Photon vs. Proton SBRT Physics Debate

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NRG Oncology Proton SBRT Virtual Workshop

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Disclaimer and Acknowledgement

- No conflict of interests
- Members of NRG proton SBRT workshop
- Emory: Yabo Fu (physics resident), Yinan Wang (dosimetrist) and Mosa Pasha (chief dosimetrist), Dr. Jun Zhou (physicist) , Dr. Higgins and Dr. Bradley (physicians)

Background

- NRG-GI003 “A PHASE III RANDOMIZED TRIAL OF PROTONS VERSUS PHOTONS FOR HEPATOCELLULAR CARCINOMA” from 2019 on

- RTOG-1308 “PHASE III RANDOMIZED TRIAL COMPARING OVERALL SURVIVAL AFTER PHOTON VERSUS PROTON CHEMORADIOTHERAPY FOR INOPERABLE STAGE II-IIIB NSCLC” to be close by 2023

- NRG-LU008 “PHASE III PROSPECTIVE RANDOMIZED TRIAL OF PRIMARY LUNG TUMOR STEREOTACTIC BODY RADIATION THERAPY FOLLOWED BY CONCURRENT MEDIASTINAL CHEMORADIATION FOR LOCALLY-ADVANCED NON-SMALL CELL LUNG CANCER” to be activated
  - Allows both Photon and Proton
  - NOT a direct comparison

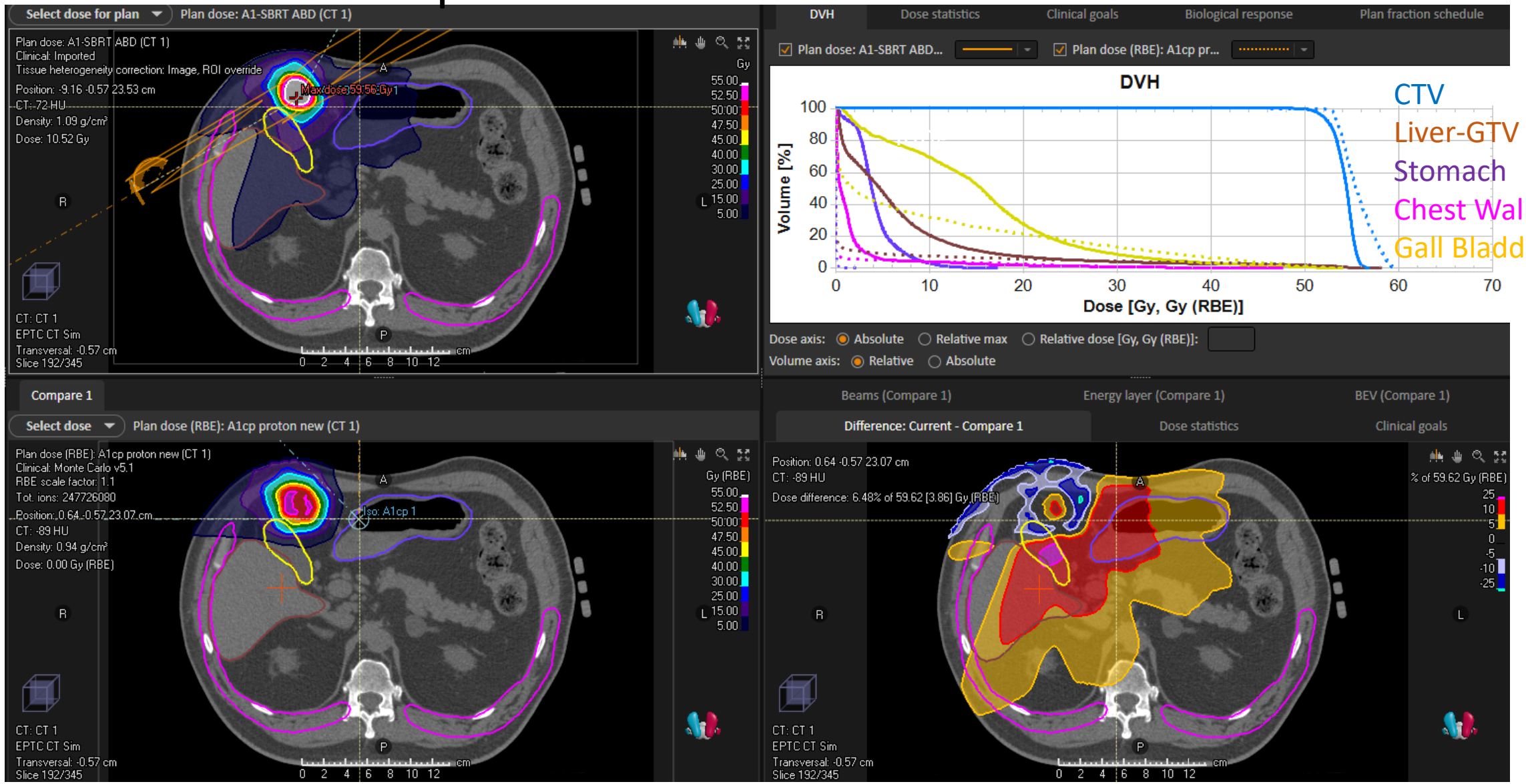
Why?

