VSL

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PRISM-eBT

EURAMET EMPIR PRISM-eBT

Een Europees samenwerkingsverband voor de ontwikkeling van primaire standaarden en herleidbaarheid voor elektronische brachytherapie

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NV·KFM
Nederlandse Vereniging
Klinisch Fysisch Medewerkers

Inhoudsopgave

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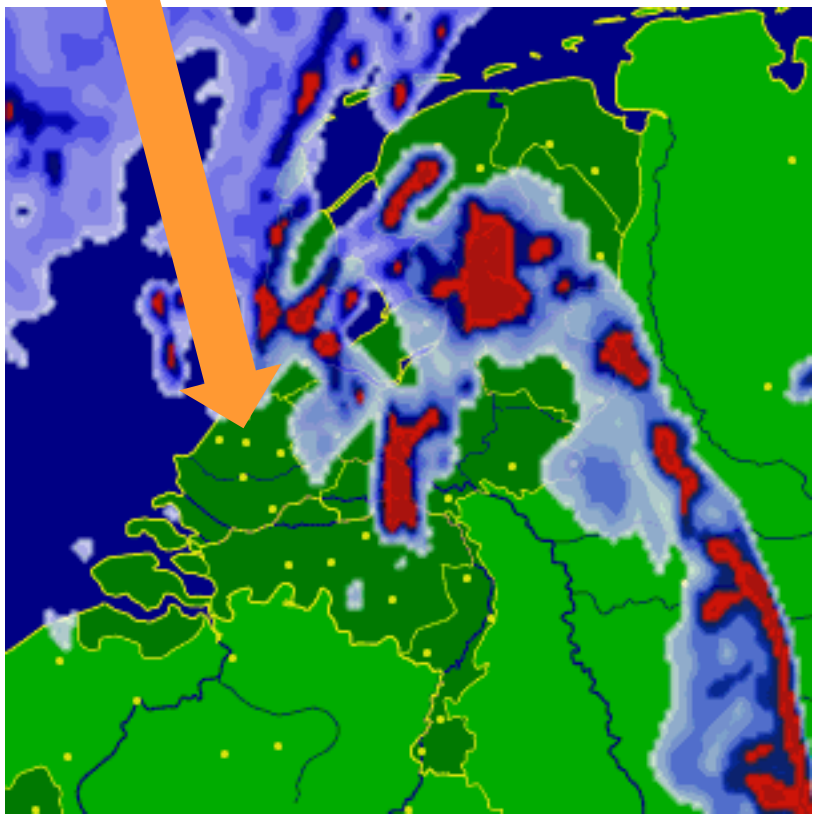
Nederlandse Vereniging Klinisch Fysisch Medewerkers

VSL, Delft, The Netherlands

"Bij VSL maken we de maten en gewichten voor Nederland."



kilogram
meter
seconde
ampère
kelvin
mol
candela

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VSL, Delft, The Netherlands

VSL is the Dutch National Metrology Institute

VSL is situated in Delft, South-West The Netherlands

METROLOGY

AND

PRIMARY MEASUREMENT STANDARDS

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Wat is … EURAMET

EURopean **A**ssociation of **MET**rology institutes

Regionale metrologieorganistaties (RMOs):

AFRIMETS
COOMET
GULFMET
APMP
SIM
EURAMET

EURAMET … coördinatie van Europese metrologie-activiteiten op het gebied van:

- onderzoek, herleidbaarheid, internationale erkenning van nationale standaarden en CMCs
- door kennisoverdracht, samenwerking tussen de Europese nationale metrologie instituten (NMIs)
- via Europese onderzoeksprogramma's:

  EMRP (2009 – 2017): European Metrology Research Programme
  EMPIR (2014 – 2024): European Metrology Programme for Innovation and Research
  EPM (2021 – 2030): European Partnership in Metrology

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Wat is …

EMPIR

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

EURAMET

European **M**etrology **P**rogramme for **I**nnovation and **R**esearch

PRISM-eBT

EMPIR coördineert Europees metrologisch samenwerkend onderzoek tussen:

- metrologie-instituten (NMIs en DIs)
- industrie
- ziekenhuizen
- universtiteiten

Ter bevordering van de Europese positie op het gebied van:

- industrie en handel
- energie(transitie)
- millieu
- gezondheidszorg
- normen
- fundamentele eenheden (SI)
- metrologische samenwerking

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Wat is … het PRISM-eBT project?

