Cleveland Clinic

Practical Scripting in mim and Pinnacle³

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Scripting at Cleveland Clinic

No Conflict of Interest

Scripting at Cleveland Clinic

- Workflow
  - CT simulation ➡ image fusion and contouring in MIM ➡ treatment planning in Pinnacle

- We use MIM scripts for
  - Auto contouring, contour processing, and contour QA

- We use Pinnacle scripts for
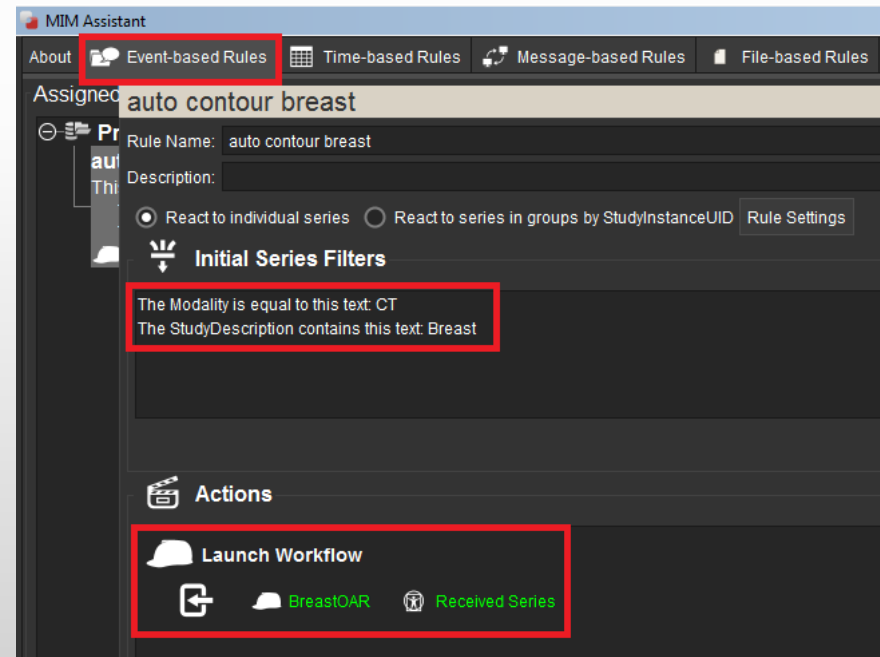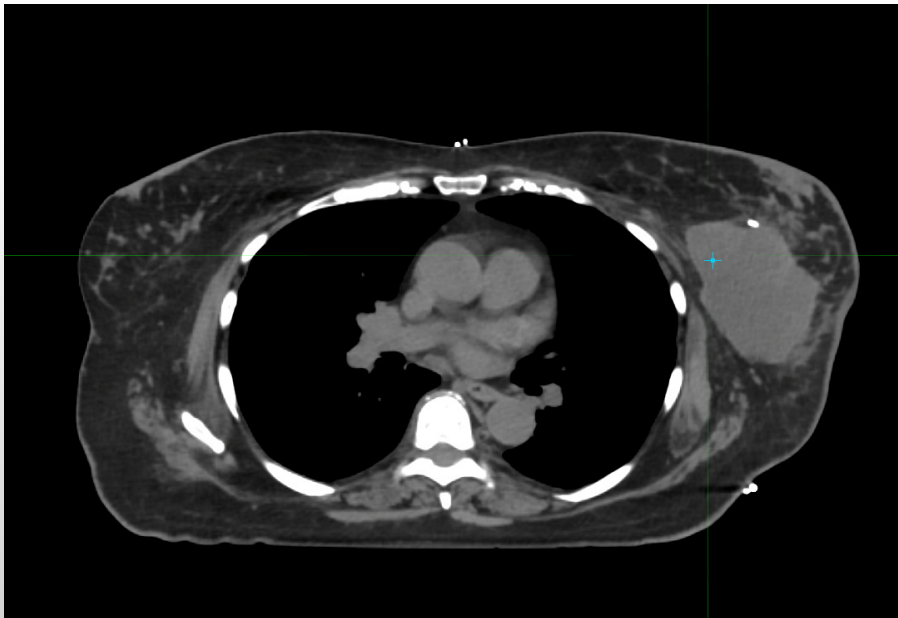 - Auto planning, plan report, and plan check

Scripting at Cleveland Clinic

- How to write scripts in MIM
  - MIM workflow
  - MIM assistant
  - MIM extension (Matlab and Java)

