IEEE SW Test Workshop

Semiconductor Wafer Test Workshop

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Probe-Tip Clean On Demand

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Introduction

- Today Probe-tip clean settings are static
- Clean interval is every x-dies or x-wafers
- How to determine the right settings?
- Not enough cleaning can cause yield loss!
- To often cleaning will “eat-up” your tips
  - When abrasive scrub is being used
  - Above all; it will cost time!
- This presentation is not about the clean-method but the clean moment!

Background

- Case study for one of our customers;
  - Customer currently uses clean interval every 100 die (worse-case setting)
  - Customer is testing the most wafers (80%) at elevated temperatures
  - As soon as probe-tips “leave” the wafer, a probe-tip soak is required before proceeding
  - Clean cycle takes ca. 5 sec
  - Soak cycle takes 120 sec (worse case setting)
  - Total cycle 125 sec!

Background

- Can we detect when cleaning should be done?
  - Wait until fails show up is not the way!
- Could we monitor the real-time parametric data and respond if a trend is detected?
  - Trend should be; values raise or fall in consecutive order
  - A threshold value should be set to initiate the clean moment

Objectives / Goals

- To clean only then when it is necessary
- Every reduction of a clean cycle will also reduce a “soak” cycle!
- The clean on demand should lead into total wafer process time reduction.
- Save probe-card life-time (scrub)

Methods / Materials / Procedures

From SE-PROBE to a Dynamic Test-cell Controller

TESTER

Daemon

DTC

SE-PROBE

OEE Module

More to come!

RTDana Module

Datalog Module

PAT Module

Trend Module

PROBER / HANDLER

Net

Methods / Materials / Procedures

- When to clean?
  - It does not matter how many needles you have, if only one requires cleaning; You have to clean the entire probe card!
- On almost every “pin” a contact-test is performed at the start of each test-cycle
  - Should we monitor all those tests and if one of them shows a consecutive increase of value; perform a clean?

Methods / Materials / Procedures

- Still remains those “pins” where no real contact test could be performed!
- We also know that some higher current carrying pins show Frittering, which could “burn” the dirt.
- Increase of C-res shows at “most contact sensitive test”
- So what would be the best suitable method?

Methods / Materials / Procedures

Most sensitive pin

DUT

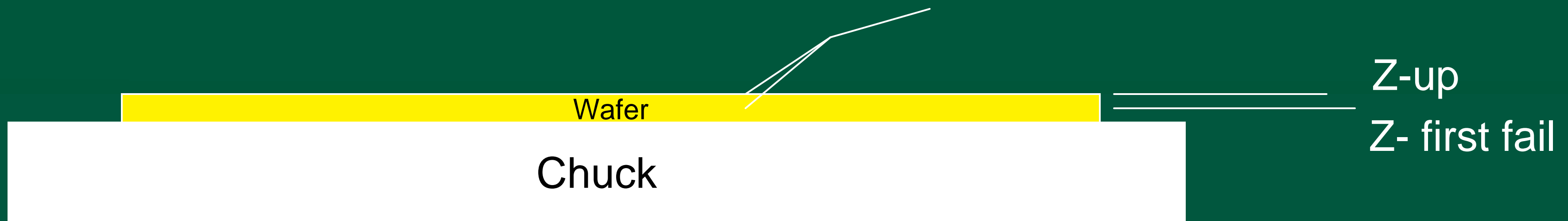
Cres increase during probing

Some pins may use signals
from a number of other pins,
Result in an add-up of all Cres values

Methods / Materials / Procedures

- Almost every device has got a most sensitive pin for “good-contact”
- How to detect this pin?
- Start with a “good” set-up on the prober
  - Acceptable probe marks
  - Good test results (bin 1 part)
- The DTC will start the first fail algorithm;
  - The Z-stage (chuck) is lowered a small steps
  - Test is repeated
  - This continues until the first fail occurs

