

Educational Background

Highest Education

1. **Level** : Doctorate
(Ph.D.)
- Field of Study** : **Engineering (Thesis subject: Laser- plasma
electron acceleration)**
- Major** : **Quantum Engineering and Systems Science**
- Institute/University** : **University of Tokyo, Graduate School of
Engineering,**
- Location** : Japan **Graduation :** Sep. 28.
Date 2001
- Supervisor:**
Prof.
Mitsuru
Uesaka

Education

2. **Level** : Master of
Science
(M. Sc.)
- Field of Study** : **Physics**
- Major** : Plasma Physics
- Institute/University** : Suez Canal University, Faculty of Science,
Physics Department
- Location** : EGYPT **Graduation :** January 5. 1997
Date
- MS**
Advisor:
Prof. M. M.

Nasr A. M. Hafz- Application at IAU

Masoud
(deceased)

Education

3. Level : Bachelor of
Science
(B. Sc.)

Field of Study : Physics

Major : Physics

Institute/University : Ain Shams University, Faculty of Science

Location : EGYPT **Graduation :** May
Date 1991

Employment and Research History

1. Country of : Hungary, EU
Workplace

Organization : Extreme Light Infrastructure (ELI-ALPS)
Name

Organization : Research
Industry

Position Title : Leading Scientist, Group leader (level of Associate
Professorship)

Date Joined : Sept.1, 2018- present

Work : Principal
Description Investigator

Nasr A. M. Hafz- Application at IAU

1. Research on intense laser-plasma interactions (applications to generation of energetic electrons, X-rays, and radiations, ...)
2. Advisor of research team.
3. Obtaining research funds.

2. Country of : Shanghai, People's Republic of China
Workplace

Organization : Shanghai Jiao Tong University, Department of
Name Physics and Astronomy

Organization : Education, Research
Industry

Position Title : Tenure-track Associate Professor

Date Joined : March, 2011- Dec. 31. 2018

Work : Principal
Description Investigator

1. Research on intense laser-plasma interactions (applications to generation of energetic electrons, X-rays, and radiations, ...)
2. Advisor of research students.
3. Teaching undergraduate and graduate physics students
4. Obtaining research funds.

3. Country of : South Korea
Workplace

Organization : Gwangju Institute of Science and Technology GIST-
Name APRI

Nasr A. M. Hafz- Application at IAU

Organization : Science & Technology
Industry

Position Title : Senior Research Scientist (Staff)

Date Joined : June 1, 2006- March. 2011

Work :
Description

4. Country of : South Korea
Workplace

Organization : Korea Electrotechnology Research Institute (KERI)
Name

Organization : Research and Development
Industry

Position Title : Visiting Scientist

Job : Laser, Plasma and electron beam science and
Specialization engineering.

Date Joined : Dec 2002

Date Left : May 2006 (3.5 yrs)

Work :
Description

R&D in laser-plasma accelerators by using a table-top Nd: Glass terawatt laser system

5. Country of : Egypt
Workplace

Organization : Atomic Energy Authority, Plasma Physics and
Name Nuclear Fusion Department

Organization : Research
Industry

Nasr A. M. Hafz- Application at IAU

Position Title : Researcher (Permanent staff) and Faculty

Job : Plasma physics, laser physics, Tokamak machines

Specialization

Working Period: May 1993 to Sept. 1998 and from Oct. 2001 to Dec. 2002.

Work Description:

Laser Thomson Scattering for discharge plasma diagnostics

**Teaching experience and graduate student supervision at
Shanghai Jiao Tong University, Department of Physics and
Astronomy**

Graduate Students Supervised

1. **Song Li** (received Ph.D. from SJTU in Dec. 2016 under my supervision). Also, he was a postdoctoral student in my team from January 2017 to December 2018.
2. **M. Mirzaie** (received Ph.D. from SJTU in March 2017 under my supervision).
3. **Qurat-ul-Ain** (received Ph.D. from SJTU in March 2019 under my supervision)
4. **Guangyu Li** (Defended his PhD thesis in January 2020, under my supervision)
5. **Kai Gao** (received MS degree from SJTU in June 2017 under my supervision)

Undergraduate Students Supervised

6. **Zezhou Liu (ID: 5117319015)** this student was working in my group for his graduation B. S. thesis. He graduated on July (2016). His thesis topic is on characterization of nonsymmetrical supersonic gas jets for laser-plasma acceleration applications.
7. **Haohan Xia (ID: 5120729016)**, this student was working in my group for his graduation B. S. thesis. He graduated on July (2016). His thesis topic is on characterization of high-density supersonic gas jets for laser ion acceleration.

Alumni

8. **M. Z. Tao** (I invited this student from CAS/IOP for 1.5 years. He has returned to Beijing in early 2014). During his stay at SJTU he has published 2 papers as a first author.
9. **(International student) A. Elsied** (an M.S. foreign student, joined my group from Sept. 2012 to June 2014 then he moved to another lab at SJTU). During this time he has published one paper as a first author
10. **Li Wenzhao (李文钊)**, this student did his undergraduate B.S. thesis under my guidance in 2015. He has graduated from SJTU and he is currently in the US for his graduate studies. Title of his thesis was “Electron Spectrum Processing For Laser Plasma Wakefield Acceleration”

Undergraduate teaching work at Shanghai Jiao Tong University

I have conducted the following teaching duties (from Spring 2012-Spring 2018)

Semester	Course	Student Number	Class Hours	Credit Hours	Students
2012, Spring	Introduction to Plasma physics	62	32	2	Undergraduate and graduate
2013, Spring	Introduction to Plasma physics	46	32	2	Undergraduate and graduate
2014, Spring	Introduction to Plasma physics	23	48	3	Undergraduate and graduate
2015, Spring	Introduction to Plasma physics	10	48	3	Undergraduate and graduate

Nasr A. M. Hafz- Application at IAU

2012, Fall	Practice of Physics Research	2	32	2	Undergraduate
2013, Spring	Practice of Physics Research	2	32	2	Undergraduate
2012, Summer	English Communications in Science (speaking part)	29	16	1	Undergraduate
2015, Fall	Fluid Mechanics	25	51	3	Undergraduate
2016, Spring	Introduction to Plasma physics	27	48	3	Undergraduate and graduate
2016, Fall	Fluid Mechanics	24	48	3	Undergraduate and graduate
2017, Spring	Introduction to Plasma physics	22	48	3	Undergraduate and graduate
2017, Fall	Introduction to Plasma physics	33	48	3	Undergraduate and graduate
2018, Spring	Fluid Mechanics	3	48	3	Undergraduates

Teaching Award (by Shanghai Municipal Government)

2015 年度上海高校外国留学生英语授课示范性课程. 上海市教育委员会. 10 万元.
(9.2015 ~ 9. 2017)

Honours and Awards

Recognition Details	Dates
Japanese Government Scholar (Monbukagakusho)	Oct. 1. 1998 ~ Sept. 30. 2001
Best Award in poster presentation. 2008 KAPRA&KPS/DPP Conference. Korea Accelerator and Plasma Research Association.	July. 4, 2008
Outstanding Researcher Award (2008), Gwangju Institute of Science and Technology (GIST).	Nov.13. 2008
제 42 회 과학의 날 표창 교육과학기술부 장관표창 (Commendation from the Minister of Education, Science And Technology, Republic of Korea.)	April, 21, 2009
Visiting Associate Professorship at Universiti Teknologi Malaysia	Feb. 2, 2010~ March 2, 2010
Visiting Professor, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences.	January 01. 2020 to September 30. 2020.

Nasr A. M. Hafz- Application at IAU


CAS President's International Fellowship Initiative (PIFI)	
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publons BROWSE COMMUNITY FAQ

NH WEB OF SCIENCE

Researchers ▸ Nasr Hafz



Nasr Hafz
"Nasr A M Hafz"
Leader of Particle Acceleration Group - SeSo Division, Extreme Light Infrastructure-Attosecond Light Pulse Source

Web of Science ResearcherID
O-1136-2015

PUBLICATIONS	TOTAL TIMES CITED	H-INDEX
66	1,040	18

Summary


Metrics

Publications


Peer review

Research Fields
LASER PLASMA ACCELERATION AND RADIATION GENERATION


Identifiers
Web of Science ResearcherID[®] O-1136-2015
ORCID 0000-0003-4371-5551
[+ VIEW FULL BIO & INSTITUTIONS](#)

 Add co-authors
We have co-authors suggestions.
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Google Scholar



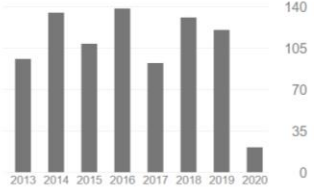
Dr. Nasr A. M. Hafz (Leading Scientist), Particle Acceleration Group Leader
Extreme Light Infrastructure- Attosecond Light Pulse Source
Verified email at eli-alps.hu - [Homepage](#)
[Laser Plasma Accelerators](#)

 FOLLOWING

TITLE	CITED BY	YEAR
<input type="checkbox"/> Stable generation of GeV-class electron beams from self-guided laser-plasma channels NAM Hafz, TM Jeong, IW Choi, SK Lee, KH Pae, VV Kulagin, JH Sung, ... Nature Photonics 2 (9), 571	341	2008
<input type="checkbox"/> Demonstration of self-truncated ionization injection for GeV electron beams M Mirzaie, S Li, M Zeng, NAM Hafz, M Chen, GY Li, QJ Zhu, H Liao, ... Scientific reports 5, 14659	79	2015
<input type="checkbox"/> Electron trapping and acceleration across a parabolic plasma density profile JU Kim, N Hafz, H Suk Physical Review E 69 (2), 026409	69	2004
<input type="checkbox"/> Bright betatron X-ray radiation from a laser-driven-clustering gas target LM Chen, WC Yan, DZ Li, ZD Hu, L Zhang, WM Wang, N Hafz, JY Mao, ... Scientific reports 3 (1), 1-5	67	2013
<input type="checkbox"/> Demonstration of a saturated Ni-like Ag x-ray laser pumped by a single profiled laser pulse from a 10-Hz Ti: sapphire laser system HT Kim, IW Choi, N Hafz, JH Sung, TJ Yu, KH Hong, TM Jeong, YC Noh, ... Physical Review A 77 (2), 023807	57	2008

Cited by

	All	Since 2015
Citations	1410	617
h-index	20	13
i10-index	34	17



Co-authors [EDIT](#)

No co-authors

■ **List of all published papers (2000 to 2019)**

2019 (at SJTU and ELI-ALPS)

1. S. Song Li, Guangyu Li, Quratul Ain, Min Sup Hur*, Antonio C. Ting, Victor V. Kulagin, Christos Kamperidis, Nasr A. M. Hafz* "A Laser Plasma Accelerator driven by two-color relativistic femtosecond laser pulses" *Science Advances* **5**, eaav7940 (2019)

I proposed, conducted and managed this research.

2. D. Papp, N. Hafz and C. Kamperidis, "Self-induced ionization injection LWFA and generation of sub-fs electron bunches with few cycle sub-TW laser pulses" *Laser and Particle Beams* **37**, Issue 2 June (2019), pp. 165-170. DOI: <https://doi.org/10.1017/S0263034619000260>

3. Guangyu Li, Song Li, Q. Ain, K. Gao, M. Mirzaie and N. Hafz* "Ultrafast dynamics of magnetic vortices and pulse collapse in a laser-under dense plasma interaction" *Physics of Plasmas* **26**, 022306 (2019).

