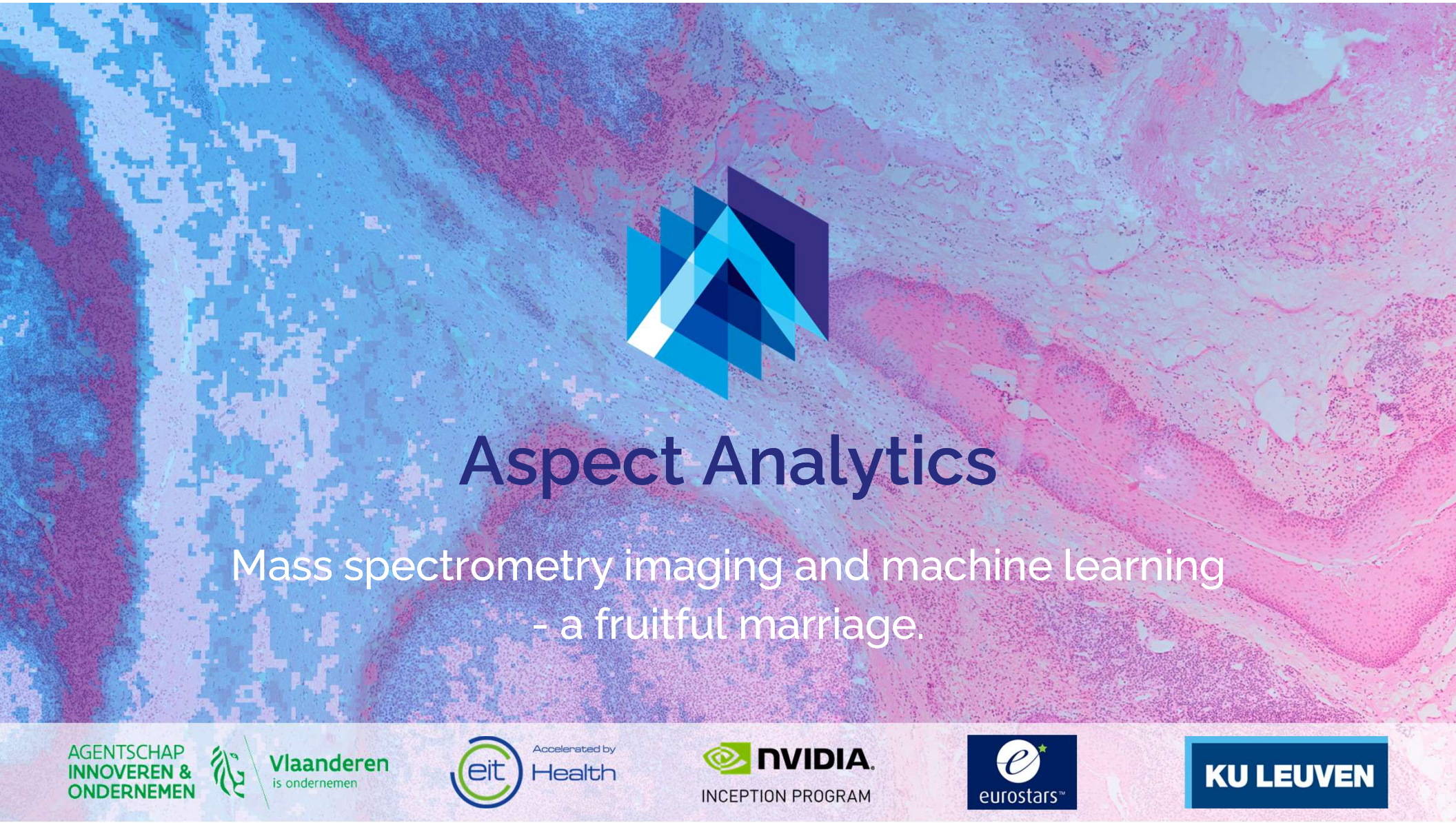


Aspect Analytics

Mass spectrometry imaging and machine learning
- a fruitful marriage.

AGENTSCHAP INNOVEREN & ONDERNEMEN
Vlaanderen is ondernemen
eit Accelerated by Health
NVIDIA INCEPTION PROGRAM
eurostars™
KU LEUVEN

