医学物理创新发展

Innovation in Medical Physics

S11

鑫海锦江大酒店拱北厅

主席：戴建荣

主席：邱　杰

2020 年 11 月 21 日　星期六　13:00-17:00		
13:00-13:05	开幕式致辞：刘志成	
上半场主持：尹勇　柏森　白彦灵　胡伟刚		
时间	**演讲者姓名和单位**	**演讲题目**
13:05-13:30	**Di Yan**　Beaumont Health System	Metabolic Imaging Feedback, Tumor Dose Response Assessment & Treatment Adaptation
13:30-13:50	**陈怀璧**　清华大学	低能电子直线加速器的新技术
13:50-14:10	**戴建荣**　中国医学科学院肿瘤医院	人工智能在放疗中的应用
14:10-14:30	**邱　杰**　北京协和医院	放疗信息化建设与区域合作
14:30-14:45	**缪一冰**　瑞典 C-RAD AB 公司	光学体表追踪技术及临床应用
14:45-15:00	**倪　成** 上海联影医疗科技股份有限公司	蒙特卡罗技术在精确放疗中的应用
15:00-15:10	点评：胡逸民　邓小武	
下半场主持：高家红　周付根　高嵩　张怀岑		
15:10-15:40	**杜一平**　上海交通大学	磁共振成像技术创新发展：从诊断走向治疗
15:40-16:00	**杨　智**　首都医科大学	CT 影像技术创新
16:00-16:15	**邱学军**　惠仁康宁 (苏州) 健康科技有限公司	《超高清医用显示器技术规范》国家行业标准制定研究进展
16:15-16:35	**耿建华**　中国医学科学院肿瘤医院	核医学成像设备技术进展
16:35-16:50	**张小元**　巨鲨医疗	医用诊断显示技术新进展
16:50-17:00	点评：包尚联　陈盛祖	

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Di Yan

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博士，Beaumont卫生系统主任物理师，教授，主要致力于先进治疗方法和技术的研究与开发。曾领导过许多前沿性的研究与技术开发工作，包括图像引导与适应性治疗，基于生物成像的肿瘤剂量反应评估/预测，治疗中器官位置变化/运动的管理，器官变形图像配准/实时在线剂量跟踪，适应性/稳健的逆向计划优化，治疗结果建模/分析，质子动态弧形治疗，及质子LET-RBE优化。1995年，第一次将图像反馈适应性放射治疗的概念和方法引入在临床放射肿瘤治疗领域。第一篇引入适应性放射疗法的出版文章被PMB杂志选为60年来医学物理历史上最重要的论文之一。《放射肿瘤学研讨，“适应性放射治疗”》的特邀编辑。曾担任13个联邦政府以及8个工业研究基金的首席研究员和联合研究员。

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C-RAD产品应用专家

光学体表追踪产品Catalyst ™ &Sentinel ™临床培训与应用支持

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清华大学工程物理系教授，粒子加速器团队负责人，曾任工物系系主任、系党委书记等职务；主要研究方向为加速结构、工业与医用加速器，近10年以主要作者发表SCI论文70余篇，其中4篇发表在物理顶级期刊Physical Review Letter上，曾获国家科技进步一等奖、国家自然科学二等奖、中国专利金奖等；现任中国粒子加速器学会常务理事、应用委员会主任。

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上海交通大学讲席教授，医学影像先进技术研究院院长。曾任国际华人医学磁共振学会主席。现任中国生物医学工程学会医学物理分会常务委员，磁共振领域顶级期刊Magnetic Resonance in Medicine副主编。

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首都医科大学生物医学工程学院教授，生物医学仪器学系主任，担任中国医药信息学会副理事长，曾作为中方主席组织和出席过多个学术性国际会议。企业工作期间，曾开发知名低剂量CT技术AIDR 3D (Google Scholar 检索超 1500 次)。

邱学军

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国家视觉与听觉健康产业技术创新联盟理事长，惠仁康宁 (苏州) 健康科技有限公司董事长、教授。中国生物医学工程学会医学物理分会副主任委员，中国电子学会生命电子学分会副主任委员，中国医疗器械行业协会视觉与听觉健康产业技术分会理事长，放射治疗设备产业技术创新战略联盟副理事长，全国音视频及多媒体系统与设备标准化技术委员会委员，《超高清医用显示器技术规范》国家行业标准工作组组长，主持完成 5 项国家 863 计划和国家科技支撑计划课题。

