



MASTER IN  
INDUSTRIAL  
MATHEMATICS

Learning 4.0 cross-institutional education  
to solve real problems in industry



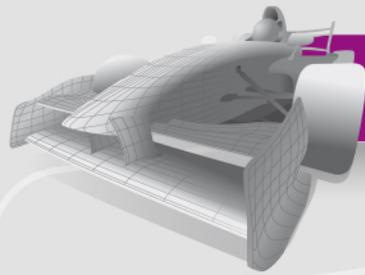
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# M2i

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<http://m2i.es/en/>  
[www.m2i.es](http://www.m2i.es)

The **Master in Industrial Mathematics (M2i)** is an official degree jointly delivered by

- University of Santiago de Compostela (USC)
- University of A Coruña (UDC)
- University of Vigo (UVigo)
- Carlos III University of Madrid (UC3M)
- Technical University of Madrid (UPM)



\* Since the academic year **2013/2014**.

\* The M2i duration is **3 semesters**

\* Offers two specializations:

- **Modelling**
- **Numerical Simulation**



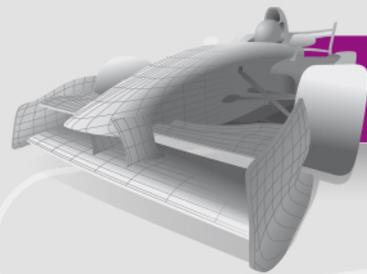
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## The coordinators of Master in Industrial Mathematics (M2i)

- University of Santiago de Compostela (USC<sup>1</sup>+<sup>1</sup><sup>g</sup> Global coordinator)
- University of A Coruña (UDC<sup>2</sup>)
- University of Vigo (Uvigo<sup>3</sup>)
- Carlos III University of Madrid (UC3M<sup>4</sup>)
- Technical University of Madrid (UPM<sup>5</sup>)

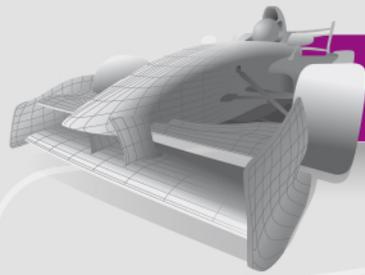


The coordinators of the M2i in the ceremony awarding a Doctor Honoris Causa degree from the USC to Prof. Amable Liñán\* (28/04/2014). From left to right A. Bermúdez<sup>1g</sup>, L. Bonilla<sup>4</sup>, A. Liñán\*, J.M. Vega<sup>5</sup>, E. VC<sup>1</sup>, C. Vázquez<sup>2</sup>, J. Durany<sup>3</sup>.



Master in Industrial mathematics (M2i): Providing a specific education to solve real problems in industry.

*ECMI Newsletter N 55*, pg 15-17, March 2014. <http://www.mafy.lut.fi/EcmiNL/issues.php?issueNumber=55>



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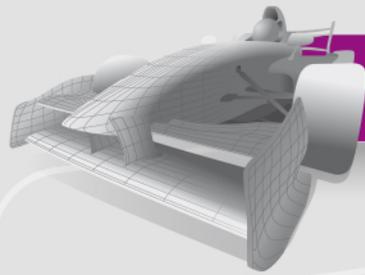
## Learning 4.0

M2i arises from the fusion of two official degrees:

- Master in Mathematical Engineering (MIM), by the universities USC, UDC and UVigo (7 editions from 2006/2007)
- Master in Mathematical Engineering (4 editions from 2006/2007) / Master in Industrial Mathematics (2 editions from 2010/20011), by the UC3M ECMI Teaching Center

[http://www.ecmi-indmath.org/?page\\_id=151](http://www.ecmi-indmath.org/?page_id=151)

The main aim of the M2i is to unify subjects of high applied mathematical contents and already taught in specific engineering masters.



# M2i

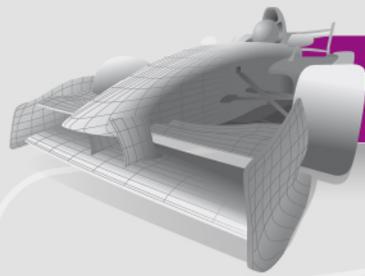
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Some ideas for this master are taken from the report by the Organization for Economic Co-operation and Development (OECD) "Global Science Forum. Report on Mathematics in Industry". ECMIMIM and the tradition of ECMI.

The **scientific and technological interests** of the M2i mainly focus on four basic aims:

1. Expand the analytical skills and knowledge of graduate students who will be part of **future** research groups and professional teams.
2. Instruct the students in mathematical **modelling** for applications in **industry**.
3. Provide specific skills in relation to the design, construction and management of **specific software** of at least one industrial sector.
4. Introduce students to the **research** topics and development related to the subjects of the program.



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M2i degree promotes a strong dynamic relationship among our main stakeholders:

### Welcoming Ceremony



- Students
- Alumni
- Faculty members
- Professionals from industry

### Applied mathematics and industry interaction forums

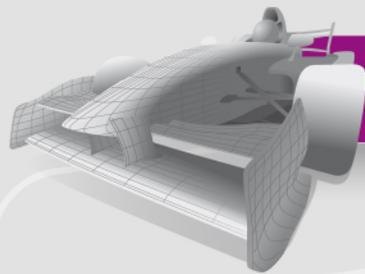


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# Students & Alumni

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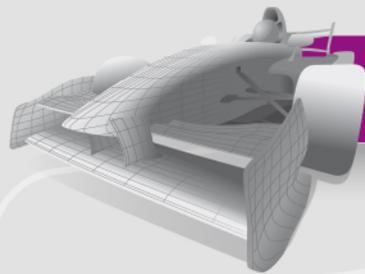
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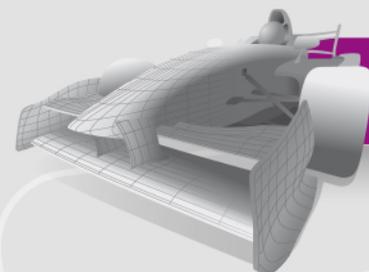
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## Entry requirements

Degrees/ academic transcripts:

