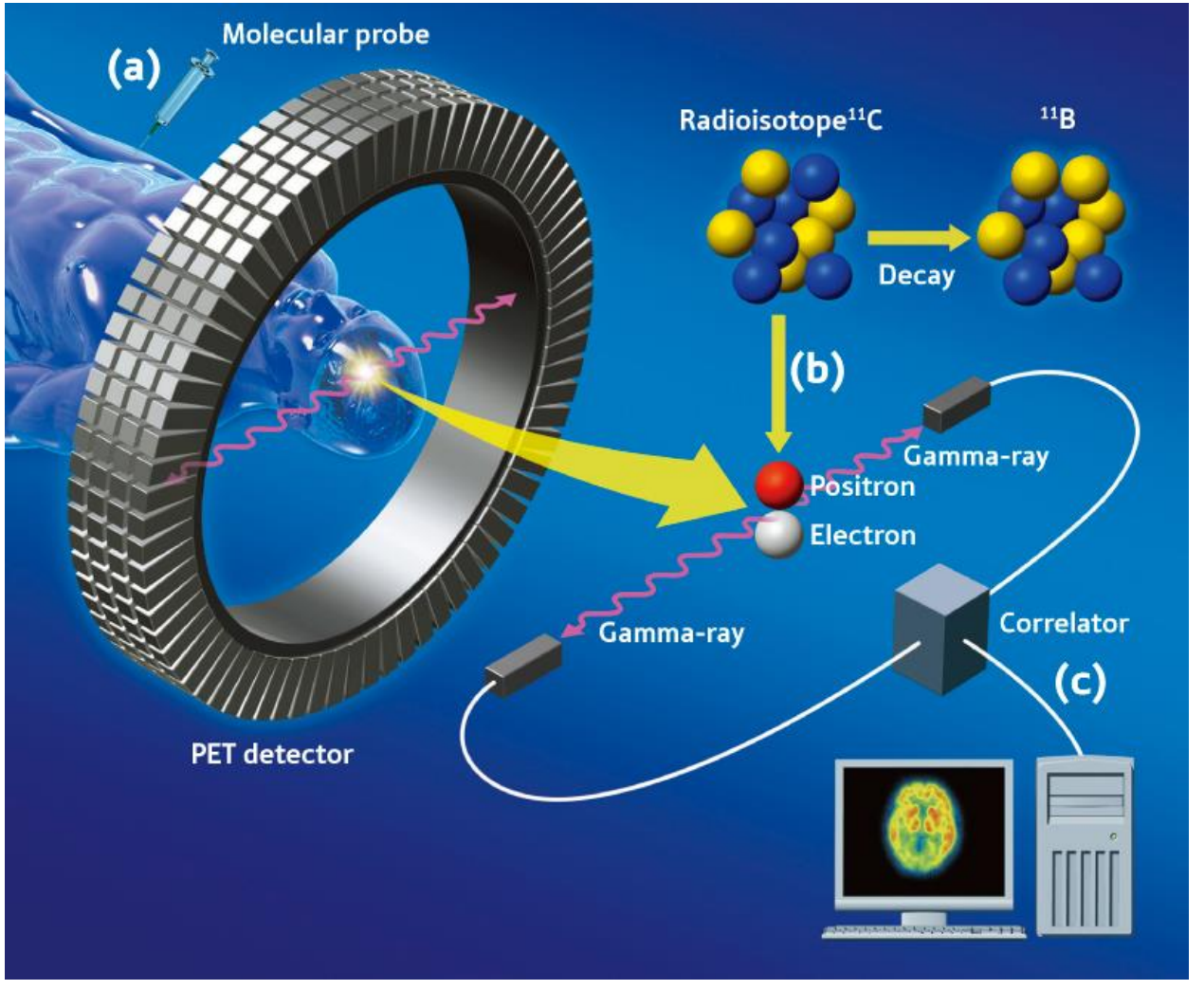
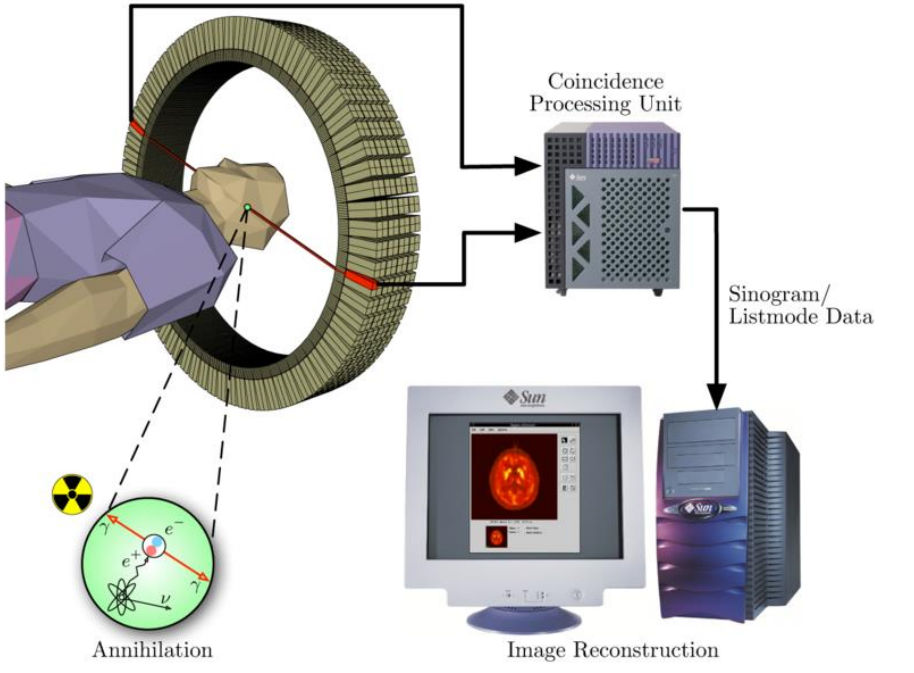
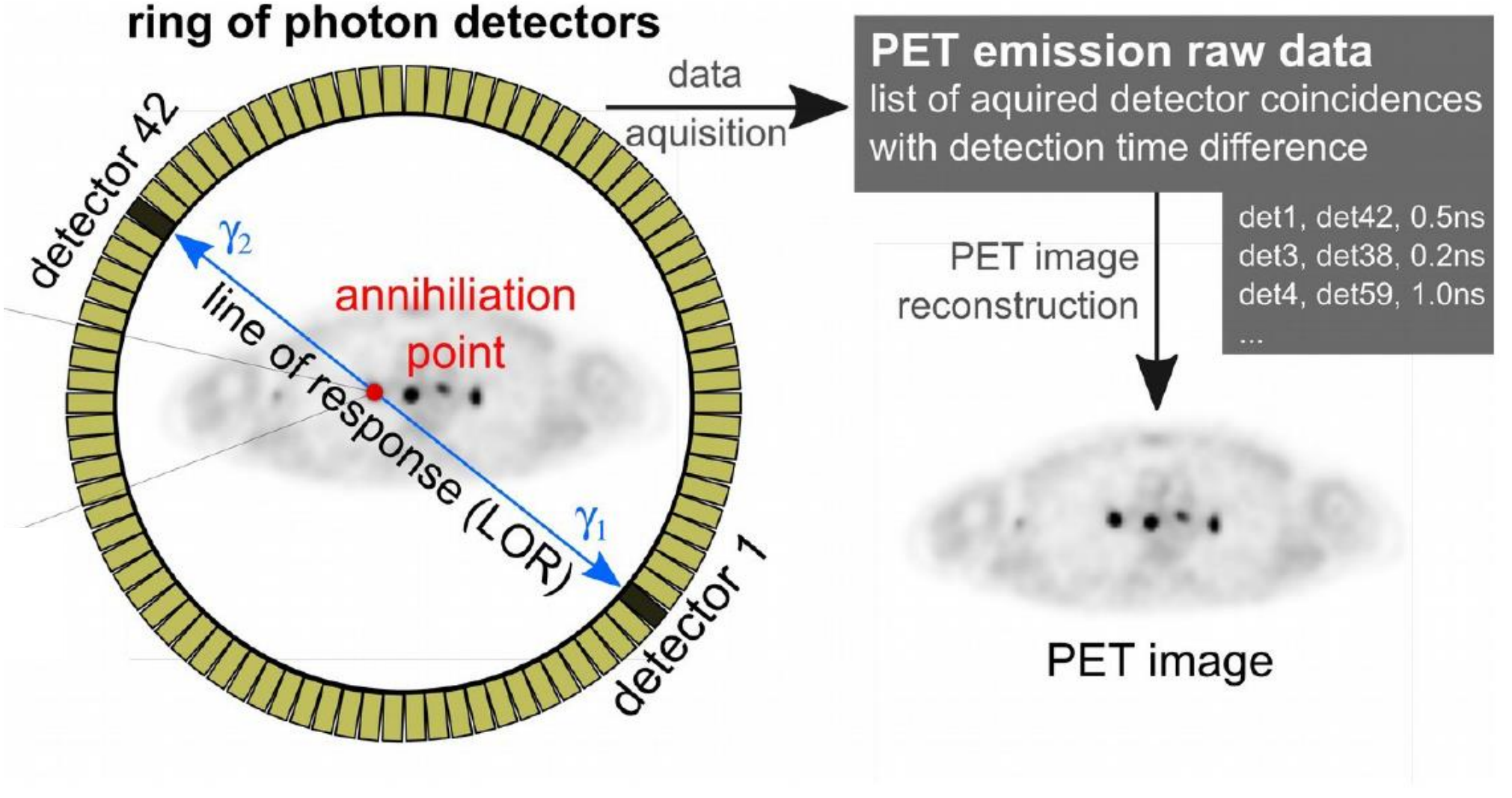
Pozitronová emisní tomografie (PET)





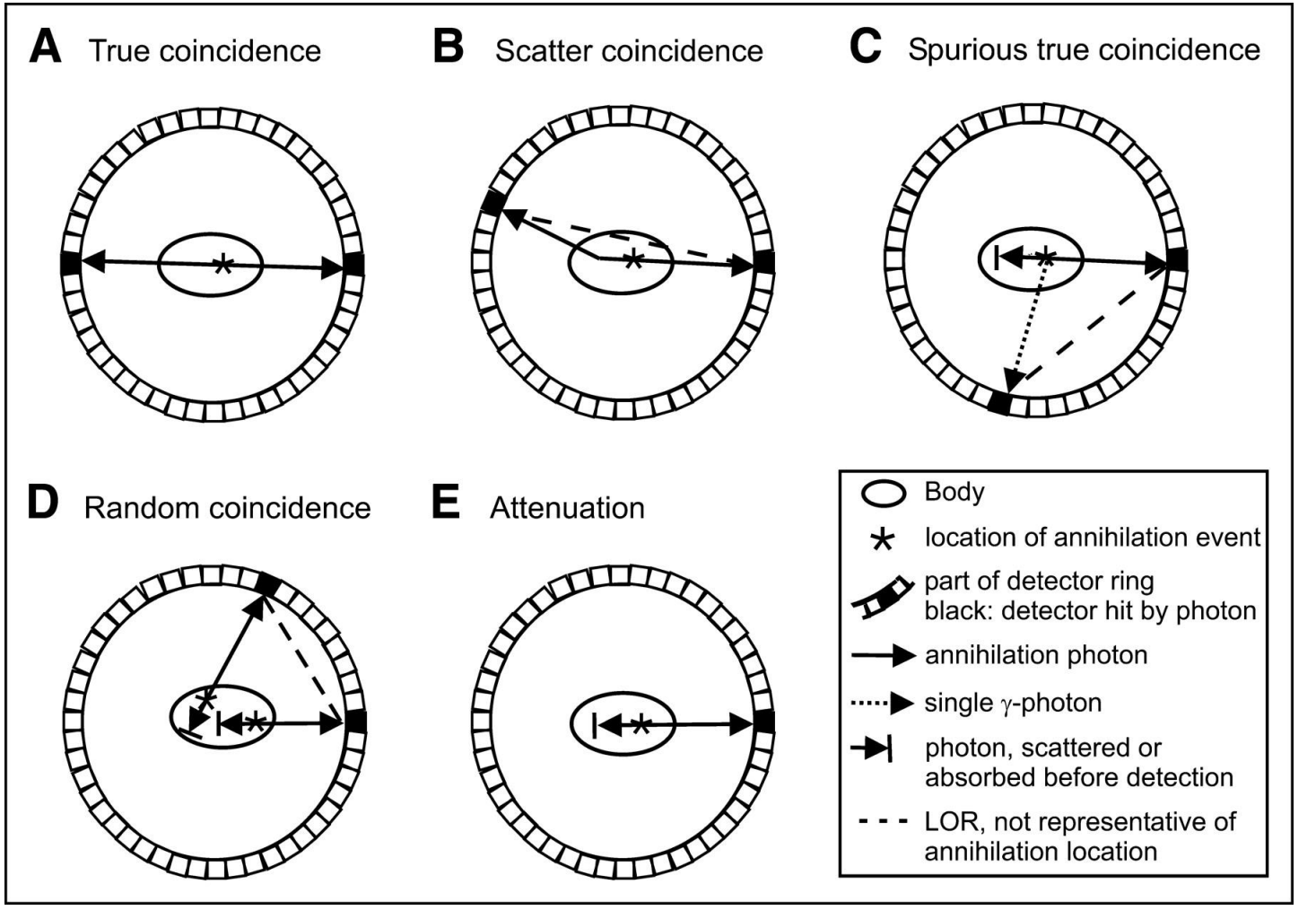
Pozitronová emisní tomografie (PET)



