2014

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

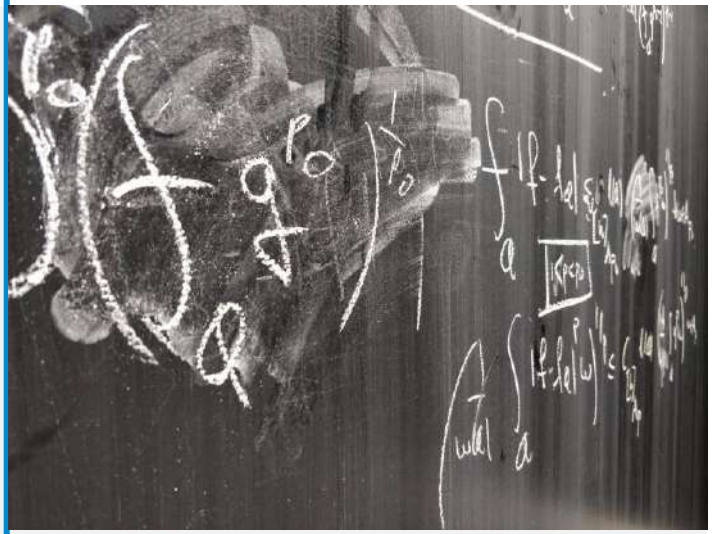
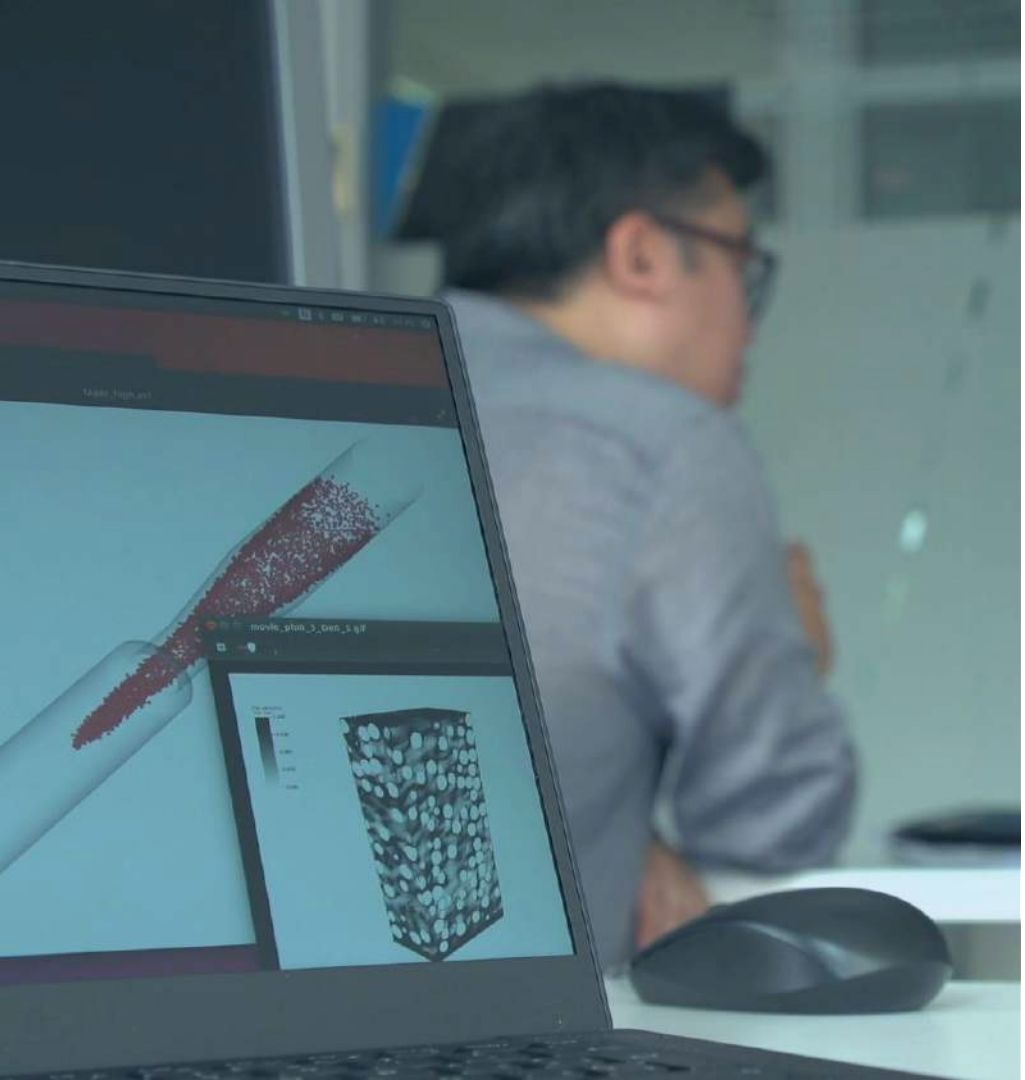


TABLE OF CONTENTS



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.

