EUROPEAN ACADEMY OF SCIENCES
IN SUPPORT OF EXCELLENCE IN SCIENCE AND TECHNOLOGY

In this issue

Editorial by Rodrigo Martins
EurASc President

Dear fellows,

This is the month of our EURASC CEREMONY 2022, to be held from October 24th to 25th, 2022 in the Fondation Universitaire, Brussels, Belgium, where we expect to meet all of you as a front-to-front event. Besides hearing the speech of our awardees, with the Blaise Pascal medals and Leonardo da Vinci prize, we will hear some distinguish speakers as the president of the European Research Council, our fellow Professor Maria Leptin, and the Professor Graça Carvalho, a distinguished member of the European parliament, involved in the areas related to science and technology committees, past minister of science and technology and higher education of Portugal, past adviser of the President Barroso and of Commissioner Carlos Moedas.

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Newletter n°14

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During the event we will hear the strategies ad commitments of the different divisions as well the involvement of our Academy in further commitments, science related.

During the conclusions of our event, we will have interventions from the vice president of the European parliament, Professor Maria Leitão Marques as well as from the programme coordinator of the European Innovation Council doctor Francesco Matteucci, among others.

Another outstanding event co-organized by our Academy and the Chinese Academy of Sciences, the Frontier Forum on Progress in Ocean Science and Technology, held online on 28-29 September 2022, was a tremendous success. It showed how global cooperation in science is vital to all of us.

Finally, I would like to thank the contributions given by our fellows, namely from Chemistry, Earth and Environmental and Physics Divisions for the contributions given, namely the one from our fellow Dimitri Batani.

We challenge all of you to give contributions to our newsletter, involving all perspectives you believe to be relevant for all of us! Indeed, if we want to go further, we need to count on all of us.

DEAR SIRS AND MADAMS, DEAR EURASC FELLOWS,

ON BEHALF OF THE PRESIDENT OF THE EUROPEAN ACADEMY OF SCIENCES, PROFESSOR RODRIGO MARTINS, WE HEREBY INVITE YOU TO ATTEND THE EURASC CEREMONY 2022 THAT WILL TAKE PLACE ON OCTOBER 24TH AND 25TH, 2022 AT THE "FONDATION UNIVERSITAIRE" IN BRUSSELS.

IT WILL BE A TWO-DAY EVENT, WITH OCTOBER 24TH DEVOTED TO THE 2020 AND 2021 AWARDS CEREMONY AND A LECTURE BY A SENIOR OFFICIAL FROM ERC. OCTOBER 25TH WILL BE RESERVED FOR THE SYMPOSIUM ON "THE FUTURE OF SCIENCES: THE EURASC VISION" AND THE 2022 AWARD CEREMONY.

FINAL PROGRAM >> HERE<<

<< REGISTRATIONS >>HERE<<

WE LOOK FORWARD TO YOUR PRESENCE.

EURASC CEREMONY 2022

EUROPEAN ACADEMY OF SCIENCES

OCTOBER 24TH & 25TH • FONDATION UNIVERSITAIRE, BRUSSELS

OCTOBER 24TH

08h30 | Guest Reception

09h00 | Welcome
EurASc President, Professor Rodrigo Martins

09h05 | Awards 2020
Leonardo Da Vinci Awards
Presentation by President, Professor Rodrigo Martins

09h10 | Leonardo Da Vinci Award 2020
Professor Klaus Müllen, Max Planck Institute
Award Delivered by: Professor Federico Rosei - Head of Materials Science Division

09h20 | Blaise Pascal Medals 2020
Presentation by Vice-President, Professor Alain Tressaud

09h25 | Blaise Pascal Medal 2020 in Mathematics
Professor Albert Cohen, Sorbonne Université
Medal Delivered by: Professor José Carrillo - Head of Mathematics Division

09h35 | Blaise Pascal Medal 2020 in Physics
Professor Sir Tejinder Singh Virdee, Imperial College London
Medal Delivered by: Professor Paul Lecoq - Head of Physics Division