PET – line of response (LOR)

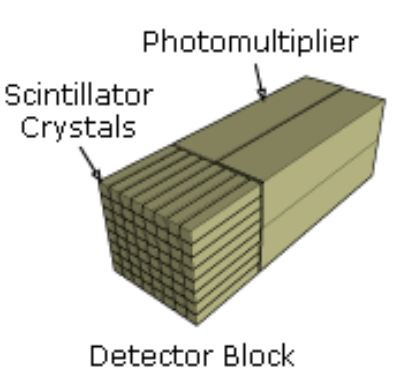
- LOR = line of response

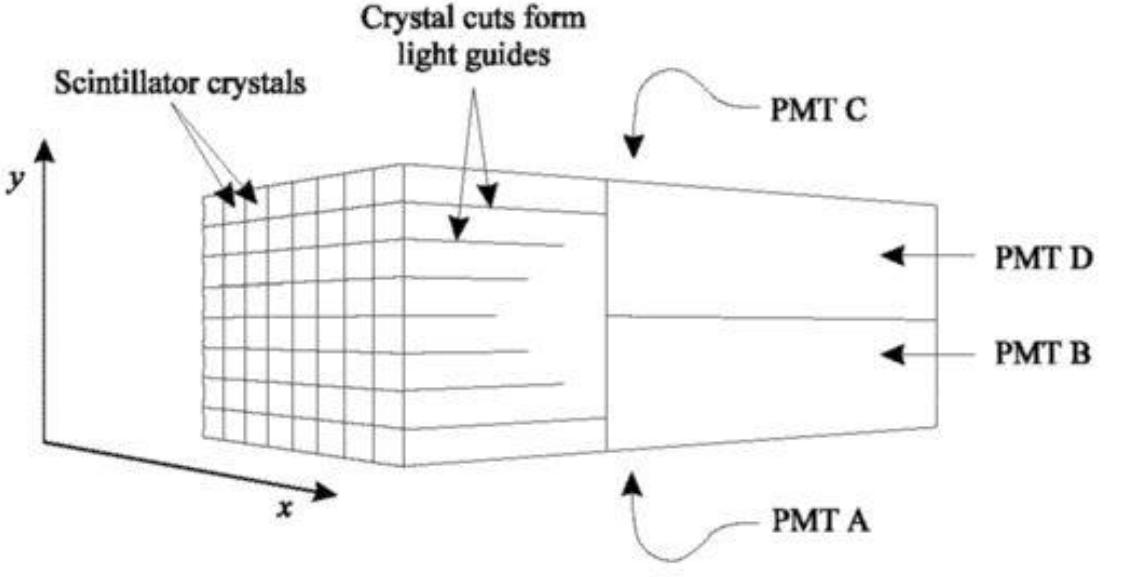
- koincidence
  - true
  - scatter
  - spurious
  - random
  - multiple

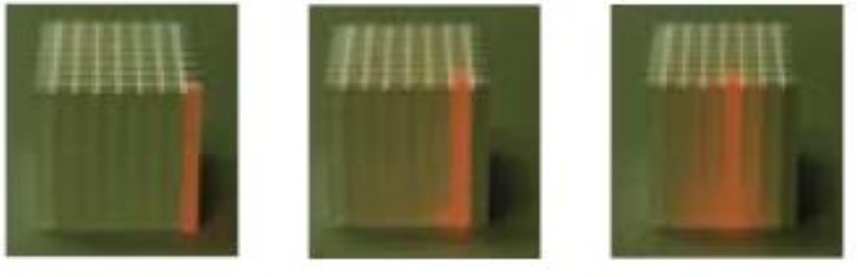


PET – detektory

- BGO ($Bi_4Ge_3O_{12}$) scintilátory + 4 fotonásobiče (PMT A,B,C,D)
- $\tau \approx 30$ ns





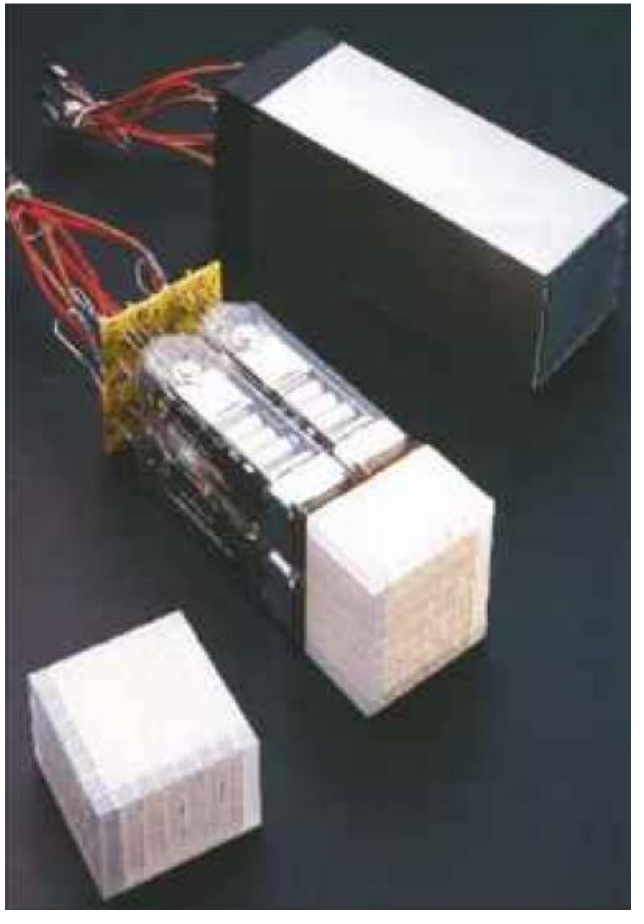


$$x = \frac{A + B - C - D}{A + B + C + D}$$

frakce signálu na PMT

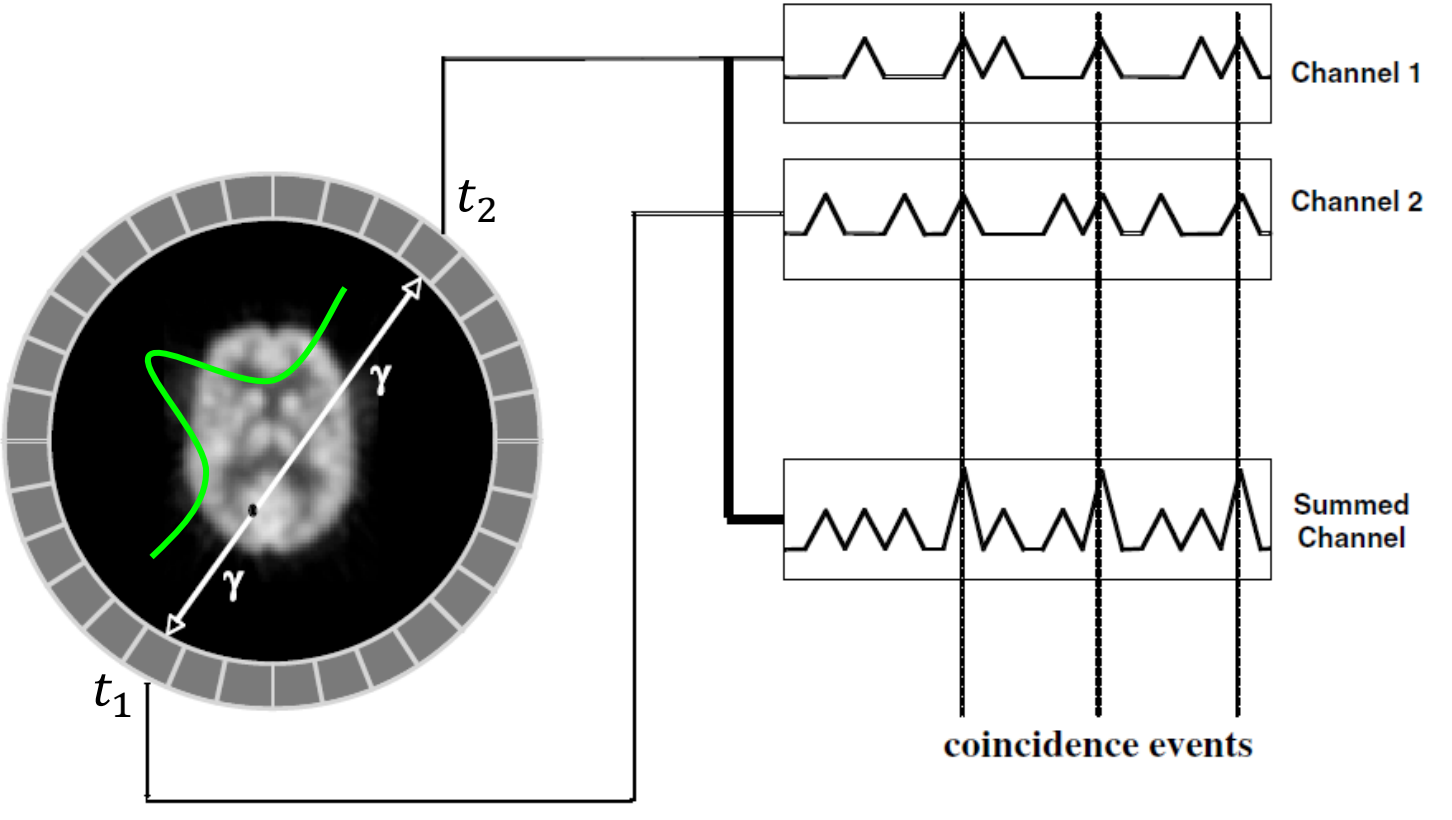
$$y = \frac{A - B + C - D}{A + B + C + D}$$

