

### 3. Visiting Professors

No.	Name	Project Title
3-1	<b>Rajendra Udyavara Acharya</b> HP: Makiko Kobayashi	Advanced Biomedical Evaluation System
3-2	<b>Josep-Lluis Barona-Vilar</b> HP: Makoto Takafuji	Development of Photo-Sensing Polymer Hybrid with Nano-Dispersed Photo-Functional Molecular Gels
3-3	<b>Pierre Breul</b> HP: Jun Otani	Visualization of inner soil behavior in double sheet pile with surface friction properties using X-ray CT and numerical simulation using DEM
3-4	<b>Maria Jose Cocero</b> HP: Tetsuya Kida	Biomass to Green Energy Conversion Technologies
3-5	<b>Patrice Jean Delmas</b> HP: Toshifumi Mukunoki	Image processing and analysis on Geotechnical and Geoenvironmental Engineering
3-6	<b>Derek Elsworth</b> HP: Atsushi Sainoki	Development of a method to simulate the mechanical behaviour of rock discontinuity during fluid injection
3-7	<b>Tomonari Furukawa</b> HP: Makoto Kumon	Study on intelligent mobile robot to escort with intention inference
3-8	<b>Olivier Hamant</b> HP: Shinichiro Sawa	Plant Cell and Developmental Biology
3-9	<b>Kwon, Ick Chan</b> HP: Takuro Niidome	Nano-medicine and Theranostics
3-10	<b>Reiko Oda</b> HP: Makoto Takafuji	Fabrication of Nano-to-Submicron-sized Exclusive Pods and Their Spatial Functionalization
3-11	<b>Zoran Ren</b> HP: Kazuyuki Hokamoto	Fabrication of various porous materials through explosive and other processes and the evaluation of such porous materials under high-rate impact loading
3-12	<b>Gioacchino (Cino) Viggiani</b> HP: Jun Otani	Application of X-ray CT
3-13	<b>Tomoyasu Mani</b> HP: Yutaka Kuwahara	Utilization of photons and spins in Functional Materials
3-14	<b>Daniel P. Zitterbart</b> HP: Kei Toda	Understanding the role of oceanic chemoattractants in marine animal navigation

HP: Host Professor

No.3-1	Advanced Biomedical Evaluation System		
Name	U Rajendra Acharya		
Affiliation	Ngee Ann Polytechnic Email: rajendra_udyavara_acharya@np.edu.sg	Title	Senior Research Fellow
Research Field	Nanomaterial Science/ Advanced Green Bio		
Host Professor	Makiko Kobayashi		
Affiliation	Kumamoto University Email: kobayashi@cs.kumamoto-u.ac.jp	Title	Professor

#### 1. Research achievements

Discussed the project entitled “Automated system and method of monitoring anatomical structures”. We filed a PCT application (PCT/SG2020/050538) on this topic in 2020 and entered national phase to Singapore, Japan, and USA in 2022.

#### 2. Overview and significance of the research collaboration with Kumamoto University

Cardiovascular disease (CVD) is the leading cause of death worldwide, and coronary artery disease (CAD) is a major contributor. Early-stage CAD can progress if undiagnosed and left untreated, leading to myocardial infarction (MI) that may induce irreversible heart muscle damage, resulting in heart chamber remodeling and eventual congestive heart failure (CHF). Electrocardiography (ECG) can detect established MI and may also be helpful for early diagnosis of CAD. For the latter especially, the ECG perturbations can be subtle and potentially misclassified on manual interpretation and/or traditional algorithms found in ECG machines. For automated diagnostic systems (ADS), deep learning techniques are favored over conventional machine learning techniques, due to the automatic feature extraction and selection processes involved. This paper highlights various deep learning algorithms exploited for the classification of ECG signals into CAD, MI and CHF conditions. The Convolutional Neural Network (CNN), followed by combined CNN and Long Short-Term Memory (LSTM) models, appear to be the most useful architectures for classification. A 16-layer LSTM model was developed in our study and validated using 10-fold cross validation. A classification accuracy of 98.5% was achieved. Our proposed model has the potential to be a useful diagnostic tool in hospitals for the classification of abnormal ECG signals.

#### 3. Prospect for further research collaboration with Kumamoto University

I started to serve as a distinguished professor in Kumamoto University. I shall continue to collaborate and write papers with Prof. Toshitaka Yamakawa, Prof. Masayuki Tanabe, and Prof. Makiko Kobayashi in the coming days.

#### 4. List of co-authored papers published between April 2021 and March 2022.

N/A

No.3-2	Development of Photo-Sensing Polymer Hybrid with Nano-Dispersed Photo-Functional Molecular Gels		
Name	Josep-Lluis Barona-vilar		
Affiliation	Instituto de Historia de la Medicina y de la Ciencia López Piñero (IHMC), Universidad de Valencia, Spain Email: Jose.Luis.Barona@uv.es	Title	Professor
Research Field	Nanomaterial Science		
Host Professor	Makoto Takafuji		
Affiliation	Faculty of Advanced Science and Technology Email: takafuji@kumamoto-u.ac.jp	Title	Professor

#### 1. Research achievements

- The collaboration project “Development of photo-sensing polymer hybrid with nano-dispersed photo-functional molecular gels” (Bilateral Joint Research Project (OP) funded by JSPS, FY2019–FY2021) has been completed.
- A doctoral student who participated in this project was awarded a PhD degree in March 2022.
- One paper has been published in the international scientific journals.
- In FY2021, Japanese and Spanish members could not visit each other because of COVID-19 pandemic.

