Interoperability of microfluidic components

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Introduction
• Real operability needs standards or at least industry wide supported design rules.
• “Markets make standards, not committees”
• Therefore identify:
  – the barriers and drivers for interoperability and standards,
  – accepted (de facto) standards,
  – technology trends,
  – dominant players and their products.
Barriers & Drivers for standards in microfluidics

**Barriers:**

- Market position of companies dominant in the market or are expecting to achieve such dominance.
- Investment in current products might become worthless.
- Diversity in the existing products already on the market.
- Lack of uniformity in our vocabulary.
- Existing standards in established industries.

**Drivers:**

- Health care: to enable diversity in testing, there are hundreds of specific tests needed, but the user wants to limit the number of instruments in the lab.
- Analytical instruments / processing equipment / R&D: to enable the selection of the best components and the ability to compare / qualify those components and the systems.
- Plug & play microfluidics.
Established standards and ongoing discussions

• Established:
  • Microplate Well Positions: ANSI/SBS 4-2004
  • Standard microscope slide: ISO 8037-1:1986 Optics and optical instruments -- Microscopes -- Slides -- Part 1: Dimensions, optical properties and marking
  • Luer interface (ISO 594:1986)

• In discussion:
  • Semi
    • SEMI: proposal for multi port interconnect in discussion. (8 parallel fluidic tubes with a center to center spacing of 0.500 mm and an ID of 0.250 mm)
    • SEMI Draft Document 4691, New standard: specification for high density permanent connections between microfluidic devices
    • SEMI MS7-0708 - Specification for Microfluidic Interfaces to Electronic Device Packages
    • SEMI MS6-0308 - Guide for design and materials for interfacing microfluidic Systems

• Nessi: mainly about sampling for process control
  • ISA-SP76, Composition Analyzers?

• DIN standardization group on microreaction technology:
  • ISO 10991 Micro process engineering - vocabulary
  • Characterization processes for microreactors.

• Microfluidics Consortium:
  • Multi port interconnects / chipsizes & design manufacturing guide

• Mf manufacturing project:
  • European initiative for the standardization and manufacturability of complex micro-fluidic devices
VDMA

- VDMA has proposed a standard “Einheitsblatt” for micro fluidic technologies. Mainly for chemical process technologies. The VDMA 66305 defines the interfaces between so-called Match-X building blocks developed by Fraunhofer (IZM and IPA), both geometric as well as functional interfaces are described.

- Producers of Match-X building blocks that follow the VDMA-66305 standard, make the building block interoperable between other building blocks produced by other parties.

3.2.2 Fluidische Schnittstelle
3.2.2.1 Grundlagen und Erläuterungen zu den Definitionen der fluidtechnischen Schnittstelle
3.2.2.2 Verbindung zwischen fluidtechnischen Bausteinen und Montagetoleranzen
3.2.2.3 Funktionale Definition der fluidtechnischen Schnittstelle
3.2.2.4 Charakterisierung der Bausteine
3.2.2.5 Messvorschrift für die Charakterisierung der fluidtechnischen Schnittstellen (vorläufig)
3.2.2.6 Beschreibung der Schnittstellenparameter
3.2.2.7 Schnittstellenbeschreibung (Zeichnungen)
De facto standards for microfluidic designers

<table>
<thead>
<tr>
<th>Length \ l</th>
<th>Width \ b</th>
</tr>
</thead>
<tbody>
<tr>
<td>45_1</td>
<td>26_1</td>
</tr>
<tr>
<td>76_1</td>
<td>39_1</td>
</tr>
<tr>
<td>76_1</td>
<td>52_1</td>
</tr>
</tbody>
</table>

microscopy slide format

Luer (ISO 594:1986)

microtiter plate format, layouts with 96, 384 or 1536 wells.
SEMI MS7-0708: Specification for microfluidic interfaces to electronic device packages

Exploded 3-D View of EFIC Package

Funcational Description of Assembled Parts

EFIC Fluidic Routing Card & Adapters

Republished with permission from Semiconductor Equipment and Materials International (SEMI) 2012
NeSSI™ Modular Sampling Systems

- New Sampling/Sensor Initiative
- Surface-mount modular component based gas and fluid handling and conditioning systems
  - ISA SP76 interface specification
  - Elastomeric o-ring seals
- Offer flexibility in design and implementation
- Allows for optimal positioning of analyzers in a process stream

