Memorial Sloan Kettering Cancer Center

Physics Opportunities in MR Imaging Research

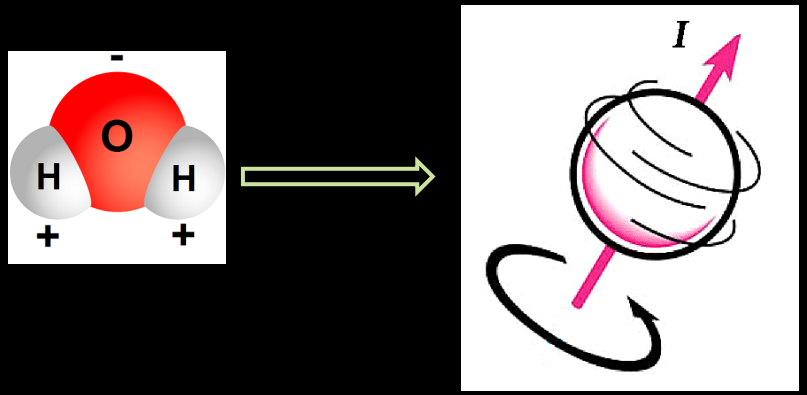
Yale Physics Professional Development Organization

September 20, 2017

Kristen L. Zakian, Ph.D.

Associate Attending Physicist

Physics PhDs excel in MRI research



It's all about spin (angular momentum)

http://mri-q.com/what-is-spin.html

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Postdoctoral Research Fellowships

- Abundant
- Will require biology/medical study in area of interest
- The more facets of MR Physics you learn, the better
- Project focus will influence career path

