Freescale Semiconductor

Probe Metrology Panel Discussion
SWT June 2006

Nadine Aldahhan
Austin, TX

Probe Facility

- Supports output of 8” and 12” Fabs
- 60% Digital, 25% M/S, 15% RF
- ~200 part numbers every month
- 14,000 Square Feet, Class 10000 clean room
- 52 Operators on 3:4:4:3 shifts for 24/7
- 12 Probe card repair operators, 3:4:4:3
- 4 Supervisors, 30 Techs, 9 Probe Engrs
- 68 Probe Test Cells: 8 A595, 8 iFlex, 12 J750, 3 J971, 112 J973, 2 A585, 11 HP93K, 3 Inovys. All TEL probers

Probe Cards

- **Probe Card Inventory: ~60% Cantilever, and 40% Vertical. Just starting with membrane for RF module devices.**
- **100% purchased**
- **In-house repair capability 24/7.**
- **All vertical probe cards are sent out for major repairs.**
- **50% of devices are multi-site x2 to x64.**
  - ~70% are logic x2 to x8
  - ~ 30% are memory x8 to x64

Probe Card Tracking

- All probe cards are bar coded
- Separate small terminals at each probe cell and in probe card repair
- Operator loads card ID, equipment ID, and lot number
- Database includes number of touchdowns, any problems at sort, repair and offline cleaning history
- Engineering (offline) must correlate and evaluate the data to determine if one particular card or one vendor has excessive troubles

Probe Card Cleaning

- **Determined frequency by yield roll-off and Cres in an extensive experiment**
- **Observed a technology impact on the need for polish**
- **Every card is cleaned every ~50 - 300 devices**
- **Test Program Triggers:**
  - SPC determined triggers using a tool at sort
  - Autobin reprobe on specific cases at end of wafer
  - Stop on consecutive failures of specific bins during sort
  - Triggers initiate OCAPs for operators and technicians to troubleshoot
- **Cleaning is done using 1-3 micron pink abrasive material, five scrubs for each clean.**

Probe Card Metrology System

- Every card is bar coded when received
- Compare vendors analyzer data with our data
- If no problems, a card is qualified and correlated before it is sent to PC inventory
- Card is tracked when issued to probe floor
- Card is tracked when setup on prober
- Any issues in probe are tracked
- If issues are not resolved at probe, the card is tracked out of probe and into repair
- In repair, card is put on our analyzer, adjusted, cleaned, re-analyzed (cres and leakage), then returned to inventory
- If then same card has another problem during the next use, it is held for engineering evaluation
- On-going monitor of tip diameter (cantilever) and tip length (vertical) to trigger rebuilds.

Problems

- **Multi-level and <60 micron pitch cantilever that are hi-pin count are hard to repair due to analyzer limitations.**
- **Vertical probe technologies challenges include:**
  - The lead time and repair time for bump is 2-4 days, whereas wirebond is 2-4 weeks.
  - Bump: recently started to run full test on analyzer for engineering use, and a subset of pins is tested for production.
  - Wirebond: some manual check is needed to verify all pins. Special cleaning is required and ongoing training is needed.
- **Bump vertical issues include:**
  - Burnt pins on cards due to no clamps set in the test program and/or slow clamps on tester.
  - Smaller needle diameters as devices have shrunk and increased pin count.
- **Limited resources to qualify new semi-abrasive cleaning material.**

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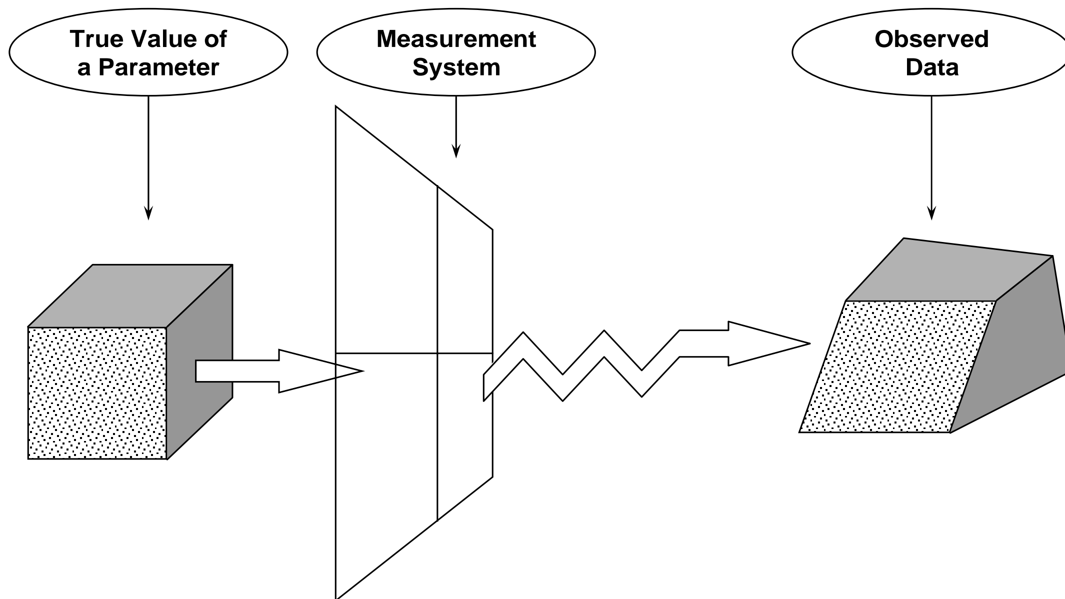
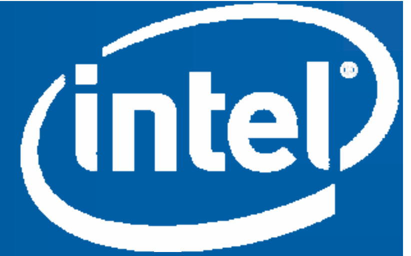




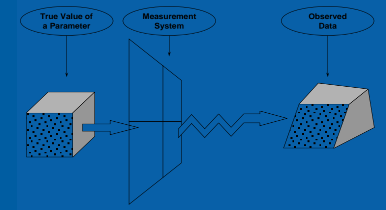
Probecard Metrology at Intel
SW Test 2006

Darren Coil WW22'06

Agenda

- Intel Sort Floor Stats
- Incoming Process
- Bad Card Review
- Key challenges and issues

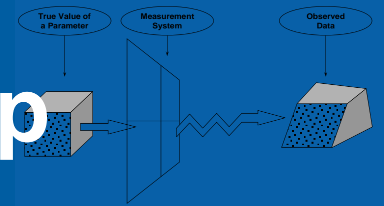
Sort Overview



- 12 World Wide HVM Sort Sites at Intel
- Process 80k wafer starts per week for 430 different products *
  - Products are digital, M/S, RF, Optical, and analog
  - Probe counts vary from 10 to 5000 per product
  - Sort Floor 153k SqFt / PCM area 8.3k SqFt *
  - Hundreds of operators rotate through PCM 24/7
- Total Cards = 2400 * with arrays from x1 to full wafer contact
  - Buckling beam - various
  - Vertical probe technologies – multiple technologies
  - Cantilever needle
- Automated Probecard history / tracking through EEproms and barcodes

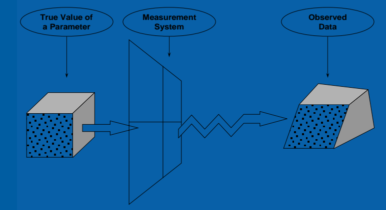
*Figure(s) is/are approximate

General Receiving and Card Setup



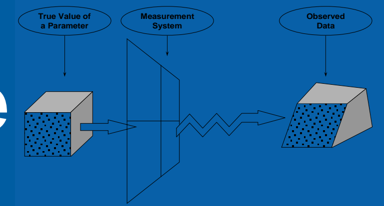
- db updated with unique Card ID
- Inspection performed against purchase requirements
  - Using probecard analyzers
  - Manual inspection of large array cards
  - electrical and dimensional information evaluated
  - Want EEProm read/write capability on metro tool……(hint hint hint)
- Cards are sent to floor for correlations or direct to production
- Barcodes are used in metrology are where available and eeproms are used when identifying cards during sort
  - Manual entry is also used at some sites with drop down selection of IDs
- Cards are measured and tracked for setup success rates
  - Other indicators like availability, repeat offender are documented

SIU Maintenance and Cleaning



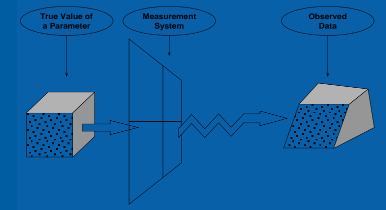
- Regular online prober cleaning is used with all technologies
  - Cleaning frequency is set by probecard technology, product and node basis
  - Use brush, abrasive lapping, and gel materials
- Most probecard technologies are run to fail or SPC fault
  - Regular PM of cards is generally done only with 1 technology

Bad Card Identification and Response



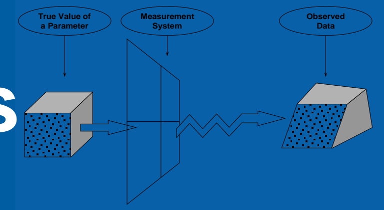
- Utilize various statistical process control algorithms during sort to identify potential bad probecard
- Card taken offline in DB
- Sent to metrology area for analysis and repair
- Brush clean prior to inspection
  - Metrology tools are not permitted to inspect a dirty card
- Post inspection, additional repair, adjustment or cleaning may occur
  - Head adjustments, head swap, probe tweaking, probe replacement, chemical clean, brush or plate cleaning, vendor RMA
  - Notes are added to card history
  - Lacking fast ergonomic repair with auto probe location,
- After meeting spec, returned to sort environment and returned to good status in db

Key Intel Challenges in Metrology



- Equipment Features and Integration
  - Safety – tooling is very heavy, no complete solution today
  - Ergonomic – scopes, operator position, auto probe location are inadequate
  - Mechanical and chemical cleaning is used, need complete solution
  - Improved equipment reliability -> too sensitive today
  - Access card data to correlate to sort performance -> Open up
  - Automate calibration and improve decision making -> tell MT what to do with card
- Decrease cost per probe repair
  - Make offline, individual probe repair stations and process available for all card technologies
  - Metrology equipment could incorporate increased automated probe manipulation

The Long and Short of our Challenges



- Metrology equipment is loaded with very useful tools and features
- In our environment, we don't have the time to use them all
  - Connecting databases is not straightforward
  - We use different vendor equipment for different feedback mechanisms
  - Our volume of sort data is massive
- We need easier access to equipment data, more automated decision making for the techs and more robust machines
- Metrology equipment to closer replicate testers

