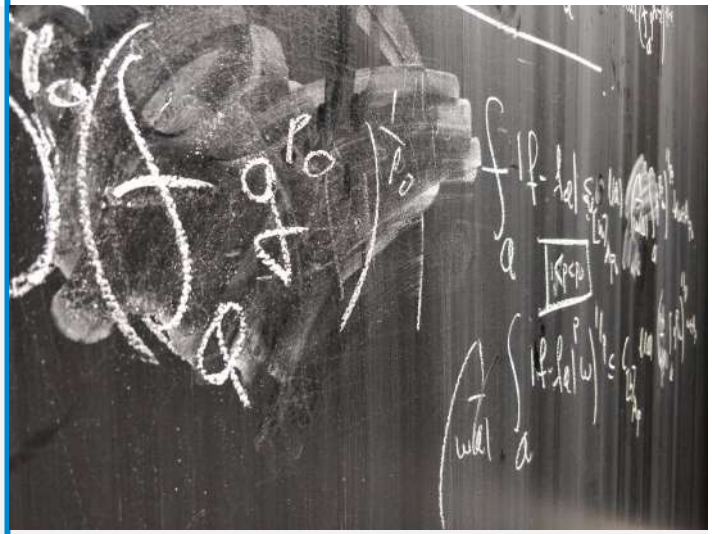
2016 ANNUAL REPORT

(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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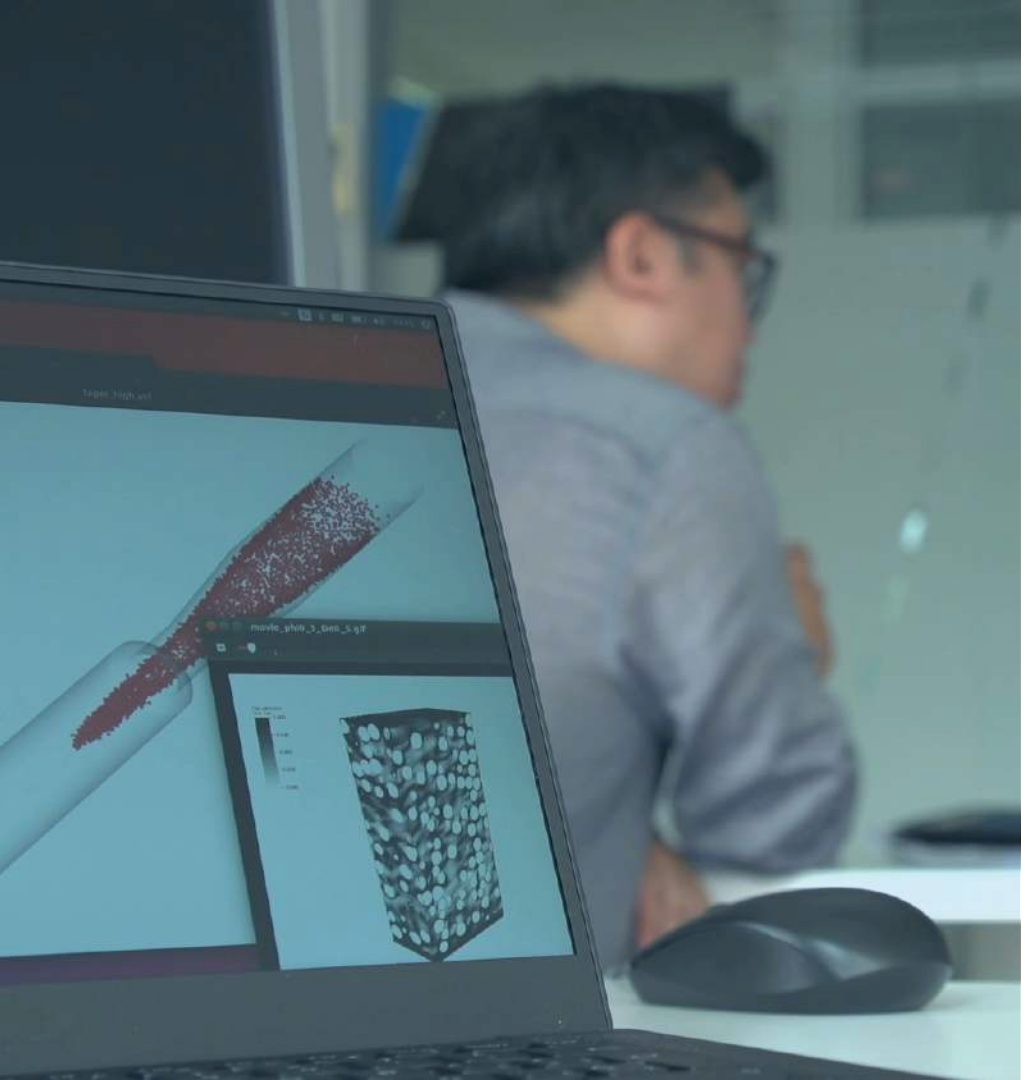