De voordelen van brachytherapie zijn bekend.

Elektronische brachytherapie heeft een aantal aanvullende voordelen:

- Het betreft röntgentoestellen tot 70 kV (geen radioactieven materialen).
- Dit heeft voordelen voor regelgeving.
- De bronen zijn relatief eenvoudige af te schermen.
- Sterke, goed gedefinieerde dosisprofielen.

Waarom dit project?

- Kalibratie en dosimetrie van de systemen is fabrikantspecifiek.
- Dosismeting is wellicht precies (lees: herhaalbaar), maar niet nauwkeurig of herleidbaar.
- Er bestaat momenteel nog geen herleidbaarheid naar internationaal geaccepteerde standaarden.
- Er bestaan nog geen normen die meetmethoden onafhankelijk maken van de fabrikantkalibratie.
- Momenteel wordt nog vaak gewerkt met grote onzekerheden: 10 % - 15 %, k = 1, is niet ongebruikelijk.

Dit remt de ontwikkeling voor veilige toepassing.

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Het PRISM-eBT project

partners

stakeholders

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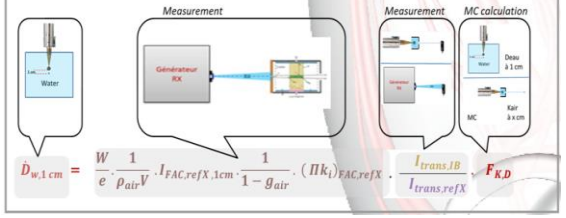
Het PRISM-eBT project

Primary and transfer standards — WP1

Establishment of:

- Primary standards for D_w.
- Transfer standards for D_w.
- Traceability chains for D_w.



$$\dot{D}_{w,1\,cm} = \frac{W}{e}\cdot\frac{1}{\rho_{air}V}\cdot I_{FAC,refX,1cm}\cdot\frac{1}{1-g_{air}}\cdot(\Pi k_i)_{FAC,refX}\cdot\frac{I_{trans,IB}}{I_{trans,refX}}\cdot F_{K,D}$$

Traceability for superficial treatment — WP2

Establishment of:

- Surface dose ($D_{70\,\mu m}$) via air kerma standards.

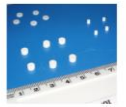
- Conversion between surface dose ($D_{70\,\mu m}$) and depth-dose (D_w, WP1).
- Traceability chains for the absorbed dose rate to water.

Characterisation and calibration of detectors for 3D dose distribution measurements — WP3

Characterisation and traceable (D_w, WP1) calibration of:

- Small volume online detectors.

- Fricke gel dosimeters.



- Characterisation and calibration of alanine dosimeters.

3D dose distribution measurements — WP4

- Measurement of the 3D dose distributions close to the eBT devices with or without applicators.
- Comparison of measurements with vendor supplied dose maps.

Creating impact & Coordination

- Dissemination of the project outputs given by close cooperation with National (DIN), European (BraphyQS) and International (IAEA) Organisations.
- IAEA substantially support this project and agreed to be the Chief Stakeholder.
- Update of IAEA Tecdoc 1274 (2 members of the JRP will be members of the Working Group).
- Medical Physics organisations are represented in the advisory board.
- All known device manufacturers and PTW want to be collaborators and attend the meetings.
- A Good Practice Guide will be provided to SDOs for uptake in their standards.
- Catalogue of validated spectra of eBT sources.
- Close collaboration of European NMIs.
- Increased competitiveness with NMIs outside Europe.
- Dissemination Workshop.

