Title: Low Dose Whole Lung Radiotherapy for High Risk Intubated Patients with COVID-19 Pneumonia and ARDS

Applicants: Harry Michael Moyses, Assistant Clinical Professor. Radiation Oncology University of California Irvine; Dante Roa, Clinical Professor, Radiation Oncology University of California Irvine: Ales Necas, Senior Scientist; Toshiki Tajima, Professor, University of California Irvine

Summary: In the early part of the 20th century the relatively new modality of radiotherapy was effectively used to treat pneumonia. With the advent of very effective antibiotics and steroids in late 1930's and 1940's the use of radiotherapy for pneumonia was abandoned and forgotten. Although radiotherapy is still used for inflammatory diseases: graves opthalmopathy and for the prophylaxis of keloids, dupuytren contractures, and heterotopic ossification after surgery. It is also used occasionally for acute and chronic inflammatory diseases not responding to antibiotics and other therapies, most notably in Germany.

In light of the COVID-19 epidemic resulting in long periods of intubation, refractory pneumonias, ARDS high mortality rates, especially in the elderly with high population penetrance and quick spread, we propose a novel approach: Low Dose Whole Lung Radiotherapy for High Risk Intubated Patients with Covid-19 pneumonia and ARDS. This would be for a specific high risk population who are refractory to other therapies for ARDS including steroids, antivirals and antibiotics, who otherwise are at a high risk of death. We would deliver very low doses which have been shown to be effective and would have minimal to no acute side effects. There are potentially some late side effects, such as uncommon secondary cancers, and therefore initially, we would enroll people over 50. This would be a randomized trial involving 20 people. 10 patients would receive the chest radiotherapy. We would deliver the radiotherapy using standard diagnostic radiotherapy equipment (e.g. c-arm) in the hospital, to minimize the movement of the patient, for convenience and to minimize the risk of COVID-19 spread.

Proposal:

The aim of this proposal is to test the effectiveness of low dose whole lung radiotherapy for high risk intubated patients with COVID-19 pneumonia and ARDS. This a preliminary project that will hopefully lead to a cure for these patients. Simultaneously, we will plan for other related projects and NIH funding . Results of this project would help in this. The likelihood of extramural funding is high. The project can begin immediately. Depending on the size of the outbreak, we hope to complete this project in the next two month.

Although this treatment has been used in the past with success, it is a randomize trial that would benefit from IRB review and family consent for enrollment.

Innovations include the use of low dose radiotherapy in the management of pneumonia and ARDS in COVID-19 patients, as well as the use of diagnostic xray equipment in the delivery of low dose radiotherapy.

Dr Moyses will prescribe the treatment and oversee the patient's clinical management as a consultant. Dr Roa will manage the delivery of the prescribed dose.

Addendum:

The Intervention is whole lung radiotherapy to 25 Gy. The experimental design is a randomized trial, radiotherapy or no radiotherapy. The primary endpoint is death. Secondary endpoints include time to death and time to extubation. Patients randomized will be 50 years or older, intubated and at high risk of death having failed standard treatment.

Twenty patients will be enrolled (10 receiving radiotherapy). This is based on a mortality rate without radiotherapy of 50% to 70%. Conservatively if 5 of 10 patients pass away in the control arm and only 2 of 10 pass away in the intervention arm, the p value would be 0.52. If 7 of 10 pass away in the control arm and only 2 of 10 pass away in the intervention arm, the p value would be 0.024. There is a good probability of having 20 patients with COVID-19 on ventilators in the next 2 months.

Facilities and Resources include: c arm x-ray machine, portable in room shielding, x-ray technician, physics calculation and dose monitoring, physician evaluation, prescription and follow up. IRB application, patient and/or family consent.

References:

How Radiotherapy Was Historically Used to Treat Pneumonia:Could it Be Useful Today? Edward J. Calabrese and Gaurav Dhawan, Yale J Biol Med 86(4):555-570, 2013.

Consensus Guidelines for Radiation Therapy of Benign Diseases: A Multicenter Approach in Germany. Oliver Micke et al, IJROBP 52(2), 496-513, 2002.