01 RESEARCH AREAS

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)
- .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**: Development of novel theoretical and computational tools for efficient and detailed simulation of multi- scale complex systems describing real life problems in biology, medicine, public health and society.
- **Description**: Improved algorithms, efficient sampling techniques, advanced models combined with observational data ensure a full exploitation of the capabilities of modern HPC in tackling the mathematical challenge of strong coupling across scales, adaptive and emergent dynamics. Pushing the boundaries of mathematics and interdisciplinary knowledge helps to reveal hidden structures of the complex systems.
- **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 Quantum Mechanics, Statistical Physics and Singularity Theory & Algebraic Geometry.
- **Description**: We study several questions of classical physics that although long known, are still not understood from the mathematical perspective, microscopic origin of macroscopic laws (like in electricity) and natural phenomena of front motion embedded into random environments. More theoretically, we study the geometry of Singularities appearing in Algebraic Geometry.
- **Applications**: Our methods could apply to, future applications of quantum technologies or forecast of wildland fire propagation to preserve natural heritage, cryptography and string theory.

001
WAVE
Linear and non-linear Waves

002
HA
Harmonic Anallysis

003
APAN
Applied Analysis

04
APDE
Analysis of Partial Differential Equations

- **Objective**: We explore and exploit the deep connections between Partial Differential Equations, Harmonic Analysis, and Applied Mathematics so as to describe the most diverse phenomena.
- **Description**: The attempt to efficiently describe real-life phenomena leads to mathematical models, often expressed in terms of PDEs, capturing the essential features of the phenomena. Solving these equations implies the use and development of sophisticated techniques of analysis together with the realisation of numerical simulations to eventually determine the validity of the models.
- **Applications**: The understanding of the fundamental principles that control relevant phenomena in physics and biology could eventually become of use for scientists working on those fields. We also expect to apply the efficient algorithms developed by our numerical simulations in real life problems.

001
HEUR
Heuristic Optimization

002
AS
Applied Statistics

003
ML
Machine Learning

05
DS
Data Science & Artificial Intelligence

- Objective: The increase in data generation (Big data) and problem sizes has made indispensable the development of new statistical and machine learning methods and algorithms for knowledge extraction and optimization.
- 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 supervised and unsupervised classification of massive data, probabilistic graphical models, time series, Bayesian optimisation, etc. In optimisation we pursue the developments of efficient metaheuristics methods.
- Applications: Massive data and optimisation problems from financial to social media, marketing, medical domains (diagnosis and prognosis), genetics, environmental modelling, demography and biostatistics, logistics, scheduling and planning.

PEOPLE 02

116 people

+21 more than in 2015

1
Scientific Director

23
Research line leaders and BCAM researchers

46
Postdoctoral fellows

7
Administration Staff Members

2
IT Members

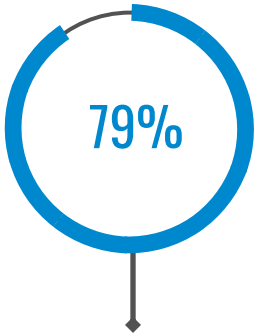
37
PhD Students

SCIENTIFIC OUTPUT 03

SCIENTIFIC PUBLICATIONS

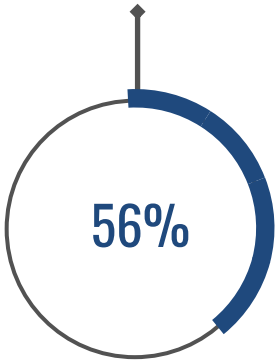
83

PUBLICATIONS INDEXED



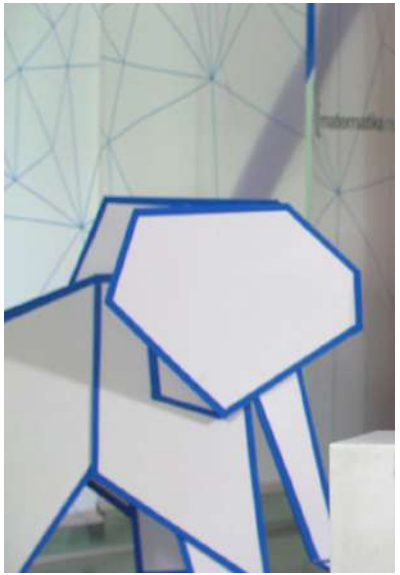
articles in Q1

articles in D1



BCAM H-INDEX

19



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 Soft Matter Physics
- SIAM Journal on Imaging Sciences
- SIAM Journal on Scientific Computing

