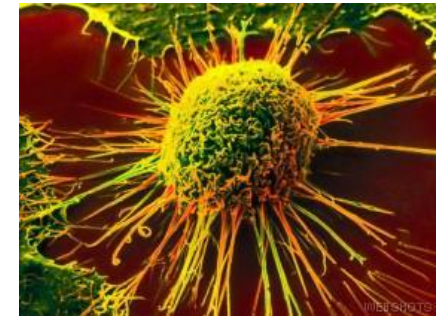# RT-GRID:
Grid Computing for Radiotherapy

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Overview

- **Radiotherapy in Context**

- **Dose calculation methods**

- **Why the Grid ?**

Cancer

- **DoH NHS Cancer Plan (2000)**

  'More than one in three people will develop cancer at some stage in their lives and one in four will die of it'.

Velindre Cancer Centre
Canolfan Ganser Felindre

Velindre Cancer Centre

- Serves 1.5M population of SE Wales & beyond

- 5000 new cancer referrals p.a.

- About 3000 for radiotherapy

What is Radiotherapy (RT) ?

- 'Radiation therapy is a clinical modality dealing with the use of ionizing radiations in the treatment of malignant neoplasias (and occasionally benign diseases).'

Principles and Practice of Radiation Oncology (Perez & Brady)

Method of RT Delivery

- Predominantly External Beam Therapy
- High energy (1-20 MeV) X-ray photons and/or electrons from linear accelerators (linacs)

RT Planning

- 'Treatment planning is the process whereby the therapeutic strategy of the radiation oncologist is realised as a set of treatment instructions together with a physical description of dose in the patient' (Williams and Thwaites, *Radiotherapy Physics*)

