North American Chinese Medical Physicists Association

Spring 2021
Volume 6 No. 1

NACMPA NEWSLETTER

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Inside this issue:

Message from President

Brian Wang, PhD
NACMPA President

Welcome to the Spring 2021 Edition of the NACMPA newsletter.

I started my two-year term as the president this year. I am excited to continue working with all members, especially closely with the Executive Committee officers. We typically hold the regular meetings between 9-10 pm ET as most officers have clinical conflicts during the day. I clearly remember Dr. Zhigang (Josh) Xu did not turn on his camera during our January meeting. After pressing, Josh reluctantly turned it on, lying in bed. He just had his second shot of the COVID vaccine early that day! It is just an example of how dedicated our teams are.

We have elections for two officers this year: secretary and board member at large. We will continue using the WeChat platform for voting in July. You can find a brief introduction of the candidates in this newsletter. Of note, a pair of imaging physicists are running for the seat of board member at large. It may be the first time, at least in recent years that I can think of, that our imaging colleagues participate in the election. As the imaging specialty has grown tremendously, there is an increasing number of our members specializing in it. We believe this is the first step to engage all medical physicists from both imaging and therapy specialties in our association. I believe it is just a matter of time when we will have an NACMPA president specializing in imaging physics!

The AAPM annual meeting is virtual again this year, and we will host a virtual annual meeting of our NACMPA between 8:00-9:30 pm EDT on Saturday, July 24th. The newly-elected officers will "meet" everyone. It will be followed by award presentations and financial reports. New to this year, I will moderate an Ask the Experts session with panelists Drs. Charlie Ma, Ping Xia, Fang-Fang Yin, and Cedric Yu. They will share their professional wisdom. Please come with your questions.

Every year, NACMPA members receive prestigious awards from professional societies. In 2021, the following members were elected as an AAPM fellow: Erli Chen, Quan Chen, Liyong Lin, An Liu, Wei Luo, Ke Nie, Ning Wen, Xiaowei Zhu. In 2020, Ning J. Yue was elected as an ASTRO fellow, while the 2021's results are not available yet. Please join me to congratulate our colleagues!

Thank you all the volunteers and officers! "See" you at our Virtual Meeting!

Seeking Contributors

NACMPA NEWSLETTER is published by the North American Chinese Medical Physicists Association on a semiannually schedule. We welcome all readers to send us any suggestions or comments on any of the articles or new features to make this a more effective and engaging publication and to enhance the overall readership experience.

Contact us: nacmpa@yahoo.com 欢迎大家投稿，并希望大家关注北美华人物理师微信公众号.

Editors: Lu Wang, PhD

2021 NACMPA Awards

陈昱华人物理师最佳奉献奖

为了感谢和表彰华人物理师志愿者的奉献和鼓励更多医学物理师参与公益活动，NACMPA由陈昱纪念基金会赞助，从2018年起设立一个新的年度奖项-陈昱华人物理师最佳奉献奖。

评议过程主要以网上实名投票的方式进行，由大家投票选出。 2021年度的获奖者是 Zhigang Xu。陈昱纪念基金会为获奖者准备一个奖状铭牌和美元现金奖励。恭喜徐志岗博士。

In Recognition of Your Outstanding Volunteering Work For the American Chinese Medical Physics Community

Yu Chen Award of Excellent Community Contribution
2021 Recipient

Zhigang (Josh) Xu, PhD

IJMPCERO Best Paper Award

Scientific Research
Open Access

International Journal of Medical Physics, Clinical Engineering and Radiation Oncology

Presents the

NACMPA Award for Excellence

to

Jialu Yu, Huazhi Geng, Yutao Gong, Mitchell Machtay, Himanshu R. Lukka, Zhongxing Liao, Ying Xiao, Wei Zou

For the Best Medical Physics Paper Published during 2020-2021 in

International Journal of Medical Physics, Clinical Engineering and Radiation Oncology

Investigation of Target Minimum and Maximum Dosimetric Criteria for the Evaluation of Standardized Radiotherapy Plan

$500 Voucher from *Scientific Research Publisher (SRP)* (Order # IJMPCERO0310; Expiry Date: July 28, 2022)

NACMPA North American Chinese Medical Physicists Association

Scientific Research Publishing Inc. USA CORPORATE SEAL 2007 DELAWARE

Ning J. Yue, PhD
Editor-in-Chief
July 28, 2021

The International Journal of Medical Physics, Clinical Engineering, and Radiation Oncology (IJMPCERO) was founded in 2012. The Editor-in-Chiefs have been Lei Xing, PhD (Stanford University), Huan Bosco Giap, MD, PhD (University of Miami), and Ning Jeff Yue, PhD (Rutgers Cancer Institute of New Jersey). The journal has been endorsed by the North American Chinese Medical Physicists Association (NACMPA) since the beginning. It is an Open Access (OA) journal, meaning that the publisher makes all articles and related content available for free on the journal's website. Since it was established, the journal has published over 250 articles with more than 765 citations. Since it is an OA, there have been over 573,000 and 929,000 downloads and views of IJMPCERO articles respectively. For example, the first IJMPCERO best paper has been cited by peer-review journals' articles more than 125 times based on Google Scholar Citation Tracking. The Best Paper Award ($500 voucher along with a framed official certificate) has been presented to the first author of the winning paper each year at the annual meeting of NACMPA since 2013. The meeting is held on Wednesday evening at the annual conference of American Association of Physicists in Medicine (AAPM) except this year will be held virtually due to pandemic.

The criteria for best paper award selection, set by the NACMPA award committee, are the 1st or senior author must be a member of NACMPA and the paper was published in 2020. This year our award committee of NACMPA has selected the following paper as the Best Paper of IJMPCERO published in 2020–Jialu Yu, Huazhi Geng, Yutao Gong, Mitchell Machtay, Himanshu R. Lukka, Zhongxing Liao, Ying Xiao, Wei Zou: **"***Investigation of Target Minimum and Maximum Dosimetric Criteria for the Evaluation of Standardized Radiotherapy Plan—Target Minimum and Maximum Evaluation* ", Vol. 9 No. 2, May 2020(https://www.scirp.org/journal/paperinformation.aspx?paperid=99126). Congratulations to all the authors!

Maria Chan, PhD
NACMPA Liaison to IJMPCERO
Past President/Chair of Board, NACMPA

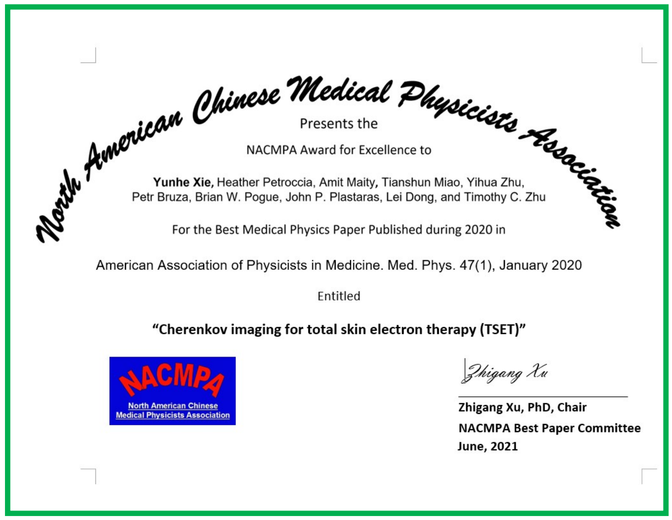
NACMPA Best Paper Award

NACMPA best paper award , established in 2018, aside recognizing the outstanding contributions to the medical physics field by the awardee(s), another goal of this award is to promote our society and hopefully draw more participations and contributions to NACMPA. Therefore, the criteria for best paper award selection, set by the NACMPA EXCOM, are

1. 1st author is a member of NACMPA
2. Publication was in 2020 and in a medical physics related journal.