Mass spectrometry imaging

A brief introduction

Mass spectrometry imaging workflow

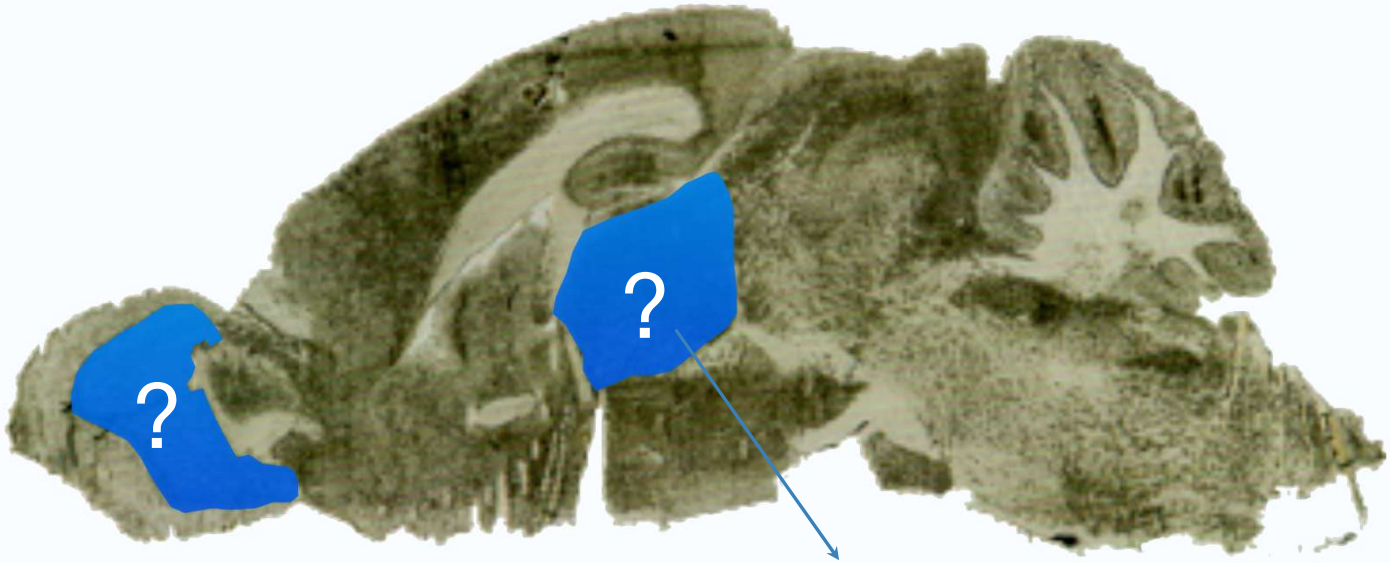
Aspect Analytics

Molecular imaging technology that
links chemical and spatial information together

Mass spectrometry imaging workflow

Aspect Analytics

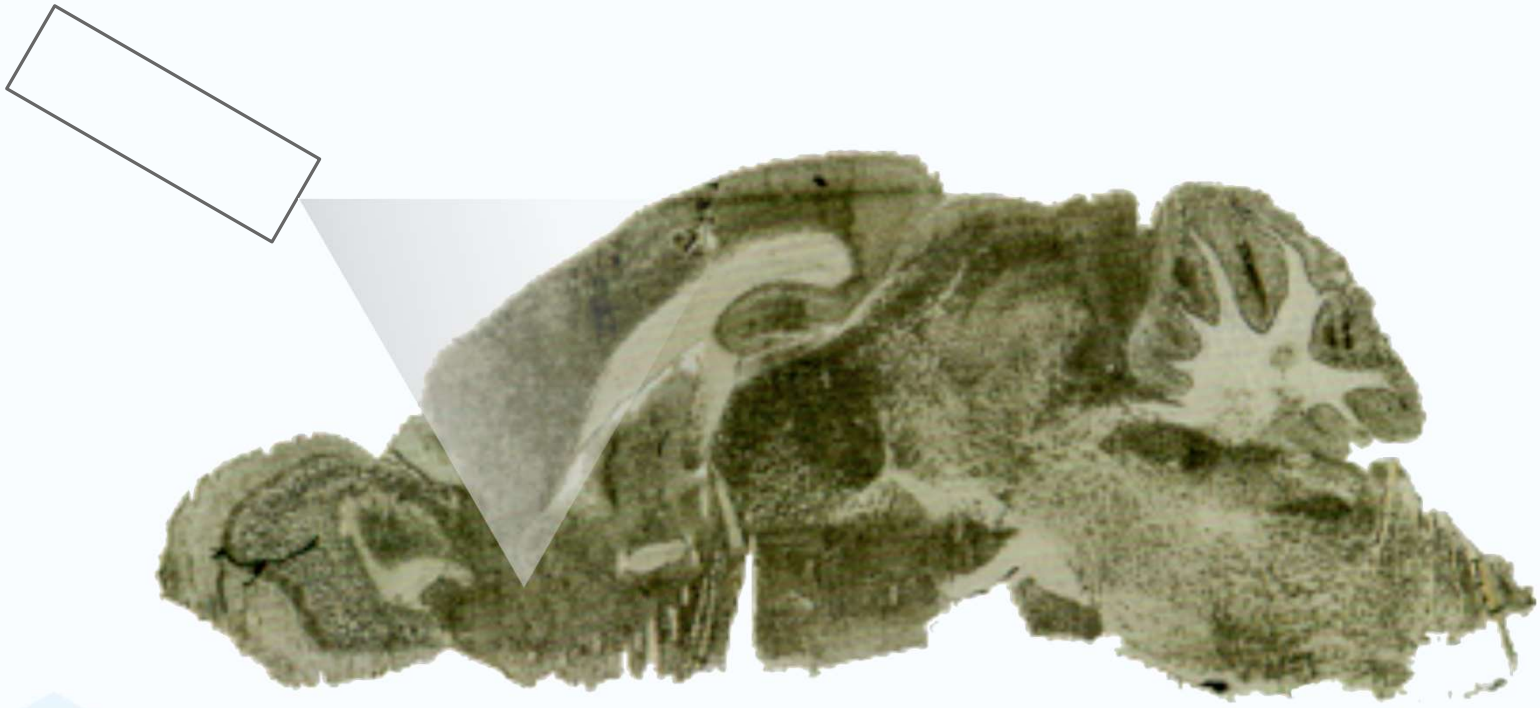
Molecular imaging technology that
links chemical and spatial information together



Which biomolecules are located in this part of the mouse brain?