- The aim is to maximise therapeutic dose to tumour volume while minimising dose to normal tissues & organs at risk
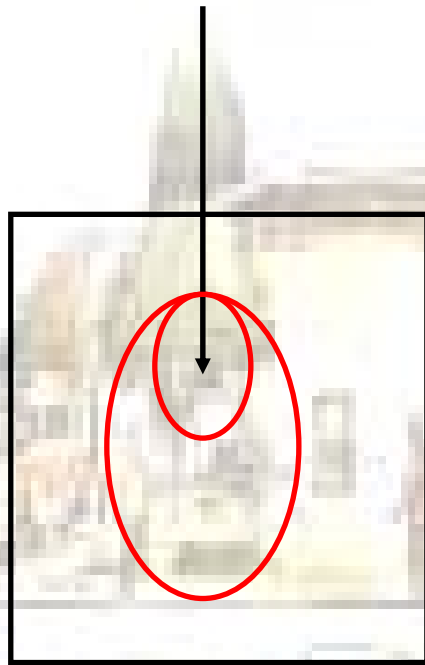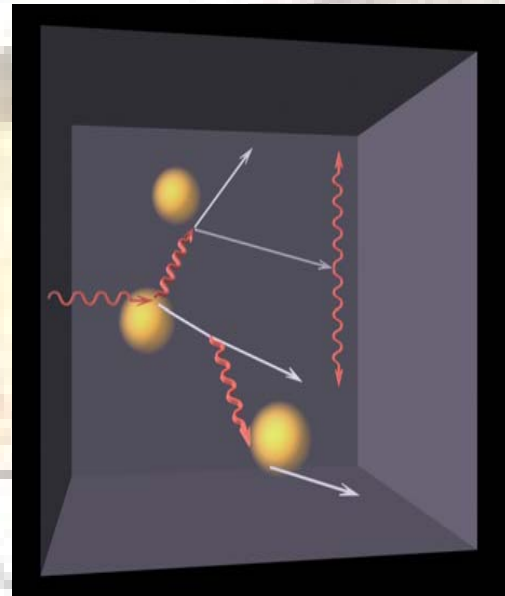
The Modern Era - 3D Planning using X-Ray CT scan data
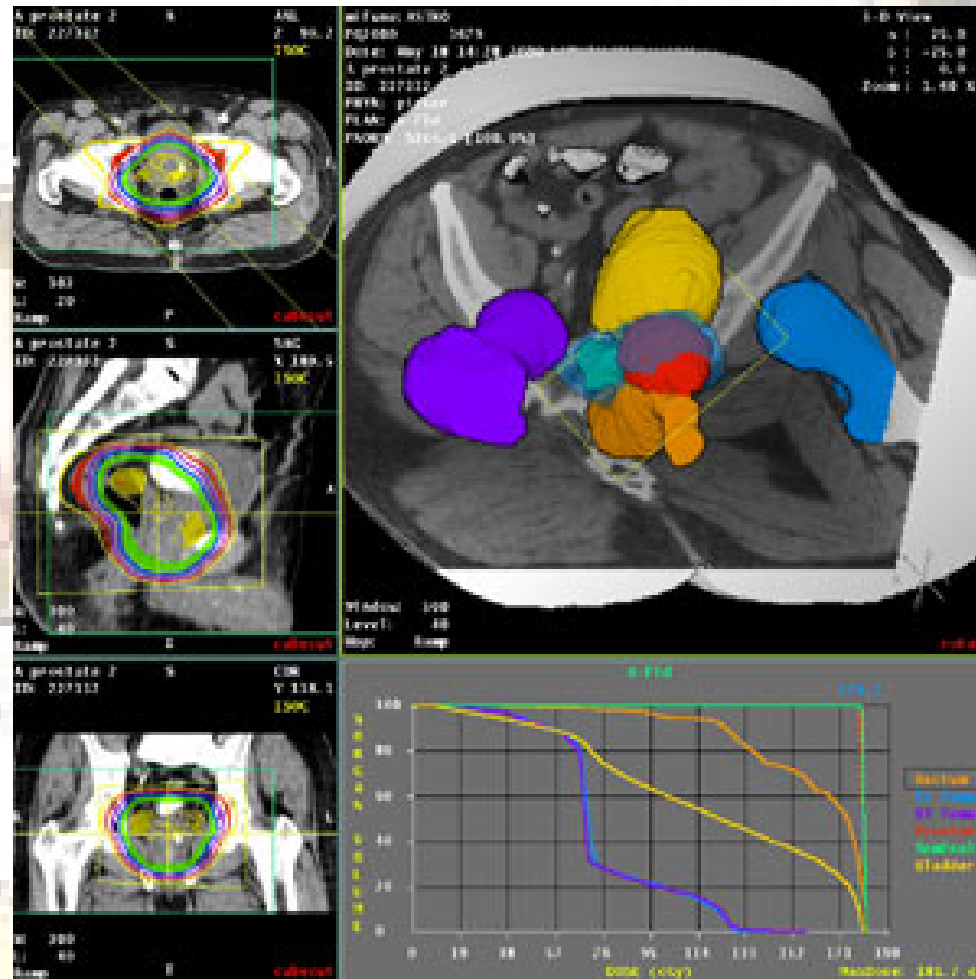
Dose Calculation Methods

- **Early 1970s: computerised RT planning using beam libraries of measured data**

- **Early 1990s: represent RT fields using convolution of elemental pencil beams**

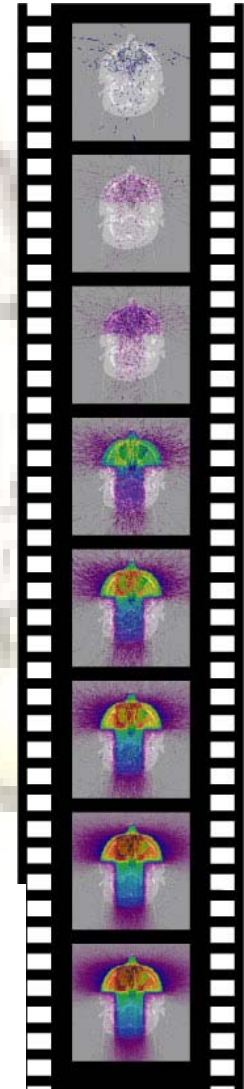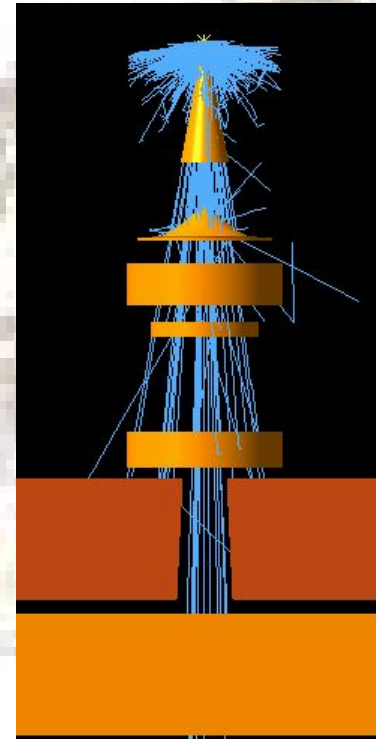- **New era: Monte Carlo simulation of radiation transport**

