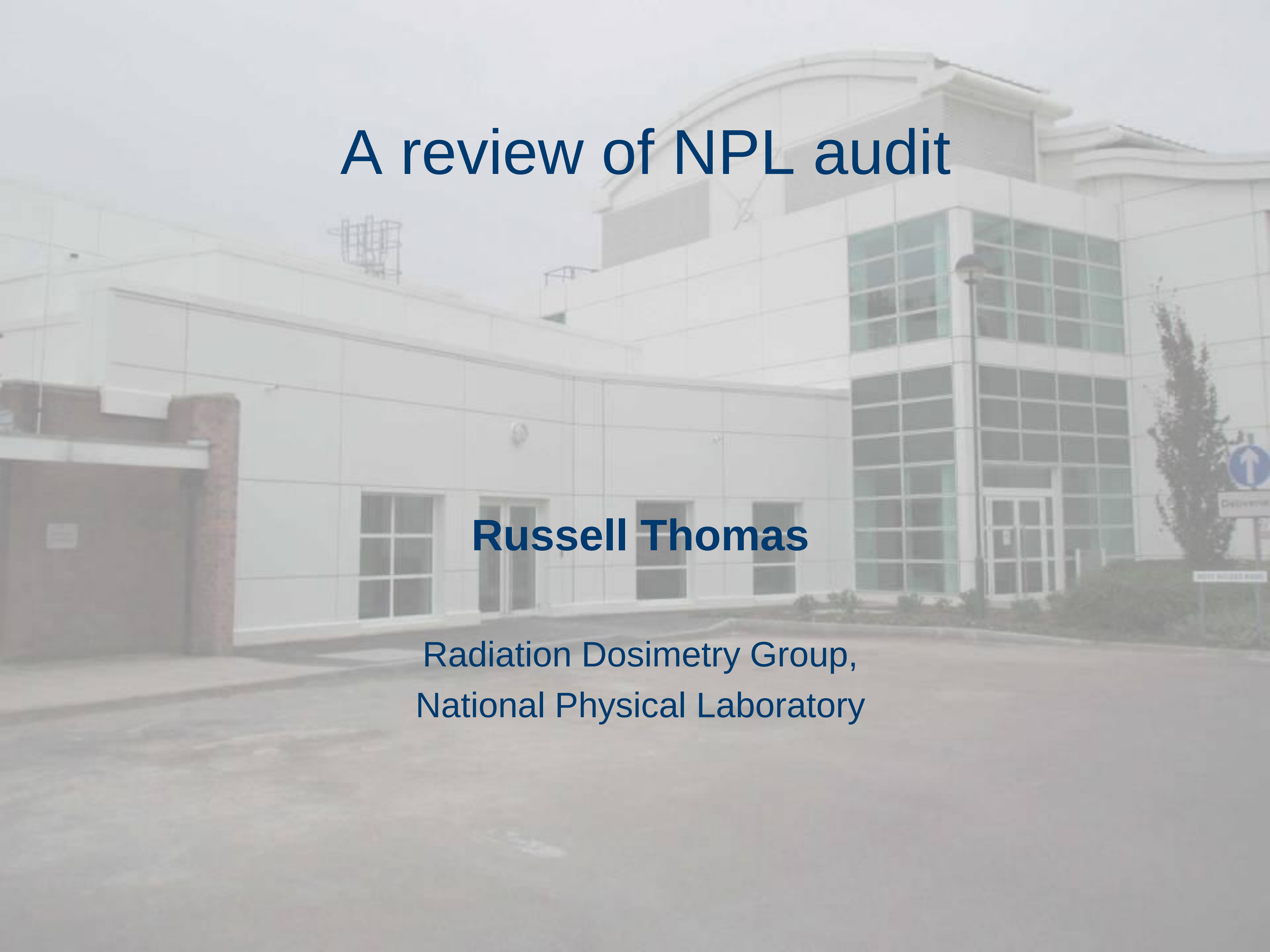


A review of NPL audit

Russell Thomas

Radiation Dosimetry Group,

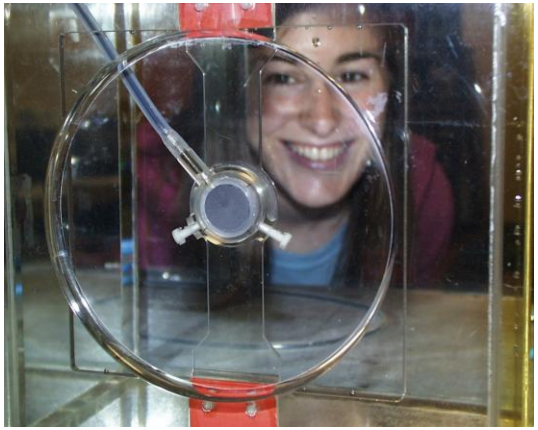
National Physical Laboratory

A review of NPL audit
or
What are we actually trying to achieve?

Russell Thomas

Radiation Dosimetry Group,
National Physical Laboratory

History



- 4th January 1994
- 1994 commenced IPEM/NPL Photon MV reference dosimetry audits
- Linking the eight regional audit groups
- Later expanded into kV Photons and Electrons (1996 & 2003)
- Support for development of Alanine based services for Gamma Knife, Tomotherapy Cyber knife, Protons and the National IMRT audit & NRRA

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Basic structure for all reference dosimetry audits:

- Beam quality
- Machine output
- Field instrument calibration

+ specific areas such as ion recombination
+ individual areas of concern

The easy "also checked"

- Temperature
- Pressure
- Laser Alignment
- SSD/Front pointer agreement
- Storage conditions of equipment
- Certification/calibration/ traceability
- <u>Not</u> Paper trails (if it's written down and you do it that's a pass even if it's not best practice)

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Audit is not just about getting two numbers to agree within a tolerance.

- My Gray = Your Gray, PASSED
  on to the next department…..
- My Gray = Your Gray, PASSED
  on to the next department…..
- My Gray = Your Gray, PASSED
  on to the next department…..

It's about the touchy feely stuff too….

It's about the touchy feely stuff too….

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Auditing – a bit like cracking a safe really!

