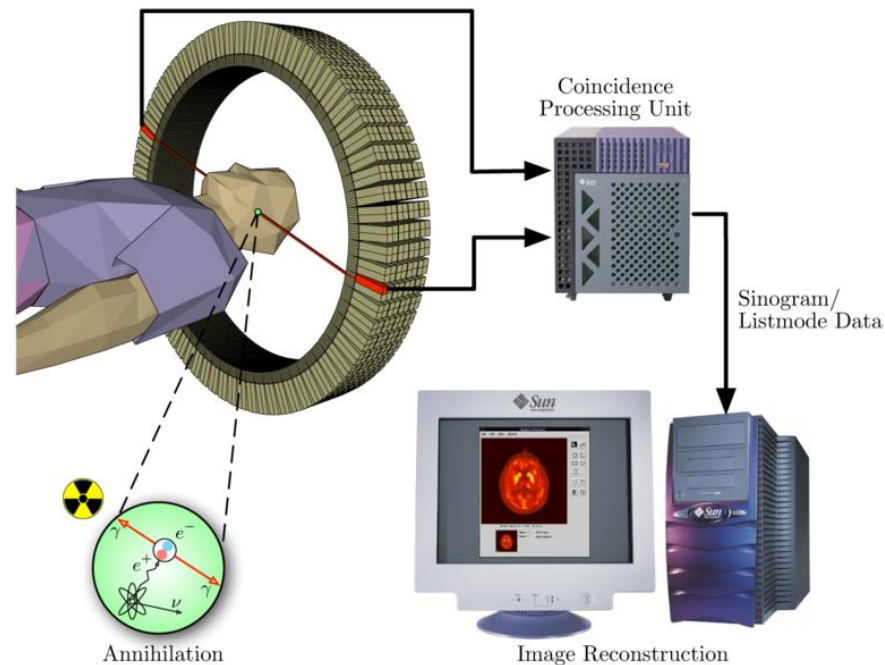
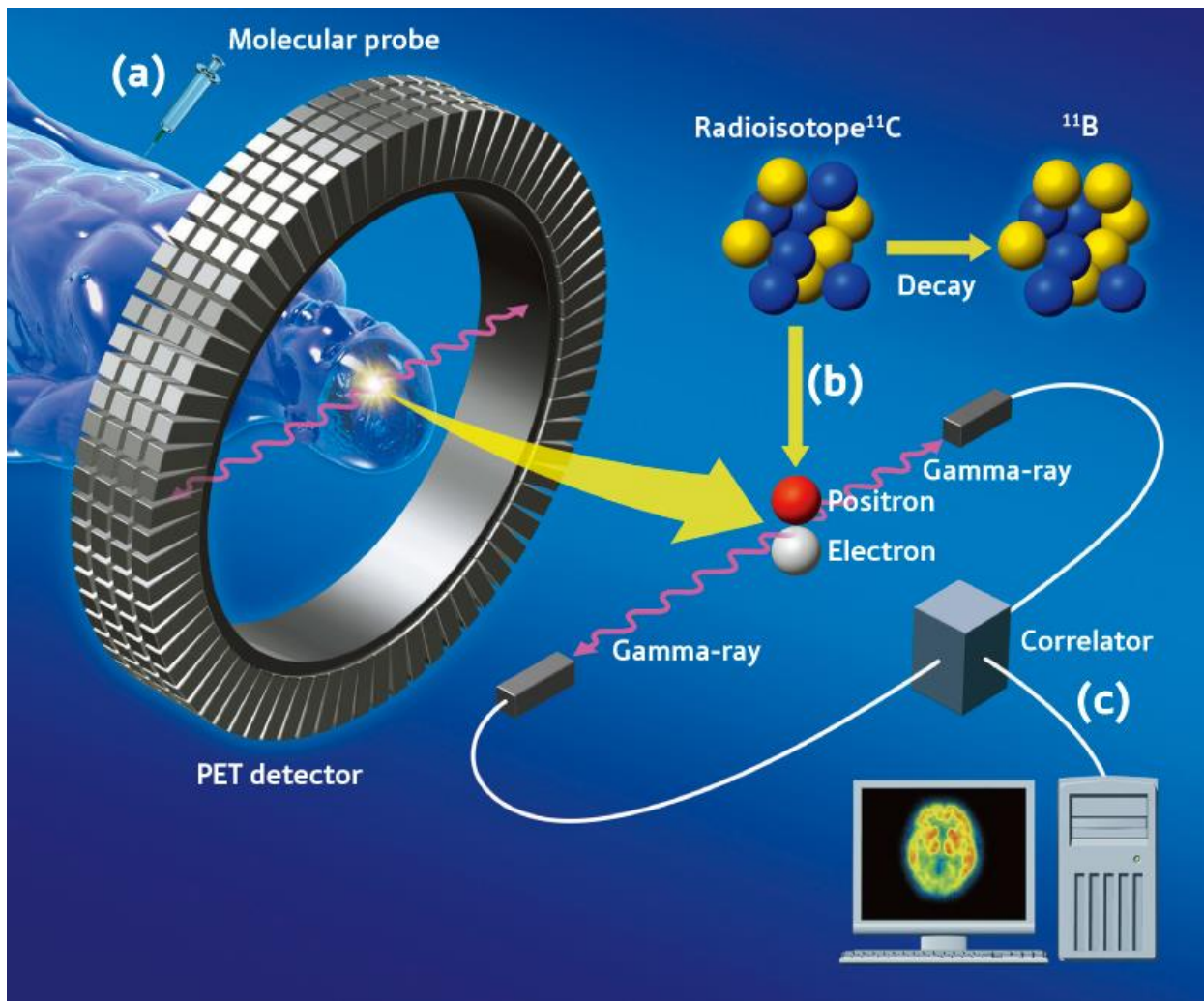
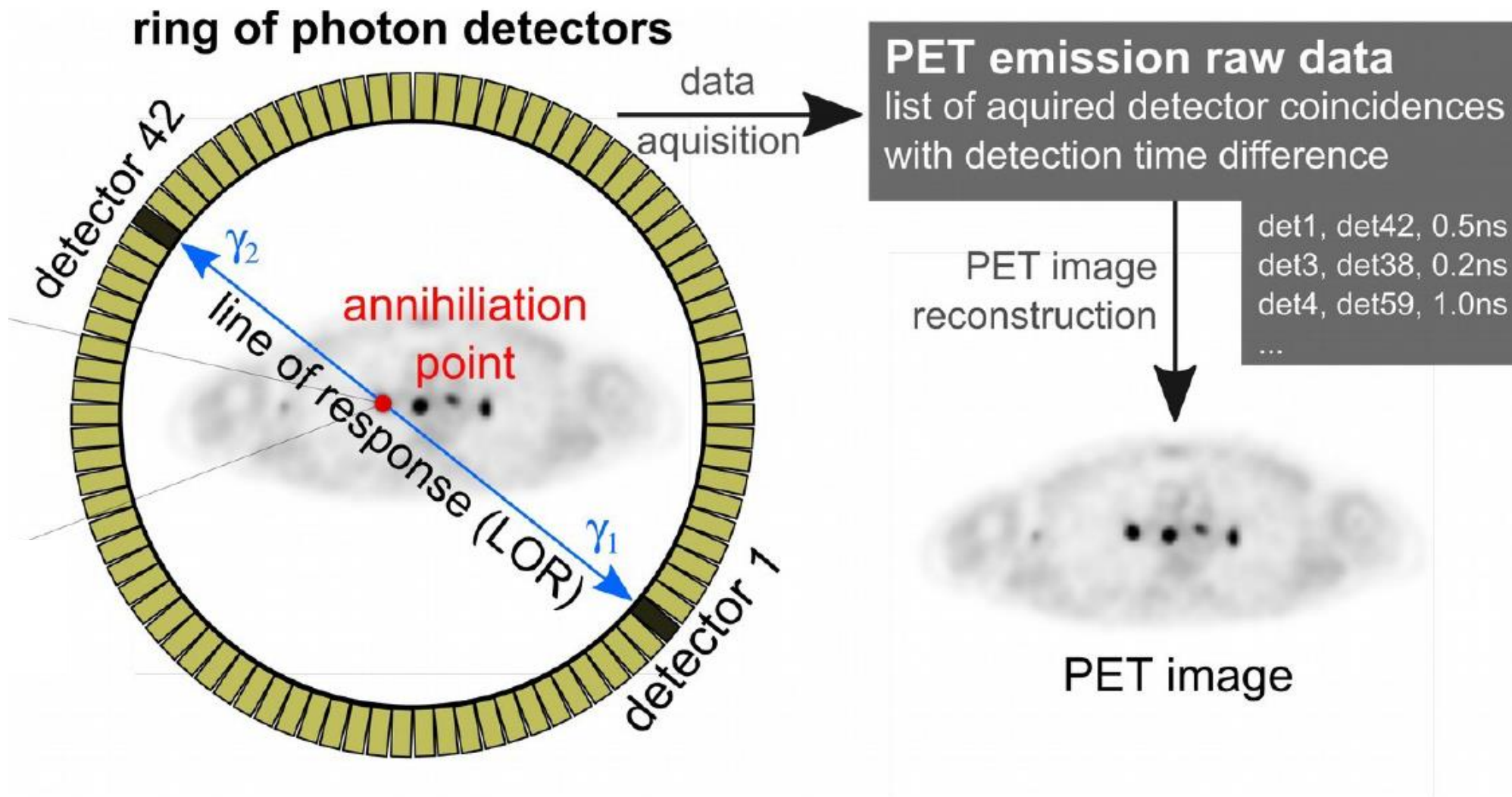


