ORTHOVOLTAGE

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- Uses conventional X-ray tube

Energy range 150-500 kV X-rays

Mostly used around 250 - 300 kVp

Applicators are used in superficial therapy

Treatment depths of around 20 mm

Penetration sufficient for palliative treatment of bone lesions relatively close to the surface (ribs, spinal cord)

- HVLs of 1-4mm of copper are common with the use of added filters.
- The SSD is typically 50cm.Very few of these machines are still in clinical use.
- The greatest limitation is the skin dose, which becomes prohibitively large when adequate doses need to be delivered to deep seated tumours

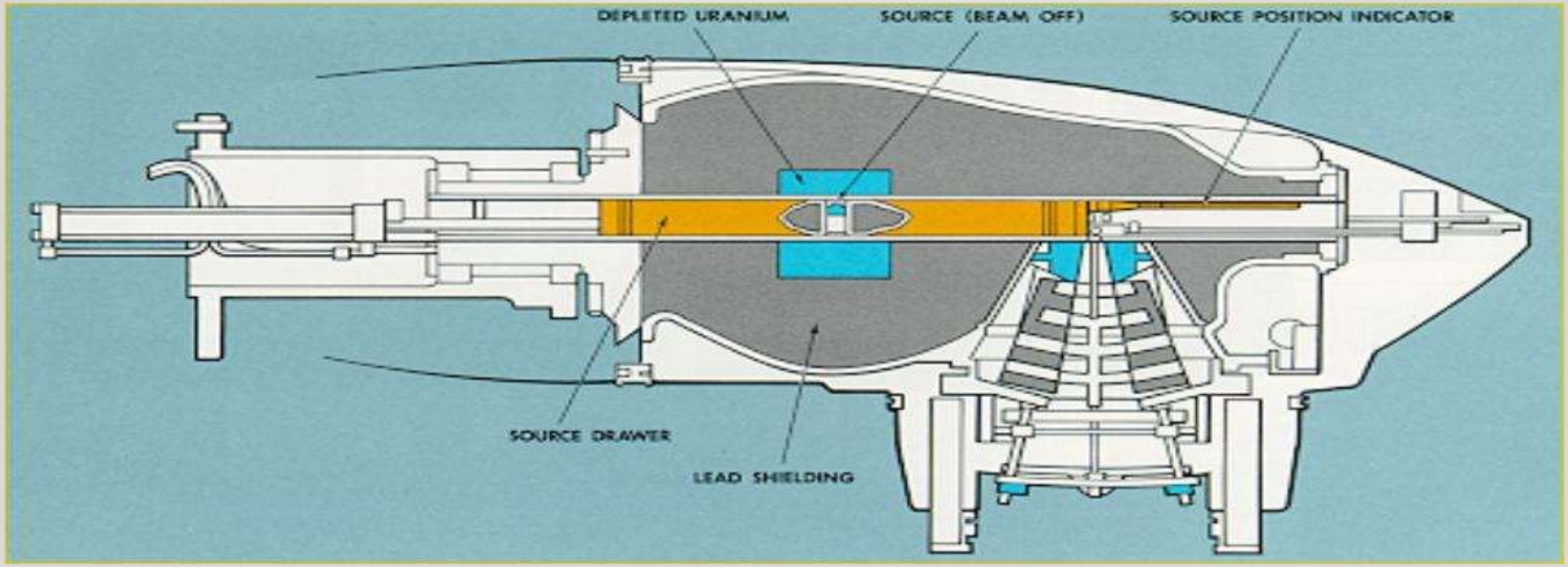
COBALT -60

- The first cobalt-60 teletherapy machine was setup in august 1951 in the saskatoon cancer clinic in Canada.
- Cobalt-60 teletherapy machine has advantages of relative constancy of beam output ,predictability of decay because of a well defined half life, and lack of day to day small output fluctuations.
- Disadvantages include the need for source replacement approximately every 4 to 5 years, poor field flatness for large field and lower depth dose compared with high energy photons generated by medical linear accelerators.

- Modern isocentric cobalt 60 machines have a source-to-axis distance of 80-100cm.
- Source activities vary from about 5,000 to 13,000 Ci in 1.5-2.0 cm diameter sources, and yield exposure rates of 150-250 R/min at 1 metre.
- Maximum field sizes of 40 * 40 cm at the machine isocentre are available on newer machines.
- The radiation consist of 1.25 MeV gamma rays having d ½ in tissue of about 10cm.

COBALT – 60 EQUIPMENT

- Source head and transfer mechanism



SOURCE HOUSING

- The source head consists of a steel shell filled with lead for shielding purpose and a device for bringing the source infront of an opening in the head from which the useful beam emerges.
- Also, a heavy metal alloy sleeve is provided to form an additional primary shield when the source is in the off position.

