Eclipse Robust Planning

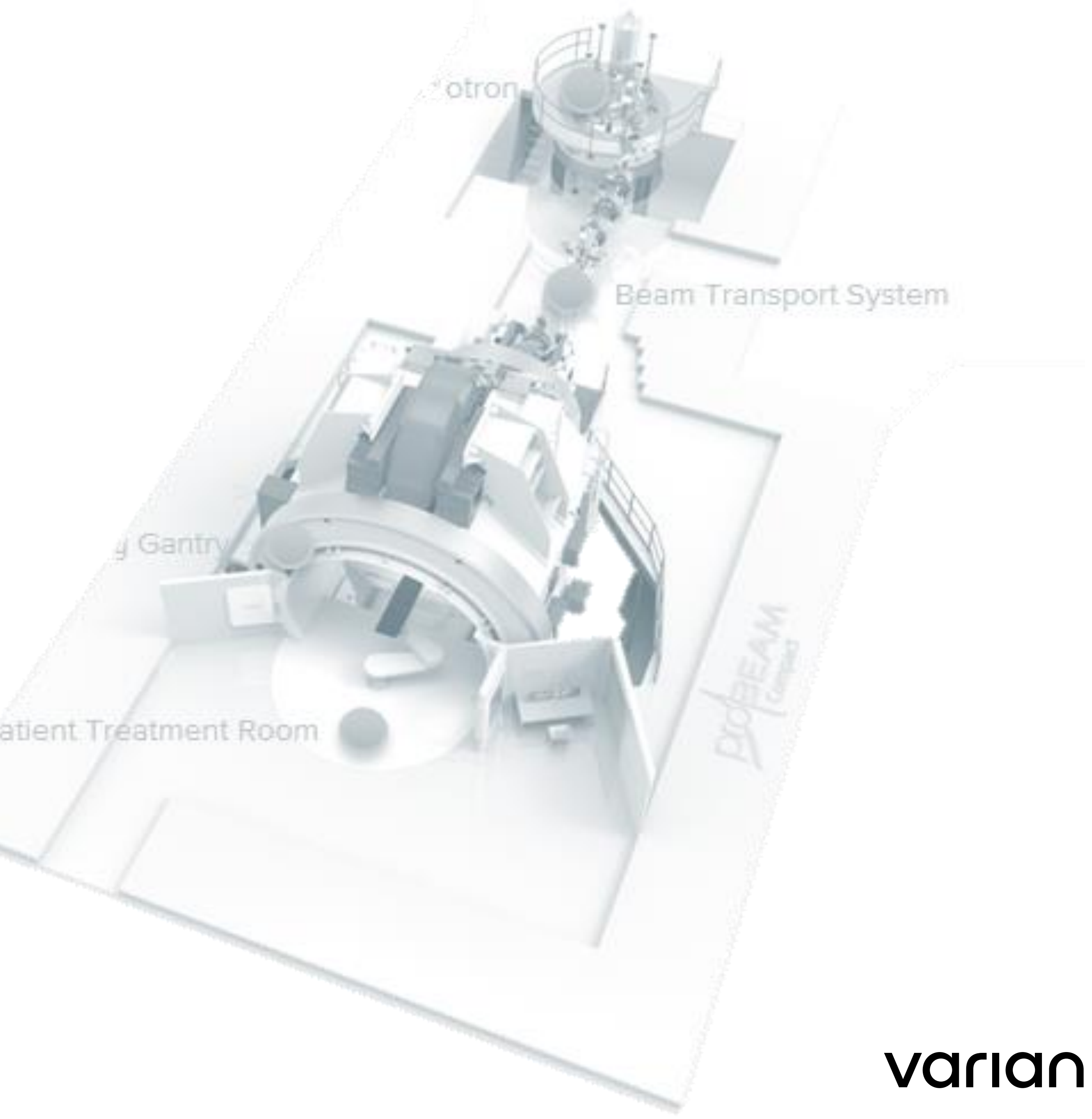
Reynald Vanderstraeten

Product Manager

Agenda

Eclipse Proton

- **Range Uncertainty**
  - **Field_Specific Target**
  - **Robust Optimization**
  - **Robust Evaluation**
- **Cases**
  - **Prostate + Lymph node**
  - **Lung case**



Range Uncertainty

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Range Uncertainty

Robust Planning

Tony Lomax, PhD

“The benefit of using protons is that they stop in the tissue.

Range Uncertainty

Robust Planning

Tony Lomax, PhD

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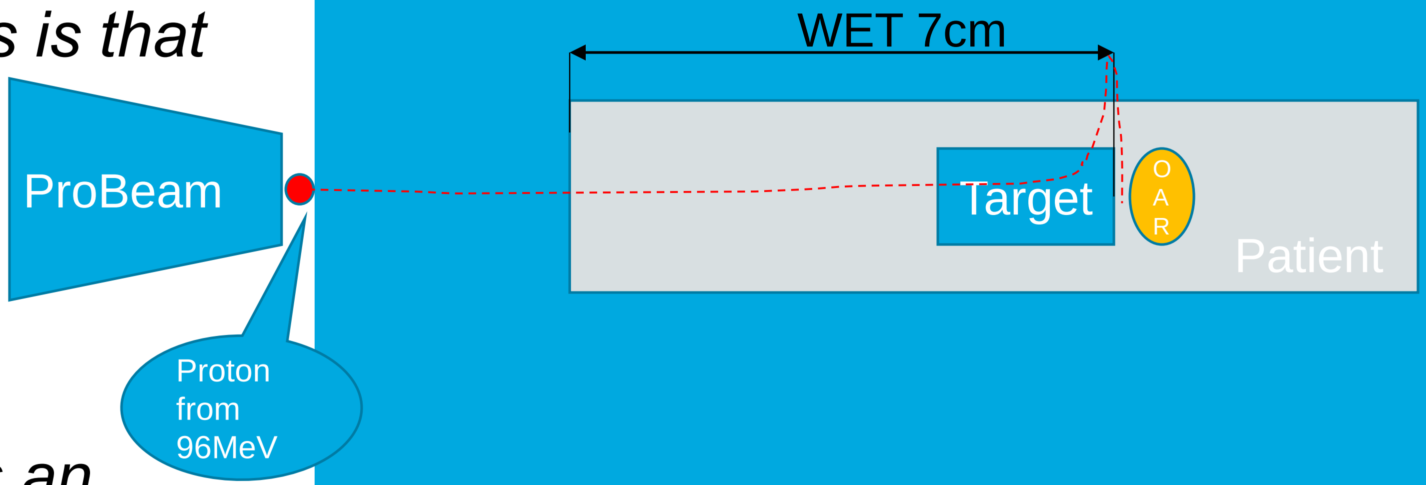
The problem is that there is an uncertainty on where they stop.”



