Korszerű képalkotó diagnosztika a rák ellen PET/CT

Pávics László

Hevesy György

- 1855-1966
- Tracer elv
- Hafnium
- Izotóp higítás
- Aktivációs analízis

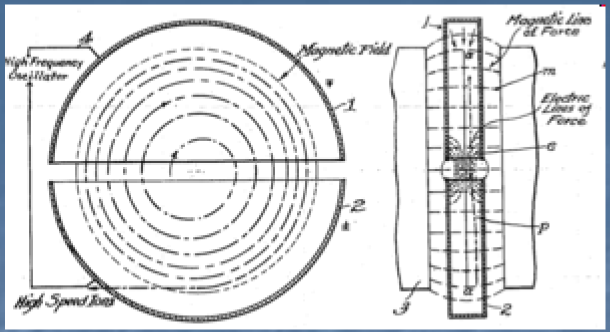
Tracer elv (Chiewitz, Hevesy 1935)

A szervezet nem tud különbséget tenni radioaktív és nem radioaktív elemek között

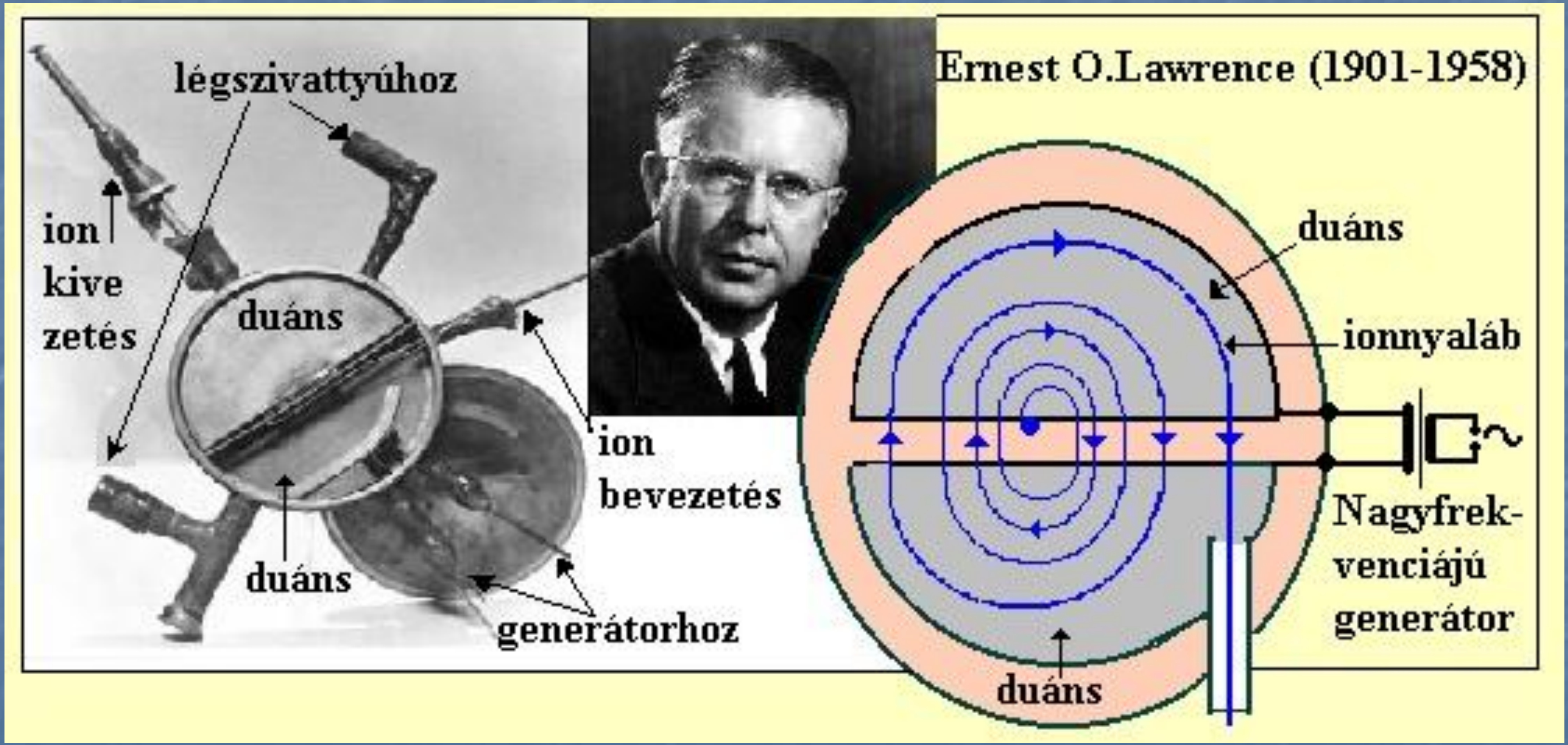
- Kis koncentráció
- Nincs farmakológiai hatás
- Leképezés kívülről
- Kvantitatív

Cyclotron

- Gál Sándor
- Szilárd Leo
- E. Lawrence
- S. Livingstone


High Frequency Oscillator
Magnetic Field
High Speed Ions
Magnetic Lines of Force
Electric Lines of Force

Cyclotron


légszivattyúhoz
ion
kive
zetés
duáns
duáns
ion
bevezetés
generátorhoz
Ernest O.Lawrence (1901-1958)
duáns
ionnyaláb
Nagyfrek-
venciájú
generátor
duáns

Cyclotron

1930

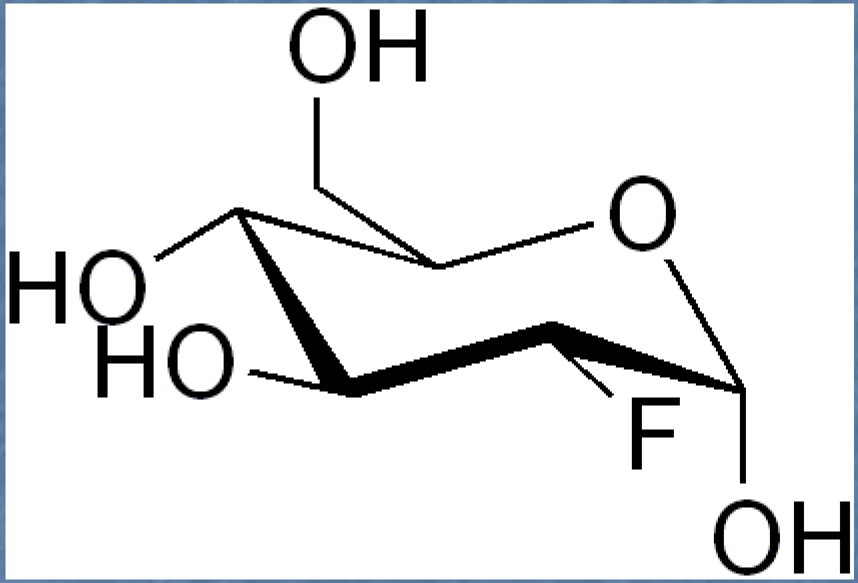
2000

Radionuclides

RADIONUCLIDE	PRINCIPAL DECAY MODE	NUCLEAR REACTION
$^{11}\mathrm{C}$	β^+	$^{11}\mathrm{B}\ (p,n)\ ^{11}\mathrm{C}$ $^{10}\mathrm{B}\ (d,n)\ ^{11}\mathrm{C}$ $^{14}\mathrm{N}\ (p,\alpha)\ ^{11}\mathrm{C}$
$^{13}\mathrm{N}$	β^+	$^{12}\mathrm{C}\ (d,n)\ ^{13}\mathrm{N}$ $^{16}\mathrm{O}\ (p,\alpha)\ ^{13}\mathrm{N}$
$^{15}\mathrm{O}$	β^+	$^{14}\mathrm{N}\ (d,n)\ ^{15}\mathrm{O}$ $^{16}\mathrm{O}\ (p,pn)\ ^{15}\mathrm{O}$
$^{18}\mathrm{F}$	β^+, EC	$^{18}\mathrm{O}\ (p,n)\ ^{18}\mathrm{F}$ $^{20}\mathrm{Ne}\ (d,\alpha)\ ^{18}\mathrm{F}$
$^{43}\mathrm{K}$	β^-, γ	$^{40}\mathrm{Ar}\ (\alpha,p)\ ^{43}\mathrm{K}$
$^{52}\mathrm{Fe}$	β^+, EC	$^{50}\mathrm{Cr}\ (\alpha,2n)\ ^{52}\mathrm{Fe}$
$^{57}\mathrm{Co}$	EC	$^{56}\mathrm{Fe}\ (p,\gamma)\ ^{57}\mathrm{Co}$
$^{67}\mathrm{Ga}$	EC	$^{66}\mathrm{Zn}\ (d,n)\ ^{67}\mathrm{Ga}$ $^{68}\mathrm{Zn}\ (p,2n)\ ^{67}\mathrm{Ga}$
$^{75}\mathrm{Br}$	β^+, EC	$^{74}\mathrm{Se}\ (d,n)\ ^{75}\mathrm{Br}$ $^{74}\mathrm{Se}\ (p,\gamma)\ ^{75}\mathrm{Br}$
$^{81m}\mathrm{Kr}$	γ	$^{79}\mathrm{Br}\ (\alpha,2n)\ ^{81}\mathrm{Rb} \xrightarrow[T_{1/2}\,=\,4.7\ \mathrm{h}]{\mathrm{EC},\ \beta^+} 81\ \mathrm{m_{Kr}}$
$^{111}\mathrm{In}$	EC	$^{111}\mathrm{Cd}\ (p,n)\ ^{111}\mathrm{In}$ $^{112}\mathrm{Cd}\ (p,2n)\ ^{111}\mathrm{In}$
$^{123}\mathrm{I}$	EC	$^{122}\mathrm{Te}\ (d,n)\ ^{123}\mathrm{I}$ $^{123}\mathrm{Te}\ (p,n)\ ^{123}\mathrm{I}$ $^{124}\mathrm{Te}\ (p,2n)\ ^{123}\mathrm{I}$ $^{127}\mathrm{I}\ (p,5n)\ ^{123}\mathrm{Xe} \xrightarrow[T_{1/2}\,=\,2.1\ \mathrm{h}]{\mathrm{EC},\ \beta^+} {}^{123}\mathrm{I}$
$^{201}\mathrm{Tl}$	EC	$^{200}\mathrm{Hg}\ (d,n)\ ^{201}\mathrm{Tl}$ $^{201}\mathrm{Hg}\ (d,2n)\ ^{201}\mathrm{Tl}$ $^{203}\mathrm{Tl}\ (p,3n)\ ^{201}\mathrm{Pb} \xrightarrow[T_{1/2}\,=\,9.4\ \mathrm{h}]{\mathrm{EC},\ \beta^+} {}^{201}\mathrm{Tl}$

GE Discovery

Fluorodeoxy-glükóz (FDG)



FDG synthesis

FÉNYEK

KÖRNYEZET


KÉP-FÚZIÓ

GE Discovery

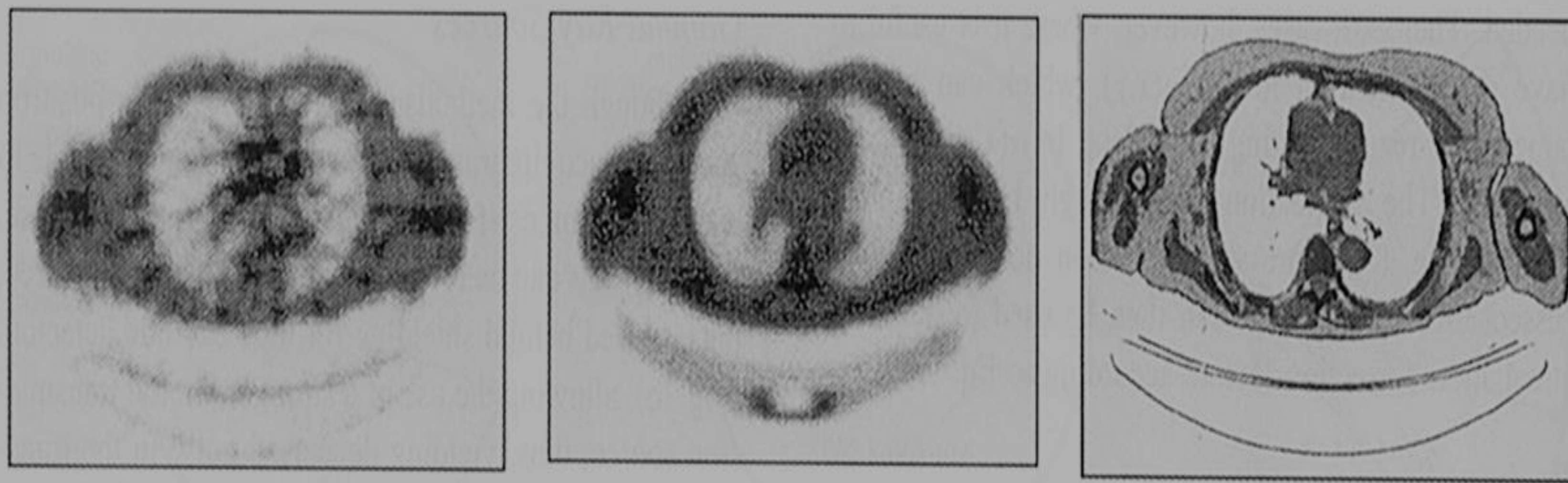
SIEMENS Biograph

Eljárások

	Felbontás tér	Felbontás idő	Érzékenység Mol/L
SPECT	0,5-1.5 mm	perc	10^{-10}-10^{-11}
PET	1-2 mm	10 mp-perc	10^{-11}-10^{-12}
Lumineszcens	3-5 mm	mp	10^{-15}-10^{-17}
Fluoreszcens	2-3 mm	mp	10^{-9}-10^{-12}

