FMH Part 2

Quality assurance in Nuclear Medicine Imaging units Legal requirements…

Silvano Gnesin PhD.
Prof. Francis R. Verdun

Institute of Radiation Physics
1007 Lausanne

UNIL | Université de Lausanne

Content

- Quality assurance (QA)
  - Legal requirements
  - Why; who; when; how
    - ORaP – Art. 74.7 (intervention of a medical physicist)
    - Technical notices
- CT
  - Dose indicators
  - DRL concept

Why QA

- Identify deviation from normal :

- Device dependent / environment dependent

- Guarantee stability of performance
- Base for Image Quality (IQ) optimization
- Legal requirement (FBPH)

Who performs QA

- Usually the tecnologist (stability tests)

- Supervision by a medical physicist

- Vendor technical support (Acceptance / Periodical maintenance)

- Supervision by a medical physicist

Principle

- Three types of tests
  - Acceptance test + reference measurements
    - Before 1st patient
    - Manufacturer
      - (better if a medical physicists is available)
  - Stability test (Routinely)
    - (User)
  - Maintenance + Status test + Update of reference
    - Manufacturer (every 6 months)

Reference Values

When QA: Timing requirements

- Stability tests (routinely)
  - Daily
  - Weekly
  - Every six months
- Maintenance– Status test – Reference
  - Every six months

Medical physicist involvement
Legal background

- Orap – Art. 74.7

74.7 Pour les applications en médecine nucléaire et en radiologie interventionnelle par radioscopie ainsi que pour la tomodensitométrie, le titulaire de l'autorisation doit faire appel périodiquement à un physicien médical selon l'al. 4.

  - Compliance with Euratom 97/43
    - Limitation
    - Justification
    - Optimization

- Technical notices
  - Unit requirements

Medical physicist requirement

Working group on radioprotection

Requirements for medical physicists in
Nuclear Medicine and Radiology

Guidelines and recommendations for application of the
radioprotection ordinance Article 74

Version 11; June 2011

Medical physicist requirement

The principal responsibilities of medical physicists are the following:

1. **Measurements** of appropriate patient / occupational / public safety related dosimetric monitoring quantities during the QC.

2. **Improving patient protection** by optimization of practices, procedures and acquisition protocols.

3. **Improving protection of the medical staff** by giving advice on machine operation and personal protective equipment, including protective garments, fixed and mobile shielding.

4. Establishing an effective **education** system in radioprotection for healthcare professionals.

Recommendation (FOPH)

Recommended hiring times of medical physicists (days/year)

Modality	QA relating to patient dose	Verification and optimization of patient and staff dose	Training and coaching of technologists and physicians *	Sum per year
CT	0.5	1	1.5	3
Fluoroscopy Cat. A	0.5	1.4	1.5	3.4
Fluoroscopy Cat. B	0.125	0.125	0.75	1
Gamma camera	0.5	0.5	1.5	2.5
PET	0.5	0.75	1.5	2.75

SPECT/CT	1	1.5	3	5.5
PET/CT	1	1.75	3	5.75

Goals

- Should not duplicate manufacturer’s tasks
  - But some basic measurements can be done
    - Check if:
      - The balance between patient dose and image quality is optimal
      - Optimize staff dose
- Work in close collaboration with the staff
- Continuous education
  - Radiation protection
  - Optimal use of the imaging unit

Requirements concerning units
Nuclear Medicine

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Département fédéral de l'intérieur DFI

Office fédéral de la santé publique OFSP
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Division Radioprotection
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Directive L-09-04

QAP Gamma-caméras, TEP et TEP-CT

1. Objet

La présente directive s'adresse aux fournisseurs et aux utilisateurs de gamma-caméras, TEP et TEP-CT. Elle a pour but de leur indiquer les démarches à suivre en matière d'assurance qualité (QAP) lors de la mise en service, de l'utilisation et de la révision périodique des Gamma-caméras. Les tests à effectuer conformément à l'ordonnance du 21 novembre 1997 sur l'utilisation des sources radioactives non scellées (OUSR) sont établis selon les normes internationales et adaptés aux connaissances techniques.

Gamma camera - Stability

Background count rate

Energy window

Uniformity

N°	Paramètres à vérifier	Périodicité	Exigences / mesures	Remarques
KP1	Taux de comptage du rayonnement ambiant	quotidien	spécifique à l'appareil	En cas de contamination, des mesures doivent être fixées
KP2	Contrôle de la fenêtre d'énergie	avant chaque examen	mesure, « peaken »	
KP3	Homogénéité	hebdomadaire		

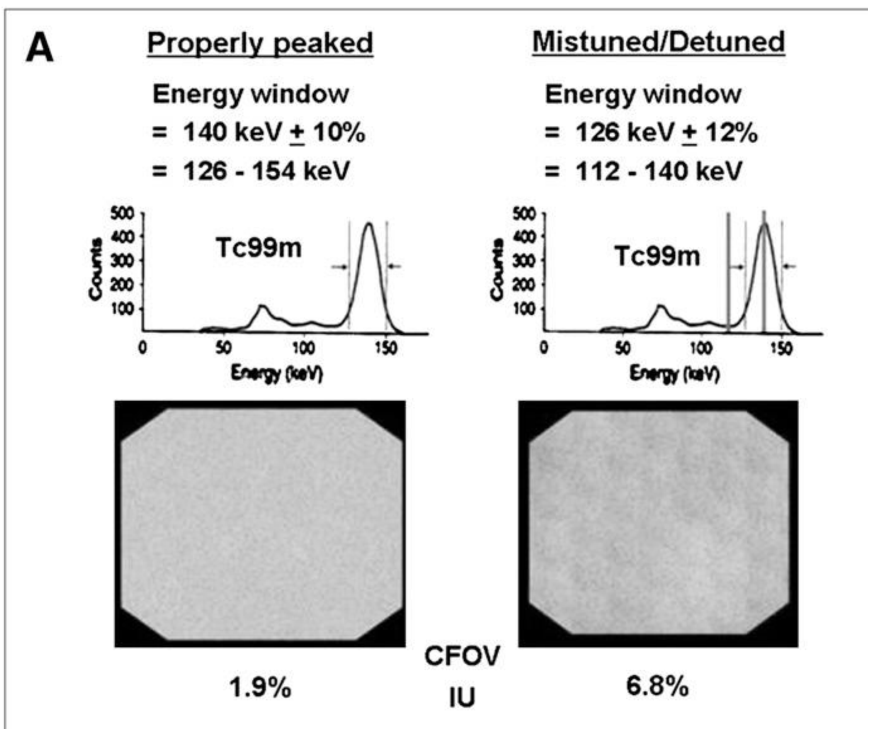
Nr.	Prüfparameter	Periodizität	Anforderungen Massnahmen	Bemerkungen
K1	Untergrundzählrate	täglich	gerätespezifisch	Massnahmen bei Kontami-nation sind festzulegen.
K2	Kontrolle des Ener-giefensters	vor jeder Untersuchung	Massnahme, peaken	
K3	Homogenität	wöchentlich		

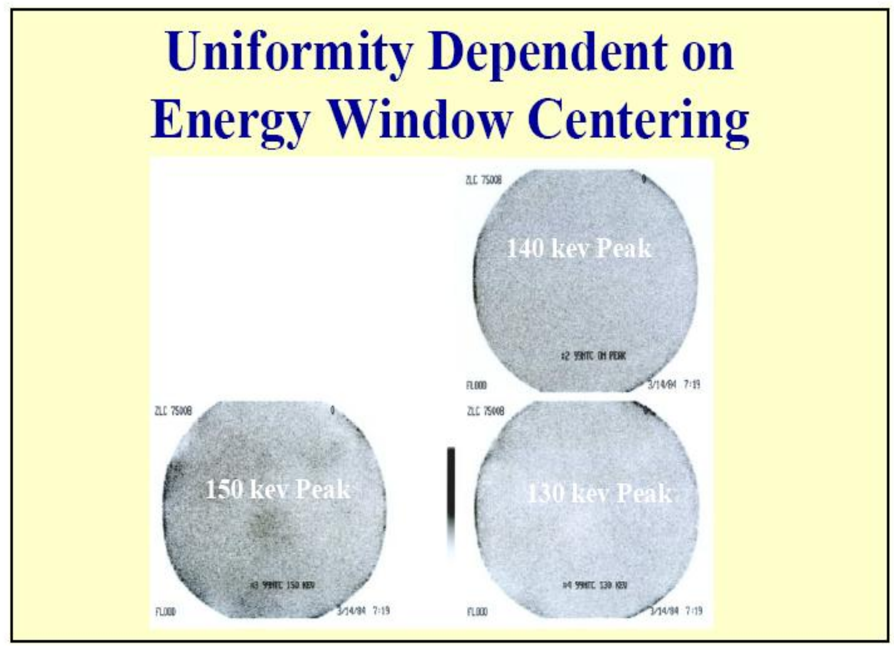
Gamma camera – background K1

- Daily : for example each evening
  - 5 minutes acquisition
    - Head orientation problem
    - Useful to identify ambient contamination (check also energy spectrum)
  - Check for spot on image
    - Clean and acquire again
    - Acquire again the day after
- Require reference values validated by manufacturer …

Gamma camera – Energy window K2

- Before each acquisition
  - Why?
    - Mistuned Energy window → Loss of counts
    - Sub-optimal scatter correction
    - Image quality problems possible (loss of uniformity)





Gamma camera – Stability (K3)

- Homogeneity
  - The matrix size matter
  - Number of counts – matrix size
    - 1Mio in 512x512
      - 262144 pixels → 3.8 counts/pixel
        - σ = 1.9 → 50% uncertainty
    - 1Mio in 64x64
      - 4096 pixels → 244 counts/pixel
        - σ = 15.6 → 6% uncertainty
  - If restricted number of counts
    - Be careful on matrix size
    - At least 1000 counts/pixel
      - σ = 31.6 → 3% uncertainty

Gamma camera - Stability

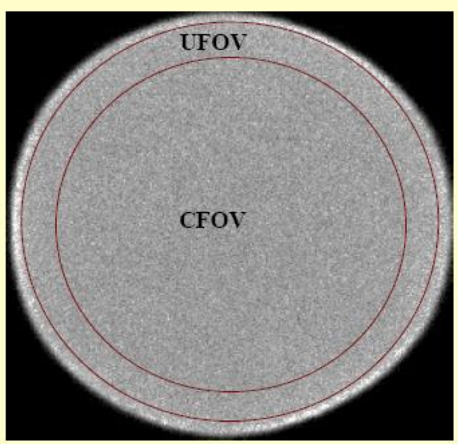
- Assessment
  - Subjective
    - Narrow window
  - Objective (Integral and Differential Uniformity)

IU → Global evaluation

Integral Uniformity (IU)
(4000 cts/cm^2 with 9-pt. smoothing in 6 mm pixels)

$$\frac{\text{Max. Pixel} - \text{Min. Pixel}}{\text{Max. Pixel} + \text{Min. Pixel}} \times 100\%$$

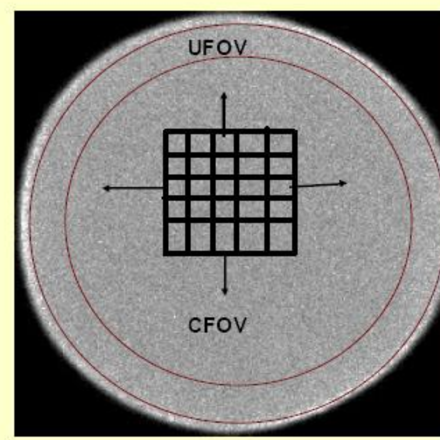
- Range of sensitivity variations over the UFOV or CFOV
- IU of 2-3 % expected



DU→ Local evaluation

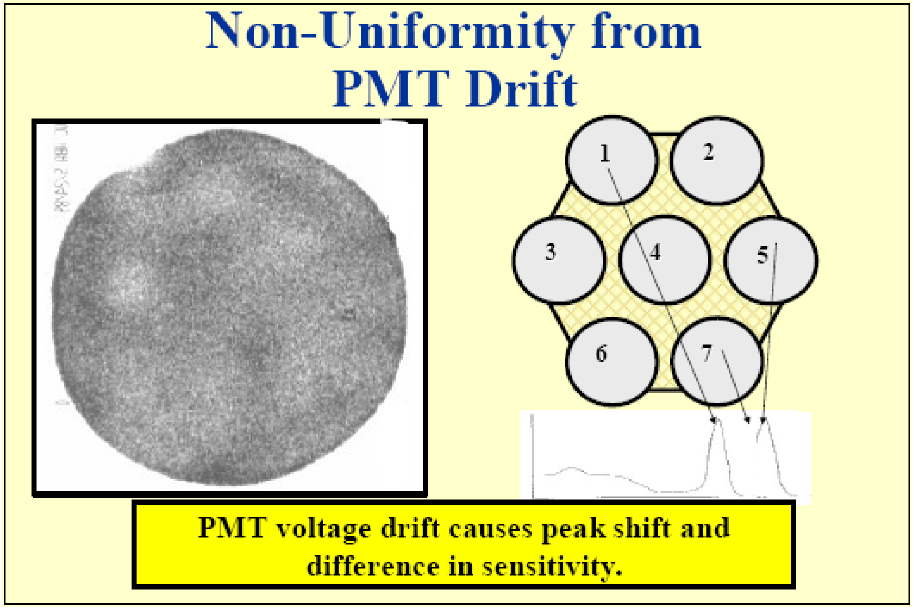
Differential Uniformity (DU)

- Maximum rate of change in sensitivity across the UFOV or CFOV
- DU of 1.5 – 2.0% expected.



Gamma camera - Stability

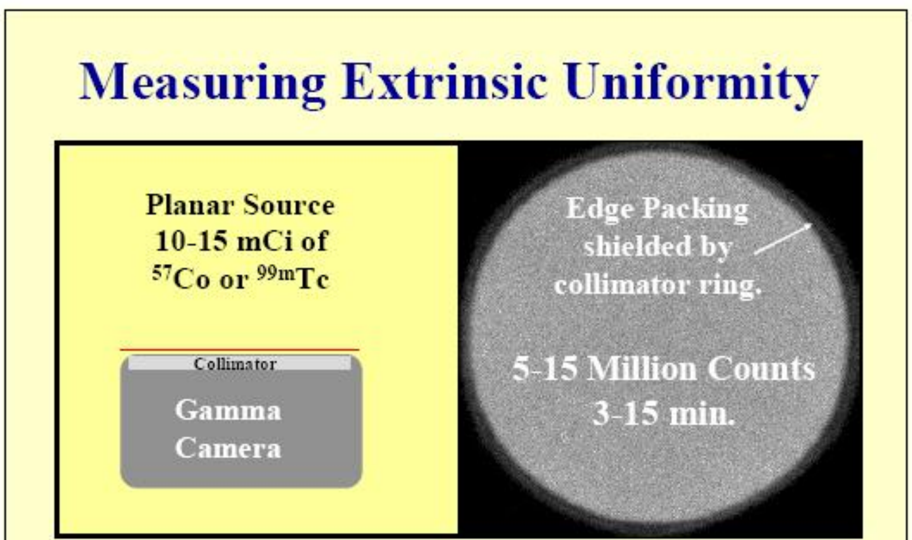
- Example



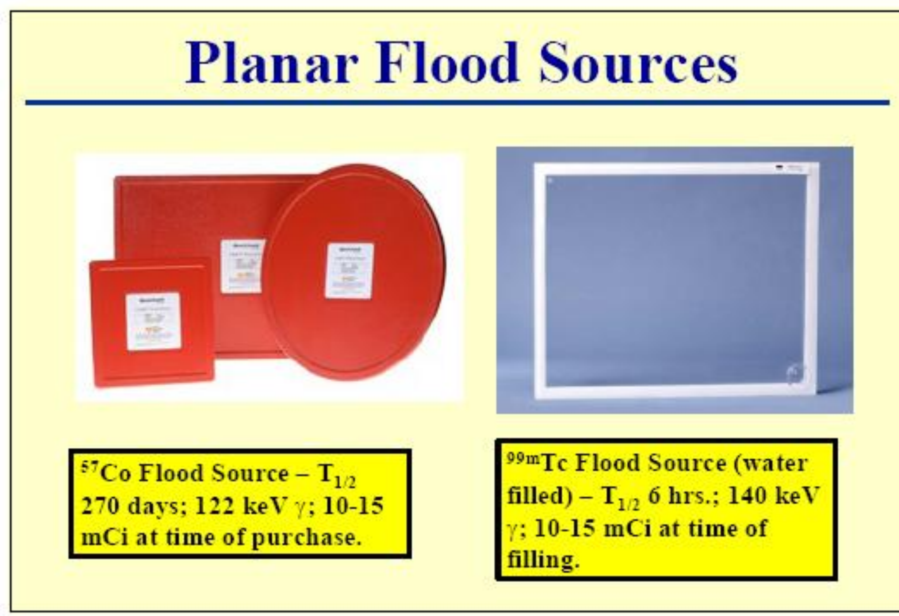
Gamma camera - Stability

- Extrinsic (with collimator on place) or system homogeneity (weekly)

(10mCi = 370MBq)

