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International Wafer-Level Packaging Conference

TOWARD A FLIP-CHIP BONDER DEDICATED TO DIRECT BONDING FOR PRODUCTION ENVIRONMENT

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set
Smart Equipment Technology

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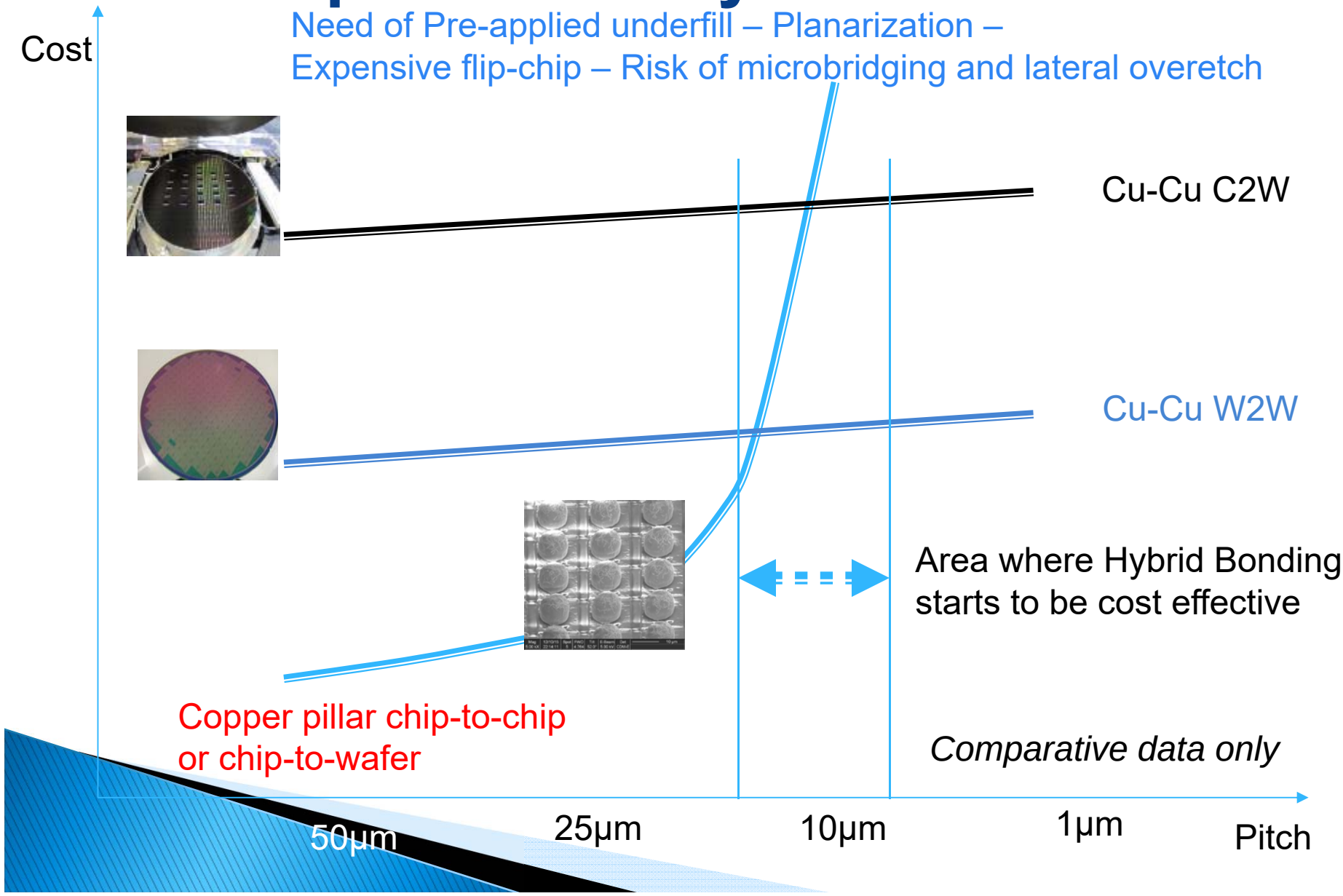
Agenda

- Introduction
- Process and Tool description
  - Die-to-Wafer direct bonding process
  - Tool overview
- Bonding tool performances evaluation
  - Particle contamination
  - Alignment accuracy
  - Equipment throughput
- Application on oxide/oxide direct bonding
- Conclusion

Introduction

- Fine Pitch and High Throughput
  - Challenges of microbumps technology
    - Undercut
    - Microbridging
  - Assets of Direct Bonding
    - Short process time
    - Bonding (and alignment) at room temperature
    - Low force
- D2W vs W2W
  - Good yield (KGD)
  - Heterogeneity of dies (type, size, thickness…)
  - Challenge of cleanliness