1. Maths, physics, engineering
2. Architecture, sciences
3. Economics, business administration

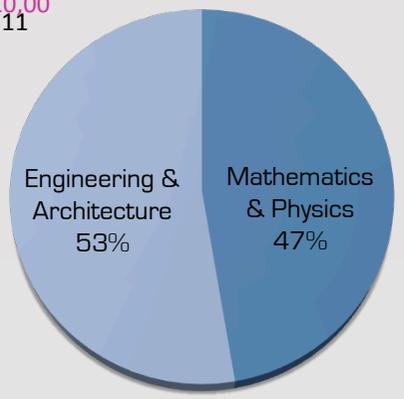
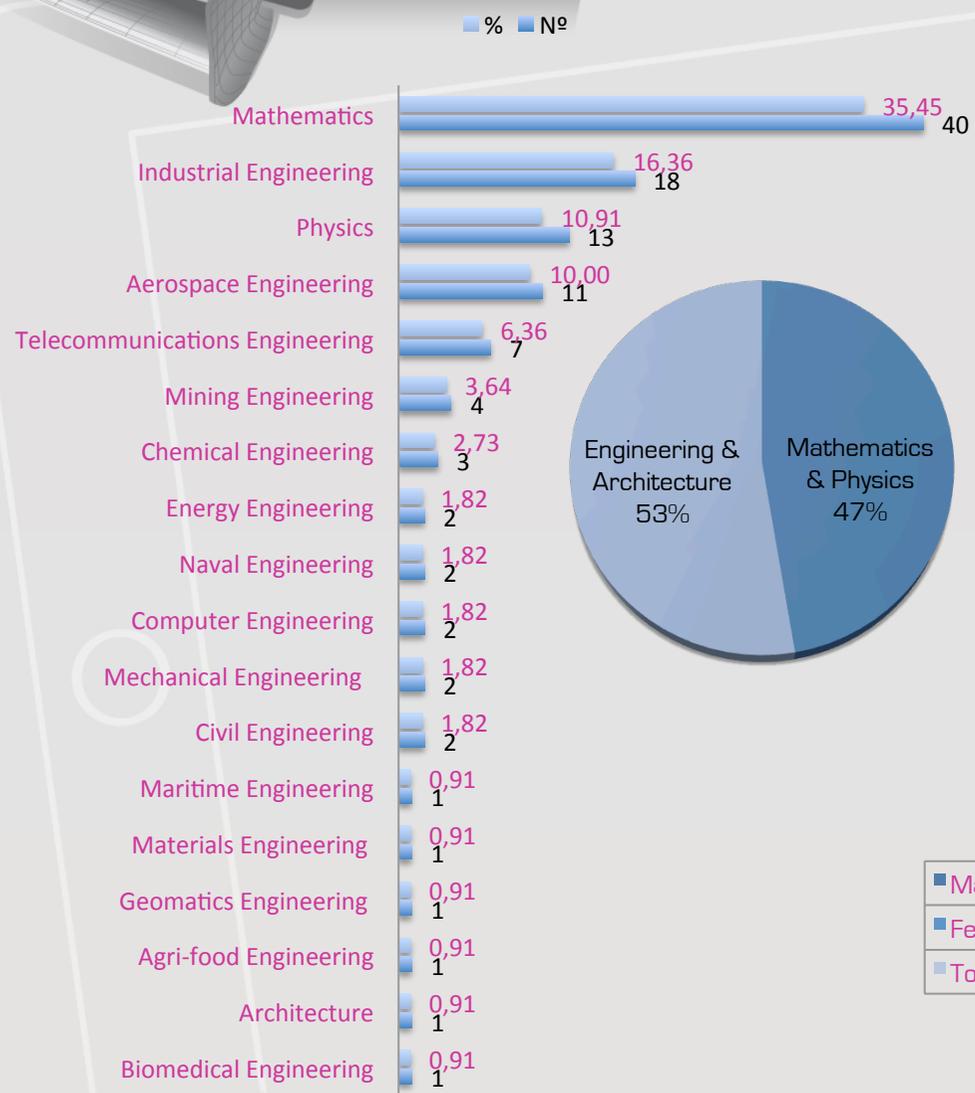




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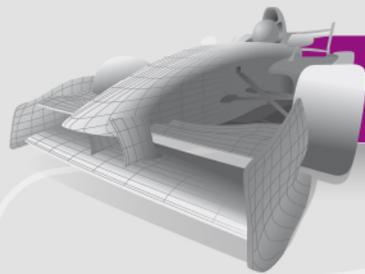


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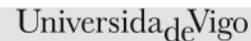
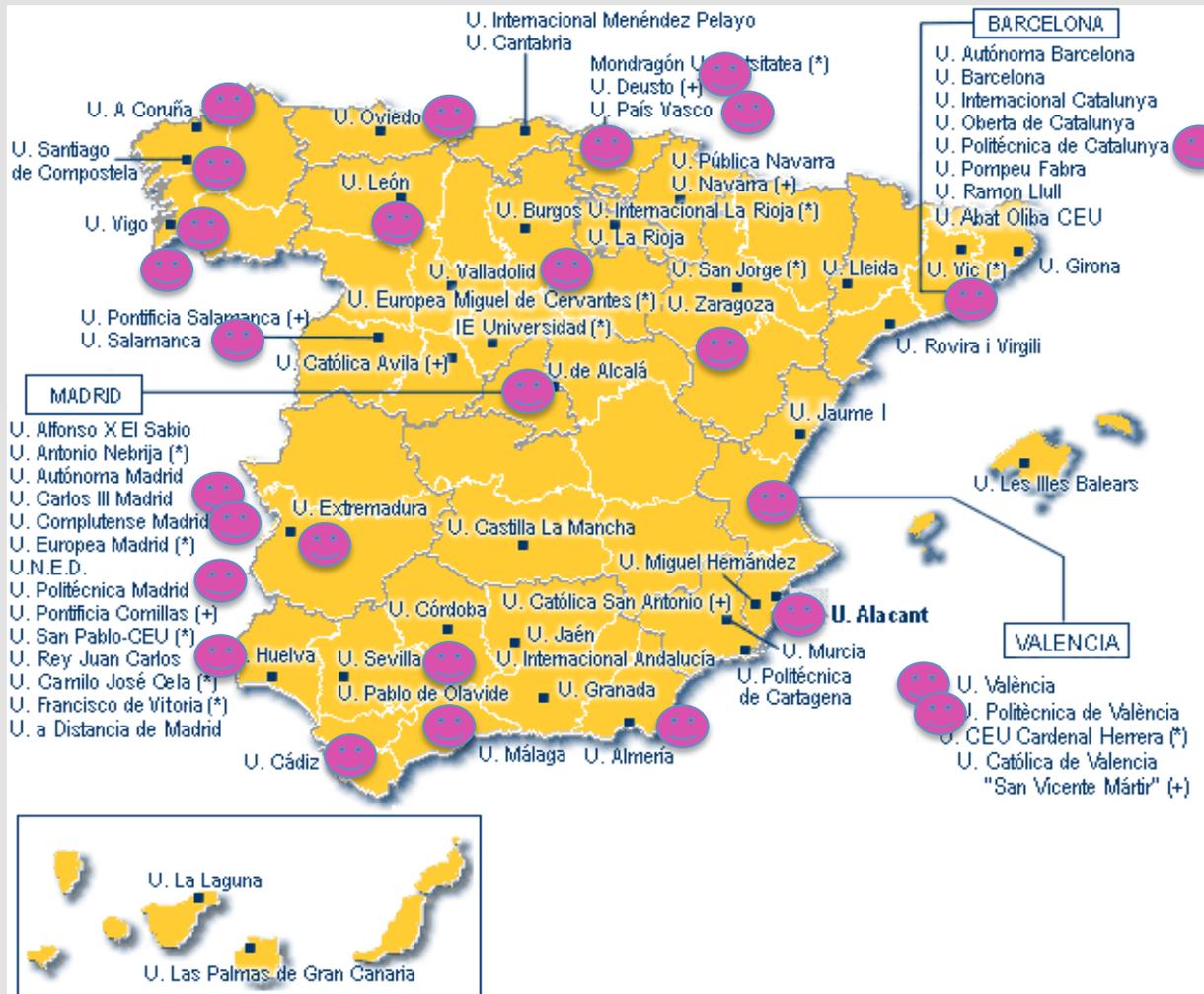


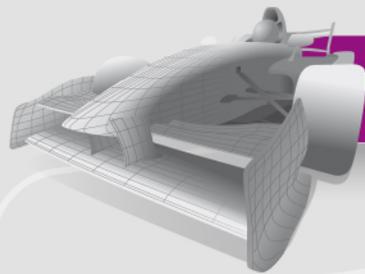
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M2i students come from the  Spanish and Portugal universities



