
# Precision Cleaning Process and Equipment Considerations for PMR media

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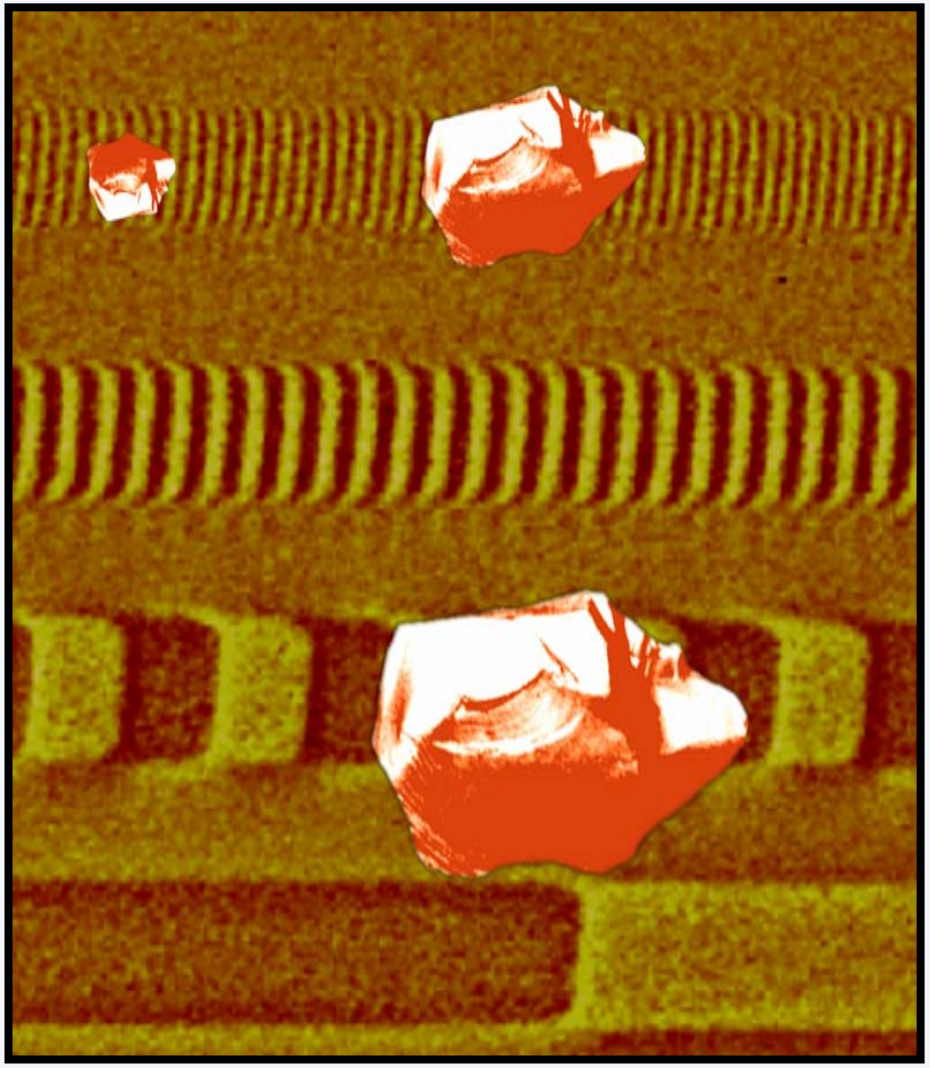
# Agenda

- Introduction
- Defect trends
- Equipment evolution
- Cleaning overview
  - Contact
  - Non-Contact
  - Drying
- PMR Considerations
- Conclusions

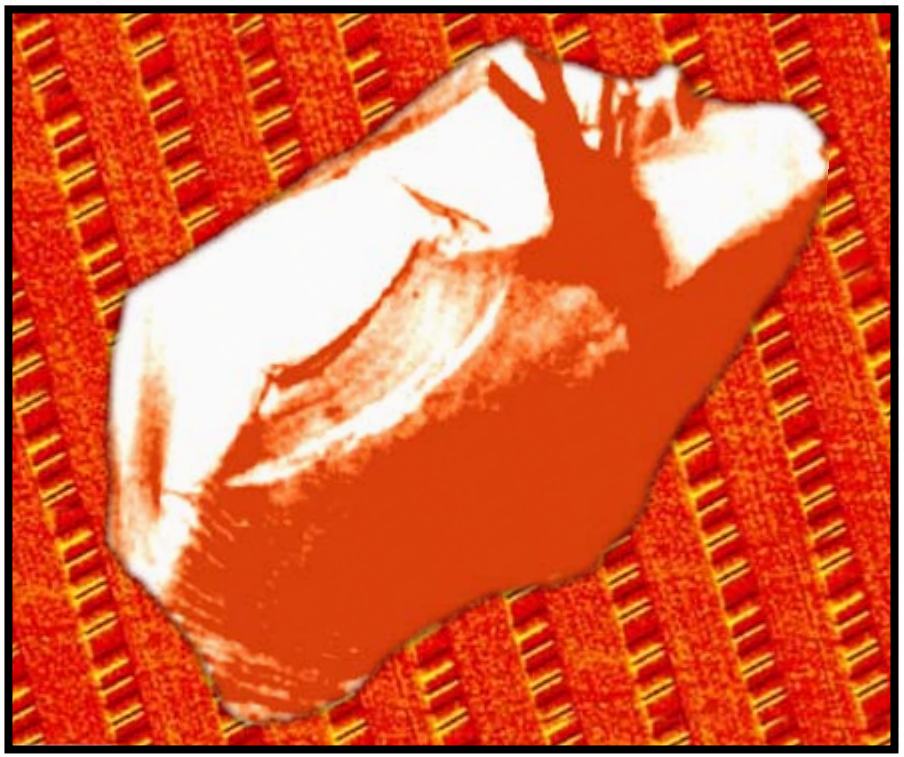


# PMR cleaning “opportunity” comment from leading Industry Analyst

*“The (PMR) head-disk interface is arguably the most intricate in the history of the HDD industry……. and cleanliness has both never been more important and less understood”*

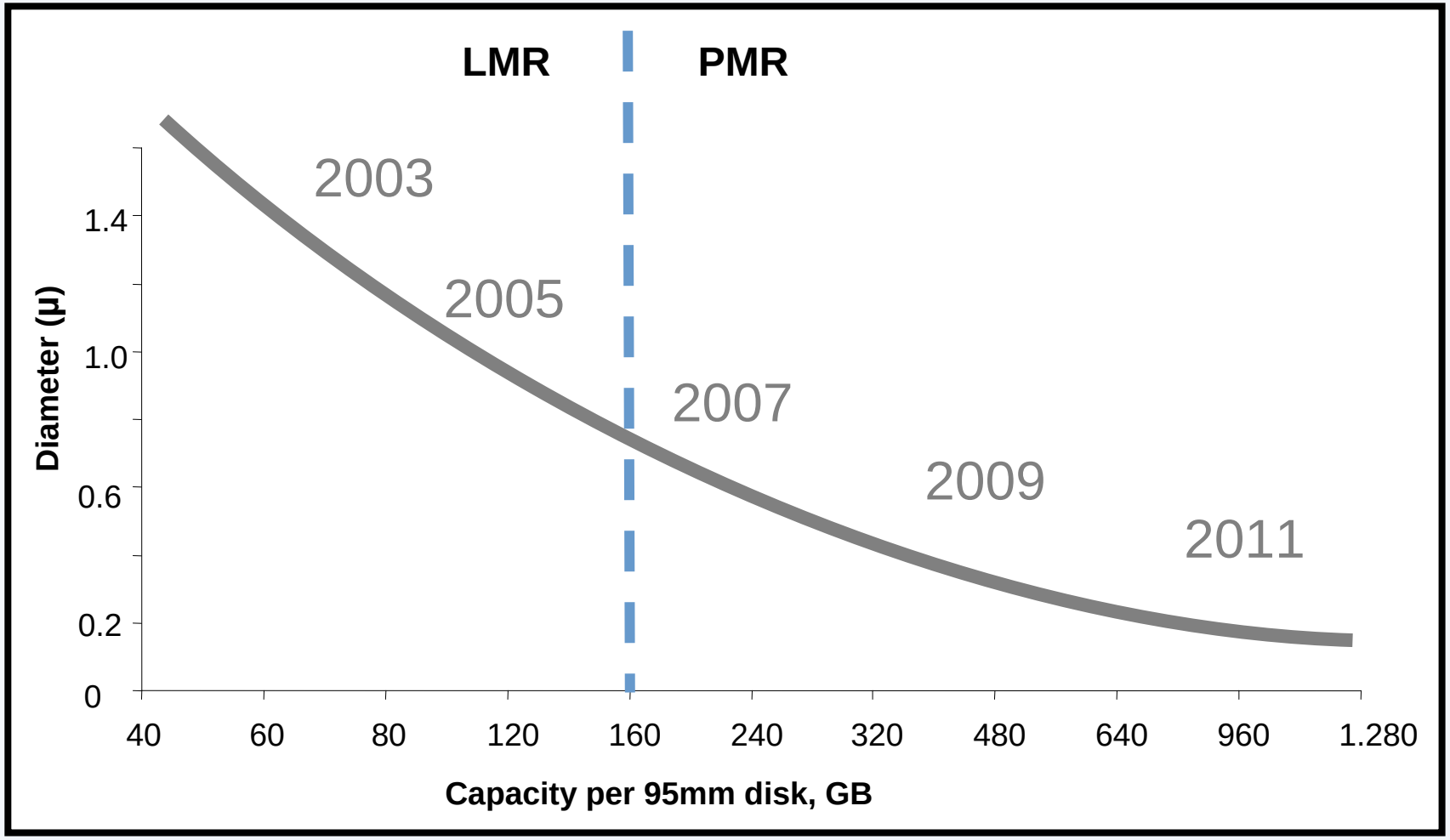
*“Focus on PMR Transition” paper*
TrendFOCUS 8/1/06

