Monte Carlo investigation of the 25MV photon beam PDD trend for an Elekta SL25 linear accelerator

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- Dr John Mills - Walsgrave Hospital
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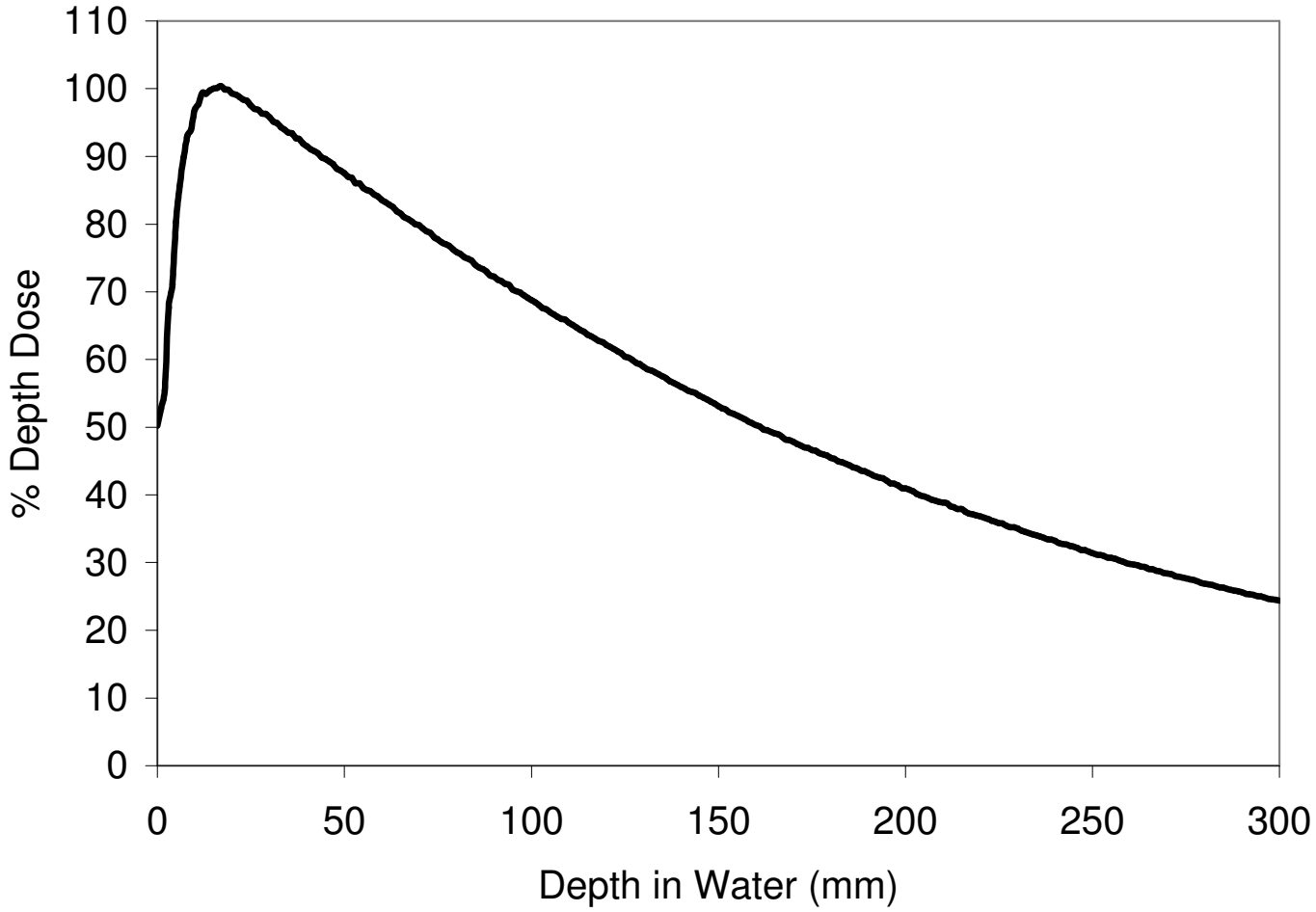
- Introduction
- A look at the Trend
- The MCNP Model
- Results

Introduction

- Medical Linear Accelerators calibrated to deliver a specific dose under particular conditions
- However there are many factors which need to be considered to determine the dose at a particular point
- Data sets are used to calculate the number of MU required for a patient's treatment
- Necessary to identify trends in data to produce data sets from measured data

