



Provincial Collaborative IMRT QA Program: The Cancer Care Ontario Experience

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D. Jaffray



Outline

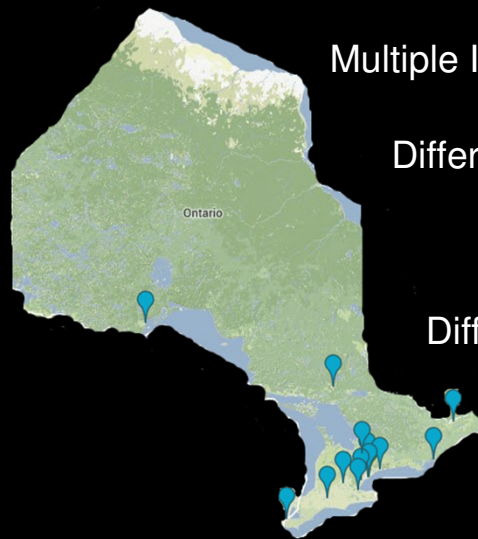
- Rationale
- Collaborative QA (CQA) Program
 - Program Development
 - Implementation
 - Results
- Next Steps



RATIONALE



IMRT Across Ontario



Multiple Institutions

Different Infrastructure

Variation in Practice

Different Resources

Variable Rate of Adoption of IMRT



IMRT Across Ontario



How do we assess
planning and delivery
performance in this
environment?



Collaborative Quality Assurance (CQA) Program

Objectives:

- Current status assessment (techniques, processes)
- Measure IMRT planning and treatment delivery performance
- Tool for continuous quality improvement



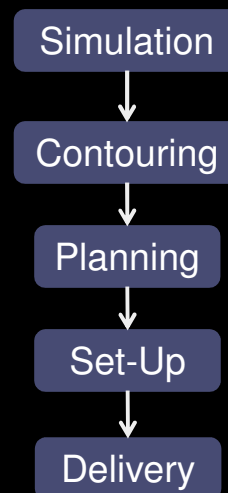
PROGRAM DEVELOPMENT

REQUIREMENTS & DESIGN

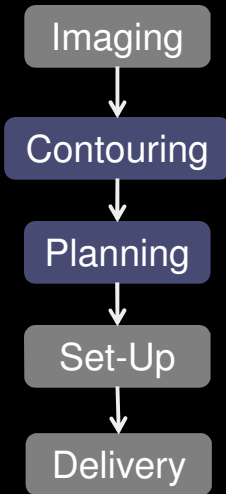


Program Requirements

- Include an end-to-end test
- On-site visit
- Compatible with multiple vendors
- Adaptability for different treatment sites and delivery techniques
- Diagnostic capabilities



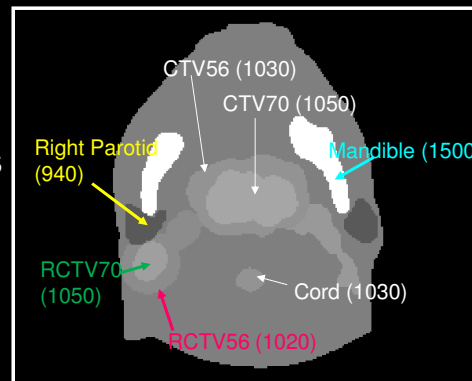
Planning Exercise



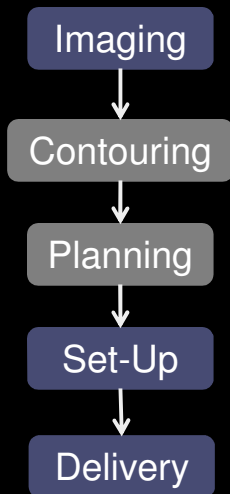
- Realistic clinical scenario
- Test clinical planning practice
- Ability to create planning exercises for different sites

Planning Exercise

- Site-specific CT datasets
- ROI burned into images for auto-contouring
- Planned using clinical processes