>> active areas of research

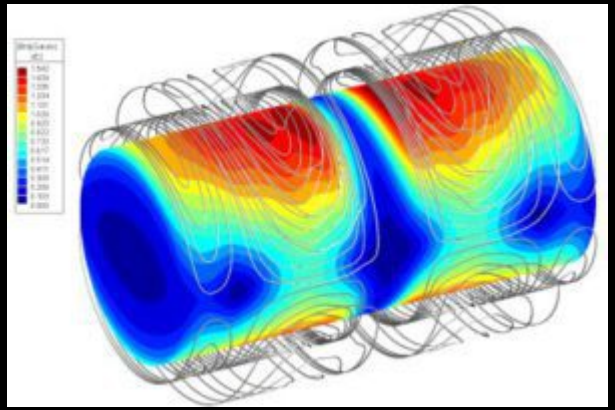
MR Research

preclinical

clinical

Hardware

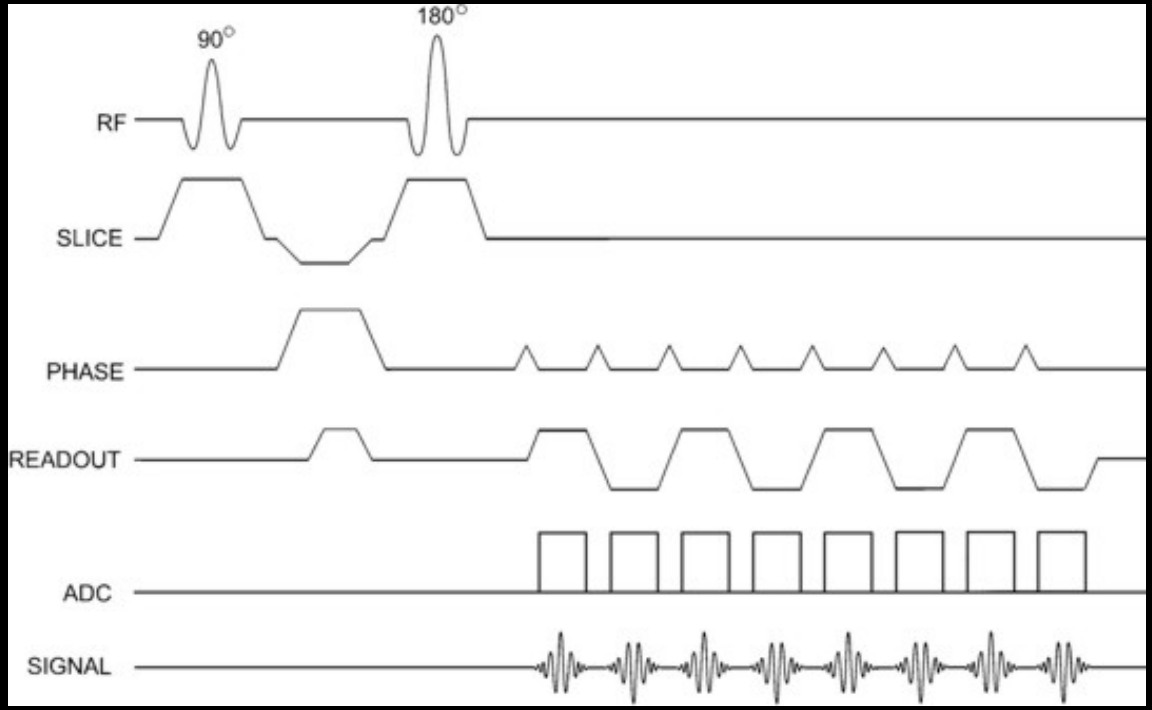
RF coils



Gradient coils

Mainly preclinical and high-field human

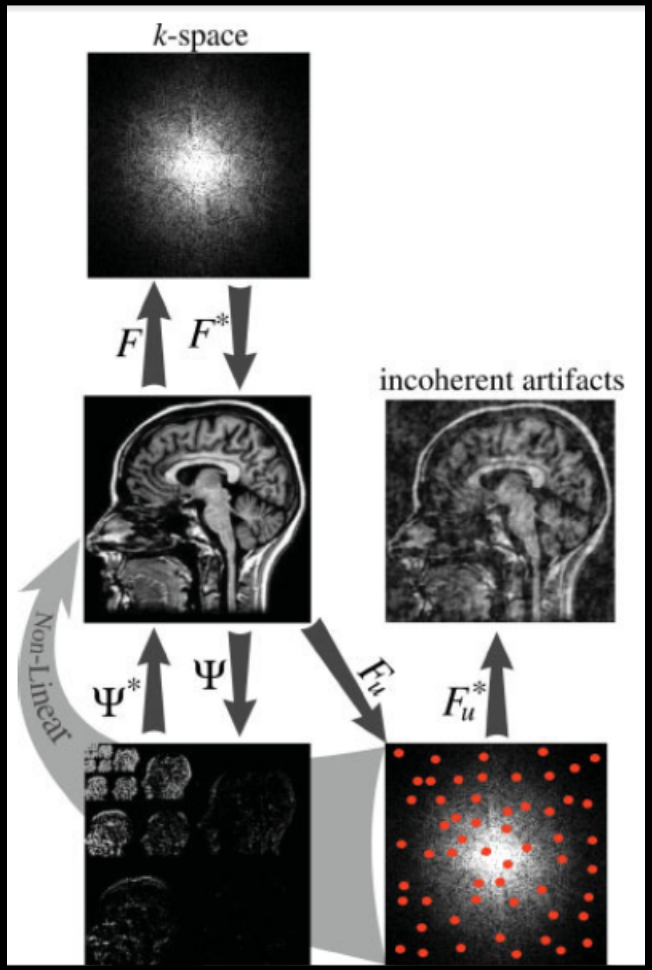
Acquisition Software: pulse programming



Preclinical and Clinical

http://bitc.bme.emory.edu/seq_dia.html

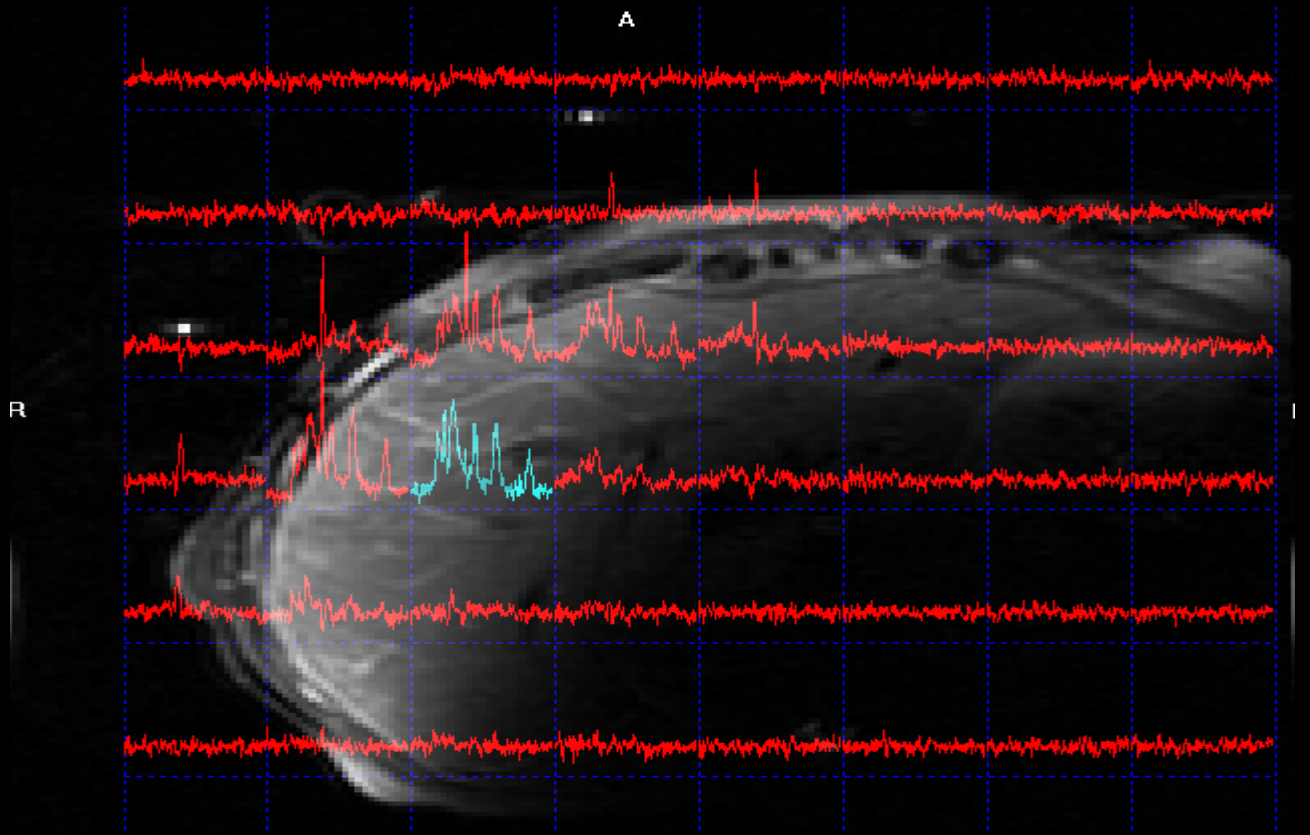
Reconstruction Software Data Analysis and Modeling



Lustig, et. al. Sparse MRI: The Application of Compressed Sensing for) Rapid MR Imaging
Magnetic Resonance in Medicine 58:1182–1195 (2007

In vitro and *in vivo*
MR spectroscopy

^{31}P magnetic resonance spectroscopic imaging: human liver



MR in Radiation Therapy

- Precision treatment planning: MR Simulator
- Real-time imaging and treatment (MR Linac)

Career Paths:

- Clinical MRI has matured
- Grant funding is scarce
- Old model doesn't always work

Postdoc $\not\rightarrow$ faculty

- Certifications may give an edge

Certifications/ Formal Recognition—

- ACR/AAPM Diagnostic board certification (includes all diagnostic imaging modalities)
- ACR MRI Physics Accreditation
- MR Safety Expert (MRSE) –new
- ACR Quality Assurance: not formalized but expertise in demand (scanner must be ACR certified for billing purposes)

Residency may provide an edge

Thanks for your attention!

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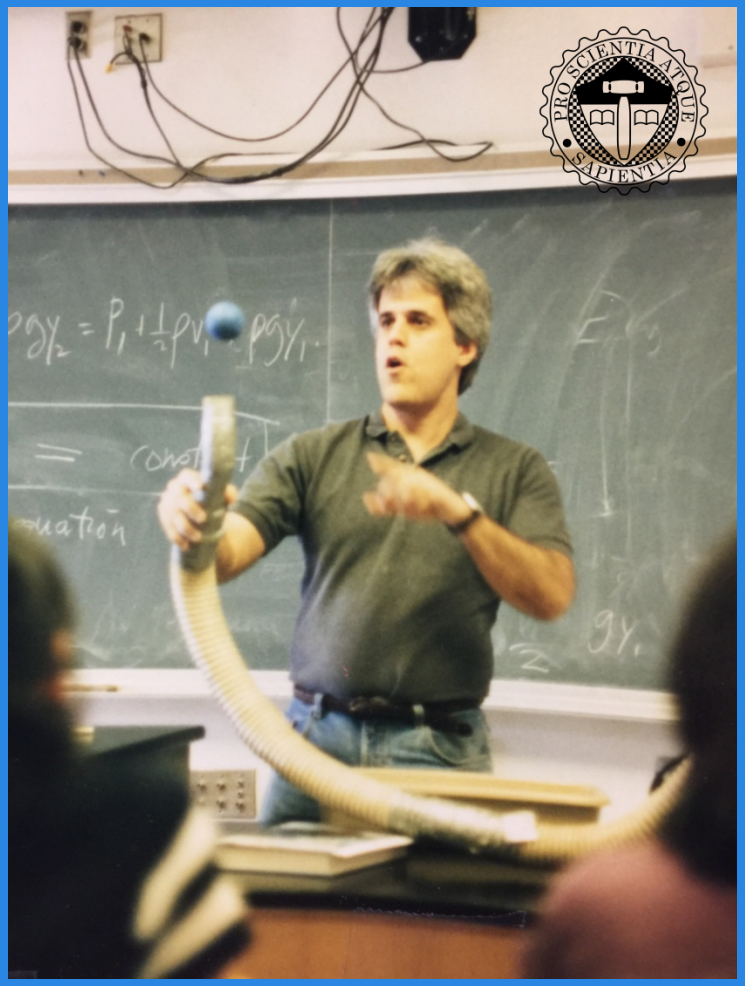
Therapeutic Medical Physics

Jim Mechalakos
Memorial Sloan-Kettering Cancer Center

September 20, 2017, Yale University

1994-1998



1994 PhD Columbia- High Energy Physics

1994-1998 Teaching- Stuyvesant, CUNY

1997- took the MCAT

1998- answered an ad on AIP website from MSK

1998- postdoc research

CT guided radiotherapy of the prostate

Courtesy Michael
Lovelock 6/20/2000

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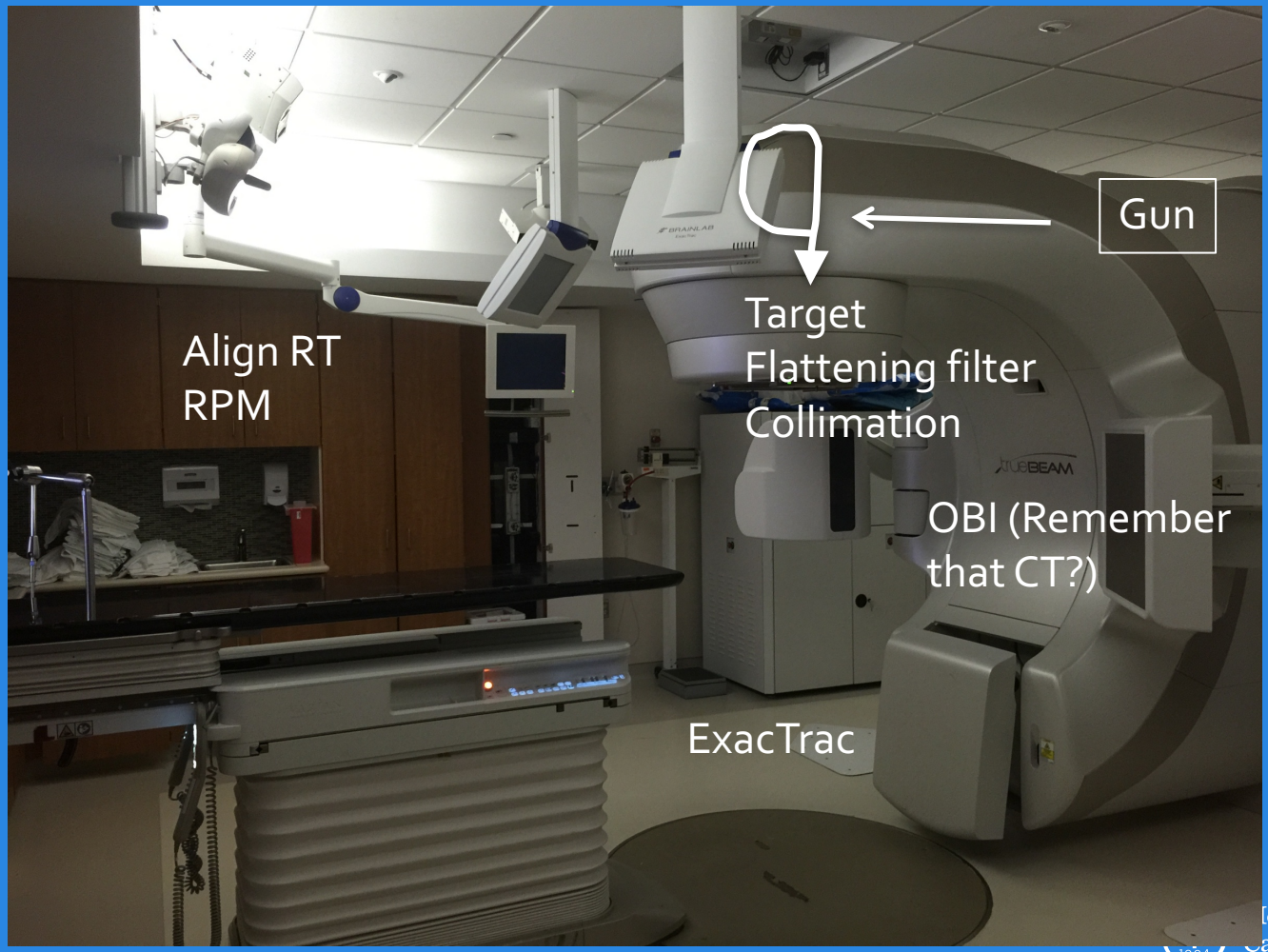
2000- Clinical training

