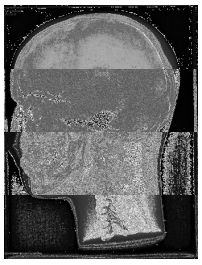
MetroHealth

Acceptance Testing Converted CR to DR Systems

Ryan Fisher, PhD

Computed Radiography (CR) vs Digital Radiography (DR)



CR

Photostimulable phosphor (PSP) screen absorbs x-rays and traps energy

Plate run through processor where laser light releases stored energy to form digital image

DR (Indirect)

Scintillator absorbs x-rays, producing light that is immediately read by flat panel Thin-Film-Transistor (TFT) array, forming the digital image

Why Transition from CR to DR?

DR Pros

- Faster image acquisition & improved throughput
- Potential for dose reduction
- Remove large bulky CR readers
- Replace multiple cassettes with a single digital panel

DR Cons

- Expensive
- Single point of failure
- Need panel for every room
- Battery life issues
- Wireless connectivity issues
- Potential practice limitations

CMS Payment Reduction

H. R. 2029

One Hundred Fourteenth Congress
of the
United States of America

AT THE FIRST SESSION

Begun and held at the City of Washington on Tuesday, the sixth day of January, two thousand and fifteen

An Act

Making appropriations for military construction, the Department of Veterans Affairs, and related agencies for the fiscal year ending September 30, 2016, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Consolidated Appropriations Act, 2016".

CMS
CENTERS FOR MEDICARE & MEDICAID SERVICES

SEC. 502. MEDICARE PAYMENT INCENTIVE FOR THE TRANSITION FROM TRADITIONAL X-RAY IMAGING TO DIGITAL RADIOGRAPHY AND OTHER MEDICARE IMAGING PAYMENT PROVISION.

p. 777

CMS Payment Reduction

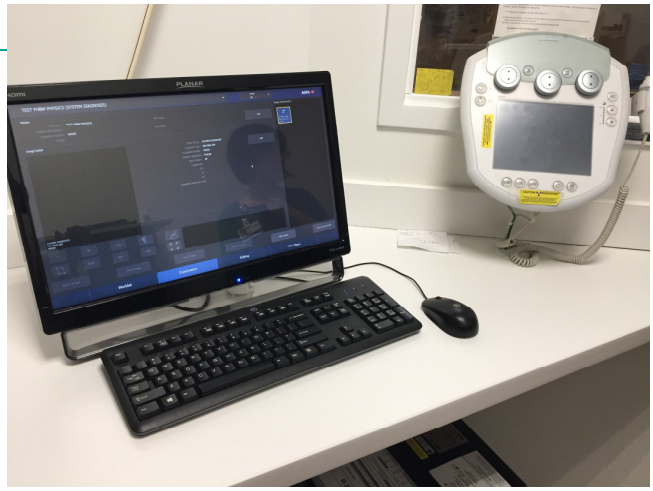
- As of Jan 1, 2018: 7% reduction in payments for imaging services taken using computed radiography.
- As of Jan 1, 2023: 10% reduction in payments
- As of 2017: 20% reduction for film

agfa.com

DR Transition Options

DR Panel Retrofit of Existing Room

- Pros
  - Cheaper than a full DR suite
  - Quick installation with minimal down time
- Cons
  - Another monitor on the counter
  - Likely no generator integration
  - Other quirks – bucky tray reset etc.