Range Uncertainty

Robust Planning

Tony Lomax, PhD

"The benefit of using protons is that they stop in the tissue.

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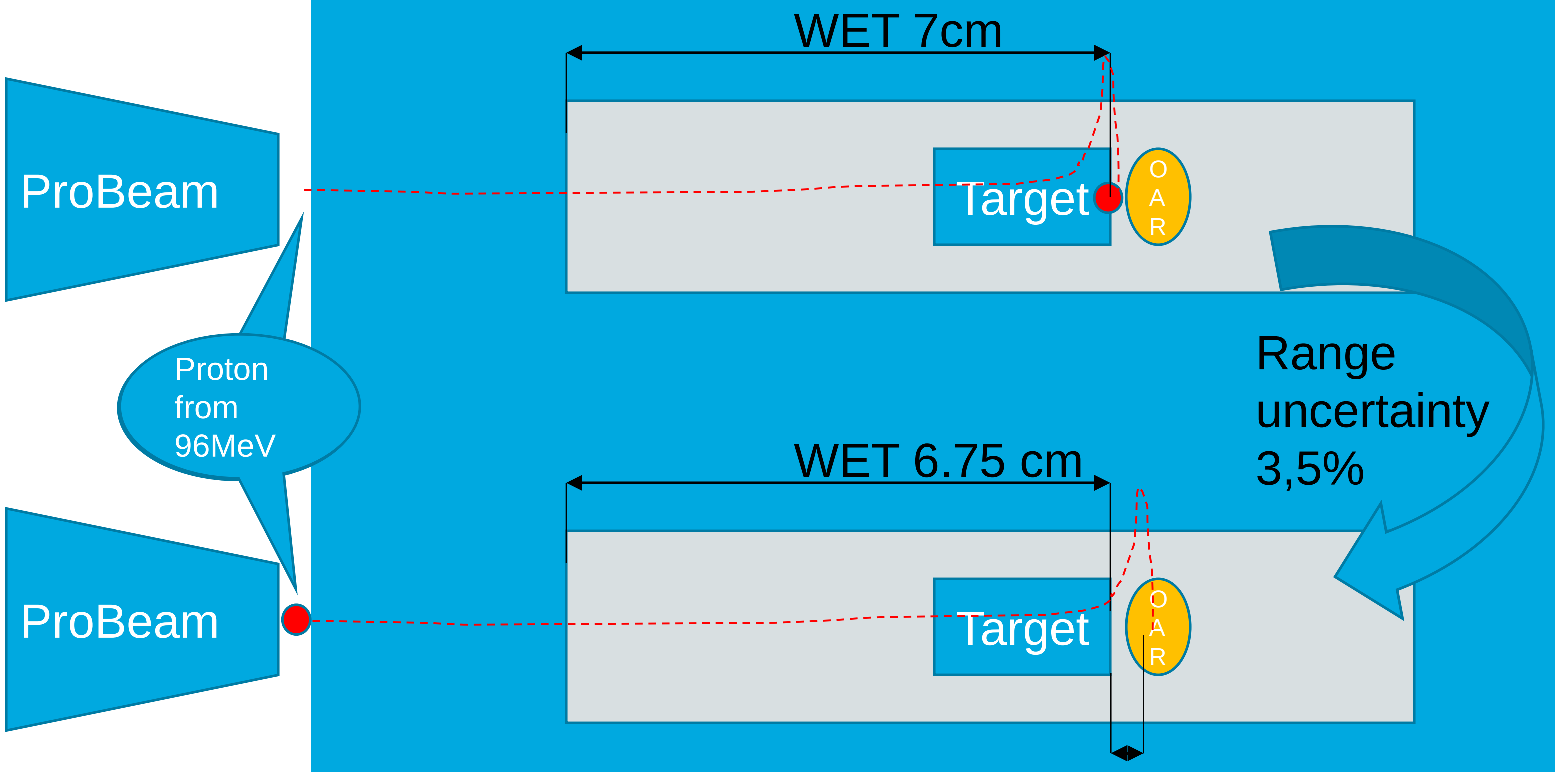
Uncertainties mitigation

- Field_Specific Target
- Robust Optimization
- Robust evaluation



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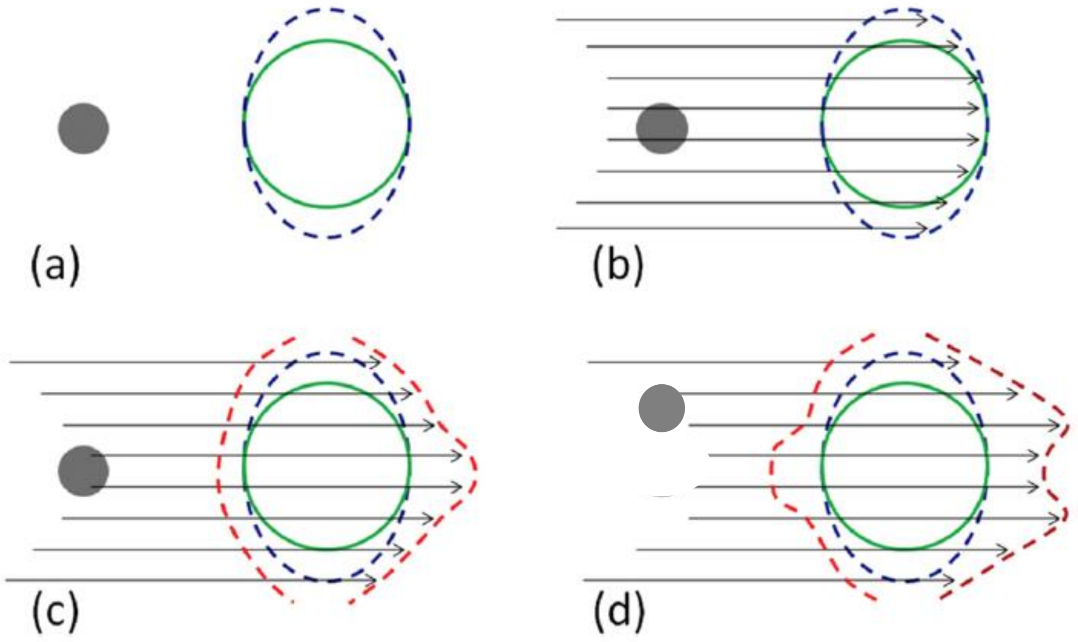
Field Specific Target

Robust Proton Planning

Field specific Target



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Int. J. Radiation Oncology Biol. Phys., Vol. 82, No. 2, pp. e329–e336, 2012

