The clinical physics aspects behind DICOM-RT

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DICOM-RT for physicists

- DICOM normative terminology
- DICOM Workflow
- Physical interpretation of DICOM attributes

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DICOM dictionary

Demography

ANSI

Tag value	Type	VR	Attribute name	Examples
(0010,0010)	2	PN	PatientsName	Germond^Jean-François^^Dr^Physicist
(0010,0020)	2	LO	PatientID	Hospital patient UID
(0010,0030)	2	DA	PatientsBirthDate	19460610
(0010,0040)	2	CS	PatientsSex	M or F or O
(300A,0002)	1	SH	RTPlanLabel	Plan 1
(300A,00B2)	2	SH	TreatmentMachineName	Precise
(300A,00C6)	2	CS	RadiationType	PHOTON or ELECTRON
(300A,00B8)	1	CS	RTBeamLimitingDeviceType	ASYMX or ASYMY or MLCX
(300A,00C0)	1	IS	BeamNumber	1
(300A,00C4)	1	CS	BeamType	STATIC or DYNAMIC
(300A,011E)	1C	DS	GantryAngle	0 - 359
(300A,0120)	1C	DS	BeamLimitingDeviceAngle	0 - 359
(300A,011C)	1C	DS	LeafJawPositions	-50.0\ 50.0 for a 10 cm field size
(300A,0114)	3	DS	NominalBeamEnergy	In MV or MeV
(300A,0086)	3	DS	BeamMeterset	= number of MU's for the beam

DICOM dictionary

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(300A,00B2)	2	S		recise
(300A,00C6)	2	CS	RadiationType	PHOTON or ELECTRON
(300A,00B8)	1	CS	RTBeamLimitingDeviceType	ASYMX or ASYMY or MLCX
(300A,00C0)	1	IS	BeamNumber	1
(300A,00C4)	1	CS	BeamType	STATIC or DYNAMIC
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Plan

X ⇔ cross-plane

Y ⇔ in-plane

IEC 61217

DICOM dictionary

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Beam

IEC 61217

mm

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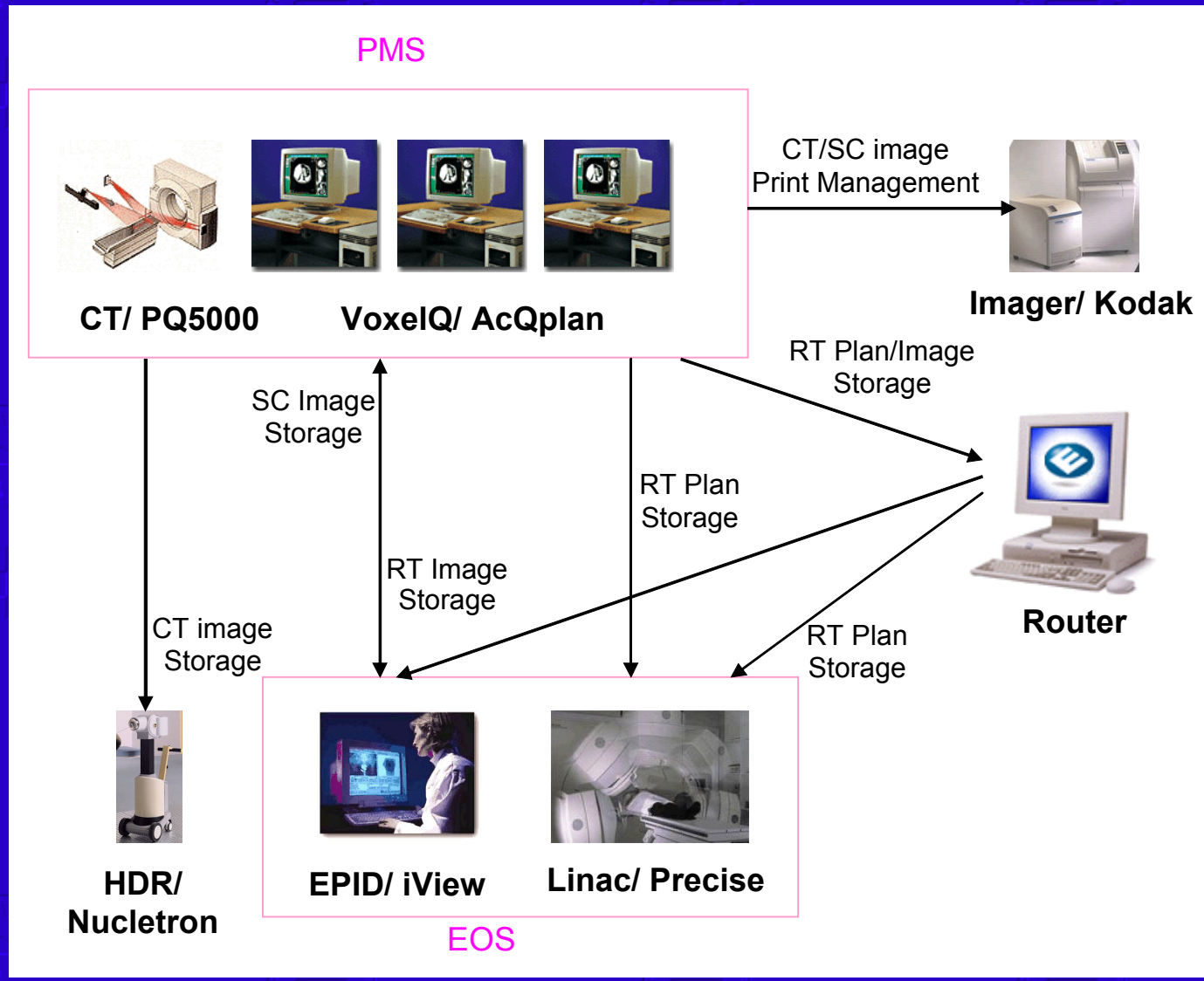
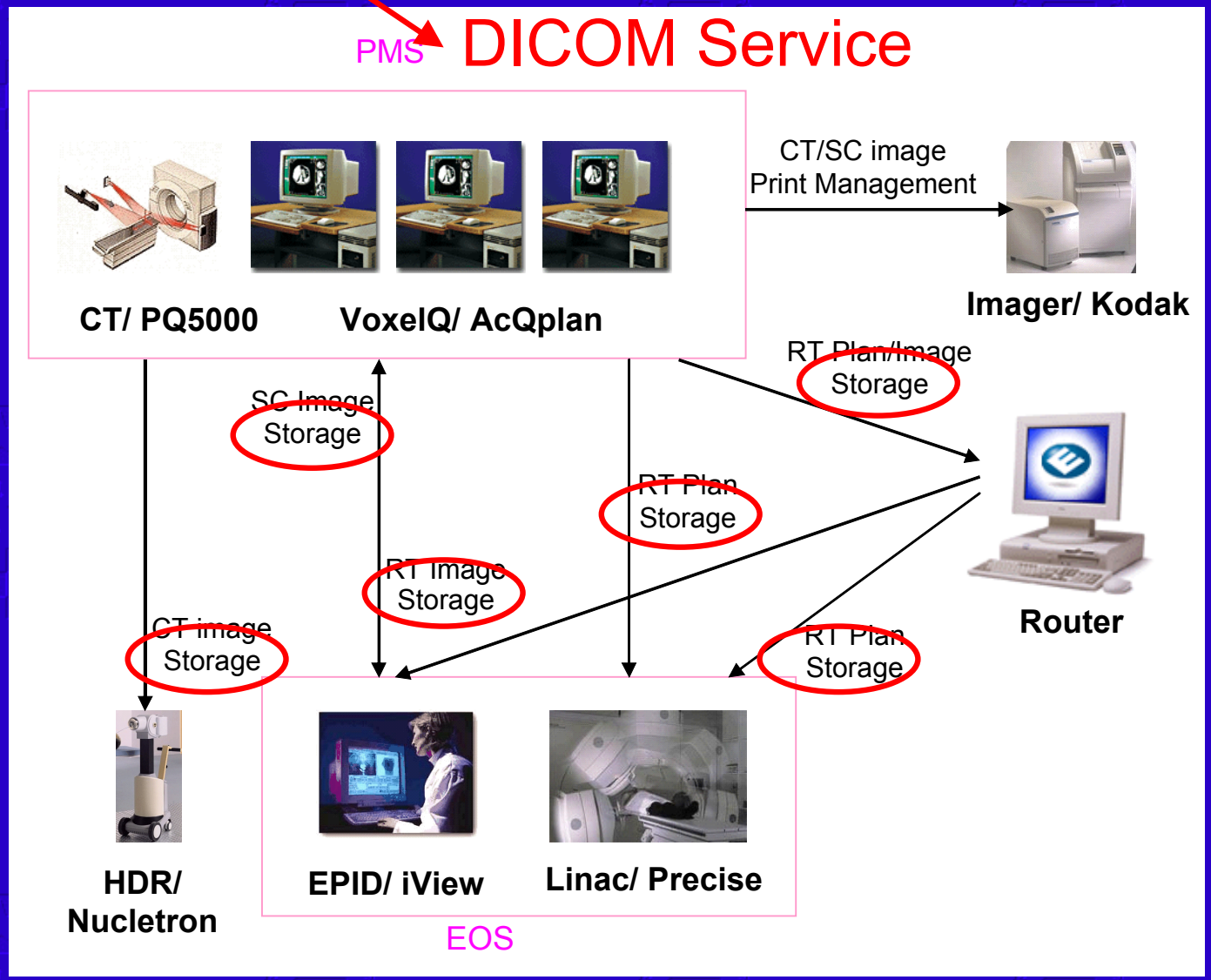
DICOM SOP topology @ HCF



DICOM SOP topology @ HCF



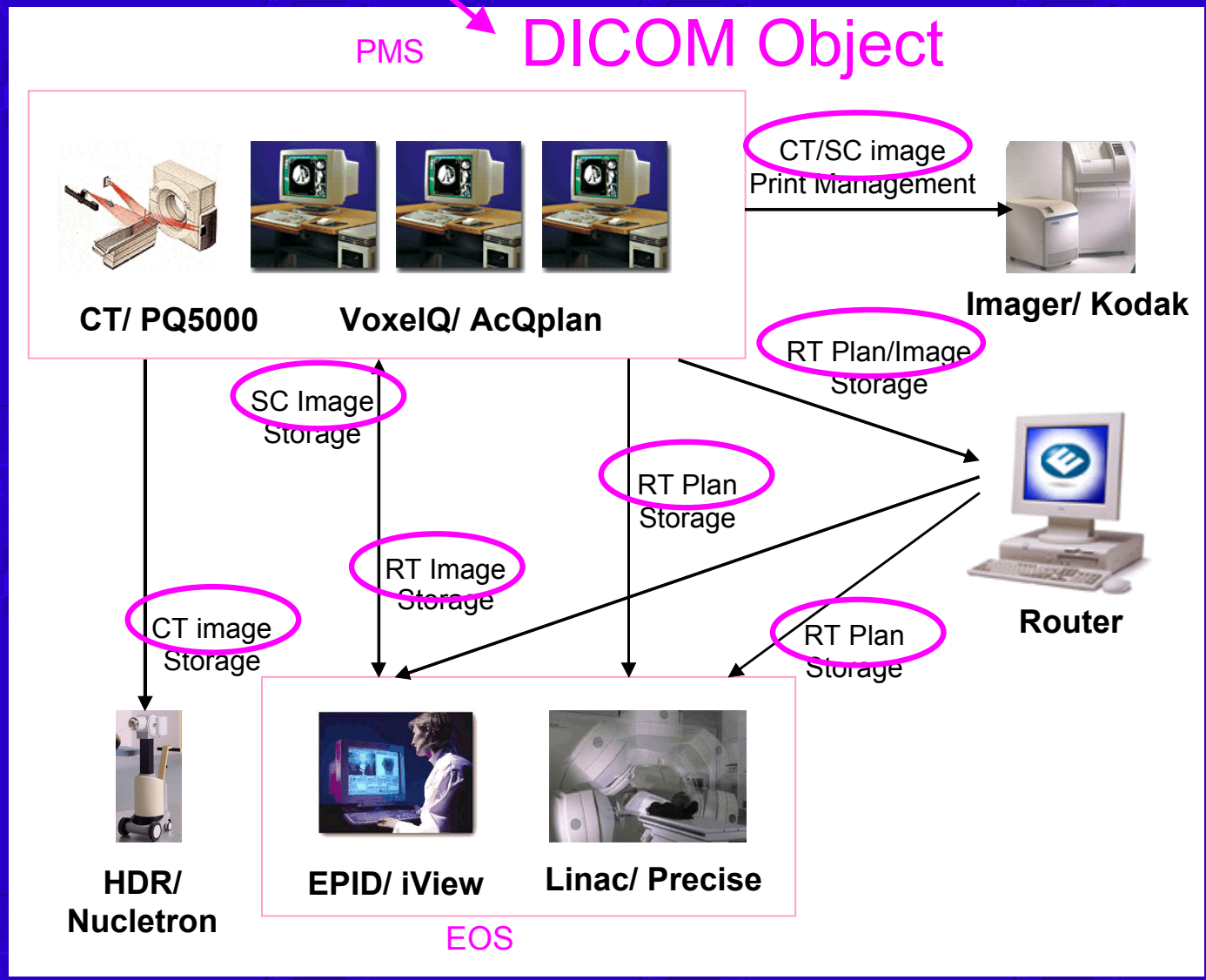
The DICOM storage service

Mapping

1. Data are extracted from the DB of modality A
2. These data are inserted into a DICOM object
3. Modality A initializes an association with modality B
4. The DICOM object is sent to modality B
5. Specific data are extracted from the DICOM object
6. These data are stored into DB of modality B

Mapping

DICOM SOP topology @ HCF



RT Workflow @ HCF

PQ5000	AcQSim	AcQplan	Router	Precise linac	iView	ACTORS
						
Acquisition CT-image						Therapist
	ROI's drawing RT-StructureSet					Doctor
						
		MLC fields RT-Plan				Doctor / Physicist / Dosimetrist
		DRR's RT-Image				Therapist
			QA + Archiving RT-Image			Auto / Physicist
		Dose calculation RT-Dose				Physicist / Dosimetrist
			QA + Archiving RT-Plan			Auto / Physicist
						
				Treatment RT-TrtRecord		Therapist
						
					Verification RT-image	Therapist / Doctor/ Physicist

Details published in Cancer/Radiotherapy 5 (2001) 172s-180s

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		DRR's RT-Image				Therapist
			QA + Archiving RT-Image			Auto / Physicist
		Dose calculation RT-Dose				Physicist / Dosimetrist
			QA + Archiving RT-Plan			Auto / Physicist
						
				Treatment RT-TrtRecord		Therapist
						
					Verification RT-image	Therapist / Doctor/ Physicist

= information flow

XT-Xxxx = DICOM objects

Details published in Cancer/Radiotherapy 5 (2001) 172s-180s

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		 MLC fields RT-Plan				Doctor / Physicist / Dosimetrist
		DRR's RT-Image	 QA + Archiving RT-Image			Therapist Auto / Physicist
		Dose calculation RT-Dose				Physicist / Dosimetrist
			QA + Archiving RT-Plan	 Treatment RT-TrtRecord		Auto / Physicist Therapist
					 Verification RT-image	Therapist / Doctor/ Physicist

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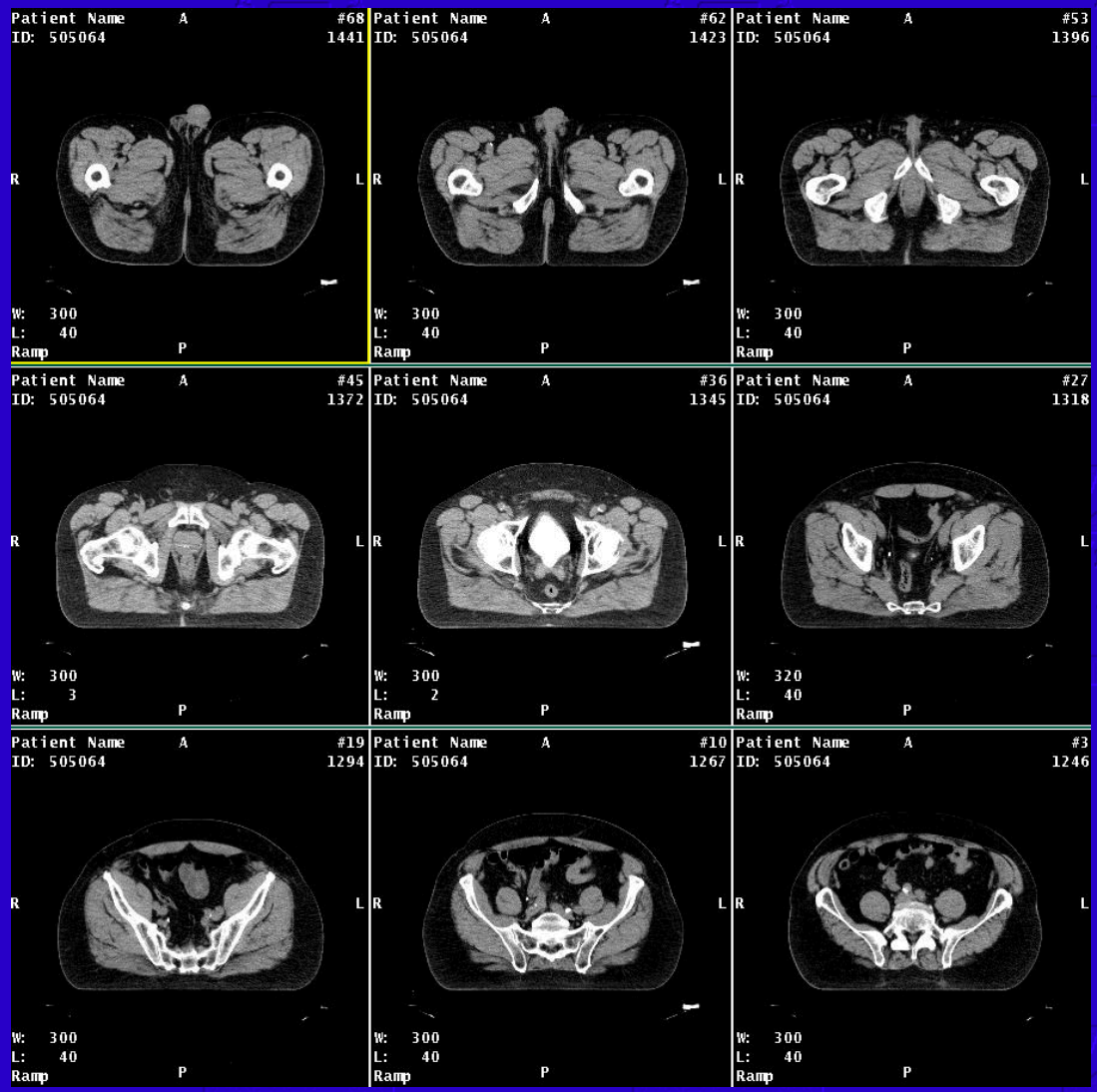
CT Image acquisition

