

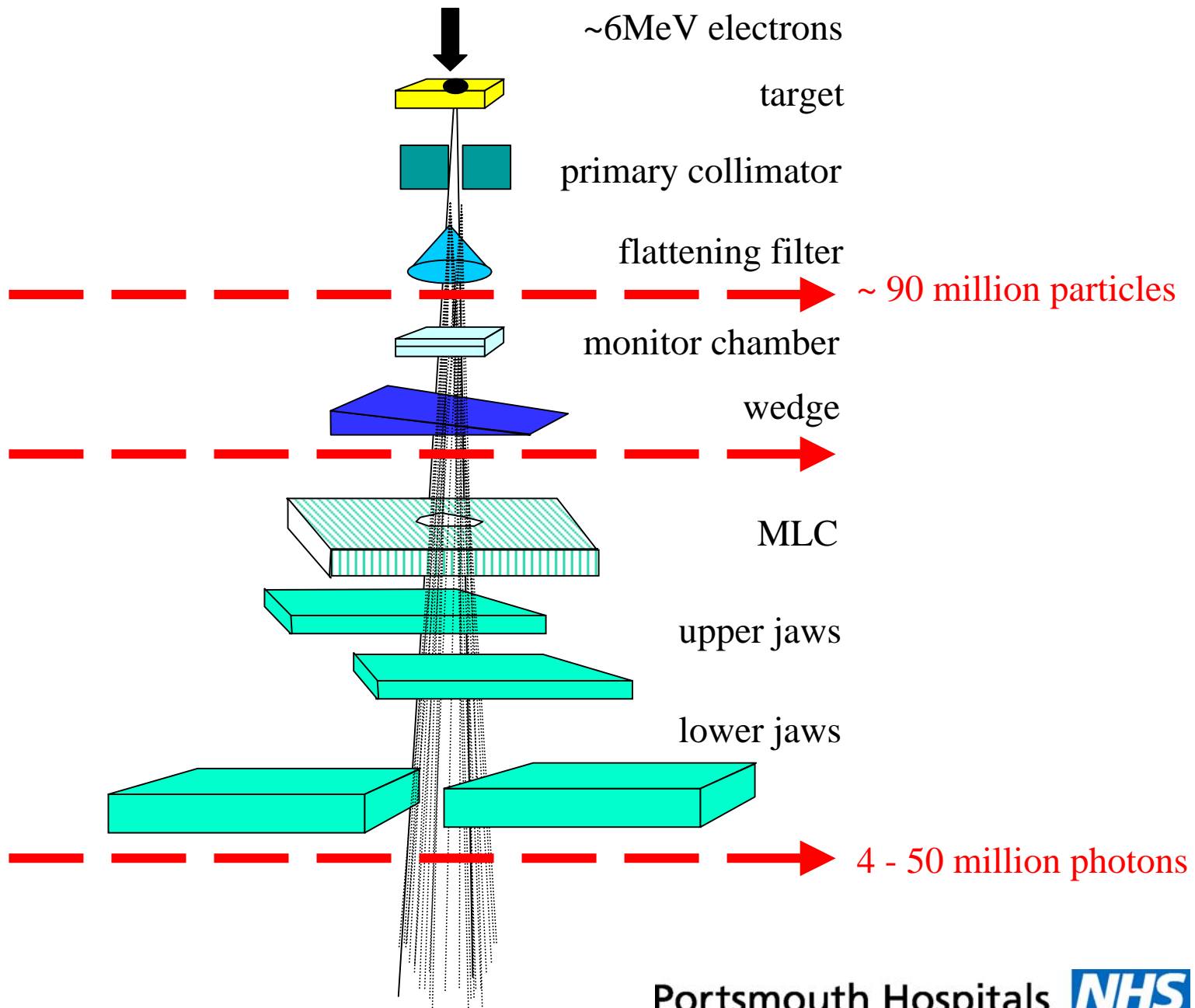
Monte Carlo modelling of a medical linear accelerator and asymmetric field head scatter

Olivia F.Naismith &
Dr M.E.Hosseini-Ashrafi

Department of Medical Physics
St Mary's Hospital, Portsmouth

Introduction

- Monte Carlo model of 6MV photon beam
- Applications of the “virtual linac”
- Example: Derivation of Head Scatter factors



