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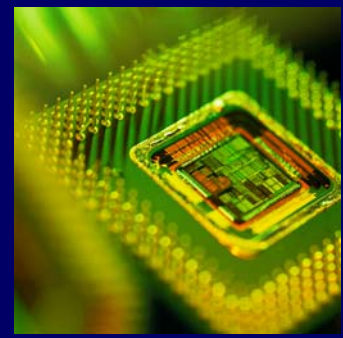
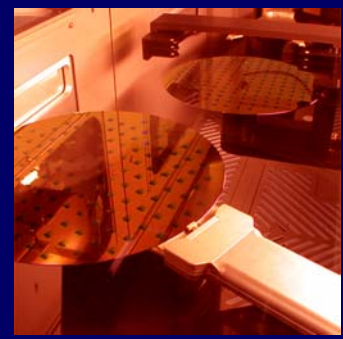
Interoperability Test Bed (ITB) Update to the SEMI 450mm IPIC



Sung-Wook Park
TK Kang
Eddy Bass
Paul Cherry
Mao-Chih Huang

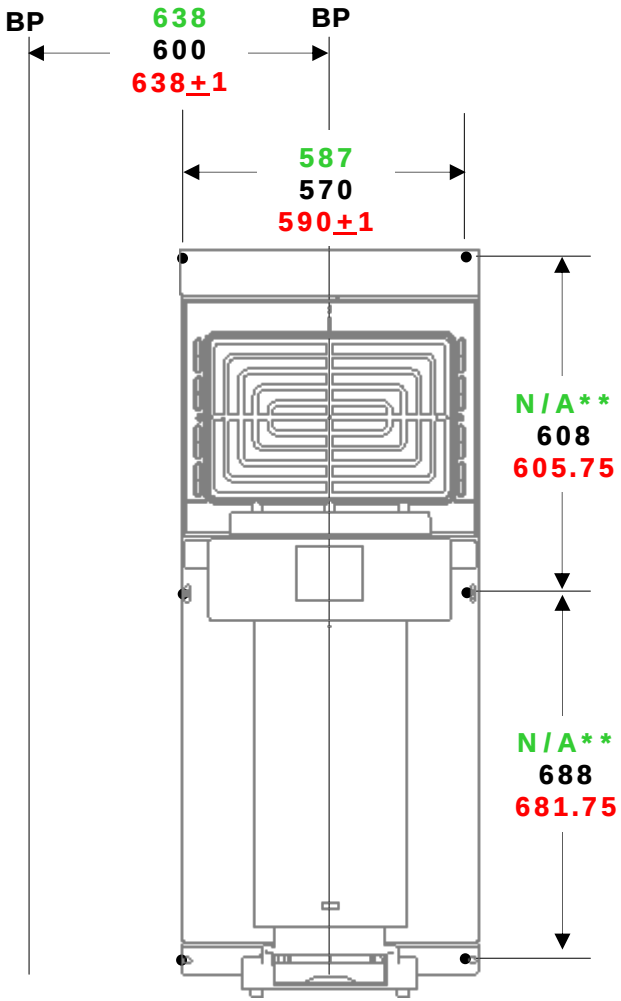


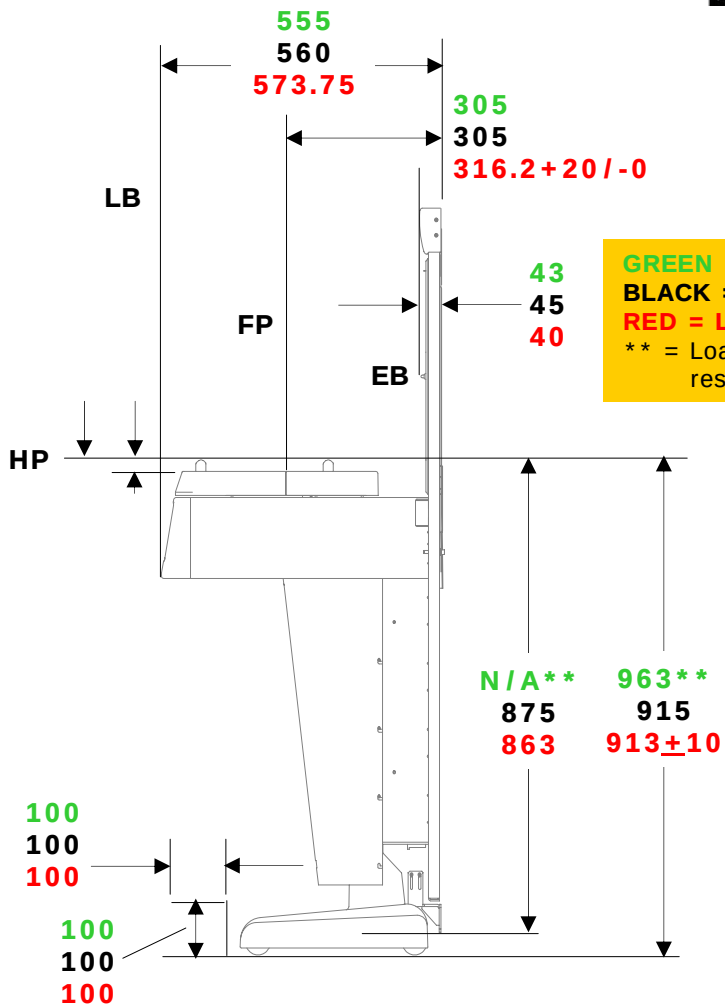
February 25 and 26, 2009

Outline

- Loadport update
  - GL/Standards Assessment
  - Loadport and EFEMs cycling update
- Pitch Budget update with new EFEM
  - New Internal EE measurements
  - Dynamic linearity measurements on 3rd EFEMs
  - Pitch Budget impact
- Summary / Next Steps

Loadport Dimension Comparison





GREEN = Latch Key
BLACK = Magnetic
RED = Loadport yellow ballot
** = Loadport mounting frame restriction

Note: Both system designed and built before blue or yellow balloting

Observations