09h45 | Blaise Pascal Medal 2020 in Chemestry
Professor Manfred Reetz, Max-Planck-Institut
Medal Delivered by: Professor Pierre Braunstein - Head of Chemistry Division

09h55 | Blaise Pascal Medal 2020 in Engineering
Professor John Katsikadelis, National Technical University of Athens
Medal Delivered by: Professor Alberto Carpinteri - Head of Engineering Division

10h15 | Blaise Pascal Medal 2020 in Materials Science
Professor Iain McCulloch, Imperial College London
Medal Delivered by: Professor Federico Rosei - Head of Materials Science Division

10h25 | *Coffee Break*

10h45 | Awards 2021
Leonardo Da Vinci Awards
Presentation by President, Professor Rodrigo Martins

10h50 | Leonardo Da Vinci Award 2021
Professor Helmut Schwarz, University of Berlin
Award Delivered by: Professor Pierre Braunstein - Head of Chemistry Division

11h00 | Blaise Pascal Medals 2021
Presentation by Vice-President, Professor Alain Tressaud

11h05 | Blaise Pascal Medal 2021 in Mathematics
Professor Maria J. Esteban, CNRS
Medal Delivered by: Professor José Carrillo - Head of Mathematics Division

11h15 | Blaise Pascal Medal 2021 in Physics
Professor Karl Leo, University of Dresden
Medal Delivered by: Professor Paul Lecoq - Head of Physics Division

11h25 | Blaise Pascal Medal 2021 in Chemestry
Professor Clément Sanchez, Collège de France
Medal Delivered by: Professor Pierre Braunstein - Head of Chemistry Division

11h35 | Blaise Pascal Medal 2021 in Engineering
Professor Isaac Elishakoff, Florida Atlantic University
Medal Delivered by: Professor Alberto Carpinteri - Head of Engineering Division

11h45 | Blaise Pascal Medal 2021 in Materials Science
Professor Andrea Ferrari, University of Cambridge
Medal Delivered by: Professor Federico Rosei - Head of Materials Science Division

12h00 | *Lunch*

13h30 | ERC Talk by Dr. Maria Leptin
President of the European Research Council - EurASc Fellow
"The importance of frontier research"

13h50 | Talk by Dr. Maria da Graça Carvalho
Member of the European Parliament
"The EU research and innovation policies"

14h10 | Round table Discussion
Conduct by A. Tressaud, P. Treguer, R. Martins and Francesco Matteucci (EIC)

15h00 | Cocktail

16h30 | EurASc General Assembly of Members

--- END DAY 1 ---

EURASC CEREMONY 2022

EUROPEAN ACADEMY OF SCIENCES

OCTOBER 24TH & 25TH • FONDATION UNIVERSITAIRE, BRUSSELS

OCTOBER 25TH

08h30 | Guest Reception

09h00 | The Future of Sciences: The EurASc vision
Opening by President, Professor Rodrigo Martins
Communications from all Divisions of EurASc, 15mn + 5mn Q&A

09h05 | Mathematics Division Communication
Delivered by: Professor José Carrillo - Head of Division

09h25 | Physics Division Communication
Delivered by: Professor Paul Lecoq - Head of Division

09h45 | Chemistry Division Communication
Delivered by: Professor Pierre Braunstein - Head of Division

10h05 | Engineering Division Communication
Delivered by: Professor Alberto Carpinteri - Head of Division

10h25 | *Coffee Break*

11h00 | Materials Science Division Communication
Delivered by: Professor Steven De Feyter - Representative of Head of Division

11h20 | Computational and Information Sciences Division Communication
Delivered by: Professor Endre Süli - Head of Division

11h40 | Earth and Environmental Sciences Division Communication
Delivered by: Professor John R. Porter - Head of Division

12h00 | Medicine and Life Sciences Division Communication
Delivered by: Professor Daniel Scherman - Head of Division

12h20 | Social Sciences and Humanities Division Communication
Delivered by: Professor Martin Carrier - Head of Division

12h40 | *Lunch*

14h00 | Awards 2022
Leonardo Da Vinci Awards
Presentation by President, Professor Rodrigo Martins

