

# Knowledge Transfer between Mathematics Industry and the Society



Alicante, 2 November 2017

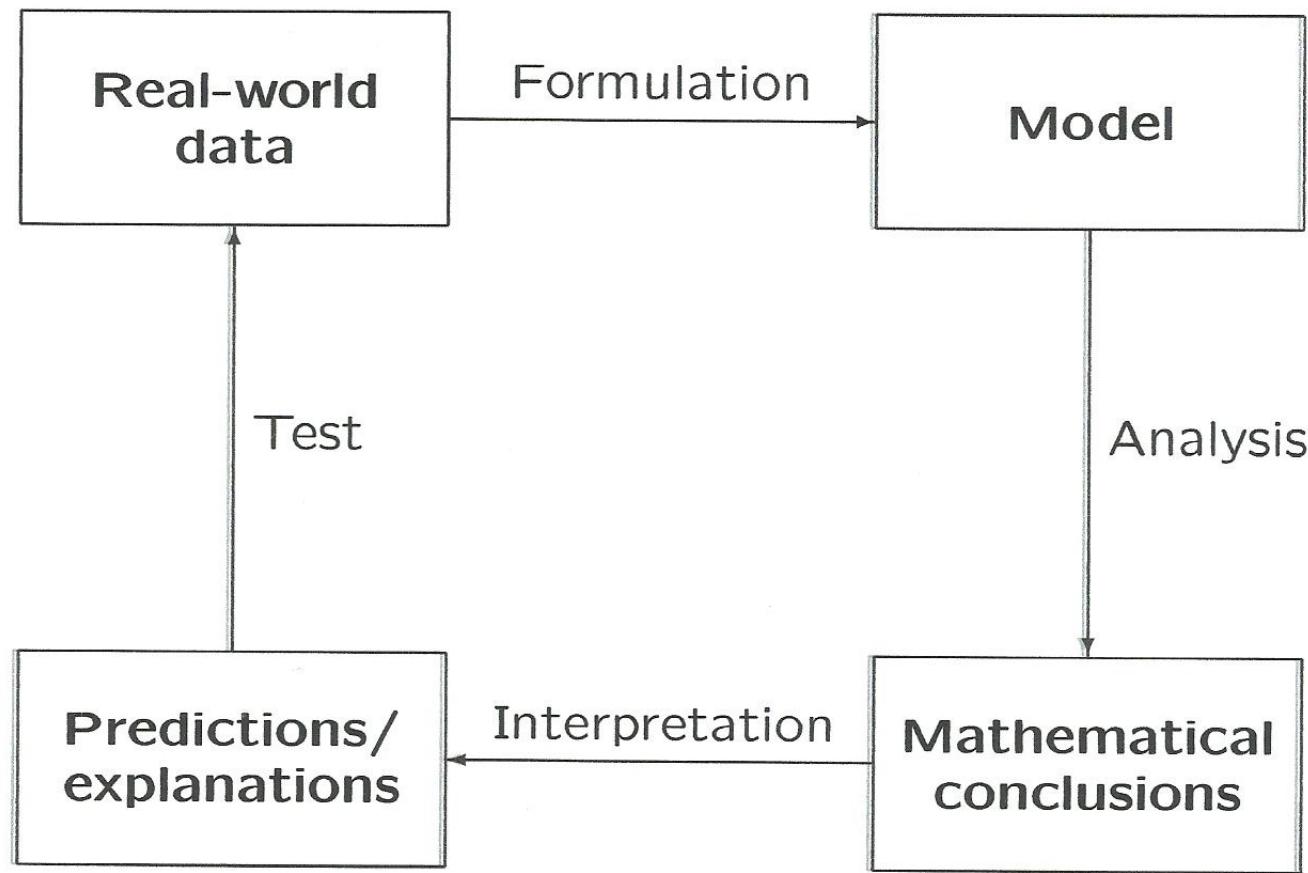
# Outline

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- BCAM
- Knowledge Transfer Unit
- Collaboration Models
- Success Stories with Industry