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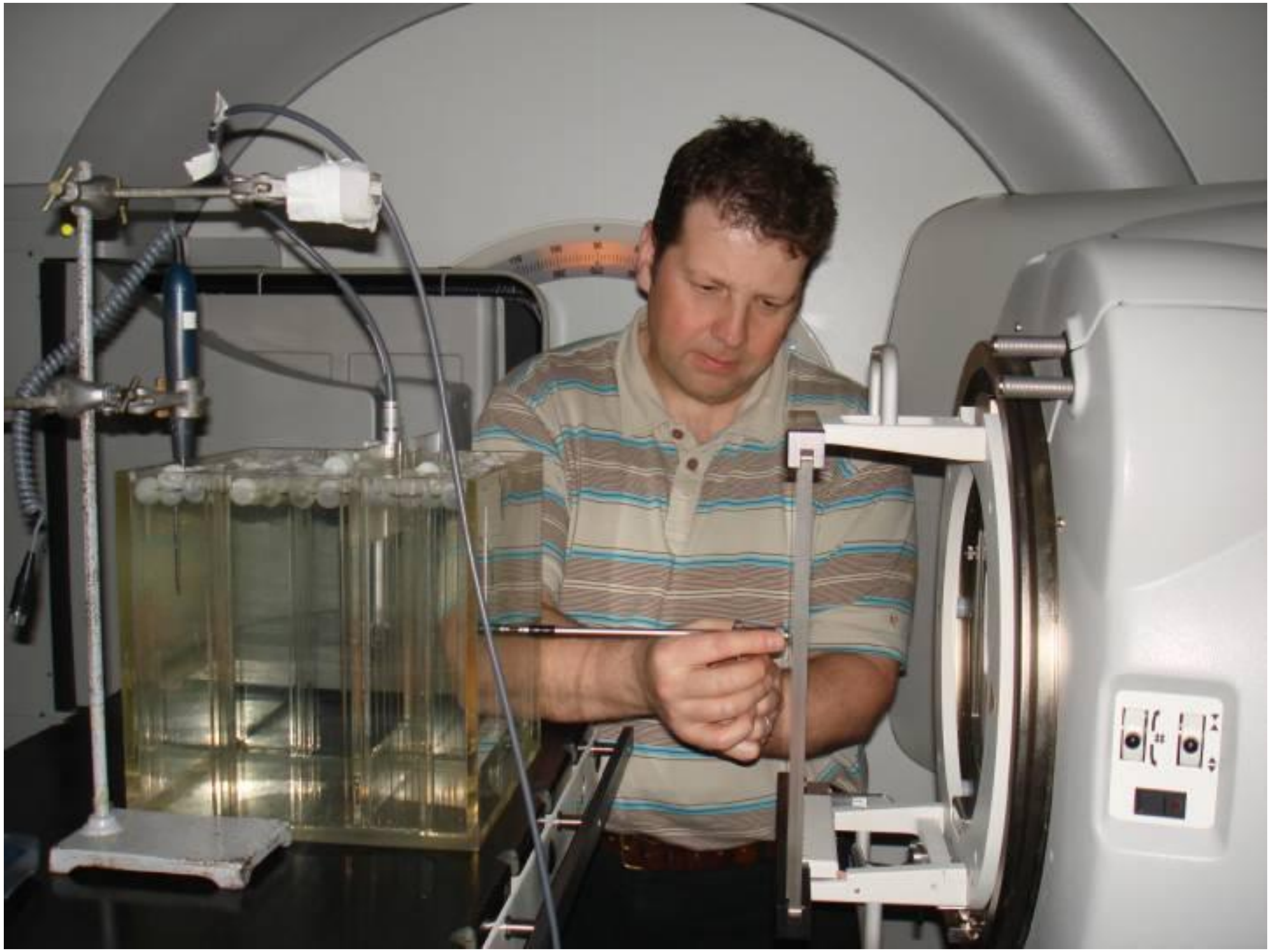
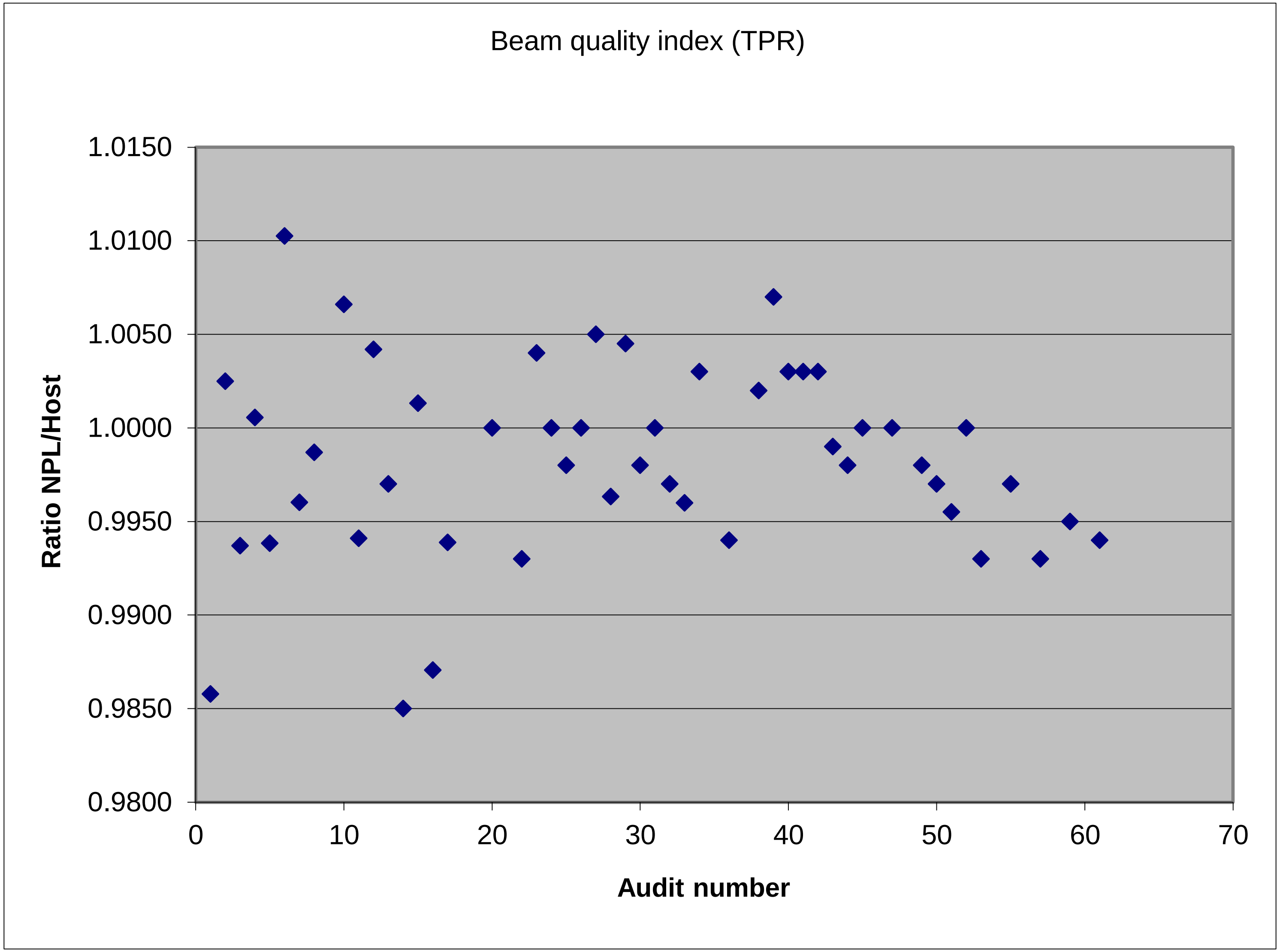
MV photon audit set up





