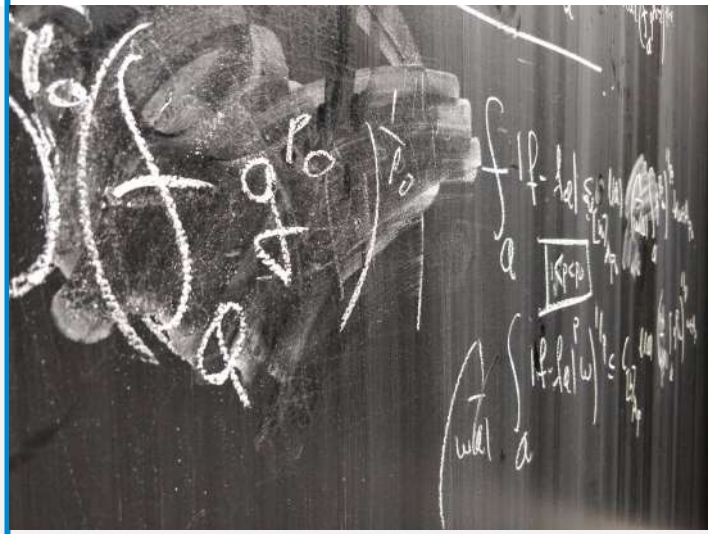
2015 ANNUAL REPORT

(bcam)
basque center for applied mathematics

EXCELENCIA
SEVERO
OCHOA

“If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is”

—von Neumann, 1947



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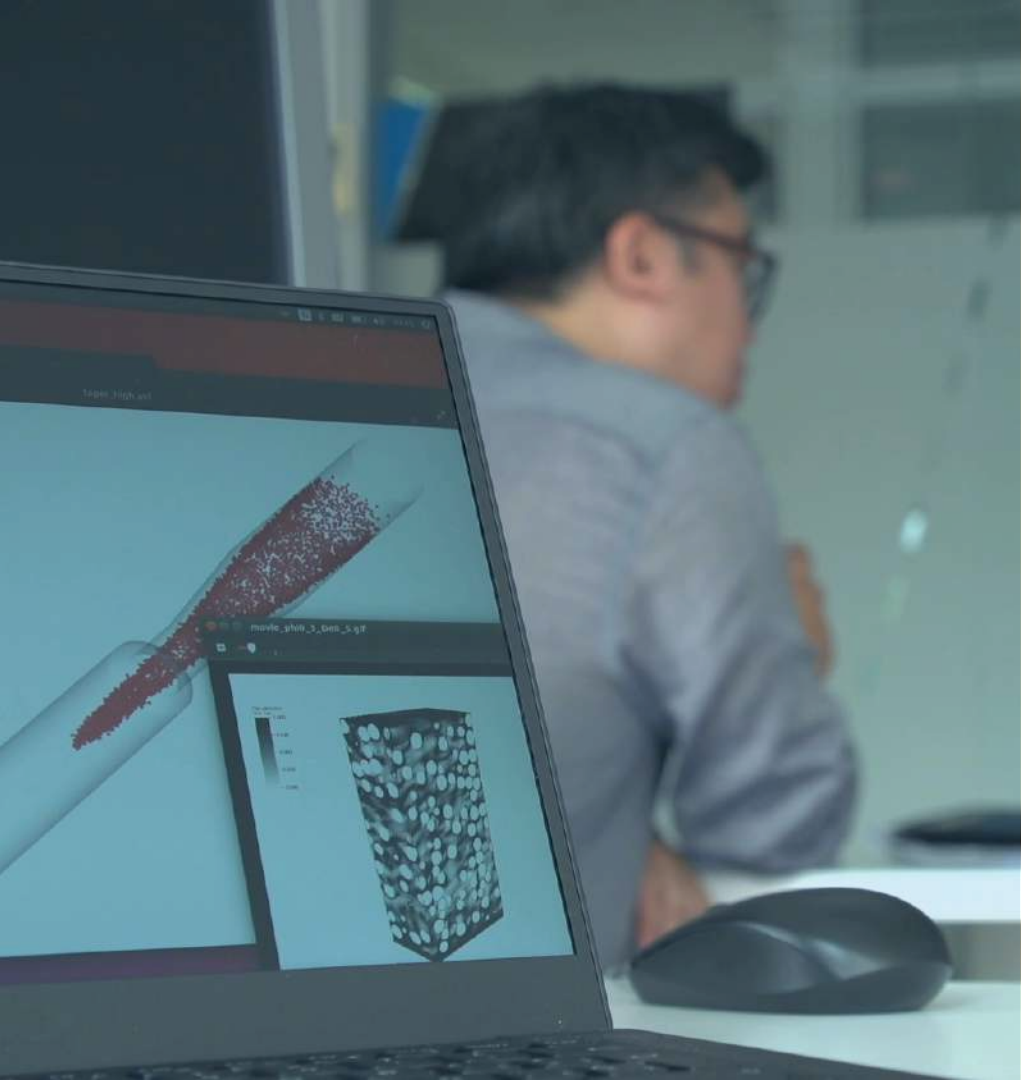