Fine pitch comparison process only - Trend



Die-to-Wafer direct bonding process

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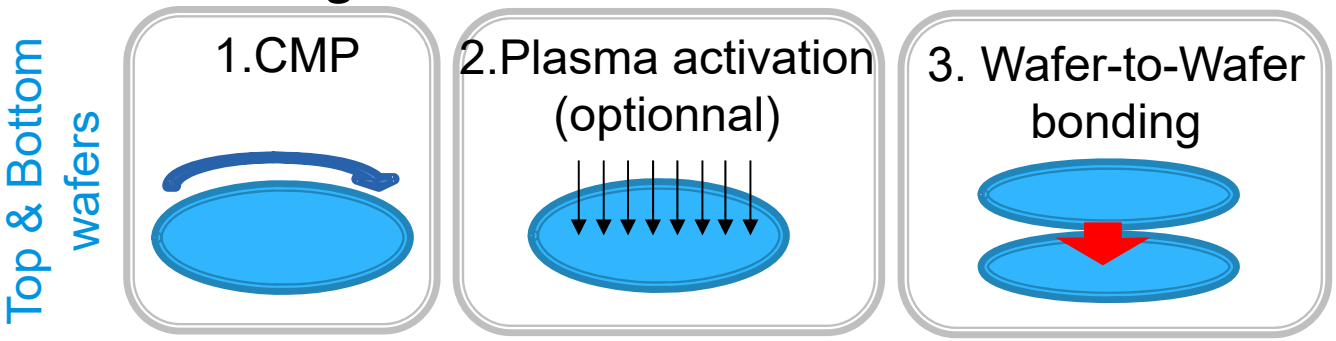
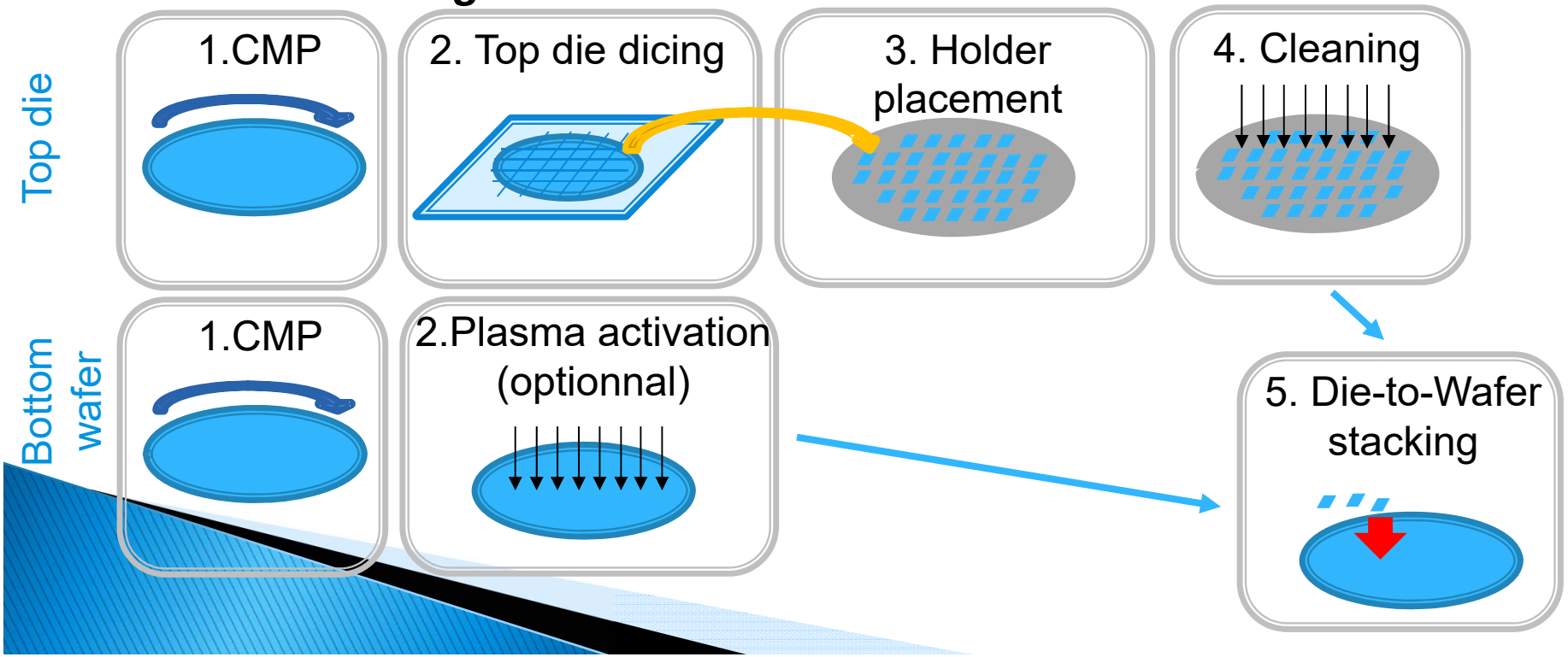
W2W bonding flow