- In general the magnetic door loadport < **latch key loadport** < **Loadport yellow ballot**

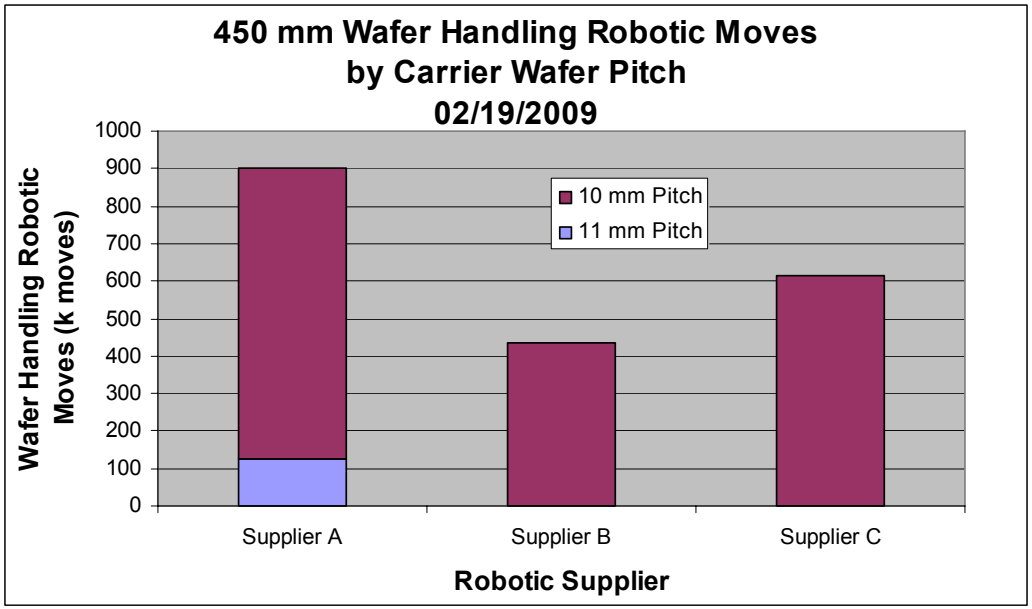
450mm Loadport Metrics Comparison

Parameter	Description	Value	Magnetic Door	Latch Key
Floor Space	**Meets standard**	0.365 m^2	0.34 m^2	0.35 m^2
Loadport cycle time	**≤ 300mm Equipment performance**	Best in Class is TBD	Open = 12 sec Close = 23 sec	Open = 5.7 sec Close = 5.6 sec
First wafer access time	**≤ 300mm Equipment performance**	Best in Class is TBD	Average Time from loadport to PM = 21.3 sec	Average Time from loadport to PM = 18.4 sec
KC Pin Electrical Resistance to ground	**Measured from KC pin to a common ground**	≤1 Ω	<1 Ω	~22 Ω
Maintenance access	**No Routine Front-Side Maintenance**	-	No Routine Front-Side Maintenance	No Routine Front-Side Maintenance
Door Closure Force	**Meets standard**	187N	Average = 210 N	Average = 98 N**