Itemized Budget:

$5000 data manager

OMB No. 0925-0001 and 0925-0002 (Rev. 03/2020 Approved Through 02/28/2023)

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Harry Michael Moyses

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Assistant Clinical Professor University of California, Irvine. Radiation Oncologist

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Southern California	-	06/1995	Radiation Oncology
University of Southern California	-	06/1991	Internship, Rotating
University of Southern California	MD	06/1990	Radiation Oncology
Harvard University	AB	06/1986	Biology

A. Personal Statement

I am a radiation oncologist with deep experience in many areas of the field. My goal is to provide the best care to my patients now and in the future. I do this through my practice now and through research, for the future.

B. Positions and Honors

Fellow American College of Radiation Oncology

American Board or Radiology, Radiation Oncology

American Board of Radiology, Hospice and Palliative Care

Member American Society of Therapeutic Radiation Oncology (ASTRO)

Member American Academy of Hospice and Palliative Medicine (AAHPM)

Radiologic Society of North America (RSNA) Research Prize 1994

C. Contributions to Science

Clinical radiation oncologist enrolling patients in SWOG, RTOG, NRG,GOG,ECOG, longstanding IRB chairman and member, teaching medical students and residents.

D. Additional Information: Research Support and/or Scholastic Performance

OMB No. 0925-0001 and 0925-0002 (Rev. 03/2020 Approved Through 02-28-2023)

A. BIOGRAPHICAL SKETCH

B. Provide the following information for the Senior/key personnel and other significant contributors.
C. Follow this format for each person. DO NOT EXCEED FIVE PAGES.

D. NAME: Roa, Dante

E. eRA COMMONS USER NAME (credential, e.g., agency login):

F. POSITION TITLE: Clinical Professor of Medical Physics – UC Irvine Radiation Oncology

G. EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
King College	B.S	05/1989	Physics
Florida State University	M.S.	05/1994	Physics
Florida State University	Ph.D.	05/1997	Nuclear Physics
Argonne National Laboratory - Postdoc		05/2001	Diagnostic Nuclear Medicine
Yale University – Fellowship		05/2003	Medical Physics - Radiotherapy

H. Personal Statement

My primary interest has always been to develop and utilize the latest technology in radiation therapy to deliver the most efficient and effective treatment to a patient. For this purpose, I have worked in

the implementation and dosimetric validation of a volumetric-modulated arc therapy (VMAT) treatment technique for stereotactic radiosurgery (SRS) which can offer patients a precise and faster SRS treatments; have investigated the potential of using human embryonic stem cells to restore cognition in patients undergoing brain radiotherapy through high dose (10Gy) irradiation to whole brain and single hippocampus of athymic nude rats using a high-precision radiation treatment technique based on VMAT.

Along with this work, I have given numerous presentations and webinars on the use of VMAT highlighting my experience its efficacy.

Furthermore, I teach physics to radiation oncology (MDs) and medical physics residents (PhDs), which is always a rewarding and stimulating experience since this group brings a clinical perspective which often differs from the analytical approach that characterizes the physics field. This is the synergy that I embrace and pursue.

1. D. Schiffner, D. Roa, J. Kuo, N. Ramsinghani and M. Al-Ghazi, The Use of RapidArc™ Volumetric Modulated Arc Therapy To Deliver Stereotactic Radiosurgery And Stereotactic Body Radiotherapy To Intracranial And Extracranial Targets. Int. J. Radiation Oncology Biol. Phys., Vol. 75, 3, S118 (2009).
2. Acharya MM, Roa DE, Bosch O, Lan ML, Limoli CL, Stem cell transplantation strategies for the restoration of cognitive dysfunction caused by cranial radiotherapy, J Vis Exp. 2011 Oct 18;(56). pii: 3107. doi: 10.3791/3107 (2011).
3. Roa DE, Schiffner DC, Zhang J, Dietrich SN, Kuo JV, Wong J, Ramsinghani NS, Al-Ghazi MS., The use of RapidArc volumetric-modulated arc therapy to deliver stereotactic radiosurgery and stereotactic radiotherapy to intracranial and extracranial targets. Med. Dosim. 37, 257 (2012).
4. Parihar VK, Acharya MM, Roa DE, Bosch O, Christie LA, Limoli CL, Defining functional changes in the brain caused by targeted stereotaxic radiosurgery, Transl. Cancer Res. April 1; 3(2): 124–137, 2014

