SW Test Workshop

Semiconductor Wafer Test Workshop

TPEG™ Mantis: a new solution for multiple advanced applications

Davide Sangiorgio — *STMicroelectronics*
Marco Sciurba — *STMicroelectronics*

Tommaso Masi — *Technoprobe*
Riccardo Vettori — *Technoprobe*

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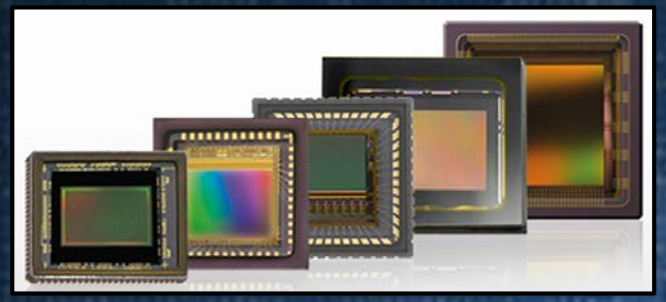
Overview

- Applications requirements
- TPEG™ Mantis concept
- TPEG™ Mantis general characteristics
- STM experience on field
- Summary

Applications Requirements

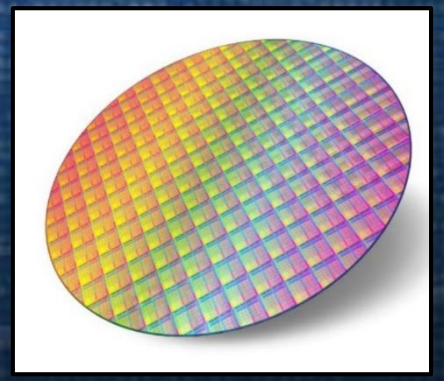
- **Customer device applications for TPEG™ MEMS MANTIS**



CMOS Image **Sensors**

NOR and NAND **Memories**

Consumer, Industrial and Auto
µControllers & **LCD Drivers**



Parametric Test (WAT, eTest, T84, ...)

Applications Requirements

- **General characteristics requested for CIS and Parametric Tests**
  - Mechanical solution that allows the passage of light through the probe card for the Imaging Sensor stimulation
  - Possibility to mount lens or diffusers in the Probe Card
  - Small scrub marks and low PAD damage
  - Controlled production of debris
  - Direct Attach solutions to minimize Probe Card cost
  - Low Signal attenuation up to 1.2 GHz
  - Good probe to probe insulation

TPEG Mantis Concept

- **Mantis probe concept**
  - Mantis is a µCantilever needle using Technoprobe TPEG™ MEMS Technology. It merges the benefits of both technologies: Vertical and Cantilever.
  - The inspiration came from…