# The incredible shrinking defect



**Particle/Defect size relation as areal density increases**

# Maximum Critical Defect Size Roadmap



# Types of Defects to be removed via cleaning

- **Particles**
  - Head/Disk Interface issues that can cause a head crash
  - Magnetic defects
  - Corrosion
  - Usually can be caught at final test, before shipment

- **Film or Stains**
  - Impairs film adhesion
  - Magnetic defects
  - Corrosion
  - Difficult to detect and can grow over time, after shipment!

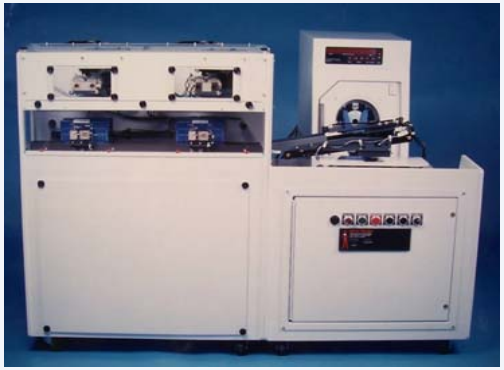
# Cleaning Process and Equipment Evolution

**1984**

Single Scrub

**150 DPH**

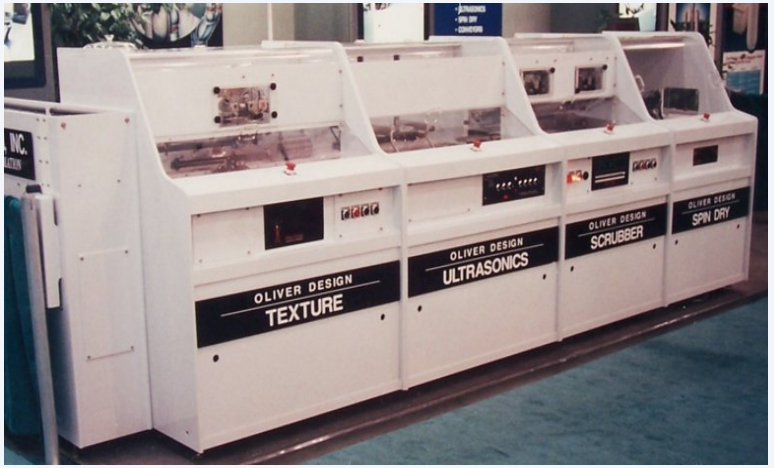
**1988**



Double Scrub + SRD

**300 DPH**

**1994**




Fully integrated, multi-step processing

**600 DPH**

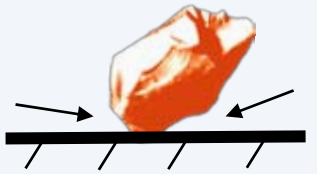
xyratex

# Advanced Cleaning Systems for PMR Media and Substrates

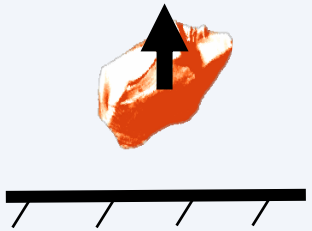
# Advanced Cleaning Systems for PMR Media

# Fundamental Cleaning Steps

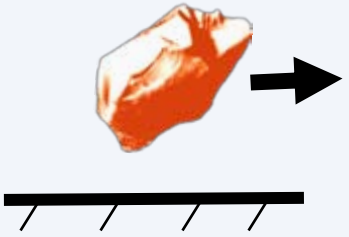
- **Particle or defect <u>undermining</u>**
  - **Use dilute soaps, detergents or performance chemistries**
  - **Weakening of molecular or physical bond**
  - **Weaking of static bond**



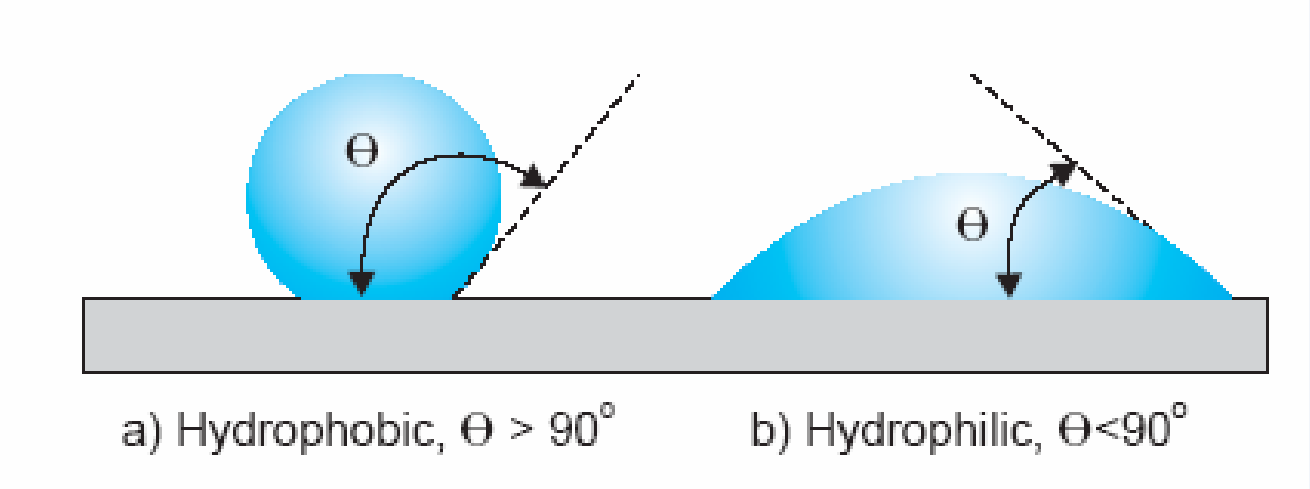
- **Particle or defect <u>detachment</u>**
  - **Contact mechanism via torsion or normal shear**
  - **Non-contact mechanisms from sonication forces**



- **Particle or defect <u>disposal</u>**
  - **Remove with filtration via recirculation**
    - High tank turnover and pump flow rates
  - **Quick dump rinse**
  - **Advanced tank design and hybrid rinsing configurations**