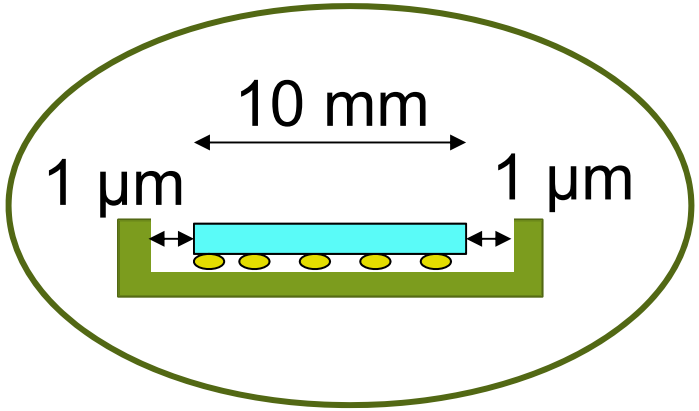


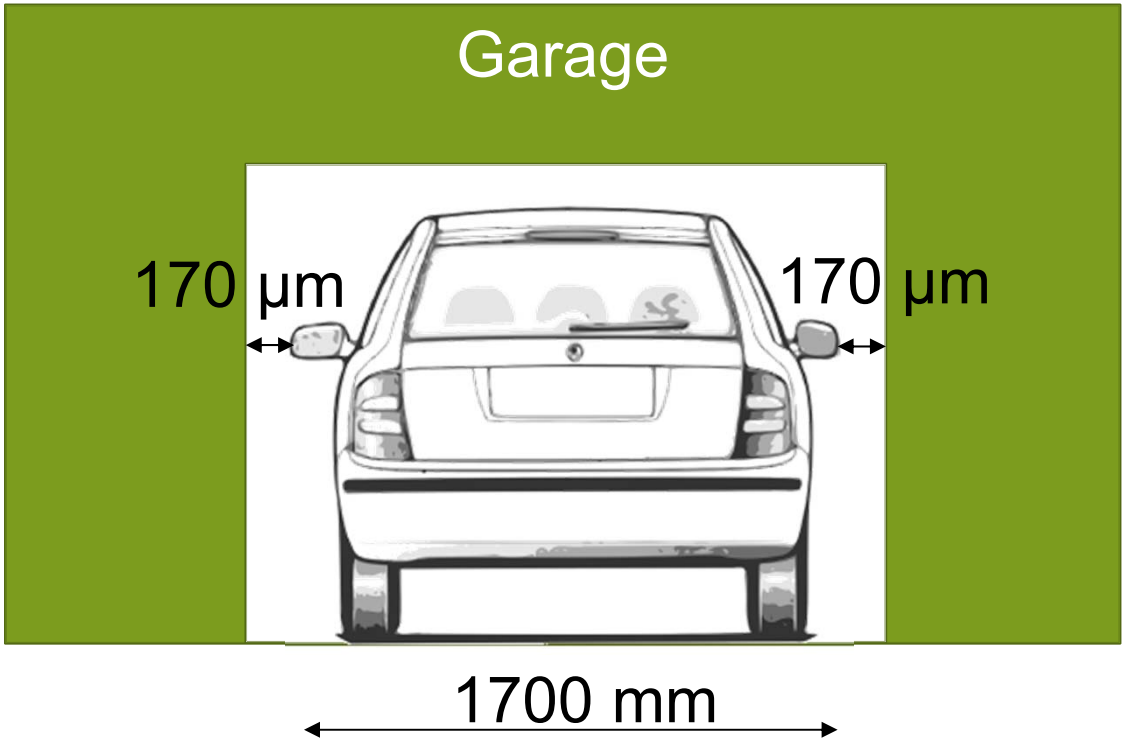
Die-to-Wafer bonding flow



Two antinomic specifications

- Main targets
  - Precision: ± 1 µm
  - Throughput: 1000 dph





Tool overview

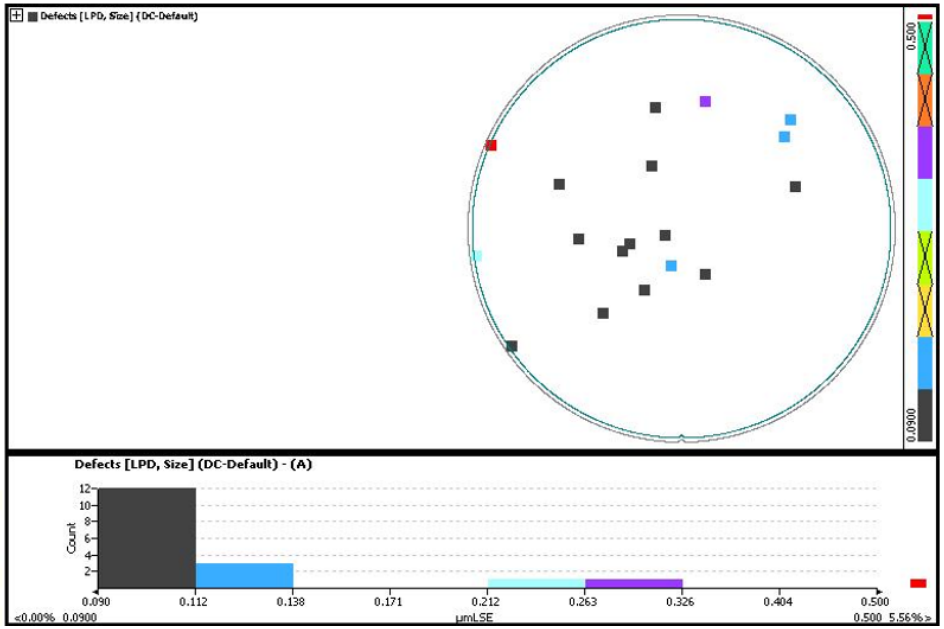
- Main targets
  - Precision: ± 1 µm
  - Throughput: 1000 dph
  - High cleanliness