I. Positions and Honors

Positions and Employment

2015– Clinical Professor – Department of Radiation Oncology – UC Irvine
2009–2015 Associate Clinical Professor – Department of Radiation Oncology – UC Irvine
2005– Medical Dosimetry Program, Co-Director - Department of Radiation Oncology – UC Irvine
2003–2009 Assistant Clinical Professor – Department of Radiation Oncology – UC Irvine
2001–2003 Postdoctoral Fellowship in Therapeutic Radiology – Yale University School of Medicine
1997–2001 Postdoctoral Associate – Argonne National Laboratory, Advanced Photon Source Division

Other Experience and Professional Memberships

2016 Chilean FONDECYT, Grant Reviewer
2015– IAEA – Invited Faculty
2014– ASTRO Refresher Course – Invited Faculty
2014– Member, AAPM Latin American Affairs Subcommittee
2013– Ad-hoc Reviewer, Journal of ALFIM
2013– Member, Asociacion Latinoamericana de Fisica Medica – ALFIM

2013– Member, Asociacion Latinoamericana de Terapia Radiation Oncologica – ALATRO
2013 The Abdus Salam International Center for Theoretical Physics – Radiotherapy Course – Invited Faculty
2011– Member, Society of Directors of Academic Physics Programs – SDAMPP
2009– Varian Medical Systems - Speaker
2009– Member, American Society for Therapeutic Radiology and Oncology – ASTRO
2006– Ad-hoc Reviewer, Medical Dosimetry
2006– Ad-hoc Reviewer, Medical Physics
2001– Member, American Association of Physicists in Medicine – AAPM
2000–2002 Member, Society of Optical Engineering – SPIE

Honors

1998 Tennessee Eastmann Scholarship, King College, Bristol, TN
1989 NSF – Summer Research Fellowship, Florida State University, Tallahassee, FL
1990 DOE/ANL – Summer Research Fellowship, Argonne National Laboratory, Argonne, IL
1992–1996 DOE/ANL – Graduate Student Assistantship, Argonne National Laboratory, Argonne, IL

2015 Peruvian Institute of Nuclear Energy – IPEN, Medical Physics Medal

J. Contributions to Science

1. **My contributions to science began in the field of experimental nuclear physics were in collaboration with scientists from other institutions I set out to investigate previously reported but not fully corroborated anomalies appearing in the energy spectra of coincident electron-positron pairs created in heavy ion collisions (e.g. U+Ta and U+Th) at energies near the Coulomb barrier - right below any fusion effects could occur. These anomalies consisted on well-defined peaks at specific energies appearing in what should have been a continuous energy spectrum from either an electron or positron. After an extensive experimental work, this project disprove the claims of these anomalies made by the original scientific group and prompted them to revisit and collect new data. This new data showed no anomalies and was consistent with our results. It was left to this group to determine the cause of these fictitious anomalies.**

   Publication list:
   http://teacher.pas.rochester.edu/Research/APEX/Publications/APEX_Publication_List.html

2. **Although basic research provided me with the opportunity to solidify my critical thinking, ingenuity and problem solving skills, it did not provide me with an immediately applicable technology that could be applied to everyday life. So I set out to work on the development of a high-spatial resolution imaging system based on photon diffraction for diagnostic nuclear medicine. Initially, this system consisted on a lens made out of concentric rings of copper crystals. Each ring consisted of crystals oriented to a specific crystalline lattice plane such that incoming gamma-rays (e.g. 141 keV from Tc-99m) from a radiopharmaceutical would be re-directed, by the lattice plan, onto a high resolution CdZnTe detector. In other words, a process similar to visible light bouncing off a mirror. I was successful in demonstrating the proof of principle of this technology by achieving spatial resolutions of less than 2 mm. This technology was subsequently acquired by an Israeli company.**

