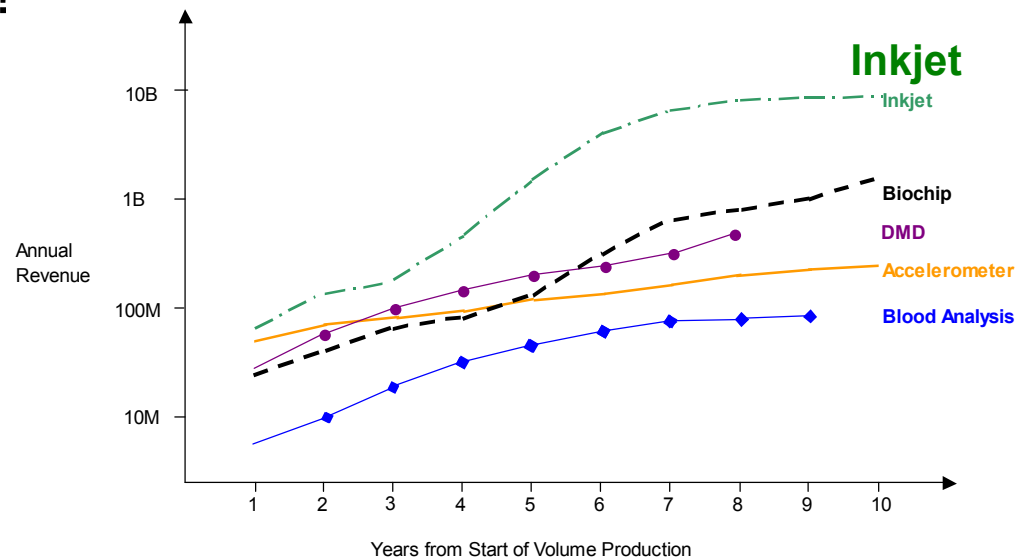


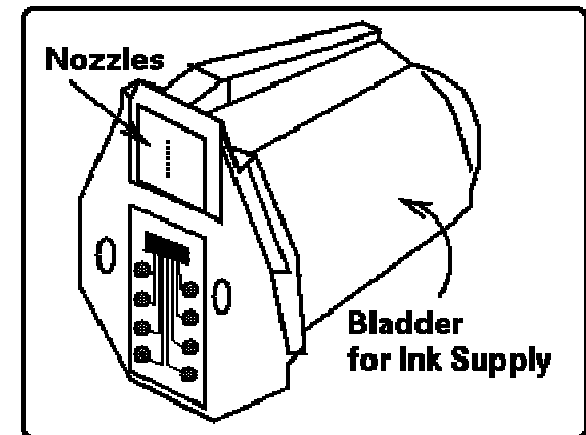
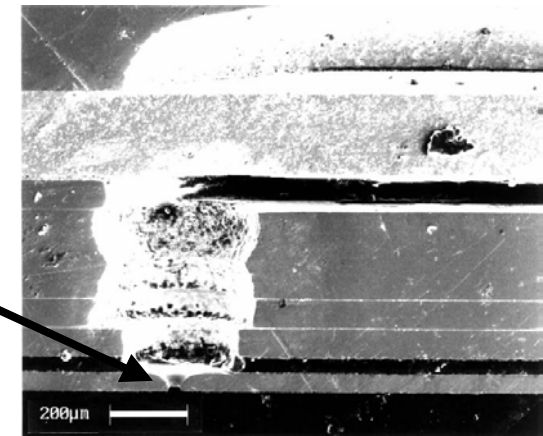
Ink Jet Printing and Dispensing

- Ink Jet Printing is the established 'killer application' for microfluidics
 - Market \$14.5Bn, CAGR 15% (2002)
 - The role model for future microfluidics applications?

