TOWARDS THE FINE PITCH

CONSTRAINTS AND METHODOLOGY

CROLLES PLANT
G PERSICO / D PAPAZIAN / R MILESI

ST CONTACTS

WRITERS	FONCTION	TEL	email	PART
Geraldine PERSICO	Probe card Engineer	33476925431	Geraldine.persico@st.com	Fine Pitch Evaluation Methodology
David PAPAZIAN	Product Engineer	33476926771	David.papazian@st.com	Contact Resistors Methodology
Roger MILESI	Maintenance MGR	33476926449	Roger.milesi@st.com	OVERVIEW

STATUS

- FINE PITCH AND LOW PAD SIZE INFLUENCE STRONGLY OUR RESULTS IN PRODUCTION IN TERM OF
  - YIELD (RETEST,BREAK OF PASSIVATION)
  - USE (EQUIPMENT,IN &OFF SITE CLEANING)
  - COST (PROBE CARD TIME LIFE,INTERNAL PROCEDURE)

TODAY THE CANTILEVER TECHNOLOGY IS FACING COMPROMISE BUT IS STILL ADAPTED TO ALLOW PRODUCTION.

CONSTRAINTS

- THE PROBLEMATICS ON CANTILEVER PROBE CARD TECHNOLOGY IS :

  HOW TO CONTROL THE OVERTRAVEL
  WHEN THE EFFECTS OF THE ADJUSTMENTS ARE VARIOUS AND OPPOSITE

FOR THIS, WE HAVE TO USE A METHODOLOGY WITH PHYSICAL CRITERIAS AND MEASUREMENTS TO FIND OUT AND USE:

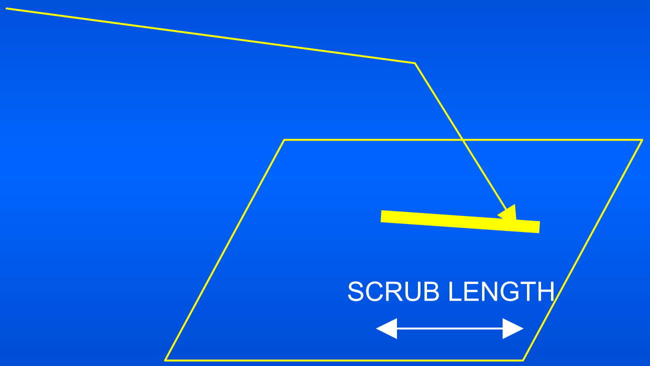
THE RIGHT LEVEL OF OVERTRAVEL WITH A CORRECT CONTROL OF THE PROCESS (PROBE CARD,PROBER)

PROBLEMATICS TO SOLVE AT THE WAFER LEVEL PROBING AND PARAMETERS TO SET UP

TO HAVE:

A GOOD CONTACT RESISTANCE ON WAFER

FOR ALL NEEDLES THE SCRUB MUST HAVE A MINIMUM LENGTH



CP MEASUREMENT ON THE SCRUB LENGTH

CP

ON LINE CONTACT RESISTANCE MEASUREMENT ON THE PRODUCT

PARAMETERS: AVERAGE VALUE -> GOOD QUALIY OF THE CONTACT **R**

STANDARD DEVIATION -> STABILITY OF THE CONTACT **SIGMA**

CLEANING -> TO KEEP THE STABILITY

PROBLEMATICS TO SOLVE AT THE WAFER LEVEL PROBING AND PARAMETERS TO SET UP

TO DO NOT HAVE:

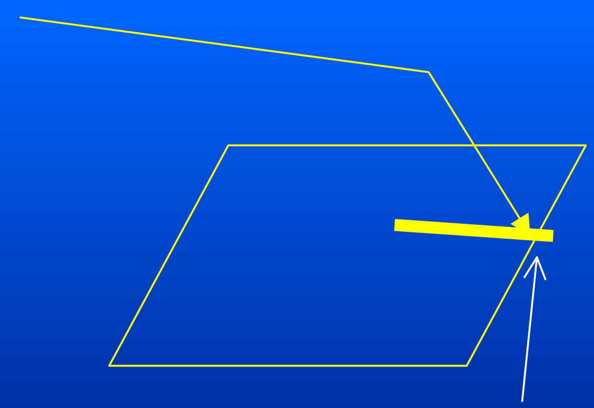
A CONTACT WITH THE SIDE OF THE PAD

SAFE GUARDBAND MUST BE KEEPED TO AVOID ANY BREAK OF PASSIVATION

CPK MEASUREMENT ON THE LENGTH AND THE WIDTH OF THE PAD

CPK LENGTH

CPK WIDTH

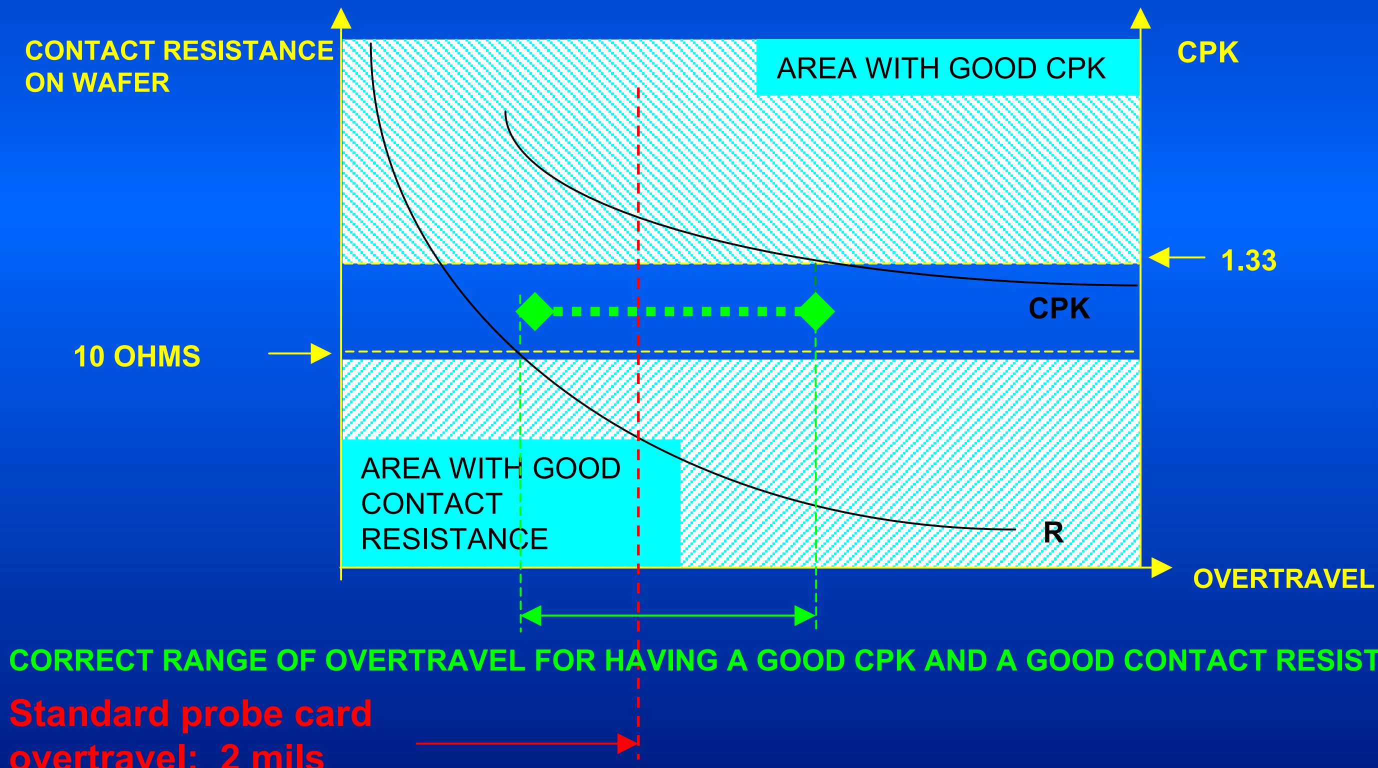


BREAK OF PASSIVATION

OVERTRAVEL ADJUSTMENTS RANGE

THE OVERTRAVEL IS CONTROLED BY THE PROBER AND BY THE USER.
ITS ADJUSTMENT IS LIMITED IN THE LOW RANGE BY A POOR CONTACT RESISTANCE VALUE AND IN THE HIGH RANGE BY A BAD CPK.

THE AIM IS TO EXTEND THE ZONE BETWEEN THE TWO CURVES, WITH PROBE CARD USING LIMITED OVERTRAVEL (2 mils standard) and a low overtravel dependence FOR HAVING CONTROLED RESULTS (R measurement, cleaning) IN SPITE OF THE PROBE CARD (planarity) AND PROBER VARIATIONS