…Nature

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…Nature

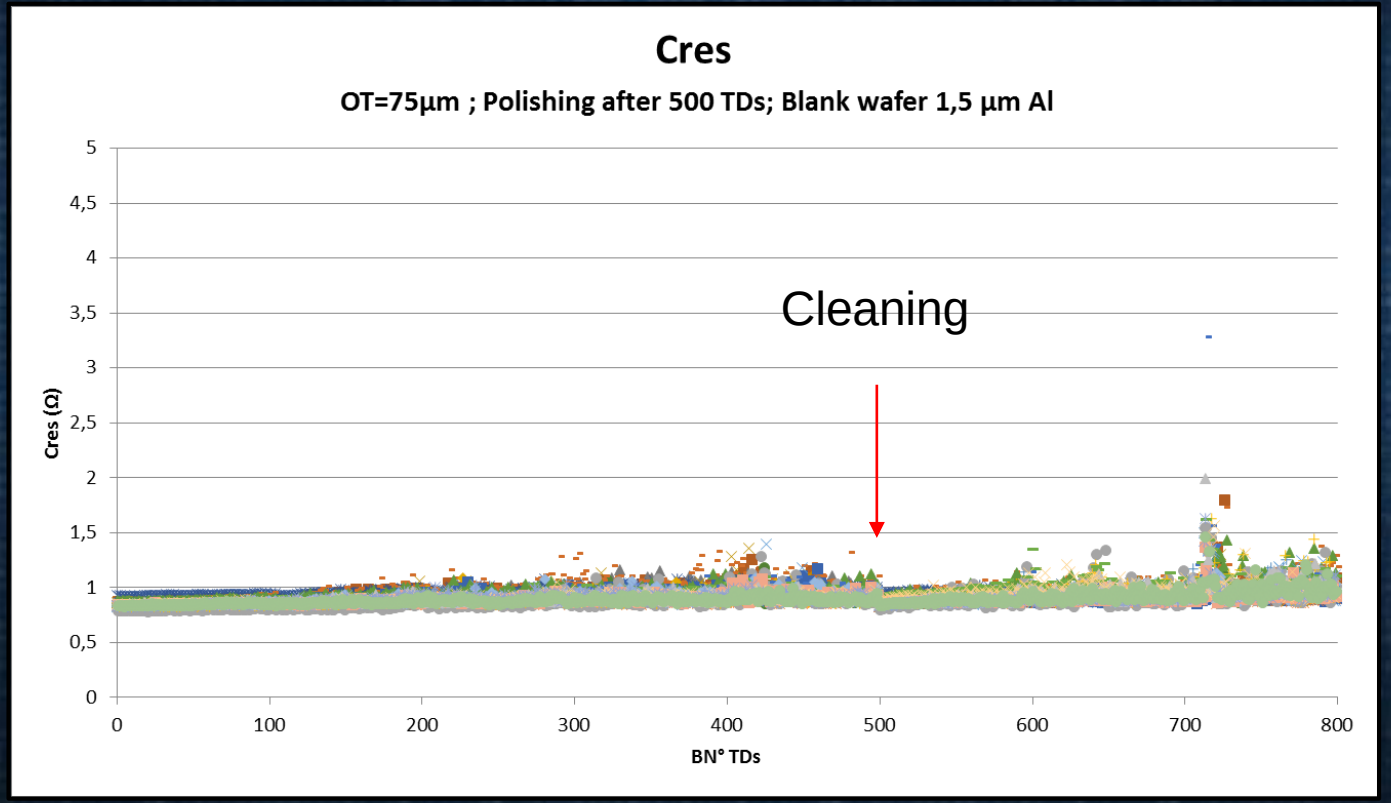
TPEG™ Mantis Internal qualification

- **Tests performed for the internal qualification**
  - Mechanical Test:
    Resistance to fatigue with 1M TDs at 120 µm Overdrive and 100K TDs on wafer edge
  - Cres Test on Blank wafer.
  - Scrub Analysis
  - Probe Current Capability
  - RF Simulation

  - Test on Customer Field:
    Pad damage analyses, Testing Yield evaluation, Life on field evaluation, etc…

Cres Test

- Cres Test performed at OT=75µm on Al Blank wafer (Al thickness 1,5 µm)
- Cleaning done after 500 TDs



Scrub analyses Vs. Temperature

- **TPEG™ Mantis scrub marks on Al Pad at different temperatures**
  - TPEG™ Mantis scrub mark highlighted with the red circle.

OT=75 µm T= -40°C

OT=75 µm T= 60°C

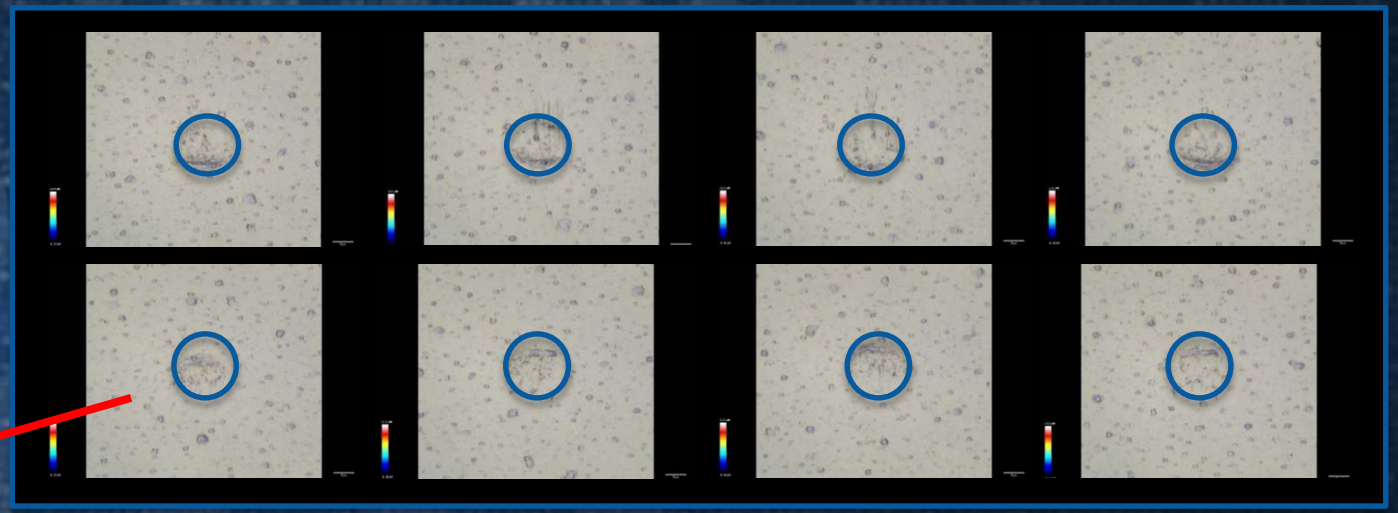
OT=75 µm T= 105°C

Scrub analyses

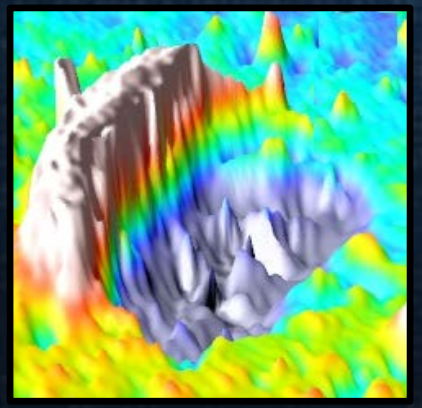
- **Statistical scrub marks collected on Al blank wafer with thickness of 1.5µm at 50 and 100µm OD**