Role in the paper: I proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my Ph.D. student).

2017-2018 (at Shanghai Jiao Tong University)

4. Q. Ain, S. Li, M. Mirzaie and N. Hafz* "Generation of GeV electron beam from a laser-plasma accelerator and its prospect as a desk-top source of energetic positrons and gamma rays for applications" *IEEE-Transactions on Nuclear Science* 10.1109/TNS.2018.2869558.

M.

5. M. Mirzaie, G. B. Zhang, S. Li, G. Kai, G. Y. Li, Q. Ain and N. Hafz* "Effect of injection-gas concentration on the electron beam quality from a laser-plasma acceleration", *Physics of Plasmas* **25**, 043106 (2018); doi: 10.1063/1.5008561

Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my Ph.D. student).

6. Song Li, Qian Zhao, **Nasr A M Hafz***, Suming Weng, Kai Gao, Mohammad Mirzaie, Guangyu Li, Quratul Ain, and Jie Zhang "Correlation between macroscopic plasma dynamics and electron beam parameters in a laser-plasma accelerator" **Plasma Physics and Controlled Fusion** **60** 085020 (2018).

Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my PDRA).

7. Q. Ain, **N. Hafz***, S. Li, M. Mirzaie, K. Gao, G. Li, J. Zhang "Generation of electron beams by ionization-injection in krypton-helium plasma and the application to generation of high-energy positron beam" **Plasma Physics and Controlled Fusion** **60** 085012 (2018)

Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my Ph.D. student).

8. Y. F. Li, D. Z. Li, K. Huang, M. Z. Tao, M. H. Li, J. R. Zhao, Y. Ma, X. Guo, J. G. Wang, M. Chen, **N. Hafz**, J. Zhang, and L. M. Chen, "Generation of 20 kA electron beam from a laser wakefield accelerator" **Physics of Plasmas** **24**, 023108 (2017) DOI: 10.1063/1.4975613

Role in the paper: supervising the experimental parts on the electron beam acceleration (~50% of this work).

9. K. Gao, **N. Hafz***, S. Li, M. Mirzaie, G. Y. Li and Q. Ain, "Online plasma diagnostics of a laser-produced plasma" **Plasma Science and Technology** **19**, 015506 (2017). DOI: 10.1088/1009-0630/19/1/015506

Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my M.Sc. student).

2016 (at Shanghai Jiao Tong University)

10. L. Chen, M. Chen, Y. Chen, **N. Hafz**, Y. Li, F. Liu, J. Ma, L. Qian, Z. Sheng, S. Weng, G. Xie, L. Yu, P. Yuan, X. Yuan, J. Zhang (note: in this paper author names are ordered alphabetically) "Laser-driven plasma accelerators and ultrafast radiation sources" **Special**

issue in **Science** "Pushing the boundaries of Scientific Research: 120 years of Addressing Global". pages 32-36 (2016)

Role in the paper: This is a review paper; I wrote the parts dealing with electron beam acceleration from our recent experiments (those compose ~ 25% of the this paper)

11. K. Huang, Y. F. Li, D. Z. Li, L. M. Chen, M. Z. Tao, Y. Ma, J. R. Zhao, M. H. Li, M. Chen, M. Mirzaie, **N. Hafz**, T. Sokollik, Z. M. Sheng & J. Zhang, "Resonantly Enhanced Betatron Hard X-rays from Ionization Injected Electrons in a Laser Plasma Accelerator" **Scientific Reports** **6**, 27633 (2016) DOI: 10.1038/srep27633

12. G. B. Zhang, **N. Hafz***, Y. Ma et al., "Laser Wakefield Acceleration Using Mid-Infrared Laser Pulses" **Chinese Physics Letters** **33**, 095202 (2016). DOI: 10.1088/0256-307X/33/9/095202

Role in the paper: proposed, supervised the simulations and wrote the paper after an initial draft by the first author.

13. **Nasr A.M. Hafz**, Song Li, Guangyu Li, Mohammad Mirzaie, Ming Zeng, and Jie Zhang, "Generation of high-quality electron beams by ionization injection in a single acceleration stage" **High Power Laser Science and Engineering** **4**, e24, DOI: 10.1017/hpl.2016.25

Role in the paper: I proposed, supervised and conducted experiments and I wrote the paper.

14. M. Mirzaie, **Nasr Hafz***, Song Li, Kai Gao, Guangyu Li, Qurat-ul-Ain, and Jie Zhang, "Laser acceleration in argon clusters and gas media" **Plasma Physics and Controlled Fusion** **58**, 034014 (2016). DOI: 10.1088/0741-3335/58/3/034014

Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my Ph.D. student).

2015 (at Shanghai Jiao Tong University)

15. M. Mirzaie, S. Li, M. Zeng, **Nasr A. M. Hafz***, M. Chen, G. Y. Li, Q. J. Zhu, H. Liao, T. Sokollik, F. Liu, Y. Y. Ma, L.M. Chen, Z. M. Sheng & J. Zhang, "Demonstration of self-

truncated ionization injection for GeV electron beams" Scientific Reports **5**, 14659 (2015).

DOI: 10.1038/srep14659

Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my Ph.D. student).

16. M. Mirzaie, **Nasr A. M. Hafz***, Song Li, Feng Liu, Fei He, Ya Cheng, and Jie Zhang,

"Enhanced electron yield from laser-driven wakefield acceleration in high-Z gas jets"

Review of Scientific Instruments **86**, 103502 (2015). DOI: 10.1063/1.4931780

Role in the paper: proposing, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my Ph.D. student).

17. Guo-Bo Zhang, Yan-Yun Ma, Han Xu, **Nasr A. M. Hafz**, Xiao-Hu Yang, M. Chen, Tong-Pu Yu, De-Bin Zou, Jian-Xun Liu, Jian-Feng Yan, Hong-Bin Zhuo, Long-Fei Gan, Li-Chao Tian, Fu-Qiu Shao, Y. Yin, and S. Kawata, *"Enhanced electron injection in laser-*

driven bubble acceleration by ultra-intense laser irradiating foil-gas targets" Physics of Plasmas **22**, 083110 (2015). DOI: 10.1063/1.4927583

Role in the paper: Shared writing of paper with first author.

18. M. Tao, **Nasr A. M. Hafz***, S. Li, M. Mirzaie, X. Ge, T. Sokollik, L. Chen, F. He, Ya Cheng, Zheng Ming Sheng, and Jie Zhang., *"High-Quality Laser-Driven Electron Beams*

by Ionization Injection in Low-Density Nitrogen Gas Jet" IEEE-Transactions on Plasma Science **43**, 539 (2015). DOI: 10.1109/TPS.2014.238788

Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author.

19. A. Elsied, **Nasr A. M. Hafz***, Song Li, M. Mirzaie, T. Sokollik, and J. Zhang, *"Generation*

of high-quality electron beams from a laser-based advanced accelerator" Chinese Physics C **39**, 067003 (2015). DOI: 10.1088/1674-1137/39/6/067003

Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my M.Sc. student).

2013-2014 (at Shanghai Jiao Tong University)

20. W. C. Yan, L. M. Chen, Lu Zhang, D. Z. Li, **N. A. M. Hafz**, J. Dunn, L. Zhang, Y. Ma, K. Huang, L. N. Su, M. Chen, Z. M. Sheng, J. Zhang, "Concurrence of monoenergetic electron beams and bright X-rays from an evolving laser-plasma bubble" **PNAS Proceedings of the National Academy of Sciences of the United States of America**, vol. **111**, 5825–5830 (2014). DOI: 10.1073/pnas.140433611
Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author.
21. Song Li, **Nasr A. M. Hafz***, Mohammad Mirzaie, Thomas Sokollik, Ming Zeng, Min Chen, Z. M. Sheng, and Jie Zhang, "Enhanced single-stage laser-driven electron acceleration by self-controlled ionization injection" **Optics Express** **22**, 29578 (2014). DOI: 10.1364/OE.22.029578
Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my PDRA).
22. D. Z. Li, W. C. Yan, L. M. Chen, K. Huang, Y. Ma, J. R. Zhao, L. Zhang, **Nasr A. M. Hafz**, W. M. Wang, J. L. Ma, Y. T. Li, Z. Y. Wei, J. Gao, Z. M. Sheng, J. Zhang, "Generation of monoenergetic electron beams with ultralow normalized emittance from a laser-plasma acceleration" **Optics Express** **22**, 12836 (2014) DOI: 10.1364/OE.22.012836
Role in the paper: supervised the experimental part on electron beam acceleration (~ 50% of the work) and wrote ~ 50 % of the paper.
23. K. Huang, D. Z. Li, W. Yan, M. H. Li, M. Z. Tao, Z. Y. Chen, X. L. Ge, F. Liu, Y. Ma, J. R. Zhao, **N. A. M. Hafz**, J. Zhang, and L. M. Chen, "Simultaneous generation of quasi-monoenergetic electron and betatron X-rays from nitrogen gas via ionization injection" **Applied Physics Letters** **105**, 204101 (2014). DOI: 10.1063/1.4902127
Role in the paper: supervised the experimental part on electron beam acceleration (~ 50% of the work) and wrote ~ 50 % of the paper.

24. Y. Ma, L. M. Chen, **N. A. M. Hafz**, D. Z. Li, K. Huang, W. C. Yan, J. Dunn, Z. M. Sheng, and J. Zhang, "Diagnosis of bubble evolution in laser-wakefield acceleration via angular distributions of betatron x-rays" *Applied Physics Letters* **105**, 16111 (2014). DOI: 10.1063/1.4900412
Role in the paper: supervised the experimental part on electron beam acceleration (~ 50% of the work) and wrote ~ 50 % of the paper.
25. Song Li, **Nasr A. M. Hafz***, Mohammad Mirzaie, Ahmed M. M. Elsied, Xulei Ge, Feng Liu, Thomas Sokollik, Mengze Tao, Liming Chen, Min Chen, Zhengming Sheng, and Jie Zhang, "Generation of electron beams from a laser wakefield acceleration in pure neon gas" *Physics of Plasmas* **21** 083108 (2014). DOI: 10.1063/1.4892557
Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my PDRA).
26. Mengze Tao, **Nasr A. M. Hafz***, Song Li, Mohammad Mirzaie, Ahmed M. M. Elsied, Xulei Ge, Feng Liu, Thomas Sokollik, Liming Chen, Zheng Ming Sheng, and Jie Zhang, "Quasimonoenergetic collimated electron beams from a laser wakefield acceleration in low density pure nitrogen" *Physics of Plasmas* **21**, 073102 (2014). DOI: 10.1063/1.4889877
Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author.
27. Song Li, **Nasr A. M. Hafz***, Mohammad Mirzaie, Xulei Ge, Thomas Sokollik, Min Chen, Zheng Ming Sheng, and Jie Zhang, "Stable laser-plasma accelerators at low densities" *Journal of Applied Physics* **116**, 043109 (2014). DOI: 10.1063/1.4891987
Role in the paper: proposed, supervised and conducted experiments and wrote the paper after an initial draft by the first author (my PDRA).
28. L. M. Chen, W. C. Yan, D. Z. Li, Z. D. Hu, L. Zhang, W. M. Wang, **N. Hafz**, J. Y. Mao, K. Huang, Y. Ma, J. R. Zhao, J. L. Ma, Y. T. Li, X. Lu, Z. M. Sheng, Z. Y. Wei, J. Gao, J. Zhang, "Bright betatron X-ray radiation from a laser-driven-clustering gas target" *Scientific Reports* **3**, 1912 (2013) DOI: 10.1038/srep01912
Role in the paper: supervised the experimental part on the electron beam acceleration (~ 50% of the work) and wrote ~ 50 % of the paper.

