Methods for Determination of CMP Pad Life:
Simulation by Conditioning vs. Wafer Passes

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Live Marathon vs. Simulated Marathon Overview

In this evaluation, an alternative method of determining pad life by conditioning simulation was evaluated against a complete wafer marathon.

<u>JSR Oxide Pad Life Determination</u>

- Pad Concept Review
- Equipment and Process Setup
- Live Marathon Compared to Simulated Marathon Data
  - Removal rate, uniformity
  - Pad life, wear rate
  - Defectivity
  - Planarity
- Summary

Innovative Technology of JSR CMP Pads

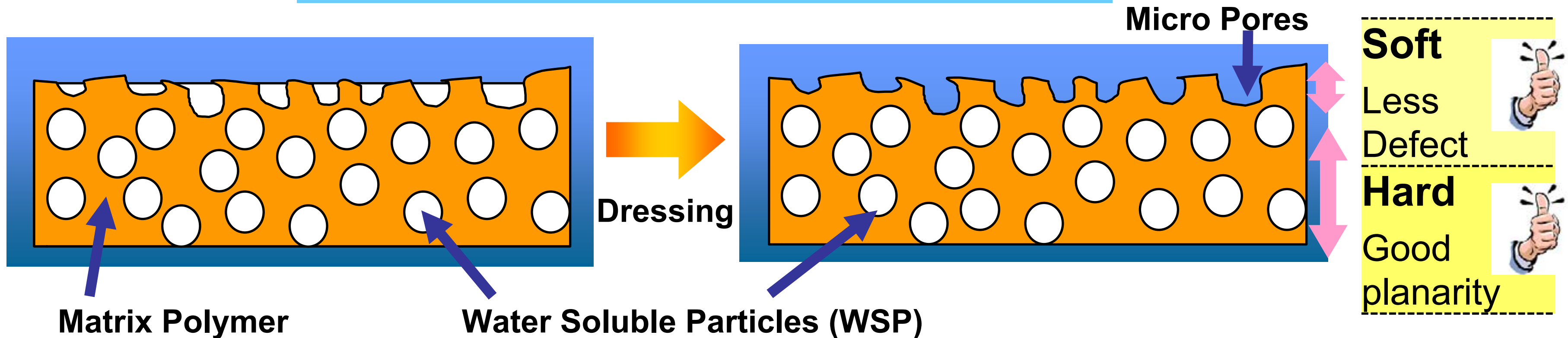
Conventional Hard Pad

- Good Planarity
- Bad Defect Performance

Conventional Soft Pad

- Bad Planarity
- Good Defect Performance

JSR CMP Pad *Solid pad with WSP*



- **When exposed to polishing liquids, the water soluble particles (WSP) at the pad surface dissolve, forming micro pores.**

