A Importância da Indústria de Semicondutores no Brasil e os Desafios para a Continuidade dos Incentivos ao Setor (Lei de Informática e PADIS)

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SBMicro Sociedade Brasileira de Microeletrônica

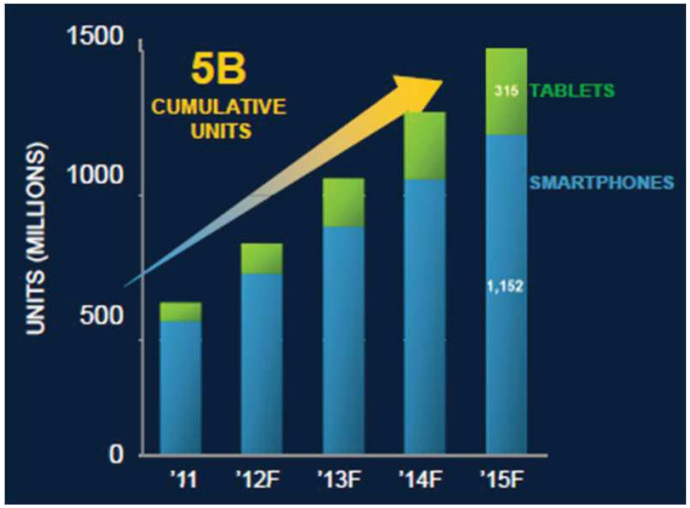
Comissão de Ciência e Tecnologia, Comunicação e Informática
Câmara dos Deputados

10 de outubro de 2019

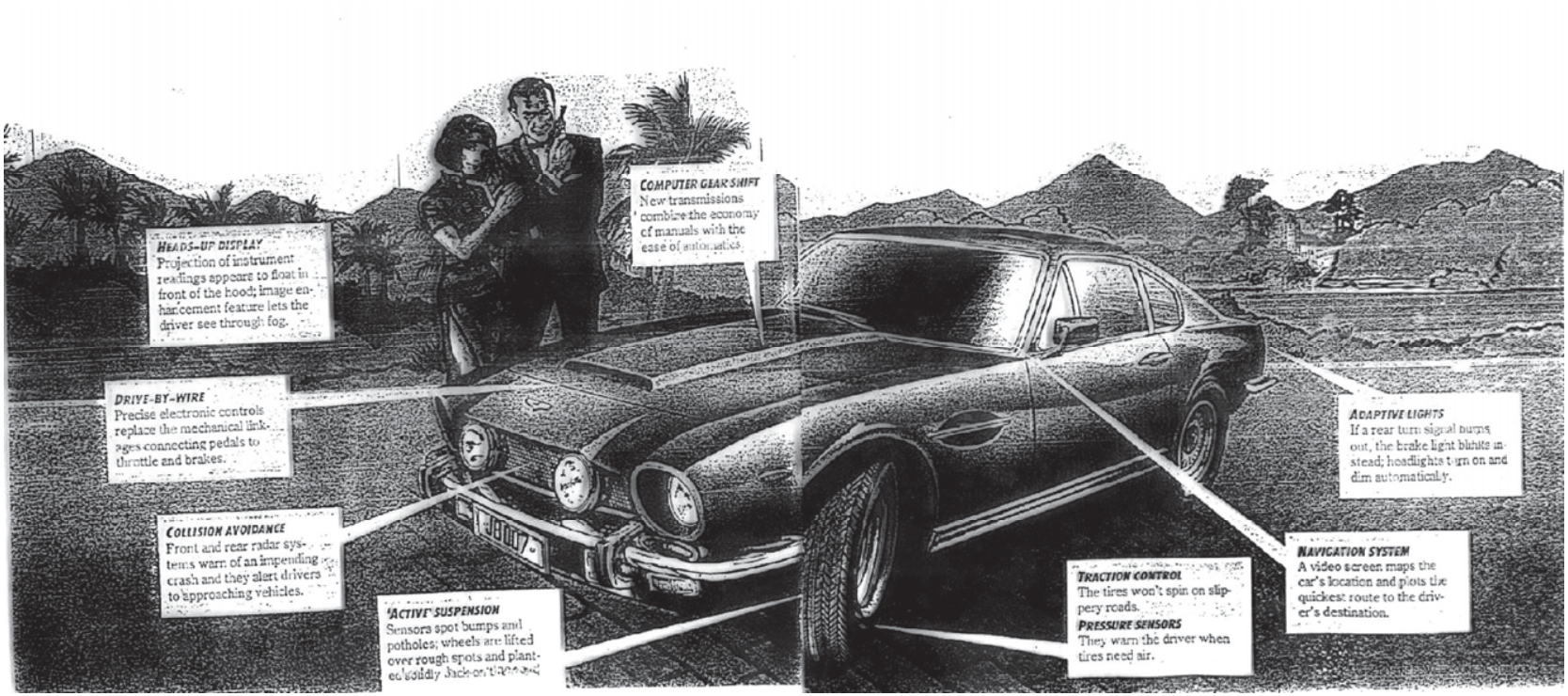
Indústria de Semicondutores

- Indústria de base – fornecedora de componentes e peças de TODAS as empresas que produzem qualquer produto eletrônico (“indústria das indústrias”)
- Indústria de BASE TECNOLÓGICA – concentra o mais alto grau de desenvolvmento tecnológico de todo o planeta!!
- Indústria chave e estratégica – Nenhum País se tornará desenvolvido sem uma indústria de semicondutores minimamente avançada com TODOS os elos da cadeia produtiva (projeto, fabricação e encapsulamento)

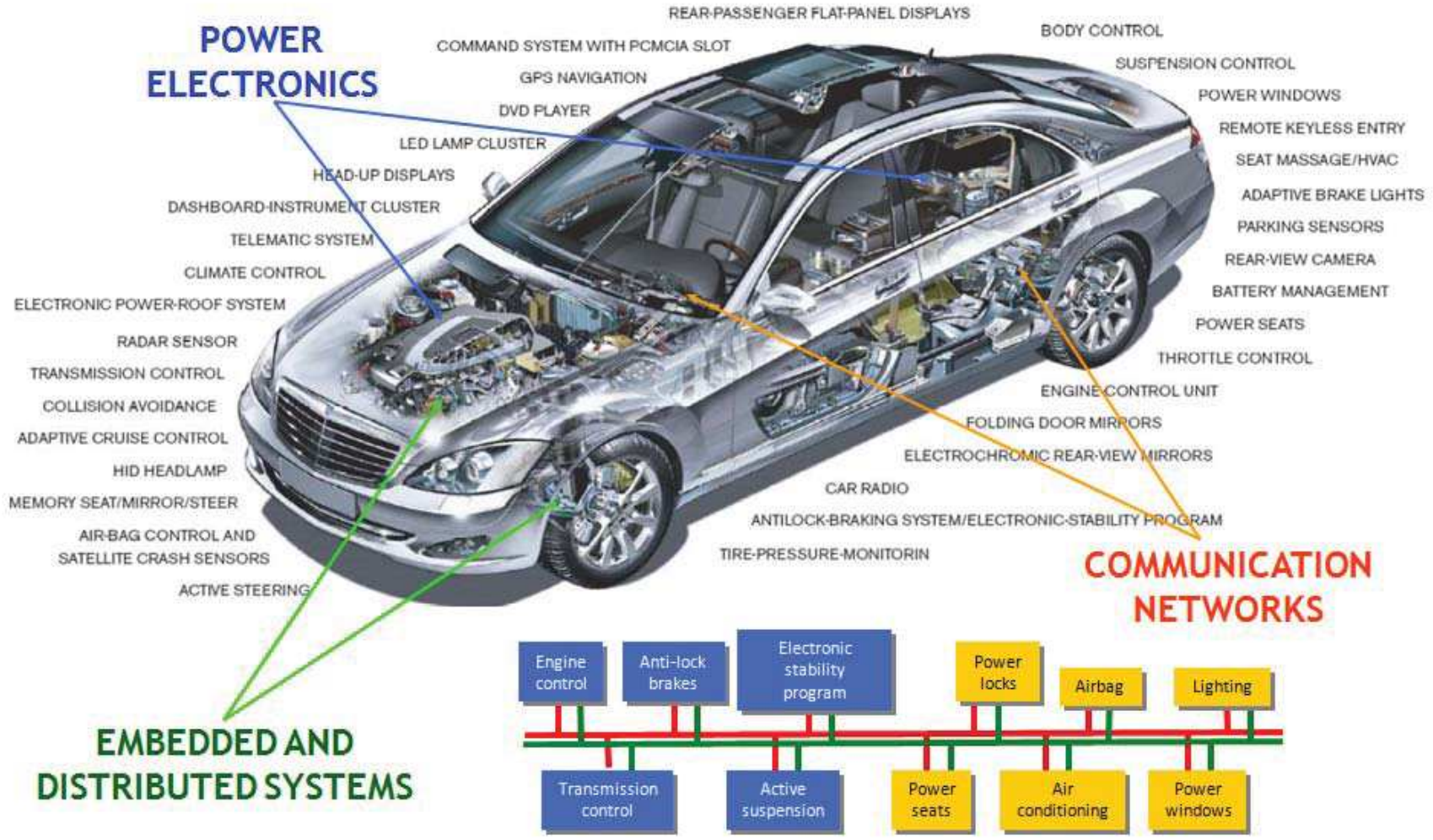
Aplicações da Microeletrônica



Aplicações em Automotiva



industrial electronics in electric cars



From applications to devices

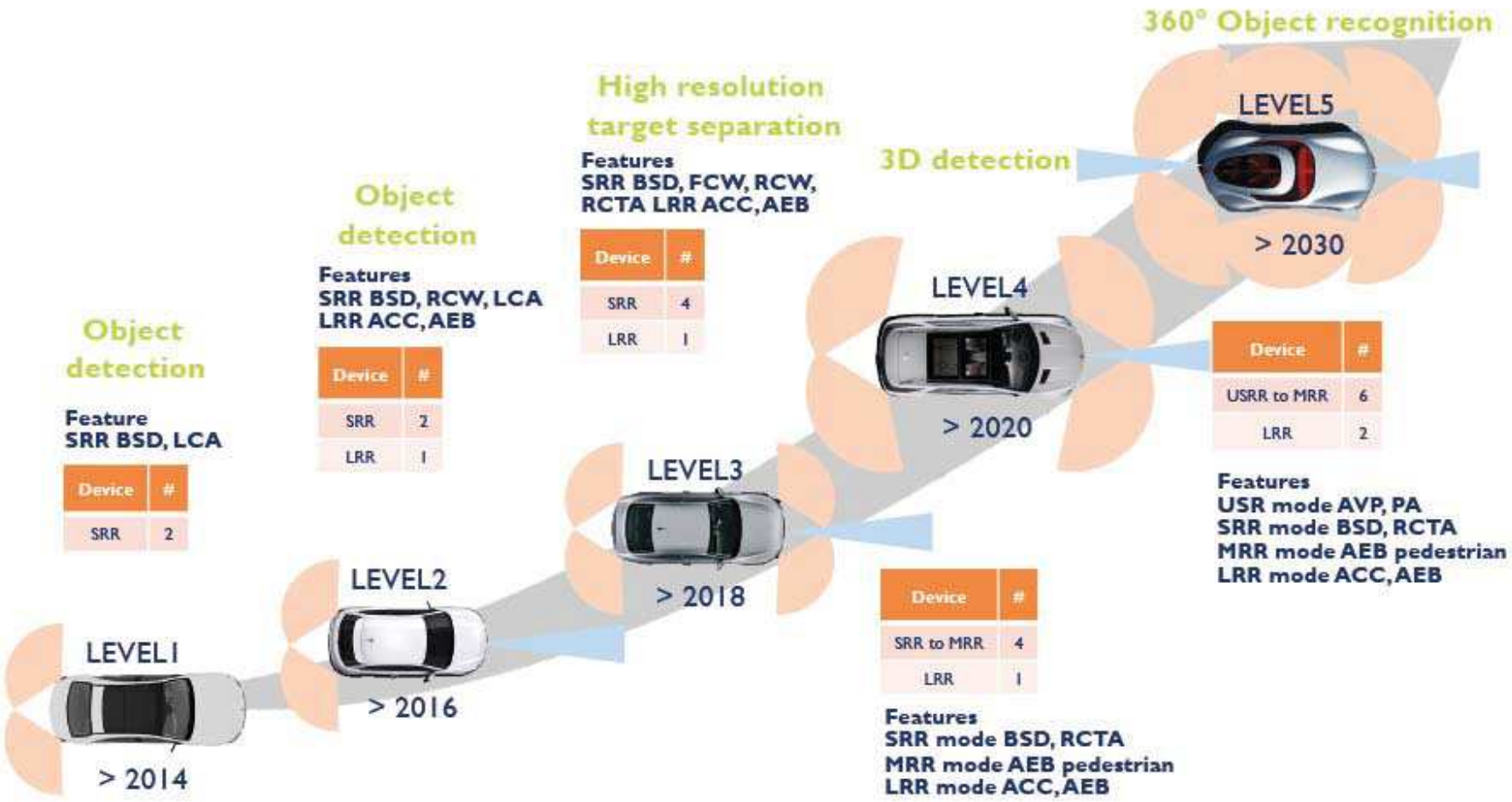
(Source: Imaging Technologies for Automotive 2016, October 2016, Yole Développement)

Main sensors to transform your car into a superhero car

(Source: Sensors and Data Management for Autonomous Vehicles report 2015, October 2015)

Radar's long-term evolution

(Source: Radar Technologies for Automotive 2018, Yole Développement, November 2017)