2012 (at Shanghai Jiao Tong University)

29. Xiaomi Zhang, Baifei Shen, Liangliang Ji, Wenpeng Wang, Jiancai Xu, Yahong Yu, Longqing Yi, Xiaofeng Wang, **Nasr A. M. Hafz**, and V. Kulagin, "Effect of pulse profile and chirp on a laser wakefield generation" *Physics of Plasmas* **19**, 053103 (2012) DOI: 10.1063/1.4714610
Role in the paper: propose the simulations and wrote the paper after initial draft by first author.
30. M. Zeng, **N. Hafz**, K. Nakajima, L. M. Chen, W. Lu, W. Mori, Z. M. Sheng, J. Zhang, "Controlled ionization-induced injection by tailoring the gas-density profile in laser wakefield acceleration" *Journal of Plasma Physics* **78**, 363 (2012). DOI: 10.1017/S0022377812000098
Role in the paper: supervised simulations and wrote the paper after initial draft by first author.

2011 (at GIST)

31. **Nasr A. M. Hafz***, "Utilizing asymmetric laser pulses for the generation of high-quality wakefield-accelerated electron beams" *Nuclear Instruments and Methods in Physics Research A* **654** (2011) 592-596. DOI: 10.1016/j.nima.2011.07.024
Role in the paper: proposed and conducted experiments and wrote the paper.
32. **N. Hafz***, S. K. Lee, T. M. Jeong, J. Lee, "Evolution of self-injected quasi-monoenergetic electron beams in a plasma bubble" *Nuclear Instruments and Methods in Physics Research A* **637** (2011) S51-S53. DOI: 10.1016/j.nima.2010.02.020
Role in the paper: proposed and conducted experiments and wrote the paper.
33. Inhyuk Nam, Min Sup Hur, Han Sup Uhm, **Nasr A. M. Hafz*** and Hyyong Suk, "Controlling the betatron oscillations of a wakefield-accelerated electron beam by

temporally asymmetric laser pulses" Physics of Plasmas **18**, 043107(2011). DOI:

10.1063/1.3577566

Role in the paper: proposed and supervised simulations and writing the paper after an initial draft by the first author.

2010 (at GIST)

34. **Nasr A. M. Hafz***, Tae Jun Yu, Seong Ku Lee, Tae Moon Jeong, Jae Hee Sung, J. Lee,

"Controlling the Pointing Angle of a Relativistic Electron Beam in a Weakly-Nonlinear

Laser Wakefield Accelerator" Applied Physics Express **3**, 076401 (2010). DOI:

10.1143/APEX.3.076401

Role in the paper: proposed and conducted experiments and wrote the paper.

2009 (at GIST)

35. I W Choi, C M Kim, J H Sung, I J Kim, T J Yu, S K Lee, Y-Y Jin, K H Pae, **N. Hafz** and

J Lee, *"Absolute calibration of a time-of-flight spectrometer and imaging plate for the*

characterization of laser-accelerated protons" Meas. Sci. Technol. **20** 115112 (2009) DOI:

10.1088/0957-0233/20/11/115112

Role in the paper: joined the experiments and wrote the paper after initial draft by first author.

36. A. S. Pirozhkov, I. W. Choi, J. H. Sung, S. K. Lee, T. J. Yu, T. M. Jeong, I. J. Kim, **Nasr**

A. M. Hafz, K. H. Pae, Y.-C. Noh, D.-K. Ko, J. Lee, A. Robinson, P. Foster, S. Hawkes,

M. Streeter, C. Spindloe, P. McKenna, D. C. Carroll, C.-G. Wahlstrom, M. Zepf, B.

Dromey, K. Markey, S. Kar, Y. T. Li, M. H. Xu, H. Nagatomo, M. Mori, A. Yogo, H.

Kiriyama, K. Ogura, A. Sagisaka, S. Orimo, M. Nishiuchi, H. Sugiyama, T. Zh. Esirkepov,

H. Okada, S. Kondo, S. Kanazawa, Y. Nakai, A. Akutsu, T. Motomura, M. Tanoue, T.

Shimomura, M. Ikegami, I. Daito, M. Kando, T. Kameshima, P. Bolton, S. V. Bulanov, H.

Daido, and D. Neely, *"Diagnostic of laser contrast using target reflectivity" Applied*

Physics Letters **94**, 241102 (2009) DOI: 10.1063/1.3148330

Role in the paper: joined the experiments

37. I. W. Choi, C. M. Kim, J. H. Sung, T. J. Yu, S. K. Lee, I. J. Kim, T. M. Jeong, **N. Hafz**, K. H. Pae, Y.-C. Noh, D.-K. Ko, A. Yogo, A. S. Pirozhkov, K. Ogura, S. Orimo, A. Sagisaka, M. Nishiuchi, I. Daito, Y. Oishi, Y. Iwashita, S. Nakamura, K. Nemoto, A. Noda, H. Daido, and J. Lee. *"Ion spectrometer composed of time-of-flight and Thomson parabola spectrometers for simultaneous characterization of laser-driven ions"* **Review of Scientific Instruments** **80**, 053302 (2009). DOI: 10.1063/1.3131628
Role in the paper: joined the experiments and wrote the paper after initial draft by first author.

2008 (at GIST)

38. **N. A. M. Hafz**, T. M. Jeong, I. W. Choi, S. K. Lee, K. H. Pae, V. Kulagin, J. H. Sung, T. J. Yu, K. H. Hong, T. Hosokai, J. Cary, D. K. Ko, J. Lee, *"Stable generation of GeV-class electron beams from self-guided laser-plasma channels"* **Nature Photonics** **2**, 571 (2008)
DOI: 10.1038/nphoton.2008.155
Role in the paper: conceived, designed, implemented, acquired data and wrote the paper
See Interview <http://www.nature.com/nphoton/journal/v2/n9/full/nphoton.2008.179.html> of **N. Hafz***, in **Nature Photonics** **2**, 580 (2008)
See Editorial <http://www.nature.com/nphoton/journal/v2/n9/full/nphoton.2008.159.html> on **N. Hafz*** in **Nature Photonics** **2**, 513 (2008)
See News and Views <http://www.nature.com/nphoton/journal/v2/n9/full/nphoton.2008.167.html> on **N. Hafz*** et al., in **Nature Photonics** **2**, 526 (2008)
39. M. Nishiuchi, H. Daido, A. Yogo, S. Orimo, K. Ogura, J. Ma, A. Sagisaka, M. Mori, A. S. Pirozhkov, H. Kiriya, S. V. Bulanov, and T. Zh. Esirkepov, I. W. Choi, C. M. Kim, T. M. Jeong, T. J. Yu, J. H. Sung, S. K. Lee, **N. Hafz**, K. H. Pae, Y.-C. Noh, D.-K. Ko, and J. Lee, Y. Oishi and K. Nemoto, H. Nagatomo and K. Nagai, H. Azuma, *"Efficient production of a collimated MeV proton beam from a polyimide target driven by an intense femtosecond laser pulse"* **Physics of Plasmas** **15**, 053104 (2008) DOI: 10.1063/1.2928161
Role in the paper: joined the experiments.

40. H. T. Kim, C.-M Kim, I. W. Choi, H. C. Kang, **N. Hafz**, S. G. Lee, J. H. Sung, T. J. Yu, K. H. Hong, T. M. Jeong, Y.-C. Noh, D.-K. Ko, J. Tummler, P. V. Nickles, W. Sandner, K. A. Janulewicz, and J. Lee, *"Characteristics of a Ni-like silver x-ray laser pumped by a single profiled laser pulse"* **J. Opt. Soc. Am. B** **25**, B76 (2008). DOI: 10.1364/JOSAB.25.000B76
Role in the paper: joined the experiments.
41. H. T. Kim, I. W. Choi, **N. Hafz**, J. H. Sung, T. J. Yu, K.-H. Hong, T. M. Jeong, Y.-C. Noh, D.-K. Ko, K. A. Janulewicz, J. Tummler, P. V. Nickles, W. Sandner, and J. Lee, *"Demonstration of a saturated Ni-like Ag x-ray laser pumped by a single profiled laser pulse from a 10-Hz Ti : sapphire laser system"* **Physical Review A** **77**, 023807 (2008). DOI: 10.1103/PhysRevA.77.023807
Role in the paper: joined the experiments.

2007 (at GIST)

42. Tae Moon Jeong, Il Woo Choi, **Nasr Hafz**, Jae Hee Sung, Seong Ku Lee, Do-Kyeong Ko, and Jongmin Lee, *"Wavefront correction and customization of focal spot of 100TW Ti : sapphire laser system"* **Japanese Journal of Applied Physics** **46**, 7724 (2007). DOI: 10.1143/JJAP.46.7724
Role in the paper: joined the experiments and wrote the paper with the first author
43. **N. Hafz***, I. W. Choi, J. H. Sung, H. T. Kim, K. -H. Hong, T. M. Jeong, T. J. Yu, V. Kulagin, H. Suk, Y.-C. Noh, D.-K. Ko, J. Lee, *"Dependence of the electron beam parameters on the stability of laser propagation in a laser wakefield accelerator"* **Applied Physics Letters** **90**, 151501 (2007). DOI: 10.1063/1.2721119
Role in the paper: proposed and conducted experiments and wrote the paper.
44. **N. Hafz**, G. H. Kim, C. Kim, and H. Suk, *"Generation of good-quality relativistic electron beam from self-modulated laser wakefield acceleration"* **International Journal of Modern Physics B** **21**, 398 (2007). DOI: 10.1142/S0217979207042173
Role in the paper: proposed and conducted experiments and wrote the paper.

2006 (at KERI)

45. **Nasr Hafz**, Min Sup Hur, Guang Hoon Kim, Changbum Kim, I. S. Ko, and Hyyong Suk, "*Quasimonoenergetic electron beam generation by using a pinholelike collimator in a self-modulated laser wakefield acceleration*" **Phys. Rev. E** **73**, 016405 (2006) DOI: 10.1103/PhysRevE.73.016405
Role in the paper: proposed and conducted experiments and wrote the paper.

2005 (at KERI)

46. **N. Hafz**, V. Kulagin, Jongmin Lee and H. Suk, "*Near-GeV electron beam from a laser wakefield accelerator in the bubble regime*" **Nuclear Instruments and Methods in Physics Research-A** **554**, 49-58 (2005). DOI: 10.1016/j.nima.2005.07.061
Role in the paper: proposed and conducted the simulations and wrote the paper.

2004 (at KERI)

47. J. U. Kim, **N. Hafz** and H. Suk, "*Electron trapping and acceleration across a parabolic plasma density profile*" **Physical Review E** **69**, 026409 (2004) DOI: 10.1103/PhysRevE.69.026409
Role in the paper: proposed the simulations and wrote the paper with the first author.
48. H. Suk, **N. Hafz**, J. Kim, H. J. Lee, "*Emittance growth of high-energy electrons produced from the laser wakefield acceleration*" **IEEE -Transactions on Plasma Science** **32**, 429 (2004). DOI: 10.1109/TPS.2004.826360
Role in the paper: joined the discussions

2003 (at KERI and University of Tokyo)

49. **N. Hafz***, H. J. Lee, G. H. Kim, J. U. Kim, H. Suk, Jongmin Lee, "*Femtosecond X-ray generation via the Thomson scattering of a terawatt laser from electron bunches produced*

from the LWFA utilizing a plasma density transition "IEEE Transactions on Plasma Science

31, 1388-1394 (2003). DOI: 10.1109/TPS.2003.820680

Role in the paper: proposed and conducted the simulations and wrote the paper.

