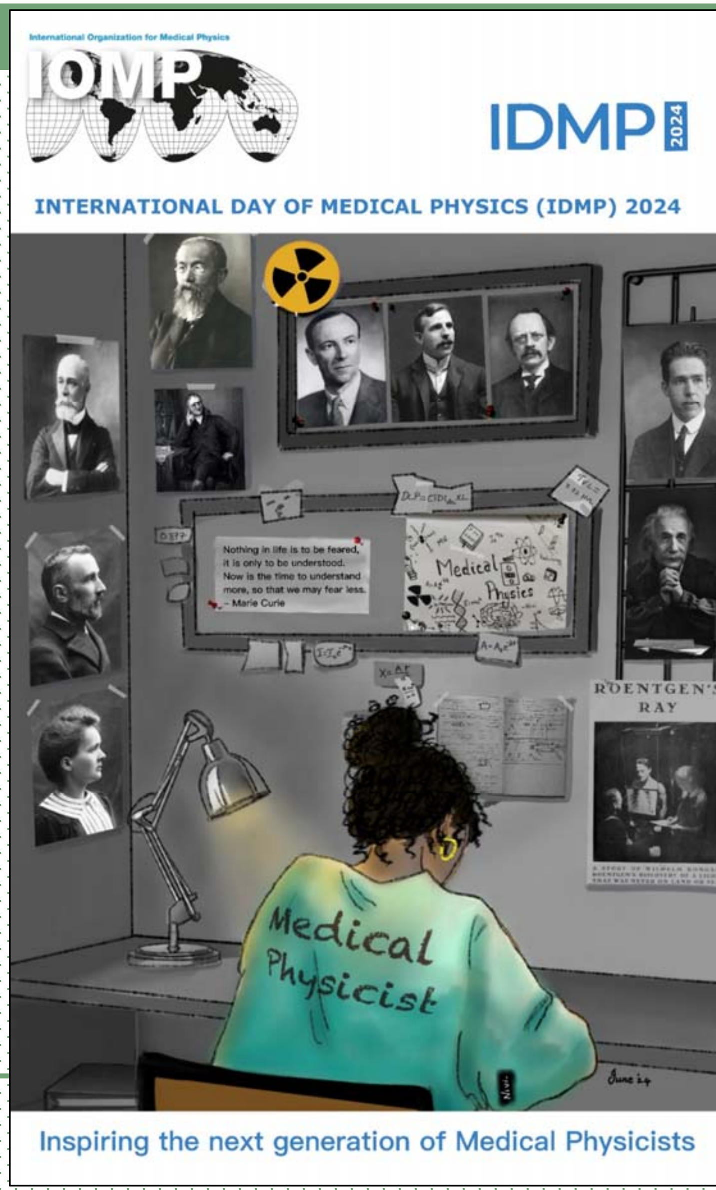
Types of RT Protection Methods in Head and Neck Cancer Patients

Dr. Mikaeel Mollazadeh

Assistant Professor of Medical Physics

Department of Medical Physics, School of Medicine,

Tabriz University of Medical Sciences


International Organization for Medical Physics
IOMP
IDMP 2024
INTERNATIONAL DAY OF MEDICAL PHYSICS (IDMP) 2024
Nothing in life is to be feared,
it is only to be understood.
Now is the time to understand
more, so that we may fear less.
- Marie Curie
Medical Physics
ROENTGEN'S RAY
Medical Physicist
Inspiring the next generation of Medical Physicists

Contents:

1. H&N cancer

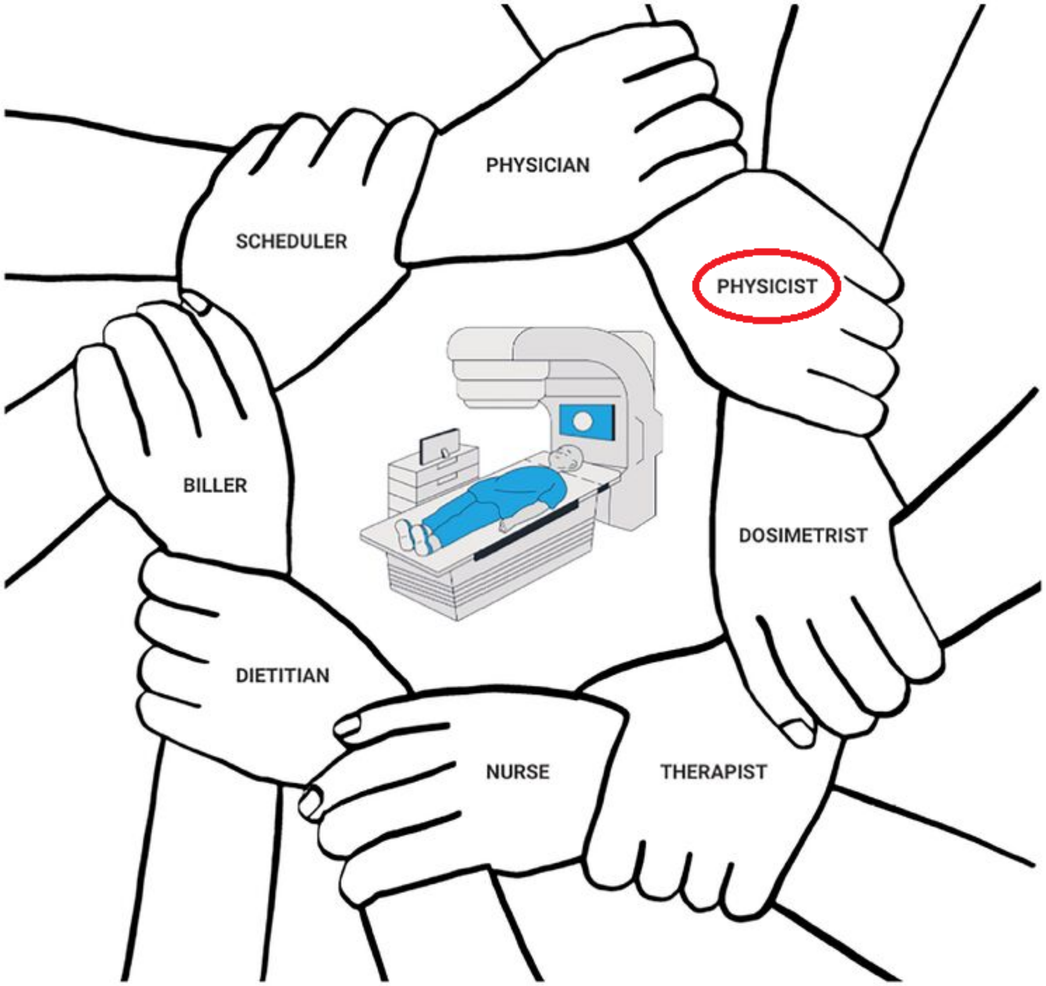
Causes of H&N cancer

1. The use of tobacco and alcoholic beverages is the most common cause of mouth, throat, larynx and tongue cancers.
2. In adults who do not use cigarettes and alcoholic beverages, the Human papilloma virus (HPV) can cause throat cancer.
3. Also, prolonged exposure to sunlight can cause lip and skin cancer.