PET – detektory



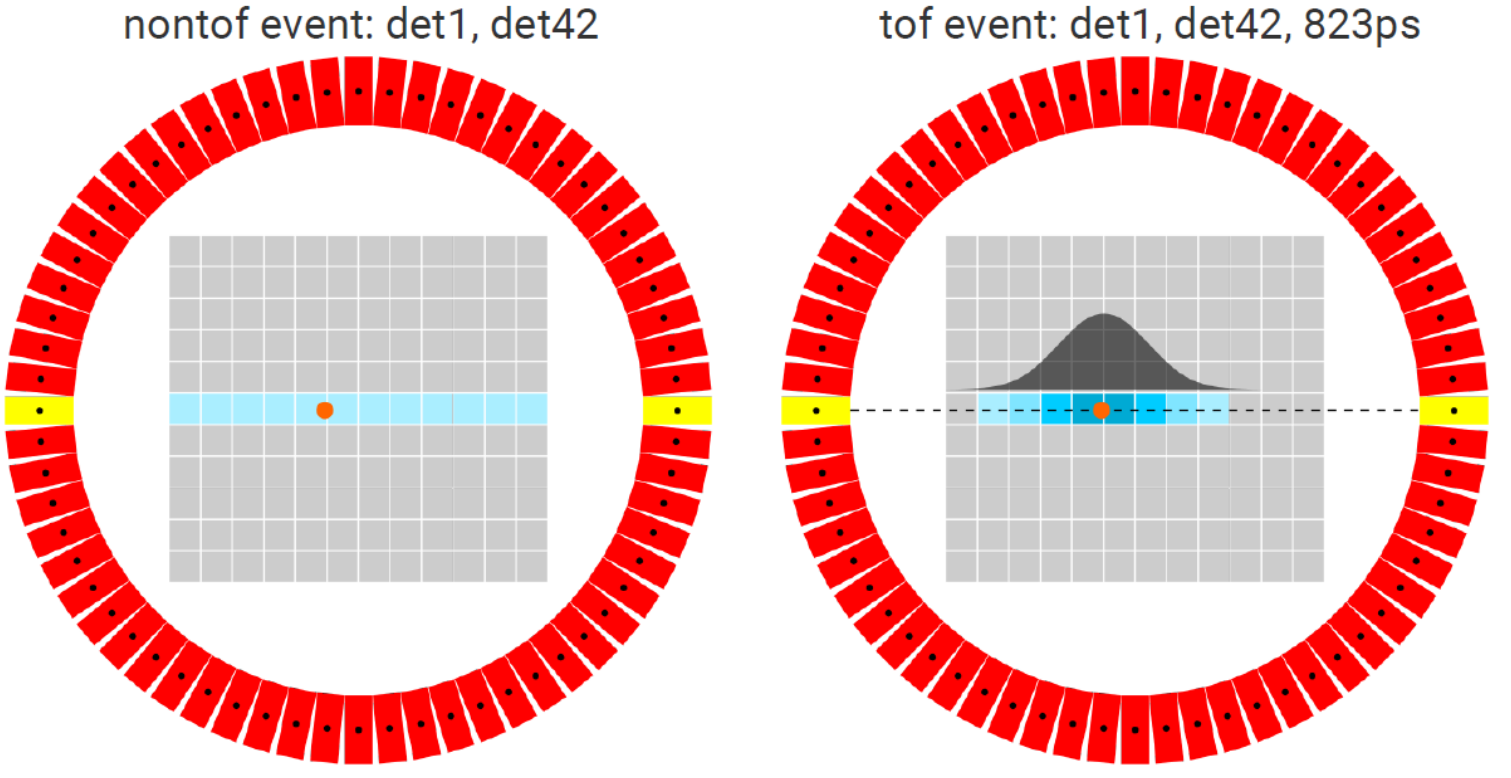
PET – time of flight (TOF)

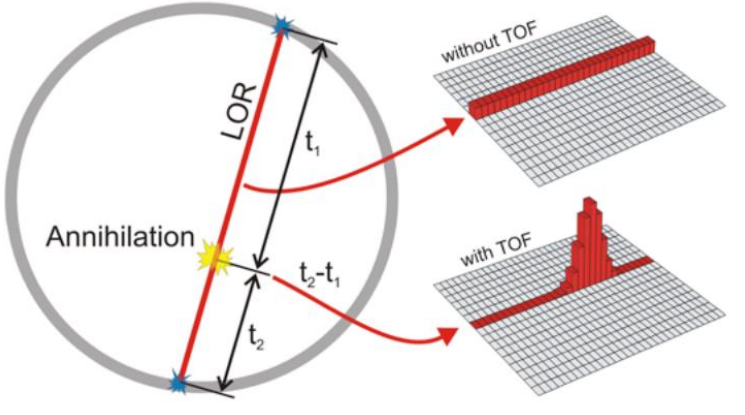
- koincidenční okno ~ 1-10 ns



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

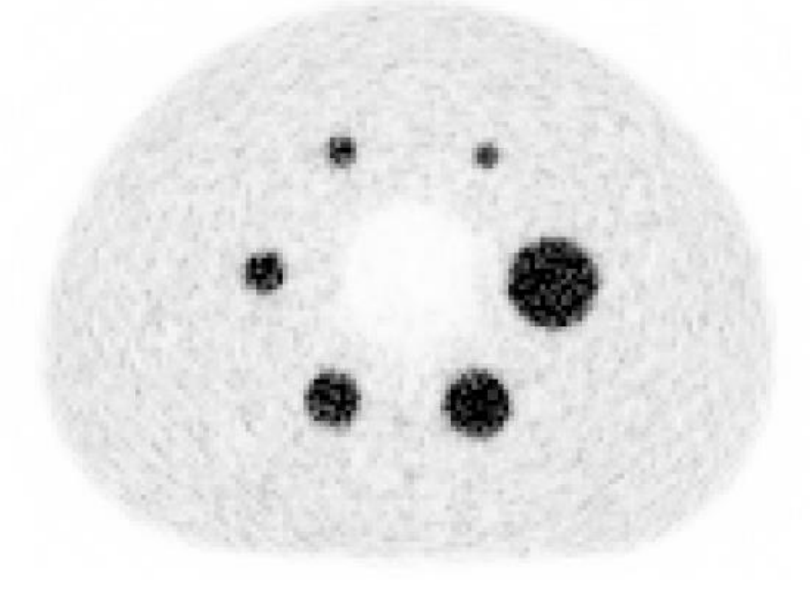
PET – time of flight (TOF)



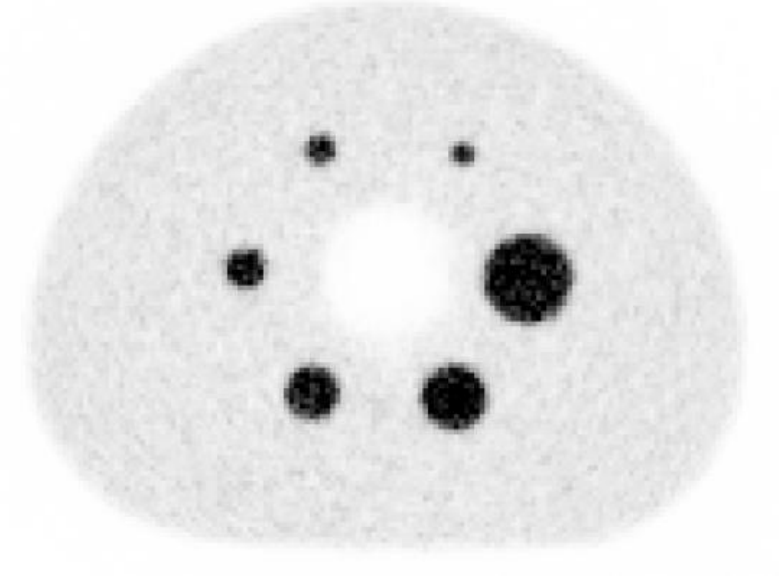


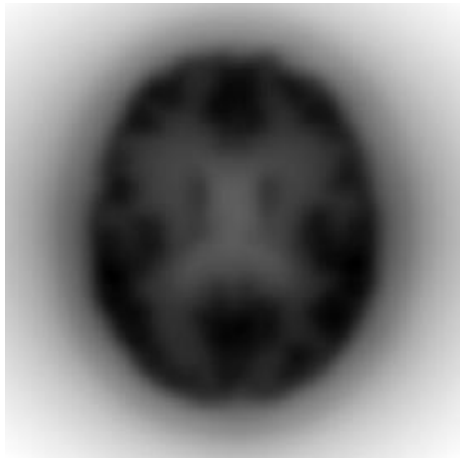
PET – time of flight (TOF)

non-tof reconstruction 112 updates

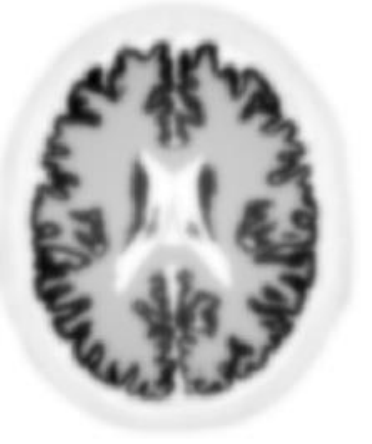


tof reconstruction 56 updates
(400 ps)





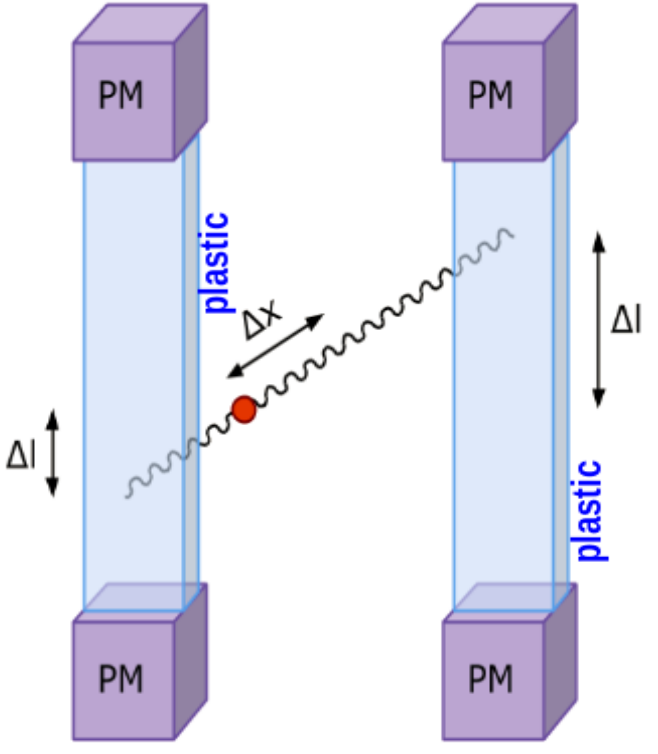
Non-TOF back-projection

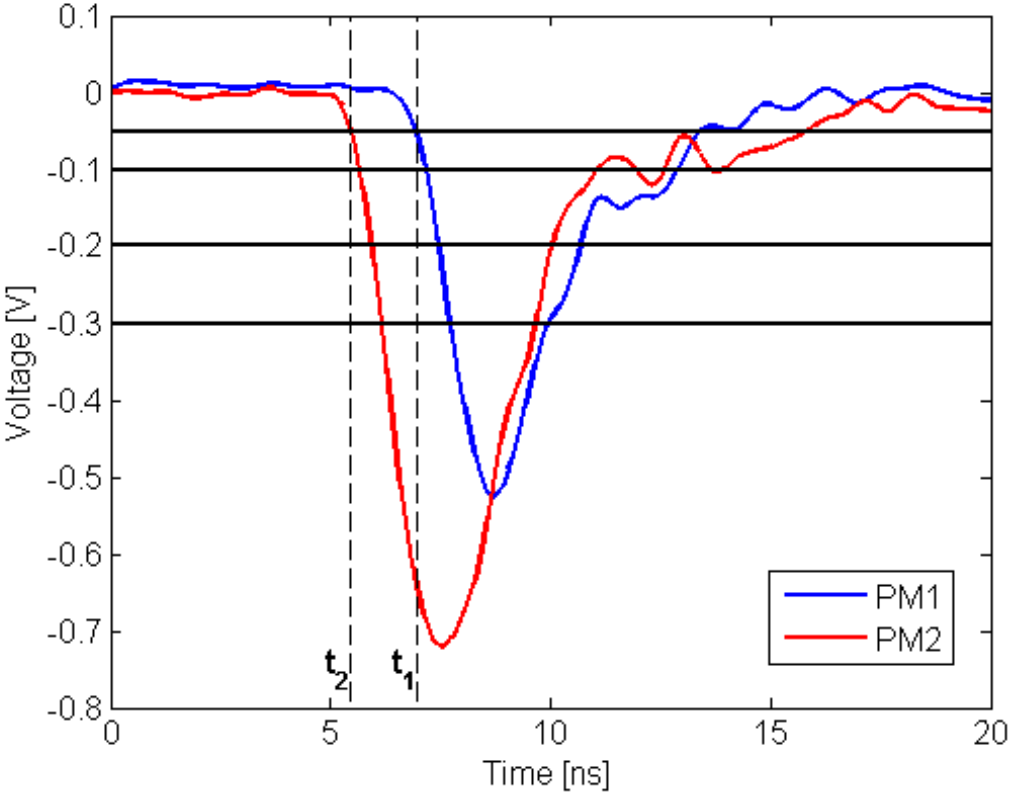


TOF back-projection (10 ps FWHM)

