DUKE RADIATION ONCOLOGY

2024 ANNUAL REPORT

Looking for the Achilles' Heel in Treatment-Resistant Tumors

Visionary Breakthroughs with Duke's Multidisciplinary Y-90 Eye Plaque Procedure

Duke's RORS Track: Fostering Our Physician-Scientists in the Workforce

Duke Radiation Oncology
Duke University School of Medicine

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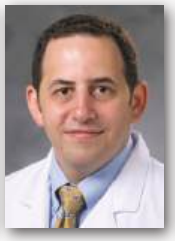

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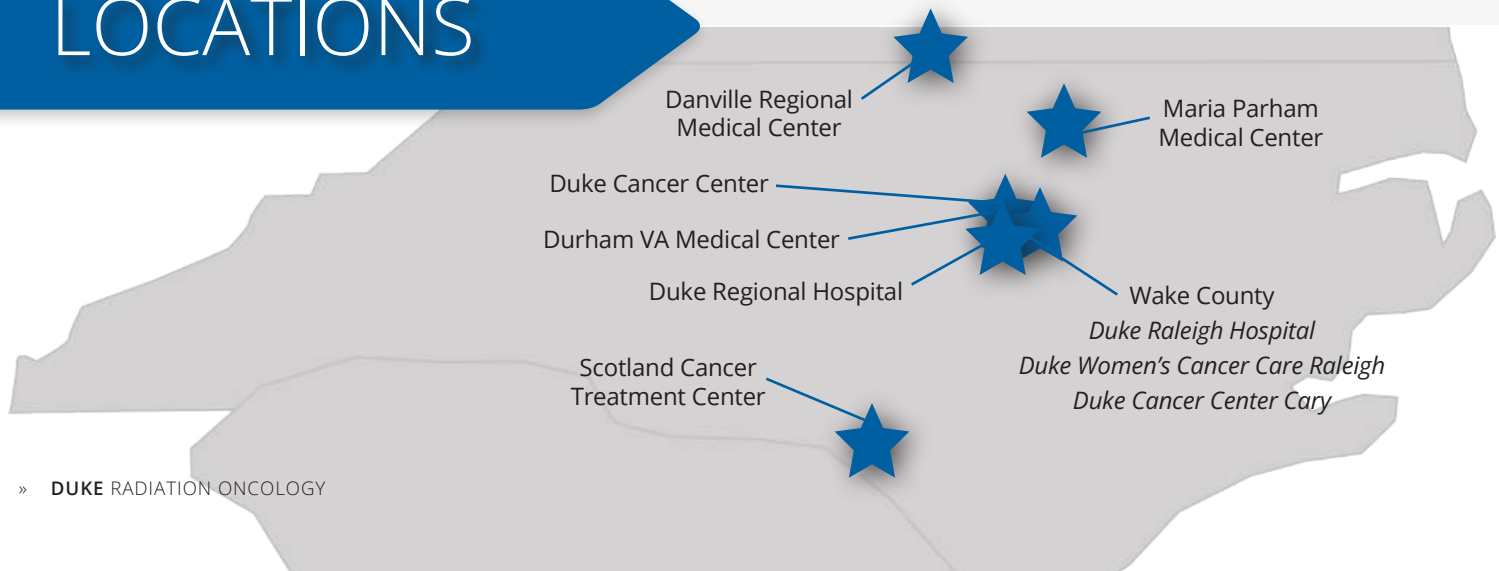

CHAIR'S MESSAGE

For the past 20 years, I have had the privilege of serving as Chair of Duke Radiation Oncology.

Over that time, I have watched our Department grow and change; we've more than doubled our employed radiation oncologists (from 16 in 2004 to 34 in 2024), and tripled our employed medical physicists (from 12 in 2004 to 36 in 2024). We now treat an average of 342 patients a day across our nine clinical locations.

More broadly, we have worked diligently to provide our patients and their families with exceptional, compassionate care at our Duke Cancer Center clinic and our many satellite locations. We have educated and trained the next generations of radiation oncology leaders in both clinical practice and research. And our labs – with specialized focuses on radiation and cancer biology and radiation physics – are pushing the frontiers of research in cancer.

It's been rewarding for all of us as a team to see the remarkable contributions, growth and commitment of our faculty, trainees and staff over these years, especially during difficult and challenging times.