0360-3016/$ - see front matter

doi:10.1016/j.ijrobp.2011.05.011

PHYSICS CONTRIBUTION

A BEAM-SPECIFIC PLANNING TARGET VOLUME (PTV) DESIGN FOR PROTON THERAPY TO ACCOUNT FOR SETUP AND RANGE UNCERTAINTIES

Peter C. Park, B.S.,*† X. Ronald Zhu, Ph.D.,† Andrew K. Lee, M.D., M.P.H.,‡ Narayan Sahoo, Ph.D.,† Adam D. Melancon, Ph.D.,† Lifei Zhang, Ph.D.,† and Lei Dong, Ph.D.†

*Medical Physics Program, Graduate School of Biomedical Sciences, The University of Texas Health Science Center at Houston, Houston, TX; and Departments of †Radiation Physics and ‡Radiation Oncology, The University of Texas MD Anderson Cancer Center, Houston, TX

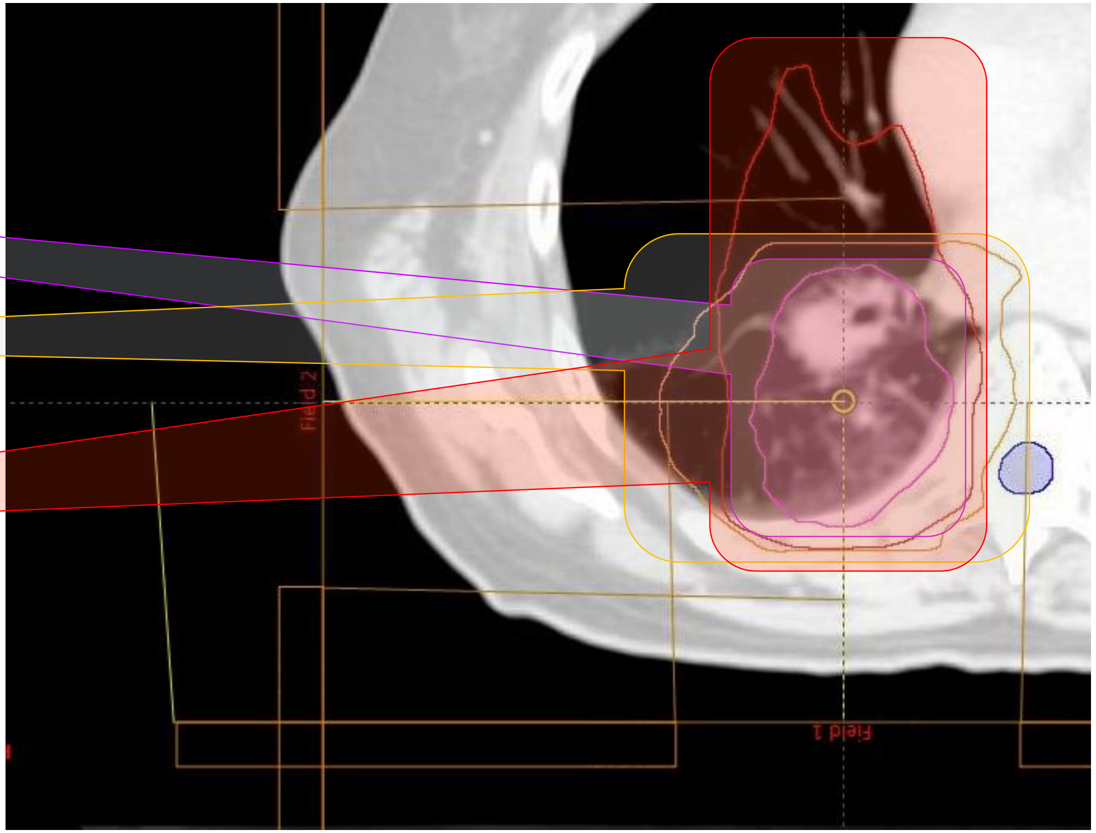
Robust Planning: fsTarget

Field specific Target (fsTarget) generation

CTV

Gantry 270°fsTarget

Gantry 180°fsTarget



Robust Optimization

Robust Proton Planning

Robust Optimization

Uncertainties

- Patient positioning uncertainty
- Range uncertainty

Optimization parameters can be a mix of optimization objectives

- robust optimization
- non-robust optimization

The DVH gives a graphical representation of the robustness of each structure

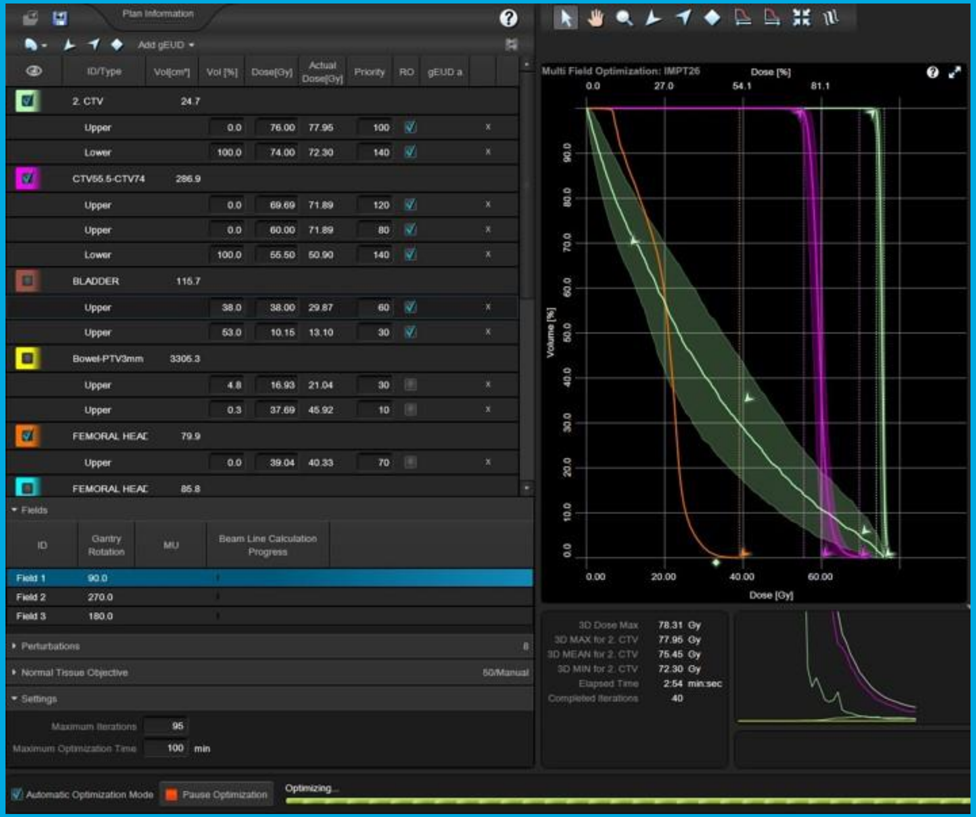
- Voxels with minimum dose
- Nominal plan DVH
- Voxels with maximum dose

