance of about 20GΩ measured )

# New EMCMs

- As soon as we got the results we have initiated new fast production run
- Wafers with 7 EMCM/wafers are being processed
- All problems realized up to know fixed
- Structuring of the first Al layers is being done at the moment
- Time estimate 6 more weeks till new EMCMs are processed
- ATG is preparing better S machine for the next round of testing - will be ready within the next 3-4 weeks

# EMCM testing summary

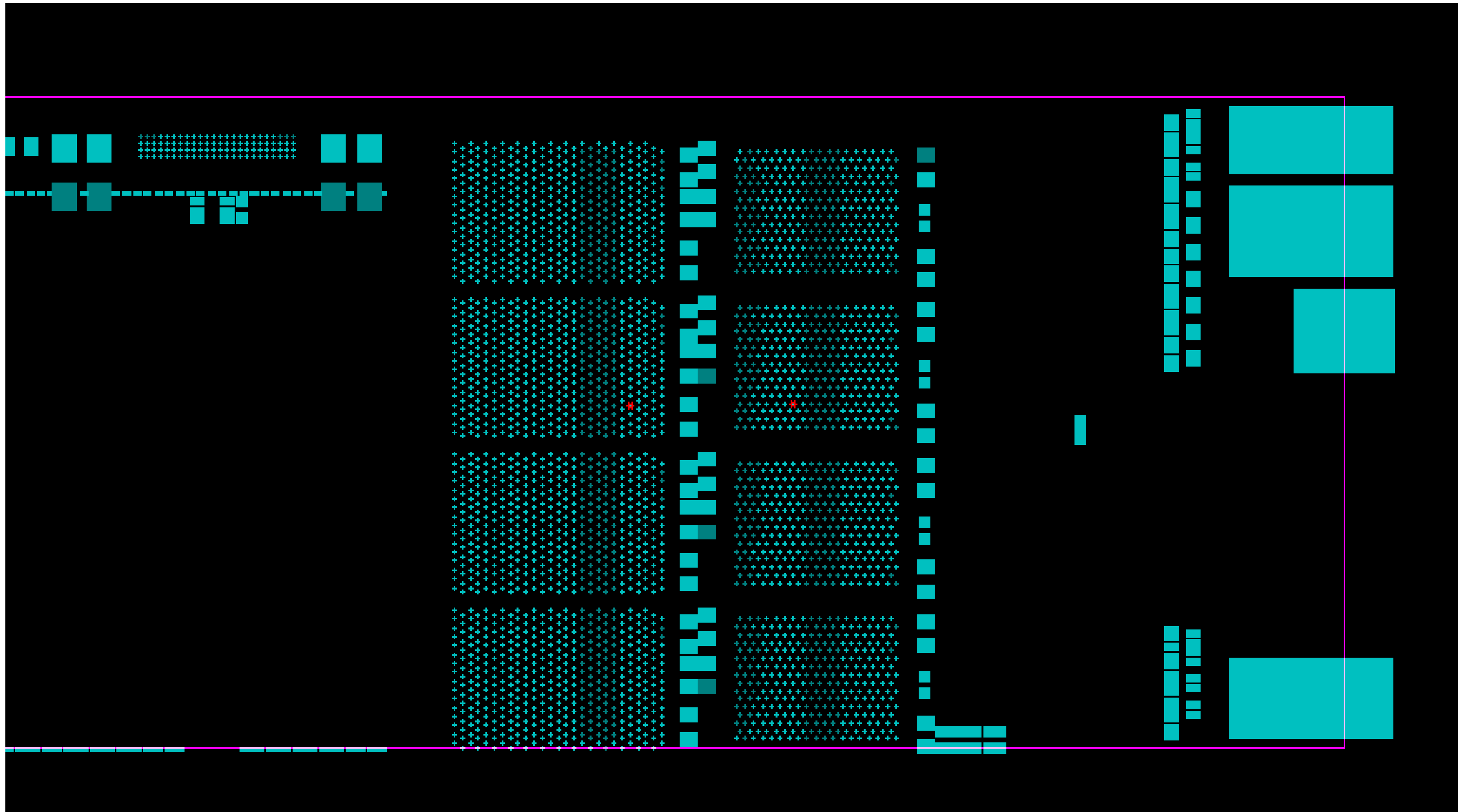
- We have 3 EMCM that we could use for further assembly.
- Wafers are getting solder stop at the moment and will be cut soon.
- New production run with 7 EMCM/wafer have been started / should be finished in about 6 weeks → Highest priority project!!
- ATG is preparing better machine S machine for the next test