A. Chang et al “Stereotactic Body Radiotherapy (SBRT) Versus Stereotactic Body Proton Therapy (SBPT)” Phase 2 trial of 12.5 Gy x 4 = 50 Gy was terminated earlier due to low accrual of 21 patients
   1) Lack of volumetric IGRT 2) Insurance available only for high risk patients

B. Three areas to increase proton SBRT use – NRG survey
   1) Improved technology: (a) Range uncertainty ↘ Target conformity ↗ (b) Robust optimization ↗ (c) Monte Carlo ↗ (d) CBCT ↗ (e) Beam repainting/Tracking ↗
   2) Clinical evidence
   3) Dissemination of Knowledge

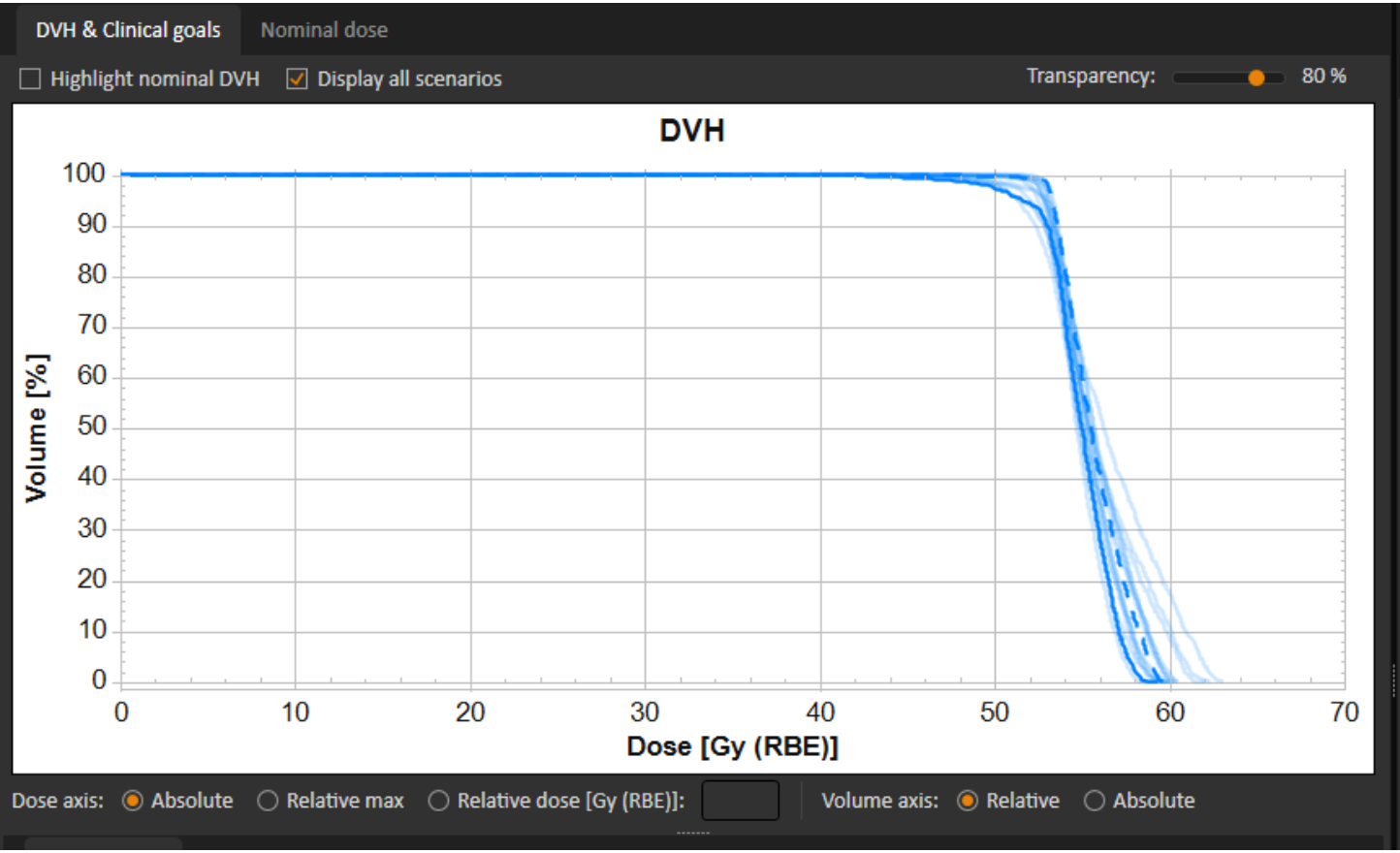
C. Three technologies to improve proton SBRT quality – NRG survey
   1) Volumetric IGRT 2) Motion management 3) Fast treatment

