

Mário J. Silva, Susana Vinga

# THE ROLE OF ADVANCED TECHNOLOGY IN HEALTHCARE

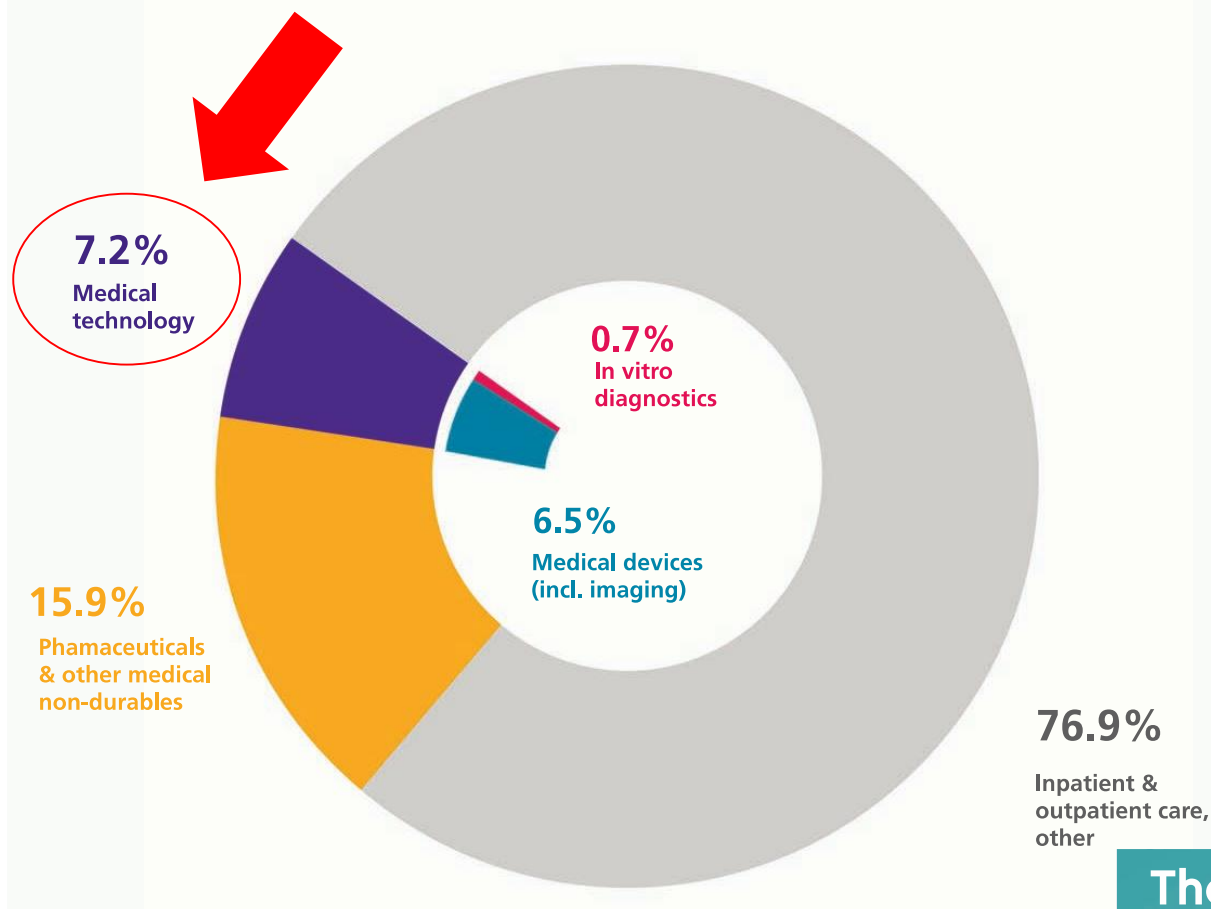
# Medtech?

Medical technology, or "medtech," may broadly include

- **medical devices,**
- **information technology,**
- **biotech,**
- **and healthcare services.**

[https://en.wikipedia.org/wiki/Health\\_technology](https://en.wikipedia.org/wiki/Health_technology)

BREAKDOWN OF TOTAL HEALTHCARE EXPENDITURE IN EUROPE (REF. 5)



