Professional Symposium
Interoperability in Radiation Oncology

IHE-RO Committee Update

IHE RO Speakers

- Tony Seibert Ph.D. Professor & Assoc Chair of Informatics, UC Davis Rad
  - Beginning of IHE – Rad
- Scott Hadley Ph.D. Assistant Professor U of Michigan Rad Onc
  - IHE RO Background
- Walter Bosch D. Sc. Associate Professor at Washington University
  - Connectathons and Testing
- Chris Pauer Senior Software Engineer Sun Nuclear
  - IHE RO Profile development

Integrating the Healthcare Enterprise: IHE…. Background, Overview, and Radiology Status

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Disclosures

- Financial

  None

- Trustee (Diagnostic Medical Physics)

  American Board of Radiology

- Author

  Essential Physics of Medical Imaging

Learning Objectives

- Provide an overview of the background, history, and process of Integrating the Healthcare Enterprise (IHE)
- Describe the space in which IHE functions and how stakeholders are involved
- Give examples of radiology profiles, actors, and transactions pertinent to the diagnostic medical physicist

Snapshot of electronic medical imaging in 1997

- Handling
- Display
- Processing
- Archive

PACS

Patient Images

RIS/HIS

Patient Information

- Demographics
- Scheduling
- Reporting
- Billing

Standards?

Conformance Statements

DICOM

HL7

Clinical Document Architecture

Communication?

Broker

Interoperability?

Proprietary implementation for Enterprise Systems

Background

- 1990's: RSNA instrumental in DICOM promotion / adoption; system interoperability required use of the HL7 standard
- 1997: Progress toward producing turnkey devices able to "plug and play" with existing standards– required definition of specific use-cases and specific architectures
- 1998: Engagement with the Healthcare Information and Management Systems Society (HIMSS) to establish momentum and direction for system *interoperability* —— ….. the IHE effort was initiated

Background

- Initially conceived as a 3 – 5 year project with the premise:
  - Annual cycle of proposed technical specifications
  - Testing of implementations occur at “connectathons”
  - Public demonstrations will demonstrate value
- Year 1:
  - Problem of *scheduling radiology workflow* from patient registration / ordering / scheduling … to … image acquisition / transfer / archival / distribution
  - Involved DICOM and HL7, with multiple devices (PACS, RIS, HIS)
  - 47 systems and 24 vendors were present at RSNA 1999

Background

- Year 2, Year 3, ……
- In 2005 there were 7 integration profiles
- In 2016 there are 21 integration profiles & 23 supplements for trial implementation (Radiology only)

Scheduled Workflow

Consistent Presentation of Images

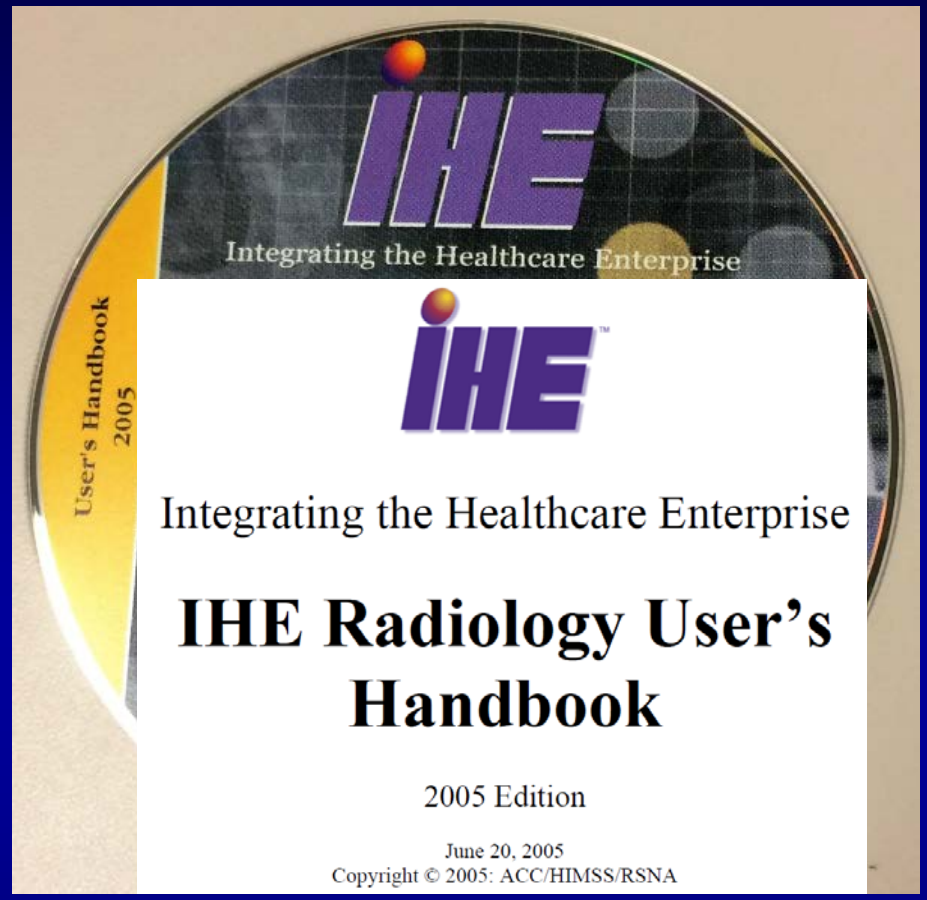
Presentation of Grouped Procedures

Key Image Notes

Evidence Documents

Assisted Protocol Setting Option

Performed Procedure Step



- Project is ongoing and now in 17th year
- IHE is now a global organization spanning multiple domains

www.ihe.net

www.iheusa.org

IHE Domain Committees

- Anatomic Pathology
- Cardiology
- Dental
- Endoscopy
- Eye Care
- IT Infrastructure
- Laboratory
- Patient Care Coordination
- Patient Care Devices
- Pharmacy
- Quality, Research and Public Health
- Radiation Oncology
- Radiology

Integrating the Healthcare Enterprise

- Initiative by healthcare professionals and industry to:
  - improve the way computer systems in healthcare share information
  - promote the coordinated use of established standards such as DICOM and HL7 to address specific clinical needs
  - enable care providers to use information more effectively in support of *optimal patient care*

Integrating the Healthcare Enterprise: What?

- Establishes Technical Framework of Integration Profiles to meet critical interoperability needs
- Guides vendor implementation strategies
- Provides effective shorthand for use in purchase specifications
- Enables providers to use information more effectively from systems developed with IHE integration profiles
- Improves system communication and eases implementation

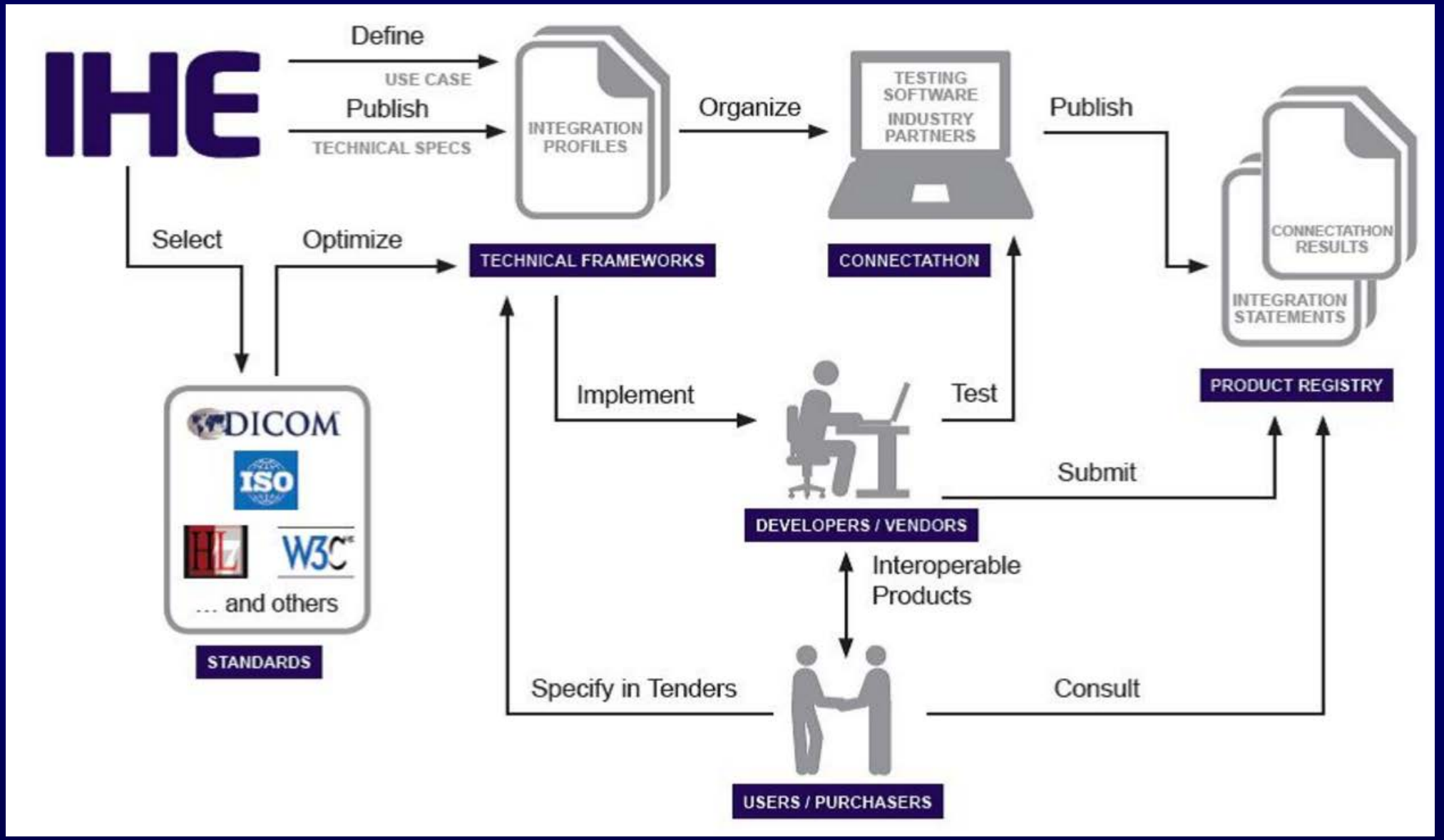
Integrating the Healthcare Enterprise: How?

- Identify a set of *use-cases* requiring a common architecture
- Define an *Integration Profile* to support those use-cases
- Define a specific clinical use case
  - Determine clinical information and workflow needs
  - Address needs by set(s) of “actors” and “transactions”

Integration Profile, Actors, Transactions, Connectathon

- *Integration Profile:* Precise description of how standards are to be implemented to address a specific clinical integration need, definitions of the clinical use case, and set of actors and transactions that address the need
- *Actor*: a system or application responsible for certain information or tasks, which supports a specific set of IHE transactions to communicate with other actors
- *Transaction*: exchange of information between actors, describing how to use an established standard (DICOM, HL7, W3C) to exchange information
- *Connectathon*: process to test implementations at a live, structured, multi-vendor event in a supervised environment

IHE process


IHE
Define
USE CASE
Publish
TECHNICAL SPECS
INTEGRATION PROFILES
Organize
TESTING SOFTWARE
INDUSTRY PARTNERS
Publish
CONNECTATHON RESULTS
INTEGRATION STATEMENTS
PRODUCT REGISTRY
Select
Optimize
TECHNICAL FRAMEWORKS
CONNECTATHON
DICOM
ISO
HL7
W3C
... and others
STANDARDS
Implement
Test
Submit
DEVELOPERS / VENDORS
Interoperable Products
Specify in Tenders
Consult
USERS / PURCHASERS

IHE profiles

Mammography Image

Integrating the Healthcare Enterprise

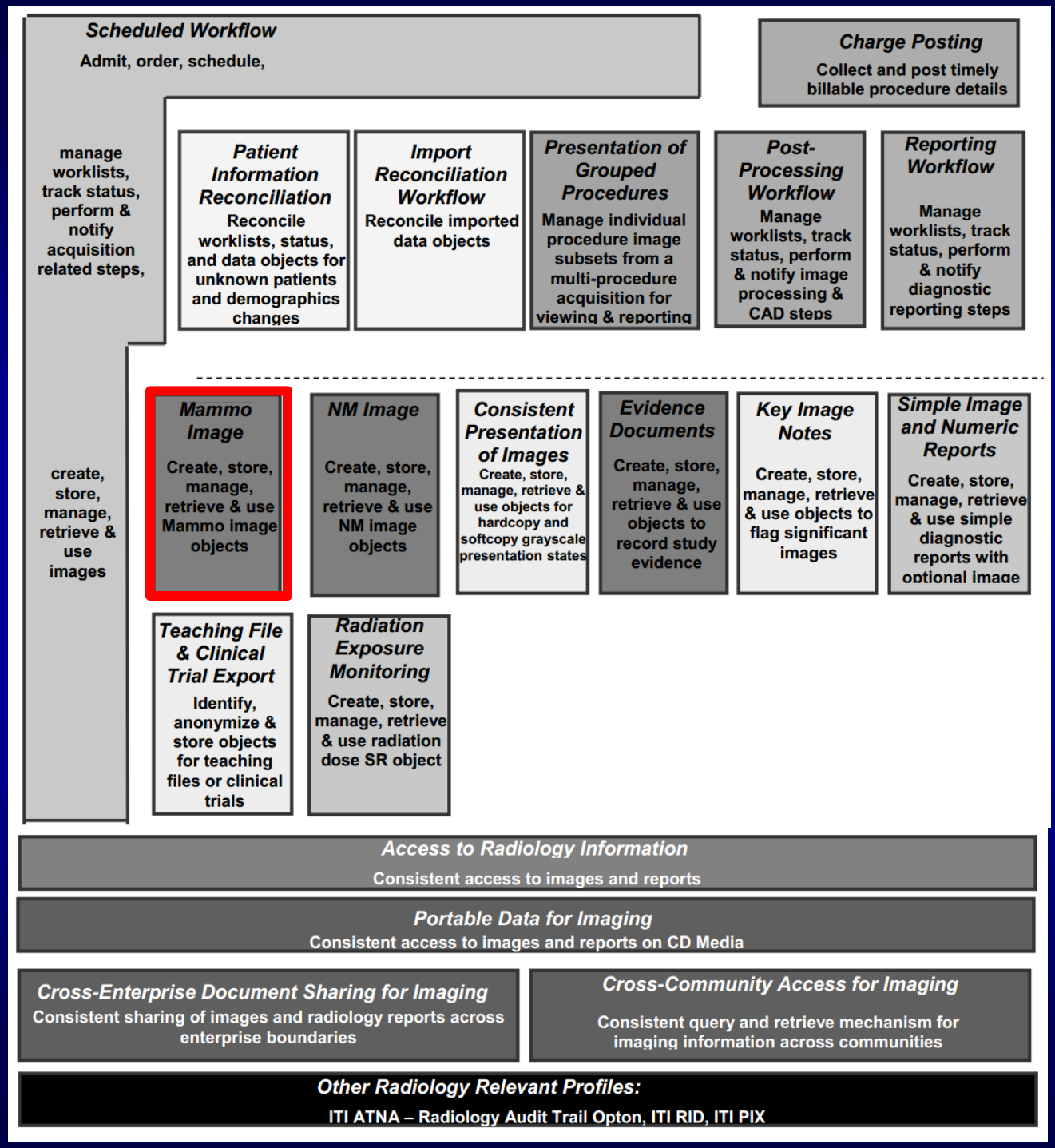
IHE

IHE Radiology (RAD) Technical Framework

Volume 1

IHE RAD TF-1

Integration Profiles

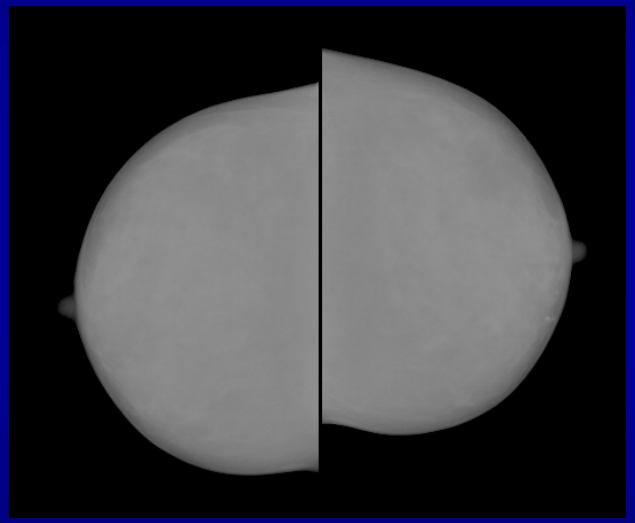


Goal: Build IHE Mammography Image Profile

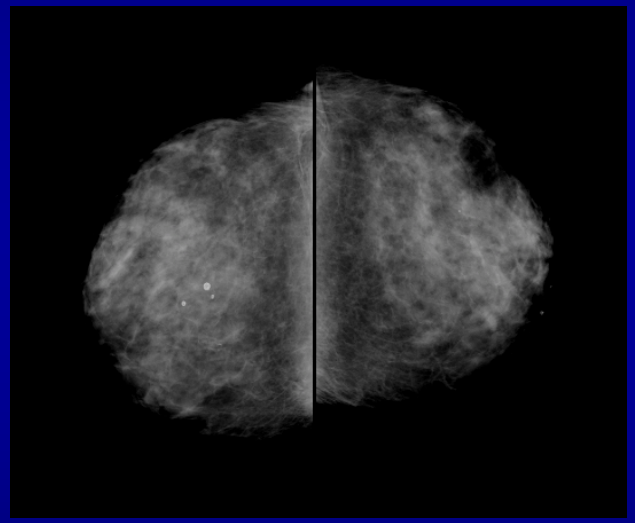
- Challenges:
  - Two types of image data
  - Different vendor attributes / image data
  - Common use of CAD
  - Importance of prior studies
  - Image size, orientation, layout
  - MQSA requirements (USA)

“For Presentation” vs “For Processing”?