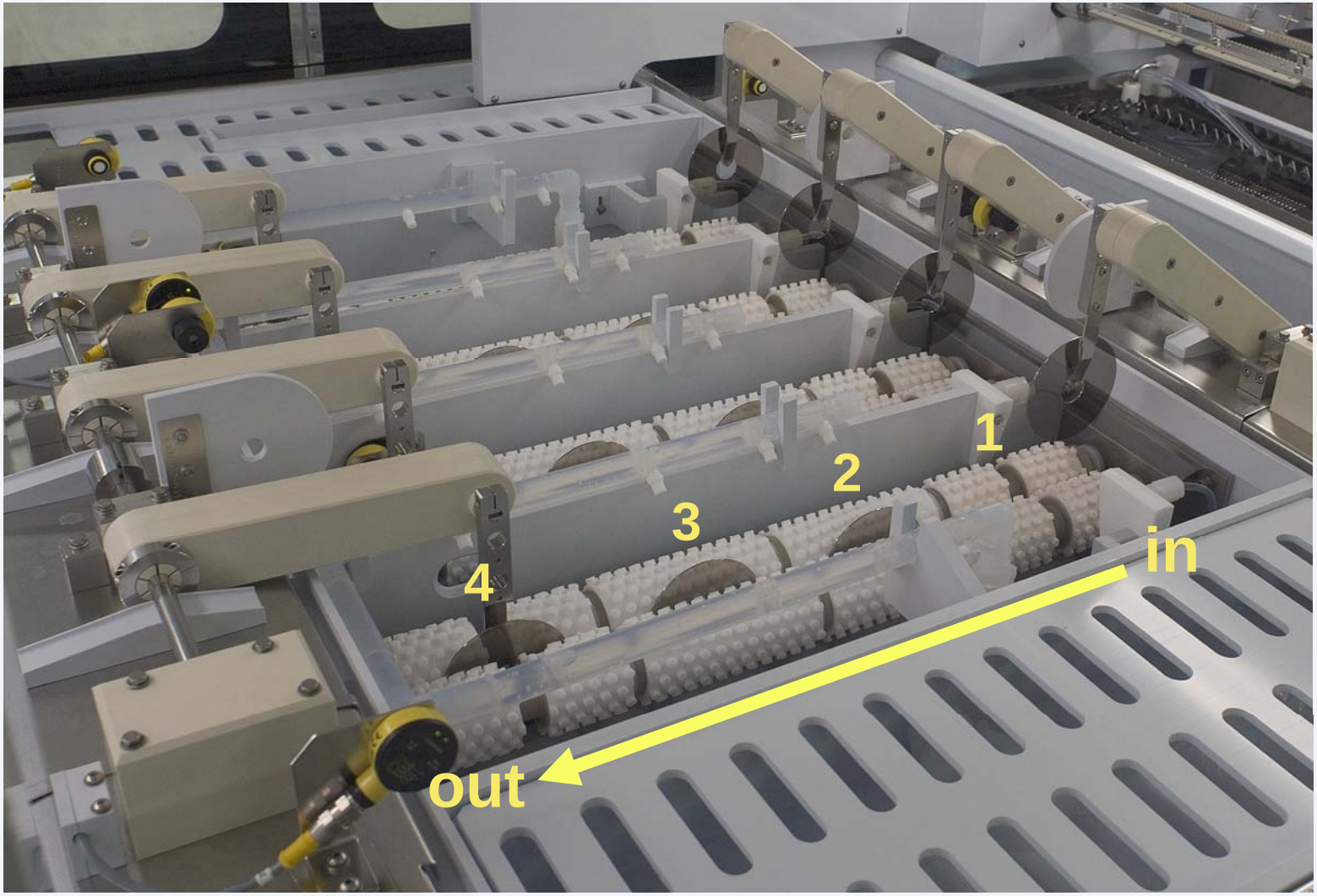
# Clean ability & Wet ability



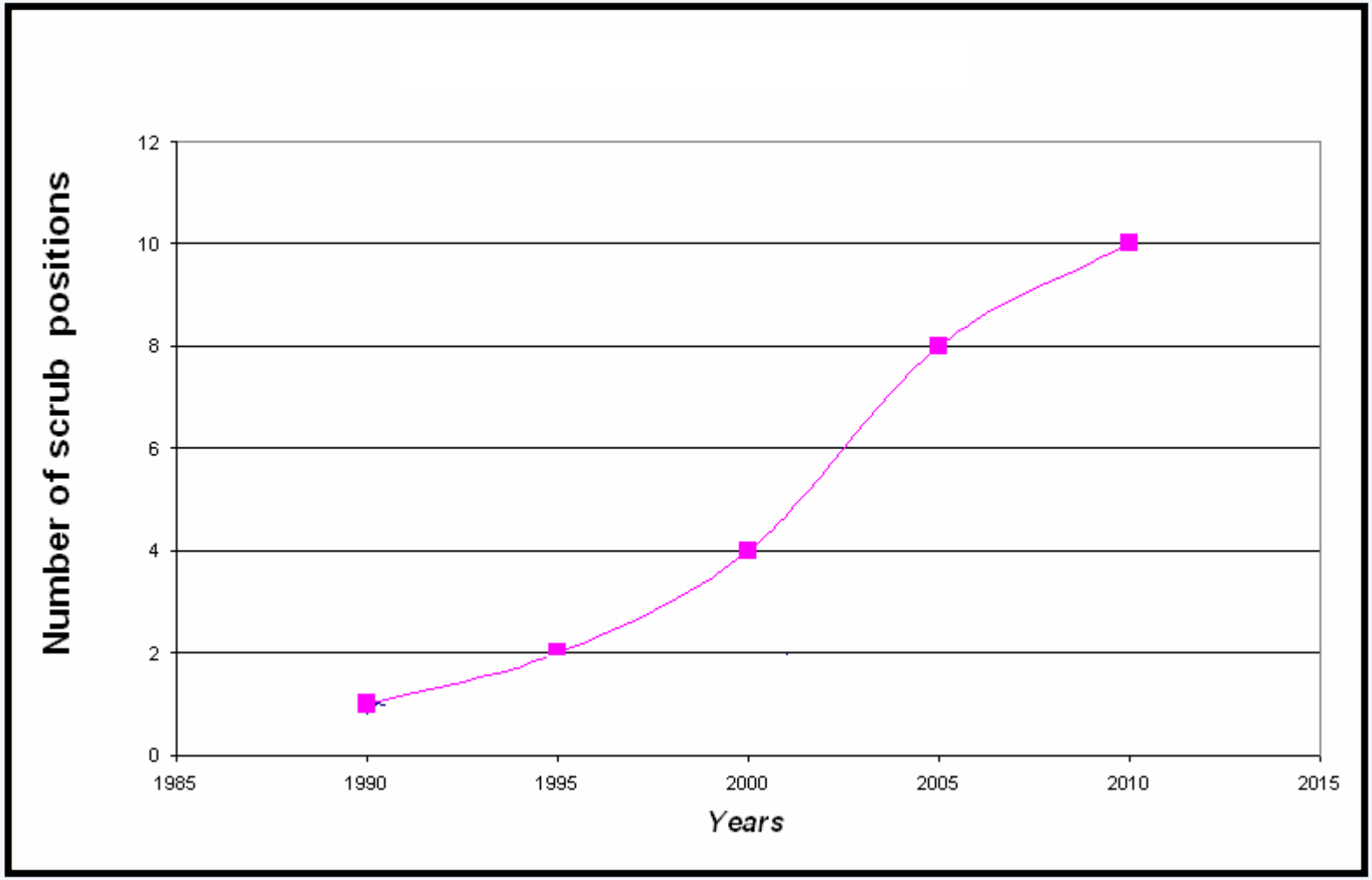

- **The key to effective cleaning and drying is insuring the surface becomes and remains hydrophilic**
  - **Insures efficient particle undermining and engulfment in fluid**
  - **Insures surface wetting is sufficient for drying performance**