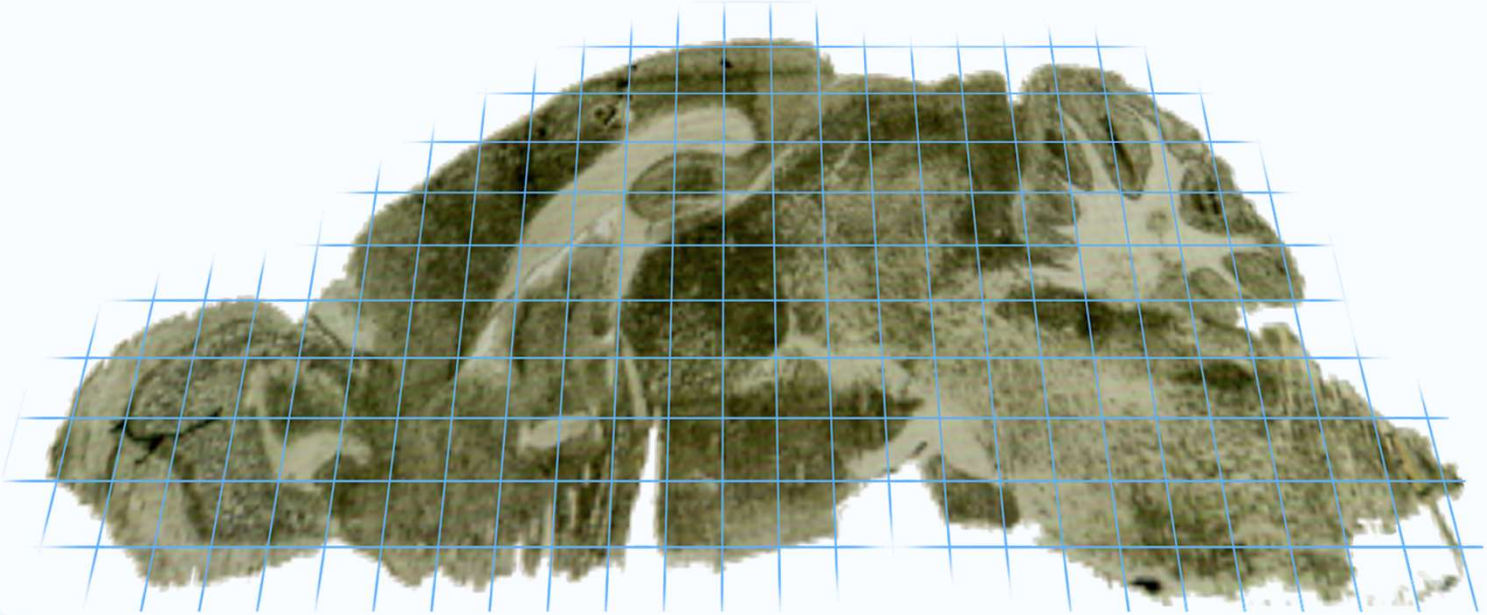
Mass spectrometry imaging workflow

Matrix application



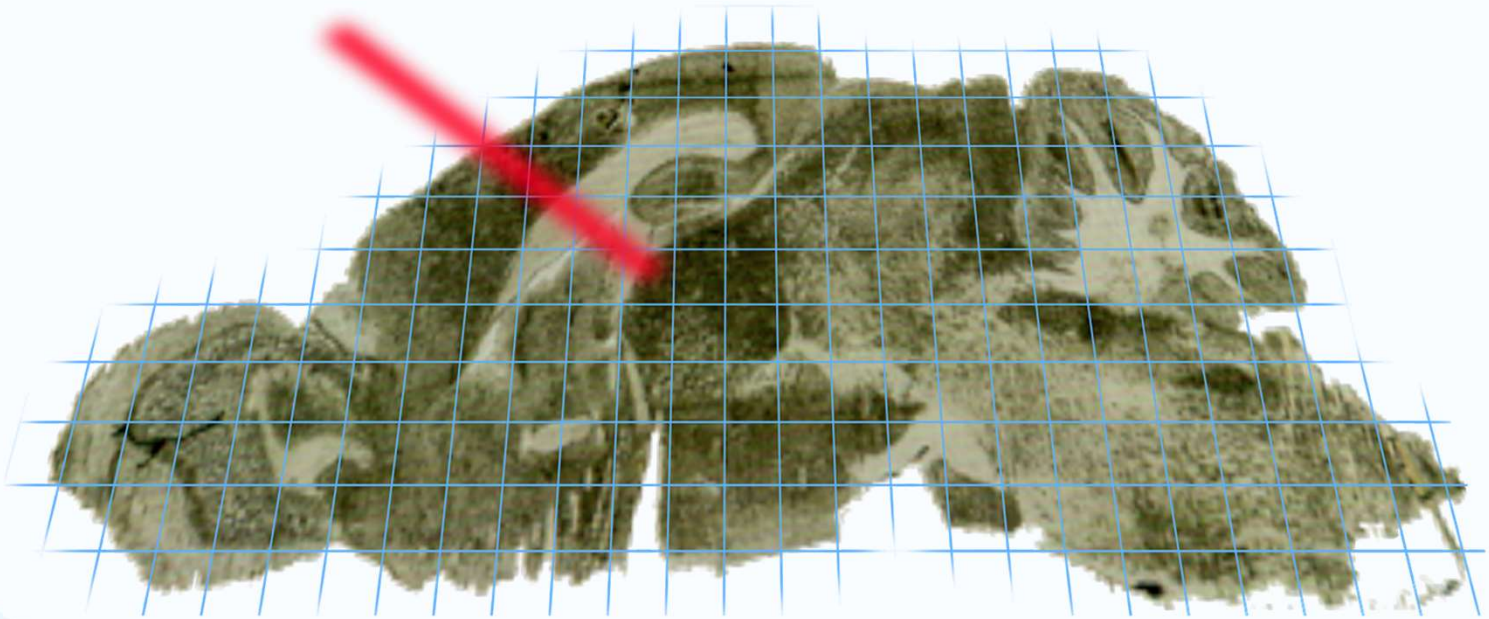
Mass spectrometry imaging workflow

Overlay tissue slice with virtual grid



Mass spectrometry imaging workflow

