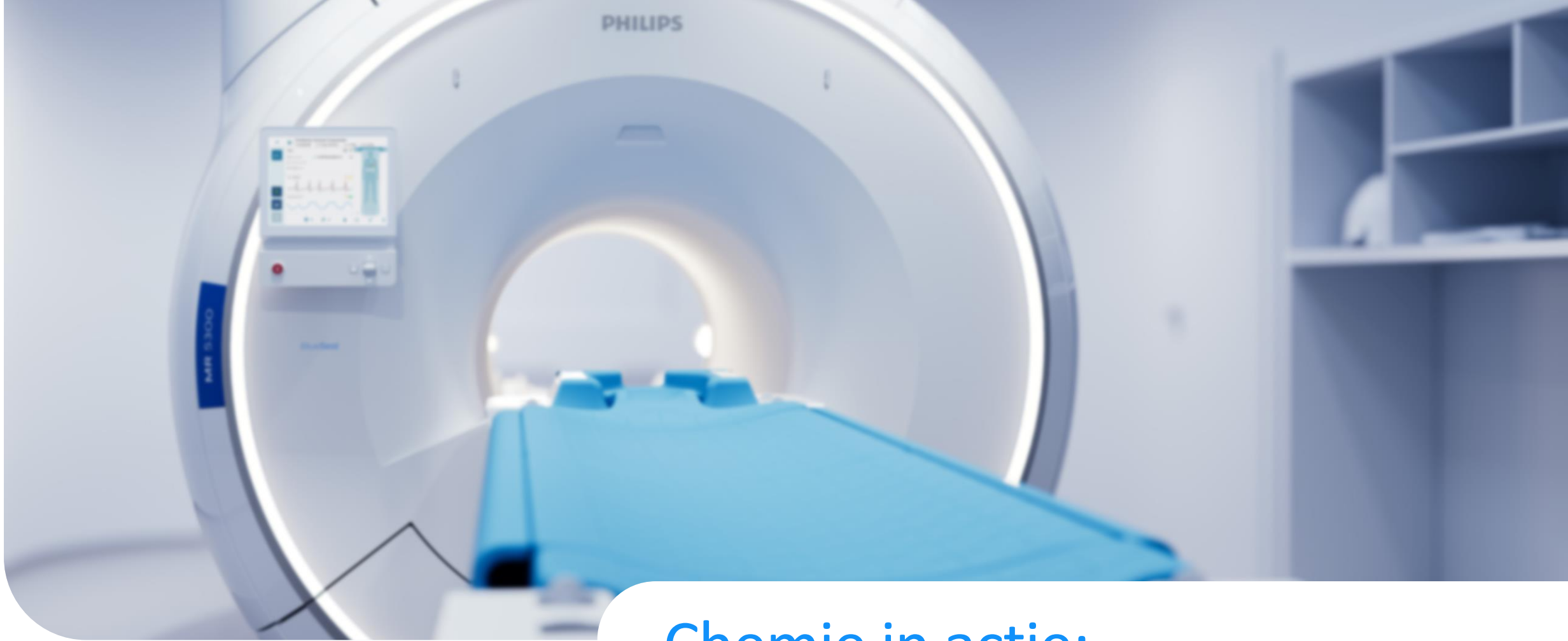




Prof. dr. Jeanine Prompers
jeanine.prompers@maastrichtuniversity.nl



Maastricht University



Maastricht UMC+

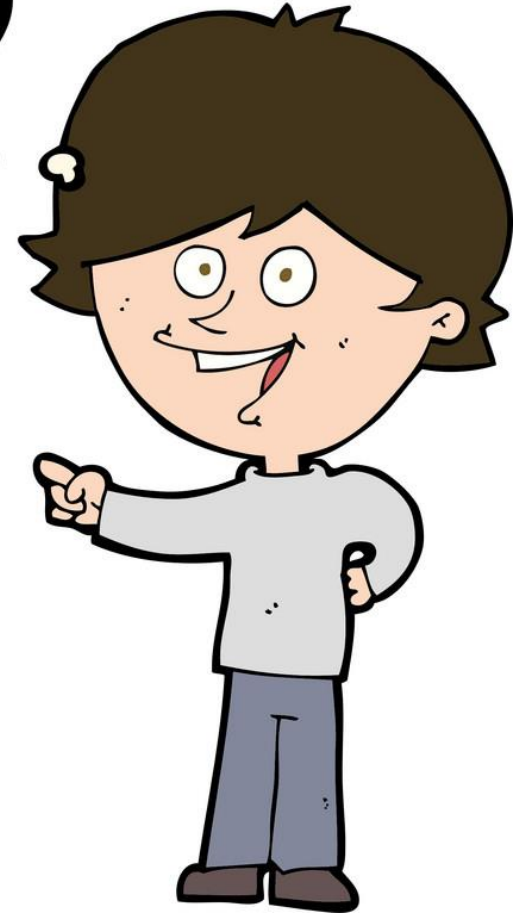
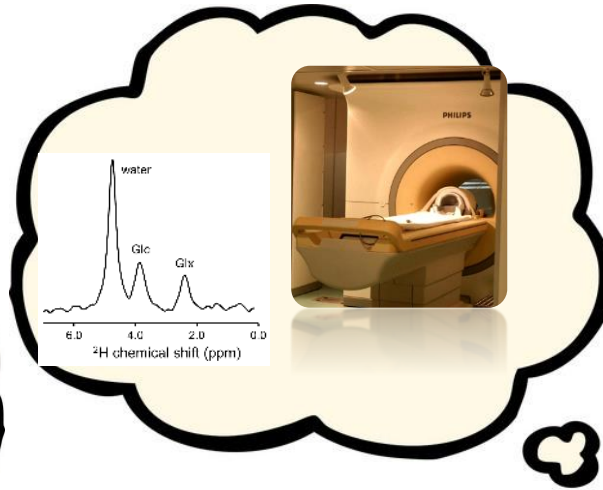
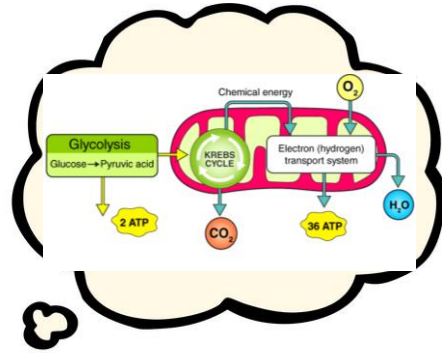


UMC Utrecht

Chemie in actie:

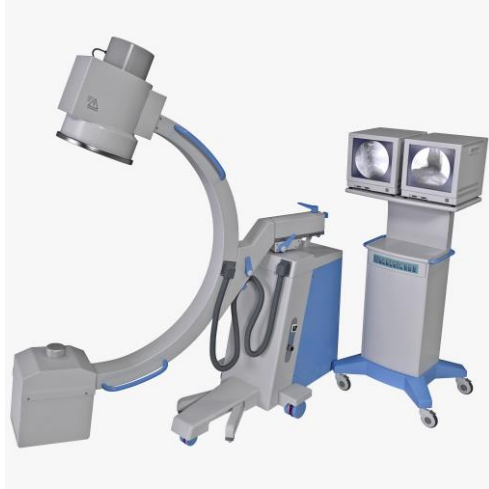
Ontdek de magie van metabole beeldvorming met MRI

Wie ben ik en waarom ben ik hier?



Beeldvorming in de kliniek

X-ray



CT



Echo



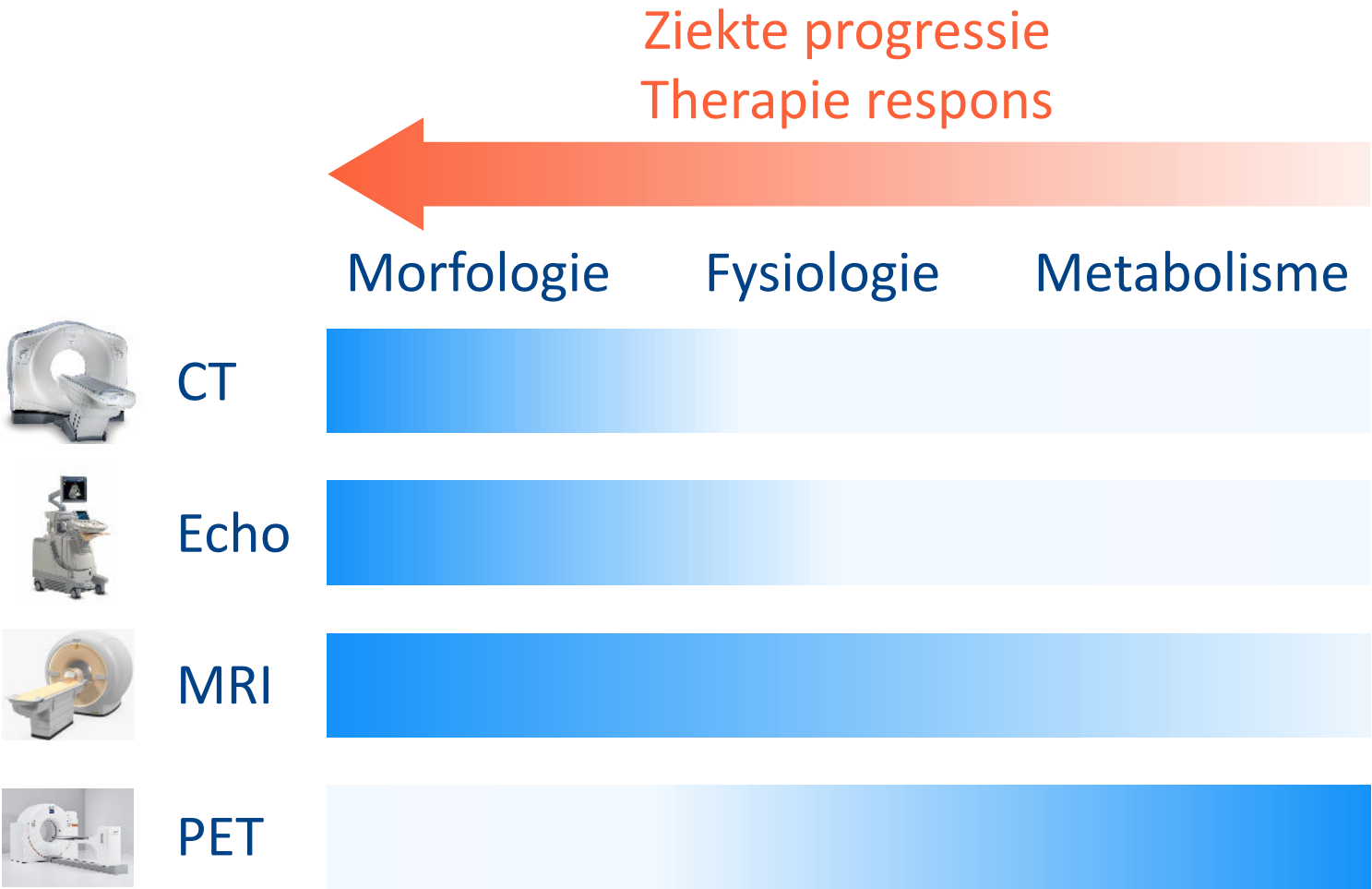
MRI



PET



Beeldvorming in de kliniek

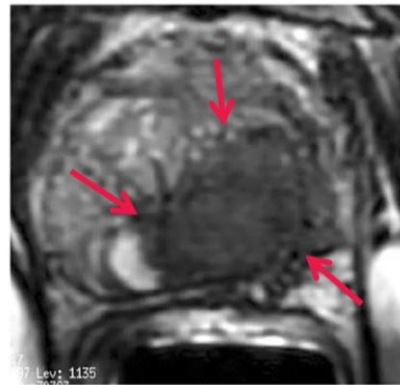


Monitoring prostaatkanker therapie: morfologie

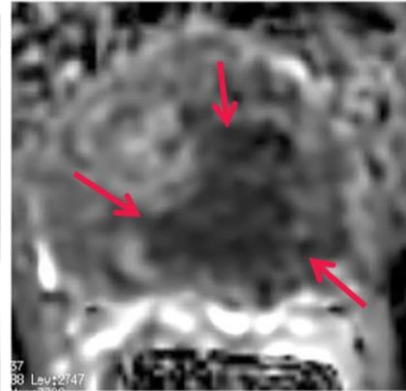
Conventionele MRI

Voor
therapie

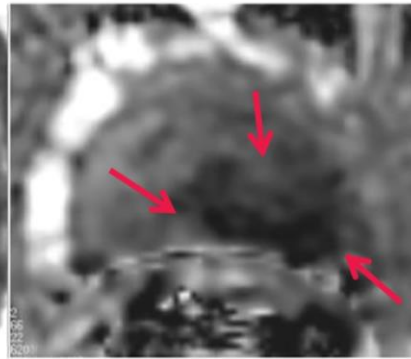
T2 wt. Image



ADC Image



Na 6
weken
therapie



Monitoring prostaatkanker therapie: metabolisme

Conventionele MRI

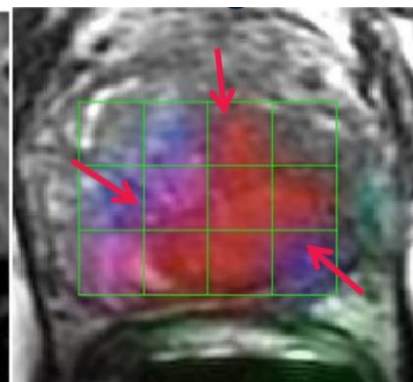
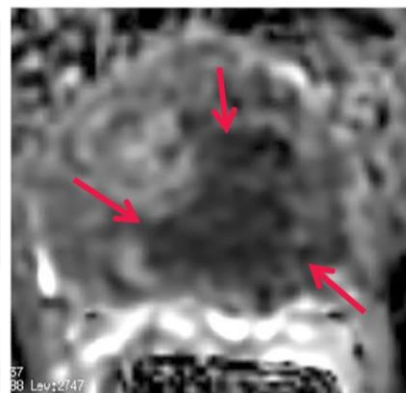
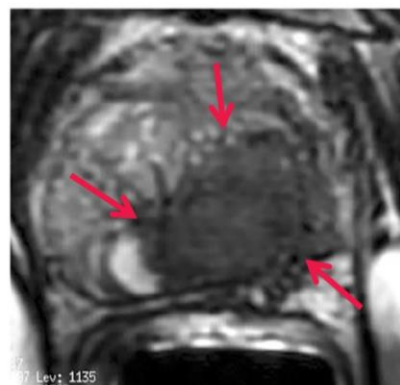
Metabole MRI

