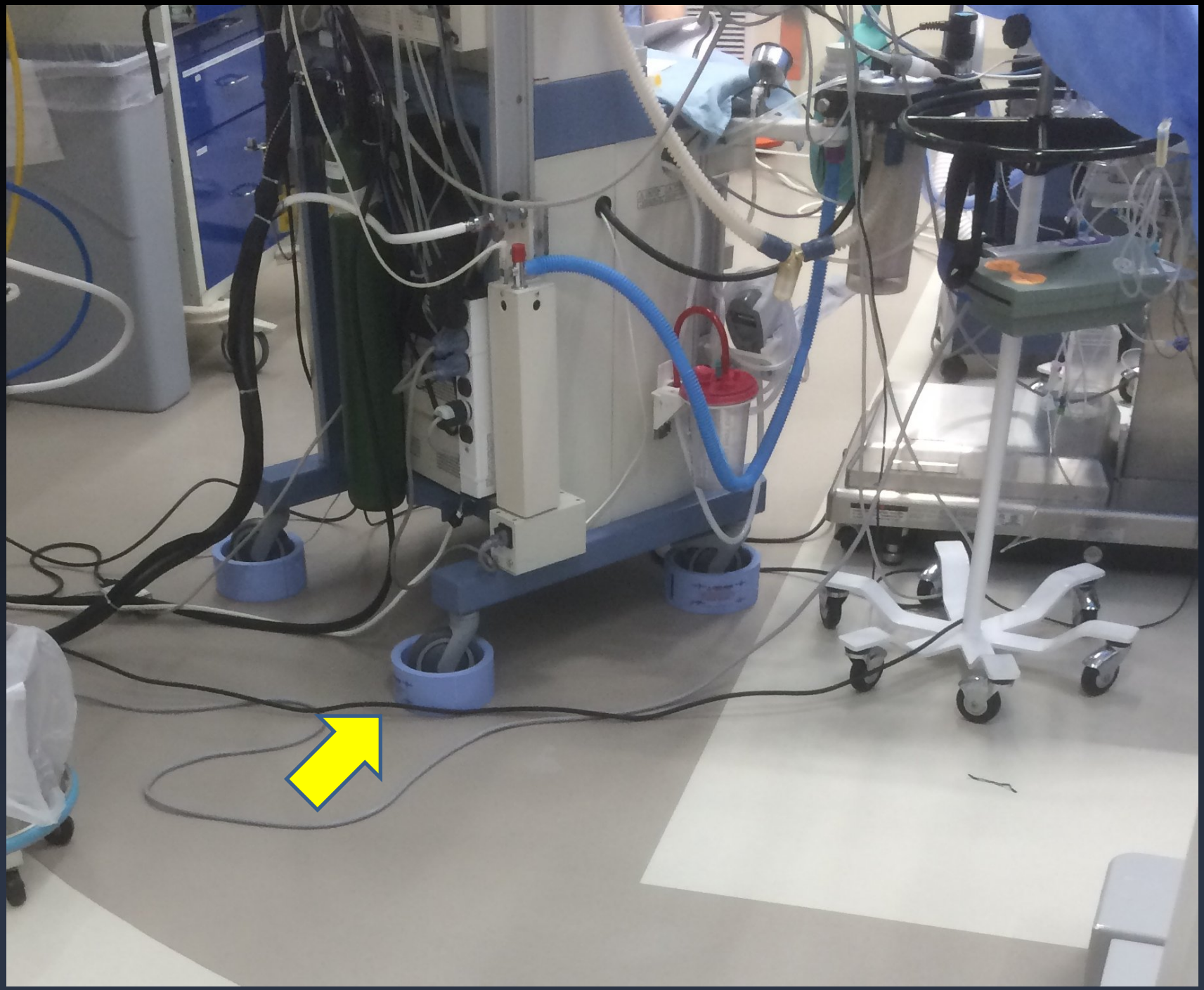
Design for Care

AAPM 2017

Tue-AB-FS4-0



Outline
Joint Therapy-Imaging Session

- Designing away error.
  A radiation oncology physicist's perspective.
  Eric Ford, PhD

- Human Factors Engineering in Software Interface Design. A Vendor's Perspective
  Cristina Negrut, MS

Outline of the session

- Designing the Optimal Reading Room Environment. A Radiology Perspective
  Elizabeth Krupinski, PhD

- Workflow Design and Errors. An Anesthesiologist's Perspective
  Aubrey Samost-Williams, MD, MS

Designing away error.
A radiation oncology physicist's perspective.

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University of Washington
Seattle, WA

UNIVERSITY OF WASHINGTON MEDICAL CENTER
UW Medicine

Disclosures

- AHRQ R18 HS022204-01
- NCI UG3 CA211310-01

Case Study
Error and Design

The lethal overdose of Lisa Norris

January 2006

Beatson Oncology Center, Glasgow, Scotland

References

- Scottish Executive Report, Oct 2006, “Unintended overexposure of patient Lisa Norris”. ISBN 0-7559-6297-4. http://www.scotland.gov.uk/Publications/2006/10/27084909/0

- IAEA Training Course 2.10. https://rpop.iaea.org/RPOP/RPoP/Content/AdditionalResources/Training/1_TrainingMaterial/AccidentPreventionRadiotherapy.htm

Clinical Background

- Lisa Norris. 15 yo female with pineoblastoma.
- Sept 2005 referred for radiotherapy.

- Intended prescription:
  - 1.75 Gy x 20 (35 Gy) to whole craniospinal axis
  - Spine fields split (upper and lower)
  - Followed by 1.8 Gy x 11 (19.8 Gy) to tumor bed
- Planning begins Dec 16. Complete Dec 19.

Background: Planning System

- May 2005. Clinic upgrades to Varis 7. Allow direct transfer of plan Eclipse->Varis *RTChart* module (previously typed in by hand)
- Use of paper forms was retained for some of the more complex cases (e.g. ‘whole CNS’)

Planning for Lisa Norris

- Rx entered in RTChart
- Treatment planning complete in Eclipse
- “Planner B” transcribes dose to paper form.

Treatment Plan: MU calc

Annex 2: A blank copy of the first page of Medulla Planning FM.14.014 as used for Lisa Norris's treatment plan

BEATSON ONCOLOGY CENTRE - QA CONTROLLED DOCUMENT

MEDULLA PLANNING FORM **FM.14.014**
TWO SPINE FIELDS

Name:	**Site:**
B.O.C. No:	**Unit:**
Radiotherapist:	**Date:**
Physics:	

Setup	Head fields isocentric; asymmetric jaws; customised shielding trays. Physics to move junction after every ..... fractions (see over).			
Site	**Head (a)**		**Upper Spine (b)**	**Lower Spine (c)**
Description	Right Lateral	Left Lateral	Posterior	Post / Sup
Field Size (approx for first ..... fractions				
Jaw Settings	x_1 y_1 x_2 y_2	x_1 y_1 x_2 y_2		
F.S.D.	ISOCENTRIC		100 cm	100 cm
Gantry Angle	90°	270°	0°	... (i.e. ..... ° to sup)
Collimators	.....° (i.e. ....° Sup End Post)	.....° (i.e. .....° Sup End Post)	90°	90°
Floor Rotation	0°	0°	270°	270°
Beam Modifier	Shielding block tray code =	Shielding block tray code =	Wax compensator (a). tray code 17	Wax compensator (b). tray code 17
Beam Weight (%)	100% (a)	100% (a)	100% (b)	100% (c)
Output (MU/100cGy)				
Dose Information	T.A.D. mid brain = 100% Normalisation = ... %		spinal cord: .....% max subcut: .....%	spinal cord: .....% max subcut: .....%

File Name: FM14014	**Page Number: 1 of: 1**	**Date: 11.8.98**
Issue Number: 1	**Authorised By:**	**Issued By:**

Beam Weight (%)	100% (a)
Output (MU/100cGy)	

Planner B entered
MU per 167 cGy instead of
MU per 100 cGy

Treatment Plan: MU calc

- Plan checked by two senior planners.
- Plan goes on to radiographer.
- Following standard calc procedure:

  Output (MU/100cGy) x Rx (175 cGy) = **159 MU**

  Should have been **94.5 MU**
- Treatment starts January 5.