01 RESEARCH AREAS

001
SWIP
Simulation of Wave Propagation

002
CFDMS
CFD Modelling and Simulation

003
CFDCT
CFD Computational Technology

01
CM
Computational mathematics

- **Objective**: To develop new mathematical methods, robust numerical schemes and software to solve complex and large-scale challenging real-life problems on massively parallel computers.
- **Description**: A strong mathematical framework is key to obtain reliable algorithms and simulations. We analyse modern numerical methods such as advanced Finite Element (AFE) or Discontinuous Petrov-Galerkin (DPG) and Finite Volume methods applied to stationary and time dependent problems. We also simulate open industrial problems, working on two platforms: BBIPED and FEniCS (CFD and multi-physics).s.
- **Applications**: Characterisation of the Earth ´s subsurface composition for CO2-sequestration and oil or gas extraction; CFD applied to biomedicine, meteorology, oceanography, aeronautics, naval architecture, acoustics and turbomachinery.

001
MSLMS
Modelling and Simulation in Life and Materials Sciences

002
MMB
Mathematical Modelling in Biosciences

003
MCEN
Mathematical, Computational and Experimental Neuroscience

02

M3A

Mathematical modelling with multidisciplinary applications

- **Objective**: Efficient and detailed simulation of complex phenomena stemming from real life problems in biology, medicine, public health and society.
- **Description**: The challenge lies in developing novel algorithmic approaches, sampling techniques and improved computational models, in order to fully exploit the capabilities of modern HPC. We also couple numerical simulation with the applications specific observation data, e.g individual anatomies reconstructed from imaging, experimental data in controlled radical polymerization, recorded data on the reservoir's production.
- **Applications**: Patient-specific simulation (cardiovascular, brain, cancer), neurodegenerative diseases, drug design, self-assembly in bio-chemical processes, energy materials modelling and uncertainty quantification. Targeted at biologists, clinicians and industries.

001
QM
Quantum Mechanics

002
SP
Statistical Physics

003
STAG
Singularity Theory and Algebraic Geometry

03
MP
Mathematical Physics

- **Objective**: At the interface between Mathematics and Physics is the so-called Mathematical Physics that at BCAM is represented by the research lines in Fluid Mechanics, Quantum Mechanics and Statistical Physics.
- **Description**: We study several questions of classical physics that although known long ago, are still not understood from the mathematical perspective, such as the dynamics of fluids, microscopic origin of macroscopic laws (like in electricity) and natural phenomena of front motion embedded into random environments..
- **Applications**: Our methods could apply to generate pseudo-random numbers, future applications of quantum technologies or forecast of wildland fire propagation to preserve natural heritage..