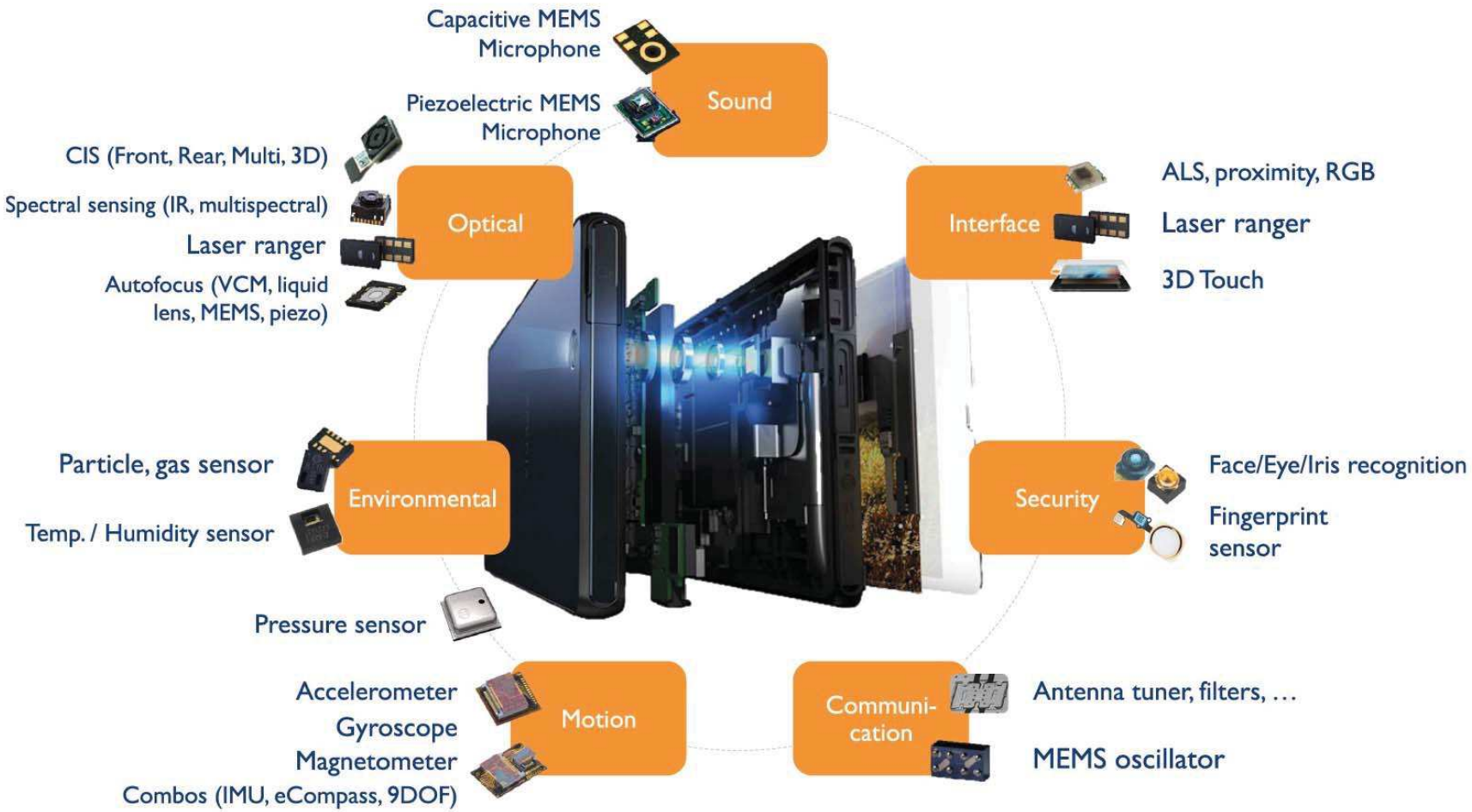
Explosion of automotive applications

(Source: Radar Technologies for Automotive 2018, Yole Développement, November 2017)

- AEB: Automatic emergency braking
- AEB VRU: Automatic emergency braking vulnerable road user
- ACC: Adaptive cruise control
- ALC: Active lane control
- AP: Automated pilot
- AVP: Automated valet parking
- BSD: Blind spot detection
- FCW/RCW: Forward/ Rear crash warning
- LCA: Lane change assist
- PA: Parking assistance
- PCW: Pre crash warning
- (R)CTA: Rear cross traffic alert
- RPCW: Rear pre crash warning
- VEA: Vehicle exit assist

Mobile value proposition

Source : Sensors for cellphones and tablets 2016 Market and Technology report, Yole Développement, June 2016



Aplicações em Medicina

Medical robotics market

(Source: Medical Robotics Technology & Market Analysis 2017, Yole Développement, November 2017)

Surgical robots

- Endoscopic
- Minimally invasive surgery
- Neurosurgery
- Non invasive radiosurgery
- Orthopedics
- Others

Hospital and ambulatory care

- Telepresence
- Telemedecine
- Blood-drawing robots
- Emergency response
- Others

Medical robotics

Prosthetics and rehabilitation

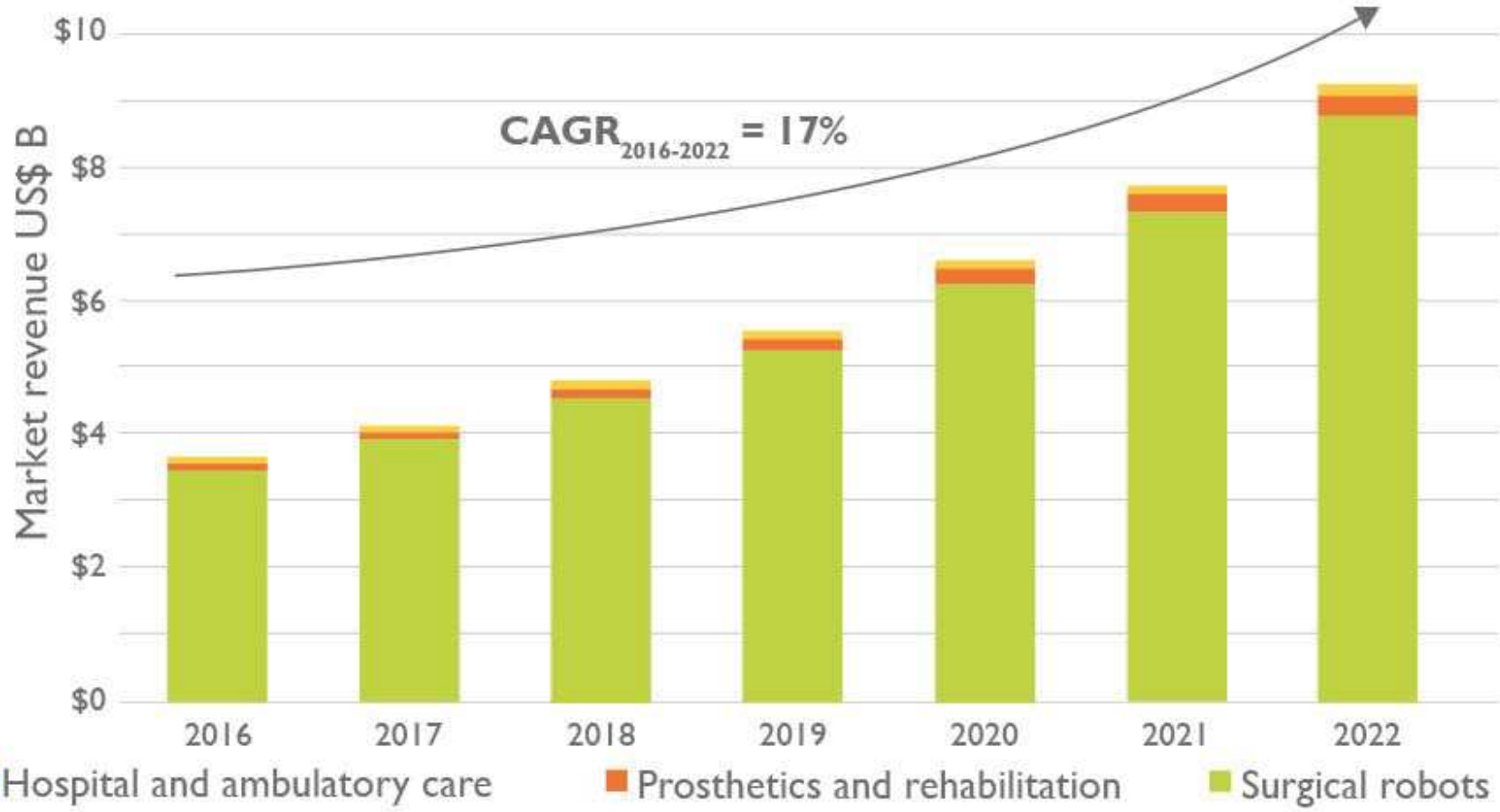
- Lower limb exoskeleton
- Upper limb exoskeleton
- Rehabilitation robots
- Prosthetics

Micro-robots

- Drug delivery
- Targeted treatment

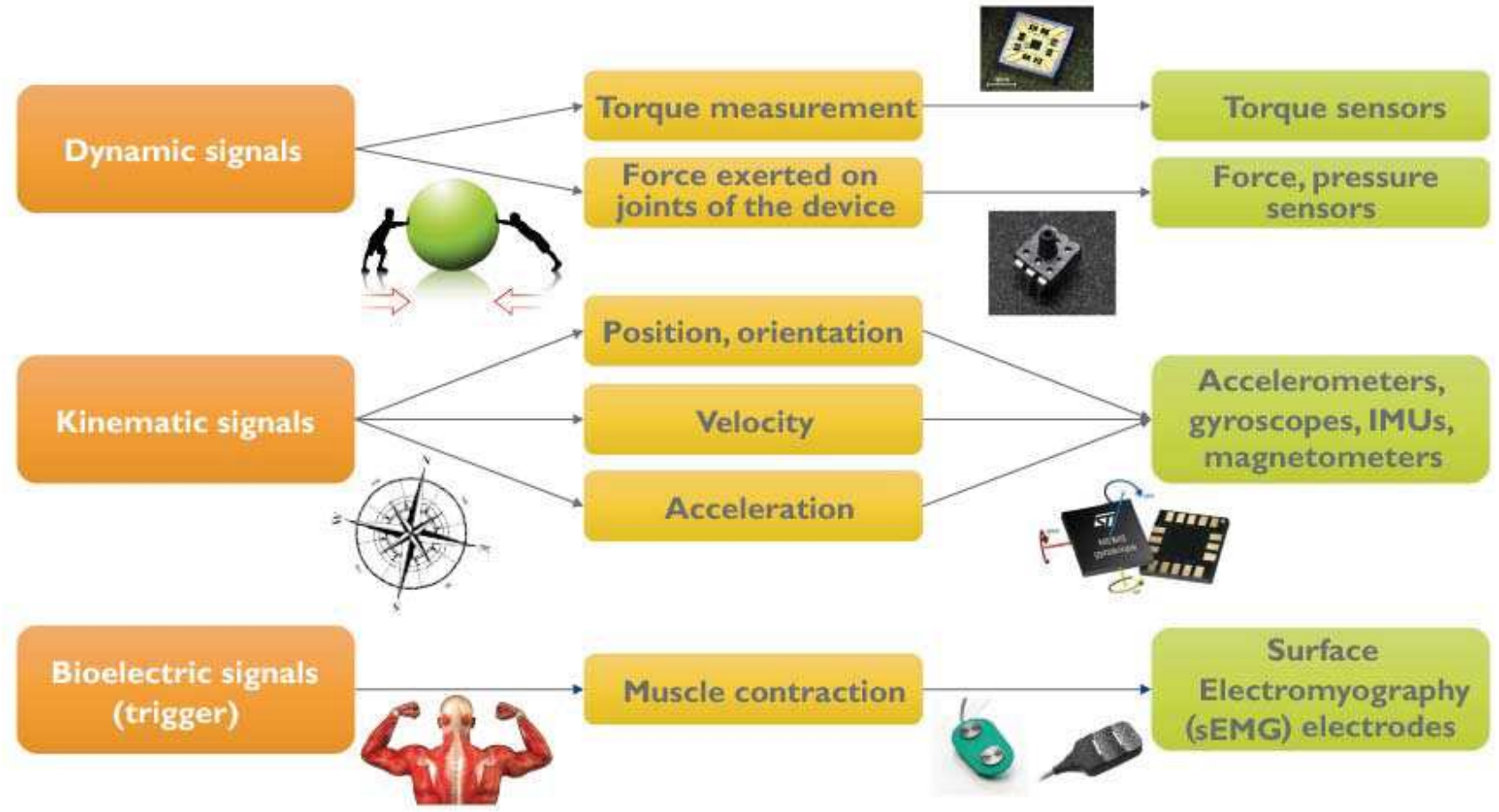
Medical robotics systems market data and forecasts in US$B 2016 - 2022

(Source: Medical Robotics Technology & Market Analysis 2017, Yole Développement, November 2017)

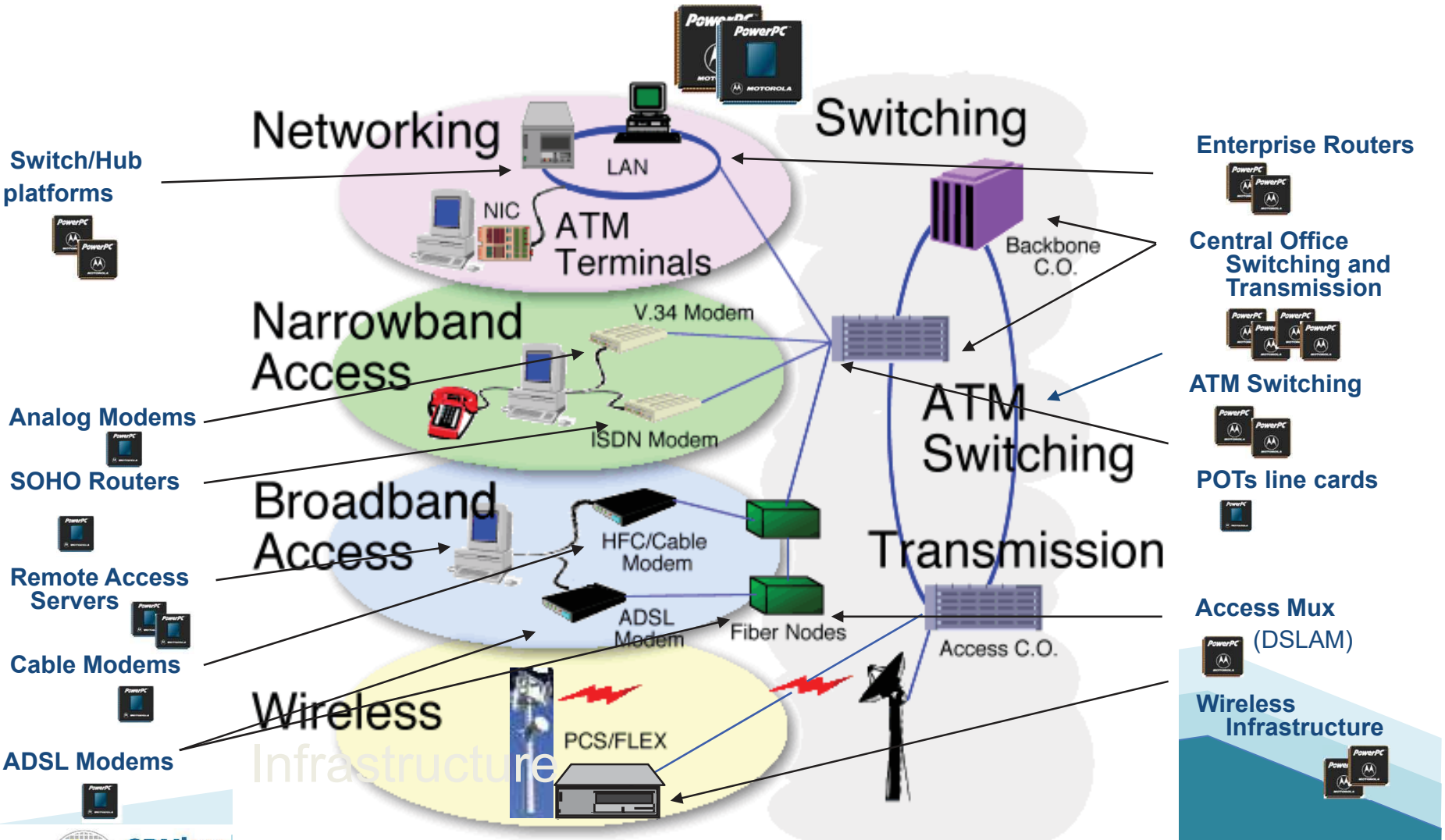


Rehabilitation robots – Different types of sensing strategies that can be combined