  Dose/fraction = 2.92 Gy instead of 1.75 Gy

Finding the Error

- Feb 1, 2006. Another case is planned by Planner B.
- Same normalization error made.
- Caught by Plan Checker D.
- Realize the mistake in Lisa Norris' plan.
- Treatment stopped immediately.

Follow Up

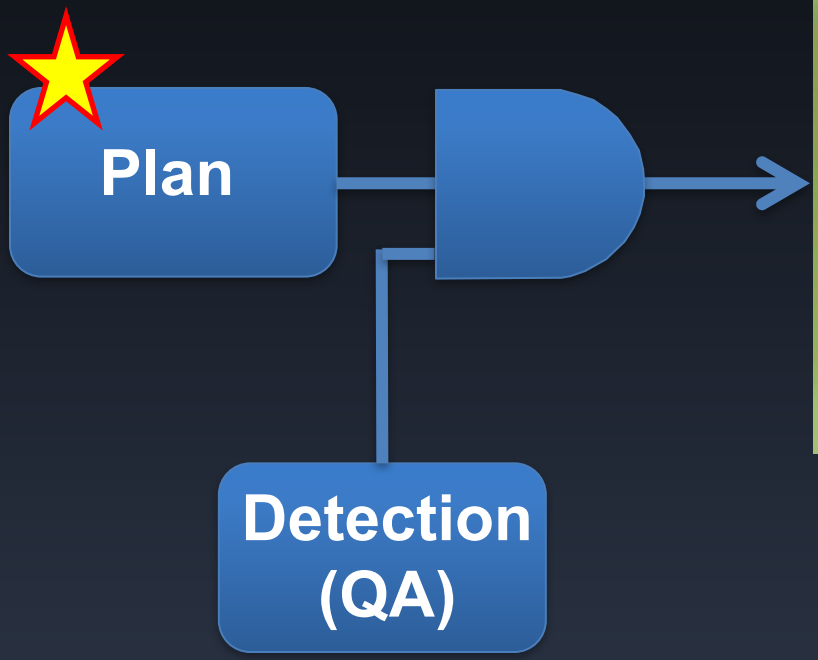
- Lisa Norris received 19 fractions
    - 2.92 Gy x 19 = 55.5 Gy
    - vs. intended 1.75 Gy x 20 = 35 Gy
    - 58% overdose