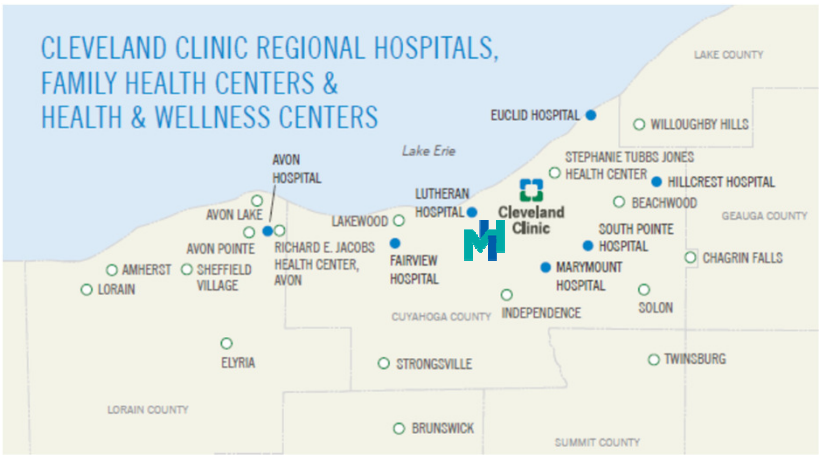


Experiences with Large Scale DR Panel Installation Project

Scope

- 38 Agfa DR 14s panels
- 25 different sites
- 10 weeks
  ~ 4 installs a week

Make	Model	Count
Shimadzu	RadSpeed	20
Reliance	ATC 725	5
Shimadzu	Fluoro Speed	3
Quantum	MC 150 Pinacle	2
Siemens	Multix Top Pro	2
Bennett	Compu-mAs	1
GE	AMX-4	1
Philips	Easy Diagnost Eleva	1
Philips	Optimus	1
Picker	RadView 65	1
Siemens	Sireskop SD	1



Notes on DR Installation Planning

Set yourself up for success

- Make Sure all appropriate people are in the loop
  - Medical Physics
  - Radiology admin
  - Site managers & technologists
  - Appropriate Radiologists
  - IT / Informatics
  - Panel vendor installation team
  - Panel vendor applications specialists
  - Field service engineers for the x-ray equipment

Notes on DR Installation Planning

Set yourself up for success

Site selection

- First rooms will likely go the slowest as you work the kinks out of your process
  - Busy standalone ED room with no other imaging options is not a good test site
  - Helps to have overflow available if things go south
- Type of x-ray room – will determine who else needs to be on-site and how difficult some steps will be
- Patient volume
- Types of exams in the room/site
- Radiologists on site?

Potential Practice Limitations

- May not be able to completely get rid of CR depending on practice needs
- Portable units in surgery areas
  - Can no longer take a plate into the surgery area with an analogue portable
- Scoliosis and long bone studies
  - May not be able to perform with single DR panel
  - May require purchasing extra hardware/stands or software licenses
- Ask panel vendor during bid process

bluestonediagnostics.com

Dose Reduction Opportunity

- Generally, DR panel target doses are lower than CR's
  - Agfa CR target doses
    - HD5.0 = 3.5 µGy
    - MD4.0 = 4.0 µGy
  - Agfa DR 14s target dose = 2.5 µGy
    - 28% lower than HD5.0
    - 37% lower than MD4.0
- Takes work to realize potential dose savings though
  Panel vendor is generally not a part of that work

Technique Standardization Opportunity

- Health system had expanded rapidly in recent years
  - ~ 200 fixed general radiography rooms
  - ~ 50 physical locations

  Large portion was Agfa CR based but not as much effort into standardizing techniques and would have liked
- Retrofit process gave chance to focus on techniques and to standardize practice
- Standardize Target Exposure Indexes (TEI) as well

Installation Process

Big Picture

1. Make sure the panel actually works properly
2. Adjust room's exposures to match the target dose
   a. AEC Calibration – photo-timed exposures
   b. APR programming – manual exposures
3. Make sure all stakeholders are on board and happy
   a. Technologists – Let them know what's going on
   b. Radiologist – is image quality acceptable?

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VENDOR INSTALLATION

Parties Involved

Panel Vendor

Hospital IT/Informatics

Site Managers & Technologists

Vendor Installation

- Vendor service engineers:
  - Install workstation and Wi-Fi
  - Ensure RIS worklist integration & proper sending to PACS
  - Ensure panel functionality and connectivity
  - Perform panel acceptance tests
- Physics generally not involved
  - Did provide updated Target Exposure Indexes
- We had vendor handle this part the afternoon/evening before we planned to do our part
- Generally took a few hours and could work around patients if needed

Physics Panel Acceptance Testing

Parties Involved

Medical Physics

Site Managers & Technologists

DR Panel Acceptance Testing

Ensure functionality of DR panel

Acceptance tests:

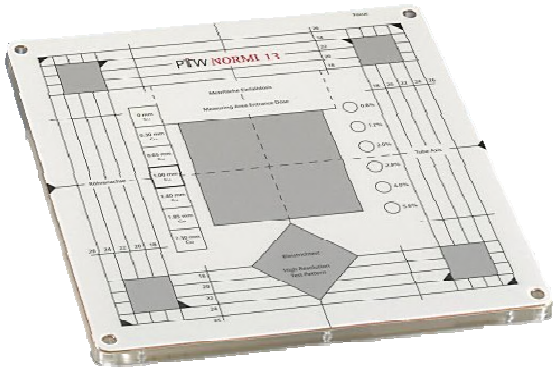
- Exposure Indicator Accuracy

Phantom Tests

- High and low contrast performance
- Dynamic Range
- Distance Accuracy

Flatfield Tests

- Uniformity
- Pixel Value Accuracy
- Artifact detection
- Clipping Level Check



ptw.de

Ask vendors about any QC/phantoms during bid process!