IBM Microelectronics

Probe Metrology Panel

Jack Courtney

Probe Facility

- Test Floor @ IBM Burlington, Vermont
  - Supports both 200mm and 300mm production
    - 12,000 wafers per week capacity at test - 24/7 production
    - 80% Digital, 20% M/S
    - Test Platforms include Advantest, Teradyne, Agilent, IBM
    - Probers – mix of Tel and EG
    - Over 7000 probes in inventory
    - Over 500 unique designs currently active
  - Resource for probe support
    - 20 Probe card fab, crib & repair technicians 24/7
    - 12 Probe Engrs - production and development

Probe Cards

- Probe Card Inventory:
  - 2900 Cobra probes – Internal design and build
  - 3700 Cantilever probes – Vendor design and build
  - 690 Vertical Membrane (TFI) probes – Internal design and build
- In-house repair capability 24/7
  - Cantilever – Tweak in-house, Rebuild at vendor
  - Cobra – 100% in-house
  - TFI – 100% in-house

Probe Card Tracking

- Inventory & Production Tracking System
  - Inventory controls - All items bar-coded
    - Check-in and sign out from central FEH crib
    - Minor maintenance performed in crib
  - Production - Wand hardware onto tester
    - Touchdowns, cleaning, problems entered into data base
  - Repair
    - Repair actions documented
    - 40% pass metrology before back into crib
    - 60% visual check only
  - Data mining – Query's generated for
    - Yield/touchdown/cleaning/repair data
  - Considering future enhancements
    - RF ID, link metrology results, auto tracking, more capacity

Probe Card Cleaning

- Insitu Cleaning
  - Cantilever - 200 to 500 touchdowns
    - Abrasive – AlOx w/mix of hard and soft backing
  - Cobra – 300 to 500 touchdowns
    - Abrasive – 3um AlOx
- Offline Cleaning
  - Cantilevers – Use metrology tool as required
  - Cobra – Manual Fixtures
  - TFI – Chemical Clean

Probe Card Metrology & Repair

- Mix of vendor and in-house probe card analyzers
  - All cantilever cards pass analyzer after repairs
  - 30% of cobra through analyzer after repair
  - TFI sees in-house analyzer @ delivery and major repairs
- Cantilever – Analyzer used for repair, clean, pre/post inspect
  - Alignment is primary criteria
- Cobra – Analyzer used for pre/post inspect
  - Contact resistance is primary criteria
- TFI – Analyzer used @ delivery
  - Contact resistance is primary criteria

Problems and Issues

- Probe Damage – Life expectancy is not stellar
  - Alignment and bent probes
  - Melted probes – Significant problem for probe heads
  - Probe dies damaged – holes worn and cracked dies
- Per pin analyzer for TFI – Improve tester utilization
  - Looking at commercial offerings
- High pin count – Cobra and TFI – Over 5k pins/probe
  - Cost, pressure, lead time, cost
- High Power
  - Multiple amps/pin proliferating across products

Probe Card Metrology

Brett Crump

7/24/2006

Overview

- Probe Card Support Model
- Probe Card Operations
- Maintenance and Metrology
- Cleaning Frequency and Methods
- Probe Card Tracking
- Challenges

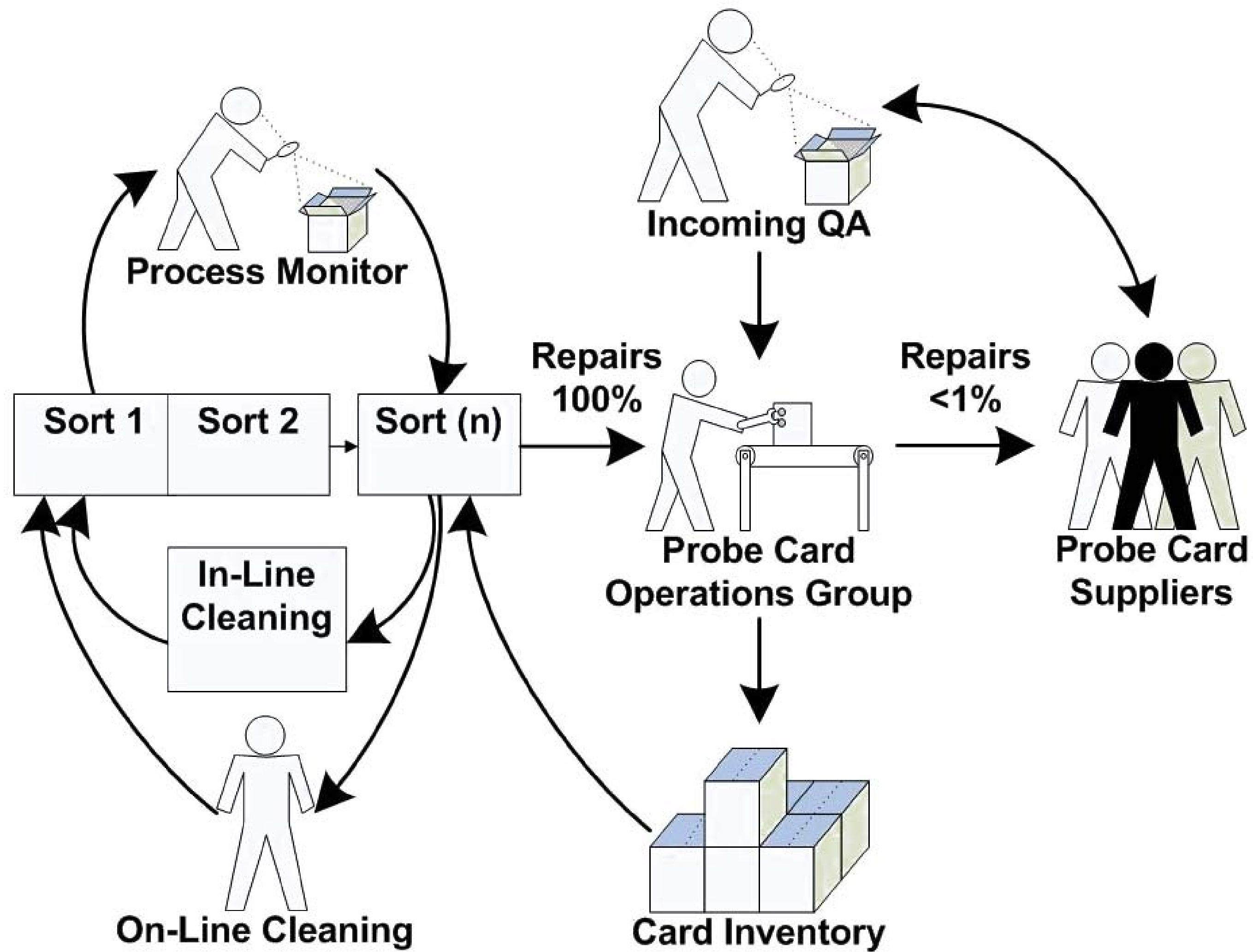
Probe Card Support Model

- Production Processes
  - Imaging – Dual-edge/Peripheral Cantilever
  - NAND Flash – Dual lead-on-edge Advanced Technologies
  - Mobile DRAM/DRAM – LOC/DLOC/Edge-bond/I-bond/KGD Advanced Technologies

Probe Card Support Model (Continued)

- Two-Phase Production Support Process
  - Operations group is 7x24
  - Includes Design, Production, and Process Engineering groups
  - 1st silicon vs. production ramp
  - Includes in-line parametric
  - Support model is different site-to-site
  - Good die are identified with a proprietary Micron wafer map

Micron Probe Card Operations



Maintenance

- Identification Criteria for Defective Cards
  - Contact reliability
  - SPC monitors – deterministic failures
  - Planarity failures
  - MTTF and number of repairs
- Repair Procedures
  - Product change
  - Problem card

Metrology

- Metrology Systems and In-line Quality Monitors
  - Probe card analyzers (several)
  - Off-line scrub mark analysis (several)
  - Probe Mark Inspection (PMI)
  - Contact reliability metrics (PTRES)

Cleaning Frequency and Methods

- Cleaning is generally an event-driven process
- Process recipes are different for Au, Al, and Cu products
- Cleaning is used to address contact reliability issues and increase PTPA success
- Gel, WC wafer, abrasive elastomers, and off-line maintenance

Probe Card Tracking

- Proprietary tracking program (PTI)
- Tracks TD counts, repair history, specifications, and is used for card technology type recipe control
- Each card has a unique electronic identifier
- Total active card inventory: >1000
- Currently researching RFID as a possibility for location tracking, card utilization, and inventory management

Challenges

- The pain of large-area contactors
- Cold/hot testing with the same card
- Parallelism error stack-up
- Test cell variance relating to probe placement precision
- Single-probe damage

Challenges (Continued)

- Lack of advanced technology suppliers
- Product life vs. cost of probe cards
- Interface densities
- Balancing projected card inventories to actual operational inventory requirements
- Was cost mentioned?

Probe Metrology Panel

Michael Harris
EBT Probe Card
Operations Engineering

Texas Instruments

Primary Probe Facility:

- TI has many probe floors
  - Data from EBT only.

- Capacity
  - 50K wafers per month,
  - 150, 200 and 300mm
  - 90% Digital, 10% M/S, 0% RF
- Stats
  - ~1200 active part numbers, ~180 monthly
  - 80K Square Feet in 2 facilities,
  - Class 10K clean room
- Staff :
  - 475 total personnel
  - 20 Probe card R&M techs, 4 shifts 24/7
- Hardware :
  - 450+ Probe Test Cells,
  - Various Testers
  - TSK probers

Toured by IMSI Sematech Probe Council in 2004

Probe Cards Types

- Technology
  - ~90% Cantilever
  - ~7% Cobra
  - ~ 3% APT*
- Inventory:
  - ~6200 Cantilever
  - ~ 600 Vertical
- Card Source
  - 100% purchased cards
- Inking
  - 100% inkless probing

*APT – Advanced Probe Card Technologies

Probe Card Tracking:

- 2 Databases
  - "Trackware" : Custom S/W for Tracking Probe Card status and location.
    - Stores TD Count, Data/Time of use. Lots/wafers processed, Physical Location and any maintenance records.
  - "Testware" : Custom S/W for storing wafer data and test program director for test cells.
- Flow / Operation
  - Probe cards are bar coded at incoming
  - Initial Status and Location updated in Trackware
  - Probe Cards are linked to test set via Testware
    - Operators scans probe card bar code during setup.
  - TD Count stored in Trackware at wafer unload by Testware.
  - Card Staus entered in Trackware when returned to shop
- Data
  - Engineering must correlate and evaluate the data to find issues.
  - Trackware Report Generator Available

Probe Card Cleaning:

- Online Cleaning
  - 8 different recipes based on card technology and IC technology
  - 3 different cleaning media

- Cleaning Recipes
  - Cards assigned to cleaning recipe by empirical process.
  - Every card is cleaned at the beginning of each new wafer

- Cleaning Intervals
  - Vary from 50 TDs to 150 TDs
  - Most at 150 TDs
  - Testware monitors : Site 2 Site, Tester 2 Tester , Bin Issues
    - May trigger either cleaning, automatic reprobe or a prompt for operator attention.

