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# Balancing Modalities: The Role of Proton Therapy and Photons in Contemporary Radiation Oncology

With Sean Odou, CMD and  
Collin Nappi, MS, CMD

The Ohio State University Comprehensive Cancer Center—Arthur G. James Cancer Hospital and Richard J. Solove Research Institute

## Disclosures

- Ohio State has a training affiliation with Varian Medical Systems
  - Varian Training Center opened at OSUMC campus in 2015



- Partnership with Nationwide Children's Hospital to form James Outpatient Care and The Ohio State University Proton Center



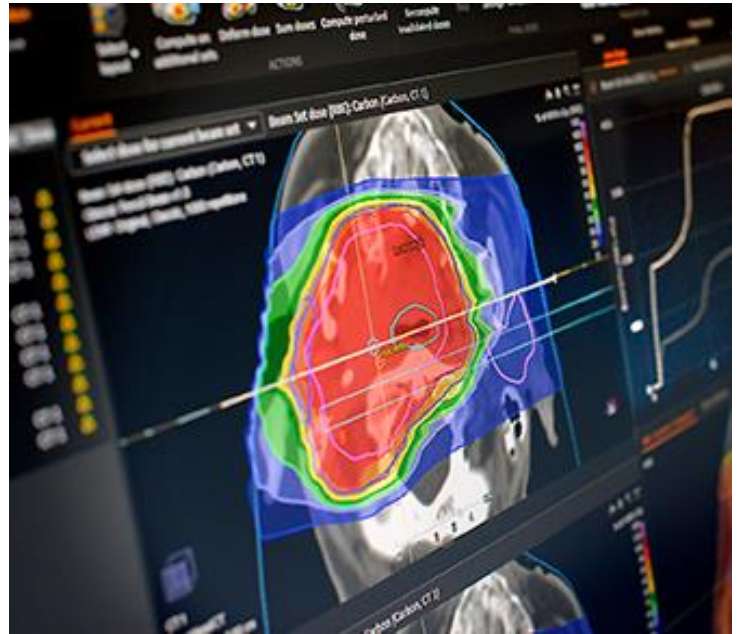
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## Summary of Software

- **ProBeam 360 (Varian)**
  - Field size 25 cm x 25 cm
- **RayStation 12A v13.1 (RaySearch Laboratories)**
- **MIM v7.3.4**
- **Eclipse v18.1 (Varian)**
- **Aria v18.1 (Varian)**
- **IHIS (Epic)**




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## This is not a debate

### PROTON


THE POSITIVE FORCE



# Vs

### PHOTON

THE SPEED OF LIGHT




**TARGETING:** PRECISE (BRAGG PEAK)

**DOSE TO HEALTHY TISSUE:** LOWER

**PENETRATION:** CONTROLLED DEPTH

**BEST FOR:** PEDIATRIC PATIENTS, RE-IRRADIATION

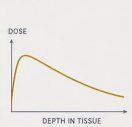


**TARGETING:** LESS PRECISE (ENTRY & EXIT DOSE)

**DOSE TO HEALTHY TISSUE:** HIGHER

**PENETRATION:** THROUGHOUT TISSUE

**BEST FOR:** LARGE OR IRREGULAR TARGETS, SINGLE ISOCENTER MULTI-TARGET SCENARIOS



DIFFERENT TOOLS. ONE MISSION: MAXIMUM TUMOR CONTROL. MINIMUM HARM.  
*Choosing the right particle for the right patient.*

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## Why This Discussion Matters

- Expansion of proton therapy availability
- Continued evolution of IMRT/VMAT techniques
- Increasing overlap in achievable dosimetry
- Need for thoughtful, patient-centered decision making

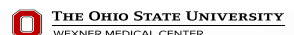
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## Learning Objectives

- Describe the physical and dosimetric principles that distinguish proton from photon therapy
- Justify when proton therapy provides clear advantages to photon therapy
- Recognize the limitations of proton therapy
- Apply practical decision-making strategies to determine which modality is most efficient

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# Introduction

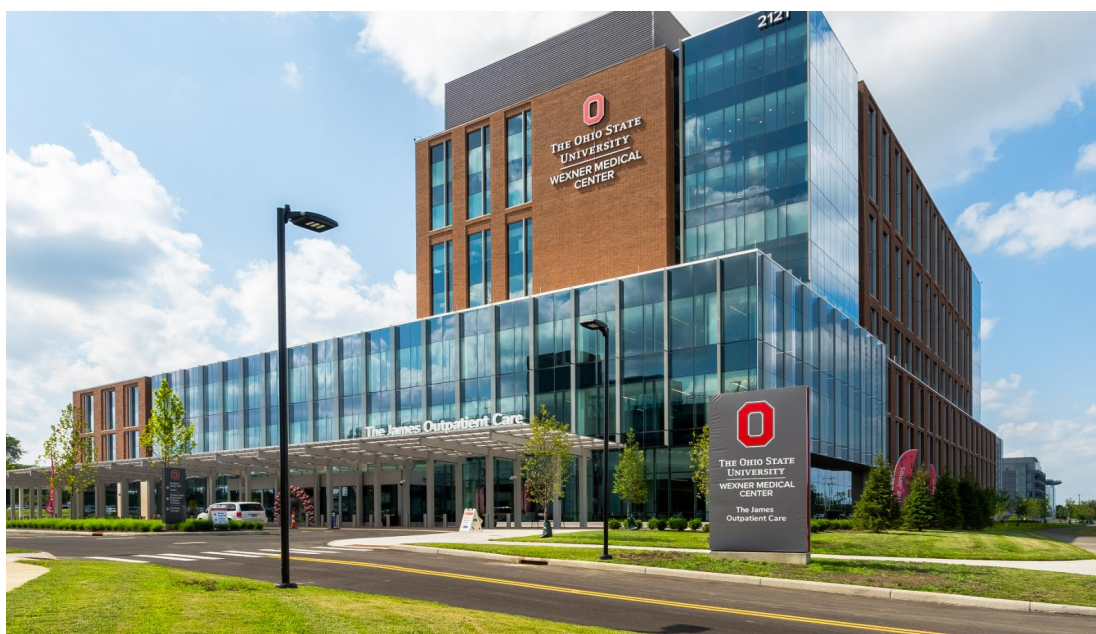
- Overview of the James Outpatient Care & Ohio State Proton Center
- The James Cancer Hospital & Stephanie Speilman Comprehensive Breast Center
- OSUMC Dosimetry Structure

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## James Outpatient Care & Proton Center



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## James Outpatient Care - Lobby



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## Pediatric Waiting Area



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## Treatment Rooms

- 2 ProBeam 360 gantries
- Research Fixed-Beam (Proton Flash)
- 1 Varian TrueBeam



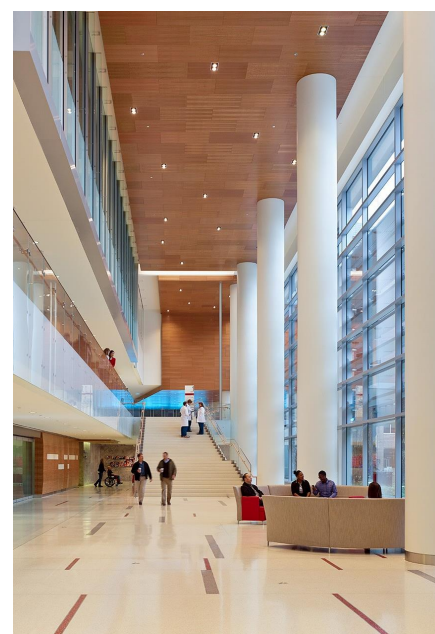
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## James Cancer Hospital

- 1 Varian Halcyon with Ethos adaptive
- 6 Varian TrueBeam Linacs (3 HD MLC, 3 SD MLC)



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# Stephanie Spielman Comprehensive Breast Center

- 2 Varian TrueBeam Linacs
- 1 HD MLC, 1 SD MLC



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## Structure of Dosimetry at James Cancer Hospital

- **Dosimetry Team:**
- 22 Photon Dosimetrists
  - **Dosimetry Manager**
  - **Asst Dosimetry Manager - Photons**
  - James Cancer Hospital - Main Campus
  - Stephanie Spielman Comprehensive Breast Center
  - James Outpatient Care
- 6 Proton Dosimetrists
  - **Asst Dosimetry Manager – Protons and JOC**
  - James Outpatient Care
  - Ohio State University Proton Center





# Proton Planning and Reality

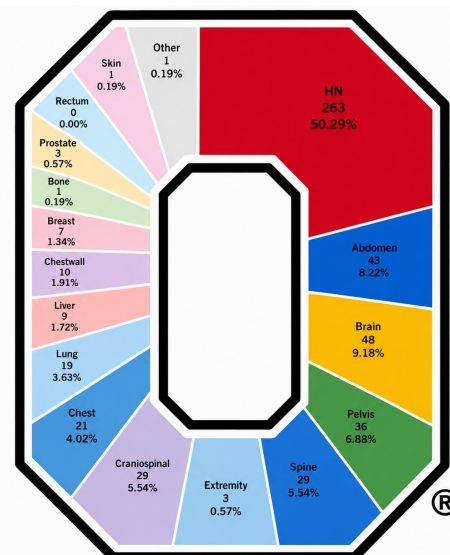
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## Proton Treatment Breakdown

- **50% HN**, **20% CNS**, **8% Abdomen**, **7% Pelvis**
- **631** treatment cases from May 2025- April 2026
- HN cases jumped from 29% to 50%
- Only ~12% of total cases at OSU (all modalities)



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# Why Are Proton HN Volumes Increasing?