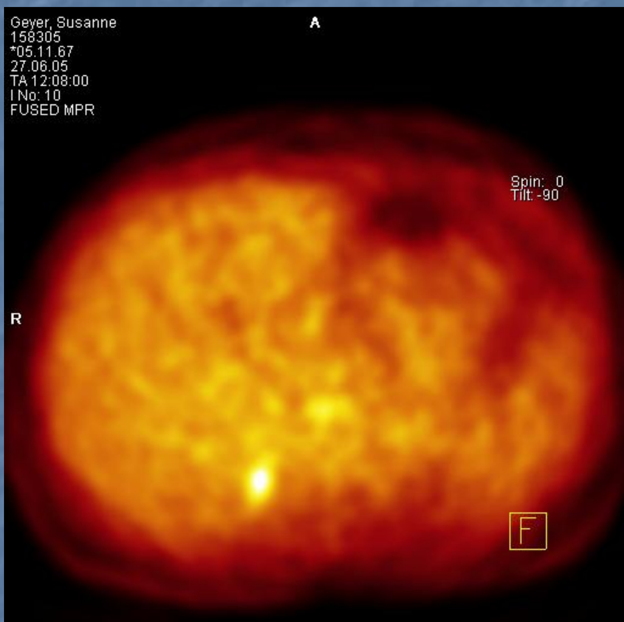
PET/CT

- Minek CT?
  - Abszorpció korrekció
  - Anatomia
- Milyen CT?
  - Low dose CT
  - Diagnosztikus CT

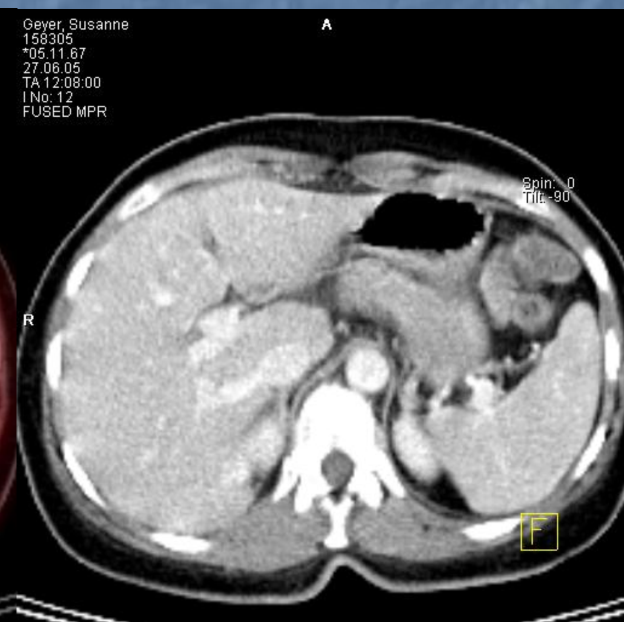


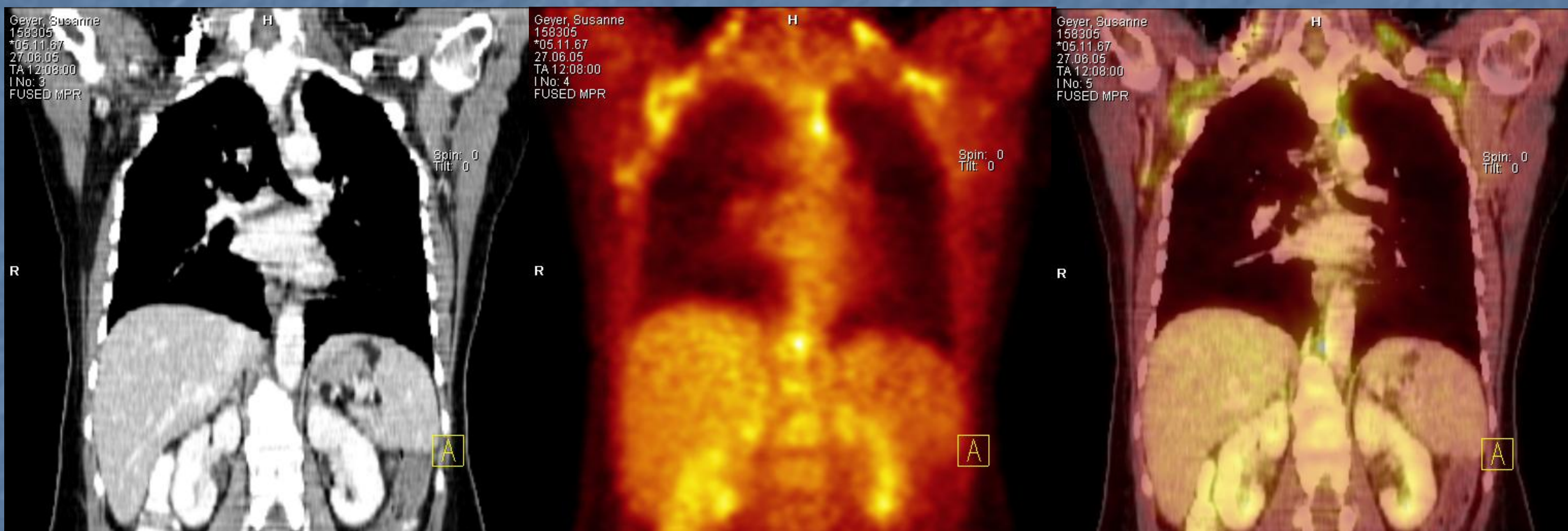
(a) $^{68}Ge/^{68}Ga$ positron source (b) ^{137}Cs gamma-ray source (c) 120 kVp x-ray source

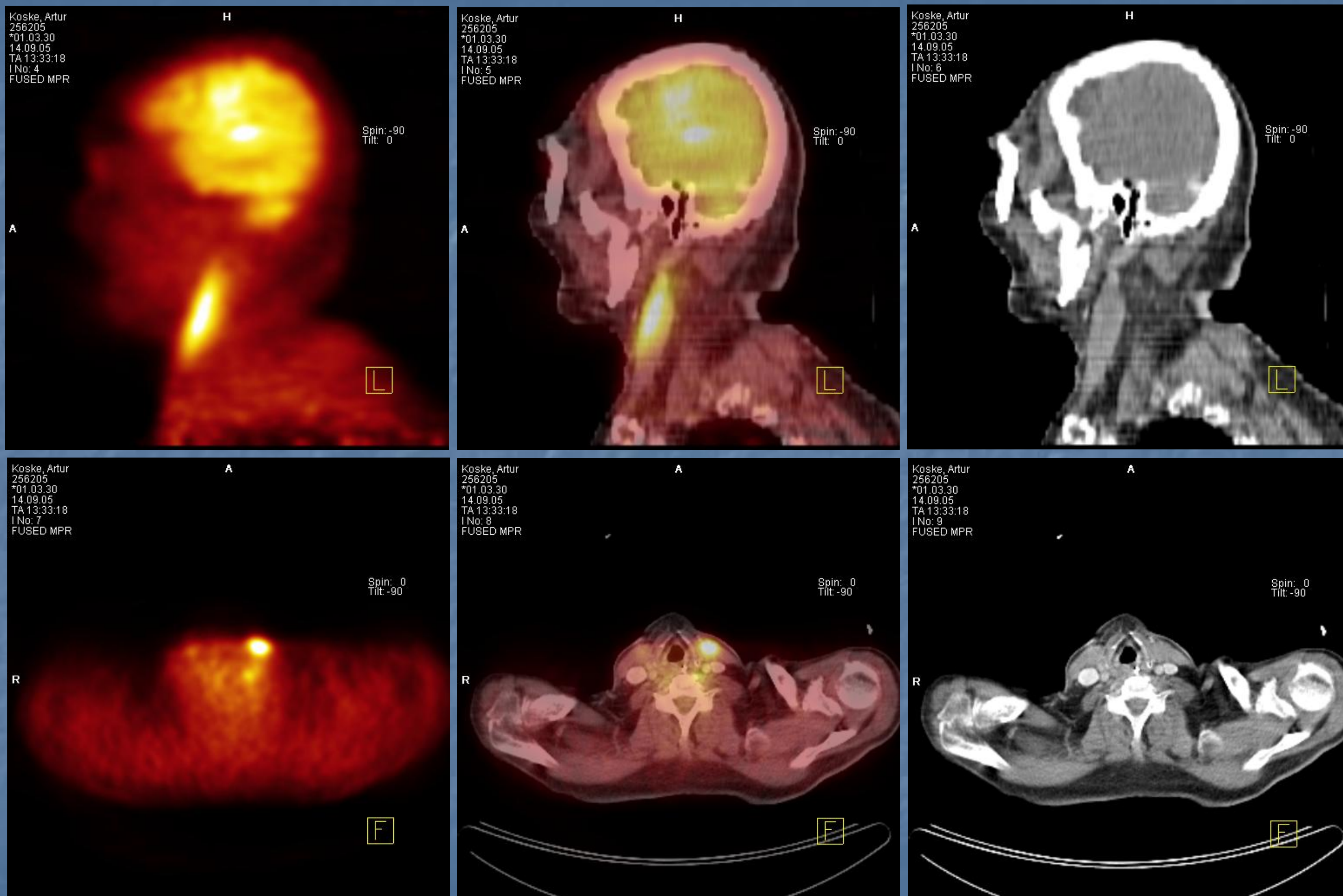
Fig 8. Anecdotal illustrations of the three transmission methods used for measured attenuation correction for PET. In these images darker regions correspond to higher density (ie, bone).