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 and brain), virtual screening for drug design, self-assembly in biological/chemical processes, modelling electroactive energy materials and uncertainty quantification in reservoir simulation.

001
QM
Quantum Mechanics

002
SP
Statistical Physics

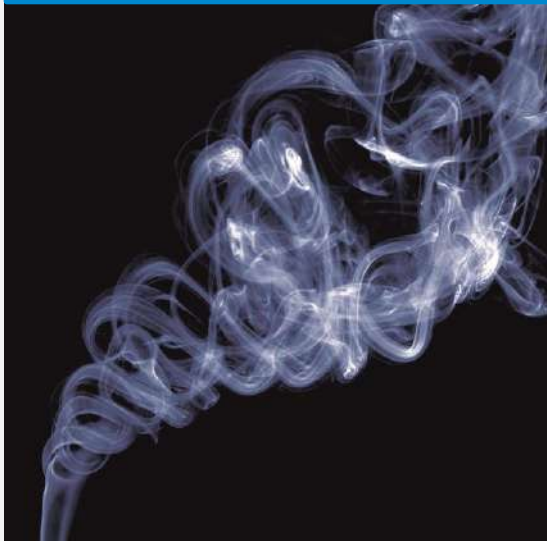
003
STAG
Singularity Theory and Algebraic Geometry

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

55 people

1
Scientific Director

12
Research line leaders and BCAM researchers

16
External Scientific Members

5
Administration Staff Members

2
IT Members

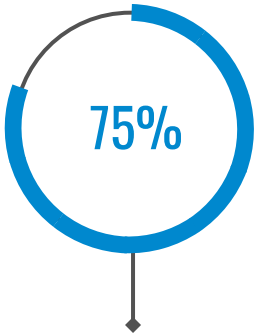
19
PhD Students

SCIENTIFIC OUTPUT 03

SCIENTIFIC PUBLICATIONS

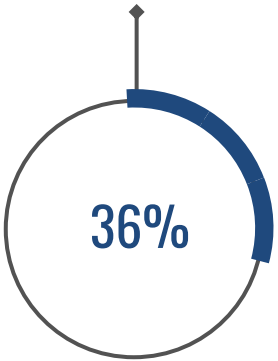
86

PUBLICATIONS INDEXED



articles in Q1

articles in D1



BCAM H-INDEX

13

1st DECILE JOURNALS

- Calculus of Variations and Partial Differential Equations
- Communications in Partial Differential Equations
- Computer Physics Communications
- Computers and Mathematics with Applications
- Foundations of Computational Mathematics
- Fractional Calculus and Applied Analysis
- IEEE Transactions on Automatic Control
- Inventiones mathematicae
- Inverse Problems
- Journal des Mathematiques Pures et Appliquees
- Journal of Computational Physics
- Journal of Differential Equations
- Journal of Scientific Computing
- Macromolecules
- Mathematical Models and Methods in Applied Sciences
- Nonlinear Analysis, Theory, Methods and Applications

