



Current and Future Research in Radiation Oncology

Heiko Enderling, PhD, FSMB

Senior Member

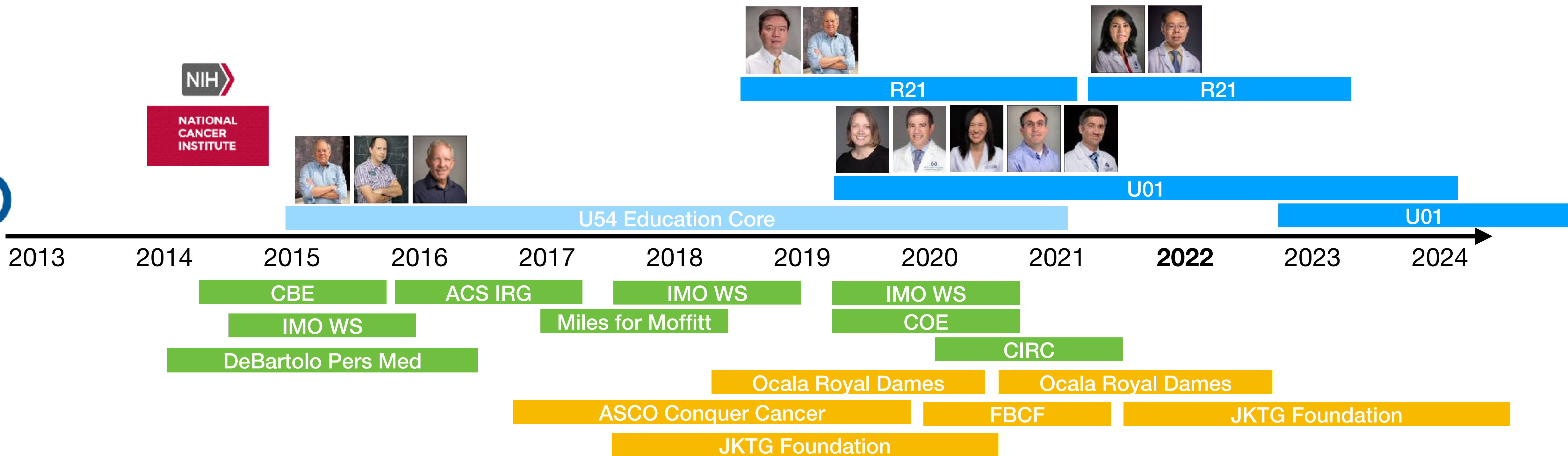
Department of Integrated Mathematical Oncology
Department of Radiation Oncology

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Tampa, FL USA

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 @HeikoEnderling







Quantitative Personalized Oncology



Mission: To integrate data-driven predictive modeling into oncology decision making



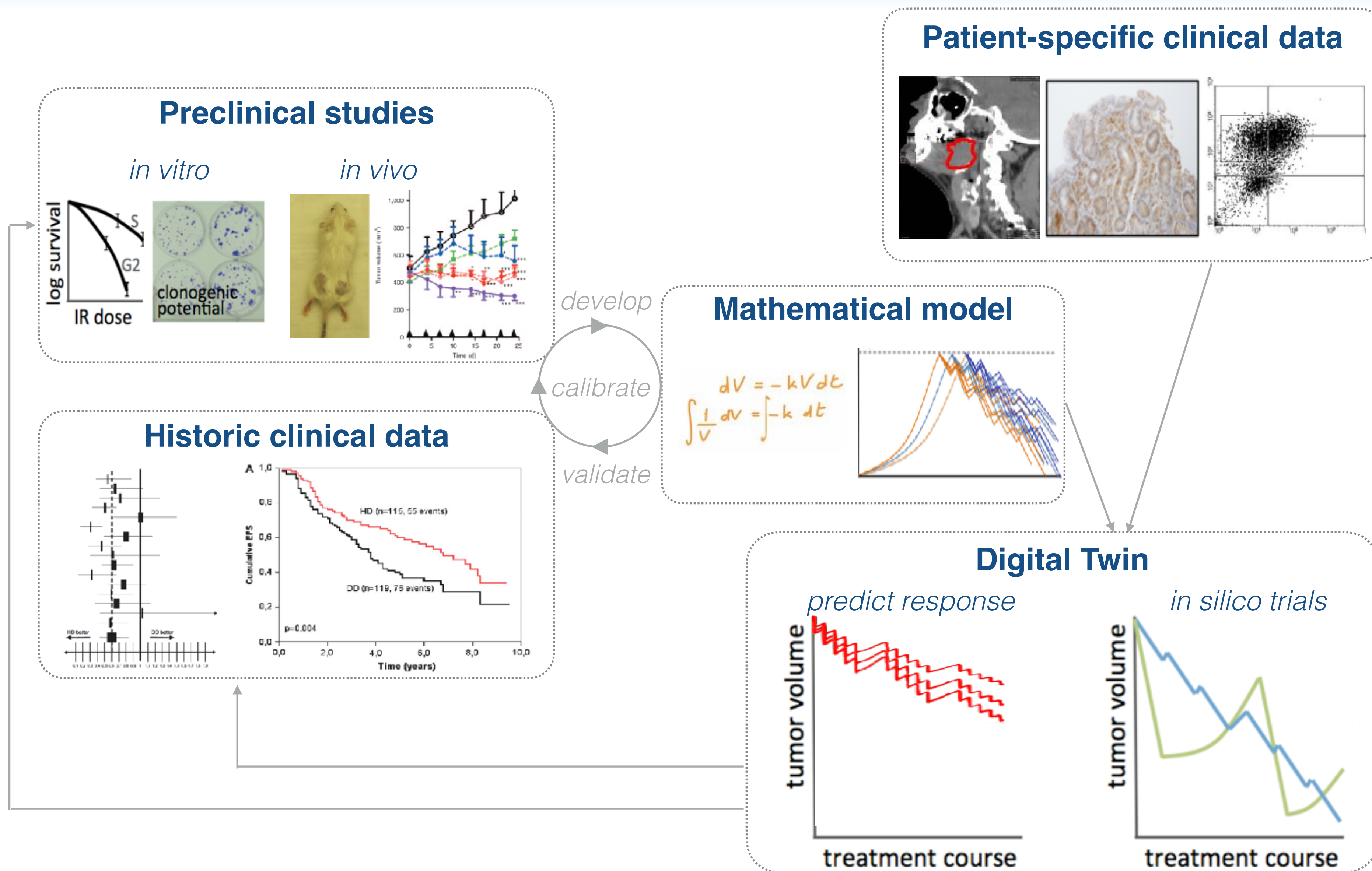
Vision: Optimal adaptive cancer therapy for each patient



Strategy:

- understand clinical needs
- foster synergistic collaborations
- build calibrated and validated predictive models that provide
 - *dynamic biomarkers of tumor growth dynamics and treatment response* and
 - *actionable triggers for treatment personalization*

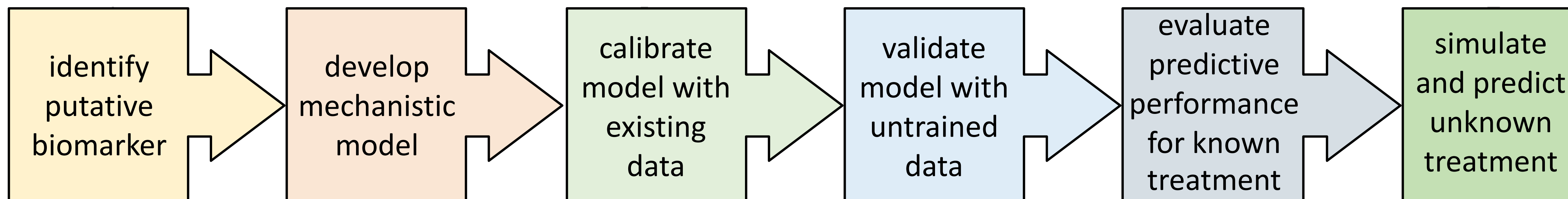
Quantitative Personalized Oncology



Predictive modeling standard



Dr. Renee
Brady-Nicholls
*now Asst. Prof.
@ Moffitt*



Bulletin of Mathematical Biology (2019) 81:3722–3731
<https://doi.org/10.1007/s11538-019-00640-x>



ON THE PROFESSION



Mathematical Models of Cancer: When to Predict Novel Therapies, and When Not to

Renee Brady¹ · Heiko Enderling¹ 



Data-Driven Predictive Modeling for Personalized Oncology

Trends in Cancer

CellPress
REVIEWS

Opinion

Integrating Mathematical Modeling into the Roadmap for Personalized Adaptive Radiation Therapy

Heiko Enderling,^{1,2,*} Juan Carlos López Alfonso,³ Eduardo Moros,² Jimmy J. Caudell,² and Louis B. Harrison²

Head and neck cancer 2

The future of personalised radiotherapy for head and neck cancer

Jimmy J Caudell, Javier F Torres-Roca, Robert J Gillies, Heiko Enderling, Sungjune Kim, Anupam Rishi, Eduardo G Moros, Louis B Harrison

THE LANCET
Oncology



Available online at www.sciencedirect.com

ScienceDirect

Physics of Life Reviews 40 (2022) 60–62

Comment

Mathematical oncology: A new frontier in cancer biology and clinical decision making

PHYSICS of LIFE
reviews

www.elsevier.com/locate/plrev

JCO® Clinical Cancer Informatics
An American Society of Clinical Oncology Journal

DECISION MAKING

Bayesian Framework to Augment Tumor Board Decision Making

Stefano Pasetto, PhD¹; Robert A. Gatenby, MD^{1,2}; and Heiko Enderling, PhD^{1,3}

cancers

Article

Predicting Patient-Specific Tumor Dynamics: How Many Measurements Are Necessary?

Isha Harshe^{1,2}, Heiko Enderling^{1,3,4} and Renee Brady-Nicholls^{1,*}

Radiation Research

Predictive Radiation Oncology – A New NCI–DOE Scientific Space and Community

Jeffrey C. Buchsbaum,^{a,1} David A. Jaffray,^b Demba Ba,^c Lynn L. Borkon,^d Christine Chalk,^e Caroline Chung,^b Matthew A. Coleman,^f C. Norman Coleman,^g Maximilian Diehn,^h Kelvin K. Droegemeier,^a Heiko Enderling,ⁱ Michael G. Espey,^a Emily J. Greenspan,^a Christopher M. Hartshorn,^a Thuc Hoang,^j H. Timothy Hsiao,^k Cynthia Keppel,^l Nathan W. Moore,^a Fred Prior,^a Eric A. Stahlberg,^d Georgia Tourassis^h and Karen E. Willcox^a

THE LAST WORD

JNCCN

NCCN
National Comprehensive Cancer Network

OFFICIAL JOURNAL OF THE NATIONAL COMPREHENSIVE CANCER NETWORK

Reimagining Cancer Staging in the Era of Evolutionary Oncology

Kedar S. Kirtane, MD^{1,*}; Mohammed U. Zahid, PhD^{2,*}; Heiko Enderling, PhD²; and Louis B. Harrison, MD³

Bulletin of Mathematical Biology (2019) 81:3722–3731
<https://doi.org/10.1007/s11538-019-00640-x>

Society for Mathematical Biology

ON THE PROFESSION

Mathematical Models of Cancer: When to Predict Novel Therapies, and When Not to

Renee Brady¹ · Heiko Enderling¹



Trends in Cancer CellPress

Science & Society

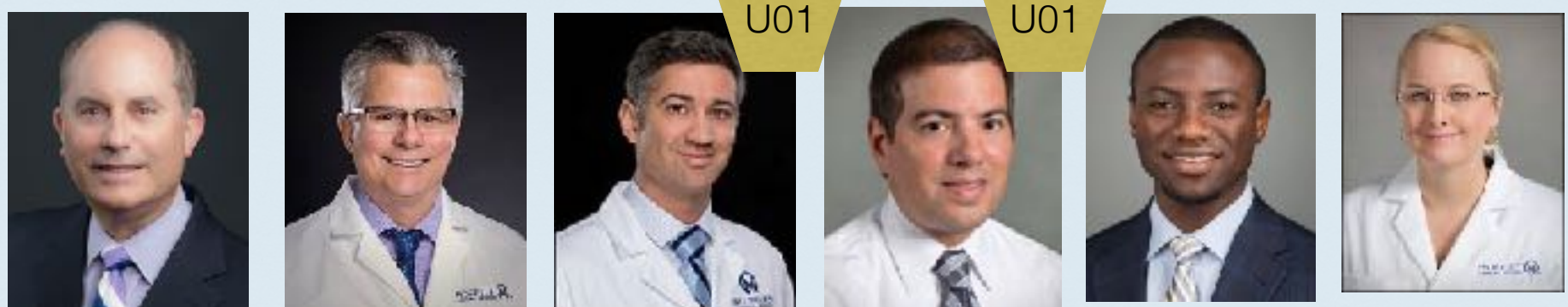
Education and Outreach in Physical Sciences in Oncology

Sierra A. Walker,^{1,2,3,20}
Anthony Pham,^{1,2,3,20}
Sara Nizzero,⁴ Mingee Kim,⁴
Bob Riter,⁵ Julie Bletz,⁶
Sheila Judge,⁷ Benette Phillips,⁸
Dorottya Noble,^{9,10} Diana Murray,¹¹
Erin Wetzel,¹² Susan Samson,^{13,14}
Mariah McMahon,¹⁵ Carl Flink,¹⁵
Jennifer Couch,¹² Claire Tomlin,¹⁶
Kristin Swanson,¹⁷
Alexander R.A. Anderson,¹⁸
David Odde,¹⁵ Haifa Shen,¹⁹
Shannon Hughes,¹²
Nastaran Zahir,^{12,*}
Heiko Enderling,^{18,*} and
Joy Wolfram^{1,2,3,19,*}



10 years of multi-disciplinary collaborations

Radiation Oncology



Louis Harrison Eduardo Moros Jimmy Caudell Javier Torres-Roca Kosj Yamoah Sarah Hoffe



Daniel Grass Peter Johnstone Roberto Diaz Michael Montejo Michael Yu Jessica Frakes

Medical Oncology



Bob Gatenby Jingsong Zhang Solmaz Sahebjam Christine Chung Robert Slebos Aaron Muncey

Tumor Biology



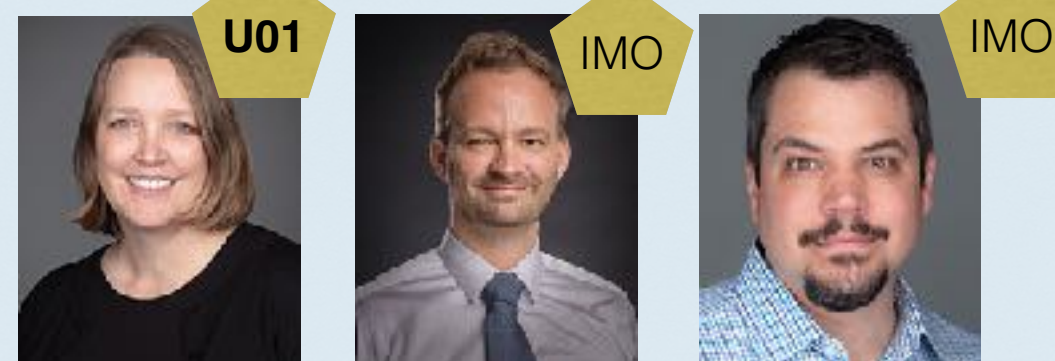
Srikumar Chellappan Conor Lynch Jennifer Binning

IMO



Sandy Anderson Joel Brown

Immunology



Shari Pilon-Thomas Daniel Abate-Data Adam Mailloux

Cancer Epidemiology



Anna Giuliano Travis Gerke Matt Schabath

HOB



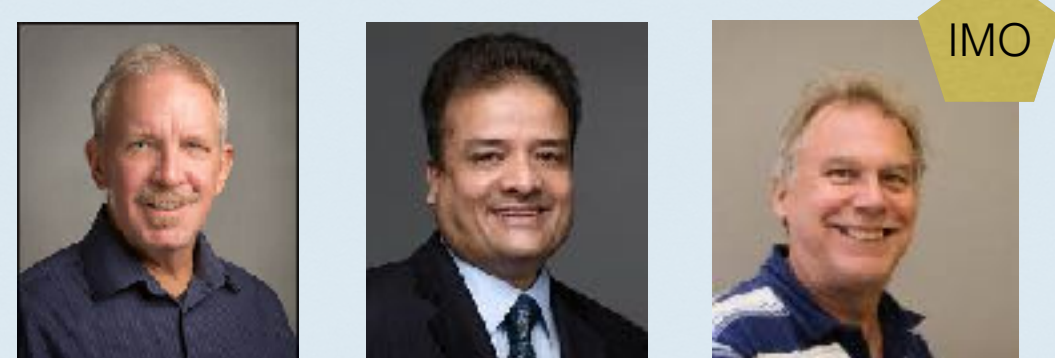
Heather Jim

Bio2



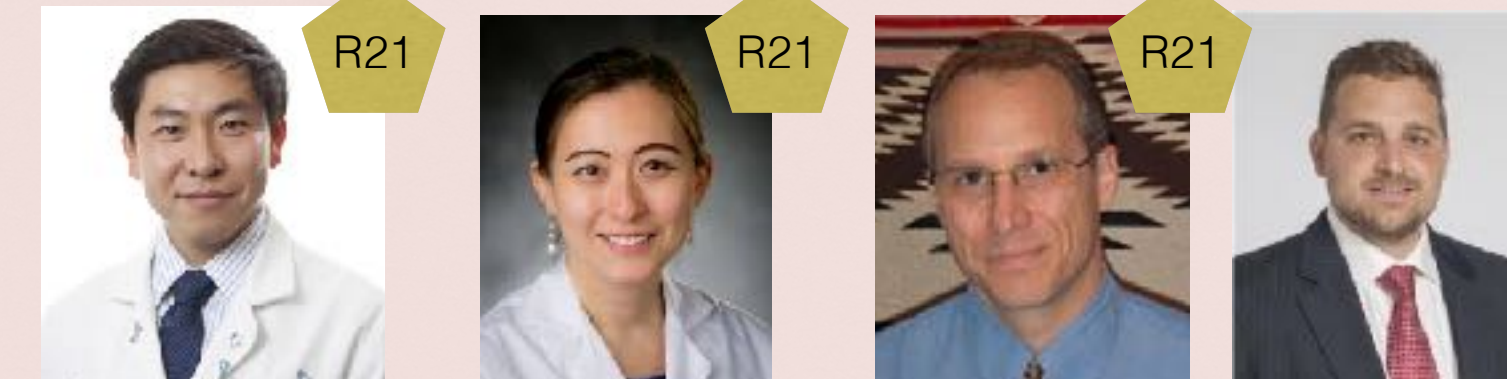
Steven Eschrich

Cancer Physiology



Bob Gillies Natarajan Raghunand Chris Whelan

US



Andrew Wang UNC Tian Zhang Duke John Nagy ASU Jacob Scott Cleveland Clinic



Dorothy Wallace Dartmouth Bryan Spring Northeastern David Goukassian Mount Sinai Dave Fuller MDACC

International



Juan Carlos L. Alfonso Braunschweig, Germany Sarah Barrett Trinity College Dublin Helen Byrne Oxford, UK

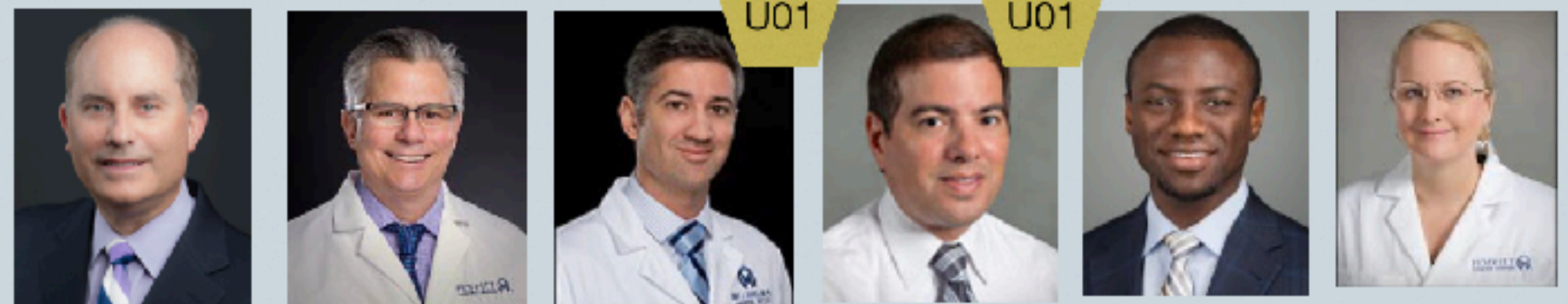


Philip Maini Oxford, UK Mohammad Kohandel Waterloo, Canada Noel Ahern NSW, Australia



10 years of multi-disciplinary collaborations

Radiation Oncology



Louis Harrison Eduardo Moros Jimmy Caudell Javier Torres-Roca Kosi Yamoah Sarah Hoffe



Daniel Grass Peter Johnstone Roberto Diaz Michael Montejó Michael Yu Jessica Frakes

- one prospective clinical trial (PSI)
- 36 publications with 11 different Moffitt RadOnc faculty
- 3 active grants (4 different Moffitt RadOnc faculty)
- 6 completed grants (5 different Moffitt RadOnc faculty)
- 1 awarded patent
- 3 provisional patents

RadOnc Moffitt co-authors:

Eduardo Moros – 15
Jimmy Caudell – 11
Lou Harrison – 10
Sungjune Kim – 5
Michael Yu – 4
Javier Torres Roca – 3
Kujtim Latifi – 3
Anupan Rishi – 2
Peter Johnstone – 2
Daniel Grass – 2
Steven Rosenberg – 1



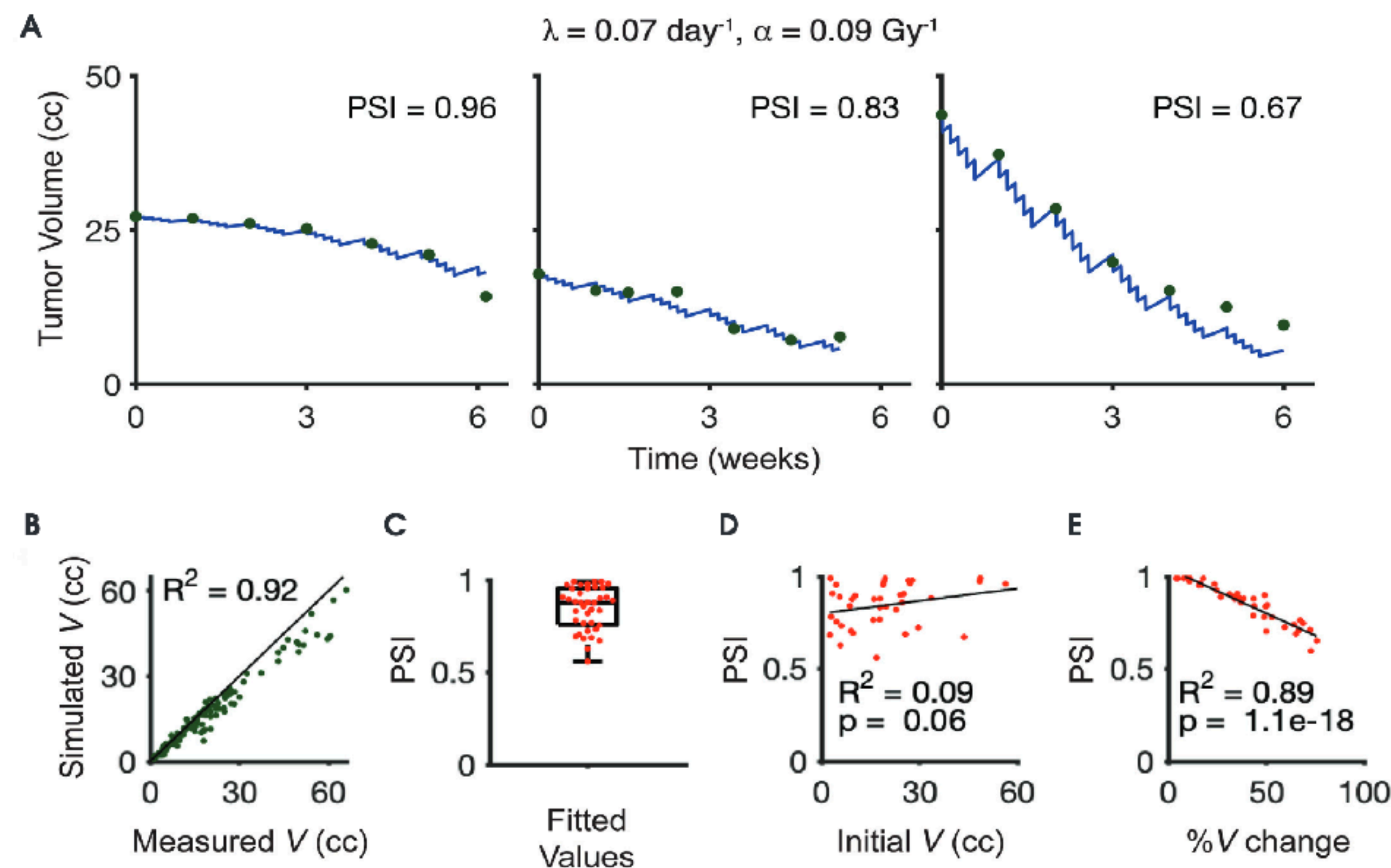
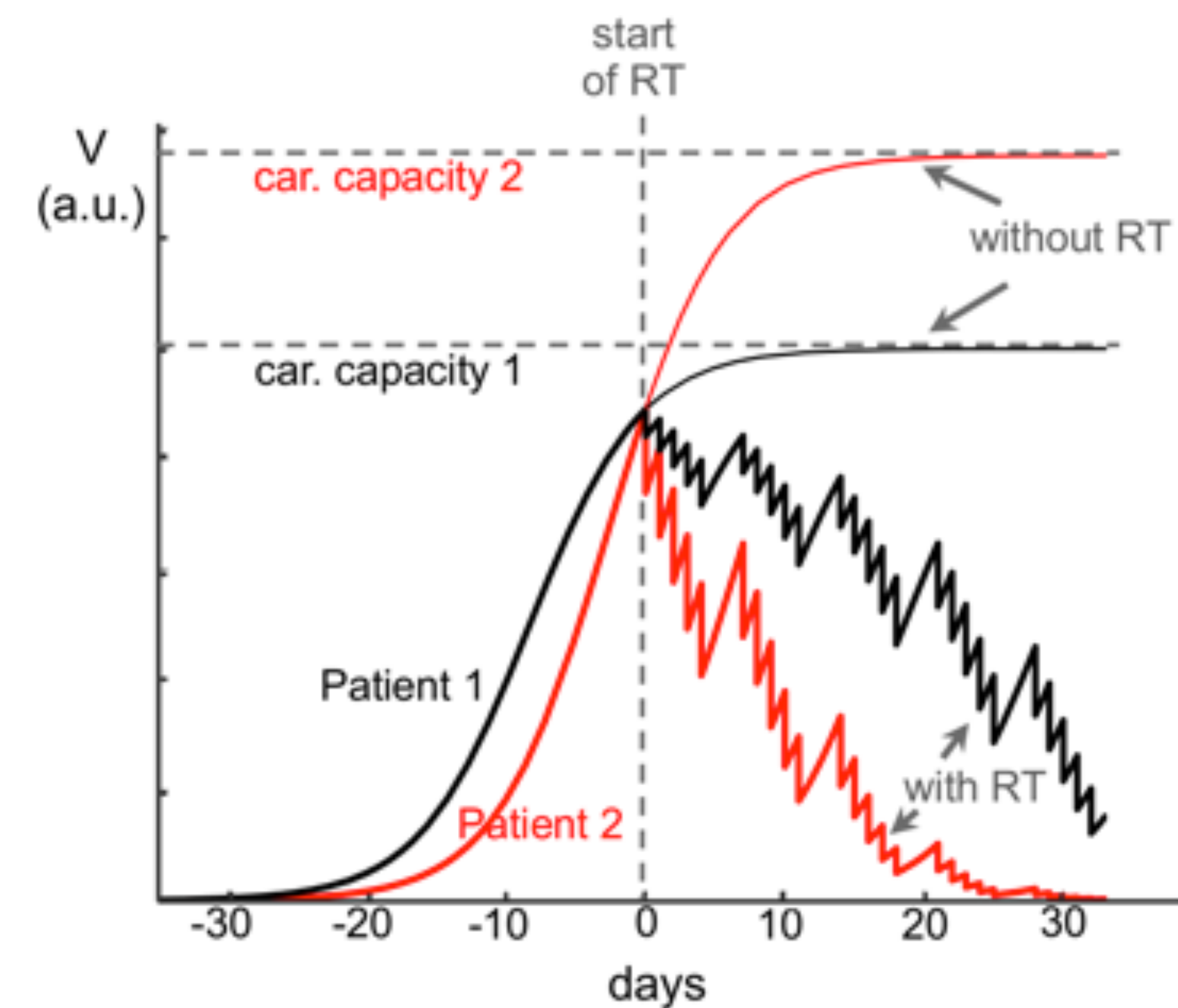
Predictive modeling to personalize radiotherapy

Proliferation Saturation Index (PSI) to personalize radiotherapy



Dr. Sotiris
Prokopiou

Dr. Mohammad
Zahid



$$\frac{dV}{dt} = \lambda V (1 - \text{PSI})$$

$$V_{\text{post-RT}} = V_{\text{pre-RT}} [1 - S(d)] (1 - \text{PSI})$$



Dr. Jimmy
Caudell



Dr. C. Dave
Fuller

Prokopiou et al. *Radiation Oncology* (2015) 10:159
DOI 10.1186/s13014-015-0465-x