Geyer, Susanne
158305
*05.11.67
27.06.05
TA 12:08:00
I No: 10
FUSED MPR
A
R
Spin: 0
Tilt: -90
F


Geyer, Susanne
158305
*05.11.67
27.06.05
TA 12:08:00
I No: 11
FUSED MPR
A
R
Spin: 0
Tilt: -90
F


Geyer, Susanne
158305
*05.11.67
27.06.05
TA 12:08:00
I No: 12
FUSED MPR
A
R
Spin: 0
Tilt: -90
F


Geyer, Susanne
158305
*05.11.67
27.06.05
TA 12:08:00
I No: 3
FUSED MPR
H
Spin: 0
Tilt: 0
R
A
Geyer, Susanne
158305
*05.11.67
27.06.05
TA 12:08:00
I No: 4
FUSED MPR
H
Spin: 0
Tilt: 0
R
A
Geyer, Susanne
158305
*05.11.67
27.06.05
TA 12:08:00
I No: 5
FUSED MPR
H
Spin: 0
Tilt: 0
R
A


Koske, Artur
256205
*01.03.30
14.09.05
TA 13:33:18
I No: 4
FUSED MPR
H
Spin: -90
Tilt: 0
A
L
Koske, Artur
256205
*01.03.30
14.09.05
TA 13:33:18
I No: 5
FUSED MPR
H
Spin: -90
Tilt: 0
A
L
Koske, Artur
256205
*01.03.30
14.09.05
TA 13:33:18
I No: 6
FUSED MPR
H
Spin: -90
Tilt: 0
A
L
Koske, Artur
256205
*01.03.30
14.09.05
TA 13:33:18
I No: 7
FUSED MPR
A
Spin: 0
Tilt: -90
R
F
Koske, Artur
256205
*01.03.30
14.09.05
TA 13:33:18
I No: 8
FUSED MPR
A
Spin: 0
Tilt: -90
R
F
Koske, Artur
256205
*01.03.30
14.09.05
TA 13:33:18
I No: 9
FUSED MPR
A
Spin: 0
Tilt: -90
R
F

PET/CT menete

- FDG i.v. beadás
- 60-90 perc várakozás
- CT topogram+ egésztest spiral CT
- PET vizsgálat

Indikációk

- Primer dg
- Staging
- Restaging
- Th. követés

Indikációk

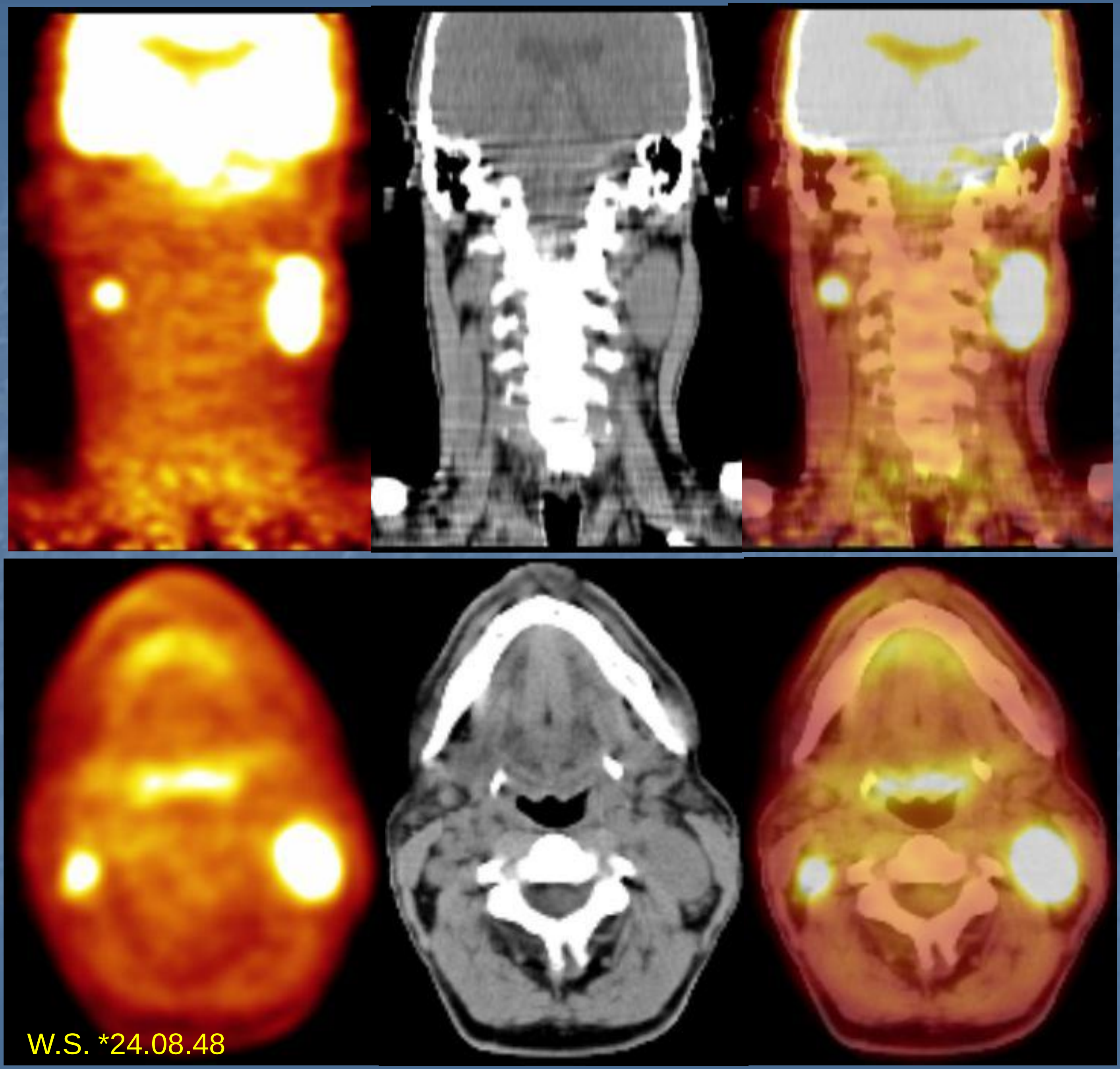
- Tüdő gócos Folyamatainak diff. Dg-je
- Tüdő cc. (nem kissejtes)
- Nyelőcső cc.
- Fej-nyaki neopláziák
- Colorectalis cc.
- Melanoma malignum

Indikációk II.

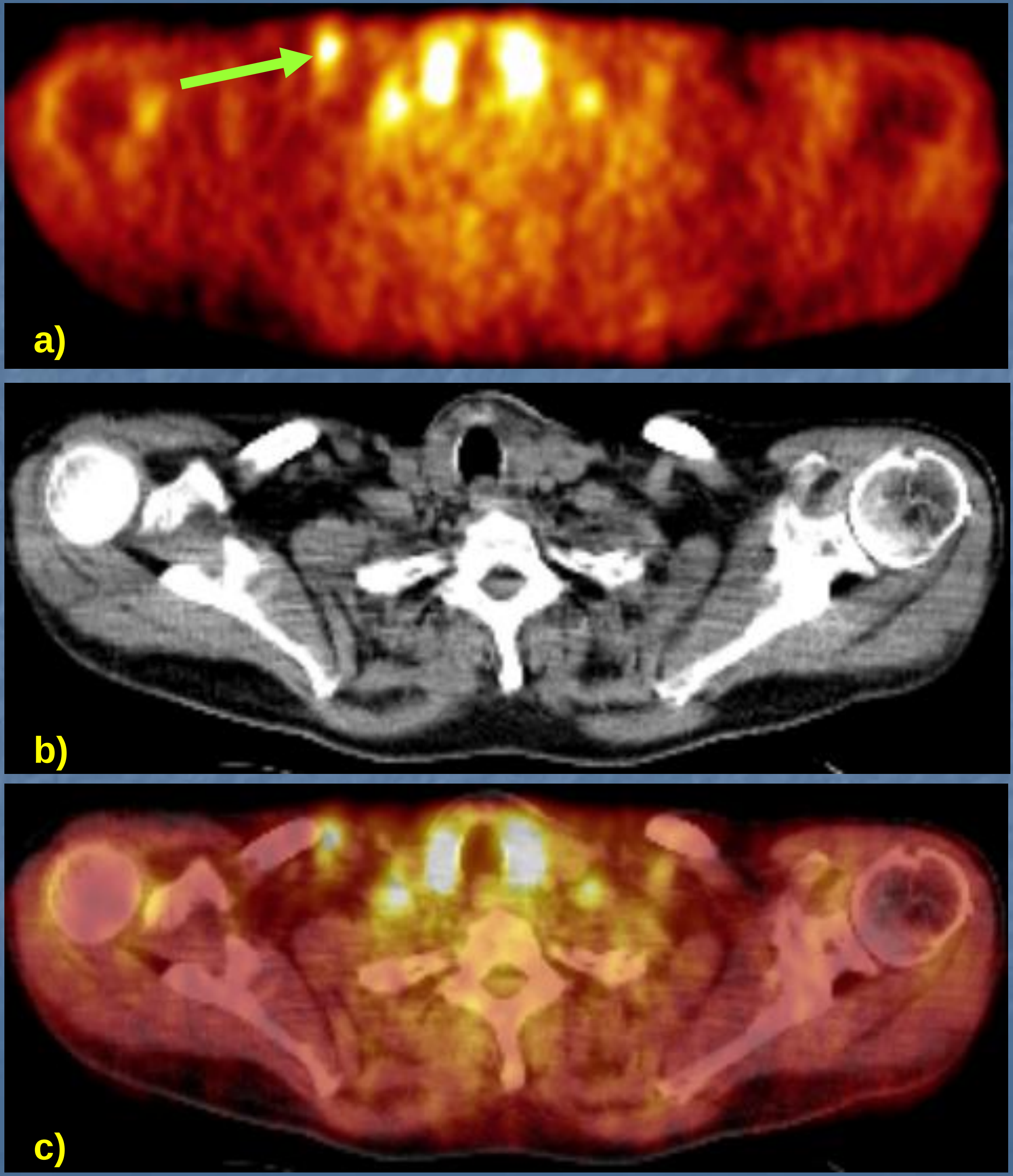
- Agy és gerincvelő rosszindulatú és ismeretlen viselkedésű daganatai
- Gyomor vékonybélrák
- Epilepszia műtét előtti kivizygálása
- Méhnyakrák
- Pajzsmirigyrák
- Emlőrák
- Lymphoma

^{18}F-FDG PET/CT tüdő carcinoma

Goerres et al. J Nucl Med 45: 66S-71S



CUP: Localisation of lymph nodes level II on right side

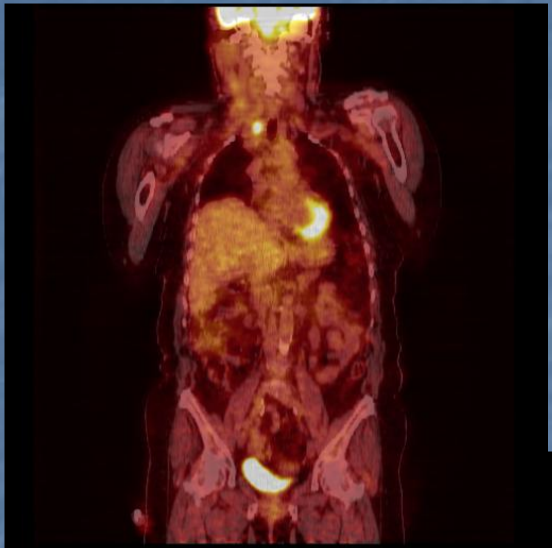


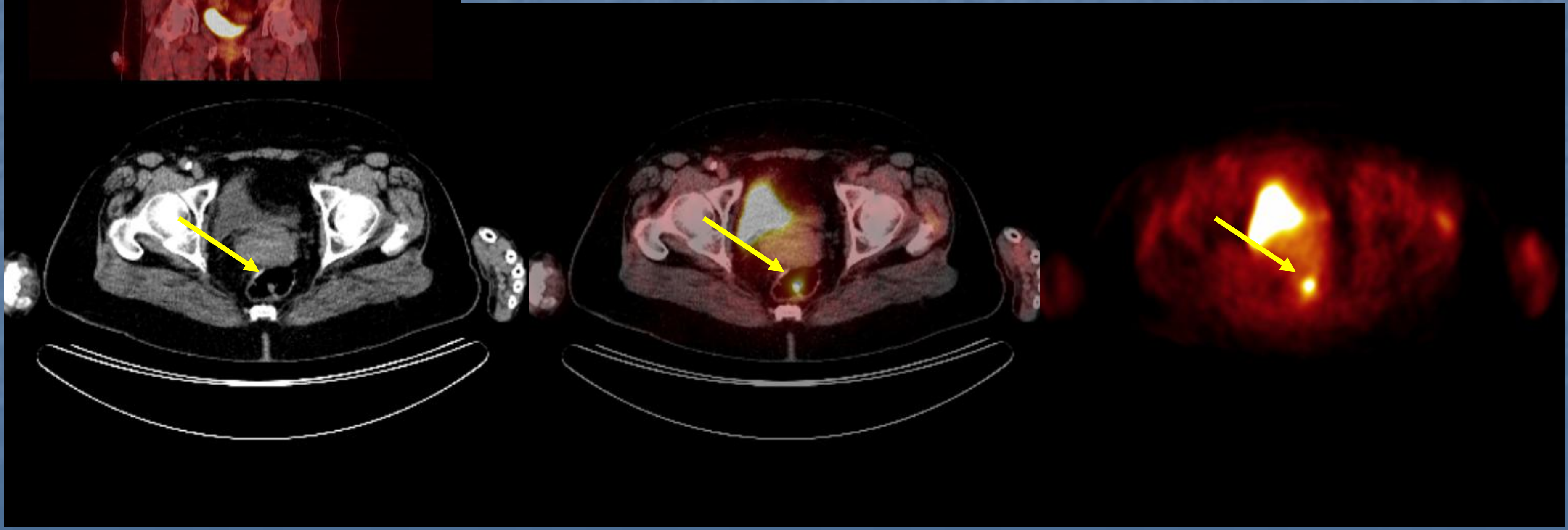
Hot spot in PET (a) (green arrow) with no corespondend tissue alteration in CT (b).