## Landmark Lancet Phase III Trial Provides Level 1 Evidence of Survival and Toxicity Benefit

### Key Findings from MD Anderson Phase III Trial:

- Randomized Phase III trial: IMPT (proton) vs IMRT (photon)
- ~440 patients across 21 U.S. centers
- Largest randomized proton H&N trial to date

### Survival Benefit:

- 90.9% 5-year overall survival with proton therapy
- 81% with traditional radiation
- ~10% improvement in overall survival
- Various quality of life / toxicity benefits noted

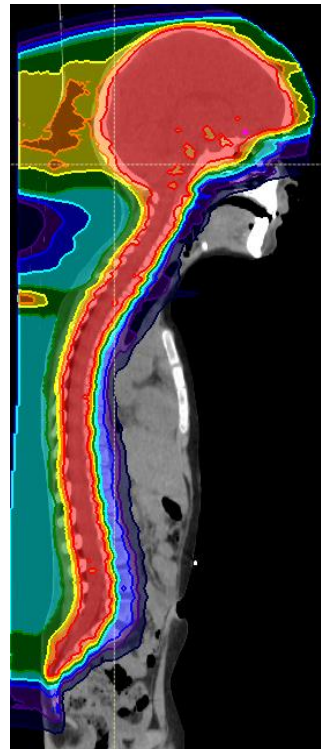
Reference: Frank SJ et al., *Lancet* 2025

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## Proton Magic




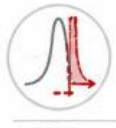





- Reduced exit dose and integral dose
- High impact clinical scenarios:
  - Pediatric patients
  - Re-Irradiation
  - Targets adjacent to critical structures



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# Where the Magic Fades

 Proton's Increased Sensitivity to the Patient	 Where the Magic Fades
 Setup variation	 Range uncertainty
 Anatomical changes	 Robust optimization complexity
 Respiratory motion	 Adaptive planning considerations
	 Impact on planning time and workflow

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# Uncertainties to Consider

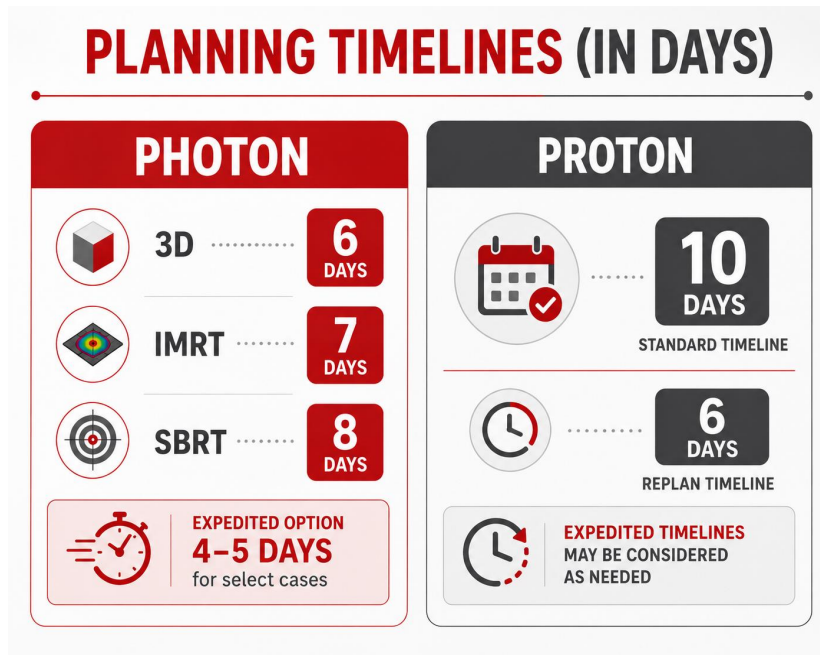
- Setup variability
- Potential tissue changes
- Artifact/contrast
- Metal/hardware/implants
  - Physics/MD acquire material information for override
- Machine delivery
- Breathing motion
- What's underneath patient (blankets, sheets)
- Treatment Couch



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# Planning Timelines



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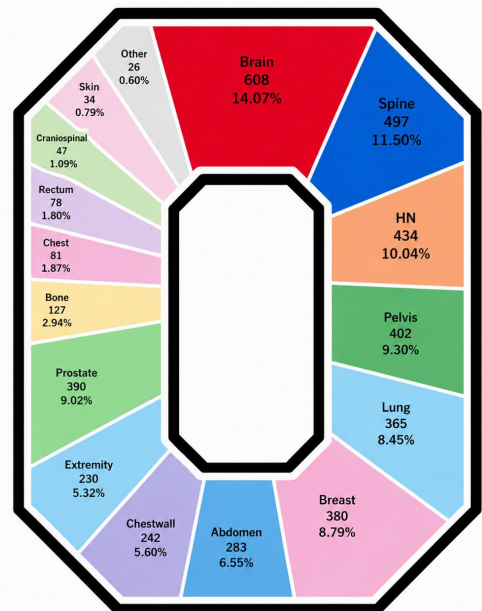
# Advanced Photon Therapy

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# Photon Treatment Breakdown

- **27% CNS**, **19% GU/GYN**, **10%HN**, **9% Breast**
- **4595** Treatment cases from May 2025- April 2026

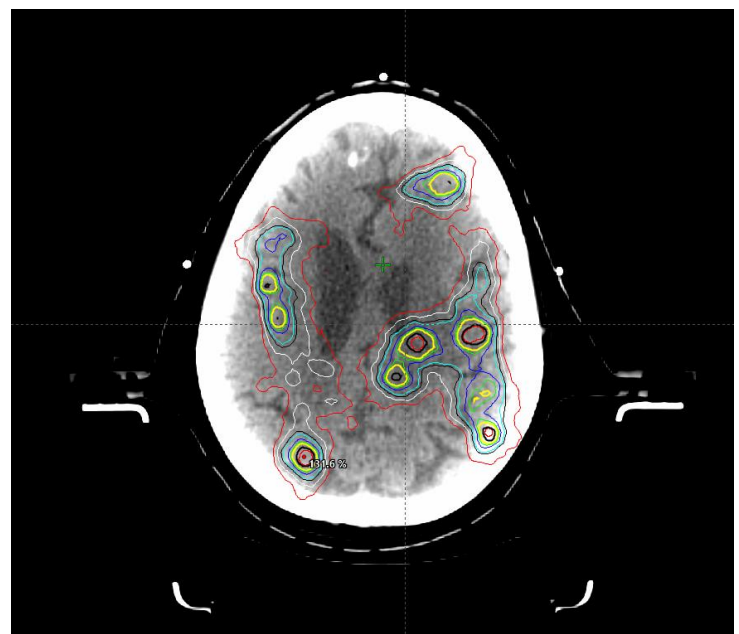


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# Clinical Scenarios Where Photons Are Often Preferred

- Large or irregular targets
- Highly mobile anatomy
- Situations requiring rapid adaptation
- Single Isocenter Multi-Target scenarios



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# Capabilities of Modern Photon Techniques

Robustness  
and  
reliability

IMRT and  
VMAT  
conformity

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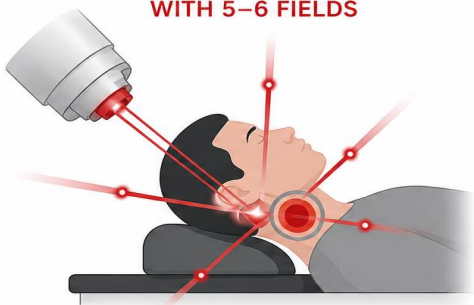
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# Proton vs. Photon Efficiency

Efficient planning and delivery

**HN PROTON THERAPY**

WITH 5-6 FIELDS



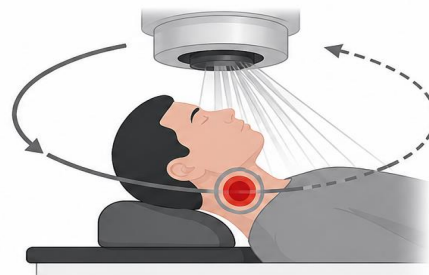
**45**  
MINUTES

TO SETUP AND TREAT

VS

**HN PHOTON THERAPY**

WITH 3 ARCS (320 DEGREES)



**20**  
MINUTES

TO SETUP AND TREAT











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# Capabilities of Modern Photon Techniques

- Efficient planning and delivery

## TIME SLOT COMPARISON

★ PHOTON		● PROTON	
 <b>STANDARD CASES</b> (Single Iso, No Anesthesia)	<b>TIME SLOT</b> <b>20</b> MINUTES 	 <b>STANDARD CASES</b> (Single Iso, No Anesthesia)	<b>TIME SLOT</b> <b>25</b> MINUTES 
 <b>MULTI ISO AND / OR ANESTHESIA</b>	<b>TIME SLOT</b> <b>40</b> MINUTES 	 <b>MULTI ISO AND / OR ANESTHESIA</b>	<b>TIME SLOT</b> <b>50</b> MINUTES 
 Photon Time Slots: <b>20 or 40 MINUTES</b>		 Proton Time Slots: <b>25 or 50 MINUTES</b>	



Multi Iso and Anesthesia cases require longer time slots to accommodate additional treatment time and patient needs.

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# Proton Therapy Prioritization

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## Why Prioritization Is Necessary

- Limited proton capacity
- Increased planning complexity
- Variable clinical benefit
- Need for responsible utilization

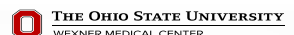
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## Screening for Proton Candidacy

- Key Triggers: Automatic Qualifying Criteria
  - Pediatric
  - Re-irradiation
  - Age (Definitive cases under 41 years old)
  - Group 1 indications (ASTRO i.e Chordomas, Chondrosarcomas)
  - Radio-sensitizing conditions (NF-1, Li-Fraumeni, etc.)
  - Critical structure proximity
  - Anticipated meaningful dose reduction

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# Delivery and Planning Considerations

- Field size limitations including robustness (25 x 25 cm)
- Post-op changes expected between simulation and treatment
- Obtaining unknown material overrides and implants
- Patient weight ( BOS frame has 330lb limit)
- Motion Management

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# Multidisciplinary Review Process

- Physician identification of potential candidates
- Early planner and physicist feasibility assessment
- Multidisciplinary discussion prior to full plan investment
- Case presentations **MUST** be accompanied by screen shares of imaging

## Proton Prioritization Request

This form is to be used to request patients be added to the Proton Prioritization case presentation list. Patient or on a COG trial should be submitted via this form but will bypass case presentation.

Hi, Sean. When you submit this form, the owner will see your name and email address.