NPL/Host 0.998 std dev 0.5%

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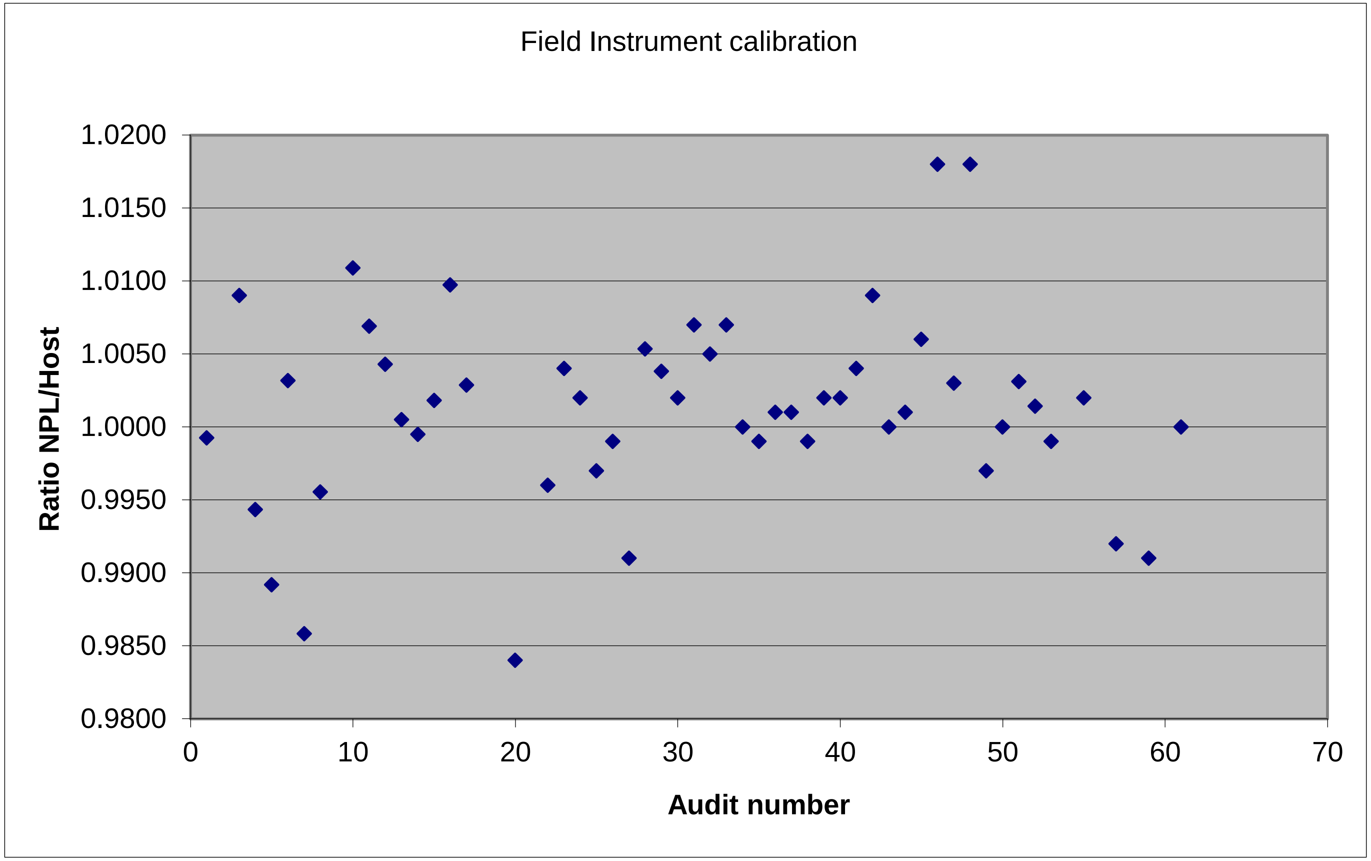
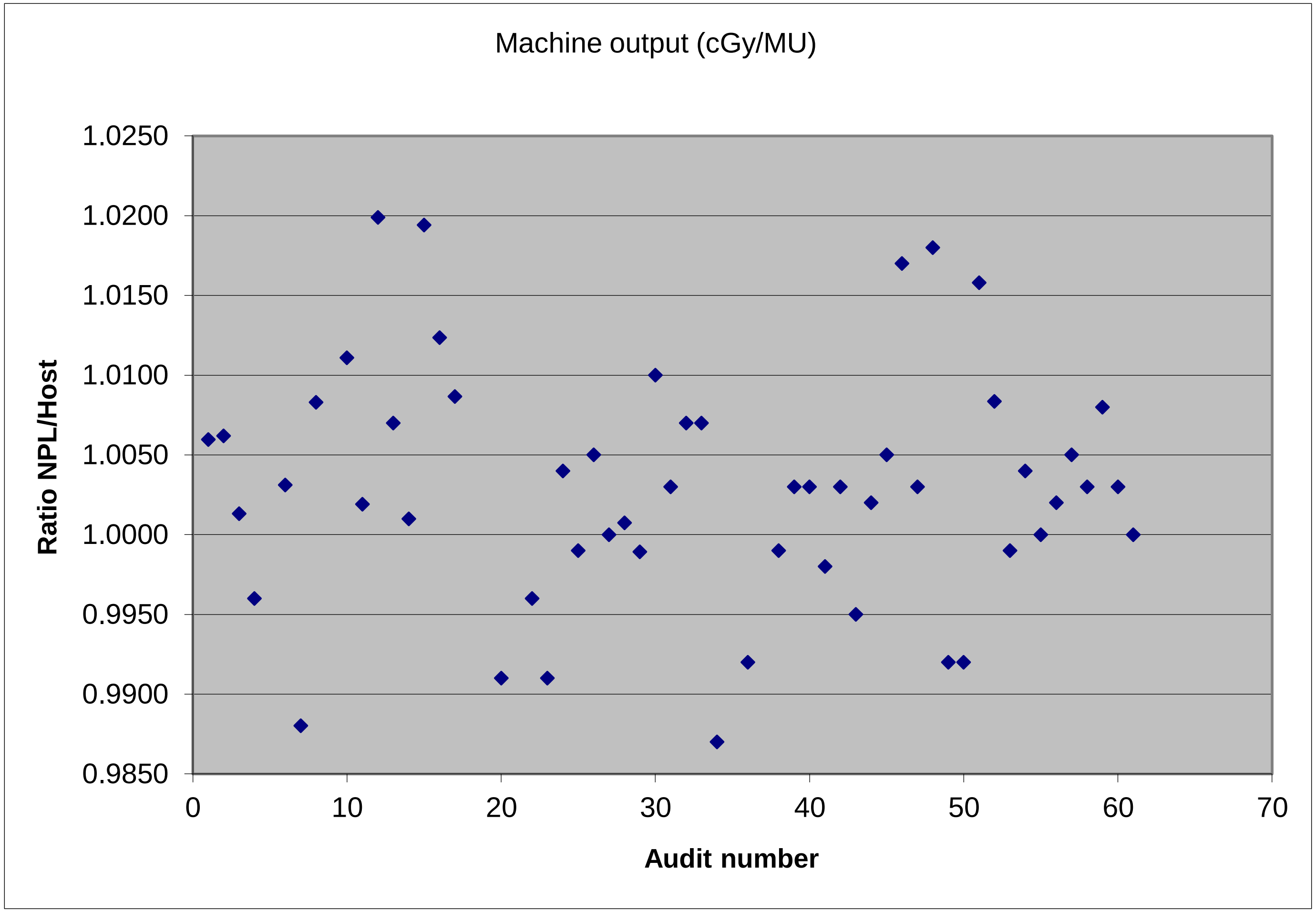
MV photon field instrument calibration