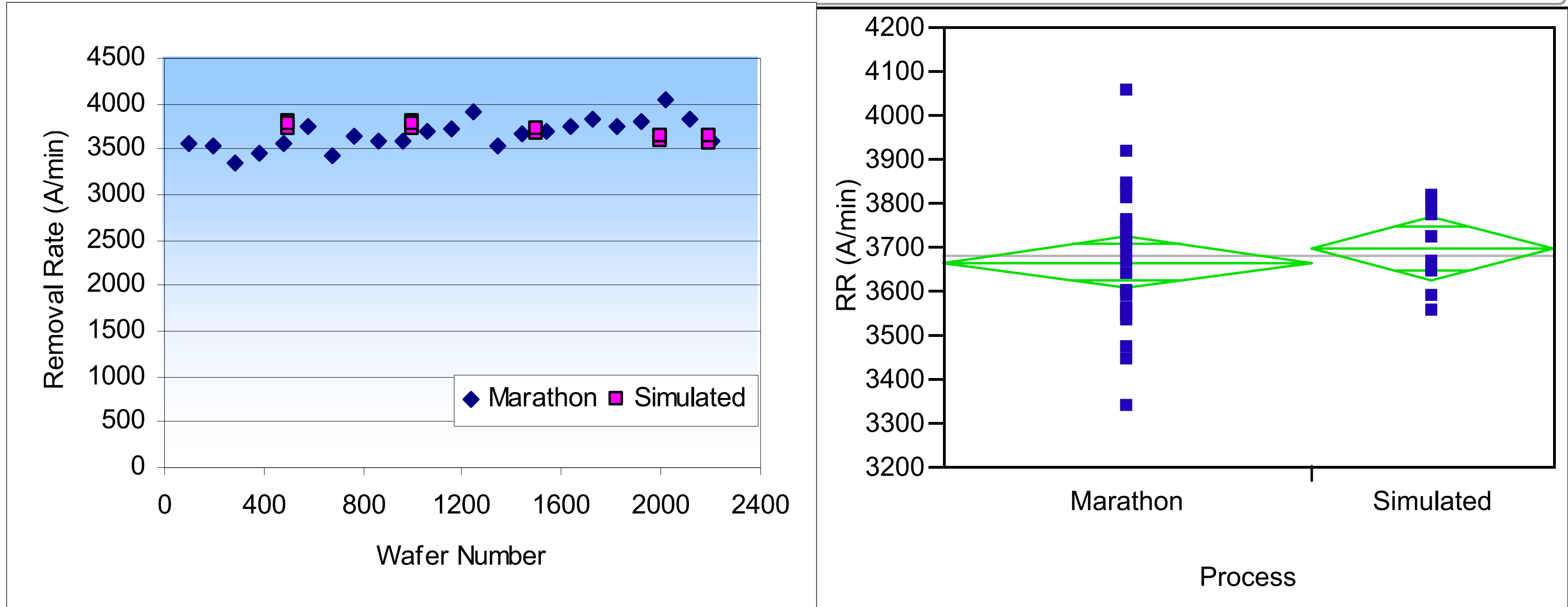
JSR Oxide Pad Marathon Setup

- Procedure
  - Live marathon – polish wafers for 60s with 15s of conditioning. Monitor wafers are recorded at every 100th wafer.
  - Simulated marathon – create pad wear by simulating wafer passes through conditioning only. Every 15s of conditioning is equivalent to one wafer pass. Monitor wafers are recorded at every 500th simulated wafer.
- Equipment
  - AMAT Mirra Mesa
  - KLA SP1 tbi
  - KLA P-15 profiler
  - n&k 3000 Analyzer
  - Mitutoyo depth gauge
- Wafers
  - 15kA TEOS blanket monitor
  - SKW 7-2 oxide pattern wafer

JSR Oxide Pad Process Parameters

- **Sequence:** Single platen test (platen 1)
- **Pad:** JSR Oxide Pad (concentric circular grooves)
- **Disc:** Saesol 80 grit
- **Slurry:** Cabot SS-25 diluted 1:1 by weight
- **Cleaner:** SC1 (megasonics), Brush 1 & 2 (DIW)
- **Process conditions:**
  - PS/CS: 97/70rpm
  - MP/RRP/IT: 5.0/6.0/5.0psi
  - Slurry flow rate: 150mL/min
  - Slurry ramp time: 5 seconds
  - Pad clean step: 6 seconds
  - Conditioning d.f.: 4.0lbf
  - Conditioning time: 25% in-situ
  - Wafer break-in: 7 minutes wafer break-in with 100% in-situ conditioning

Live Marathon vs. Simulated Marathon Removal Rate Stability



- A total of **2208 wafers** were polished for the live marathon.
- A total of **2200 wafers** were simulated by conditioning for the accelerated test.
- Removal rate remained stable across both pad life marathons and there was no statistical difference in the RR means of the two methods.
- RR WTWNU was 4.3% with a standard deviation of 154A/min for the live marathon.