a. Smither RK and Roa DE. Crystal diffraction lens for medical imaging. Progress in Biomedical Optics and Imaging. Proceedings of SPIE Vol 3977: 342-352, 2000.
b. Roa DE**,** Smither RK. A copper crystal lens for medical imaging: first results. SPIE International Symposium on Medical Imaging 2001, San Diego, California. February 2001.
c. Smither RK, Roa DE. The physics of medical imaging with crystal diffraction lenses. SPIE International Symposium on Medical Imaging 2001, San Diego, California. February 2001.
d. Roa DE, Smither RK, Zhang X, Nie K, Shieh YY, Ramsinghani NS, Milne N, Kuo JV, Redpath JL, Al-Ghazi, MSAL, Caligiuri P. Development of a New Photon Diffraction Imaging System for Diagnostic Nuclear Medicine, Netherlands: Springer, 2006.

3. Another project that I performed was to investigate the dose at sub-millimeter distances from Sr/Y-90 source train from a Novoste Beta-Cath system used for irradiation of a blood vessel after balloon/stent angioplasty. This work was paramount because it was the first experimental verification of the dose delivered to a blood vessel at a very close distance to data provided by Monte Carlo simulations. Dose measurements at submillimeter distances required irradiating Gafchromic film in a very controlled setup environment consisting of liquid and solid water multiple times.

   a. Roa DE, Song H, Yue N, d'Errico F and Nath R., Measured TG-60 Dosimetric Parameters of the Novoste Beta-Cath ^{90}Sr/Y Source Trains for Intravascular Brachytherapy. Proceedings of the Cardiovascular and Revascularization Therapy (CRT) Volume/Issue: vol 3/3-4 pp 199 – 204 (2003).
   b. Roa DE, Song H, Yue N, D'Errico F and Nath R, Dosimetric characteristics of the Novoste Beta-Cath Sr/Y-90 source trains at sub-millimeter distances. Med. Phys. 31: 1269-1276, 2004.

K. Research Support

Completed Research Support

IRG-98-279-04
Roa (PI) 02/01/2005 – 01/31/2006
American Cancer Society
Overall sensitivity assessment via Monte Carlo calculations of a new high spatial resolution cancer imaging system for nuclear medicine and molecular imaging
The goal of this project was to determine the efficiency and sensitivity of a photon diffraction imaging system for detecting 1-2mm tumors using computer simulations.
Role: PI

School of Medicine – College of Medicine on Research and Graduate Academic Programs

Roa (PI) 2006/2007
Fiscal Year

Efficiency Assessment of a High Spatial Resolution Imaging System for Nuclear Medicine using Monte Carlo Simulations

This project is a continuation of the work that started under the support the support of the American Cancer Society grant described above.

Role: PI

OMB No. 0925-0001 and 0925-0002 (Rev. 03/2020 Approved Through 02-28-2023)

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. DO NOT EXCEED FIVE PAGES.

NAME: Necas, Ales

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Principal Scientist

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Florida, Gainesville	B.S.	05/2000	Physics
University of California, Irvine	M.S.	05/2004	Physics
University of California, Irvine	Ph.D.	05/2007	Physics

A. Personal Statement

To improve quality of live and living conditions of humanity everywhere through science.
In my position at TAE I have researched plasma transport, neutral gas transport, micro and macro instabilities with fluid and PIC codes; I have utilized NERSC and ORNL super computers. I have collaborated with experimentalists and engineers designing next stage -- $100M – machine as well as scientist from PPPL etc. My latest work applies laser driven fusion (CAIL, RPA,) towards the incineration of nuclear spent fuel; I am working with Toshiki Tajima and Gerard Mourou (2018 Nobel Prize in Physics) among others.