Source: IC Knowledge LLC

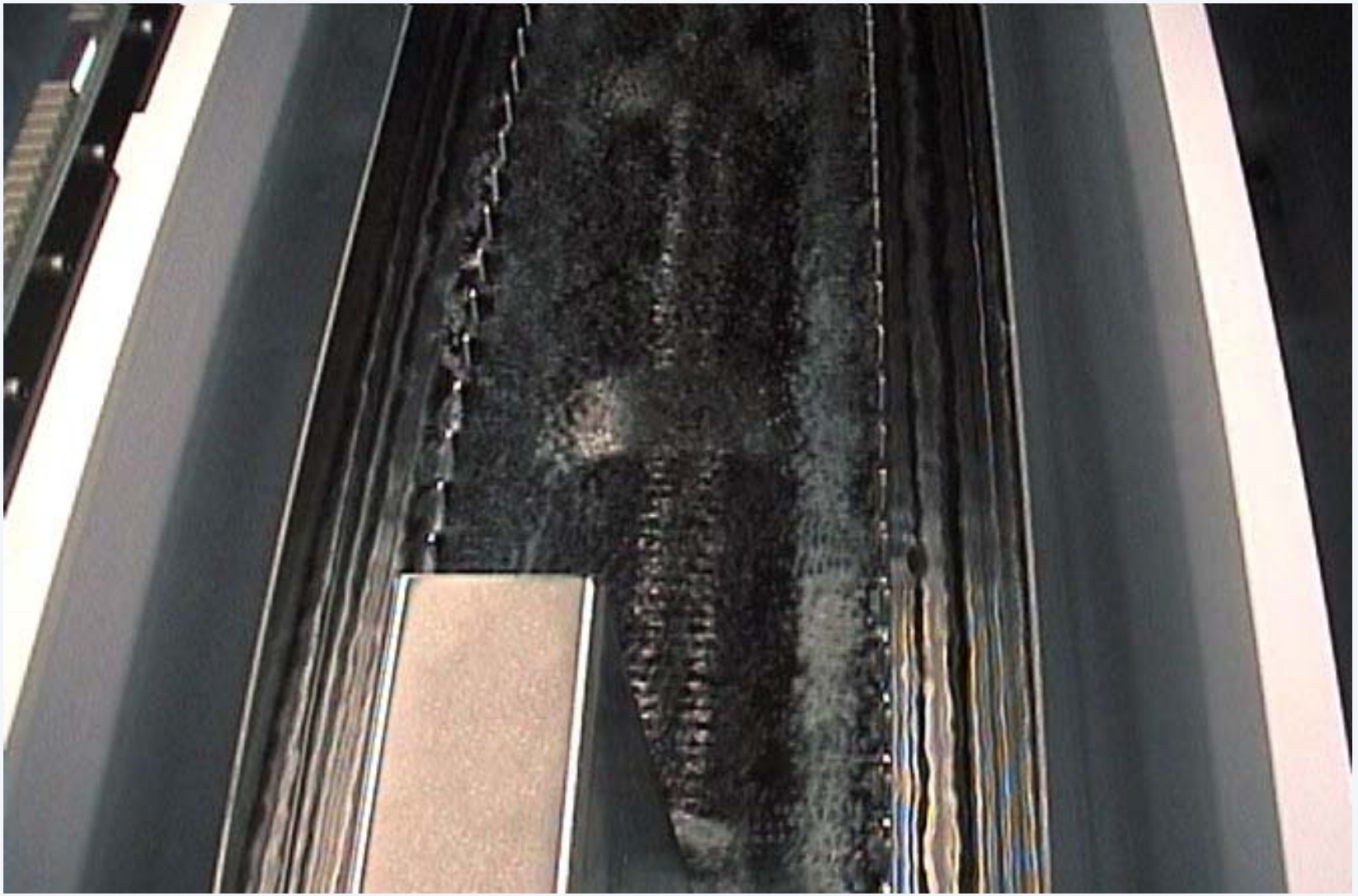
# Advanced Cascade Scrubbing – 2400 DPH



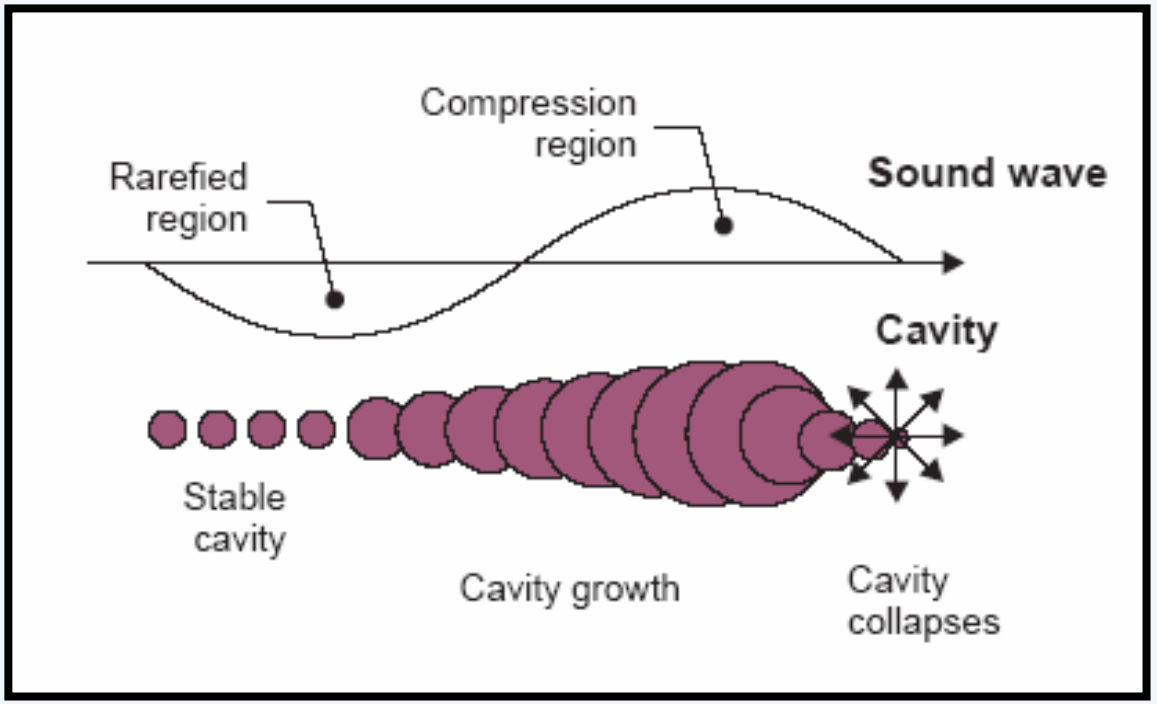
# Scrub Trends – more is better



# Ultrasonics



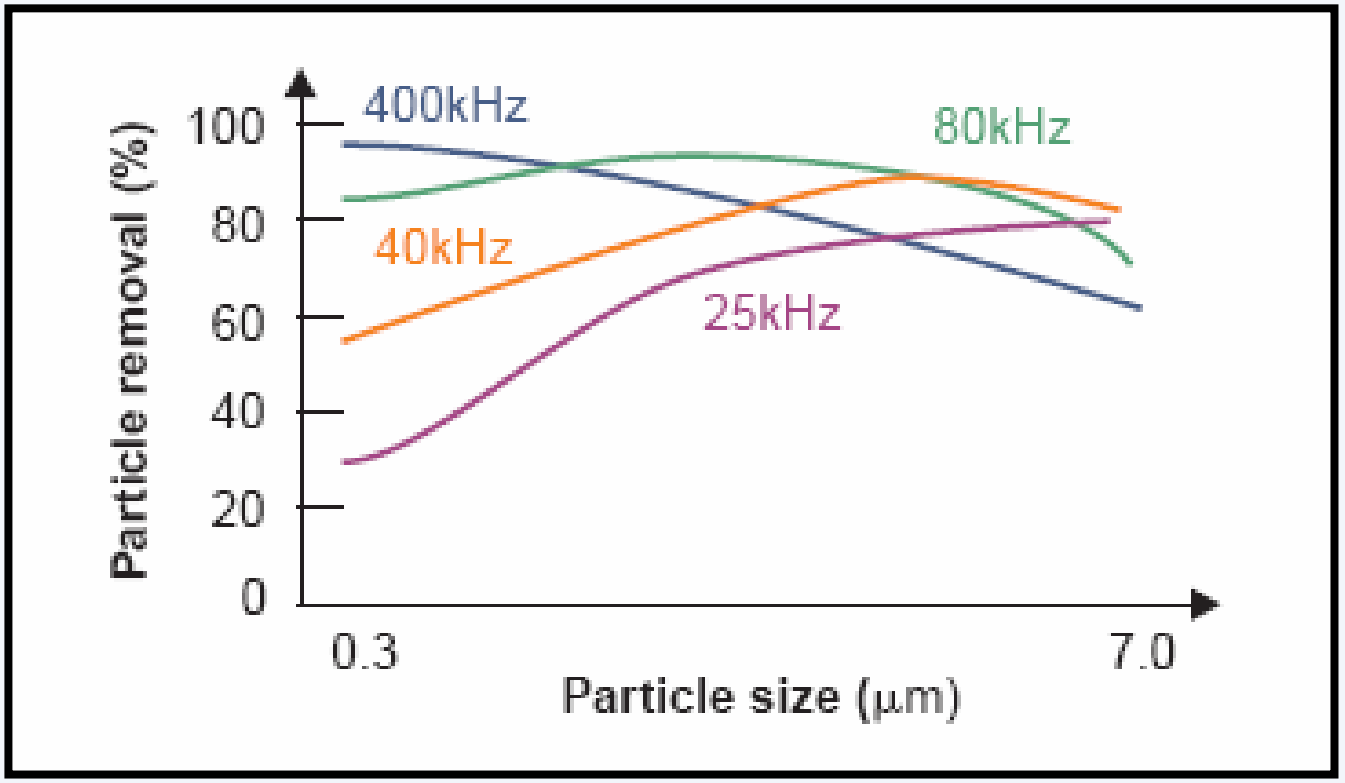
# Fundamentals of Ultrasonic Cleaning – Cavitation Forces