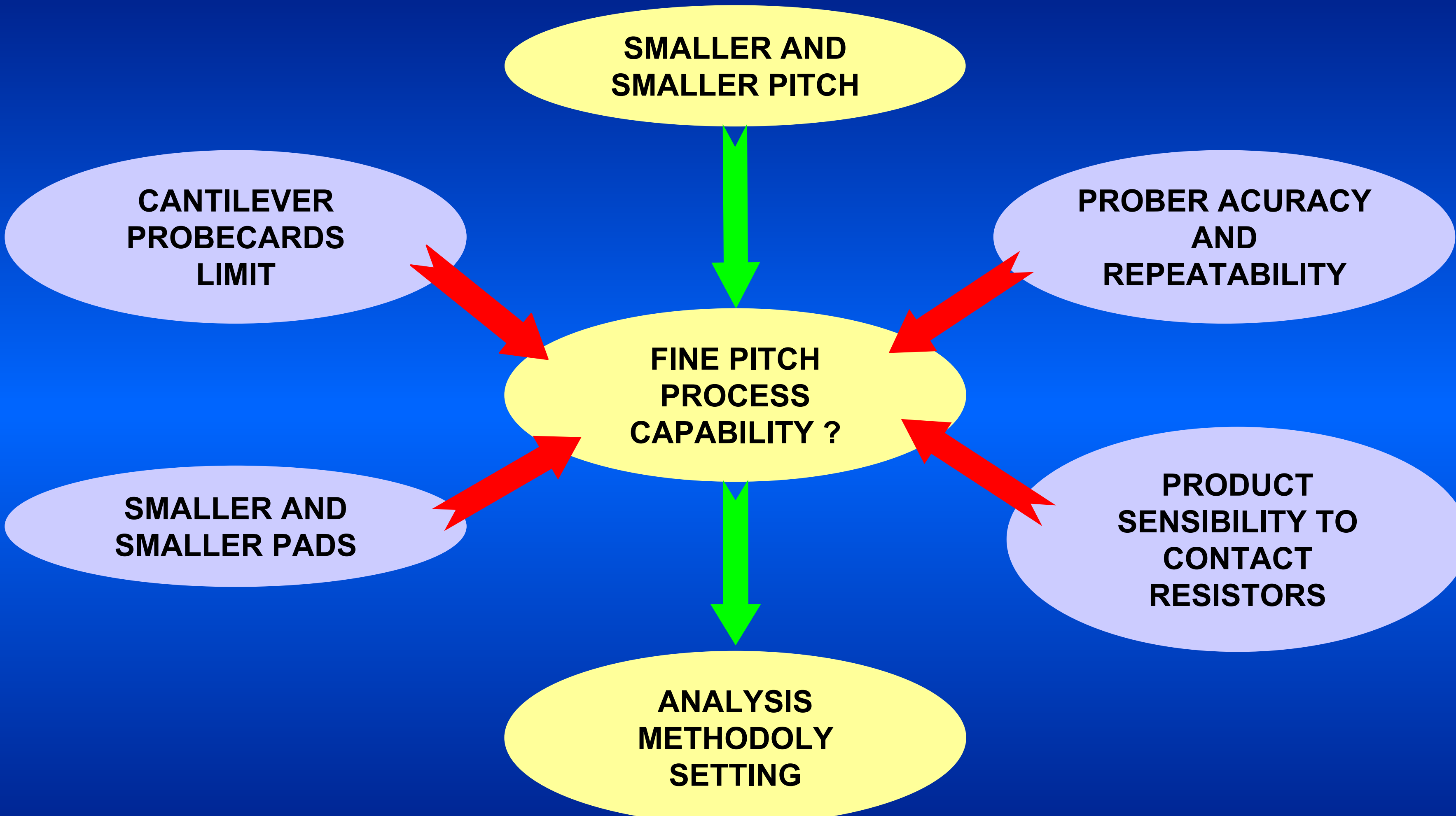
AIM IS TO HAVE A CONTACT

WITH THE LOWEST CONTACT RESISTANCE

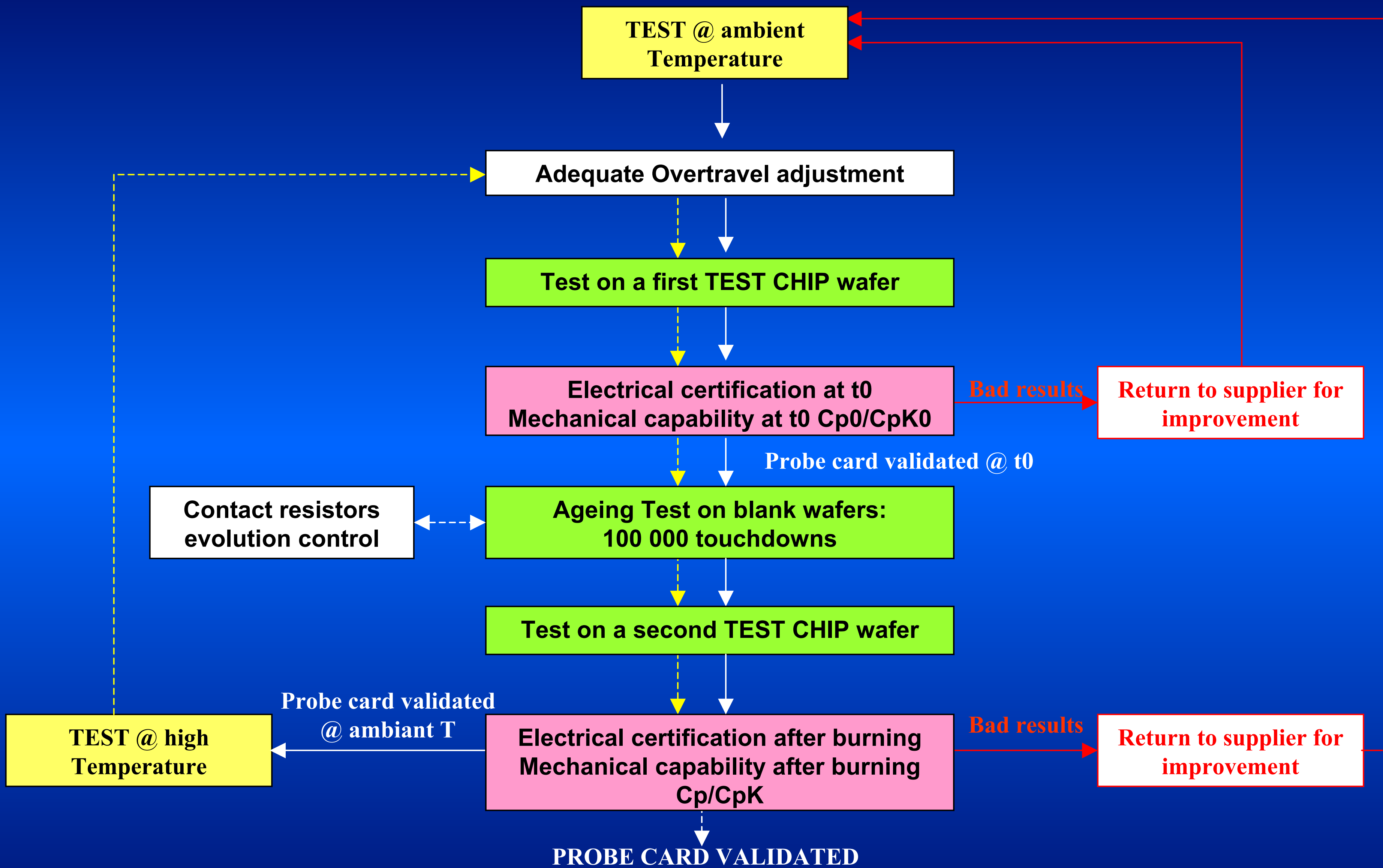
AND

NON DESTRUCTIVE FOR THE PAD PASSIVATION AND FOR THE PROBE

FINE PITCH PROJECT CHALLENGE



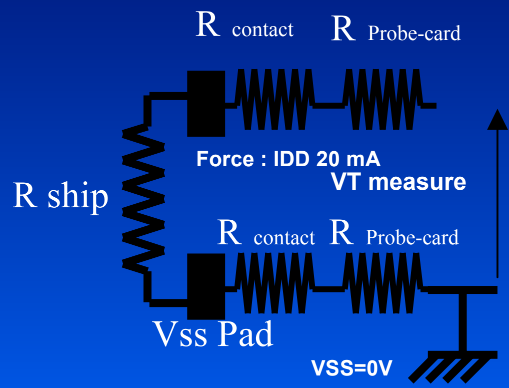
VALIDATION METHODOLOGY



Contact Resistor methodology
General Principle

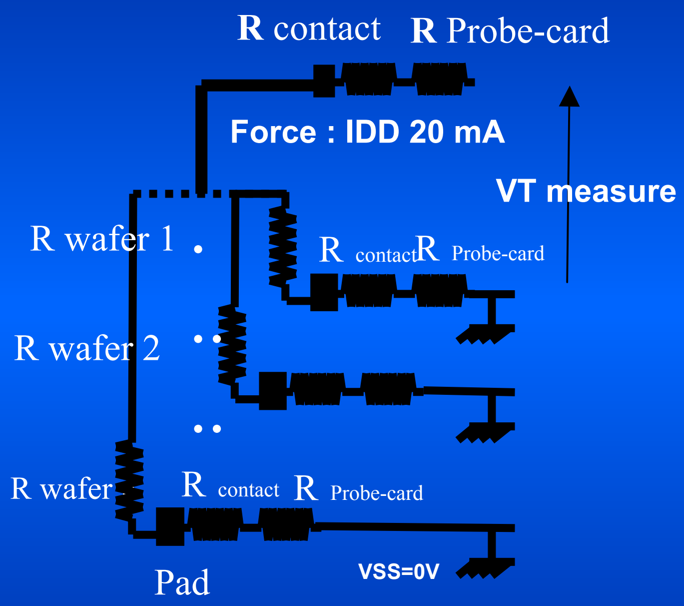
- To force a current through a needle
  - Current has to be defined by : Tester accuracy, Needles specifications
  - At the moment: I=20mA
- To measure a voltage on the same needle to extract the mean of the contact resistors Rc values
  - U measured = (Rc + R others) * I forced
  - By hypothesis R others is known & steady
    (sum of R needle, R pad …. Rdyn diode)
  - At the moment: Rc max= 10 Ohms (clamp value)
- To extract the 6*SIGMA of the Rc values

Contact Resistor methodology
3 steps



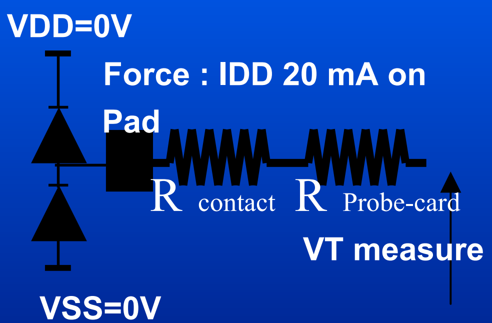
1- New probe card qualification (on Test Chip)

– Measure Between two pads linked to a known resistor



2- Ageing step qualification (on blank wafer)

– Measure contact resistor between 1 needle and all others



3- Production monitoring (on customer product)

– Measure on a diode pad (like advanced continuity test)