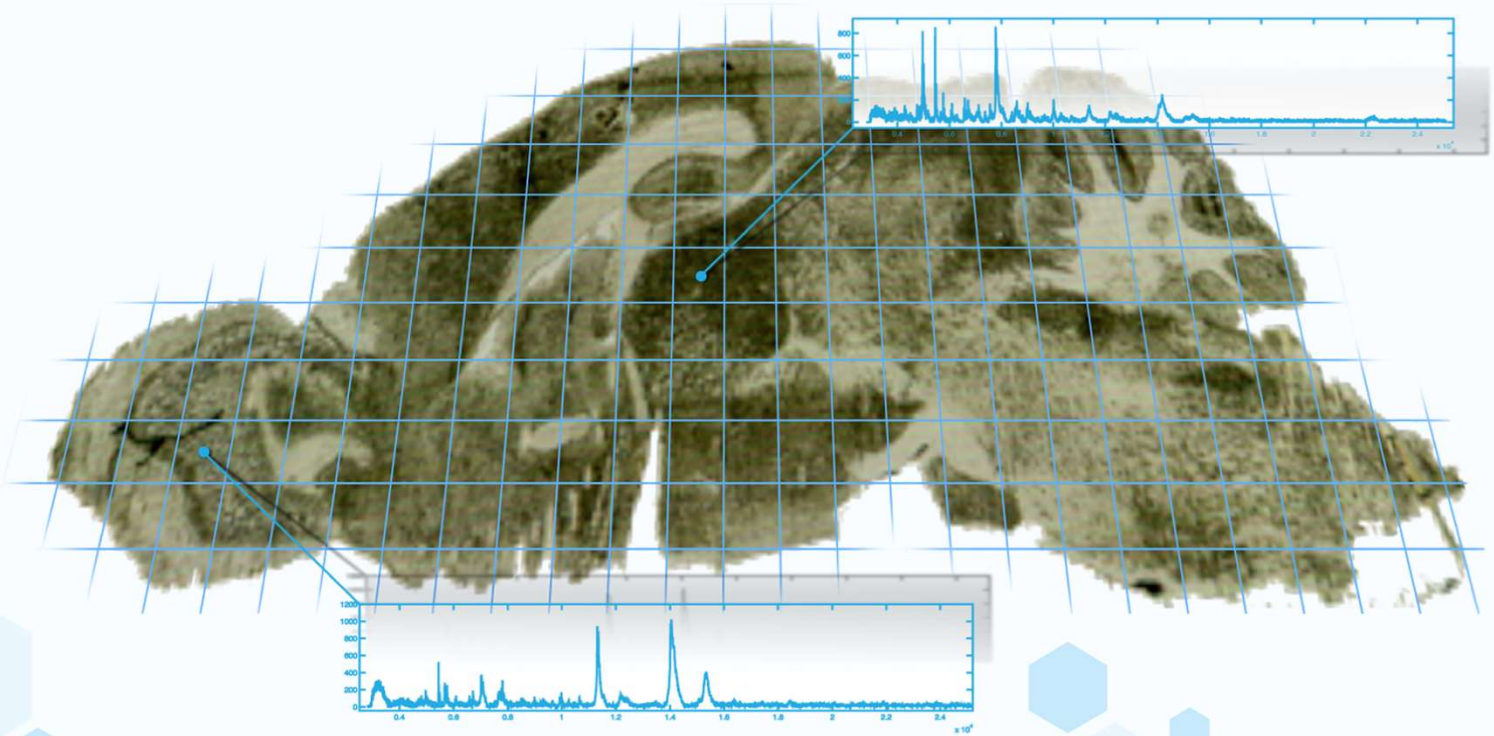
Perform MALDI mass spectrometry at each gridpoint

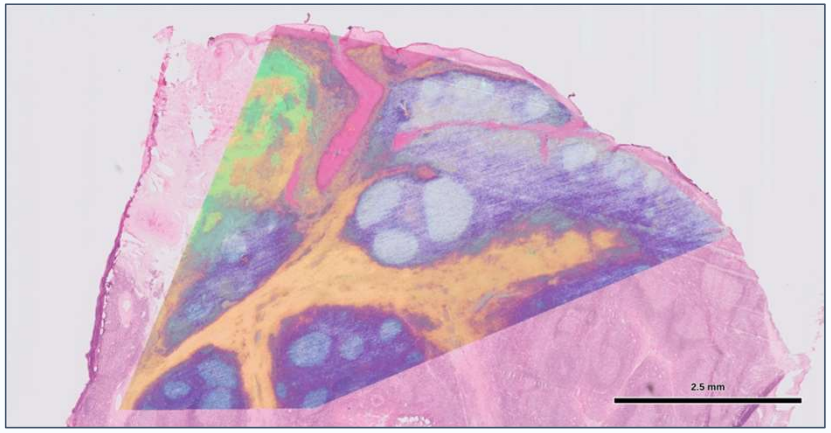


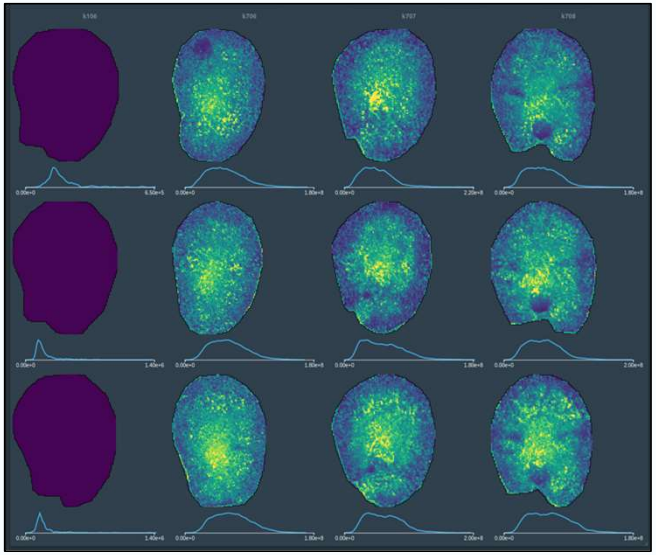
MALDI = Matrix Assisted Laser Desorption and Ionization