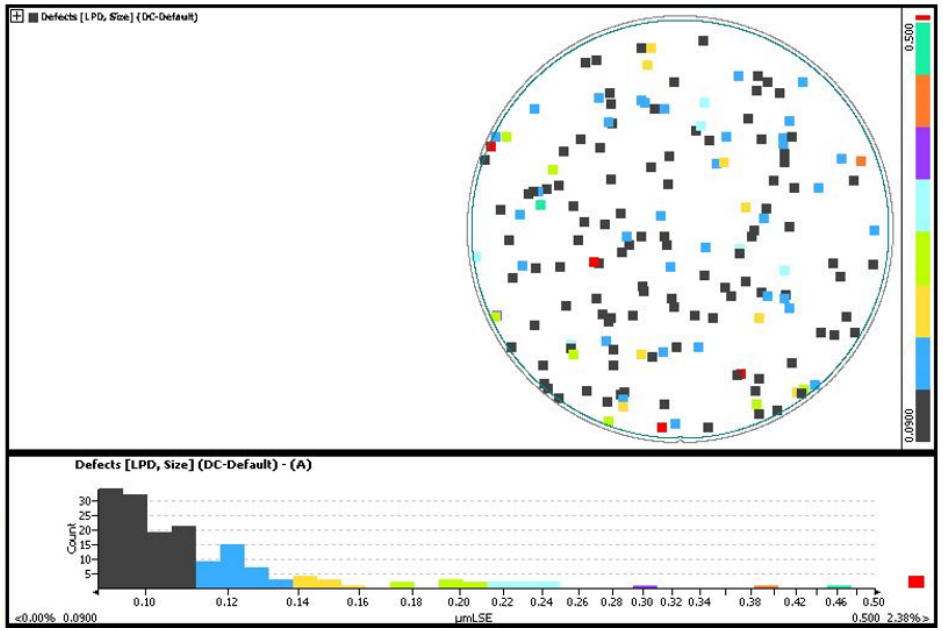
Particle contamination

- Method
  - Measurement of number of particles on wafers
  - Just after cleaning
  - After running tests under various conditions

Particle contamination

- One example: Influence of Y axis
  - Theoretical throughput = 1000 dph
  - Low level of contamination = 150 added particles in 1 hour





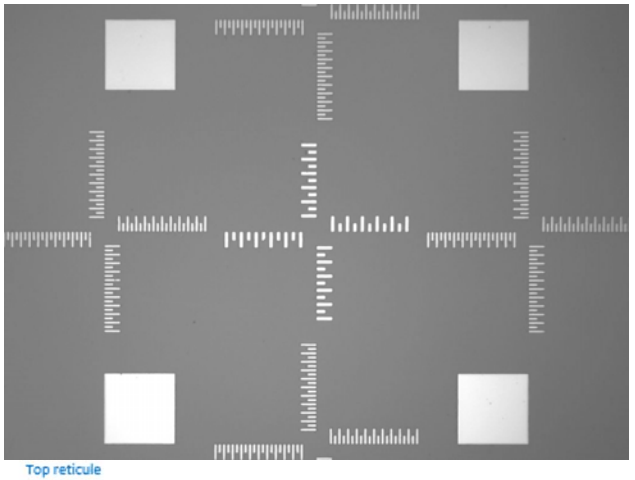
Particle contamination

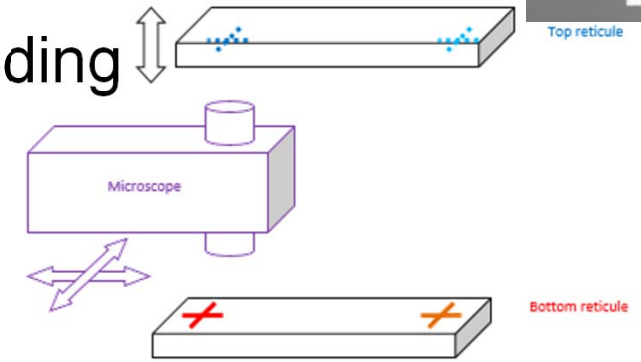
- Synthetic results table
  - Acceptable level of contamination for the process
  - Nevertheless, continuous corrective actions plan on feeder

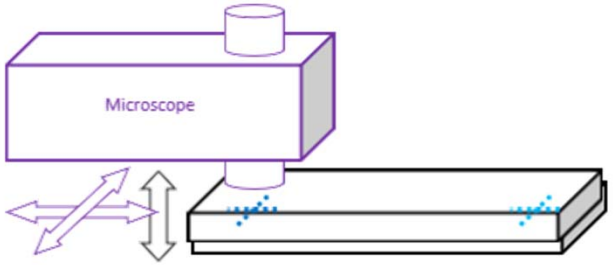
COMPARISON BETWEEN NUMBER OF PARTICLES				
Particle size [nm]	Reference Wafer	Cleanroom	Chuck	Support Holder
Box #	1	4	7	10
Initial (just after cleaning)				
90-500	13	43	17	19
> 500	0	1	1	0
After test (added particles)				
90-500	200	121	147	322
> 500	16	5	3	67

Alignment accuracy

- Method
  - Transparent reticles
  - Alignment before bonding by microscope
  - Check post-bond accuracy by microscope

