

Comparison of different Monte Carlo codes in electron transportation

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History of MCNP codes (1)

- **MCNP** is a general purpose code for coupled neutron/photon/electron Monte Carlo transport code
- In 1980s MCNP3, 3A and 3B were released
- 4A was released in 1993
- 4B in 1997 with enhanced photon physics

History of MCNP codes (2)

- **4C in 2000 with enhancement of electron physics**
- **MCNP 5 in 2003 with improvements in photonuclear collision physics, etc.**
- **MCNP X Ver 2.4.0 released in 2002 includes higher energies and more particles.**

Literature Review (1)

- ❑ **Published papers have covered up to MCNP 4C**
- ❑ **Love *et al* (1988) compared EGS4, MCNP4A and 4B for calculation of central axis absorbed dose.**
- ❑ **Jeraj *et al* (1999) compared the MCNP 4B in two energy indexing algorithms (ITS & Default) with EGS4.**
- ❑ **Edward (1999) studied the computer run time for MCNP 4A and 4B**

Literature Review (2)

- ❑ Wang (2001) investigated the absorbed dose differences between MCNP 4B, EGS4 and EGSnrc
- ❑ Cross *et al* (2001) used ACCEPT code and MCNP4B for measuring the absorbed dose in eye applicators.
- ❑ Schaart *et al* (2002) found discrepancies between MCNP4C results and ITS 3.0
- ❑ Schibani *et al* (2002) compared different codes (GEPTS, EGSnrc and MCNP4C) for electron transport.

This Study :

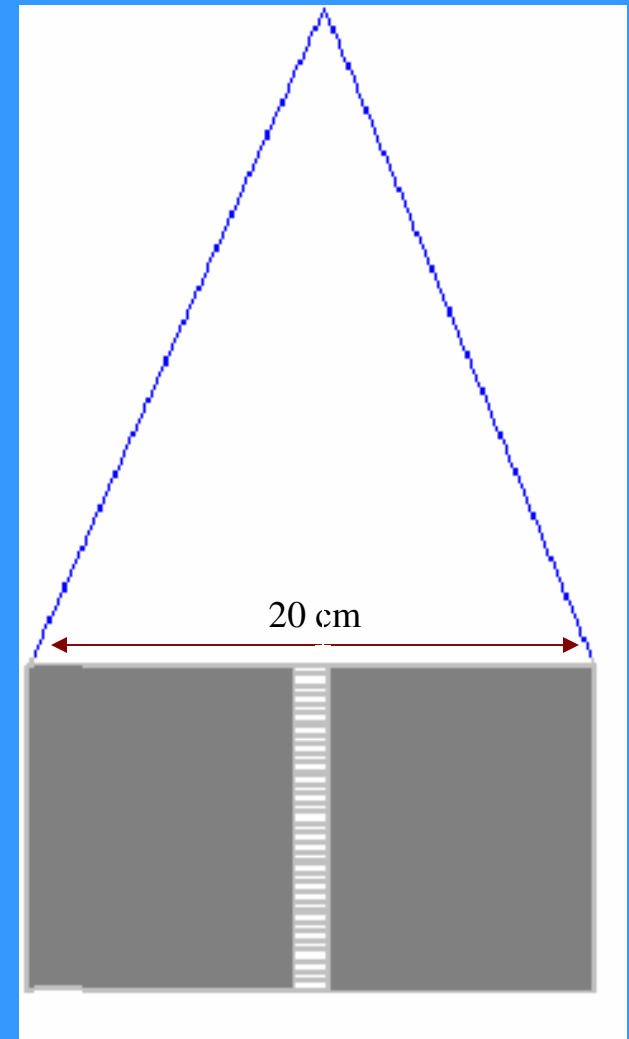
- **Comparison the more recent MCNP versions (MCNP 5 Ver 1.2 and 1.3 and MCNP X ver 4.2.0 with MCNP4A, 4B, 4C**

Main Comparisons in this Work

- ❑ **Central axis absorbed dose**
- ❑ **Energy spectra at three planes (phantom surface and at 3 and 5 cm deep planes)**
- ❑ **Computational efficiency**