We are very pleased to share our 2024 Annual Report, which includes standout stories about each of our missions – patient care, research and education – as well as a highlight on our physics division, prominent news stories and a "by the numbers" look at Duke Radiation Oncology.

Christopher Willett, MD
Chair, Department of Radiation Oncology

ACKNOWLEDGEMENTS

Our annual report primarily covers fiscal year 2023. Thank you to everyone who contributed their time and expertise to this report, especially Miriam Ellis; Randy Grimes; and J.T. Solomon, CPA, MBA.

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Department Mission

We pledge to provide expert, compassionate and prompt clinical service to our patients; to generate new knowledge concerning causes, prevention and treatment of cancer; to transmit new knowledge from our clinical and laboratory research; and to actively participate in and further the missions of the Duke Cancer Institute, Duke Health and Duke University.

Looking for the Achilles' Heel in

TREATMENT-RESISTANT TUMORS

by Mary-Russell Roberson

Click to learn more about the Eyler Lab and recent awards

While cancer treatment has come a long way, **Christine Eyler, MD, PhD**, isn't satisfied. "We could do a lot better," she said. Dr. Eyler, the Butler Harris Assistant Professor in Radiation Oncology, hopes her research will help find more effective ways to vanquish tumors. She examines how tumors change during radiation treatment, with the goal of identifying new targets for therapy.

She is currently investigating rectal cancer, which is typically treated with radiation and chemotherapy at the same time. "Tumors may evolve to be more resistant to chemoradiation," she said, "but it may open up an Achilles' heel of sorts, where they become increasingly susceptible to another treatment."

In the future, rectal cancer patients might receive an additional therapy midway through the standard treatment, to take advantage of an Achilles' heel. "We're far away from that now," Dr. Eyler said, "but there are reasons to think that might be something we can achieve."

A Better Way to Study Cancer in the Lab

To investigate the changes that tumors go through during treatment, Dr. Eyler uses rectal cancer organoids, which are three-dimensional cultures of cells from patients' tumors. The cells came from rectal cancer biopsies from 20 patients. Organoids, unlike traditional flat cell cultures, contain some of the structural features of real tumors. "That culture method allows them to maintain some of the complexity and heterogeneity that are evident in patients' tumors," she said. "I fundamentally believe they are better study models."

Dr. Eyler subjects the organoids to treatments including radiation and chemotherapy and investigates how tumor response changes over time. "The tumor might be responsive at the beginning but a certain population of cells might survive and have an advantage as the treatment goes on," she said. "I'm interested in tracking tumor evolution in response to therapy."

She looks at both genetic changes and epigenetic changes. Genetic changes are differences in the actual genetic code, while epigenetic changes affect how or whether certain genes are expressed. Tumors from different patients will likely respond in different ways, leading to different susceptibilities. In the future, that might translate to personalized treatment based on a patient's tumor profile.

If Dr. Eyler can find some Achilles' heels in treated rectal tumors, she hopes she'll be able to develop new treatment strategies and partner with others in the department to evaluate the new strategies in clinical trials.

> ***It's not a clear, straight path to patient benefit, but these are the questions that build the field.***

Looking to Epigenetics for Cancer's Origins

In addition to studying irradiated rectal cancer, Dr. Eyler uses new technology to learn about how epigenetic changes promote cancer growth in the first place. A common type of epigenetic change is called methylation, in which the addition or subtraction of a molecule called methyl influences gene expression.

Another epigenetic player involves the architecture of chromatin, the proteins that form the structural scaffolding for DNA. Changes in the architecture of chromatin can bring certain proteins and genes in a long DNA strand close to one another, influencing whether or not those genes are expressed. Dr. Eyler is using new technology to shine a light on that architecture.

"There's this whole epigenetic chromatin code that influences the regulation of important genes in normal biology as well as cancer biology," Dr. Eyler said. She suspects that changes in chromatin structure could explain such things as the absence of tumor-suppressing genes in cancerous tumors.

"There are a lot of genes in cancer that get dysregulated – not through mutation or methylation – and we don't know how or why," she said. "My hypothesis is that they have altered chromatin structure and regulation."

Understanding how gene dysregulation leads to cancer could yield important new information about how to stop it. "It's not a clear, straight path to patient benefit," she said, "but these are the questions that build the field to be able to make those advances."