The 2021 NACMPA best paper award goes to:

Yunhe Xie, Heather Petroccia, Amit Maity, Tianshun Miao, Yihua Zhu, Peter Bruza, Brian W. Pogue, John P. Plastaras, Lei Dong, and Timothy C. Zhu: “Cherenkov imaging for total skin electron therapy (TSET)”



North American Chinese Medical Physicists Association

Presents the

NACMPA Award for Excellence to

Yunhe Xie, Heather Petroccia, Amit Maity, Tianshun Miao, Yihua Zhu, Petr Bruza, Brian W. Pogue, John P. Plastaras, Lei Dong, and Timothy C. Zhu

For the Best Medical Physics Paper Published during 2020 in

American Association of Physicists in Medicine. Med. Phys. 47(1), January 2020

Entitled

“Cherenkov imaging for total skin electron therapy (TSET)”

NACMPA North American Chinese Medical Physicists Association

Zhigang Xu

Zhigang Xu, PhD, Chair
NACMPA Best Paper Committee
June, 2021

NACMPA Service Award

North American Chinese Medical Physicists Association

In recognition and appreciation of your outstanding services to the NACMPA, as an executive officer:

Zhigang (Josh) Xu, PhD, DABR
President (2019-2020)

NACMPA North American Chinese Medical Physicists Association

President
(July 2021)

North American Chinese Medical Physicists Association

In recognition and appreciation of your outstanding services to the NACMPA, as an executive officer:

Yin Zhang, PhD.
Treasurer (2019-2020)

NACMPA North American Chinese Medical Physicists Association

President
(July 2021)

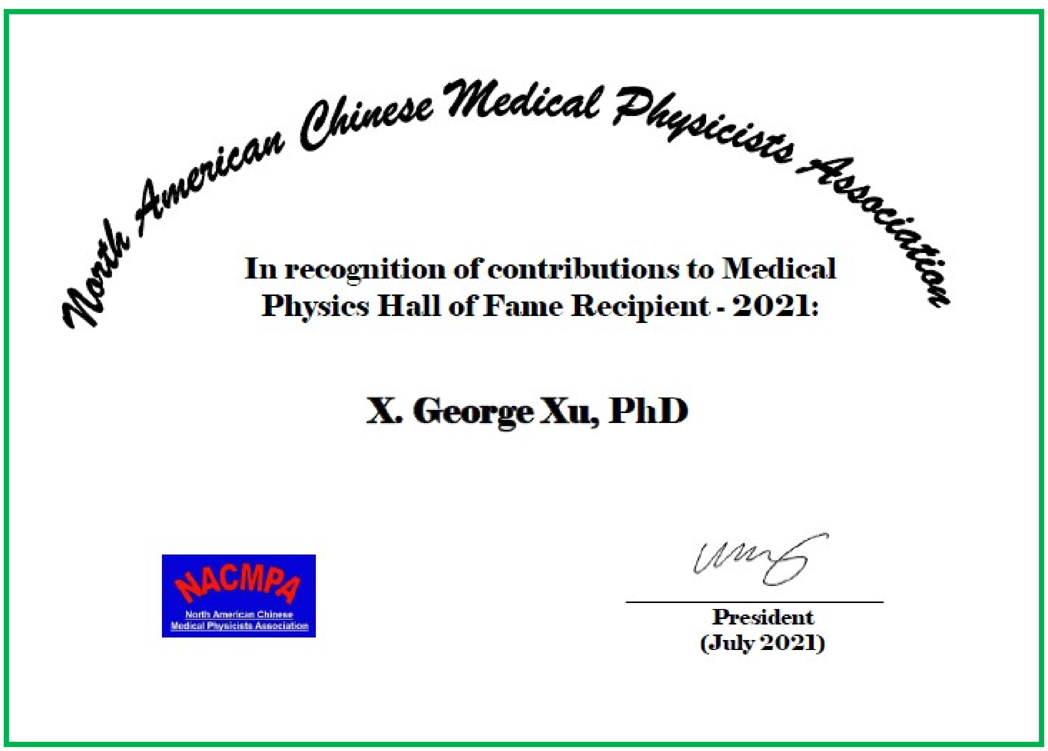
2021 NACMPA service awards go to Zhigang Xu and Yin Zhang who have both completed two extraordinary years of service to NACMPA. Zhigang Xu is completing his term as the President of NACMPA and Yin Zhang is concluding his position as the Treasurer of NACMPA for 2019-2020. Their contributions to the organization have been widely recognized.

NACMPA Hall of Fame Award

X. George Xu, PhD
NACMPA member

The NACMPA Hall of Fame award is an annual award to acknowledge the individual who made outstanding contribution to the field of medical physics through research or clinical work, or the individual who was outstanding in service in NACMPA. Due to the outstanding accomplishments and the significant contributions to NACMPA, Dr. X. George Xu has been selected by NACMPA Awards Committee to receive the 2021 NACMPA Hall of Fame Award, the highest honor of NACMPA. Congratulation!

Until 2020, Prof. X. George Xu spent 25 years at Rensselaer Polytechnic Institute (Troy, New York) where he carried out extensive health/medical physics research projects, graduated 40 graduate students, published 200 peer-reviewed articles and 400 abstracts, wrote 5 industrial/commercial software packages. He is a fellow of HPS, ANS, AAPM, and AIMBE, an elected council member of the NCRP, an editorial board member of PMB and MP. He has received numerous awards including the CIRMS Randal S. Caswell Award for Distinguished Achievements (2015), HPS Distinguished Scientific Achievement Award (2018), AAPM Edith H. Quimby Award for Lifetime Achievement in Medical Physics (2020), ANS Arthur Holly Compton Award in Education (2020), ANS Rockwell Lifetime Achievement Award in Radiation Protection and Shielding (2020). Prof. Xu is currently the director, Institute of Nuclear Medical Physics, the University of Science and Technology of China (Hefei, China).

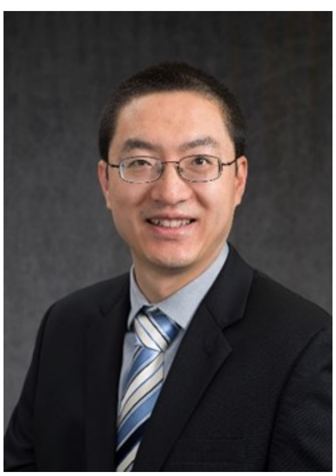


Candidates for Board Member at Large 2021-2022

Shaohua Liu, PhD
NACMPA member

Dr. Liu obtained his Ph.D. degree in nuclear physics from Vanderbilt University (Nashville, TN) in 2010, after graduating from Beijing Normal University with BS and MS degrees in physics. He worked in Oak Ridge National Lab and University of Kentucky Accelerator Lab before moving on to the CAMPEP Accredited Imaging Physics Residency program at West Physics (Atlanta, GA). After working for two large healthcare systems (one on the east coast and the other on the west coast) and a consulting group in Texas, he is now a faculty member in the Department of Radiology at Baylor College of Medicine (BCM) (Houston, TX), where he is the licensed medical physicist and X-ray Radiation Safety Officer for Harris Health System Ben Taub General Hospital.

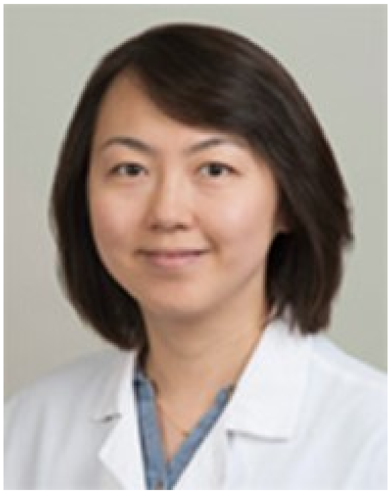
Dr. Liu has been a reviewer for several physics journals including Nature and Physical Review Letters and the medical physics journal JACMP. He also has a strong publication record in nuclear physics, and he plans to establish his publication record in imaging medical physics at BCM. Dr. Liu is very willing to serve our medical physics community. He believes that NACMPA is a great Chinese physicist community in North America. And It will be his great privilege to serve the excellent organization, representing imaging physicists.



Kai Yang, PhD
NACMPA Member

Dr. Kai Yang is Assistant Professor of Radiology at Harvard Medical School and a diagnostic medical physicist at Massachusetts General Hospital. Prior to his current appointment in the Division of Diagnostic Physics at MGH, he held faculty positions at University of California, Davis and University of Oklahoma. Dr. Yang received his Ph.D. degree in Biomedical Engineering from University of California, Davis in 2007. At MGH, Dr. Yang provides clinical service and consultation for Radiology and Radiation Oncology and is responsible for the quality control of all the x-ray and ultrasound related imaging equipment. Focusing on CT and breast imaging, Dr. Yang has authored/co-authored more than 65 peer-reviewed publications and three book chapters. He is currently a member of AAPM CT subcommittee, MOC subcommittee, Working Group on DICOM Coordination (as WG21 CT Representative) and Task Group 322 (Color Displays in Medicine).

