INTERNSHIP REPORT

REPORT ON MEDICAL EQUIPMENT AND THEIR APPLICATIONS

SUBMITTED BY

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SIEMENS Healthineers

FROM	TO
5 APRIL 2021	20 APRIL 2021

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ACKNOWLEDGEMENT

This internship opportunity I had with Siemens Healthineers was a great chance for learning and professional development. I want to thank my advisers and everyone at the company for their patience and assistance during my on-site training.

My deepest gratitude to Mr. Debdeep Nandi and Mr. Narayana Kumar, who despite being extraordinarily busy with their duties took time out to hear, guide, and keep me on the correct path. Special thanks to T Ravindra Reddy, Siemens-Healthineers HR department, the staff members and Engineers, for their patience and assistance during my training at their company.

During the period of internship, I have learned the working principles and the components used in various Medical Equipment such as MRI, CT machine, Ultrasound, CATH LAB, C-Arm, Fixed and mobile X-ray, Gamma camera, and PET-CT. I learned about various software and hardware involved in each piece of equipment.

I perceive this opportunity as a big milestone in my career development. I will strive to use gained skills and knowledge in the best possible way to attain desired career objectives. Hope to continue cooperation with all of you in the future.

Yours Sincerely,

Sivakumar Ramakrishnan

Place: Chennai

Date: 21.04.2021

Information about the company

Siemens Healthineers AG (formerly Siemens Healthcare, Siemens Medical Solutions, Siemens Medical Systems) is the parent company for several medical technology companies and is headquartered in Erlangen, Germany. The company dates its early beginnings in 1847 to a small family business in Berlin, co-founded by Werner von Siemens. Siemens Healthineers is connected to the larger corporation, Siemens AG. The name Siemens Medical Solutions was adopted in 2001, and the change to Siemens Healthcare was made in 2008. In 2015, Siemens named Bernd Montag as its new global CEO. In May 2016, the business operations of Siemens Healthcare GmbH were rebranded "Siemens Healthineers."

A leader in medical technology, Siemens Healthineers is constantly innovating its portfolio of products and services in its core areas of diagnostic and therapeutic imaging and laboratory diagnostics, and molecular medicine. Siemens Healthineers is also actively developing its digital health services and enterprise services.

Currently, the company is working on bringing robots into the healthcare sector as utilizing them in medicine is a promising trend in the future.

Information about the internship position

I joined Siemens-Healthineers for an internship program as a trainee to learn about various medical equipment. While the central focus was on learning the components involved, I also learned the science and concepts behind the working of that equipment.

Description of the internship experience

As an intern in the service and maintenance department, I was asked to report to the respective service engineers on given locations On-site every day. I visited several prestigious hospitals, medical warehouses, medical colleges during this period and observed how well everything was organized. Additionally, I clarified all my doubts regarding the particular equipment.

The tasks I undertook included:

- Meeting and getting to know the respective service engineers.
- Observing the laboratory and Warehouse.
- General analysis of Components used.
- Understanding the Concepts used behind each piece of equipment.
- Drafting reports based on the observation.

DETAILS OF THE LOCATIONS

LOCATION	DATE	EQUIPMENT OBSERVED	GUIDE
VIJAYA HEALTH CARE, VADAPALANI	05.04.2021	**CT - SCAN**	Mr. Venkatesh
INSTITUTE OF CHILD HEALTH, EGMORE	07.04.2021	**CATH LAB**	Mr. Manoj
AARTHI SCANS AND LAB, TONDIARPET	08.04.2021	**MRI**	Mr. Rupesh
SIEMENS WAREHOUSE, PAMMAL	09.04.2021	**ULTRASOUND**	Mr. Vijay
BHARAT MEDICAL HOSPITAL, SELAIYUR	12.04.2021	**C – ARM**	Mr. Vijay
BILLROTH HOSPITAL, AMANJIKARAI	13.04.2021	**CT – SCAN**	Mr. Dilli Babu
APOLLO HOSPITAL, CHENNAI	15.04.2021	**GAMMA CAMERA**	Mr. Dilli Babu
MIOT INTERNATIONAL HOSPITAL, PORUR	16.04.2021	**MOBILE X-RAY**	Mr. Raja
APOLLO PROTON CANCER CENTRE, CHENNAI	19.04.2021	**PET- CT**	Mr. Dilli Babu
AARTHI SCANS AND LAB, MADIPAKKAM	20.04.2021	**MRI**	Mr. Rupesh

1.1 WHAT IS CT?

A computerized tomography scan (CT scan) uses computers and rotating X-ray machines to create cross-sectional images of the body. These images provide more detailed information than conventional X-ray images. They can show the soft tissues, blood vessels, and bones in various parts of the body by producing signals that are processed by the machine's computer to generate cross-sectional images or "slices" of the body.

Fig 1– 64 slice Somatom CT

MODEL NAME: CT SOMATOM DEFINITION

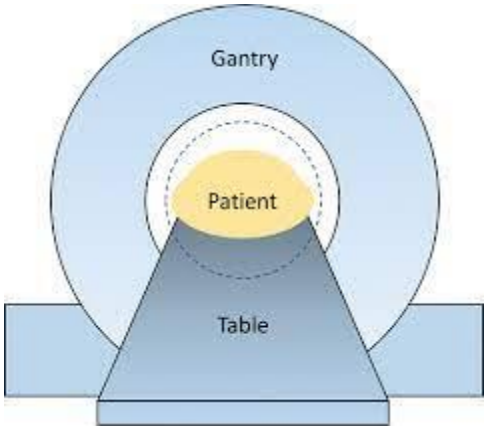
1.2 CONSTRUCTION OF CT

Main Components of CT:

1. Gantry
2. Data Acquisition System
3. Operating Console

GANTRY:

The gantry assembly is the largest component. It is made up of all the equipment related to the patient, including the patient support, the positioning couch, the mechanical supports, and the scanner housing. It also contains the x-ray tube, as well as detectors to detect x rays, a collimator.



Source: Internet

DATA ACQUISITION SYSTEM:

Once the X-ray is generated and passed through the patient, it gets collimated and falls on the detector. The Detector finds the intensity of radiation absorbed by the patient and we get feedback in the form of current and voltage. Pre-Amplifiers are used to enhance the signals and the analog signal is then converted to digital such that it can be processed and reconstructed using the Image Recon System.

