Current State of MEMS Technology in Canada

Canadian Microelectronics Corporation

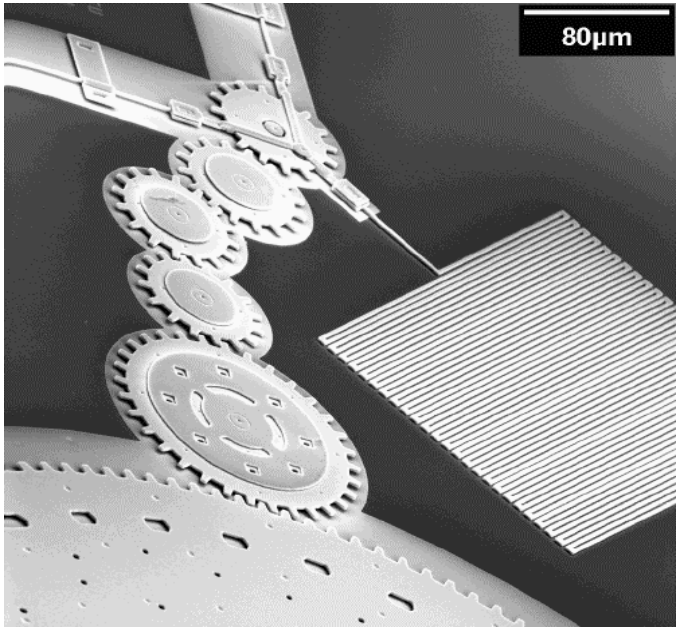
A Cost-Effective Nationwide Laboratory for Canada's Universities to enable world-class Research and Training in Microsystems and Microelectronics

Established in 1984 as a collaboration between Canadian industry, universities and the Federal Government

Canadian Achievements

Some examples from universities:

- **Jed Harrison, University of Alberta**
  - **Microfluidics: the first to use fluorescence detection with applications to single cell analysis, clinical diagnostics, and genetic analysis**
- **Michael Brett, University of Alberta**
  - **U of A MicroFab facility**
- **Ted Hubbard, DalTech**
  - **SEGS on-line wet etch simulator**
- **Ion Stiharu, Concordia University**
  - **Micro-pressure sensors and tactile imager for the space dexterous hand**



Micromechanical D/A converter used in micromachine doptical multiplexer (Professor Ash Parameswaran, Simon Fraser University)

More Canadian Achievements

Some examples from industry:

- **Micralyne Inc. (formerly AMC)**
  - **non-captive MEMS fab since late 80's**
  - **Microfluidics Tool Kit " uTK"**
- **i-STAT Corp.**
  - **manufacture of fluid analysis systems**
- **Goal Semiconductor**
  - **on-chip temperature compensation, microbolometers, and diffractive optics**
- **Cronos (a JDS Uniphase company)**
  - **only MEMS supplier of bulk, surface, and high-aspect ratio micromachining**
- **Xros (acquired by Nortel Networks)**
  - **a leader in fully photonic switching networks**

MEMS Research Infrastructure

- **INO (National Optics Institute)**
  - **manufacturing processes for micro-optical components**
- **Photonics Research Ontario (PRO)**
  - **in-house laser micromachining for material research investigations, product prototyping and small volume production services.**
- **Institute for Microstructural Sciences (IMS) at the National Research Council of Canada (NRC)**
  - **in-house fabrication using surface micro-machining techniques**
- **Canadian Microelectronics Corporation (CMC)**
  - **multi-project runs for academic researchers**

CMC is a Not-for-Profit Corporation

CMC's Mission:

- CMC will ***stimulate and support the pursuit of excellence in research***, scholarship and training in microelectronics and microsystems at Canadian research and education institutions
- CMC will ***enable the development of people*** who have the enterprise, knowledge and skills in microelectronics and microsystems needed to contribute to the Canadian community
- CMC will actively ***support the transfer of research and expertise into practical applications***, in partnership with research, educational and commercial organizations

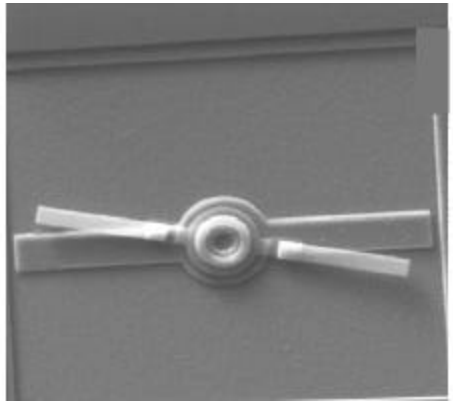
How did CMC get into this?

