



# Assessment of Automated Radiotherapy Plan Generation for Bladder Cancer using the Ethos TPS



Matt Bolt, Charlotte Shelley, Rachel Hollingdale,  
Andy Barnard, Chris South, Liz Adams

St Luke's Cancer Centre  
Royal Surrey Hospital, Guildford



# Today's Talk

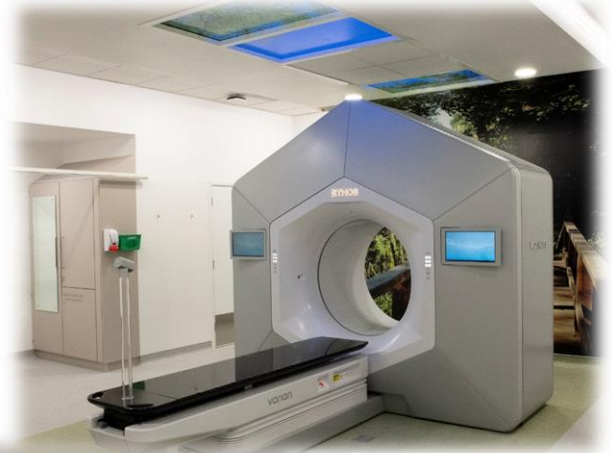
- Background
- Ethos system overview
- Plan template development
- Plan assessment method
- Results
- Future developments



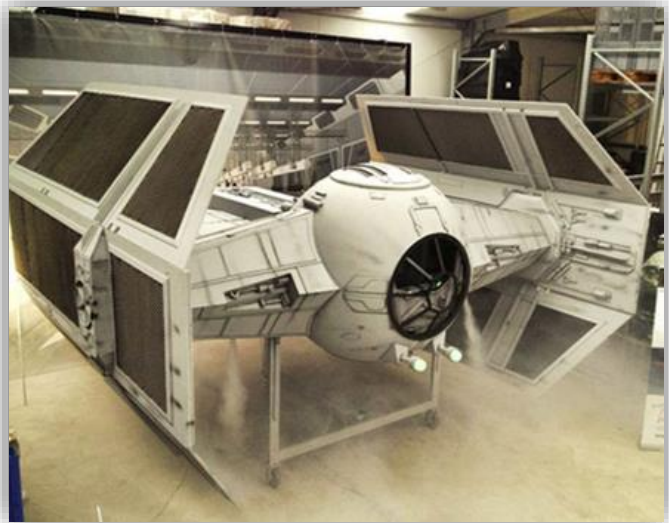


## Study background

- Varian Ethos clinical for IGRT August 2020
- First online adaptive treatment Jan 2021



# BIR Annual Radiotherapy and Oncology Meeting 2021 (Part2)






# Ethos overview

- Template based planning/treatment
- Template used to generate CBCT guided daily plan
  - No user interaction during plan generation
- Intelligent Optimisation Algorithm
  - Generates required optimisation structures internally
  - Works to lower OAR doses and maintain target dose



## Ethos overview

Edit Target

Color 

Structure Name






Meaning

Derived Structure   $\Sigma$   $\Sigma$


**Auto margin**  $\swarrow$

**Clinical priority**  $\downarrow$

**Clinical goals** {

Clinical Goals	Phase	Goal	Variation	Priority	
	Phase 1	<input type="text" value="D0.10cm3&lt;=104.0%"/>	D0.10 cm3 <= <input type="text" value="105.0"/> %	<input type="text" value="1-Most Important"/>	
		<input type="text" value="D98.0%&gt;=95.0%"/>	D98.0 % >= <input type="text" value="93.0"/> %	<input type="text" value="1-Most Important"/>	
		<input type="text" value="Dmax&lt;=105.0%"/>	Dmax <= <input type="text" value="107.0"/> %	<input type="text" value="R-Report Value Only"/>	
		<input type="text" value="Dmin&gt;=95.0%"/>	Dmin >= <input type="text" value="90.0"/> %	<input type="text" value="R-Report Value Only"/>	
		<input type="text" value="Dmean&gt;=100.0%"/>	Dmean >= <input type="text" value=""/> %	<input type="text" value="R-Report Value Only"/>	