Notes: Both systems designed and built before blue or yellow balloting. System optimization not yet completed

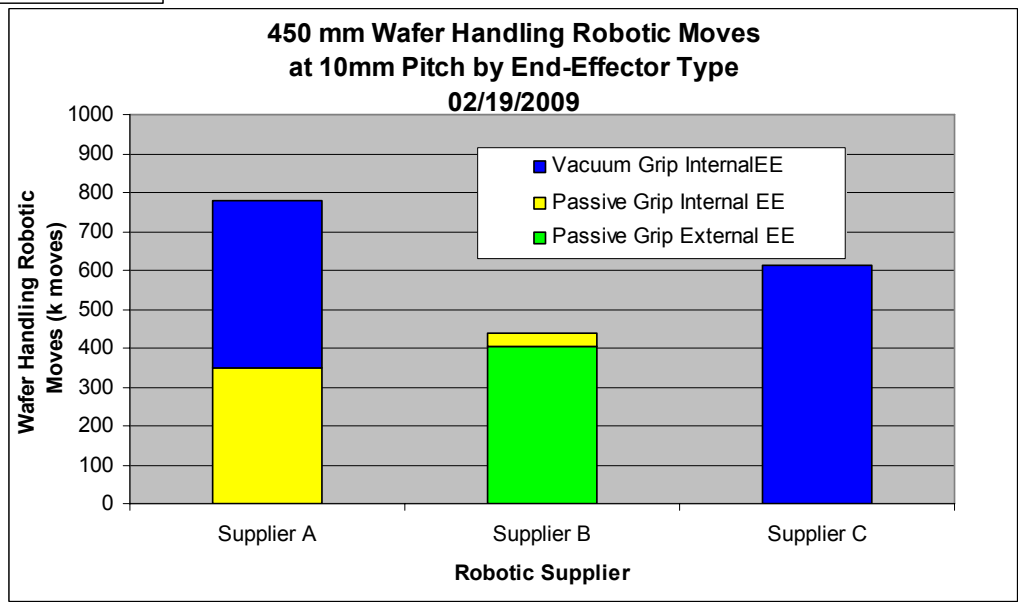
** = from Supplier “B” documentation

EFEMs Cycling Status

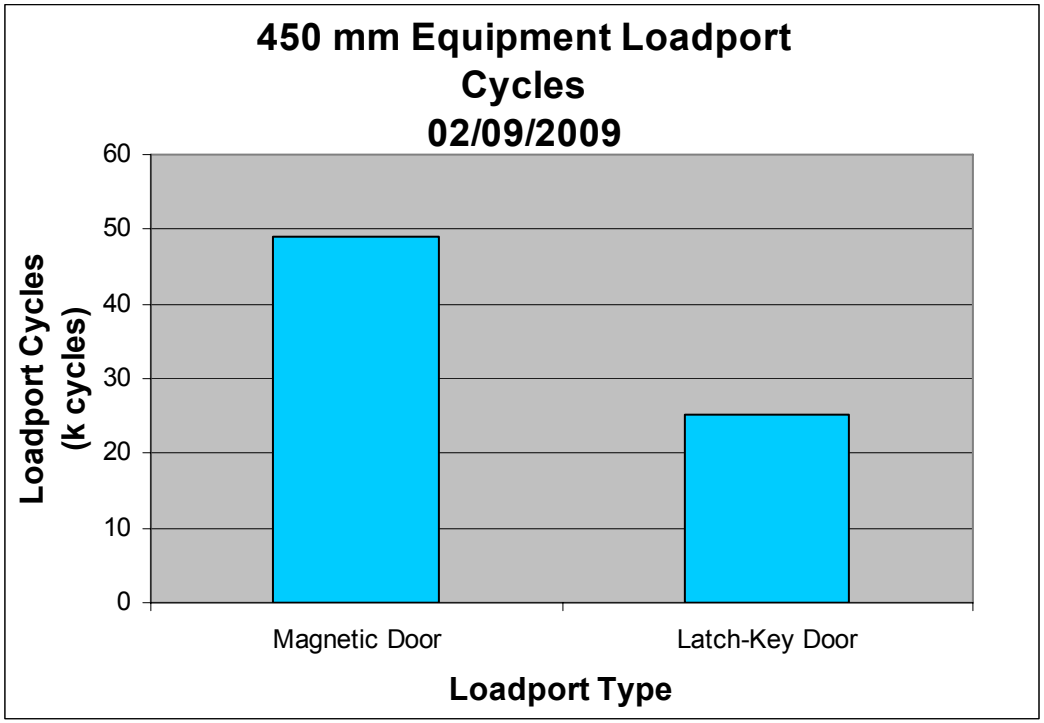


- > 1.95 million robot moves completed to date with 450mm wafers (including >1.83 million moves to/from 10mm pitch carriers)

- > 57% of 10mm pitch moves with vacuum grip EE
- > 78% of 10mm pitch moves with Internal EE



Loadport Cycling Status



- > 74k loadport cycles (i.e., open and close) completed to date with prototype carriers

