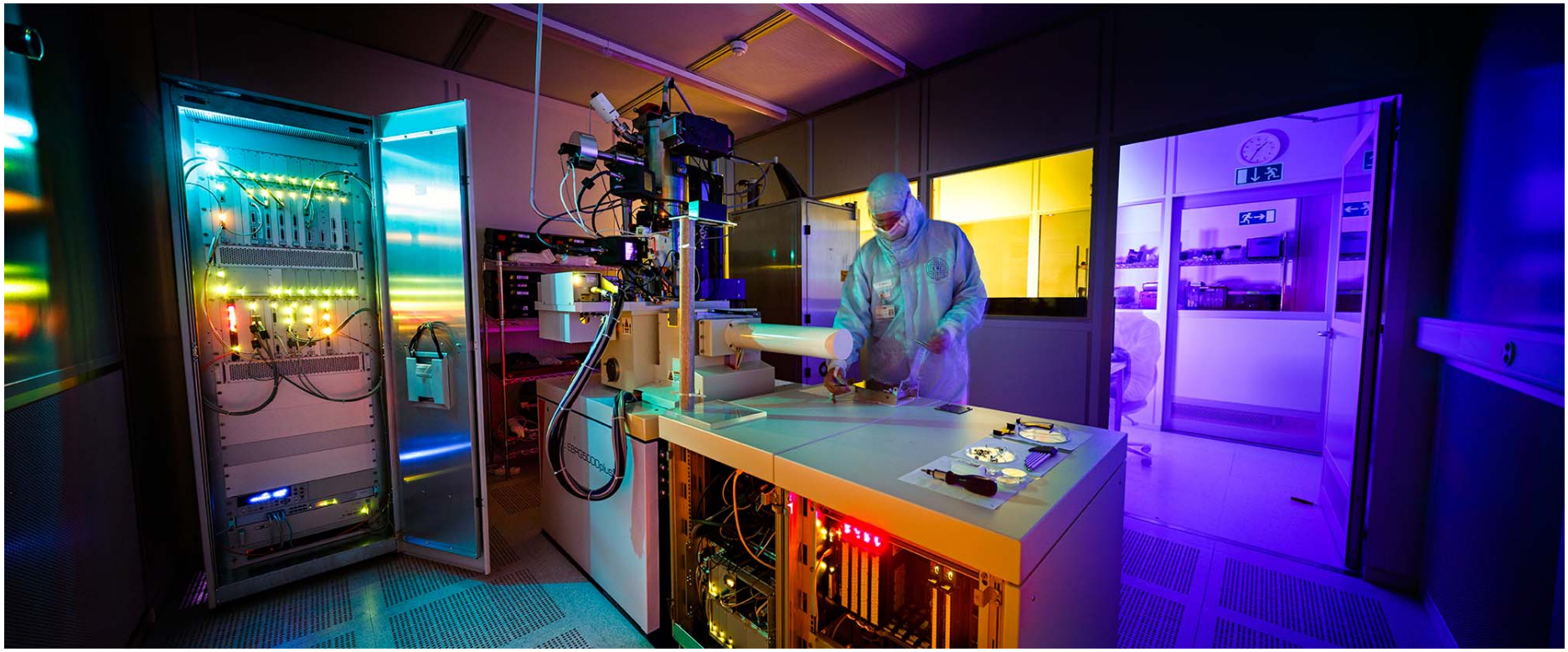
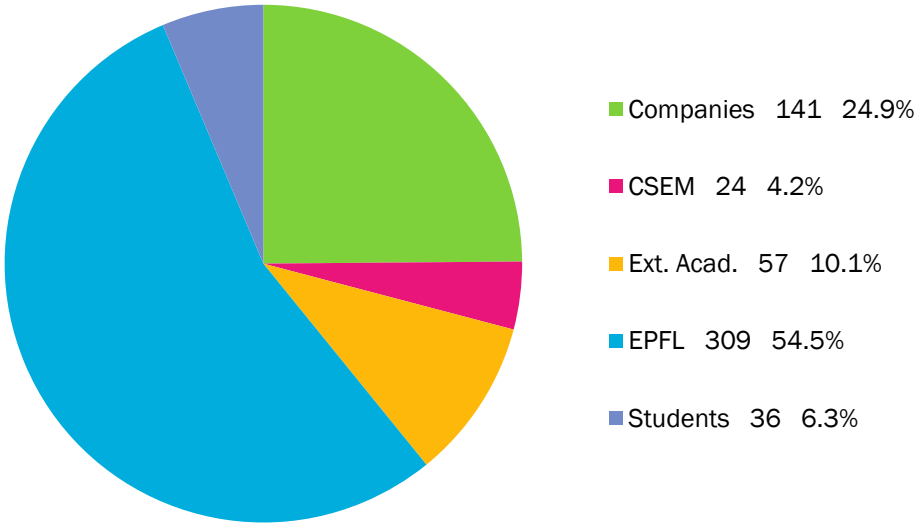