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WP2 PRISM-eBT: **Traceability for superficial treatment**

WP2

Traceability for superficial (skin) external treatment

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WP2 PRISM-eBT: **Traceability for superficial treatment**

Zeiss INTRABEAM

Xoft Axxent

Elekta Esteya

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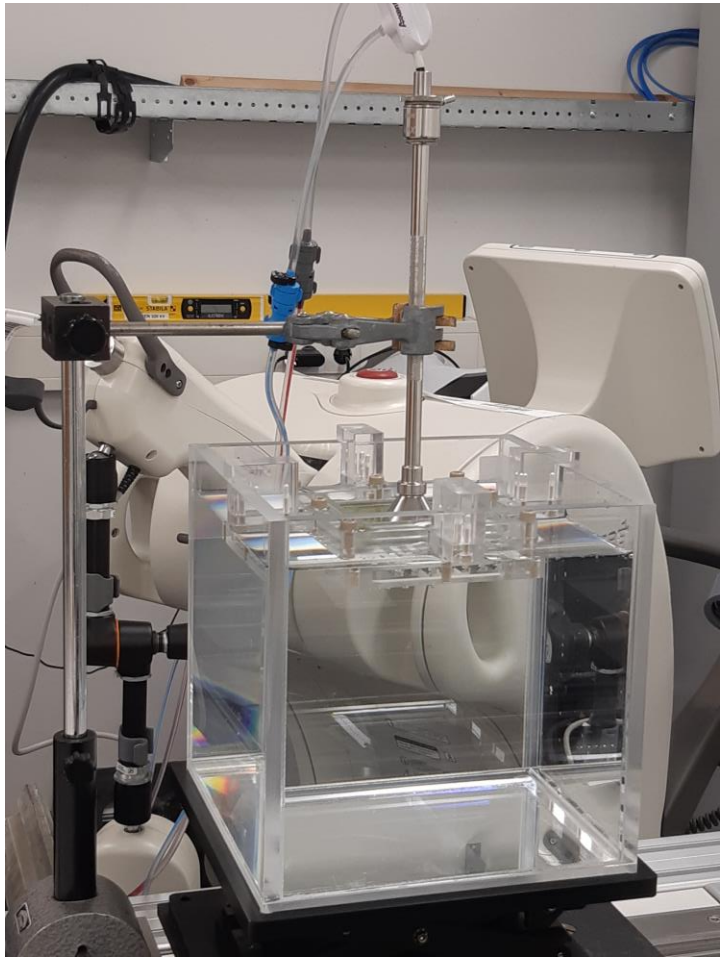
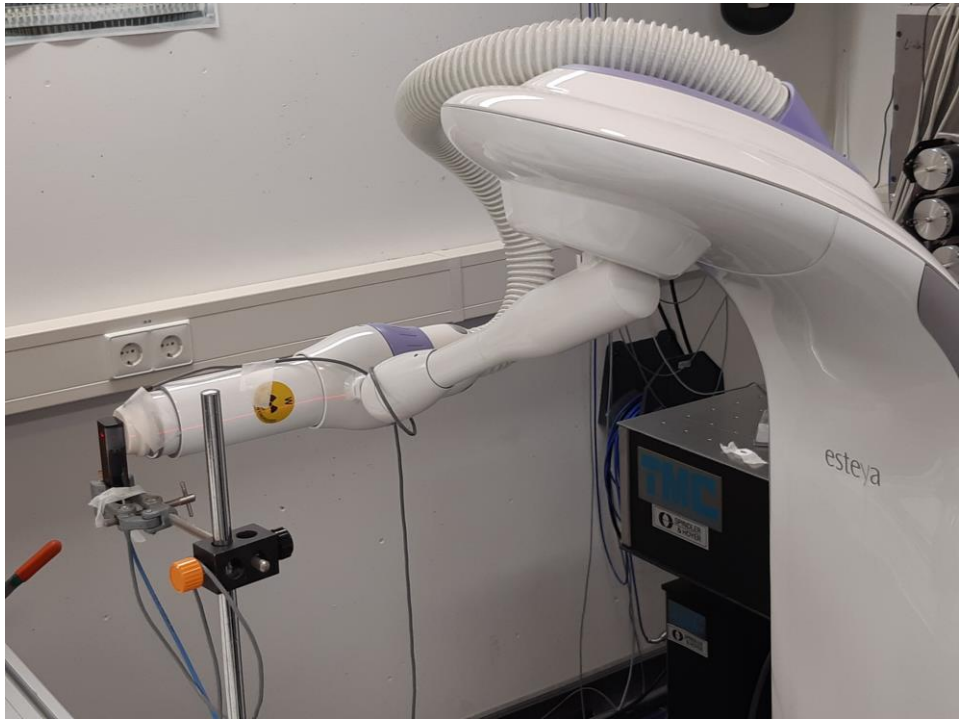
WP2 PRISM-eBT: **Traceability for superficial treatment**