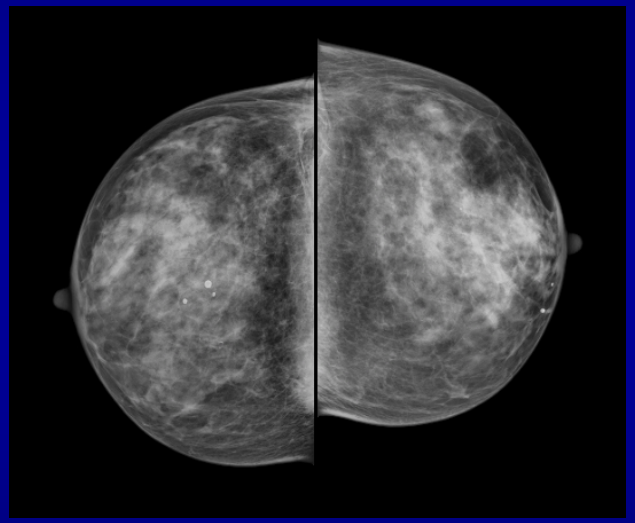
- Which image provides an equalization of the breast skin line?
- Which image is used by CAD in mammo?



Detector corrections, gain map corrections, no enhancement,
“For Processing”



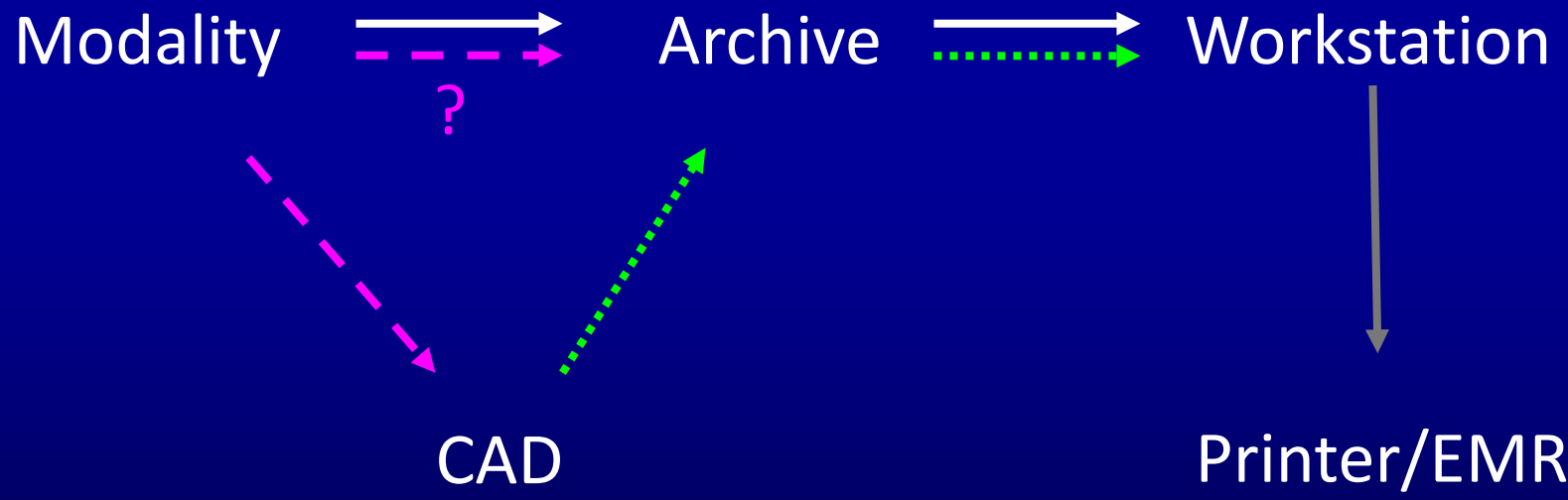
Simple linear contrast & brightness corrections, *no advanced processing*



Skin equalization processing and non-linear enhancement
“For Presentation”

Types of Image Data

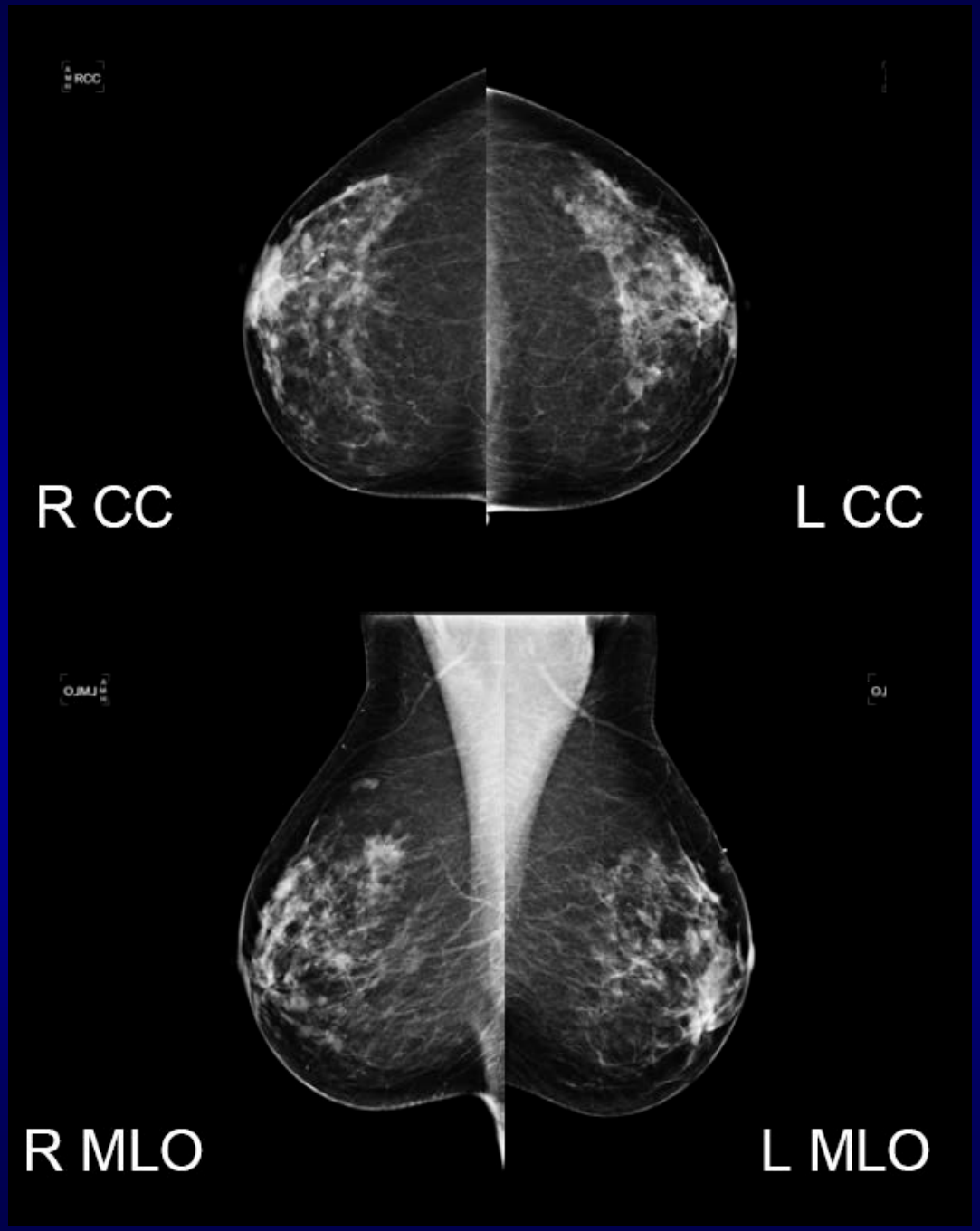
- "For Presentation" image data
- "For Processing" image data
- Mammo CAD structured report



Hanging Protocols

- Determined by
  - View type (CC vs. MLO)
  - Specialty view type
  - Laterality
  - Patient orientation

Preferred layout



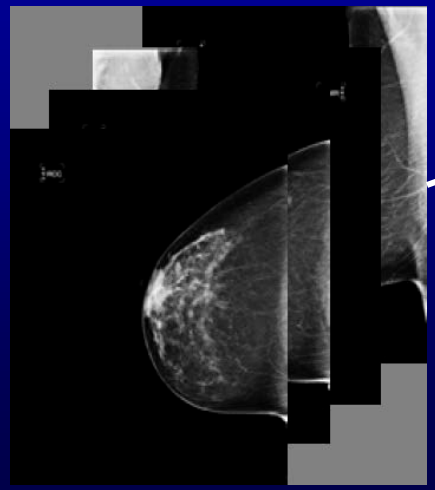
From IHE presentation

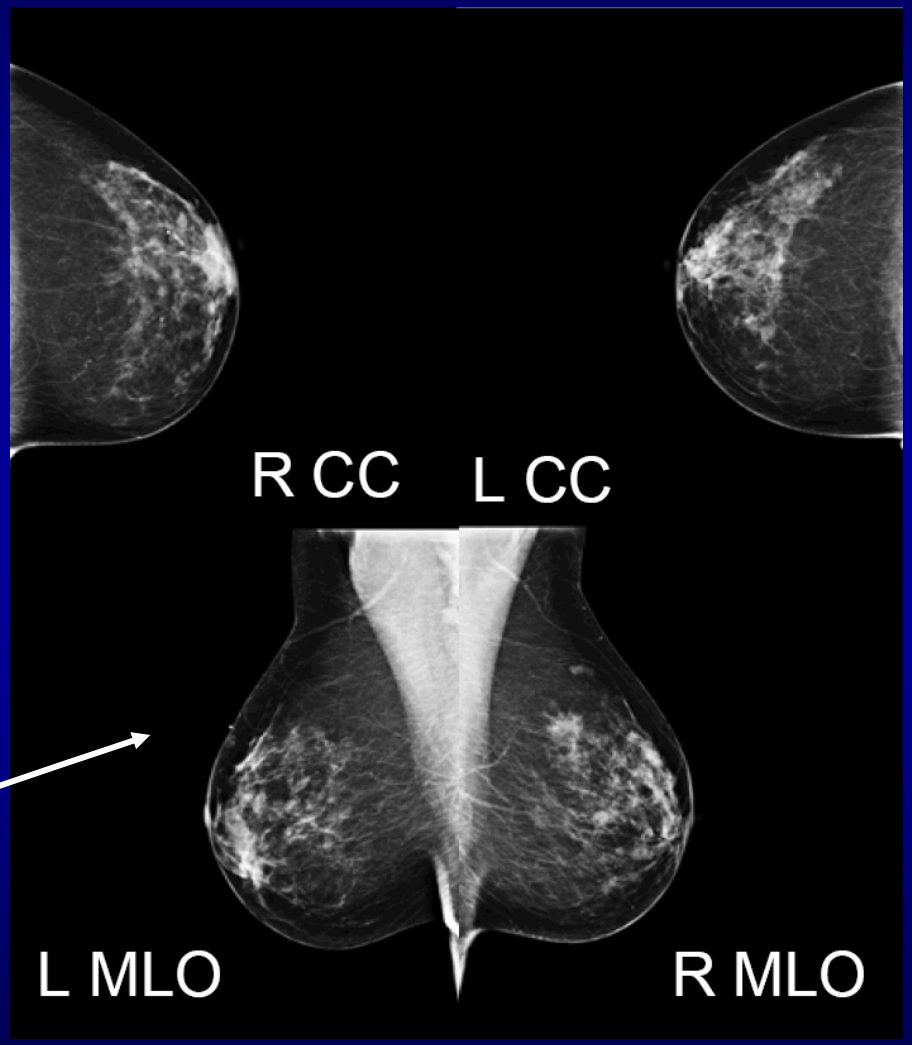
Hanging Protocols

- Generic image display
  - Series based
  - Image order as acquired
  - Image orientation as acquired

