



Workshop On X-Ray Imaging Dosimetry

**INTRODUCTION TO MODALITY SPECIFIC
MEASUREMENT PROCEDURES:**

INTERVENTIONAL (INCL. C-ARMS, CBCT)

INTERVENTIONAL X-RAY SYSTEMS



IT'S LIKE CONVENTIONAL PROJECTION X-RAY

- Generator
- X-ray tube
- Filter (or a set of filters)
- DAP-meter
- Grid
- Detector

IT'S LIKE CONVENTIONAL PROJECTION X-RAY – WITH SOME EXTRA FLAVOUR

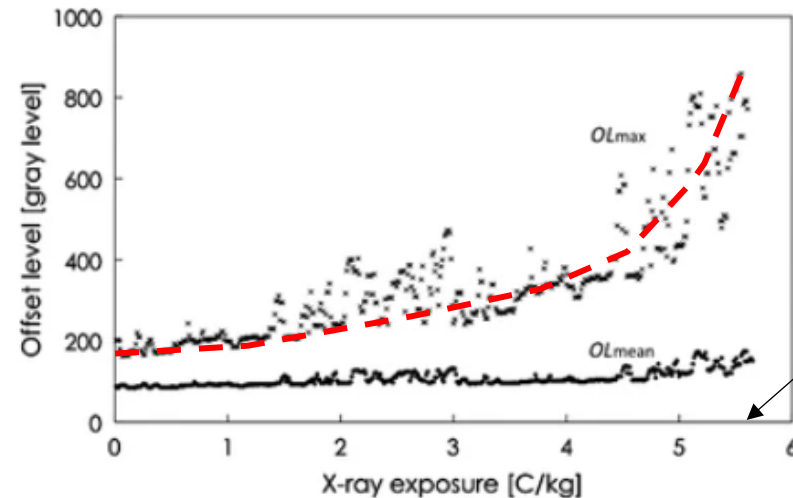
- X-ray tube or two
- Detector always in x-ray beam path
- Patient table and mattress
- Variable FSD and FDD
- Grid may not be removable (C-arms)
- AEC is ON by default
- Imaging modes to choose from
 - fluorography, radiography, angiography, 3D angio, CBCT
 - low dose, normal dose, high dose, 0.5-30 pps etc.
- Zoom factor, wedge-filters, finger-filter, copper filter

IT'S LIKE CONVENTIONAL PROJECTION X-RAY – WITH SOME EXTRA FLAVOUR

- Detector always in x-ray beam path
 - Flat panel detector degradation accelerated by radiation dose

Teramoto, A., Kajihara, T., Suzuki, S. *et al.* Development of quality control system for flat-panel detectors. *Radiol Phys Technol* 4, 164–172 (2011)