OPERATING CONSOLE:

The operating console is the master control center of the CT scanner. Typically, this console is made up of a computer, a keyboard, and multiple monitors. The operator's console controls such variables as the thickness of the imaged tissue slice, mechanical movement of the patient couch, and other radiographic technique factors.

SOFTWARE:

Syngo

OTHER PARTS:

Gantry related components:

Rotating Components:

Master of Rotation controller is responsible for all the rotating components such as Slip rings, Collimator, Detector, X-ray Tube, HV Tank.

Other components such as Power Distribution Control, Patient Handling System, Image Control System, Image Recon System are also involved in the construction of CT machine.

1.3 WORKING PRINCIPLE

Unlike a conventional x-ray, which uses a fixed x-ray tube, a CT scanner uses a motorized x-ray source that rotates (possible due to slip rings) around the circular opening of the gantry. During a CT scan, the patient lies on a bed that slowly moves through the gantry while the x-ray tube rotates around the patient, shooting narrow beams of x-rays through the body. Instead of film, CT scanners use special digital x-ray detectors, which are located directly opposite the x-ray source. As the x-rays leave the patient, they are picked up by the detectors and transmitted to a computer.

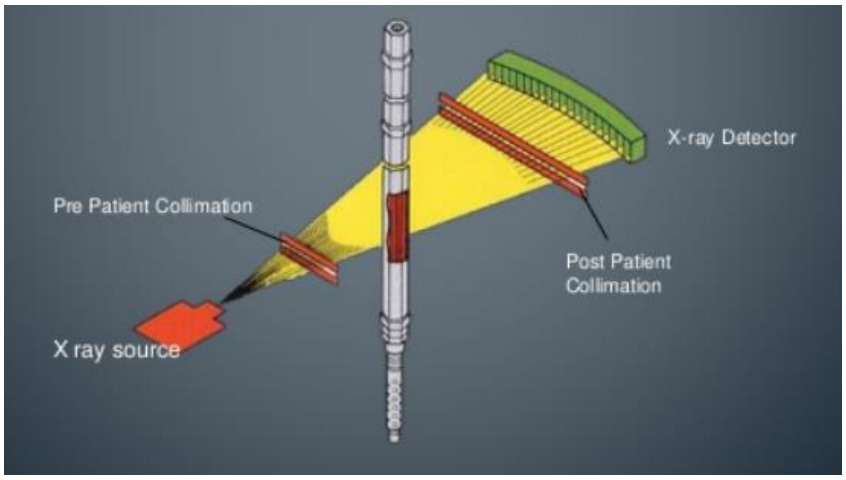


Fig: X-ray production and detection

Each time the x-ray source completes one full rotation, the CT computer uses mathematical and image processing techniques to construct a 2D image slice of the patient. The thickness of the tissue represented in each image slice usually ranges from 1-10 millimeters. When a full slice is completed, the image is stored and the motorized bed is moved forward incrementally into the gantry. The x-ray scanning process is then repeated to produce another image slice. This process continues until the desired number of slices is collected.

Fig: Workflow

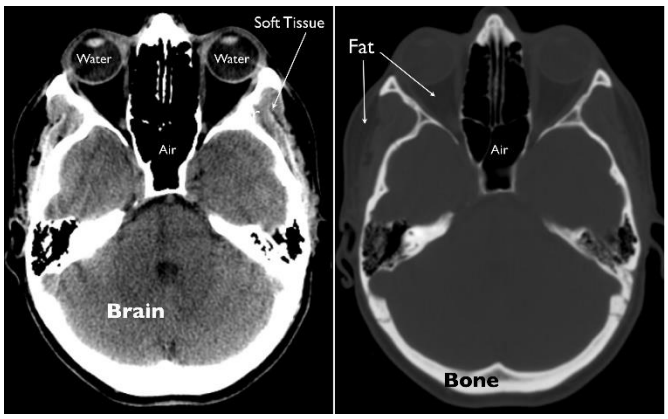
With enough 2-D slices, one can generate the 3-D image using image reconstruction techniques for better visualization purposes. In addition to this, dense structures within the body such as bone are easily imaged, whereas soft tissues vary in their ability to stop x-rays and, thus, may be faint or difficult to see. For this reason, intravenous (IV) contrast agents have been developed that are highly visible in an x-ray or CT scan and are safe to use in patients. Contrast agents contain substances that are better at stopping x-rays and, thus, are more visible on an x-ray image. For example, to examine the circulatory system, a contrast agent based on 'Iodine' is injected into the bloodstream to help illuminate blood vessels. This type of test is used to look for possible obstructions in blood vessels, including those in the heart. Oral contrast agents, such as barium-based compounds, are used for imaging the digestive system, including the esophagus, stomach, and Gastrointestinal tract.

1.4 WHY CT?

CT scans can be used to identify disease or injury within various regions of the body. For example, detecting tumors or lesions within the abdomen. A CT scan of the heart to analyze various types of heart disease or abnormalities. CT can also be used to image the head to locate injuries, tumors, clots leading to stroke, hemorrhage, and other conditions. It can image the lungs to reveal the presence of tumors, pulmonary blood clots etcetera. A CT scan is particularly useful when imaging complex bone fractures, severely eroded joints, or bone tumors since it usually produces more detail than would be possible with a conventional x-ray.

1.5 TYPES OF CT BASED ON SLICES

- Single slice
- Multi slice
    - Dual
    - 4, 6, 8 -Slice
    - 16 Slice
    - 32 Slice
    - 64 Slice
    - 128 Slice



TYPES:

1. Spiral CT
2. Electron Beam Tomography
3. CT Perfusion imaging

1.6 ADVANTAGES AND DISADVANTAGES

Advantages of computerized tomography scanning

- Better detail compared with ultrasonography and conventional X-rays.
- Relatively quick compared with MRI scanning.
- Most systems can be scanned – for example, brain to the leg.

Disadvantages of computerized tomography scanning

- Requires breath-holding which some patients cannot manage.
- CT scans of the brain can be affected by bone nearby.
- High doses of radiation are involved in CT scanning - chest CT scan is equivalent to 350 chest X-rays; CT abdomen to 400 chest X-rays and CT pulmonary angiography 750 chest X-rays.
- There is also a risk of childhood cancer and leukemia in mothers who have imaging during pregnancy. However, some of the studies are small and difficult to interpret due to confounding factors. Imaging to aid potentially fatal conditions during pregnancy should not be withheld.