OT=50µm

OT=100µm



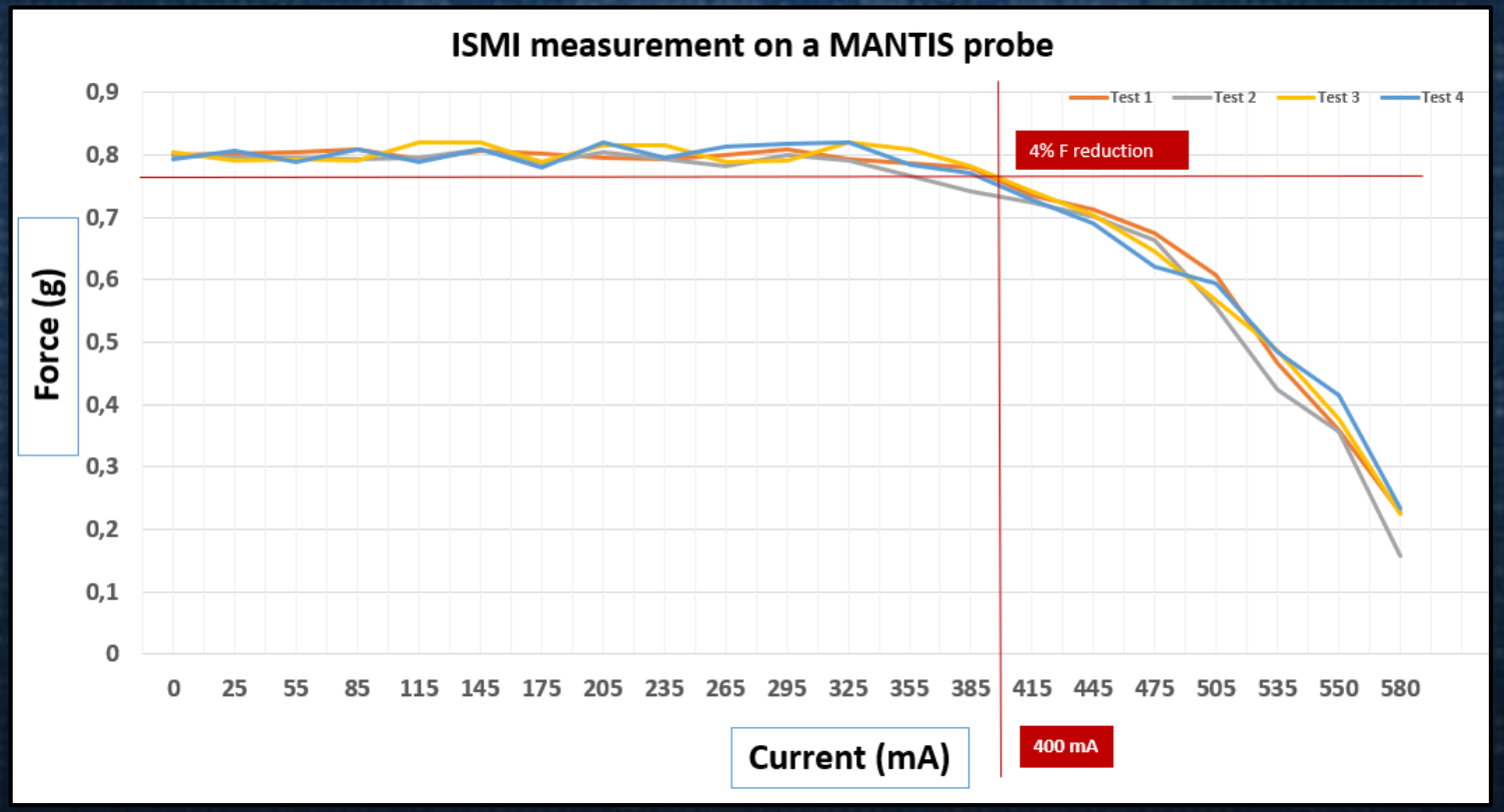
- **Results:**



- At OT = 50um: Scrub length max = 16 µm, Scrub depth max = 290nm
- At OT = 100um: Scrub length max = 22 µm, Scrub depth max = 390nm