Supplier "B" End-Effector measurement comparison

Attribute	Passive Grip Internal
EE Material	Ceramic
EE Structure Thickness (mm)	3.00
EE Pad Thickness (mm)	0.75
EE Deflection with Wafer (mm)	0.50
Dynamic Linearity / Vibration (mm) (Lift Clearance values)	0.373 (0.571)

Robot Linearity – Supplier "B"
Passive Grip Internal End-Effector

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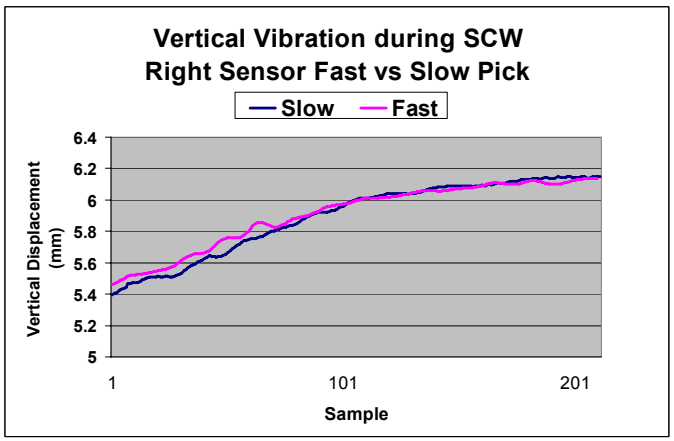
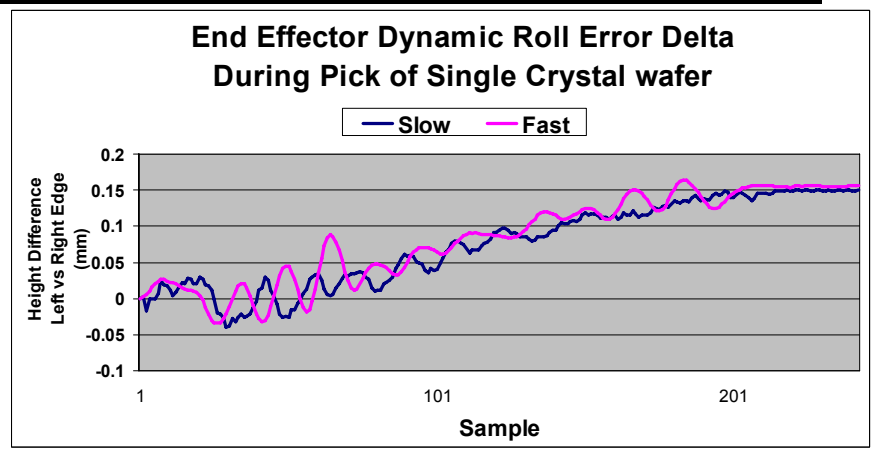
Single Crystal Wafer (SCW) Robot Linearity Supplier "B" Latch-Key Loadport

