IAEA Absorbe Doz Protokolleri ve Klinik Uygulamalar

FOTONLAR İÇİN REFERANS DOZİMETRİ –IAEA 398

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İçerik

- Giriş
- Neden Yeni Protokol
- TRS 398 -Fotonlar
- Protokol Karşılaştırması TRS398/TRS277
- IAEA Doz Karşılaştırma Sonuçları
- Özet

Code of Practice ???

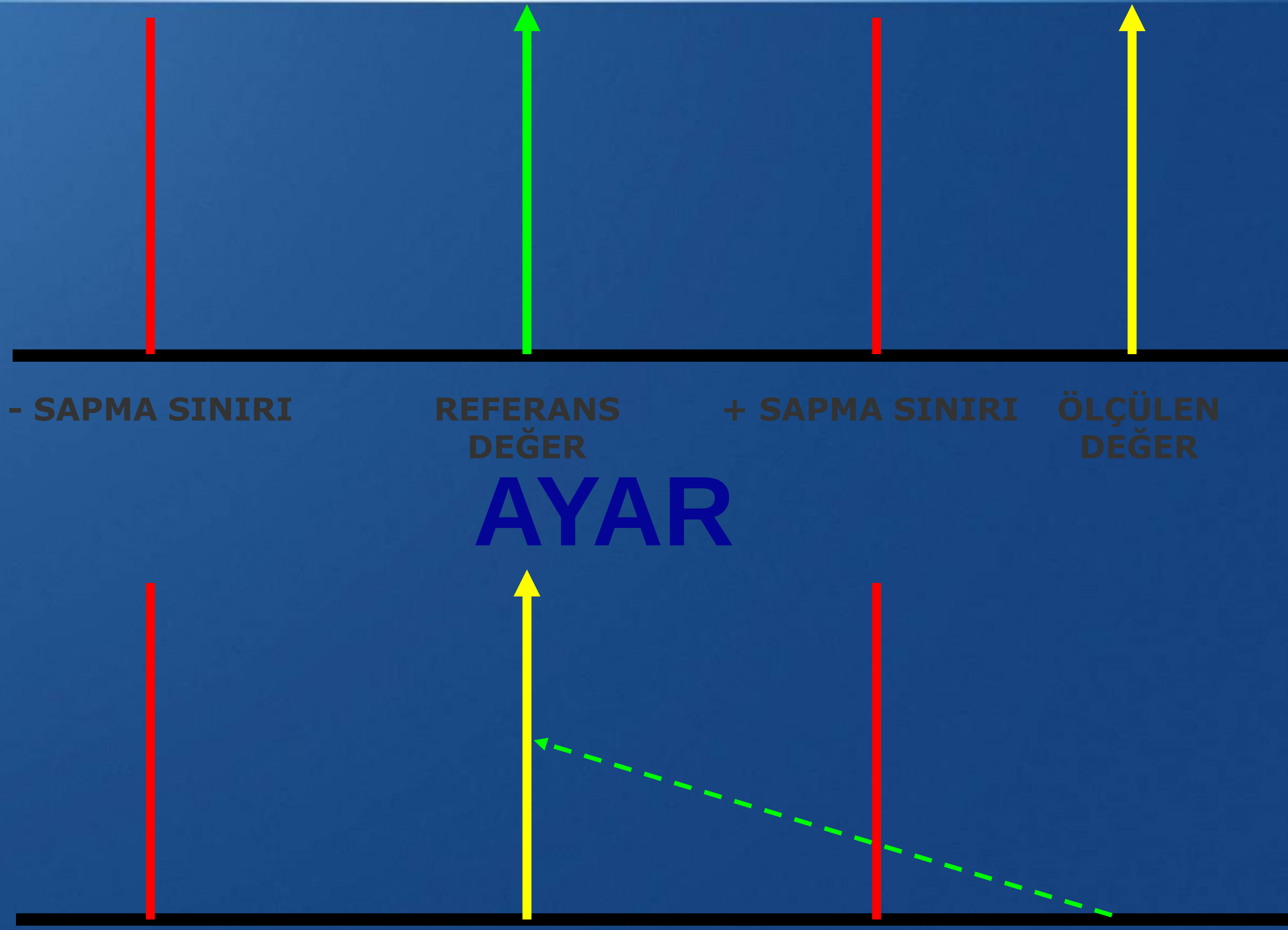
- Suda absorbe dozun kalibre edilmiş bir iyon odası ile nasıl ölçüldüğünün ve hesaplandığının **Prosedürü**
- Ana amaç=Tutarlılık
- Temel bilgi,
  - Ekipman hakkında bilgi,
  - Kalibrasyon faktörü üzerine bilgi,
  - Demet kalitesinin spesifikasyonu ,
  - Demet kalitesinin ölçüm şartları
  - Referans ölçüm şartları,
  - Ölçülen datanın absobe doza dönüştürmek için gerekli dönüşüm faktörlerinin beli

- **PROTOKOL**
  - **Doğruluğu bilinen bir ölçüm standardı veya sistemi**

Kalibrasyon Nedir?

- **Kalibrasyon,**
  - Belirlenmiş koşullar altında,
    - Doğruluğu bilinen bir ölçüm standardını veya sistemini kullanarak diğer test ve ölçüm aletinin doğruluğunun ölçülmesi,
    - Sapmalarının belirlenmesi,
    - Doküman haline getirilmesi için kullanılan ölçümler dizisidir,

KALİBRASYON

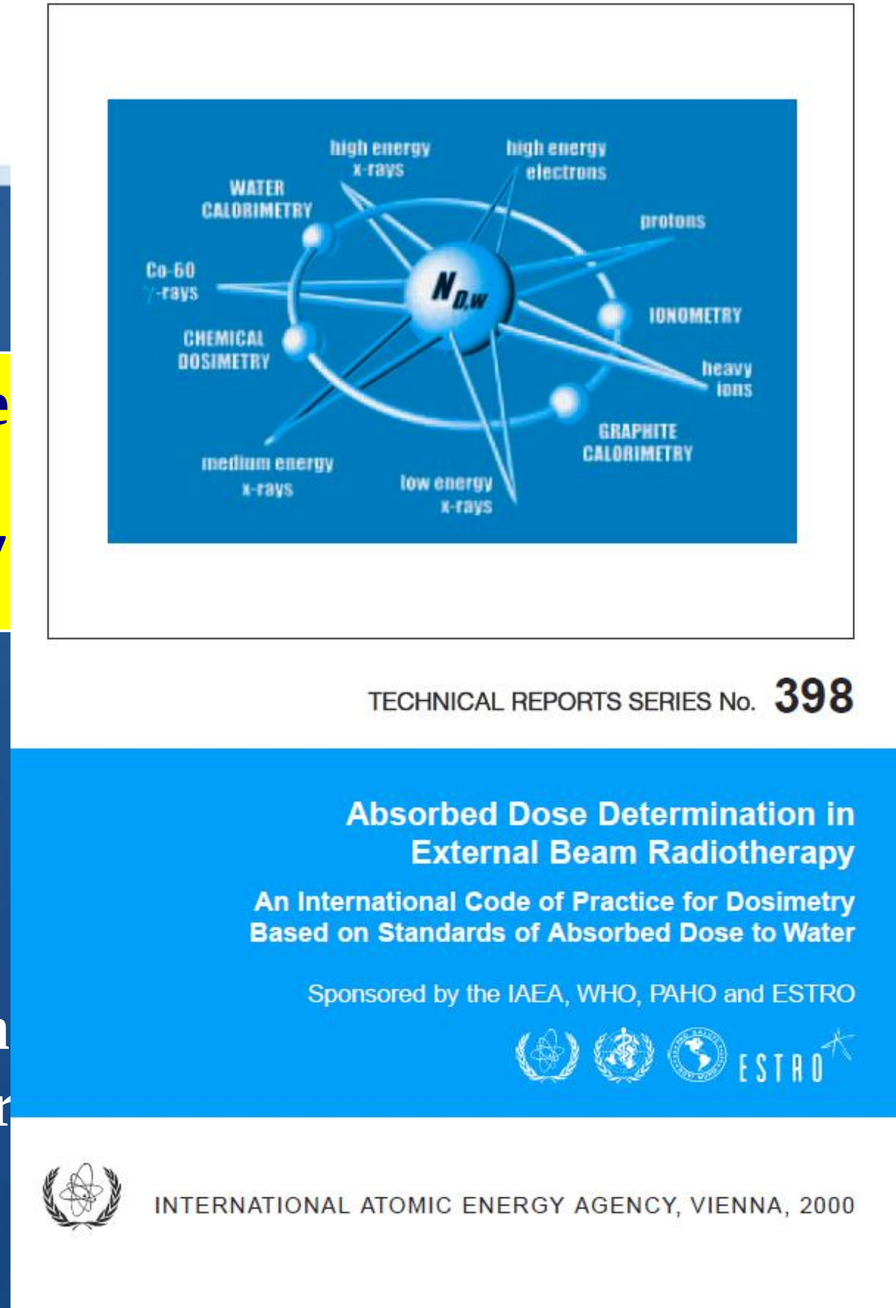


Tarihçe

1987

N_K-base
IAEA
TRS-27

Internation
Codes of Pr
Dosimetry



2000

$_w$-based
AEA
RS-398

Neden Yeni Protokol

Neden yeni bir protokole geçme ihtiyacı duyduk?

Yeni protokolün avantajları NELERDİ?

Neden Yeni Protokol

1. Dozimetri zincirinde tahmin etmesi zor belirsizlikler içeren aşamalar ve komponentler vardı. Örneğin Hava Kerma tabanlı ölçümlerde absorbe doza geçmek için iyon odası bağımlılığı olan dönüşüm faktörlerine ihtiyaç duyuluyordu. Ve bu faktörler aynı model iyon odaları arasındaki özellikle üretim farklılığından doğan farkı dikkate almıyordu,
2. Avrupa'da birçok farklı doz protokolünün kullanılması referans dozimetride inhomojenite oluşturmaktaydı,
3. Eski protokolde olmayan yeni ekipmanların kullanılmaya başlanması,
4. PSDL lerde Dw elde etmek için kullanılan farklı yöntemler,

TRS 398 in Avantajları

- Belirsizlikleri azaltıyor
- PSDL ler için daha GÜÇLÜ bir sistem
- Farklı Radyasyon tiplerine ve demek kalitelerine hitap ediyor
- Daha az faktör gerekiyor kullanıcı için kolay ve pratik
- NDw direkt olarak kullanılıyor.

  Sadece enerji kalitesi için düzeltme var

TRS 398 in Avantajları

- **Belirsizlikleri** azaltıyor
- **PSDL** ler için daha GÜÇLÜ bir sistem
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- Daha az faktör gerekiyor kullanıcı için kolay ve **pratik**
- **N_{Dw} direkt olarak kullanılıyor.**

  Sadece enerji kalitesi için düzeltme var

TRS 277 deki Tahmini Belirsizlik

TABLE XXIII. COMBINED UNCERTAINTIES IN THE DIFFERENT PHYSICAL QUANTITIES OR PROCEDURES

The values of the uncertainties correspond to one standard deviation.
Step 2 in the calibration procedure

Type of physical quantity or procedure	Uncertainty (%)		
	^{60}Co gamma rays	High energy X-rays	Electrons
Interaction coefficients (k_m, k_{att}, $s_{w,air}$, p_u; also uncertainties due to input parameters are included, i.e. $\bar{E}_0$, TPR_{10}^{20})	2.4	2.6	3.2
Field instrument measurements in the therapy beam	0.5	1	1
Dose monitor of the therapy unit	0.5	1.5	1.5
Combined uncertainty	2.5	3.2	3.7

TRS 398 deki Tahmini Belirsizlik Q_0 CO_{60}

TABLE 11. ESTIMATED RELATIVE STANDARD UNCERTAINTY[a] OF D_w AT THE REFERENCE DEPTH IN WATER FOR A ^{60}Co BEAM

Physical quantity or procedure	Relative standard uncertainty (%)
Step 1: Standards laboratory[b]	
$N_{D,w}$ calibration of secondary standard at PSDL	0.5
Long term stability of secondary standard	0.1
$N_{D,w}$ calibration of the user dosimeter at the standards laboratory	0.4
Combined uncertainty of step 1	*0.6*
Step 2: User ^{60}Co beam	
Long term stability of user dosimeter	0.3
Establishment of reference conditions	0.5
Dosimeter reading M_Q relative to timer or beam monitor	0.1
Correction for influence quantities k_i	0.3
Combined uncertainty of step 2	*0.6*
Combined standard uncertainty of D_w (steps 1 + 2)	**0.9**