Probe Card Metrology System:

- **Ground Rules:**
  - **Card state and location is tracked from initial order to the mfg floor to the shop.**
  - **Trackware is the "diary" for all information on the cards**
    - Lots processed, wafers tested, tester used, movement, repairs done in house, or when sent out, TD accumulation, PM triggers, notes by any personnel may be entered on a card's record.
  - **90% Manual tracking, but bar code loading of data.**
- **Card Flow**
  - **Card arrives with Vendors out going test files, checked at incoming.**
  - **Cards are sent to PC library nearest to tester**
  - **Operators check card out, mount on prober, location updated.**
  - **Card return to shop as a Pass/Fail or PM. Location Updated.**
  - **Based on various rules, returning cards are cleaned, checked for P/A and then returned to library or repaired if needed.**
  - **"Churning" cards (based on history) held for engineering evaluation**

Challenges

- Epoxy Ring Technology
  - Small bond pads coupled with multi-site cards are exhibiting higher than expected mis-alignment damage.
  - Interior bond pads are troublesome
  - 125C testing adversely affecting mechanical performance.
- Card Maintenance
  - Analyzer to bond pad correlation is much more critical for offline alignment work.
  - Large pin count cards take excessive amounts of repair time and analyzer time. Frequent pin detection misses cause retest.
- Moving to APC
  - Pitch and multi-site still challenging
  - Upfront Cost requires careful payback analysis

Probe Metrology Panel

Southwest Test Workshop 2006

Jens Kober

Member Technical Staff – SORT Test Engineer

AMD

13-June-2006

Probe Facility

- 100% microprocessor
- About 15 different part numbers
- Class 1000 clean room
- 4 shifts – 24/7 shift system

Probe Cards

- 100% vertical array testing
- 5-20% I/O and 80-95% PWR/GND pins
- Multiple probe card suppliers for the same device
  - Interchangeable probe heads
- 100% in-house repair
  - 24/7 in-house repair capability

Probe Card Tracking

- In-house developed probe card tracking system
- All probe cards have RF-ID tags as an identifier
- There is no typing by the operator – automated checking of
  - Process operation ID
  - Cassette/FOUP-ID
  - Product-ID
  - Lot-ID
  - Test program
  - Probe card
  - Prober setup
- In respect of probe cards we track all
  - Touchdowns
  - On-/off-line signal pin planarity data
  - All probe card maintenance events (including the activities done during the probe card maintenance)
- We track all metrology system parameters for each probe card

Probe Card Cleaning

- Empirically determined on- and off-line probe card cleaning recipes
  - historical data used as a base line for cleaning frequencies and parameters
- There are basic parameters that only depend on the probe technology/supplier as well as parameters that are product/technology related
- Depend on prober features/parameters for on-line cleaning
- Off-line cleaning done at the metrology system and in-house developed tools/methods

Probe Card Metrology System

- Same tracking system as in the test floor is also used on the metrology systems
- Do a complete incoming inspection for each probe card
  - Has to match AMD's criteria (probe card suppliers know our requirements)
- All metrology system data from each maintenance event are tracked/stored into our database
  - Repair events are documents
  - Preventive maintenance events are tracked

Problems

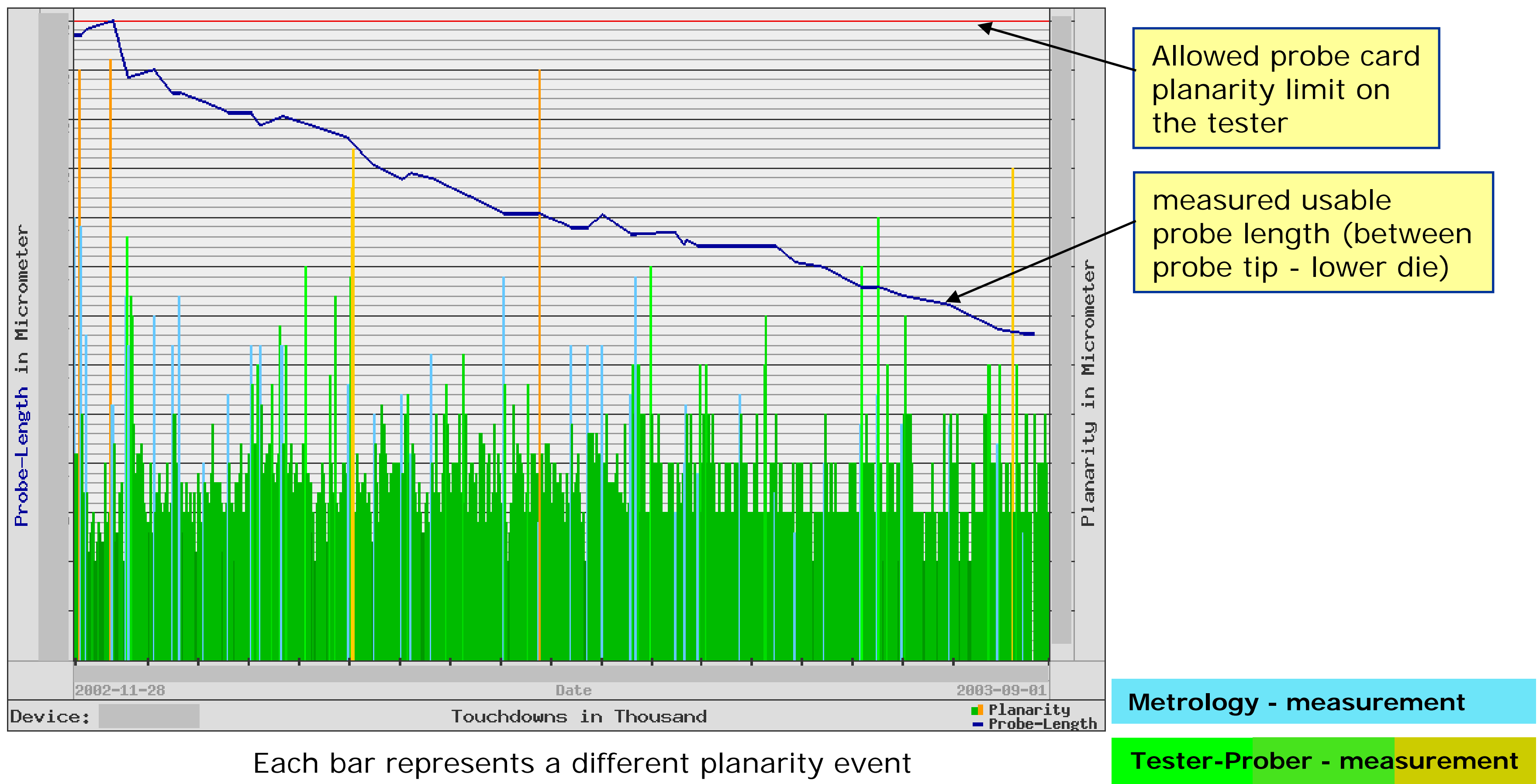
- Metrology companies need to keep up with our requirements
  - Disconnect between prober (on-line) and metrology system (off-line) features/parameters
  - New probe technologies (tip shapes) are not recognized by the metrology tools
  - Metrology tools do not match the performance of the prober/test systems in respect to probe card related parameters
- Metrology companies need to provide sufficient internal resources/capabilities
  - Priorities based on the overall need -> new probe technologies seem to get very little support (depends on probe card company also)

Outlook

- Probe card and metrology companies need to better engage
  - Success of new probe technologies will also depend on how successful those technologies can be run on the metrology tool
- Would like to see the metrology companies to engage with the prober companies
  - Probe technology that runs on the prober does not per default run on metrology systems
- Customers are willing to pay >100K per probe card (consumable part) but hesitate to pay for metrology systems (long term investment)
  - Customers need to re-think their strategy in respect to investments in metrology systems