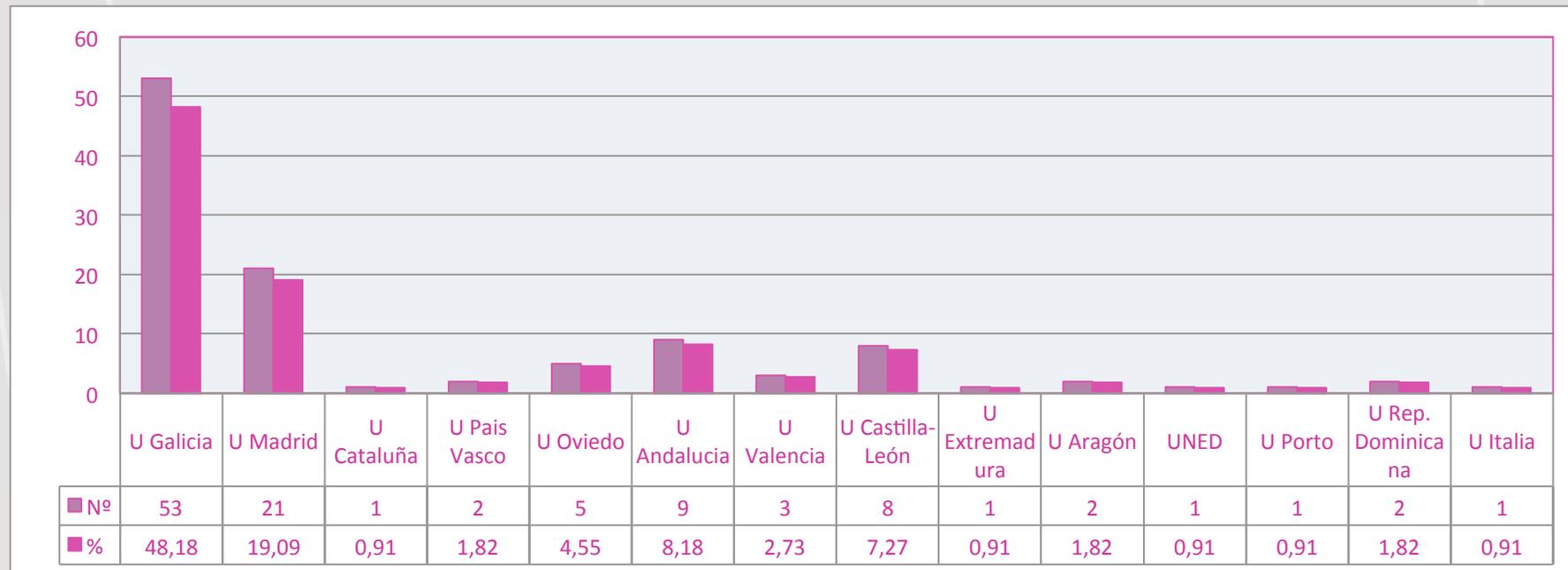


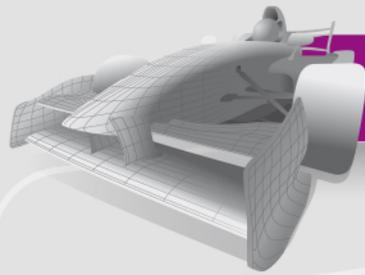
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## M2i students come from the Spanish universities





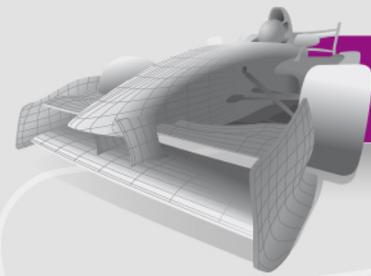
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## Alumni

- Regular information on jobs offers, courses, seminars is sent to both alumni and current students.
- Since May 2012 we are very involved in a LinkedIn group for alumni and current master students called:  
    “MIM & M2i - Estudiantes y egresados”  
with 177 members



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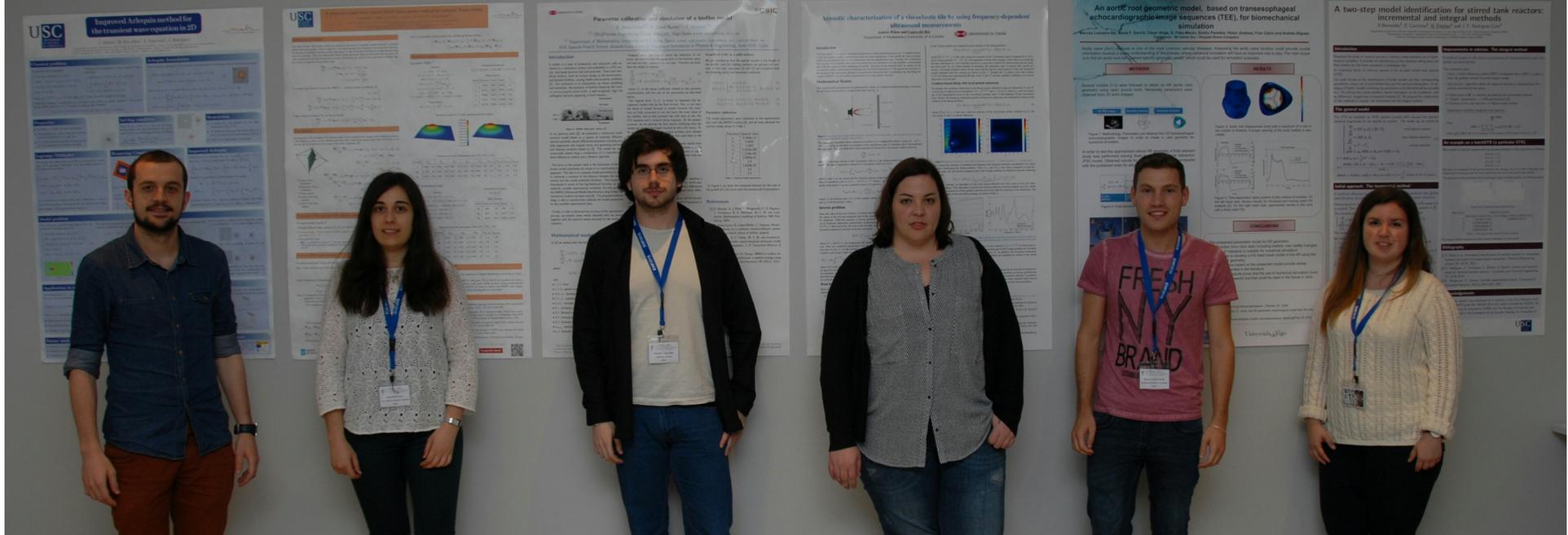
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### Alumni

#### XVII ESCUELA HISPANO-FRANCESA JACQUES-LOUIS LIONS SOBRE SIMULACIÓN NUMÉRICA EN FÍSICA E INGENIERÍA



GIJÓN, DEL 6 AL 10 DE JUNIO DE 2016

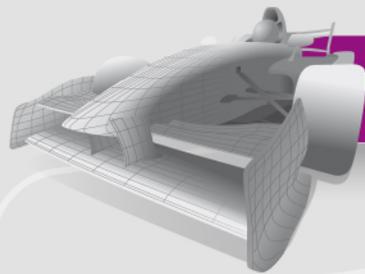


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## Alumni

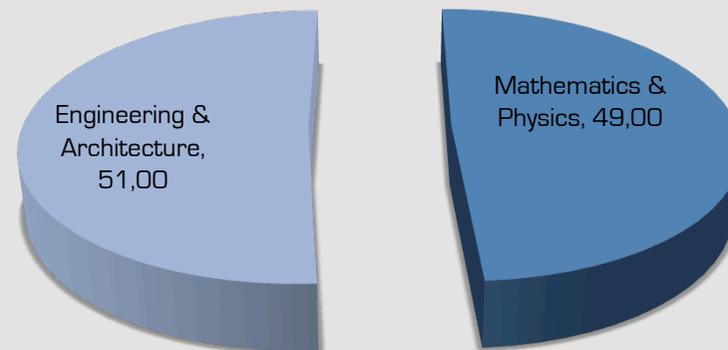
Some results of the survey to the seven Graduating classes of students of the Master in Mathematical Engineering (MIM), by the universities USC, UDC and UVigo

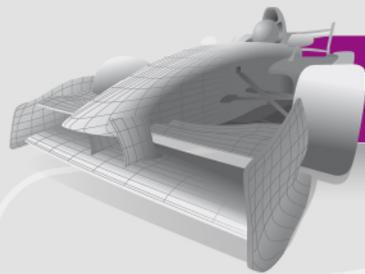
53 answers:

Male 36 (70%)

Female 16 (30%)

