The ROYAL MARSDEN
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Accuracy of portal dosimetry in hybrid IMRT and VMAT treatment of the prostate

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Introduction

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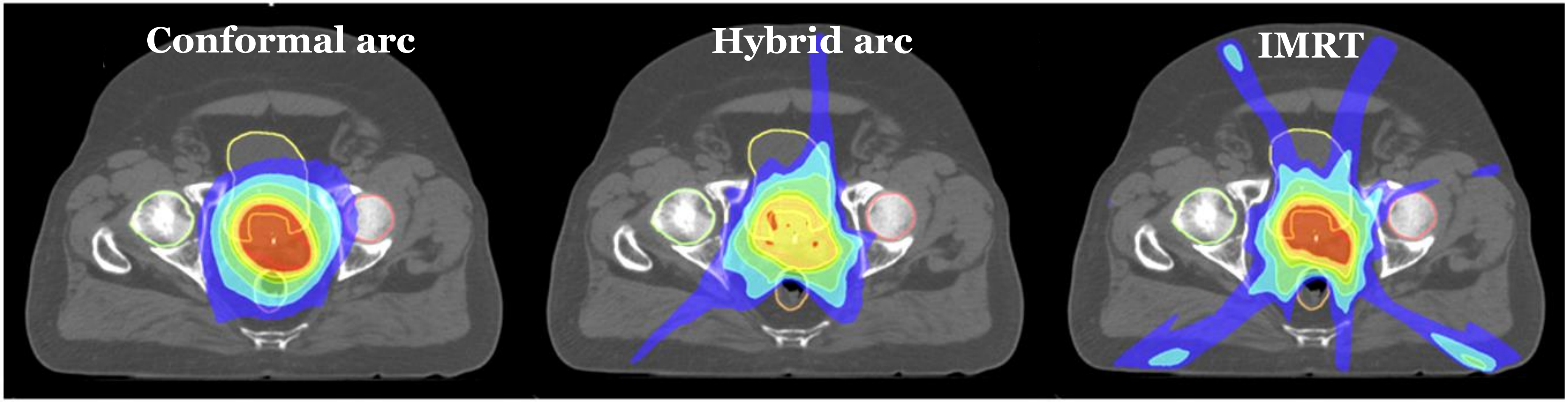
Hybrid IMRT / VMAT

Envisaged before VMAT was widely available
Studied by adding IMRT to conformal VMAT arcs
Method proposed for choosing IMRT directions



Earl et al., US patent 2004/0071261 (2004)
Robar and Thomas, Med. Dosim. 37: 358-368 (2012)
Matuszak et al., Med. Phys. 40: 071713 (2013)

This study

Builds on the work of Matuszak et al.

Uses the same arc parameters for all cases

Incorporated into AutoBeam in-house software

Evaluates application to prostate radiotherapy

Focuses on in-treatment portal dosimetry

AutoBeam

Methods

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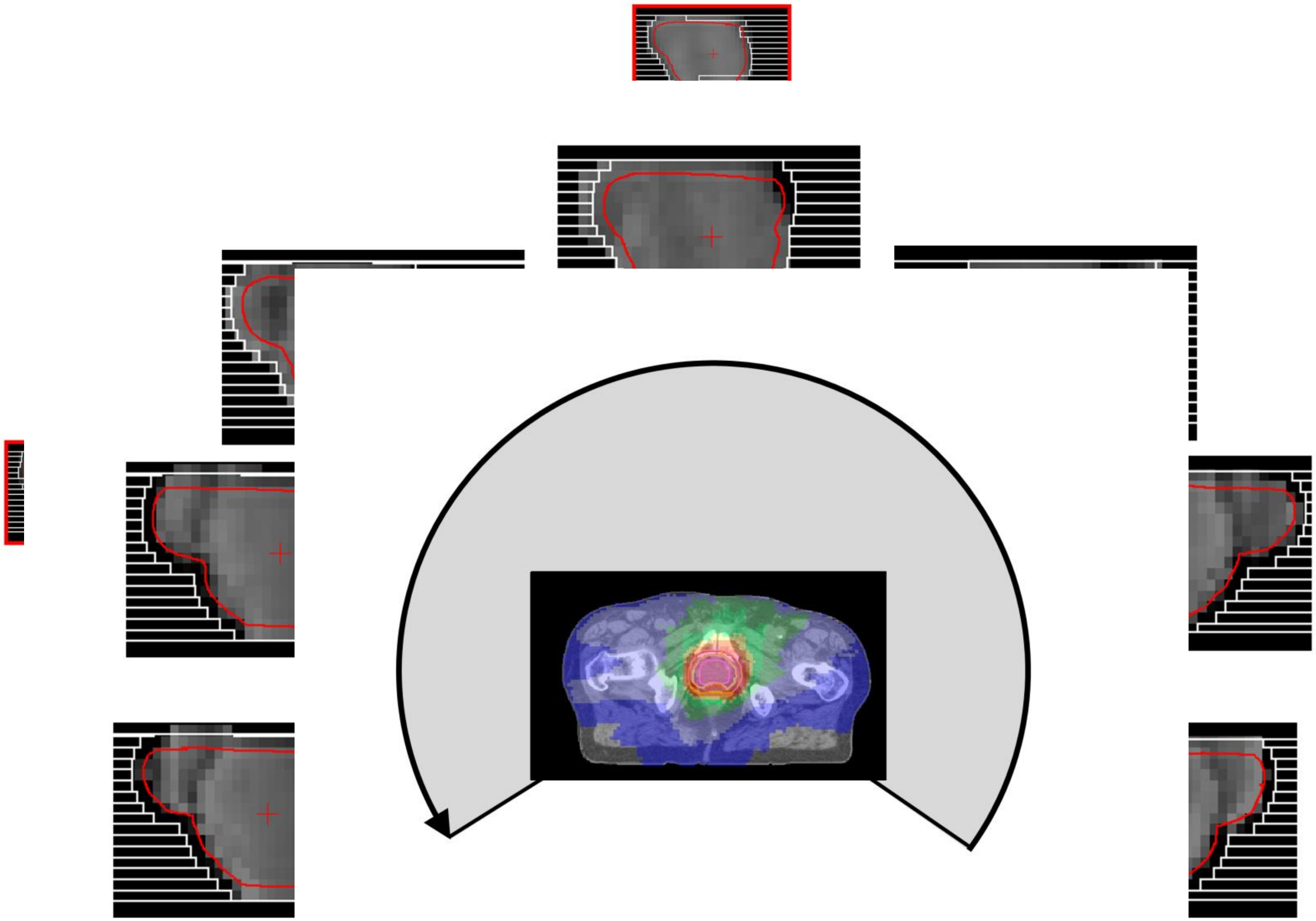
Hybrid IMRT / VMAT method