Methods / Materials / Procedures

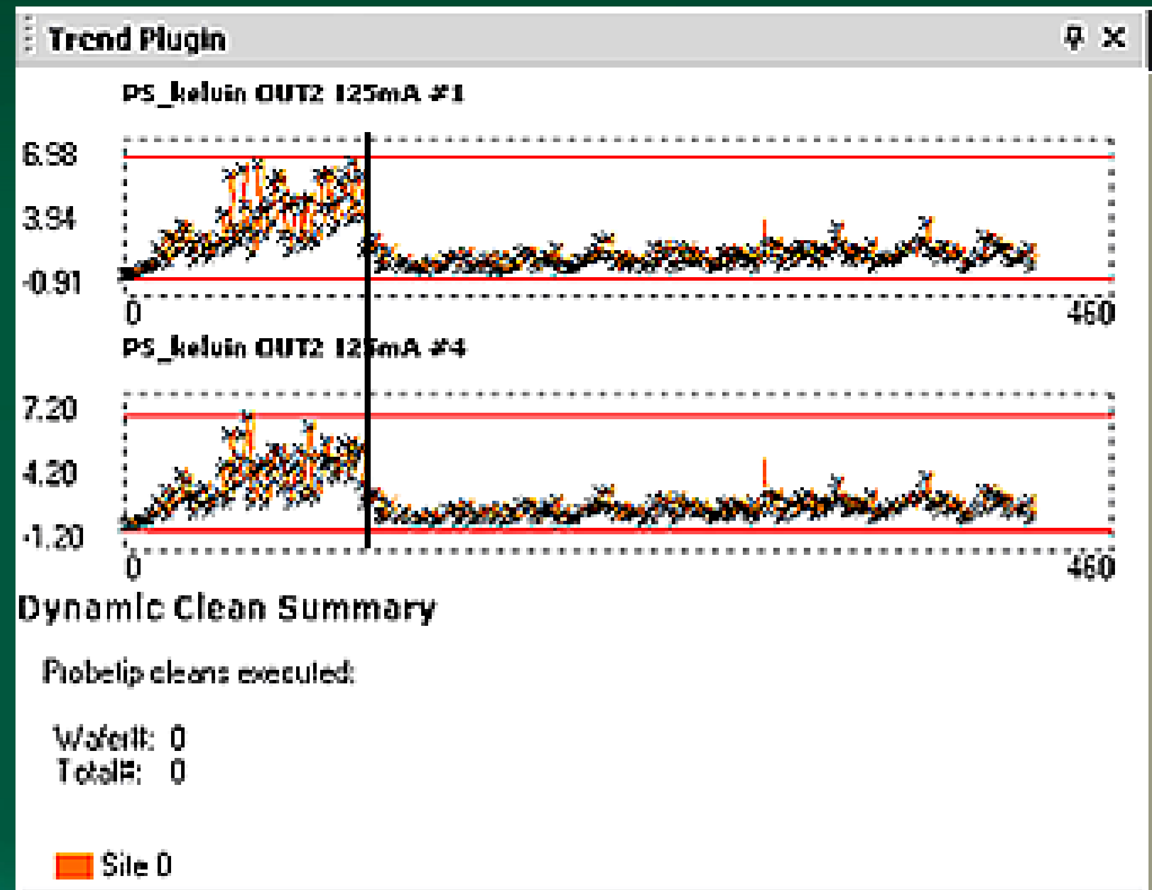


Methods / Materials / Procedures

- For the first test generating a fail;
  - test-number is stored.
- This “search” for the first failing test is now repeated a few times on the same die and a check is performed on repeatability of the results. The found test(s) is(are) classified as the “most contact sensitive test(s)”
- The next step is to repeat the “search” on a few more die locations.