Degrees/Academic transcripts





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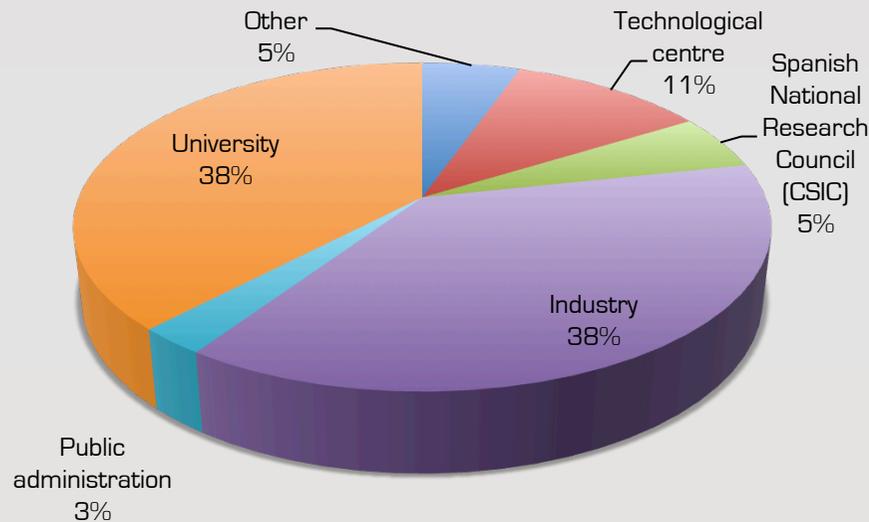
## Alumni

Are you currently employed?

Yes: 79.2%

[24,5% are students]

### Type of company



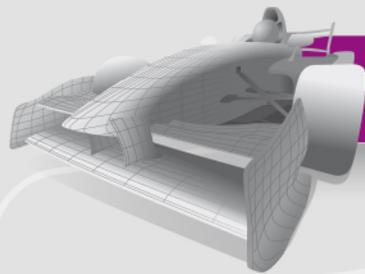
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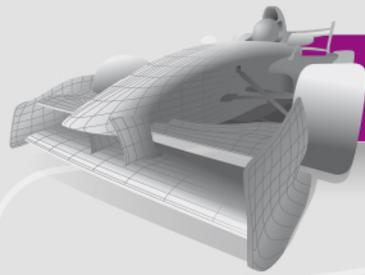
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Have you had or do you currently have a contractual relationship with the company/institution that proposed the problems of your Master's dissertation?

Yes: 37.8%

Degree of correlation between the working activity and the MIM

Very high	29.7%
High	37.8%
Acceptable	18.9%
*Very high +High	67.5%



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## Alumni

Do you think that the knowledge acquired in your company should be included in the MIM?

It is not necessary for the MIM: 65.2%

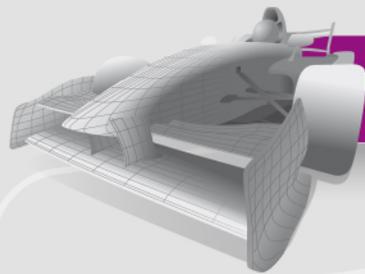
Yes: 17.4%

Would you recommend the MIM to a person who finishes this year his studies of degree/degree or engineering?

Yes: 92.5%

No: 3.8%

N/A: 3.8%



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### MIM students come from the Spanish universities

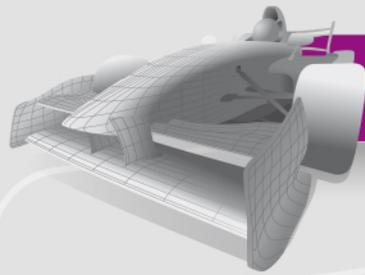


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- 🇹🇷 Istanbul Teknik Üniversitesi (Turquía)
- 🇩🇪 RWTH Aachen University (Alemania)
- 🇺🇾 Universidad de la República (Uruguay)
- 🇦🇷 Universidad de San Martín (Argentina)
- 🇦🇷 Universidad Nacional de Córdoba (Argentina)
- 🇺🇿 Urgench State University (Uzbekistan)
- 🇮🇹 Sapienza Università di Roma (Italia)
- 🇮🇹 Università Politecnica delle Marche (Italia)

MIM students come from the non-Spanish universities 🇹🇷

- 🇪🇺 Erasmus
- 🌍 Erasmus Mundus



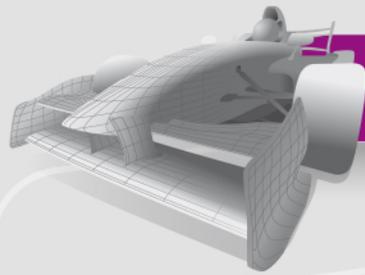
## As an international student...



I am **Umid Karimov from Uzbekistan**. I received my Masters in Mathematical Engineering (Máster en Ingeniería Matemática-MIM) in 2010 as an Erasmus Mundus student. I didn't realize how fortunate I am to be a part of the MIM until after I finished it.

The resources made available to the students for research and conferences are outstanding, but the most exceptional aspect is the high degree of access to a **dedicated and engaging faculty**. MIM has amazing professors who are greatly concerned about their students. My experience was distinguished by a number of professors in the program that served as **genuine mentors** to me and encouraged me throughout in both my teaching and research. **As an international student**, this support was invaluable, and I am deeply thankful for the energy and time those professors invested in me.

Great professors, fellow students, very diverse backgrounds, all the aspects of the program made my **learning experience the best possible**. Currently, I am teaching at the Department of Applied Mathematics and Mathematical Physics at the Urgench State University, Uzbekistan.



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the right choice for me...



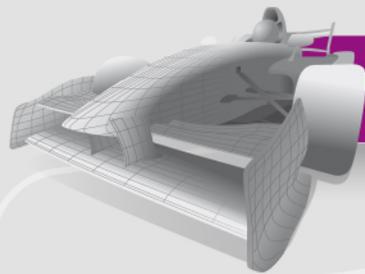
**Mathematics Engineering** gave me technical knowledge in practical and interesting areas.

The master was definitely **the right choice for me**, and provided me with many opportunities.

This master program gives you a solid understanding of the **Numerical Methods** and Finite Elements principles that are at the foundation of many of the **models** used in engineering. It gave me the skills to work with some **software** tools.

Mathematics Engineering not only does an **excellent job at teaching** a highly valued and well respected technical skill set, but more importantly, the program develops your **critical thinking** and problem solving skills that are applicable to a wide variety of fields.

**Aygul Babadjanova** (An Erasmus Mundus student in 2008).  
Uzbekistan.



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“Great team around the Master”



Academic training before the Master: **Licenciatura Matemáticas, U Sevilla**  
Work experience since the beginning of the Master: **ITMATI, Phd, Weierstrass Institute**

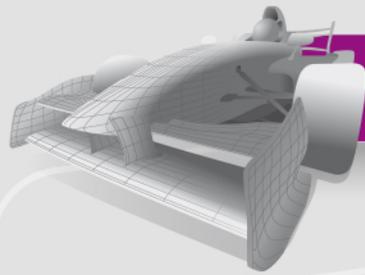


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“Very effective for the discovery and resolution of problems in the different areas where mathematics are present.”



**Beatriz Salvador Mancho,**  
**USC \*Premio Fin de Máster 2013-2015**

Academic training before the Master:  
Grado en Matemáticas, Universidad de Valladolid

Work experience since the beginning of the Master:  
Universidade da Coruña (Phd, FPI)

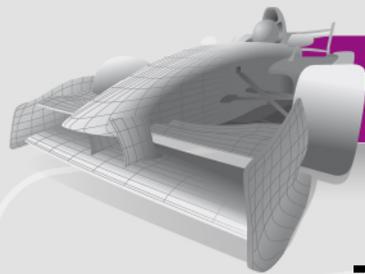


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# The Mathematical Way to the Oscars



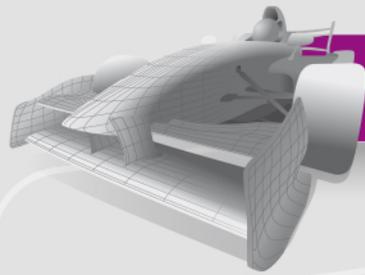
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“A master with great atmosphere between faculty and students, where it is noticed the effort to offer quality education and to approach business sector to students.”