TRS 398 deki Tahmini Belirsizlik
Q_o Yüksek Enerjili Fotonlar

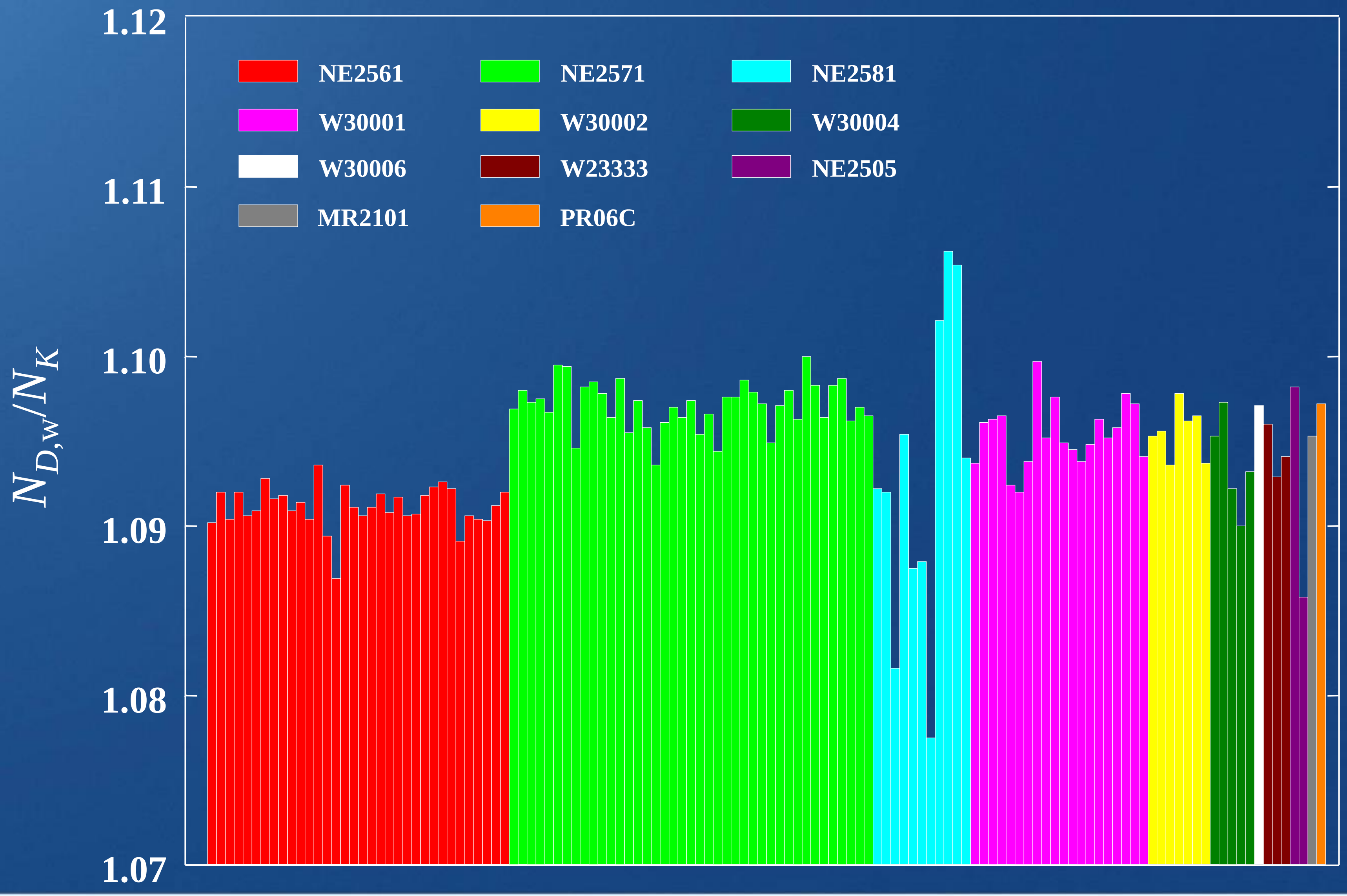
TABLE 15. ESTIMATED RELATIVE STANDARD UNCERTAINTY [a] OF $D_{w,Q}$ AT THE REFERENCE DEPTH IN WATER AND FOR A HIGH ENERGY PHOTON BEAM, BASED ON A CHAMBER CALIBRATION IN ^{60}Co GAMMA RADIATION

Physical quantity or procedure	Relative standard uncertainty (%)
Step 1: Standards laboratory [b]	
$N_{D,w}$ calibration of secondary standard at PSDL	0.5
Long term stability of secondary standard	0.1
$N_{D,w}$ calibration of the user dosimeter at the standard laboratory	0.4
Combined uncertainty of step 1	*0.6*
Step 2: User high energy photon beam	
Long term stability of user dosimeter	0.3
Establishment of reference conditions	0.4
Dosimeter reading M_Q relative to beam monitor	0.6
Correction for influence quantities k_i	0.4
Beam quality correction k_Q (calculated values)	1.0 [c]
Combined uncertainty of step 2	*1.4*
Combined standard uncertainty of $D_{w,Q}$ (steps 1 + 2)	**1.5**

Farklı Enerjilerde Belirsizlikler –TRS 398

Co-60 gamma-rays	0.9
High-energy photons	1.5
High-energy electrons	1.4-2.1
Low energy X-rays	2.2-4.0
Medium energy X-rays	1.9-3.4
Proton beams	2.0-2.3
Heavy ions	3.0

İyon Odaları Arası Variyasyonlar



TRS 398 in Avantajları

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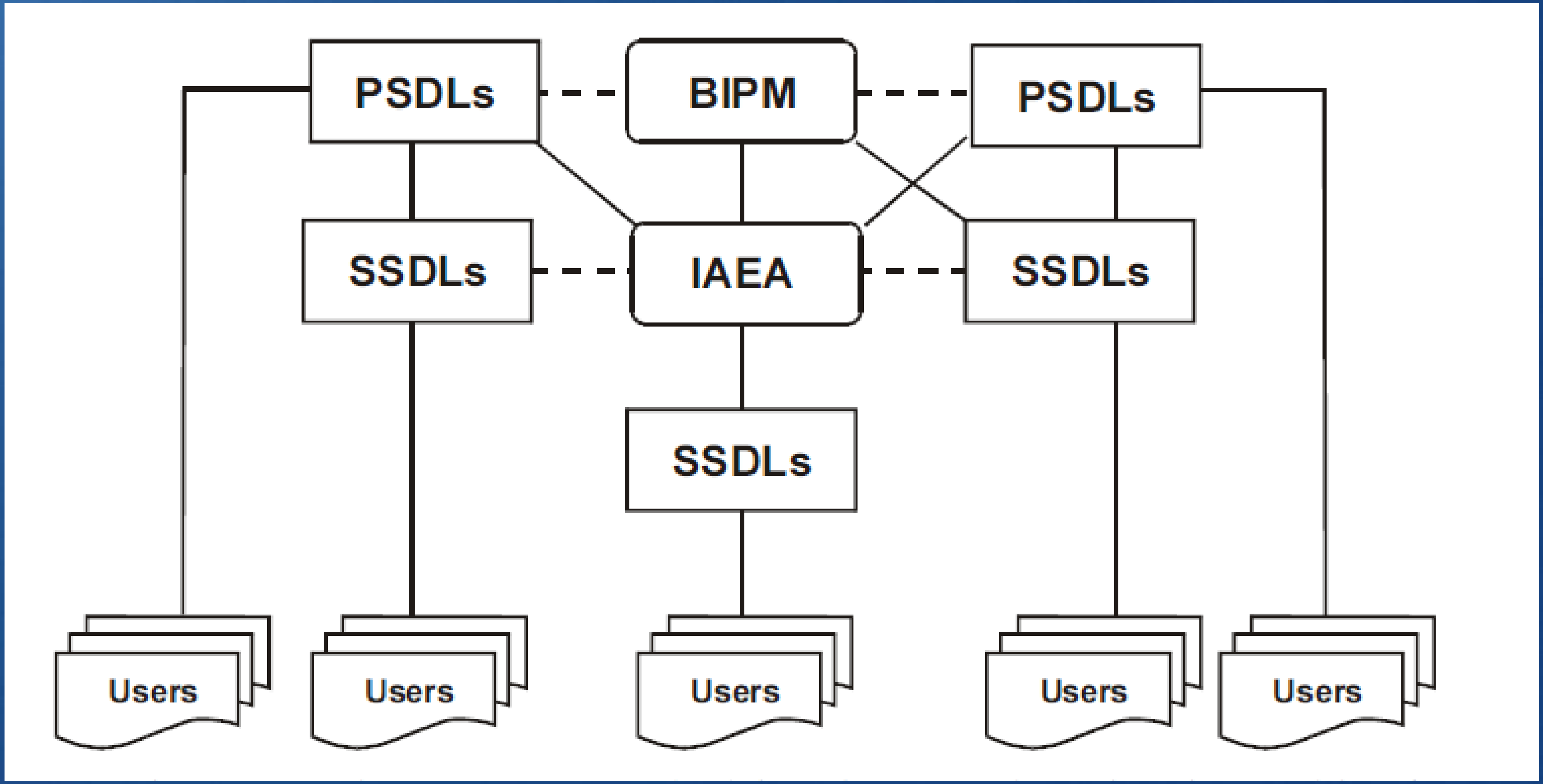
- **PSDL** ler için daha GÜÇLÜ bir sistem
- **Farklı Radyasyon tiplerine** ve demek kalitelerine hitap ediyor
- Daha az faktör gerekiyor kullanıcı için kolay ve **pratik**
- N_{Dw} **direkt olarak kullanılıyor.**