DR Panel Acceptance Testing

Ensure functionality of DR panel

Consisted of several tests:

- Exposure Indicator Accuracy
- High and low contrast performance
- Dynamic Range
- Distance Accuracy
- Uniformity
- Pixel Value Accuracy
- Artifact detection
- Clipping Level Check

Test Setup

Measure the sensitivity of the panel, which is used later to adjust the AEC target values

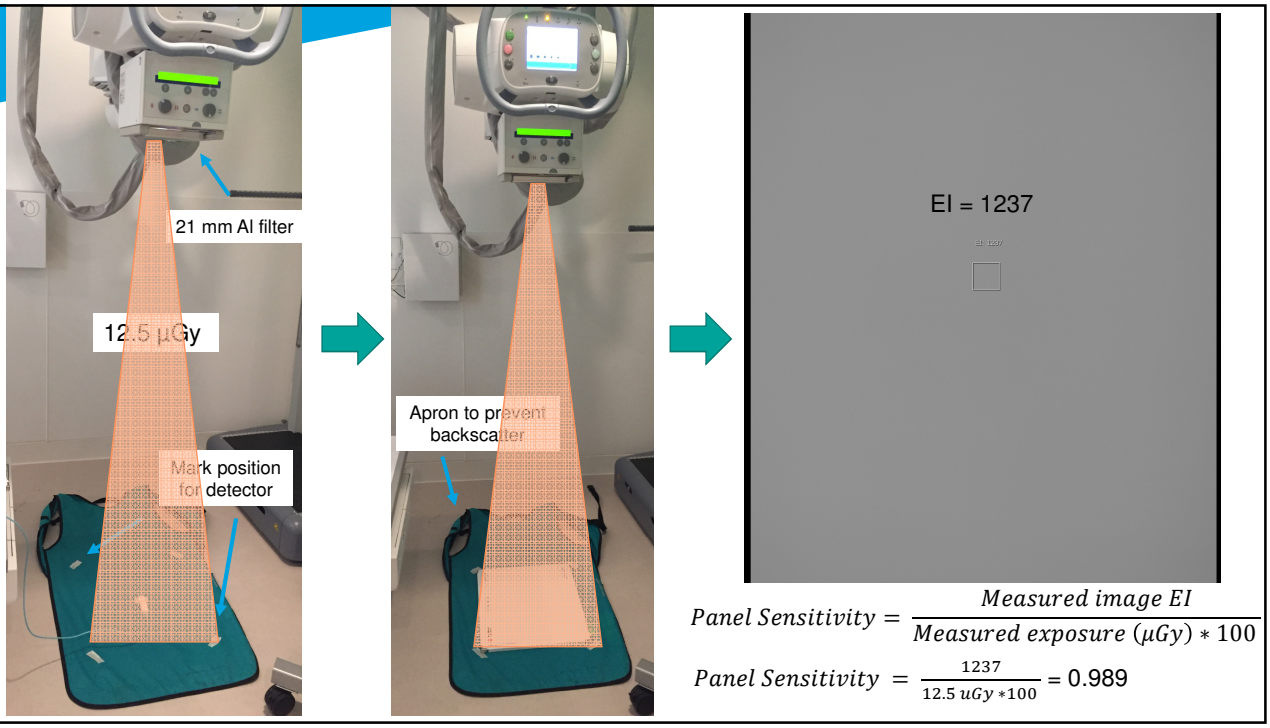
- SID: ≥ 180 cm – minimize heel effect
- RQA 5 beam quality (~ 70 kVp, ~ 6.8 mm Al HVL)
- Measure entrance air kerma in µGy with meter
- Place DR panel in beam and shoot same technique
- Measure Exposure Index (EI)* and compare to expected value

$$EI = c_0{}^* K_{CAL}$$

w/ $c_0 = 100$

We normally shoot for ~ 10 µGy, which should give an EI of ~ 1000

*make sure to use proper exam tag if vendor requires!