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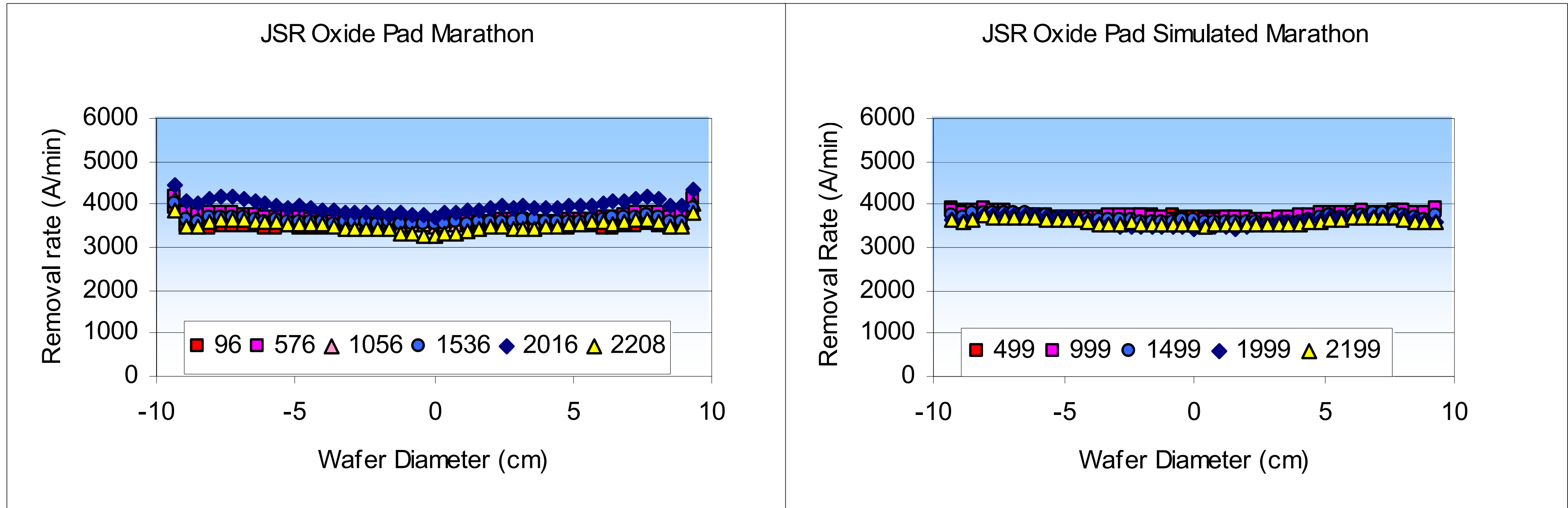
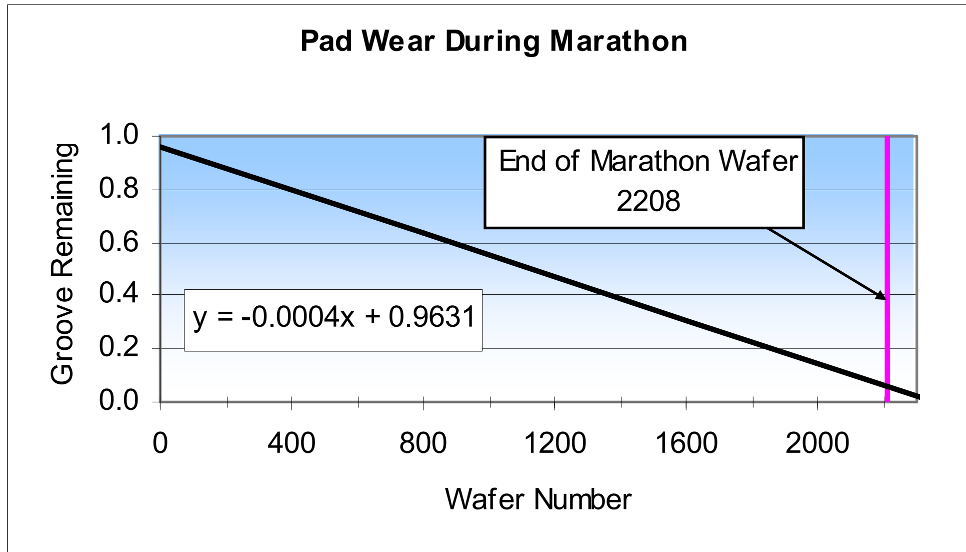
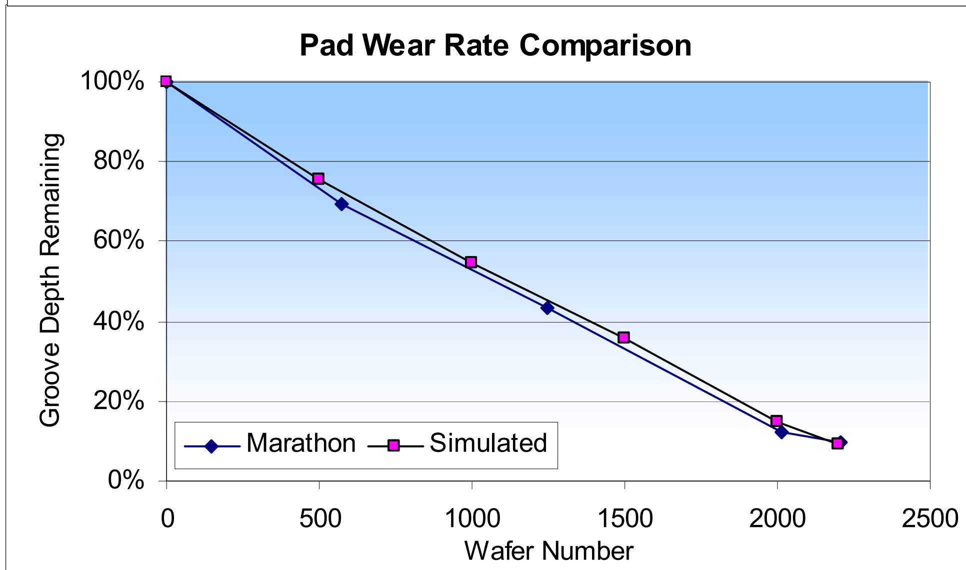
Live Marathon vs. Simulated Marathon Removal Rate Profiles