# Mathematical Modelling Process



# Co-creating Value with Research in Mathematics

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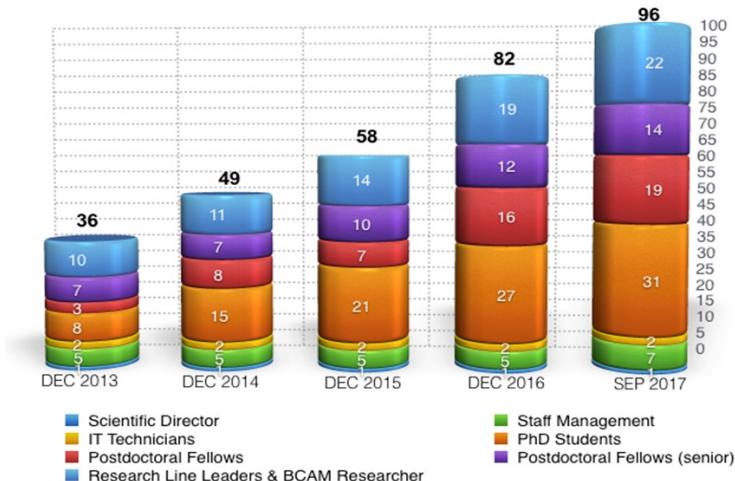
## How:

- Developing new mathematical methods and software
  - Adapting existing ones
- 
- Experts from the practice and mathematicians have to work together in order to **solve a real-world problem**.
  - They must **determine a common language** to define and describe a problem.



# BCAM – Basque Center for Applied Mathematics

- BCAM is a research centre constituted in 2008 as a non-profit association.
- Aligned with the **Basque Science & Technology Strategy** within **BERC** (*Basque Excellence Research Center*) network and collaborating with the University, Technology Centres, Corporations and the rest of the R&D&I agents.
- BCAM was awarded in 2014 by MINECO with  accreditation.



Position	Total
Scientific Director	1
Research Line Leader & BCAM researcher	22
Postdoctoral Fellow	33
PhD students	31
IT Technicians	2
Staff Management	7
<b>TOTAL</b>	<b>96</b>

**NOTE:** additionally there is an average of 10 visiting researchers (visiting fellows and interns) at the center

# BCAM – Basque Center for Applied Mathematics

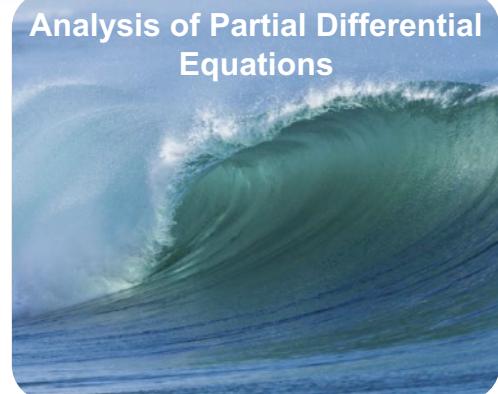
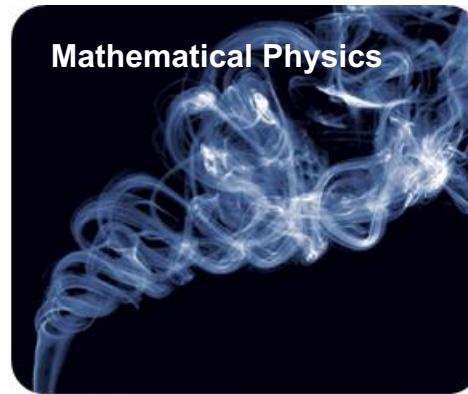
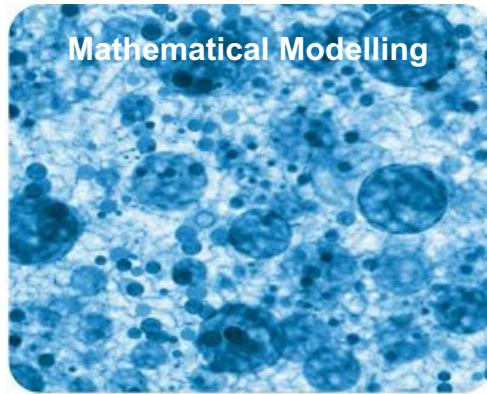
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# BCAM Research Areas



# BCAM mission: “*Mathematics in the service of society*”

Excellence  
**research** in the  
frontiers of  
mathematics

Interact with  
**industry** and  
R&D&I agents

Become a relevant  
**node in the**  
**international**  
**mathematics**  
**research network**

