Digital radiography

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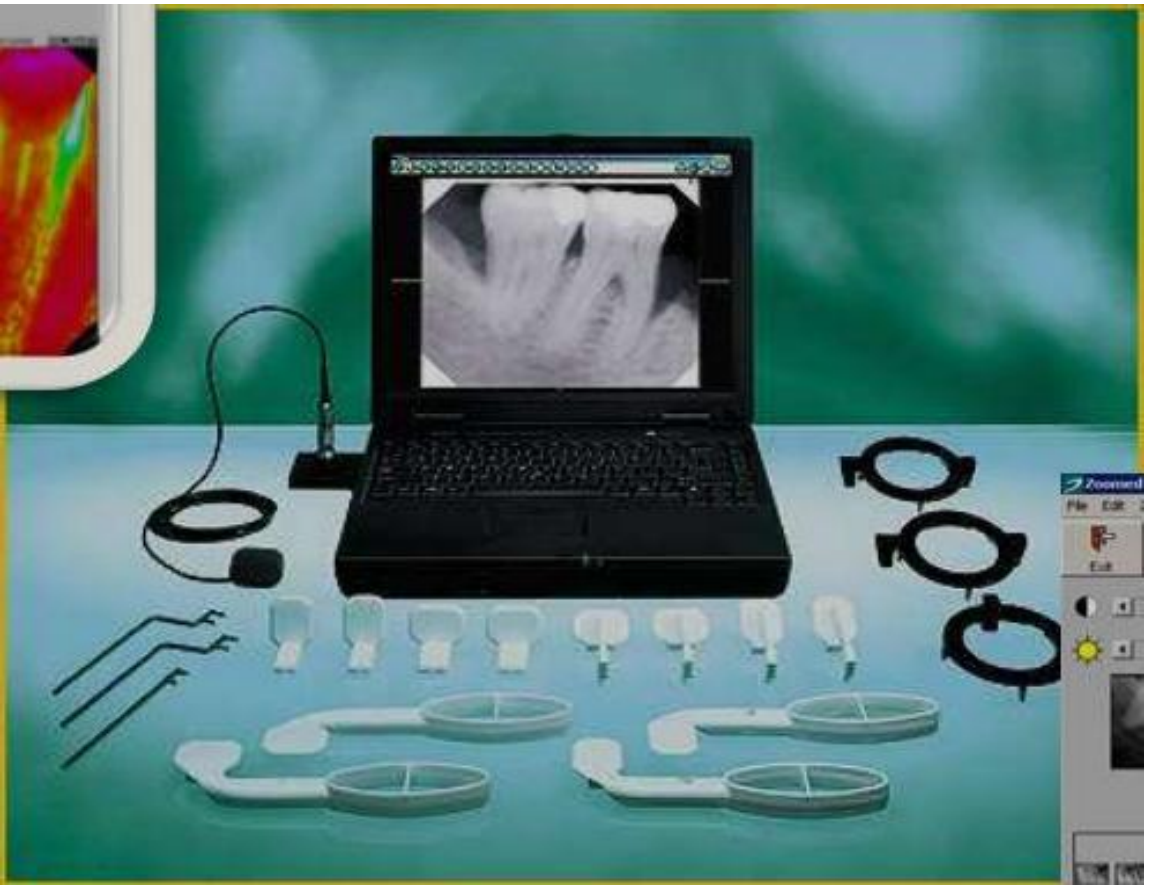

Prof. Abbas Ay Taher

TYPE OF IMAGES USED IN DENTISTRY :

Conventional:

Conventional radiographs are taken on photographicstyle film, which must be chemically developed. **Technology now offers dentists another option -- digital radiography**

Digital

Digital radiographs are captured electronically, loaded into, viewed and stored on the office's main computer system

Main Components of Digital Imaging System

- **The x-ray source**
- **The detector:** it measures the photon intensity of the x-ray beam and convert it into electrical signal (analog signal)
- **Analog-digital converter (ADC)** or **digitizer:** is used to change the analog signal to a numeric representation based on the binary number system recognizable by the computer.
- **Image display:** which are conventional computer monitors, thin film transistor used in laptop or flat panel computer displays, hard copies (like film printer or paper printer)

Definitions Charge coupled device (CCD):

A solid state detector used in many devices (e.g. fax machine) in **D.R.** a **CCD** is an image receptor **found in the intraoral sensor**

D.R.: A filmless imaging system, a method of getting a **radiographic image using a sensor**, **breaking it into electronic pieces** and **presenting and storing the image using a computer**.

Digital substraction: it's a method of reversing the gray scale as an image is viewed, i.e. radiolucent images (normally black) appear white and radiopaque images (Normally white) appear black.

Pixel: A discrete (smallest) unit of information also termed (picture element).

Sensor: it's a small detector that is placed intraorally to capture a radiographic image.

Digital imaging produces a dynamic image in which the visual characteristics of density and contrast can be manipulated to meet specific diagnosis or to correct errors in exposure techniques.

"A picture is worth a thousand words"
"Knowledge is valuable"
"Don't waste it"

Digital imaging produces a dynamic image in which the visual characteristics of density and contrast can be manipulated to meet specific diagnosis or to correct errors in exposure techniques.

Since the discovery of X-rays in 1895, film has been the primary medium for capturing, displaying, and **storing radiographic images**.

Digital radiography is a technology that dental practitioners are **the most familiar** and **comfortable with in terms of technique and interpretation**.Is the latest advancement in dental imaging and is slowly being adopted by the dental profession

Digital imaging incorporates computer technology in the **capture**, **display, enhancement**, and **storage of direct radiographic images.**

Digital imaging offers some **distinct advantages over film,** but like any emerging technology, it presents new and **different challenges for the practitioner to overcome**

INVASIVE angiography, arthrography, sialography ,AND
NON INVASIVE normal images of different types. ,

IONIZED – x-ray, ct scan , gama ray, AND
NON IONIZED , MRI, Ultrasongraphy, E Scan

Non invasive method of imaging used in dentistry:

In addition to the Conventional x-ray (intra oral or extra oral techniques), photographs ,the laser-based methods will be emphasis. In orthodontics, 3D laser scanners are increasingly being used to establish database for normative population and cross-sectional growth c

orthognatic surgical and r

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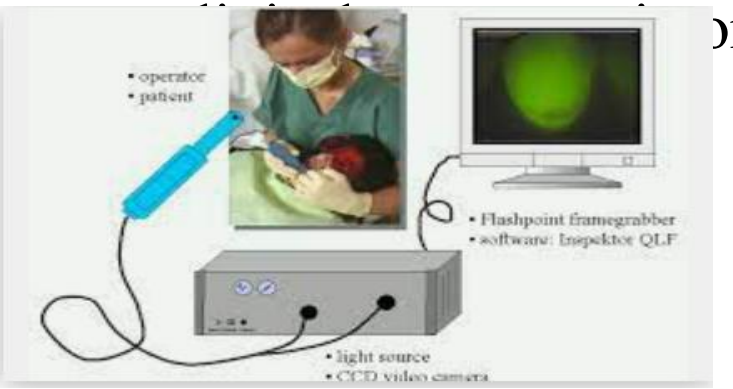
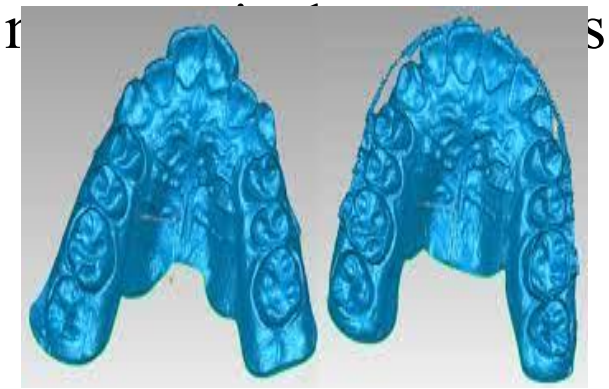
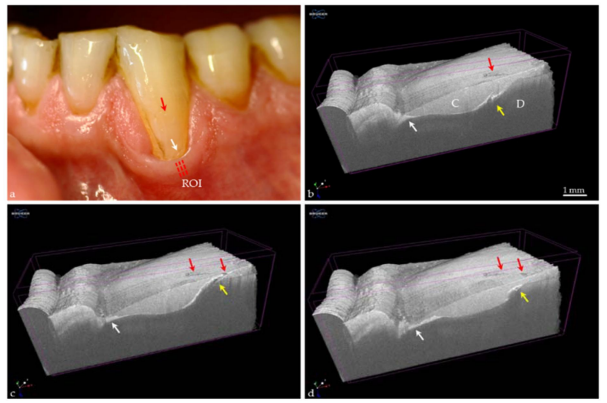




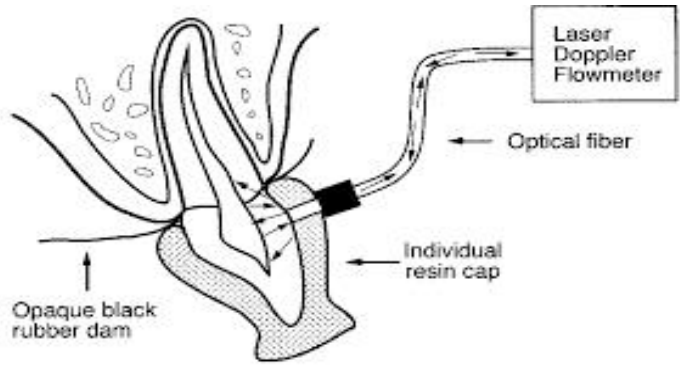
In prevention the main methods for diagnostic of demineralization and caries detection in early stages are represented by laser fluorescence - Quantitative Light Florescence (QLF);

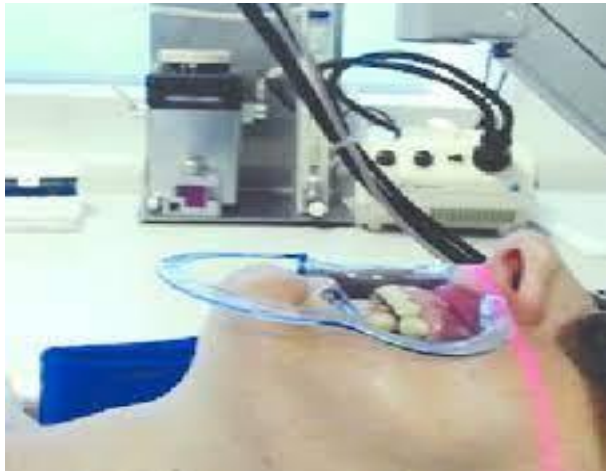
DiagnoDent-system-655nm; FOTI-Fiberoptic transillumination; DIFOTI-Digital Imaging Fiberoptic transillumination; and Optical Coherence Tomography (OCT).



Optical Coherence Tomography (OCT).

In odontology, Laser Doppler Flowmetry (LDF) is a noninvasive real time method used for determining the tooth vitality by monitoring the pulp microcirculation in traumatized teeth, fractured teeth, and teeth undergoing different conservative treatments.





In periodontology, recently study shows the ability of LDF to evaluate the health of gingival tissue in periodontal tissue diseases but also after different periodontal treatments.

Methods of Acquiring a Digital Image

Digital images are acquired either:

• **Directly** _ using a sensor or imaging plate replacing conventional film.

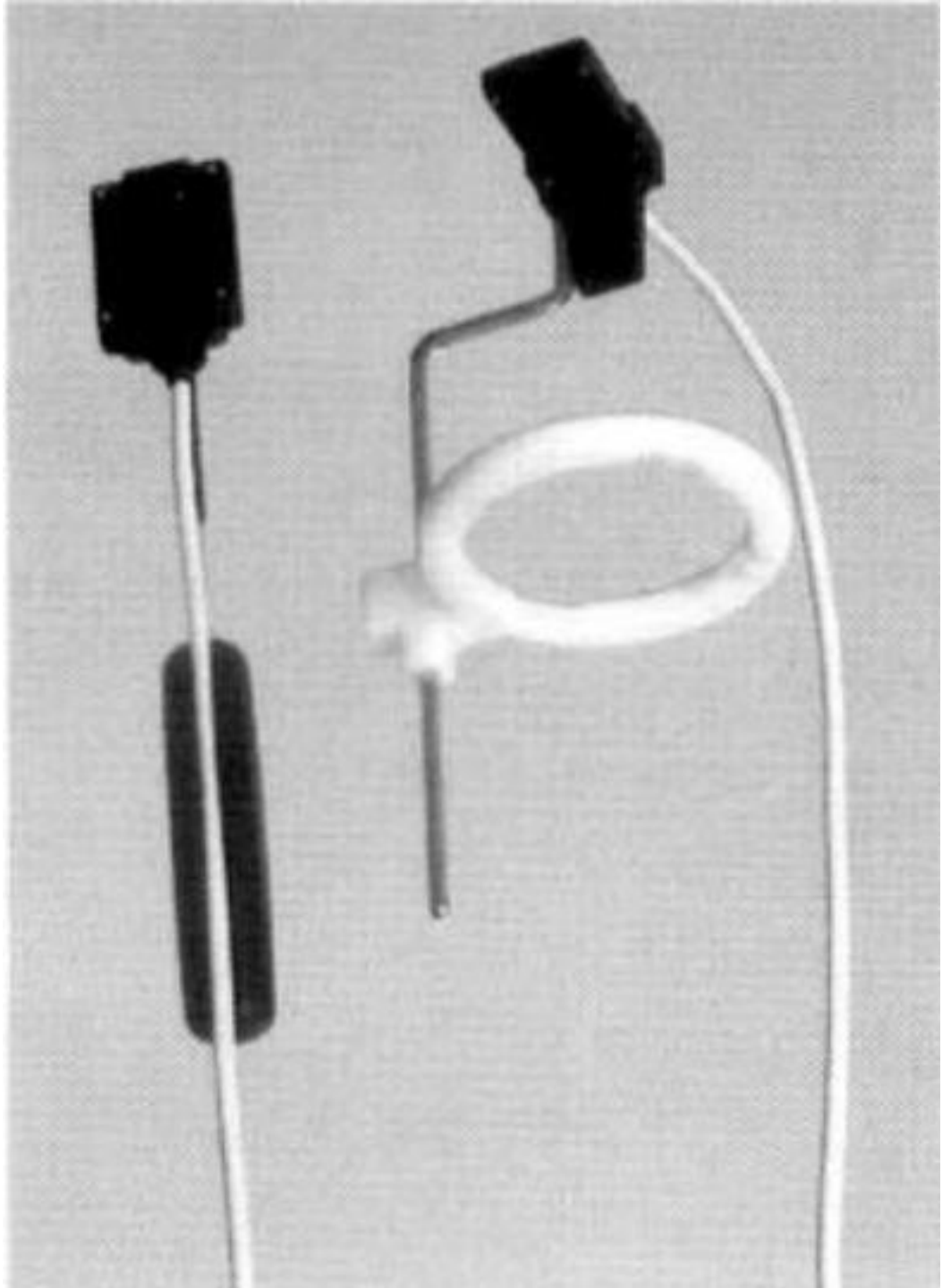
• **Indirectly** _ by scanning and digitizing a film-captured imageirect digital imaging systems are divided into two types:

1- Real time or corded:

This system use conventional x-ray machine but conventional film is replaced by either a CCD (charge coupled device) or a CMOS (complementary metal oxide semiconductor) sensor which is connected to the computer via a cable (or cord).

The X-ray photons that reach the sensor are converted to light, and **picked by the CCD/CMOS** and **converted into an electrical charge which**, **once produces a digital image on the monitor of the computer (so called real time).**

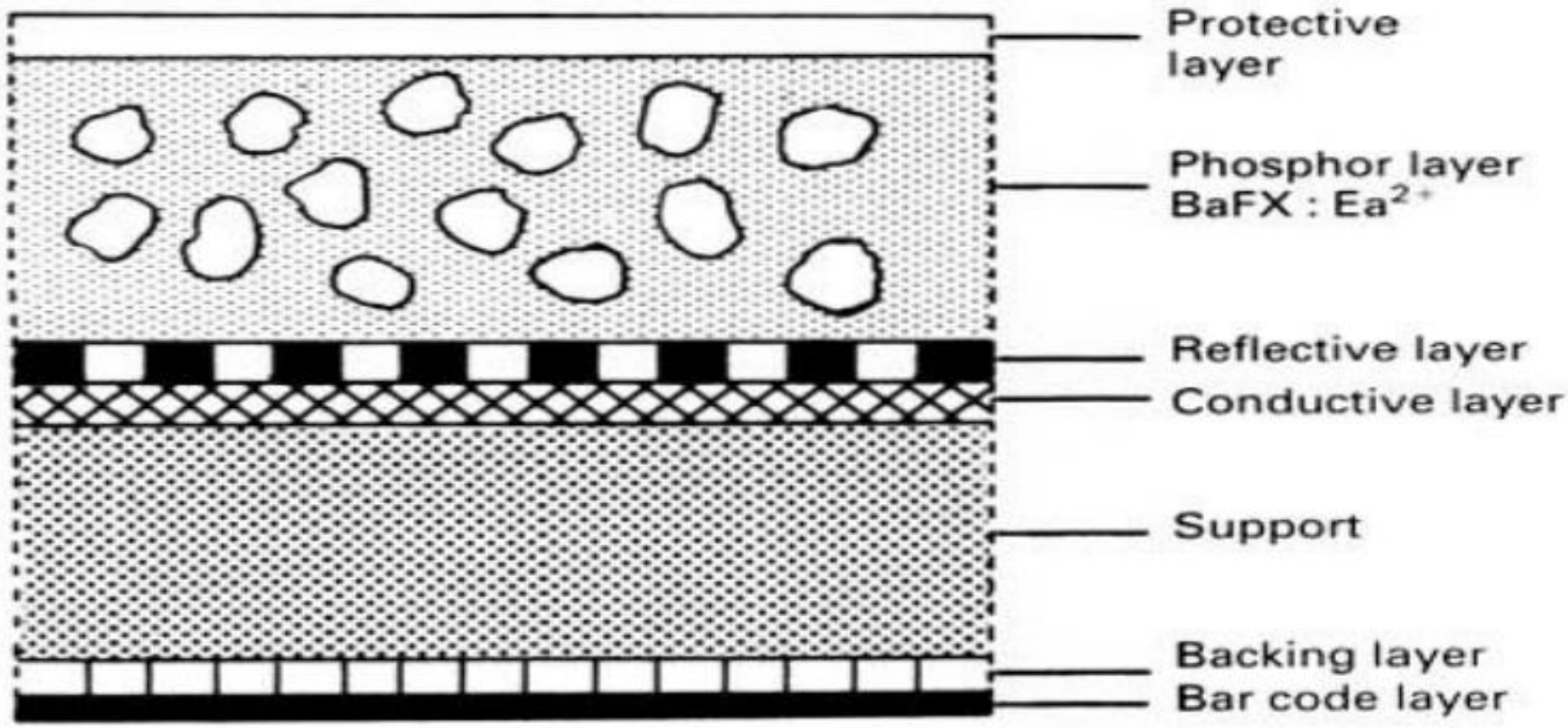
Specially designed intraoral sensor holders similar to those used for conventional film, have been developed, when used clinically, the sensors need to be covered with a protective plastic barrier envelope for infection control purposes.



2- Photostimulable phosphor storage plate or cordless

In This system the conventional film is replaced by photostimulable phosphor imaging plates (PSPP)
The phosphor layer absorbs and stores the X-ray energy. The image plate is then placed in a reader where it is scanned by a laser beam. The stored X-ray energy in the phosphor layer is released as light, the information is displayed as a digital image on the monitor The time taken to read the plate depends on the system being used, and the size of the plate, but usually varies (1 – 5) minutes.
The intraoral plates are inserted into protective barrier envelopes and can then be used in conventional film holders.