Pyruvate-to-lactate
metabolic flux

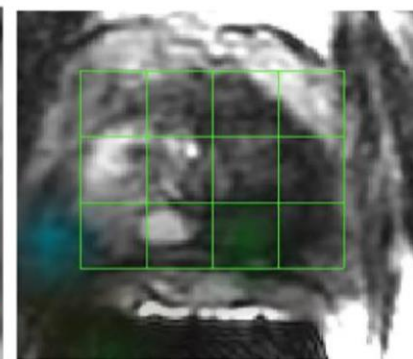
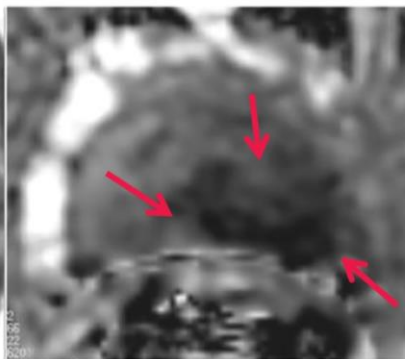
T2 wt. Image

ADC Image

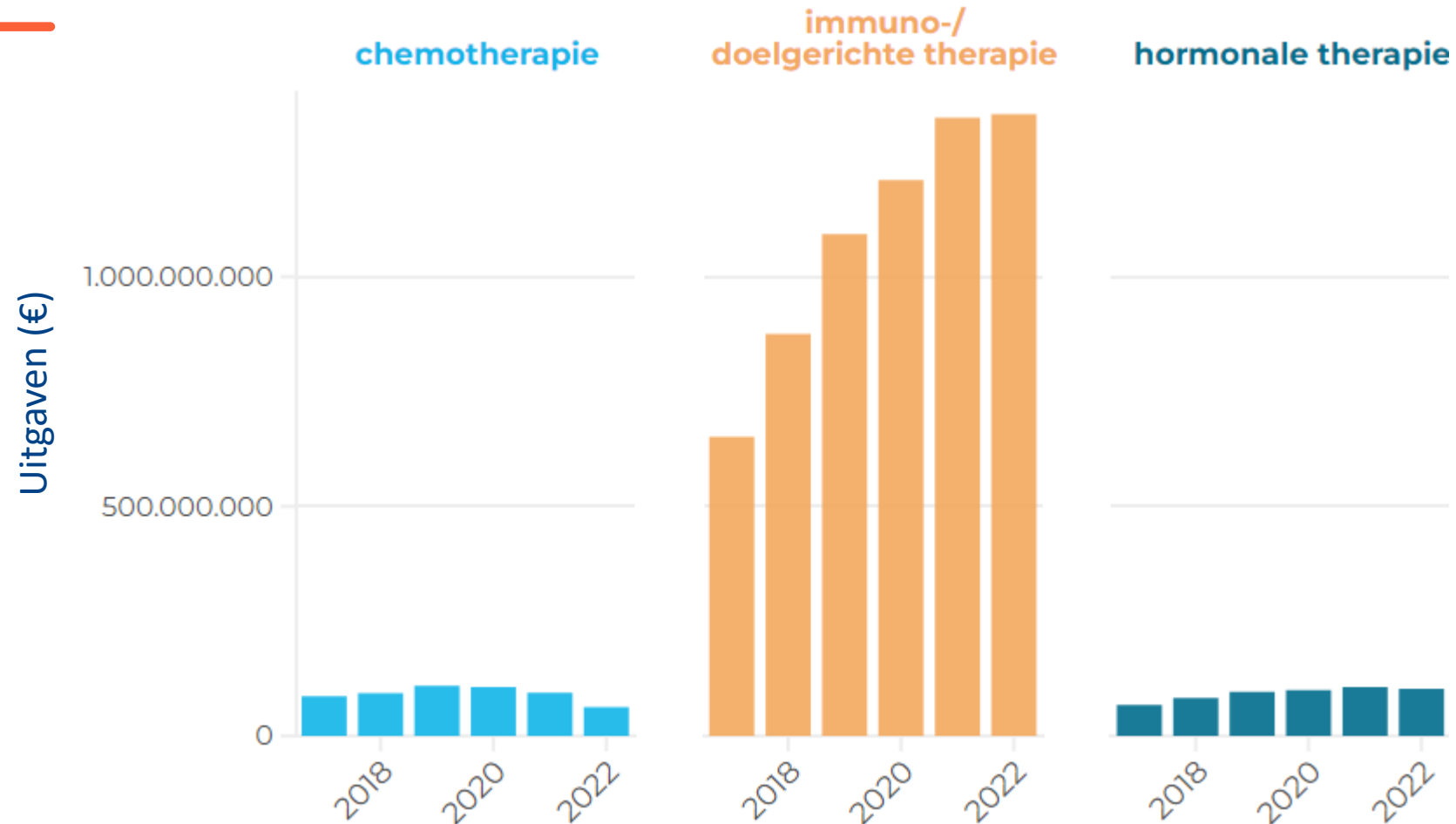
Voor
therapie



Na 6
weken
therapie

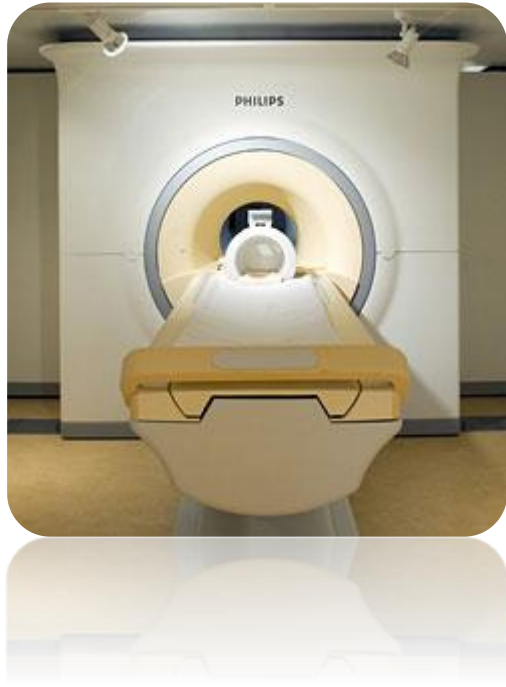


Uitgaven kankermedicatie Nederland

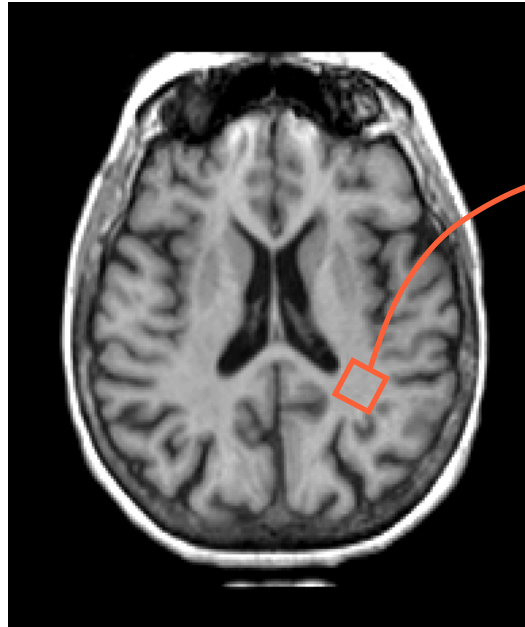


- Nieuwe (dure) behandelingen niet effectief in elke patiënt
→ Vroege voorspelling van therapierespons belangrijk

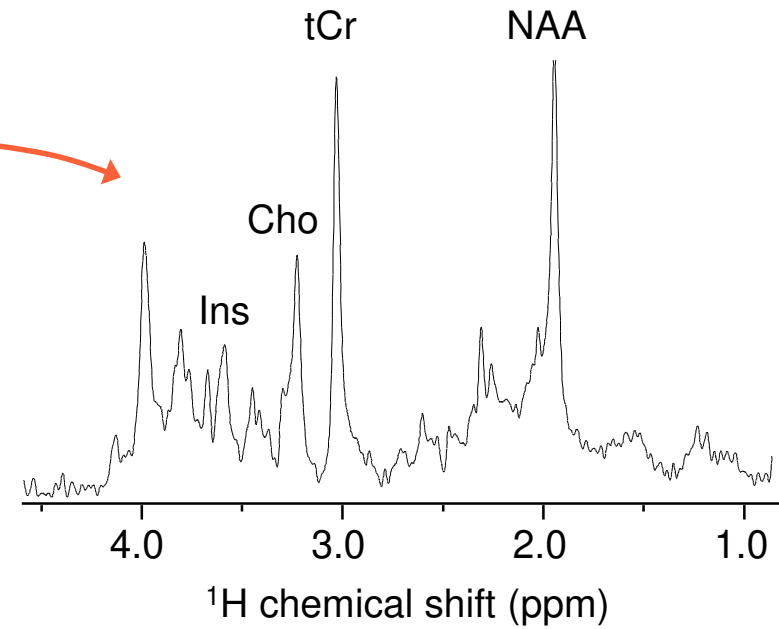
Van MRI naar metabole beeldvorming



MR imaging
water

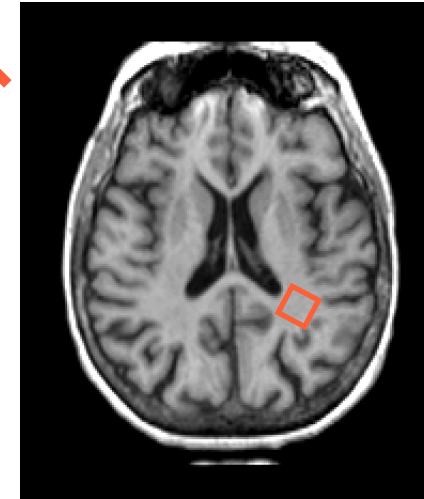
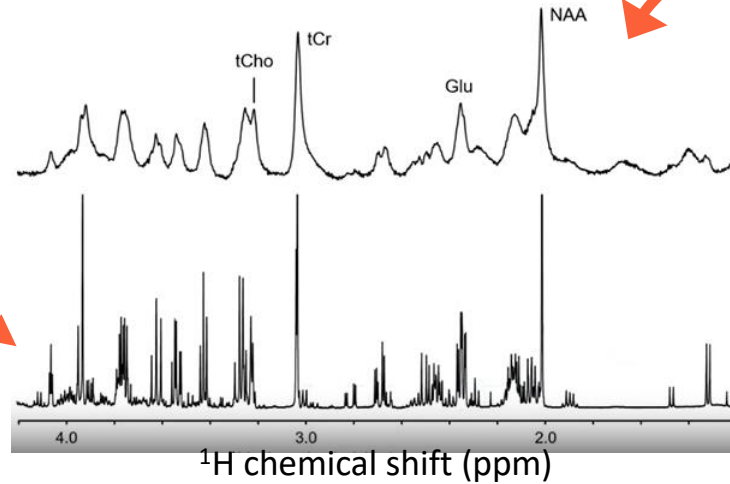
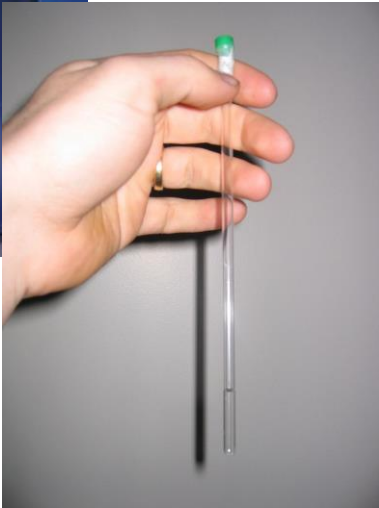


MR spectroscopie
metabolieten



Nucleaire Magnetische Resonantie Spectroscopie

NMR



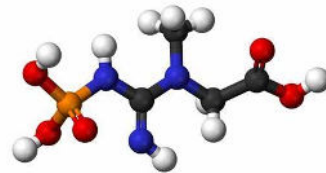
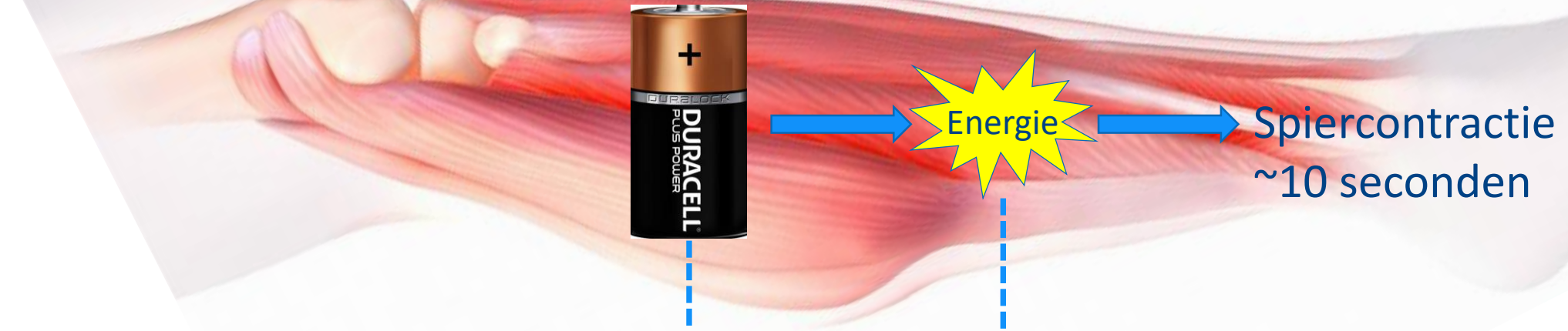
In vivo MRS



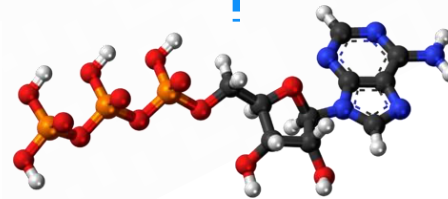
Hoeveel seconden kun je voluit sprinten?



