

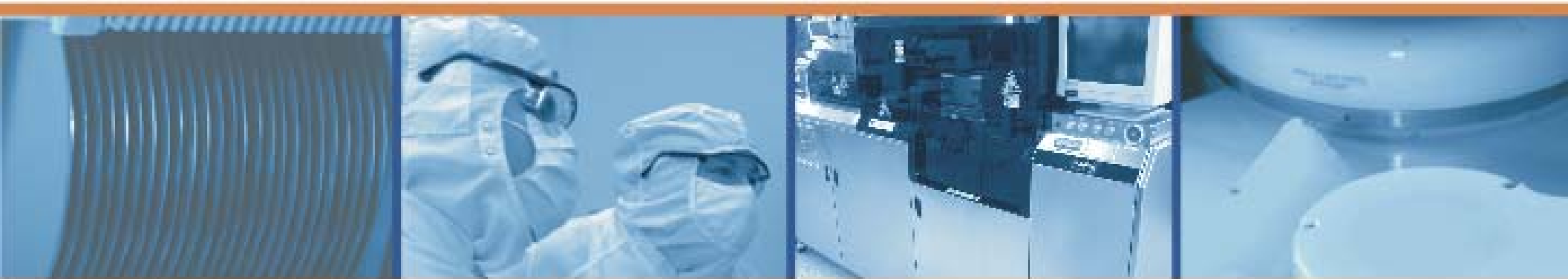
# Leveraging Outsourced CMP Foundry Capabilities for Process-level Development through Full Production

by

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Presented to NCCAVS CMP Users Group