"PACS" layout

Stacked series

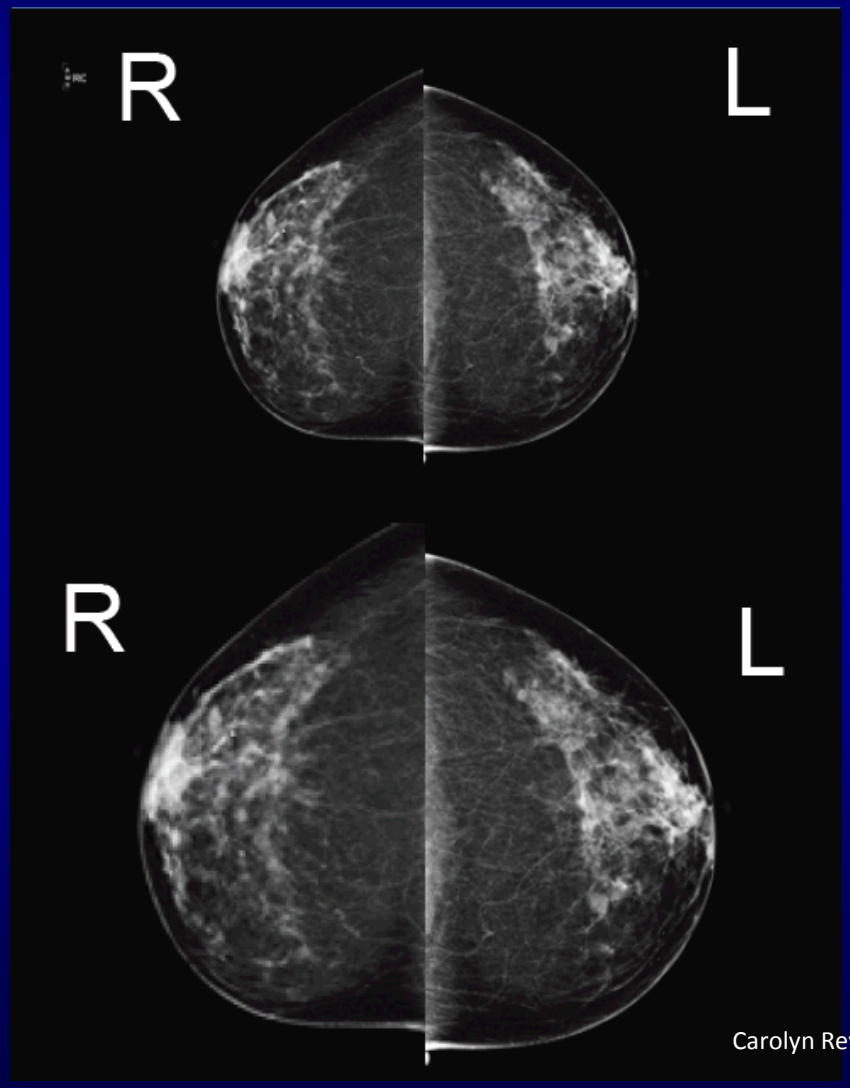


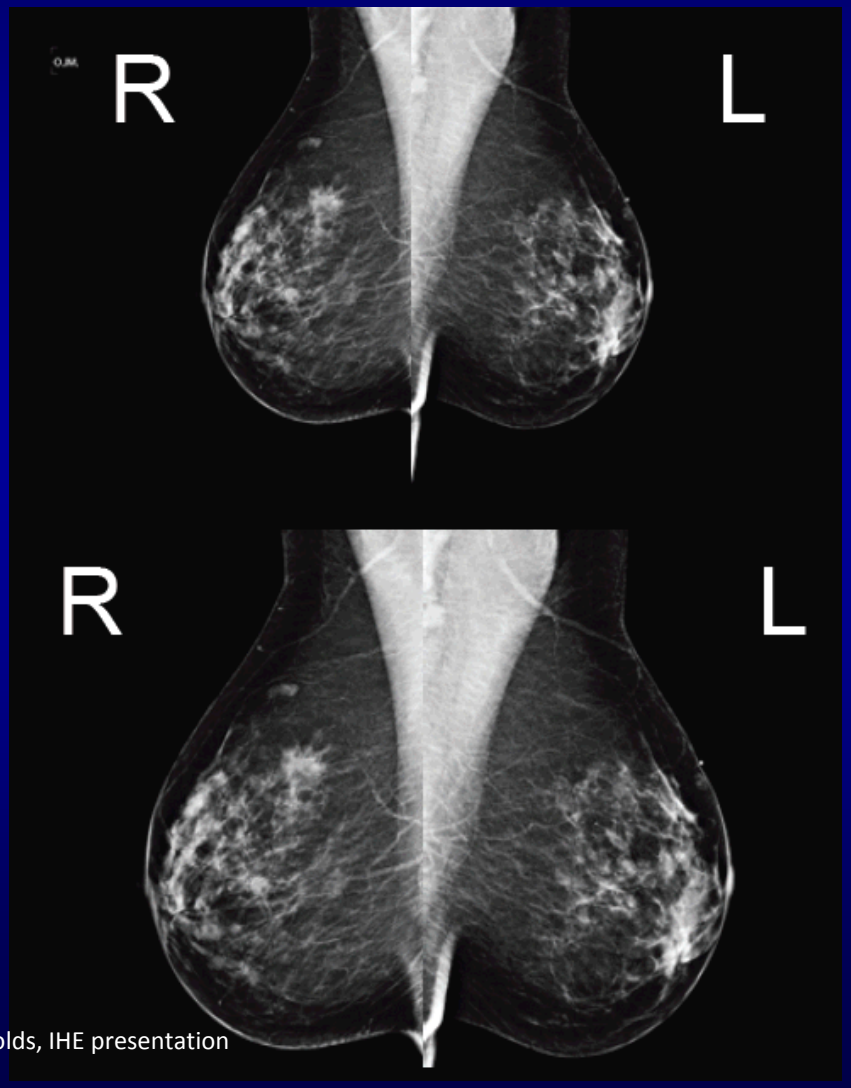


Carolyn Reynolds, IHE presentation

Variances in image size

- Typical “Fit to Viewport” effect

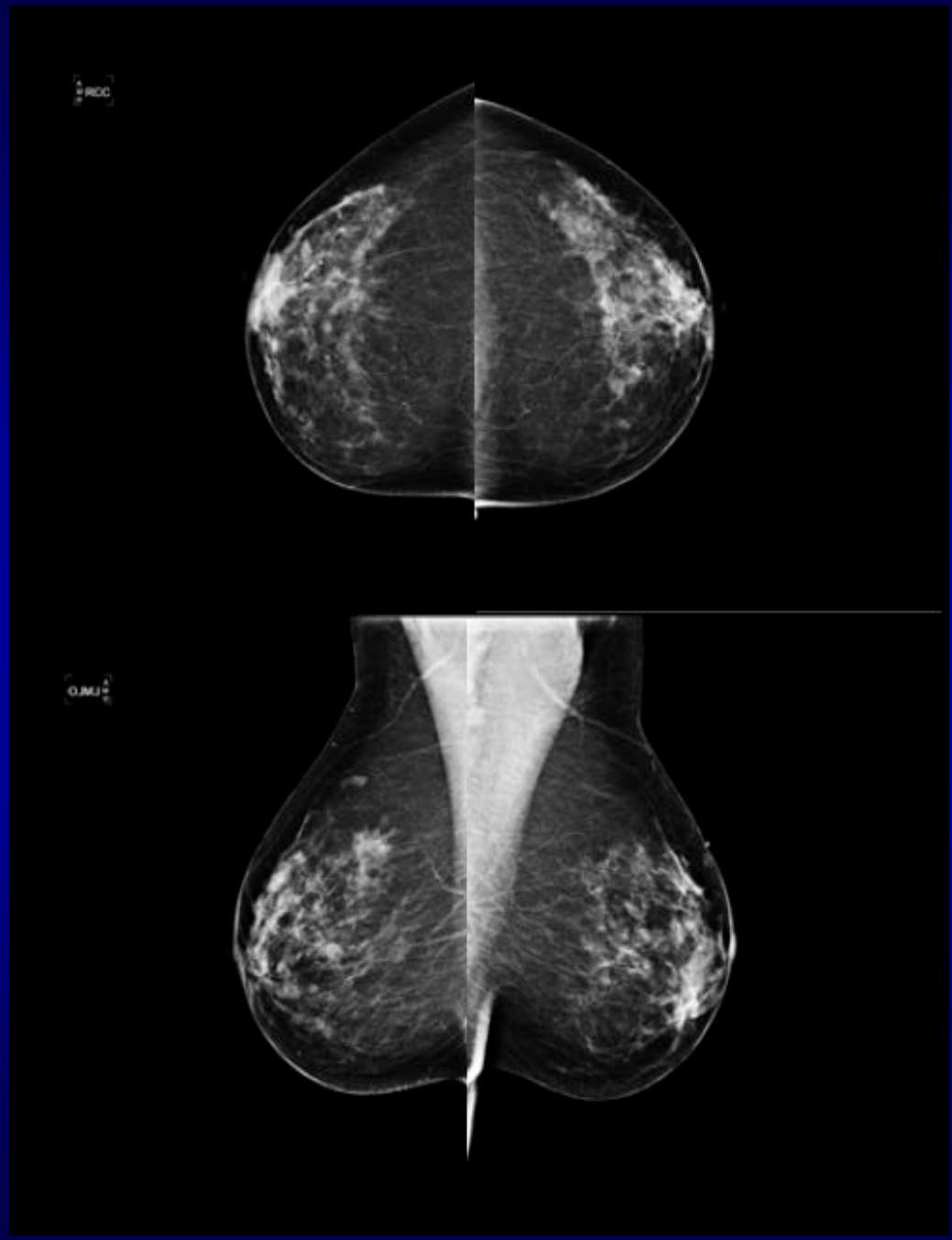




Carolyn Reynolds, IHE presentation

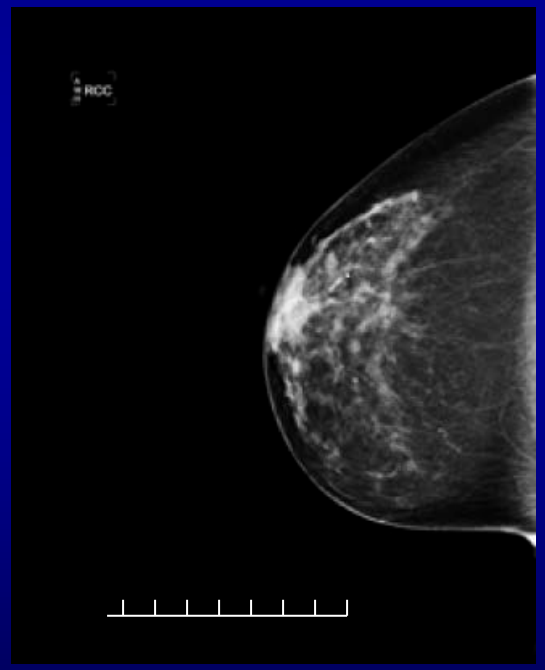
Recognizing tissue vs air

- Window / Level adjustments
  - Recognize skin line
  - Pad outside data to pre-determined value
- Maintain black air gap during window / level operations and inverted pixel data



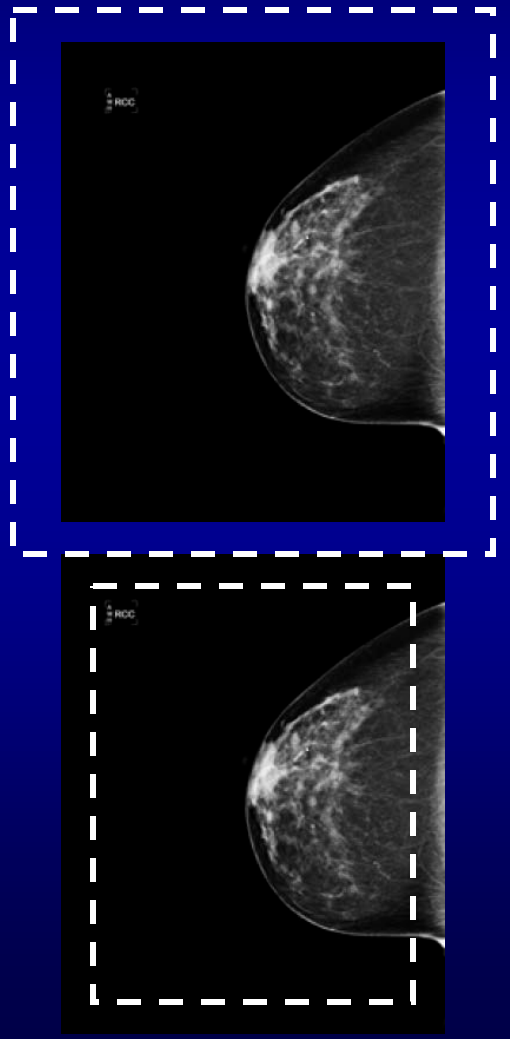
True size film printing

- Film size vs. detector size
- Precision with <2% error

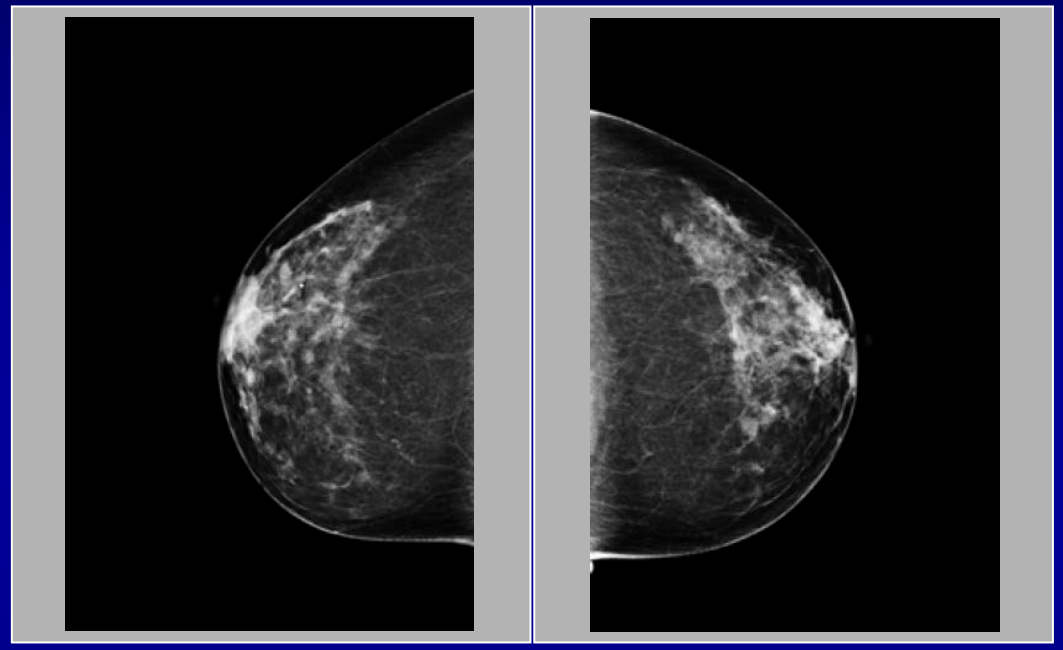


24 x 30 cm

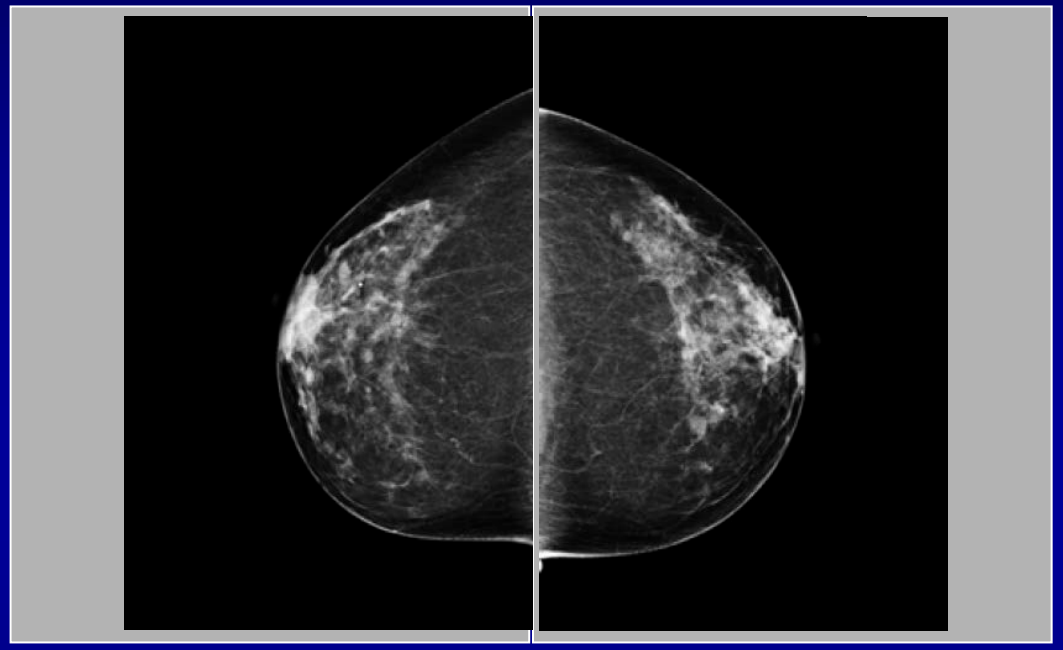
18 x 24 cm



Printing: minimal borders at chest wall



Centered images



Images offset on chest wall side:
Minimal borders

Mammography Image: Integration via IHE

- Meets desire to have multiple FFDM vendors, and use any vendor's workstation for diagnosis
- Ensures FFDM modalities provide adequate information for downstream applications
- Ensures systems support required data objects for interoperability
- Defines image display and printing operations for effective and efficient diagnosis

IHE profiles

Radiation Exposure Monitoring

Integrating the Healthcare Enterprise

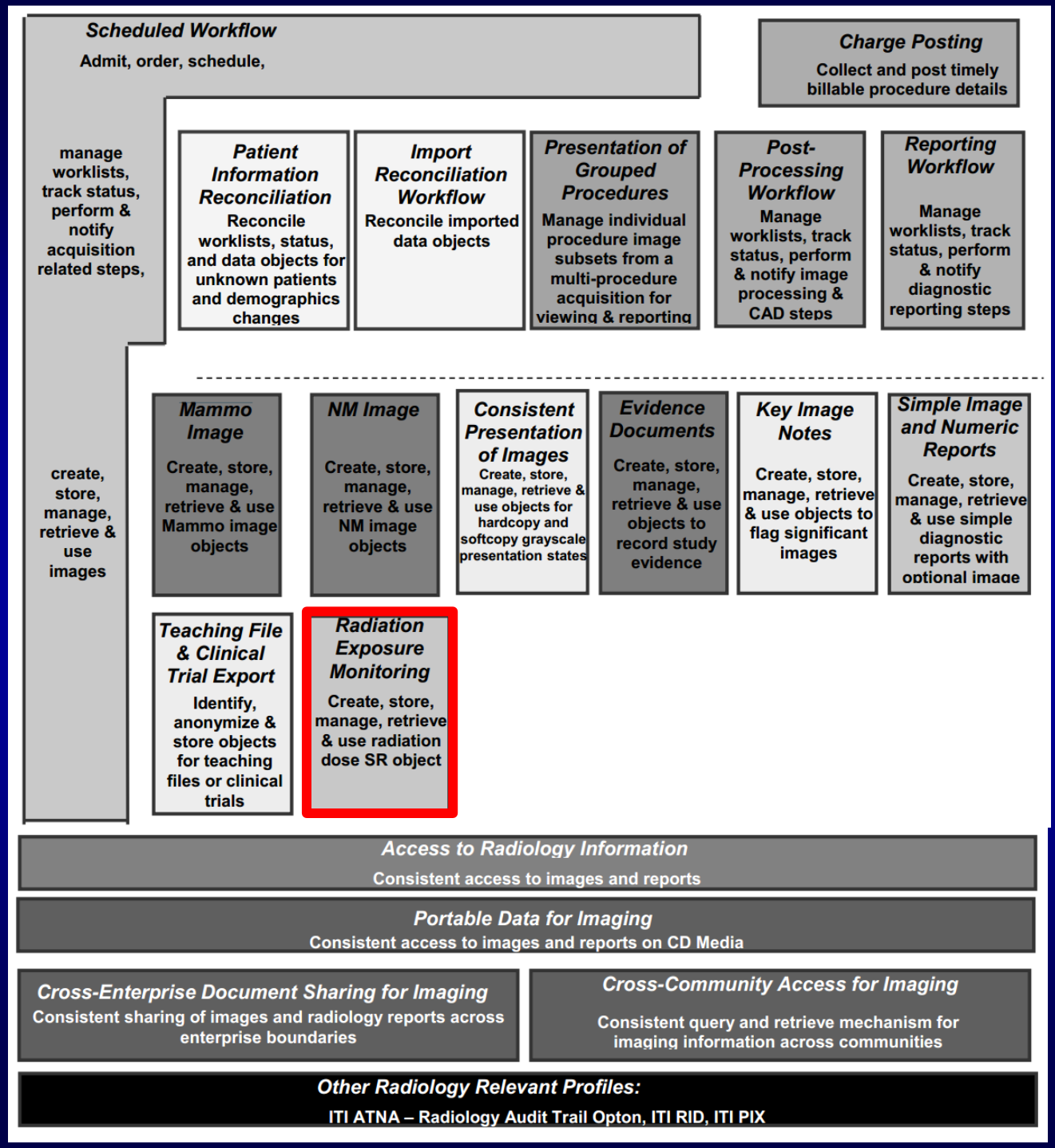
IHE

IHE Radiology (RAD) Technical Framework

Volume 1

IHE RAD TF-1

Integration Profiles



Radiation Exposure Monitoring

- Create, store, manage, retrieve, and use the DICOM Radiation Dose Structured Report object