001
WAVE
Linear and non-linear Waves

002
HA
Harmonic Anallysis

003
APAN
Applied Analysis

04

DCN

Partial differential equations, control and numerics

- Objective: We develop accurate adaptive numerical methods mimicking the evolution of solutions of PDEs to assist on control and design processes. We also study nonlinear partial differential and kinetic equations.
- Description: The challenge is to develop numerical methods for which the presence of possible high frequency numerical components does not destroy the true dynamics of continuous solutions and to identify those that eventually diverge because of the spurious numerical solutions..
- Applications: Shape design in aeronautics and aerospace, electrical and hydraulic networks and social behaviour and population dynamics, quantum gases and aerosols.

001
HEUR
Heuristic Optimization

002
AS
Applied Statistics

003
ML
Machine Learning

05
DS
Data Science

- **Objective**: The increase in data generation (Big data) has made indispensable the development of new statistical and machine learning methods and algorithms for knowledge extraction.
- **Description**: In the applied statistics field, the main topics of our research are semi-parametric regression, multidimensional smoothing, (Bayesian) hierarchical models, computational statistics...Regarding Machine learning, we work on probabilistic graphical models (PGM), mainly focused on the automatic learning of PGMs from data.
- **Applications**: Massive data problems from particle physics to e-commerce, social media, financial, marketing, medical domains (diagnosis and prognosis), genetics , environmental modelling, demography and biostatistics..

PEOPLE 02

75 people

+20 more than in 2014

1
Scientific Director

11
Research line leaders and BCAM researchers

30
Postdoctoral fellows

5
Administration Staff Members

2
IT Members

26
PhD Students

SCIENTIFIC OUTPUT 03

SCIENTIFIC PUBLICATIONS

92

PUBLICATIONS INDEXED

78%

articles in Q1

articles in D1

39%

BCAM H-INDEX

16

1st DECILE JOURNALS

- Annales Scientifiques de l'Ecole Normale Superieure
- Chemical Reviews
- Coastal Engineering
- Computer Methods in Applied Mechanics and Engineering
- Computers and Mathematics with Applications
- IEEE Transactions on Automatic Control
- IEEE Transactions on Robotics
- Journal of Differential Equations
- Journal of Statistical Mechanics: Theory and Experiment
- Mathematical Models and Methods in Applied Sciences
- Physical Review E - Statistical, Nonlinear, and SoL MaMer Physics
- SIAM Journal on Imaging Sciences
- SIAM Journal on Scientific Computing