Hybrid planning

Five prostate patients retrospectively studied

Prescription 74, 71, 60 Gy in 37 fractions

Single 220° arc with 111 segments in 20° groups

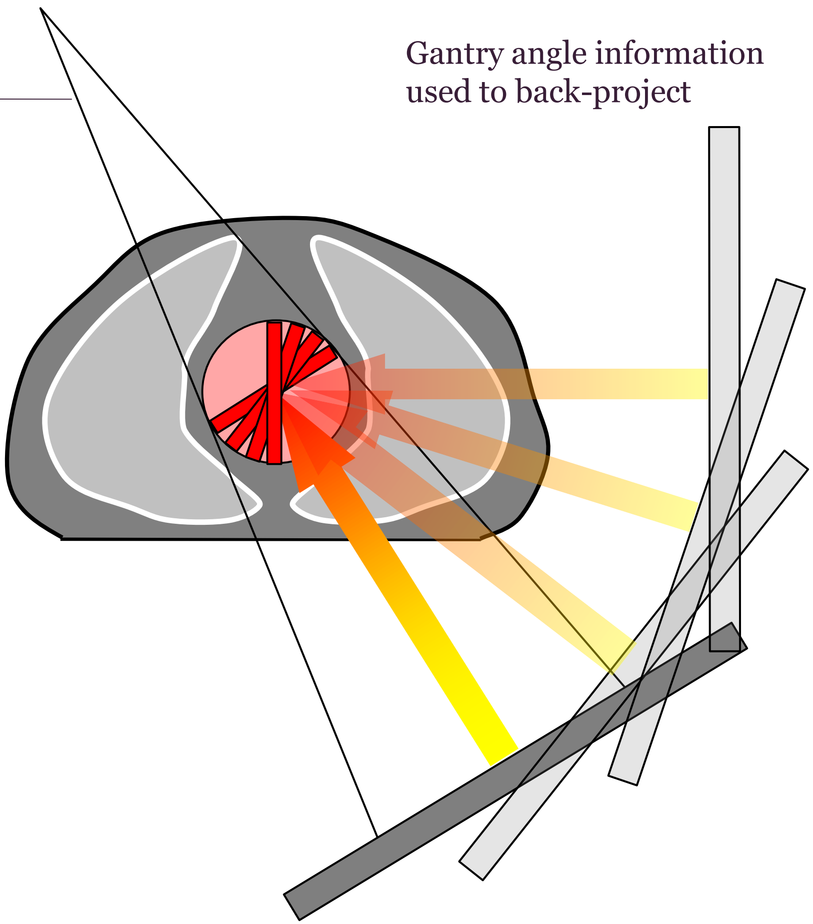
Fluence optimisation, sequencing, aperture optimisation