  Sadece enerji kalitesi için düzeltme var

Radyasyon Metrolojisi için Uluslararası Ölçüm Sistemi



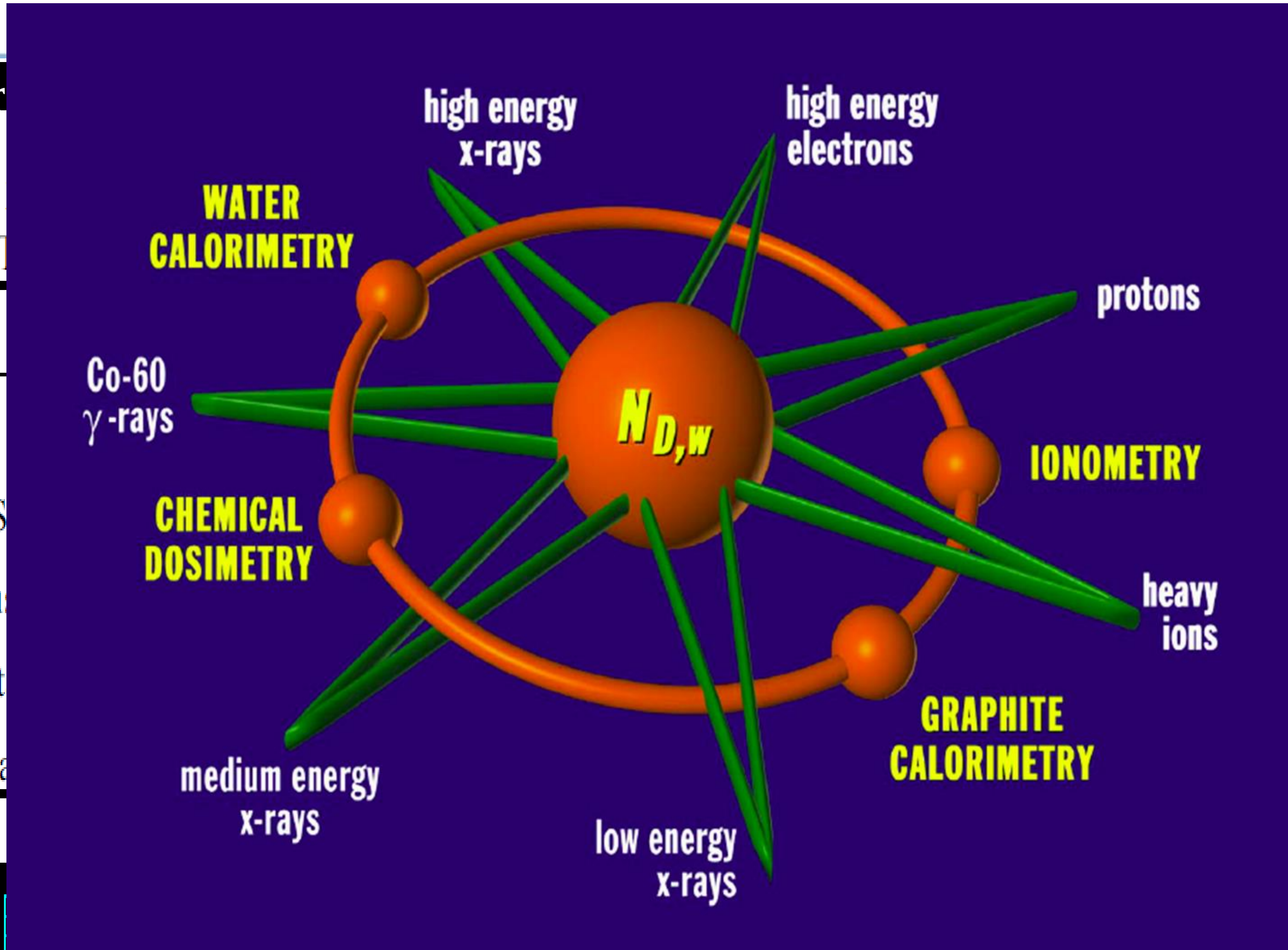
PSDL ler için Güçlü bir Sistem

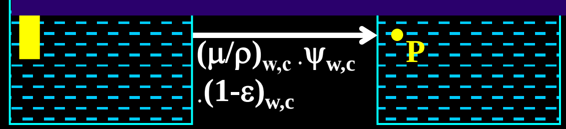
Water calor

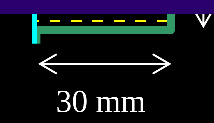
TABLE
TO WA

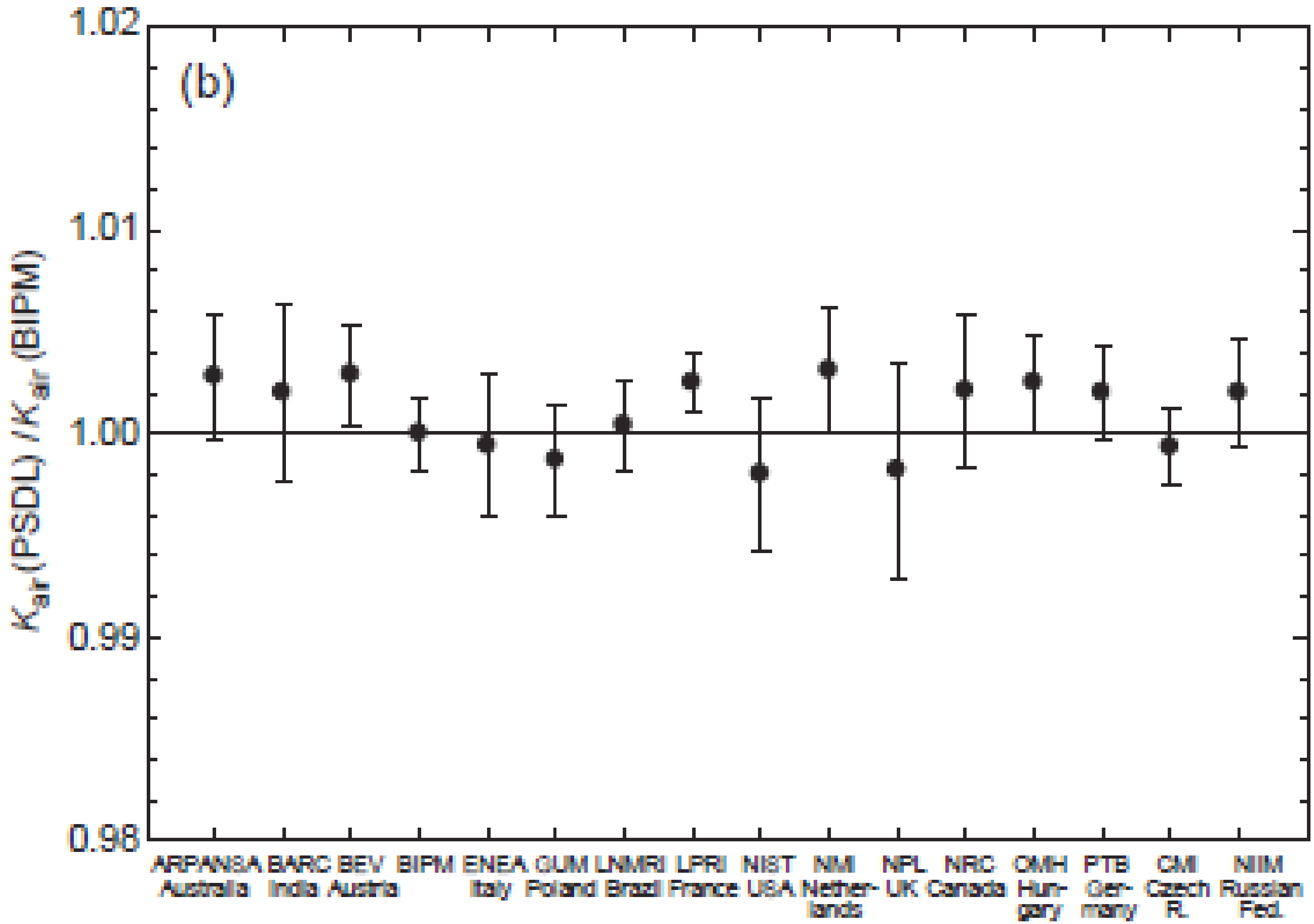
ED DOSE

PSDL	
BIPM	ter
ARPANS	
BEV (Au	ter
ENEA (It	
LPRI (Fr	



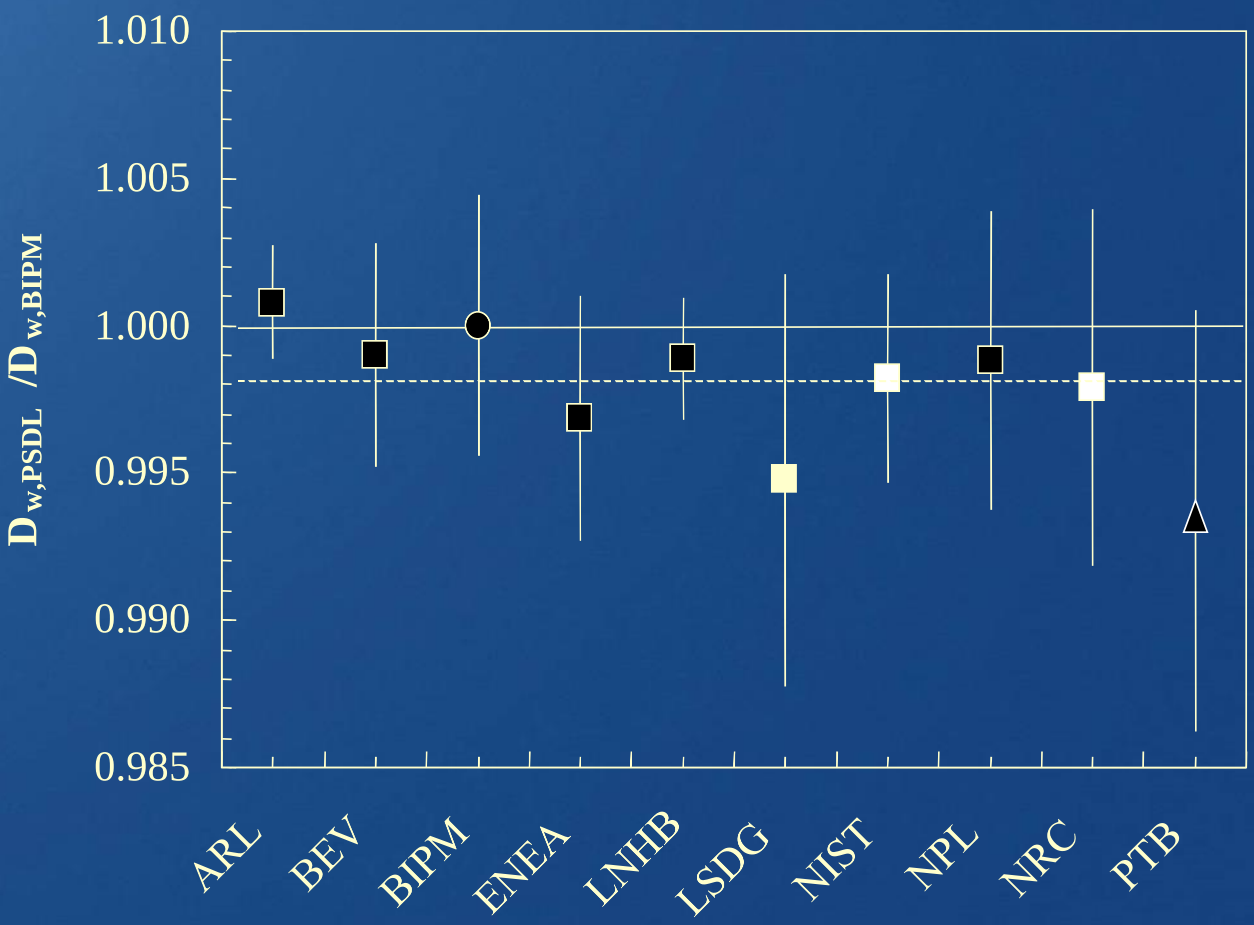






(b)
1.02
1.01
1.00
0.99
0.98
Kair(PSDL) / Kair (BIPM)
ARPANSA Australia
BARC India
BEV Austria
BIPM
ENEA Italy
GUM Poland
LNMRI Brazil
LPRI France
NIST USA
NMI Nether-lands
NPL UK
NRC Canada
OMH Hun-gary
PTB Ger-many
CMI Czech R.
NIIM Russian Fed.

PSDL lerin BIPM le Karşılaştırılması



TRS 398 in Avantajları

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- **Farklı Radyasyon tiplerine** ve demek kalitelerine hitap ediyor
- Daha az faktör gerekiyor kullanıcı için kolay ve **pratik**
- **N_{Dw} direkt olarak kullanılıyor.**
  Sadece enerji kalitesi için düzeltme var

TRS 398 in Çözüm Bulduğu Radyasyon Tipleri

1.3. Types of radiation and range of beam qualities

The present Code of Practice provides a methodology for the determination of absorbed dose to water in the low-, medium- and high-energy photon beams, electron beams, proton beams and heavy-ion beams used for external radiation therapy. The ranges of radiation qualities covered in this document are given below (for a description of the beam quality index see the corresponding Sections):

(a) low-energy x-rays with generating potentials up to 100 kV and HVL of 3 mm Al (the lower limit is determined by the availability of standards) [4]

(b) medium-energy x-rays with generating potentials above 80 kV and HVL of 2 mm Al [4]

(c) ^{60}Co gamma-radiation

(d) high-energy photons generated by electrons with energies in the interval 1 MeV to 50 MeV, with $TPR_{20,10}$ values between 0.50 and 0.84

(e) electrons in the energy interval 3 MeV to 50 MeV, with a half-value depth, R_{50}, between 1 g cm^{-2} and 20 g cm^{-2}

(f) protons in the energy interval 50 MeV to 250 MeV, with a practical range, R_p, between 0.25 g cm^{-2} and 25 g cm^{-2}

(g) heavy ions with Z between 2 (He) and 18 (Ar) having a practical range in water, R_p, of 2 g cm^{-2} to 30 g cm^{-2} (for carbon ions this corresponds to an energy range of 100 MeV/u to 450 MeV/u, where u is the atomic mass unit).

TRS 398 in Avantajları

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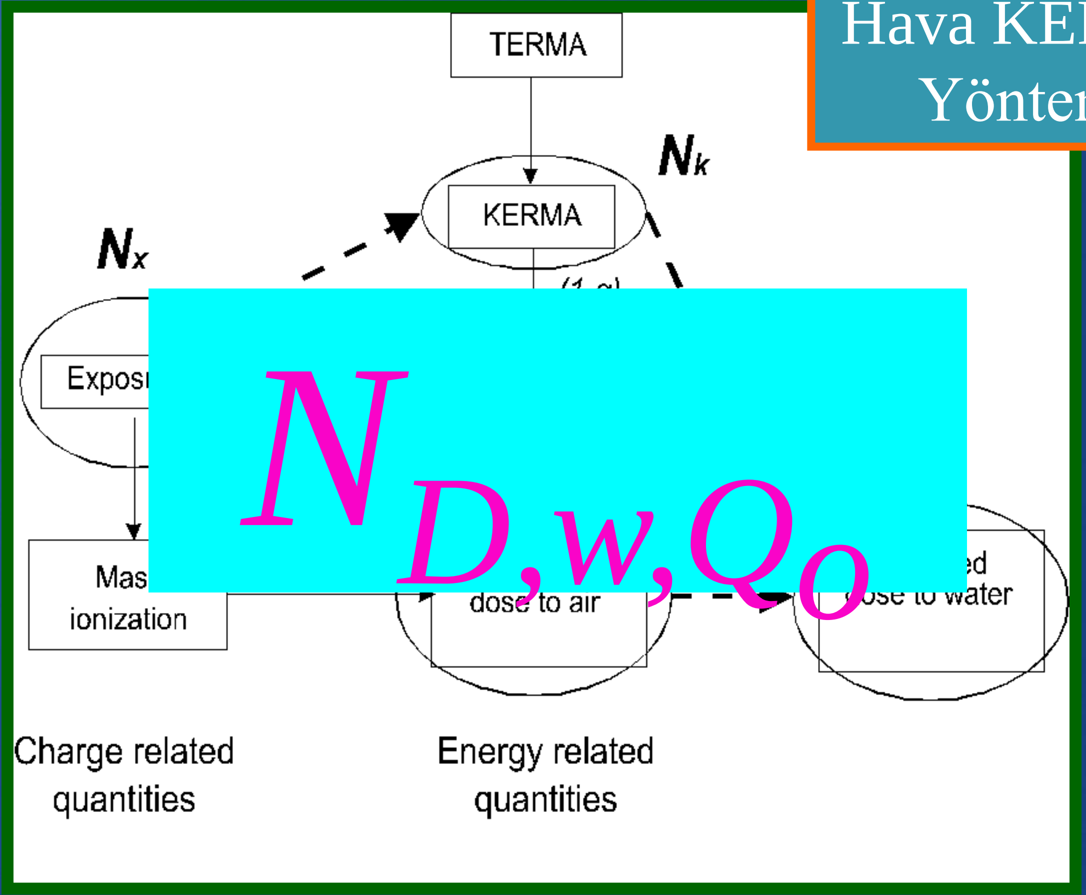
- **Daha az faktör gerekiyor kullanıcı için kolay ve pratik**
- **N_{Dw} direkt olarak kullanılıyor.**
  Sadece enerji kalitesi için düzeltme var

Basit Formalizm

Hava KERMA Yöntemi



$$N_{D,w,Q_0}$$

NK-ND,air -ND,w Formalizminin Farkları

	TRS 277	TRS 398
(1)	K_{air,Q_o}	D_{w,Q_o}
(2)	$N_K = \dfrac{K_{air,Q_o}}{M_{Q_o}}$	$N_{D,w,Q_o} = \dfrac{D_{w,Q_o}}{M_{Q_o}}$
(3)	$N_{D,air,Q_o} = \dfrac{\overline{D}_{air,Q_o}}{M_{Q_o}}$ $= N_K \times (1-g) \times k_{att} k_m k_{cel}$	
(4)	$N_{D,air,Q} = N_{D,air,Q_o} = N_{D,air}$	
(5)	$D_{w,Q} = \overline{D}_{air,Q_o} \times (s_{w,air})_Q \times p_Q$	
(6)	$D_{w,Q} = M_Q \times N_{D,air} \times (s_{w,air})_Q \times p_Q$	$D_{w,Q} = M_Q \times N_{D,w,Q_o} \times k_{Q,Q_o}$

REFERANS DOZİMETRİ

FOTONLAR

$N_{D,w}$ Tabanlı Formlizmin

- Kalibrasyon yapılan Q_o enerjisnde:

$$D_{w,Q_o} = M_{Q_o} N_{D,w,Q_o}$$

$$M_{Q_o} = M_{raw} k_{TP} k_{elec} k_{pol} k_s$$

- *Farklı diğer Q enerjisinde*:
(foton, elektron, proton, ağır parçacıklar)

$$D_{w,Q} = M_Q N_{D,w,Q_o} k_{Q,Q_o}$$

Demet Kalite Faktörü

Nedir k_{Q,Q_0} ?