Train and  
**attract**  
talented  
scientists

Disseminate  
mathematics  
and its  
**applications**  
**within society**

Knowledge Transfer  
(Mathematical Modelling Process)

# BCAM Scientific Platforms

**BCAM  
Scientific  
Platforms**

## Core in Applied Mathematics

- Fourier Analysis
- Numerical Analysis
- Algebraic Geometry
- Probability and Statistics
- Partial Differential Equations

## Computational Mathematics

- Modelling
- Computer Simulations
- Numerical, Stochastic and Montecarlo methods

## Applications of Mathematics

- Industry: CFD, Electric Power...
- Health: Hospitals, Medical Images...
- Social: Finances, Networks...
- Other applications

# BCAM - Knowledge Transfer Unit

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- The aim is to coordinate contacts to external actors and builds up a database of potential partners for applied projects.
- In particular, highest opportunities to transfer knowledge to society are in the following research areas:
  - Computational Mathematics
  - Data Science
  - Mathematical Modelling with Multidisciplinary Applications

We are flexible in terms of collaboration models, **customizing our offer** to suit the specific needs of each company/partner.

# Collaboration Models

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- **Strategic Partnerships**
  - BCAM's capabilities are aligned with the cross-technology domains of the **RIS3\* Euskadi Strategy**, which defines 3 smart specialization priorities:
    - 1) Advanced Manufacturing
    - 2) Energy
    - 3) Biosciences and Health
  - **Joint Research Labs**
    - on Big Data (with Tecnalia and UPV/EHU)
    - on Offshore Renewable Energy
  - **Member of Committee of the BCSC – Basque Cybersecurity Center**



\*RIS3: "Research and Innovation Strategies for Smart Specialization"

# Collaboration Models (cont.)

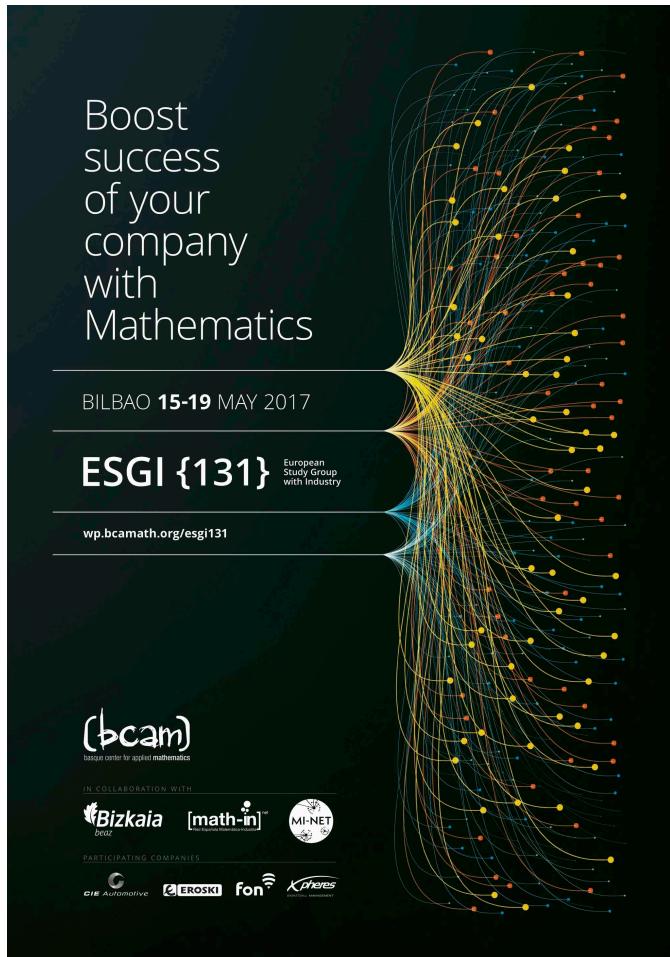
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- **Collaborative projects and agreements** (e.g.: external funding, grants, or contracts)
- BCAM researchers supervise **Master and PhD Thesis** in collaboration with companies (real-problems with mathematical solutions)
- **Joint positions**
  - Innovative formula for knowledge transfer
  - Research positions supported by BCAM and the company / research center:



- **Training courses for industrialists**

# ESGI - European Study Group with Industry



- Starting in **Oxford in 1968**.
- 131<sup>st</sup> edition held in Bilbao 15-19 May 2017
- ESGIs are internationally recognized as problem-solving forums for knowledge transfer.
- Industrialists bring a problem to one of these week-long brainstorming workshops that are attended by a group of mathematicians with varied expertise.