#### 2. Overview and significance of the research collaboration with Kumamoto University

Although there were no mutual visits in FY2021, the joint research proceeded, and the bilateral joint research project, which started in 2019, was completed in this year. A doctoral student who participated in this project was awarded a PhD degree in March 2022.

#### 3. Prospect for further research collaboration with Kumamoto University

Prof. Josep BARONA is scheduled to visit Japan in the fall of FY2022 for future research collaborations.

#### 4. List of co-authored papers published between April 2021 and March 2022.

Non (One paper by researchers from Kumamoto University was published)

No.3-3	Visualization of inner soil behavior in double sheet pile with surface friction properties using X-ray CT and numerical simulation using DEM		
Name	Pierre Breul		
Affiliation	Polytech Clermont / Enseignant Dpt Génie Civil Email: pierre.breul@uca.fr	Title	Professor
Research Field	Nanomaterial Science/ Green Energy/ Environmental Science/ Advanced Green Bio/ Other (Geotechnical Engineering)		
Host Professor	Jun Otani		
Affiliation	Email: junotani@kumamoto-u.ac.jp	Title	Professor

#### 1. Research achievements

As an active researcher in the field of X-ray CT and micromechanics of geomaterials, I organized a workshop as a visiting professor. During my stay in Kumamoto, I performed the following activities:

- 1) Regular research meeting with PhD candidate, Mr. Hideharu Sugimoto and Prof. Toshifumi Mukunoki.
- 2) Mr. Sugimoto has studied abroad at My lab. from April in 2022 to March in 2023 as double degree program between Polytech Clermont and Kumamoto University.

#### 2. Overview and significance of the research collaboration with Kumamoto University

These activities will be able to contribute:

- 1) Enhancement of worldwide activities with X-Earth center,
- 2) Enhancement of international collaboration, and
- 3) Development of human resources which are not only faculty members but also graduate students

#### 3. Prospect for further research collaboration with Kumamoto University

Since April 2022, Mr. Sugimoto has visited and stayed at our laboratory to study together. Now, it is possible to well discussion using ZOOM or others before study abroad so we would like to encourage bot students to go abroad by organizing online workshop. Especially, X-Earth Center of Kumamoto University has great X-ray CT scanner and it will get suitable data for DEM analysis to compare the actual phenomena and numerical results in micro scale. This kind of study will accelerate the progress of micro-macro mechanics. We do hope to prepare good data to publish one good journal paper next year.

#### 4. List of co-authored papers published between April 2021 and March 2022.

Under writing

No.3-4	Biomass to Green Energy Conversion Technologies		
Name	Maria Jose Cocero		
Affiliation	High Pressure Research Group/Department of Chemical Engineering and Environmental Technology, Valladolid University (Spain) Email: mjcocero@iq.uva.es	Title	Professor
Research Field	Green Energy/ Advanced Green Bio		
Host Professor	Tetsuya KIDA/ Armando QUITAIN		
Affiliation	Department of Applied Chemistry & Biochemistry, Kumamoto University Email: tetsuya@kumamoto-u.ac.jp Center for International Education, Kumamoto University Email: quitain@kumamoto-u.ac.jp	Title	Professor

### 1. Research achievements

Due to cross-border travel restrictions related to COVID-19 pandemic, researcher and student mobilities were still not possible this academic year. However, the following research-related and online academic activities were carried out:

1.1 Supervision of an alumnus from Kumamoto University, Dr. Elaine G. Mission, under the Marie-Curie Individual Fellowship Program. She was a doctoral student under the mentorship of Prof. Tetsuya Kida and Prof. Armando Quitain. She is currently working on research related to biomass utilization using microwave and supercritical fluid technologies for 2 years until September 2022.

1.2 Online lecture in the Global Team Teaching/COIL subject related to “Perspectives on Biomass Utilization”, being offered at the Center for International Education and participated by a total of about 50 undergraduate students from Kumamoto University and Sepuluh Nopember Institute of Technology (ITS, Indonesia) and other ASEAN universities.

1.3 Application to AY2022 JSPS Bilateral Joint Research Project

1.4 Application to AY2022 JST Sakura Science Exchange Program including one participant from Valladolid University

### 2. Overview and significance of the research collaboration with Kumamoto University

The research collaboration on the use of green technologies (supercritical fluid and microwave) for biomass utilization with Kumamoto University (KU) started more than a decade ago with Prof. Motonobu Goto, and was renewed by Dr. Armando T. Quitain when he visited as an IROAST Young Researcher in 2017 for half a year. This collaboration also supported visits of 8 promising young students from Kumamoto under TOBITATE Ryugaku Japan Program or IJEP Scholarship, significantly broadening the global perspectives of participating students to the science and technology of this promising environment-related topic on biomass utilization.

Consultation and discussion with the students significantly helped them improved their research capability. Collaboration with prominent researchers like Prof. Maria Jose Cocero guided the students the right direction for their respective research topics. This also gave them rare opportunity to have a discussion with world-renowned and leading scientists/international researchers in this field, thereby improving their research capability and global mindset.

