DELIVERABLE D5.4

DISSEMINATION AND ACADEMY-INDUSTRY DAY REPORT AND PLANNING, 2ND PERIOD

Work package	Related tasks	Dissemination level	Document nature	Estimated delivery date	Status
WP5	T5.3, T5.4	Public	Report	31/03/2020	submitted

Editor	Contributing partners	Reviewers
Francesca Moresco (TUD) Christian Joachim (CNRS)	TUD CNRS	Katharina Amsel (TUD)

MEMO – Mechanics with molecules
MEMO has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 766864.

DOCUMENT HISTORY

Version	Date	Author/editor	Description
0.1	23/03/2020	Francesca Moresco (TUD)	First version
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1.0	03/04/2020	Francesca Moresco (TUD)	Final version

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EXECUTIVE SUMMARY

MEMO aims to communicate and disseminate the project results within the scientific and industrial community as widely as possible and also to a large public via the NanoCar Race. This report summarizes the dissemination activities in months M13 – M30 and provides a plan for these activities during the remaining 18 months of project (M31 – M48).

1. DISSEMINATION STRATEGY

GENERAL PRINCIPLES

Dissemination and communication are key activities for the success of the MEMO project. The work package 5 manages the corresponding activities. All consortium partners are aware of and committed to ensure good dissemination and communication of the results during and after the course of the project to achieve its sustainable impact. The MEMO consortium is committed to an active dissemination strategy of the project´s aims and outcomes, following the principles of **Open Science**.

TARGET GROUPS

MEMO strives for a **target-group tailored communication**. A stakeholder analysis has identified the following target audiences for dissemination activities:

- Industry, such as clock industry, microelectronics industries, spatial industries, energy provider's large companies, as well as many high-tech SMEs
- Scientific community, especially in the research fields of surface science, chemical synthesis, nanoscience
- Students, the project will be presented during regular lectures and invited guest lectures at high schools; In particular, the Nanocar Race is very attractive for the young generation
- General public (via, for example, the Nanocar Race)

DISSEMINATION TOOLS

To maximize the outreach of the project and to allow for a target group specific communication, MEMO makes use of a mix of different communication tools:

- Project website
- Press releases
- Science-to-public initiatives ("Dresden Science Night", science fairs, and diverse local Open Day)
- Scientific publications
- Contributions at international conferences
- Organization of scientific workshops
- Academy-Industry Days
- International molecule car race ("Nanocar Race")
- Publication of the project on Research Gate

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2. IMPLEMENTATION OF DISSEMINATION ACTIVITIES

PROJECT IDENTITY

MEMO has its own corporate design, which includes the abbreviation MEMO, a logo, dedicated colours and fonts. Templates are available for PowerPoint presentations, meeting and project documentation etc. These are consistently used by all partners for external communication activities. CI compliant slides for presenting the MEMO project outside the consortium have been developed and are available for all consortium members.

***Figure 1**. Logo for the MEMO project*

PROJECT WEBSITE & SOCIAL MEDIA

To **target a broad audience** MEMO has set up a **website** that contains information about the project progress (cf. D5.1). The MEMO website can be accessed through the following link: www.memo-project.eu
A QR code (Quick Response) leading to the MEMO website is included in all printed communication of MEMO.

***Figure 2**. QR Code for the MEMO website*

MEMO website contains a general part describing the goal of the project and the participating groups. News are made available not only under the relevant top menu, but are now also visible on all sub-pages (fig. 3). They are continuously being updated. Furthermore, the following sections receive regular updates:

- Public events
- Scientific publications
- Public deliverables
- Nanocar Race II

As the 2nd Nanocar Race is approaching, information accompanying the Race steadily increases and the relevant section provides current updates.

***Figure 3**. Screenshot of the MEMO website*

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Besides the project website it is planned to use social media channels to better steer an accelerated communication connected to the Nanocar Race II. To enable real-time releases and communication with target groups, Twitter has been chosen as the most suitable one for MEMO and will be set up in the second half of the project.

PRESS RELEASES AND OTHER NON-SCIENTIFIC PUBLICATIONS

Press releases were issued by TUD, GRAZ and CSIC with regard to scientific MEMO related developments and connected to NanoCar Race II. After publication on press releases on institutional homepage (e.g. https://tu-dresden.de/tu-dresden/newsportal/news/weltrekord-bei-der-erforschung-von-p-elektronenstrukturen-forschungsteam-gelingt-erstmals-die-synthese-von-dodecacen?set_language=en), local newspapers and/or scientific journals picked up and published own news (e.g. https://www.chemeurope.com/en/news/1165011/scientists-succeeds-in-producing-dodecacene-for-the-first-time.html). The approaching Nanocar Race II as well as the finalisation of MEMO project is likely to increase the press coverage – not only regarding publications but also other communication channels.

***Table 1**. List of MEMO published and planned non-scientific publications (planned publications in italics)*

Institution	Type of Activity	Short Description (Relevance for MEMO)	related WP	Date	
GRAZ	Press release	„Mit Licht Moleküle gezielt bewegen“ / Kleine Zeitung	WP1-WP2	11/2018	M14
GRAZ	Press release	Cover page of Angewandte Chemie International Edition (Volume 57, No 46, Nov 2018)	WP1-WP2	11/2018	M14
GRAZ	Press release	"Die Stadt Graz in einzelnen Silberatomen“, Kleine Zeitung, 1.11.2018	WP1-WP2	11/2018	M14
CNRS	Non-scientific and non-peer-reviewed publication (popularised publication)	Talk to broad audience: Molecular wheels, vehicles and motors, 6th Electronic Device forum Kyoto, Japan	WP2	10/2019	M25
GRAZ	Press release	Election of the article „How to control single-molecule rotation” as an “Editors’ Highlight” by Nature Communications	WP1-WP2	12/2019	M27
CISC	Video/Film	Talk in Tabakalera "Exploring the nanoworld in a nanocar" by C. Joachim and N. Lorente	WP5	01/2020	M28
CSIC	Press release	"La carrera de coches mas minusculua". Noticias de Gipuzkoa	WP5	02/2020	M29
TUD	Press release	World record in research on π-electron structures: Team succeeds in producing dodecacene for the first time / www.tu-dresden.de, www.cfaed.tu-dresden.de, www.chemeurope.com	WP1	02/2020	M29
TUD	Flyer	Open Talk Nanocar race	WP5	03/2020	M30
CNRS	*Communication Campaign (e.g. Radio, TV)*	*Broadcast of NanoCar Race II*	*WP5*	*tbc*	*M33*

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***Figure 4**. Screenshots of the MEMO press releases*

***Figure 5**. Flyer for Open Talk presenting "Nanocar Race II"*

***Figure 6**. Recording of public presentation at the San Sebastian town Cultural Center Tabakalera "Exploring the nanoworld in a nanocar" by C. Joachim and N. Lorente published via Youtube (https://www.youtube.com/watch?v=picvvKbxwcg&feature=youtu.be)*