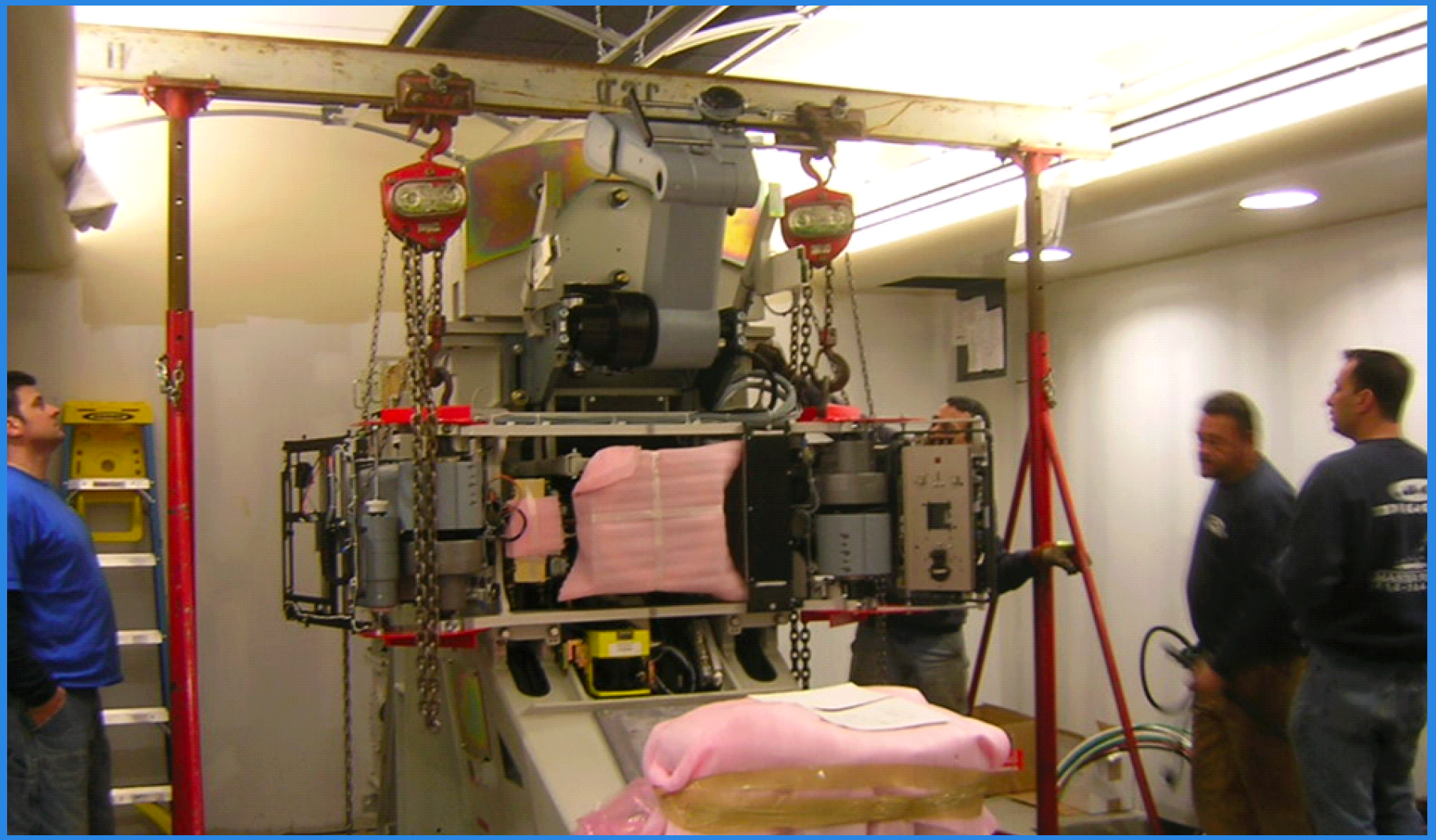
- Most medical physics careers have a clinical component
- Required to safely practice clinical medical physics, also required for licensure and certification
- Rotations
  - Radiation safety
  - Dosimetry/calibration
  - Treatment Planning
  - Brachytherapy

Calibration and dosimetry

Machine QA
Patient specific measurements

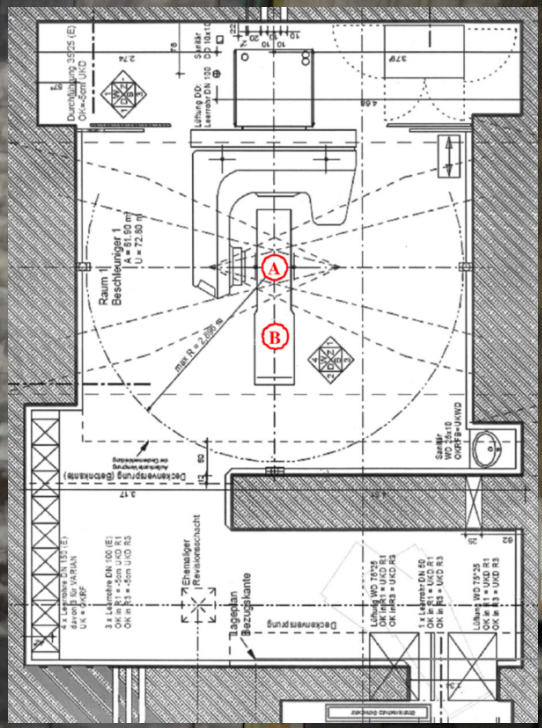


Linac Installation



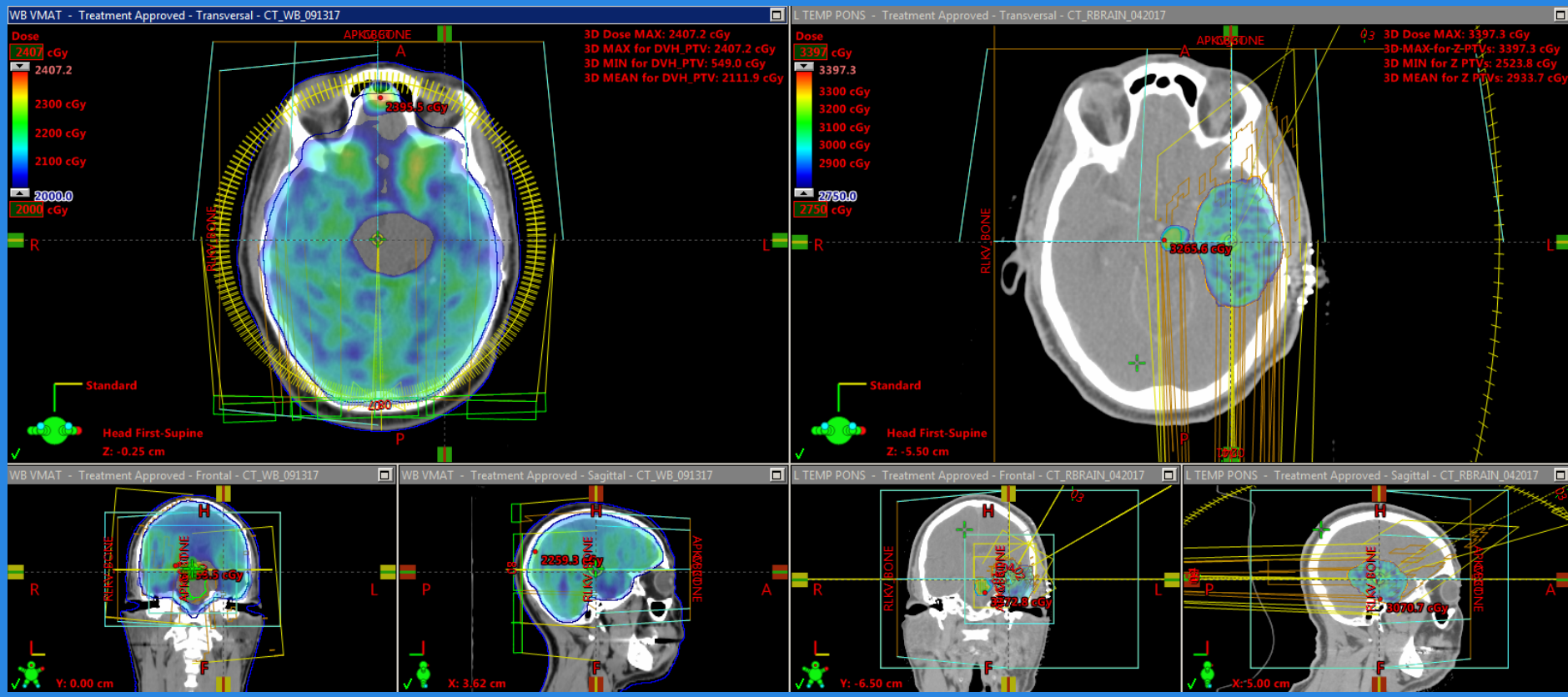
Radiation safety

Shielding design, room surveys, patient education…



Treatment Planning

Designing of treatment plans for external beam therapy
Analysis of previous treatment
CT, MR, PET imaging