14h05 | Leonardo Da Vinci Award 2022
Professor Anny Cazenave, International Space Science Institute
"Space observations of climate change"
Award Delivered by: Professor John R. Porter - Head of Earth and Environmental Sciences Division

14h35 | Blaise Pascal Medals 2022
Presentation by Vice-President, Professor Alain Tressaud

14h40 | Blaise Pascal Medal 2022 in Mathematics
Professor Alain-Sol Sznitman, ETH Zurich
"On disconnection and random interlacements"
Medal Delivered by: Professor José Carrillo - Head of Mathematics Division

14h55 | Blaise Pascal Medal 2022 in Physics
Professor Susan Scott, Australian National University
"Singularities of space-time and gravitational waves"
Medal Delivered by: Professor Paul Lecoq - Head of Physics Division

15h10 | *Coffee Break*

15h30 | Blaise Pascal Medal 2022 in Chemestry
Professor Gary J. Schrobilgen, McMaster University, Canada
"Chemistry at the Edge of the Periodic Table"
Medal Delivered by: Professor Pierre Braunstein - Head of Chemistry Division

15h45 | Blaise Pascal Medal 2022 in Engineering
Professor Marco Amabili, McGill University, Canada
"Nonlinear Vibrations Of Shells: From Classical Problems To Soft Biological Matter"
Medal Delivered by: Professor Alberto Carpinteri - Head of Engineering Division

16h00 | Blaise Pascal Medal 2022 in Materials Science
Professor Claudia Felser, Max Planck Institute for Chemical Physics of Solids, Germany
"Topology and Chirality"
Medal Delivered by: Professor Steven De Feyter - Representative of Head of Materials Science Division

16h15 | Diplomas presentation to EurASc new fellows (2020, 2021 & 2022)
Delivered by Hélène de Rode, A. Tressaud, P. Treguer and R. Martins

16h30 | Conclusions

--- END DAY 2 ---

ATTENTION

New web address
New email address

www.eurasc.eu | contact@eurasc.eu

As you all know, in August this year we started to restructure our website, as it was causing problems that were impossible to solve under the current conditions. This process took longer than expected because we were hoping not to lose the .org domain, which eventually happened.
As a result, the European Academy of Sciences has now a new address of website and email:

- website www.eurasc.eu
- e-mail contact@eurasc.eu

We kindly ask you to use the following email address from now on.

We are resuming all communication activity, reactivating all our means (website; email and social networks)

Chemistry Division

Pierre Braunstein
Head of Chemistry Division of EurASc,
Emeritus CNRS Research Director
Institute of Chemistry (UMR 7177 CNRS) | University of Strasbourg

We are pleased that 4 new members were elected in May 2022.
These are, in alphabetic order :

Mara Freire, University of Aveiro, Portugal, is a Research Coordinator of the group Biomedical and Biomimetic Materials, at CICECO-Aveiro Institute of Materials, University of Aveiro, Portugal. She has made very significant contributions to the (i) development of cost-effective purification processes for high-value biopharmaceuticals; and sustainable recovery processes for added-value compounds with therapeutic properties from biomass; and to the (ii) synthesis and application of ionic liquids as therapeutic drugs.

Abhik Ghosh is Professor at the Department of Chemistry and Arctic Center for Sustainable Energy Coordinator, The Arctic University of Norway, N-9037 Tromsø, Norway,has made major scientific contributions on three key areas – computational chemistry, noninnocent ligands and their interactions, and 4d and 5d element chemistry.
He pioneered e.g. the synthesis and study of 5d metallocorroles – a remarkable class of size-mismatched complexes that combine a contracted porphyrin ligand and a large 5d transition metal ion.

Magdolna Hargittai is a research professor of structural chemistry at the Department of Inorganic and Analytical Chemistry, Budapest University of Technology and Economics. Her research focuses on the determination and modeling of inorganic systems, especially metal halides. She determined numerous unusual structures by combining advanced gas-phase electron diffraction with information from other diffraction and spectroscopic techniques, and quantum chemical calculations. She coauthored the most successful monograph, Symmetry through the Eyes of a Chemist.