EPFL MICRONANOFABRICATION ANNUAL REVIEW MEETING

EPFL MICRONANOFABRICATION ANNUAL REVIEW MEETING

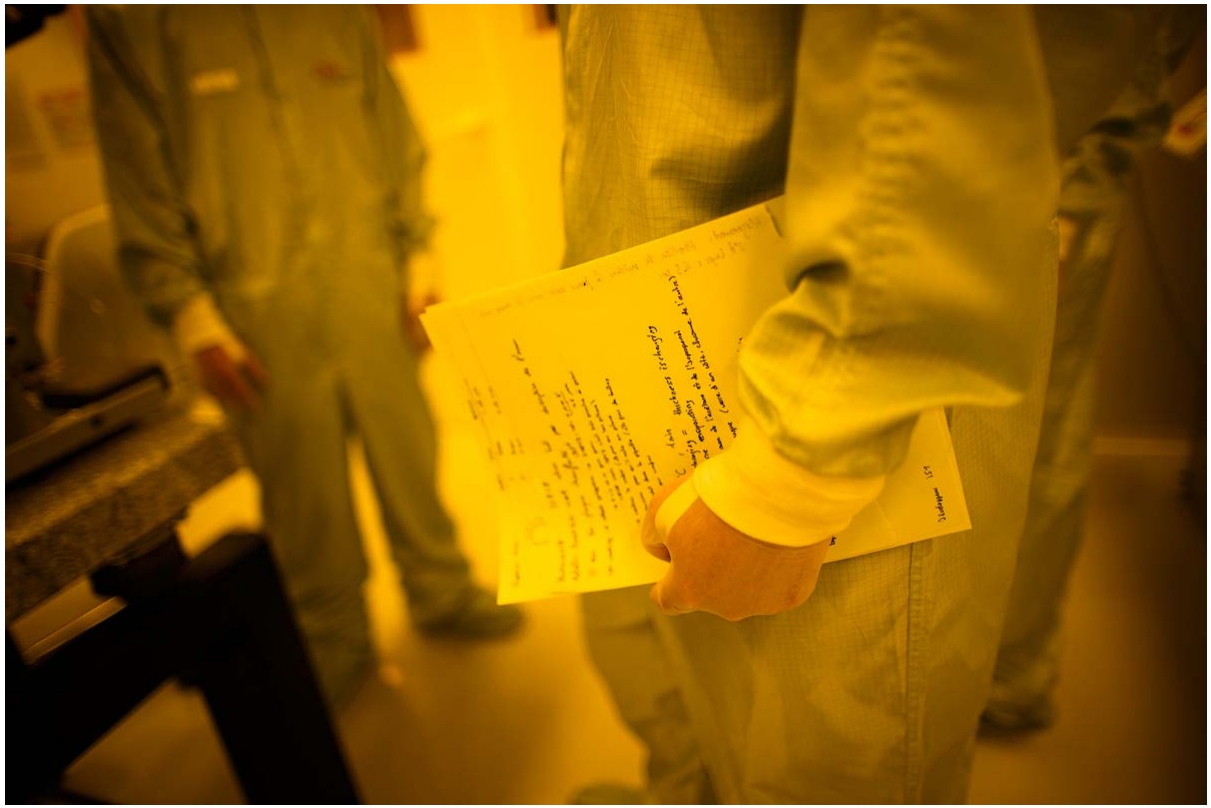
WELCOME & THANKS

- Welcome to the 14th edition of the CMi MicroNanoFabrication Annual Review Meeting
- Many thanks for your participation
- 567 participants registered (with 40% from outside of EPFL, 25% from companies)
- +33% compared to 2012