$$Panel\ Sensitivity = \frac{Measured\ image\ EI}{Measured\ exposure\ (\mu Gy) * 100}$$

$$Panel\ Sensitivity = \frac{1237}{12.5\ uGy * 100} = 0.989$$

DR Panel Acceptance Testing

Ensure functionality of DR Panel

Consisted of several tests:

- Exposure Indicator Accuracy
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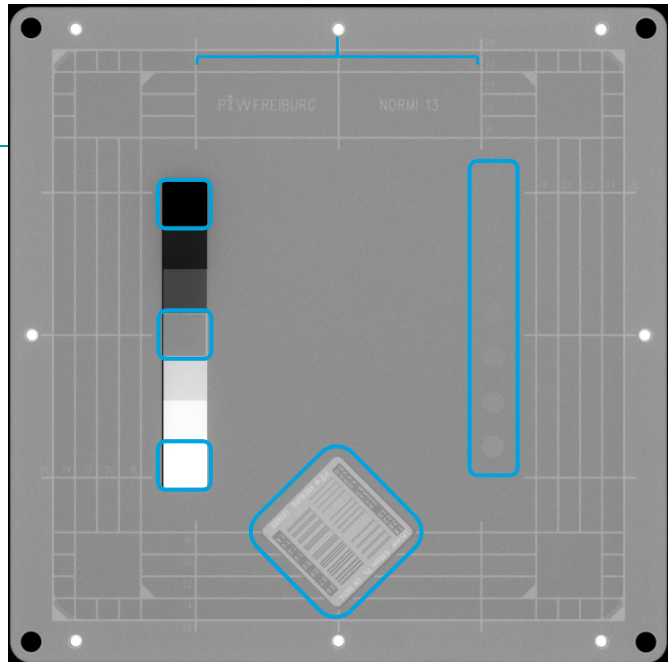

DR Panel Acceptance Testing

Ensure functionality of DR Panel

Consisted of several tests:

- Exposure Indicator Accuracy
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- Clipping Level Check

- Shoot flat field image at ~ 10 uGy to plate and record PVI pixel values for 9 ROIs
- Test also measures PVI value accuracy, which is mostly redundant to the EI accuracy test we did earlier
- Perform general artifact detection on flat field image
- Make second shot at ~ 2x the dose and look for clipping or banding in image

DR Panel Acceptance Testing

Ensure functionality of DR Panel

Consisted of several tests:

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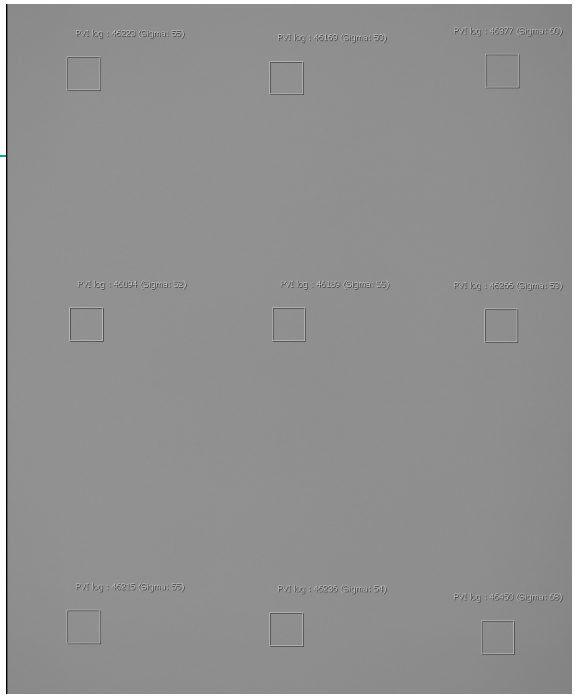


AEC Calibrations

Parties Involved

Medical Physics

Field Service Engineers

Site Managers & Technologists

AEC Calibrations

Adjust photo-timed doses to new panel

- Big picture: Adjust the AEC cutoff level to the entrance dose requirements of DR panel
  (obviously need to know what the target dose for the detector is)
- This likely means lowering the cutoff value from whatever was in place for CR
- Vendor may have their own procedure
  - Shimadzu had a calibration process w/ increasing acrylic thickness at 60, 80, 100, & 120 kVp
- Otherwise, several options for calibration set up:
  - Phantom - Acrylic @ bucky vs Al or Cu @ the collimator
  - Wall board - kVp and SID options

AEC Calibrations

Our Setup

Single Point AEC Calibration

Table Bucky
- 40”/102 cm SID
- 80 kVp
- 7” PMMA on table, centered in beam
- Grid in
- Center AEC cell