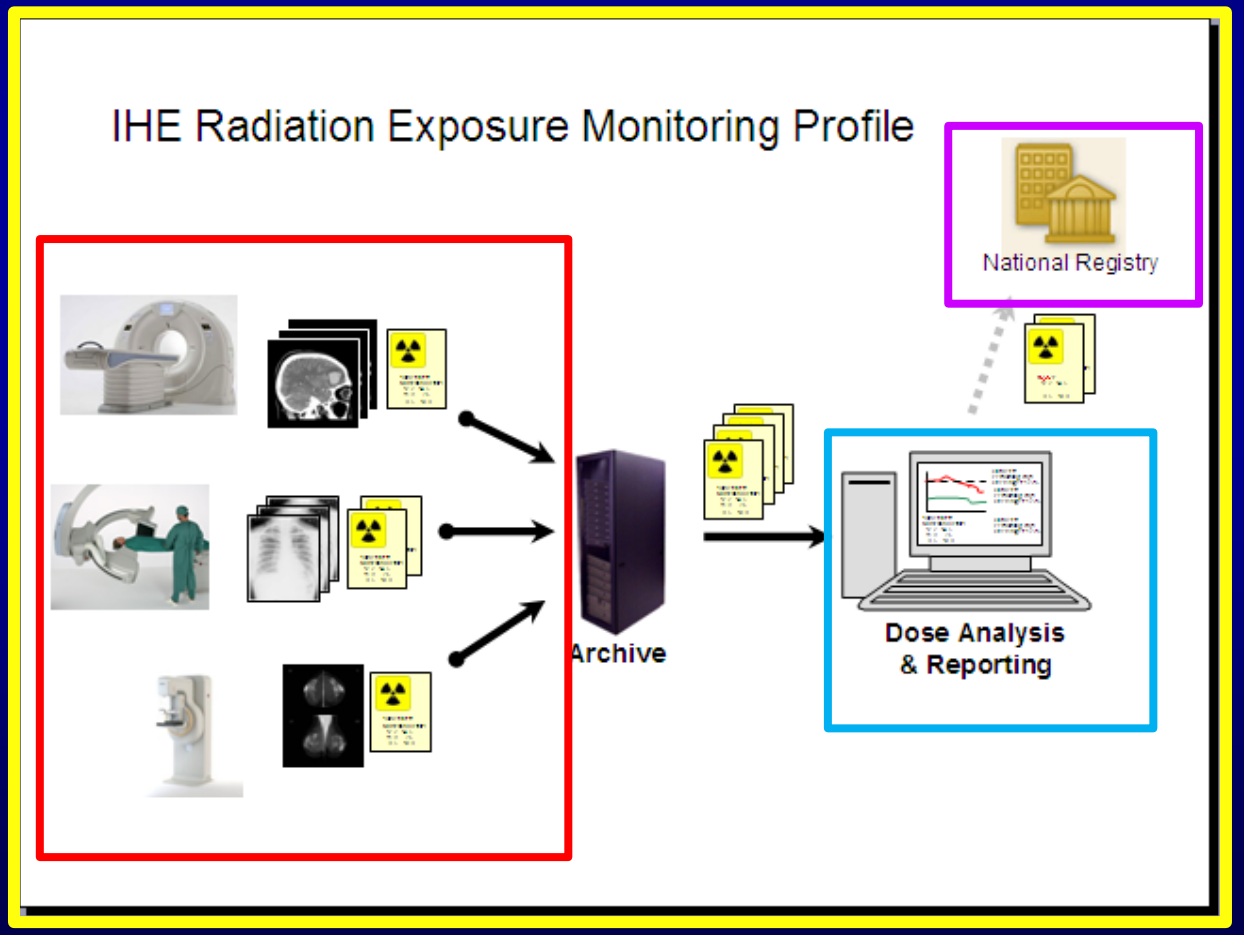
Radiation Exposure Monitoring (REM) – 2012

The profile allows dose information to be collected and evaluated without imposing a significant administrative burden on staff

The profile describes how radiation reporting systems can submit dose reports to centralized registries

The REM Profile requires imaging modalities to **export radiation exposure details in a standard format**

The radiation reporting system is expected to **perform relevant dose QA** analysis



Radiation Dose Structured Report (RDSR): IR example

x469

XA Neuro
IR CEREBRAL ANGIOPLASTY
Performed: /2014 5:57 PM
AXIOM-Artis IRMH 1627 Bi-PL

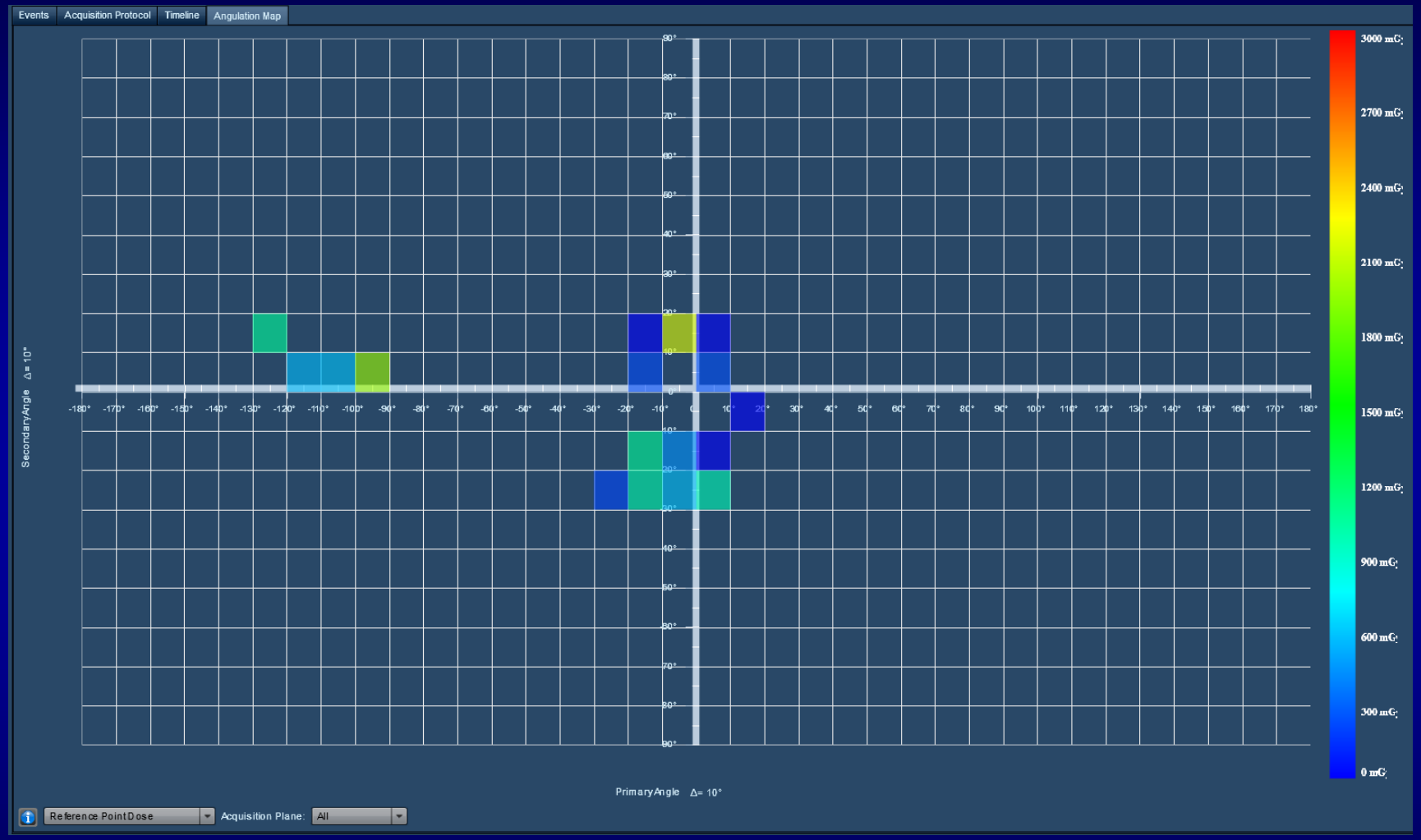
M DOB: Age at Exam: 29y

Dosimetry | Patient Protocols | RDSR | DICOM | Protocol | Logbook

PDF | Table

Type	Protocol	DAP [mGy-cm2]	Reference Point	Reference Point [	Beam On Time [n	kVp	mA	mAs	Start Time	Primary Angle [de	Secondary Angle	Fluoro Mode	Pulses per Secor	Number of Pulses	Pulse Width [ms]	Focal Spot Size [r	Distance Source	Distanc
Stationary Acquis	LICA	21809	15cm from Isocer	106.29	3537.3	75	159	562.43	2014-12-24 01:48	-117.8	5		4	39	90.7	0.3	1217	750
Stationary Acquis	LICA	20788	15cm from Isocer	172.59	3537.3	88	223	788.817	2014-12-24 01:48	-8.1	18.9		4	39	90.7	0.6	1200	750
Fluoroscopy	FL- Neuro	616	15cm from Isocer	5.11	3987.8	75	64.7	258.01	2014-12-24 01:47	-8.1	18.9	Pulsed	7.5	157	25.4	0.3	1200	750
Fluoroscopy	FL- Neuro	72	15cm from Isocer	0.35	527.1	70	47.6	25.089	2014-12-24 01:47	-117.8	5	Pulsed	7.5	21	25.1	0.3	1217	750
Fluoroscopy	FL- Neuro	97	15cm from Isocer	0.8	637.5	75	64.5	41.118	2014-12-24 01:47	-8.1	18.9	Pulsed	7.5	25	25.5	0.3	1200	750
Fluoroscopy	FL- Neuro	260	15cm from Isocer	1.33	2152.8	70	40.1	86.327	2014-12-24 01:46	-117.8	5	Pulsed	7.5	104	20.7	0.3	1217	750
Fluoroscopy	FL- Neuro	10	15cm from Isocer	0.33	301.2	71	65.5	19.728	2014-12-24 01:46	-117.8	5	Pulsed	7.5	12	25.1	0.3	1217	750
Fluoroscopy	FL- Neuro	613	15cm from Isocer	3.98	1447.8	75	64.7	93.672	2014-12-24 01:46	-14.3	18.9	Pulsed	7.5	57	25.4	0.3	1200	750
Fluoroscopy	FL- Neuro	425	15cm from Isocer	6.99	2358.5	90	64.7	152.594	2014-12-24 01:46	6.5	-25.6	Pulsed	7.5	89	26.5	0.3	1200	750
Fluoroscopy	FL- Neuro	240	15cm from Isocer	7.93	1569.4	104	64.6	101.383	2014-12-24 01:45	6.5	-25.6	Pulsed	7.5	59	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	738	15cm from Isocer	24.41	4867.8	104	64.6	314.459	2014-12-24 01:45	6.5	-25.6	Pulsed	7.5	183	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	204	15cm from Isocer	6.74	1330	104	64.5	85.785	2014-12-24 01:44	6.5	-25.6	Pulsed	7.5	50	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	335	15cm from Isocer	22.31	3005.8	115	64.5	193.874	2014-12-24 01:44	6.5	-25.6	Pulsed	7.5	113	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	439	15cm from Isocer	29.24	3990	115	64.5	257.355	2014-12-24 01:43	6.5	-25.6	Pulsed	7.5	150	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	712	15cm from Isocer	47.42	6384	115	64.6	412.406	2014-12-24 01:43	6.5	-25.6	Pulsed	7.5	240	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	1227	15cm from Isocer	81.69	11331.6	115	64.6	732.021	2014-12-24 01:42	6.5	-25.6	Pulsed	7.5	426	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	497	15cm from Isocer	8.17	2340.8	94	64.6	151.215	2014-12-24 01:41	5.3	-25.6	Pulsed	7.5	88	26.6	0.3	1200	750
Stationary Acquis	LICA	5934	15cm from Isocer	203.58	3174.5	99	199.3	632.677	2014-12-24 01:40	-117.8	5		4	36	90.7	0.6	1217	750
Stationary Acquis	LICA	12532	15cm from Isocer	205.97	3268.8	113	174.1	569.098	2014-12-24 01:40	5.3	-25.6		4	36	90.8	0.6	1200	750
Fluoroscopy	FL- Neuro	290	15cm from Isocer	4.76	1303.4	95	64.5	84.069	2014-12-24 01:40	5.3	-25.6	Pulsed	7.5	49	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	23	15cm from Isocer	1.25	180.6	84	65.5	11.829	2014-12-24 01:40	-117.8	5	Pulsed	7.5	7	25.8	0.3	1217	750
Fluoroscopy	FL- Neuro	83	15cm from Isocer	2.64	160.2	105	64.4	10.316	2014-12-24 01:39	5.3	-25.6	Pulsed	7.5	6	26.7	0.3	1200	750
Fluoroscopy	FL- Neuro	977	15cm from Isocer	65.07	7926.8	119	64.5	511.278	2014-12-24 01:39	5.3	-25.6	Pulsed	7.5	298	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	119	15cm from Isocer	7.93	961.2	119	64.4	61.901	2014-12-24 01:38	5.3	-25.6	Pulsed	7.5	36	26.7	0.3	1200	750
Fluoroscopy	FL- Neuro	62	15cm from Isocer	4.3	1703	86	65.6	111.716	2014-12-24 01:38	-117.8	5	Pulsed	7.5	65	26.2	0.3	1217	750
Fluoroscopy	FL- Neuro	1076	15cm from Isocer	71.63	8618.4	119	64.5	555.886	2014-12-24 01:37	5.3	-25.6	Pulsed	7.5	324	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	202	15cm from Isocer	13.98	5554.4	86	65.5	363.813	2014-12-24 01:37	-117.8	5	Pulsed	7.5	212	26.2	0.3	1217	750
Fluoroscopy	FL- Neuro	41	15cm from Isocer	2.82	348.4	119	64.1	22.332	2014-12-24 01:37	5.3	-25.6	Pulsed	7.5	13	26.8	0.3	1200	750
Fluoroscopy	FL- Neuro	378	15cm from Isocer	24.28	2899.4	118	64.5	187.011	2014-12-24 01:34	5.3	-25.6	Pulsed	7.5	109	26.6	0.3	1200	750
Fluoroscopy	FL- Neuro	50	15cm from Isocer	3.49	1414.8	85	65.5	92.669	2014-12-24 01:34	-117.8	5	Pulsed	7.5	54	26.2	0.3	1217	750
Fluoroscopy	FL- Neuro	27	15cm from Isocer	0.93	502	80	65.5	32.881	2014-12-24 01:34	-117.8	5	Pulsed	7.5	20	25.1	0.3	1217	750
Fluoroscopy	FL- Neuro	190	15cm from Isocer	6.28	1121.4	107	64.5	72.33	2014-12-24 01:34	5.3	-25.6	Pulsed	7.5	42	26.7	0.3	1200	750
Fluoroscopy	FL- Neuro	510	15cm from Isocer	16.86	3005.8	107	64.5	193.874	2014-12-24 01:31	5.3	-25.6	Pulsed	7.5	113	26.6	0.3	1200	750
Stationary Acquis	LICA	5873	15cm from Isocer	201.47	3080.4	102	193.7	596.673	2014-12-24 01:30	-117.8	5		4	34	90.6	0.6	1217	750
Stationary Acquis	LICA	6651	15cm from Isocer	219.88	3400	125	146.4	497.76	2014-12-24 01:30	5.3	-25.6		4	34	100	0.6	1200	750
Fluoroscopy	FL- Neuro	173	15cm from Isocer	8.55	507.3	114	64.5	32.72	2014-12-24 01:29	5.3	-25.6	Pulsed	7.5	19	26.7	0.3	1200	750

Angulation map



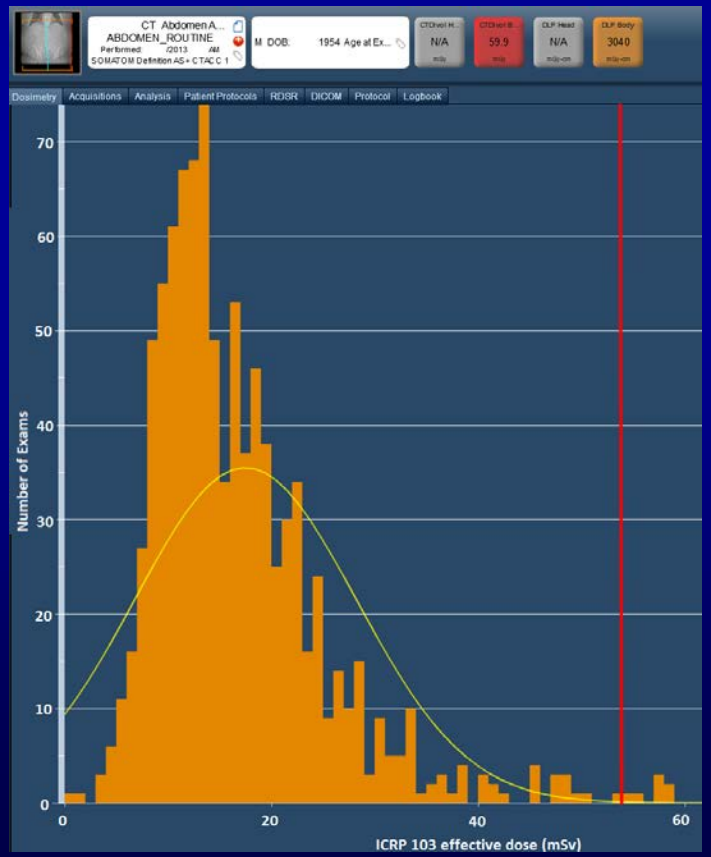
- Reference point: 11007 mGy
- Largest dose by position: 2200 mGy

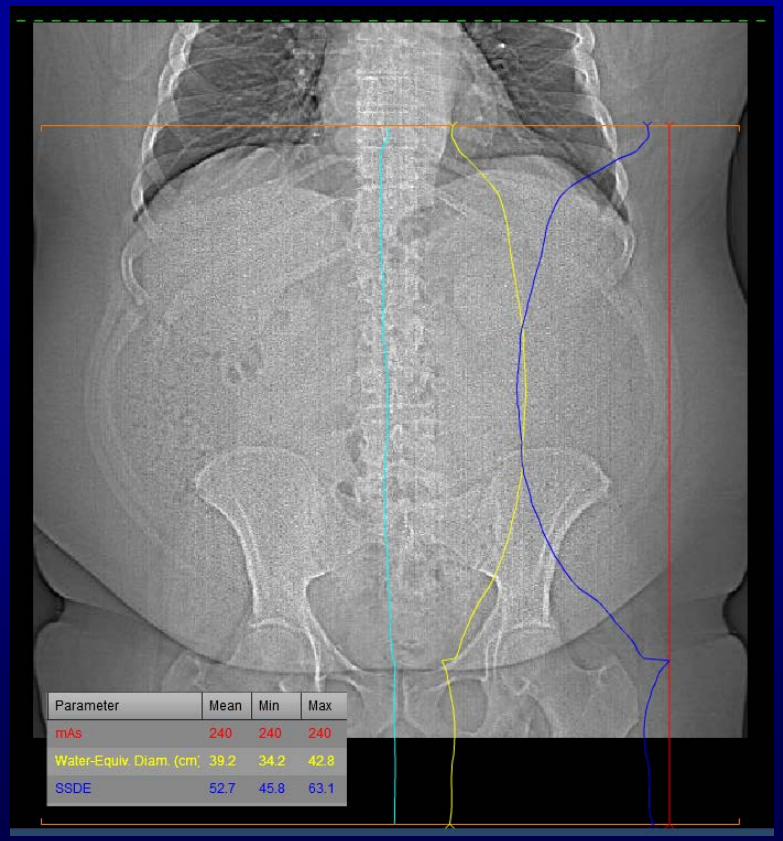
Radiation Dose *metrics*

- Modalities:
  - **Computed Tomography**
    - CTDIvol & DLP
  - **Interventional Radiology, Cardiology & Fluoroscopy**
    - DAP, RP AK, kV – mAs, geometry tracking
  - **Radiography**
    - Exposure index, Deviation Index: IEC 62494-1
  - **Mammography**
    - Average Glandular Dose, Incident dose, Compression