# Pozitronová emisní tomografie (PET)

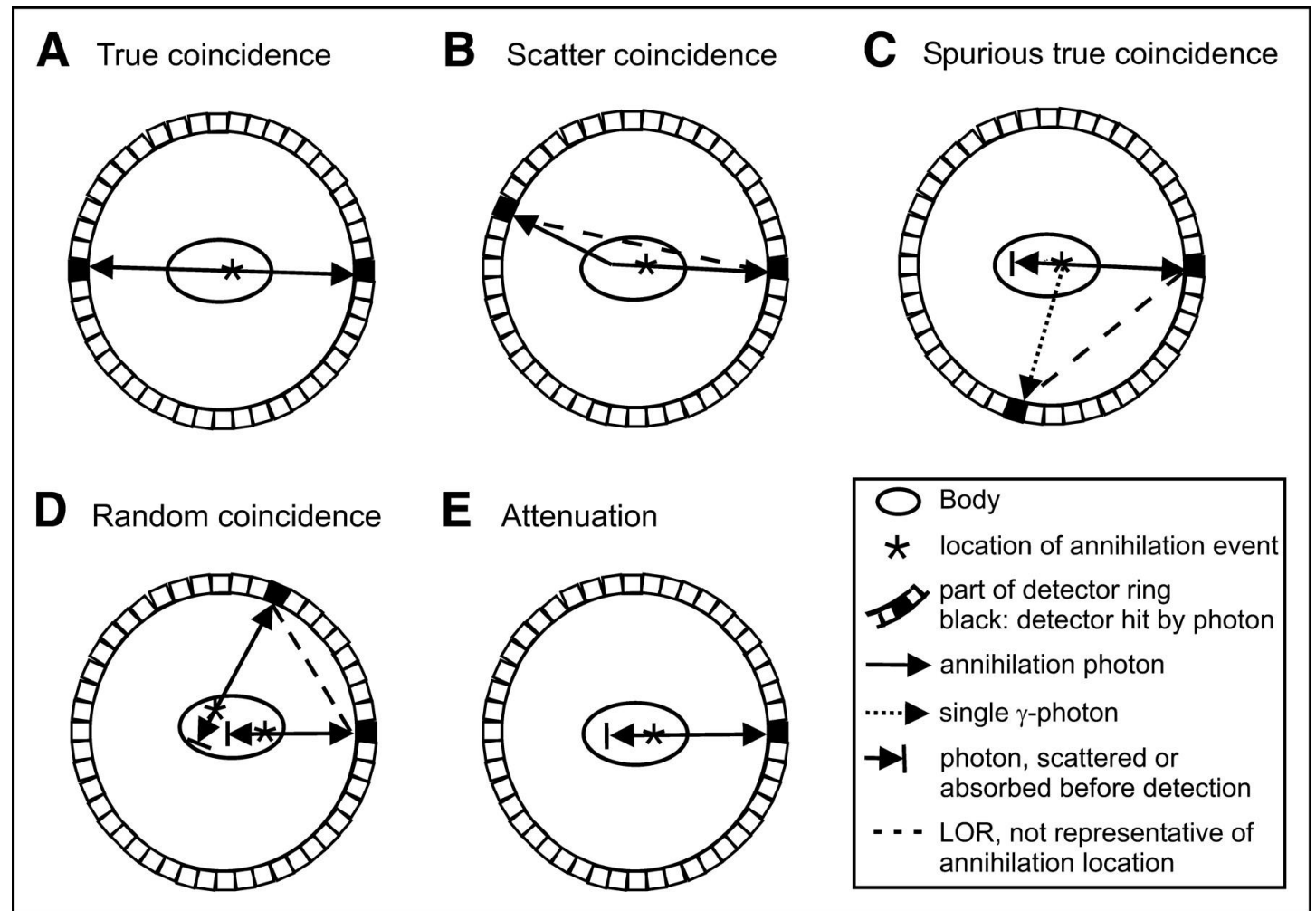


# Pozitronová emisní tomografie (PET)



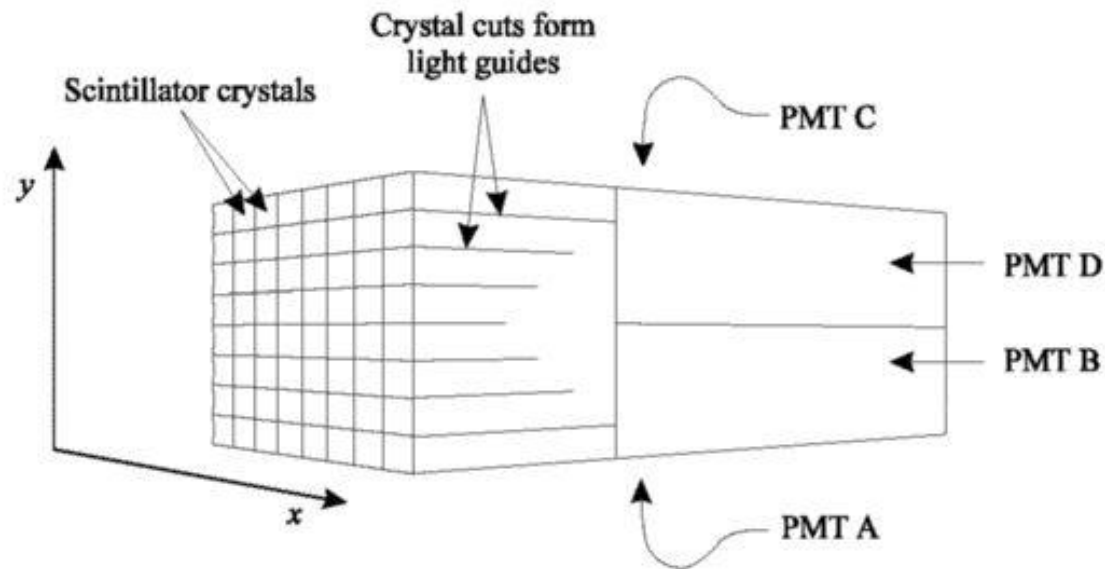
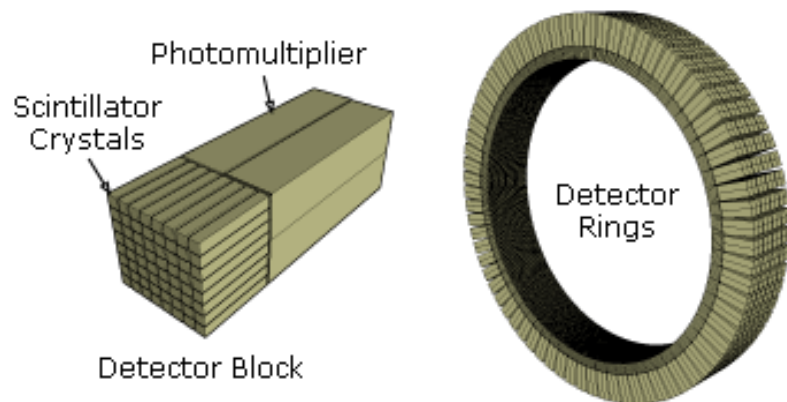
# PET – line of response (LOR)

- LOR = line of response
- coincidence
  - true
  - scatter
  - spurious
  - random
  - multiple



# PET – detektory

- BGO ( $\text{Bi}_4\text{Ge}_3\text{O}_{12}$ ) scintilátory + 4 fotonásobiče (PMT A,B,C,D)
- $\tau \approx 30 \text{ ns}$



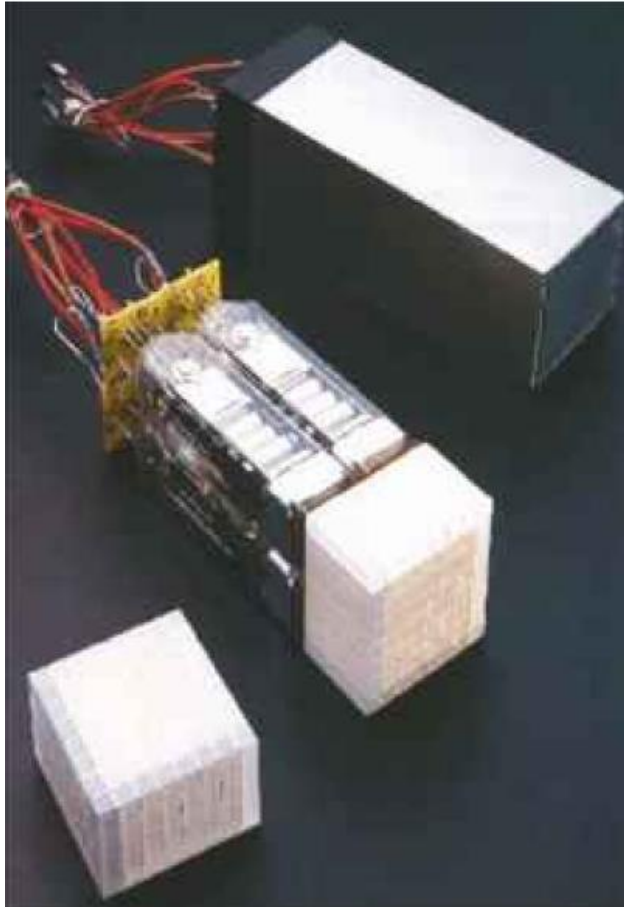
$$x = \frac{A + B - C - D}{A + B + C + D}$$