Follow Up

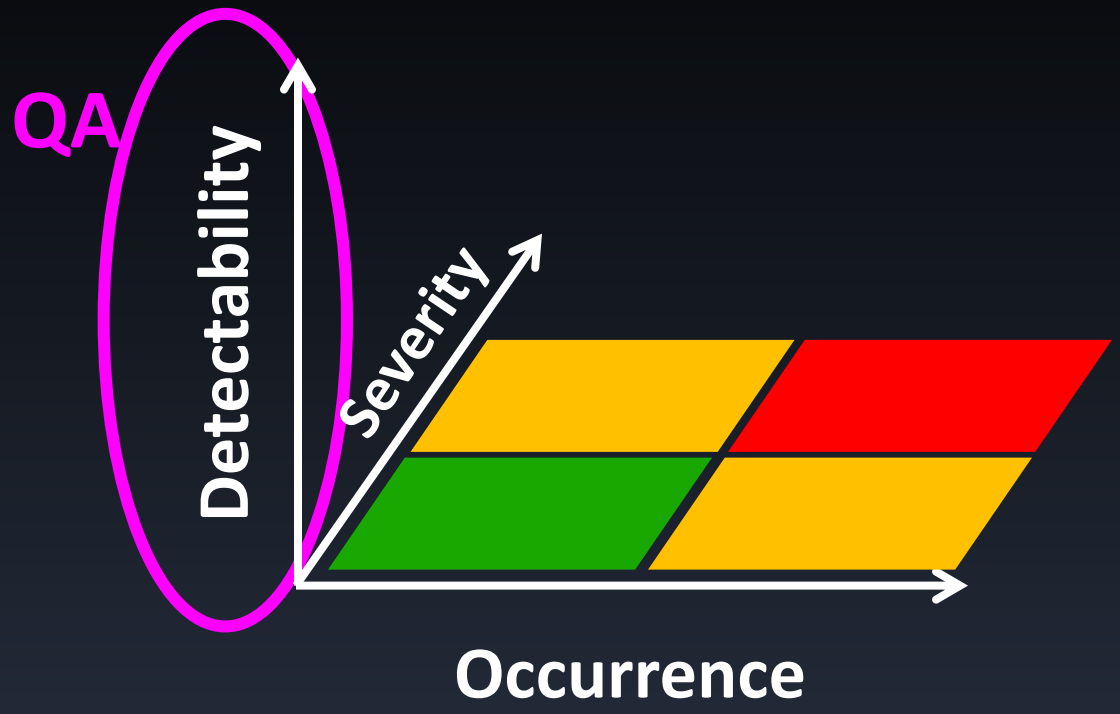
- Lisa Norris died nine months later

Stopping Errors
Quality Control

Stopping Errors
A traditionalist approach



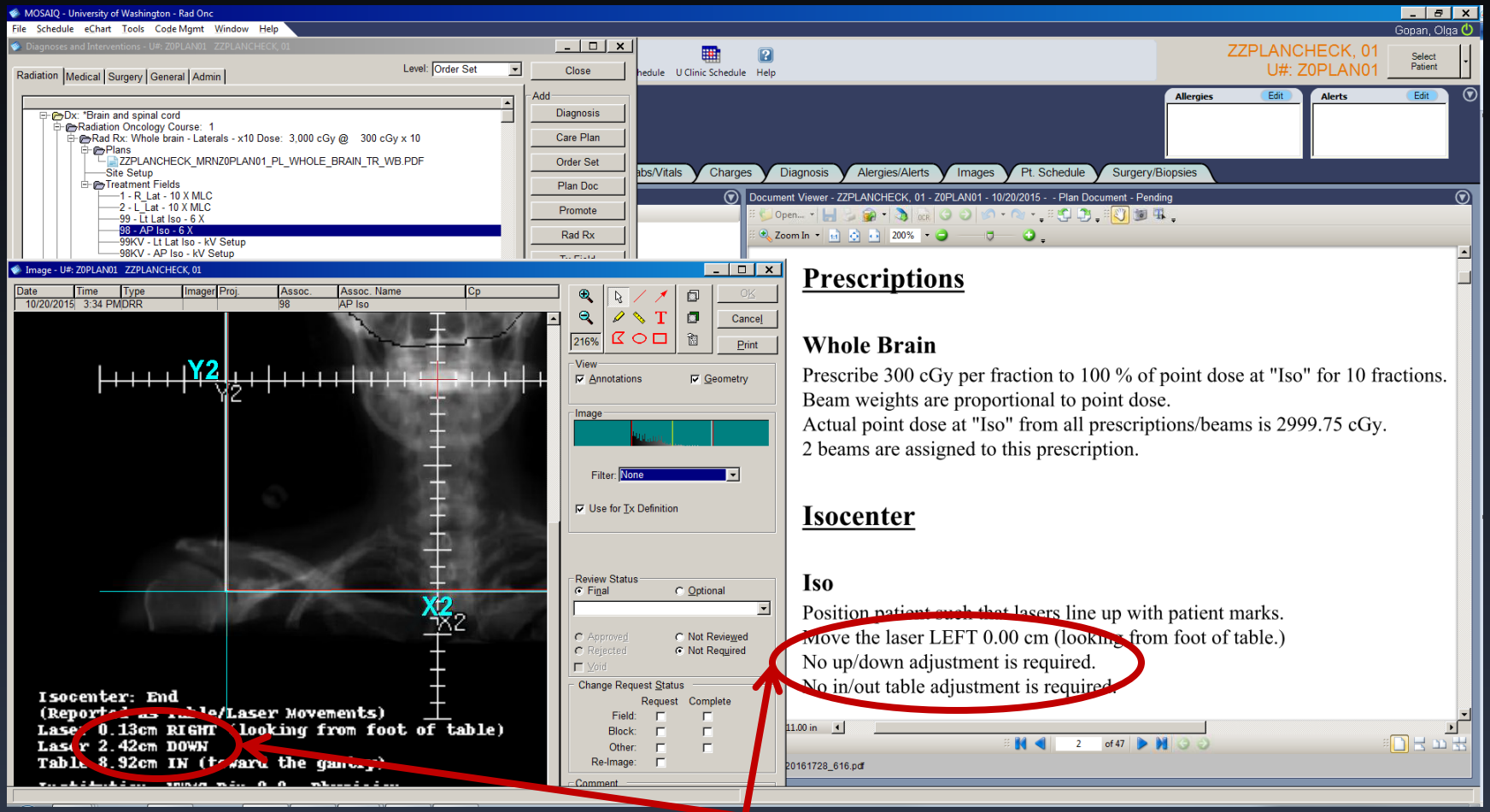
Risk ala TG-100 and FMEA



Risk = *S x O x D*

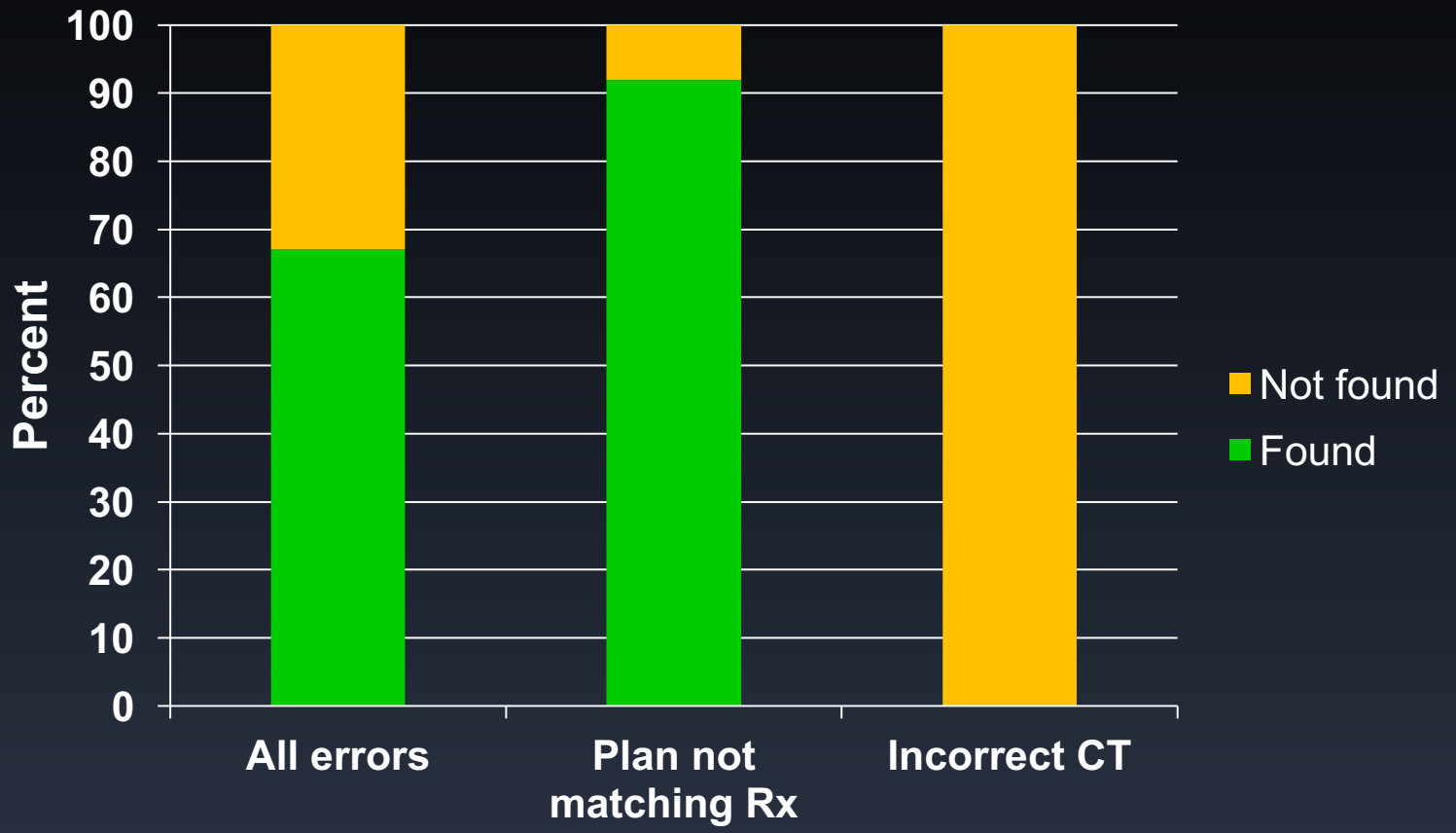
AAPM Task Group 100, Huq et al. 2016

“Mock” plan with embedded errors