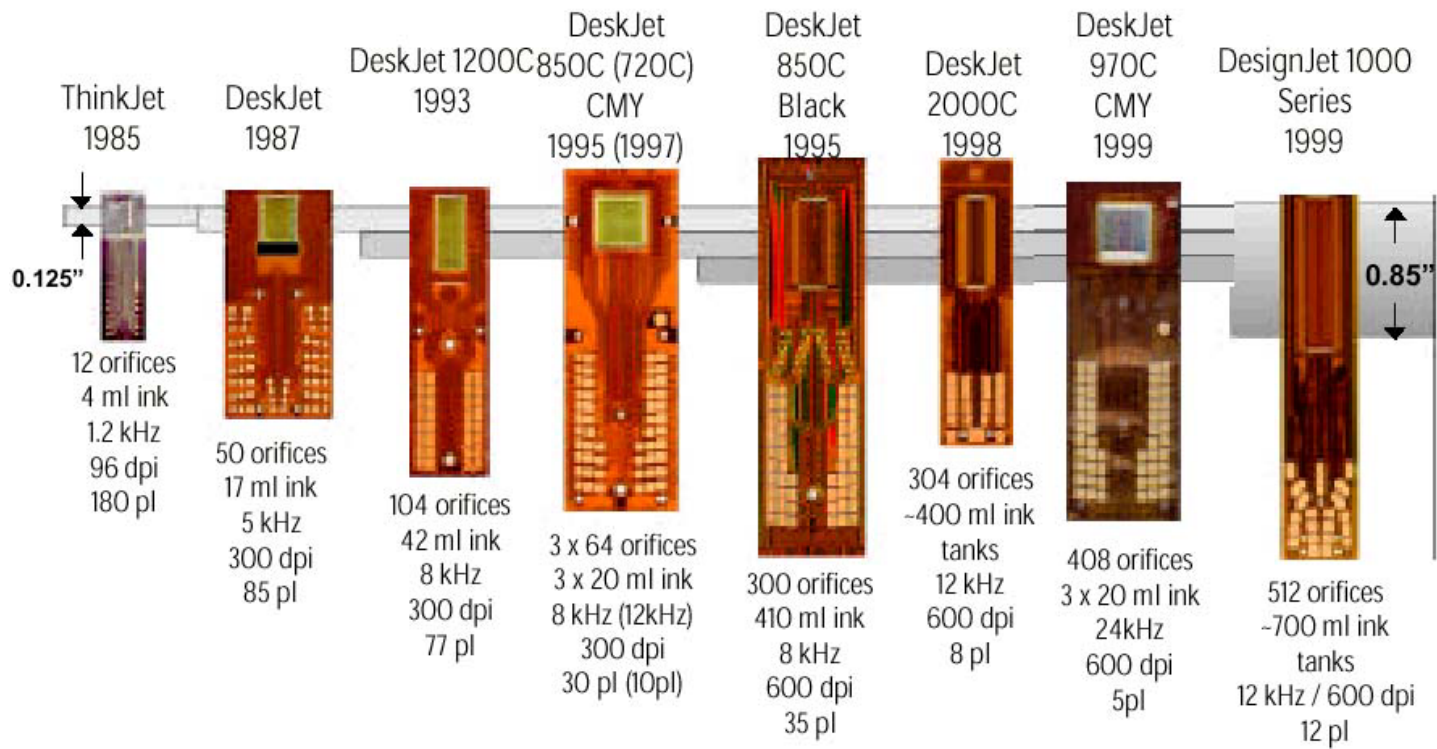


Microfluidics - Ink Jet Print Heads

- Challenge
 - Provide mechanical, electrical and fluidic interfaces
 - Integrate fluidics, actuators and electronics
 - Commodity products in a competitive, performance driven market
- Unique application that can only be realised with Microfluidics + other MNT
- Solution
 - Dedicated end-end production facility