October 13, 2004

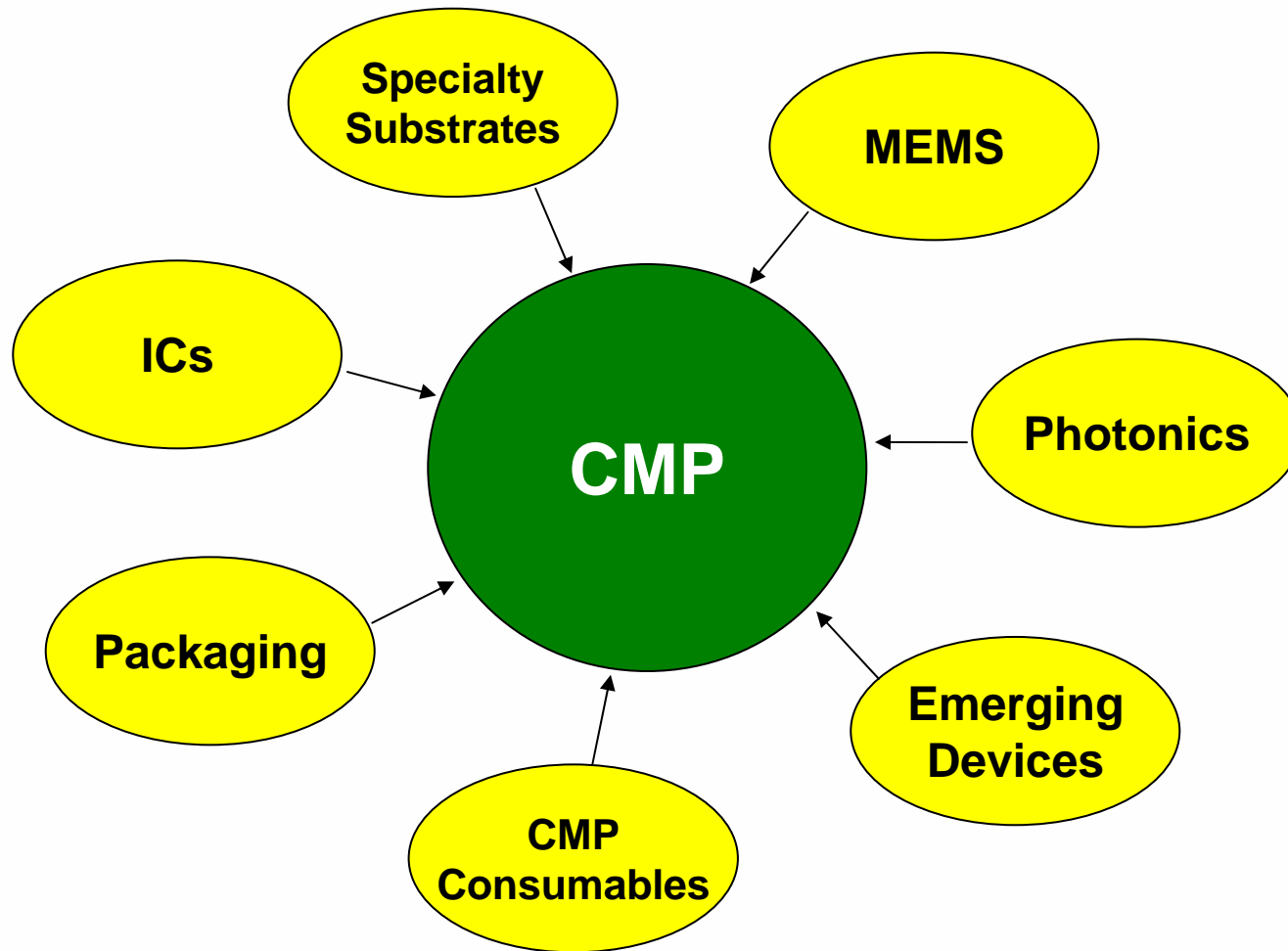


**entrepix**  
YOUR CMP PARTNER

- **Why outsource CMP?**
- **Development**
  - Technology issues and financial impact
  - Example: CMP Pad Supplier
- **CMP Integration and Qualification**
  - Technology issues and financial impact
  - Example: Small Device Manufacturer
- **Production Outsourcing**
  - Technology issues and financial impact
  - Example: Major IDM
- **Comments and conclusions**

- **Once prized as a competitive advantage ... now CMP is recognized a necessary process for most advanced IC designs and many emerging technologies.**
  - **CMP is more available, no longer kept behind a black curtain**
  - **Still high cost and long implementation time**
  - **Requires extensive process and integration expertise**
  - **Now “mainstream” on oxide, W, STI, Cu ... others underway**
  - **Critical to achieving acceptable yield on many device flows**

- **Lower Risk**
  - Leverage technical expertise and known baseline processes
- **Faster Execution**
  - Tap into existing facility, equipment, and process technology
  - Reduce implementation time by 12 months or more
- **Lower Cost**
  - Zero capital required
  - Much lower unit costs for low to moderate volume production



# Three Example Scenarios:

- **Development**
  - Technology issues and financial impact
  - Example customer: psiloQuest, Inc.\* (CMP pad supplier)
- **Integration and Device Qualification**
  - Technology issues and financial impact
  - Example customer: Medtronic, Inc.\* (Medical device supplier)
- **Production**
  - Technology issues and financial impact
  - Example customer: Current CMOS fab needing more capacity

\* Company names used with permission.  
All other names of Entrepix customers are withheld.

## Typical needs for a CMP development project:

- Credible wafer-level data on all major metrics
- Screening trials
- Process optimization and sensitivity to major variables
- Stability tests over multiple trials
- Extended life tests and inputs into failure mode analysis
- Honest technical feedback from an independent perspective
- Complete data package for market launch

 All of these can be obtained from a properly equipped CMP outsource provider

# CMP Development Project Comparison

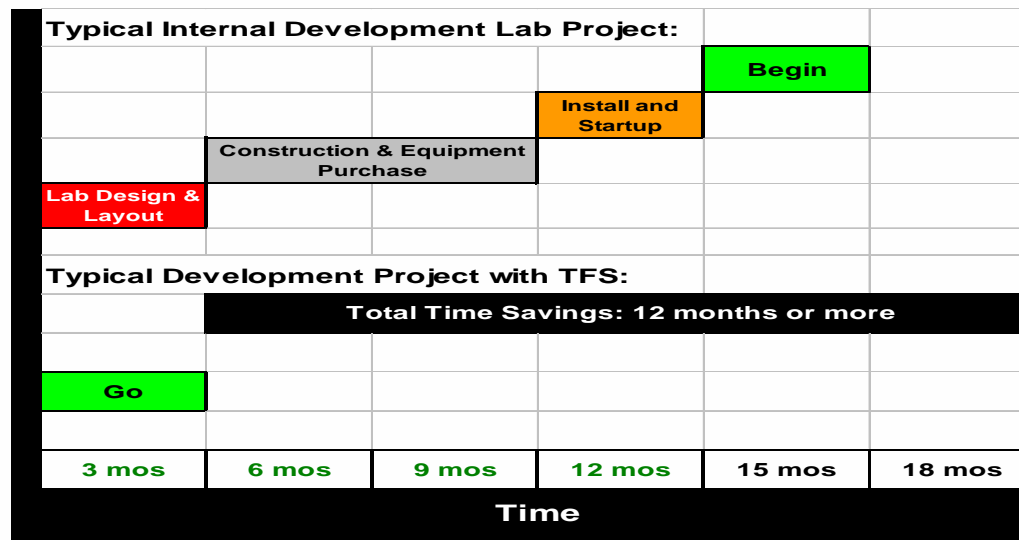
## Internal Development:

- Capital Invest: \$ 1.5 M
- Several Engrs + Staff: \$ 1.0 M/Yr
- Time to Develop: 18-24 mo.
- Multiple learning cycles

## Outsourced Development:

- Capital Invest: \$ 0
- One Sr. Engineer: \$150K/Yr
- Time to Develop: 6-9 mo.
- Leverage existing processes, staff, experience, and consulting