- How to write scripts in Pinnacle
  - Easy way: record and edit
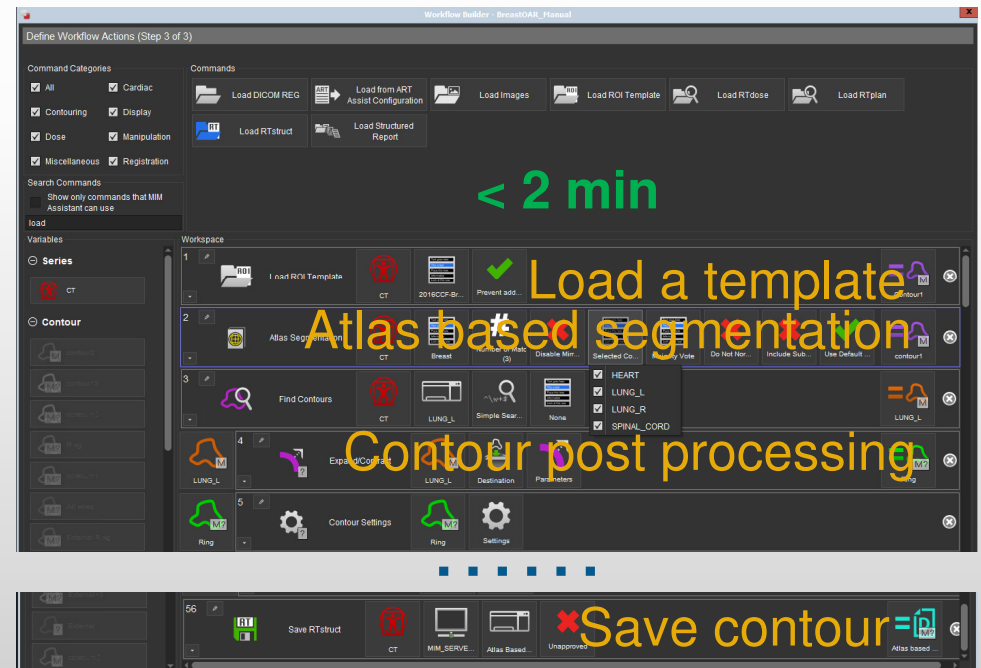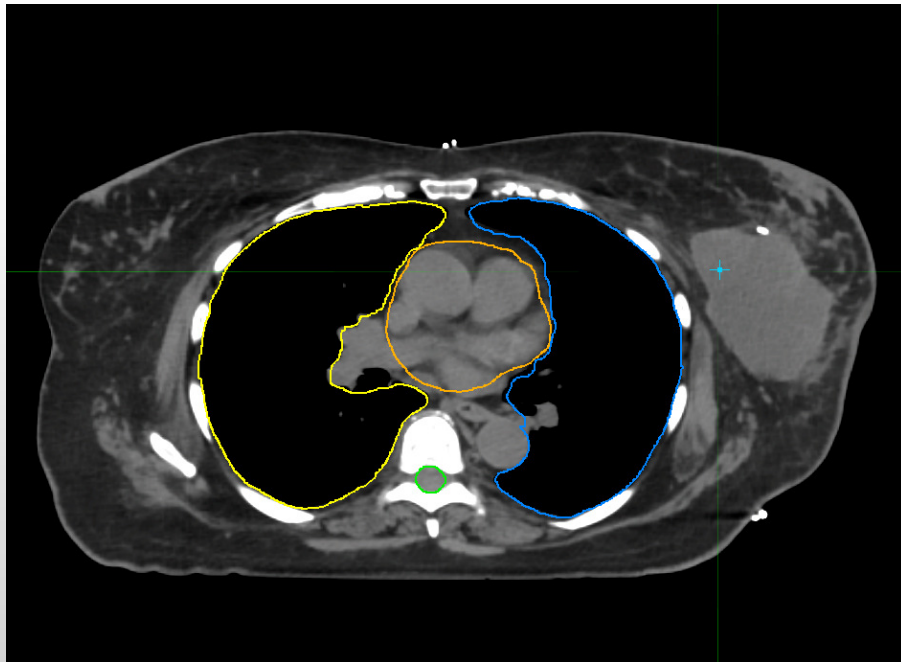 - Plug-in (C++ and Python)

A patient example

- A breast CT
 - A MIM assistant recognizes the treatment site and launches an auto contouring workflow

A patient example

- Auto segmentation for normal structures
  - A MIM workflow performs atlas-based segmentation for heart, lungs, and spinal cord, and save the contours