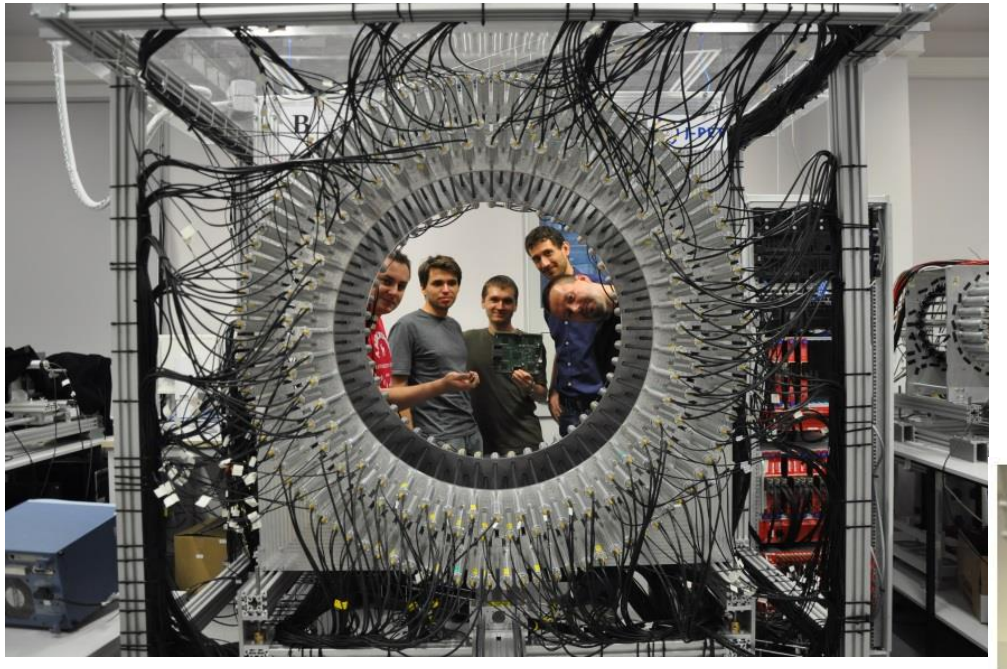
J-PET

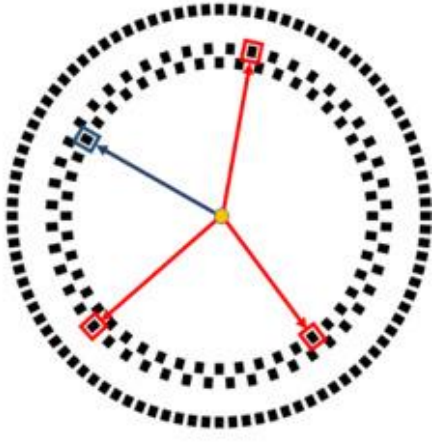
- J-PET (Jagiellonian-PET Tomography), Krakow
- plastické scintilátory (levné, snadno tvarovatelné)
- time of arrival (TOA) $\rightarrow \Delta l$, time of flight (TOF) $\rightarrow \Delta x$



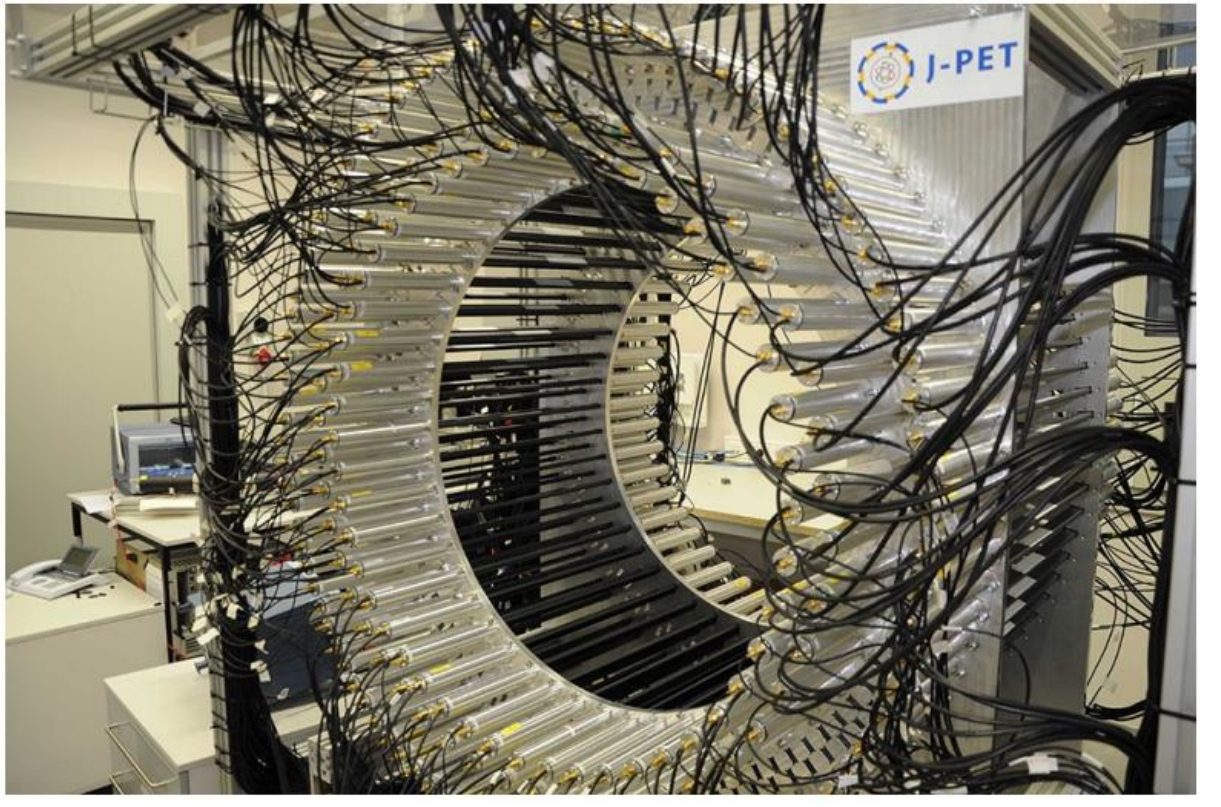


J-PET





J-PET



PET – radiofarmaka

- označení sloučenin radioizotopy
- sledování *in-vivo*
- senzitivita ~ pmol

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

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

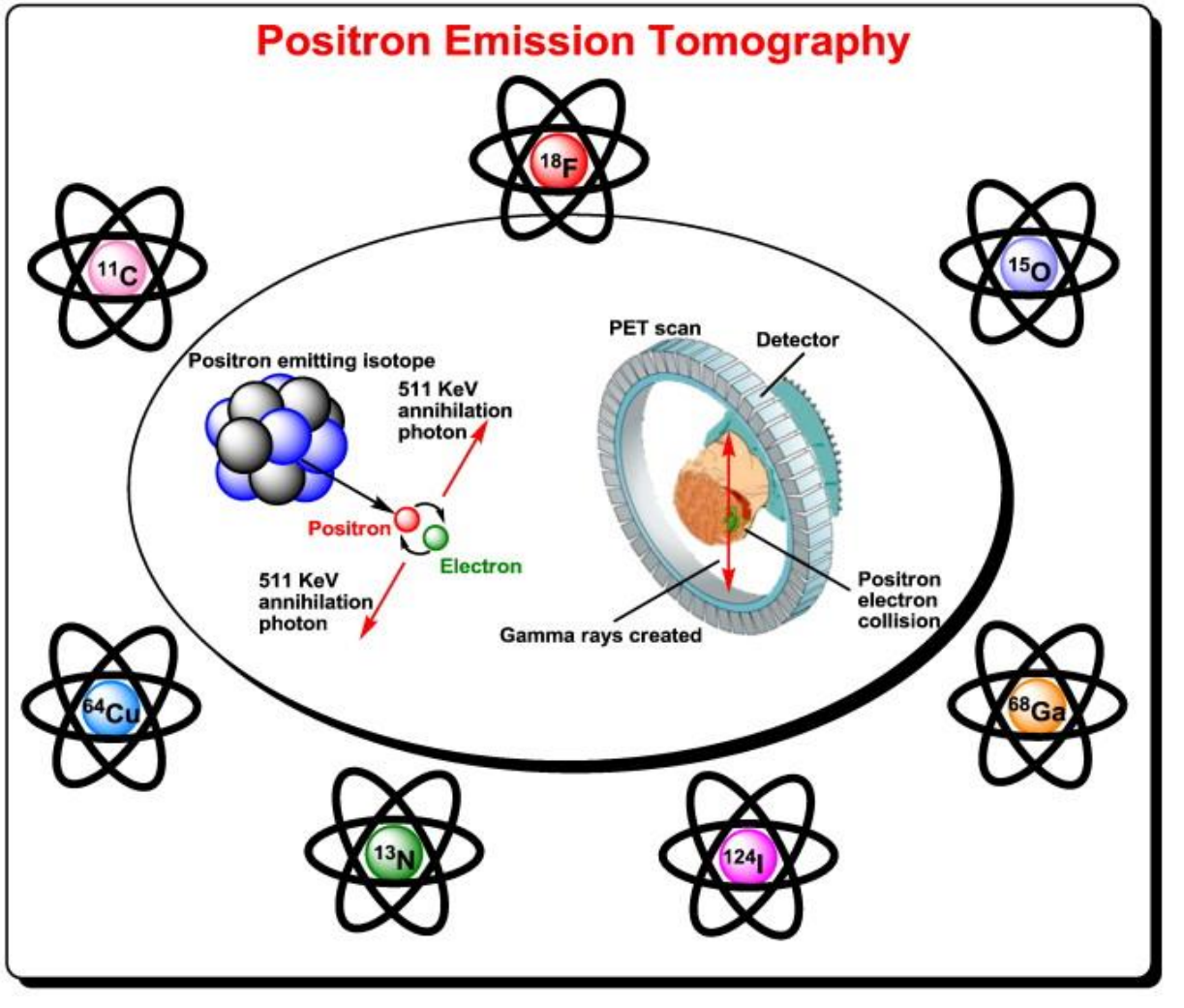
  ^{15}O ($T_{1/2}$ = 2 min)

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

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

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

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



PET – radiofarmaka

- označení sloučenin radioizotopy

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

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

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

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

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

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

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

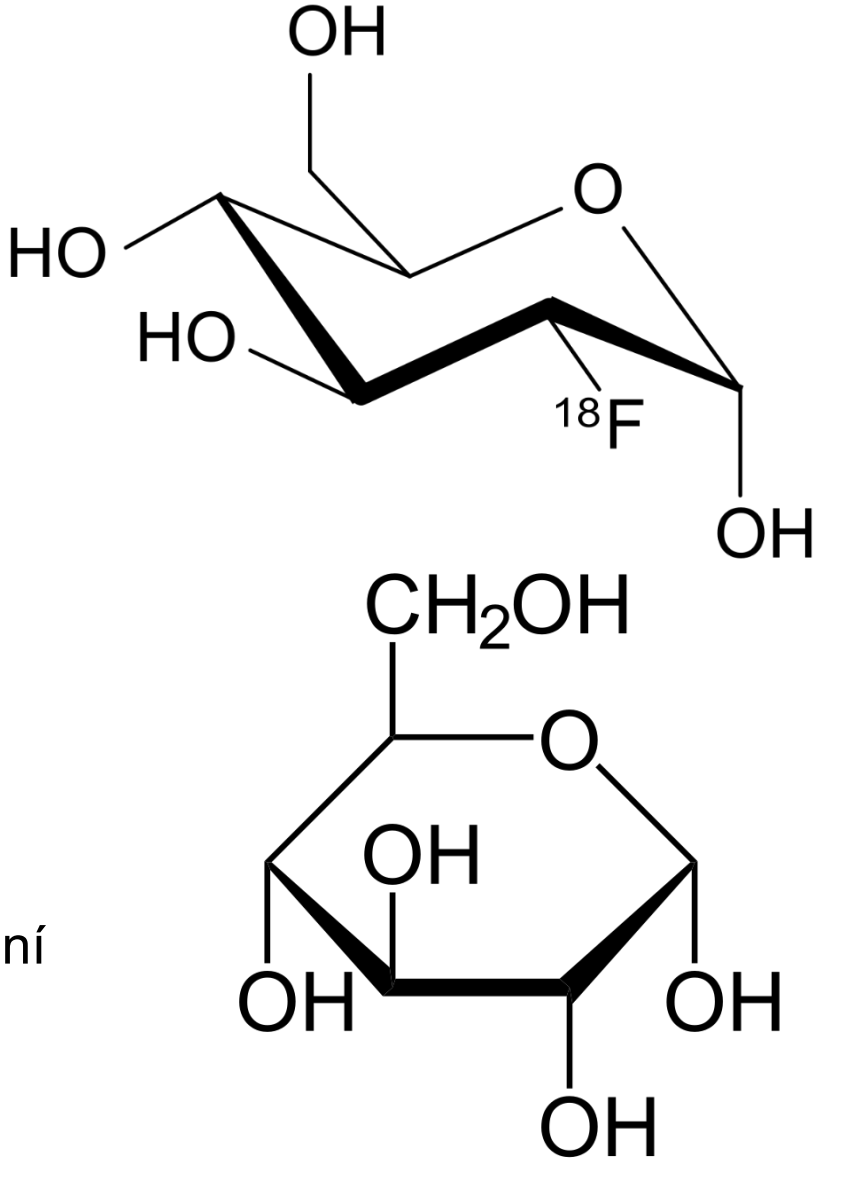
1. získání radionuklidu
   - viz zdroje pozitronů
2. příprava a značení účinné látky
   - izotopové výměnné reakce
   - chemická syntéza
3. příprava požadované lékové formy
   - parentální
   - perorální
   - inhalační
   - lokální
4. kontrola kvality
   - stanovení aktivity
   - radionuklidová čistota
   - radiochemické znečištění
   - biologická čistota