NPL/Host

1.001

std dev 0.7%



NPL/Host 1.003 std dev 0.7%

Nisbet/Host 1.003 std dev 1.0%

Thwaites/Host 1.003 std dev 1.5%

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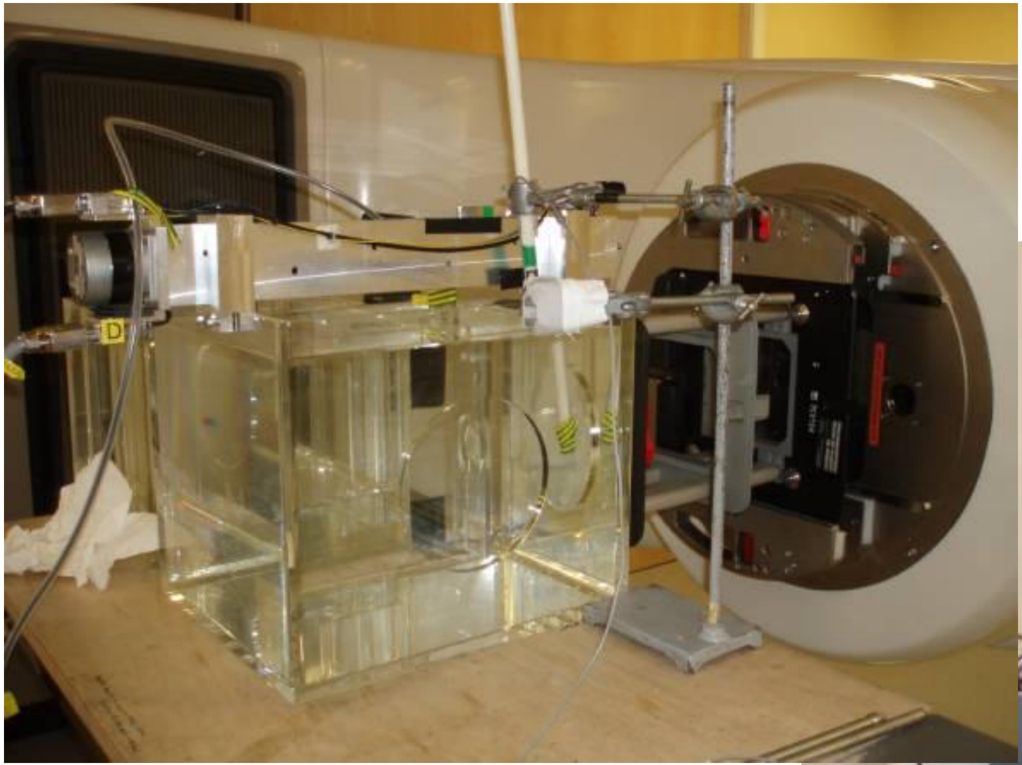
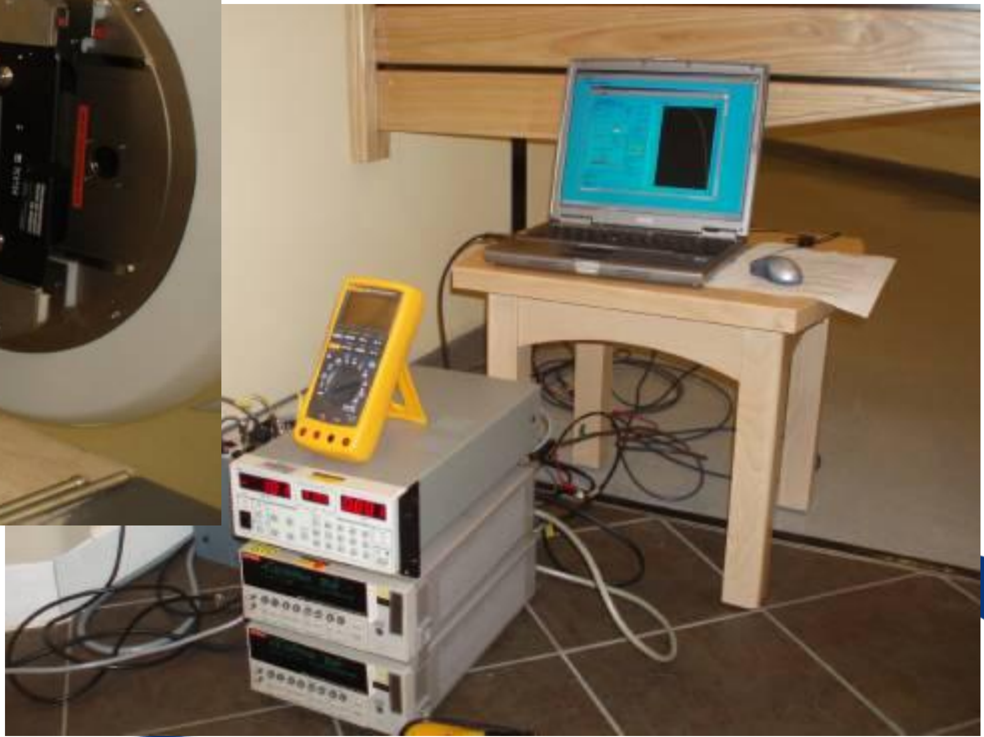
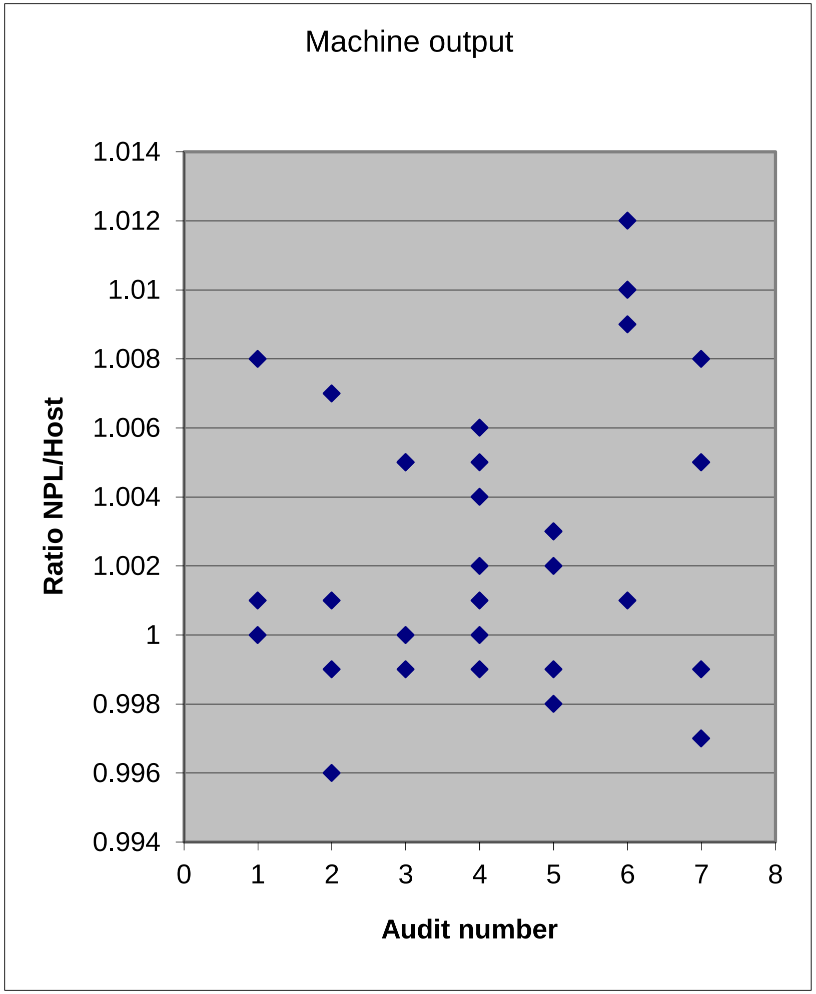
Electron 2003 C of P
Depth dose measurements in water

