quantification: cost or benefit?

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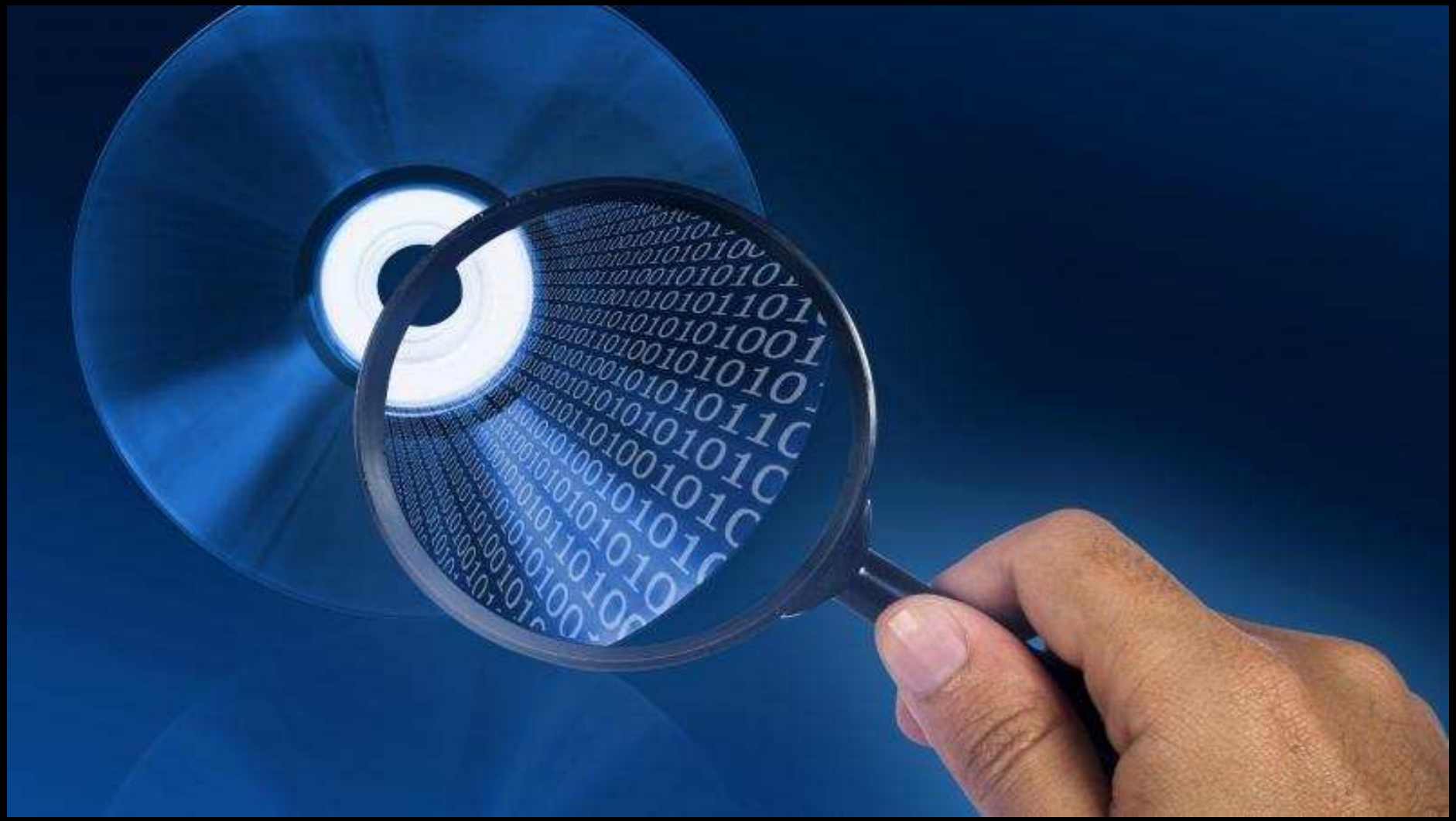
Why is this important for us ?