Probe Card Tracking-System – Vertical Probe Technology

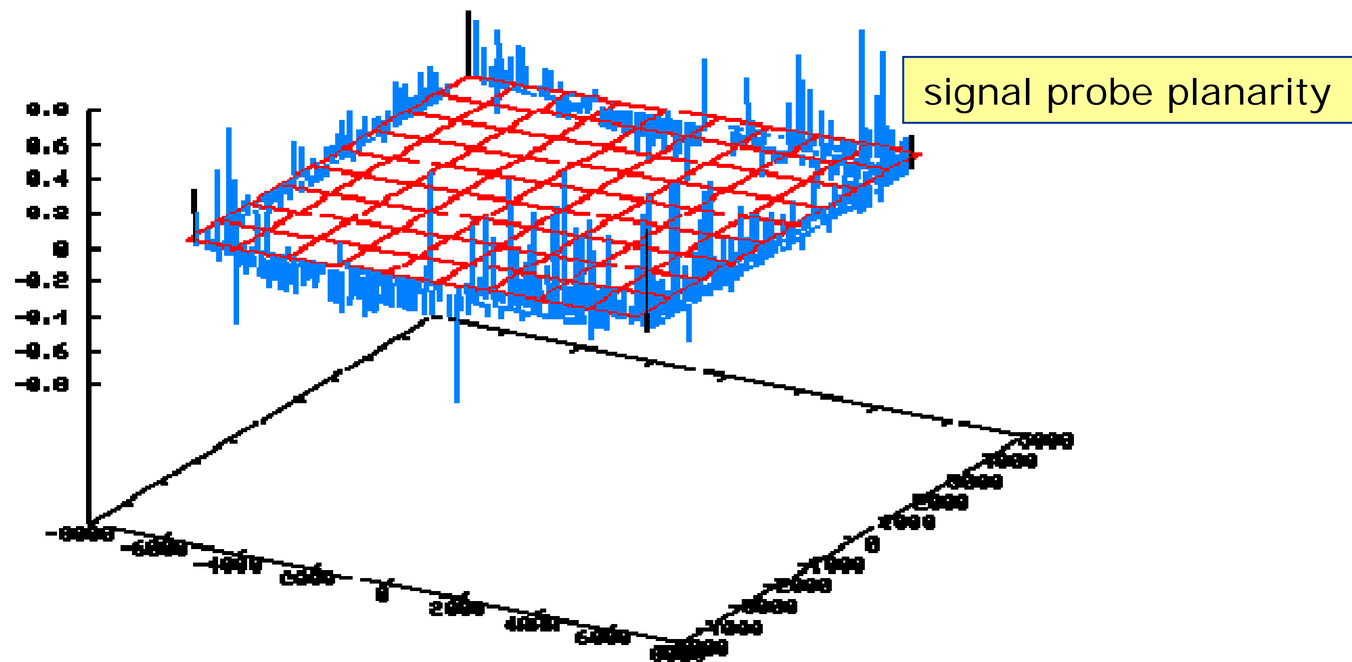
Combined Test Floor and Metrology Data



Each bar represents a different planarity event

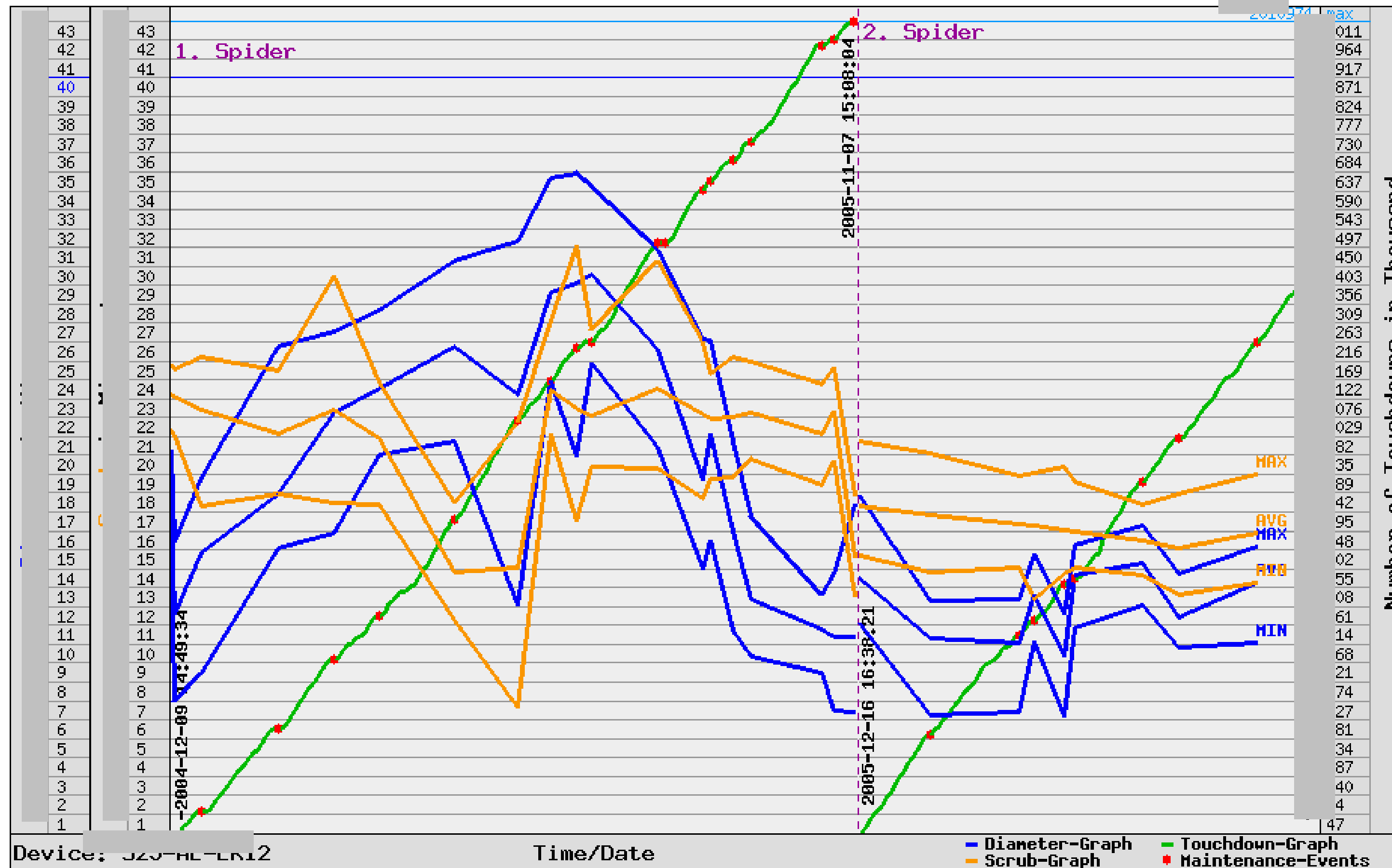
Probe Card Tracking-System – Vertical Probe Technology

Metrology Data



Probe Card Tracking-System – Cantilever Probe Technology

Combined Test Floor and Metrology Data



PHILIPS

Probe Metrology Panel

Southwest Test Workshop 2006

Ger Koch

Contents

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    1.1 Sites, how organized
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3. Metrology methods
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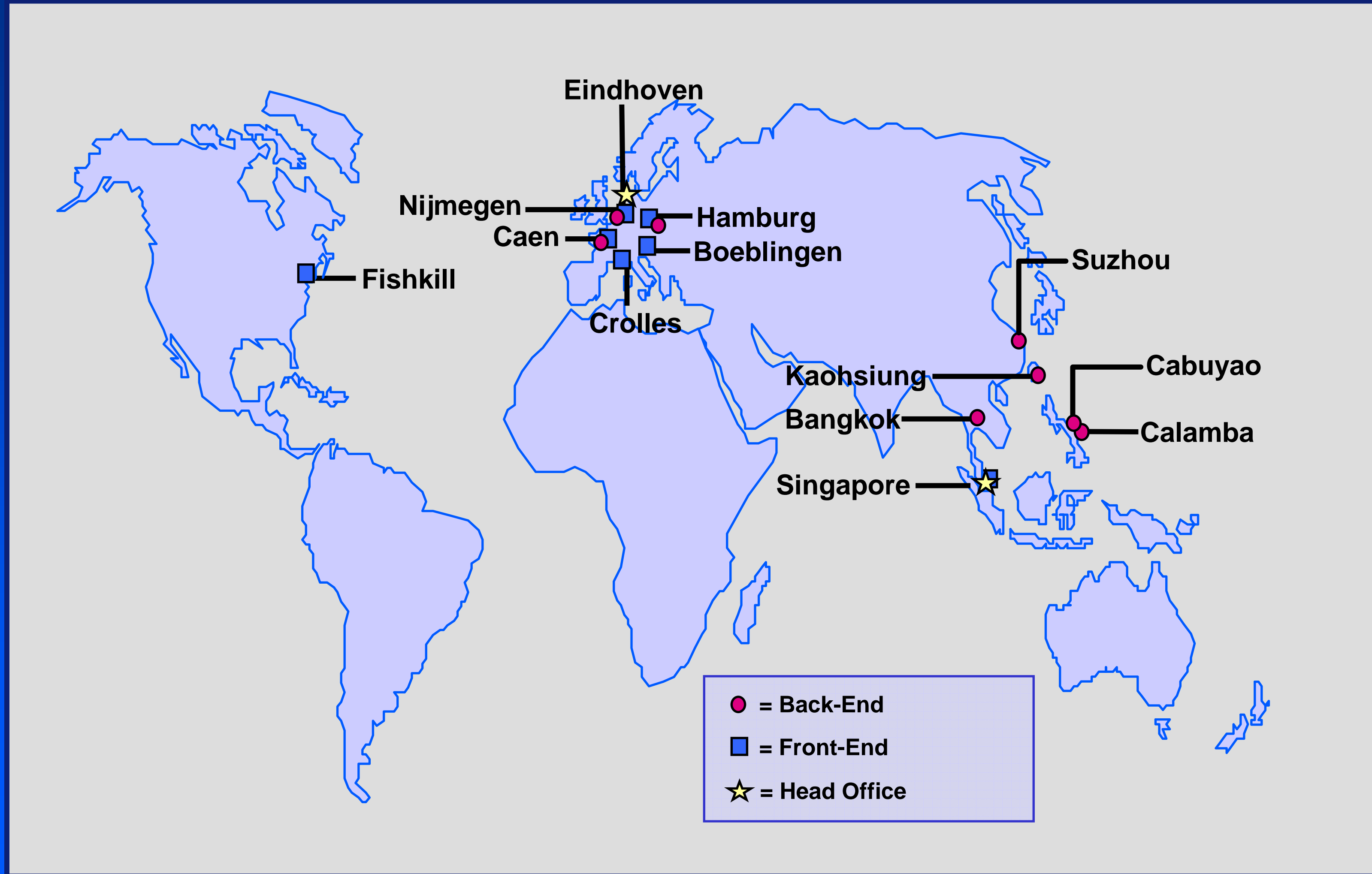
5. Trends & Issues

1. IC Manufacturing Organization (IMO)

- It combines both Foundry (Front-End) and Assembly & Test (Back-End) capabilities into one integrated manufacturing organization.
- Manufacturing sites in Asia, Europe and United States.

1.1 IMO Sites



1.1 IMO international co-operation model

Within the IMO test department, relevant for Probe processes:

- **Prober User Group**
- **Hardware Standardization Group**
- **Fab Automation Group**

Co-operation between disciplines is key!

- standardization of probe processes, incl. prober platforms.
- Knowledge sharing
- Shop floor control (incl. wafermap handling)
- Test data management

1.2 Key figures

- Supporting production of over 40k wafers/wk (4" - 12")
- IC's & discrete
  - Everything but "*pentiums*" & *stand alone memory*
- Processes: CMOS down to 0.09, Bipolar, Bi-, BCDMOS, QUBIC, '++'
- Total number of probers: over 650
  - Prober platforms:
    - EG & TSK
    - Mostly ambient & Hot, some tri-temp
- Total number of testers: over 1500
  - Test platforms: Agilent, Credence, LTX, Philips, Spea, Teradyne
- Test environment:
  - General BE: Class 10000, Cleanroom: Class 1000
- Over 15.000 probecards in inventory
- Over 2000 active products

1.3 Probecards

- Probecard Technologies:
  - 88% Cantilever (epoxy & blades)
    - internal & external designs and (re)build
  - 10% Vertical
    - Vendor design
  - 2% other (membrane)
    - Internal & external design and (re)build

- Cleaning:
  - on-line: 1um & 3um AlOx. Cleaning interval: 100-300 touchdowns
  - off-line: chemical cleaning, sand paper, brush

- Preventive maintenance (avg 100k TD)

2. Probecard tracking system

- **Integral part of Shop Floor Control system**
- **Key tracking parameters:**
  - **# touch downs**
  - **repair history**
  - **location**
  - **cleaning method**

3. Metrology methods

Applied methods vary per site and per technology

- Tip diameter increase triggers P.M. ⟶ re-shaping, repair (change spider)
- TD monitoring
- PCA check after each off line cleaning stage
  - planarity
  - x, y accuracy
  - tip diameter
  - Cres, leakage, PCB components
- Retest Recovery monitoring

4.1 MiT, Retest Recovery monitoring

R^x are monitored for all wafers for all probers.