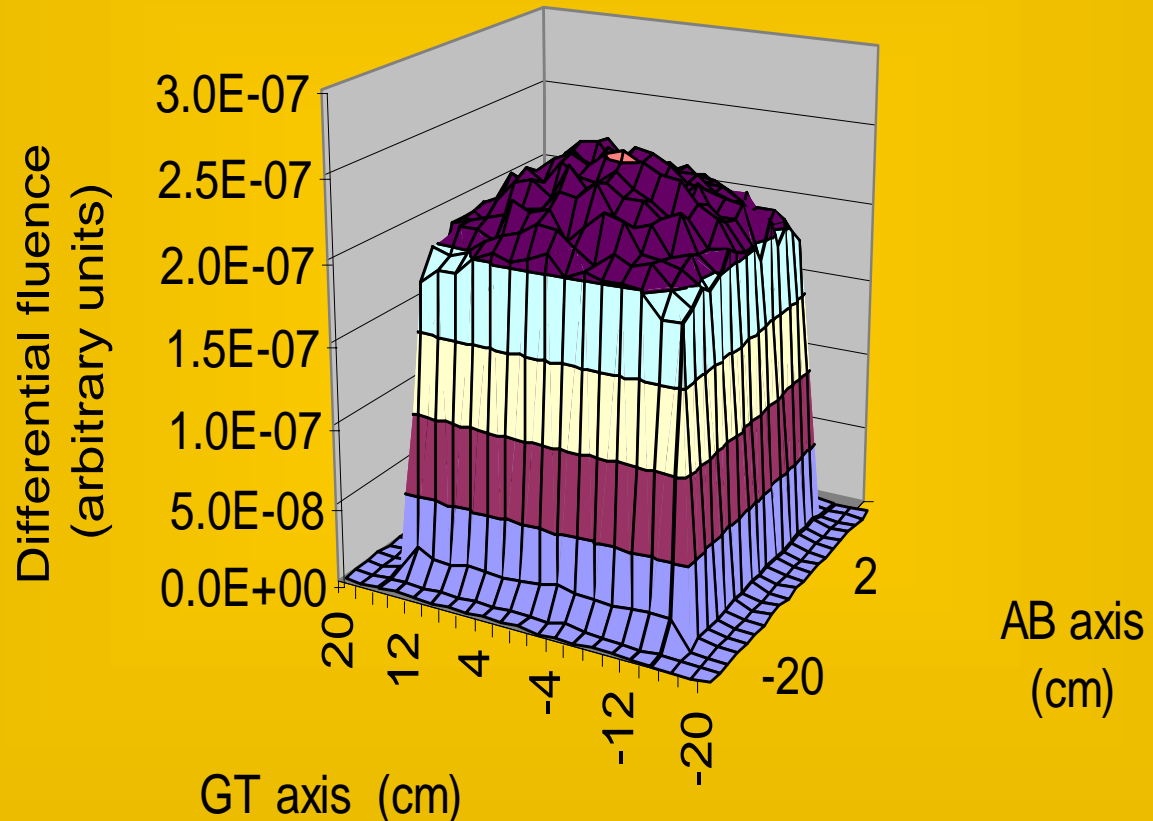
Applications of linac model

- Determination of energy spectrum and energy fluence distributions – to verify beam characteristics and for treatment planning system optimisation

The photon beam produced by the linear accelerator is inhomogeneous both in *energy* and *intensity*