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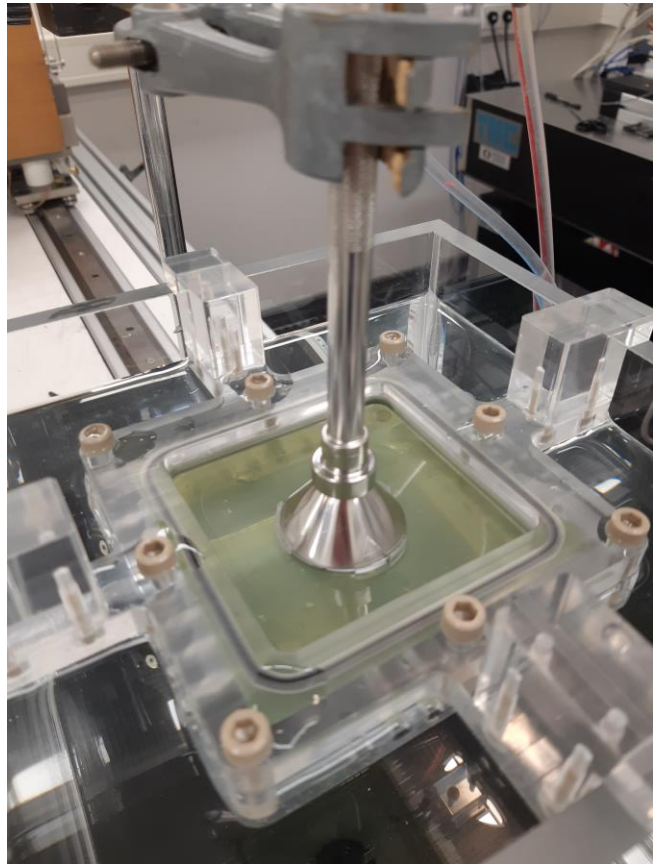
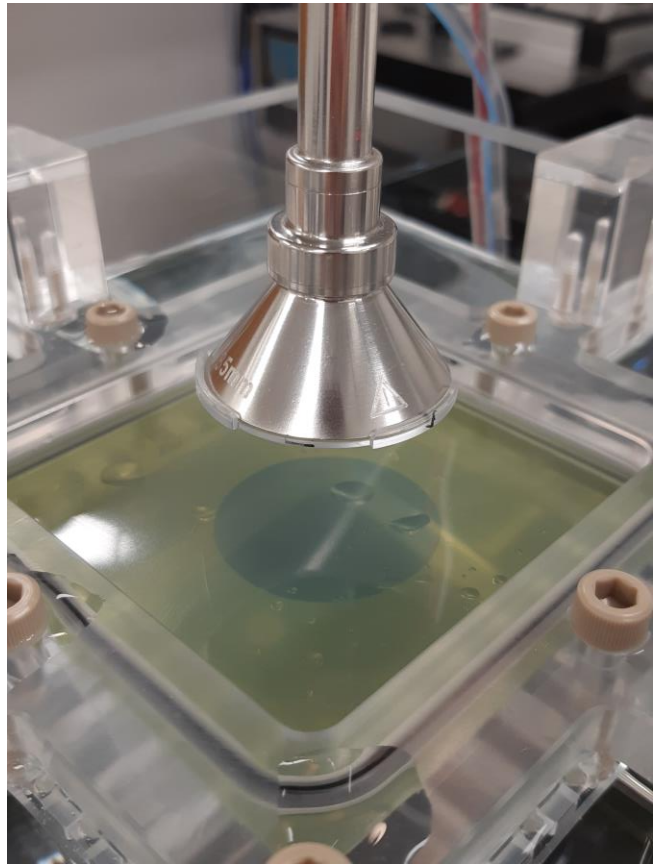
WP2 PRISM-eBT: **Traceability for superficial treatment**