7 early signs of H&N cancer

1. Cervical lumps
2. Voice change
3. Oral gland
4. Raising blood
5. Swallowing problems
6. Skin changes
7. Persistent earache

2. Roles (RO, RT, MP)

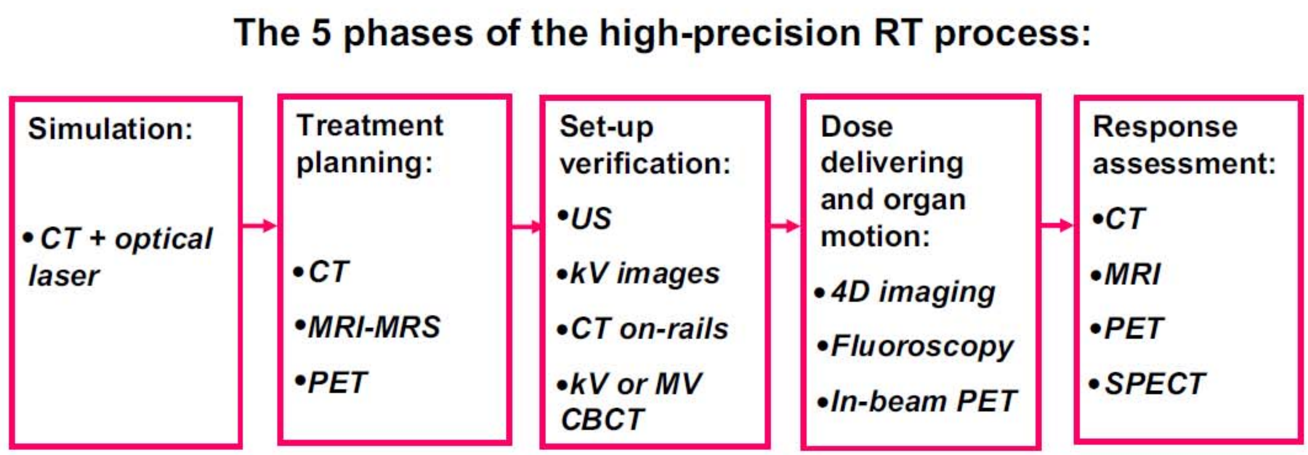

PHYSICIAN
SCHEDULER
PHYSICIST
BILLER
DOSIMETRIST
DIETITIAN
NURSE
THERAPIST

Roles (RO, RT, MP)

		Roles
Radiation Oncologist	RO	**Advice about treatment options and consent for treatment Target and normal tissue delineation** **Prescription of radiotherapy** **Planning review and approval** **Monitoring of treatment Patient follow-up**
Radiation Therapist	RT	**Patient information and support Simulation** **Planning** **Producing and checking treatment plans Data transfer and monitor unit calculations Daily radiotherapy delivery** **Treatment verification** **Monitoring the patient on a daily basis**
Medical Physicist	MP	**Specification of equipment used in therapy and imaging Facility design, including shielding calculations Commissioning of diagnostic, planning and treatment equipment and software** **Dosimetry assurance** **Quality assurance of diagnostic, planning and treatment equipment and software**

3. Roles (Imaging)

Roles (Imaging)



Schematic view of the imaging modalities used or now investigated in the high-precision RT process (*CT* computed tomography, *MRI* magnetic resonance imaging, *MRS* magnetic resonance spectroscopy, *US* ultrasonography, *kV* kilovoltage, *MV* megavoltage, *CBCT* cone beam CT)

What Radiologists Should Know

In medical imaging, CT artifacts can be a common challenge, yet understanding them is crucial for accurate diagnosis, making it essential for radiologists to recognize and understand them.

Artifacts are distortions or errors in the imaging data, leading to misleading images. Recognizing and mitigating these artifacts is essential for ensuring the best patient care.

one

Beam Hardening

This results in streaks or dark bands, particularly around dense structures like bone. It occurs because lower-energy X-rays are absorbed more than higher-energy ones.

two

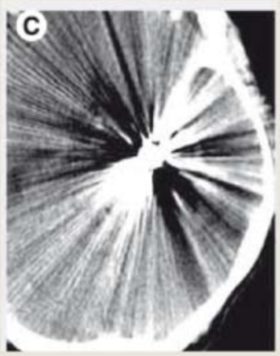
Motion Artifacts

These occur when a patient moves during the scan, leading to blurring or ghosting of the image.

three

Metal Artifacts

Seen as streaks or starburst patterns, these are caused by the presence of metal objects within the body, such as dental fillings or surgical implants.



Four

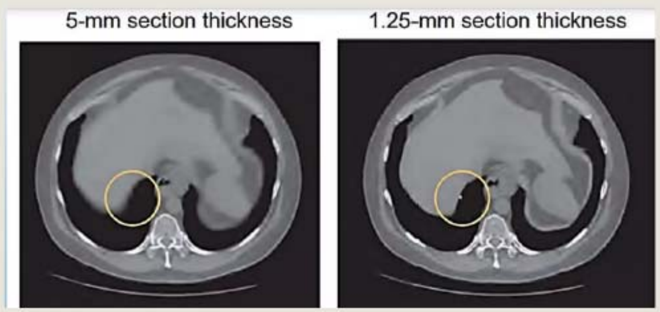
Ring Artifacts

These appear as concentric rings in the image, often caused by detector malfunctions or calibration errors.

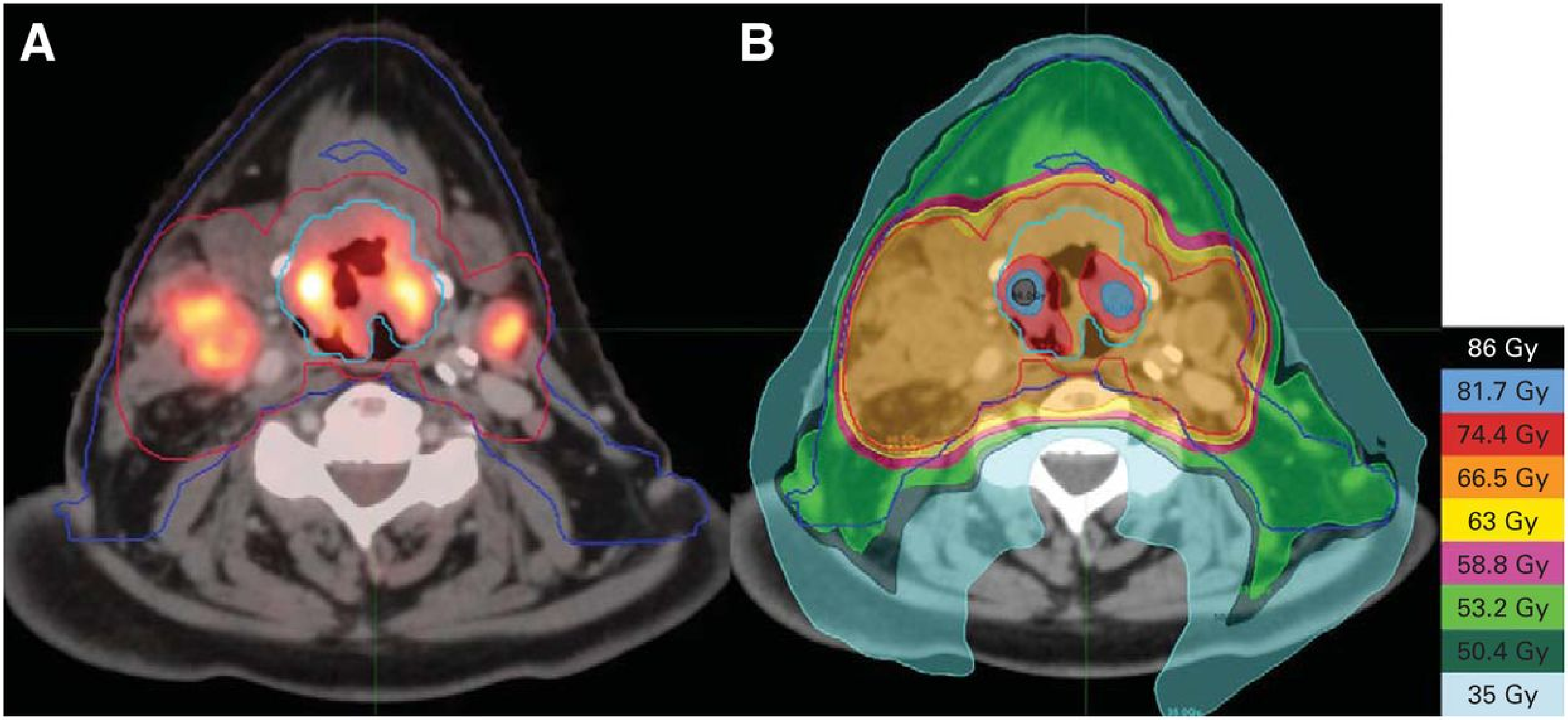
Five

Partial Volume Artifacts

occurs when tissues of widely different absorption are encompassed on the same CT voxel producing a beam attenuation proportional to the average value of these tissues.