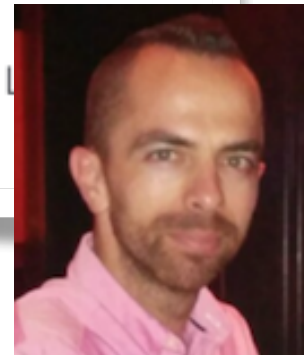
RESEARCH

Open Access



A proliferation saturation index to predict radiation response and personalize radiotherapy fractionation

Sotiris Prokopiou¹, Eduardo G. Moros^{2,3}, Jan Poleszczuk¹, Jimmy Caudell², Javier F. Torres-Roca², Kujtim Latifi², Jae K. Lee⁴, Robert Myerson⁵, Louis B. Harrison² and Heiko Enderling^{1*}



Bull Math Biol (2018) 80:1195–1206
<https://doi.org/10.1007/s11538-017-0279-0>



SPECIAL ISSUE : MATHEMATICAL ONCOLOGY

Predicting Patient-Specific Radiotherapy Protocols Based on Mathematical Model Choice for Proliferation Saturation Index

Jan Poleszczuk^{1,3} · Rachel Walker¹ · Eduardo G. Moros² · Kujtim Latifi² · Jimmy J. Caudell² · Heiko Enderling^{1,2} 



INTERNATIONAL JOURNAL OF RADIATION BIOLOGY
<https://doi.org/10.1080/09553002.2019.1589013>

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

 OPEN ACCESS  Check for updates

Proliferation saturation index in an adaptive Bayesian approach to predict patient-specific radiotherapy responses

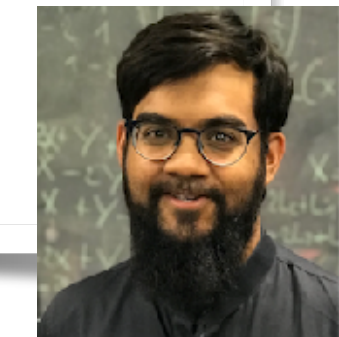
Enakshi D. Sunassee^a, Dean Tan^a, Nathan Ji^a, Renee Brady^a, Eduardo G. Moros^{b,c}, Jimmy J. Caudell^b, Slav Yartsev^d, and Heiko Enderling^{a,b}



APPLIED RADIATION ONCOLOGY

Proliferation Saturation Index to Characterize Response to Radiation Therapy and Evaluate Altered Fractionation in Head and Neck Cancer

Mohammad U. Zahid, PhD; Abdallah S.R. Mohamed, MD; Kujtim Latifi, PhD; Anupam Rishi, MD; Louis B. Harrison, MD; Clifton D. Fuller, MD, PhD; Eduardo G. Moros, PhD; Jimmy J. Caudell, MD, PhD; Heiko Enderling, PhD

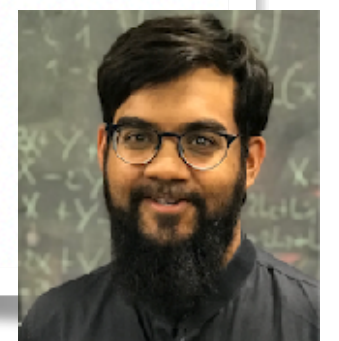


Physics Contribution

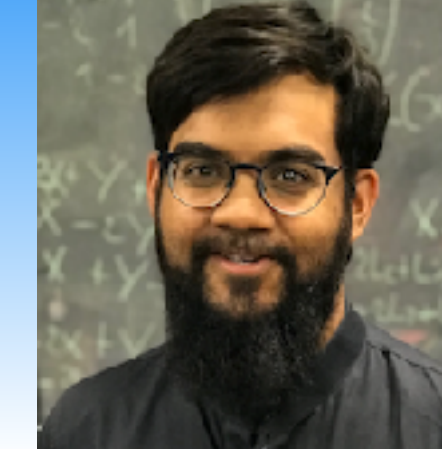
Forecasting Individual Patient Response to Radiation Therapy in Head and Neck Cancer With a Dynamic Carrying Capacity Model

Mohammad U. Zahid, PhD, * Nuverah Mohsin, BS, *, †
Abdallah S.R. Mohamed, MD, ‡ Jimmy J. Caudell, MD, PhD, §
Louis B. Harrison, MD, § Clifton D. Fuller, MD, PhD, †
Eduardo G. Moros, PhD, § and Heiko Enderling, PhD *, §

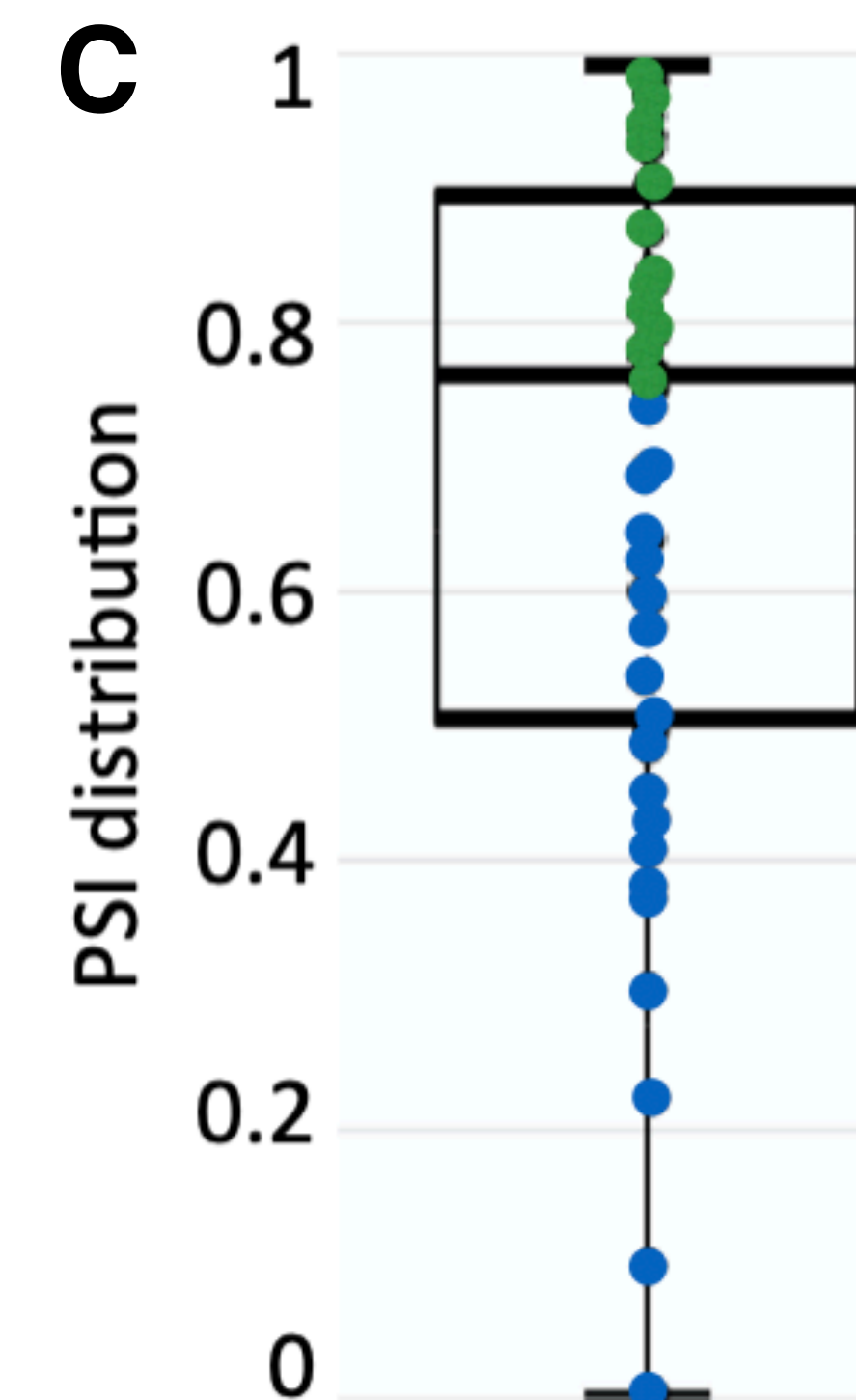
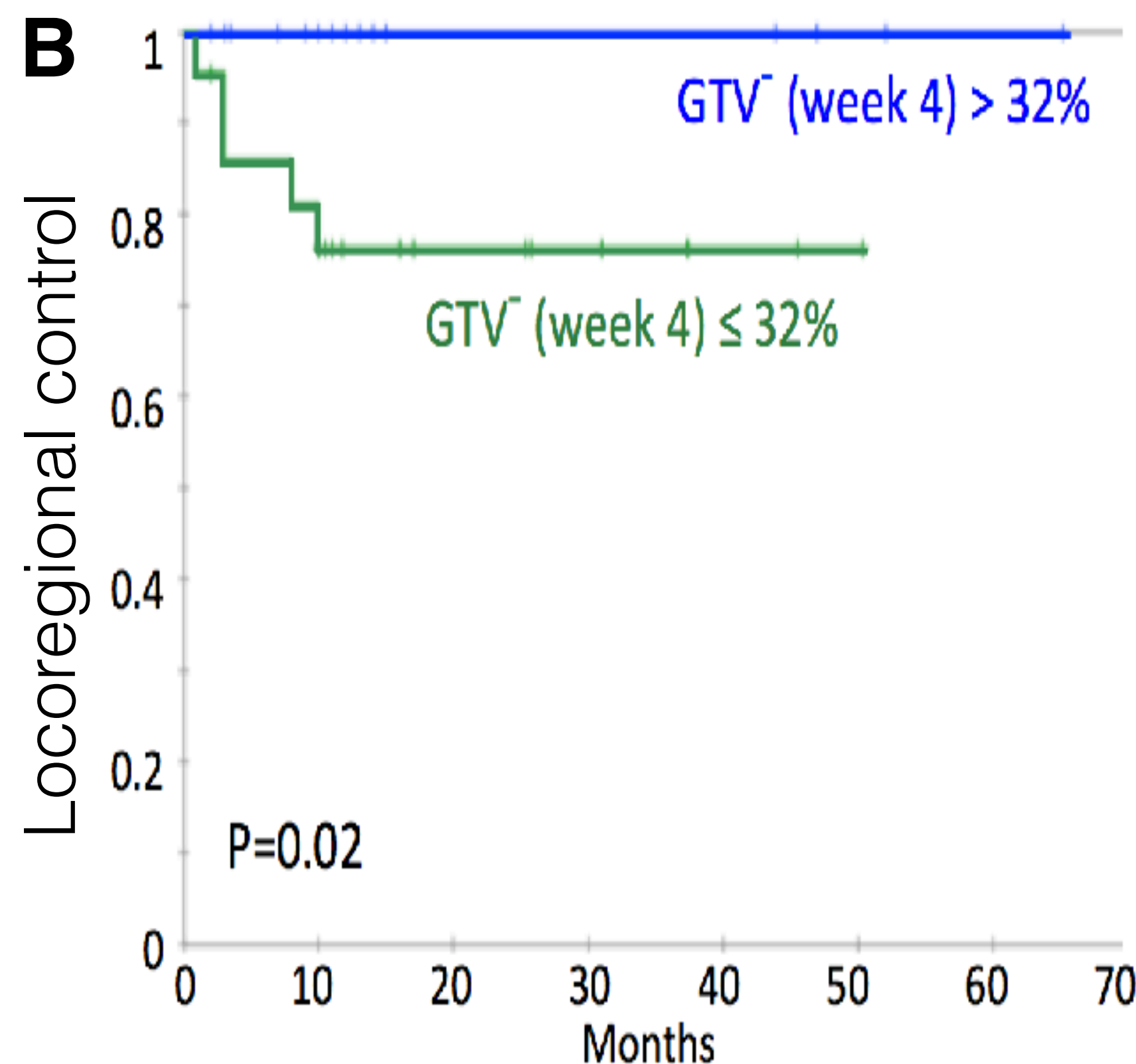
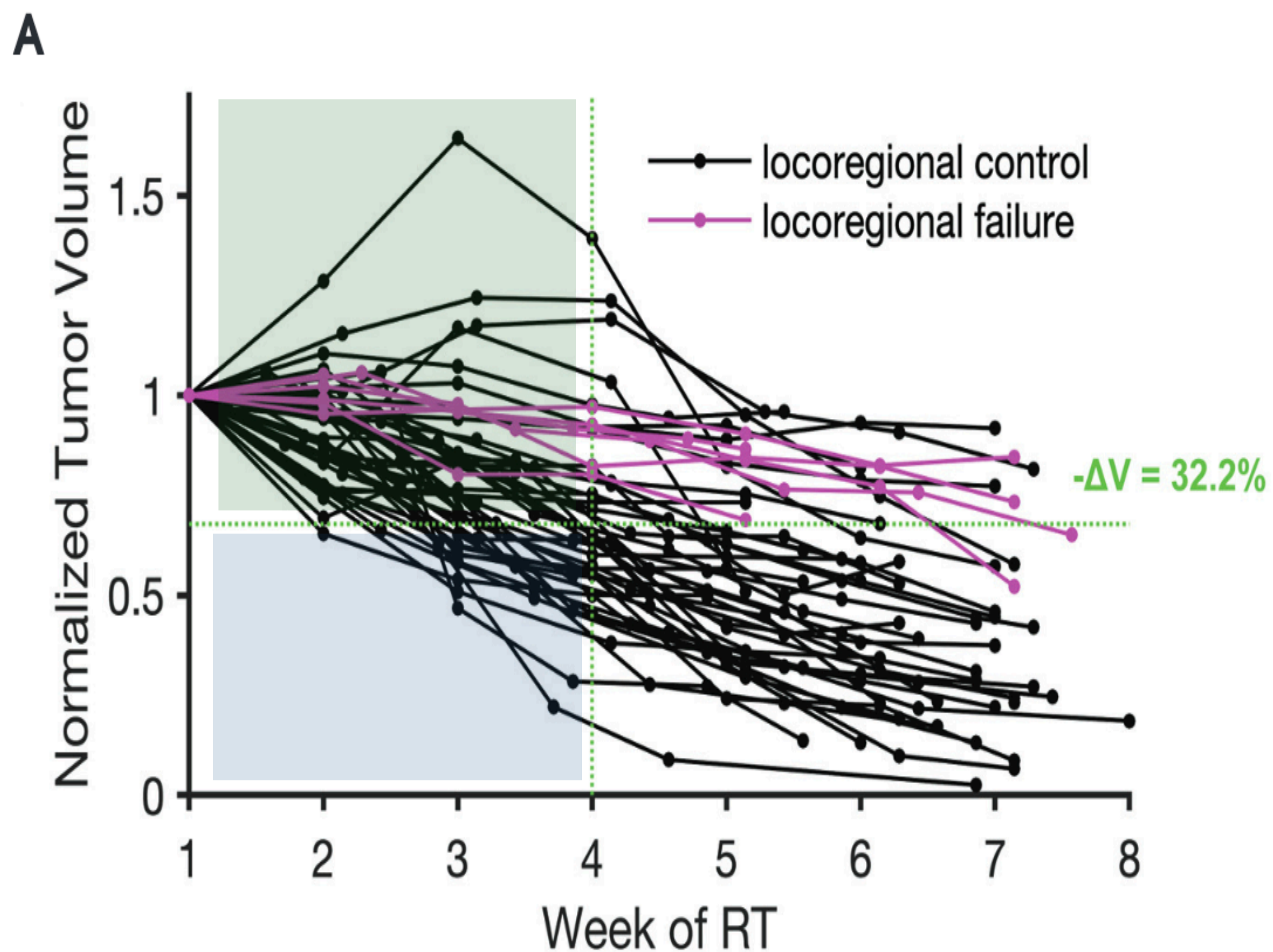
International Journal of
Radiation Oncology
biology • physics
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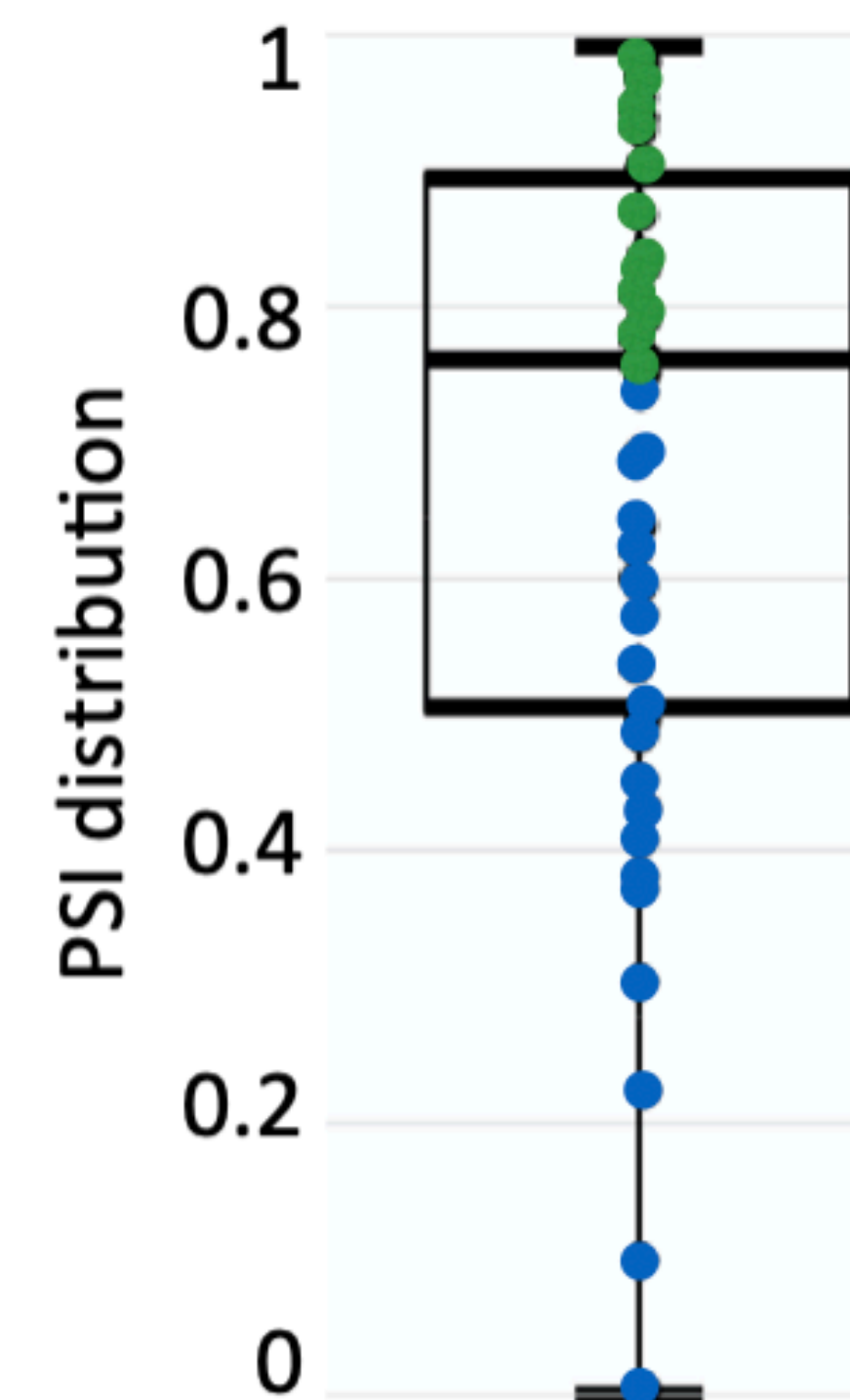
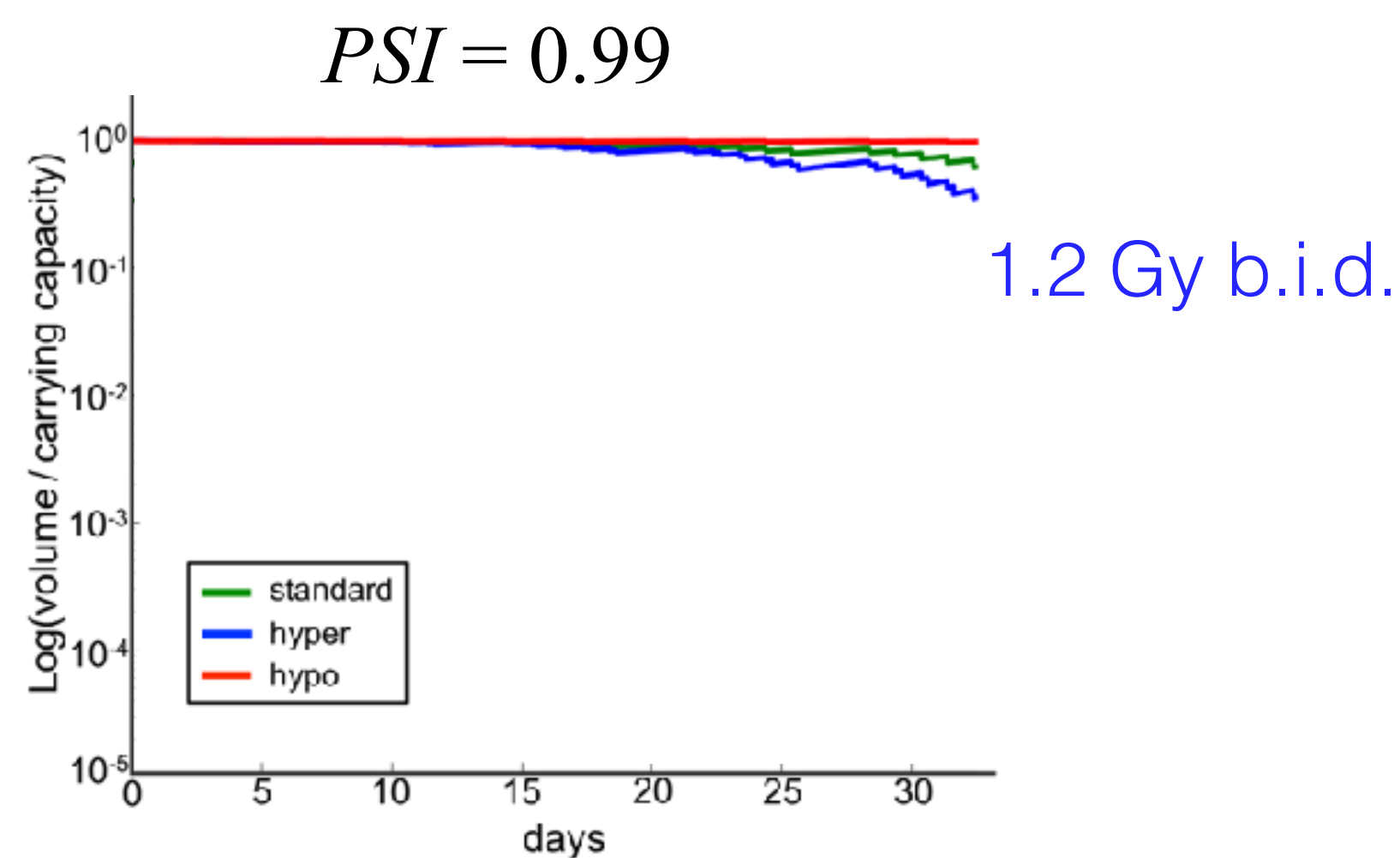
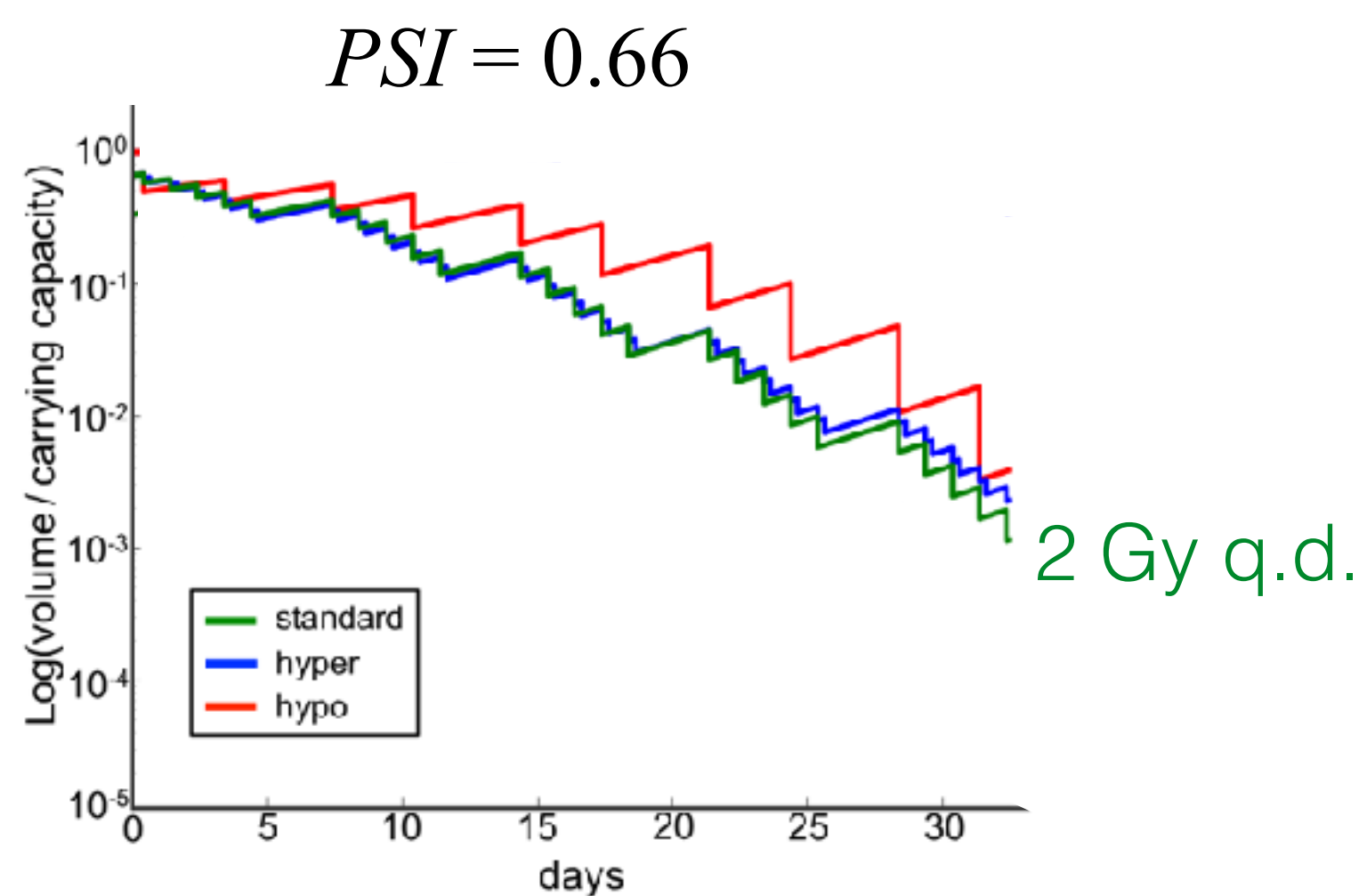
Volume reduction correlates with Locoregional Control (LRC) and pre-RT PSI



Dr. Mohammad
Zahid



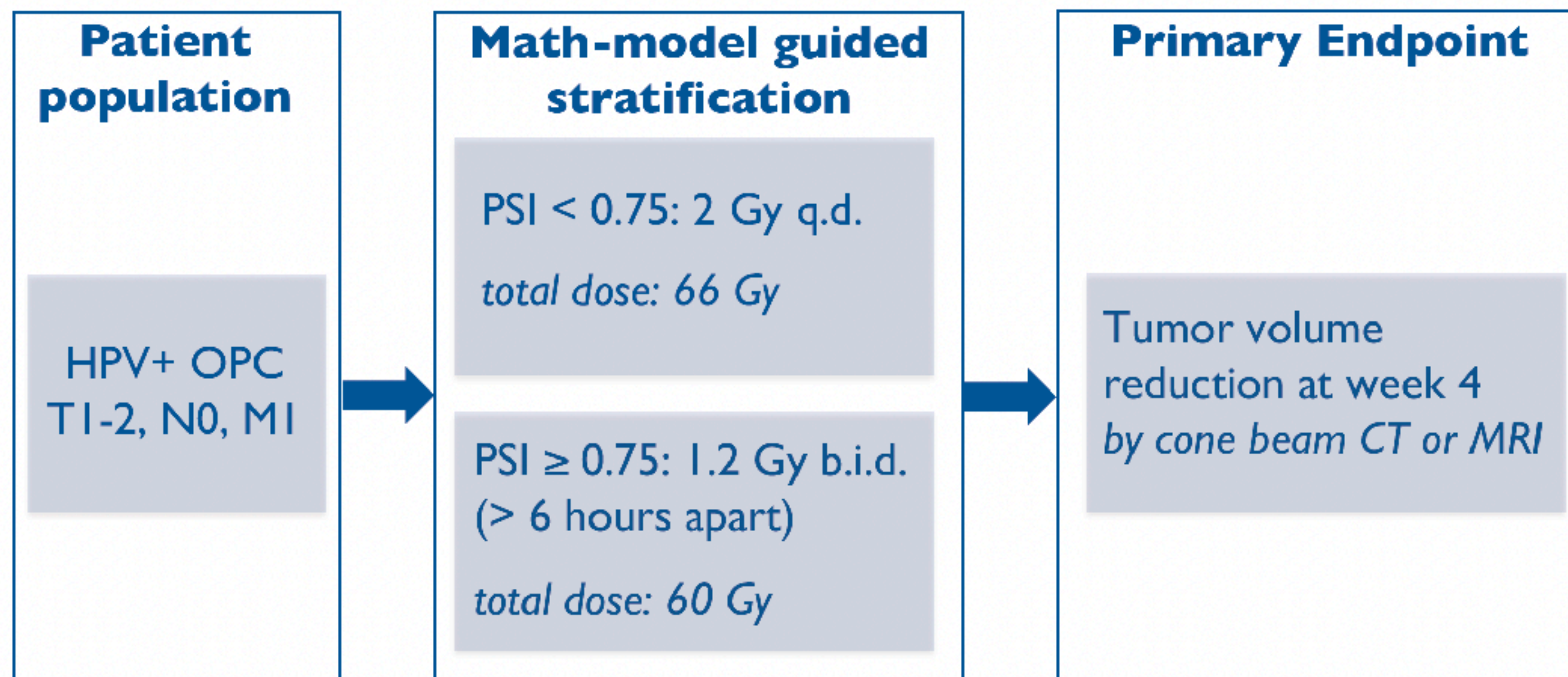
High PSI better treated with hyperfractionation