## Ángel Ferrán Pousa, USC

Academic training before the Master:  
Grado en Física, USC

Work experience since the beginning of the Master:

DESY (Deutsches Elektronen-Synchrotron  
[https://www.desy.de/index\\_eng.html](https://www.desy.de/index_eng.html))

EUPRAXIA IS A PROPOSED EU DESIGN STUDY ON A "EUROPEAN PLASMA RESEARCH ACCELERATOR WITH EXCELLENCE IN APPLICATIONS"

<http://www.eupraxia-project.eu/eupraxia-for-beginners.html>



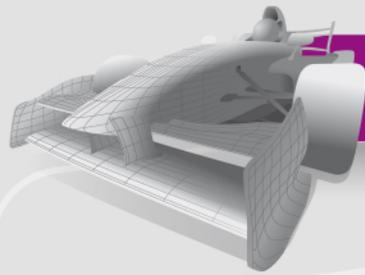
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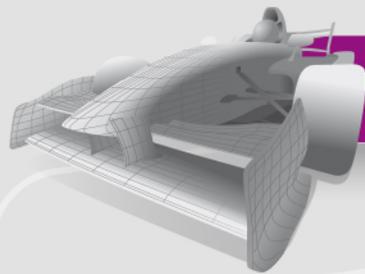
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## For this talk Ángel Ferrán **wanted to share with us:**

Expertise in numerical simulations, including the mathematical background and programming **skills**, have been **key competences that have allowed me to get a PhD position at DESY** in a topic in which I had no previous experience.

The reason for this is that in this field (Laser-Plasma Wakefield Acceleration) a great part of the research is done via numerical simulations, so even if one is not familiar with the physical background, it is always useful **to have someone who knows well how to do simulations** and that can contribute to the development of the codes.

Typically, physics students don't have a very extensive training in these topics, **so having done the M2i left me in a very good position.**



Author: Ángel Ferran Pousa

Supervisors: Óscar López Pouso (USC), Ruddy Brionnaud (Next Limit Technologies)

### ABSTRACT

Traditional simulation tools for Computational Fluid Dynamics (CFD), based on solving the Navier-Stokes (NS) equations with numerical methods like Finite Volumes, have two big inconveniences: they require the user to spend countless hours preparing a suitable mesh and they have a very low efficiency for parallel computation.

The Lattice Boltzmann Method [1] (LBM) is an alternative scheme for CFD simulations that is based on solving the discretized Boltzmann equation with simplified collision dynamics:

$$F_i(x + \Delta x, t + \Delta t) - F_i(x, t) = Q_i \quad (1)$$

Where  $F_i$  is the particle distribution function and  $Q_i$  the collision operator. This is a much simpler numerical scheme than solving NS, it is computed on a regular lattice and allows for tremendous parallel efficiency.

This project, proposed by the company Next Limit Technologies, consisted on simulating a series of test cases with their software XFlow, a young CFD code based on the LBM, with the objective of validating its results against experimental data and other numerical codes.

In particular, one thermal simulation (T-Junction [2]) and two multiphase test cases (Rising Bubble [3] and Rayleigh-Taylor instability [4]) were studied.

Overall, the obtained numerical results showed a mixed success, indicating a need for further enhancements in the implementation of the different numerical solvers involved. Only a small subset of data is presented here.

### RESULTS



Fig. 1: Overview of the T-Junction simulation. Averaged temperature field after 16s.

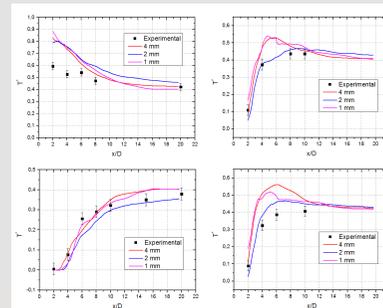


Fig. 2: Temperature profiles along the top, left, bottom and right sides of the pipe for different lattice resolutions compared against experimental data.

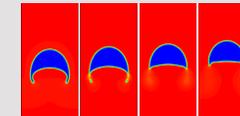


Fig. 3: Overview of the rising bubble case. Shape of the bubble at different time steps during the simulation.

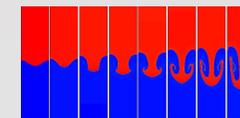
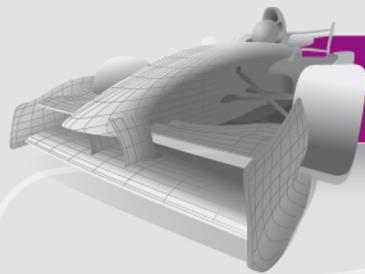


Fig. 4: Evolution of the Rayleigh-Taylor instability as obtained with XFlow.

### REFERENCES

- [1] S. Succi. The Lattice Boltzmann Equation for Fluid Dynamics and Beyond. Oxford University Press, 2001.
- [2] BL Smith et al. Report of the OECD/NEA-Vattenfall T-junction Benchmark exercise. NEA/CSNI Report, 2011.
- [3] S. Hysing et al. Proposal for quantitative benchmark computations of bubble dynamics. Univ., 2007.
- [4] J. Guermond, L. Quartapelle. A projection FEM for variable density incompressible flows. JCP, 165(1):167-188, 2000.

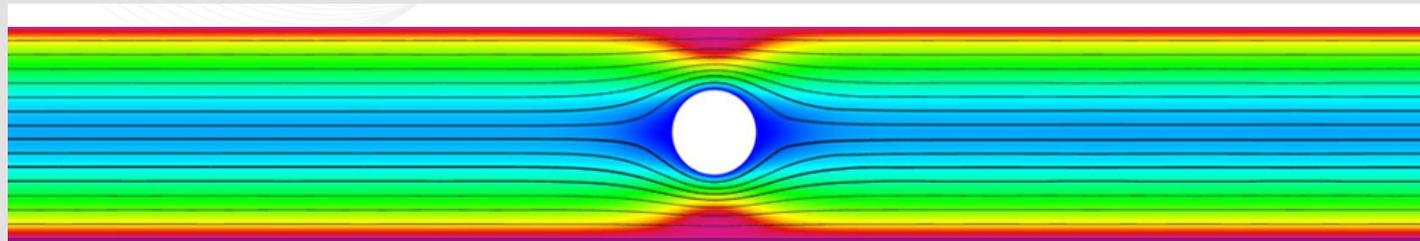


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## Faculty



### FACULTY

Our faculty members are renowned professionals with extensive experience in the field of modelling and numerical simulation.

Guests will include specialists in their scientific and/or technical field.