Candidates for Secretary 2021-2022



Yingli Yang PhD
NACMPA Member

Yingli Yang Ph.D. received her B.E. of Biomedical Engineering from Tsinghua University, Beijing, China and Ph.D. in Bioengineering from Columbia University in 2008. Dr. Yang is an Associate Professor in the Department of Radiation Oncology at UCLA David Geffen School of Medicine. She obtained her PhD in magnetic resonance spectroscopic imaging from Columbia University and finished her therapy medical physics residency training at the Memorial Sloan Kettering Cancer Center. Dr. Yang is currently the Chief Medical Physicist for the UCLA MR-guided Radiotherapy System (ViewRay Inc.). Her research focuses on advanced development of MRI guided Radiation Therapy techniques, including MR-only simulation, dynamic multidimensional imaging for treatment planning and functional imaging for assessing tumor response to radiation. Dr. Yang has published 40+ papers in the field of therapeutic physics and imaging. She is an Associate Editor for the Journal of Clinical and Applied Medical Physics and has served as reviewer for several high-impact journals. Dr. Yang has organized and presented in educational and SAM sessions at AAPM annual meetings and has given 20+ international and national invited talks.

Dandan Zheng, PhD
NACMPA Member

Started as an undergraduate biology major at USTC, I slowly transitioned my way into medical physics when I pursued a PhD in Applied Science Engineering and a double major MS in Biomedical Engineering at UC Davis. I excitedly jumped into the field when Dr. John Boone told me after one lecture that since almost all medical physicists came from physics or engineering background, I will have a unique niche as a former biologist. Twenty years later, I am still trying to find that niche. My journey included a therapy physics postdoc and then three years on faculty at Virginia Commonwealth University, and since 2012 at University of Nebraska Medical Center, where I am currently a Professor and Physics Residency Director. I serve on a few committees for AAPM and ASTRO, related to my research interest in therapy imaging and educational interest on residency training. I am also an avid reviewer for a variety of journals and CAMPEP residency accreditation. If elected, I would be privileged to serve the NACMPA community, using this wonderful network and platform to help our member find your niche.

资深物理系主任谈领导艺术

Clifton Lin, PhD, NACMPA Hall of Fame Award recipient in 2008

Introduction

When Lu Wang wrote and asked me to write an article for the NACMPA newsletter on the current and future development of medical physics, I quickly declined, as my views on that subject would be superficial. Instead, for that assignment, I suggested that she engage Chinese medical physicists who are KOLs in leadership role (you know who you are!). Indeed, I am happy to note that many medical physicists of Chinese descent have become leaders in our chosen specialty, and hope that many more will be similarly successful.

Upon reflection, I wrote back to Lu, and ask if I could share my personal experience on leadership. I am grateful for this opportunity and hope my random thoughts below would be helpful, or at least mildly interesting, to those aspiring to be leaders, and for those who already are. One note of caution - my intent is not to set metrics by which leaders are to be judged, but only to express views based on my personal experience.

As a brief background, I received my PhD in nuclear physics from the University of Washington (Seattle). After 3 years at MSKCC as a post-doc trainee and research staff in radiation biophysics, and 5 years at MGH/Harvard as Assistant/Associate Medical Physicist and Assistant Professor, I became "Chief of Medical Physics" at the George Washington University Hospital - what a grand title for leading a group of 4, including myself! The group eventually increased to 8 persons, before I decamped to UCSF, which, at the time, had about 30 persons in the medical physics section. I then went to MSKCC, where the independent department of Medical Physics grew from ~120 to ~180 staff members, from 1989 to 2007. On the way, I gradually learned, from my numerous mistakes, both big and small.

Teamwork

Medical physics is a team-sport - the leader is the captain, the coach, the manager, and, importantly, a team member. The leader must also represent the team in matters that relates to other teams, e.g. radiation oncologists, radiotherapists, administration etc. Thus, the responsibilities of the lead medical physicist are broad and numerous, and to be effective one must develop skills beyond the study of medical physics. In fact, I have known a number of excellent medical physicists who would shunt the managerial drudgery and refused line-responsibilities, i.e. to be a boss of others. And, because most medical physicists are not trained to be a manager, it would be a good idea for would-be leaders to take courses (or at least read books) on managerial skills. Of the many attributes needed in a medical physics leader, the following are essential:

- Fairness and Integrity: These are perhaps the most important qualities in a leader. In being fair and honest, in avoiding favoritism, and in being transparent in the managerial process, will earn you the trust, and respect, of your team members. In being fair, advancement should be based entirely on merit and performance. I would strongly discourage, and even forbid, "behind-the-closed-door" complaint by person A of person B; instead, encourage them to resolve their difference themselves, and only come to you in case of an impasse, and for you to act as an ombudsman.

- Be a member of the team: By that I mean that you actually do real work. In the distant past, a few NBA teams had player-coaches (e.g. Bill Russell of the Boston Celtics, Lenny Wilkens of the Portand Trail Blazers), i.e. playing and coaching at the same time.

资深物理系主任谈领导艺术(cont.)

That perhaps is not the best analogy, but I do think that doing real work gives the lead medical physicist a better perspective, and an identify as a real member of the team. I once said to a reluctant staff, "I would not ask you to do something that I would not do myself". And, during a period of staff shortage at MSKCC, when many treatment planners were lured away for their experience in IMRT, I volunteered to do the weekly chart-check, to the amusement of some and the horror of others.

- Diligence: You most probably progressed through the career ladder by working hard, so continue to do so. As a leader, strive for the mantra of being the "first one in, last one out". Be demanding, particularly on yourself, only then would others respect your demand. I frequently worked on weekends, and still do, both by necessity and desire; and used to roam the hallway of the department on weekends to both show my presence and see who else are working on weekends.
- Advocacy: As the captain, you need to advocate for those on your team – to make known the importance of their work, to protect their rights, to seek appropriate renumeration, and, when occasions demand, stand up for them. I once threatened to withdraw brachytherapy support from an ophthalmology surgeon who made demeaning remarks to a medical physics staff until he apologized.
- Communication: Being able to communicate clearly and succinctly is a necessary skill for a leader. This is beyond 'shop-talk' about medical physics and its practice, it extends to managerial communication, advocacy, interaction with other intradepartmental and inter-departmental groups, and with administration, etc. For most of us, with English being a second language, improvement through training courses may be beneficial.

Relation with Clinicians and Dealing with Administration

This topic is complex and intricate. The situation can also be institution-specific, depending on the administrative structure and the reporting relationship. As a side note, AAPM recently has a MP3.0 Webinar series on Transformational Medical Physics - with Episode 4 on "How can physicists meaningfully interact with administrators?", which has useful discussions.

In most institutions, the medical physics group reports to the department chair, who usually is a radiation oncologist. (In some cases, medical physics may have a reporting relationship with hospital or department administration; with no personal experience for that situation, I would not comment on it. Also, there may also be reporting relationship with radiology, and my comments below would likely be applicable in that situation as well. As an aside, at MSKCC, I reported directly to the Physician-in-Chief as Chairman of an independent Department of Medical Physics, as did the Chairs of Radiation Oncology and Radiology.)

Between the Chief of Radiation Oncology and the Head of Medical Physics

Know your boss: This is really important, and something to pay attention to, even and especially before accepting the position. One key point is whether the chief radiation oncologist respects medical physicists as true partners. As the attitudes of a leader often influence his staff, respect for medical physics by the chief radiation oncologist will translate to the same respect by other radiation oncologists in the group. Thus, a radiation oncologist who considers medical physicists as technicians is certainly someone to avoid. Try to establish mutual trust and camaraderie from the get-go. It is desirable for the chiefs of radiation oncology and medical physics to jointly set goals, priorities and metrics of performance. Another item to understand is the management style of your boss – knowing that in advance will inform you as to your modus operandi, so as to avoid possible conflicts.

Communication: Agreeing upon a mutually acceptable pattern, frequency, mode, etc. of communication with your boss is important. In general, a regularly scheduled face-to-face meeting is a good idea, as it signifies the important professional relationship between the two of you. Important occurrences (e.g. a reportable incidence) should be communicated immediately. How and whether other occurrences (e.g. a machine being down) should be communicated should be discussed and agreed upon. A clear and transparent communication process will ensure that there are no surprises on either side.

