



(2005-2014)



(2008-2019)



(2017-2019)



BUN
(1999-2003)



Pico-Inside
(2005-2009)



AtMol
(2011-2014)



(2014-2017)



(2017-2021)

Projets FET-OPEN

C. Joachim

CEMES-CNRS Toulouse (France)

MANA-NIMS Tsukuba (Japan)

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- 1996 - 98 Contrat Esprit IV- Mel Ari: "Nanowires" (800 KF)
- 1997- 01 Contrat TMR: "Atomic/Molecular manipulation" (1,2 MF)
- 2000 - 03 Contrat IST-FET « Bottom-up nanomachine »
Coordinateur, 7 partenaires (18 MF), 1 industriel
- 2002 - 06 Contrat TMR "Applications of Molecular Manipulation in Information Science & Technologies" (AMMIST) (1,4 MF)
- 2005 – 09 Contrat IST-FET projet Intégrée « Pico-Inside »
Coordinateur, 15 partenaires (7 Meuros), 2 industriels.
- 2008 – 12 Contrat ICT-FET Coordination Action « Nano-ICT » (0.4 Meuros)
- 2010 - 14 Contrat ICT-FET FP7, Projet Intégré « AtMol »,
Coordinateur, 11 partenaires (7 + 4 Meuros) (CEA-LETI & A*STAR Singapore)
- 2014 – 17 Contrat ICT-FET FP7 Projet Intégré PAMS
Participant, 5 partenaires (5 Meuros), 1 industriel
- 2017 – 21 Contrat ICT-FET, H2020 FET open « MEMO » Mechanics with Molecule(s),
Directeur Scientifique, 6 partenaires (4.9 Meuros)





AtMol

(2011-2014)



16 décembre 2015





- Présentation synthétique de votre projet (sujet, enjeux, partenaires)
- Votre rôle dans le projet ?



Horizon 2020

Call: H2020-FETOPEN-2016-2017

(FET-Open – Novel ideas for radically new technologies)

Topic: FETOPEN-01-2016-2017

Type of action: RIA

(Research and Innovation action)