Nominal gantry speed 3 deg/s

CO, LM, HY0, HY25, HY50, HY75 and HY100

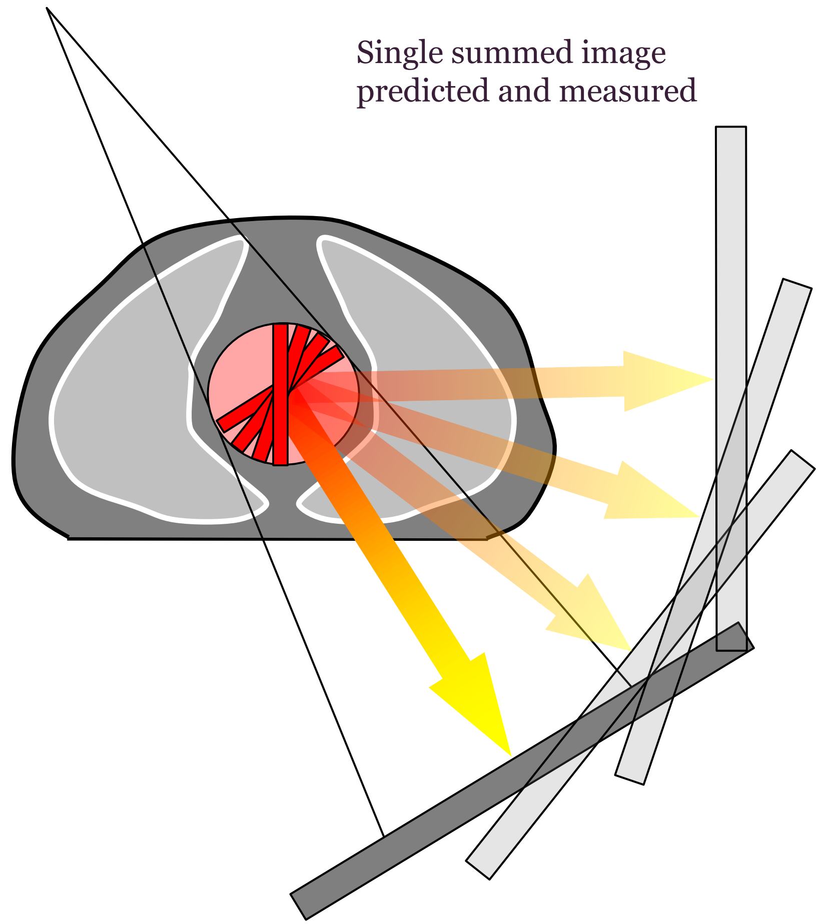
Portal Dosimetry for VMAT

Gantry angle information used to back-project



Back projection

Single summed image predicted and measured



Forward projection

Image prediction model

$$I_{ij}^{in-field} = d_{ij} \cdot a^{2} \cdot f_{j}\left(s_{j}\right) \cdot c_{i} \cdot \exp\left(-\mu_{j}\left(s_{j}\right) \cdot r_{ij}^{m}\right)$$

Isocentre dose
Inverse square
Field-size factor
Pixel-specific factor
Attenuation coefficient
Equivalent path length

$$I_{ij}^{out-of-field} = \overline{d} \cdot h\left(\overline{r}\right) \cdot s_{j}$$

Mean isocentre dose
Scatter factor
Field size

$$I_{ij}^{panel} = \left(I_{ij}^{in-field} + I_{ij}^{out-of-field}\right) \otimes \sum_{n=1}^{2} k_{n}$$

Total projected dose
Gaussian scatter kernels

Bedford et al. Med. Phys. 41: 021725 (2014)