(Source: Medical Robotics Technology & Market Analysis 2017, Yole Développement, November 2017)



TUDO ACABA NUM CHIP



Indústria de Semicondutores no Brasil

SBMicro Sociedade Brasileira de Microeletrônica

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Câmara dos Deputados

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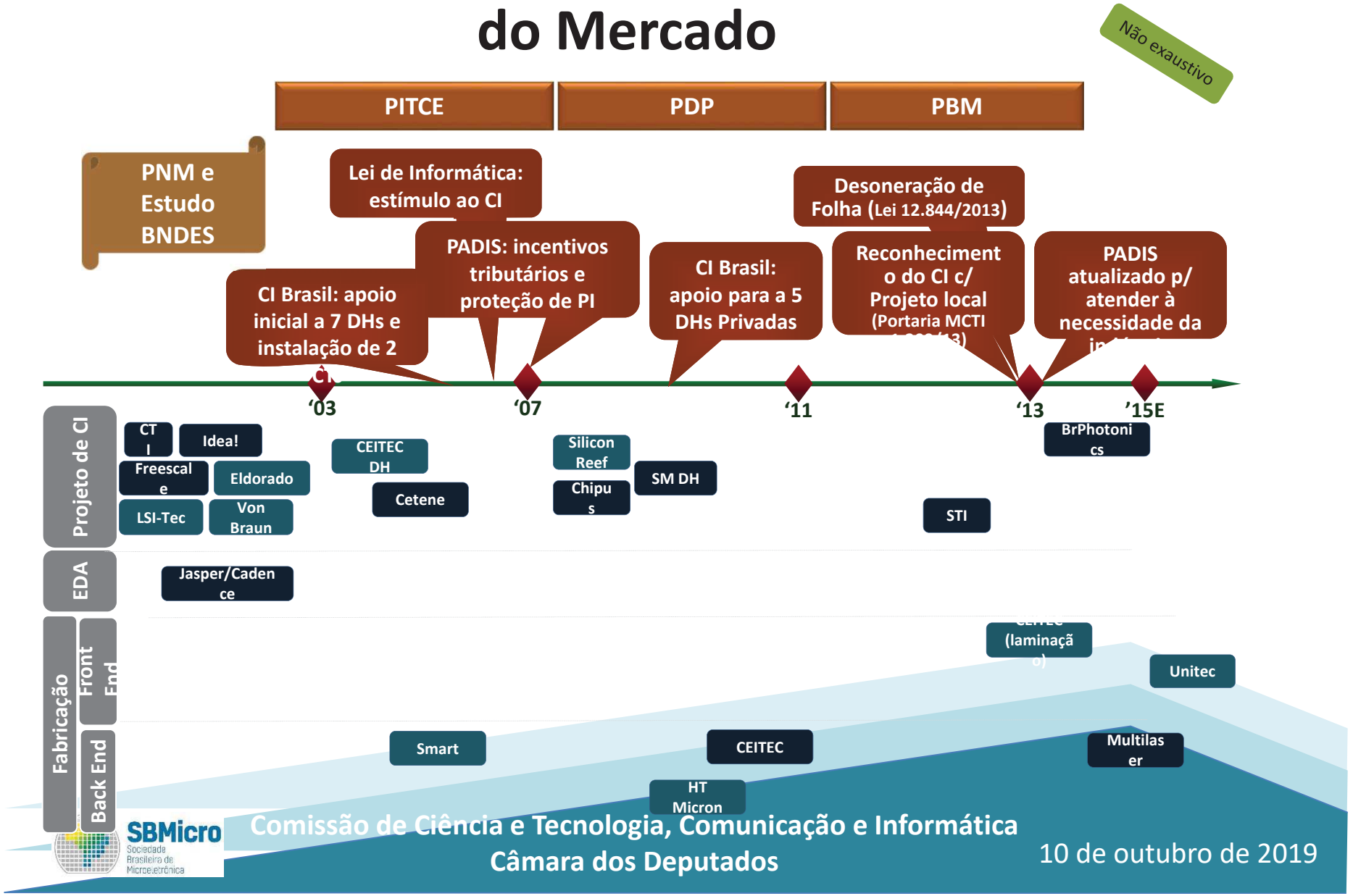
Linha do tempo da Política Industrial e resposta do Mercado



Ecossistema de Microeletrônica no Brasil (2015)

CEITEC S.A
semiconductors

unitec

Fabricação
2 plantas

Encapsulamento
3 plantas

Projeto de CI
9 DHs / Fabless

- **Faturamento superior a R$ 1 bilhão / ano**
- **1.500 mil empregos**
- **Investimentos superiores a US$ 1 bilhão**

Fabricação

Fabricação

- UNITEC
  - BNDES + Corporacion America + BDMG + Matec + IBM
  - *Fabless* + capacidade produtiva
  - Tecnologia madura (130 nm e 90 nm / 200 mm)
  - Foco: IoT, tecnologias inovadoras (ex: microfluídica)
- CEITEC
  - Empresa Estatal vinculada ao MCTI
  - *Fabless* + capacidade produtiva (parcialmente em operação)
  - Portfólio concentrado em RFID de baixa, média e alta frequência

BNDES **US$ 340 milhões**

Corte, Encapsulamento e Teste

Back-end

MULTILASER

- Smart
  - Controlada pelo fundo Silverlake
  - 550 empregados e 20 engenheiros P&D
  - DRAM, NAND, LPDRAM, eMMC e eMCP: Tecnologia local em linha com mercado mundial
- HT Semicondutores
  - DRAM
  - Parceria com a Unisinos
- Multilaser
  - Fabricante de equipamentos de informática (consumo próprio + terceiros)
  - DRAM e NAND
- CSEM – (* não possui projeto PADIS)
  - Centro de P&D com *spin off* de empresas
  - Encapsulamento cerâmico de alto valor agregado (aplicações específicas)
  - Eletrônica impressa

Projetos de CIs

Projetos de CIs

- Centros Cativos
  - **Freescale** (mais de 150 projetistas): CI de Ferrari ao Uno
  - **Cadence** (50 a 100) e STI (até 5): centro de P&D global

Fabless

  - **CEITEC** (31 a 50): RFID
  - **SMDH**: primeiro microcontrolador nacional

Fabless verticalizadas

  - ICTs privadas: **Eldorado** (50 a 100), **LSI-Tec** (31 a 50)
  - ICTs públicas: **CTI** (21 a 30)

DH & SIP

  - **Chipus** (11 a 20): parceria com *foundries* internacionais, crescimento consistente de faturamento
  - **Idea** (6 a 10): licenciamento de IPs de TV Digital para americana SEVA

FORÇAS DE MERCADO

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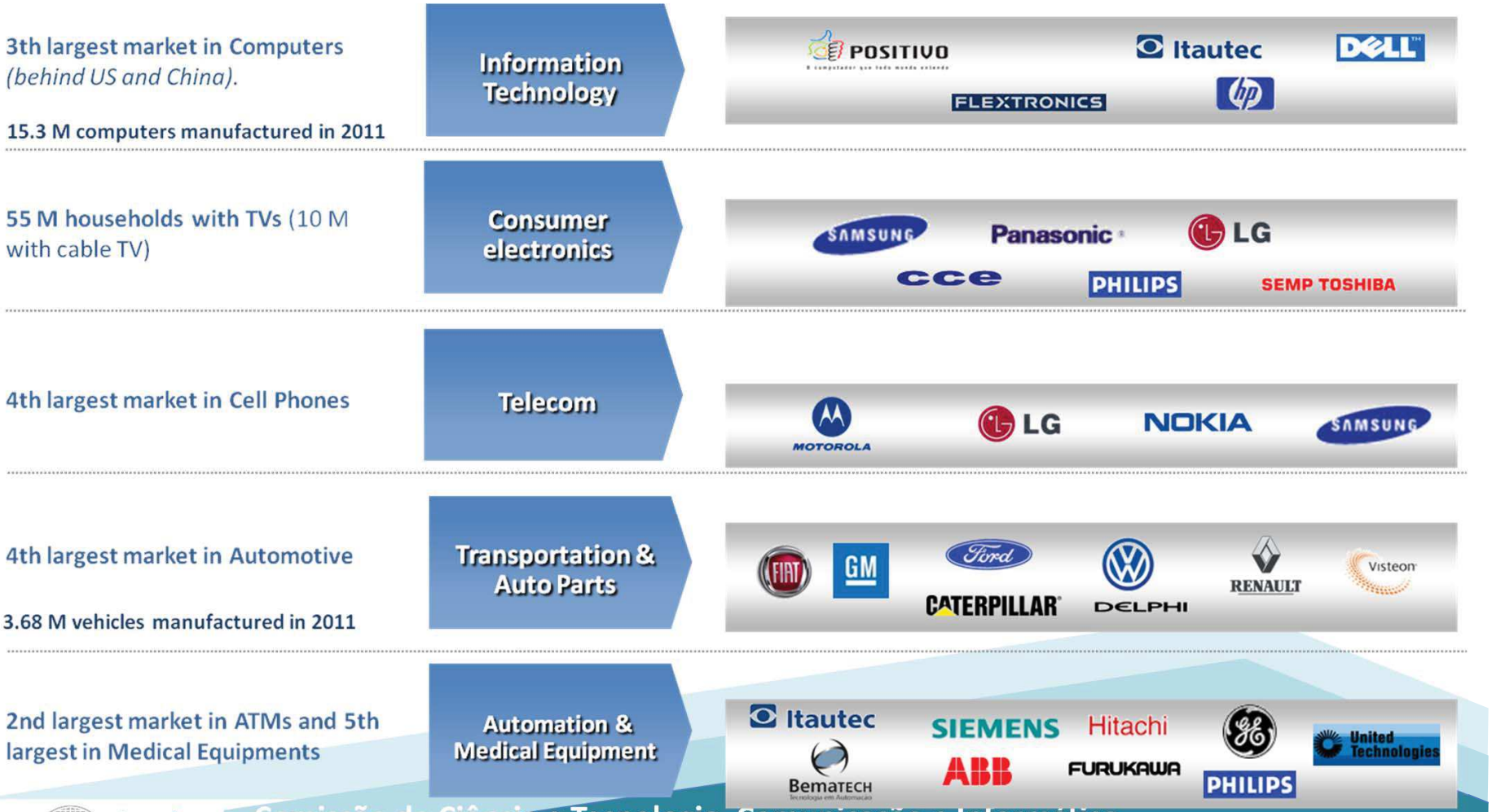
Câmara dos Deputados

10 de outubro de 2019

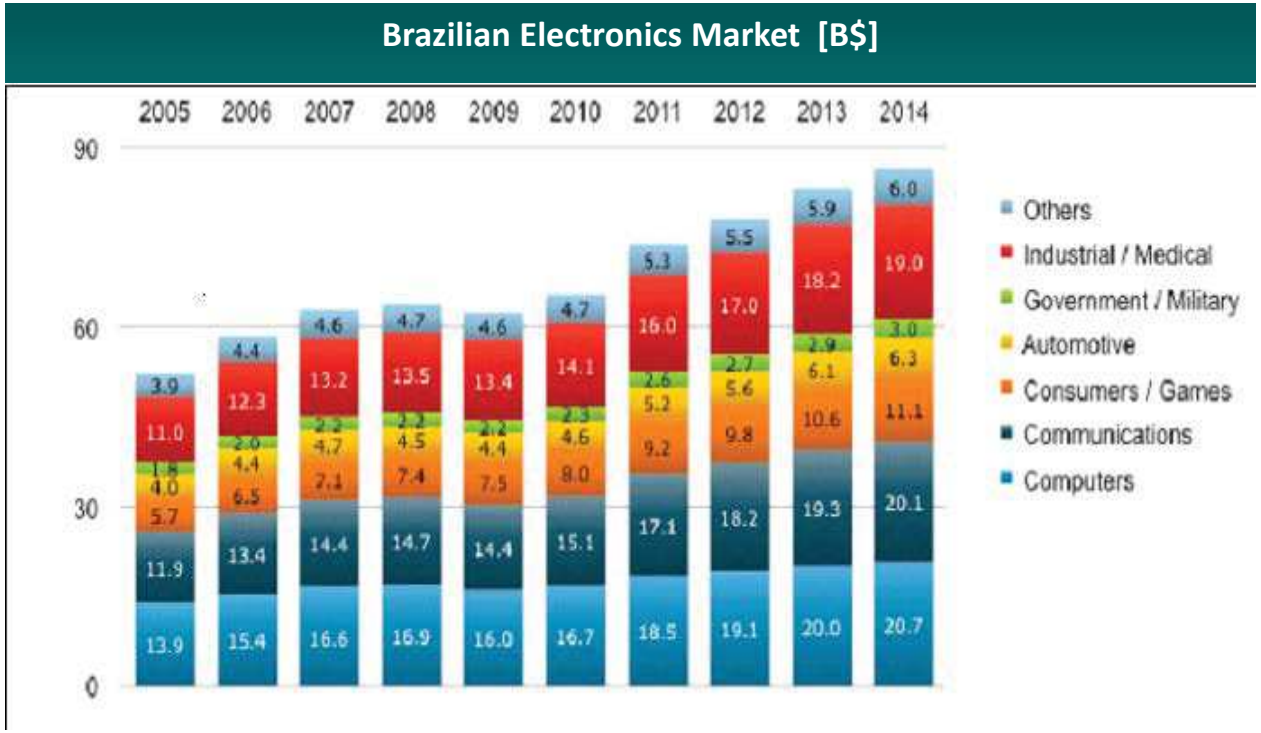
O que impulsiona o investimento direto estrangeiro (FDI) no Brasil?