Strategic Planning: Be involved in important projects and strategic planning, especially involving expansion programs and equipment/vendor selection.
Establishing a culture of trust, respect and teamwork will benefit the entire enterprise.

Between Administration and the Head of Medical Physics

An essential aspect of the work of the chief medical physicist is her/his interaction with hospital and departmental administration. The most effective approach in such interaction is to adopt the concept of working with administration as a team. Indeed, the chief medical physicist has an administrative role as well, and thus should appreciate, and appropriately assess, "both sides of the equation".
It behooves one to understand the administrative structure and business model of one's organization. In interacting with administration, one should also be familiar with their lingo, such as service-line, cost-center, line-item etc. As billing and budget are invariably linked, the chief medical physicist should be cognizant of the medical physics aspect of billing and collection (which will obviously change with the pending Alternative Payment Model by CMS).
In accordance of its importance in patient-care, radiation safety, continued quality improvement, medical physics should be visible in the organization, and to the administration. The chief medical physicist and/or a designate should be on, or chair, the appropriate committees, e.g. radiation safety. (I participated in, and chaired for several years, the Credential Committee of Memorial Hospital; it was for the first time that a non-MD chaired that committee, I think.)
It is almost unavoidable, that in certain situations, there will be different viewpoints. Whereas such differences should be aired and discussed, one must be careful to avoid an adversarial position. Agreeing to disagree could be a temporary solution – but always end a meeting with a positive attitude to consider alternatives and a path forward.

Academic and Scholarly Endeavors

In academic institutions such as medical colleges and their affiliated hospitals, things can get complicated in a hurry. For example, the college and hospital may be separate enterprises, each with its own budget and administrative structure. Adequate coverage on the myriads of scenarios is beyond the scope of this article. The following are certain niblets.
The chief physicist must be familiar with the system/procedure of appointment and promotion in the different tracks of the medical college, and be able to explain these to the medical physics faculty; and if the faculty can digest those A&P documents on their own, so much the better. And, as the university committees on appointment and promotion are generally unfamiliar with the medical physics profession, shepherding a faculty's career development through the process requires considerable skill and effort. Medical physicists being neither fish nor fowl, i.e. unlike medical doctors and basic scientists, the nature of their work and path to academic advancement must be explained to the university committees on appointment and promotion.
Scholarly activities and research productivity are invariably linked to academic advancement. While in theory, faculties are allotted protected time for such endeavors, the reality, on account of commitment and responsibilities to clinical operation, much research are done in the evenings and on weekends! Nevertheless, it is clearly the chief medical physicist's job to foster independent and collaborative research, and explore ways to support them, e.g. through research grants.
While there may be discussion on academic freedom, my own bias is that 'innovation' in medical physics should be aimed at 'implementation', with a view to benefit patient care.

Participation in Scientific and Professional Organizations

There is much to be said about participation in scientific and professional organization such as the AAPM and its local chapters. Aside from opportunities to learn about the science and the clinical practices in medical physics, such participation avail lessons in professional engagement, interaction in group settings, speaking in public, and working in committees.
If my upbringing is typical (at least for my generation), our personalities tend to be passive, reserved, and inexperienced in public engagement. Thus, there are obstacles to overcome; however, do not over-react to the extent of speaking out without adhering to the Chinese adage of "think thrice, then act". And, as Plato said: "Wise men speak because they have something to say; fools because they have to say something."
In closing, the above is my views and biases based on the constraint and limitation of my own experience, in era past. As circumstances evolve so must leaders learn and adapt. I wish you the best.

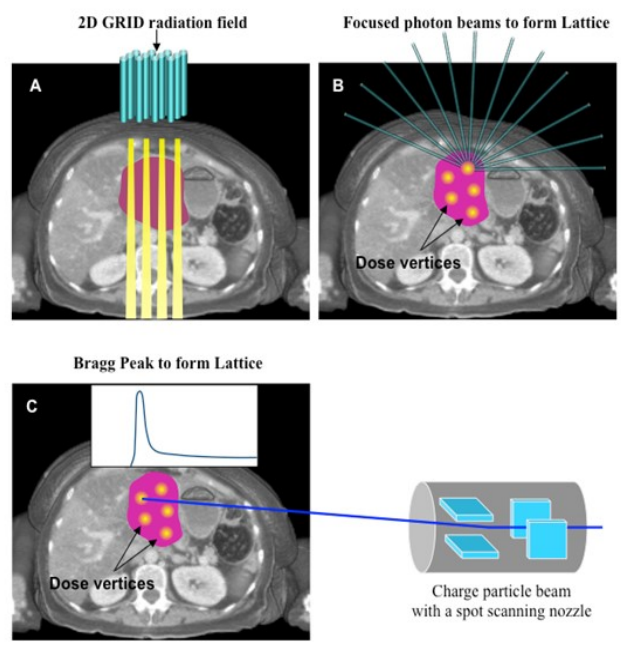
点阵放疗（LATTICE-RT）的发展与临床应用现况

吴晓东

Xiaodong Wu, PhD, NACMPA Member

放疗的剂量分割常规上以时间为尺度，但剂量的体积分割或空间分割法（Spatially fractionated Radiation Therapy, 或 SFRT) 也有着悠久的历史。早在上世纪50 年代，为了用kV X-射线治疗大体积肿瘤又不伤及皮肤，Kohler 首先提出格栅放疗（GRID-RT）的概念[1]。格栅放疗是通过格栅准直器将照射野均匀分割成等间隔的小射线束，对大肿瘤实施单次大剂量(10-25 Gy)照射，在靶区内形成非均匀的高低剂量区，剂量学上表现为峰谷效应（Peak-and-Valley effect) [2]。从早期的kV X-射线技术到近代放疗器械技术的发展，以及高能X-射线的应用，格栅放疗一直不是放疗的主流技术。然而近10年来，得益于放射生物学，尤其是放射免疫学研究的一系列新发现，放疗的时空分割重新得到重视。SFRT, Micro-beam-RT 和 FLASH-RT 成为学术界新的研发焦点，期望在放射治疗效果上有新的突破。虽然放疗界对其治疗机理还未达成共识，但结合多年的实践经验数据和近20年放射生物学的研究成果，对SFRT的认识目前主要有以下两个方向：1. 可对大肿瘤进行安全的部分高剂量照射；2. 由SFRT诱发的旁观者效应（bystander effect）和远隔效应（abscopal effect)可提高局部和系统疗效。SFRT的临床应用和研究也基本上围绕对这两个方向的认识开展[3,4,5]。从安全性的方向出发，SFRT作为安全加量治疗的手段已经得到比较广泛的认可，其临床应用在近几年也显著增加。利用SFRT诱发旁观者效应和远隔效应仍然处在基础研究和临床研究阶段。

鉴于现代放疗技术的快速发展和广泛应用，三维点阵式放疗技术（LATTICE Radiation Therapy 或 LRT）于2010 年被第一次提议[6]。利用精确的三维聚焦（图像引导下的IMRT，VAMT，或质子，重离子束)与传统的二维GRID相比较，LATTICE-RT 对深层大体积肿瘤的照射更具灵活性，并可在更大程度上降低对正常组织的放射毒性。图为三维LATTICE技术与传统二维GRID 技术的比较。



从上世纪50年代至今，GRID放疗的临床应用数量虽然不多，但其技术已较为成熟[7]。在美国最早将LATTICE技术应用于临床的是佛罗里达州的创新癌症中心（Innovative Cancer Institute, Miami, Florida），从2010年至今已收治各种大肿瘤病例80余例。福建协和

医院从2017年开始使用LATTICE技术，至今也已收治病人百余例。LATTICE技术较为灵活，不需要采用特制的格删准直器。基于美国创新癌症中心和福建协和医院的治疗经验，参与临床应用的物理和医生团队对LATTICE的技术参数做了初步分析，并为放疗界同行提供了光子LATTICE-RT的参考值[8,9,10]。目前在全球范围内采用LATTICE技术收治晚期大肿瘤病人的治疗中心（包括美国的Mayo Clinic）陆续增加。上海质子重离子医院和纽约质子中心也开始推进离子LATTICE-RT的研发工作。