- Imaging field moves towards quantification
- PET is the best quantitative procedure
- PET still needs to qualify as prognostic and predictive biomarker, e.g.
  - response evaluation
  - stratification for adjuvant therapy
- Concern: repeat baseline scans because initial scan did not meet the standard (cost, ALARA)
- Good news: way ahead of competing technologies



FDG PET(-CT)
EANM Procedure Guidelines
for Tumour PET Imaging (1.0)

PET imaging / SUV uncertainties

Technical factors

– Relative calibration between PET scanner and dose calibrator (10%)
– Residual activity in syringe (5%)
– Incorrect synchronization of clocks (10%)
– Injection vs calibration time (10%)
– Quality of administration (50%)

Physics related factors

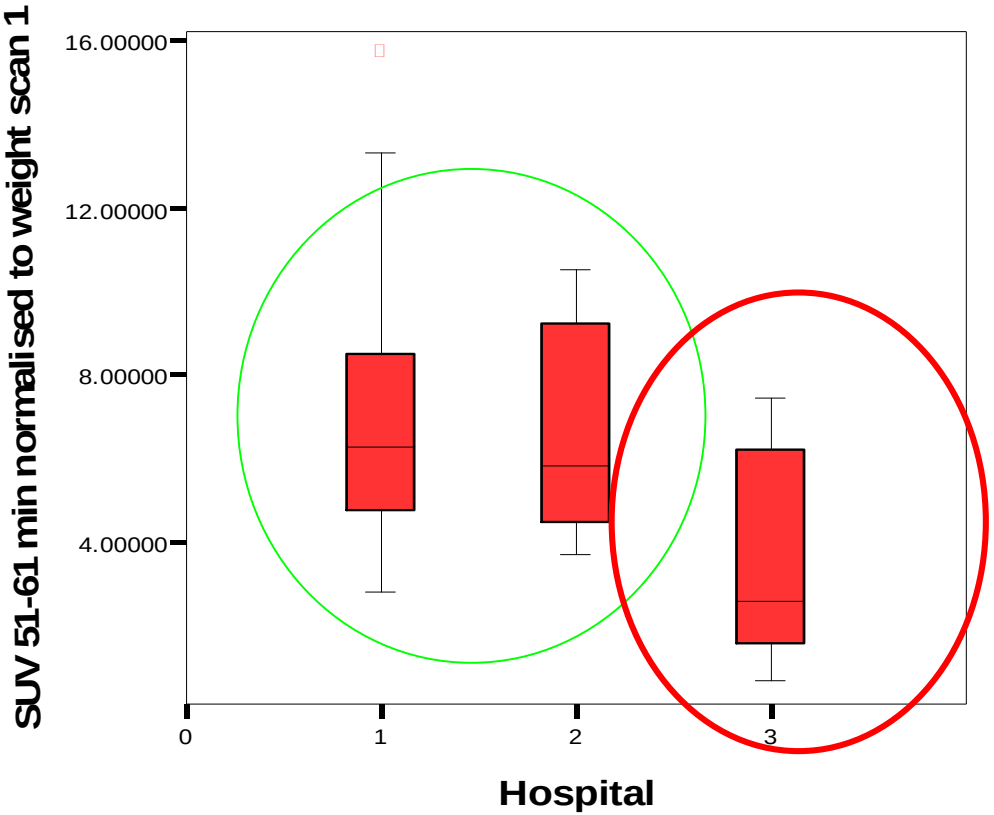
– Scan acquisition parameters (15%)
– Image reconstruction parameters (30%)
– Use of contrast agents (15%)
– ROI (50%)

Biological factors

– Uptake period (15%)
– Patient motion and breathing (30%)
– Blood glucose levels (15%)

R. Boellaard 2009, J Nucl Med Supplement Issue 50: 11S

Why do we need a guideline for quantitative FDG PET ?