$$y = \frac{A - B + C - D}{A + B + C + D}$$

frakce signálu na PMT

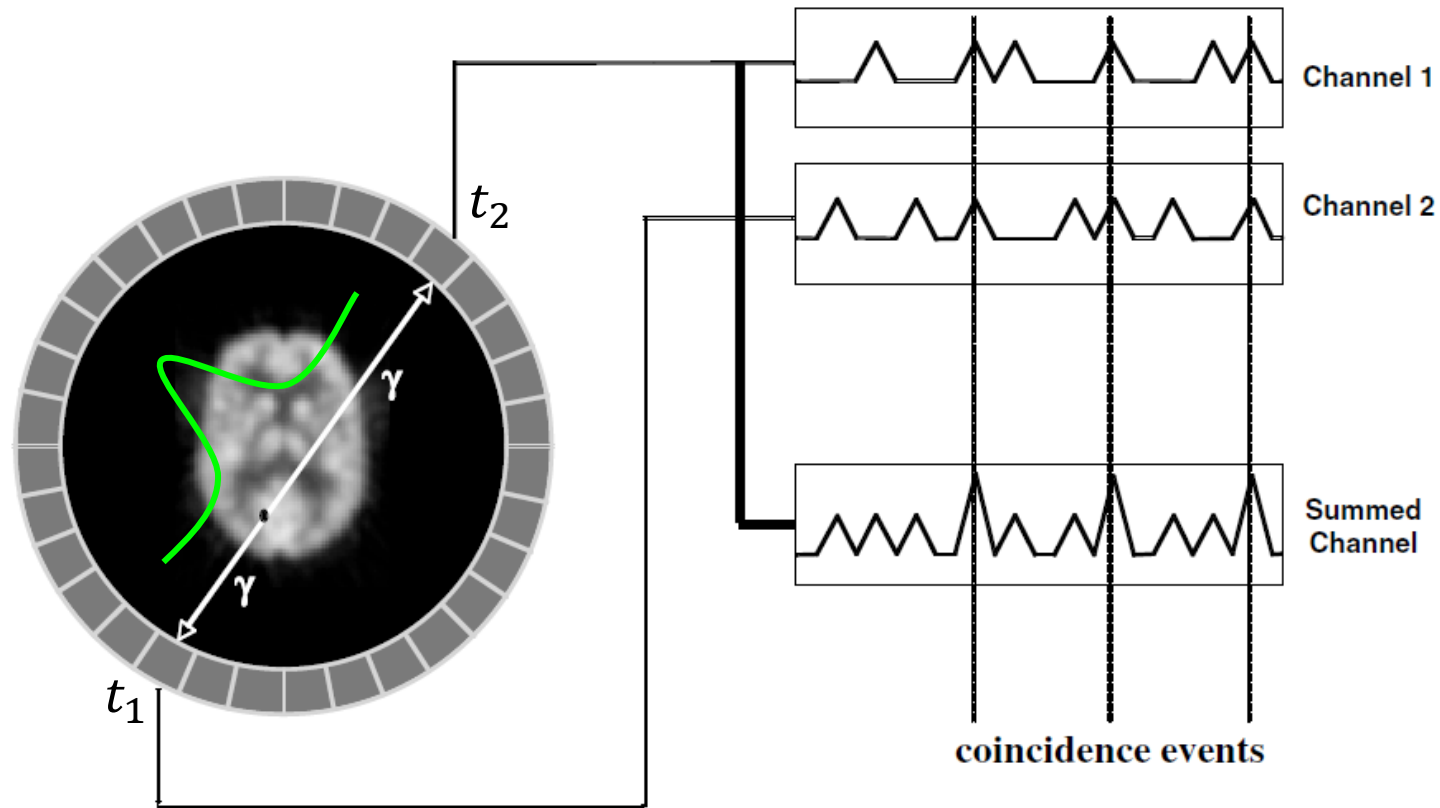


# PET – detektory



# PET – time of flight (TOF)

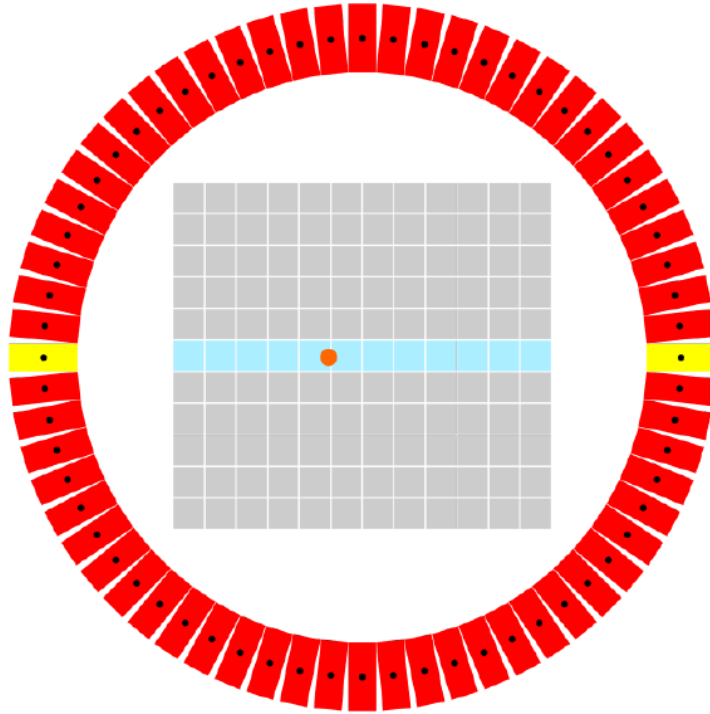
- koincidenční okno ~ 1-10 ns



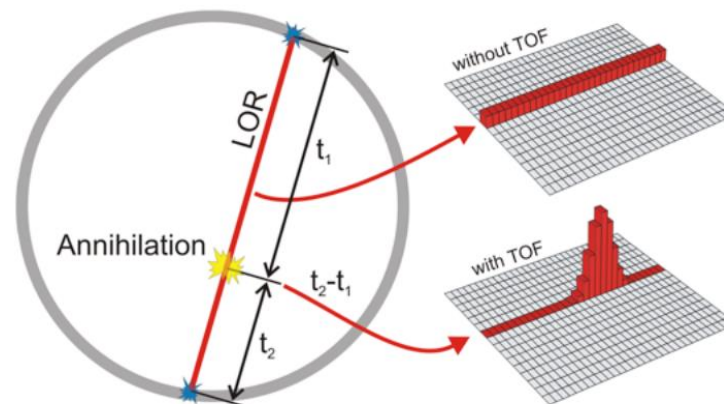
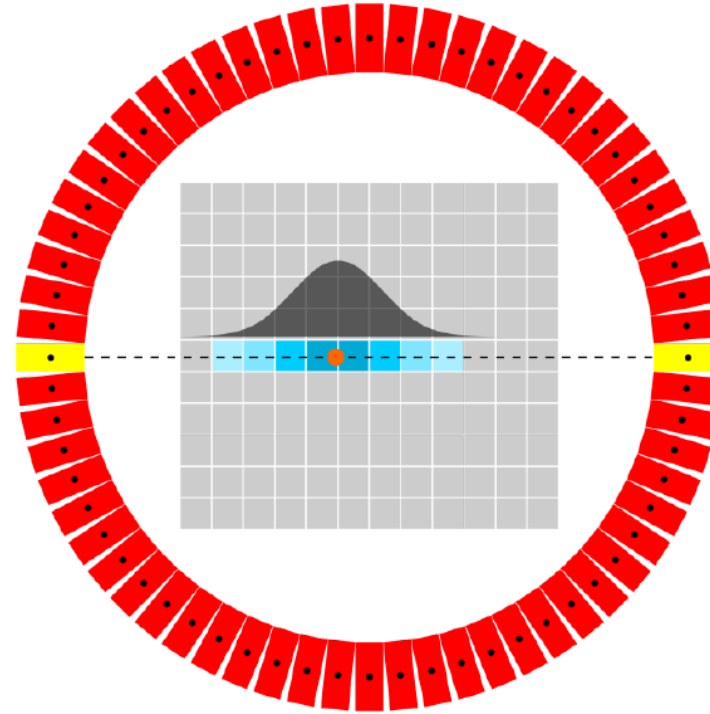
- time-of-flight (TOF) → časové rozlišení ~ 0.5 ns
- lokalizace na line of response (LOR): FWHM ~ 15 cm

# PET – time of flight (TOF)

nontof event: det1, det42

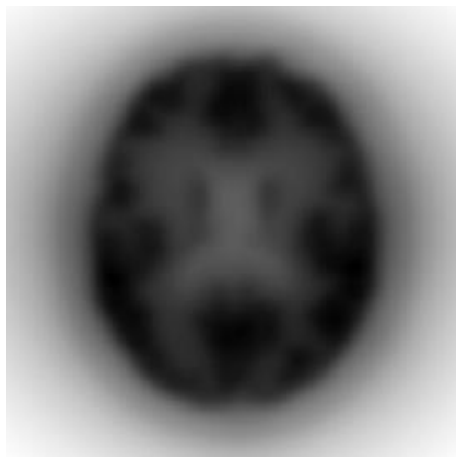
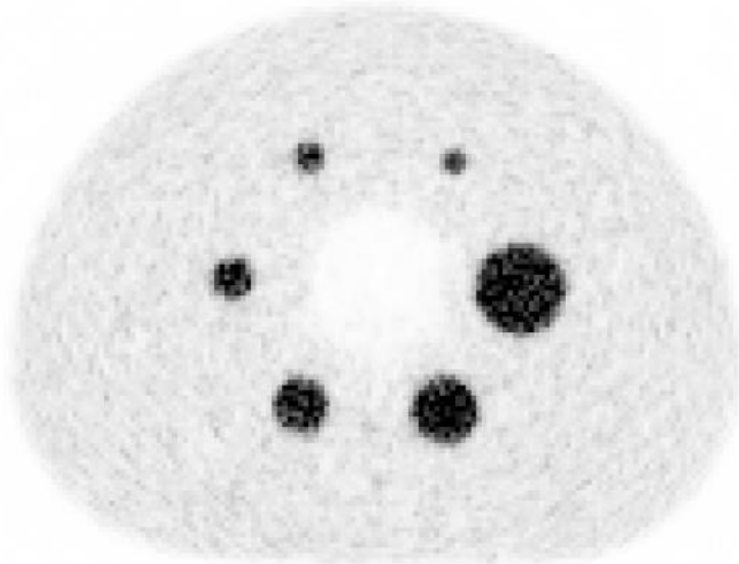


tof event: det1, det42, 823ps



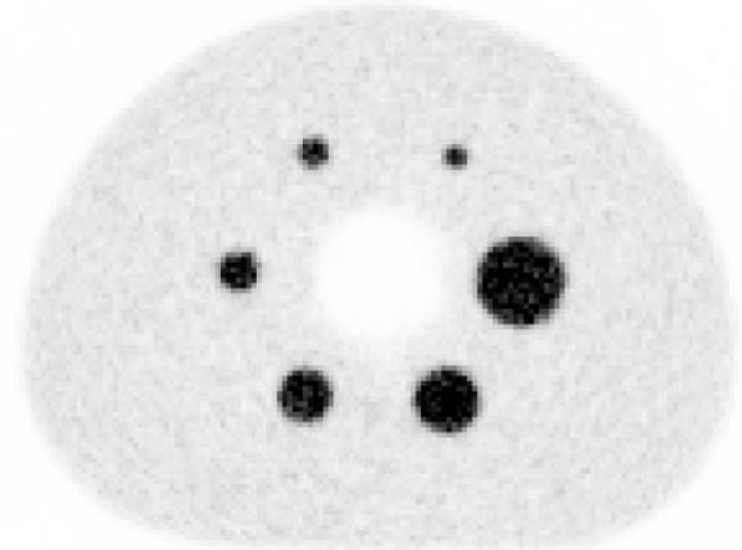
# PET – time of flight (TOF)

non-tof reconstruction 112 updates



Non-TOF back-projection

tof reconstruction 56 updates  
(400 ps)

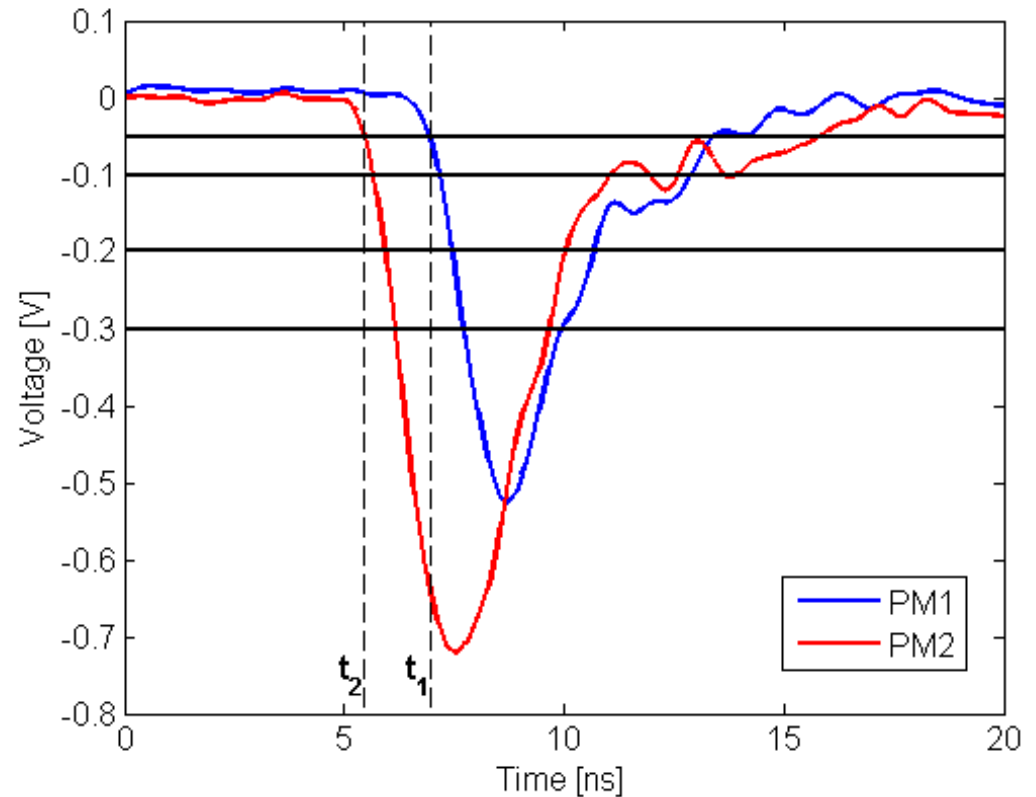
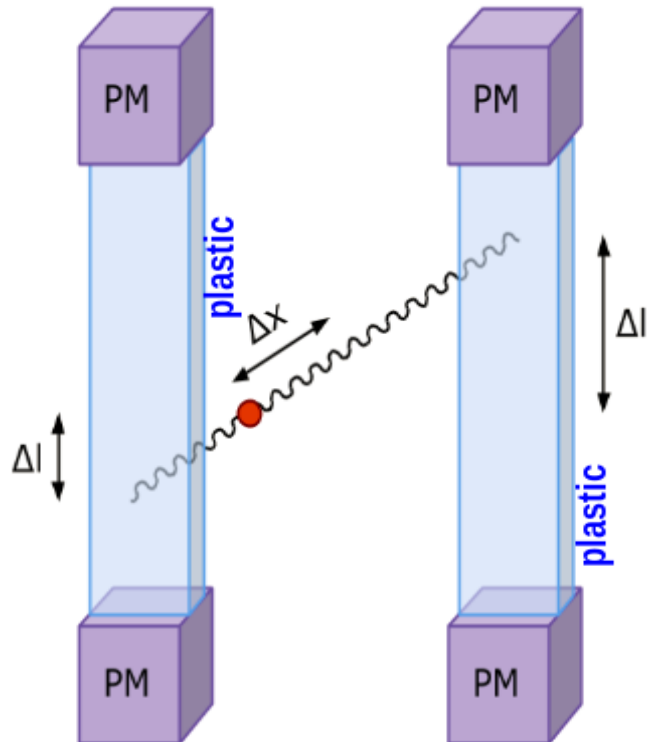