## The European Medical Technology Industry

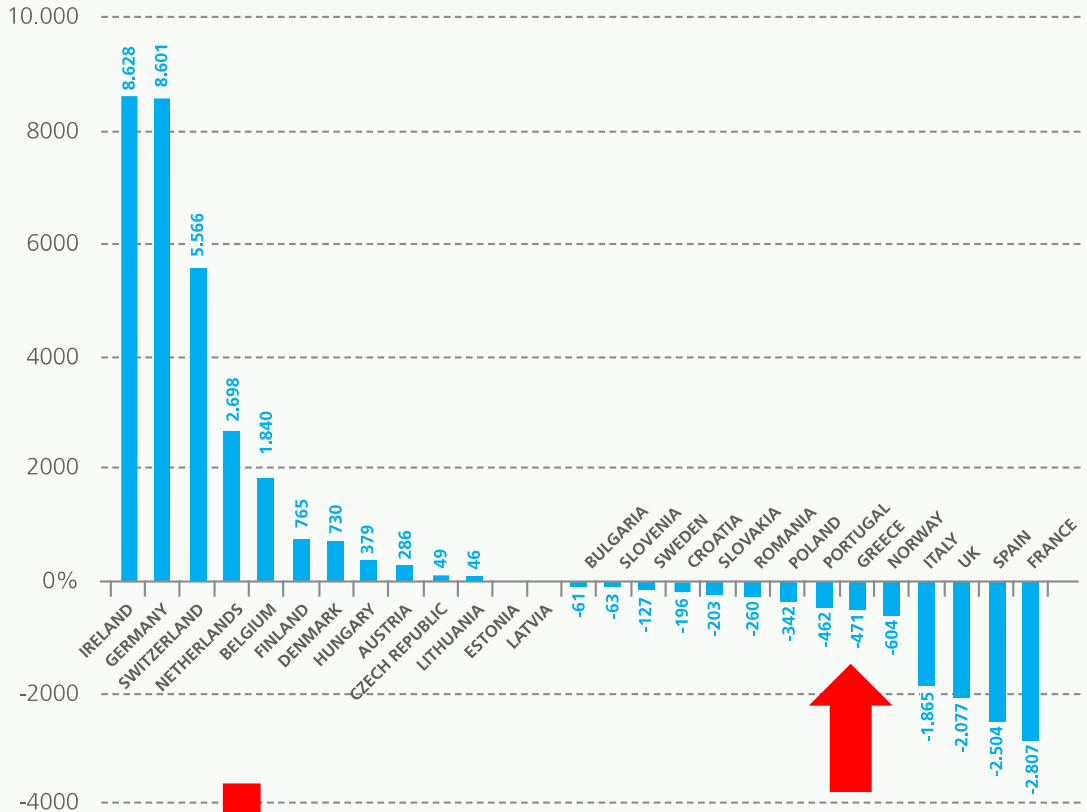
– in Figures / 2018



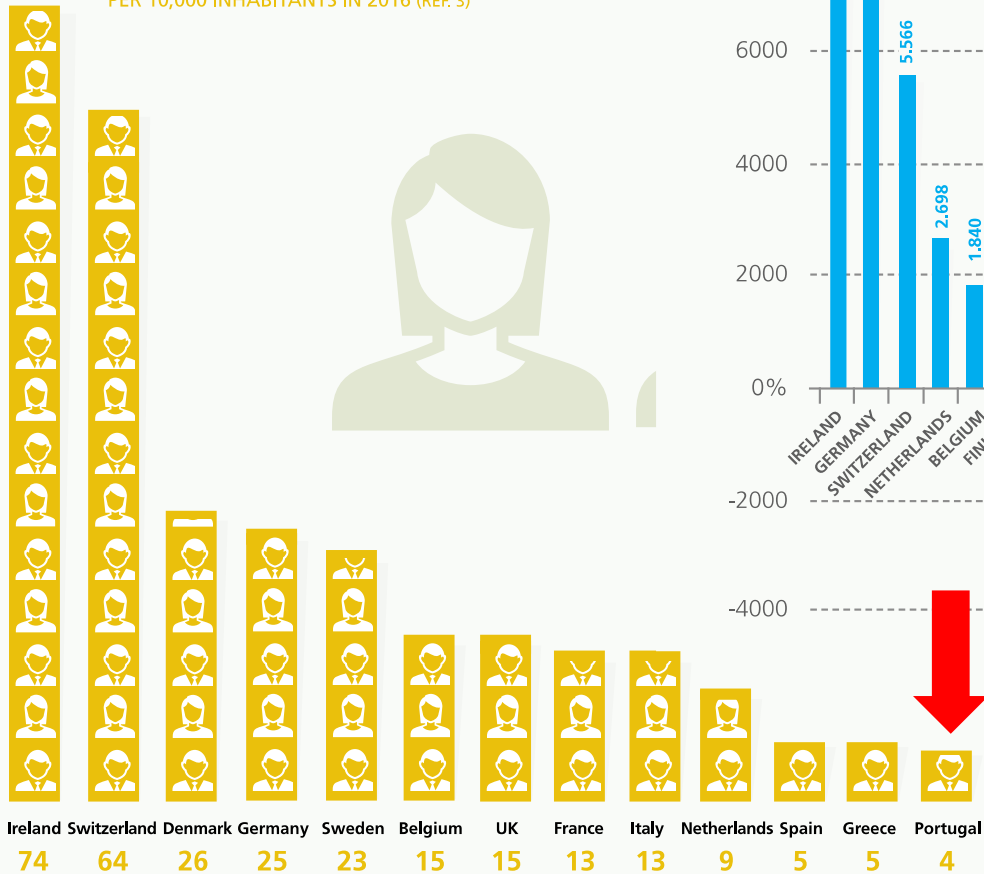
MedTech Europe  
from diagnosis to cure

## MEDICAL DEVICE TRADE BALANCE BY COUNTRY (INCLUDING INTRA-COMMUNITY TRADE, MILLION EUROS), 2016 (REF. 6)

MILLIONS



NUMBER OF PEOPLE DIRECTLY EMPLOYED IN THE MEDICAL PER 10,000 INHABITANTS IN 2016 (REF. 3)

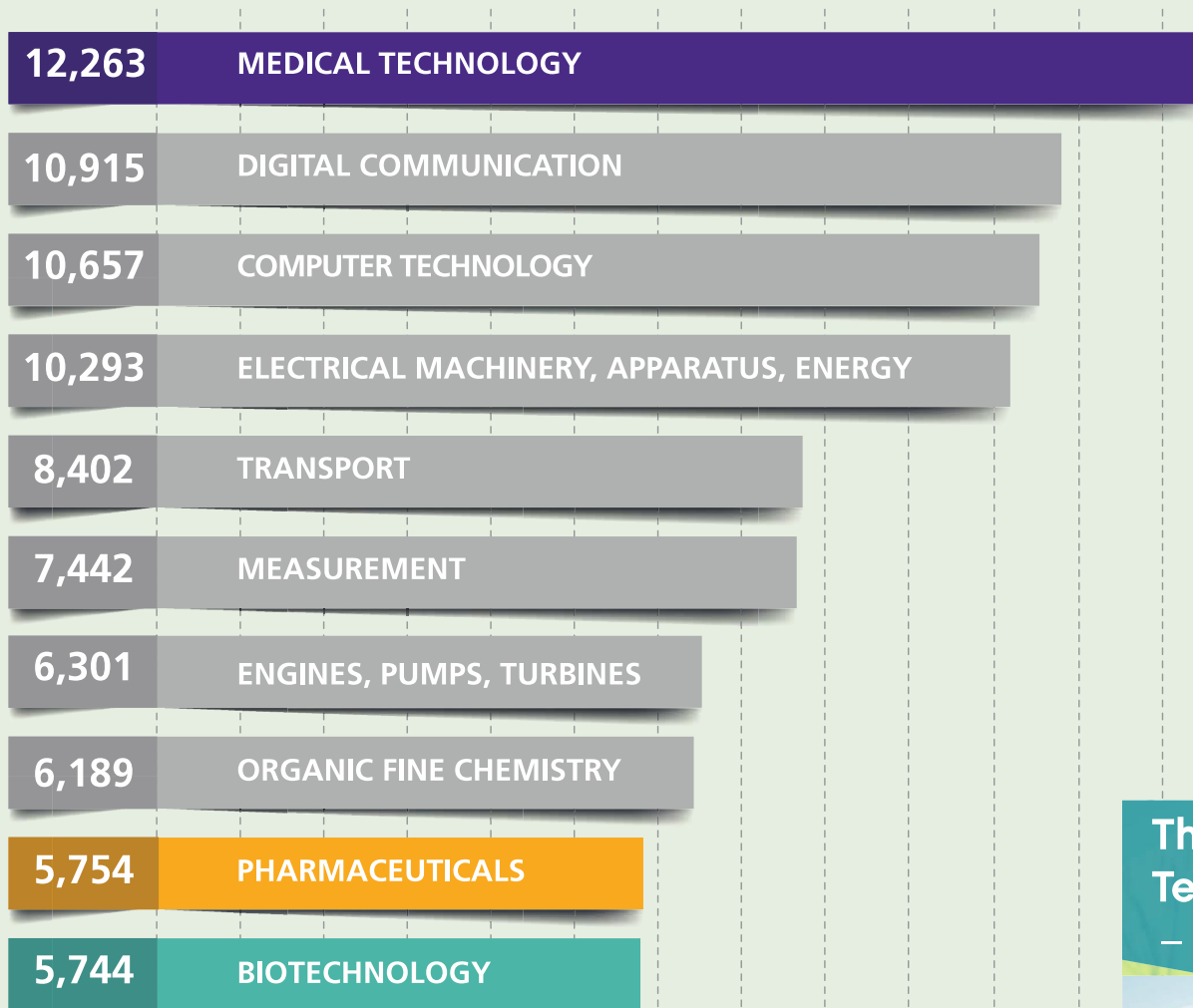


The European Medical  
Technology Industry  
– in Figures / 2018



## TOP 10 TECHNICAL FIELDS IN PATENT APPLICATIONS.

NUMBER OF PATENT APPLICATIONS FILED WITH EPO, 2016 (REF. 1)

