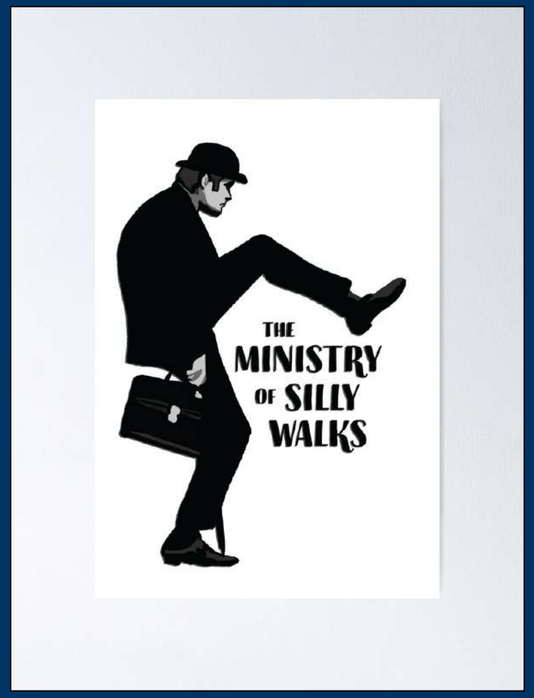
Catalan Clinical Audit
Network for Quality Improvement
in Radiotherapy

What to do when we do not have standards?

Prof. Dr. Dirk Verellen



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Objectives of the lecture

- Radiation oncology evolves, standards follow …
- Some examples
  - MSQA and PSQA
  - BELdART quid?
- Focus on patient safety and quality

IMRT as an example on introducing new technology

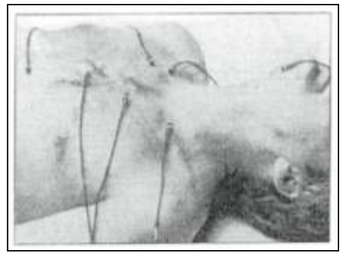
Technology implementation races ahead of guidelines

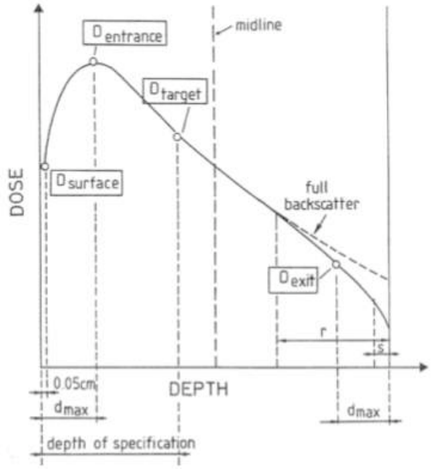
- Small field dosimetry
- In vivo dosimetry
- Independent dose calculation