OUTLINE

- Users
- Projects
- Technology
- Tools

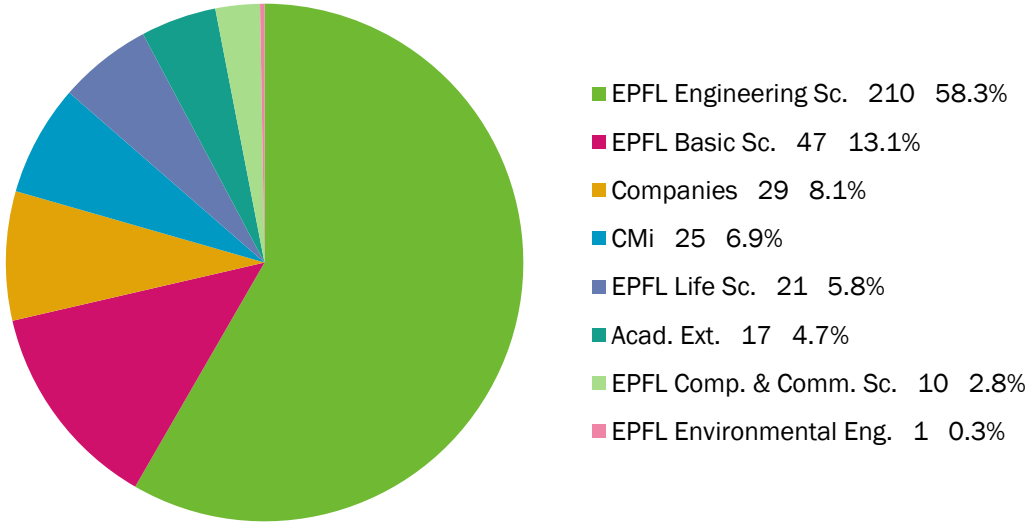


USERS IN 2012

EPFL Engineering Sc.		Basic Sc.	Life Sc.	Ext. Ac.	Companies
STI-CBT-LBO	STI-IMT-LMIS1	SB-ICMP-LASPE	SV-BMI-LNMC	CERN	Abionic
STI-CMI	STI-IMT-LMIS2	SB-ICMP-LOEQ	SV-BMI-LSYM	CSEM	Aleva
STI-IBI-CLSE	STI-IMT-LMIS4	SB-ICMP-LPMC	SV-GHI-UPKIN	ETHZ-Basel	Asulab
STI-IBI-LBEN	STI-IMT-LMTS	SB-ICMP-LPN	SV-IBI-LMBM	FEMTO-DMA	Axetris
STI-IBI-LBNC	STI-IMT-LO	SB-ICMP-LPQM1	SV-IBI-UPDEPLA	Metas	Biocartis
STI-IBI-LBNI	STI-IMT-LOB	SB-ICMP-LQM	SV-IBI-UPLUT	Uni-Basel	Bruker
STI-IBI-LHTC	STI-IMT-LPM	SB-IPSB-LCB	SV-IBI-LDCS	Uni-Fribourg	Debiotech
STI-IEL-GR-JPC	STI-IMT-LPMAT	SB-IPSB-LPMV			Karmic
STI-IEL-GR-SCI-IEL	STI-IMT-LSBI	SB-ISIC-LEPA	ENAC-IA-LIV		Lemoptix
STI-IEL-LANES	STI-IMT-NAM	SB-ISIC-LIMNO	ENAC-IIE-DISAL		MCH-processing
STI-IEL-LSM	STI-IMT-OPT	SB-ISIC-LPI			Nanoworld
STI-IEL-NANOLAB	STI-IMT-SAMLAB				Novagan
STI-IGM-LFMI	STI-IMX-LC				Oerlikon
STI-IGM-LTCM	STI-IMX-LMM		IC-ISIM-LSI1		Qwane
STI-IMT-ESPLAB	STI-IMX-LMSC				Rolex
STI-IMT-GR-SCI-HL	STI-IMX-LP				Sercalo
STI-IMT-LAI	STI-IMX-LTC				Sigatec
STI-IMT-LAPD	STI-IMX-LTP				SilMach
STI-IMT-LIS	STI-IMX-SUNMIL				Soitec
235 (38)		47 (11)	32 (9)	17(8)	29 (19)

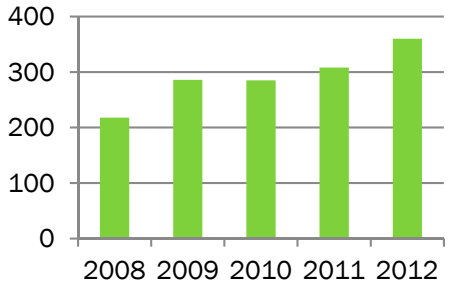
- Total: 360 users (+17%)
- Total: 85 labs or companies

USERS IN 2012



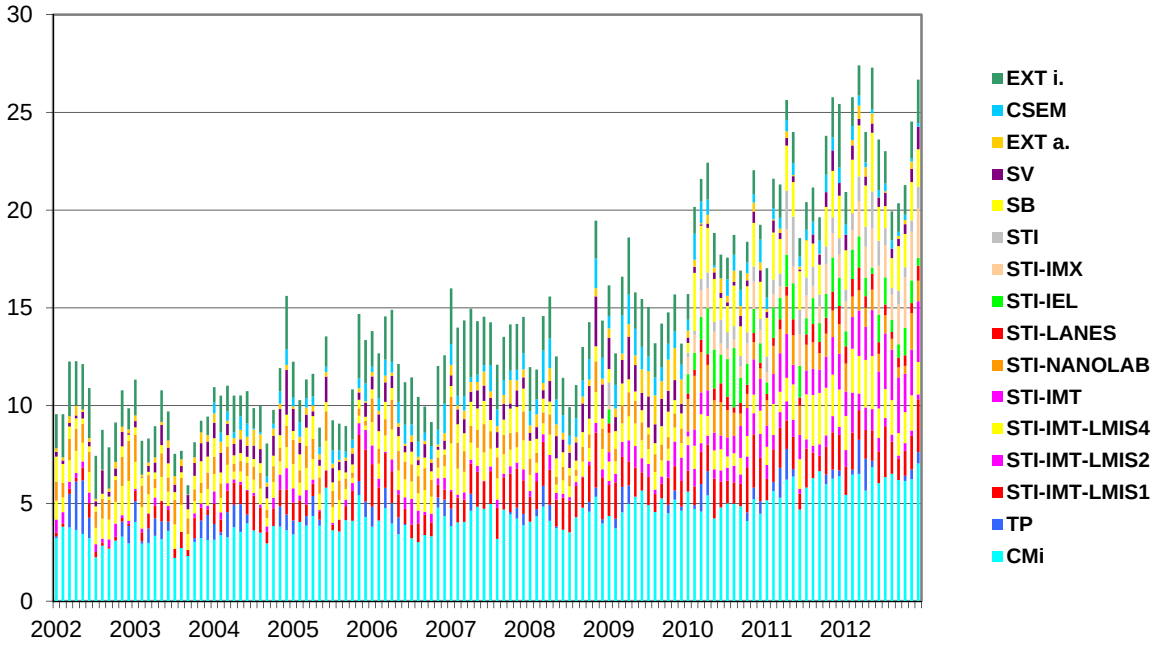
- For the next 5 years we expect an annual growth of 10%

