

19-20 October 2023
Parque de las Ciencias, Granada, Spain

The 21st International Workshop on Ceramic Breeder Blanket Interactions (CBBI-21)

Organized by





TABLE OF CONTENTS

Welcome	3
Committees	4
Venue	5
Topics	7
Programme schedule	8
Useful information	9
List of participants	11



WELCOME to the biannual event that brings together the community of ceramic breeder scientists and technologists: the **21st International Workshop on the Ceramic Breeder Blanket Interactions (CBBI-21)**.

Organized under the auspices of the *IEA Implementing Agreement on the Nuclear Technology of Fusion Reactors*, and in conjunction with the **International Conference on Fusion Materials (ICFRM-21)**, the **CBBI-21** will be held from **19th to 20th October 2023**, in the beautiful and historical city of **Granada, Spain**.

In the context of the CBBI workshop, researchers, engineers and technologists, involved in the development of the fusion breeding-blanket solid concept, meet to exchange the latest progress in the design, behaviour, testing and modelling of materials and components based on lithium-ceramics.

Closer to the end of ITER, the **CBBI-21** should be the stage to show updates of TBMs development in those countries involved, and a debate forum for its exploitation towards DEMO-like fusion power plants.

The proximity of IFMIF-DONES Granada, as a large materials' testing facility, will allow our community to know first-hand how to be prepared for validating models and testing the behaviour of ceramic breeders with fusion neutrons.

As in previous editions, the **CBBI-21** should serve as a focal point for technical discussions and information exchange improvement of the ceramic breeder blanket as the system for tritium fuel production and energy extraction in a fusion energy reactor.



Committees

Local Organizing Committee

Chair - María González, CIEMAT-LNF, Spain

Fernando Sánchez, Marcelo Roldán, Guiomar Delgado, Elisabetta Carella and Teresa Hernández – CIEMAT-LNF, Spain

José Aguilar and Ruth Maldonado – IFMIF-DONES España, Spain

Program Advisory Board

M. Abdou (UCLA, USA)

M-Y. Ahn (KFE, South Korea)

L. V. Boccaccini (KIT, Germany)

P. Chaudhuri (IPR, India)

X. Chen (CAEP, China)

K. Feng (SWIP, China)

A. Ibarra (CIEMAT & IFMIF-DONES España, Spain)

Y. Kawamura (QST, Japan)

R. Knitter (KIT, Germany)

T. Terai (University of Tokyo, Japan)



Venue



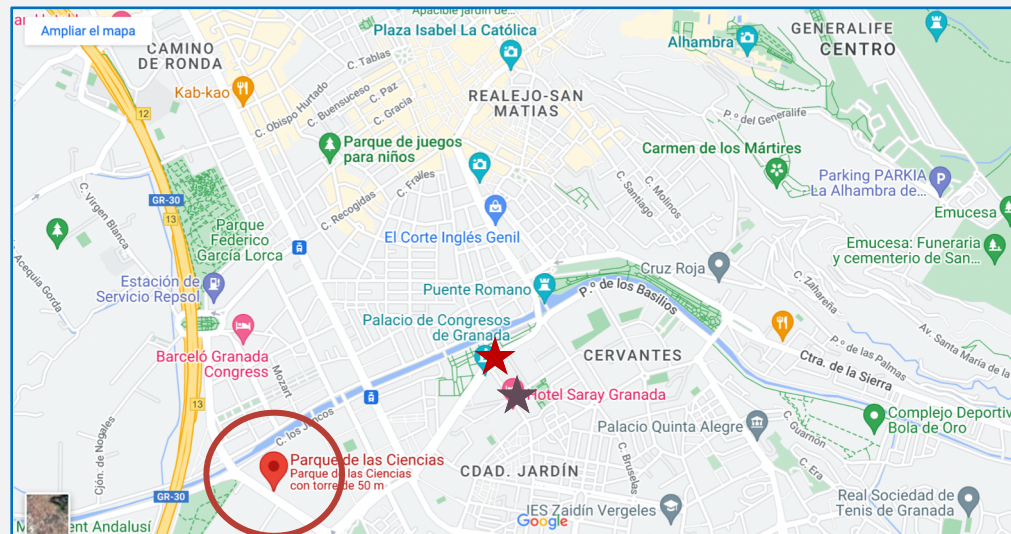
Which can be reached ...