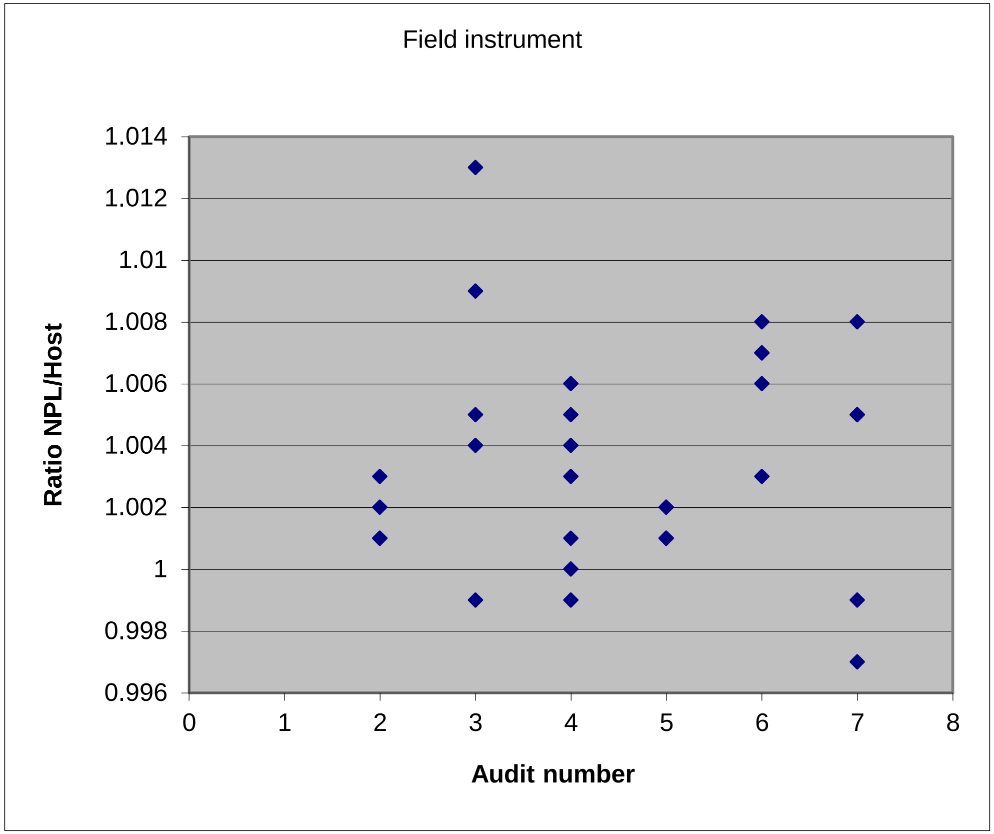




Electron 2003 C of P measurements in solid water

Electrons 2003
C of P





NPL/Host 1.003 std dev 0.3%

NPL/Host 1.003 std dev 0.4%

Nisbet/Host 0.994 std dev 1.8%

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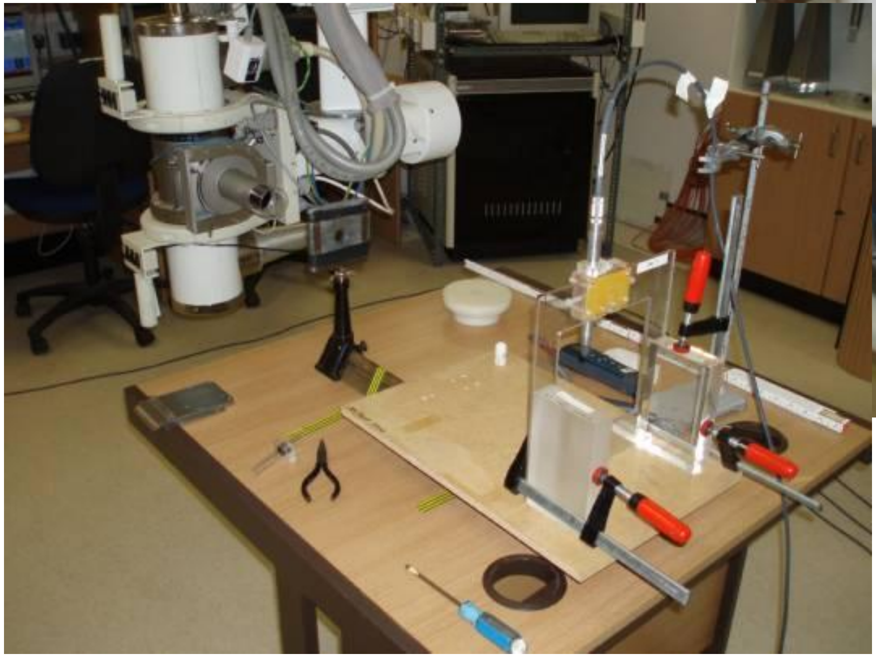
kV set up for HVL measurements