Energie in de spier

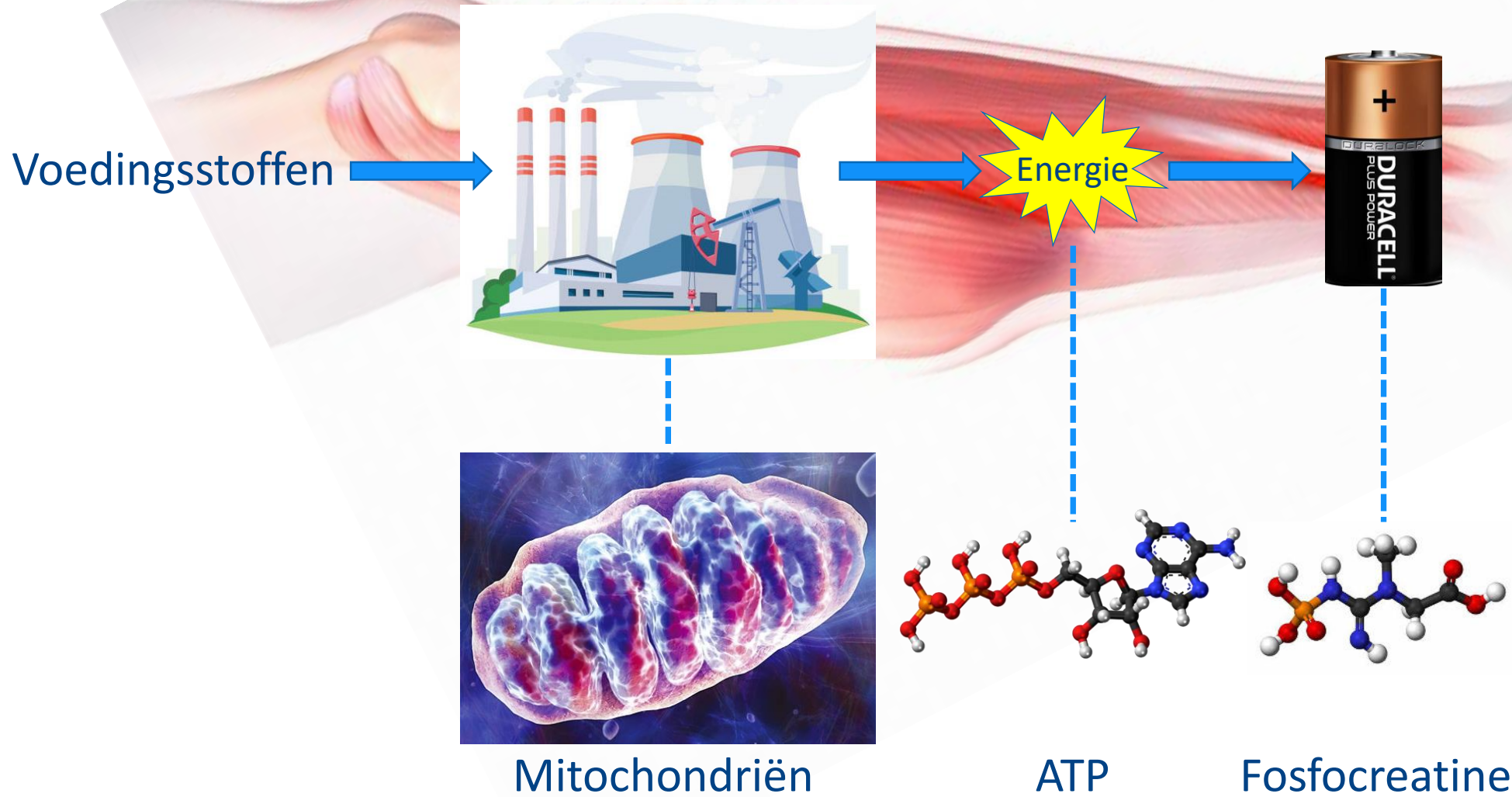


Fosfocreatine

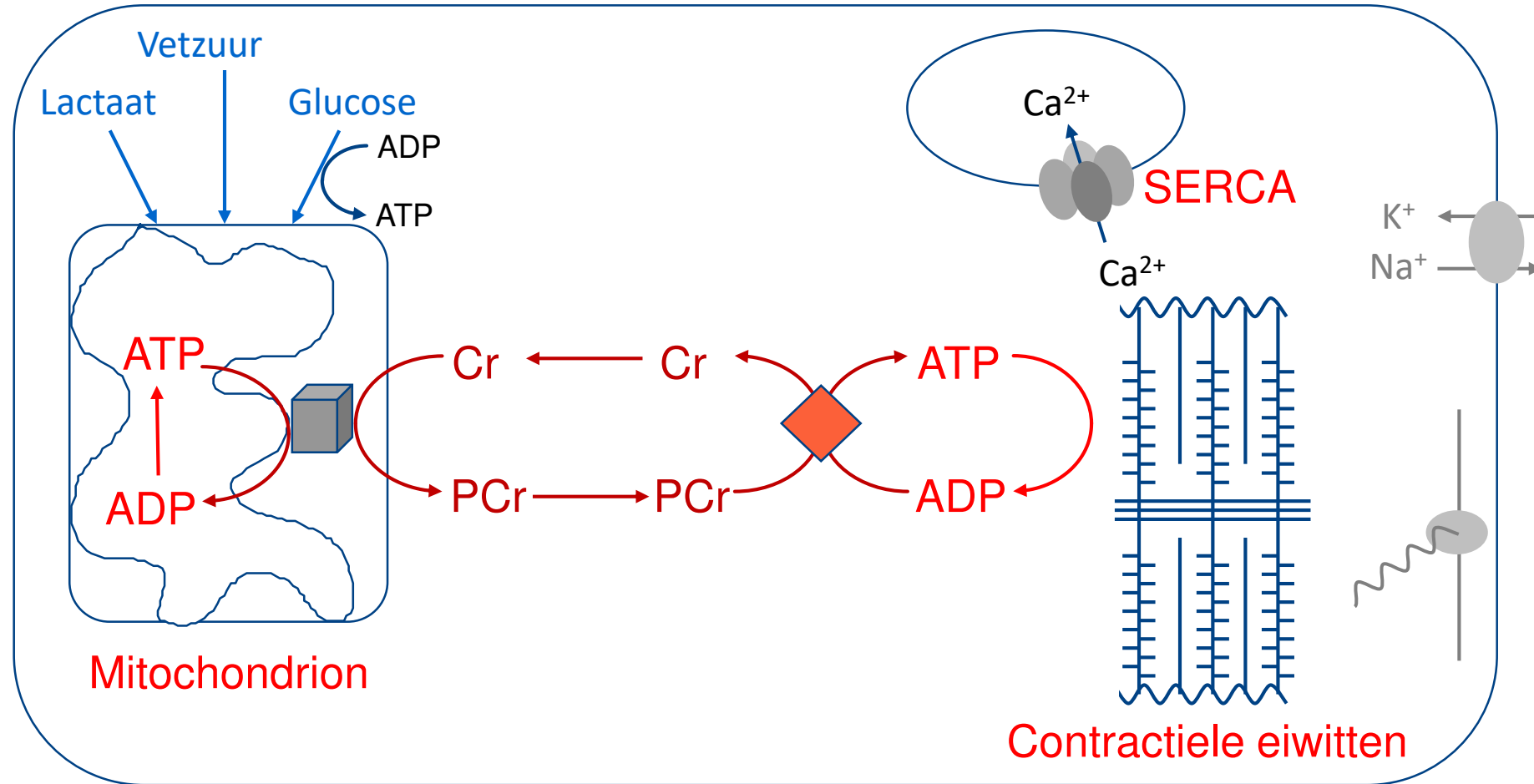


ATP

Energie in de spier



Energie in de spier



Mitochondriaal creatine kinase



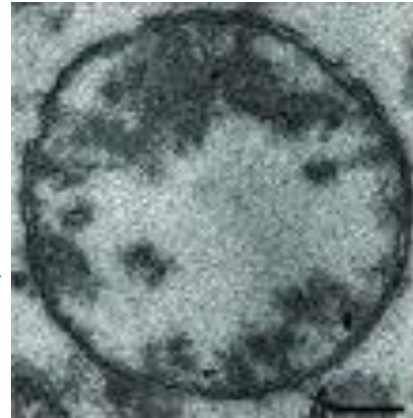
Cytosolisch creatine kinase

Mitochondriën: energiecentrales van de spier



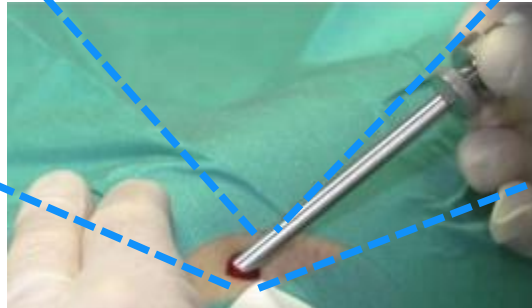
Gezonde mitochondriën

- Sporten en bewegen



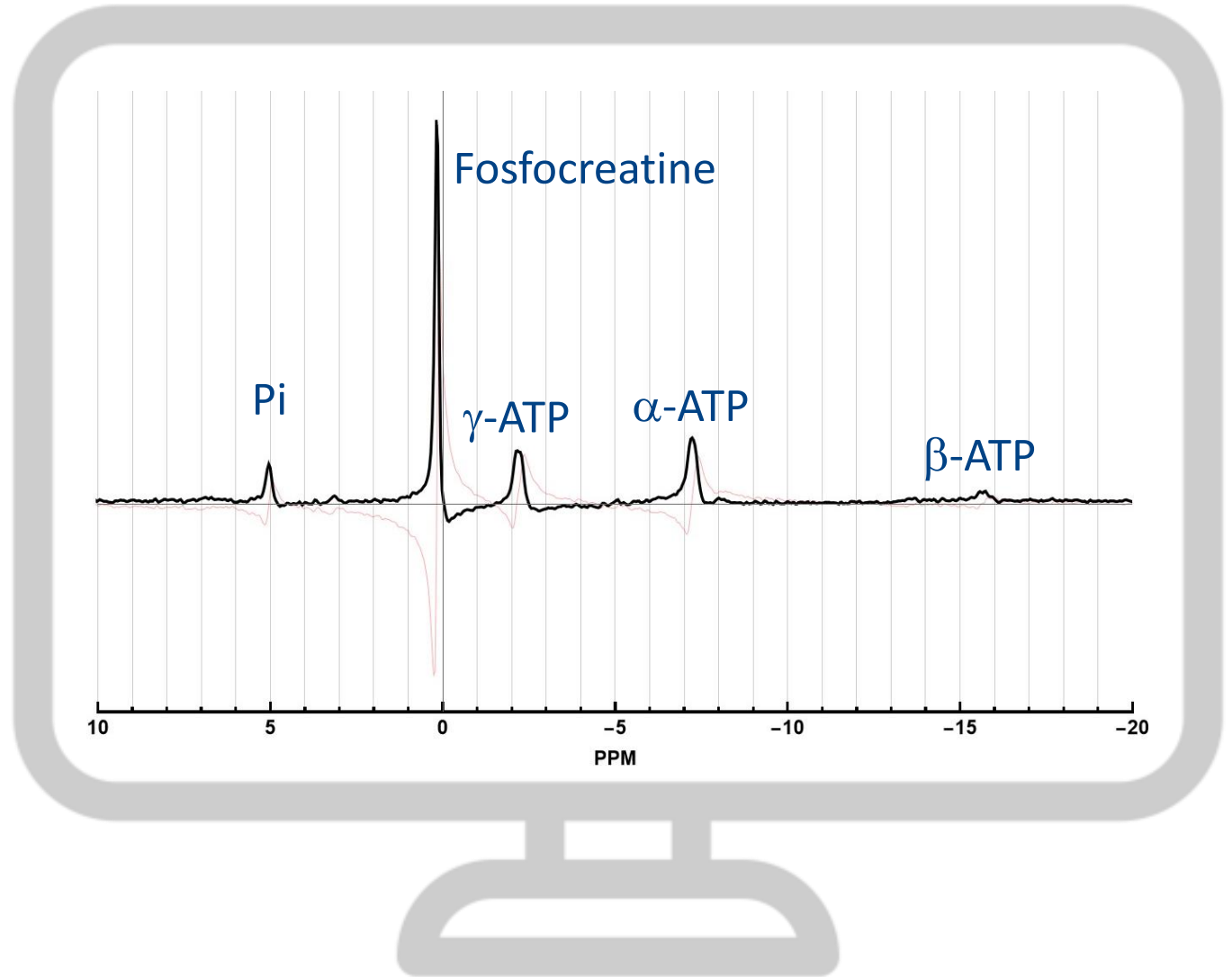
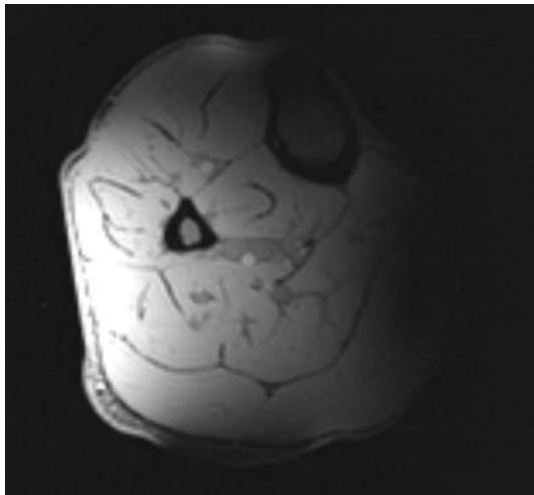
Beschadigde mitochondriën

- Spierziekten
- Diabetes
- Hartfalen
- Sommige medicijnen tegen kanker
- ...

