



## The role of the National Physical Laboratory in monitoring and improving dosimetry in UK radiotherapy

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Russell Thomas (NPL) setting up the NPL MV audit equipment

### Introduction

The National Physical Laboratory, in collaboration with the Institute for Physics and Engineering in Medicine [IPEM] operates an audit programme to ensure national consistency in radiotherapy dosimetry in the UK. The present programme covers dosimetry of megavoltage photons, electrons (3-22 MeV) and low and medium energy (10-300 kV) photons. The aim of each audit is to verify the local measurement of absorbed dose at the radiotherapy centre. The audit measurements – principally beam quality and linac output – are made following the same protocol as the clinic but using different equipment. The audit is not an absolute measurement of the absorbed dose but amounts to a check that the equipment used by the centre is operating as expected and that the Code of Practice is being implemented correctly. The protocols used in the UK are IPSM 1990 [1] for high-energy photons, IPEM 2003 [2] for electrons and IPEM 1996 [3] and IPEM 2005 [4] for low energy photons. For the purpose of these audits, NPL maintains a set of calibrated ionisation chambers.

### Background

Radiotherapy centres in the UK are organized by the IPEM into eight geographical regions for the purpose of inter-departmental audits. Within each region hospitals audit dosimetry, treatment planning, record keeping etc. A national audit was reported by Thwaites et al [5], who carried out a dosimetric comparison of megavoltage



Electron beam output measurements in solid water

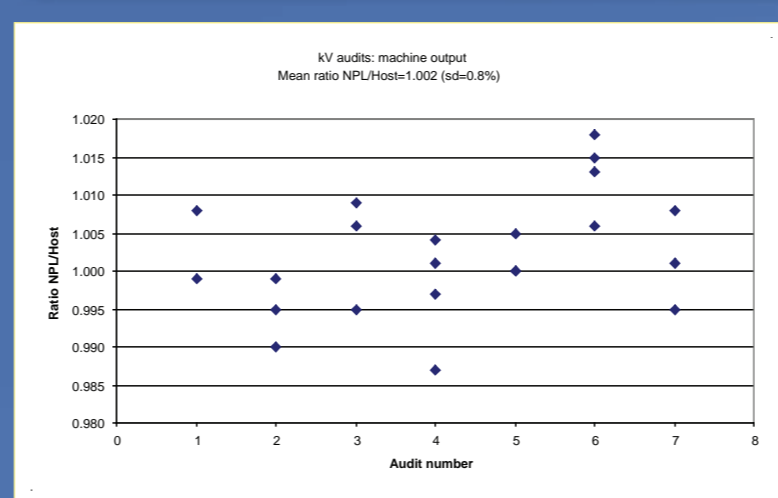
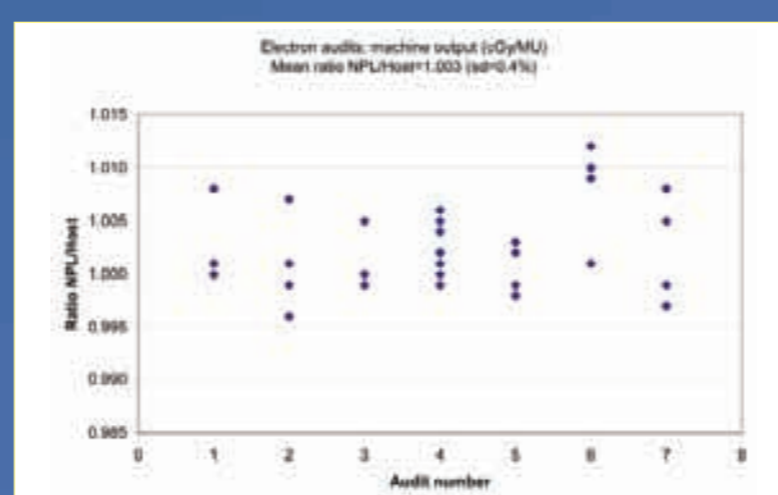
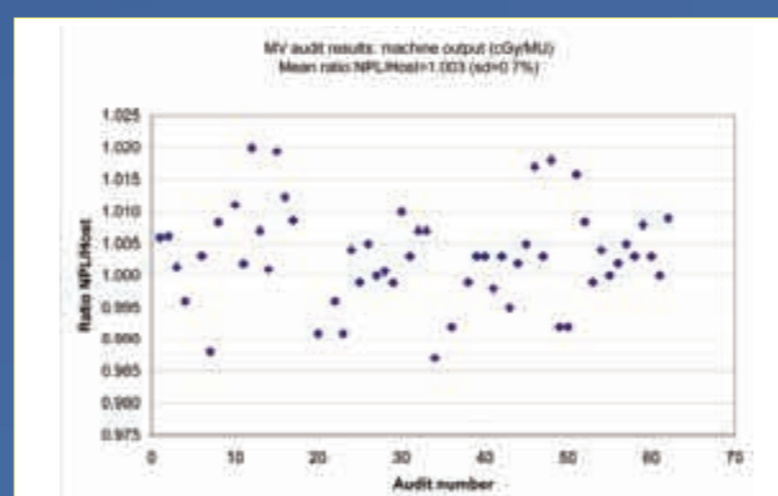
photon beams in all UK centres, obtaining a mean value for the ratio audit/local dose of 1.003 with a standard deviation of 1.5%. In three cases, the results differed from unity by 3% or more. In 1997 Nisbet et al [6] carried out a similar exercise for photon and electron beams, finding standard deviations of 1% for photons and 1.8% for electrons. For photon beams, the

worst-case agreement was 2.6%. Since 1994, the intra-regional audits organized by IPEM have been supplemented by dosimetry audits carried out by NPL, whose staff visit one department from each region in turn. The aim of these extra audits is twofold: to pick up any inter-regional differences which would be missed by the IPEM, and to check the dissemination of the UK standard of absorbed dose to the end of the calibration chain, by measuring absorbed dose under reference conditions by following the appropriate UK Code of Practice. The scope of these audits was extended in 2000 to include electron beams, and in 2003 to include low-energy kV X-rays. NPL has also visited the first Tomotherapy units installed in the UK to perform output measurements prior to patient treatment.

### Results

Modality	Ratio NPL/Host		
	Beam quality	Output	Field instrument calibration
Megavoltage photons	0.998 ± 0.005	1.003 ± 0.007	1.001 ± 0.007
Electrons	-	1.003 ± 0.004	1.003 ± 0.003
Low and medium energy photons	1.018 ± 0.047	1.002 ± 0.008	1.002 ± 0.006

The table summarises the results in terms of the mean of the ratio of NPL to the host. The standard deviation of the mean is also given. To date, nearly 70 audits have been performed. Consistent and similar agreement between NPL and the hosts has been achieved for all modalities. The mean results for MV and electron beam audits also agree well with the previous assessments by Thwaites and Nisbet, but with a decrease in the standard deviation. The graphs show the results of the NPL audits in terms of the output measurements for each modality.



Measurement of kV beam quality (HVL)

### Future work planned

- Sale of audits outside of the IPEM scheme
- Continue with kV, MV and electron audits
- Extend the scope of audits to include HDR Brachytherapy, small-field, and IMRT
- Improve tie-in with individual audit regions
- National electron audit of all radiotherapy departments in collaboration with Royal Surrey County Hospital

### References

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