- k_{Q,Q_0} =Referans demet kalitesi Q_o ile kullanılan demet kalitesi Q arasındaki farkı düzeltir.

$$\boxed{k_{Q,Qo} = \frac{N_{D,W,Q}}{N_{D,W,Qo}}}$$

$k_{Q,Qo}$ nun Teorik Tanımı

based on Bragg-Gray cavity theory

$$k_{Q,Q_0} = \frac{(s_{w,air})_Q}{(s_{w,air})_{Q_0}} \frac{(W_{air})_Q}{(W_{air})_{Q_0}} \frac{p_Q}{p_{Q_0}} \approx \frac{(s_{w,air})_Q}{(s_{w,air})_{Q_0}} \frac{p_Q}{p_{Q_0}}$$

(elektron ve foton demetleri için)

- Tüm yüksek enerjili demetler için geçerli
- Fotonlar için hesaplanan k_Q ve ölçülen (by PSDLs) çoğu iyon odası için uyum içinde
- *Sadec* p_Q ve p_{Qo} iyon odası faktörlerdir.
- Düşük ve Orta seviye enerjili X-Işınlarında Bragg-Grayy şartları olmadığından yukarıda formalizm çalışmaz.

$N_{D,w}$ – Bize Nasıl Ulaşıyor

(1) N_{D,w,Q_0} + k_{Q,Q_0}(adı geçen iyon odası için direk olarak ölçülen deneysel)

(2) (2) N_{D,w,Q_0} + belirli $N_{D,w,Q}$ serileri

$\Rightarrow k_{Q,Q_0} = N_{D,w,Q} / N_{D,w,Q_0}$

$\Rightarrow$ (1)

(3) N_{D,w,Q_0}

$\Rightarrow$ Hesaplanan k_{Q,Q_0} (Tablo 6.III)

(4) N_{D,w,Q_0} + jenerik deneysel k_{Q,Q_0} (iyon odası tipleri için)

Etki Parametrelerini Düzeltmek

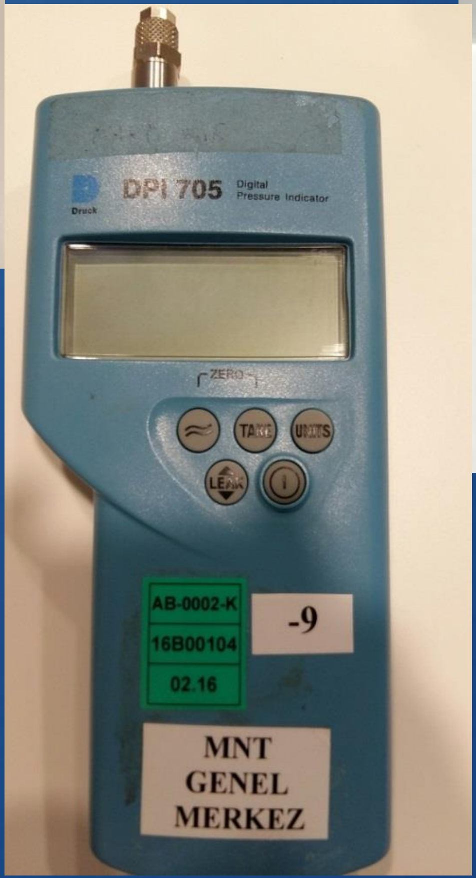
- Basınç , Isı ve Nem : kTP

$$k_{Tp} = \frac{(273.15 + T)}{(273.15 + T_0)} \frac{p_0}{p}$$

- Elektrometre Kalibrasyonu : kelec

  Ayrı bir kalibrasyon faktörü yoksa 1 kullan.

BASINÇ VE ISI ÖLÇERLER



Etki Parametrelerini Düzeltmek

- Polarite Etkisi :kpol

$$k_{pol} = \frac{|M_+| + |M_-|}{2M}$$

kpol > 0.5%   ise iyon odasını kullanma

- İon Rekombinasyon Etkisi : ks
- Ağır iyonlar dışında genelde rekombinasyon < 0.2%

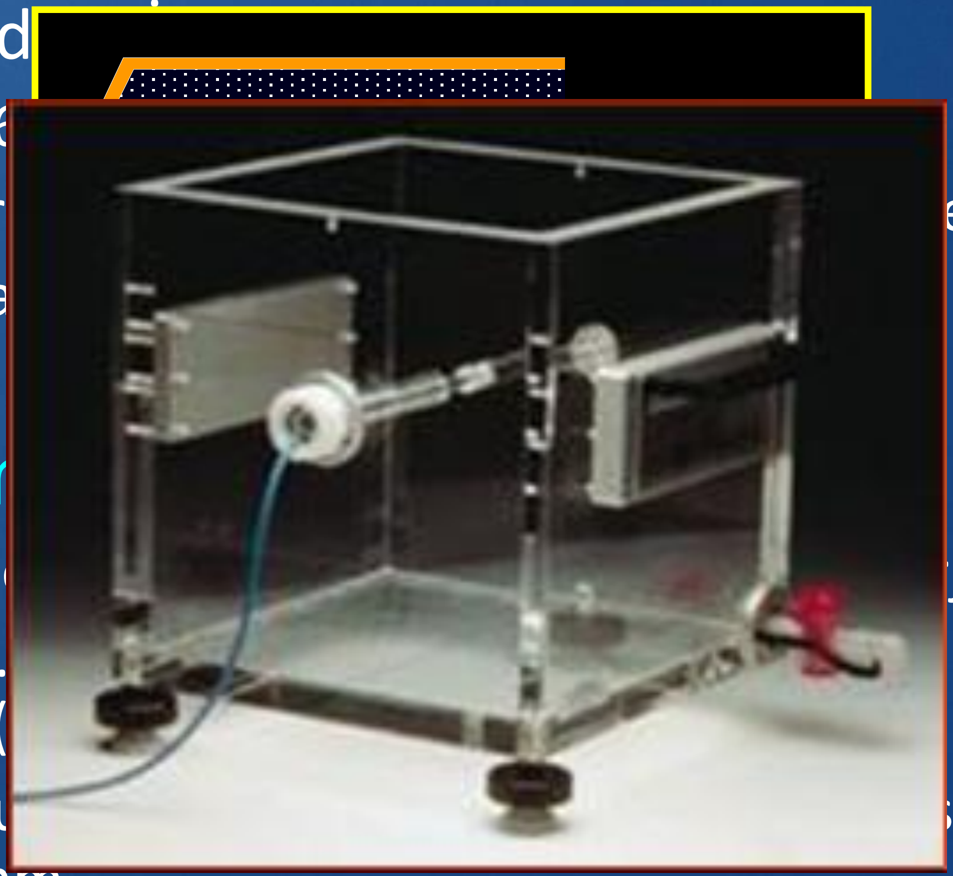
(V_1/V_2) 2 Voltaj Tekniği

$$k_s = a_0 + a_1\left(\frac{M_1}{M_2}\right) + a_2\left(\frac{M_1}{M_2}\right)^2 \quad \text{(for pulsed beams)}$$

$$k_s = \frac{(V_1/V_2)^2 - 1}{(V_1/V_2)^2 - (M_1/M_2)} \quad \text{(for continuous beams)}$$

Ölçümlerinde Dozimetrik Ekipman

- İyon odaları FOTON
  - Silind
    - 0.6
    - Gr   eli
    - Na



- Fanto
    - H   j
    - 0.
      (
    - Su   luğu 0.1 - 0.3 mm

TABLE 4.I. CHARACTERISTICS OF CYLINDRICAL IONIZATION CHAMBER TYPES (*as stated by manufacturers*).

Ionization chamber type [a]	Cavity volume (cm^3)	Cavity length (mm)	Cavity radius (mm)	Wall material	Wall thickness ($g\ cm^{-2}$)	Build-up cap material [b,c]	Build-up cap thickness [b,c] ($g\ cm^{-2}$)	Central electrode material [c]	Waterproof
PTW 23333 (3 mm cap)	0.6	21.9	3.1	PMMA [e]	0.059	PMMA	0.356	aluminium	N
PTW 23333 (4.6 mm cap)	0.6	21.9	3.1	PMMA [e]	0.053	PMMA	0.551	aluminium	N
PTW 30001 Farmer	0.6	23.0	3.1	PMMA [e]	0.045	PMMA	0.541	aluminium	N
PTW 30010 Farmer	0.6	23.0	3.1	PMMA [e]	0.057	PMMA	0.541	aluminium	N
PTW 30002/30011 Farmer	0.6	23.0	3.1	graphite	0.079	PMMA	0.541	graphite	N
PTW 30004/30012 Farmer	0.6	23.0	3.1	graphite	0.079	PMMA	0.541	aluminium	N
PTW 30006/30013 Farmer	0.6	23.0	3.1	PMMA [e]	0.057	PMMA	0.541	aluminium	Y
PTW 31002 flexible	0.13	6.5	2.8	PMMA [e]	0.078	PMMA	0.357	aluminium	Y
PTW 31003 flexible	0.3	16.3	2.8	PMMA [e]	0.078	PMMA	0.357	aluminium	Y
PTW 31006 PinPoint	0.015	5.0	1.0	PMMA [e]	0.078			steel	Y
PTW 31014 PinPoint	0.015	5.0	1.0	graphite	0.086			aluminium	Y
SNC 100700-0 Farmer	0.6	24.4	3.1	PMMA	0.060	PMMA	0.536	aluminium	N
SNC 100700-1 Farmer	0.6	24.4	3.1	graphite	0.085	PMMA	0.536	aluminium	N
Victoreen Radocon III 550	0.3	4.3	2.5	Delrin	0.529		0.536		N
Victoreen Radocon II 555	0.1	23.0	2.4	polystyrene	0.117	PMMA	0.481		N
Victoreen 30-348	0.3	18.0	2.5	PMMA	0.060	PMMA	0.360		N
Victoreen 30-351	0.6	23.0	3.1	PMMA	0.060	PMMA	0.360		N
Victoreen 30-349	1.0	22.0	4.0	PMMA	0.060	PMMA	0.360		N
Victoreen 30-361	0.4	22.3	2.4	PMMA	0.144	PMMA	0.360		N
Scdx-Wellhöfer CC01	0.01	3.6	1.0	C-552	0.088			steel	Y
Scdx-Wellhöfer CC04/IC04	0.04	3.6	2.0	C-552	0.070			C-552	Y
Scdx-Wellhöfer CC08/IC05/IC06	0.08	4.0	3.0	C-552	0.070			C-552	Y
~~Scdx-Wellhöfer IC06~~	~~0.08~~	~~4.0~~	~~3.0~~	~~C-552~~	~~0.068~~			~~C-552~~	~~Y~~
~~Scdx-Wellhöfer IC10~~	~~0.14~~	~~6.3~~	~~3.0~~	~~C-552~~	~~0.068~~			~~C-552~~	~~Y~~
Scdx-Wellhöfer CC13/IC10/IC15	0.13	5.8	3.0	C-552	0.070			C-552	Y
Scdx-Wellhöfer CC25/IC25	0.25	10.0	3.0	C-552	0.070			C-552	Y
Scdx-Wellhöfer FC23-C/IC28 Farmer shortened	0.23	8.8	3.1	C-552	0.070	POM [f]	0.560	C-552	Y
Scdx-Wellhöfer FC65-P/IC 69 Farmer	0.65	23.1	3.1	POM [f]	0.057	POM [f]	0.560	aluminium	Y
Scdx-Wellhöfer FC65-G/IC 70 Farmer	0.65	23.1	3.1	graphite	0.073	POM [f]	0.560	aluminium	Y

Ölçüm Pratikleri

- Dozimetrenin Stabilitesi
  - Kontrol kaynağı kullanılmalı
- Elektrometrenin Stabilitesi
  - Yaklaşık 30 dk önce açılmalı
- Ön ışınlama :2 Gy -5Gy
- İlk 1-2 Okumayı atın
- Polarite modifikasyonu sonrası yaklaşık 20 dk bekleyin
- Sızıntı testi <0.1% Ölçüm den

TABLE 6.III. CALCULATED VALUES OF k_Q FOR HIGH-ENERGY PHOTON BEAMS, FOR VARIOUS CYLINDRICAL IONIZATION CHAMBERS AS A FUNCTION OF BEAM QUALITY $TPR_{20,10}$