Worldwide first prospective clinical trial to test mathematics-guided radiation fractionation



Dr. Jimmy Caudell



Interim analysis

49 patients

Median age: 64 (range 30-82)

41 men (83.7%) and 8 women (16.3%)

Median PSI: 0.95 (range -2.8 – 1.8)

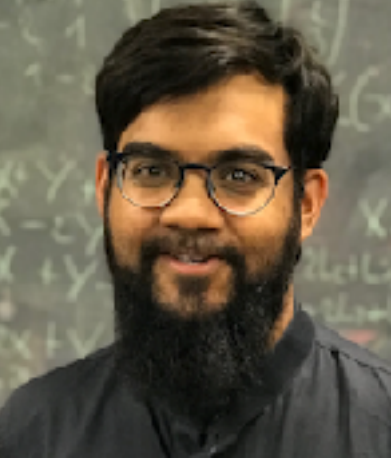
HFx: 38 patients (77.6%)

QD: 11 patients (22.4%)

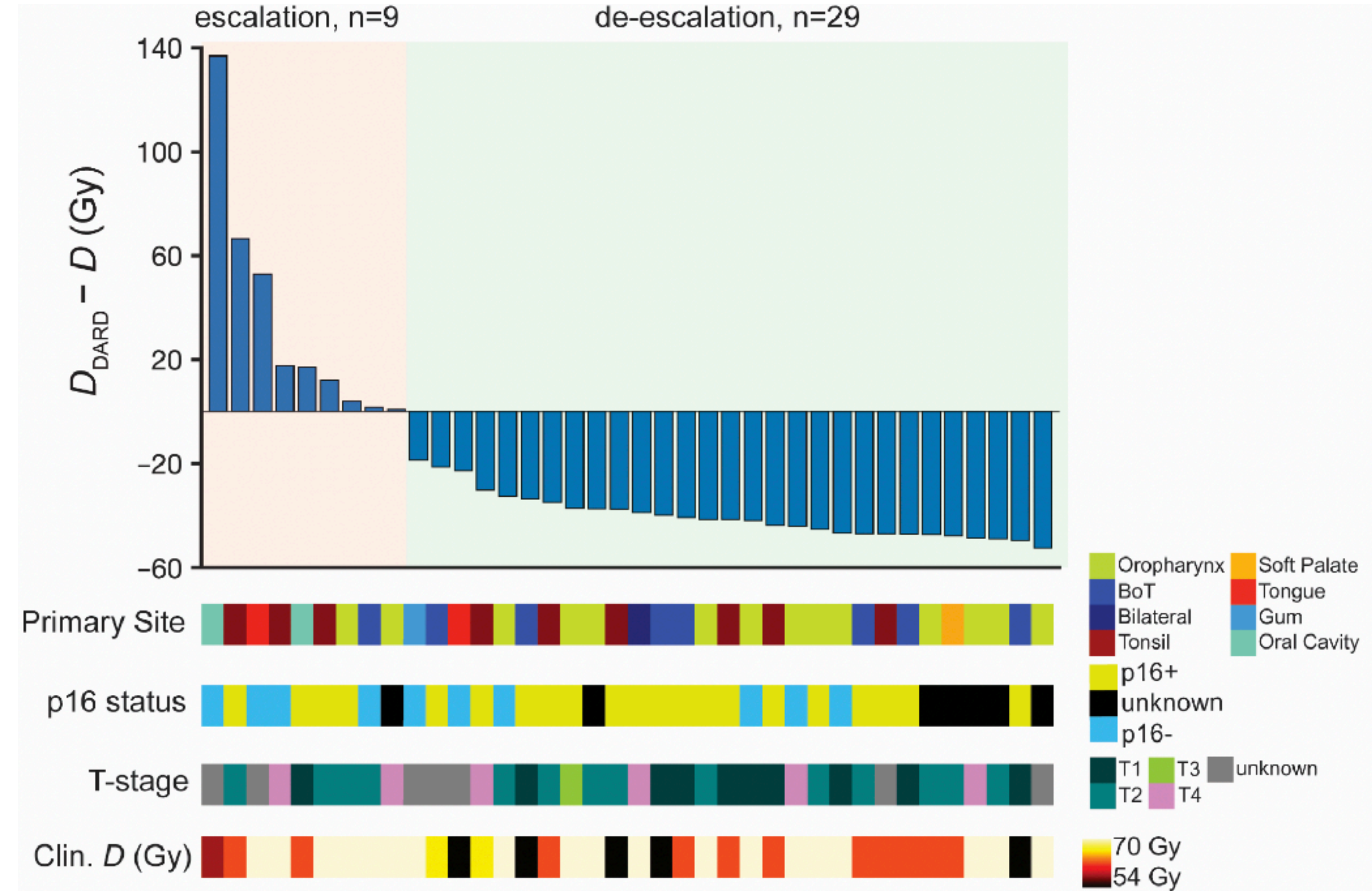
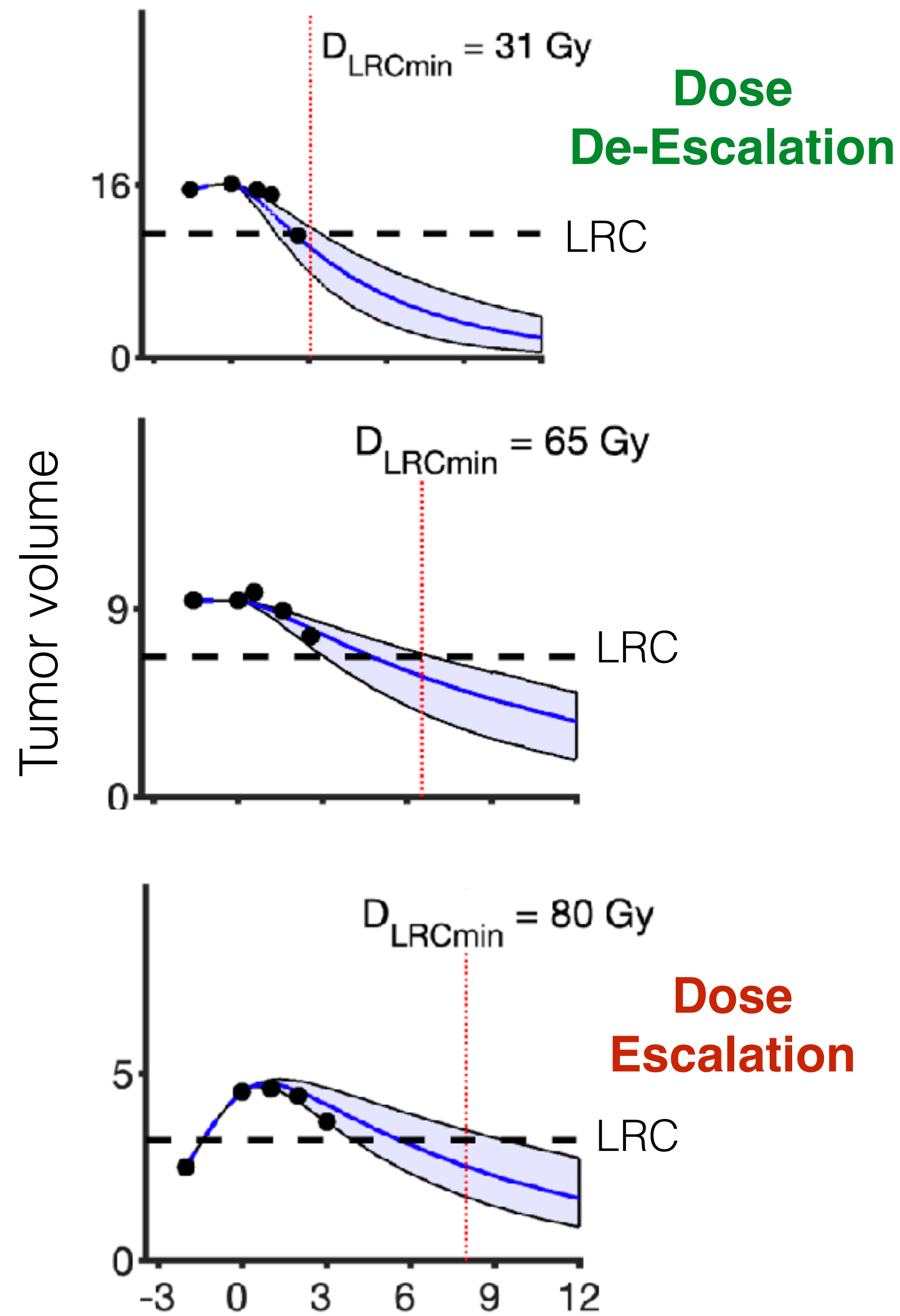
Volumetric response at 4 weeks: median 42.5% reduction.

30 of 49 (61.2%) patients met the criteria ≥ 32% reduction in tumor volume by week 4.

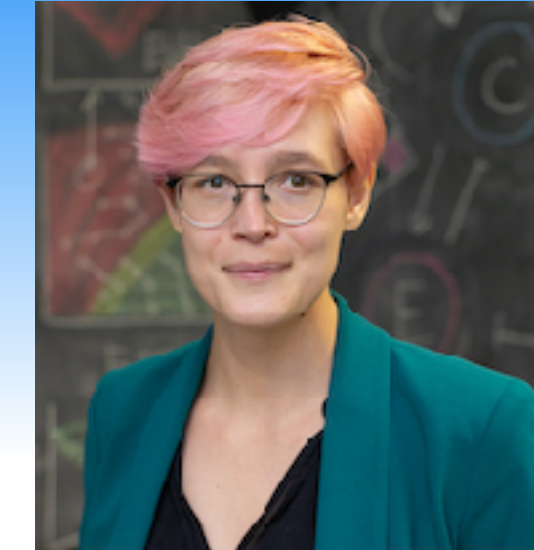
DARD - Dynamics Adapted Radiation Dose



Dr. Mohammad
Zahid



Radiation effects on tumor-immune interactions



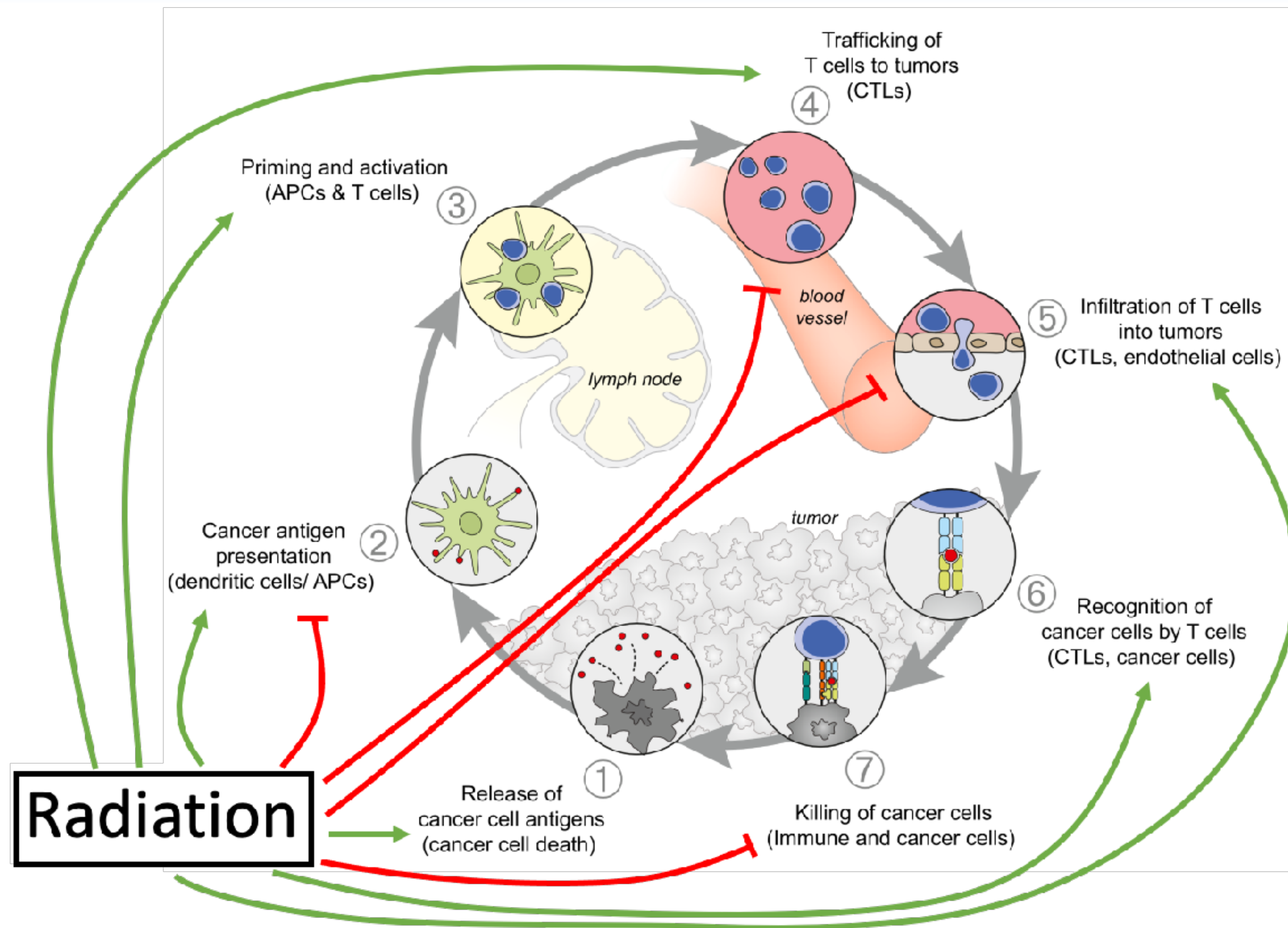
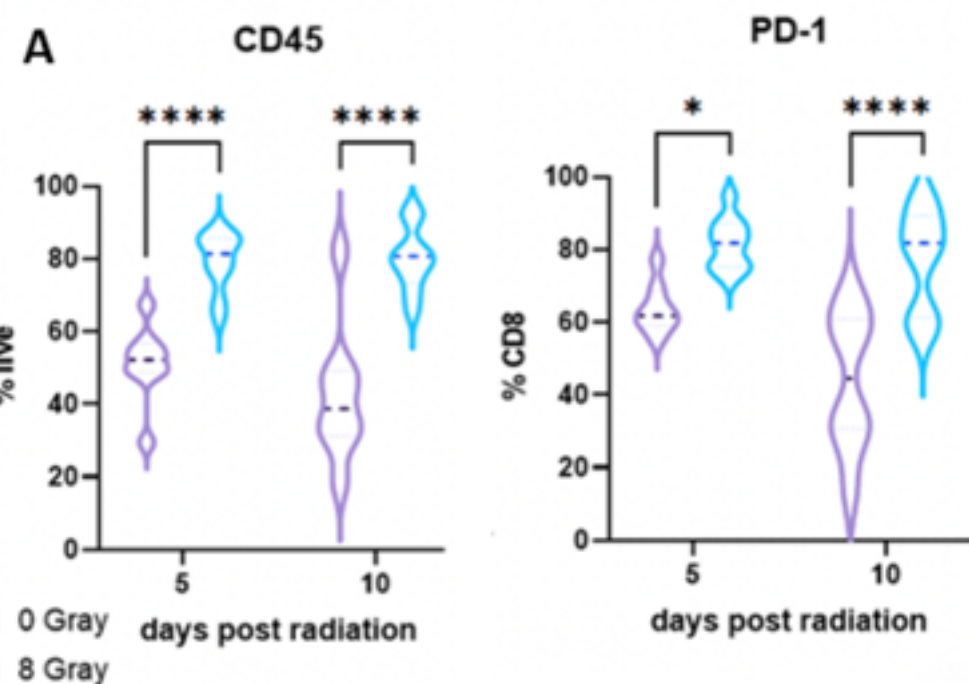
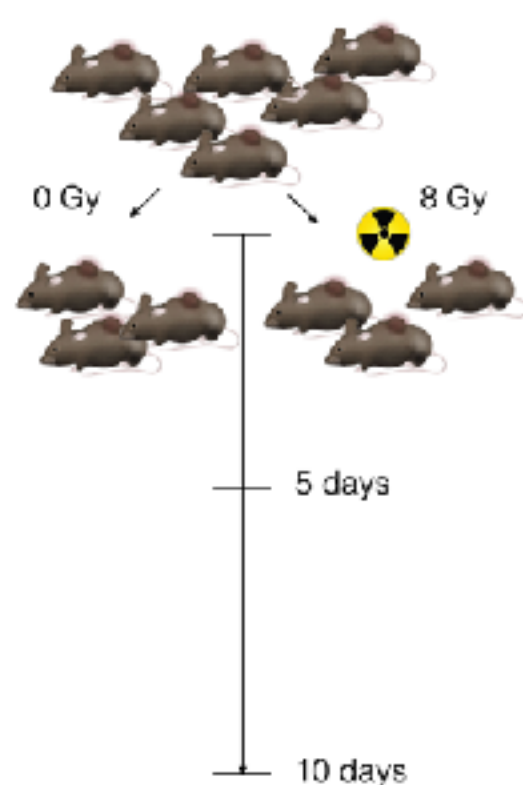
Rebecca Bekker



Dr. Shari
Pilon-Thomas



Nina
Obertopp



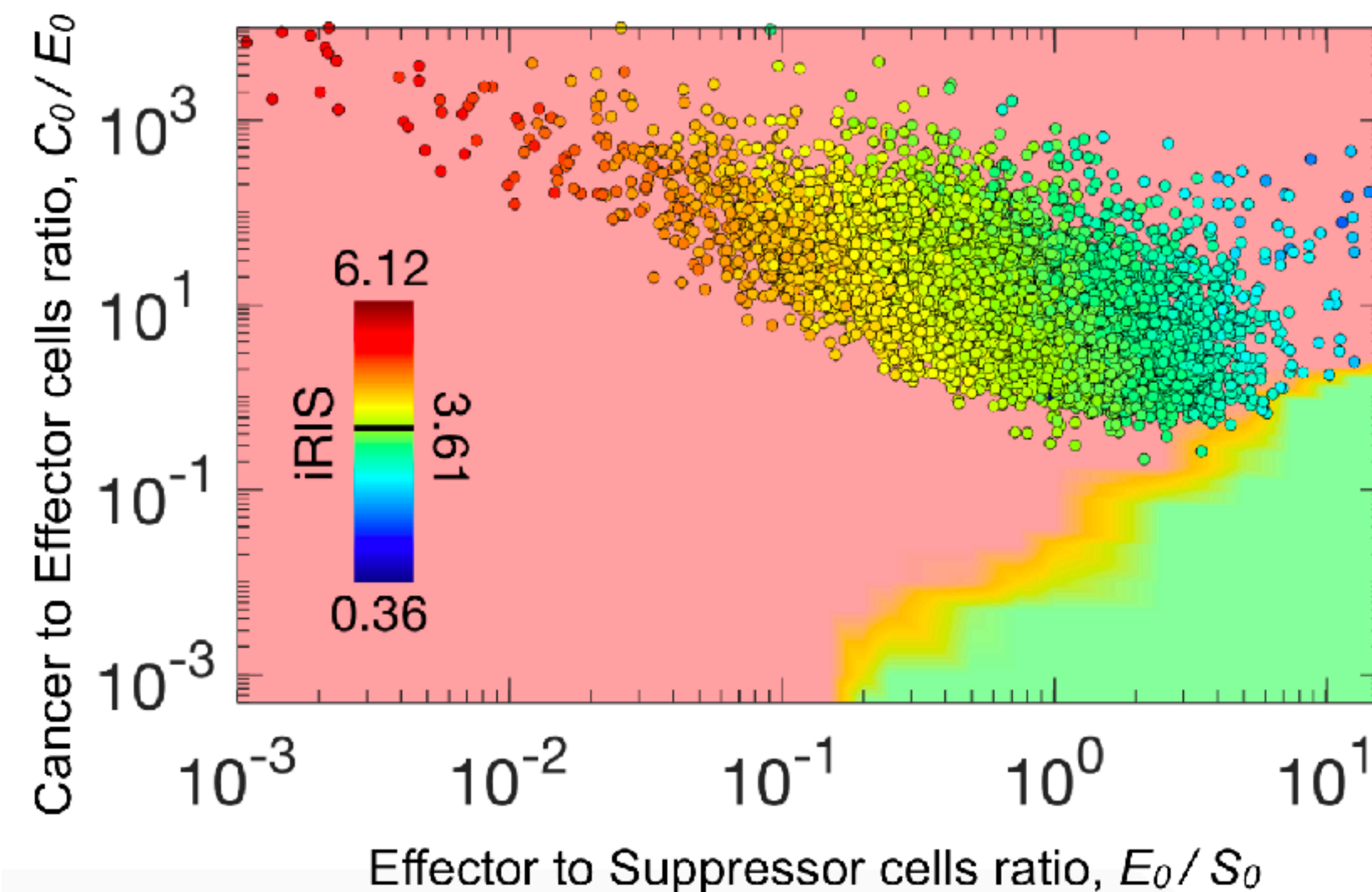
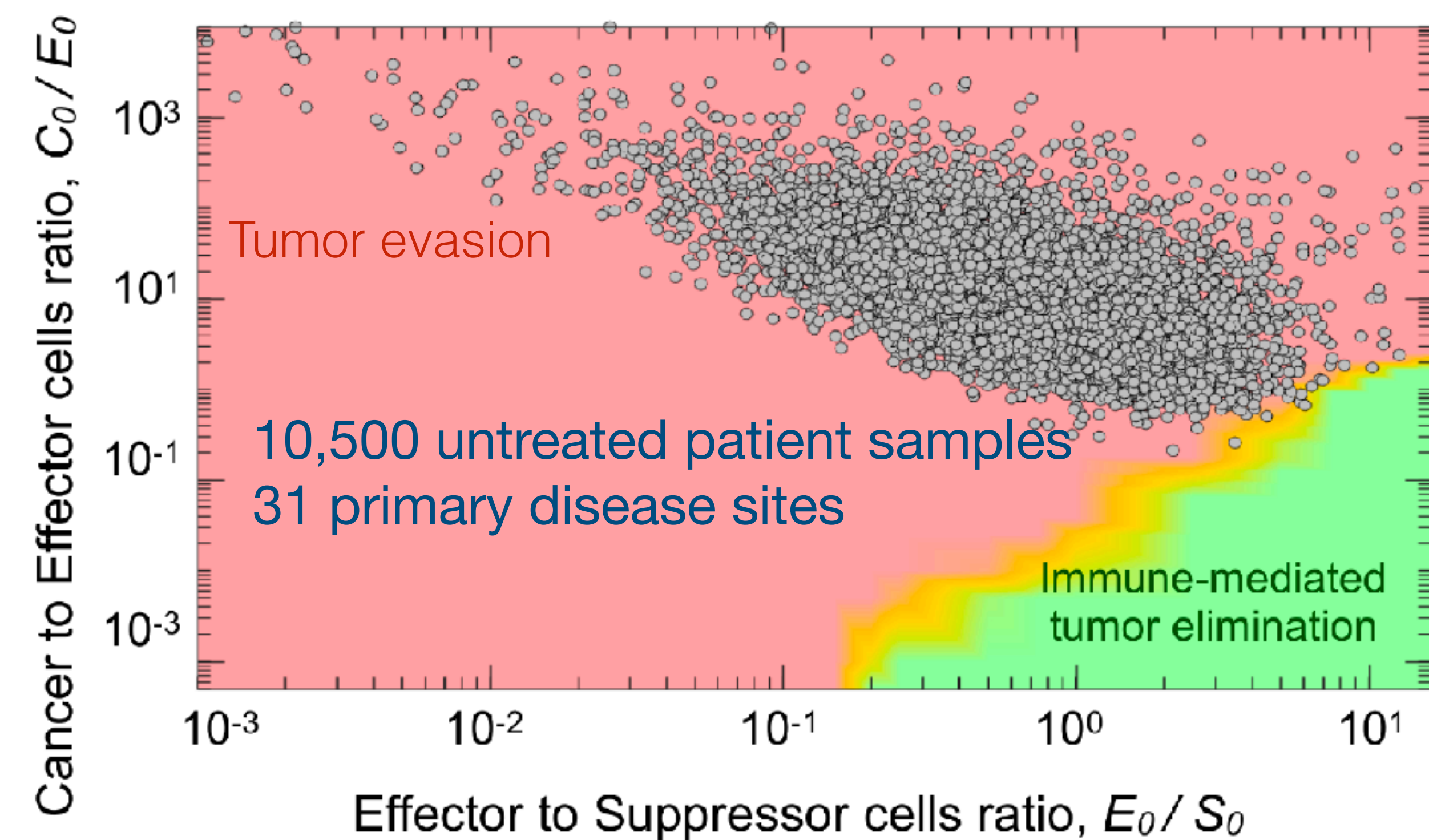
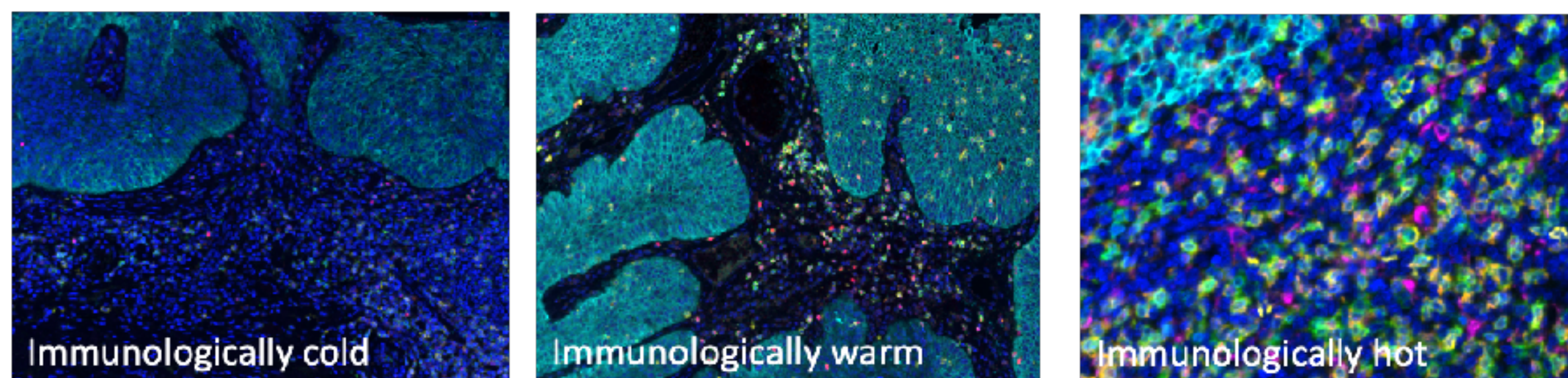
Chen & Mellman (2013)
PMID: 23890059