R^x data used for:

- Direct feedback towards the operators (“MIT: Map in Time” system)
- Engineering purposes to prove effectiveness of process improvements

Next steps:

1. Online Cres monitoring (real SPC!)
2. Apply “smart” post processing techniques, to optimize the integral test process (incl. but not limited to probing only)

"on-the-fly“ actions, based on MiT

Diagnosis by system
(Production + RM)

Problem List

Diary Review Meeting

Production
SOP check

Call out for support

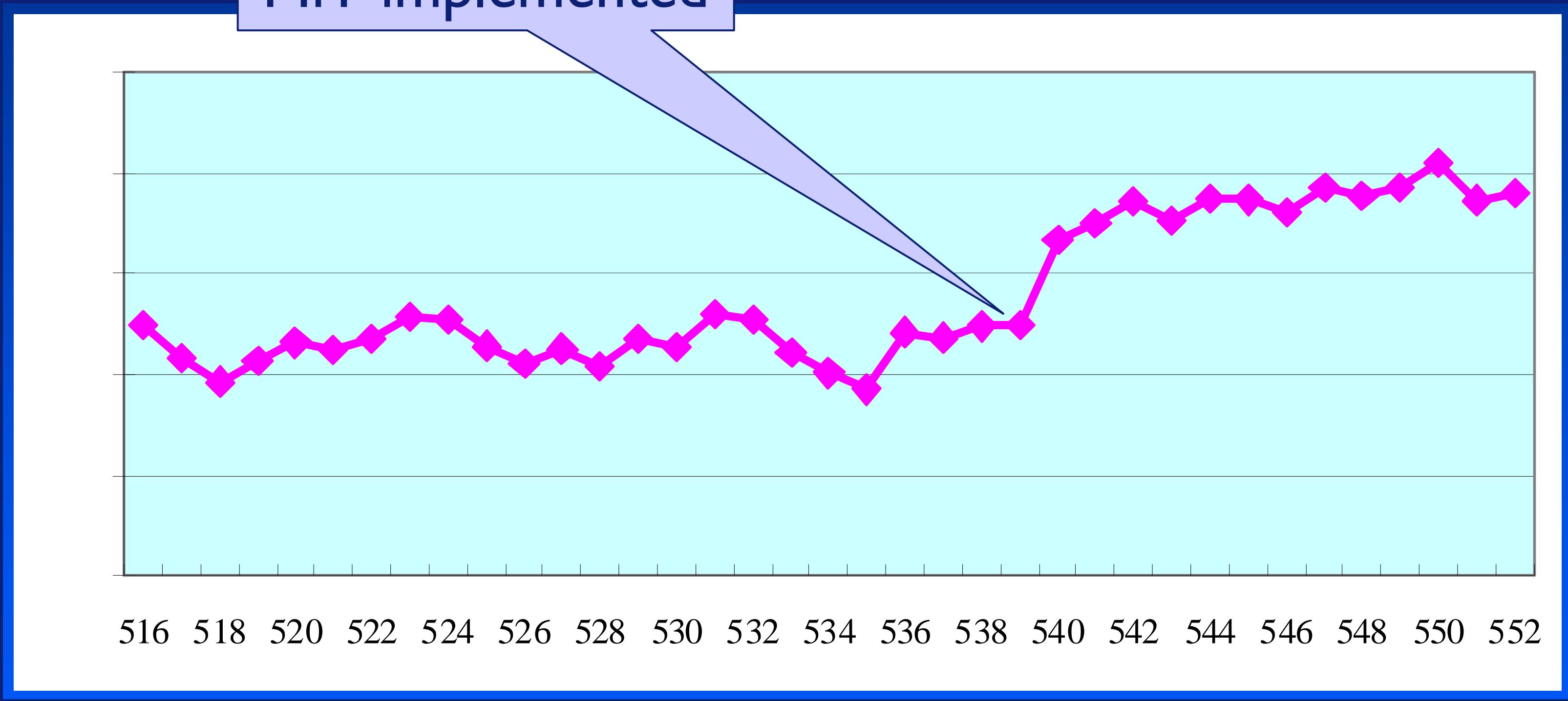
System
Engineering

Process
Engineering

Type
Engineering

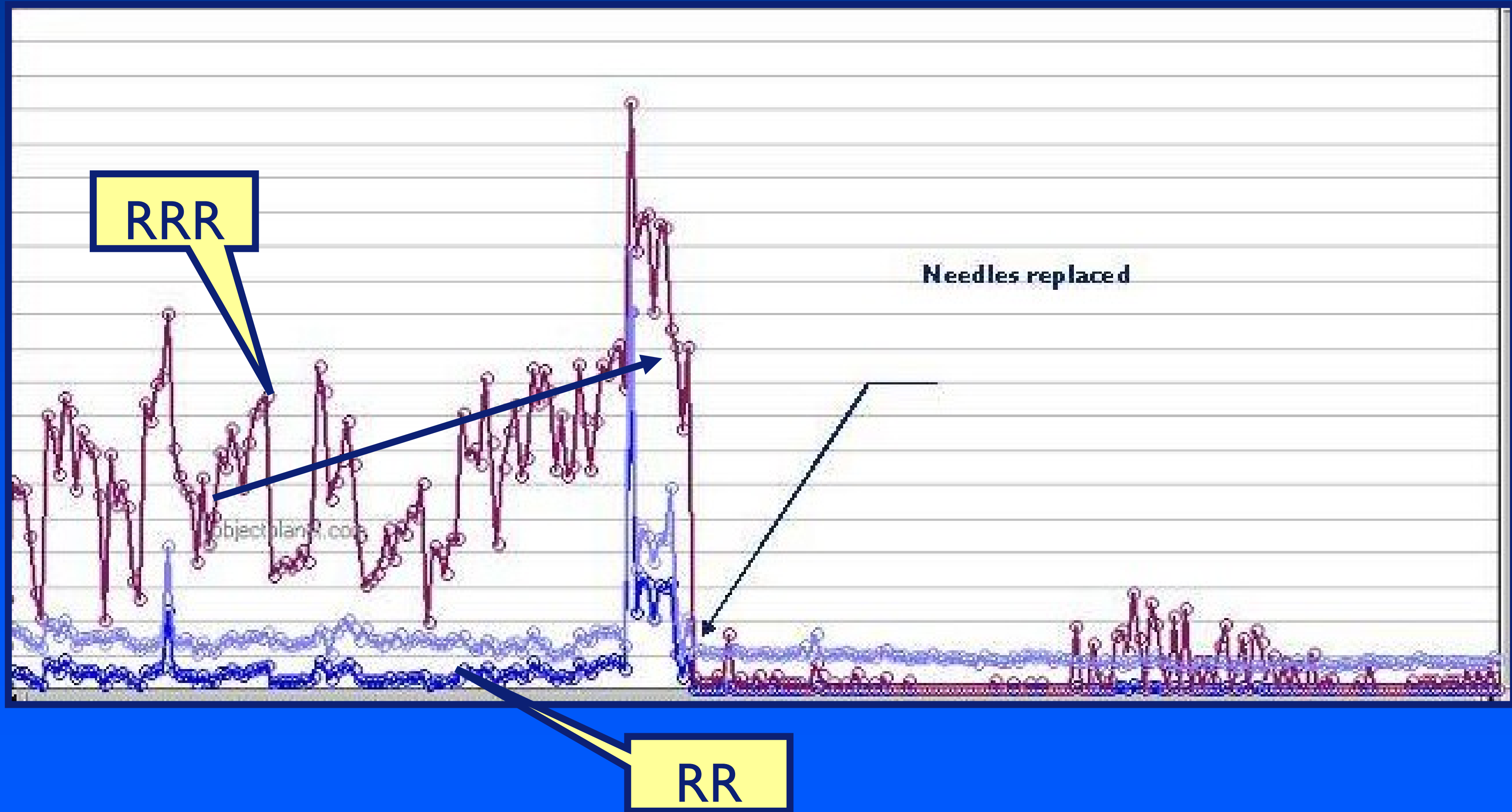
Product
Engineering

Effect of MIT on tester utilization

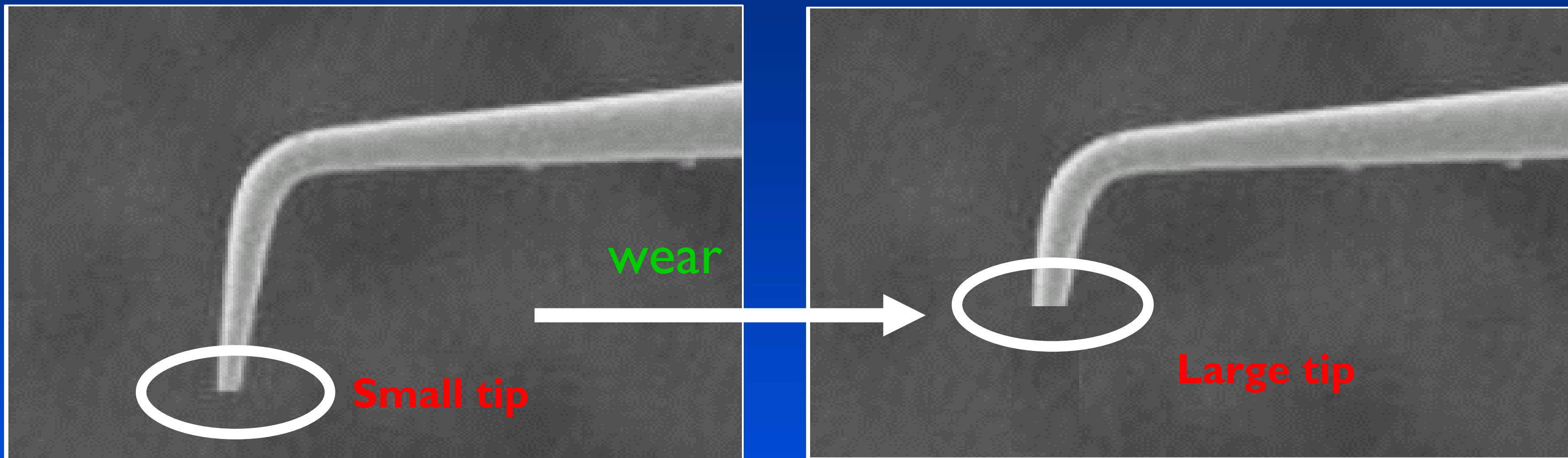


Retest Recovery monitoring

R^x reduction, replacing (vertical) probes

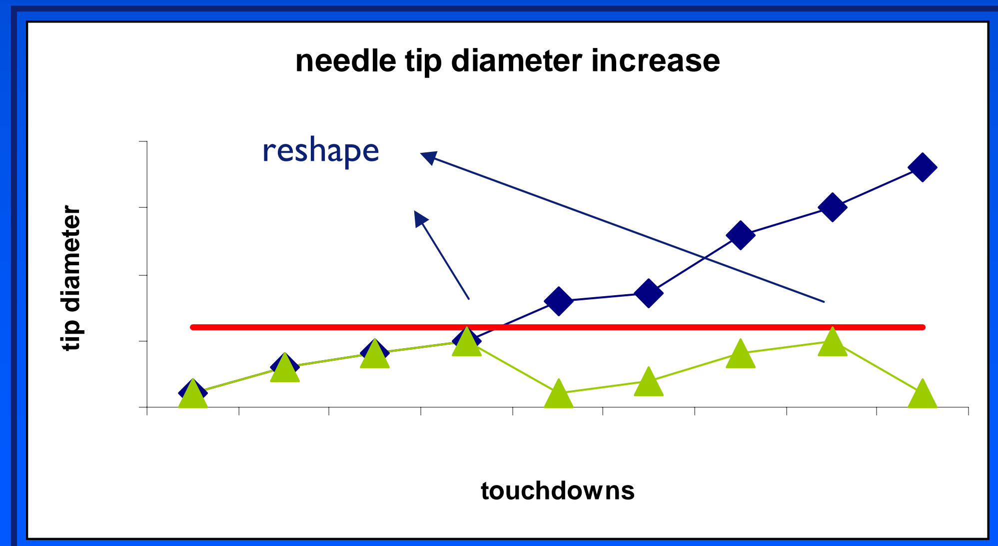


4.2 Tip diameter



Needle tip re-shaping by prolonged z-only cleaning on special foil

For flat and semi-round!