Recent (2009) observation on site differences in SUV
-Site 1 & 2 closely followed NL standardized protocol
-Site 3 did not – almost factor 2 lower SUV on average

The EANM guideline for FDG PET(-CT) provides recommendations for:

Minimizing physiological or biological effects by patient preparation guidelines

Procedures to ensure accurate FDG administration

Matching of PET study statistics ('image quality') by prescribing FDG dosage as function of patient weight, type of scanner, acquisition mode and scan duration

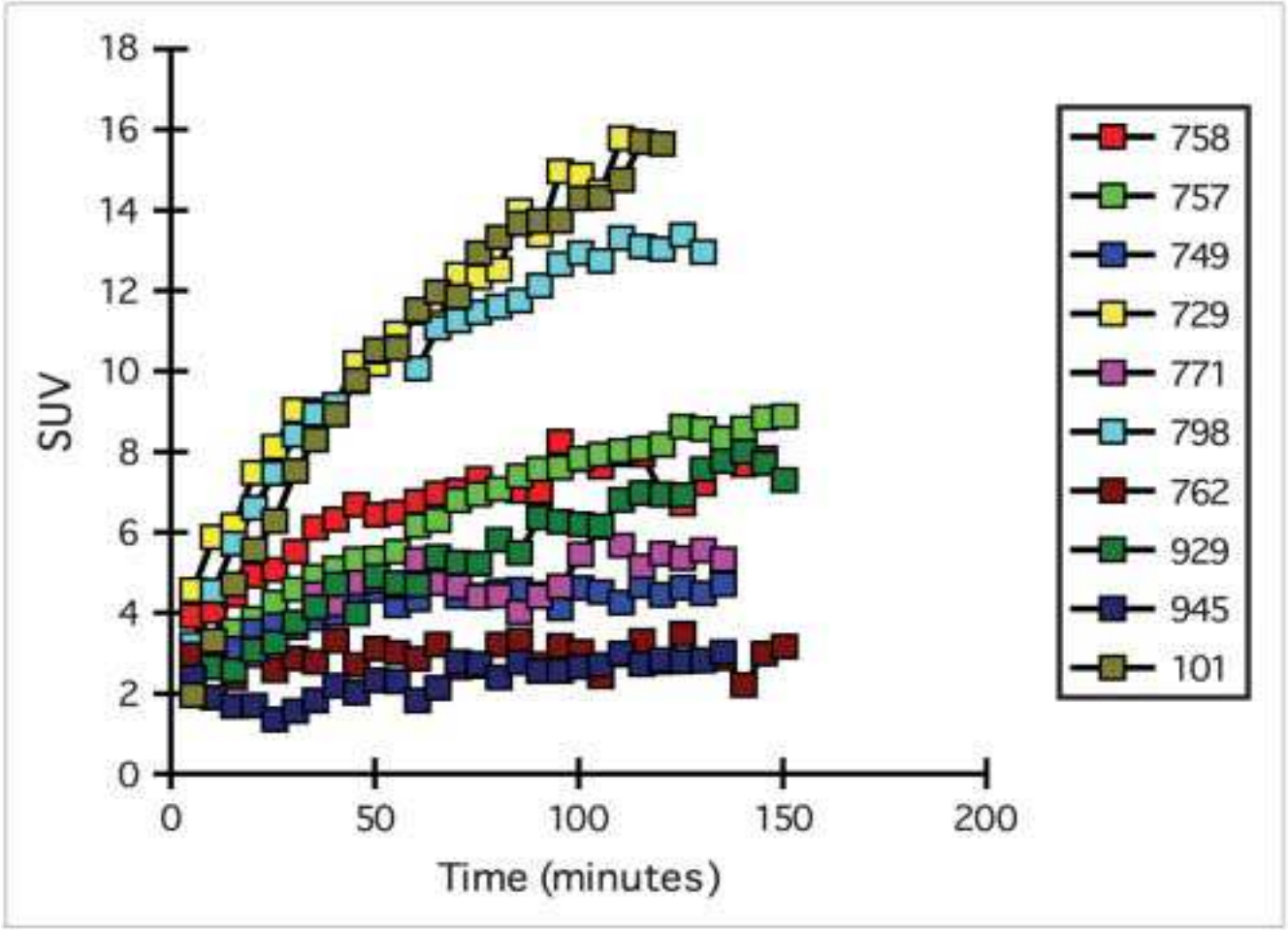
Matching of image resolution by specifying image reconstruction settings and providing activity concentration recovery coefficients specifications (QC experiment)

Standardization of data analysis by prescribing region of interest strategies and SUV measures

Multi-center QC/QA procedures for PET and PET/CT scanners

Factors affecting SUV

biological factors – uptake period



Lowe VJ *et al*. Optimum scanning protocol?for FDG-PET evaluation of pulmonary malignancy. J Nucl Med. 1995

FDG dosage and acquisition
‘image quality and quantification’

Dosage and acquisition definitions aim at matching NEC (statistics, ‘image quality’) across scanners/institutes (to avoid upward bias in SUV).