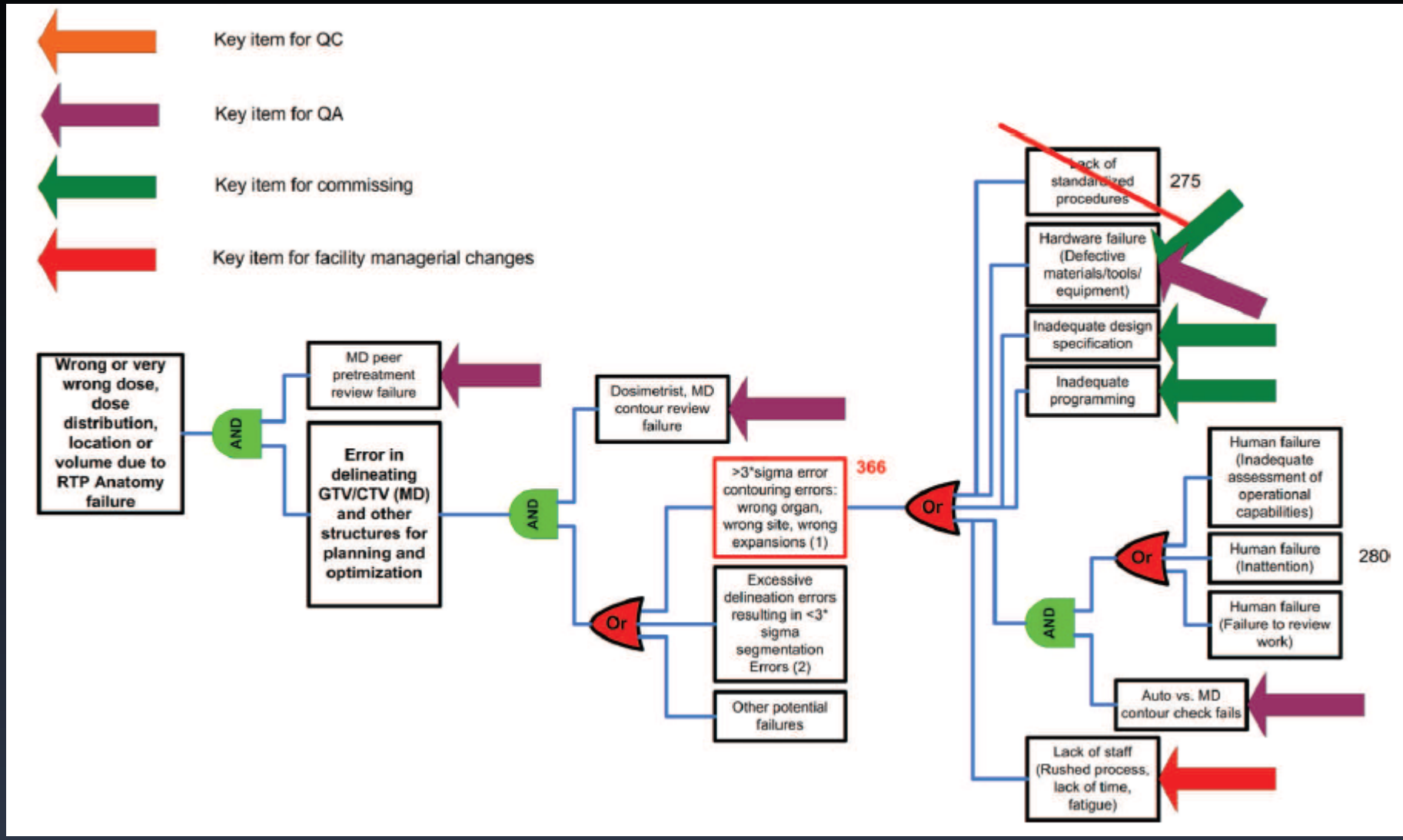
Error: incorrect isocenter location

Results: Mock Plan Error Checks



Gopan, Ford et al. 2017

Quality Control Using Checks: TG-100



AAPM Task Group 100, Huq et al. 2016

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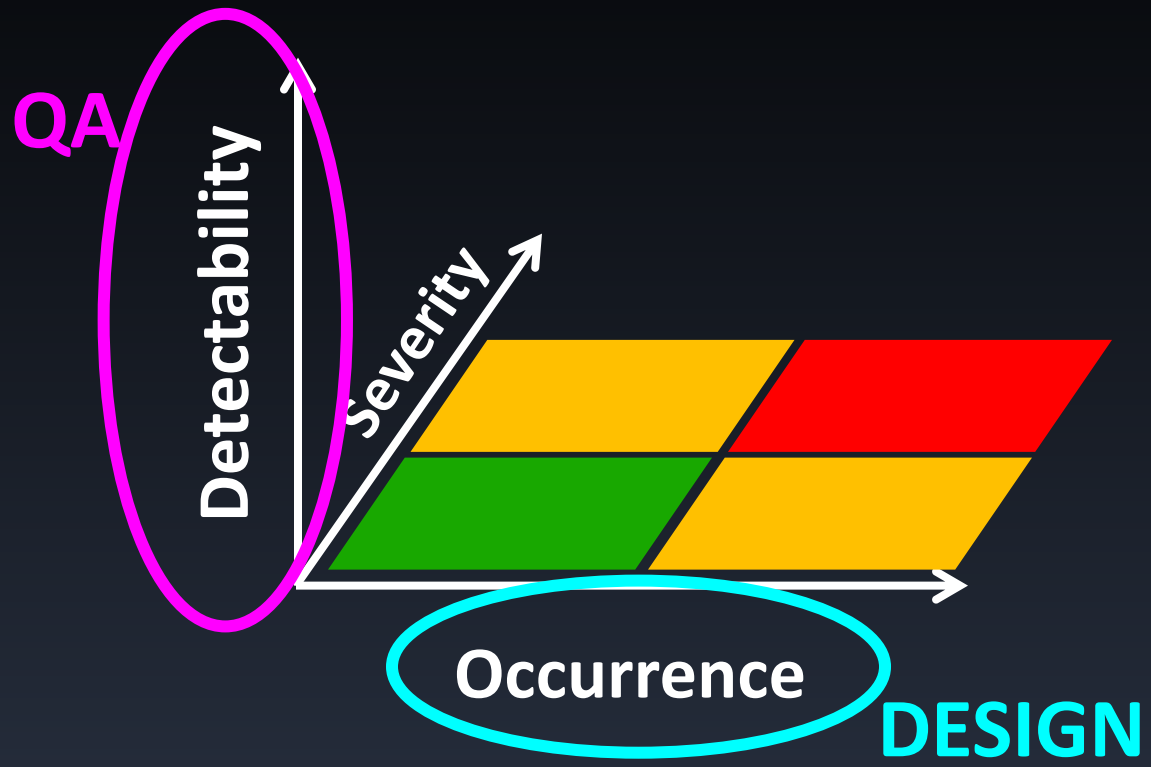
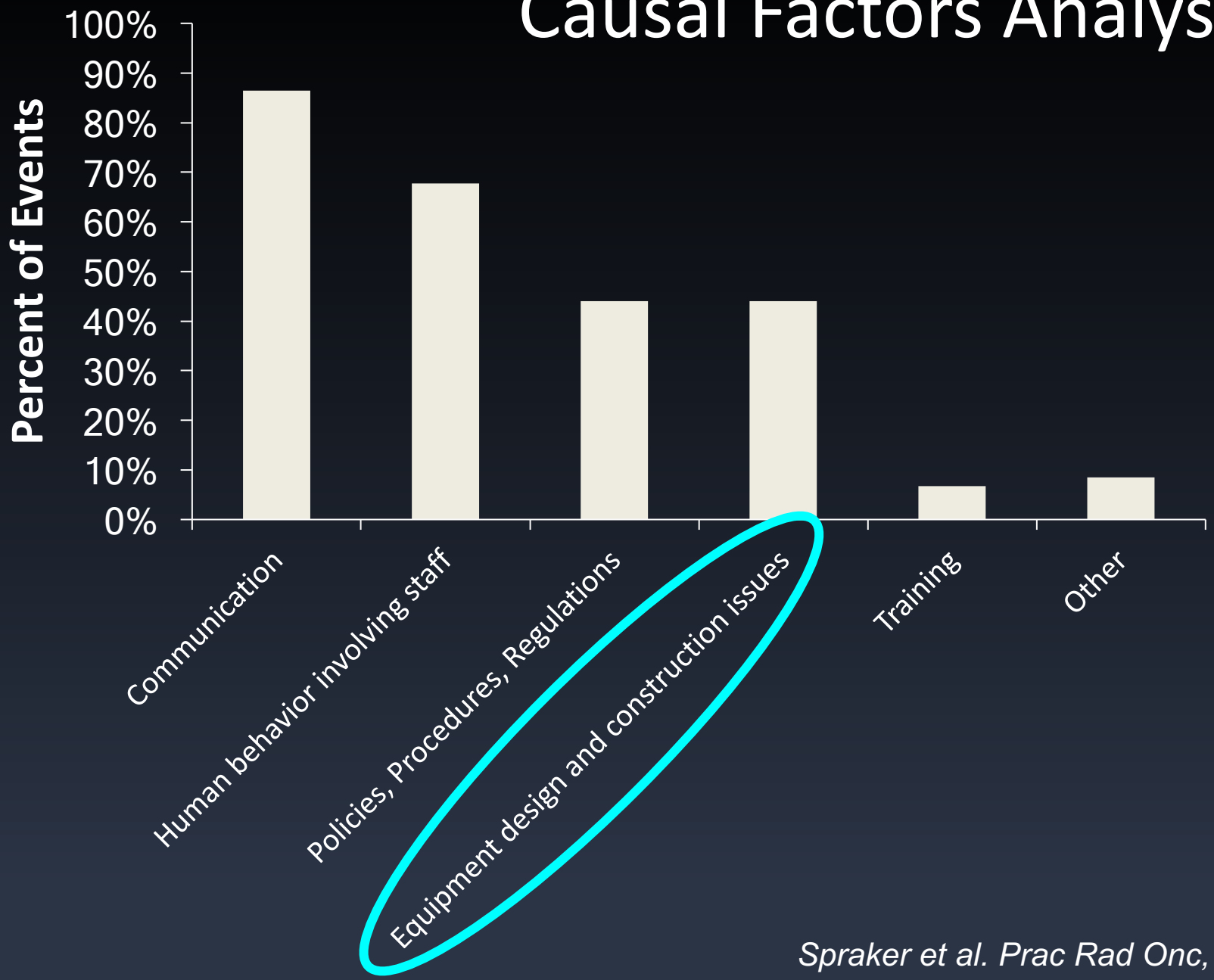