Dose Calculation Methods

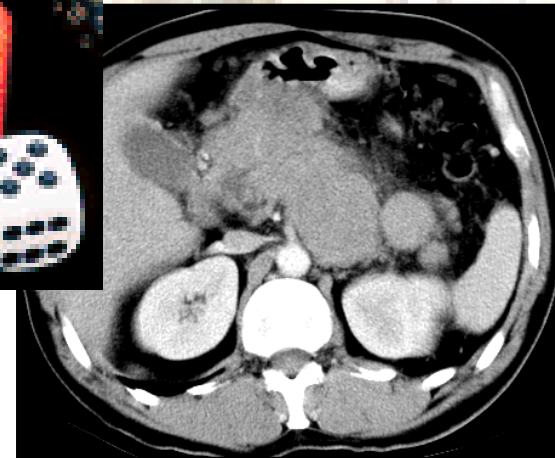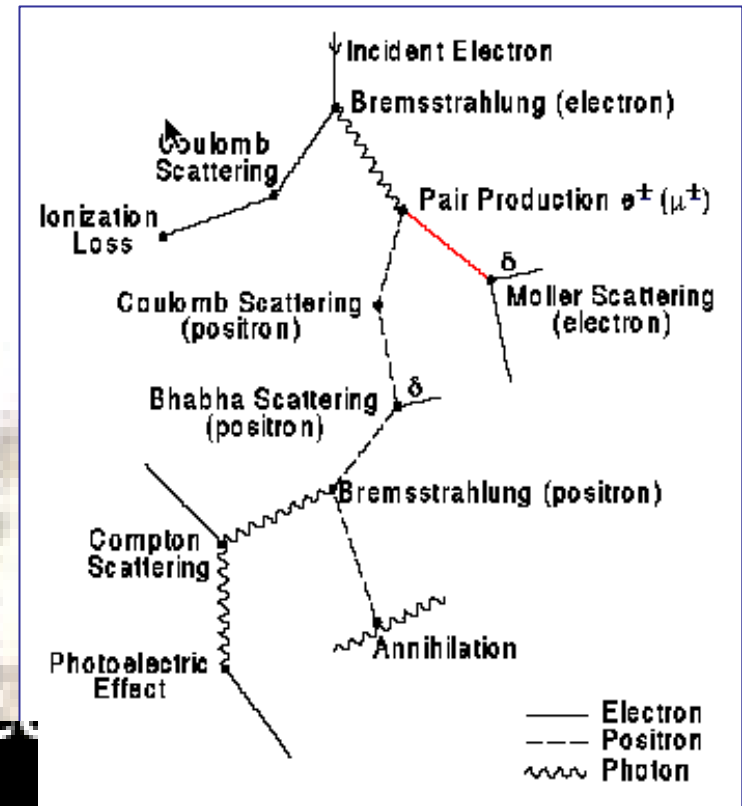**Conventional**

Convolution of pencil beams

The Future

'Full Monte' Carlo dose calculation

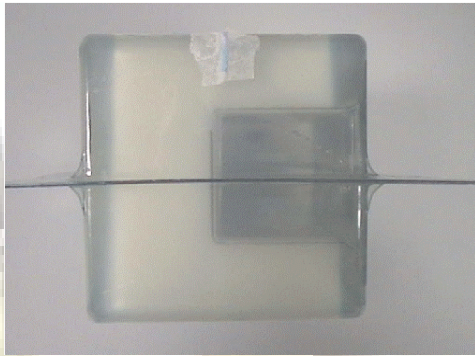# WHAT DOES THE MONTE CARLO APPROACH INVOLVE ?