A Roundabout Journey to the Clinic

As an undergraduate at Duke, Dr. Eyler planned to pursue a PhD and become a scientist. Those plans changed after she became friends with the son of **Henry Friedman, MD**, the James B. Powell, Jr. Distinguished Professor of Pediatric Oncology. Dr. Friedman had a hunch she would excel as a physician. So he invited her to shadow him in the clinic.

Dr. Eyler already knew she loved science, but she discovered she loved interacting with patients too. That's how she ended up becoming a physician-scientist, earning her PhD and MD at Duke. "She really captures the concept of physician-scientist," said **Christopher Willett, MD**, chair of the Department of Radiation Oncology. "She's a model clinician and has been highly productive and innovative at an early point in her career."

Dr. Eyler, who describes herself as an "I love everything" person, said the combination of patient care and lab work suits her. And she finds that her clinic days provide the fuel for her lab days. "I get a lot of my drive and motivation from seeing what patients go through," she said.

VISIONARY BREAKTHROUGHS

with Duke's Multidisciplinary Y-90 Eye Plaque Procedure

by Sarah Brady, Vickie Frye and Tori Hall

Duke has long been recognized as a leading high-volume provider of eye plaque procedures, catering to patients across North Carolina and neighboring states. **Junzo Chino, MD**, a radiation oncologist and Duke's director of brachytherapy, noted that Duke "treats several hundred patients with conventional eye plaques every year."

But in June 2023, Duke became one of only three treatment sites in the U.S. certified to utilize a novel high dose-rate (HDR) yttrium-90 (Y-90) brachytherapy procedure. "Because of our wide referral base, some of our patients are not appropriate candidates for conventional eye plaques," said Dr. Chino. "Those patients are the ones that may benefit from the Y-90 procedure."

The Y-90 procedure, cleared by the Food and Drug Administration for episcleral brachytherapy of ocular tumors and benign growths, involves placing a disc of yttrium-90 on an applicator. This approach effectively treats small lesions from a variety of different diseases and conditions, including conjunctival squamous cell carcinomas, keloids and melanomas. Remarkably, most procedures are completed within five to 10 minutes.

> ***We're honored to have been chosen as one of the first centers in the country to offer this innovation in patient care.***

"We're honored to have been chosen as one of the first centers in the country to offer this innovation in patient care," said **Miguel Materin, MD**, division chief of ocular oncology and ophthalmologist. "Y-90 is an incredibly less-invasive procedure that replaces traditional therapy and will positively contribute to the evolution of ocular oncology on a national scale."

Treatment Benefits

When compared to a traditional eye plaque procedure in which the plaque is worn for multiple days, the benefits of the Y-90 procedure are astronomical. "There's no need for the patient to admitted to the hospital or sent home with an active plaque in place, so it's actually more cost-efficient than a traditional eye plaque," said Dr. Chino. "It's also a safer option, as it eliminates the uncertainty of having the patient in public with an active plaque."

Another notable advantage of the Y-90 program is its ability to treat anterior lesions. Historically, limited radiation treatment options existed for patients with these lesions who had already completed chemotherapy and/or undergone conservative surgical measures because of the difficulty of suturing and positioning plaques on the anterior surface of the eye. "It's a whole new avenue for patients with these small anterior lesions," said Dr. Chino.

A Team Effort

In collaboration with the Duke Department of Ophthalmology, Dr. Chino has worked with Dr. Materin to successfully perform the Y-90 procedure on ten patients, with plans for more in the future.

During initial consults, patients are evaluated to determine whether they are a good fit for the Y-90 procedure. If so, using tumor measurements, the team calculates the time to the appropriate depth and then provides quality assurance during pre-planning. In the operating room, Dr. Chino attaches the Y-90 disc to the applicator, then delivers the source to the ophthalmologist. Physicists monitor the time as the source is applied. The procedure is over in a matter of minutes.

"All of brachytherapy is a team sport," said Dr. Chino. "None of this happens without a high degree of collaboration between the surgeon, the radiation oncologist and a dedicated physics team, as well as the nurses, surgical coordinators, recovery staff and assistants in the operating room. Every role in this group is absolutely critical to ensure we're on top of our game and each procedure is done as safely and effectively as possible."

> ***All of brachytherapy is a team sport. None of this happens without a high degree of collaboration.***

Expanding Horizons

Dr. Chino expects Duke's Y-90 procedures to ramp up in the future, especially since larger disc sizes will be released soon, which will expand the number of patients who can benefit from this technology.