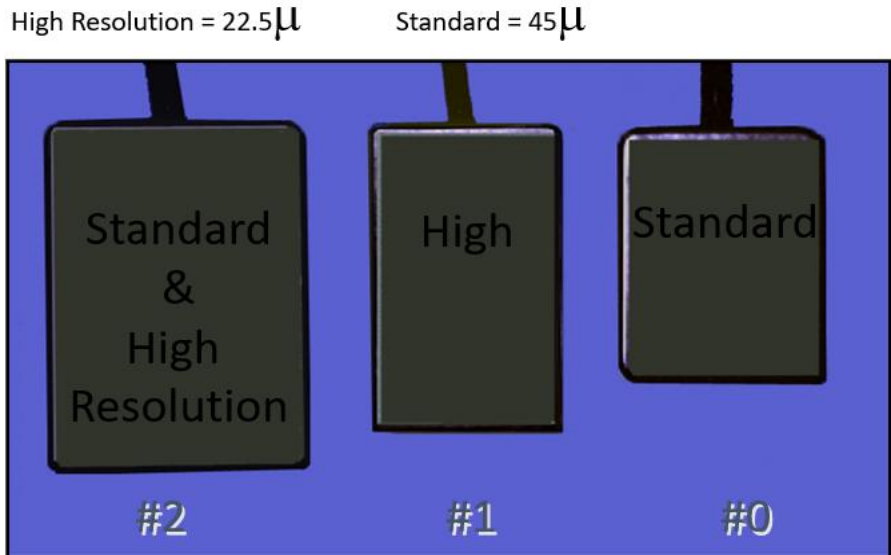
Cross-section of a typical phosphor imaging plate



Digital Dental Radiology:

- Digital radiographs are captured electronically, loaded into, viewed and stored on the office's main computer system.
- Digital radiographs can be enhanced in many ways; enlarged or reduced, colorized, lightened or darkened. Accurate measurements can be taken right off the screen.
- Radiographs can be added to computerized patient files, printed on paper for the patient to take home, incorporated into letters or memos, and electronically transmitted to insurance companies or referral dentists.
- Digital radiography is not only versatile; it also eliminates the costs and space required for darkrooms, film, and processing chemicals.
- Radiation levels are substantially **reduced (up to 90%),** making the procedure safer for the patient and staff. In addition, time, money, and paperwork are saved in storing and transmitting the images electronically. With digital radiography, it's possible for a general practitioner to e-mail a radiograph to a specialist for consultation while his or her patient is still in the chair
- Intra-oral

- Panoramic
- Cephalometric
- Sinus and Skull
- Tomography
- CT
- MRI



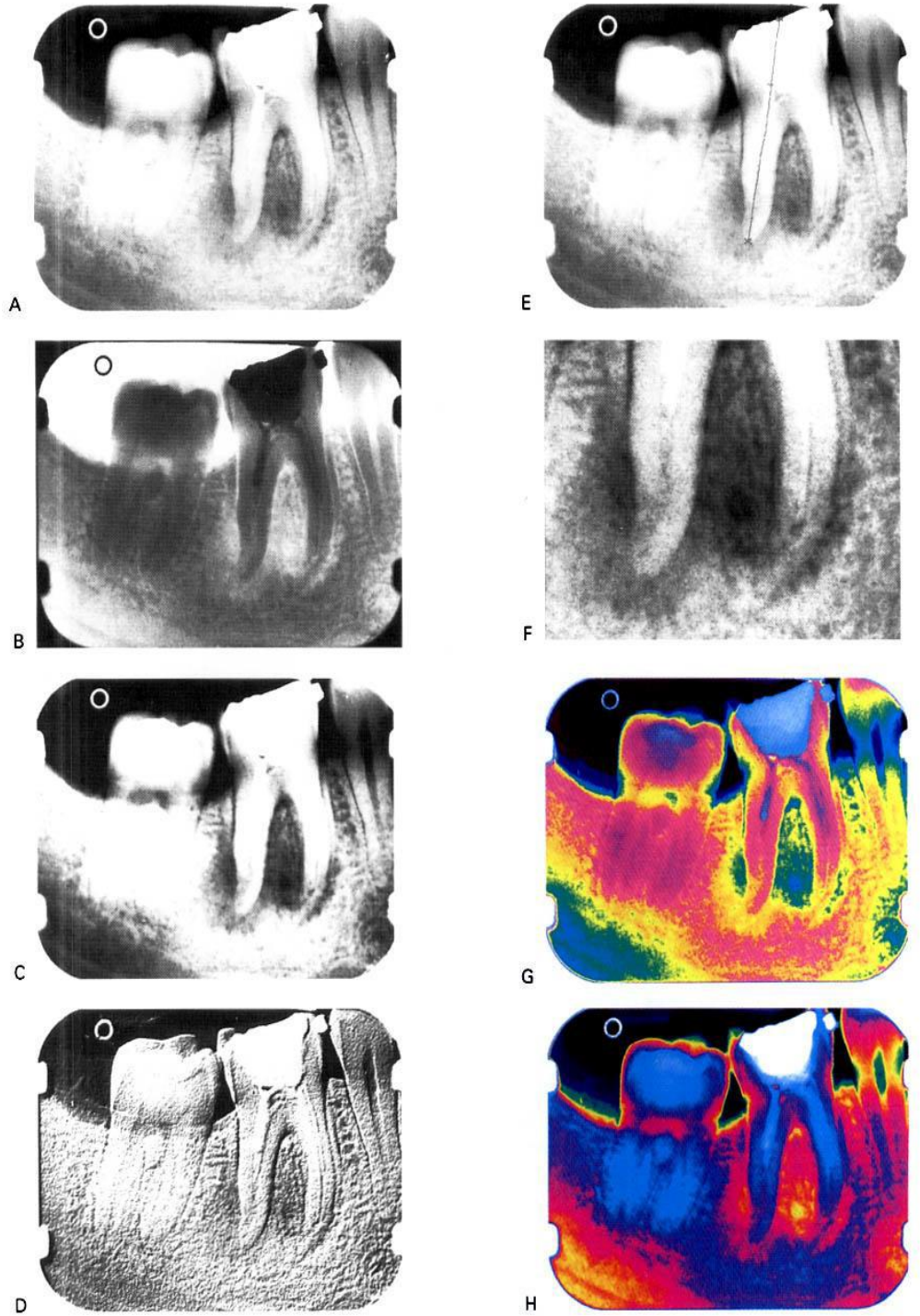
Theory:

As computers deal **with numbers** and **not pictures**, a radiographic image within a computer is represented as a **sequence of numbers**. This image may be considered as a **grid** or **matrix of tiny boxes** or **pixels**. **Each pixel has an x and y axis**. **Each number, and hence each pixel has an appropriate shade of grey**.

The range of numbers is normally from (0 - 256) with 0 representing black, 256 representing white and all others are shades of grey.

The pictures can be changed by giving the pixels different numbers. The coordinates of pixels may be changed also, and the shades of grey may be altered or using different colures. These variables are the basis for what is called (image processing or image manipulation).