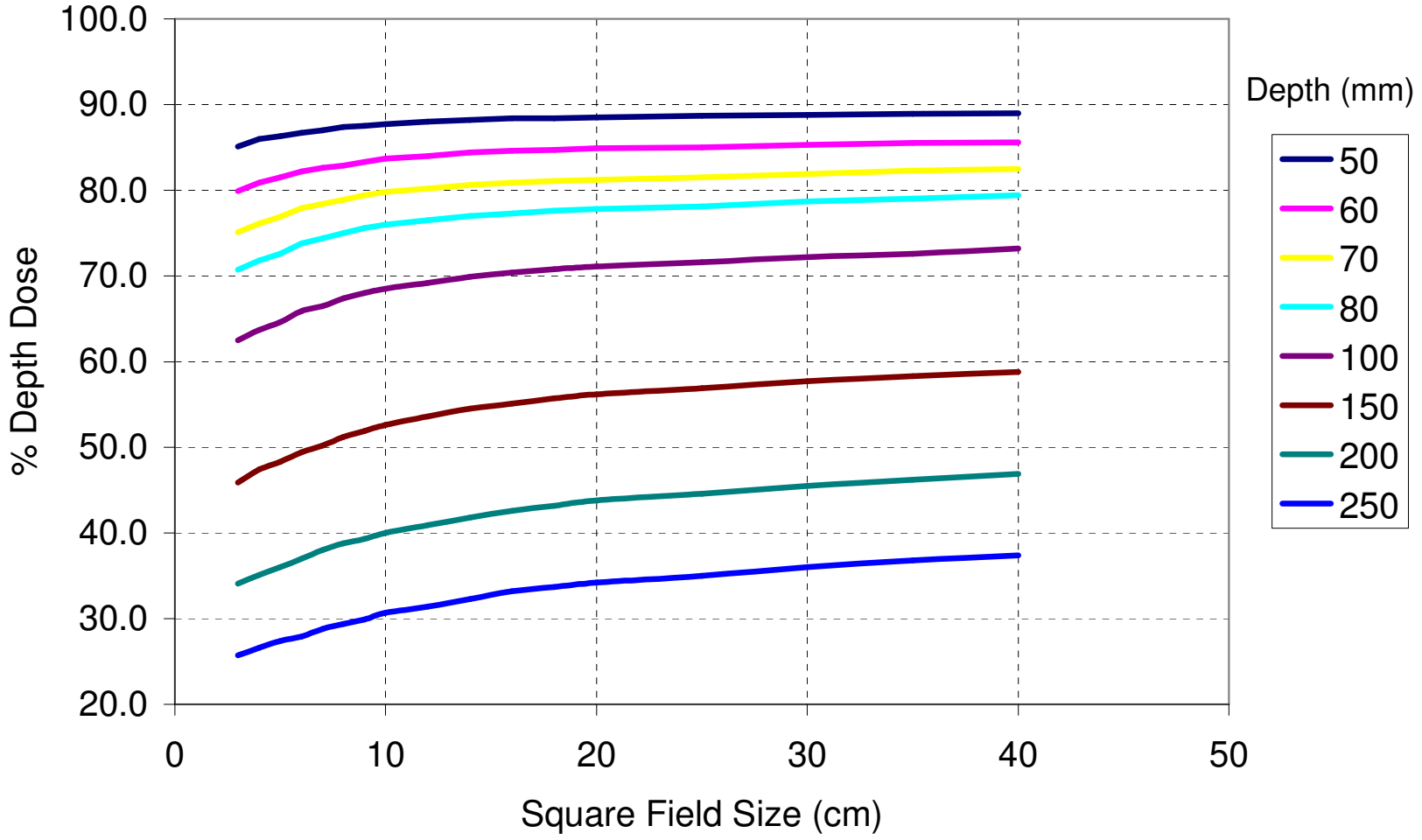
6MV Percentage Depth Dose



PDD trend with Field Size

- Phantom Scatter increases Central axis Percent Depth Dose (PDD) values with field size as extra scattered photons reach the central axis with increasing depth