Arnold et al (2018)
PMID: 29551910

Individual patients have tumor-immune ecosystem composition of immune escape



Dr. Daniel
Grass



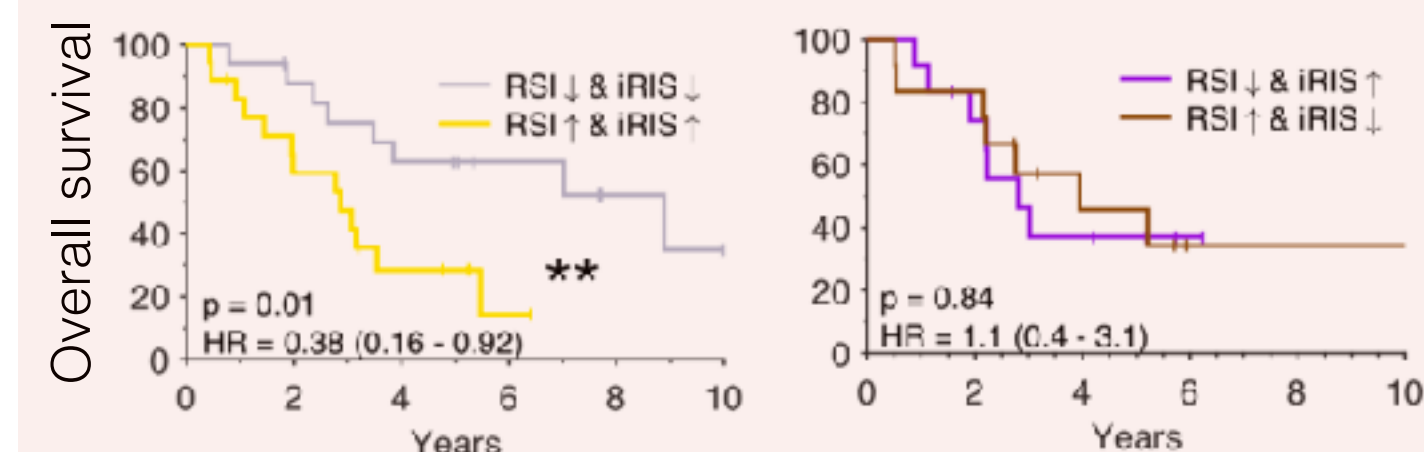
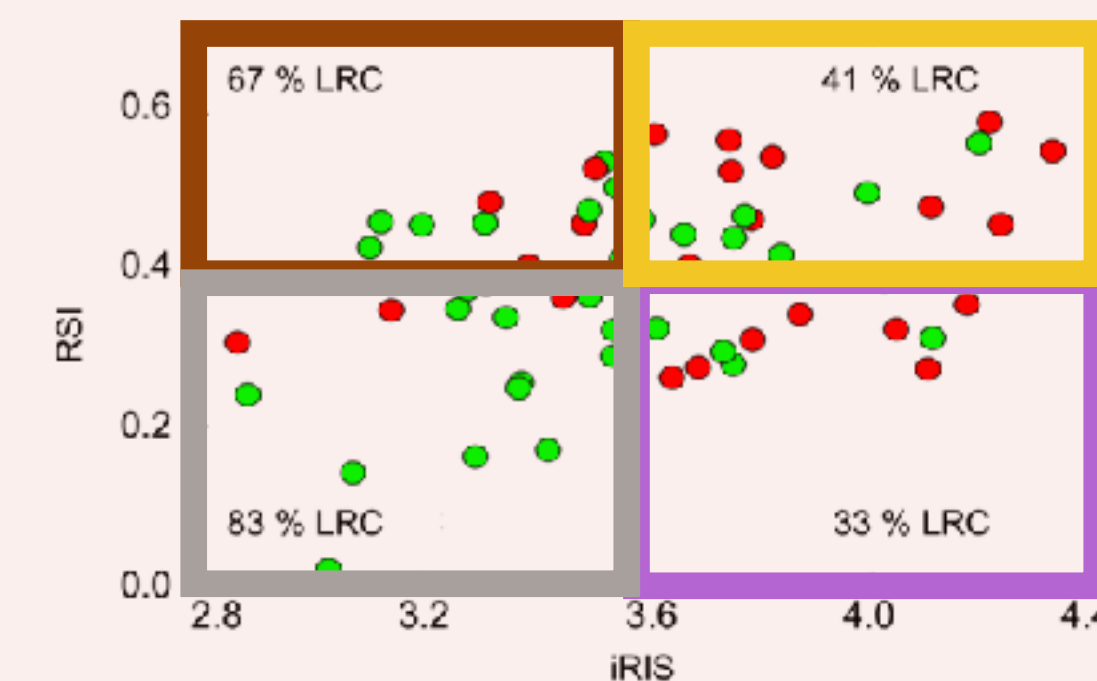
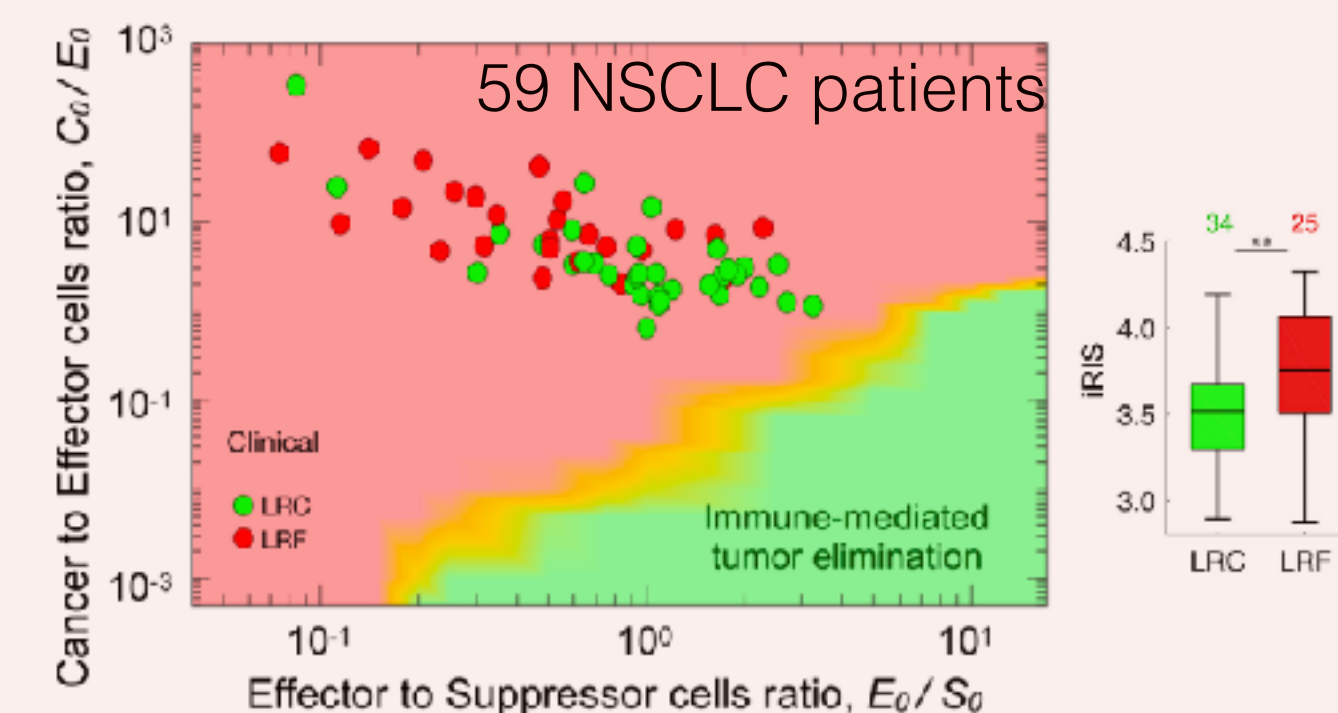
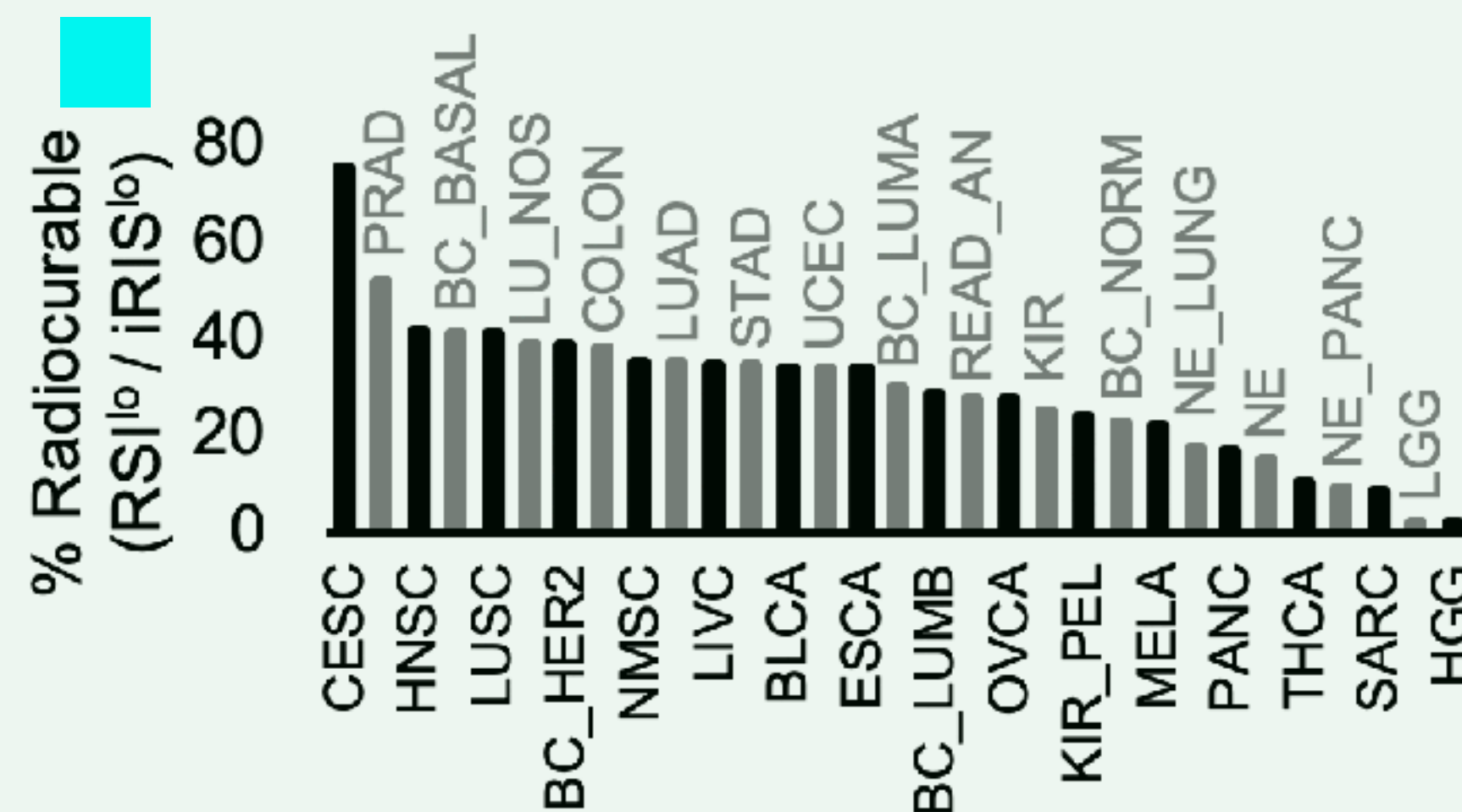
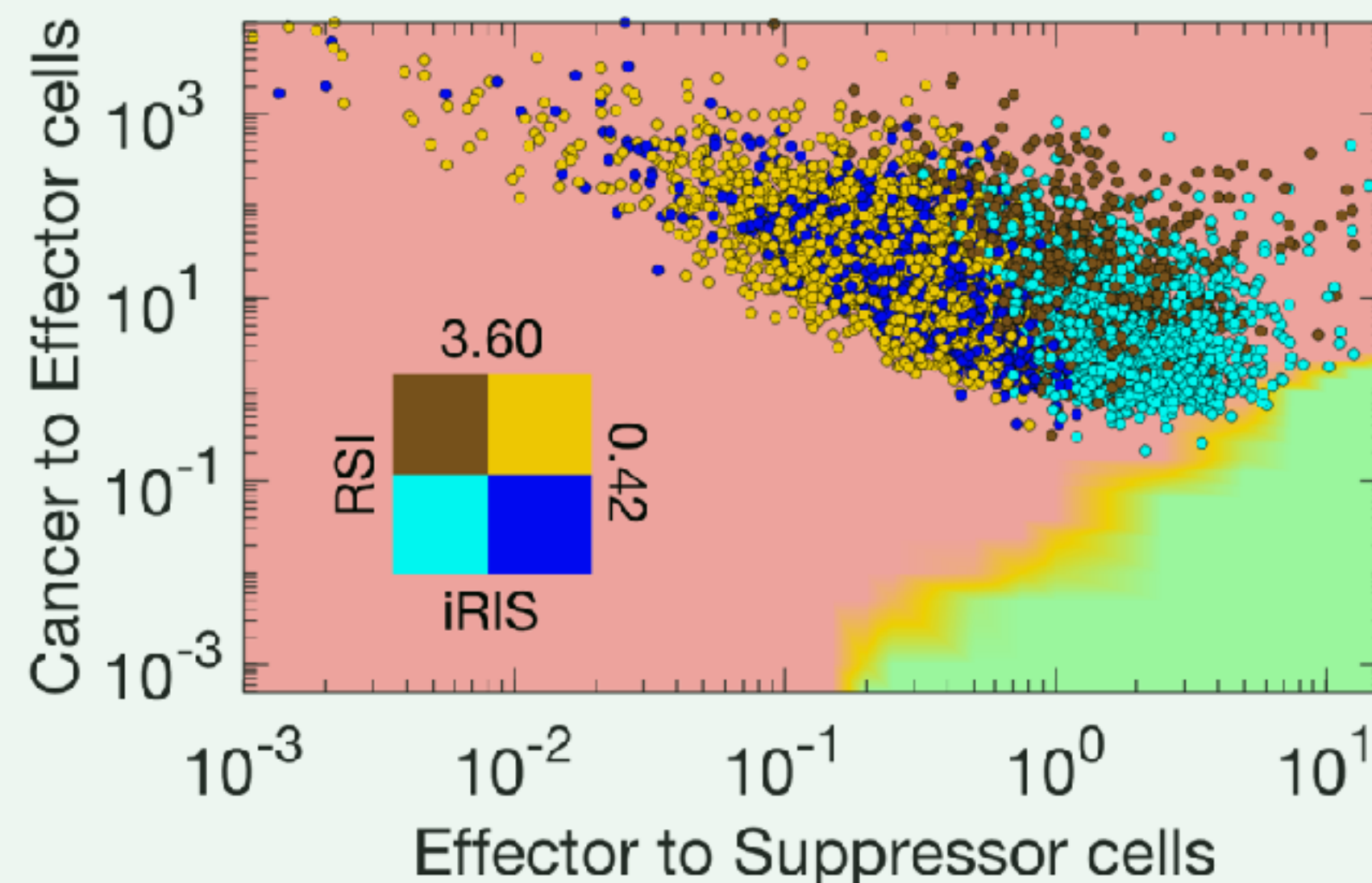
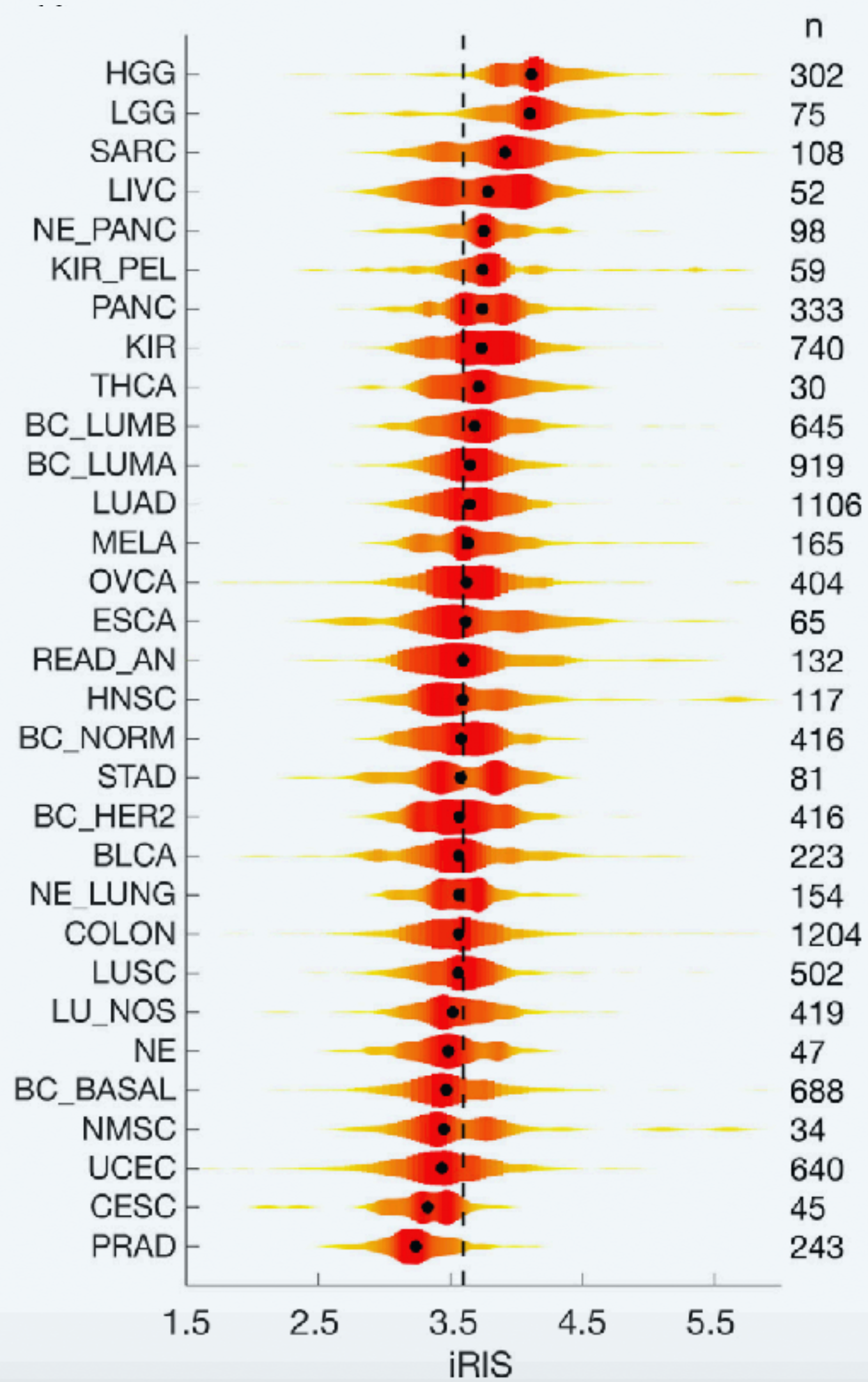
$$iRIS = \frac{1}{2} \min(d_{IMTE}) + \log_{10}(S_0)$$

$$d_{IMTE} = \sqrt{\left(\log_{10}\left(\frac{E_0}{S_0}\right) - \log_{10} X\right)^2 + \left(\log_{10}\left(\frac{C_0}{E_0}\right) - \log_{10} Y\right)^2}$$

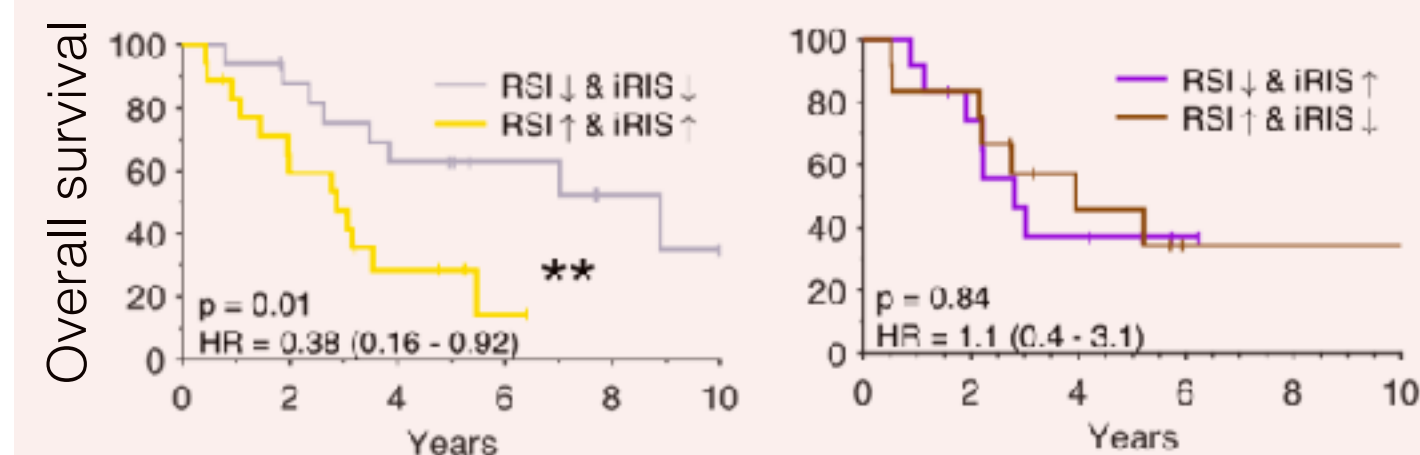
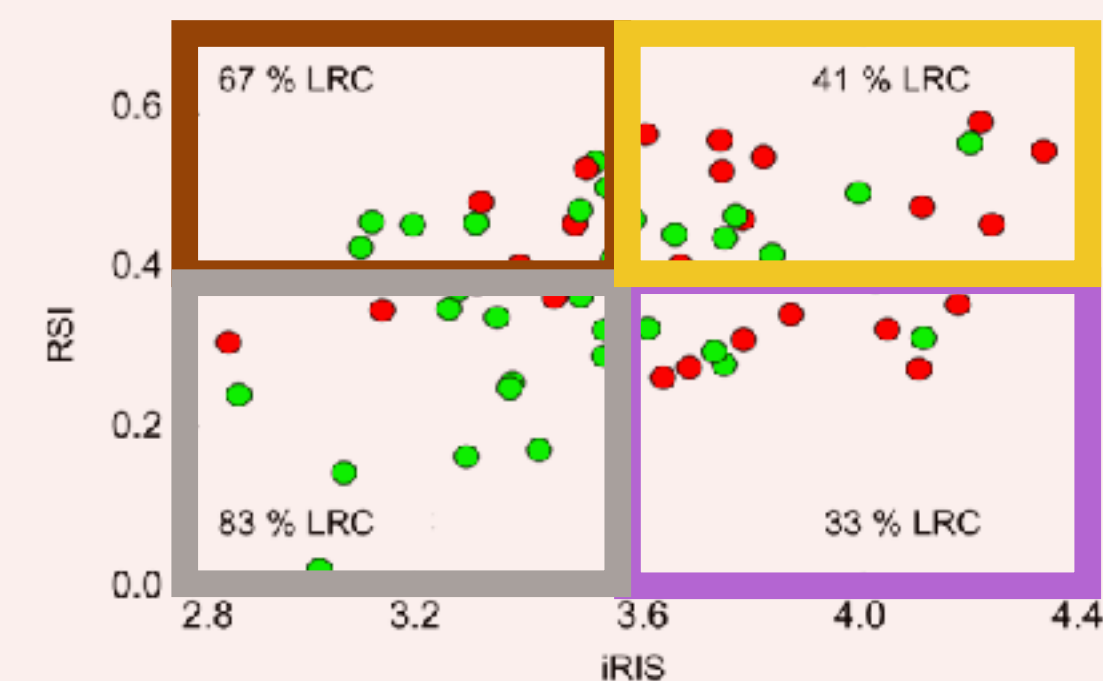
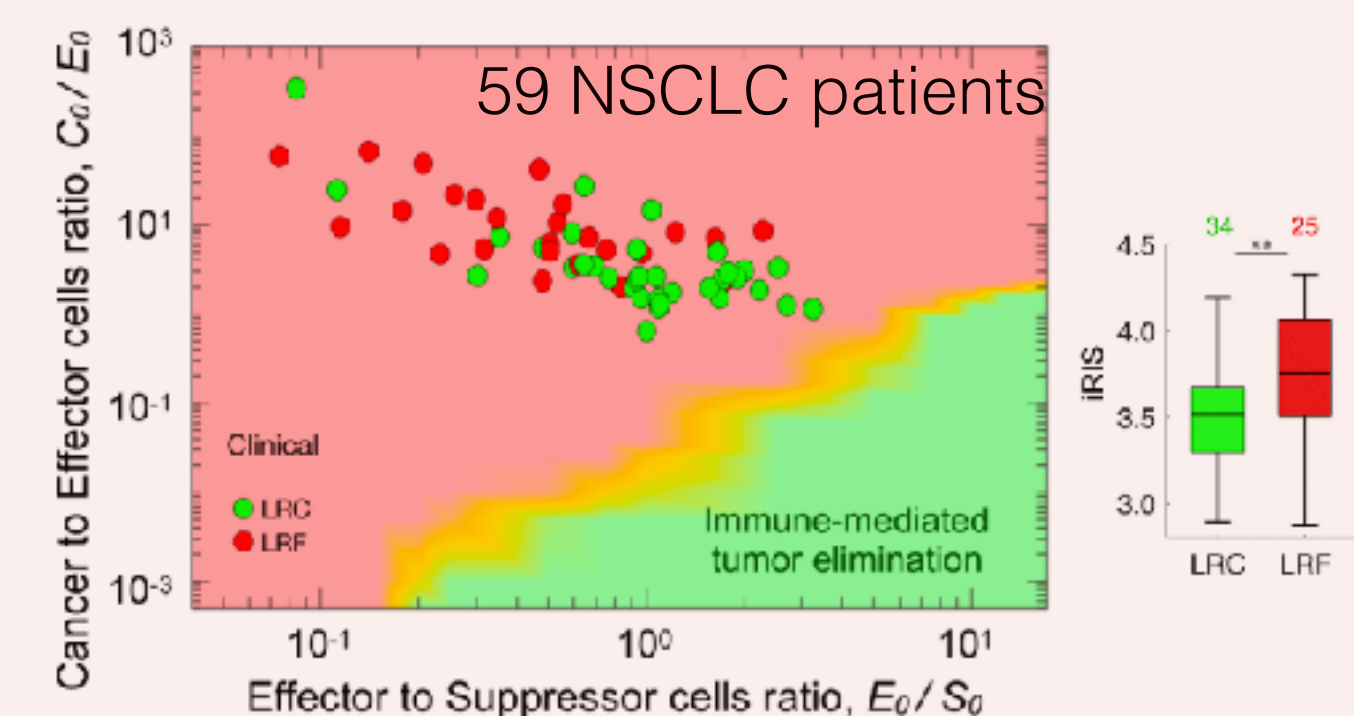
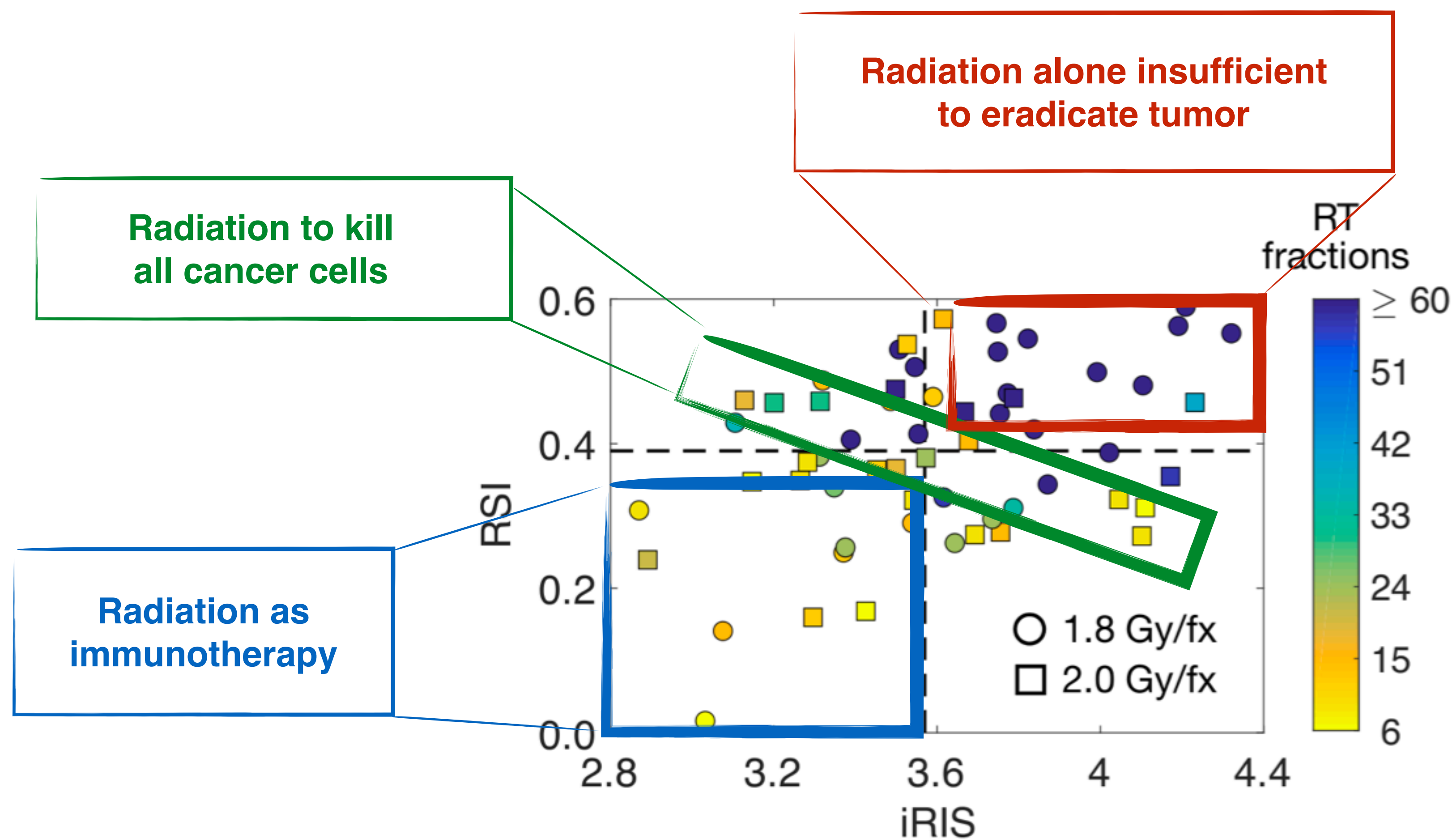
iRIS^{lo}/RSI^{lo} correlate with radiocurability