Dose Delivery (Measurement)



- Multiple measurements in single set-up
- Static gantry and rotational delivery
- Image Guidance

ArcCHECK™



- Helical distribution of diodes
- 21 cm array diameter and length
- Insert can be used
- Software compares measured and planned dose

Standard Plan Test

- Plan provided by CQA (Linac-specific plan)
- Isolate impact of planning practices



Standard Plan Test

- Plan provided by CQA (Linac/MLC-specific plan)
- Isolate impact of planning practices

	Center's Plan	Standard Plan
Low Pass Rate		
High Pass Rate		



Standard Plan Test

- Plan provided by CQA (Linac/MLC-specific plan)
- Isolate impact of planning practices

	Center's Plan	Standard Plan	
Low Pass Rate	✓	✓	Machine performance or Beam Model
High Pass Rate			



Standard Plan Test

- Plan provided by CQA (Linac/MLC-specific plan)
- Isolate impact of planning practices

	Center's Plan	Standard Plan	
Low Pass Rate	✓		Difference in Planning Practice
High Pass Rate		✓	

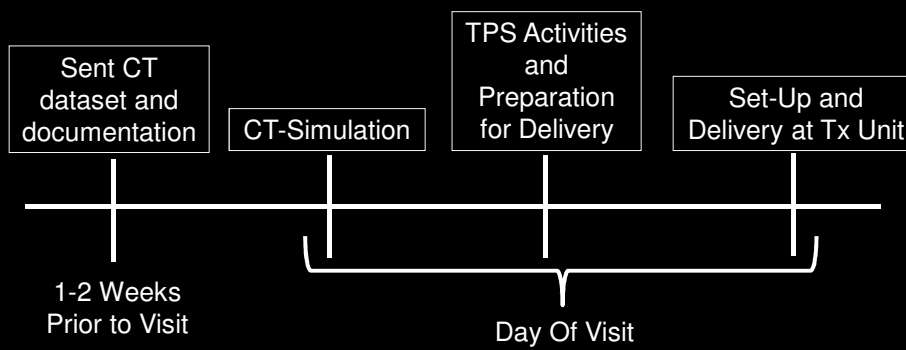


PROGRAM IMPLEMENTATION

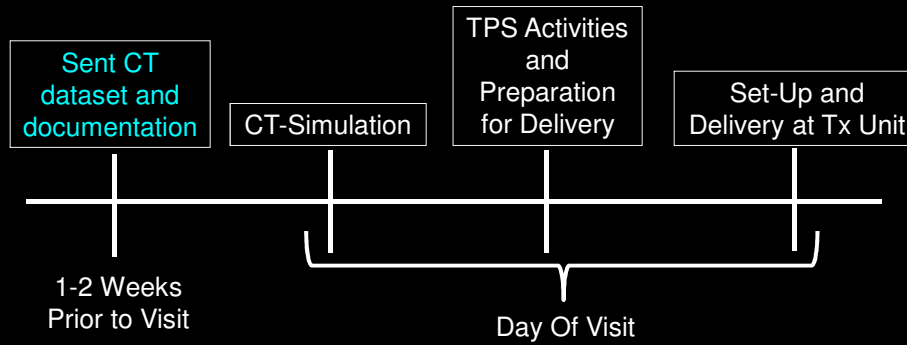
YEAR ONE



Visit Schedule



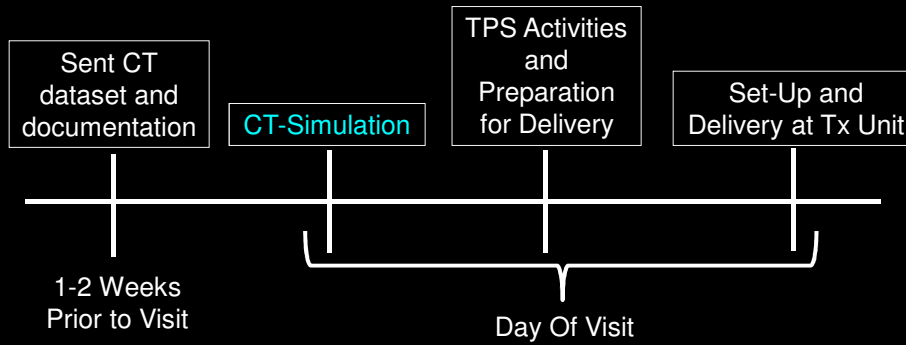
Visit Schedule



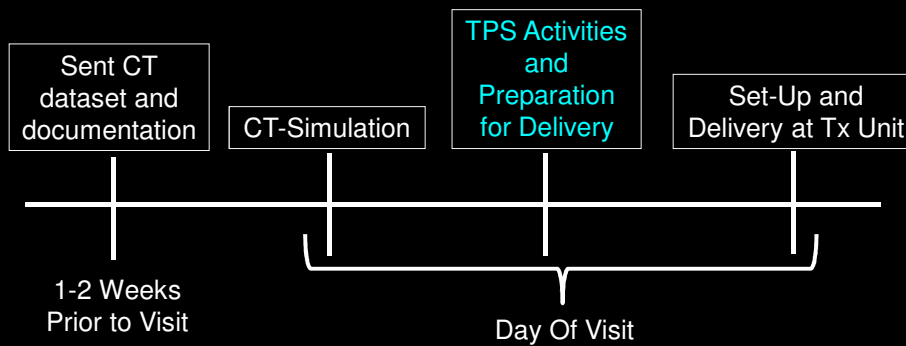
Planning Exercise

ROI	Dose Metric	Objective
PTV 70 Gy	$V_{100\%}$ (70 Gy)	> 95%
	$V_{95\%}$ (66.5 Gy)	> 99%
	Mean Dose	< 105%
PTV 56 Gy	$V_{100\%}$ (56 Gy)	> 95%
	$V_{95\%}$ (53.2 Gy)	> 99%
Left Parotid	Mean Dose	< 26 Gy
	$D_{50\%}$	< 30 Gy
Cord	Maximum Dose	< 45 Gy
Brainstem	Maximum Dose	< 45 Gy
Normal Tissue	V_{60Gy}	< 5%

Visit Schedule

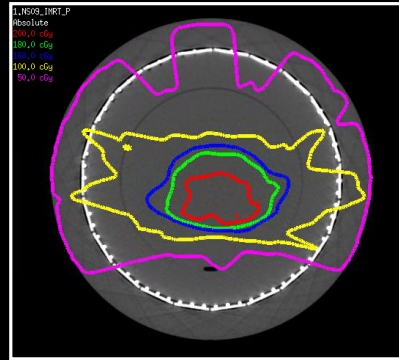


Visit Schedule

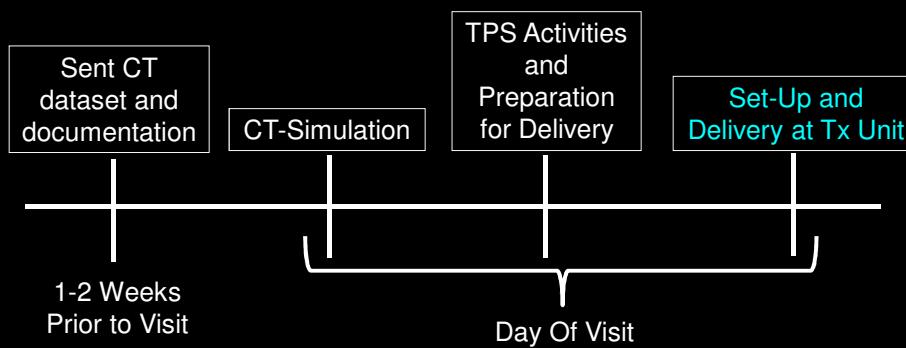


TPS Activities

- Images transferred to TPS
- Re-compute dose on phantom for H&N Plan
- Import Standard Plan and compute dose
- Compute calibration test field
- Transfer reference images to linac for set-up