\* Required

1. Please enter the patient's **MRN**

\* [ ]

Enter your answer

2. Please enter the patient's **First Name**

\* [ ]

Enter your answer

3. Please enter the patient's **Last Name**

\* [ ]

Enter your answer

4. Please enter the **patient's diagnosis and treating ICD10**, if known

\* [ ]

Enter your answer

5. Please enter the **consult date** this patient was seen or will be seen

\* [ ]

Please input date (M/d/yyyy)

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# Scoring and Dosimetric Considerations

## Scoring Configuration

Configuring scoring weights, sub-component scores, and priority thresholds

Dimension Weights   **Clinical Urgency**   Administrative   Priority Thresholds   Version History

Age Scoring		Diagnosis Scoring	
Pediatric	10	High Priority (Sarcoma/Pediatric)	10
Unknown Age	5	CNS	7
Young Adult	8	Head & Neck	5
Adult	5	Default	3
Elderly	3		
Young Adult Threshold	40 years		
Elderly Threshold	65 years		

Treatment Intent		Re-irradiation	
Curative	10	Prior Radiation Present	8
Definitive	10	Prior Radiation Absent	2
Palliative	1		
Other	4		

## Physics / Dosimetry

**Physics/Dosimetry Checklist** v1 Active + Create New Version

Physics and dosimetry feasibility assessment checklist  
Created by on Invalid Date Edit

10 Items			
Label	Type	Required	Enabled
1 Protons Provide Dosimetric Benefit vs Photons	Toggle	No	Yes
2 OAR Goals Achievable With Protons	Toggle	No	Yes
3 In-Field Hardware Limits Proton Feasibility	Toggle	No	Yes
4 Rad-Sensitive Devices Limit Feasibility	Toggle	No	Yes
5 Target Size Within Field Delivery Limits	Toggle	No	Yes
6 Anatomy Change/Body Habitus Concerns	Toggle	No	Yes
7 Table Weight Limit OK	Toggle	No	Yes
8 Motion Management Required	Toggle	No	Yes
9 Motion Assessment Notes	Textinput	No	Yes
10 Multiple isocenters (2+)	Toggle	No	Yes

**Checklist Items (10)** + Add Item

- Protons Provide Dosimetric Benefit vs Photons Toggle ✎ 🗑
- OAR Goals Achievable With Protons Toggle ✎ 🗑
- In-Field Hardware Limits Proton Feasibility Toggle ✎ 🗑
- Rad-Sensitive Devices Limit Feasibility Toggle ✎ 🗑
- Target Size Within Field Delivery Limits Toggle ✎ 🗑
- Anatomy Change/Body Habitus Concerns Toggle ✎ 🗑
- Table Weight Limit OK Toggle ✎ 🗑
- Motion Management Required Toggle ✎ 🗑
- Motion Assessment Notes Toggle ✎ 🗑
- Multiple isocenters (2+) Toggle ✎ 🗑

Can only be selected if option 5 (Target Size Within Field Delivery Limits) is Yes

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## Role of Comparative Planning

- Defining success metrics up front
- Objective evaluation of benefit vs complexity
- Avoiding "proton by default" planning
- Backup photon planning in case of proton downtime
- Increasing cases involving hybrid of modalities

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# Real-World Planning Comparisons

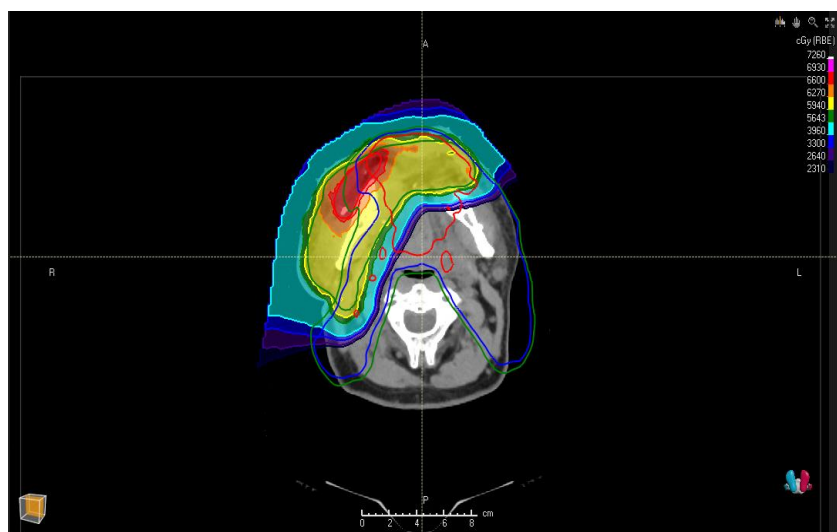
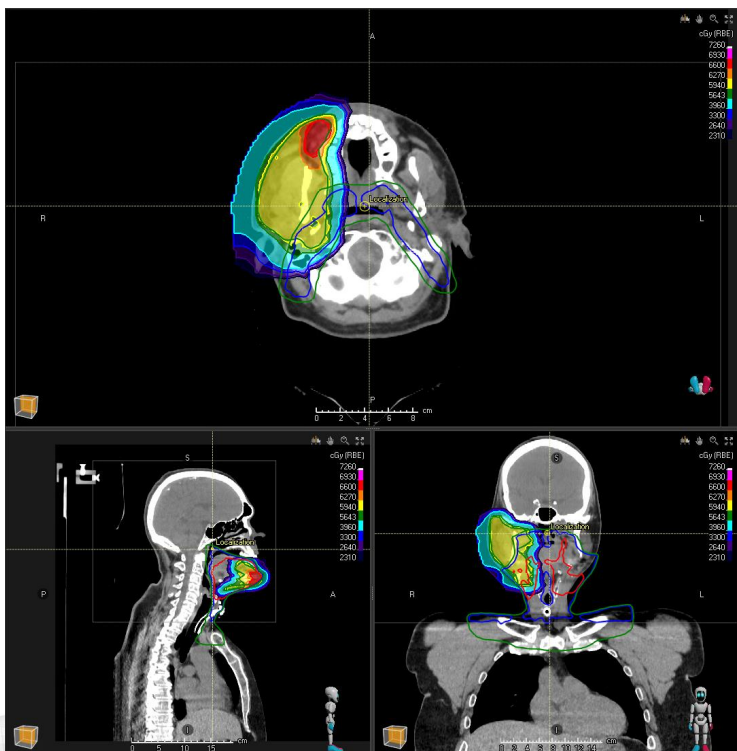
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## Unilateral Head and Neck – Re-Irradiation

- Adult (50M) with overlapping prior irradiation, curative intent



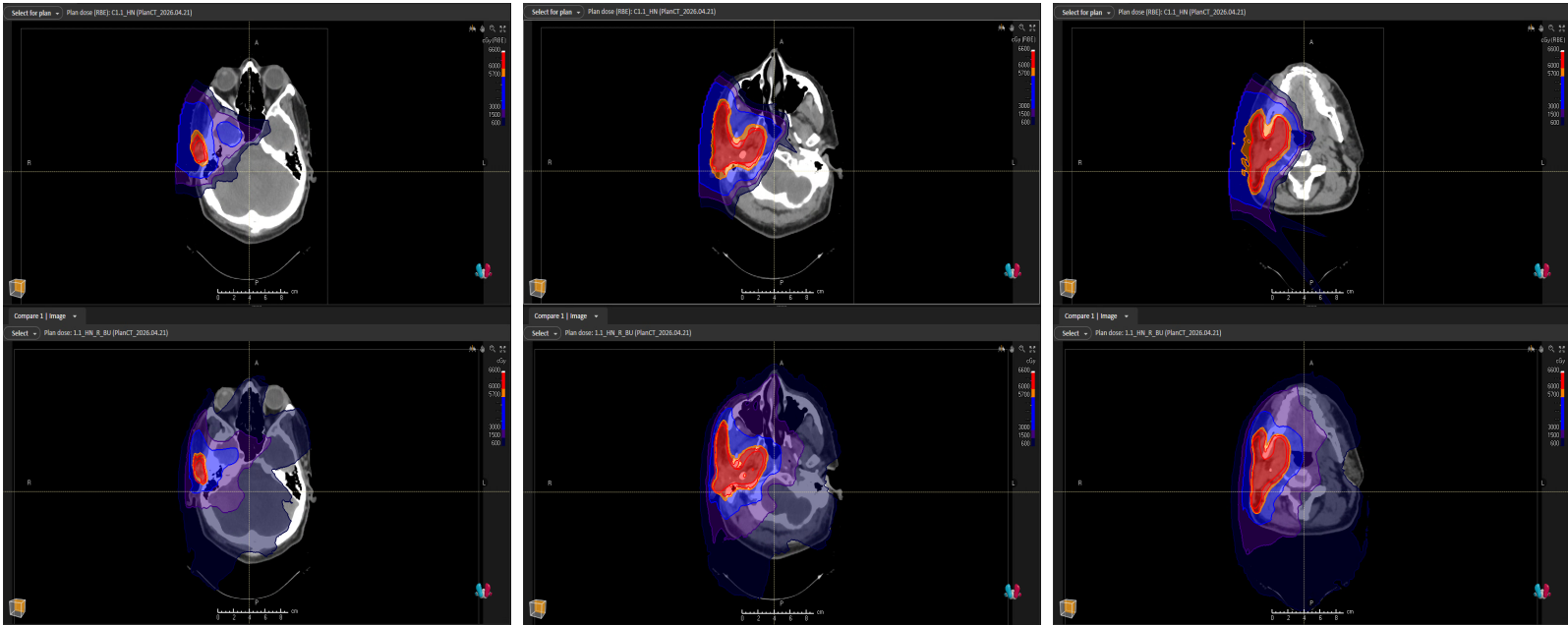
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# Unilateral Head and Neck – Initial Irradiation

- Adult (51 M) with no prior irradiation, curative intent

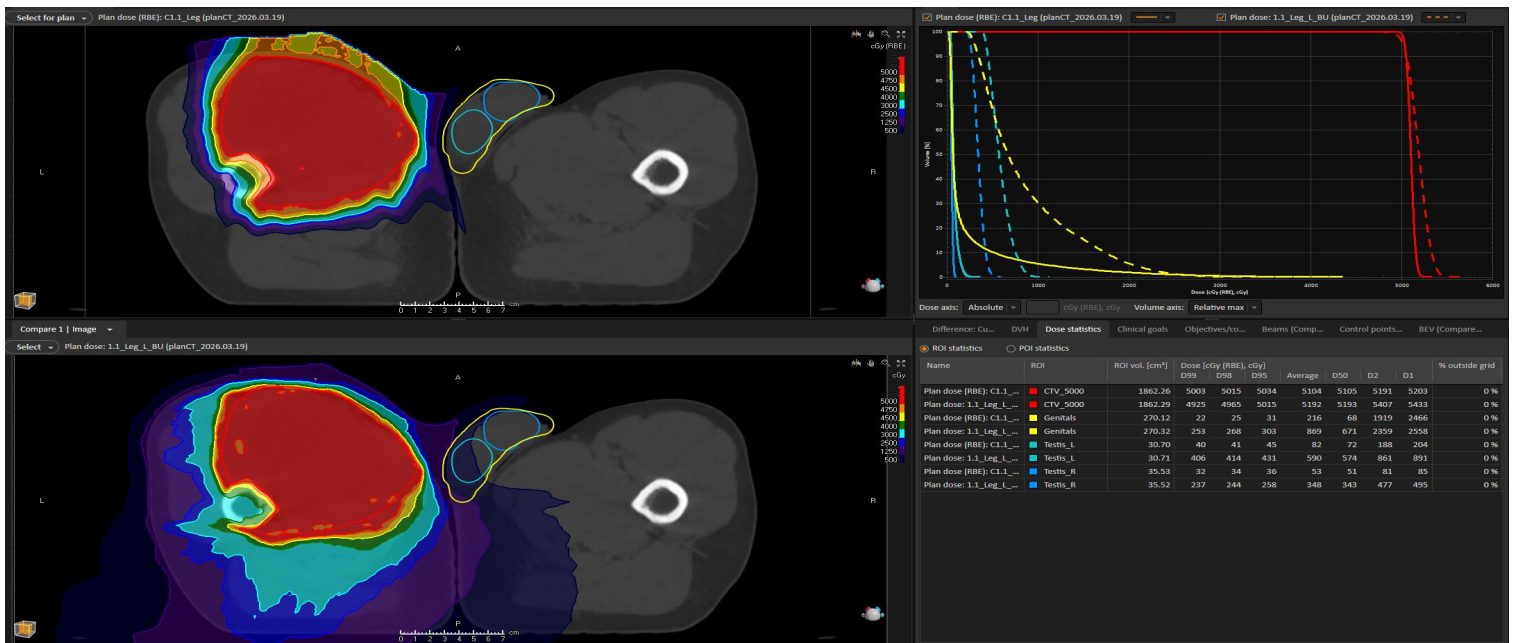


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# Proximal Critical Structures