Mass spectrometry imaging workflow

Result: mass spectrum at each gridpoint



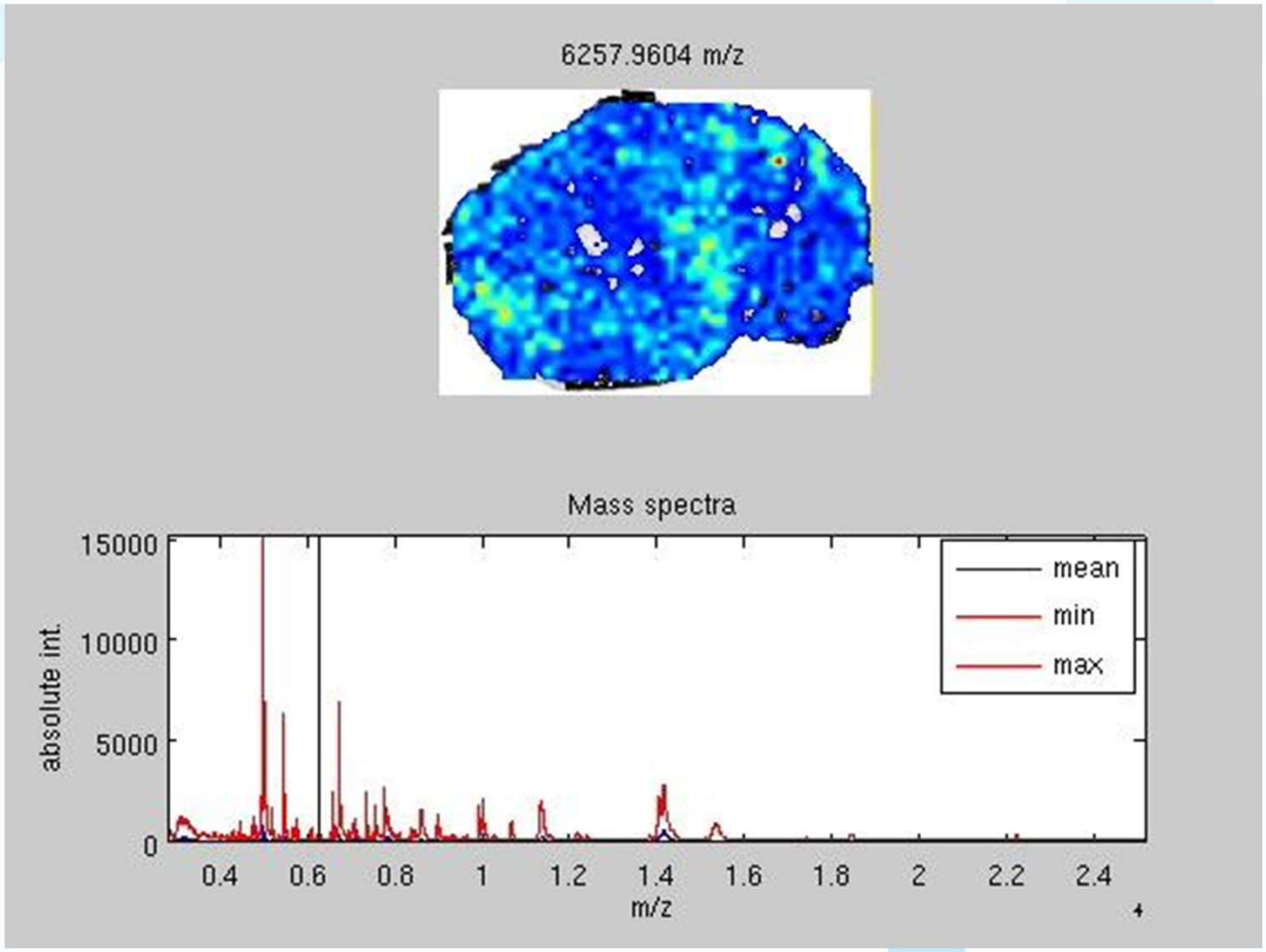




Biomarker discovery &
clinical diagnostics

Drug discovery