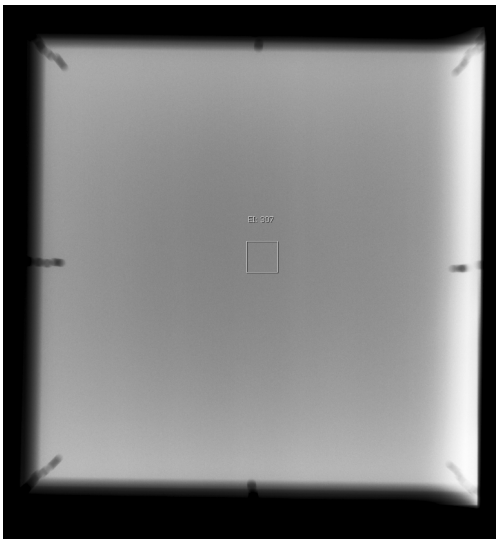
Wall Bucky
- 72”/183 cm SID
- 120 kVp
- 7” PMMA centered in beam
- Grid in
- Center AEC cell

AEC Calibrations

Setting your Target

Use Exposure Index as target variable

- Target EI should be panel's target dose in µGy x 100
  - IEC definition of EI preferred
  - S-value gets more complicated
- For the Agfa 14s, the target dose is 2.5 µGy
  - Target EI was ~ 250
- We took the extra step of scaling the AEC target by the measured sensitivity of the panel
- Most of the Agfa panels were within +/- 10% so this part wasn't critical, but the IEC tolerance for EI accuracy is +/- 20% so it could be a bigger issue
  - For target = 250, ±20% EI range 175 – 325



AEC Calibrations

Process

1. Position Phantom at bucky and shoot phototimed exposure under calibration conditions
2. Measure Exposure Index (EI) in center of PMMA
3. Have FSE adjust gain on AEC & reshoot
4. Repeat until you get close enough to your target.
   - We were generally able to get within 20% of the target without much difficulty
   - Ease of gain adjustment can vary greatly with equipment, which can affect how close you're able to get to the target EI
5. Do the same thing all over again for the wall bucky

APR Reprograming

Parties Involved

Medical Physics

Field Service Engineers

Site Managers & Technologists

Programmed Manual Techniques

Overview

1. Settle on a standard technique chart
   - Work with technologists and radiologists
   - Exams may vary at different sites based on practice
   - Account for patient size variations
2. Scale existing CR techniques to new DR target dose
   - We just scaled mAs down w/ no kVp adjustments
3. Program new techniques into the control panel
   - Some systems much more straight forward than others
   - May or may not need service engineers
   - Manual or upload-able
4. Print and post technique chart as needed

TABLETOP

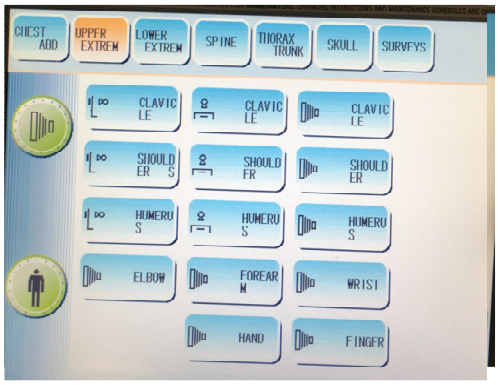
Exam Group	View	SID (in)	Grid	Manual Technique kVp	mAs
Ankle	AP	40	N	60	2.5
	OBL	40	N	60	2.5
	LAT	40	N	60	2.5
Elbow	AP	40	N	60	2.0
	OBL	40	N	60	2.0
	LAT	40	N	60	2.0
Finger	AP	40	N	55	1.2
Foot	AP	40	N	56	2.0
	LAT	40	N	58	2.0
Forearm	AP	40	N	58	2.0
Hand	AP / OBL	40	N	60	1.5
	LAT	40	N	63	1.5
Heel	LAT	40	N	60	2.5
	Axial	40	N	66	4.9
Hip	Hip	40	N	68	6.8
	cross-table	40	N	85	37.1
Humerus	Humerus	40	N	65	3.1
Knee	AP	40	N	65	2.0
	LAT	40	N	65	2.0
	Tunnel	40	N	70	2.5
	Merchant	40	N	70	2.5
Shoulder	Axilary	40	N	70	4.9
Tib/Fib	Leg	40	N	65	2.5