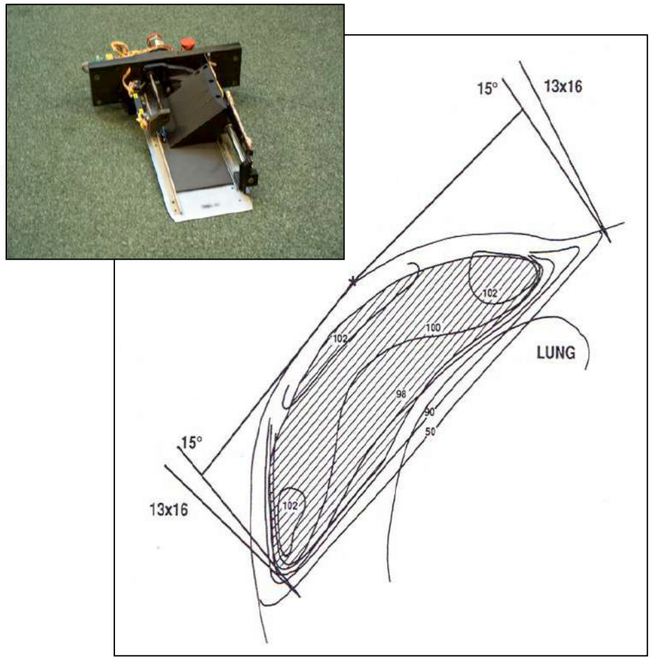
Learning from the past …

We learn from our mistakes …

- In vivo dosimetry

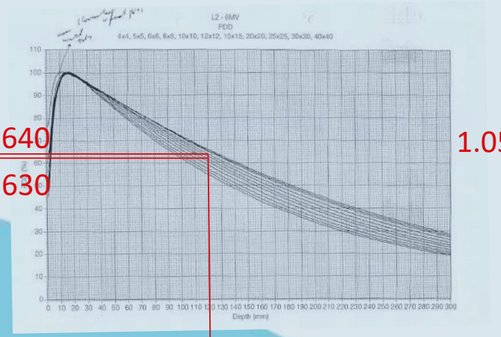


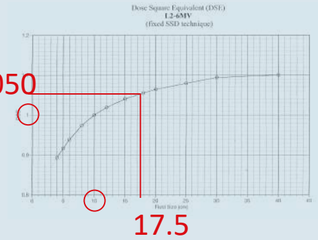




- Independent MU calculation

- TD = 200cGy
- d = 12cm
- SSD = 100cm
- FS = 17.5x17.5cm²



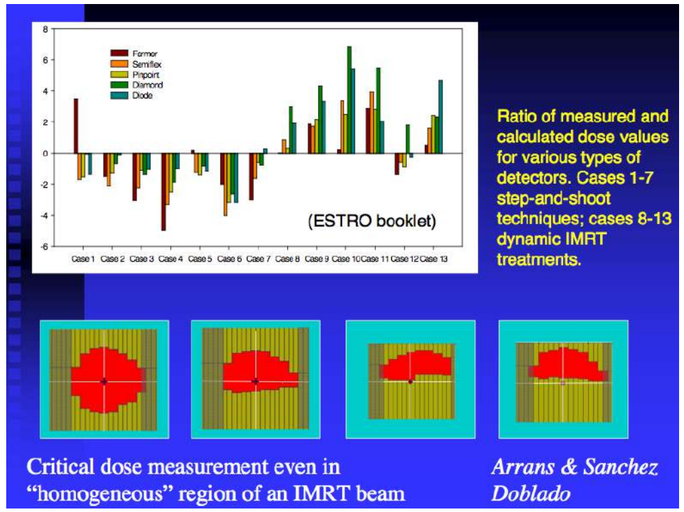


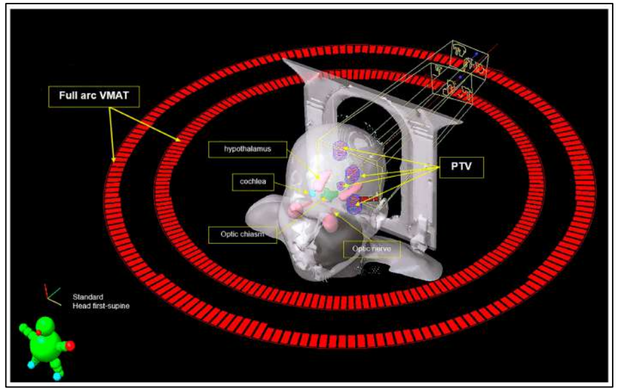
- OF(17.5x17.5) = 1.050
- PDD (12, 15x15) = 0.630
- PDD (12, 20x20) = 0.640

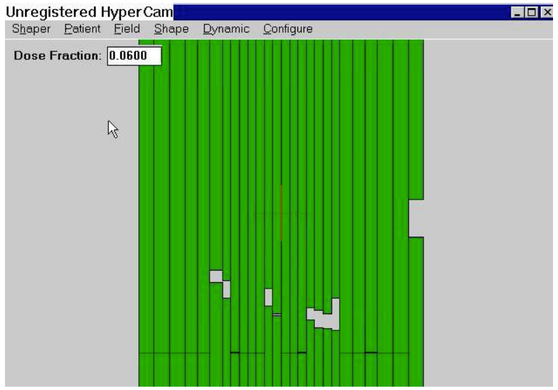
➡ PDD (12, 17.5x17.5) = 0.635

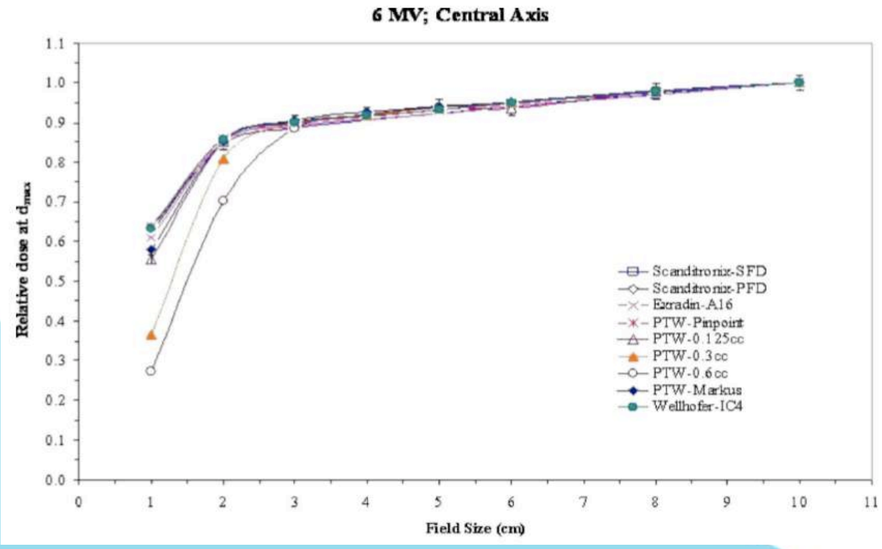
MU = 200 / (0.635x1.050) = 299.96 ~ 300MU

Absolute dose calibration



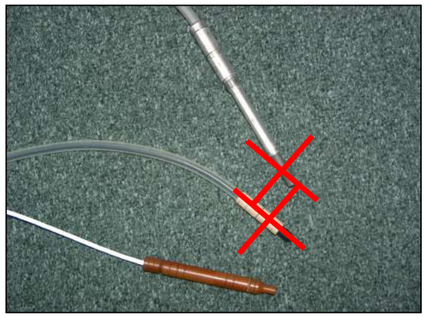






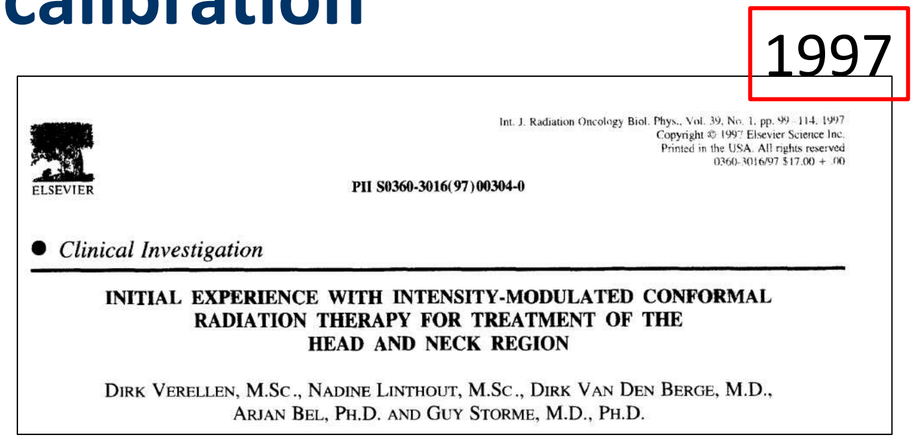
Das IJ, *et al.*, Med Phys, 2008

In this case ... size matters



Absolute dose calibration

1997



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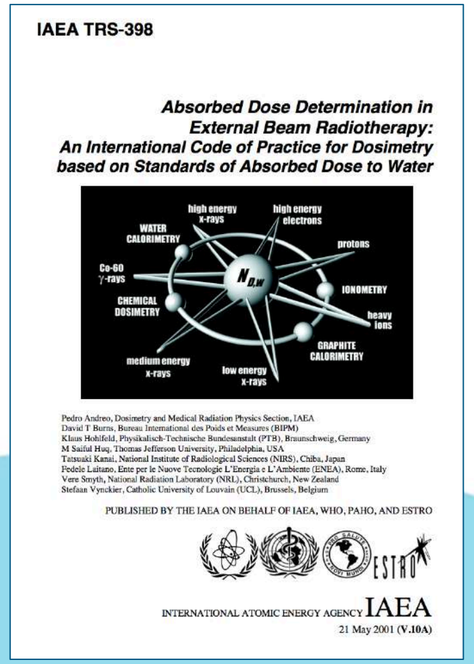
● *Clinical Investigation*