3. Prospect for further research collaboration with Kumamoto University

Research collaboration with Kumamoto University will be further strengthened by continuous exchange of researchers and students. With subsequent visits in the future, it is expected that a new set of students will benefit from it, and more research papers will be jointly published from this extended collaboration.

4. List of co-authored papers published between April 2021 and March 2022.

N/A

No.3-5	Image processing and analysis on Geotechnical and Geoenvironmental Engineering		
Name	Patrice Delmas		
Affiliation	The University of Auckland Email: p.delmas@auckland.ac.nz	Title	Associate Professor
Research Field	Environmental Science/Image processing		
Host Professor	Toshifumi Mukunoki		
Affiliation	Email: mukunoki@kumamoto-u.ac.jp	Title	Professor

### 1. Research achievements

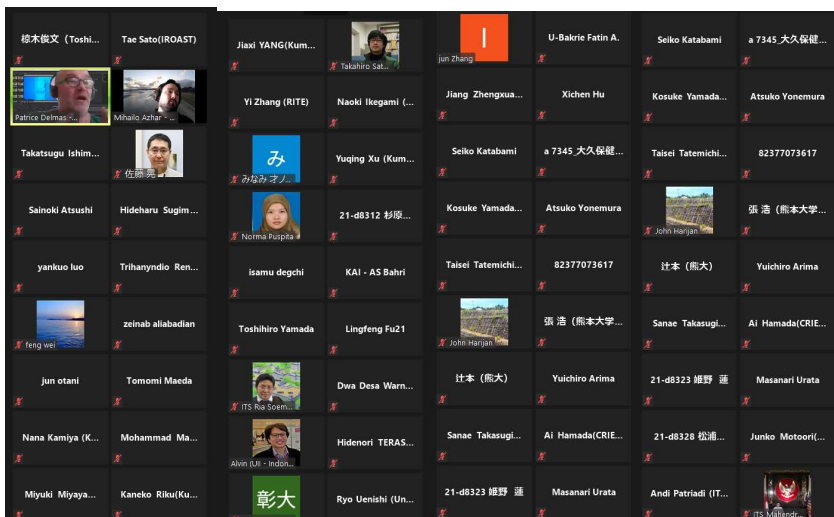
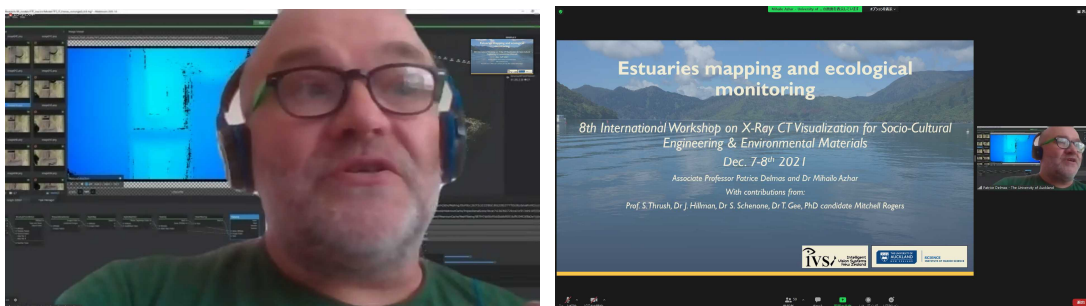
To upgrade Plug-in of Image J to perform EM algorithm calculation for image segmaentation.

### 2. Overview and significance of the research collaboration with Kumamoto University

These activities will be able to contribute:

- 1) Enhancement of worldwide activities with X-Earth center,
- 2) Enhancement of international collaboration, and
- 3) Development of human resources which are not only faculty members but also graduate students

As an active researcher in the field of X-ray CT and micromechanics of geomaterials, I organized *Interdisciplinary Imaging Research* in a workshop as a visiting professor on Dec. 8<sup>th</sup>, 2021.



### The 8th International Workshop

on X-Ray CT Visualization for Socio-Cultural Engineering  
& Environmental Materials, 2021

- Challenge to Medicine, Science-Engineering Collaboration -

Dec. 7-8th, 2021

[Workshop Top](#) [Greeting](#) [Committee](#) [Program](#) [Submission](#) [Proceedings](#)

## Committee

### Organizing Committee

- Toshifumi Mukunoki, General Chair
- Akira Sato, Vice Chair
- Atsushi Sainoki, Secretary General
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- Yoshitaka Nakanishi, Prof
- Yuichiro Arima, Associate Prof
- Takatsugu Ishimoto, Associate Prof
- Shinichiro Sawa, Prof
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### External Supporting Members

- Patrice Delmas, Associate Prof, The University of Auckland
- Cino Viggiani, Prof, Université Grenoble Alpes
- Koichi Nishiyama, Prof, Miyazaki University

Prof. Patrice Delmas

Figure 1. Committee member of IWX2021

### 3. Prospect for further research collaboration with Kumamoto University

Prof. Mukunoki and I applied JSPS Invitational Fellowship for Research in Japan in 2021. Unfortunately our proposal was not accepted. Now, X-Earth center has three great CT scanner so I have many opportunity to visit Kumamoto University and promote research with respect to image analysis for Prof. Mukunoki's project. Moreover, I have some good UAV and spectral camera so I can also contribute the monitor slope for natural disaster study. Prof. Mukunoki also has same idea already so I would like to come to Kumamoto with my team soon.