2002 (at University of Tokyo)

50. M. Uesaka, T. Watanabe, and **N. Hafz**, **Japan Society of Applied Physics, JSAP-International** **5**, 14-21 (2002).

Role in the paper: wrote 50 % of the paper.

51. R. G. Hemker, **N.M. Hafz**, and M. Uesaka, "Computer simulations of a single-laser double-

gas-jet wakefield accelerator concept" Physical Review Special Topics - Accelerators and

Beams **5**, 041301-041308 (2002). DOI: 10.1103/PhysRevSTAB.5.041301

Role in the paper: joined the design of the simulations and wrote the paper with the first author.

2001 (at University of Tokyo)

52. **Nasr A. M. Hafz**, R. Hemker, A. Zhidkov, H. Okuda, W. Ghaly, K. Kinoshita, T. Hosokai,

K. Yoshii, T. Ueda, T. Watanabe, M. Uesaka, "Laser-plasma electron linear accelerator"

International Journal of Applied Electromagnetics and Mechanics **14**, 271-276 (2003).

Role in the paper: proposed and conducted the simulations and wrote the paper.

53. Mitsuru Uesaka, Takahiro Watanabe, Tetsuya Kobayashi, Toru Ueda, Koji Yoshii, Guozhong Wu, Xifeng Li, Yusa Muroya, Jun Sugahara, Kenichi Kinoshita, **Nasr Hafz**, Hiroyuki Okuda, Teppei Nishihara, Yohei Terada, Kazuhisa Nakajima, Yosuke Katsumura,

"Hundreds- and tens-femtosecond time-resolved pump-and-probe analysis system"

Radiation Physics and Chemistry **60**, 303-306 (2001). DOI: 10.1016/S0969-806X(00)00366-2

Role in the paper: joined the discussions

2000 (at University of Tokyo)

54. Mitsuru Uesaka, Kenichi Kinoshita, Takahiro Watanabe, Jun Sugahara, Toru Ueda, Koji Yoshii, Tetsuya Kobayashi, **Nasr Hafz**, Kazuhisa Nakajima, Fumio Sakai, Masaki Kando,

Hideki Dewa, Hideyuki Kotaki, and Shuji Kondo, "*Experimental verification of laser photocathode RF gun as an injector for a laser plasma accelerator*" **IEEE Transactions on Plasma Science** **28**, 1084- 1093 (2000). DOI: 10.1109/27.893293

Role in the paper: joined the discussions and wrote the paper with the first author

55. **Nasr Hafz***, Mitsuru Uesaka, James Koga, Kazuhisa Nakajima, "*Numerical analysis of 10's femtosecond relativistic electron beam generation using single 12 TW 50 fs laser pulse*" **Nuclear Instruments and Methods in Physics Research A** **455**, 148-154 (2000). DOI: 10.1016/S0168-9002(00)00722-1

Role in the paper: proposed and conducted the simulations and wrote the paper.

SCI Korean Journals

56. **N. Hafz**, C.B.Kim, G.H. Kim, J.U.Kim, H. Suk, Jongmin Lee, "*Thomson scattering of a TW laser from plasma-accelerated electrons: An all-optical method to generate femtosecond soft and hard X-rays*" **Journal of the Korean Physical Society** **44**, 1274-1281 (2004)

Role in the paper: proposed and conducted the simulations and wrote the paper.

57. J. U. Kim, C. Kim, G. H. Kim, **N. Hafz**, H. Suk, "*A method for electron-beam generation through the use of a terawatt laser and plasma interactions and future experimental plans*" **Journal of the Korean Physical Society** **44**, 1294-1297 (2004).

Role in the paper: proposed the simulations.

58. J. Kim, H. Jang, S. Yoo, M. Hur, I. Hwang, J. Lim, V. Kulagin and H. Suk, I. W. Choi, **N. Hafz**, H. T. Kim, K.-H. Hong, T. J. Yu, J. H. Sung, T. M. Jeong, Y.-C. Noh, D.-K. Ko and J. Lee, "*Quasi-monoenergetic electron-beam generation using a laser accelerator for ultra-short X-ray sources*" **Journal of the Korean Physical Society** **51**, 397 (2007).

Role in the paper: proposed and joined in the experiments

59. **Nasr A. M. Hafz***, Tae Moon Jeong, Seong Ku Lee, IL Woo Choi, Ki Hong Pae, Victor V. Kulagin, Jae Hee Sung, Tae Jun Yu, John R. Cary, Do-Kyeong Ko, and Jongmin Lee,

"Laser Acceleration of Electron Beams to the GeV-class Energies in Gas Jets" **Journal of the Optical Society of Korea (JOSK)** **13**, No. 1, March 2009, pp. 8-14. DOI: 10.3807/JOSK.2009.13.1.008

Role in the paper: proposed and conducted the experiments.

60. Chang Il Choi, Dong Hoon Lee, Byoung Hwi Kang, and Yong Kyun Kim, Il Woo Choi, Jae Hee Sung, Chul Min Kim, I Jong Kim, Tae Jun Yu, Seong Ku Lee, Ki Hong Pae, **Nasr Hafz**, Tae Moon Jeong, Do-Kyeong Ko, and Jongmin Lee "Radiography with Low Energy

Protons Generated from Ultraintense Laser-plasma Interactions" **Journal of the Optical Society of Korea (JOSK)** **13**, No. 1, March 2009, pp. 28-32. DOI: 10.3807/JOSK.2009.13.1.028

Role in the paper: joined the experiments.

61. Il Woo CHOI, Hyung Taek KIM, **Nasr A M. Hafz**, Tae Jun YU, Jae Hee SUNG, Seong Ku LEE, Chul Min KIM, I Jong KIM, Young-Chul NOH, Do-Kyeong KO, and Jongmin LEE, "Target Diagnostic Systems for Proton, Electron, and X-ray Generation Experiments

Based on Ultraintense Laser-Target Interactions" **Journal of the Korean Physical Society**, **55** (517-527) 2009.

Role in the paper: joined the experiments

62. **N. Hafz***, T. M. Jeong, S. K. Lee, J. H. Sung, I. W. Choi, T. J. Yu, J. Lee, V. Kulagin, Y. U. Jeong, "Laser-driven Electron Acceleration and Future Applications to Compact Light Sources" **Journal of the Korean Physical Society** **56**, No. 1, (241-246) 2010.

Role in the paper: proposed the paper and wrote it.

Non-SCI publications

63. Tao M, Huang K, Li D, **N. Hafz** et al. Quasi- Mono-Energetic Electron Beams from a Laser-Driven Argon Clustered Gas Target for Radiation Medicine, "**Insights Med Phys.** (2017), 2:1"

64. I. W. Choi, **N. Hafz**, T. M. Jeong, H. T. Kim, C. M. Kim, T. J. Yu, J. H. Sung, K. H. Hong, S. K. Lee, Y. C. Noh, D. K. Ko, J. Lee, S. Orimo, A. Yogo, A. Sagisaka, K. Ogura, M. Mori, Z. Li, J. Ma, A. S. Pirozhkov, S. V. Bulanov, M. Nishiuchi, H. Daido, Y. Oishi, K. Memoto,

- S. Nakamura, Y. Iwashita, T. Shirai, A. Noda, *Laser Driven Relativistic Plasmas Applied for Science, Industry, and Medicine-The 1st International Symposium* edited by S. V. Bulanov and H. Dido. CP1024, 165-172. 2008 American Institute of Physics
65. Il Woo Choi and **Nasr Hafz** (in Korean), 물리학과 첨단기술 June 2007 9 (**Physics and High Technology** pp. 9-19, (June 2007)).
66. K.A. Janulewicz, J. Tümmeler, P.V. Nickles, H.T. Kim, I.W. Choi, **N. Hafz**, C.M. Kim, H. C. Kang, J. H. Sung, T. J. Yu, K. H. Hong, T. M. Jeong, J. H. Kim, Y. -C. Noh, D.-K. Ko, J. Lee. *Soft X-Ray Lasers and Applications VII*, edited by Gregory J. Tallents, James Dunn, *Proc. of SPIE* Vol. 6702, 67020A, (2007)
67. Tae Moon Jeong, Il Woo Choi, **Nasr Hafz**, Jae Hee Sung, Do-Kyeong Ko, Jongmin Lee, *Adaptive Optics for Laser Systems and Other Applications*, edited by Gilles Cheriaux, Chris J. Hooker, Michal Stupka, *Proc. of SPIE* Vol. 6584, 65840H, (2007)

Books

68. “Free Electron Laser”, Edited by Sándor Varró, Chapter 5: pages 119-150 “Laser-Driven Table-Top X-Ray FEL”, by K. Nakajima, Aihua Deng, Hitoshi Yoshitama, **Nasr A. M. Hafz**, Haiyang Lu, Baifei Shen, Jiansheng Liu, Ruxin Li and Zhizhan Xu. ISBN 978-953-51-0279-3, published by InTech, Rijeka, Croatia, March, 2012.

Invited, Oral Talks and Lectures

69. “Novel laser-plasma electron acceleration experiments at SJTU based on ionization injection and two-color laser pulses “AFAD2018, 9th Asian Forum for Accelerators and Detectors, January 28 -31, 2018, Daejeon Convention Center, Daejeon, Korea
Invited Talk: Nasr A. M. Hafz
70. “Recent Progress on laser-plasma acceleration at SJTU”. Chinese Physical Society Meeting, Sichuan University, Chengdu, Sichuan. China. Sep 8-10, 2017
Invited Talk: Nasr A. M. Hafz
71. “Recent Progress on laser-plasma acceleration at SJTU”. The 4th International Symposium on Laser Interaction with Matter (LIMIS 2016), Chengdu, Sichuan. China Nov. 6-9, 2016.
Invited Talk: Nasr A. M. Hafz

72. *"Generation of energetic electrons, positrons, x-ray and gamma ray beams by laser-plasma acceleration using 200 TW 30 fs laser system"* Chinese Physical Society Meeting, Beijing Sept 2-5, 2016.
Invited Talk: Nasr A. M. Hafz
73. *"Recent Progress on Laser Wakefield Acceleration using 200 TW Laser System at Shanghai Jiao Tong University"* 2016 URSI Asia Pacific Radio Science Conference, August 21-25, 2016 Seoul, South Korea.
Invited Talk: Nasr A. M. Hafz
74. *"Recent progress on laser-plasma acceleration experiments at Shanghai Jiao Tong University"* the 7th Asia Summer School and Symposium on Laser Plasma Acceleration and Radiation. July 17-23, 2016 Shanghai Jiao Tong University, Shanghai, China.
Invited Talk: Nasr A. M. Hafz
75. *"Recent progress on laser-plasma acceleration experiments at Shanghai Jiao Tong University"* International Conference on High Energy Density Sciences 2016. May 17-20, 2016 Yokohama, Japan.
Oral Talk: Nasr A. M. Hafz
76. *"Laser-plasma Acceleration Research at Shanghai Jiao Tong University"* The 2nd International Symposium on High-Power Laser Science and Engineering. March 15-18, 2016 Suzhou, China.
Invited Talk: Nasr A. M. Hafz
77. *"Laser Wakefield Acceleration Research at Shanghai Jiao Tong University"* The 17th National Conference on Plasma Science and Technology 16-19 Aug. 2015, Chengdu, Sichuan, China.
Invited Talk: Nasr A. M. Hafz
78. *"Laser-Plasma Acceleration Experiment at Shanghai Jiao Tong University"* Laser Plasma Acceleration Workshop 2015 (LPAW2015), Guadeloupe, France, May 10-15, 2015,

Session Chair: Nasr A M. Hafz

79. "Laser Wakefield Acceleration Research at Shanghai Jiao Tong University", International Workshop on Strong Field Physics and Ultrafast Phenomena (SFPIP 2014) 31st Oct~ 4th Nov/Zhangjiajie, China

Invited Talk: Nasr A. M. Hafz

80. "Electron Beam Acceleration & X-ray Beam Generation by Laser-Plasma Interactions" (Focusing on the experimental sides), The 4th Summer School on Intense Laser Science and Engineering, Shanghai Jiao Tong University, Shanghai, China, 27 July– 1 August (2014).