By **foot**: 15 min from the city centre

By **bus**: **Line 5**, **Line 11**, **Line 21**, **Line C5**

By **underground**: Stop at Alcazar del Genil

The workshop will be held at the **Parque de las Ciencias de Granada** (Av. de la Ciencia, s/n, 18006 Granada).





Venue



Registration of participants will be carried out in the desk at the main hall, conveniently identified with the workshop logo on the digital panels above the stand.

Sessions will be held in **CINE3 Auditorium**, which will be properly indicated with a roll-up panel.

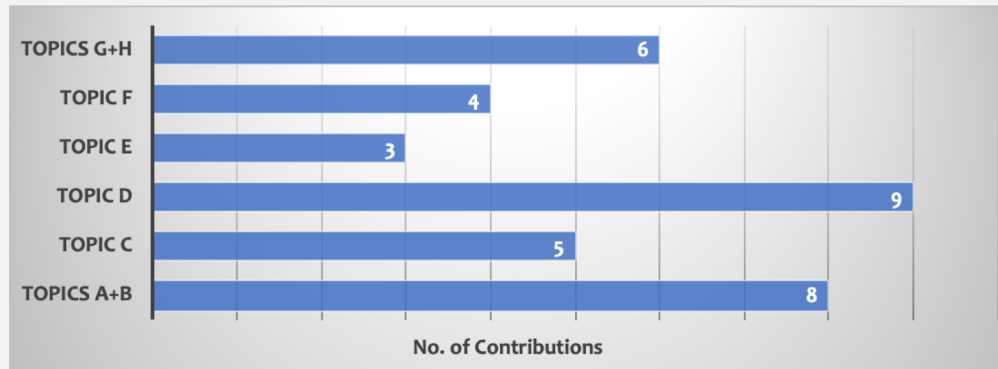


**VENUE
RECEPTION**



Topics

- A. Ceramic breeder pebble production and lithium enrichment methodology
- B. Physical properties and microstructure of ceramic pebbles
- C. Pebble Bed thermo-mechanics: modelling and experiments
- D. Irradiation behaviour
- E. T inventory. T transport simulation and release
- F. Safety issues: lithium corrosion barrier and T permeation coatings
- G. Ceramic breeder ITER Test Blanket Modules
- H. Update on DEMO-like BB designs