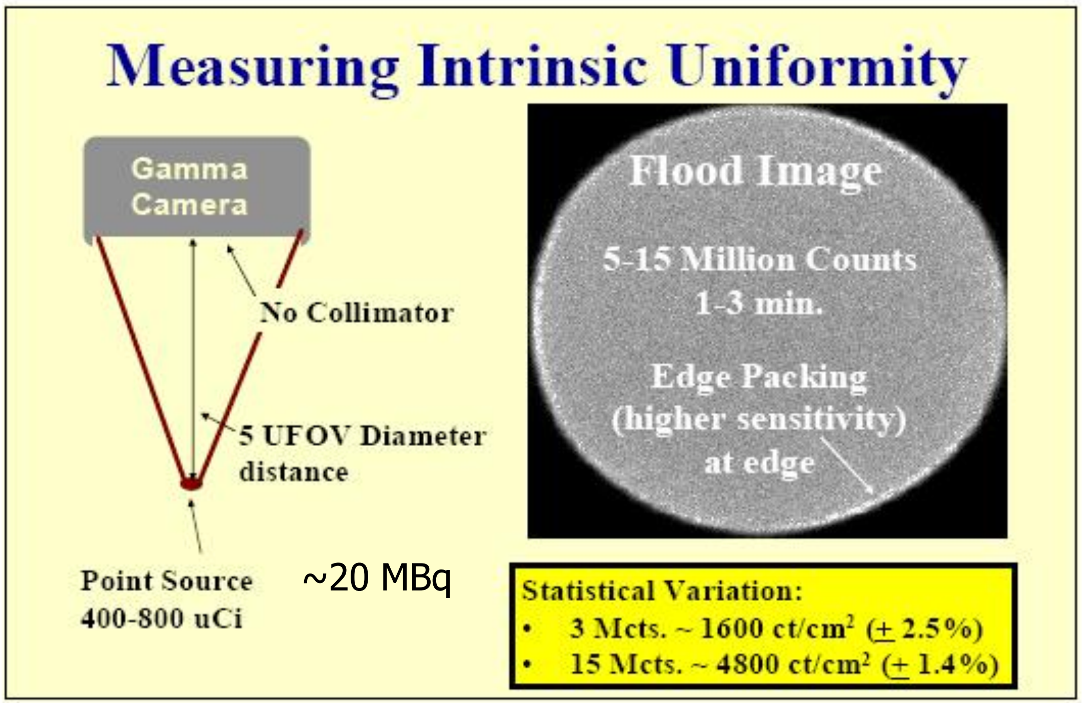


< 40kcps to avoid dead-time count-loss



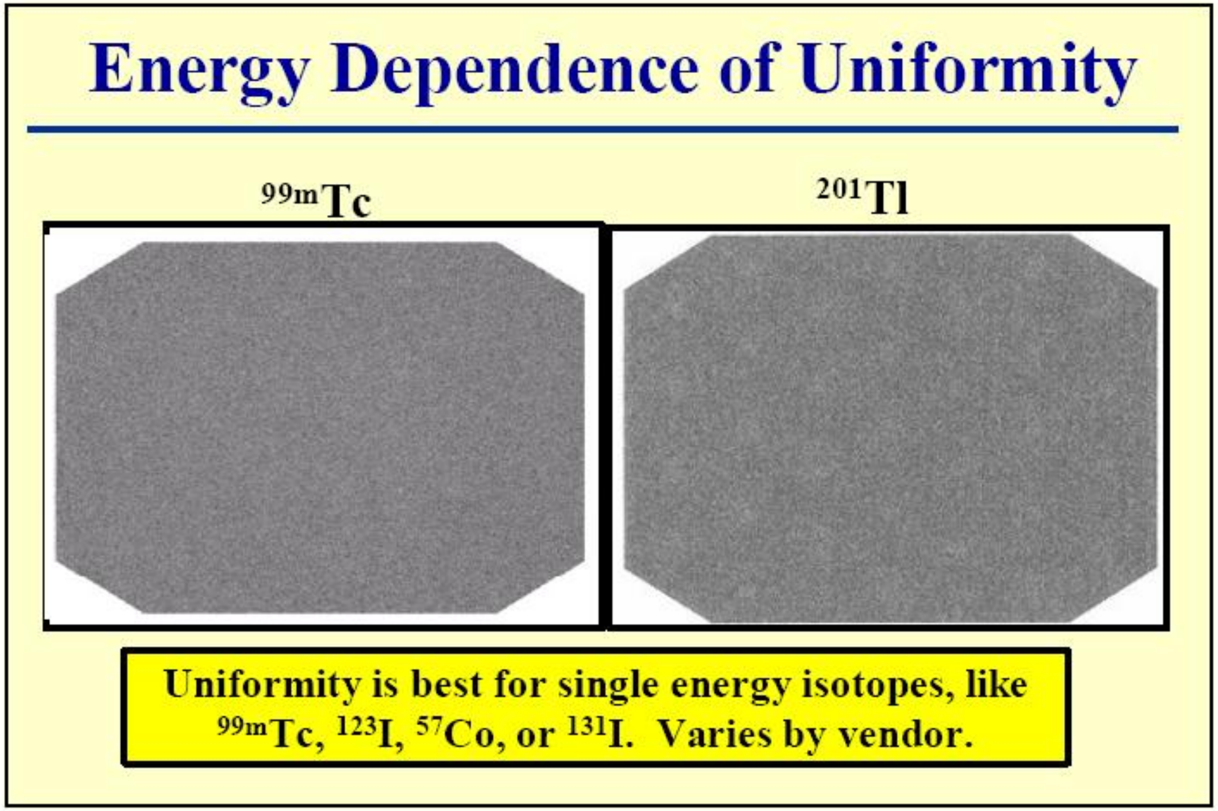
Gamma camera - Stability

- Intrinsic (without collimator) homogeneity (each 6 months)



Gamma camera - Stability

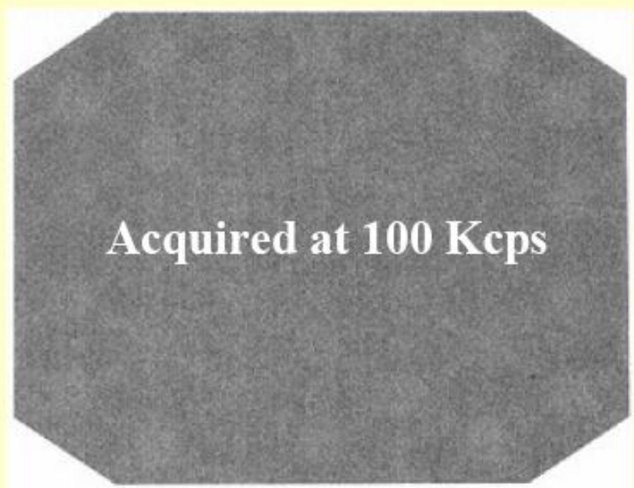
- Be careful on the fact that:



Gamma camera - Stability

- Be careful on the fact that:

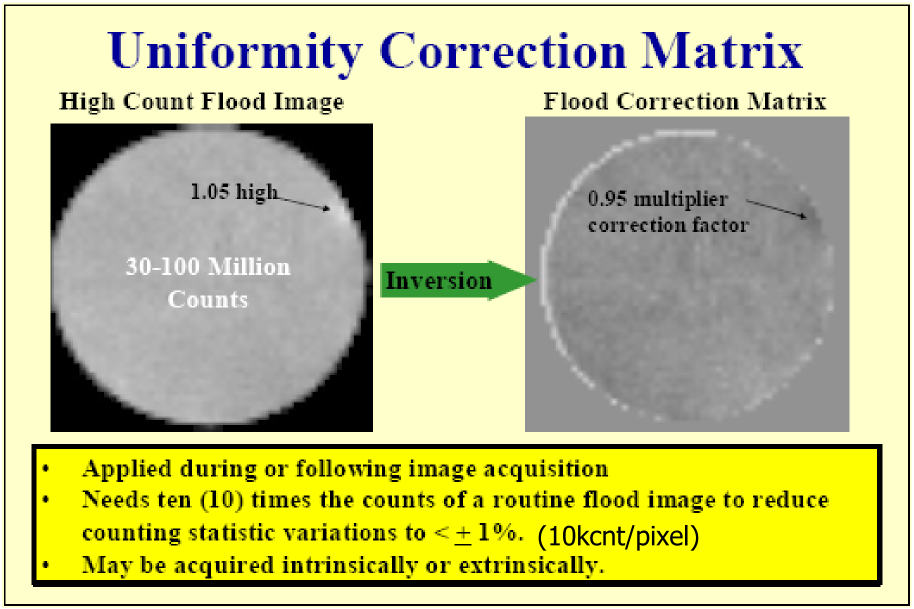
Non-Uniformity at High Count Rates

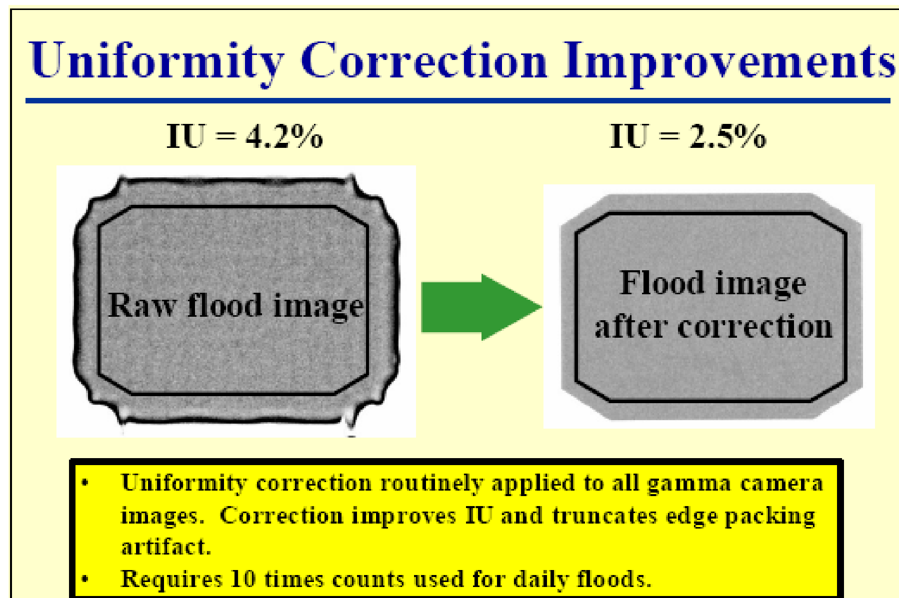


High count rates also leads to loss of resolution and linearity

Gamma camera - Stability

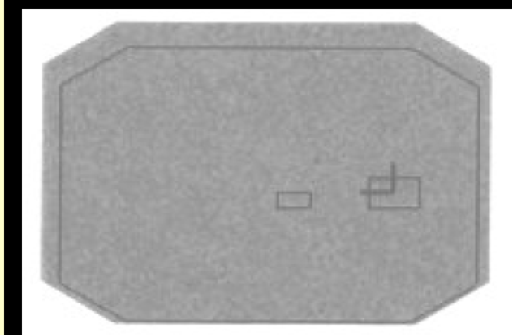
- Calibration (six-months)





Gamma camera - Stability

Quantitate Daily Floods



Full Report of Uniformity Analysis
NAME: 3-04-97 ID: INTR FLD DATE:

UFOV

Integral Uniformity = 2.87%

	Counts	Location
Minimum	7132	(34, 33)
Maximum	7554	(46, 32)

Row Differential Uniformity = 1.69%
Column Differential Uniformity = 1.55%

	Diff.	Location
Max Row	251	(42, 32)
Max Col	230	(46, 28)

CFOV

Integral Uniformity = 2.87%

	Counts	Location
Minimum	7132	(34, 33)
Maximum	7554	(46, 32)

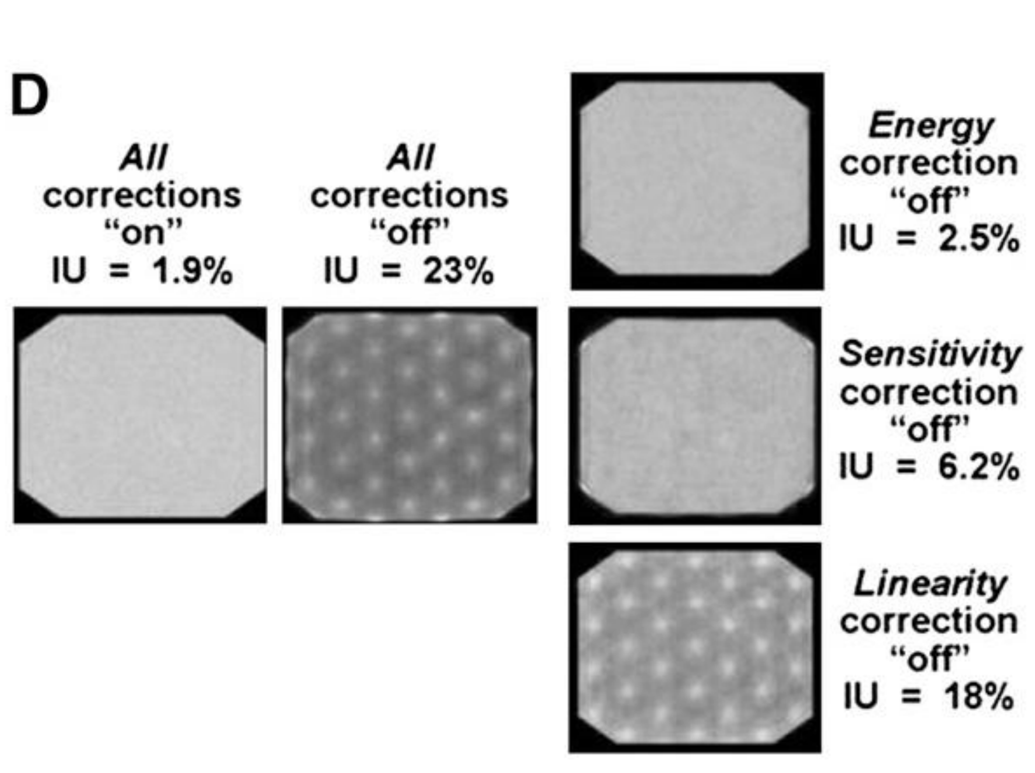
Row Differential Uniformity = 1.69%
Column Differential Uniformity = 1.55%

	Diff.	Location
Max Row	251	(42, 32)
Max Col	230	(46, 28)

- High Counts > 10-15 million counts for large area detectors
- Consistent source strength with count rate < 40,000 cps.
- Consistent source positioning.

Gamma camera - Stability

- Calibration



Full calibration by applying all correction
Vendor @ periodic maintenance (every 6 months)

P. Zanconico, Routine Quality Control of Clinical Nuclear Medicine Instrumentation: A Brief Review J. Nucl. Med. 49 (2008)

Gamma camera - Stability

- Summary
  - Intrinsic (without collimator) calibration requires
    - Precise point source and scatter free condition
    - Beam as parallel as possible (5 FOV far point-like source)
  - Extrinsic (with collimator on place)
    - Planar flood source
    - Required for each collimator (LE, ME, HE)
    - Includes intrinsic calibration
      - At least weekly

Gamma camera – Stability reference levels and action levels

Pre-Assigned Action Levels

I. **Good** – no further evaluation needed
II. **Marginal** – repeat flood once; if still marginal next day/week contact Physicist or supervisor to determine status; a re-calibration may be necessary.
III. **Unacceptable** – repeat flood once; if still unacceptable contact Physicist or supervisor to determine status; a re-calibration may be necessary

Gamma Camera	Intrinsic Uniformity – IU in UFOV	Extrinsic Uniformity – IU in UFOV
Vertex	I – below 3.5 II – 3.5 – 5.0 III – above 5.0	I – below 5.0 II – 5.0 – 6.0 III – above 6.0
Forte I	I – below 3.5 II – 3.5 – 5.0 III – above 5.0	I – below 5.0 II – 5.0 – 6.0 III – above 6.0
Forte II	I – below 3.5 II – 3.5 – 5.0 III – above 5.0	I – below 5.0 II – 5.0 – 6.0 III – above 6.0

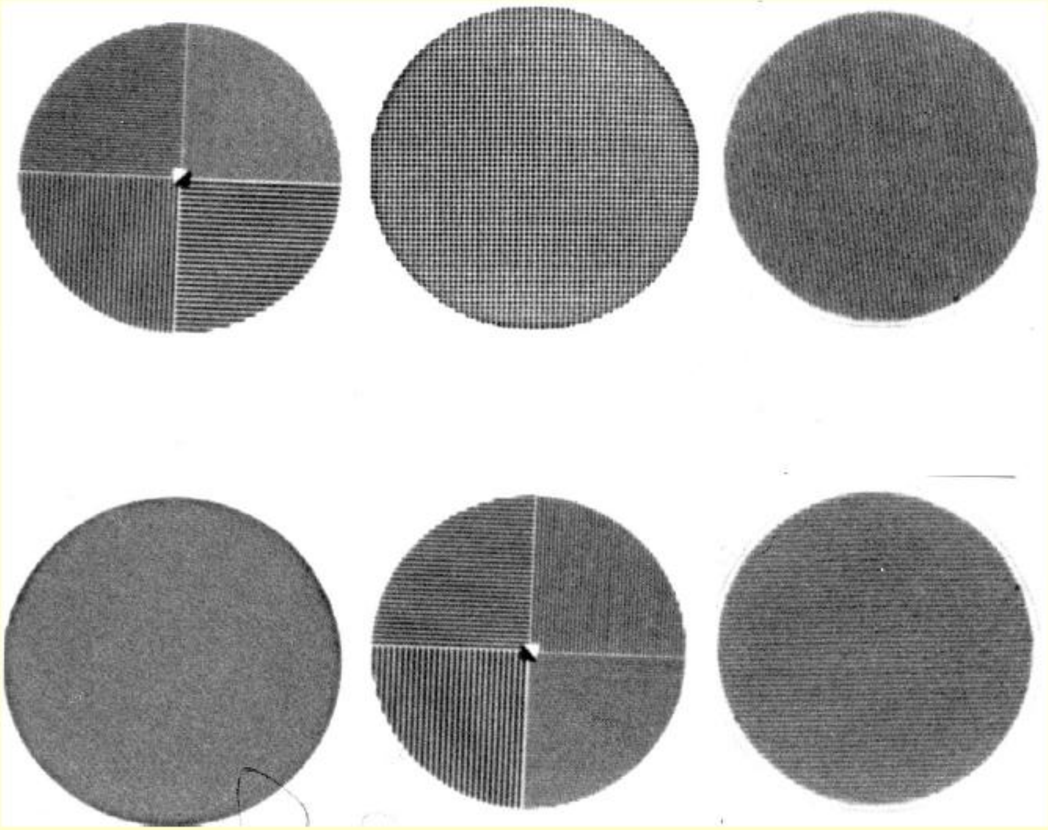
Irregradless of IU, if a single tube is visible in the flood image, contact Physicist or supervisor to determine status.