# Dissemination Activities

## 1. Specialized workshops, seminars and courses for researchers

## 2. Joint workshops with industry and health sector

- Numerical Resolution of Inverse Problems
- QBIO – Workshop on Quantitative Biomedicine for Health and Disease
- Bilbao meeting on Analysis and PDEs
- Fractional Calculus, Probability and Non-Local Operators: Applications and Recent Developments
- BiDAS – Bilbao Data Science Workshop
- Workshop on Nonlinear Dynamics in Biological Systems

M4TEMOZIOA  
2015

Matematikaren hitzordua | Cita con las Matemáticas

HITZALDIA | CONFERENCIA

Jean-Pierre Bourguignon  
*Sound, shape, and harmony*

Matematika, teknologia eta  
berrikuntzara  
irakurketa topaketa  
a las matemáticas,  
la tecnología y  
la innovación.



BCAM Workshop:  
Quantitative Biomedicine for Health and Disease  
3rd Edition  
Feb 21-22, 2017. Bilbao, Spain

Program Chairs:

Luca Gerardo-Giorda (BCAM, Bilbao)  
Sebastiano Stramaglia (Univ. Bari)  
Jesus M Cortes (BioCruces, Bilbao)

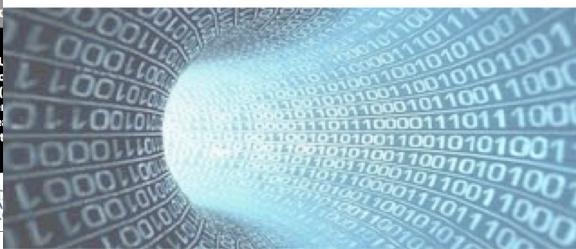
Confirmed speakers:

Oscar Camara Rey (UCL)  
Marina de Tommasi (Universidad de Zaragoza)  
Adelalde de Vecchi (Universidad de Zaragoza)  
Luca Faes (Univ. Trieste)  
Jean-Fredéric Gerbeau (Inria)  
Plamen Ivanov (Bulgarian Academy of Sciences)

Local Organizers:

Luca Gerardo-Giorda (BCAM)  
Nicole Cusimano (BCAM)

First Bilbao Data Science Workshop  
December 19th-20th, 2016



Data Science and Big Data are two key areas for positive interdisciplinary science involving applied mathematics, statistics and computer science. A number of challenges in all those three areas of research require new approaches to support the big data era. BiDAS (Bilbao Data Science) workshop is the first event at BCAM focused on attracting researchers in a variety of fields involving Data Science research.

### Keynote Speakers:

- Humberto BUSTINCE, Public University of Navarra, Spain
- João GAMA, University of Porto, Portugal
- Ifaki INZA UPV/EHU, Spain
- Yvan SAEYS, University of Ghent, Belgium
- Javier del SER, TECNALIA & BCAM & UPV/EHU, Spain
- Jacobo de UNA University of Vigo, Spain

# Dissemination Activities

## 3. Dissemination for the general public about Mathematics interacting with culture



# Dissemination Activities

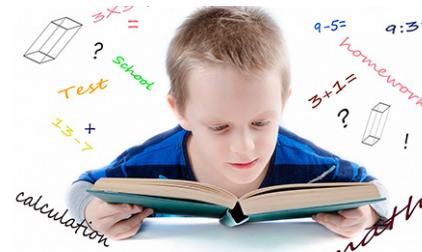
## 4. Promote scientific vocation and gender balance



“Inspire young girls in  
Science and Technology”

aupatuz

Young students with high capacities visit BCAM in order to explore in depth the role of researchers in our daily lives.