THURSDAY, 19th October 2023		
	9:00	WORKSHOP OPENING SESSION
Ceramic pebble production and properties. Chaired by T. Chikada		
1	9:20	INVITED. How to define a specification for ceramic breeder pebbles? <i>Regina Knitter, Milan Zmitko</i>
2	9:40	ACB Pebble Production: Increasing the Capacity of the KALOS Process in Time for ITER <i>Oliver Leys, Julia Leys, Regina Knitter</i>
3	10:00	R&D progress of the tritium breeding functional materials and pebble bed technology for the solid breeding blanket at SWIP <i>Baoping Gong, Juemin Yan, Hao Cheng, Long Wang, Long Zhang, Xiaoyu Wang, Yonglin Feng</i>
4	10:20	System design to fabrication the Core-shell type tritium breeder <i>Young Ah Park, Young Soo Yoon, Yi-Hyun Park</i>
5	10:40	Long-term annealing performance of Li-6 enriched biphasic Li ₄ SiO ₄ /Li ₂ TiO ₃ pebbles <i>Julia Leys, Christina Odemer, Oliver Leys, Regina Knitter</i>
11:00 COFFEE BREAK		
Ceramic pebble production and irradiation behaviour (I). Chaired by R. Knitter		
6	11:20	INVITED: Status of lithium ceramic breeder materials development, characterizations and R&D activities <i>Paritosh Chaudhuri, Harsh Patel, Chirag Sedani, Maulick Pancha, Aroh Shrivastava</i>
7	11:40	Development of Lithium Titanate Ceramic Pebbles By Freeze Granulation and Freeze Drying Method <i>Aroh Shrivastava, Paritosh Chaudhuri</i>
8	12:00	Fabrication and characteristics of Li ₂ TiO ₃ pebbles fabricated by using powder injection molding process <i>Yi-Hyun Park, Young Ah Park, Young Soo Yoon, Mu-Young Ahn</i>
9	12:20	Results of neutron irradiation experiments with Li ₄ SiO ₄ /Li ₂ TiO ₃ at the WWR-K research reactor <i>Timur Kulsartov, Zhanna Zaurbekova, Regina Knitter, Gunta Kizane, Julia Leys, Asset Shaimerdenov, Saulet Askerbekov, Magzhan Aitkulov, Yevgen Chikhray, Inesh Kenzhina</i>
10	12:40	In-situ neutron irradiation experiment for EU reference ceramic breeder material. <i>Julia Leys, A. Shaimerdenov, Sh. Gizatulin, T. Kulsartov, Y. Chikhray, I. Kenzhina, M. Ionescu-Bujor, R. Knitter</i>
13:00 LUNCH TIME		
ITER TBMs and Compatibility issues. Chaired by P. Chaudhuri		
11	14:00	INVITED. The HCCP Test Blanket Module: Current Status in Development and Qualification of Ceramic Breeder Material and an Overview of Open Issues <i>Milan Zmitko, Regina Knitter, Alessandro G. Spagnuolo</i>
12	14:20	Progress of design and analyses of CN HCCB TBM for ITER <i>Xinghua Wu, Qixiang Cao, Long Zhang, Xiaoyu Wang</i>
13	14:40	ORNL Status and Progress in Research on Ceramic Breeder Blanket Materials <i>Xiao-Ying Yu, Yutai Katoh, Takaaki Koyanagi, German Samolyuk, and Weicheng Zhong</i>
14	15:00	Development of a novel breeding blanket using the solid-type PbLi ₂ eutectic alloy for CFETR <i>Keqiang Jiang, Qirun Wu, Lei Chen, Songlin Liu</i>
15	15:20	Corrosion of F82H in ceramic breeder pebble bed and its effect on hydrogen permeation <i>Keisuke Mukai, Shunsuke Kenjo, Naoto Iwamatsu, Bakr Mahmoud, Takumi Chikada, Juro Yagi, Satoshi Konishi</i>
15:40 AFTERNOON BREAK		
16	16:00	INVITED: Microstructural change and deuterium permeation of ZrO ₂ -coated steel exposed to solid tritium breeder pebbles <i>Takumi Chikada, Wataru Matsuura, Julia Leys, Marcin Rasinski, Suguru Nakano, Jae-Hwan Kim, Taehyun Hwang, Tsuyoshi Hoshino, Masaru Nakamichi</i>
17	16:20	Corrosiveness of solid tritium breeders to RAFM steel considering evaporated lithium compound and irradiation. <i>Qiang Qi, Chi Wang, Yingchun Zhang, Haishan Zhou, Songlin Liu, Guang-Nan Luo</i>
18	16:40	Microstructure, corrosion behavior, and mechanical properties of ARAA after compatibility test with Li ₂ TiO ₃ pebbles <i>Yunsong Jung, Yi-Hyun Park, Duck Young Ku, Youngah Park, Mu-Young Ahn, Seungyon Cho</i>
17:00 Round table "Ceramic breeding pebbles: production and behaviour". Chaired by M. Zmitko and K. Mukai		
DAY'S SESSION CLOSING		