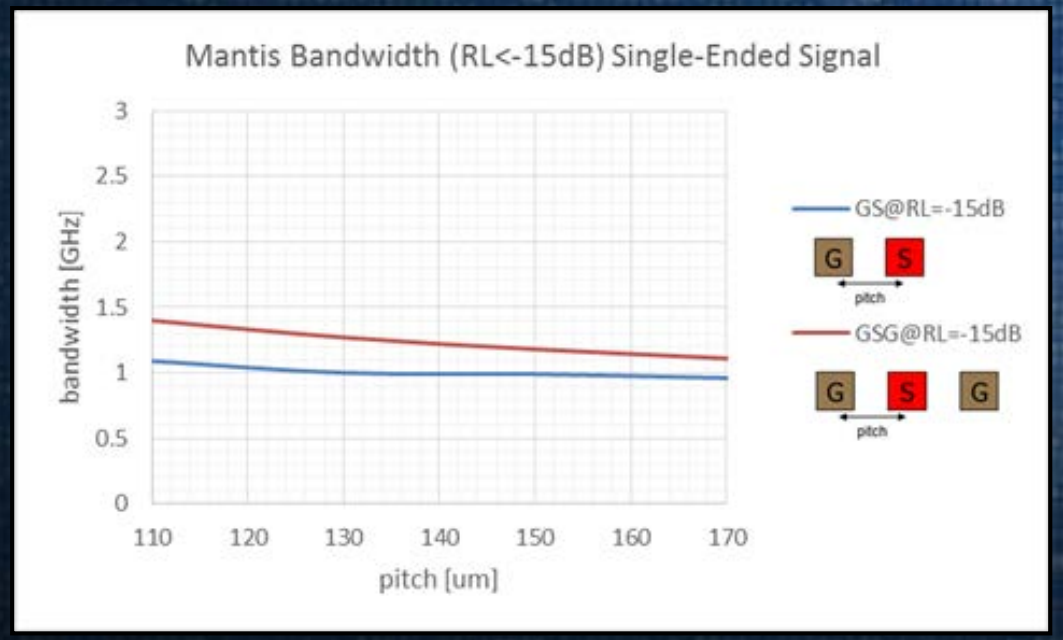
CCC analyses

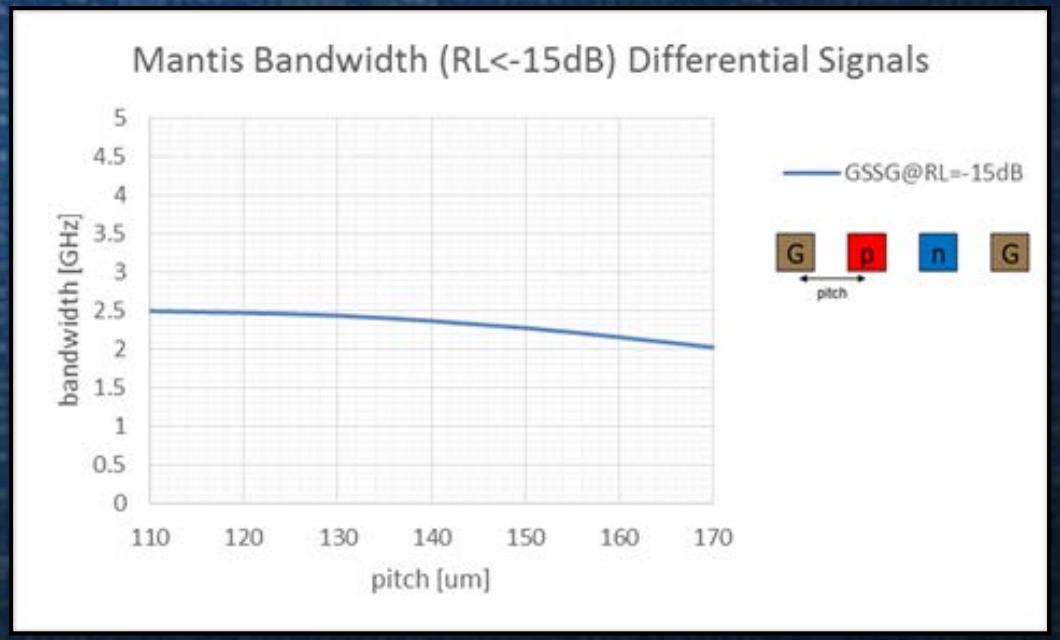
- **CCC performed with the ISMI 09 method**
  - The current TPEG™ Mantis probe, has a 20% force reduction at 500 mA
  - Max CCC limit at 4% of force reduction is 400 mA. This is the limit for TPEG™ Mantis probe
  - The CCC can be increased customizing the probe.



RF Simulations (Return Loss ≤ 15dB)

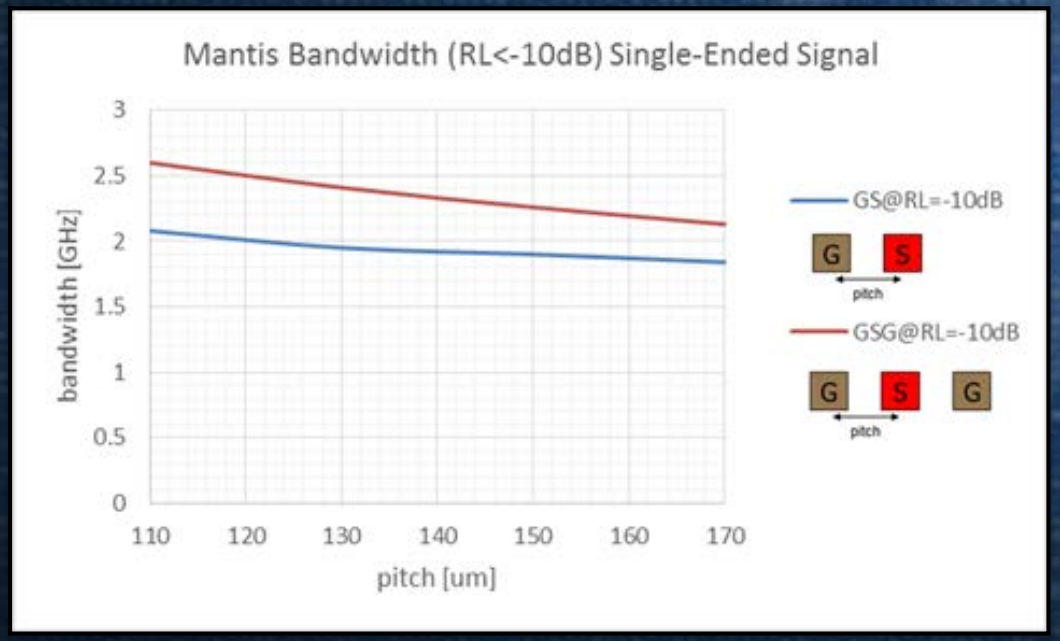
- **Technoprobe performed RF simulations with different kind pitches and Signal modes.**
  - TPEG Mantis bandwidth has been simulated with different configurations.
  - The RL is maintained under 15 dB at 1 GHz for a large pitch window with Single Ended Signals and 2 GHz with Differential Signals.

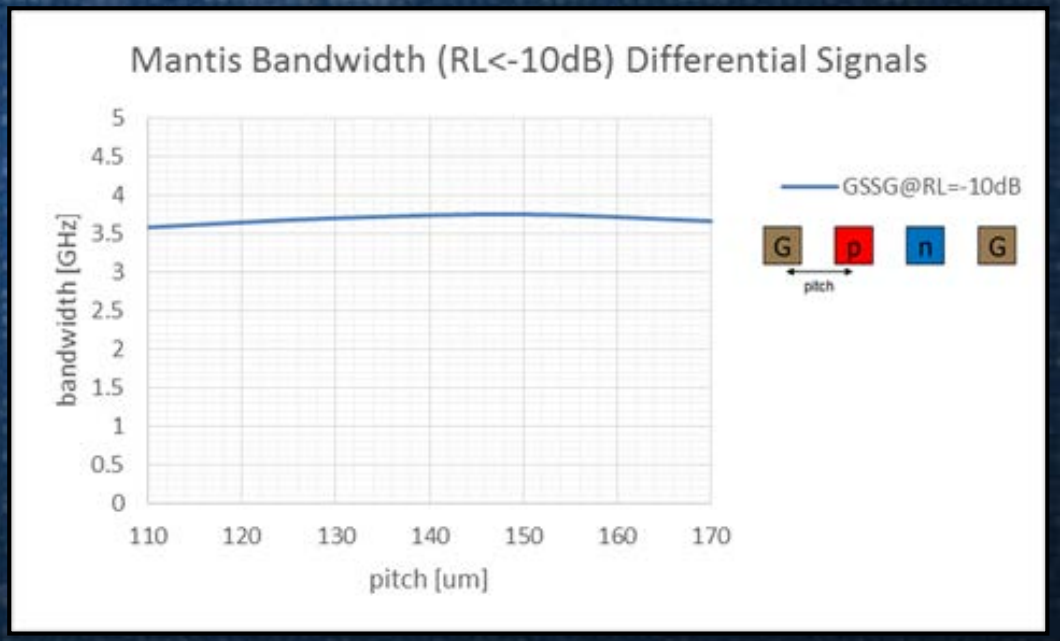




RF Simulations (Return Loss ≤ 15dB)