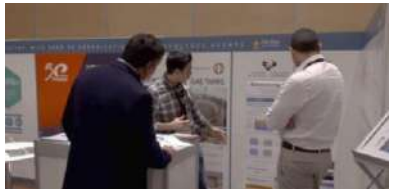
MASTER & PHD THESIS

6

ONGOING PHD STUDENTS IN 2014

+8

NEW PHD STUDENTS



THESIS DEFENDED IN 2014

3

4

MASTER THESIS DEFENDED IN 2014

04 PROGRAMMES

PARTICIPANTS IN OUR PROGRAMMES

10 Visiting fellows

15 Interns

118 Visitors

COLLABORATORS 05

KNOWLEDGE TRANSFER UNIT

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

euskampus FUNDAZIOA

CIC energiGUNE energy cooperative research centre

POLYMAT Basque Center for Macromolecular Design and Engineering

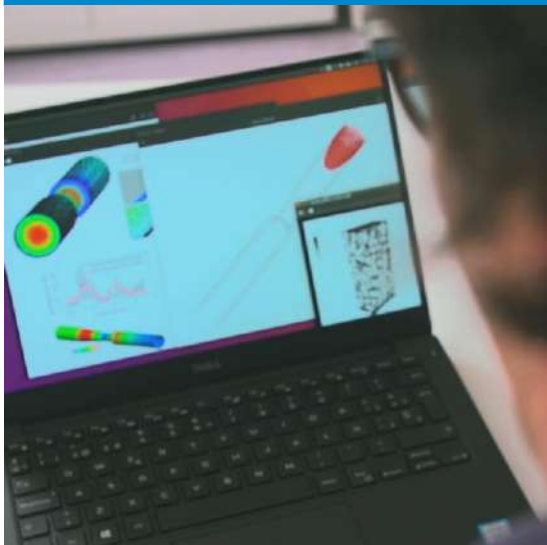
Ingeniaritza Goi Eskola Teknikoa
Escuela Técnica Superior de Ingeniería
Bilbao

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

tecnalia Inspiring Business

bc3 BASQUE CENTRE FOR CLIMATE CHANGE Klima Aldaketa Ikergai

B/S/H/ BOSCH SIEMENS



NEW INTERNATIONAL AGREEMENTS

UNIVERSITÉ PARIS-SACLAY

UNIVERSITÀ DI BOLOGNA

UNIVERSITÀ DEGLI STUDI DI PADOVA

UNIVERSITÀ DEGLI STUDI DI TORINO

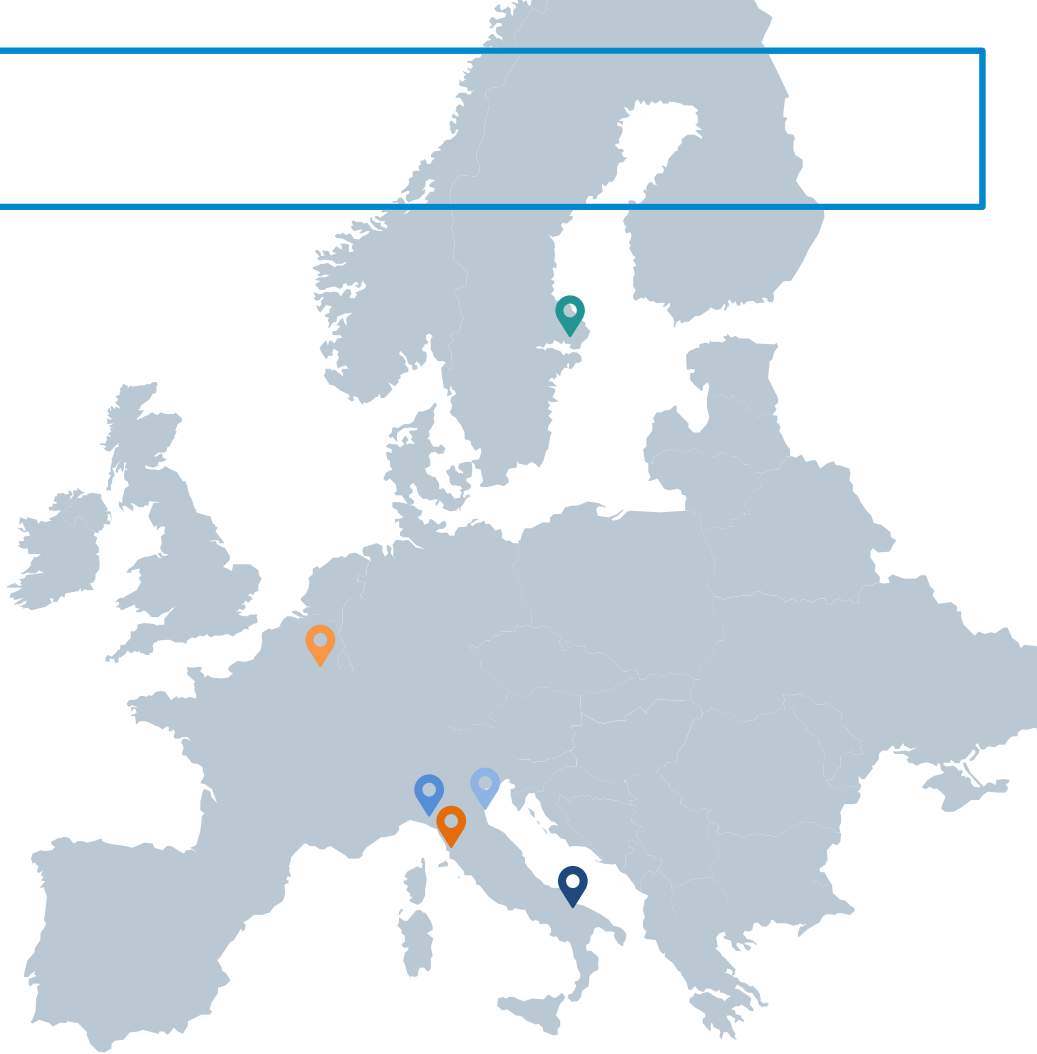
UNIVERSITÀ DEGLI STUDI DI BARI “ALDO MORO”