- **Ultrasonic sound waves moving through the cleaning fluid create cavities (cavitation) during the rarefied region of the wave**
- **Cavities grow and then collapse or implode, causing high forces to be applied for detachment of defect**

Source: IC Knowledge LLC

# Ultrasonic Cleaning

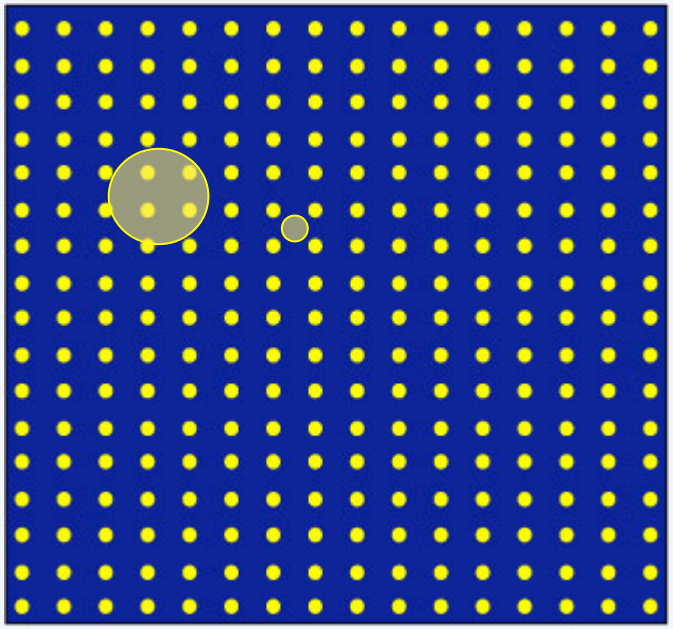



**Multiple Ultrasonic frequencies are required to insure acceptable removal efficiencies are met over the broad range of particles sizes present on incoming substrates**