Roles (Imaging)



4. Protection in RT

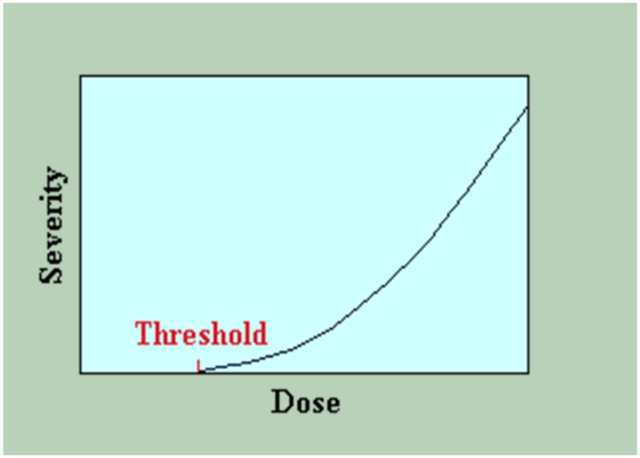
Radiation effects

Deterministic effects:
There exists a certain level, the "Threshold", **below which the effect will be absent.**

Example: Cataract, Erythema, Infertility, etc.

Stochastic effects
Severity of effects on human beings, increase with increasing doses (Without "threshold')

Example: Cancer, Genetic effects, etc.



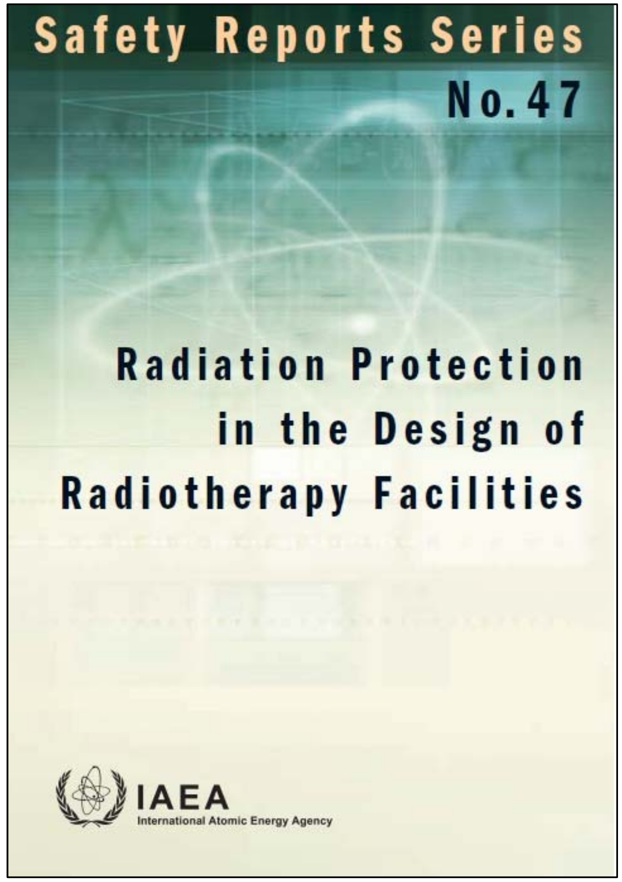
Protection in RT

اثرات حاد: تهوع- کسالت- بالا رفتن دما- تغییرات خونی

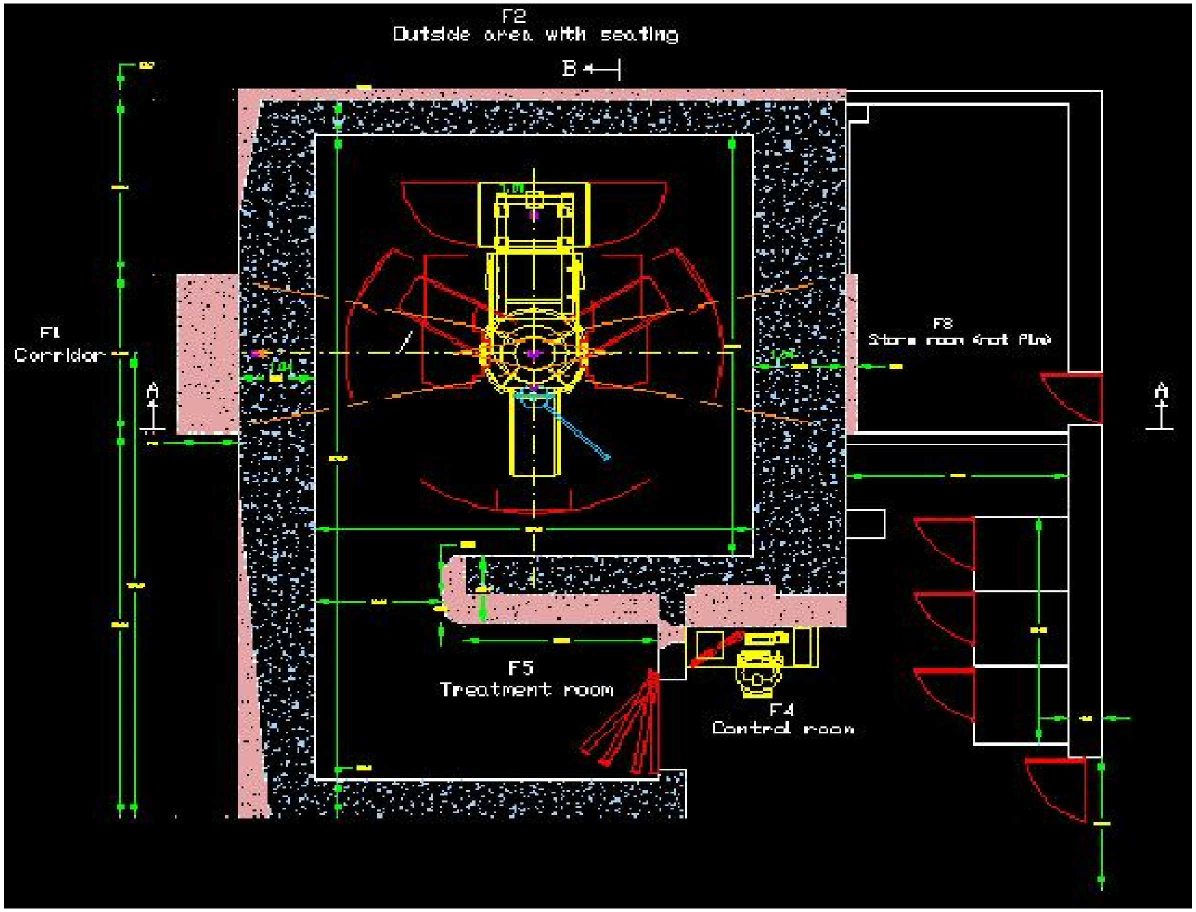
از ۲۵۰ تا ۵۰۰ میلی‌گری به بالا: تغییر در CBC
بعد از ۲ گری: سندروم خون‌سازی، کاهش یا قطع فعالیت مغز استخوان
از ۱۰ گری به بالا: سندروم معده‌ای - روده‌ای
از ۲۰ گری به بالا: سندروم دستگاه عصبی، بیهوشی و مرگ ظرف چند ساعت

اثرات مزمن و تاخیری:
از ۱ گری به بالا: سرطان (خون) در طول ۵ تا ۲۰ سال
کوتاهی عمر و یا آب مروارید

Protection in RT



An example


F2
Outside area with seating
F1
Corridor
F3
Store room (not PA)
F5
Treatment room
F4
Control room

Protection in RT

Ozone- Siemens standards

Ozone Production

The system produces a very small amount of ozone during operation, <10 parts per billion per hour during continuous operation, with room volume of 130 m^3. There are no special ventilation requirements caused by ozone generation.