A patient example

- Auto segmentation for auto planning
  - A MIM workflow segments wires, identifies landmarks and creates targets for auto planning
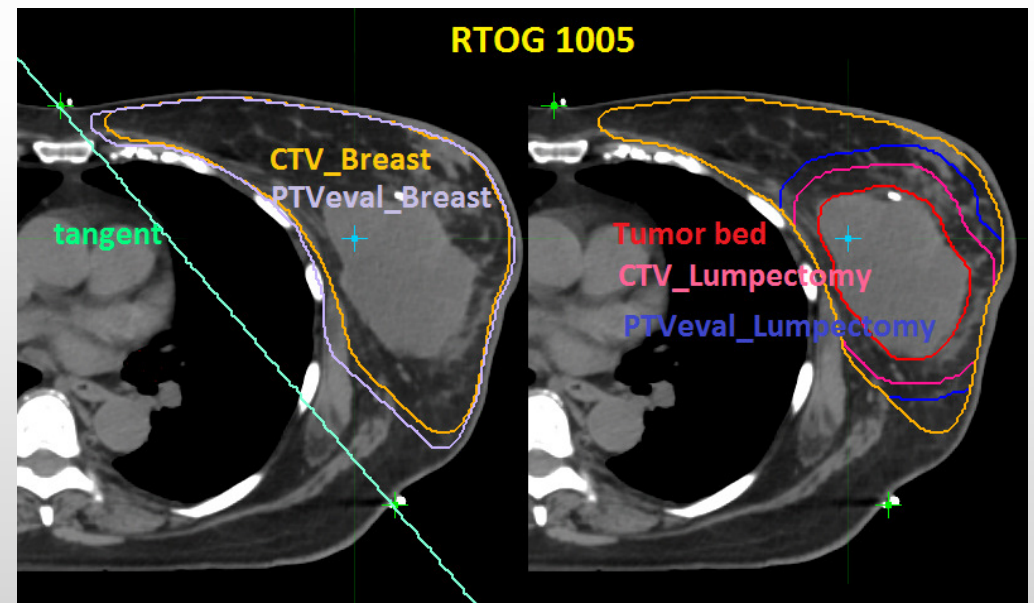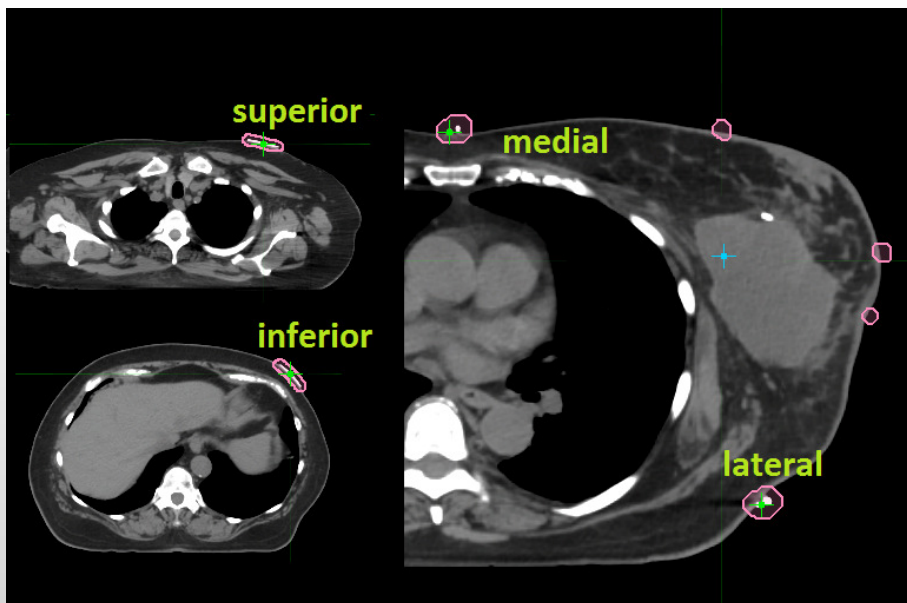
A patient example

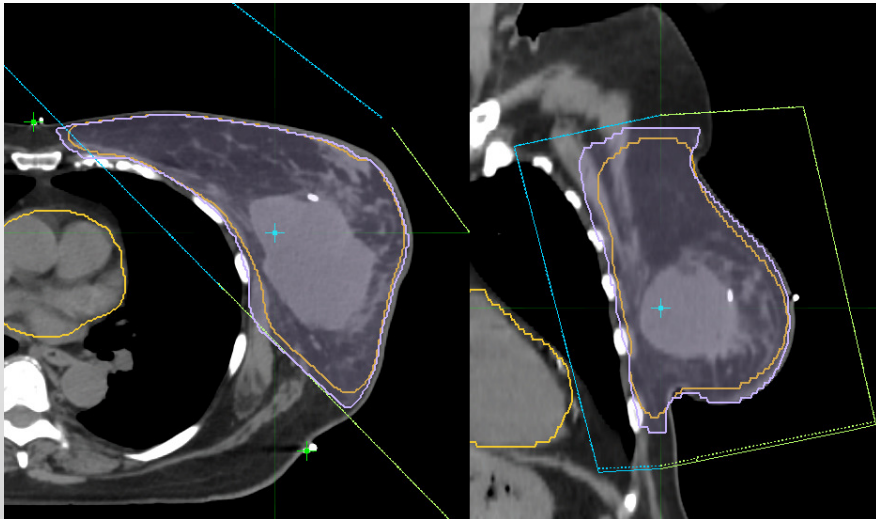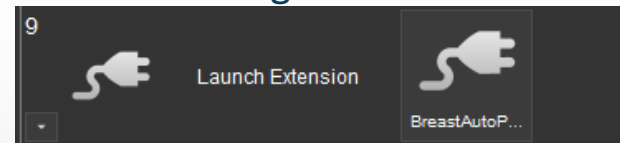- Auto planning : create beams
  - A MIM extension using MATLAB sets beams to landmarks, optimizes beam angles, jaw positions and beam block

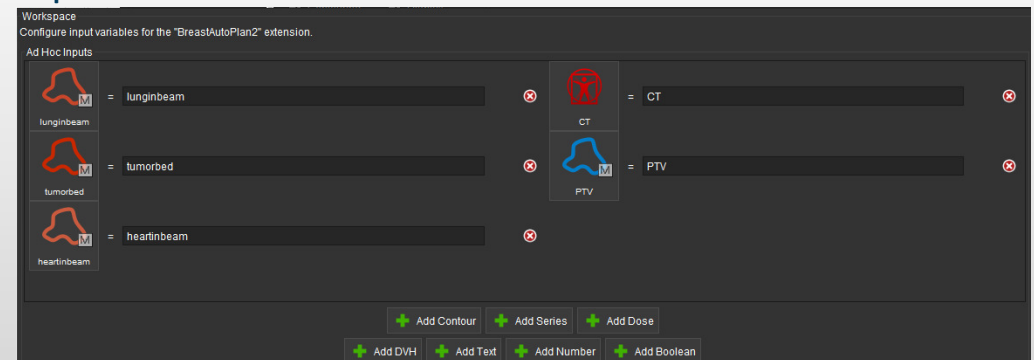To cover 95% of PTVeval_breast while minimizing:

$$f = 50 \times \% \text{ heart volume in the beam} + \% \text{ lung volume in the beam}$$

Extension integrated into workflow

Input of extension:

Output of extension: a Pinnacle script for auto planning

A patient example

- Auto planning – hybrid IMRT
  - A pinnacle script creates a hybrid IMRT plan (3D + IMRT)
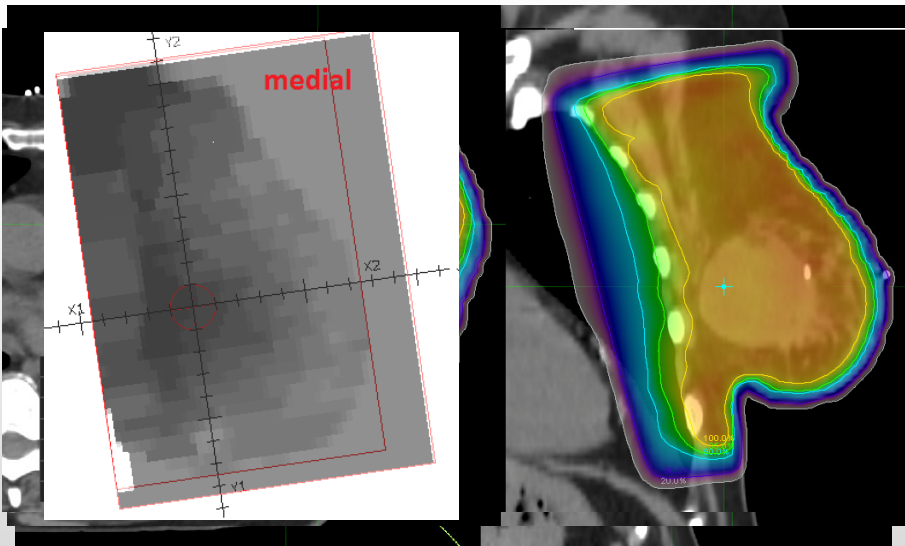
Localization, couch removal, CT to density table, wire density override and set dose grid

Add a 3D prescription including two static tangent beams; beam weight optimization

3D prescription: prescribe to max dose

Add a IMRT prescription with two step and shoot tangent beams

Optimize IMRT prescription to deliver uniform dose to breast and reduce dose to OARs

A patient example

- Auto contour vs manual Contour for this patient
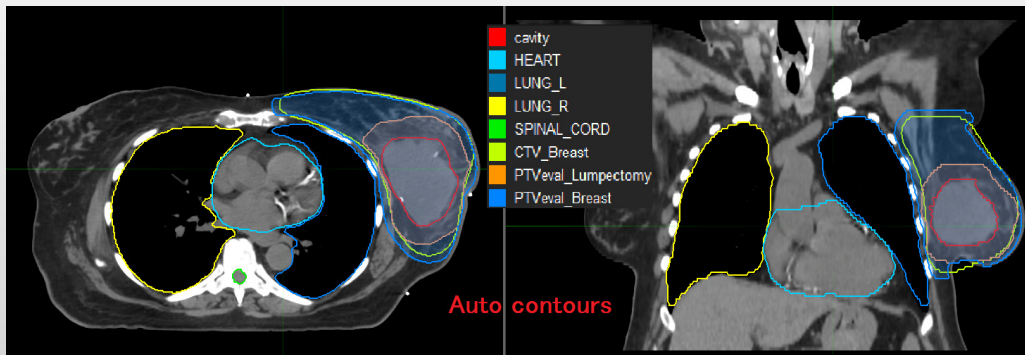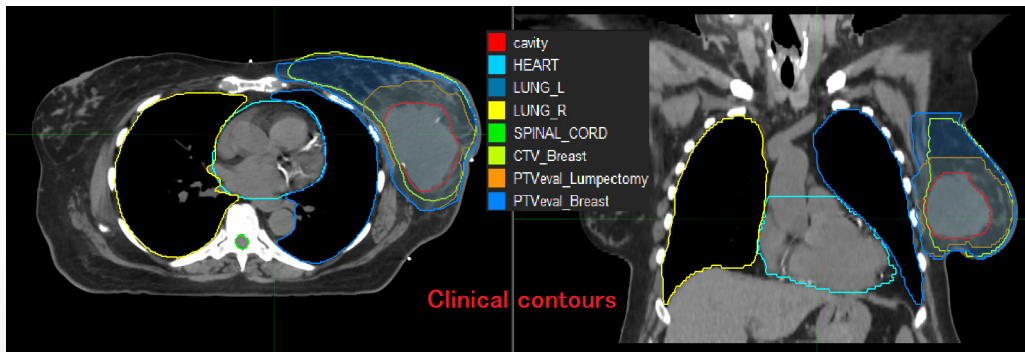
	Dice	Mean Hausdorff Distance/mm
Lung_L	0.98	0.6
Lung_R	0.98	0.5
Heart	0.92	2.0
Spinal_Cord	0.90	0.5
CTV_Breast	0.80	6.5
PTVeval_Breast	0.84	5.5