### 4. List of co-authored papers published between April 2021 and March 2022.

Under writing



No.3-6	Development of a method to simulate the mechanical behaviour of rock discontinuity during fluid injection		
Name	Derek Elsworth		
Affiliation	The Pennsylvania State University USA Email: <a href="mailto:elsworth@psu.edu">elsworth@psu.edu</a>	Title	Professor
Research Field	Green Energy		
Host Professor	Atsushi Sainoki		
Affiliation	Email: <a href="mailto:atsushi_sainoki@kumamoto-u.ac.jp">atsushi_sainoki@kumamoto-u.ac.jp</a>	Title	Associate Professor

### 1. Research achievements

Fluid injection into a rock mass from industrial processes can cause perceivable seismic events that may raise public concern. This seismicity can be caused by injection-induced fluid pressure in the rock mass causing slip on faults. Here we provide a method to distinguish between aseismic and seismic mobilisation and to predict fault movement due to anthropogenic fluid injection. This was achieved by extending a two-dimensional fully coupled fluid and mechanical loading extended finite element model (X-FEM) via development of a dynamic analysis module as a standalone code in Matlab. This code considers fluid flow along the fault as well as into the rock mass and uses a directly proportional equivalent injected flow rate into the fault as the input. This model was validated by comparing the resultant pressure and normal and shear displacements calculated at the centre of the fault against observations from a decametre-scale in-situ experiment. The main results were that not only the mechanics of the fault could be simulated using this approach, but that the simulation correctly predicted the onset of seismicity and transition to dynamic analysis and at similar seismic magnitudes to observations. Parametric studies investigated the influence of the flow rate (when injecting a constant volume of water) and the effect of rate and state frictional parameters in representing modes of seismicity. The main conclusion is that this modelling technique using X-FEM provides an accurate method in accurately predicting modes, location and timing of fault remobilisation due to fluid injection inclusive of important precursory aseismic fault movements. These results are important, since they demonstrate the applicability of this X-FEM approach in accurately predicting the mechanics of fault reactivation and the resultant seismicity, aiding in the design and scheduling of fluid injection operations and in the optimisation of operational parameters.

### 2. Overview and significance of the research collaboration with Kumamoto University

Sainoki laboratory at Kumamoto University has developed a novel numerical simulation code in the framework of the Extended Finite Element Method, whereby it is possible to simulate the mechanical behaviour of a fault during fluid injection into the fault whilst considering the rock-fluid coupling behaviour with high accuracy and saving the RAM. G3 Lab at Penn State conducted an experiment in the field, where fluid was injected into a natural fault situated at a great depth. The data obtained from the experiment are used in this collaborative research to improve the accuracy of the numerical simulation code and further investigate the dynamic behaviour of the fault during fluid injection related to the occurrence of induced earthquake. Through this research collaboration, it would be possible to develop a technology that can mitigate the risk for induced seismicity during fluid injection related to various green energy-related engineering projects, such as geothermal energy development and carbon capture and sequestration, thus contributing to sustainable energy development.

3. Prospect for further research collaboration with Kumamoto University

Various experimental data can be provided by G3 Center at Penn State, which can be utilized for the numerical simulation. By combining the XFEM-based numerical simulation with the experimental data, further investigation on the fluid injection-induced fault-slip can be achieved, thus contributing to the development of safe and sustainable green energy technologies.

4. List of co-authored papers published between April 2021 and March 2022.

Schwartzkopff, A.K., Sainoki, A., Elsworth, D., 2021. Numerical simulation of mixed aseismic/seismic fault-slip induced by fluid injection using coupled X-FEM analysis, IJRMMS, 147, 104871 (Impact Factor = 7.135)

No.3-7	Study on intelligent mobile robot to escort with intention inference		
Name	Tomonari Furukawa		
Affiliation	Department of Mechanical and Aerospace Engineering, University of Virginia, USA Email: tf4rp@virginia.edu	Title	Professor
Research Field	Robotics and computational/experimental mechanics		
Host Professor	Makoto Kumon	Title	Professor
Affiliation	Faculty of Advanced Science and Technology Email: kumon@gpo.kumamoto-u.ac.jp		

### 1. Research achievements:

There have been several achievements through the invitation. In summary, achievements include:

1. Experimental results: As proposed in the project, the primary aim of this invitation was to develop an intelligent mobile robot that escorts with intention inference. We developed an identical system at Kumamoto University so that we could do experiments collaboratively. We conducted experiments and collected data.
2. Mapping capability: In order for safe navigation, a robot escort needs to develop and update a map. This necessitates the capability of Simultaneous Localization and Mapping (SLAM). As Kumon has been working on the detection of loop closure for SLAM, we worked on the mapping capability as part of the escorting robot project.
3. Vision capability: In addition to mapping, the escorting robot needs high-precision vision since it observes human behavior and its environment. As Furukawa has been working on high-precision vision based on photometric stereo, we also worked on the vision capability as part of the escorting robot project.