Tamanho do Mercado e sólida base industrial

Non-exhaustive list



Um Mercado interno crescente de eletrônicos



Uma crescente economia orientada a negócios com um enorme Mercado de eletrônicos

O PROGRAMA CI BRASIL

- IC DESIGN HOUSE
- CENTROS DE TREINAMENTO DE PROJETISTAS

Centros de treinamento

- CT-RS – UFRGS, Porto Alegre – Início: April 2008
- CT-SP – USP, São Paulo – Início: August 2014

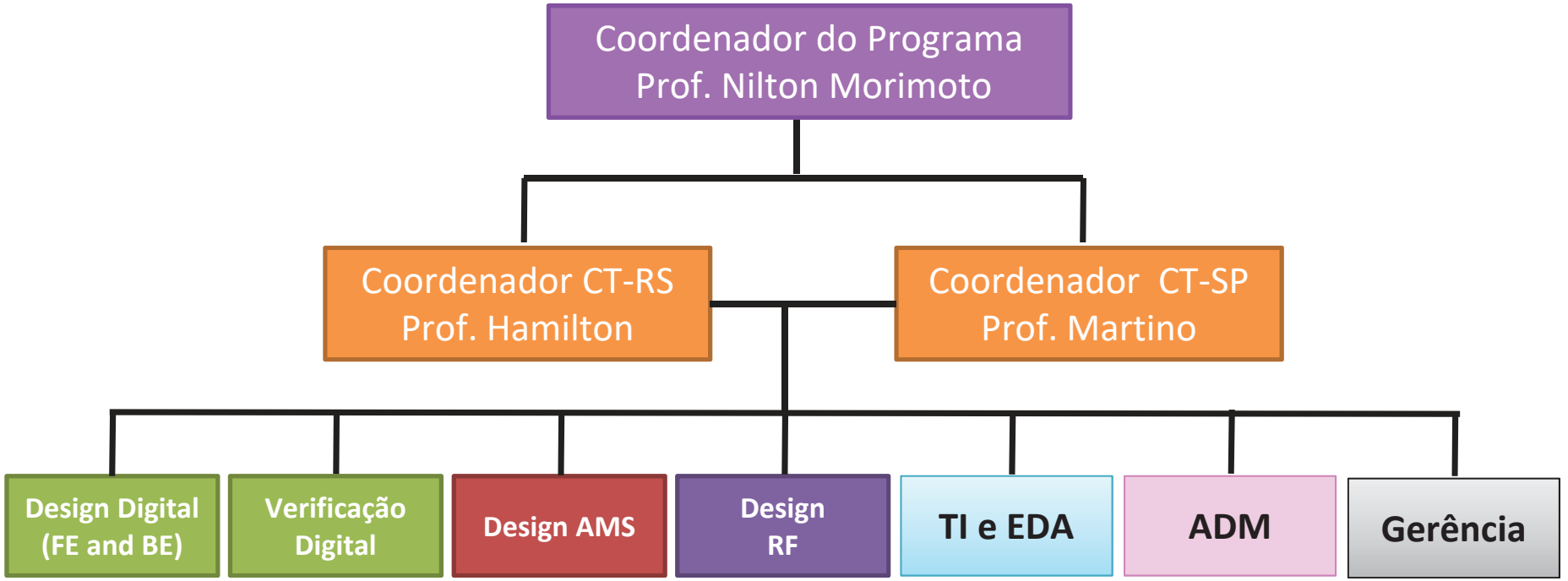
Recursos humanos formados

- Mais de 890 projetistas ate Fev 2019
  - Digital flow 506
  - AMS flow 218
  - RF flow 169
- 50 Projetistas em treinamento (março 2019)

CT-RS - Laboratórios

CT-SP – Laboratórios – GD04 (A e B)

Organização dos Centros de Treinamento



- Objetivo do Programa

- Prover conhecimento em todo o fluxo digital e analógico de desenvolvimento de Circuitos Integrados
- Lecionar aspectos teóricos e práticos no desenvolvimento de Circuitos Integrados
- Dar-lhe experiência prática ao implementar projetos desafiadores (simular um ambiente industrial de desenvolvimento de circuitos integrados)

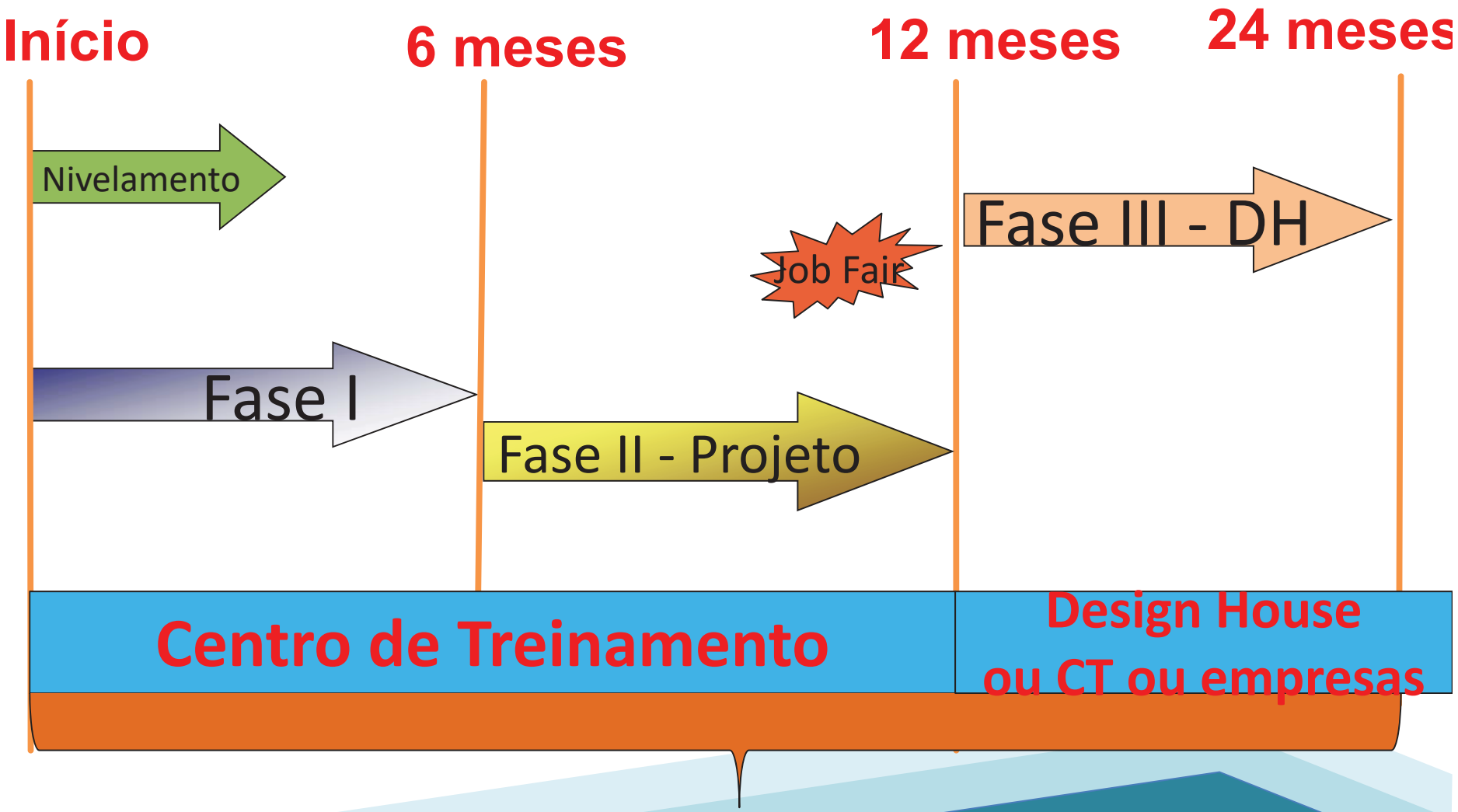
- Estrutura do Curso

Fase I – Fundamentação Teórica /Ferramentas

Fase II - Potiguara – Transponder para o sistema de coleta de dados brasileiro na tecnologia CMOS

Fase III – Estágio em DHs / Centros de P&D/Empresas

- Estrutura do Curso



- Fase I

Fundamentação Teórica

Nivelamento	LV01 - Linux e Octave
	LV02 - RedMine, SVN e Lyx
	LV03 - Portas Lógicas e Eletrônica Básica
	LV04 - Arquitetura de Sistemas
	LV05 - Caracterização de Dispositivos
	LV06 - Fluxo de Projeto
	LV07D - Orientação ao Objeto
	LV07A - Fluxo de Projeto Analógico e RF
	LV08 - Introdução ao Verilog

Geral	BG - I. SEMICONDUCTOR BUSINESS
	BG - II. IC PROCESSES AND DEVICES
	BG - III. PACKAGING
	BG - IV. TEST AND DFT

- Fase I - Digital

Fundamentação Teórica

BD - A. IC ARCHITECTURE
BD - B. IC DESIGN
BD - C. PHYSICAL DESIGN

Projetos Práticos

PD – A1. Architecture and RTL
BD – B1. Verification
BD – B2. Logic Synthesis
PD – C. Physical Synthesis

Ferramentas

TD - A1. VERILOG
TD - A2. INCISIVE SIMULATOR
TD - A3. COMPREHENSIVE COVERAGE
TD - B1. UVM Course
TD - B3. Enterprise Manager
TD - B4. BASIC STATIC TIMING ANALYSIS
TD - B6. RTL COMPILER
TD - B7. CONFORMAL EQUIVALENCE CHECKING
TD - C1. FIRST ENCOUNTER
TD - C2. NANOROUTE
TD - C3. ENCOUNTER TIMING SYSTEM
TD - C5. QRC CELL-LEVEL EXTRACTION
TD - C6. VIRTUOSO ASSURA - DRC AND LVS

- Fase I - AMS + RF

Sinais mistos e Rádio frequência (AMS + RF)

Fundamentação Teórica

(BA-01) BA - A. ANALOG DESIGN

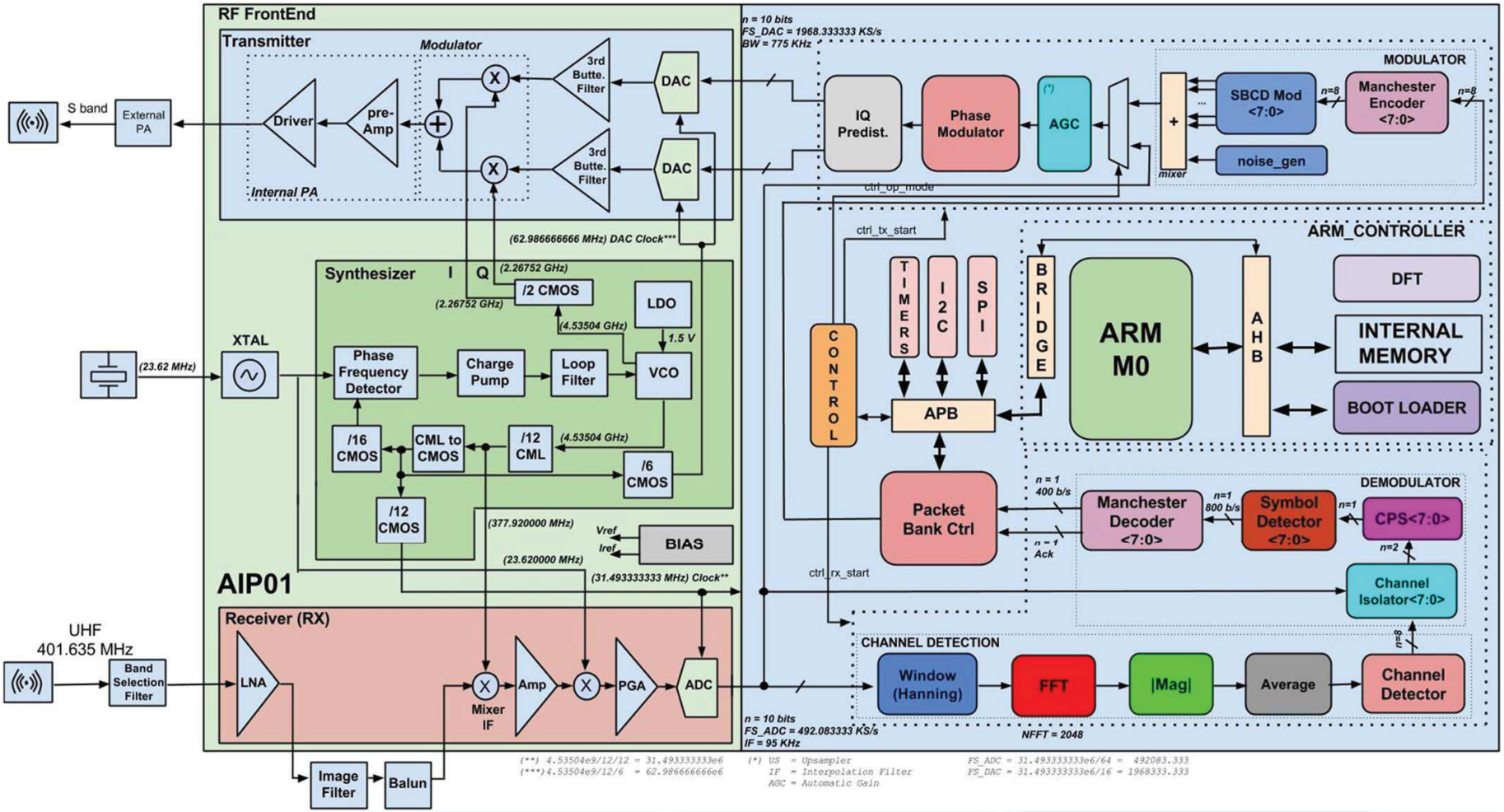
(BA-02)BA - B1. MIXED-SIGNAL DESIGN

(BA-03) BA - B2. RF DESIGN

Ferramentas

TA - A1. ANALOG DESIGN ENVIRONMENT
TA - A2. SPECTRE CIRCUIT SIMULATOR
TA - A3. ANALOG MODELING - VERILOG A
TA - B1. VIRTUOSO AMS DESIGNER
TA - B2. SPECTRE RF TOOLS
TA - A4. VIRTUOSO LAYOUT EDITOR
TA - A5. VIRTUOSO LAYOUT XL EDITOR
TA - A6. VIRTUOSO CHIP ASSEMBLY ROUTER
TA - A7. ASSURA VERIFICATION
TA - A8. QRC TRANSISTOR-LEVEL EXTRACTIOI
TA - B3. ULTRASIM FULL-CHIP SIMULATOR
TA - B4. AMS CMOS PHYSICAL IMPLEMENTATION