INITIAL EXPERIENCE WITH INTENSITY-MODULATED CONFORMAL RADIATION THERAPY FOR TREATMENT OF THE HEAD AND NECK REGION

DIRK VERELLEN, M.SC., NADINE LINTHOUT, M.SC., DIRK VAN DEN BERGE, M.D., ARJAN BEL, PH.D. AND GUY STORME, M.D., PH.D.



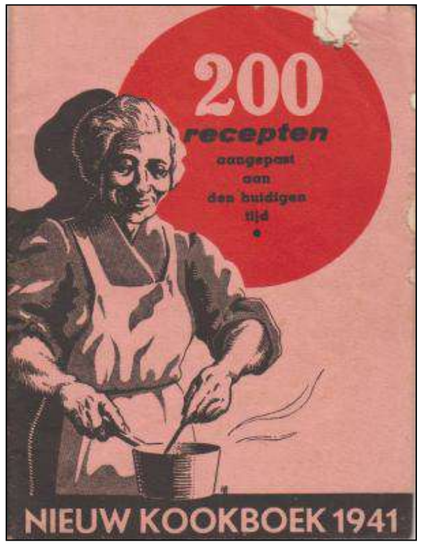
IAEA TRS-398

Absorbed Dose Determination in External Beam Radiotherapy: An International Code of Practice for Dosimetry based on Standards of Absorbed Dose to Water

Pedro Andreo, Dosimetry and Medical Radiation Physics Section, IAEA
David T Burns, Bureau International des Poids et Measures (BIPM)
Klaus Hohlfeld, Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany
M Saiful Huq, Thomas Jefferson University, Philadelphia, USA
Tatsuaki Kanai, National Institute of Radiological Sciences (NIRS), Chiba, Japan
Fedele Laitano, Ente per le Nuove Tecnologie L'Energia e L'Ambiente (ENEA), Rome, Italy
Vere Smyth, National Radiation Laboratory (NRL), Christchurch, New Zealand
Stefaan Vynckier, Catholic University of Louvain (UCL), Brussels, Belgium

PUBLISHED BY THE IAEA ON BEHALF OF IAEA, WHO, PAHO, AND ESTRO

INTERNATIONAL ATOMIC ENERGY AGENCY IAEA
21 May 2001 (V.10A)



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Journal of the ICRU

ICRU REPORT 91

Prescribing, Recording, and Reporting of Stereotactic Treatments with Small Photon Beams

INTERNATIONAL COMMISSION ON RADIATION UNITS AND MEASUREMENTS

MEDICAL PHYSICS

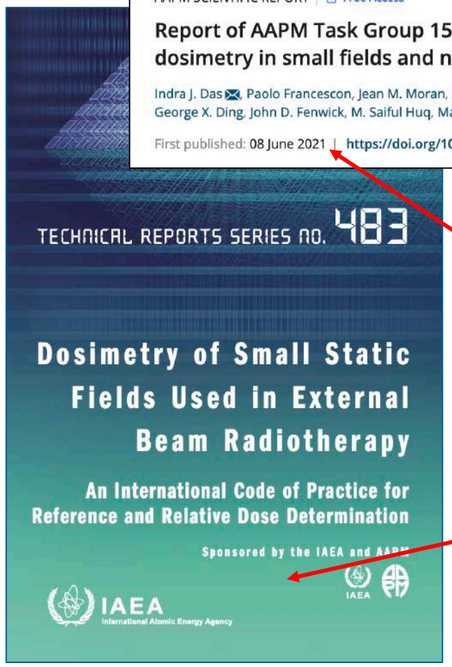
The International Journal of Medical Physics Research and Practice

AAPM SCIENTIFIC REPORT | Free Access

Report of AAPM Task Group 155: Megavoltage photon beam dosimetry in small fields and non-equilibrium conditions

Indra J. Das, Paolo Francescon, Jean M. Moran, Anders Ahnesjö, Maria M. Aspradakis, Chee-Wai Cheng, George X. Ding, John D. Fenwick, M. Saiful Huq, Mark Oldham, Chester S. Reft, Otto A. Sauer,