KTH – ROYAL INSTITUTE OF TECHNOLOGY

KAUST – KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

FUNDAÇAO LUIZ ENGLERT

INSTITUTO DE MATEMÁTICA Y ESTADÍSTICA – IME/USP



06 FUNDING

PARTICIPATING INSTITUTIONS

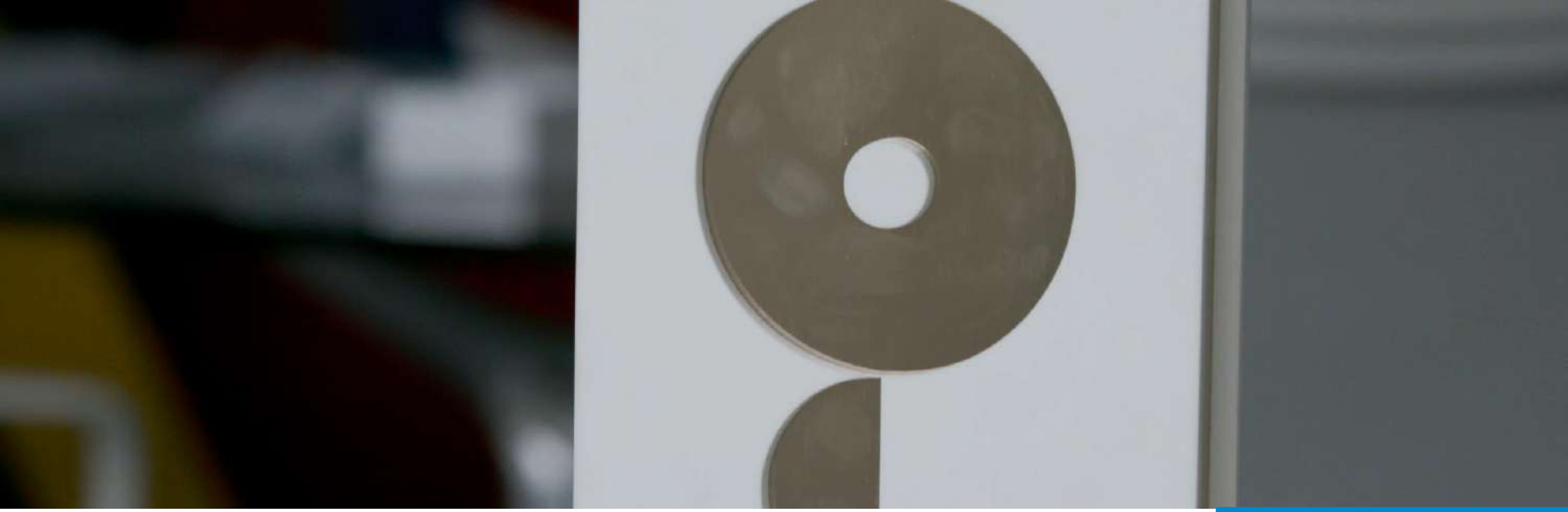
EUSKO JAURLARITZA
GOBIERNO VASCO

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

Bizkaia foru aldundia diputación foral

GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

EXCELENCIA SEVERO OCHOA

Obra Social "la Caixa"