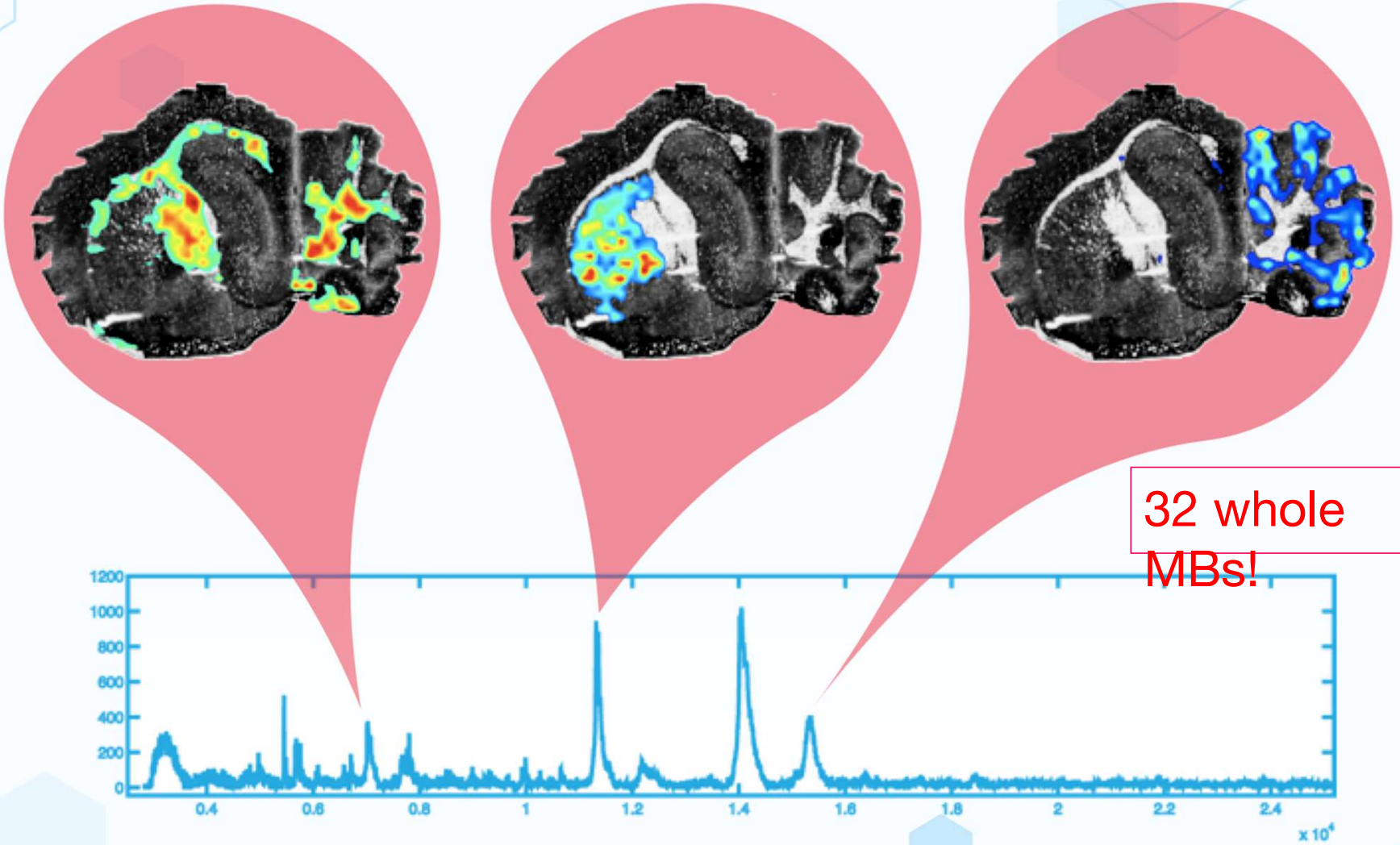
How did I end up here?



Prof. Raf Van de Plas

Prof. Etienne Waelkens

2009 R. Van de Plas, B. De Moor & E. Waelkens



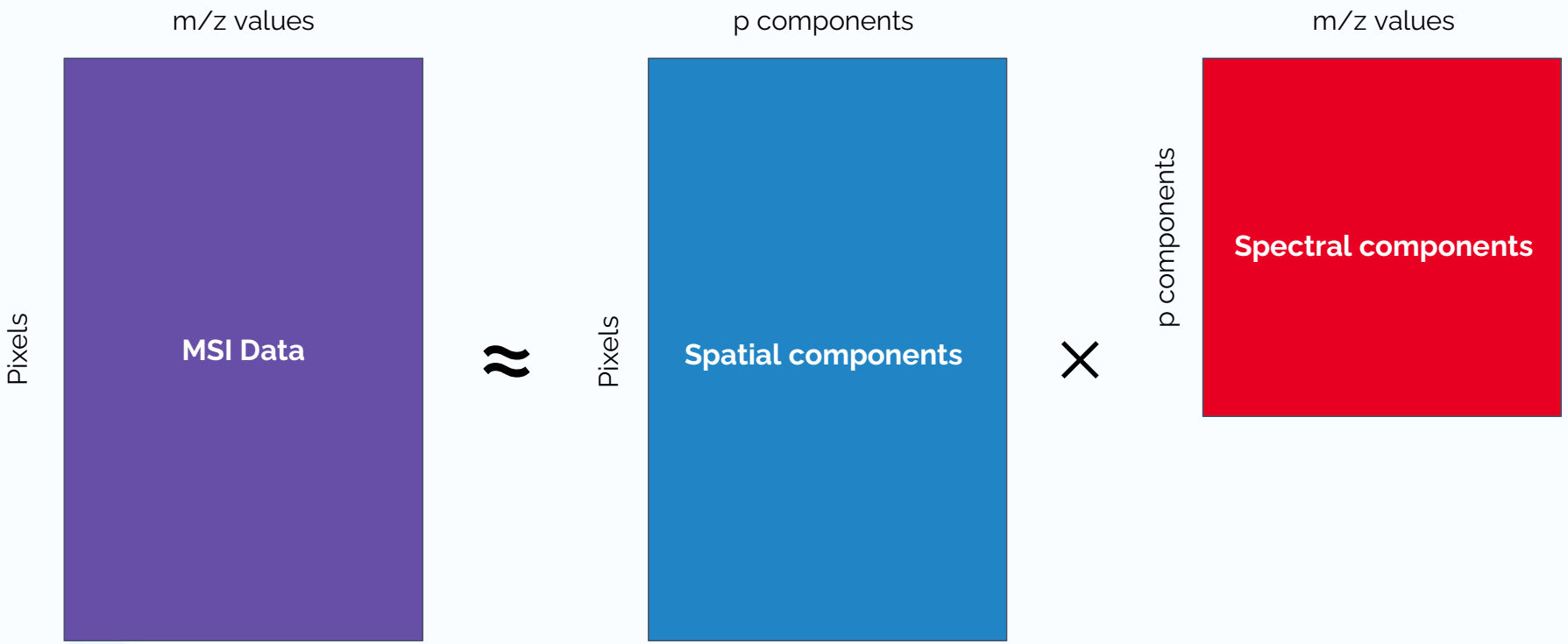
32 whole MBs!