Increased radiation dose awareness

- Access to radiation dose software
- Identification of high-dose studies (why?)
- Provision of patient-specific dose metrics





The IHE REM profile

- Addresses the efficient collection and distribution of dose information, but is *just a tool*…..
- Profile removes data collection and management burdens
- ….. But it is up to the site to put the information to use

IHE Radiology: expanding applications and implemenations

Current technical framework

- Radiology Scheduled Workflow (SWF)
- Patient Information Reconciliation (PIR)
- Consistent Presentation of Images (CPI)
- Presentation of Grouped Procedures (PGP)
- Access to Radiology Information (ARI)
- Key Image Note (KIN)
- Simple Image and Numeric Report (SINR)
- Charge Posting (CHG)
- Post-processing Workflow (PWF)
- Reporting Workflow (RWF)
- Evidence Documents (ED)
- Portable Data for Imaging (PDI)
- Nuclear Medicine Image
- Cross-enterprise Document Sharing for Imaging (XDS-I)
- Mammography Image
- Import Reconciliation Workflow (IRWF)
- Teaching File and Clinical Trial Export (TCE)
- Radiation Exposure Monitoring (REM) - Added 2012-07-24
- Cross-Enterprise Document Sharing for Imaging (XDS-I.b) - Added 2012-07-24
- Cross-Community Access for Imaging (XCA-I) - Added 2013-09-16
- Imaging Object Change Management (IOCM) - Added 2014-07-30

Supplements for Trial Implementation

- Basic Image Review (BIR) - Revised 2012-07-24
- Chest X-Ray CAD Display (CXCAD) - Published 2010-06-17
- Clinical Decision Support Order Appropriateness Tracking (CDS-OAT) - Published 2015-06-12
- Cross-Enterprise Document Reliable Interchange of Images (XDR-I) - Revised 2014-07-30
- CT/MR Perfusion Imaging with Contrast (PERF) - Revised 2015-04-21
- Digital Breast Tomosynthesis (DBT) - Revised 2015-04-21
- Extensions to the Portable Data for Imaging (PDI) Integration Profile - Published 2009-21-06
- Image Fusion (FUS) Integration Profile - Published 2006-04-13
- Imaging Object Change Management Extension (IOCM Extension) - Revised 2015-04-21
- Import Reconciliation Workflow (IRWF.b) - Published 2012-06-15
- Invoke Image Display (IID) - Revised 2015-04-21
- Mammography Acquisition Workflow (MAWF) - Revised 2010-11-16
- Management of Radiology Report Templates (MRRT) Revised 2015-04-21
- Mobile Access to Health Documents for Imaging (MHD-I) - Published 2014-05-30
- MR Diffusion Imaging (DIFF) - Published 2009-06-21
- Multiple Image Manager/Archive (MIMA) - Revised 2012-07-24
- Nuclear Medicine Image Integration Profile (NMI) with Cardiac Option - Published 2007-05-17
- Post-Acquisition Workflow (PAWF) - Published 2012-06-15
- Radiation Exposure Monitoring for Nuclear Medicine (REM-NM) - Published 2016-04-22
- Radiology Remote Reading Workflow (RRR-WF) - Published 2015-12-14
- Scheduled Workflow.b (SWF.b) - Revised 2015-07-24
- Stereotactic Mammography Image (SMI) - Published 2013-06-11
- Web-based Image Capture (WIC) - Published 2015-04-21

IHE-RO

- Radiation Oncology implementations
- Uniquely applied to interoperability challenges in management of RO operations and workflow
- Detailed overview in the subsequent presentations

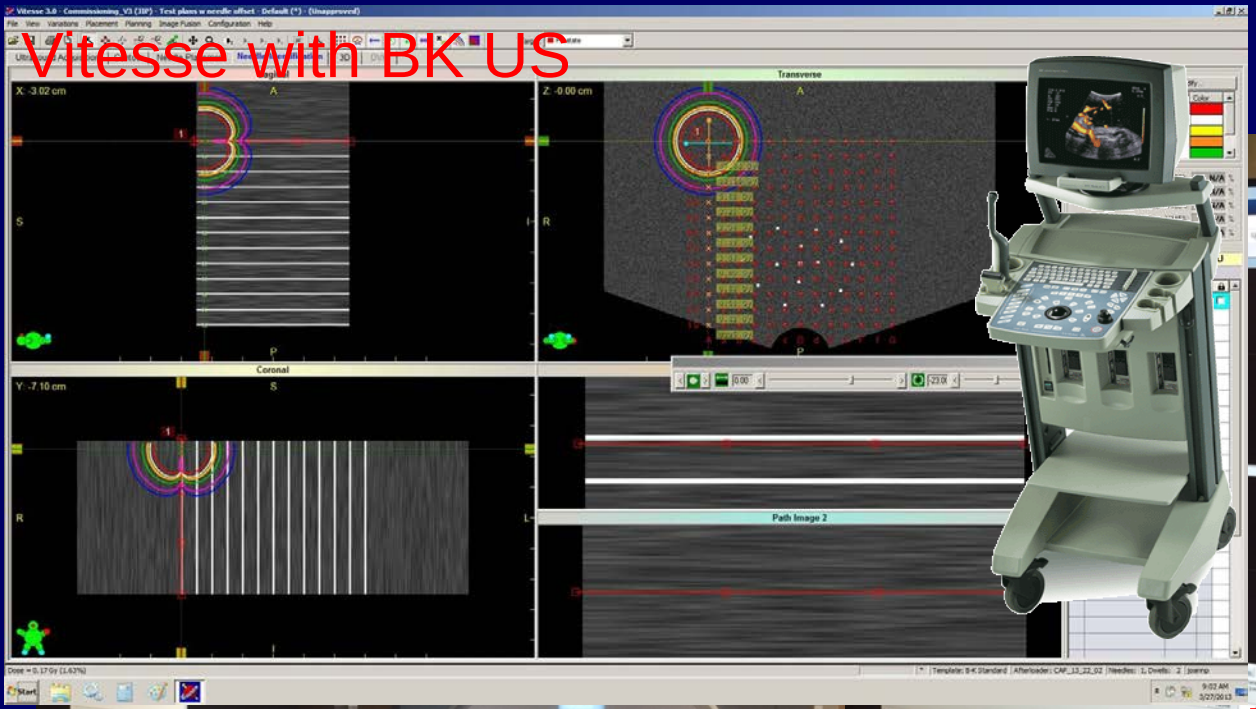
Summary

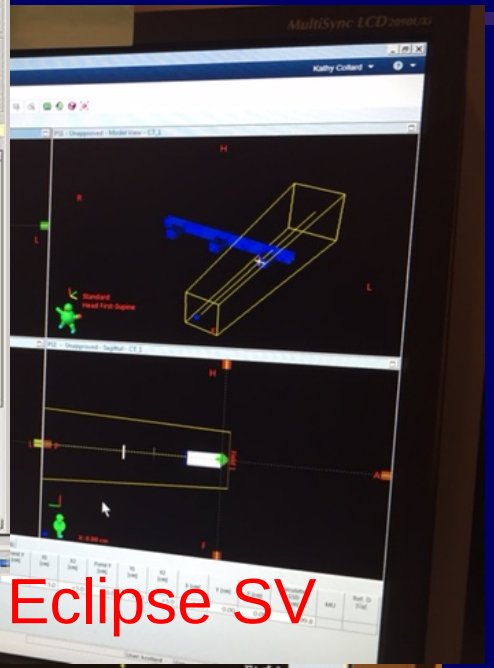
- From limited expectations & planned extinction, IHE is expanding and evolving to solve critical clinical interoperability needs
- IHE defines Integration Profiles that use standards to solve interoperability problems
- The Technical Framework contains the Integration Profiles that have gone through the validation (connectathon) process
- Specifying IHE Integration Profiles in RFPs ensures compatibility and functionality for given tasks and interoperability

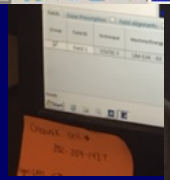
IHE For Radiation Oncology IHE-RO

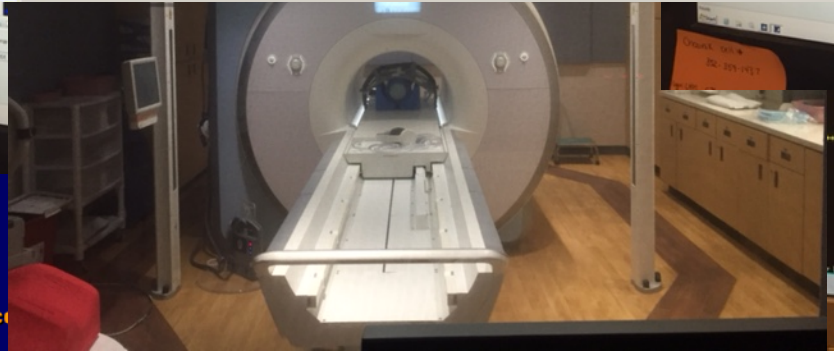
Scott W. Hadley PhD

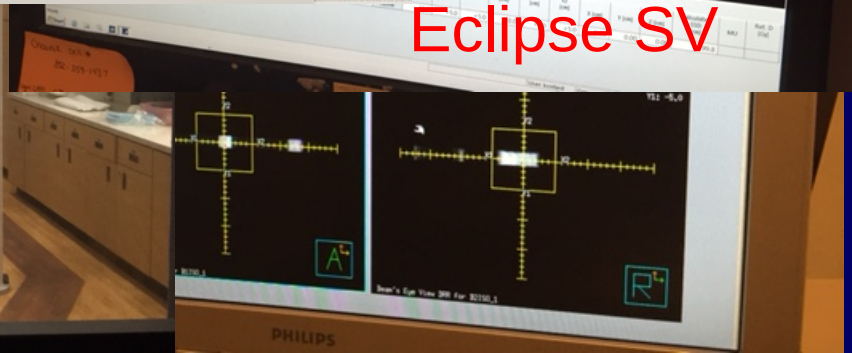
The Department of Radiation Oncology
University of Michigan











Radiation Onc

Epic

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Why is IHE-RO Important?

- ASTRO's 6-point patient protection plan
  - 5) Further developing our Integrating the Healthcare Enterprise – Radiation Oncology (IHE-RO) connectivity compliance program to ensure that medical technologies from different manufacturers can safely transfer information to reduce the chance of a medical error.
- Promotes discussion and correction of protocols / standards for data communication to improve the reliability and safety of data exchange in radiation oncology
- Provides a mechanism for inter-manufacturer testing of radiation oncology products prior to delivery
  - Domain Pre-testing
  - Connectathon

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IHE RO Organization ASTRO sponsored and AAPM supported

- Task Force Co-Charis
  - Dick Fraass Ph.D FAAPM, FASTRO, FACR Cedars-Sinai
  - John Buatti MD University of Iowa
- Planning Committee
  - Alf Sicochi Ph.D. West Virginia University
  - Mark Pepelea, Philips Healthcare
  - Bridget Koontz, Duke University Medical Center
- Steering Committee – Various and Sundry MDs and PhD
- Technical Committee
  - Scott Hadley Ph.D. University of Michigan
  - Chris Pauer, Sun Nuclear

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IHE RO alphabet soup

- BRTO – Basic RadioTherapy Object
  - Simulation, set iso/fields, calculated dose, delivery
- ARTI – Advanced RT Integration
  - 3DCRT, IMRT, Dynamic Wedge, Arc, VMAT, …
- MMRO – MultiModality image registration for RO
  - CT to CT, CT to MRI, Exchange of contours, Dose Display
- TDW – Treatment Delivery Workflow
  - Exchange of Plan to/from Device and Treatment Management System

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Imaging Tec
Melinda Tasch

7 Planning Systems

- IMRT
- SRS
- Brachy
- Irr'g Fields
- Conf' Arc
- Adaptive Planning
- Img' Registration
- Multi' Image Support
- TMS Integration

Radiation Oncology

Photon algorithms	Ray-Tracing and Monte Carlo	Convolution Superposition
Electron algorithms	N/A	N/A
Proton algorithms	N/A	N/A
Dosimetric portal image calculation (Can the system calculate an expected dose distribution at the plane of an electronic portal imaging device?)	N/A	N/A
Framework / architecture	Robotic	Ring gantry
BEAM DATA CONFIGURATION		
Electronic approval	Yes	N/A
Analysis tools	Yes	Yes
Physics table output	Yes	N/A
INTERFACES / INTEGRATION		
DICOM RT objects supported	RTImage, RTSSet, RTDose	RTImage, RTSSet, RTDose
RTOG / ATC DICOM compliance	Yes	Yes
Information systems supported	Aria, Mosaiq	Aria, Mosaiq
Other features	Planning and delivery systems fully integrated, sharing a common database	Beam data comes pre-installed with the sys for TomoHelical and direct modes

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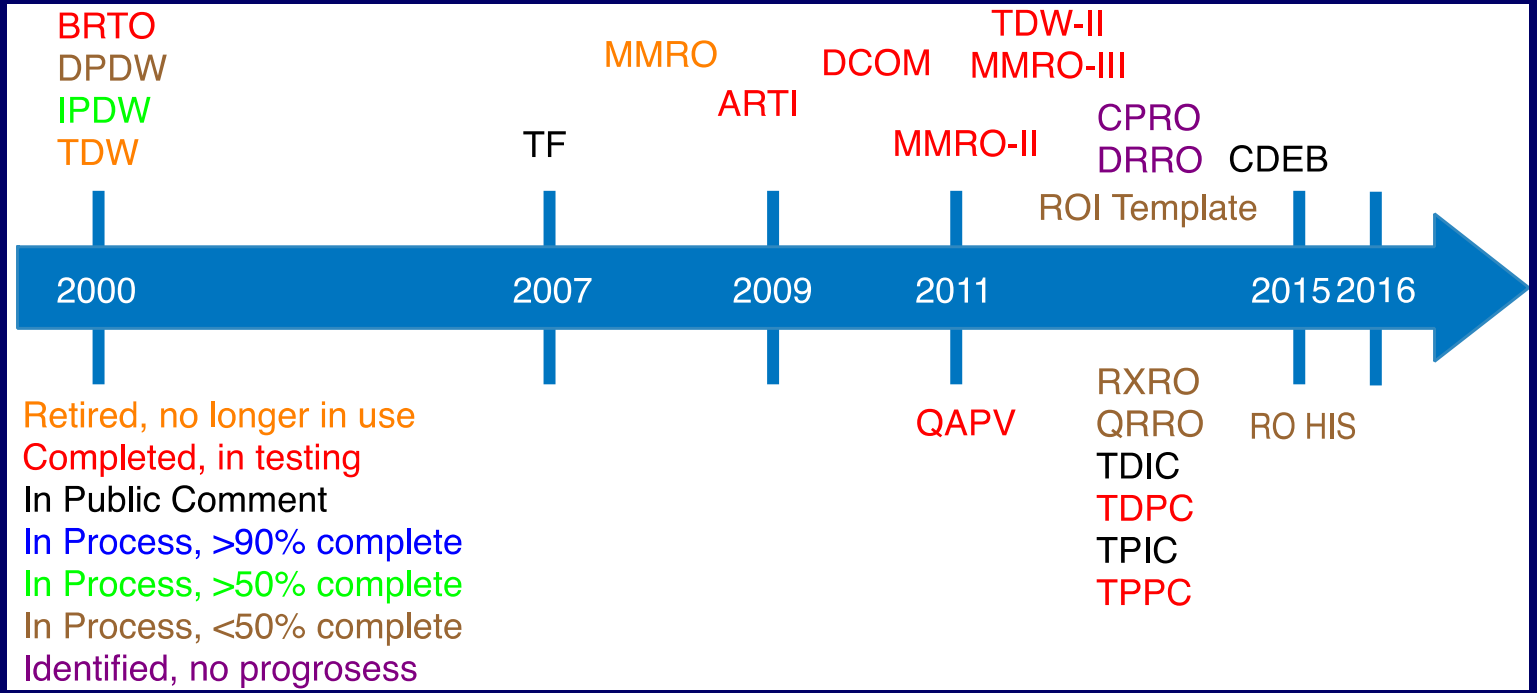
IHE RO Timeline



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What are the Standards?

- DICOM (Digital Imaging and Communications in Medicine)
  - DICOM is a standard for handling, storing, printing, and transmitting information in medical imaging.
  - DICOM enables the integration of scanners, servers, workstations, printers, and network hardware from multiple manufacturers
  - http://medical.nema.org
- HL7 (Health Level 7)
  - HL7 is an international community of healthcare subject matter experts and information scientists collaborating to create standards for the exchange, management and integration of electronic healthcare information.
  - HL7 promotes the use of such standards within and among healthcare organizations to increase the effectiveness and efficiency of healthcare delivery for the benefit of all.
  - http://www.HL7.org

Parts from http://www.wikipedia.org

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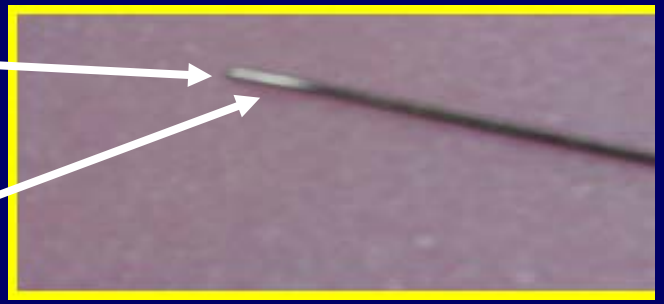
Real TC Example

- The abbreviation ”SSD” stands for?
  - Source to SKIN distance?
  - Source to SURFACE distance?
- HDR source position refers to which of the following?