- Total: 360 users (+17%)
- Total: 85 labs or companies



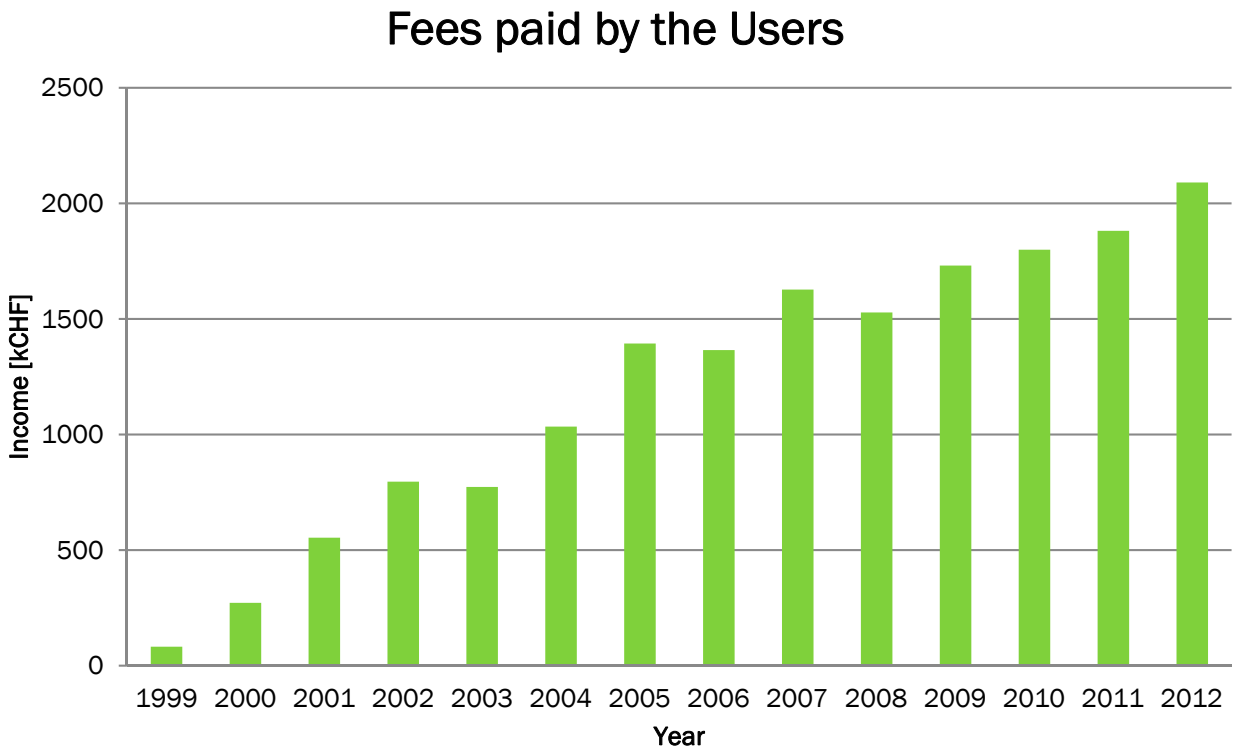
USERS IN 2012

2002-2012
Average Cleanroom Occupancy in the daytime



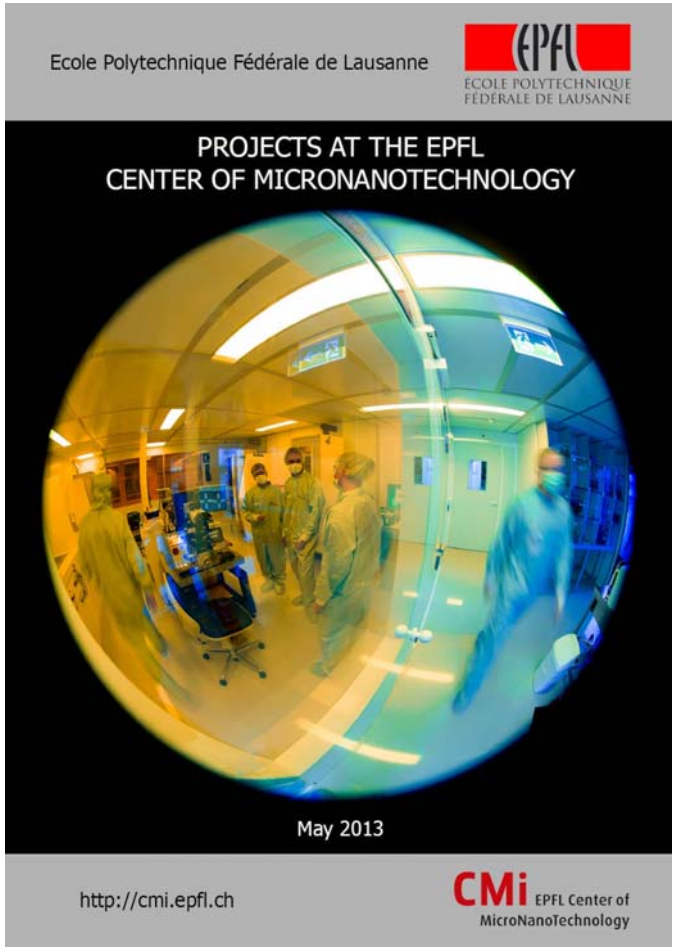
- We observe a very regular growth of the average cleanroom occupancy over the years
- Occupancy peaks with not less than 40 to 45 Users simultaneously