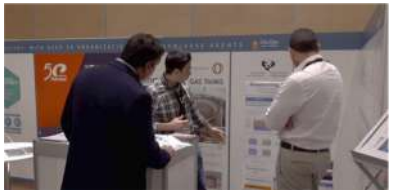
MASTER & PHD THESIS

18

ONGOING PHD STUDENTS IN 2016

+9

NEW PHD STUDENTS



THESIS DEFENDED IN 2016

3

5

MASTER THESIS DEFENDED IN 2016

04 PROGRAMMES

PARTICIPANTS IN OUR PROGRAMMES

17 Visiting fellows

27 Interns

128 Visitors

COLLABORATORS 05

KNOWLEDGE TRANSFER UNIT

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

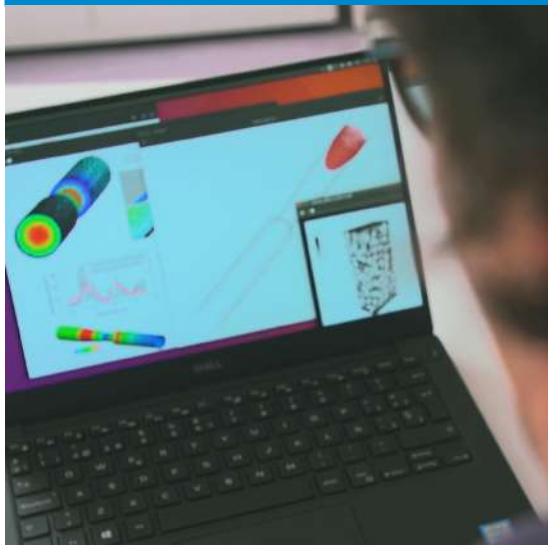
bio eusko fundazioa
Fundación Vasca de Innovación e Investigación Sanitarias