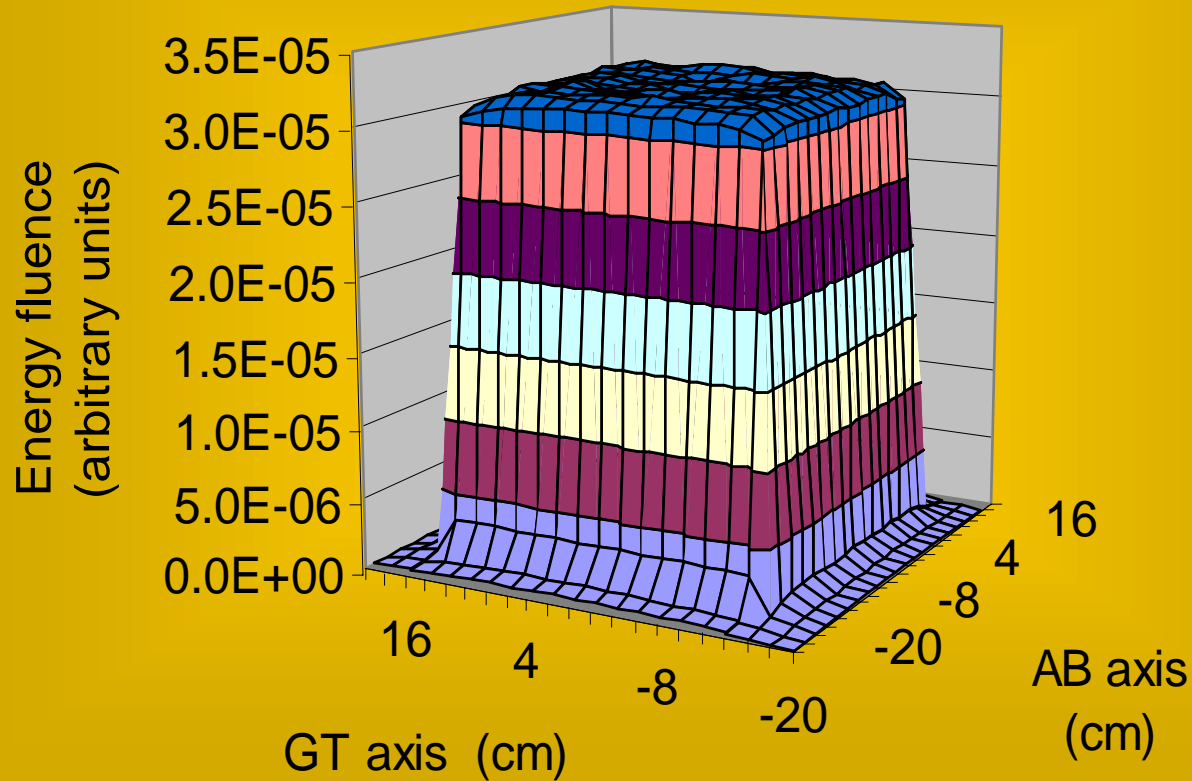
The variation is symmetric for open fields

Isocentre plane fluence in the 4.5 MeV to 4.75 MeV energy interval; 30 x 30 cm open field



The energy fluence is invariant to within 0.5 %

**Isocentre plane energy fluence variation;
30 x 30 cm open field**



Applications of linac model

- Determination of energy spectrum and energy fluence distributions
- Calculation of off-axis ratios for asymmetric fields
- Calculation of head scatter factors for symmetric and asymmetric fields