(1) Magee, R. M., Necas, A., Clary, R., Korepanov, S., Nicks, S., Roche, T., ... & Tajima, T. (2019). Direct observation of ion acceleration from a beam-driven wave in a magnetic fusion experiment. *Nature Physics*, *15*(3), 281-286.
(2) Nicks, B., Necas, A., Tajima, T., Magee, R., Roche, T., & TAE Team. (2019). Beam-Driven Ion-Cyclotron Modes in FRC. *APS*, *2019*, UP10-154.
(3) Binderbauer, M. W., Guo, H. Y., Tuszewski, M., Putvinski, S., Sevier, L., Barnes, D., Necas, A.. & Brandi, F. (2010). Dynamic formation of a hot field reversed configuration with improved confinement by supersonic merging of two colliding high-β compact toroids. *Physical review letters*, *105*(4), 045003.
(4) Tajima, T., & Necas, A. (2016, March). Robustness of waves with a high phase velocity. In *AIP Conference Proceedings* (Vol. 1721, No. 1, p. 020006). AIP Publishing LLC.

B. Positions and Honors

Positions and Employment

2007 – 2010 **Scientist at TAE Technologies**
2010 – 2018 **Senior scientist at TAE Technologies**

2018 – Present Principal scientist at TAE Technologies

Other Experience and Professional Memberships

2006 – APS membership
2015 -- Co-organized and Chaired Hybrid Code R & D Workshops
2016 – ANS membership
2016 -- Organized and chaired the Alternative Fusion Concepts APS-DPP
2017 -- Co-organized and Chaired APS Satellite Meeting for Compact Tori,
2018 -- Chaired the Private Fusion Companies Session at the 2018 Winter ANS Meeting in Orlando.
2019 March.– Co-organized Transmutator Workshop, Ecole Polytechnique, Paris, France.
2019 Nov.– Co-organized Transmutator Workshop, Szeged, Hungary.

C. Contribution to Science

1. My early work is related to the study of the field reversed configuration plasma equilibrium (FRC) and its application to fusion. FRC plasmas are high beta and we have shown they have excellent properties with respect to stability and transport. I have studied stability using NIMROD code, and transport using the CFRX code. Under this umbrella I studies equilibria, neutral beam injection, neutral gas evolution, impurity transport and emission. My main goal of each theoretical study was to match experimental results, propose new experiments and extrapolate to different parameter regime. I worked closely with D. Barnes, R. Milroy, E. Belova. My work benefited from a collaborative environment with Princeton Plasma Physics Lab, University of Wisconsin, University of Washington, ORNL, NERSC and others.
    a. Binderbauer, M. W., Tajima, T., Tuszewski, M., Schmitz, L., Smirnov, A., Gota, H., A. Necas, ... & Yang, X. (2016, March). Recent breakthroughs on C-2U: Norman's legacy. In *AIP Conference Proceedings* (Vol. 1721, No. 1, p. 030003). AIP Publishing LLC.
    b. Binderbauer, M. W., Guo, H. Y., Tuszewski, M., Putvinski, S., Sevier, L., Barnes, D., Necas, A.. & Brandi, F. (2010). Dynamic formation of a hot field reversed configuration with improved confinement by supersonic merging of two colliding high-β compact toroids. *Physical review letters*, *105*(4), 045003.

2. Neutral beam injection into plasma is used for heating. However, understanding the effects on the plasma stability are paramount. I studied neutral beam injection with an MHD and a PIC code. With the MHD code I addressed the macro instability modes such as tilt or n=2 mode. With the PIC codes we address micro instabilities, we showed beams drive modes whose phase velocity is much greater than the thermal velocity of the plasma. Such mode does not couple to the bulk thermal plasma but rather drive a small population of energetic particles. This has been shown with NPA and neutron detector experimentally.
    a. Magee, R. M., Necas, A., Clary, R., Korepanov, S., Nicks, S., Roche, T., ... & Tajima, T. (2019). Direct observation of ion acceleration from a beam-driven wave in a magnetic fusion experiment. *Nature Physics*, *15*(3), 281-286.
    b. Nicks, B., Necas, A., Tajima, T., Magee, R., Roche, T., & TAE Team. (2019). Beam-Driven Ion-Cyclotron Modes in FRC. *APS*, *2019*, UP10-154.