Dr. Javier
Torres-Roca



iRIS^{lo}/RSI^{lo} correlate with radiocurability



PSI

RSI

iRIS

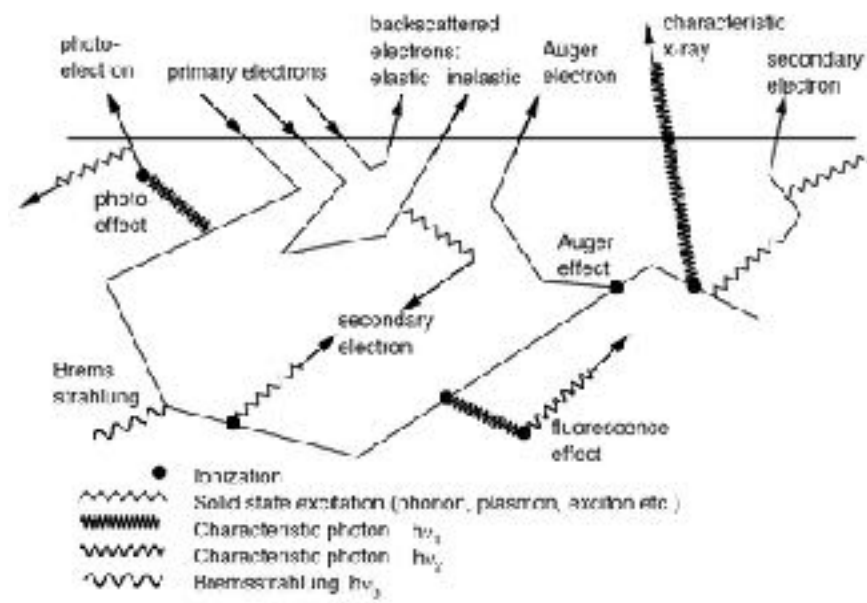
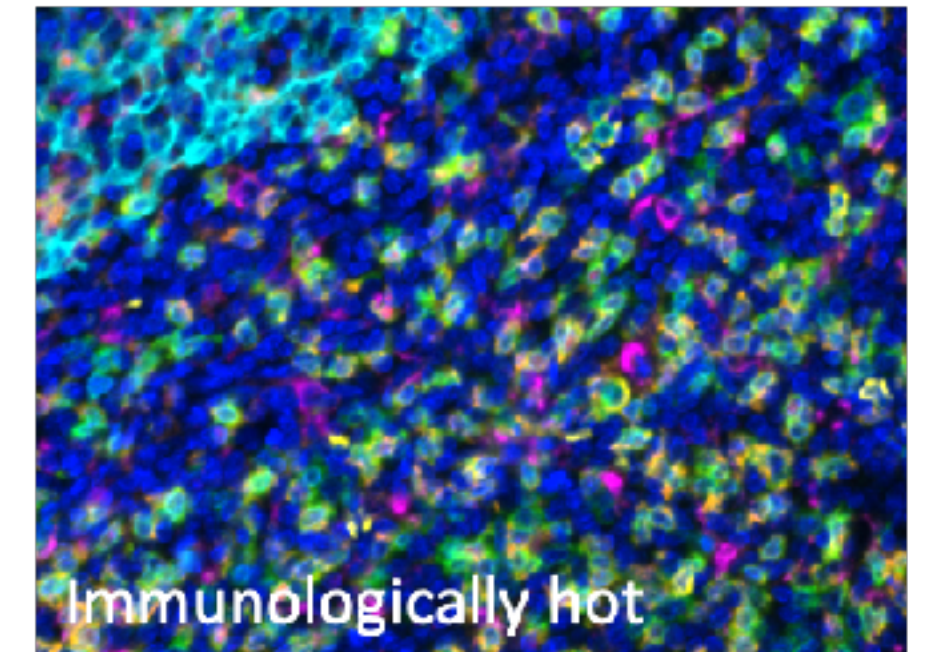
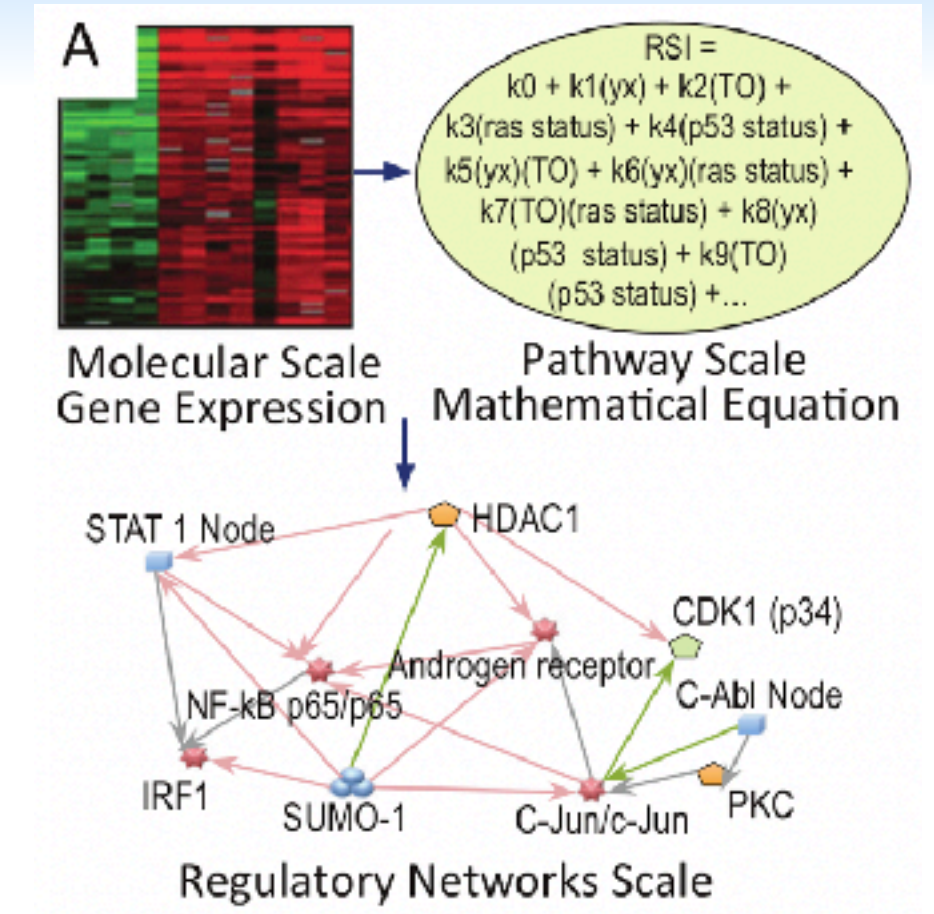
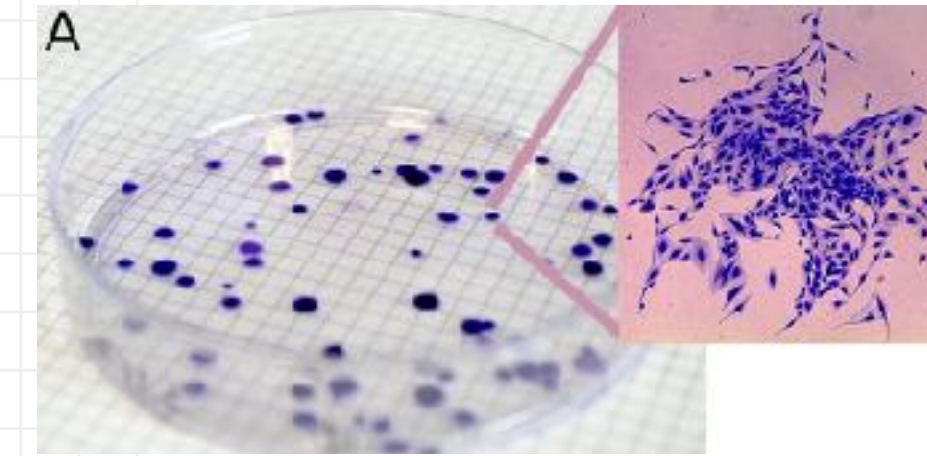
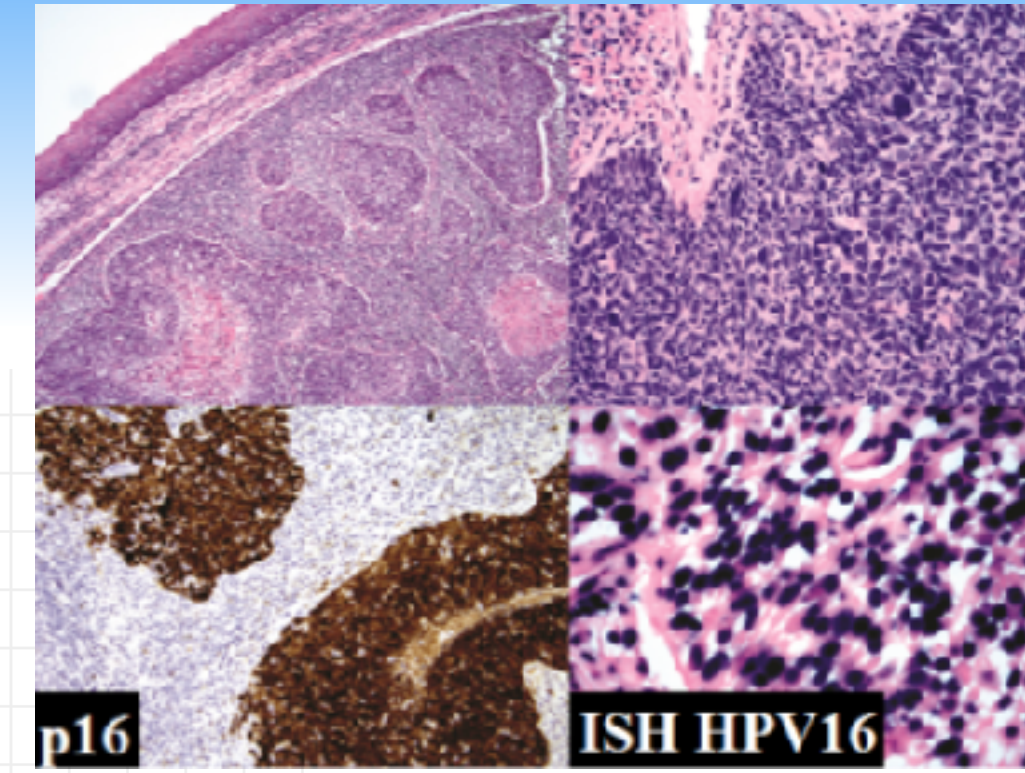
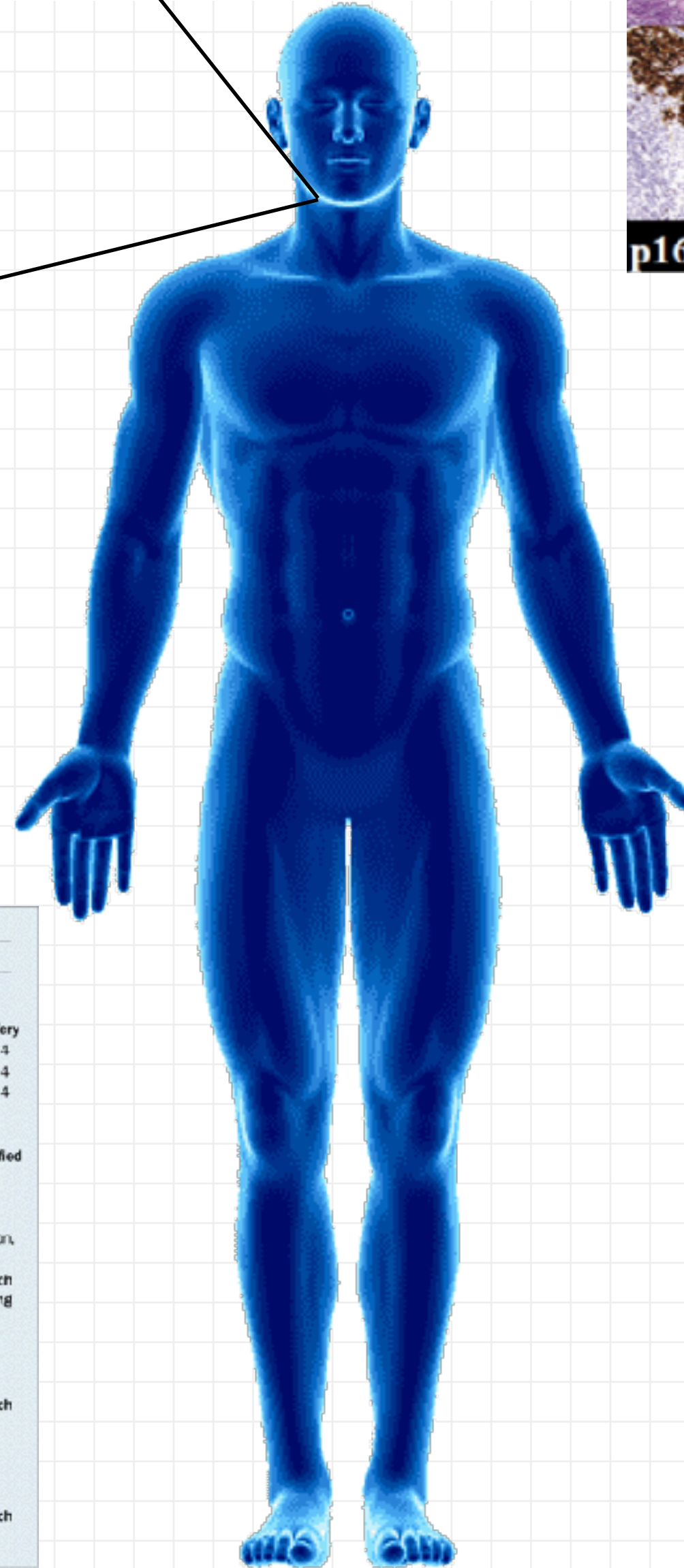
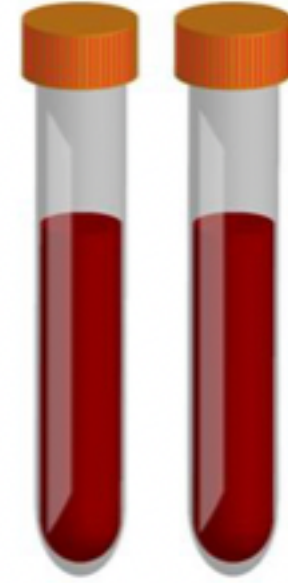
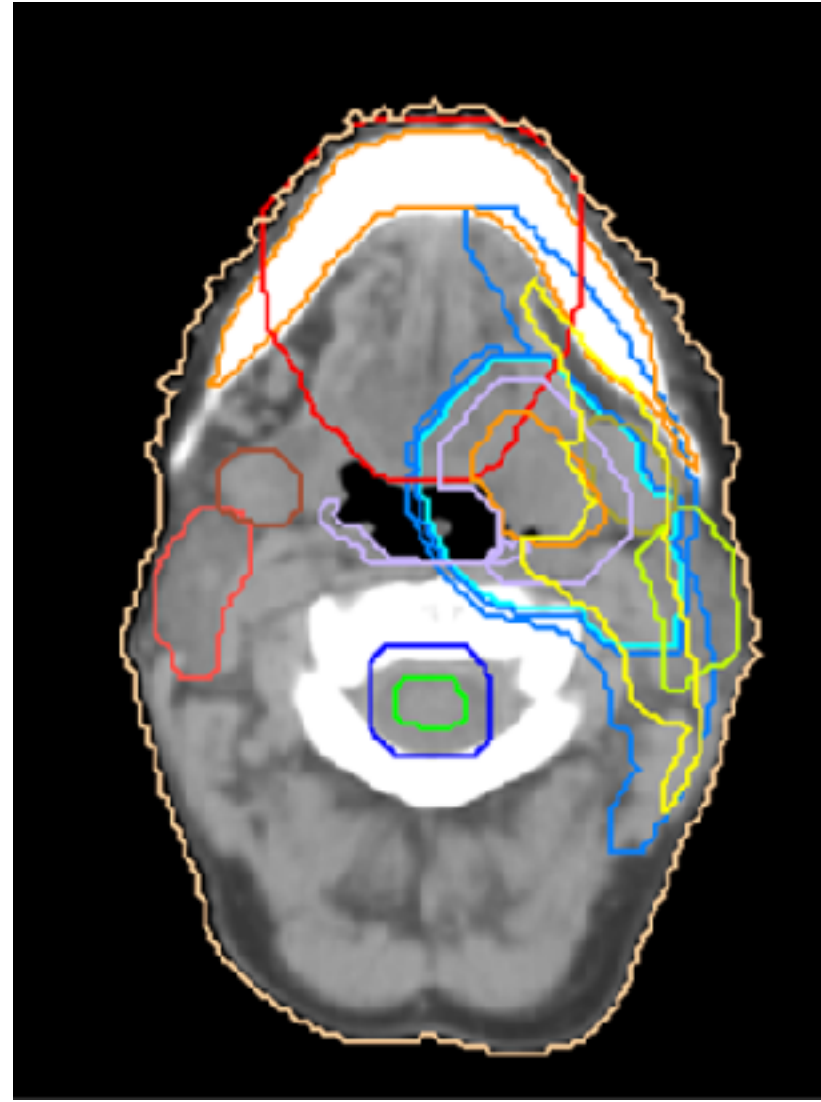
patient-specific prescription of

- total radiation dose
- radiation dose fractionation
- concurrent / adjuvant / neoadjuvant Tx

based on multidisciplinary
pathological, mathematical,
genomics & immune biomarkers



↑ response
↑ outcomes
↑ QOL



Name: _____
Date: _____

1. Please rate the current (i.e. last 2 weeks) SEVERITY of your insomnia problem(s)

	None	Mild	Moderate	Severe	Very
Difficulty falling asleep:	0	1	2	3	4
Difficulty staying asleep:	0	1	2	3	4
Problem waking up too early:	0	1	2	3	4

2. How SATISFIED/dissatisfied are you with your current sleep pattern?

Very satisfied	1	2	3	Very dissatisfied
0				4

3. To what extent do you consider your sleep problem to INTERFERE with your daily functioning (e.g. daytime fatigue, ability to function at work/daily chores, concentration, memory, mood, etc.)

Not at all interfering	A little	Somewhat	Much	Very much interfering
0	1	2	3	4

4. How NOTICEABLE to others do you think your sleeping problem is in terms of impairing the quality of your life?

Not at all noticeable	Barely	Somewhat	Much noticeable	Very much
0	1	2	3	4

5. How WORRIED/distressed are you about your current sleep problem?

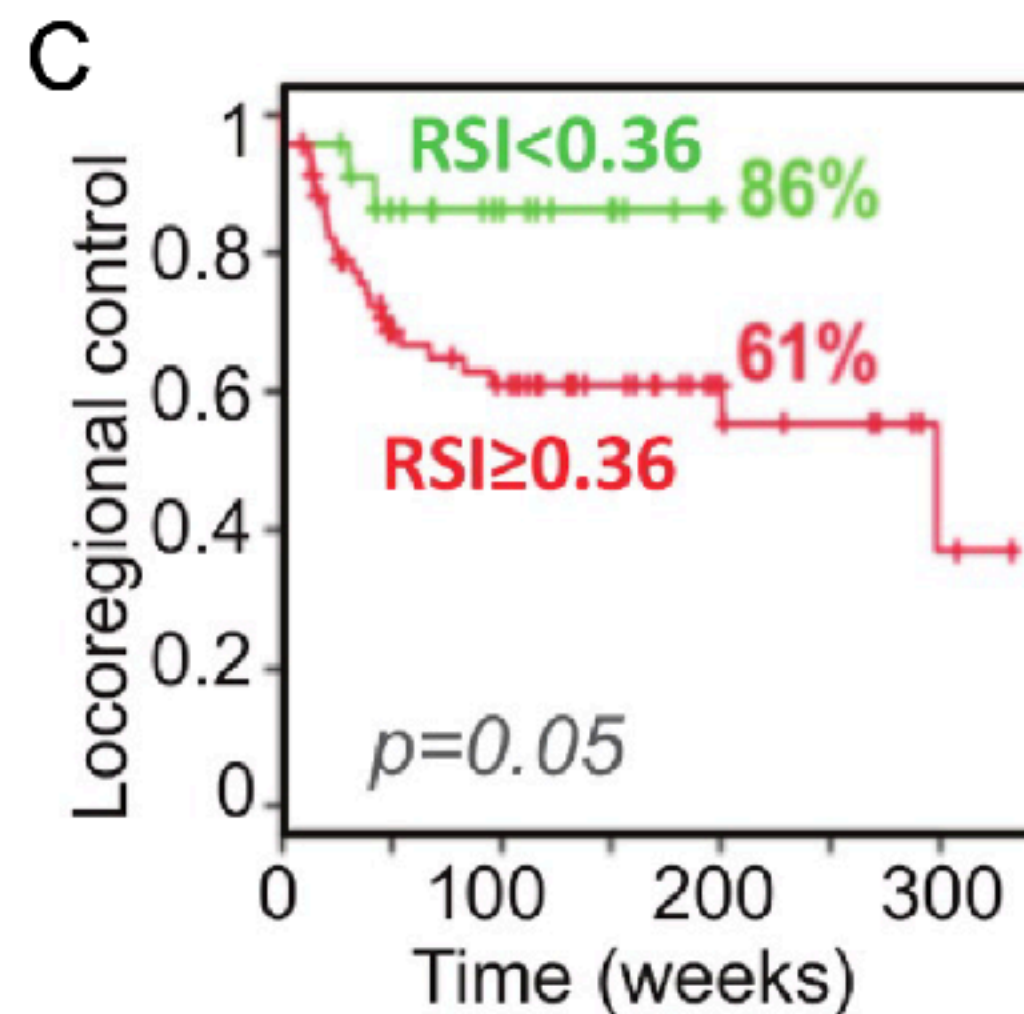
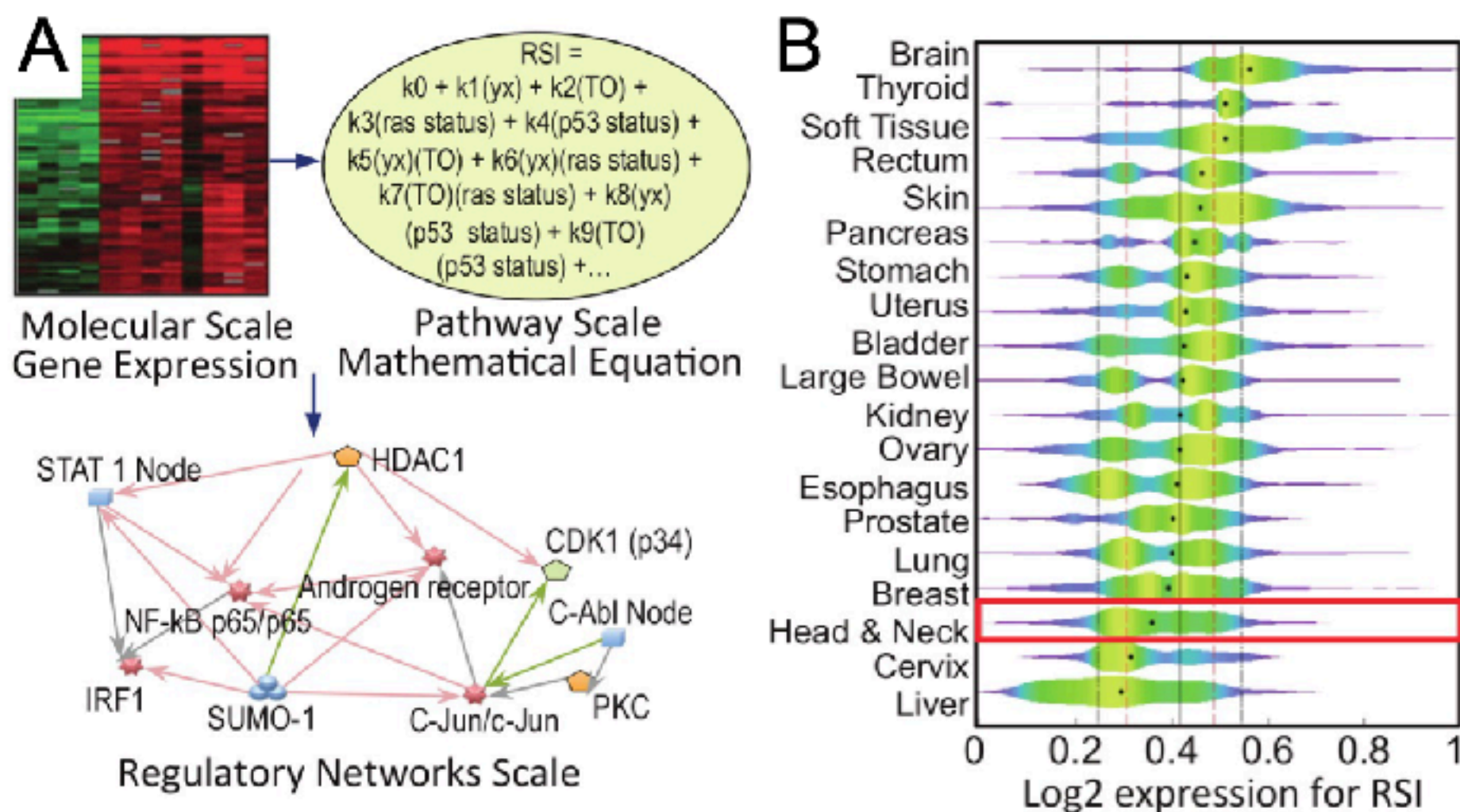
Not at all	A little	Somewhat	Much	Very much
0	1	2	3	4



Molecular signature of radiation response



Dr. Javier
Torres-Roca



A GENE EXPRESSION MODEL OF INTRINSIC TUMOR RADIOSENSITIVITY: PREDICTION OF RESPONSE AND PROGNOSIS AFTER CHEMORADIATION

STEVEN A. ESCHRICH, PH.D.,* JIMMY PRAMANA, M.D.,† HONGLING ZHANG, PH.D.,* HAIYAN ZHAO, B.S.,* DAVID BOULWARE, M.S.,* JI-HYUN LEE, DR.PH.,* GREGORY BLOOM, PH.D.,* CAIO ROCHA-LIMA, M.D.,† SCOTT KELLEY, M.D.,* DOUGLAS P. CALVIN, M.D.,* TIMOTHY J. YEATMAN, M.D.,* ADRIAN C. BEGG, PH.D.,† AND JAVIER F. TORRES-ROCA, M.D.*

SYSTEMS BIOLOGY MODELING OF THE RADIATION SENSITIVITY NETWORK: A BIOMARKER DISCOVERY PLATFORM

STEVEN ESCHRICH, PH.D.,* HONGLING ZHANG, PH.D.,† HAIYAN ZHAO, B.S.,† DAVID BOULWARE, M.S.,† JI-HYUN LEE, DR.PH.,† GREGORY BLOOM, PH.D.,* AND JAVIER F. TORRES-ROCA, M.D.,†§

Validation of a Radiosensitivity Molecular Signature in Breast Cancer

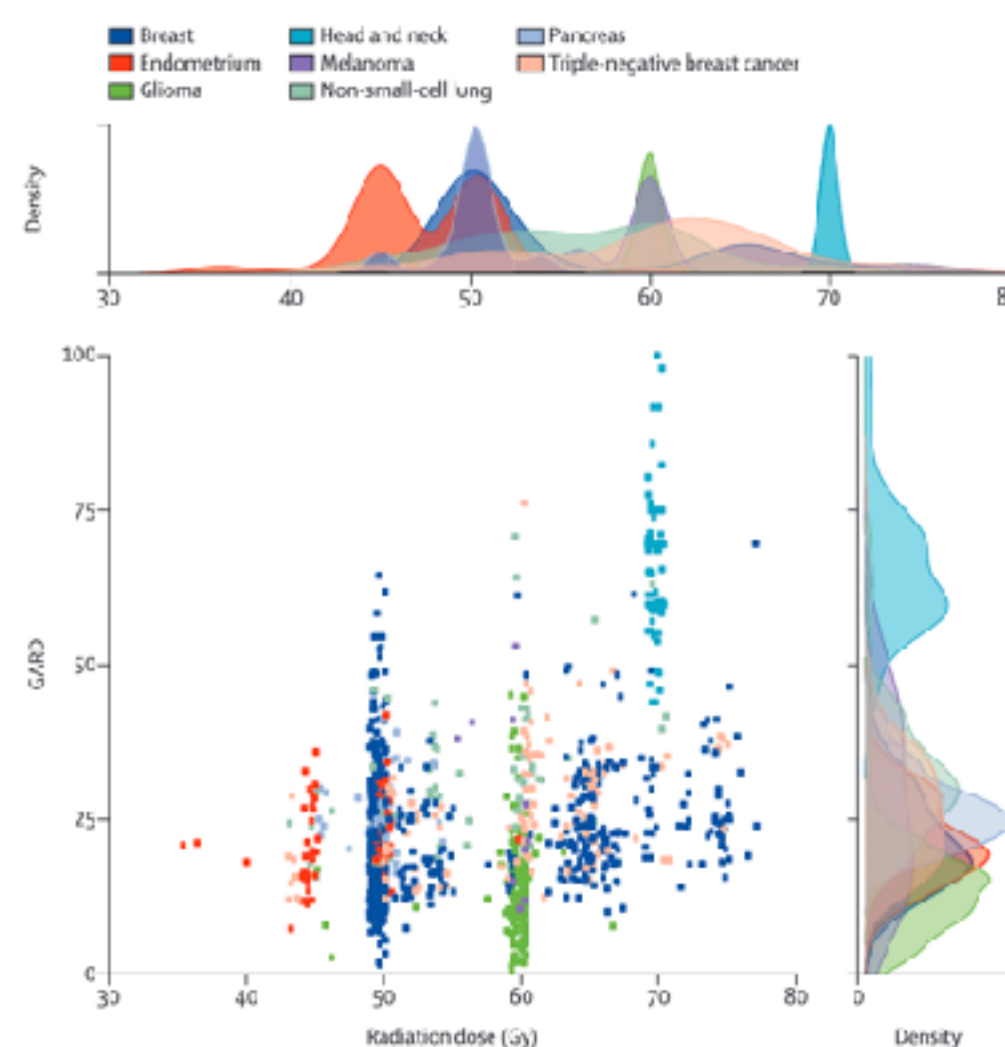
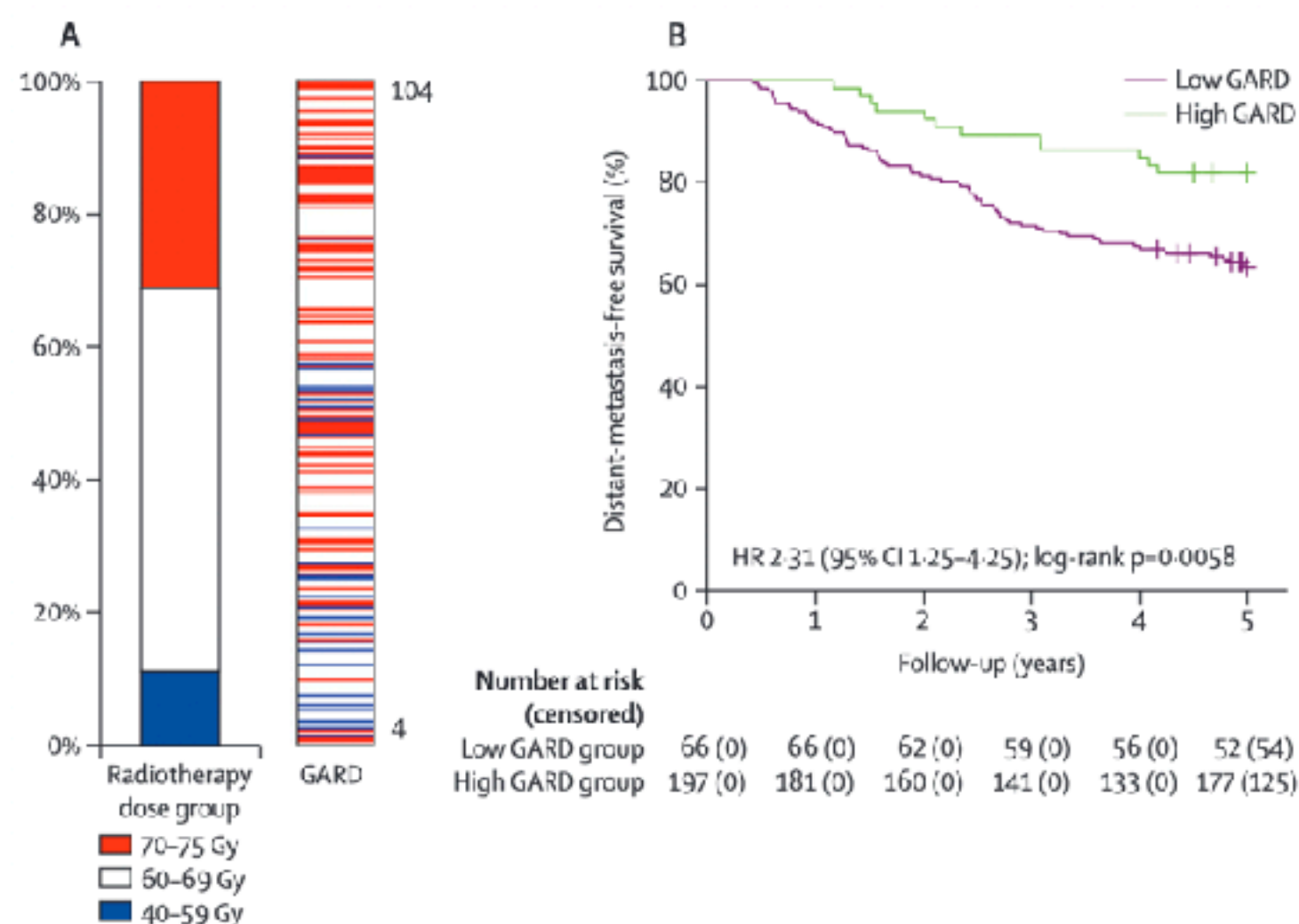
Steven A. Eschrich¹, William J. Fulp², Yudi Pawitan³, John A. Foekens⁴, Marcel Smid⁵, John W.M. Martens⁶, Michelle Echevarria⁷, Vidya Kamath¹, Ji-Hyun Lee², Eleanor E. Harris⁴, Jonas Bergh⁶, and Javier F. Torres-Roca^{3,4}