First published: 08 June 2021 | https://doi.org/10.1002/mp.15030 | Citations: 1



TECHNICAL REPORTS SERIES NO. 483

Dosimetry of Small Static Fields Used in External Beam Radiotherapy

An International Code of Practice for Reference and Relative Dose Determination

Sponsored by the IAEA and AAPM

IAEA International Atomic Energy Agency

2021

2017

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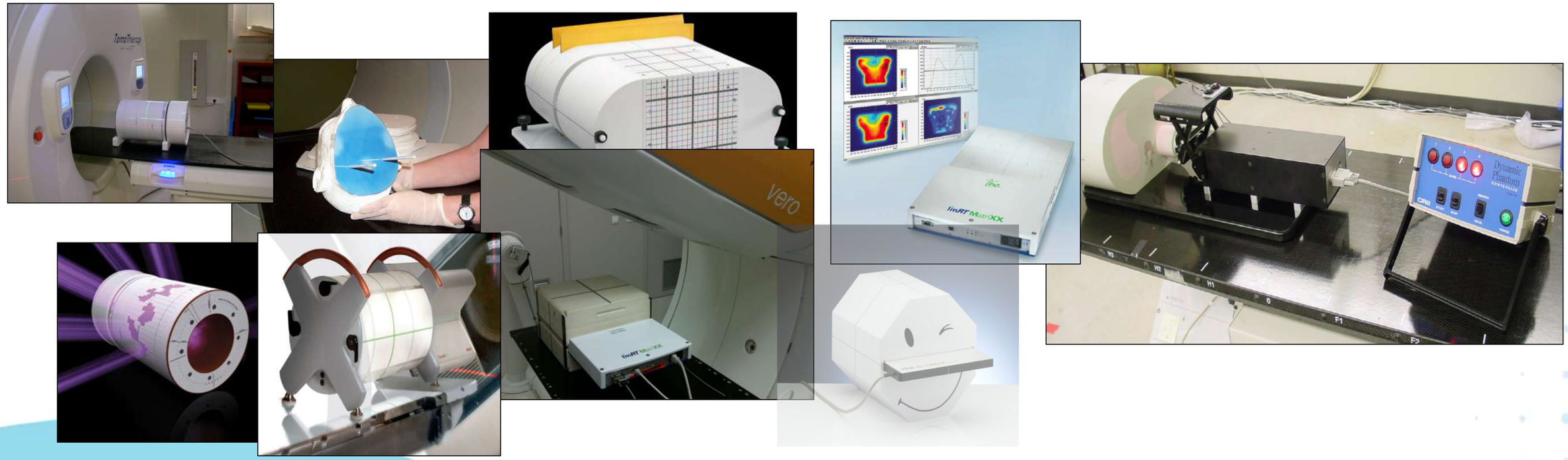
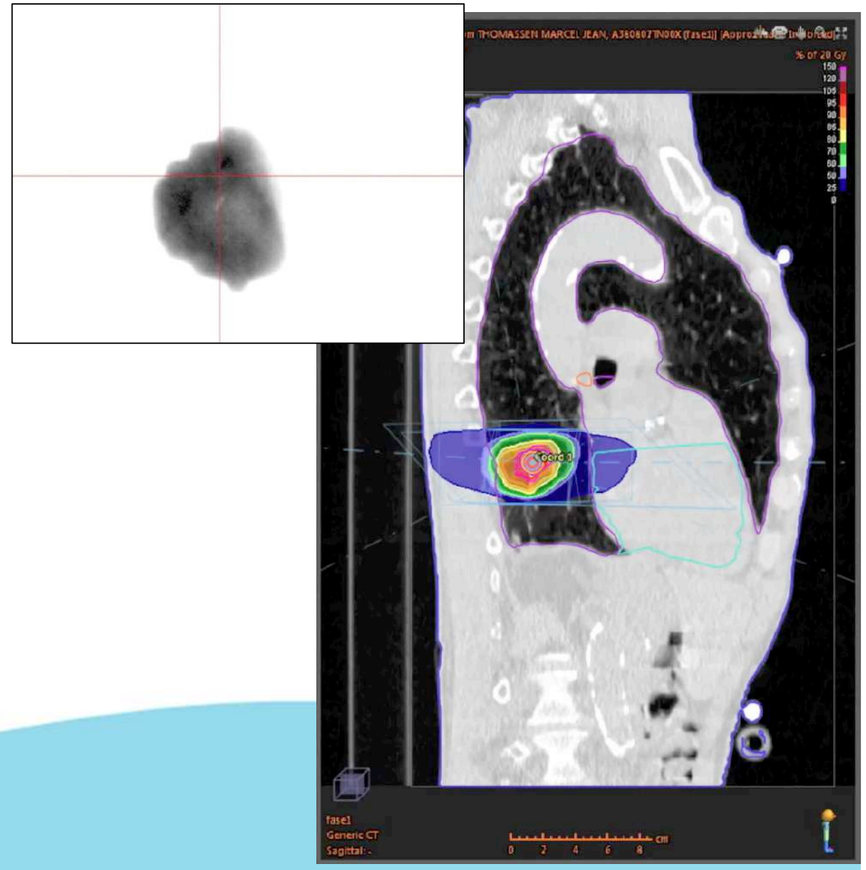
Patient specific QA

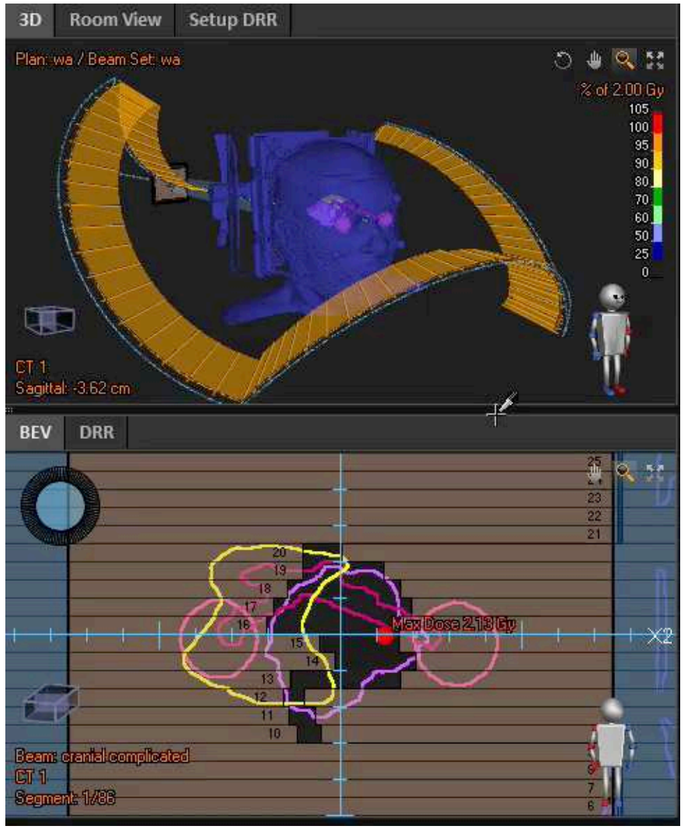
In vivo dosimetry was no longer feasible … so we “exaggerate” commissionning …