(Adapted from Andreo [20]*)*

$TPR_{20,10}$

Atenüsayon Özelliği

Ionization chamber type [a]	0.50	0.53	0.56	0.59	0.62	0.65	0.68	0.70	0.72	0.74	0.76	0.78	0.80	0.82	0.84
PTW 23323 micro	1.003	1.003	1.000	0.999	0.997	0.993	0.990	0.987	0.984	0.980	0.975	0.967	0.960	0.953	0.941
PTW 23331 rigid	1.004	1.003	1.000	0.999	0.997	0.993	0.990	0.988	0.985	0.982	0.978	0.971	0.964	0.956	0.945
PTW 23332 rigid	1.004	1.003	1.001	0.999	0.997	0.994	0.990	0.988	0.984	0.980	0.976	0.968	0.961	0.954	0.943
PTW 23333	1.004	1.003	1.001	0.999	0.997	0.994	0.990	0.988	0.985	0.981	0.976	0.969	0.963	0.955	0.943
PTW 30001/30010 Farmer	1.004	1.003	1.001	0.999	0.997	0.994	0.990	0.988	0.985	0.981	0.976	0.969	0.962	0.955	0.943
PTW 30002/30011 Farmer	1.006	1.004	1.001	0.999	0.997	0.994	0.992	0.990	0.987	0.984	0.980	0.973	0.967	0.959	0.948
PTW 30004/30012 Farmer	1.006	1.005	1.002	1.000	0.999	0.996	0.994	0.992	0.989	0.986	0.982	0.976	0.969	0.962	0.950
PTW 30006/30013 Farmer	1.002	1.002	[illegible]	[illegible]	[illegible]	0.994	[illegible]	0.988	0.984	0.980	0.975	0.968	0.960	0.952	0.940
PTW 31002 flexible	1.003	1.002	1.000	0.999	0.997	0.994	0.990	0.988	0.984	0.980	0.975	0.968	0.960	0.952	0.940
PTW 31003 flexible	1.003	1.002	1.000	0.999	0.997	0.994	0.990	0.988	0.984	0.980	0.975	0.968	0.960	0.952	0.940
PTW 31006 PinPoint	1.004	1.003	1.001	0.999	[illegible]	0.995	[illegible]	0.989	0.985	0.980	0.974	0.966	0.959	0.951	0.940
PTW 31014 PinPoint	1.004	1.003	1.001	0.999	0.998	0.995	0.992	0.989	0.985	0.980	0.975	0.967	0.959	0.952	0.941
SNC 100700-0 Farmer	1.005	1.004	1.001	0.999	0.998	0.995	0.992	0.989	[illegible]	0.981	0.976	0.969	0.962	0.954	0.943
SNC 100700-1 Farmer	1.007	1.006	1.003	1.001	0.999	0.997	0.995	0.993	0.990	0.986	0.983	[illegible]	0.969	0.961	0.951
Victoreen Radocon III 550	1.005	1.004	1.001	0.998	0.996	0.993	0.989	0.986	0.983	0.979	0.975	0.968	0.961	0.954	0.943
Victoreen Radocon II 555	1.005	1.003	1.000	0.997	0.995	0.990	0.986	0.983	0.979	0.975	0.970	0.963	0.956	0.949	0.938
Victoreen 30-348	1.004	1.003	1.000	0.998	0.996	0.992	0.989	[illegible]	0.982	0.978	0.971	0.966	0.959	0.951	0.940
Victoreen 30-351	1.004	1.002	1.000	0.998	0.996	0.992	0.989	0.986	0.983	0.979	0.974	0.967	0.960	0.952	0.941
Victoreen 30-349	1.003	1.002	1.000	0.998	0.996	0.992	0.989	0.986	[illegible]	0.980	0.976	0.969	0.962	0.954	0.942
Victoreen 30-361	1.004	1.003	1.000	[illegible]	0.996	0.992	0.989	0.986	0.983	0.979	0.974	0.967	0.960	0.953	0.942
Scdx-Wellhöfer CC01	1.002	1.002	1.002	1.001	1.000	0.999	0.996	0.994	0.991	0.986	0.981	0.972	0.964	0.956	0.944
Scdx-Wellhöfer CC04/IC04	1.001	1.001	1.001	1.000	0.999	0.997	0.995	0.992	0.989	0.984	0.979	0.970	0.962	0.953	0.941
Scdx-Wellhöfer CC08/IC05/IC06	1.001	1.001	1.001	1.000	0.999	0.997	0.995	0.993	0.989	0.985	0.980	0.972	0.964	0.955	0.943
Scdx-Wellhöfer CC13/IC10/IC15	1.001	1.001	1.001	1.000	0.999	0.997	0.995	0.993	0.989	0.985	0.980	0.972	0.964	0.955	0.943
Scdx-Wellhöfer CC25/IC25	1.001	1.001	1.001	1.000	0.999	0.997	0.995	0.993	0.989	0.985	0.980	0.972	0.964	0.955	0.943
Scdx-Wellhöfer FC23-C/IC28 Farmer shortened	1.001	1.001	1.001	1.000	0.999	0.997	0.995	0.993	0.990	0.985	0.980	0.972	0.964	0.955	0.943
Scdx-Wellhöfer FC65-P/IC69 Farmer	1.003	1.002	1.001	0.999	0.998	0.995	0.993	0.990	0.986	0.981	0.976	0.968	0.960	0.952	0.940
Scdx-Wellhöfer FC65-G/IC70 Farmer	1.005	1.004	1.002	1.000	0.998	0.997	0.995	0.992	0.989	0.985	0.981	0.973	0.966	0.958	0.947

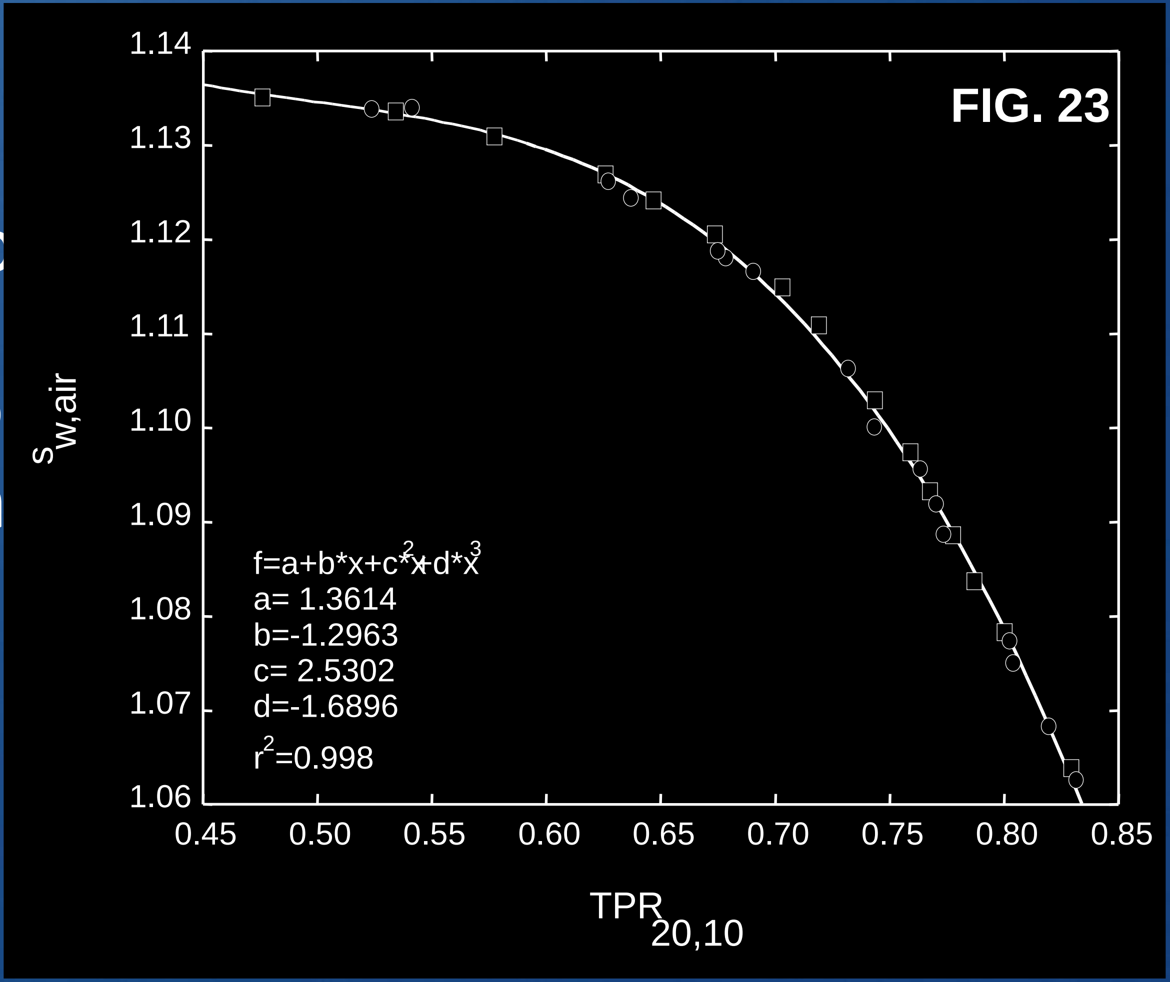
[a] Some of the chambers listed in this table fail to meet some of the minimum requirements described in Section 4.2.1. However, they have been included in this table because of their current clinical use.

Demet Kalitesi Belirleyiciler

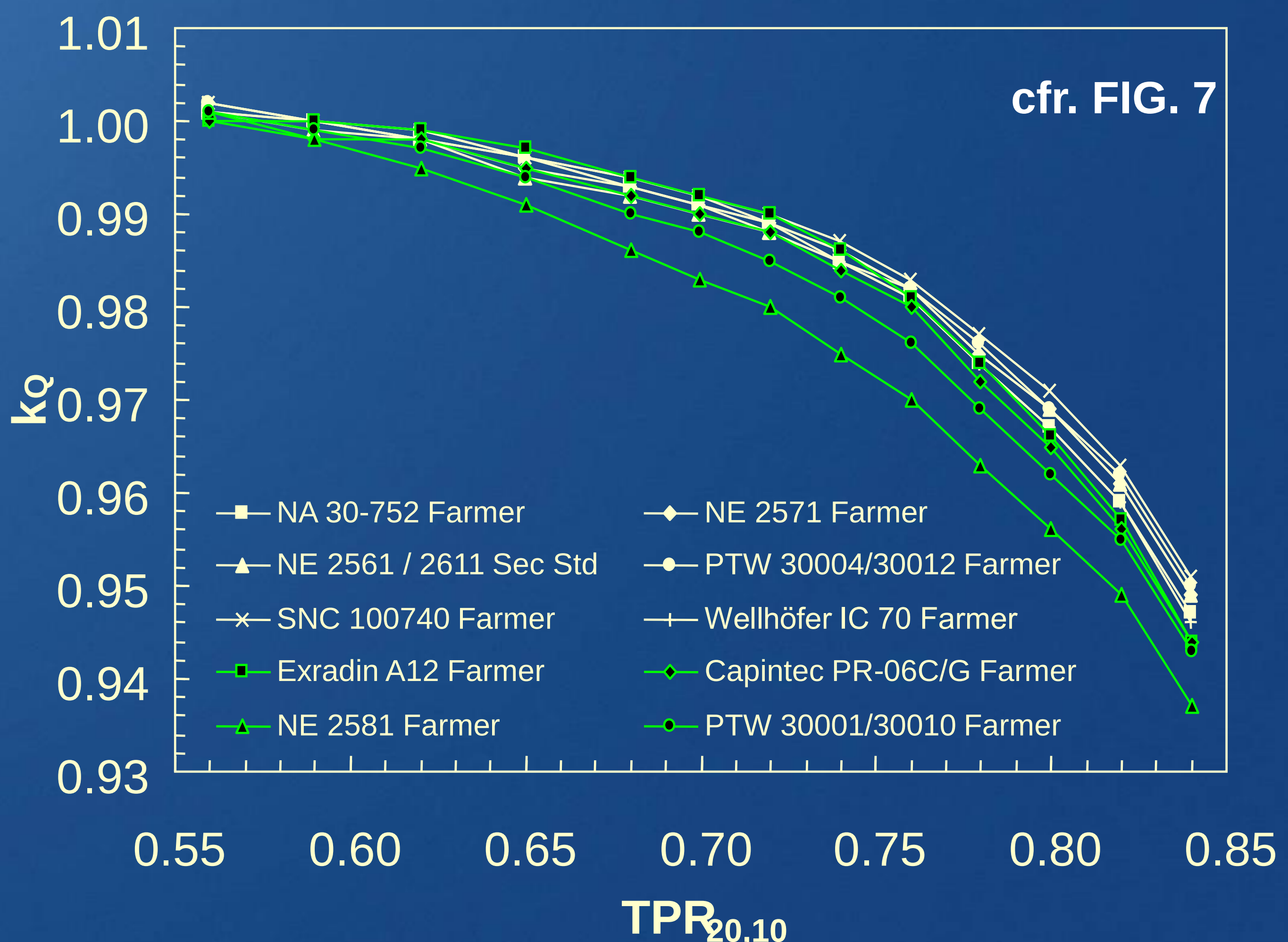
- Nominal Akselerator Potansiyeli
- $TPR_{20,10}$
- D_{80}
- PDD(10)
- PDD(10)x (AAPM TG51)

Neden $TPR_{20,10}$?