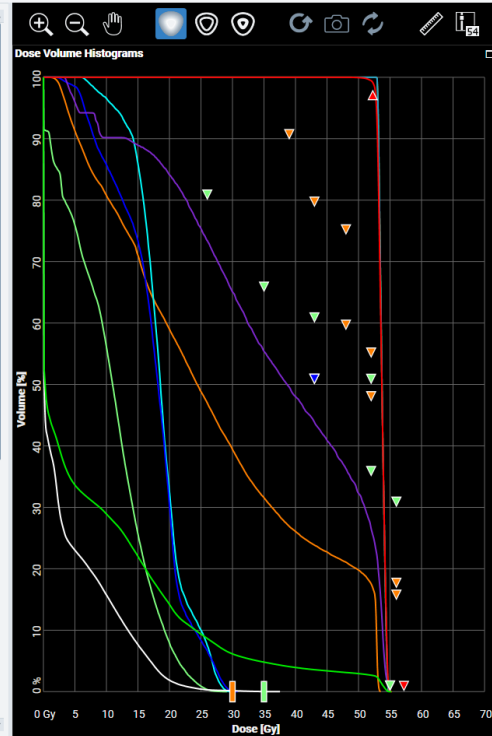
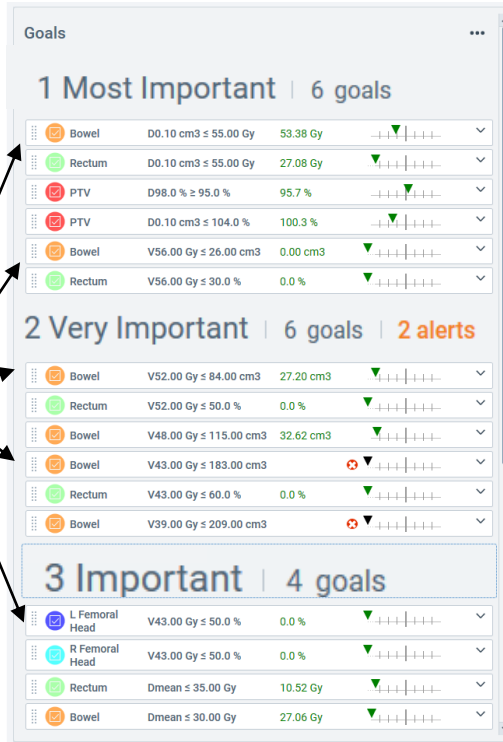
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 Delete Target



## Optimiser

Clinical Goals in order of priority





# Plan template development

- Optimiser is template driven
- Optimisation process is NOT interactive
- The order of clinical goals needs to be determined
- Need to consider patient beyond the planning scan
  - Same template is used for each fraction
- Developed based on 4 patient plans. Iterative process!