如上所述，LATTICE技术目前的临床应用主要以加量为目的。以诱发旁观者效应和远隔效应为目的的LATTICE-RT需要与免疫治疗（如PD-1抑制剂）结合并用，它牵涉到的技术参数较为复杂。福建协和医院在2020年报道了第一例LATTICE和免疫联合治疗的成功病例[11]。

应对SFRT日益增长的关注，美国的NCI和放射外科协会（RSS）于2018联合举办了首届放疗时空分割技术峰会，并成立物理、生物和临床专题组，旨在通过全球性合作将SFRT的基础研究和临床应用提升到新的高度。经过两年多的努力，一系列临床试验提案有望在近期内启动[12]。

放疗是攻克癌症的关键手段之一。时空分割的新理念和技术为放疗拓展了新的空间，尤其对晚期大肿瘤的治疗具有重要临床意义。与放射免疫治疗的理念与临床实践相似，SFRT仍需要更深层次的研究，其更有效的临床应用有赖放疗界更广泛的合作 。

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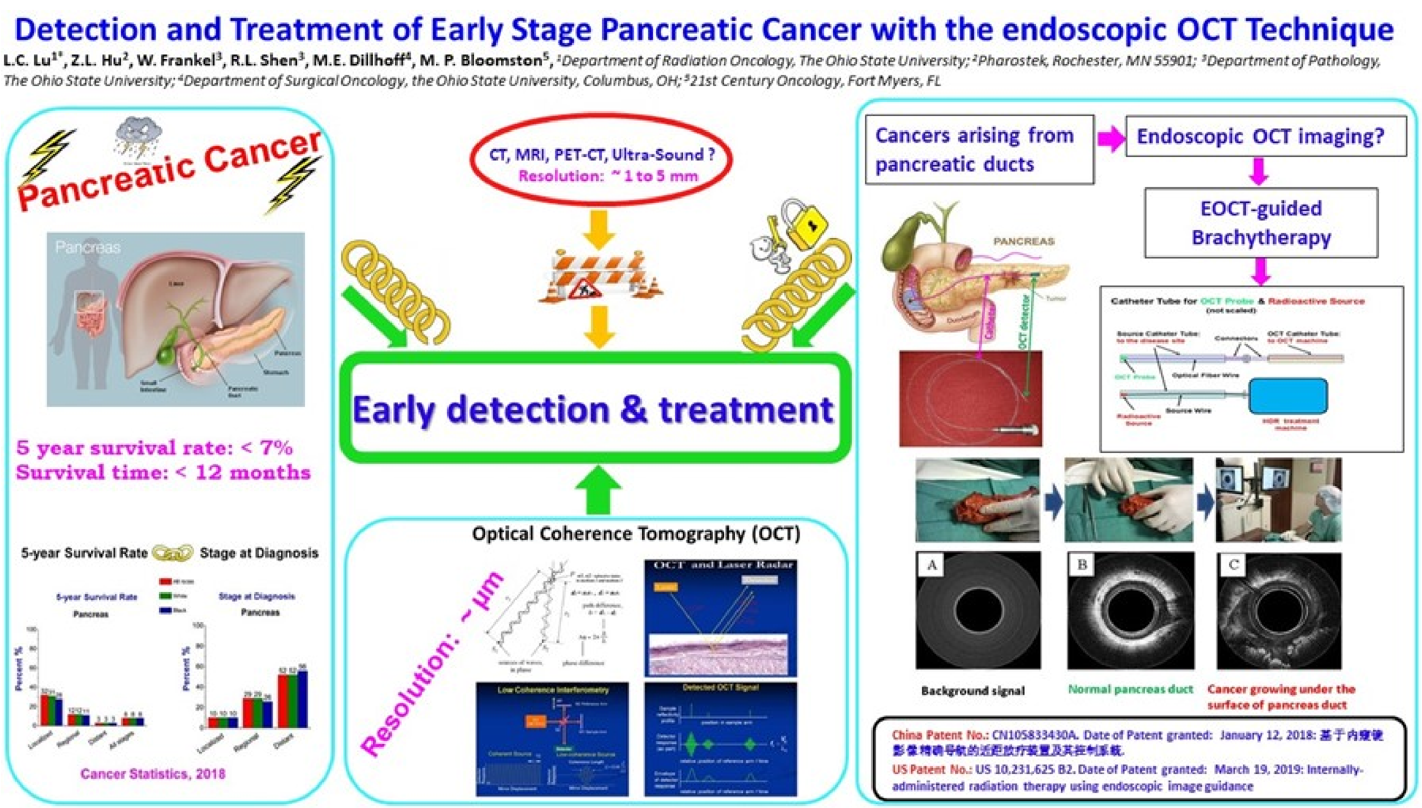
Endoscopic Image-guided Technique to Detect and Treat Cancers with Radiation Therapy

Lanchun Lu, PhD
NACMPA Member

A new endoscopic image-guided technique has recently been proposed and developed by Drs. Lanchun Lu, Zhilin Hu, Wendy Frankel, et al. to detect and treat ductal types of diseases such as cancers of the pancreas, esophagus, rectum, bronchus, and other aero digestive organs that are suitable for use with an endoscopic device. This innovative technology was first applied by these researchers on early detection and treatment of pancreatic cancer. Using the endoscopic imaging technique, they built a high-resolution 3-dimensional endoscopic optical coherence tomography (Endo-OCT) imaging device to detect early stage pancreatic cancers and treat them with Endo-OCT-guided brachytherapy. The preliminary research results were reported in a recent paper "Using Endoscopic Optical Coherence Tomography to Detect and Treat Early-Stage Pancreatic Cancers" published in Frontiers in Oncology, 15 March 2021, https://www.frontiersin.org/articles/10.3389/fonc.2021.591484/full. The technology integrates a custom-built ultra-high resolution (at the level of ~µm) endoscopic 3-dimensional OCT diagnostic imaging device with a commercial high dose rate brachytherapy system (HDR), resulting in a compact, portable, easy-to-operate, and low-cost Endo-OCT image-guided high dose rate brachytherapy (OCT-IGHDR) system. The system has the dual functions of diagnosis and treatment that can precisely detect and measure the location and size of the early-stage pancreatic cancer or premalignant lesions and then treat them from the inside of the pancreatic duct with an accurate and focused dose while greatly reducing the radiation toxicity to the neighboring tissues and organs.

The key feature of this technology is that the catheter tube used for Endo-OCT imaging stays temporarily inside the patient's body and plays a role as the common pathway to deliver a localized treatment, such as brachytherapy, that focuses on the discovered lesion. When the Endo-OCT system is used for diagnostic imaging, a specific connector called the OCT-Brachy connector (OBC) is used as a bridge to connect the OCT imaging catheter to the source catheter tube that has already been inserted into the pancreatic duct. The OCT detector moves starting from the OCT catheter and passes through the bridge connector to the source catheter. It then arrives at the possible disease site to take the OCT images. As soon as the cancer is found, located, and decided to be treated with radiation therapy, the Endo-OCT detector will be pulled out from the source catheter. Next,, the Endo-OCT catheter is disconnected from the source catheter, which will still stay at the original position for use in treatments. After the treatment plan is completed by using the acquired Endo-OCT images, the source catheter is connected to the HDR unit to perform the treatment. Switching from the diagnosis mode to the treatment mode is easy and convenient.

As it is well known, pancreatic cancer is one of the most lethal cancers with very low survival rates, owing to no satisfactory techniques available for early detection in current clinical practice. For many patients, by the time they are diagnosed with pancreatic cancer using the currently available techniques in clinic, the disease has already progressed significantly, which leaves few options for treatment. Early detection and treatment of the disease is the key to prolonging patients' lives. Most pancreatic cancers initially arise from the epithelial lining of small and narrow pancreatic ducts. A millimeter-size tumor may have already caused serious effects on the patient, but the tumor would have been difficult to be detected by current available imaging techniques such as MRI, CT, PET-CT, or ultrasound, for which the spatial resolution are all at the level of one millimeter or worse. Compared with MRI, CT, PET-CT, or ultrasound, the endoscopic OCT developed by Drs. Lu, Hu, Frankel et al. is able to detect a tumor or abnormal tissue structure as small as 7 µm, providing a method to detect pancreatic cancer at its very early stage, and hence lead to early treatment. The endoscopic catheter allows the radioactive source to move internally to the discovered tumor and deposit focus and high dose to it, avoiding the situation of external beam radiation therapy where radiation beams must pass through surrounding healthy tissues and many organs at risk before reaching the tumor, which limits the required high dose to the tumor. This new and patented technology sheds light on improving the pancreatic cancer survival rate and even curing patients, giving hope for many devastating pancreatic cancers. The figure below illustrates the innovative system with dual functions of early diagnosis and OCT-guided HDR brachytherapy for pancreatic cancer developed by Drs. Lu, Hu, Frankel, et al., which has been patented in China and the United States.