Risk = *S x O x D*

AAPM Task Group 100, Huq et al. 2016

Causal Factors Analysis



Spraker et al. Prac Rad Onc, 2017

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File Name: FM14014	**Page Number: 1 of: 1**	**Date: 11.8.98**
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Beam Weight (%)	100% (a)
Output (MU/100cGy)	

Could the process / form be designed to prevent error from happening in the first place?

Data-driven design

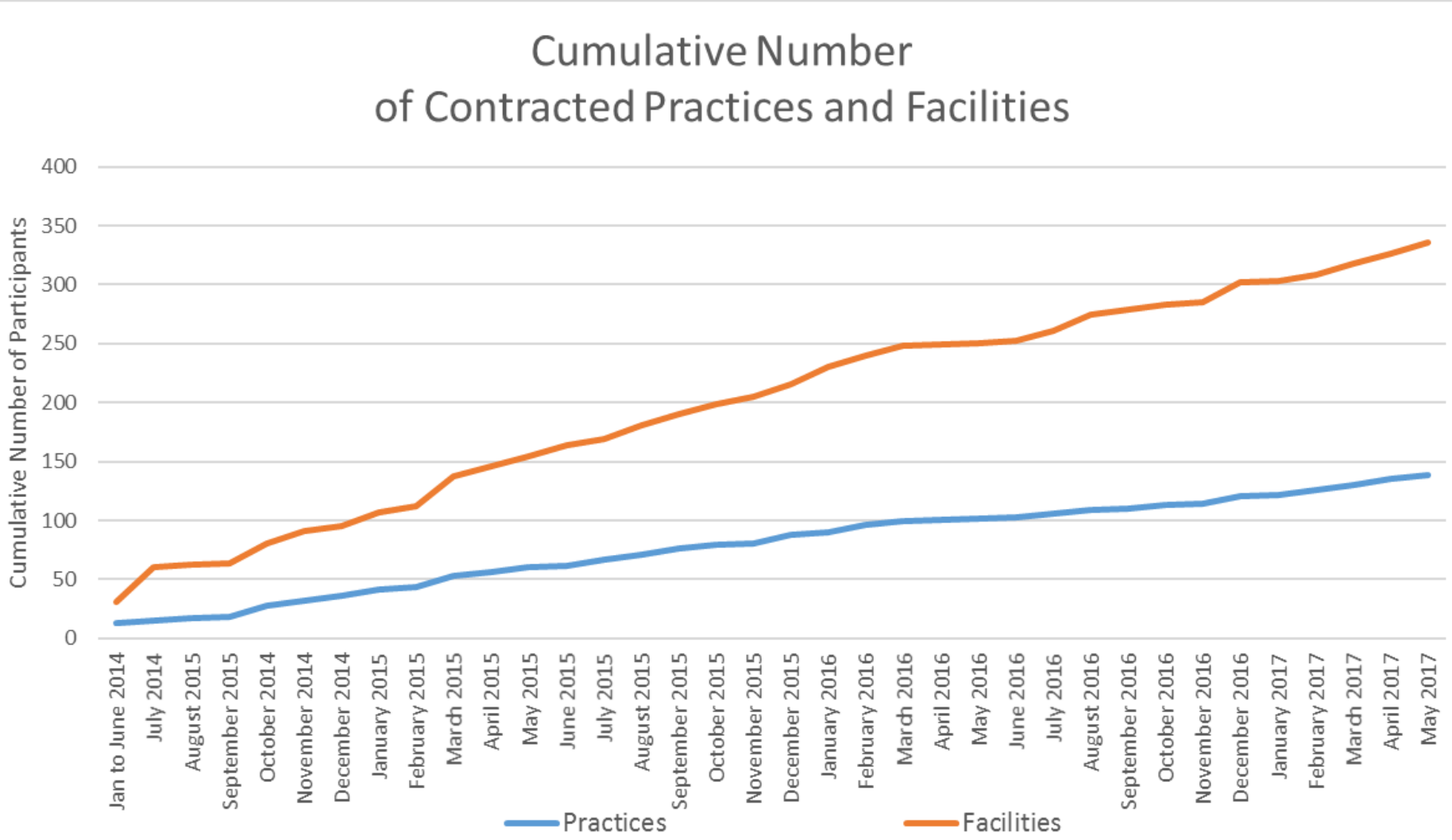
RO-ILS

RADIATION ONCOLOGY
INCIDENT LEARNING SYSTEM

Sponsored by ASTRO and AAPM

The RO-ILS mission is to facilitate safer and higher quality care in radiation oncology by providing a mechanism for shared learning in a secure and non-punitive environment.

