

# Pienten keilojen dosimetriaprotokollat ja suositukset - tilannekatsaus

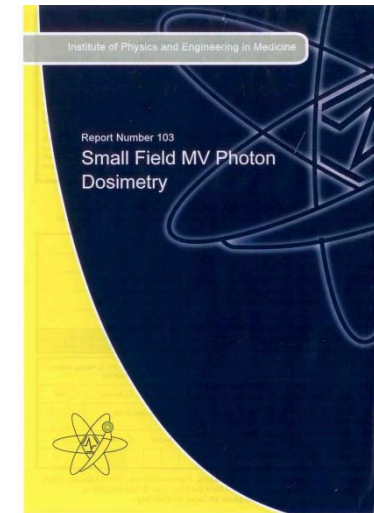
Teemu Siiskonen  
STUK

# Yleistilanne

- IPEM Report 103: Small Field MV Photon Dosimetry
- IAEA/AAPM Code of Practice for the Dosimetry of Static Small Photon Fields
  - Linkki IAEA:n TRS 398 päivitykseen
  - Taustaa mm. IDOS 2010 Proceedings (H. Palmans)
- ICRU Report Committee 23 on Prescribing, Recording and Reporting Stereotactic Treatments with Small Photon Fields
- AAPM Raportit
  - Guideline 5.a (2015): Commissioning and QA of External Beam Treatment Planning System Dose Calculations
  - AAPM Task Group 101: Stereotactic Body Radiation Therapy
  - AAPM Task Group 155: Small field dosimetry

# IPEM Report 103

- Fysikaalinen pienten keilojen dosimetrian tausta
  - Ilmaisimien ominaisuudet, mittaustekniikat
  - Suhteelliset annosmittaukset eri ilmaisimilla
  - Referenssidosimetria
- Referenssidosimetria
  - "It is desirable that ionisation chambers remain the reference instruments... Work is required before guidance can be given on the smallest field at which a given chamber can be used without correction"
  - "Liquid-filled ionisation chambers, diodes, diamonds and radiochromic films could be used for beam output measurements of smaller fields"



# IPEM report 103

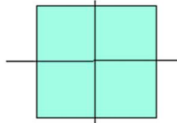
- Suhteellinen dosimetria
  - Profiilit ja puolivarjo
    - "The most suitable detectors ... are radiochromic film and diodes"
    - "Liquid ionisation chambers may form a promising alternative..."
    - "A detector size  $< 0.50$  mm is adequate for resolving narrow field penumbrae"
    - "Measurements of profiles ... needs to have a size of the order of  $0.01$  cm<sup>3</sup>"
  - Syväannosmittaukset
    - "Suitable detectors are mini-ionisation cylindrical and parallel plane chambers"
    - "Sensitive volume equal or less than  $0.01$  cm<sup>3</sup>"
    - "Radiochromic films is known to give the best resolution in very small fields"
    - Same recommendations for TPR/TMR measurements
  - Tuottotekijät
    - "Most suitable detectors are small parallel plane liquid-filled ionisation chambers, diodes and radiochromic film"

# IAEA/AAPM Code of practice

## 1 REFERENCE DOSIMETRY

$$D_{w, Q_{msr}}^{f_{msr}} = M_{Q_{msr}}^{f_{msr}} N_{D, w, Q_0} k_{Q, Q_0} k_{Q_{msr}, Q}^{f_{msr}, f_{ref}}$$

Broad beam reference field  $f_{ref}$



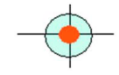
$N_{D, w, Q_0} k_{Q, Q_0}$

Hypothetical reference field  $f_{ref}$

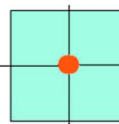


● ≡ Ionization chamber

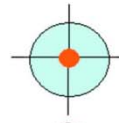
Machine specific reference field  $f_{msr}$



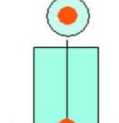
Radiosurgical collimators  
Ø as low as 1.8cm