Ideal room temperature for CT: 22 (+3 or – 3) degree Celsius

2.1 WHAT IS CATH LAB?

Cardiac catheterization (also called cardiac Cath, heart Cath, or coronary angiogram) is a procedure that allows the doctor to see how well your blood vessels supply your heart. During the test, doctors put a long, narrow tube called a catheter into a blood vessel in your arm or leg and guide it to your heart with the aid of a special X-ray machine. Doctors use contrast dye that they inject into your blood vessel through the catheter to create X-ray videos of your valves, coronary arteries, and heart chambers. The Laboratory in which this procedure is applied to diagnose and treat the patient is called the Cath Lab in general.

Fig: CATH LAB ARTIS ZEE

Source: Siemens – Healthineers

MODEL NAME: ARTIS ZEE

2.2 CONSTRUCTION

CATH LAB CONSIST OF

- Fluoroscopy
- Patient Couch
- Image intensifier
- viewing monitors
- Real time ECG, Blood pressure, Oxygen Saturation measurements
- Injector Pump
- Catheters
- Angioplasty balloons
- Defibrillator
- Ultrasound

It also consists of:

- Image Acquisition system
- Image Visualizing system
- Examination Control system
- Table Control module
- System Control module

2.3 BASIC WORKING PRINCIPLE (WORKFLOW)

The patient is exposed Continuously to the X-ray for live fluoroscopic imaging shown in the monitor. The X-rays are captured by a device called an image intensifier. Contrast agents are added for better visuals as arteries are faintly visible through X-rays,

The Doctors then insert the Catheter through the arm or leg and perform Angioplasty (A procedure used to open narrow or blocked arteries) by attaching a stent with a balloon to clear the block.

In this GIF below, we can see the arteries with the help of contrast agents

Source: Internet

2.4 TYPES OF MOUNTING

- Floor-mounted system
- Ceiling-mounted system
- Biplane system

2.5 TYPES OF MOVEMENT

- Cranial
- Cordial
- Swivel

2.6 USE CASES OF CATHERIZATION

- **Angioplasty:** Inserting a catheter with a tiny balloon at the tip. When this balloon is inflated, it pushes plaque out and widens your artery.
- **Biopsy:** Taking a small sample of tissue from your heart.
- **Repair of heart defects:** Closing a hole in the heart or stopping a leak in a valve.
- **Stent placement:** Placing a tiny mesh tube called a stent into the artery to help keep it open.

2.7 BENEFITS AND LIMITATIONS:

- A heart attack can be prevented or stopped in progress, saving the heart muscle from life-threatening damage.
- Sometimes arteries are so severely blocked that it would not be safe to put balloons or stents into them. These patients are referred to a heart surgeon for possible heart bypass graft surgery. Cardiac catheterization can provide the surgeon with an idea of the arteries, showing the surgeon where to bypass the blocked artery.

3.1 WHAT IS MRI?

Magnetic resonance imaging (MRI) is a test that uses powerful superconducting electromagnets, radio waves, and a computer to make detailed pictures of the inside of your body.

Doctors use this test to diagnose or to see how well the patient has responded to the treatment. Unlike X-rays and computed tomography (CT) scans, MRIs don't use the damaging ionizing radiation of X-rays.

Fig: Siemens – MAGNETOM ESSENZA 1.5T & MAGNETOM SEMPRA 1.5T

Source: Internet

MODEL NAME(s): MAGNETOM ESSENZA & MAGNETOM SEMPRA with field strength of 1.5 Tesla

3.2 COMPONENTS OF MRI

- Console unit
- Magnet unit
- Cabinet

The major components of an **MRI scanner** are: the main magnet, which polarizes the sample, the shim coils for correcting inhomogeneities in the main magnetic field, the gradient coil system which is used to localize the MR signal and the RF system, which excites the sample and detects the resulting NMR (Nuclear Magnetic Resonance) signal. The room is RF shielded to avoid any interference.

- Cold head
- Liquid Helium Quenching (Maintained at -270 degree Celsius)
- Gradient Coil (Field can be applied in any spatial coordinate)
- Transmitter and Receiver coils
- RF Amplifiers and modulation unit.
- Software used: SYNGO
- Emergency buttons (Quenching, Cutting off the supply in case of emergency)

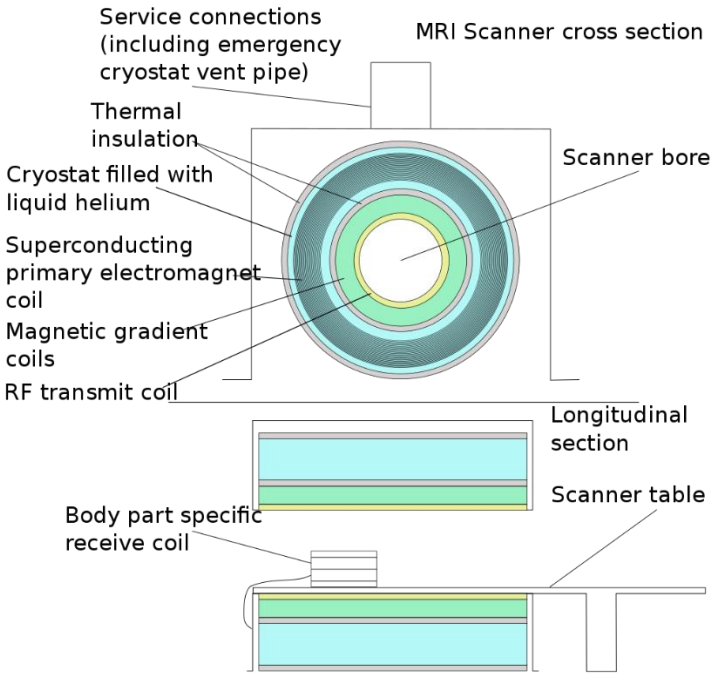


Fig: Major Components in MRI

Source: Internet

3.3 WORKING PRINCIPLE

Our body consists of water, which in turn consists of Hydrogen atoms spinning at random angles. When high voltage electricity is applied to the superconducting electromagnet, a strong magnetic field is generated that aligns those hydrogen atoms inside our body in the direction of the magnetic field. Then RF waves of certain energy well enough to excite the hydrogen atoms for a certain period are given through RF coils. These excited atoms cannot be in a higher energy state for a long time. And when it comes to the lower energy state from the higher energy state, it tends to lose energy in the form of heat and emits EM Waves (or RF signals).