Superposition yields location above the right clavicule (c).

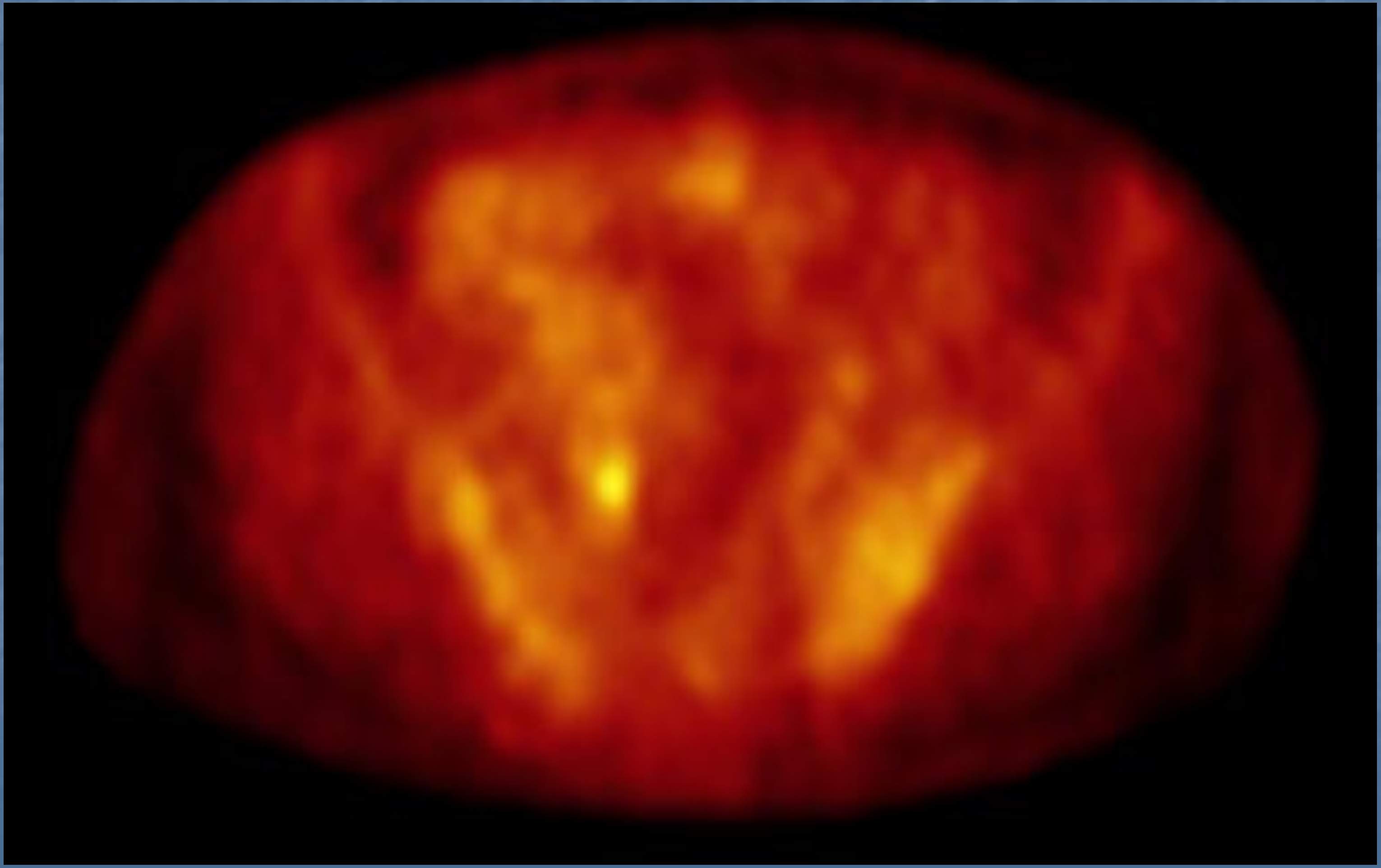
Histologically proven to be a squamous cell carcinoma as a metastasis of re-current laryngeal cancer. Only 6 weeks later before biopsy this metasta-sis was evident in CT with contrast agent.