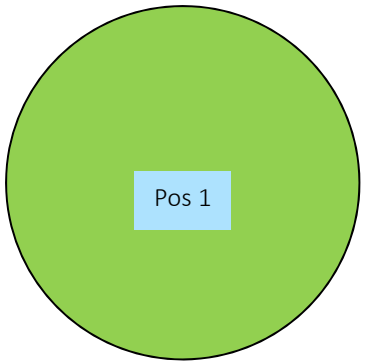


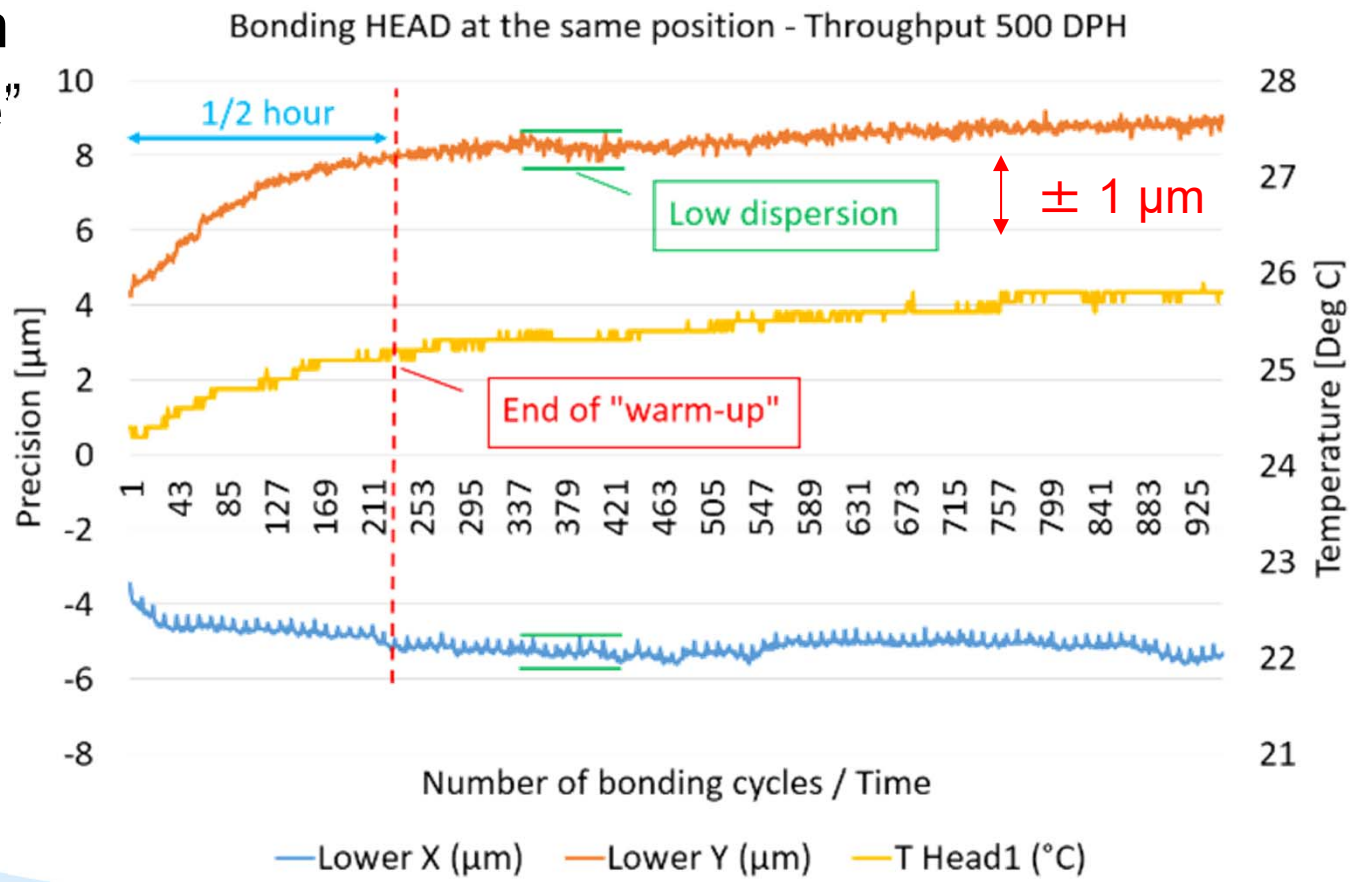




Alignment accuracy

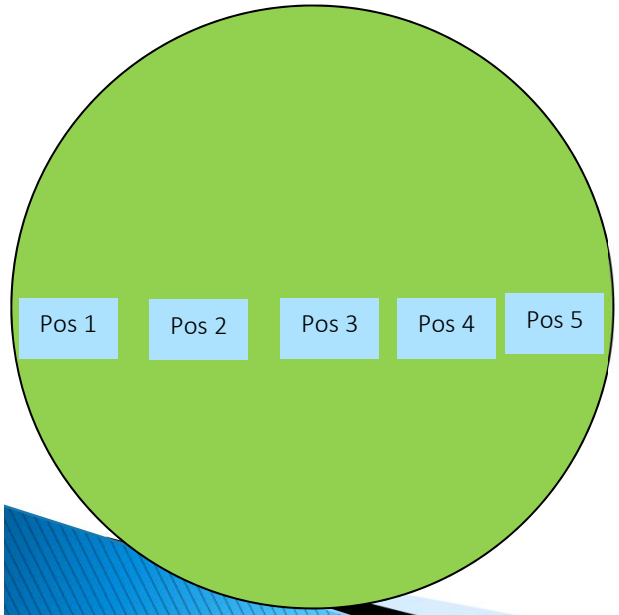
- Repeatability
  - 1 position = Center of wafer
  - Low dispersion
  - “Warm-up time”