- Mind the detector – especially for repeated measurements, AEC off, no phantom

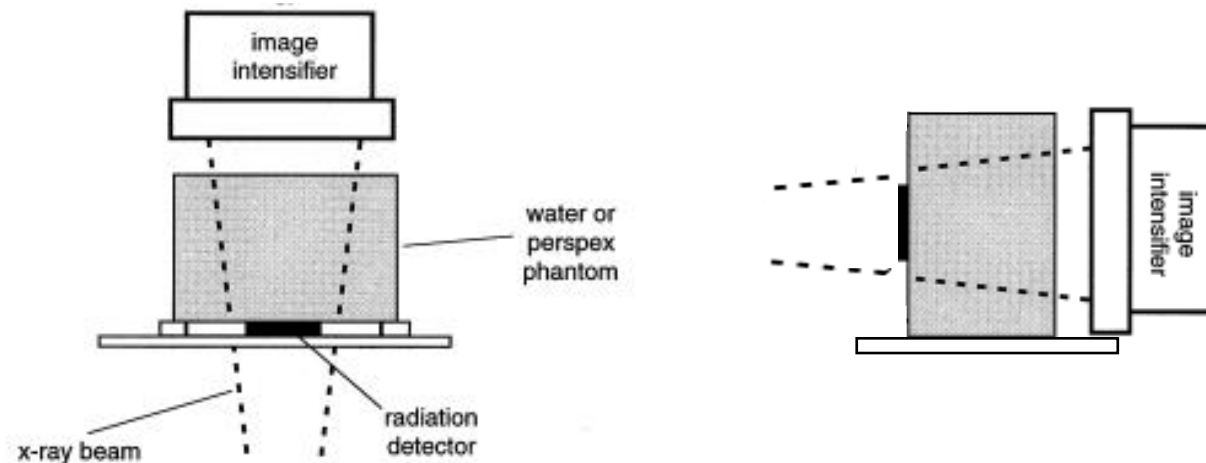


~100kV
430 000 mAs



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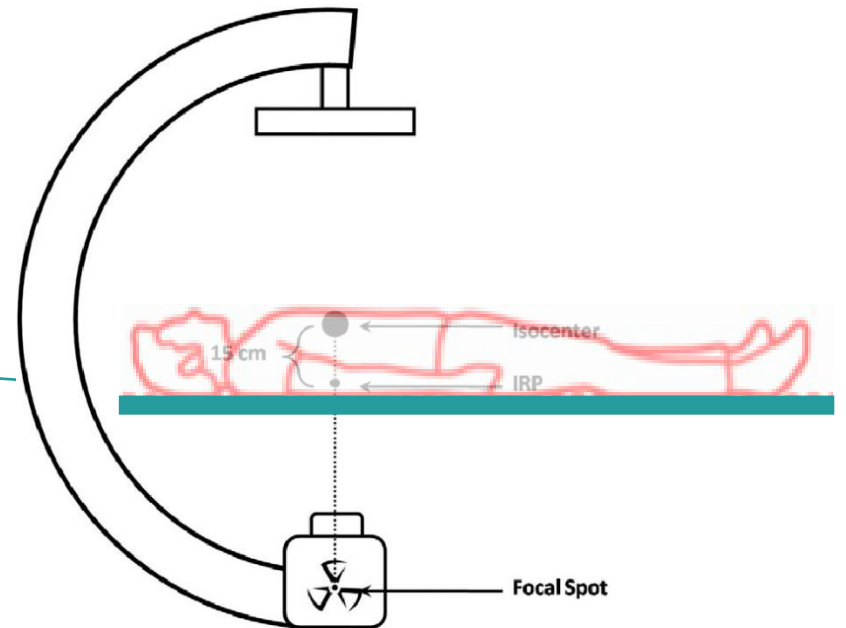
- Patient table and mattress sometimes in beam
 - Aluminium equivalent thickness from specs e.g.
 - Tabletop 1.5 mmAl
 - Mattress 0.5 / 1.0 mmAl
 - 90% transmission for 50 keV & 1 mmAl
 - 80 kV HVL ~3 mmAl



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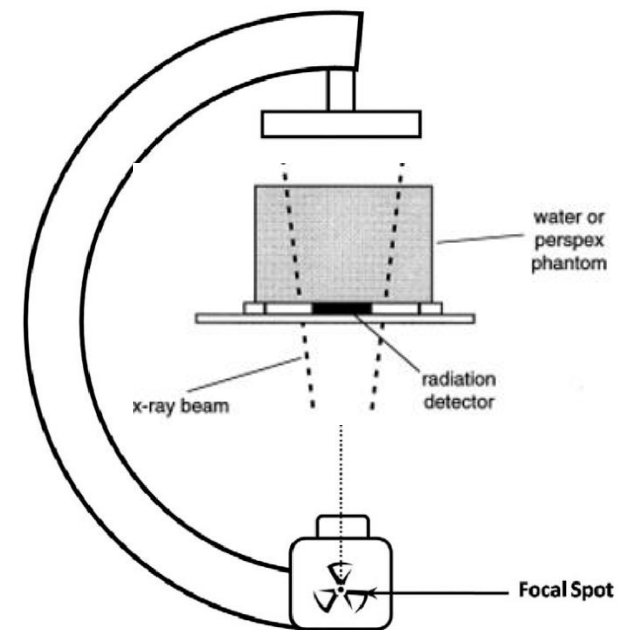
- Variable FSD and FDD
 - FDD eg. 90-120 cm
 - $K_{a,r}$ at reference point
 - In air
 - $K_{a,r} \neq$ patient skin dose
 - FSD, position, angulation etc.