http://www.aapm.org/meetings/amos2/pdf/29-7895-49774-307.pdf

Gamma camera – SPECT

SPECT Quality Control

- Gamma camera must operate at optimum performance.
- Uniformity is critical



Gamma camera

COR Acquisition is a Calibration

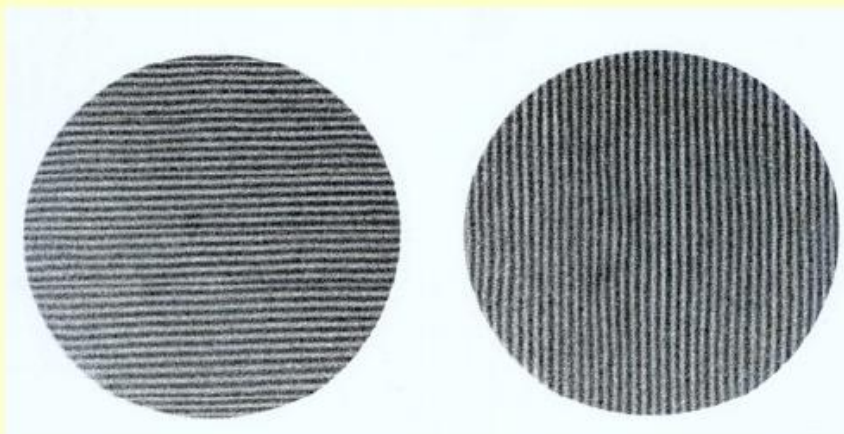
- Used to correct patient images
- Extrinsic calibration for both 180 and 90 degree detector separations
- Must follow manufacturer recommendations regarding number and placement of sources
- Sources must have sufficient activity
- Completed monthly

Center-of-Rotation Artifact

P1 2	Valeurs de correction pour le centre de rotation	TR + semestriel

Gamma camera

Measure Spatial Linearity with PLES Phantom

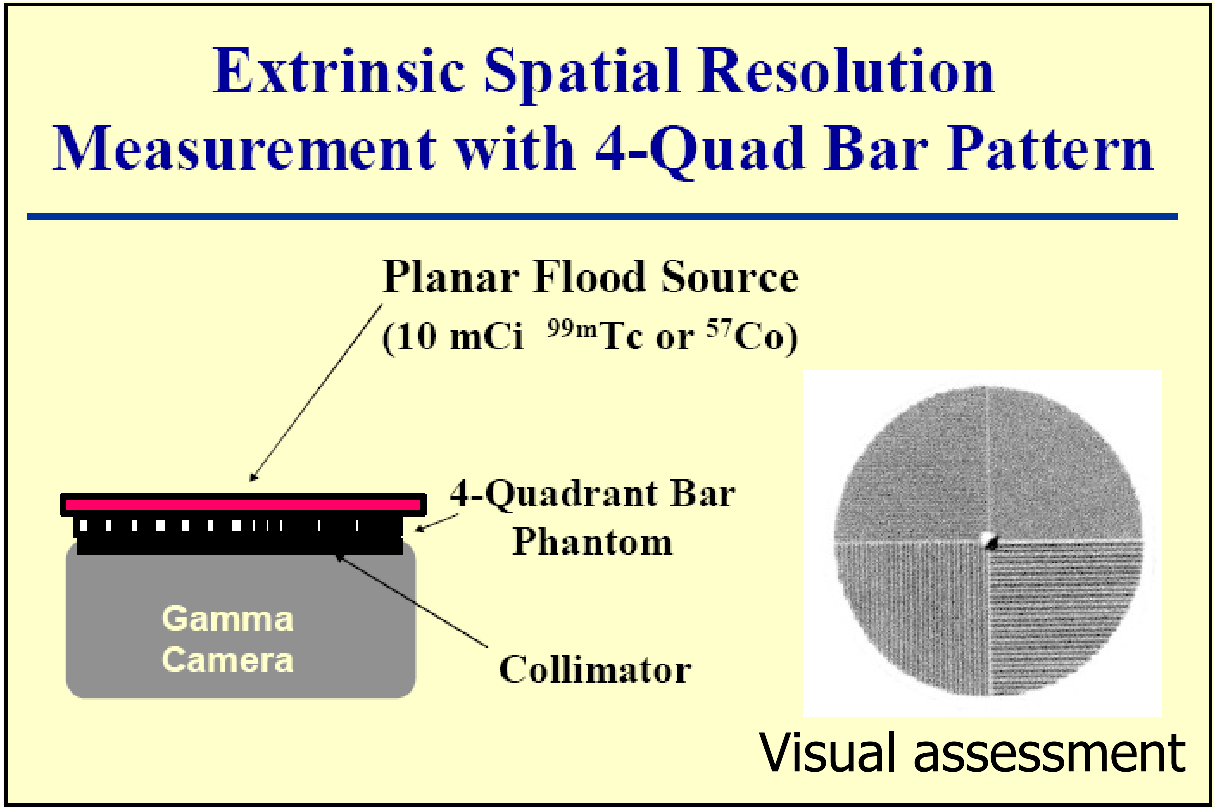


Deviation from straight line of less than 1.0 mm for UFOV.

Images of PLES (parallel line equal spacing) phantom with ^{99m}Tc source

P9	Linéarité géométrique	TR	NEMA 3.1
	Linéarité du système	TR + semestriel	Comparaison visuelle

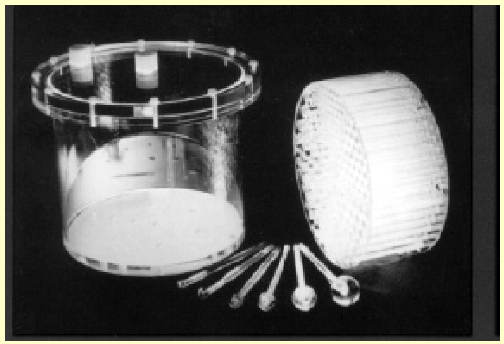
Gamma camera

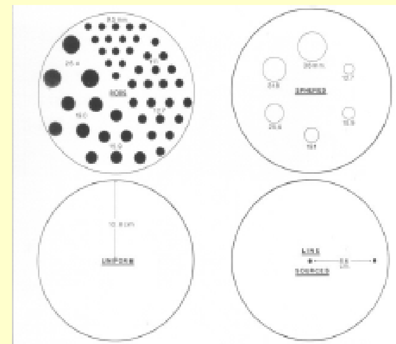


P5	Résolution du système	TR	NEMA 2.4 TR avec tous les collimateurs, CE uniquement avec le plus utilisé
		TR + semestriel	Fantôme à barres, comparaison visuelle avec référence

Gamma camera – SPECT

Jaszczak SPECT Phantom





Standard:

- **Cold Rods – 16.0, 12.7, 11.1, 9.5, 7.9, 6.4 mm**
- **Cold Spheres – 38.0, 31.8, 25.4, 19.1, 15.9, 12.7 mm**

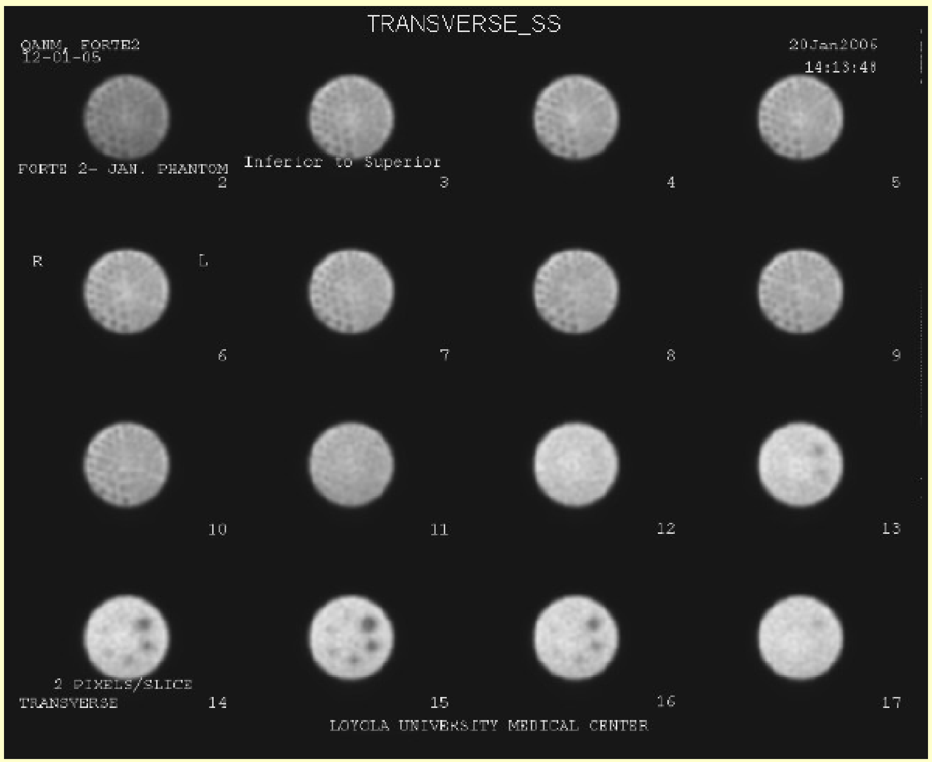
Deluxe:

- **Cold Rods – 12.7, 11.1, 9.5, 7.9, 6.4, 4.8 mm**
- **Cold Spheres – 31.8, 25.4, 19.1, 15.9, 12.7, 9.5 mm**

P1 3	Qualité des images en coupe	TR + semestriel	Selon les données du fabricant, fantôme de type Jaszczak

Gamma camera - Jaszczak

SPECT Phantom Study



- **Quarterly acquire SPECT phantom studies with 2-3 time counts obtained clinically.**
- **Reconstruct at highest resolution filter.**
- **Look for bullseye artifacts. If present, new intrinsic correction flood needed.**
- **Look for consist transaxial resolution. If resolution loss, acquire new COR.**

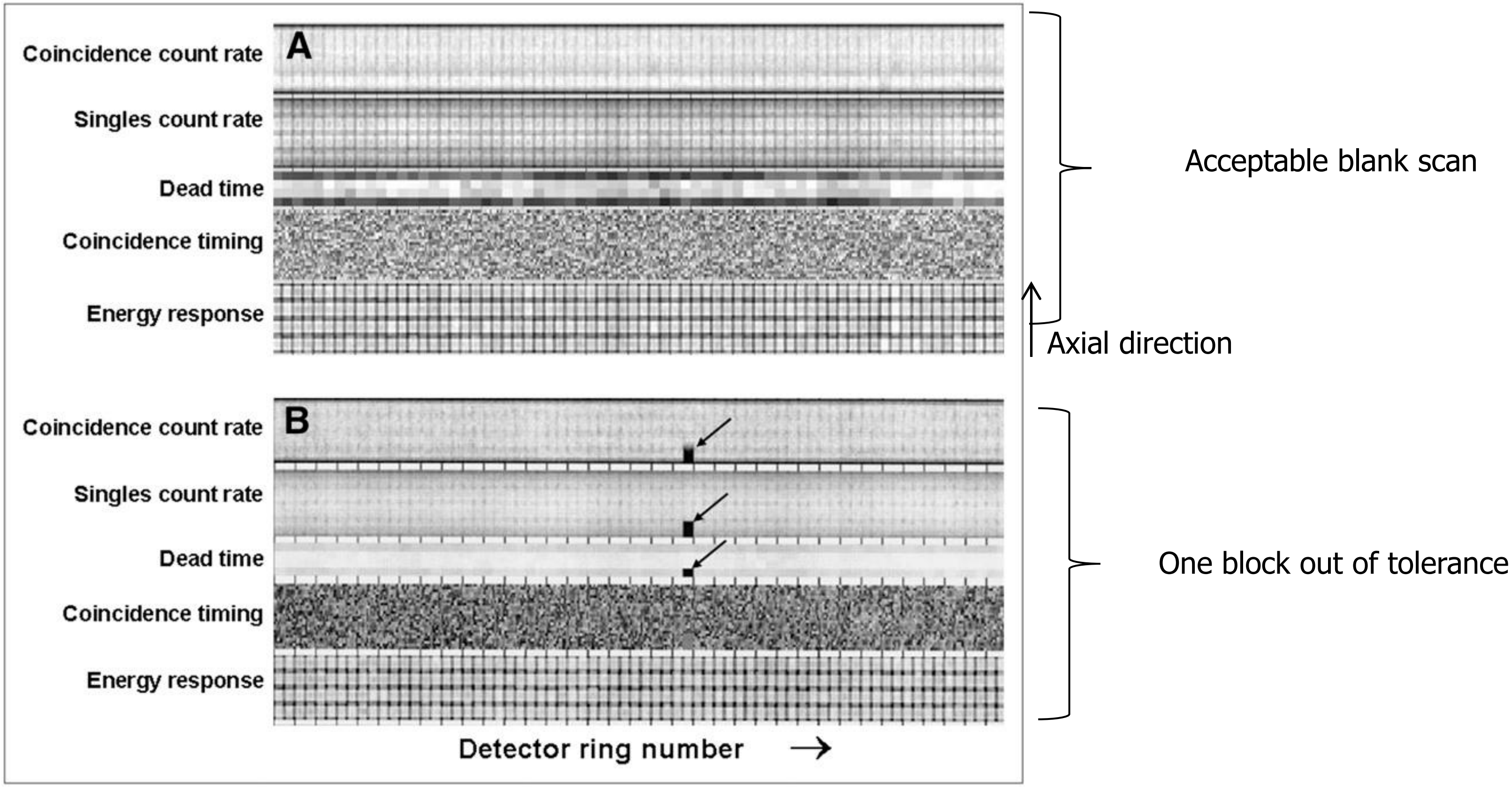
QA in PET - Stability

N°	Paramètres à vérifier	Périodicité	Remarques
KP-1	Vérification du photomultiplicateur (PM) -Facteur d'amplification (gain) - Offset PM - Homogénéité	chaque jour ouvrable	
KP-2	Contrôle de la fenêtre d'énergie - Réglage - Résolution FWHM	chaque jour ouvrable	Utilisation d'une source de positrons
KP-3	Temps de coïncidence	chaque jour ouvrable	
KP-4	Vérification visuelle du système - Comparaison du sinogramme	chaque jour ouvrable	
KP-5	Vérification de la calibration du système avec un fantôme adéquat	semestriel	env. 250 MBq F-18 (p. ex. avec fantôme de type Jaszczak) Valeur de référence tirée de P6

Nr.	Prüfparameter	Periodizität	Bemerkungen
KP-1	Überprüfung der Photomultiplier PM - Verstärkungsfaktor - Offset PM - Homogenität	arbeitstäglich	
KP-2	Kontrolle des Energiefensters - Einstellung - FWHM Auflösung	arbeitstäglich	Verwendung einer Positronen-Quelle
KP-3	Koinzidenz-Timing	arbeitstäglich	
KP-4	Visuelle Systemüberprüfung - Vergleich der Sinogramme	arbeitstäglich	
KP-5	Überprüfung der Systemkalibrierung mit geeignetem Testphantom	halbjährlich	ca. 250MBq F-18 (z.Bsp. mit Jaszscak-Phantom) Referenzwert aus Z6

PET – KP1-KP4

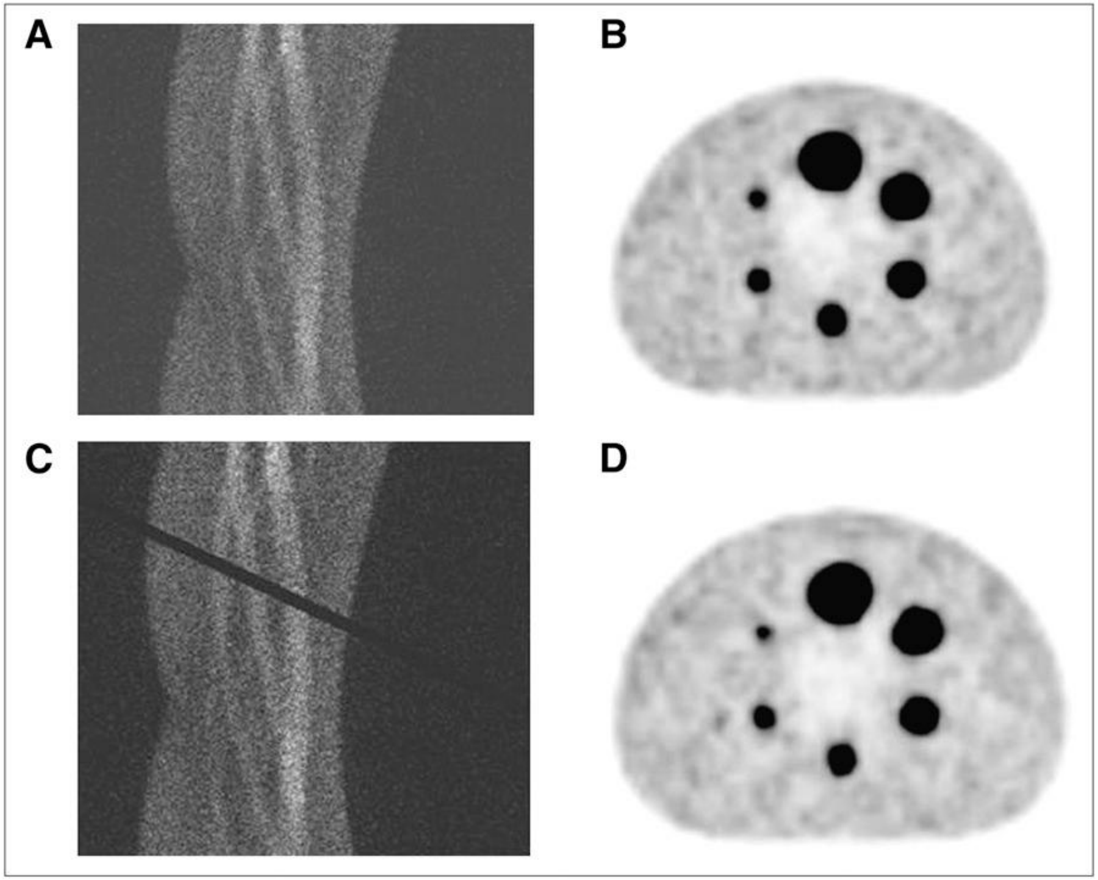
- Done automatically during calibration
  - Should be documented