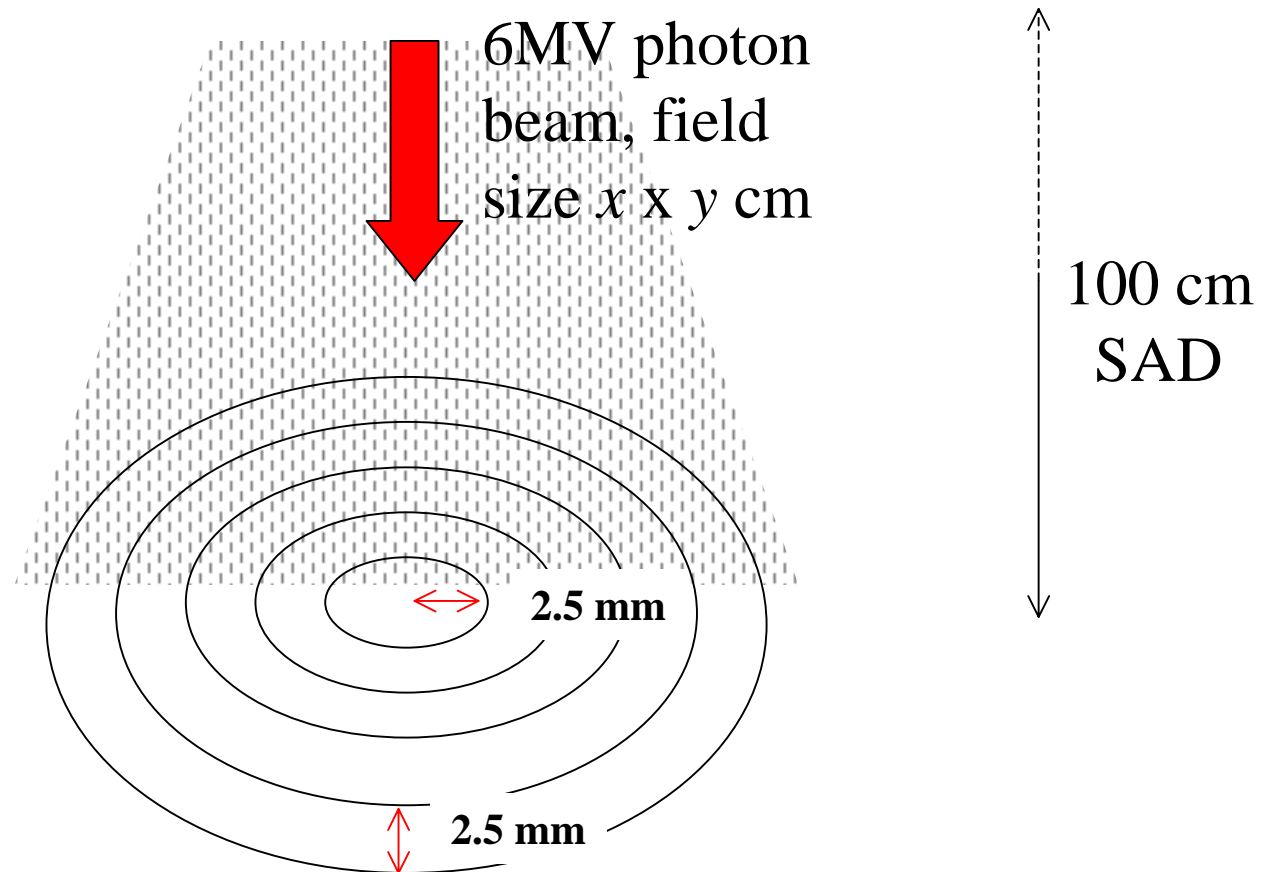
Head Scatter

$$H(x,y) = D(x,y) / D(10,10)$$

The head scatter factor is defined as the ratio of the absorbed dose in water, measured in air, at the isocentre for a field to that measured for the reference field (10x10 cm²)

Head scatter factors are one of the basic quantities needed to calculate monitor unit (MU) settings for linear accelerator radiation fields.