- **Technoprobe performed RF simulations with different kind pitches and Signal modes.**
  - TPEG Mantis bandwidth has been simulated with different configurations.
  - The RL is maintained under 10 dB at 1,8 GHz for a large pitch window with Single Ended Signals and 3.5 GHz with Differenzial Signals.





TPEG Mantis Description

- **Target Key Values**
  - Low Force
  - Low Pad Damage with controlled and limited scrub mark in all the OD range
  - X and Y alignment comparable to Vertical MEMS Needle
  - Good Z planarity comparable to high end Vertical MEMS Needle
  - Possible to use Direct Attach PCB or Interposer (no need of complex and high costs MLOs or MLCs)
  - Low constrains in layout capability
  - Same tip size during entire lifetime
  - Good Current Carrying Capability that can be customized.
  - High parallelism

TPEG Mantis Specs

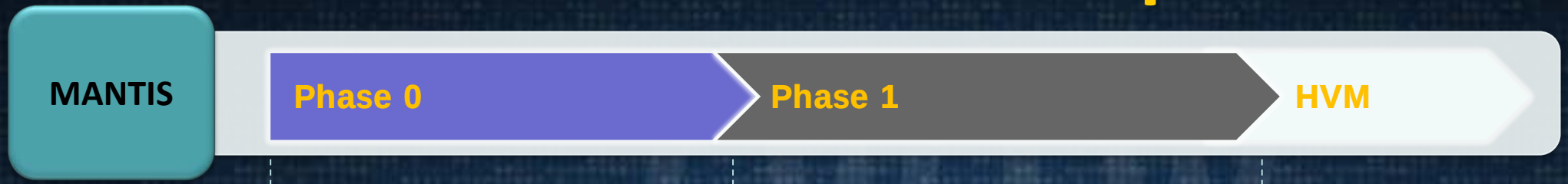
PARAMETER	TPEG™ MEMS MANTIS
Contact Diameter	16±4 µm
Usable Tip Length	> 200µm
Max pin count	> 20.000 pins
X, Y alignment accuracy and Z planarity	X,Y ± 10 µm; Z electrical plan Δ 20 µm
Min pitch and configuration	50µm linear configuration(Probes from 2 directions)
Pin Current (CCC ISMI 2009)	400 mA
Force (at 75µm OD)	3.0 g
Working OD / Max OD	75µm / 100 µm

STMicroelectronics Experience

STMicroelectronics qualification criteria

- **STM used a High Volume product for qualification and benchmark of Mantis technology vs. STM standard one. ST qualification conditions:**
  - No PAD damaged at maximum OT and maximum number of passes
  - No crack under PAD at maximum OT and maximum number of passes
  - Scrub marks size and position within spec
  - Yield aligned (or better) to standard production card
  - No “special requirement” for cleaning
  - The above conditions to be verified at 0-time and after production (150kTDs)

STM evaluation plan



T0 – Incoming:

- Probe card information summary and qualification data
- Electrical and mechanical analysis and qualification
- Probing DOE results
- Conclusion

T1 - 150kTDs:

- Probe card information summary and qualification data
- Electrical and mechanical analysis and qualification
- Probing DOE results
- Conclusion

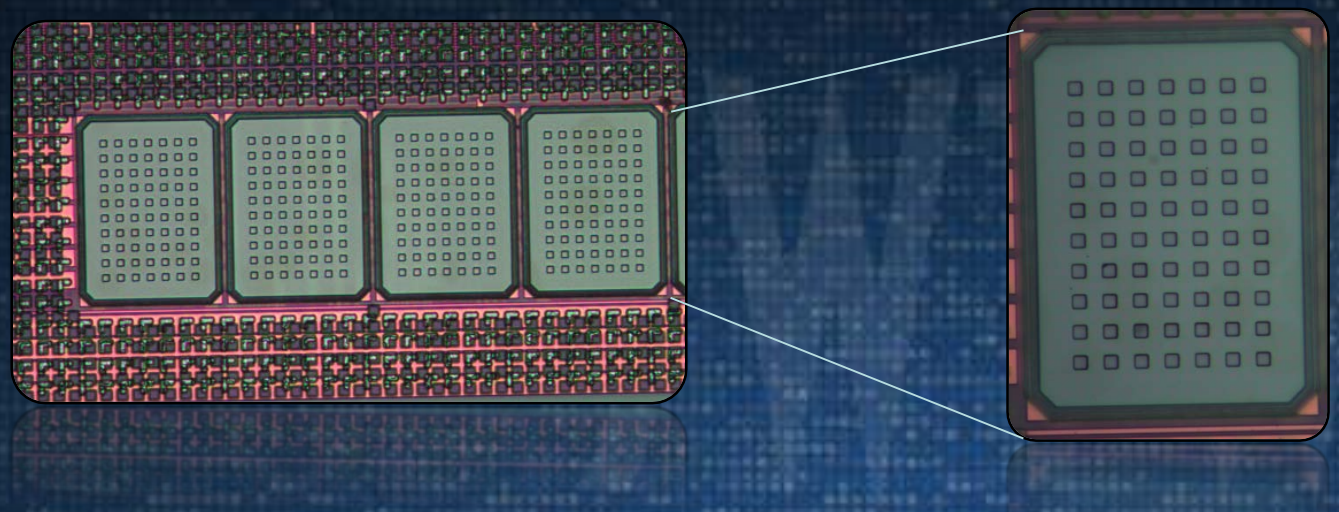
TF – 1M TD:

- Lifetime Evaluation
- Uptime Evaluation
- Conclusion

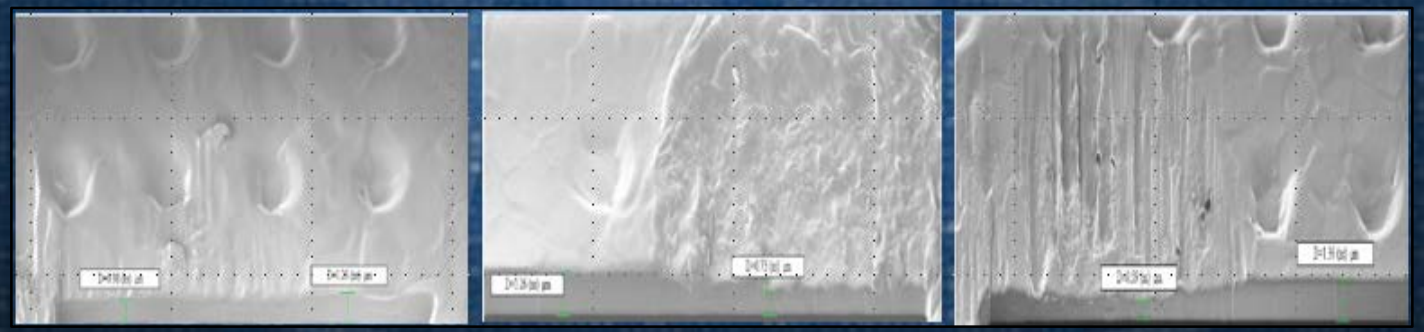
Before starting

- **Probecard design**
  - X16 DUTs
  - 320 springs
- **Working overdrive**
  - 80µm
- **T0 and T1 probing DOE conditions**
  - Number of passes: 12
  - Overdrive from 60µm to 120µm
- **Cleaning material**
  - ITS PP150

PAD damage evaluation at T0



No crack under passivation under worst conditions OD=120µm (with 12passes)



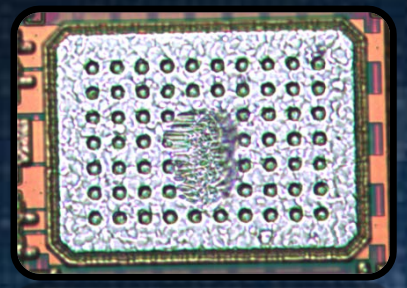
No crack under passivation under worst conditions