NeSSI generation III systems: microanalytical devices such as lab on chip for process and water control.
Standardization activities in Germany

**working on standardization for micro fluidic components:**
- **DECHEMA Fachgruppe Mikroverfahrenstechnik**
  Board Members: Dietrich (mikroglas), Stenger (Evonik), Dittmeyer (KIT)
- **DIN Arbeitsausschuss Mikroverfahrenstechnik**
  Chairman: Dietrich (mikroglas)

**activities:**
- standard of fluidic interfaces proposed by
- terminology norm ISO 10991 already in place
- DIN norm on explosion protection with micro fluidic components in preparation will be published in approx. 2 months
- research project on standardization of residence time measurement approved will start in July 2012 for 1 year  --> standard equipment and measurement procedure
De facto standard in fittings (for instance chromatography)

- **Fittings:**
  - low pressure fluid transfer: thread $\frac{1}{4}$-28; flat bottom configuration
  - high pressure fluid transfer: 10-32: coned configuration of port

- **Tubing:** 1.6 and 3.2 mm
What is not standard?

• “CD format”: different sizes, the only common factor: making use of centrifugal forces.
• “Credit card”: meaning something about the size of a credit card.
• “Platform technology” owned and used by just one company.
There are international specifications (e.g. ECMA-130) which describe the physical characteristics of a Compact Disc. (see http://www.ecma-international.org/publications/files/ECMA-ST/Ecma-130.pdf)

For the adaption for microfluidic application at least following parameters should be standardized:
- inner diameter (ECMA-130, 8.2)
- clamping area (ECMA-130, 8.4)
- outer diameter (ECMA-130, 8.7)
- distance of microfluidic structures to the clamping area and to the outer circumference (handling/bonding zone)

**Proposed characteristics and tolerances:**
- inner diameter: 15.0mm -0, +0.2mm
- clamping area: between diameter 26mm (max) and 33mm (min)
- outer diameter: 120mm +-0.5mm
- thickness: a minimum thickness of 1.2mm is proposed
- distance of structures to the clamping area >3.5mm
- distance of structures to the outer circumference >5mm
TBD: Creditcard size format

– Outer dimensions of the chip:
  • length: 85.6mm +-0.5mm; width: 54.0mm +-0.5mm
  • a minimum thickness of 1.2mm
  • corner radius: 3.18 mm +-0.03mm (3 corners)
  • bevel: 6mm x 6mm - 45° (1 corner)

– Distance of microfluidic structures to the outer edges at the larger sides >4mm

– Space reserved for interconnections: at the smaller sides a depth of 5.5. mm.

– Port holes following the earlier given positions for clamped interconnections or Luer contacts
Technology trends?
Bewildering number of technologies and concepts

Bionas.
Simultaneous measurements of:
- pH
- O2 consumption
- Adhesion/confluency
- Online/real time measurements
No consensus about methodology let alone technology (example HIV diagnostics)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Technology Details</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>BD FACScount</td>
<td>Flow cytometer, microbeads, fluorescence, Calibration needed; need of additional chemicals</td>
<td>available</td>
</tr>
<tr>
<td>Partec Cyflow</td>
<td>Flow cytometer, Simple sample pretreatment needed; dry stored chemicals, 6 months shelf life</td>
<td>Near market?</td>
</tr>
<tr>
<td>Alera Pima analyser</td>
<td>Fluorescence, image analyzing, Dried reagents on board</td>
<td>Released 2009</td>
</tr>
<tr>
<td>Chembio</td>
<td>Immuno assay</td>
<td>Launched 2013</td>
</tr>
<tr>
<td>BCR</td>
<td>Elisa, Fluorescence, nanodetectors</td>
<td>Near market?</td>
</tr>
<tr>
<td>Visitec</td>
<td>Measures CD4 protein; immobilized with antibodies, visual readout, Chemicals do not need cold storage</td>
<td>Near market</td>
</tr>
<tr>
<td>Zyomyx</td>
<td>Bonded to heavy particles, separated by density; magnetic beads used to remove monocyte contamination</td>
<td>close to launch,</td>
</tr>
<tr>
<td>Daktari CD4 counter</td>
<td>No labeling, no optics. On board chemicals Microfluidic cell, cartridge, lysate impedance spectroscopy, chromatography</td>
<td>Field test ongoing</td>
</tr>
<tr>
<td>Wave 80</td>
<td>Cartridge, integrated sample preparation, microarray? On board chemicals</td>
<td>Prototype</td>
</tr>
<tr>
<td>Diagnostic chips</td>
<td>Electrical readout, electro kinetic pumping</td>
<td>Prototype</td>
</tr>
<tr>
<td>Mbio</td>
<td>Cartridge, optical waveguide, Fluorescence</td>
<td>In development</td>
</tr>
<tr>
<td>LeukoDX</td>
<td>Cartridge, Fluorescence</td>
<td>In development</td>
</tr>
<tr>
<td>QuantumDX</td>
<td>Nanowire based FET, PCR, microfluidic cartridge</td>
<td>Expected in 2015</td>
</tr>
<tr>
<td>Oj-Bio</td>
<td>SAW with antibodies, mobile phone based</td>
<td>Concept only</td>
</tr>
<tr>
<td>DFA</td>
<td>Paper based</td>
<td>Concept only</td>
</tr>
</tbody>
</table>
Roadmap for food diagnostics