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南京巨鲨显示科技有限公司副总经理，分管显示所有销售片区 (大区、省区)、X 光产品部 (含 COD0NIC 产品线)、工会委员会，国际销售管理部全球技术支持，协助董事长管理研发中心

倪 成

2013 年 - 至　今：联影医疗科技有限公司放疗事业部 CEO
2010 年 -2013 年：联影医疗科技有限公司软件事业部 CEO
2002 年 -2010 年：西门子迈迪特磁共振 (深圳) 有限公司研发副总
1999 年 -2002 年：深圳迈迪特仪器有限公司合伙人，研发副总
1995 年 -1999 年：Oxford Magnet Technology,UK
研发工程师（磁共振超导磁体）
1992 年 -1995 年：University of Bristol，UK
博士后 (微波成像方向）
1990 年 -1993 年：University of Wales Swansea
高级助研 (生物磁场方向）
1987 年 -1993 年：University of Southampton
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Metabolic Imaging Feedback, Tumor Dose Response Assessment & Treatment Adaptation

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Human tumors of the same or different histology, stage and site exhibit a broad range of heterogeneity in radiation dose response. The potential advantages to have optimal dose distribution for eradication of heterogeneous tumors have been creatively proposed long time ago. In the past, the "gold standard" to measure tumor intrinsic radiosensitivity was a soft agar clonogenic assay using cells derived from primary tumor biopsies to calculate a surviving fraction at 2 Gy (SF2). More recently, a gene expression-based radiosensitivity index (RSI) has been developed by training a linear regression model to predict the experimental SF2 value for multiple cancer cell lines from nine different disease sites, based on the expression of ten specific genes extracted from an interaction network developed using a systems biology approach. However, similar to the in vitro clonogenic assay, this molecular assay does not take into account the microenvironment of the human tumor and provides only a single averaged parameter for each human tumor. Therefore, as with the clonogenic assay, it cannot identify the intra-tumoral heterogeneity of dose response for the individual human tumors.

Tumor dose response assessment at the imaging voxel level has become clinically achievable in recent years with using a biological imaging feedback, i.e. acquiring PET/CT or MR images during the treatment course. This ability could facilitate novel clinical applications such as designing adaptive dose distributions at the tumor voxel level based on the distribution of tumor voxel dose response and/or boosting dose to the most resistant focal regions in tumor with using different therapy modalities. This presentation outlines a specific method and modeling to assess and quantify the inter/intra-tumoral heterogeneities of baseline metabolic activity and dose response, as well as their impacts on inter/intra-tumoral control probability variations and treatment dose prescription, at the PET image voxel level.

低能电子直线加速器的新技术

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目前主流放疗设备均采用低能电子直线加速器作为放射源，其性能参数对放疗设备的设计直观重要。加速器新技术的应用，包括先进功率源技术、X 波段、超导射频技术、能量快速切换等等也将带来新型加速器设计，给未来放疗设备的实现与发展提供了更多的技术支撑。本报告将讲述低能电子直线加速器技术的最新发展，以及未来在放疗技术上的潜在应用。

Low energy electron linear accelerators (LINAC) are widely used as the radiation sources in the radiotherapy equipment. Parameters of the linac is critical to the design of a radiotherapy machine. Application of new particle accelerator technologies, including innovative RF sources, X-band technologies, superconducting radio-frequency, fast energy switch, etc., will bring the new design of linear accelerators and will contribute to future radiotherapy technologies. This talk will present the recent developments of electron linacs and the potential applications in radiotherapy.

人工智能在放疗中的应用

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因在算法、算力和大数据三个方面均取得重要进展，近年人工智能的应用越来越广泛，其中医疗是最重要的应用领域之一。放疗是医疗领域的一部分，是治疗肿瘤的三大手段之一。和医疗领域的其它部分相比，放疗实践具有大型设备多、流程数字化程度高的特点，是人工智能应用的绝佳场景。目前人工智能在放疗的应用主要包括六个方面：自动勾画感兴趣区域；自动设计放疗计划；自动质量控制；图像生成和配准；预测器官运动；预测放疗疗效。这六个方面的应用成熟度不同，其中前五个方面相对成熟，已在一些研究型医院得到不同程度的常规应用，最后一个方面还处于研究阶段。