A patient example

- Auto plan vs manual plan for this patient
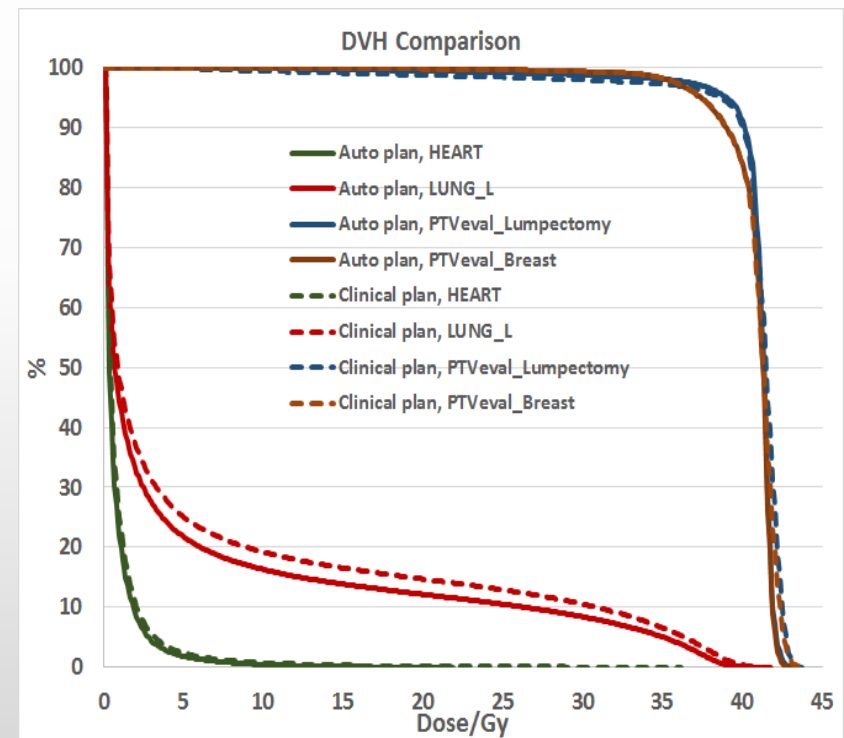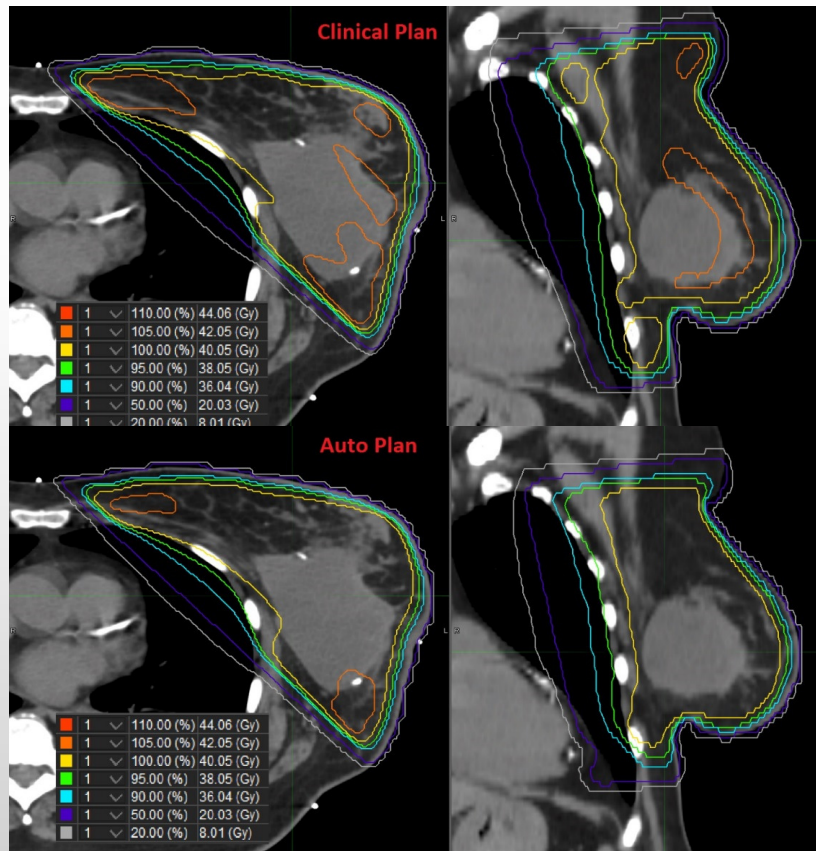
A patient example

- Auto vs manual for 30 breast patients
  - 20 left breast (10 free breathing, 10 breath hold) and 10 right breast patients

Auto Contour vs Clinical Contour

	Heart	Lt lung	Rt Lung	Cord
Dice Coefficient	0.94	0.97	0.98	0.91
Mean Hausdorff distance/mm	1.47	0.68	0.69	0.45

A patient example

- Plan export
  - A pinnacle script checks planning parameters

Pinnacle Plan Information

Patient:	Demo, Breast,	Patient ID:	20190711
Plan:	autoplan3	Trial:	Trial_1
Date of record:	07/11/2019 10:12		