TOF back-projection (10 ps FWHM)

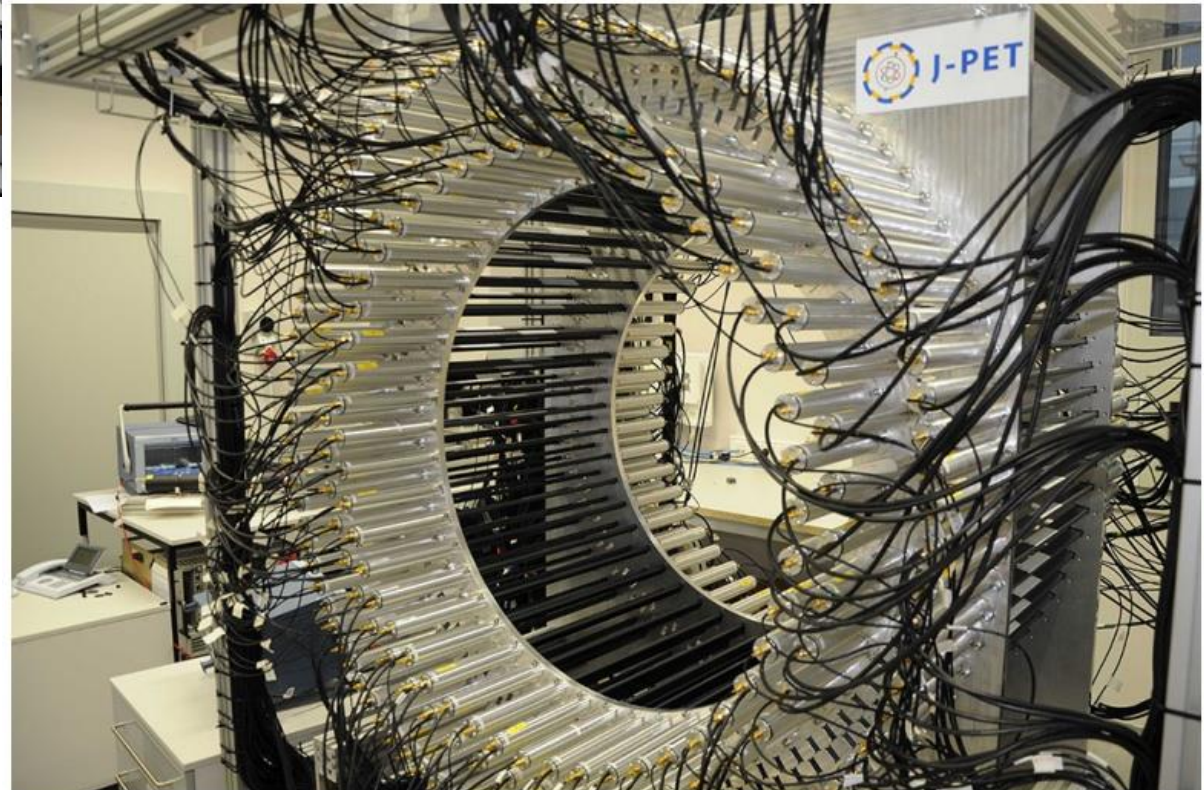
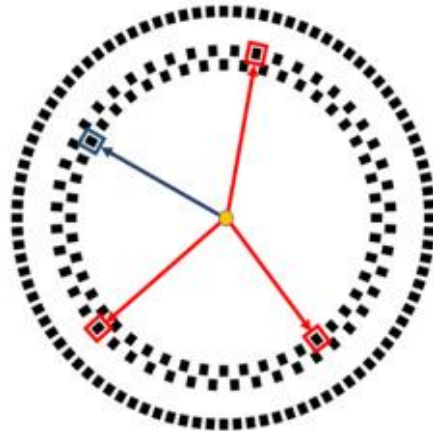
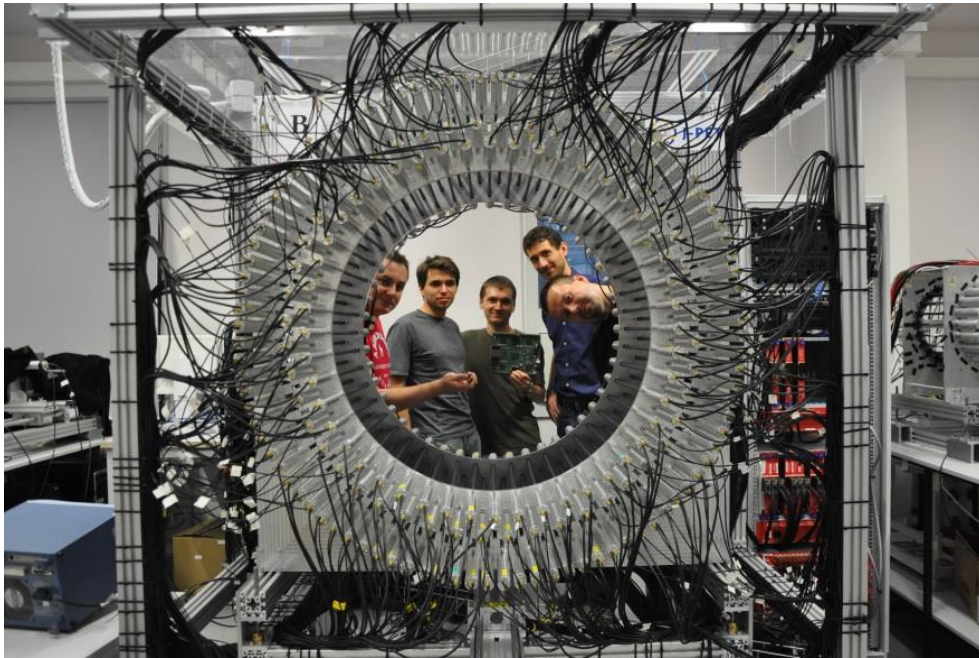


# J-PET

- J-PET (Jagiellonian-PET Tomography), Krakow
- plastické scintilátory (levné, snadno tvarovatelné)
- time of arrival (TOA)  $\rightarrow \Delta l$ , time of flight (TOF)  $\rightarrow \Delta x$



# J-PET



# PET – radiofarmaka

- označení sloučenin radioizotopy

- sledování *in-vivo*

- senzitivita ~ pmol

$^{11}\text{C}$  ( $T_{1/2} = 20.4$  min)

$^{13}\text{N}$  ( $T_{1/2} = 9.9$  min)

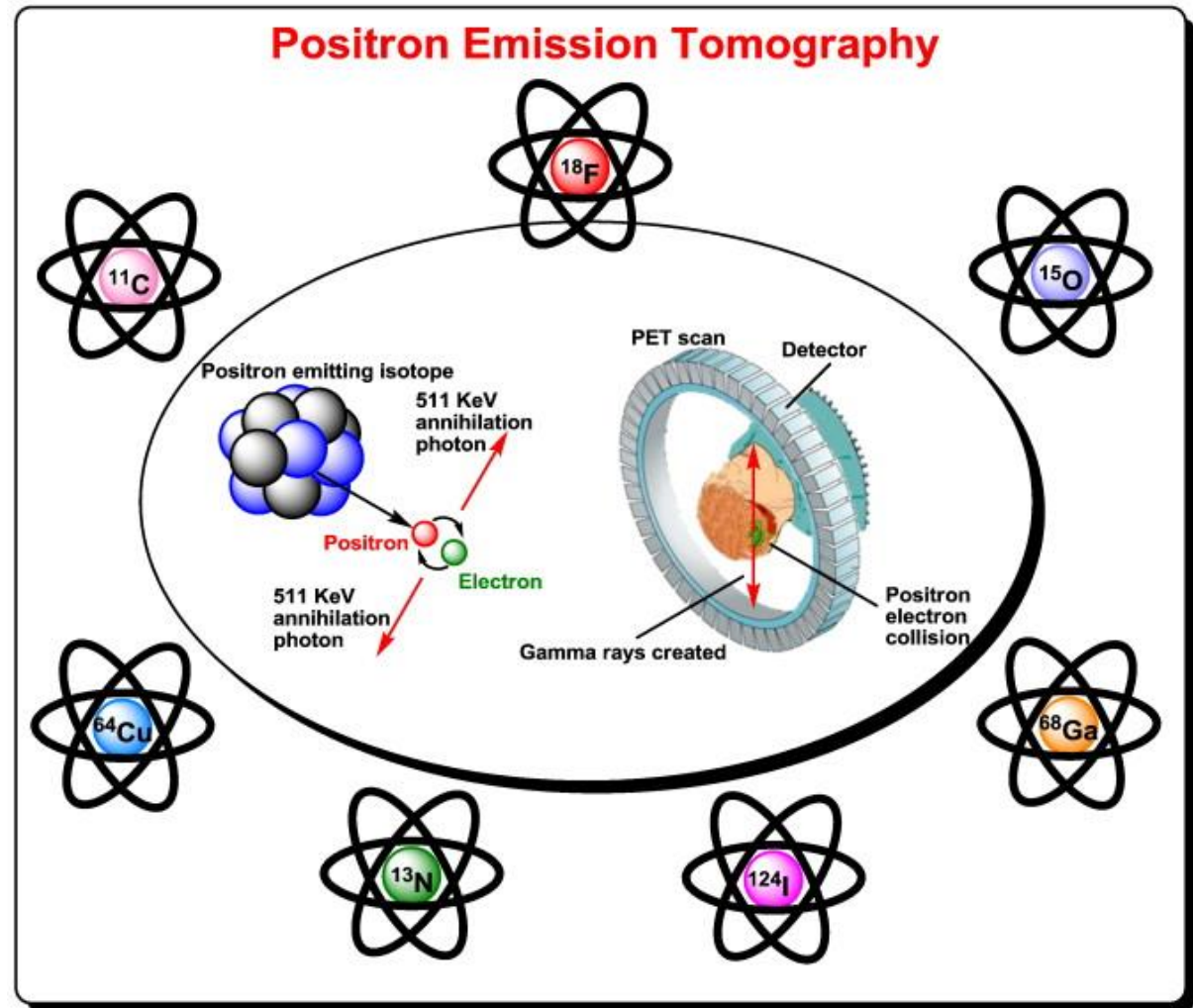
$^{15}\text{O}$  ( $T_{1/2} = 2$  min)

$^{18}\text{F}$  ( $T_{1/2} = 109.8$  min)

$^{64}\text{Cu}$  ( $T_{1/2} = 12.7$  h)

$^{68}\text{Ga}$  ( $T_{1/2} = 68$  min)

$^{124}\text{I}$  ( $T_{1/2} = 4.2$  d)



# PET – radiofarmaka

- označení sloučenin radioizotopy

$^{11}\text{C}$  ( $T_{1/2} = 20.4$  min)

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$^{68}\text{Ga}$  ( $T_{1/2} = 68$  min)

$^{124}\text{I}$  ( $T_{1/2} = 4.2$  d)

1. získání radionuklidu

- viz zdroje pozitronů

2. příprava a značení účinné látky

- izotopové výměnné reakce
- chemická syntéza

3. příprava požadované lékové formy

- parentální
- perorální
- inhalační
- lokální

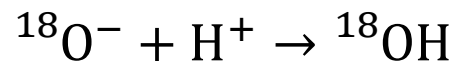
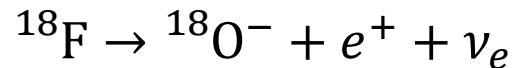
4. kontrola kvality

- stanovení aktivity
- radionuklidová čistota
- radiochemické znečištění
- biologická čistota