Donglin Jiang is Strategy Hiring University Professor at the National University of Singapore. He has made major fundamental contributions to diverse areas of polymer chemistry, including dendritic polymers, conjugated microporous polymers, and two-dimensional polymers and covalent organic frameworks. He has established strong networks and efficient collaborations with various scientists of European countries.
We welcome these new members and look forward to interacting more closely with them.

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Earth and Environmental Sciences Division

John R. Porter
Head of the Earth and Environmental Division of EurASc
Faculty of Science, University of Copenhagen, Denmark

I am very pleased to present some of the activities with which Fellows have been engaged recently and are also ongoing. Thanks to all who contributed and to Kerstin Ledin for assembling the material. When I report these eight activities, I will add the email addresses of the proponents so Fellows can contact each another, if they are interested in a colleague's research.

NEWS:

We offer hearty congratulations to Professor Anny Cazenave from the International Space Sciences institute (ISSI), Bern Switzerland and the Centre National d'Études Spatiales, France for her Leonardo da Vinci Award in 2022.

The following have been elected and are welcomed as Fellows to the Division:

- Professor David Barry - Ecole Polytechnique Fédérale de Lausanne, Switzerland.
- Professor Gustau Camps-Valls - Universitat de València, Spain.
- Dr Mandea Mioara - Centre National d'Études Spatiales, France.
- Professor Pierre Friedlingstein - Ecole Normale Supérieure, France.
- Professor Ruben Sommaruga - University of Innsbruck, Austria.
- Professor Dr Doerthe Tetzlaff - Humboldt-Universität, Germany.

ACTIVITIES:

Online China-Europe Frontier Forum on Progress in Ocean Science and Technology – 28th & 29th September 2022.

This was the second edition, organised by the European Academy of Sciences (EurASc) and the Chinese Academy of Sciences (CAS) in association with IUEM-UBO. Led by Paul Tréguer (IUEM-UBO Brest , France) and Jing Zhang (ECNU, CAS) and colleagues, this event saw European and Chinese researchers speak on ocean-based climate action, big data management for ocean science and technology, digital twins of the ocean component of the Digital Earth Initiatives and the global coastal ocean. The wholly virtual meeting was attended by more than 300 participants.
Contact: Paul Tréguer at Paul.Treguer@univ-brest.fr.

Climate change melts away unique cultural heritages.
A new subdiscipline in archaeology has emerged as a result of the changing climate - glacial archaeology. It is based on the fact that objects and things, that at one time were lost intentionally or unintentionally, start to melt out of glaciers and permanent snow patches as the climate heats up. The things, that are often very well preserved, were lost during previous warmer periods, but then captured in and preserved by ice and snow. For an archaeologist, organic materials can have been preserved in the ice for thousands of years. A famous example is Ötzi, the ice man that was found on the border between Italy and Austria. There is also the Canadian iceman, or Kwäday Dän Ts'ìnchi, translated to 'the long-ago person found' – (what a surname!), who was radiocarbon dated to sometime between 1720 and 1850 CE. Others are the frozen Inuit Qilakitsoq mummies found on Greenland dated to some 1475 ± 50 years old.
Contact: Kerstin Lidén at kerstin.liden@arklab.su.se

Global wheat production could benefit from closing the genetic yield gap.
This is work from Mikhail Semenov and colleagues. In a paper in Nature Food (https://doi.org/10.1038/s43016-022-00540-9), their results show that current wheat cultivar yields are substantially below achievable genetic yield potentials. Their quantitative estimation of the large, unexploited global wheat genetic yield gap, estimated at 51% of maximum crop yield, could underpin strategic priorities for wheat improvement and genetic adaptation. Exploiting the existing genetic yield gap through crop genetic improvement and adaptation could greatly benefit global wheat production and provide a useful roadmap for plant scientists and breeders. Their article formed the frontispiece of the Nature Food edition of July 2022, volume 3, number 7.
Contact: Mikhail Semenov at Mikhail.Semenov@rothamsted.ac.uk