Projeto Fase II – Arquitetura do IP Transponder



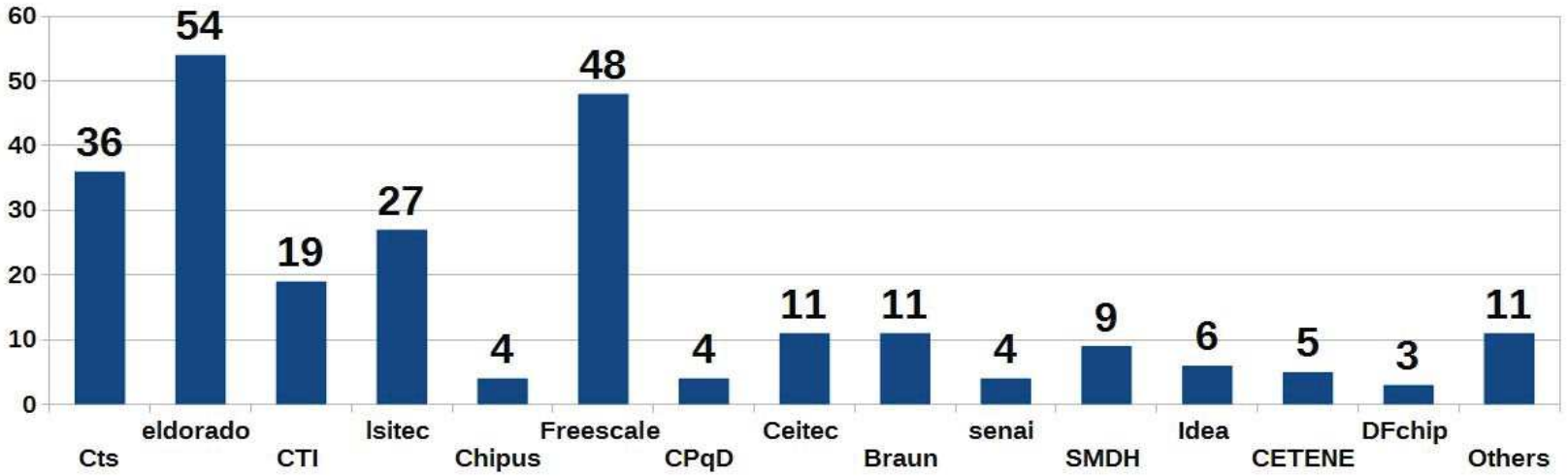
- IC Brazil Program Results

893 IC Designers have been graduated throughout these years!!

- Survey results for all students

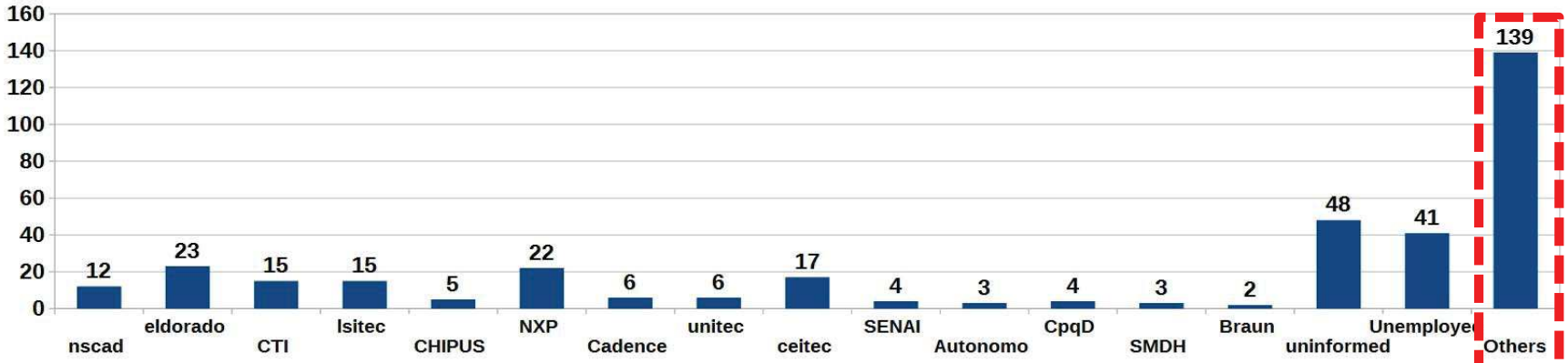
Total Samples: 365

- **Name:**
- **Training year (Edition):**
- **Training Center:**
- **Track:**
- **Have you been selected for Phase 3 ?**
- **What was the company's Phase 3?**



- Survey results for all students

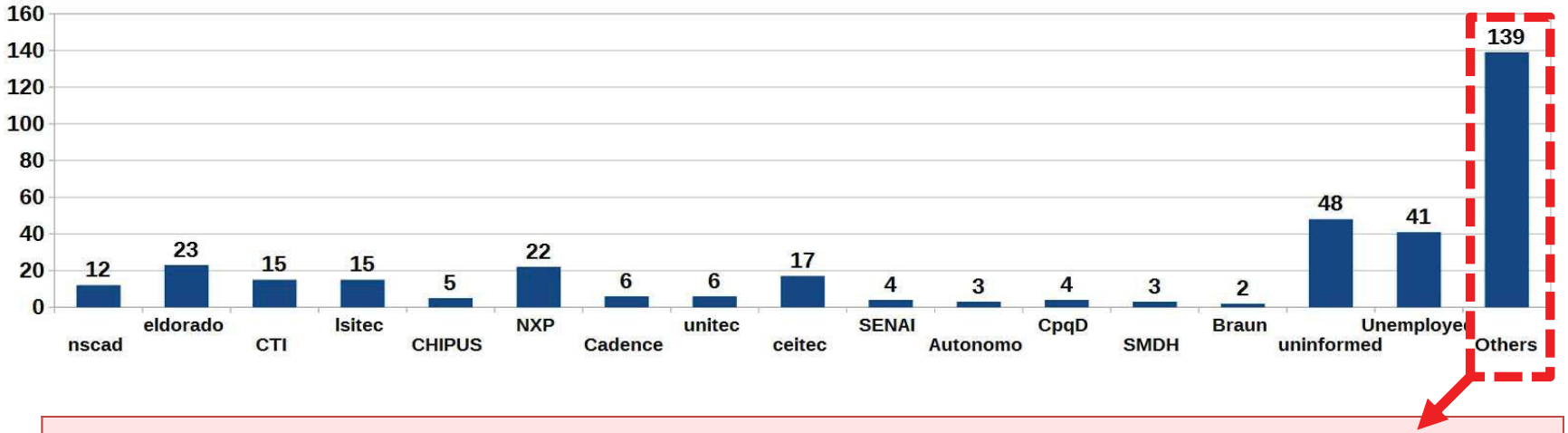
Total Samples: 365



National companies			
Mectron	Delfino & Chamas DCF Naturais LTDA	VLASolutions	Votorantim Energia
JPTE ENGENHARIA LTDA	BrPhotonics	Linx	Gireplast
Embrasul	Empro	Bobsien P&D	Engelig
Eletrotrafo	DBserver	Digistar Telecomunicações S/A	3e Eficiencia Energetic Engenharia
Helo Medical Maceió	Freedom Veículos Elétricos	RS Brasil	Eletrostamp
Connectcom - UOL	Skylane Optics	Phi Innovations	Zenvia Mobile
MACNICA DHW LTDA		Raizen	

- Survey results for all students

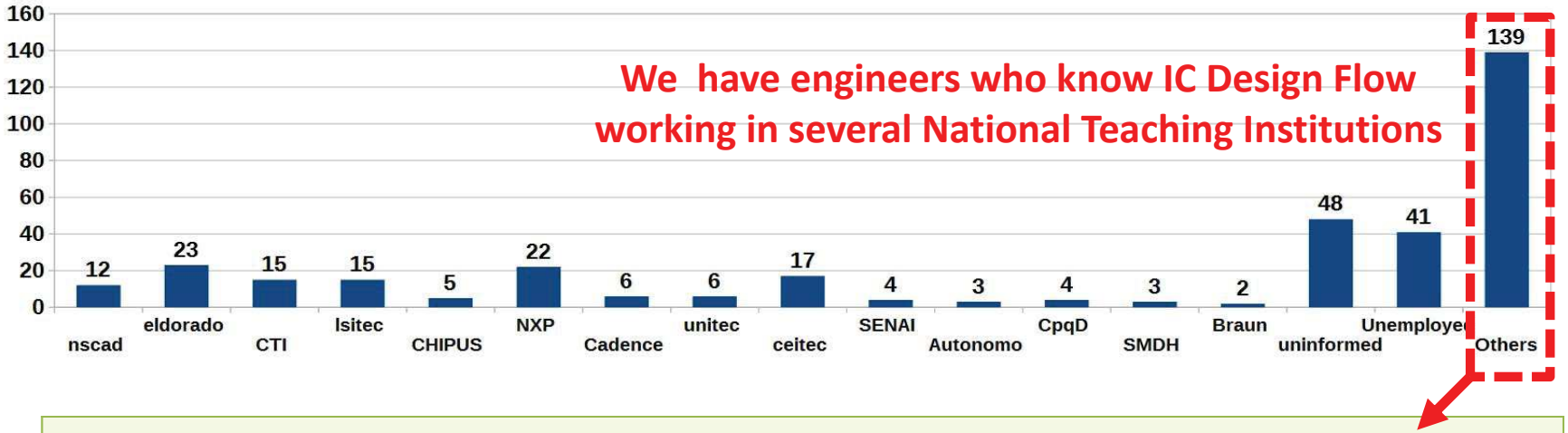
Total Samples: 365



Multinational Corporations			
Tensorcom	Orca Systems	Dwyer Instruments	Ericsson
AnSem NV	Dialog Semiconductor	Nangate	General Motors
HMT Microelectronics	Terphane Ltda	RDI Software	Carestream Health do Brasil
Whirlpool SA	Technicolor	Broadcom/USA	RG ELECTRONICS
Sensingtex	XConnect Global Networks Ltd	Smart Modular Technologies	Áxis
HP	YPF	ARM	Denso do Brasil

- Survey results for all students

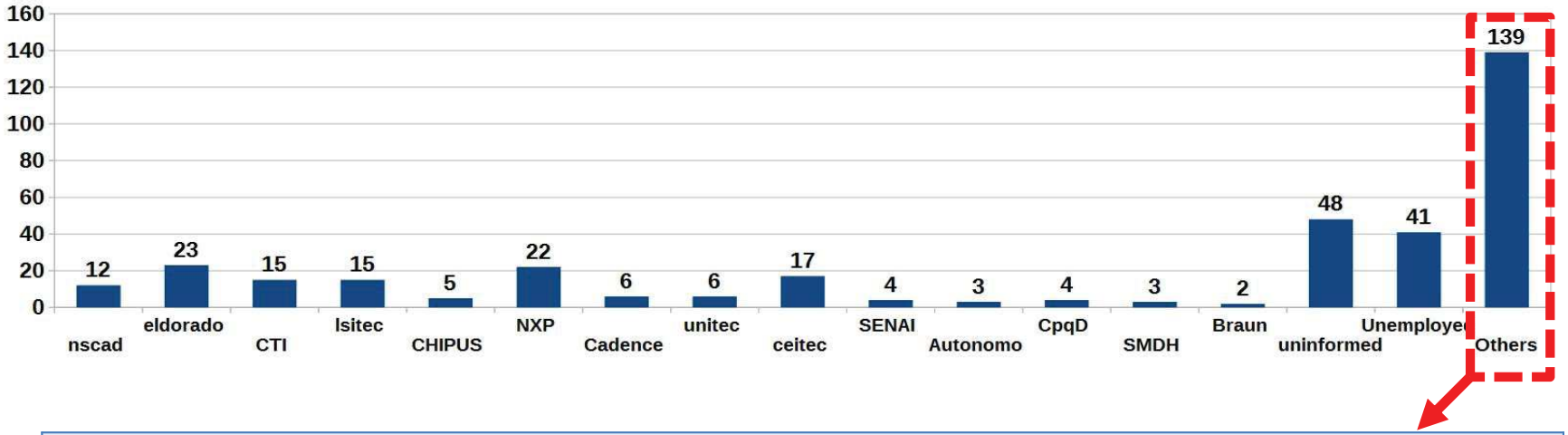
Total Samples: 365



National Teaching Instutions			
UFERSA	IFMT	PUCRS	LESC
UNISC	UFRGS	IFRN	UFABC
IFRS	UFPEL	UFPE	USP
Unochapecó	IFSP	IFSUL	IFSP
UNIFEI	UNICAMP	IFNMG	UFAC
UEMS	UFSM	UFSC	UFAM
IFC	Faculdade Estácio	IFPB	

- Survey results for all students

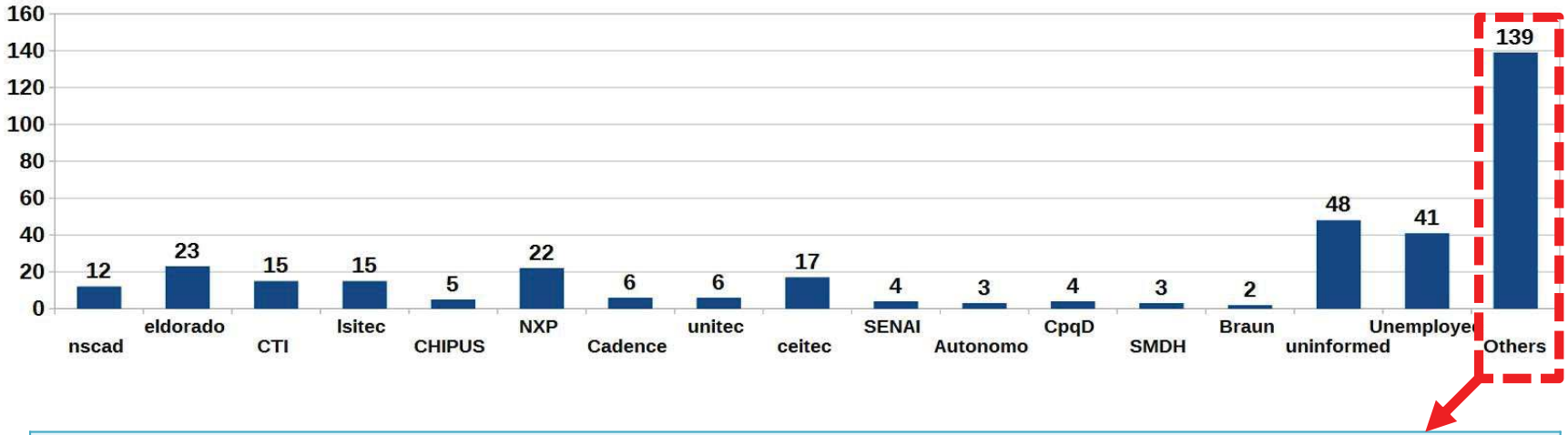
Total Samples: 365



Teaching International Institutions			
KU Leuven	Technische Universiteit Eindhoven	Universidad Central na Colombia	Grenoble INP
UPC Barcelonatech	imec	Bielefeld University	Hochschule Mannheim
Udelar	Pontificia Universidad Catolica del Peru	Thales Research and Technology	

- Survey results for all students

Total Samples: 365



Government agencies and alike.			
Ministério do Planejamento, Desenvolvimento e Gestão	Força aérea brasileira	INMETRO	INPE
CNPEM	SERPRO	IBAMA	Anatel
Ministério da Defesa	Fogafín da Colombia	Poder Judiciário Federal	SMED Secretaria de Educação da Bahia
Camara dos Deputados	Dataprev	Marinha do Brasil	MCTIC
Prodemge	cetene	Banrisul	Ministério Público da Bahia
Ministério Público Federal			

A Lei de Informática e o PADIS são fundamentais para a continuidade de todas as atividades da indústria de semicondutores no Brasil.