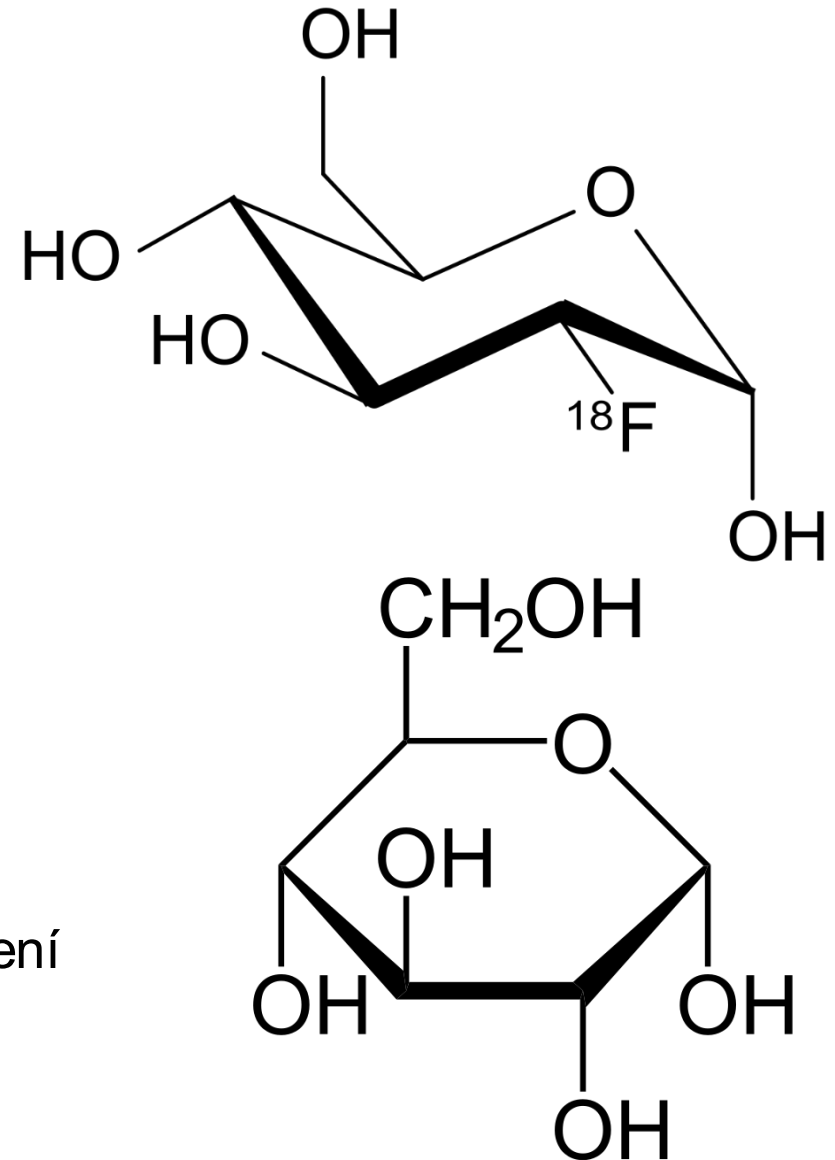
# PET – radiofarmaka

- FDG: ( $^{18}\text{F}$ )-fluorodeoxyglukóza

- zobrazení metabolické aktivity
- příjem stejný jako glukóza
- metabolizace po rozpadu  $^{18}\text{F}$

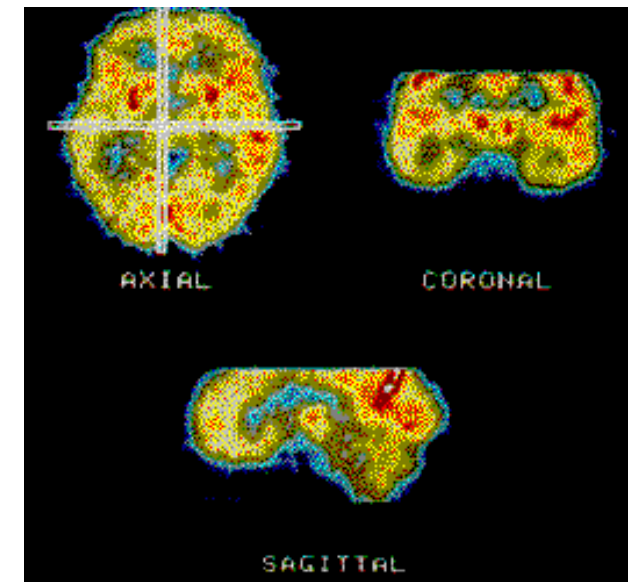
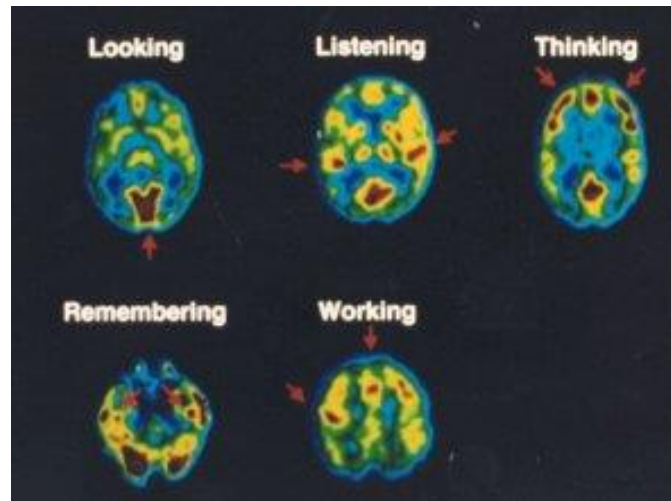
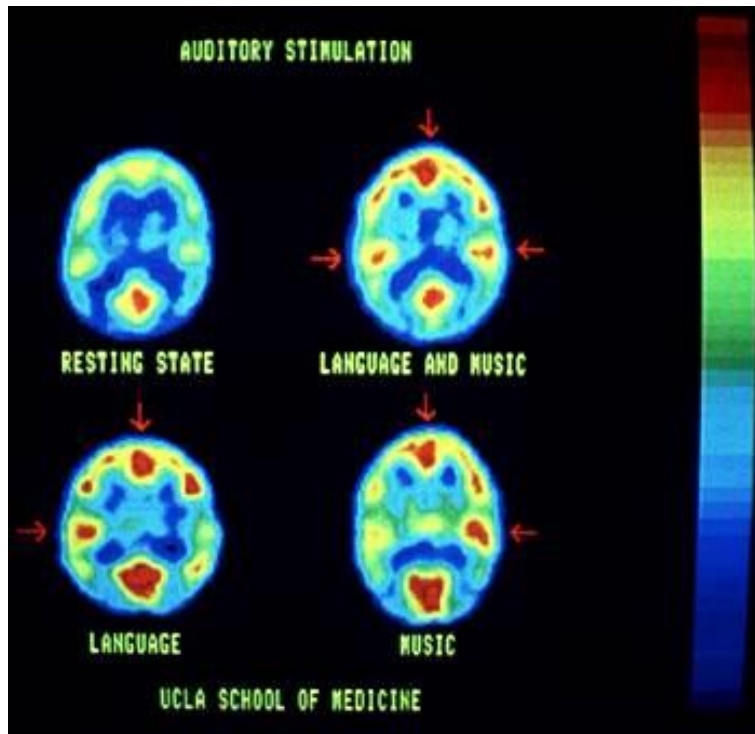
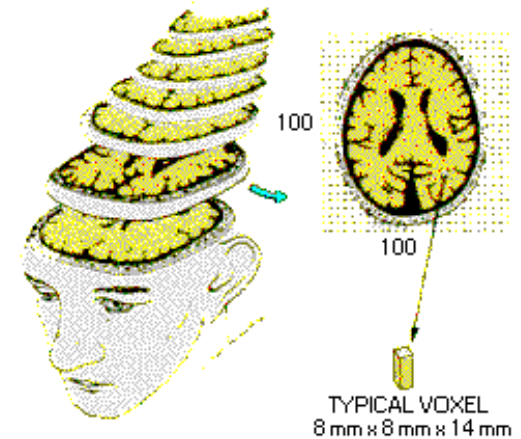
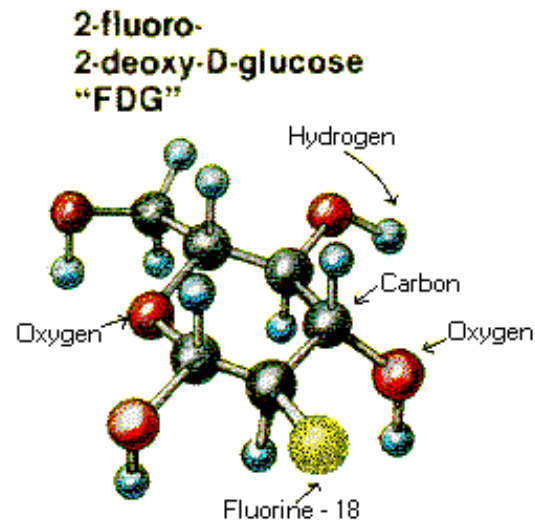


- přímá vs nepřímá fluorizace
- dlouhá doba života
  - syntéza, transport, PET imaging
- nízká energie  $\beta^+$  (0.64 MeV)
  - krátký dolet a vysoké prostorové rozlišení
- typická aktivita 100 – 400 MBq
- dávka ozáření do 2 – 10 mSv