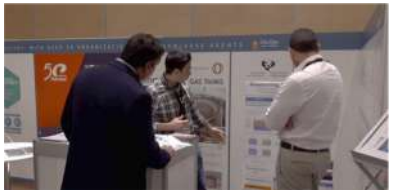
MASTER & PHD THESIS

14

ONGOING PHD STUDENTS IN 2015

+12

NEW PHD STUDENTS



THESIS DEFENDED IN 2015

1

3

MASTER THESIS DEFENDED IN 2015

04 PROGRAMMES

PARTICIPANTS IN OUR PROGRAMMES

13 Visiting fellows

27 Interns

116 Visitors

COLLABORATORS 05

KNOWLEDGE TRANSFER UNIT

COLLABORATORS IN THE FRAMEWORK OF THE BASQUE SCIENCE, TECHNOLOGY & INNOVATION NETWORK

Universidad del País Vasco
Euskal Herriko Unibertsitatea

euskampus FUNDAZIOA

Osakidetza

CIC energiGUNE
energy cooperative research centre

POLYMAT
Basque Center for Macromolecular Design and Engineering

Ingeniaritza Goi Eskola Teknikoa
Escuela Técnica Superior de Ingeniería Bilbao

ETXE-TAR

MedLumics
Enlightening Healthcare

tecnalia Inspiring Business

Bilbao Bizkaia Ur Partzuergoa
Consorcio de Aguas Bilbao Bizkaia

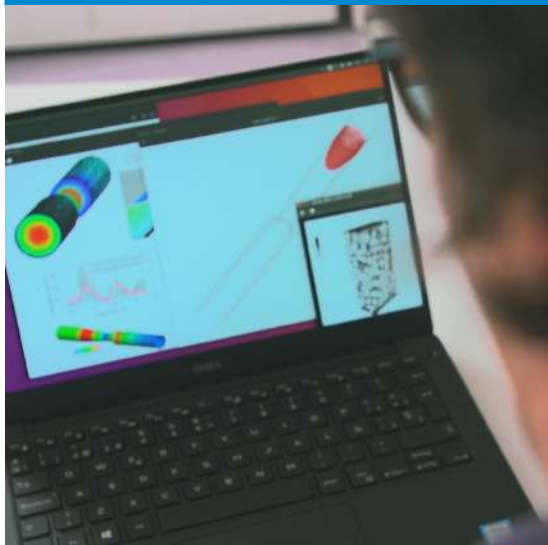
biocruces bizkaia

TEXAS
The University of Texas at Austin

bio
eusko fundazioa
Fundación Vasca de Innovación e Investigación Sanitarias

[math-in].net
Red Española Matemática-Industria

Case Western Reserve University EST. 1826



NEW INTERNATIONAL AGREEMENTS

UNIVERSITÁ DEGLI STUDI DI TORIO

TECNISCHE UNIVERSITÄT BRAUNSCHWEIG

NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY OF ZAGREB

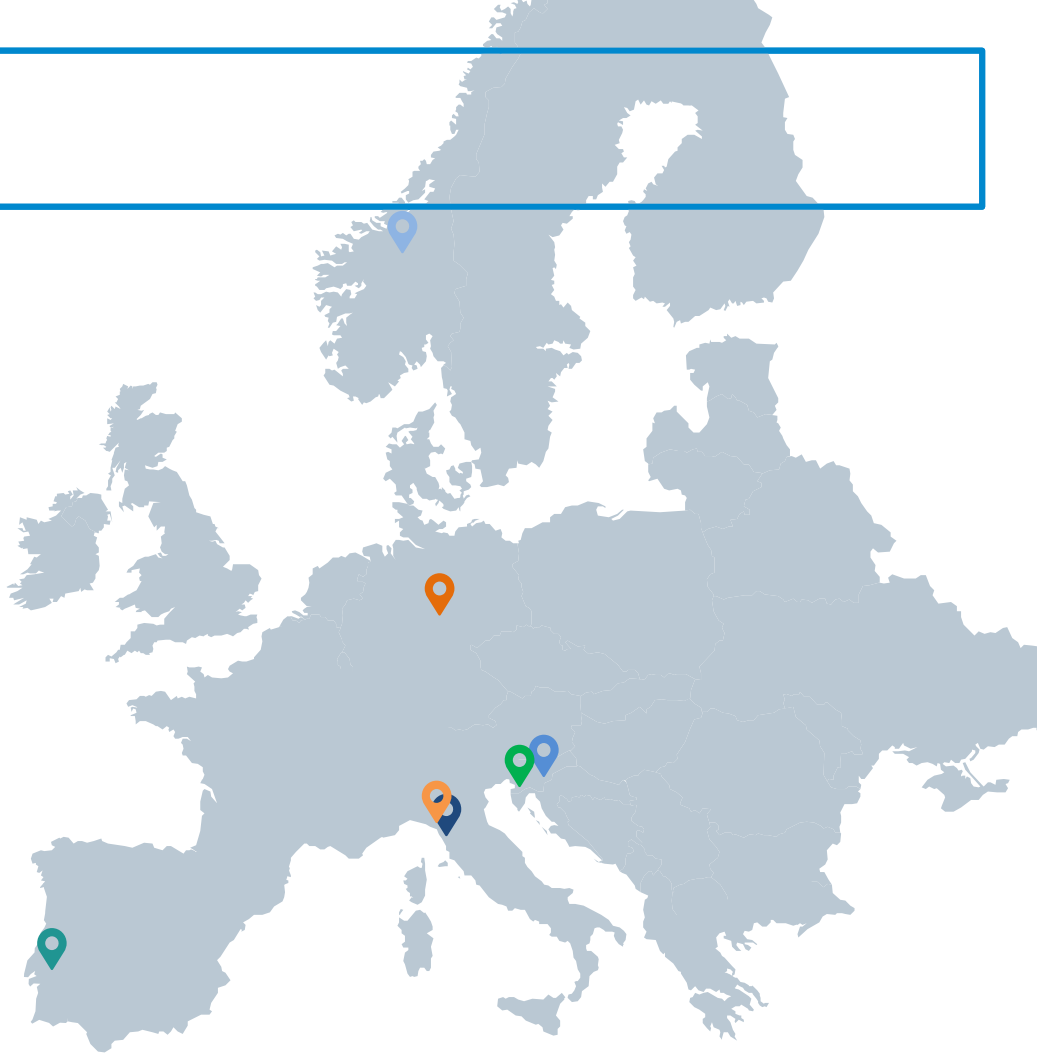
INSTITUTO DI SCIENZA E TECNOLIGIE DELL` INFORMZACIONE “A FAEDO”