USERS IN 2012

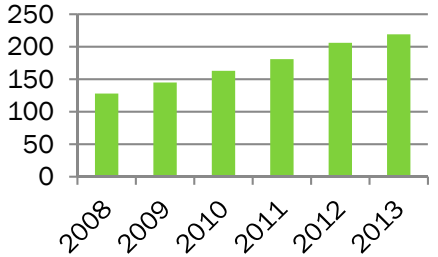


- Users's fees growth over the last 14 years
- The fees cover 25% of the total costs (8 MCHF/year)

ABSTRACTS IN 2013



- 219 abstracts (+6%)



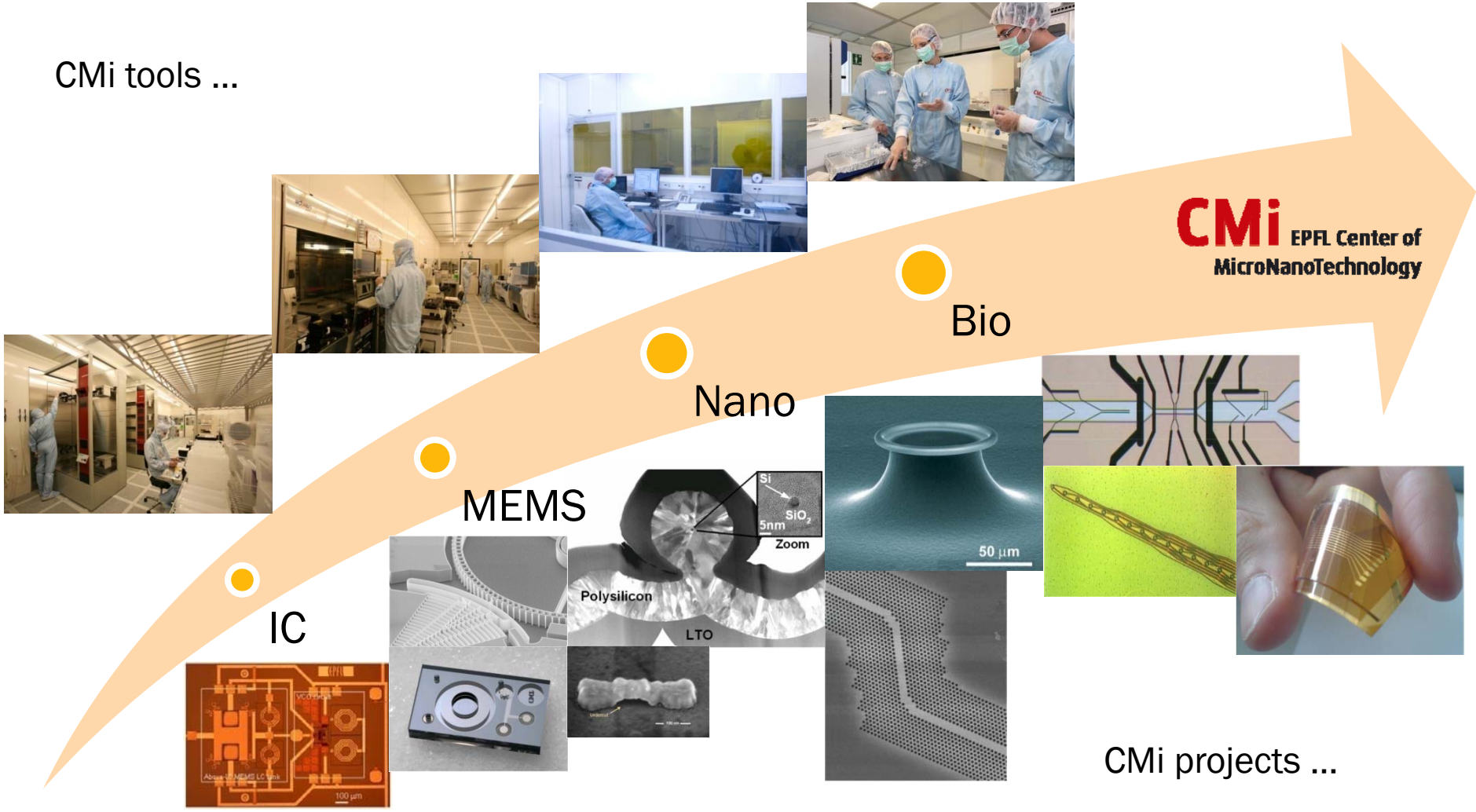
USERS & PROJECTS: THE REAL VALUE

- The Users and their Projects are the real value of the CMi
- The CMi is not producing wafers but it is participating to produce top quality PhD students
- The increase of the Users is the key indicator of the success of the CMi

- Large variety of processes
- World class equipment
- Dedicated staff

TRENDS IN MICRO- NANO- TECHNOLOGIES

CMi tools ...



CMi projects ...