CT image data set scan time is: 2017-06-12 08:17:30 **CT date and time**

Remove couch top Y to Isocenter of "ISO" vertical distance = 29.1 cm, with 0.5cm sag, Iso-Vertical at 28.6 cm **Table vertical**
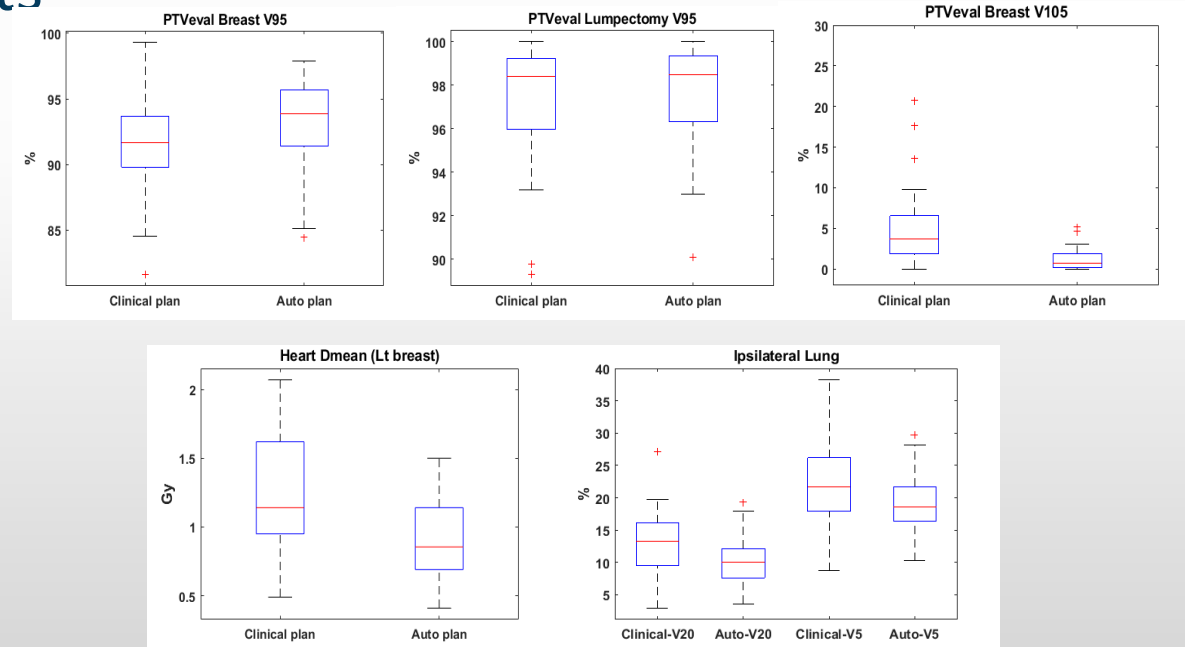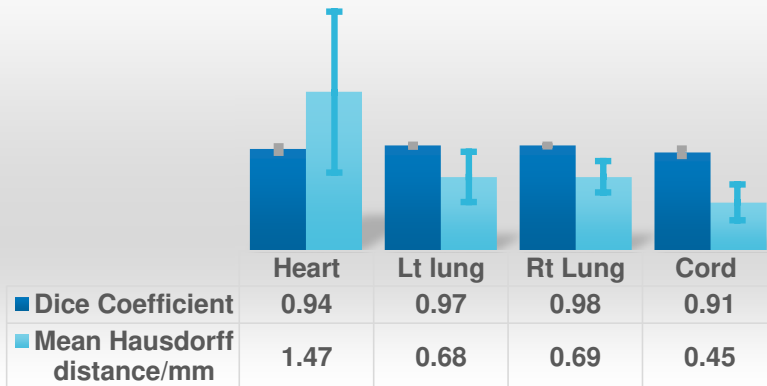
SetUp Beam SSD information: **SSDs of set up beams**

ASU 88.16

ISO-Vertical 29.1, with addition 0.5cm sag, at 28.6 cm

The cross check on the beam consistency shows as below: **Other checks**

LINAC machine name inconsistency is detected.

Inconsistency between the beam name and the gantry or table angles is detected, use standard name convention.

Inconsistency between the beam name and the filed ID is detected.

Beam ISO inconsistency is detected.

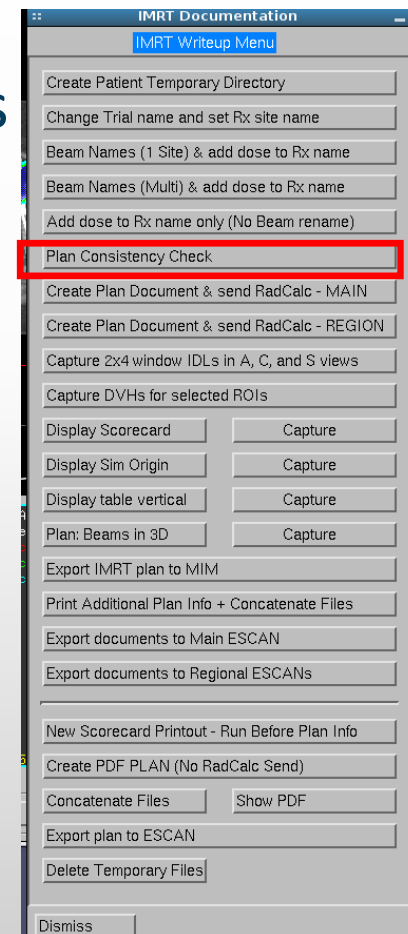Reference point inconsistency is detected.

Iso center shifts are detected. Please document the shifts in MOSAIQ.

MIM Export status:

Please export plan to MIM

- 20 items checked via scripting
  - Correct beam names
  - All beams associated with the same Isocenter and treatment machine
  - Potential collision check
  - Couch inserted for SBRT plan, use small grid size
  - No 180^0 in VMAT plans
  - Field size and MLC limits
  ......