OD=80µm/12passes
Scrub depth 280nm

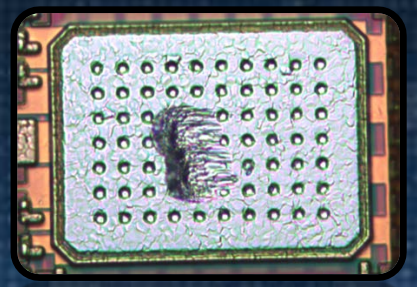
OD=100µm/12passes
Scrub depth 530nm

OD=120µm/12passes
Scrub depth 770nm

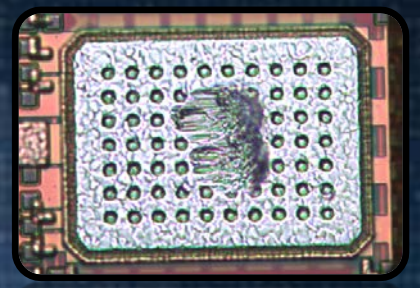
Scrub mark evaluation at T0



OD=80µm
12 passes



OD=100µm
12 passes

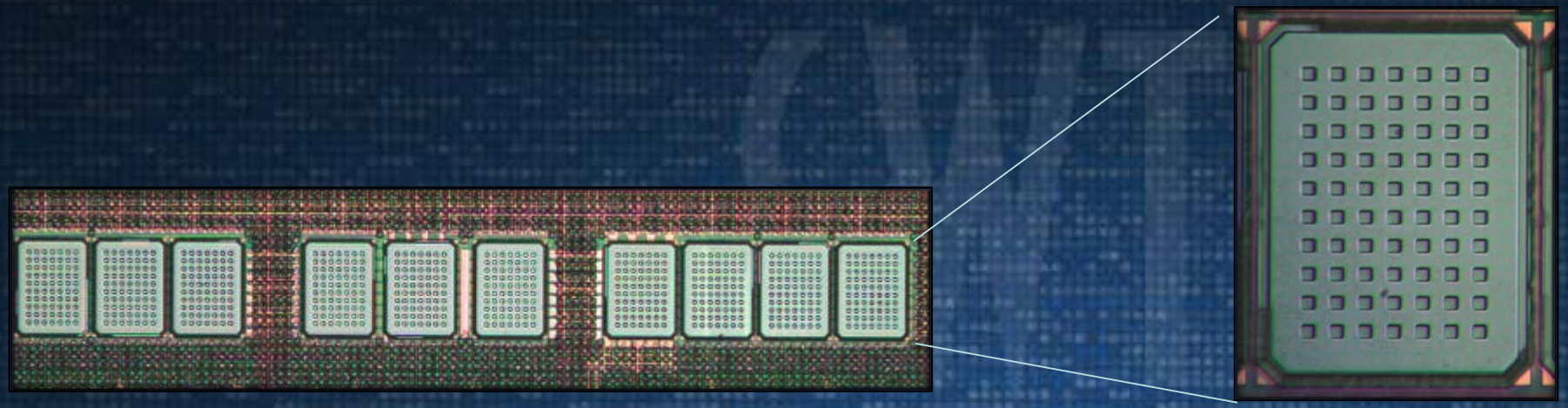


OD=120µm
12 passes

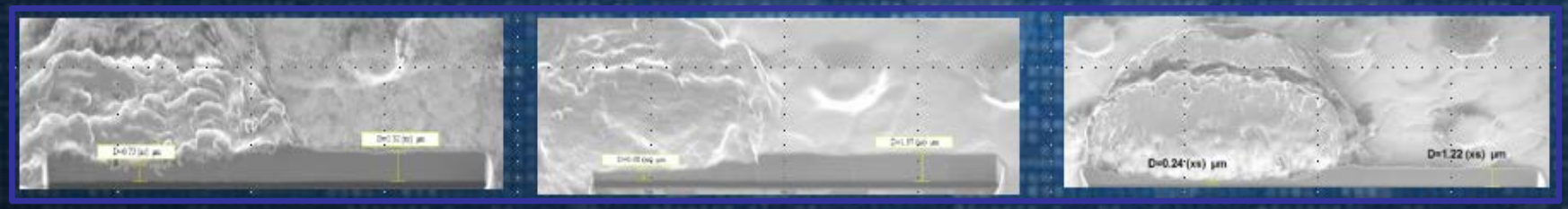
OD	PAD edge Y-margin Cpk	PAD edge X-margin Cpk	Scrub Length Cp	Scrub Width Cp
60µm	6.80	5.00	2.68	3.03
80µm	7.28	3.25	3.46	3.01
100µm	9.06	3.01	3.45	4.03
120µm	3.31	3.03	4.82	2.69

Scrub marks area under worst conditions within spec (<400µm2 vs. 3400µm2 Square Bonding PAD size)

PAD damage evaluation at T1=150kTDs



No damage under metal layer with the worst conditions OD=120µm (with 12passes)



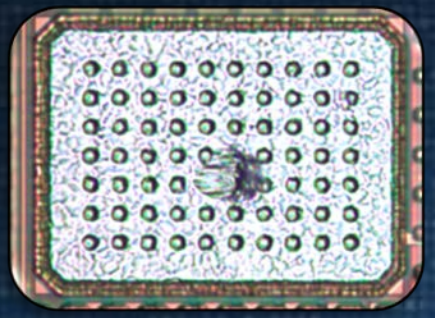
No damage under metal layer under worst conditions