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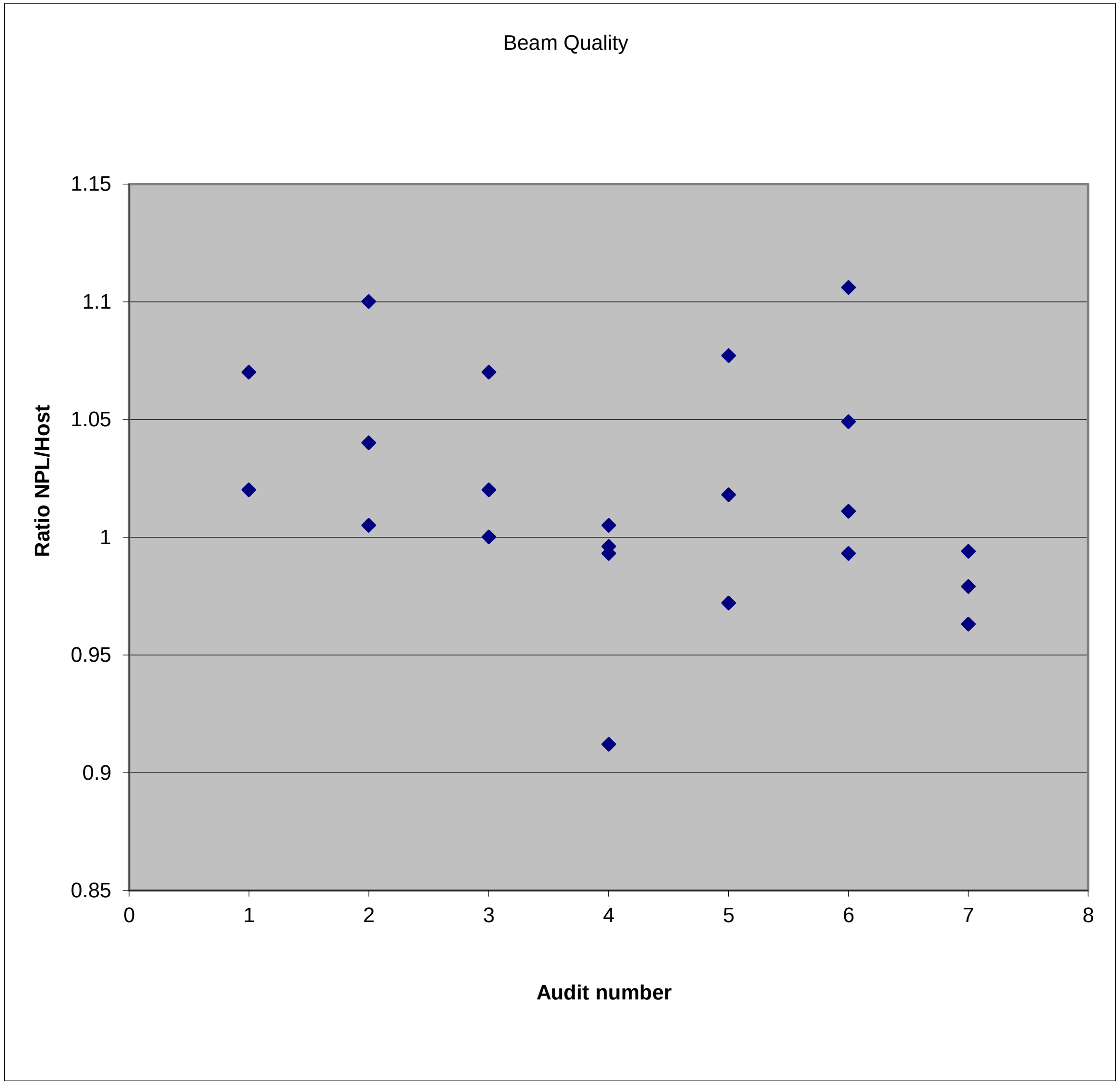
kV audit results