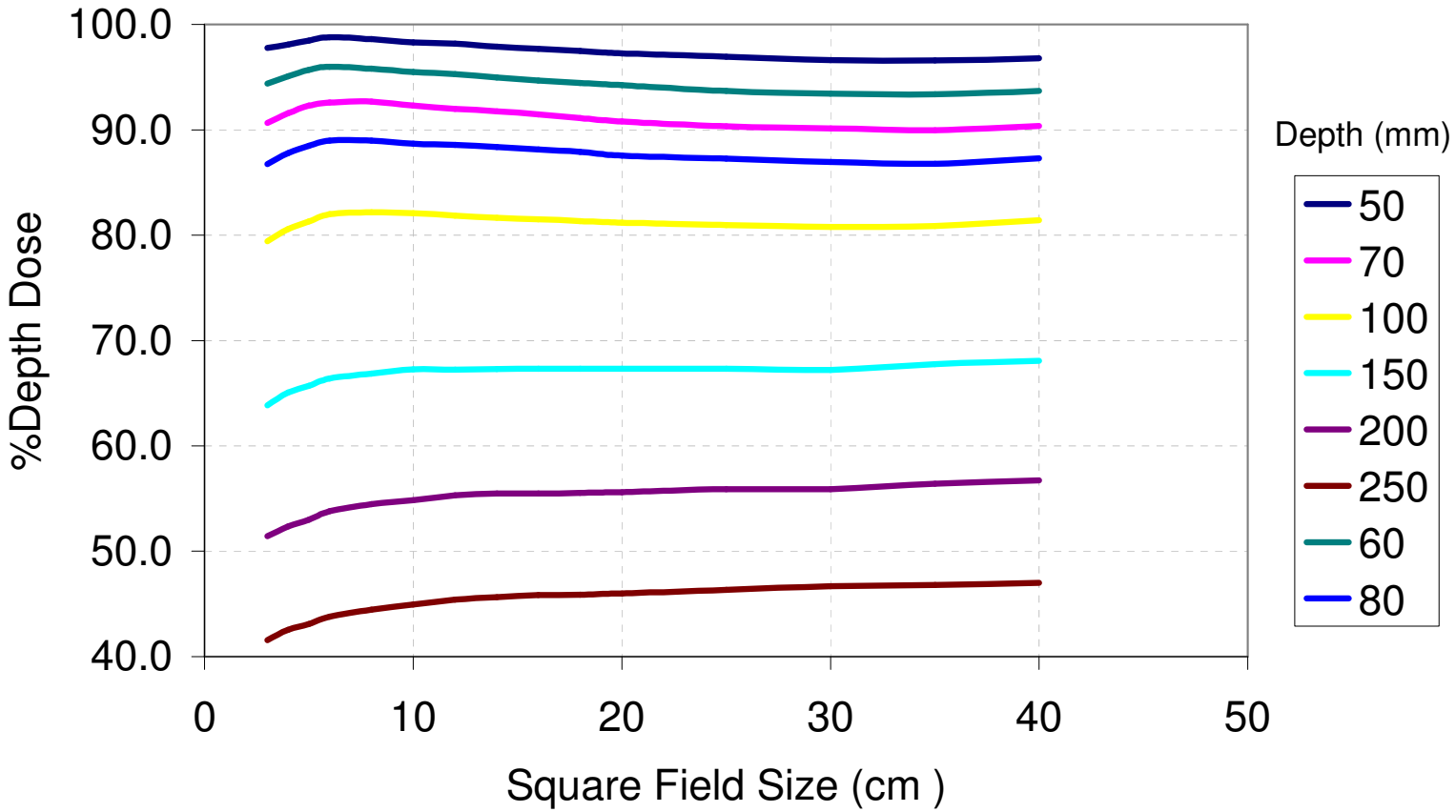
6MV PDD Trend With Field Size



PDD trend with Field Size

- An increase in head scatter will tend to decrease the central axis PDD with field size.
- Electron contamination increases with field size bringing the depth of maximum dose closer to the surface
- Data is normalised to to the reference depth d_m (The depth of maximum dose for a 10x10 field)
- Results in more complex shape for 25MV as Head Scatter and electron contamination are more significant at higher Energy

25 MV PDD Trend With Field Size



Aim

- Increase confidence in data by reproducing trend in PDD with MCNP
- Confirm reason for trend
- Model relative contribution from head scatter and electron contamination and identify sources of both
- First use of MCNP model developed by Abass