Proposal number: 737154

Proposal acronym: MEMO

Deadline Id: H2020-FETOPEN-1-2016-2017





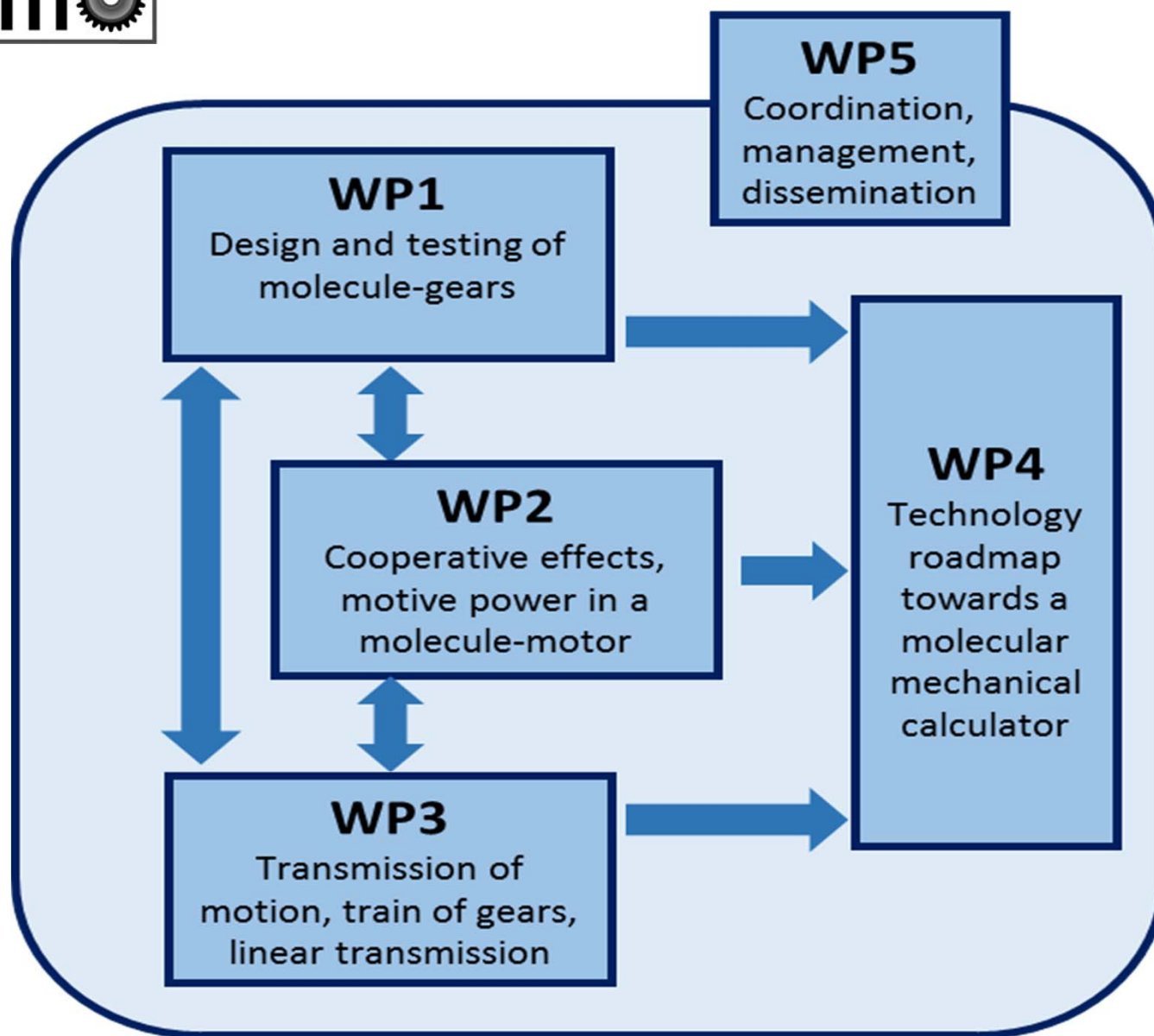
Proposal ID 737154

Acronym **MEMO**

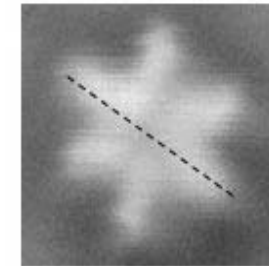
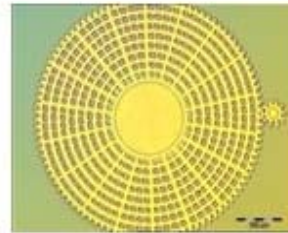
List of participants

#	Participant Legal Name	Country
1	TECHNISCHE UNIVERSITAET DRESDEN	Germany
2	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	France
3	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	Spain
4	UNIVERSITAET GRAZ	Austria
5	UNIVERSITE DE LIEGE	Belgium
6	THE UNIVERSITY OF MANCHESTER	United Kingdom