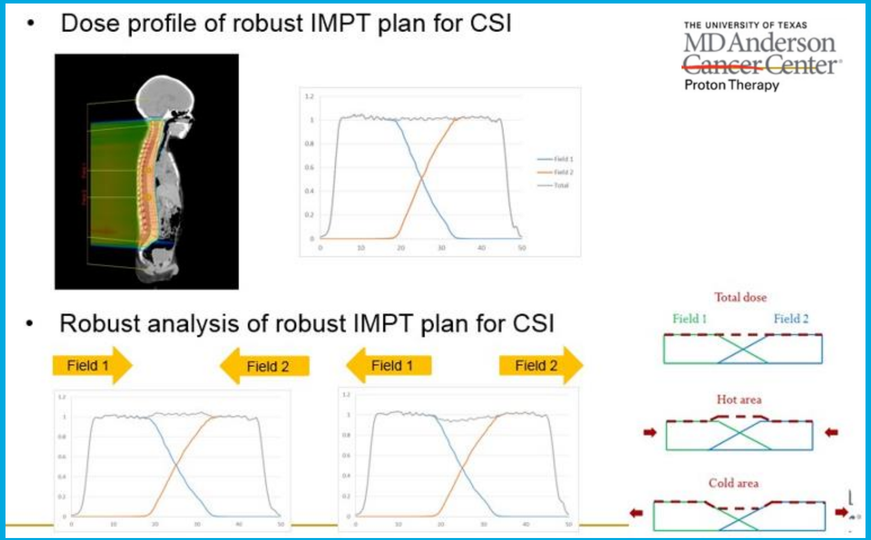
Plan Uncertainty Parameters

- All fields move together in the X/Y/Z directions

Field Uncertainty Parameters

- Each field moves individually





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Users Experience

Upenn: Robust Optimization

- Dr. Lei Dong (Head of the physics department at Upenn) and Dr. Alexander Lin
  - *We really like it and are very pleased with the plans we have been generating*
  - *Dr. Lin mentioned it is at first hard to get people to move away from the PTV, but once they robustly evaluated the plan quality, they were very happy*
  - *30% of the patients now are planned with CTV-based robust optimization, but this will grow.*

Robust IMPT optimization - improving planning strategies

International Journal of
Radiation Oncology
biology • physics

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Physics Contribution

CrossMark

Superiority in Robustness of Multifield Optimization Over Single-Field Optimization for Pencil-Beam Proton Therapy for Oropharynx Carcinoma: An Enhanced Robustness Analysis

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[*]Department of Radiation Oncology, University of Pennsylvania, Philadelphia, Pennsylvania; [†]OncoRay—National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, and Helmholtz-Zentrum Dresden—Rossendorf, Dresden, Germany; and [‡]Helmholtz-Zentrum Dresden—Rossendorf, Institute of Radiooncology - OncoRay, Dresden, Germany

Received Dec 5, 2016, and in revised form Jun 1, 2017. Accepted for publication Jun 13, 2017.

Summary

Dose distributions in intensity modulated proton therapy might be prone to setup errors and range uncertainties. Plan robustness can be improved by adequate planning strategies. We compare the performance of single-field and robust multifield optimized plans for postsurgery intensity modulated proton therapy for oropharynx carcinoma. The

Purpose: To compare the difference in robustness of single-field optimized (SFO) and robust multifield optimized (rMFO) proton plans for oropharynx carcinoma patients by an improved robustness analysis.

Methods and Materials: We generated rMFO proton plans for 11 patients with oropharynx carcinoma treated with SFO intensity modulated proton therapy with simultaneous integrated boost prescription. Doses from both planning approaches were compared for the initial plans and the worst cases from 20 optimization scenarios of setup errors and range uncertainties. Expected average dose distributions per range uncertainty were obtained by weighting the contributions from the respective scenarios with their expected setup error probability, and the spread of dose parameters for different range uncertainties were quantified. Using boundary dose distributions created from 56 combined setup error and range uncertainty scenarios and considering the vanishing influence of setup errors after 30 fractions, we approximated realistic worst-case values for the total treatment course. Error bar metrics derived from these boundary doses are reported for the clinical target volumes (CTVs) and organs at risk (OARs).

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Robust Evaluation

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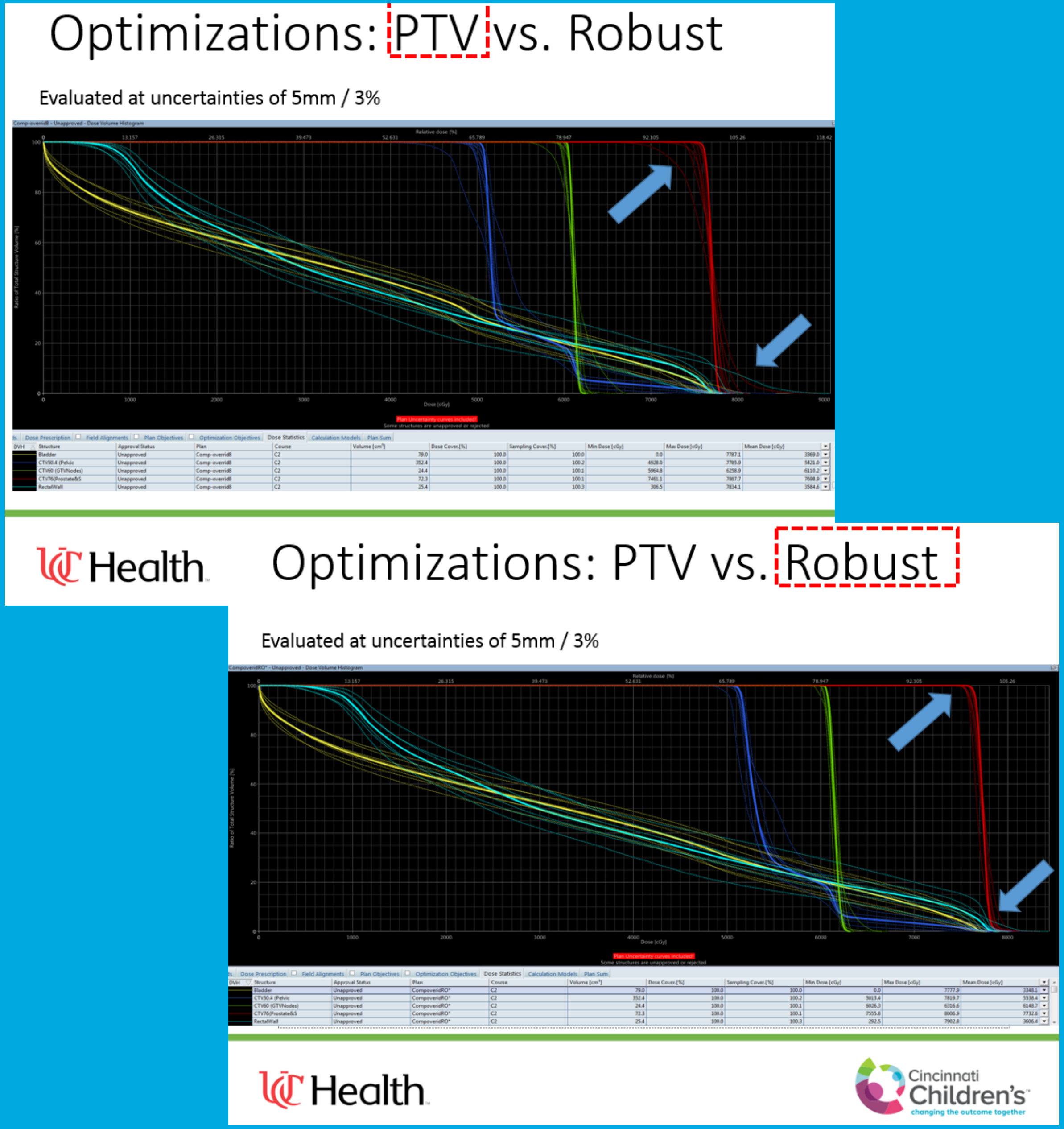