UNIVERSITY OF SANTIAGO DE COMPOSTELA

Department of Applied Mathematics and others

UNIVERSITY OF A CORUNA

Department of Mathematics and

others

UNIVERSIDAD DE VIGO

Department of Applied Mathematics and others

CARLOS III UNIVERSITY OF MADRID

Gregorio Millán Insitute and others

TECHNICAL UNIVERISTY OF MADRID

Department of Applied Mathematics and others

OTHER UNIVERSITIES AND RESEARCH CENTRES

Collaborators



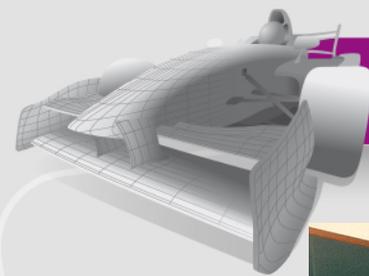
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**M2i**

MASTER IN INDUSTRIAL MATHEMATICS

<http://m2i.es/en/>  
[www.m2i.es](http://www.m2i.es)

## Relationships with Industry



97 European Study Group with Industry  
(11-14/11/2013, USC)



ECMI 2014

European Consortium for Mathematics in Industry



ECMI 2016: 19th edition, Santiago de Compostela on 13-17th June 2016

ITMATI Instituto Tecnológico de Matemática Industrial

Web: [//www.itmati.com/](http://www.itmati.com/)



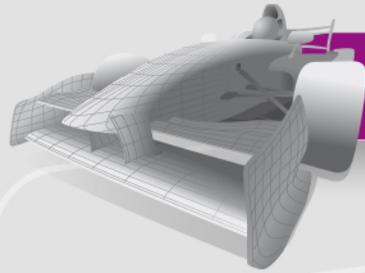
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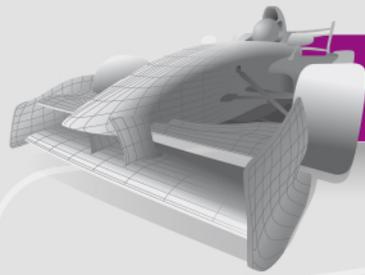
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## Relations with Industry

- Due to the **Workshop on Industrial Problems** we have signed more than **60** agreements with regional, national and international **companies** that collaborate with M2i.
- These companies present problems on which the students and teachers work in the **Workshops on Industrial Problems and on Modelling**.
- Some of these problems may become the subject of the **Master's dissertation**.
- These companies and technological centers also offer **internships** to students.





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## Companies

List of companies with this agreement are listed at:

<http://www.m2i.es/en/?seccion=empresas>

Empresas con las que ya se ha formalizado en el curso 2014-15 el convenio de colaboración con el M2i:

- Biomedicine & Health
- Economics & Finances
- Energy & Environment
- Logistics and transport sectors

ArcelorMittal Centro de Servicios Compartidos, S.L  
<http://spain.arcelormittal.com/>

Centro Tecnológico de Supercomputación de Galicia  
[www.cesga.es](http://www.cesga.es)

CO2 Smart Tech, S.A.  
[www.co2st.es/](http://www.co2st.es/)

Endesa Generacion, SA  
[www.endesa.es](http://www.endesa.es)

Etulos Solute  
[www.solute.es//](http://www.solute.es//)

Factorias Vulcano, S.A.  
[www.factoriasvulcano.com/](http://www.factoriasvulcano.com/)

Fundación CIDETEC  
[www.cidetec.es](http://www.cidetec.es)

Fundación Instituto de Hidráulica Ambiental de Cantabria  
[www.ihcantabria.com](http://www.ihcantabria.com)

Fundación Ramón Domínguez  
[www.fundacionramondominguez.es](http://www.fundacionramondominguez.es)

GMV Aerospace & Defence SAU  
[www.gmv.com/en](http://www.gmv.com/en)

Idealos  
[www.idealos.es](http://www.idealos.es)

Ikerlan S. Coop  
[www.ikerlan.es](http://www.ikerlan.es)

Instituto Tecnológico de Matemática Industrial  
[www.itmati.com](http://www.itmati.com)

Mathlas Consulting, S.L.  
[mathlas.com/](http://mathlas.com/)

Mestrelab Research, S.L.  
[mestrelab.com](http://mestrelab.com)

Next Limit Dynamics S.L.  
[www.nextlimit.com](http://www.nextlimit.com)

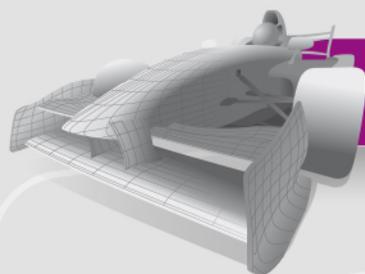
Rodman Polyships  
[rodman.es](http://rodman.es)

Russula, S.A.  
[www.russula.com](http://www.russula.com)

Silicio FerroSolar, S.L.  
[www.ferroatlantica.es](http://www.ferroatlantica.es)

Tecnologías Avanzadas Inspiralía, S.L.  
[www.inspiralia.com/](http://www.inspiralia.com/)

## Companies



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List of companies with this agreement are listed at:

<http://www.m2i.es/en/?seccion=empresas>

- Biomedicine & Health
- Economics & Finances
- Energy & Environment
- Logistics and transport sectors

Abengoa  
[www.abengoa.com](http://www.abengoa.com)

Acuanorte  
[www.acuanorte.es](http://www.acuanorte.es)

Adatica  
[www.adatica.com](http://www.adatica.com)

AFI  
[www.afi.es](http://www.afi.es)

AMES  
[www.ames.es](http://www.ames.es)

AMV Soluciones  
[www.amvsoluciones.com](http://www.amvsoluciones.com)

Analistas Financieros Internacionales  
[www.afi.es](http://www.afi.es)

Aqua Ambiente Servicios Integrales, SA  
[www.aquaambiente.es](http://www.aquaambiente.es)

AXA Group Solutions  
[www.axa.es/Seguros/Particulares/seguros.aspx](http://www.axa.es/Seguros/Particulares/seguros.aspx)

BALIÑO  
[www.balino.com](http://www.balino.com)

BANESTO  
[www.banesto.es](http://www.banesto.es)

BBVA  
[www.bbva.es](http://www.bbva.es)

CASTROSÚA  
[www.castrosua.com](http://www.castrosua.com)

Cedervall España, S.A.  
[www.cedervall.com](http://www.cedervall.com)

Centro de Investigación Forestales de Lourizan  
[www.escuelalourizan.es](http://www.escuelalourizan.es)

Centro de Observación y Teledetección Espacial SAU  
[www.grupotecopy.es/es/nosotros/organizacion/cotesa.html](http://www.grupotecopy.es/es/nosotros/organizacion/cotesa.html)

Centro de Supercomputación de Galicia (CESGA)  
[www.cesga.es](http://www.cesga.es)

Centro Tecnológico Aimen  
[www.aimen.es](http://www.aimen.es)

Centro Tecnológico de Automoción de Galicia (CTAG)  
[www.ctag.com](http://www.ctag.com)

Château Luchey-Halde  
[www.luchey-halde.com](http://www.luchey-halde.com)

CIE Automotive  
[www.cieautomotive.com](http://www.cieautomotive.com)

Confederación Hidrográfica del Miño-Sil  
[www.chminosil.es](http://www.chminosil.es)

ELINSA  
[www.elinsa.org/](http://www.elinsa.org/)

Endesa Generación, SA  
[www.endesa.es](http://www.endesa.es)

Fundación CIDAUT  
[www.cidaut.es](http://www.cidaut.es)

Fundación Instituto de Hidráulica Ambiental de Cantabria  
[www.ihcantabria.com/es/fundacionih](http://www.ihcantabria.com/es/fundacionih)

Fundación para el Fomento de la Calidad Industrial y el Desarrollo Tecnológico de Galicia  
[www.fundacioncalidade.org](http://www.fundacioncalidade.org)

Gallega de Mecanizados Electronicos  
[www.gamelsa.com](http://www.gamelsa.com)

GMV Aerospace & Defence SAU  
[www.gmv.com/en](http://www.gmv.com/en)

Grupo Antolin Ingeniería, S.A.  
[www.grupoantolin.com](http://www.grupoantolin.com)

Grupo Ferroatlántica  
[www.ferroatlantica.es](http://www.ferroatlantica.es)

Iberdrola Energías Renovables de Galicia, SA  
[www.iberdrola.es](http://www.iberdrola.es)

Idealos  
[www.idealos.es](http://www.idealos.es)

Ikerlan S. Coop  
[www.ikerlan.es](http://www.ikerlan.es)

INDAR  
[www.ingeteam.com/Es.aspx](http://www.ingeteam.com/Es.aspx)