P. Zanconico, Routine Quality Control of Clinical Nuclear Medicine Instrumentation: A Brief Review J. Nucl. Med. 49 (2008)

PET – KP1-KP4

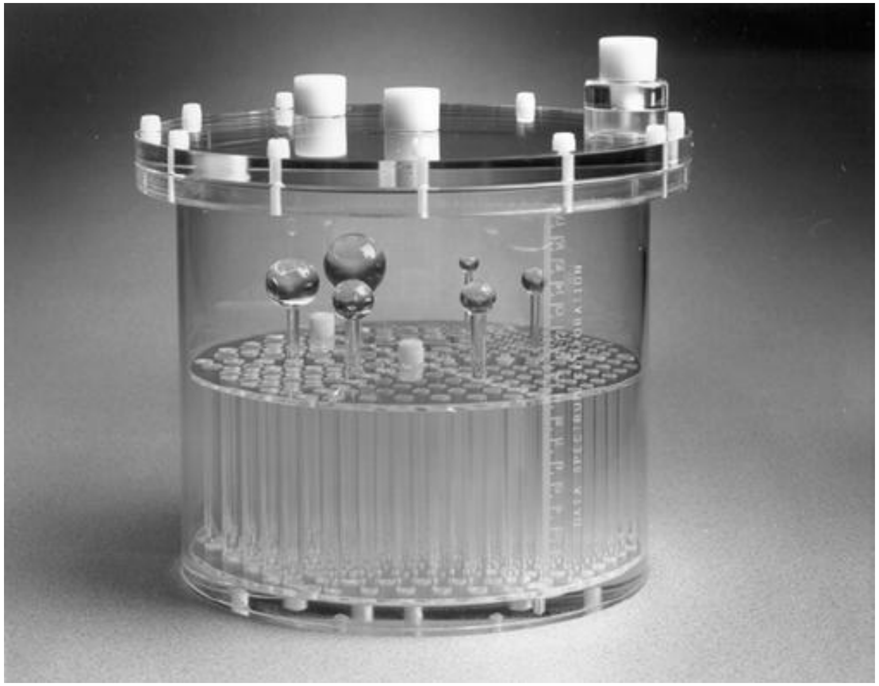
- Evaluate possible use of the PET while waiting for manufacturer intervention



P. Zanconico, Routine Quality Control of Clinical Nuclear Medicine Instrumentation: A Brief Review J. Nucl. Med. 49 (2008)

PET – Stability – KP 5

- Image quality (each 6 month)

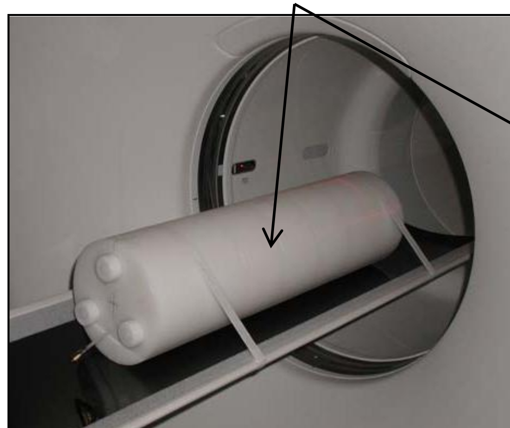


PET – Acceptance : the phantoms

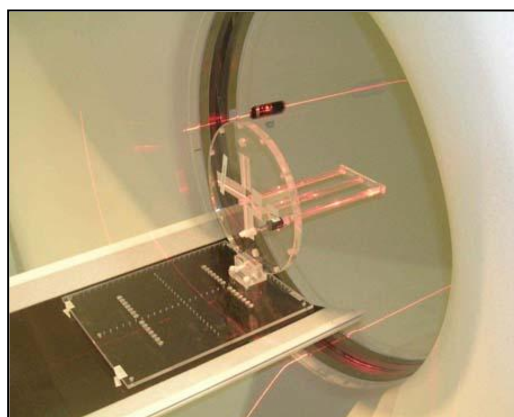
Vendor under medical physicist supervision

NEMA NU-2 Tests

Scatter is accounted for

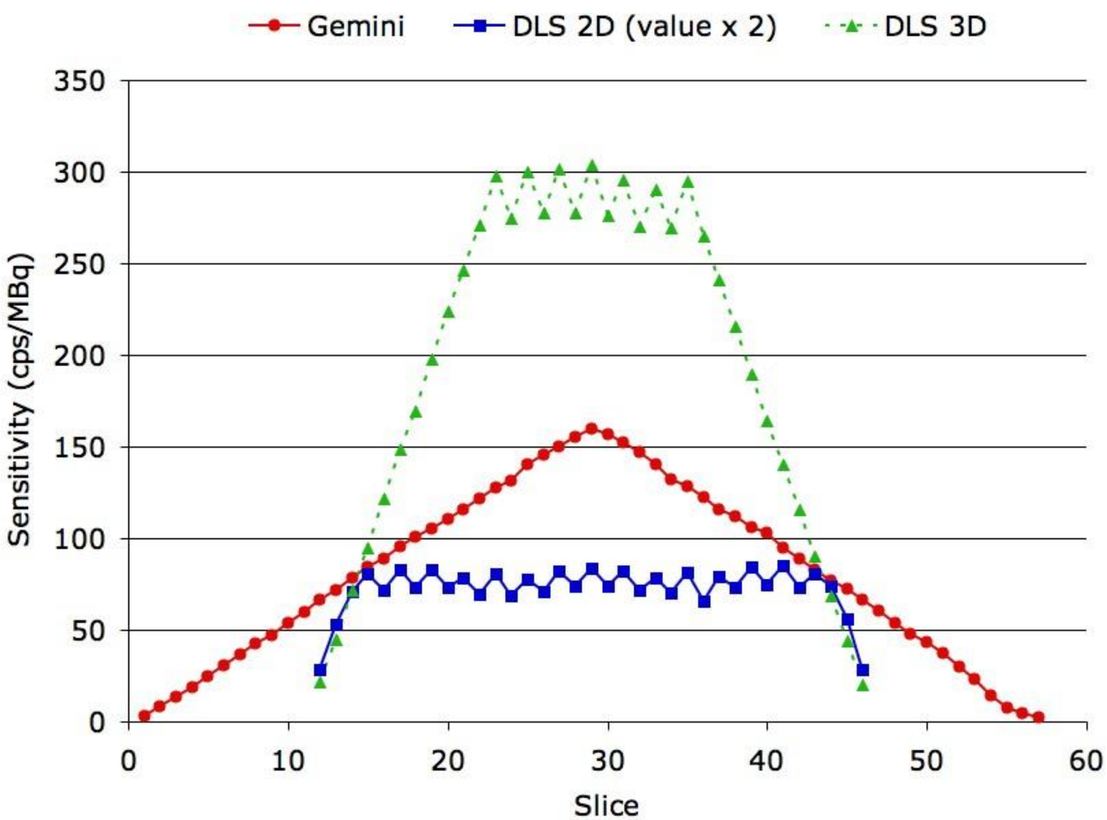


System Sensitivity



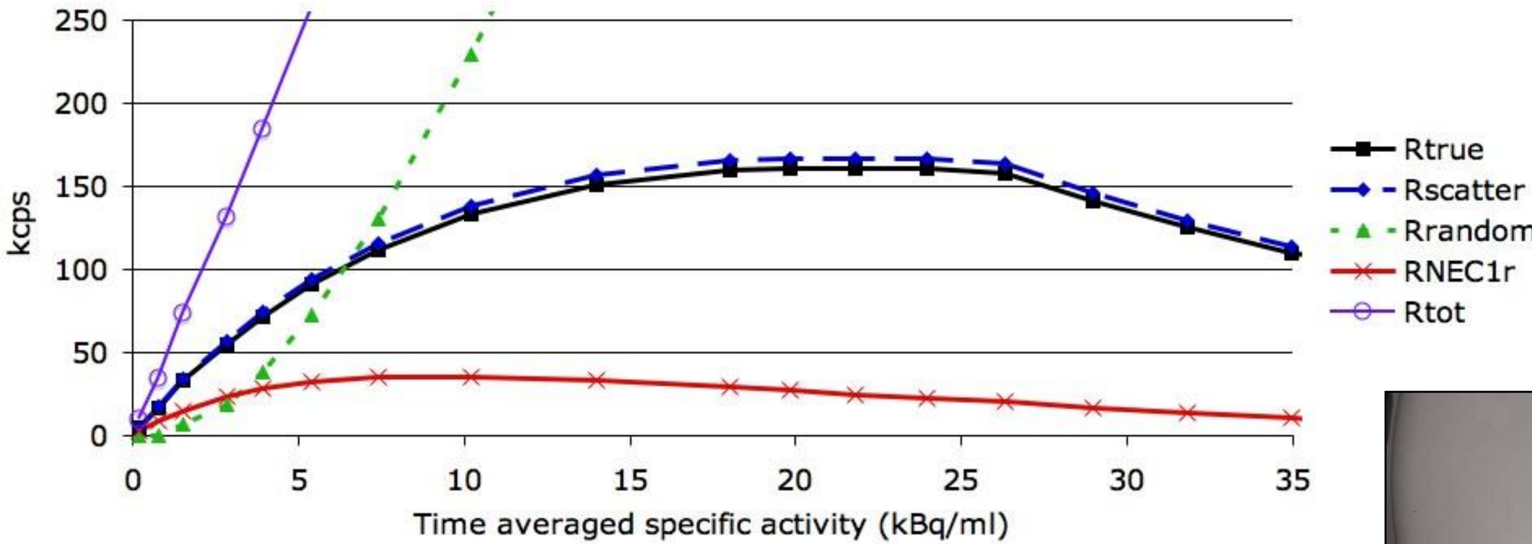
P1: Space resolution
Line sources (150 MBq/mL F-18)
-On axis
-Off axis

PET – Acceptance



P3	Sensibilité	TR	NEMA NU-2001, partie 5 F-18 avec une activité de 10 MBq env.

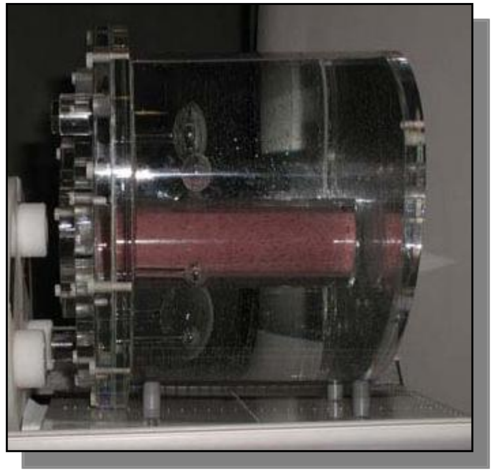
PET – Acceptance

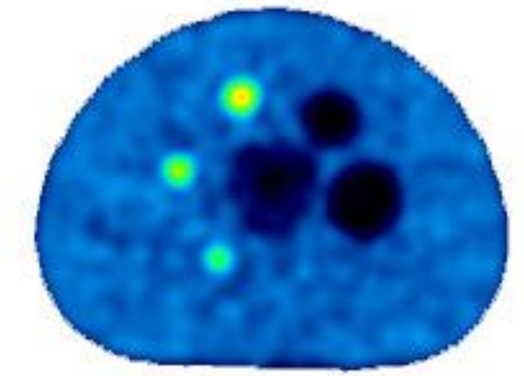


P2	Mesure du rayonnement diffusé, perte de comptage, mesures du taux de comptage fortuit	TR	NEMA NU2-2001, partie 4 Exécution avec une activité clinique relevante (0,5 GBq env.), comparaison des résultats avec les mesures du fabricant selon les normes NEMA.

Fortunately not the entire NEC curve

PET – Acceptance: image quality





P5	Qualité de l'image, précision de la correction pour l'atténuation et la diffusion	TR	NEMA NU2-2001, partie 7 F-18 avec une activité de 250 MBq env.
P6	Qualité de l'image, précision de la correction pour l'atténuation et la diffusion	TR	Etablissement de la référence pour le contrôle de stabilité avec fantôme (p. ex. avec fantôme de type Jaszczak) en utilisant l'algorithme recommandé pour l'application clinique. Valeur de référence pour le test KP5

- Recovery coefficient and hot contrast in hot spheres
- Cold contrast in cold spheres
- Background calibration
- Signal Variability in lung

Different lesion/background
Activity ratios (4:1, 5:1, 8:1)

PET - CT

- Legal CT requirements need to be satisfied also

Schweizerische Eidgenossenschaft
Confédération suisse
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Département fédéral de l'interieur FDI
Office fédéral de la santé publique OFSP
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Division radioprotection
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Etabli: 21.11.2005
N° révision: 1 31.01.2008

Directive R-08-08
Assurance de la qualité des tomodensitomètres (CT)

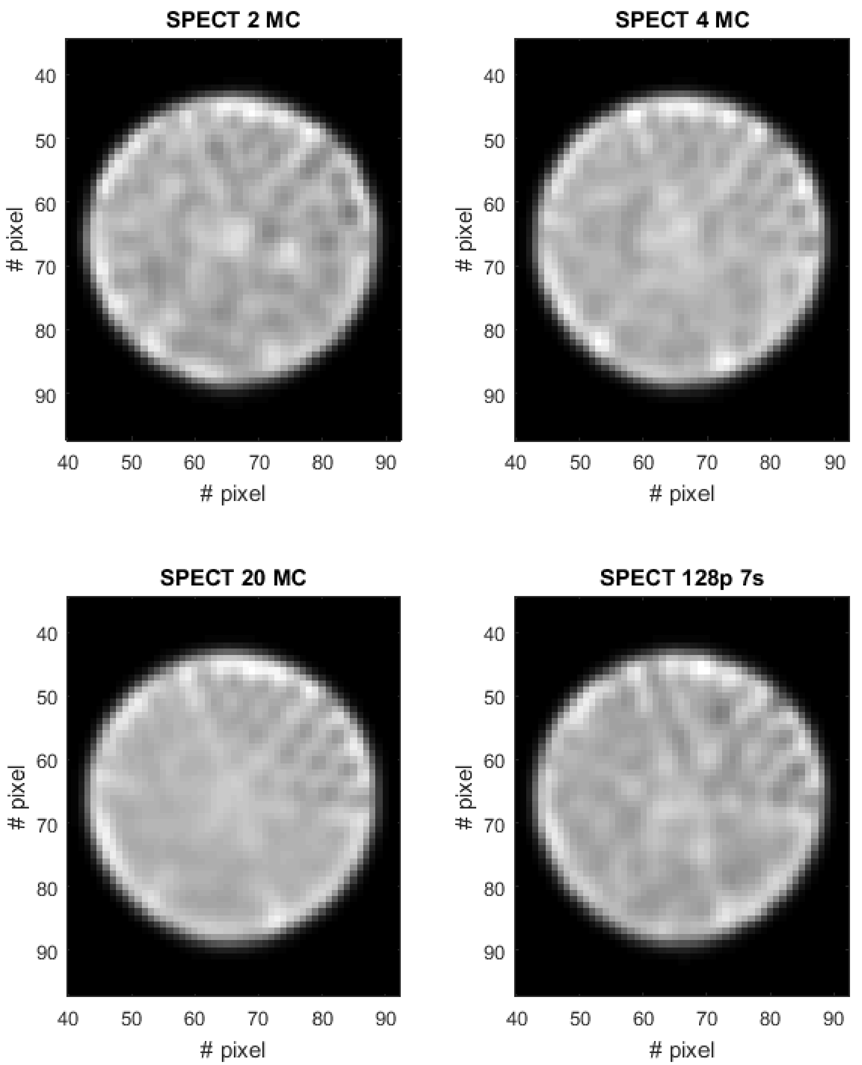
1. Objet

La directive a pour objet de préciser le type, l'envergure et la périodicité des mesures visant à assurer la fonctionnalité et la qualité des tomodensitomètres (CT), des appareils de restitution d'images ainsi que des systèmes de documentation d'images. De manière générale, les mêmes procédures que pour les installations radiologiques classiques s'appliquent considérant néanmoins des spécificités des installations.