A genome-based model for adjusting radiotherapy dose (GARD): a retrospective, cohort-based study

Jacob G Scott, Anders Berglund, Michael J Schell, Ivaylo Mihaylov, William J Fulp, Binglin Yue, Eric Welsh, Jimmy J Caudell, Kamran Ahmed, Tobin S Strom, Eric Mellon, Puja Venkat, Peter Johnstone, John Foekens, Joe Lee, Eduardo Moros, William S Dalton, Steven A Eschrich, Howard McLeod, Louis B Harrison, Javier F Torres-Roca

Pan-cancer prediction of radiotherapy benefit using genomic-adjusted radiation dose (GARD): a cohort-based pooled analysis

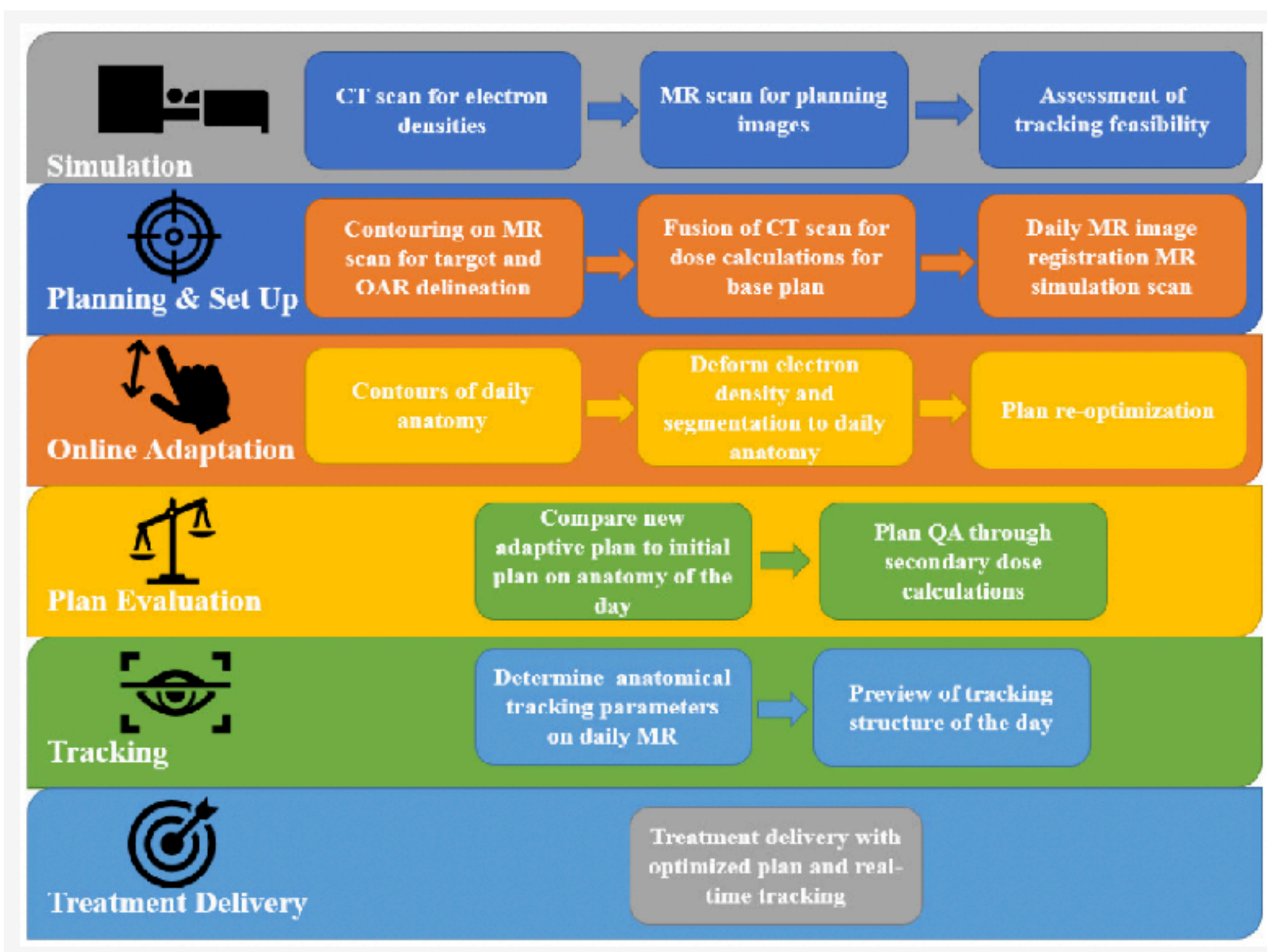
Jacob G Scott*, Geoffrey Sedor*, Patrick Ellsworth, Jessica A Scarborough, Kamran A Ahmed, Daniel E Oliver, Steven A Eschrich, Michael W Kattan*, Javier F Torres-Roca*



MR-guided adaptive radiation therapy



Dr. Stephen
Rosenberg



Stereotactic Magnetic Resonance-Guided Adaptive and Non-Adaptive Radiotherapy on Combination MR-Linear Accelerators: Current Practice and Future Directions

John Michael Bryant¹, Joseph Weygand¹, Emily Keit¹, Ruben Cruz-Chamorro¹, Maria L Sandoval¹, Ibrahim M Oraiqat¹, Jacqueline Andreozzi¹, Gage Redler¹, Kujtim Latifi¹, Vladimir Feygelman¹, Stephen A Rosenberg¹

A Practical Workflow for Magnetic Resonance-Guided Stereotactic Body Radiation Therapy to the Pancreas

Austin J Sim¹, Sarah E Hoffe², Kujtim Latifi², Russell F Palm², Vladimir Feygelman², Susan Leuthold², Marsha Dookhoo², Maria Dennett², Stephen A Rosenberg², Jessica M Frakes³

MR-guided stereotactic body radiation therapy for intracardiac and pericardial metastases

Austin J Sim¹, Russell F Palm¹, Kirby B DeLozier¹, Vladimir Feygelman¹, Kujtim Latifi¹, Gage Redler¹, Iman R Washington¹, Evan J Wuthrick¹, Stephen A Rosenberg¹

Magnetic Resonance-Guided Stereotactic Body Radiation Therapy/Hypofractionated Radiation therapy for Metastatic and Primary Central and Ultracentral Lung Lesions

Maria L Sandoval¹, Austin J Sim², John M Bryant¹, Menal Bhandari¹, Evan J Wuthrick¹, Bradford A Perez¹, Thomas J Dilling¹, Gage Redler¹, Jacqueline Andreozzi¹, Louis Nardella¹, Vladimir Feygelman¹, Kujtim Latifi¹, Stephen A Rosenberg¹

Patient-reported outcomes



Dr. Peter Johnstone

jj/mm	03/09	13/09	17/09	24/09	01/10	08/10	15/10	21/10	28/10	04/11	11/11	17/11	25/11	01/12	11/12	16/12	20/12	26/12	30/12	06/01	14/01	20/01	22/01	28/01	03/02	11/02	17/02	25/02	02/03
aa	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	16	16	16	16	16	16	16	16	16	16
Weight	65.7	65.8	66.4	66.8	67.4	66.8	66.8	66.6	66.6	67	67	66.7	65	65	66	66.3	66.3	66.3	67	66	66	66.5	66.1	64.6	63.4	63.2	63.2	62.9	62.1
Weight variation	-2.7	-2.8	-3.4	-3.8	-4.4	-3.8	-3.8	-3.6	-1.7	-3	-0.8	-0.9	0.7	0.8	0.4	0.5	1.1	0.5	-0.2	0.6	0.6	0.5	1.9	2.1	1.6	1.8	2.8	3.4	4.2
Appetite loss	1	0	0	0	0	1	1	0	1	0	1	2	2	1	0	0	0	2	2	1	1	3	2	2	2	2	1	1	1
Weakness	1	1	2	1	2	2	1	1	2	1	0	3	3	1	1	1	2	2	2	2	2	2	1	2	2	2	2	2	1
Pain	0	0	1	0	0	1	3	0	0	0	0	2	2	0	1	0	0	0	1	1	1	2	2	1	0	3	1	0	0
Cough	2	1	1	1	2	0	3	0	2	2	2	2	2	2	1	1	2	3	2	2	3	3	3	2	3	2	2	1	2
Breathlessness	1	1	2	1	2	1	2	1	2	2	2	0	2	1	1	0	1	2	2	2	2	2	2	2	2	2	2	1	1
Depression	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fever	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
Face swelling	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Lump under skin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Voice changing	0	0	1	0	0	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blood in sputum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Objective response
after induction
chemotherapy:
Maintenance



Progression:
→ Docetaxel



Progression:
→ Nivolumab



Innovations in research and clinical care using patient-generated health data

Heather S L Jim¹, Aasha I Hoogland¹, Naomi C Brownstein², Anna Barata¹, Adam P Dicker³, Hans Knoop⁴, Brian D Gonzalez¹, Randa Perkins⁵, Dana Rollison⁶, Scott M Gilbert⁷, Ronica Nanda^{8,9}, Anders Berglund², Ross Mitchell², Peter A S Johnstone⁸

Patient-reported outcomes regarding radiation therapy in patients with multiple myeloma

Ronica Nanda^{1,2}, David Boulware³, Rachid Baz⁴, Diane Portman⁵, H Michael Yu¹, Heather Jim², Peter A S Johnstone^{1,2}

Congruence of multiple patient-related outcomes within a single day

Peter A S Johnstone^{1,2}, Hailey W Bulls³, Jun-Min Zhou⁴, Jae K Lee⁴, Diane Portman⁵, Hsiang-Hsuan Michael Yu⁶, Heather Jim³

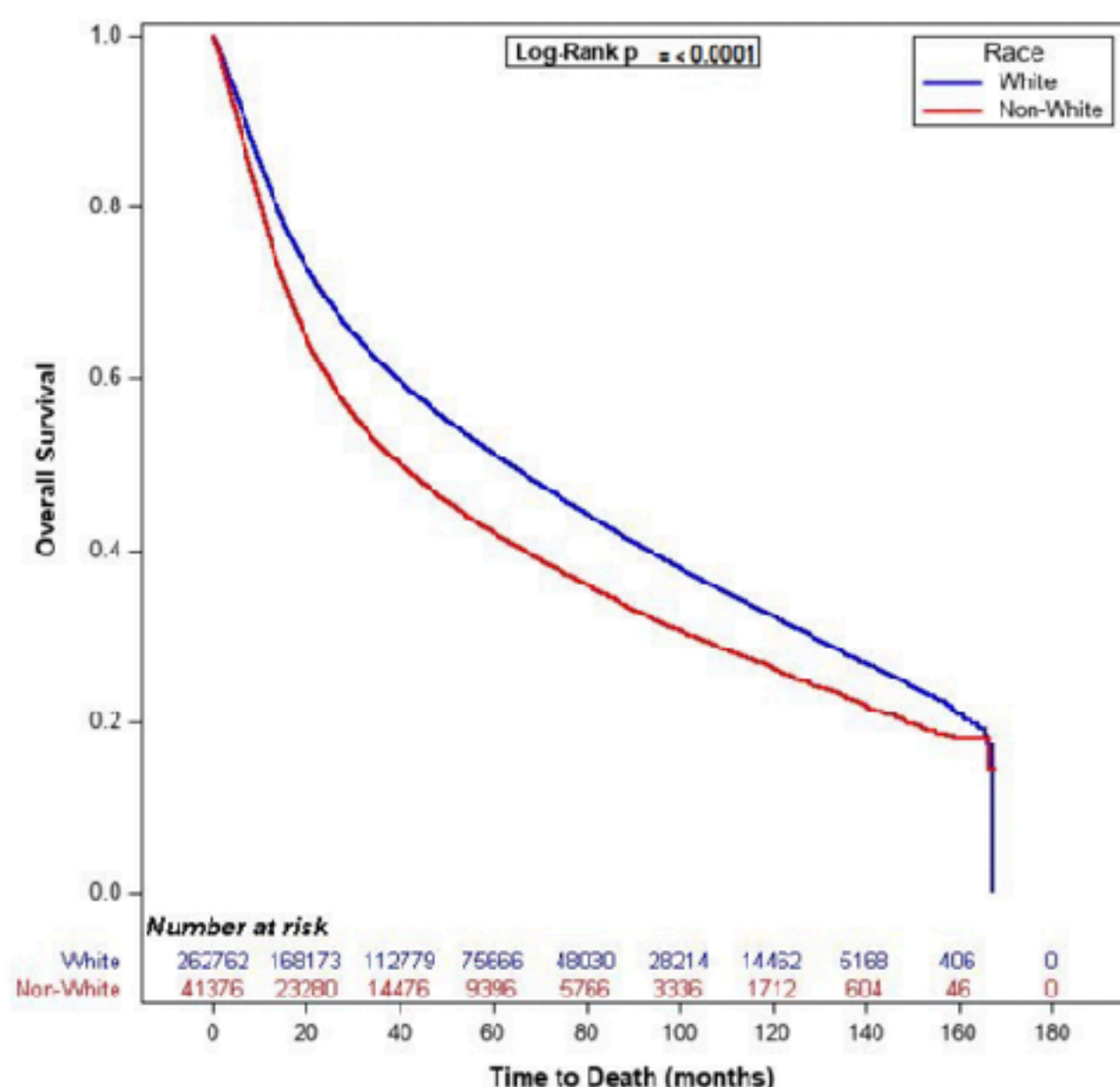
Patient reported outcomes in advanced penile cancer

Irini Youssef¹, Aasha I Hoogland², Jad Chahoud³, Philippe E Spiess³, Heather Jim², Peter A S Johnstone⁴

Health disparities in radiation oncology



Dr. Kosj
Yamoah

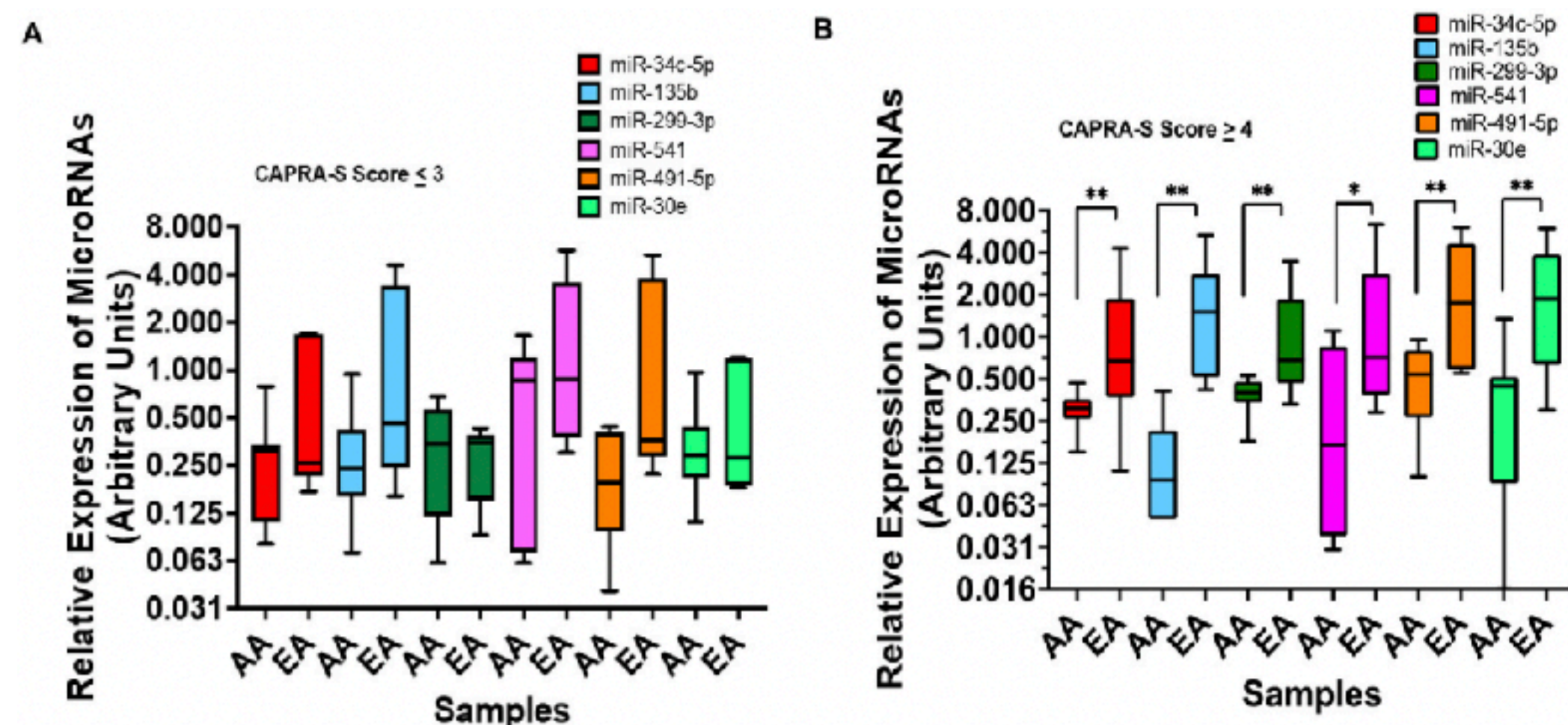


Differential Expression of miRNAs Contributes to Tumor Aggressiveness and Racial Disparity in African American Men with Prostate Cancer

Richard Ottman¹, Kavya Ganapathy¹, Hui-Yi Lin², Carlos Diaz Osterman³, Julie Dutil³, Jaime Matta³, Gilberto Ruiz-Deya³, Liang Wang⁴, Kosj Yamoah⁵, Anders Berglund⁶, Ratna Chakrabarti¹, Jong Y Park⁷

Disparities in Survival Outcomes among Racial/Ethnic Minorities with Head and Neck Squamous Cell Cancer in the United States

Sujith Baliga¹, Vedat O Yildiz¹, Jose Bazan¹, Joshua D Palmer¹, Sachin R Jhawar¹, David J Konieczkowski¹, John Grecula¹, Dukagjin M Blakaj¹, Darrion Mitchell¹, Christina Henson², Kenneth Hu³, Kosj Yamoah⁴, Mauricio E Gamez⁵



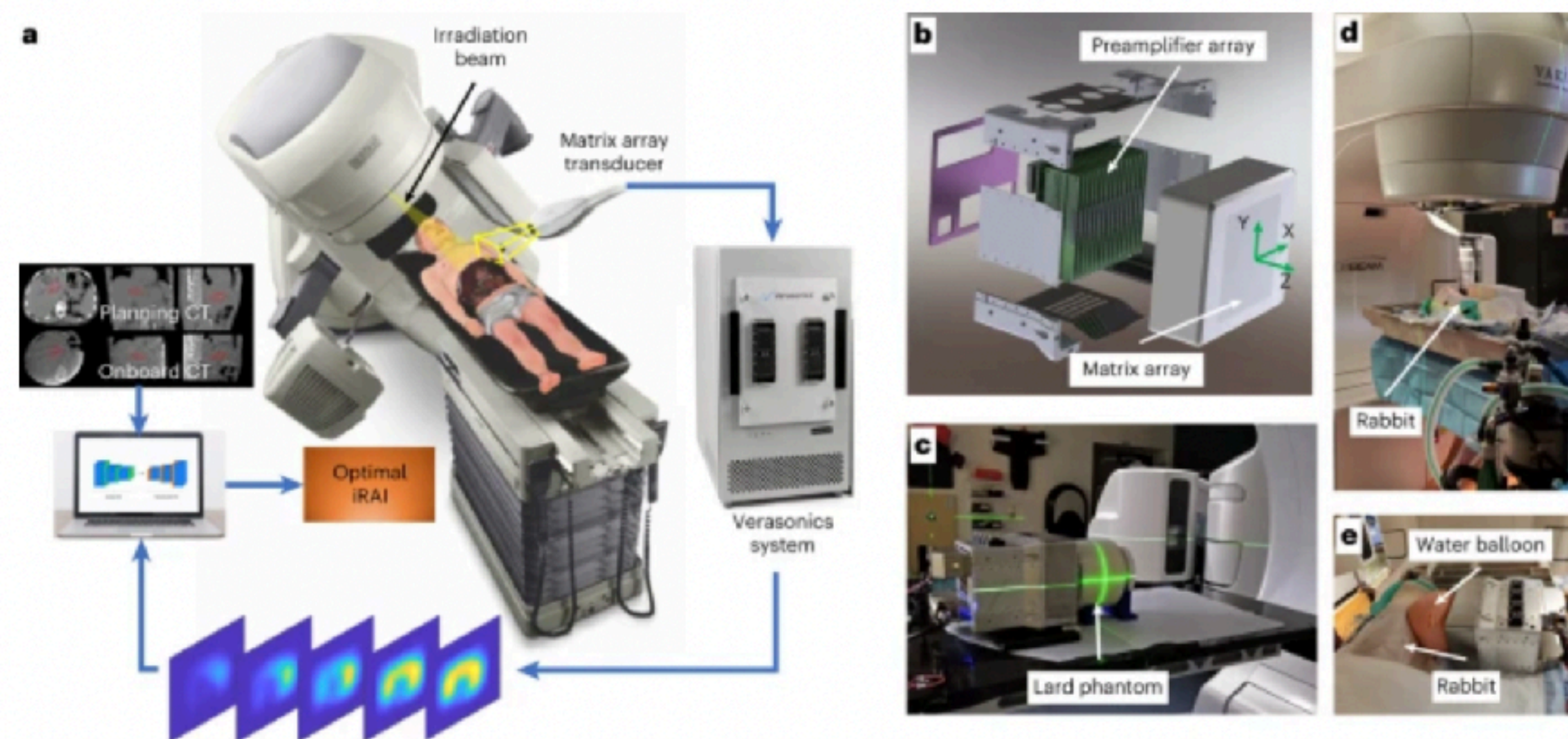
The imperative for clinical trial diversity: Perspectives in the context of prostate-specific membrane antigen-targeted imaging

Hae Lin Cho¹, Subha Perni², Anthony V D'Amico³, Kosj Yamoah⁴, Edward Christopher Dee⁵

Ionizing radiation acoustic imaging



Dr. Ibrahim
Oraiqt



Real-time, volumetric imaging of radiation dose delivery deep into the liver during cancer treatment.

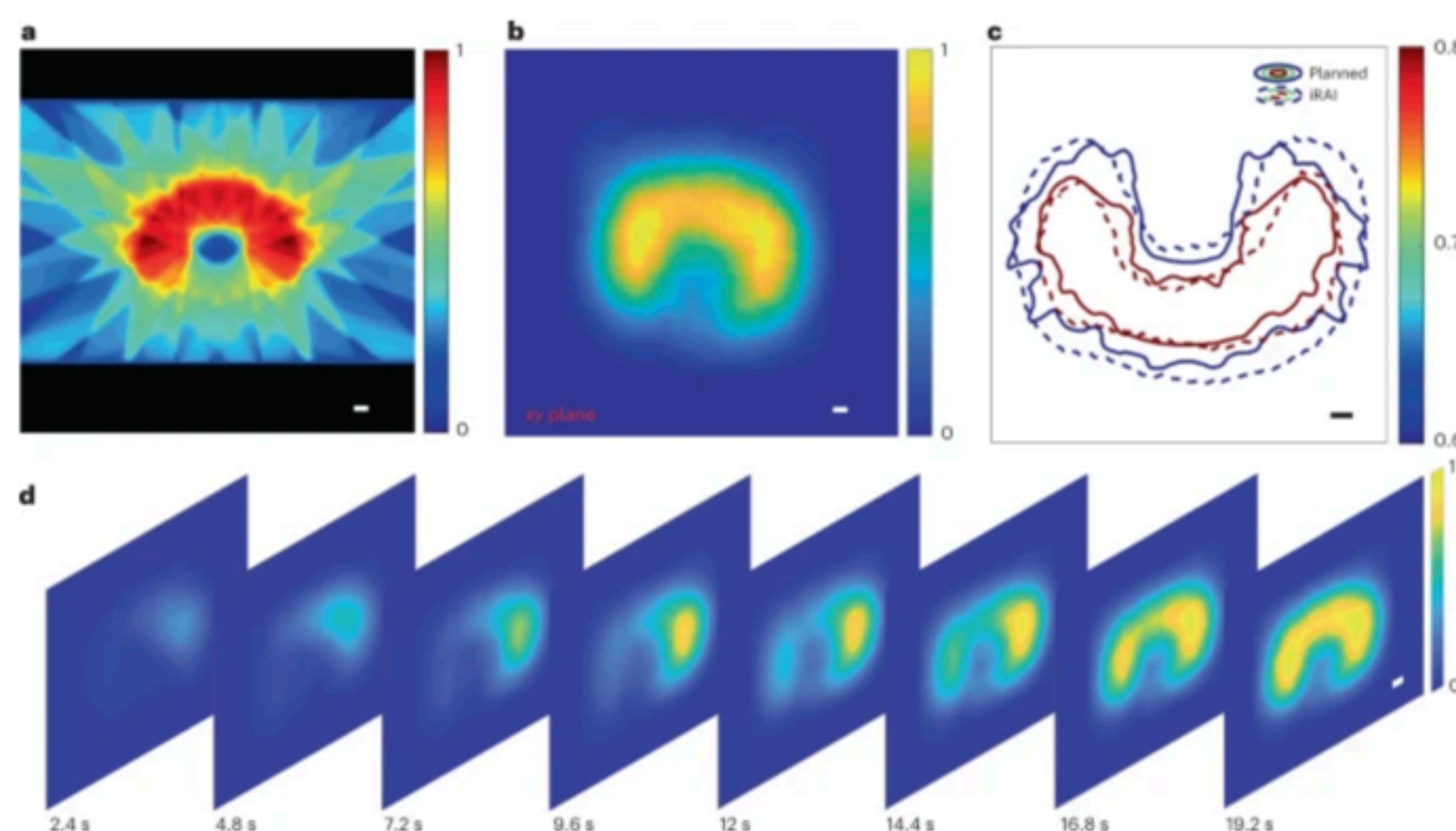
Zhang W, Oraiqt I, Litzenberg D, Chang KW, Hadley S, Sunbul NB, Matuszak MM, Tichacek CJ, Moros EG, Carson PL, Cuneo KC, Wang X, **El Naqa I.**