Programmed Manual Techniques

Shimadzu RADspeed

We were able to update a master APR and upload it to other RADspeed rooms via USB

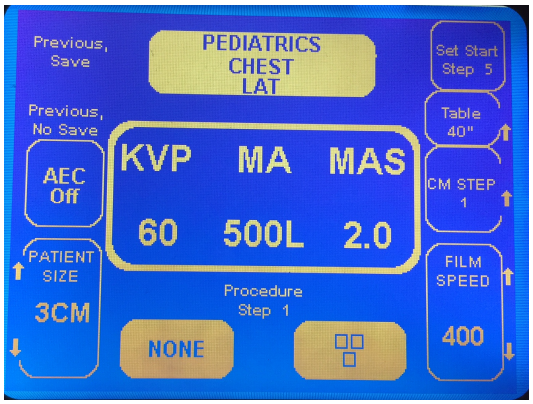
- Saved a bunch of time since 20 of the panel installs were RADspeed rooms
- Needed to update firmware versions on several rooms
- Couldn't crossover to the FLUOROspeed RF systems
- Rearranged exam tags at some sites



Programmed Manual Techniques

Possible Snags

- Patient sizes
  - Some systems have multiple sizes for every view
  - May auto-scale kVp/mAs based on "standard" or may have to manually adjust each one
  - May need more input from techs for techniques
  - Ask technologists how they use the equipment
- Variation in views/exams
  - Different rooms may perform different exams
  - Only updated existing exams & didn't add all
  - Techs are used to where exam tags are located



Installation Process Summary

1. Vendor installation of panel & workstation	Done afternoon/evening prior to everything else. Generally 2-3 hours
2. Physics panel acceptance test	Generally less than 30 min
3. Recalibration of AEC systems	1-3 hours depending on set up
4. Reprogramming APRs	0-3 hours depending on set up

- We could typically turn a room over in 3-4 hours
- In total < 1 day to fully install DR panel

Installation Process Summary

- Initially give yourself a lot of time to account for unknowns
- Programming APRs can be a huge time sink, depending on the particulars
  - Investigate specific equipment prior to starting a room
- Good coordination of all parties = can get everything up in < a day
- Could have time gaps in between steps as well if schedules don't allow
  - Worst case, you're just using the same exposure levels you previously were using until AEC and techniques can be adjusted

Technologist Training

Parties Involved

Medical Physics

Panel Vendor Applications

Site Managers & Technologists

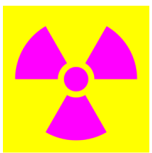
Technologist Training

This all works best when people know what's going on…

- Let technologists know about the new panel
  - Expect photo-timed mAs values to be lower
  - Follow updated APRs & lower manual mAs
  - Use DI for reference
  - Keep an eye out for any image quality issues and let physics know
- This may or may not be covered by applications

Cut your old mAs in half!!

New DR panel requires ~ half the dose you're used to



Use programmed techniques as a starting point

Confirm Image Quality with Radiologists

Parties Involved

Medical Physics

Radiologists

Site Managers & Technologists

Confirm Image Quality

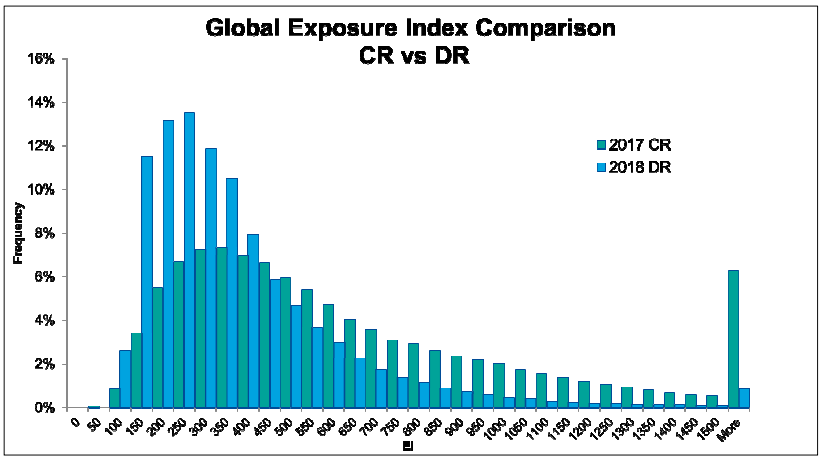
This all works best when people know what's going on…