### 2. Overview and significance of the research collaboration with Kumamoto University

Kumon and Furukawa started their collaboration in 2007 when Kumon came to University of New South Wales (UNSW) where Furukawa worked at that time for his sabbatical. Their collaboration has continued for nearly 15 years, and the topics of collaboration during the period include not only robot escorting, robotic mapping and robotic vision but also sound localization, drones and multi-robot cooperation. Furukawa visited Kumamoto University as JSPS Fellow in 2013 and 2021. He also visited Kumamoto University as IROAST Visiting Professor in 2017, 2018 and 2019. Kumon had his sabbatical with Furukawa in 2007 (UNSW) and 2019 (VT/UVA). In addition, there were several other visits. The collaboration has resulted in over 10 refereed papers. Kumon's graduate student studied with Furukawa at VT for a few months as an exchange student, and Furukawa's graduate student also studied with Kumon at Kumamoto University for a few months under the National Science Foundation (NSF) program. It is a rare case that the collaboration continued intensively for such a long time.

### 3. Prospect for further research collaboration with Kumamoto University

We keep exploring external funding and leverage external funding for their collaboration. Kumon was Senior Personnel of Furukawa's NSF project on sound localization and invited to VT. Furukawa was also invited to Kumamoto University through Kumon's grant. We keep exploring external funding to support their collaboration in addition to the IROAST program.

4. List of co-authored papers published between April 2021 and March 2022.

Y. Qin, M. Kumon and T. Furukawa, "Estimation of a Human-Maneuvered Target Incorporating Human Intention," *Sensors*, Vol. 21, No. 16: 5316, 2021.  
<https://www.mdpi.com/1424-8220/21/16/5316>

No.3-8	Plant Cell and Developmental Biology		
Name	Olivier Hamant		
Affiliation	INRAE, CNRS Email: olivier.hamant@ens-lyon.fr	Title	Professor
Research Field	Advanced Green Bio		
Host Professor	Sinichiro Sawa		
Affiliation	GSST/IRCAEB Email: sawa@kumamoto-u.ac.jp	Title	Professor

#### 1. Research achievements

We hypothesized that plant stem integrity depends on the epidermal resistance to mechanical stress, and we have identified about stem integrity requires a load-bearing epidermis by using Arabidopsis genetic approach.

#### 2. Overview and significance of the research collaboration with Kumamoto University

Kumamoto University has launched IRCAEB in GSST for agricultural research. Our collaboration is related to agricultural perspective, and this collaboration is quite important for the development of Agricultural Research Activity in KU.

#### 3. Prospect for further research collaboration with Kumamoto University

Now, our university have IRCAEB in GSST, and many plant researchers are working. Professor Hamant is one of the leader in the plant science field, and we could collaborate not only in science or grant application but also education between KU and Europe.

#### 4. List of co-authored papers published between April 2021 and March 2022.

N/A

No.3-9	Nano-medicine and Theranostics		
Name	Ick Chan Kwon		
Affiliation	Biomedical Research Institute, Korea Institute of Science and Technology (KIST), Korea Email: ikwon@kist.re.kr	Title	Principal Research Scientist
Research Field	Nanomaterial Science		
Host Professor	Takuro Niidome		
Affiliation	Faculty of Advanced Science and Technology Email: niidome@kumamoto-u.ac.jp	Title	Professor

## 1. Research achievements

In the last decades, the development of nanocarriers for the efficient delivery of drugs offers a wide range of biotechnology applications. Due to the advantage of the size, nanomaterials have been shown to be robust drug delivery systems and may be useful for encapsulating drugs and enabling more precise targeting with a controlled release by various external stimulation (ex. pH, ROS, Temperature, and so on). Nanomedicine has revolutionized existing cancer therapies through the improvement of pharmacological kinetics and dynamics. As well, image-guided drug delivery can be used for various purposes, ranging from simple and straightforward biodistribution studies to extensive and elaborate experimental setups aiming to enable “personalized medicine”, and to improve the efficacy of combined modality anticancer therapy. Despite the enormous progress in the field of nanotherapeutics, the use of artificially synthesized nanocarriers still faces several challenges, including rapid clearance from blood circulation, off-target effects, and ineffective nanoparticles (NPs) transfer in patients with advanced forms of cancer. Furthermore, NPs will encounter multiple physiological barriers that influence their effectiveness, such as blood circulation, NPs-protein interaction, extravasation into tumor tissue or the tumor microenvironment (TME), phagocytic sequestration, and renal clearance.

Prof. Kwon is an expert in smart nanomaterials for bioimaging. He gave us information for state-of-art diagnosis and drug delivery systems and lots of advice for our research unit. His support will be a great basis for our research activities for the development of novel therapeutic approaches. Although he could not come to IROAST and have a chance to talk together due to the pandemic of COVID-19 in 2020, in 2021, we are going to have chances to talk through the web system, and exchange information about our research work and the progress of this research field in the world.

## 2. Overview and significance of the research collaboration with Kumamoto University

Under pandemic, we couldn't contact face-to-face. However, the border starts to be opened and travel will be possible soon. Dr. Kwon wishes that the IROAST's research support for young researchers and interdisciplinary collaboratives are kept expanding.

Since 2019, Dr. Kwon provide polymers that were developed/patented by Dr. Kwon. The provided polymers were modified in the Lee lab for advanced application. His research team kept support to modified polymers and evaluated the properties. Furthermore, Dr. Kwon keeps advising for immune cell-mediated delivery for suggesting a new paradigm in the field of lung inflammatory diseases. Dr. Kwon and Lee's lab keep closely discussing the project every month with involved students and step forward to reach the final goal.