Users Experience

Cincinnati: Robust Optimization
Robust Evaluation

- Anthony Mascia, PhD
  - *We decided to adopt Robust Optimization almost exclusively*
  - *What plans are improved by robust optimization in our experience*
    - *Bilateral head and neck*
    - *Prostate + Nodes*
    - *Craniospinal*
    - *Clival chordoma*
    - *Plans requiring an "aggressive" multi-field optimized, IMPT plan especially at high Rx relative to OARs*

Robust IMPT optimization –
Robust target coverage

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Workshop 2: Robust Proton Planning

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Citrix environment

Workshop 2

25 Citrix accounts

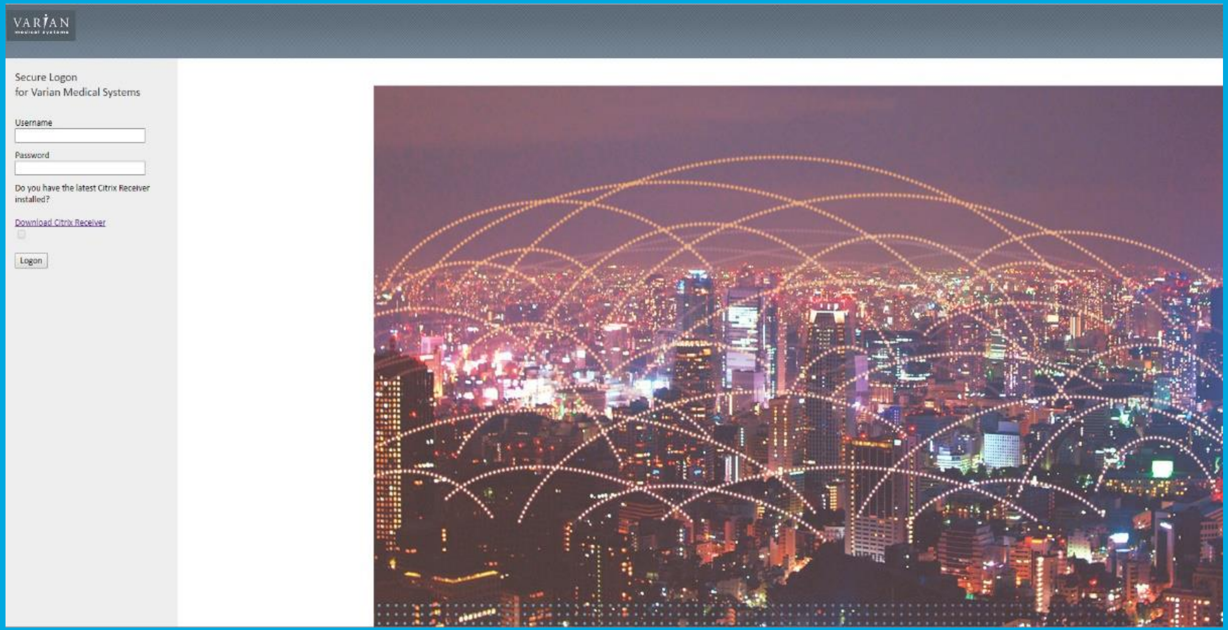
- Username: Enlight0x (x = 1 → 25)
- Password: 3nL1gHt_@0x! (x = 1 → 25)

2 clinical cases

- EnlightC100x (x = 1 → 25)
- EnlightC200x (x = 1 → 25)

Small users guide available at the workstations

Ask if you need support!