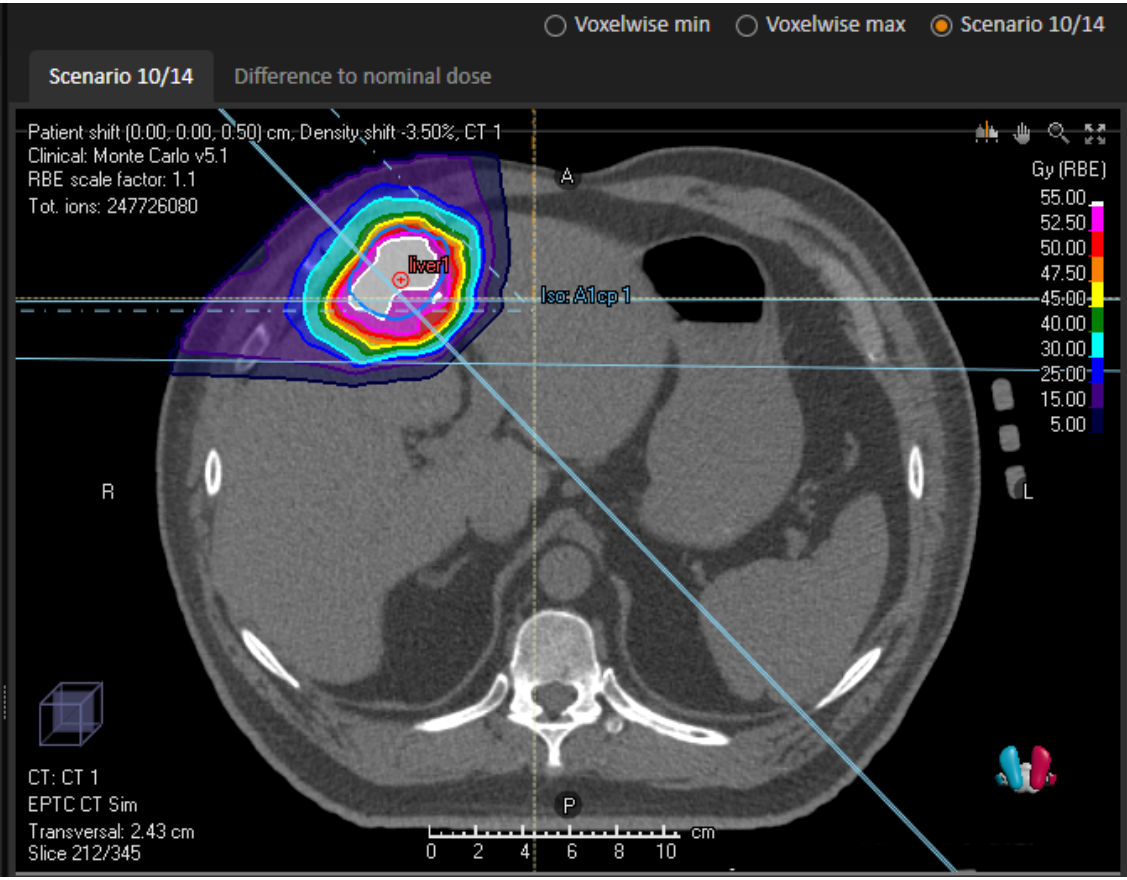
A NRG-GI003 patient



1. Proton improves integral dose at OARs (liver, stomach, chest wall) and body outside proton beam paths
2. Photon is better at body inside proton beam paths and gall bladder