### 3. Prospect for further research collaboration with Kumamoto University

Dr. Kwon was invited for joining the WPI project of IRCMS. If Kumamoto University will be granted the WPI program, he will contribute delivering nanodiamonds to the developmental stage of each organ. The project is a world-first trial and many international researchers in different fields will be gathering at Kumamoto and performing interdisciplinary research.

No.3-10	Fabrication of Nano-to-Submicron-sized Exclusive Pods and Their Spatial Functionalization		
Name	Reiko Oda		
Affiliation	Centre national de la recherche scientifique (CNRS), Université de Bordeaux, France Email: r.oda@cbmn.u-bordeaux.fr	Title	Research Director
Research Field	Nanomaterial Science		
Host Professor	Makoto Takafuji		
Affiliation	Faculty of Advanced Science and Technology Email: takafuji@kumamoto-u.ac.jp	Title	Professor

### 1. Research achievements

- The second term of joint research project, Laboratoire International Associé “Chiral Nanoobjects for Photonic Application (LIA-CNPA)” supported by Agence Nationale de la Recherche (ANR) France, is proceeding.
- The collaboration project “Fabrication of nano-to-submicron-sized exclusive pods and their spatial functionalization” (Grants-in-Aid for Fostering Joint International Research (B) funded by JSPS, FY2017–FY2021) is progressing well, but the decision was made to extend the project through FY2022 to allow for reciprocal visits.
- Dr. Nanami Hano, a member of the research unit “Nano-organics and Nano-hybrids”, has joined Reiko Oda’s group as a JSPS Overseas Research Fellow from March, 2022. She will accommodate in UB for two years and may accelerate our collaborations.
- Two co-authored papers have been published in the international scientific journals.
- In FY2021, Japanese and French members could not visit each other because of COVID-19 pandemic.

### 2. Overview and significance of the research collaboration with Kumamoto University

Although we were not able to realize mutual visits in FY2021, we have been able to implement our joint studies so far without delay. Research results were published in two papers in the distinguished international journals, and several research presentations were made at domestic and international conferences. The project, in which young researchers and graduate students participated, also contributed to the development of young researchers. In particular, Dr. Nanami Hano, a member of the research unit “Nano-organics and Nano-hybrids”, joined to Dr. Reiko ODA's laboratory as a JSPS Overseas Research Fellow for two years from March 2022, which is expected to accelerate our collaborations.

### 3. Prospect for further research collaboration with Kumamoto University

We have applied for the research fund (Bilateral Joint Research Projects, JSPS) with other members of the University of Bordeaux and plan to further expand our joint research framework with the University of Bordeaux. The renewal of the exchange agreement with the University of Bordeaux is planned in FY2022, and we believe that the contribution of our research exchanges will be significant.



4. List of co-authored papers published between April 2021 and March 2022.

- 1) Enantioselective self-assembled nanofibrillar network with glutamide-based organogelator  
N. Nagatomo, H. Oishi, Y. Kuwahara, M. Takafuji, R. Oda, T. Hamada H. Ihara  
*Nanomaterials*, Vol. 11(6), 1376, **2021**. DOI: 10.3390/nano11061376. Special issue  
“Self-assembled nanostructures for molecular recognition” (Special editors: Makoto  
Takafuji and Hirotaka Ihara)
  
- 2) Lanthanide ion-doped silica nanohelix: a helical inorganic network acts as a chiral source  
for metal ions  
T. Harada, H. Yanagita, N. Ryu, Y. Okazaki, Y. Kuwahara, M. Takafuji, S. Nagaoka, H.  
Ihara, R. Oda  
*Chemical Communications* (RSC), Vol. 57, pp. 4392-4395, **2021**. DOI:  
10.1039/d1cc01112j

No.3-11	Fabrication of various porous materials through explosive and other processes and the evaluation of such porous materials under high-rate impact loading		
Name	Zoran Ren		
Affiliation	Faculty of Mechanical Engineering, University of Maribor Email: zoran.ren@um.si	Title	Professor
Research Field	Nanomaterial Science/ Green Energy/ Environmental Science/ Advanced Green Bio/ Other (Materials processing)		
Host Professor	Kazuyuki Hokamoto		
Affiliation	Institute of Industrial Nanomaterials Email: hokamoto@mech.kumamoto-u.ac.jp	Title	Professor

### 1. Research achievements

Due to the continuing pandemic, we could not realize the planned research exchanges, which reflected in reduced combined research activities. We have taken advantage of the online communication to keep in touch, which led to the successful publication of one joint article in high-ranked international journal. We plan to return to regular research exchanges in the second half of 2022 and in 2023.

### 2. Overview and significance of the research collaboration with Kumamoto University

The joint research work objective is to continue to perform frontier research of cellular structure designs on different length scales for their broader use in the next generation of engineering (lightweight structures, energy absorbers), medical (vascular stents and scaffolds), sports (cellular textiles, vibration mitigation) and other products. The collaborative research effort leads to significant advances in design, production technology, geometrical and mechanical characterization of new metamaterials with cellular structures with the efficient application of theoretical, analytical, experimental, and computational research methods. The research focuses on developing new cellular metamaterials designs with specifically tailored (individualized) mechanical properties (stiffness, damping, energy absorption, etc.) by a careful combination of cell topology and morphology with efficient use of (multi)material combinations to achieve their best structural and functional performance in new products with advanced multifunctional properties. We adapt, upgrade, and propose new characterization methodologies using improved testing rigs supported by advanced computational simulations throughout the entire research process.