A second activity on ocean-based climate action via the Europe - China WG that followed the First China -Europe Frontier Forum, has reported that, as a consequence of anthropogenic perturbations, the global ocean is warming, acidifying, losing oxygen and sea ice, and sea level is rising. Drastic reductions in the emission of greenhouse gases is urgently needed, which includes ocean energy substitution for fossil energy. The researchers show that the ocean offers numerous opportunities to reduce the causes and consequences of climate change, globally and locally. A wide range of ocean-based measures to enhance societal climate adaptation are currently implemented worldwide to deal either with coastal risks or changes in ocean resources. Ocean-related measures should not be considered as a substitute for climate mitigation on land or non ocean-based adaptation measures. These must be strongly pursued for the benefit of the atmosphere, the ocean, and socio-ecological systems.
Contact: Jean-Pierre Gattuso at jean-pierre.gattuso@imev-mer.fr

A further contribution has provided evidence that carbon removal using coastal blue carbon ecosystems is uncertain and unreliable. In a paper in Frontiers in Climate, volume 4, (https://doi.org/10.3389/fclim.2022.853666) seven issues that affect the reliability of carbon accounting for this approach are considered with the conclusion that costs are highly uncertain, with lower-range estimates unrealistic for wider application, such as climate mitigation action, either for carbon-offsetting or for inclusion in Nationally Determined Contributions. The restoration of coastal blue carbon ecosystems is nevertheless highly advantageous for climate adaptation, coastal protection, food provision and biodiversity conservation. Such action can therefore be societally justified in very many circumstances, based on the multiple benefits that such habitats provide at the local scale.
Contact: Jean-Pierre Gattuso at jean-pierre.gattuso@imev-mer.fr

On a similar theme in a **paper in Global Ecology and Biogeography** volume 31 (https://doi.org/10.1111/geb.13515) colleagues showed that macroalgal forests are a major biome with a global area of 6.06–7.22 million km2, dominated by red algae, and NPP of 1.32 Pg C/year, dominated by brown algae. It is fascinating to know that the global macroalgal biome is comparable, in area and NPP, to the Amazon forest, but is globally distributed as a thin strip around shorelines. Macroalgae are expanding in polar, subpolar and tropical areas, where their potential extent is also largest, likely increasing the overall contribution of algal forests to global carbon sequestration.
Contact: Dorte Krause-Jensen at dkj@ecos.au.dk

Following the joint proposal of Jeffrey Sachs (President UN Sustainable Development Solutions Network), together with Professors Phoebe Koundouri, Yannis Ioannidis and Fellow Christos Zerefos acting as co-directors, they **launched in May 2022 the creation of the UN SDSN Global Climate Hub.** This initiative was based on the need for governments worldwide to take immediate decisive action to reduce the impact of climate change. The goal is to provide science-based advice for combating the aggravating climate crisis and prevent further deterioration. The Climate Hub will use all extensive data, knowledge and technologies provided by experts in various fields to implement country-specific action plans to be adopted and reinforced by society. In addition, Professor Zerefos proposed that the Greek Government created a flexible international mechanism to protect natural and cultural heritage monuments from climate change. This initiative has been included in UN activities by the Secretary General of the UN, and supported by UNESCO, the World Meteorological Organization and several NGOs.
Contact: Christos Zerefos at zerefos@geol.uoa.gr

Finally, a **paper in PNAS** (https://doi.org/10.1073/pnas.2109217118) formulated ten facts about land systems for sustainability. Land use is central to addressing sustainability issues, including biodiversity conservation, climate change, food security, poverty alleviation, and sustainable energy. The authors synthesized knowledge accumulated in land system science, into ten hard truths that have strong, general, empirical support. The ten facts were as follows: 1) Meanings and values of land are socially constructed and contested; 2) land systems exhibit complex behaviors with abrupt, hard-to-predict changes; 3) irreversible changes and path dependence are common features of land systems; 4) some land uses have a small footprint but very large impacts; 5) drivers and impacts of land-use change are globally interconnected and spill over to distant locations; 6) humanity lives on a used planet where all land provides benefits to societies; 7) land-use change usually entails trade-offs between different benefits-"win-wins" are thus rare; 8) land tenure and land-use claims are often unclear, overlapping, and contested; 9) the benefits and burdens from land are unequally distributed; and 10) land users have multiple, sometimes conflicting, ideas of what social and environmental justice entails.
Contact: John R Porter at jrp@plen.ku.dk