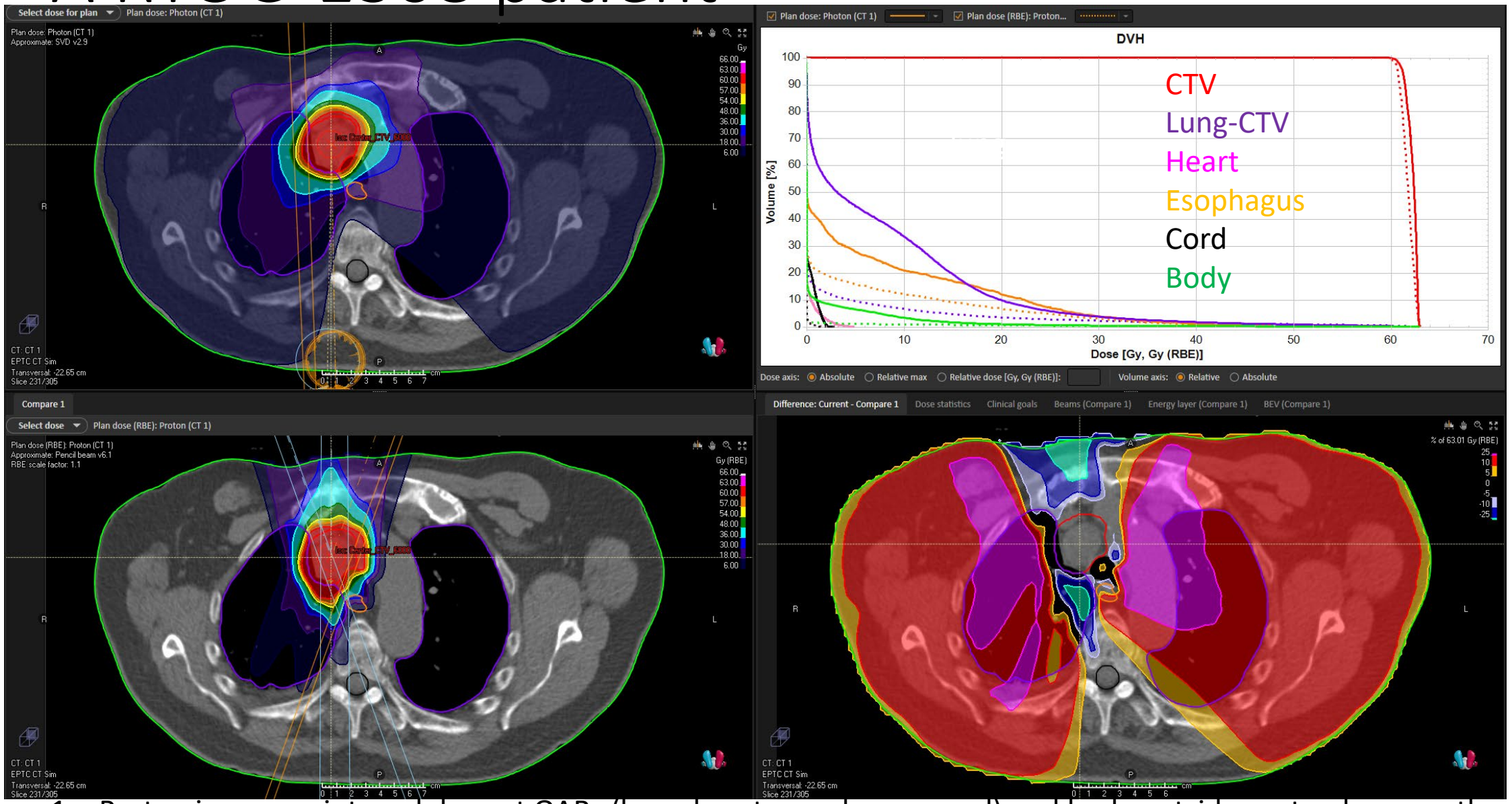
Worst Case Robust Scenario





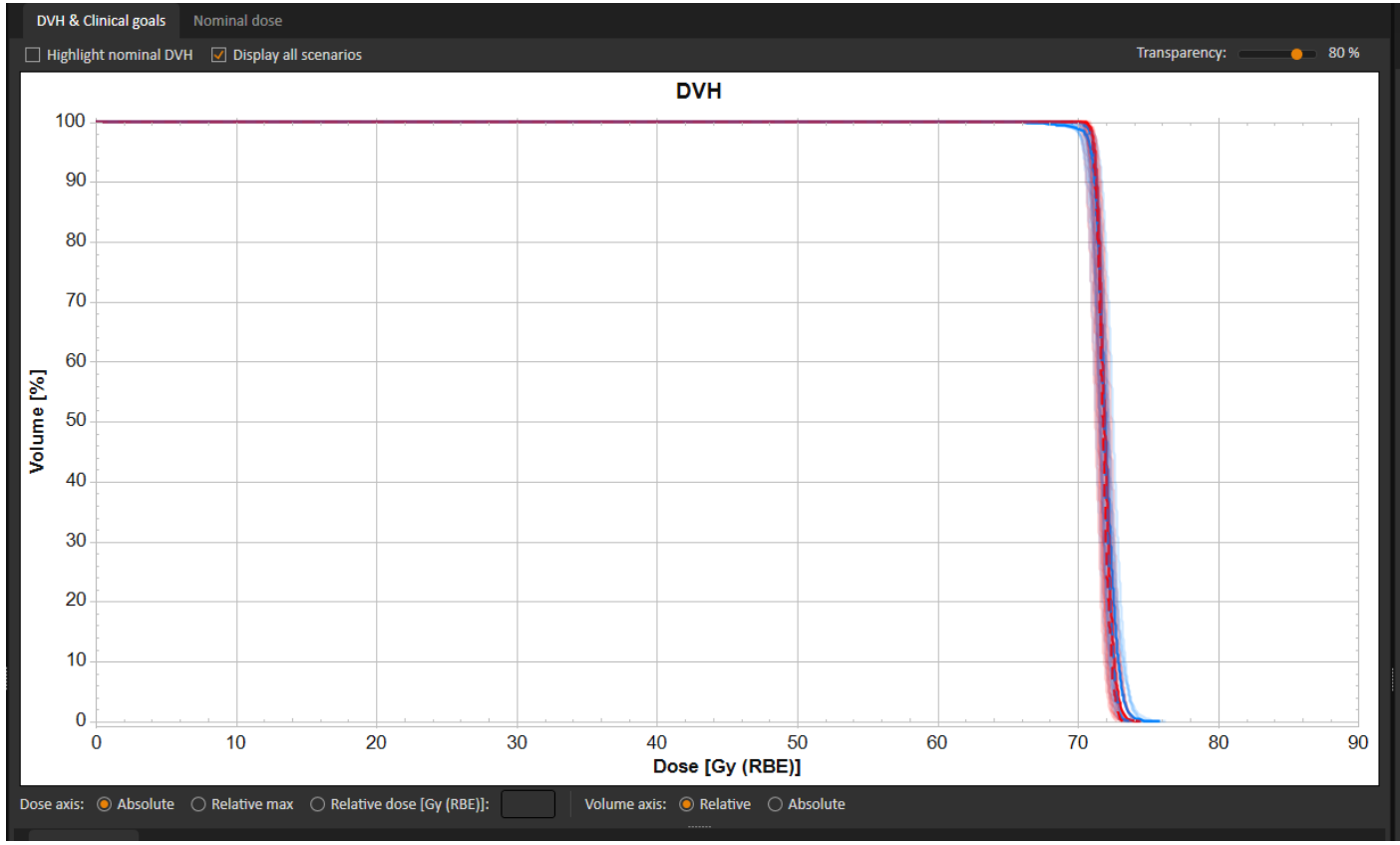
1. 14 robust scenarios in combination of 5% range and 3.5 mm setup uncertainties
2. Worst case appears at 5 mm setup anterior and 3.5% more range