MCNP tally geometry model



Field sizes and off-axis positions

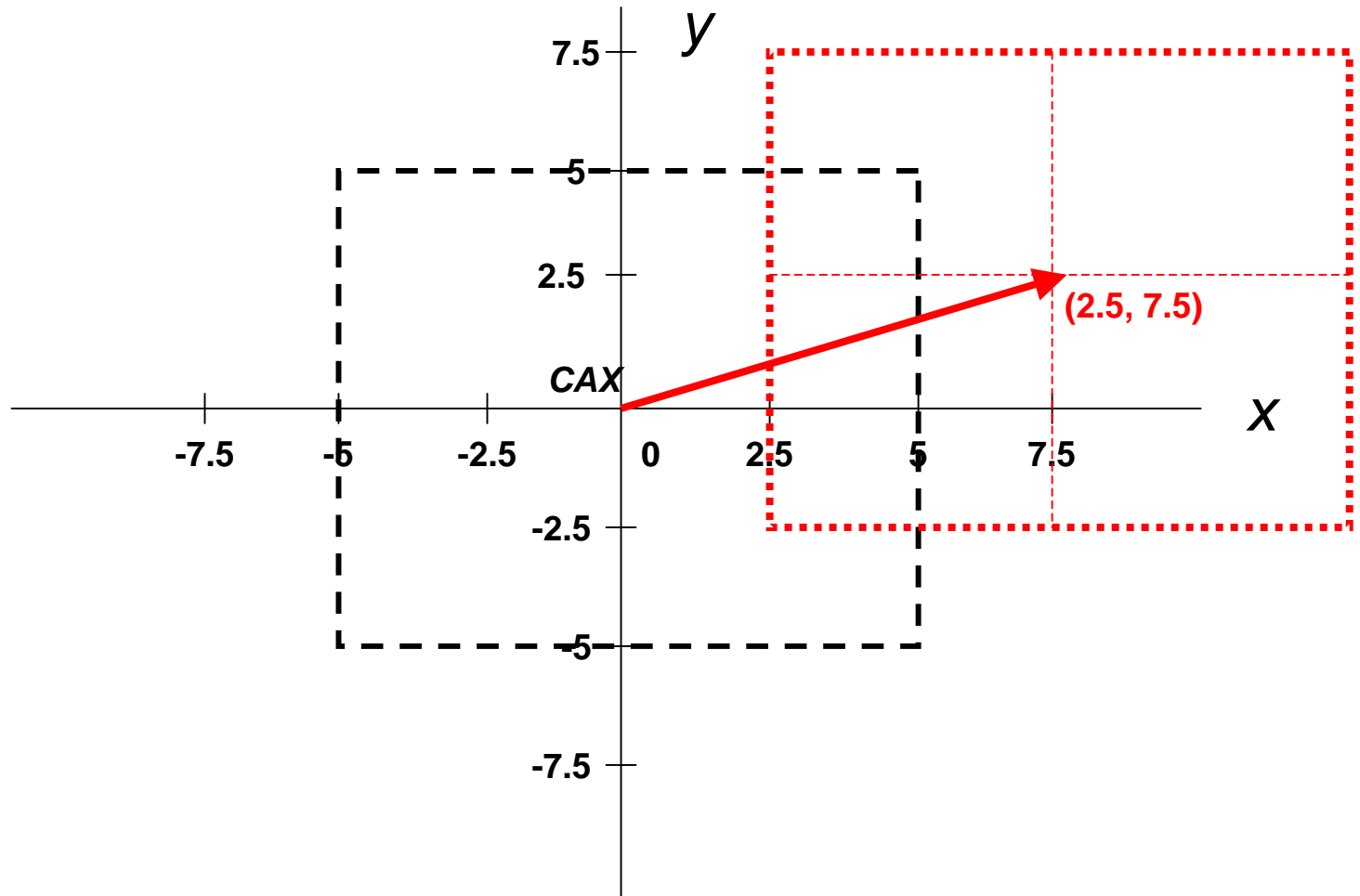
Symmetric fields

Field size (cm ²)
1 x 1
2 x 2
3 x 3
4 x 4
5 x 5
6 x 6
8 x 8
10 x 10
15 x 15
20 x 20
30 x 30
40 x 40

Asymmetric fields

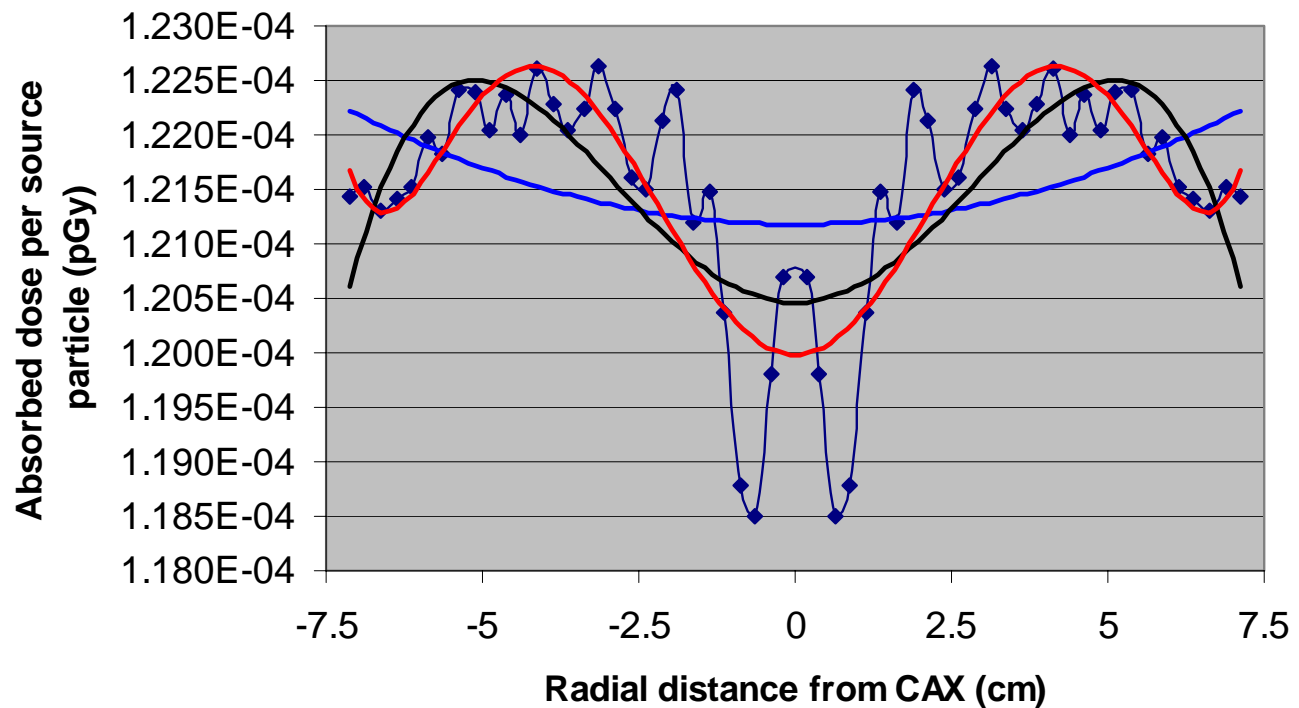
		Field size (cm ²)		
x-asym (cm)	y-asym (cm)	5 x 5	10 x 10	15 x 15
-2.5	0			
2.5	0			
-5	0			
5	0			
-7.5	0			
7.5	0			
0	7.5			
-2.5	7.5			
2.5	7.5			
-5	7.5			
5	7.5			
-7.5	7.5			
7.5	7.5			