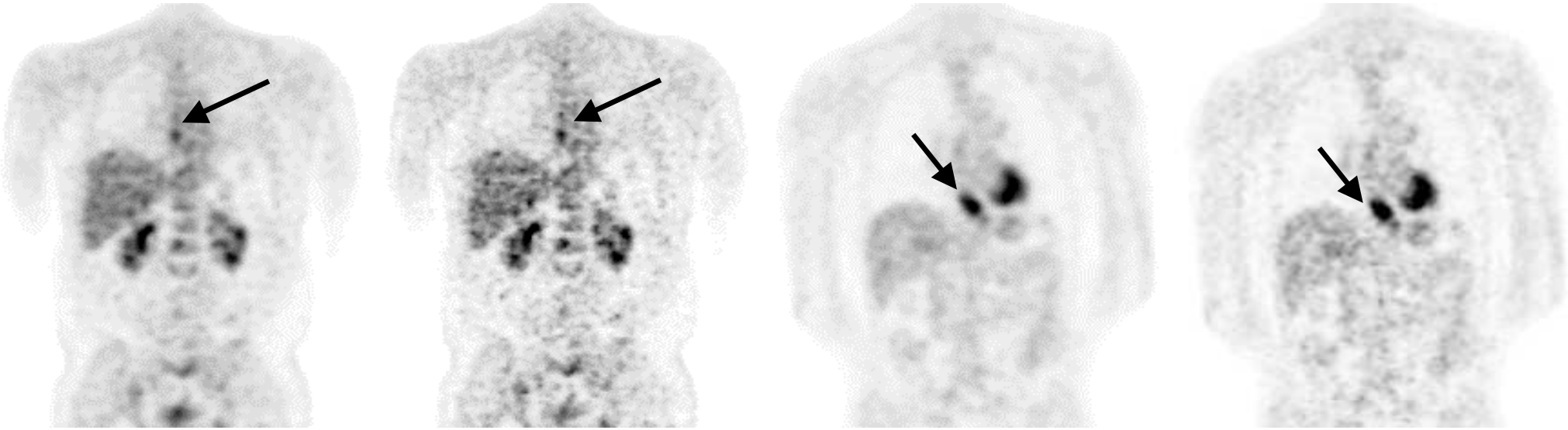
Dosage is given as function of patient weight, scan mode, bed overlap and scan duration.

Image reconstruction

Defined reconstruction settings aim at matching final image resolution (~7 mm FWHM=PET/CT) / convergence / contrast recovery across scanners, as this aspect has a large impact on quantification.

Reconstruction settings will be based on MC-QC results

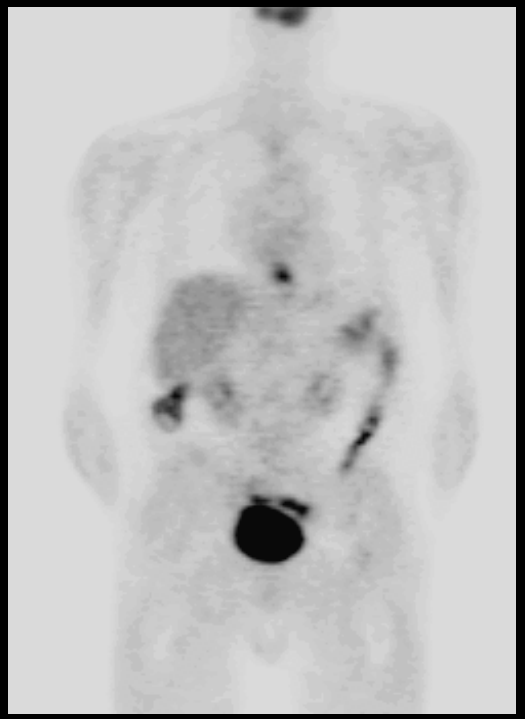
Effects of different number of OSEM iterations, as seen in the Netherlands, on SUV