Indizen Technologies  
[www.indizen.com](http://www.indizen.com)

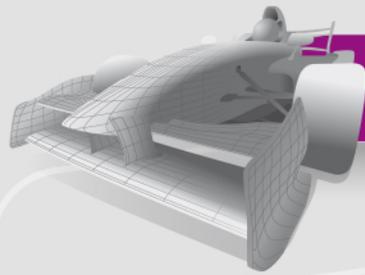
Inergy Automotive Systems  
[www.inergyautomotive.com/Pages/Home.aspx](http://www.inergyautomotive.com/Pages/Home.aspx)

Inspiralia  
[www.inspiralia.com](http://www.inspiralia.com)

Instituto de Ciencias de la Construcción Eduardo Torroja  
[www.ietcc.csic.es](http://www.ietcc.csic.es)

Instituto de Hidráulica Ambiental "IH Cantabria"  
[www.ihcantabria.com](http://www.ihcantabria.com)

Instituto de Investigaciones Marinas del Vigo  
[www.iim.csic.es](http://www.iim.csic.es)



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**Companies**

**For this talk different**

**Companies and Institutions**

**wanted to share with us their opinion about  
the interplay between them and M2i...**



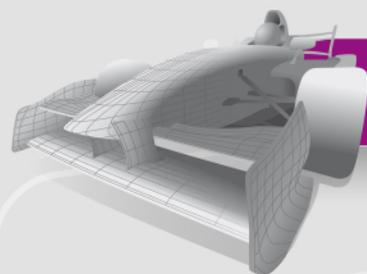
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## Companies

**M** Mestrelab Research  
chemistry software solutions

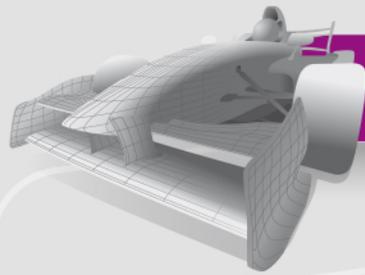


Santiago López  
(Egresado MIM)

**MESTRELAB RESEARCH S.L.** is an R&D company specialized in the development of **software tools** for analytical chemistry and biochemistry applications supplied to research labs in the **pharmaceutical, biotech, materials development and chemical industries and in government and academic institutions.**

Founded and based in Santiago de Compostela, Galicia (Spain), **MESTRELAB** supports chemistry research by providing applications which enable scientists workflows in many different industries and markets. Physical Chemistry, Mathematics and Information Science are the scientific and technical pillars under its products and activities.

**MIM Alumni/ M21 collaborator:** Santiago Ponte *Scientific SW Developer*



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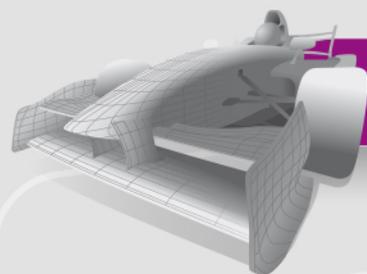
## Companies

[MESTRELAB RESEARCH S.L.](#) is proud of being among the participants in some of the activities in and around the **Master in Industrial Mathematics**.

- The succesful interplay began in late 2012 and since then Mestrelab has **contributed four industrial mathematical problems** rooted in the core of its activities and needing expertise in fields comprising optimization, linear algebra, inverse problems and low-rank approximation.
- Letting alone the importance of the results achieved by the students, **Mestrelab has greatly benefitted from the very exposition and discussions of every problem with the Master's students and teachers.**

**Mestrelab intends to keep healthy that interplay, and convinced about the mutual benefits arising from it. "**

**M** Mestrelab Research  
chemistry software solutions



**M2i**

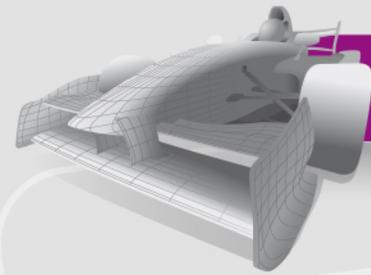
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## Companies

### ITMATI

**ITMATI**

“Because innovation is in the people and the knowledge in mathematical technology is our greatest asset, our aim **is to attract talented people** formed professionally in the Master in Industrial Mathematics (**M2i**) to work on projects of applied mathematics developed by **ITMATI** with **companies all around the world.**”



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## Companies

### ArcelorMittal

#### At a glance



With annual achievable production capacity of approximately 114 million tonnes of crude steel, and some 210,000 employees across 60 countries, **ArcelorMittal** is the world's leading steel and mining company.

With an industrial presence in 19 countries, we are the leader in all major global steel markets including automotive, construction, household appliances and packaging, with **leading research and development and technology**, sizeable captive supplies of raw materials, and outstanding distribution networks.



## Companies

### ArcelorMittal

“Collaboration with the USC **Master on Industrial Mathematics** has been very fruitful.

- The whole process **is really focused on solving real problems in the industry.**
- In our case, we were invited to expose our issue to the students and professors, so they **could define the best way** of solving it.
- Interaction between the student who worked on the problem, the professor in charge of supervising the advances achieved by the student and our company was **very fluid and satisfying.**
- Result were completely **aligned with the interest of our company.**“





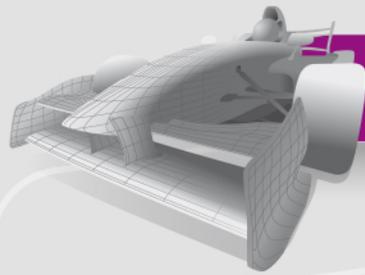
## Companies

### ENDESA



“From 1976, **ENDESA** has been developing intense industrial activities related with mining and electrical production in the Galician town of As Pontes (A Coruña).

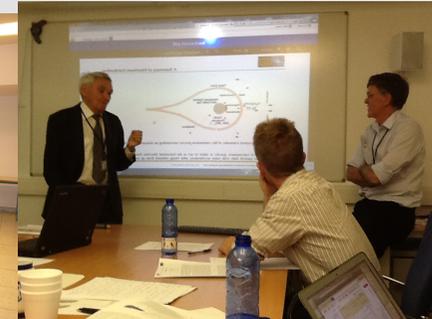
- Over the years, numerous technical challenges have required **collaboration with the university**.
- A notable example is the mathematical modelling of diverse phenomena accomplished, initially, by the Facultad de Matemáticas of the USC and, nowadays, by the **Máster en Matemática Industrial**.
- The developed models embraced fields such as **optimization of industrial problems and prediction of meteorological phenomena**.
- The valuable information provided **allows the improvement of the facilities** and has always being an enriching experience for all the participants.”



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## IT technologies

- M2i takes advantage of the IT technologies by using a modern videoconferencing system which simultaneously allows students and teachers of the different M2i sites to connect in **real time**.
- Additionally, the teaching sessions of a large part of the subjects are **recorded [Video lecture]** so that the students can access the classes from home.
- Students have also access to **professional software** during the Master.

### COMPANIES

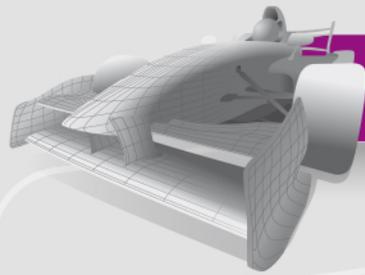
Companies who have lend their software to be freely use in the M2i:



ANSYS Fluent used in Professional software in fluid mechanics.



MIKE used in Professional software in environmental issues.