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SCIENTIFIC PUBLICATIONS

The results of MEMO are published in high-ranked, peer-reviewed scientific journals. When deciding for a journal and/or conference for publication of project ideas and results, the MEMO consortium takes into consideration reputation and quality (peer review, impact factor) but also offered open access options. However, it is not always be possible to publish the golden way, i.e. publishing immediately in open access mode via a peer-reviewed Open Access Journal as not all top-tier conferences and journals offer such an option. In these cases, we used green open access that hosts most of the top-tier journals of interest in our research domain. Publishing the green way means archiving and depositing of the published article or final peer-reviewed manuscript by the author in an online repository before, alongside or after its publication, depending on the publishers' Open Access policies. The following repositories are being used for providing green open access:

- HAL Archives Ouvertes (https://hal.archives-ouvertes.fr/) – offered by CNRS
- Arxiv (https://arxiv.org/) – offered by Cornell University
- QCOSA (https://qucosa.de/) – offered by Saxon State and University Library Dresden

***Table 2**. List of MEMO published and planned articles in scientific journals (planned publications in italics)*

Institution	Authors, Title, Journal	DOI	Date of Publication	
TUD	T. Lehmann, A. Croy, R. Gutierrez, G. Cubinerti: Time-dependent framework for energy and charge currents in nanoscale systems, Chemical Physics Volume 514, 25 October 2018, Pages 176-182	doi.org/10.1016/j.chemphys.2018.01.011	10/2018	M13
TUD	F. Eisenhut, J. Meyer, J. Krüger, R. Ohmann, G. Cuniberti and F. Moresco, Inducing the controlled rotation of single o-MeO-DMBI molecules anchored on Au(111), Surf. Sci., (2018)	doi.org/10.1016/j.susc.2018	12/2018	M15
CNRS / UT3	C. Kammerer, G. Erbland, Y. Gisbert, T. Nishino, K. Yasuhara and G. Rapenne: Biomimetic and Technomimetic Single Molecular Machines, Chemistry Letters, Vol. 48, No. 4 (2019)	doi.org/10.1246/cl.181019	01/2019	M16
TUD / CNRS	H.H. Lin, A. Croy, R. Gutierrez, C. Joachim, G. Cuniberti: Current-induced molecular rotation in open quantum system: a rotational Anderson-Holstein model, J. Phys. Commun. 3 025011.	doi.org/10.1088/2399-6528/ab0731	02/2019	M17
TUD	D. Skidin, F. Eisenhut, M. Richter, S. Nikipar, J. Krüger, D. Ryndyk, R. Berger, G. Cuniberti, X. Feng, F. Moresco, 93. On-surface synthesis of nitrogen-doped nanographenes with 5-7 membered rings, Chem. Commun. 55, 4731-4734 (2019)	doi.org/10.1039/C9CC00276	04/2019	M19
CSIC	N. Kocic, D. Blank, P. Abufager, N. Lorente, S. Decurtins, Si-X Liu, J. Repp: Implementing functionality in molecular self-assembled monolayers. Nano Letters 19, 2750 (2019), 10.1021/acs.nanolett.8b03960	doi.org/10.1021/acs.nanole	04/2019	M19
CNRS	W.H. Soe, S. Srivastava, C. Joachim: A Train of Single Molecule-Gears, The Journal of Physical Chemistry Letters, 10/2019	doi.org/10.1021/acs.jpclett.9b02259	10/2019	M25
GRAZ	G.J. Simspon, V. García-López, A.D. Boese, J.M. Tour, L. Grill: How to control single-molecule rotation, Nature Communications, 10/2019	doi.org/10.1038/s41467-019-12605-8	10/2019	M25
CNRS / UT3	G. Erbland, S. Abid, Y. Gisbert, N. Saffon-Merceron, Y. Hashimoto, L. Andreoni, T. Guérin, C. Kammerer, G. Rapenne: Star-shaped ruthenium complexes as prototypes of molecular gears, Chemistry A European Journal, 10.1002/chem.201903615	doi.org/10.1002/chem.201903615	10/2019	M25
CSIC	B. Verlhac, N. Bachellier, L. Garnier, M. Ormaza, P. Abufager, R. Robles, M.-L. Bocquet, M. Ternes, N. Lorente, L. Limot: Atomic-scale spin sensing with a single molecule at the apex of a scanning tunneling microscope, Science 366, 623 (2019)	doi.org/10.1126/science.aax	11/2019	M26
CNRS / UT3	Y. Gisbert, S. Abid, G. Bertrand, N. Saffon-Merceron, C. Kammerer, G. Rapenne: Modular synthesis of pentaarylcyclopentadienyl Ru-based molecular machines via sequential Pd-catalysed cross couplings. Chem. Commun. 55, 14689–14692 (2019).	10.1039/c9cc08384g	11/2019	M26
CSIC / CNRS	W.H. Soe, C. Manzano, R. Robles, N. Lorente, C. Joachim: On-Surface Atom by Atom Assembled Aluminium Bi-Nuclear Tetrabenzophenazine Organo-Metallic Magnetic Complex, Nano letters 20, 384 (2020)	doi.org/10.1021/acs.nanole	12/2019	M27