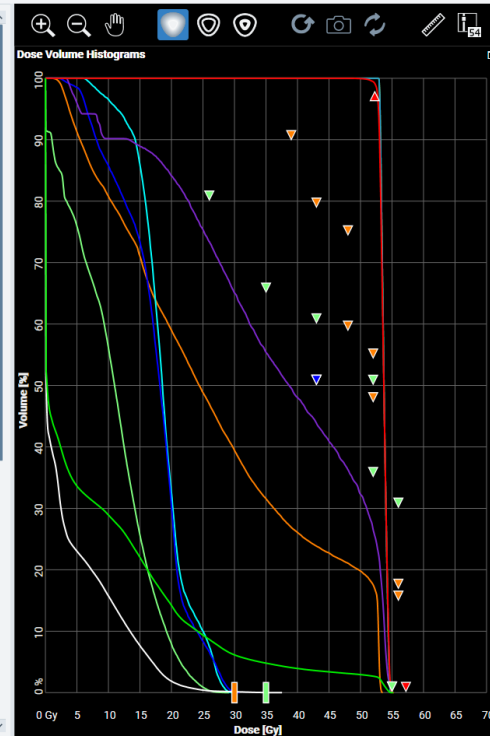
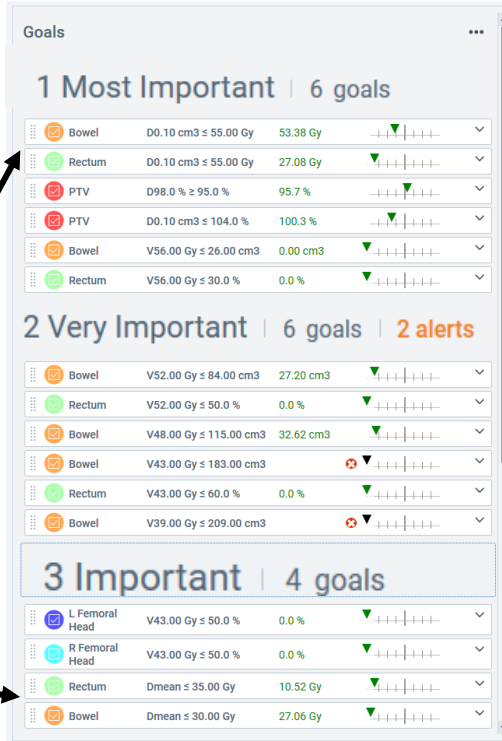




## Optimiser Tricks

Hotspot reduction

Lower OAR doses





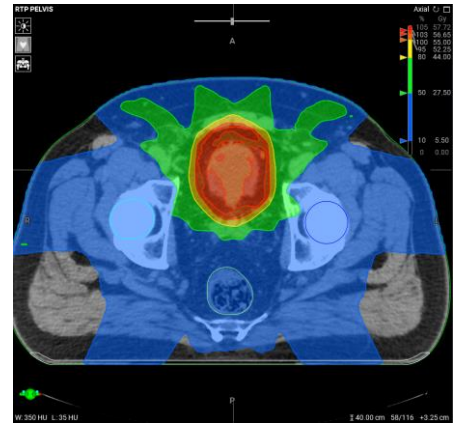
# Plan quality assessment

- Eight previously treated patients
  - Bladder 64Gy/32#, VMAT on Truebeam
- IMRT plans (9 field) generated on Ethos
  - IMRT has speed benefits for online ART and Ethos VMAT plans generally not as good
  - Normalised to median PTV dose
- Compare to constraints in local clinical protocol



# Plan quality assessment

1. Is plan generation repeatable?
  - Generate 10 plans using same template on single patient
2. Are plans clinically acceptable?
  - PTV coverage
  - OAR dose statistics compared
  - Clinician review