Tip of the Wire?

Middle of Active Source?



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Profile Life Cycle

- Idea submission from
  - IHE RO members PC, SC, TC
  - Draft Clinical use cases & Impact Statements
  - Ranked in terms of importance and prioritized
- TC investigates and determines
  - Available standard for implementation
  - Possible technical issues with profile

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Profile Life Cycle

- TC Drafting Phase
  - Profile has champion from vendor to do major drafting
  - Drafting happens off line as well as at Face to Face meetings of TC
  - Possible to send “CP”s Change Proposals back to DICOM
- TC Final Draft
  - Sent to IHE for Public Comment phase
- Trial Implementation
- Final, Available for Connectathon Testing
- Deprecation when replaced

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What happens after the Connectathon?

- Successful results (specific by IHE profile/actor) are published by the sponsors (www.ihe.net/connectahons)
  - Found on ASTRO website
- Vendors self-certify, by publishing *IHE Integration Statements*: Precise and explicit public interoperability commitment fro a specific commercial product.
  - Found on vendor website or ask for copy with RFP

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ARTI Clinical Impact Statement

"How will this get me home 20 minutes earlier" – Dick Fraass

Clinical Impact:

This profile describes the accepted way to export external beam plans delivered on a linac. Where there has been ambiguity in defining plan data at each point in the delivery, this profile defines one way to report it – for example, motorized wedge monitor units, electron field sizes and dynamically arc beams. The goal of this profile is to be able to intercommunicate. An individual reading this profile should be able to identify the required elements of such an export for a specific type of plan.

The profile also demands that the user can display the original plan content on the receiving system and thus allow the user to compare the original data to the receiving system's internal, working version of the plan. This can serve as an auditing tool if information doesn't match up after a data transfer. This profile facilitates this by specifying the mandatory, minimally available data for comparison of plans. This allows the user to see the original plan content so that it is readable not just in DICOM format.

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RXRO "Prescription" Use Cases

- HIS/EMR Draft of MD Intent
  - Transfer to OIS
  - OIS updates Rx after simulation
  - Planning system pick up Rx from OIS
  - Plan is produced and updated Rx sent to OIS/HIS/EMR
- Context Specific Displays of information
  - "Simple" display for Tx Delivery
  - "Full" information for planning and review

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IHE Integration Statement

IHE Integration Statement			
Vendor	**Product Name**	**Version**	**Date (dd/mm/yyyy)**
Big Medical Buisness	RIS2003	3.4	15/10/2003
Integration Profiles Implemented	**Actors Implemented**	**Options Implemented**	
Scheduled Workflow	Department System Scheduler/Order Filler	None	
Scheduled Workflow	Performed Procedure Step Manager	None	
Patient Information Reconciliation	Department System Scheduler/Order Filler	None	
Internet address for vendor's IHE information :			
http://www.big-buisness.com			
Links to Standards Conformance Statements for the implementation			
Health Level 7	http://www.big-buisness.com/HL7		
Dicom	http://www.big-buisness.com/DICOM		
Links to general information on IHE			
In North America: http://www.rsna.org/IHE	In Europe: http://www.ihe-europe.org	In Japan: http://www.jira-net.or.jp/ihe-j	

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RFP Language Example

Vendor shall:

1. Provide AMC with DICOM conformance statements for the DICOM components of the System.
2. Vendor shall provide an IHE integration statement for the System, which explicitly identifies which IHE Actor or Actors, as defined by the IHE Technical Frameworks, System implements.
3. Warrant that the System, as quoted and configured in this Agreement shall, at a minimum, and at no further cost to AMC, implement all the transactions of all the IHE integration profiles in which the Actor or Actors specified in paragraph 2 above are defined. System shall also implement all of the options of each profile such that deployment of the optional components of IHE integration profiles shall be at the sole discretion of AMC.
4. Provide a timeline for the implementation of integration profiles required in paragraph 3 above, but which are not yet available. XXX percent of payment for System shall be retained by AMC until such time as requirements of paragraph 3 are completed
5. Insure that no 'protected health information' as defined by the Health Insurance Portability and Accountability Act (HIPAA), is 'burned in' to image pixels. All such information MUST be presented as DICOM group 6000 overlays or as gray scale presentation states, such that this information may be removed from display by downstream information systems. Any device which does not comply with this requirement must use DICOM group 0028, Element 0301 (Burned In Annotation)

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IHE RO Website

http://www.ihe-ro.org/

↓ Name	ID	State	Started	Document	Doc Version	Clinical Impact	Profile Proposal	Profile Overview	Main
Advanced RT Objects Interoperability	ARTI	Final Text	2004	ARTI Supplement v1.6 ARTI Spreadsheet v1.4	1.6	ARTI Clinical Impact Statement	ARTI Proposal	Advanced RT Objects Interoperability	Bruce
Basic RT Objects Interoperability	BRTO	Published in Technical Framework	2004	Volume 1, Volume 2 *CP for High-resolution contours(draft)*	1.8	BRTO Clinical Impact Statement	Normal Treatment Planning-Simple	Basic_Radiation_Therapy_Objects	Bruce
Basic RT Objects Interoperability II	BRTO-II	In Public Comment, planned review in June 2016	2015	BRTO-II Rev 1.1	1.1	BRTO-II Clinical Impact Statement	Fix Me!	Fix Me!	Sven Siekm
Consistent Dose for External Beam	CDEB	Voted Pulbic Comment May 2016	2014	CDEB 1.8	1.8	Fix Me!	Fix Me!	Fix Me!	Chris
Consistent	CPRO	Draft	2013	Fix Me!		CPRO	Fix Me!	Fix Me!	user

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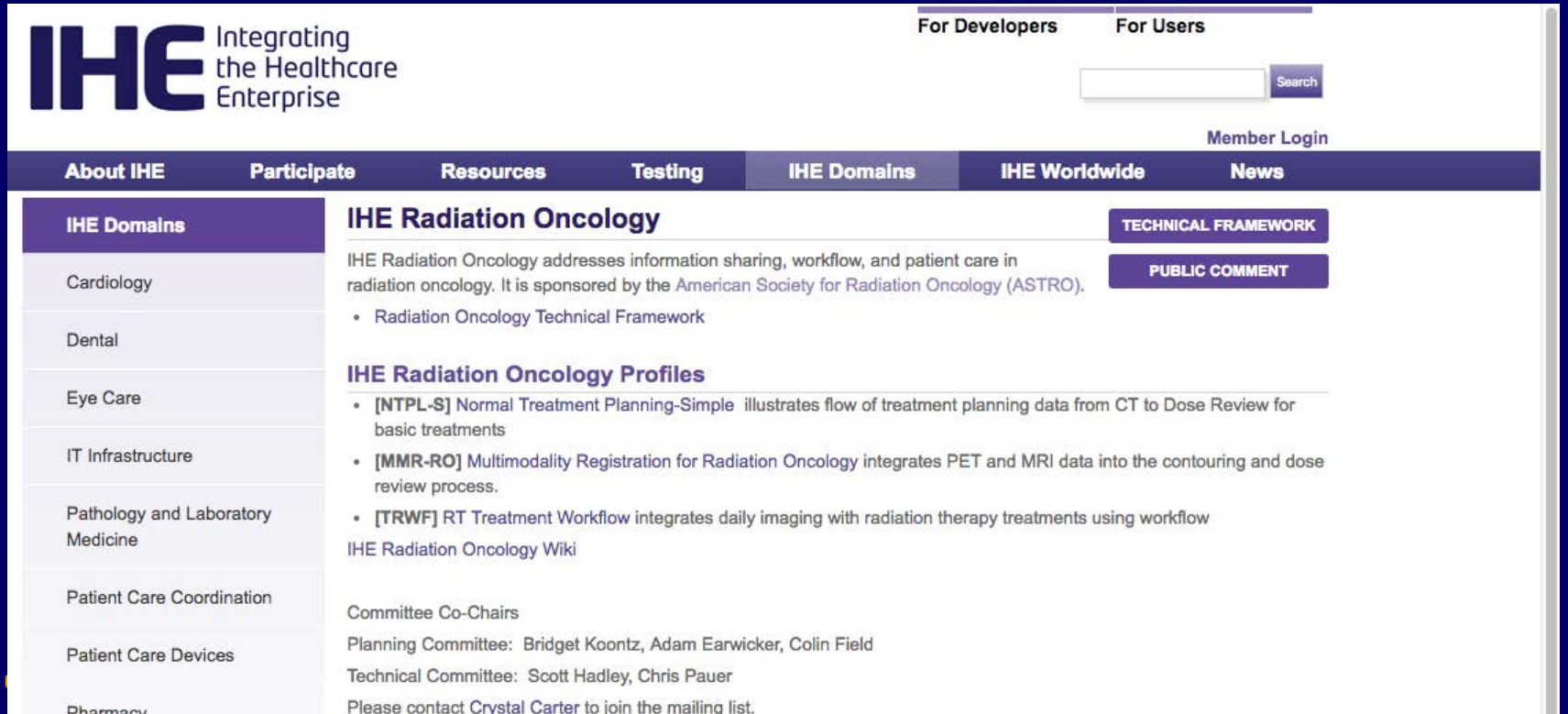
IHE Website

http://www.ihe.net/Radiation_Oncology/



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ASTRO Website

https://www.astro.org/IHE-RO.aspx

Products that have passed the IHE-RO testing process

The following products have passed integration tests.* Access either an "Integration Statement" or a vendor developed statement that you can use for your RFPs below.

Accuray

TomoHD (2010)

BrainLab

RT Elements 1.0 (2015)
iPlanRT Dose 4.5.4 (2015)
iPlanRT Dose 4.5 (2010)
iPlan RT Image 4.0 (2008)

ELEKTA

MOSAIQ Data Director (MDD) (2010)
MOSAIQ Oncology PACS (2008)
MOSAIQ Oncology PACS (2007)

Integrating the Healthcare Enterprise: Connectathons and Testing

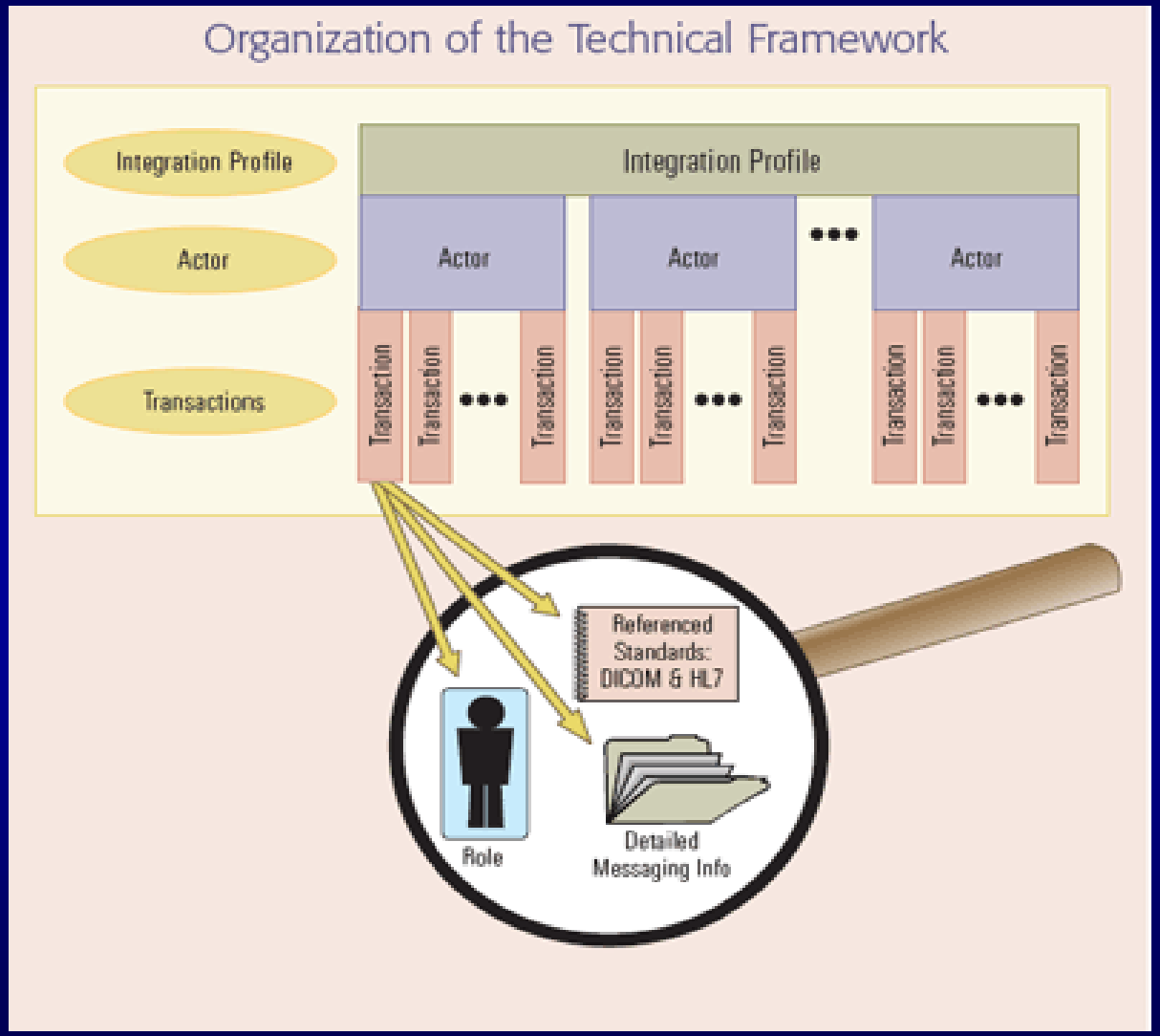
W.R. Bosch, D.Sc.
Department of Radiation Oncology
Washington University in St. Louis
IHE-RO Test Manager

Washington University in St. Louis
School of Medicine

IHE Process

1. **Define** a clinical use case involving connectivity.
2. **Create** Integration Profiles to specify how existing data standards are to be used for solve clinical problems.
3. **Test** the adherence of clinical systems to Profile specifications.
4. **Publish** results to assist users in selecting interoperable systems.

IHE Testing



IHE Testing is based on specifications laid out in the Technical Framework

Vendors register to test products as one or more Actor(s) within an Integration Profile.

Adherence is tested by demonstrating

1. Behavior (input, output, display) conforms to requirements for each “Transaction”.
2. Successful exchange of clinical information with other vendors’ products playing the role of other Actors in the Profile.

What is a Connectathon?

Cross-vendor, live, supervised, structured test event

- All participating vendors' products tested together in the same place/time.
- Experts from each vendor available for immediate problem resolution… fixes are often done in minutes, not months!!
- Each vendor tests with multiple trading partners (actual product to product).
- Testing of real-world clinical scenarios with IHE Integration Profiles.
- Supervised by test monitors, i.e. "judges".

Connectathons

- IHE NA Connectathon (annual since 1999)
  - Radiology and 9 other domains
  - >100 vendors, >550 engineers
  - Cleveland Convention Center
  - January 23-27, 2017

- IHE-RO Connectathon (since 2007)
  - Radiation Oncology Domain
  - 5-8 vendors
  - Philips, Madison, WI
  - October 17-21, 2016

IHE-RO Connectathon

- Annual, week-long event
  - ½ day setup
  - ½ day cleanup
- Hosted at ASTRO HQ, vendor facilities, and academic centers
- Supervised, informal test events ("Domain Pre-Testing") have also been held between connectathons.

IHE-RO Connectathon Venues

Year	Connectathon	Domain Pre-Testing
2006		ASTRO, Fairfax, VA
2007	ASTRO HQ, Fairfax, VA	
2008	MD Anderson, Houston, TX	Brainlab, Munich, Germany
2009	ASTRO HQ, Fairfax, VA	Siemens, Erlangen, Germany
2010	ASTRO HQ, Fairfax, VA	Fundación Iavante, Granada, Spain
2011	ASTRO HQ, Fairfax, VA	Elekta, Stockholm, Sweden
2012	ASTRO HQ, Fairfax, VA	Washington Univ., St. Louis, MO
2013	ASTRO HQ, Fairfax, VA	Brainlab, Munich, Germany
2014	ASTRO HQ, Fairfax, VA	Varian, Zug, Switzerland *
2015	Sun Nuclear, Melbourne, FL	Raysearch, Stockholm, Sweden *
2016	Philips, Madison, WI	

* Included formal testing

IHE-RO Test Process

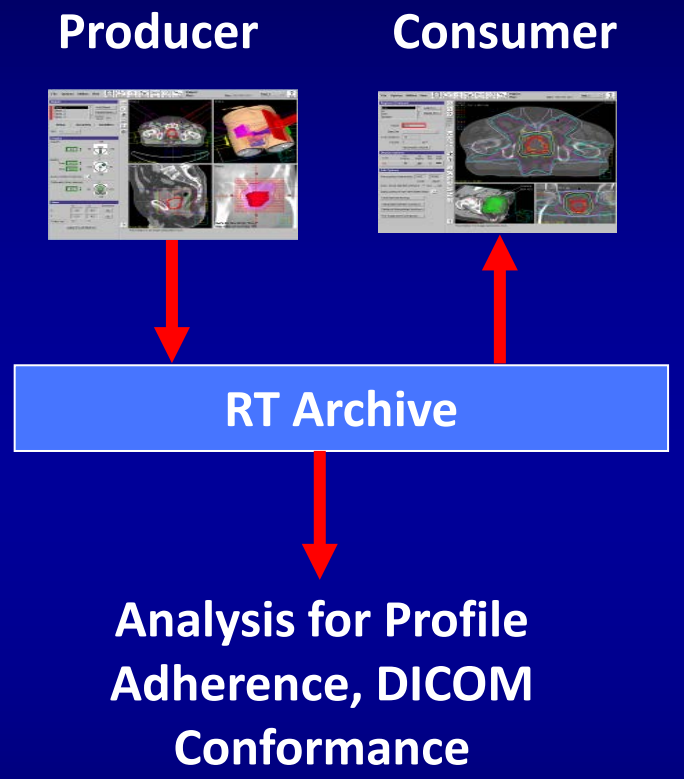
- IHE-RO judges select test cases and provide instructions for participants to interact with multiple test partners.
- Adherence to a profile is demonstrated for each Actor by successful transactions with
  - 3+ upstream Actors
  - 3+ downstream Actors

Connectathon Judges

- Volunteers (clinical physicists and physicians) who assist in testing adherence of products to IHE-RO Profiles.
- Assist vendors in creating meaningful test data.
  - The purpose of testing is NOT to see which product is “best”.
  - Want test data and plans to be as clinically relevant as practical.
- Compare data displayed by “producer” and “consumer” Actors
  - Side-by-side comparison of product displays.
  - Assure consistent interpretation of information in both products.