- Young adult (31M) with high priority diagnosis, curative intent

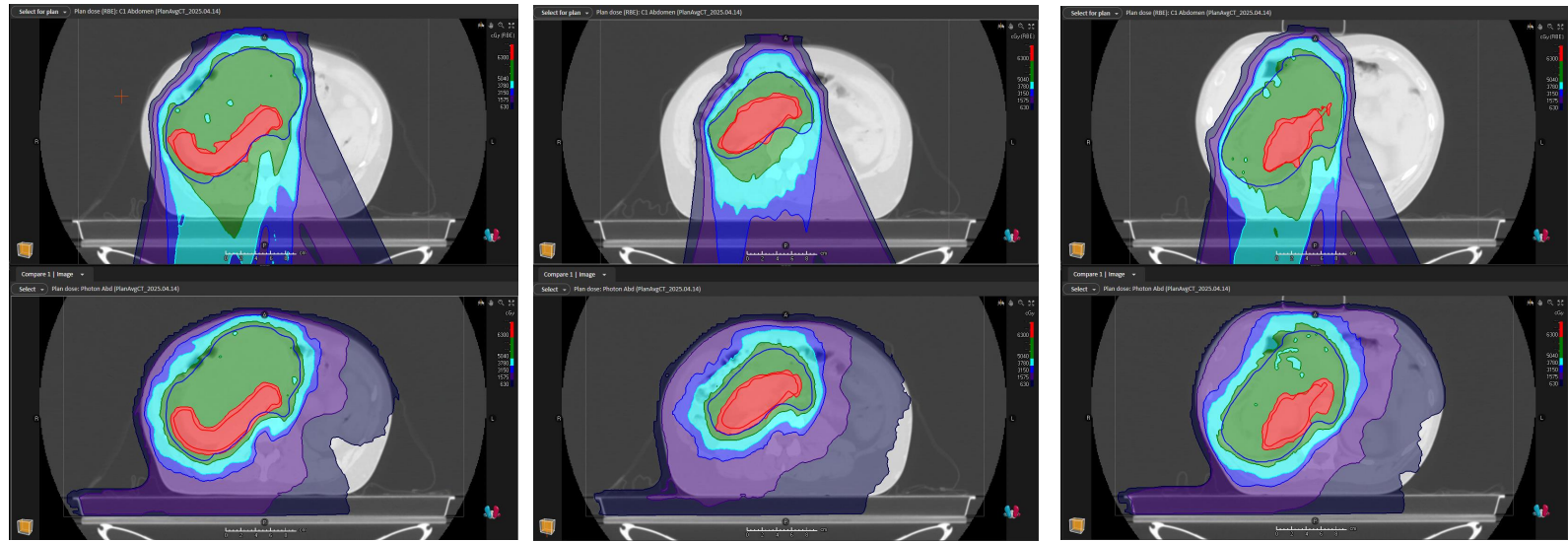


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# Large, Irregular Tumor Volume

- Young adult (40 M) with curative intent and no prior irradiation
- Multi-iso proton, large range uncertainty, bowel in and out of field

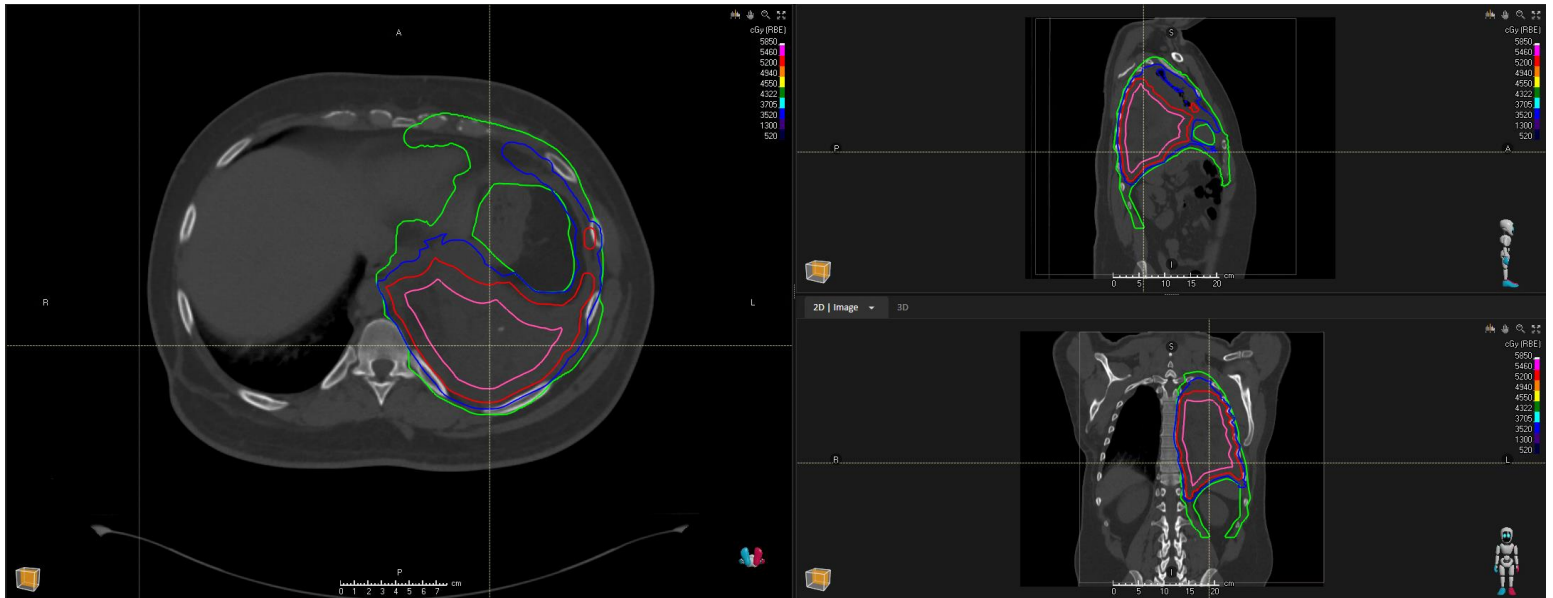


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# Poor Prognosis with Complex Treatment

- Adult (50 M) with high priority diagnosis and prior irradiation, palliative intent

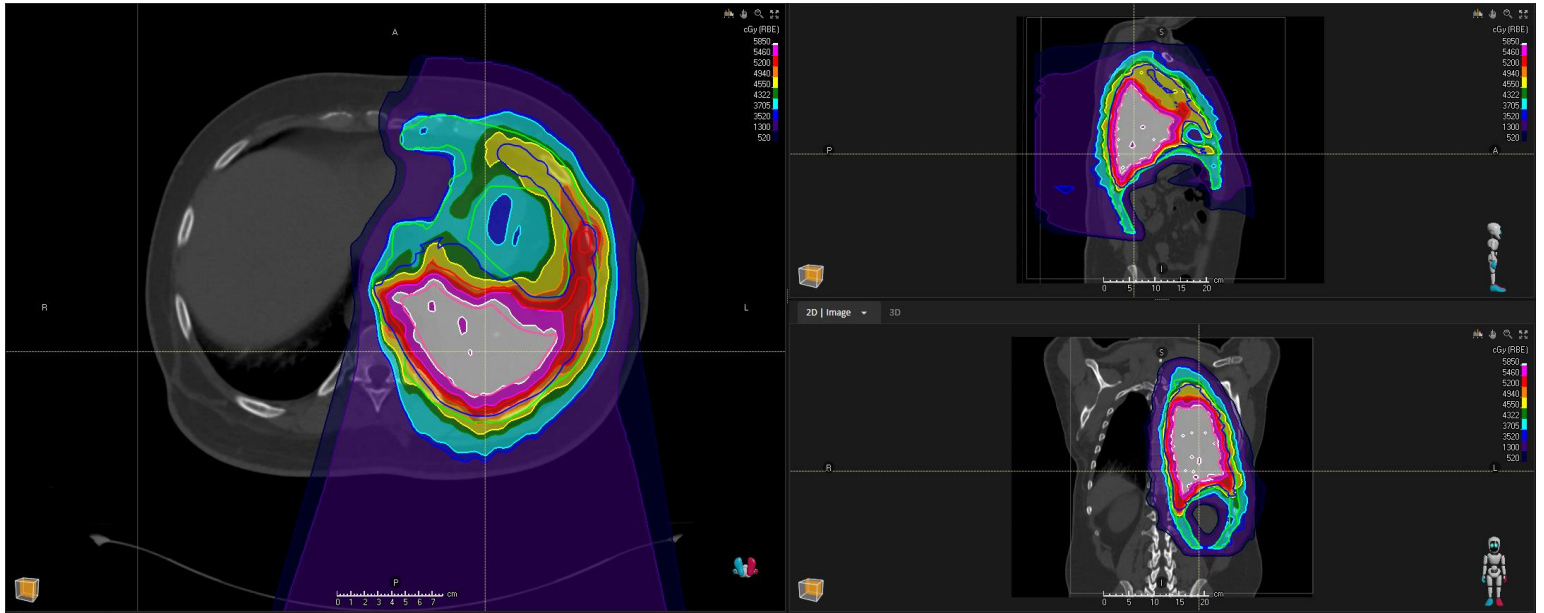


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# Poor prognosis with Complex Treatment