- Backup slides follow …

EMCM (ZMI-5) WaferP6

**DUT2 – open**

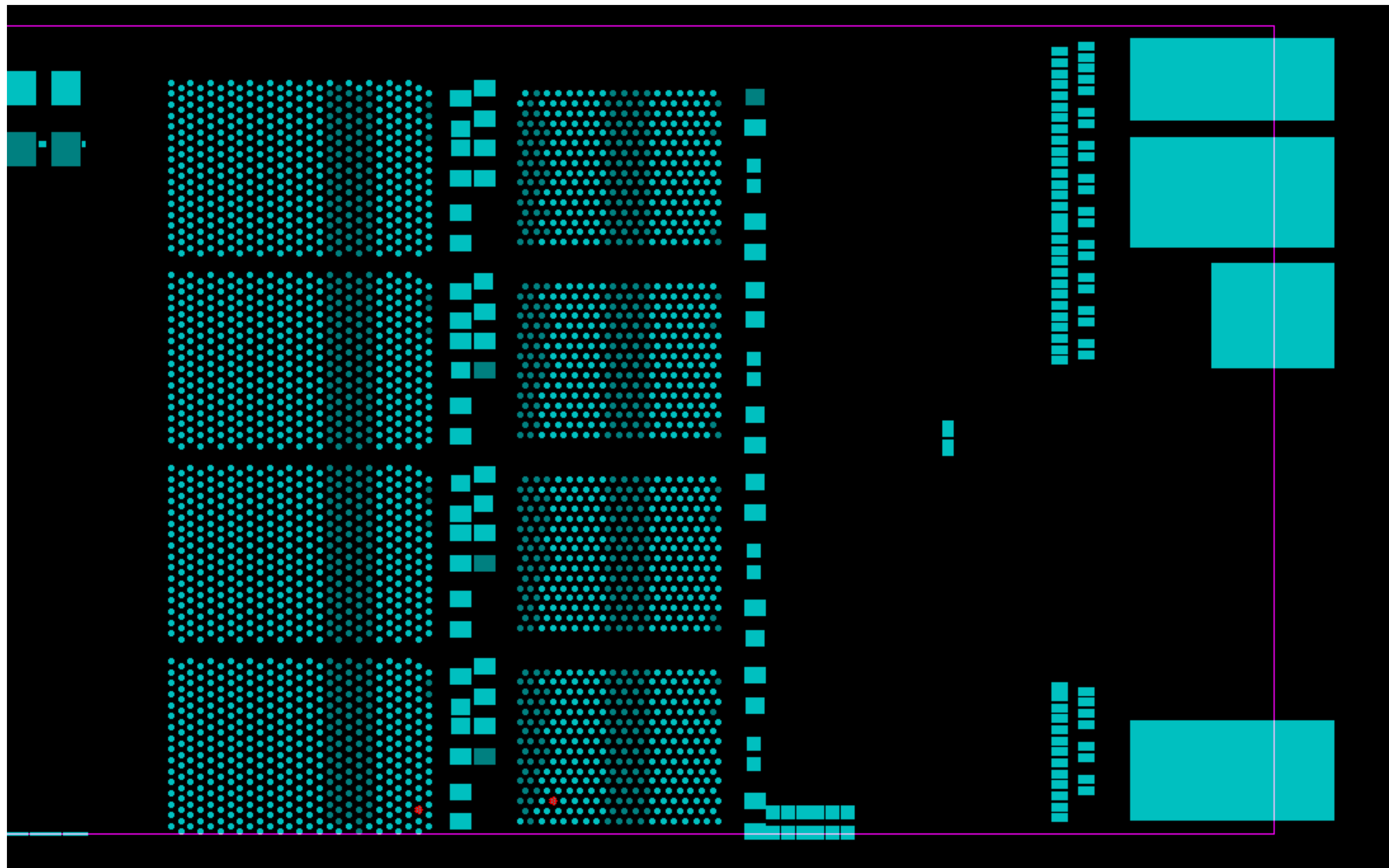
Pad 3033 - 3032



EMCM (ZMI-5) WaferP6

**DUT2 – open**

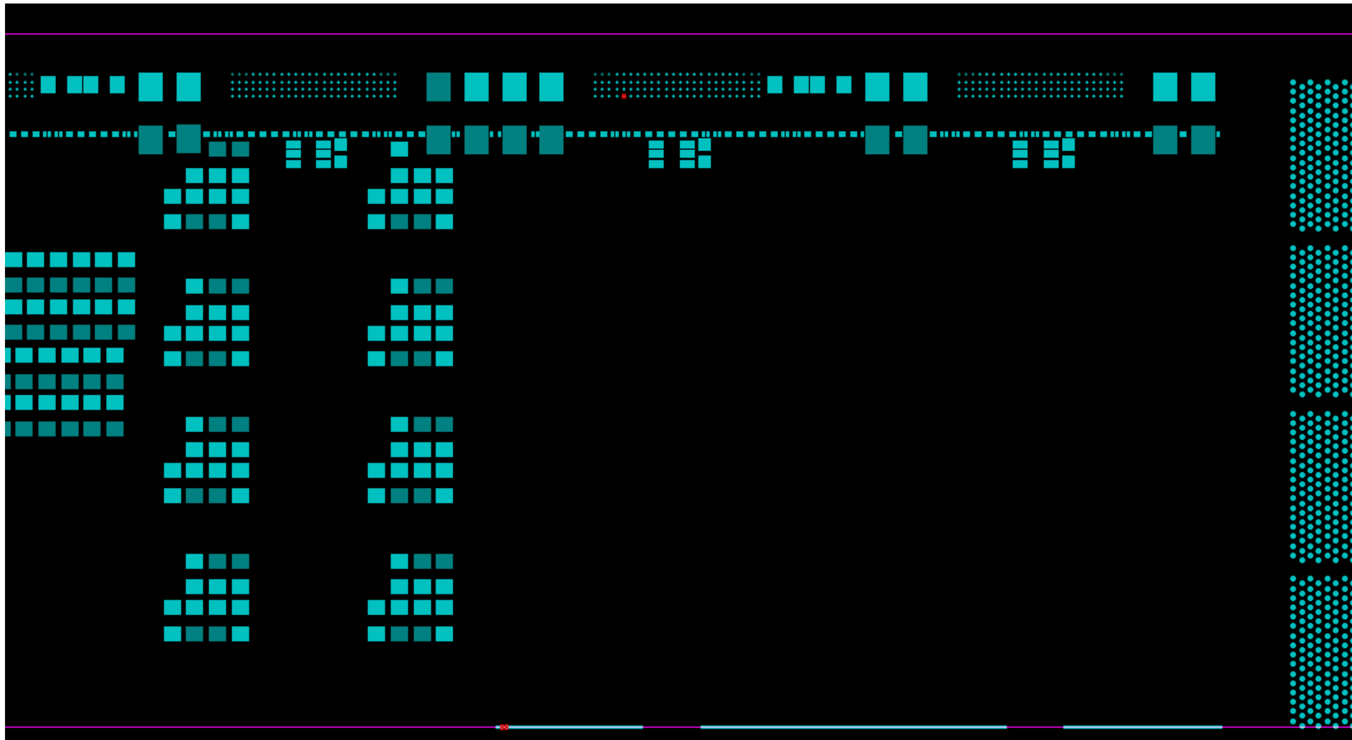
Pad 1290 - 1289