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Physics Division

Dimitri Batani
Member of Physics Division of EurASc
CELIA - Centre Lasers Intenses et Applications | Université de Bordeaux

In August 2021, the researchers working at the National Ignition Facility (NIF) of the Lawrence Livermore National Laboratory (California), have been able to obtain 1.35 MJ fusion energy out of a deuterium-tritium target irradiated by 1.93 MJ of laser energy. This is [1] a historical milestone that the scientific community has achieved after decades of efforts, since when the concept of laser-driven inertial confinement thermonuclear fusion (ICF) for energy production was proposed publicly at the beginning of the 70's by Basov in the Soviet union (co-Nobel laureate for the invention of the laser) and Nuckolls [2] in the United States . [3]

The record 1.35 MJ of output fusion energy was eight times higher than the yield obtained in previous best measurements [4] and about 100 times better than what was obtained 10 year ago during the so-called 'National ignition Campaign" performed at NIF. [5] With this result, the "breakeven" milestone, that requires the fusion energy yield to be equal to the input laser energy, is only a small step away, proving unambiguously the validity and the feasibility of the ICF concept. Almost simultaneously, very good results have been obtained in the field of Magnetic Confinement Fusion at the European JET Tokamak at Culham in the UK. Both NIF and JET [6] results have attracted the interest of the large public, the decision makers , and the scientific community towards the topic of nuclear fusion in general, and laser-driven fusion in particular.

Fusion energy holds the promise of being ecological acceptable (no CO_2 emission, no significant production of long-living nuclear wastes) and having a practical "infinite" reservoir of fuel. The hope of fusion as an alternative source of energy, indeed comes at a moment in which there are huge concerns both about the global warming and about the energetic dependence of Europe. It is therefore important to look at what are the next steps which are needed in order to go from breakeven to net energy gain, and what can be in particular the contribution of the European Scientific community.

The first key question is that the National Ignition Facility uses the so-called *indirect drive* scheme in which the capsule containing the nuclear fuel (mix of deuterium and tritium), is enclosed in a high-Z cavity, called "Holhraum". When the inner walls of the cavity are irradiated by the 192 NIF laser beams, they give rise to intense X-ray emission that ablates of the outer surface of the capsule, accelerating the fuel inwards in a rocket-like behavior. The capsule hence implodes, at a velocity of the order of 400 m/s, compressing the fuel and increasing its density by more than 1000 times. At the same time at the end of the implosion (stagnation) part of the kinetic energy of the imploding capsule is converted to heating of the central part of the capsule (so-called "hot-spot") to a temperature higher than 5 keV.

These are the conditions needed to trigger the D-T fusion reactions , each of which releases a 14.1 MeV neutron and a 3.5 MeV α-particle. In order to get high gain fusion the α-particles need to be stopped inside the fuel surrounding the hot spot, heating it, and creating a propagating thermonuclear wave which gradually burns most of the fuel.
The compression of the fuel and the creation of the hot spot need an almost perfectly spherical implosion. This indeed explains why NIF, and most laboratories working on ICF worldwide, have chosen the indirect drive approach. The X-rays generated inside the confined cavity very quickly become an almost perfect black-body radiation and, as it is well known, blackbody radiation has many interesting physical properties including the fact that it is isotropic an uniform, therefore being able to drive a very symmetric implosion.[7] However this is done at a high price: the energy loss involved in the intermediate step of conversion of laser light to X-rays can be more than 50%.

In order to progress towards high gain ICF, we need to remove this intermediate step and move towards "direct drive" ICF in which the capsule is illuminated directly by the laser light as indeed was originally proposed by Basov and Nuckolls. The problem of direct-drive is indeed that any asymmetry in laser illumination (or any defect in the target) reflects immediately in a non-uniform implosion due to the onset of hydrodynamic instabilities (Rayleigh-Taylor).