- Hypo-fractionated 5850/5200/4540/3705 SIB in 15fx

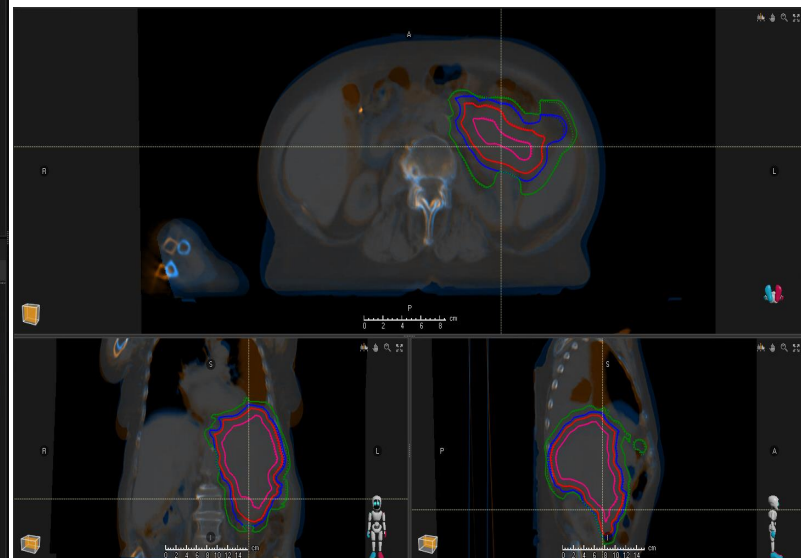
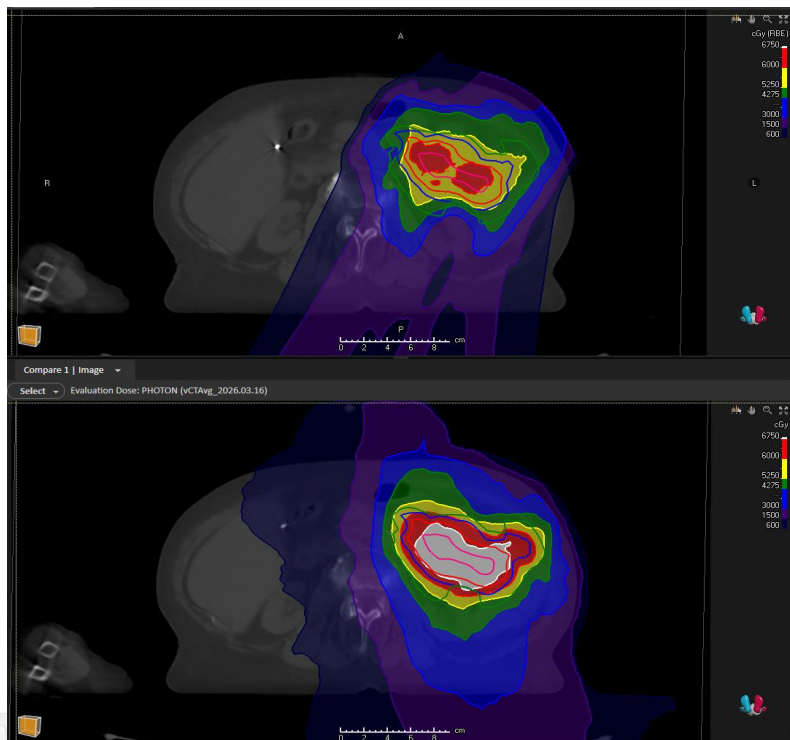


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# Unfavorable anatomy – Loose Skin and Variable Filling

- Elderly adult (83 F) with high priority diagnosis and no prior irradiation, curative intent
- 15fx hypo-fractionated abdomen

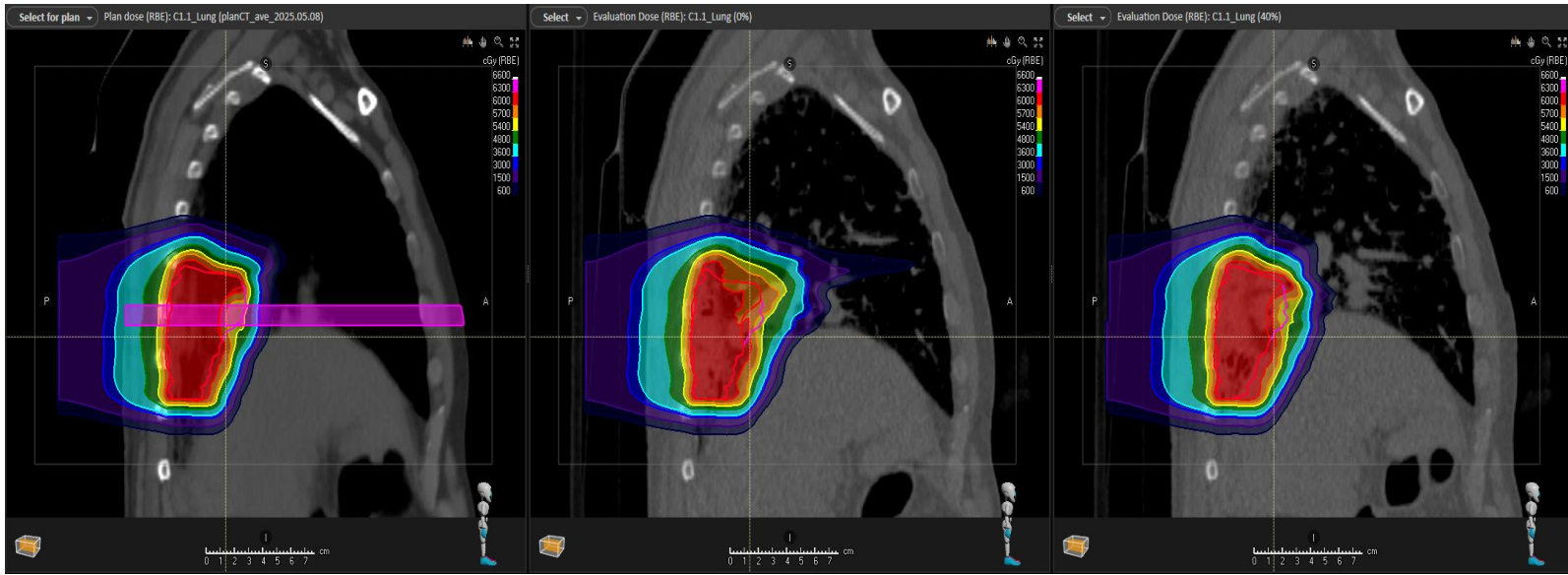


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# High Motion

- Elderly adult (68 M) with severe interstitial lung disease, curative intent

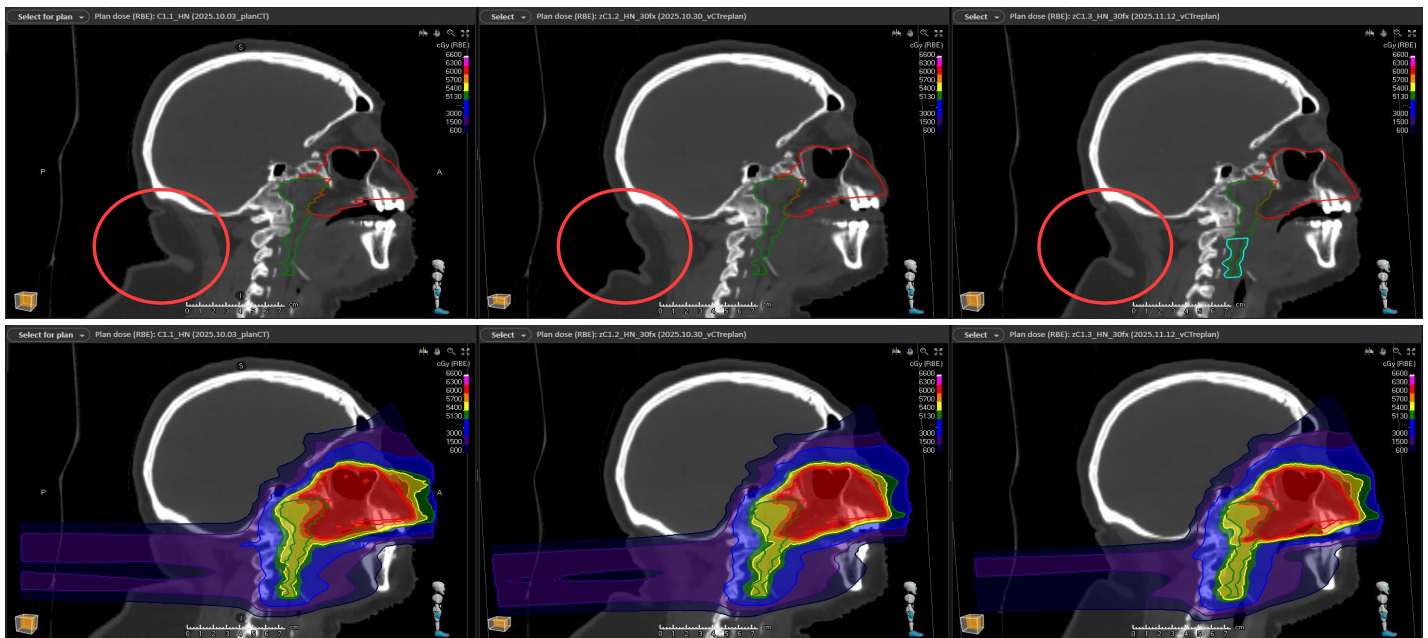


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# Unfavorable anatomy – Inconsistent Neck Fold