# EMCM (ZMI-5) WaferP6

**DUT1 – open**

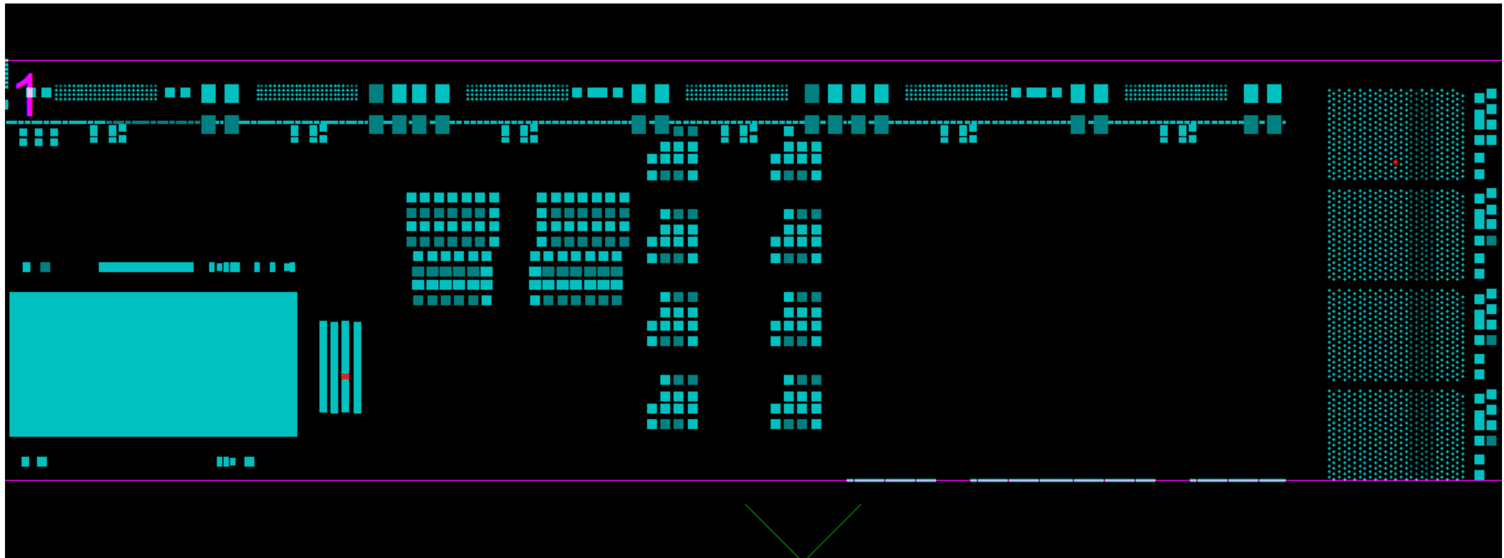
Pad 293 - 294



EMCM (ZMI-5) WaferP6

**DUT1 – open**

Pad 2126 - 2127



EMCM (ZMI-5) WaferP4

**DUT2 – open**

SwitcherB Output