MCNP Model

- MCNP4C2
- Detailed specification of the Elekta SL 25 head structure and materials
- 22MeV Gaussian Electron Beam matched to measured data using beam quality index
- Relative doses were extracted as energy deposition tallies using the *F8 tally card
- $5*10^7$ histories resulting in a statistical error of less than 2%

MCNP Model - Geometry

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  09/07/04 12:45:00
C ELEKTA25 is a monte carlo
 program to full simulation of

probid =   09/07/04 12:38:21
basis:   YZ
( 0.000000, 1.000000, 0.000000)
( 0.000000, 0.000000, 1.000000)
origin:
(    0.00,     0.00,   -20.00)
extent = (   22.00,    22.00)

.
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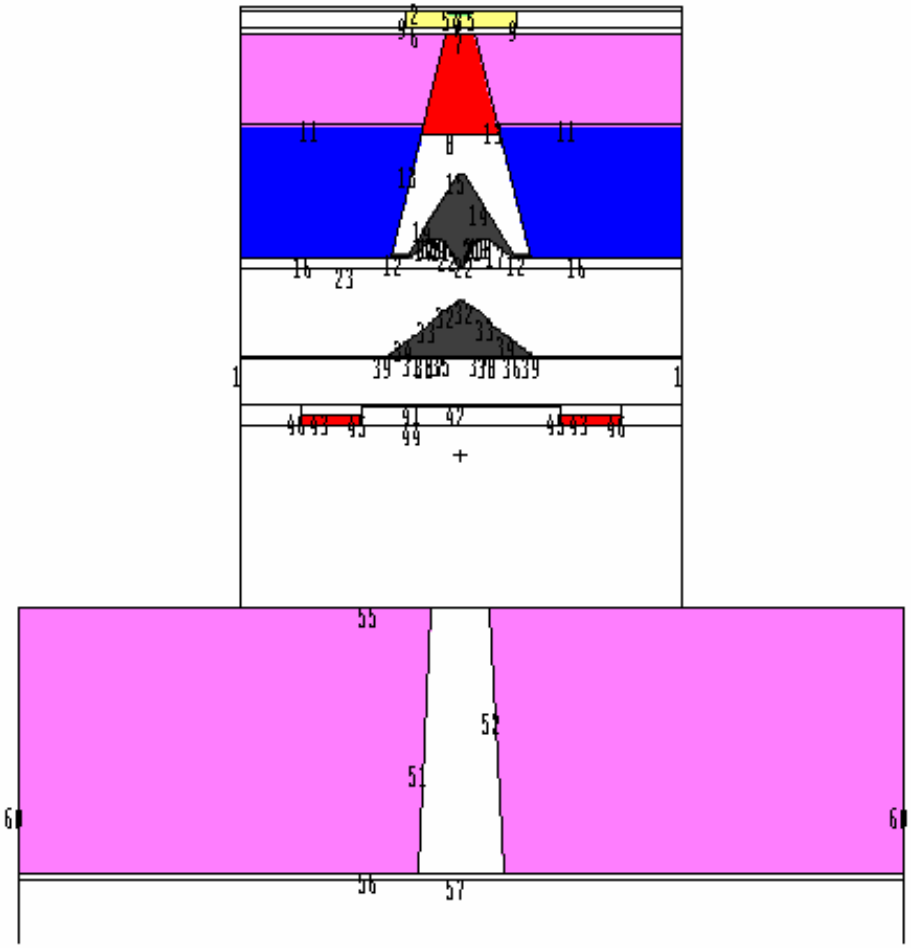
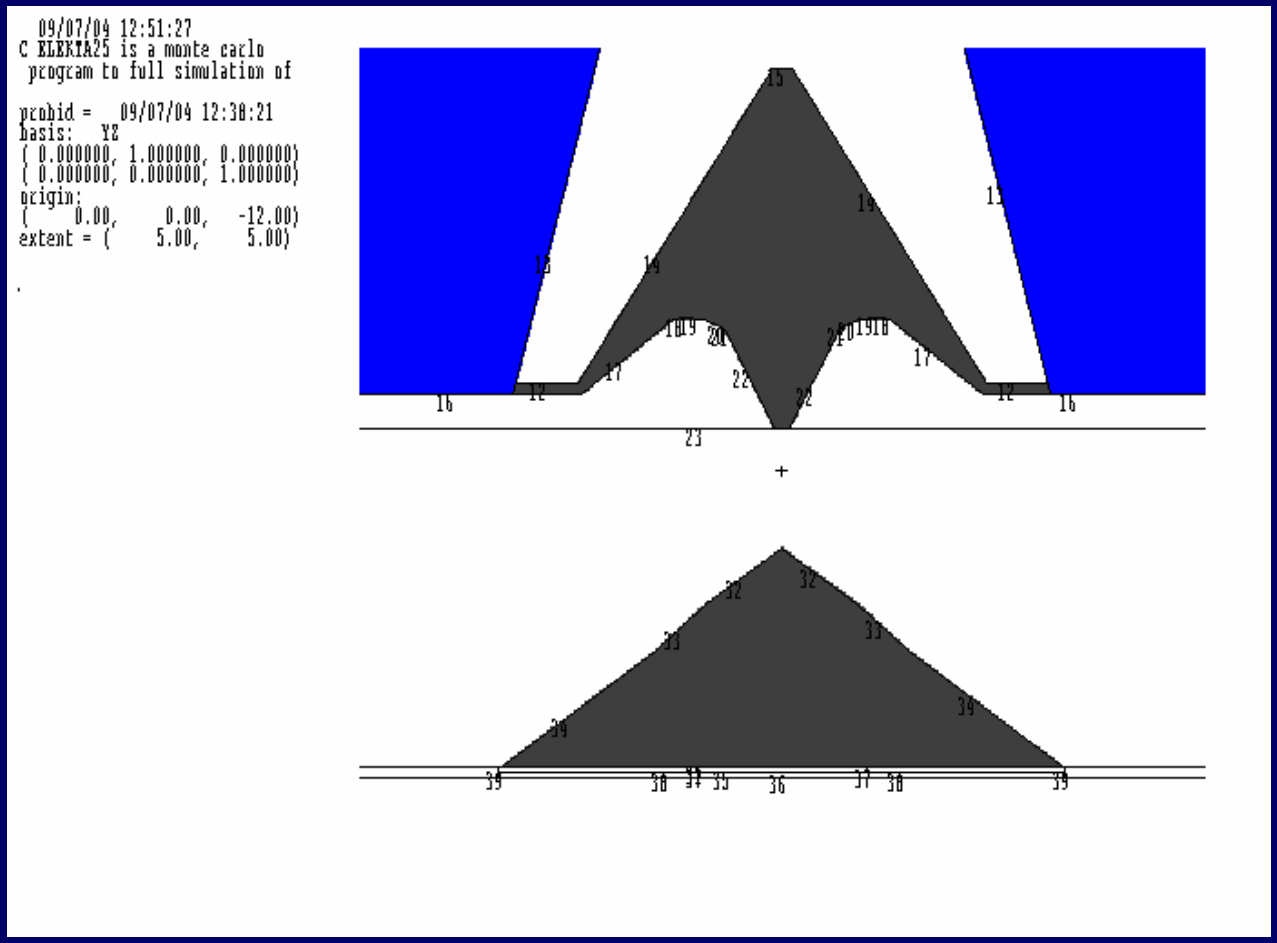
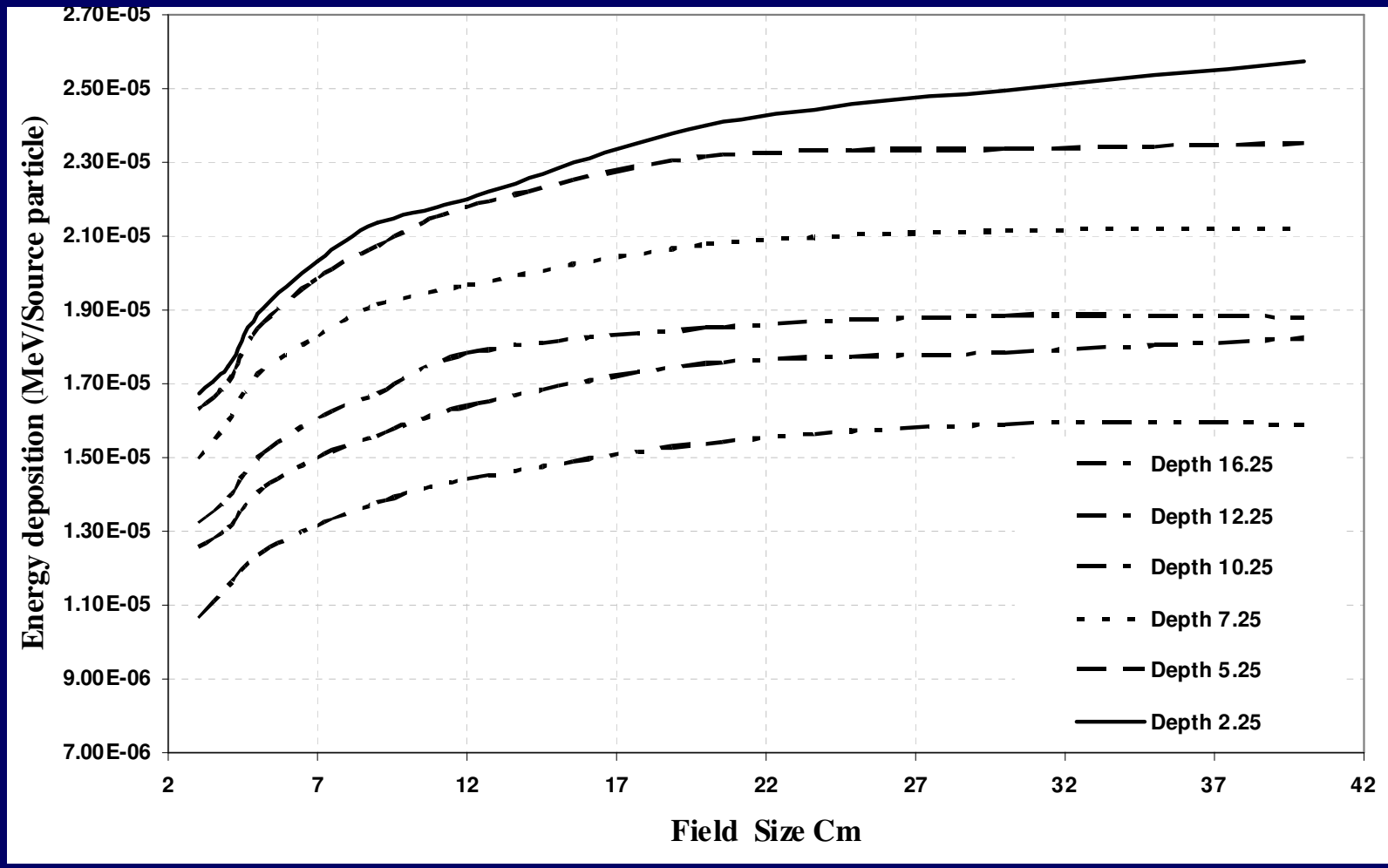