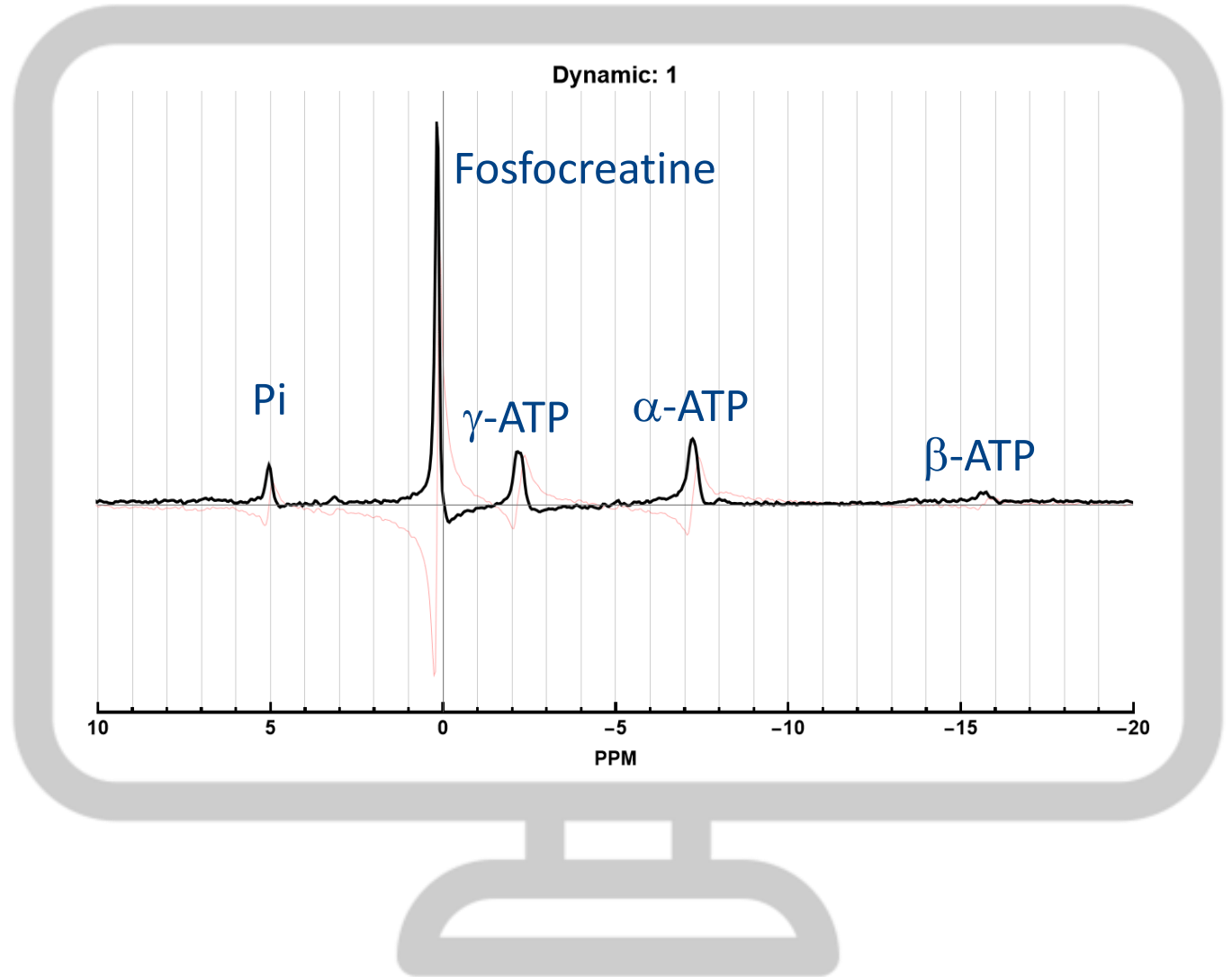
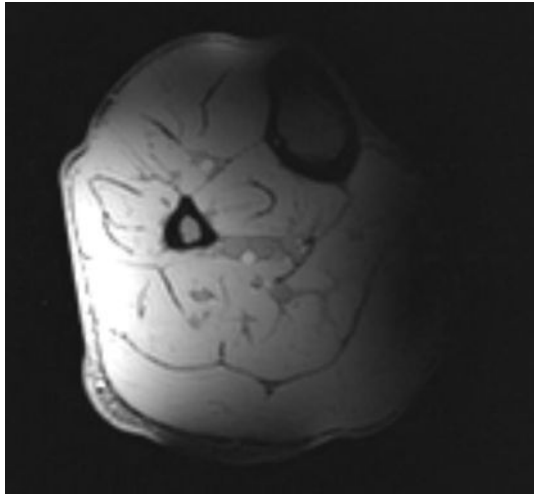


Spier biopt

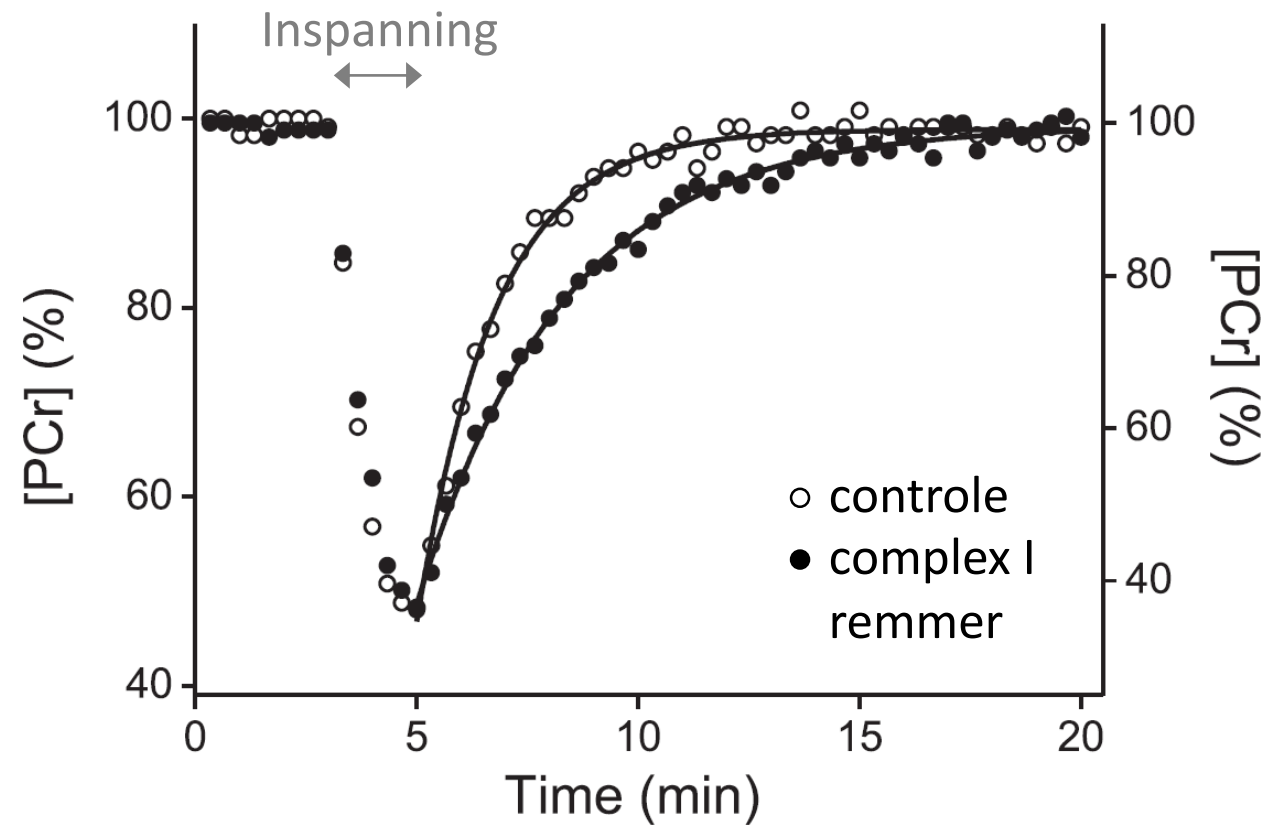
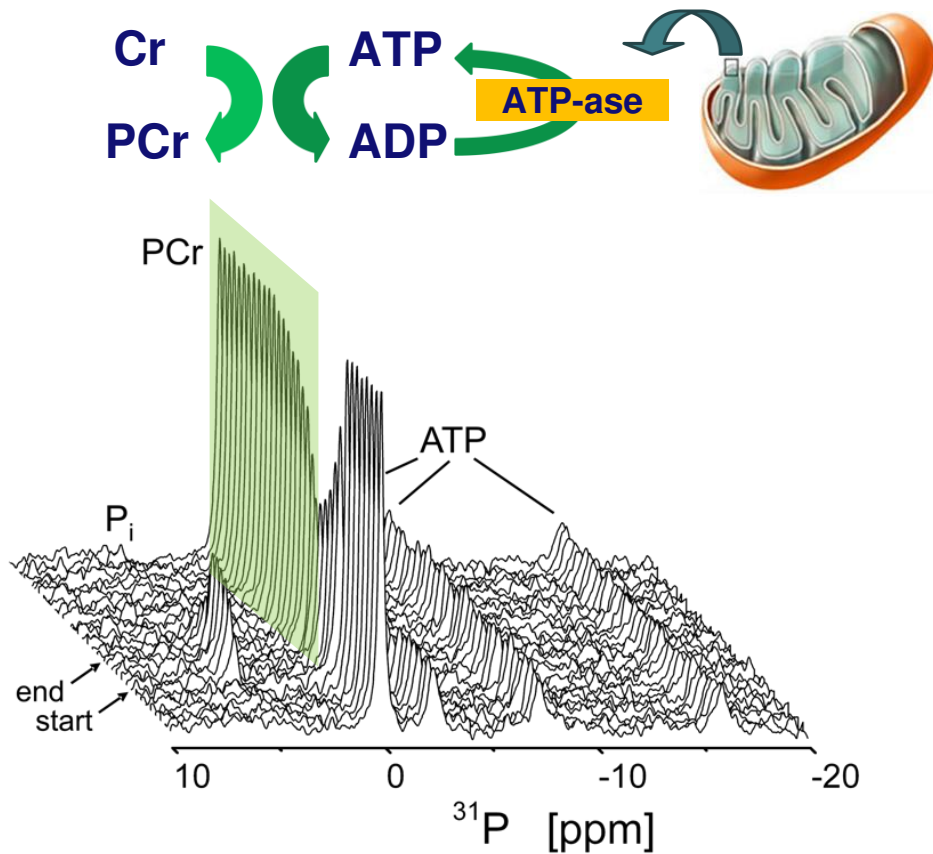
De werking van mitochondriën meten met ^{31}P MRS



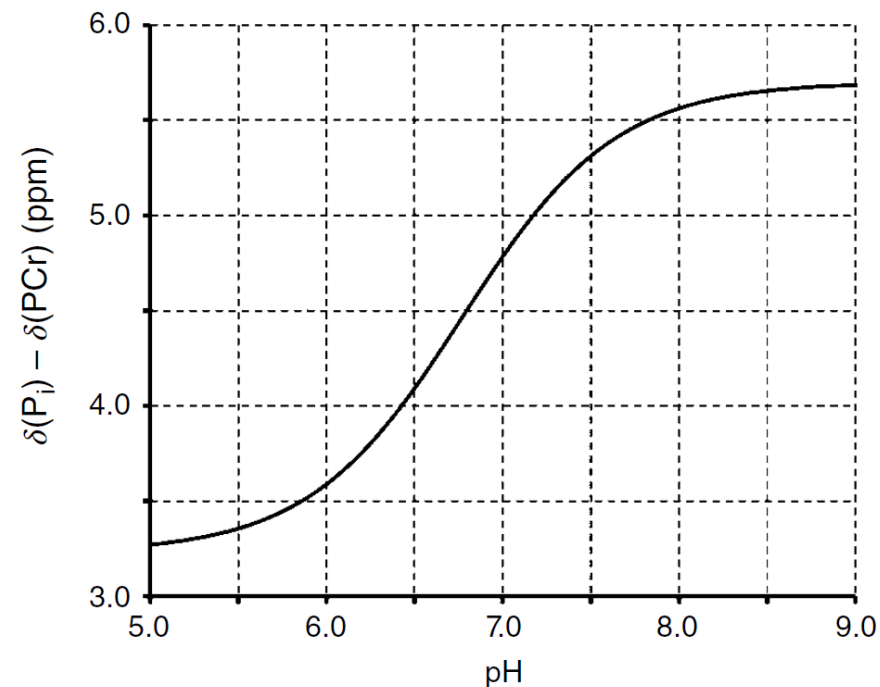
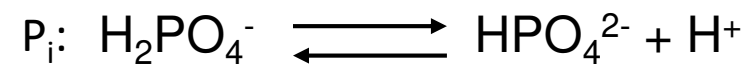
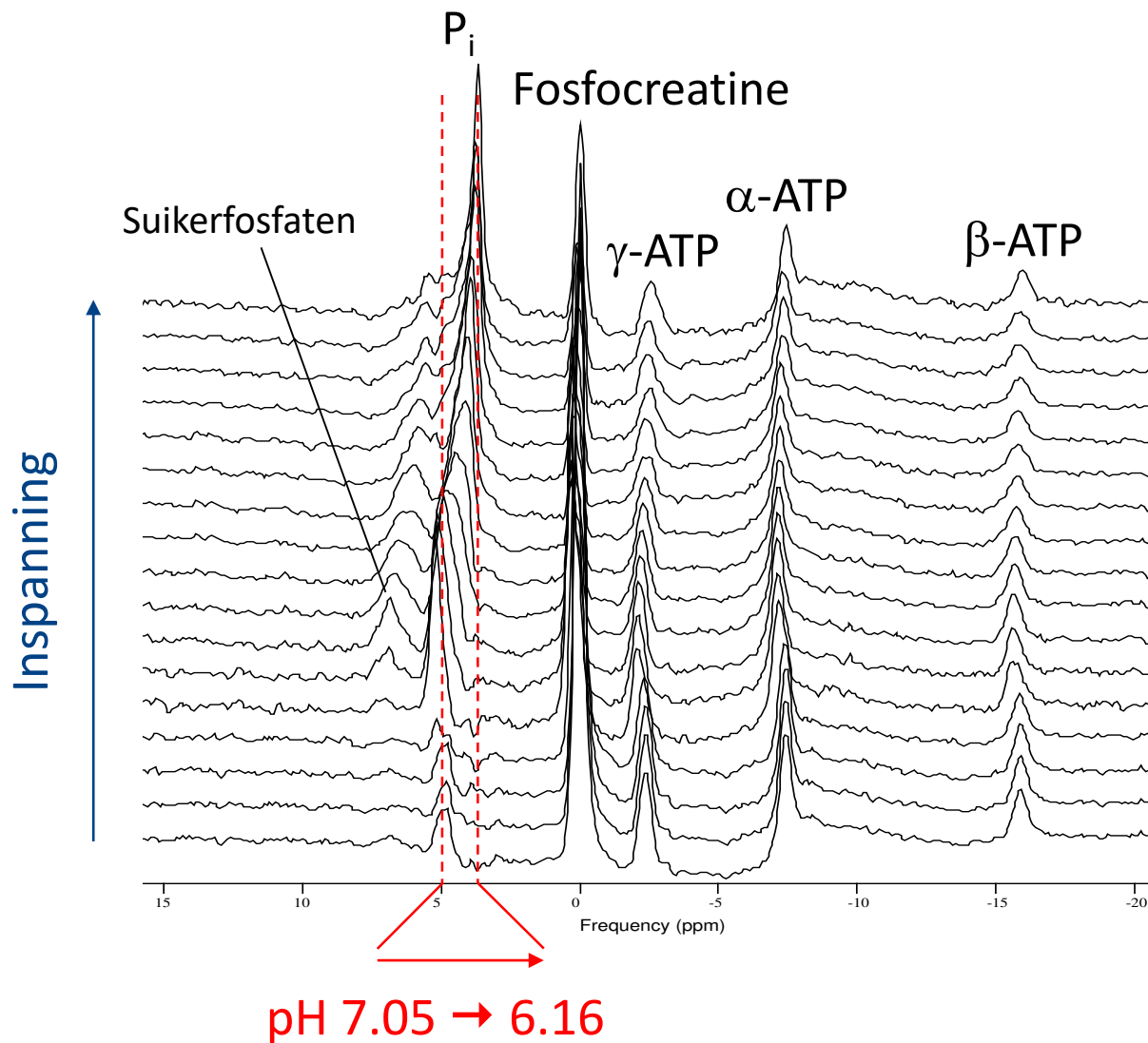
De werking van mitochondriën meten met ^{31}P MRS