HISTORICAL MILESTONES

IC & MEMS 1998	• CMi created in 1998 & Cleanroom opened in March 1999 • Basic Microelectronics processes • MEMS processes like Deep silicon etching & SU-8
Nano 2007	• Electron Beam Lithography acquired in 2007 • Focused Ion Beam in 2004 • Atomic Layer Deposition in 2011
Bio & New Materials 2010	• Cleanroom extension opened in 2010 for more flexibility and cheaper access • **Operated now in 24/7 mode** since 2012 • PDMS, SU-8, Chemistry, Metrology, Non-conventional processes
Materials Diversity 2013	• Ion Beam Etching: a key instrument to pattern a huge variety of exotic materials
Renewal & Capacity 2013 & 2014	• Photolithography: Mask Fabrication – Coater & Developer – Mask Aligner • PVD • Dry Etching

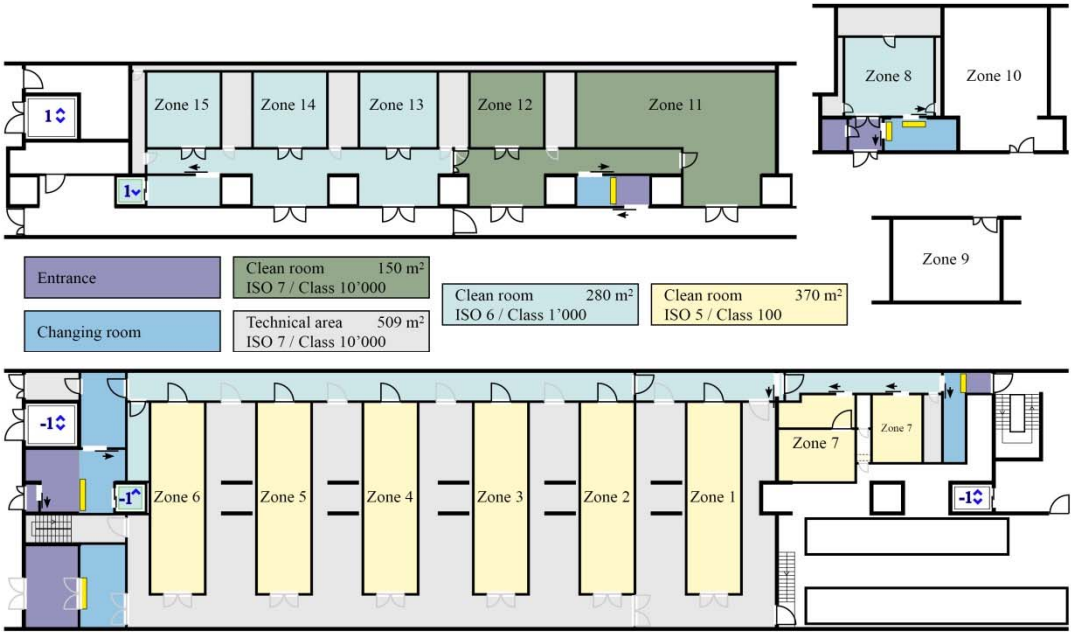
CLEANROOM EXTENSION

- CMi BM+1 was inaugurated 2 years ago
- CMi BM+1 is very instrumental in developing new fields of activities

CLEANROOM EXTENSION

- CMi BM+1

- CMi BM-1



CMi BM+1 mainly dedicated to:

- Metrology
- Wet Chemistry
- Photolithography
- PDMS processing
- Thin films
- Backend activities
- Exploratory processes

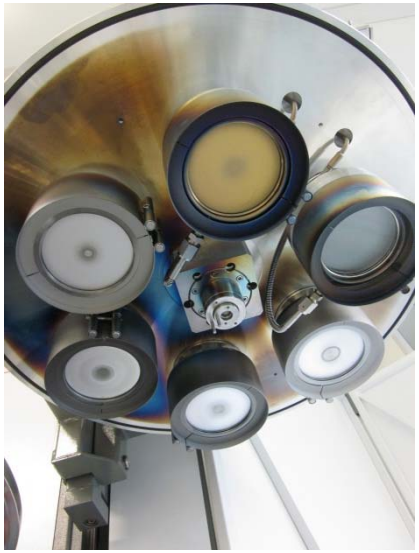
Total Surface	NEW surface
1300m^2	300m^2

- CMi BM+1 is now open 24/7 (except for wet chemistry)
- Well equipped with a wide variety of processes