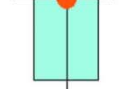
BrainLAB micro MLC  
10cm x 10cm



CyberKnife  
Ø 6.0 cm



GammaKnife  
Ø 1.6/1.8 cm



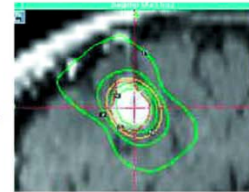
TomoTherapy  
5cm x 20cm

## RELATIVE DOSIMETRY

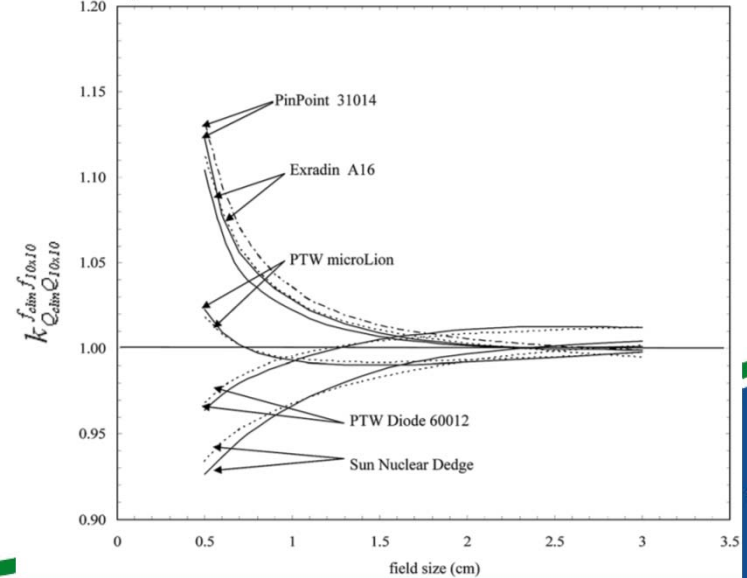
$$D_{w, Q_{clin}}^{f_{clin}} = D_{w, Q_{msr}}^{f_{msr}} \Omega_{Q_{clin}, Q_{msr}}^{f_{clin}, f_{msr}}$$

$\Omega_{Q_{clin}, Q_{msr}}^{f_{clin}, f_{msr}}$

Clinical  $f_{clin}$



e.g. a GammaKnife clinical plan



Työn alla, ks. Med. Phys. 35, 5179 (2008)

$$k_{Q_{msr}, Q}^{f_{msr}, f_{ref}} = \frac{D_{w, Q_{msr}}^{f_{msr}} / M_{Q_{msr}}^{f_{msr}}}{D_{w, Q}^{f_{ref}} / M_{Q}^{f_{ref}}}$$

## ICRU Report Committee 23

- Ei kovin paljoa infoa tarjolla – ICRUn [www-sivut](http://www-icru.org):

Progress in radiation therapy requires the ability to compare clinical results achieved in different centers using different radiation modalities and protocols. Thus a common language for reporting fractionation schedules, doses, and techniques is required for optimum treatment. ICRU has devoted considerable effort in that direction. ... The concepts and definitions in these latter reports remain the basis of reports adapting these principles to a series of reports on Prescribing, Recording, and Reporting different therapies: Electron-Beam Therapy [Report No. 71 (2004)], Proton-Beam Therapy [Report No. 78 (2007) – joint report with International Atomic Energy Agency (IAEA)], Intensity-Modulated Photon-Beam Therapy (IMRT) [Report No. 83 (2010)]. Three additional reports in the series are in preparation: Ion-beam Beam Therapy, **Stereotactic Treatments with Small Photon Beams** and Brachytherapy for Cancer of the Cervix.

# AAPM raportit

- AAPM TG101 (SBRT) Recommendation
  - Vaaditaan dosimetri, jonka paikkaresoluutio on 1 mm tai parempi
  - Ilmaisimen sisähalkaisijan pitäisi olla vähemmän kuin puolet mitattavan keilan puoliarvoveveydestä
- AAPM Guideline 5.a
  - Ohjeet ja suositukset annossuunnittelun vastaanotosta ja laadunvarmistuksesta
  - Pienimmille keiloille ja puolivarjoihin diodi
    - Myös muovituikeilmaisimet, mini- ja mikrokammiot
- TG 155 (Small field dosimetry) julkaistaan Medical Physicsissä (2016?)

“An IAEA-AAPM working group has provided a framework for reference dosimetry in non-compliant beams and the measurement of field output factors small fields. The AAPM TG-155 has adopted this framework to provide guidelines on relative dosimetry.” (I Das and J Seuntjens, 2015)

# Tutkimustarpeet lääketieteellisessä säteilyn käytössä (CERN expert group)



# Työpaja helmikuussa 2016

- Particle therapy
  - Clinical priority: relative biological effectiveness (RBE)
  - A strong need for a scientific network (could be hosted by CERN)
- Imaging
  - Predicting the needs for the coming years is an almost impossible task
  - EXPLORER project: whole body PET
    - Reduce scanning times, improve sensitivity and spatial resolution, whole-body PET, new detectors
  - Functional imaging with CT (biomarkers with metal nanoparticles)
- Radioisotopes and medical data
  - MEDICIS: a facility for the production of innovative isotopes (e.g.  $^{152,155}\text{Tb}$ )
  - Personalized medicine, combination of several data sources and registers, decision-support systems
  - Collaborations with ESS and Myrrha important