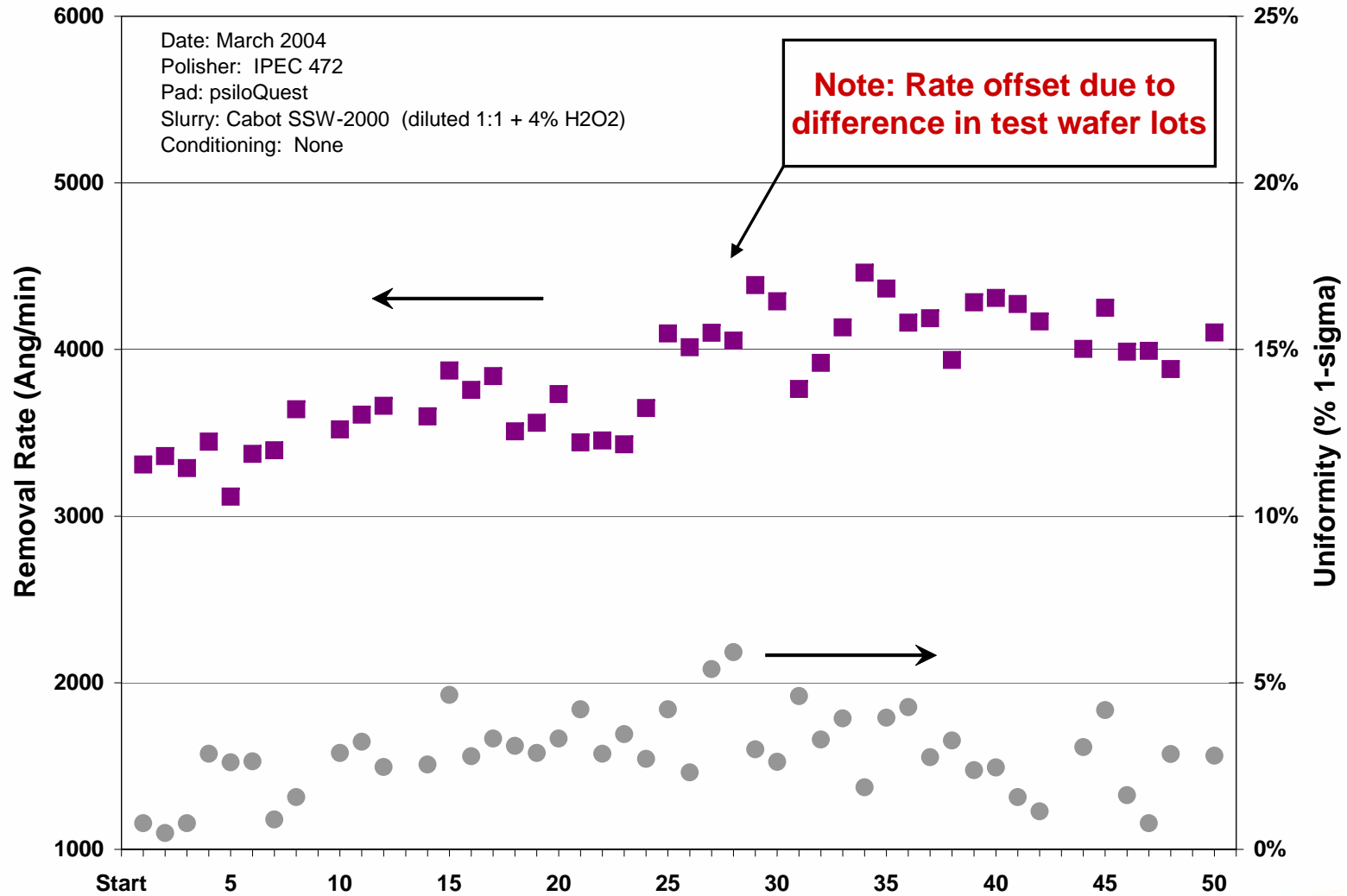
## Time to Implement:





# Development: Example Customer

- *psiloQuest, Inc.*
  - *CMP pad supplier trying to penetrate mainstream market*
  - *Previously invested in their own internal apps lab*
  - *Needed additional capability, esp. for cleans and defectivity*
- *Results*
  - *Improved product characterization (verified by customers)*
  - *Through joint efforts, pad was qualified for use with 3rd party mainstream production wafers*
  - *Recent decision to shut down internal lab and outsource all applications work through Entrepix*



- **Typical needs for CMP integration and qual:**
  - **Technical inputs into composition and thickness of layers**
  - **Feedback to design team on CMP module sensitivities**
  - **Guidance on consumables choices**
  - **Starting point CMP processes**
  - **Short process runs for prototype devices**
  - **Honest technical feedback from an independent perspective**
  - **Optimized CMP processes with ability to ramp when needed**