- Direct sensing: benchtop, < less then 1 hr, trained staff needed
- Microfluidic based: lab instrument, < 24 hr, expert staff needed
- Online: Automatic In line & less then 1 sec
- Vision: With compact sample treatment module: handheld, <10 min, process operators

A vision on pathogen detection in the dairy industry

Sensor sensitivity
- pg/ml
- ng/ml

Timeline:
- 2010
- 2015
- 2020
- 2025
- 2030

Roadmap:
- Available
- Module
- Component
- Work in progress
- Integration level

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Integration: a key driver for smaller and faster diagnostic devices.

• Drivers:
  – Need for small sample sizes.
  – Ease of use / robustness.
  – Need for low cost disposables.
  – Short time to measurement result.

• Challenges:
  – Microfluidics doesn’t scale as easy as electronics (or even as mechanics) & electrons are electrons, but in microfluidics.................!
  – Combining electronic, mechanical, fluidic and optical components or structures.
  – Technology and business environment are immature.
Always integrate microfluidics?

<table>
<thead>
<tr>
<th></th>
<th>PoC third world</th>
<th>PoC (home)</th>
<th>PoC (other)</th>
<th>Central Lab</th>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acceptable time to result</strong></td>
<td>Seconds to minutes</td>
<td>Seconds to minutes</td>
<td>&lt; 6 minutes</td>
<td>Up till half an hour</td>
<td>Up till several hours</td>
</tr>
<tr>
<td><strong>Cost of instruments</strong></td>
<td>Up to a few 100’s of $</td>
<td>Up to a few k$</td>
<td>Up to a few k$</td>
<td>Up to 100’s of k$</td>
<td>Up to a few M$</td>
</tr>
<tr>
<td><strong>Staff</strong></td>
<td>Untrained</td>
<td>Untrained</td>
<td>Semi trained</td>
<td>Trained</td>
<td>Highly specialized</td>
</tr>
<tr>
<td><strong>Cost of disposables</strong></td>
<td>&lt; 0.5 $</td>
<td>Preferable</td>
<td>Preferable</td>
<td>Up to 10’s of $</td>
<td>Less relevant</td>
</tr>
<tr>
<td><strong>Number of tests running in parallel</strong></td>
<td>1</td>
<td>1</td>
<td>1-10</td>
<td>Typical 10-20</td>
<td>Less relevant, but flexibility needed</td>
</tr>
<tr>
<td><strong>Level of integration to be expected</strong></td>
<td>Very high</td>
<td>Very high</td>
<td>High</td>
<td>low</td>
<td>Very low</td>
</tr>
</tbody>
</table>
Identified integration concepts:

- The whole process from input sample to result (detected electrically or optically):
  - Chip: all microfluidic functions in one chip.
    - on the market: glass, polymer, silicon chip.
    - In development: paper, roll to roll manufactures films etc..
  - “CD”: centrifugal driven microfluidic flow
  - Card: microfluidic plate with additional components like a biochip mounted on top of the plate, the fluidic does not leave the microfluidic plate.
  - Cartridge: the fluid is transferred from one component to another in a plane or in a 3D configuration.
  - Not integrated: connections by tubing and wires.
Technology trends in microfluidics