Invited Lecture: Nasr A. M. Hafz

81. "Laser-Plasma Electron Acceleration Research at Shanghai Jiao Tong University", International Scientific Spring (ISS-2014), National Centre for Physics (NCP), Quaid-i-Azam University (QAU) Campus, Islamabad, Pakistan, 10-14 March 2014

Author: Invited Talk: Nasr A. M. Hafz

82. "Enhanced electron energy in a plasma-based accelerator using chirped laser pulses" First ICTP-NCP College on Plasma Physics, National Centre for Physics (NCP), Quaid-i-Azam University (QAU) Campus, Islamabad, Pakistan, 11-15 Nov., 2013

Oral talk: Nasr A. M. Hafz

83. "Effect of laser temporal profile on the characteristics of an electron beam produced by a laser wakefield accelerator." Program for Sino-German Symposium on Laser Acceleration and Applications of Lasers at Accelerators 2011 (LAALA 2011), 5-8 December, 2011, Institute of Physics, Chinese Academy of Sciences, Beijing.

Invited Talk: Authors: Nasr Hafz

84. Possible Observation of Energy Doubling in a Hybrid Laser-Plasma Wakefield Accelerator

Laser Plasma Accelerators Workshop 2011, Wuzhen, China, June: 20-24, 2011.

Oral Talk: N. Hafz

85. "Recent Progress in Laser Wakefield Acceleration Experiments" The 5th Asian Summer

Nasr A. M. Hafz- Application at IAU

School and Symposium on laser-plasma acceleration and radiation, August 16-20 2010.
Shanghai Institute of Optics and Fine Mechanics, Shanghai, China.

Invited Talk: Nasr Hafz

86. *"Stable generation of GeV-class electron beam from self-guided laser-plasma channels"*

Conference: Ultrashort Electron and Photon Beam Techniques and Applications,
Sept. 7-11, 2009, Shaanxi-Xi'an, China.

Invited Talk: Nasr Hafz

87. *"Stable generation of GeV-class electron beam from self-guided laser-plasma channels"*

Conference: The 4th Asian Summer School and Symposium on laser-plasma
acceleration and radiation, August 17-21 2009. Hsinchu, Taiwan.

Invited Talk: Nasr Hafz

88. *"Laser-driven electron beam acceleration and future application to compact light
sources."*

Conference: The Second International Symposium on Laser-Driven Relativistic
Plasmas Applied to Science, Industry and Medicine. Kansai Photon Science Institute
of the Japan Atomic Energy Agency, Kizugawa City, Kyoto, Japan, January 18-24,
2009. AIP conference proceedings, CP1153, pp. 167.

Oral Talk: N. Hafz

89. *"Recent laser-Plasma Acceleration Experiments at APRI."*

Conference: The 15th International Symposium on Laser Spectroscopy SOLS 2008,
Nov. 13-14, 2008. KAERI, Daejeon Korea.

Invited Speaker: N. Hafz

90. *"Laser Wakefield Acceleration Research at APRI"*

Conference: The 4th Asian Laser Symposium on Intense Laser Science. ASILS4.
APRI, Gwangju Institute of Science and Technology November 3-6, 2008. Gwangju
Korea.

Invited Speaker: N. Hafz

91. *"Generation of GeV-electron beams from laser-plasma interactions"*

Conference: The Optical Society of Korea Summer Meeting 2008, July 9-11. 2008.
Phenex Park, Peocheong, South Korea.

Invited Speaker: N. Hafz

92. *"APRI short-wavelength-source program"*

Authors: K.A. Janulewicz, H.T. Kim, C.M. Kim, I.W. Choi, H. C. Kang, **N. Hafz**, S. K. Lee, J. H. Sung, T. J. Yu, K. H. Hong, T. M. Jeong, Y. -C. Noh, D.-K. Ko, J. Lee

Conference: ALTA-2008 Advanced Lasers and Their Applications, Jeju University (2008.5.1~3). Proceedings Pages: 14-15.

93. *"GeV-class electron beam generation from laser-plasma channels in the self-guiding*

regime" Conference: The 5th User Workshop of Ultrashort Quantum Beam Facility, Advanced Photonics Research Institute, Gwangju Institute of Science and Technology, May 22, 2008, Gwangju, South Korea.

Invited Speaker: N. Hafz

94. *"Laser Plasma Electron Acceleration Research at the APRI in Korea"*

Conference: First International Workshop on Prospectives of High Density Short Pulse Lasers, 7-11 January 2008, NILES, Giza, EGYPT.

Invited Speaker: N. Hafz

95. *"Effect of Stability of Intense Laser propagation on the Quality of electron beams*

produced by the laser wakefield acceleration"

Conference: ALTA- 2007, Advanced lasers and their Applications, May3-5, 2007. Jeju University (2007.5.3~5.5). Proceedings Book Pages: 7-8

Oral Talk: N. Hafz

96. *"Monoenergetic electron beam generation with ultrahigh intensity lasers"*

Authors: Nasr Hafz

Conference: Optical Society of Korea, Annual Meeting 2007, Feb8-9, APRI, GIST.

Korea. Proceedings Book Pages: 74-75.

Oral Talk: N. Hafz

97. *"Electron Beam Acceleration in Plasma by the Laser Wakefields "*

Conference: Atomic Energy Society Meeting of Japan (AESJ), Sept. 27-28 (2007), KitaKyushu, Japan.

Invited Speaker: N. Hafz

98. *"Laser plasma electron acceleration at APRI- GIST"*

Conference: 2006 Korea-Japan Workshop on Advanced Accelerator Technology, Nov.1, 2006 HyangBiPa A Hall, Hotel TEMF, Gyeongju, Korea. Organized by Division of Quantum Engineering and Nuclear Fusion, KNS.

Oral Talk: N. Hafz

99. *"Electron beam generation from laser-plasma accelerator at KERI"*

Conference: KAPRA Workshop_ July 8-9, 2005, Cherwon, Korea.

Oral Talk: N. Hafz

100. *"Ultrashort X-ray source based on the nonlinear Thomson scattering of femtosecond*

lasers from plasma accelerated electron beams"

Conference: Proceedings of IVEC2003, Fourth IEEE International Vacuum Electronics Conference May 28-30, 2003, Seoul Korea, proceedings book, pp. 286-287.

Invited Speaker: N. Hafz

101. *"Numerical Simulation for Plasma Electron Acceleration by 12TW 50fs Laser Pulse."*

Conference: Proc. of AAC2000, ed. P. Colestock and S. Kelley, American Institute of Physics (AIP), Conference Proceedings 569, 122-126, 2001.

Oral Talk: N. Hafz

102. *"Electron Single Bunch Acceleration from Laser-Plasma at the University of Tokyo."*

Conference: PAC 2001, Proceedings of the 2001 IEEE Particle Accelerator

Conference pp. 3969-3971 (Held in Chicago, Illinois, USA, June 18-22, 2001 , FPAH126.

Oral Talk: N. Hafz

103. *"Electron Single Bunch Acceleration from Laser-Plasma at the University of Tokyo."*

Conference: Proceedings of the 26th Linear Accelerator Meeting In Japan Held in High Energy Accelerator Research Organization, Tsukuba, Japan, pp. 355, 2001.

Oral Talk: N. Hafz

104. *"Laser-Plasma Electron Linear Accelerator."*

Conference: Applied Electromagnetics and Mechanics, Proceedings of the 10th International Symposium on Applied Electromagnetics and Mechanics (Held in Tokyo, Japan) ed. T. Takagi and M. Uesaka, Japan Society of Applied Electromagnetics and Mechanics, 367-368, 2000.

Oral Talk: N. Hafz

105. *"Ultra-Short Relativistic Electron Beam Generation from Laser-Plasma Interaction."*

Conference: Proceedings of the Annual Meeting of the Atomic Energy Society of Japan (Held in Ehime University), pp. 118, 2000.

Oral Talk: N. Hafz

106. *"First Electron Beam from Helium Laser-Plasma with 12 TW 50 fs Laser Pulses"*

Conference: Proceedings of the Fall Meeting of the Atomic Energy Society of Japan (Held in Aomori University), pp. 97, 2000.

Oral Talk: N. Hafz

107. *"Plasma Cathode Using Single T3 Laser Beam-Wakefield Wavebreaking in Plasmas"*

Conference: Proceedings of the 12th Symposium on Accelerator Science and Technology, pp. 570-572, 1999, Wako, Saitama, Japan.

Oral Talk: N. Hafz

108. *"10 femtosecond Relativistic Electron Beam Generation in Plasma via Wake Wave-*

breaking"

Conference: Proceedings of the Fall Meeting of the Atomic Energy Society of Japan (Held in Niigata University), pp. 104, 1999.

Oral Talk: N. Hafz

109. *"Femtosecond Relativistic Electron Beams from Plasma by using Wake wave*

Breaking"

Conference: International Symposium on New Visions in Laser-Beam Interactions, Fundamental Problems and Applications of Laser-Compton Scattering. October, 11-15, 1999, Tokyo.

Oral Talk: N. Hafz

110. *"10 fs Relativistic Electron Beam Generation by Laser Plasma Wakefield and*

Wavebreaking"

Conference: Workshop on Beam Physics 1999, 15-17 November, 1999 SPring-8, Hyogo, JAPAN.