ISOCENTRIC TECHNIQUE

- An isocentric technique is where all beams used in a radiation treatment have a common focus point.
- The idealized intersection point of the gantry axis of the collimator and treatment table is known as the mechanical isocenter.
- Isometric technique require less patient repositioning as multiple field arrangements can be delivered with gantry and collimator movements , reducing treatment times.

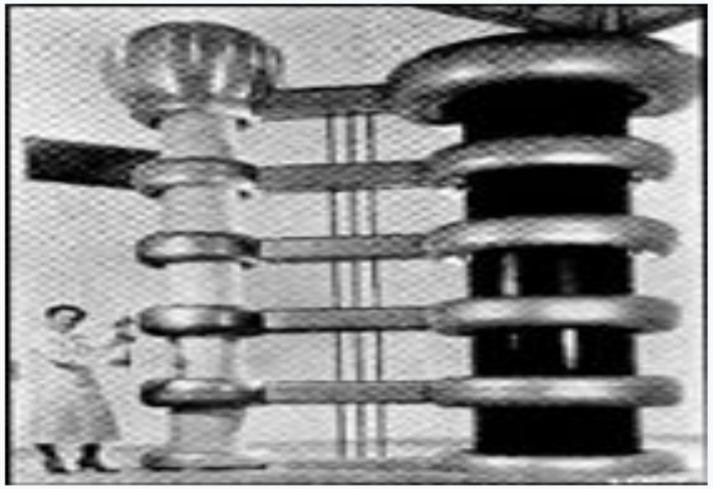
WORKING

- The movements of the linear particle accelerator are threefold;
- 1.the gantry rotates (like a big crane arm)
- 2.the collimeter twists in the head of the gantry
- 3.the bad swings around on the floor
- All of these moments in the modern linac occur around an axis that runs through the isocentric.
- In this way if the centre of the target area in the patient's body is moved to coinside with the isocenter, then all motions of the machines will remain centred on the target.
- This way, non-target areas will only receive short durations of radiation , reducing damage to them, while the target area receives constant radiation

MEGAVOLTAGE X-RAYS

- Megavoltage x-rays are produced by linear acclerators operating at voltages in excess of 1000 kV(1 MV) range , and therefore have an energy in the MeV range.
- They are used in medicine in external beam radiotherapy to treat neoplasms , cancers and tumors.
- Beams with the voltage range of 4-25 MV are used to treat deeply buried cancers because radiation oncologists find that they penetrate well to deep sides with in the body.
- Lower energy x-rays , called orthovoltage x-rays , are used to treat cancers closer to the surface.
- Megavoltage x-rays also have higher relative biological effectiveness than orthovoltage x-rays.

Megavoltage X-rays



Early megavolt x-ray machine installed at Los Angeles Institute of Radiotherapy, 1938. Before linacs, high voltage x-ray tubes *(left column)* powered by million volt transformers *(right column)* were used to produce penetrating x-rays

ELECTRON BEAM ACCELERATORS

- In this accelrators , the beam current is reduced and the x ray target is retraced.
- An electron scattering foil is moved into place on the beam centre line so that the accelerated pencil beam strikes it in order to broaden the beam and produce a flat field across the treatment field.
- The scattering foil consists of dual lead foils.
- The thickness of the first foil ensures that most of the electrons are scattered with only a mimimum of bremsstrahlung x-ray.
- The second foil is generally thicker in the central region and is used to flatten the field.

- The bremsstrahlung produced appears as x-ray contamination of the electron beam and is usually less than 5% of the maximum dose.
- An electron applicator is mounted below the movable collimator jaws to provide final field collimation.

BETATRON

- The operation is based on the principle that an electron in a changing magnetic field experiences acceleration in a circular orbit.
- The accelerating tube is shaped like a hollow doughnut and is placed between the poles of an alternating current magnet.
- A pulse of electrons is introduced into this evacuated doughnut by an injector at the moment an alternating current cycle begins.
- As the magnetic field rises , electrons experience acceleration continuously and spin with increasing velocity around the tube.
- By the end of the first quarter cycle of the alternating magnetic field , the electrons have made several thousand revolutions and achieved maximum energy.

- At this instant or earlier , depending on the energy required , the electrons are then made to spiral out of the orbit by an additional attractive force.
- The high energy electrons then strike a target to produce x-rays or a scattering foil to produce a broad beam of electrons.
- The x-ray dose rates and field size capabilities of medical betatrons are low compared with medical linacs and even modern cobalt units.
- But in the electron therapy mode , the beam current is adequate to provide a high dose rate.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