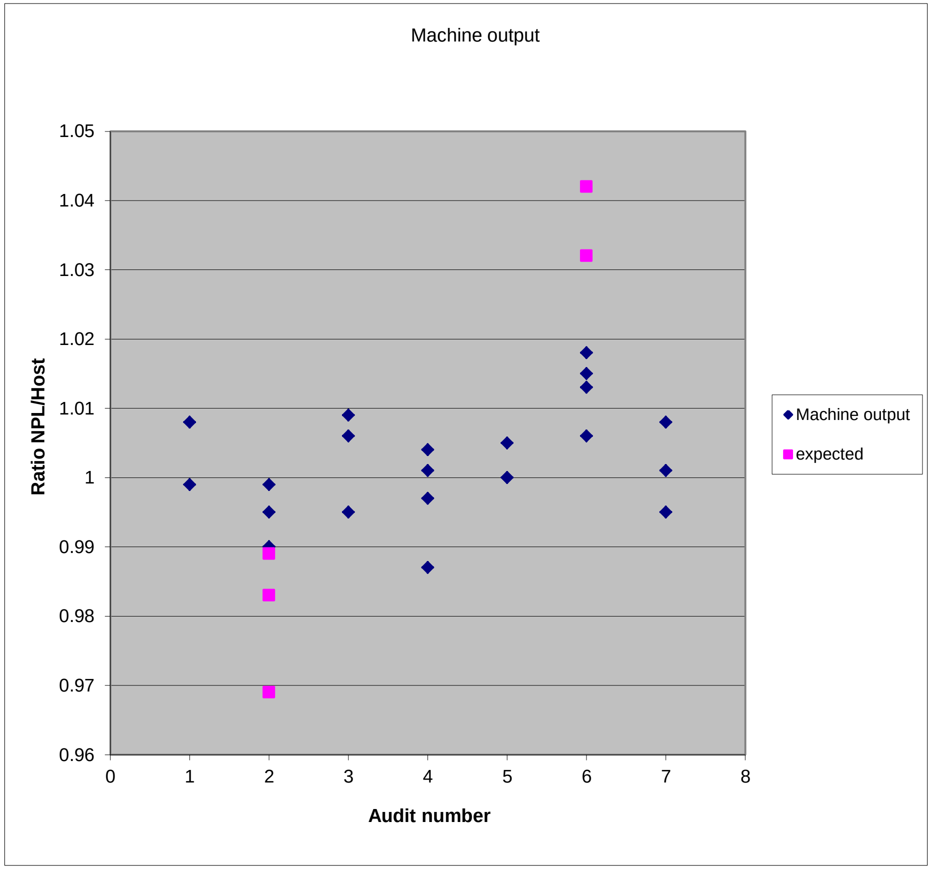


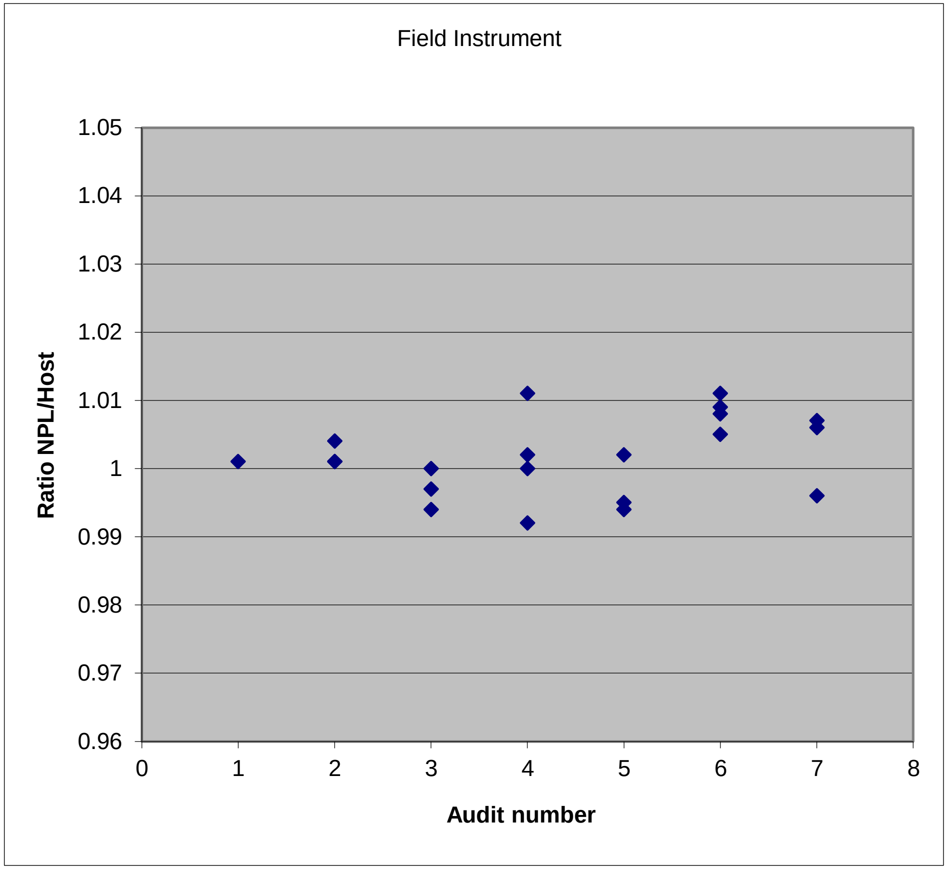
NPL/Host

1.018

std dev 4.7%

kV audit results





NPL/Host 1.002 std dev 0.8%

(1.5%)

NPL/Host 1.002 std dev 0.6%

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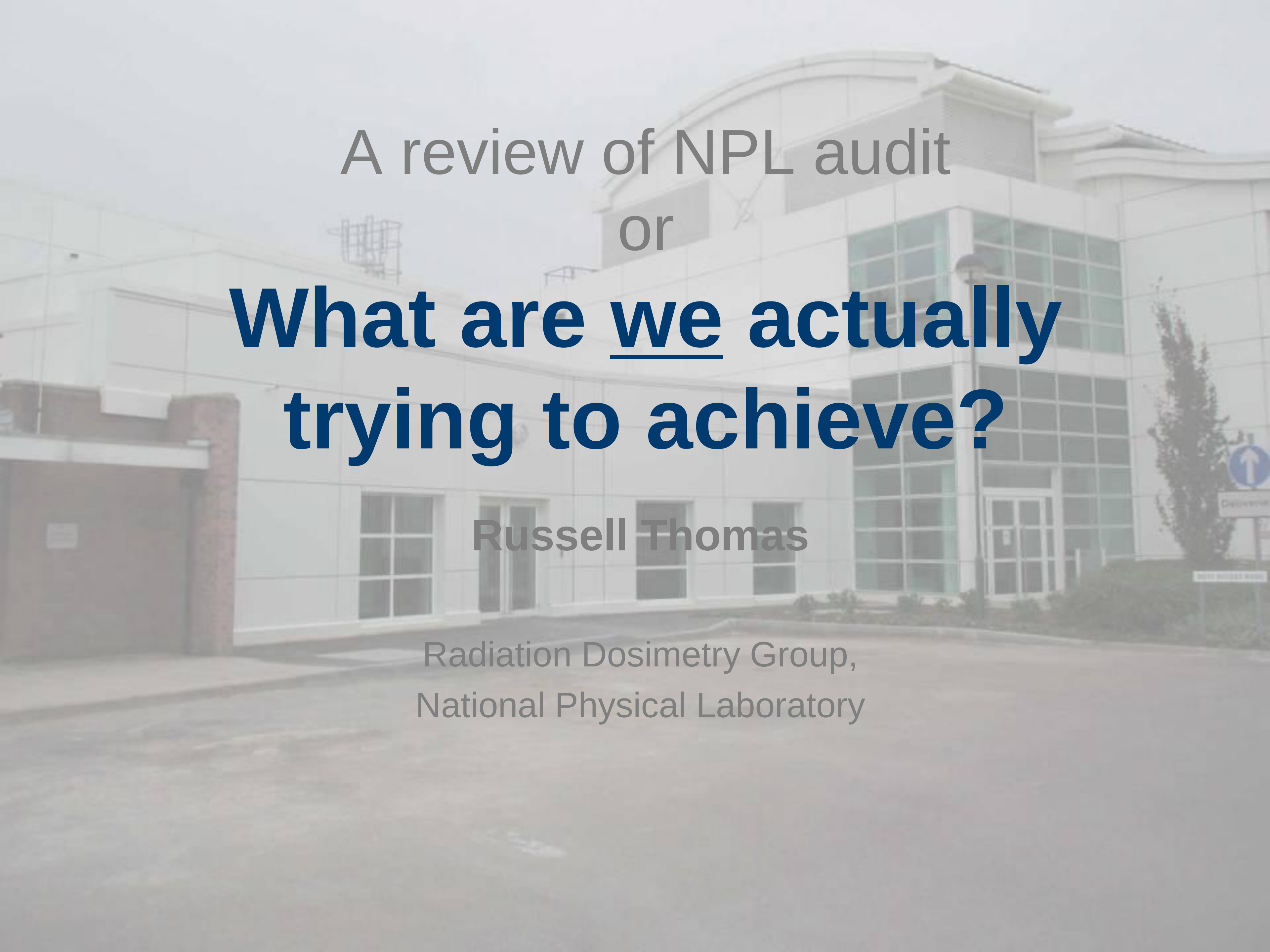

A review of NPL audit

or

What are we actually trying to achieve?

Russell Thomas

Radiation Dosimetry Group,

National Physical Laboratory

NPL is usually about uncertainty to 1 part in so many million

“NPL's atomic clock revealed to be the world's most accurate”

"Together with other improvements of the caesium fountain, these models and numerical calculations have improved the accuracy of the UK's caesium fountain clock, NPL-CsF2, by reducing the uncertainty to 2.3×10^{-16} - the lowest value for any primary national standard so far."