Zufallsbefund bei SD-Ca



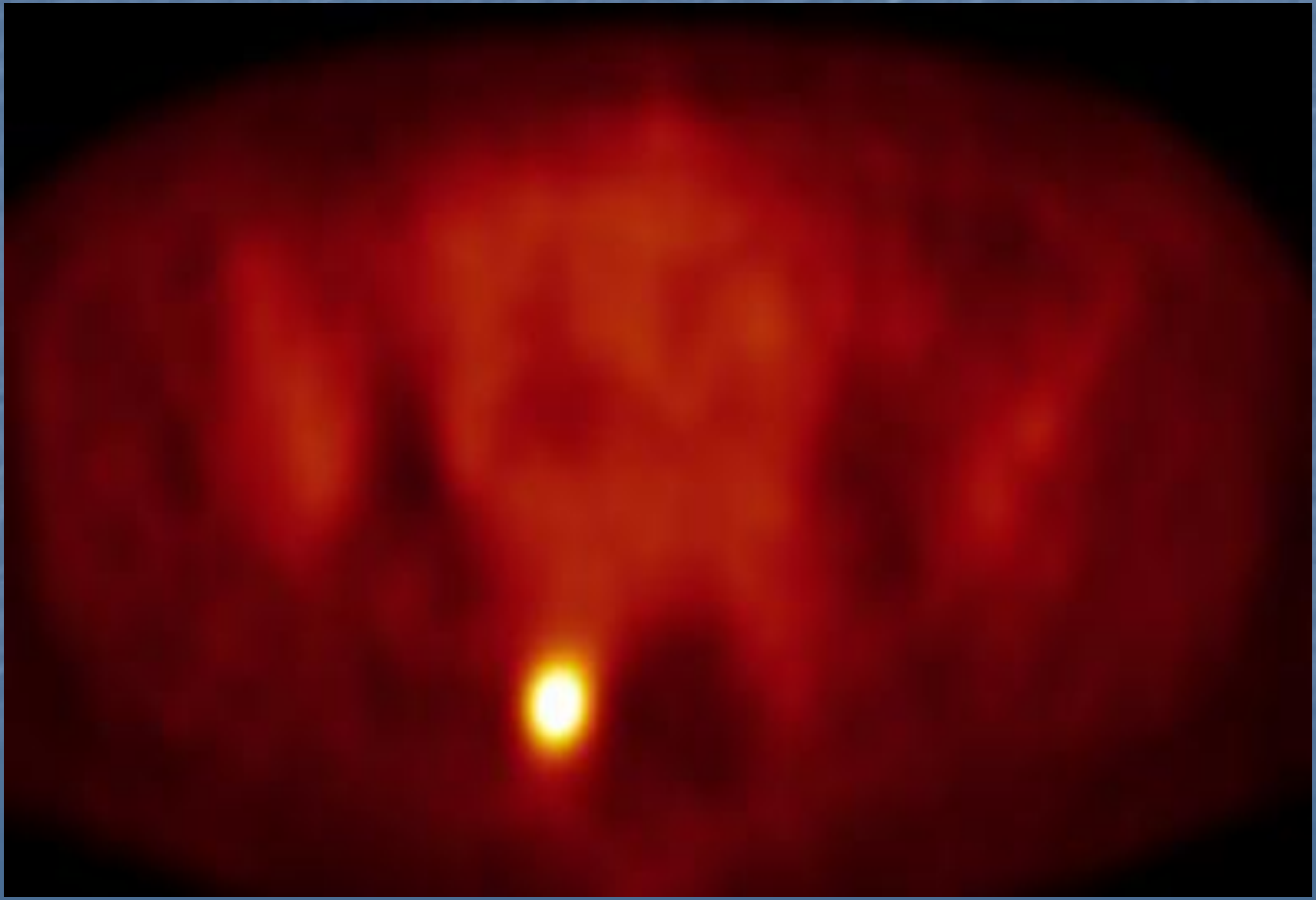


M. G. (female; 60 years old; elevated CEA)

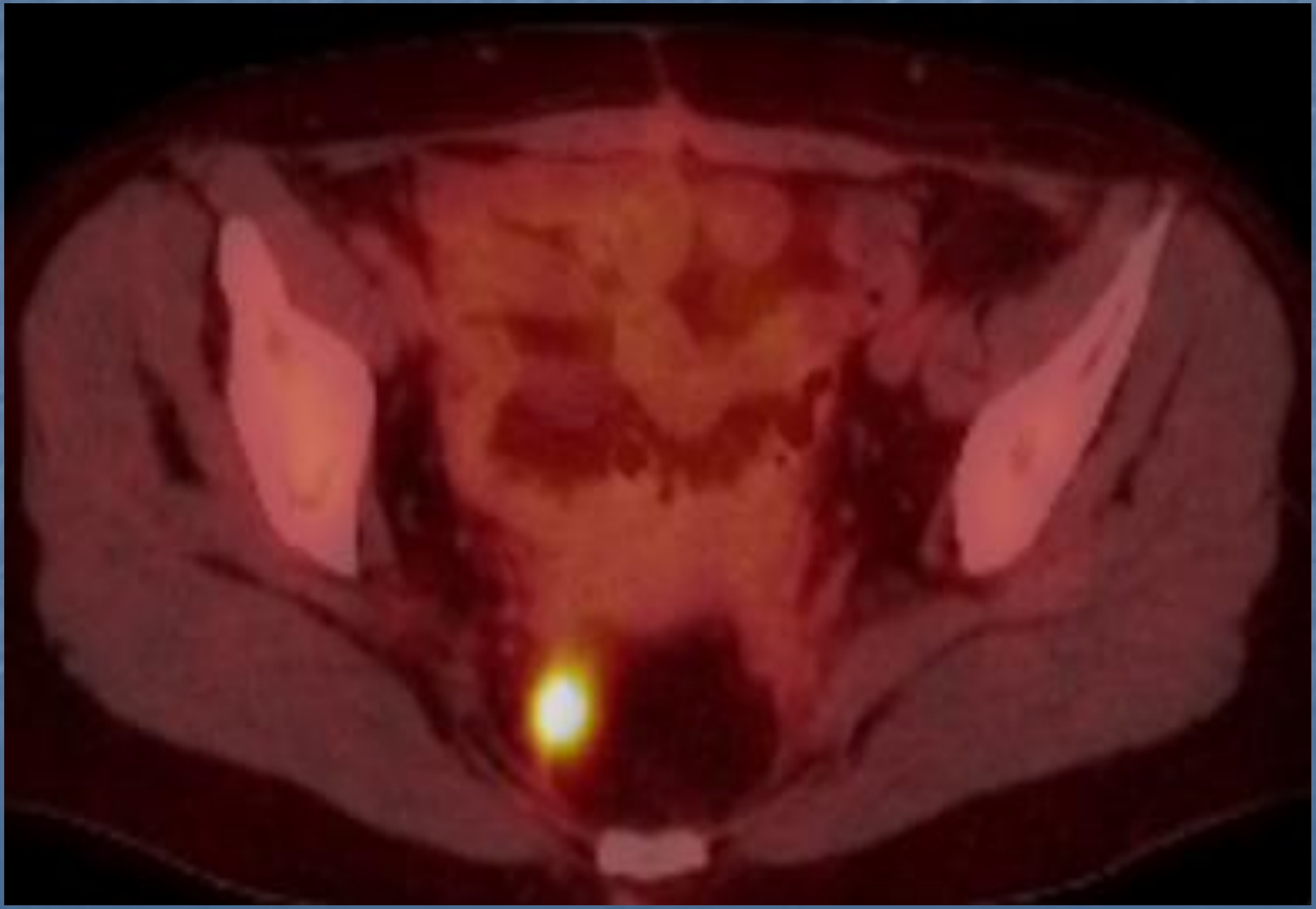


M. G. (female; 60 years old; elevated CEA)

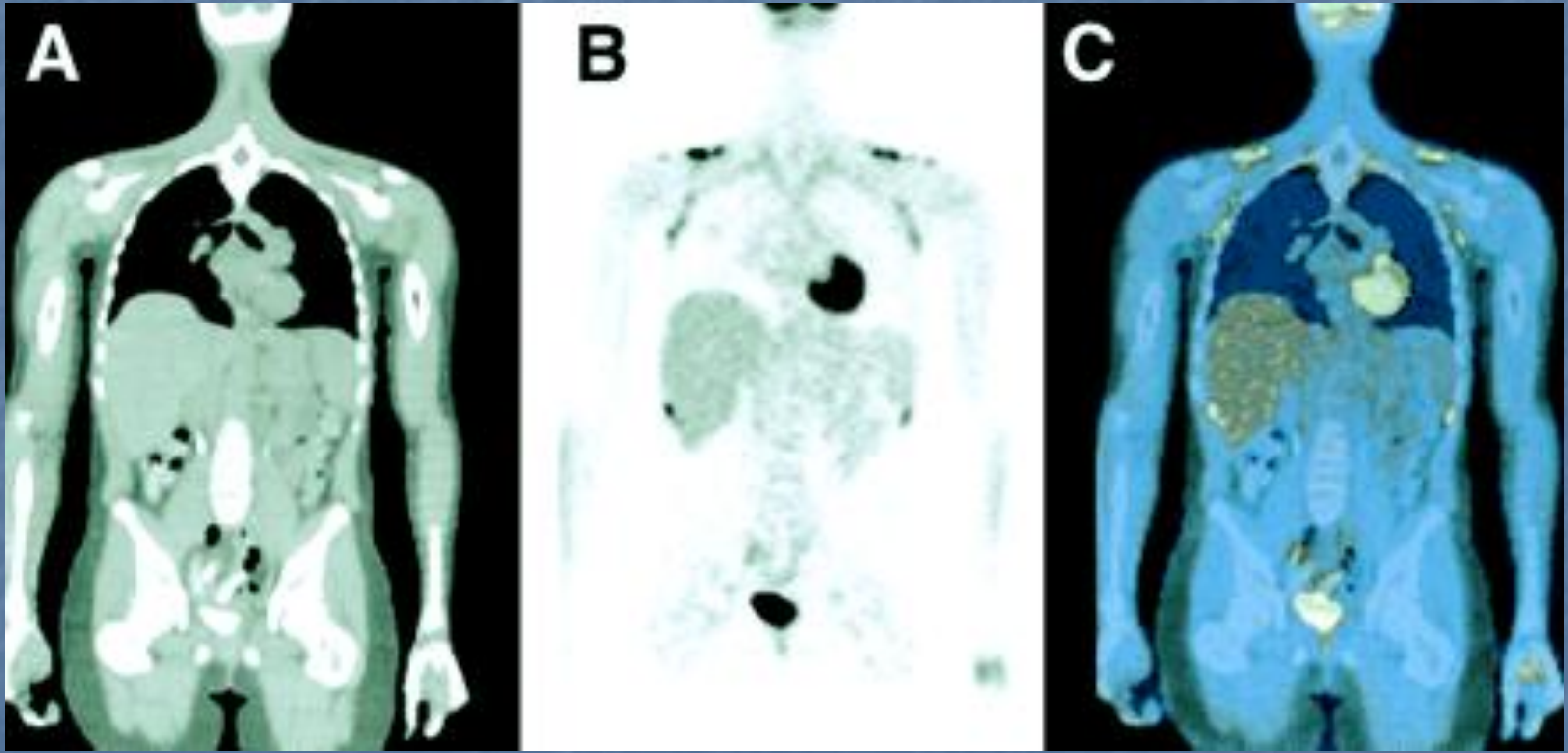
M. G. (female; 60 years old; elevated CEA)



M. G. (female; 60 years old; elevated CEA)



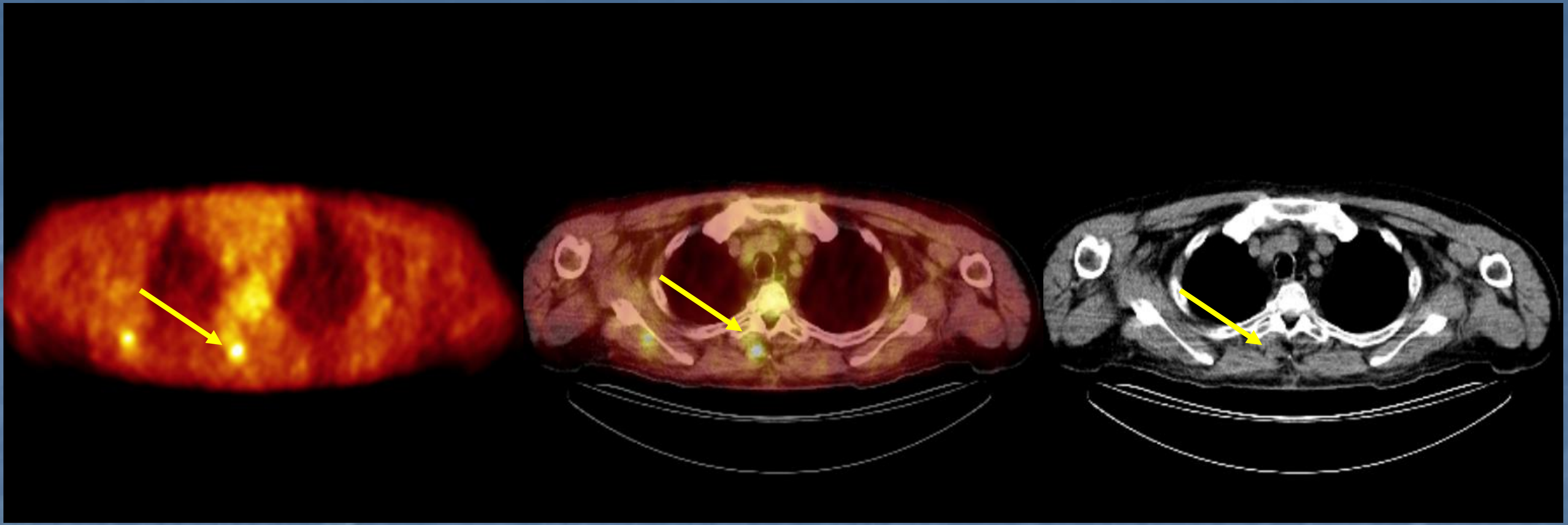
^{18}F-FDG PET/CT Hodgkin lymphoma

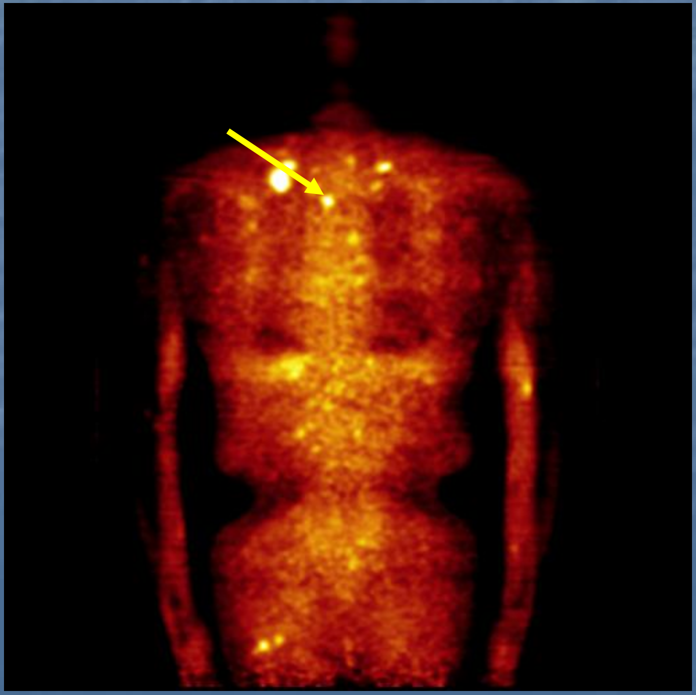


Schöder et al. J Nucl Med 45:72S-81S

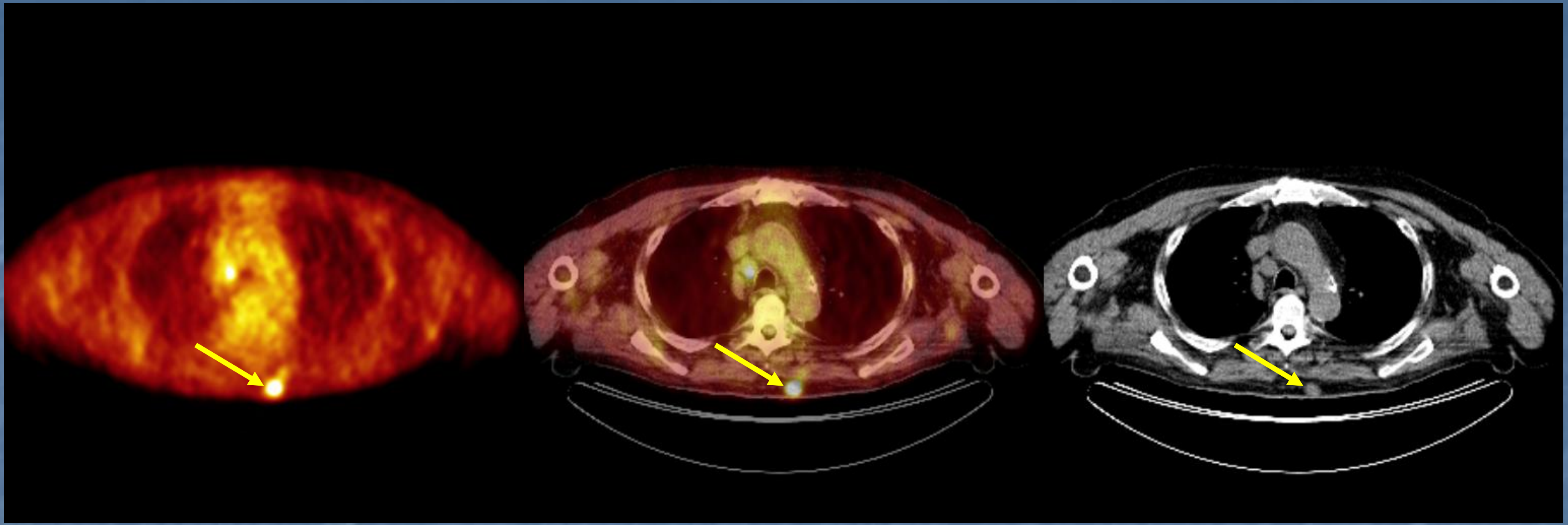
Indikációk

- Melanoma Diagnózis, Staging, Restaging
- Emlő cc. Standard képalkotó modalitások kiegészítő vizsgála
  - Staging távoli met.
  - Restaging loc. rec., met.
  - Th. követés