- 1980s: University Pioneering work
- CMC supports university research:
  - 1994: access Mitel 1.5-micron CMOS
  - 1996: post-processing recipe “Can-MEMS”
  - 1998: MST Survey Report... “BEAMS”
  - 1999: Micromachining Workshop
  - 2001: Micromachining Workshop

CMC Manufacturing Roadmap

- Leading-edge MOS: 0.18-micron today, 0.1-micron by 2005
- “RF”: 45 GHz SiGe option in 2001, 100 GHz option by 2005
- MEMS: MUMPs & CMOS today, next-generation research options for surface and bulk by 2005
- Optoelectronics: spec with NRC, expand in step with research and development interests by 2005
- Packaging (cross-cuts the above): conventional today leading into finer features, BGA/COB/MCM, with increasing customization

Released Bearing
Professor T. Hubbard
Dalhousie University



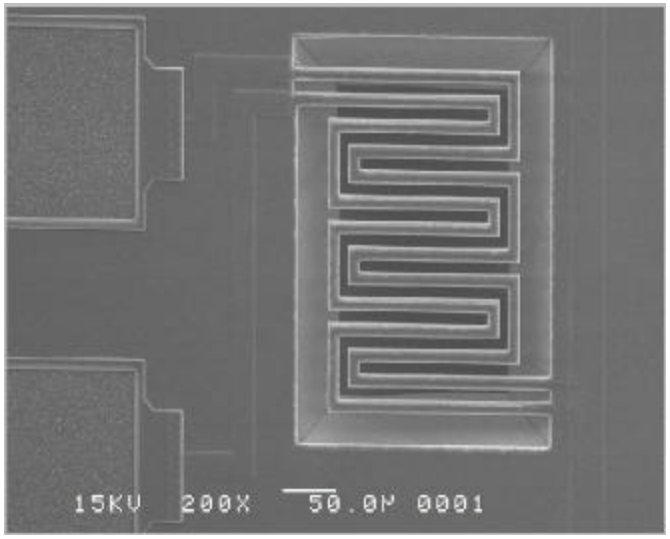
"BEAMS"