NOTE — **It is important to adhere to the local authorities's health requirements for standard ventilation of treatment rooms in hospitals.**

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Ozone

Energies up to 21 MeV are produced by the MEVATRON electron beam. Interaction of the beam and air produces ozone and isotopes of nitrogen. The recommended maximum permissible concentration of these gases is 0.1 parts per million (ppm) for ozone, and 5 ppm for isotope N3 of nitrogen. The treatment room must be adequately ventilated at all times. An exhaust blower must be used during operation of the linear accelerator, and the exhaust system must be capable of about 10 exchanges of room volume per hour. Refer to *National Council on Radiation Protection and Measurements* (NCRP) Reports 49, 51, and 57.

PRIMUS Linear Accelerator TH02-010.891.01.08.02 04.07 — Page 26 of 104 CSSDOCS — Siemens AG Medical Solutions

Siemens Medical Systems, Inc. Oncology Care Systems Group — 55 02 773 Rev A 11/99 — BEAMVIEW System Manual Precautions

Protection in RT

Ozone- IAEA standards

replacing ordinary concrete with other materials will have serious financial implications; for example, high density concrete (5 g/cm^3) will cut the barrier thickness roughly to half of that required for ordinary concrete, but on a per volume basis the costs of the shielding material will increase by a factor of 30. The difference is even more pronounced when steel or lead is used for

A similar problem is posed by the direct activation of elements in (x, n) reactions, such as ^{15}O (half-life 2 minutes) and ^{13}N (half-life 10 minutes). The radioactivity in treatment room air is removed by efficient room ventilation. The ventilation also handles the removal of ozone and noxious gases, in addition to the removal of radioactive gases, through 6–8 air exchanges per hour.

dose.

Neutrons can activate other elements, which remain radioactive and will contribute to the radiation exposure of radiotherapy staff entering the treatment room after a high energy photon beam treatment. The radionuclides from activated components of a linac are generally short lived (of the order of seconds to a few minutes).

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The concrete primary and secondary barriers designed to protect against photon dose are quite adequate to protect against electrons and contamination neutrons. However, neutrons undergoing multiple scattering along the maze can present an unacceptable radiation level in the control area, thus requiring a specially designed door.

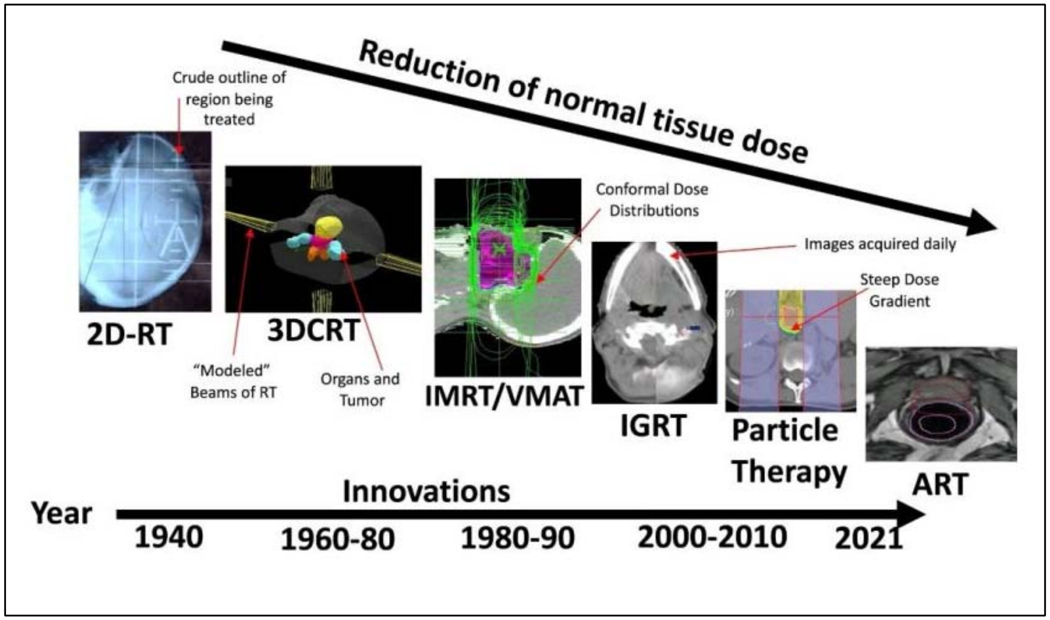
16.18.7. Door of a linac room

The door of a high energy linac installation may require shielding against X rays and neutrons scattered through the maze towards the linac control area. High energy neutrons are more of a problem than low energy photons.