FRIDAY, 20th October 2023		
T Inventory and Safety issues. Chaired by M. Roldán		
1	9:00	INVITED. Design update of the European DEMO Helium Cooled Pebble Bed breeding blanket <i>Guangming Zhou, Anoop Rethesh, Jin Hun Park, Ion Cristescu, Francisco A. Hernández, Christina Köhly</i>
2	9:20	Tritium transport model of lithium-based ceramic pebbles in Ecosimpro. <i>Carlos Moreno, Almudena Rueda, Jenifer Serna, Fernando R. Ugorri</i>
3	9:40	Application of tritium transport model on a DEMO breeding blanket system. <i>Yonghee Lee, Alice Ying, Mu-Young Ahn, Hyung Gon Jin, Seong-bo Moon</i>
4	10:00	Study on Hydrogen Isotope Permeation Behavior of High-Entropy Alloys Coatings. <i>Long Wang, Zhihao Hong, Yonglin Feng, Baoping Gong, Xiaoyu Wang, Long Zhang</i>
5	10:20	Modelling transport of fragmentation and dust particles in granular tritium breeder material inside fusion reactors. <i>Dario Passafiume, Marc Kamlah</i>
6	10:40	Development of a system-level code and application to the tritium transport for the water cooled ceramic breeder blanket. <i>Songlin Liu, Xueli Zhao, Lei Chen</i>
11:00 COFFEE BREAK		
Pebble Bed Thermomechanics. Chaired by F. Sánchez		
7	11:20	INVITED: Plans for Breeding Blanket Test Facility in KFE <i>Mu-Young Ahn, Min Ho Chang, Yoo Lim Cheon, Seungyon Cho, Moses Chung, Hyoseong Gwon, Namil Her, SeongHee Hong, Hyun Wook Kim, Sungjin Kwon, Jae-Uk Lee, Yonghee Lee, Youngmin Lee, Sungbo Moon, Yi-Hyun Park</i>
8	11:40	Effects of vibration conditions, spatial confinement and friction on mixing and segregation characteristics of mixed pebble beds for CFETR WCCB blanket. <i>Yong Liu, Lei Chen, Cong Wang, Chongyang He, Songlin Liu</i>
9	12:00	Thermal, uniaxial compression and flow simulations of packed beds of spherical and elliptical shaped pebbles. <i>Harsh Patel, Maulik Panchal, Paritosh Chaudhuri</i>
10	12:20	A study of purge flow characteristics and effective thermal conductivity of pebble bed: Experiments and Simulation by ANN <i>Chirag Sedani, Maulik Panchal, Paritosh Chaudhuri</i>
11	12:40	Simulation of Mechanical, Thermal, and Flow Characteristics of Pebble Beds for Solid-type Ceramic Breeding Blanket <i>Youngmin Lee, Dongwoo Sohn, Mu-Young Ahn, Yi-Hyun Park, Seungyon Cho</i>
13:00 LUNCH TIME		
Ceramic pebble irradiation behaviour (II). Chaired by J. Leys		
12	14:00	INVITED: The scope of the future IFMIF-DONES facility and how it can be applied in breeder ceramics <i>Santiago Becerril, in behalf of the IFMIF-DONES España team</i>
13	14:20	Fabrication and tritium release properties of advanced tritium breeder: Li ₄ (Si,Ti) _{0.4} ceramic pebble <i>Juemin Yan, Baoping Gong, Hao Cheng, Long Zhang, Xiaoyu Wang, Xiaojun Chen, Chengjian Xiao</i>
14	14:40	Influence of various radiation types on radiation-induced processes in lithium orthosilicate-based ceramic breeder materials. <i>Arturs Zarins, Anna Ansone, Mareks Senko, Janis Cipa, Andris Antuzevics, Liga Avotina, Larisa Baumanne, Gunta Kizane, Maria Gonzalez, Julia M. Leys, Regina Knitter</i>
15	15:00	Secondary Ion Mass Spectrometry (SIMS) as an important tool to track compositional variations from ion-implanted and ion-damaged Advance Ceramic Breeder (ACB) compositions. <i>Guilomar Delgado, María González</i>
16	15:20	TEM studies in support of the high radiation resistance of ion-irradiated advanced ceramic breeders. <i>Marcelo Roldán, María González, Fernando Sánchez</i>
15:40 AFTERNOON BREAK		
17	16:00	Is H-isotope effectively trapped in structural defects of ion-beam damaged ceramic breeders? <i>María González, Marta Malo, Alejandro Morroño, Arturs Zarins, Gunta Kizane, Marcelo Roldán, Fernando Sánchez</i>
16:20 Round table "Updating HCPB BB towards ITER and DEMO". Chaired by G. Zhou and M-Y Ahn		
WORKSHOP CLOSING SESSION		



Useful Information

INSTRUCTIONS to SPEAKERS

Authors of accepted abstracts must give an ORAL PRESENTATION in **CINE3 Auditorium** at **Parque de las Ciencias de Andalucía, Granada, Spain**.

For the presentation, the speaker's registration is required in advance. Registration will be open until **Monday, 9th October 2023**.

The room will be equipped with a PC with Windows 10 operating system and Microsoft Office 2019, projector and screen. Presentations cannot be made from a personal laptop.

The presentation should be prepared in PowerPoint, following a 16:9 format.

Use an appropriate number of slides, keeping in mind that the presentation should last only 15 minutes, followed by 5 minutes for open questions to the speaker. In order to avoid stretching out a tight two-day schedule, the presentation time will be strictly observed by the session chair. Therefore, a maximum of 15 slides is highly recommended. If using a Macintosh to prepare your PowerPoint presentation, please ensure that it works on a Windows 10 PC. Videos must be embedded in the PowerPoint, not linked to a website.

Presentations as a ppt or pdf document must be sent to

CBBI-21@ciemat.es

well in advance, to be ready on the day of the session.