De werking van mitochondriën meten met ^{31}P MRS



Verzuring van de spier



$$\text{pH} = \text{pK}_A + \log \left(\frac{\delta - \delta_{\text{HA}}}{\delta_A - \delta} \right)$$

$$\text{pK}_A = 6.77$$

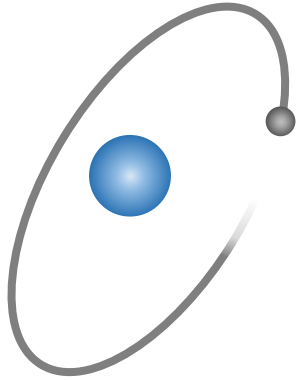
$$\delta_{\text{HA}} = 3.23 \text{ ppm}, \delta_A = 5.70 \text{ ppm}$$

De werking van mitochondriën meten met ^{31}P MRS

Onderzoek naar:

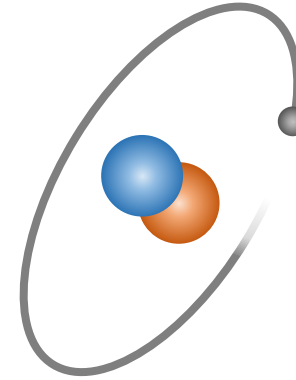
- Trainingsprogramma's voor (top)sporters
- Effectiviteit van nieuwe (dure) medicijnen voor spierziekten
- Bijwerkingen van bepaalde behandelingen voor kanker
en hoe we die bijwerkingen kunnen voorkomen, bijv. met beweegprogramma's

Deuterium



Proton – ^1H

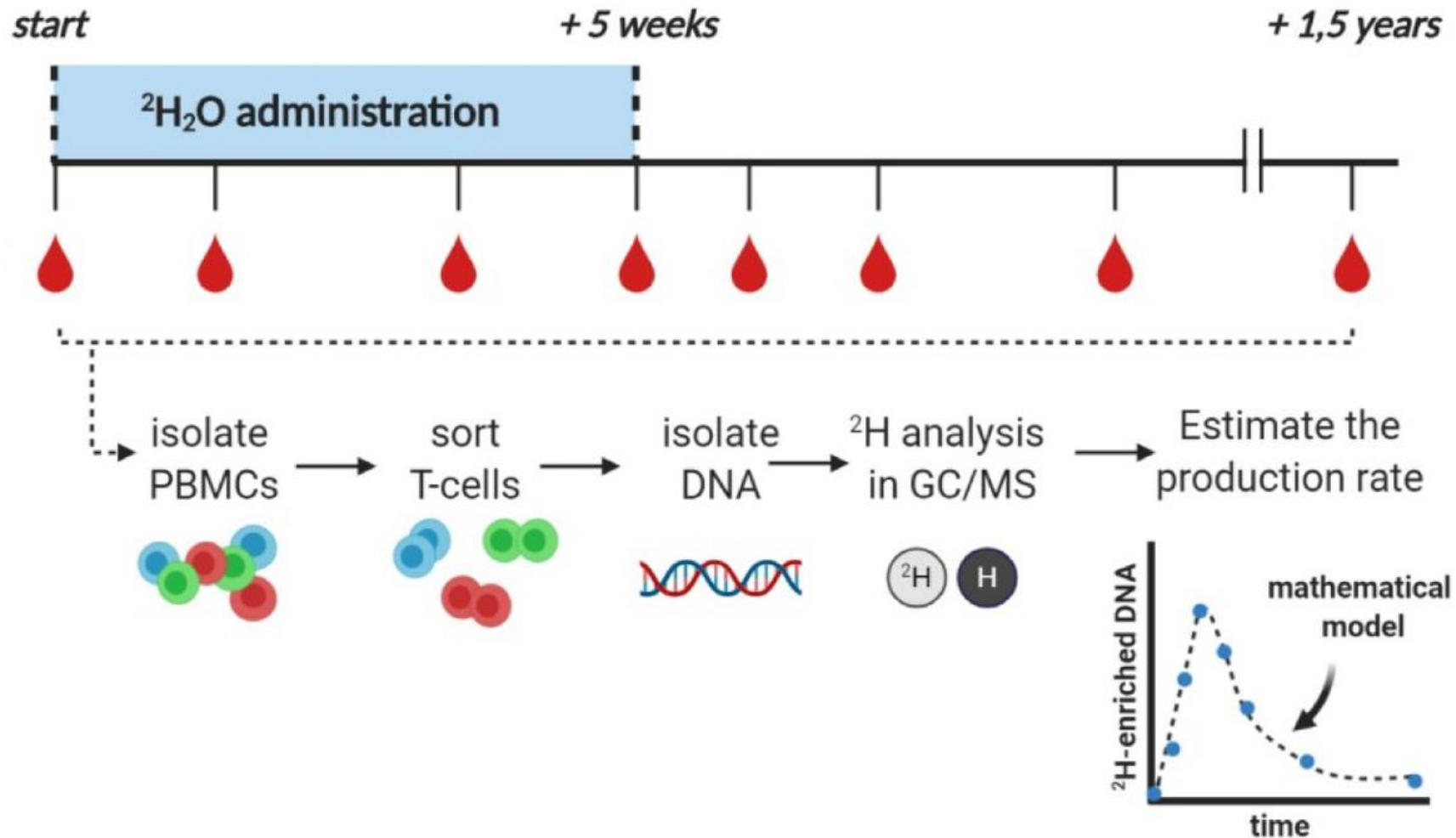
- Stabiel
- Kernspin $\frac{1}{2}$
- Natuurlijk voorkomen: 99.99 %



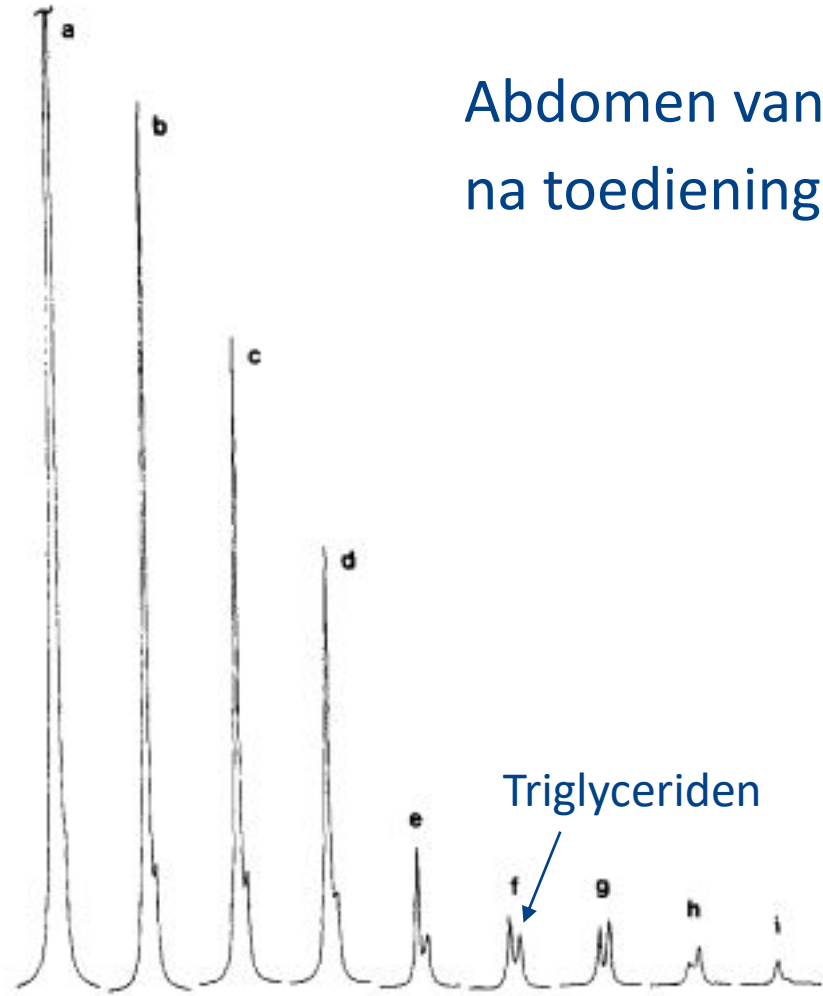
Deuterium – ^2H of D

- Stabiel
- Kernspin 1
- Natuurlijk voorkomen: 0.0115 %

Deuterium in biomedisch onderzoek

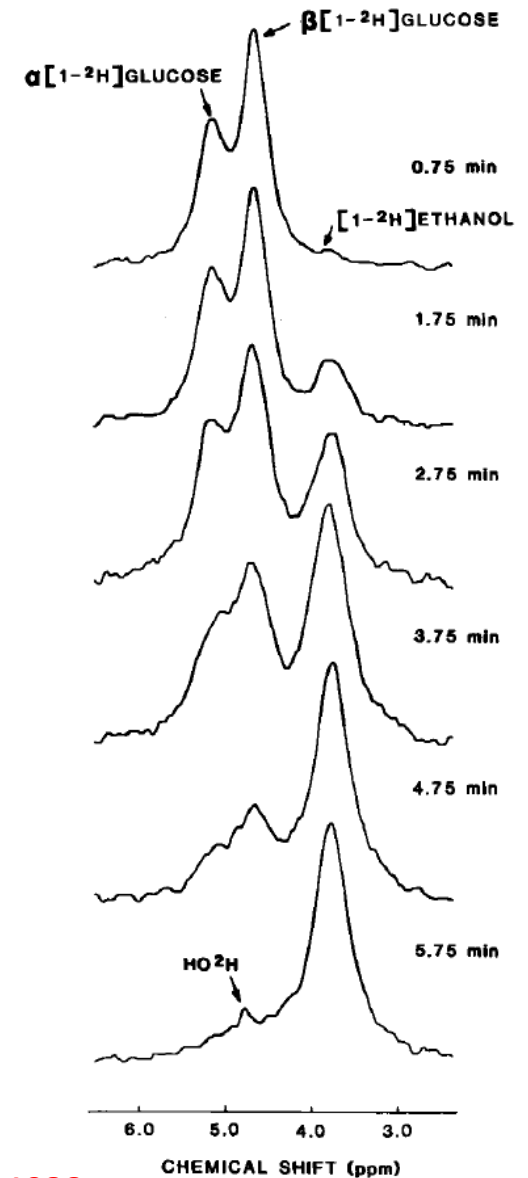


Meten van metabolisme met ^2H MRS



Abdomen van muis
na toediening D_2O

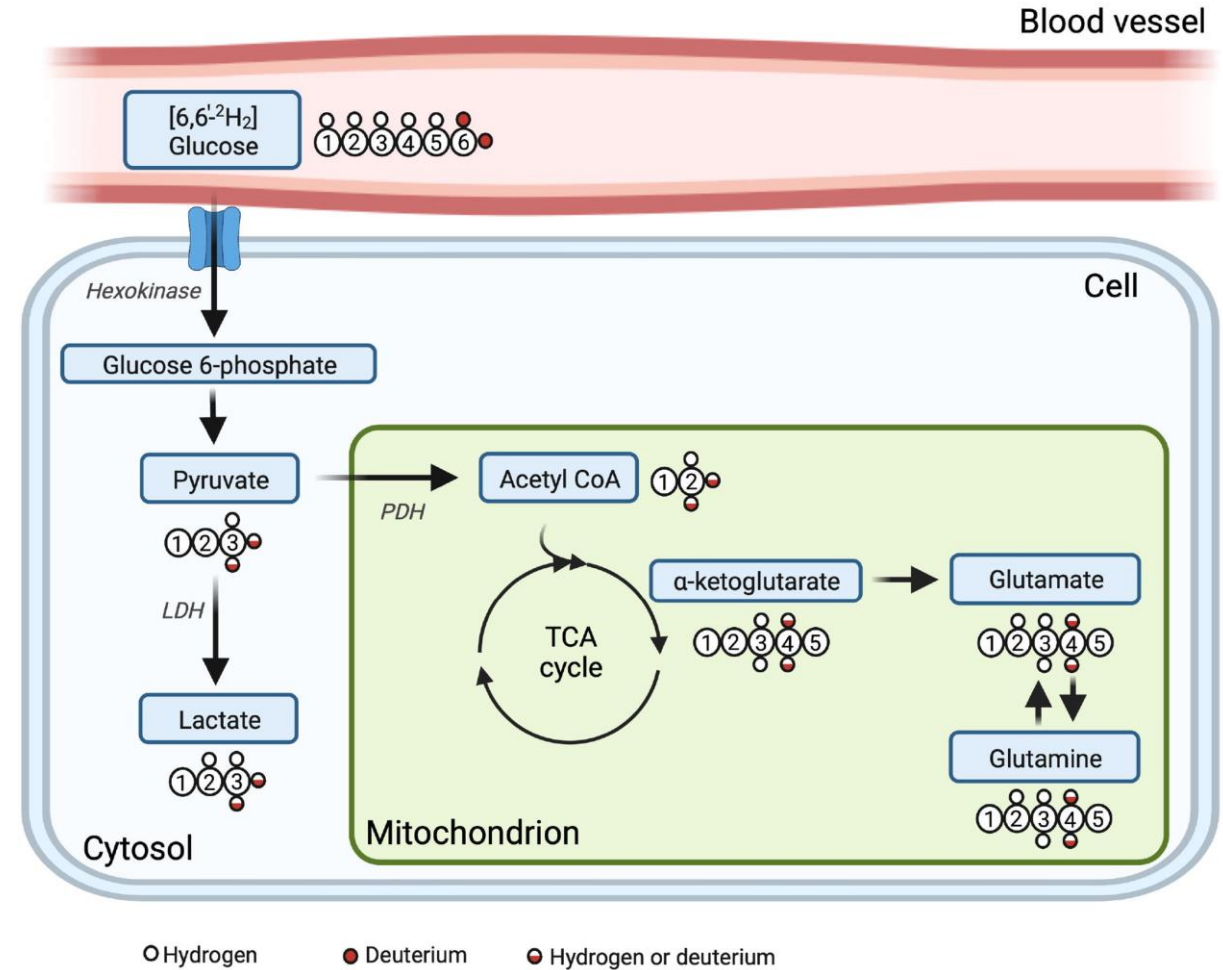
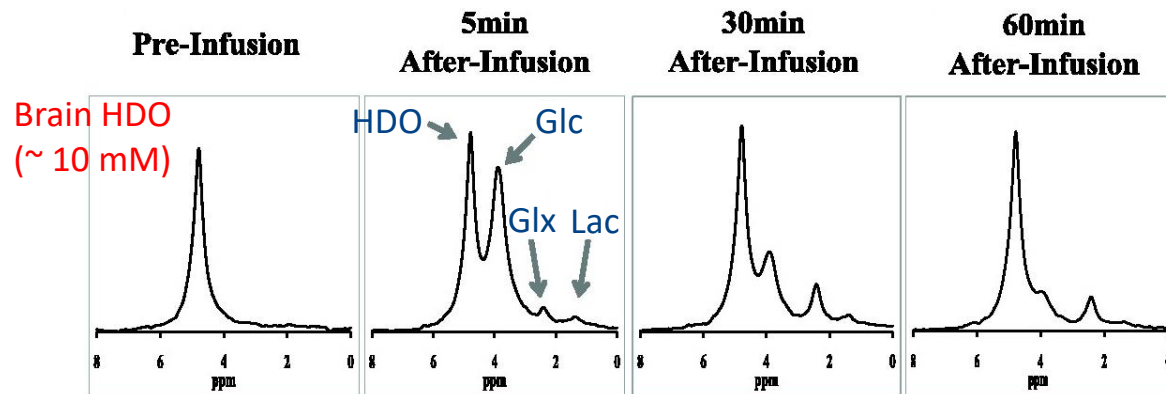
Zymomonas mobilis cellen
na toediening
 $[1-^2\text{H}]$ glucose