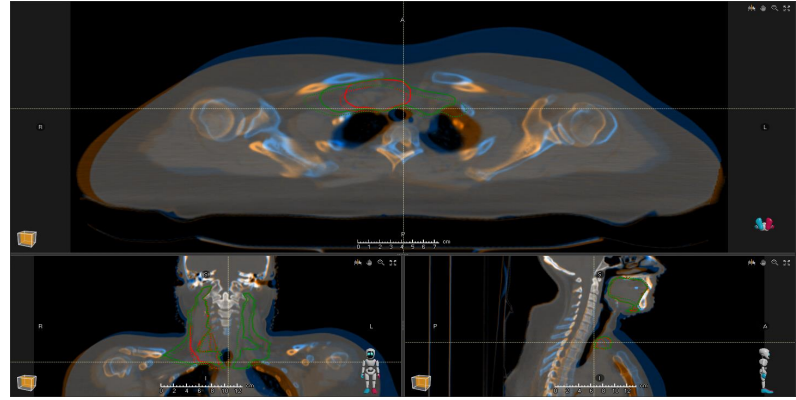
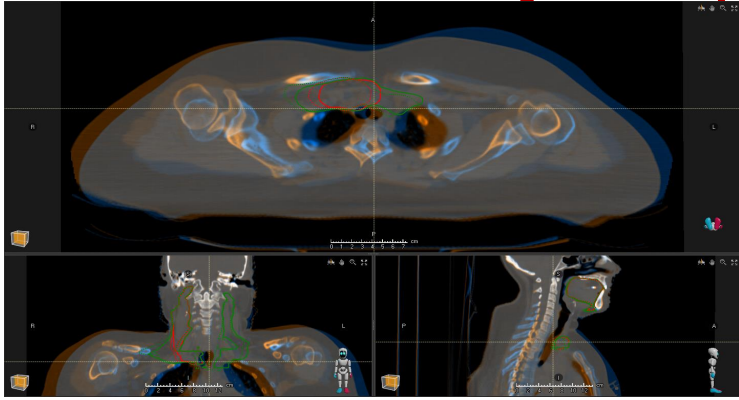
- Young adult (35 F) with curative intent and no prior irradiation



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# Unfavorable anatomy – Setup Variation

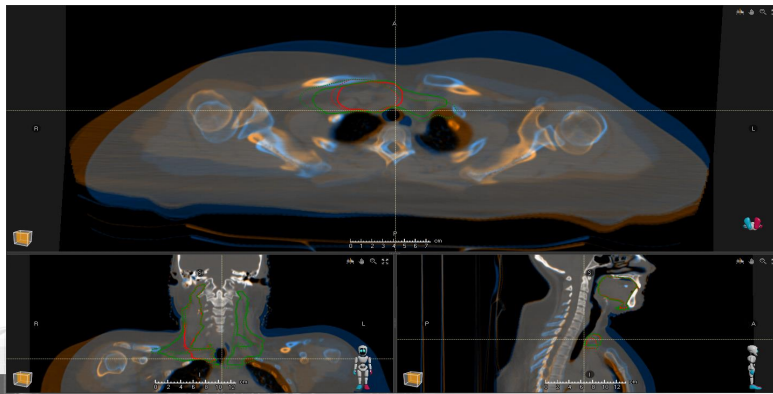


▪ vCT: 05/21/2025

▪ vCT: 05/23/2025

▪ Young adult (32 F) with curative intent and no previous irradiation

▪ vCT: 06/04/2025



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# Unfavorable anatomy – Setup Variation

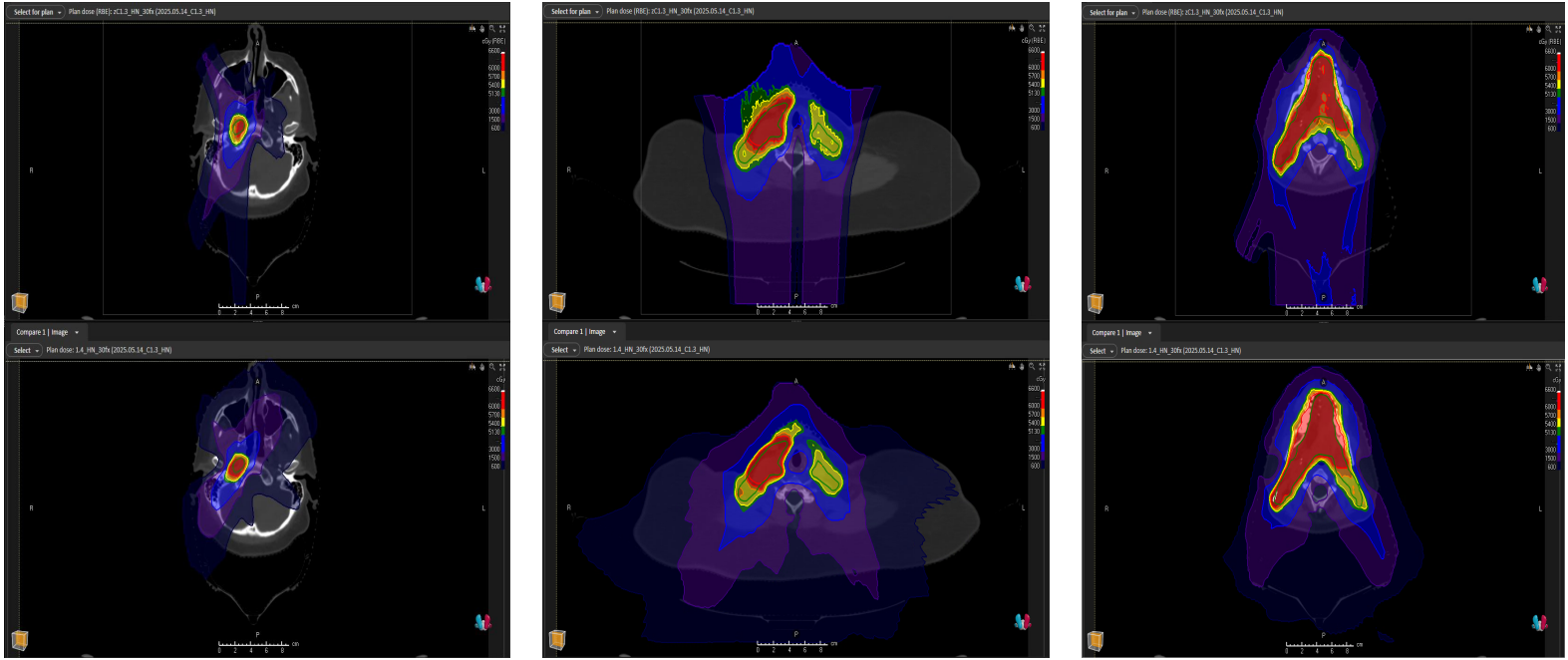
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	C1 HN		
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Thu 5/8/2025 2:40 PM	1.2_HN	12 (12 App)	0
Fri 5/9/2025 2:50 PM	1.2_HN	4 (4 App)	0
Mon 5/12/2025 2:31 PM	1.2_HN	13 (13 App)	0
Tue 5/13/2025 2:40 PM	1.2_HN	14 (14 App)	0
Wed 5/14/2025 2:40 PM	1.2_HN	8 (8 App)	0
Thu 5/15/2025 2:38 PM	1.2_HN	7 (7 App)	0
Fri 5/16/2025 2:34 PM	1.2_HN	7 (7 App)	0
Mon 5/19/2025 2:31 PM	1.2_HN	3 (3 App)	0
Tue 5/20/2025 2:40 PM	1.2_HN	11 (11 App)	0
Wed 5/21/2025 2:46 PM	1.3_HN	10 (10 App)	0
Thu 5/22/2025 2:34 PM	1.3_HN	10 (10 App)	0
Fri 5/23/2025 2:39 PM	1.3_HN	13 (13 App)	0
Tue 5/27/2025 2:32 PM	1.3_HN	9 (9 App)	0
Wed 5/28/2025 2:34 PM	1.3_HN	7 (7 App)	0
Thu 5/29/2025 2:16 PM	1.3_HN	11 (11 App)	0
Fri 5/30/2025 2:26 PM	1.3_HN	24 (24 App)	0
Mon 6/2/2025 2:50 PM	1.3_HN	7 (7 App)	0
Tue 6/3/2025 2:30 PM	1.3_HN	9 (9 App)	0
Wed 6/4/2025 1:37 PM	1.3_HN	6 (6 App)	0
Thu 6/5/2025 2:16 PM	1.3_HN	5 (5 App)	0
	C1 HN Phot		
Fri 6/6/2025 3:27 PM	1.4_HN	3 (3 App)	0
Mon 6/9/2025 12:22 PM	1.4_HN	7 (7 App)	0
Tue 6/10/2025 12:13 PM	1.4_HN	9 (9 App)	0
Wed 6/11/2025 2:21 PM	1.4_HN	5 (5 App)	0
Thu 6/12/2025 12:31 PM	1.4_HN	5 (5 App)	0
Fri 6/13/2025 4:29 PM	1.4_HN	3 (3 App)	0
Mon 6/16/2025 2:51 PM	1.4_HN	7 (7 App)	0
Tue 6/17/2025 3:33 PM	1.4_HN	7 (7 App)	0
Wed 6/18/2025 11:50 AM	1.4_HN	3 (3 App)	0
Fri 6/20/2025 2:36 PM	1.4_HN	5 (5 App)	0
Mon 6/23/2025 3:43 PM	1.4_HN	3 (3 App)	0

▪ Lots of imaging!

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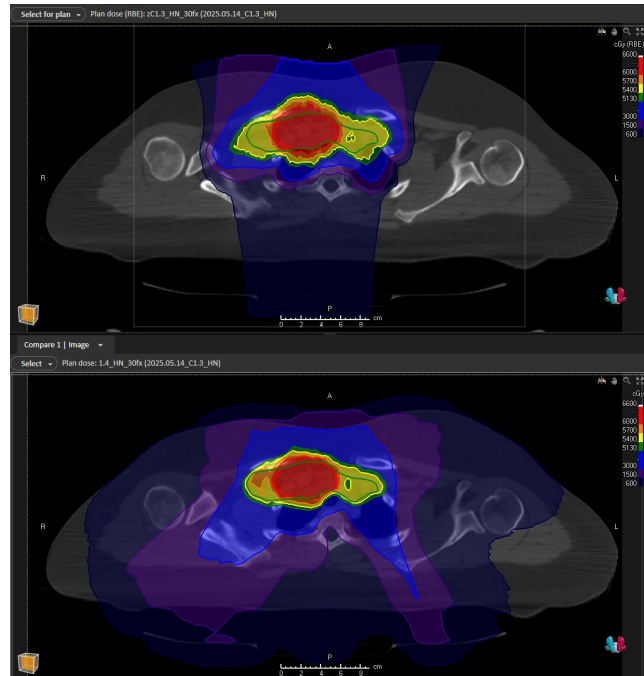
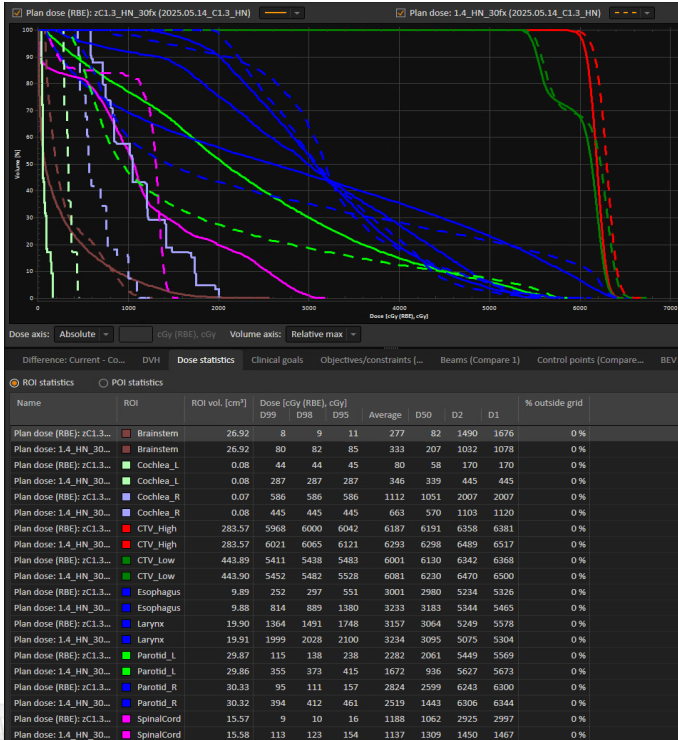
# Unfavorable anatomy – Setup Variation