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Institution	Authors, Title, Journal	DOI	Date of Publication	
TUD / CNRS	F. Eisenhut, T. Kühne, F. García, S. Fernández, E. Guitián, D. Pérez, G. Trinquier, G. Cuniberti, C. Joachim, D. Peña, F. Moresco, Dodecacene Generated on Surface: Reopening of the Energy Gap, ACS Nano 14, 1011–1017 (2020)	doi.org/10.1021/acsnano.9b	12/2019	M27
TUD / CNRS	F. Eisenhut, T. Kühne, F. García Saleta Fernández, E. Guitián Dolores Pérez, G. Trinquier, G. Cuniberti, C. Joachim, D. Peña, F. Moresco: Dodecacene Generated on Surface: Reopening of the Energy Gap	doi.org/10.1021/acsnano.9b	12/2019	M27
GRAZ	L. Grill, S. Hecht: Covalent on-surface polymerization, Nature Chemistry, 12, 115, 2020	doi.org/10.1038/s41557-01	01/2020	M28
CSIC	V. Zobač, R. Robles, N. Lorente: Directionality in van der Waals Interactions: The Case of 4-Acetylbiphenyl Adsorbed on Au (111), J. Phys. Chem. C 124, 4545 (2020)	doi.org/10.1021/acs.jpcc.9b	02/2020	M29
TUD / CNRS	H.-H. Lin, A. Croy, R. Gutierrez, C. Joachim, and G. Cuniberti: Mechanical Transmission of Rotational Motion between Molecular-Scale Gears, Phys. Rev. Applied 13, 034024	doi.org/10.1103/PhysRevApplied.13.034024	03/2020	M30
TUD / CNRS	*F. Eisenhut, T. Kühne, J. Monsalve, S. Srivastava, D. A. Ryndyk, G. Cuniberti, O. Aiboudi, F. Lissel, V. Zobac, R. Robles, N. Lorente, C. Joachim and F. Moresco, Exclusive One-Way Rotation of a Single Molecule-Rotor on a Gold Surface, SUBMITTED*	*tbc*	*planned*	*planned*
LIEGE/CNRS	*X. Li, D. Sluysmans, Y. Gisbert, C. Kammerer, G. Rapenne, A.-S. Duwez*	*tbc*	*planned*	*planned*
CNRS / UT3	*S. Abid, G. Erbland, C. Kammerer, G. Rapenne: Prototypes of molecular gears with an organometallic piano-stool architecture, submitted (book chapter)*	*tbc*	*Planned*	*planned*
CNRS / UT3	*Y. Gisbert, A.M. Sirven, G. Rapenne, C. Kammerer: Design and synthesis of a nano-winch, submitted (book chapter)*	*tbc*	*Planned*	*planned*
CNRS / UT3	*T. Nishino, H. Takeuchi, F. Lim, K. Yasuhara, C. Martin, C. Kammerer, G. Rapenne: A dipolar nanocar based on a dissymmetric porphyrin platform, in preparation.*	*tbc*	*Planned*	*planned*
CNRS / UT3	*S. Abid, C. Kammerer, G. Rapenne: Synthesis of a family of dissymmetric pentaarylcyclopentadienyl Ru-based molecular gears, in preparation.*	*tbc*	*Planned*	*planned*
CSIC/ CNRS/ TUD	*R. Robles, V. Zobac, K. H. Au Yeung, F. Moresco, C. Joachim, N. Lorente: Supramolecular Chemistry Based on 4-Acetylbiphenyl on Au(111). Submitted to PCCP*	*tbc*	*submitted*	*submitted*
CSIC	*Mohammed SG Mohammed, Luciano Colazzo, Roberto Robles, Ruth Dorel, Antonio M Echavarren, Nicolás Lorente, Dimas G de Oteyza: Electronic Decoupling of Polyacenes from the Underlying Metal Substrate by sp3 Carbon Atoms, arXiv:2003.00748*	tbc	*submitted*	*submitted*

The proceedings of the first MEMO International Workshop "Building and Probing Small" described in the next section, will be published as **volume 13 of the Springer book series "Advances in Atom and Single Molecule Machines"** created CNRS Toulouse in 2012 with 12 volumes already published (http://www.springer.com/series/10425). The title of the book is "Building and Probing Small for Mechanics", the editor is Christian Joachim (CNRS). The following chapters from MEMO partners and external scientist are under preparation:

- **Introduction: from the Anthycytera astronomical clock to miniature mechanical calculators**
  P. Abeilhou, C. Joachim (MEMO Partner P2 CNRS)
- **Microfabrication of gears and ratchets for microscale mechanical calculators**
  C. Bourgerette, L. Noé, S. Pinaud, C. Joachim (MEMO Partner P2 CNRS)
- **Fabricating solid state gears at the nanoscale**
  D. Mailly, G. Faini (MEMO Partner P2 CNRS)
- **Prototypes of molecular gears with an organometallic piano-stool architecture**

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S. Abid, G. Erbland, C. Kammerer, G. Rapenne (MEMO Partner P2 CNRS)

- **Design and synthesis of a nano-winch**
  Y. Gisbert, A.M. Sirven, G. Rapenne, C. Kammerer (MEMO Partner P2 CNRS)
- **Chemical anchoring of molecular rotors**
  O. Aiboudi, F. Lissel (external contribution)
- **Rotation of Adsorbed molecules induced by tunneling electrons**
  N. Lorente, C. Joachim (MEMO Partners P2 CNRS and P3 CSIC)
- **Anchoring molecular rotors by on-surface synthesis**
  T. Kühne, K.H. Au Yeung, F. Eisenhut, F. Moresco (MEMO Partner P1 TUD)
- **Transmission of Rotational Motion between Molecule-Gears**
  W.H. Soe, S. Srivastava, C. Joachim (MEMO Partner P2 CNRS)
- **A simple train of PF3 molecule-gears and its mechanics**
  S. Srivastava, W.H. Soe, C. Joachim (MEMO Partner P2 CNRS)
- **Modelling of Molecule-Scale Single Gears and Gear Trains**
  H.-H. Lin, A. Croy, R. Gutierrez, G. Cuniberti (MEMO Partner P1 TUD)
- **Five minutes in the life of a molecular shuttle: near-equilibrium measurements of shuttling dynamics with optical tweezers**
  K. M. Lemishko, T. Naranjo, E.M. Pérez, B. Ibarra (external contribution)
- **Motion and Nanomechanical effects in Supramolecular Catalysts**
  A. Goswami, I. Paul, P.K. Biswas, M. Schmittel (external contribution)

A second book of the same Springer series is planned for the last period of the MEMO project and it will be related to Nanocar Race II (see next section).

CONFERENCES, WORKSHOPS AND OTHER EVENTS

MEMO has organized the first edition of the *Building and Probing Small symposium*, concerning the design, synthesis and characterization of functional molecules in supramolecular chemistry and biology. It brought together an outstanding yet diverse group of chemists and biophysicists. We were committed to making this event fully international, and we are happy to have attracted participants from 15 countries across America, Asia, and Europe. The symposium took place on 25 – 27 March 2019 in the prestigious rooms and gallery of the Palace of the Academies in Brussels.

We had a great line-up of invited speakers, among which Nobel Chemistry Laureate Sir Fraser Stoddart and many world-leaders in molecular machines, supra-molecular chemistry, and single-molecule force spectroscopy. The programme included 5 plenary lectures, 11 keynote lectures, short communications, and a poster session with 29 posters. In total, we had 58 scientific contributions and 77 participants.

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***Figure 7**. Homepage of the MEMO Workshop "Building and Probing Small".*

***Figure 8**. Group photo of the participants to the MEMO Workshop "Building and Probing Small".*

In addition, **participation in conferences, symposia and workshops** is also a significant part of the project's work (cf. Table 3). Whenever possible, the MEMO project accepts invitations to present posters or give talks in addition to accepted research papers and at exhibition booths. In this way, contact to the worldwide community and dissemination of results is ensured. A corporate project presentation has been prepared and is regularly updated to facilitate and foster manifold project presentation. Plans for upcoming events have already or are likely to be affected by the Covid-19 pandemic impairments (e.g. The cancelation of the MEMO session at the DPG Spring Meeting of the Condensed Matter Section, the cancelation of the Phoenix MRS conference in the US organized by MEMO partners and where MEMO was largely invited). However, MEMO strives to resume conference and workshop activities as quickly as possible while focusing on less effected dissemination channels.

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The participation of **science-to-public initiatives** is regularly taking place in all partner institutions. Particularly the "Dresden Science Night" – attracting up to 40.000 visitors per year – represents a major dissemination opportunity directed not only towards the general public, but also towards politicians and scientists (particularly of different disciplines). During the last "Dresden Science Night" on 14 June 2019 (www.wissenschaftsnacht-dresden.de/) the MEMO activities where presented during a session called "Molecular Machines", including laboratory visit, posters and short presentations.