Methods / Materials / Procedures

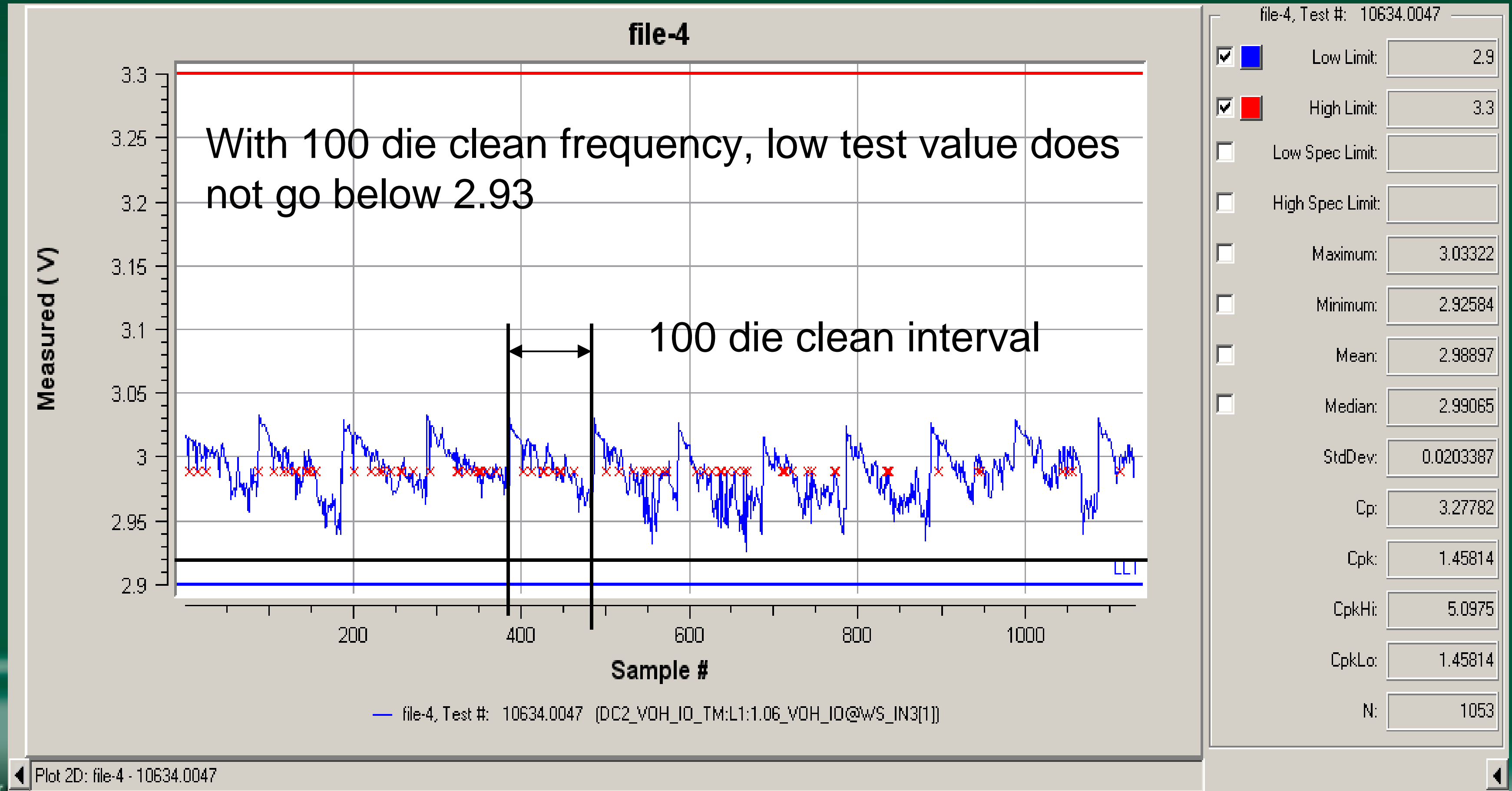
- Start with normal over-travel
- Decreased over-travel with small steps
- At black line, back to starting value



Methods / Materials / Procedures

- Alternative method to detect contact sensitive tests:
  - Test wafer without cleaning
  - Analyze tester datalog file
  - Look for those tests which show increase trend after a while
- Even when cleaning is used at static setting;
  - It could be visible to see the value "resetting" after each clean

Real wafer data with clean every 100 die



Real data with clean every 100 die

- This test shows contact resistance sensitivity
- After each clean the value “jumps” back
- Clearly the 100 die clean interval is recognizable
  - In fact more tests did show this behavior
- Values stay well above the minimum test limit.
- It is a save setting! But too often?