- Saf bir
- Elektro … yor.
- İyon o … etkilen



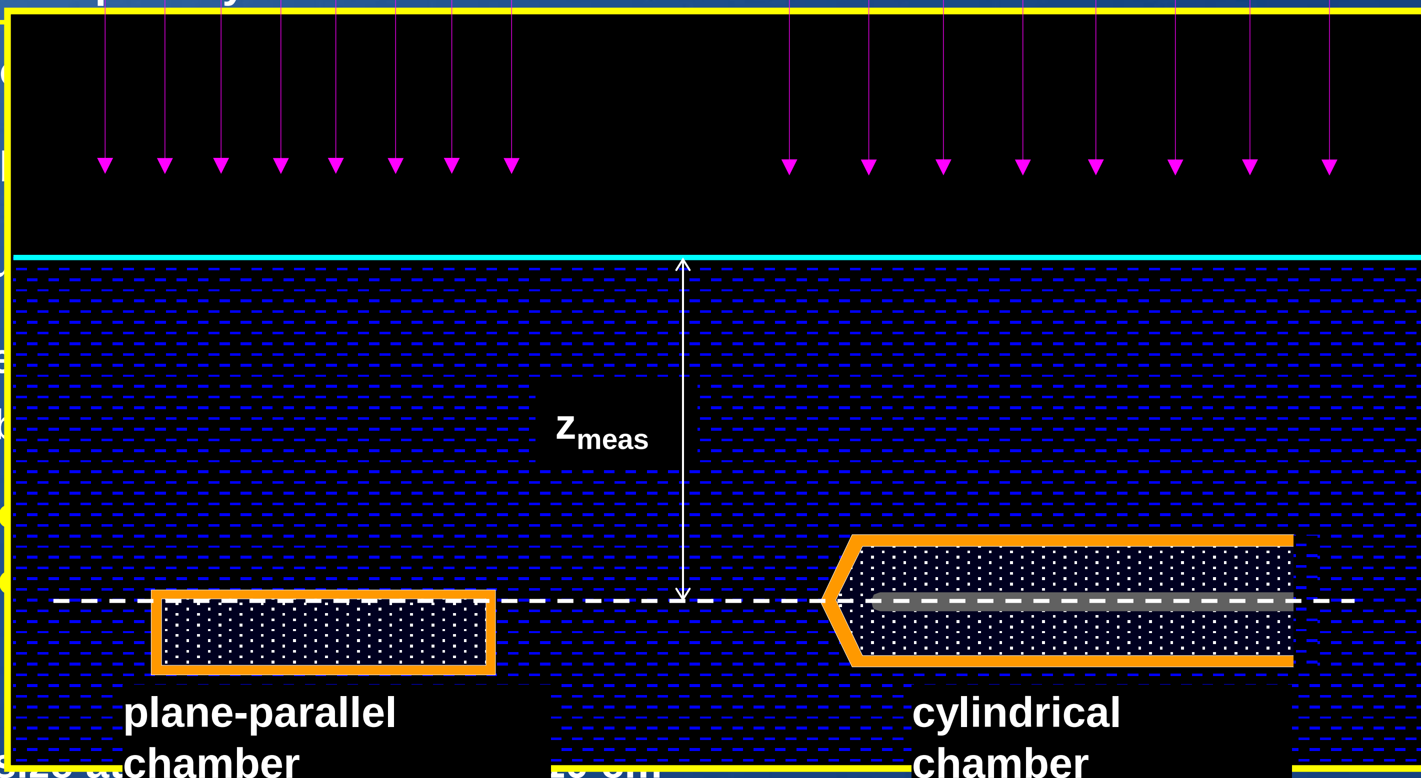
k_Q Değerleri



graphical procedure also involved a unique correspondence between MV and ionization ratios, similar to the drawback pointed out for the NACP recommendations [8, 166]. Andreo and Brahme [78] showed that the use of only the nominal accelerator potential, ignoring the actual penetration properties of a clinical beam, could yield variations of up to 1.5% in the stopping-power ratio. It is mainly for this reason that the use of $TPR_{20,10}$ was considered to be the more appropriate choice for radiotherapy beams, rather than using the nominal accelerating potential.

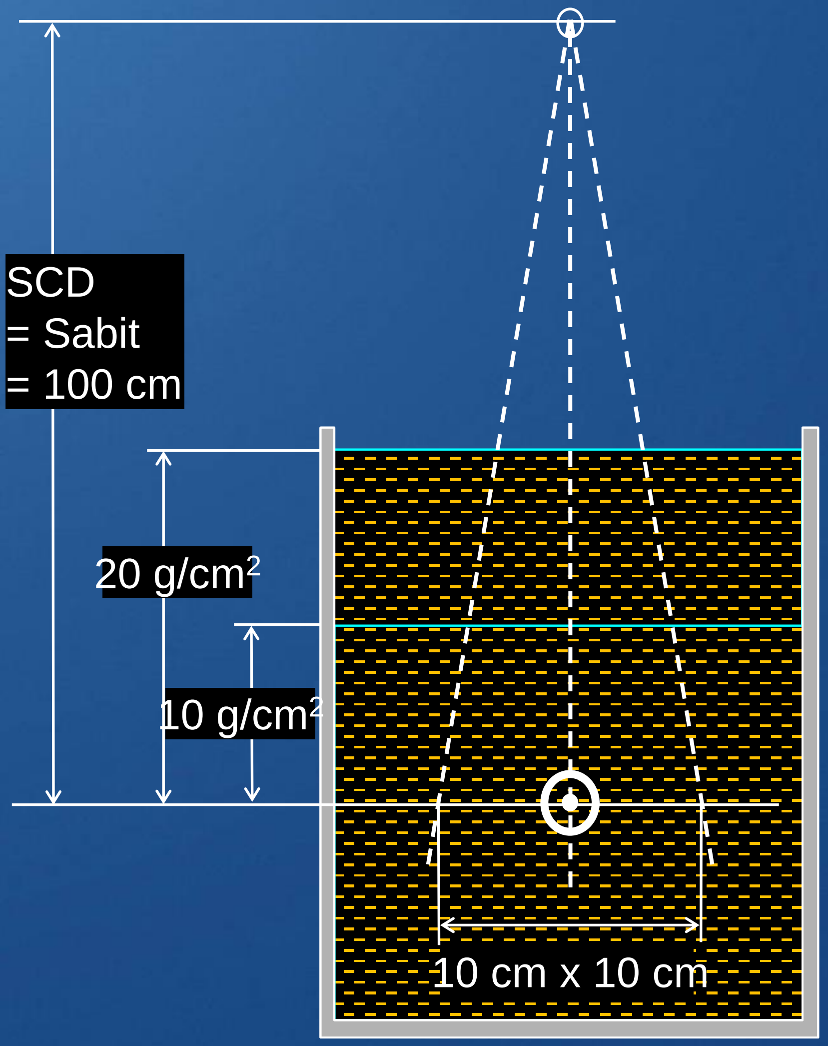
$TPR_{20,10}$ Belirlenmesinde Referans Şartlar

Influence quantity	Reference value or reference characteristics
Phant	
Chamb	
Measu	
Refere	cavity volume
chamb	at its centre
Positi	nent depths
point	
SCD	
Field s	



[a] The field size is defined at the plane of the reference point of the detector, placed at the recommended depths in the water phantom

Demet Kalitesi: $TPR_{20,10}$ Belirlenemsi

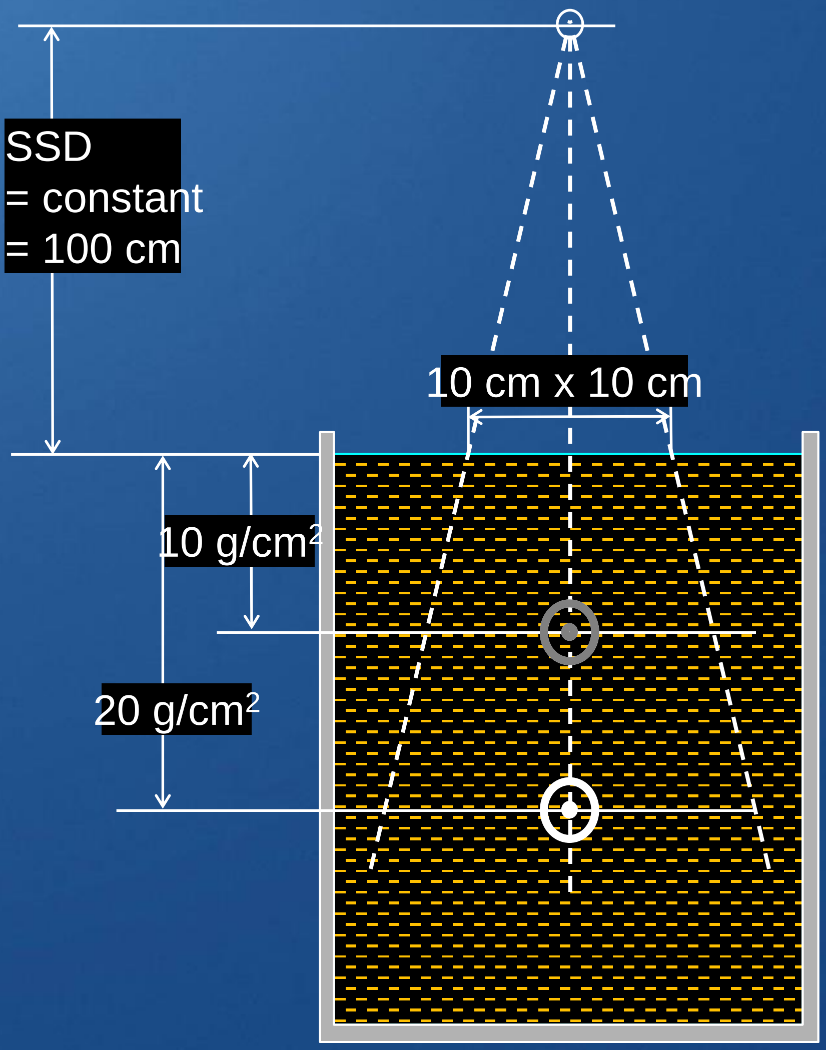


$\Rightarrow M_{10}$

$\Rightarrow M_{20}$

$$TPR_{20,10} = \frac{M_{20}}{M_{10}}$$

Demet Kalitesi: $TPR_{20,10}$ Belirlenemsi



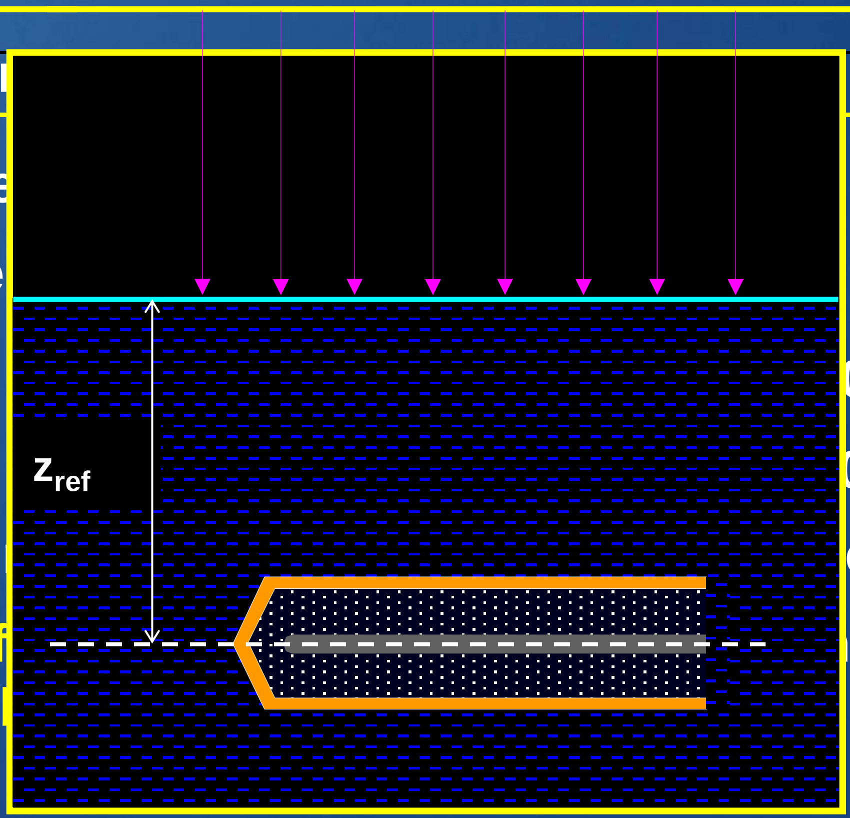
$$\Rightarrow M_{10}$$

$$\Rightarrow M_{20}$$

$$PDD_{20,10} = \frac{D_{20}}{D_{10}} \approx \frac{M_{20}}{M_{10}}$$

$$TPR_{20,10} = 1.2661\,PDD_{20,10} - 0.0595$$

D_w Belirlemenin Referans Şartları



Influence qua	reference characteristics
Phantom mate	
Chamber type	
Measurement	0 g/cm² (or 5 g/cm²)
	0 g/cm²
Reference poi	entre of the cavity volume
Position of ref point of cham	t depth z_{ref}
SSD/SCD	
Field size	10 cm x 10 cm

Formalizm

$$D_{w,Q}\ (zref) = M_Q\ ND,_{w,Qo}\ k_{Q,Qo}$$

- $M_Q = M_{raw}\ k_{TP}\ k_{elec}\ k_{pol}\ k_s$

  M_{raw} : z_{ref} de dozimetrik okuma

- N_{D,w,Q_0} : İyon odasının Q_0 enerjisinde kalibrasyon faktörü
- k_{Q,Q_0} : Demet kalite faktörü