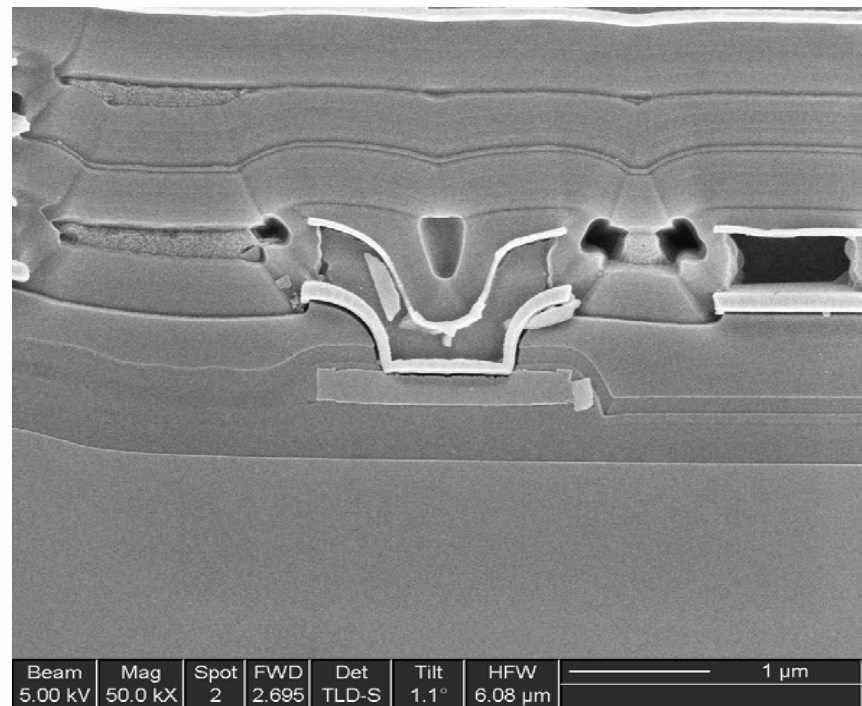
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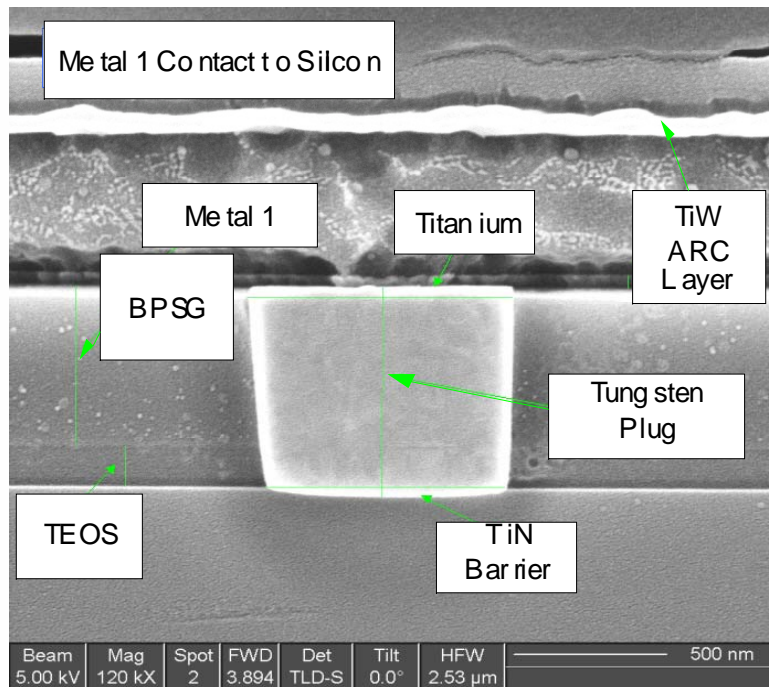


# Example CMP Integration and Qual:

- **Medtronics, Inc.**
  - Small production fab for medical devices
  - Unique device integration, including thin CrSi resistor layer
  - Running 0.6-0.8 um and desires to shrink to 0.35 um
  - Extreme focus on reliability
- **Results**
  - Straight to 3-level CMP integration with both ILD and W CMP
  - Debugged on existing mask set using < 50 product wafers
  - Less than 8 months total from concept to first silicon out
  - First lot to reach probe floor yielded working devices
  - Design team now working on new masks and qual plans

- **BPSG Reflow**
  - Smooth Step but not planar
- **Hot Metal Dep.**
  - Acceptable metal step coverage at 50%
- **SOG Gap Fill**
  - Acceptable planar surface, but not good enough to shrink