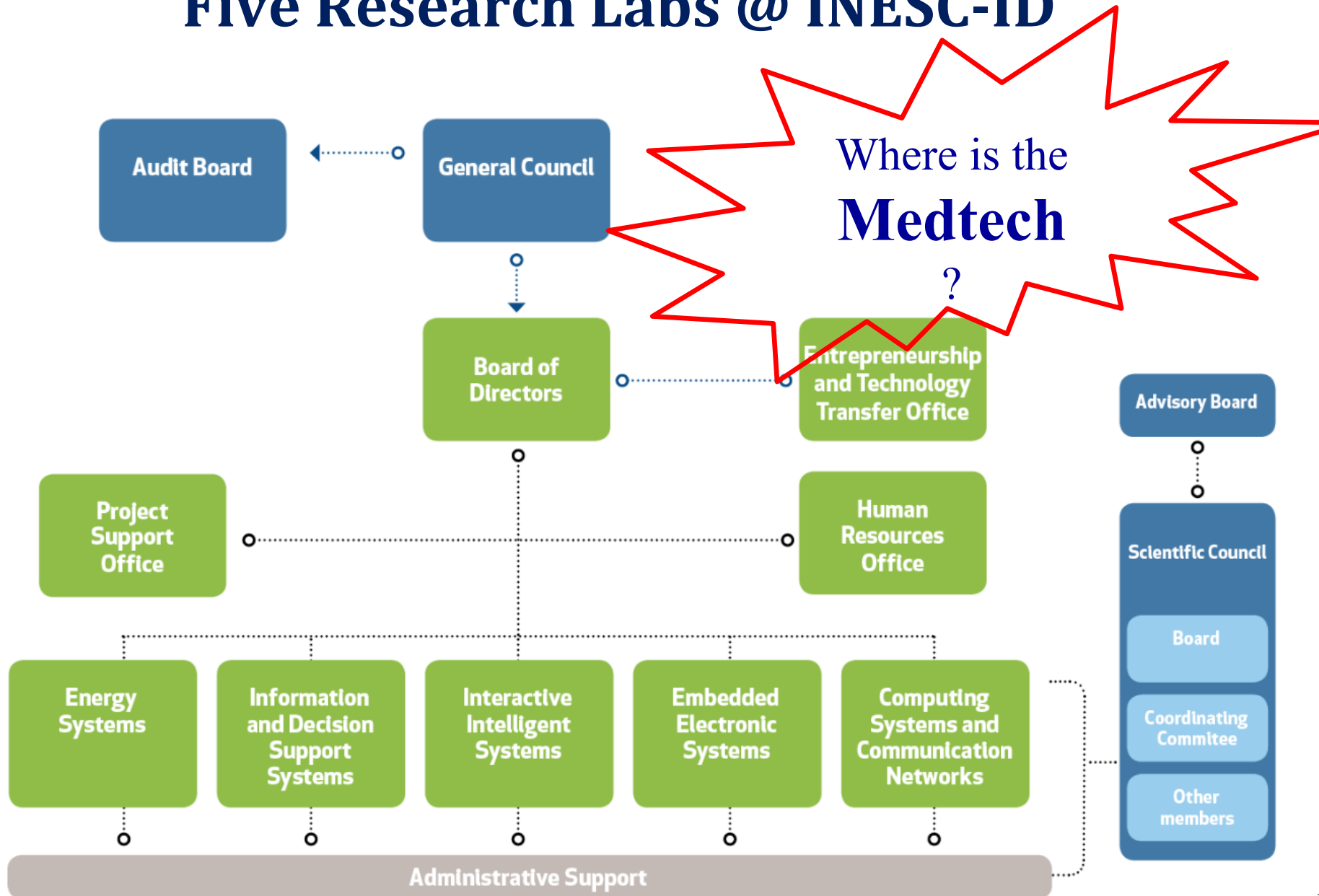


**The European Medical  
Technology Industry**  
– in Figures / 2018

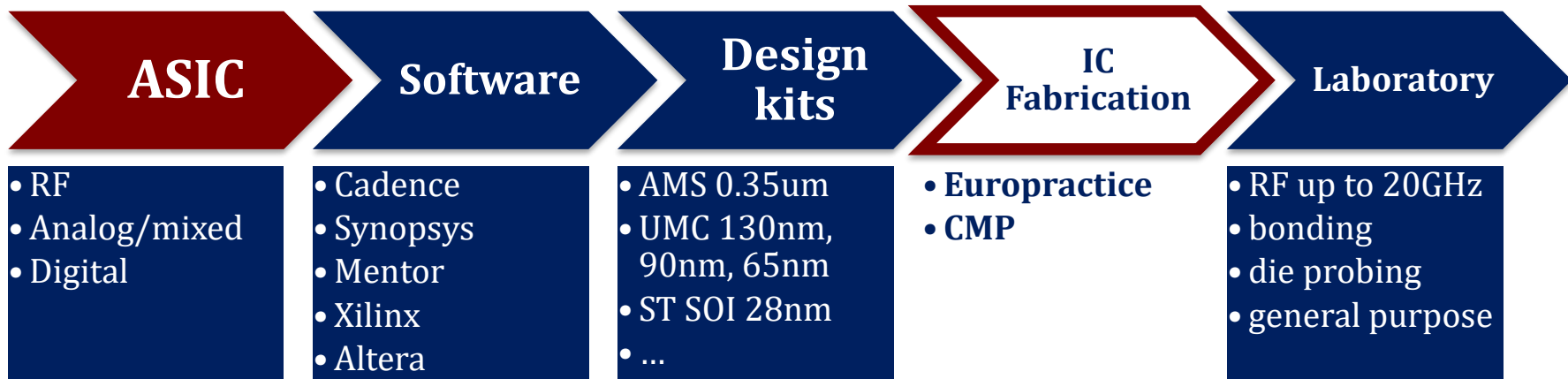
 **MedTech Europe**  
from diagnosis to cure