Herontdekking van ^2H MRS



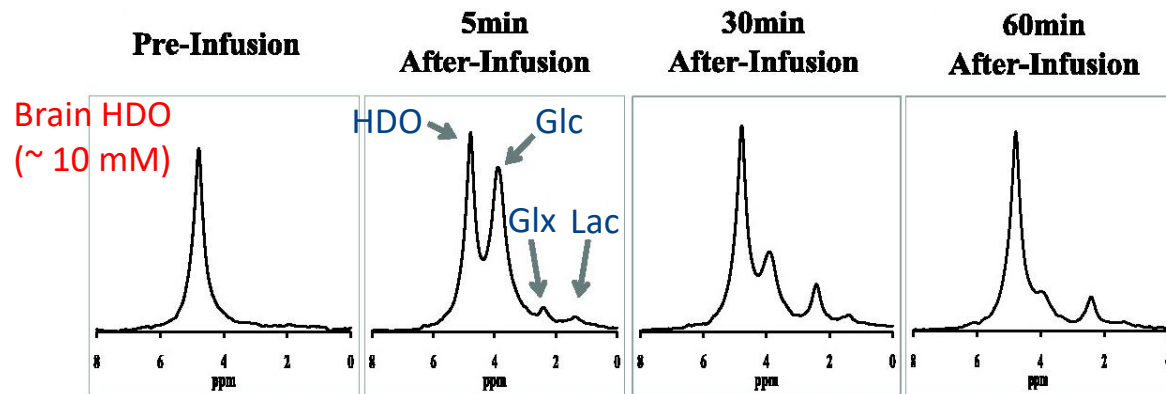
Brein rat na toediening
 $[6,6'\text{-}^2\text{H}_2]\text{glucose}$