SUVmax = 4.0	5.9	6.4	8.6
SUV 50%= 3.0	4.1	4.6	5.9

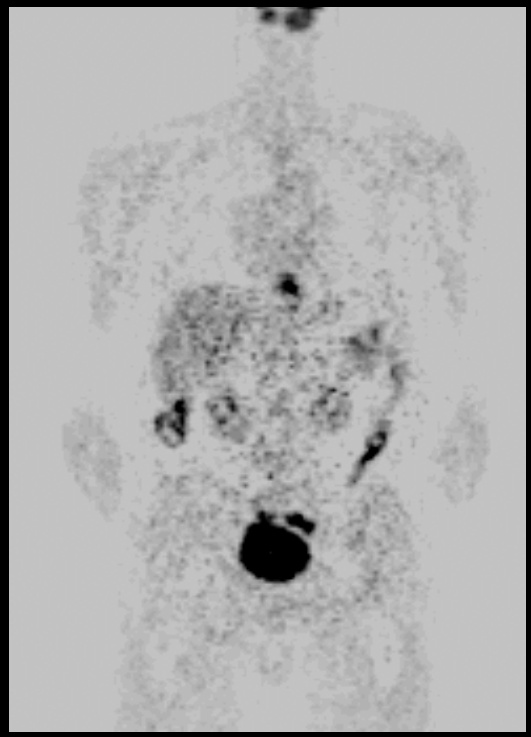
Good imaging practice

visually optimal



together with

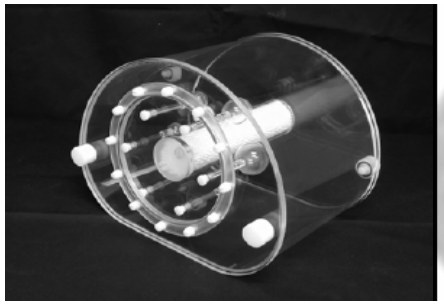
quantitatively optimal

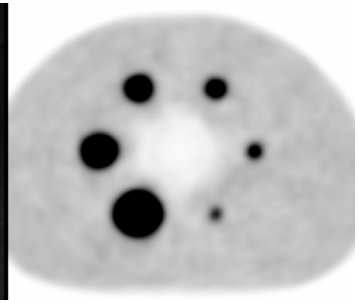


Multi-center QC and calibration

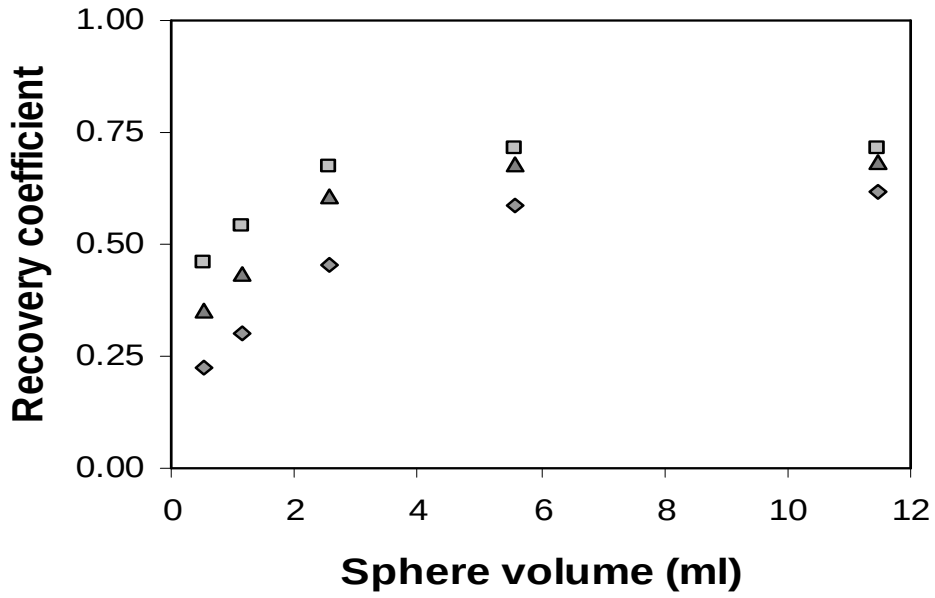
1. Daily QC conform standard procedure of system / manufacturer
2. Calibration QC using (cylindrical) phantom (15-30cm diameter)
3. “Adjusted” NEMA NU 2-2001 Image Quality procedure/measurement to measure recovery coefficients as function of sphere size (= ‘effective image resolution’)
4. CT-QC cf recommendations of ESR/national law
5. Misc. QC (e.g. for scales, alignment etc)