Retreatment to the brain- rigidly fused previous treatment to compare irradiated areas

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Brachytherapy

Implantation of radioactive sources (HDR, LDR)

Radiation oncologist Michael Zelefsky delivers brachytherapy — the placement of radioactive seeds into the prostate gland — with the assistance of an intraoperative CT unit called the O-Arm, which gives real-time snapshots of the prostate.

https://www.mskcc.org/blog/treating-prostate-missile-delivery-high-dose-radiation

2001-today

- 2001- Joined MSKCC regional faculty in Dover-Denville, NJ
  - Full range of clinical work + research in organ motion and machine workload
- 2003- returned to Main Campus in Treatment Planning group as an Assistant Attending Physicist
  - Clinical Treatment Planning
  - Research in Head and Neck cancer, IGRT
- 2009- Became section head of Treatment Planning

2001 until today

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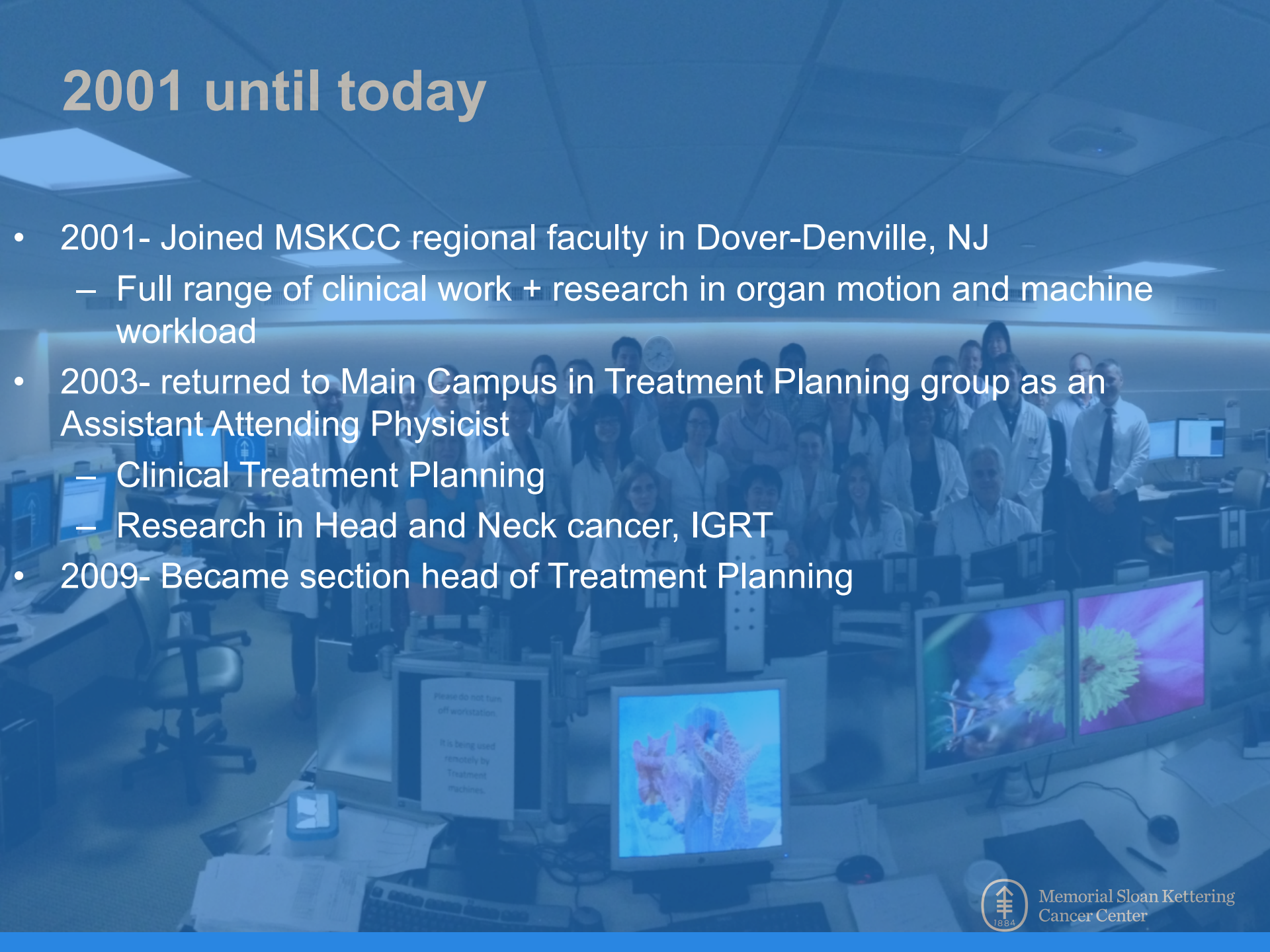
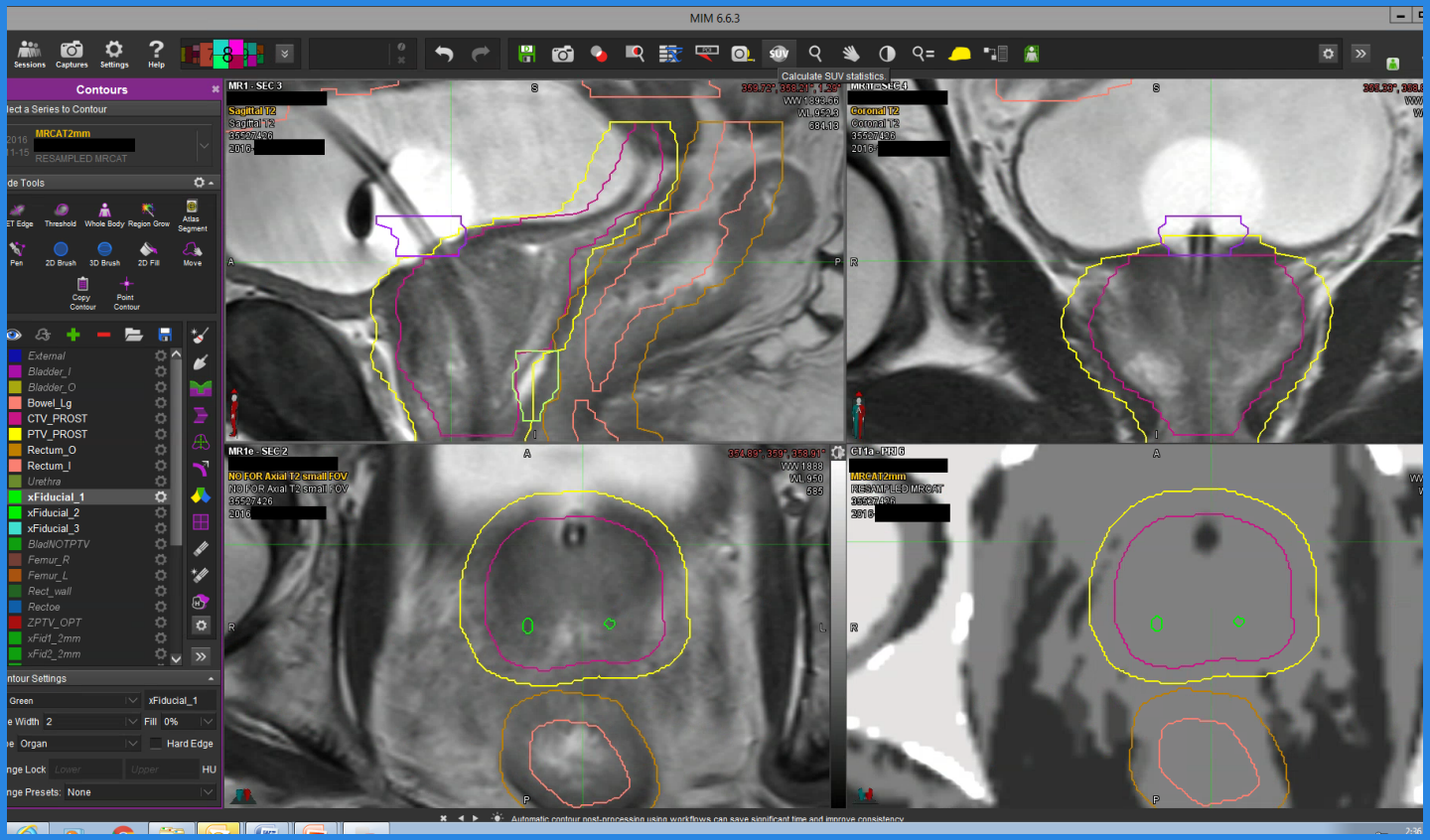