Zmax daki Soğurulan Doz

(i) SSD set-up

Percentage depth-dose at z_{ref} for a 10 cm x 10 cm field size: PDD (z_{ref}=____ g cm^{-2}) = _________ %

Absorbed-dose calibration of monitor at z_{max}:

$$D_{w,Q}(z_{max}) = 100\ D_{w,Q}(z_{ref}) \,/\, PDD(z_{ref}) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\ \text{Gy MU}^{-1}$$

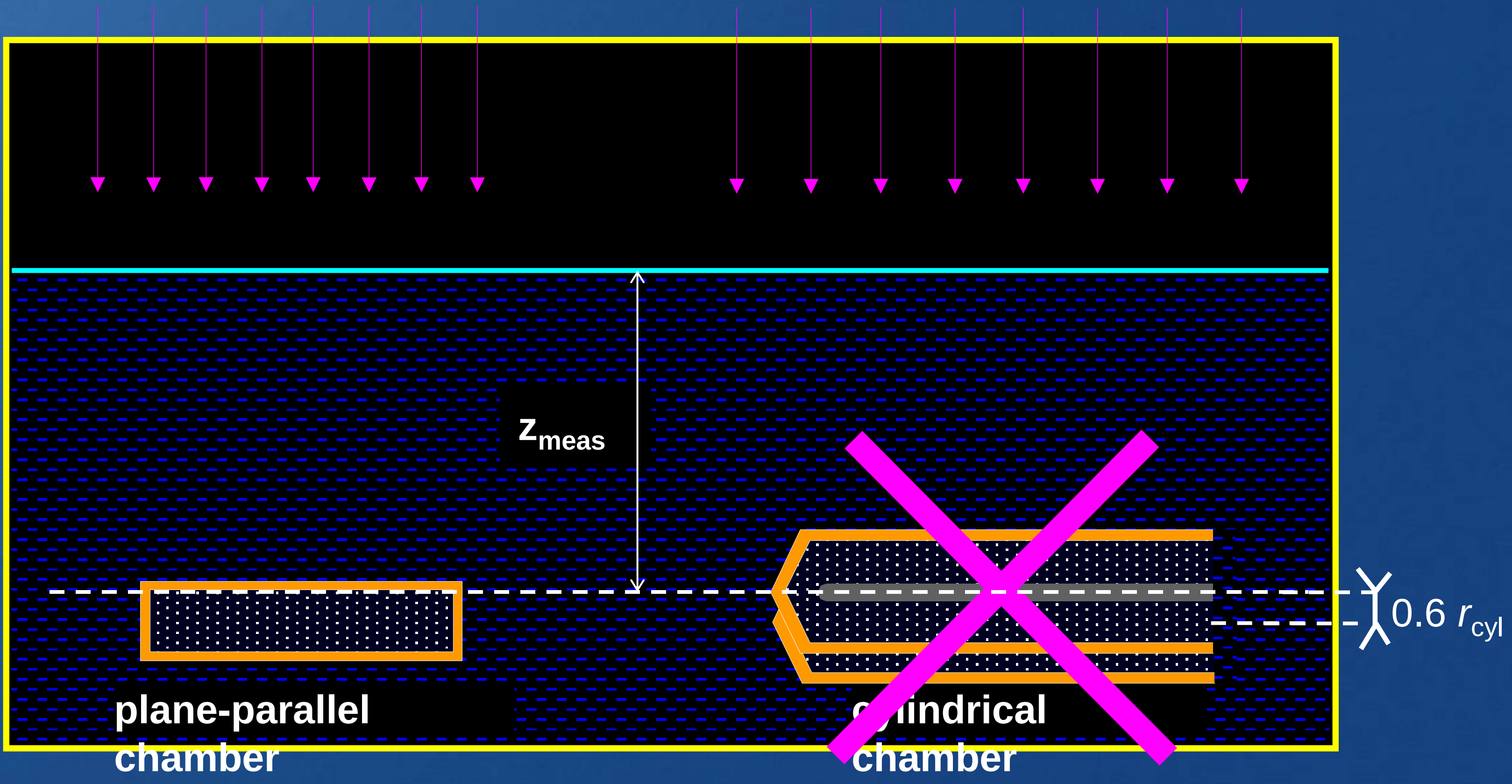
(ii) SAD set-up

TMR at z_{ref} for a 10 cm x 10 cm field size: TMR (z_{ref}=____ g cm^{-2}) = __________

Absorbed-dose calibration of monitor at z_{max}:

$$D_{w,Q}(z_{max}) = D_{w,Q}(z_{ref}) \,/\, TMR(z_{ref}) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\ \text{Gy MU}^{-1}$$

PDD Ölçümü



Yüksek Enerjili Foton lar için WorkSheet

Worksheet for the determination of the absorbed dose to water in a high-energy photon-beam

User: **Neolife Bucharest TrueBeam** Date: **17.01.2014**

Radiation treatment unit and reference conditions for $D_{w,Q}$ determination

Accelerator:			Nominal Acc Potential:	**6**	MV
Nominal dose rate:	**600,0**	MU min^{-1}	Beam quality, Q ($TPR_{20,10}$)	**0,667**	
Reference phantom:	**water**		Set up:	☑ SSD	☐ SAD
Reference field size:	**10x10**	cm x cm	Reference distance:	**100**	cm
Reference depth z_{ref} :	**10,0**	g cm^{-2}			

Ionization chamber and electrometer

Ion. chamber model	PTW 30006 / 30013		Serial No.:	**7088**	
Chamber wall	material:	**PMMA**	thickness:	**0,057**	g cm^{-2}
Waterproof sleeve	material:		thickness:		g cm^{-2}
Phantom window	material:		thickness:		g cm^{-2}

Abs. dose-to-water calibration factor [a] N_{D,w,Q_0} = **0** ☑ Gy/nC ☐ Gy/rdg

Calibration quality Q_0: ☑ Co-60 ☐ photon beam Calibration depth: **5** g cm^{-2}

If Q_0 is photons, give $TPR_{20,10}$:

Reference conditions for calibration

P_0: **101,3** kPa T_0: **22,0** °C Rel. humidity: **50** %

Polarizing potential V_1: **400** V

Calibration polarity: ☑ +ve ☐ -ve ☑ corrected for polarity effect

User polarity: ☑ +ve ☐ -ve

Suda Ölçüm Yapıldı.Kullanılan protokol TRS 398

MERKEZ: Neolife Bucharest TrueBeam

Tarih: 20,12,2013

$$TPR_{20,10} = 1.2661\,PDD_{20,10} - 0.0595$$

6 MVFFF için Verim Ölçümü

TPR2010= 0,630

PDD 20,10= 0,5448

T= 18,70 °C
P= 1018 mbar

Zref=10 cm
SSD= 100cm
Alan=10x10
İyon Odası= 30013 Seri No: 7088
Elektrometre UnidosWebline Seri No: 256
Bias Voltaj = 400
r = 3.1mm (0.6cc PTW 30013)

P_0=1013,25mBar
T_0=20°C

$$k_{TP} = \frac{(273.2 + T)}{(273.2 + T_o)} \frac{P_o}{P}$$

ktp= 0,9842

ks= 1,005 (6MV için recombinasyon faktörü-398 e gore)
kpol= 1,000 (6MV için polarizasyon faktörü-398 e gore)
N_{Dw}= 54,130 mGy/nC (PTW 30013 iyon odası için 2013 sertifika değeri)

M1 ort = 11,850 nC

6 MV için TPR = 0.630 Sudakı TPR degeri

TPR = 0.630 için kQ,Qo= 0,9960 (IAEA TRS 398 syf 67 PTW 30013)

PDDzref = 63,0700 (6MV 10*10 alanda 10cm derinlikteki %DD değeri)

$D_{W,Q}(z_{ref})$ =M1*NDw*ks*kpol*kQ,Qo*Ctp

Fraklı TRS Protokolünün Karşılaştırması

IAEA TRS-398 karşı IAEA TRS-277:

Palmans et al 2002, Phys. Med. Biol. 47 421-440

	Beam type	Energy	$TPR_{20,10}$	$\%dd(10)_x$
1	Varian Clinac 2300C/D	6 MV	0.672	66.4
2	Siemens MD	6 MV	0.676	67.6
3	Elekta SL75	6 MV	0.681	67.2
4	Elekta SL25	6 MV	0.686	67.9
5	Elekta SL18	15 MV	0.757	75.7
6	Varian Clinac 2300C/D	15 MV	0.762	76.2
7	Siemens MD	15 MV	0.770	78.2
8	Elekta SL*i*plus	18 MV	0.776	80.0

IAEA TRS-398 karşı IAEA TRS-277

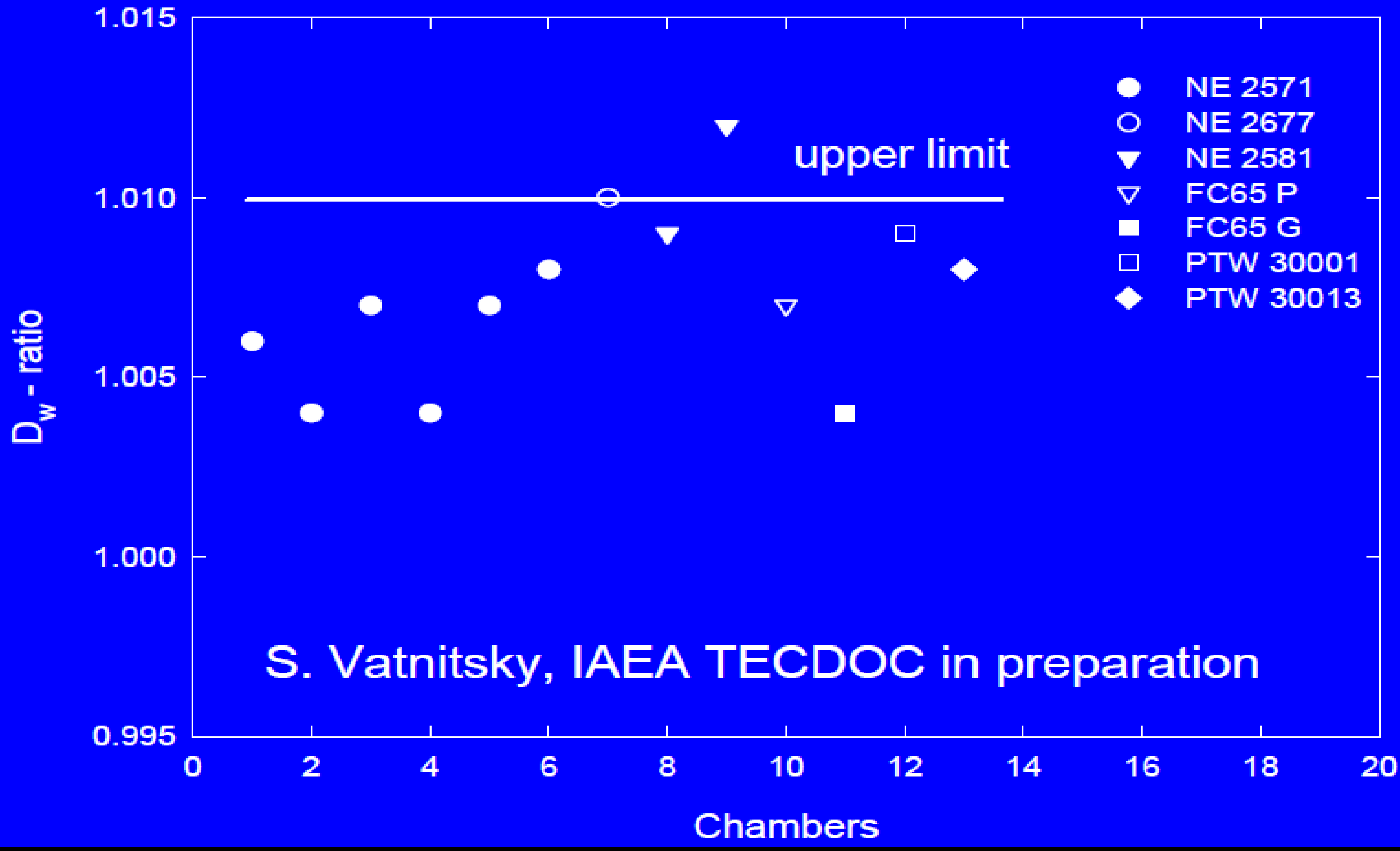
	NE2571	PTW-30004	Well-FC65G
1	1.003	1.006	1.001
2	1.002	1.006	1.001
3	1.002	1.006	1.001
4	1.002	1.005	1.001
5	1.002	1.005	1.001
6	1.002	1.005	1.001
7	1.002	1.005	1.001
8	1.003	1.006	1.002

IAEA TRS-398 karşı IAEA TRS-277:

Araki and Kubo 2002, Med. Phys. 29, 857-868

chamber	TRS-398 / TRS-277
PTW 's	1.011 - 1.017
NE2571	1.008 - 1.014
PR-06C	1.012 - 1.017
Exr A12	1.007 - 1.012

D_w for ^{60}Co beams TRS-398 vs. TRS-277



IAEA-TECDOC-1455

Implementation of the International Code of Practice on Dosimetry in Radiotherapy (TRS 398): Review of testing results

Final report of the Coordinated Research Projects on Implementation of the International Code of Practice TRS 398 at Secondary Standards Dosimetry Laboratories and Hospitals

IAEA
International Atomic Energy Agency

June 2005

TABLE 5.VII. COMPARISON OF RATIOS OF ABSORBED DOSES TO WATER DETERMINED FOLLOWING THE RECOMMENDATIONS OF IAEA TRS 398 AND AAPM TG-51 FOR PHOTON BEAM DOSIMETRY USING FARMER-TYPE CHAMBERS WITH AN $N_{D,W}$ CALIBRATION AT ^{60}Co. RESULTS ARE QUOTIENTS OF ABSORBED DOSES TO WATER, $D_W(TRS\ 398)/D_W(TG\text{-}51)$, GIVEN AS A FUNCTION OF THE CLINICAL BEAM QUALITIES. ALL MEASUREMENTS WERE MADE AT A REFERENCE DEPTH OF 10 CM ACCORDING TO THE EXPERIMENTAL CONDITIONS GIVEN IN TABLE 5.I. THE RESULTS ARE FROM REF [46].