2009 R. Van de Plas, N.Verbeeck, B. De Moor & E. Waelkens

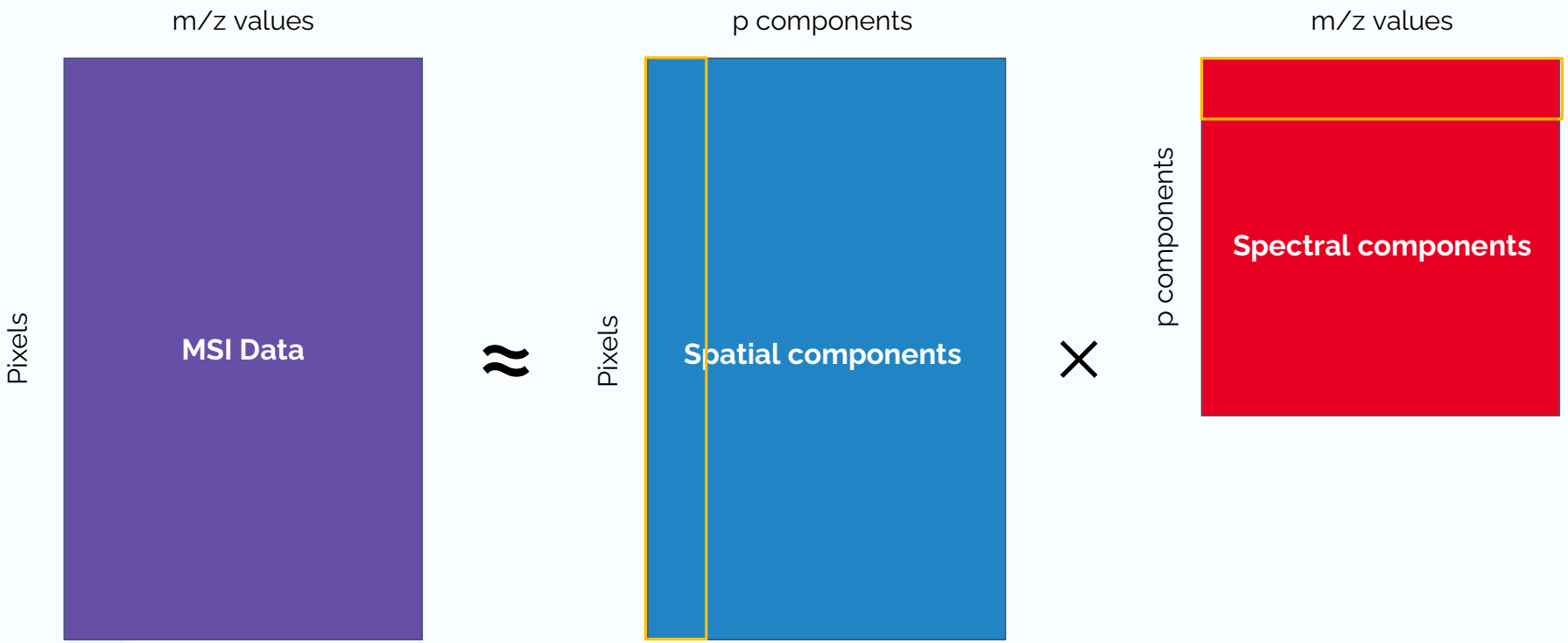
- 10.000's of ion images in a single experiment
- ~1.5 TB data in a single experiment

How to deal with all that data?