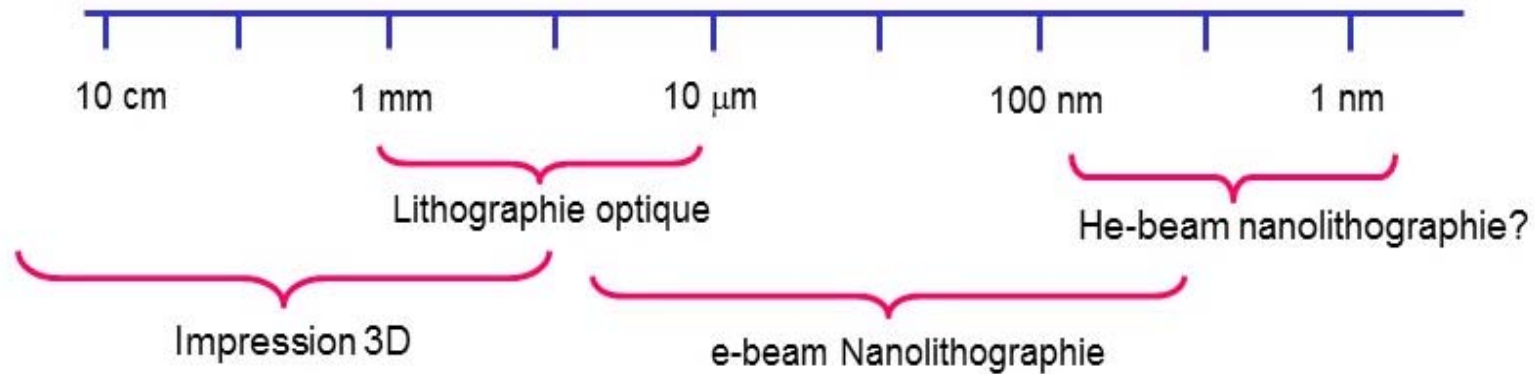
Anticythère, 200 BC



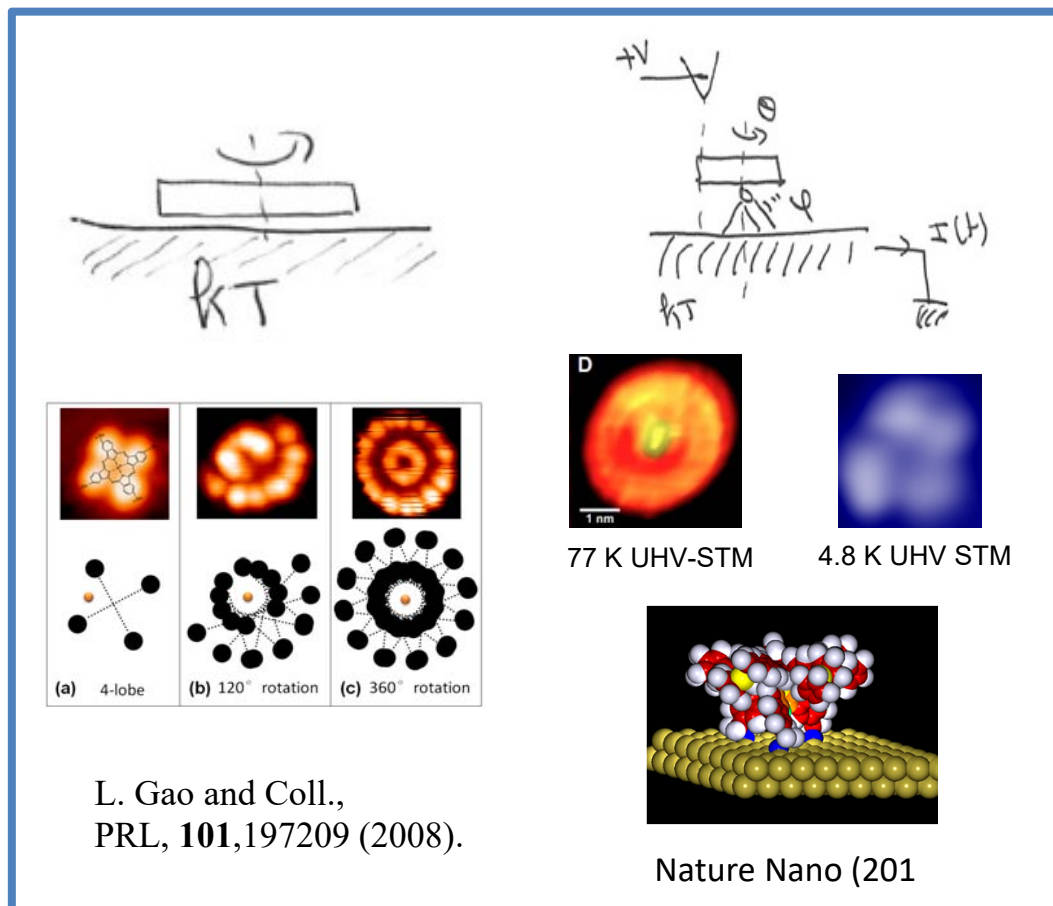
$\delta = 10 \text{ nm}$



$\delta = 0.4 \text{ nm}$

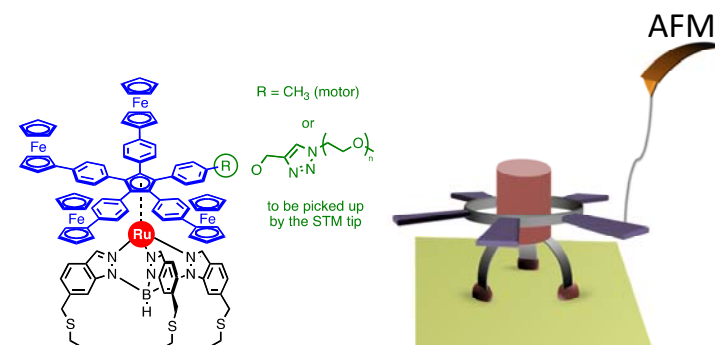


MEMO WP1 Objectives: Design, chemical synthesis, deposition, and assembly of molecule-gears. AFM (in solution) & STM (LT-UHV) controlled rotation of a single molecule-gear mounted on its atomic scale axle. Progressive extension to larger diameters single molecule-gear.