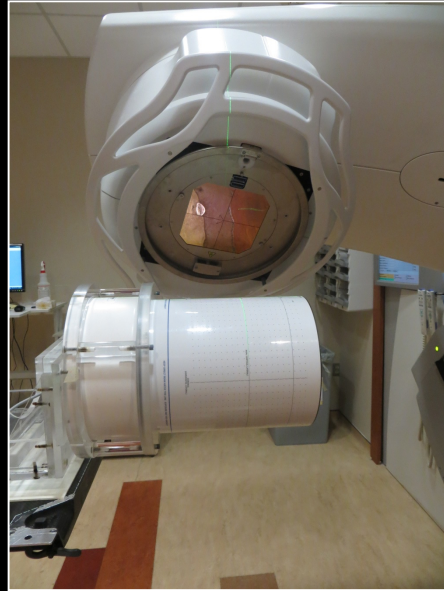


Visit Schedule



Dose Delivery

- Phantom Set-Up
- Centre's own IMRT plan
- Standard Plan
- Assess measured to planned dose agreement



PROGRAM RESULTS

YEAR ONE

Year 1 Results

- 13 visits completed
- 4 Delivery Systems and 5 TPS
- 16 H&N plans
 - 12 IMRT, 3 VMAT and 1 TomoTherapy
- High compliance with treatment planning objectives
- Variation in planning technique



CCO IMRT QA Program Preliminary Report

Institution: _____
 Date of Visit: _____
 Contact Physicist: _____
 Linear Accelerator Tested: _____
 Treatment Planning System: _____

Planning Exercise Summary:

Region of Interest	Dosimetric Parameter (Planning Objective)	XXX Results	Range* (n = 6)
modPTV70	V100% (>95%)		81 – 98.4
	V95% (>99%)		98.5 – 100
	Mean Dose (<73.5 Gy)		71.3 – 74.6
modRPTV70	V100% (>95%)		93.4 – 98.1
	V95% (>99%)		99.5 – 100
	Mean Dose (<73.5 Gy)		72.6 – 73.6
modAllPTV70	V100%		84.9 – 97.9
	V95%		98.6 – 100
	Mean Dose (Gy)		71.7 – 74.2
modAllPTV56	V100% (>95%)		94.8 – 97.8
	V95% (>99%)		98.9 – 99.7
	Mean Dose (<26Gy)		23.1 – 28.3
Left Parotid	D50% (<30Gy)		19 – 23.7
	Mean Dose (Gy)		31.4 – 61.9
	D50%		25.4 – 62.9
Right Parotid	Max Dose (<45Gy)		33.1 – 43.9
	Max Dose (<45Gy)		30 – 43.2
	Max Dose (Gy)		71.2 – 76.6
Normal Tissue	V60Gy (<5%)		0.2 – 2.8

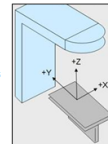
Dosimetric Results:

Localization Method:

Evaluation Criteria	10x10 Field	Range* (n = 6)	IMRT Plan	Range* (n = 6)	Ref. Plan	Range* (n = 4)
3% & 2 mm DTA		95.6 – 100		83.7 – 97.6		83.3 – 97.9
3% & 3 mm (7)		95.6 – 100		92.9 – 99.6		94.5 – 99.9

Comments:

- Test results indicate that there was a phantom set-up error of approximately 1 mm inferiorly (-Y)
- Results possibly affected by leaf positioning errors (Y2)
- Suggest examining beam model in penumbra region for improvement in results
- Absolute dose results will follow in the final report, with results from all provincial institutions



Basic Plan Characteristics:

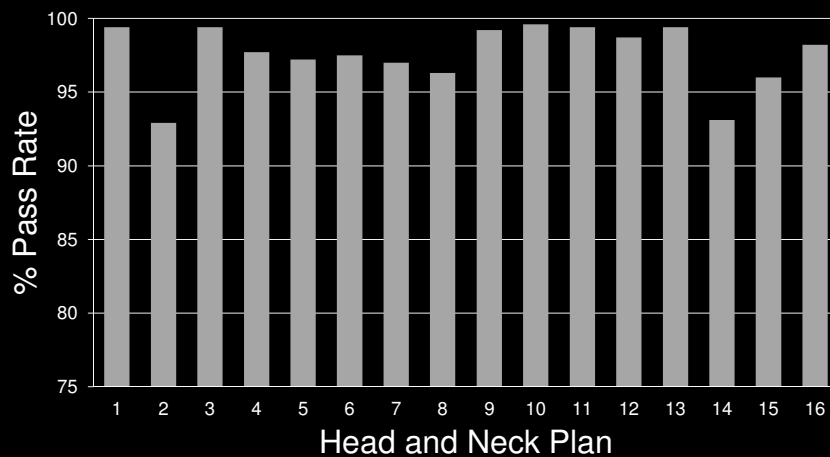
Characteristic	Institution's Plan	Range* (n = 6)
# of Beams		2 (Arcs), 6 – 10
# of Couch Kicks		0 – 4
# of Segments		39 – 138
# of MU		459 (Arcs), 591 – 780

Date of Report:	
Report Completed By:	Andrea McNiven
Report Reviewed By:	Daniel Létourneau

* The range includes the results from all of the centres that have participated at this point in time. A final report will be sent once all tests are completed. The reference plan is the IROC vendor specific plan that is tested at each centre. In future reports, when numbers are increased, the range will be specific to a single vendor. At this point in time, it includes all vendors.



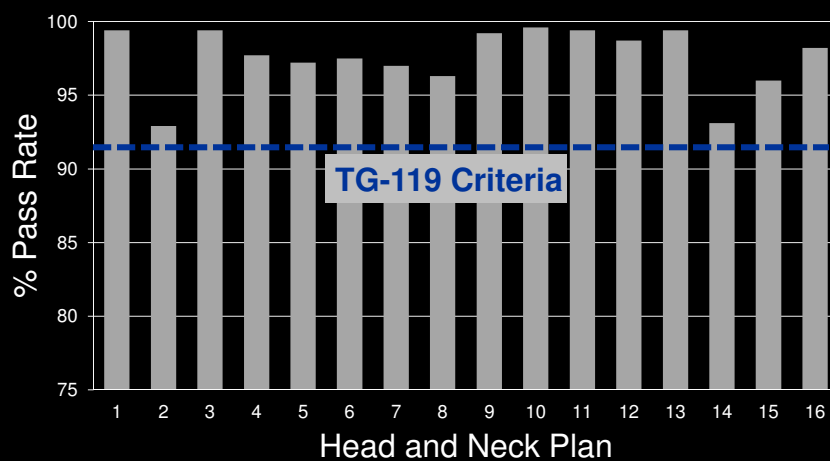
3%/3mm Gamma



Létourneau et al. IJORBP, 2013



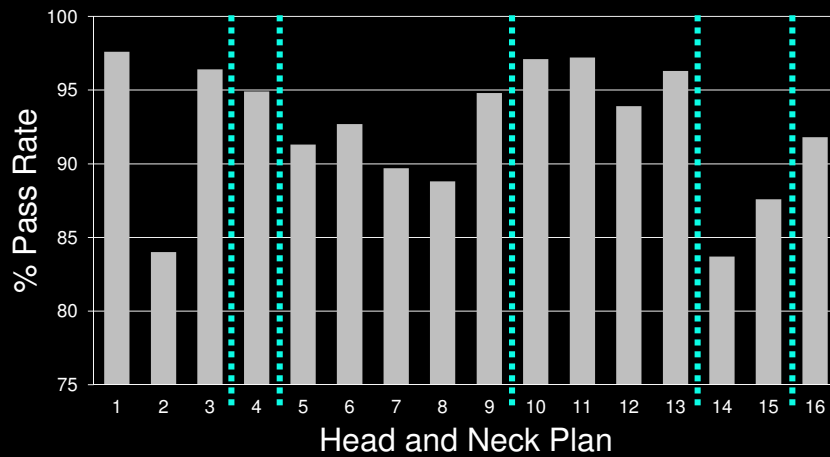
3%/3mm Gamma



Létourneau et al. IJORBP, 2013
Ezzell et al. Med Phys, 2009



3%/2mm Composite (DTA)