Invited Speaker: N. Hafz

Invited Lectures/colloquia (1 hour/lecture) at the following Institutions:

- 109. Korea Electrotechnology Research Institute, Korea (September 2001)
- 110. Japan Atomic Energy Agency, Kansai Photon Science Institute, Kizugawa, Kyoto (Oct. 1. 2007)
- 111. Ain Shams University, Faculty of Science, Physics Dept., Cairo, EGYPT. (January 12, 2008)
- 112. Chungbuk National University, Physics Department, Korea (October 6, 2008)
- 113. Lancaster University, Physics Department, UK (May 1, 2008)
- 114. National Tsing-Hua University, EE-department. Taiwan (March 20, 2009)
- 115. National Synchrotron Radiation Research Center, Taiwan (March 20, 2009)
- 116. Kyungpook National University, Physics Department, Korea (Jan. 13, 2009)
- 117. Universiti Teknologi Malaysia, Physics Department, Malaysia (March 1, 2010)
- 118. Shanghai Jiao Tong University, Physics Department, (August 19, 2010)

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119. Shanghai Institute of Optics and Fine Mechanics, Shanghai, China (May 10, 2011)
120. Al-Azhar University, Department of Physics, Cairo, Egypt, January 2013
121. National Institute for Enhanced Laser Sciences (NILES), Cairo University, January 2013
122. Ain Shams University, Faculty of Science, Department of Physics, January 2013
123. National University of Defense and Technology (NUDT), Changsha, China (April 4th 2014)
124. Cairo University, Department of Physics, Cairo, Egypt (February 15, 2016)
125. Zewail University of Science and Technology, 6th October City, Giza, Egypt (February 18, 2016).
126. Institute of Engineering Physics, College of Science, National University of Defense and Technology (NUDT), Changsha, China (March 31, 2016)
127. Peking University, State Key Laboratory of Nuclear Physics and Applications, April 18, 2016.
128. University of Tokyo, Nuclear Professional School, Graduate School of Engineering, May 18, 2016.
129. Shanghai Institute of Optics and Fine Mechanics, Shanghai, China (July 14, 2016)
130. East China Normal University, Shanghai, China (July 26, 2016)
131. RIKEN-SPring8 Center, Japan (August 31, 2017)
132. University of Lancaster (via Skype), Physics Department, UK (September 8, 2017)
133. University of Strathclyde, Department of physics, UK (March 22, 2018)
134. University of Central Florida, Department of Physics, USA (Feb 20, 2019)

■ *List of accomplished research projects*

No.	Project Name	Institution Sponsoring Research	Research Dates	Research Budget
①	(PI) effect of Asymmetric Laser pulse on laser-plasma acceleration process	Natural Science Foundation of China	1. 2012 to 12. 2015	(820,000 RMB ≈122,000 \$
2	(PI) Multi-GeV electron beam acceleration using 200 TW laser and ionization injection scheme	Natural Science Foundation of China	1. 2017 to 12. 2020	880,000 RMB ≈131,000 \$
3	(Deputy PI) Betatron X-rays from laser-plasma accelerator	Natural Science Foundation of China	1. 2014 to 12. 2018	3.8 Million RMB ≈567,000 \$
⑤	(Deputy PI) Gamma ray generation from laser-plasma accelerators	Natural Science Foundation of China	1. 2014. to 12. 2017	870000 RMB≈129,000 \$)
⑤	(PI) Equipment and lab establishment.	Shanghai Jiao Tong University	1. 2012. to 12. 2016	1 Million RMB (150,000 \$),
⑤	(PI) Special Funds	Shanghai Jiao Tong University	2016-2017	200,000 RMB (30,000 \$)

Teaching Statement

As I mentioned in the cover letter, I have 8 years of teaching experience to undergraduate physics students of Shanghai Jiao Tong University from 2011 to 2018. I was teaching plasma physics and fluid mechanics courses. My course won the Model Course Award by Shanghai Municipal Government for 3 years from 2018 to 2020. Also, my courses were on the top/best courses taught at SJTU as of 2018.

If I join IAU, I will be happy to teach primary courses in electricity and magnetism for freshmen students, however, I am also capable of teaching advanced courses on electromagnetics theory to senior students majored in physics or EE and computer science. I am also capable of teaching solid state physics/quantum mechanics since I have very strong foundations in physics. I am also capable of teaching semiconductor physics and device physics which are major courses for senior engineering and physics students.

If I get an opportunity to teach graduate students, I'd like to teach the course of my major research in lasers, plasma physics and particle accelerators.

I am a native English speaker and Arabic is my mother tongue. I, therefore, guarantee an excellent communication with students and colleagues.

Research Statement

Forward: I have been an active scientist in the area of high-field laser physics, particularly on laser-plasma electron accelerators since I started in 1998 my Ph.D. study at the Graduate School of Engineering of the University of Tokyo. At that time, we had 12 TW 50 fs laser system, I worked hard to establish an electron acceleration setup where we succeeded in generating electron beams by my graduation in September 2001. Then I moved to KERI in South Korea to join a group having 2 TW 700 fs laser system, I established an electron beam acceleration setup there and we obtained monoenergetic 5 MeV electron beams (PRE-2006), almost simultaneously with the famous Laser based generation of Dream Beam in Nature 2004. Then I got a staff researcher position at GIST in South Korea where I used 100 TW laser system to generate 1 GeV electron beam from 1 cm plasma for the first time ([Nat. Photon. 2008](#)). Then, I moved as a faculty member of Shanghai Jiao Tong University (SJTU) where I established an outstanding group of Ph.D. students which reported high-quality GeV electron beams from ionization injection as well as the first results from a two-color laser acceleration ([Science Advances 2019](#)). Then finally, I moved to ELI as a Leading Scientist and a Group Leader to establish a few electron beamlines based on unique laser facilities with high rep. rates. I just started my job at ELI in Sept. 2018. That is a short history tells my extreme focus on the laser-driven electron beam acceleration research for 20 years and the efforts I made in all the labs I joined. All of my experimental work in the mentioned field has been reported in > 60 SCI papers and 70 non-SCI papers, conference and lectures presentations worldwide, please see my CV.

I propose to initiate a research group on the interaction of intense laser pulses and an underdense plasma medium, specifically, on the laser-plasma electron acceleration and all its associated radiation (X-rays through THz) emissions coherent and/or incoherent. Such a subject, which is suitable to a university laboratory (either in an electrical & computer engineering school or the physics school), requires a CPA (chirped pulse amplification) laser system delivering e.g. a few TW 10s fs pulses @10Hz or it could be a sub-TW 10s fs @1kHz.

By focusing those laser pulses to relativistic intensities ($I \geq 10^{18} \text{W/cm}^2$) into mm or cm scale underdense plasma, one can establish a laser-plasma accelerator (LPA) generating relativistic electron beams whose energy and geometrical/propagation characteristics are determined by the laser power, the plasma density and size. I believe such kind of laser facility (Multi-TW, TW, sub-TW) can be acquired at IAU with some collective efforts after I hopefully join.

I would be very glad to establish a laser electronics team to work on electron acceleration based on the well-known, standard technique of laser wakefield acceleration (LWFA, Tajima & Dawson 1979). Depending on the laser system's parameters which put constraints on the available plasma parameters, it is easy to design the accelerator performance/parameters such as electron beam energy, rep. rate, current etc. As a rule of thumb, a tightly focused 1 TW laser power is capable of generating 10-MeV electron beams, while a very tightly focused sub-TW laser generates MeV electron beams. Those all-relativistic electrons emit EM radiation due to their transverse oscillating motion during their acceleration inside the plasma wave (such a

radiation is called “betatron radiation”). The spectrum distribution (an integral of a modified Bessel function $K_{5/3}$) of such radiation is determined by the electron beam energy, electron number per bunch, divergence angle, and the plasma density etc. X-rays betatron radiation emission is a common feature for LWFA employing 10s-100s TW laser systems [see my publications list during 2013~2016]. Whereas such a radiation could have a much lower (than X-rays) frequency (e.g. a broad THz radiation spectrum) if the laser power is around 1 TW level or so. Although such a specific THz emission is incoherent, it could be useful for some applications, especially, if the laser system and so the LWFA accelerator are operating at a high rep. rate such as 100 Hz or 1kHz (operating a LWFA @1kHz rep. rate is simply managed through a continuous gas flow from a narrow gas nozzle in a vacuum chamber pumped by strong vacuum system). To my knowledge, there has been neither a previous research work on the betatron THz radiation emission from a LWFA operating with TW-level lasers nor the method I mention is a common technique for the THz rad generation. Yet, I am still very interested in the ultrashort X-ray betatron radiation for applications such as phase-contrast imaging, micro tomography and ultrafast dynamic studies in solid-state physics if we will have a larger laser system in the future.

I have been focusing in the past few years on achieving electron beams with extremely high-quality from the LWFA. Namely, I was generating monoenergetic electron beams with an energy-spread of about 1%. To achieve this, we invented two techniques: one is called self-truncated ionization injection (published in M. Mirzaie et al. *Scientific Reports* 2015) the other is through employing a two-color LWFA scheme (S. Li et al., *Science Advances*, 2019).

I will continue working on those topics both experimentally and numerically for their extreme importance. This is because if we realize 0.1% energy-spread electron beams with a reasonable number of electrons per bunch (current), one can easily build a compact FEL (free electron laser) for generating coherent radiation (the radiation wavelength depends on the electron beam gamma) which are many orders of magnitude brighter than the incoherent emission and significantly cheaper than the conventional FEL devices. This would compose a revolution in science and technology.

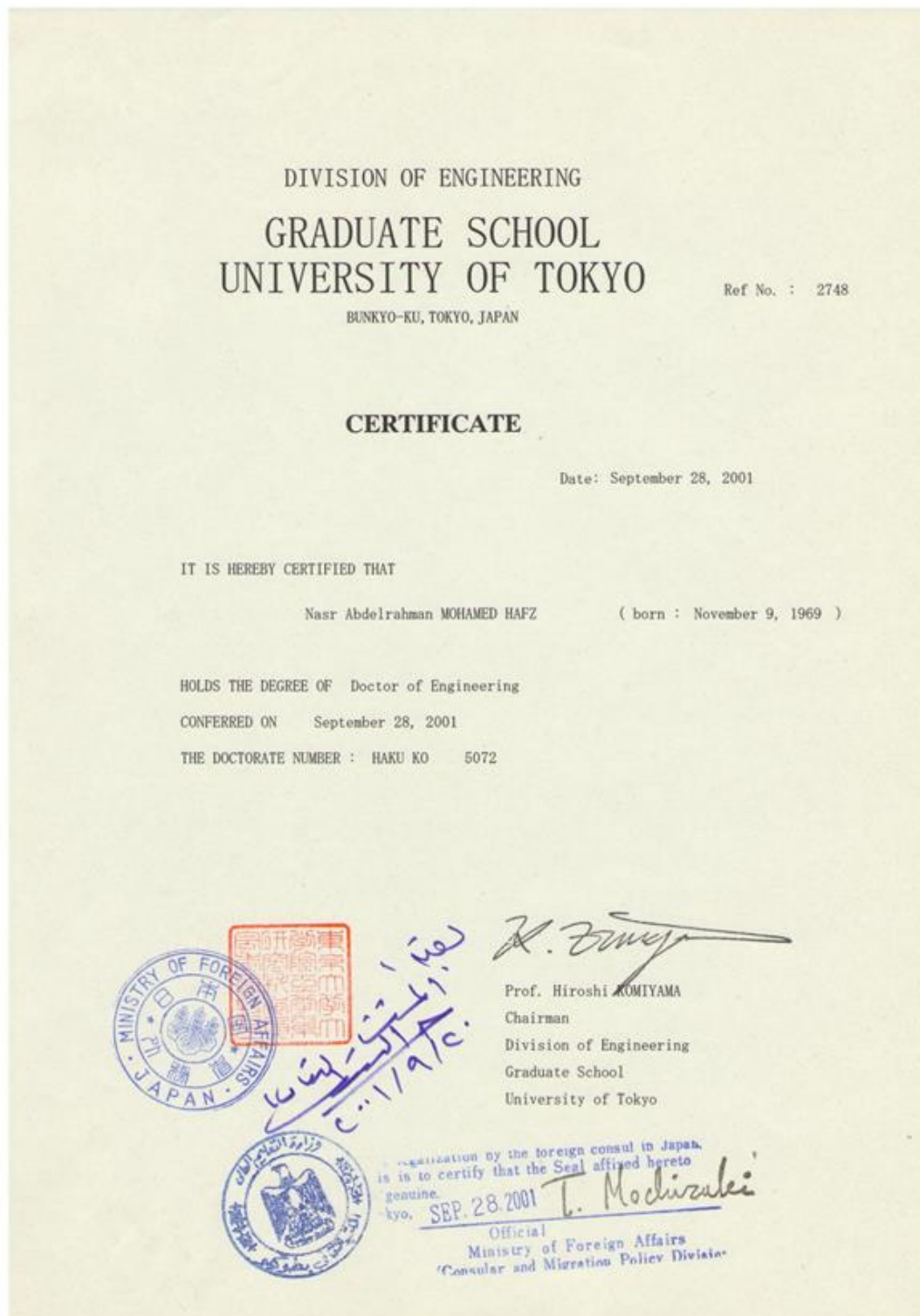
Relativistic electron beams/electronics (laser-plasma accelerators) are themselves a rich material for radiation/beam physics studies; e.g. those electron beams are extremely short (around 1 fs) in duration. Such an important property can be exploited in the emission of CTR (coherent transition radiation) in the NIR and 100s THz spectrum range. That is an active and important topic as an electron beam diagnostics method and as a radiation source. Also, having relativistic electron beam from the LWFA which is ultrashort and, by nature, in a perfect synchronism with the drive ultrashort laser pulses, such an electron beam can scatter the laser to relativistically Doppler shifting the IR frequency towards much harder frequencies which are in the X-ray range, the phenomenon called “Thomson back-scattering”. Conducting such a research in a laser-plasma accelerator laboratory is much easier than doing this in a conventional accelerator facility, mainly due to the inherent synchronization of the electron beam and laser pulses in the former.