Serie of objects

CT-Image

=> Virtual patient



CT-Image IOD Module Table

Entity Name	Module Name	Usage
Patient	Patient	M
Study	Study	M
	Patient Study	U
Series	General Series	M
Frame of Reference	Frame of Reference	M
Equipment	General Equipment	M
Image	General Image	M
	Image Plane	M
	Image Pixel	M
	Contrast/bolus	C
	Cine	C
	Multi-Frame	C
	CT Image	M
	Overlay Plane	U
	Modality LUT	U
	VOI LUT	U
	Approval	U
	Curve	U
	Audio	U
	SOP Common	M

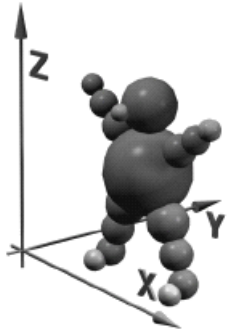
CT-image attributes

Tag value	VR	Value	DICOM name
(0008,0060)	CS	[CT]	Modality
(0028,0030)	DS	[0.9375\0	PixelSpacing
(0020,0032)	DS	[0.00\0.00\-91	ImagePositionPatient
(0028,0010)	US	512	Rows
(0028,0011)	US	512	Columns
(7fe0,0010)	OW	03e8\007e\00	PixelData
(0028,0101)	US	12	BitsStored

Image Plane

Image Pixel

CT



RT Workflow @ HCF

PQ5000	AcQSim	AcQplan	Router	Precise linac	iView	ACTORS
 Acquisition CT-image						Therapist
	 ROI's drawing RT-StructureSet					Doctor
		 MLC fields RT-Plan				Doctor / Physicist / Dosimetrist
		DRR's RT-Image	 QA + Archiving RT-Image			Therapist Auto / Physicist
		Dose calculation RT-Dose				Physicist / Dosimetrist
			QA + Archiving RT-Plan	 Treatment RT-TrtRecord		Auto / Physicist Therapist
					 Verification RT-image	Therapist / Doctor/ Physicist

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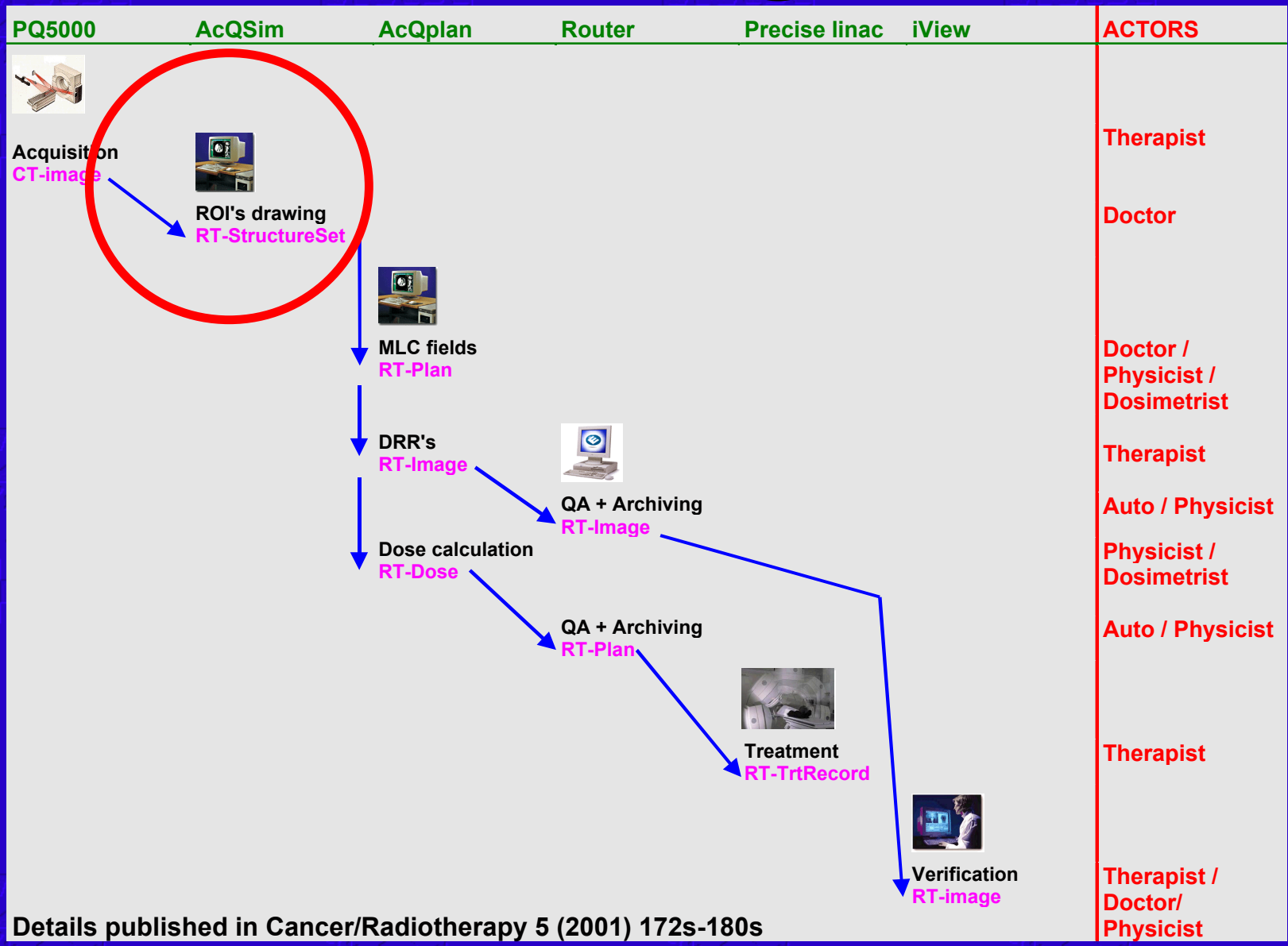
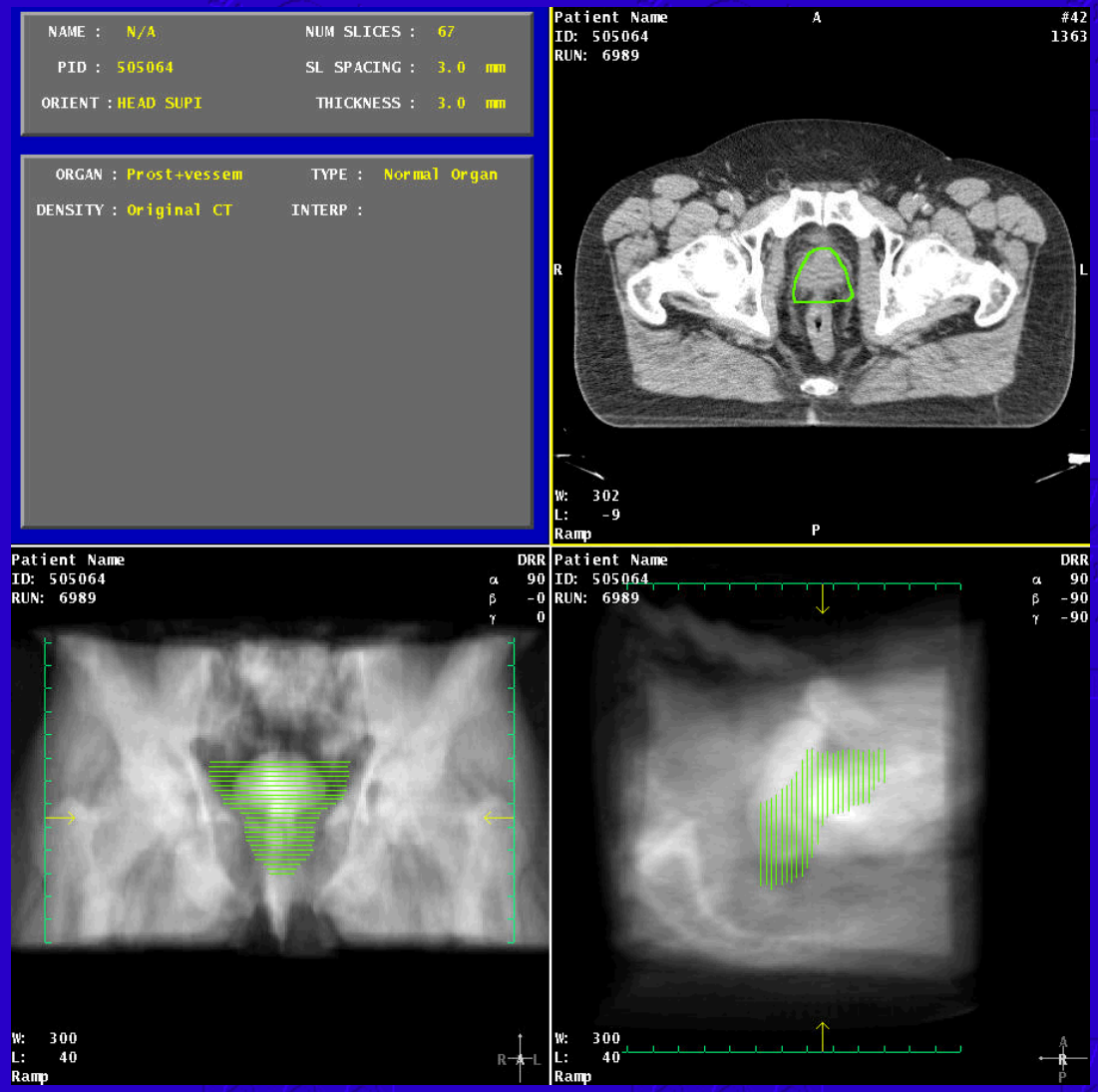
RT Workflow @ HCF



Organs localization

Contouring of

- **GTV**
- **Organs at risk**



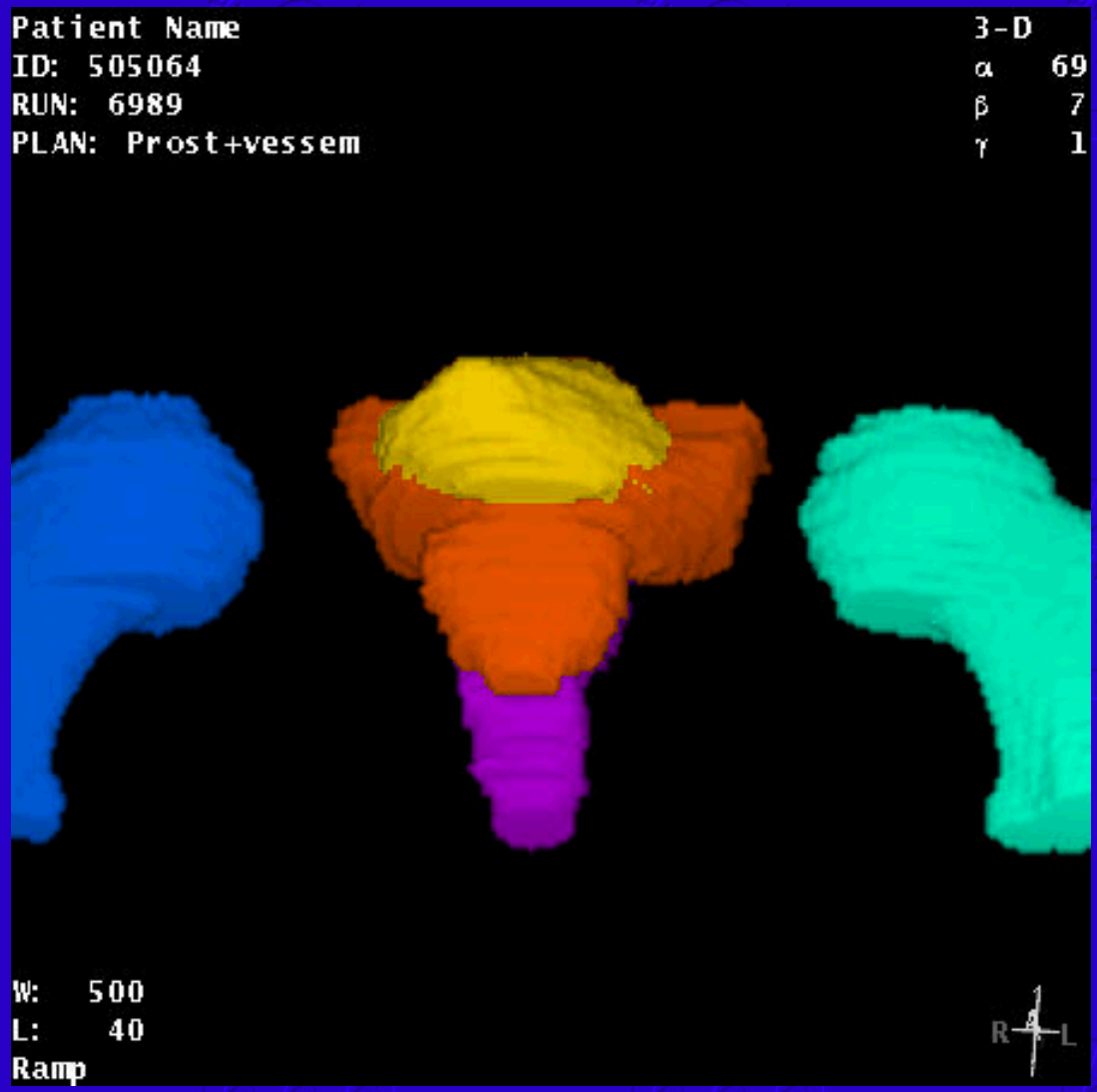
Organs localization

GTV +

Organs at risks

=> Same object

RT-StructureSet



RT-StructureSet IOD Module Table

Entity Name	Module Name	Usage
Patient	Patient	M
Study	Study	M
	Patient Study	U
Series	RT Series	M
Equipment	General Equipment	M
RT Structure Set	Structure Set	M
	ROI contour	M
	RT ROI Observations	M
	Approval	U
	Audio	U
	SOP Common	M

RT-StructureSet attributes

Tag value	VR	Value	DICOM name
(0008,0060)	CS	[RTSTRUCT]	Modality
(3006,0022)	IS	[0] or [1] c	ROI
(3006,0026)	LO	[Prostate]	
(3006,002a)	IS	[255\255\255]	DisplayColor
(3006,0042)	CS	[CLOSED_PLANAR]	ContourGeometricType
(3006,0046)	IS	[47]	NumberOfContourPoints
(3006,0050)	DS	x y z [161.25\318.75 … 804.50 … \120.00	ContourData
(3006,00a4)	CS	[PTV] or [CTV] or [GTV] or [ORGAN] or [AVOIDANCE] or [EXTERNAL] or [BOLUS] or [CONTRAST_AGENT] …	RTROIInterpretedType

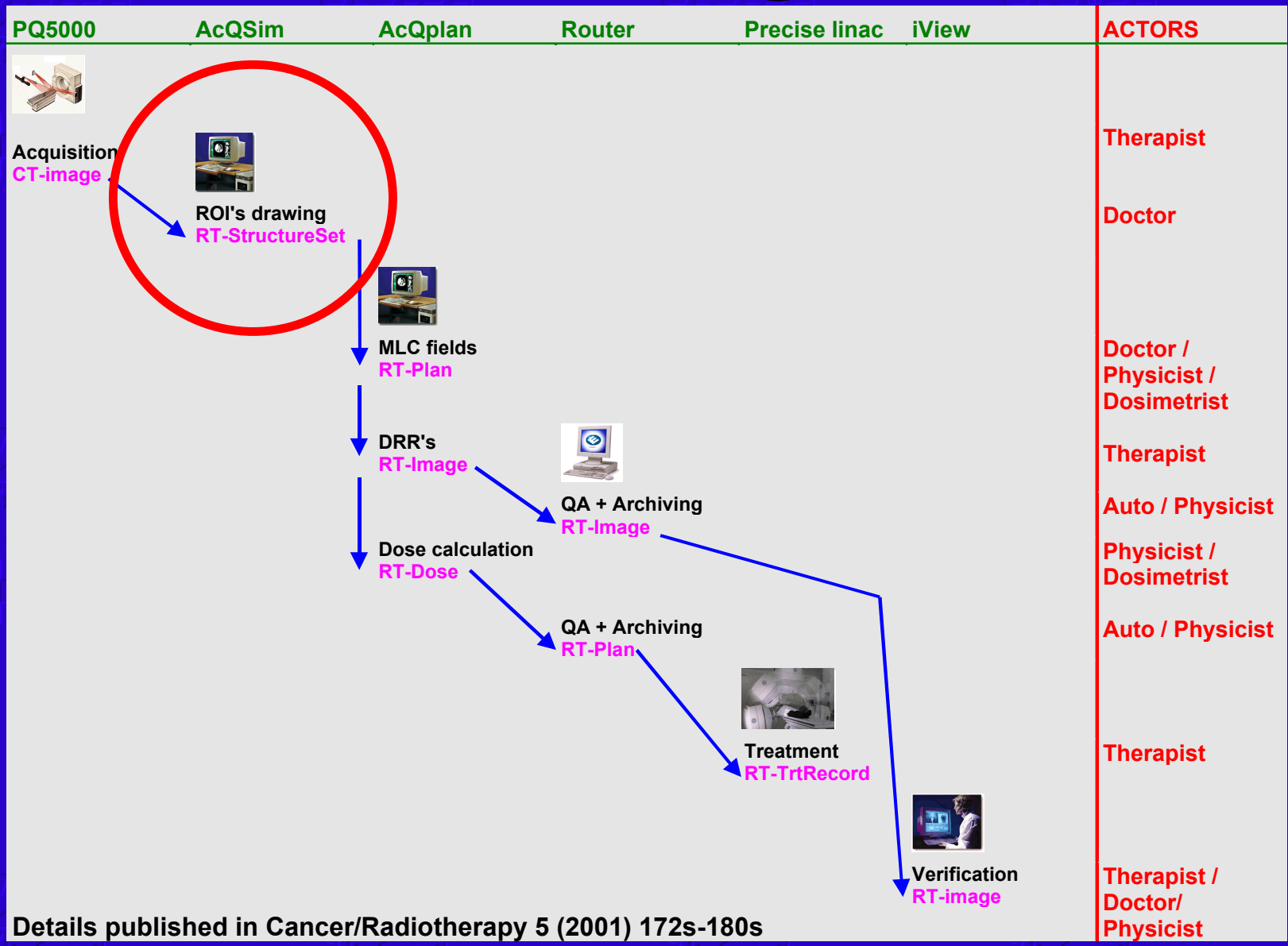
Structure Set

ROI Contour

Séquence

RT ROI Observation

RT Workflow @ HCF



RT Workflow @ HCF

PQ5000	AcQSim	AcQplan	Router	Precise linac	iView	ACTORS
						
Acquisition CT-image						Therapist
	ROI's drawing RT-StructureSet					Doctor
						
		MLC fields RT-Plan				Doctor / Physicist / Dosimetrist
		DRR's RT-Image				Therapist
			QA + Archiving RT-Image			Auto / Physicist
		Dose calculation RT-Dose				Physicist / Dosimetrist
			QA + Archiving RT-Plan			Auto / Physicist
						