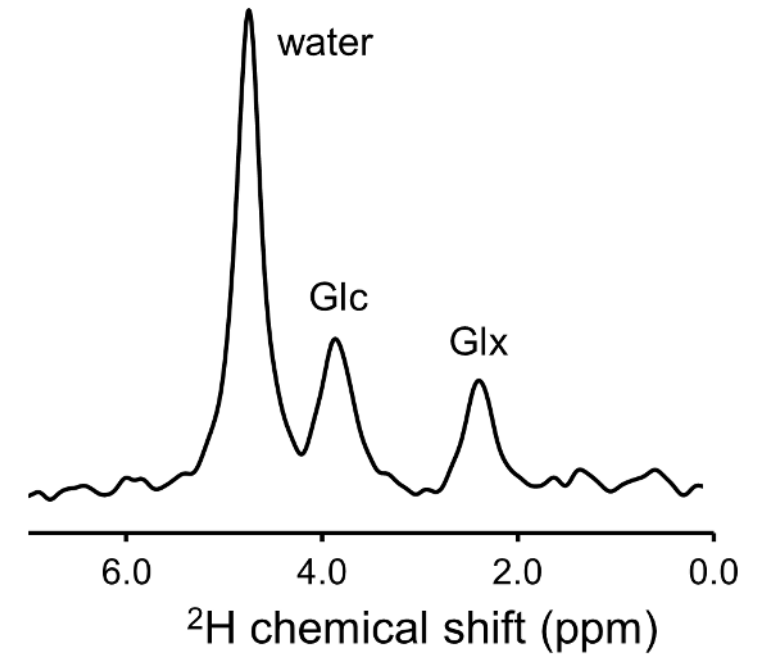
Herontdekking van ^2H MRS



Brein rat na toediening
 $[6,6'\text{-}^2\text{H}_2]\text{glucose}$

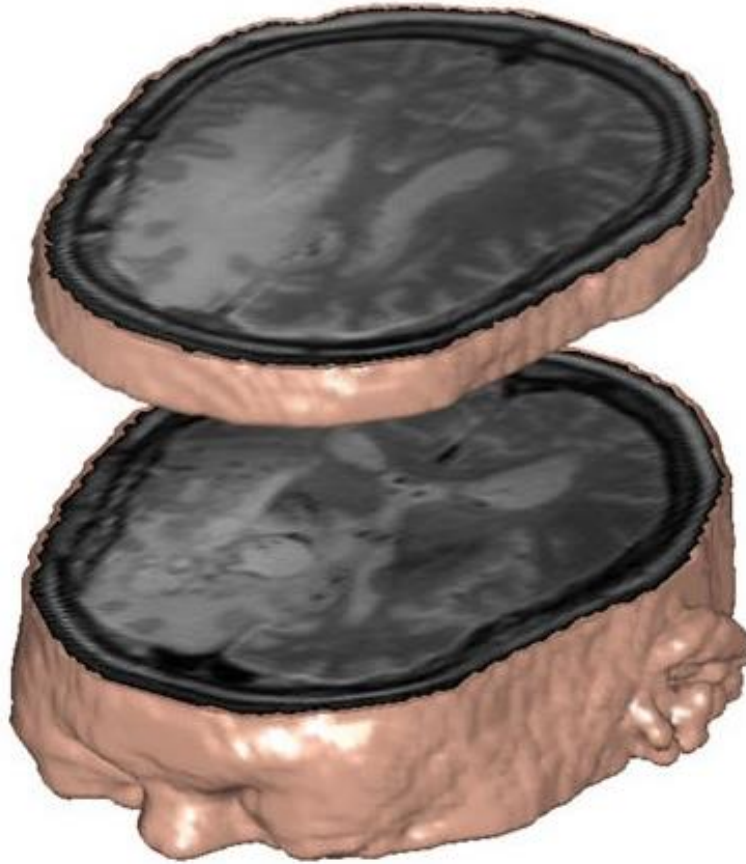


Brein mens na drinken
 $[6,6'\text{-}^2\text{H}_2]\text{glucose}$

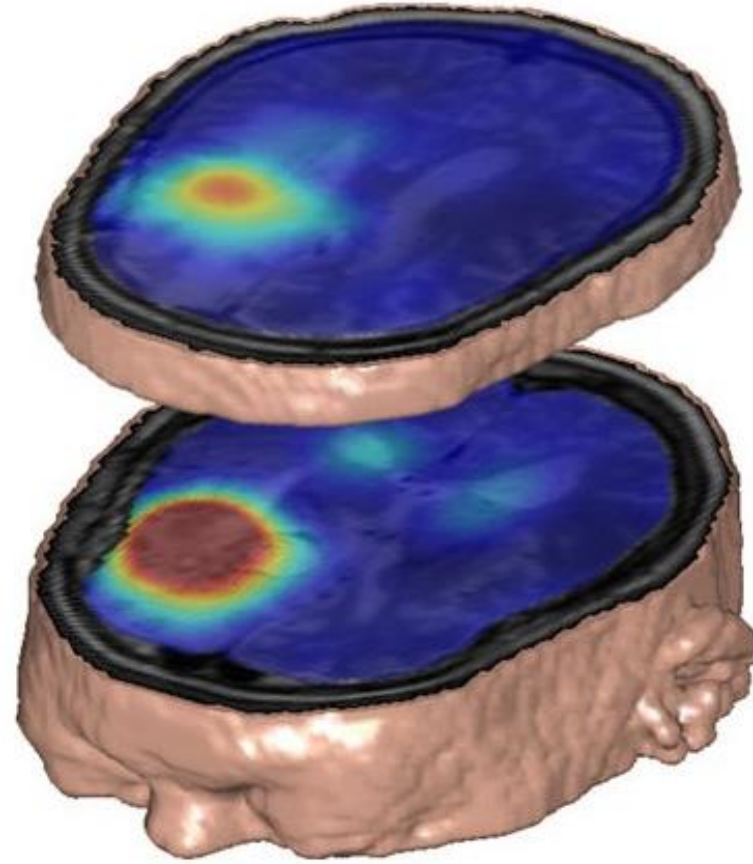


Deuterium metabolite imaging van hersentumoren

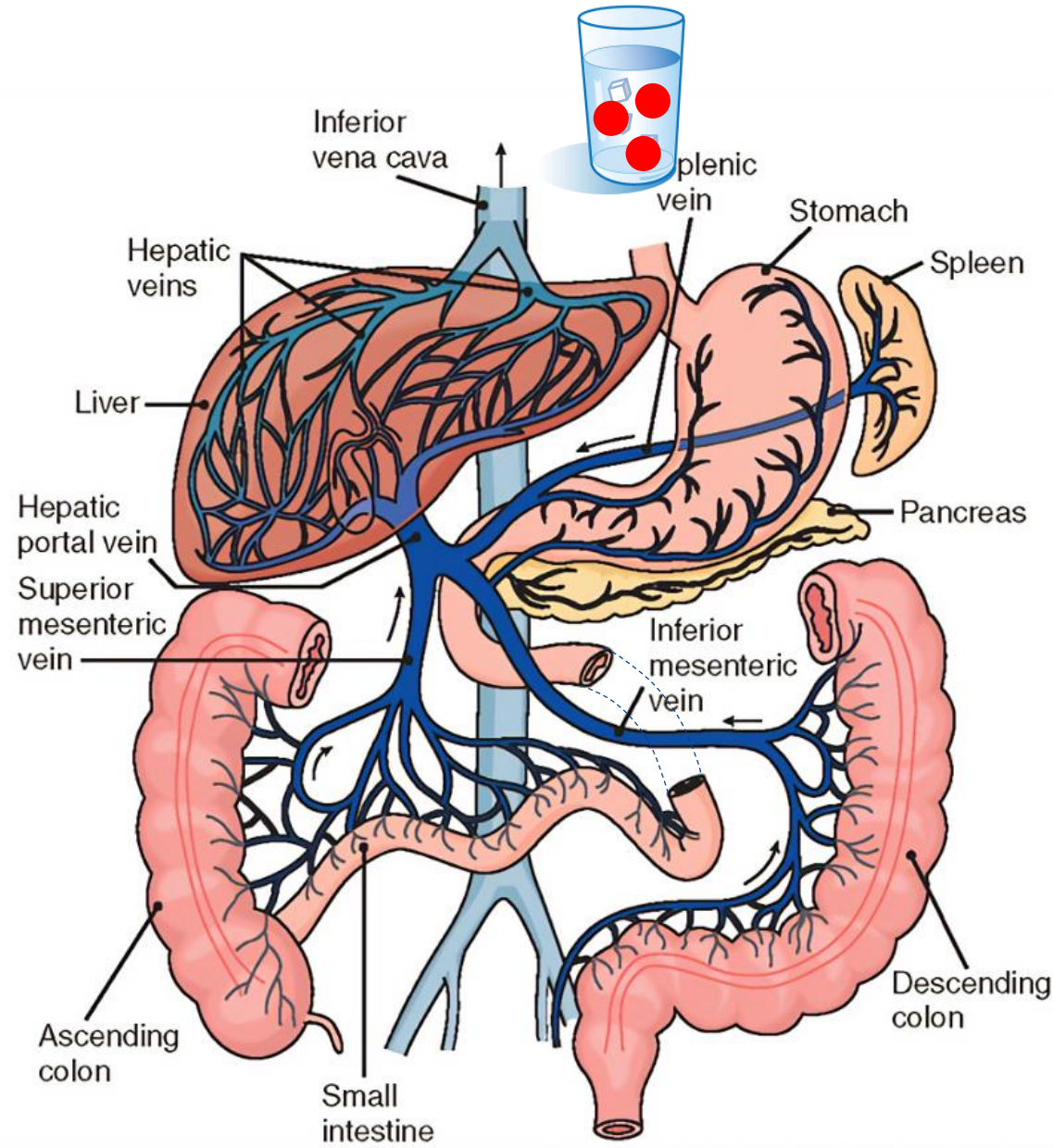
MRI



^2H MRSI: Lactate/Glx

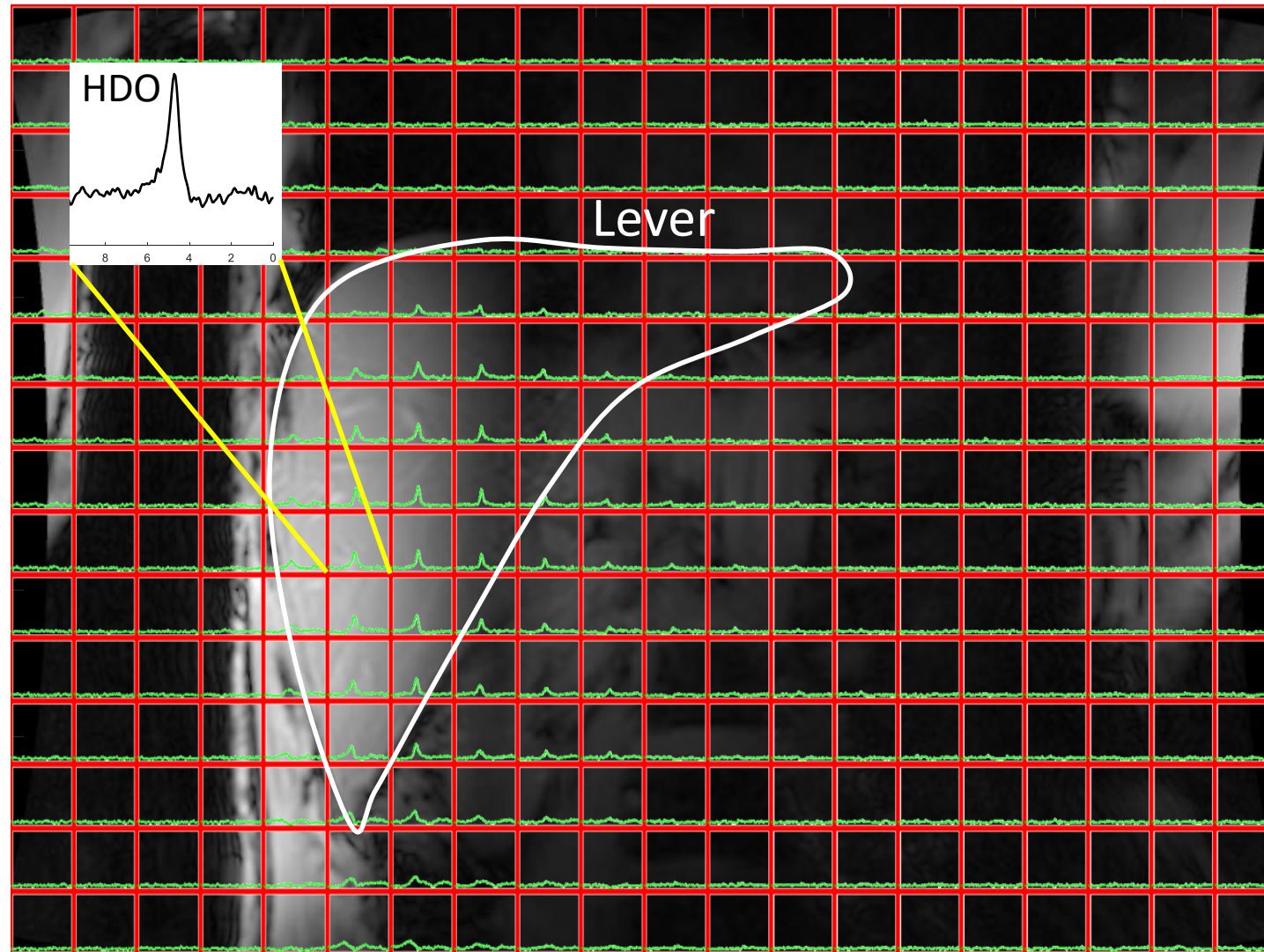


[6,6'-²H₂]glucose volgen in het lichaam



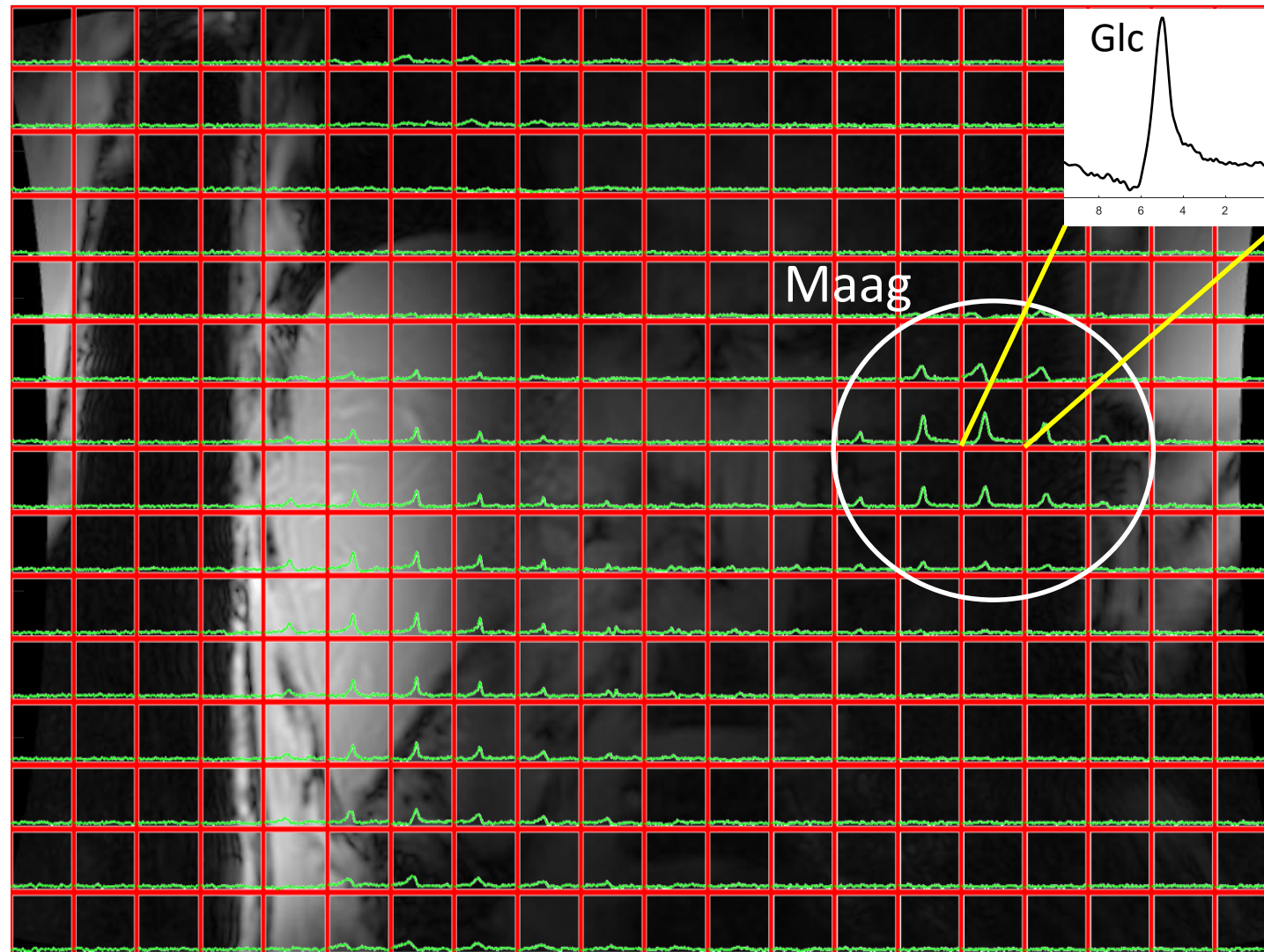
[6,6'- $^2\text{H}_2$]glucose volgen in het lichaam