Launched: June 2014


Cumulative Number
of Contracted Practices and Facilities
Cumulative Number of Participants
400
350
300
250
200
150
100
50
0
Jan to June 2014
July 2014
August 2015
September 2015
October 2014
November 2014
December 2014
January 2015
February 2015
March 2015
April 2015
May 2015
June 2015
July 2015
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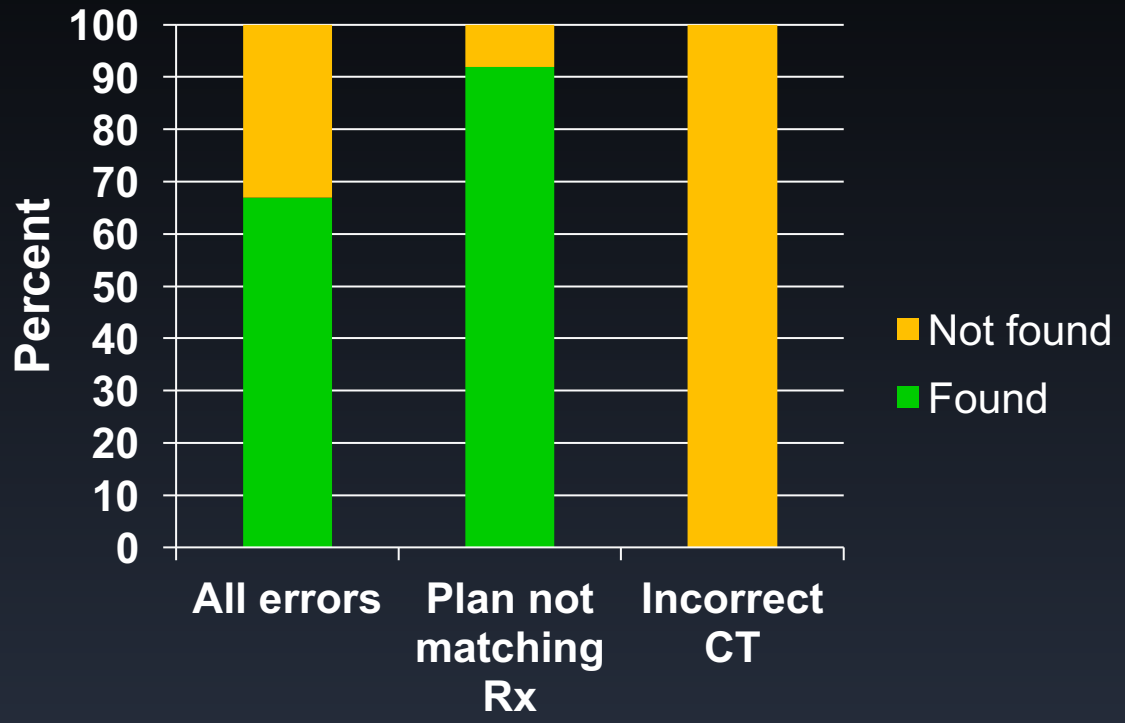
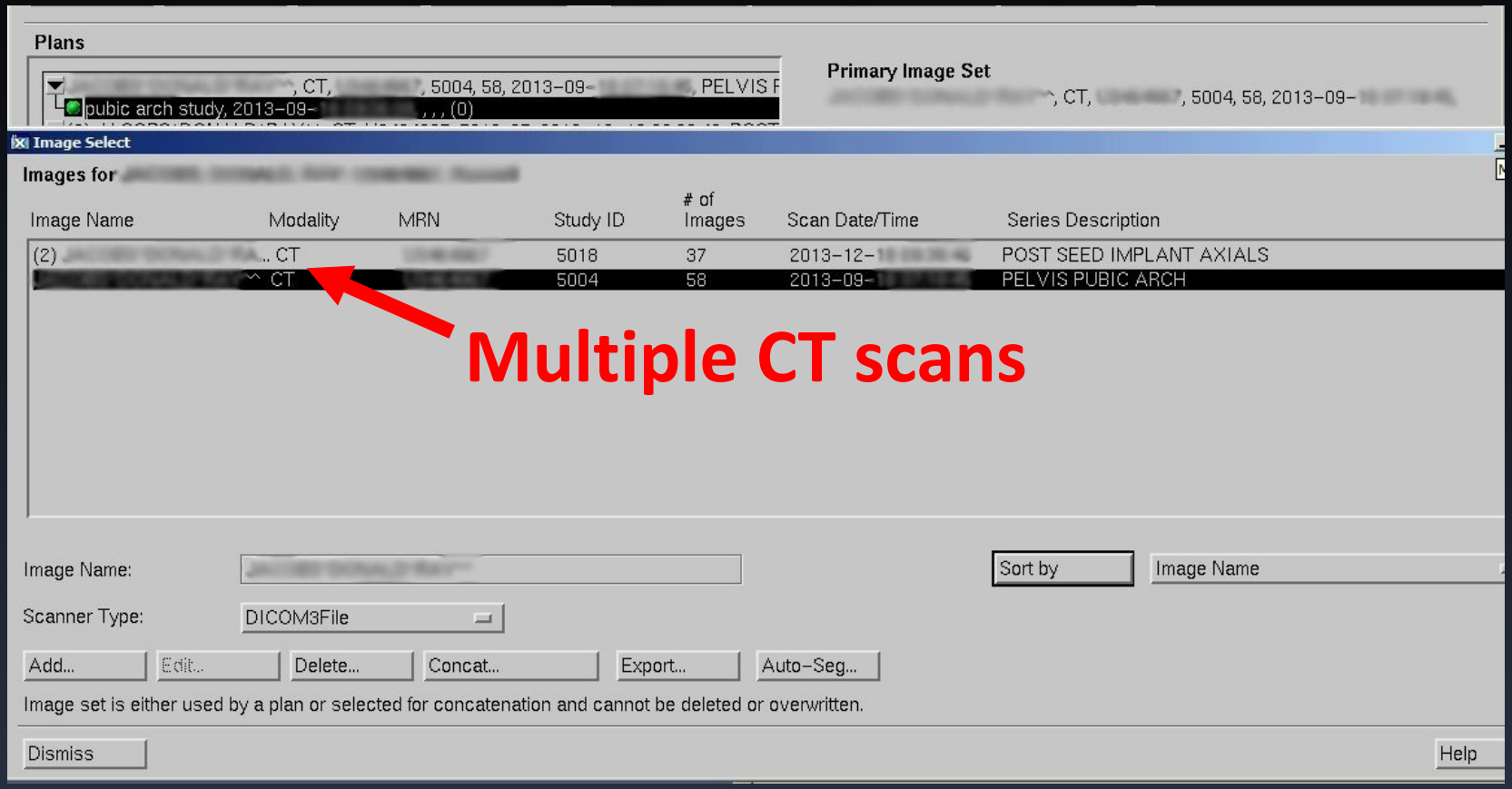
May 2017
Practices
Facilities

Data-driven design



- CT in TPS and isocenters

CT import window



Plan document

Patient Name:		Time:	2013−08−
Patient ID:		Comment:	
Plan Name:	L5−S2	Institution:	UWMC Pin_9.0
Trial Name:	L__ Approved	Physician/Physicist:	I
Revision:	**R04.P03.D03**	Planner:	
Lock Status:	The plan was locked by '		

Plan Setup

PT firstname, lastname

Primary Data Set Name:	[redacted]
Primary Data Set Dimensions:	232 slices, 512 x 512 pixels
CT to Density Table Name:	*CT Sim Aug05*
Patient Position:	On back (supine) Head First
Couch:	Removed at Y = −10.29
Body Board Angle:	None
Number of Photon Beams:	2
Number of Stereo Beams:	0
Number of Electron Beams:	0
Number of Brachy Sources:	0
Outside−Patient Air Threshold:	0.60 g/cm^3