Test Archive

- A DICOM ARCHIVE is used to store
  - Initial test datasets
  - Output data from “Producer” Actors
  - Input data for “Consumer” Actors
- Initial test dataset
  - Starting data for the first Actor in a Profile
  - Stored in the Archive before testing begins
  - Each vendor starts with their own test dataset instance (Patient ID with vendor code)
- Data produced by Profile Actors can be retrieved for troubleshooting and analysis by judges.
- The Archive is supplied and operated by a vendor volunteer.



Advanced RT Integration Profile

- Exchange of treatment plan content (DICOM RT Plan)
  - **Producer** (TPS)
  - **Consumer** (TPS/TMS)
- Constraints on plan content are specified for each of 14 *beam techniques*:

Basic Static Beam	Virtual Wedge Beam
Static MLC Beam	Static Electron Beam
Arc Beam	Step & Shoot Beam
MLC Arc Beam	Sliding Window Beam
Conformal Arc Beam	IMAT/VMAT Beam
Hard Wedge Beam	Stereotactic Beam
Motorized Wedge Beam	Stereotactic Arc Beam

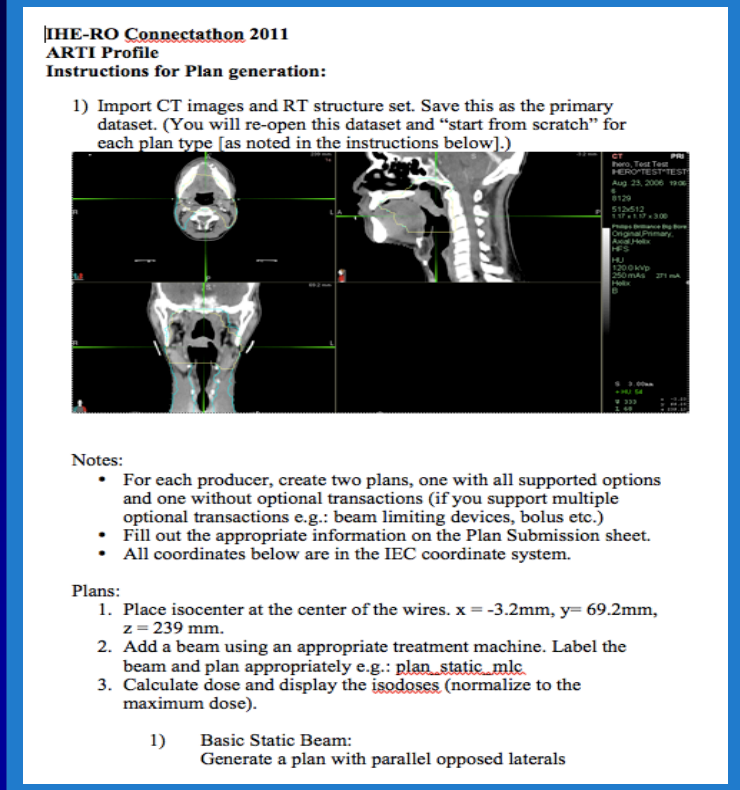
Advanced RT Integration Profile Constraints

'PES & NOTES - BY BEAM TECHNIQUE ARTI ACTOR

ARTI-Odd # Storage/Even # Retrieval			ARTI-19/20 Step & Shoot		ARTI-21/22 Sliding Window		ARTI-23/24 IMAT/VMAT	
Attribute	Tag	DICOM Type	Type	Attribute Note	Type	Attribute Note	Type	Attribute Note
Beam Sequence	(300A, 00B0)	1	R+*		R+*		R+*	
>Beam Number	(300A, 00C0)	1	R+*	Shall be >=1	R+*	Shall be >=1	R+*	Shall be >=1
>Beam Name	(300A, 00C2)	3	R+		R+		R+	
>Beam Type	(300A, 00C4)	1	R+*	Shall be STATIC	R+*	Shall be DYNAMIC	R+*	Shall be DYNAMIC
>Radiation Type	(300A, 00C6)	2	R+*	Shall be PHOTON	R+*	Shall be PHOTON	R+*	Shall be PHOTON
>High-Dose Technique Type	(300A, 00C7)	1C	O+*	If present, shall be NORMAL	O+*	If present, shall be NORMAL	O+*	If present, shall be NORMAL or HDR If present, may not be ignored
>Treatment Machine Name	(300A, 00B2)	2	R+*		R+*		R+*	
>Primary Dosimeter Unit	(300A, 00B3)	3	R+	Shall be MU	R+	Shall be MU	R+	Shall be MU
>Source-Axis Distance	(300A, 00B4)	3	R+*		R+*		R+*	
>Beam Limiting Device Sequence	(300A, 00B6)	1	R+*		R+*		R+*	
>>RT Beam Limiting Device Type	(300A, 00B8)	1	R+*	At least 1 MLC shall be present	R+*	At least 1 MLC shall be present	R+*	Shall have at least 1 MLC
>>Leaf Position Boundaries	(300A, 00BE)	2C	R+*	Shall be present for MLCs May or may not be present for jaws, may be ignored for jaws	R+*	Shall be present for MLCs May or may not be present for jaws, may be ignored for jaws	R+*	Shall be present for MLCs May or may not be present for jaws, may be ignored for jaws
>Referenced Patient Setup Number	(300C, 006A)	3	R+*	Shall be >= 1	R+*	Shall be >= 1	R+*	Shall be >= 1
>Treatment Delivery Type	(300A, 00CE)	3	R+*		R+*		R+*	
>Number of Wedges	(300A, 00D0)	1	R+*	Shall be 0 or 1 If 1, see Hard Wedge Modifier	R+*	Shall be 0 or 1 If 1, see Hard Wedge Modifier	R+*	Shall be 0
>Wedge Sequence	(300A,00D1)	1C	R+*	Required if Number of Wedges is non-zero	R+*	Required if Number of Wedges is non-zero		NA (no Wedge)

Advanced RT Integration Profile Test Procedure

- **Test datasets are created** for each vendor and stored in an Archive (CT images and RT Structure Set).
- Plan producers retrieve test datasets and **create and store RT Plans for each beam technique** per planning instructions.
- Plan **consumers retrieve producers' plans** from the archive and display them.
- Judges **compare side-by-side plan displays** on producer and consumer systems to check consistency.
- Goal: **demonstrate successful exchange with 3+ partners**



IHE-RO Connectathon 2011
ARTI Profile
Instructions for Plan generation:

1) Import CT images and RT structure set. Save this as the primary dataset. (You will re-open this dataset and "start from scratch" for each plan type [as noted in the instructions below].)

Notes:

- For each producer, create two plans, one with all supported options and one without optional transactions (if you support multiple optional transactions e.g.: beam limiting devices, bolus etc.)
- Fill out the appropriate information on the Plan Submission sheet.
- All coordinates below are in the IEC coordinate system.

Plans:

1. Place isocenter at the center of the wires. x = -3.2mm, y= 69.2mm, z = 239 mm.
2. Add a beam using an appropriate treatment machine. Label the beam and plan appropriately e.g.: plan_static_mlc
3. Calculate dose and display the isodoses (normalize to the maximum dose).

1) Basic Static Beam:
Generate a plan with parallel opposed laterals

Advanced RT Interoperability Profile Test Instructions

IHE Radiation Oncology - ARTI Profile Testing

The Advanced RT Integration (ARTI) Profile is tested by importing CT image and Structure Set test data in a Producer Actor, creating a treatment plan (and dose) for a supported beam type, and exporting the plan (and dose) to an Archive for retrieval by a test partner (Consumer Actor). Side-by-side comparison of plan displays on the Producer and Consumer Actors is used to verify interoperable exchange of plan information.

General Instructions

- Import and save CT images and RT structure set for both supine and prone patients. Import the multiple brain mets patient if you are testing stereotactic beams.
- For each producer, create two plans, one with all supported options and one without options (if you support multiple options e.g.: beam limiting devices, bolus etc.)

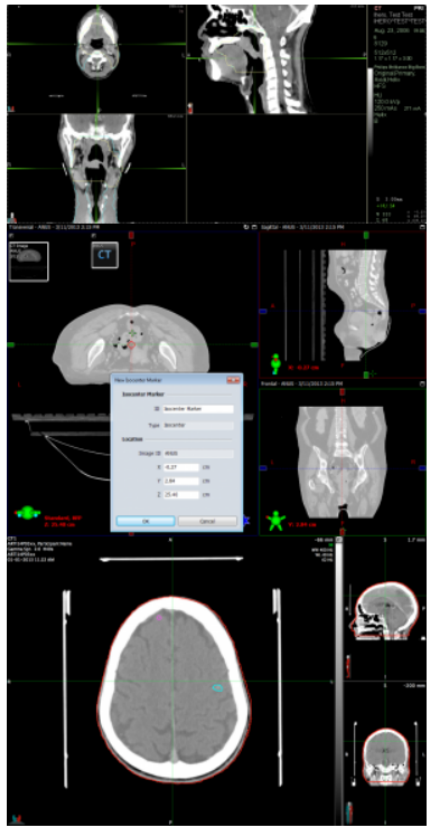
- Place isocenter as follows:
  - **Supine patient:** x = -3.2mm, y = 69.2mm, z = 239 mm (DICOM)
  - **Prone patient**: x = -2.7mm, y = 28.4mm, z = 254 mm (DICOM)
  - **Brain mets patient**: isocenter 1: x = 42.4mm, y = -194.3mm, z = -65.0mm; isocenter 2: x = -10.2mm, y = -256.8mm, z = -66.0mm (DICOM)
- Specify a total dose of 54 Gy (27 x 2 Gy fractions) to ptv54, unless otherwise specified.
- Label the plan appropriately: e.g., plan_static_mlc
- If possible, store each plan and dose in its own DICOM Series and use the Series Description to identify the ARTI Actor, i.e. beam type, that produced it.
- If possible, do not include setup beams in the plan.

Test Datasets

Three patient datasets are available for testing ARTI Actors:

- **ARTI15A01**xx - **Supine** (head/neck) patient
- **ARTI15A02**xx - **Prone** (anal-canal) patient
- **ARTI15A03**xx - Multiple brain mets patient (for stereotactic beams)

Note: xx is a vendor code for the Producer Actor.



Plans

Note: the numbering below is different from the numbering used in the Supplement ftp://ftp.ihe.net/RadiationOncology/Supplements/ARTI/IHE-RO_ARTI_Supplement_V1-6_2014-02-25.docx

1. **Basic Static Beam**: Generate a plan with two opposing lateral beams
2. **Basic Static MLC Beam**: Generate a plan with two opposing lateral beams
3. **Motorized Wedge Beam**: Generate a plan with AP and right lateral beams
4. **Hard Wedge Beam**: Generate a plan with AP and right lateral beams
5. **Virtual Wedge Beam**: Generate a plan with AP and right lateral beams
6. **Arc Beam**: Generate a plan with two lateral arcs (0 -270, 0 – 90)
7. **Conformal Arc**: Generate a plan with two lateral arcs (0 -270, 0 – 90)
8. **MLC Arc Beam**: Generate a plan with two lateral arcs (0 -270, 0 – 90)
9. **Step & Shoot Beam**: Generate 5 beams, use structure *ptv18* as target
10. **Sliding window Beam**: Generate 5 beams, use structure *ptv18* as target
11. **Static Electron Beam**: Generate a plan with a 10 x 10 applicator, 110 SSD, 9 MeV energy. Note: the isocenter is different than in other plans
12. **IMAT/VMAT Beam**: Generate a VMAT/IMAT plan, use structure *ptv18* as target
13. **Stereotactic Beam**: Generate a stereotactic plan
14. **Stereotactic Arc Beam**: Generate a stereotactic arc plan

- Instructions for testing ARTI Plan Producer Actors
- Also includes a table of detailed plan parameters to be used.

Connectathon Scoring

- ARTI checklist of plan parameters used for side-by-side comparison of Producer and Consumer Actors

MLC ARC BEAM Result: ____Pass ____Fail

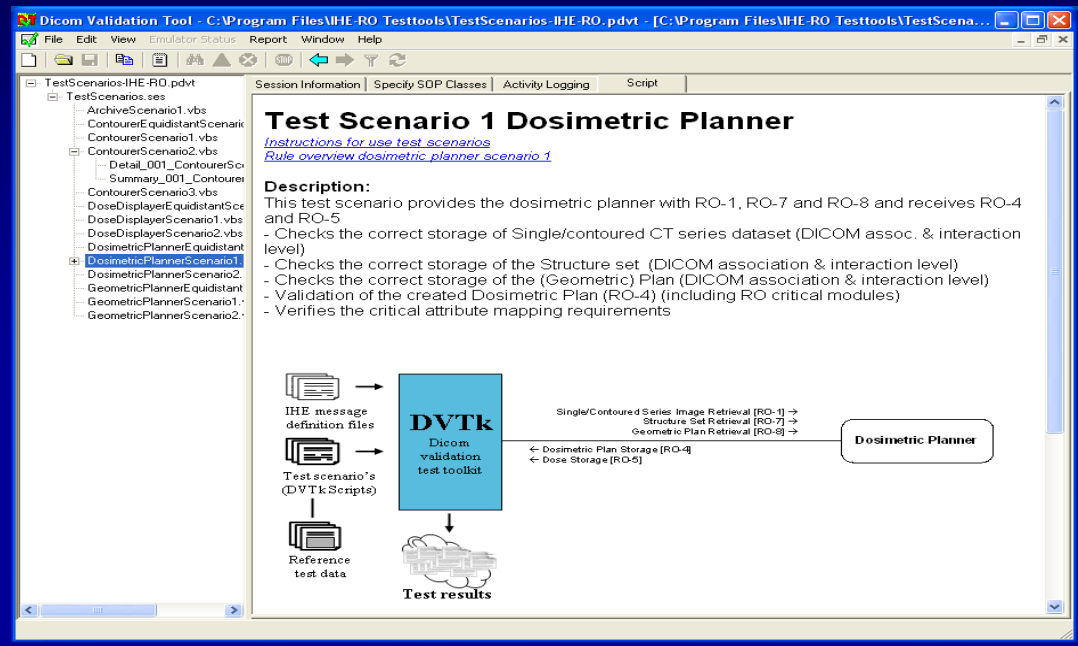
	Producer	Consumer	Discrepancy/Comments
Plan Name			
Gantry Start Angle(s)			
Gantry Stop Angle			
Energy			
Couch			
Collimator			
Field Size			
SSD			
MU			
Wedge ID/ Applicator			
Wedge orientation			
MLC shape review			
# control points			
Control pt meterset			
Orientation			
Isocenter			
Structure display			
Dose display			
Ref point dose			

IHE-RO Integration Profiles in Testing

- Basic RT Objects Profile (BRTO)
- Advanced RT Integration Profile (ARTI)
- Multi-Modality Image Registration for Radiation Oncology (MMRO-II)
- Dose Compositing Profile (DCOM)
- Treatment Delivery Workflow-II (TDW-II)

IHE-RO Test Tools

- Test Tool software is used to
  - Assist manufacturers with in-house software testing,
  - Assess readiness of products to participate in formal testing at Connectathons,
  - Assist testers in the formal testing process.
- Connectathon participants must demonstrate that their products pass Test Tool validation by submitting Test Tool results to judges.