L. Gao and Coll.,
PRL, **101**,197209 (2008).

Nature Nano (201)



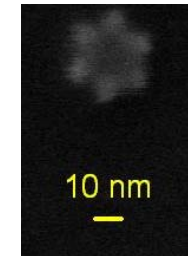
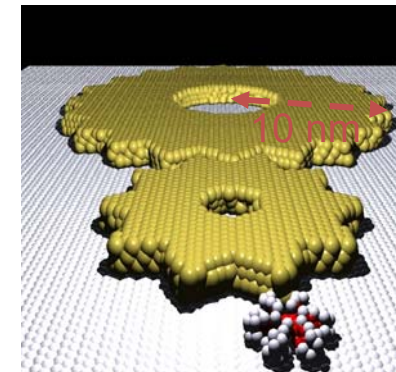
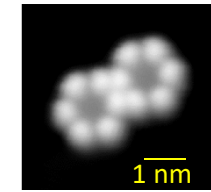
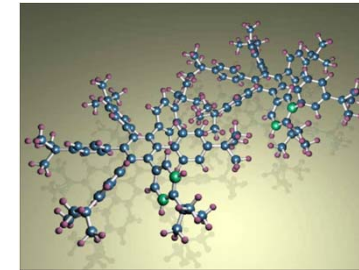
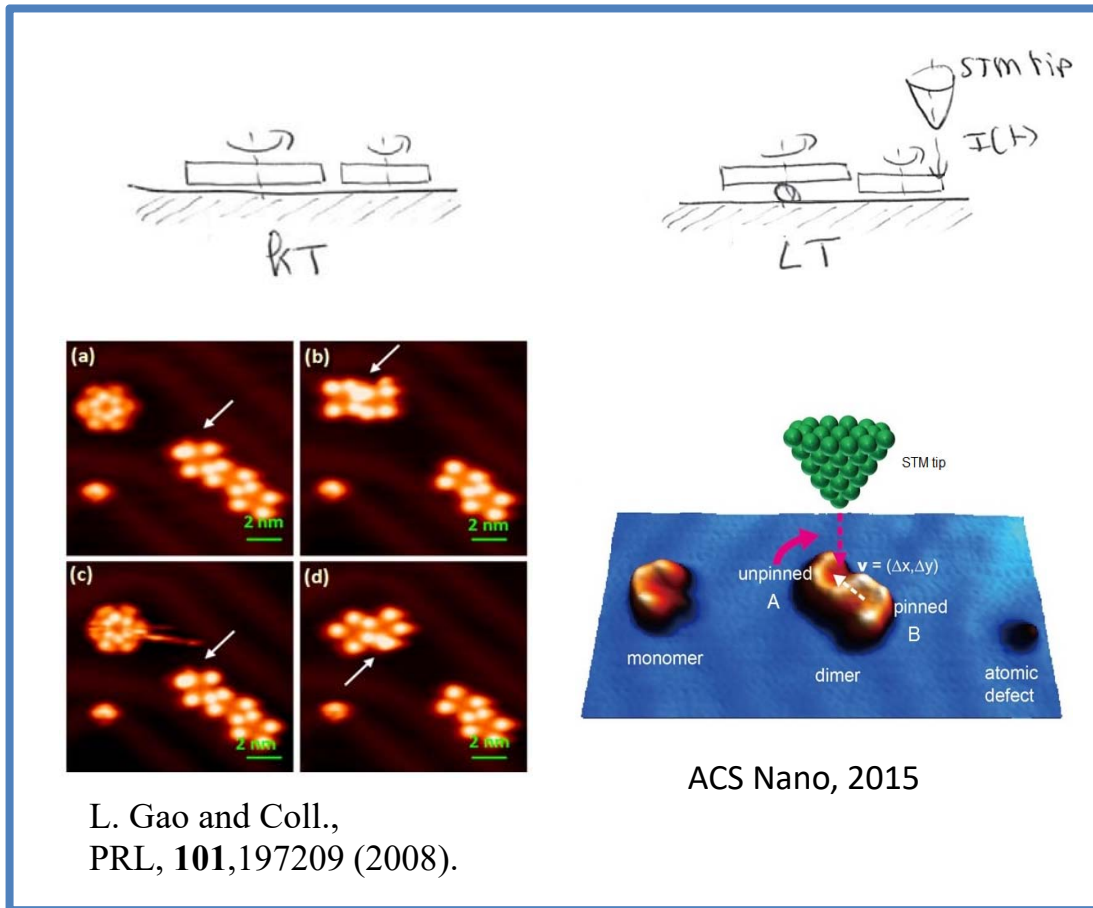
Measure of the Motive power
Theory of motive power



Collective effects?