$$K_{a,r} = 1,0 \text{ mGy}$$



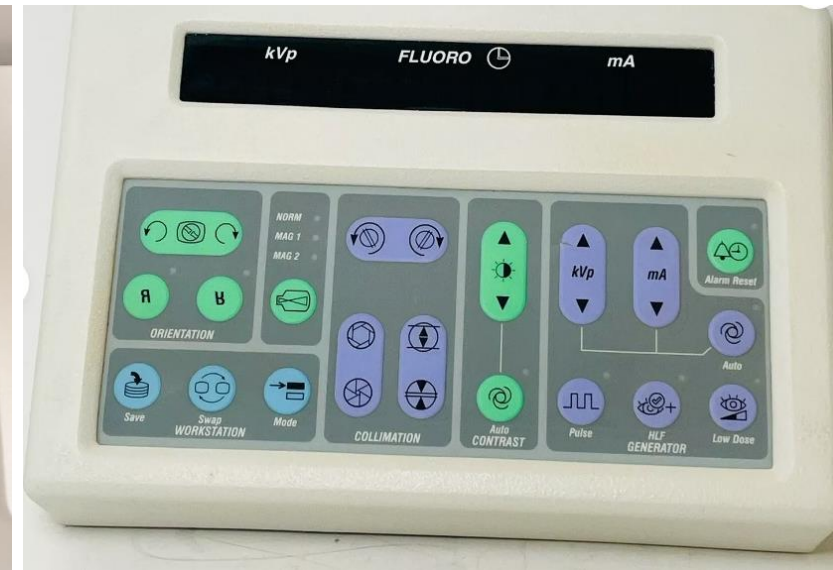
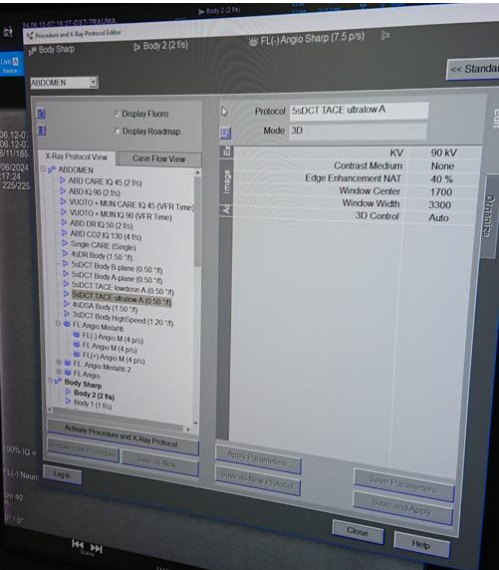
IT'S LIKE CONVENTIONAL PROJECTION X-RAY – WITH SOME EXTRA FLAVOUR

- Grid may not be removable (C-arms)
- AEC is ON by default
 - Manual settings for kV, mA, ms, filter would be preferred for QA or QC purposes
 - Service mode may solve your problems
 - Getting to the service mode may be problem



IT'S LIKE CONVENTIONAL PROJECTION X-RAY – WITH SOME EXTRA FLAVOUR

- Imaging modes to choose from
 - Fluorography, radiography, angiography, 3D angio, CBCT
 - Low dose, normal dose, high dose, 0.5-30 pps
 - Zoom levels
 - All under AEC control



IT'S LIKE CONVENTIONAL PROJECTION X-RAY – WITH SOME EXTRA FLAVOUR

- Imaging modes to choose from
 - IAEA TRS 457
 - Measurement of entrance surface air kerma rate
 - (8) Expose the phantom under automatic brightness control and record the dosimeter reading, \dot{M} , tube voltage, tube current and the image intensifier settings. Repeat the measurement three times and record dosimeter readings, \dot{M}_1 , \dot{M}_2 and \dot{M}_3 .
 - (9) Repeat step 8 for all image intensifier field sizes, dose rates and automatic brightness control options in normal clinical use.