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Prostate + Lymph node

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Case 1

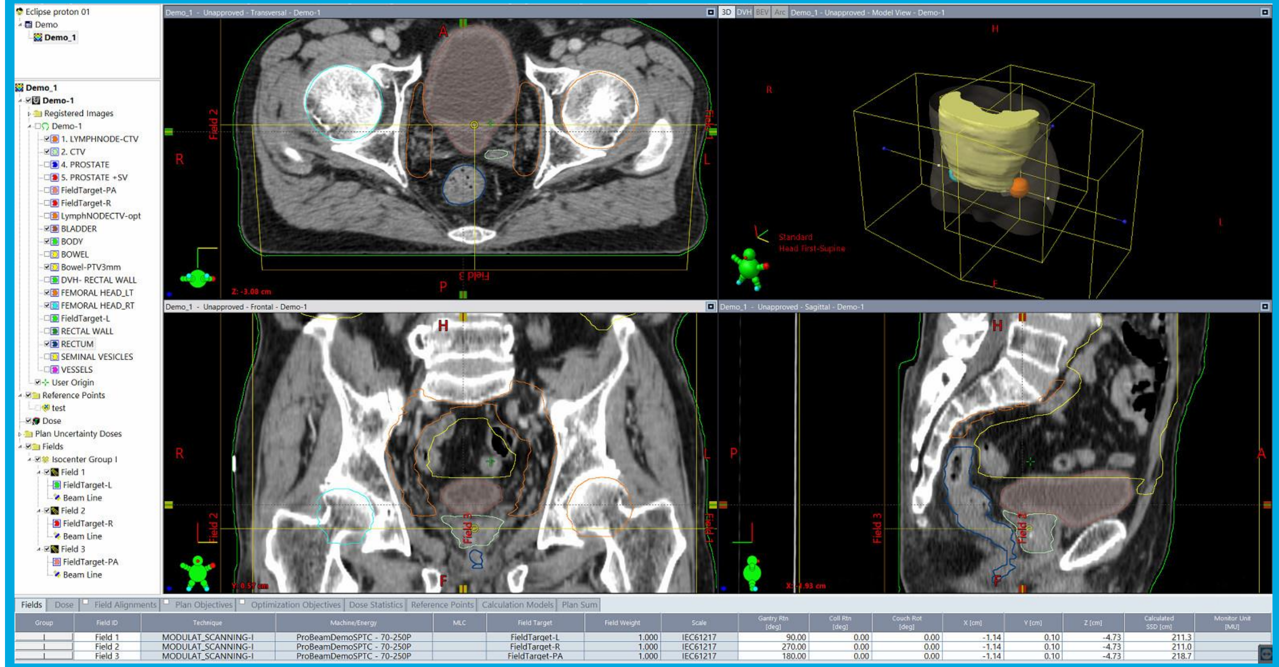
Robust Planning

Description

- Target1: 1.LYMPHNODE-CTV
  - Prescription: 56Gy
- Target2: 2.CTV:
  - Prescription: 74Gy
- OAR
  - BLADDER
  - Bowel-PTV3mm
  - FEMORAL HEAD_LT
  - FEMORAL HEAD_RT
  - RECTUM

Plan

- Create your beam arrangement

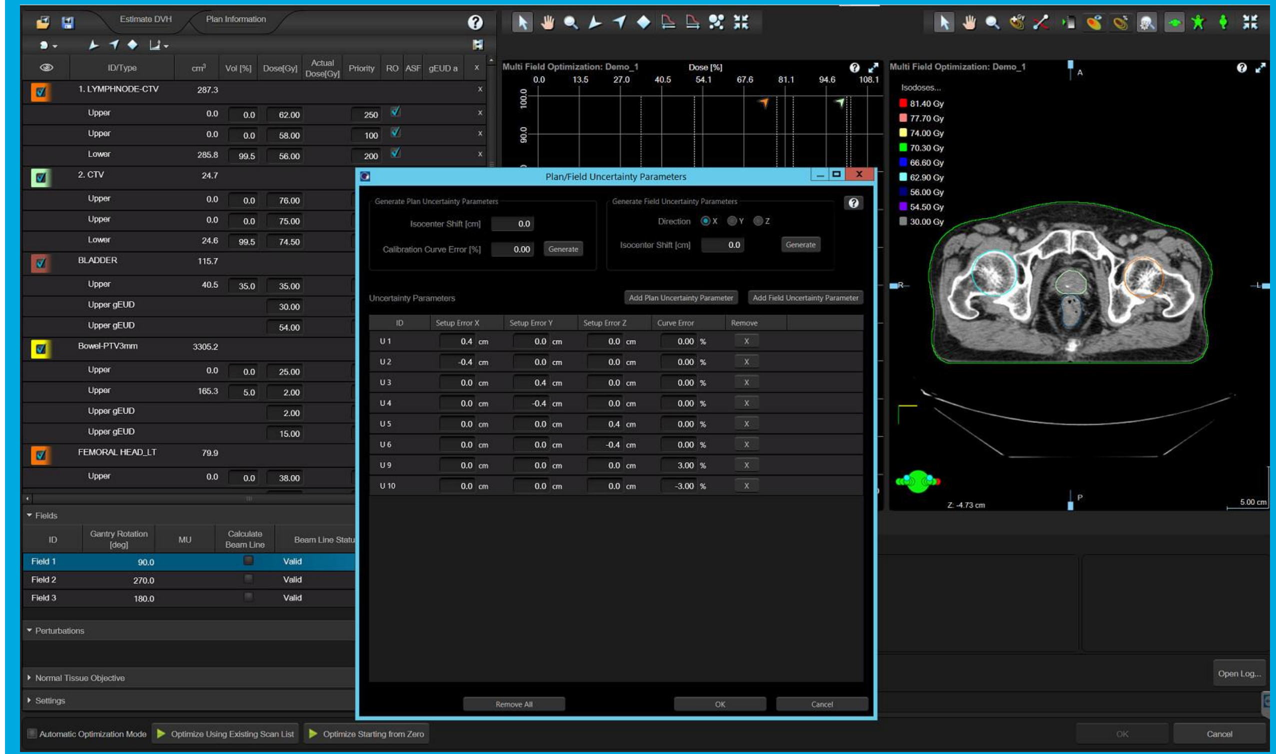


Case 1

Robust Planning

Robust Optimization

- Perform Robust Optimization
  - Optimizing on the CTV
- Select the uncertainties
  - Patient Positioning = Isocenter shift
  - Range uncertainty = Calibration curve error
- Select the Objectives that needs to be robust optimized.