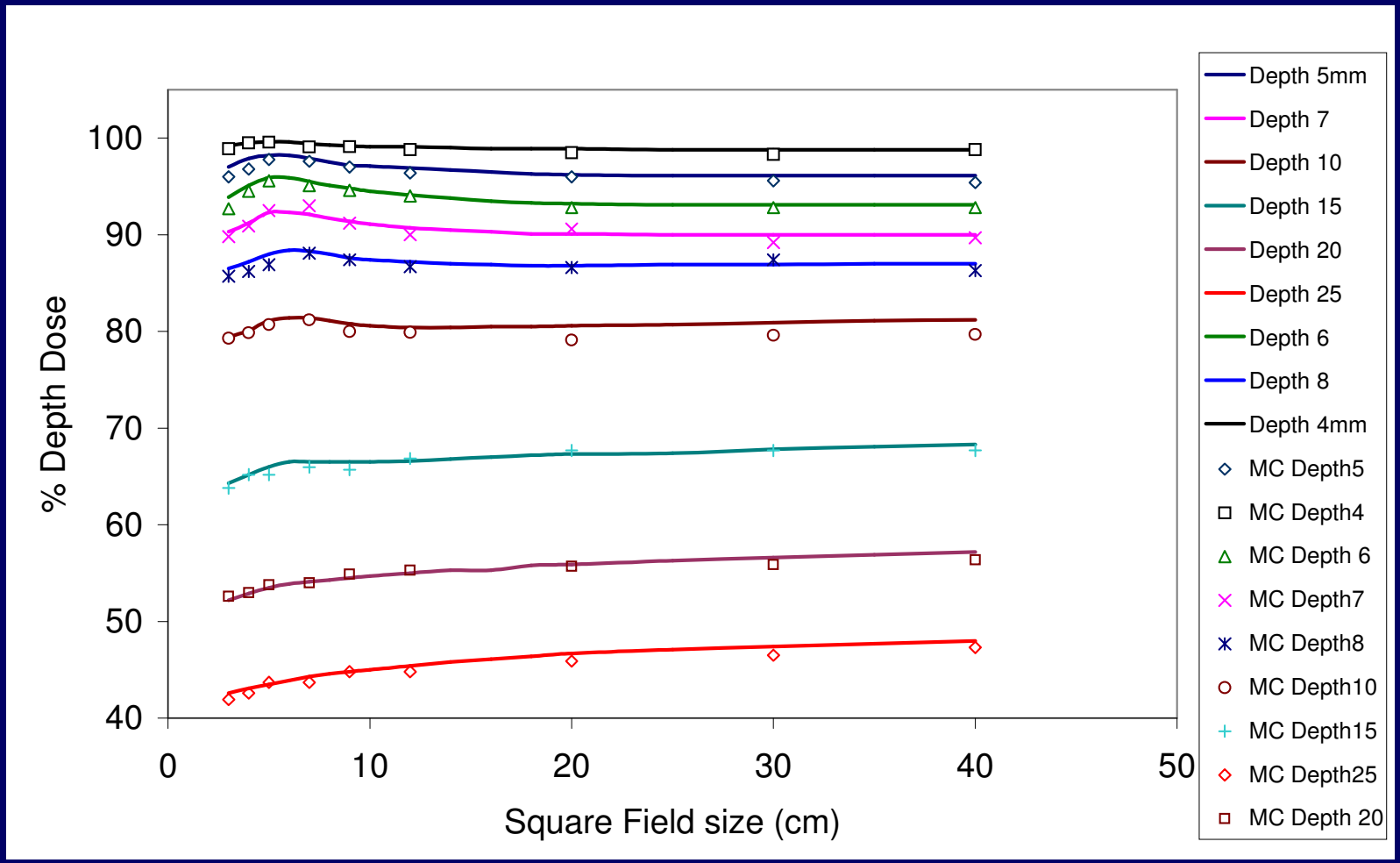
25MV Filter Geometry



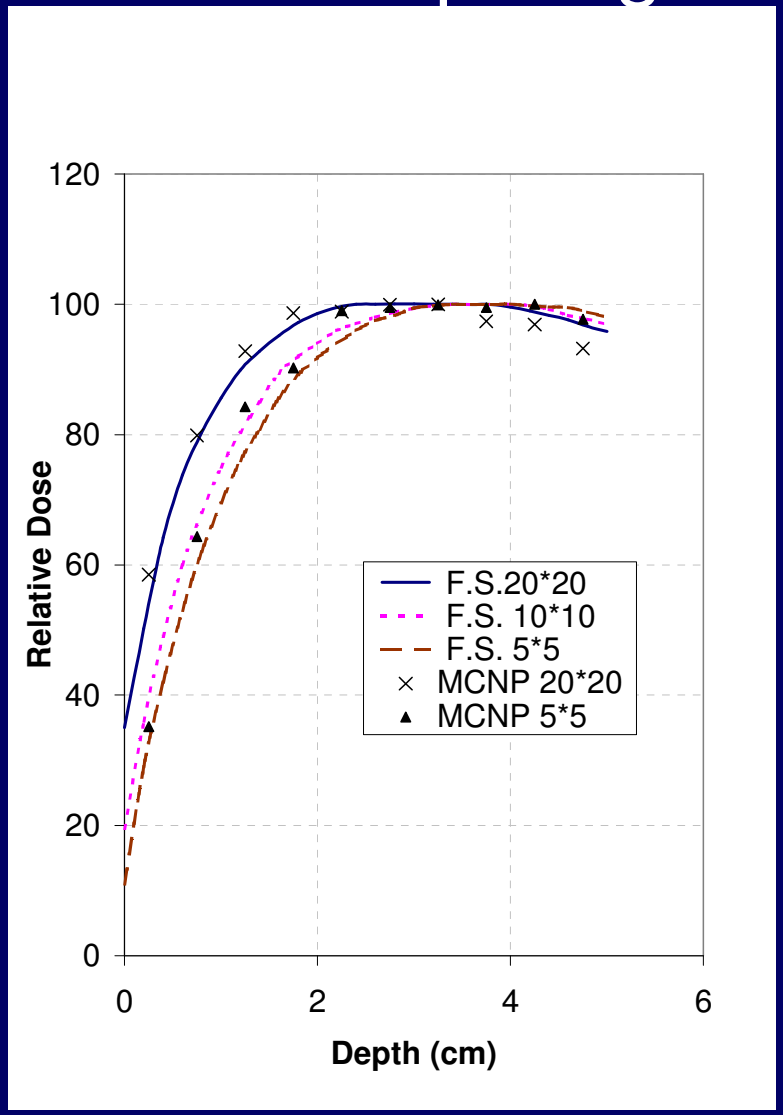
MCNP *F8 Tally at Depth in Water



Data Normalised to d_m



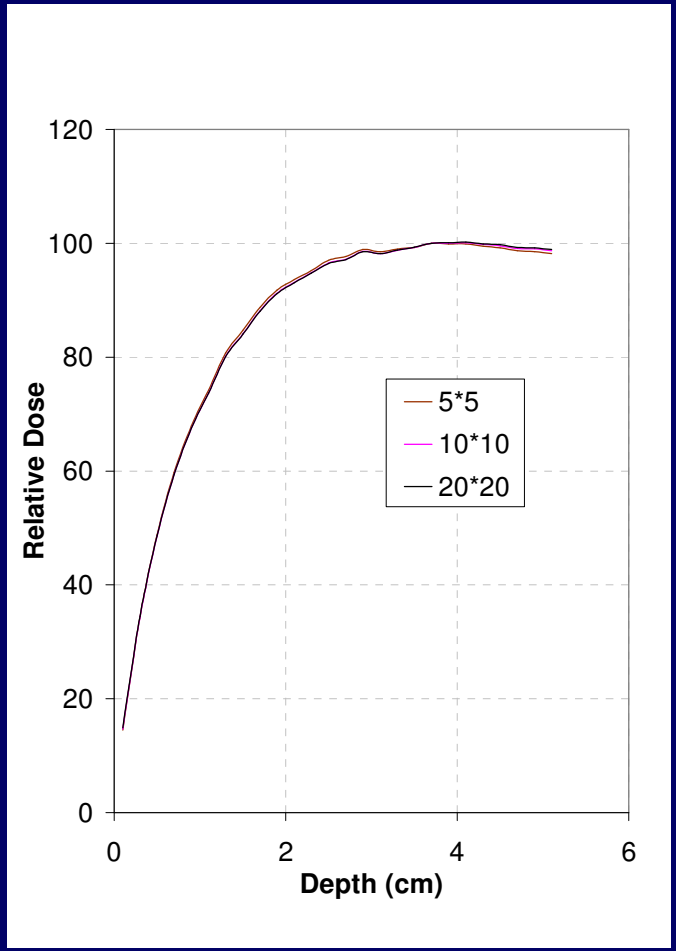
Depth Dose in Build up Region



Point Source Model

- Minimise Head Scatter and Electron Contamination removing all head structure except secondary collimators
- MCNP Point Source reconstructed using energy and angular distribution from full MCNP model

Point Source Model



PDD with and without Head Structure

Full Model

	Field Size (cm)		
Depth (cm)	5	10	20
5	97.8	96.8	96.0
10	80.7	79.6	79.7

Point Source Model

	Field Size (cm)		
Depth (cm)	5	10	20
5	99.1	99.6	99.8
10	81.9	83.8	84.6

Difference

	Field Size (cm)		
Depth (cm)	5	10	20
5	1.3	2.8	3.8
10	1.2	4.2	4.9

Conclusion

- Trend has been reproduced using MCNP
- Effect confirmed as scatter from head structure using point source model
- More work required to separate Head Scatter and Electron Contamination effect
- Increase use of Monte carlo Methods in department with development of Abbass' model + Beam + Electron Treatment Planning

END

- G. Luxton and M. A. Astrahan, “ Characteristics of the high-energy photon beam of a 25 MeV accelerator”, Med. Phys. 15(1) 82–7 1988
- J. R. Palta, K. Ayyangar,I. Daftari and N. Suntharalingam ‘‘Characteristics of photon beams Philips SL25 accelerators”, Med. Phys. 17(1), 106–116 1990.