Dose Grid Geometry

	Lateral	Ant−Post	Sup−Inf	Units
Resolution	0.400	0.400	0.400	cm
Dimension	119	97	109	Pixels
Origin	−23.415	−22.922	−18.840	cm
Reference Point	−0.00	4.61	0.00	cm

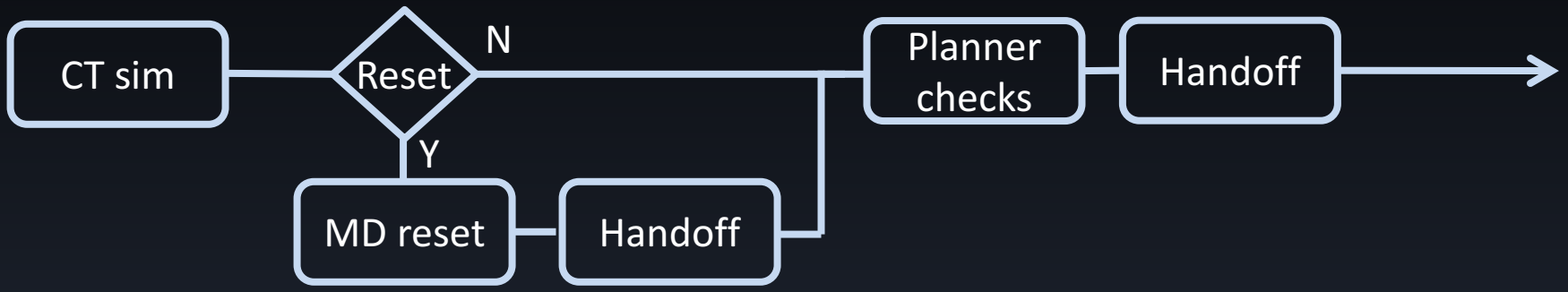
Top Slice of CT Extended:	0.00 cm
Bottom Slice of CT Extended:	0.00 cm

Region of Interest Density Overrides:

Failure Modes

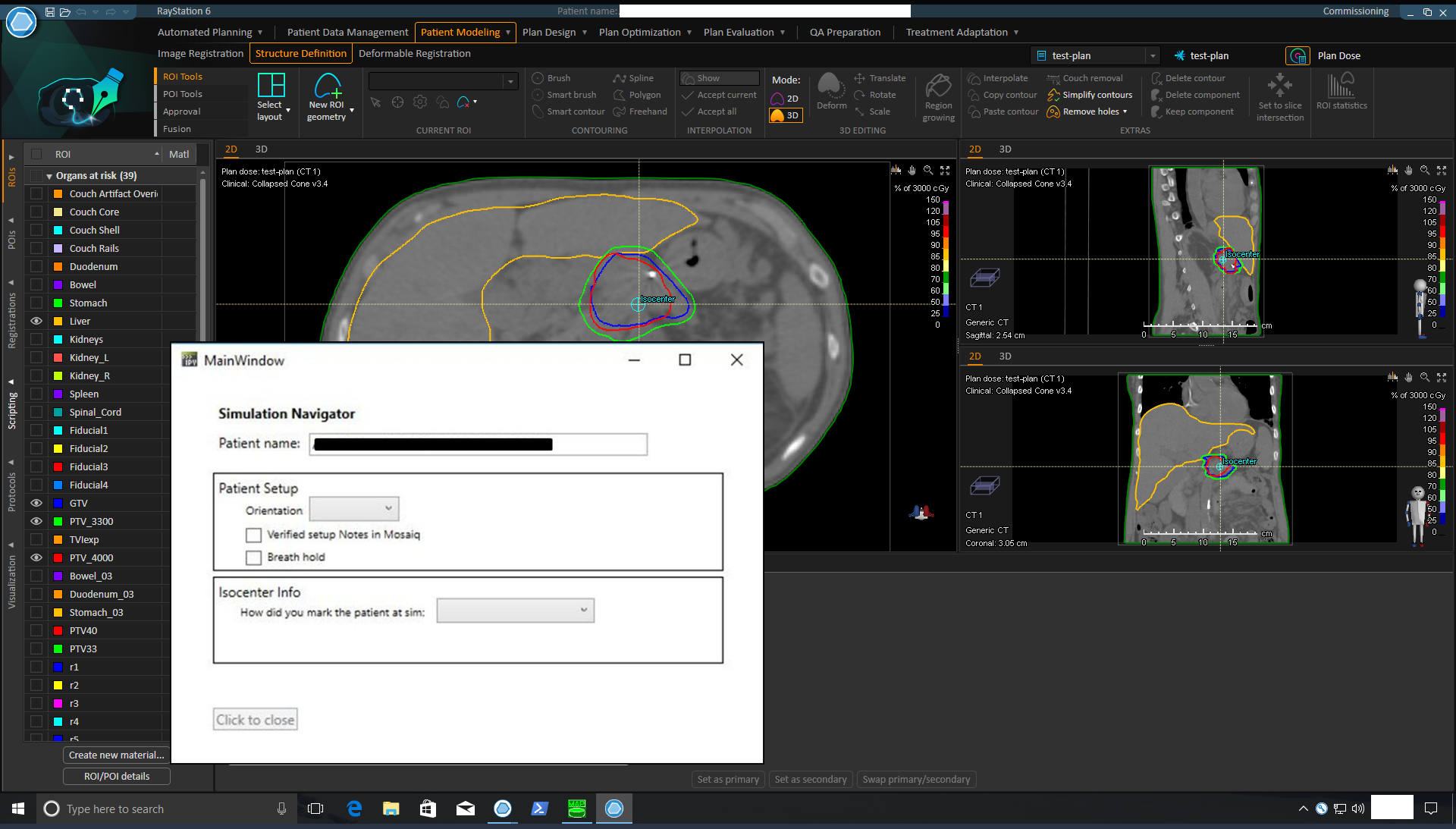
1. Wrong CT scan loaded into TPS

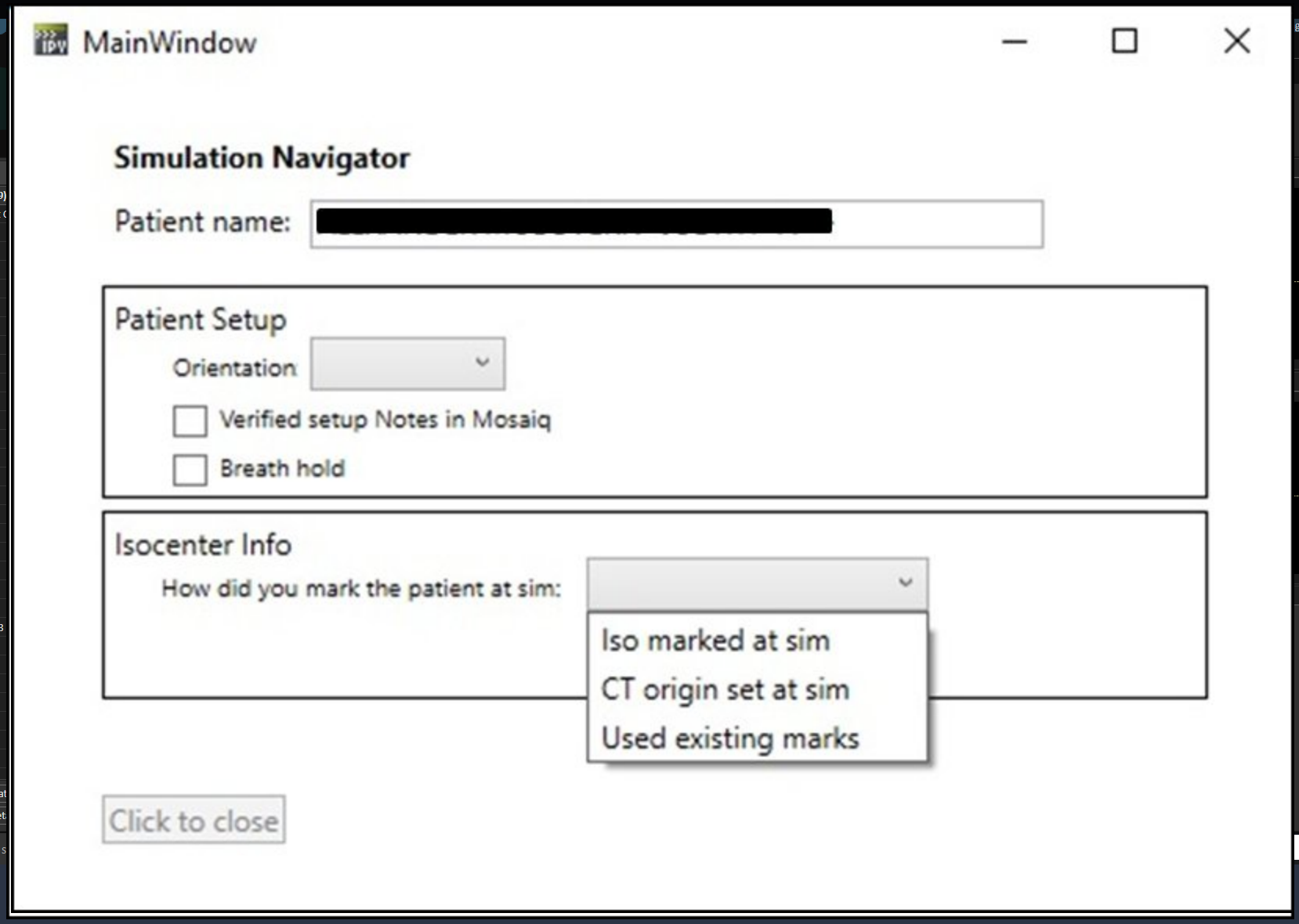
Isocenter Handling



Failure Modes

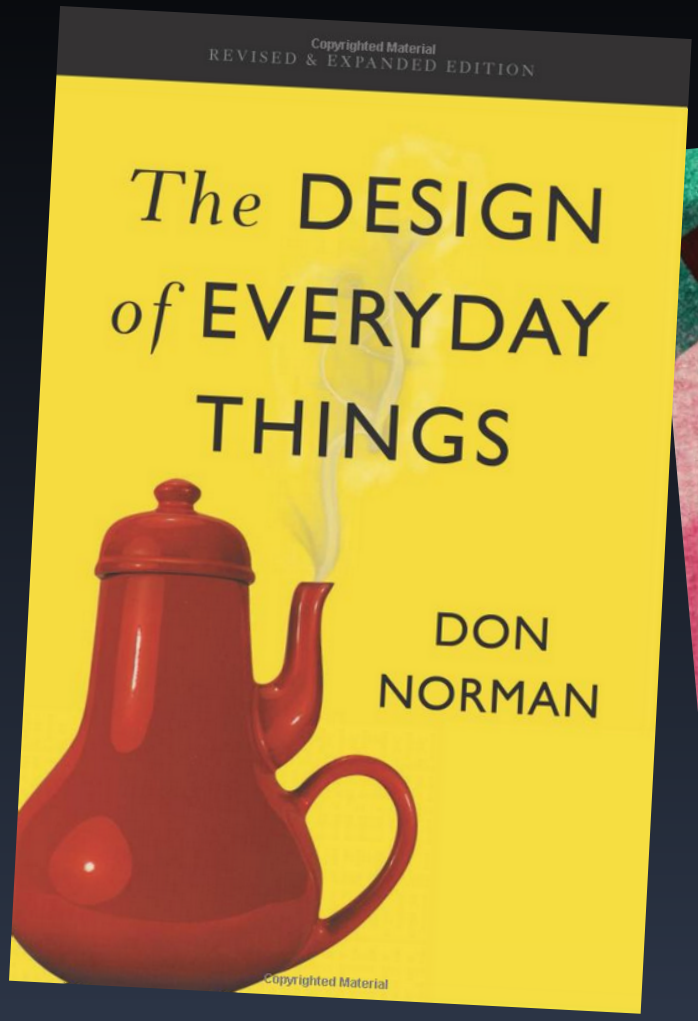
1. Wrong CT scan loaded into TPS
2. Isocenter move after sim not communicated


RayStation 6
Patient name:
Commissioning
Automated Planning
Patient Data Management
Patient Modeling
Plan Design
Plan Optimization
Plan Evaluation
QA Preparation
Treatment Adaptation
Image Registration
Structure Definition
Deformable Registration
test-plan
Plan Dose
ROI Tools
POI Tools
Approval
Fusion
Select layout
New ROI geometry
CURRENT ROI
Brush
Spline
Smart brush
Polygon
Smart contour
Freehand
CONTOURING
Show
Accept current
Accept all
INTERPOLATION
Mode:
2D
3D
Deform
Translate
Rotate
Scale
3D EDITING
Region growing
Interpolate
Copy contour
Paste contour
Couch removal
Simplify contours
Remove holes
Delete contour
Delete component
Keep component
EXTRAS
Set to slice intersection
ROI statistics
ROI
Matl
Organs at risk (39)
Couch Artifact Overri
Couch Core
Couch Shell
Couch Rails
Duodenum
Bowel
Stomach
Liver
Kidneys
Kidney_L
Kidney_R
Spleen
Spinal_Cord
Fiducial1
Fiducial2
Fiducial3
Fiducial4
GTV
PTV_3300
TVIexp
PTV_4000
Bowel_03
Duodenum_03
Stomach_03
PTV40
PTV33
r1
r2
r3
r4
Create new material...
ROI/POI details
Plan dose: test-plan (CT 1)
Clinical: Collapsed Cone v3.4
% of 3000 cGy
Isocenter
CT 1
Generic CT
Sagittal: 2.54 cm
Coronal: 3.05 cm
MainWindow
Simulation Navigator
Patient name:
Patient Setup
Orientation
Verified setup Notes in Mosaiq
Breath hold
Isocenter Info
How did you mark the patient at sim:
Click to close
Set as primary
Set as secondary
Swap primary/secondary
Type here to search


MainWindow
Simulation Navigator
Patient name:
[redacted]
Patient Setup
Orientation
Verified setup Notes in Mosaiq
Breath hold
Isocenter Info
How did you mark the patient at sim:
Iso marked at sim
CT origin set at sim
Used existing marks
Click to close

Conclusions & Future Directions

Further reading



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Olga Gopan, PhD
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Jing Zeng, MD
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Gabrielle Kane, MD

UW Rad Onc Quality Team

National Cancer Institute

Department of Health & Human Services • USA

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