Phantom study

Agility MLC and iViewGT portal imager

300 mm x 300 mm x 200 mm Solid Water

Single beam sequence

Median treatment time determined

Isocentre dose checked with 0.6 cm^3 ionisation chamber

Calculated and measured images compared using gamma index

Measured images increased by 1% per 25% IMRT

– Correction for loss of image at start/end of segments

Results

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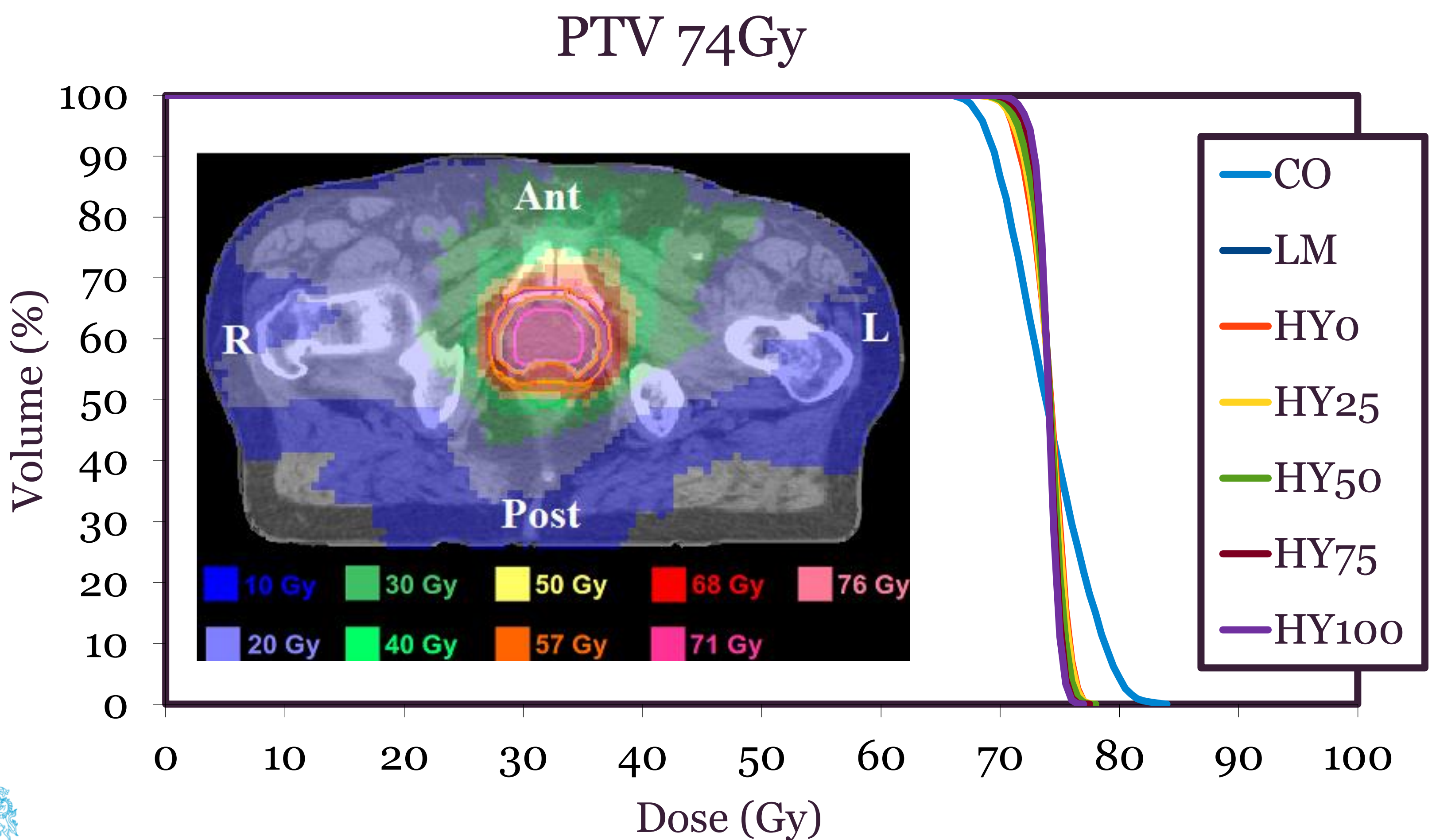
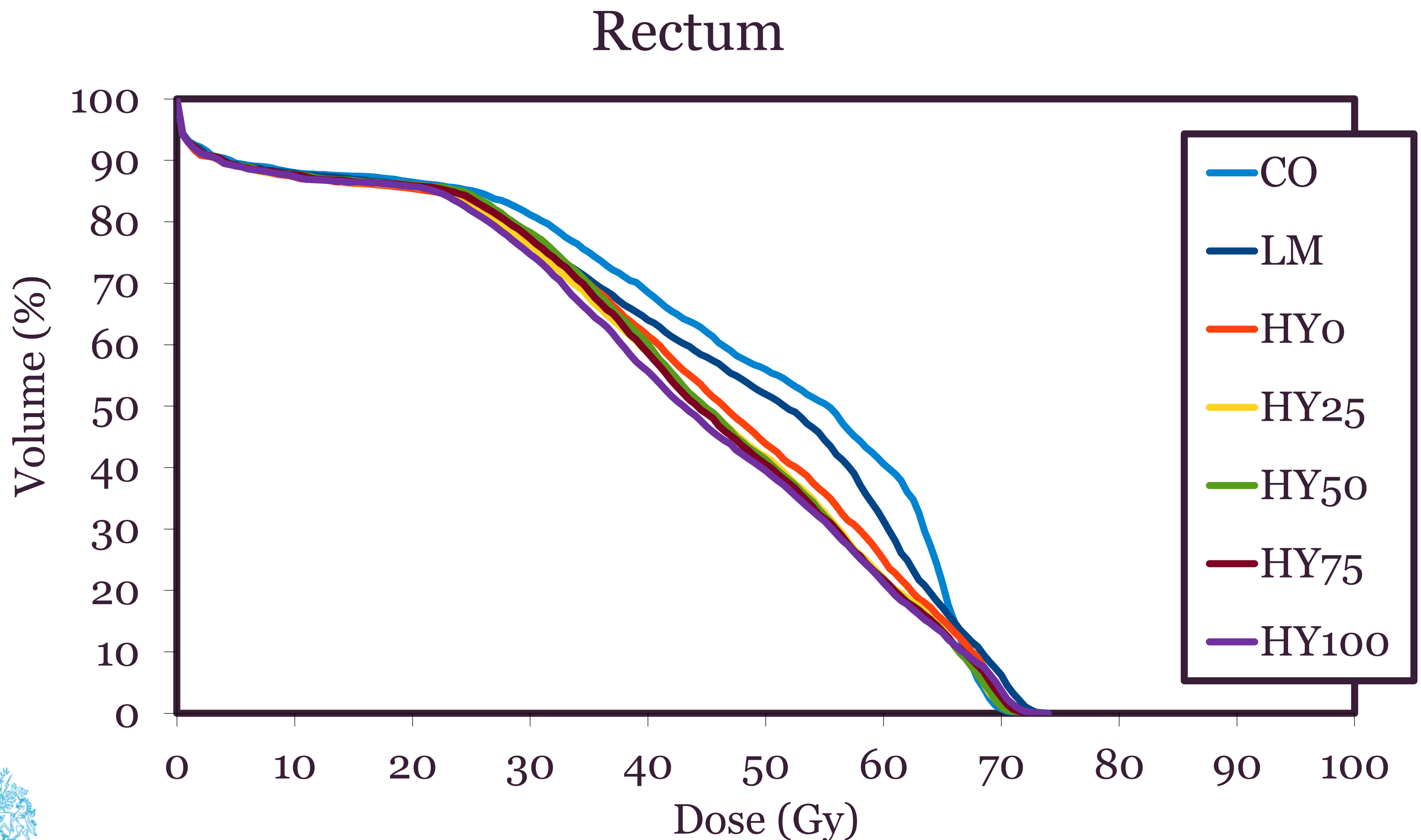
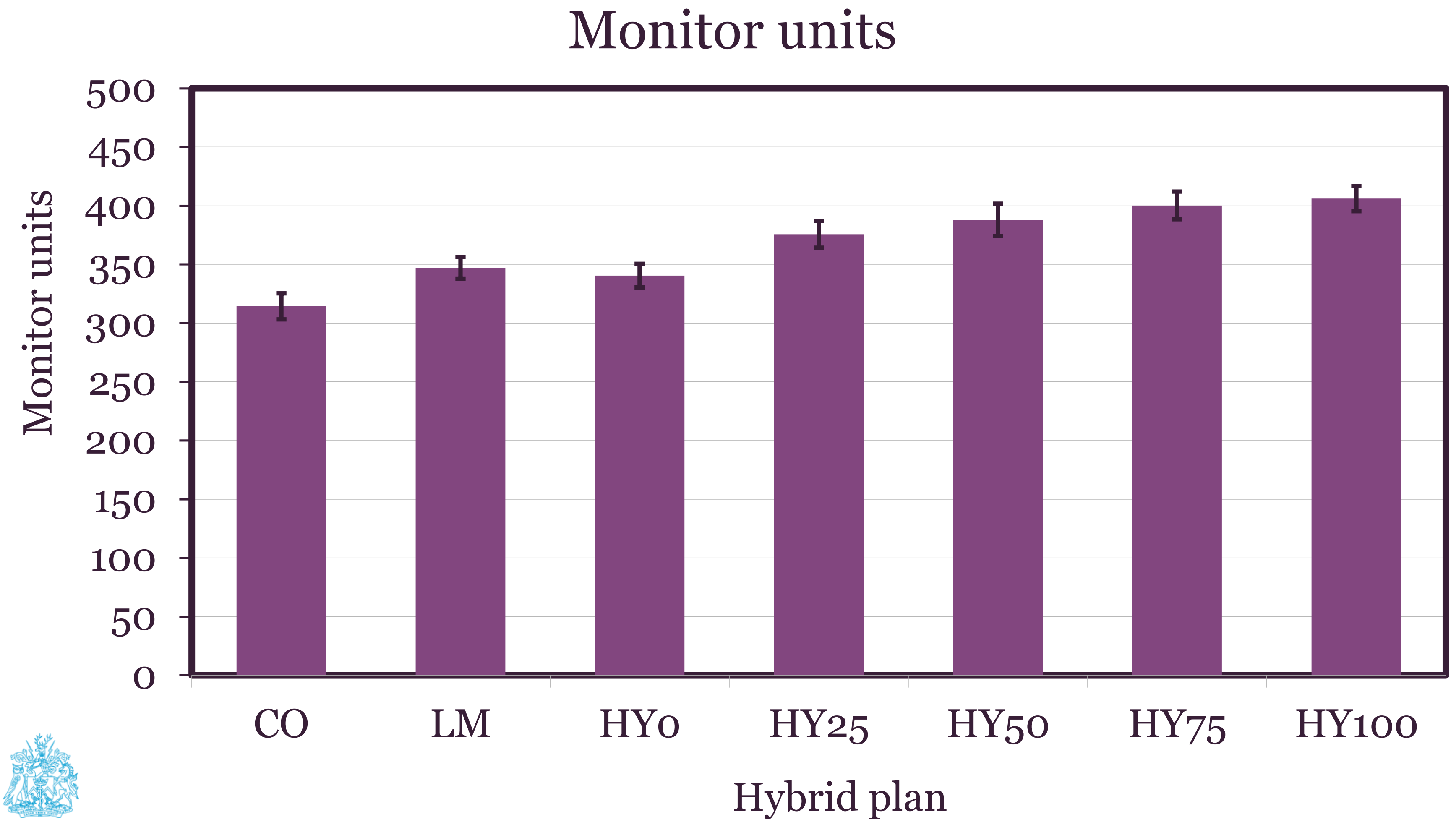
Planning results: PTV (74 Gy) homogeneity