1. Chips suppliers are becoming component suppliers.
2. Well array testing is developing into more complex testing more akin to real life situations.
3. Digital microfluidics is seen as a way to miniaturize well array testing further.
4. More efficient and faster sample preparation units (PCR in a few minutes).
5. The industry is looking for technologies that don’t need labeling, i.e. biomarker specific sensors.
6. The industry is looking for technologies that don’t need time consuming PCR, i.e. hyper sensitive sensors.
7. Plug and play microfluidic instruments, cartridges, chip holders, connectors etc. are emerging.
Plug and play microfluidics
Not integrated? Then plug and play!

But: Interoperability?
Off the shelf Microfluidics

- Main application: R&D and analytical testing
- Dominant players: Dolomite, MFCS, Micronit, thinXXs, others?
- Important resellers: Labsmith (MFCS), Cole Palmer (thinXXS, Micronit), etc.

- Standards for interconnection of components / subsystems would help the market.
# Chip to tube connectors

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Pressure</th>
<th>Ease of connect</th>
<th>Supported by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanoport</td>
<td>&lt;69 bar</td>
<td>-</td>
<td>IDEX</td>
</tr>
<tr>
<td>Tube over an olive</td>
<td>&lt;3 bar</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Captite</td>
<td></td>
<td>-</td>
<td>Labsmith, MFCS</td>
</tr>
<tr>
<td>(Mini) Luer</td>
<td>&lt;80 C</td>
<td>&lt;2 bar</td>
<td>ThinXXS, MFCS, Translume, IBID etc.</td>
</tr>
</tbody>
</table>

Useful, generally accepted but not very practical
### Types of Seal
Ratings — 5 = good, 1 = poor. Although cost is an important criteria it’s not provided as it depends on which complementary components are used to allow the seal to operate.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Application</th>
<th>Solvent resistance</th>
<th>Pressure rating</th>
<th>Re-use</th>
<th>Usability</th>
<th>Dead volume</th>
<th>Cost</th>
<th>Comments</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesive</td>
<td>Bonding a length of tubing to a port on the microfluidic device with epoxy or other suitable adhesive</td>
<td>A</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flared/flanged</td>
<td>The flattened surface of a tube is pressed against the flat surface of a chip</td>
<td>A</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td></td>
<td>Resistance depends on material used. High stress loads on chip (connector/interface designed to withstand)</td>
<td>Diba</td>
</tr>
<tr>
<td>Interference fitting</td>
<td>Two components (ferrule and port, or connector/port) are screw or press-fit together</td>
<td>A</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
<td>Luer</td>
</tr>
<tr>
<td>Push in</td>
<td>Tube is pushed into recess to create interference fit</td>
<td>A</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td>Uni Cal.</td>
</tr>
<tr>
<td>Nipple/Barb</td>
<td>Soft wall tubing is stretched over a conical or cylindrical shaped device</td>
<td>A</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td>Value Plastics</td>
</tr>
<tr>
<td>Needle through membrane</td>
<td>A needle is pushed through a typically elastomeric membrane</td>
<td>A</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td></td>
<td>limited pressure range.</td>
<td>Cytocentrics</td>
</tr>
<tr>
<td>Gasket</td>
<td>Mechanical (typically Elastomer) seal compressed between two components to prevent fluid leakage. May or may not grip and seal onto a tube.</td>
<td>B</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td></td>
<td>Complicated and expensive connector design</td>
<td>Dolomite</td>
</tr>
<tr>
<td>Ferrule</td>
<td>A metal or polymer ring, tube or cap, placed at or fastened to the end of a tube</td>
<td>B</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td></td>
<td>Complicated to design for multiconnects. Only one component to change in the event of a seal failure</td>
<td>Omnifit</td>
</tr>
<tr>
<td>O-ring</td>
<td>An elastomer ring of circular cross-section compressed between two components to prevent fluid leakage. May or may not grip and seal onto a tube.</td>
<td>A</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td>Generic</td>
</tr>
<tr>
<td>Free path</td>
<td>Introducing liquids into an open port on the microfluidic device with the use of an external delivery system such as a pipette</td>
<td>A</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td></td>
<td>Possibility of leaks and spills, contamination. Discrete delivery. Lack of overpressure restricts the applicability of the microfluidic device.</td>
<td>?</td>
</tr>
</tbody>
</table>
Classes of application
A: up to 2 bar (14, 3 psig or 29 psi) to include practically all PoC. Loc like instruments for instance for biochemical testing.
B: Up to 100 bar (1450 psi) we find here many gasflow sensors etc.
C: The last are the connectors for analytical instruments like GC: up to 1000 or even 3000 bar.