OD=80µm/12passes
Scrub depth 580nm

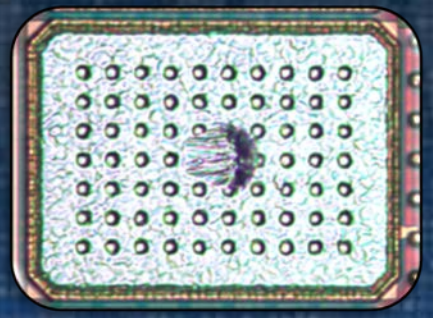
OD=100µm/12passes
Scrub depth 890nm

OD=120µm/12passes
Scrub depth 970nm

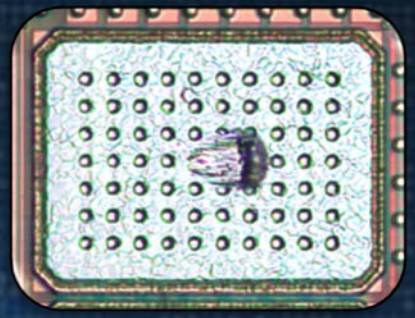
Scrub mark evaluation at T1=150kTDs



OD=80µm
12 passes



OD=100µm
12 passes



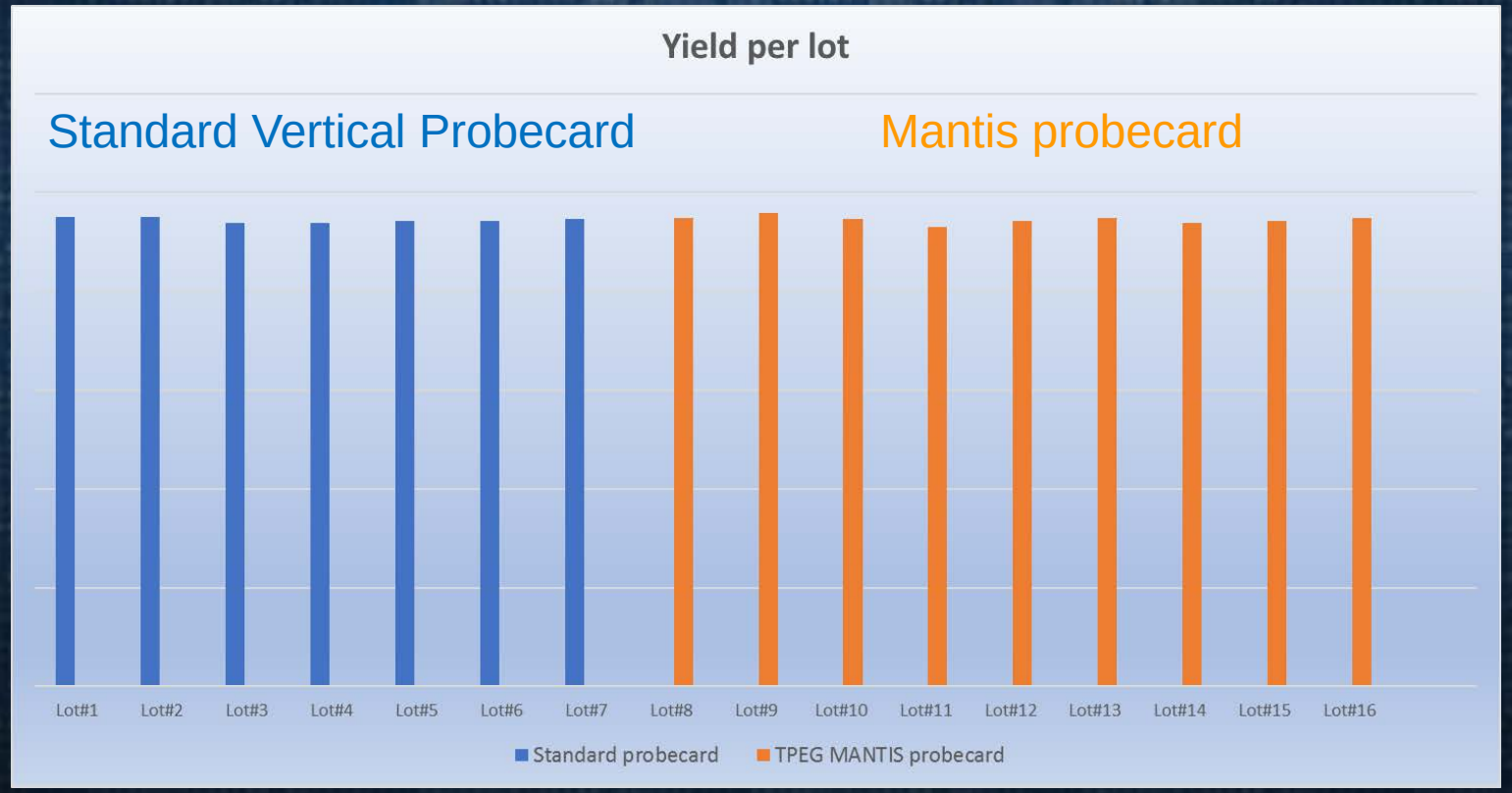
OD=120µm
12 passes

OD	PAD edge Y- margin Cpk	PAD edge X-margin Cpk	Scrub Length Cp	Scrub Width Cp
80µm	5.04	4.28	4.02	3.01
100µm	8.77	6.75	2.43	3.43
120µm	9.45	5.06	4.8	4.02

Scrub marks area under worst conditions within spec (<400µm2 vs. 3400µm2 Square Bonding PAD size)

Yield benchmark from T0 to T1 to today

- **The probecard is in production since end of 2017 with the same cleaning material as the reference probecard**



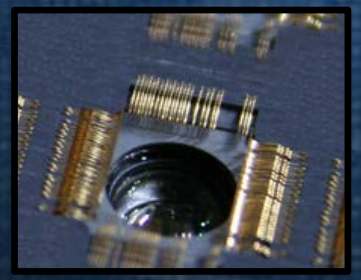
Yield aligned to standard production solution

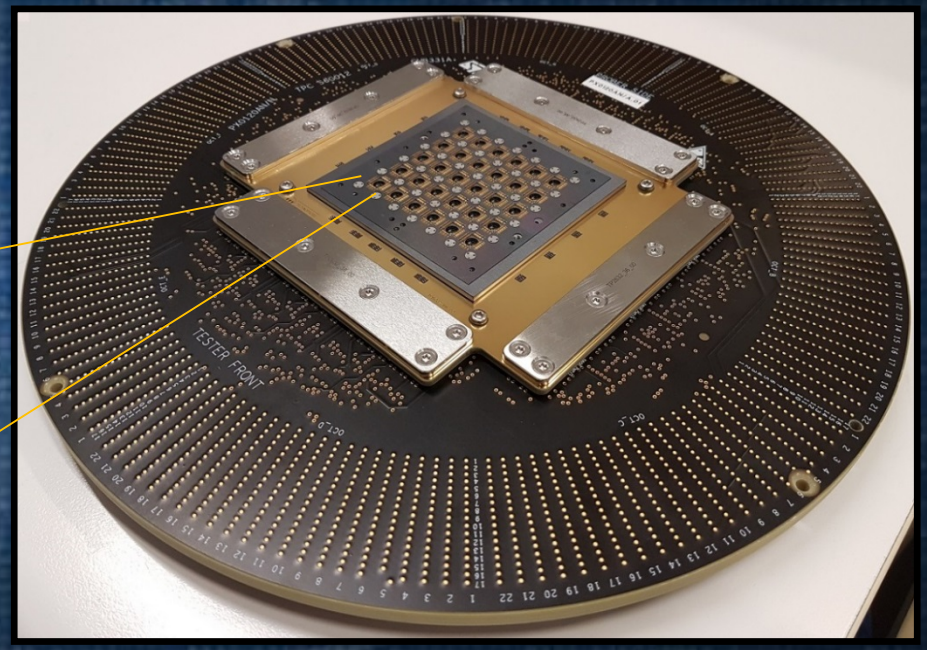
STM Conclusion

- **Qualification**
  - TPEG MEMS Mantis probecard passed all the qualification criteria
- **High Volume production**
  - TPEG MEMS Mantis probecard is in production since end of 2017
  - It reached 1.2MTDs without any issue so far
  - Uptime 99%
  - Tip consumption 30µm (on total 220µm usable tip)
  - We will keep monitoring it…

Next

- **CMOS Image Sensor probecard**
  - 3600 probes
  - x30
  - Status: in qualification





Thanks for your Support !

Davide Sangiorgio
STMicroelettronics
davide.sangiorgio@st.com

Marco Sciurba
STMicroelettronics
marco.sciurba@st.com

Tommaso Masi
Technoprobe
tommaso.masi@technoprobe.com

Riccardo Vettori
Technoprobe
Riccardo.vettori@technoprobe.com