***Figure 9**. Logo of the Dresden Science Night.*

The event had the following program (translated from German): "Molecular machines: Take a look with us at the scanning tunnel microscope to see how we work on the smallest machines made of molecules. Miniaturization does not stop anywhere. We present a scanning tunneling microscope, which we use for the visualization and manipulation of individual atoms and molecules. We are thus working on the smallest machines that consist of individual molecules and can function as electronic components of the future."

For the next Dresden Science Night in June 2020 we plan a dedicated event for the presentation of Nanocar Race II with movies, laboratory visits and games for children. We hope that this event will not be affected by the Covid-19 pandemic impairments. The corresponding one organized by the MEMO partner P4 Graz for May 2020 was already canceled.

***Table 3**. Dissemination events with MEMO contribution (planned events in italics)*

Institution	Type of Activity	Short Description (Relevance for MEMO)	related WP	Date	
GRAZ	Participation to a Conference	Keynote lecture at the 5th International Conference on Physical and Theoretical Chemistry/Title: "Manipulation of Single Molecules at Surfaces: Wires, Switches and Motors"/Edinburgh	WP1-WP2	10/2018	M13
GRAZ	Participation to an Event other than a Conference or a Workshop	Invited talk at the Institute of Physical Chemistry/Polish Academy of Sciences/Title: "Manipulation of functional molecules - from single atoms to the Nanocar Race"/Warsaw, Poland	WP1-WP2	11/2018	M14
GRAZ	Participation to an Event other than a Conference or a Workshop	Invited talk at the "Mikro- und Nanoanalytik Seminar"/Title: "Functional molecules at the atomic scale: Imaging, manipulation and assembly"/Institute of Electron Microscopy and Nanoanalysis (FELMI)/Graz, Austria	WP1-WP2	01/2019	M16
LIEGE	Organisation of a Workshop	1st MEMO Workshop (Brussels): "Building and Probing Small"	WP5	03/2019	M18
GRAZ	Participation to a Workshop	Keynote speaker at the Symposium "Building and Probing Small"/"Manipulation of Single Molecules: Wires, Switches and Motors"/Brussels	WP1-WP2	03/2019	M18
GRAZ	Participation to a Workshop	Contributed talk at the Building and Probing Small International Symposium/Ttile: "How to control single-molecule rotation"/Palace of the Academies/Brussels, Belgium	WP1-WP2	03/2019	M18

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Institution	Type of Activity	Short Description (Relevance for MEMO)	related WP	Date	
LIEGE	Participation to a Workshop	Building and Probing small symposium, 25-27 March 2019. 2 Poster presentations	WP2	03/2019	M18
TUD	Participation to a Conference	DPG Spring Meeting Regensburg (Germany), poster "Anchoring strategies for a molecular gear on Au(111)"	WP1	03/2020	M18
TUD	Participation to a Conference	DPG Spring Meeting Regensburg (Germany), poster Epiminotetracenes on Au(111)	WP1-WP3	03/2020	M18
TUD	Participation to a Conference	DPG Spring Meeting Regensburg (Germany) oral presentation "Inducing the Controlled Rotation of Single o-MeO-DMBI Molecules Anchored to Au(111)"	WP1-WP3	03/2020	M18
CNRS	Organisation of a Workshop	"Building and Probing Small", Brussels, Belgium	WP1-WP2	03/2019	M18
GRAZ	Participation to a Conference	Contributed talk at the Spring Meeting of the German Physical Society/Title: "Rotation of a Single-Molecule Dipole"/University of Regensburg/Regensburg, Germany	WP1-WP2	04/2019	M19
TUD	Participation to a Workshop	Symposium "Building and probing small" Brussels, Belgium oral presentation"The MEMO project"	WP1-WP4	03/2020	M19
TUD	Participation to a Workshop	Symposium "Building and probing small" Brussels, Belgium, poster Epiminotetracenes on Au(111)	WP1-WP5	03/2020	M19
TUD	Participation to a Workshop	Symposium "Building and probing small" Brussels, Belgium, poster poster "Anchoring strategies for a molecular gear on Au(111)"	WP1-WP6	03/2020	M19
GRAZ	Organisation of a Conference	10th Symposium "Physical Chemistry and Electrochemistry in Austria" of the Austrian Chemical Society (GÖCh)/TU Wien	WP1-WP2	05/2019	M20
LIEGE	Participation to a Conference	International scanning probe microscopy conference, May 26-29, 2019. Oral communication: Single-Molecule Mechanics of Synthetic Folding Molecules	WP2	05/2019	M20
TUD	Exhibition	Dresden Science Night	WP5	06/2019	M21
CNRS	Participation to a Conference	Gordon Research Conference: Artificial Molecular Switches and Motors, Holderness School, Holderness NH, USA	WP1-WP2	06/2019	M21
CNRS	Participation to a Conference	ISNA 18, 18th International Symposium on Novel Aromatic Compounds, Sapporo, Japan	WP1	07/2019	M22
CNRS	Participation to a Conference	ESOC 2019, European Symposium on Organic Chemistry, Vienna, Austria	WP1	07/2019	M22
GRAZ	Participation to an Event other than a Conference or a Workshop	Invited talk at the Middle Common Room (MCR) Seminar/Title: "Imaging single molecule motion: Molecular machines and the nanocar race"/Wadham College/Oxford, UK	WP1-WP2	08/2019	M23
GRAZ	Participation to an Event other than a Conference or a Workshop	Invited talk at the London Centre for Nanotechnology (LCN) Seminar/Title: "Single molecules at surfaces: Wires, switches and motors"/University College London (UCL)/London, UK	WP1-WP2	08/2019	M23
GRAZ	Participation to an Event other than a Conference or a Workshop	Invited talk at the Physical Chemistry Seminar/Title: "Single molecules manipulation on surfaces: From covalent chemical reactions to molecular wires"/University of Oxford/Oxford, UK	WP1-WP2	08/2019	M23
CNRS	Organisation of a Conference	Symposium on "Molecular Nanomachines" at the 28th International Materials Research Congress, Cancun, Mexico	WP1	08/2019	M23
GRAZ	Participation to a Conference	Invited talk at the "Confinement-Controlled Chemistry" Symposium/Title: "Chemical Processes of Single Molecules in Confined Spaces: Every Atom Counts"/Ruhr-University Bochum (Germany)	WP1-WP2	09/2019	M24