PET – radiofarmaka

- FDG: (^{18}F)-fluordeoxyglukóza
  - zobrazení metabolické aktivity
  - příjem stejný jako glukóza
  - metabolizace po rozpadu ^{18}F

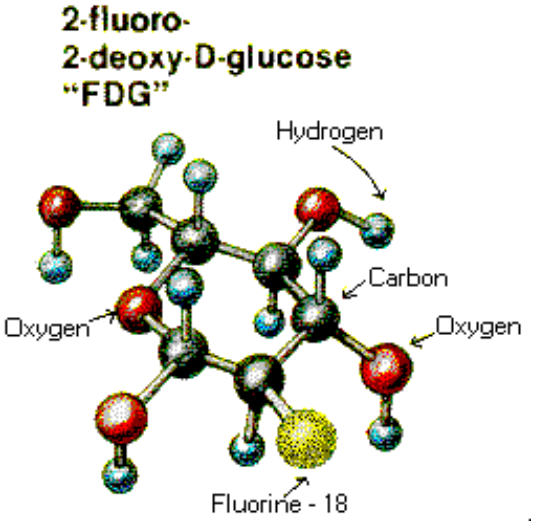
$$^{18}\mathrm{F} \rightarrow {}^{18}\mathrm{O}^{-} + e^{+} + \nu_e$$
$$^{18}\mathrm{O}^{-} + \mathrm{H}^{+} \rightarrow {}^{18}\mathrm{OH}$$

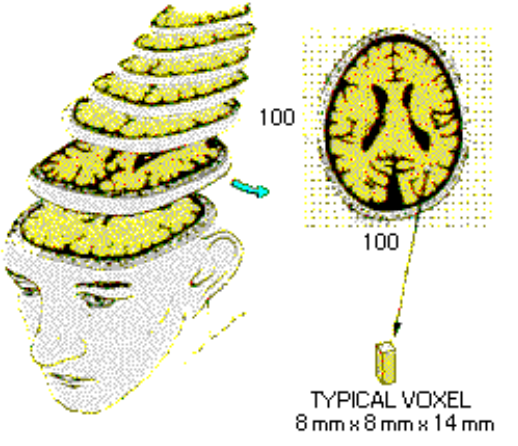
  - přímá vs nepřímá fluorizace
  - dlouhá doba života
    → syntéza, transport, PET imaging
  - nízká energie β^{+} (0.64 MeV)
    → krátký dolet a vysoké prostorové rozlišení
  - typická aktivita 100 – 400 MBq
  - dávka ozáření do 2 – 10 mSv

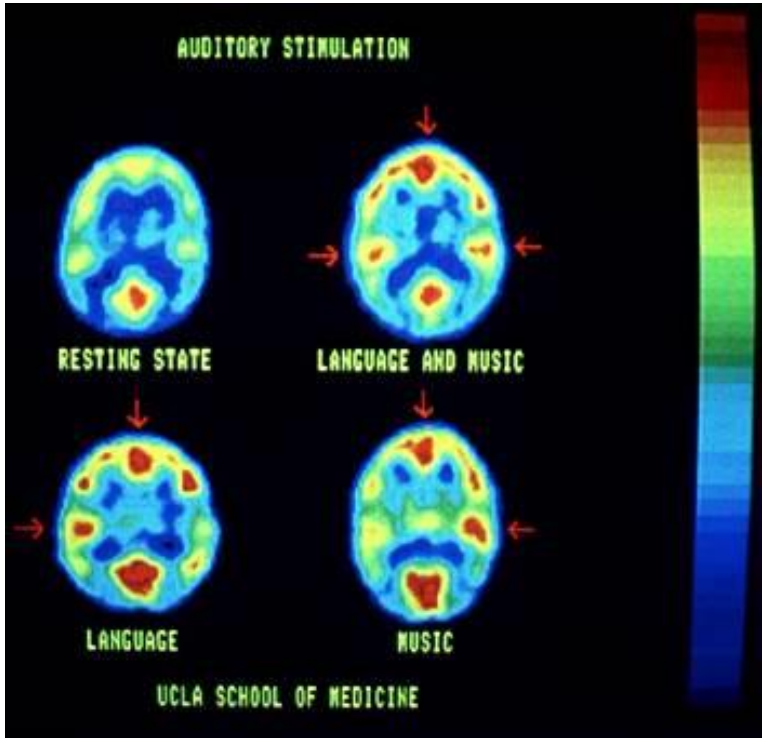


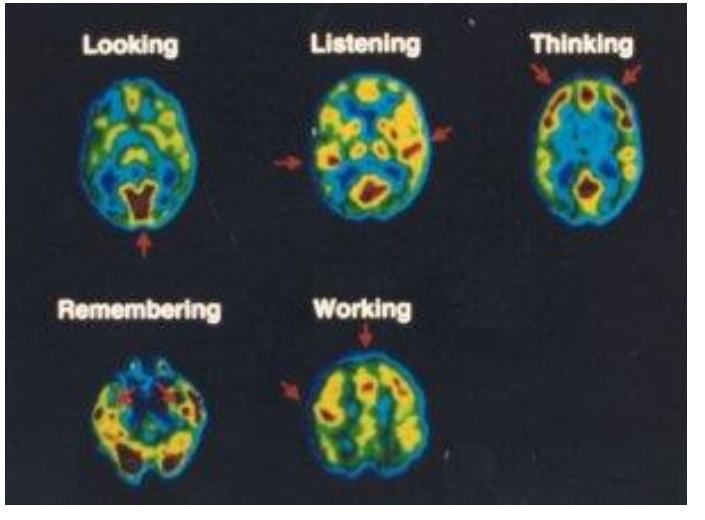
PET – zobrazení aktivity mozku

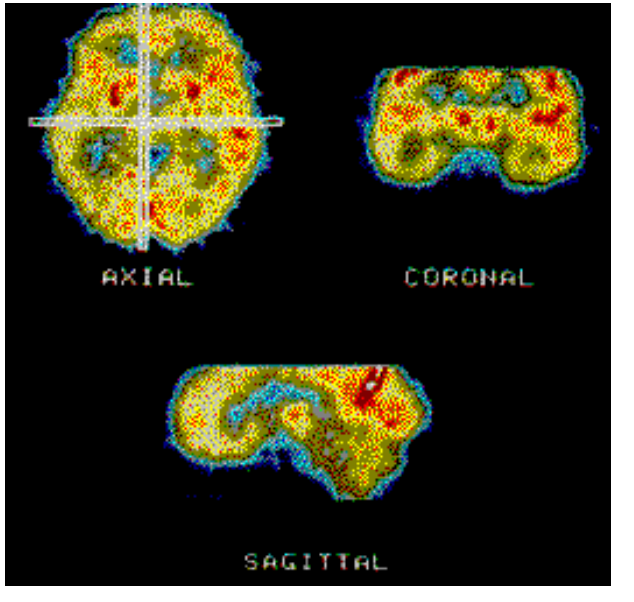
- FDG – ^{18}F (označená glukóza)
- zobrazení aktivity mozku





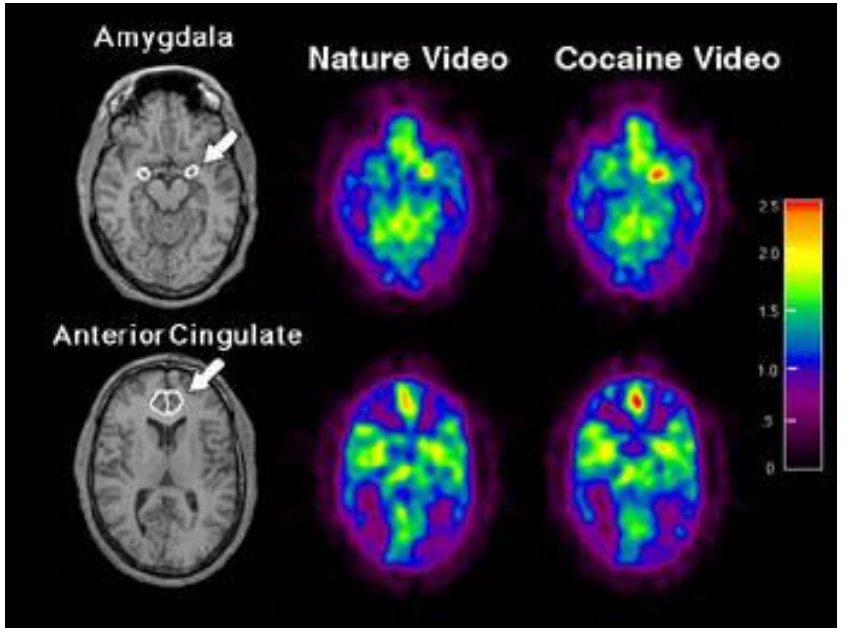






PET – zobrazení aktivity mozku

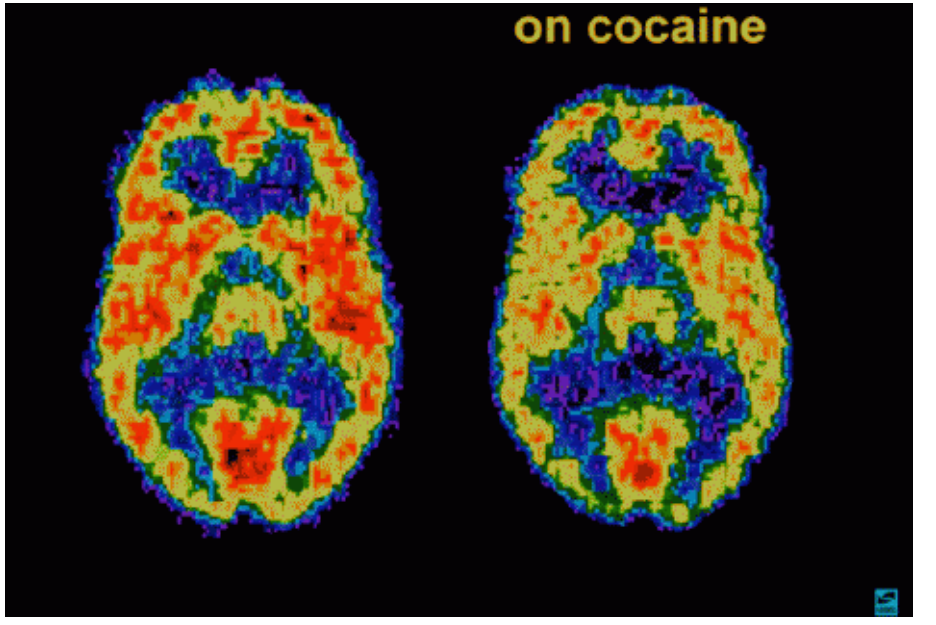
- FDG – ^{18}F (označená glukóza)
- zobrazení aktivity mozku