"We also expect the Y-90 procedure to grow in popularity because many of these patients, especially those with anterior plaques, have no other option except for radical surgery," said Dr. Chino. "As our program continues to develop, and we publish on this and publicize our efforts, it will really allow for a development of a network of referring providers for these patients who have no other option."

DUKE'S RORS TRACK

Fostering Our Physician-Scientists in the Workforce

by Sarah Brady

When **Pete Hendrickson, MD, PhD**, finishes his residency in 2024, his graduation will mark not only a personal accomplishment, but an institutional one as well – he will be the first trainee to complete residency through the novel Radiation Oncology Research Scholar (RORS) track at Duke Radiation Oncology.

The Road to Radiation Oncology

Dr. Hendrickson's interest in genetics-based research began during his time in college. "The human genome sequencing project had recently finished, and genetics was front and center in science," he recalled. "Everyone knew this was going to transform how we study and practice medicine. I fell in love with it right away."

That led him to two years in a clinical research lab at Northwestern University and the Children's Memorial Hospital of Chicago (now Lurie Children's Hospital). "Although the very basic science research I was doing as an undergrad was exciting in its own way, it wasn't until I got here that I realized science is so much more than an academic pursuit. At the end of the day, it's about leveraging lab-based discoveries to help real people. That's when I realized the MD/PhD pathway was right for me."

Dr. Hendrickson completed his MD/PhD at the University of Utah, where he became interested in cancer genomics and developmental biology. He completed his PhD thesis in the lab of Bradley Cairns, PhD (an HHMI investigator at the Huntsman Cancer Center), where he made a seminal discovery identifying DUX4 as a master regulator of embryonic cell fate. He decided to match into radiation oncology. "I knew I wanted to see and treat cancer patients and radiation oncology to me was the most intellectually and professionally rewarding of the oncology-based disciplines," he said. "And scientifically, I think I saw a unique opportunity in radiation oncology to build on my interests and experience in genomics in a way that could meaningfully impact patient outcomes."

Enter Duke Radiation Oncology. When Dr. Hendrickson started looking into residencies, Duke stood out. "I felt Duke was at the forefront of research in oncology, and more specifically radiation

> ***Science is so much more than an academic pursuit … it's about leveraging lab-based discoveries to help real people.***

oncology," he said. He reached out to one of Duke's PIs early on, and even before applying to residencies, "Duke just seemed like the right fit." What solidified his decision was the establishment of the RORS track in 2019, and his chance to be the first RORS trainee.

The RORS Track

The RORS track, a first-of-its-kind program nationally, was developed by faculty at Duke to provide a pathway for radiation oncologist physician-scientists to become independent laboratory investigators. The RORS track combines a research-intensive residency with the opportunity to continue mentored research post-residency as an instructor, allowing a total of 45 months of dedicated scholarly effort. The unique aspect of the program is early commitment at the time of the residency match to candidates with strong backgrounds and high potential for success. The long research time horizon and strong institutional support allows RORS scholars the opportunity to think big and try bold, high-impact projects to rapidly generate data and lead to early career development awards.

"Although radiation oncology is one of the key cancer disciplines, it is the only one that does not have a specific track to guide trainees to become independently funded investigators," said **Joseph Salama, MD**, residency program director and co-creator of the RORS track. Despite many MD/PhD graduates entering the field of radiation oncology in past years, there are few externally funded physician-scientists, and only a fraction of NIH cancer research funding is awarded to investigators in radiation oncology. In creating the RORS track, Dr. Salama and others hoped to bolster young physician-scientists in the field by providing an adequate training structure and continued mentored research time after residency. "The RORS track is meant to provide the time, structure and funding to make a runway for trainees so that they can lead their own independent research lab after residency."

This protected time the RORS pathway offers is especially critical to young physician-scientists – time to delve into projects, time to cultivate ideas, time to make meaningful contributions to the field and, maybe most critically, time to apply for K08 awards to facilitate the transition to being an independent physician-scientist.

Reflections on Training

"At the end of the day, the RORS track is the most direct path to success as a physician-scientist in this field," Dr. Hendrickson said. As the first RORS trainee, he says he has "benefitted most from the close-knit community of faculty at Duke who have mentored me in all aspects of the training path from bench to bedside." Now, with four other RORS trainees in the residency program, "I think we're starting to build a pipeline for success that is going to be helpful for younger RORS trainees. "Most importantly, I can't emphasize how important it is to be in an environment where there are others who are doing the same thing and who share a common vision for their career."