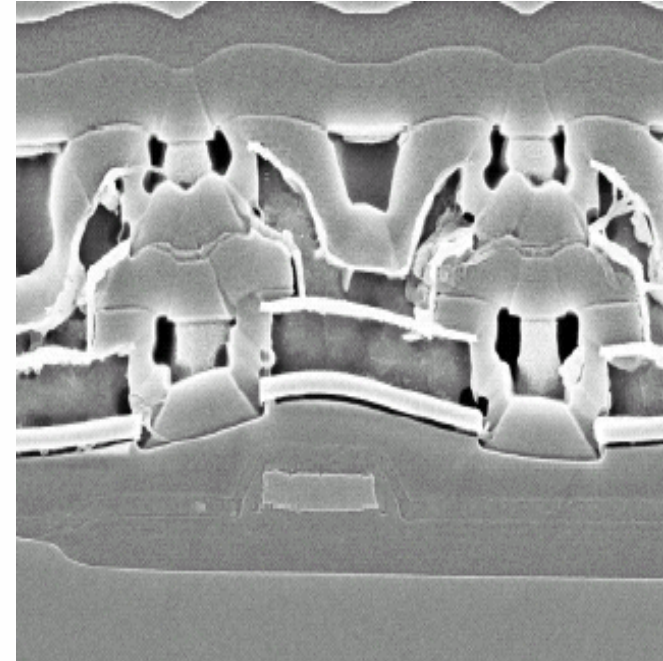
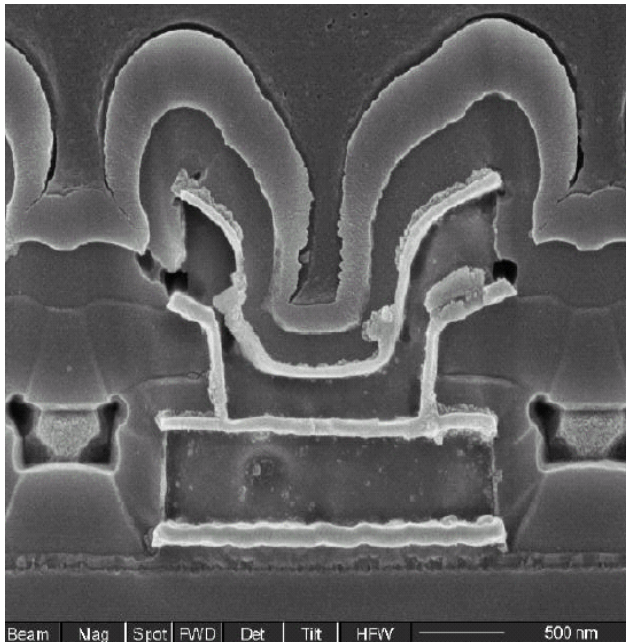




- **Good Contact to Substrate**
- **Ultra Flat BPSG**
  - **Photolithography is improved.**
  - **Planarization is improved**

