TraMeXI

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Current status of dosimetry

Short introduction to current situation with clinical measurements

stuk RADIATION AND NUCLEAR SAFETY AUTHORITY
CZECH METROLOGY INSTITUTE
INMRI ISTITUTO NAZIONALE DI METROLOGIA DELLE RADIAZIONI IONIZZANTI ENEA
TÉCNICO LISBOA
IMBIH STÄDTISCHES KLINIKUM BRAUNSCHWEIG
PTB Physikalisch-Technische Bundesanstalt National Metrology Institute
HUS Helsinki University Hospital
TENMAK NÜKEN
Bambino Gesù OSPEDALE PEDIATRICO
VSL National Metrology Institute
EEAE ΕΛΛΗΝΙΚΗ ΕΠΙΤΡΟΠΗ ΑΤΟΜΙΚΗΣ ΕΝΕΡΓΕΙΑΣ GREEK ATOMIC ENERGY COMMISSION
Institutul Național de Metrologie
skbs

Data sources

- Questionnair for clinical users on XMM usage (> 90 replies)
- Literature review (74 papers / guidelines / recommendations)

Areas of main usage of XMM

General radiography / fluoroscopy

- X-ray tube output measurements (91 %)
- Regular QC (90 %)
- Check of conformance of dose values displayed from the X-ray unit, e.g. KAP (76 %)
- HVL measurements (44 %)
- Patient dose estimation (43 %)
- Research (35 %)
- Reference device (25 %)

Mammography

- Regular QC (78 %)
- X-ray tube output measurements (74 %)
- Check of conformance of dose values displayed from the X-ray unit, e.g. KAP (66 %)
- HVL measurements (40 %)
- Patient dose estimation (36 %)
- Research (26 %)
- Reference device (15 %)

Areas of main usage of XMM - required precision / repeatability

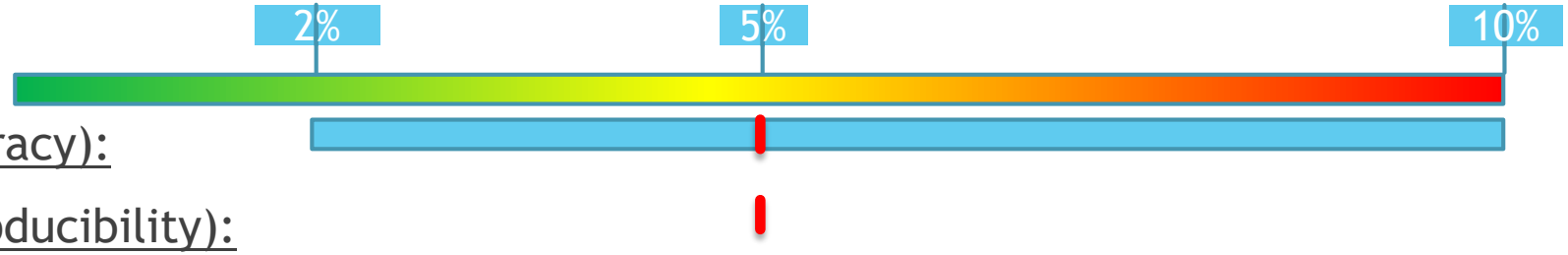
High precision area:

- Acceptance testing (check of compliance to absolute thresholds)
- Research (investigation of small effects)
- Reference device usage (further devices are linked to XMM results)

Moderate precision area:

- Constancy tests (check of compliance, often accepting larger deviations)
- Patient dose estimations (conversion factors to patient doses refer to average patients, only. Thus, high individual precision is never possible)

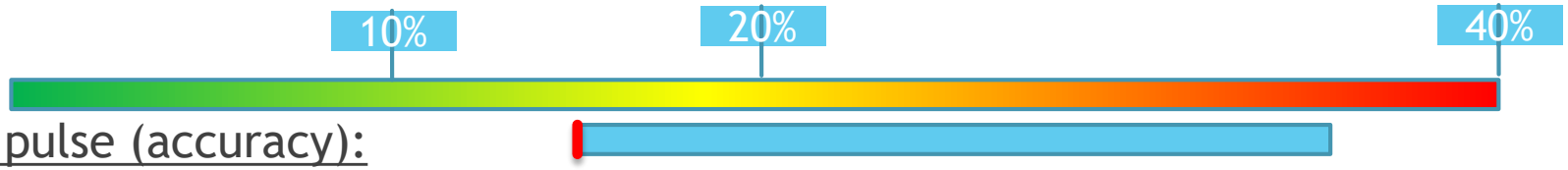
Requested tolerances for rad / flu / dent – from clinical survey



kV (accuracy):

kV (reproducibility):