- CT in SPECT/CT and PET/CT are considered as stand-alone CT

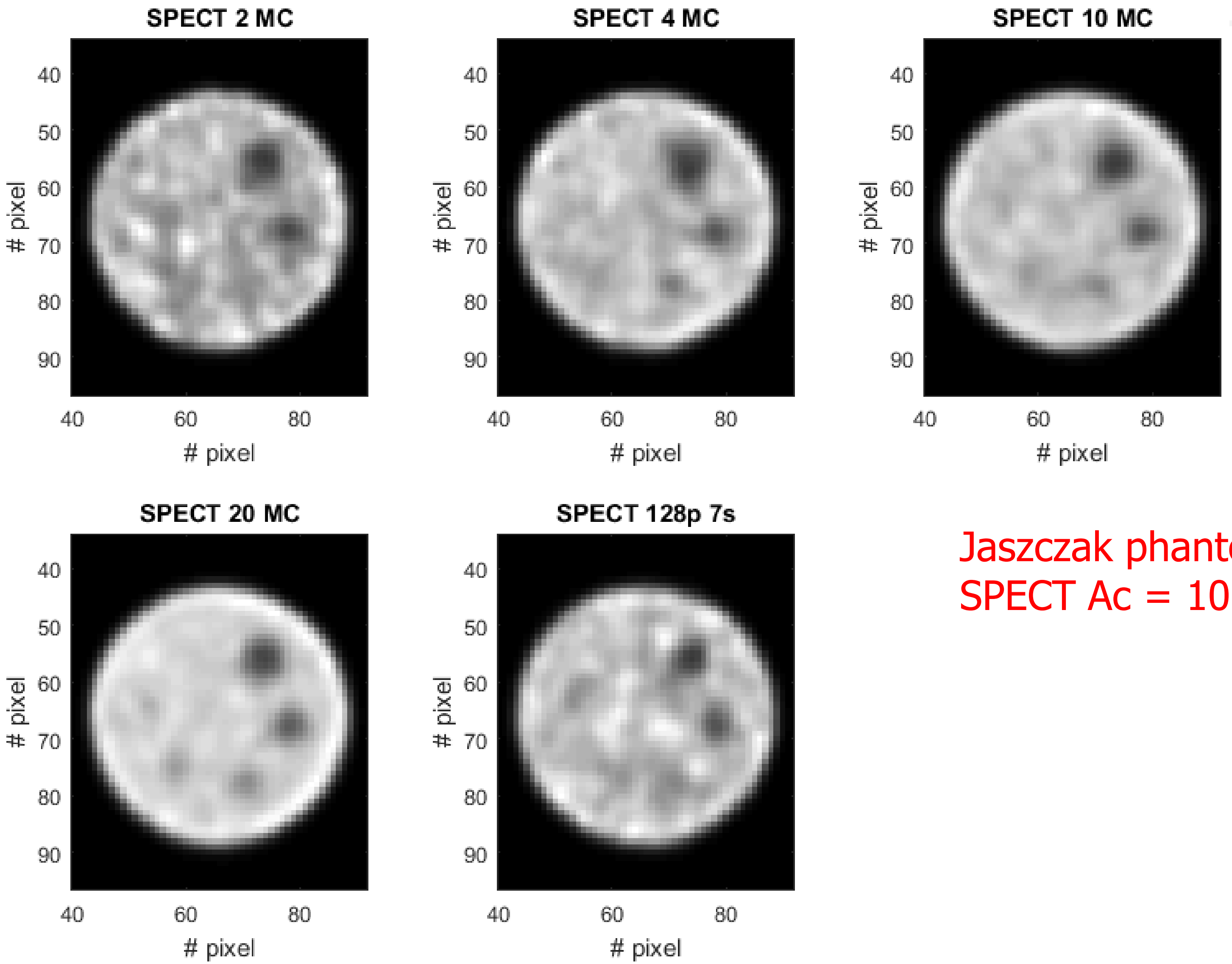
- Image fusion to be controlled
- Attenuation correction to be controlled

PET and SEPCT clinical relevant conditions



Jaszczak phantom
SPECT Ac = 10 kBq/mL

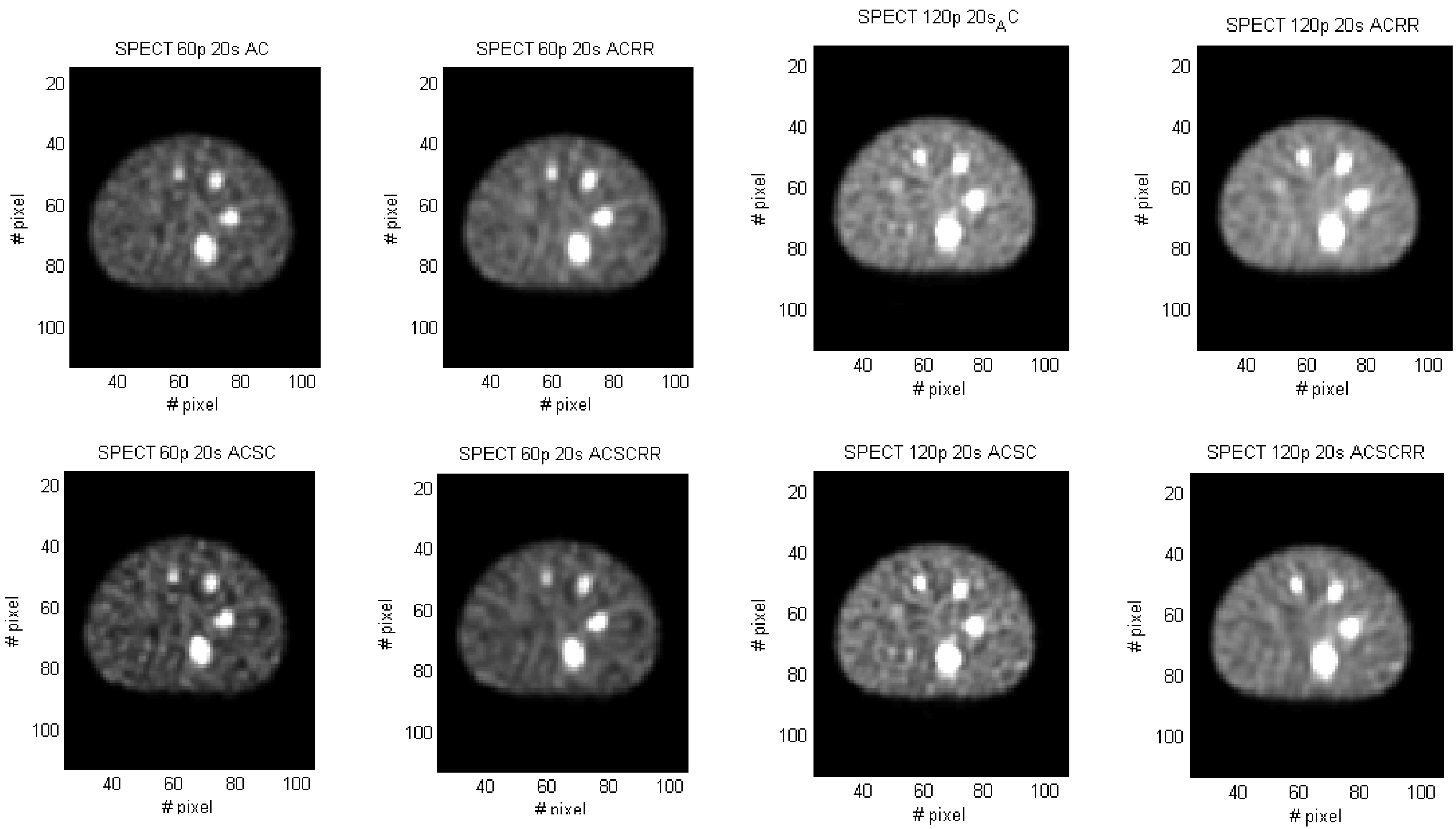
PET and SEPCT clinical relevant conditions



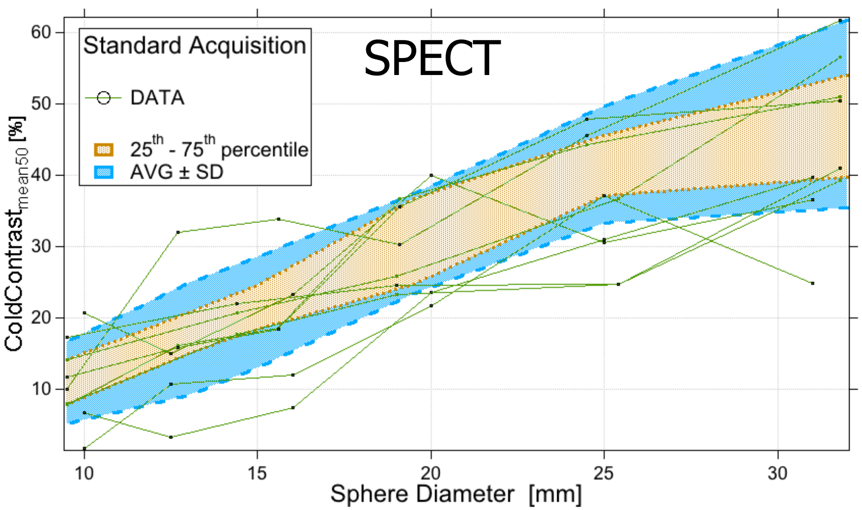
Jaszczak phantom
SPECT Ac = 10 kBq/mL

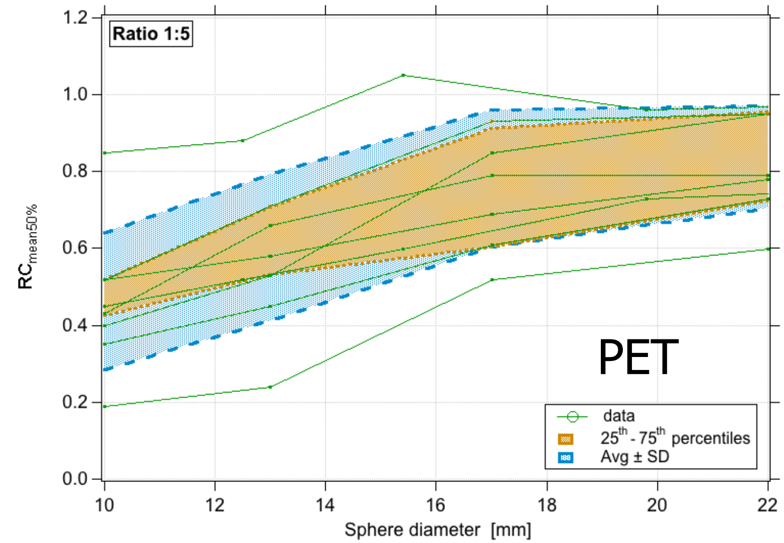
PET and SEPCT clinical relevant conditions

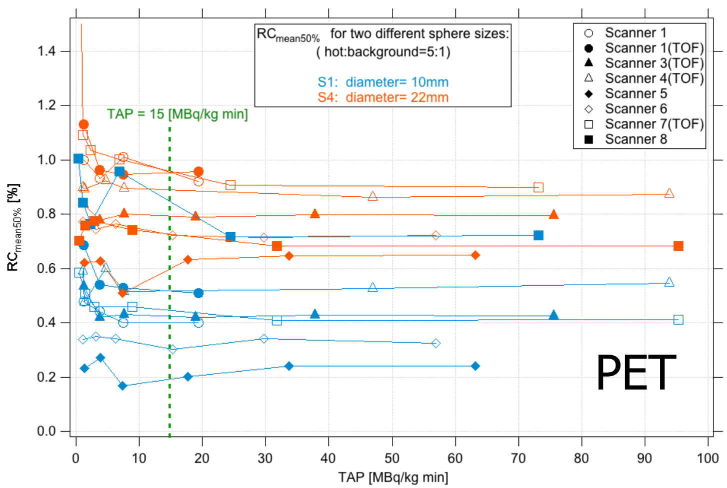
NEMA NU2 phantom SPECT Ac = 10 kBq/mL

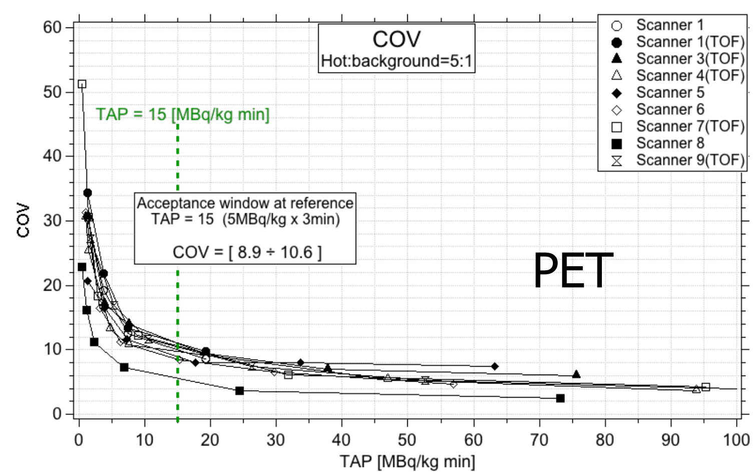


PET and SEPCT clinical relevant conditions









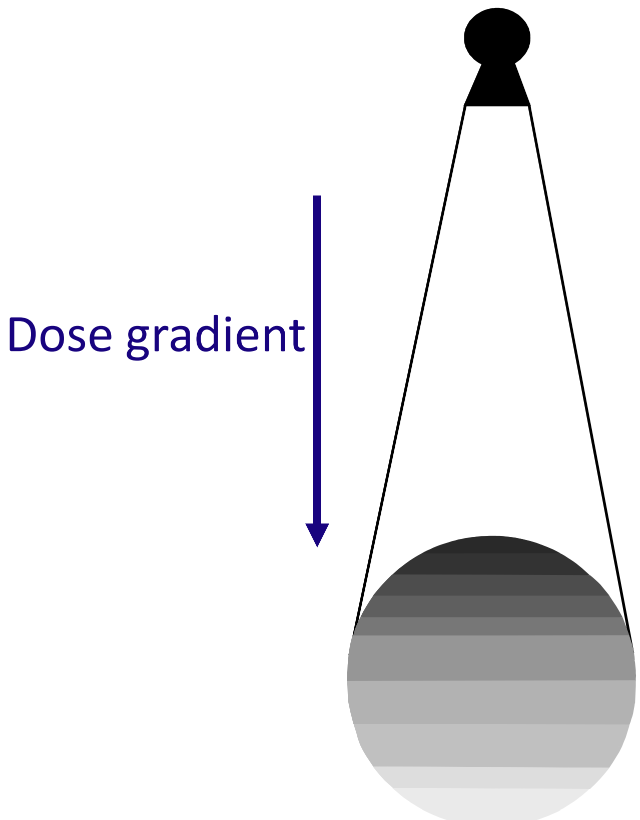
PET and SEPCT clinical relevant conditions

Optimization of acquisition/reconstruction protocols... for both PET and SPECT according to clinical requirements

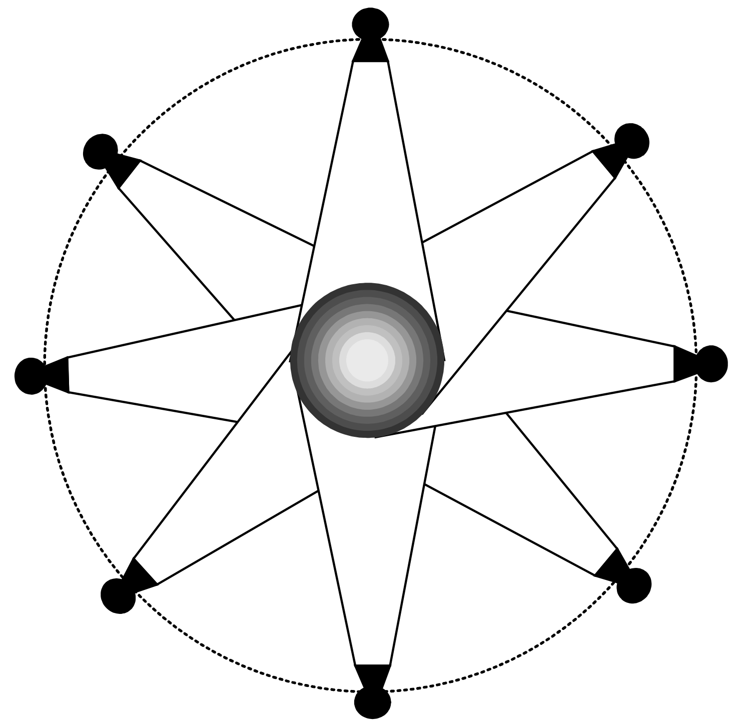
Reduce dose to the patient ?
in PET it seems to be possible

-New technologies (iterative reconstruction with TOF + PSF)
-Large detector rings
-SiPM detector (coming now in the market)

Dose distribution in CT



Circular symmetry of the dose distribution

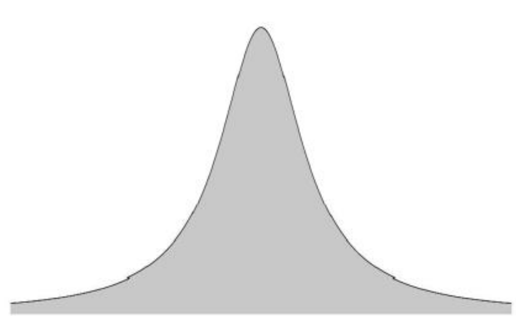


The CT dose Index (CTDI)

dose units: Energy/mass = J/Kg = Gy (usually mGy)