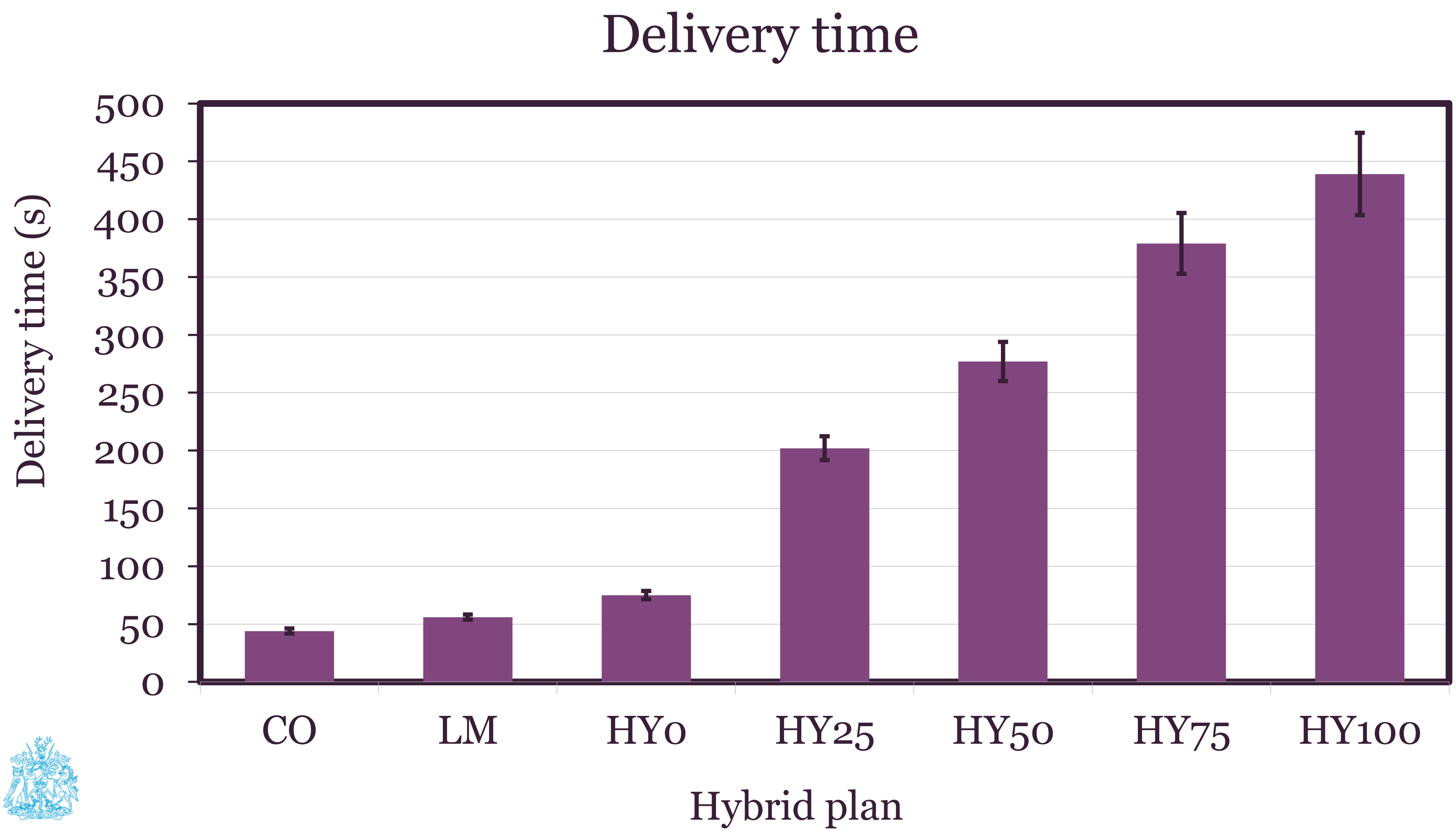
Planning results: rectal dose



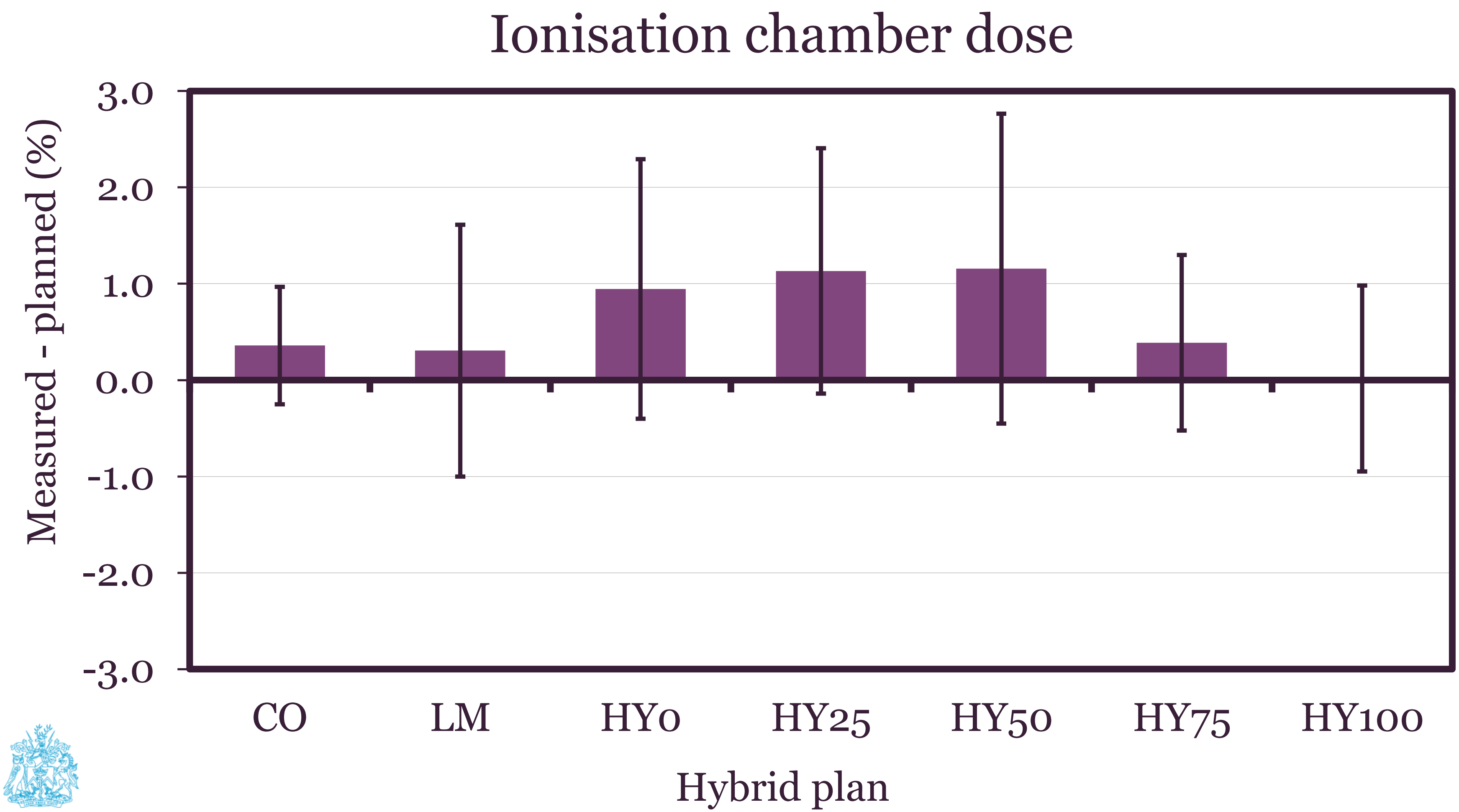
Mean (±1 SD) monitor units



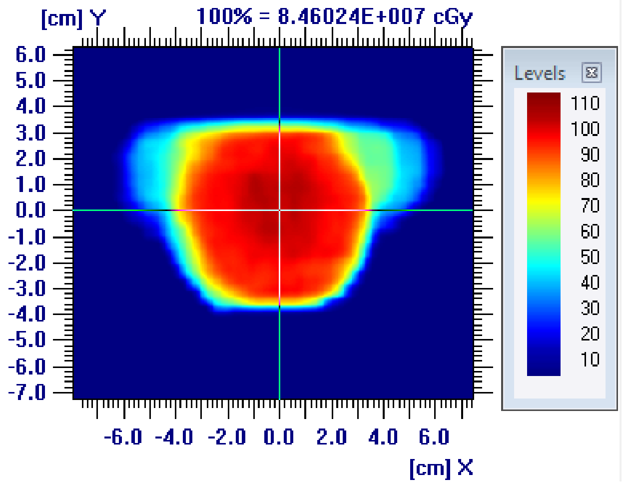
Mean (±1 SD) delivery time



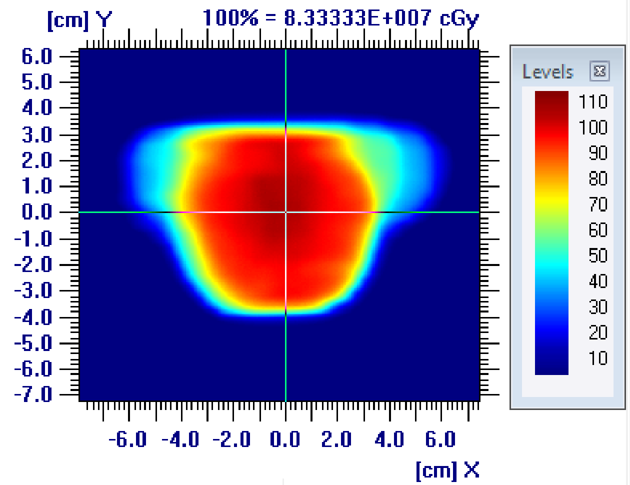
Mean (±1 SD) ionisation chamber dose



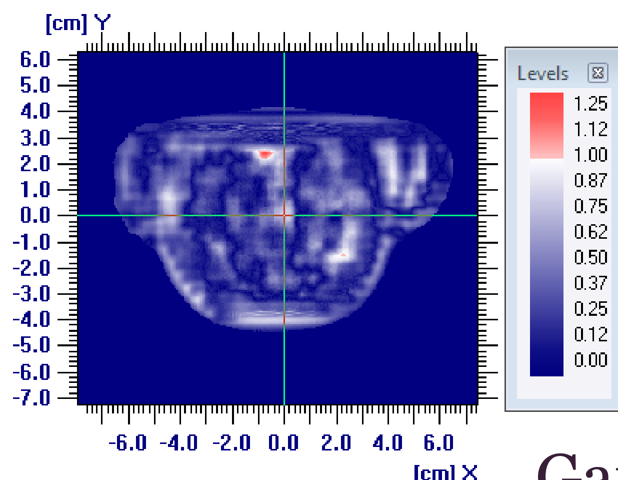
Phantom results: integrated images