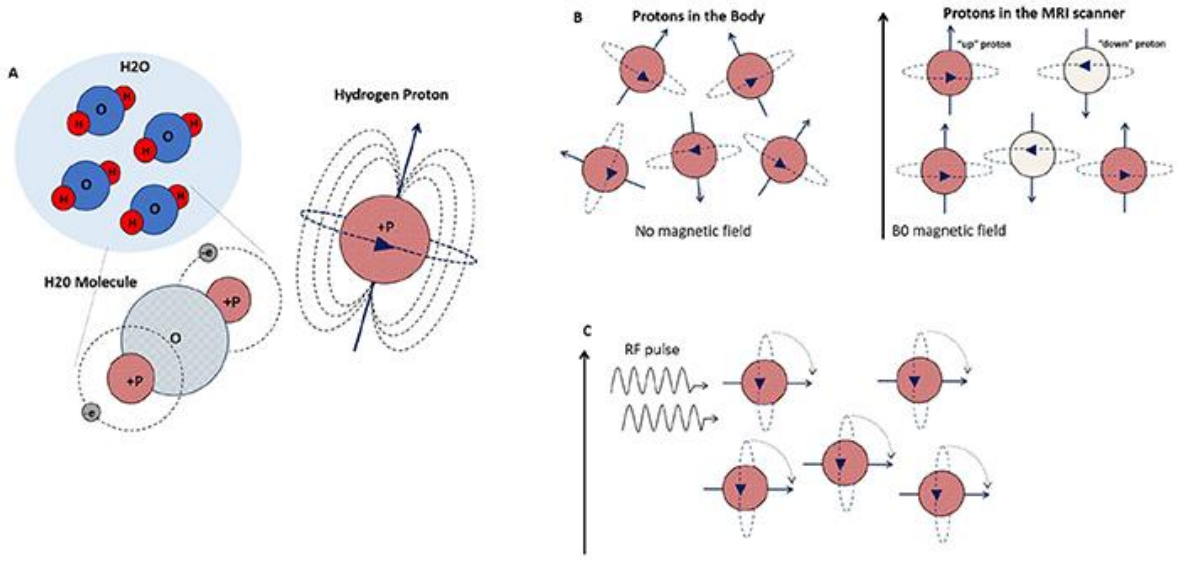


Fig: Hydrogen atom spin

- These Waves/signals are picked up, Pre-amplified, denoised, and then fed to the image reconstruction unit to get the final output.
- This process is made sure to work under ideal conditions such as to maintain resonant frequency for maximum efficiency, helium quenching to maintain the temperature constant.
- The receiver coil is adjusted to get the frequencies of 63.6 MHz

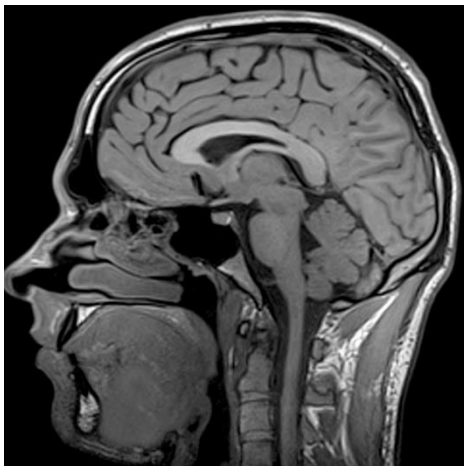


Fig: Head MRI

3.4 USES AND LIMITATIONS OF MRI

- MRIs can be done on different parts of your body. It's especially useful for looking at soft tissues and the nervous system.
- There is also functional purpose of MRI as it can be used to monitor the functions of brain under various circumstances.
- Used to check health of various organs and also diagnose bone infections, cancer, brain injury, blocked blood vessels etc.
- Unlike X-rays and computed tomography (CT) scans, MRIs don’t use the damaging ionizing radiation of X-rays.

Certain people with metal inside their body can't get this test, including those with:

- Some clips used to treat brain aneurysms
- Pacemakers and cardiac defibrillators. Pacemakers under MRI have a high chance of getting disrupted making the heart beat rhythm uneven.
- Certain metal coils placed in blood vessels
- Metals plates for fixing fractured bones.
- Quenching must be done 24/7 to make sure liquid helium doesn’t escape.

4.1 WHAT IS ULTRASOUND?

Ultrasound imaging uses sound waves to produce pictures of the inside of the body. It is used to help diagnose the causes of pain, swelling, and infection in the body's internal organs and to examine a baby in pregnant women and the brain and hips in infants. It's also used to help guide biopsies, diagnose heart conditions, and assess damage after a heart attack. Ultrasound is safe, non-invasive, and does not use ionizing radiation.

Fig: Siemens – ACUSON JUNIPER

MODEL NAME: Acuson Juniper

4.2 COMPONENTS

- AC Power supply
- Transmitter and Receiver circuit
- Processing board
- Convex and linear probes with different channels
- Backend Board
- Transducer and gel

4.3 WORKING PRINCIPLE

- High-frequency sound waves travel through the probe (Transducer) into the body via gel.
- These waves get bounced back after hitting the walls of an organ (depends on how deep the wave can penetrate) and are collected using the receiver circuit and amplified.
- These signals are then converted to digital bits and processed into images for diagnostic purposes.
- Since they only use sound waves, they are harmless.