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Institution	Type of Activity	Short Description (Relevance for MEMO)	related WP	Date	
GRAZ	Participation to a Conference	Invited talk at the Frontier Science Symposium “Molecules at Surfaces: What do we really know?”/Title: "Single Molecules at Surfaces: Reactions, Switching and Dynamics"/University of Liverpool (UK)	WP1-WP2	09/2019	M24
CSIC	Participation to a Workshop	Oral presentation at the "Molecules at Surfaces: What do we really know?" University of Liverpool, United Kingdom/ Title: Isospin-flip spectroscopy.	WP2	09/2019	M24
TUD	Participation to a Conference	chem2Dmat2019, Dresden (Germany) oral prresentation "Functional molecular structures synthetized on surface"	WP1	09/2020	M24
GRAZ	Exhibition	Various contributions to the "Lange Nacht der Wissenschaften") (open day)/presentations, laboratory tours, discussions with the public/University of Graz	WP1-WP2	10/2019	M25
GRAZ	Participation to an Event other than a Conference or a Workshop	Presentation at TEDx lab2app/Title: "Single Molecules as Nanomachines: From Atoms to the Smallest Racers"/Max-Planck-Institute for Solid State Research/Stuttgart, Germany	WP1-WP2	10/2019	M25
GRAZ	Participation to an Event other than a Conference or a Workshop	Invited talk at the IBM Research Centre Zürich/Title: "Molecular motion at surfaces"/Zürich, Switzerland	WP1-WP2	10/2019	M25
CNRS	Participation to a Conference	JCO 2019, Journées de Chimie Organique, Palaiseau, France	WP1-WP2	10/2019	M25
CSIC	Participation to a Workshop	2nd MEMO Academy-Industry Day Inmunity to radiation	WP5	11/2019	M26
GRAZ	Participation to a Conference	Invited talk at the Surface Science Symposium/Title: "Manipulation of Single Molecules: Wires, Switches and Motors"/Institute for Molecular Science/Okazaki, Japan	WP1-WP2	12/2019	M27
GRAZ	Participation to an Event other than a Conference or a Workshop	Invited talk at the National Institute for Materials Science (NIMS)/Title: "On-Surface Polymerization: Insights at the Single Molecule Level"/Tsukuba, Japan	WP1-WP2	12/2019	M27
GRAZ	Participation to a Conference	Invited talk at the XXII. Symposium on Atomic, Cluster and Surface Physics/Title: "Single-Molecule Motion at Surfaces"/St. Moritz, Switzerland	WP1-WP2	02/2020	M29
GRAZ	Participation to an Event other than a Conference or a Workshop	Invited talk at the School of Chemistry/University of St Andrews/Title: "Controlling the motion of a single dipolar molecule"/St Andrews, UK	WP1-WP2	02/2020	M29
LIEGE	Participation to a Conference	XXII. Annual Linz Winter Workshop on Advances in Single-Molecule Research for Biology & Nanoscience. Invited talk: Forces and mechanics of synthetic functional molecules	WP2	31/02/2019	M29
TUD/ GRAZ	Organisation of a Workshop	DPG Spring Meeting, organization of a workshop titled "Functional Molecules at Surfaces: Motion and Intramolecular Processes" in Dresden (Germany)	WP1	03/2020	M30
TUD	Organisation of a Workshop	MRS Spring Meeting in Phoenix, USA Organization of a symposium titled "Nanomanipulation of Materials",at the 2020 MRS Spring Meeting in Phoenix, USA	WP1-WP3	04/2020	M31
TUD	*Exhibition*	*Dresden Science Night*	*WP5*	*tbc*	*M33*
LIEGE	*Participation to a Conference*	*Pacifichem 2020, Hawaii, USA. 15-20 December 2020. 2 invited lectures at 2 different symposia.*	*WP2*	*12/2020*	*M39*
CNRS	*Organisation of a Conference*	*Symposium on “Molecular Engines” at Pacifichem Conference, Hawaï, USA*	*WP2*	*12/2020*	*M39*
GRAZ	*Participation to an Event other than a Conference or a Workshop*	*Presentation at a TEDx event about Nanomachines/disseminated as movie on youtube*	*WP1-WP2*	*tbc*	*tbc*

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SECOND INTERNATIONAL NANOCAR RACE

Until to the 24th February 2020, the Nanocar Race II organization progresses as programmed (see table below). However, starting on the 2nd of March 2020 and initially from China and Japan, the race preparation around the world stopped suddenly because of the Covid-19 pandemic. Transportations cancelled, public meetings cancelled, Universities and Research Laboratories closed up to mid-May 2020 (optimistically) depending on the parts of the world.

Pre-registration	Feb 2018: opening	Jun 2018: closing
Selection	Sept 2018: Meeting of the organizing Committee	Jan 2019: Decision of the organizing Committee
Final registration	Jan 2019: Opening	Jan 2020: Closing
Nanocar race preparation	From Jan 2020	to March 2021
Committee on-site visit to the team	During year 2020	
Nanocar Race II	Spring 2021	

Table 4. *Organization calendar of the Nanocar Race II*

According to the above planning, years 2018 and 2019 were used by MEMO Partners CNRS: (1) to consolidate the pre-registration of each of the teams which have declared their interest by filling up the official pre-registration form in 2018, (2) to refine the Nanocar Race II rules according to scientific and technical discussions with those teams and (3) to prepare the MEMO CNRS campus for the technical organization of Nanocar Race II in Spring 2021 (see the Figure below).

During year 2019, the Nanocar Race II committee (https://www.memo-project.eu/flatCMS/index.php/Nanocar-Race-II) sent three detailed information bulletins to all the pre-registered team (05/05/19, 29/09/19 and 19/12/19) to define step by step the Nanocar Race II event and rules (available on demand). The 19/12/19 bulletin announces that a specific on-site visit committee is going to visit in 2020 each pre-registered team to guaranty that each team is (1) well synchronized (between designer, chemists, surface physicists and surface quantum chemists), (2) well equipped with a very stable LT-UHV-STM and (3) really committed to Nanocar Race II in particular for the dissemination actions. It was also announced that at the end of each on-site visit, a certificate will be delivered to the visited team to acknowledge that it is well prepare and is accepted for the Nanocar Race II competition. During the on-site visit, each team has 30 min to present its team, 30 min to answer questions and has to organize a technical visit on its LT-UHV-STM instrument engaged for Nanocar Race II. The list of questions was established before starting those on-site visits by the Nanocar Race II organization committee and is the same for all the teams for legal purpose.