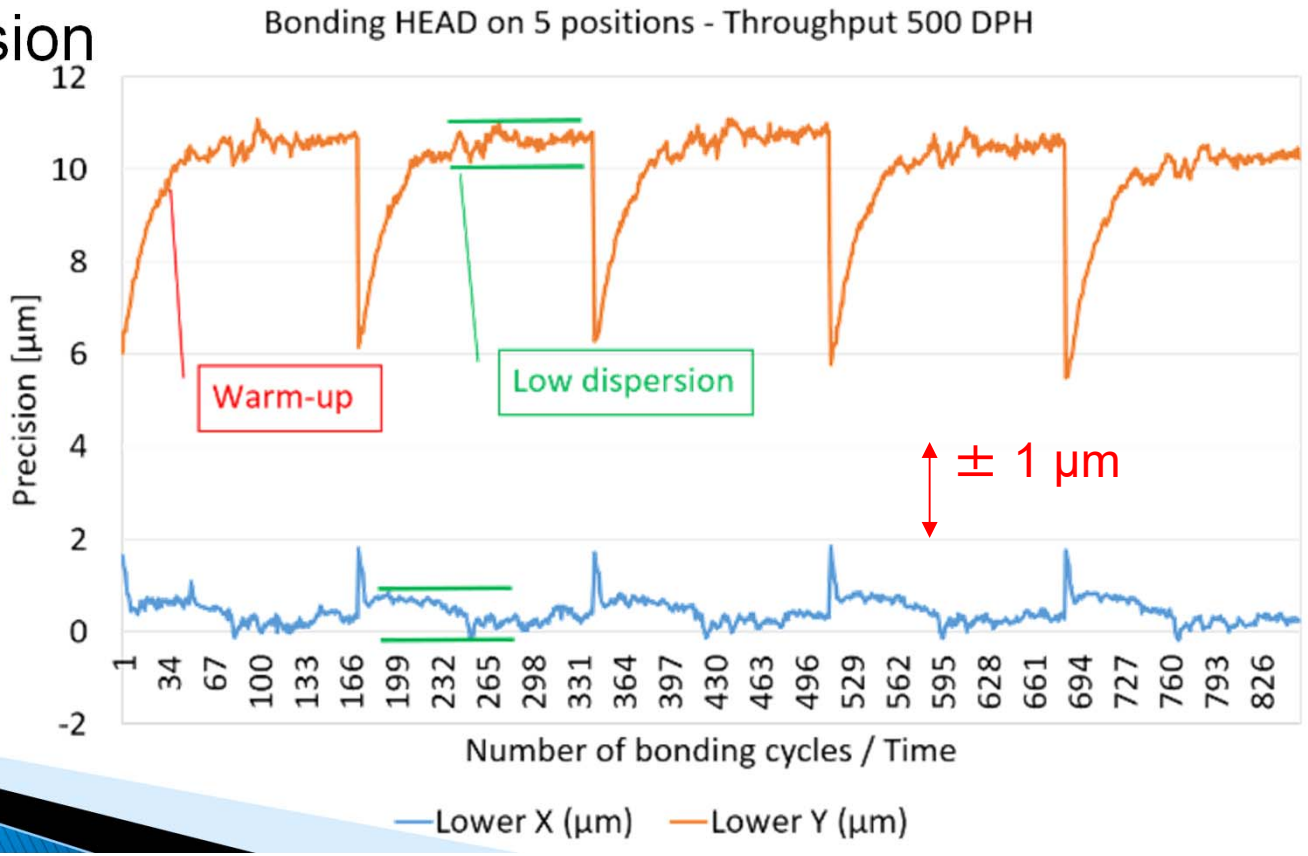




Alignment accuracy

- Repeatability
  - 5 positions = on Diameter of wafer
  - Low dispersion
  - “Warm-up time”
  - Promising precision