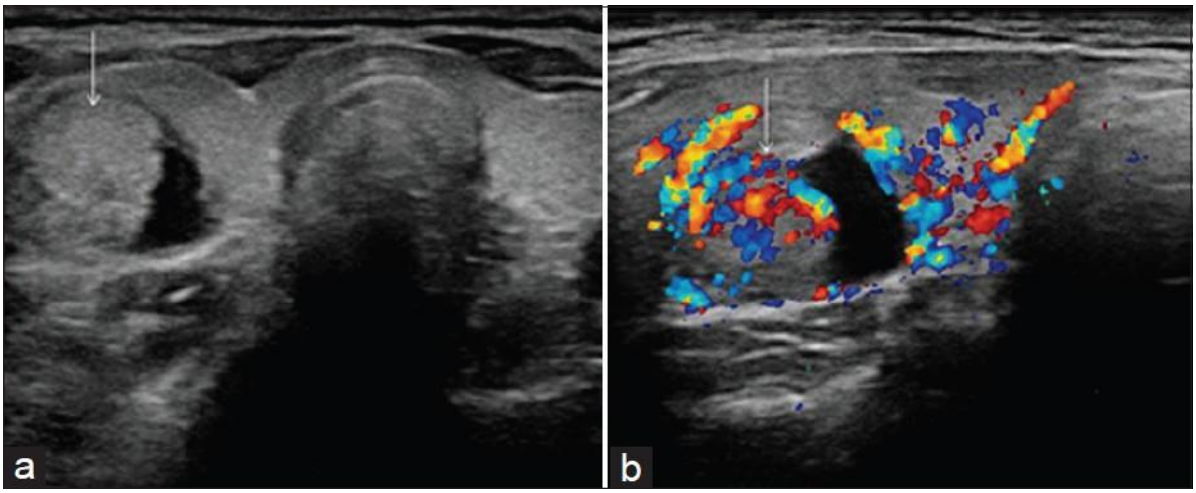


Fig: Ultrasound of Thyroid with Doppler

A Special method called the Doppler effect is used to determine the blood and also visualize the flow of air or blood through the pipes or coronary arteries. The movement of blood cells causes a change in the pitch of the reflected sound waves. This is called the Doppler effect. If there is no blood flow, the pitch does not change.

4.4 DOPPLER ULTRASOUND

Doppler ultrasound is a special ultrasound technique that evaluates movement of materials in the body. It allows the doctor to see and evaluate blood flow through arteries and veins in the body.

There are three types of Doppler ultrasound:

- **Color Doppler** uses a computer to convert the Doppler measurements into an array of colors to show the speed and direction of blood flow through a blood vessel.
- **Power Doppler** is a newer technique that is more sensitive than color Doppler and capable of providing greater detail of blood flow, especially when blood flow is little or minimal.
- **Spectral Doppler** displays blood flow measurements graphically, in terms of the distance traveled per unit of time, rather than as a color picture. It can also convert blood flow information into a distinctive sound that can be heard with every heartbeat.

4.5 USES

Ultrasound is a useful way of examining many of the body's internal organs:

- heart and blood vessels
- liver
- gallbladder
- spleen
- Lung, Bowl
- pancreas
- kidneys
- bladder, pelvis
- uterus, fetus
- eyes
- thyroid and parathyroid glands
- Pain swelling and infections

5.1 WHAT IS C – ARM?

A C-arm is an imaging scanner intensifier. The name derives from the C-shaped arm used to connect the **x-ray source** and **x-ray detector**.

C arms have radiographic capabilities, though they are used primarily for **fluoroscopic imaging** during surgical, orthopedic, and emergency care procedures.

The devices provide high-resolution X-ray images in real-time, thus allowing the physician to monitor progress and immediately make any corrections.

Fig: Siemens – Multimobil 5E

MODEL NAME: MULTIMOBIL 5E

5.2 COMPONENTS

X-ray generator

It is placed inside the frame where the C-arm is mounted. It can be directly controlled by the workstation unit and the operator can even modify the operation of the system in real-time. Even with an increased x-ray power, there is a complete flexibility in imaging and since the exposure time is less, the risk involved here is almost null.

Imaging System

C-arm's powerful imaging system can perform multiple movements in a single procedure. This much-needed advantage comes in handy during a variety of surgical procedures namely ortho, urology and cardiology. This entire system is very much compact and light in weight so that they will allow multiple positioning along with a wide range of motion. However, they remain firm in the mounted position and there is zero possibility of misalignment in between the procedure.

Workstation Unit

The entire operation of the C-Arm is controlled with the help of this workstation unit. It contains multiple handles enabling movements and positioning, switches that control power supply and light exposure, a cable hanger, controls for radiographic and Fluro settings, several connecting cables, hard disk and writers, advanced image enhancement software to reduce noises, contrast/bright controls, monitors, zoom control and a brake pedal.

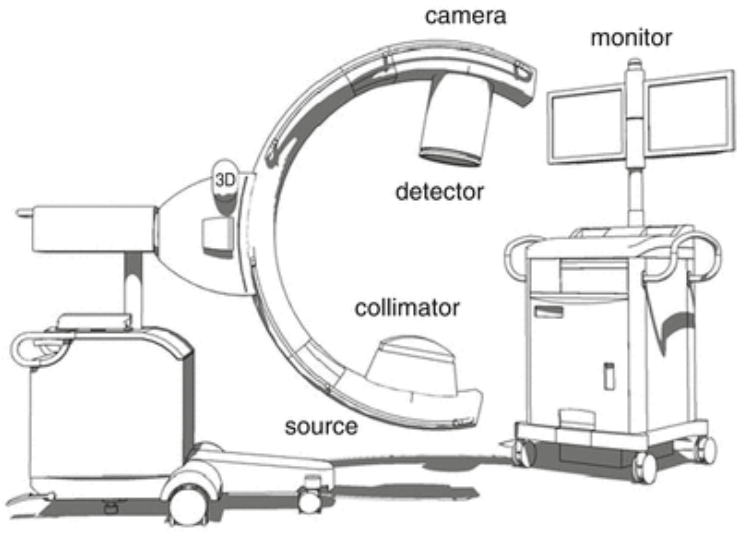


Fig: C-ARM Components

Source: Internet

5.3 WORKING PRINCIPLE

A C-arm comprises a generator (X-ray source), and an image intensifier or flat-panel detector. The C-shaped connecting element allows movement horizontally, vertically and around the swivel axes, so that X-ray images of the patient can be produced from almost any angle. The generator emits X-rays that penetrate the patient's body.

The image intensifier or detector converts the X-rays into a visible image that is displayed on the C-arm monitor. The doctor can identify, and check anatomical details on the image such as blood vessels, bones, kidney stones and the position of implants and instruments at any time.

Adjusting the Address improves the FPS.

5.4 APPLICATIONS OF C-ARM

Applications of C-Arm systems

- Various studies including digestive, cardiac, ortho, reproductive and blood circulation systems.
- If there is a need to place needles or stents during a complicated surgery, C-Arm is taken into consideration.
- During surgeries, the real-time view of the gallbladder, liver, bone and several structures can be obtained. Multiple views of the same part are possible, thus enabling the systems to reconstruct a 3D model of the inner parts later.