Patient specific QA

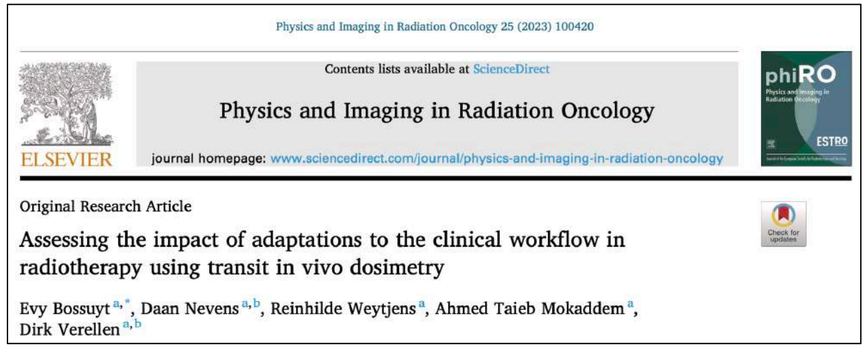
What about (manual) independent MU verification?





Patient specific QA

Patient specific QA … Today


Physics and Imaging in Radiation Oncology 25 (2023) 100420

Contents lists available at ScienceDirect

Physics and Imaging in Radiation Oncology

journal homepage: www.sciencedirect.com/journal/physics-and-imaging-in-radiation-oncology

Original Research Article

Assessing the impact of adaptations to the clinical workflow in radiotherapy using transit in vivo dosimetry

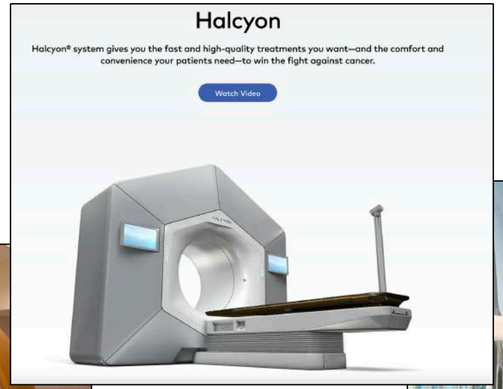
Evy Bossuyt [a,*], Daan Nevens [a,b], Reinhilde Weytjens [a], Ahmed Taieb Mokaddem [a], Dirk Verellen [a,b]

- Patient-specific pre-treatment QA and *in vivo* dosimetry are performed for every patient using the PerFraction platform (Sun Nuclear), which includes:

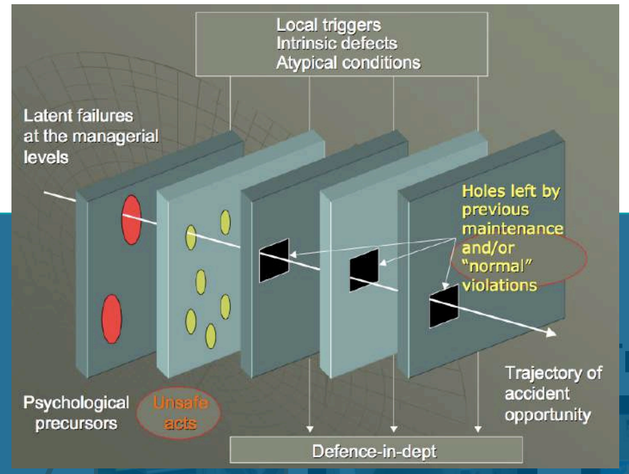
- Independent MU calculation,
- Dose transmission measurements, pre-treatment,
- Dose transmission measurements, during treatment (in vivo)

Implementing a new “established” technique

- Vendors are selling complex equipment as **plug&play** to facilities with **understaffed-undertrained** staff.
- Hospitals are using internal **procedures and workflows** that are **not adapted** to these new technologies.
- Software and hardware is continuously being **upgraded**.