Geometry

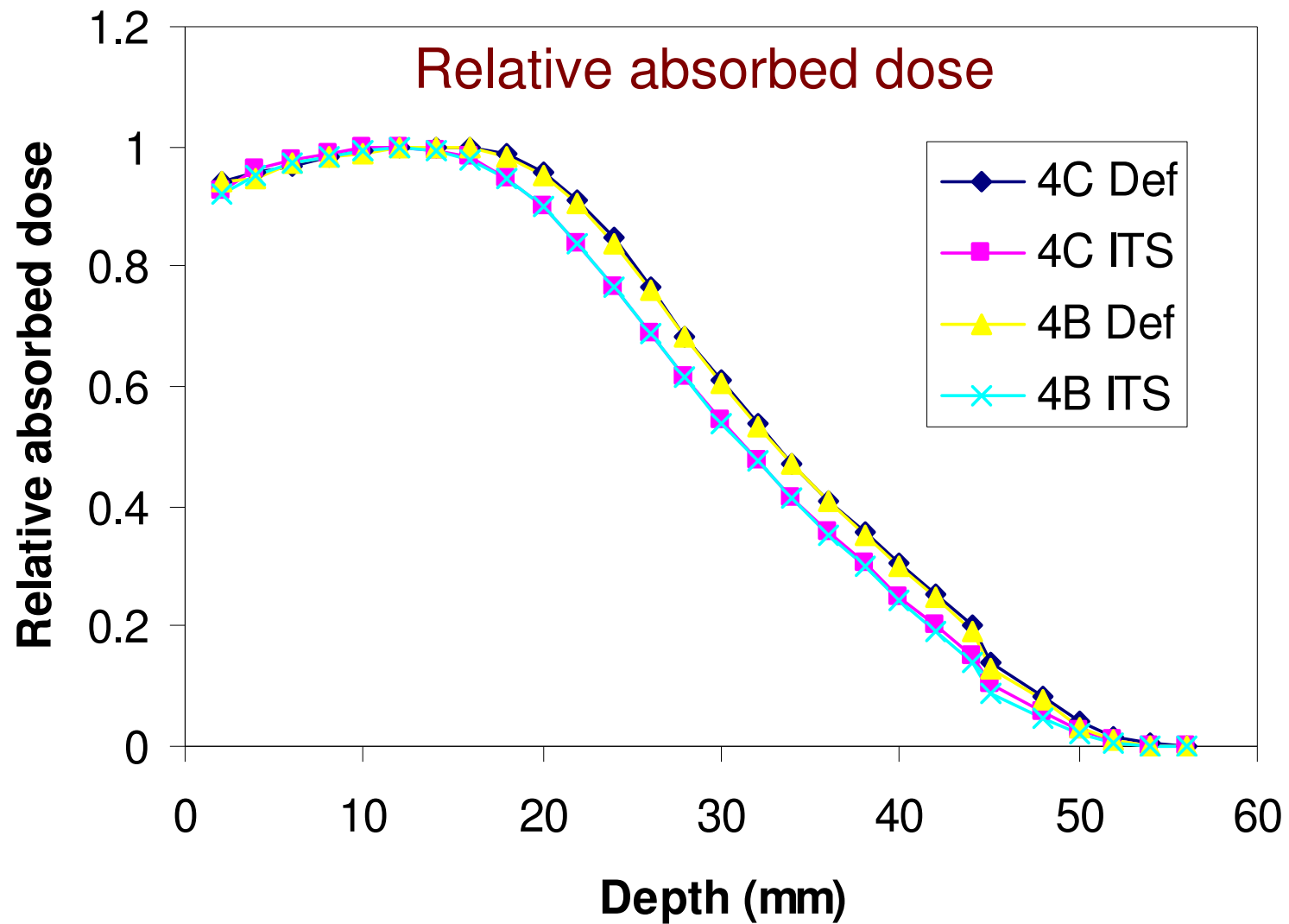
- ❑ A point source with 10 MeV energy, at 100 cm source-to-surface distance, water phantom
- ❑ Scoring cells
- ❑ NPS 10^6
- ❑ Statistical uncertainty under 0.01%
- ❑ Variance reduction