5. Trends and Issues

- Low-k & Pad on Active dictate low gram forces, high planarity
- Trends in:
  - Pitch/padsize, Temperature, Current, Frequency, …….
- Cres conditioning
- Vendor probecard leadtime versus TpT waferfab
- Tracking of separate heads, PCB's etc
- Probecards become "loadboards"

OK, we can probe this product, "but"

If Temp<85 deg C

If current <250 mA

If Freq. < 1 gHz

If …

PHILIPS

Probe Metrology Panel

Qimonda
Production 300

Infineon
Production 200

Qimonda
RDC

Office Buildings

Support & Backend

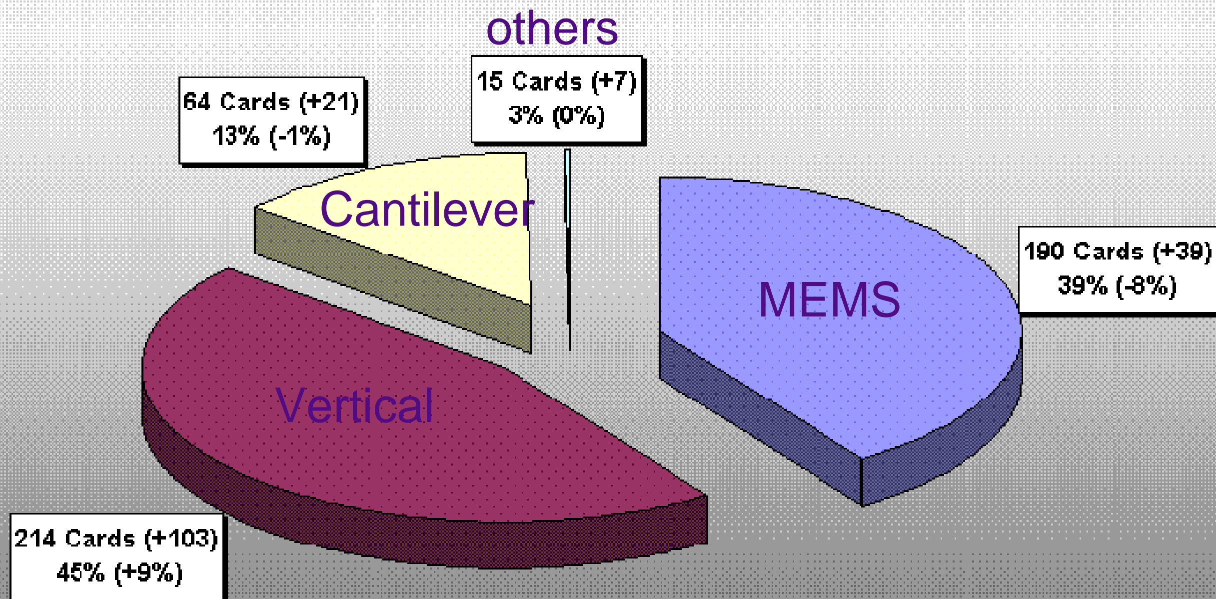
Bird View Qimonda Dresden/Germany

Probe Facility

- Supports total output of 12” Pilot Fab *& 8” Fab*
- WSPW: 7.200 300mm, 6.000 200mm *& 6.000 200mm* (production & development)
- Technologies: 110nm, 90nm, 70nm, 60nm, 50nm and beyond
- DRAM, graphic RAM, Flash up to 1GB (~25 products), ~5 Test chips
  & Logic (~20 products), Smart card (~45 products), ~15 Test chips
- standard test flow, KGD, RDL, -10°C… 127°C
- 3.700 Square Meter, Class 1000 clean room
- 120 Operators on 4 shifts for 24/7
- 2 Probe card Techs (Repair) + 1 Eng (Incoming inspection) normal shift
- 1 Probe card Tech per shift for cleaning & analysis
- 1 Supervisor & 3 Techs per shift, 10 Probe Engrs *& 5 Probe Engrs n. shift*
- Tester: ADVANTEST 8x T5365, 30x T5571, 8x T5771, 16x T5375, 17x HP4072
  Teradyne 19x J750, 1x Catalyst, 3x J971, 10x SPEA, 1x A93K, 13x HP4072
- Prober: ~120x Accretech AP-M-90 … UF3000, 6x TEL P8

Infineon

Probe Cards



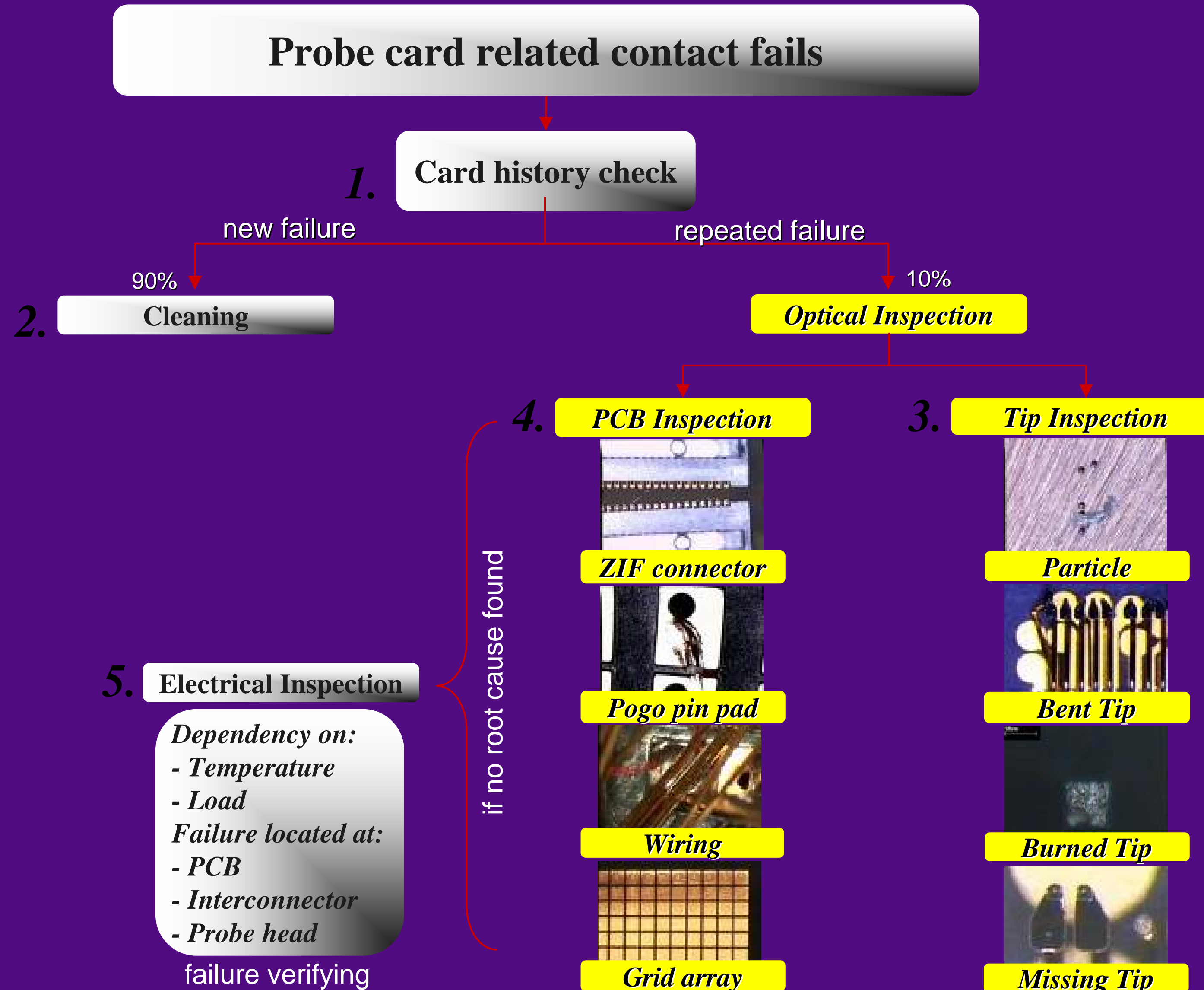
~100x 300mm, 300x 200mm active probe cards Memory