3. The pB^{11} reaction as well as DT reaction generates neutrons, to study the neutron transport I used the MCNP code collaboration with University of Wisconsin. During this study we

sampled neutron source and followed the interaction with all the reactor components as well as generation of secondary particles. The pB11 reactor also generates copious amounts of Bremsstrahlung, I used MCNP code to also study the photon transport. The goal of this study was to ensure safety and security to personnel, study of shielding, activation, with a special attention to shielding of cryostat for superconducting magnetic coil and sensitive electronics associated with a beam system.

4. In my latest work I am using the field of laser acceleration of ions and electrons to generate copious neutrons for the purpose of transmutation of spent nuclear fuel. to transmute transuranic elements (TRU) separated from the spent nuclear fuel (SNF) and dissolved in a molten salt to form a subcritical core whose liquid state allows and facilitates safety, laser irradiation and monitoring of chemical and physical properties. In this transmutation concept (the transmutator) the neutrons are generated via a beam-target fusion whereas the beam is created by laser-irradiation of nanometric foils through the Coherent Acceleration of Ions by Laser (CAIL) process. This relatively low deuteron energy is catapulted by the fusion and eventually by the secondary fission processes. The combination of the use of the molten salt and laser allows us to introduce a rapid feedback control of the system's operation. The transmutator is an integral part of the partitioning and transmutation (P&T) concept whereas radiotoxicity of SNF is significantly reduced together with the required storage duration and volume. To enable this transmutator, we introduce an integrated ideas and processes in the areas of: (1) laser, (2) neutronics, (3) first wall material and (4) chemistry.

    a. T. Tajima, A. Necas, G. Mourou, S. Gales, and M. Leroy, Spent Nuclear Fuel Incineration by Fusion-driven Liquid Transmutator Operated Realtime by Laser, Fusion Science and Technology, Submitted
    b. A. Necas, T. Tajima, G. Mourou, K. Osvay, C. Kamperidis, G. Korn, S. V. Bulanov, J. Wheeler, M. Matys and P. Valenta, Unification of the Radiation Pressure Acceleration and the Coherent Acceleration of Ions by Laser, Phys. Rev. Accel. Beams, Submitted
    c. Joshua Tanner, Ales Necas, Kaleb Hatfield, Sydney Gales, Sylvain David, Gregory Huxtable, Toshiki Tajima, Neutronic Transmutation in Molten Salts. In preparation.
    d. M. Navarro, A. Necas, T. Tajima, T. Massard, M. Elbakhshwan, C. Falconer, W.Doniger, E. Barraza-Valdz, K. Hat_eld, A. Muchnikov, K. Sridharan, A.Couet, Advanced Carbon-Based Materials for a Transmutator First Wall. In preparation.

Complete List of Published Work in MyBibliography:

D. Additional Information: Research Support and/or Scholastic Performance

Ongoing Research Support

University of Szeged/ELI-ALPS/ELI-Beamline Necas (co-PI) 09/17/2017 – Present

Transmutation of spent nuclear fuel.

Multi-disciplinary and international project to transmute spent nuclear fuel (SNF). The goal is to reduce the needed SNF storage duration from 100,000 years to 1,000 years and reduce the required storage volume 100x.

Role: (co-PI)

OMB No. 0925-0001 and 0925-0002 (Rev. 03/2020 Approved Through 02-28-2023)

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors. Follow this format for each person. **DO NOT EXCEED FIVE PAGES**.

NAME: Tajima, Toshiki

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Norman Rostoker Chair Professor, University of California at Irvine

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Tokyo	BS	3/1971	physics
University of Tokyo	MS	3/1973	physics
University of California at Irvine	PhD	12/1975	physics

A. Personal Statement

I benefitted from the giants and colleagues to be what I am. I would like to serve to return from what I learned from these to the good of the scientific community and the humanity.

Professor Tajima is a theoretician whose research investigates accelerator physics, plasma physics, fusion, laser physics, astrophysics and medical applications of physics, authoring over 500 papers and 8 books in total. Most prominently, he is the inventor (with Prof. John Dawson) of laser wakefield acceleration (LWFA) and has been involved in a number of theoretical and collaborative experimental projects around the world.