Investigação	<ul style="list-style-type: none"> <li>Promover a consolidação das equipas de investigação contrariando lógicas de fragmentação e assegurando a massa crítica</li> </ul>
	<ul style="list-style-type: none"> <li>Promoção de projetos com alinhamento estratégico entre a academia e as empresas</li> </ul>
	<ul style="list-style-type: none"> <li>Fomentar a harmonização entre a investigação fundamental e a investigação aplicada e promover o diálogo entre academia e empresas</li> </ul>
	<ul style="list-style-type: none"> <li>Ligação dos centros de investigação com as unidades de cuidados de saúde</li> </ul>
Transformação de conhecimentos	<ul style="list-style-type: none"> <li>Registo de patentes e proteção dos spin-offs das universidades</li> </ul>
	<ul style="list-style-type: none"> <li>Registo internacional de patentes</li> </ul>
	<ul style="list-style-type: none"> <li>Internalização de competências nas áreas de propriedade intelectual nas instituições</li> </ul>
	<ul style="list-style-type: none"> <li>Atração de investimento direto estrangeiro (IDE) nos domínios da investigação clínica /transformação conhecimentos</li> </ul>
Indústria	<ul style="list-style-type: none"> <li>Desenvolvimento e comercialização de produtos e serviços que deem resposta aos problemas de saúde que mais afetam as populações</li> </ul>
	<ul style="list-style-type: none"> <li>Internacionalização de bens transacionáveis e estabelecimento de parcerias ou modernização tecnológica dos processos de fabrico</li> </ul>
	<ul style="list-style-type: none"> <li>Investimento industrial nas áreas dos biológicos, dispositivos médicos high tech ou dos biomateriais</li> </ul>
	<ul style="list-style-type: none"> <li>Áreas não industriais, nomeadamente de engenharia, desenvolvimento de aplicações e serviços</li> </ul>
Serviços	<ul style="list-style-type: none"> <li>Diagnóstico especializado, por exemplo a nível molecular, terapias celulares para medicina regenerativa, e desenvolvimento e produção de biofármacos</li> </ul>
	<ul style="list-style-type: none"> <li>Área dos ensaios clínicos de fase I/II/III e IV</li> </ul>
	<ul style="list-style-type: none"> <li>Turismo de saúde/turismo médico</li> </ul>
	<ul style="list-style-type: none"> <li>Envelhecimento Saudável: projetos colaborativos entre operadores e a comunidade de I&amp;D e promovendo a investigação e aplicação de processos avançados de envelhecimento ativo e bem-estar</li> </ul>
	<ul style="list-style-type: none"> <li>Atração e acolhimento de investigadores e estudantes estrangeiros</li> </ul>

# Five Research Labs @ INESC-ID



# Microelectronics for Health Applications



## Electroceuticals/Implants/Lab-on-chip/etc

- Require Integrated Sensors w/microelectronics: single/arrays



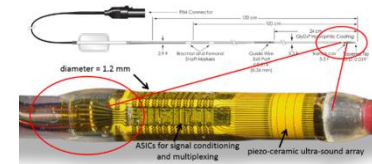
# Recent new projects - Related Applications

## POSITION II

**Ecsel-783132-Position-II-2017-IA**

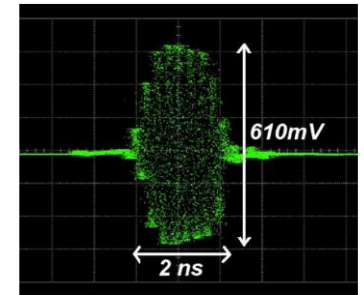
**WP2** In-tip AD Conversion

**WP5** Soft Encapsulation for Smart Implants



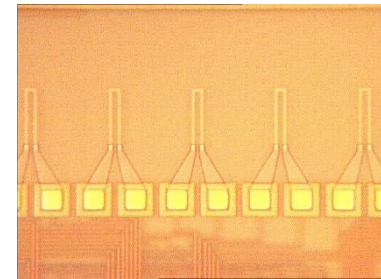
## UNSEEN .: UWB Non-Invasive Screening for Breast Cancer

**LISBOA-01-0145-FEDER-031416**



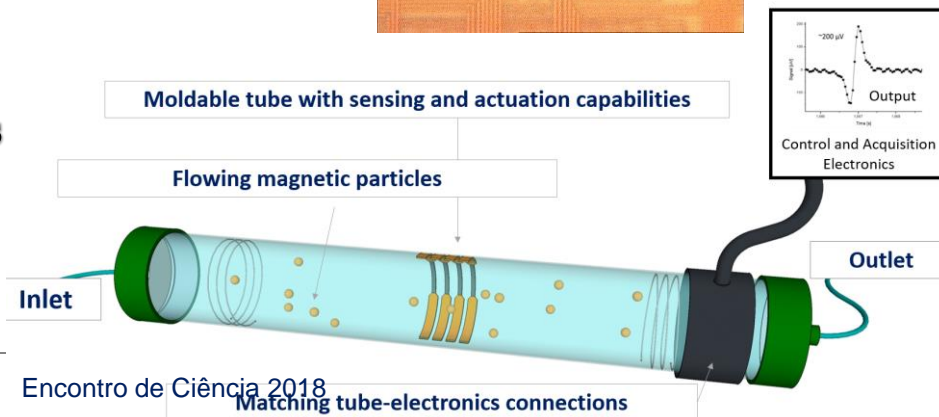
## MagScopy4IHC .: High-resolution Magnetic Scanner for Immunohistochemistry