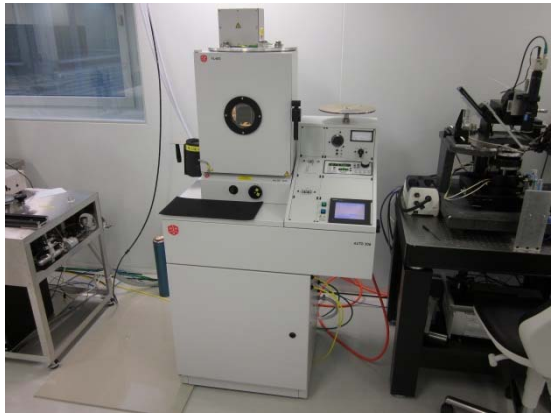
NEW TOOLS ACQUIRED IN 2012

- Alliance Concept DP650 Sputter (budget 2011)
- Edwards Auto 306 Joule Evaporator (Prof. Lacour & CMi)
- SPTS APS LPX Dielectric RIE (Prof. Kippenberg)
- XeF2 etcher (Prof. Kippenberg)
- Jipelec JetFirst 200 RTP
- Toho FLX 2320-S Stress Measurement System
- Wire Bonder (Prof. Popovic)
- Idonus chip to chip bonder (Prof. Radenovic & CMi)
- Idonus Shadow Mask Aligner (Prof. Lacour & CMi)
- LIFT Laser Induced Forward Transfer (Prof. Brügger)
- Veeco IBE NEXUS IBE350Si (installed in 2013)
- ICMP Kenosistec KS500C Dielectric Sputter
- ICMP Süss MA6 Mask aligner
- ICMP Oxford SiC Process upgrade (Aleva)
- ICMP X-Rays
- ICMP Labspin Coater

NEW TOOLS ACQUIRED IN 2012



Alliance Concept DP650
Sputtering tool



Edwards Auto 306 Joule Evaporator
(Prof. Lacour & CMi)

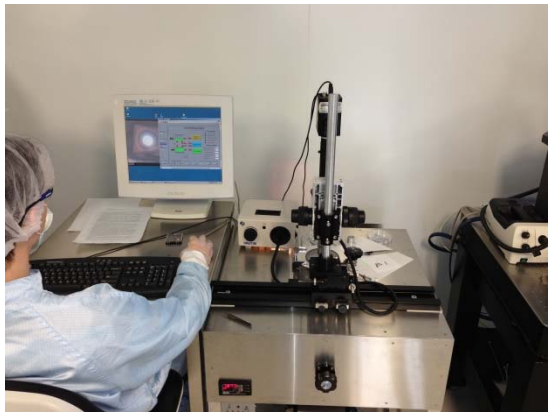
NEW TOOLS ACQUIRED IN 2012

SPTS APS ICP Dielectric RIE
(Prof. Kippenberg)

- > 550 nm/min etch rate in SiO2

NEW TOOLS ACQUIRED IN 2012

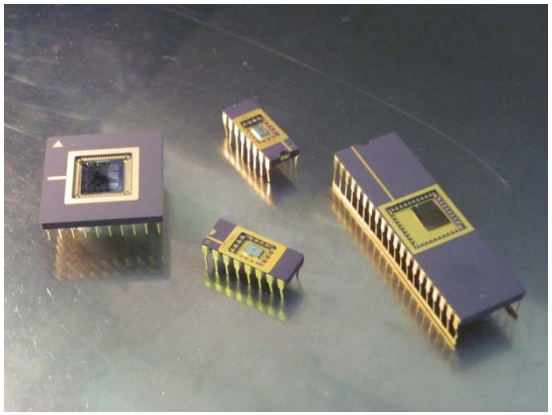
Jipelec JetFirst 200 RTP



XeF2 etcher (Prof. Kippenberg)

NEW TOOLS ACQUIRED IN 2012

Toho FLX 2320-S Stress Measurement System



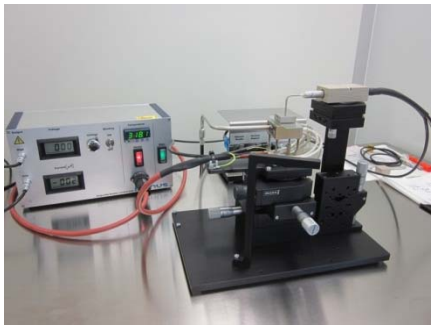
Wire Bonder
(Prof. Popovic)

NEW TOOLS ACQUIRED IN 2012

Fraunhofer Laser Induced Forward Transfer
(Prof. Brügger)

Laser Induced Forward Transfer (LIFT):

- accurate deposition (10-80um spot size)
- thermally and mechanically sensitive material
- proteins, living cells, bioactive substances, …



Idonus chip to chip bonder
(Prof. Radenovic)

Idonus Shadow Mask Aligner
(Prof. Lacour)

NEW TOOLS ACQUIRED IN 2012

Veeco IBE NEXUS IBE350Si
(Installed in 2013)

Presentation by Veeco
This afternoon

- 350mm ion beam diameter
- 1.5% uniformity on 100mm wafers
- SIMS for endpoint detection
- World class tool
- Adapted for milling a huge variety of materials
- 100mm & 150mm wafer size compatible

NEW TOOLS ACQUIRED IN 2012

Etch Rates of Common Materials utilizing 700 eV Ar ions (1.2 mA/cm2) at Normal Incidence	
Material	**Etch Rate (Angstroms / Minute)**
Au	3040
Pt	1310
Pd	1780
Cu	1670
Al	1060
Ti	400
TiW	610
Cr	810
Cr_2O_3	310
Al_2O_3	320
NiFe (81/19)	850
TiN	380
Photoresist (AZ)	480
$LiNbO_3$	720
AlTiC	260
Si	750
SiO_2	720
Ta	540

- Etch rates of common materials
- → selectivity against PR

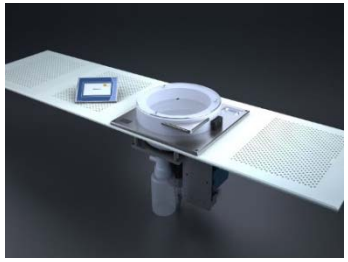
NEW TOOLS ACQUIRED IN 2012 (ICMP)