605

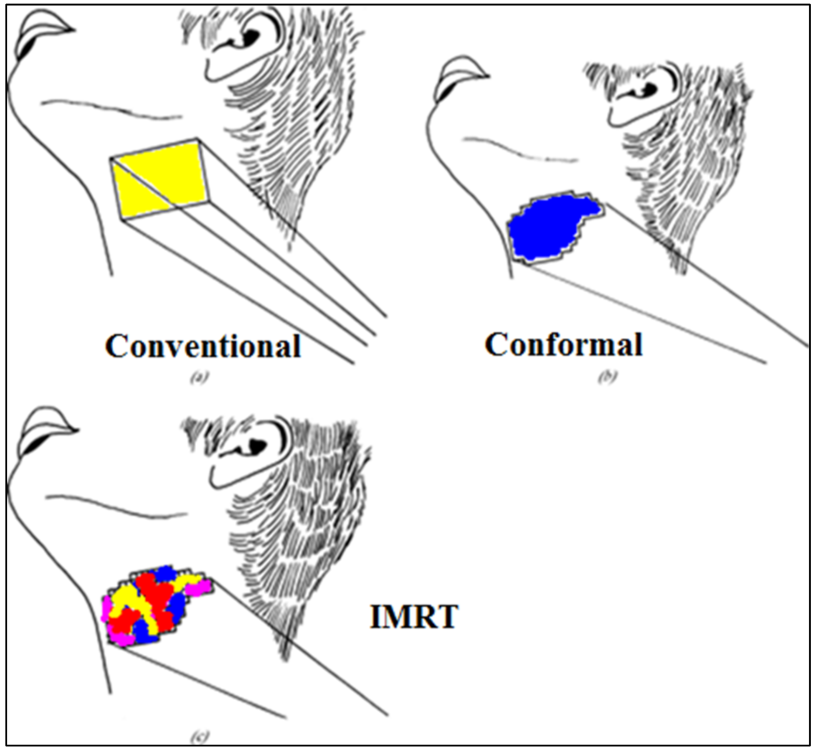
5. Types of RT methods

The Evolution of Radiation Therapy

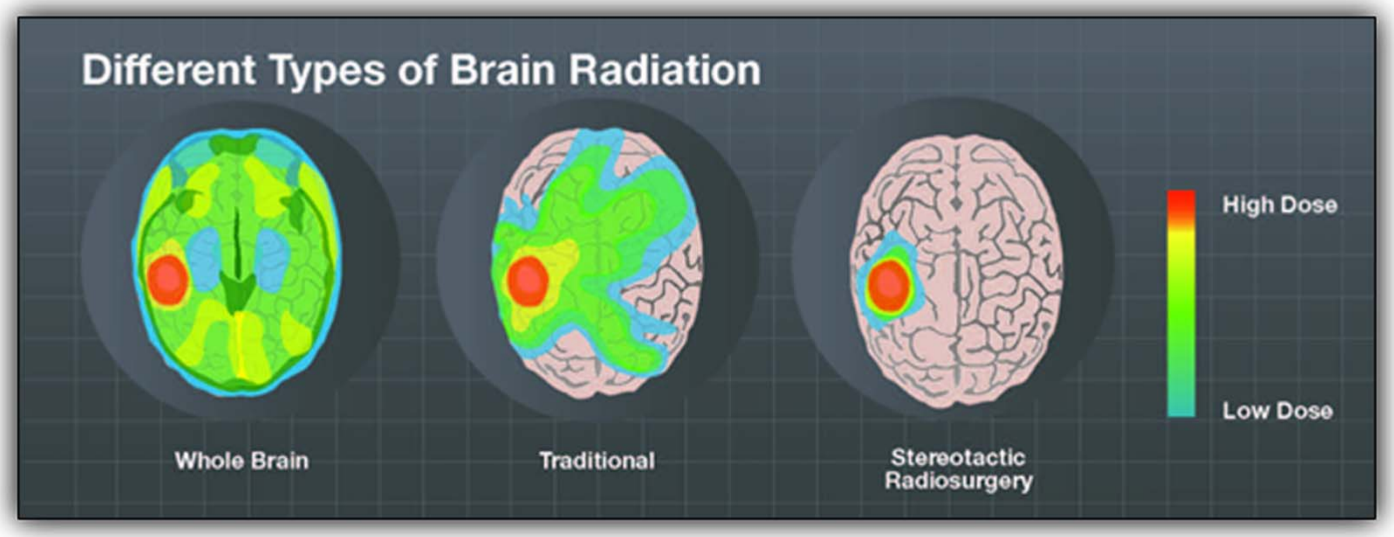


- **Max** dose to the **target**, **Min** dose to the **healthy tissues**.

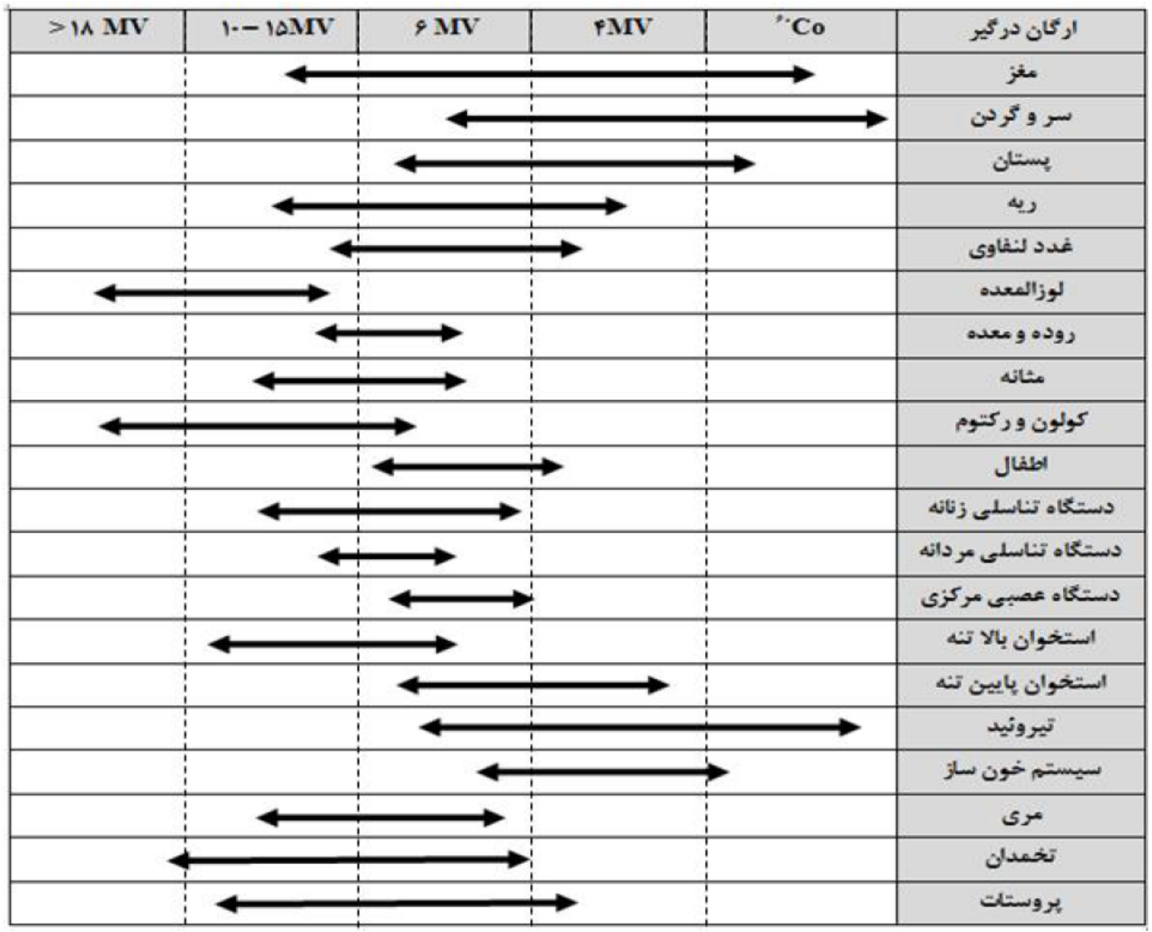
Types of RT methods



Types of RT methods



جدول ۱. محدوده انرژی فوتون مناسب برای درمان ارگان‌های مبتلا به سرطان.



مجلهٔ پژوهش فیزیک ایران، جلد ۱۵، شمارهٔ ۲، ویژه‌نامه، تابستان ۱۳۹۴
مهناز منتظم[1]، سیدربیع مهدوی[2] و فرشاد قاسمی[1]

Types of RT methods

CyberKnife

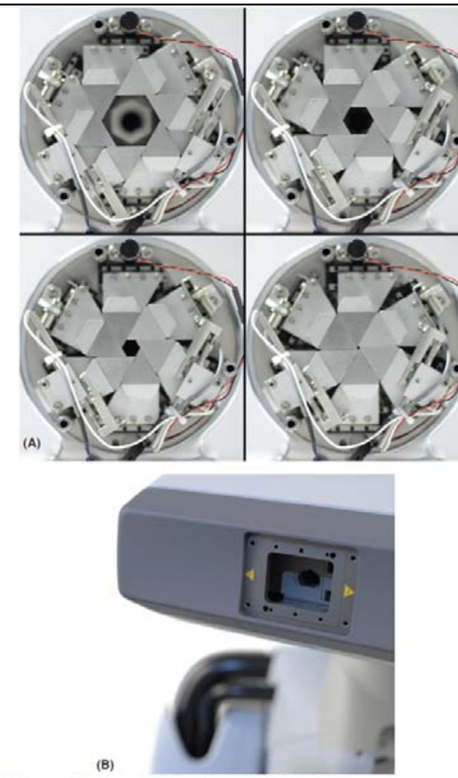


FIGURE 7.8 Closeup of the CyberKnife (A) Iris collimator and (B) InCise MLC.

GammaKnife

Advantages of Gamma Knife technology:

1- Reduction of side effects.
2- Patients can be treated in 1 session on the same day and go home.
3- There is no need for a period of recovery and rest.
4- There is no need to cut the patient's hair.
5- It does not cause hair loss.
6- The amount of harmful radiation to healthy brain tissue is reduced.