Research Development on FLASH Proton Therapy

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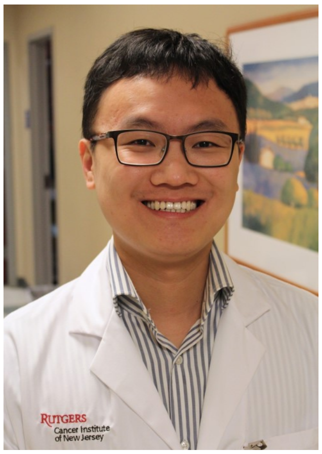

Bo Liu, PhD, NACMPA Member

Ultrahigh dose rate radiotherapy, also called "FLASH" therapy, has been given great attention in the Radiation Oncology community following the in-vivo study published by Favaudon et al[1], which demonstrated ultrahigh dose rate radiotherapy could improve normal tissue sparing while retaining equivalent tumor control compared to conventional dose rate radiotherapy. The biological mechanism of FLASH effect is not currently understood and multiple proposed hypotheses are under active investigation. To date, a vast majority of published pre-clinical data was obtained with low-energy electron beams. However, due to the low penetrating property of electron beams, their application in diseases with deeply seated tumors is limited. Therefore, there has been a great interest in developing FLASH techniques and investigating FLASH effects using proton as the radiation source.

FLASH Animal Study with MEVION S250i Proton Accelerator

MEVION S250i (Mevion Medical Systems, Littleton, MA, USA) is a single-room compact Proton Therapy System equipped with gantry-mounted synchrocyclotron and pencil beam scanning technology. Mevion presented its first pre-clinical results of FLASH research, demonstrating the FLASH effect using a commercial MEVION S250i proton accelerator. The study results showed a clear signal in improved survival curves for FLASH irradiated mice. This study also demonstrated FLASH effect at the Bragg Peak, indicating the promise of combining Bragg peak dose conformality and FLASH normal tissue sparing in one delivery system. This animal study was modeled after a benchmark experiment performed with electron beams by researchers at Stanford University[2] and aimed to increase the survivability of healthy mice when delivering doses at FLASH dose rates, which are lethal when delivered at conventional dose rates.

In this experiment, fifty healthy, non-tumor-bearing mice received abdominal irradiation within the range of 10-19 Gy. The radiation was delivered using a single scattered beam with the targets covered by a spread-out-Bragg Peak using a ridge fil-

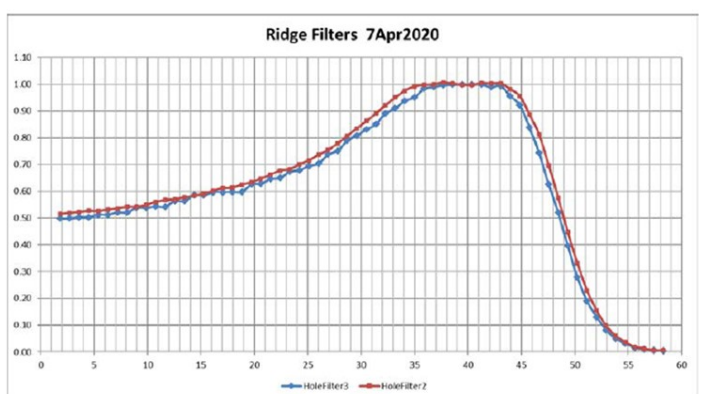

Figure 1. Percentage Depth Dose for Proton FLASH Animal Study

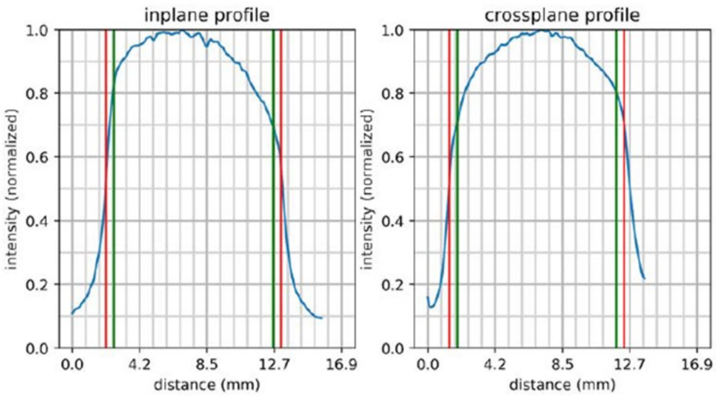

Figure 2. Inplane and Crossplane Dose Profile for Proton FLASH Animal Study

ter. Figure 1 and 2 show the PDD and profiles of the experimental proton beam. Thirty of the mice received a dose at FLASH dose rate of 100 Gy/s, and twenty of them received at conventional dose rate of 0.1 Gy/s. The study showed a clear separation of survivability between the two groups, indicating better than normal tissue sparing with FLASH dose rate delivered at the Bragg Peak.

FLASH Development Using Proton Pencil Beam Scanning Technique

While FLASH effect was successfully demonstrated in animal study using scattered proton beam, Pencil Beam Scanning (PBS) remains a very attractive solution to realize normal tissue sparing with FLASH effect as well as dose conformality. In PBS technique, Mevion proton accelerators have inherent advantages to achieve ultrahigh dose rates and fast delivery speeds necessary for FLASH therapy thanks to its unique Direct Beam Delivery (DBD) system architecture (see Fig 3).

The DBD system, which is a standard feature in the MEVION S250i, is well suited for delivering high-quality, efficient proton delivery needed for future FLASH clinical applications. The scanning magnet is capable of 3 ms spot switching, and the energy modulation system can switch as fast as 50 ms. Furthermore, both are engineered with intrinsic capability for further reductions in delivery time. Most importantly, because the range shifting material is placed at the end of the beamline, the DBD features a highly efficient system where transmis-