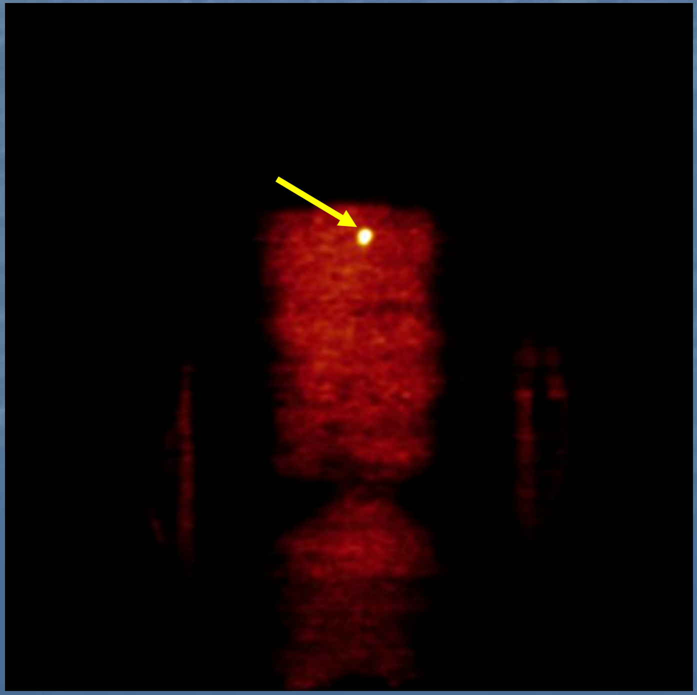




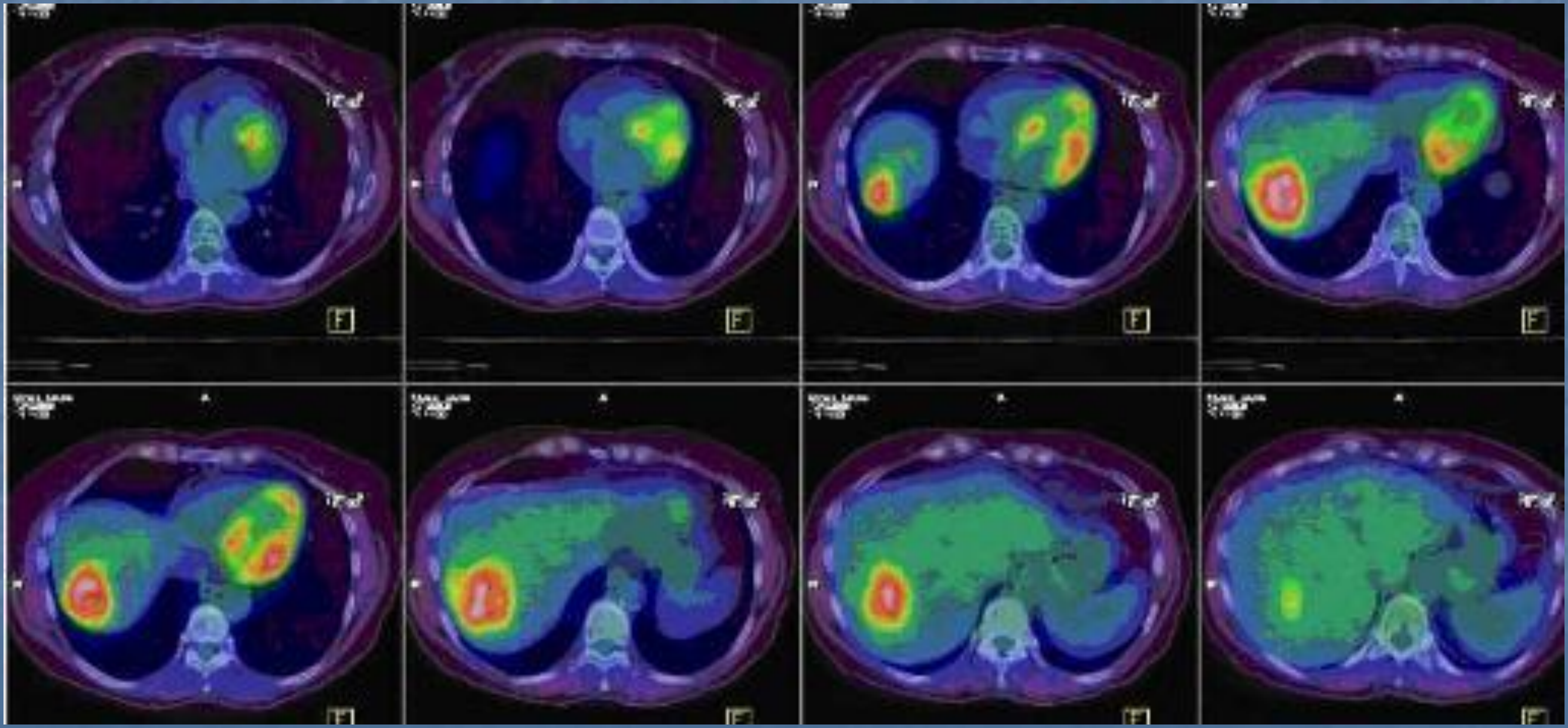
Malignant Melanoma



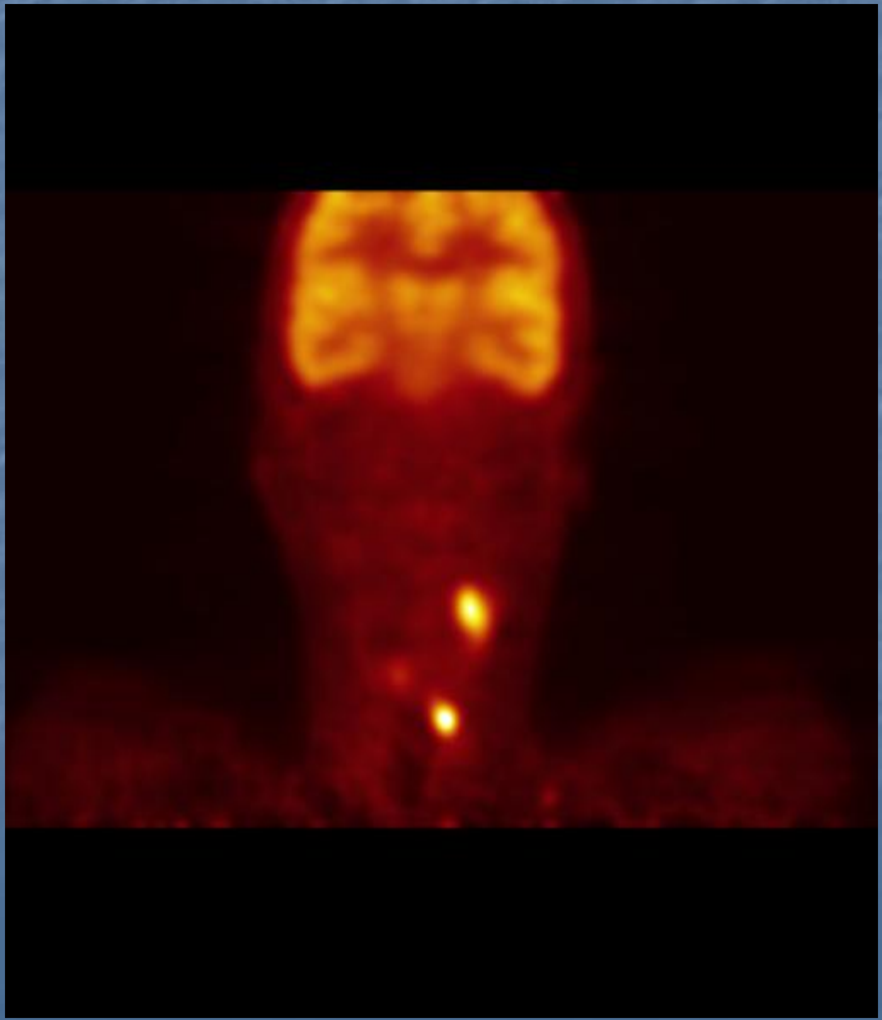
Malignant Melanoma

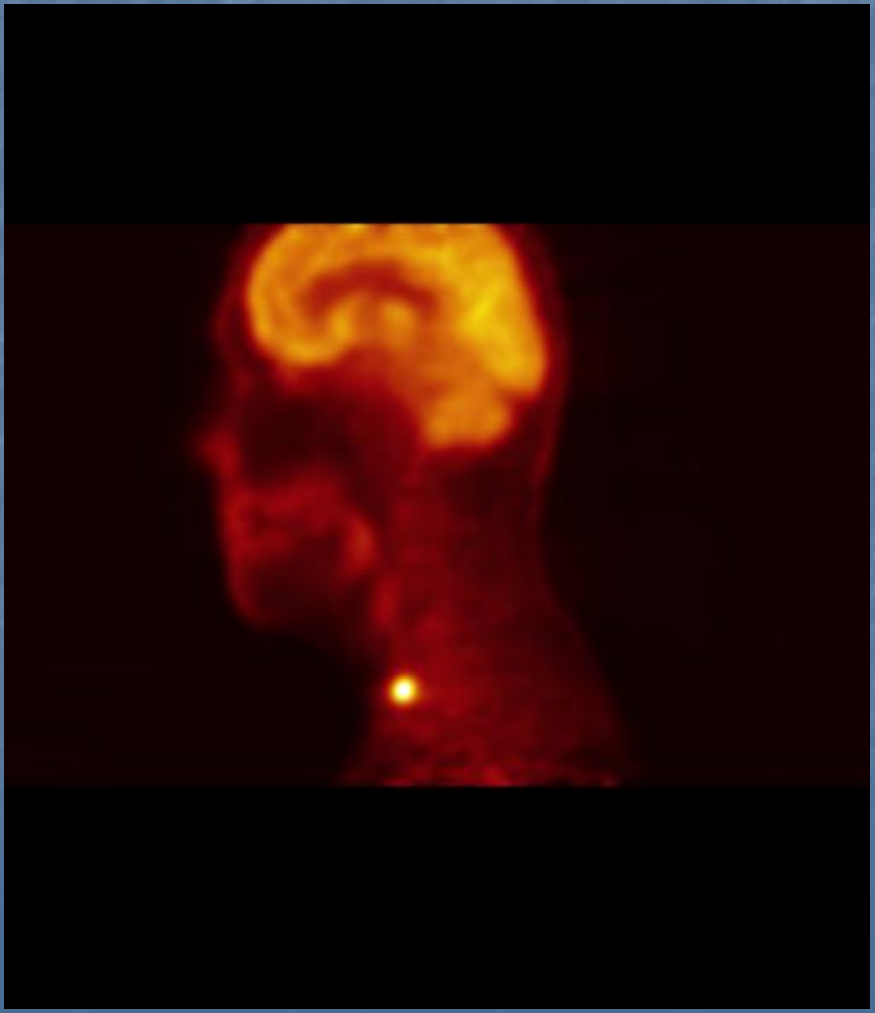


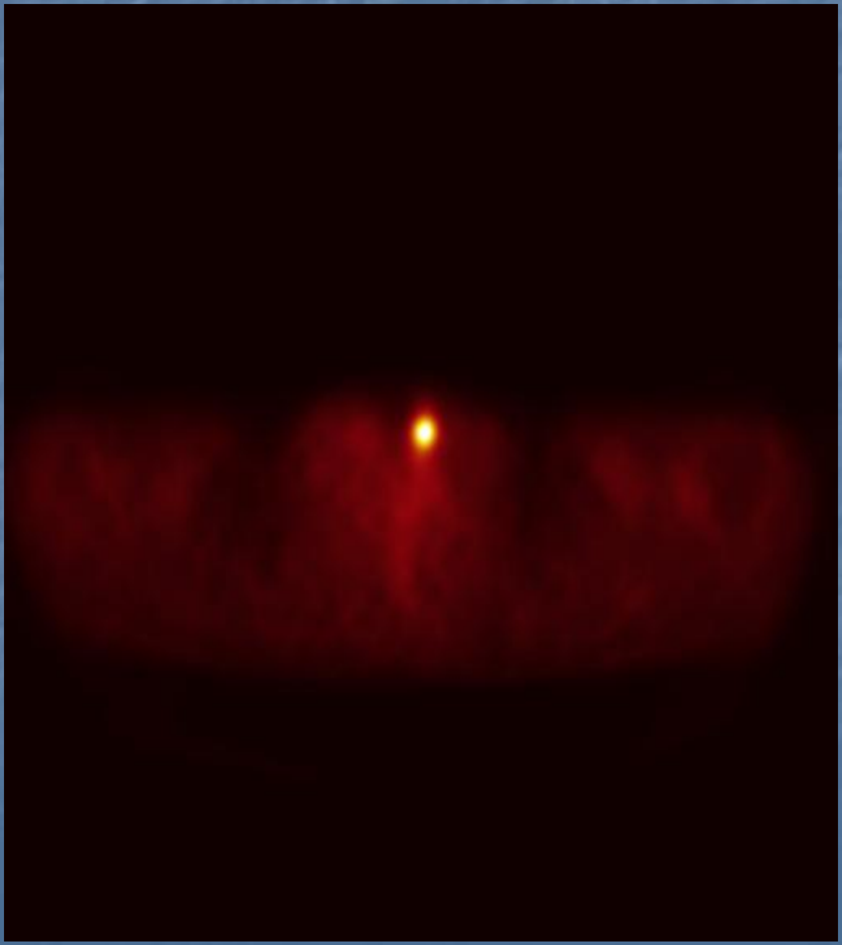
^{18}F-FDG PET/CT
emlő carcinoma, májmetasztázis