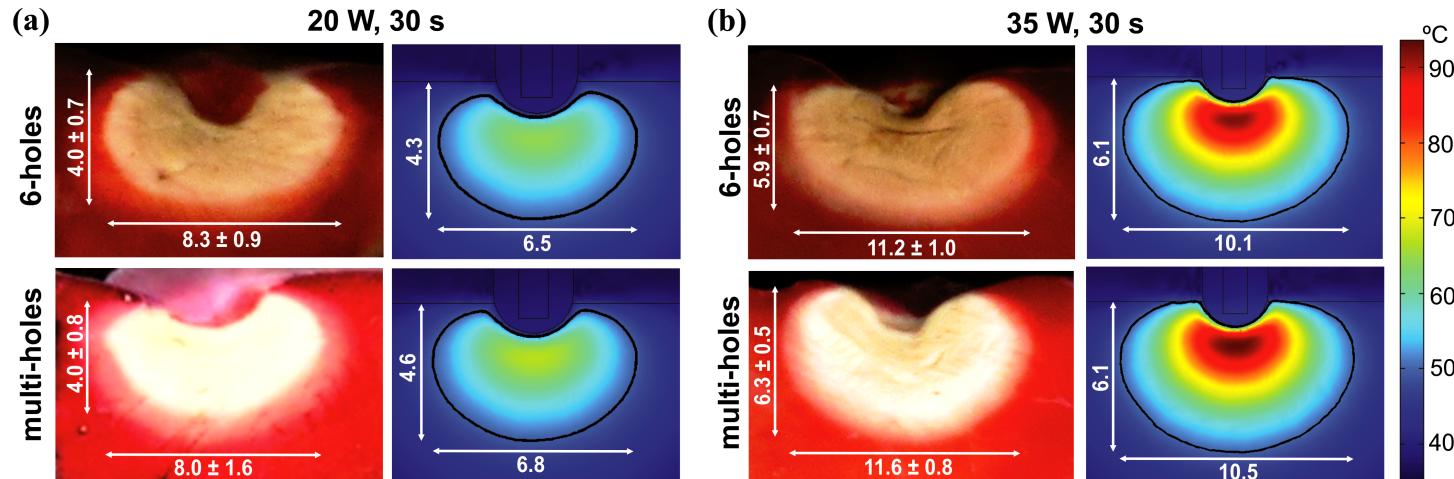
training  
and technical advice



# Success Stories with Industry



- **Project:** Computational modelling for cardiac radiofrequency ablation
- **Goal:** Explore if the optical information recorded would predict the size and quality of the thermal lesion created in the cardiac tissue.
- **Success indicator:** Better understanding of biophysics and more accurate diagnosis of cardiac tissue.



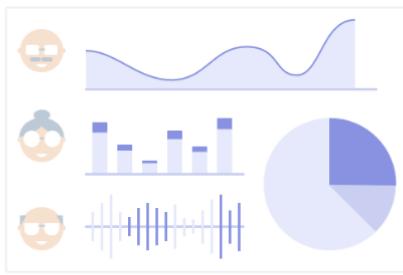
**Research article:** “Computational Modeling of Open-Irrigated Electrodes for Radiofrequency Cardiac Ablation Including Blood Motion-Saline Flow Interaction” *Plos ONE* (2017)

# Success Stories with Industry

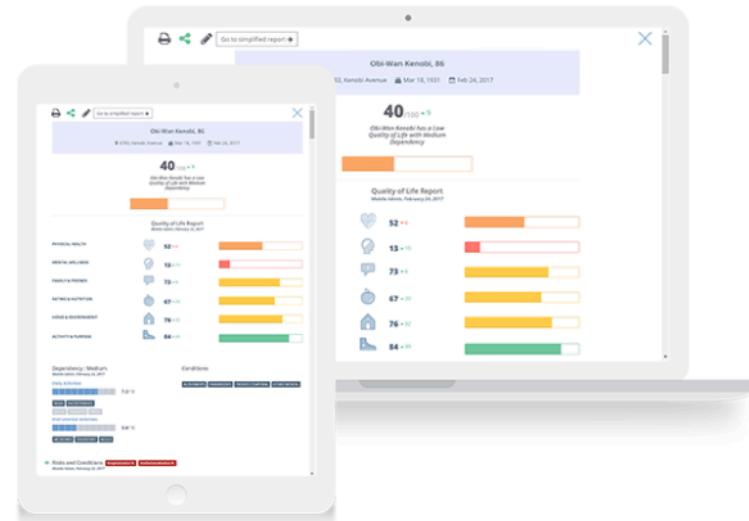


- Project: **Statistical analysis of SeniorGrowth assessment tool for Quality of Life of senior people**
- Goal: One of the objectives was to build a predictive model that links specific care actions with corresponding risks and conditions. In addition, Quality of Life statistical models with benchmark comparisons were built.
- Success indicator: International private funding.