Professor Toshiki Tajima currently holds the Rostoker Chair in the Department of Physics and Astronomy at UC Irvine, which aims to extend Professor Norman Rostoker's legacy in plasma physics and applied physics. Tajima was Professor Rostoker's first PhD student at UC Irvine. Between his stints at UC Irvine, he was The Jane and Roland Blumberg Professor in Physics at the University of Texas at Austin, where, among other projects, he started the first DoE-sponsored laser wakefield acceleration project (with Prof. Downer) in 1993. He also part of the team that first demonstrated the experimental Proof-of-Principle of LWFA in 1994,1995. He subsequently served as Director-General of the Kansai Photon Science Institute of the Japan Atomic Energy Agency as well as Chair Professor at Ludwig Maximilian University.

He has been serving as Chair of the International Committee for Ultrahigh Intensity Lasers (ICUIL), Chairman of Extreme Light Infrastructure-Nuclear Physics (ELI-NP) International Science Advisory Board, Deputy Director of the International Center for Zetta- and Exawatt Science and Technology (IZEST) based at École
Polytechnique, and a Member of Visiting Committee of CEA of France. Currently, Prof. Tajima also serves as Chief Science Officer of Tri Alpha Energy, a private company that aims to develop and commercialize fusion energy technology.

He has been awarded the Enrico Fermi Prize (Italian Physical Society), the Nishina Memorial Prize (Nishina Memorial Foundation), the Blaise Pascal Chair award (France), and the Einstein Professorship (Chinese Academy of Sciences), Fellow of American Physical Society, among other honors.

B. Positions and Honors

Positions and Employment

1976-1980 Assistant and Associate Research Physicist, UCLA, Los Angeles
1980-2001 Assistant, Associate, Full Professor of Physics, and
The Jane and Roland Blumberg Professor in Physics, and Professor of Computational and Applied Math, University of Texas, Austin
1998-2001 Special Assistant to the Associate Director, Lawrence Livermore National Laboratory, University of California
2000-2002 Special Project Advisor, Stanford Linear Accelerator Center, Stanford University
2002-2008 Japan Atomic Energy Research Institute (later, Japan Atomic Energy Agency)
2007-2008 Director General: Kansai Photon Science Institute, and
Deputy Director General: Quantum Beam Science Directorate and Director: Photo Medical Research Center
2008-2012 Specially Appointed Professorship, KEK High Energy Accelerator Laboratory, Tsukuba
2008-2012 Specially Appointed Researcher; Guest Researcher, Japan Atomic Energy Agency
2008-2011 Chair Professor, Munich Advanced Centre Fellow, Ludwig Maximilian University, Germany
2011-Present Norman Rostoker Chair Professor at UC Irvine, CA
2011-Present Chief Science Officer, TAE Technologies, Lake Forest, CA

Other Experience and Professional Memberships

1989-1993 SSC Laboratory
1995-2000 Lawrence Berkeley Laboratory, University of California, Berkeley, (Affiliated)
1999-2000 Department of Applied Science, University of California at Davis,
2018- American Physical Society GPAP Chair
2011- ELI-NP ISAB Chair,
2015- **CEA permanent Visiting Committee Member**.

Honors

1988 - Fellow, American Physical Society (for laser acceleration)
2005 - Farrington Daniels Award (for laser driven particle therapy)
2006 - Suwa Prize (laser acceleration)
2006 - Nishina Memorial Prize (laser acceleration)
2009 - The Blaise Pascal Chair awarded (high field science)
2013 - Einstein Professorship of Chinese Academy of Science ((high fields cience)
1973 - Fellow, Japan Society for the Promotion of Science Member, National Research Council (Commission
H) of the National Academy of Science (global magnetospheric dynamics)
1997 - Robert W. Hamilton Award (University Cooperative Society)
1999 - JAERI Excellence Prize (high field science simulation)
2008 - Fellow, JAEA (photo-medical research)
2008 - JAEA President's Award (relativistic mirror)
2012 - Achievement Prize, Laser Society of Japan (laser engineering)
2015 - Enrico Fermi Prize,
2016 - Russian Academy of Sciences member,
2018 - S.
Chandrasekhar
Prize, 2019 - R.
Wilson Prize,
2019 - H. Alfven
Prize.
2020 - Charles Townes Award