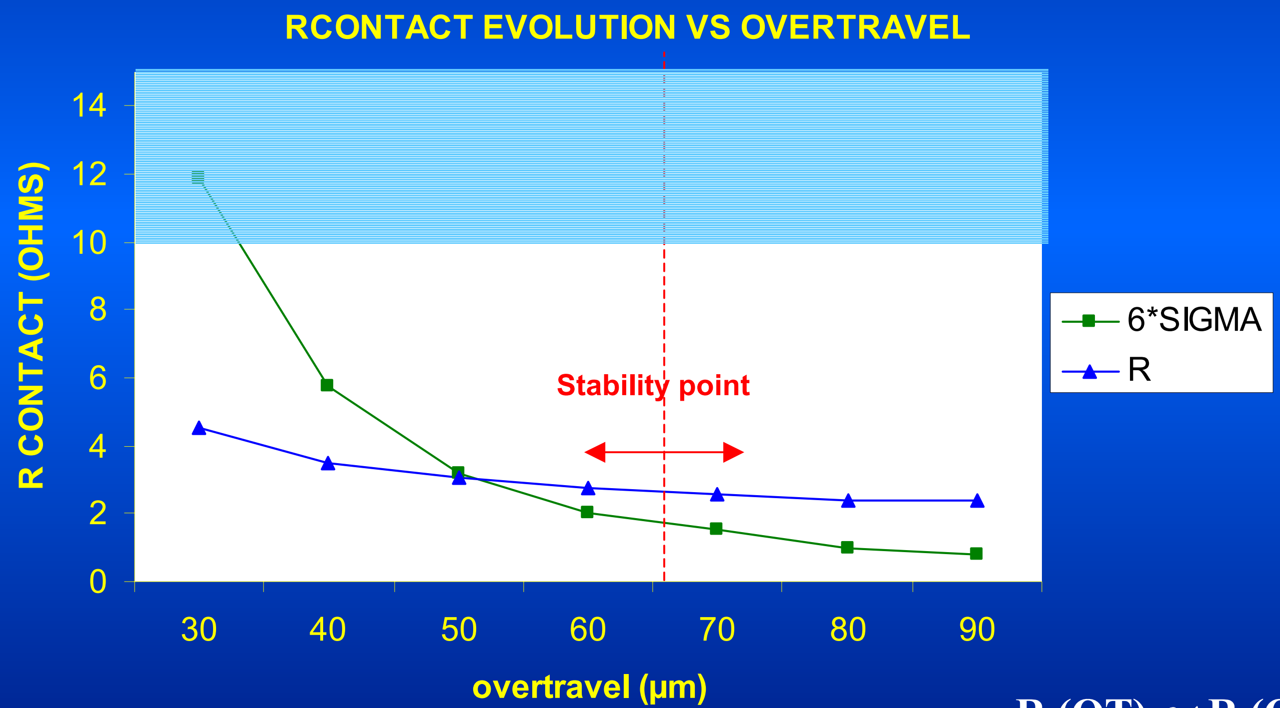
ONLY STEP 1 AND 2 ARE USED IN THE FINE PITCH VALIDATION METHODOLOGY

PROBECARD OVERTRAVEL ADJUSTMENT

Adequate overtravel adjustment on one die:

=> 6 SIGMA(contact resistors on all pads) < 10 ohms

=> average contact resistors R stability at this overtravel



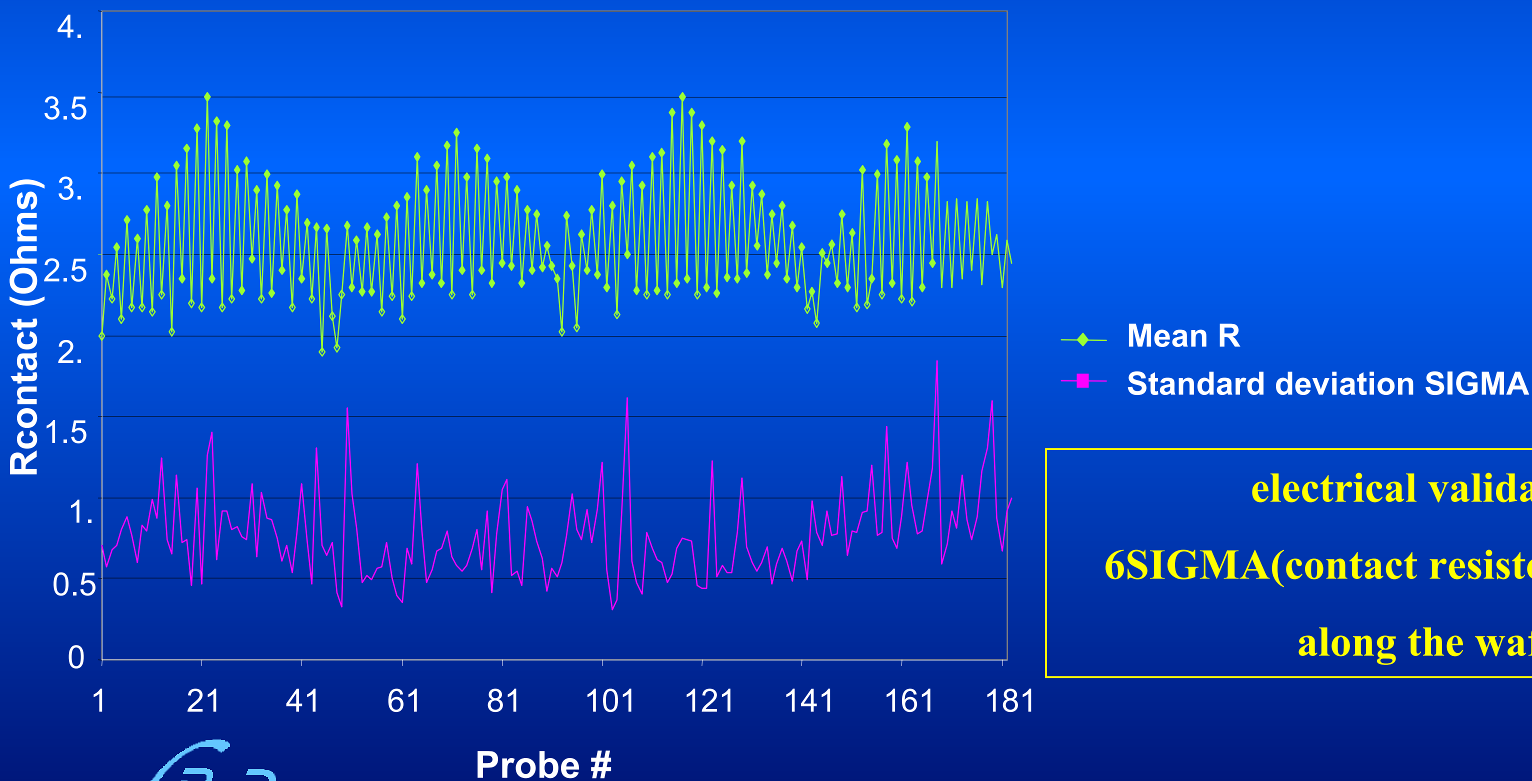
R (OT) ≈ R (OT –5µm) ≈ R (OT + 5µm)