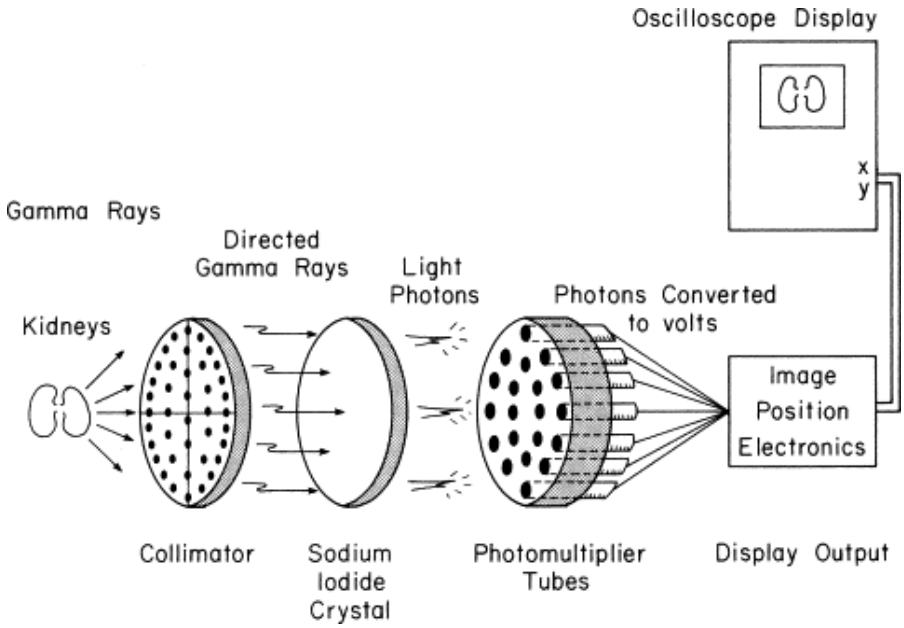
6.1 WHAT IS GAMMA CAMERA?

Gamma cameras are based on the detection of gamma rays emitted from radionuclides. Radionuclides can be ingested or injected into the body. The camera accumulates counts of gamma photons, which are detected by crystals in the camera. Just like an X-ray, the gamma camera will yield a two-dimensional projection of a three-dimensional object. A tomographic version of the gamma camera is called SPECT, which yields slices through the body. Because the detection techniques of gamma cameras and SPECT are based on the same concept, the same radioisotopes can be used for both techniques. Commonly used isotopes include technetium-99m, iodine-123, and indium-111.

Fig: GAMMA CAMERA

Source: Siemens

6.2 COMPONENTS



- Collimator
- Scintillator
- PMT – Photo Multiplier tube
- Sodium Iodide activated Thallium crystal
- ADC

6.3 WORKING PRINCIPLE

- Gamma radiation emitted from the radionuclide administered to the patient (most commonly **Tc-99m)** (Technetium 99m) travels in all directions.
- A fraction of the radiation travels towards the gamma camera, of that an even smaller fraction travel at the correct angle to the septa of the collimator and is allowed to strike the crystal.
- When the gamma photon strikes the crystal, a light photon is produced, this light photon is then converted into an electrical signal and amplified by the photomultiplier tube (PMT) and is further amplified by the pre-amplifiers.
- The amount of light reaching the photomultiplier is proportional to the electrical signal produced.
- Analog to digital converters then convert the signal.

- Positioning circuits then determine the X-position and Y-position of the interaction of the gamma-ray and the crystal.

$$^{99}_{42}Mo \rightarrow {}^{99m}_{43}Tc + \beta^- + \overline{\nu}_\beta \qquad \text{(electron decay)}$$

$$^{99m}_{43}Tc \rightarrow {}^{99}_{43}Tc + \gamma \text{ (at 140 keV)} \qquad \text{(isomeric transition)}$$

- The summing circuit produces an energy (Z) signal created by adding all of the individual signals from the pre-amplifiers.
- Correction circuits then correct for errors in the positioning and energy of the interactions. The X, Y and Z signals are then processed and displayed on a computer.
- Here the source is the patient themselves unlike in previous cases.

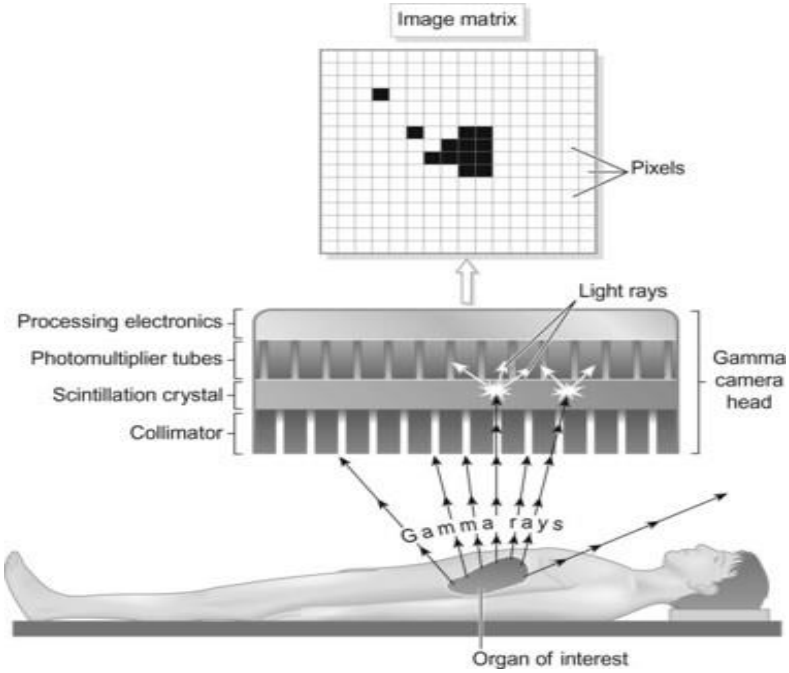


Fig: Image matrix

Noted: Half-life of Technetium 99m is 6 Hrs.

6.4 APPLICATIONS

- It is used to locate cancerous tumors, minor bone fractures, abnormal functioning of organs and other medical problems.
- Iodine-131 is used to detect thyroid (a gland that absorbs Iodine) problems.
- Technetium-99 is used to find tumors in the body.
- Gamma camera give structural and functional image of body organs, Bone scan. Myocardial Perfusion, Lung's scan, Kidney function.