Radiotherapy Workflow



Simulation

Image registration Delineation

Treatment Planning

reatment

Follow

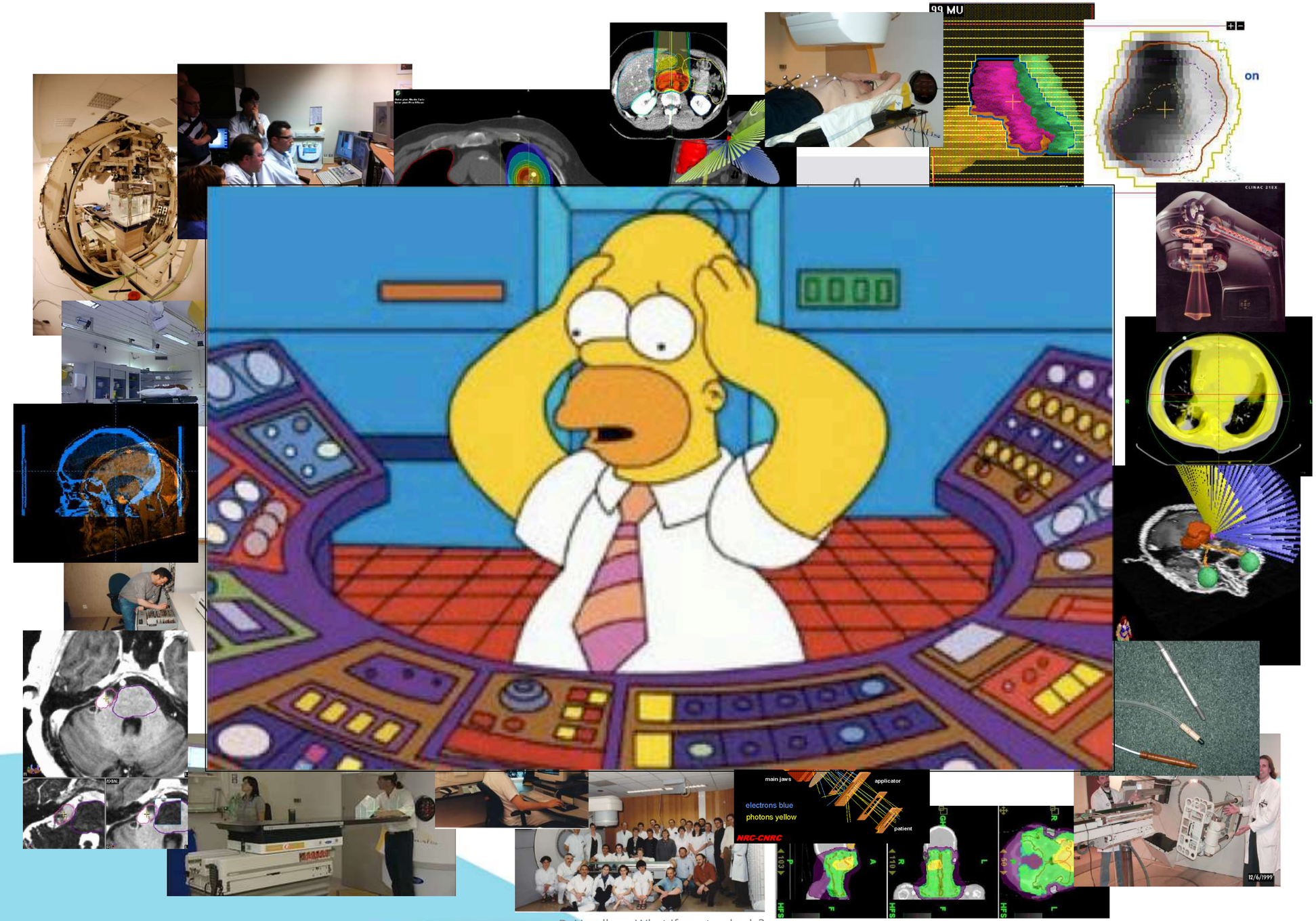
Adaptive Radiotherapy

Re-irradiation

Learning from experience we introduced appropriate SAFETY BARRIERS

Co-funded by the European Union

Radiotherapy Workflow … all in one?


99 MU
on
CLINAC 21EX
main jaws
applicator
electrons blue
photons yellow
patient
NRC-CNRC

Efficiency, Standardization, Quality & Safety

AORN JOURNAL
THE OFFICIAL VOICE OF PERIOPERATIVE NURSING

Patient Safety First

Using Aviation Safety Measures to Enhance Patient Outcomes

Russell M. Rivers, Diane Swain RN, William R. Nixon

First published: 01 January 2003 | https://doi.org/10.1016/S0001-2092(06)61385-9 | Citations: 18

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ABSTRACT

Recent media reports have put a spotlight on the increasing number of medical errors occurring in US health care institutions. In contrast to health care's increasing error rate, the aviation industry is experiencing a decreasing error rate. Could the safety techniques used in the aviation industry be applied to health care? This article explores that question. The dynamics of the surgical suite are not unlike those of the cockpit of an airplane; therefore, perioperative services was selected to pilot test the aviation model of safety training. *AORN J* 77 (Jan 2003) 158-162.

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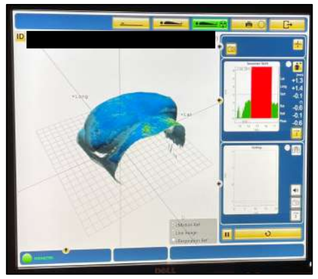
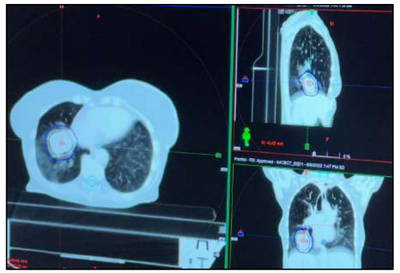
Automate or perish