Use the Power of Data to Prove  
Your Impact on Seniors



Take your senior care service to a whole new level with data intelligence.



# Success Stories with Industry



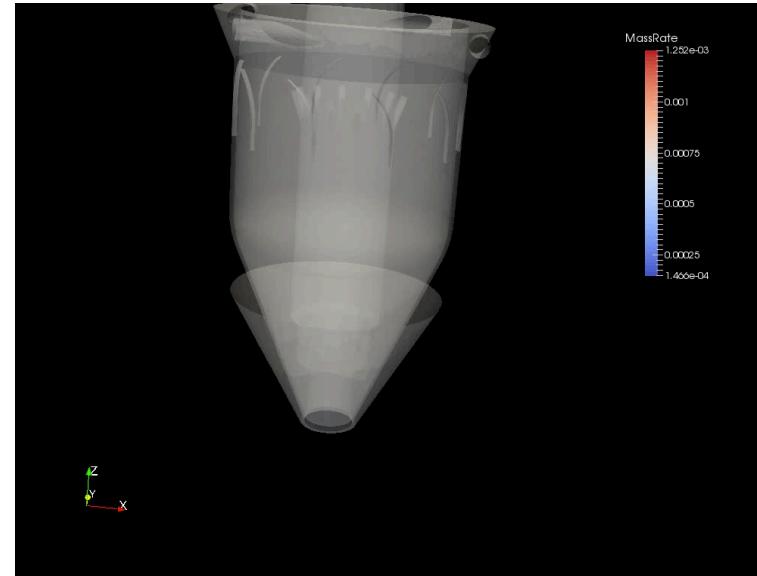
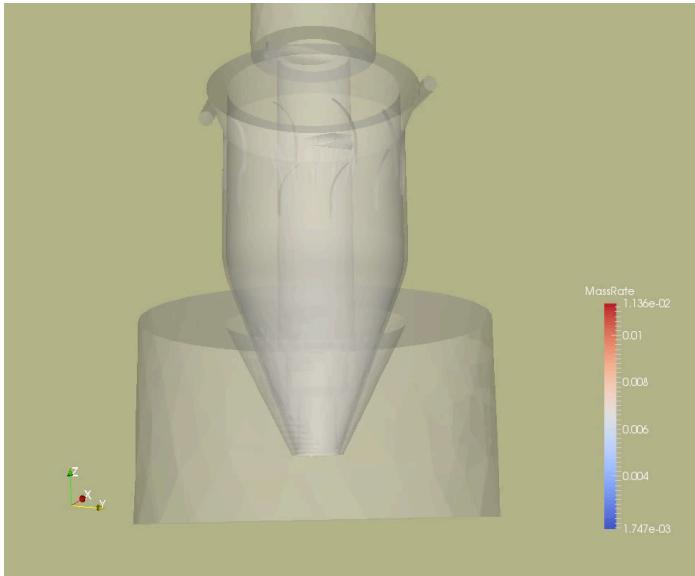
- Project: **Analysis of oil price market**
- Goal: Adjustments in the pricing policy considering probabilistic approaches and scenario analysis. Efficient support for decision making and risk analysis.
- Success indicator: Better understanding of the market data for decision making.



# Success Stories with Industry



- Project: **Reduction of beam deposition processing time** within the framework of “FRACTAL – Development of Spanish-Technology-Based Advanced Manufacturing and Prototyping Systems for Strategic Components via Laser Assisted Powder Sintering”.
- Goal: Design a suitable powder feeding system to be used with the laser device developed by ETXE-TAR.
- Success indicator: The project was funded by CDTI through CIEN Strategic Programme.