In recent years, due to the breakthrough of algorithm, the rapid growth of calculation power and the exponential accumulation of big data, artificial intelligence has been widely used in many fields, of which the application in medicine is one of the most important field. Radiotherapy, belonging to the field of medicince, is one of the three major methods for turmor treatment. Compared with other fields of medicine, radiotherapy has the characteristics of large-scale equipment and high degree of digitalization of processes, which is a perfect scenario for artificial intelligence application. At present, the application of artificial intelligence in radiotherapy mainly includes the following six aspects: automatic regions of interest contouring, automatic treatment plan design, automatic quality control, image generation and regisitration, organ movement prediction, radiotherapy outcome prediction. The development of the appliactions in these aspects is different. The applications in the first five aspects are more well-developed, and have been used in research hospitals to certain degrees. The application in the last aspect is still at research stage.

放疗信息化建设与区域合作

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放射治疗作为肿瘤治疗的主要手段得到越来越广泛的应用，随着放疗技术向着更加精准的方向不断发展，放疗质控和管理也显得更加重要。放疗过程要求严格，流程长，环节多，技术复杂，数据量大等特点，使得传统的放疗管理方式逐渐不能满足现代化放疗科的要求，放疗信息化建设变得迫在眉睫。本次演讲主要介绍以下几个方面：我院在通过放疗信息化建设优化放疗流程及管理模式的一些经验及体会，基于网络平台的放疗流程、质控流程、设备状况管理及放疗大数据挖掘工作。通过云平台实现的远程治疗。医联体模式经验分享及放疗信息化建设的未来展望。

As the main method of tumor treatment, radiotherapy has been used more and more widely. With the continuous development of radiotherapy technology in a more precise direction, the quality control and process management of radiotherapy become more important. The strict requirements of the radiotherapy equipment, long processes, multiple links, complex technology, and large data volume have made traditional radiotherapy management methods gradually unable to meet the requirements of modern radiotherapy departments, and the construction of modern radiotherapy information system has become urgent. This speech mainly introduces the following aspects: PUMCH's experience and suggestion in optimizing the radiotherapy process and management mode through radiotherapy information system. The radiotherapy process, quality control process, equipment condition management and radiotherapy big data mining work based on the network platform. Remote treatment and remote quality control t through cloud platform. Experience sharing of 'Medical Consortium Model' and future prospects of radiotherapy informatization construction.

光学体表追踪技术及临床应用

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近年来光学体表追踪技术在放疗领域逐渐兴起，许多单位也开始配置应用这一技术。其利用结构光等成像技术实现患者三维轮廓成像，不产生额外电离辐射，同时提升放疗精准度和安全性。光学体表追踪技术有广泛的应用，在定位阶段，通过监测与引导患者呼吸实现自由呼吸 4D 扫描和深吸气屏气 DIBH 扫描。在治疗阶段，能够提供实时反馈完成患者摆位，在治疗中进行实时患者监控，以及实施包括深吸气屏气的呼吸运动管理治疗。治疗类型从传统的乳腺照射，胸部腹部照射，到 SBRT/SRS 立体定向外科照射，光学体表追踪技术均能在精准度和安全性上提供保障，并且新的应用领域包括儿科乃至粒子放疗等，国内外专家也在不断探索中。本演讲以 C-RAD 产品为例，介绍光学体表追踪技术及其临床应用。

Optical surface tracking technique is growing in radiotherapy for recent years. Many facilities have deployed and implemented this technology. It is capable of capture 3D surface image of patients in real-time with technologies like structured light. It improves accuracy and safety in radiotherapy while generating no extra ionized radiation. Optical surface tracking technique has a wide range of application in radiotherapy. During simulation, free breath 4D scan and deep inspiration breath hold scan can be acquired with the system tracking and guiding patients' breath. During treatment, the technology supports patient positioning with real-time feedback, patient monitoring throughout the treatment fraction and motion management (as beam-gating in free-breathing or deep-inspiration-breath-hold). For treatment sites from traditional breast radiation, thoracic and abdominal sites, to SBRT/SRS stereotactic radiation, optical surface tracking is providing support for accuracy and safety. And researchers are also exploring its application in pediatrics, particle therapy and so on. This presentation is taking C-RAD products as an example, to introduce optical surface tracking technique and its clinical application.