Asymmetric field configuration

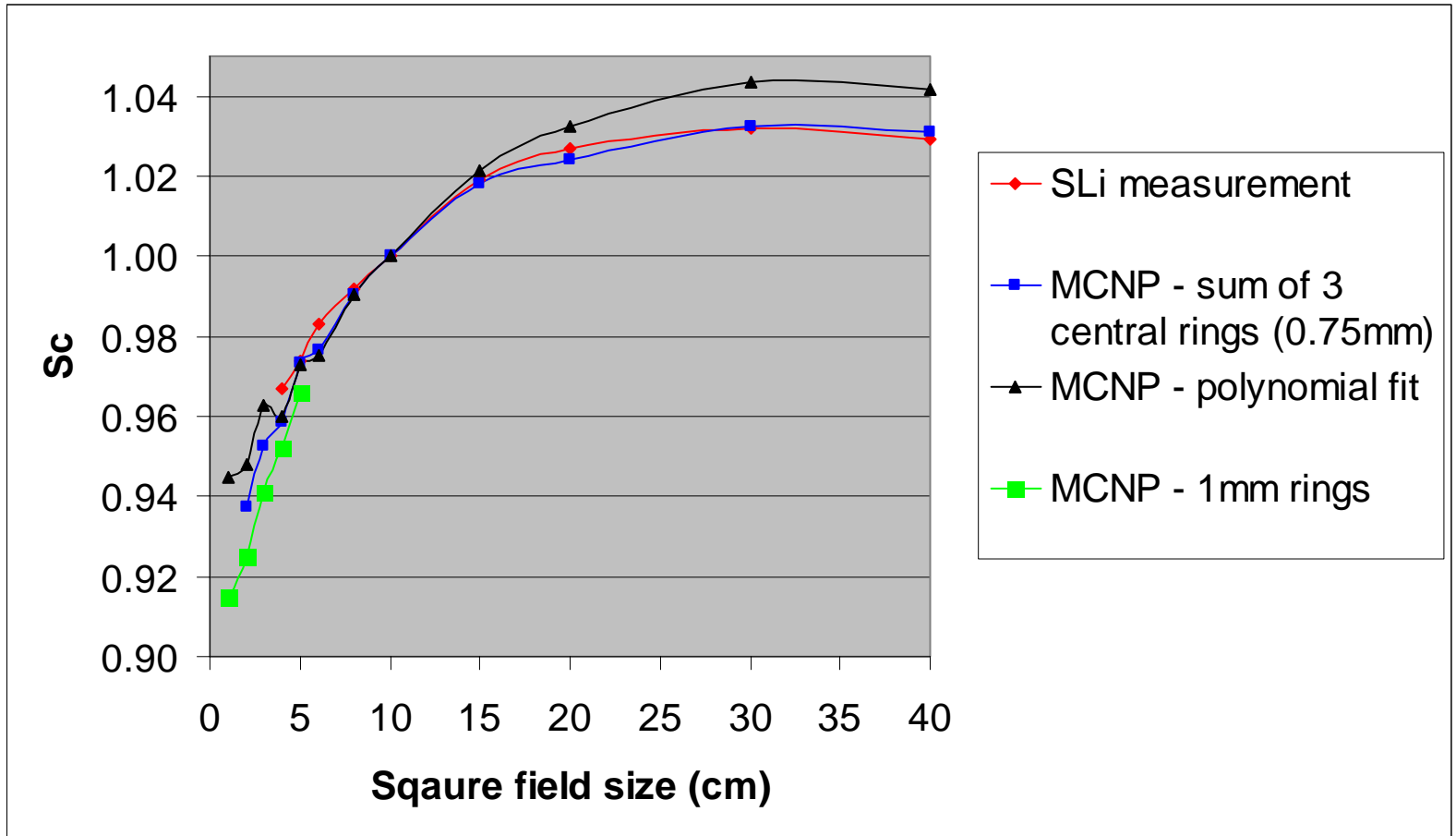


Calculation of dose at field centre