Source: IC Knowledge LLC

# Sonic Frequency - simplified

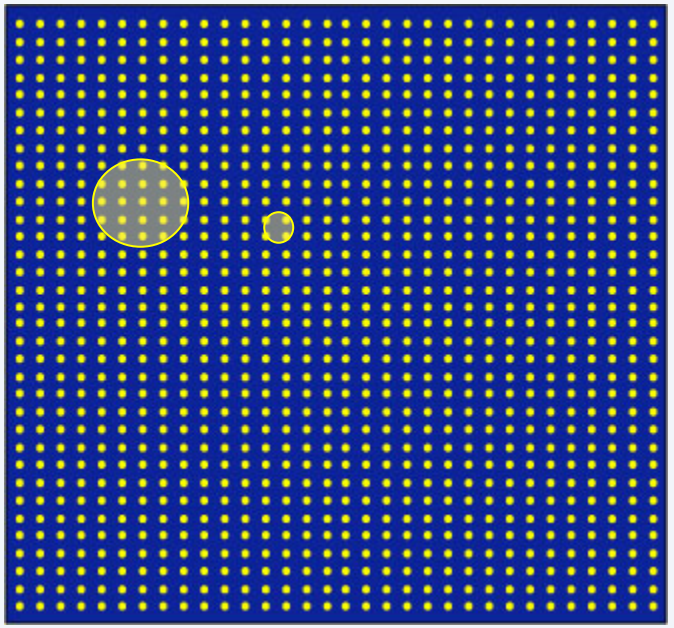
104 KHz



**Removing large particles easy but causes pitting defects**

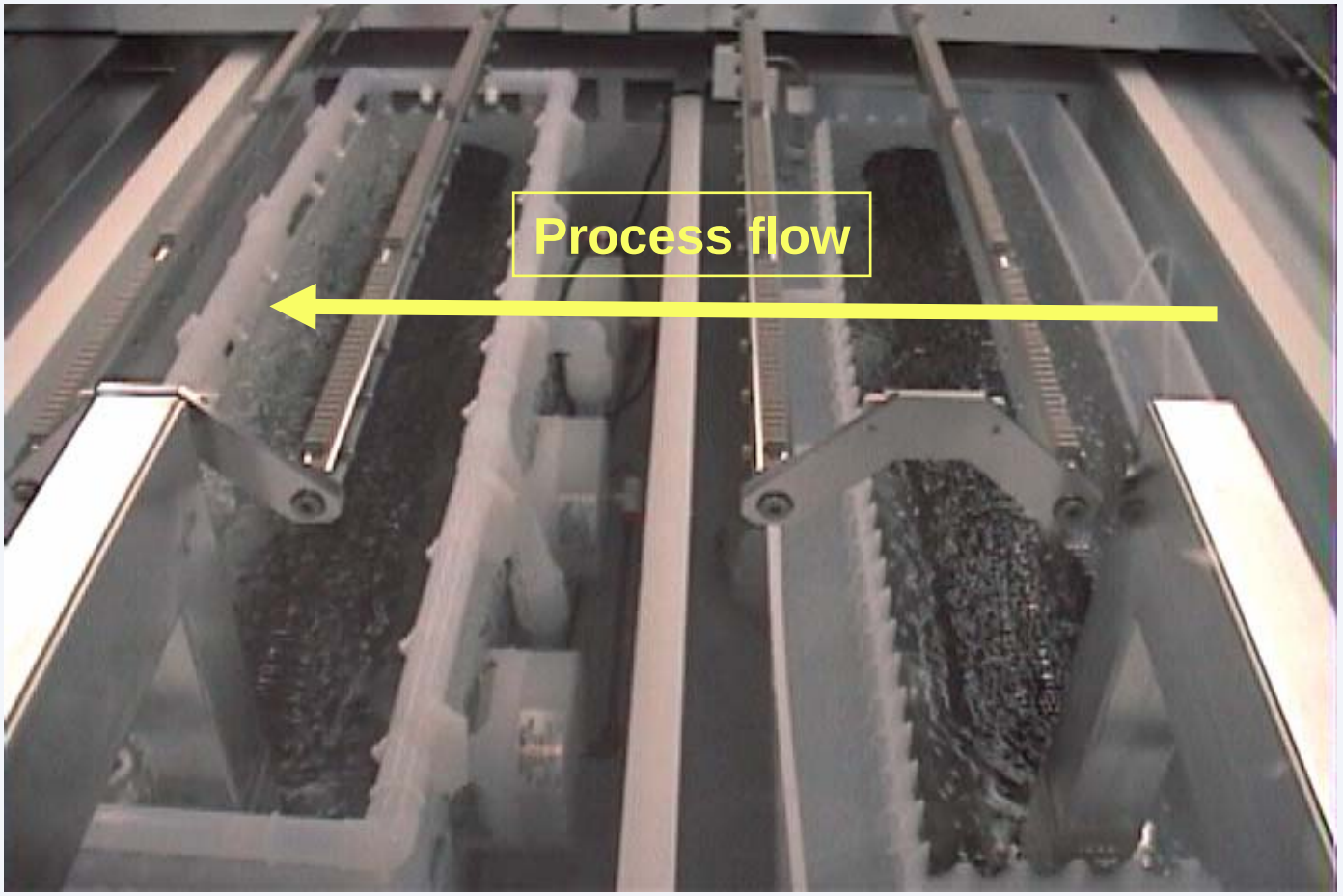
**Small particles not removed**

400 - 480 KHz



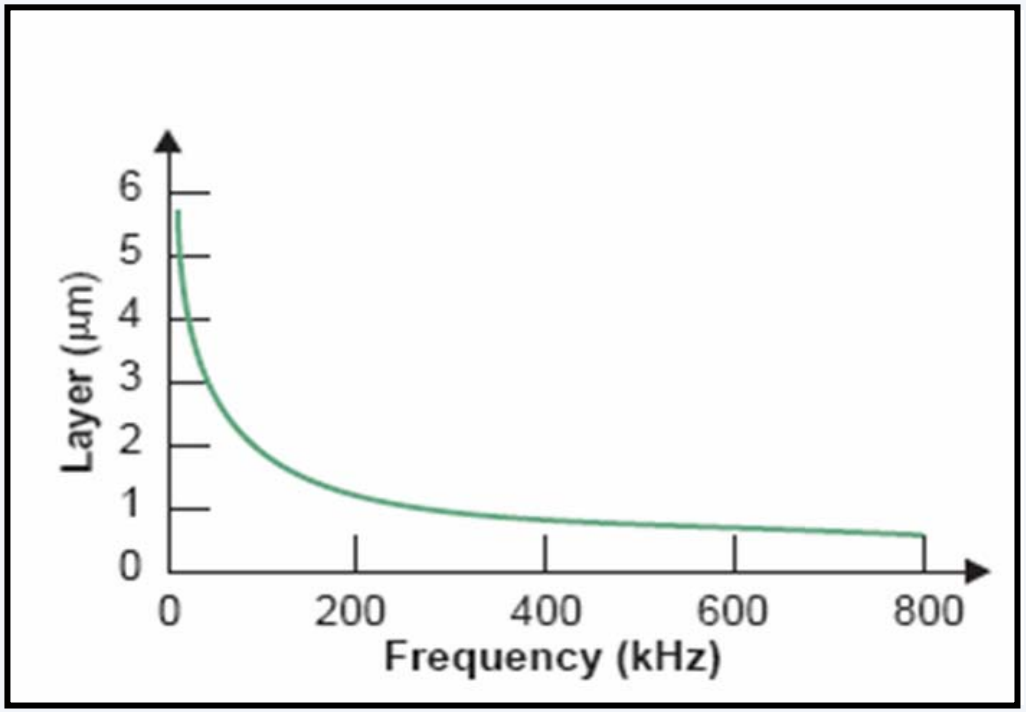
**Removes both large particles and smaller particles effectively**