**LISBOA-01-0145-FEDER-031200**

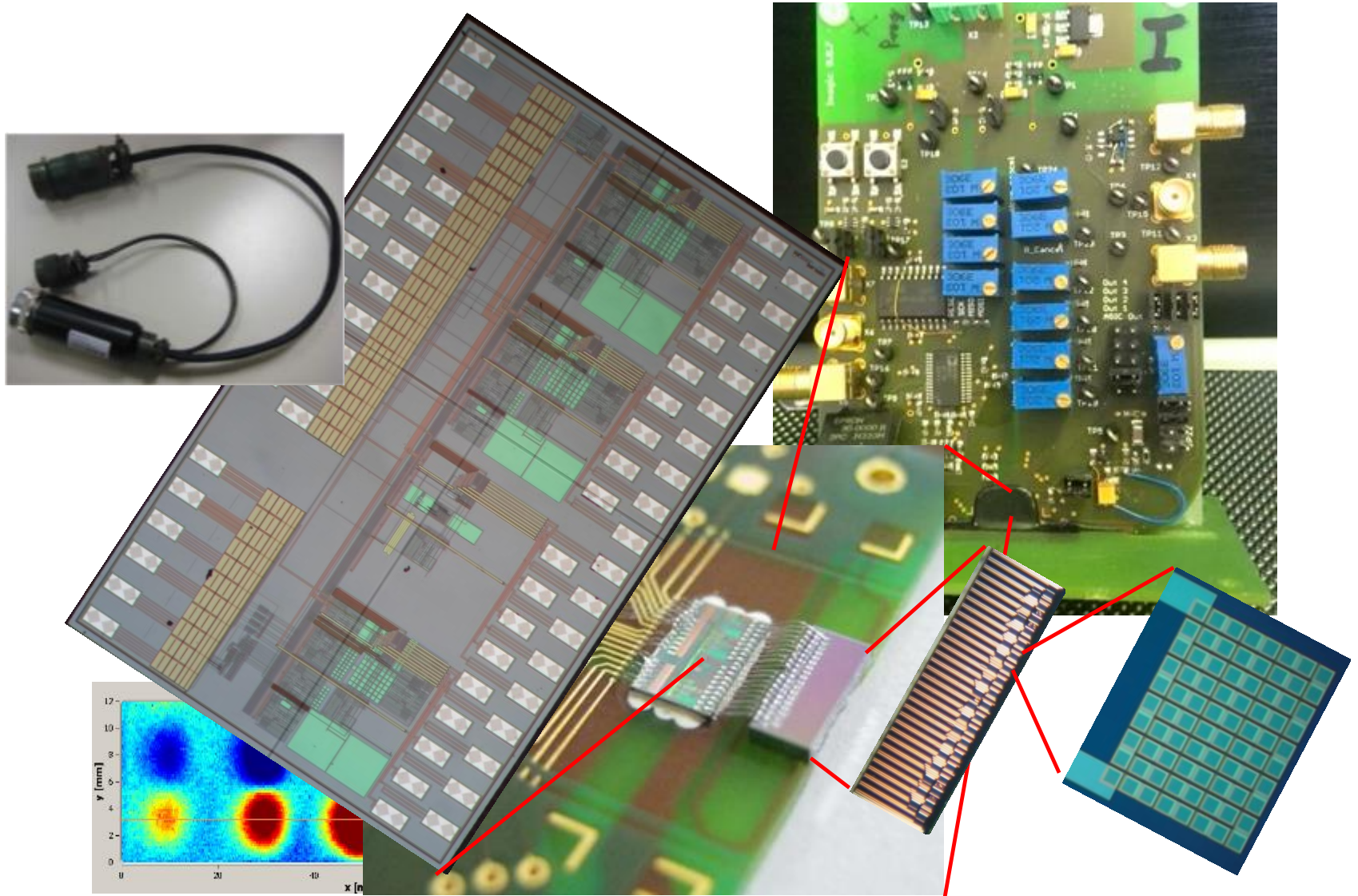


## STARCHIP .: Smart Tubular sensing and actuation devices for lab-on-CHIP platforms

**FP7-AAT-2012-RTD-LO**



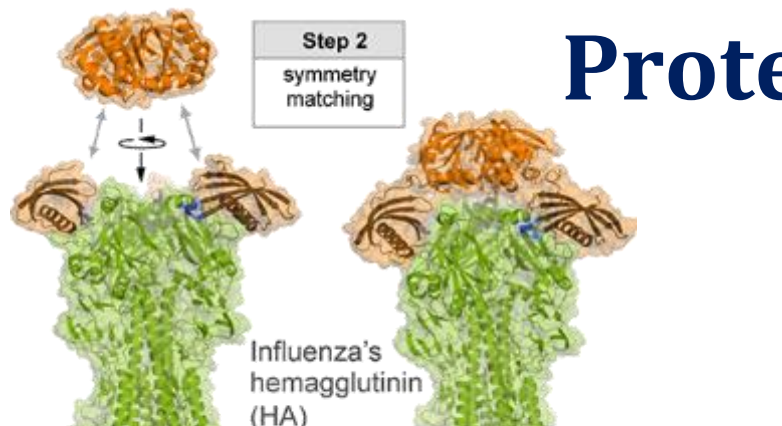
# Sensor Interface with Processing



Collaboration with INESC-MN

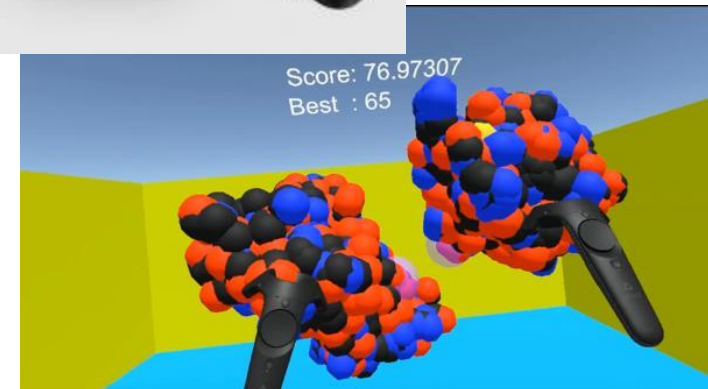
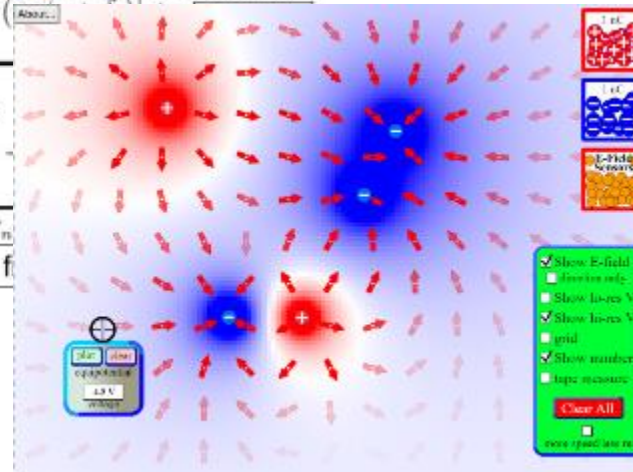


# Protein docking



$$U(\vec{R}) = \sum_{\text{bonds}} k_i^{\text{bond}} (r_i - r_0)^2 + \sum_{\text{angles}} k_i^{\text{angle}} (\theta_i - \theta_0)^2 + \sum_{\text{dihedrals}} k_i^{\text{dihe}} [1 + \cos(\phi_i - \phi_0)] + \sum_{i,j} 4\epsilon_{ij} \left[ \left( \frac{\sigma_{ij}}{r_{ij}} \right)^{12} - \left( \frac{\sigma_{ij}}{r_{ij}} \right)^6 \right]$$

PDB file  
geometry  
parameters  
Topology



Collaboration with ITQB

# BioData.pt

Portuguese Biological Data Network

12 National partners consortium

....also the Portuguese **Node** of  
**ELIXIR**

(European Life Sciences Infrastructure for Biological Information).

ELIXIR's vision for the future is to provide researchers in academia and industry with **seamless access to biological information** that will revolutionise discovery in the life sciences, by **integrating data at different levels of analysis**, for example from molecular biology to industrial solutions.



BioData.pt

Lisb@20<sup>20</sup>



REPÚBLICA  
PORTUGUESA

Ciência, Tecnologia  
e Ensino Superior

PORTUGAL  
2020



UNIÃO EUROPEIA  
Fundos Europeus  
Estruturais e de  
Investimento



Infraestrutura  
Nacional de  
Computação  
Distribuída



# PRECISE - Accelerating progress toward the new era of precision medicine (SAICTPAC/0021/2015)

*“We believe this is the right time to start broadly applying the concept of prevention and treatment strategies that take individual variability into account, so that one day all patients will be offered customized care with treatments that match each individual's molecular profile and personal history. PRECISE aims to accelerate progress of Portuguese health care toward the new era of precision medicine.”*

**Keywords: Precision Medicine, Health technologies, Oncology, Immunology**



# Statistical and machine learning methods for clinical data

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## Clinical decision support systems for personalized medicine

1. **Outlier detection and robust regression**
  - ← Survival analysis and Cox regression
  - ← Supervised classification and logistic regression
2. **Structured sparse models for multi-omics patient data**
  - ← Analysis of short time series (Patient stratification, biomarker discovery)
  - ← Regularized optimization (Network-based)
  - ← Joint models (Longitudinal + Survival)

<https://vre.precisemed.org/>

# PRECISE VRE

PRECISE Project Virtual Research Environment

Search



[Home](#) [Get Started](#) [Explore](#) [Analytics](#) [Social](#) [About](#) [Sign in](#)

## Explore

Domain workflows and databases

[Explore workflows](#)