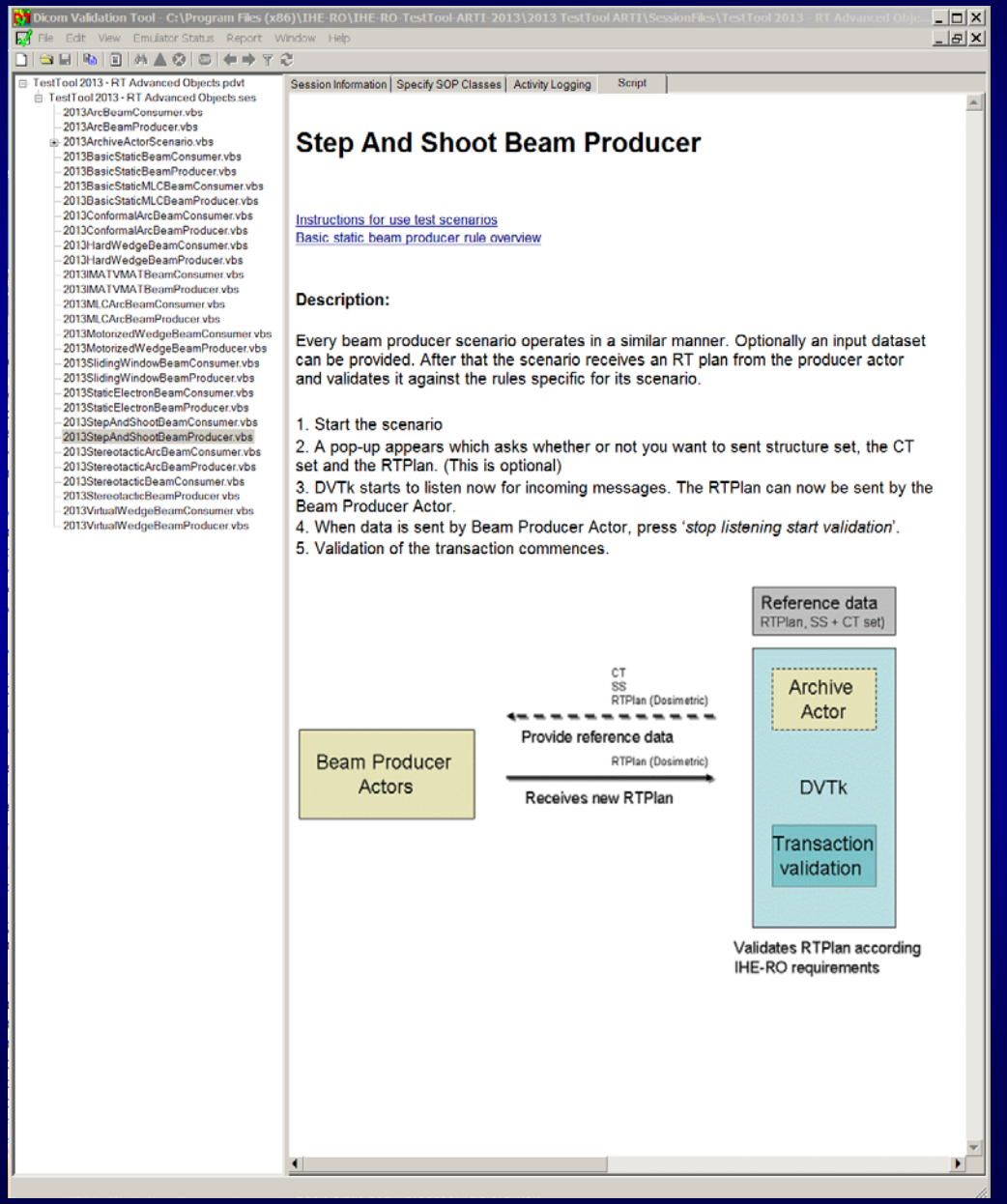
DVTk opensource project, main contributors Philips and ICT Automatisering

- IHE-RO Test Tools are developed and maintained by ICT Automatisering, using the open-source DICOM Validation Toolkit (DVTk).

IHE-RO Test Tool Operation

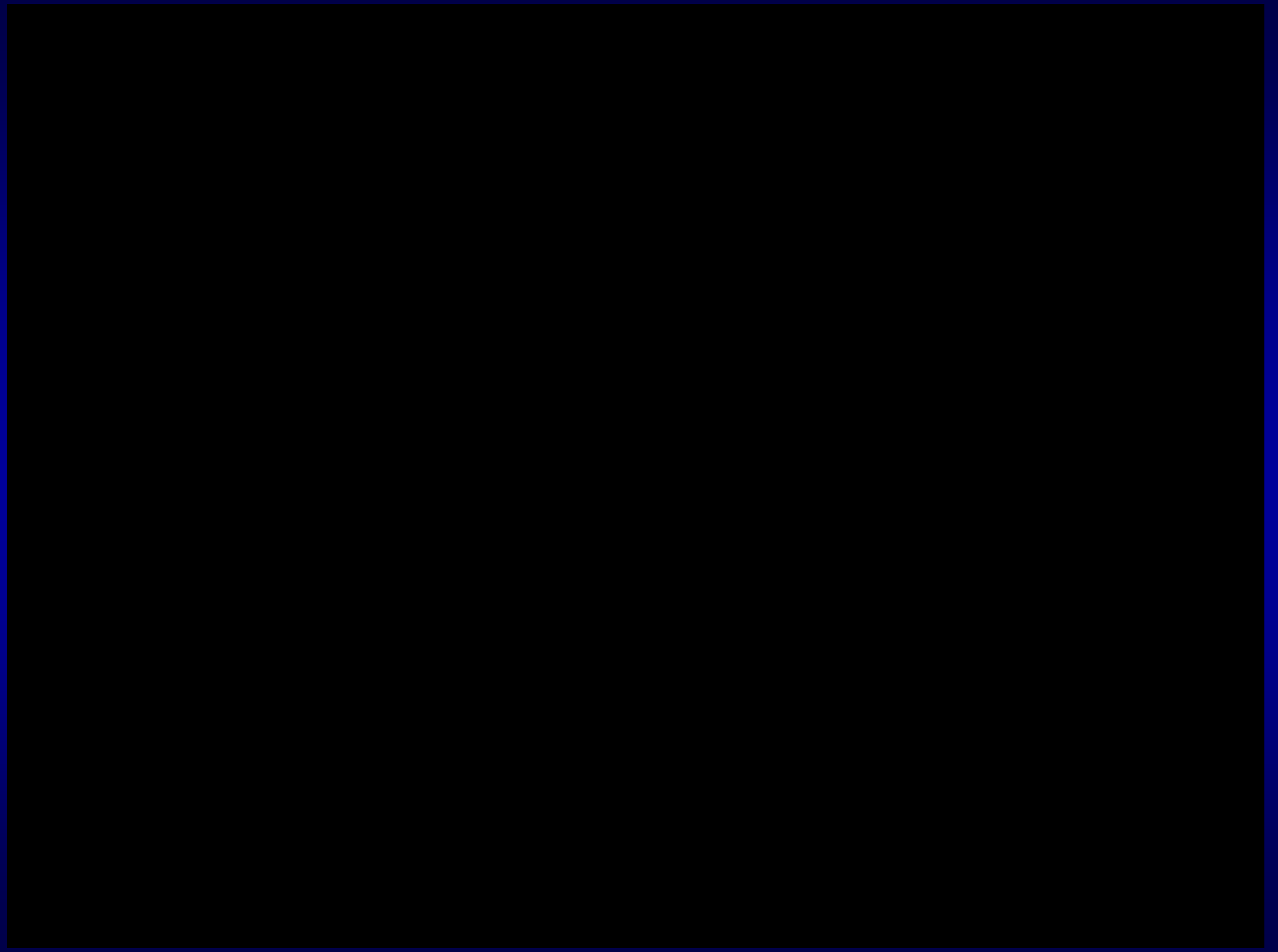
- Test Tool software
  - Simulates the behavior of other Actors in a Profile as a surrogate test partner,
  - Provides reference input data to the Actor under test,
  - Validates the content of data objects produced by the Actor.

C8.8.14 RT Beams Module				
Attribute	**Tag**	**IHE -Rule**	**Description**	**Code Rule**
> Beam Number	(300A,00C0)	R+*	Shall be >= 1.	IsRequiredRule ValueEqualOrHigher
> Beam Type	(300A,00C4)	R+*	Shall be STATIC.	IsRequiredRule / ValueRule
> Radiation Type	(300A,00C6)	R+*	Shall be PHOTON.	IsRequiredRule / ValueRule
> High-Dose Technique Type	(300A,00C7)	O+*	If present, shall be NORMAL	OptionalRule / ValueRule
> Primary Dosimeter Unit	(300A,00B3)	R+	Shall be MU.	IsRequiredRule ValueRule
>> RT Beam Limiting Device Type	(300A,00B8)	R+*	At least 1 MLC shall be present	IsRequiredRule BeamLimitingDevice
>> Leaf Position Boundaries	(300A,00BE)	R+*	Shall be present for MLCs.	



Connectathon Test Results

- Connectathon successes are published.
- Incomplete test(s) or failures are NOT published.
- Vendors release Integration Statements for “IHE-RO Compliant” products to indicate the specific Profile(s) and Actor(s) for which the product has been successfully tested.
- Integration Statements for products that have passed the IHE-RO testing process can be found on the ASTRO website (search “IHE-RO testing”)
- Systems tested at a Connectathon must match those referenced in the manufacturer’s Integration Statement. Re-testing is needed if some part of the product that affects interoperability is changed.



2013 IHE-RO Connectathon video courtesy of Christof Schadt, Brainlab AG.


Thank You

Profile Development

Chris Pauer
Senior Engineer, Sun Nuclear
IHE-RO Technical Committee Co-chair

Vendor Participation

IHE-RO Meeting, consisting of staff from 8 vendors and multiple clinical sites

Benefits of Vendor Participation

- Profiles will work!
- Problem Solving
  - Vendors get familiar with peer device issues, and are often able to read logs of other device to troubleshoot issues
  - Network of Contacts for vendor troubleshooting grows in number and trust.
- This all leads to quicker understanding and resolution of site problems.

Realities of Profile Priorities

- Profiles ARE based on clinical use cases
- There is a priority and weighting process
  - What is most critical to the clinical flow
  - What can realistically be addressed by technical solutions
    - How does it affect treatment critical functioning of device?
    - Are there standards to support the data and transactions?
    - Is it an interoperability problem?
  - Weighting on difficulty of implementation / profile creation
  - How will it sell?
- Some profiles are not strictly driven by clinical use cases, but the behavior or data is technically needed to support basic correct operation.
- In the end, it is perceived demand for a given behavior that is key to it being developed into a profile, and then being included in product. The clinical user is key to driving profile development!

Content and Workflow – RO Planning and Treatment Delivery

- As noted earlier, there are…
  - Content profiles – dictate specific relationships of data in existing standards
  - Workflow profiles – describe what is the order and content, from the content profiles, that transactions and signaling should be in place to claim that an actor's behavior is "correct".

Content and Workflow – RO Planning and Treatment Delivery

- Content profiles – DICOM standard by itself is not enough to guarantee the consistency of a treatment description.

Content – RO Planning and Treatment Delivery

Arc Beam:

>> RT Beam Limiting Device Type	(300A,00B8)	R+*	Shall be 2 jaws, MLC shall not be present
>> Leaf Position Boundaries	(300A,00BE)	O+*	NA (no MLC) May or may not be present for jaws, may be ignored for jaws

MLC Beam:

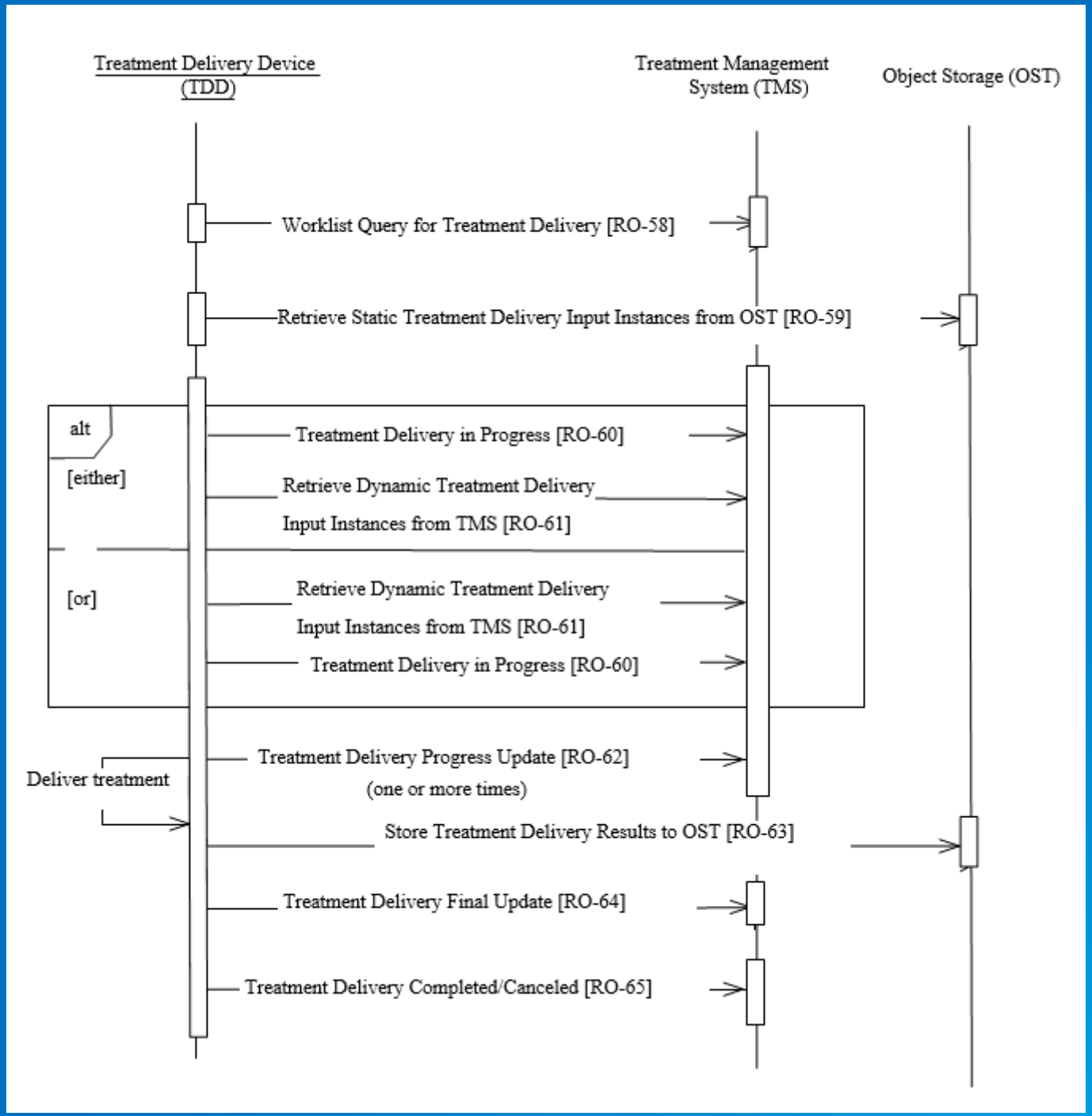
>> RT Beam Limiting Device Type	(300A,00B8)	R+*	Shall have at least 1 MLC
>> Leaf Position Boundaries	(300A,00BE)	R+*	Shall be present for MLCs May or may not be present for jaws, may be ignored for jaws

DICOM Standard:

RT Beam Limiting Device	**Type of beam limiting device (collimator).** Enumerated Values: **X - symmetric jaw pair in IEC X direction** **Y - symmetric jaw pair in IEC Y direction** **ASYMX - asymmetric jaw pair in IEC X direction** **ASYMY - asymmetric pair in IEC Y direction** **MLCX - multileaf (multi-element) jaw pair in IEC X direction** **MLCY - multileaf (multi-element) jaw pair in IEC Y direction**

Content and Workflow – RO Planning and Treatment Delivery

- As noted earlier, there are…
  - Workflow profiles – describe what is the order and content, from the content profiles, that transactions and signaling should be in place to claim that an actor's behavior is "correct".
- One ongoing challenge – The language and appearance of the solution does not always translate back clearly to the Use Case it is addressing
- Clinical Impact Statements


Treatment Delivery Device (TDD)
Treatment Management System (TMS)
Object Storage (OST)
Worklist Query for Treatment Delivery [RO-58]
Retrieve Static Treatment Delivery Input Instances from OST [RO-59]
alt
[either]
Treatment Delivery in Progress [RO-60]
Retrieve Dynamic Treatment Delivery Input Instances from TMS [RO-61]
[or]
Retrieve Dynamic Treatment Delivery Input Instances from TMS [RO-61]
Treatment Delivery in Progress [RO-60]
Deliver treatment
Treatment Delivery Progress Update [RO-62]
(one or more times)
Store Treatment Delivery Results to OST [RO-63]
Treatment Delivery Final Update [RO-64]
Treatment Delivery Completed/Canceled [RO-65]

Working Safety Concerns into Profiles

- Every profile is weighed as far as how it addresses safety issues
  - Patient identification requirements
  - Identification of key treatment plan parameters
  - Example from Treatment Delivery Workflow-II:
    - *All comparisons of Meterset values in RT Plan and RT Beams Delivery Instruction instances retrieved from the TMS must agree with corresponding TDD local data within clinically meaningful precision (as defined by the TDD).*
    - *Meterset values in RT Plan and RT Beams Delivery Instruction instances retrieved from the TMS must satisfy*
      - *a. Continuation Start Meterset >= 0*
      - *b. Continuation Start Meterset <= Beam Meterset*
      - *c. Continuation End Meterset <= Beam Meterset*
      - *d. Continuation End Meterset >= Continuation Start Meterset*
    - *Inconsistency in Fraction Number is handled at the discretion of the TDD.*
    - *In case of inconsistency between RT Plan and RT Beams Delivery Instruction instances retrieved from the TMS and local data, the TDD must either (1) refuse treatment or (2) require user to override in a recorded and auditable manner.*

Working Safety Concerns into Profiles

- Specific profile work:
  - Quality Assurance with Plan Veto (QAPV) - Checks for harmful data configurations, which may result in severe adverse events to patients. Ready for Trial Implementation.
  - Prescriptions (RXRO) – Consistency in Radiotherapy Prescription display, description and transfer. Required a refinement of DICOM to represent Prescription differently. Currently in development.
  - Template Exchange – Bring consistency to description and workflow when referring to a treatment site in patient.
  - QA Workflow Profile – Quality Assurance workflow in Radiotherapy is under-represented in IHE. Attempt to bring consistency, transparency and more speed to device communications for QA.

IHE RO Future Works

- Current Future Profile Development
  - RXRO – RT Prescription Exchange
  - ROTI – Structure Template Exchange
  - RO HIS – Exchange with HIS/EMRs
    - Daily fractionation, Billing, Appointments
  - Deformable Image Alignment
  - Brachy – Plan Exchange
- Testing for …
  - MMRO – MultiModality in RO
  - DCOM - Dose compositing
  - TDW II – Treatment Delivery Workflow

IHE RO Future Works

- Use the RPF language for your next purchase
- Ask vendors about integration statements
- Community Participation, We need to hear …
  - Integration needs
  - Use cases to determine scope of profile
  - Public Comments welcome