### 3. Prospect for further research collaboration with Kumamoto University

Kumamoto University is a very friendly academic and research institution with great facilities and excellent professors and students. Many excellent specialists work at the Institute of Industrial Nanomaterials, covering the fields essential for developing and characterizing new metamaterials. The Institute also has at its disposal some excellent and unique research equipment, like the powder gun and 2 explosion pits together with the measuring equipment, which together enables quality observations of materials behaviour at very high strain rates.

Research groups at both partner institutions have significant and complementary experiences in fabrication, characterization and computational modelling of novel engineering materials. The cooperation contributes to the effective transfer of knowledge between the partner institutions. Since the undertaken research effort is scientifically and industrially significant for both partner institutions, it is safe to assume that future research collaboration will result in important scientific findings, published in high ranking reviewed scientific journals and possibly some new patents for industrial application.

4. List of co-authored papers published between April 2021 and March 2022.

Nishi, M., Tanaka, S., Mori, A., Vesenjak, M., Ren, Z., Hokamoto, K.  
Mechanism Elucidation of High-Pressure Generation in Cellular Metal at High-Velocity Impact  
(2022) *Metals*, 12 (1), art. no. 128.

No.3-12	Application of X-ray CT		
Name	Gioacchino (Cino) Viggiani		
Affiliation	Laboratoire 3SR, UGA, Grenoble, France Email: cino.viggiani@3sr-grenoble.fr	Title	Professor
Research Field	Advanced Green Bio		
Host Professor	Jun Otani		
Affiliation	Faculty of Advanced Science and Technology Email: junotani@kumamoto-u.ac.jp	Title	Professor

### 1. Research achievements

As an active researcher in the field of X-ray CT and micromechanics of geomaterials, I organized a workshop as a visiting professor. During my stay in Kumamoto, I performed the following activities:

- 1) Research meeting with the members of X-Earth Center (about X-ray CT applications) (please check IROAST HP)
- 2) International workshop on X-Earth (IWX) with the members of X-Earth Center (please check IROAST HP)
- 3) One of master students in Otani's lab. has studied abroad at 3SR from September in 2021 to July in 2022.

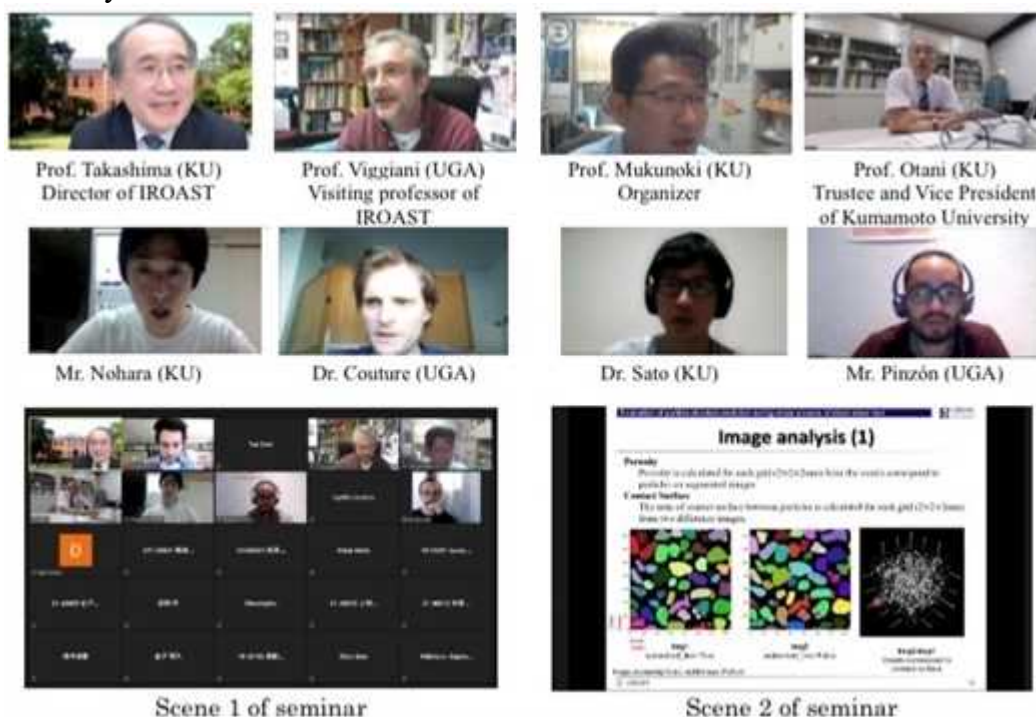


Photo.1 Screenshot of Online research meeting held on May, 2021.

### 2. Overview and significance of the research collaboration with Kumamoto University

These activities will be able to contribute:

- 1) Enhancement of worldwide activities with X-Earth center,
- 2) Enhancement of international collaboration, and
- 3) Development of human resources which are not only faculty members but also graduate students

### 3. Prospect for further research collaboration with Kumamoto University

In fact, we have discussed about research collaboration with Kumamoto University and Caltech in the United States, of which Prof. Andrade is now also visiting professor at IROAST. All three institutions are very active for the research on micro mechanics and the use of X-ray CT in geomaterials. I hope we will have some further steps for these joint activities next year.