Pois são através destes mecanismos que, direta ou indiretamente, fomentam todas as atividades da indústria de semicondutores no País.

Thank You

Obrigado

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ACKNOWLEDGMENTS

MINISTÉRIO DA
CIÊNCIA, TECNOLOGIA,
INOVAÇÕES E COMUNICAÇÕES

PÁTRIA AMADA BRASIL
GOVERNO FEDERAL

CNPq
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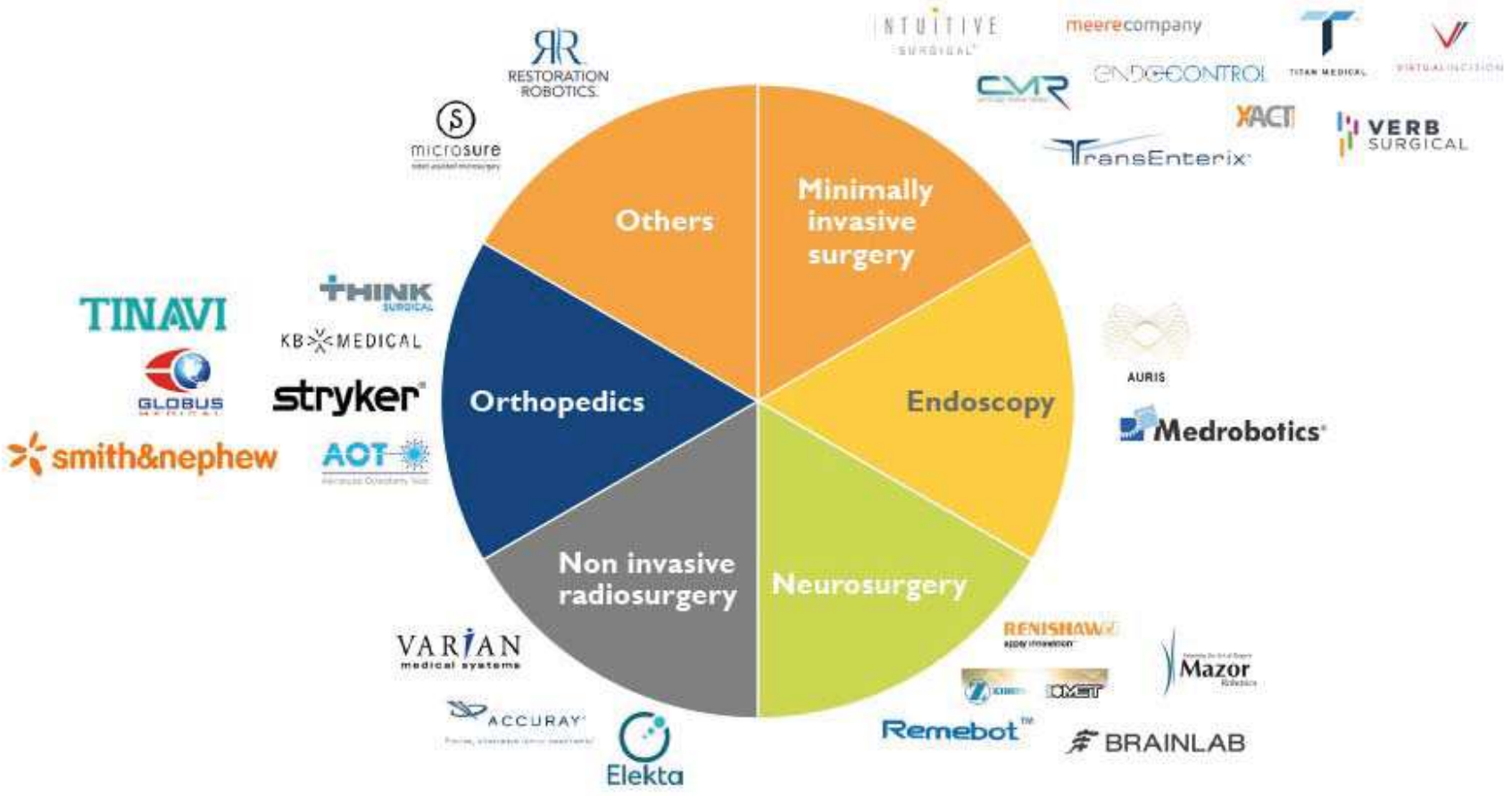
FINEP
FINANCIADORA DE ESTUDOS E PROJETOS
MINISTÉRIO DA CIÊNCIA E TECNOLOGIA

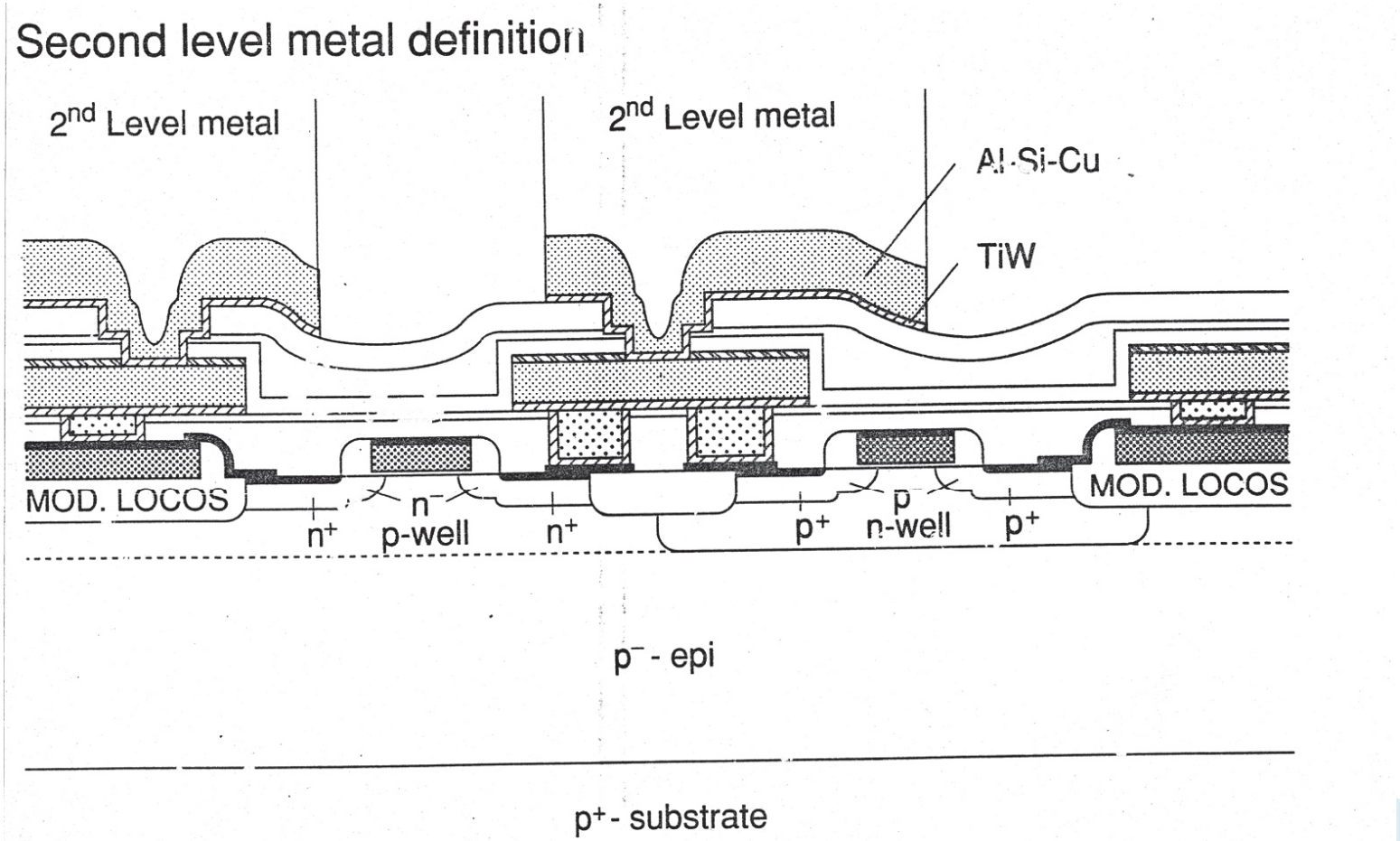
BNDES
O BANCO DO DESENVOLVIMENTO DE TODOS OS BRASILEIROS

Surgical robotics - Main players per applications

(Source: Medical Robotics Technology & Market Analysis 2017, Yole Développement, November 2017)



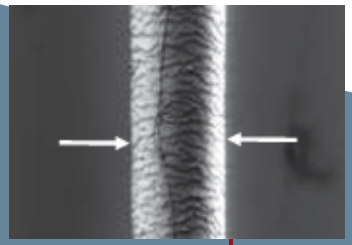
Inversor CMOS



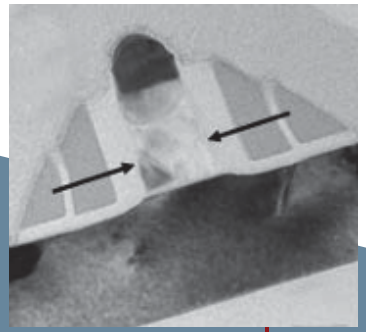
Micro-structures moving towards Nano-structures

Human: ~2 m
= 2,000,000,000 nm

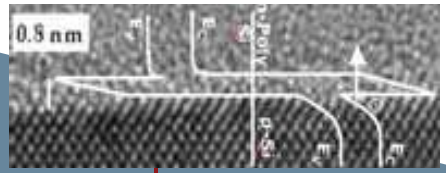
Human Hair:
60 µm = 60,000 nm



Transistor Gate: 40 nm



High-performance
gate-oxide: 0.8 nm



cm mm µm nm

10^{0} 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8} 10^{-9} 10^{-10} 10^{-11}

Flea: ~1 mm
= 1,000,000 nm

Blodd-cell:
7.5 µm = 7,500 nm

DNA: 3.4 nm

Si-Atom: 0.22 nm

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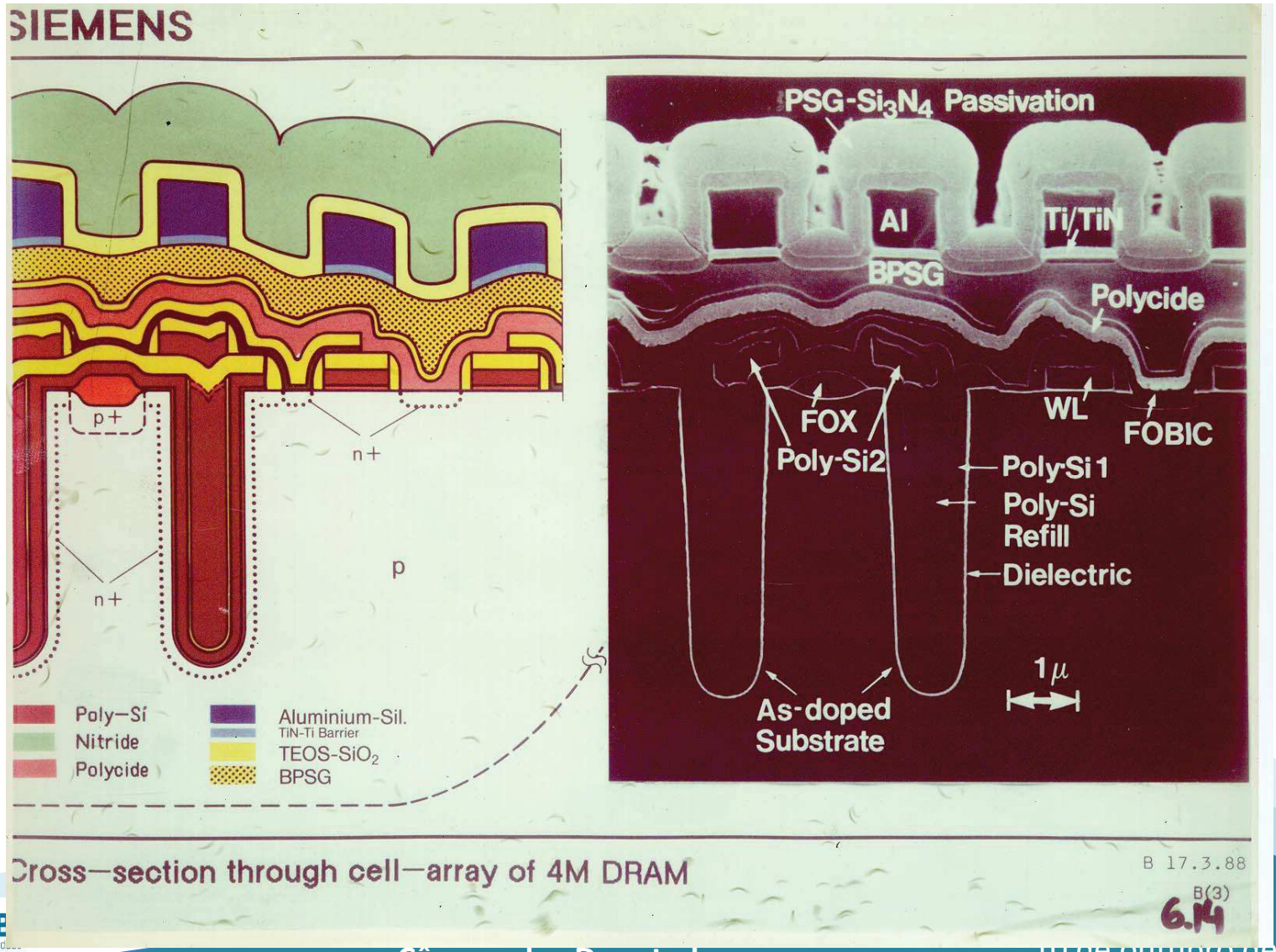
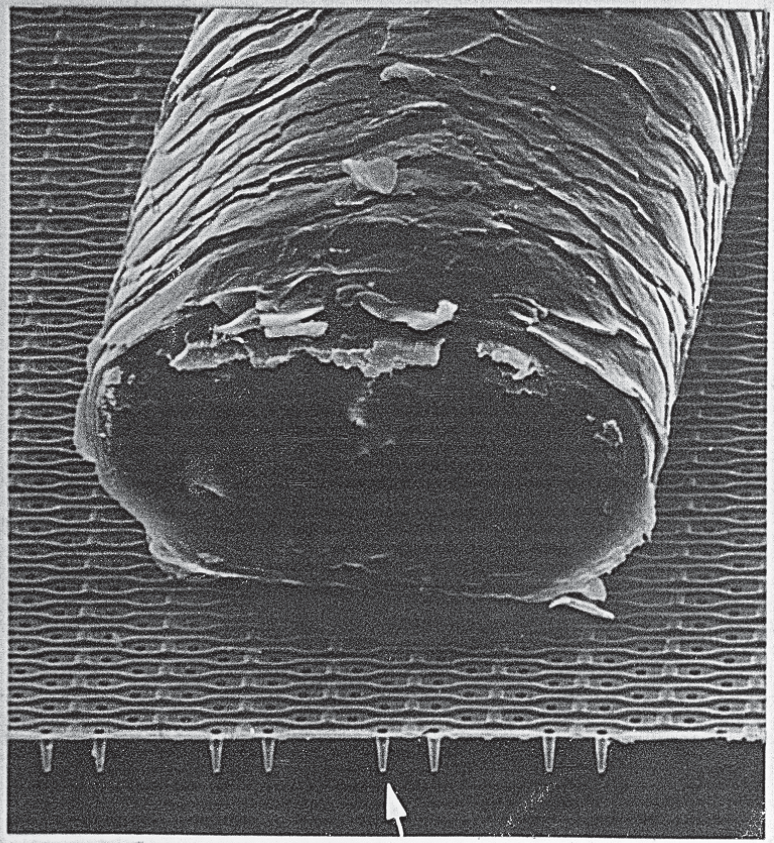
Comissão de Ciência e Tecnologia, Comunicação e Informática
Câmara dos Deputados