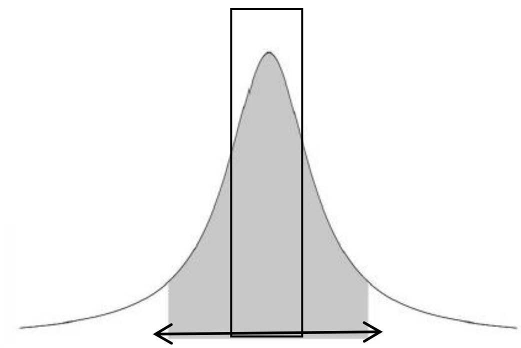
Use pencil chamber to measure dose from single rotation including scatter tail

D(z) = axial (z) dose profile



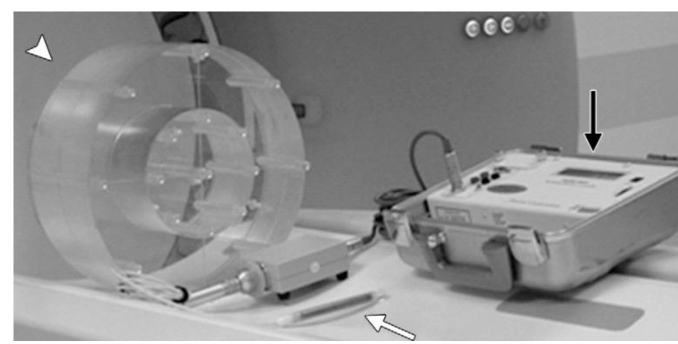
$$CTDI = \frac{1}{nT}\int_{-\infty}^{+\infty} D(z).dz$$

nT = nominal axial beam width



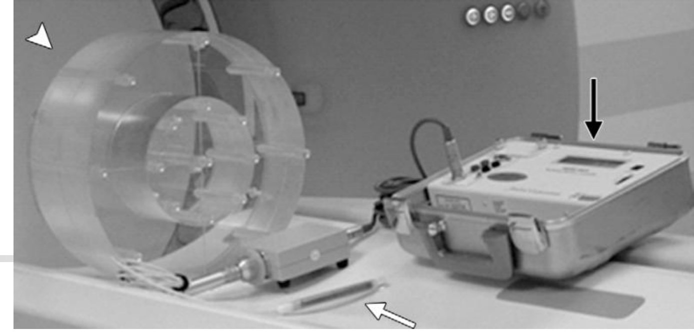
$$CTDI_{100} = \frac{1}{nT}\int_{-50}^{+50} D(z).dz$$

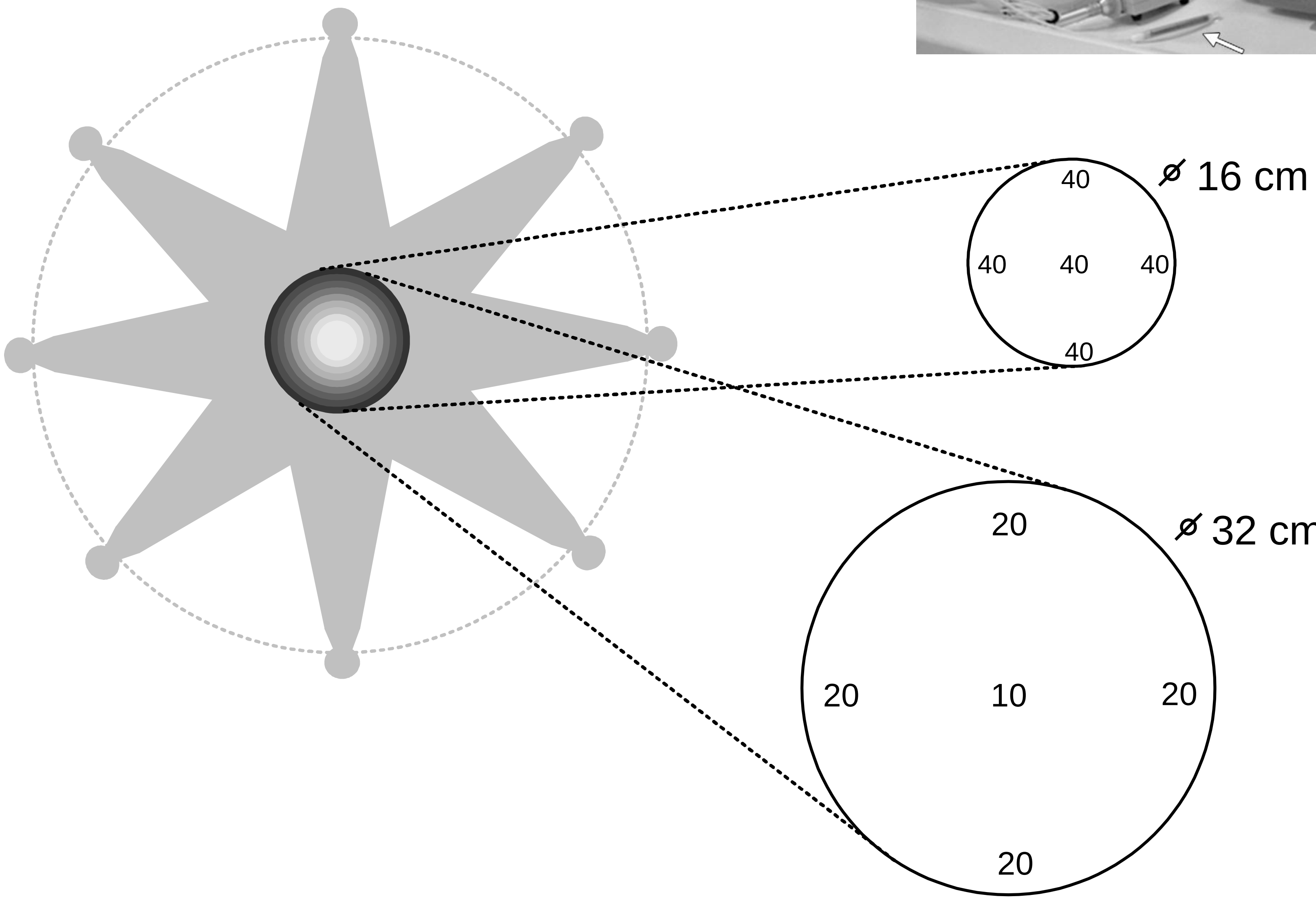
$$CTDI_{100} = \frac{D_m \times 100}{nT}$$



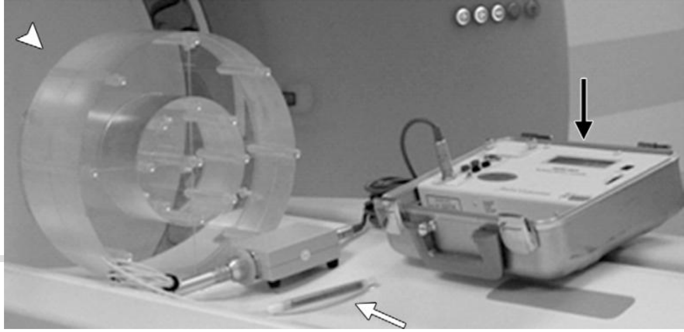
C. McCollough et Al, Radiology 2011; 259:311–316

Average dose and diameter

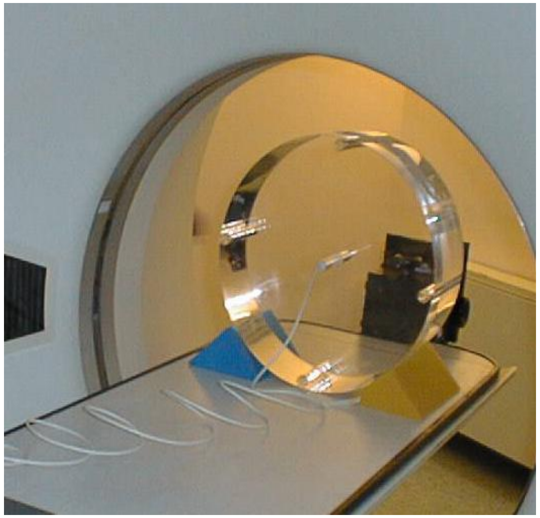




$CTDI_w$



- Weighted CTDI ($CTDI_w$)



- Dose indicator in PMMA cylinders
  - Ø 16 cm : Adult (head neck) – Pediatric
  - Ø 32 cm : Adult (body)

$$CTDI_w = 1/3\ CTDI_{center} + 2/3\ CTDI_{periphery}$$

Same scan parameters → $CTDI_{w,16\ cm} \sim 2 \times CTDI_{w,32cm}$

$${}_nCTDI_w = CTDI_w/mAs$$ in a 360 tube rotation

CTDI$_w$ - CTDI$_{vol}$

- Sequential acquisition
  - $CTDI_w = {}_nCTDI_w \times mAs$
    - mAs for one 360° tube rotation
- Helical acquisition
  - $CTDI_{vol} = CTDI_w \ / \ pitch$

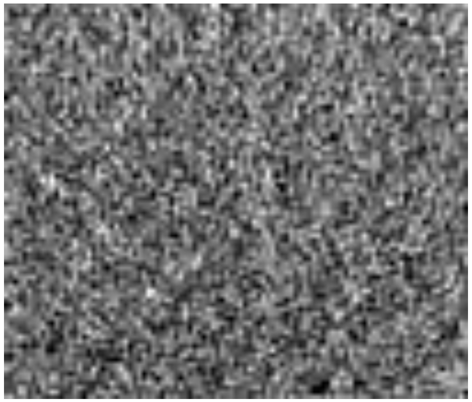
$$\text{Pitch} : \frac{\text{Table displacement in1 tube rotation(mm)}}{\text{X-ray beam collimation (mm)}}$$

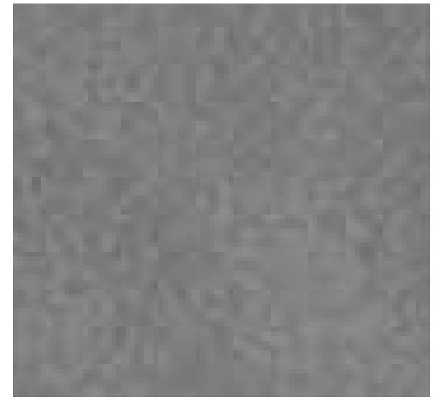
Be careful with 140 kV

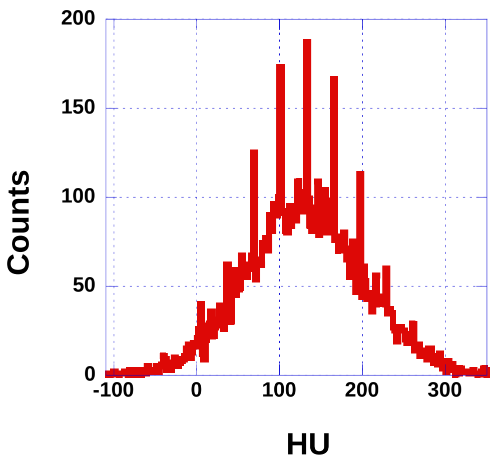
Typical values of ${}_nCTDI_{vol}$ (mGy/mAs)

	${}_nCTDI_{air}$	${}_nCTDI_w$ Tête	${}_nCTDI_w$ Tronc
80 kV	**0.20**	**0.07**	**0.035**
120 kV	**0.40**	**0.20**	**0.10**
140 kV	**0.55**	**0.30**	**0.15**

$CTDI_w$ ou $CTDI_{vol}$ and image quality

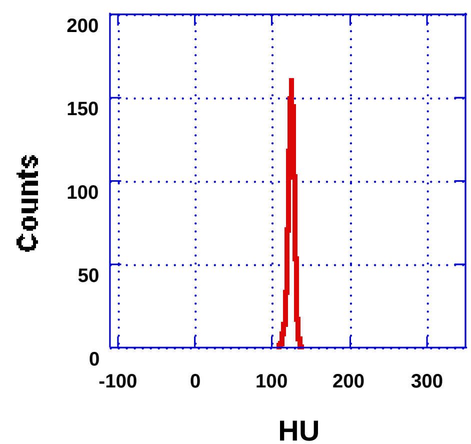






σ = 75

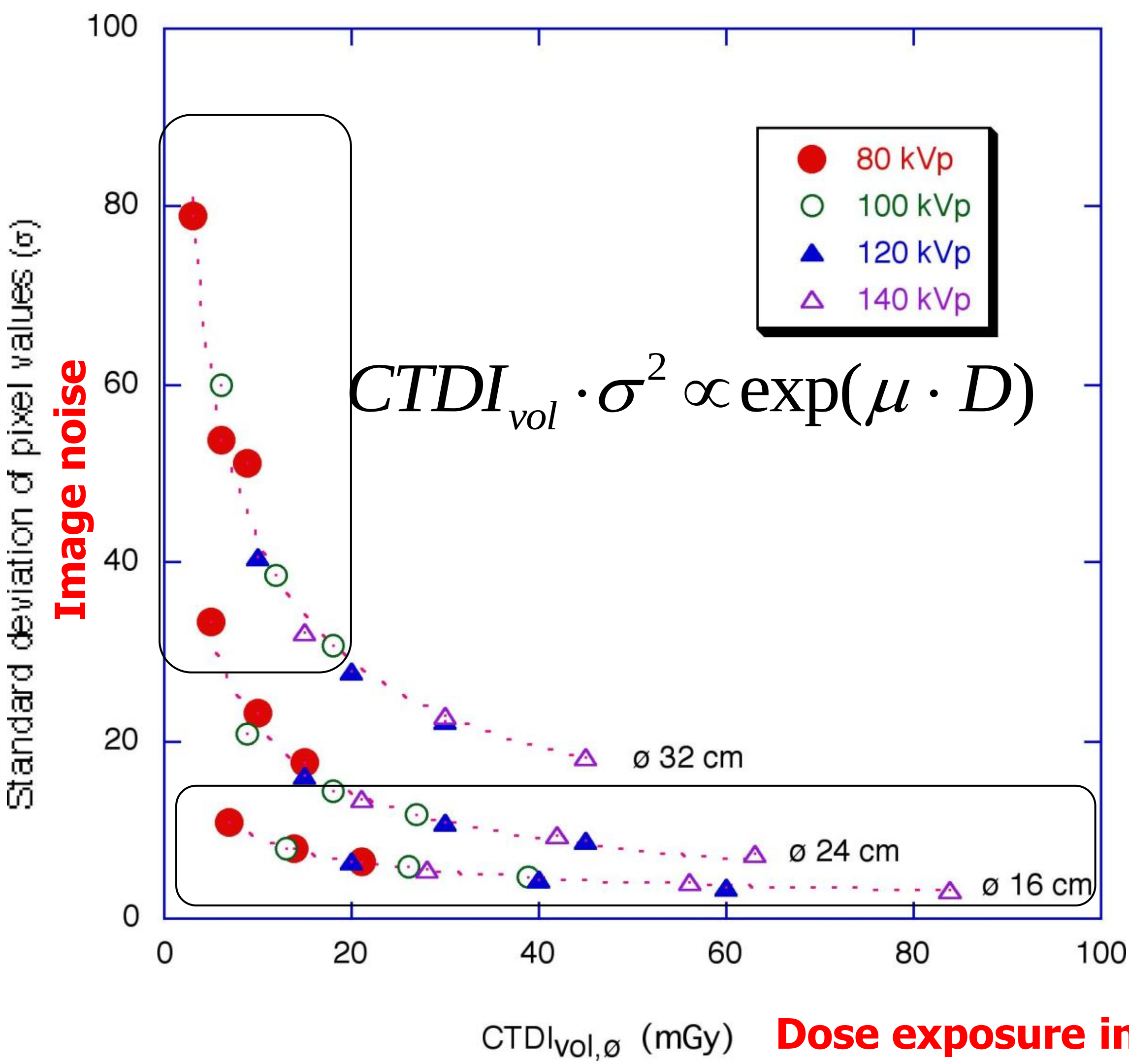
$CTDI_W$ = 5 mGy



σ = 5

$CTDI_W$ = 60 mGy

Patient size, CTDI and image noise



$$CTDI_{vol} \cdot \sigma^2 \propto \exp(\mu \cdot D)$$

Dose exposure index

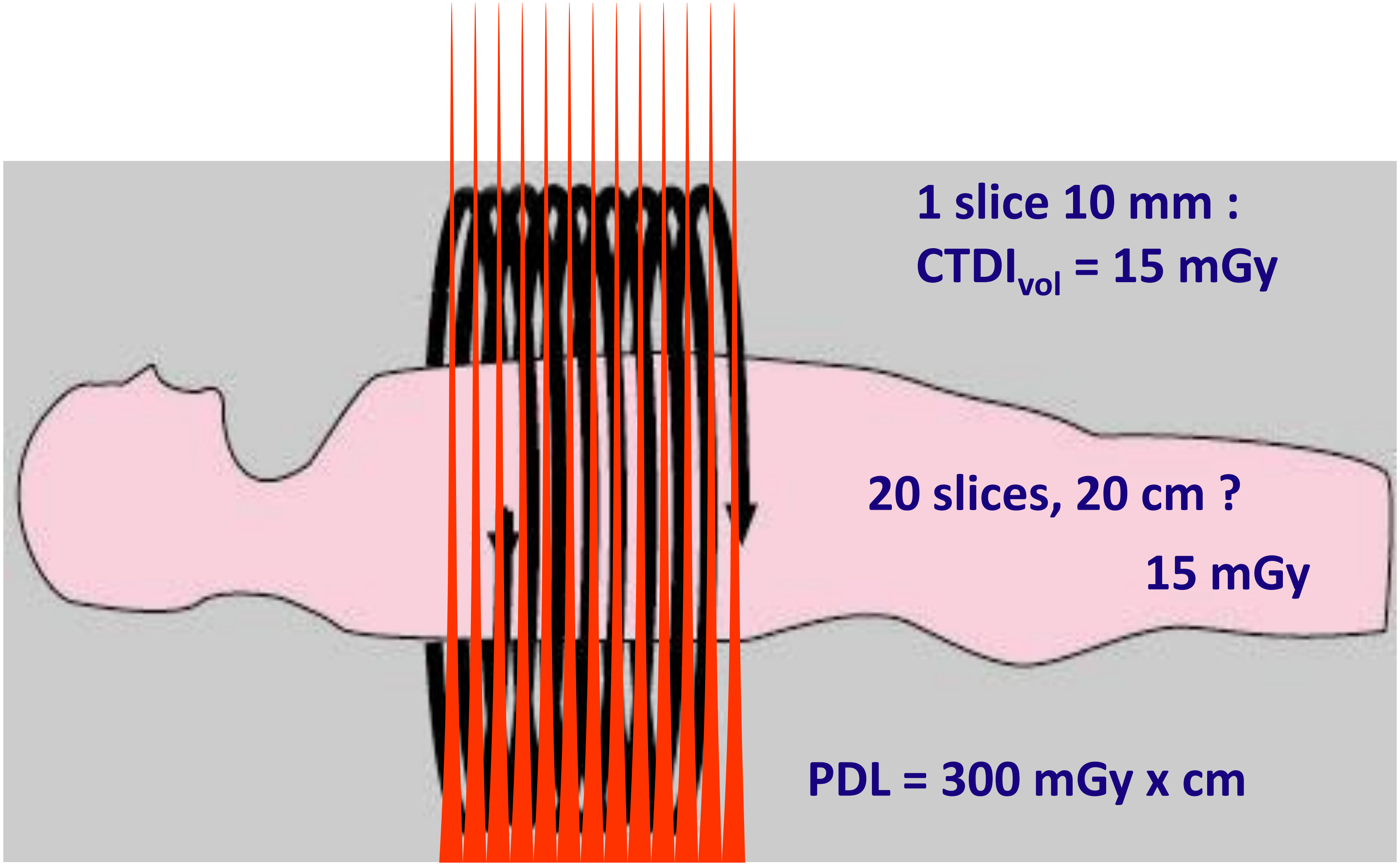
In large phantoms (large D)
Low energy beam (low kV) results in strong degradation on image quality
High level of noise