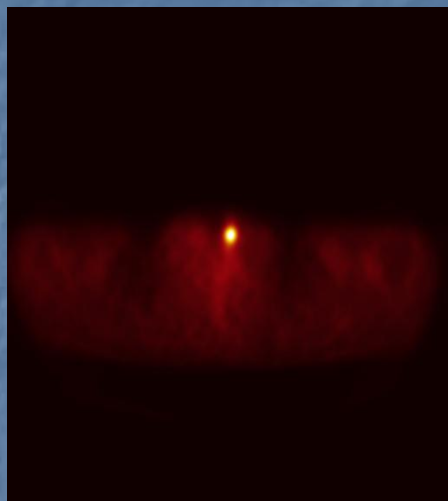


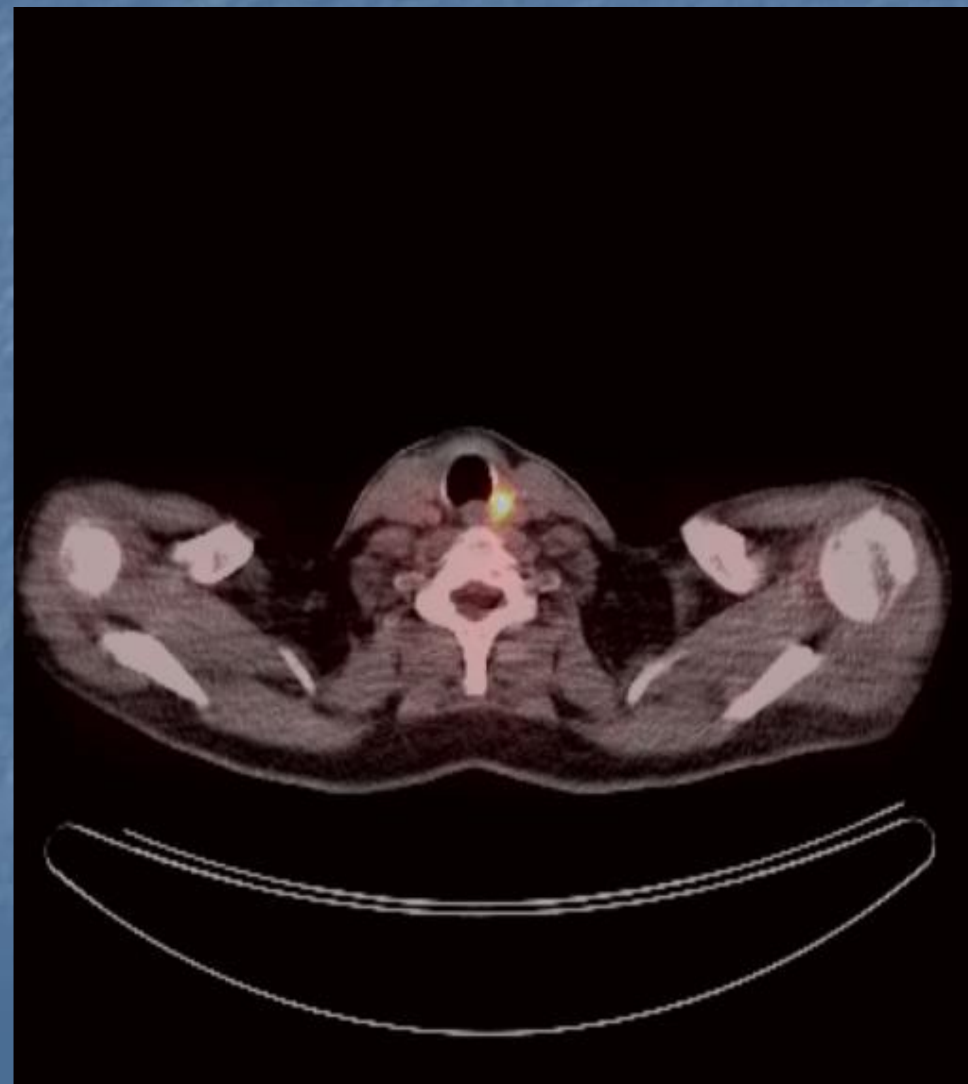
SNM

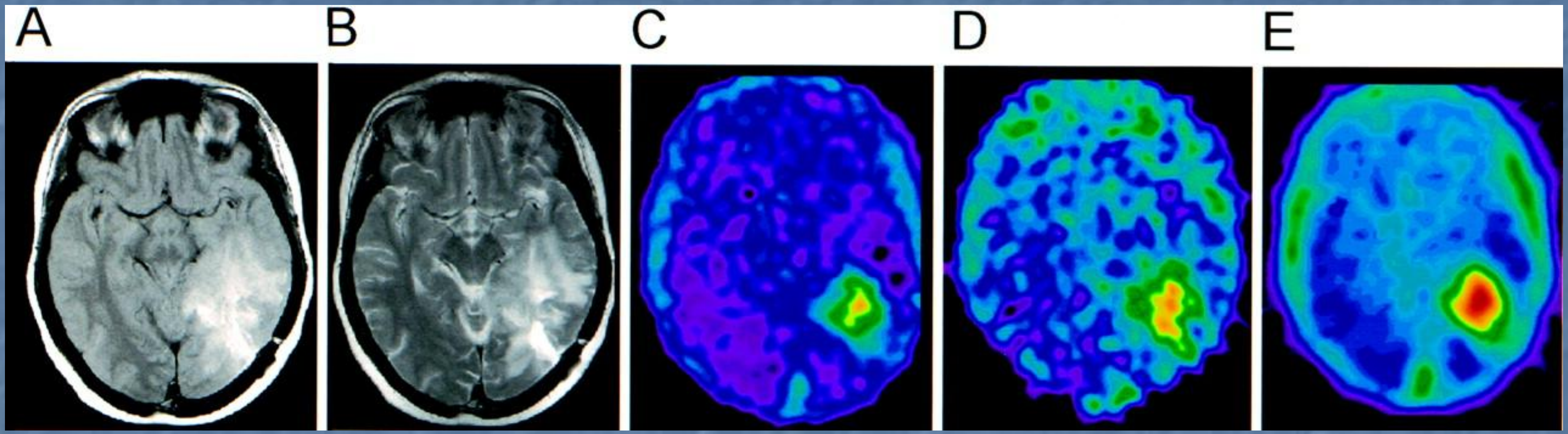






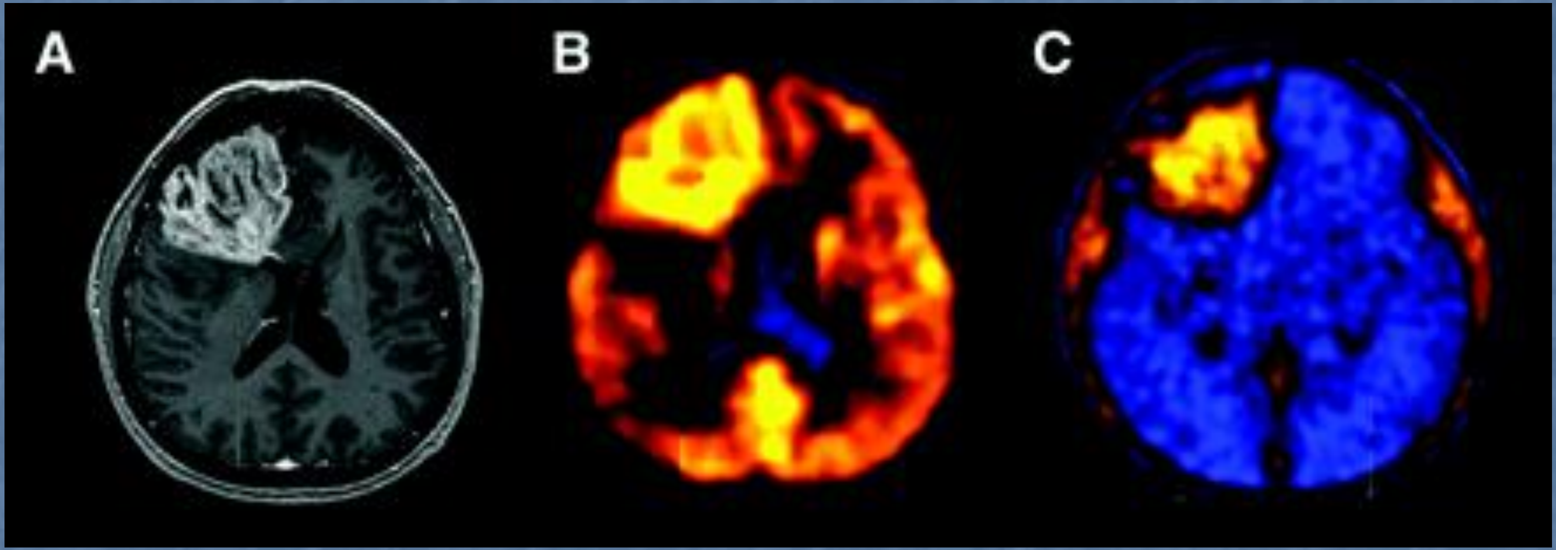





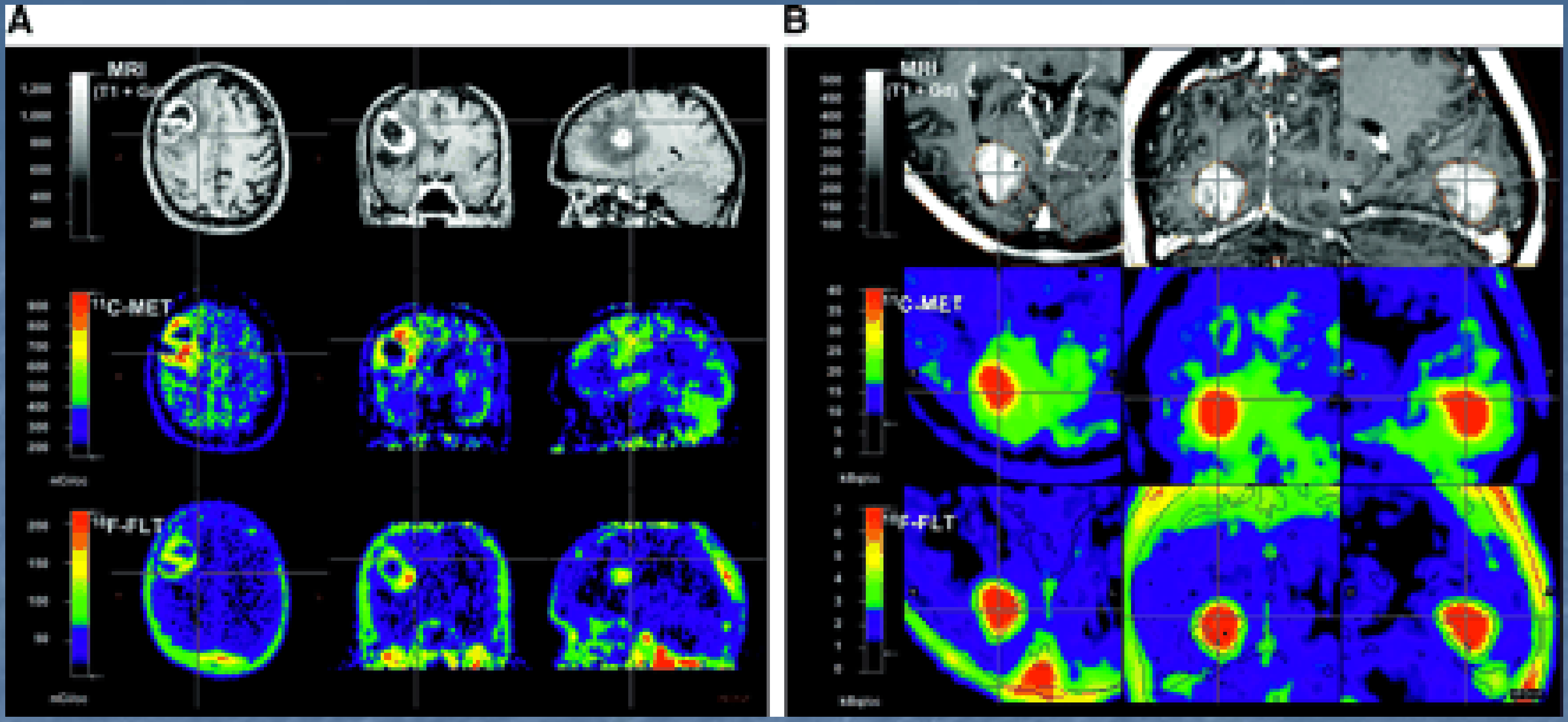


- Proton density (A) and T2-MR (B) images of patient 2 with glioblastoma multiforme in left temporal lobe. 76Br-Bromide PET raw-count images from 60 to 90 min (C) and 24 to 24.5 h (D) after injection. (E)