PROBECARD ELECTRICAL CERTIFICATION

Probecard Electrical certification on a test wafer

=> Contact resistors measurement for all probes on all dies: contact resistors database

=> Standard deviation SIGMA and average value R of each probe contact resistance along the wafer



electrical validation:

6SIGMA(contact resistors)<10 ohms

along the wafer

CONTACT RESISTORS CONTROL DURING AGEING

- Adequate overtravel is determined at t0
- The same SET UP is conserved during the whole evaluation process

If all probe have a contact resistance < CLAMP VALUE: GOOD DIE

If at least one probe has a contact resistance > CLAMP VALUE: OPEN

PROBLEM	POSSIBLE SOLUTION
Probe does not touch the wafer	REALIGNMENT
Probe is too dirty	ONLINE CLEANING
	OFFLINE CLEANING

LOW CONTACT RESITORS CAN BE MAINTAINED BY A REGULAR AND ADAPTED ON LINE CLEANING

PROBECARD MECHANICAL CAPABILITY

SCRUB MARKS DATABASE

Scrub marks database can be acquired by 2 methods: automatically with the Waferworkx from APPLIED PRECISION or with a manual sampling

	WAFERWORKX DATABASE	MANUAL DATABASE
Number of points	All pads of all dies of the wafer: > 40 000 points	Sample of 5 dies per wafer and 12 pads per die => 60 points
Acquisition	Optic and automatic material	Manual inspection and measurements
Advantages	Possibility to determine the contribution of process, probe card and prober separately **Process capability related to the complete process**	All datas are checked visually => more reliability
Disadvantages	Need to clean the database to have a better reliability	Take a long time

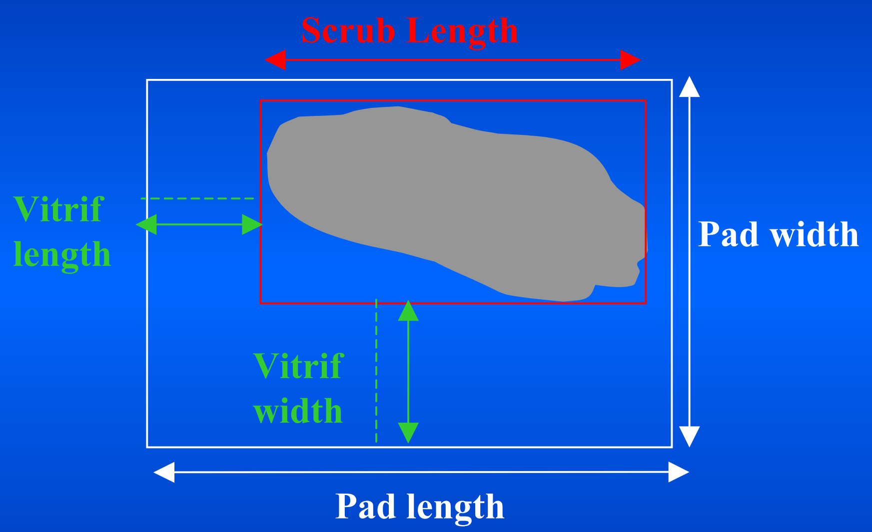
Scrub marks characteristics:

- Scrub length

- Vitrif length and vitrif width

PROBECARD MECHANICAL CAPABILITY
Parameters Definition

Quality indicators (process capability) in the width and in the length directions of the pad => Calculations of adapted capability coefficients