# Megasonics – Final cleaning and rinsing prior to dry




**Quick Dump Rinse** **Recirculated Rinse**

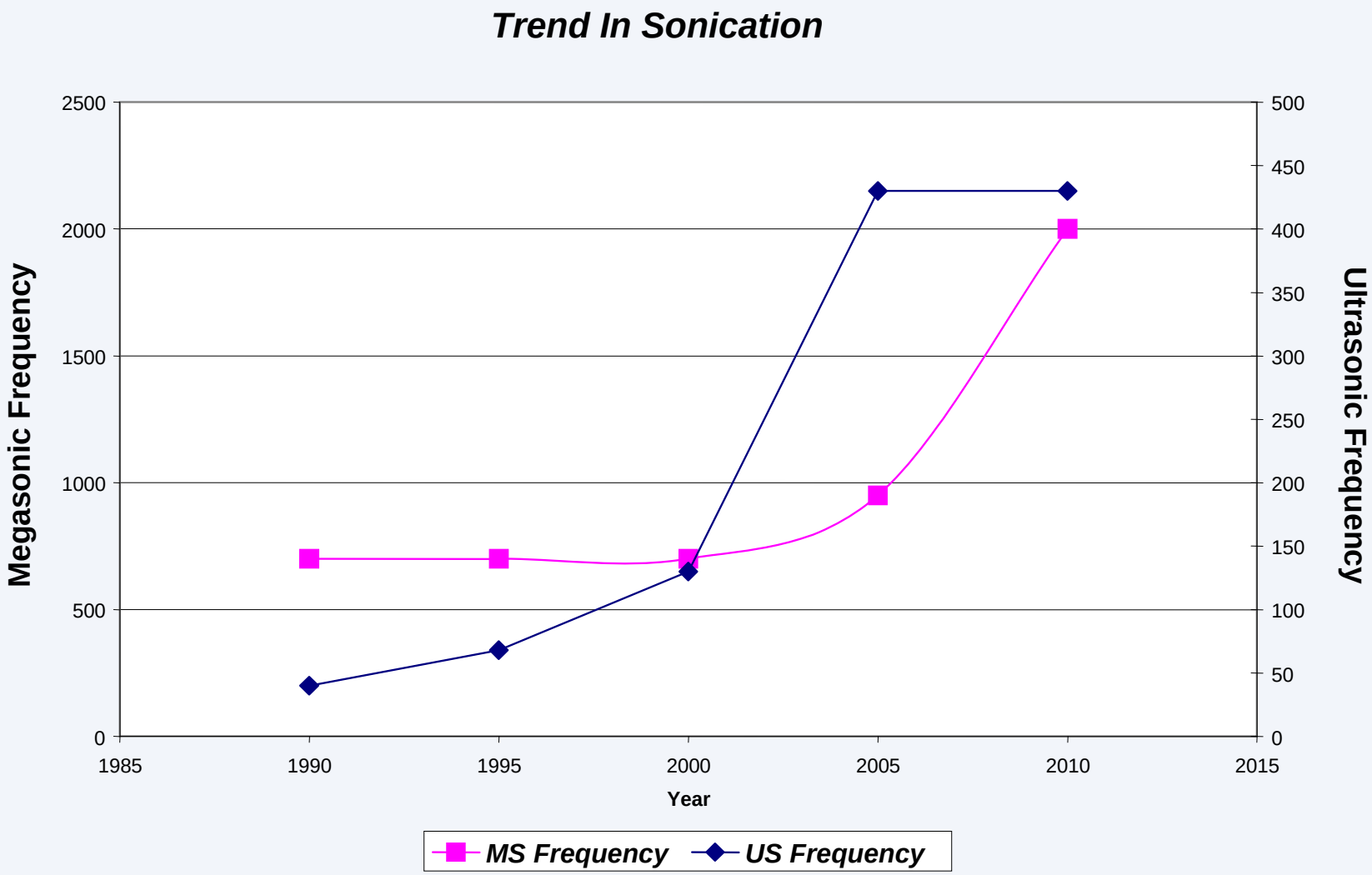
# Fundamentals of Megasonic Cleaning



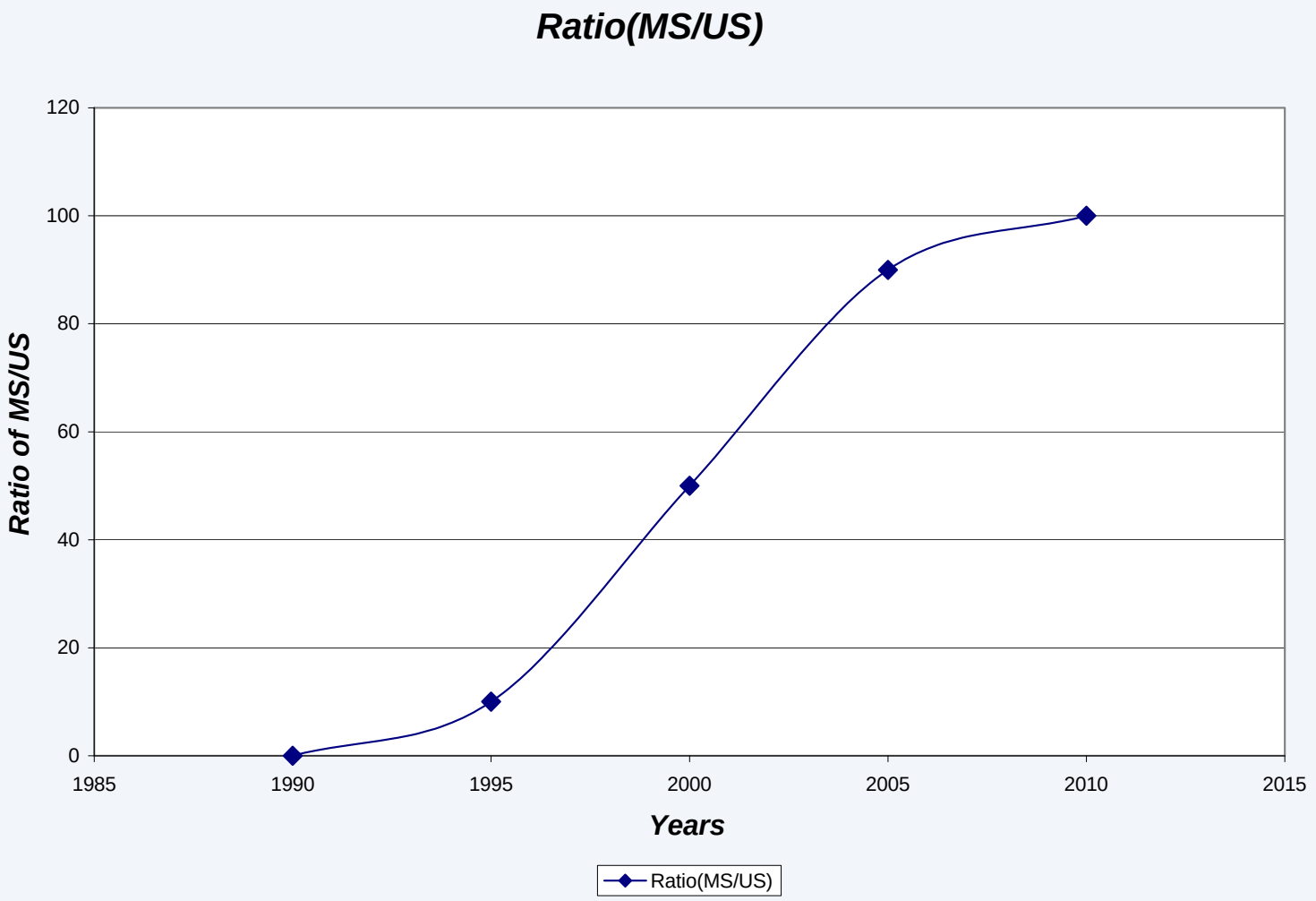

- **Megasonic cleaning is excellent for removing smallest sizes particles, required prior to drying**
  - **Thinning of the boundary layer surrounding the particles**
  - **High velocity pressure waves**

Source: IC Knowledge LLC

# Sonication Trends



# Megasonics is Trending Toward 100% Use



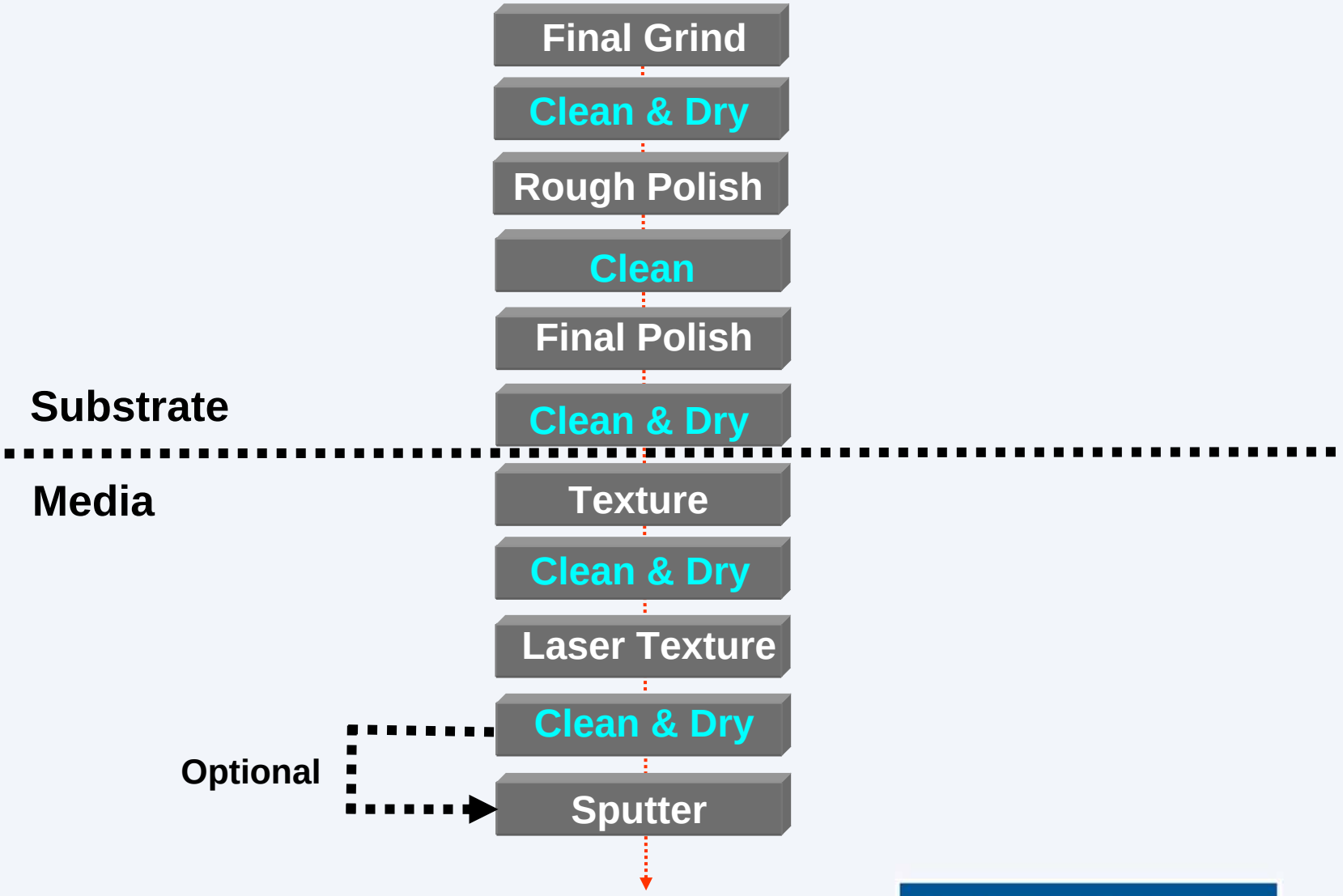
# Drying Technology Roadmap

| Drying Technology | Comments |
|---|---|
| 1. Spin Rinse Drying | Particle generation - moving parts<br>Throughput issues<br>No longer used in media cleaning |
| 2. Hot IPA Process | Yield issues with NiP, Glass OK<br>Safety, Environmental and COO issues<br>Being eliminated in media cleaning |
| 3. Hot DI | Particle neutrality<br>Lower temperature processes possible<br>Dual hand-off eliminates contact points<br>Continuous development for PMR and beyond is occuring |