磁共振成像技术创新发展：从诊断走向治疗

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经过四个多世纪的发展，磁共振成像已经成为临床精准诊断最重要的手段之一。磁共振成像的观察对象经历了从结构 - 功能 - 代谢的演进；磁共振的图像信息，正在从定性的对比度到生理参数定量化的转变。然而，磁共振成像一直难以实现从诊断到治疗的跨越。成像速度慢是主要瓶颈。随着磁共振成像序列技术和重建算法的创新发展、特别是机器学习技术的应用，为克服成像速度瓶颈提供非常有力的工具。本演讲将介绍磁共振成像技术的新进展，以及在实时治疗导航中的前沿应用。

In the past decades, MRI has developed into one of the most commonly used precision diagnostic tools. The study objects of MRI have evolved from structures to functions, and to metabolic processes. MRI has also moved from qualitative presentations to quantification of biological parameters. Nevertheless, it has been quite slow for MRI to move from diagnosis to treatment. The primary bottleneck is the low scan speed of MRI in comparison with other imaging techniques, such as X-ray and ultrasound. The recently innovative development in pulse sequence techniques, reconstruction algorithms, and especially the applications of machine learning techniques have paved the way to overcome the bottleneck of scan speed. This talk will present the latest development in MRI and the progresses in real-time MRI guidance for clinical treatment.

CT 影像技术创新

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CT 影像是现代医学筛查、诊断和治疗中不可或缺的重要影像手段。自从 CT 技术出现以来，在临床需求和质控的驱动下，从前端成像到后端图像应用，都经历了多方面和充满生机的发展。在成像方面，如 CT 设备的结构、不断追求的辐射安全性、动态成像、显微或相衬成像、多能谱成像等技术的开发，不断为 CT 影像开启更多的应用场景。层出不穷的成像算法使图像质量不断的趋于极致，同时也使 CT 的辐射安全性更加改善。在后端应用方面，各种以人工智能影像分析为基础的筛查和诊断技术不断出现，基于多模影像手术规划、导航和评估的智能机器人手术系统等，带来了临床实践的变革，结合新的云计算、大数据和人工智能的发展，CT 影像技术和应用会有更多的创新开发。

X-ray Computed tomography (CT) is an important imaging technology in disease screening, diagnosis, and therapeutic process. With the drive of clinical demands and safety-quality requirements, CT technology, from the imaging chain to the end image applications, has been one of the most active and multifaceted development fields. At the imaging side, the research and development have resulted in great outcomes in the structures of the CT equipment, radiation safety, dynamic imaging, microscopic/phase-contrast imaging, and multi-spectral CT, etc. Various reconstruction technologies also push the image quality onto new levels and make CT imaging safer. The progress of the imaging technologies opens the opportunities for more CT applications. At the application side, image analysis based on AI technologies has been actively studied in disease screening and diagnosis. CT imaging is also important in the surgical planning, navigation, and outcome evaluation in robotic surgeries. Combined with the development of the cloud computing, big data, and AI technologies, there must be new horizons for the CT imaging.

《超高清医用显示器技术规范》国家行业标准制定研究进展

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医用显示器是目前所有医学影像诊断系统、精确放疗系统、数字化介入手术系统、医用机器人系统、以及医疗数字化、信息化、智能化及医疗质量控制等的极为重要的支撑性基础关键部件设备。近几年来超高清（4K、8K 等）显示技术正在快速发展，医用显示器技术也在伴随着不断发展中，过去的一些基于 CRT、高清及全高清的一些规范标准已经不适应新的技术要求。本国家行业标准制定研究填补国内空白，符合当前和未来医疗显示设备技术发展、市场应用和显示视觉健康要求，其主要技术内容包括：在超高清技术条件下新的医用显示器技术性能及参数要求（如超高清分辨率、亮度、对比度、高广色域、灰阶、DICOM 医学图像及画质要求、均匀性和一致性要求、人眼视觉健康防护要求等），以及相应的测试方法和法规等。