### Bioinfo Workflows

See and use the workflows that other users have made public



### Databases

Search domain-specific public repositories for information



### Public Data

Resources that provide public data for research



### News / Publications

Keep up with the latest news on Precision Medicine



### External Tools

Public services that might be useful in Precision Medicine

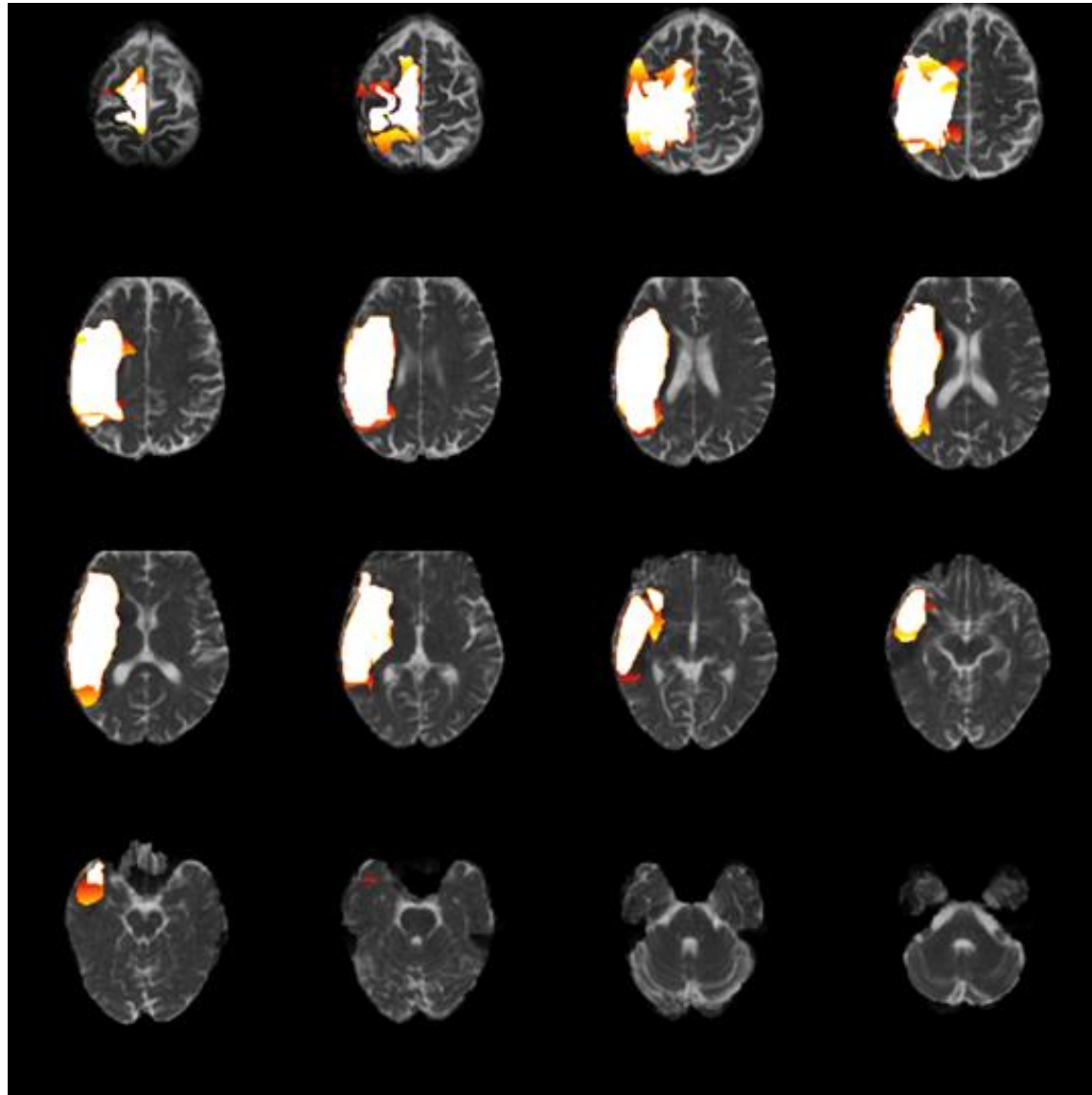


### Get Started

Confused? No worries, we have made tutorials for you

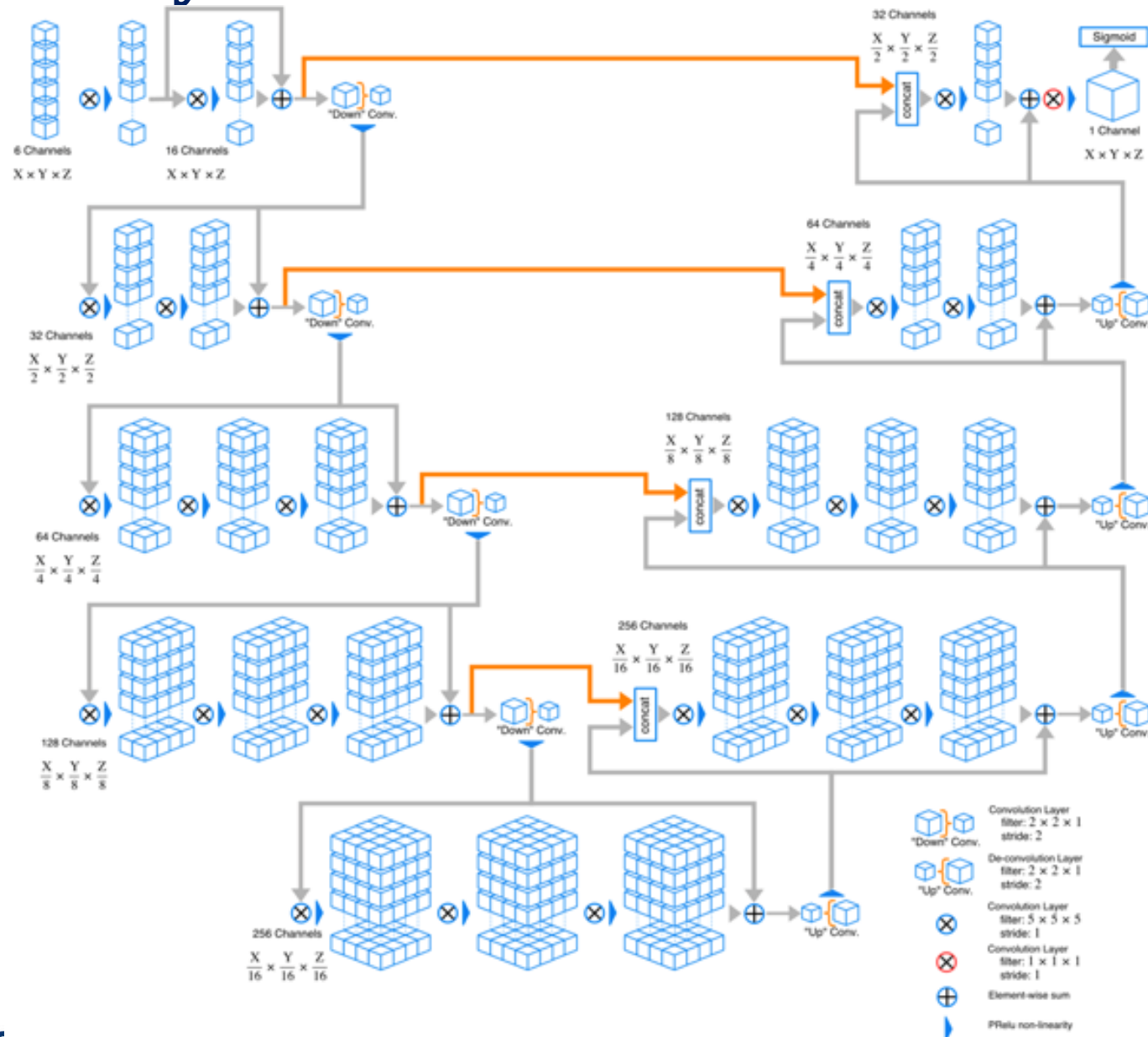


# Stroke challenge





# Fully Connected Neural Network



# Text Mining on Clinical Records



Contents lists available at ScienceDirect

Journal of Biomedical Informatics

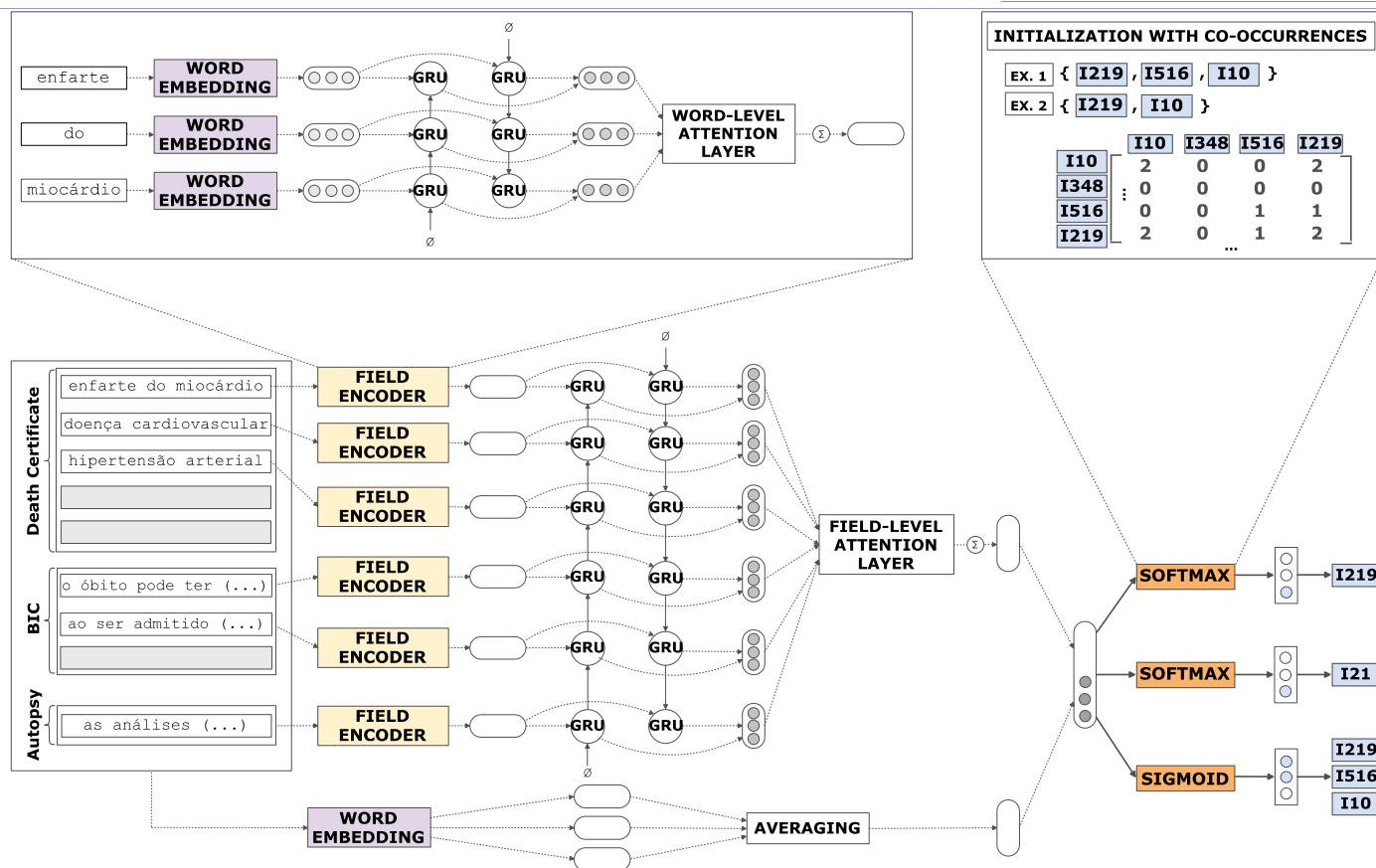
journal homepage: [www.elsevier.com/locate/yjbin](http://www.elsevier.com/locate/yjbin)



Deep neural models for ICD-10 coding of death certificates and autopsy reports in free-text

Francisco Duarte<sup>a,\*</sup>, Bruno Martins<sup>a</sup>, Cátia Sousa Pinto<sup>b</sup>, Mário J. Silva<sup>a</sup>

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<sup>b</sup> Direção-Geral da Saúde, Portugal