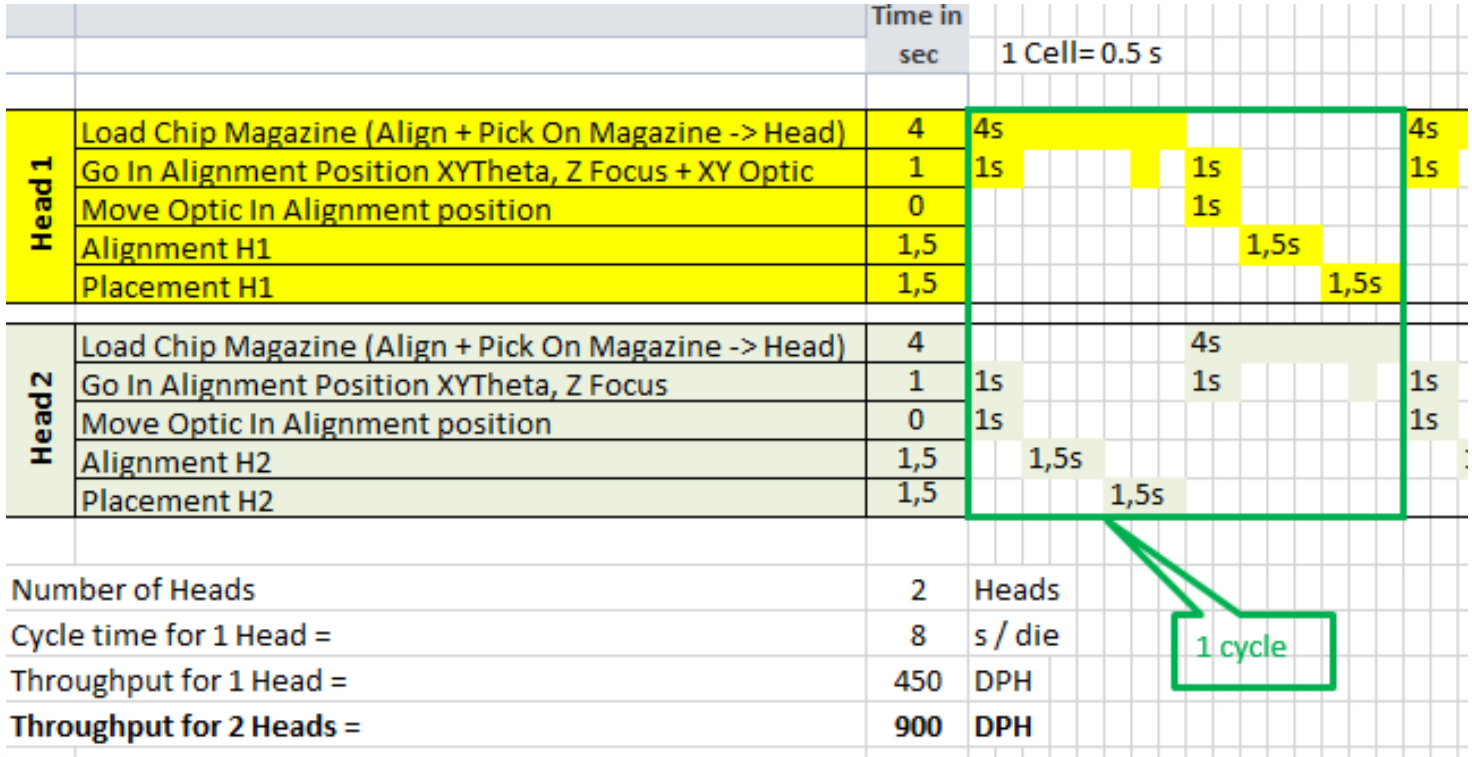




Equipment throughput

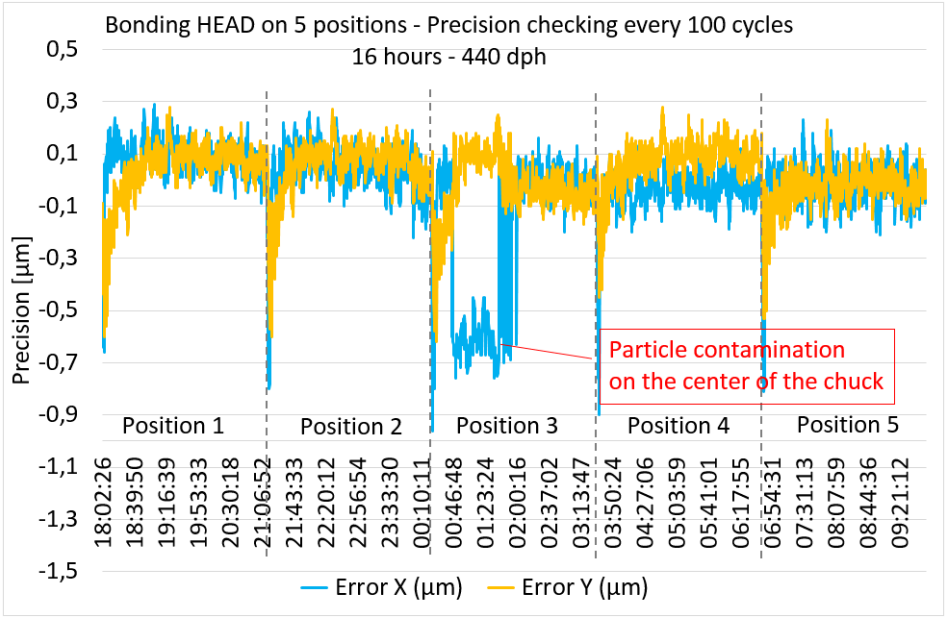
- Theoretical throughput = 900 dph
  - Elementary steps
  - Hidden time / in sequence

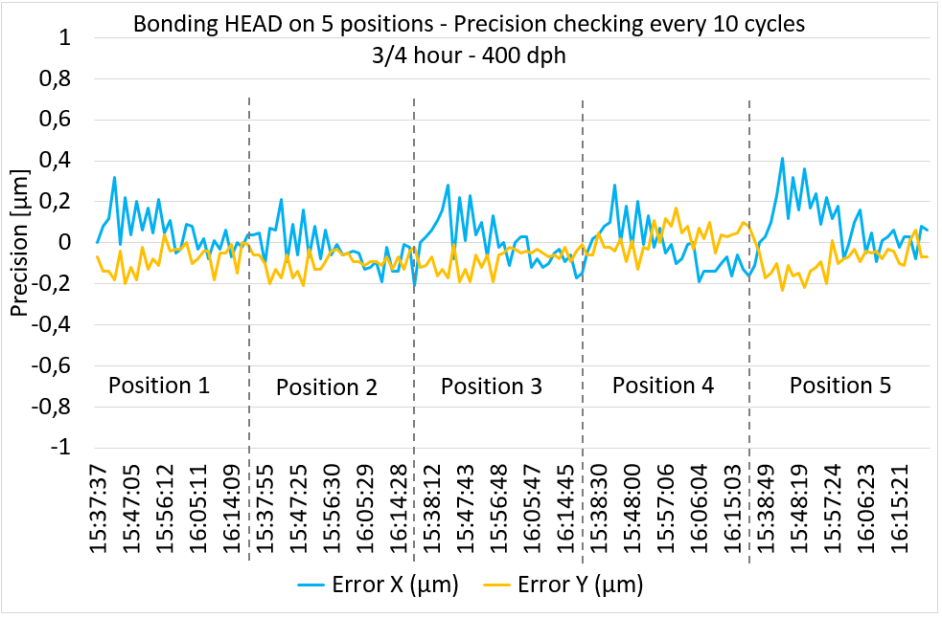
		Time in sec
Head 1	Load Chip Magazine (Align + Pick On Magazine -> Head)	4
	Go In Alignment Position XYTheta, Z Focus + XY Optic	1
	Move Optic In Alignment position	0
	Alignment H1	1,5
	Placement H1	1,5
Head 2	Load Chip Magazine (Align + Pick On Magazine -> Head)	4
	Go In Alignment Position XYTheta, Z Focus	1
	Move Optic In Alignment position	0
	Alignment H2	1,5
	Placement H2	1,5
Number of Heads		2
Cycle time for 1 Head =		8
Throughput for 1 Head =		450
Throughput for 2 Heads =		**900**