Also, the plasma wave itself (which is a density wave whose phase is propagating at almost the speed of light) is a rich topic of an active research in laser-plasma physics in which I am also very interested. The importance of diagnosing the plasma wave (measuring its amplitude, phase,

velocity etc.) reflects directly on the LWFA performance, which means that the more we understand about the plasma wave the more one can predict the accelerator performance. The diagnosis of the plasma waves used for LWFA can be conducted using a probe laser beam (after being shortened to a few-cycle duration) which crosses the plasma transversally as the main drive LWFA propagates.

In summary, I will be happy and I am capable of to establishing a group on the use of laser systems for electron beam acceleration and radiation generation, i.e. relativistic electronics, at IAU with the available and achievable resources.

Documents





**DIVISION OF ENGINEERING
GRADUATE SCHOOL
UNIVERSITY OF TOKYO**
BUNKYO-KU, TOKYO, JAPAN
OFFICIAL RECORD

Date: September 28, 2001

Name: MOHAMED HAFZ Nasr Abdelrahman
(FAMILY NAME) (GIVEN NAME)

Date of Birth: November 9, 1969

Major Subject: Quantum Engineering and Systems Science

Period Attended: From October, 1998 To September, 2001
(MONTH) (YEAR) (MONTH) (YEAR)

Degree Awarded: Hakushi (Kō gaku) (Doctor of Engineering)
(JAPANESE) (ENGLISH)





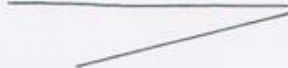
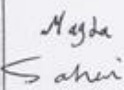
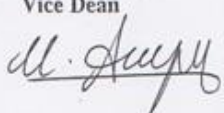
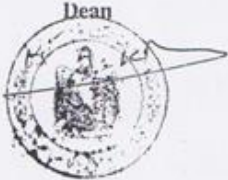
Date Awarded: September 28, 2001


(Note: Maximum evaluation is 100 and the lowest passing mark is 60. A signifies 100 to 80, B signifies 79 to 70, C signifies 69 to 60.)
We have no system of grade-point average and ranking.

Title of Course	Unit	Grade
Advanced Nuclear Reactor Analysis	2	A
Advanced Quantum Beam Engineering I	2	A
Advanced Research in Quantum Engineering and Systems Science	10	A
Quantum Engineering and Systems Science II E	2	A
Quantum Engineering and Systems Science III E	2	A
Quantum Engineering and Systems Science IV E	2	A
Plasma Physics and Controlled Fusion E	1	A
Doctor's Thesis	-	Pass

Organization by the foreign consul in Japan.
This is to certify that the Seal affixed hereto
genuine.
Tokyo, SEP. 28. 2001 T. Mochizuki
Official
Ministry of Foreign Affairs
(Consular and Migration Policy Division)

Signature: H. Komiyama
Prof. Hiroshi KOMIYAMA
Chairman
Division of Engineering
Graduate School
University of Tokyo

 SUEZ CANAL UNIVERSITY FACULTY OF SCIENCE ISMAILIA EGYPT		  Date: 5/1/1997
CERTIFICATE		
Name of Student	:	NASR ABDEL RAHMAN MOHAMED HAFZ
Degree Awarded	:	Msc in PHYSICS
Subject of Study	:	LASER SCATTERING in PLASMA
Major Grade	:	
Date of Graduation	:	5/1/1997
 N. B. : " The certificate is issued at the request of the student "		
 Vice Dean 	 Dean	



AIN SHAMS UNIVERSITY
FACULTY OF SCIENCE

Administration Office
Cairo - A.R.E

LIST OF GRADES

Date : 19

Ref. :

Name of Student : Nasr Abd Elrhman Mohamed Hafz

Degree Awarded : B.Sc. (Physics)

Graduation Date : May 1991

Major Grade : Excellent - 91.71%

First Year 1987 - 19 88			Second Year 1988 - 19 89			Third Year 1989 - 19 90			Fourth Year 19 90 - 19 91		
Subjects	Hours per week	Grade	Subjects	Hours per week	Grade	Subjects	Hours per week	Grade	Subjects	Hours per week	Grade
Pure Math.											
101		Pass (9.88)	Physics			301		Excellent.	401		Excellent.
102		Pass (9.88)	201		Very Good	302		Excellent.	402		Excellent.
Applied Math.			202		Very Good (Good)	303		Very Good	403		Excellent.
111		Pass	203		(Good)	304		Very Good	404		Excellent.
112		Pass (5.89)	Math.		(Good)	305		Excellent.	405		Excellent.
Physics			201		Pass	306		Very Good	406		Excellent.
101		Excellent (Good)	202		Pass	307		Very Good	Math.		
102		(Good)	203		Pass (Good)	Math.			421		Excellent.
Chemistry			211		Pass	321		Excellent.	422		Excellent.
101		Very Good	212		Pass	322		Very Good			
102		Pass									
Language Social Science											
		Pass (5.89)			Pass						
Major grade					(Good)						

Nasr

Ain Shams Univ. Press. 417/24/1983/1000

Registrar *Carim*

Hoda

Dean *[Signature]*


AIN SHAMS UNIVERSITY
FACULTY OF SCIENCE
Administration Office
Cairo — A.R.E.



Date : 7/8/..... 19 91

CERTIFICATE

Name of Student NASR ABD EL-RAHMAN MOHAMED HAFIZ
Degree Awarded B.Sc.
Subject of Study (Physics)
Major Grade Excellent 91.71%
Date of Graduation May 1991

N. B. :
This certificate is issued at the request of the student.

Samir Hada
Registrar



Dean

Ain Shams Univ. Press 525/87.1988 10,000



Certificate No. 2008-47



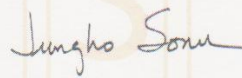
Outstanding Research Award

This Award is Presented to

Dr. Nasr Hafz

Senior Researcher,
Advanced Photonics Research Institute

in recognition of his contributions to scientific
research at GIST, on this memorable 15th
Anniversary of GIST.

A handwritten signature in black ink, reading 'Jung-Ho Sonu'.

Jung-Ho Sonu, Ph.D.

November 13, 2008

President of
Gwangju Institute of Science and Technology

KOREA ELECTROTECHNOLOGY RESEARCH INSTITUTE
(641-120) 28-1 SUNGJU-DONG CHANGWON CITY KYUNGNAE KOREA
<http://www.keri.re.kr> TEL : +82-55-280-1114

NO. 06003069

CERTIFICATE OF EMPLOYMENT

Address	Na-206 KERI Apts., Gaeumjeong-Dong, Changwon-si, Gyeongsangnam-do, Korea		
Name in full	Nasr Abdelrahman Mohamed Hafiz		
Date of birth	Nov. 09, 1969	Passport No.	316139
Section	Industry Applications Research Laboratory Advanced Accelerator Research Group		
Position	Foreign Scientist	Purpose	Experience certificate
Period of Employment	Dec. 27, 2002 ~ PRESENT		

This is to certify that the above-named person (has been, had been) employed by Korea Electrotechnology Research Institute since Dec. 27, 2002

May. 30, 2006

Park, Dong-Wook, Ph.D

President

KERI



This certificate is printed by electrophotograph.

the person
in charge



Issue No. : 2011 - 14

Date : February 21, 2011



CERTIFICATE OF EMPLOYMENT

Name in Full : Nasr A. Mohamed Hafz

Date of Birth : November 9, 1969

Gender : Male

Department : Advanced Photonics Research Institute

Current Position/Title : Senior Research Scientist

Career Fact : 2006. 06. 01 ~ Present

This is to certify that the above-mentioned person has been employed by the Gwangju Institute of Science and Technology.

Jungho Sonu

President



Gwangju Institute of Science and Technology

261 Cheomdan-gwagi-ro(Oryong-dong), Buk-gu, Gwangju 500-712 Republic of Korea
TEL: +82-62-715-2114 FAX: +82-62-715-2300 <http://www.gist.ac.kr/>

No. 2006-20



CERTIFICATE OF APPOINTMENT

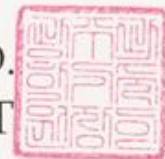
Nasr A. M. Hafiz, Ph.D.

In accordance with the regulations of the Gwangju Institute of Science and Technology, Nasr A. M. Hafiz, Ph.D. is hereby appointed as a Senior Research Scientist in the Advanced Photonics Research Institute.