& ~450 logic probe cards

Quantit

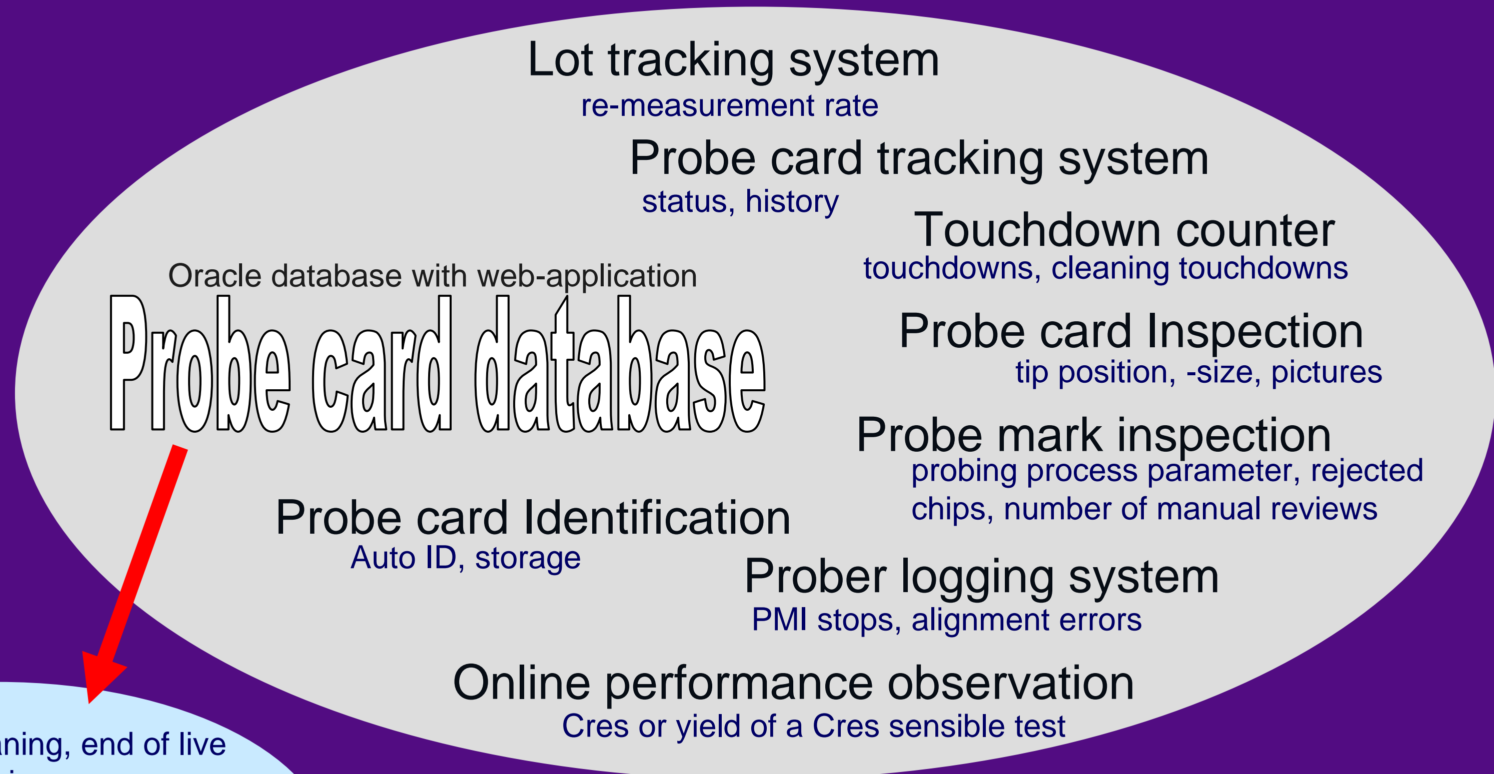
Probe Card Repair

Formularized maintenance flows



Probe Card Tracking

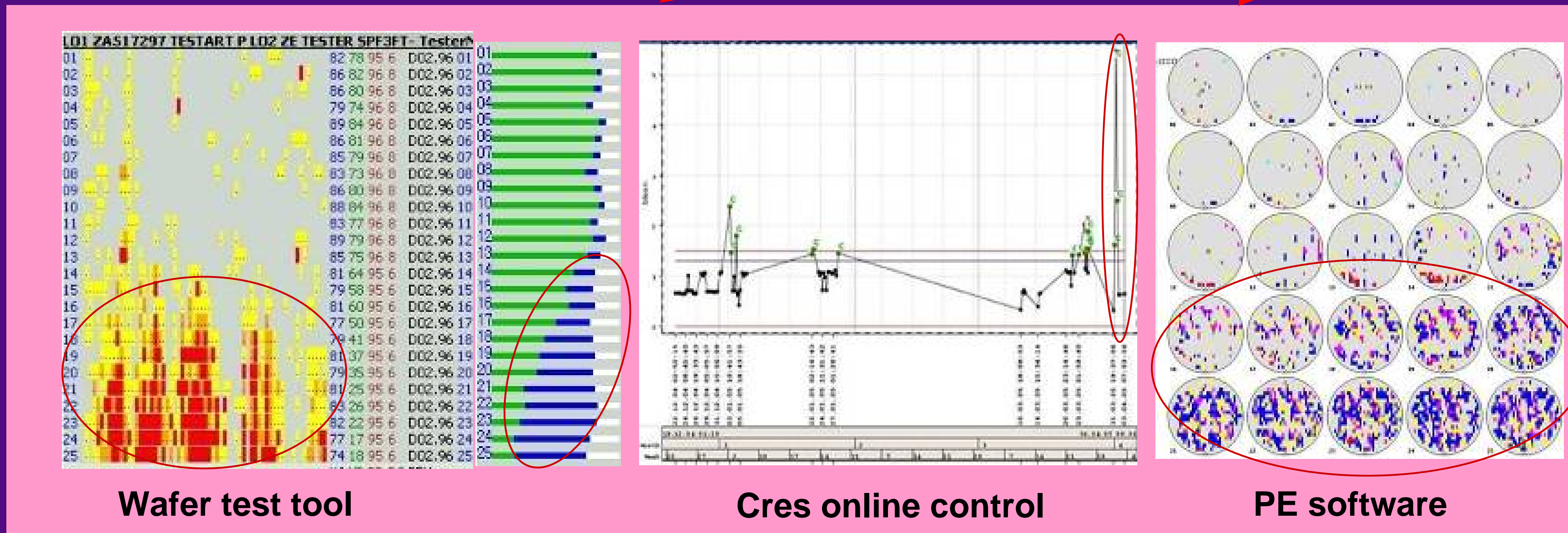
Increased Importance



Trigger for cleaning, end of live
Trigger for repair
Inputs for measurement program
Input for capacity planning
PC vendor quality feedback,
Probing process feedback
Task manager, ...