## Thinning over step.

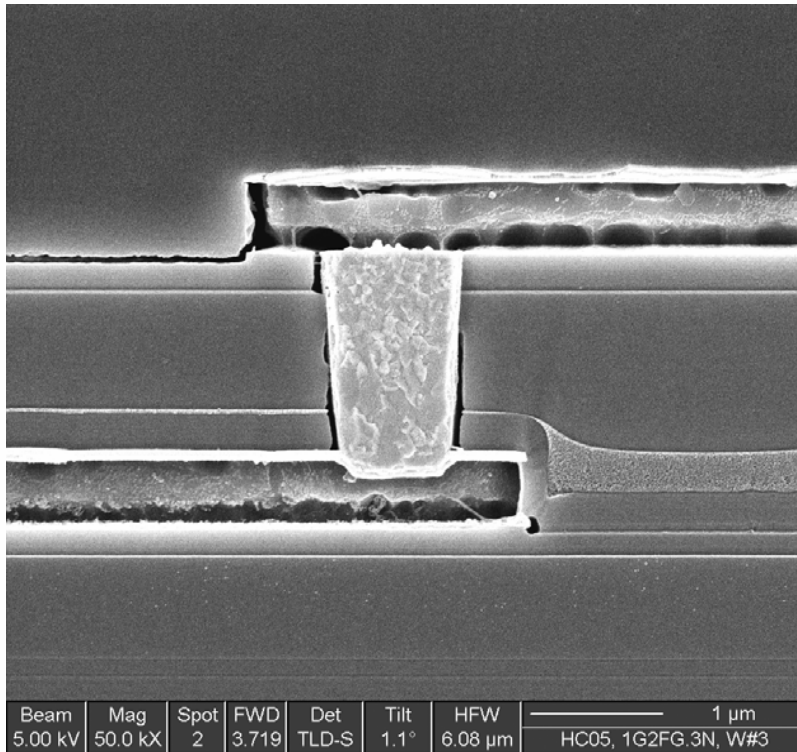
- Less than 20% coverage on corners



## Poor ILD Planarization.

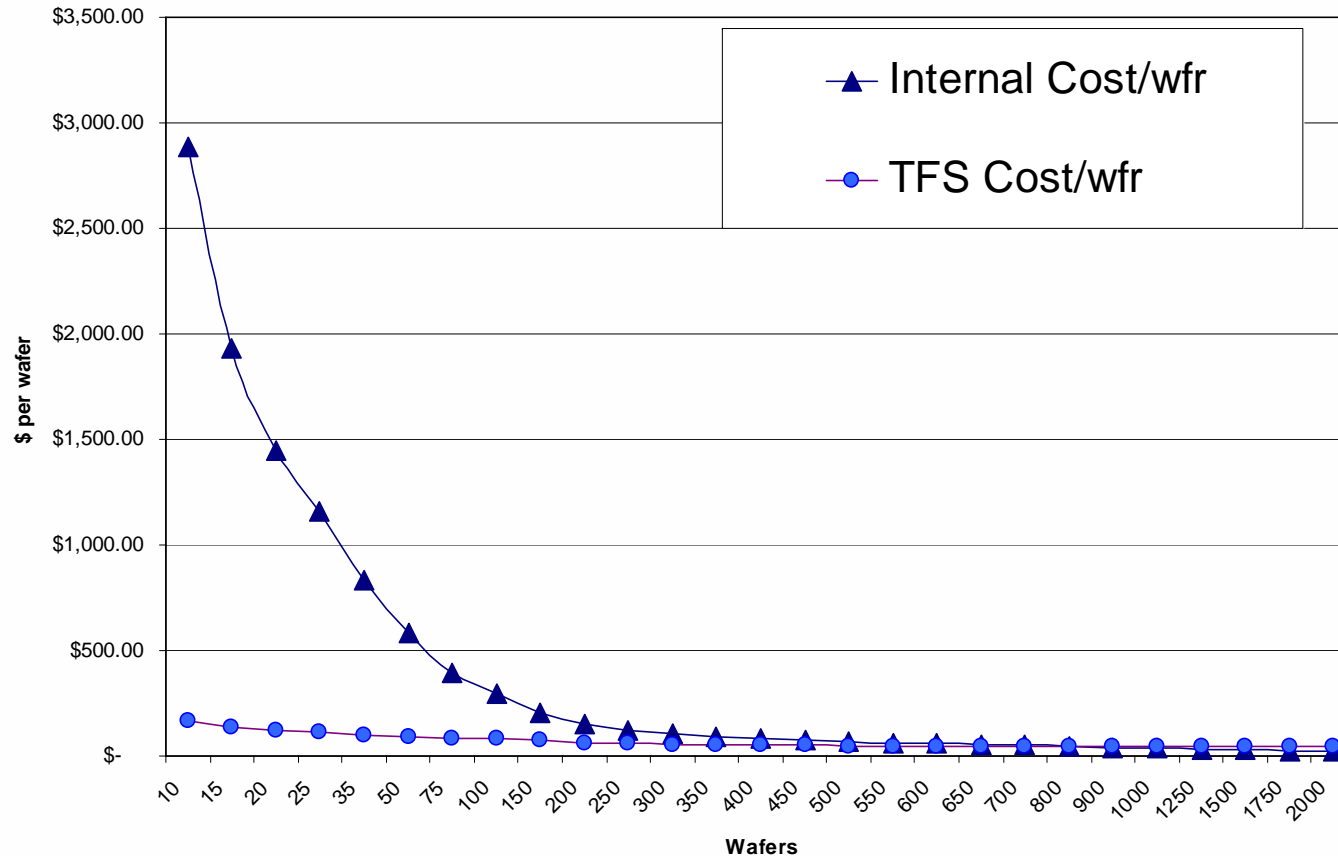
- Has negative impact for photolithography
- Limits design flexibility





- **Step coverage no longer an issue.**
- **Ultra flat surface.**
  - Enhances photolithography.
  - More flexibility in design.

# CMP FastForward™ Cost per wafer comparison:



Total Fab Solutions CONFIDENTIAL

Oct. 20

**Bottom Line:** Low volume cost differential is enormous  
High volume cost differential is minimal

## Typical needs for production outsourcing:

- Ability to match process outputs of in-fab toolset
- Equivalent yield
- Consistent day-to-day performance
- SPC and acceptable quality standards
- Systems and infrastructure to handle wafer flow
- Properly trained staff
- Ability to ramp quickly .... Up or down !



**All of these can be obtained from a properly equipped CMP outsource provider**

# Production Outsource Comparison

## Internal CMP Production:

- Capital Invest: \$1.5 M
  - Ox-CMP capacity \$ 4.9 M
  - W-CMP capacity \$ 2.5 M
  - Cu module \$ 4.6 M
- Staff: \$1.0 M/Yr
- Time to implement: 18-24 mo.