Voor drinken



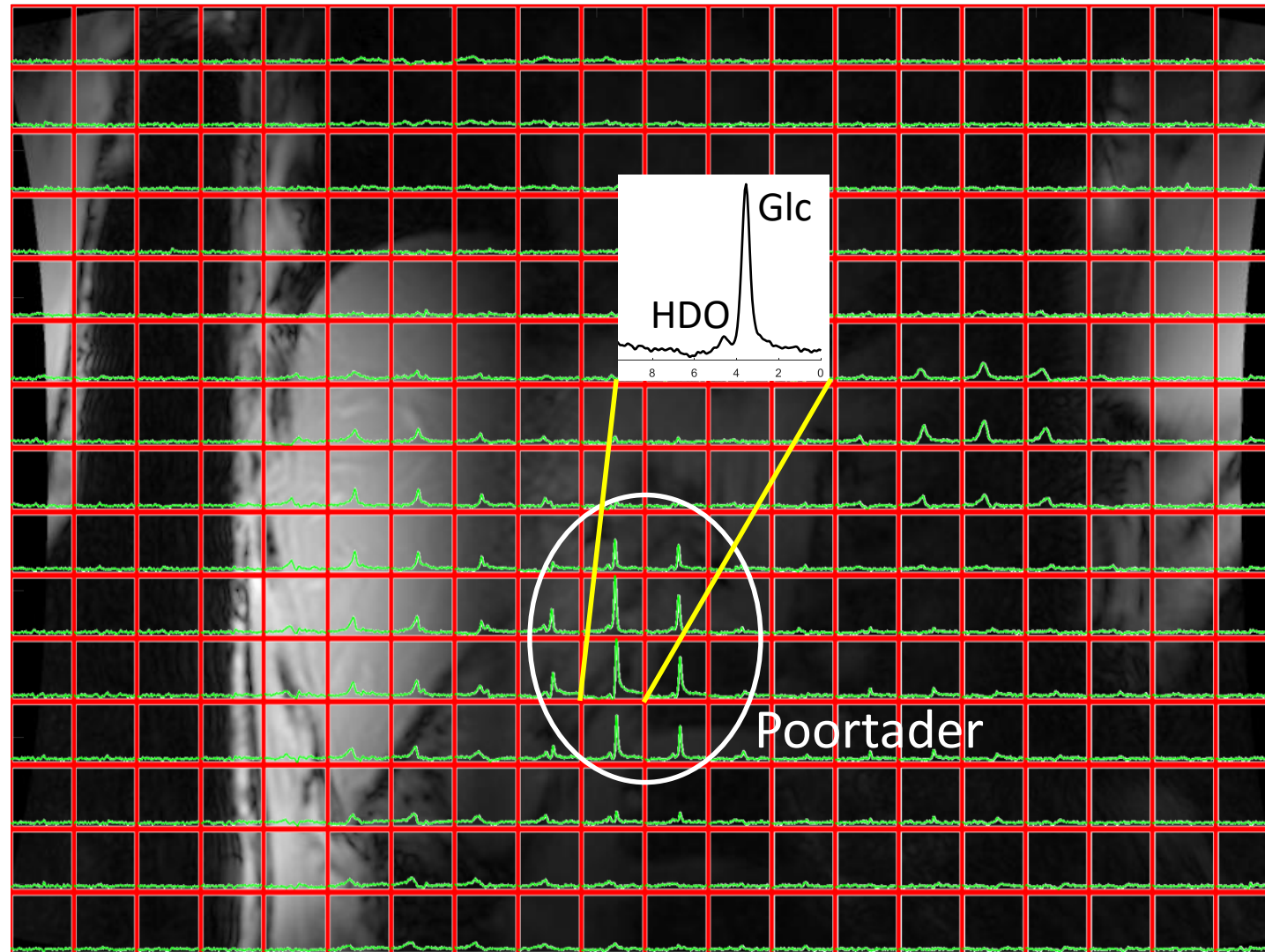
[6,6'-²H₂]glucose volgen in het lichaam

Direct na
drinken



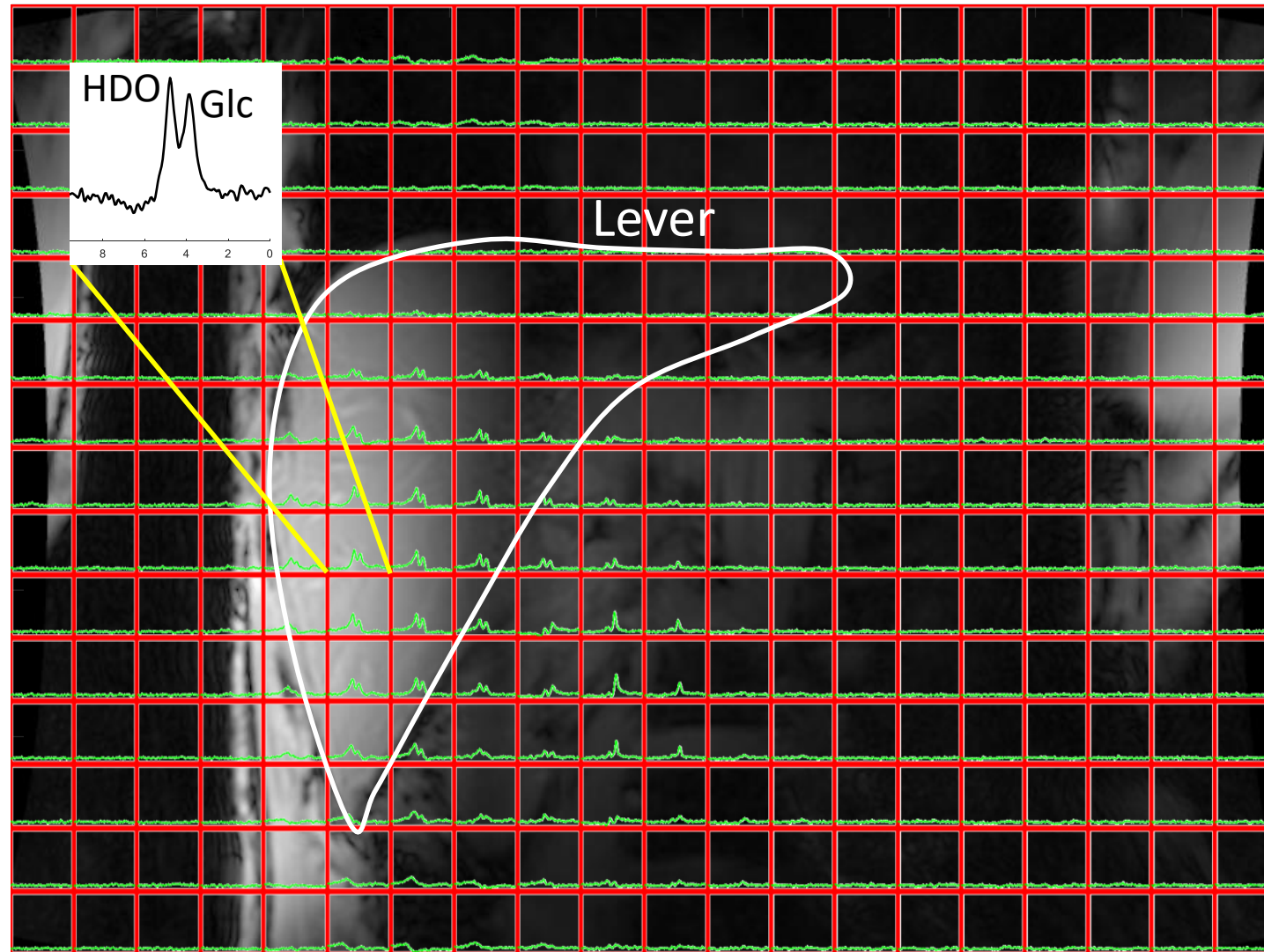
[6,6'-²H₂]glucose volgen in het lichaam

20 min na
drinken

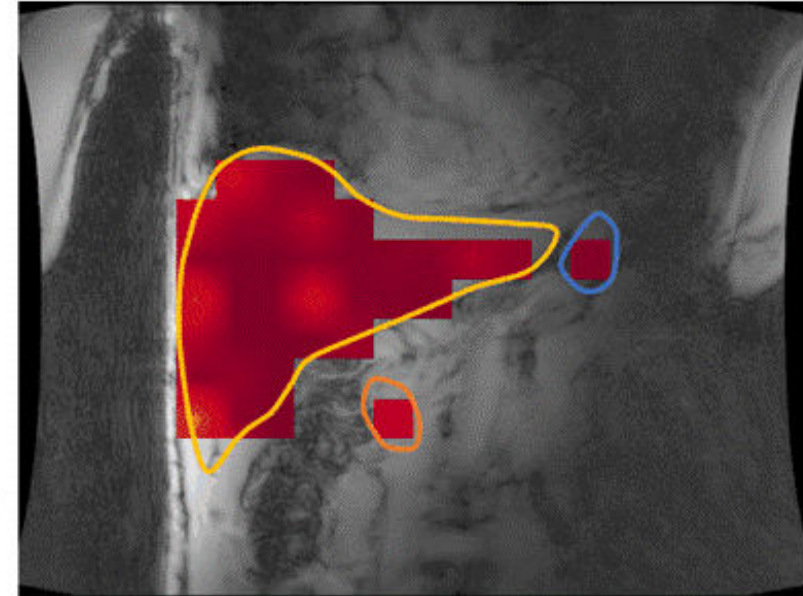
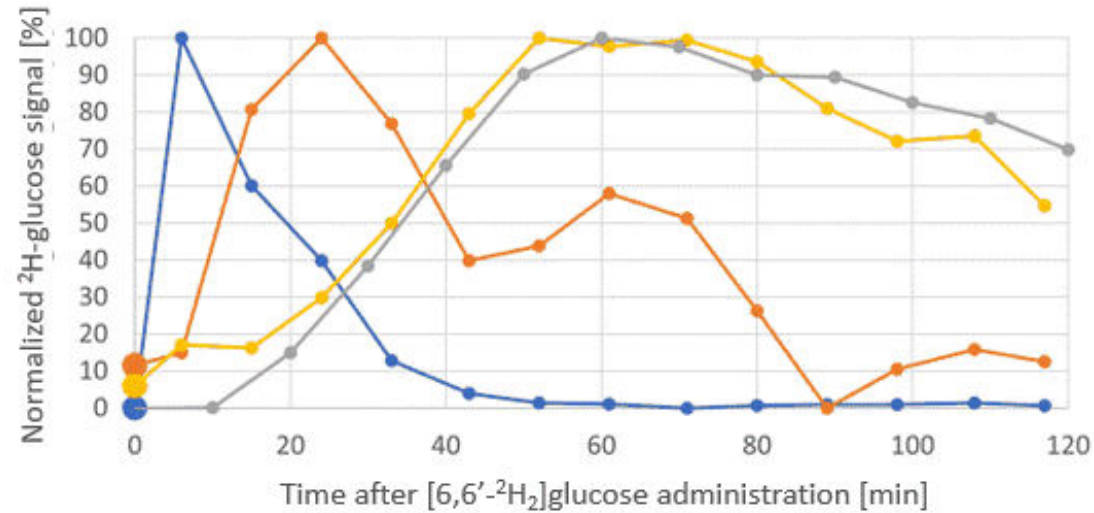


[6,6'- $^2\text{H}_2$]glucose volgen in het lichaam

50 min na
drinken

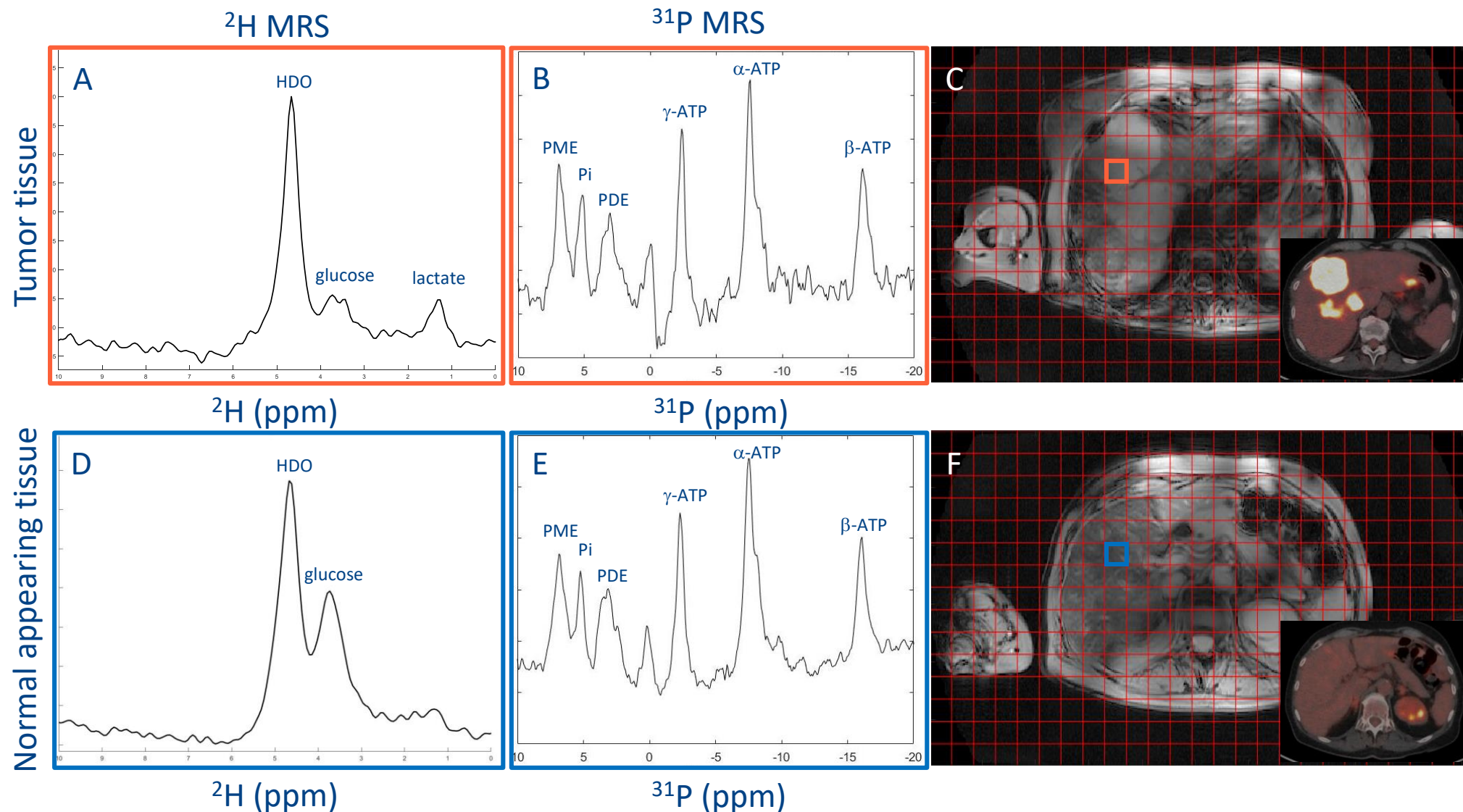


[6,6'-²H₂]glucose volgen in het lichaam

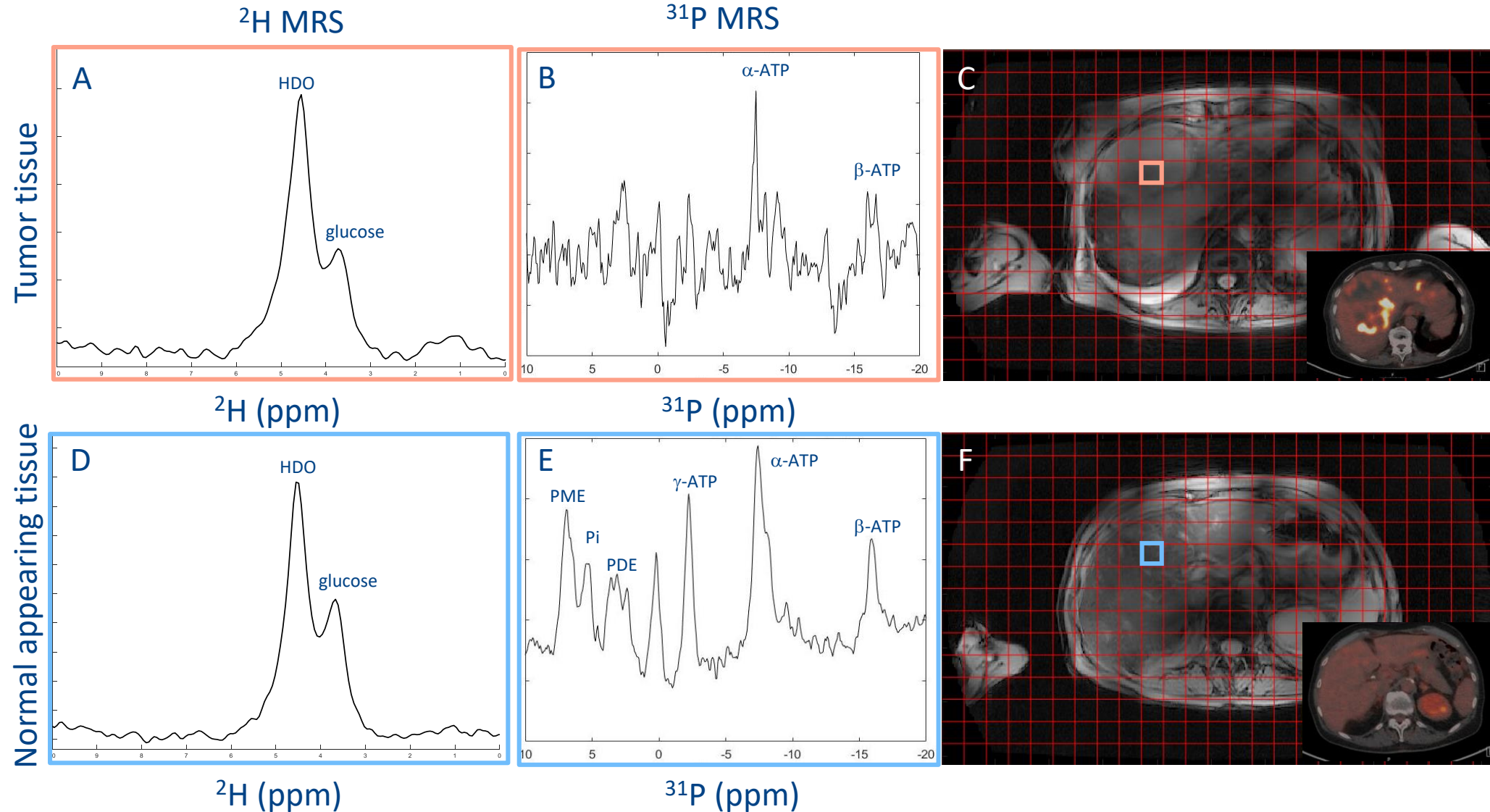


- Stomach
- Portal vein
- Liver
- Plasma

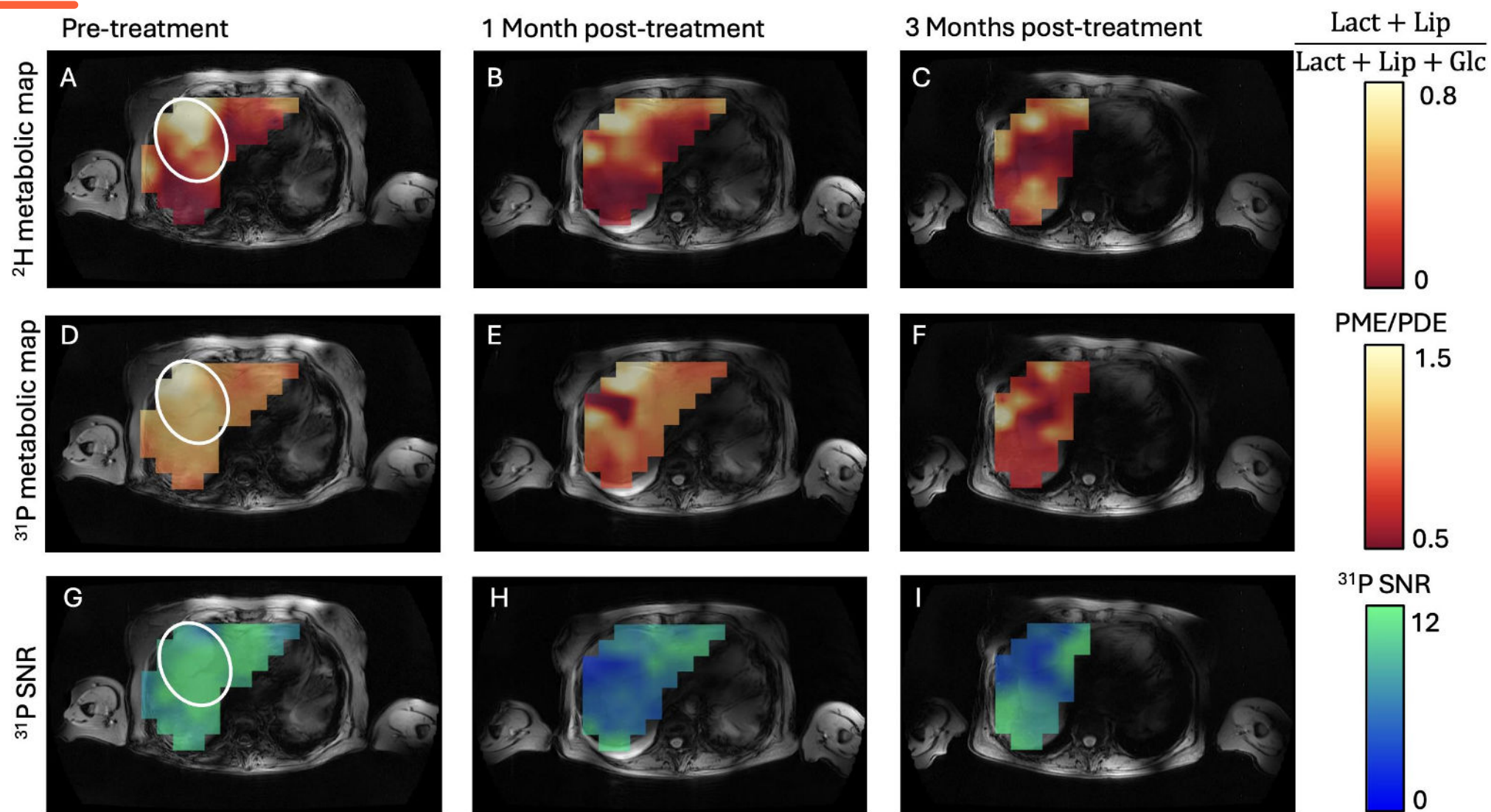
Patiënt met lever metastasen: voor behandeling



Patiënt met lever metastasen: na behandeling



Patiënt met lever metastasen



Metabole beeldvorming met MRI

- MRI visualiseert anatomie en metabole processen
- Inzicht in werking van menselijk lichaam
- Inzicht in ontstaan en verloop van ziektes
- Toepassingen in klinische setting: vroege voorspelling therapierespons