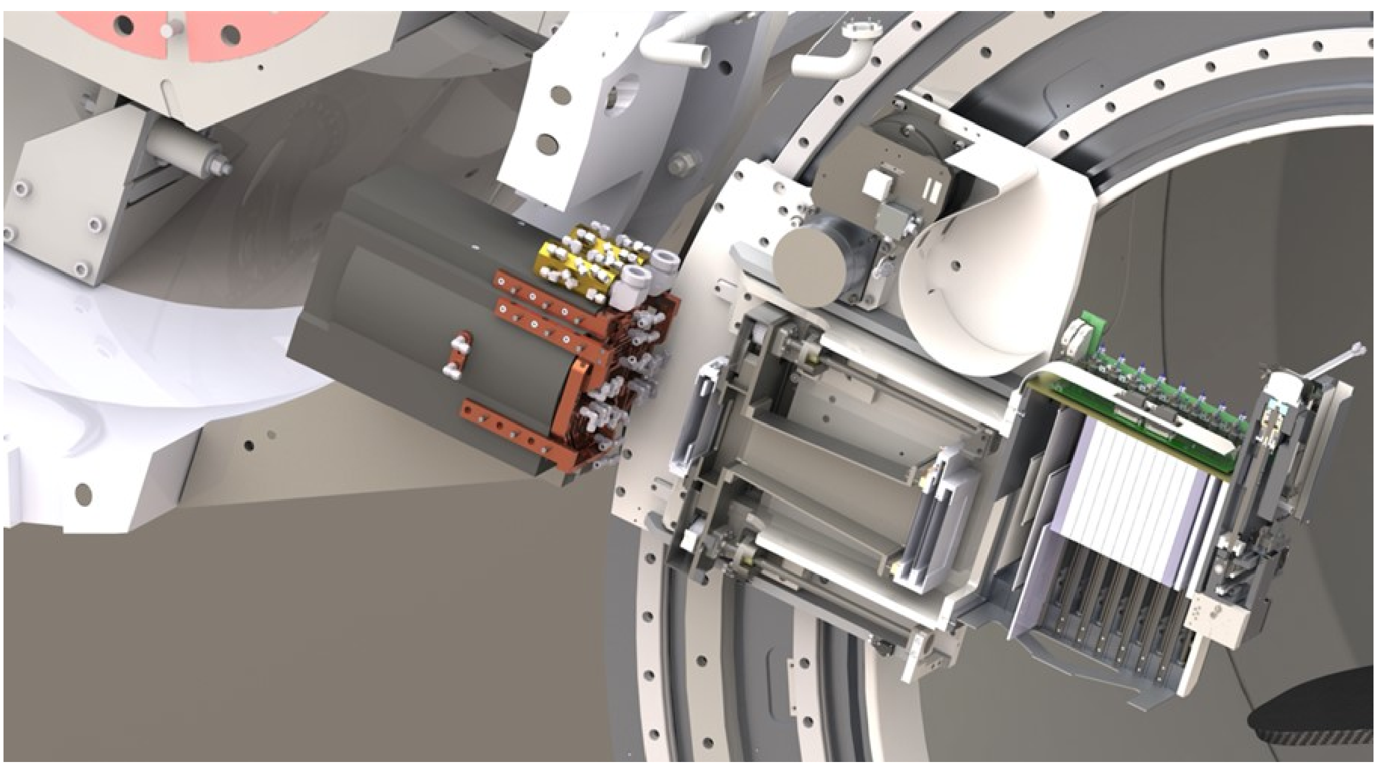

Figure 3. Diagram of MEVION S250i Direct Beam Delivery system

Research Development on FLASH Proton Therapy (cont.)

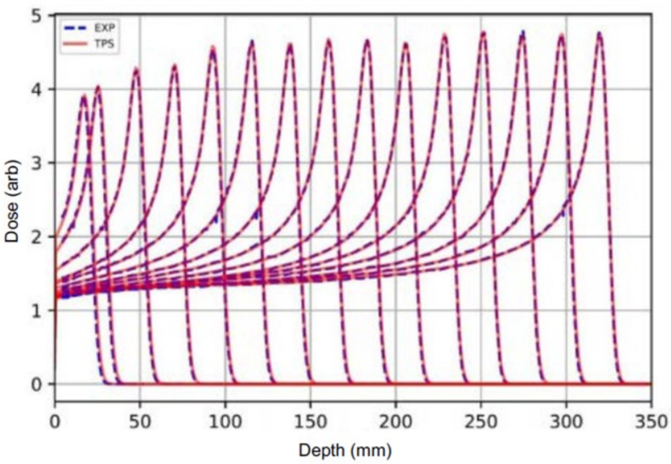

Figure 4. Mevion proton transmission > 70% at energy as low as 50 MeV

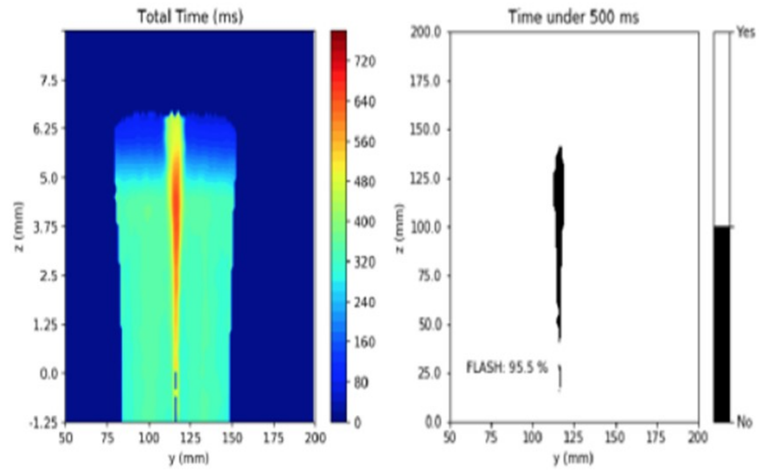

Figure 5. Two smaller volumes combined into a larger one receiving FLASH dose rate.

sion efficiency does not drop below 70% for proton energies as low as 50 MeV, as shown in figure 4. This design enables a Bragg Peak FLASH delivery at all treatment depths rather than a “shoot-through” or transmitting delivery. These core strengths of DBD makes it possible for Mevion proton accelerators to take advantage of FLASH effect and distal normal tissue sparing in its PBS technique.

Another area of Mevion’s active research explores methods to optimize the delivering sequence to reduce the delivery time so that every voxel within a treatment field receives radiation in ultrahigh dose rate. To achieve FLASH effect in a large volume, Mevion can deliver radiation to small volumes separately with the use of its Adaptive Aperture system. Those individual small volumes can then be combined to create a large volume. Figure 5 shows that a large volume is divided into two small volumes with each receiving radiation separately[3]. The black cloud on the gray scale plot indicated only a small portion of the whole volume did not receive FLASH dose rate. This technique offers the possibility to combine both IMPT and FLASH in one delivery system.

Moreover, it delivers protons in pulses due to its synchrocyclotron accelerator. The instantaneous dose rate or intra-pulse dose rate is much higher than its time-averaged dose rate. This unique feature enables research directions to understand the relative roles of instantaneous dose rate within a pulse versus time-averaged dose rate within a whole delivery in FLASH proton therapy.

FLASH Research Platform

Mevion has collaborated with scientists from Siteman Cancer Center at Barnes Jewish Hospital and Washington University in St. Louis on a series of FLASH tests on a MEVION S250i production system. The team successfully delivered over 200 Gy/s dose rate and this work was published on the Medical Physics[4]. This collaboration is focusing on dosimetry and calibration.

The developed FLASH research platform enables a fast switch between clinical and FLASH research mode. The switch is realized by attaching FLASH accessory mounted directly onto Nozzle. The accessory includes dosimetry system, beam apertures, ridge filters and energy absorbers (figure 6), which can be flexibly shaped and controlled for small animal studies. Currently, the Mevion machines are able to achieve time averaged dose rate of more than 100 Gy/s, intrapulse dose rate of 10^4 Gy/s, and FLASH dose volume of $2cm^3$. A higher dose rate and large dose volume is under development.

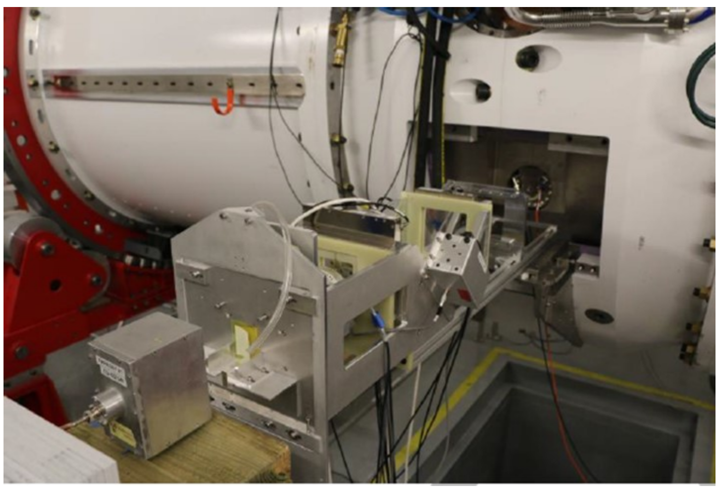

Figure 6. Mevion FLASH Research Accessory Prototype

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North American Chinese Medical Physicists Association

肿瘤热疗临床应用的热物理问题

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摘要

肿瘤热疗目前已成为继手术、放疗、化疗及免疫疗法之后的第五大治疗方法，还被称为“绿色”肿瘤治疗方法。本文叙述了肿瘤热疗以及相关的热物理学的概念，并对临床上不同的肿瘤热疗方式、机理及其与放化疗的协同作用进行了简要说明。本文还阐述了现阶段临床上常用的肿瘤热疗加热技术（微波、射频、超声波）的特点及其优劣，并对目前常用的热疗测温技术存在的问题做了简单的介绍。文章最后对肿瘤热疗技术进行了展望，希望加强热物理基础的研究工作，多方共同合作，使肿瘤热疗更安全有效地应用到临床工作中。