ICD-10 codes for causes of death by analyzing free-text descriptions in death certificates, autopsy reports and clinical bulletins, from the Portuguese Ministry of Health. The neural network also takes as input the hierarchical structure of ICD-10. Experimental results show that the proposed model achieves accuracy for ICD-10 chapters, blocks, and full-codes. Through examples, we illustrate interpretable results, useful for public health surveillance.

# Medical UI/UX // Graphics

## Ongoing Work

### Radiology

Virtual Reality for Radiologists in the Reading Room  
CAVE COLON  
Voxel TIPs

### Surgical Planning

IMPLANTAR  
Laparoscopic HUD

### Surgical Navigation

Voxel Explorer

### Rehabilitation

# Speech and Language Technologies for Health

- Assistive Technology
- Screening, diagnosis, therapy and monitoring
- Active ageing
- Medical text





# Screening, diagnosis, therapy and monitoring

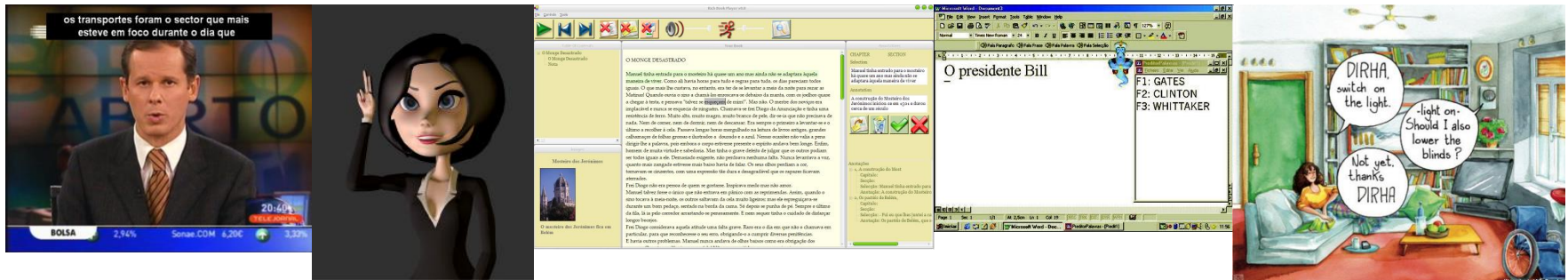
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- Linguistic features (=> Speech-to-text)
  - Semantic Fluency test
    - Name items belonging to a given semantic category (e.g., animals)
  - Picture description
    - Syntactic, semantic and information impairment, ... detected in among patients with dementia (e.g. Alzheimer's disease)