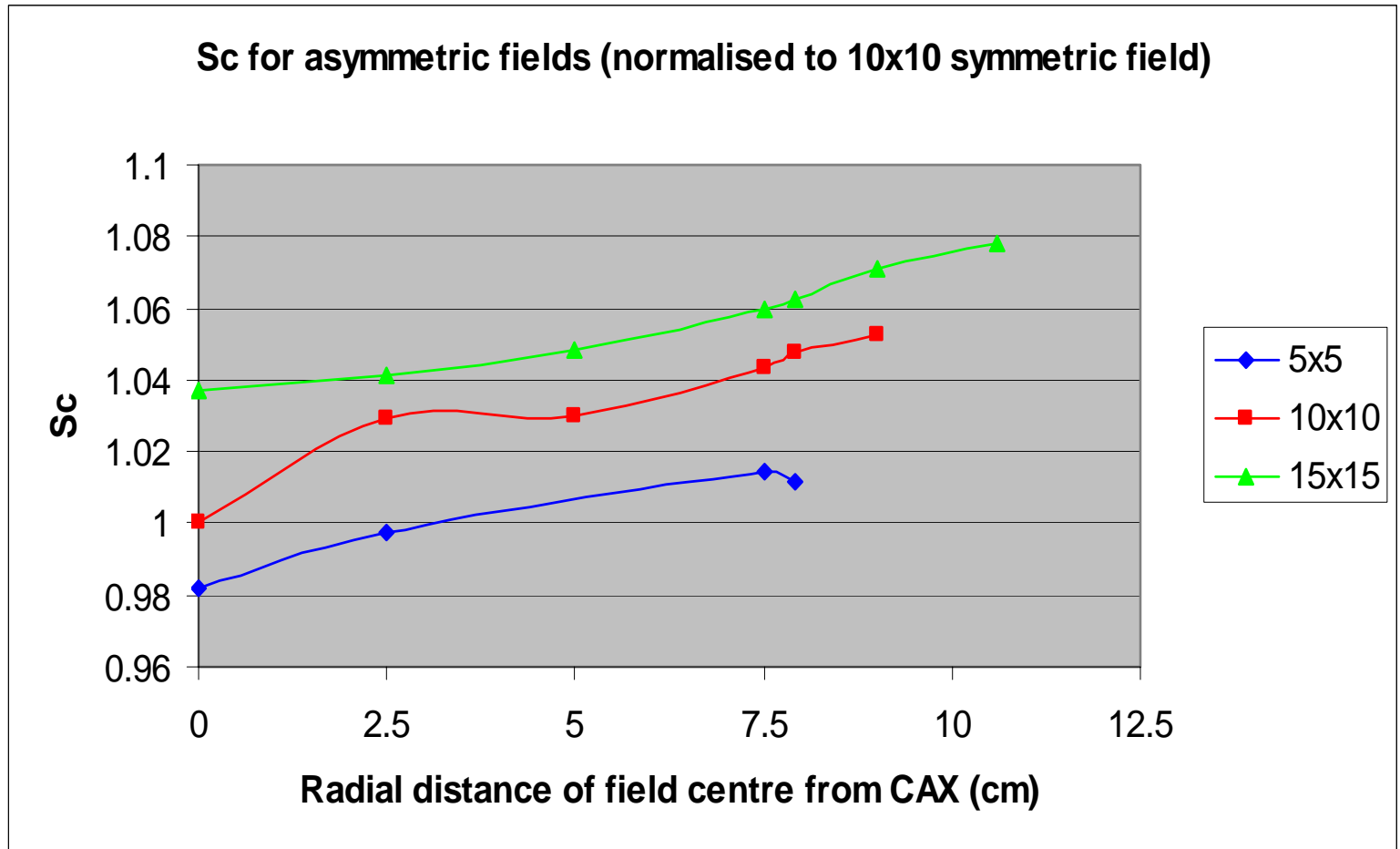
Absorbed dose as function of distance along beam profile for 15x15cm symmetric field