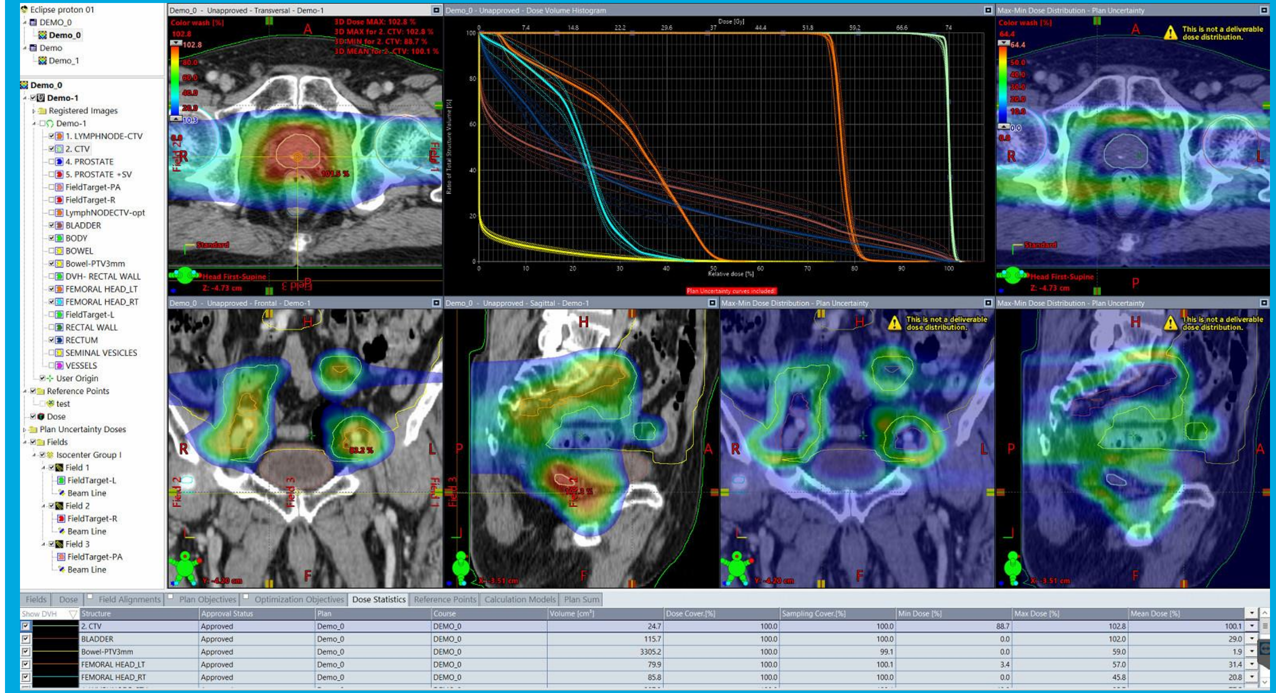


Case 1

Robust Planning

Robust Evaluation

- Evaluate the Robustness of the plan
  - Plan Uncertainty dose
- Plan Uncertainty dose in DVH
- Max-Min Dose Distribution



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Lung

Case 2

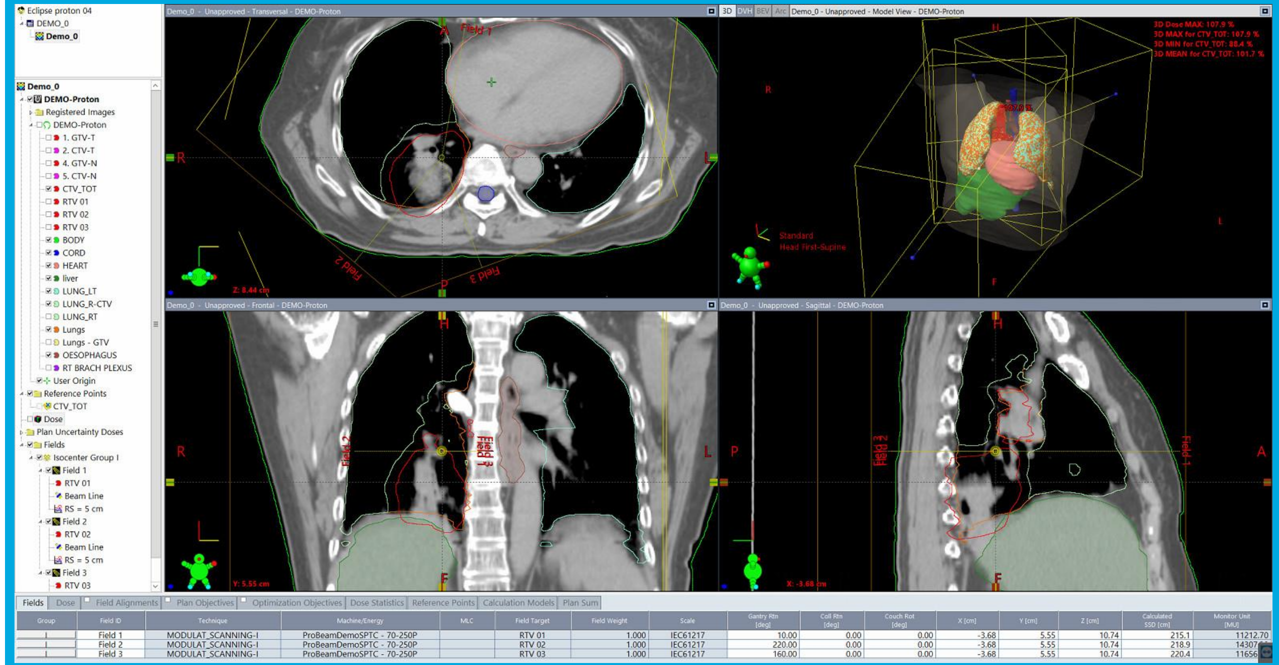
Robust Planning

Description

- Target: CTV_TOT
  - Prescription: 66Gy
- OAR
  - LUNG_LT
  - LUNG_RT
  - HEART
  - Liver
  - OESOPHAGUS
  - CORD

Plan

- Create your beam arrangement



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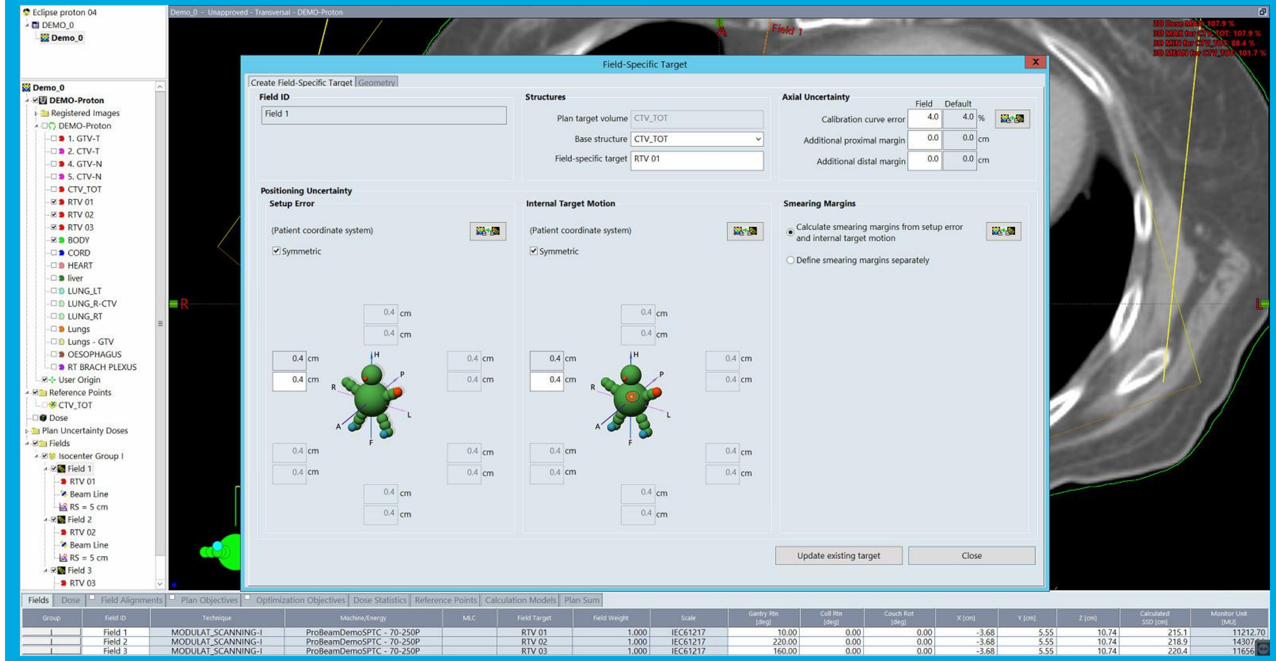
Case 2