Computer simulation of fine details of interactions in complex patient anatomy
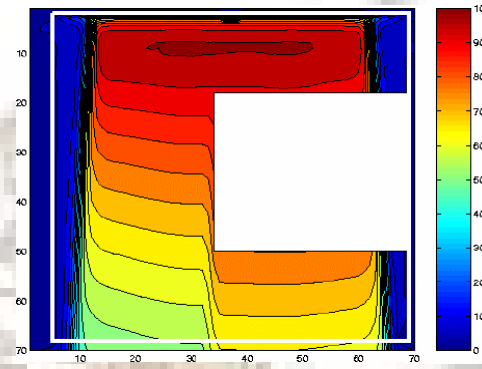
Why Monte Carlo ?
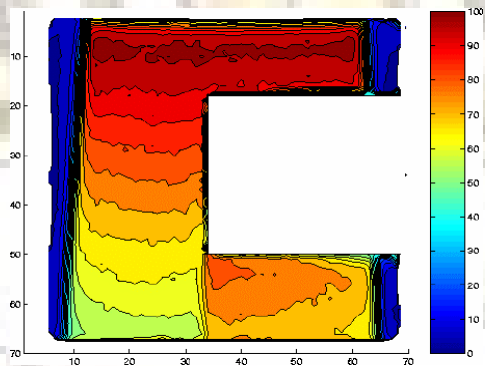# Effects of inhomogeneity (e.g. air spaces)
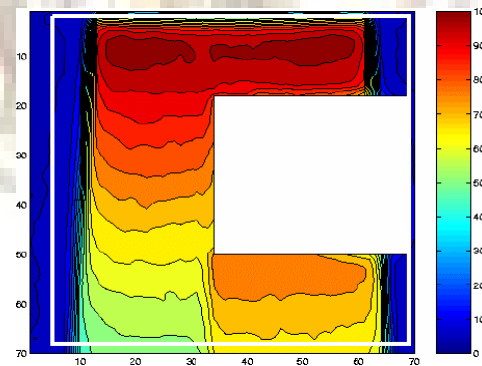
Irradiated Gel Phantom