In small phantoms (small D - Pediatrics)
Low energy beam (low kV) can be used to reduce dose exposure with litle degradation in image quality

Dose length product

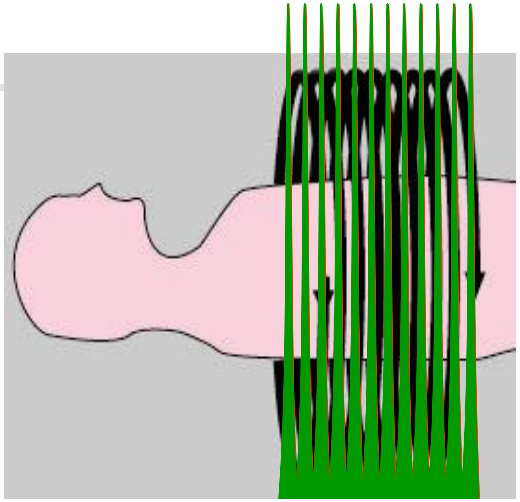
DLP = $CTDI_{vol}$ x L (mGy.cm)

DLP : measure of the total absorbed energy



Example

- Scanner 16 detector row
  - Beam Energy = 120 kV
  - Charge : 80 mAs
  - Slice thickness : 5 mm
  - Pitch = 1.0
  - Length : 30 cm



$CTDI_{vol}$ = 8.0 mGy

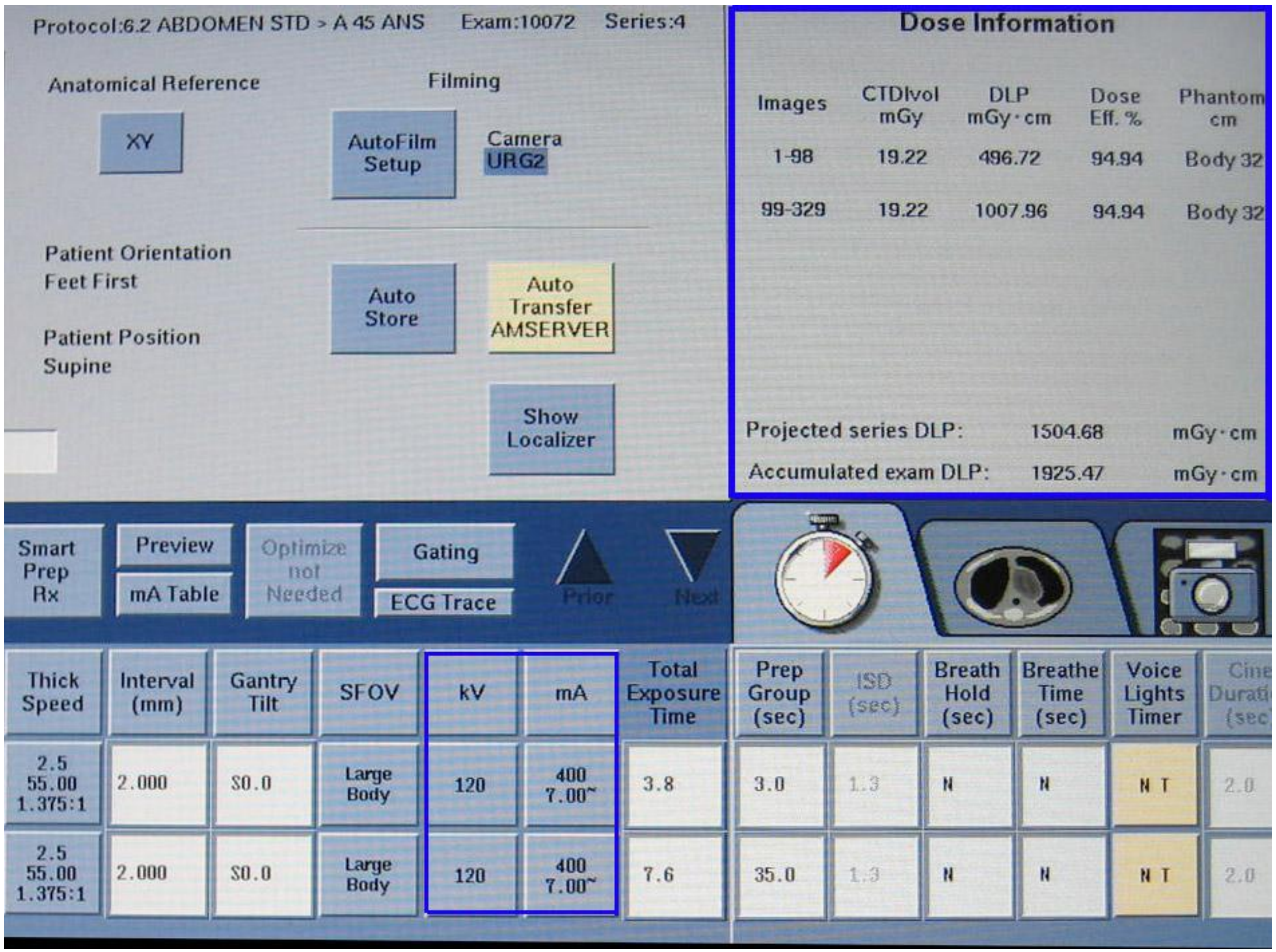
PDL = 240.0 mGy.cm

200 mAs

$CTDI_{vol}$ = 20.0 mGy

PDL = 600.0 mGy.cm

Where to find the information



CTDI : average dose within a slice
→ image noise level

DLP : total number of photons
→ Effective dose

CT : what is low dose ?

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Département fédéral de l'intérieur DFI

Office fédéral de la santé publique OFSP
Unité de direction Protection des consommateurs

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Division radioprotection
www.str-rad.ch

Référence: R-06-06mf
Etabli le: 01.04.2010
N° révision:

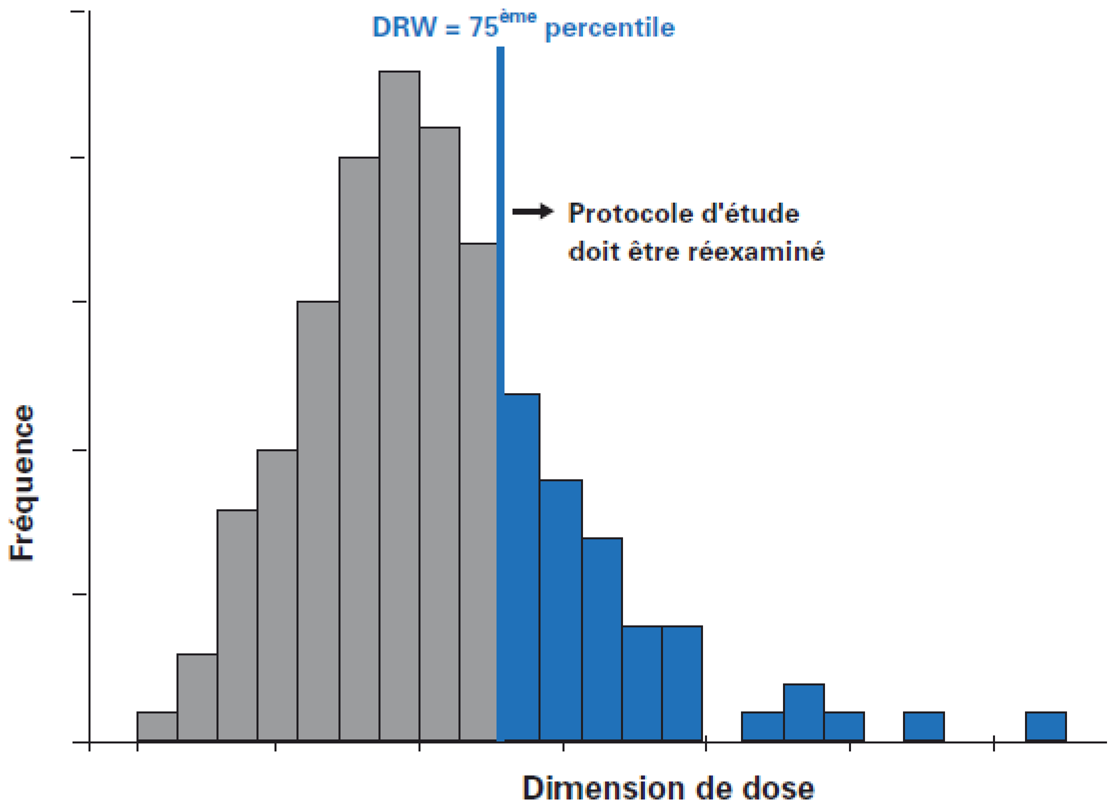
Notice R-06-06
Niveaux de référence diagnostiques en tomodensitométrie

Tableau 1 : NRD et valeurs cibles pour adultes

	Examen / problématique	**NRD (75e percentile)**		**Valeur cible (25e perc.)**	
		$CTDI_{vol}$ [mGy]	PDL [mGy·cm]	$CTDI_{vol}$ [mGy]	PDL [mGy·cm]
1	**Crâne / cerveau** Examens standards, recherche de métastases, abcès cérébral, …	**65**	**1000**	**45**	**600**
8	**Thorax (tissus, osseux, HR)** Infiltrations, adénopathie, localisation focale, …	**10**	**400**	**5**	**250**
13	**Abdomen/bassin** Examens standards, urgence (douleurs abdomina-les), abcès, lymphadénopathie rétropéritonéale, …	**15**	**650**	**10**	**350**

Dose reference levels (DRL) – NRD - DRW

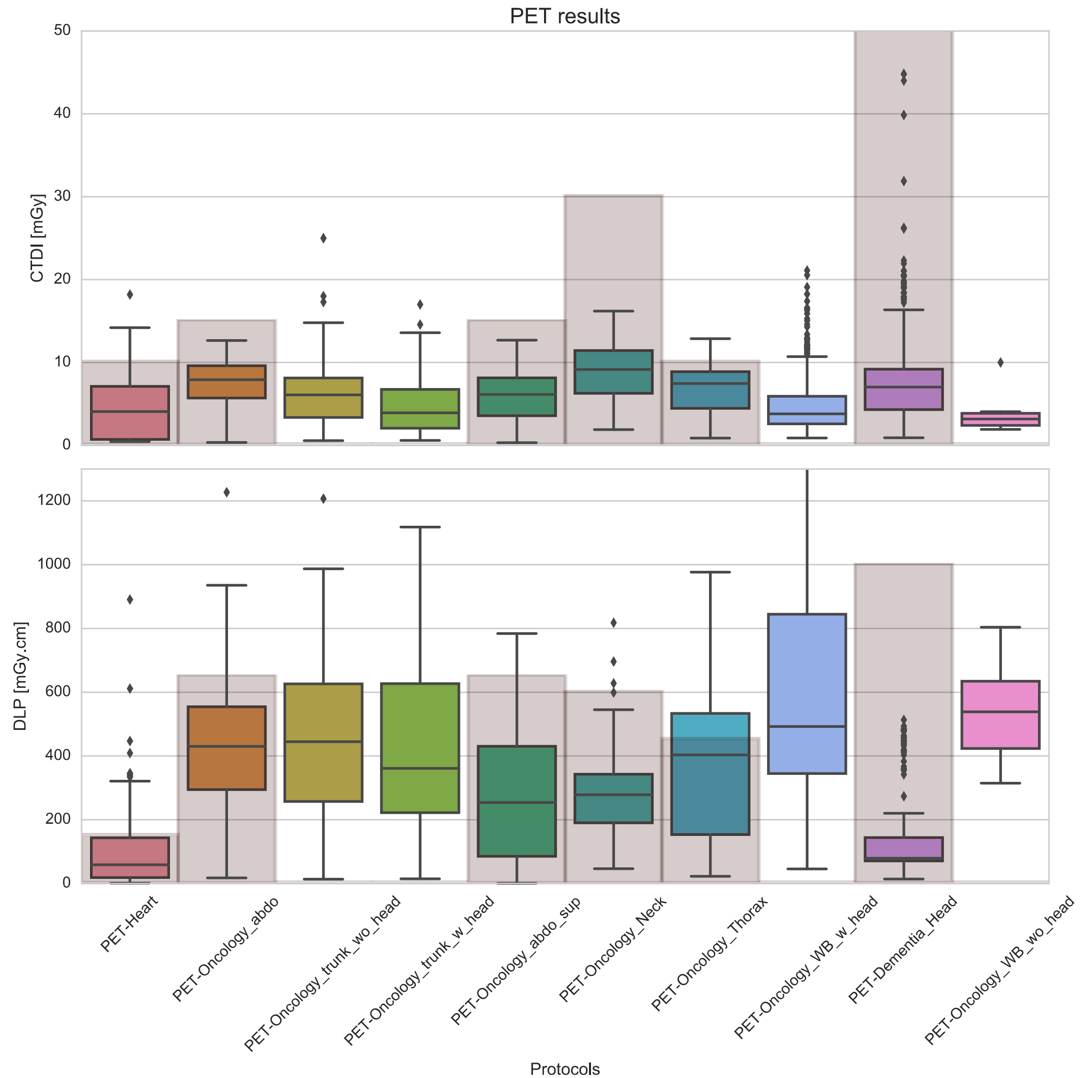
Figure 7 : Représentation schématique visant à déterminer les niveaux de référence diagnostiques