## Outsourced CMP Production:

- Capital Invest: \$ 0
- One Sr. Engineer: \$150K/Yr
- Time to Develop: 3-6 mo.
- Leverage existing production capacity, processes, staff, experience, and consulting

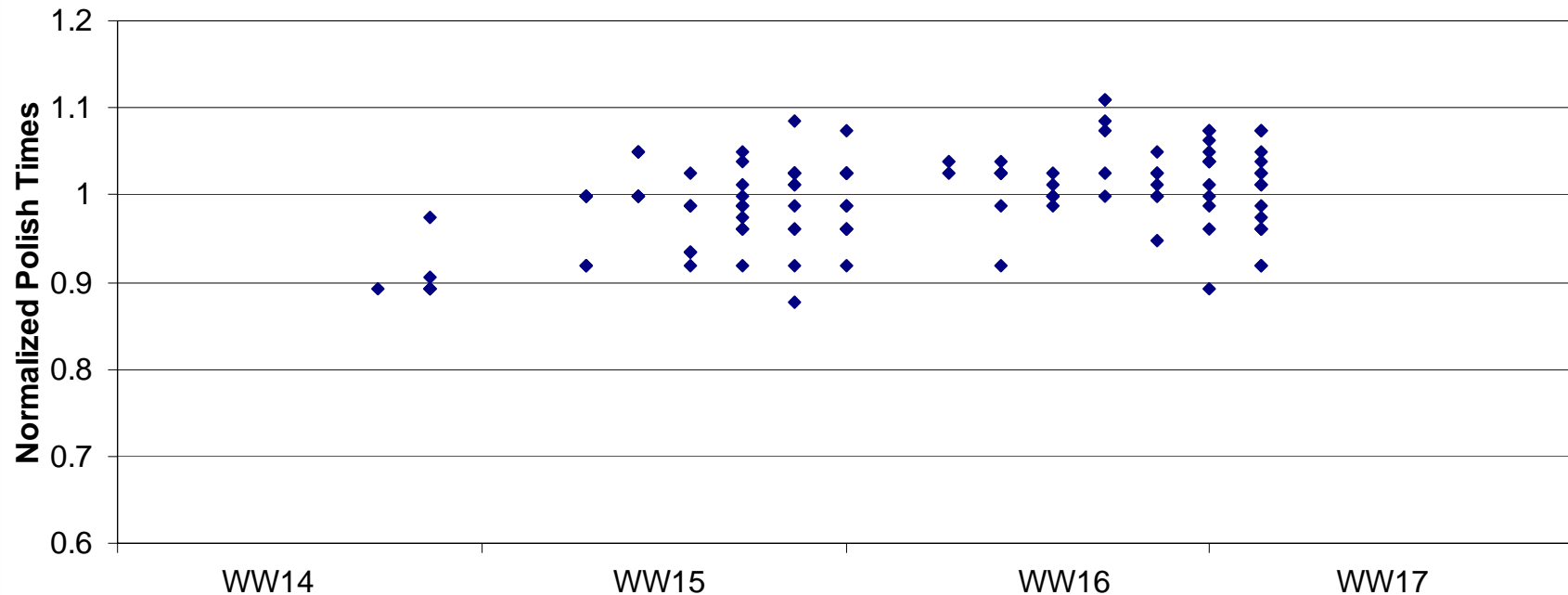
## Time to Implement:

<b>Project Phases</b>	<b>Typical Internal Capacity Expansion Project:</b>			
				Production Ramp
			Qualification	
	Equip. Purchase & Delivery			
	<b>Typical CMP Capacity Ramp with TFS:</b>			
	Time Savings: 6-9 mos			
		Prod. Ramp		
	Qualification			
	3 mos	6 mos	9 mos	12 mos
	<b>Time</b>			

- **Major IDM**
  - Production fab running at full CMP capacity
  - Strong desire to ramp wafer starts, but bottleneck at CMP
  - Ordered more CMP tools, but timing delayed from starts ramp
  - Willing to consider outsource CMP
- **Results**
  - Close monitoring of contamination proved comparable to fab
  - Qualified both tungsten and oxide CMP at 3 levels
  - Yield was equivalent to in-fab toolset on first 1000 wafers
  - Outsource CMP enabled fab to achieve die out targets that would otherwise have been missed

## Daily Production Data

(103 wafer lots - Random mix of contact, via1 & via2)