C. Contribution to Science

1. Inventor and incubator of the Laser Wakefield Accelerator (with J. Dawson) in 1979. This single (1979) publication created a paradigm shift in a way an electron can be accelerated.

a. Tajima, T., & Dawson, J. M. (1979). Laser electron accelerator. *Physical Review Letters*, *43*(4), 267.
b. Tajima, T., & Dawson, J. M. (1981). Laser beat accelerator. *IEEE Transactions on Nuclear Science*, *28*(3), 34163417.
c. Tajima, T. (1985). High energy laser plasma accelerators. *Laser and Particle Beams*, *3*(4), 351-413.

2. Coherent Acceleration of Ions by Laser. Invention of ion acceleration using combination of laser and nanometric foils.

a. Tajima, T. (2016). Recent Progress in Laser Ion Acceleration. In *Laser-Driven Particle Acceleration Towards Radiobiology and Medicine* (pp. 295-313). Springer, Cham.
b. Tajima, T., Habs, D., & Yan, X. (2009). Laser acceleration of ions for radiation therapy. In *Reviews Of Accelerator Science And Technology: Volume 2: Medical Applications of Accelerators* (pp. 201-228).
c. Tajima, T., & Malka, V. (2020). Laser plasma accelerators. *Plasma Physics and Controlled Fusion*, *62*(3), 034004.
d. Necas, A., and Tajima, T. et al., "Unification of the Radiation Pressure Acceleration and the Coherent Acceleration of Ions by Laser," Submitt. to Phys. Rev. Accel. Beams (2019).

3. Development of novel numerical algorithms. I performed simulation of Tokamaks and high beta machines as well as astrophysical plasmas spanning length scales and time scales over many orders of magnitude. To simulate, I developed and co-developed new algorithms and extended, e.g., the magnetohydrodynamic and particle in cell simulations. I summarized my experience in the Computational plasma physics textbook.

a. Tajima, T., Leboeuf, J. N., & Dawson, J. M. (1980). A magnetohydrodynamic particle code with force free electrons for fluid simulations. *Journal of Computational Physics*, *38*(2), 237-250.
b. Leboeuf, J. N., Tajima, T., & Dawson, J. M. (1979). A magnetohydrodynamic particle code for fluid simulation of plasmas. *Journal of Computational Physics*, *31*(3), 379-408.
c. Brunel, F., Leboeuf, J. N., Tajima, T., Dawson, J. M., Makino, M., & Kamimura, T. (1981). Magnetohydrodynamic particle code: Lax-Wendroff algorithm with finer grid interpolations. *Journal of Computational Physics*, *43*(2), 268288.
d. Barnes, D. C., Kamimura, T., Leboeuf, J. N., & Tajima, T. (1982). *Implicit-particle simulation of magnetized plasmas* (No. DOE/ET/53088--68). Texas Univ.
e. Tajima, T. (2018). *Computational plasma physics: with applications to fusion and astrophysics*. CRC Press.

1978. Contributed in launching of the Fukuda Fusion Initiative,
1993. JAERI Kansai Establishment,
2011. EU Extreme Light Infrastructure,
2017. Chinese SEL (Station for Extreme Light)

Complete List of Published Work in My Bibliography:

http://www.physics.uci.edu/tajima/publist-tajima.pdf

D. Additional Information: Research Support and/or Scholastic Performance

Ongoing Research Support

University of Szeged/ELI-ALPS/ELI-Beamline Tajima (PI) 09/17/2017 – Present Transmutation of spent nuclear fuel.
Multi-disciplinary and international project to transmute spent nuclear fuel (SNF). The goal is to reduce the needed SNF storage duration from 100,000 years to 1,000 years and reduce the required storage volume 100x.
Role: (PI)