Standardization & Automation

Efficiency & Optimization



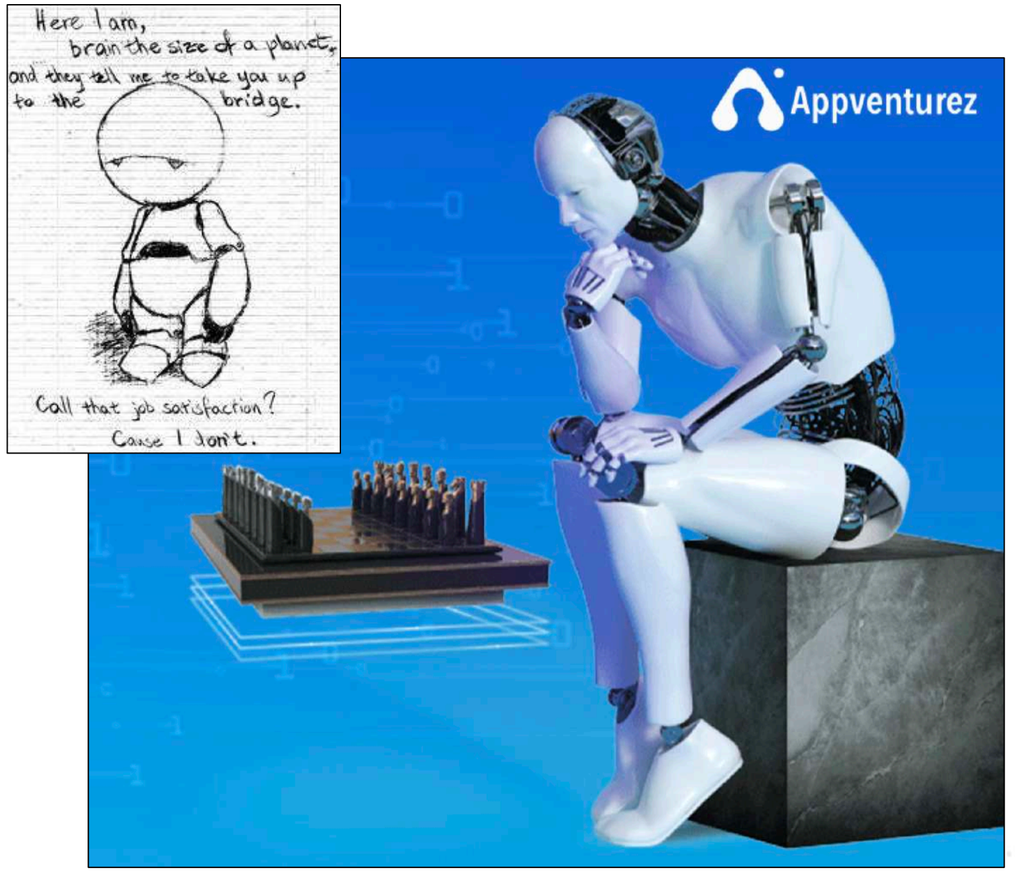


Safety & Quality

Complexity increases … enters automation …

With large scale introduction of scripting and AI (computerized black boxes),

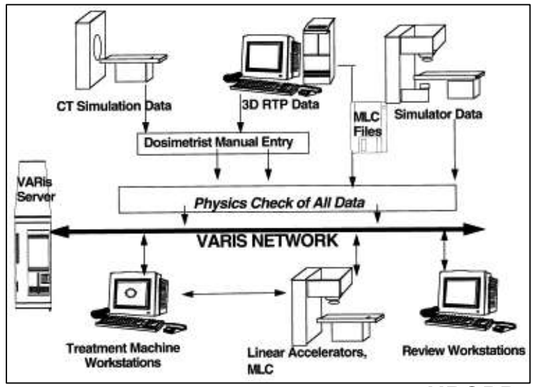
the role of human interaction needs rethinking



Complexity increases … enters automation …

Similar to the introduction of R&V systems at the end of the previous century:

- It was introduced to ***mitigate human errors and reduce repetitive tasks***
- But people started to verify these tasks as if it was human, *… **by performing repetitive tasks** …*



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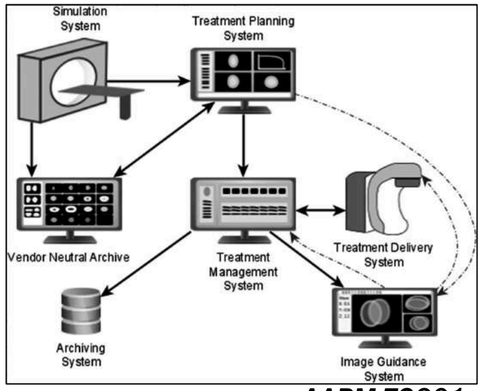
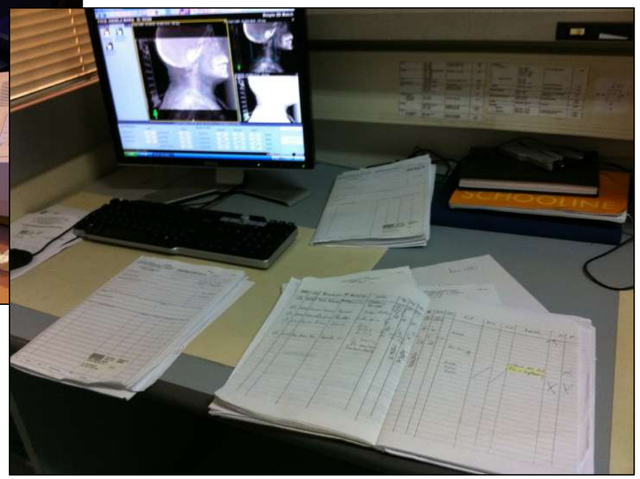


AAPM TG201

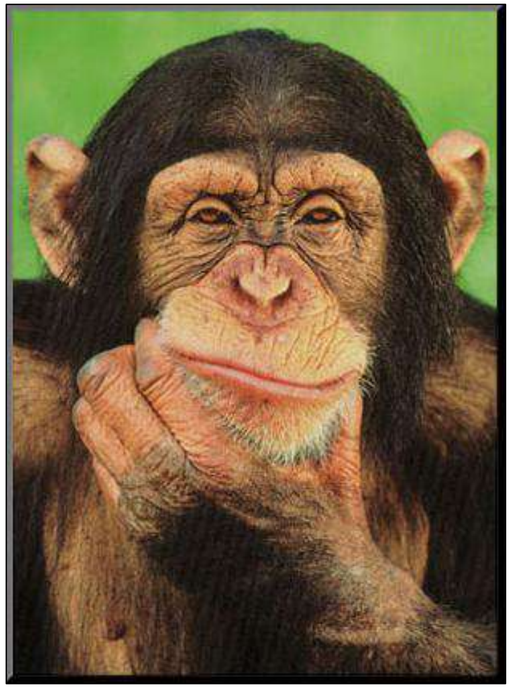


Standards on MSQA and PSQA?

Hypothetical sitution …

What if during an audit, a centre claims that **MSQA can be minimized**?

- Modern technology comes with efficient self-tests, the system will have an interlock before our MSQA detects it,
- Service engineers “know” what they’re doing,



What if the centre also claims, **independent dose calculation is useless**, because:

- The algorithm is less accurate than the clinical algorithm,
- Redundency after upgrades is tested, so the accuracy is maintained,