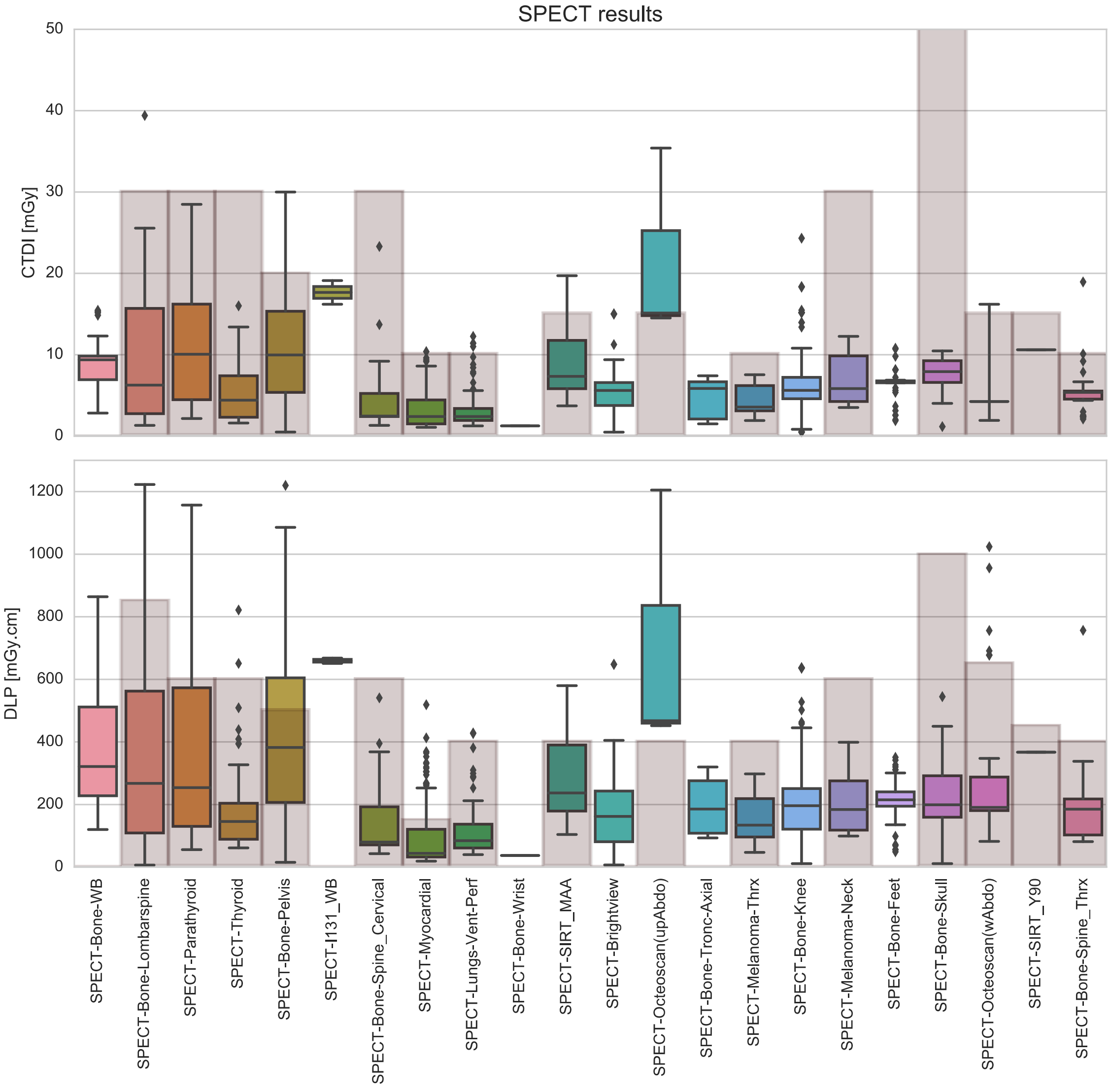
Résultats 2008 Radioprotection

Editeur: Office fédéral de la santé publique
Date de publication: mai 2009

DRL CT in nuclear medicine (PET/CT) Survey 2016/2017



DRL CT in nuclear medicine (SPECT/CT) Survey 2016/2017

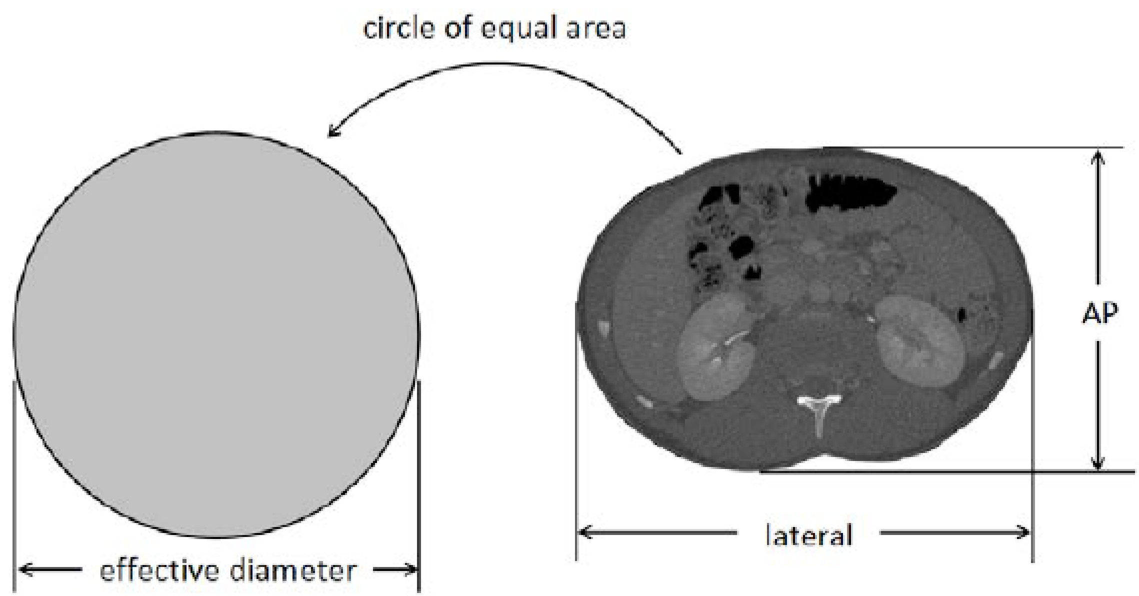


SSDE (Size Specific Diameter equivalent)

Scout acquisition

Figure 2. The anterior posterior (AP) and lateral dimension, along with effective diameter are illustrated in this figure. The lateral dimension can be determined from a PA or AP CT radiograph, and the AP dimension can be determined by a lateral CT radiograph. The effective diameter corresponds to a circle having an area equal to that of the patient's cross section on a CT image. Some investigators have also used patient perimeter (circumference) as a metric of patient size.

Equivalent diameter



$$effective\ diameter = \sqrt{LAT \times AP}$$

AAPM Report No. 204

CTDI → SSDE

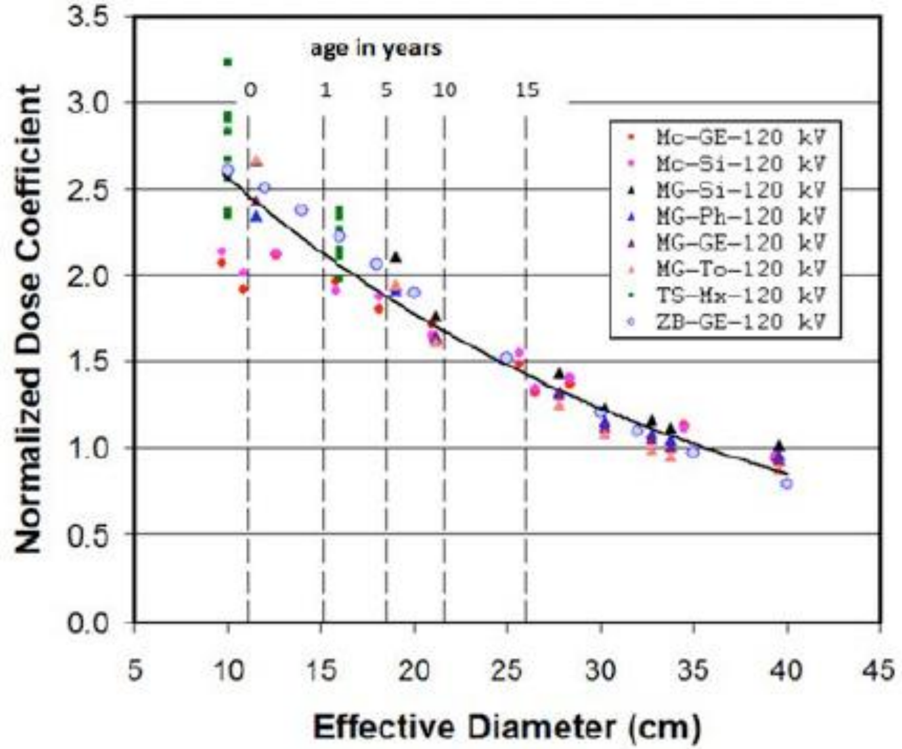
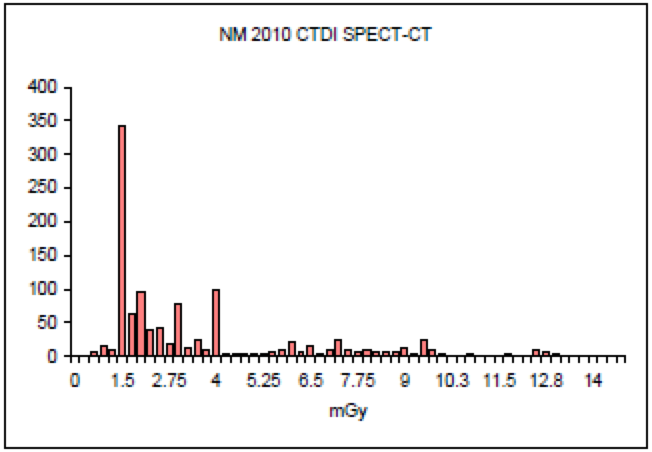
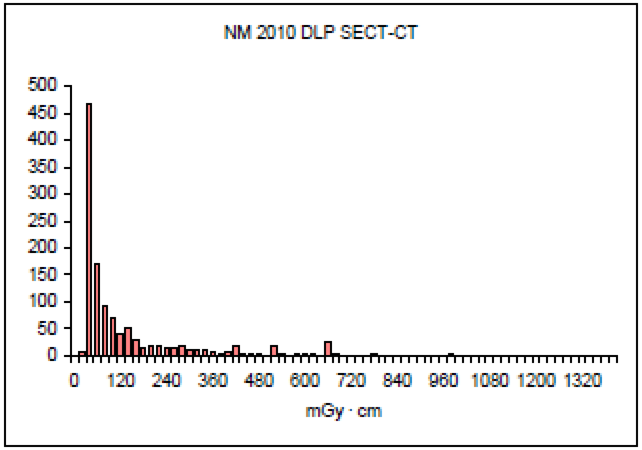


Figure 4. The normalized dose coefficient for the 32 cm PMMA $CTDI_{vol}$ phantom is shown as a function of effective diameter.

AAPM Report No. 204

2010 survey – SPECT/CT*

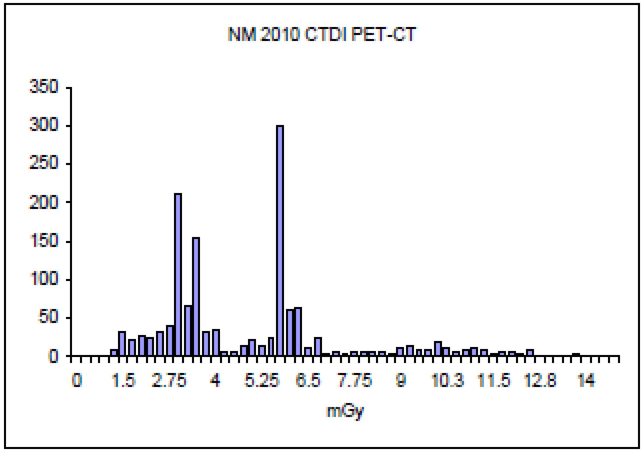


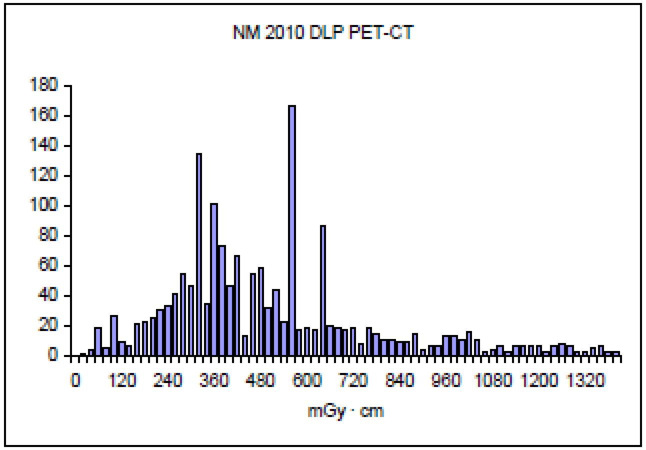


- < $CTDI_{vol}$ > : 2.3 mGy
  - domaine : 1 – 10 mGy
- < PDL > : 56 mGy.cm
  - Domaine : 20 – 400 mGy.cm
- E : 1.0 mSv [0.3 – 6.8]

*Hans Roser, Basel, preliminary results

2010 survey – PET/CT*





- < $CTDI_{vol}$ > : 5.5 mGy
  - Domaine : 1 – 15 mGy
- < PDL > : 456 mGy.cm
  - Domaine : 20 – 1400 mGy.cm
- E : 7.8 mSv [0.3 – 23.8]

*Hans Roser, preliminary results

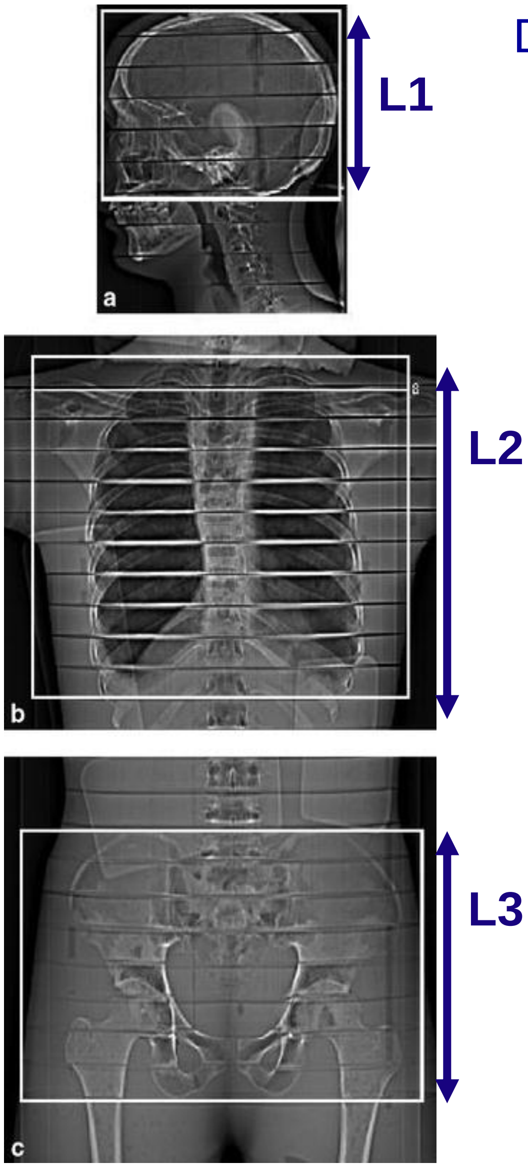
Annexe 4

Examen	L-08-01 NRD [MBq]	Activité appl. 70kg [MBq]	Produit Radiopharmaceutique	Partie du corps	CPR: CPR Long. [mm]	CPR: CPR-PDL [mGy.cm]	CHUV - GE Discovery 670: Long. [mm]	CHUV - GE Discovery 670: PDL [mGy.cm]	CHUV - GE Discovery 670: $CTDI_{vol}$ [mGy]	CHUV - GE Infinia Hawkeye 4: Long. [mm]	CHUV - GE Infinia Hawkeye 4: PDL [mGy.cm]	CHUV - GE Infinia Hawkeye 4: $CTDI_{vol}$ [mGy]
Système osseux	700	Cf. Annexe 3	Tc-99m	Colonne vertébrale	264-275	350	664	542	8.16	419 (4)	125 (4)	2.98 (4)
			DPD/MDP/HDP									
				Bassin/hanche	274	220	306 (3)	253	8.26			
				Genoux	98	100	306 (3)	253	8.26			
				Pieds	98-233	100	306 (3)	253	8.26			
Parathyroïde	555	490	Tc-99m MIBI	Cou	98	100	235 (5)	237	10.1	194	111.1	5.72
Poumon	180	148	Tc-99m	Thorax	275-946	120	314	72	2.29	315	94	2.98
Myocarde	300+900	(1) Cf. Annexe 3	Tc-99m MIBI (Cardiolite)	Partie inferieure du thorax	130-180							
Cerveau	800	(2)	Tc-99m ECD (Neurolie)	Crane	160-239	180						
Récepteurs tumoraux	200	Cf. Annexe 3	I-123 MIBG	Thorax et abdomen	319-389	140	432	142	3.29	419	125	2.98
Récepteurs tumoraux	180	Cf. Annexe 3	In-111 Octreoscan	Thorax et abdomen	319-389	140	410	119	2.9	388	115.7	2.98

(1) L'imagerie Myocardique en SPECT/CT n'est plus d'actualité au sein du service. A sa place PET/CT Rb82 .
(2) L'imagerie SPECT du cerveau adopte une correction de l'atténuation basée sur la méthode de Chang. Le CT n'est pas effectué.
(3) Champ de vue souvent étendu pour correspondre au champ de vue de la gamma-caméra.
(4) Procédure standard pour la correction d'atténuation et le repérage anatomique. Longueur de scan correspondant au champ de vue de la gamma caméra. Le rapport PDL / Longueur reste largement à l'avantage du protocole CHUV.
(5) Procédure pré-chirurgicale. Champ de vue étendu pour les besoins du chirurgien. Rapport PDL / Longueur constant.


DoseWatch
Silvano Gnesin
Patient Search
Tracking
Analysis
Reporting
Administration
CT DLP Analysis per Protocol
1.3 PET-CT TRONC BAS
Filters
Study Description Details
Mean DLP
648.75 mGy.cm
Median DLP
672.65 mGy.cm
Min. DLP
39.57 mGy.cm
P25 DLP
510.94 mGy.cm
P75 DLP
811.79 mGy.cm
Max. DLP
1329.51 mGy.cm
Number of Studies
813
Number of Alerts
0
Alert Rate
0.00 %
Patient Age (Range)
59 (-94)
Timeline
Warning
Alert
Bar Graph
Scatter Plot
1m
3m
6m
YTD
1y
All
From
2014-02-18
To
2014-05-19
DLP mGy.cm
500
0
02-24
03-03
03-10
03-17
03-24
03-31
04-07
04-14
04-21
04-28
05-05
05-12
05-19

From DLP to effective dose



Dose length product x	Conversion factor =	Effective dose
$PDL\ 1 = CTDI_w \times L1$	x 0.0023	= E1
	x 0.0054	
$PDL\ 2 = CTDI_{vol} \times L2$	x 0.017	= E2
	x 0.015	
$PDL\ 3 = CTDI_{vol} \times L3$	x 0.019	= E3

$$E = \Sigma E_i$$

Conclusion

- Problems
  - Some manufacturers are reluctant to perform the required tests
    - Check
      - If requirements are fulfilled
      - If range of acceptance values are provided (especially for stability tests)
    - Acceptance test → included in purchase contract
  - Be careful when quoting “low dose” CT
- Advantages
  - Strategy compatible with international standards
  - Quantitative measurements available
  - Stability tests : simple and not time consuming