The screenshot shows the website for the 8th International Workshop on X-Ray CT Visualization for Socio-Cultural Engineering & Environmental Materials, 2021, held from Dec. 7-8th, 2021. The page is titled "Committee" and lists the following members:

- Organizing Committee**
  - Toshifumi Mukunoki, General Chair
  - Akira Sato, Vice Chair
  - Atsushi Sainoki, Secretary General
  - Jun Otani, Prof
  - Yoshitaka Nakanishi, Prof
  - Yuichiro Arima, Associate Prof
  - Takatsugu Ishimoto, Associate Prof
  - Shinichiro Sawa, Prof
  - Hidenori Terasaki, Prof
  - Naoki Ikegami
- External Supporting Members**
  - Patrice Delmas, Associate Prof, The University of Auckland
  - Cino Viggiani, Prof, Université Grenoble Alpes
  - Koichi Nishiyama, Prof, Miyazaki University

A box labeled "Prof. Cino Viggiani" has an arrow pointing to his name in the list of External Supporting Members.

Figure 1. Committee member of IWX2021

### 4. List of co-authored papers published between April 2021 and March 2022. Under writing

No.3-13	Utilization of photons and spins in Functional Materials		
Name	Tomoyasu Mani		
Affiliation	University of Connecticut USA Email: tomoyasu.mani@uconn.edu	Title	Assistant Professor
Research Field	Nanomaterial Science		
Host Professor	Yutaka Kuwahara		
Affiliation	Email: kuwahara@kumamoto-u.ac.jp	Title	Assistant Professor

#### 1. Research achievements

I could not alternately visit to Kumamoto city this year due to the COVID-19 crisis. Prof. Kuwahara and me discussed about recent research results by e-mail and online. We submitted a paper including those results to an international journal.

#### 2. Overview and significance of the research collaboration with Kumamoto University

Our collaboration is based on a mutual interest of developing novel functional molecules/materials, specifically those containing chiral moieties. The collaborations are two-fold: one is to help Prof. Kuwahara's work on chiroptical properties of supramolecular assemblies and the other is to jointly investigate a new series of small emissive molecules with chiral moieties. This collaboration enables us to expand our understanding of ways to design molecules/materials with new chiral effects.

#### 3. Prospect for further research collaboration with Kumamoto University

I sent the new compounds to Prof. Kuwahara for chiroptical analysis at the Kumamoto Univ. We expect to accelerate our collaborations for those analytical results.

#### 4. List of co-authored papers published between April 2021 and March 2022.

##### *Paper publication*

Y. Kuwahara, M. Ito, T. Iwamoto, M. Takafuji, H. Ihara, N. Ryu, T. Mani, Chemical redox-induced chiroptical switching of supramolecular assemblies of viologens, *RSC Advances*, 2022, **12**, 2019-2025. (DOI: 10.1039/D1RA08984F)

##### *Conference Presentation*

M. Ito, Y. Kuwahara, N. Ryu, T. Mani, H. Ihara, M. Takafuji, Chiroptical properties and their stability for supramolecular assemblies of viologen-modified glutamide derivatives and their reduced derivatives, The International Chemical Congress of Pacific Basin Societies (Pacifichem 2020), *Hybrid* (online and onsite at Hawaii, USA), Dec. 21, 2021.

No.3-14	Understanding the role of oceanic chemoattractants in marine animal navigation		
Name	Daniel P. Zitterbart		
Affiliation	Woods Hole Oceanographic Institution USA Email: dpz@whoi.edu	Title	Associate Scientist
Research Field	Environmental Science		
Host Professor	Kei Toda		
Affiliation	Faculty of Advanced Science and Technology Email: todakei@kumamoto-u.ac.jp	Title	Professor

### 1. Research achievements

Dr. Zitterbart could not visit Kumamoto University in 2021 as well as in 2020 due to situation of COVID-19. Our collaboration is basically based on joined field research and it was difficult to conduct effectively these two years. However, Dr. Zitterbart visited Antarctic in November to perform preliminary survey for Emperor Penguin's chemoattractants. It will lead to Antarctic joined survey in 2022. In March, Dr. Zitterbart did onboard measurement of chemicals in the North Atlantic Ocean to investigate role of oceanic chemicals in behavior of whales. Two measurement devices were used, one is developed by Dr. Toda and the other is by Dr. Zitterbart with assistance from Dr. Toda. In addition, we have validated sampling/analysis method, which we used in Antarctic Ocean, March 2020. Data obtained in Antarctic were rearranged to be ready for submitting manuscripts.

### 2. Overview and significance of the research collaboration with Kumamoto University

This is the international collaboration among USA, Japan, Germany, and Sweden. World top researchers joined from the field of physical remote monitoring, chemical analysis, acoustical oceanography, and ocean animal behavior.

### 3. Prospect for further research collaboration with Kumamoto University

Dr. Zitterbart and Dr. Toda are actively working on extending the collaboration. This is expressed in jointly planned field experiments (up to 6 in the next 3 years) and in coordinated Research proposals across Japanese and US funding agencies to fund our field experiments. After initiation of a student exchange program, we plan to have concurrent PhD students in this research fields at both institutions.

### 4. List of co-authored papers published between April 2021 and March 2022.

None from April 2021 to March 2022.