Equipment throughput

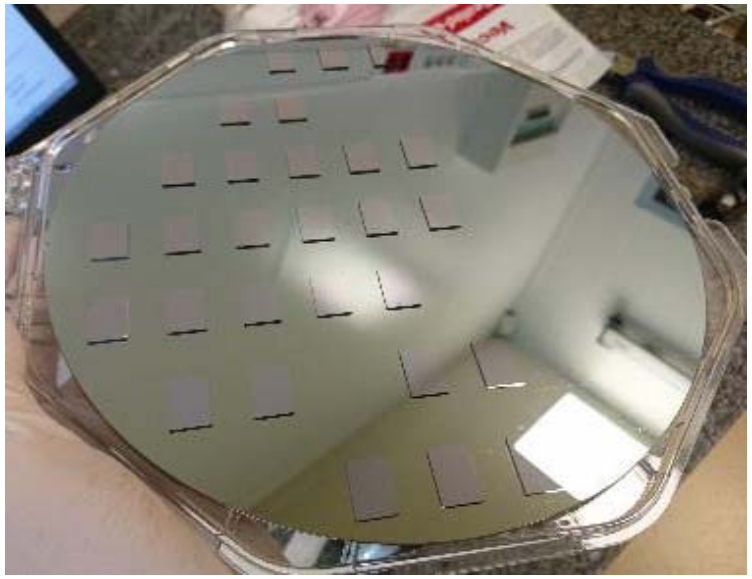
- Throughput vs Accuracy
  - Trade-off
  - Promising Throughput and Precision





Application on oxide/oxide direct bonding

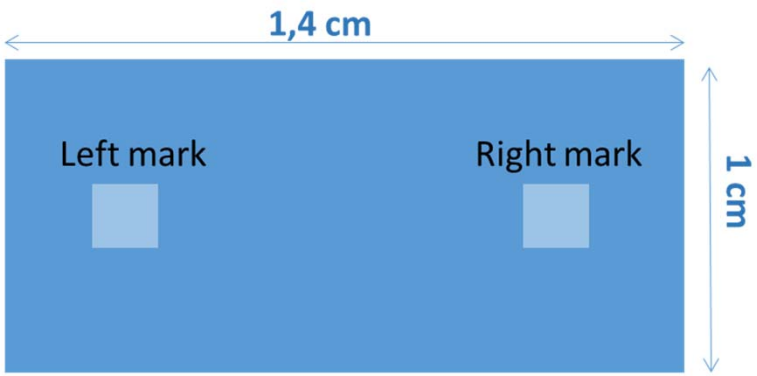
- Conditions
  - 1 x 1,4 mm² dies with 2 verniers
  - 750 nm of TEOS oxide
  - CMP + dicing
  - 28 dies on Ø 200 mm wafer
  - 450 dph



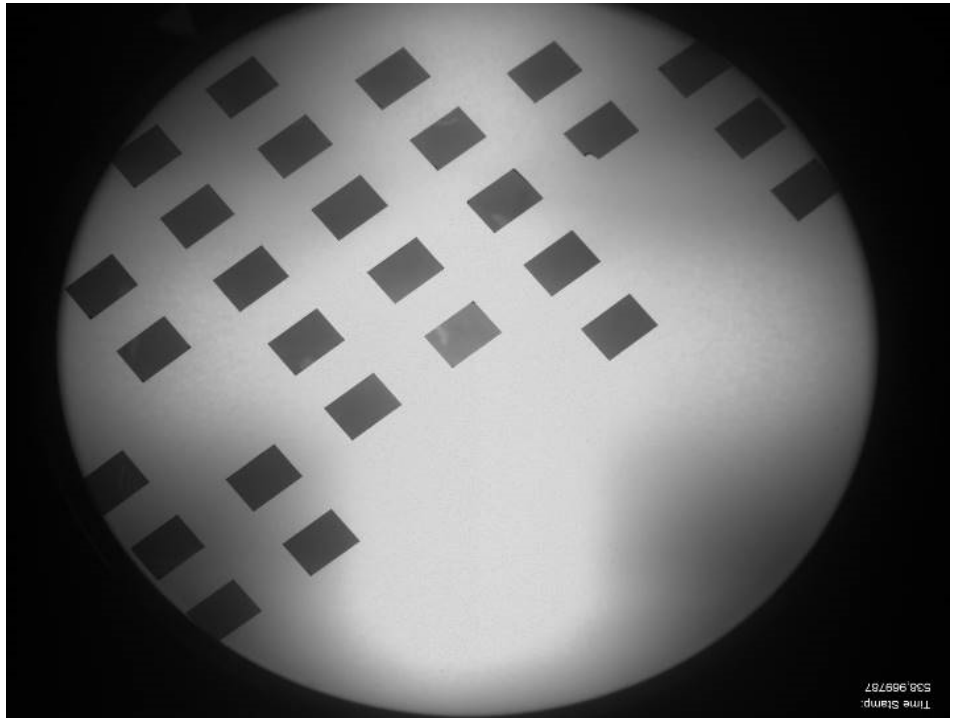
Application on oxide/oxide direct bonding

Results

- Process in line with direct bonding challenges



	X	Y
Left mark	+/- 0,8µm	+/- 1µm
Right mark	+/- 0,8µm	+/- 0,9µm



Conclusion

- Main targets
  - Precision → Dispersion < ± 0,25 µm
    → Post-bond accuracy < ± 1 µm
  - Throughput → ≈ 500 dph
  - High cleanliness → Acceptable level
    → Actions on progress
- Future work
  - Continue qualification of beta tool
  - Harvest measurements on precision, throughput, cleanliness
  - Qualify the process on active device , full morphological and electrical characterization
  - Demonstration on customers components possible in 2018

Thank you for your attention!

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