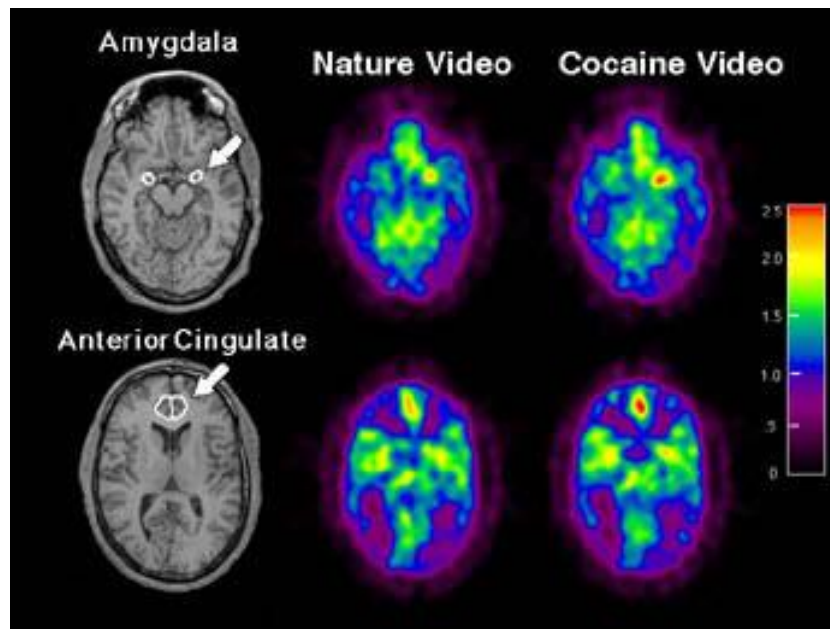
# PET – zobrazení aktivity mozku

- FDG –  $^{18}\text{F}$  (označená glukóza)
- zobrazení aktivity mozku



# PET – zobrazení aktivity mozku

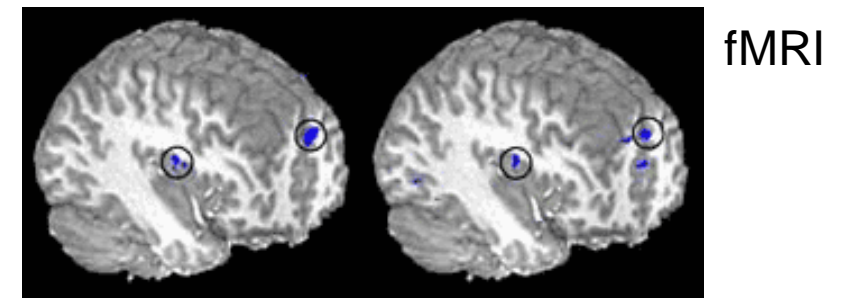
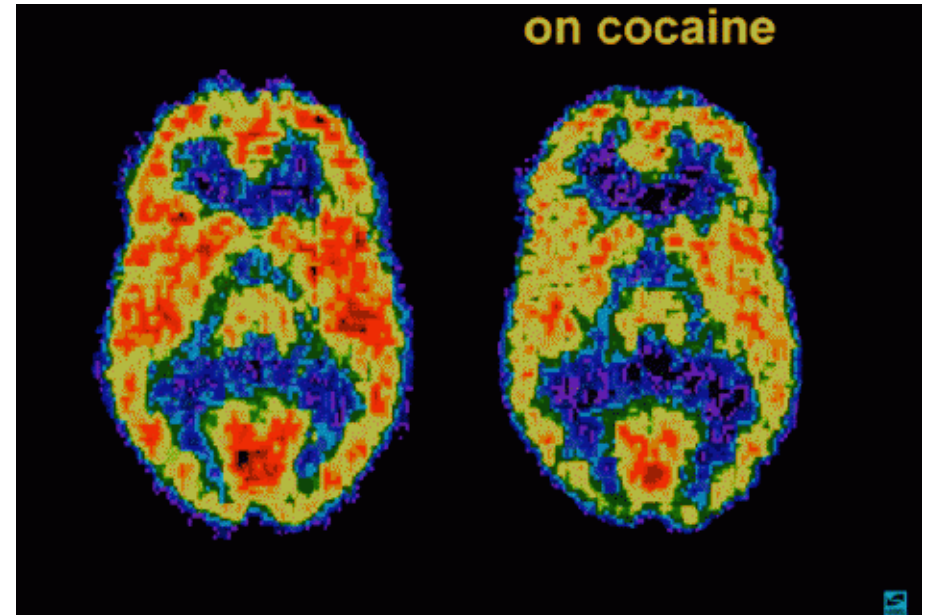
- FDG –  $^{18}\text{F}$  (označená glukóza)
- zobrazení aktivity mozku



reakce závislých pacientů na film o kokainu

P. Zickler *NIDA NOTES* 16 2 (2001)

PET



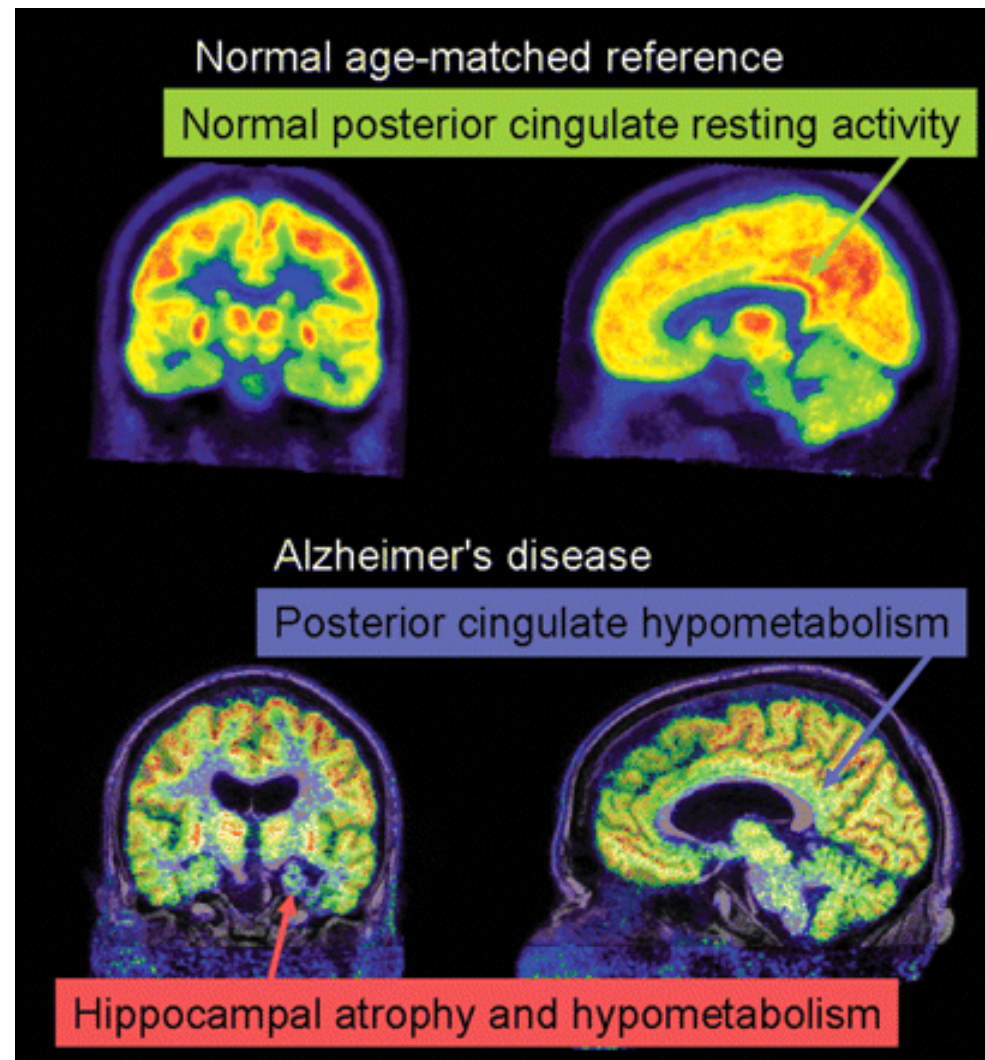
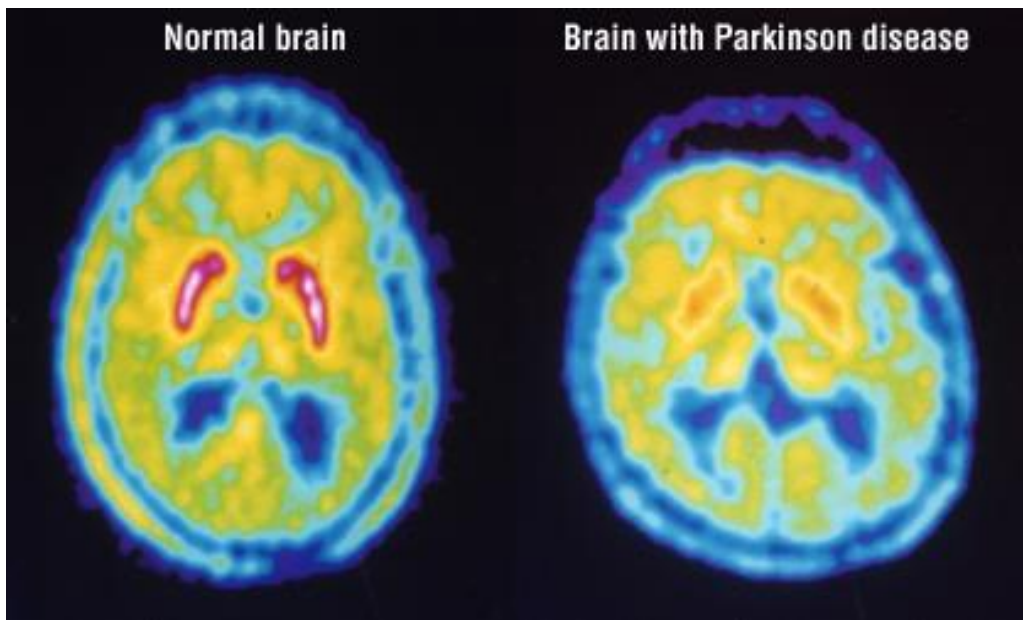
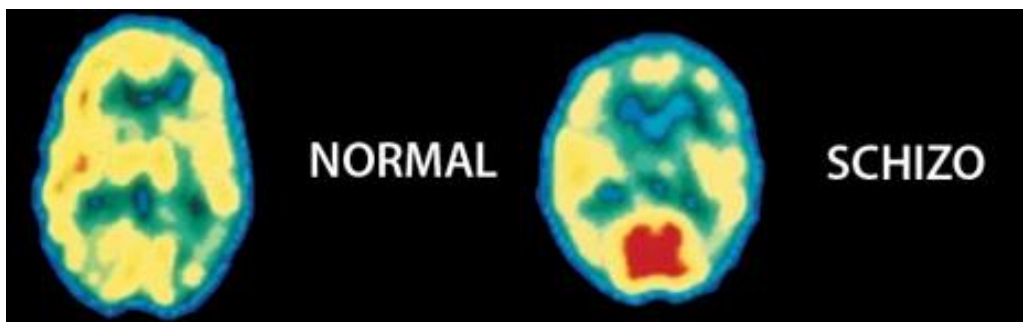
uživatel drog  
(film o kokainu)

muž neužívající drogy  
(„sexuální film“)

fMRI

# PET – zobrazení aktivity mozku

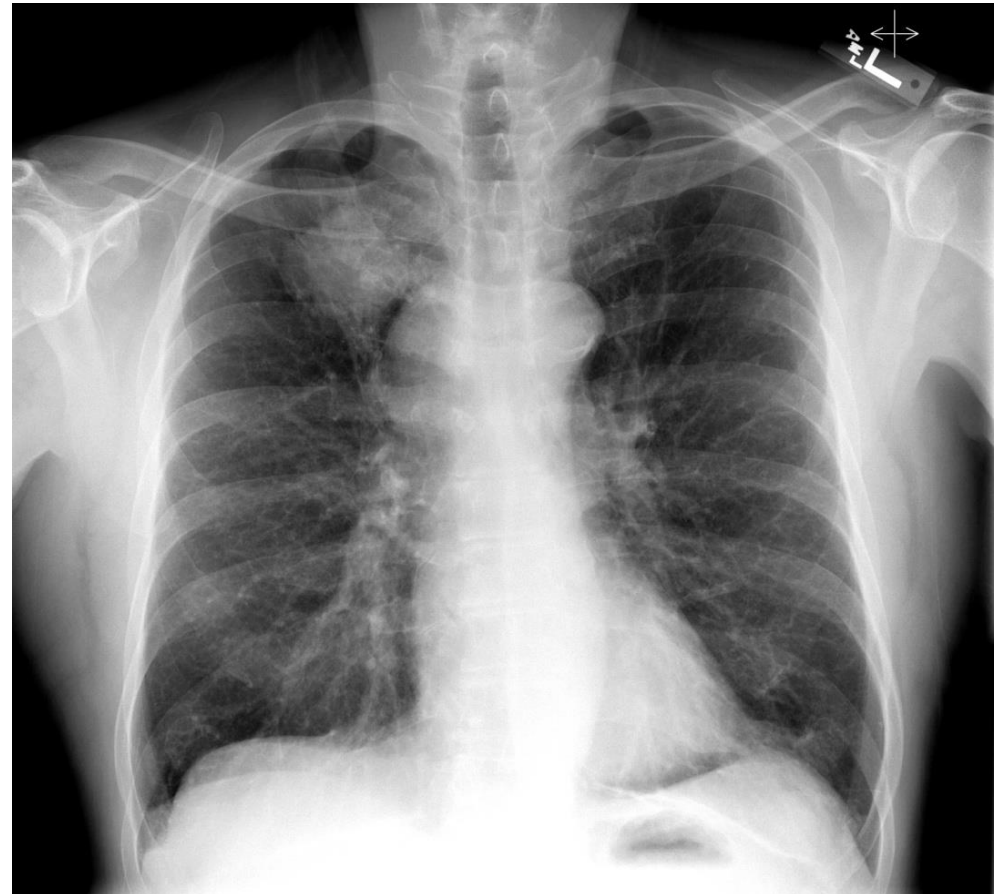
- FDG –  $^{18}\text{F}$  (označená glukóza)
- výzkum duševních nemocí