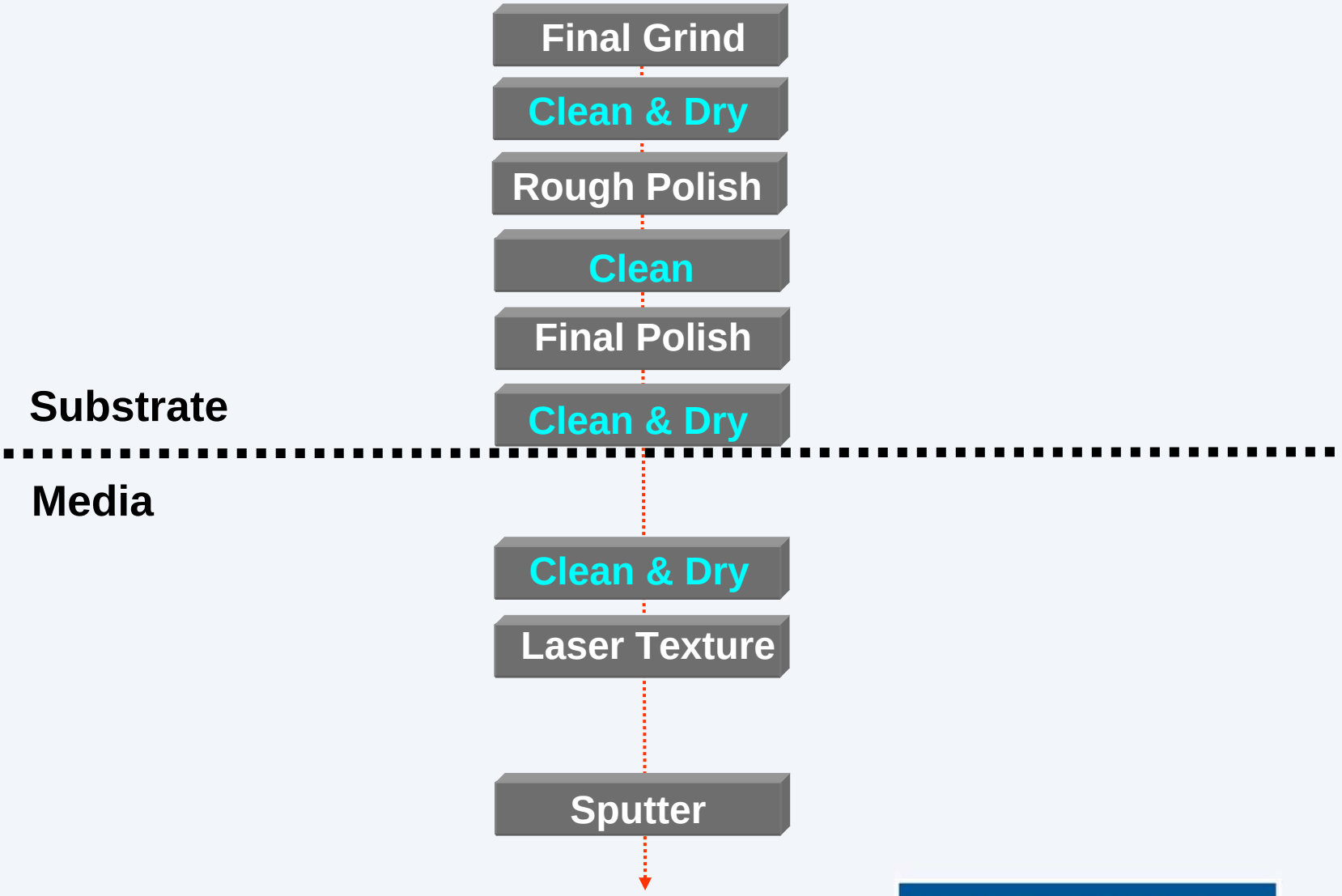
# Tool Considerations

- **Key criteria**
  - **Technology capability**
    - Contact, Scrubbing PRE
    - Non-contact, tank designs and sonic frequency and power density
    - Drying, glass and metal flexibility, particle size neutrality, temperature
    - Environmental control and particle generation control
  - **Operational capability**
    - COO, utilization, DT%, MTBF, MTTR, flexibility, extendibility
  - **Throughput**
    - Highest volume provides lowest cost
    - Lower volume for output granularity or line matching concept
    - Multiple size capability allows for best of both worlds
  - **Floor space consumption**
  - **Global/Local service and technical support**
  - **Price/Warranty/Availability of critical spares**
  - **Manufacturing location should be near region of use**
  - **R & D capability to provide continuous innovation and process improvement**

# Substrate & Media Process Flow – LMR



# Substrate & Media Process Flow – PMR



# Information on PMR Cleaning Requirements

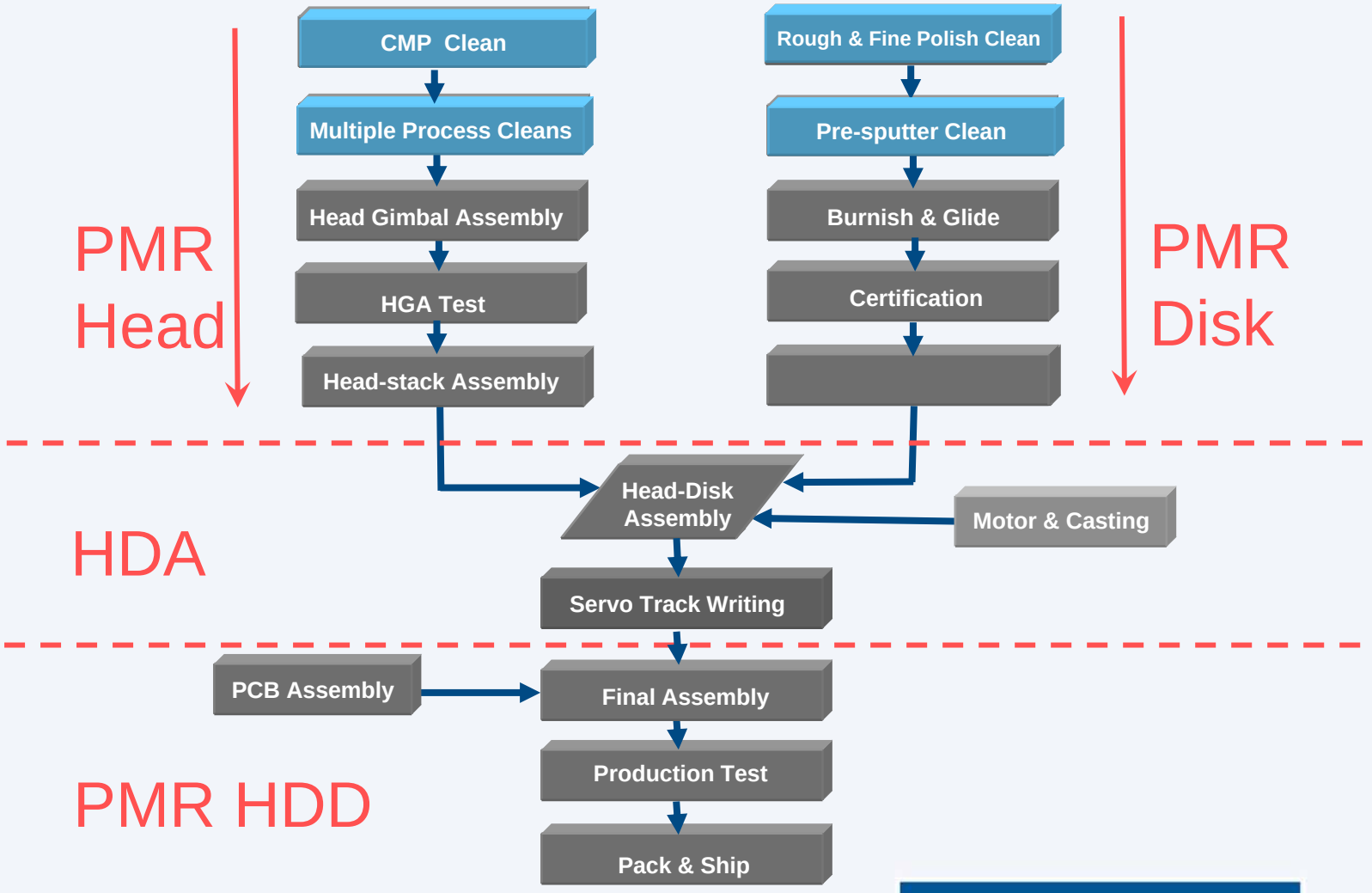
- **PMR media cleaning requirements are distinctly different than LMR;**
  - **PMR substrates are fundamentally different than LMR substrates due to the amount of incoming surface variability, so from a cleanability perspective PMR is more challenging than ever, because;**
    - PMR media does not require a texture step to aid in magnetic orientation, so the substrate surface enters the pre-sputter cleaner with an aged surface that is hydrophobic, consisting of:
      - A thin oxide surface layer, based on time and storage environment metrics due to the fact substrates arrive from all over the world
      - Polish induced surface asperities (scratches, nodules and ridges)
      - Adhered particles not removed by the final cleaning step after polish due to existing lower capability
      - Loosely adhered, environmentally added particles

# Final Comments and Considerations on PMR Cleaning Requirements

- **PMR is prone to single point “Killer” defect at ~ 1µ and below**
- **PMR requires several cleaning improvement considerations**
  - **Substantially improved cleaning requirements for incoming substrates due to texture process elimination**
  - **More aggressive scrubbing, longer scrubbing times and/or increased surface contact**
  - **More complex soaps or aggressive chemistry**
  - **Improved rinsing prior to drying, so particle free disks enter the dryer**
  - **Higher frequency, multiple frequency megasonics and higher power densities**
  - **Enhanced drying environment, to minimize particle adders, contact points and insuring complete drying**

# PMR HDD – Precision Cleaning Processes

**Precision cleaning is playing an increasingly important role in other areas:**



# End of Presentation

- Q & A