A RTOG-1308 patient



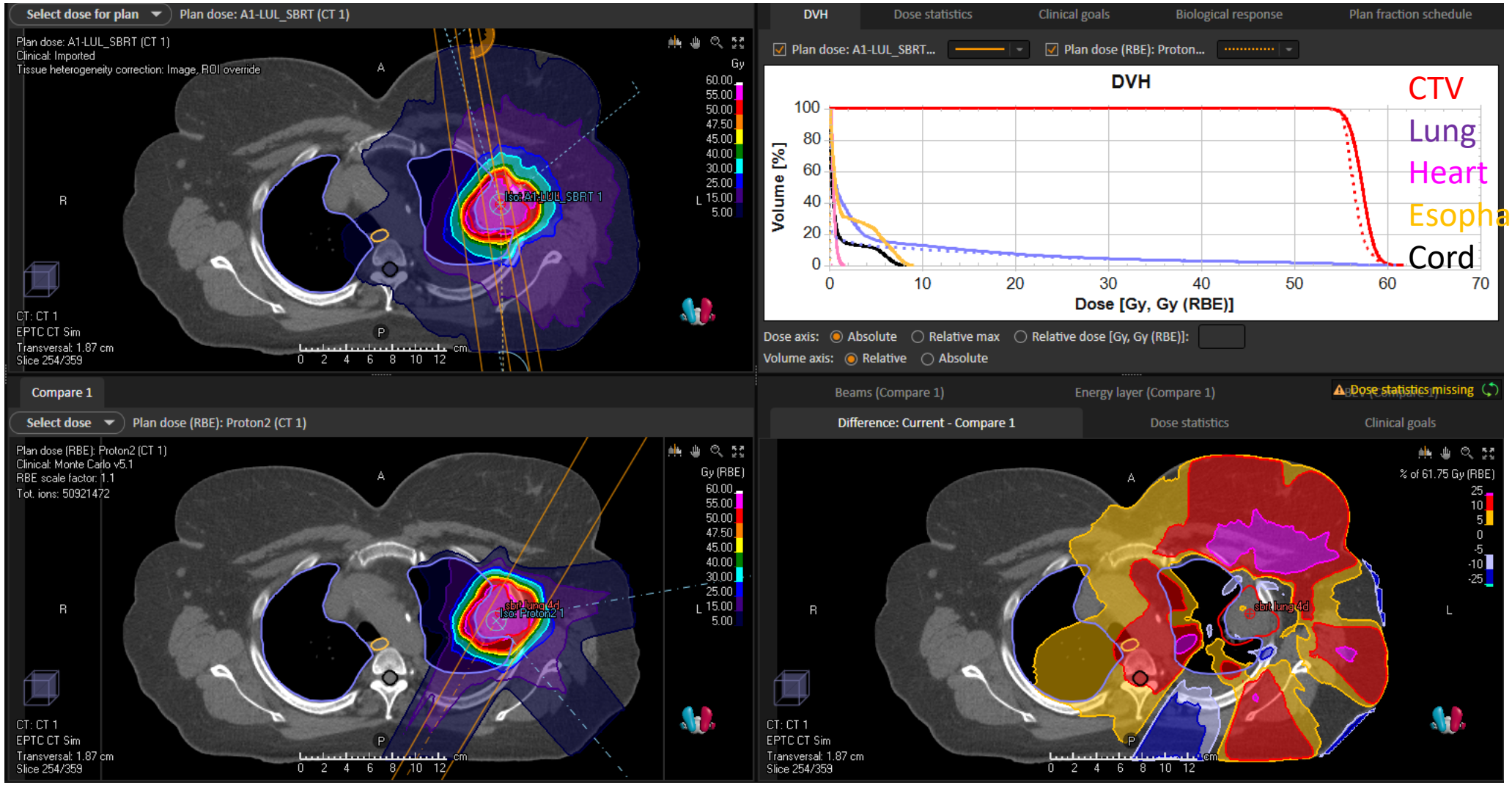
1. Proton improves integral dose at OARs (lung, heart, esophagus, cord) and body outside proton beam paths
2. Photon is better at body inside proton beam paths

Worst Case Robust Scenario



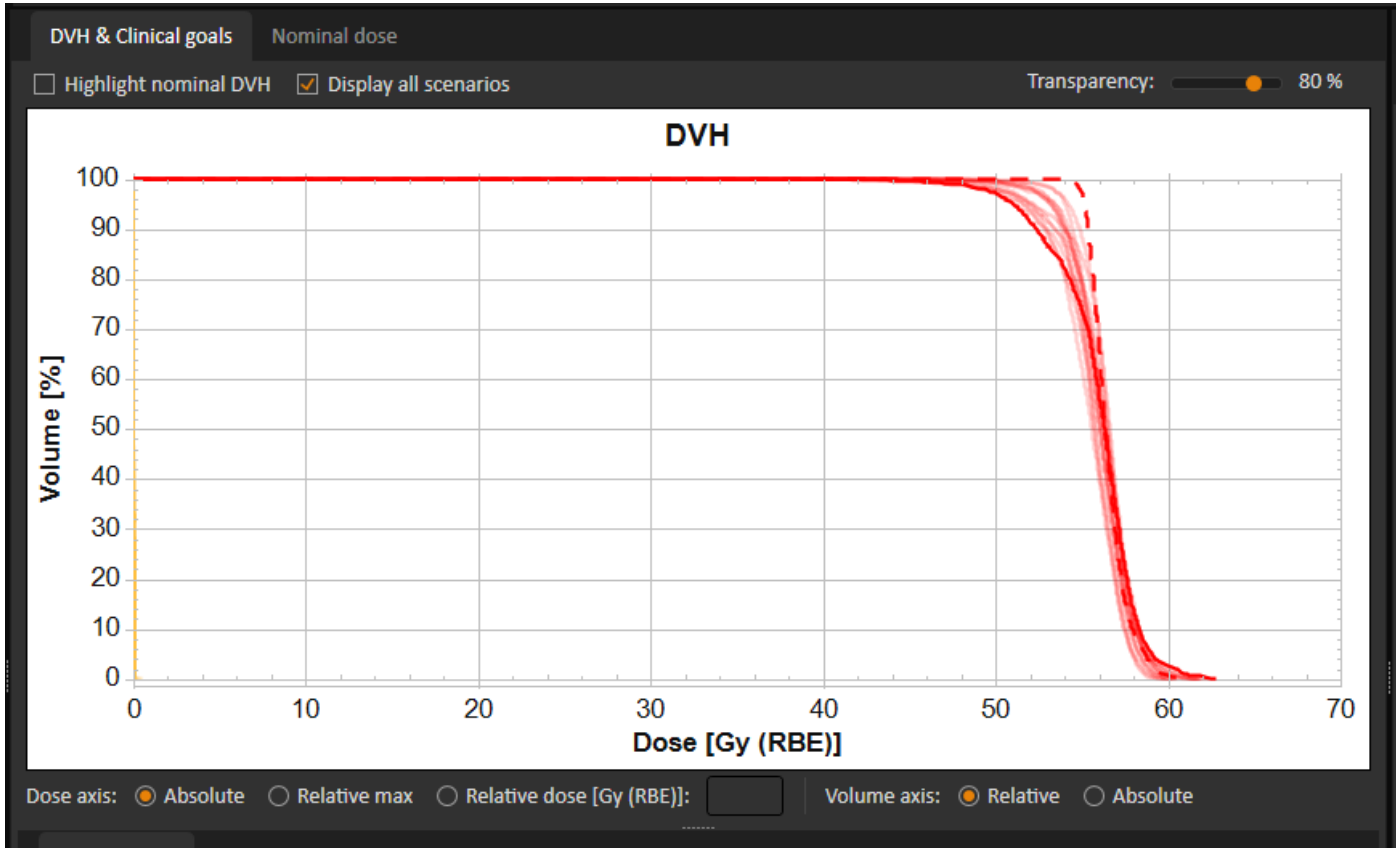
1. 14 robust scenarios in combination of 5% range and 5 mm setup uncertainties
2. Worst case appears at 5 mm setup right and 5% more proximal range