Kenosistec
sputter KS500C

- For dielectric Bragg reflectors

Süss MA6

X-Rays



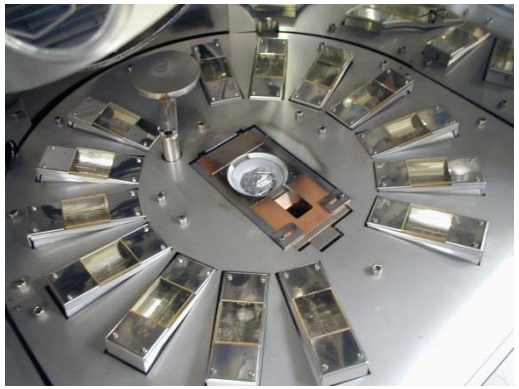
Labspin coater

INVESTMENT PROPOSAL – 2013

Thin Film Evaporator for CMi BM+1	Ordered
Direct Writing System (replacement 12 years)	PO 2013
FTIR	PO 2013
Photoresist Coat & Develop (remplacement >20 ans)	PO 2013-2014
Mask Aligner (16 years)	PO 2013-2014
ICP RIE Metal (17 years)	PO 2014

INVESTMENT PROPOSAL – BUDGET 2013

- Thin Film Evaporator EVA 760 Alliance Concept
  - Ordered
  - To be delivered in January 2014 and installed in CMi BM+1



INVESTMENT PROPOSAL – BUDGET 2013

- New Direct Writing Laser
  - Replacement of our 12 years old tool
  - Discontinuance of Spectra Physics Water-Cooled Ion Lasers
  - Writing errors due to electronics obsolescence
  - Conversion issues due computer & software obsolescence
  - Mix & match not possible due to stage & writing inaccuracy

- The new generation of tools show spectacular progress in many aspects:
  - speed
  - resolution
  - stitching
  - conversion software
  - …

INVESTMENT PROPOSAL – BUDGET 2014

- New automatic Coater Developer to backup:
  - Rite Track > 20 years
  - EVG 150 permanently overbooked

INVESTMENT PROPOSAL – BUDGET 2014

- New Mask aligner :
  - Replace the MA150 20 years old
  - Backup the MA6 permanently overbooked

INVESTMENT PROPOSAL – BUDGET 2014

- New RIE Metal Etcher
  - Replace our STS which is 17 years old

PROGRAM

- Very exciting program
- 13 presentations spanning an exceptionally broad range
- One common point:
  - MicroNanoFabrication
- Don't forget to visit the posters
- WiFi code at the end of the participants list

CMi EPFL Center of MicroNanoTechnology

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

MicroNanoFabrication Annual Review Meeting

Date: Tuesday May 7th, 2013
Time: 09h30 – 17h00
Place: EPFL, Forum Rolex Learning Center, RLC E1 240

Program:

09h30-10h00	Coffees and croissants, distribution of badges and proceedings
10h00-10h05	***Benoît Deveaud-Plédran**, Dean of Research*, Welcome address
10h05-10h15	***Philippe Renaud** and **Philippe Flückiger** (http://cmi.epfl.ch)*, Introduction
10h15-10h35	***Albert van den Berg** (http://www.utwente.nl/ewi/bios)*, Micro- and nanofabrication for lab on a chip
10h35-10h55	***Anna Fontcuberta i Morral** (http://lmsc.epfl.ch)*, III-V nanowires for solar cells
10h55-11h15	***Peter Pfluger** (http://www.tronicsgroup.com/)*, Towards new devices through new MEMS/NEMS fabrication technologies
11h15-11h45	**Break**
11h45-12h00	***Romuald Houdré** (http://loeq.epfl.ch)*, Hollow photonic crystal structures for sensing and optical trapping
12h00-12h15	***Davide Balma** (http://lc.epfl.ch)*, PZT thin films for fast and low-voltage MEMS applications
12h15-12h30	***André Mercanzini** (http://www.aleva-neuro.com)*, From zone 1 to the human brain: How Aleva developed a medical device at CMi
12h30-14h00	**Lunch & Poster Session**
14h00-14h15	***Matthias Lutolf** (http://lscb.epfl.ch)*, Engineering hydrogel microfluidics for stem cell biology
14h15-14h30	***Victor Brasch** (http://k-lab.epfl.ch)*, Frequency comb generation in silicon nitride microresonators
14h30-14h45	***Michael Fey** (http://www.bruker.com)*, NMR on the micro scale: Challenges and solutions
14h45-15h15	**Break**
15h15-15h30	***Herbert Shea** (http://lmts.epfl.ch)*, Artificial muscles on a chip
15h30-15h45	***Ivan Minev** (http://lsbi.epfl.ch)*, Soft neural electrodes for mechanically challenging applications
15h45-16h00	***Patrice Minotti** (http://www.silmach.com)*, Airflow control using distributed servoMEMS actuators
16h00-16h15	***Adrian Devashayam** (http://www.veeco.com)*, Patterning of magnetic sensors and piezoelectric devices by ion beam etch
16h15-17h00	**Cocktails & Poster Session**

THANKS FOR YOUR ATTENTION

ENJOY THE CONFERENCE