Research- Development – bringing new ideas into the clinic



Direct collaboration with MR physicists

Creation of pseudo-CT's from MR scans for dose calculations

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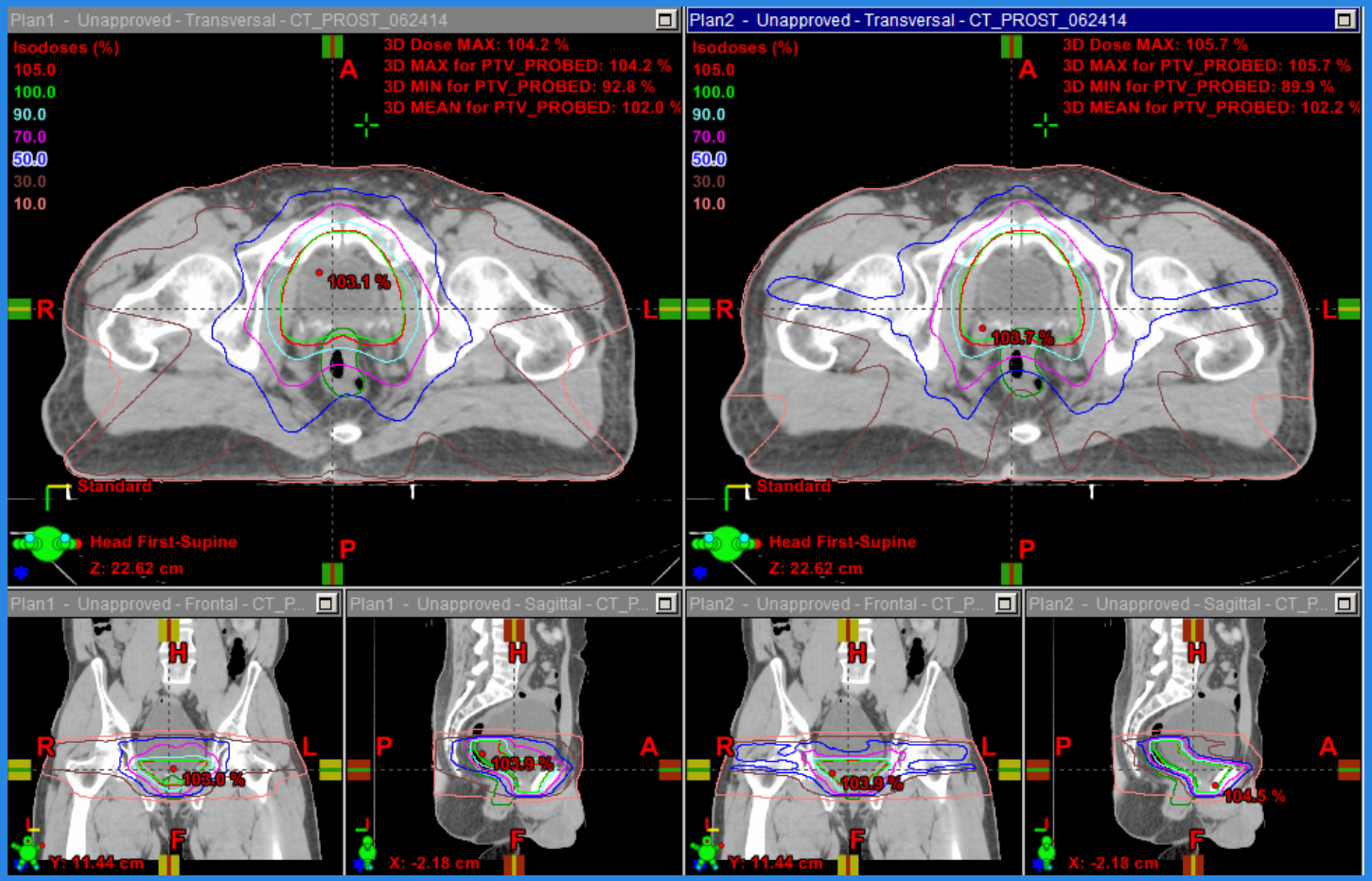
ECHO- Expedited Constrained Hierarchical Optimization

Planner's Plan

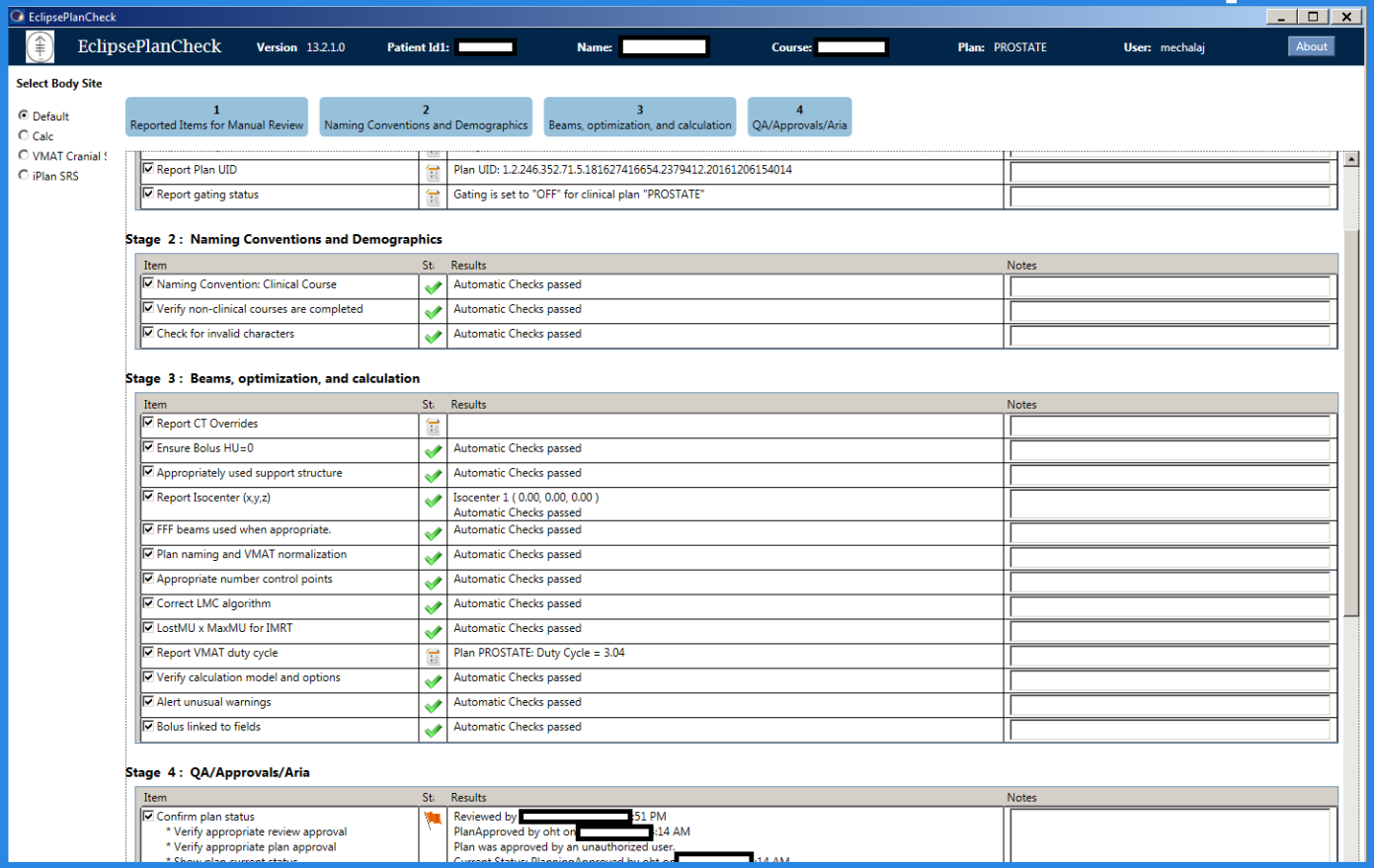
ECHO Plan



A form of automated treatment planning that delivers superior intensity modulated plans.