Click to read about Dr. Hendrickson's current research directions

RADIATION PHYSICS

The Division of Radiation Physics at Duke has a long history and a strong track record of clinical excellence, trainee education and groundbreaking research. Division strengths include stereotactic body radiation therapy, stereotactic radiosurgery and brachytherapy treatment programs; a comprehensive physics quality assurance program; and established research programs in imaging, image analysis, treatment optimization and 3D dosimetry.

A dedicated clinical research team assists with IRB protocols, clinical trials and research grant submission and administration. In addition, the division is committed to safety, with a robust safety and incident learning program and a focus on process automation and optimization.

Major physics research directions include novel radiotherapy techniques; 3D dosimetry and optical bio-imaging; 4D radiotherapy and motion management; hyperthermia; quality assurance and safety; novel brachytherapy techniques; knowledge-based planning and decision support; radiosurgery; SBRT; image guidance; novel CBCT image acquisition and reconstruction; cardiac RT; medical imaging science; AI; adaptive therapy; and radiomic analysis.

Deshan Yang, PhD, was recruited as the physics research director in December 2021 to continue building the physics research portfolio, manage physics research efforts and mentor faculty members on research projects and grant preparation.

Duke University Medical Physics Graduate Program

The Duke University Medical Physics Graduate Program (MPGP) was established in 2004 as a unique program that represented all four areas of medical physics: diagnostic imaging, medical health physics, nuclear medicine and radiation therapy. **Mark Oldham, PhD**, professor of radiation oncology, is the current program director. Over the past two decades, the program has graduated almost 400 students in both MS and PhD pathways.

Click to read more about the Duke MPGP

Duke University Radiation Therapy Physics Residency Program

Click to read more about physics residents

The Duke University Radiation Therapy Physics Residency Program has been continuously CAMPEP accredited for 15 years. **Anna Rodrigues, PhD**, and **Yongbok Kim, PhD**, serve as program co-directors. While the two-year residency program is clinically-oriented, research is encouraged. Program faculty have consistently demonstrated their commitment to mentorship and scholarly activities. In the past five years, residents have produced 45 presentations at national meetings such as AAPM and ASTRO and 31 peer-reviewed publications.

NEWSMAKERS

Click to read more news from Duke Radiation Oncology

Lee awarded R01 for radiation-induced oral mucositis research

Chang-Lung Lee, PhD, was awarded a $2.5 million, five-year R01 grant by the NIH to support the investigation of novel therapeutic strategies that will prevent or reduce radiation-induced oral mucositis without sacrificing tumor control. Dr. Lee is PI on the grant; co-investigators are **Mark Oldham, PhD**, and **Yvonne Mowery, MD, PhD**.

Lafata awarded R01 for computational oncology research

Kyle Lafata, PhD, was awarded a $2.25 million, five-year R01 grant by the NIH/NCI to interrogate treatment resistance and immune dysregulation in head and neck cancer using multiscale imaging and applied mathematics. Dr. Lafata is PI on the grant. Co-investigators are **David Brizel, MD**; **Yvonne Mowery, MD, PhD**; **Chunhao Wang, PhD**; **Tammara Watts, MD, PhD**; and **Sara Jiang, MD**.

Palta selected for ALICE program

Manisha Palta, MD, was selected to participate in the 2024 ALICE (Academic Leadership, Innovation and Collaborative Engagement) program. ALICE is a year-long leadership development opportunity for women faculty in the Duke University School of Medicine.

McDuff selected for LEADER program

Susan McDuff, MD, PhD, was selected to participate in the 2024 LEADER (Leadership Development for Researchers) program. The program is designed for junior faculty who are leading a research group and driving their own research agenda.

Reitman awarded ALSF grant

Zachary Reitman, MD, PhD, was awarded an Alex's Lemonade Stand Foundation for Childhood Cancer (ALSF) 'A' Award Grant in the amount of $800,000 over four years for "Modulation of STING to enhance the efficacy of treatments for diffuse midline glioma." The Reitman Lab is investigating highly therapeutically relevant molecular processes to inform future combination treatment strategies for pediatric diffuse midline gliomas. Current studies will determine if pediatric clinical trials should focus on drugs that target stimulator of interferon genes.