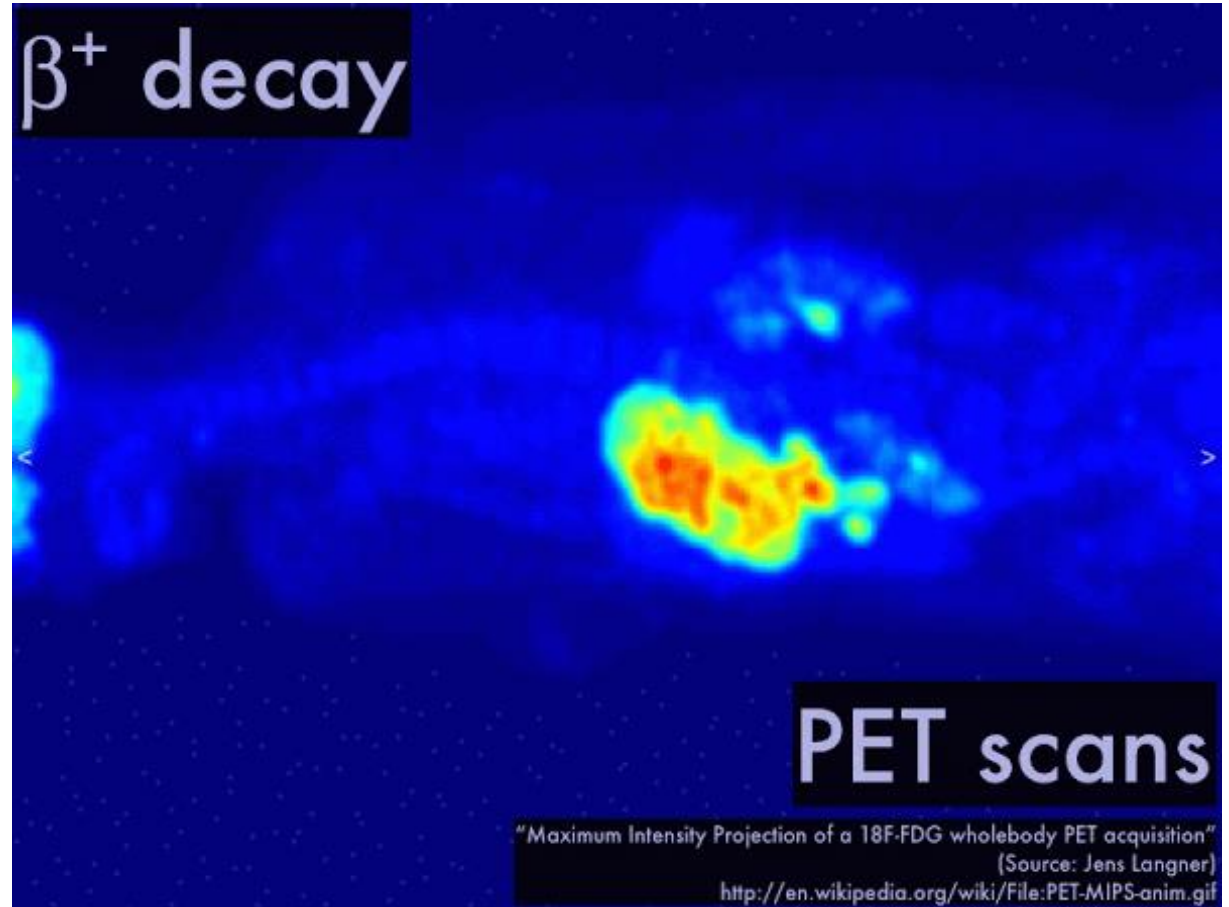
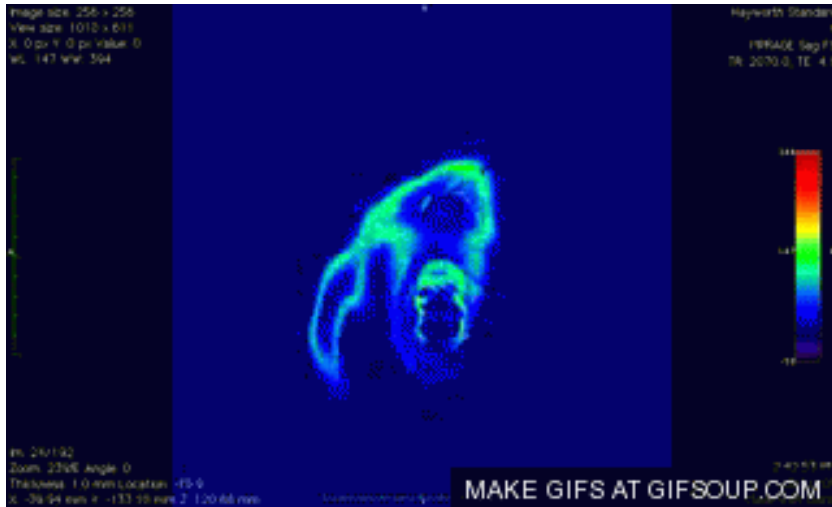


# PET – zobrazení nádorů

- FDG –  $^{18}\text{F}$  (označená glukóza)
- rakovinové buňky mají vyšší metabolickou aktivitu → vyšší spotřeba glukózy

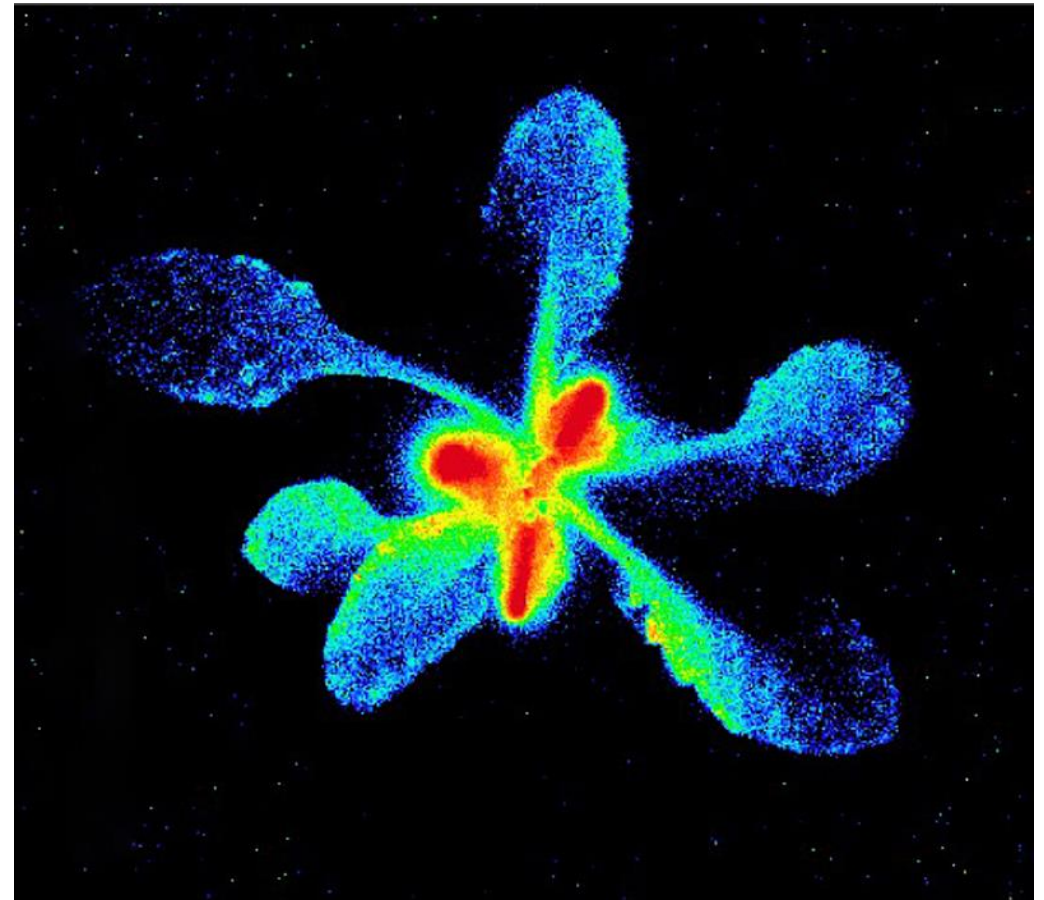
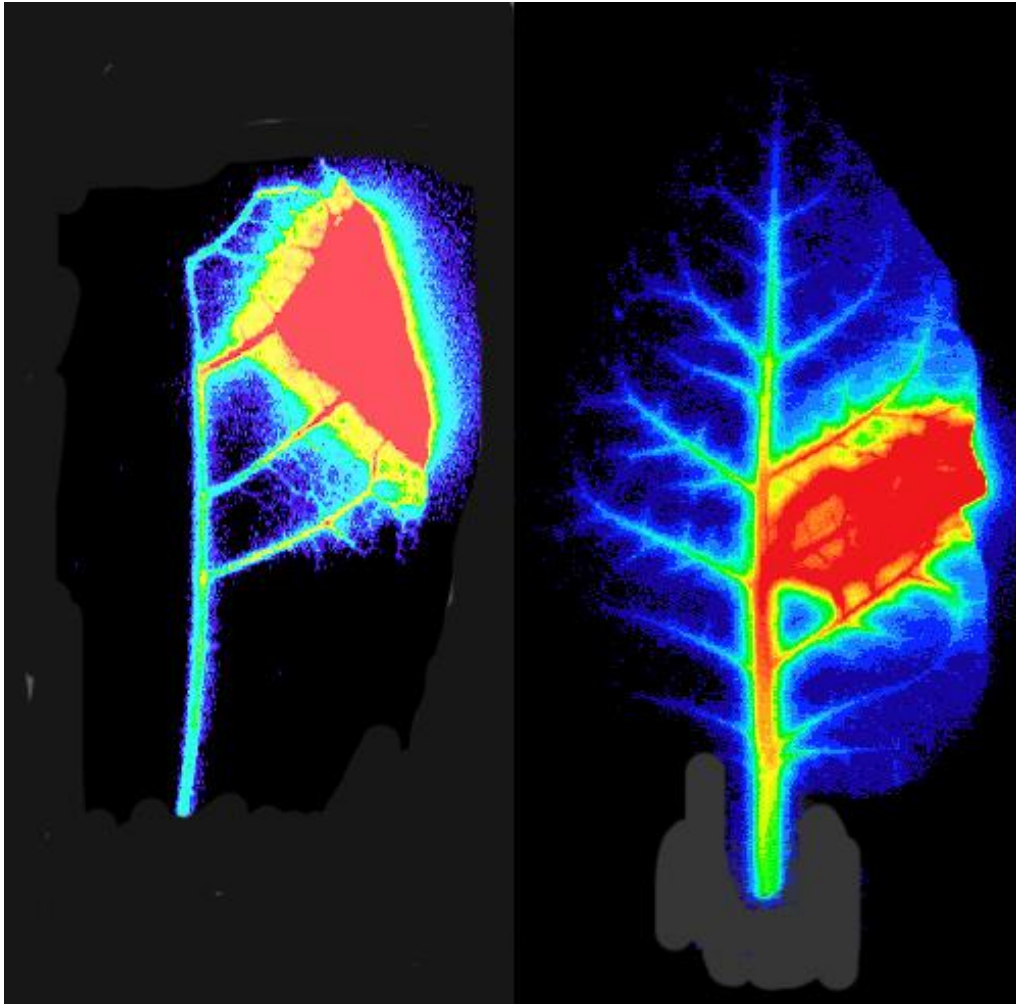