Product Roadmap HP Ink-Jet Print Heads



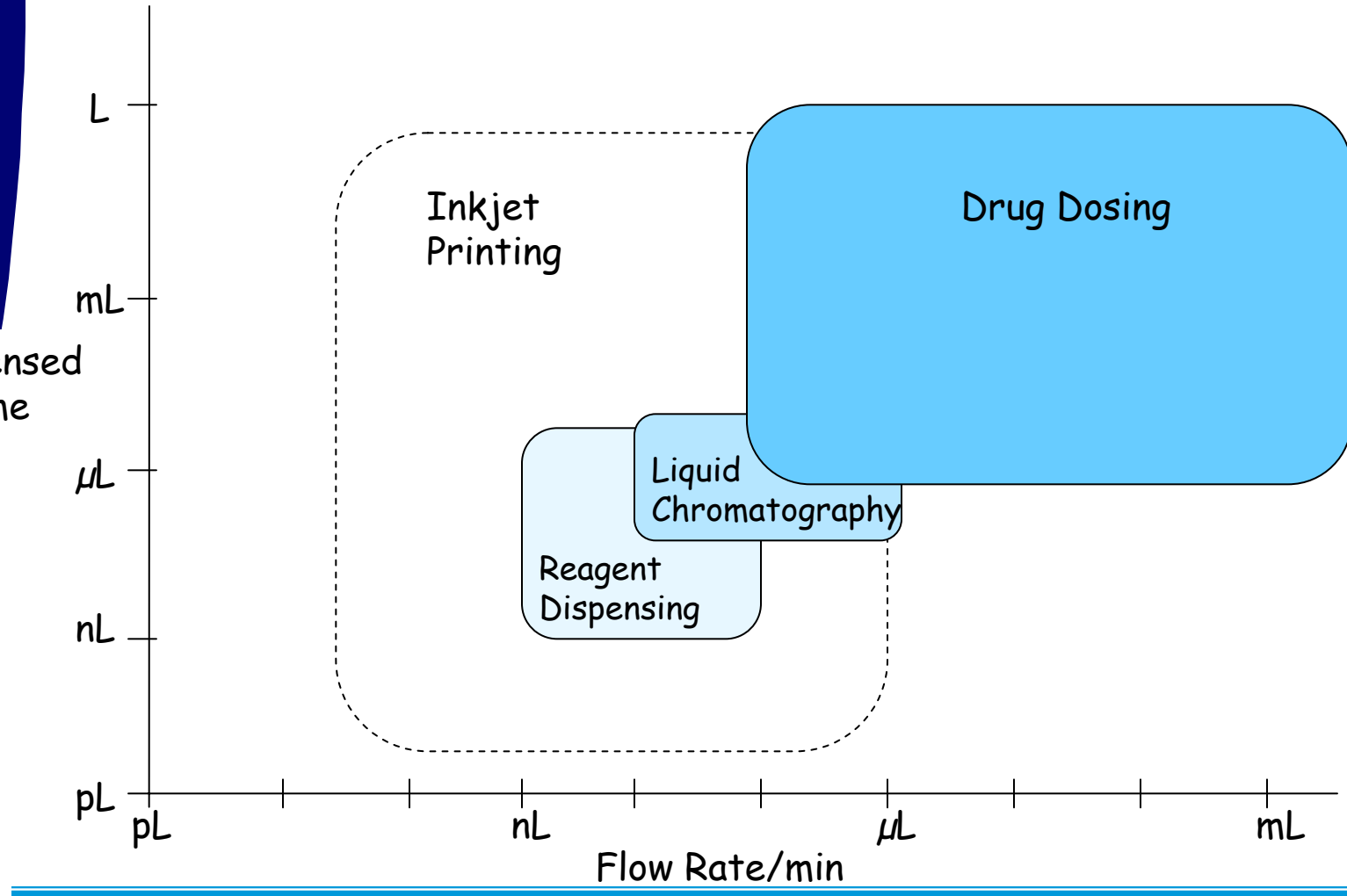
Courtesy of Hewlett-Packard/
Pivotal Resources