一、前言

热疗可以用于良性疾病的治疗也可以用于恶性肿瘤的辅助治疗。早于1866年德国医生Busch报道了一名经病理学证实的面部肿瘤患者因感染丹毒而发高烧，高热后肿瘤消退的病例。1898年美国医生Westemark首次使用射频线圈作为辐射器对宫颈癌进行加热治疗。奥地利医生Jauregg给一名中枢神经系统梅毒病毒感染者接种疟疾患者的血液，诱发高热，疗效显著，成为当时治疗中枢神经系统梅毒感染的标准方法，并获得1927年诺贝尔医学及生理学奖。肿瘤热疗的迅猛发展自20世纪70年代，主要涵盖热物理学、热生物学和临床三部分。本文仅讨论肿瘤热疗中的热物理问题。

二、肿瘤热疗的定义和及热物理学：

肿瘤热疗（Hyperthermia）是指应用不同的热源（微波、射频、超声、红外、磁介导等）提高肿瘤组织或全身的温度，使肿瘤组织温度上升到有效治疗温度（41-43℃或者更高）并维持一段时间，引起肿瘤细胞生长受阻或死亡，而不损伤正常细胞的治疗方法。它是利用热杀伤及其继发效应来治疗肿瘤。

热物理学包括加热物理因子的理论及原理、加温材料与技术、加热中的温度测量、以及热场分布与热疗治疗计划等。目前阻碍热疗发展的最重要两个问题是热剂量学问题，即如何得到最佳的SAR（能量吸收-生物组织的相关性）和无损测温的问题。

三、肿瘤热疗分类：

1. 以临床治疗所用温度可分为超高温热疗（60℃以上）、常规温热治疗（43℃）和亚高温治疗（39℃-41℃）。
2. 以加温深度和部位不同又分为浅部热疗、深部热疗（包含腔内）和全身热疗等。需要强调腔内加温是深部热疗的一种，它是指对人体自然腔体（口腔、鼻咽部等）、或自然腔道（食道、宫颈阴道、直肠）的加温。
3. 以加热频率不同可分为微波、射频、超声波、激光、红外、磁介导热疗等。表1展示了不同加热源，不同治疗温度与不同治疗区域三者之间的相互关系。

表1 不同加热源，不同治疗温度与不同治疗区域三者之间的相互关系

治疗区域	特点	超高温（60℃以上）	常规热疗（43℃）	亚高温（39℃-41℃）
浅表热疗	局部加温，加热直径小于15cm，加热深度小于6cm	可用	常用	一般不用
深部热疗	区域性加温，加热深度大于6cm	可用	常用	可用
全身热疗	将体温人为提高到治疗温度	不可用	不可用	可用
腔内热疗	利用人体天然体腔（通道）进行区域性加温	可用	可用	一般不用
热灌注	包括腹腔、胸腔、膀胱等	不可用	常用	可用
组织间热疗	通过微创的方式将辐射器短时间植入组织间进行局部加温	常用	可用	不用
加热源		微波、射频、HIFU、激光	射频、微波、超声、热水	红外、高能微波、电感射频+红外

四、常规热疗的机理以及与放化疗的协同作用

人体温度上升易使肿瘤血管闭塞，42℃以上热直接杀灭肿瘤细胞。不同类型的癌细胞对热敏感性不同；同时温度上升增加肿瘤血流量，能够增强放射线或药物的敏感性。将热疗作为放射线增敏剂，加强射线对肿瘤细胞的杀灭，这需要加热和放射治疗同时应用；或者序贯应用。另一方面，利用热对放射线抵抗的肿瘤细胞特殊的热细胞毒作用，在相同的放射剂量时对放射线抵抗的肿瘤细胞造成

更多的杀灭。

细胞第一次加温后会引起对后续加温的抗拒现象，从而影响肿瘤细胞对再次加温的敏感性，也会影响分次放疗和化疗的敏感性，这一现象称之为热耐受，但热耐受不是细胞固有特性，是一种暂时现象，其在24小时最明显， 36-72小时后可完全消失。

因此，临床应用时应讨论两个问题：一是放疗与加温的序贯问题（或前或后，间隔时间应该在1小时以内，超过4小时热增敏作用消失）；二是热耐受问题（两次热疗的间隔时间要大于48小时）。

五、常用加热技术的特点比较

现阶段，临床上常用的加热技术有微波加热、射频加热以及超声波加热等。表2展示了三种常用加热方式临床技术的优缺点对比。

表2 微波、射频和超声波加热临床技术特点比较

加热方式及频段	辐射器技术	代表商用机型	优势	劣势
微波加热433MHz、915 MHz、2450 MHz	体表用透镜型波导式、腔内用偶极子式	中国江苏诺万N9000/N9001	1、非侵袭局部加热； 2、无脂肪过热； 3、加热效率较好； 4、易于加热表浅肿瘤。	1、肌肉组织中衰减大； 2、测温要求高，需无扰； 3、需要屏蔽室。
射频加热8MHz、13.56MHz、27.12MHz、40.68MHz； 75-120MHz可调	电容式、电感式、偶极子天线环型相阵列式	日本VinataRF-8；美国BSD-2000，	1、可加热较大体积； 2、深部加热需冷却水系统； 3、无需屏蔽室。	1、无水冷时脂肪极易过热疼痛； 2、电场分布不易均匀控制； 3、只可用于脂肪薄的部位<厚度1.5cm>。
超声波加热0.3-5MHz	压电陶瓷单阵元式、多阵元式、相控阵列式	以色列InSightec ExAblate； 中国重庆海扶JC200	1、脂肪不易过热： 2、测温较容易； 3、穿透性、指向性及聚焦性能好； 4、适合于浅表及深部肿瘤加热。	1、不能穿透含空气腔，在软组织与骨骼界面上声波反射明显，产生骨痛； 2、聚焦型设备结构复杂，定位技术要求高 3、测温方式为有损测温，病人痛苦。

六、热疗常用的温度测量方法

肿瘤热疗发展缓慢的主要原因之一是受到测温技术准确性和精度限制的影响，目前热疗常用的测温方法各有所短，简单介绍如下：

1. 热敏电阻温度计（半导体温度计）：它的温度与电阻二者变化并非线性，呈指数关系，在仪表上的刻度也呈指数形式。由于热敏电阻稳定性差，不能互换，需要经常用标准温度计校正。
2. 热电偶测温：热电偶作为天线把微波信号传入检测器，也称之为噪声，读出的信号不仅含温度信息，也含微波信号；电磁感应使金属导线产生涡流而自热。
3. 液晶测温：液晶薄膜的颜色随温度变化而呈现不同的颜色，多为实验应用定性的测量辐射器温度场分布。
4. 光纤测温：不受强电磁场的干扰，对磁场分布无影响；其缺点是易损坏、价格高，体内深部热疗不能实现无损测温。
5. 电阻抗测温：借助于组织电压的分布测量确定温度分布，同样生物电阻抗信息非常复杂，影响温度的准确性，且阻抗的测定有频率依赖。
6. 红外热成像测温：可以利用皮肤表面的温度信息通过生物热传导模型重构体内目标区域三维温度场分布图像，但其准确性需要近一步研究明确。
7. 磁共振成像测温：利用MR图像与温度的依赖相关性可构建三维温度场分布，但其精度受组织类型影响，且设备昂贵。

七、热疗及其物理学的展望

热疗作为继手术、放疗、化疗、免疫治疗后第五大肿瘤治疗方法，针对不同部位肿瘤治疗其临床实现方式多种多样，是一门历史悠久但又十分年轻的现代新学科，具有很高的临床使用价值。但类比放射治疗设备和技术的迅猛发展，热疗设备技术发展相对缓慢，临床工作者迫切需要了解目标治疗区域的三维热场温度场分布，虽然目前美国BSD公司生产的BSD-2000环形阵列深部热疗系统集成了Philips公司的MR图像引导，可实现实时测温，能解决临床热剂量的问题，但设备过于昂贵，并未推广到中国，所以具有自主知识产权的国产热疗系统有待开发。

基于此，热疗需要更多地进行热物理基础研究工作，包括不同技术的加热原理，更符合临床的辐射器的设计，热治疗计划系统的开发，图像引导在热疗中的应用、更高精度测温技术的研究等等。

除此之外，热疗还急需相关部门制定更规范化的治疗方案、临床使用指南、设备性能标准等等。

综上所述，肿瘤热疗是一门非常有潜力的肿瘤“绿色”治疗方法，通过各方加强合作，使肿瘤热疗更健康地更有序地快速发展，更规范地应用于临床，使患者受益。

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