MEMO WP2 objectives: Measuring the motive power resulting from the step by step rotation of a single molecule-motor including experiments in UHV (STM) and in solution (AFM) and theoretical calculations to optimize the motive power. Investigate collective effects with many molecule-motor working in parallel for transmission of motion to a solid state nanoscale gear.

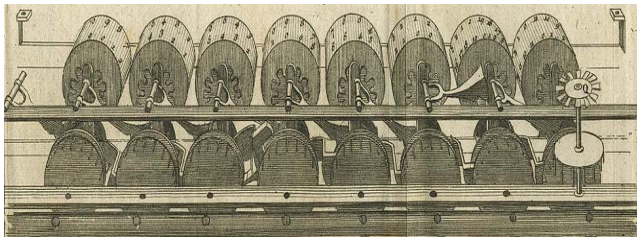




MEMO WP3 Objectives: Transmission of motion along a train of molecule-gears and a chain of molecular flip-flops. Transmission of motion between a molecule-gear and a solid state nano-gear.



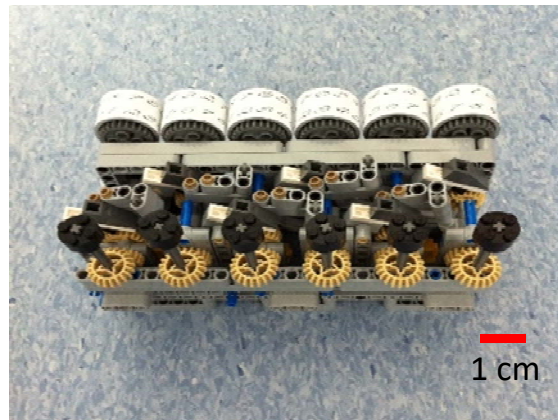
Pascaline



1642

3 cm

Lego Pascaline



1 cm

2014

Molecular
Pascaline ?

MEMO

MEMO WP4 Objectives. Determination of the technology nodes needed to design a realistic nanoscale molecular mechanical calculator. This roadmap will be explored node after node starting from the millimeter down to the molecular scale. Each node is tested experimentally by constructing the corresponding calculating unit with a carry. The last node is the molecular design of a molecular Pascaline using the WP1 to WP3 experimental results.



MEMO Dissemination WP5 Objectives.

Task 5.1: Scientific coordination.

Task 5.2: Administrative management. Administrative support through TUD-EPC. Supervision of all related issues regarding legal, financial, and administrative issues (P1).

Task 5.3: Dissemination of results. MEMO will organize two international workshops on single molecule mechanics and machineries, with at least $\frac{1}{2}$ of the invited speakers coming from outside MEMO. The proceeding of those workshops will be published in the Springer book series "*Advances in Atom and Single Molecule Machines*" created by P2-Toulouse in 2012 with 9 volumes already published (<http://www.springer.com/series/10425>).