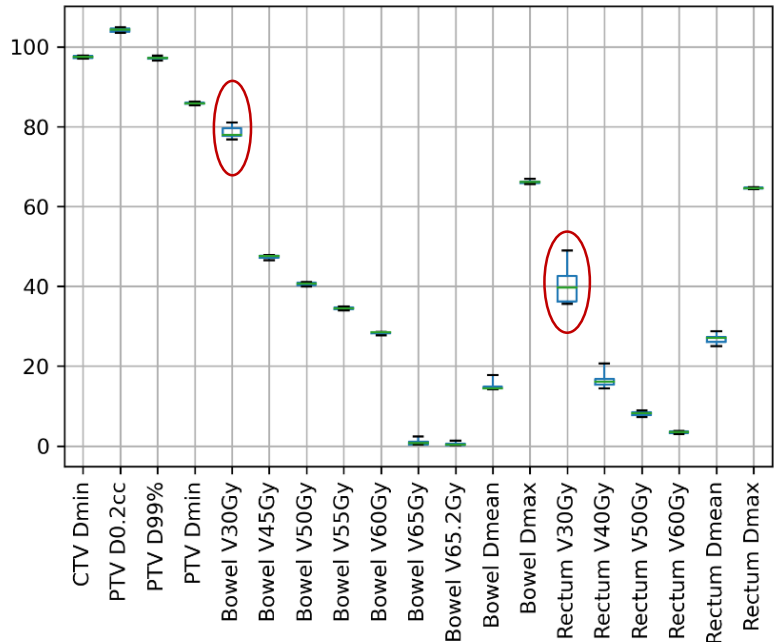
# Results - Plan reproducibility

- Most dose-volume parameters were very stable in the repeated plans.
  - PTV D0.2cc, D99% and Dmin were all within 0.5% (1SD)
- Greatest variations were seen for parameters not explicitly included in the optimisation goals
  - These were generally the lower doses



## Results – Plan reproducibility

- Largest variations seen on parameters which were not included in the optimisation
- These were the lower doses (V30Gy)



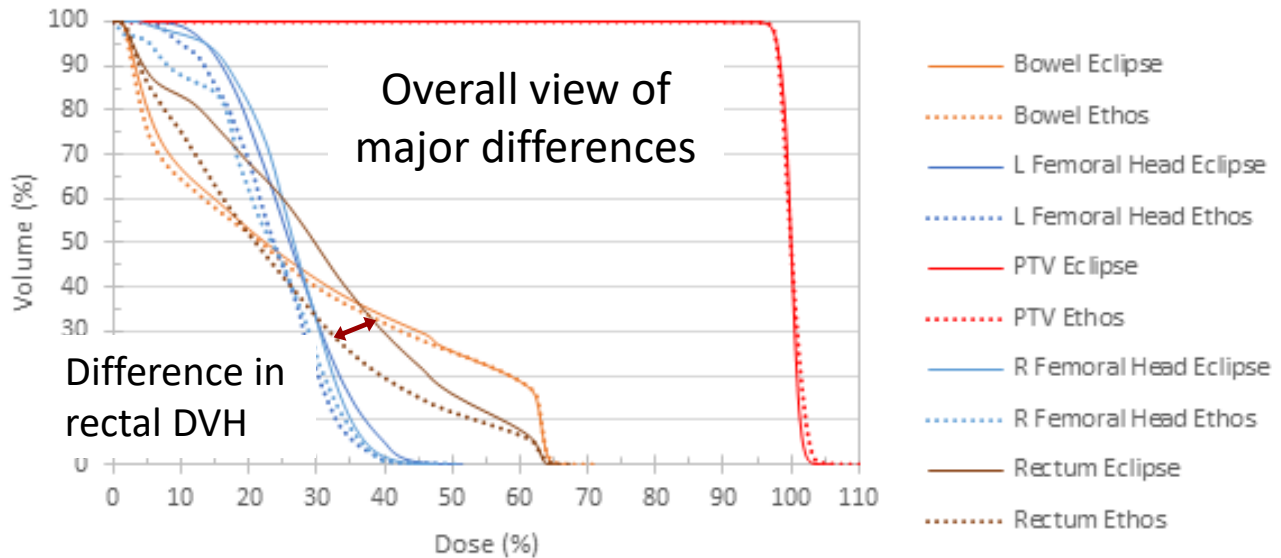


## Results – Plan comparison

- Ethos plans met all clinical constraints with no further intervention for six of the seen patients
- One patient had reduced PTV coverage;  
This patient also required significant PTV compromise on original Eclipse plan



# Average DVH comparison





## Plan comparison – PTV

- Patient which required compromise to coverage on Eclipse also had similar on Ethos.
- High doses kept out of OARs