Absolute activity concentration recoveries – NEMA NU 2 2001 IQ Phantom

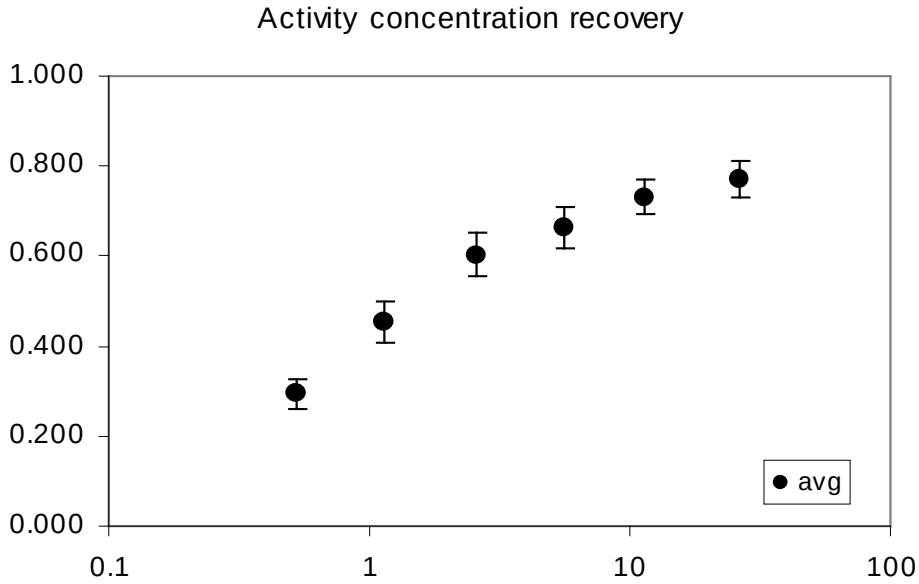




w/o



with standardisation



‘ phantom war ’ upcoming ?

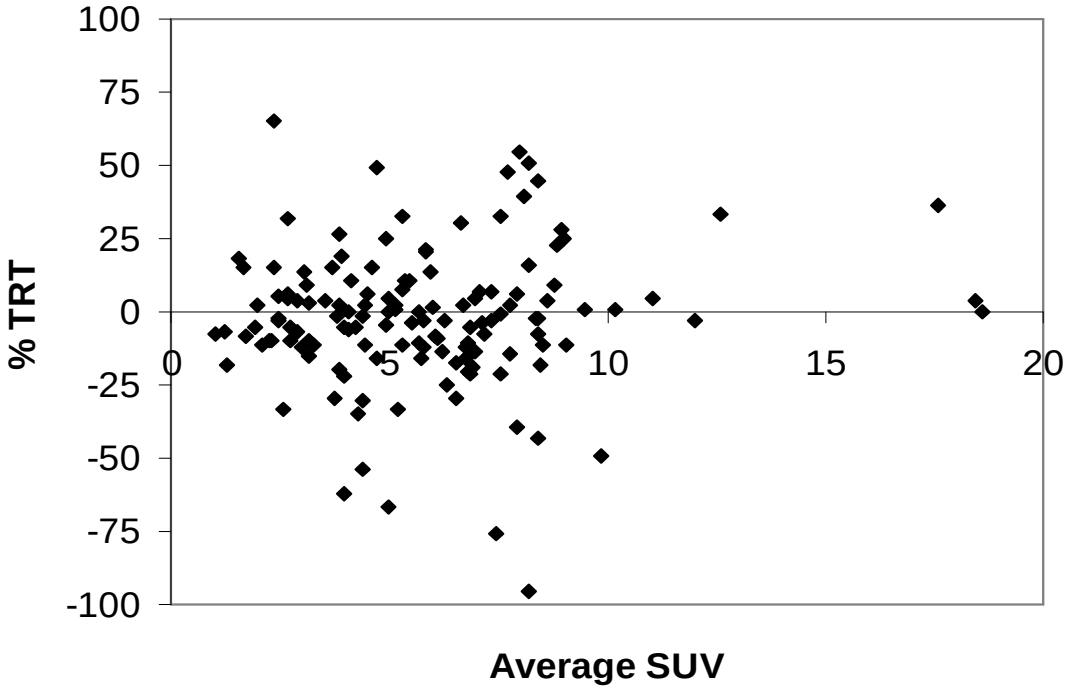
- NEMA: handling -, range of spheres ++
- ACR
- SNM: handling ++, few spheres