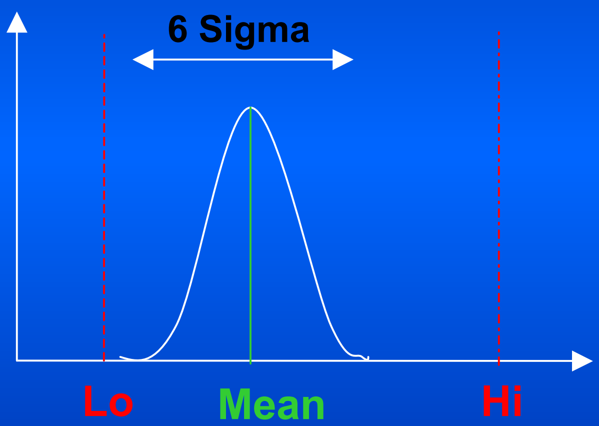


*** Vitrif = minimum distance between the edge of the scrub and the edge of the pad**

*** Scrub size is defined by the scrub length and the scrub width**

Capability coefficients
Definition

- The Cp represents the width of the distribution between the limits. Cp has to be >2 to have a good homogeneity and reproducibility.
- The CpK represents the center of the distribution. CpK has to be >1,33 to have a well-centered process.



⚠ **For a gaussian distribution**

Cp = (Hi – Lo) / 6 Sigma

CpK = Min [IHi – MeanI / 3 Sigma ; IMean –LoI/ 3 Sigma)

with Sigma = Std deviation

FINE PITCH CAPABILITY
CpK VITRIF LENGTH

VITRIF LENGTH

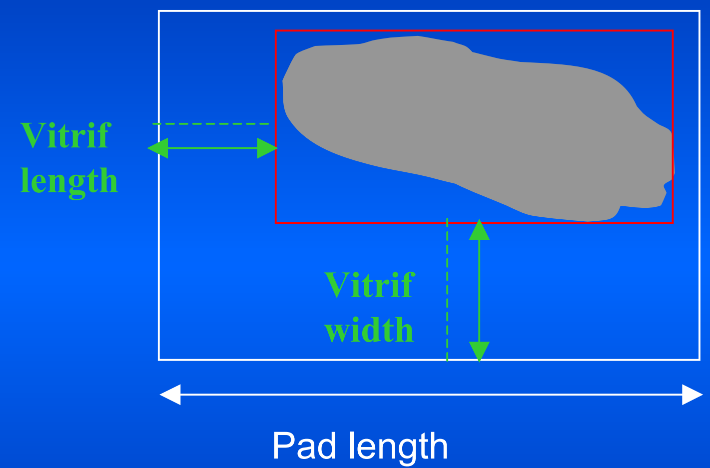
↓ **TO HAVE A SECURED PROBING**

MINIMUM VALUE

↓

CpK VITRIF LENGTH

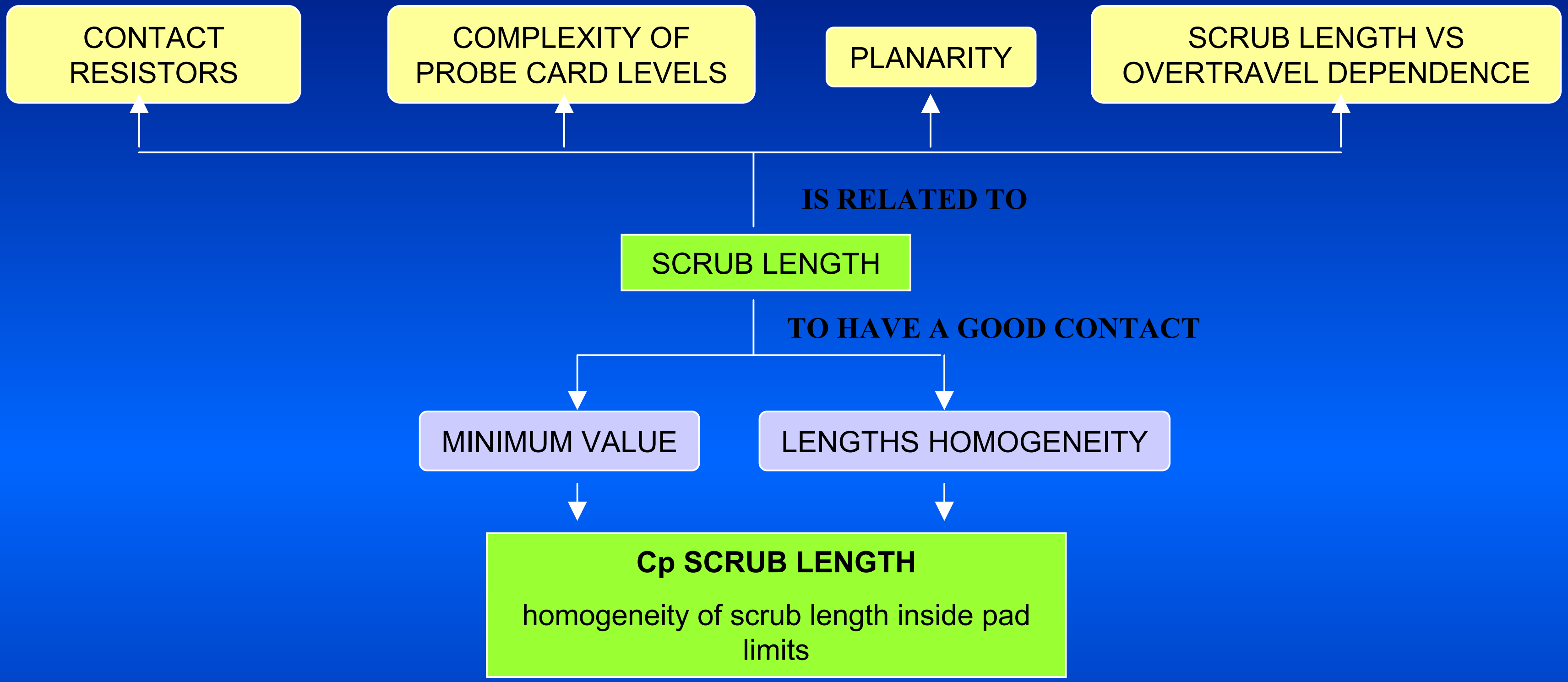
Capability of the process to have a minimum distance from the scrub to the passivation