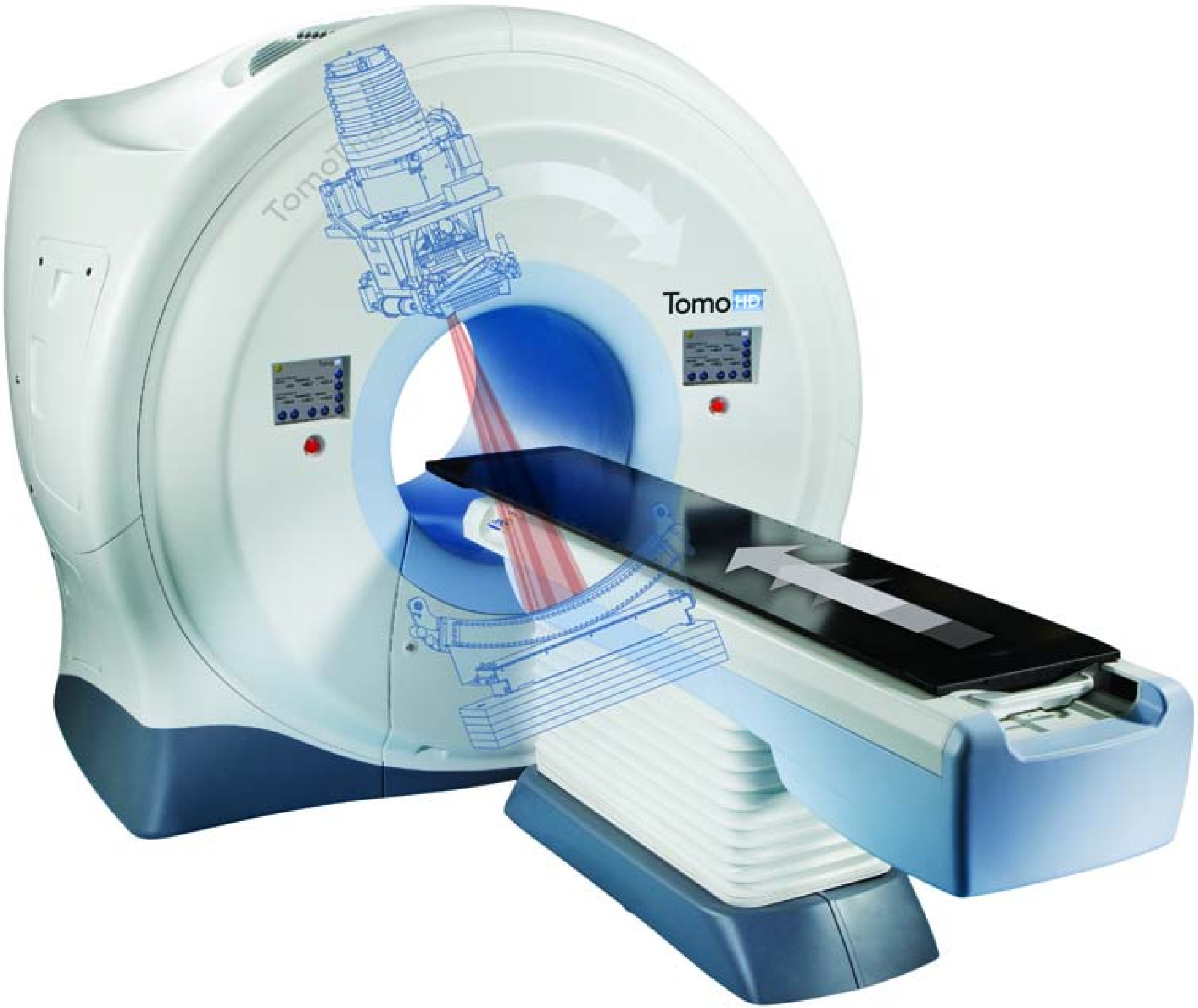
- **Disadvantageous:**

1. Source replacement
2. Treat only intracranial lesions
3. Limited field size/shaping (up-to 5.3 cm)

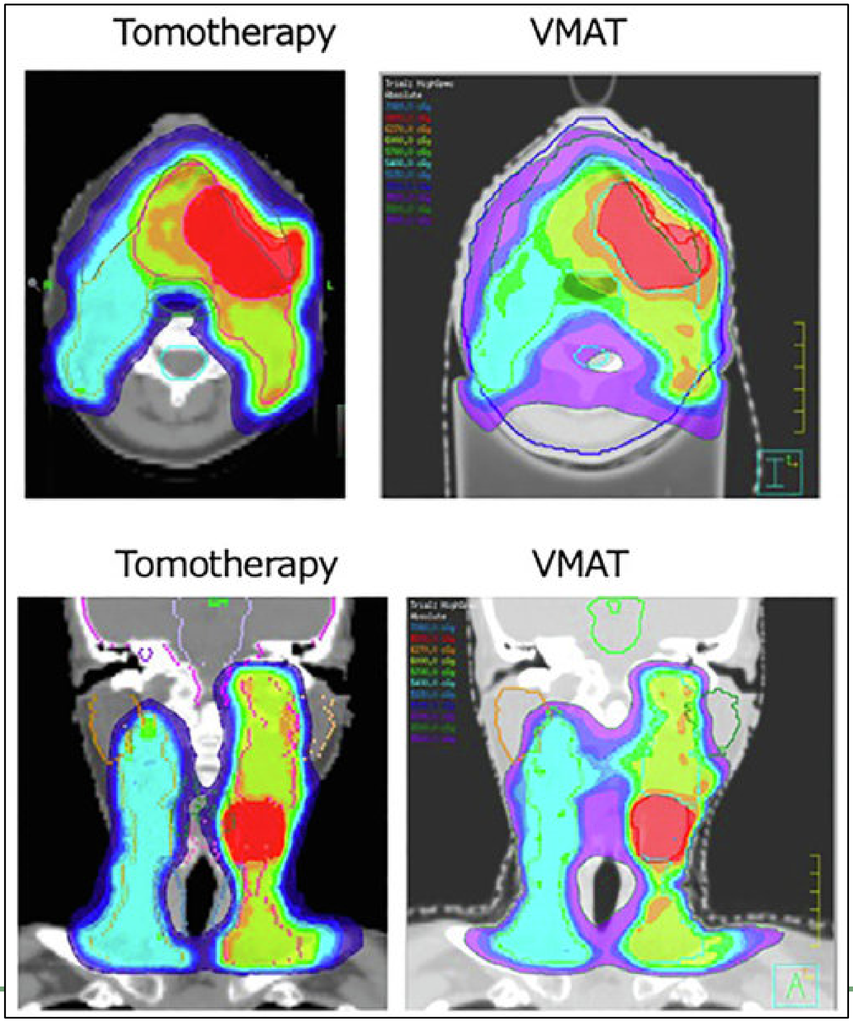
Fig. 2.1 Elekta GammaKnife® Icon unit, which collimates 192 Cobalt-60 sources to deliver multiple beams simultaneously