SCUOLA INTERNAZIONALE SUPERIORE DI STUDI AVANZATI

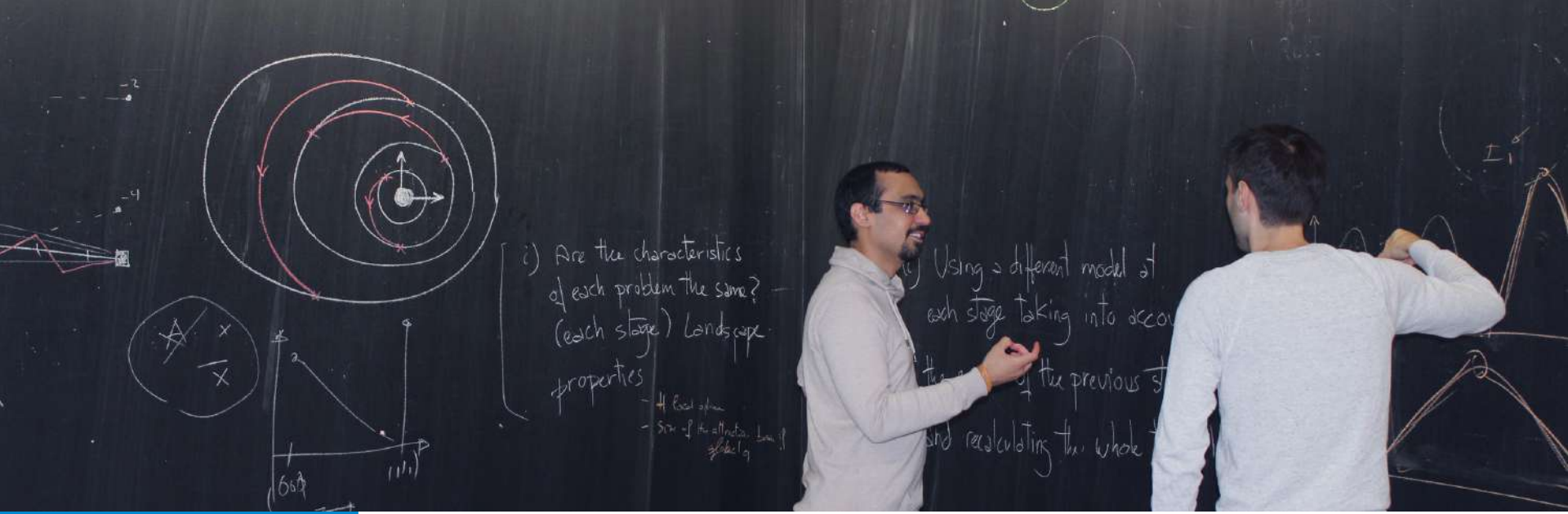
INSTITUTO DE TECNOLOGIA QUÍMICA E BIOLÓGICA

THE UNIVERSITY OF TEXAS AT AUSTIN

CASE WESTERN RESERVE UNIVERSITY



06 FUNDING



PARTICIPATING INSTITUTIONS

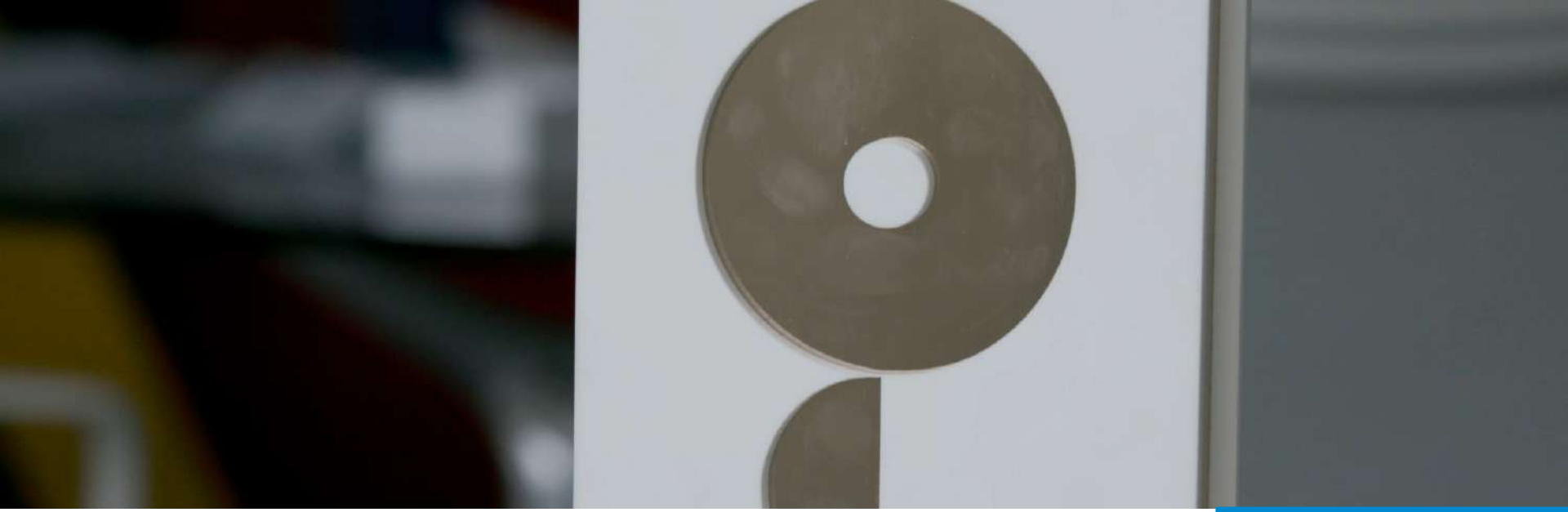
EUSKO JAURLARITZA
GOBIERNO VASCO

ikerbasque
Basque Foundation for Science

Bizkaia
foru aldundia
diputación foral

innobasque
berrikuntzaren euskal agentzia
agencia vasca de la innovación

Universidad del País Vasco
Euskal Herriko Unibertsitatea



EUSKO JAURLARITZA GOBIERNO VASCO

ikerbasque Basque Foundation for Science

Bizkaia foru aldundia diputación foral

CIC energiGUNE energy cooperative research centre

EXCELENCIA SEVERO OCHOA

GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD

TEXAS The University of Texas at Austin

imus

MedLumics Enlightening Healthcare

Bilbao Bizkaia Ur Partzuergoa Consorcio de Aguas Bilbao Bizkaia

Obra Social "la Caixa"

IBERDROLA

ETXE-TAR

Bizkaia talent

PUBLIC & PRIVATE FUNDING

DISSEMINATION 07

SCIENTIFIC & TRANSFER ACTIVITIES

52 seminars

BCAM Scientific Seminars
& Working groups

14 workshops

QBIO, BIDAS, FCPNLO…

14 courses

UPV/EHU Joint courses
& BCAM Courses

basque center for applied mathematics

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