IT'S LIKE CONVENTIONAL PROJECTION X-RAY – WITH SOME EXTRA FLAVOUR

- Filters (typical angio systems)
 - Siemens 2.5mmAl + 0.1... 0.9 mmCu
 - Philips 2.5mmAl + 0.2... 1.0 mmCu
 - Canon 1.8mmAl + 0.2... 0.5 mmCu



ACME CORPORATION

Calibration Certificate

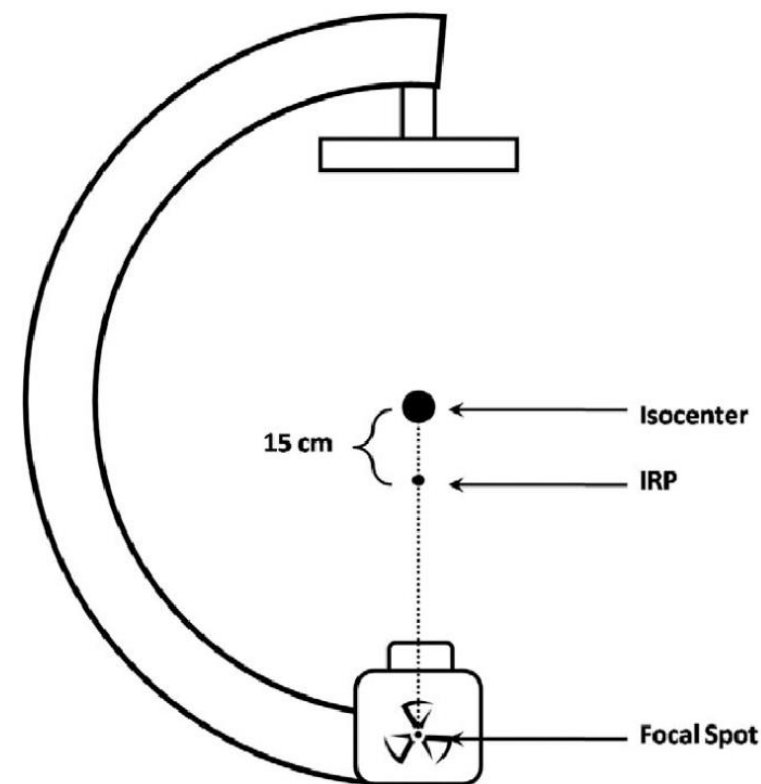
Air Kerma – continued



Set Voltage	Anode Target	Nominal tube filtration	Added filtration	Air Kerma Rate $\mu\text{Gy/s}$	Instrument setting	Standard	Deviation from standard	Deviation limit	Uncertainty
50 kV	W	2.5 mm Al	0 mm Al	1139	R/F low	364.3 μGy	-0.7 %	3.6 %	1.4 %
70 kV	W	2.5 mm Al	0 mm Al	751.5	R/F low	240.3 μGy	-0.3 %	3.5 %	1.5 %
100 kV	W	2.5 mm Al	0 mm Al	727.1	R/F low	233.7 μGy	0.6 %	3.6 %	1.5 %
50 kV	W	2.5 mm Al	0 mm Al	1139	R/F low				
70 kV	W	2.5 mm Al	0 mm Al						

IT'S LIKE CONVENTIONAL PROJECTION X-RAY – WITH SOME EXTRA FLAVOUR

- CBCT
 - Variety of methods for CBCT
 - $K_{a,r}$ at reference point
 - AAPM Report 190:
 - Load the beam to get ~100kV
 - Measure at isocenter (with IC)
 - Minimize scatter
 - Correct for geometry
 - Continuous monitoring during rotation may yield extra info





KIITOS – THANK YOU