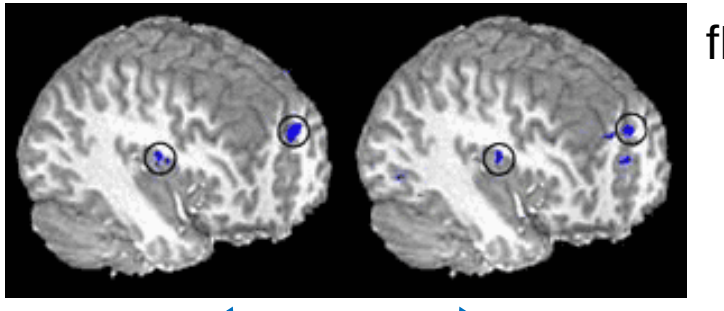


PET

reakce závislých pacientů na film o kokainu

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





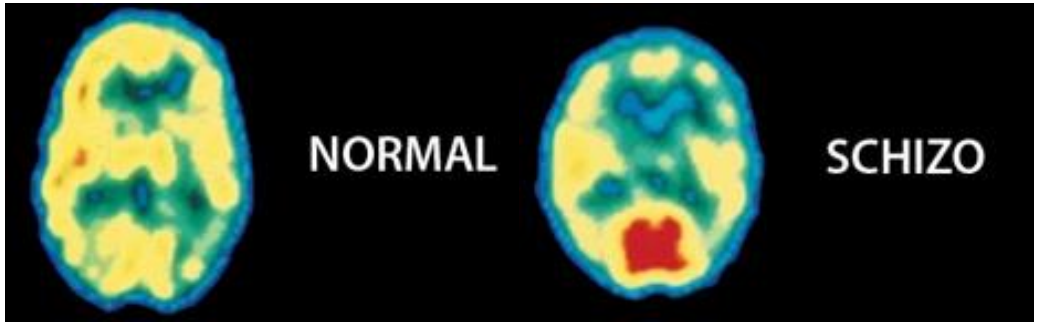
fMRI

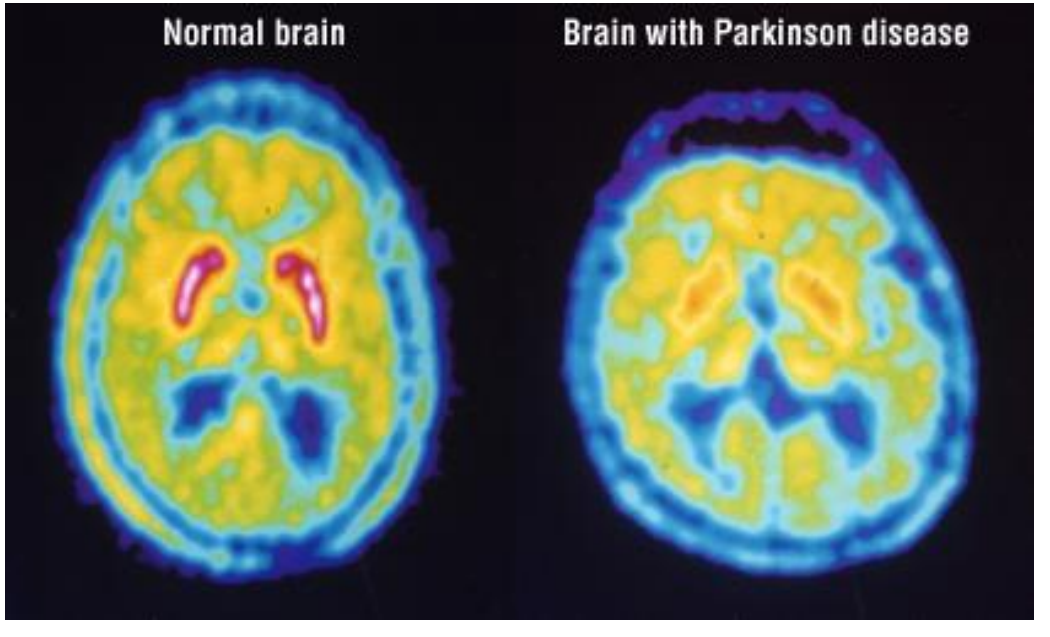
uživatel drog
(film o kokainu)

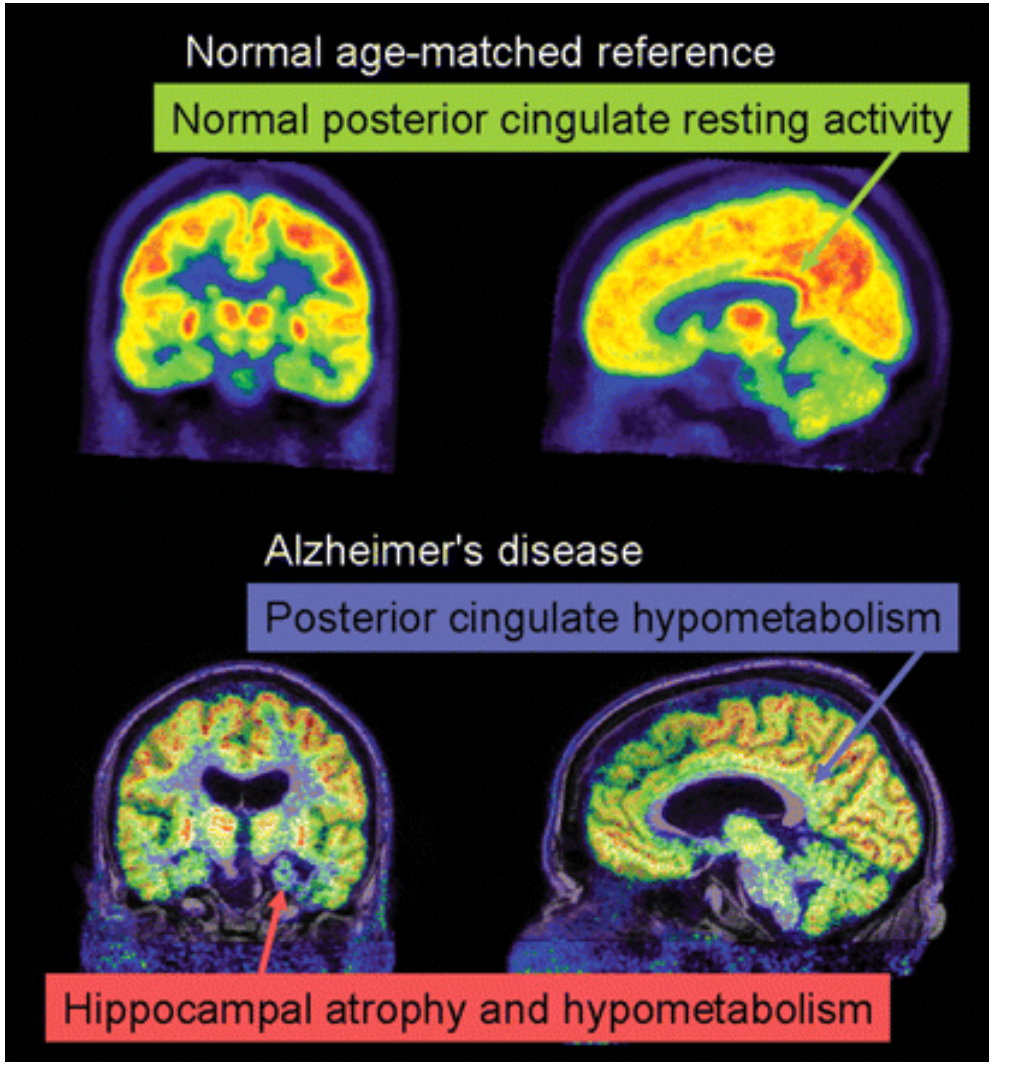
muž neužívající drogy
(„sexuální film“)