Courtesy L. Hong

Software development-
Automated Plan Check Tool- scripted QA



- Mundane tasks that can be done by a computer are scripted.
- Ensures robust QA
- Allows for a higher level review of the plan

Courtesy S. Berry

Sim → Contour → Optimize → QA → Treat

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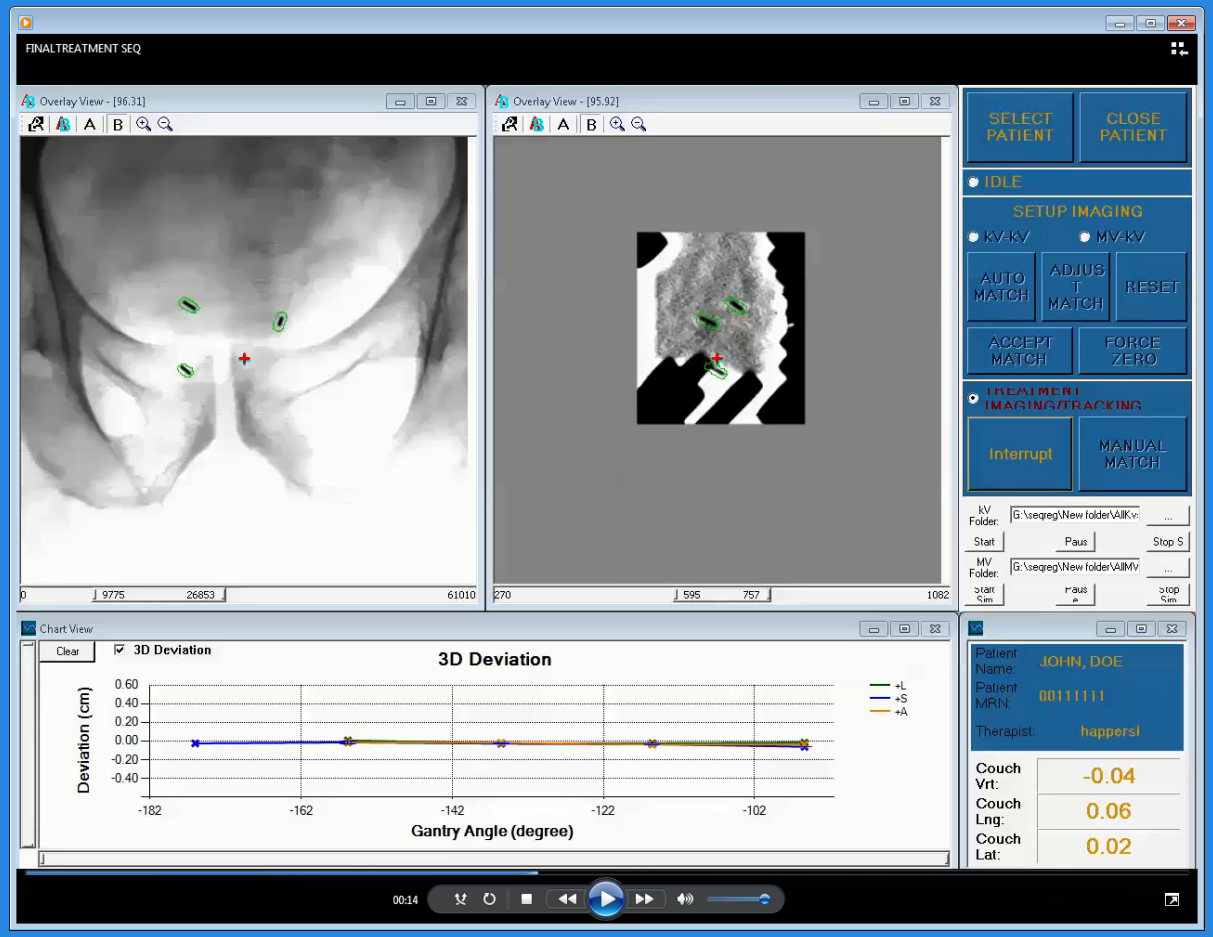
MV/kV imaging

Simultaneous MV and kV imaging during treatment with real time marker detection and shift determination



Courtesy L. Happersett

Sim → Contour → Optimize → QA → Treat

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Professional pathway in clinical medical physics

- CAMPEP accredited medical physics degree or certificate
- CAMPEP accredited residency
  - 2 years of clinical rotations
  - PhD's can do 2+2 (2 research/2 clinical)
- ABR certification
  - Part 1- general
  - Part 2- clinical medical physics
  - Part 3- oral exam
- Licensure

DEPARTMENT OF MEDICAL PHYSICS

Residents

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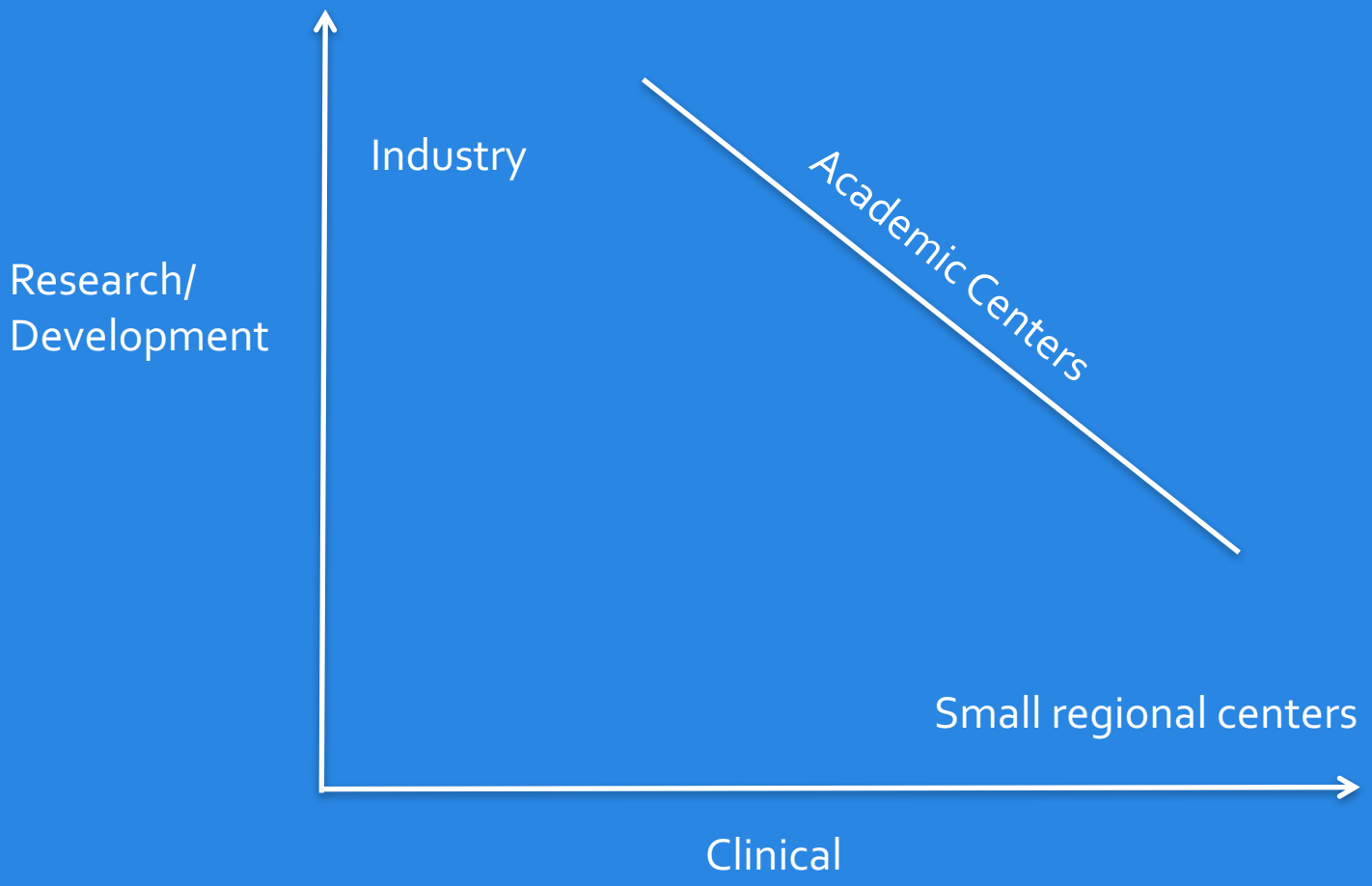
Types of careers



Panel on Medical Physics at Yale

Ross Boltyanskiy

2017.09.20

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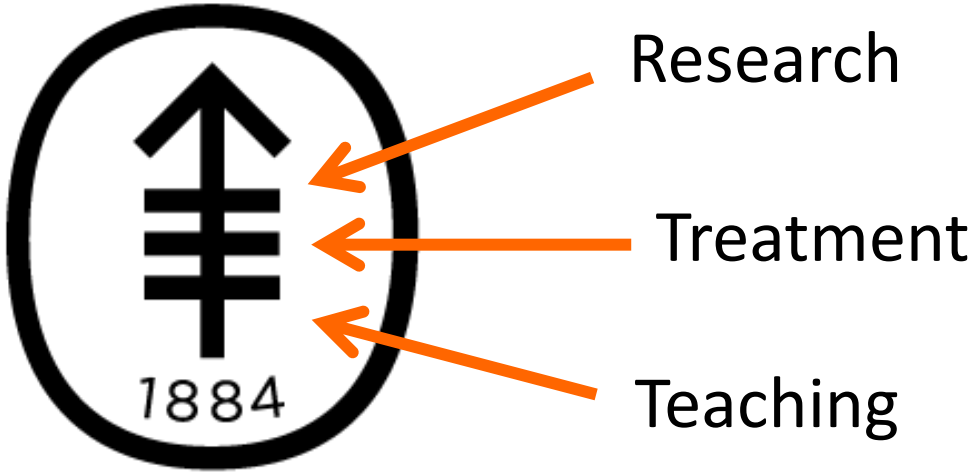