Wafer run without clean to 680 TD's

- First reject after ca 500 die (red marker)
- Clean at 680th die

file-2

2.93 value from static clean

3.05
3
2.95
2.9
2.85

LLT

200
400
600
800

Sample #

file-2, Test #: 10634.0047 (DC2_VOH_IO_TM:L1:1.06_VOH_IO@WS_IN3[1])

Methods / Materials / Procedures

- After analyzing the gathered data; the clean recipe can be generated;
  - Test number(s) to monitor
  - Per test number the threshold (should be set before real failures occur)
  - Minimum clean interval to get rid of the debris (even if this does not harm the test results)
  - Clean probes at each wafer change
- Cleaning on demand now takes place when the selected test(s) show consecutive increase/decrease in value plus go trough the threshold level.

Test number 10634.0047

- Test data generated on wafer without tip clean for 1st 650 die.
- Test result show a overall down-ward trend
- Around 500 die the 1st reject red circle
- Need clean before 1st reject
- Proposal for clean recipe;
  - Low threshold at 2.95
  - Consecutive number (trend width) at 5
- Then no clean until orange marked area (380 die)
  - Brings almost 75% saving in clean cycles
- Green area shows value decrease but no 5 values consecutively below the threshold

Results / Relevant Findings / Key Data

file-2

threshold value

3.05
3
2.95
2.9
2.85

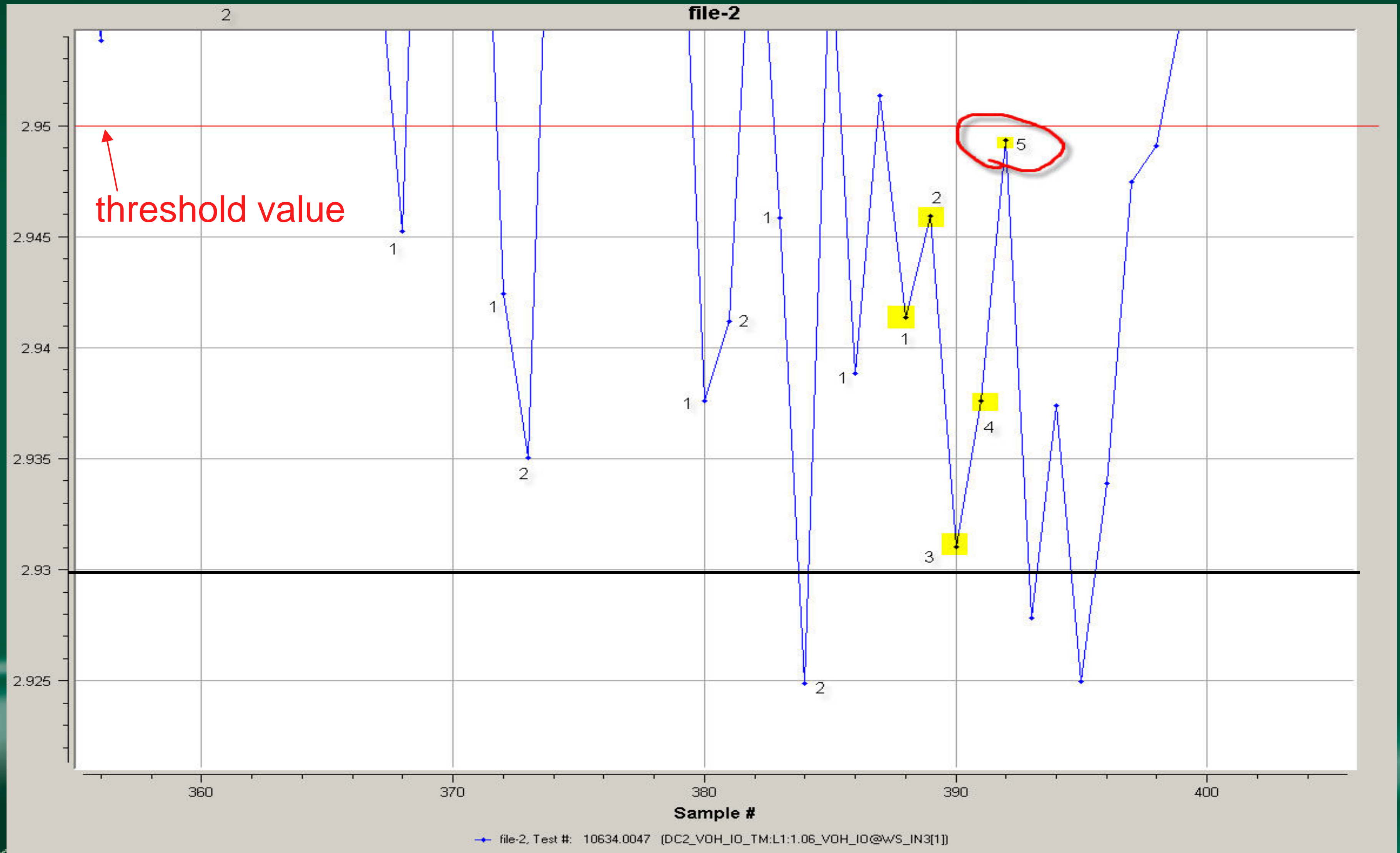
LLT

200
400
600
800

Sample #

file-2, Test #: 10634.0047 (DC2_VOH_IO_TM:L1:1.06_VOH_IO@WS_IN3[1])

Zoom in on clean moment



Results / Relevant Findings / Key Data

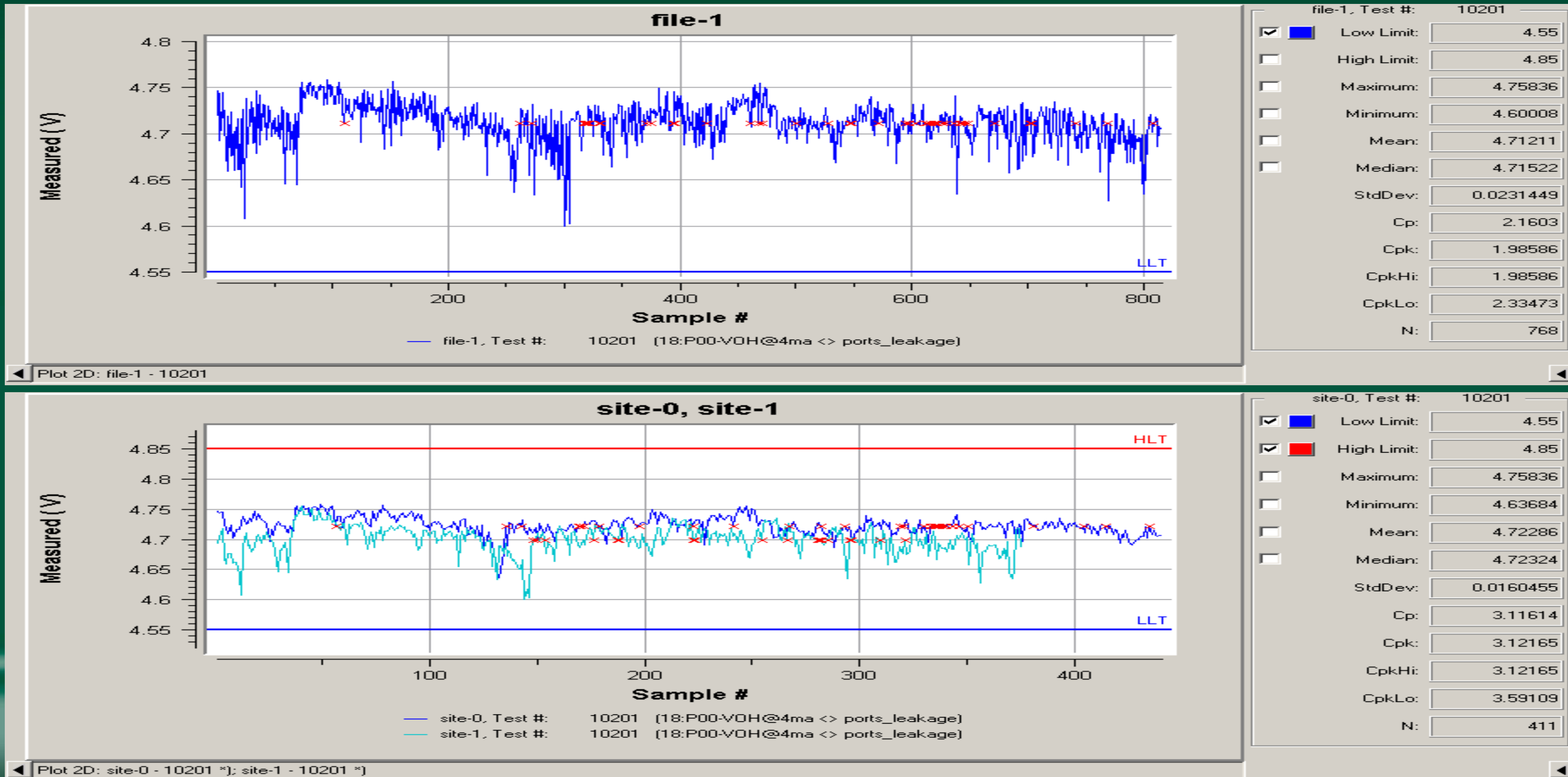
- How does it work in practice?