- Web-based *"Info-center"*

- *"BEAMS Chamber"...* database of MEMS researchers and capabilities

- Links to CMC-supported technology**...**

Micro-pressure Gauge
University of Waterloo

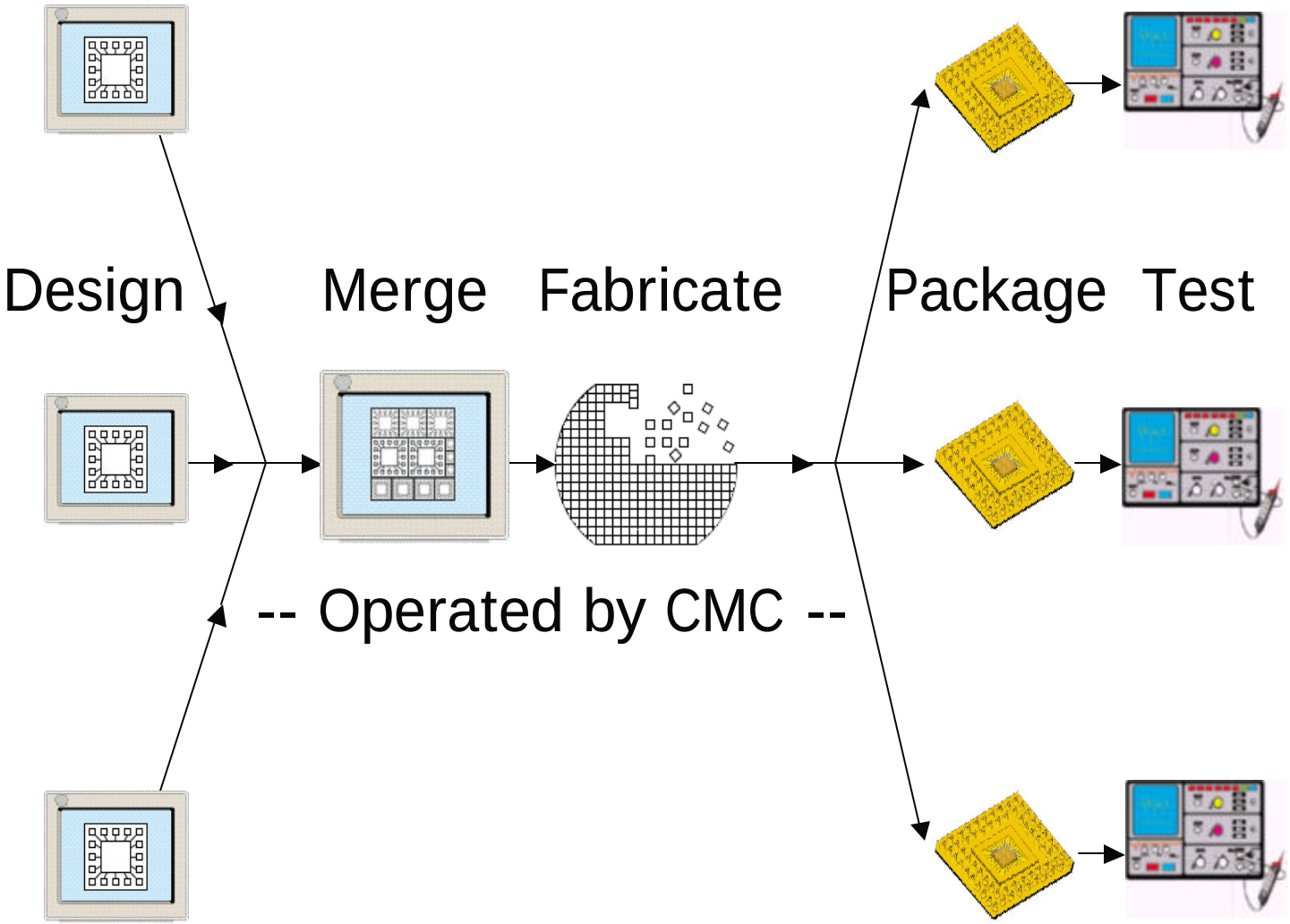


CMC support for MEMS

1999-Present: *BEAMS* Program

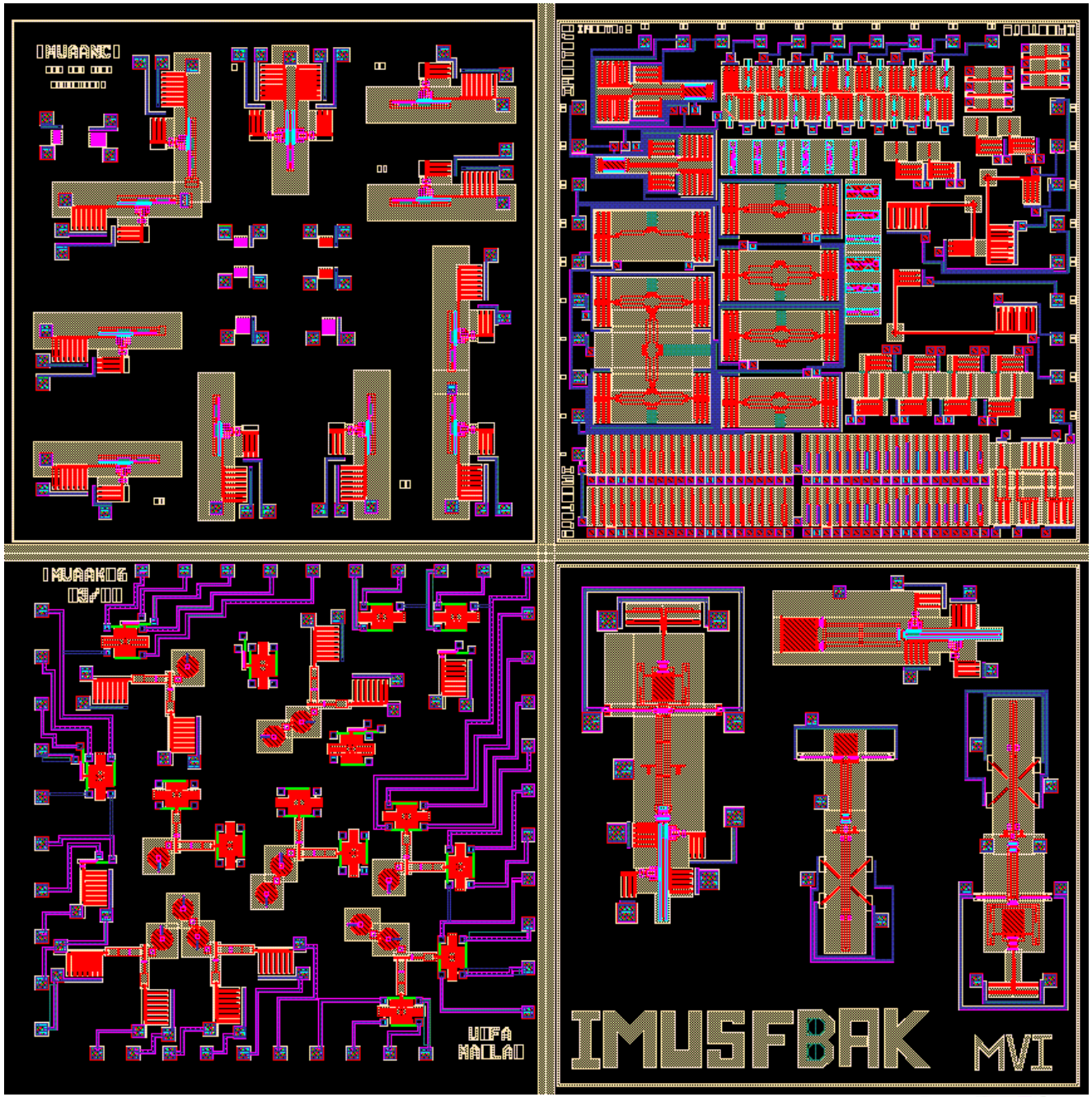
- Bulk processing using 1.5 micron CMOS with user-based postprocessing
- Surface micromachining through Cronos' Multi-User MEMS Processes (MUMPs) program