Rodrigues named president-elect of SDAMPP

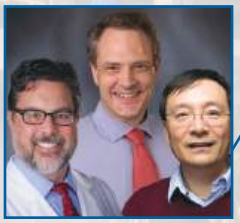
Anna Rodrigues, PhD, was named president-elect of The Society of Directors of Academic Medical Physics Programs (SDAMPP) for 2024, beginning a three-year service on the presidential chain. Among her responsibilities, she will organize the SDAMPP Annual Meeting to be held in July at the American Association of Physicists in Medicine (AAPM) Annual Meeting in Los Angeles, California.

Ayala-Peacock named NRG Committee vice chair

Diandra Ayala-Peacock, MD, has been named the NRG Oncology Radiation Oncology Committee vice chair. The Scientific Core Committee aides in cross-group collaboration and engagement for radiation oncology research.

Team awarded R21 for work with ultra-high dose rate electron beam

Scott Floyd, MD, PhD; **Mark Oldham, PhD**; and Physics faculty **Ying Wu, PhD**, were awarded a $413,971, two-year R21 grant by the NIH for the project "Exploring synthetic lethality with a novel very high energy electron FLASH radiation beam."



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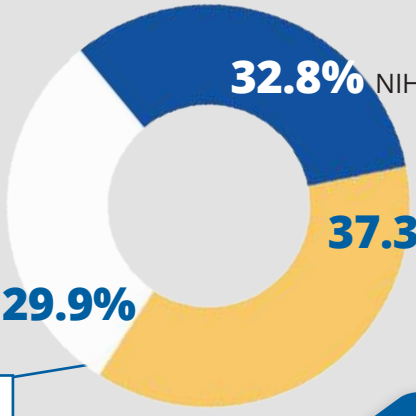
RESEARCH



32.8% NIH ($1,018,182)

37.3% Industry and other ($1,157,871)

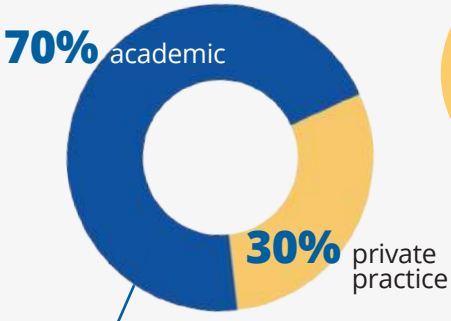
29.9% Non-profit ($928,159)

Total research awards ($3,104,212)

867
5-year clinical trial accrual

EDUCATION

RADIATION ONCOLOGY RESIDENCY PROGRAM



70% academic

30% private practice

Non-military alumni postgraduate job placement

ranked **#14** nationally

ranked **#3** in the South

ranked **#2** nationally for VA affiliation

First jobs taken by graduates of the Duke University residency program in Radiation Oncology (1983-2024)

PATIENT CARE

IN DUKE-OWNED CLINICS

our tech

13 linear accelerators

8 TrueBeam
3 STx Radiosurgery
1 Clinac 2100
1 Ethos-Adaptive RT (coming 2025)

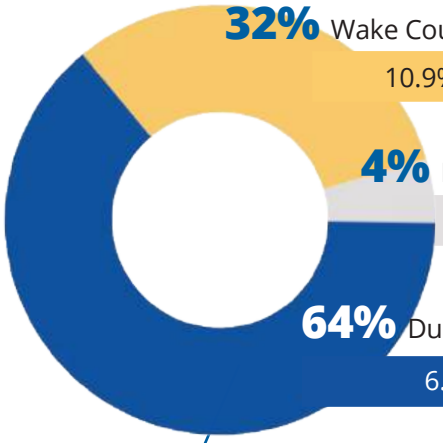
5 dedicated CT scanners

1 dedicated PET-CT scanner

1 dedicated MRI scanner (3T)

2 Varian GammaMed afterloaders

1 dedicated Mobil CT scanner



32% Wake County (1,572)
10.9% growth since 2022

4% Duke Regional (220)
2.3% growth since 2022

64% Duke Hospital (3,187)
6.4% growth since 2022

Annual new treatment starts for calendar year 2023 (4,979; 7.6% growth since 2022)

our people

34 radiation oncologists

36 medical physicists

15 radiation oncology residents

4 radiation therapy physics residents

11 APPs

57 radiation therapists

21 dosimetrists

34 nursing team members

7 clinical trials team members