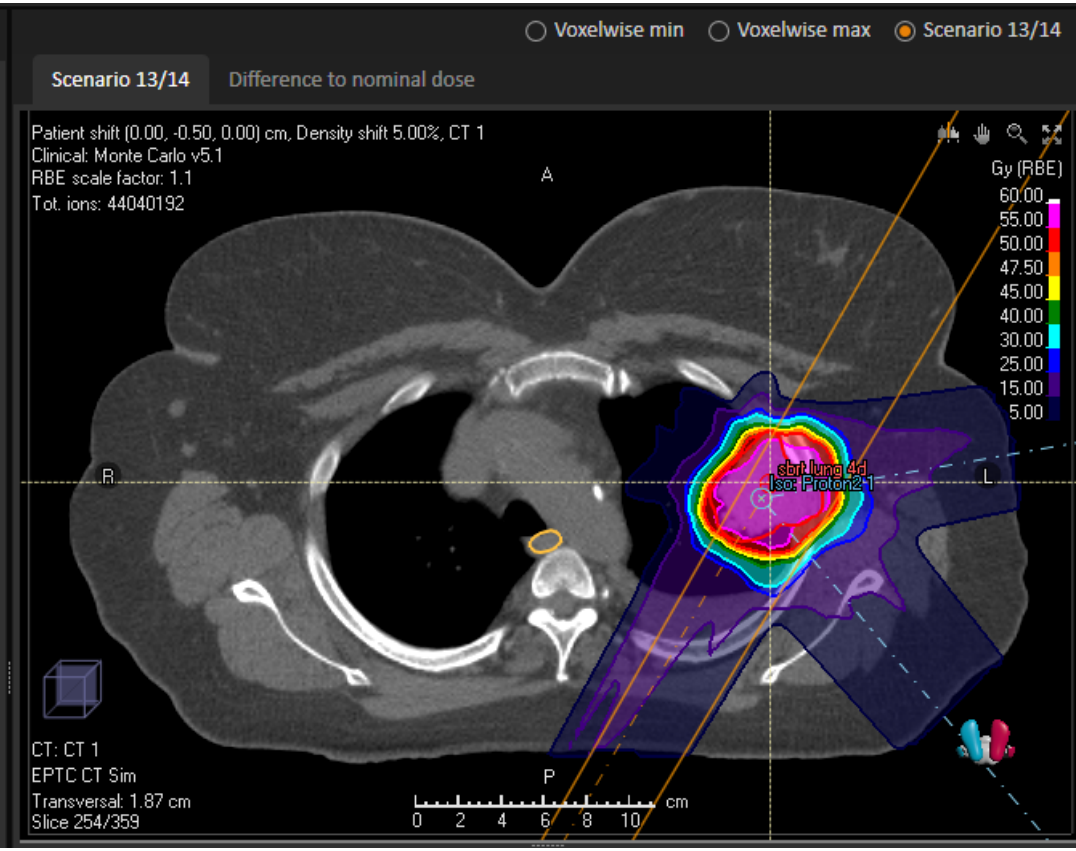
Lung SBRT vs. SBPT – Dr. Higgins's case- large



1. Proton improves integral dose at OARs (lung, heart, esophagus, cord) and body outside proton beam paths
2. Photon is better at body inside proton beam paths