# BCAM & Industry/Society



B/S/H/



Bilbao Bizkaia Ur Partzuergoa  
Consorcio de Aguas Bilbao Bizkaia

Baltogar

ETXE-TAR  
group



**b**iocruces  
health research institute



MedLumics  
Enlightening Healthcare

SeniorGrowth

LAGUN ARO



TEXAS  
The University of Texas at Austin



[math-in]  
Red Española Matemática-Industria

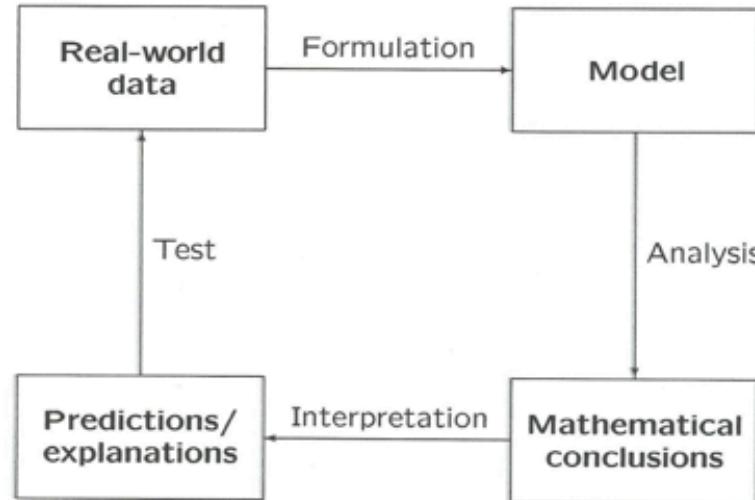
tecnalia

Obra Social "la Caixa"

Fundación  
IBERDROLA

Fundación BBVA

# Co-creating Value with Research in Mathematics



$$\frac{a(x)}{2} + \sum_{k=1}^{\infty} (a_k(x) \cos kx + b_k(x) \sin kx)$$
$$a_k(x) = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \cos kx \, dx$$
$$b_k(x) = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \sin kx \, dx$$

```
209: limit_val = a;
210: $( "#limit_val" ).val(a);
211: update_slider();
212: function(limit_val){
213: $( "#word-list-out" ).text(" ");
214: var b = 0;
215: var c = 1();
216: var d = a * c / 4 + parallel;
217: var e = a * c / 4 + parallel;
218: var f = a * c / 4 + parallel;
219: var g = a * c / 4 + parallel;
220: var h = a * c / 4 + parallel;
221: var i = a * c / 4 + parallel;
222: var j = a * c / 4 + parallel;
223: var k = a * c / 4 + parallel;
224: var l = a * c / 4 + parallel;
225: var m = a * c / 4 + parallel;
226: var n = a * c / 4 + parallel;
227: var o = a * c / 4 + parallel;
```

$$b+2\left\{1+\frac{x^2\ln\lambda_0\Gamma'(1/\lambda_0)}{\lambda_0^{1/2}}\right\}+2\left\{a-\frac{\ln\lambda_0\Gamma(1/\lambda_0)}{2\lambda_0^{1/2}\Gamma'(1/\lambda_0)\lambda_0^{1/2}}\right\}$$
$$+2\int a-\frac{\ln\lambda_0\Gamma(1/\lambda_0)}{2\lambda_0^{1/2}\Gamma'(1/\lambda_0)\lambda_0^{1/2}}\,$$
$$+2\left\{\frac{\alpha\lambda_0^2\ln\lambda_0\Gamma'(1/\lambda_0)}{\lambda_0^{1/2}\Gamma(1/\lambda_0)^2}-2\lambda_0\ln\lambda_0\Gamma(1/\lambda_0)\right\}$$
$$+\alpha^2\lambda_0^2\ln\lambda_0\Gamma'(1/\lambda_0)^2$$
$$+\frac{2}{\lambda_0^2}\alpha^2\lambda_0^2\ln\lambda_0\Gamma(1/\lambda_0)^2+\frac{2}{\lambda_0^2}\alpha^2\lambda_0^2\ln\lambda_0\Gamma'(1/\lambda_0)^2$$
$$+\frac{2}{\lambda_0^2}\alpha^2\lambda_0^2\ln\lambda_0\Gamma(1/\lambda_0)\Gamma'(1/\lambda_0)$$

# Thank you!

## Eskerrik asko!

## ¡Muchas gracias!