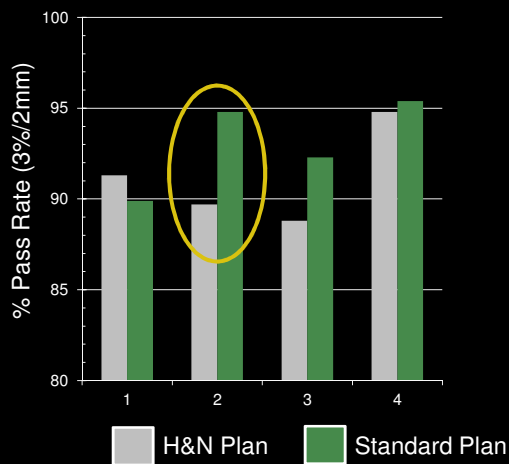


Létourneau et al. IJORBP, 2013
Thomas et al. IJORBP, 2012



Standard Plan

Group 1

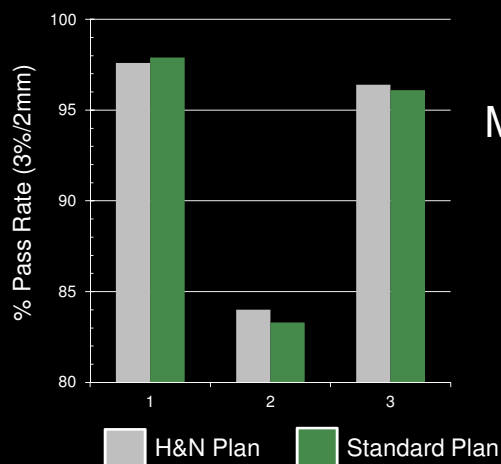


Difference in Planning Practice



Standard Plan

Group 2



Machine Performance
and/or
Beam Model



Year 1 Summary

- Quantitative evidence of good practice
 - Satisfy AAPM TG-119 guidelines
- Tighter tolerances highlight room for improvement
- Impact of system commissioning
- Provided some feedback for quality improvement



PHASE TWO

YEAR 2 to 6

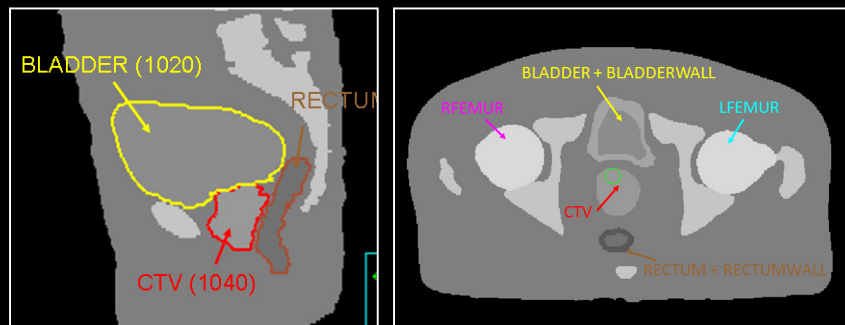
Focus

- New Anatomic Sites
- Repeat Deliveries
- More Diagnostic Tests
- Better Feedback