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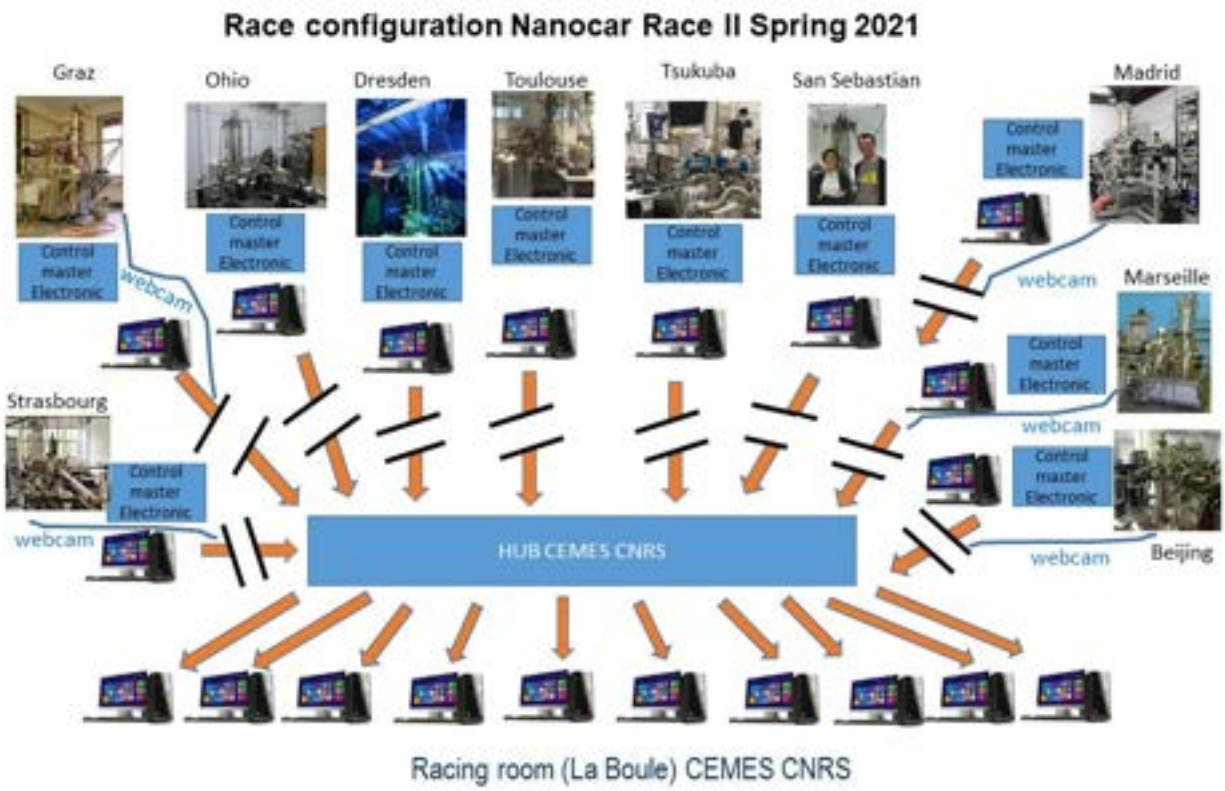

Figure 10. *The technical implementation to be ready in Spring 2021 on the CNRS-UT3 CEMES campus for Nanocar Race II. The team on-site visits are also organized to certify the technical compatibility of this implementation with all the 10 teams local network access and communication bandwidth. On the CEMES campus a very specific optical fiber Hub will be deployed.*

As listed below per team, the CNRS Toulouse Nanocar Race II director (Christian Joachim) used the French diplomatic network (and the CNRS decentralized administration for the 3 French pre-registered teams) to have a refereeing process external to MEMO including also an external technical expert coming from the country of the on-site visited team. The French Embassy of the concerned countries was very enthusiastic to contribute to such an on-site visit protocol, helping the MEMO project by asking generally the Scientific Attaché of the Embassy to participate to the on-site visit. The interest for MEMO is that French embassies are knowing very well per country the scientific and cultural environments. This is helping MEMO to largely amplify largely the MEMO research dissemination around the world via cultural events using the Nanocar Race concept including the organization of conference per country at schools, colleges and Universities.

Before the Covid-19 crisis, the calendar for the on-site visits was determined in synchronization with all the 10 pre-registered teams to Nanocar Race II as follows:

- **15 January 2020, 14h00**: On-site visit to the Japanese Tsukuba team: "**MANA-Tsukuba Works**"
  On-visit committee: K. Ariga, C. Joachim, J. Maleval (Tokyo French Embassy), T. Hasegawa (Waseda University – External expert.)

- **30 January 2020, 09h30**: On-site visit to the Spanish San Sebastian team: "**SANCAR**"

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On-visit committee: F. Moresco, C. Joachim, E. Mayoral (Bilbao, French Embassy. Madrid), We-Hyo Soe (CNRS - External expert).

- **6 February 2020, 16h00**: On-site visit to the French Strasbourg team: **"STRAS-NANOCAR"**
  On-visit committee: C. Joachim, H. Nierengarten (CNRS DR10), J.P. Launay (Uni. Toulouse - External expert).

- **28 February 2020, 14h00**: On-site visit to the Toulouse French-Japanese team**: "TOULOUSE-NARA"**
  On-visit committee: C. Joachim, S. Roques (CNRS DR14) J. Lagoutte (CNRS, External expert).

- **24 March 2020, 10h30**: On-site visit to the Dresden German team: **"GAZE"** (C-19: shifted)
  On-visit committee: C. Joachim, T. Simon (French Embassy, Berlin), A. Erbe (Helmotz, External expert).

- **1 April 2020, 9h30**: On-site visit to the Madrid Spanish-Swedish team**: "NANOHISPA"** (C-19: shifted)
  On-visit committee: C. Joachim, A. Carrière (French Embassy, Madrid), C. Sanchez-Sanchez (Uni. Madrid, ESISNA - External expert).

- **14 April 2020, 14h00**: On-site visit to the American Ohio team: **"Bobcat Nanodragster »** (C-19: shifted)
  On-visit committee: C. Joachim, J. Dat (French Embassy, Chicago)

- **28 April 2020, 14h00**: On-site visit to the Marseille French-Canadian team: **"CARAMU"** (C-19: shifted)
  On-visit committee: C. Joachim, K. Baligand (CNRS DR12), S. Gauthier (CNRS - External expert),

- **13 May 2020, 14h00**: On-site visit to the Austrian-American team: **"NANOGRANDPRIX"** (C-19: shifted)
  On-visit committee: F. Moresco, C. Joachim, M. Belland (French Embassy, Vienna) M. Sterrer (Uni.Graz - External expert)

- **Week 24, June 2020:** On-site visit to the Chinese Shanghai-Beijing team: **"G-Sunjet"** (C-19: shifted)
  On-visit committee: C. Joachim, K. Ariga, P. Arnaud (French Embassy, Beijing) and an External expert.

The Japanese Tsukuba, the Spanish San Sebastian, the French Strasbourg and the Toulouse French-Japanese teams were all very proud to get signed their official Certificate to participate to the Nanocar Race II. All those teams have very well communicated around this on-site visit event (Press, Twitter, face book large public conference at cultural centers and more scientific like conference at their university). CNRS-UT3 has now to re-organize the 6 on-site visits which were shifted in time due to the Covid-19 pandemic. The new calendar will normally be established in May-June 2020.

To boost the dissemination of the MEMO research and the Nanocar Race II preparation, MEMO has determined the date of the next MEMO workshop. It will be the 9th and 10th December 2020 in Toulouse at the occasion of the annual French C'NANO conference. Satellite of this annual conference will be also the occasion for the 10 pre-registered teams to be officially presented to a large public, to the C'NANO participants and to the press in a plenary session organized on the 8th December 2020 at 18h15 for the young generation interested to be present. Notice that in average on Google, the number of hits is actually between 100 000 and 130 000 per month.