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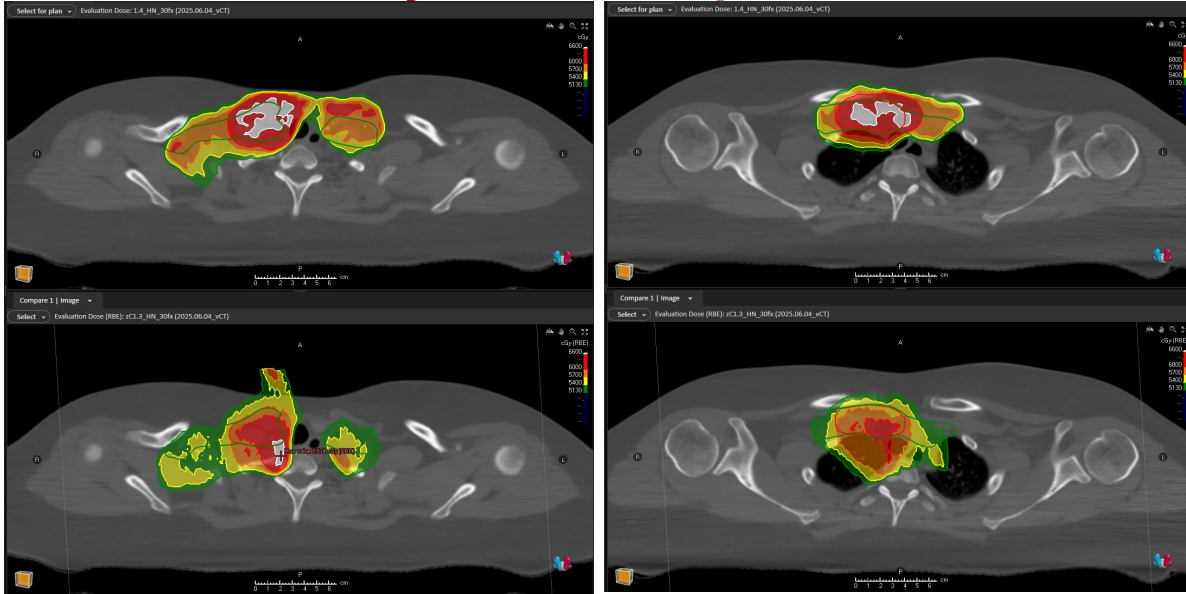
# Unfavorable anatomy – Setup Variation



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# Unfavorable Anatomy – vCT Comparison



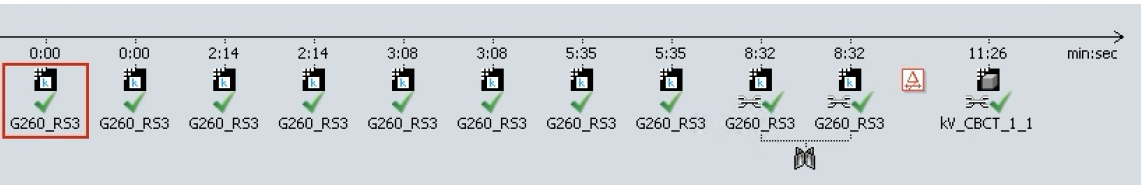
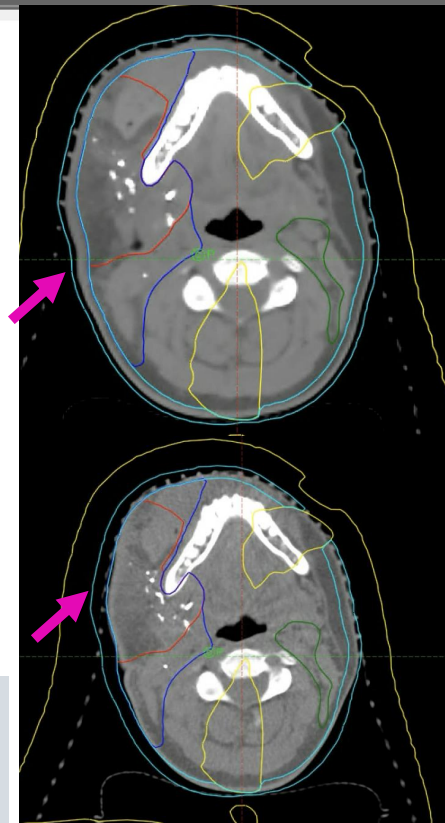
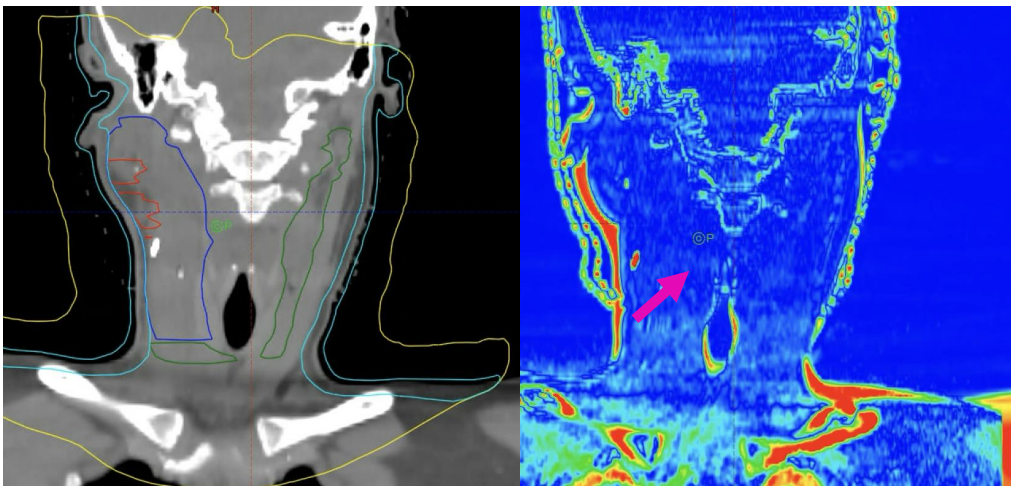
98	Evaluation Dose (RBE): zCL3_HN...	BODY	At most 0 cGy (RBE) dose at 0.03 cm <sup>3</sup> volume	6898 cGy (RBE)	🚩
98	Evaluation Dose: 1.4_HN_30fx (2...	BODY	At most 0 cGy dose at 0.03 cm <sup>3</sup> volume	6929 cGy	🚩
99	Evaluation Dose (RBE): zCL3_HN...	CTV_High	At least 95.00 % volume at 5700 cGy (RBE) dose	98.10 %	✅
99	Evaluation Dose: 1.4_HN_30fx (2...	CTV_High	At least 95.00 % volume at 5700 cGy dose	99.52 %	✅
99	Evaluation Dose (RBE): zCL3_HN...	CTV_Low	At least 95.00 % volume at 5130 cGy (RBE) dose	97.55 %	✅
99	Evaluation Dose: 1.4_HN_30fx (2...	CTV_Low	At least 95.00 % volume at 5130 cGy dose	99.01 %	✅
100	Evaluation Dose (RBE): zCL3_HN...	CTV_High	At least 98.00 % volume at 6000 cGy (RBE) dose	85.56 %	🚩
100	Evaluation Dose: 1.4_HN_30fx (2...	CTV_High	At least 98.00 % volume at 6000 cGy dose	98.97 %	✅
100	Evaluation Dose (RBE): zCL3_HN...	CTV_Low	At least 98.00 % volume at 5400 cGy (RBE) dose	86.50 %	🚩
100	Evaluation Dose: 1.4_HN_30fx (2...	CTV_Low	At least 98.00 % volume at 5400 cGy dose	98.09 %	✅

# Bulky, Rapidly Changing Tumors

- Young adult (22 F) with curative intent and no previous radiation
- Importance of CT sim timing