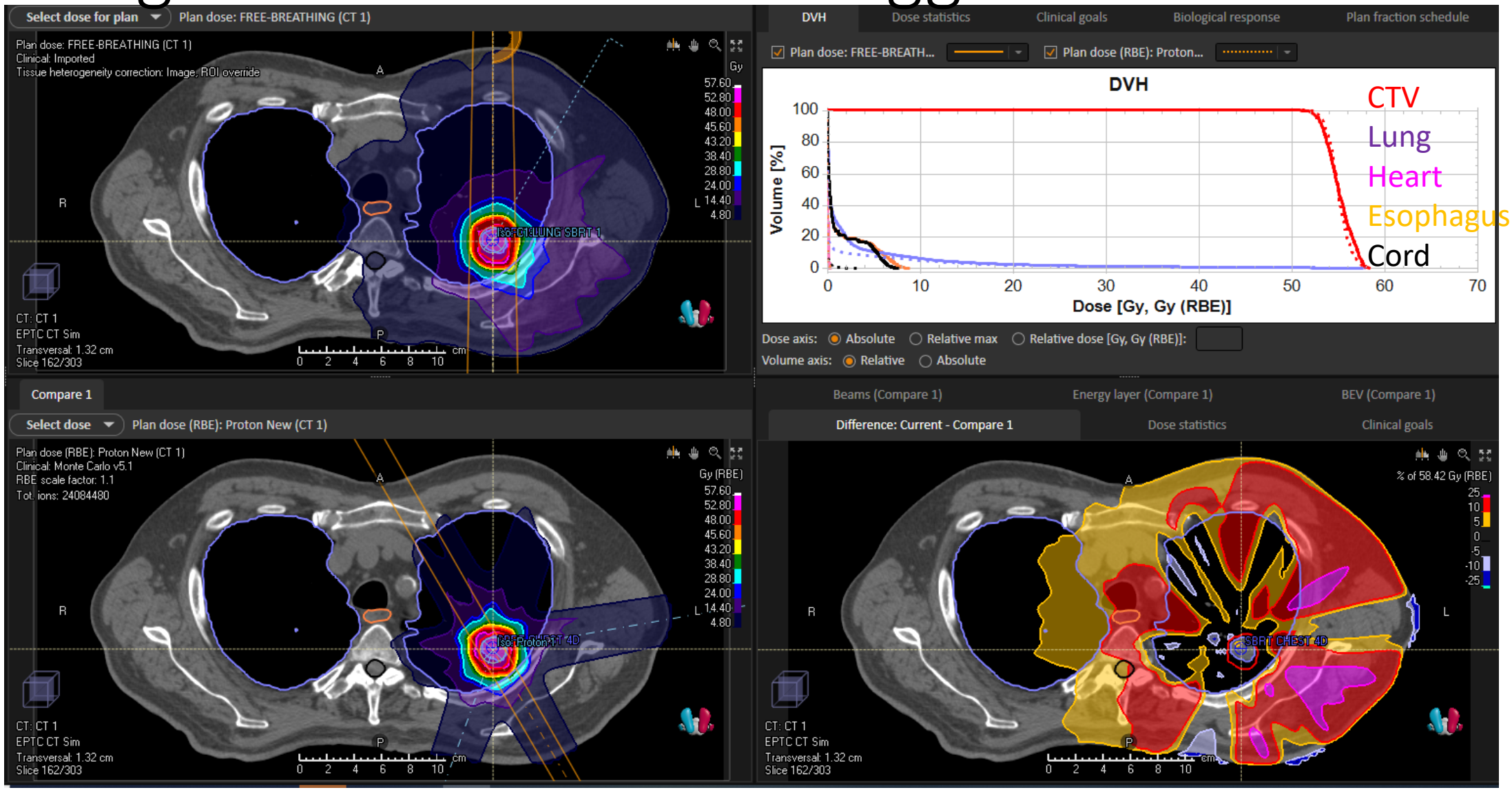
Worst Case Robust Scenario





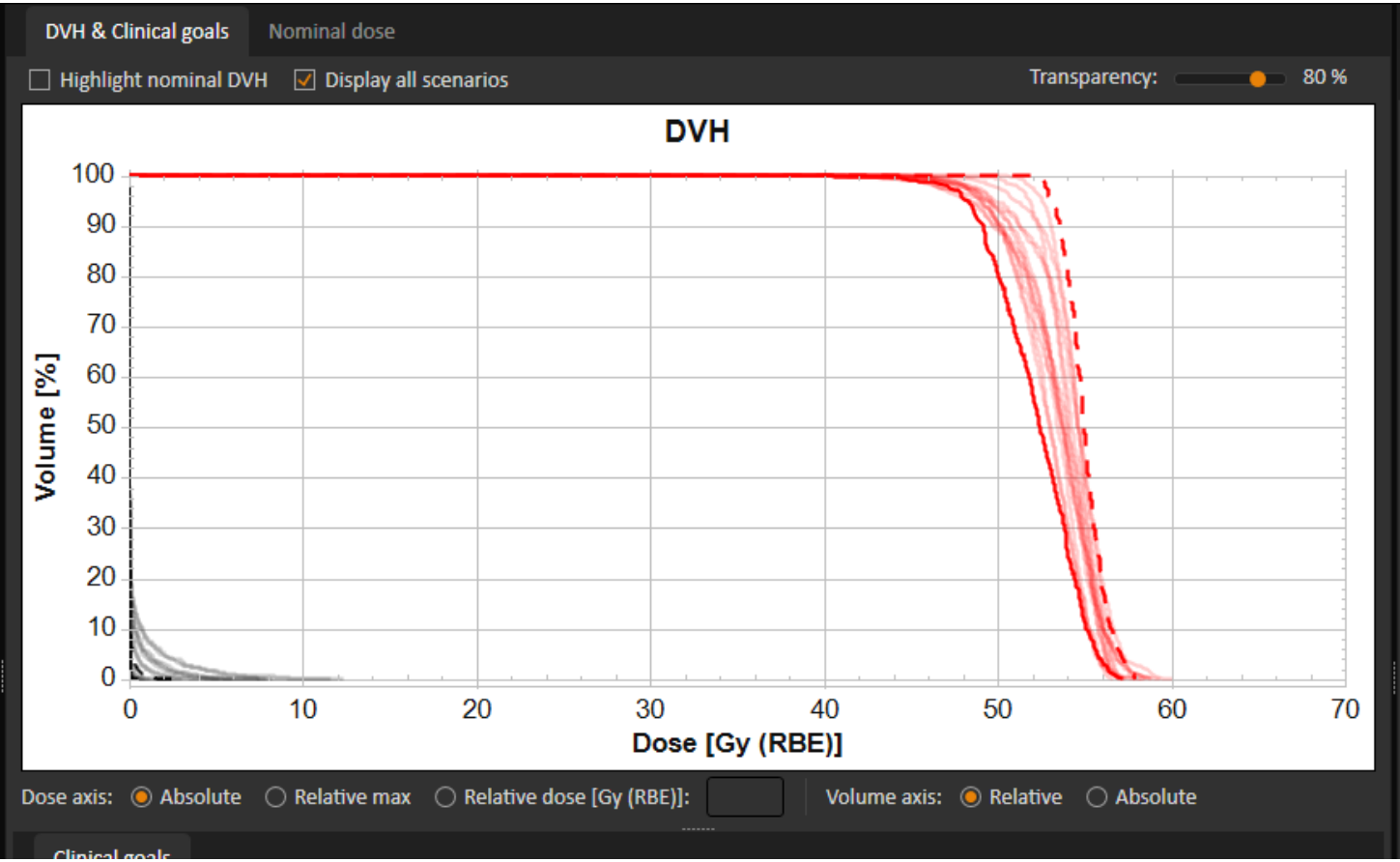
1. 14 robust scenarios in combination of 5% range and 5 mm setup uncertainties
2. Worst case appears at 5 mm setup superior and 5% more proximal range