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

ИКИ

BioCruces
HEALTH RESEARCH INSTITUTE

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



NEW INTERNATIONAL AGREEMENTS

CHARLES UNIVERSITY

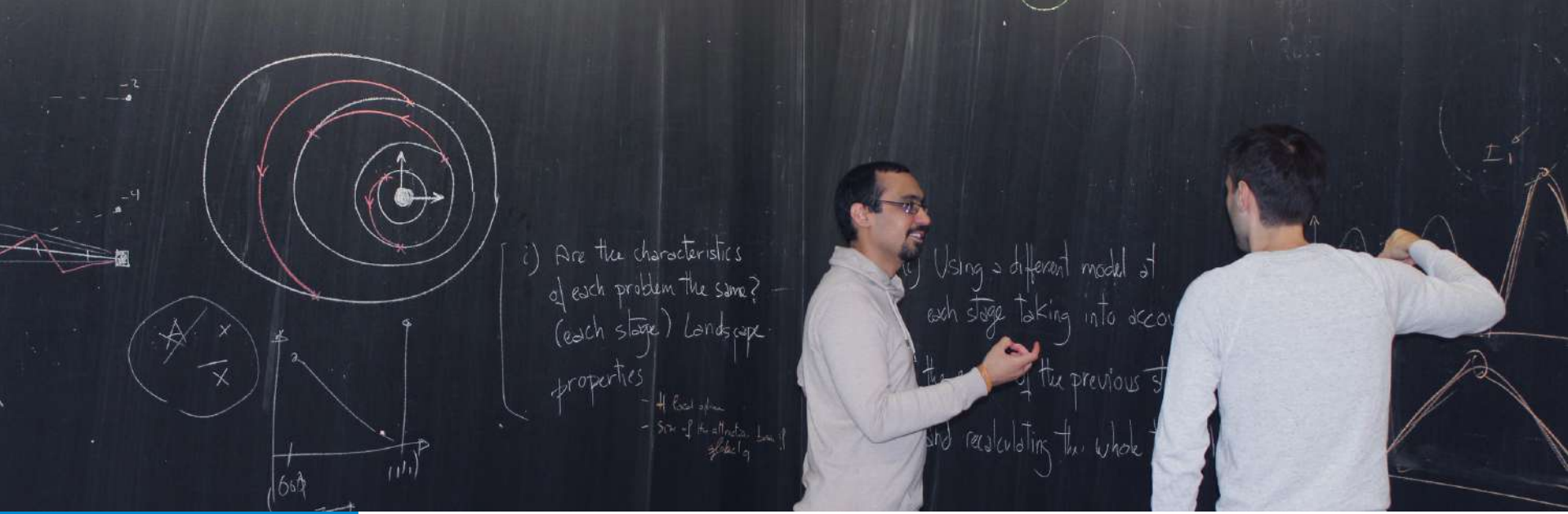
POLITÉCNICO MILANO

UNIVERSITÀ DE BOLOGNA

HKH

SENIOR GROWTH

06 FUNDING



PARTICIPATING INSTITUTIONS

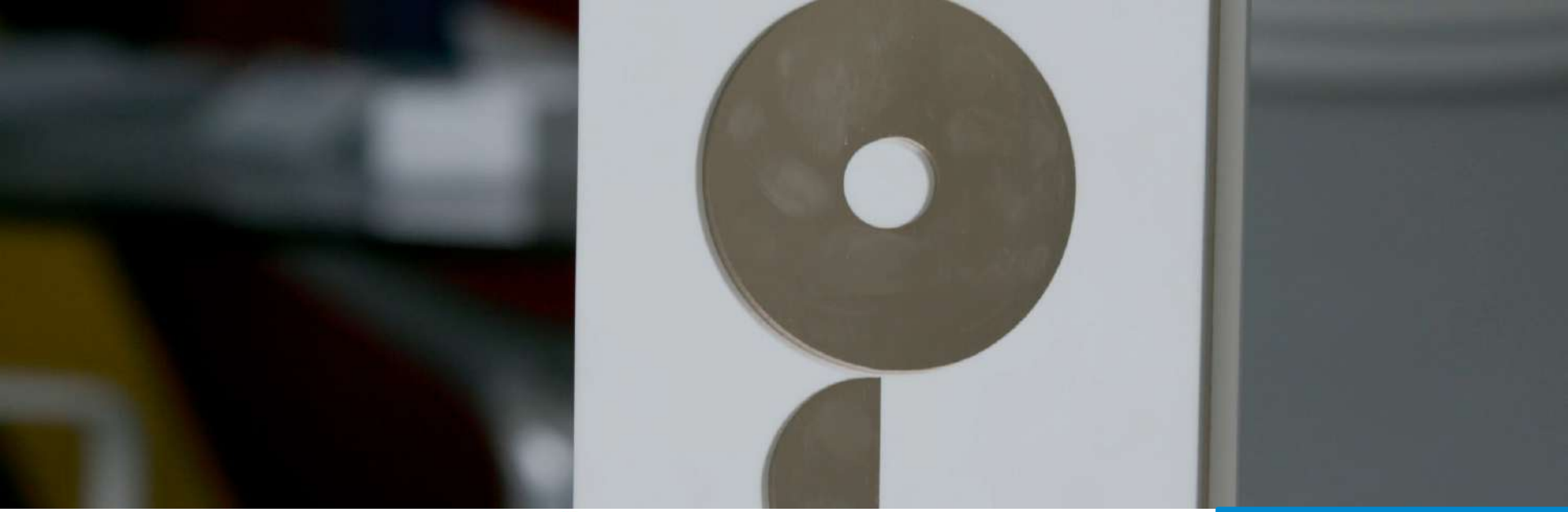
EUSKO JAURLARITZA
GOBIERNO VASCO

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

EMAKUNDE EMAKUMEAREN EUSKAL ERAKUNDE INSTITUTO VASCO DE LA MUJER

CIC energiGUNE energy cooperative research centre

EXCELENCIA SEVERO OCHOA

GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD

ETXE-TAR

imus Instituto Universitario de Investigación de Matemáticas de la Universidad de Sevilla "Antonio de Castro Brzezicki"

Bilbao Bizkaia Ur Partzuergoa Consorcio de Aguas Bilbao Bizkaia

Obra Social "la Caixa"

IBERDROLA

tecnalia

Bizkaia talent

CDTI

THE UNIVERSITY OF TEXAS AT AUSTIN

azti tecnalia

MedLumics Enlightening Healthcare

PUBLIC & PRIVATE FUNDING

DISSEMINATION 07

SCIENTIFIC & TRANSFER ACTIVITIES

69 seminars
BCAM Scientific Seminars
& Working groups

15 workshops
QBIO, BIDAS, FCPNLO…

14 courses
UPV/EHU Joint courses
& BCAM Courses

basque center for applied mathematics

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