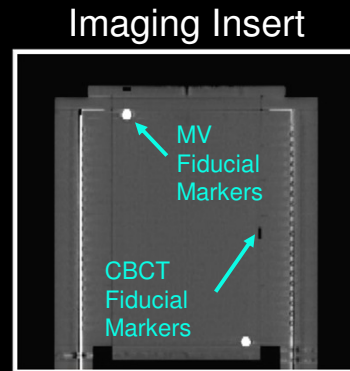
Year 2 Development

- New planning exercise: Prostate



Phantom Positioning

- Facilitate CBCT image guidance
- MV markers for phantom setup error assessment by CQA
(Accuracy: 0.2 mm and 0.1 °)



Ren, AAPM, 2013

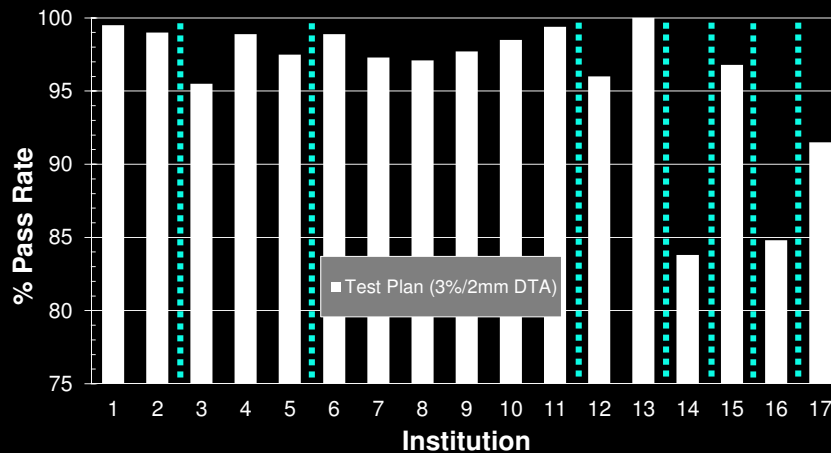


Year 2 Results

- 14 Centres Visited
- Measurements on 22 linacs
- H&N plans were redelivered
- 17 Prostate Plans (12 VMAT and 5 IMRT)
- Independent assessment of phantom setup errors



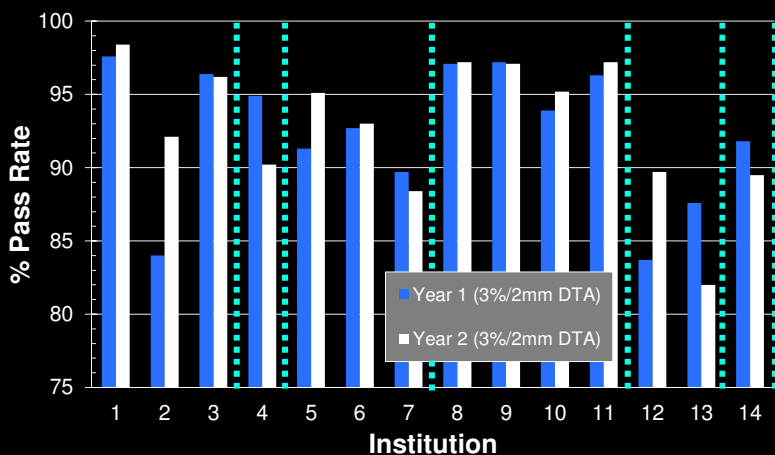
Prostate Plans



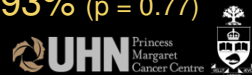
Prostate: 96% vs. H&N: 92% ($p = 0.03$)



H&N Repeat Delivery



H&N Year 1: 92% vs. H&N Year 2: 93% ($p = 0.77$)



Year 2 Summary

- Higher performance for prostate (simpler task)
- Increase use of rotational delivery
- Year-to-year performance variation (H&N):
 - Variation at institutional level
 - No change on average
- Small phantom setup error
(usually < 1.5 mm and 1°)



Next Steps

- Developing new anatomic sites
- Repeat deliveries for constancy assessment
- Increase feedback specificity with diagnostic tests:
 - Phantom setup error ✓
 - MLC positioning
 - Beam model tests
- Encouraging transfer of expertise
 - Eliminating anonymity