				Treatment RT-TrtRecord		Therapist
						
					Verification RT-image	Therapist / Doctor/ Physicist

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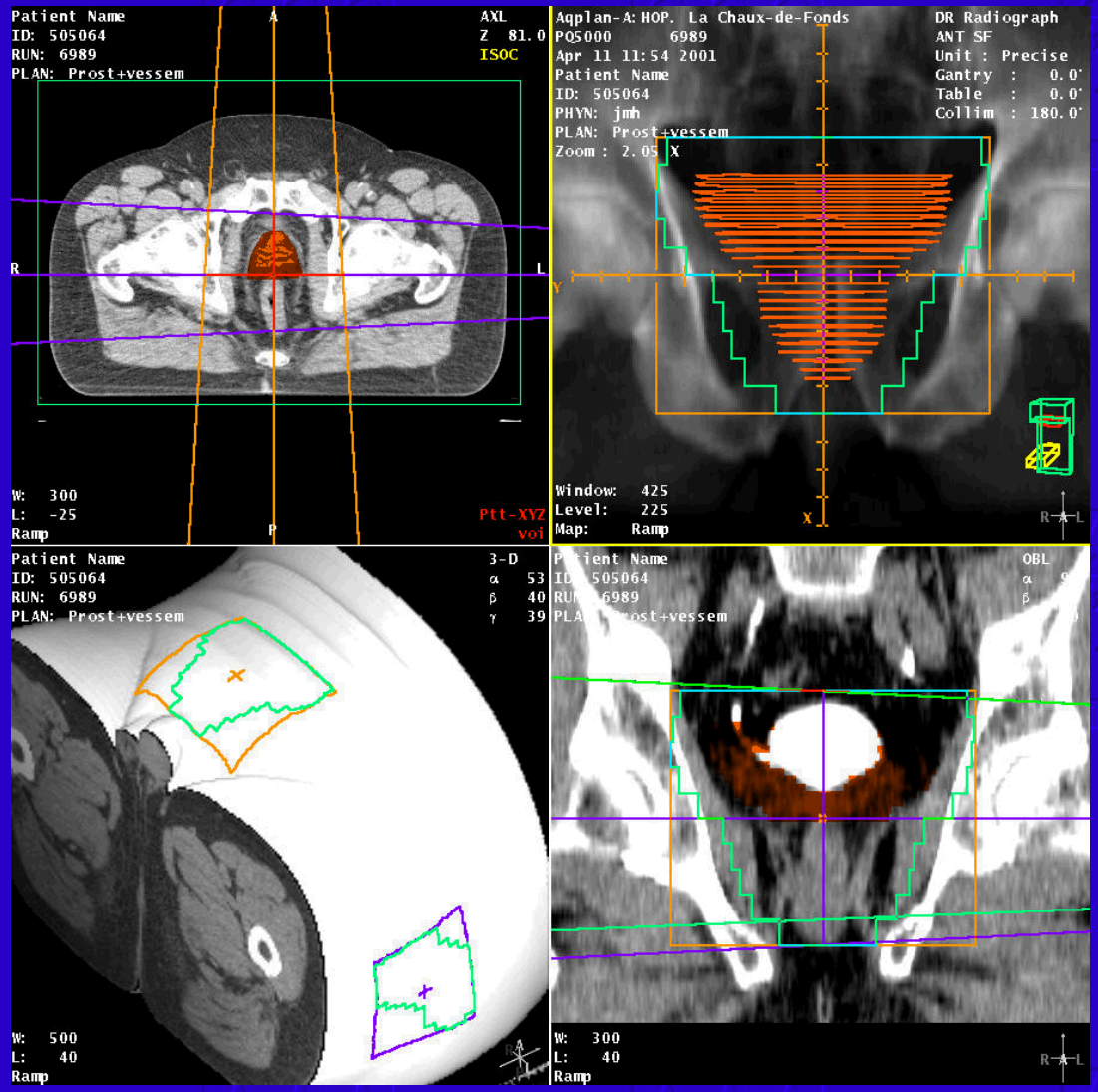
Fields simulation

Object RT-Plan



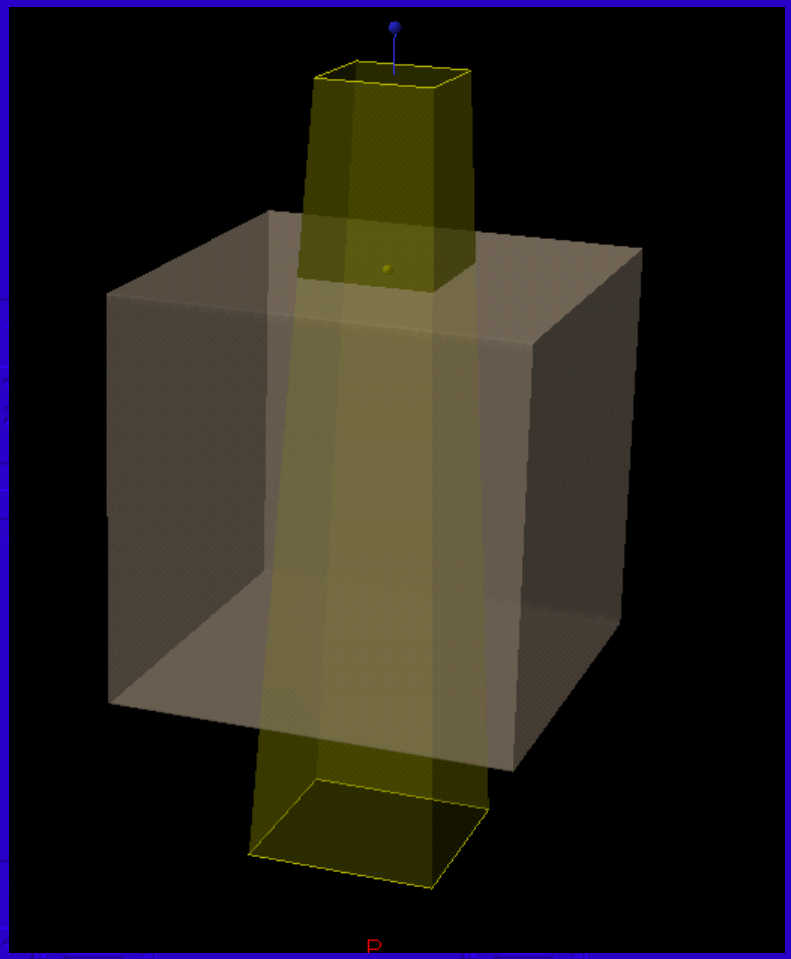
RT-Plan IOD Module Table

Entity Name	Module Name	Usage
Patient	Patient	M
Study	Study	M
	Patient Study	U
Series	RT Series	M
Equipment	General Equipment	M
Plan	RT General Plan	M
	RT prescription	U
	RT Tolerance Tables	U
	RT Patient Setup	U
	RT Fraction Scheme	U
	RT Beams	C
	RT Brachy Application Setups	C
	Approval	U
	Audio	U
	SOP Common	M

Geometry in

Example 1:

Standard 10x10 AP 6MV beam



Standard 10x10 AP 6MV beam

Sequence of 2 control points:

```
(300a,0111) SQ    (Sequence with explicit Length #=2)    # ControlPointSequence

(300a,0112) IS    [0]                                    # ControlPointIndex
(300a,0114) DS    [6]                                    # NominalBeamEnergy

  (300a,011a) SQ    (Sequence with explicit Length #=2)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-50.0\50.0]                         # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-50.0\50.0]                         # LeafJawPositions

(300a,011e) DS    [0.0]                                  # GantryAngle
(300a,0120) DS    [0.0]                                  # BeamLimitingDeviceAngle
(300a,0122) DS    [0.0]                                  # PatientSupportAngle
(300a,0134) DS    [0.0]                                  # CumulativeMetersetWeight

(300a,0112) IS    [1]                                    # ControlPointIndex
(300a,0134) DS    [100.0]                                # CumulativeMetersetWeight
```

RT-Plan Beams Module

Standard 10x10 AP 6MV beam

Control Point 0: Setup the geometry of the beam

```
(300a,0111) SQ    (Sequence with explicit Length #=2)    # ControlPointSequence

(300a,0112) IS    [0]                                    # ControlPointIndex
(300a,0114) DS    [6]                                    # NominalBeamEnergy

  (300a,011a) SQ    (Sequence with explicit Length #=2)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-50.0\50.0]                         # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-50.0\50.0]                         # LeafJawPositions

(300a,011e) DS    [0.0]                                  # GantryAngle
(300a,0120) DS    [0.0]                                  # BeamLimitingDeviceAngle
(300a,0122) DS    [0.0]                                  # PatientSupportAngle
(300a,0134) DS    [0.0]                                  # CumulativeMetersetWeight

(300a,0112) IS    [1]                                    # ControlPointIndex
(300a,0134) DS    [100.0]                                # CumulativeMetersetWeight
```

RT-Plan Beams Module

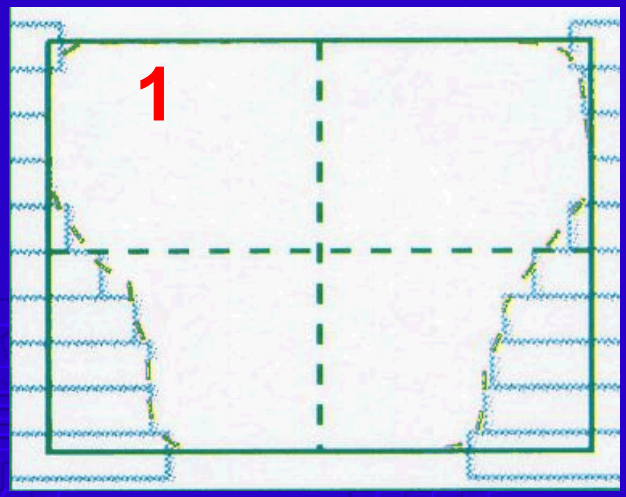
Standard 10x10 AP 6MV beam

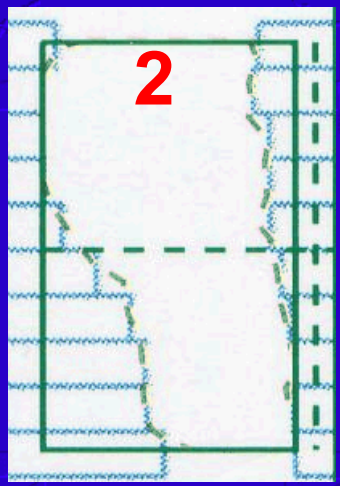
Control Point 1: Deliver irradiation

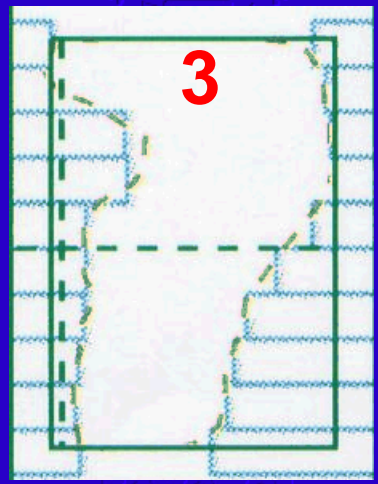
```
(300a,0111) SQ    (Sequence with explicit Length #=2)    # ControlPointSequence

(300a,0112) IS    [0]                                    # ControlPointIndex
(300a,0114) DS    [6]                                    # NominalBeamEnergy

  (300a,011a) SQ    (Sequence with explicit Length #=2)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-50.0\50.0]                         # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-50.0\50.0]                         # LeafJawPositions

(300a,011e) DS    [0.0]                                  # GantryAngle
(300a,0120) DS    [0.0]                                  # BeamLimitingDeviceAngle
(300a,0122) DS    [0.0]                                  # PatientSupportAngle
(300a,0134) DS    [0.0]                                  # CumulativeMetersetWeight

(300a,0112) IS    [1]                                    # ControlPointIndex
(300a,0134) DS    [100.0]                                # CumulativeMetersetWeight
```

RT-Plan Beams Module

Example 2:
3 segments Step and Shoot IMRT







Step and Shoot IMRT

Machine capability:

```
(300a,00b6) SQ    (Sequence with explicit Length #=3)     # BeamLimitingDeviceSequence
  (300a,00b8) CS    [ASYMX]                                   # RTBeamLimitingDeviceType
  (300a,00bc) IS    [1]                                       # NumberOfLeafJawPairs
  (300a,00b8) CS    [ASYMY]                                   # RTBeamLimitingDeviceType
  (300a,00bc) IS    [1]                                       # NumberOfLeafJawPairs
  (300a,00b8) CS    [MLCX]                                    # RTBeamLimitingDeviceType
  (300a,00bc) IS    [40]                                      # NumberOfLeafJawPairs
  (300a,00be) DS    [-200.0\-190.0\-180.0\-170.0\-160.0\
                     -150.0\-140.0\-130.0\-120.0\-110.0\
                     -100.0\-90.0\-80.0\-70.0\-60.0\
                     -50.0\-40.0\-30.0\-20.0\-10.0\
                     0.0\10.00\20.00\30.00\40.00\
                     50.00\60.00\70.00\80.00\90.00\
                     100.0\110.0\120.0\130.0\140.0\
                     150.0\160.0\170.0\180.0\190.0\200.0]  # LeafPositionBoundaries


(300a,00c4) CS    [STATIC]                                  # BeamType
(300a,00c6) CS    [PHOTON]                                  # RadiationType
(300a,00d0) IS    [0]                                       # NumberOfWedges
(300a,00e0) IS    [0]                                       # NumberOfCompensators
(300a,00ed) IS    [0]                                       # NumberOfBoli
(300a,00f0) IS    [0]                                       # NumberOfBlocks
(300a,0110) IS    [5]                                       # NumberOfControlPoints

(300a,0111) SQ    (Sequence with explicit Length #=5)     # ControlPointSequence
```

RT-Plan Beams Module

Step and Shoot IMRT

Machine capability: Jaws & MLC

```
(300a,00b6) SQ    (Sequence with explicit Length #=3)    # BeamLimitingDeviceSequence
  (300a,00b8) CS    [ASYMX]                                  # RTBeamLimitingDeviceType
  (300a,00bc) IS    [1]                                      # NumberOfLeafJawPairs
  (300a,00b8) CS    [ASYMY]                                  # RTBeamLimitingDeviceType
  (300a,00bc) IS    [1]                                      # NumberOfLeafJawPairs
  (300a,00b8) CS    [MLCX]                                   # RTBeamLimitingDeviceType
  (300a,00bc) IS    [40]                                     # NumberOfLeafJawPairs
  (300a,00be) DS    [-200.0\-190.0\-180.0\-170.0\-160.0\
                     -150.0\-140.0\-130.0\-120.0\-110.0\
                     -100.0\-90.0\-80.0\-70.0\-60.0\
                     -50.0\-40.0\-30.0\-20.0\-10.0\
                     0.0\10.00\20.00\30.00\40.00\
                     50.00\60.00\70.00\80.00\90.00\
                     100.0\110.0\120.0\130.0\140.0\
                     150.0\160.0\170.0\180.0\190.0\200.0]  # LeafPositionBoundaries

(300a,00c4) CS    [STATIC]                                 # BeamType
(300a,00c6) CS    [PHOTON]                                 # RadiationType
(300a,00d0) IS    [0]                                      # NumberOfWedges
(300a,00e0) IS    [0]                                      # NumberOfCompensators
(300a,00ed) IS    [0]                                      # NumberOfBoli
(300a,00f0) IS    [0]                                      # NumberOfBlocks
(300a,0110) IS    [5]                                      # NumberOfControlPoints

(300a,0111) SQ    (Sequence with explicit Length #=5)    # ControlPointSequence
```

RT-Plan Beams Module

Step and Shoot IMRT

Machine capability: Modalities

```
(300a,00b6) SQ    (Sequence with explicit Length #=3)     # BeamLimitingDeviceSequence
  (300a,00b8) CS    [ASYMX]                                 # RTBeamLimitingDeviceType
  (300a,00bc) IS    [1]                                     # NumberOfLeafJawPairs
  (300a,00b8) CS    [ASYMY]                                 # RTBeamLimitingDeviceType
  (300a,00bc) IS    [1]                                     # NumberOfLeafJawPairs
  (300a,00b8) CS    [MLCX]                                  # RTBeamLimitingDeviceType
  (300a,00bc) IS    [40]                                    # NumberOfLeafJawPairs
  (300a,00be) DS    [-200.0\-190.0\-180.0\-170.0\-160.0\
                     -150.0\-140.0\-130.0\-120.0\-110.0\
                     -100.0\-90.0\-80.0\-70.0\-60.0\
                     -50.0\-40.0\-30.0\-20.0\-10.0\
                     0.0\10.00\20.00\30.00\40.00\
                     50.00\60.00\70.00\80.00\90.00\
                     100.0\110.0\120.0\130.0\140.0\
                     150.0\160.0\170.0\180.0\190.0\200.0]  # LeafPositionBoundaries

(300a,00c4) CS    [STATIC]                                # BeamType
(300a,00c6) CS    [PHOTON]                                # RadiationType
(300a,00d0) IS    [0]                                     # NumberOfWedges
(300a,00e0) IS    [0]                                     # NumberOfCompensators
(300a,00ed) IS    [0]                                     # NumberOfBoli
(300a,00f0) IS    [0]                                     # NumberOfBlocks
(300a,0110) IS    [5]                                     # NumberOfControlPoints

(300a,0111) SQ    (Sequence with explicit Length #=5)     # ControlPointSequence
```