PET – zobrazení aktivity mozku

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

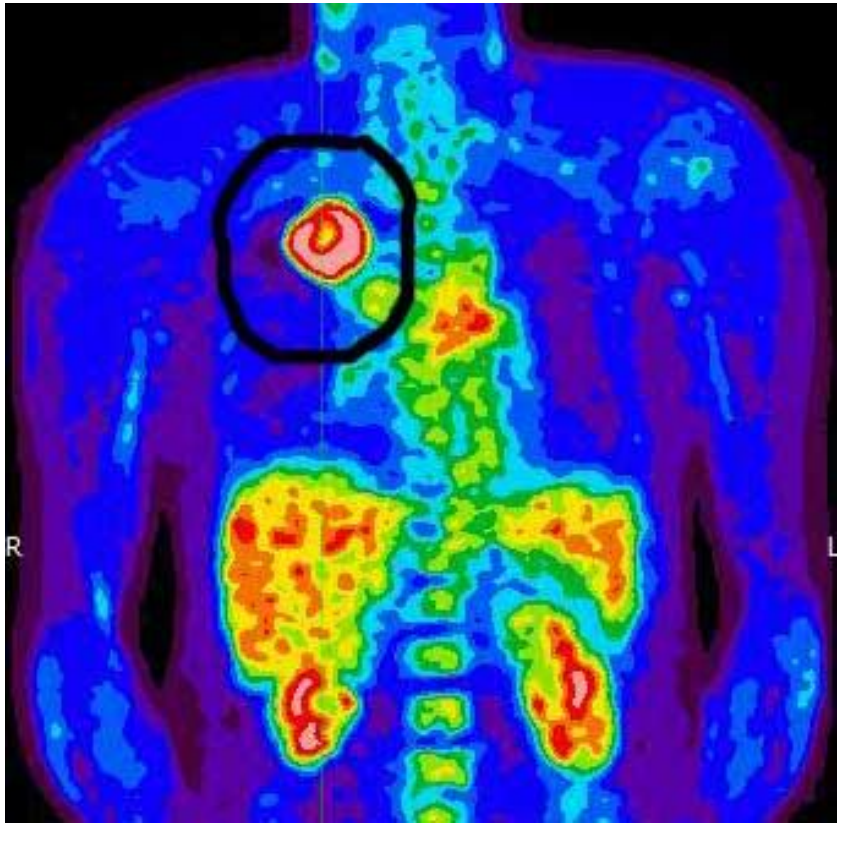


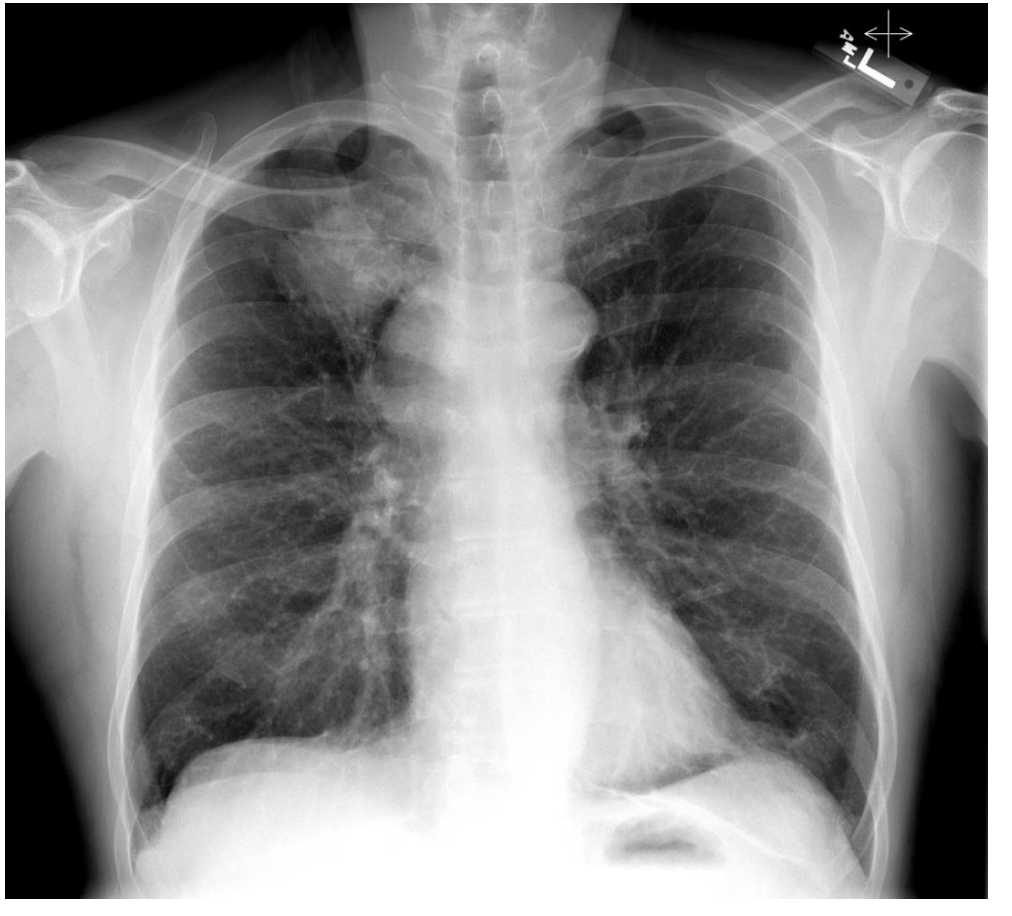




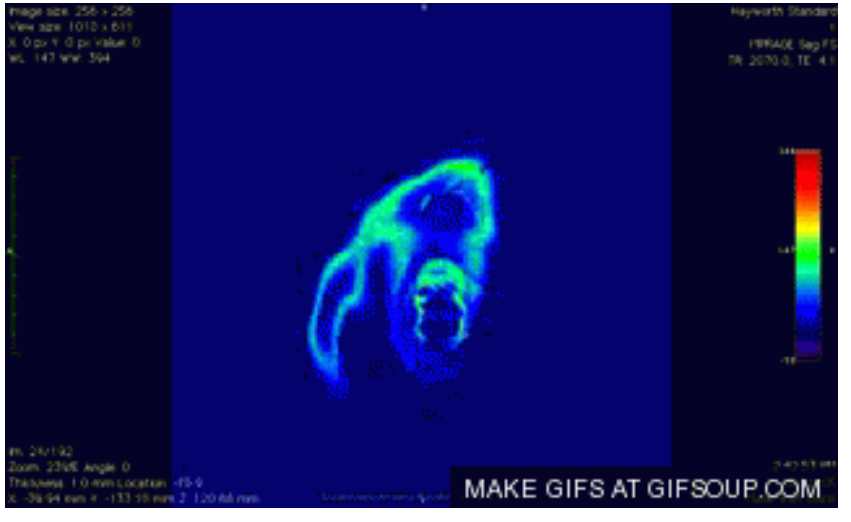
PET – zobrazení nádorů

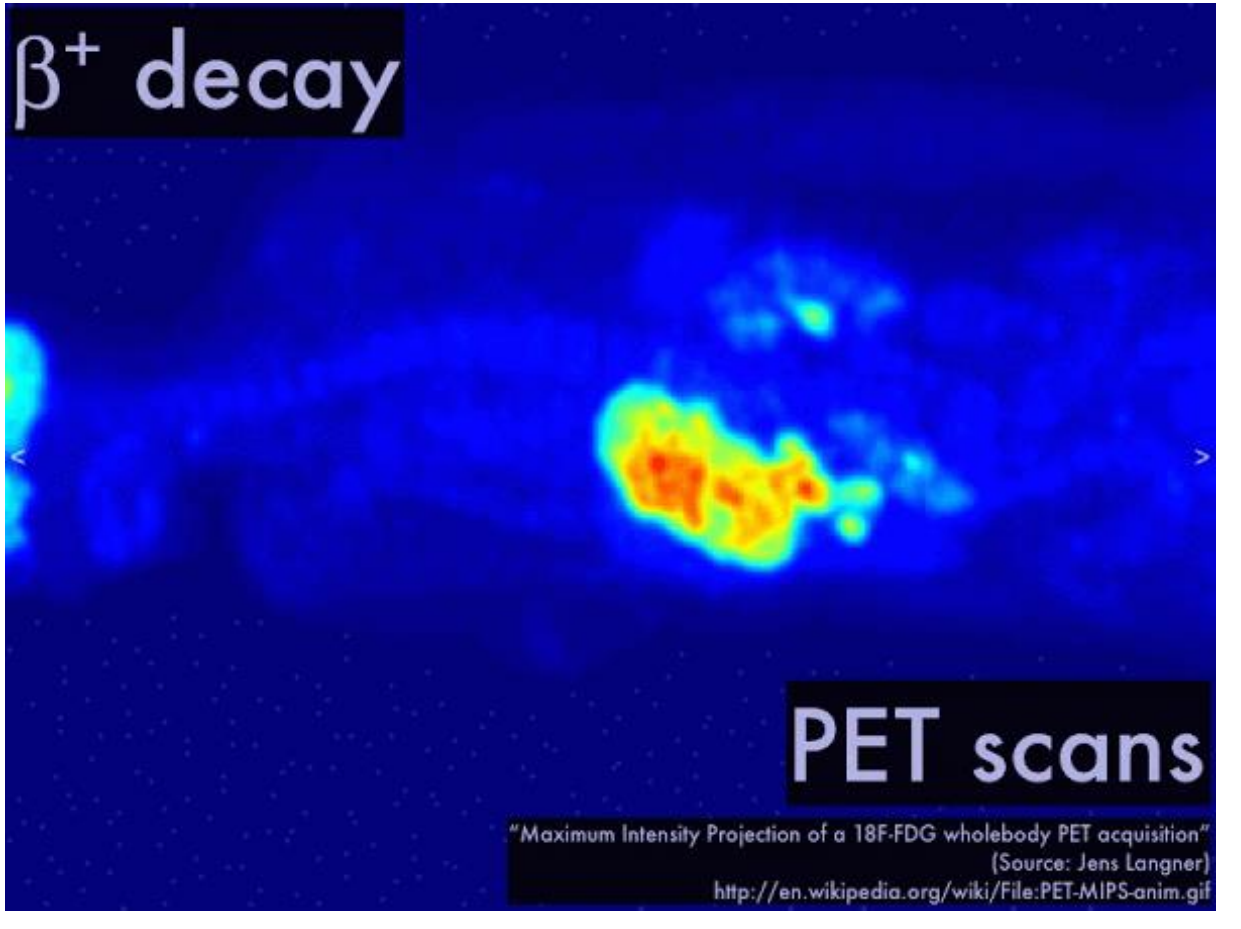
- FDG – ^{18}F (označená glukóza)
- rakovinové buňky mají vyšší metabolickou aktivitu → vyšší spotřeba glukózy





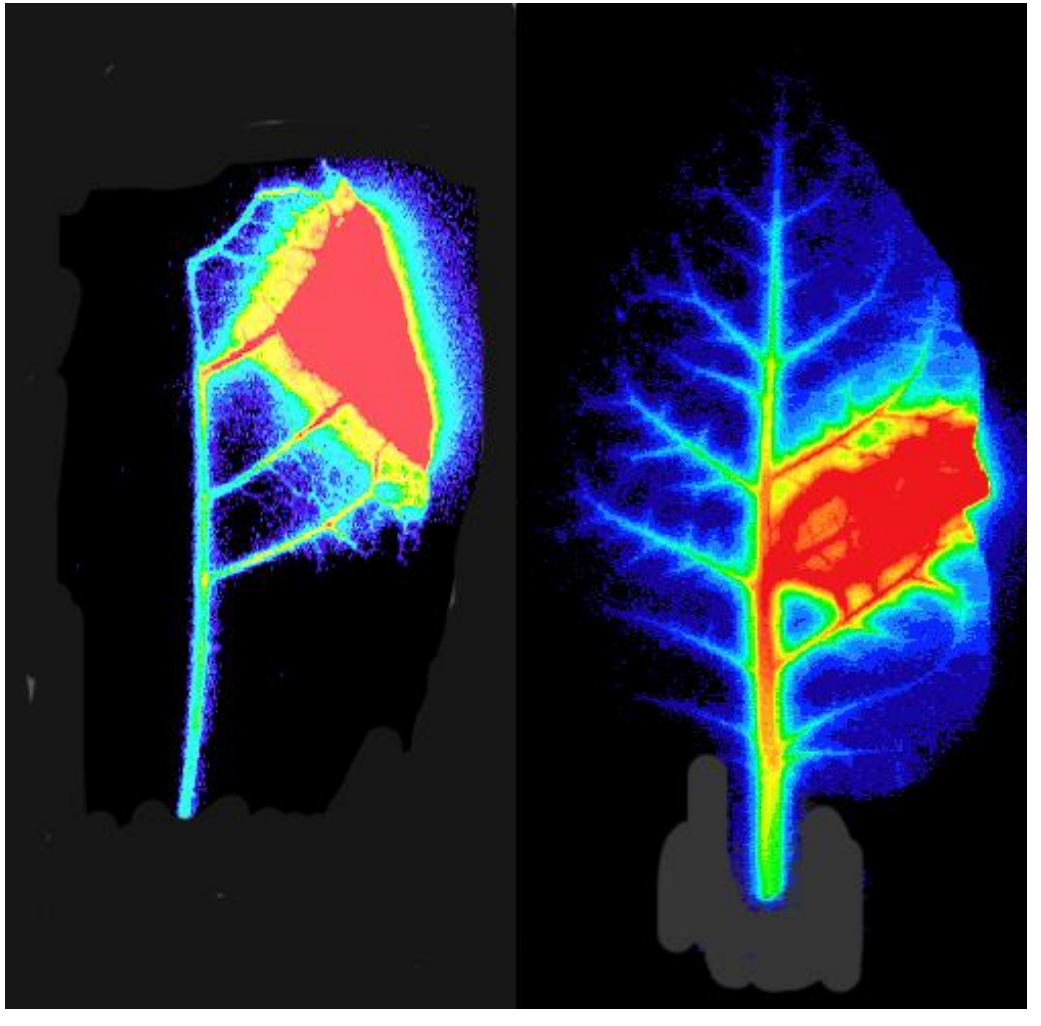
Pozitronová emisní tomografie (PET – FDG)

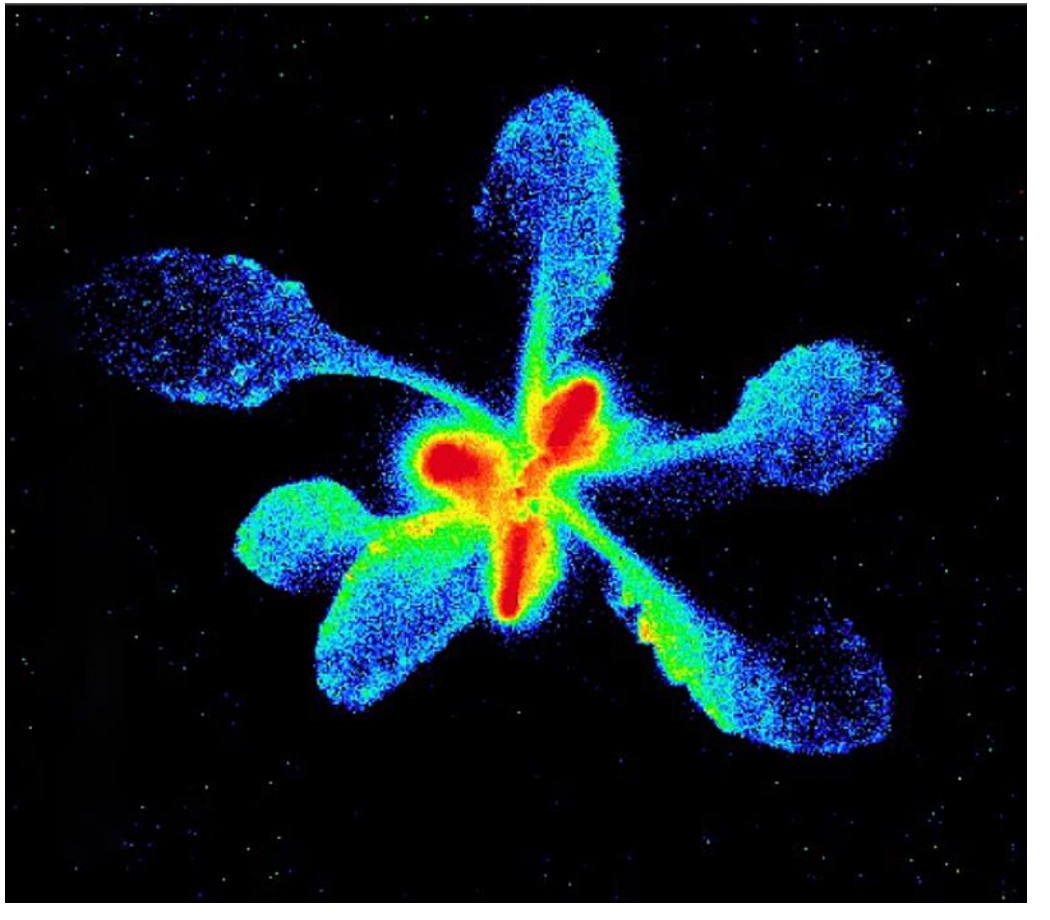




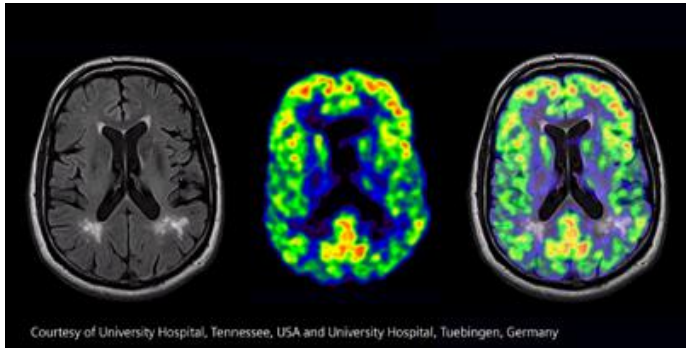
Pozitronová emisní tomografie (PET)