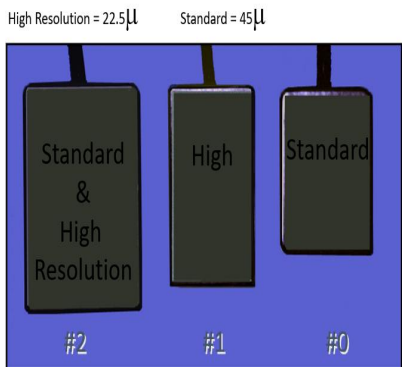
Despite being able to alter the final image, the computer cannot provide any additional real information to the original image. **It should be remembered that although enhancement may make images look aesthetically more pleasing, it may also cause clinical information to be lost and diagnoses compromised.**

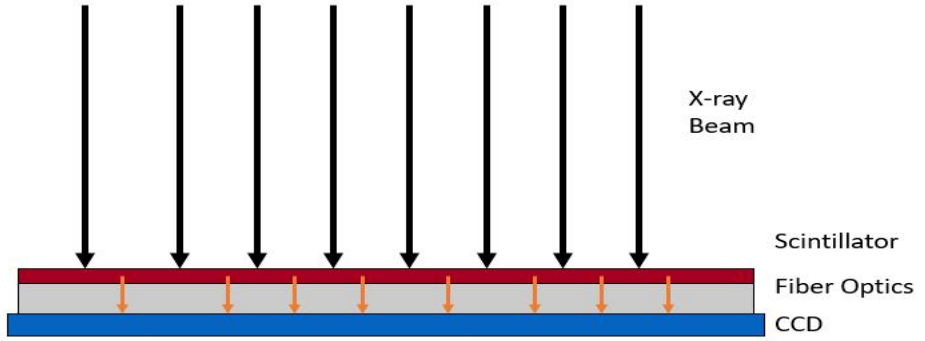


A Original image. **B** Inverted/reversed. **C** Altered contrast. **D** Embossed or pseudo 3-D. **E** Automated measurement. **F** Magnified **G** and **H** Pseudo-colored.

Advantages of Digital Radiology

- No Darkroom
- No Chemical Processing
- Lower Cost Per Image
- Instant Viewing of Images
- Less Radiation to Patient
- Image Processing and Analysis
- Transmission of Images for Consultation



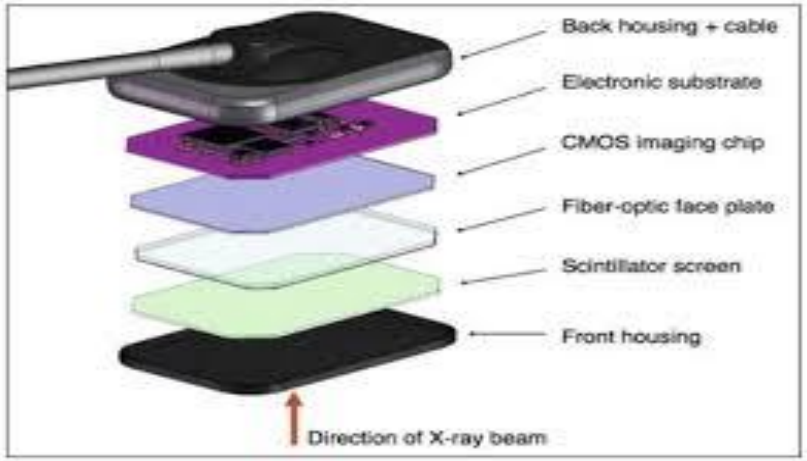


Two main types of digital imaging currently exist:
Indirect and **direct.** The doctor can use his or her existing x-ray equipment to take digital radiographs using either method.

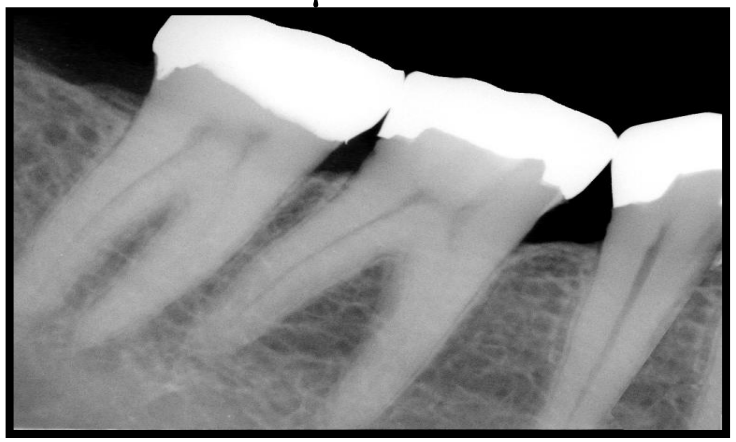
Types of receptor: • CCD, • CMOS, • Flat panel detectors, • PSP

CCD/CMOS-based Sensor: CD sensors create high-quality, low-noise images.
CMOS sensors are usually more susceptible to noise.
Because each photosite on a CMOS sensor has several transistors located next to it, the light sensitivity of a CMOS chip tends to be lower, as many of the photons hit the transistors instead of the photosite.

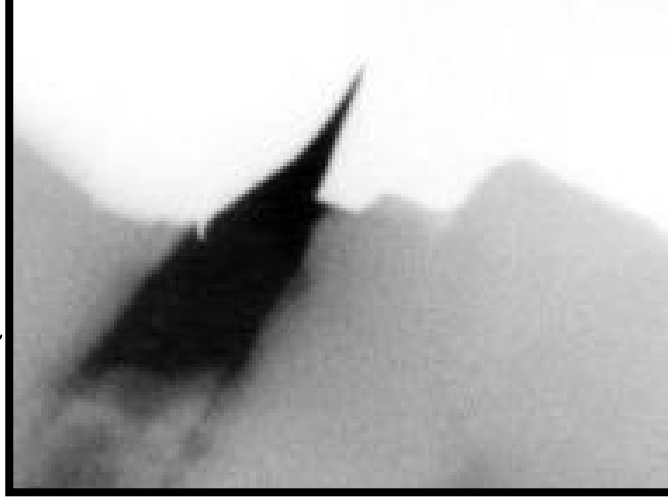
Indirect Digital Radiography :



CCD/CMOS - 45µ



CCD/CMOS - 22µ

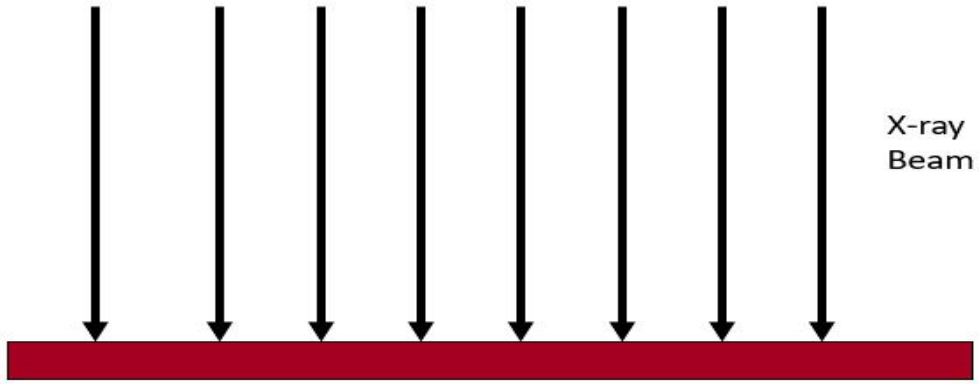


To take a periapical exposure, the hygienist or x-ray technician places a small photosensitive imaging plate (coated with phosphorus) into a sterile wrapper and inserts it into the patient's mouth just like a conventional X-ray film card. The X-ray is taken, and the exposed plate is then loaded into a scanner, or processor, which reads the image and converts it to digital form. The photo at left shows a sampling of imaging plates, two cylindrical plate holders, and the box-like scanner which holds the cylinders and reads the images as the cylinders spin inside. Imaging plates can be re-used thousands of times, and they are available in different sizes to match conventional x-ray films, including panoramic and pan/ceph. The larger plates are simply loaded into the existing pan or pan/ceph film carriers