time: 10 % or 1 ms

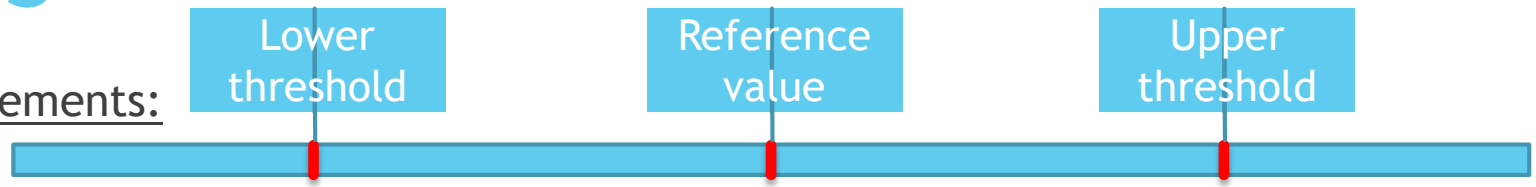


Dose per pulse (accuracy):

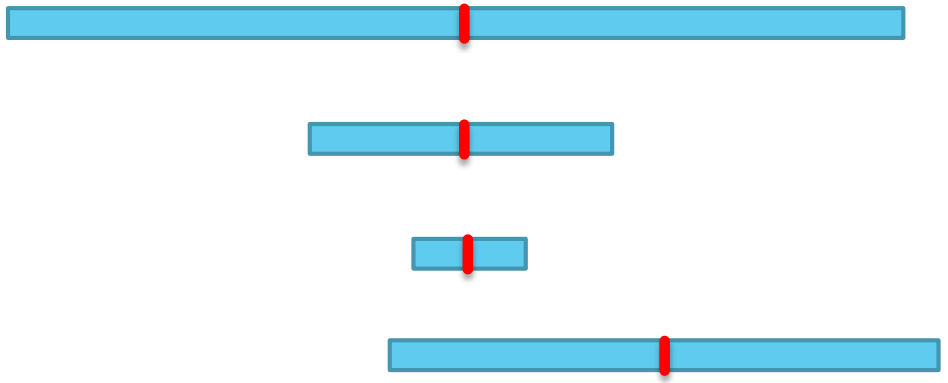
Dose per pulse (reproducibility):

Stated tolerances – literature survey background

QC requirements:



Measurement cases:



Conclusion:

- It is possible to prove compliance with given thresholds, only, if uncertainty of measurement is sufficiently small
- Ideally, uncertainty of a measurement result should be lower than one fifth of the tolerance (including setup and environmental influences)
- In many cases this is not possible, nowadays, in radiation measurements
- Suggested factor: 2-4 for measurement device

Stated tolerances – literature survey dose

Statistics: 55 publications

Stated needs from clinical usage / QC / research:

- Linearity: 10 %
- Detection of deviations for base value: 20 %
- Reproducibility: 5 %
- Dosimetry purposes: 6 %

Minimum specifications:

- Accuracy (QC purposes): 5 %
- Reproducibility: 1,5 %
- Dosimetry / research: 1,5 %

Current IEC standard:

Linearity: 20 %
Reproducibility: 5 %
Air kerma rate (intervention): 35 %

Stated tolerances – literature survey voltage (kVp)

Statistics: 45 publications

Stated needs from clinical usage / QC / research:

- acceptable deviation – rad / flu / dent: 5-10 %
- achievable deviation – mammo / CT: 2 %
- Reproducibility: lower by a factor of two

Minimum specifications:

- Accuracy (QC purposes): 1,5 %
- Reproducibility: 1 %

Current IEC standard:

Accuracy (general): 8 %
Accuracy / reproducibility (mammo): 5 %

Stated tolerances – literature survey HVL / total filtration

Statistics: 10 publications

Stated needs from clinical usage / QC / research:

- Research: 2 % - 3 %
- For QC miniumum values are stated, generally

Minimum specifications:

- Research: 1 %
- QC (specified in regulations): 5 %

Compromize:

- Accuracy: 5 %
- Reproducibility: 2 %

Stated tolerances – literature survey time / pulse width

Statistics: 27 publications

Stated needs from clinical usage / QC / research:

- Accuracy (> 10 ms): 5 % (2 % for mammo)
- Accuracy (≤ 10 ms): 10 %
- Reproducibility: 5 %

Minimum specifications:

- Accuracy: 2 %
- Reproducibility: 2 %

Current IEC standard:

10% + 1 ms (loading time)
10 % + 0,2 mAs (current-time product)

Conclusions

- XMM are widely used in clinics for QC, research and patient dosimetry
- Proving compliance with limiting values requires suffciently high precision of measurement devices
- Different fields of application have different needs for precision
- Reasonable specification levels can be deduced from clinical needs
- Current IEC standards claim lower levels of precision
- There has to be found a compromize between technical feasibility, costs and clinical / research interests

Thank you for your attention!

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