Predicted

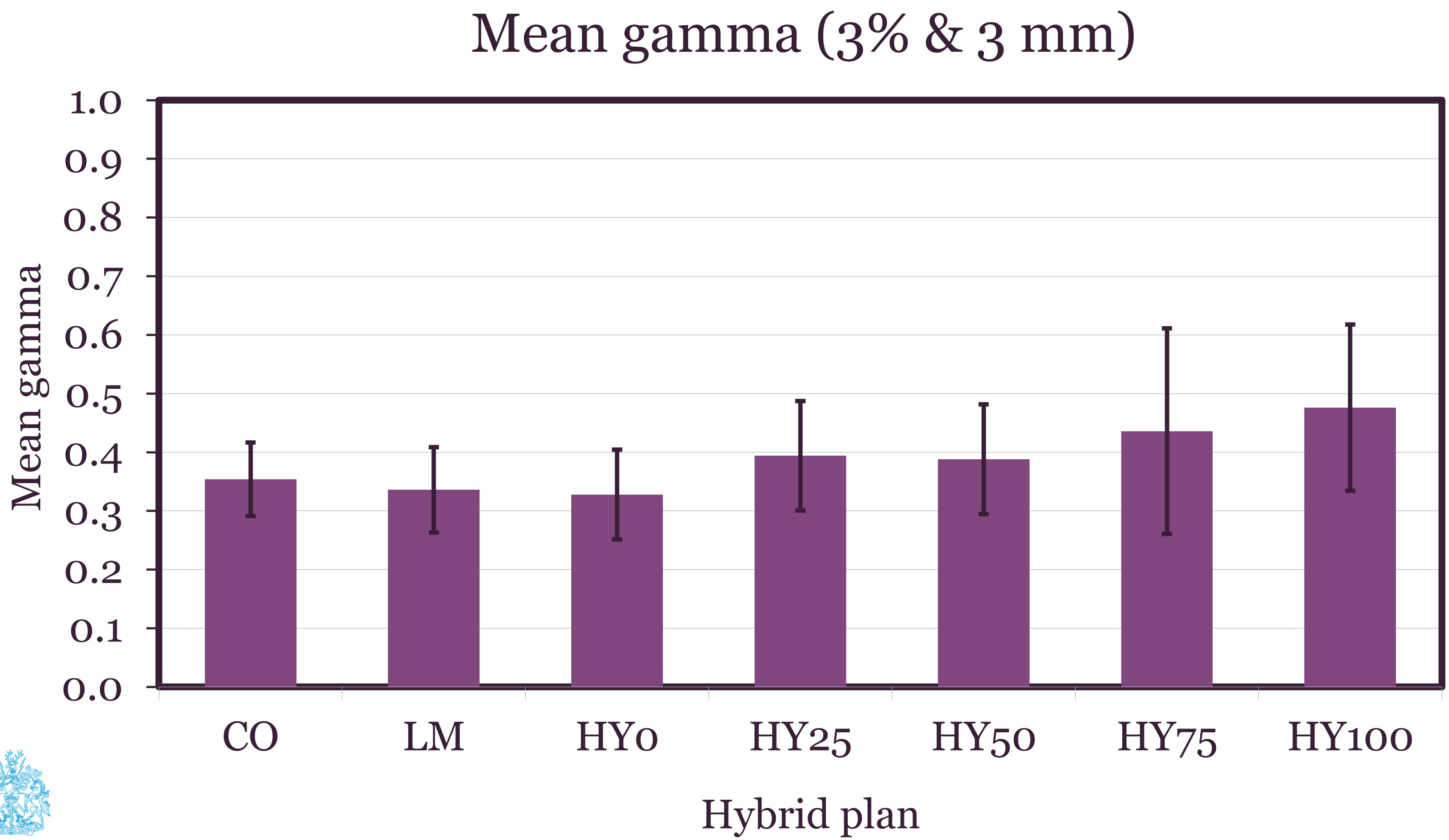


Measured

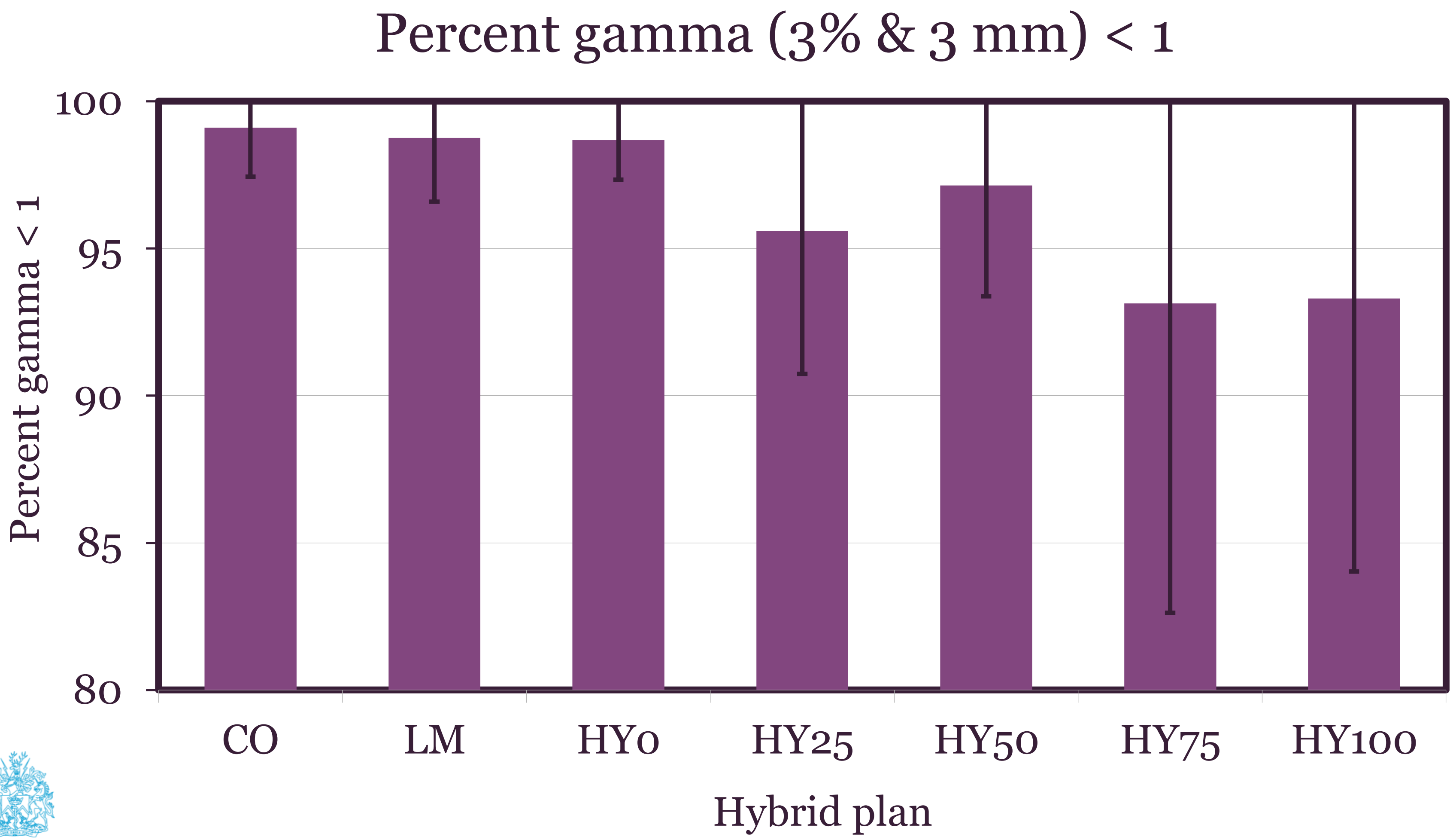


Gamma (3% & 3 mm)

Mean (±1 SD) mean gamma



Mean (±1 SD) percent gamma < 1



Conclusions

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Conclusions

Results broadly agree with Matuszak et al.

Increasing IMRT gives improved rectal sparing and increased monitor units

25% IMRT is an attractive option

Successful hybrid delivery with single beam

Portal image prediction successfully implemented for hybrid therapy

Accuracy 3% and 3 mm

Potential for other treatments and sites

Acknowledgments

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NHS

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