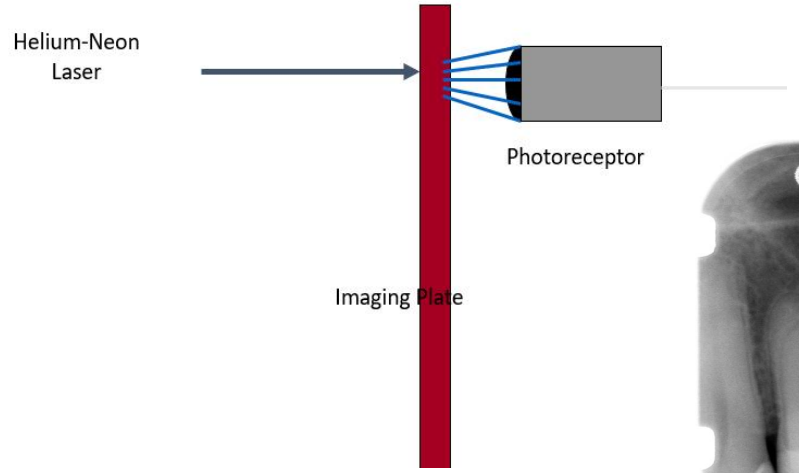
Digital image subtraction

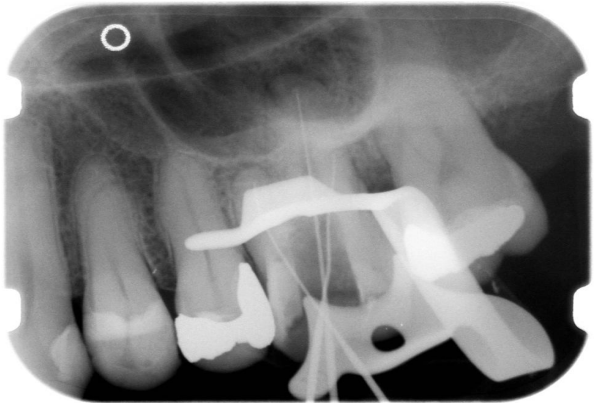
When two images of the same object are registered and the image intensities of corresponding pixels are subtracted, a new difference image is produced. **This is useful in the diagnosis of (periodontal diseases, carious lesions, evaluation of small changes in the condylar position and assessment of dental implant).**

Storage Phosphor



Storage Phosphor





Storage Phosphor

Diagnostic Accuracy

Primary Dental Caries

Recurrent Dental Caries

Periodontal Disease

Periapical Lesions

Endodontic File Length Determination

Tomography

CCD Extra-oral Radiograpy

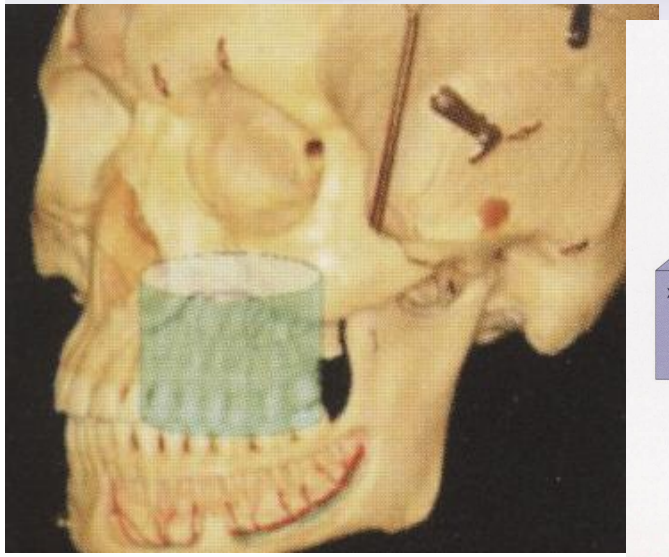
Panoramic Radiography

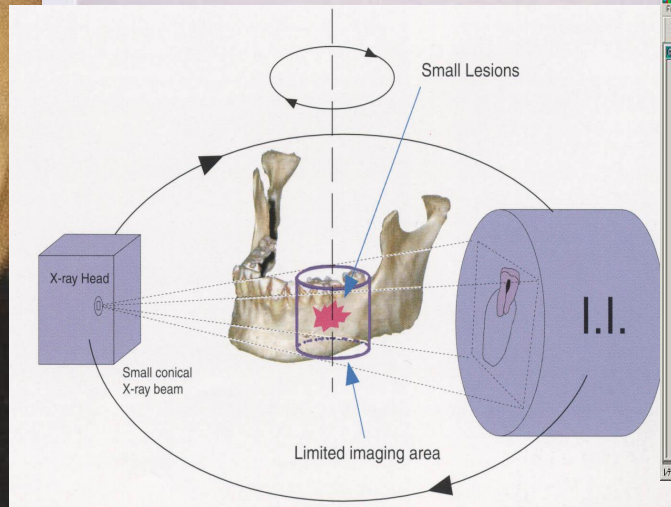
Cephalometric Radiography

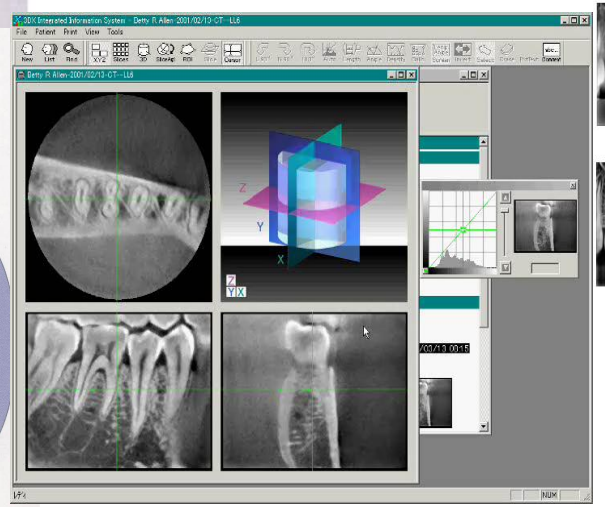
Three Dimensional Imaging

- TACT

- Small Volume CT(CBCT)