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WP2 PRISM-eBT: **Doel**

To establish a dosimetric methodology for superficial (skin) treatment with eBT devices, in terms of **absorbed dose to water at the surface of a water phantom** (based on IAEA-TRS398, AAPM-TG61, DIN 6809-4 and NCS-10)**:**

$$D_w(d_{surface})$$

Dose to surface will be converted to dose to 1 cm depth via radiochromic film in a water phantom:

$$D_w(d_{1cm})$$

Target uncertainties (k = 1)

$$u[D_w(d_s)] = 3.5\ \%$$

$$u[D_w(d_{1cm})] = 5\ \%$$

WP2 PRISM-eBT: beoogd formalisme

based on NCS-10 and AAPM TG-61

$$D_{\mathrm{w,surface}} = K_{air} \cdot \left(\frac{\bar{\mu}_{\mathrm{en}}}{\rho} \right)^{\mathrm{w}}_{\mathrm{air}} \cdot B_{\mathrm{w}}$$

NOTE:

The actual D_w at the phantom surface is neither measurable nor clinically relevant.

However:

for low-energy photons TCPE is present at a specific (small) depth in the phantom

>>

D_w is therefore only defined at the minimum depth at
which TCPE is achieved (neglecting attenuation over this depth)

Thus:

TCPE is assumed at the ‘phantom surface’ starting at D_{max} (≥ 70 µm)

WP2 PRISM-eBT: basis is NCS-10 (en AAPM TG-61)

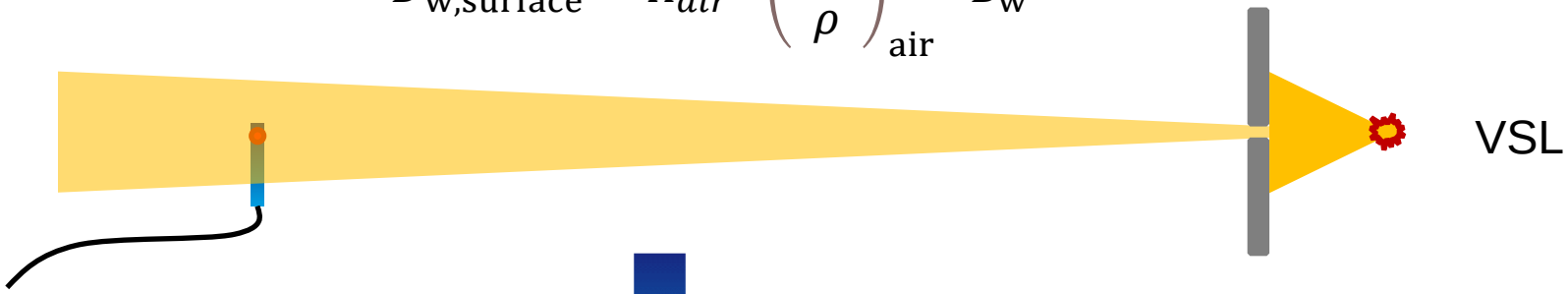
apply from left to right

$$D_{\mathrm{w,surface}} = K_{air} \cdot \left(\frac{\bar{\mu}_{\mathrm{en}}}{\rho} \right)_{\mathrm{air}}^{\mathrm{w}} \cdot B_{\mathrm{w}}$$

WP2 PRISM-eBT: beoogd formalisme

apply from left to right

$$D_{\mathrm{w,surface}} = K_{air} \cdot \left(\frac{\bar{\mu}_{\mathrm{en}}}{\rho} \right)_{\mathrm{air}}^{\mathrm{w}} \cdot B_{\mathrm{w}}$$