# Pozitronová emisní tomografie (PET – FDG)

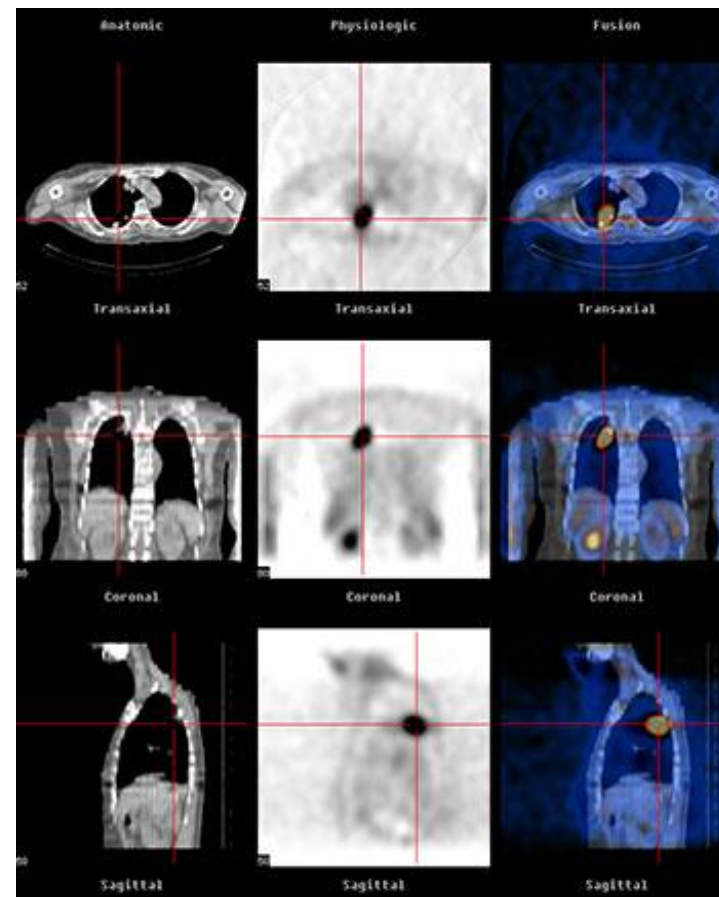
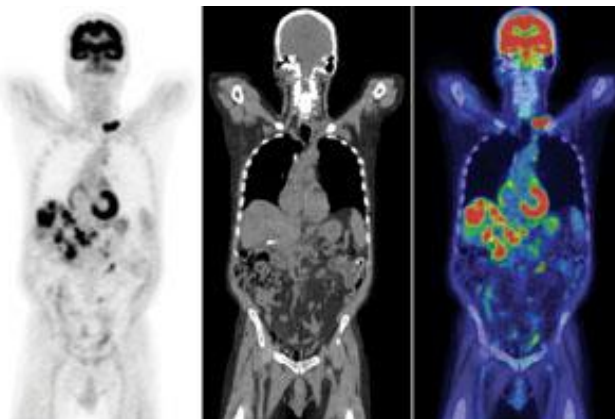
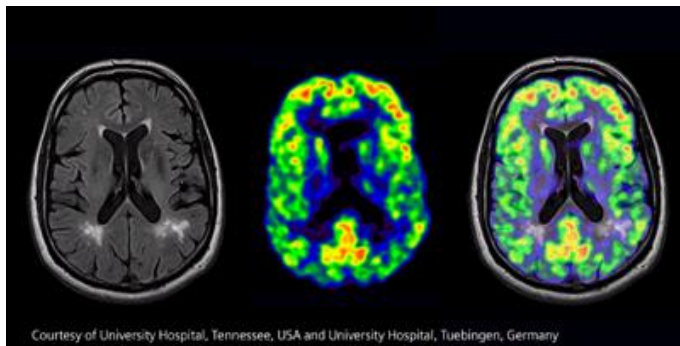


# Pozitronová emisní tomografie (PET)

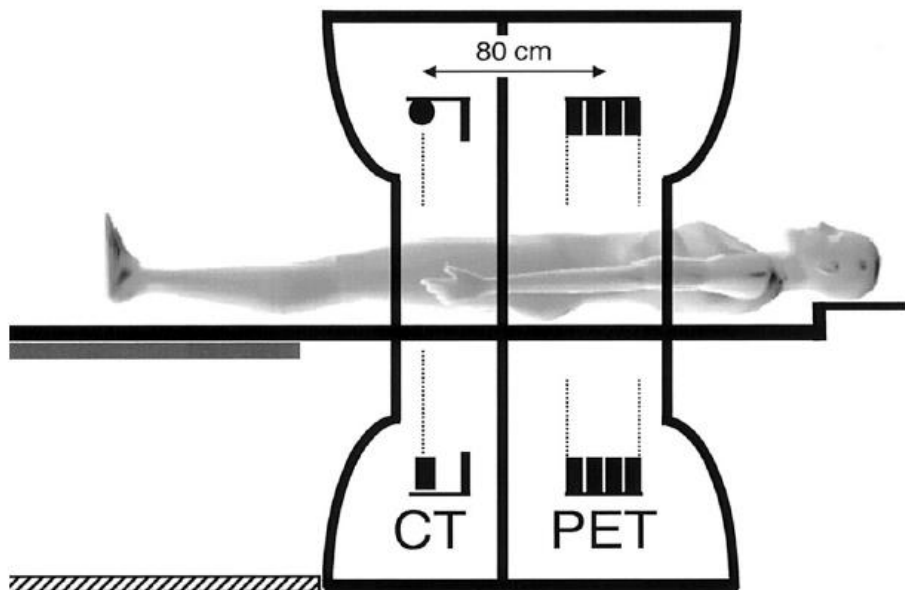
- ukládání cukru v rostlinách ( $^{11}\text{C}$ ,  $T_{1/2} = 20.4$  min)



# Pozitronová emisní tomografie (PET) kombinovaná s CT

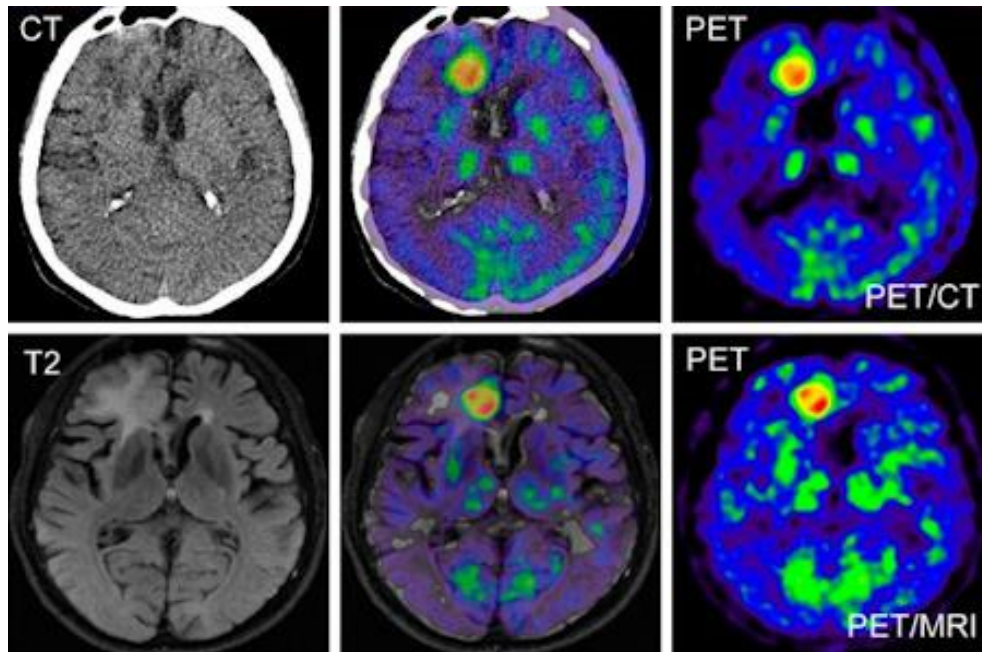


# Pozitronová emisní tomografie (PET) kombinovaná s CT



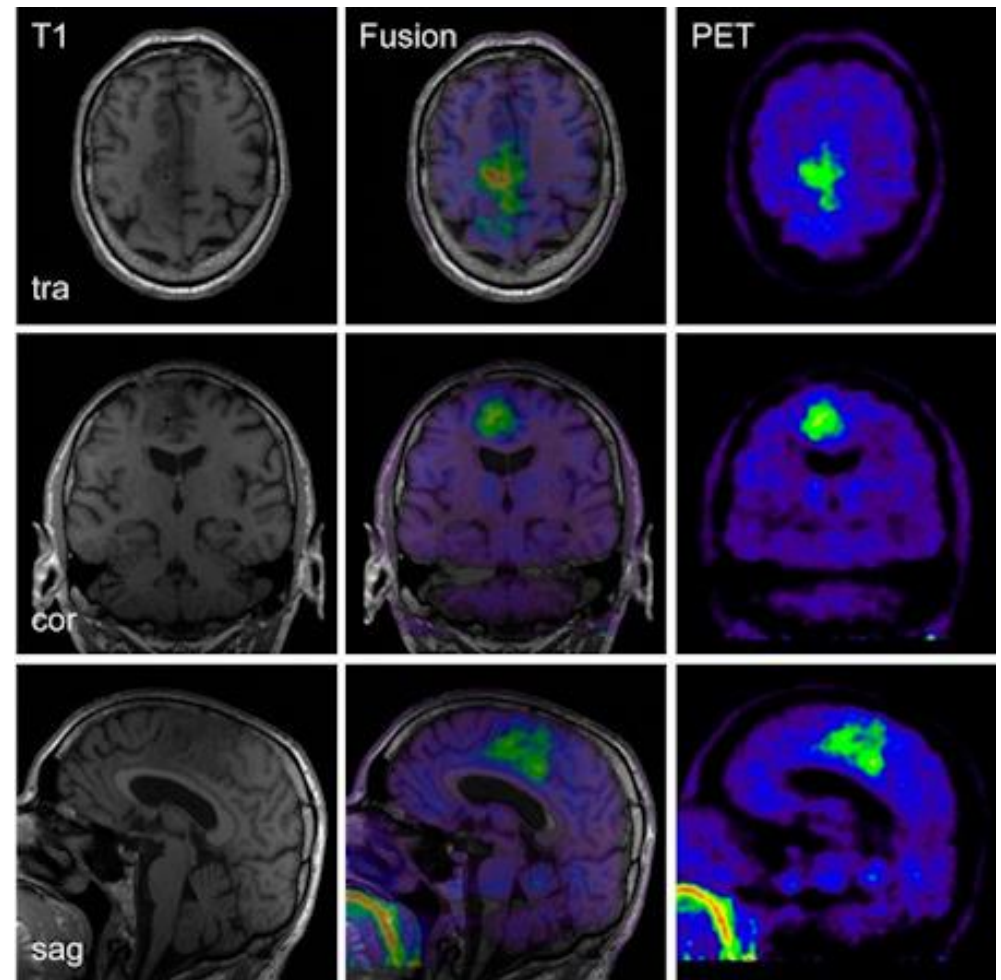
# Pozitronová emisní tomografie (PET) kombinovaná s MRI

PET + CT



PET + MRI

PET + MRI



# Pozitronová emisní tomografie (PET) kombinovaná s MRI



Philips TOF-PET/MRI (525 ps)



GE TOF-PET/MRI (400 ps)