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2021

NANOCAR RACE II

15 January 2020

Registration certificate to the Spring 2021 Nanocar Race II

In the name of the Nanocar Race II organization committee, we have met and listen today, the 15 th January 2020 the presentation of the MANA-NIMS team pre-registered for Nanocar Race II. We have appreciated the design of the molecule-vehicle engaged in this competition, the chemistry involved, the nice performances of the LT-UHV-STM instrument where the molecule-vehicle will be driven and also the theory support and specifically the A.I. involvement. We acknowledge that the preferred running surface for the MANA-NIMS team is Ag(111) or Au(111).

We have also trouble checked that the LT-UHV-STM instrument engaged in the competition by the MANA-NIMS team can be remotely controlled from Toulouse France and that preliminary tests can be performed by a member of the team from CEMES-CNRS Toulouse during the "Single Molecule Mechanics" MEMO workshop in November 2020 in Toulouse. The MANA-NIMS team had confirmed that one representant of its team will be present for the team's official presentation in Toulouse also in November 2020.

We thank the MANA-NIMS team for having answered all our questions confirming that it is well preparing its participation to Nanocar Race II. We confirm that the MANA-NIMS team from Tsukuba (Japan) is now fully registered for the Nanocar Race II competition in Spring 2021.

In the name of the nanocar Race II organization committee,

K. Ariga	C. Joachim	T. Hasegawa	J. Maleval
NIMS Prof. University of Tokyo Nanocar Race II organization committee	CEMES-CNRS Nanocar Race II Director	Prof. Waseda University External Expert	Director CNRS Tokyo Office

https://memo-project.eu/flatCMS/index.php/Nanocar-Race-II

Figure 11. *Example of the official Certificate attributed to the Japanese Tsukuba team after the on-site visit. Pr. K. Ariga and Dr. C. Joachim are members of the Nanocar Race II organization committee, Pr. T. Hasegawa is a well know LT-UHV STM expert in Japan not belonging to NIMS and Dr. J. Maleval is the Tokyo CNRS French Embassy representative.*

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A first budget for Nanocar race II was communicate to the MEMO project officers on the 6th of May 2019 and revised on demand on the 16th of December 2019. This estimated budget was also used to start to attract institutional and private sponsors. Just before the Covid-19 crisis, CNRS-UT3 had already started to explore sponsorship for 2021. The French Foundation "Fondation de la Maison de la Chimie" had accepted to provide 10 Keuros to support the general organization of Nanocar Race II. After a first negative answer of the FIA (Federation Internationale de l'Automobile") by a letter dated 30th October 2018 (letter available on demand), CNRS Nanocar Race II Director will contact again its General Secretary Xavier Malenfer to start again some negotiations helped by the CNRS President Alain Petit following the 27th November 2019 meeting in Paris. We may have also to anticipate a decrease of private and public sponsoring funds for the years to come which may impact the organization of Nanocar Race II in Spring 2021 and MEMO may have to shift it to Fall 2021.

Second Academy-Industry Day

To establish bilateral links with the European industry is a declared goal of the MEMO project. While the project participants are coming from the academic community, and the MEMO goals are mainly of fundamental scientific relevance, MEMO is actively looking for a productive collaboration with the industry organizing regular meetings (Academy-Industry Days) with interested industrials. These meetings make possible to involve for example the clock industries, the microelectronics industries, the spatial industries, the energy provider's large companies, as well as many high-tech SMEs in the MEMO progresses and to promote dissemination to the industry.

The second Academy-Industry day took place in 28 November 2019 (M26) in the seminar room of the Pico-Lab CNRS partner campus in Toulouse. The list of participants is shown in Fig. 12.

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Immunity to radiations?
2nd MEMO-Industry meeting
(28 November 2019)
Pico-Lab CEMES CNRS UPR 8011
29, Rue J. Marvig 31055 Toulouse

Feuille d'émargement

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Figure 12. *List of participants to the second MEMO-Industry day in Toulouse.*

In Fig. 13 the program of this 2nd MEMO Academy-Industry day is reported. The confidential slides of the presentations have been shared only between the participants because of the very sensible data reported especially concerning satellites and nuclear power stations. In the first part of the meeting, Francesca Moresco (MEMO coordinator, P1-TUD) presented the last MEMO results with a special attention to the miniaturization of mechanical machinery, which can be considered as one solution of the problem of immunity to radiations of micro-electronic systems used in space or for control system in nuclear power plans. In this occasion, MEMO shares with the participants the summary table of Vol. 12 of the Springer Series "Advances in Atom and single Molecule Machines" to be out in February 2020. This Vol. 12 is dealing with "Atomic switches". Two chapters are devoted to radiations damage robustness of nano-mechanical systems in space and on earth as compared with CMOS technology in particular for memory and FPGA chips. Those experiments were conducted by NEC-Japan around orbit earth on board a satellite launched in November 2018 by JAXA.

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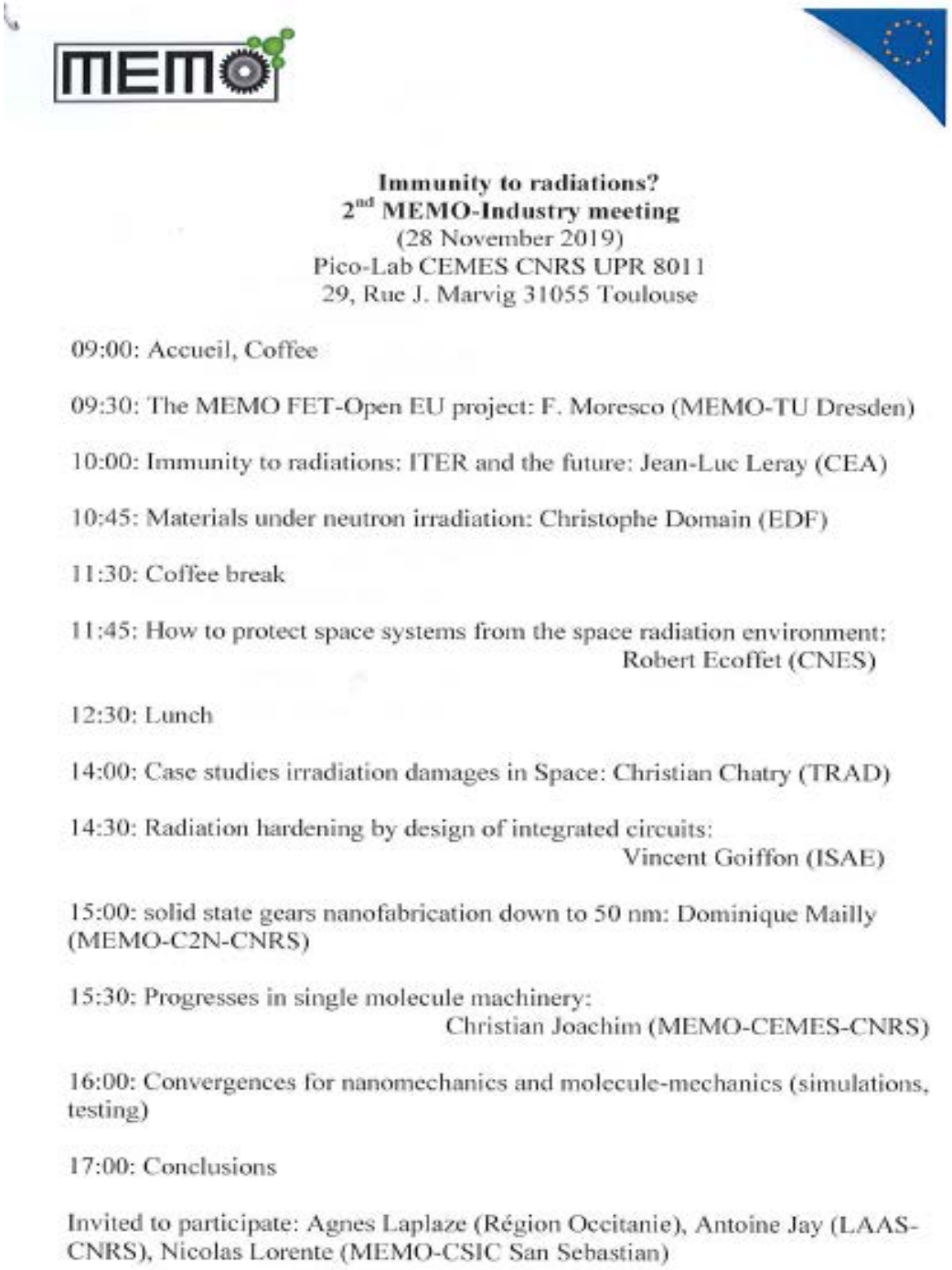