Slot	Wafer	Operation	Left Sensor (mm)	Right Sensor (mm)	EE Dynamic ROLL Error - Baseline Wafer (mm)	EE Dynamic ROLL Error - Fast Wafer (mm)	Maximum of EE Vertical Vibration Error (mm)	Maximum Effective EE Roll Error (mm)	Total Robot Linearity Error (mm)	Lift Clearance contribution (mm)
8	SCW 1	PICK	0.141	0.150	0.190	0.198	0.150	0.223	0.373	0.521
8	SCW 1	PLACE	0.112	0.119	0.169	0.179	0.119	0.201	0.320	0.455
8	SCW 2	PICK	0.135	0.150	0.186	0.179	0.150	0.209	0.359	0.499
8	SCW 2	PLACE	0.115	0.133	0.172	0.150	0.133	0.194	0.327	0.456
		MAX	**0.141**	**0.150**	**0.190**	**0.198**	**0.150**	**0.223**	**0.373**	**0.521**
		MIN	**0.112**	**0.119**	**0.169**	**0.150**	**0.119**	**0.194**	**0.320**	**0.455**
		AVG	0.126	0.138	0.179	0.177	0.138	0.207	0.345	0.483
		STDEV	0.014	0.015	0.010	0.020	0.015	0.012	0.025	0.033





New Internal Passive Grip End-Effector and robot architecture produces reduced vibration amplitudes with Single Crystal Wafers

Supplier "B" Passive Grip Internal EE Pitch Budget

From SEMI Ballot 4570

Item	Description	Wafer Pitch Budget "D"	Lift Clearance Budget "D"	Wafer Pitch Budget "F"	Lift Clearance Budget "F"	Supplier "B" Passive Grip Internal EE Measured Wafer Pitch Budget (mm)	Supplier "B" Passive Grip Internal EE Lift Clearance Budget Measured (mm)
1	Thickness of Wafer	0.95	0.95	0.95	0.95	0.950	0.950
2	Wafer Deflection under Gravity	0.16		0.20		0.159	N/A
3	Process Induced Warp	1.00	0.50	1.00	0.50	1.000	0.500
4	Initial Warp	0.10	0.00	0.10	0.00	0.100	0.000
5	Tolerance of nominal wafer seating planes	1.00	1.00	1.00	1.00	1.000	1.000
6	Carrier Placement Error	0.2	0.2	0.2	0.2	0.200	0.200
7	EE Structure	2.86		3.11		3.000	N/A
8	EE Wafer Contact Pads	0.75		0.47		0.750	N/A
9	EE Inclination/Curvature without wafer	0.00		0.00		0.000	N/A
10	EE Inclination/Curvature with wafer		0.80		0.80	N/A	0.800
11	Inclination of Robot Motion	Partly included in 12	Partly included in 12	Partly included in 12	Partly included in 12	Partly included in 12	Partly included in 12
13	Vertical Vibration of EE (P-P)	0.52	0.69	0.91	1.29	0.373	0.521
14	Robot teaching and alignment error	1.00	1.00	0.00	0.00	1.000	1.000
15	EE Roll Error	0.07	0.07	0.00	0.00	0.050	0.050
16	Desired Safety Margin	0.00	0.00	0.00	0.00	0.000	0.000
17	Thickness of Wafer Support		4.00		4.00	N/A	4.000
	TOTAL (mm)	8.60	9.21	7.94	8.74	**8.582**	**9.021**

- Effective sag due to EE compensation
- EE Thickness and pad height
- Robotic linearity
- Static Roll error measure

- 3rd example EFEM that Falls within 10mm pitch goal

Summary / Next Steps

- Summary
  - All robotic test systems meet the 10mm pitch / lift clearance budgets
    - Supplier “A” vacuum grip EE has less EE structure and pad contributions and includes compensation for wafer sag
    - Supplier “B” new Internal EE and robot architecture demonstrates less dynamic linearity contributions and similar compensation for wafer sag
    - Supplier “C” has robotic teach compensation to reduce EE/robot and load port alignment error
  - Over 900K cycles (1.83 M robot moves) completed at 10mm pitch
- Next Steps
  - Install and test 2nd latch key loadport in late March
  - Install slide-latch loadport/EFEM system and begin testing in Q1
  - Install / test new external EE to determine performance and pitch budget impact
  - Increase cycle counts on loadports and EFEMS to determine reliability against metrics