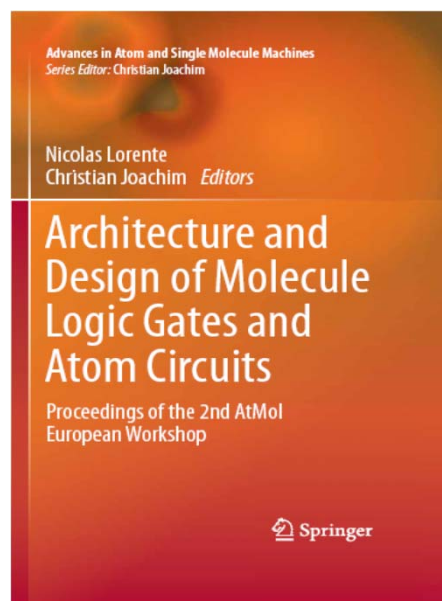
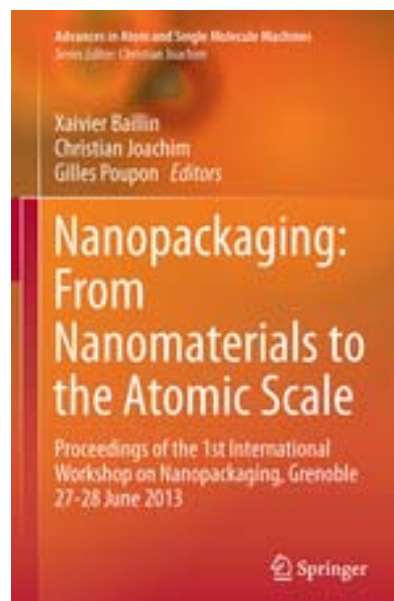
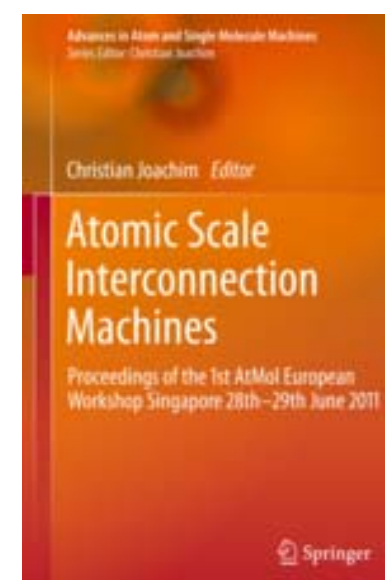
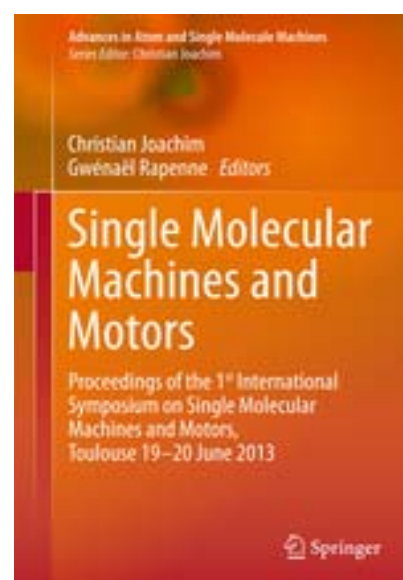
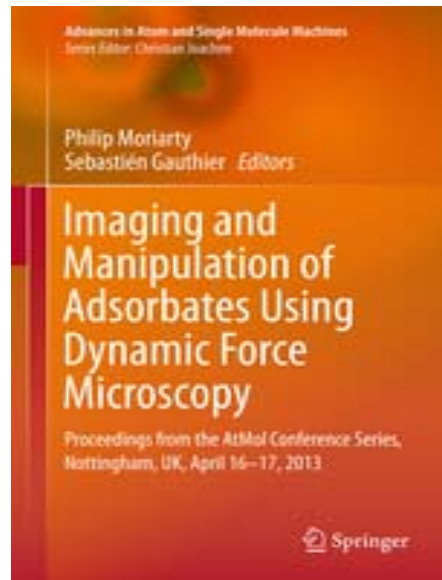
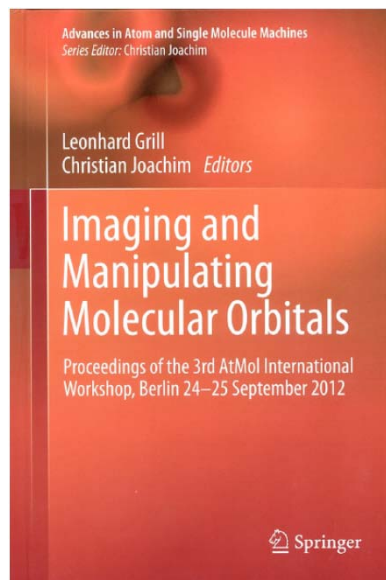
Task 5.4: Exploitation of results: MEMO will organize three Academy-Industry days to favor exchanges and synergy with the industry.

Task 5.5: International molecule-car race. MEMO will take over the second edition of the Nanocar race in 2021.