# M2i

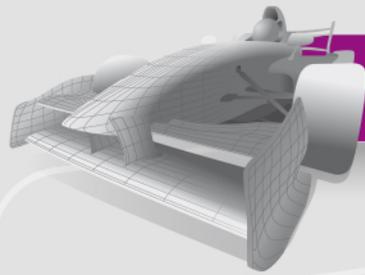
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## Program

- Basic Training (24 compulsory ECTS)
- Modelling Specialization Module [MS] ( \*\* ) (24 ECTS)
- Numerical Simulation Specialization Module [NSS] ( \*\* ) (24 ECTS)
- Optional Module ( \*\* )
- Master Dissertation (30 compulsory ECTS)

( \*\* ) The 12 optional ECTS compulsory can be obtained from any of the non compulsory modules



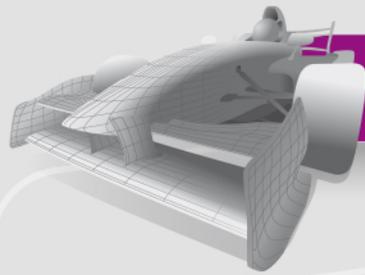
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## Basic Training (24 compulsory ECTS)

- Numerical methods and programming (6 ECTS)
- Ordinary differential equations / Dynamical systems (6 ECTS)
- Partial differential equations (6 ECTS)
- Numerical methods for partial differential equations (6 ECTS)



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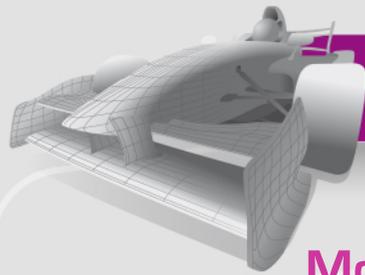
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## Basic Modelling

[Choose 6 compulsory ECTS to obtain the MS and NSS]:

- Acoustics (6 ECTS)
- Electromagnetism and optics (6 ECTS)
- Fluid mechanics (6 ECTS)
- Mathematical modelling in finance (6 ECTS)
- Mathematical modelling in environmental science (6 ECTS)
- Solid mechanics (6 ECTS)

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## Modelling Specialization Module [MS] ( \*\* ) (24 ECTS)

**Basic Modelling** (Choose 6 compulsory ECTS to obtain the MS)

**Advanced Modelling** (Choose 6 compulsory ECTS to obtain the MS):

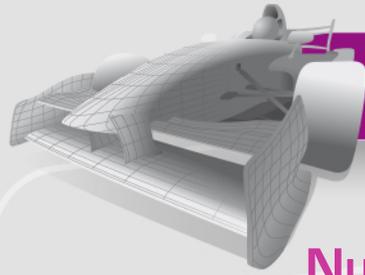
- Fluidthermal MEMS and Power MEMS (6 ECTS)
- Modelling in Biomedicine (6 ECTS)
- Multidisciplinary Optimal Design (6 ECTS)
- Turbulence (6 ECTS)

**Perturbation methods** (6 compulsory ECTS to obtain the MS)

**Topics in Applied Mathematics** (Choose 6 compulsory ECTS to obtain the MS):

- Inverse Problems and Image Reconstruction (6 ECTS)
- Optimization and control (6 ECTS) Stability of physical systems (6 ECTS)
- Variational analysis of partial differential equations (3 ECTS)
- Wavelet Transform Applied to Engineering (6 ECTS)

( \*\* ) The 12 optional ECTS compulsory can be obtained from any of the non compulsory modules



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## Numerical Simulation Specialization Module [NSS] ( \*\* ) (24 ECTS)

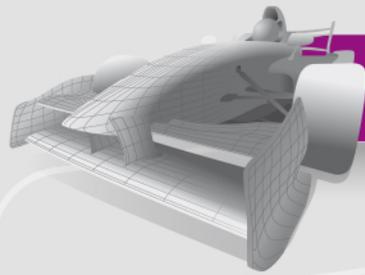
**Basic Modelling** (Choose 6 compulsory ECTS to obtain the NSS)

**Continuum mechanics** (6 compulsory ECTS to obtain the NSS)

**Professional Software in Numerical Simulation** (Choose 12 compulsory ECTS to obtain the NSS):

- Computer-aided design (CAD) (6 ECTS)
- Professional Software in Acoustics (6 ECTS)
- Professional Software in Electromagnetism and Optics (6 ECTS)
- Professional Software in Environmental Science (6 ECTS)
- Professional Software in Finance (6 ECTS)
- Professional Software in Fluid Mechanics (6 ECTS)
- Professional Software in Solid Mechanics (6 ECTS)

[ \*\* ] The 12 optional ECTS compulsory can be obtained from any of the non compulsory modules

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## Optional Module [ \* \* ]

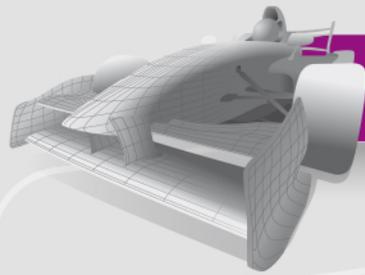
### Advanced Numerical Methods

- Advanced finite elements (3 ECTS)
- Advanced finite volumes (3 ECTS)
- Advanced scientific computing with Matlab (6 ECTS)
- Boundary element methods (3 ECTS)
- Numerical methods for large systems of equations (3 ECTS)
- Stochastic numerical methods (6 ECTS)

### Computing

- Computer architectures and operative systems (3 ECTS)
- Computer networks and distributed computing (3 ECTS)
- Parallel computing (3 ECTS)
- Programming in C++ (3 ECTS)

[ \* \* ] The 12 optional ECTS compulsory can be obtained from any of the non compulsory modules



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## Master Dissertation (30 compulsory ECTS):

- Workshop on Modelling (3 optional ECTS)
- Modelling Weeks (3 optional ECTS)
- Workshop on Projects Methodology (3 optional ECTS)
- Workshop on Software Engineering (3 optional ECTS)
- **Workshop on Industrial Problems (6 compulsory ECTS)**
- Internships in Companies/Technological centres (3 optional ECTS)
- Internships in University (3 optional ECTS)

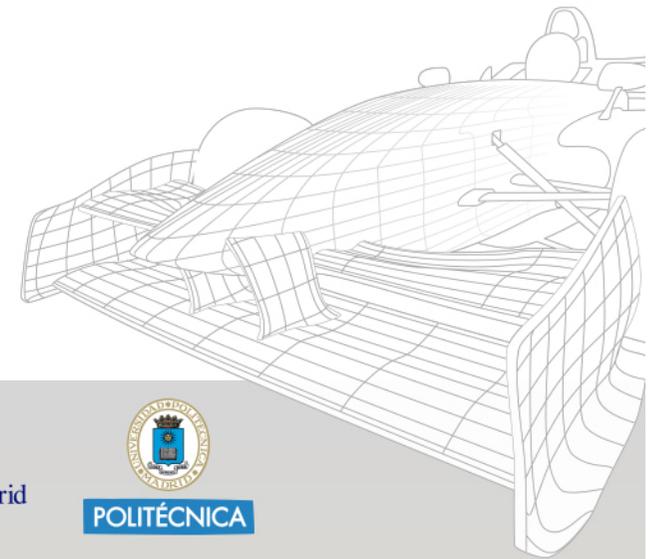
\***Dissertation (18 compulsory ECTS):** The topic will be chosen by students and supervised by a faculty member from the proposals introduced by the different companies/technological centres in the Workshop on Industrial Problems and the Workshop on Modelling.



# MASTER IN INDUSTRIAL MATHEMATICS

Thank you very much for your time and attention!

[www.m2i.es/en](http://www.m2i.es/en)  
[info@m2i.es](mailto:info@m2i.es)



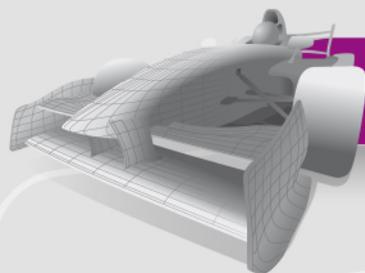
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Universidade de Vigo



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[www.m2i.es](http://www.m2i.es)

# M2i

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Que tu futuro no sea una incógnita



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[info@m2i.es](mailto:info@m2i.es)



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