June 1, 2006



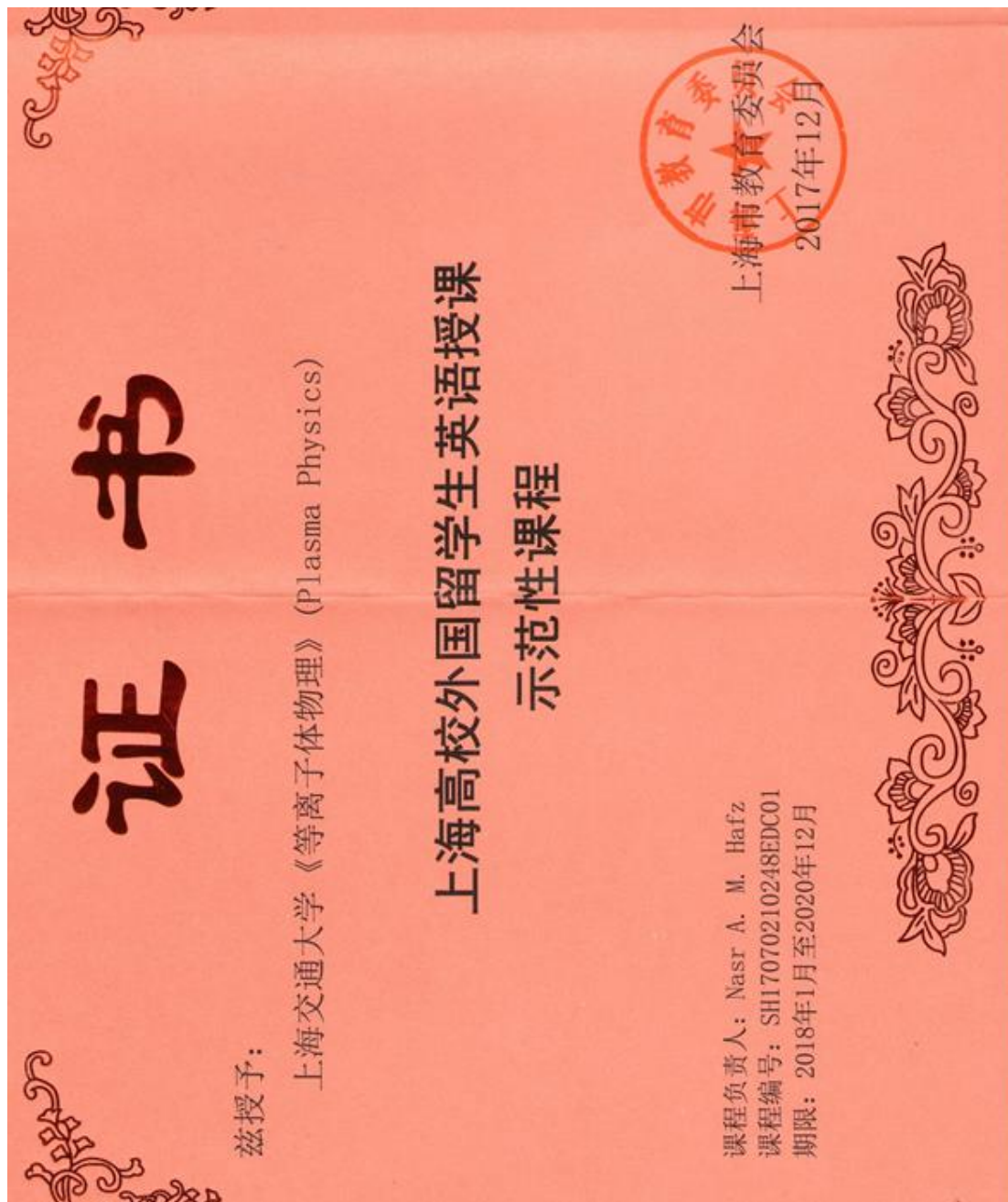
Sung K. Huh, Ph.D.
President of GIST



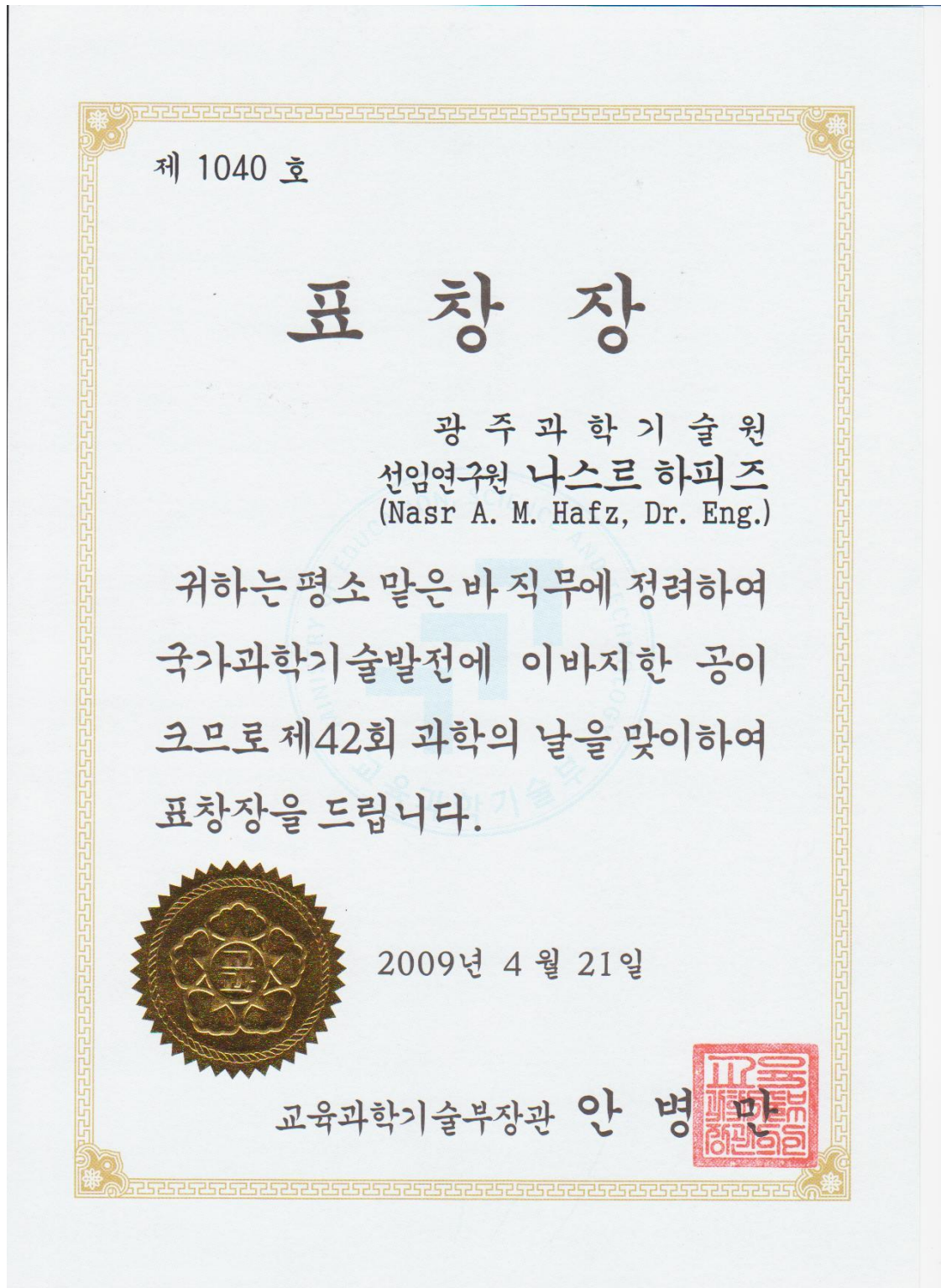
**This is an employment certificate of Associate Professorship
at Shanghai Jiao Tong University**

上海交通大学高级专业技术职务聘书			
姓 名	NASR HAFIZ	专业技术职务	聘任时间
性 别	男	副教授	2012.05.21
工 号	50302	本聘期专业技术职务	起止时间
出生年月	1969.11.09	副教授	2016.03.01-2019.02.28
专 业	激光等离子体物理		
工作部门	物理与天文学院		
证书编号	2012JG080		
发证日期	2018-01-16		
校长 (签章)		上海交通大学	

**This is an Award for the Model Course” by Shanghai
Municipal Government**



This is an outstanding research award by the Ministry of
Science and Technology of Korea



INTERVIEW

Accelerators moving on

Particle accelerators are one of the most remarkable pieces of apparatus to come out of twentieth century science. *Nature Photonics* spoke to Nasr Hafz who, with the help of colleagues, is working towards more compact and thus more affordable accelerators based on lasers.

Tell us about your research.

Our work at the Advanced Photonics Research Institute in Korea involves accelerating electrons using laser beams. We inject laser light into a plasma (an ionized gas) and excite the plasma in such a way that very strong electric fields are created over very short distances — on the order of a few millimetres. Charged particles — in our case electrons — can then be accelerated by this electric field. It turns out that we can generate the same field strength over a distance of less than 1 cm that conventional radiofrequency cavities can only create over several hundreds of metres. That is the advantage of the laser-plasma approach.

How exactly does the electric field develop?

The plasma is full of electrons and ions. As the laser travels through the plasma it causes charge separation, leaving behind it a so-called wakefield — a longitudinal plasma oscillation. Some of the electrons in the plasma get trapped in the wakefield and travel along with this wave for a certain distance — typically a few millimetres — before they dephase, at which point they no longer acquire any more energy from the plasma oscillation. We extract the electrons at that point. To make this work, we have to design the length of the plasma and the plasma density very carefully to make sure the electrons do not dephase too quickly.

Tell us more about the laser system you use.

Our experimental room is about 5 m wide and 15 m long. Half of that is taken up by the laser system. We use extremely intense laser beams with powers of up to 50 TW, and pulses that are 35 fs long. The ion motion within the plasma is at a rate of the order of picoseconds, so the pulse duration has to be shorter than that to make sure the beam is stable as it travels through the plasma and does not get disturbed. The spot size of the focused laser beam is about 25 μm full-width at half-maximum. Previous experiments have used 5- or 10- μm spot sizes, but we have found that a larger focal spot produces a more energetic, more stable beam of electrons.



Accelerator players: Nasr Hafz (left) and Jongmin Lee (right).

We focus the laser in the plasma using various optics, to ensure that the light beam travels as far as possible before it diffracts. There are several techniques to overcome the diffraction. If the laser beam is very intense, as in our case, an effect known as self-guiding can occur, in which the laser essentially focuses itself and can travel over larger distances.

What about the plasma?

The interaction chamber is housed in a shielded room and is less than 2 m long. We use several-millimetre-long jets of helium gas as the source of the plasma. This is in contrast with other accelerators that rely on capillaries instead of gas jets, which are much harder to control and tend to be less compact. Our gas jets are high-quality supersonic jets with a Mach number of five, and they are emitted vertically to interact with the laser beam. It is important that the gas jet has a sharp profile so that it doesn't defocus the laser prior to interaction.

The experiment sounds simple in theory, but in practice it isn't. One run of the experiment takes 1–2 months to complete. The laser-plasma interaction has to be very finely tuned. For example, it takes many trials just to focus the laser correctly onto the gas jet.

So what kind of acceleration do you achieve?

We have managed to create electron beams with energies over 1 GeV that are, crucially, very stable and reproducible (the energy of the accelerated electrons fluctuates less than 5%). Only two groups have successfully managed to produce gigaelectronvolt-scale electron beams — us and researchers at Lawrence Berkeley National Lab, who also have access to a 50-TW laser beam. The Berkeley group used a similar laser system but the plasma was about ten times longer. The stability of the acceleration process is critical if laser-based accelerators are to become a practical reality, and that requires a very stable laser system.

Where next?

Many labs around the world, including ours, are building petawatt-class lasers. With petawatt light (and larger spot sizes) we expect to be able to reach far higher electron beam energies — of the order of tens of gigaelectronvolts. Petawatt lasers also allow us to study the interaction of laser light with certain solids to generate protons and X-rays. In the next year or so our aim is to use 100-TW beams of light. We have already produced electron beams with 2–3 GeV of energy, but the number of electrons at these energies was small.

In the longer term, Jongmin Lee (the project leader) is planning to move into free-electron-laser (FEL) work, which is a very exciting area of research. Free-electron lasers use electrons instead of gases or solids as the lasing medium and could lead to high-intensity ultrashort sources of X-rays. Conventional FELs are very expensive with most of the cost going towards the construction of large linear accelerators. Our hope is to eventually create an X-ray FEL using our compact electron accelerators at a much cheaper price.

Interview by Amber Jenkins.

Hafz and his colleagues have an Article on laser-plasma accelerators on page 571 of this issue.