7.1 WHAT ARE MOBILE X-RAYS?

Portable or mobile x-ray units are considered as mobile equipment as they are equipped with wheels that enable it to me moved to different locations with a Hospital or health care unit. These are powered by an electric motor supplied by a battery that assists the movement when the Radiographer drives the mobile unit with less effort.

Fig: Mobile X-rays

Source: Siemens-Healthineers

MODEL: MULTIMOBIL 2.5

7.2 COMPONENTS

Mobile radiographic units consist of a wheeled cart that transports an x-ray generator (line- or battery-powered transformer), an x-ray tube and moveable tube stand, collimators, and a film cassette or flat-panel detector storage drawer. Battery-powered units also contain a battery and charging system, and self-propelled units contain a motor drive.

SMPS, IGBT, High Tension Tank.

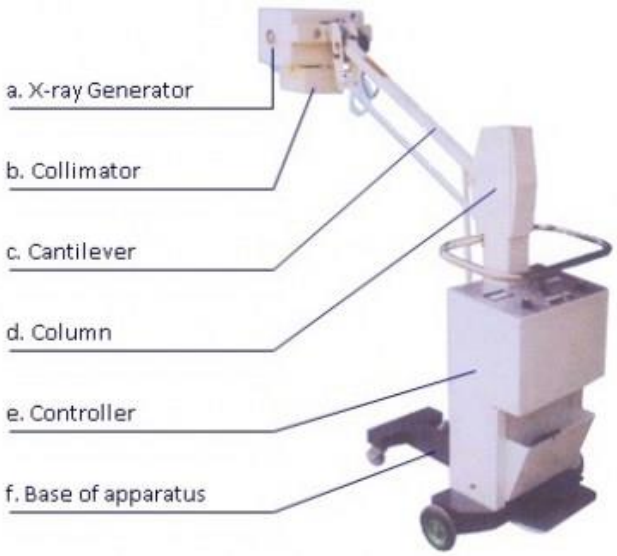
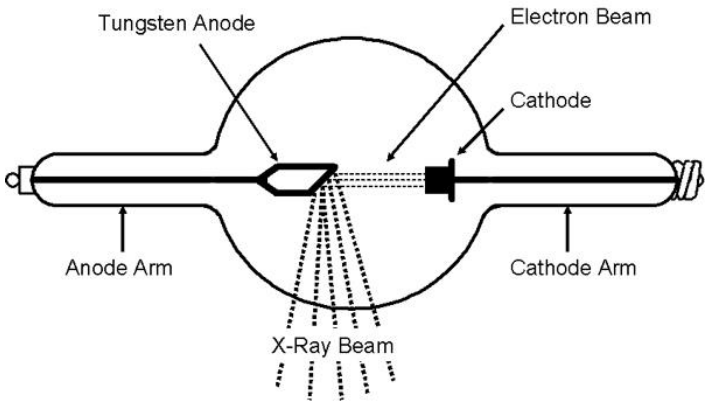
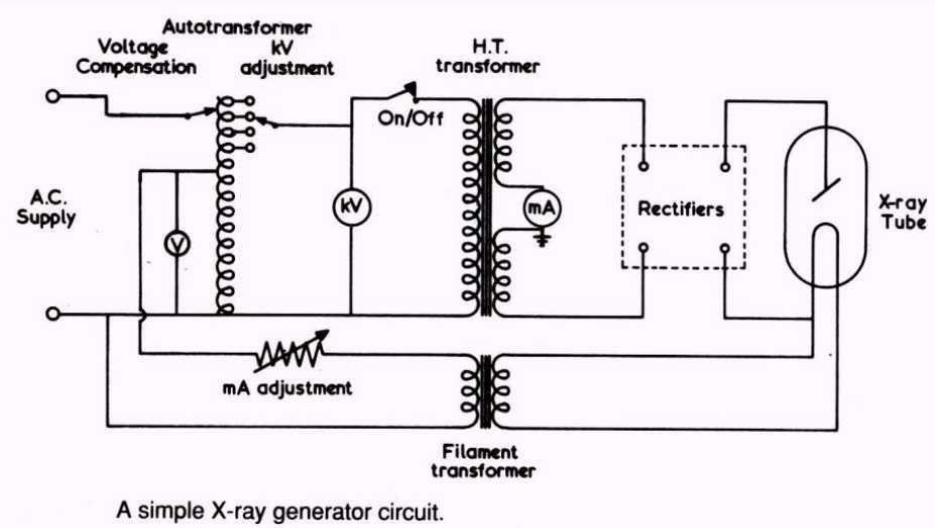


Fig: Components

7.3 WORKING PRINCIPLE



- X-rays are produced by the x-ray tube (an evacuated tube with an anode and a cathode) when a stream of electrons, accelerated to high velocities by a high-voltage, collides with the tube's target anode.
- A set of collimators confines the primary beam to the approximate size and shape that will cover only the area of diagnostic interest.
- Mobile CR units capture images using a photostimulable-phosphor plate. Mobile DR units are equipped with built-in or tethered flat panel detectors, which use a scintillator material to convert x-rays to visible light.
- An array of photodiodes on the aSi layer absorbs the light and translates it into a signal for digital display.
- On some units, the x-ray exposure is powered directly from the line voltage. While on others, the input line voltage charges the battery that powers the x-ray exposure.



A simple X-ray generator circuit.

7.4 APPLICATIONS

- Diagnose Bone structure
- Fractures
- Some Tumors
- Blood Vessel Blockage
- Foreign Objects

8.1 WHAT IS PET-CT?

A procedure that combines the pictures from a positron emission tomography (PET) scan and a computed tomography (CT) scan. The PET and CT scans are done at the same time with the same machine. The combined scans give more detailed pictures of areas inside the body than either scan gives by itself. A PET-CT scan may be used to help diagnose disease, such as cancer, plan treatment, or find out how well treatment is working. It is also called positron emission tomography-computed tomography scan.