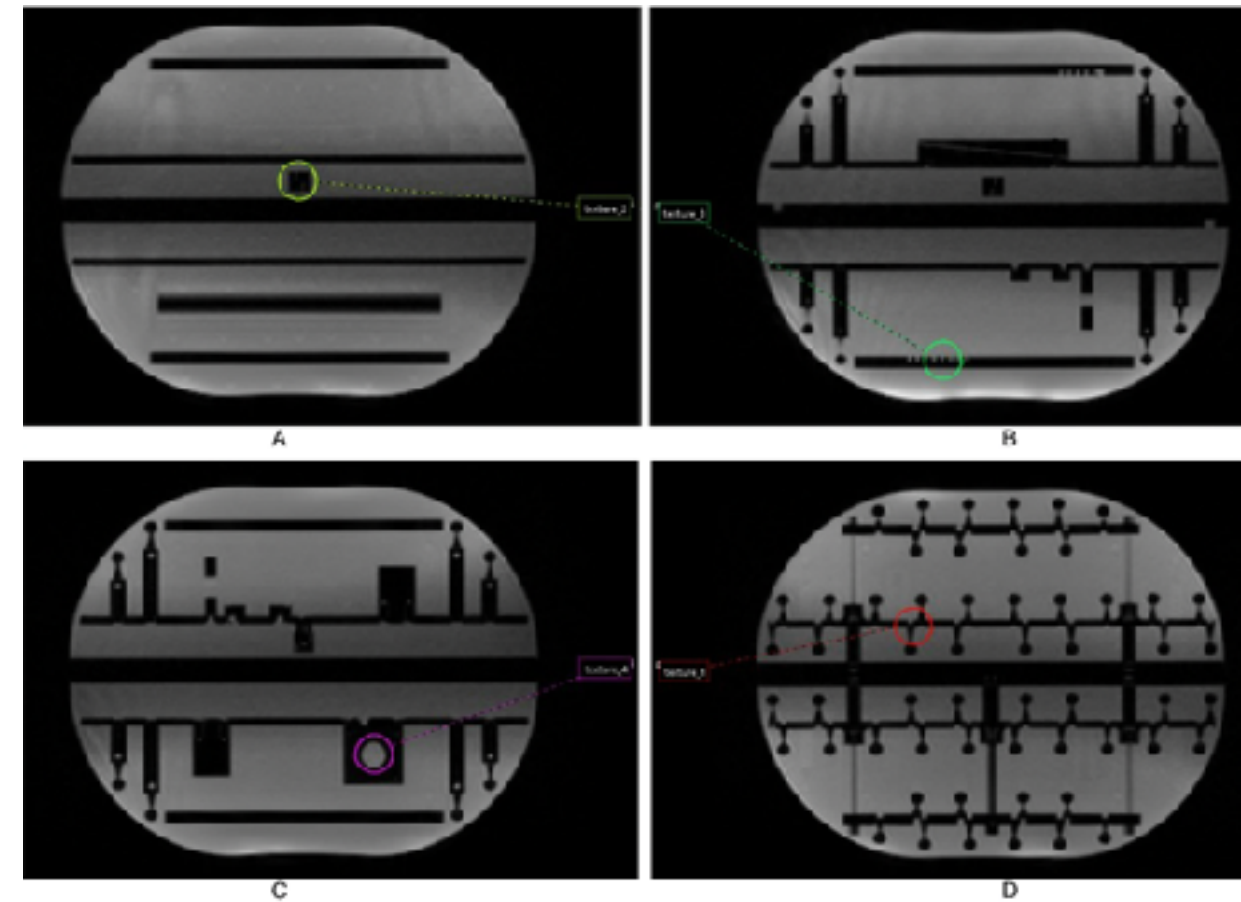
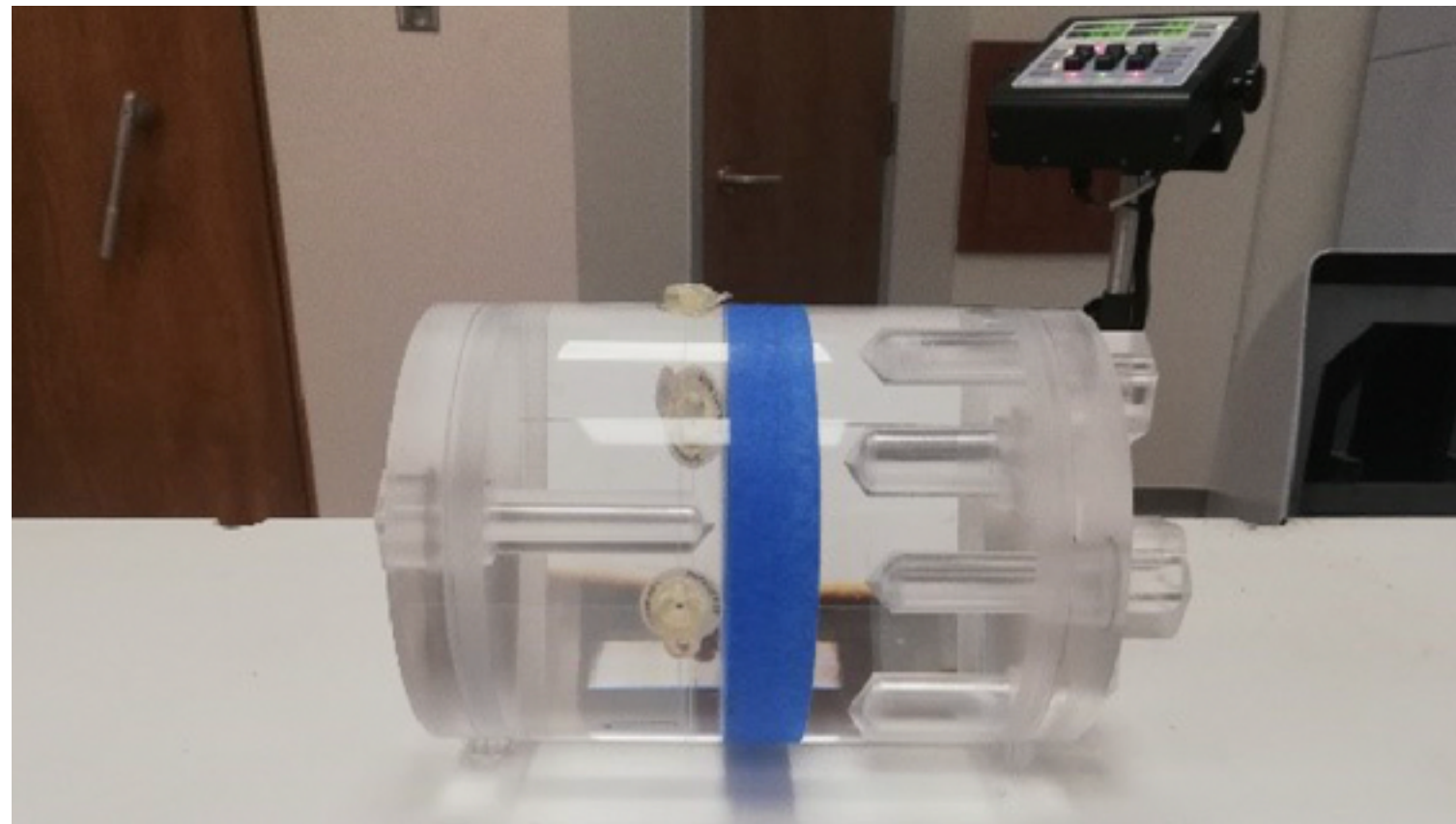
A simulation study of ionizing radiation **acoustic** imaging (iRAI) as a real-time dosimetric technique for ultra-high dose rate radiotherapy (UHDR-RT).

Ba Sunbul NH, Zhang W, Oraiqt I, Litzenberg DW, Lam KL, Cuneo K, Moran JM, Carson PL, Wang X, Clarke SD, Matuszak MM, Pozzi SA, **El Naqa I.**

An ionizing radiation acoustic imaging (iRAI) technique for real-time dosimetric measurements for FLASH radiotherapy.

Oraiqt I, Zhang W, Litzenberg D, Lam K, Ba Sunbul N, Moran J, Cuneo K, Carson P, Wang X, El Naqa I.





Robustness Assessment of Images From a 0.35T Scanner of an Integrated MRI-Linac: Characterization of Radiomics Features in Phantom and Patient Data

Rebecka Ericsson-Szecsényi ¹, Geoffrey Zhang ², Gage Redler ², Vladimir Feygelman ², Stephen Rosenberg ², Kujtim Latifi ², Crister Ceberg ¹, Eduardo G Moros ²

Evaluation of an MRI linac magnetic isocenter walkout with gantry rotation in the presence of angle-specific corrections.

Lotey R, Latifi K, **Moros EG**, Feygelman V.

Phys Med Biol. 2023 Apr 10;68(8). doi: 10.1088/1361-6560/acc724.

PMID: 36958055



Triggered kV Imaging During Spine SBRT for Intrafraction Motion Management.

Koo J, Nardella L, Degnan M, Andreozzi J, Yu HM, Penagaricano J, Johnstone PAS, Oliver D, Ahmed K, Rosenberg SA, Wuthrick E, Diaz R, Feygelman V, Latifi K, **Moros EG**, Redler G.

A Monte Carlo Method for Determining the Response Relationship between Two Commonly Used Detectors to Indirectly Measure Alpha Particle Radiation Activity.

Tichacek CJ, Budzevich MM, Wadas TJ, Morse DL, **Moros EG**.

Demographics Table				
MRN	DOB	Lname	Fname	DeathDate
12345	1/1/1900	Doe	Jane	1/1/1990
12346	1/2/1901	Doe	John	1/2/1990

TreatmentCourse Table						
MRN	TreatmentCourse	RadiationStart	RadiationEnd	Site	TotalDose	DosePerFraction
12345	1	1/1/1970	2/1/1970	R Breast	5000	200
12345	2	10/1/1970	10/14/1970	Whole Brain	3000	300
12346	3	5/1/1980	5/5/1980	LUL SBRT	5000	1000
12346	4	6/1/1981	6/6/1981	RUL SBRT	5400	1800
12346	5	12/1/1982	12/6/1982	RLL SBRT	4800	1200

Chemotherapy Table			
ChemotherapyID	TreatmentCourseID	Chemotherapy	Date
1	1	Adriamycin/Cytosan	9/1/1969
2	1	Adriamycin/Cytosan	9/21/1969
3	1	Adriamycin/Cytosan	10/15/1969
4	1	Adriamycin/Cytosan	11/7/1969

Artificial Intelligence Research: The Utility and Design of a Relational Database System

Thomas J Dilling ¹



Safety Survey

Mobile Unit



Welcoming Researchers



Acceptance testing setup

First beam
countdown



Dr. Moros

Dr. El Naqa

Dr. Oraiqat

Dr. Latifi

Mobetron Flash Radiation Unit Install

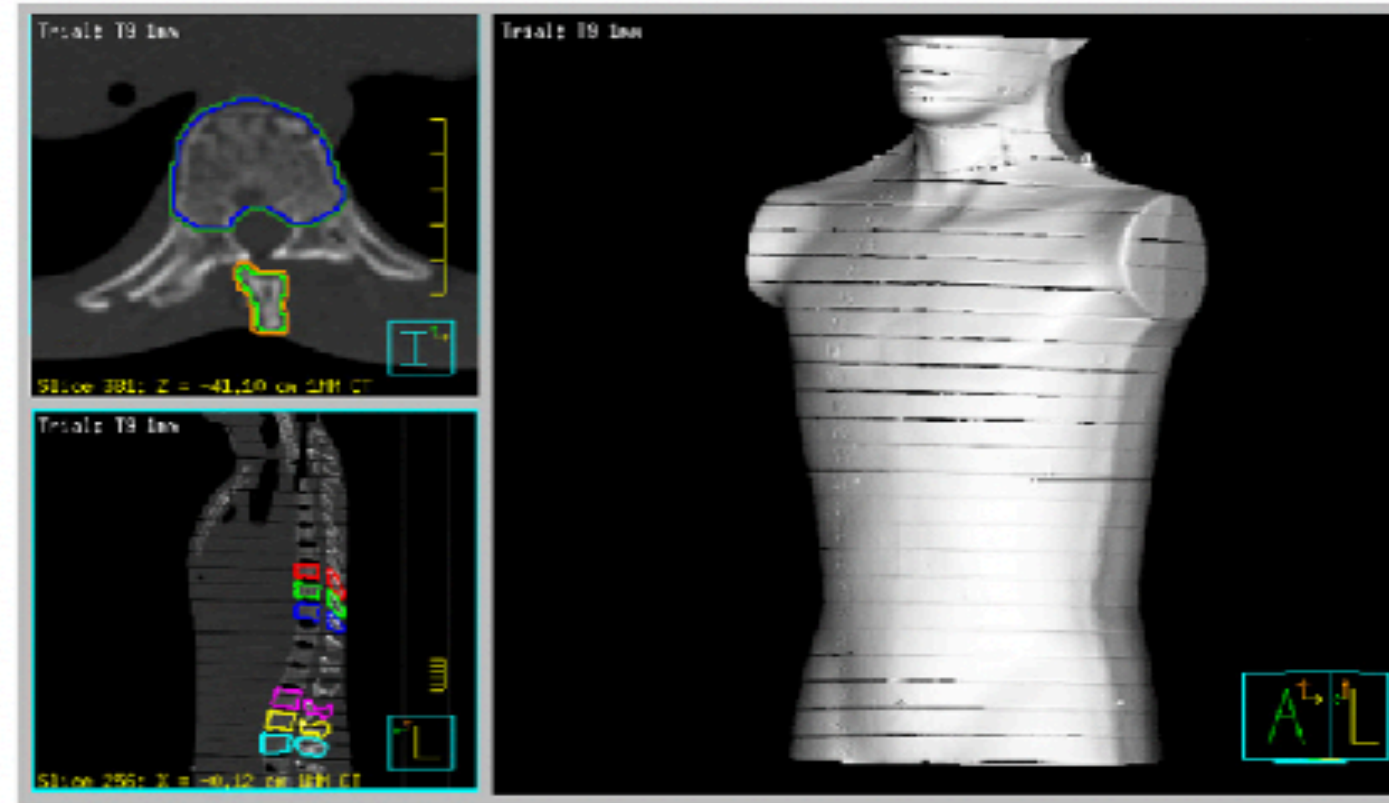
New pathways in
Radiotherapy Research

Radiation Oncology Residency Program



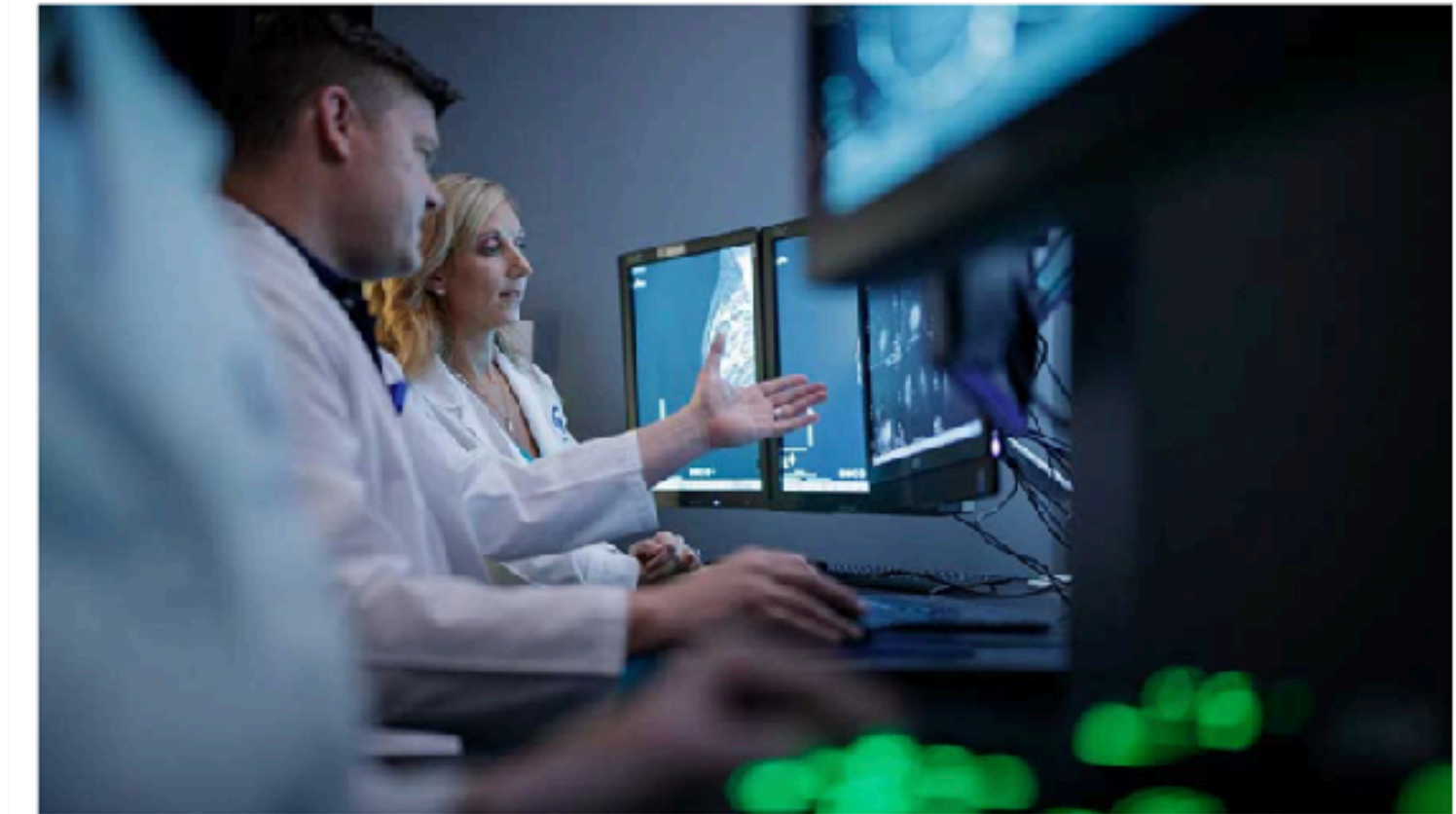
The Radiation Oncology Residency Program at Moffitt Cancer Center is sponsored by the [University of South Florida Office of Graduate Medical Education](#). Moffitt Cancer Center serves as the primary training site and assumes ultimate responsibility for the residency program. The James A. Haley Veterans' Administration Hospital and the University of Florida Proton Therapy Institute in Jacksonville, Florida, serve as participating training institutions (three months each). The residency

Medical Physics Residency Program



The **CAMPEP** accredited radiation oncology physics residency at Moffitt Cancer Center is a two-year program for individuals with an MS or PhD in medical physics from a CAMPEP accredited graduate program or individuals having completed a

Medical Physics PhD Program

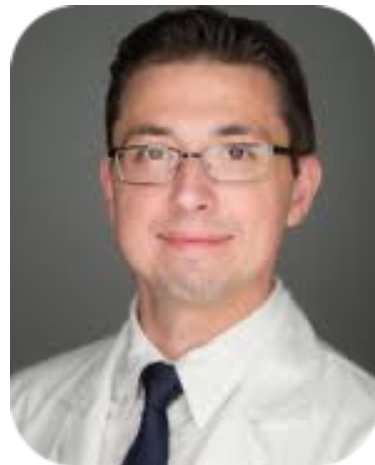


Ph.D. in Applied Physics With Concentration in Medical Physics

This CAMPEP-accredited degree program is a cooperative effort between the University of South Florida's Department of Physics and the H. Lee Moffitt Cancer Center and Research Institute's Departments of Radiation Oncology, Diagnostic



Dr. Jessica Frakes



Dr. Stephen Rosenberg



Dr. Gage Redler



Dr. Eduardo Moros

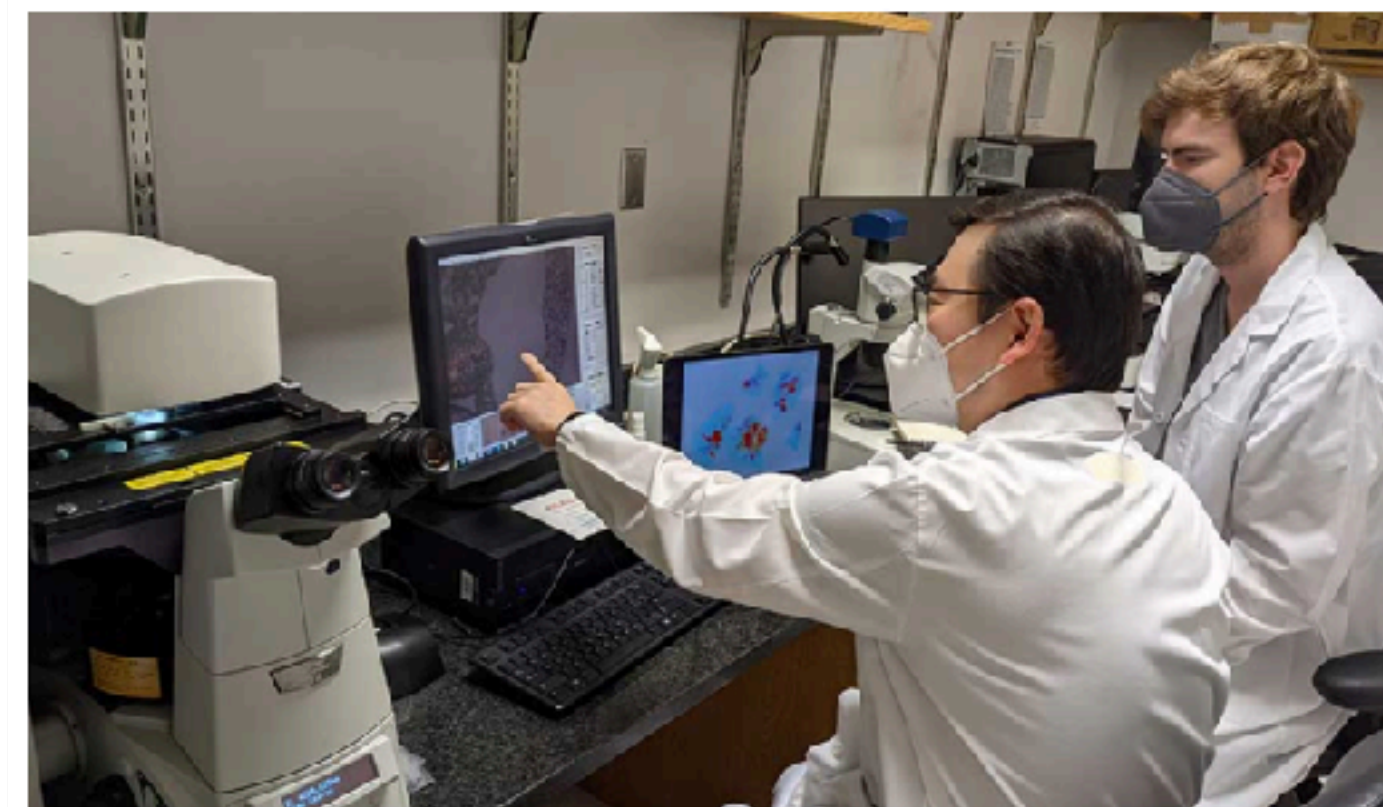


Integrated Mathematical Oncology



The Integrated Mathematical Oncology Major consists of focused training in mathematical modeling for cancer biology and clinical oncology problems. Students will also receive interdisciplinary training in the broader field of cancer biology and immunology through coursework and immersion in the Moffitt Cancer Center's research endeavors.

Integrated Program in Cancer and Data Science (ICADS) T32



Collaborative, cutting-edge research projects at the forefront of cancer and data science are central to the ICADS Program. In this training program, fellows in cancer biology and data science work in unison to attack a complex biological or population scale problem, bringing together critical puzzle pieces that drive interdisciplinary team science.



USF Health

University of South Florida

Honors & Awards

USF Medical Engineering Team Wins First Place In National NIH Competition

September 1, 2021 · 3:10 pm | [USF Health Honors and Awards](#)



National Institute of
Biomedical Imaging
and Bioengineering



Jeri Francoeur



Moffitt Patient Publishes in *Neoplasia*

In a recent mathematical oncology study led by Moffitt instructor Dr. Renee Brady-Nicholls, the team developed the first metastatic castration-resistant prostate cancer patient-specific mathematical model to use early prostate-specific antigen treatment response dynamics to predict subsequent responses to adaptive abiraterone acetate, demonstrating the putative value of integrating mathematical modeling into clinical decision making.

Mr. Robert Butler, the Moffitt enrolled on the clinical study analyzed in this article and Physical Sciences in Oncology Center (PSOC) patient advocate, contributed to this study with his patient experience and co-authored his first research article, published in the journal *Neoplasia* in September.

Congratulations to Mr. Butler and to Moffitt authors Drs. Renee Brady-Nicholls, Jingsong Zhang, Robert Gatenby, and Heiko Enderling!

[PMID: 34298234](#)



Pictured are Drs. Heiko Enderling, left, and Robert Gatenby, right, presenting a framed and signed copy of the article to Robert Butler.

Robert Butler



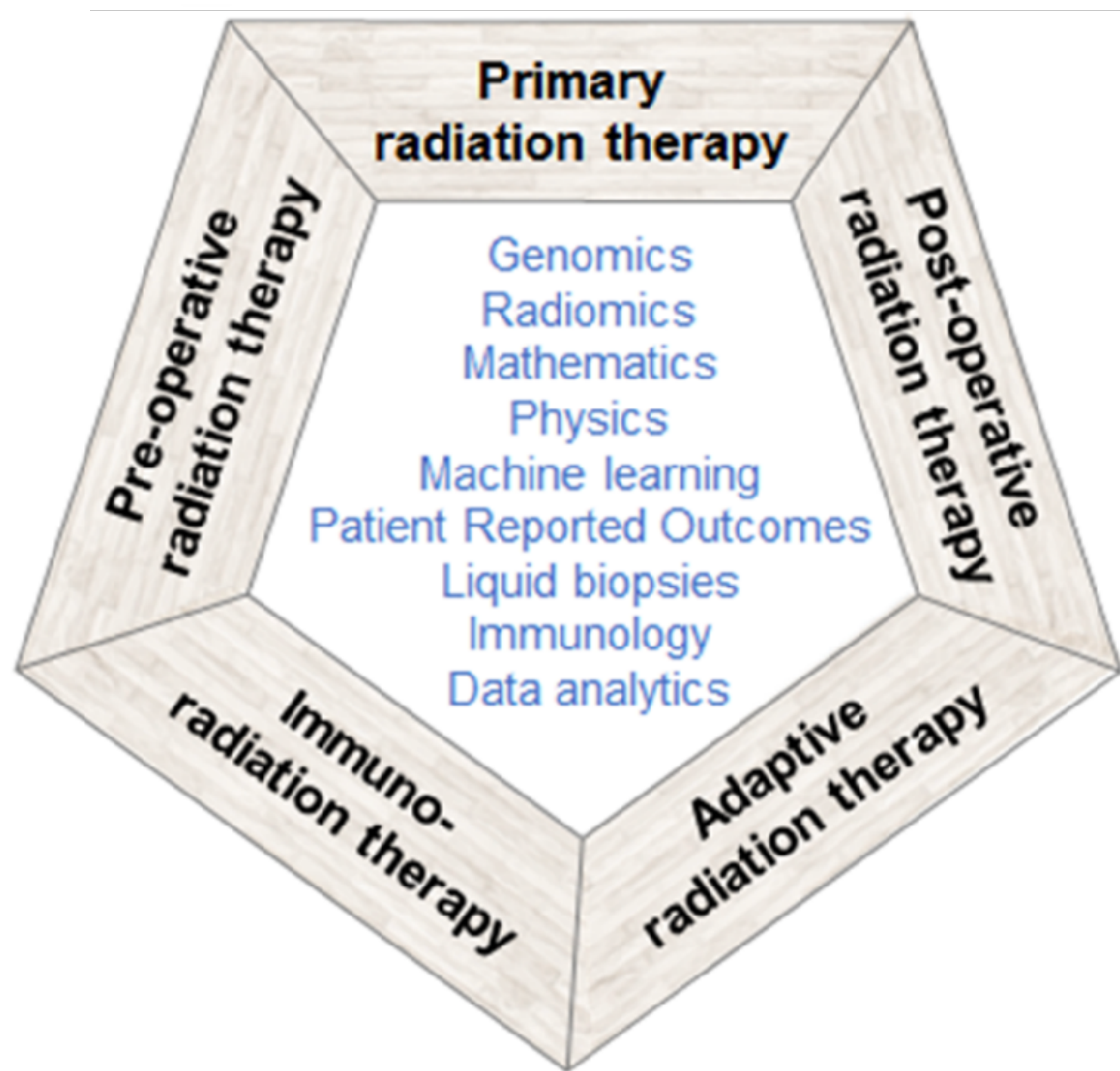
MoffittPSOC @MoffittPSOC · 19 Oct 2017

Our patient advocate Jeri Francoeur @FrancoeurJeri discusses benefits of including patients and patient advocates into research #2017PSON