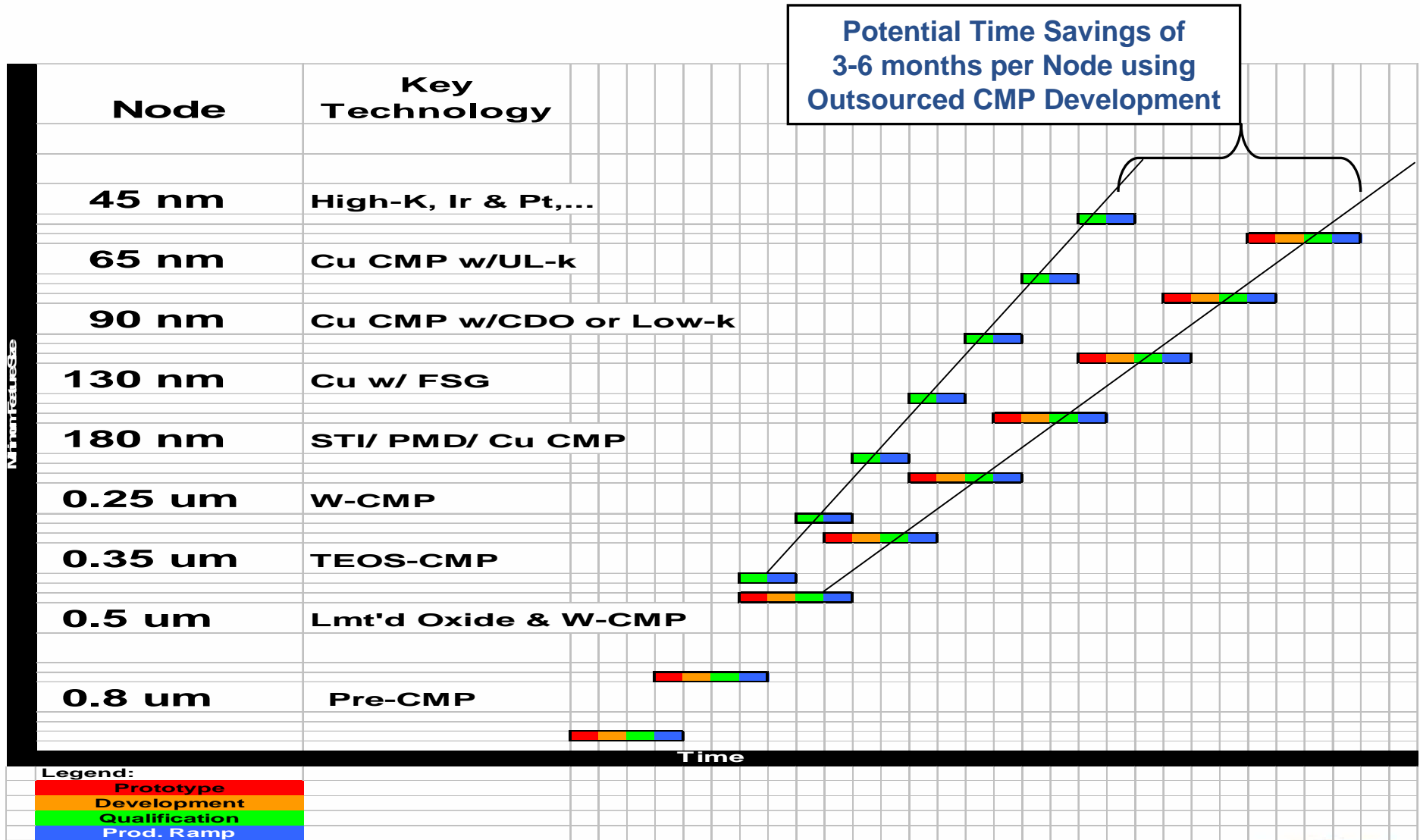
- Now over 125 production lots
- Yield equivalent to in-fab process tools
- Extremely low scrap rate
- Proven process repeatability

- **Internal development requires additional investments for each node :**
  - Dedicated development teams for each node
  - Increasing investment in new equipment and facilities dedicated to new materials: Oxide, W, STI, Cu...

Or...

- **Outsourcing development leverages processes and integration expertise of the outsource provider:**
  - Reduces time to qualify new process by 6-18 months
  - Eliminates capital investment
  - Reduces risks by using proven solutions

# Repeated Development Cycles Impact





# Summary:

## Reasons to outsource CMP

- **Lower Risk**
  - Immediate access to proven process technology and expertise
  - Minimize complexity associated with polishers, cleaners, chemical delivery, filtration, metrology, consumables, etc.
- **Faster Execution**
  - Rapid prototyping, development projects or process qualification
  - Reduce implementation time an average of 12 to 18 months
- **Substantial Cost Benefits**
  - Reduce or eliminate capital expenditures
  - Lower unit costs
- **Production Impact**
  - Perform engineering trials without taking your polishers off line
  - Flexible manufacturing capacity when you need it

- Entire staff at Entrepix, with specific thanks to the following individuals:
  - Jeanie Simmons
  - Patrick Grimes
  - Donna Grannis
  - Roy McCoy
  - Jim Dekarske
  - Tim Knippa
- *psiloQuest, Inc.*
  - *Tony Clark*
- *Medtronics, Inc.*
  - *Ralph Danzl*
- *Many other customers who, though unnamed here, have helped us prove that CMP outsourcing works.*

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