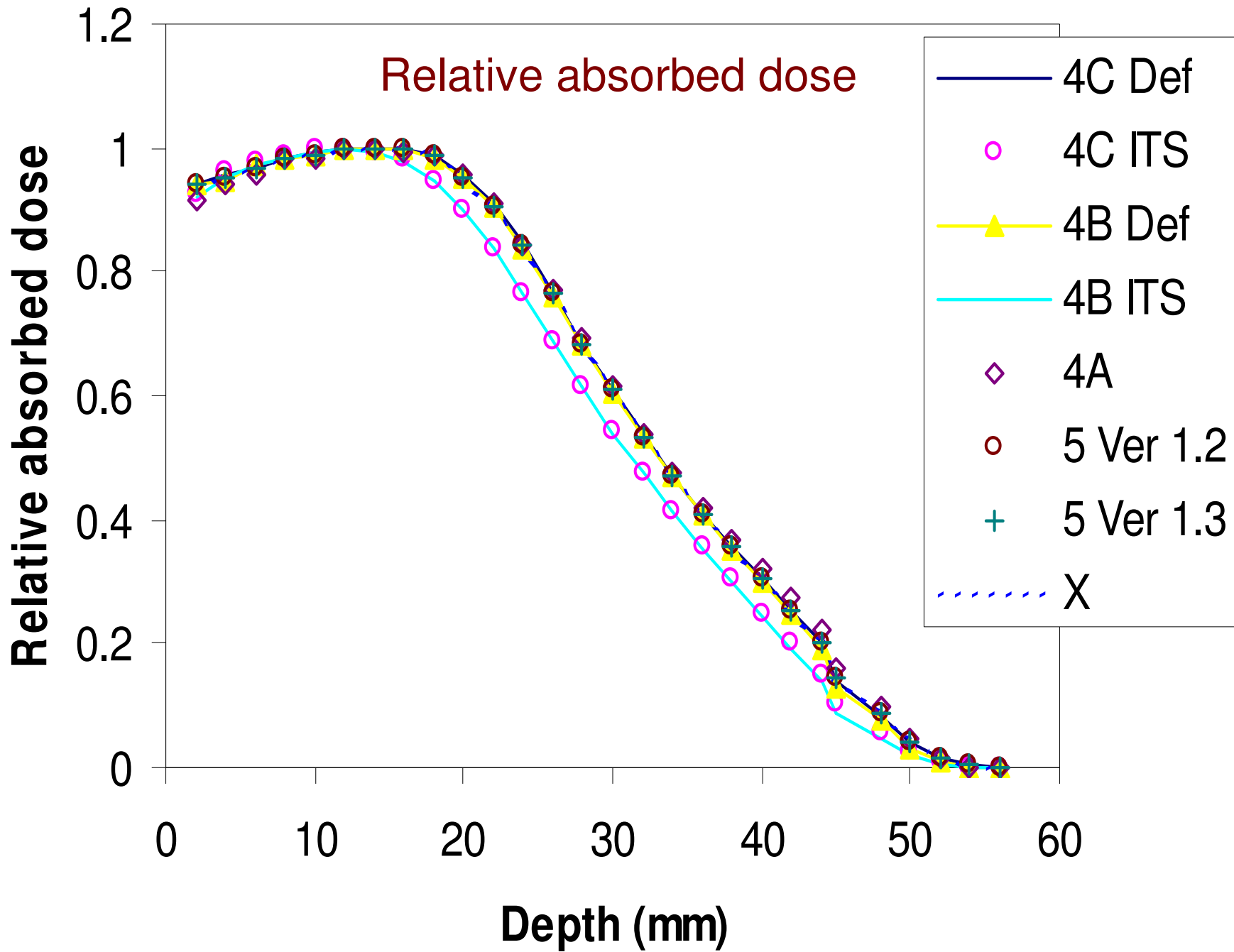


Three PCs were used

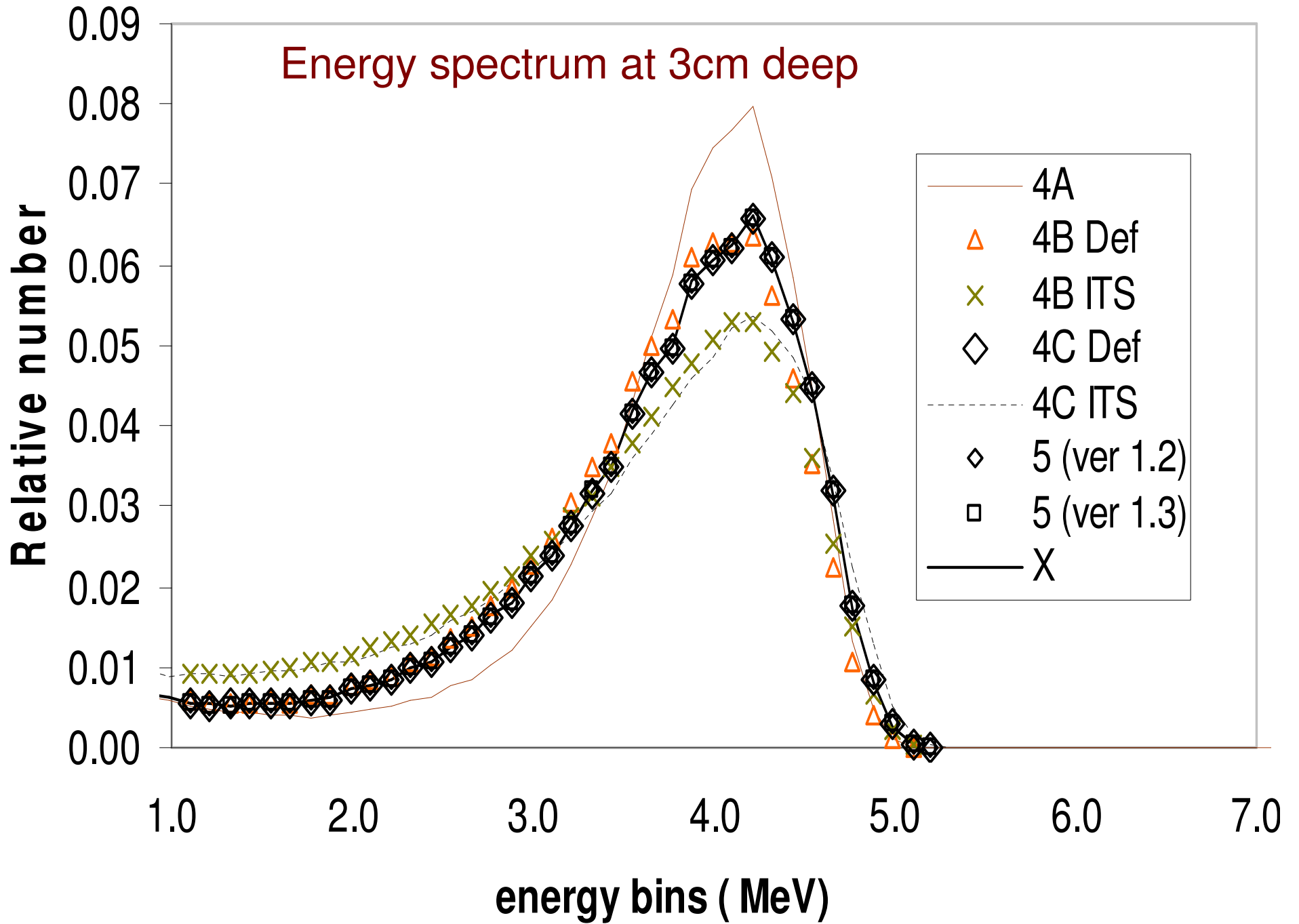
- ❑ **PC A (2× 2 GHz CPU, 512 MB RAM), Windows XP**
- ❑ **PC B (750 MHz CPU, 2 GB RAM), Windows 2000**
- ❑ **PC C (2.8 GHz CPU, 256 MB RAM), Windows XP**

Results





Energy spectrum at 3cm deep



MCNP Codes	Energy indexing	Computer run time
4A	Default	687 min (PC A)
4B	Default	737 min (PC A)
	ITS	576 min (PC A)
4C	Default	512 min (PC A)
	ITS	396 min (PC A)
X	Default	640 min (PC C)
5 (ver 1.2)	Default	1242 min (PC B)
5 (ver 1.3)	Default	1237 min (PC B)

Conclusions (1)

- ❑ In MCNP codes for electron transportation differences of up to 15% in absorbed dose results are seen between ITS and Default algorithm.
- ❑ Indexing algorithm rather than choice of code governs the depth dose curves.
- ❑ The choice of indexing algorithm has a negligible effect on energy spectra at the surface of phantom, but has a greater effect at deeper depths.

Conclusions (2)

- ❑ ITS indexing resulted in a shorter computation time compared to the default mode.
- ❑ These results indicate that, under the examined conditions, the codes 4B and later behave similarly in terms of the resulting depth dose characteristics.
- ❑ The trends for the energy spectrum are not as clear and require further investigation (higher electron energies, more complex geometries).