Distinctive factors
- multiple interconnections
- a small area
- leak tight
- easy to assemble
- chemically resistant
- Smooth fluidic transitions, the ideal interconnect design is one that has the least possible effect on fluid flow.
- low dead volume
- low cost to assemble, and be amenable to automated assembly
- Reversibility; (Cost of servicing and flexibility of system)
- Leak rate; (Loss of fluid and entrance of bubbles)
- Maximum pressure; (High pressures need robust design of the connector)
- Change of cross-section; (influences degassing due to sudden pressure drops and carryover)
- Maximum temperature; (Choice of materials for connector/device)
- Compatibility of materials. (Influences reliability of sample and carryover)
## Multi port interconnects

<table>
<thead>
<tr>
<th></th>
<th>Temperature</th>
<th>Pressure (bar)</th>
<th>Ease of connect</th>
<th>Supported by</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quick connect</strong></td>
<td>Room temperature?</td>
<td>&lt;6.9</td>
<td>++ (magnets)</td>
<td>SFC</td>
<td>Commercial available</td>
</tr>
<tr>
<td><strong>Dolomite</strong></td>
<td>-15 to &lt;150 C</td>
<td>&lt;30</td>
<td>+ (clamped)</td>
<td>Dolomite</td>
<td>Commercial available</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Top and edge connectors, 4, 8, 12 channels, tubing OD 1.6mm; TFE, perfluorelastomer</td>
</tr>
<tr>
<td><strong>University of California</strong></td>
<td>?</td>
<td>&lt;3.4</td>
<td>+?</td>
<td>-</td>
<td>In development</td>
</tr>
<tr>
<td><strong>Diagnostic Biosensors</strong></td>
<td>Room temperature?</td>
<td>Low pressures?</td>
<td>+?</td>
<td>Commercial available</td>
<td>4 channels, connects to Luer, Acrylic, Polycarbonate</td>
</tr>
<tr>
<td><strong>Micro-plumbers</strong></td>
<td>Room temperature?</td>
<td>Low pressures?</td>
<td>+ (clamped)</td>
<td>Micro-plumbers</td>
<td>Commercial available</td>
</tr>
<tr>
<td><strong>Navel Research Lab</strong></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>Patented, license possible</td>
</tr>
<tr>
<td><strong>Mycor solutions</strong></td>
<td>4-50 C</td>
<td>&lt;2 bar</td>
<td>++</td>
<td>Henne van Heeren enabling MNT</td>
<td>Commercial available 2 channels</td>
</tr>
</tbody>
</table>
Chipholders /microfluidic adapters