IMRT Documentation

IMRT Writeup Menu

- Create Patient Temporary Directory
- Change Trial name and set Rx site name
- Beam Names (1 Site) & add dose to Rx name
- Beam Names (Multi) & add dose to Rx name
- Add dose to Rx name only (No Beam rename)
- Plan Consistency Check
- Create Plan Document & send RadCalc - MAIN
- Create Plan Document & send RadCalc - REGION
- Capture 2x4 window IDLs in A, C, and S views
- Capture DVHs for selected ROIs
- Display Scorecard — Capture
- Display Sim Origin — Capture
- Display table vertical — Capture
- Plan: Beams in 3D — Capture
- Export IMRT plan to MIM
- Print Additional Plan Info + Concatenate Files
- Export documents to Main ESCAN
- Export documents to Regional ESCANs
- New Scorecard Printout - Run Before Plan Info
- Create PDF PLAN (No RadCalc Send)
- Concatenate Files — Show PDF
- Export plan to ESCAN
- Delete Temporary Files

Dismiss

Additional scripting examples

- Auto contouring
  - MIM assistant rules and workflows developed to auto segment OARs for six body sites

| Site	OARs	Number of patients March 2017-March 2019
Brain	Brain, Brainstem, Globe_L, Globe_R, Spinal cord	242
Head and Neck	Brainstem, Cochlea_L, Cochlear_R, Mandible, Spinal_Cord, Trachea	180
Breast	Heart, Lung_L, Lung_R, Spinal_Cord	331
Thorax	Heart, Lung_L, Lung_R, Spinal_Cord	449
Abdomen	Heart, Lung_L, Lung_R, Spinal_Cord, Liver, Kidney_L, Kidney_R	123
Male Pelvis	Bladder, Femur_L, Femur_R, Rectum	157

Additional scripting examples

- Contour QA
  - A MIM workflow (with extension using JAVA) checks all contours in the list for "simple" errors (missing contour, stray volume, hole, laterality mislabel, skipping slices etc.)

Percent Error (head and neck, 100 patients)
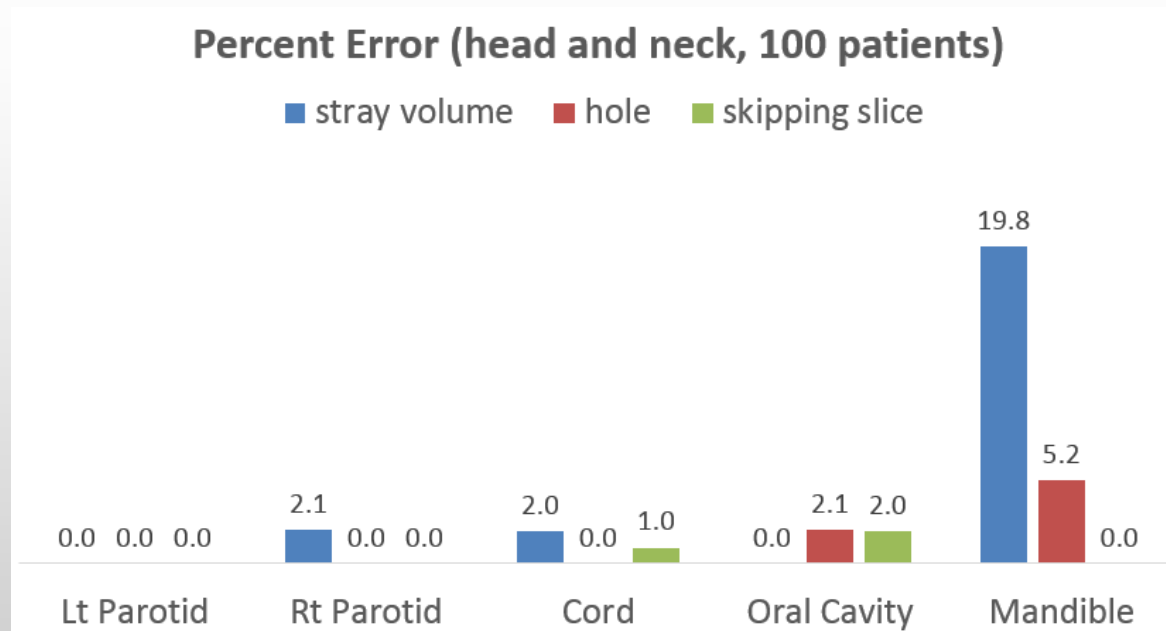
Additional MIM scripting examples