10 de outubro de 2019

Capacitor tipo trincheira



SIEMENS



Human hair on

trench cell array

of 4Mbit DRAM

(after removal of the

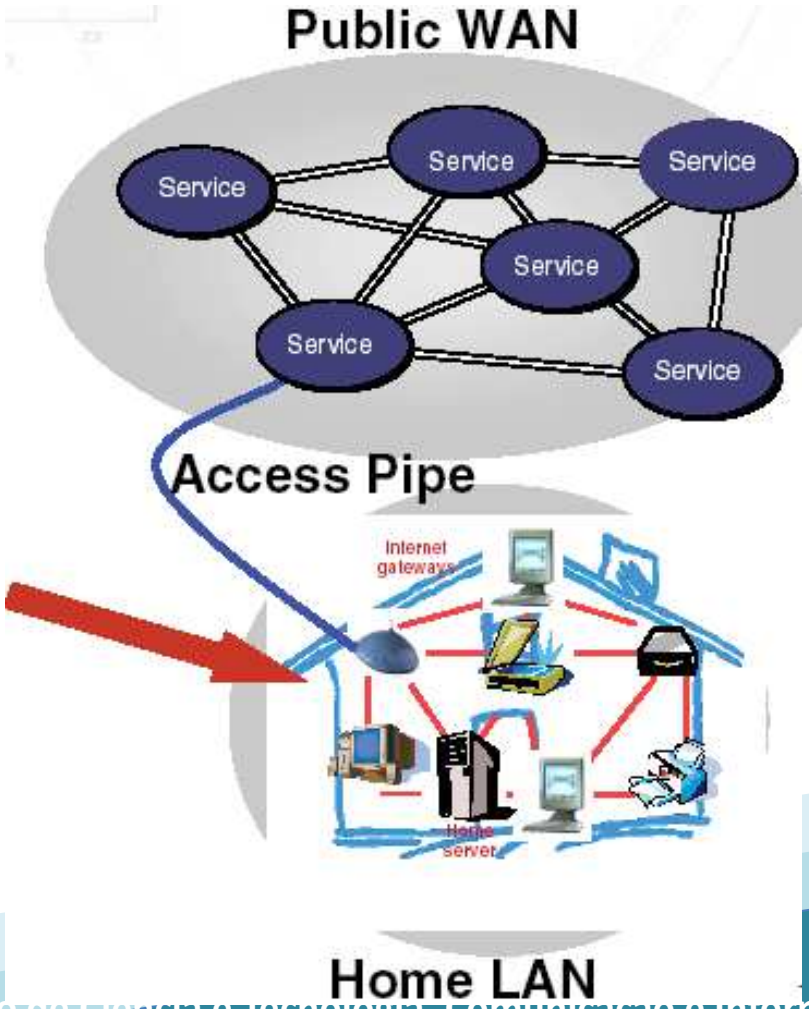
trench etch mask)

Human Hair on sub—µm Structures -2-

6

Aplicações em Casa inteligente

Residential Network

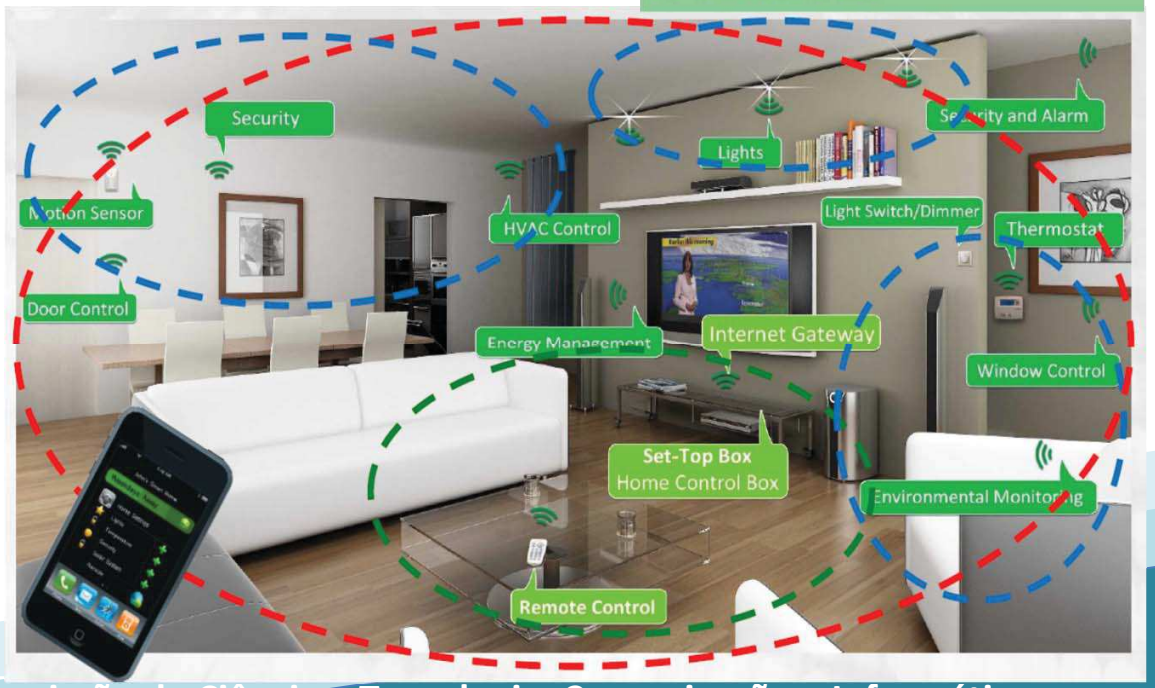


25$ ultimate
IoT module

Many technologies and more emerging
Technology in essence “not yet” affordable

but….

600 million homes
estimated 100 devices per home
60 billion nodes

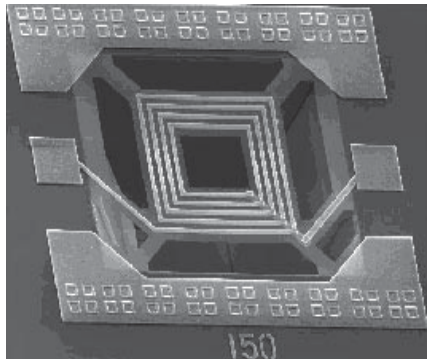


Source : Greenpeak, at GSA Munich 2014

Outras Aplicações

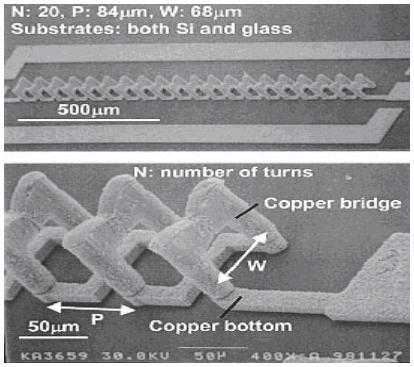
MEMS-Based RF Components

Inductors



1nH Q~2-28@6-18GHz

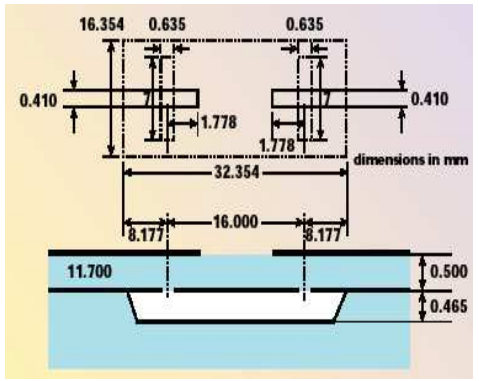
[Y. Sun, et al., IEEE IMS-1998]



2.3nH Q~25@8.4GHz

[Yoon, et. al., IEEE EDL-20, 1999]

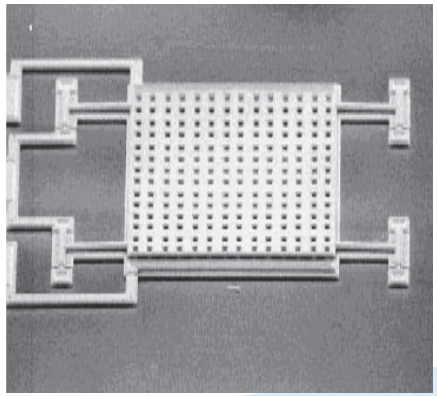
Cavity Resonator



Q~500@10GHz

[Papapolymerou, et. al., *IEEE MWGL-7*, 1997]

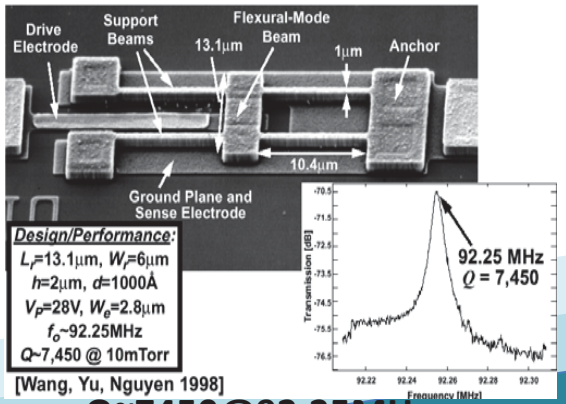
Varactor



C_0~2.05pF
C_{Tune}~1.5:1
Q~20@1GHz
V_{Tune}~0-4V

[Dec and Suyama , IEEE MTT-46, 1998]

MEM Resonator

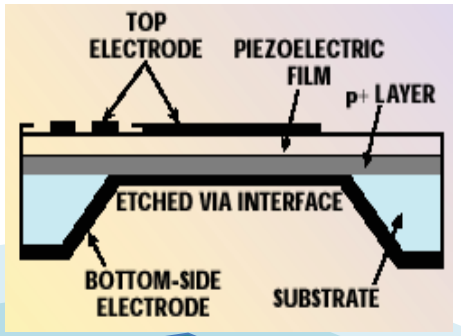


[Wang, Yu, Nguyen 1998]

Q~7450@92.25MHz

[Wang, Yu, Nguyen, 1998]

FBAR Resonator

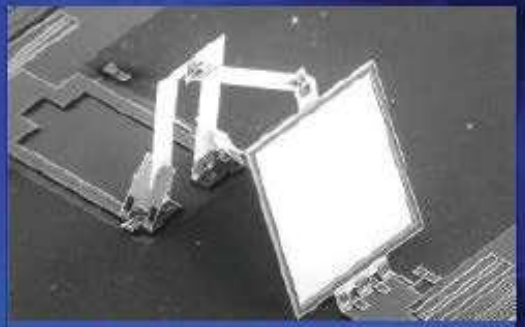


Q~>1000@1.5-7.5GHz

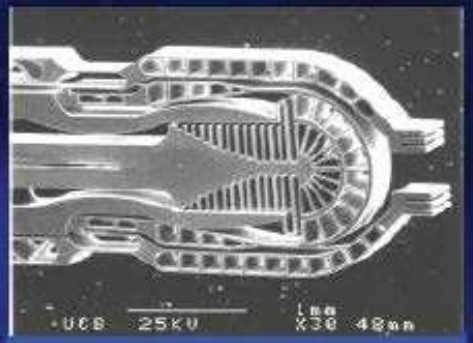
[Krishnaswamy, *Microwaves & RF*, 1991]