Drivers

- Explosion in home/small office computing
 - Move away from large centralised facilities
 - Industrial demand for small print runs
 - Call for better quality, full colour graphics 'on demand'
 - Cost
 - Capital vs Running cost
 - Ease of use
-

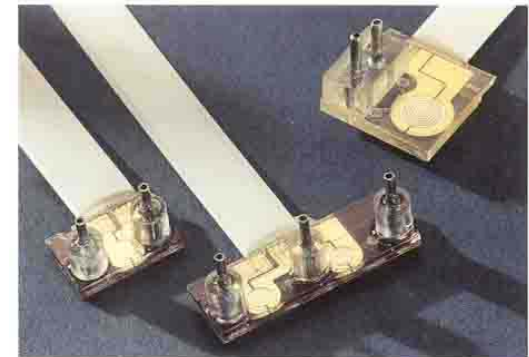
Micropump Roadmap

Dispensed Volume



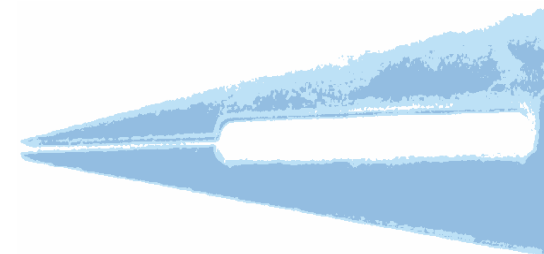
Market Drivers

- Microdispensing potential new market for Ink Jet technology
 - Key driver – performance relative to conventional technology
- Market will segment by volume, flow requirements
 - Ink Jet printing
 - Valves
 - Micropumps
 - Pens
- Other considerations
 - Interaction between fluid and delivery methods



Three different types of micropumps.