- The removal rate profile was stable across the both wafer marathon methods.
- Monitor wafers were placed at 100 wafer intervals for the live marathon and at 500 wafer intervals for the simulated marathon
- The average removal rate WIWNU was **2.9%** for the live marathon and **2.2%** for the simulated marathon

Live Marathon vs. Simulated Marathon Pad Wear Rate





- End of pad life was determined by remaining groove depth
- After 2208 wafers, **~10% groove depth remained** for the live marathon.
- After 2200 wafers, **~9% groove depth remained** for the simulated marathon.
- The simulated marathon shows the same pad wear rate as the live marathon.

Pad life estimation based on groove depth can be approximated accurately by the conditioning simulation method.

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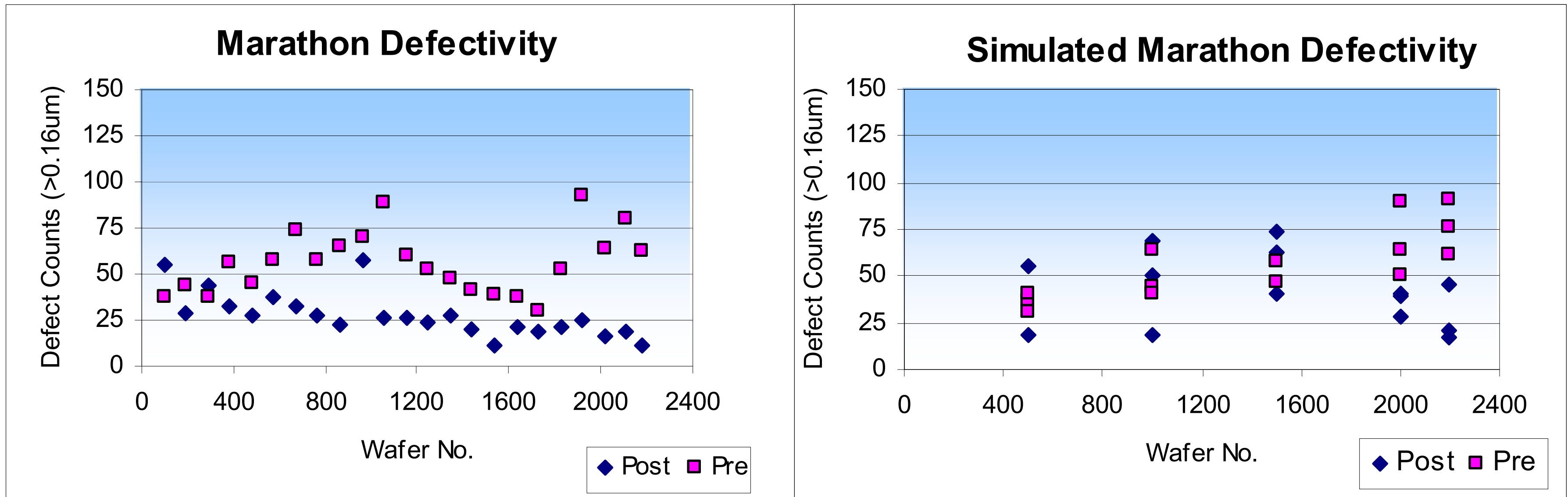
Live Marathon vs. Simulated Marathon Defect Performance