Results / Relevant Findings / Key Data

- Expect full recovery direct after clean
  - Measured value of 1st die after clean is not above the threshold!
  - We had to change settings in recovery check mechanism (selectable after x-die)
- Needed to implement site to site independency
  - For multi-side probe cards
  - If one of the sites requires cleaning, looking at the total-data did not initiate the clean in time!
- Needed to exclude “real-rejects” from consecutive count.
- How to handle geographical variation;
  - Different threshold towards the edge of a wafer?

site to site independency

Total-data



Site to site data

site to site independency

Site-0 and site-1 vary a lot

site1, site0

Measured (V)

0.8
0.7
0.6
0.5
0.4
0.3
0.2

HLT

LLT

100 200 300 400

Sample #

site1, Test #: 11302 (18:P11-VOL@10ma <> ports_leakage)

site0, Test #: 11302 (18:P11-VOL@10ma <> ports_leakage)

Discussion of Results

- Test-cell requires a DTC
- A tester Daemon must be available
- Clean on demand is dynamic process
- Reduction on clean cycles
- No yield concession
- Soak time has massive effect on total process time
- No clean-wafer has taken into account yet!

Strengths

- Clean only then when necessary
  - Based on device specific recipe
  - Real time parametric data monitoring
  - Depending on amount of debris, causing increase of Cres, probe-card live time is expanded due to less clean cycles.
  - DTC can do in the same time a lot of other actions and control (not limited to dynamic clean)
  - Reporting, know where in the map clean took place
  - Probe card Dbase including yield and clean history

Weaknesses

- Each product requires a clean recipe
  - Find the most Cres sensitive pin(s)
- Recipe creation requires engineering skills
- Additional hardware/intelligence is required per test-cell
- Perhaps the recipe should be linked to the probe-card?

Summary / Conclusion

- It is possible to dynamically control when probe tip clean is needed by adding a DTC
- Depending on quality of product, total process time reduction has been achieved.
- The shorter the test time the higher saving results were achieved.
- Reduction of clean cycles also reduces the amount of soak cycles when test at high temperatures. (in fact this is most of the saving)

Follow-On Work

- Come up with “Plug and Play” recipe creation.
- Work out the detail when “clean-wafer are being used i.s.o. clean unit next to chuck.
- Focus on soak time control, don’t soak longer then necessary.

Thank You

- Let us clean on demand!
- Questions?