3 segments

RT-Plan Beams Module

Step and Shoot IMRT

1st segment: CP0 & CP1

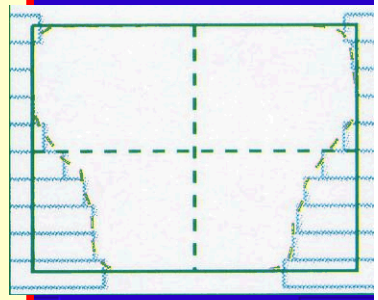
```
(300a,0112) IS    [0]                                    # ControlPointIndex
(300a,0114) DS    [6.0]                                  # NominalBeamEnergy

  (300a,011a) SQ    (Sequence with explicit Length #=3)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-60.0\60.0]                         # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                         # LeafJawPositions
  (300a,00b8) CS    [MLCX]                               # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \-60.0\-55.1\-45.0\-41.2\-32.5\ …
                    \32.5\41.2\45.0\55.1\60.0\ …
                     0.0\0.0\0.0\0.0\0.0]                # LeafJawPositions

(300a,011e) DS    [180.0]                                # GantryAngle
(300a,011f) CS    [NONE]                                 # GantryRotationDirection
(300a,0120) DS    [0.0]                                  # BeamLimitingDeviceAngle
(300a,0121) CS    [NONE]                                 # BeamLimitingDeviceRotationDirection
(300a,0122) DS    [0.0]                                  # PatientSupportAngle
(300a,0123) CS    [NONE]                                 # PatientSupportRotationDirection
(300a,0125) DS    [0.0]                                  # TableTopEccentricAngle
(300a,0126) CS    [NONE]                                 # TableTopEccentricRotationDirection
(300a,0128) DS    (no value available)                   # TableTopVerticalPosition
(300a,0129) DS    (no value available)                   # TableTopLongitudinalPosition
(300a,012a) DS    (no value available)                   # TableTopLateralPosition
(300a,0134) DS    [0.0]                                  # CumulativeMetersetWeight

(300a,0112) IS    [1]                                    # ControlPointIndex
(300a,0134) DS    [0.290]                                # CumulativeMetersetWeight
```

RT-Plan Beams Module

Step and Shoot IMRT

Control Point 0: Setup the geometry of 1st segment

```
(300a,0112) IS    [0]                                    # ControlPointIndex
(300a,0114) DS    [6.0]                                  # NominalBeamEnergy

  (300a,011a) SQ    (Sequence with explicit Length #=3)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-60.0\60.0]                         # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                         # LeafJawPositions
  (300a,00b8) CS    [MLCX]                               # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \-60.0\-55.1\-45.0\-41.2\-32.5\ …
                    \32.5\41.2\45.0\55.1\60.0\ …
                     0.0\0.0\0.0\0.0\0.0]                # LeafJawPositions

(300a,011e) DS    [180.0]                                # GantryAngle
(300a,011f) CS    [NONE]                                 # GantryRotationDirection
(300a,0120) DS    [0.0]                                  # BeamLimitingDeviceAngle
(300a,0121) CS    [NONE]                                 # BeamLimitingDeviceRotationDirection
(300a,0122) DS    [0.0]                                  # PatientSupportAngle
(300a,0123) CS    [NONE]                                 # PatientSupportRotationDirection
(300a,0125) DS    [0.0]                                  # TableTopEccentricAngle
(300a,0126) CS    [NONE]                                 # TableTopEccentricRotationDirection
(300a,0128) DS    (no value available)                   # TableTopVerticalPosition
(300a,0129) DS    (no value available)                   # TableTopLongitudinalPosition
(300a,012a) DS    (no value available)                   # TableTopLateralPosition
(300a,0134) DS    [0.0]                                  # CumulativeMetersetWeight

(300a,0112) IS    [1]                                    # ControlPointIndex
(300a,0134) DS    [0.290]                                # CumulativeMetersetWeight
```

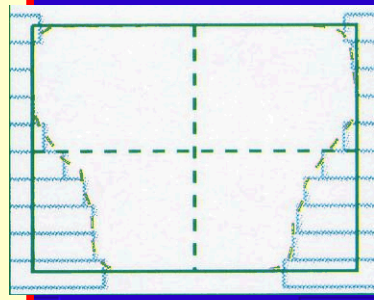


RT-Plan Beams Module

Step and Shoot IMRT

Control Point 1: Deliver irradiation w/o movements

```
(300a,0112) IS    [0]                                    # ControlPointIndex
(300a,0114) DS    [6.0]                                  # NominalBeamEnergy

  (300a,011a) SQ    (Sequence with explicit Length #=3)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-60.0\60.0]                         # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                         # LeafJawPositions
  (300a,00b8) CS    [MLCX]                               # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \-60.0\-55.1\-45.0\-41.2\-32.5\ …
                    \32.5\41.2\45.0\55.1\60.0\ …
                     0.0\0.0\0.0\0.0\0.0]                # LeafJawPositions

(300a,011e) DS    [180.0]                                # GantryAngle
(300a,011f) CS    [NONE]                                 # GantryRotationDirection
(300a,0120) DS    [0.0]                                  # BeamLimitingDeviceAngle
(300a,0121) CS    [NONE]                                 # BeamLimitingDeviceRotationDirection
(300a,0122) DS    [0.0]                                  # PatientSupportAngle
(300a,0123) CS    [NONE]                                 # PatientSupportRotationDirection
(300a,0125) DS    [0.0]                                  # TableTopEccentricAngle
(300a,0126) CS    [NONE]                                 # TableTopEccentricRotationDirection
(300a,0128) DS    (no value available)                   # TableTopVerticalPosition
(300a,0129) DS    (no value available)                   # TableTopLongitudinalPosition
(300a,012a) DS    (no value available)                   # TableTopLateralPosition
(300a,0134) DS    [0.0]                                  # CumulativeMetersetWeight

(300a,0112) IS    [1]                                    # ControlPointIndex
(300a,0134) DS    [0.2901]                               # CumulativeMetersetWeight
```



RT-Plan Beams Module

Step and Shoot IMRT

Segments 2&3: CP2, CP3, CP4 & CP5

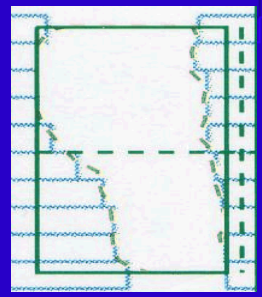
```
(300a,0112) IS    [2]                                          # ControlPointIndex
  (300a,011a) SQ    (Sequence with explicit Length #=3)      # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                                  # RTBeamLimitingDeviceType
  (300a,011c) DS    [-60.0\-5.0]                             # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                                  # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                             # LeafJawPositions
  (300a,00b8) CS    [MLCX]                                   # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \-60.0\-55.1\-45.0\-41.2\-32.5\ …
                    \-5.1\-5.5\-8.2\-10.3\-10.9\ …
                     0.0\0.0\0.0\0.0\0.0]                     # LeafJawPositions
(300a,0134) DS    [0.290]                                      # CumulativeMetersetWeight

(300a,0112) IS    [3]                                          # ControlPointIndex
(300a,0134) DS    [0.663]                                      # CumulativeMetersetWeight

(300a,0112) IS    [4]                                          # ControlPointIndex
  (300a,011a) SQ    (Sequence with explicit Length #=3)      # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                                  # RTBeamLimitingDeviceType
  (300a,011c) DS    [-2.0\60.0]                              # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                                  # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                             # LeafJawPositions
  (300a,00b8) CS    [MLCX]                                   # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \20.0\8.0\8.0\80\5.0\ …
                    \32.5\41.2\45.0\55.1\60.0\ …
                     0.0\0.0\0.0\0.0\0.0]                     # LeafJawPositions
(300a,0134) DS    [0.663]                                      # CumulativeMetersetWeight

(300a,0112) IS    [5]                                          # ControlPointIndex
(300a,0134) DS    [1.000]                                      # CumulativeMetersetWeight
```

RT-Plan Beams Module

Step and Shoot IMRT

CP2 : Setup the geometry of segments 2

```
(300a,0112) IS    [2]                                      # ControlPointIndex
  (300a,011a) SQ    (Sequence with explicit Length #=3)    # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                                # RTBeamLimitingDeviceType
  (300a,011c) DS    [-60.0\-5.0]                           # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                                # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                           # LeafJawPositions
  (300a,00b8) CS    [MLCX]                                 # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \-60.0\-55.1\-45.0\-41.2\-32.5\ …
                    \-5.1\-5.5\-8.2\-10.3\-10.9\ …
                     0.0\0.0\0.0\0.0\0.0]                  # LeafJawPositions
(300a,0134) DS    [0.290]                                  # CumulativeMetersetWeight

(300a,0112) IS    [3]                                      # ControlPointIndex
(300a,0134) DS    [0.663]                                  # CumulativeMetersetWeight

(300a,0112) IS    [4]                                      # ControlPointIndex
  (300a,011a) SQ    (Sequence with explicit Length #=3)    # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                                # RTBeamLimitingDeviceType
  (300a,011c) DS    [-2.0\60.0]                            # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                                # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                           # LeafJawPositions
  (300a,00b8) CS    [MLCX]                                 # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \20.0\8.0\8.0\80\5.0\ …
                    \32.5\41.2\45.0\55.1\60.0\ …
                     0.0\0.0\0.0\0.0\0.0]                  # LeafJawPositions
(300a,0134) DS    [0.663]                                  # CumulativeMetersetWeight

(300a,0112) IS    [5]                                      # ControlPointIndex
(300a,0134) DS    [1.000]                                  # CumulativeMetersetWeight
```

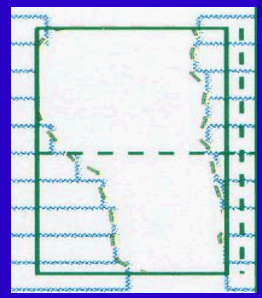


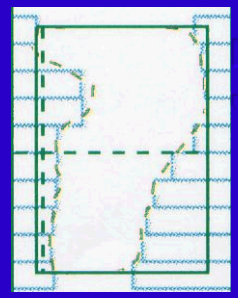
RT-Plan Beams Module

Step and Shoot IMRT

CP2 & CP4 : Setup the geometry of segments 2 & 3

```
(300a,0112) IS    [2]                                    # ControlPointIndex
  (300a,011a) SQ    (Sequence with explicit Length #=3)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-60.0\-5.0]                         # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                         # LeafJawPositions
  (300a,00b8) CS    [MLCX]                               # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \-60.0\-55.1\-45.0\-41.2\-32.5\ …
                    \-5.1\-5.5\-8.2\-10.3\-10.9\ …
                     0.0\0.0\0.0\0.0\0.0]                # LeafJawPositions
(300a,0134) DS    [0.290]                                # CumulativeMetersetWeight

(300a,0112) IS    [3]                                    # ControlPointIndex
(300a,0134) DS    [0.663]                                # CumulativeMetersetWeight

(300a,0112) IS    [4]                                    # ControlPointIndex
  (300a,011a) SQ    (Sequence with explicit Length #=3)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-2.0\60.0]                          # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                         # LeafJawPositions
  (300a,00b8) CS    [MLCX]                               # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \20.0\8.0\8.0\80\5.0\ …
                    \32.5\41.2\45.0\55.1\60.0\ …
                     0.0\0.0\0.0\0.0\0.0]                # LeafJawPositions
(300a,0134) DS    [0.663]                                # CumulativeMetersetWeight

(300a,0112) IS    [5]                                    # ControlPointIndex
(300a,0134) DS    [1.000]                                # CumulativeMetersetWeight
```



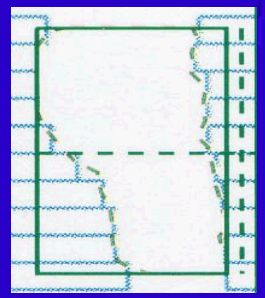


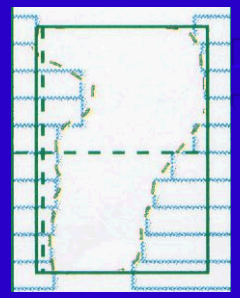
RT-Plan Beams Module

Step and Shoot IMRT

CP3 & CP5 : Deliver irradiation w/o movements

```
(300a,0112) IS    [2]                                    # ControlPointIndex
  (300a,011a) SQ    (Sequence with explicit Length #=3)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-60.0\-5.0]                         # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                         # LeafJawPositions
  (300a,00b8) CS    [MLCX]                               # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \-60.0\-55.1\-45.0\-41.2\-32.5\ …
                    \-5.1\-5.5\-8.2\-10.3\-10.9\ …
                     0.0\0.0\0.0\0.0\0.0]                # LeafJawPositions
(300a,0134) DS    [0.290]                                # CumulativeMetersetWeight

(300a,0112) IS    [3]                                    # ControlPointIndex
(300a,0134) DS    [0.663]                                # CumulativeMetersetWeight

(300a,0112) IS    [4]                                    # ControlPointIndex
  (300a,011a) SQ    (Sequence with explicit Length #=3)  # BeamLimitingDevicePositionSequence
  (300a,00b8) CS    [ASYMX]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-2.0\60.0]                          # LeafJawPositions
  (300a,00b8) CS    [ASYMY]                              # RTBeamLimitingDeviceType
  (300a,011c) DS    [-45.0\45.0]                         # LeafJawPositions
  (300a,00b8) CS    [MLCX]                               # RTBeamLimitingDeviceType
  (300a,011c) DS    [0.0\0.0\0.0\0.0\-0.0\...
                    \20.0\8.0\8.0\80\5.0\ …
                    \32.5\41.2\45.0\55.1\60.0\ …
                     0.0\0.0\0.0\0.0\0.0]                # LeafJawPositions
(300a,0134) DS    [0.663]                                # CumulativeMetersetWeight

(300a,0112) IS    [5]                                    # ControlPointIndex
(300a,0134) DS    [1.000]                                # CumulativeMetersetWeight
```





RT-Plan Beams Module

RT-Plan IOD Module Table

Entity Name	Module Name	Usage
Patient	Patient	M
Study	Study	M
	Patient Study	U
Series	RT Series	M
Equipment	General Equipment	M
Plan	RT General Plan	M
	RT prescription	U
	RT Tolerance Tables	U
	RT Patient Setup	U
	RT Fraction Scheme	U
	RT Beams	C
	RT Brachy Application Setups	C
	Approval	U
	Audio	U
	SOP Common	M

Dosimetry in

RT-Plan dosimetry

1) Beams dosimetry

```
(300a,0070) SQ    (Sequence with explicit Length #=1)     # FractionGroupSequence
  (300a,0071) IS    [1]                                   # FractionGroupNumber
  (300a,0078) IS    [35]                                  # NumberOfFractionsPlanned
  (300a,0080) IS    [2]                                   # NumberOfBeams

(300c,0004) SQ    (Sequence with explicit Length #=2)     # ReferencedBeamSequence
    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [102.5]                             # BeamMeterset
    (300c,0006) IS    [1]                                 # ReferencedBeamNumber

    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [97.5]                              # BeamMeterset
    (300c,0006) IS    [2]                                 # ReferencedBeamNumber
```

RT-Plan Fraction scheme Module

RT-Plan dosimetry

1) Beams dosimetry

Number of fractions

```
(300a,0070) SQ    (Sequence with explicit Length #=1)     # FractionGroupSequence
  (300a,0071) IS    [1]                                   # FractionGroupNumber
  (300a,0078) IS    [35]                                  # NumberOfFractionsPlanned
  (300a,0080) IS    [2]                                   # NumberOfBeams

(300c,0004) SQ    (Sequence with explicit Length #=2)     # ReferencedBeamSequence
    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [102.5]                             # BeamMeterset
    (300c,0006) IS    [1]                                 # ReferencedBeamNumber

    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [97.5]                              # BeamMeterset
    (300c,0006) IS    [2]                                 # ReferencedBeamNumber
```

RT-Plan Fraction scheme Module

RT-Plan dosimetry

1) Beams dosimetry

Number of beams (example: AP-PA)

```
(300a,0070) SQ    (Sequence with explicit Length #=1)     # FractionGroupSequence
  (300a,0071) IS    [1]                                   # FractionGroupNumber
  (300a,0078) IS    [35]                                  # NumberOfFractionsPlanned
  (300a,0080) IS    [2]                                   # NumberOfBeams

(300c,0004) SQ    (Sequence with explicit Length #=2)     # ReferencedBeamSequence
    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [102.5]                             # BeamMeterset
    (300c,0006) IS    [1]                                 # ReferencedBeamNumber

    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [97.5]                              # BeamMeterset
    (300c,0006) IS    [2]                                 # ReferencedBeamNumber
```

RT-Plan Fraction scheme Module

RT-Plan dosimetry

1) Beams dosimetry

Beam 1 -> 1Gy / 102.5 MU

```
(300a,0070) SQ    (Sequence with explicit Length #=1)     # FractionGroupSequence
  (300a,0071) IS    [1]                                   # FractionGroupNumber
  (300a,0078) IS    [35]                                  # NumberOfFractionsPlanned
  (300a,0080) IS    [2]                                   # NumberOfBeams

(300c,0004) SQ    (Sequence with explicit Length #=2)     # ReferencedBeamSequence
    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [102.5]                             # BeamMeterset
    (300c,0006) IS    [1]                                 # ReferencedBeamNumber

    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [97.5]                              # BeamMeterset
    (300c,0006) IS    [2]                                 # ReferencedBeamNumber
```

AP

RT-Plan Fraction scheme Module

RT-Plan dosimetry

1) Beams dosimetry

Beam 1 -> 1Gy / 102.5 MU Beam 2 -> 1Gy / 97.5 MU

```
(300a,0070) SQ    (Sequence with explicit Length #=1)     # FractionGroupSequence
  (300a,0071) IS    [1]                                   # FractionGroupNumber
  (300a,0078) IS    [35]                                  # NumberOfFractionsPlanned
  (300a,0080) IS    [2]                                   # NumberOfBeams

(300c,0004) SQ    (Sequence with explicit Length #=2)     # ReferencedBeamSequence
    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [102.5]                             # BeamMeterset
    (300c,0006) IS    [1]                                 # ReferencedBeamNumber

    (300a,0082) DS    [230.6\241.2\-1270.4]               # BeamDoseSpecificationPoint
    (300a,0084) DS    [1.000]                             # BeamDose
    (300a,0086) DS    [97.5]                              # BeamMeterset
    (300c,0006) IS    [2]                                 # ReferencedBeamNumber
```