- Defect performance was very stable across 2208 wafers for the live marathon.
- Average defect counts were 27 and 41 for the live and simulated marathon.
- **Defects were slightly higher for the simulated run due to a difference in surface roughness from the long conditioning runs.**

Marathon Ave. Counts		Sim. Marathon Ave. Counts	
Pre	56	Pre	57
Post	**27**	Post	**41**

SP1 tbi settings

Min. Size >0.16um

High Sensitivity Mode

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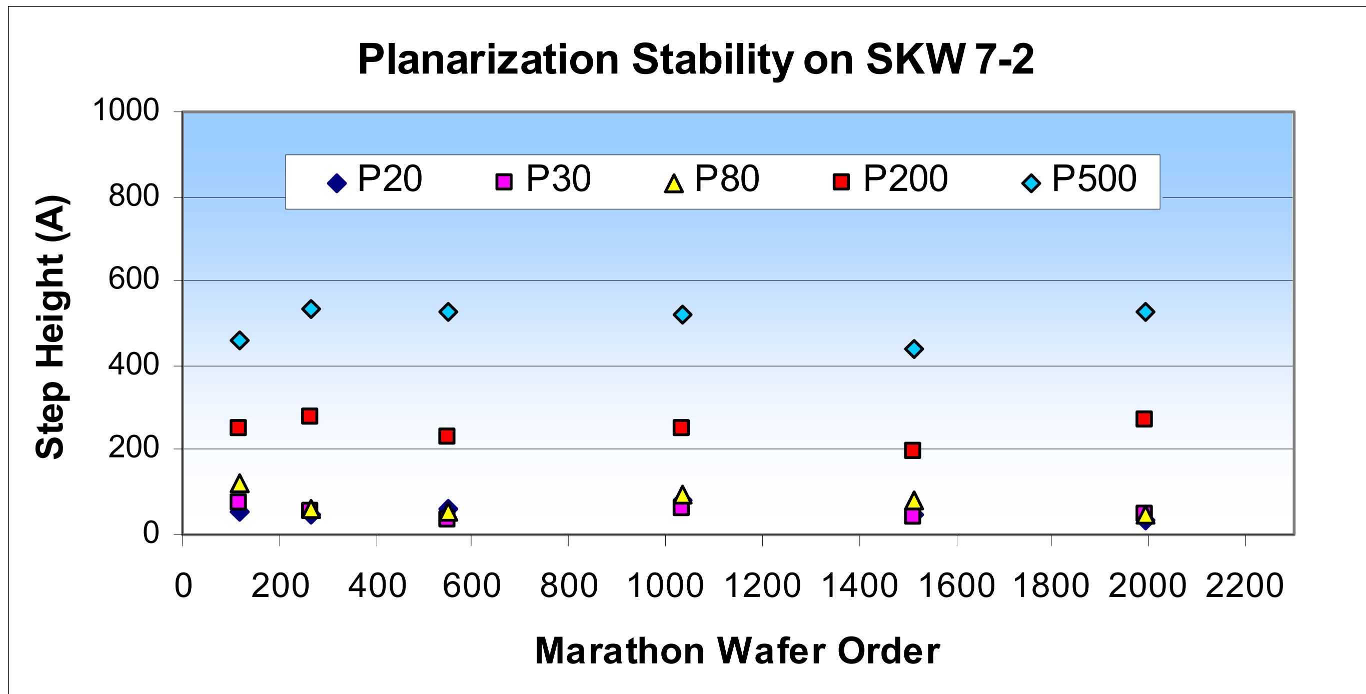
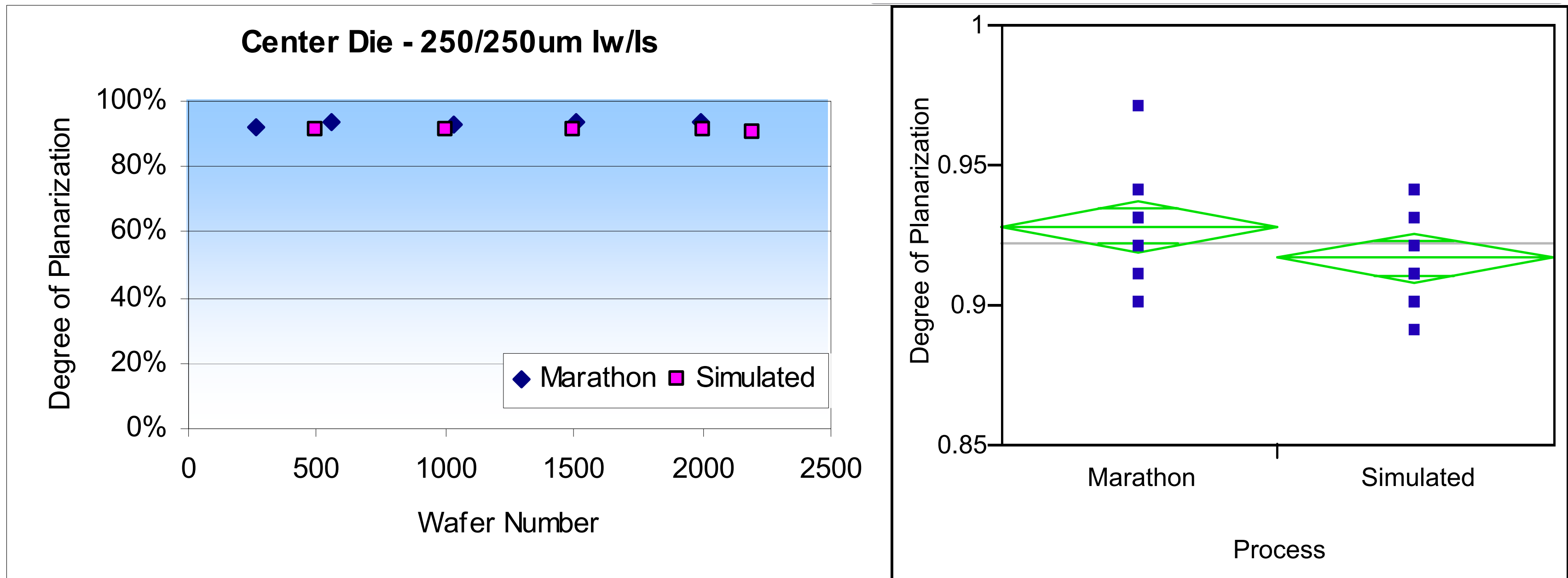
Live Marathon Planarization Performance



- Planarization capability was stable across the marathon run as shown by measurements on 50% density line/space structures at 20um, 30um, 80um, 200um and 500um pitch.

Live Marathon vs. Simulated Marathon Degree of Planarization



- The degree of planarization was determined by the original step height of a 250/250um line/width array after 90sec of polish.
- Comparison of the means for degree of planarization for center, middle and edge die do not show significant difference between the live and simulated marathons.

Live Marathon vs. Simulated Marathon Summary

- The simulated marathon achieved the same pad life as the actual wafer marathon
  - A total of 2208 wafers were polished on JSR oxide pad for the live marathon.
  - 2200 wafer passes were simulated on the JSR oxide pad using only 6% of the wafers required for the full marathon
- It was concluded that the JSR oxide pad shows only 1% difference in final pad groove depth between the simulated wafer marathon and actual wafer marathon.
- Other metrics such as removal rate, WIWNU, and planarity were not compromised in the simulated pad life test.
- The assumption holds true that the pad wear rate for JSR oxide pad is fully attributed to pad conditioning and therefore pad life evaluations can be determined in a more cost and time effective manner by simulation.