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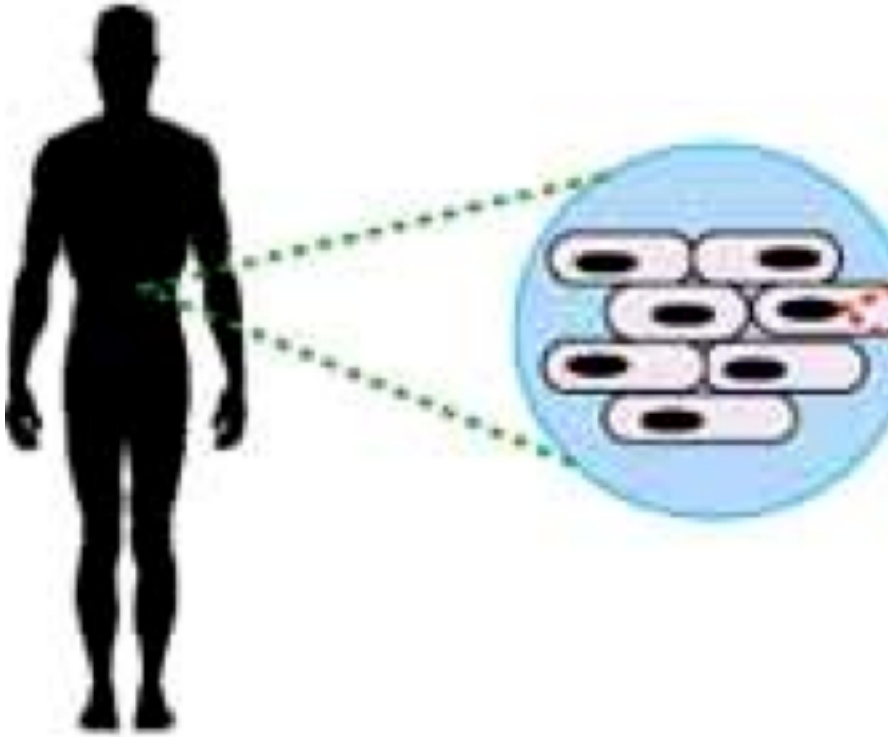
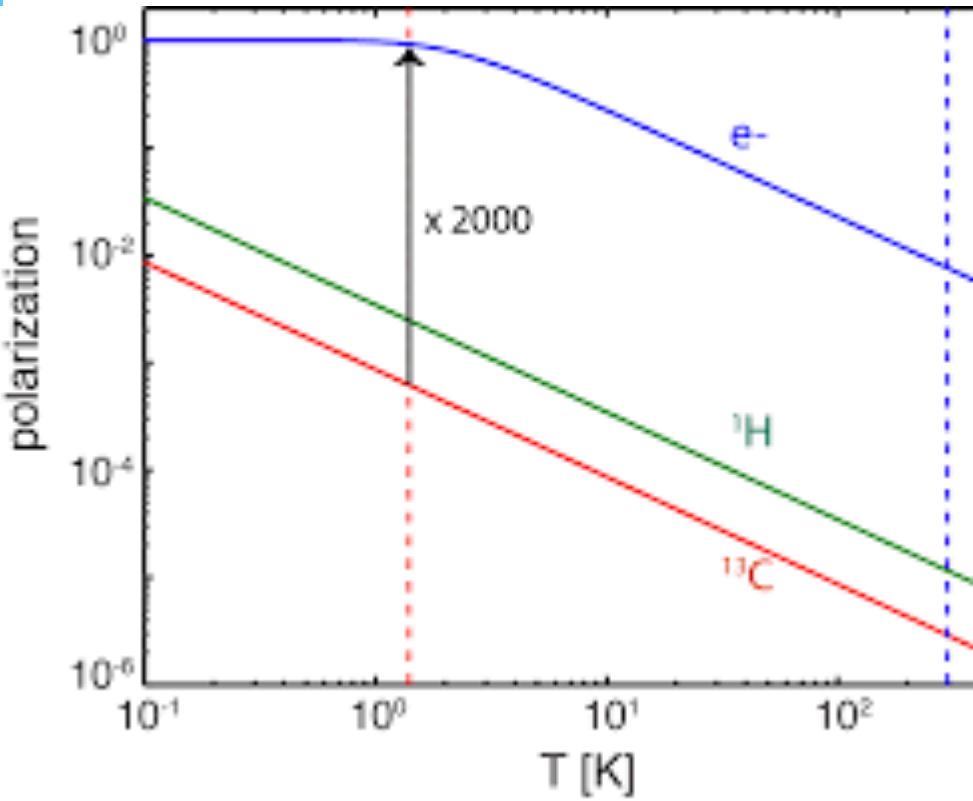
What am I doing at MSK?

Advancing MRI technology towards better diagnostic accuracy and higher resolution



Identifying high grade tumors based on metabolic activity

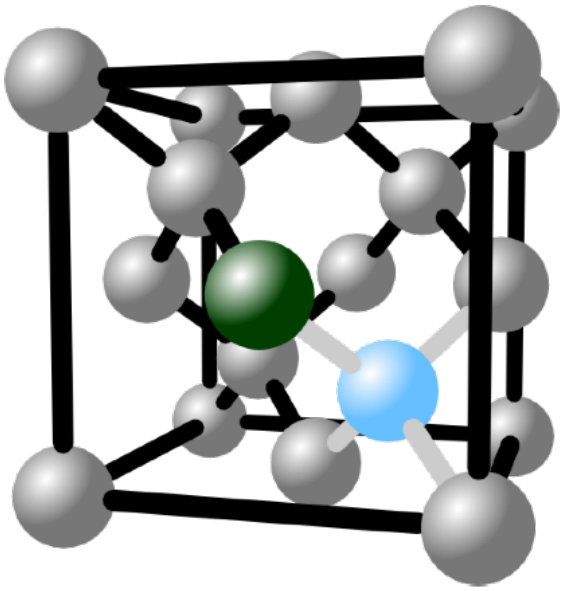
Hyperpolarized pyruvate and lactate imaging in the human brain



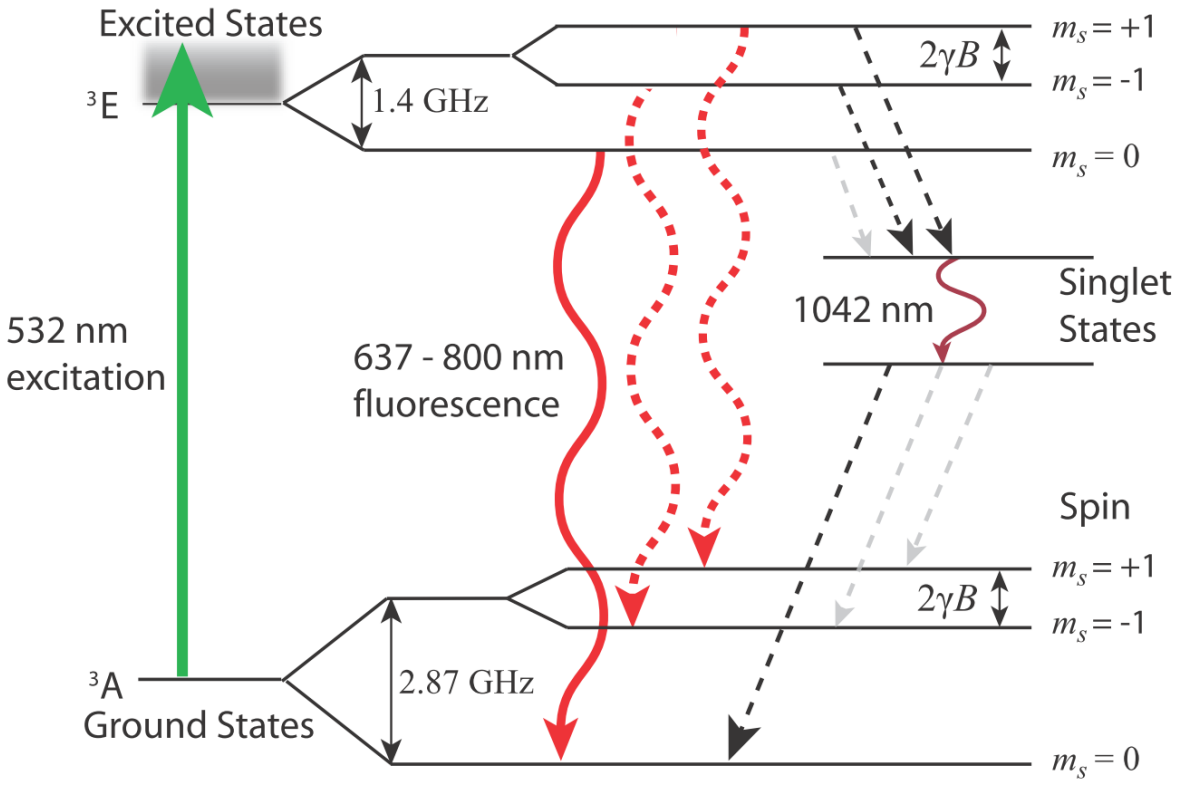
Developing technology for ultra sensitive magnetic detection