At present, medical display device is a very important basic key component or equipment for all medical image diagnosis system, accurate radiotherapy system, digital interventional surgery system, medical robot system, and medical digitization, informatization, intelligentization and medical quality control. In recent years, UHD (Ultra High Definition, 4K, 8K, etc.) display technology is developing rapidly, and medical display device technology is also developing continuously. Some previous specifications based on CRT, HD and full HD can no longer meet the new technical requirements. The national industry standard formulation research will fill the domestic blank, and meet current and future medical display device technology development, market application and visual health requirements. Main technical contents of this industry standard include: under the condition of UHD display technology, the new medical monitor's technical performance and parameters requirements (such as UHD resolution, luminance, contrast, high wide color gamut, grayscale, DICOM medical image and image quality, uniformity and consistency requirements, human vision health protection requirements, etc.), and the corresponding test method and regulations, etc.

核医学成像设备技术进展

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1) 核医学成像设备现状

目前我国核医学成像设备 SPECT(/CT)、PET/CT、PET/MR 的装机量、临床使用情况，及其发展动态

2) 核医学成像设备的配置新政策

2018 年以来 , 我国发布了一系列新的大型医用设备配置管理政策。国家新政策下核医学成像设备 SPECT(/CT)、PET/CT、PET/MR 的配置许可、使用管理和配置规划，新政策下医疗机构配置 PET/CT 所需机构条件、人员条件、工作基础及配套设施等条件。

3) 核医学成像设备新技术及其进展

SPECT(/CT) 新技术及其进展：CZT 探测器、CZT 通用型 SPECT(/CT)、心脏专用 SPECT(/CT) 机型

PET(/CT/MR) 新技术及其进展：晶体、光电转换器件 SiPM、TOF、DOI、FSF、新重建算法等新技术。

use management and equiping plan of nuclear medical imaging equipment SPECT (/ CT), PET / CT and PET / MR under the new national policy

Abstract

1) Current status of nuclear medical imaging equipment

The installed capacity, clinical application and development trend of SPECT(/CT), PET/CT and PET/MR in China were stated.

2) New policy for configuration of nuclear medical imaging equipment

A series of new large-scale medical equipment management policies have been issued in China since 2018. The management and quantity plan of Equipping nuclear medical imaging equipment SPECT(/CT), PET/CT and PET/MR were analyzed. The hospital requirements, staff requirements, previous works and supporting facilities were presented.

3) Characteristics of new technology and development trend of nuclear medical imaging equipment

Characteristics of new technology and development trend of SPECT(/CT): CZT detector, CZT general SPECT(/CT), cardiac SPECT(/CT) equipment.

Characteristics of new technology and development trend of PET(/CT/MR): crystal, photoelectric converter SiPM, TOF, DOI, FSF and new reconstruction algorithm.

医用诊断显示技术新进展

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为了使医院诊断的更加便捷以及智能，应运而生了多种医用诊断显示的新技术。第一，在普遍应用的 DICOM 校正技术的基础上，综合考虑了环境光照，影像内容，人眼感光个体差异以及入眼总光通量等因素，从而使任何人在任何环境对任何医院影像都能获得更好的区分度；第二，采用神经网络训练和检出技术，以达到区分不同部位组织的目的，对不同部位影像做出个性化敏感区域凸显，以提高对早期轻微病灶的检出率；第三，在凸显敏感区域的基础上，根据人眼感光曲线做出对应还原。主要采取敏感窗口凸显、高色深扩展、和整体色彩还原等系列技术应用的综合算法，保证在综合应用需要下，具有逼真的还原性。本演讲将介绍医用诊断显示技术的新进展。

In order to make hospital diagnosis more convenient and intelligent, a variety of new technologies for medical diagnosis and display have emerged. First, on the basis of the commonly used DICOM correction technology, factors such as ambient lighting, image content, individual differences in the sensitivity of the human eye, and total luminous flux into the eye are taken into consideration, so that anyone can obtain better images from any hospital in any environment. Good discrimination; second, use neural network training and detection technology to achieve the purpose of distinguishing different parts of the tissue, and make personalized sensitive areas highlighting in different parts of the image to improve the detection rate of early minor lesions; Third, on the basis of highlighting the sensitive area, make a corresponding restoration according to the human eye's sensitivity curve. It mainly adopts comprehensive algorithms for sensitive window highlighting, high color depth expansion, and overall color restoration, to ensure that it is realistically reducible under the needs of comprehensive applications.This talk will present the latest development of medical diagnostic display technology.