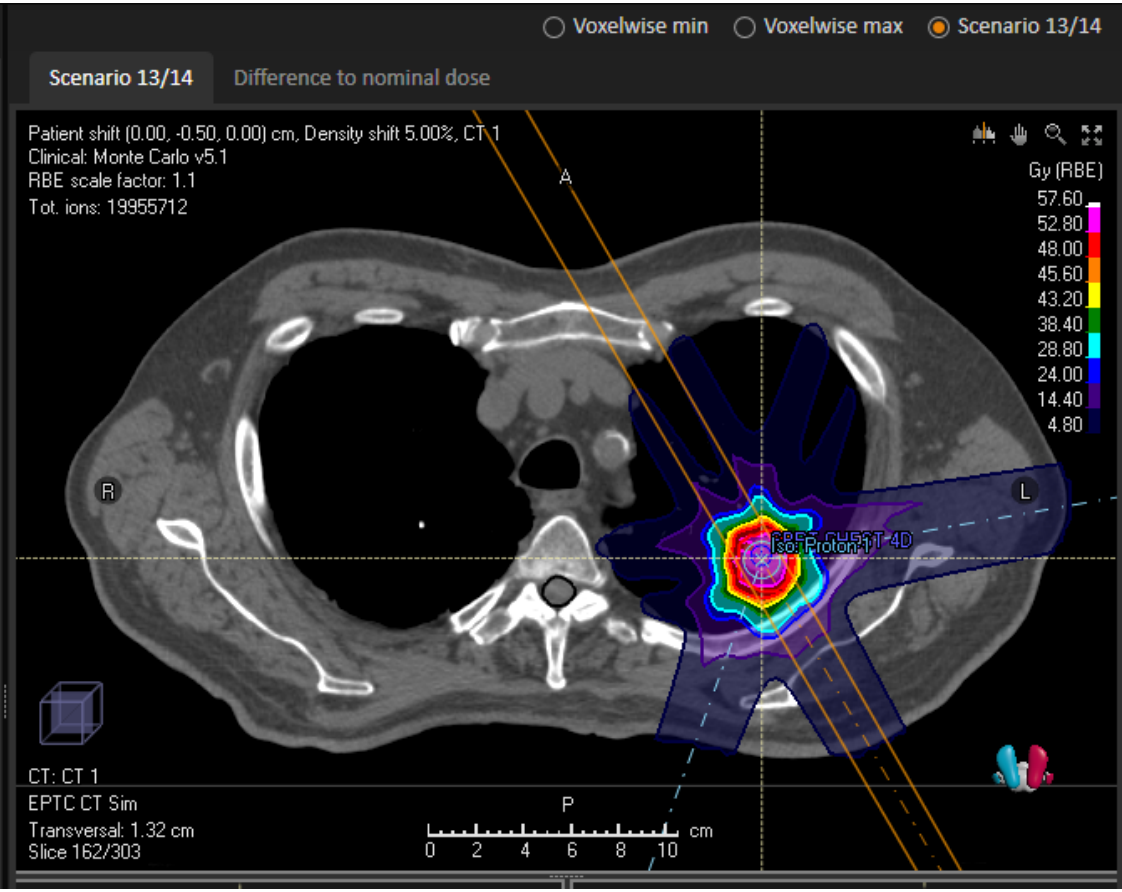
Lung SBRT vs. SBPT – Dr. Higgins's case- small



1. Proton improves integral dose at OARs (lung, esophagus, cord) and body outside proton beam paths with negligible heart dose
2. Photon is better at body inside proton beam paths

Worst Case Robust Scenario





1. 14 robust scenarios in combination of 5% range and 5 mm setup uncertainties
2. Worst case appears at 5 mm setup anterior and 5% more distal range. Can provide robust OAR if needed.

Conclusion

- Proton SBRT is better than photon SBRT at cutting integral dose and most OAR
- Photon SBRT needs smaller marginal area to cover target with possible advantage at immediate adjacent OAR constrained by maximum dose
- Robust planning/IGRT/Monte Carlo can ensure proton target coverage
- Do not assume photon SBRT is the only treatment option for small target

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