- MemsCap MEMSPro CAD package and technology files available to qualified members (based on Tanner LEDIT)
- Cadence-based design kit (CAD tools, technology files)

Research Activity Flow

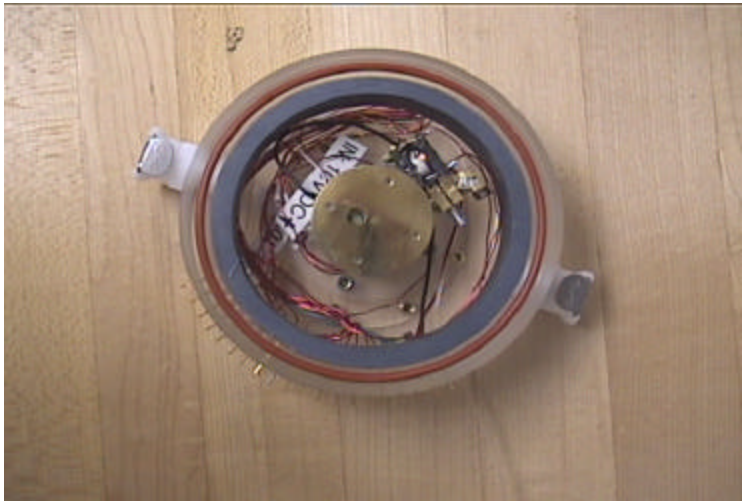


Multiproject Fabrication Run... Type 2

4 designs (or design libraries) from 3 universities use Cronos MUMPS for MEMS research



Universal test box for MEMS
(Professor Ion Stiharu, Concordia U)



Looking Ahead

Initiatives at Canadian universities:

- **McGill University (Peter Gruetter) - $6 million CFI grant for MEMS/micromachining facility**
- **École Polytechnique (Michel Meunier) – MEMS applications in aerospace, biomedicine and electronics. A $10 million MINI grant will help support MEMS work.**

Looking Ahead

Canadian industry:

- Continued technology development and marketing.
  - **Example:** i-STAT produces tens of millions of biosensor MEMS devices annually.
- Increased collaborative research with universities facilitated by infrastructure organizations such as CMC, NSERC, and PRO and new funding initiatives.
  - **Example:** NSERC/COM-DEV Industrial Chair with focus on RF-MEMS at the University of Waterloo

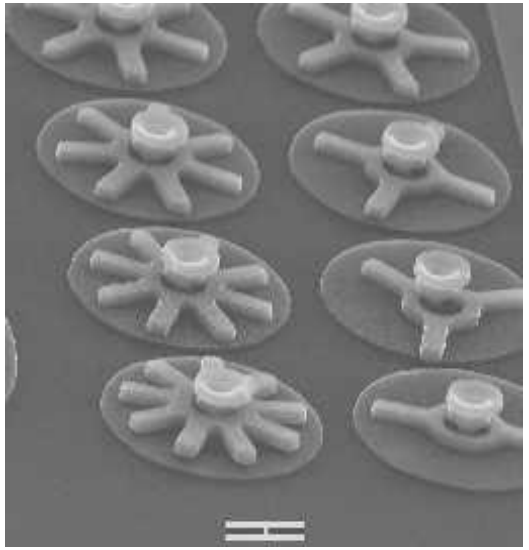
Universities, MEMS Research, CMC

UNIVERTSITIES	*AREA OF INTEREST*
Laurentian University	Optics
McGill University	Optics, Technologies, Sensors-Actuators-MEMS devices
University of Waterloo	Optics, Telecom, Micro Fluidics, CAD-Modeling-Simulation
Carleton University	Telecom, Technologies
University of Manitoba,	Telecom
Concordia University	Technologies, Micro Fluidics, Sensors-Actuators-MEMS devices, Testing
University of Alberta	Technologies, Micro Fluidics, Sensors-Actuators-MEMS devices
École Polytechnique de Montréal	Technologies, Micro Fluidics, Sensors-Actuators-MEMS devices
Queen's university	Technologies, Sensors-Actuators-MEMS devices
DalTech-Dalhousie University	Micro Fluidics, Sensors-Actuators-MEMS devices, Testing
Simon Fraser University	Technologies, Micro Fluidics, Sensors-Actuators-MEMS devices, CAD-Modeling-Simulation
University of Toronto	Sensors-Actuators-MEMS devices
University of Windsor	Micro Fluidics, Sensors-Actuators-MEMS devices, CAD-Modeling-Simulation
University of Calgary	Sensors-Actuators-MEMS devices

Companies and Institutes, MEMS

INSTITUTE & INDUSTRY	*AREA OF INTEREST*
Photonics Research Ontario	Optics, Technologies (Laser Micromachining)
Micralyne Inc	Technologies, Micro Fluidics
Institut National d'optique (INO)	Optics, Technologies
Institute for Microstructural Sciences (NRC)	Telecom, Technologies
Medtronic of Canada Limited	Micro Fluidics
Mitel Semiconductor,	Photonics
COM DEV International, Corporate	Telecom, Technologies
i-STAT Corp	Technologies, Micro Fluidics
JDS Uniphase Corporation	Optics
Goal Semiconductors	Optics
Infolytica Corporation	CAD-Modeling-Simulation
Integrated Engineering Software	Simulation Software (Micro Fluidics, Sensors-Actuators-MEMS devices)

Test Structure for Evaluating Optically Actuated Microsystems
(Dr. Niall Tait, Professor, Carleton University, and Dr. Robert Gauthier, Professor, Laurentian University)



Closing Remarks

- **Canadian universities**
  - significant achievements, wide range of ongoing research
  - new facilities and infrastructure via new funding initiatives
- **Research infrastructure**
  - organizations provide expertise and access to fabrication
- **Canadian industry**
  - need access to research expertise and trained people
  - growing collaboration with university researchers
  - established base for development and production

Let's add Canadian aerospace interests to the mix

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