Gesim: Micell

microLIQUID

microflexis

Invenios

Dolomite

Micronit

Eksigent

SIMtech

12/09/2014

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<table>
<thead>
<tr>
<th>Company</th>
<th>Product</th>
<th>Fluidic ports</th>
<th>Chip layout</th>
<th>Specs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micronit</td>
<td>Fluidic Connect 4515</td>
<td>Inserted chip, 10 ports (also electrical contacts)</td>
<td>To 1.6 mm tube</td>
<td>15*45 mm family &amp; 25 x 75</td>
</tr>
<tr>
<td>microLIQUID</td>
<td>Up to 6 fluidic and 16 electrical ports</td>
<td>Luer</td>
<td>10<em>10 / 30</em>20/ 45*15 mm</td>
<td></td>
</tr>
<tr>
<td>Dolomite</td>
<td>Mitos Chip Holder H</td>
<td>Used in connection with one or two clamped 4 port interconnects</td>
<td>To 1.6 mm tube</td>
<td>22.5<em>15.0</em>4.0 mm</td>
</tr>
<tr>
<td></td>
<td>Mitos Chip Holder C</td>
<td>Used in connection with one clamped 4 port interconnect</td>
<td>To 1.6 mm tube</td>
<td>7<em>15.0</em>4 mm</td>
</tr>
<tr>
<td>Invenios/ Mikroglass</td>
<td>Several holders</td>
<td>1/4” UNF thread</td>
<td>118 x 28 mm / 118 x 73 mm</td>
<td></td>
</tr>
<tr>
<td>Micrux</td>
<td>ENC-SUB-801</td>
<td>Integrated contacts on PCB and integrated wells, no fluidic ports</td>
<td>1/4” UNF thread</td>
<td>38*13 *0,75 mm</td>
</tr>
<tr>
<td>UCL Micrux</td>
<td>(R&amp;D activity)</td>
<td>2 ports</td>
<td>25*75 mm ?</td>
<td></td>
</tr>
<tr>
<td>MFCS/ Gesim</td>
<td>MicCell</td>
<td>4 ports</td>
<td>25<em>75 mm or 22</em>22 mm</td>
<td>&lt;6 bar; &lt;100 C?</td>
</tr>
<tr>
<td>SIMtech</td>
<td>AHQ 010</td>
<td>10 ports</td>
<td>M6 Nut</td>
<td>25<em>75 &amp; 50</em>75 mm</td>
</tr>
</tbody>
</table>
AGREED SPECIFICATIONS
(MICROFLUIDIC CONSORTIUM)

The following sheets give the preferred formats for chip sizes and position of microfluidic ports. All dimensions in mm.
Credit card size or double microscope slide?
Microscope slide format

- Area reserved for microfluidic functionalities
- Area reserved for handling or electrical contacts
- Microfluidic port
Glass chip to be used in chipholders

15 +/- 0.30

45 +/- 0.30

2.5

5

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Chip layout for clamped interconnects
Design guide for chip layout & connections

**Material**
- Polymer
- Glass

**Chipsize**
- Microtiterplate: 127.76 * 85.48 mm
- Microscope slide: 75 * 25 mm
- Microscope slide: 75 * 25 mm
- 45 * 45; 45 * 15; 30 * 30; 30 * 15; 15 * 15 mm

**Connection**
- Miniluer
- Miniluer
- Clamped
- Clamped

From MF5 design guide for microfluidics

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A roadmap for microfluidic interconnections?

- **Luer**
  - Single port, <2 bar, 5-50 C

- **Clamped**
  - Multiport, <30 bar, 0-200 C

- Fully integrated? (? <? bar, ? C)

Port pitch (mm): 4.5, 3, 1.5, 0.75
Still to define

- Area reserved for clamping
- Tolerances dimension holes
- Tolerances all other dimensions including thickness chip
- Chemical inertness
- Tube dimensions
- Intended sealing method, port size (inside diameter), port spacing, port location, number of ports in a row or array, any physical alignment features, and the material composition of the flow path.
- Classes of applications?
- CD and CC formats
Classes of application

• A: up to 2 bar (14.3 psig or 29 psi), temperature: -20 to 100°C?
  – to include practically all PoC, LoC like instruments for instance for biochemical testing.

• B: Up to 100 bar (1450 psi), temperature: -20 to 200°C?
  – gasflow sensors, microreactors etc.

• C: up to 1000 or even 3000 bar, temperature: -20 to 200°C?
  – Analytical instruments like GC, MS.
Microfluidic motherboard concepts

- Chip to chip
- Component to component horizontally using gaskets
- Component to component horizontally using tubes
- Chip to board (chips placed vertical)

Epigem
Ehrfeld
Labsmith
Not yet tried, but enabled by new developments
Work to do / discussion points

- Taxonomy
- Credit card size definition
- Low cost microfluidic interconnections?
- Pumping / fluidic control standards
- Sample volumes / flows
- Qualifications / measurement materials/dimensions
- Standard Autofluorescence Test Method
- Mobile phone platform?
Low cost disposable interconnects?

• Those interconnects should:
  – Have the simplicity of Luer interfaces,
  – be multi connect,
  – be self aligned,
  – having no dead volume, and
  – be low cost (<< 1 $)

• The temperature regime however is room temperature and the pressure can be < 1bar or even negative pressure.
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