PA

RT-Plan Fraction scheme Module

RT-Plan dosimetry

2) Definition of reference dose points

```
(300a,0010) SQ    (Sequence with explicit Length #=2)     # DoseReferenceSequence
  (300a,0012) IS    [1]                                   # DoseReferenceNumber
  (300a,0014) CS    [COORDINATES]                         # DoseReferenceStructureType
  (300a,0016) LO    [ICRU point]                          # DoseReferenceDescription
  (300a,0018) DS    [230.6\241.2\-1270.4]                 # DoseReferencePointCoordinates
  (300a,0020) CS    [TARGET]                              # DoseReferenceType
  (300a,002c) DS    [70.0]                                # TargetMaximumDose

  (300a,0012) IS    [2]                                   # DoseReferenceNumber
  (300a,0014) CS    [COORDINATES]                         # DoseReferenceStructureType
  (300a,0016) LO    [Bladder]                             # DoseReferenceDescription
  (300a,0018) DS    [225.1\198.6\-1275.3]                 # DoseReferencePointCoordinates
  (300a,0020) CS    [ORGAN_AT_RISK]                       # DoseReferenceType
  (300a,002c) DS    [45.0]                                # OrganAtRiskMaximumDose
```

RT-Plan Prescription Module

RT-Plan dosimetry

2) Definition of reference dose points

1. ICRU 2. Bladder

```
(300a,0010) SQ    (Sequence with explicit Length #=2)     # DoseReferenceSequence
  (300a,0012) IS    [1]                                     # DoseReferenceNumber
  (300a,0014) CS    [COORDINATES]                           # DoseReferenceStructureType
  (300a,0016) LO    [ICRU point]                            # DoseReferenceDescription
  (300a,0018) DS    [230.6\241.2\-1270.4]                   # DoseReferencePointCoordinates
  (300a,0020) CS    [TARGET]                                # DoseReferenceType
  (300a,002c) DS    [70.0]                                  # TargetMaximumDose

  (300a,0012) IS    [2]                                     # DoseReferenceNumber
  (300a,0014) CS    [COORDINATES]                           # DoseReferenceStructureType
  (300a,0016) LO    [Bladder]                               # DoseReferenceDescription
  (300a,0018) DS    [225.1\198.6\-1275.3]                   # DoseReferencePointCoordinates
  (300a,0020) CS    [ORGAN_AT_RISK]                         # DoseReferenceType
  (300a,002c) DS    [45.0]                                  # OrganAtRiskMaximumDose
```

RT-Plan Prescription Module

RT-Plan dosimetry

Use the control points concept

```
FROM MODULE RT-PLAN FRACTION ScHEME:

(300a,0084) DS    [1.000]                                  # BeamDose
(300a,0086) DS    [102.5]                                  # BeamMeterset

FROM MODULE RT-PLAN BEAMS:

(300a,010e) DS    [100.0]                                  # FinalCumulativeMetersetWeight
(300a,0111) SQ    (Sequence with explicit Length #=2)      # ControlPointSequence

(300a,0112) IS    [0]                                      # ControlPointIndex
(300a,0134) DS    [0.0]                                    # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
...

(300a,0112) IS    [1]                                      # ControlPointIndex
(300a,0134) DS    [20.0]                                   # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.200]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.122]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
```

RT-Plan Entity

RT-Plan dosimetry

1. For each beam, dose in Gy and MU's are given

```
FROM MODULE RT-PLAN FRACTION SCHEME:

(300a,0084) DS    [1.000]                                  # BeamDose
(300a,0086) DS    [102.5]                                  # BeamMeterset

FROM MODULE RT-PLAN BEAMS:

(300a,010e) DS    [100.0]                                  # FinalCumulativeMetersetWeight
(300a,0111) SQ    (Sequence with explicit Length #=2)      # ControlPointSequence

(300a,0112) IS    [0]                                      # ControlPointIndex
(300a,0134) DS    [0.0]                                    # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
...

(300a,0112) IS    [1]                                      # ControlPointIndex
(300a,0134) DS    [20.0]                                   # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.200]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.122]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
```

AP

RT-Plan Entity

RT-Plan dosimetry

2. @CP0: The cumulative coefficients are set to 0

```
FROM MODULE RT-PLAN FRACTION ScHEME:

(300a,0084) DS    [1.000]                                  # BeamDose
(300a,0086) DS    [102.5]                                  # BeamMeterset

FROM MODULE RT-PLAN BEAMS:

(300a,010e) DS    [100.0]                                  # FinalCumulativeMetersetWeight
(300a,0111) SQ    (Sequence with explicit Length #=2)      # ControlPointSequence

(300a,0112) IS    [0]                                      # ControlPointIndex
(300a,0134) DS    [0.0]                                    # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
...

(300a,0112) IS    [1]                                      # ControlPointIndex
(300a,0134) DS    [20.0]                                   # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.200]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.122]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
```

RT-Plan Entity

RT-Plan dosimetry

2. @CP1: MU given = 102.5 / 100.0 x 20.0 = 20.5

```
FROM MODULE RT-PLAN FRACTION SCHEME:

(300a,0084) DS    [1.000]                                  # BeamDose
(300a,0086) DS    [102.5]                                  # BeamMeterset

FROM MODULE RT-PLAN BEAMS:

(300a,010e) DS    [100.0]                                  # FinalCumulativeMetersetWeight
(300a,0111) SQ    (Sequence with explicit Length #=2)      # ControlPointSequence

(300a,0112) IS    [0]                                      # ControlPointIndex
(300a,0134) DS    [0.0]                                    # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
...

(300a,0112) IS    [1]                                      # ControlPointIndex
(300a,0134) DS    [20.0]                                   # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.200]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.122]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
```

RT-Plan Entity

RT-Plan dosimetry

2. @CP1: Dose @ pt1 = 1.000 x 0.200 = 0.2 Gy

```
FROM MODULE RT-PLAN FRACTION SCHEME:

(300a,0084) DS    [1.000]                                  # BeamDose
(300a,0086) DS    [102.5]                                  # BeamMeterset

FROM MODULE RT-PLAN BEAMS:

(300a,010e) DS    [100.0]                                  # FinalCumulativeMetersetWeight
(300a,0111) SQ    (Sequence with explicit Length #=2)      # ControlPointSequence

(300a,0112) IS    [0]                                      # ControlPointIndex
(300a,0134) DS    [0.0]                                    # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
...

(300a,0112) IS    [1]                                      # ControlPointIndex
(300a,0134) DS    [20.0]                                   # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.200]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.122]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
```

RT-Plan Entity

RT-Plan dosimetry

2. @CP1: Dose @ pt2 = 1.000 x 0.122 = 0.122 Gy

```
FROM MODULE RT-PLAN FRACTION SCHEME:

(300a,0084) DS    [1.000]                                  # BeamDose
(300a,0086) DS    [102.5]                                  # BeamMeterset

FROM MODULE RT-PLAN BEAMS:

(300a,010e) DS    [100.0]                                  # FinalCumulativeMetersetWeight
(300a,0111) SQ    (Sequence with explicit Length #=2)      # ControlPointSequence

(300a,0112) IS    [0]                                      # ControlPointIndex
(300a,0134) DS    [0.0]                                    # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
...

(300a,0112) IS    [1]                                      # ControlPointIndex
(300a,0134) DS    [20.0]                                   # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.200]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.122]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
```

RT-Plan Entity

RT-Plan dosimetry

3. @CPN-1: MU given = 102.5 / 100.0 x100.0 = 102.5

```
FROM MODULE RT-PLAN FRACTION ScHEME:

(300a,0084) DS    [1.000]                                  # BeamDose
(300a,0086) DS    [102.5]                                  # BeamMeterset

FROM MODULE RT-PLAN BEAMS:

(300a,010e) DS    [100.0]                                  # FinalCumulativeMetersetWeight
(300a,0111) SQ    (Sequence with explicit Length #=2)      # ControlPointSequence

(300a,0112) IS    [0]                                      # ControlPointIndex
(300a,0134) DS    [0.0]                                    # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
...

(300a,0112) IS    [N-1]                                    # ControlPointIndex
(300a,0134) DS    [100.0]                                  # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [1.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.641]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
```

RT-Plan Entity

RT-Plan dosimetry

3. @CPN-1: Dose @ pt1 = 1.000 x 1.000 = 1 Gy

```
FROM MODULE RT-PLAN FRACTION SCHEME:

(300a,0084) DS    [1.000]                                  # BeamDose
(300a,0086) DS    [102.5]                                  # BeamMeterset

FROM MODULE RT-PLAN BEAMS:

(300a,010e) DS    [100.0]                                  # FinalCumulativeMetersetWeight
(300a,0111) SQ    (Sequence with explicit Length #=2)      # ControlPointSequence

(300a,0112) IS    [0]                                      # ControlPointIndex
(300a,0134) DS    [0.0]                                    # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
...

(300a,0112) IS    [N-1]                                    # ControlPointIndex
(300a,0134) DS    [100.0]                                  # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [1.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.641]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
```

RT-Plan Entity

RT-Plan dosimetry

3. @CPN-1: Dose @ pt2 = 1.000 x 0.641 = 0.641 Gy

```
FROM MODULE RT-PLAN FRACTION SCHEME:

(300a,0084) DS    [1.000]                                  # BeamDose
(300a,0086) DS    [102.5]                                  # BeamMeterset

FROM MODULE RT-PLAN BEAMS:

(300a,010e) DS    [100.0]                                  # FinalCumulativeMetersetWeight
(300a,0111) SQ    (Sequence with explicit Length #=2)      # ControlPointSequence

(300a,0112) IS    [0]                                      # ControlPointIndex
(300a,0134) DS    [0.0]                                    # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
...

(300a,0112) IS    [N-1]                                    # ControlPointIndex
(300a,0134) DS    [100.0]                                  # CumulativeMetersetWeight
(300c,0050) SQ    (Sequence with explicit Length #=2)      # ReferencedDoseReferenceSequence
  (300a,010c) DS    [1.000]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [1]                                    # ReferencedDoseReferenceNumber
  (300a,010c) DS    [0.641]                                # CumulativeDoseReferenceCoefficient
  (300c,0051) IS    [2]                                    # ReferencedDoseReferenceNumber
```

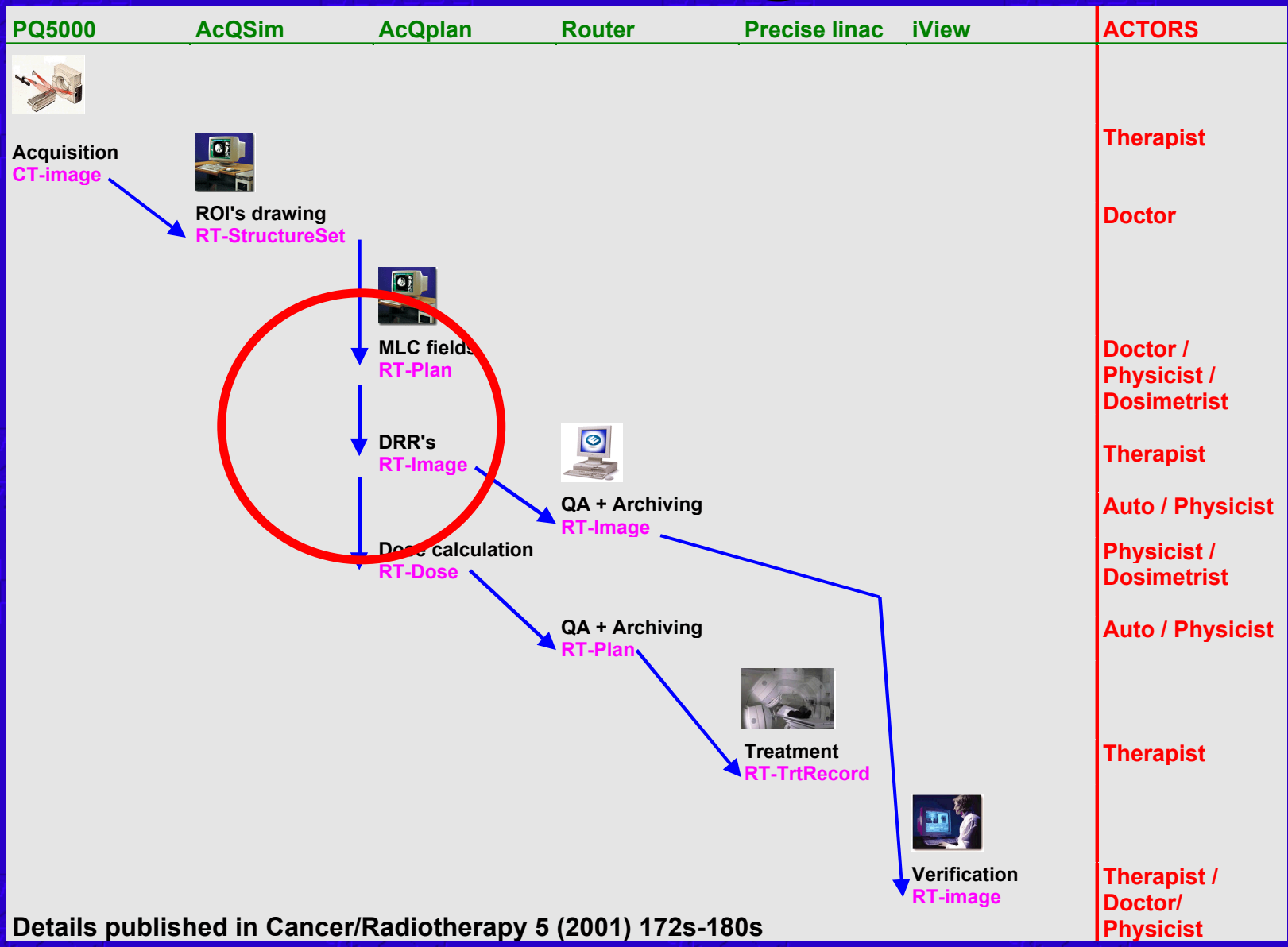
RT-Plan Entity

RT Workflow @ HCF

PQ5000	AcQSim	AcQplan	Router	Precise linac	iView	ACTORS
						
Acquisition CT-image	 ROI's drawing RT-StructureSet					Therapist Doctor
		 MLC fields RT-Plan				Doctor / Physicist / Dosimetrist
		DRR's RT-Image	 QA + Archiving RT-Image			Therapist Auto / Physicist
		Dose calculation RT-Dose				Physicist / Dosimetrist
			QA + Archiving RT-Plan	 Treatment RT-TrtRecord		Auto / Physicist Therapist
					 Verification RT-image	Therapist / Doctor/ Physicist

Details published in Cancer/Radiotherapy 5 (2001) 172s-180s

RT Workflow @ HCF

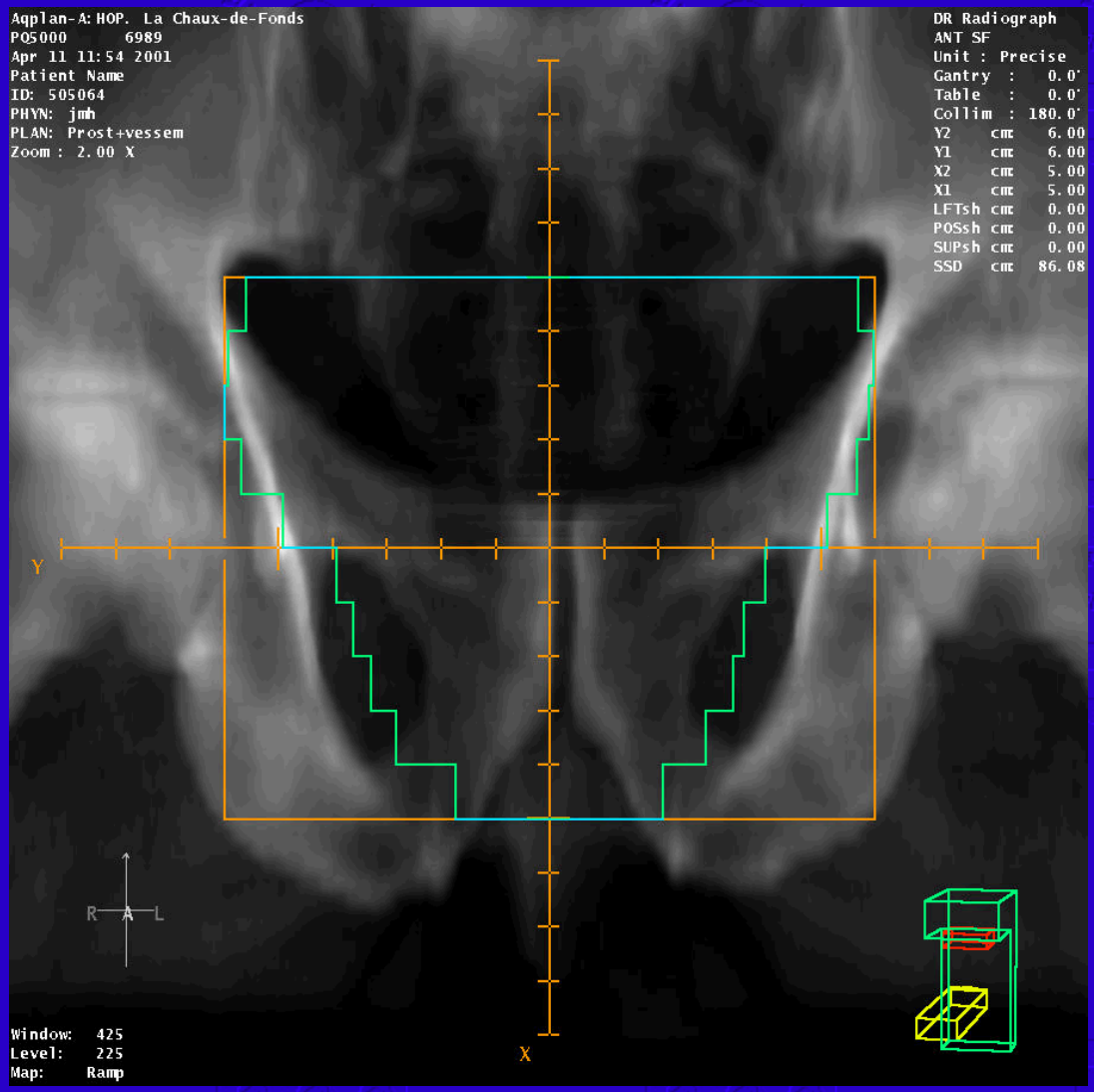


Simulation images

DRR's :