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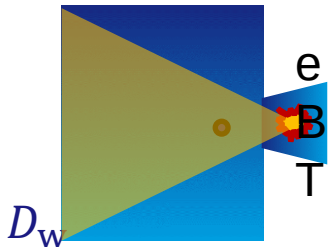
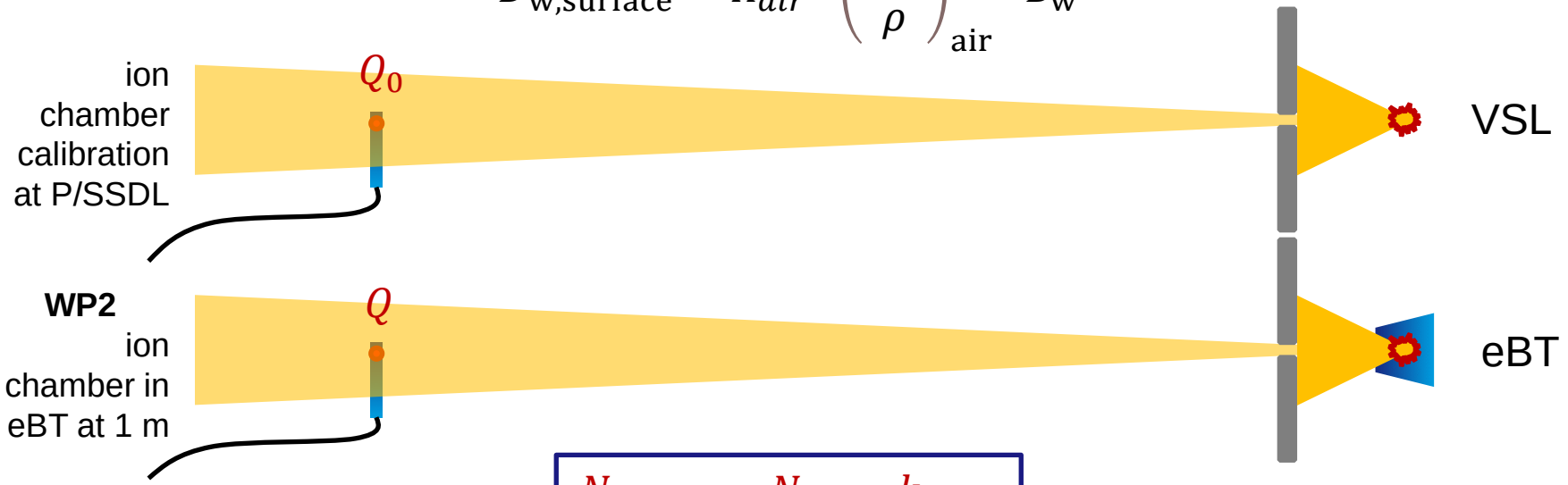


WP2 PRISM-eBT: beoogd formalisme

apply from left to right

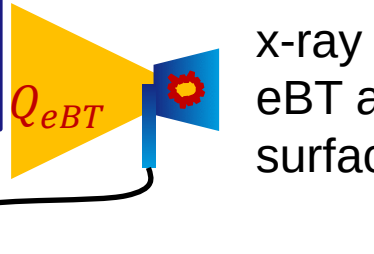
$$D_{\mathrm{w,surface}} = K_{air} \cdot \left(\frac{\bar{\mu}_{\mathrm{en}}}{\rho}\right)^{\mathrm{w}}_{\mathrm{air}} \cdot B_{\mathrm{w}}$$



$$N_{K,Q_{eBT}} = N_{K,Q_0} \cdot k_{Q_{eBT}}$$

$$k_{Q,eBT} = \frac{N_{K,Q_{eBT}}}{N_{K,Q_{1m}}} = \left[\frac{K_{air,eBT.}}{K_{air,1_m}}\right]_Q \cdot \left[\frac{M_{air,1_m}}{M_{air,appl.surf.}}\right]_Q$$