Fig: Siemens – PET CT Biograph Vision

MODEL: BIOGRAPH VISION

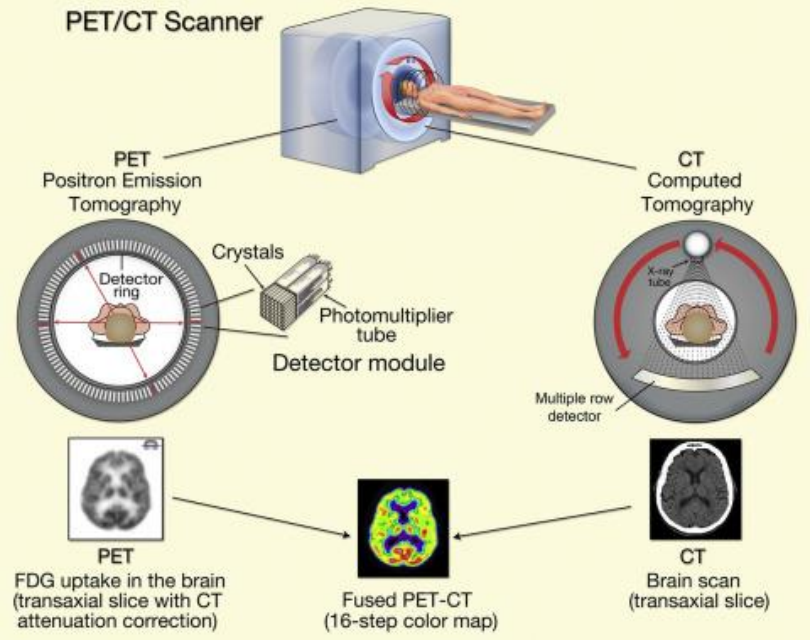
8.2 COMPONENTS

There are 4 main components a PET scan machine, the **gantry** (frame) that houses the detection apparatus with a large patient port (opening), the **subject table** that moves in and out of the patient port allowing for a complete scan, the **detector/camera system** that captures the image, and a **computer system** that processes and presents the images.

RADIOTRACERS (18F-FDG) such as 18F-fluoro-2-deoxy-glucose (18F-FDG).

Coolants such as Ethylene Glycol

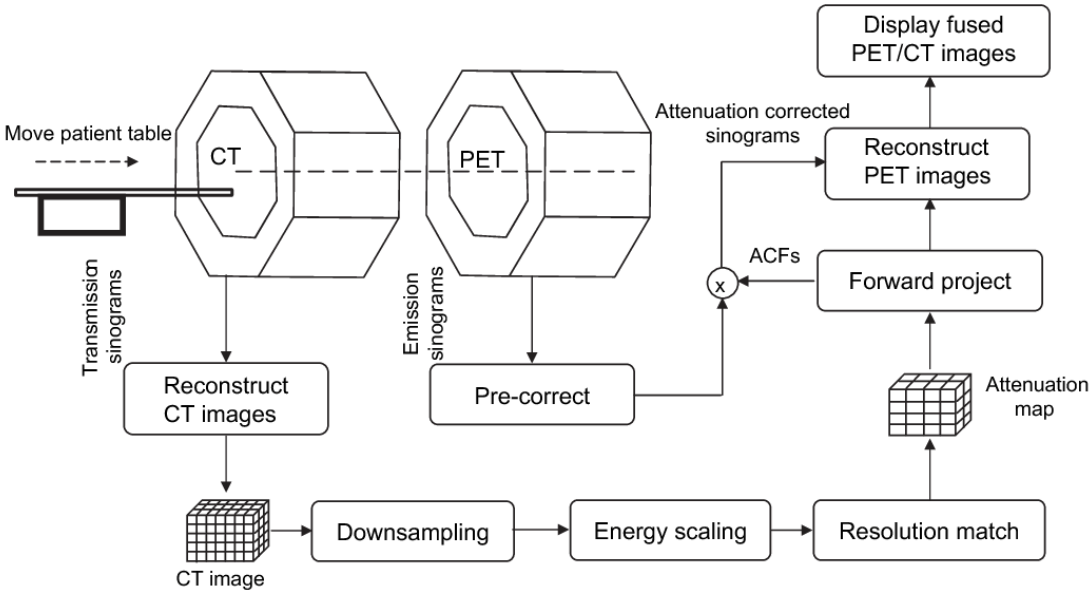
And the same components used in CT Machine as explained previously.



8.3 WORKING PRINCIPLE

- The most common tracer used for PET scans is 18F-fluoro-2-deoxy-glucose (18F-FDG), which is a radioactively labeled form of glucose.
- Glucose is a simple sugar that is the body's main source of energy and it is carried throughout the body in the bloodstream.
- Because all cells need energy to properly function and divide, glucose is found in every tissue and organ.
- When a cell needs energy, it collects glucose and processes it (via glycolysis and respiration) into a usable form of energy.

- PET scans take advantage of this process to create images. Cancer cells tend to use much more glucose than normal cells.
- Therefore, cancer cells (and tumors) collect more of the radiotracer and appear as a different color on the resulting images.
- The radiotracer 18F-FDG is frequently used because it is readily transported into cells. Once in cells, the chemical is phosphorylated into FDG-6-phosphate. The newly created molecule (FDG-6) is trapped within the cell and will no longer participate in metabolism.
- 18F-FDG is an unstable molecule because it contains excess protons and once inside the body it begins to break down. As it breaks down it emits positrons, a positive electron, which break down further, **releasing 2 equivalent photons in opposite directions.**
- These photons are detected by a camera inside the PET unit, producing a high-resolution 3-dimensional image.



8.4 ADVANTANGES

- PET helps to visualize the biochemical changes taking place in the body, such as the metabolism (the process by which cells change food into energy after food is digested and absorbed into the blood) of the heart muscle.
- In general, PET scans may be used to evaluate organs and/or tissues for the presence of disease or other conditions. PET may also be used to evaluate the function of organs, such as the heart or brain. The most common use of PET is in the detection of cancer and the evaluation of cancer treatment.

CONCLUSION

From my internship at Siemens Healthineers, I was able to get a better understanding of how these medical equipment works. I enjoyed working with the respective engineers and staff and observe and learn the working principles and components involved in different equipment. I still have a long way to go to gain in-depth knowledge and understanding in this field but this practical experience has given me a better understanding and laid a foundation.

Overall, my internship at Siemens Healthineers has exceeded my initial expectations. I was able to practically visit various hospital sites where much high-end medical equipment is operational and understand the principles of their operation. It was a truly rewarding experience to be in a fantastic environment and make connections that will last a lifetime. I could not be more thankful.