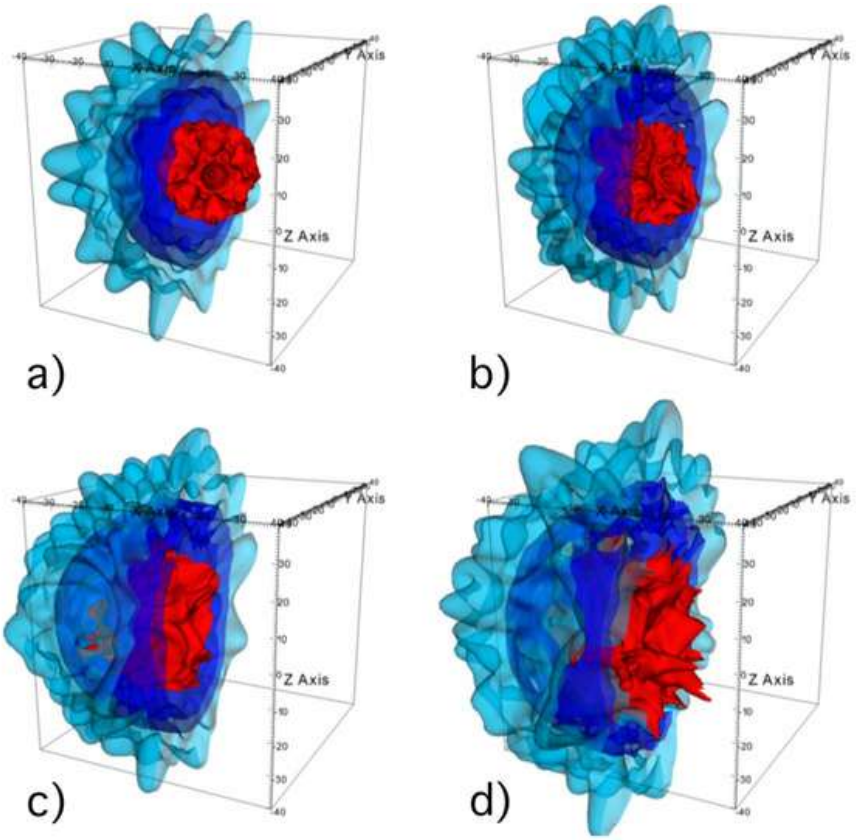

Figure 1: Hydrodynamics simulations showing the deformation of the DT target just before the end of the implosion (at a time corresponding to 25% of the neutron peak)
Red is the limit of the DT gas contained inside the shell (the "hot spot")
Light blue is the part of the shell at 10 g/cm3 and dark blue the part of the shell at 50 g/cm3
a) ideal case
b) taking into account an error in the energy balance among different laser beams
c) error in energy balance and in pointing of the beams
d)error in energy balance and in pointing plus initial misplacement of the target
All these cases do not take into account the phenomena of CBET (Cross Beam Energy transfer)
COURTESY OF ARNAUD COLAITIS, CELIA, BORDEAUX

Fig. 1 shows how min different situation the uniformity of implosion can be severely degraded. More recently, however, significant progress has been made also in the field of direct-drive, also by applying deep learning techniques to optimize the performance of implosions.[8]
In addition, advanced ignition schemes for direct drive ICF were proposed with the aim of overcoming the stringent requirements on the compression uniformity and symmetry of the original direct drive scheme to achieve central hot-spot ignition. These schemes are based on the separation of the compression phase and the ignition phase. The first phase here is just intended to compress the fuel, without creating the hot spot (which is done in the ignition phase). This allows imploding more massive and ticker targets at lower implosion velocities, which makes the implosion more stable and the target more resistant towards deformations induced by hydro-instabilities. Among these schemes the *shock-ignition* scheme[9, 10] foresees a first phase of moderate compression followed by an ignition phase driven by a converging shock generated by a high intensity laser spike at the end of the compression phase. The scheme is expected to achieve high gain with moderate laser energy and it is currently considered as one of the most promising approaches for direct-drive Inertial Fusion Energy (IFE) research.