IBERDROLA

Bizkaia talent

PUBLIC & PRIVATE FUNDING

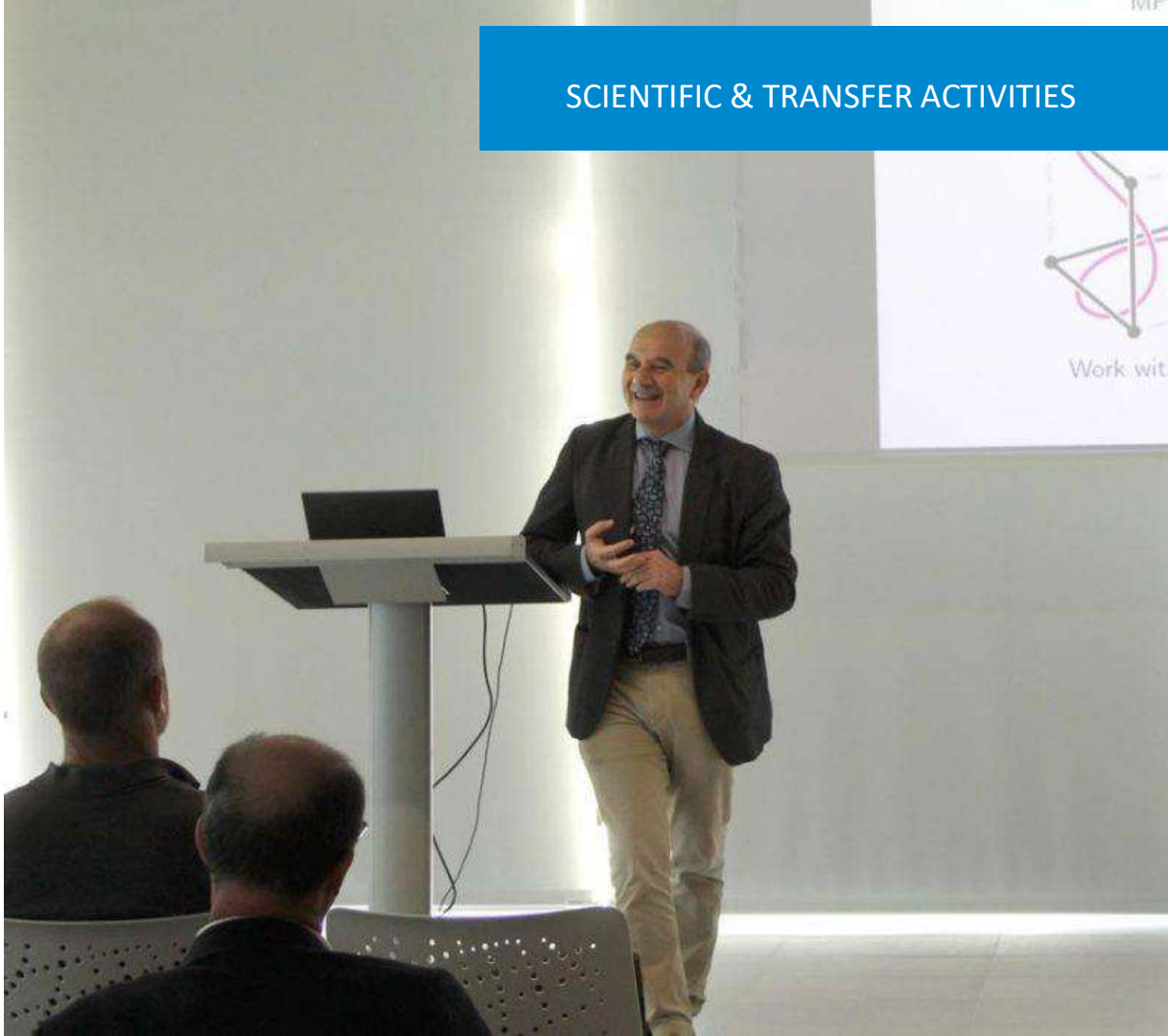
DISSEMINATION 07

SCIENTIFIC & TRANSFER ACTIVITIES

48 seminars
BCAM Scientific Seminars & Working groups

14 workshops
QBIO, BIDAS, FCPNLO...

7 courses
UPV/EHU Joint courses & BCAM Courses



basque center for applied mathematics

Alameda Mazarredo 14
48009 Bilbao, Basque Country (Spain)
Tel. +34 946 567 842
www.bcamath.org