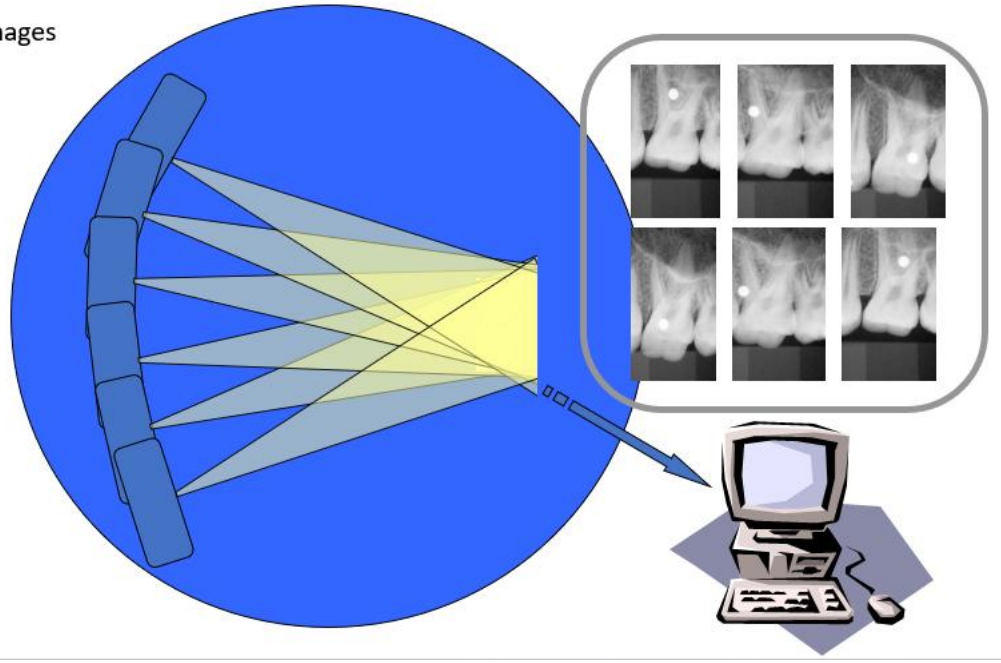




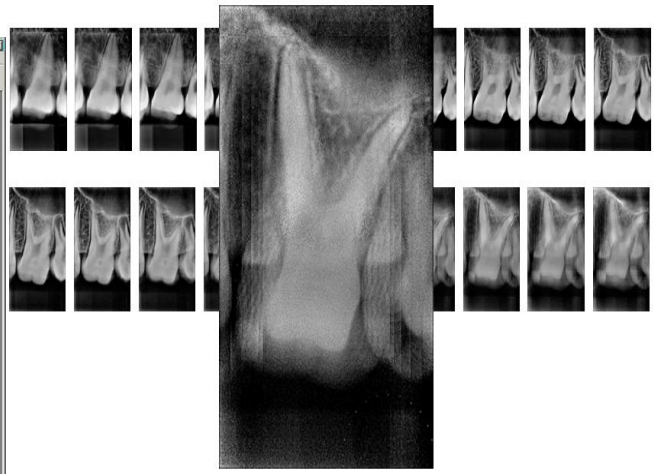


TACT™ Methodology

Series of images taken from different angles



Slices of a maxillary molar

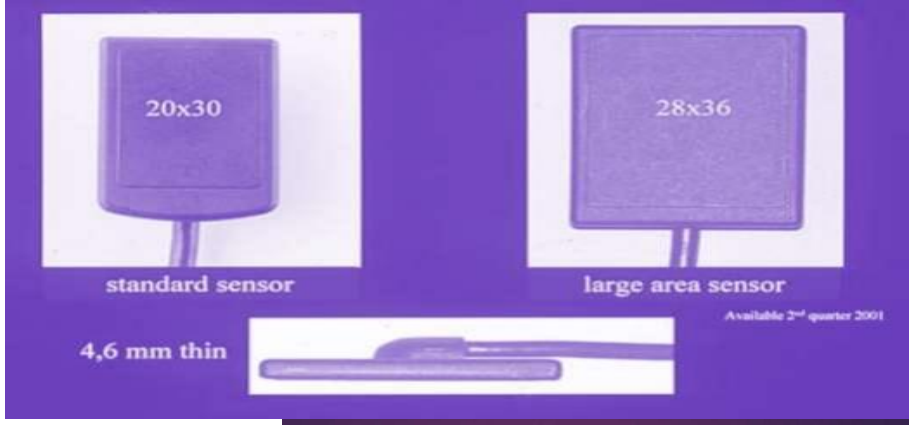


Solid State Technology Uses semi-conductor based detectors

CCD 2. CMOS

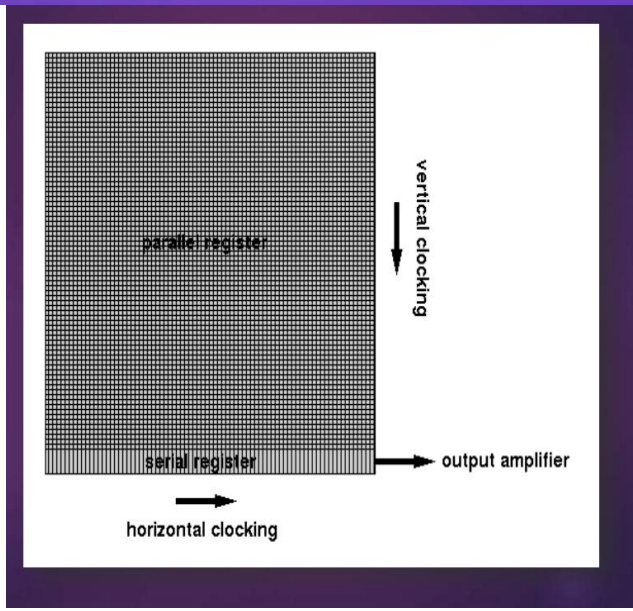
Consist of thin wafer of silicon with electronic circuit

Consist of matrix, amplifier in plastic housing



STAGE OF DIGITAL IMSAGE APPERANCE:

Exposure to radiation
Break the covalent bond in silicon atoms produce electron hole pair
Electron attracted towards most positive potential in device – create charge packet
Charge pattern formed from individual pixels forms latent image
Bucket brigade form of charge transfer
Finally transferred to amplifier
Transmitted as voltage
Analog to digital converter Image display



Computer Aided Diagnosis (CAD):