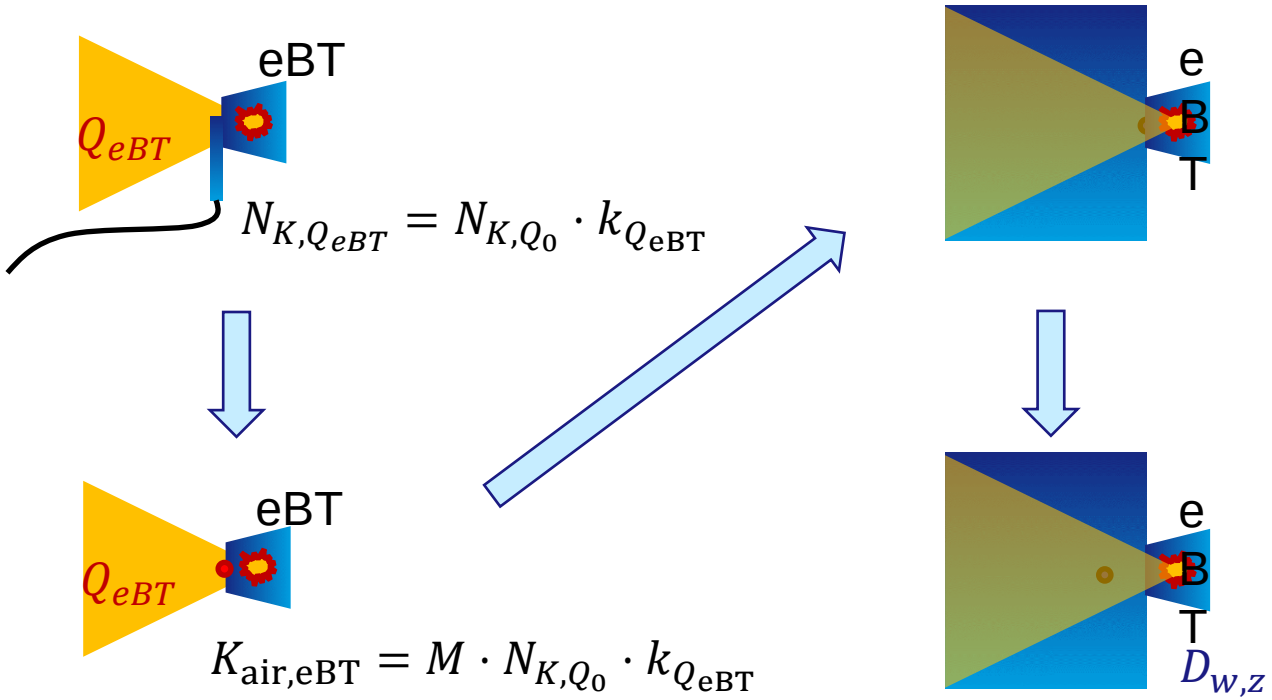
MC measured



x-ray from eBT at surface

WP2 PRISM-eBT: beoogd formalisme

$$N_{K,Q_{eBT}} = N_{K,Q_0} \cdot k_{Q_{\mathrm{eBT}}}$$



$$D_{\mathrm{w,surf}} = K_{\mathrm{air,eBT}} \cdot B_{\mathrm{w,eBT}} \cdot \left(\frac{\bar{\mu}_{\mathrm{en}}}{\rho}\right)^{\mathrm{w}}_{\mathrm{air}}$$

MC spc

$$D_{\mathrm{w,z}} = D_{\mathrm{w,sur}} \cdot k_{z,eBT}$$

measured

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PRISM-eBT: WP2 Traceability for superficial treatment

Potential achievements:

Based on the eBT X-ray spectra, conversion factors for air-kerma (K_a) to surface-dose-to-water ($D_{w,surface}$) can be determined in a consistent way via existing protocols (NCS-10, AAPM TG-61 or DIN 68094) or by modification of the Monte Carlo calculations – with small uncertainties of ~5% (k=1).
For the first time a collection of beam spectral data was obtained under similar circumstances in order to establish eBT dosimetry for superficial systems in a consistent way.

Potential impact:

The impact of the current work will be, that, independent of the system used, a potential method will become available that enables users of different superficial eBT-devices to obtain comparable results in terms of absorbed surface-dose-to-water, $D_{w,surface}$.

Future work (2022):

$D_{w,surface}$ of the phantom, extending this to a depth of 1 cm in a water phantom and then comparing this with the results obtained with standards developed in other work packages of the project, i.e. in WP1.

Questions & Answers …

Wie van jullie gebruikt eBT systemen voor oppervlakte (huid) therapie?