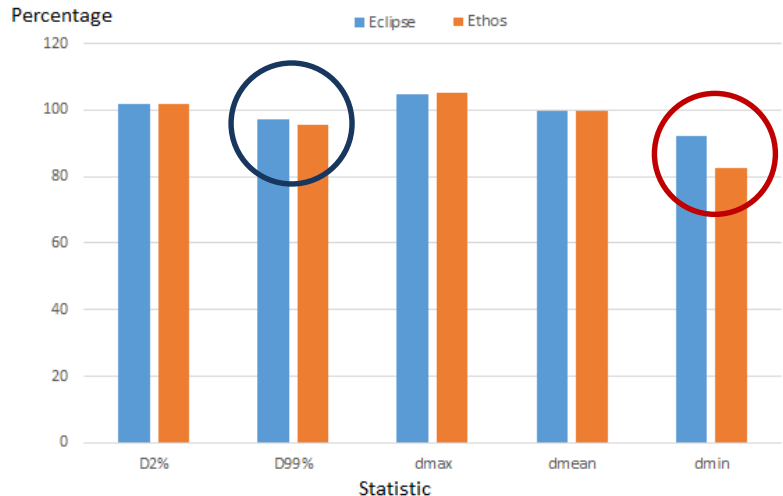






## Plan comparison – PTV

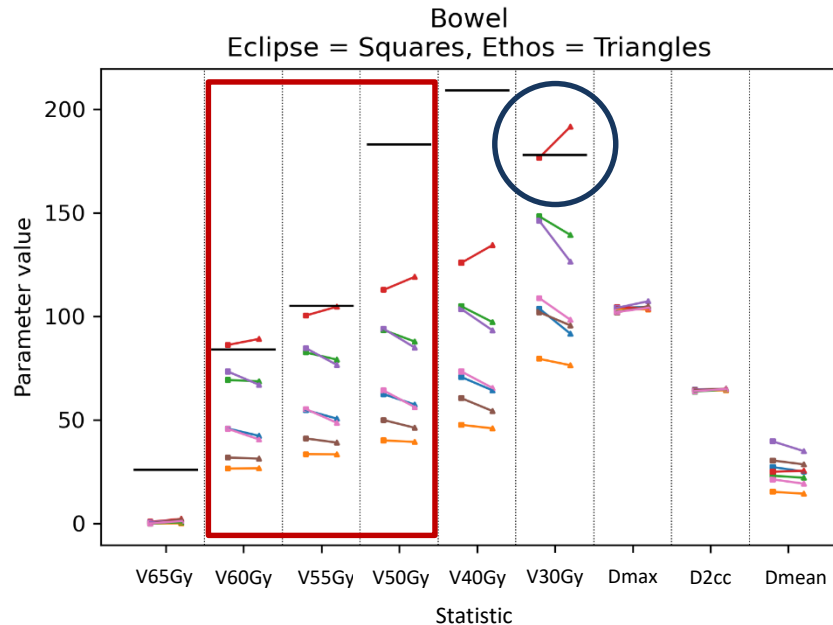
- Coverage (D99) slightly reduced on Ethos (p=0.03)
  - $97.1 \pm 0.7\%$  (Eclipse)
  - $95.7 \pm 1.3\%$  (Ethos)
- Some differences due to algorithm