PAP Cytology & Oral Brush Biopsy, Mammography,Chest X-ray Screening

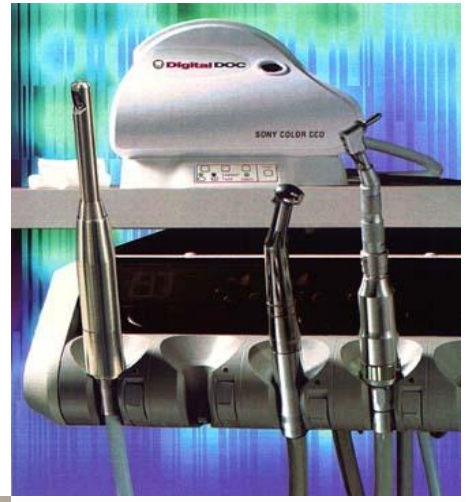
Periodontal Diseases,Dental Caries

CAD systems do not necessarily have to be better than the clinician, just help him not miss obvious lesions

The DICOM Standard

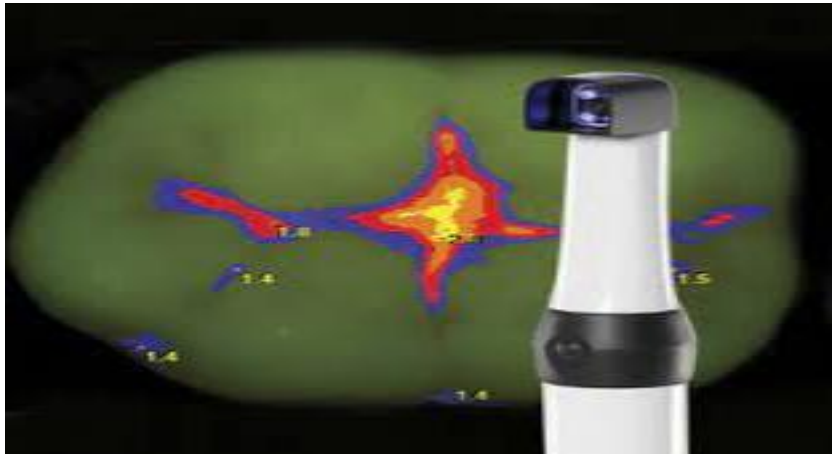
The Digital Imaging and Communications in Medicine (DICOM) Standard is a detailed specification that describes semantics and syntax for exchanging images and associated information. The standard applies to the operation of the interface which is used to **transfer data** in and out of an imaging device.











What is DICOM?

Digital Imaging and Communication in Medicine

Standard for communication of images and image related information between devices

International in scope

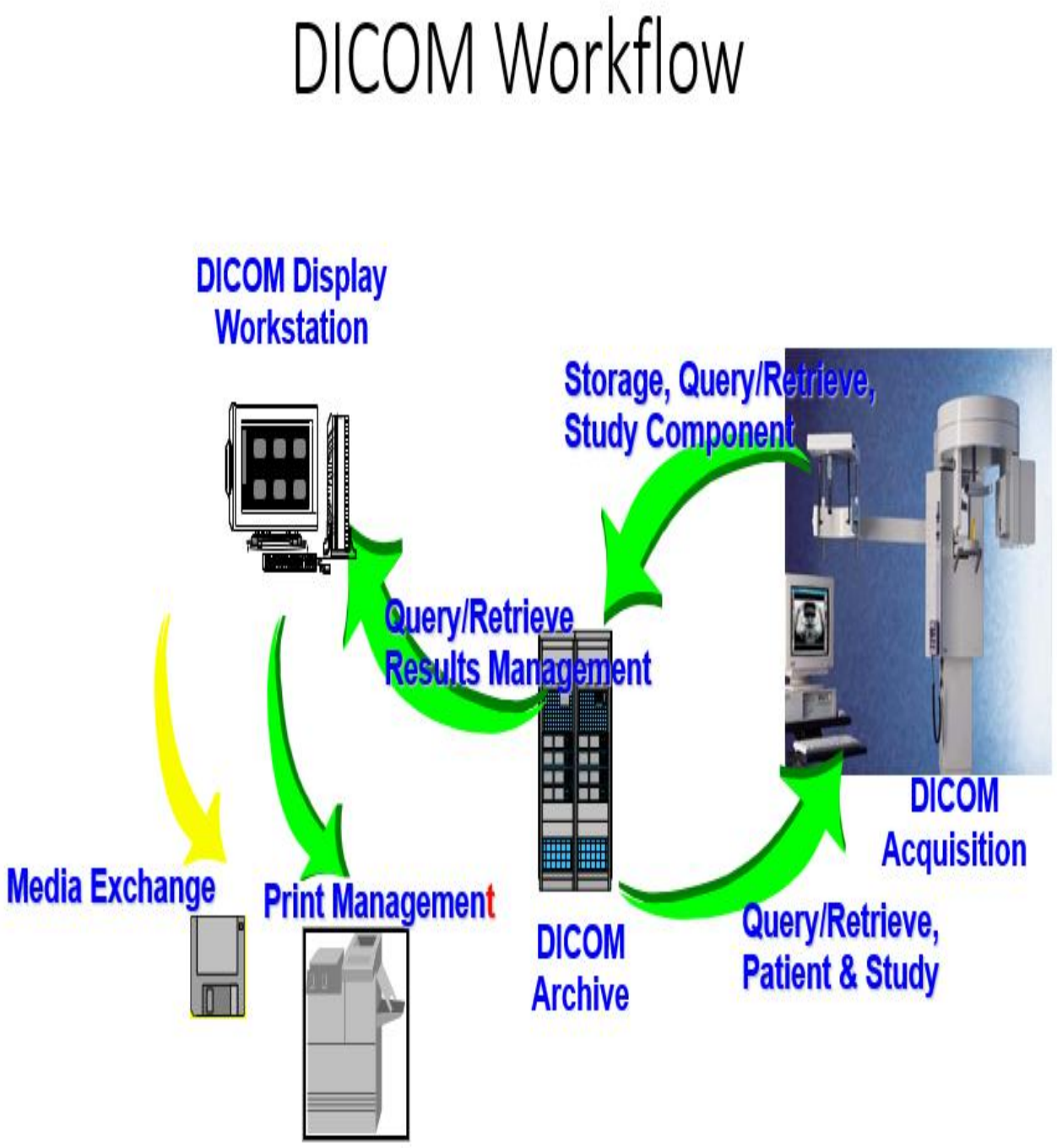
All biomedical imaging

Voluntary standard

DICOM is Biomedcial Informatics

“the storage, retrieval, sharing, and optimal use of biomedical information, data, and knowledge for problem solving and decision making.” Edward Shortliffe

“model formation, implementation of the model, application of implementaion to the real world, evaluation of the implementation”



Disadvantages of Digital Imaging:

1- Expensive, especially panoramic systems
2- Long-term storage of the images although this should be solved by saving them on CD-ROM
3- Digital image security and the need to back up data
4- The connecting cable (or cord) can make intraoral placement of these system's sensor difficult.
5- Loss of image quality and resolution on the hard copy-out when using thermal, laser or ink-jet printers
6- Image manipulation can be time-consuming and misleading to the inexperienced
7- While manufacturers provide safeguards to any tampering with original images within their own software, it is relatively easy to access these images using cheap software and to change them


THANK
YOU!