Serie of objects

RT-Image

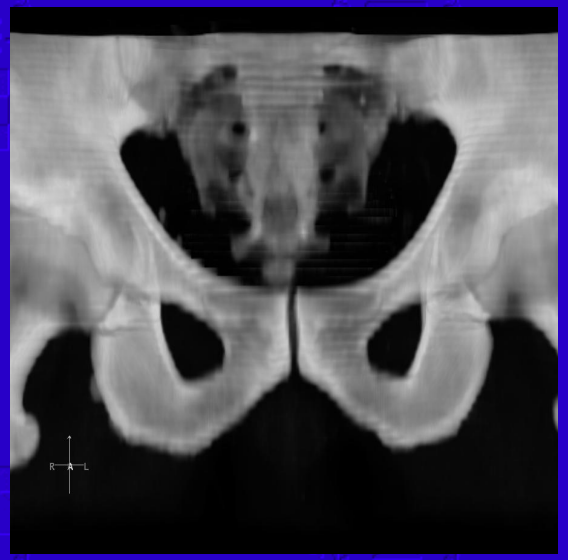


RT-Image IOD Module Table

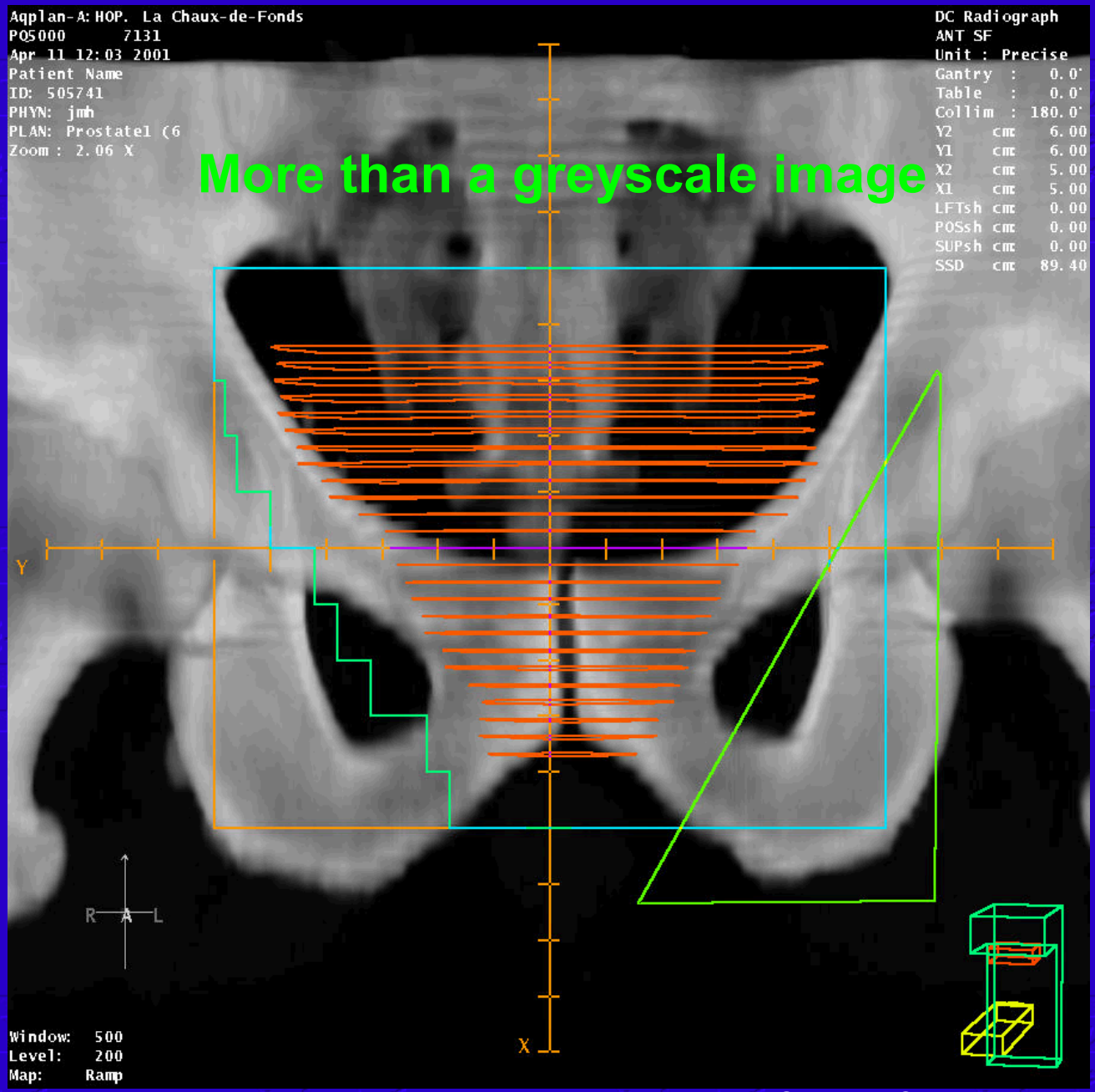
Entity Name	Module Name	Usage
Patient	Patient	M
Study	Study	M
	Patient Study	U
Series	RT Series	M
Frame of Reference	Frame of Reference	U
Equipment	General Equipment	M
Image	General Image	M
	Image Pixel	M
	Contrast/bolus	C
	Cine	C
	Multi-Frame	C
	RT Image	M
	Modality LUT	U
	VOI LUT	U
	Approval	U
	Curve	U
	Audio	U
	SOP Common	M

RT-Image pixel module

Tag value	VR	Value	DICOM name
(0008,0060)	CS	[RTIMAGE]	Modality
(3002,0012)	DS	[-80.99\80.99]	RTImagePosition
(3002,0011)	DS	[0.32\0.32]	ImagePlanePixelSpacing
(0028,0010)	US	512	Rows
(0028,0011)	US	512	Columns
(0028,0101)	US	8	BitsStored
(7fe0,0010)	OW	ffff\8cff\8d8d\ …\bebe\bebe\65be	PixelData



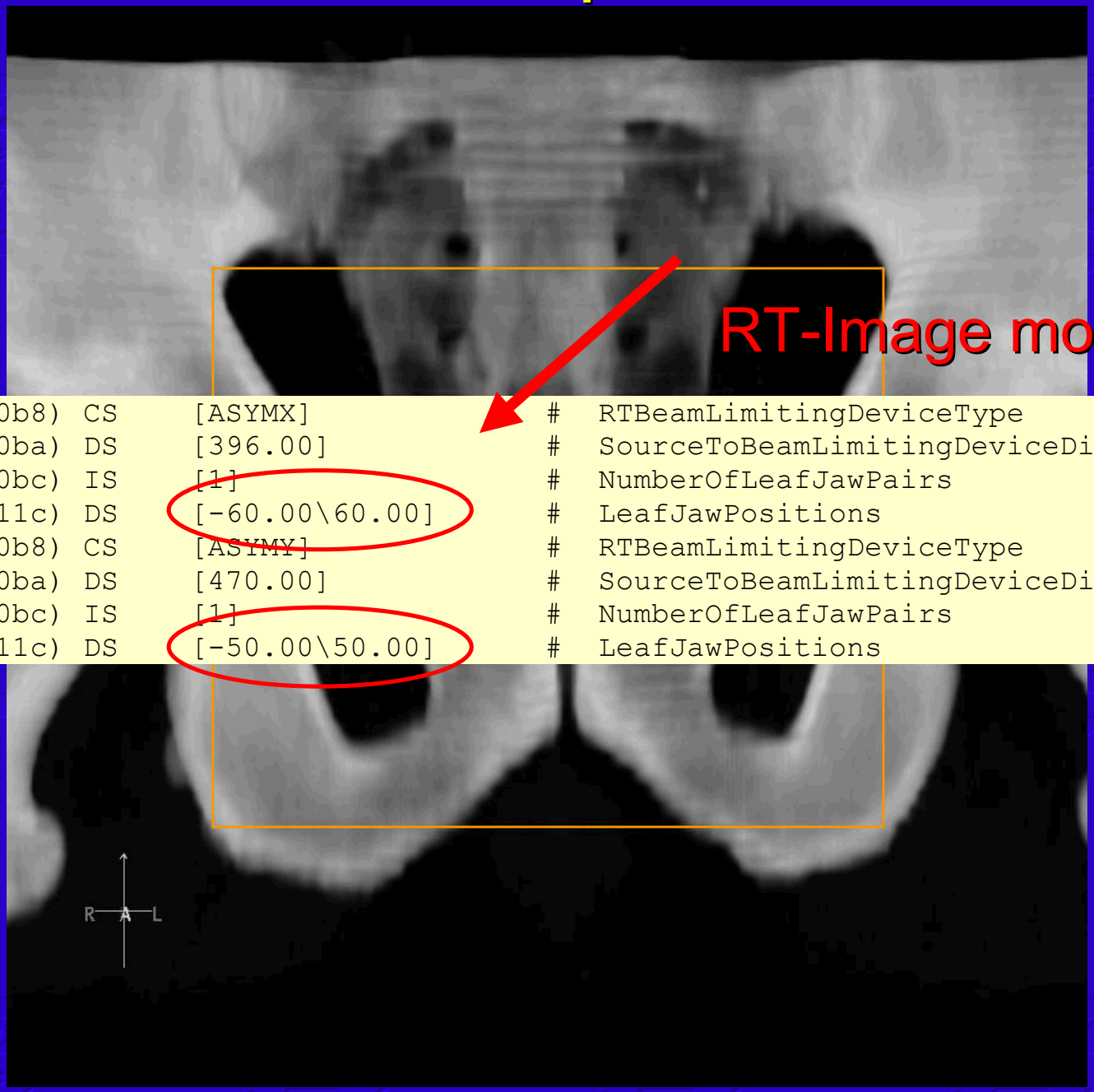
Visualization of the RT-Image IOD



RT-Image IOD Module Table

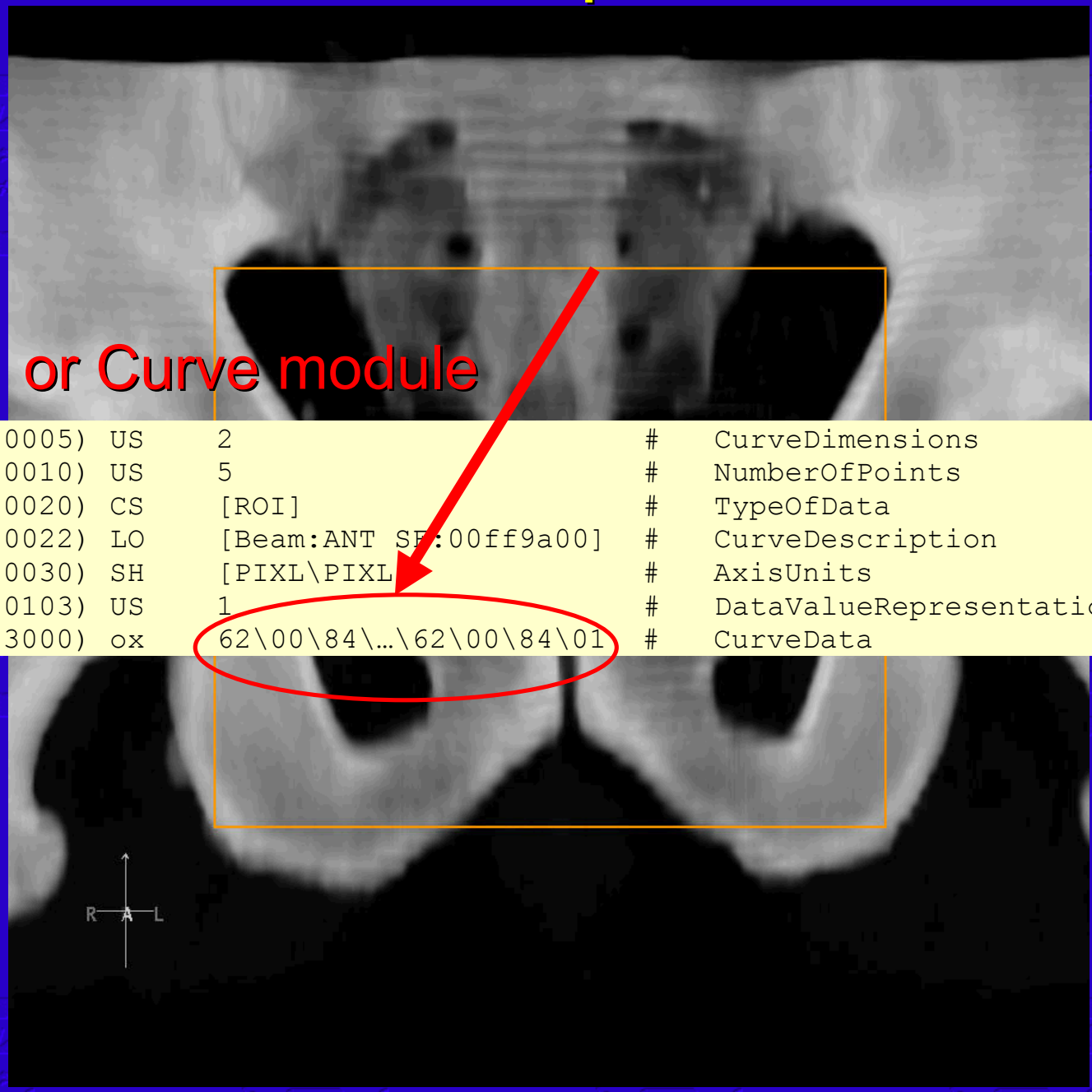
Entity Name	Module Name	Usage
Patient	Patient	M
Study	Study	M
	Patient Study	U
Series	RT Series	M
Frame of Reference	Frame of Reference	U
Equipment	General Equipment	M
Image	General Image	M
	Image Pixel	M
	Contrast/bolus	C
	Cine	C
	Multi-Frame	C
	RT Image	M
	Modality LUT	U
	VOI LUT	U
	Approval	U
	Curve	U
	Audio	U
	SOP Common	M

1: Jaws aperture



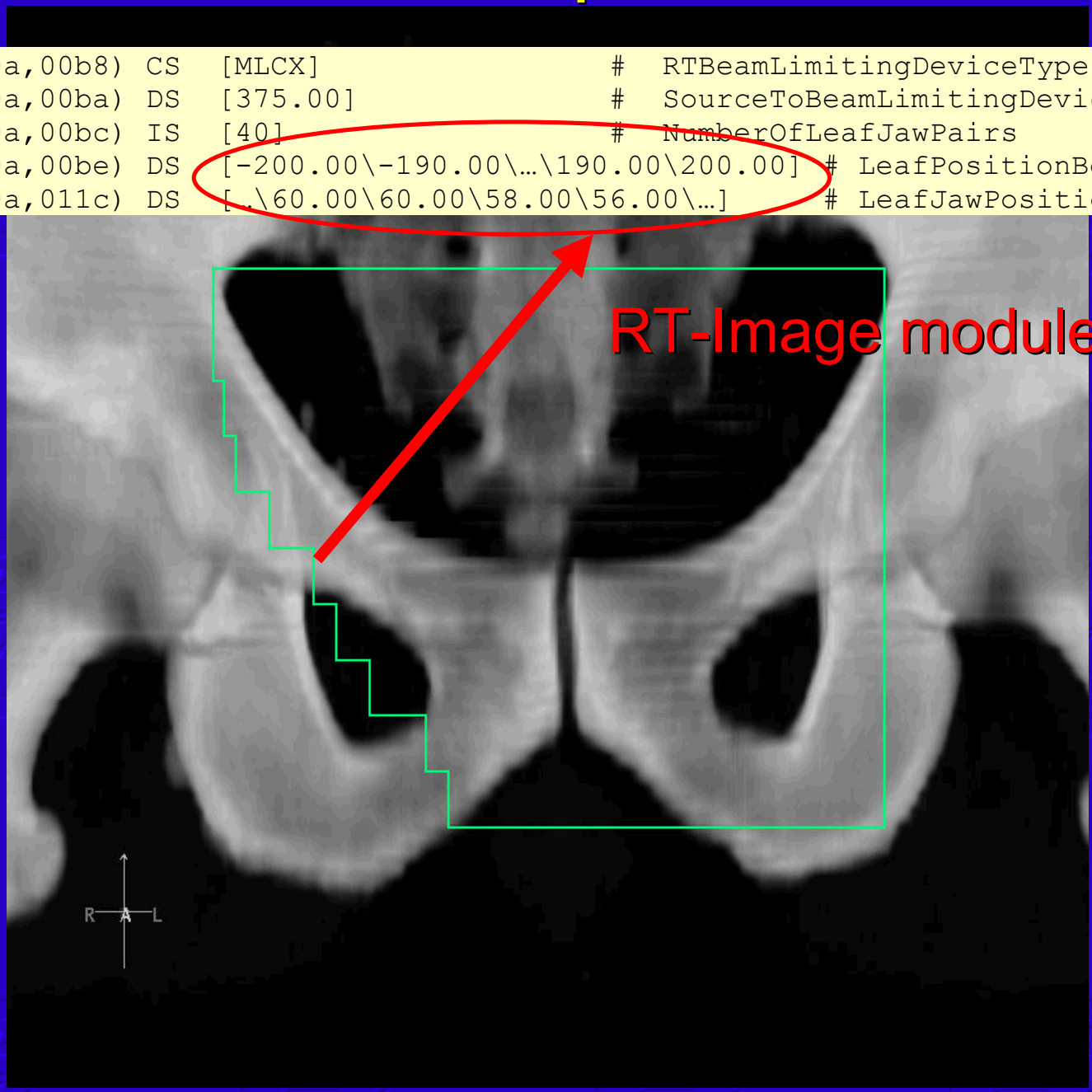

```
(300a,00b8) CS    [ASYMX]              #  RTBeamLimitingDeviceType
(300a,00ba) DS    [396.00]             #  SourceToBeamLimitingDeviceDistance
(300a,00bc) IS    [1]                  #  NumberOfLeafJawPairs
(300a,011c) DS    [-60.00\60.00]       #  LeafJawPositions
(300a,00b8) CS    [ASYMY]              #  RTBeamLimitingDeviceType
(300a,00ba) DS    [470.00]             #  SourceToBeamLimitingDeviceDistance
(300a,00bc) IS    [1]                  #  NumberOfLeafJawPairs
(300a,011c) DS    [-50.00\50.00]       #  LeafJawPositions
```