Probe Card Cleaning

Smart cleaning trigger is a must

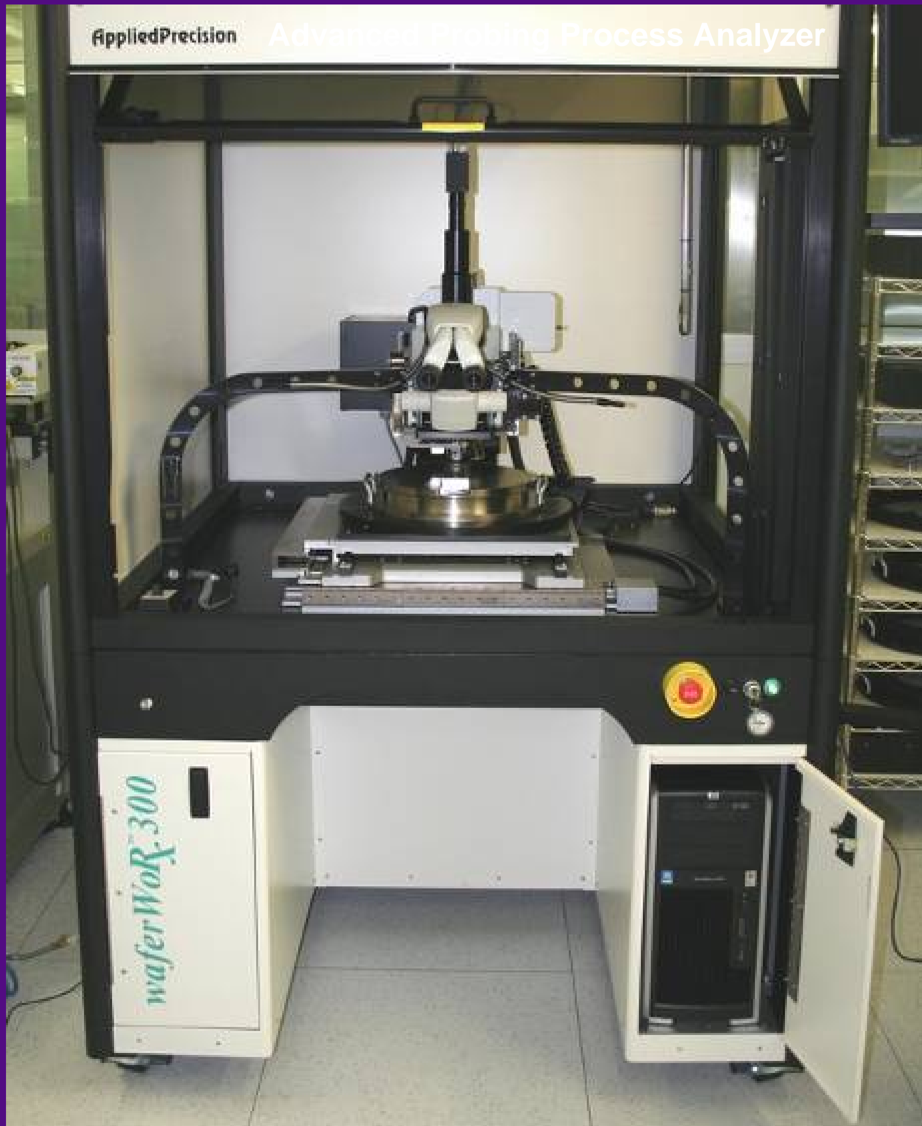


…but check the scrubs marks before

bad scrub –
missing overdrive

Probe Card Metrology System

The biggest strategy change



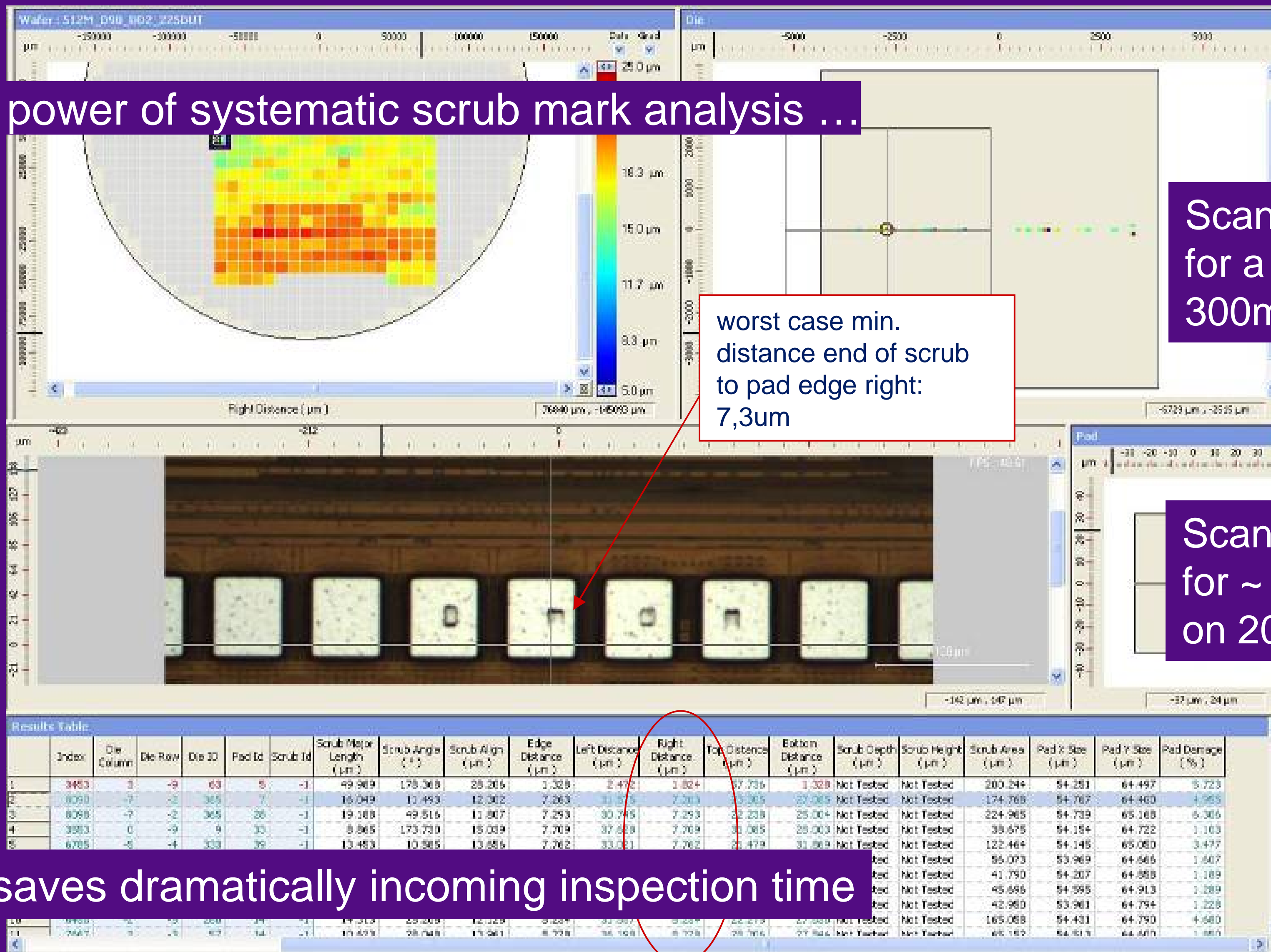
Tasks for the inspection tool sorted by importance

- significant reduction of incoming inspection time for LAA probe cards
- offset/scaling assessment (manufacturing & temperature related; fast response to the manufacturer)
- Probing process assessment (process window, equipment, setup, …)
- fast root cause analysis for performance issues
- fast tip (automated) inspection (incoming/ wear control)
- Cleaning optimization
- Check of backend requirements (pad damage; scrub hill, exposed oxide)
- Particle on wafer assessment (is a particle critical for the probe card?)
- Probing process developments (thinner alu, rerouting, bumps, less probing particles, contact on Au,…)
- “little” repairs (beam adjustments, single needle cleaning)

probe card & wafer inspection system
probing process analysis
probe card repair

Probe Card Metrology System

The power of systematic scrub mark analysis …



Scan time: 7min for a full probed 300mm wafer

Scan time: 27min for ~ 200.000 pads on 200mm wafer

… saves dramatically incoming inspection time

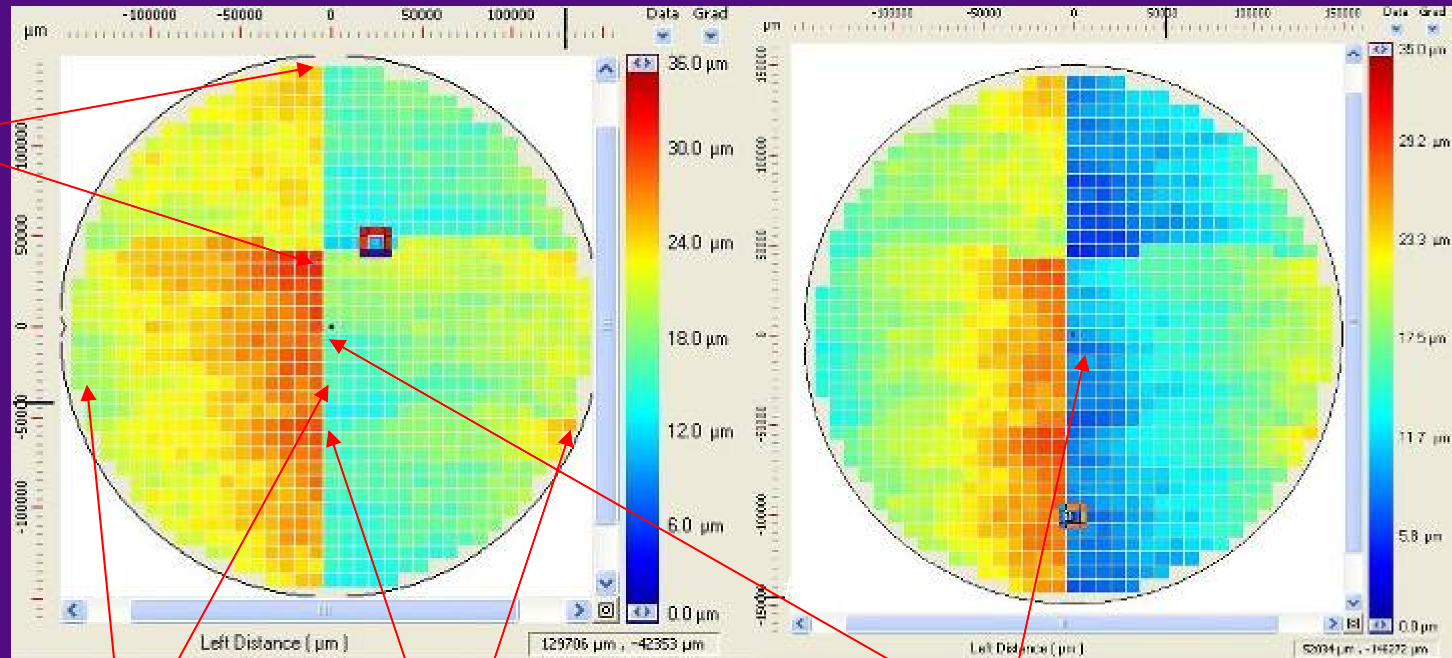
Probe Card Metrology System

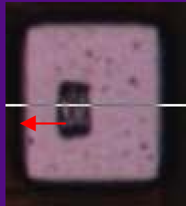
The power of systematic scrub mark analysis …

diff. btw. 1st/3rd touchdown ~4um

wafer load

quality control after new prober setup





diff. btw. left/right wafer half ~7um

prober

diff. btw. left/right probe array side ~5um

probe card

X-movement ~7um after 4h

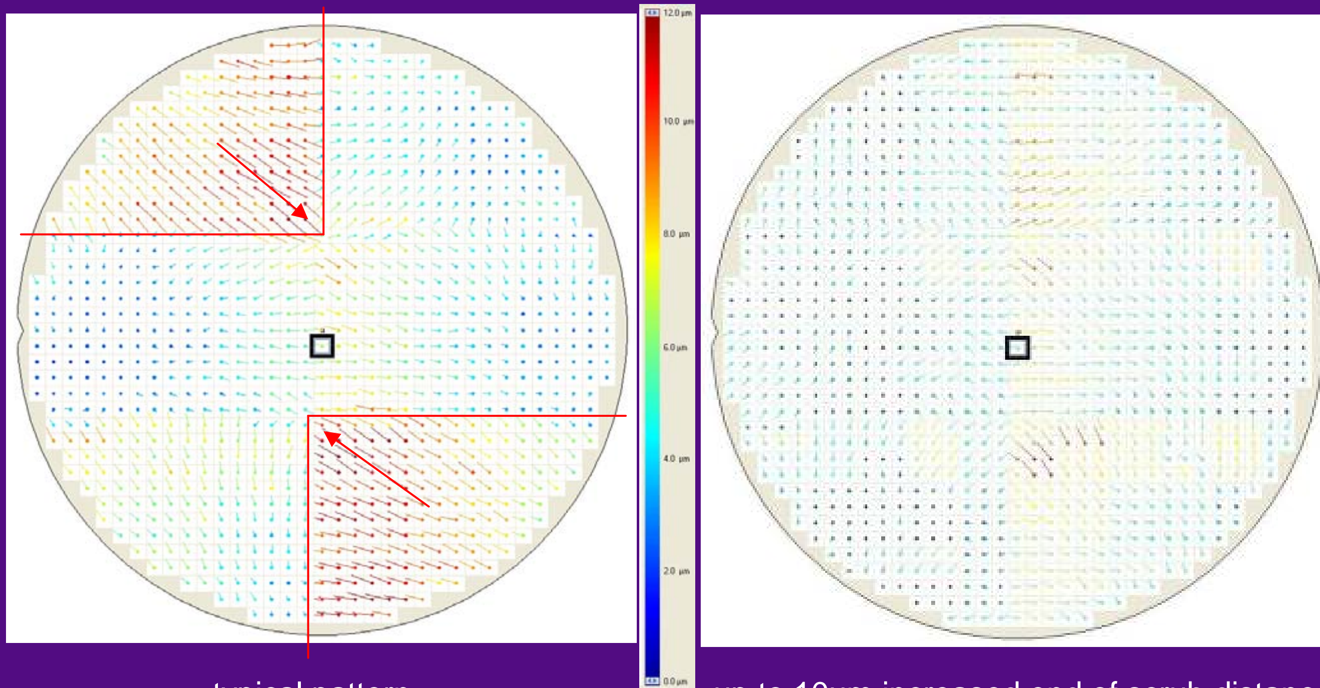
X-drift

… gives you valuable hints for probing process optimization

Probe Card Metrology System

The power of systematic scrub mark analysis …

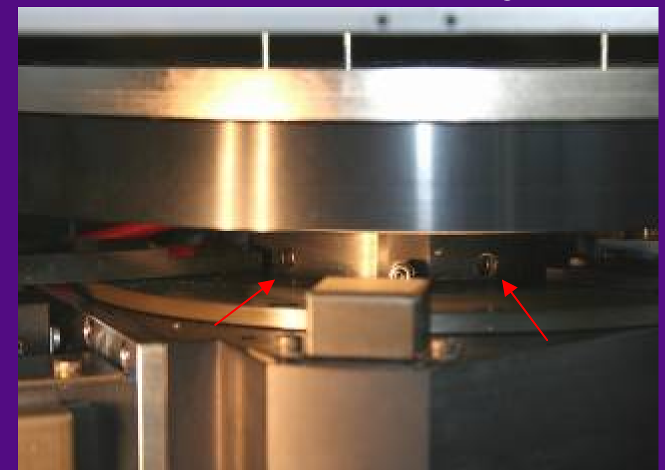
Scrub x/y- position vector view



typical pattern
“chuck with loose screws”

up to 10um increased end of scrub distance
to the pad edge after maintenance

Screws for chuck fixing



Screws getting loose due to
temperature change & probing force

… will increase your yield!