Immunity to radiations?
2nd MEMO-Industry meeting
(28 November 2019)
Pico-Lab CEMES CNRS UPR 8011
29, Rue J. Marvig 31055 Toulouse

09:00: Accueil, Coffee

09:30: The MEMO FET-Open EU project: F. Moresco (MEMO-TU Dresden)

10:00: Immunity to radiations: ITER and the future: Jean-Luc Leray (CEA)

10:45: Materials under neutron irradiation: Christophe Domain (EDF)

11:30: Coffee break

11:45: How to protect space systems from the space radiation environment: Robert Ecoffet (CNES)

12:30: Lunch

14:00: Case studies irradiation damages in Space: Christian Chatry (TRAD)

14:30: Radiation hardening by design of integrated circuits: Vincent Goiffon (ISAE)

15:00: solid state gears nanofabrication down to 50 nm: Dominique Mailly (MEMO-C2N-CNRS)

15:30: Progresses in single molecule machinery: Christian Joachim (MEMO-CEMES-CNRS)

16:00: Convergences for nanomechanics and molecule-mechanics (simulations, testing)

17:00: Conclusions

Invited to participate: Agnes Laplaze (Région Occitanie), Antoine Jay (LAAS-CNRS), Nicolas Lorente (MEMO-CSIC San Sebastian)

***Figure 13**. Program of the second MEMO-Industry day.*

After the introduction, contributions from the nuclear, space and micro-electronics industry representatives demonstrated how in many area of modern technologies where mechanical and electronic devices are submitted to intense irradiations (electrons, neutrons or heavy ions), it is of importance to protect or substitute micro-electronics by another technology. This is in particular the case for Nuclear power plants

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decommissioning, for the new ITER sur-generator being built up in the south-east of France and in space where all the satellites are constantly irradiated.

The ITER scientific advisor for irradiations presented 2 contributions: one about the structural building problem to protect all the measurement equipment's necessary to stabilize the Tokamak functioning and another presentation about the damages created by hard dose of neutrons scattering on actual micro-electronics and sensors equipment. It turns out that in ITER, the actual micro-electronic equipment supposed to control and stabilize the Tokamak functioning in 2035 will only last a few seconds under the estimated neutrons flux. Possible solutions envisaged to protect the stabilization of functioning are hydraulic, vacuum tubes controllers, exploring single molecule electronic or nanoscale mechanical calculators associated with mechanical memories. This is exactly on line with the research developed in MEMO. This presentation was completed by a contribution from the national French agency EDF describing the actual problem of irradiations hardening in the actual nuclear power plans.

The RADECS president from CNES was also present representing the space industry explaining the irradiations problem in space. They are less problematic in term of elementary particle flux per second but more on the long term according to the life time of a satellite and to the multiplication of micro-satellite constellation project coming from US and Europe. Since the hydraulic and vacuum tubes solutions are not possible in space, the space industry (including military applications) is also considering alternative solution like nano-mechanical devices. This presentation was completed by 2 presentations coming from the engineering school ISAE-Sup'Aero working on redundant architectures to attenuate the irradiation impacts on space micro-electronics systems and by a presentation from the SME "TRAD" from Toulouse developing hardware testing and simulations to evaluated hardening strategies in on-board micro-electronic systems. The Occitanie Region was also represented because of the large impact on the aerospace industry of the irradiation problem is space. The Occitanie Region is also trying to favour the creation of SME in this strategic field of industrial activity.

At the end of the meeting and before the discussion, the MEMO labs from CNRS presented its details realizations on nanofabricating the first part of a planar mechanical calculator with 80 nm in diameter solid state gears and the first train of molecule-gears with a carry. This was a good demonstration on how the exploration of the mechanical interactions between a single molecule-gear and a solid state nano-gear of interest for MEMO is pulling the improvement of solid state nano-gear fabrication and miniaturisation. Such a miniaturization can be one solution for constructing mechanical calculator and mechanical memories for control systems requiring a robustness under intense particles irradiations.

After the presentations, which were very active with a lot of questions, the participants discussed under the coordination of Christian Joachim important questions like:

- The future of mechanical calculators and mechanical memory for space and nuclear applications. A specific question was raised by the ITER representative about solution for mechanical memory devices.
- The possibility that MEMO deliver some chips with nanofabricated solid state gears for irradiations was discussed with the practical problem on how to study the results of such irradiations when radiative irradiations is used.
- Questions was raised by the MEMO theory representative together by the TRAD representative about the simulation of irradiations defects and the resulting cascade of events when a surface equipped with nanoscale solid state gears is irradiated. This can be a new case study as compared to the usual semi-conductor surface and bulk irradiation simulations

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- Interrogations were raised concerning the NEC-Japan experiments on board a JAXA satellite in space where an atomic switch FPGA was installed as a passenger equipment. MEMO will provide to CNES, EDF and RADECS the 2 chapters of the Vol. 12 of the Springer series “Advances in Atom and Single Molecule machines” when available in February 2020.

After the meeting, some participants provided their presentation and manifested the interest of keeping contacts with the MEMO project. This is the case for the nano-fabrication of planar nano-mechanical calculators which may be a solution for ITER whose first test will be performed in 2027. In Fig. 9 some pictures of the day are reported.

Figure 14. *Photos of the second MEMO Academy-Industry day with a strict restricted access considering the sensible topic of irradiations is space and inside nuclear power plans.*

The third Academy-Industry Day is planned in for the next project period. Its organization and the location will be discussed during the next project Meeting in San Sebastian in January 2020.

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