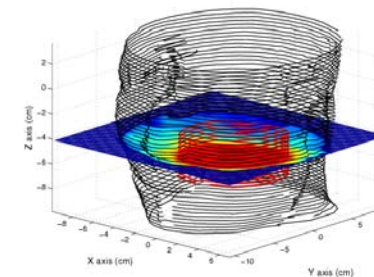
Pencil Beam Calculation

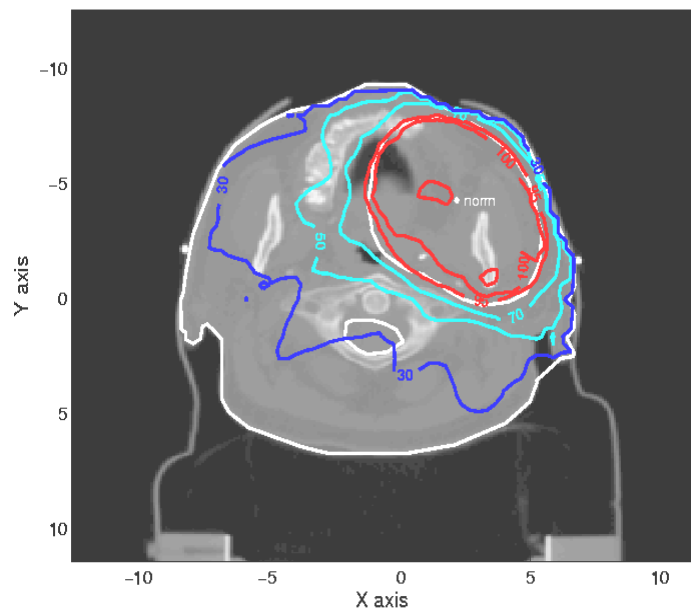
MRI Gel Dose Measurement

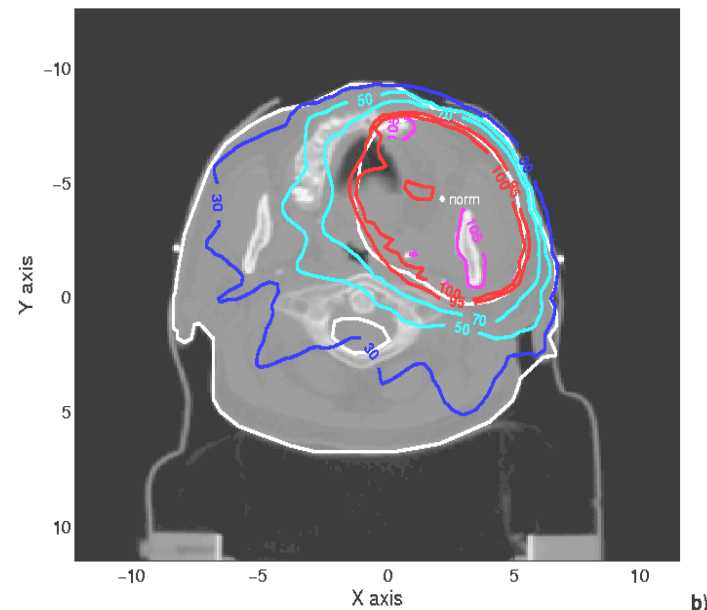BEAM Monte Carlo Simulation

Peter Love, PhD Thesis (UW, 2001)
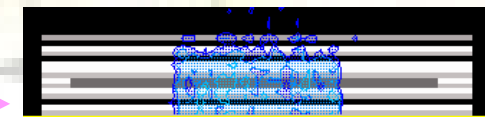
Head & Neck RT

Convolution

Monte Carlo

Emiliano Spezi, PhD Thesis (UW, 2003)

Full Monte Carlo Simulation of the Radiotherapy System
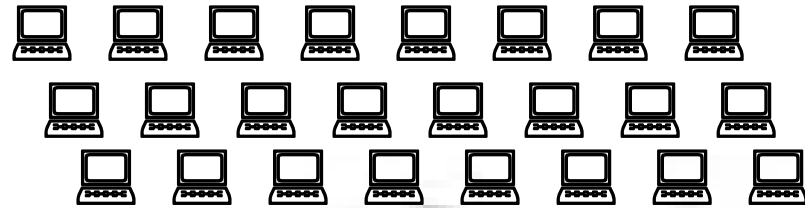
RADIATION SOURCE

PATIENT

X-RAY VERIFICATION PORTAL IMAGER
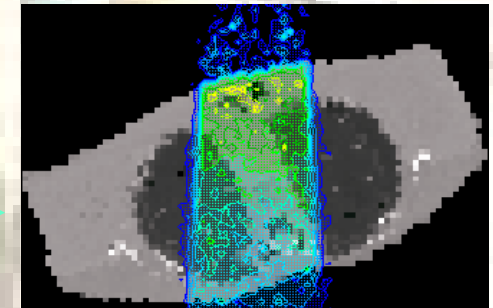
"Monte Carlo Portal Dosimetry"

Mary Chin, PhD Thesis (UW,2005)

let many computers work on the same job simultaneously

MC simulation of a patient plan can take WEEKS on a PC

Need to simulate with billions of particles

BUT- Monte Carlo is a computationally expensive gold standard !

HIGH-THROUGHPUT COMPUTING

1. BEOWULF @ University of Surrey

2. SGI pool @ Welsh e-Science Centre

3. Non-dedicated 'Condor' pool of 500+ PCs

4. NGS (UK National Grid Service)

Computer Scientists sort out the computers

we take care of the science

e-Science

Recent Developments

- 3-yr £400K EPSRC Funding from Oct'05

- 'The Development of Monte Carlo Techniques for Verification of Conformal Radiotherapy using the UK e-Science Grid' (D.W.Walker, D.G.Lewis, J.P.Giddy & P.W.Chin)

EPSRC
Engineering and Physical Sciences Research Council

Summary

- **Our collaboration with WeSC has already shown it is both feasible and beneficial to utilise GRID computing facilities for Monte Carlo in RT**

- **Availability of GRID computing resource offers the prospect of implementing a clinically useful Monte Carlo RT planning facility on a national basis**

Acknowledgements

Collaborators:

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