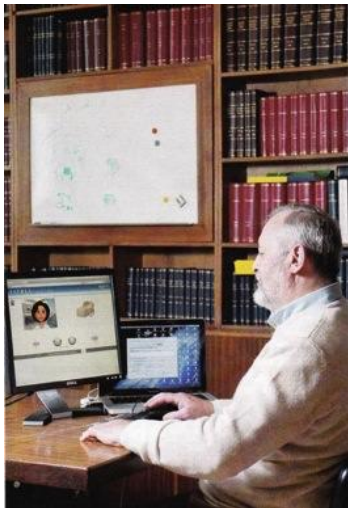
# Assis=ve Technology

- Hearing impairment (sub=tling, LGP translator, ...)
- Visual impairment (TTS for content access, spoken books, ...)
- Cerebral palsy (TTS with virtual keyboards and word predic=on)
- Physical impairments (control, home-autom=on, ...)



# □ VITHEA – Virtual therapist for Aphasia

- Therapist module: create, edit, delete patients exercises
- Patient module: access to therapy sessions
- Tracks patients evolution



Used in 4 hospitals  
~160 users,  
~1400 exercises (19 types)  
Four prizes  
1 year demo at  
“EUREKA GOES CRAZY”

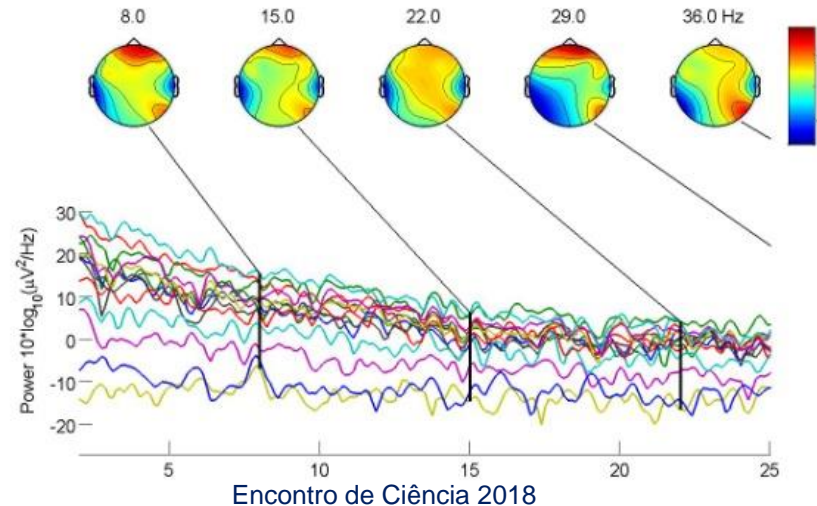
# Advanced brain data analysis

**EEG data is 4D:** observation, *spatial*, *spectral* and *temporal* dimensions

Lack of algorithms to describe **comprehensive brain patterning**

**Two paradigms:**

1. Unsupervised unraveling of intentions based on brain signal responses
2. **Well-defined brain patterns to be trained and reproduced to isolate intention**





# Advanced brain data analysis

- **Comunnication** and remote control of **interfaces**
  - (medical, transports, domotics, robotics, games)
- Navigation in virtual environments
- **Well-being** and **neuroplasticity**:
  - motor and cognition recovery
  - developing latent skills; fast learning



## Challenges:

- Low-cost yet reliable brain wearables
- Adequate brain patterning (learnability and reachability)

# Healthcare Information Systems

- Public Health Informatics
  - Integrating Sentinel Surveillance Systems and Electronic Health Records
  - Automated Daily Mortality Surveillance Systems
  - Mass Gatherings



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ULisboa**  
Faculdade  
de Ciências  
da Universidade  
de Lisboa



**IGOT**  
Instituto de Geografia e  
Ordenamento do Território



**ie**  
Instituto de  
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UNIVERSIDADE DE LISBOA



**Faculdade de Psicologia**  
UNIVERSIDADE DE LISBOA

**b  
a** **belas-artes  
ulisboa**

EIT Health @ ULISBOA: a community of 18  
schools, 76 research centres and more  
than 8000 researchers



# BeHealsy

## PhD in Biomedical Engineering and Health Systems

### CEMACUBE

Common European Master's  
Course in Biomedical Engineering



AIM: to train students in innovation and entrepreneurship in Biomedical Engineering

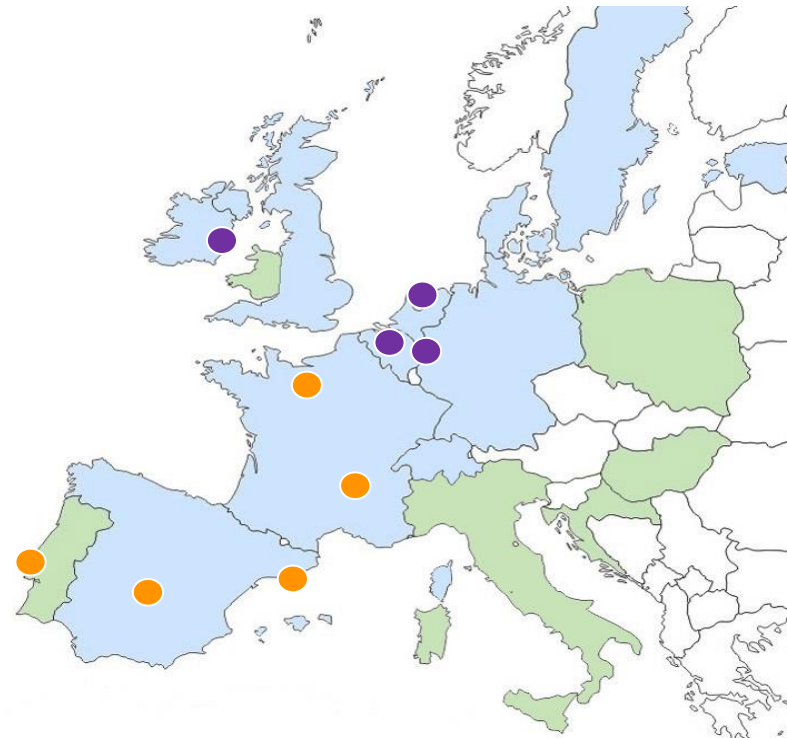
### MTiH

Master Technological  
Innovation in Health



AIM: to offer a federation of Master programmes in Biomedical and Health Engineering.

#### Non-academic partners involved in Master



# Medtech @ INESC-ID



TECH  
NOLOGY  
FROM  
SEED