1: Jaws aperture



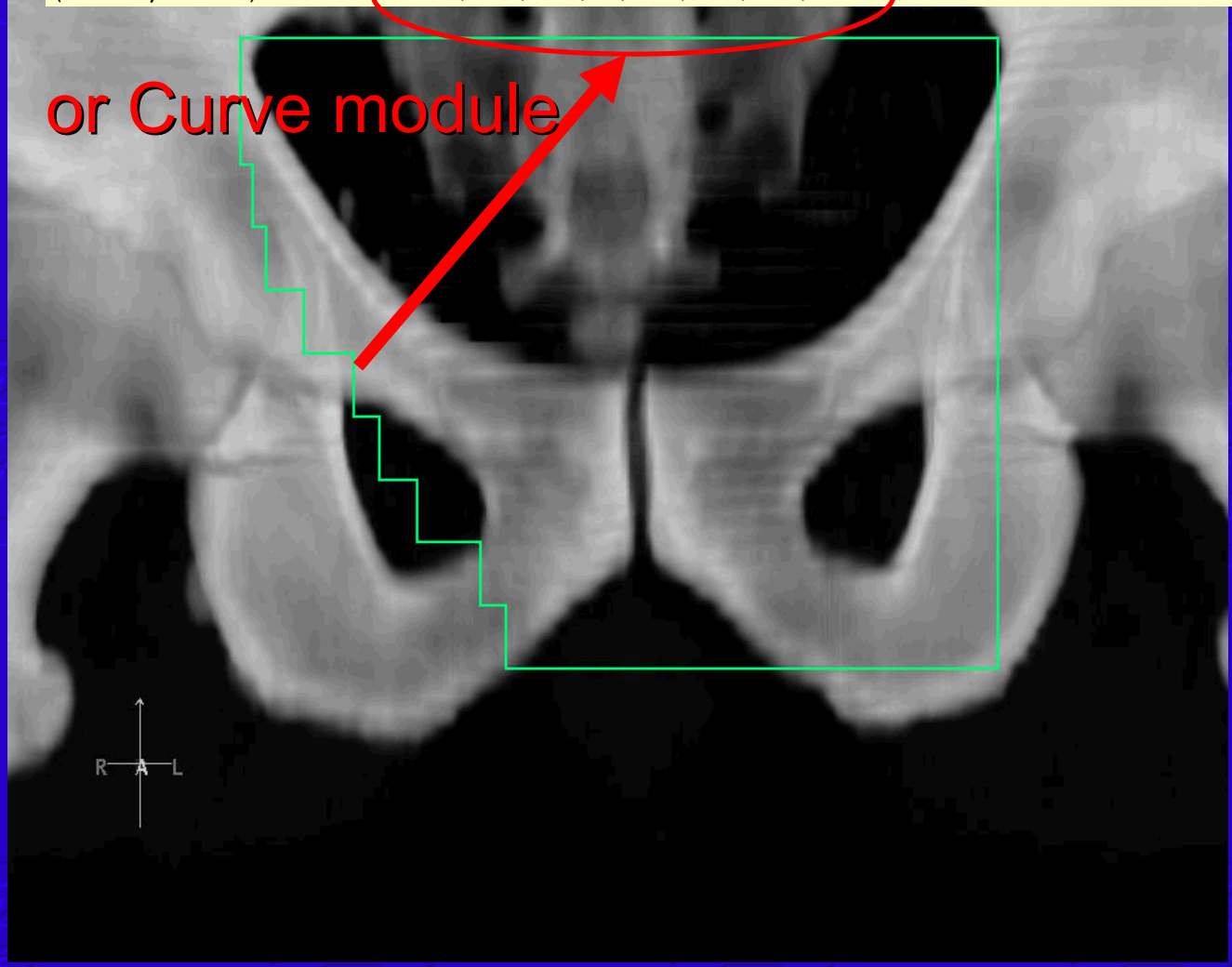
2: MLC aperture

```
(300a,00b8) CS   [MLCX]                          #   RTBeamLimitingDeviceType
(300a,00ba) DS   [375.00]                        #   SourceToBeamLimitingDeviceDistance
(300a,00bc) IS   [40]                            #   NumberOfLeafJawPairs
(300a,00be) DS   [-200.00\-190.00\…\190.00\200.00] # LeafPositionBoundaries
(300a,011c) DS   [.\60.00\60.00\58.00\56.00\…]     # LeafJawPositions
```

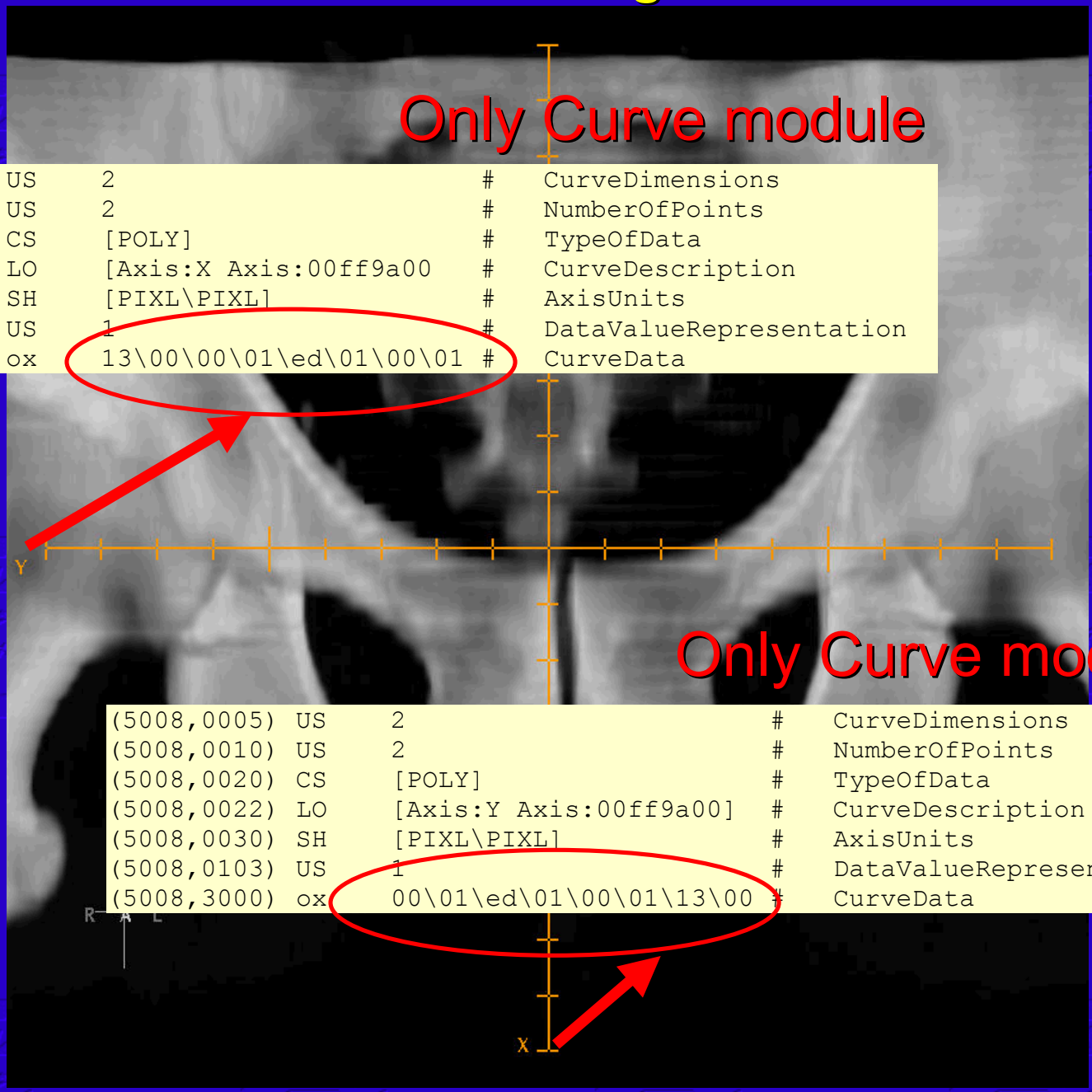


2: MLC aperture

```
(5002,0005) US    2                          #   CurveDimensions
(5002,0010) US    41                         #   NumberOfPoints
(5002,0020) CS    [ROI]                      #   TypeOfData
(5002,0022) LO    [MLC:MLC:0000ff7a]         #   CurveDescription
(5002,0030) SH    [PIXL\PIXL]                #   AxisUnits
(5002,0103) US    1                          #   DataValueRepresentation
(5002,3000) ox    9e\01\7c\…\9e\01\7c\00     #   CurveData
```



3: Axis and image center

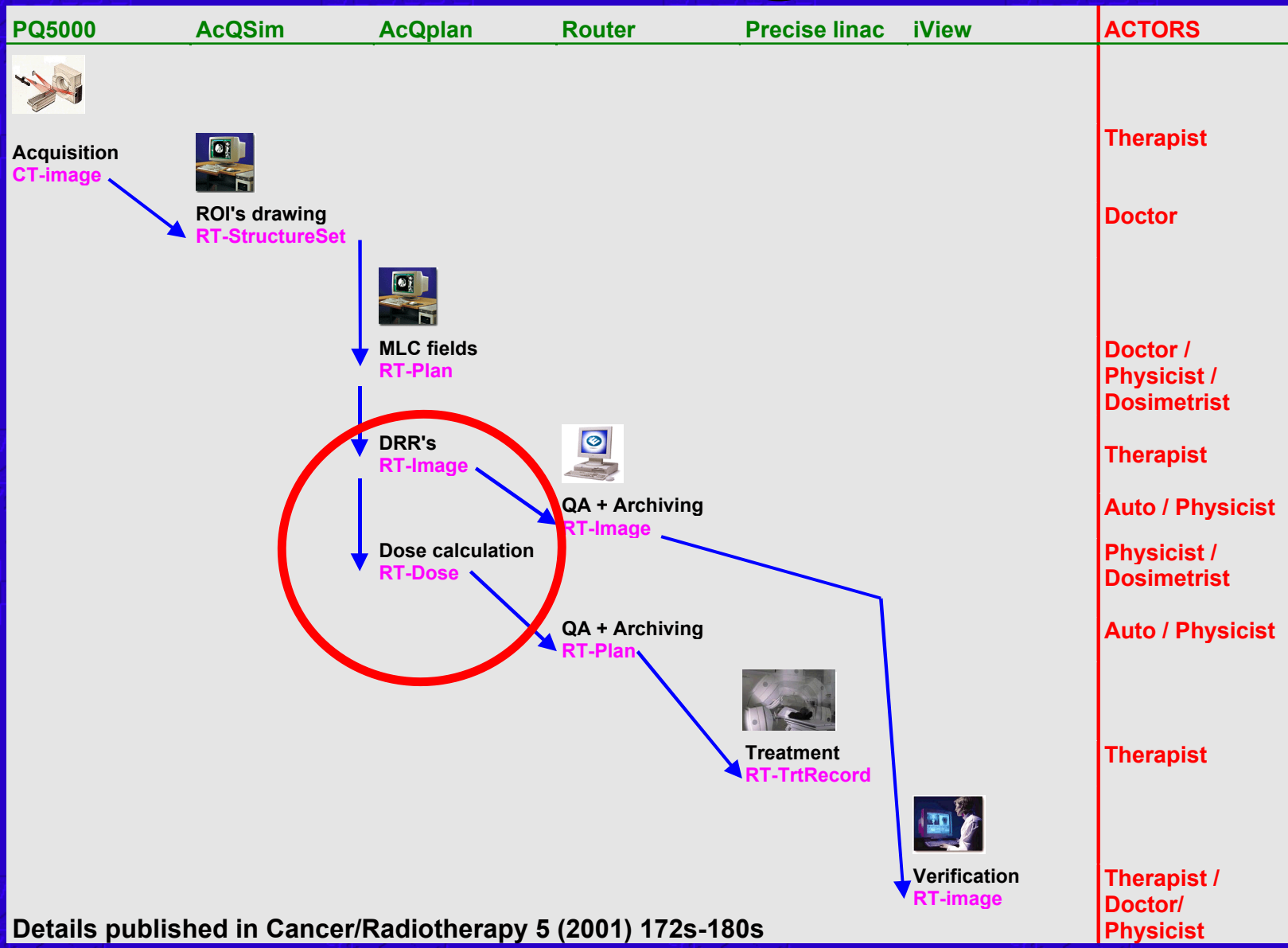


RT Workflow @ HCF

PQ5000	AcQSim	AcQplan	Router	Precise linac	iView	ACTORS
						
Acquisition CT-image	 ROI's drawing RT-StructureSet					Therapist Doctor
		 MLC fields RT-Plan				Doctor / Physicist / Dosimetrist
		DRR's RT-Image	 QA + Archiving RT-Image			Therapist Auto / Physicist
		Dose calculation RT-Dose	QA + Archiving RT-Plan	 Treatment RT-TrtRecord	 Verification RT-image	Physicist / Dosimetrist Auto / Physicist Therapist Therapist / Doctor/ Physicist

Details published in Cancer/Radiotherapy 5 (2001) 172s-180s

RT Workflow @ HCF

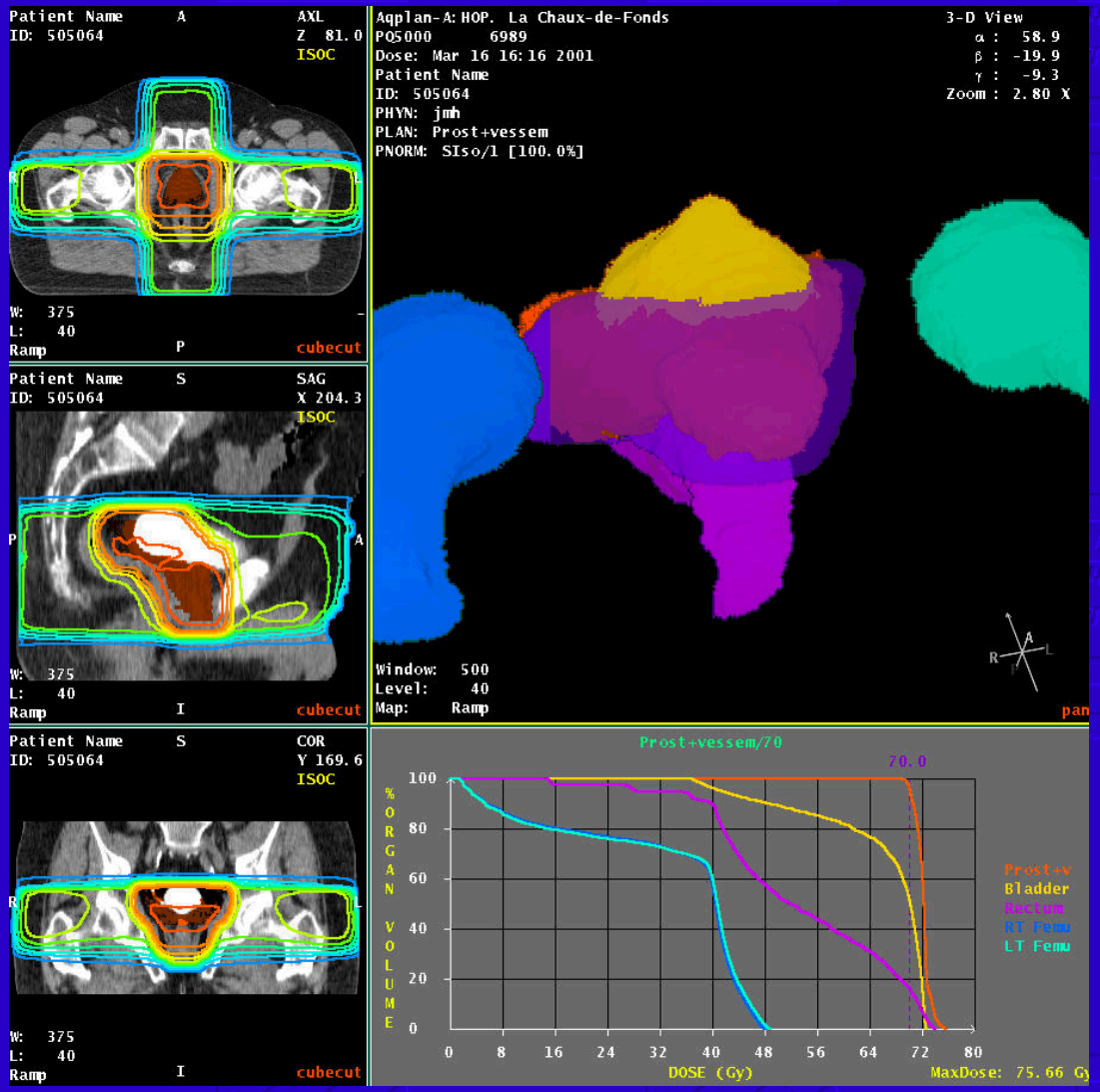


Dose distribution

- Dose matrix
- Isodose curves
- Isodose surface
- DVH

=>

1 object RT-Dose



RT-Dose IOD Module Table

Entity Name	Module Name	Usage
Patient	Patient	M
Study	Study	M
	Patient Study	U
Series	General Series	M
Frame of Reference	Frame of Reference	M
Equipment	General Equipme	
Dose	General Image	
	Image plane	C
	Image Pixel	C
	Multi-Frame	C
	RT Dose	M
	RT DVH	U
	Structure Set	C
	ROI contour	C
	RT Dose ROI	C
	Overlay Plan	U
	Multi-frame Overlay	U
	Audio	U
	Modality LUT	U
	SOP Common	M

Dose matrix

RT-Dose attributes

Tag value	VR	Value	DICOM name
(0008,0060)	CS	[RTDOSE]	Modality
(0028,0030)	DS	[2.50\2.50]	PixelSpacing
(0020,0032)	DS	[49.51\99.51\-1487.1	ImagePositionPatient
(0028,0010)	US	109	Rows
(0028,0011)	US	154	ns
(7fe0,0010)	OW	fc80\000a\67c8\	ixelData
(0028,0008)	IS	[76]	NumberOfFrames
(0028,0101)	US	32	BitsStored
(3004,0002)	CS	[GY] or [RELATIVE]	DoseUnits
(3004,0004)	CS	[PHYSICAL] or [EFFECTIVE] or [ERROR]	DoseType
(3004,000a)	CS	[FRACTION] or [BEAM] or [PLAN]	DoseSummationType
(3004,000c)	DS	0.00\3.00\6.00\9.00\12.00... 216.00\219.00\222.00\225.00	GridFrameOffsetVector
(3004,000e)]	DS	[.000000989]	DoseGridScaling