Courtesy of Debiotech

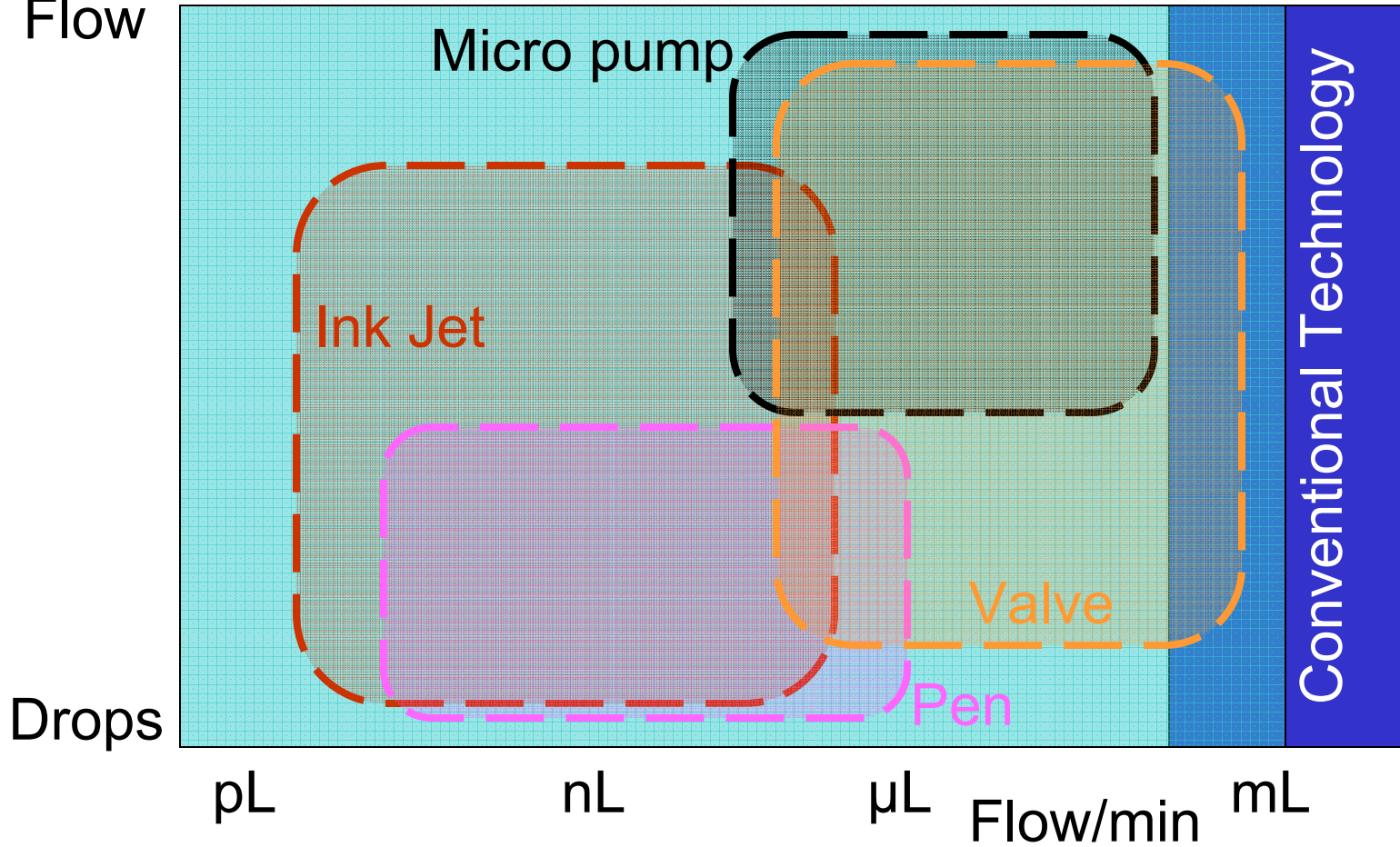


← Few mm →

Dispensing Technologies



Continuous
Flow



Barriers

- Cost
 - Performance
 - Damage to fluids
 - Continuous vs. pulsed flow
 - Existing, mature, well characterised and cost effective technologies delivering sub-mL and up
-

Development of Market

- Will remain a niche technology serving markets where performance/price tradeoff is acceptable
 - Lab analysis
 - Drug delivery (very slow transfer to production)
 - ...
-

Food, Beverage and Personal Care

- Household consumer products
 - Consumers concerns dominate market
 - Cost
 - Safety
 - Product quality
 - 'Grey Goo' fears
 - Companies:
 - Many SME's specialising in a niche
 - Few large, broad based companies
 - ❖ Unilever, Nestlé, P&G etc.
-

Food, Beverage, Personal Care



- Application areas:
 - Process and quality control
 - Manufacturing
 - ❖ Volume manufacturing
 - ❖ Additives, point of sale dispensing
 - R&D
 - Drivers
 - Lower cost, point of use analysis
 - Lower cost production of Nanodispersions and Nanoparticles
 - Improvements in product performance
 - Reduction in wastage
 - Monitoring of previously inaccessible hazards=> better safety
 - Mass Customisation
-

Choice of materials

- Disposable applications – polymers
 - Point of use
 - Portable monitoring
 - Fixed applications
 - Glass, Metal, Polymer – match needs of chemistry for manufacturing and cleaning
 - Volume manufacturing
-

Barriers

- Existing, mature, capable technologies
 - Technology is complex and needs multidisciplinary approach.
 - Cost/reliability of production equipment
 - Incomplete supply chain e.g. process equipment manufacturing.
 - General lack of awareness of benefits of microfluidics
 - There is a lack of market pull for microfluidics into this market.
 - Backlash against overhyped new technologies
 - Consumer fear
 - Insufficient product differentiation
-