Energy [MV]	TRS 398 beam quality $TPR_{20,10}$	TG-51 beam quality $\%dd(10)_x$	Chamber Type	No. of chambers studied	$\frac{D_w(\mathrm{TRS\ 398})}{D_w(\mathrm{TG-51})}$
6	0.680	67.4	NE 2571	1	1.001
			PTW 30001	1	1.000
18	0.778	80.1	NE 2571	1	1.003
			PTW 30001	1	1.002
25	0.799	83.0	NE 2571	1	1.002
			PTW 30001	1	1.000

TABLE 5.VIII. COMPARISON OF RATIOS OF ABSORBED DOSES TO WATER DETERMINED FOLLOWING THE RECOMMENDATIONS OF IAEA TRS 398 AND DIN 6800-2 CoPS FOR PHOTON BEAM DOSIMETRY USING FARMER-TYPE CHAMBERS WITH $N_{D,w}$ CALIBRATION AT ^{60}Co. RESULTS ARE QUOTIENTS OF ABSORBED DOSES TO WATER, D_w(TRS 398)/D_w(DIN 6800-2), GIVEN AS A FUNCTION OF THE CLINICAL BEAM QUALITIES. ALL MEASUREMENTS WERE MADE AT A DEPTH OF 5 CM FOR 6 MV PHOTON BEAMS AND AT A DEPTH OF 10 CM FOR 15 MV PHOTON BEAMS ACCORDING TO THE EXPERIMENTAL CONDITIONS GIVEN IN TABLE 5.I. RESULTS ARE FROM REF. [47].

Energy [MV]	Beam quality	Chamber Type	No. of chambers studied	$\frac{D_w(\text{TRS } 398)}{D_w(6800-2)}$
6	0.672	PTW 30006	1	1.002
15	0.765	PTW 30006	1	1.001

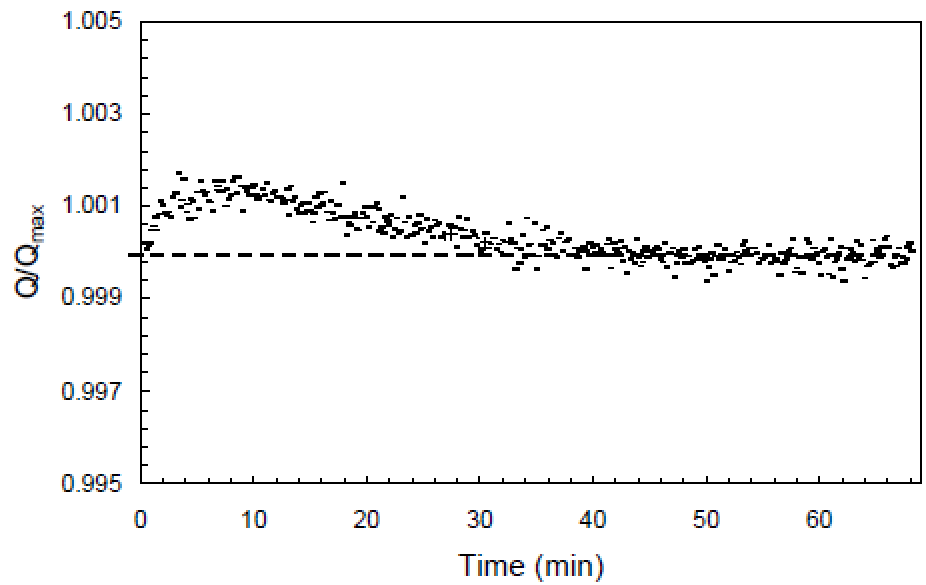


Fig. 5. Stabilization time for a Keithley 6517 and a PTW 23333 ionization chamber. A full stabilization is achieved after about 30 min.

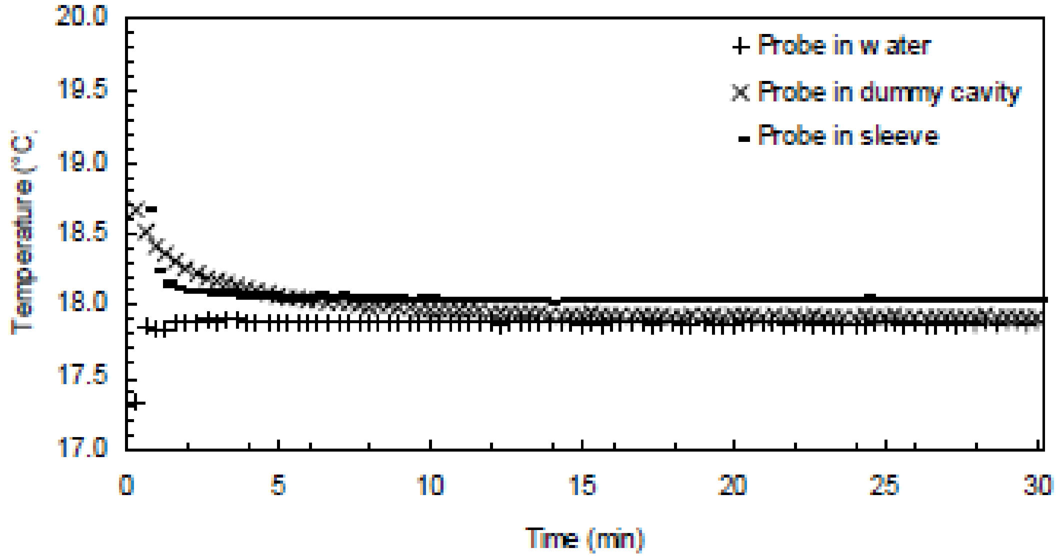


Fig. 8. Temperature variations in air and water. The figure shows no significant difference between different ways of temperature measurements if the probe is immersed in water, placed inside a dummy cavity ion chamber or inside a waterproof sleeve.

Dw(TRS 398/ Dw TRS 277)

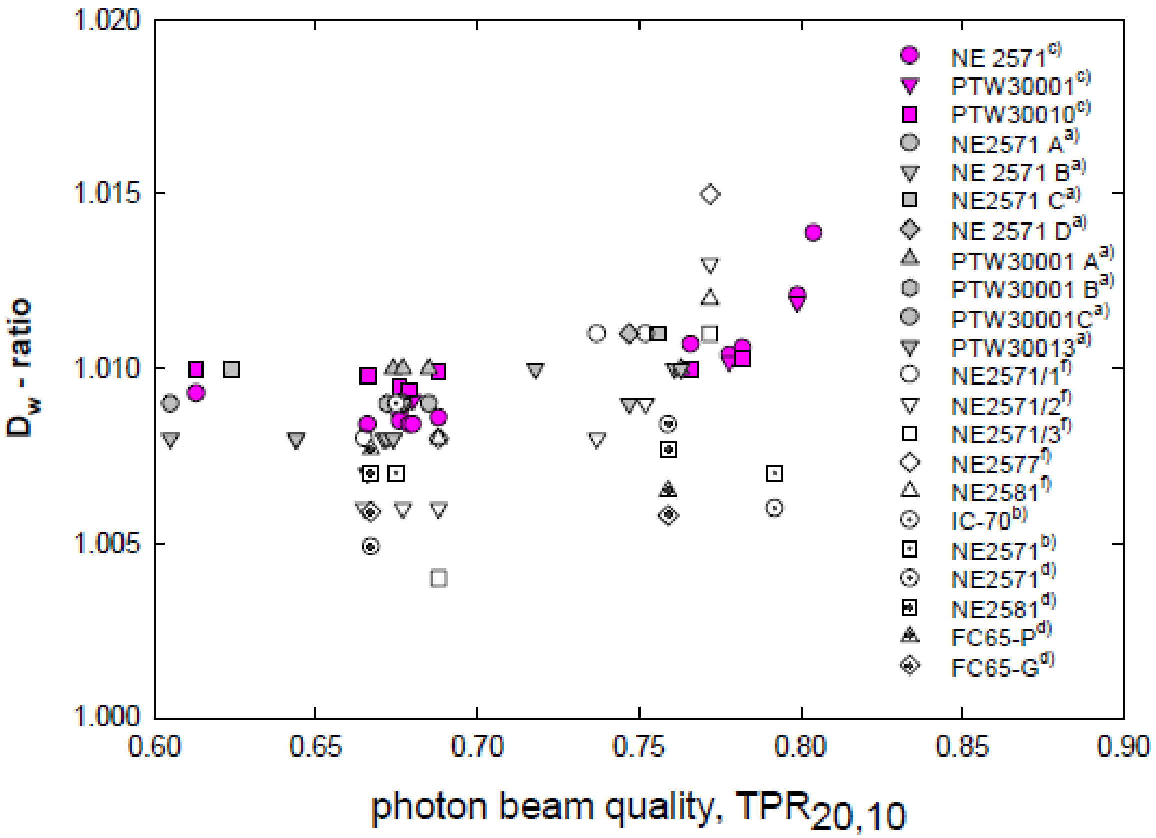


Fig 13. Experimental comparison of absorbed dose ratios Dw(TRS 398)/Dw(TRS 277) (2nd ed) in clinical photon beams measured according to the conditions described in Table 5.I. Symbols representing results for various chamber types are given inside the figure. Two participans used several chambers of the same type, these chambers are labelled as NE 2571A, NE2571B, NE2571C, NE2571D, PTW30001A, PTW30001B, PTW30001C - for participant a); and as NE2571/1, NE2571/2, NE2571/3 - for participant f).

5.6. Recommendations

For the most commonly used clinical photon beams ($0.605 \leq TPR_{20,10} \leq 0.799$) , the absorbed doses measured following the recommendations of TRS 398 are approximately 1% higher than those obtained with TRS 277 using Farmer type chambers with an $N_{D,w}$ calibration at ^{60}Co . Thus, when a transition is made from TRS 277 to TRS 398, the user is expected to measure a dose that is approximately 1% higher than that measured by TRS 277. Users are advised to check carefully their experimental conditions and relevant calibration coefficients if the ratio of absorbed doses, D_w(TRS 398)/D_w(TRS 277), measured by them fall outside of the range $1.005 \leq D_w(\text{TRS 398})/D_w(\text{TRS 277}) \leq 1.015$.


DOĞRU
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YANLIŞ
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IAEA Dose Quality Auidit Service

IAEA
Atoms for Peace
الوكالة الدولية للطاقة الذرية
国 际 原 子 能 机 构
International Atomic Energy Agency
Agence internationale de l'énergie atomique
Международное агентство по атомной энергии
Organismo Internacional de Energía Atómica

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Phone: (+43 1) 2600 • Fax: (+43 1) 26007
Email: Official.Mail@iaea.org • Internet: http://www.iaea.org

In reply please refer to: 326-E2.20
Dial directly to extension: (+431) 2600-28331

2018-11-19

Dear participant in the IAEA/WHO (PAHO) Postal Dose Quality Audit Service:

Below please find the results for your dosimeter set(s), irradiated in **Batch 297**.

Dosimeter set #	Within 5% acceptance limit?
16491	Yes
16492	Yes
16493	Yes
16494	Yes
16495	Yes

Your dosimetry audit results are within our 5% acceptance limit and no further action is required on your part. You will be invited to participate in a new audit run in approximately two years' time.

Thank you for having participated in this audit run.

Yours sincerely,

Joanna Izewska, PhD
Head, Dosimetry Laboratory
Dosimetry and Medical Radiation Physics
Section (DMRP)
Division of Human Health

Enclosure

Information note: Copies of these results are made available to WHO (and to PAHO for participants in Latin America and the Caribbean) and to your Country Coordinator, where existing.

MNT-Neolife IAEA TLD Result 2018

- Turkey 17 Linac
  - 45 Energy(6MVFF,6MV FFF,10MV,10MVFFF,15MV,18MV)

- Romania 3 Linac
  - 8 Energy (6MVFF,10FFF,6MV,10MV, 15MV)

- Bulgaria 4 Linac
  - 10 Energy (6MVFF,10FFF,6MV,10MV, 15MV)
- **Results**
  - 30 Energy 0% deviation
  - 23 Energy ±1% deviation
  - 9 Energy ±2% deviation
  - 1 Energy ±3% deviation

Özet

- Suda absorbe doz temelli TRS 398 gerek foton gerekse elektronlarda belirsizlikleri önemli ölçüde minimize etmiştir. (Güçlü Dw Standardı)
- Tüm terapatik enerjilerde bir standart sağlamıştır
- Yaptığınız işin doğruluğunu mutlaka 2. bir kuruluşa (IAEA veya RPC) kontrol ettirin.

TEŞEKKÜRLER

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