The Diversity of MEMS and academic research

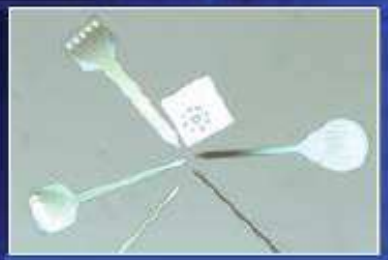
Univ Michigan - Vibratory Gyroscope



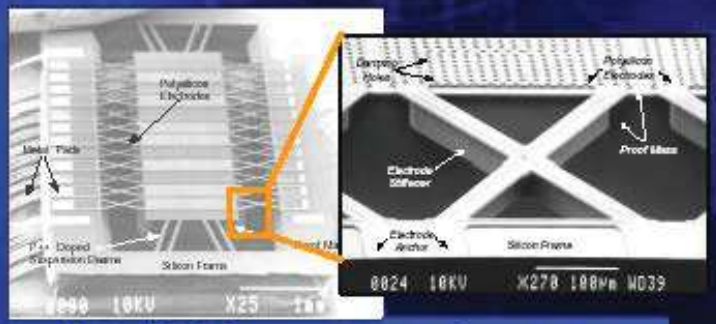
UC Berkeley – BSAC Micro mirror



UC Berkeley: BSAC–C Keller Silicon Tweezers



U Michigan: Passive Micromachined Silicon Microprobes: K wise



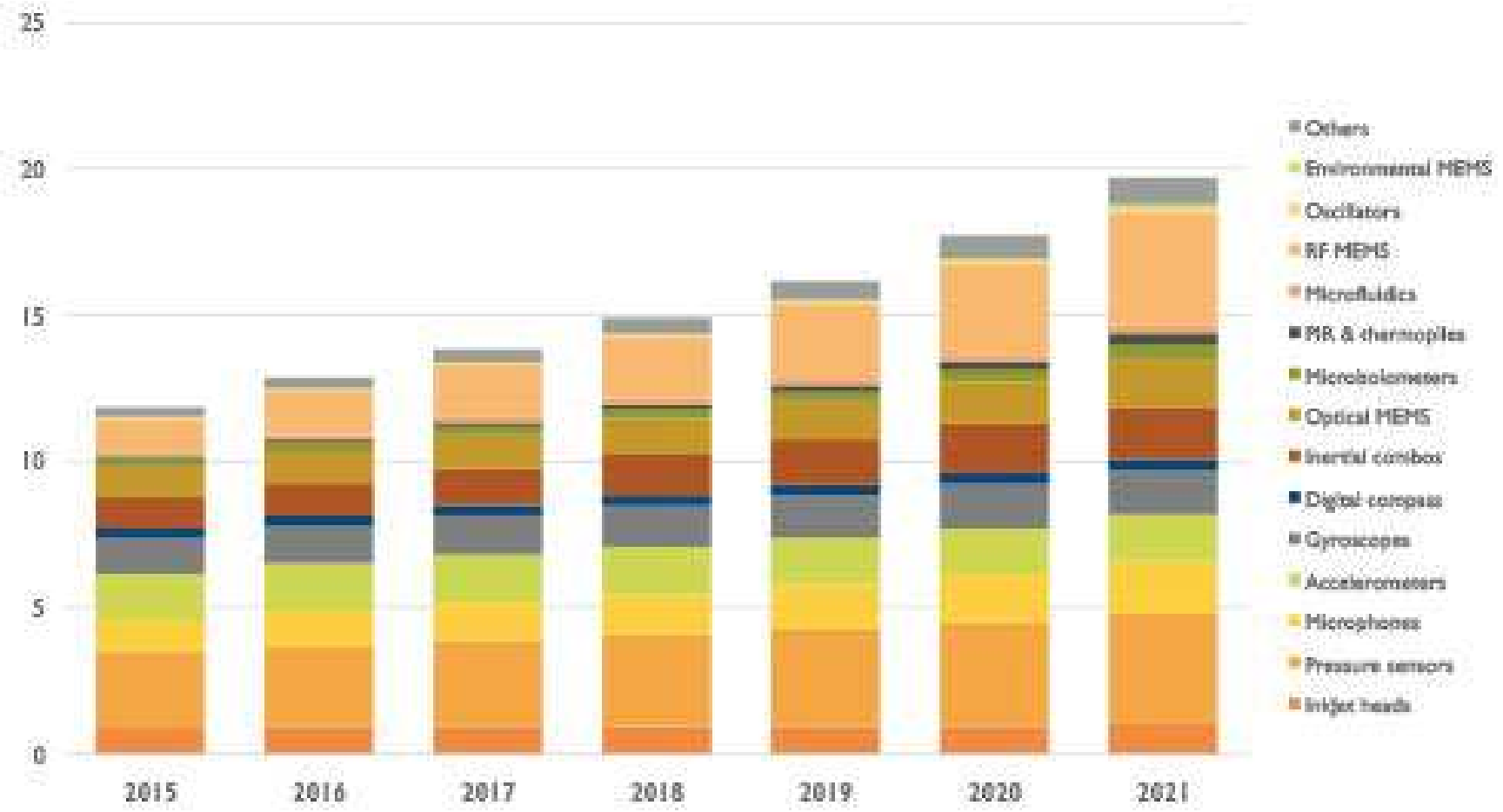
Univ Michigan – µg-accelerometer

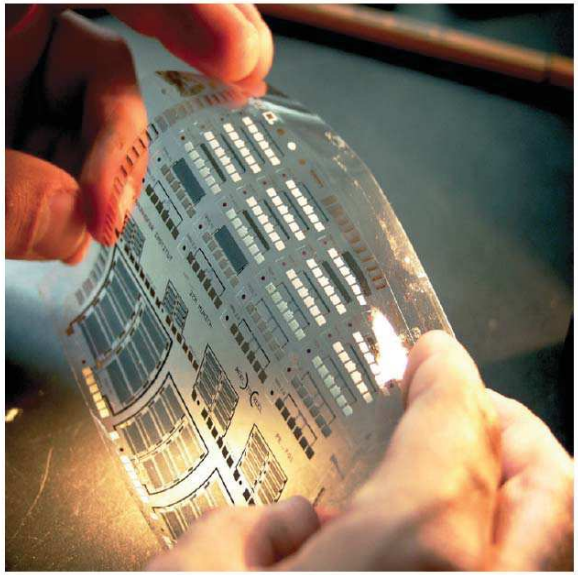
MIT: Turbo Machinery

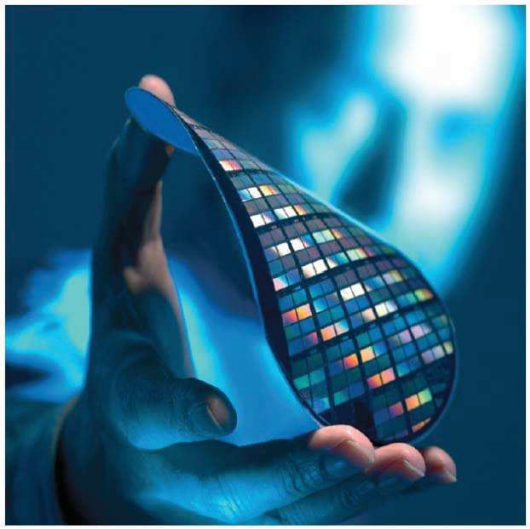
intel

2015-2021 MEMS market forecast in US$B

(Source: Status of the MEMS Industry 2016, May 2016, Yole Développement)

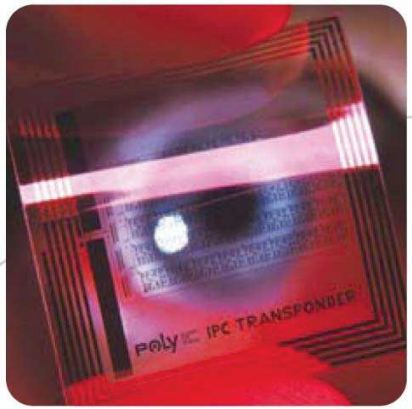




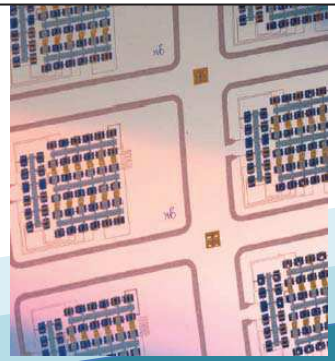


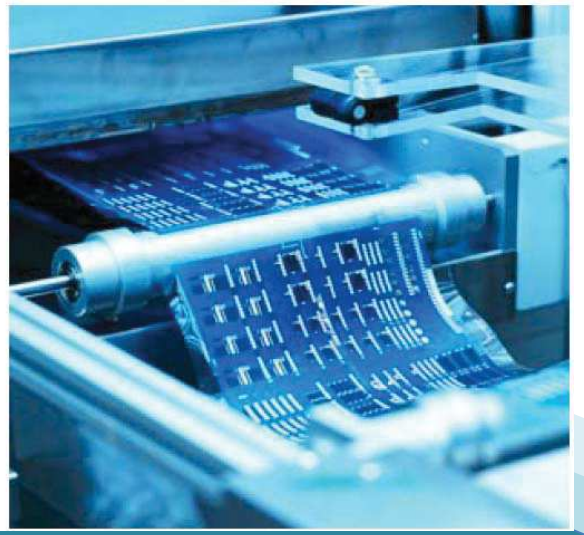
Reel to Reel

Fraunhofer IZM Institut Zuverlässigkeit und Mikrointegration

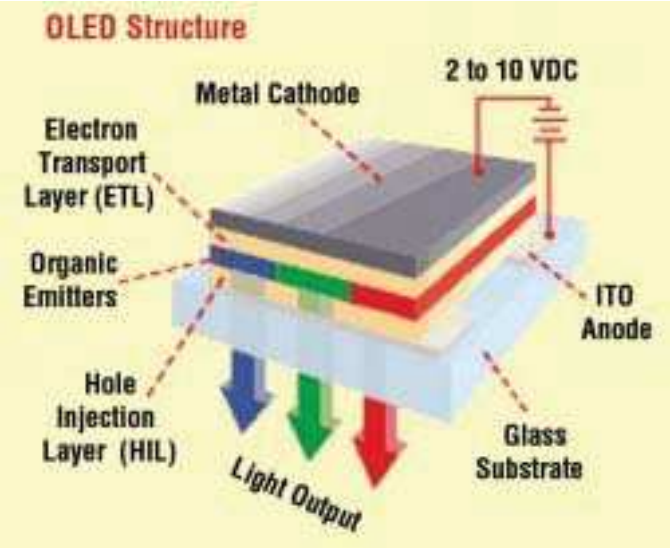


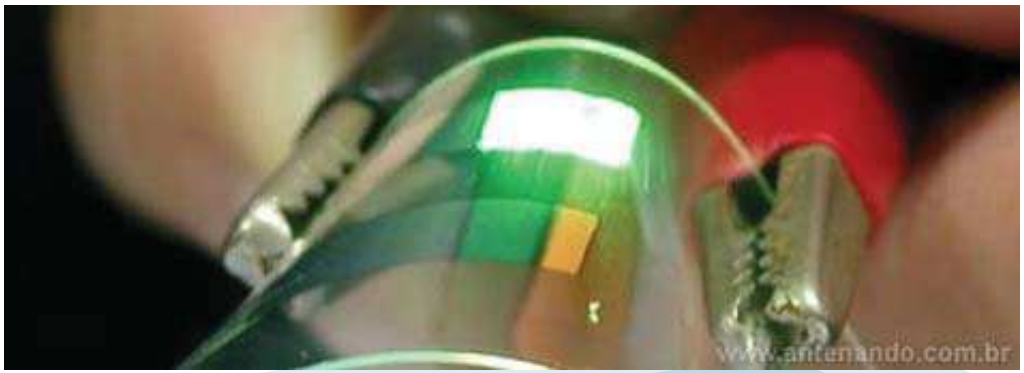
PolyIC The chip printers





OLEDs
Organic Ligth-Emittng Diodes





SOLAR ENERGY

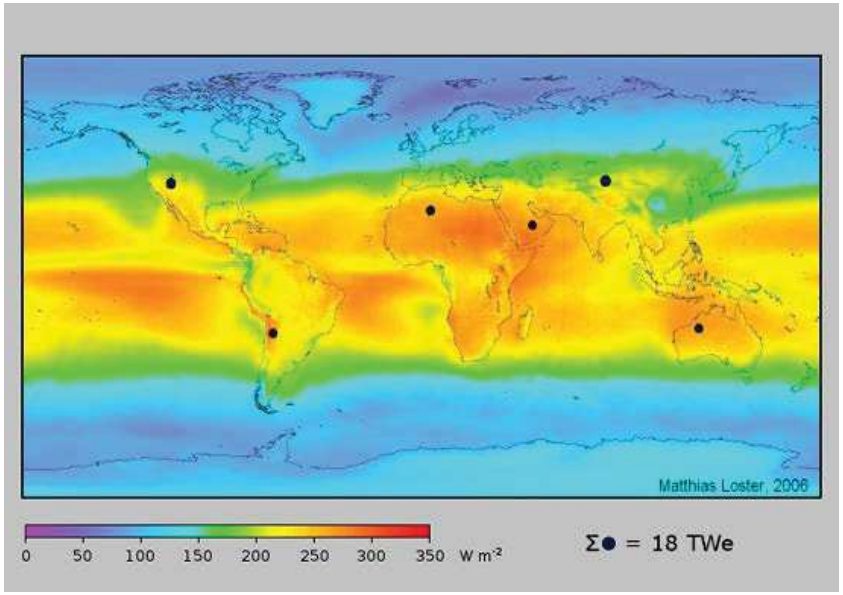
PHOTOVOLTAIC DEVICES

SBMicro Sociedade Brasileira de Microeletrônica

Comissão de Ciência e Tecnologia, Comunicação e Informática
Câmara dos Deputados

10 de outubro de 2019

Average Insolation in the planet



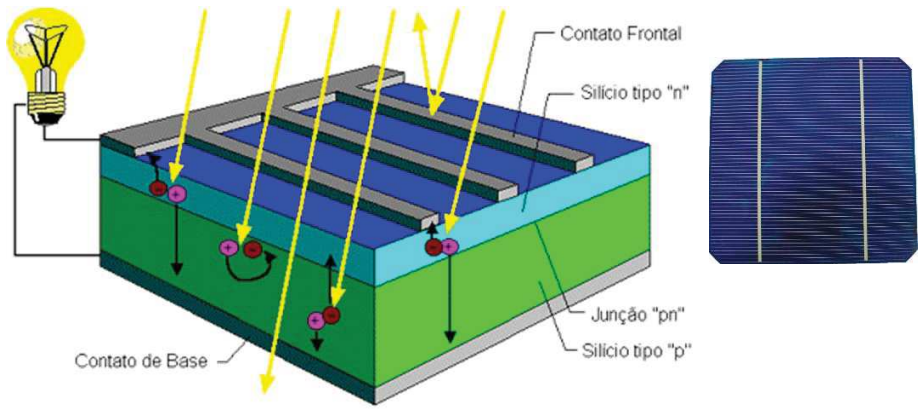
40-MW PV-Plant CdTe - Waldpolenz, Germany

Vatican Solar Panel Roof

2.400 panel 300 kilowatt-hour

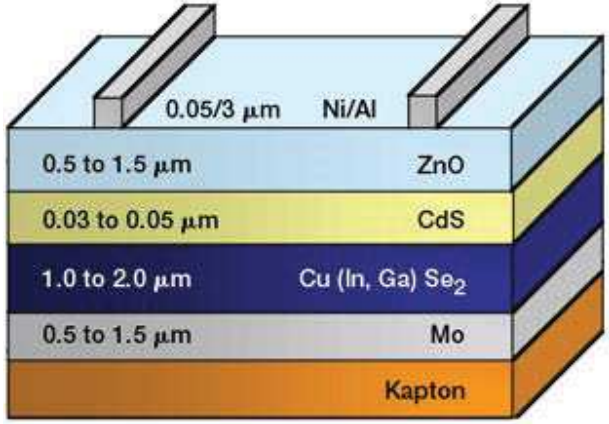
PV – First generation

Monocrystalline silicon – Homojuction device. Best devices: 30 %.



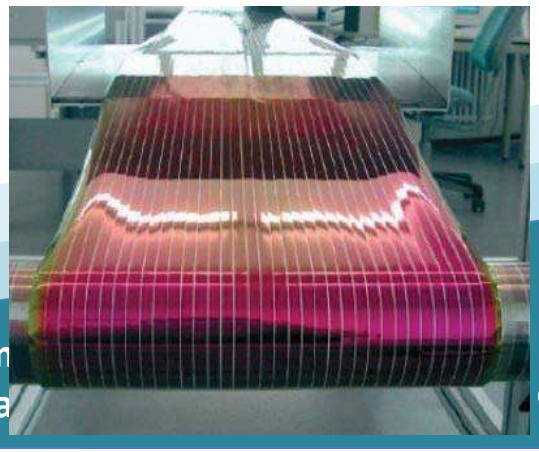
PV – Second Generation

Thin films: CdTe, amorphous silicon, etc. Heterojunction.



PV – Third Generation

Organic materials, including electronic plastics, quantum dots, biomolecules, etc. Flexible electronics.



Game of Drones

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