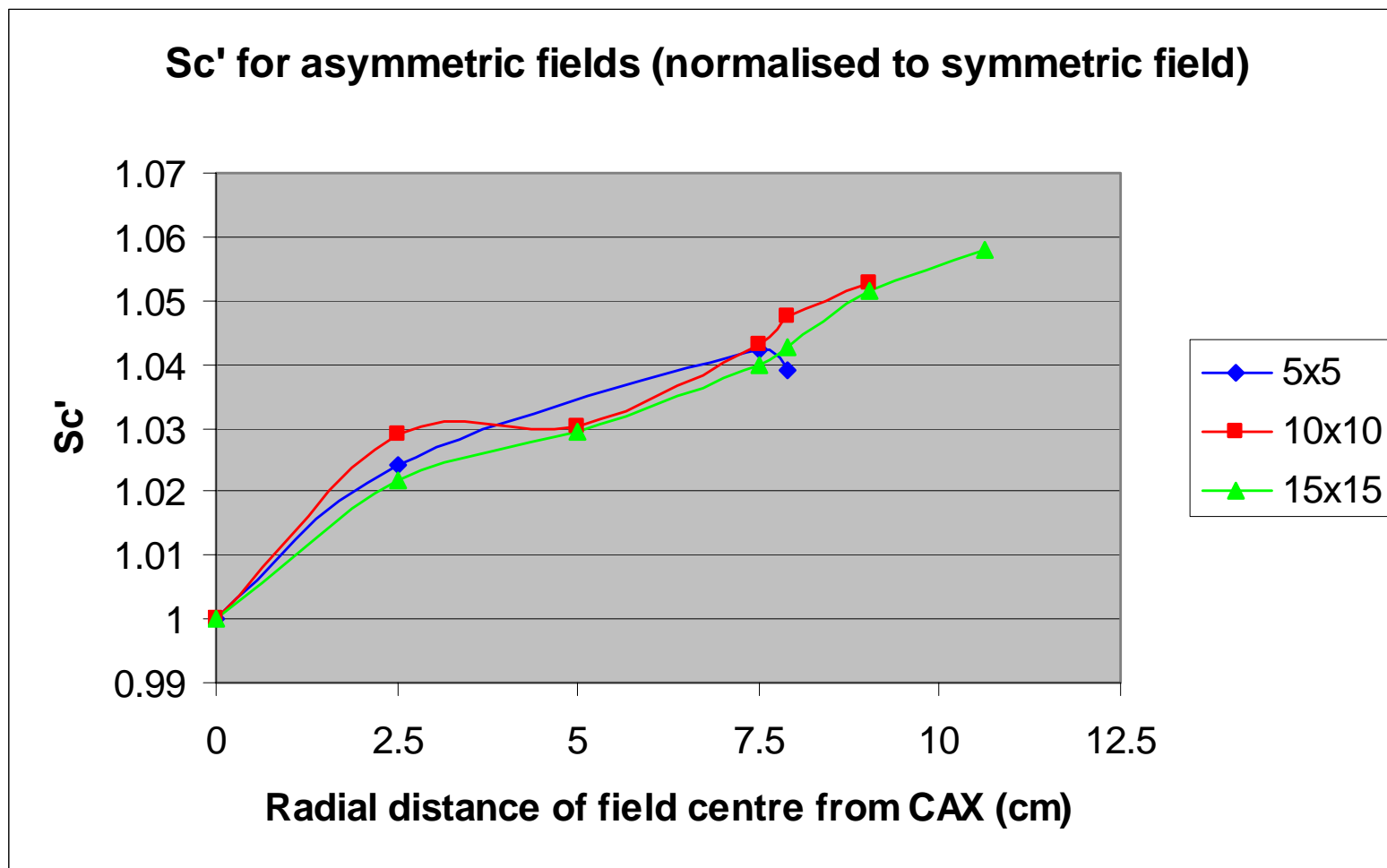
Variation of S_c with field size – Symmetric fields



Variation of S_c with field asymmetry



Variation of Sc' with field asymmetry



Future work

- Modelling 10MV photon beam
- Electron contamination in photon fields
- Applications in small field dosimetry

- Modelling of MicroSelectron brachytherapy source