- ICRU 24 - Dose delivery to the primary target should be within +/- 5% of the prescribed value (some literature is quoting that this should be within +/- 2%)

- ICRU 24 - Dose delivery to the primary target should be within +/- 5% of the prescribed value (some literature is quoting that this should be within +/- 2%)

- Uncertainty on the NPL calibration of the Secondary Standard 2611 chamber is

  +/-1.5%

UK Codes of Practice

Phys. Med. Biol., 1990, Vol. 35, No 10, 1355–1360. Printed in the UK

Code of Practice for high-energy photon therapy dosimetry based on the NPL absorbed dose calibration service

Prepared by a working party of the Institute of Physical Sciences in Medicine consisting of S C Lillicrap (Chairman), B Owen, J R Williams and P C Williams and approved by the IPSM Scientific Committee

Received 18 June 1990

1. Introduction

The current Code of Practice for high-energy photon dosimetry (HPA
on the use of an NE 2561 ionisation chamber calibrated in air by co
the primary standard of exposure or air kerma for 2 MV x-radiation a
Physical Laboratory (NPL). To derive absorbed dose to water from a m
water, the instrument reading is multiplied by the NPL calibration fac
energy-dependent conversion factor, C_λ. The phantoms and methods
for the transfer of a calibration from a secondary standard to other in
for the measurement of machine output were described by NPL (1974)

With the aim of improving the accuracy of photon dosimetry, NPL
a calibration service for high-energy photon beams in terms of absorbed
based on a graphite calorimeter as the primary standard (Burns *et*
expected that the 2 MV, C_λ derivation of absorbed dose to water and
dose calibration service will co-exist as alternative approaches to high-
dosimetry for the foreseeable future and that NPL will continue to mai
primary standard.

The purpose of this Code of Practice is to recommend procedures
field instruments using a secondary standard which has been calibrate
absorbed dose service, and procedures for measuring radiation output fr
unit or a high-energy accelerator.

The procedures assume that the secondary standard and the field in
consist of an unsealed ionisation chamber connected to an electromete

The recommended secondary standard dosemeter for high-energy ph
in the UK continues to be the NPL Secondary Standard X-ray Ex
manufactured by NE Technology Ltd (chamber NE 2561 and electron
or Dosemaster NE 2590).

The previous Code of Practice (HPA 1983) remains valid and shou
be used where a secondary standard has been calibrated in air only, a
NPL absorbed dose service. Secondary Standard Centres will need to co
to change to the absorbed dose calibration service and, if so, when. A
centres will be issued by the Institute of Physical Sciences in Medicine

0031-9155/90/101355+06$03.50

Phys. Med. Biol. 41 (1996) 2605–2625. Printed in the UK

The IPEMB code of practice for the determination of absorbed dose for x-rays below 300 kV generating potential (0.035 mm Al–4 mm Cu HVL; 10–300 kV generating potential)

Prepared by a Working Party of the IPEMB with the following members: S C Klevenhagen (Chair), R J Aukett, R M Harrison, C Moretti, A E Nahum and K E Rosser

Institution of Physics and Engineering in Medicine and Biology, 4 Campleshon Road, York YO2 1PE, UK

Received 28 September 1996

Abstract. This new code of practice for the determination of absorbed dose for x-rays below 300 kV has recently been approved by the IPEMB and introduces the following changes to the previous codes: (i) The determination of absorbed dose is based on the air kerma determination (exposure measurement) method. (ii) An air kerma calibration factor for the ionization chamber is used. (iii) The use of the F (rad/röentgen) conversion factor is abandoned and replaced by the ratio of the mass–energy absorption coefficients of water and air for converting absorbed dose to air to absorbed dose to water. New values for ratios of these coefficients are recommended. Perturbation and other correction factors are incorporated in the equations. (iv) New backscatter factors are recommended. (v) Three separate energy ranges are defined, with specific procedures for each range. These ranges are: (a) 0.5 to 4 mm Cu HVL: for this range calibration at 2 cm depth in water with a thimble ion chamber is recommended. (b) 1.0 to 8.0 mm Al HVL; for this range calibration in air with a cylindrical ion chamber and the use of tabulated values of the backscatter factor are recommended. (c) 0.035 to 1.0 mm Al HVL; for this range calibration on the surface of a phantom with a parallel plate ionization chamber is recommended.

Contents

0031-9155/96/122605+21$19.50 2605

Institute of Physics Publishing — Physics in Medicine and Biology
Phys. Med. Biol. 48 (2003) 2929–2970 — PII: S0031-9155(03)65222-X

The IPEM code of practice for electron dosimetry for radiotherapy beams of initial energy from 4 to 25 MeV based on an absorbed dose to water calibration

IPEM Working Party: D I Thwaites (Chair), A R DuSautoy, T Jordan, M R McEwen, A Nisbet, A E Nahum and W G Pitchford

Institute of Physics and Engineering in Medicine, Fairmount House, 230 Tadcaster Road, York, YO24 1ES, UK

Received 25 June 2003
Published 3 September 2003
Online at stacks.iop.org/PMB/48/2929

Abstract
This report contains the recommendations of the Electron Dosimetry Working Party of the UK Institute of Physics and Engineering in Medicine (IPEM). The recommendations consist of a code of practice for electron dosimetry for radiotherapy beams of initial energy from 4 to 25 MeV. The code is based on the absorbed dose to water calibration service for electron beams provided by the UK standards laboratory, the National Physical Laboratory (NPL). This supplies direct $N_{D,w}$ calibration factors, traceable to a calorimetric primary standard, at specified reference depths over a range of electron energies up to approximately 20 MeV. Electron beam quality is specified in terms of $R_{50,D}$, the depth in water along the beam central axis at which the dose is 50% of the maximum. The reference depth for any given beam at the NPL for chamber calibration and also for measurements for calibration of clinical beams is $0.6R_{50,D} - 0.1$ cm in water. Designated chambers are graphite-walled Farmer-type cylindrical chambers and the NACP- and Roos-type parallel-plate chambers. The practical code provides methods to determine the absorbed dose to water under reference conditions and also guidance on methods to transfer this dose to non-reference points and to other irradiation conditions. It also gives procedures and data for extending up to higher energies above the range where direct calibration factors are currently available. The practical procedures are supplemented by comprehensive appendices giving discussion of the background to the formalism and the sources and values of any data required. The electron dosimetry code improves consistency with the similar UK approach to megavoltage photon dosimetry, in use since 1990. It provides reduced uncertainties, approaching 1% standard uncertainty in optimal conditions, and a simpler formalism than previous air kerma calibration based recommendations for electron dosimetry.

0031-9155/03/182929+42$30.00 Printed in the UK 2929

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What are WE trying to achieve? Is it :-

- Just not getting caught with our pants down
- Delivering a “legal” dose
- Are we fulfilling a tick box exercise? ie traceability and audit – done!

What are WE trying to achieve? Is it :-

- Just not getting caught with our pants down
- Delivering a “legal” dose
- Are we fulfilling a tick box exercise? ie traceability and audit – done!

or

- Are we aiming for best practice and treatment
- As tight a consistency of dose delivered to individuals across a patient population

NPL National Physical Laboratory

A statement made to me by a clinical oncologist -

"Accurate dosimetry is not that important"

A statement made to me by a clinical oncologist -

“Accurate dosimetry is not that important”

….but if you can’t get your reference dosimetry right, no complex treatment you deliver will be “correct”.

NPL National Physical Laboratory

- In my view audit, and indeed reference dosimetry audit, is a crucial component in the provision of the complex radiotherapy that is, and will become, available with current and future technology.

But there are issues:-

- Hidden costs

But there are issues:-

- Hidden costs
- Pressure on staff time
- People feel over audited
- Value and benefit
- Regulation
- Lack of senior management understanding

National Physical Laboratory

Thank you, questions?