Matthias Bruehlmeier és mts-iPaul Scherrer Institute, Center for Radiopharmaceutical Science, Villigen, Switzerland



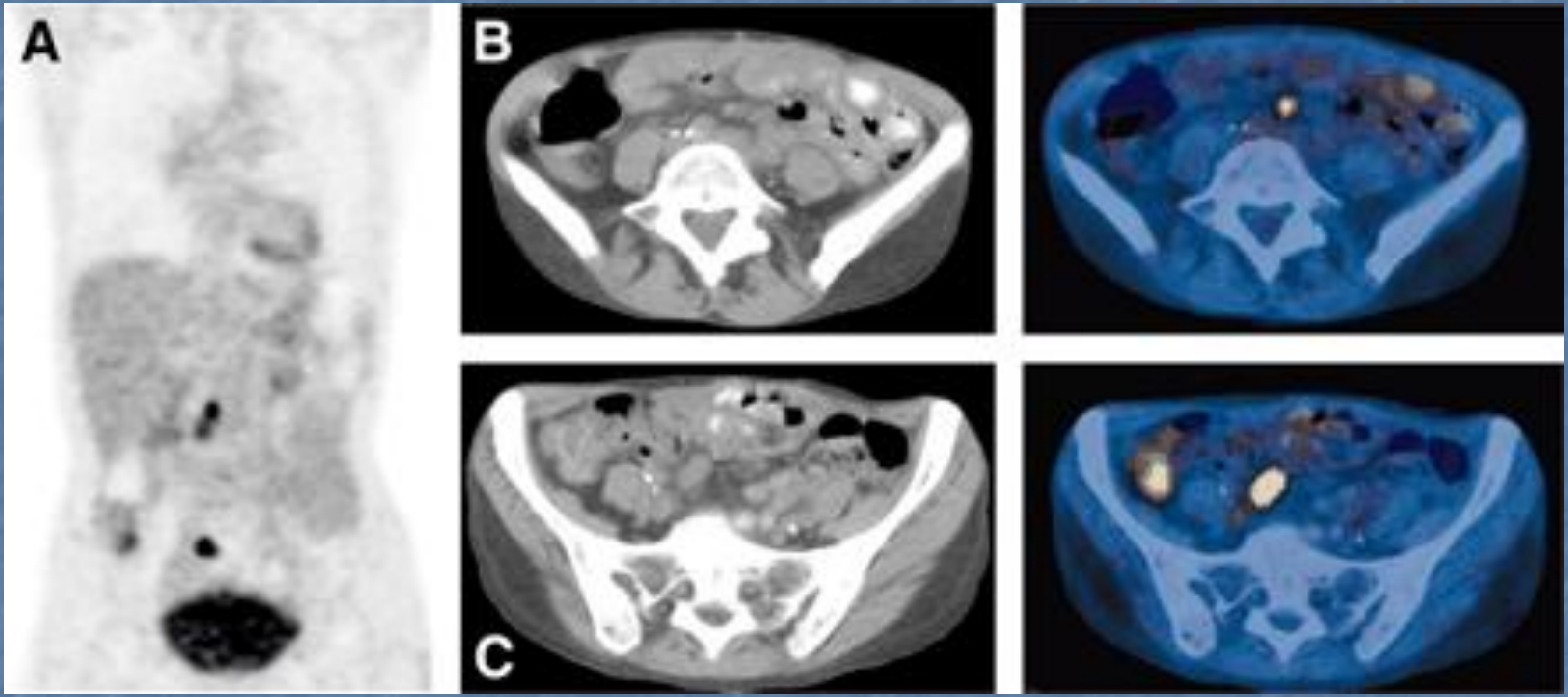
(A) MRI (contrast-enhanced T1-weighted image), 18F-FDG PET (B) and 18F-FLT PET (C).



Two patients with highly intense 18F-FLT accumulation that was found mainly in areas of breakdown of blood–brain barrier as depicted by gadolinium-enhanced MRI. A 64-y-old man with newly diagnosed glioblastoma (A) and 26-y-old woman with newly diagnosed WHO grade I astrocytoma (B). In both patients, 11C-MET PET is suggestive of a larger extent of tumor as depicted by gadolinium MRI.

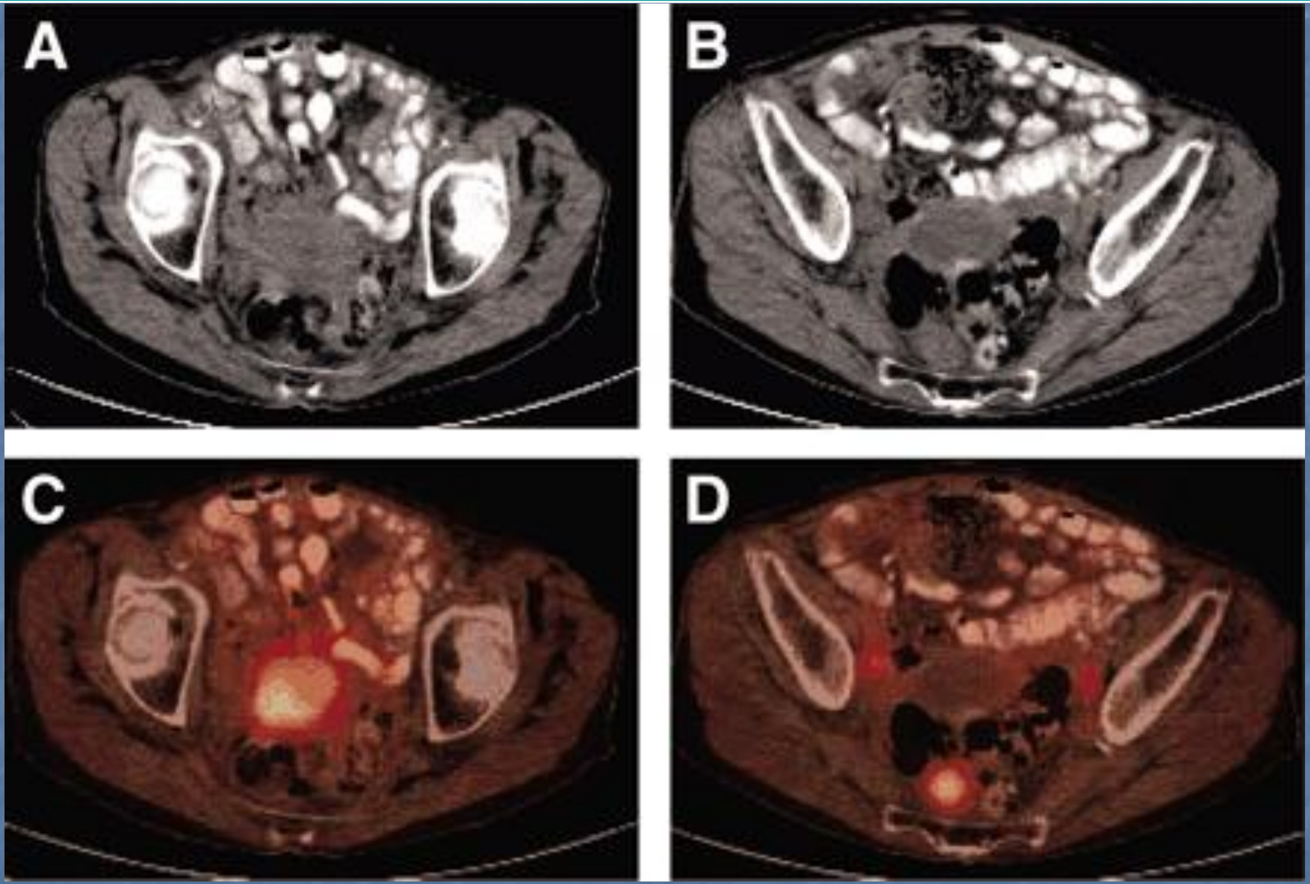
Andreas H. Jacobs és mts-i Max Planck Institute for Neurological Research, Cologne, Germany

^{18}F-FDG PET/CT, rekurráló ovarium carcinoma



Pandit-Taskar et al JNM 46: 1842-1850, 2005

^{18}F-FDG PET/CT rekurráló cervix carcinoma



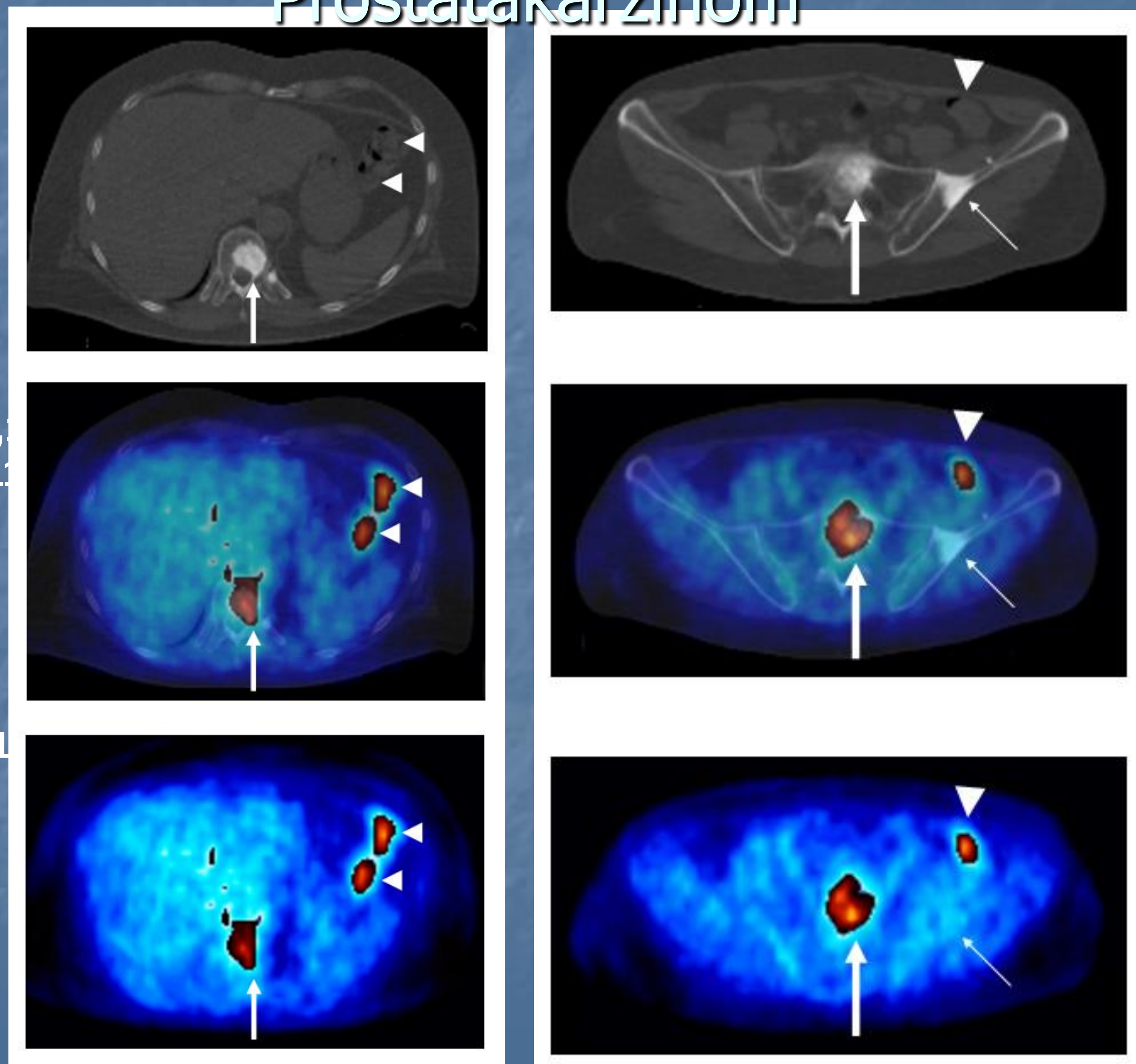
Pandit-Taskar et al JNM 46: 1842-1850, 2005

18F-Fluoracetat PET/CT eines Patienten mit multiplen Knochenmetastasen eines Prostatakarzinom

Aufnahme
Ca. 70 min. p.i.

Speichernde Metastasen
SUV mean **2,82 – 4,**
SUV max **3,36 – 5,1**

Leber
SUV mean **2,35 – 2,71**
SUV max **3,0 – 3,58**



CT

PET/CT

PET

A.Matthies et al.
EJNM (in press)