Springer book series « Advances in Atom and Single Molecule Machines »



 : 3 volumes





MEMO INDUSTRY DAY

August 30, 2018

Dresden

Contact:

Francesca Moresco, francesca.moresco@tu-dresden.de

Alexander Croy, alexander.croy@tu-dresden.de

Location: QF Hotel, Neumarkt 1, 01067 Dresden



ARITHMEUM
rechnen einst und heute




TAGHeuer

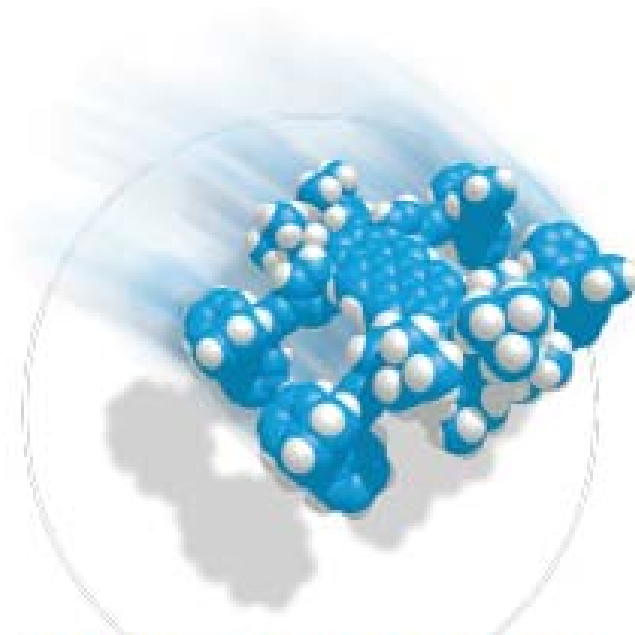


NOMOS
GLASHÜTTE





<https://memo-project.eu/>



NANOCAR RACE II 2021

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

(Pre-registration up to end June 2018)

<https://memo-project.eu/flatCMS/index.php/Preregistration>





- De quel(s) soutien(s) avez-vous bénéficié lors du montage du projet ? Ingénieur projet, consultant, autre ?
- Comment le consortium du projet a-t-il été constitué ? Déjà existant, recherche de compétences complémentaires, autre ?
- Quelles difficultés (éventuelles) avez-vous rencontrées ?



En 2009: réunion de préparation du projet AtMol (2010-2014)





Visite de la Pascaline au musée de Dresde



Diner de Préparation



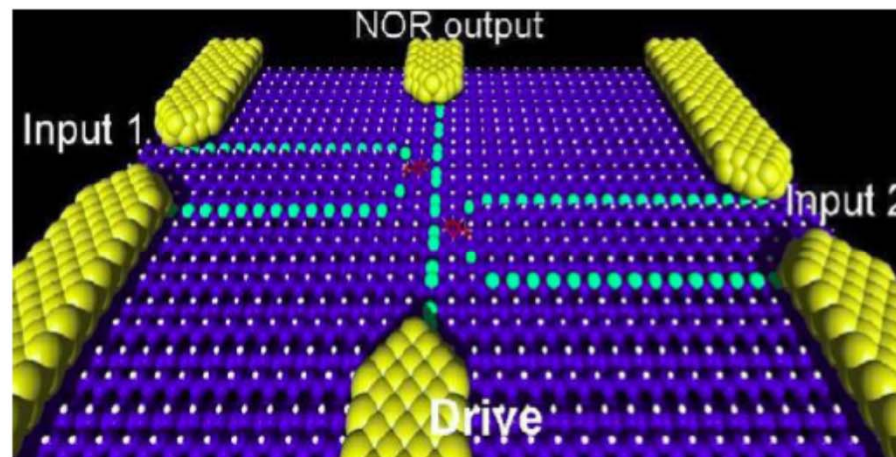
- Comment avez-vous abordé les « Gatekeepers » dans votre proposition ?
 - Long-term vision
 - Breakthrough scientific and technological target
 - Novelty
 - Foundational
 - High-risk
 - Interdisciplinary



MECHANICS VERSUS ELECTRONICS

in atomic scale devices, mechanics can have several advantages

- insensitive to radiation
- high frequency possible
- input/output of data: friction versus stray capacitance





OPEN QUESTIONS

towards a molecule machine technology

- molecule gears
- motive power of a molecule motor
- transmission of motion over several orders on magnitude
- design of complex machines





- Quelles recommandations/bonnes pratiques pour les candidats au futures appels FET Open ?