## Plan comparison – Bowel

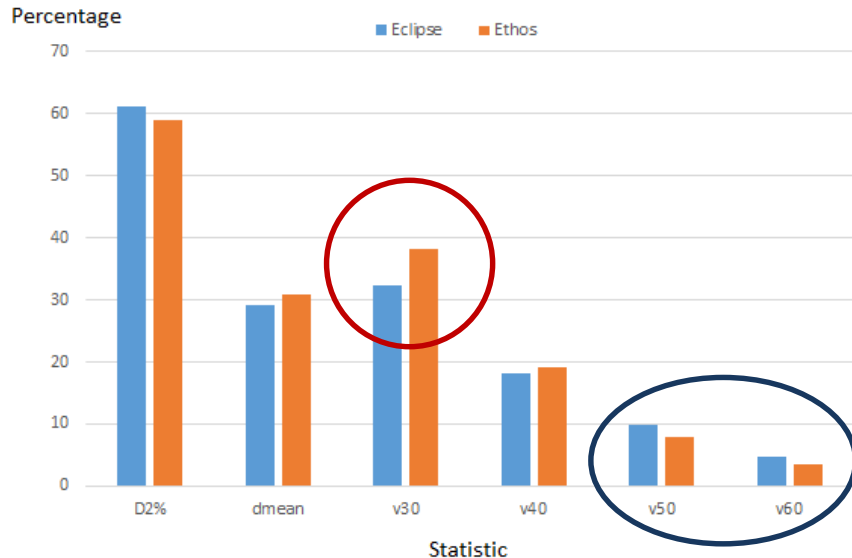
- Statistically significant reduction for doses >50Gy
- V60Gy reduced from  $54.1 \pm 22.5\text{Gy}$  to  $49.9 \pm 20.5\text{Gy}$  ( $p=0.02$ )
- Template doesn't work for all patients





## Plan comparison – Rectum

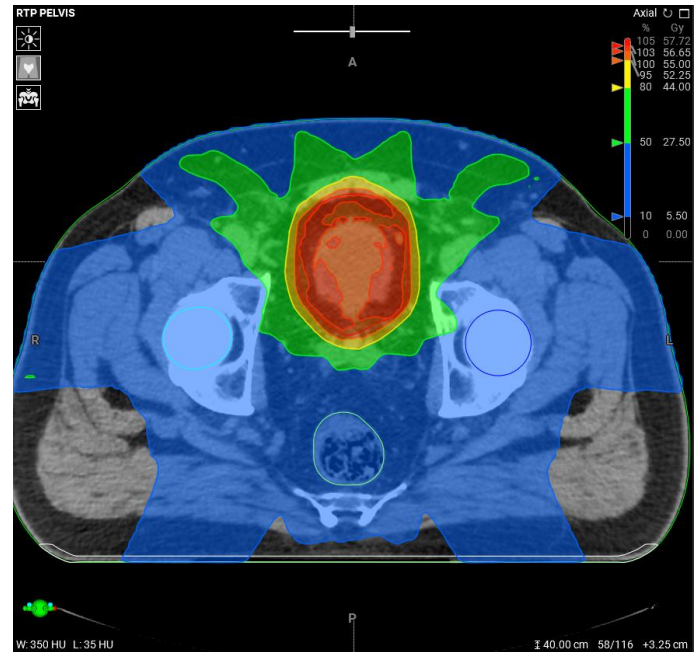
- Rectal volume receiving  $>50\text{Gy}$  were reduced.
- However greater low doses.
- All within tolerance





# Plan comparison – Dose distribution

- Main differences in distribution due to planning technique (IMRT vs VMAT)
- When planned using same technique largely similar
- Generally more AP weighted





# Conclusions

- For a majority of cases plans generated on the Ethos TPS were clinically acceptable using the developed template and require no further user interaction.
  - This means the template and optimisation should be suitable for daily online adaption.
- Plan quality was reproducible
  - Greatest DVH variation where optimiser is not explicitly given dosimetric goals.



# Does it work?

- Cannot just rely on inputting the clinical goals and expect a good plan
  - E.g. need additional goals to remove hotspots
  - Coverage vs OAR doses for each fraction
- ✓ So far have treated 2 bladder patients.
- ✓ Both used template with no further modifications



# Further work

- Prostate
  - Template developed and in clinical use
  - 2 patients currently on treatment using same template
- Cervix
  - Study into removal of ITV when planning which shows promising results



## Thank you

matthew.bolt@nhs.net



@RSCH\_RTphysics