- Let radiologists know ahead of time what's happening
- Poke your head in once you start doing patients and ask questions
  - This can get complicated depending on your practice
  - Who reads what, from where?
  - Plan your install strategy to set up for success
- Vendor selection can make this a larger issue as well
  - Different vendors have different processing
  - "Unacceptable" vs. "different" image quality

filmviewer.com

Confirm Image Quality and Dose

- Check exam statistics afterwards to verify practice
- EI Data from 8 workstations at 5 sites
  - One year of CR data (~134k exams)
  - 3 months of DR data (~40k exams)
- Average reduction in EI:
  - Photo-timed exams – 41%
  - Manual exams – 55%
- Also saw Standard deviation of DI reduce for almost all exams groups
- Can be a good Department PR win to help justify costs / your job



Post Installation Issues

Parties Involved

Medical Physics

Field Service Engineers

Radiologists

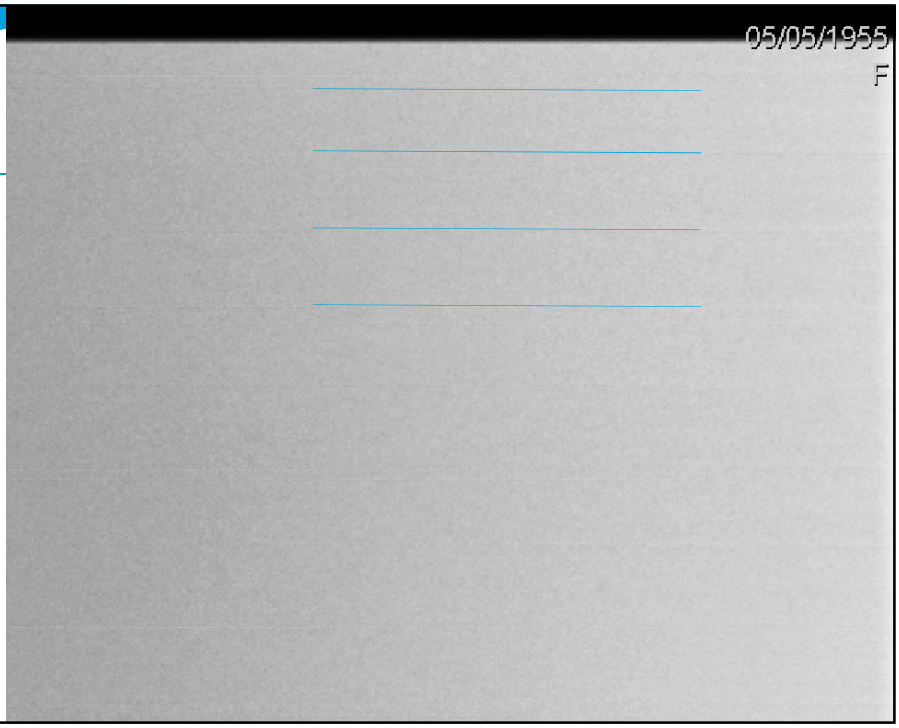
Site Managers & Technologists

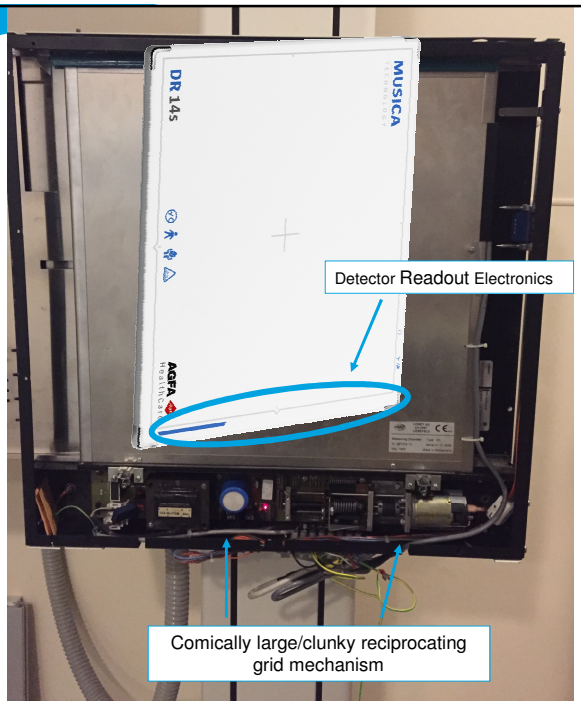
Artifacts

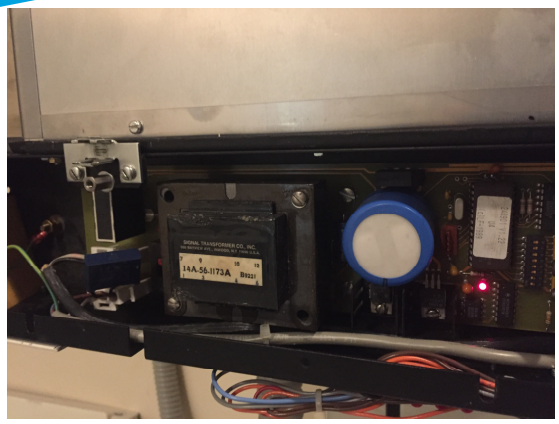
Intermittent, evenly spaced line artifacts showing up in images

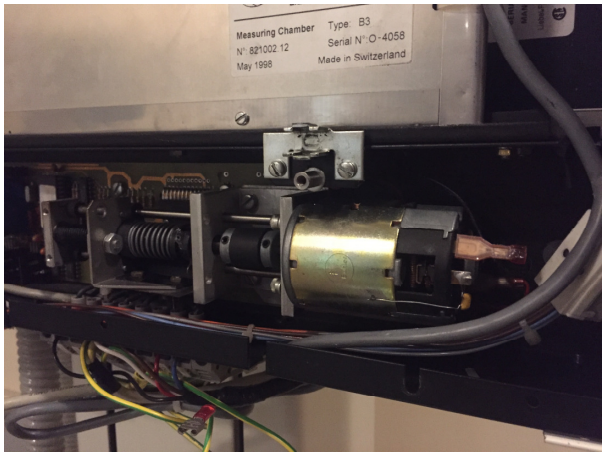
Artifacts

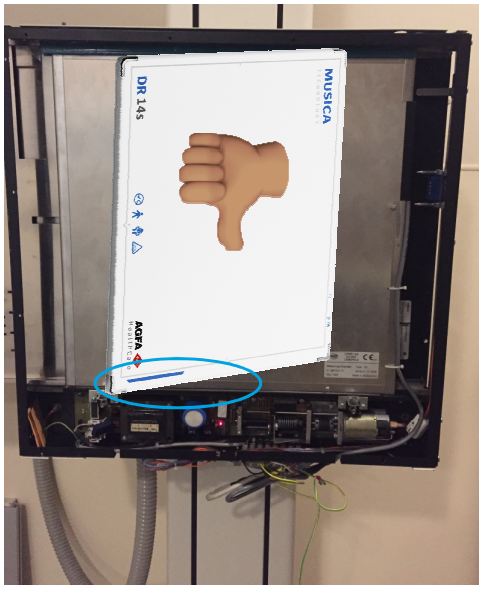
Flatfield Image

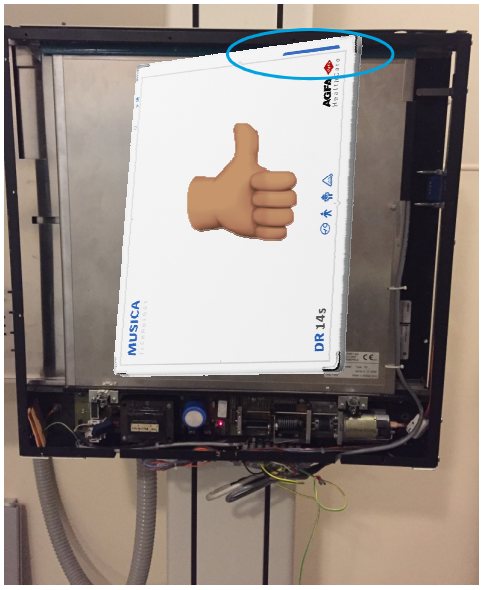



DR 14s
MUSICA
AGFA
Detector Readout Electronics
Comically large/clunky reciprocating grid mechanism




Measuring Chamber
Type: B3
N°: 821002 12
Serial N°: O-4058
May 1998
Made in Switzerland





Key Takeaways

CR to DR Transition

- Dose reduction possible, but it doesn't happen by itself
- Planning and coordination of multiple parties required
- Difficulty of project impacted by specifics of vendor selection and existing equipment
- All in all, this went a lot smoother than I thought it would
- Generally ~ ½ day room down time for physics testing


MetroHealth
Thanks!