Robust Planning

Field_Specific Target

- Base Structure = CTV
- Enter the uncertainties
  - Position uncertainty
    - Setup error
    - Internal target motion
  - Axial Uncertainty (range uncertainty)
- Field_Specific Target is beam specific, repeat for each beam



Case 2

Robust Planning

Robust Optimization

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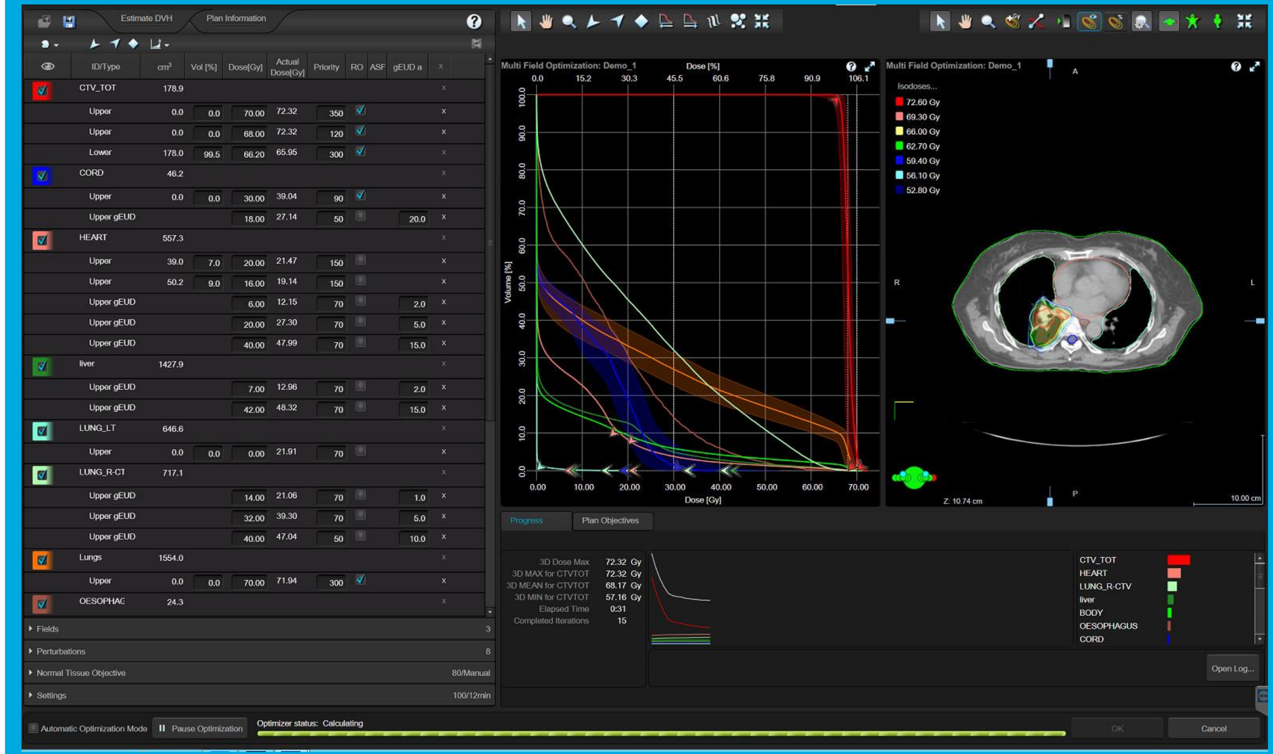

Case 2

Robust Planning

Robust Evaluation

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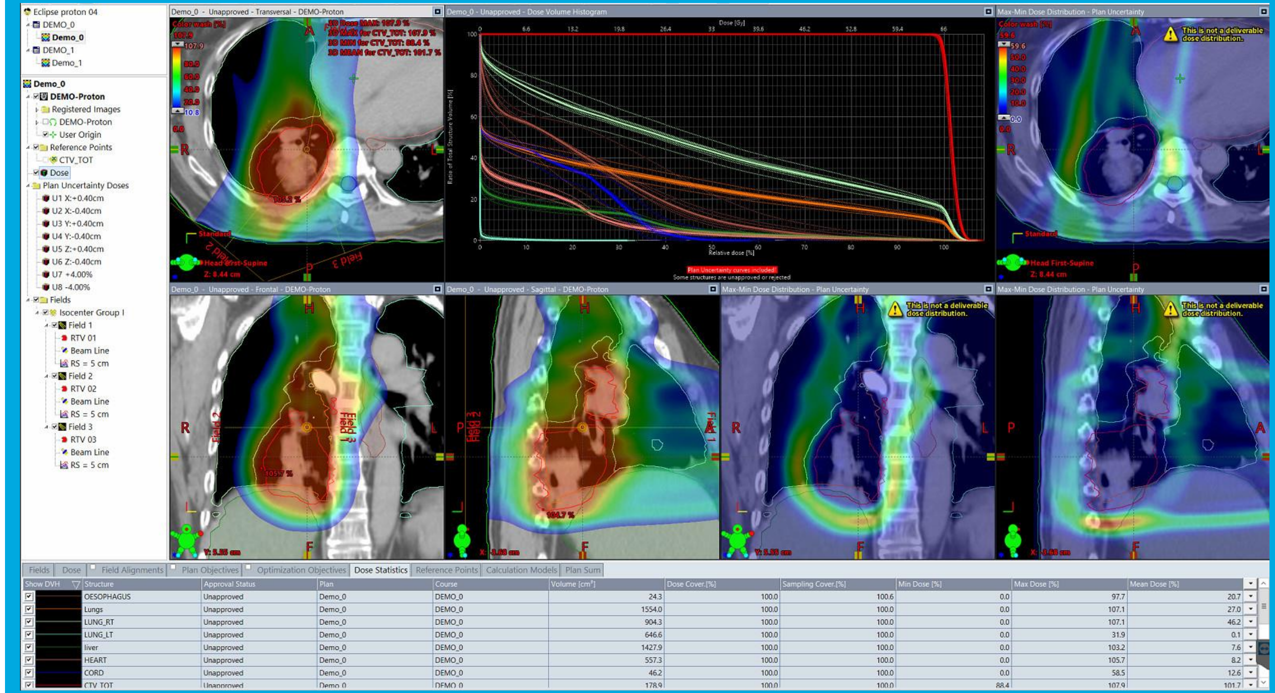

(Thank You)