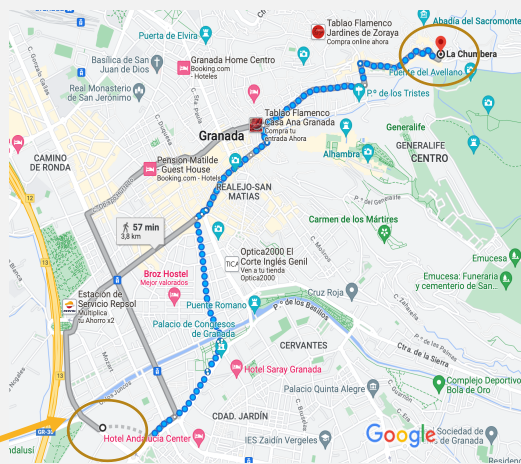
Useful Information

The **Parque de las Ciencias de Andalucía** is a science museum. Showing the workshop badgets, the free exhibitions can be visited, except those requiring pre-registration. Among the free ones, the newly opened IFMIF-DONES exhibition might be particularly interesting.

A **typical Spanish dinner (tapas)** with a **flamenco show** has been organized at La Chumbera restaurant (Camino del Sacromonte, 107, 18010 Granada) for Thursday 19 October.



Workshop venue
Parque de las Ciencias





List of Participants

Mu-Young Ahn, Korea Institute of Fusion Energy, Republic of Korea

Anna Anson, University of Latvia, Institute of chemical physics, Latvia

Saulet Askerbekov, Institute of Nuclear Physics, Kazakhstan

Pedr Charlesworth, University of Oxford, United Kingdom

Paritosh Chaudhuri, Institute for Plasma Research (IPR), India

Takumi Chikada, Shizuoka University, Japan

Guiomar Delgado Soria, CIEMAT, Spain

María González, CIEMAT, Spain

Ángel Ibarra, Consorcio IFMIF-DONES España, Spain

Kecheng Jiang, Institute of Plasma Physics, Hefei Institutes of Physical Science, Chinese Academy of Sciences, China

Yunsong Jung, Korea Institute of Fusion Energy, Republic of Korea

Inesh Kenzhina, Kazakh-British Technical University, Kazakhstan

Regina Knitter, Karlsruhe Institute of Technology, Germany

Yonghee Lee, Korea Institute of Fusion Energy, Republic of Korea

Youngmin Lee, Korea Institute of Fusion Energy, Republic of Korea

Julia Leys, Karlsruhe Institute of Technology, Germany

Oliver Leys, Karlsruhe Institute of Technology, Germany

Songlin Liu, Institute of Plasma Physics, Hefei Institutes of Physical Science, Chinese Academy of Sciences, China

Yong Liu, Institute of Plasma Physics, Chinese Academy of Sciences (ASIPP), China

Jorge Maestre, Universidad de Granada, Spain



Roth Markus, Focused Energy GmbH, Germany
Keisuke Mukai, National Institute for Fusion Science, Japan
Jin Hun Park, Karlsruhe Institute of Technology, Deutschland
Yi-Hyun Park, Korea Institute of Fusion Energy, Republic of Korea
Young Ah Park, Korea Institute of Fusion Energy, Republic of Korea
Dario Passafiume, Karlsruhe Institute of Technology, Germany
Harsh Patel, Institute for Plasma Research (IPR), India
Qiang Qi, Institute of Plasma Physics, Chinese Academy of Sciences, China
Marcelo Roldán, CIEMAT, Spain
Fernando Sánchez, CIEMAT, Spain
Chirag Sedani, Institute for Plasma Research (IPR), India
Asset Shaimerdenov, Institute of Nuclear Physics, Kazakhstan
Aroh Shrivastava, Institute for Plasma Research (IPR), India
Charlie Thorogood, University of Sheffield, United Kingdom
Long Wang, Southwestern Institute of Physics (SWIP), China
Xinghua Wu, Southwestern Institute of Physics (SWIP), China
Xiao-Ying Yu, Oak Ridge National Laboratory (ORNL), USA
Arturs Zarins, Daugavpils University, Faculty of Natural Sciences and Health Care, Latvia
Zhanna Zaurbekova, Kazakh-British Technical University, Kazakhstan
Guangming Zhou, Karlsruhe Institute of Technology (KIT), Germany
Milan Zmitko, Fusion for Energy (F4E), Spain





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Dr. María González
CIEMAT-LNF. Avda, Complutense, 40
28040 Madrid, Spain