Louis Harrison

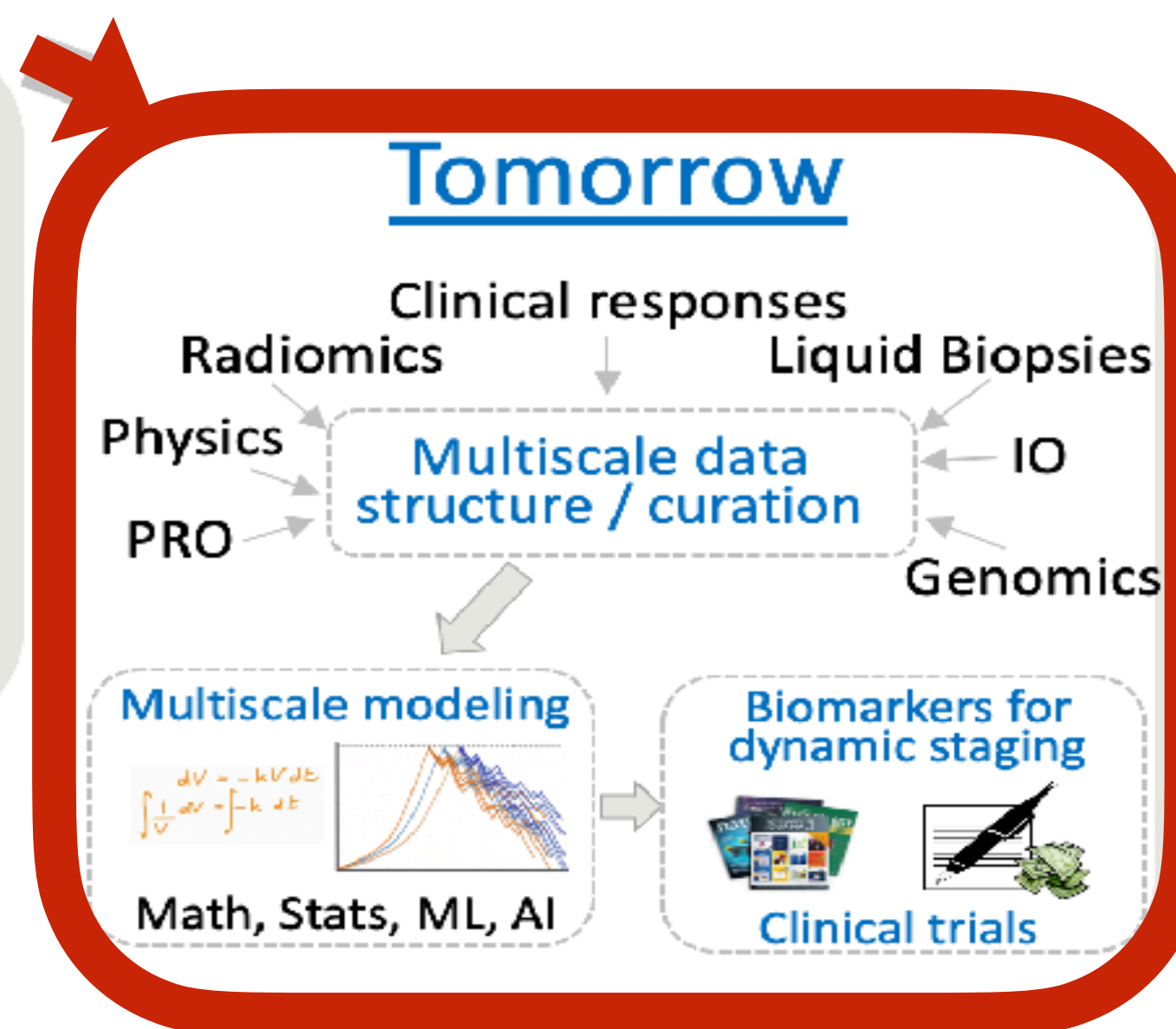
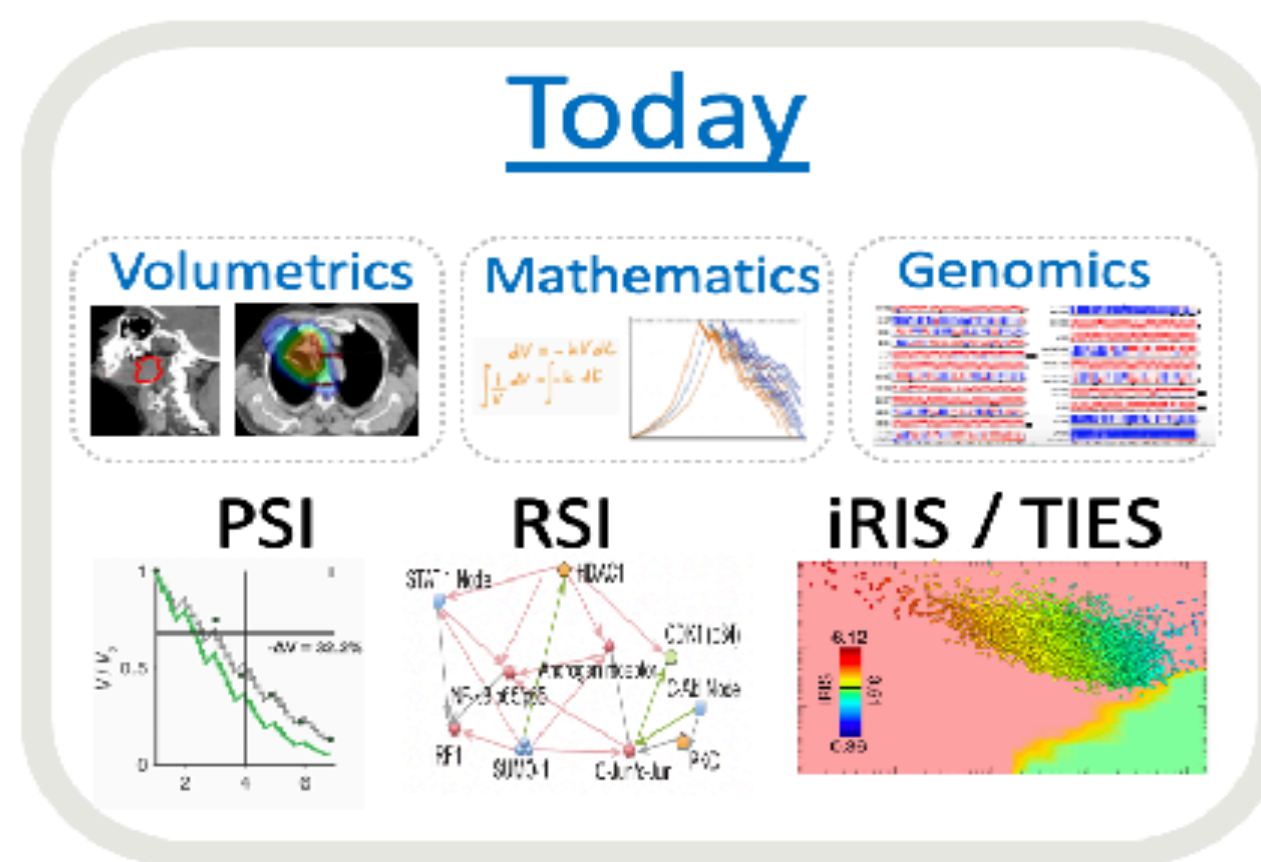
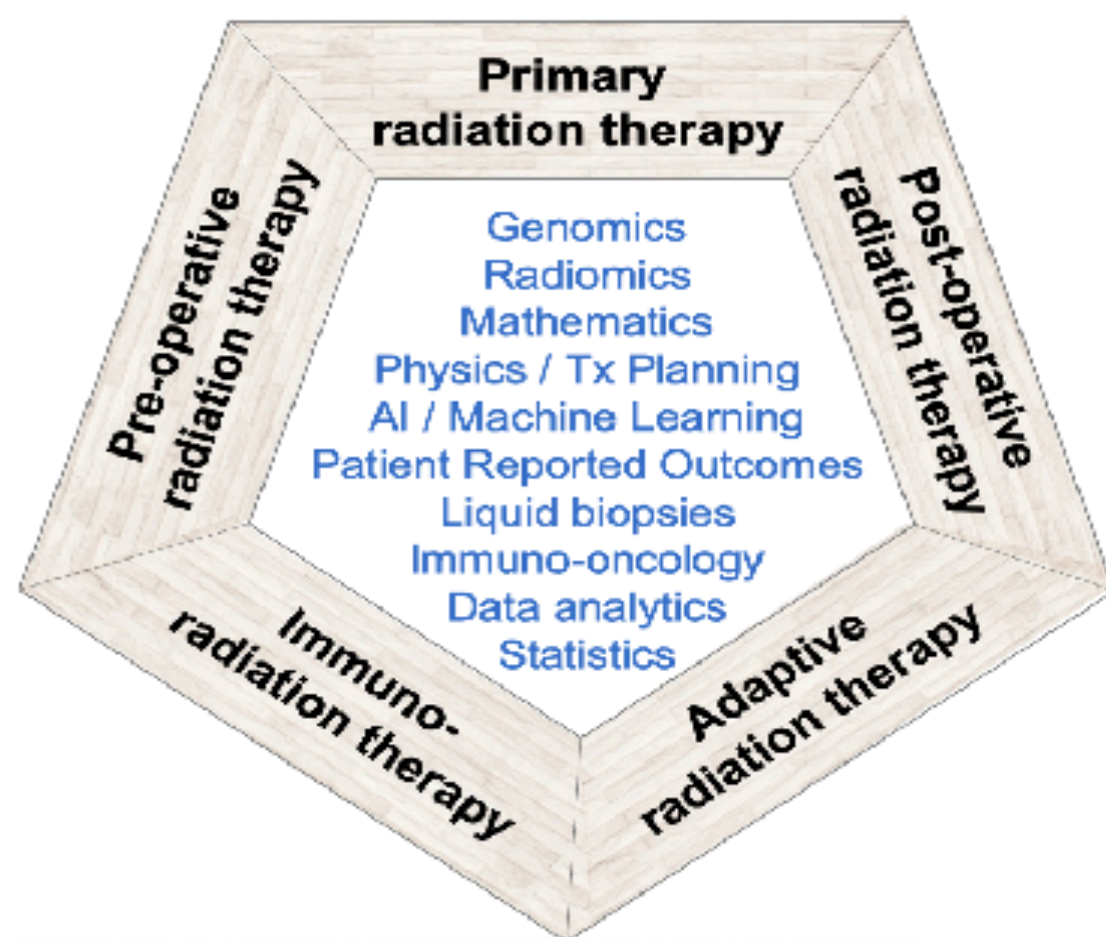


To develop a new model of *anatomically* and *biologically* personalized radiation therapy, *adapted* during treatment as triggered by individual patient and response characteristics, using novel *dynamic biomarkers* and principles of *evolutionary oncology*.

Moffitt as Global Epicenter of precision radiation oncology



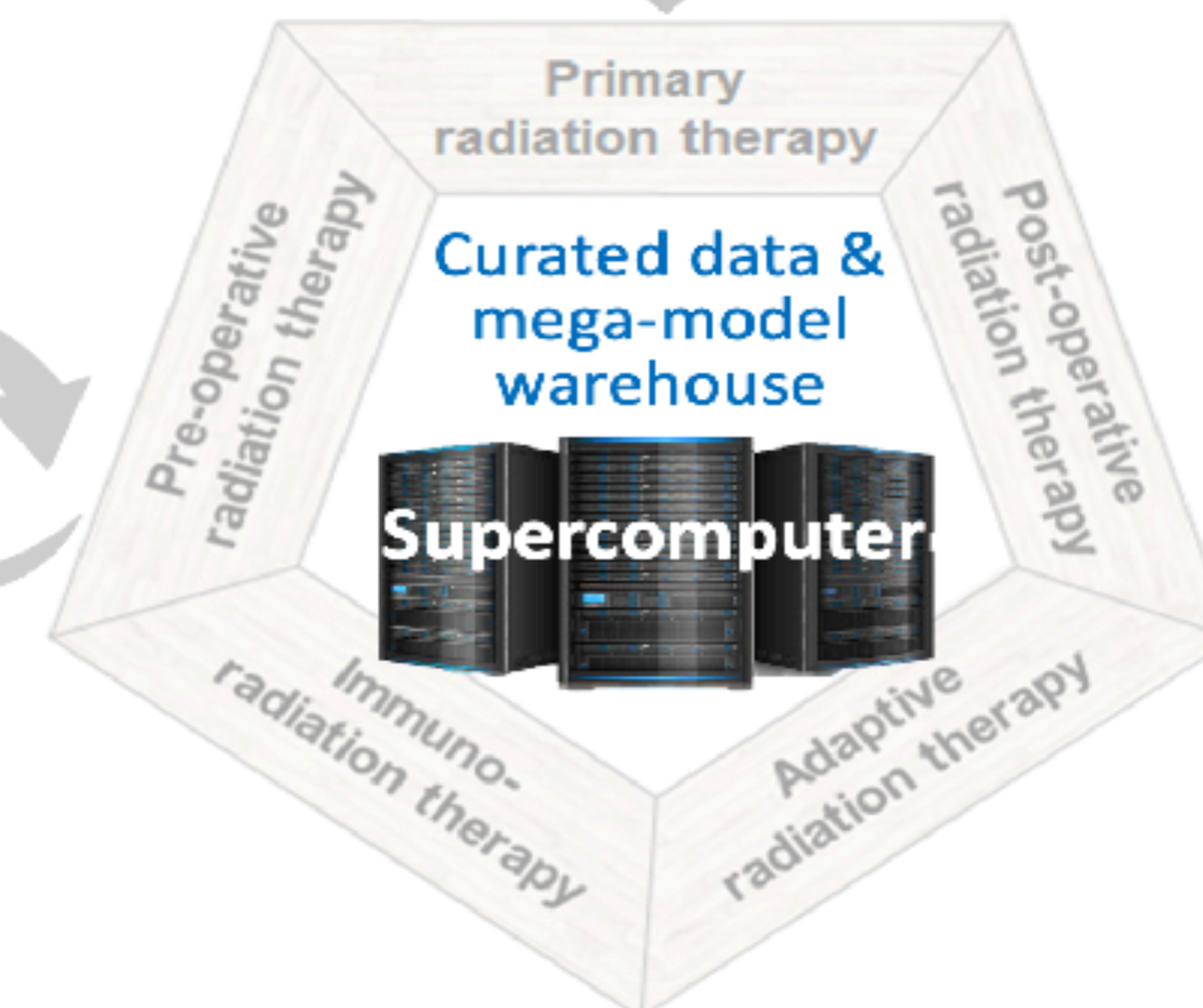
Louis Harrison



Future of Radiation Therapy (FORT)

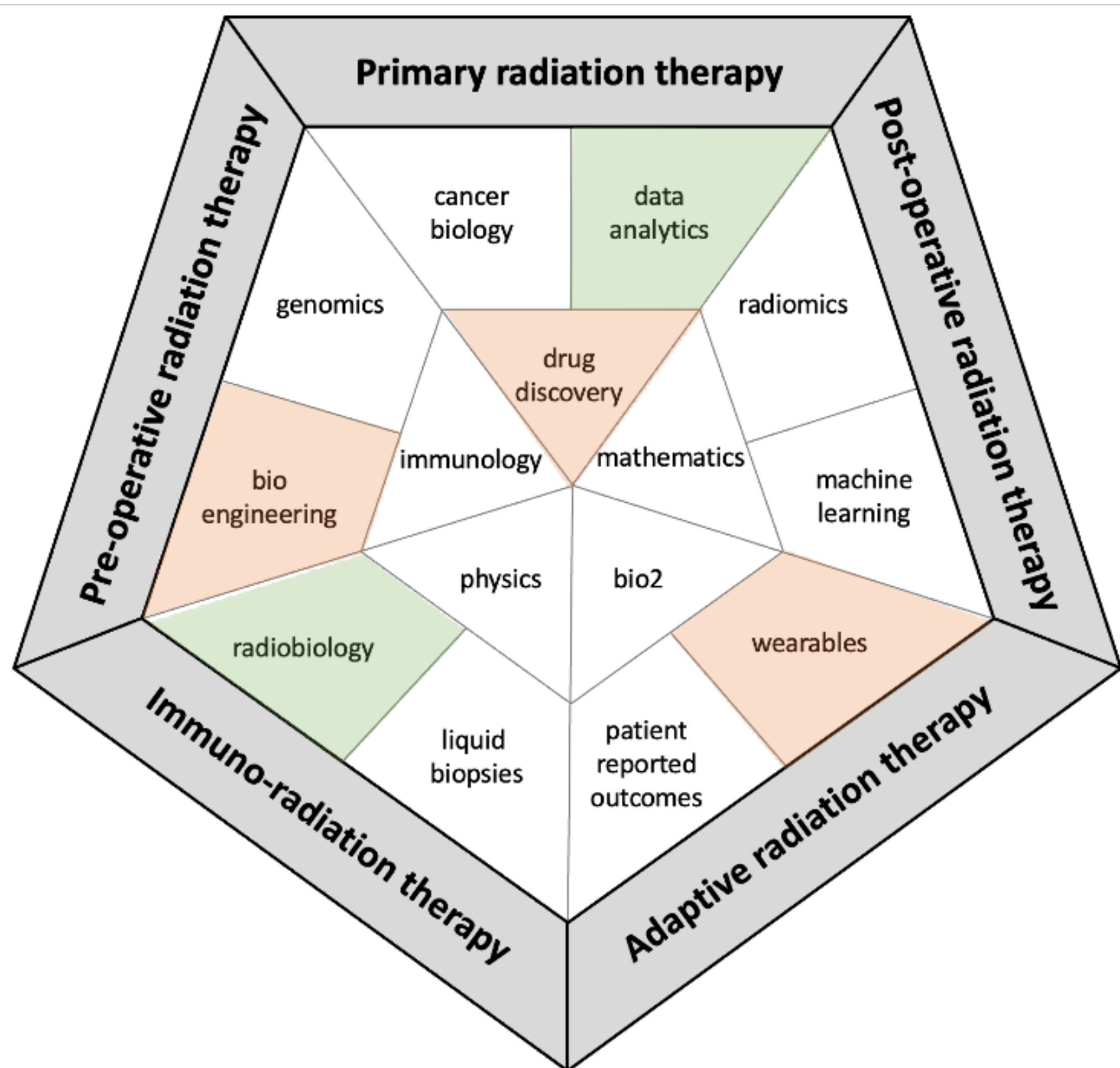


Personalized
biologically & anatomically
adaptive radiotherapy





FORT2.0 - Future of Radiation Therapy



Mission

Dramatically accelerate research and data-driven radiation oncology practice.

Translate successful research approaches to point of care using robust, reproducible, and trustworthy procedures.

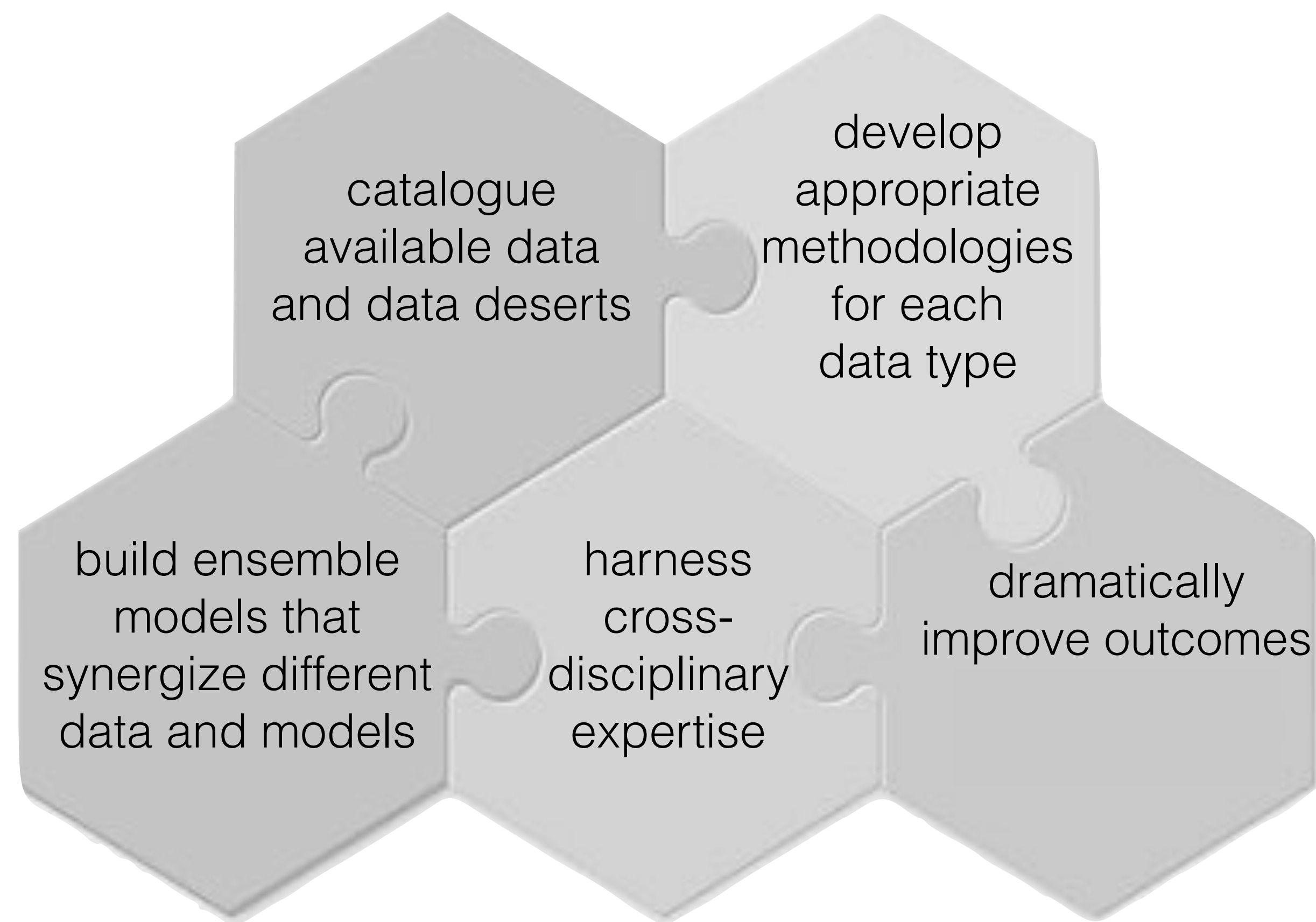
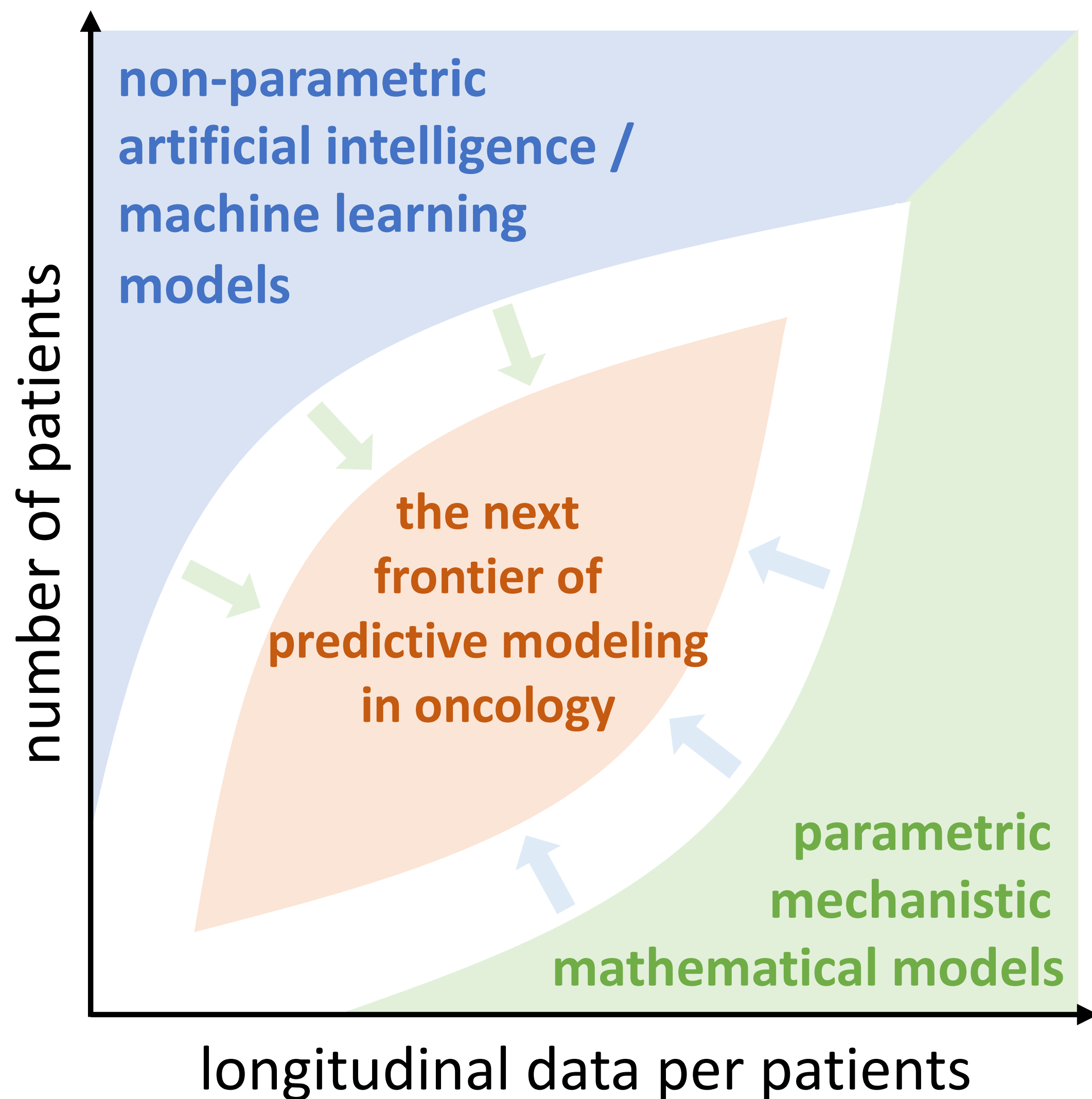
Impact decision making to improve cancer outcomes.

Strategy

Develop a synergistic basic, translational, and clinical research portfolio for extramural R01 funding.

Develop an R01 portfolio to position Moffitt RadOnc for competitive SPORE, P01, U54 program awards.

FORT2.0 - Future of Radiation Therapy





Radiation Oncology Translational Research Program

- to support F.O.R.T



Phase 1: Biobank Development

Phase one of the ROTR program will focus on the development of the RO specific biobank and hiring of key ROTR positions. This phase will require multiple meetings with key stakeholders for process development and buy-in. Phase 1 will span September 2022-June 2023

Phase 2: Biobank and Protocol Support Launch

Phase 2 will focus on the successful launch of the RO specific biobank (prospective patient accrual/targeted collections, retrospective tissue collection. Additionally, support for protocol development will be made available during this Phase. This Phase will be launched at a department wide meeting. This Phase will span July 2023-September 2023

Phase 3: Protocol Activation and Grant Support

Phase 3 will focus on activation of ROTR specific protocols for active accrual or active lab work. This will be led by the ROTR programs coordinator. Additionally, grant support will be offered to all RO faculty by the ROTR project specialist. This phase will span October 2023-March 2024

Phase 4: Maintenance

Phase 5 will focus on the maintenance of the biobank and support of existing studies developed in Phases 1-3. Phase 4 will span April 2024 on.

Phase 5: Expansion

Phase 5 will focus on the development of new study/grant development and expansion in to additional areas developed through the initiation of Phases 1-4. A SPORE application may be appropriate during this phase. This phase will span June 2024 on.



FORT2.0 - Future of Radiation Therapy

Anatomically
and biologically
optimized and
personalized
adaptive
radiation
dose and dose
fractionation

Decipher the
immunological
consequences
of radiotherapy

Initiate and
accelerate
research on
proton and
FLASH radiation

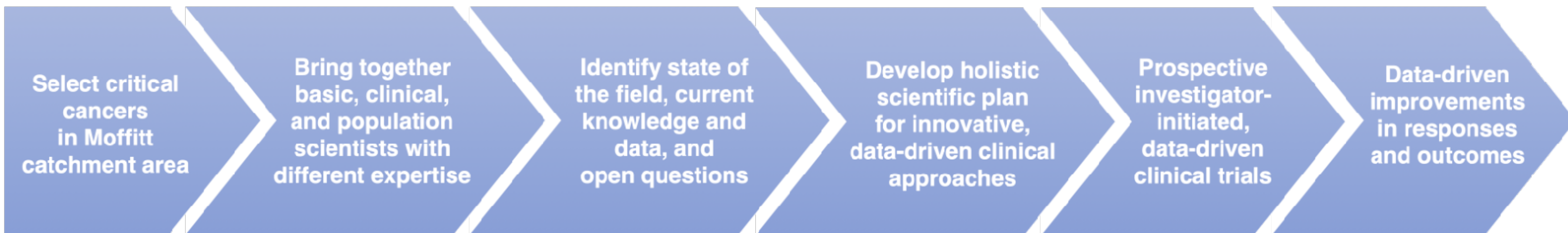
Synergize drug
discovery with
radiation
research across
the biological
and temporal
scales



FORT2.0 - Future of Radiation Therapy



Implementation





FORT2.0 - Future of Radiation Therapy



Strategic appointments / hires

- Vice Chair for Research, Radiation Oncology
- Radiation Oncology Data Scientist
 - Catalogue existing data sets, curate data for research, identify data deserts
 - Report to Radiation Oncology Chair / ACD Research Informatics
- Radiation Biology Faculty
 - Translational radiation biology
 - Academic particle medical physics (Proton/FLASH)
 - Multiscale radiomics -> treatment delivery data science



FORT2.0 - Future of Radiation Therapy



Strategic investments

- Research symposium
 - Bring in the latest and greatest from Rad Onc for Moffitt to learn
 - Scout for prospective graduate students, postdocs, faculty
- FORT fellowship
 - Support a resident or postdoc to perform strategic research towards our priority missions
- Pilot research funding
 - Support strategic research towards extramural funding, pilot clinical trials
- Radiation oncology research seminar series
 - Establish Moffitt RadOnc as research-driven department



Acknowledgements

Moffitt Cancer Center



MD Anderson

C. Dave Fuller

Abdallah S.R. Mohamed

Cleveland Clinic

Jacob Scott

Braunschweig University

Juan Carlos Lopez Alfonso

Patents

U.S. Patent 10/301,793:

Radiotherapy targeted to promote a systemic abscopal effect

U.S. Patent 62/900,003:

Modeling variability in radiosensitivity and tumor immune contexture to personalize radiotherapy
(*provisional*)

U.S. Patent 62/944,804:

Methods for prostate cancer intermittent adaptive therapy (*provisional*)

U.S. Patent 63/010,327:

Forecasting Individual Patient Response to Radiotherapy with a Dynamic Carrying Capacity Model (*provisional*)

U.S. Patent 62/040,579:

Predicting glioma treatment response (*provisional*)

U.S. Patent 63/176,039:

Time or tidal volume splitting ventilator and methods of use (*provisional*)

U.S. Patent 63/279,994:

Bayesian Framework to Augment Tumor Board Decision Making (*provisional*)

Funding



U01 CA244100

R21 CA234787

R21 CA263911

U01 (NOA pending)