Convenient quantum optical properties

Defect in a diamond



Kay Daniel Jahnke, Dissertation, 2012



Rainer Siegfried Pfeiffer, Dissertation, 2012

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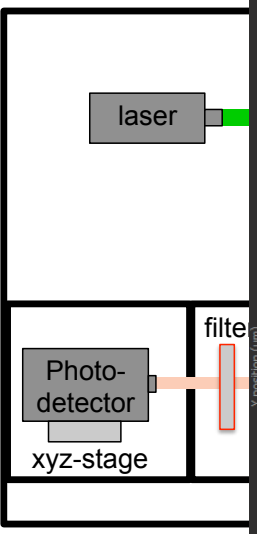
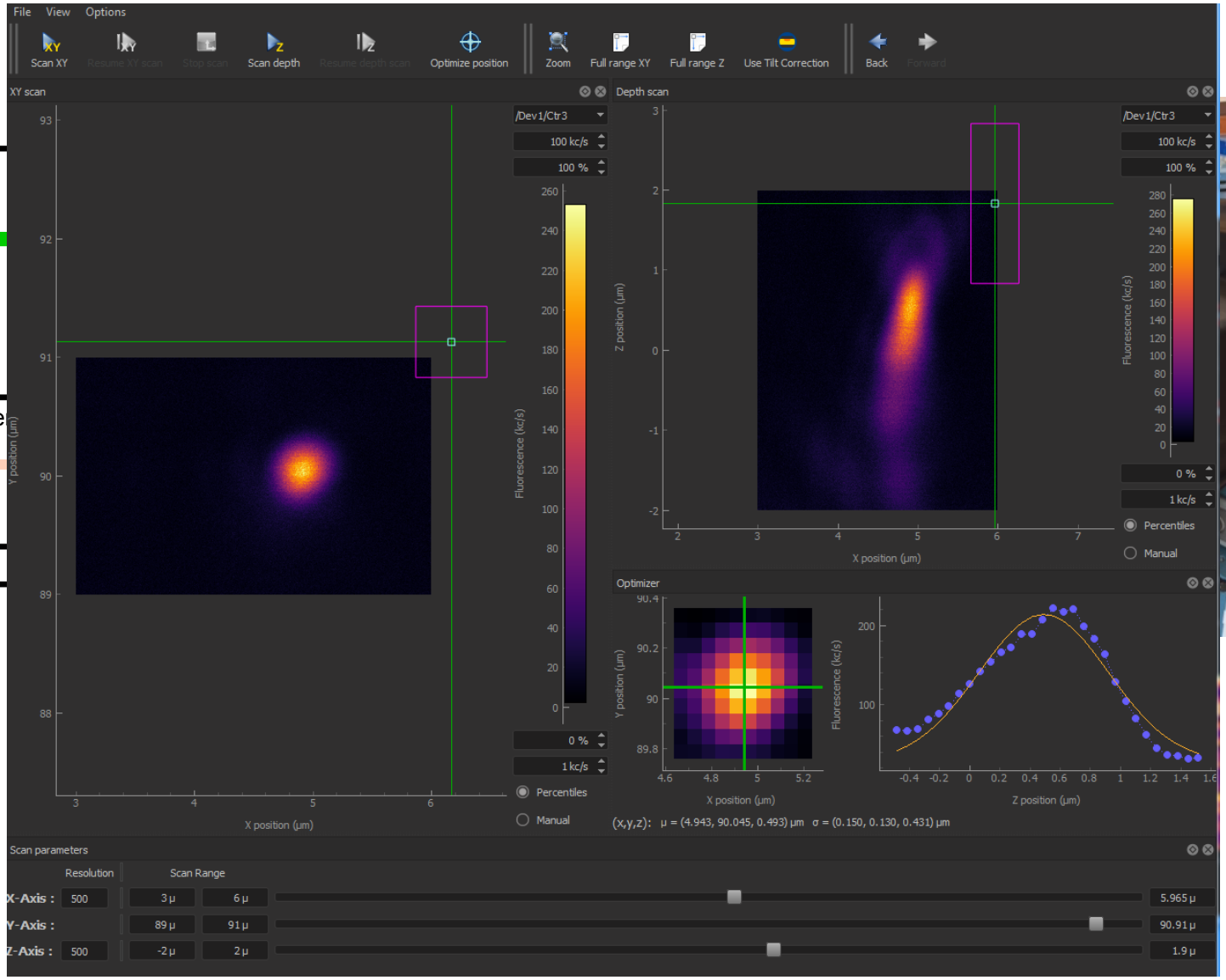
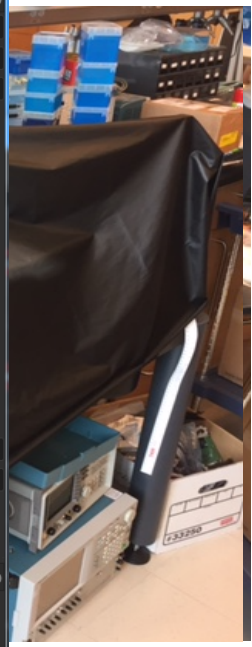




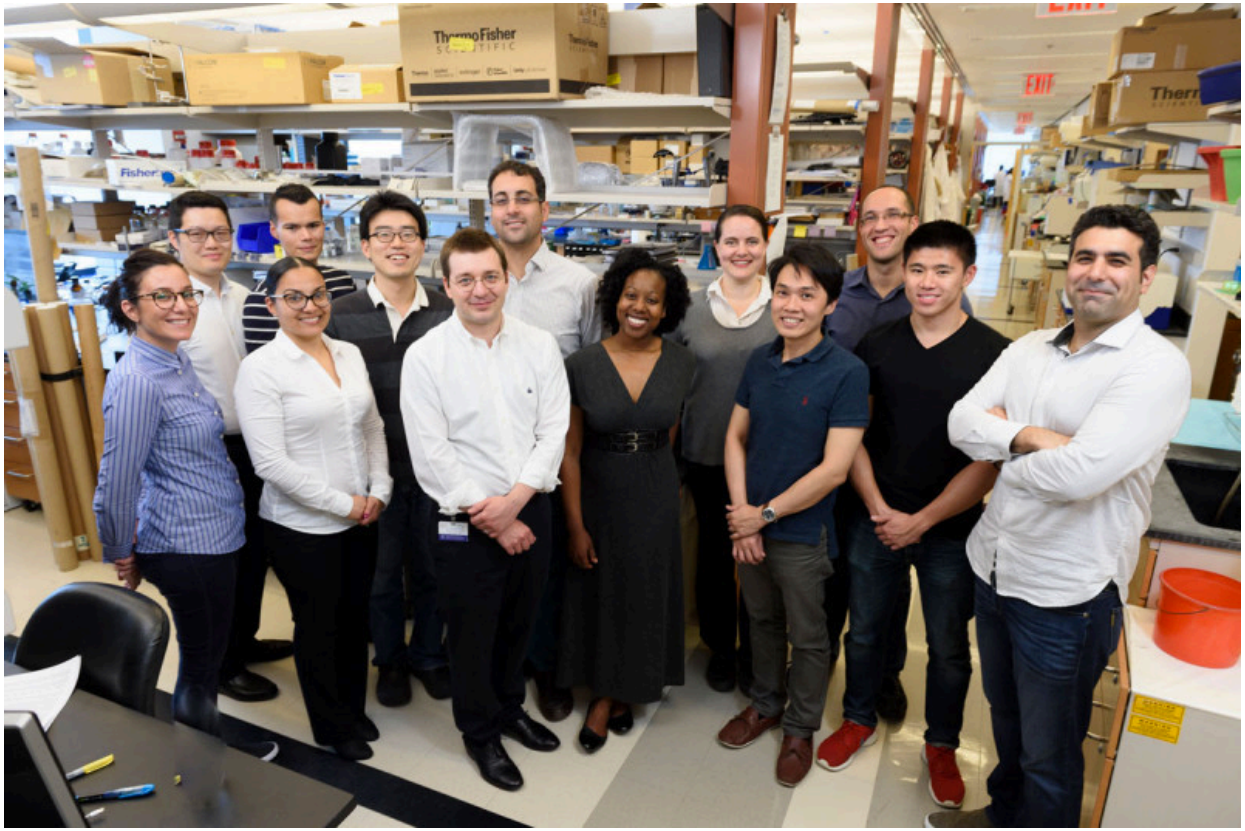


Benefits & challenges of working at MSK and transitioning to a new (biomedical) field

Challenges	Benefits
(1) For physicists and engineers the resources are more limited.	(1) Amazing resources aligned with the agenda of the institute
(2) Talks, conversations, collaborations more narrowly focused.	(2) Postdoc / Research staff time is valued tremendously
(3) Could be difficult to “break into” a new scientific community.	(3) Flexibility is similar to academia at least on the postdoc level
	(4) Incredible opportunities to expand knowledge base

Questions and Following up

Ross Boltyanskiy
rossbolt@gmail.com



Thank you!