Development of the Market

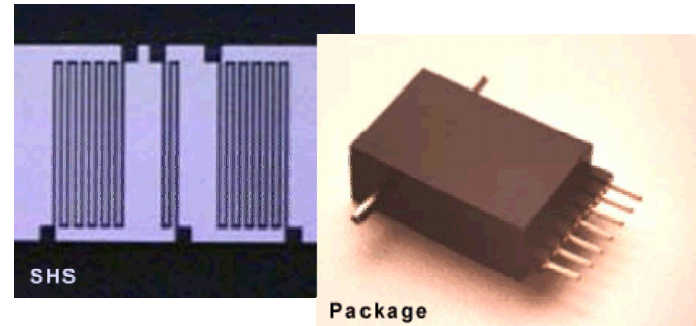
- Process and quality control
 - Gradual introduction of instrumentation for improved monitoring in supply chain
 - Unlikely to displace existing technologies in <10 years
 - Manufacturing
 - Volume manufacturing – very unlikely to see significant manufacturing with microfluidics for at least 10-20 years
 - Additives, point of sale dispensing – No truly compelling application in sight, still in technology development. Some opportunities will emerge in 5-10 years.
 - R&D
 - Will remain as a small niche market unless volume manufacturing takes off
-

Instrumentation and Sensors

- Market for microfluidics devices supplied to make stand alone instruments and sensors for example
 - Process control instruments (e.g. Mass Flow Controller)
 - Inline measurement tools
 - Many companies selling into industrial and chemical process, automotive, Household appliance, Food & personal care...
 - NOT sensors that are part of e.g. a Lab-on-a-chip device
-

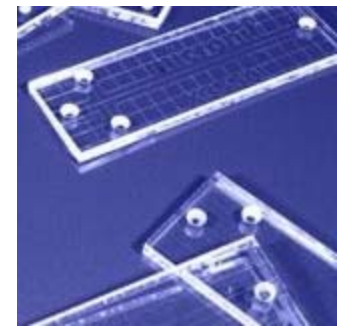
Examples

- MFC's Burkert, Brookes (Quantim), TMP



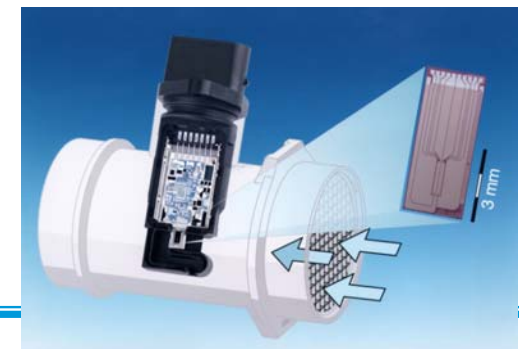
Courtesy of TMP BV

- Micro Electrophoresis



Courtesy of Micronit BV

- Micro Gas Chromatograph, HPLC
- Micro flow sensors, pressure sensors
- Micro sieves



Courtesy of Robert Bosch GmbH

Drivers

- Improved Accuracy
 - Smaller sample volumes, lower flow rates
 - In-situ sample preparation
 - Cost reduction
 - Ease of use
 - Portability
 - Integration with electronic and mechanical components
 - Monitoring previously inaccessible contaminants
 - Safety
 - Yield
-

Market Development

- Microfluidic devices on market now
 - Automotive
 - CE chips
 - MFC's
 - Microfluidics will be a niche technology capturing applications where size (of sensor/sample) is of critical importance
 - Less than 5% of the total market, but high degree of penetration in some niches e.g. automotive
-

Barriers

- Existing technologies deliver good cost/performance tradeoff
 - Looking for trace contaminants in large volumes
 - Multiphase substances
 - General lack of awareness of benefits of microfluidics
 - There is a lack of market pull for microfluidics into this market.
-

Open Discussion

- And now it's over to you....

 - Kalyan will be sending you a short questionnaire on the event by email, please fill it in

 - ...Remember File,Exit to leave
-