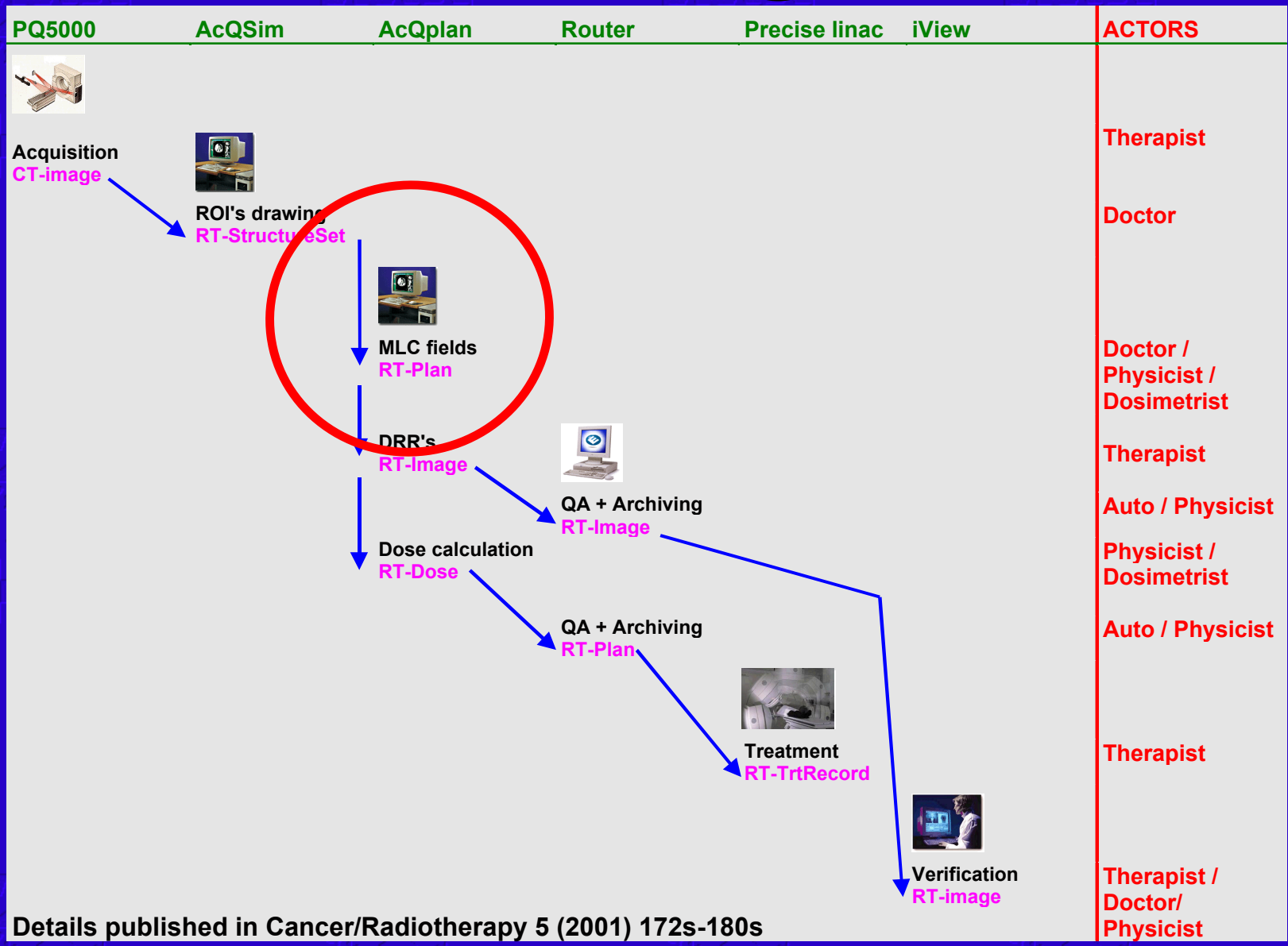
Image Plane

Image Pixel

Frame of Reference

RT Dose

RT Workflow @ HCF



RT Workflow @ HCF

PQ5000	AcQSim	AcQplan	Router	Precise linac	iView	ACTORS
						
Acquisition CT-image						Therapist
	ROI's drawing RT-StructureSet					Doctor
						
		MLC fields RT-Plan				Doctor / Physicist / Dosimetrist
		DRR's RT-Image				Therapist
			QA + Archiving RT-Image			Auto / Physicist
		Dose calculation RT-Dose				Physicist / Dosimetrist
			QA + Archiving RT-Plan			Auto / Physicist
						
				Treatment RT-TrtRecord		Therapist
						
					Verification RT-image	Therapist / Doctor/ Physicist

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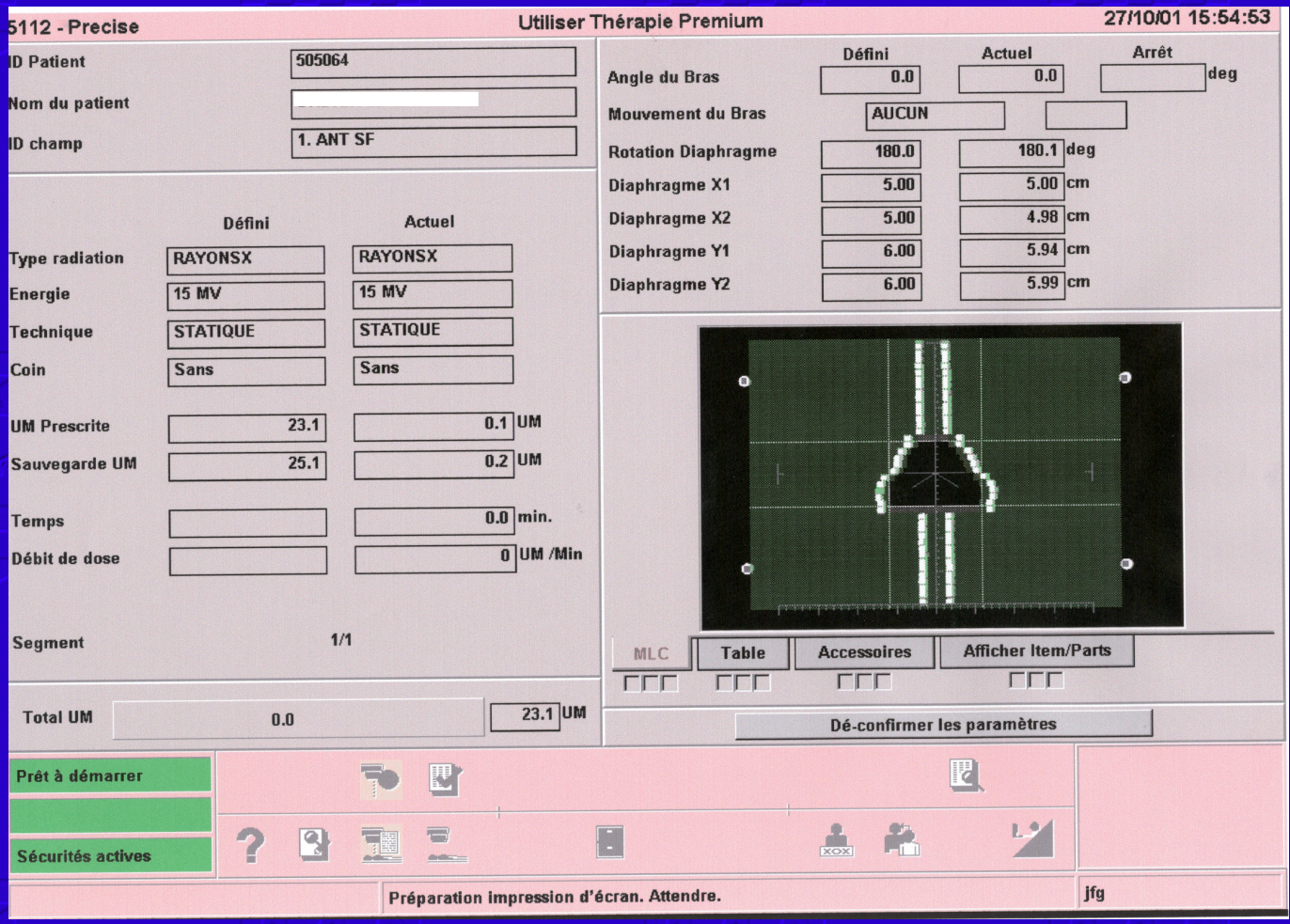
Treatment delivery

Object RT-Plan => linac DB



Treatment delivery

Object RT-Trt-Record => printer

ID Patient : 506457 Page 1 Version 1.0

Page des séances

La Chaux-de-Fonds - Service d'Oncologie-Radiothérapie

Nom du patient :
Ne le : : 26/04/1925
Sexe : MASCULIN

Volume traitement : PROSTATE 70 Gy
Nom de la phase : DICOM:[PROSTATE 70 Gy]
Date d'enregistrement : 11/10/01

Date	Séan	Linac	Champ	UM	AXE (97 %)	Total		Total		Total		Total	Term	Ind.	
25/10/01 13:34:15		Precise	1.1	20.3	0.20	0.20							501		
25/10/01 13:35:09		Precise	2.1	107.0	0.30	0.50							501		
25/10/01 13:36:37		Precise	3.1	67.3	0.50	1.00							501		FP
25/10/01 13:38:39		Precise	4.1	67.0	0.50	1.50							501		DK
25/10/01 13:40:06		Precise	5.1	46.8	0.50	2.00							501		
26/10/01 13:44:33		Precise	1.2	20.3	0.20	2.20							501		
26/10/01 13:45:30		Precise	2.2	107.0	0.30	2.50							501		DK
26/10/01 13:46:31		Precise	3.2	67.3	0.50	3.00							501		FP
26/10/01 13:47:57		Precise	4.2	67.0	0.50	3.50							501		
26/10/01 13:49:14		Precise	5.2	46.8	0.50	4.00							501		

RT Workflow @ HCF

PQ5000	AcQSim	AcQplan	Router	Precise linac	iView	ACTORS
						
Acquisition CT-image	 ROI's drawing RT-StructureSet					Therapist Doctor
		 MLC fields RT-Plan				Doctor / Physicist / Dosimetrist
		DRR's RT-Image	 QA + Archiving RT-Image			Therapist Auto / Physicist
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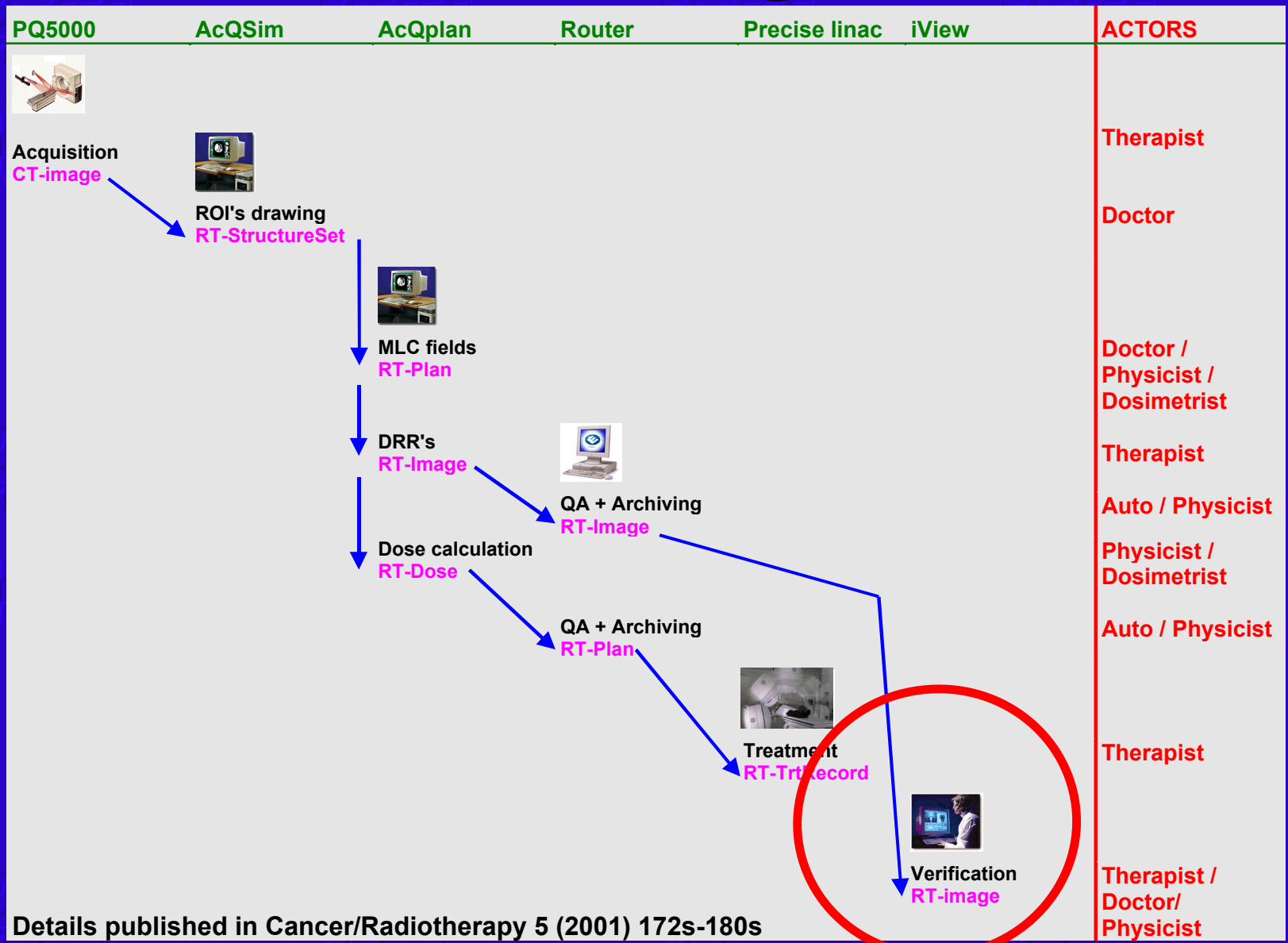
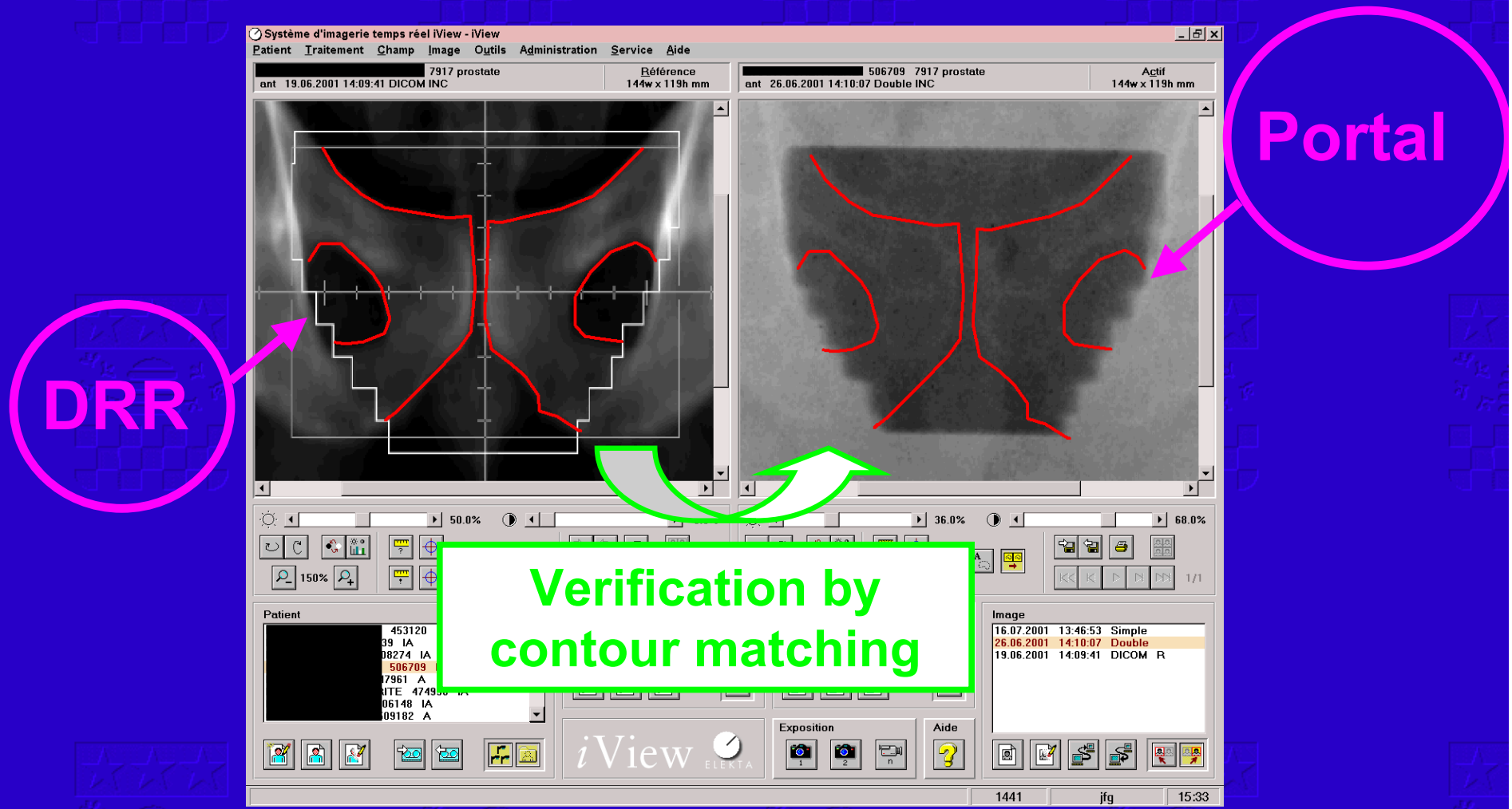
RT Workflow @ HCF



Details published in Cancer/Radiotherapy 5 (2001) 172s-180s

Electronic Portal Imaging

= serie of objects RT-Image's



RT Workflow @ HCF

PQ5000	AcQSim	AcQplan	Router	Precise linac	iView	ACTORS
						
Acquisition CT-image						Therapist
	ROI's drawing RT-StructureSet					Doctor
						
		MLC fields RT-Plan				Doctor / Physicist / Dosimetrist
		DRR's RT-Image				Therapist
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		Dose calculation RT-Dose				Physicist / Dosimetrist
			QA + Archiving RT-Plan			Auto / Physicist
						
				Treatment RT-TrtRecord		Therapist
						
					Verification RT-image	Therapist / Doctor/ Physicist

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Physicist's conclusions

- Learn DICOM terminology
- Describe your clinics workflow
- Look at physical attributes mapping
- Motivate and train all the actors
- Establish electronic QA