Low Limit (µm)	High Limit (µm)
5	/

The Vitrif width is less critical than the Vitrif Length if no important scrub angle

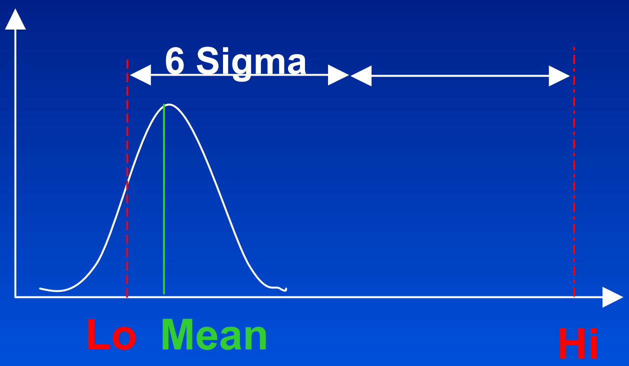
FINE PITCH Capability
Cp SCRUB LENGTH



Low Limit (µm)	Average (µm)	High Limit (µm)
5	25	45

Capability coefficients

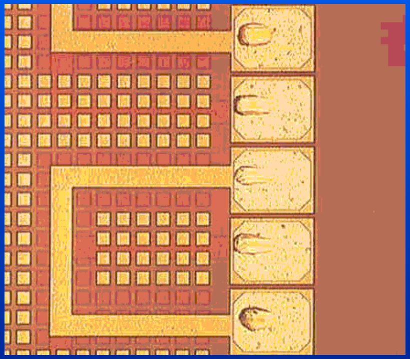
EXAMPLES



GOOD Cp – LOW CpK

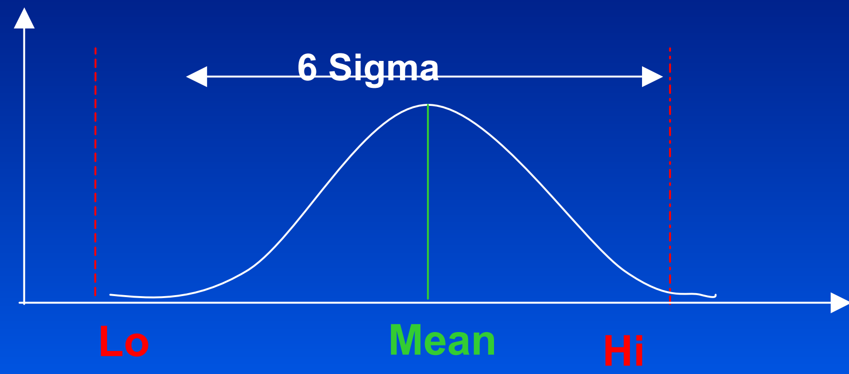
⇒Thin distribution

⇒ Bad centering



-Cp Vitrif Length correct: good homogeneity of vitrif length values

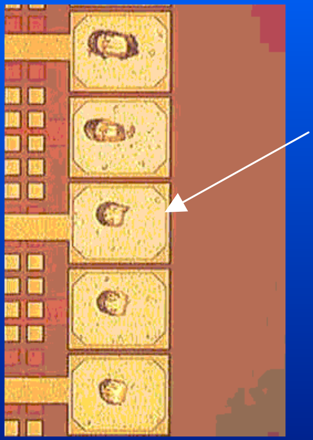
-CpK Vitrif Length very low: vitrif length values under limits



GOOD CpK – LOW Cp

⇒Large distribution

⇒ Good centering



-CpK Scrub Length correct: mean value is correct

-Cp Scrub Length very low: bad homogeneity of scrub length

RESULTS AND LIMITATIONS

***Wafer** probe marks analysis have been supported by KUMMER in France, which represents APPLIED PRECISION*

This methodology has been used with the probe cards suppliers TECHNOPROBE to qualify the WAVE technology (fine pitch technology) and with K&S.

- **ACHIEVEMENTS**
  - Objective probecard quality parameters defined:

    Cp Scrub Length / CpK Vitrif Length
  - Probecard certification methodology
  - Quantified parameters for epoxy probe cards technology improvements
  - Hardware and process control
- **LIMITATIONS**
  - FINE PITCH limitation is tightly related to probecard cleaning: ONLINE and OFFLINE