N°	Description	M1-M12	M13-M30	M31-M48
WP1	MOLECULE-GEARS			
T1.1	Atomic scale axle construction			
T1.2	Synthesis of larger molecule-gears			
T1.3	Number of rotational stations			
	<i>Milestones:</i>		◇	◇
	<i>Deliverables:</i>	■	■	■
WP2	COOPERATIVE EFFECTS			
T2.1	Driving a single molecule-motor			
T2.2	Molecule-motors monolayer self-assembly			
T2.3	Collective effects			
T2.4	Theory of molecule-motor motive power			
	<i>Milestones:</i>		◇	◇
	<i>Deliverables:</i>	■	■	■
WP3	TRANSMISSION OF MOTION			
T3.1	Transmission from molecule to molecule			
T3.2	Solid state nano-gear nanofabrication			
T3.3	Transmission to solid state gears			
T3.4	Theory of energy redistribution			
	<i>Milestones:</i>	◇	◇	◇
	<i>Deliverables:</i>	■	■	■
WP4	TECHNOLOGY ROADMAP			
T4.1	The 10 mm to 1 mm node			
T4.2	The 1 mm to 10 μm node			
T4.3	The 10 μm to 100 nm node			
T4.4	The 100 nm to 10 nm node			
T4.5	The molecular Pascaline node			
	<i>Milestones:</i>		◇	◇
	<i>Deliverables:</i>	■	■	■
WP5	MANAGEMENT AND DISSEMINATION			
T5.1	Scientific coordination			
T5.2	Administrative management			
T5.3	Dissemination of results			
T5.4	Exploitation of results			
T5.5	International molecule-car race			
	<i>Milestones:</i>		◇	◇
	<i>Deliverables:</i>	■	■	■



Table 3.1c: List of Deliverables

Deliverable (number)	Deliverable name	WP N°	Lead participant	Type	Dissemination level	Deliv. date
D1.1	Report on the implementation of different axle strategies	WP1	P2-Toulouse	R	PU	12
D1.2	Report on molecule-gears of different \emptyset	WP1	P2-Toulouse	R	CO	30
D1.3	Report on the rotation of single molecule-gears	WP1	P2-Toulouse	R	CO	48
D2.1	Report on motive power measurements	WP2	P5-Liege	R	CO	12
D2.2	Report on cooperative effects on self-assembled layers driving a solid-state nano-gear	WP2	P5-Liege	R	PU	30
D2.3	Theory of the motive power of a molecule-motor and collective effects	WP2	P5-Liege	R	CO	48
D3.1	Report on transmission of motion between molecules	WP3	P4-Graz	R	CO	12
D3.2	Report on the nanofabrication of solid state nano-gears	WP3	P4-Graz	R	CO	30
D3.3	Report on the transmission of motion between molecule-gears and a solid state nano-gear	WP3	P4-Graz	R	PU	48
D4.1	10 mm to 1 mm and 1 mm to 10 μ m nodes assessed	WP4	P2-Toulouse	R	PU	12
D4.2	10 μ m to 100 nm node solid state nano-gear mechanical calculator	WP4	P2-Toulouse	R	CO	30
D4.3	Design of a molecular mechanic Pascaline with carry	WP4	P2-Toulouse	R	CO	48
D5.1	Project management handbook	WP5	P1-Dresden	R	PU	6
D5.2	Project website	WP5	P1-Dresden	DEC	PU	2
D5.3	Dissemination and Academy-Industry day report, 1 st period	WP5	P1-Dresden	R	PU	12
D5.4	1 st periodic report on achievements	WP5	P1-Dresden	R	PU	12
D5.5	Dissemination and Academy-Industry day report, 2 nd period	WP5	P1-Dresden	R	PU	30
D5.6	2 nd periodic report on achievements	WP5	P1-Dresden	R	PU	30
D5.7	Dissemination and Academy-Industry day report, 3 rd period	WP5	P1-Dresden	R	PU	48
D5.8	2 nd periodic report on achievements	WP5	P1-Dresden	R	PU	48
D5.9	Exploitation and use plan	WP5	P1-Dresden	DEC	PU	48
D5.10	2 vol. Springer series "Advances in Atom and single molecule machines"	WP5	P1-Dresden	DEC	PU	48
D5.11	Report on 1 st molecule-car race	WP5	P2-Toulouse	DEC	PU	12
D5.12	Report on 2 nd molecule-car race	WP5	P2-Toulouse	DEC	PU	30



MEMO (H2020 n° 766864)

Mechanics with Molecules