- Clearance check
  - A MIM extension using MATLAB inserts treatment table, contours immobilization devices, and checks for collision
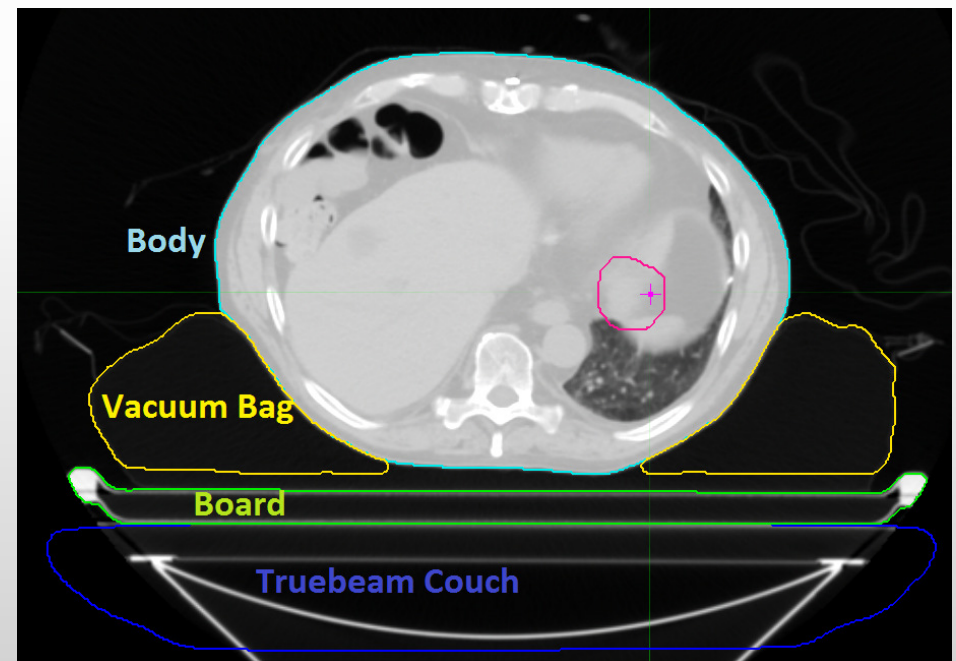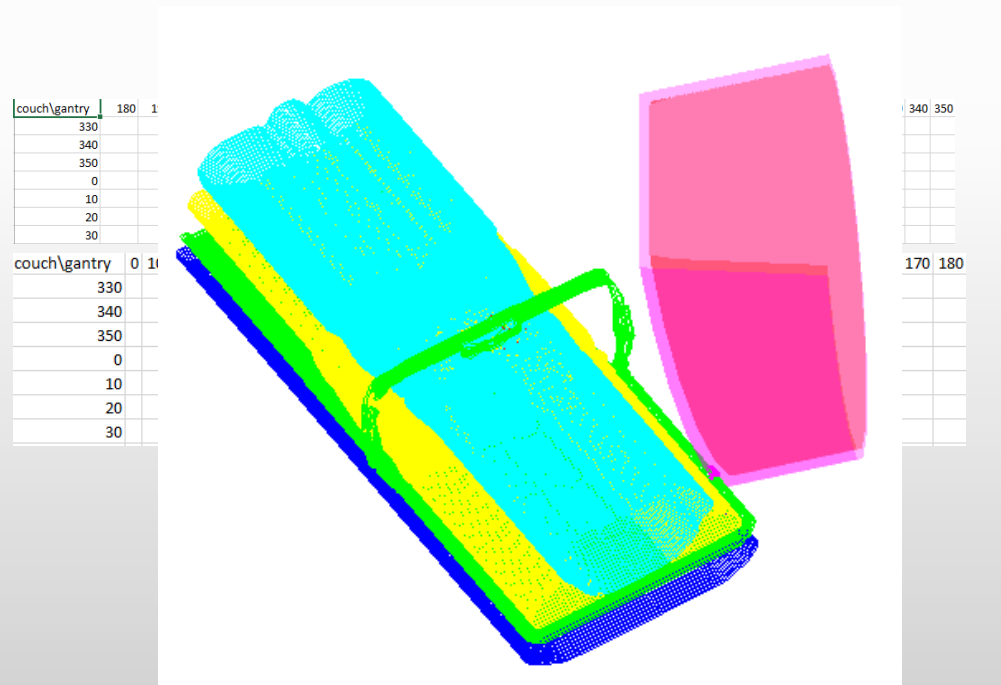
Additional scripting examples

- Using Pinnacle script to detect a suboptimal plan
  - Why? MLC limitation

The max leaf travel range for each bank in the same beam was restricted to 14.5 cm

14.5cm

MLC A10
All MLCs in Bank A

A10

Information
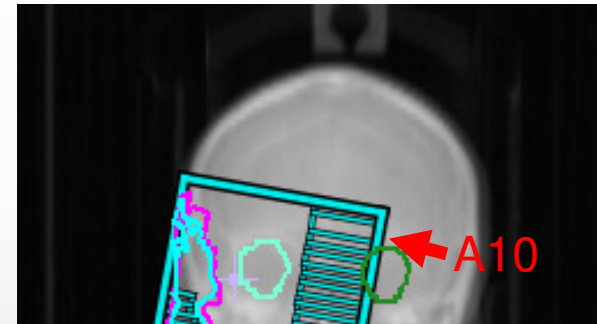
ℹ Beam: A1 182-178, The MLC travel range maxed out 14.5 cm for Bank A. Please check segment [38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72] for MLC positions. ⬜The MLC travel range maxed out 14.5 cm for E

OK

segment number
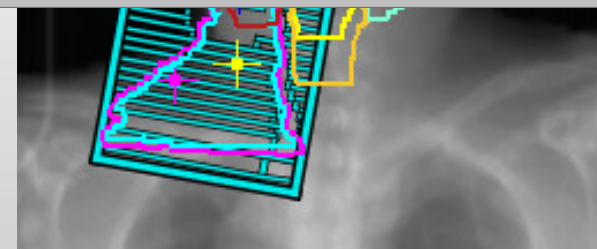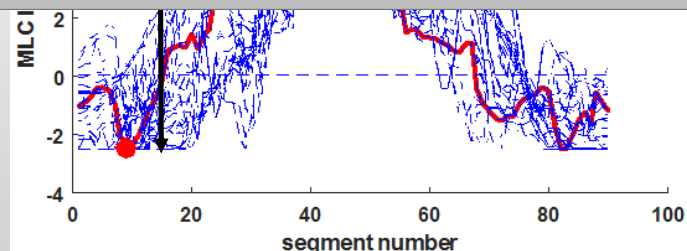
Summary

- Automation using scripts improves safety, efficiency and quality

- At Cleveland Clinic
  - We use MIM scripts (workflows, assistant rules and extensions) for auto contouring, contour processing, and contour QA
  - We use Pinnacle scripts/plugins for auto planning, plan export, and chart check

Thank you

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