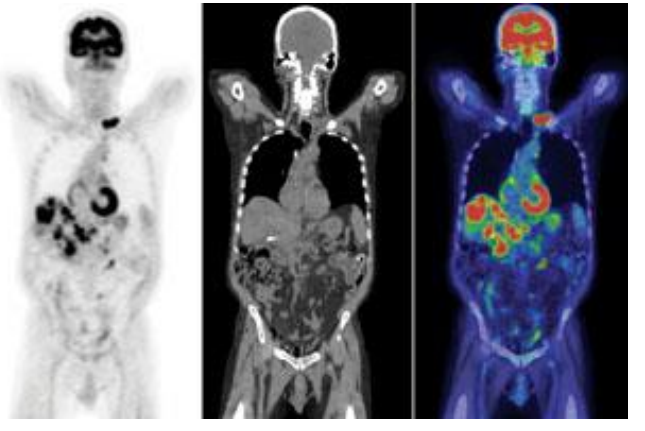
- ukládání cukru v rostlinách (^{11}C, $T_{1/2}$ = 20.4 min)

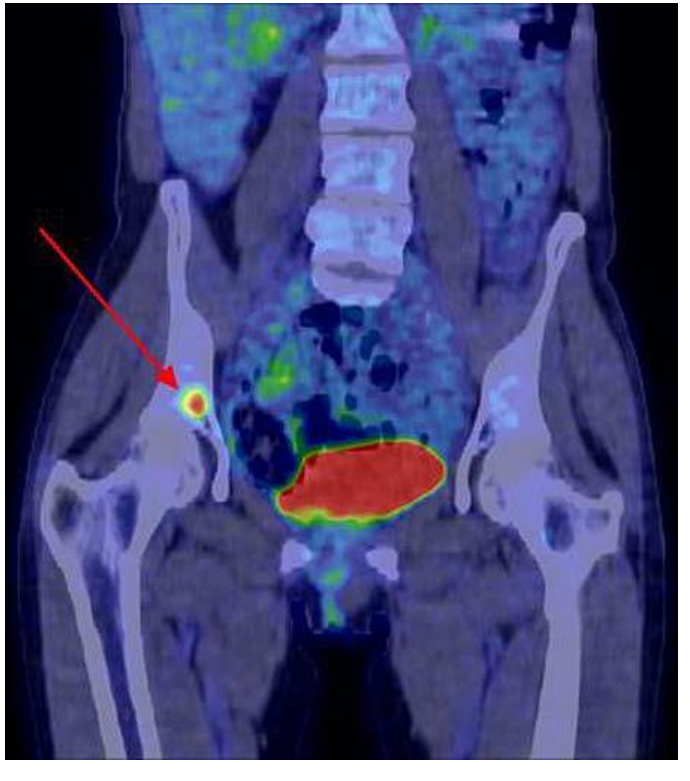


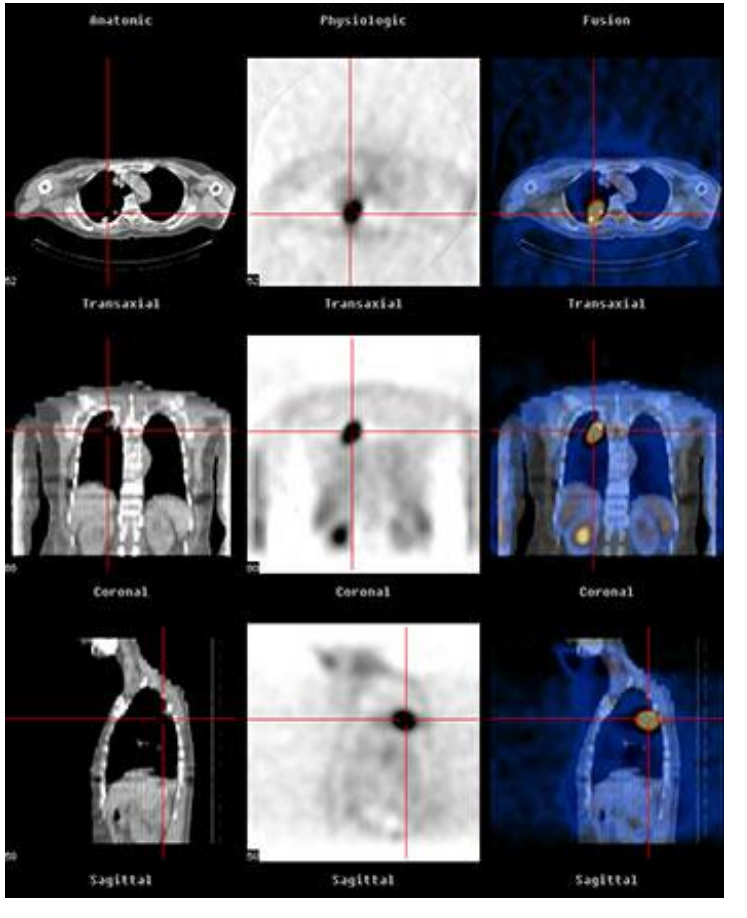


Pozitronová emisní tomografie (PET) kombinovaná s CT

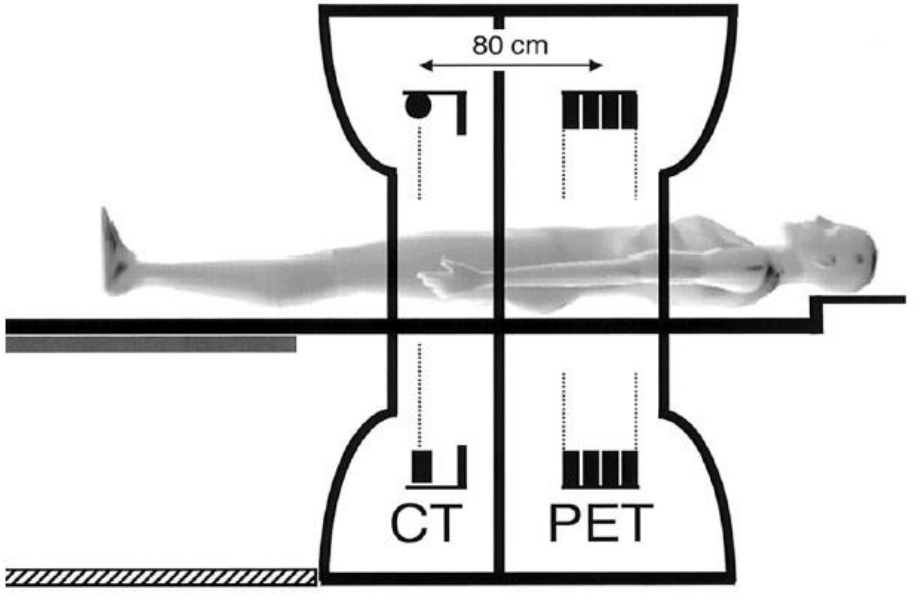






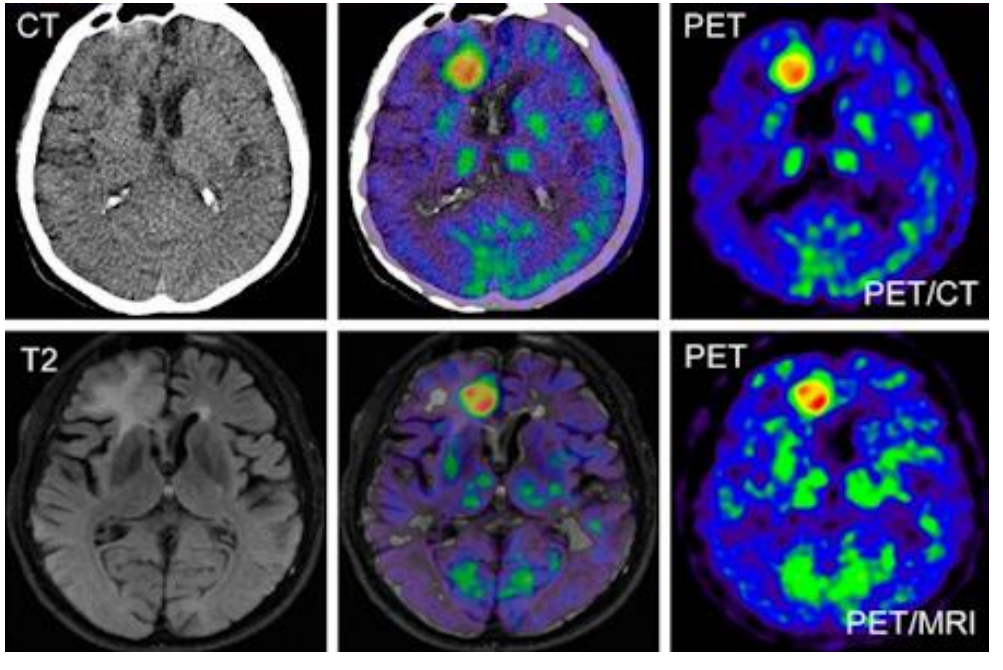


Pozitronová emisní tomografie (PET) kombinovaná s CT



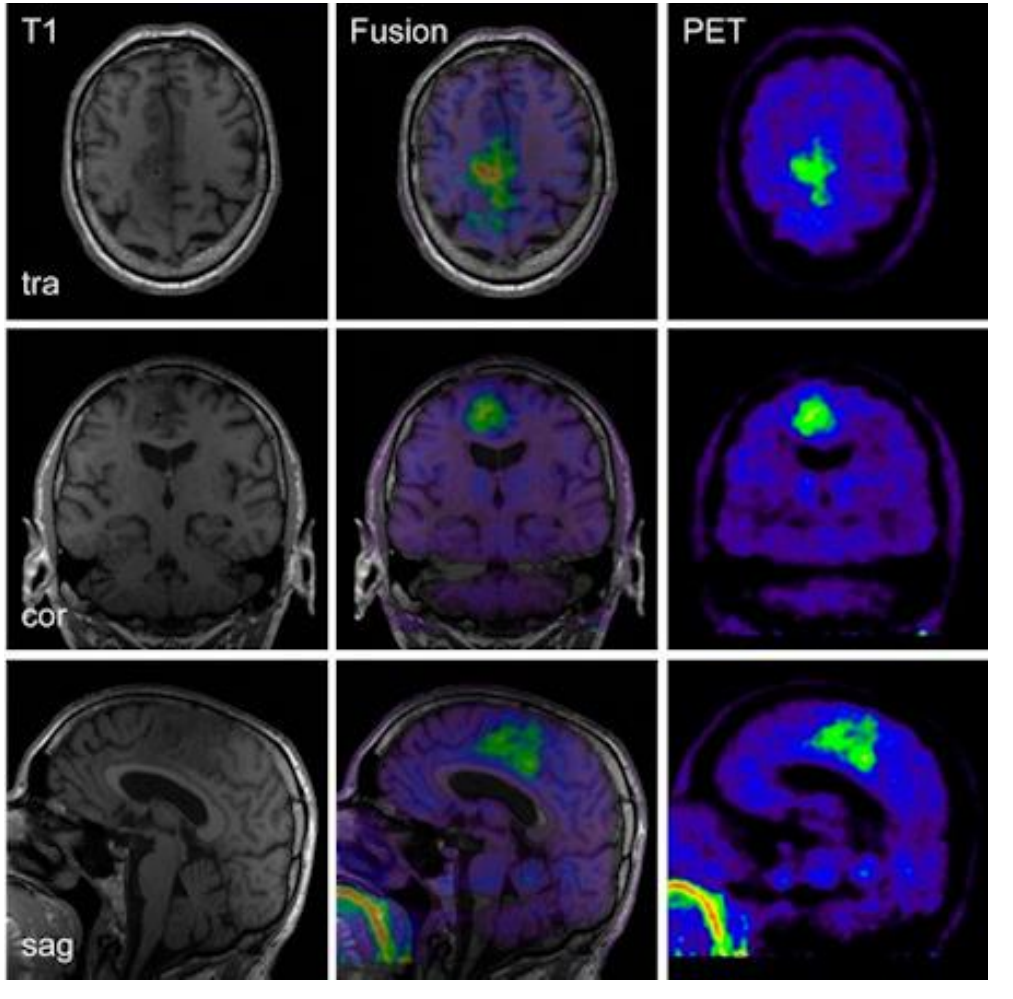
Pozitronová emisní tomografie (PET) kombinovaná s MRI

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)