calibrations underway

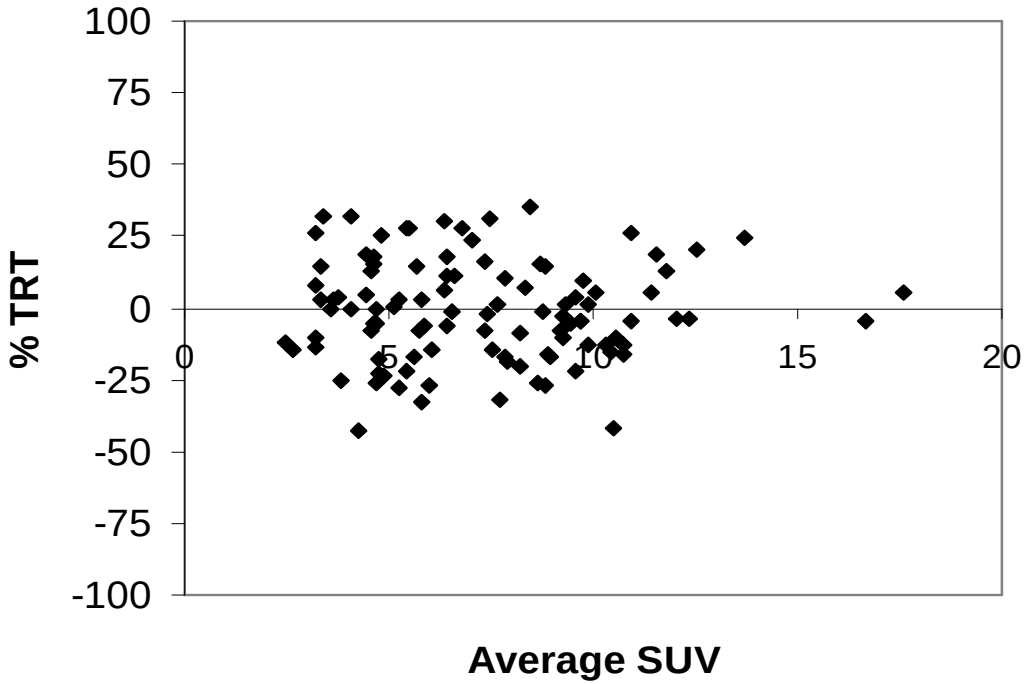
you do not need a physicist,
any tech can do this after instruction

Effects of central QA and data analysis (SUV_{max})

All, local read



QA, central read



Centralized QA mainly removes outliers

EORTC imaging group activities

(as a sequel to NL HOVON initiative – Zijlstra et al.)

- implement guideline (SOP, QA/QC) with EANM
- keosys platform

- proposal to EANM:
    - -regional / national coordinators
    - -accreditation

UK multi-centre PET clinical trials network

Multi-centre trials network operating since 2002

Informal network set up by St Thomas' PET Centre

FDG PET only

3 Studies completed / 2 in progress / 2 in preparation

Accreditation and QC procedures

Standardised data acquisition / analysis

Anonymised data transfer

Centralised or local reporting

Future developments

Adoption of trials network by UK National Cancer Research Institute (NCRI)

Develop audit processes

Improved IT infrastructure

Introduce new tracers

Currently ~21 accredited sites

Courtesy of M. O'Doherty

Status of multi-centre calibration in NL

QC studies performed in ~ 23 sites

Disapproved

3 : deviation > 30% (1 corrected)

1 : deviation of ~ 15%

Approved

8 : deviation of 5 to 7%

11: deviation < 5%

quantification

=

benefit,

for patients & science

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