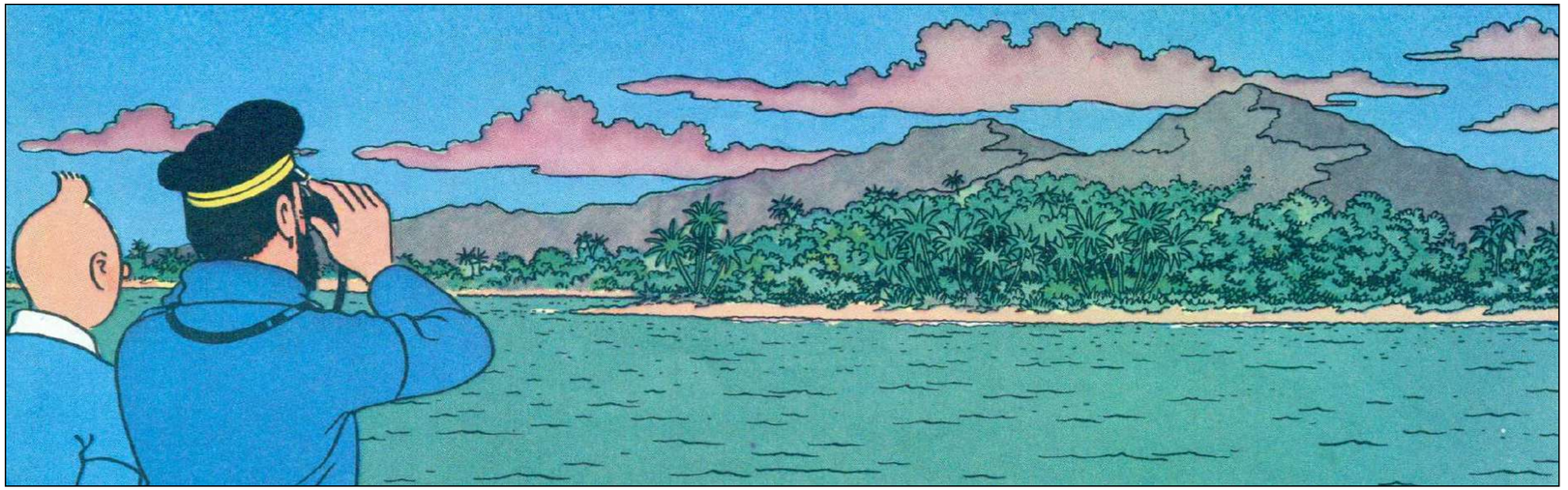
What if the centre **omits PSQA and IVD** if the plan fits criteria of class solution?

- PSQA is only re-commissioning,
- EPID-IVD is not sensitive-specific, with many falls-positives / falls-negatives.

Standards on MSQA and PSQA?

- **MSQA**:
  - With increasing techniques and technology, we add more and verification tests … **redundency versus efficiency**
  - Vendors and equipment become more reliable and come with efficient “**self-tests**” … user specific MSQA almost never discovers “new” errors.
  - **How to maintain “independent” QA**?
- **PSQA**:
  - Pre-treatment QA does not include the patient, hence is it not merely **re-checking commissioning**?
  - With **intelligent complexity metrics, class solutions and AI**: can’t we abandon or at least reduce PSQA?
  - 99.99% of PSQA pass … **it’s a waste of time**?
  - **IVD is really PSQA as it includes the patient**: but if an error ocurs, it’s too late (especially as we tend to hypofractionate or introduce oART …)
- Re-evaluate the combination MSQA-PSQA on a regular basis:
  - By default standards are obsolete?
  - Ask yourself: **if an error ocurs, will the MSQA-PSQA catch it**? … FMEA!!!

What are we lookin’ for?



Ensuring that *what has been planned, really has been delivered!!*

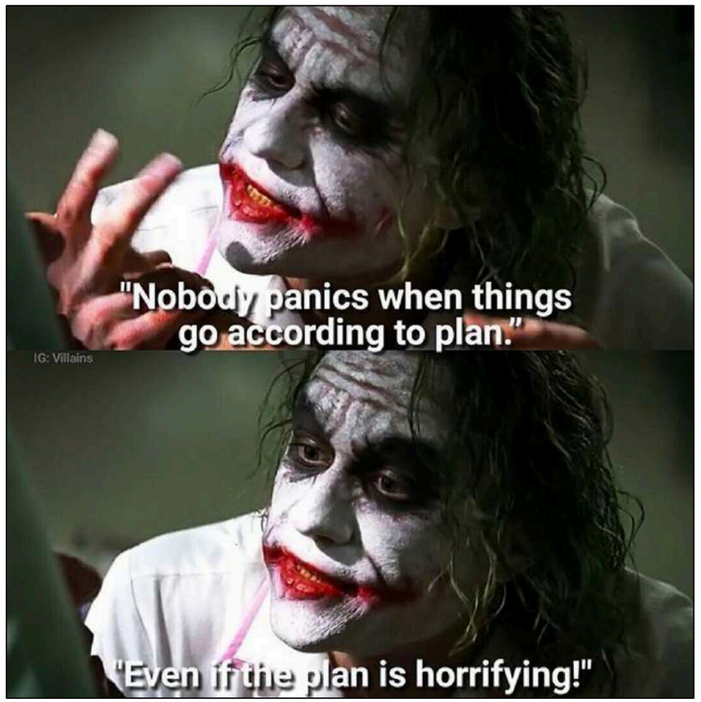
- ***… for each patient!!***
- **… every fraction!!**
- **… in a safe way!!**

Due to the complexity of Radiation Oncology, QA and safety is more than pre-treatment verifications, but process oriented.

Dosimetry audits and standards …

- “An **external dosimetry audit** is mandatory **PRIOR** to clinical implementation of a linac”

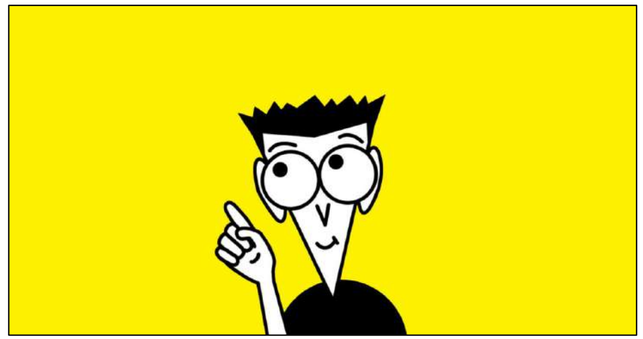
- What are the tolerances, who decides on these tolerances?
- Basic dosimetry audit or complex techniques?
- What if audit fails for, let’s say 1 electron energy only?
- What in case of dispute, experimental set-up errors?



See presentation on ”How to maintain a permanent audit service”

Summary

- The audit is NOT a pass/fail exam, it’s advisory
- Focus on patient safety and quality
- It’s more than MSQA and PSQA: process oriented QA



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