What is the situation in Europe? Europe is strongly supporting fusion research through its participation to the International Thermonuclear Experimental Reactor (ITER) currently in construction in Cadarache (France), as well as other devices such as the JET torus, the stellarator Wendelstein 7-X at the Max Planck Institute for Plasma Physics (Germany), and other machines.
In contrast, the implication of Europe in IFE is more limited, even if the European scientific community has provided in the past very significant contributions to ICF research. The HiPER (High Power Laser Energy Research) infrastructure project (2006-2013) was included in the 2006 European Strategic Forum for Research Infrastructures (ESFRI) Roadmap and was aimed at exploring the science and technology of laser-driven fusion schemes, with a special focus on advanced ignition schemes.[11] Another equally important objective of HiPER was to build a sustainable, long-term, basic science programme in a wide range of associated fields and applications. HiPER allowed for the first time to tackle not only target ignition and burning but also reactor relevant issues like chamber design and materials under IFE conditions.

Now that the MJ energy yield demonstrated at NIF confirms ICF as a viable solution for fusion energy, many European scientists are strongly advocating the establishment of a new IFE programme in Europe aimed at pursuing the original HiPER objectives and developing a roadmap to assess the feasibility of an IFE power plant based on burning of deuterium and tritium [HiPER+].[12, 13]

An important mission of this initiative is to design and build an “intermediate” European facility delivering a laser energy of the order of 100 kJ, (which can in a second (but not far) phase will be scaled up to the MJ scale, i.e. full ignition energy. Such intermediate facility dedicated to laser fusion energy will allow to scale up the many years of successful investigations carried out at several laser facilities in Europe, like PALS in Prague, Vulcan and Orion in the UK, LULI in France and Phelix in Germany. At the same time such facility will allow addressing essential issues like development high repetition rate laser and target technologies, development of materials capable of withstanding the extreme conditions of future fusion reactors, and also, similarly to Magnetic Confinement, the issues related to first wall of the vacuum chamber and blanket design
This scientific endeavor involves a fairly large community that is now supported for networking activities by EURO fusion. An intermediate-energy facility, working at repetition rate, will allow the scientific community to establish a science and technology IFE programme in Europe, and to investigate the needs and unlock the challenges of future high-repetition-rate IFE configurations.

In this context, the recent EU large investments in the Extreme Light Infrastructure (ELI) have generated a strong involvement of the European laser industry that is now prepared to respond to the challenges posed by a possible IFE infrastructure. Indeed one important point and a clear change with respect to the past is also that the recent positive results connected to fusion, in both ICF and MCF, have triggered a real “fusion rush” witnessed by the involvement of many industries in fusion projects but also, more surprisingly, by the creation of fusion-dedicated companies in the United States, Europe, Japan, Australia, China and India. Today there are at least 26 companies worldwide working on fusion, either in MCF, ICF or adopting alterative schemes, some of them having raised private funds in the B€ range. While it is clear that some of these companies are proposing unrealistic objectives (i.e. the exploitation of commercial electricity from fusion in the next 10 years), others are based on much more sound scientific projects, and all of them contribute to promote and advance the research in the field.

In conclusion, the moment seems favorable to fast advancing the research on fusion for energy in an unprecedent mix of private and public support. Among the many actors in the field, an increasing role in the international fusion landscape is played by China, both MCF and ICF. China is today an essential partner of the ITER project, private companies are also starting to work on fusion, and Chinese scientists are contributing to the development of ICF through the opening of their laser facilities to the International scientific community (SG II Up in Shanghai, SG III P in MianYang) and by proposing new approaches to direct-drive and indirect drive inertial fusion. In this context, the Physics division of the European Academy of Science is advancing towards the realization of a collaboration agreement with the Chinese Academy of Science and the Chinese Physical Society in the field of fusion in particular and laser and photonics more in general.

Hopefully, EURASC can also play a positive role in supporting all-European initiative like the cited HIPER+ project.

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