Types of RT methods

Tomotherapy



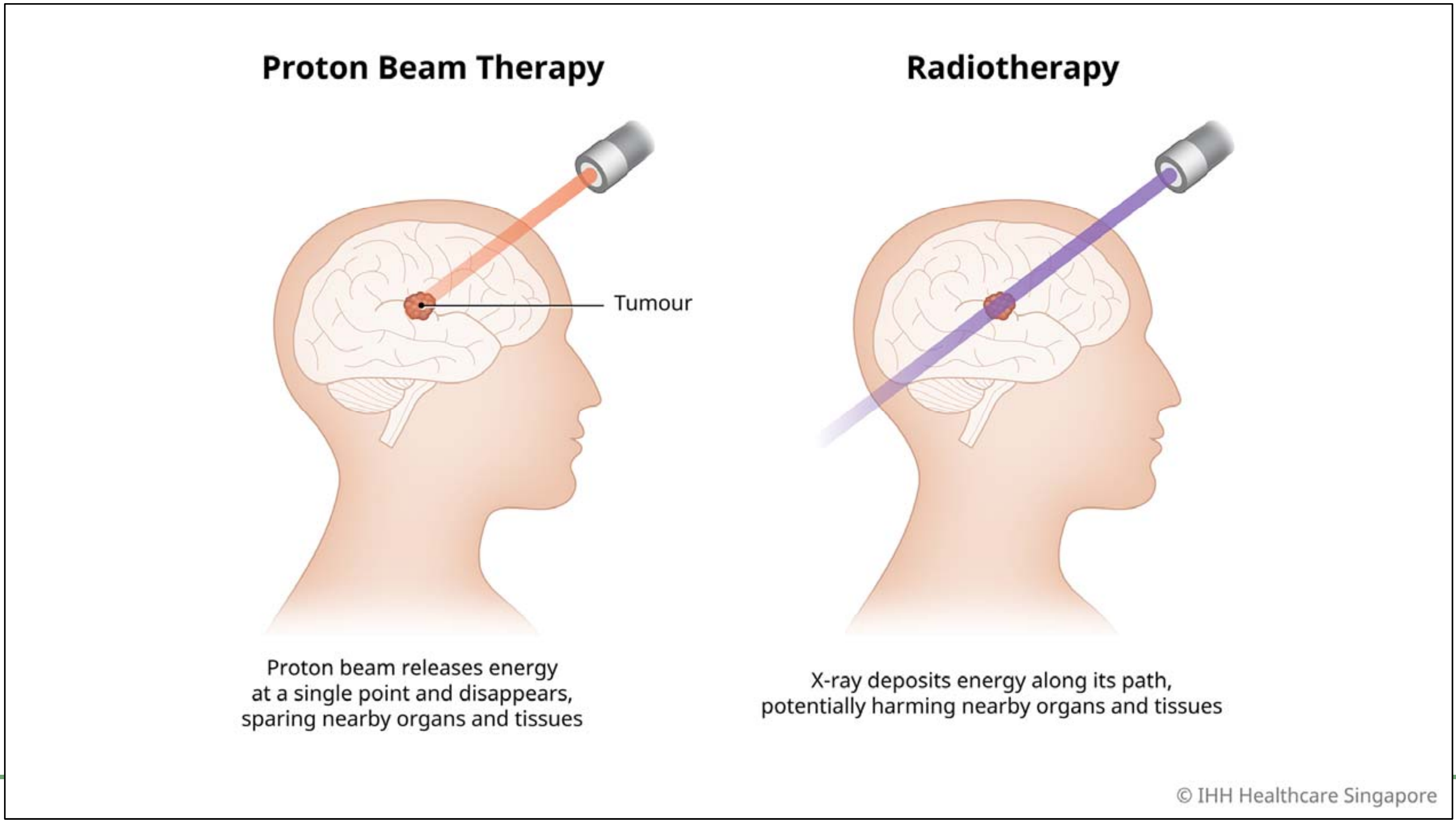
Tomotherapy



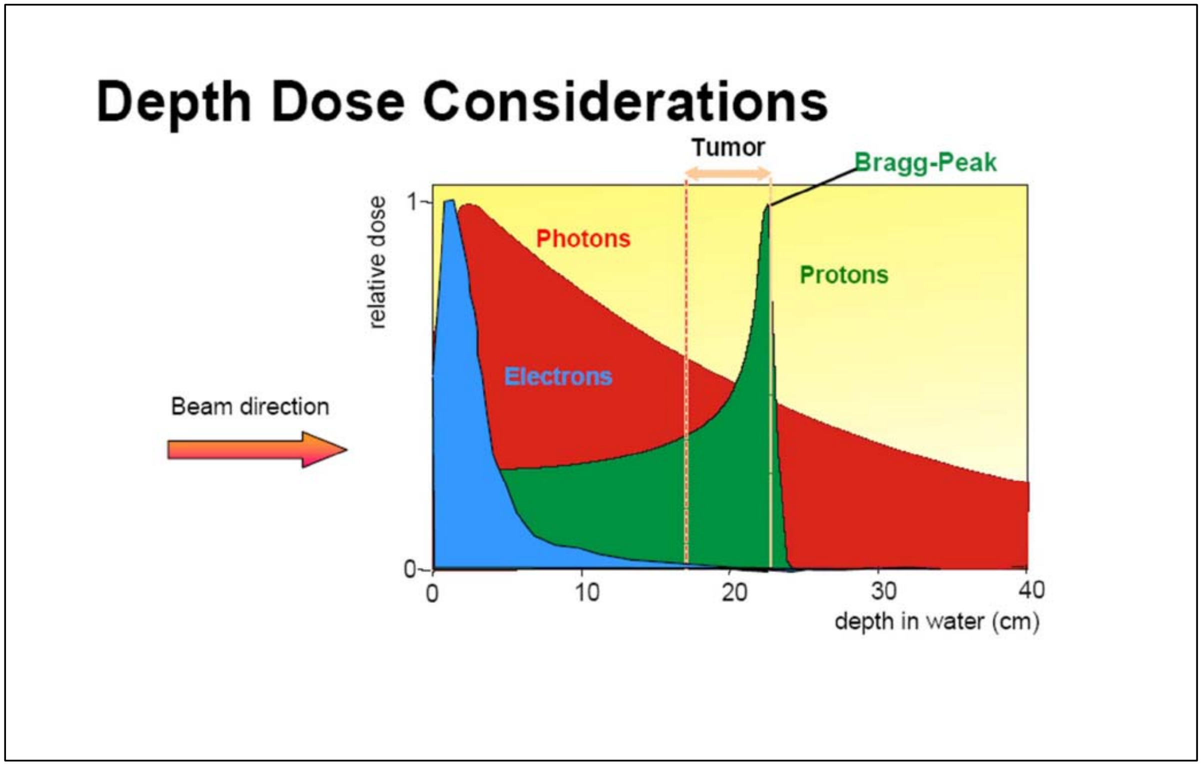
Proton Therapy

Types of RT methods

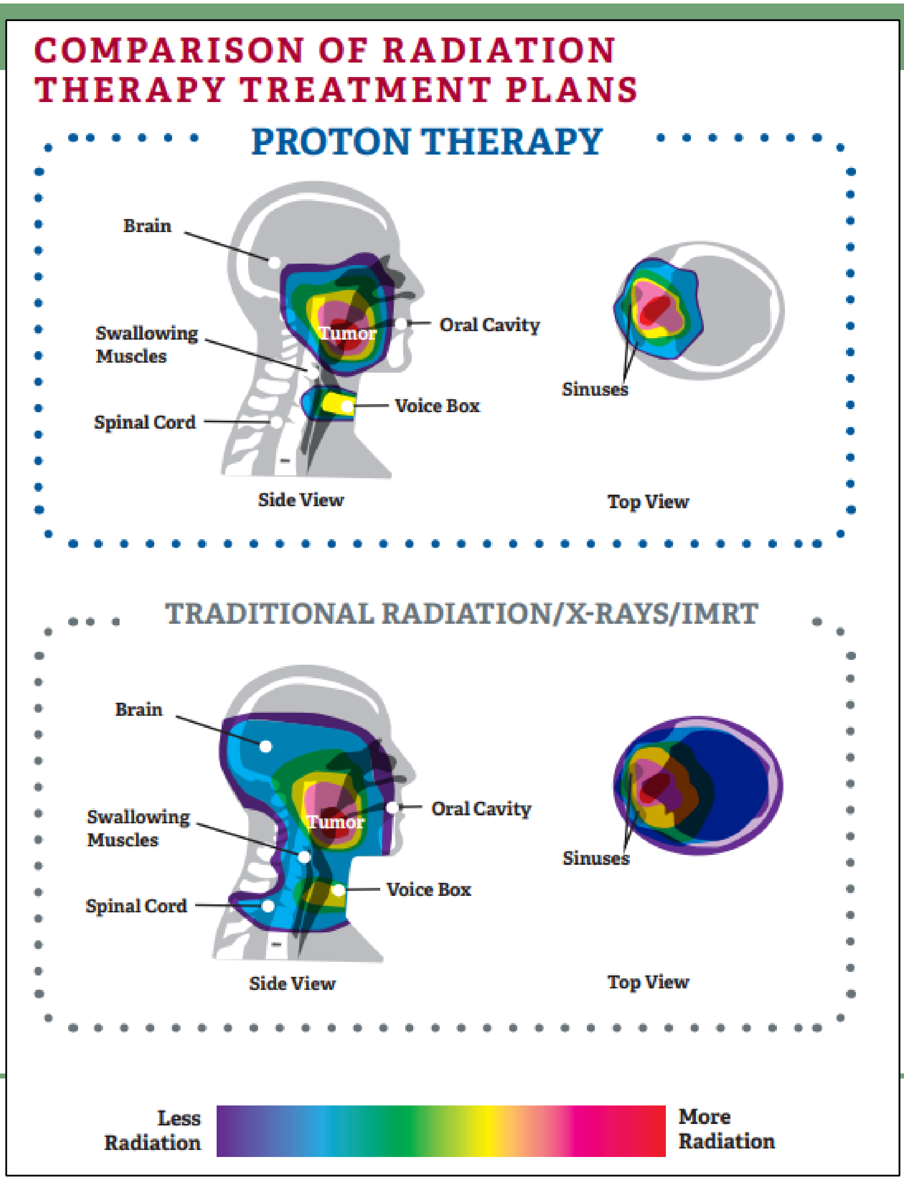
Proton Therapy



Proton Therapy

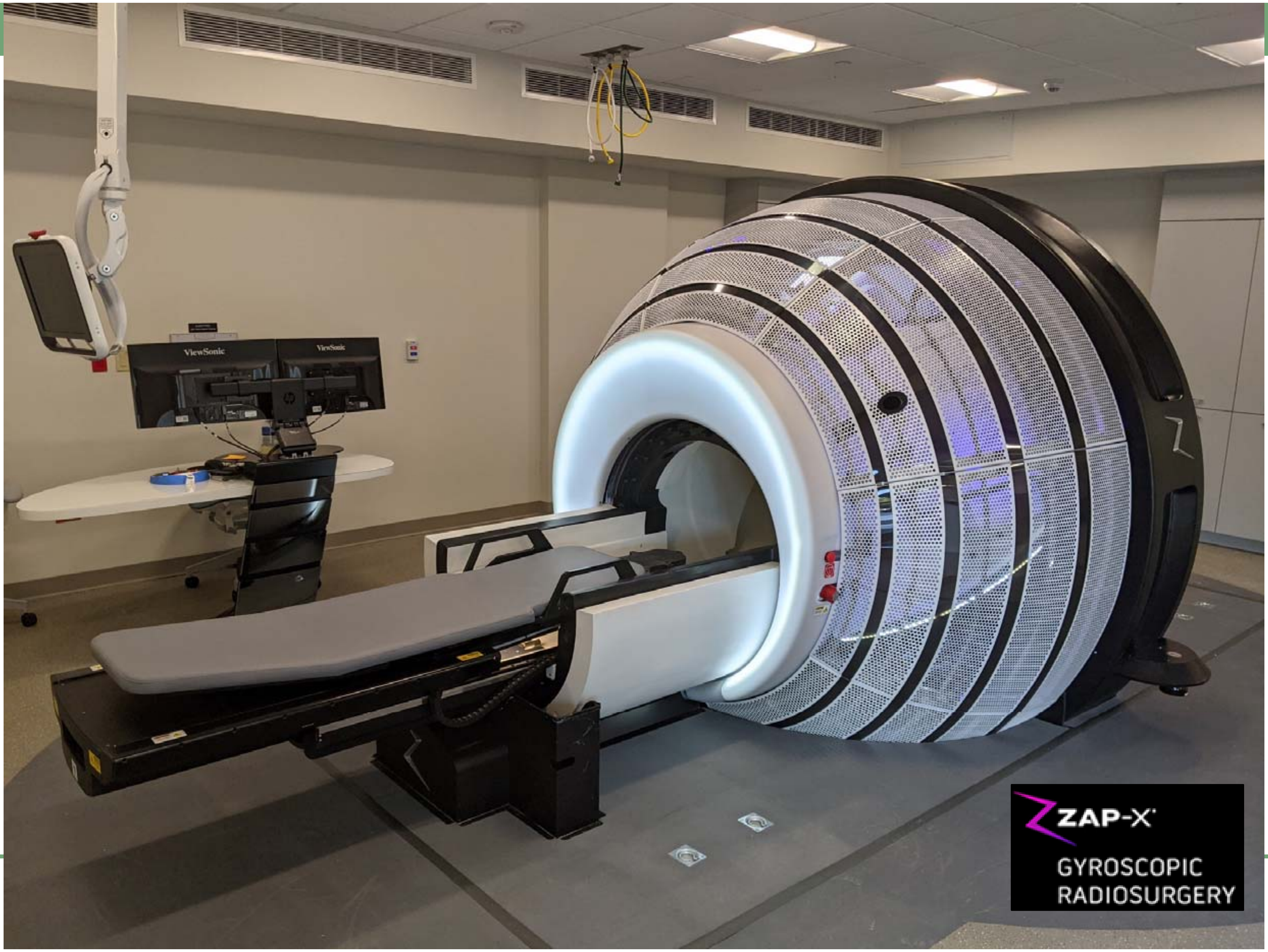


Proton Therapy



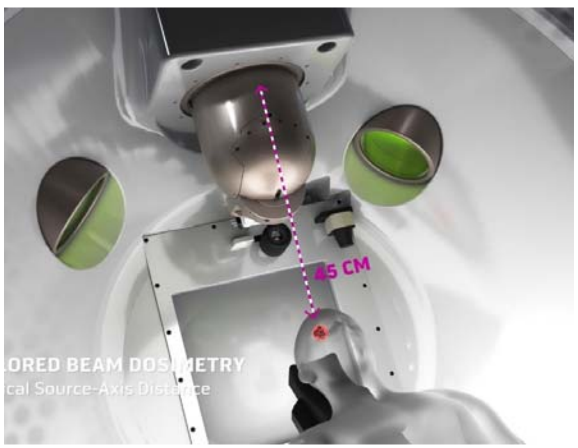
Types of RT methods

Brachytherapy


ViewSonic
ViewSonic
ZAP-X
GYROSCOPIC
RADIOSURGERY

Types of RT methods

1. Built for Radiosurgery (Brain-head and neck tumors)
   An innovative design focused solely on SRS
2. 3 MV- 1500 MU/min Linac
3. Source-Axis Distance (45 cm)
4. self-shielding technology
5. 8 Beam Apertures: 4-25 mm
6. Sub-Millimetric Targeting Accuracy



7. Intra-Fraction Image Guidance Throughout the Treatment
8. Automated Isocenter Realignment
9. Non-Coplanar
10. 2π Steradian Coverage (~360°)
11. Real-Time Beam Dosimety
12. Vault-Free (No Need for Bunkers)

References:

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THE END