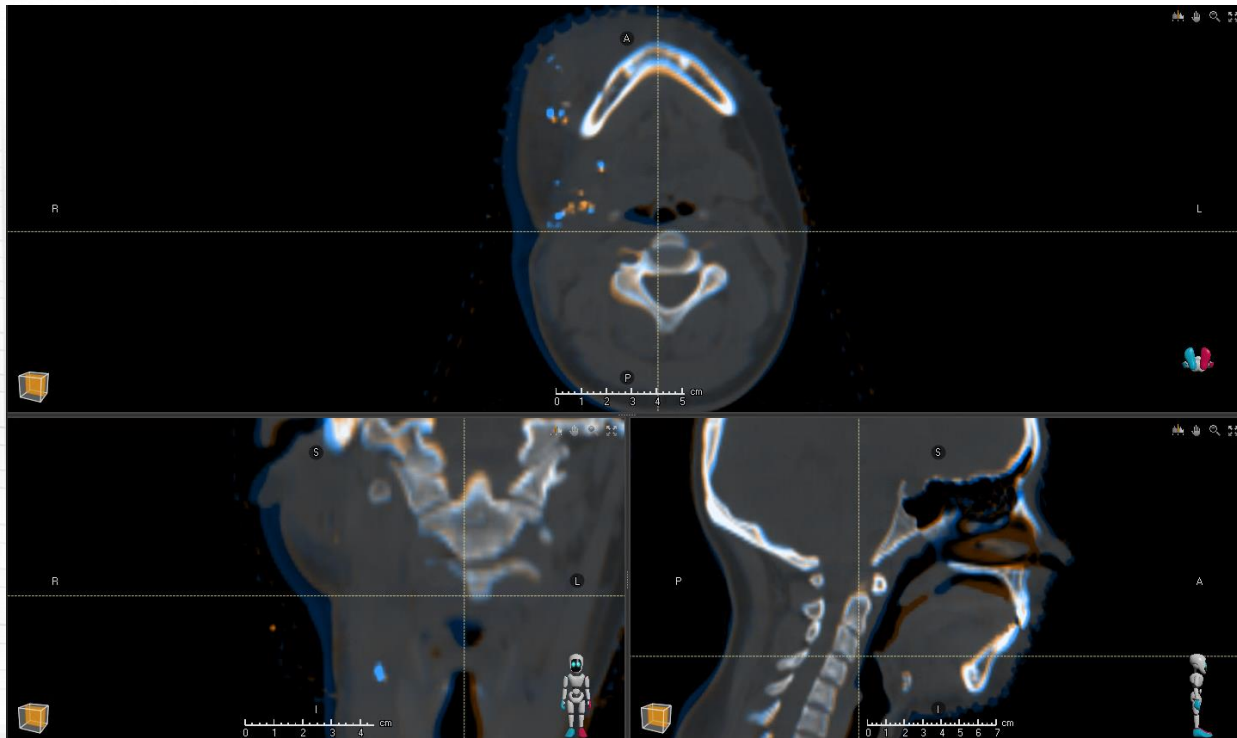
	1/14	1/29	2/6	2/20	2/28	3/6	3/11	3/14
Initial Sim		vSim: 1.1HN	vSim: 1.2 HN	vCT	1.3 HN	vCT	Ad hoc vCT	Ad hoc vCT
		Tissue loss		Tissue Loss		dose deviations from shoulder positioning	Access new tissue changes	Abscess drainage
		Replan initiated		Replan initiated		Too urgent to hold treatment, too late to replan		
		Delay of treatment						

# Example: 1/29 V-Sim



## 1/29 vCT:

- Implications of swelling at CT sim



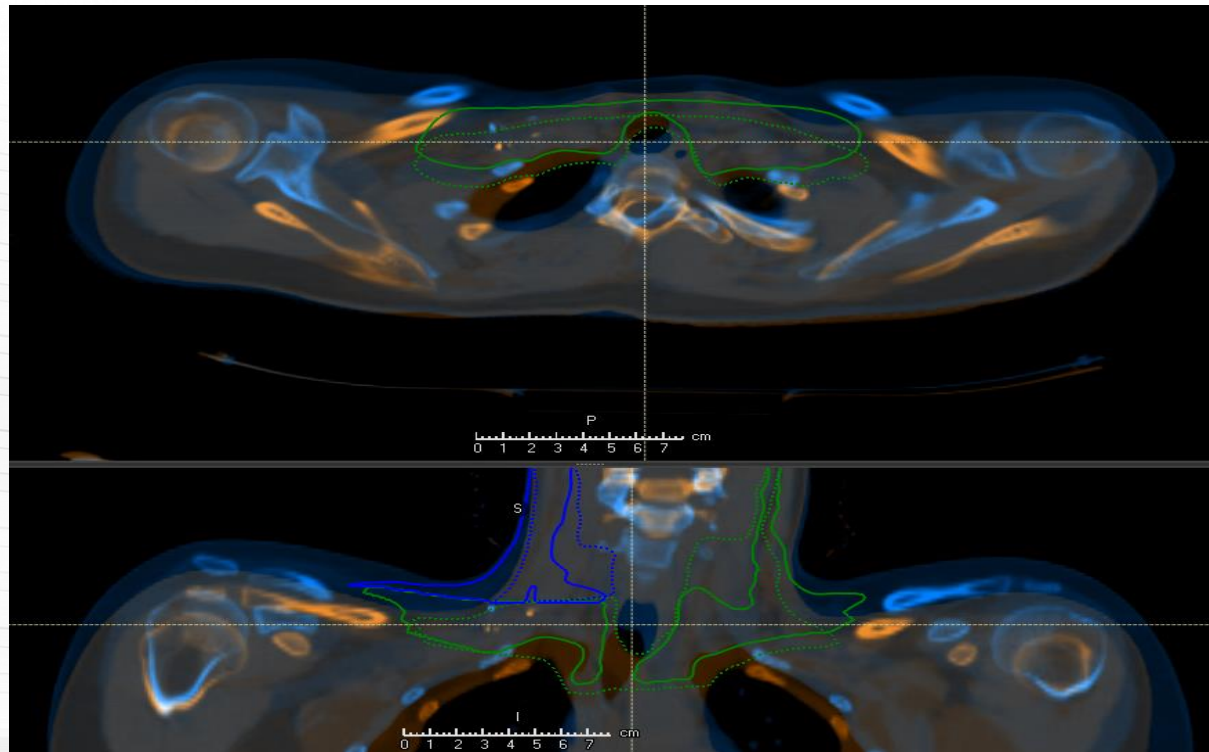
# 1/29 vCT:

- Significant tissue changes observed on the vsim day, so an ad-hoc vCT was performed and used for the first replan (first plan never was treated)

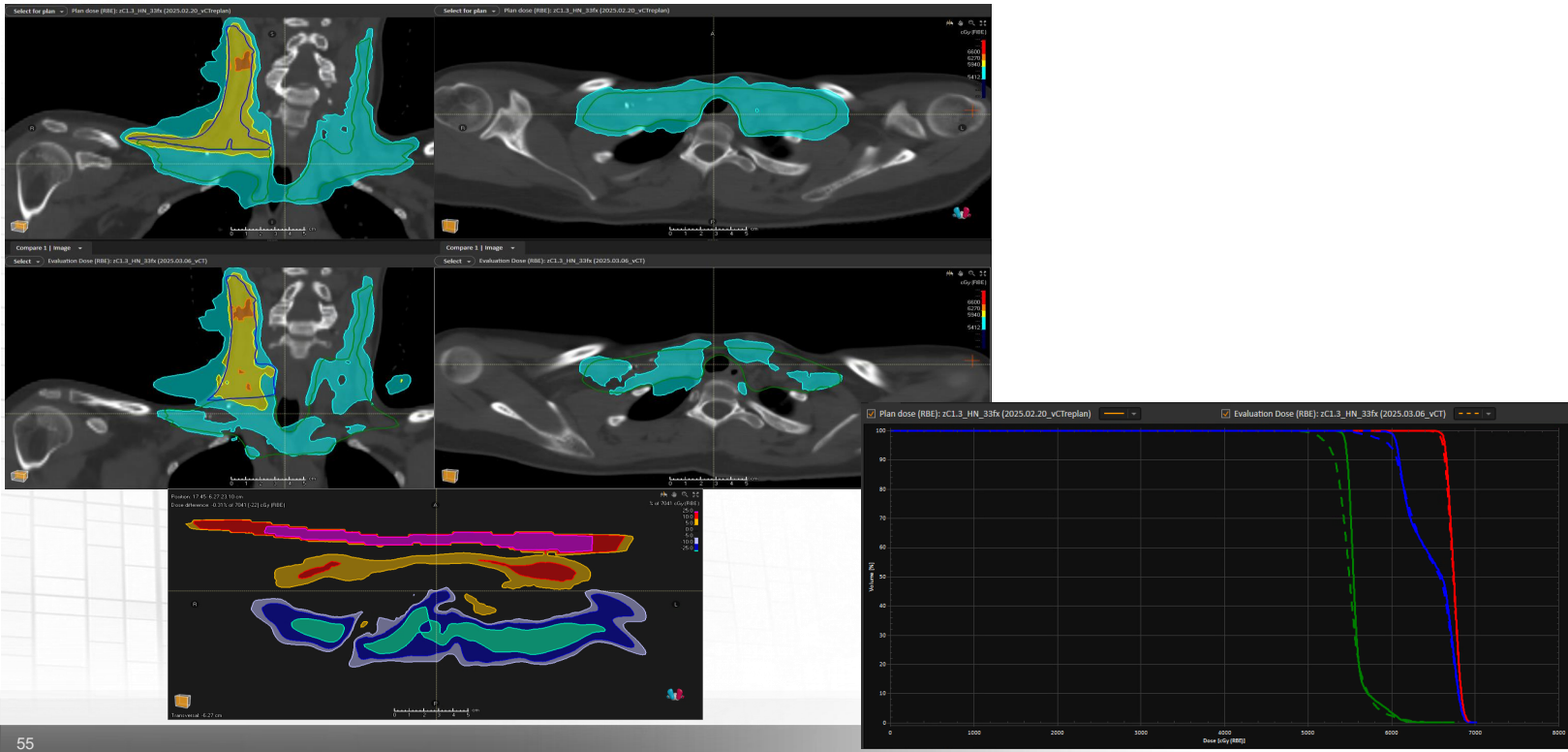


# 3/6 vCT

- Setup difference over time



# 3/6 vCT



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# Practical Decision Framework

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## Key Questions During Modality Selection

- What is the primary clinical priority?
- How sensitive is this plan to uncertainty?
- Will proton advantages remain consistent under real-world conditions?

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## Red Flags in Proton Planning

- Excessive sensitivity to setup or anatomy
- Overly complex robustness trade-offs
- Marginal benefit over photons
- Hypofractionation cases (Less time for replan/adjustments for the unknown)

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# Where the Real Magic Happens

- **The Dosimetrist's "Spellbook"**
  - Clinical Judgement
    - *When the DVH looks incredible...and that's exactly the problem*
  - Experience
    - *Confidence built on a strong foundation of past difficulties*
  - Intentional Trade-Offs
    - *You can't beat physics...only negotiate with it*
  - Clinical Intent  $\iff$  Deliverable Plans
    - *From ambitious goals to defensible decisions: "Treat Everything, Spare Everything"*



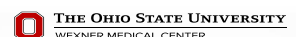
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## Key Takeaways

- Proton therapy is powerful; but not universal
- Photon therapy remains essential and often optimal
- Thoughtful prioritization improves outcomes and efficiency
- The real magic happens at the workstation!

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# Thank You

We encourage you to reach out if you have any questions.

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To learn more about Ohio State's cancer program, please visit [cancer.osu.edu](http://cancer.osu.edu) or follow us in social media:



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