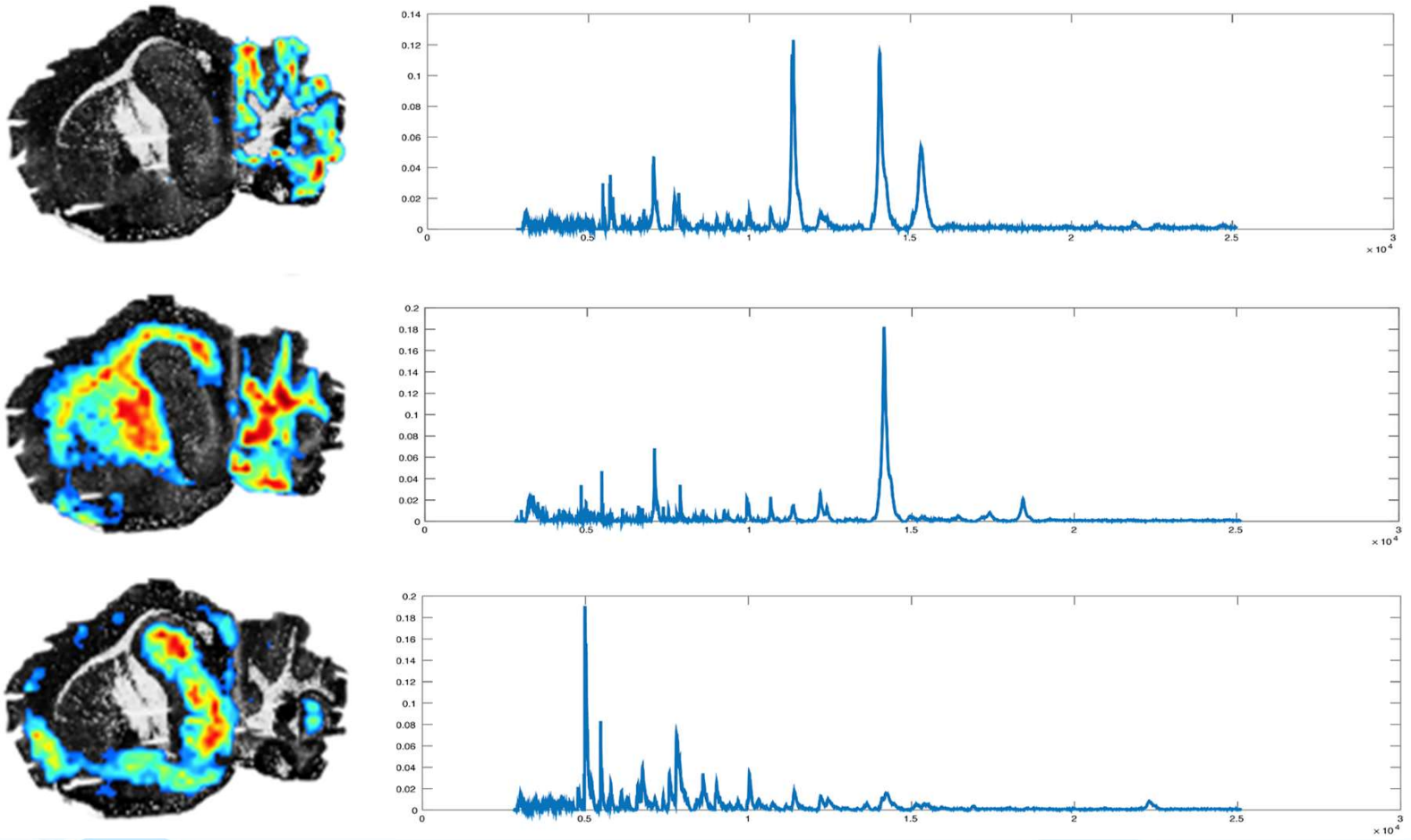
Matrix decomposition



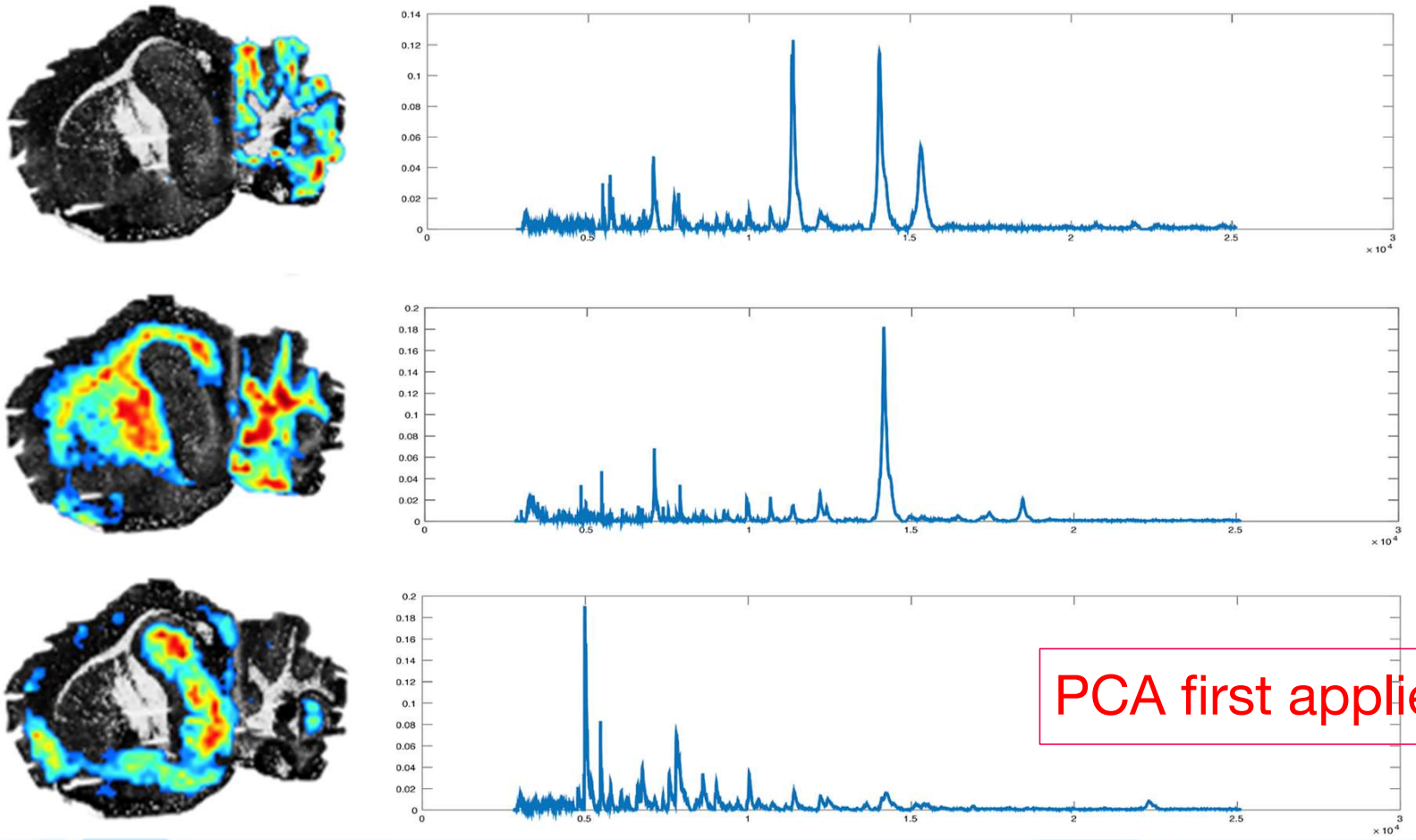
Matrix decomposition



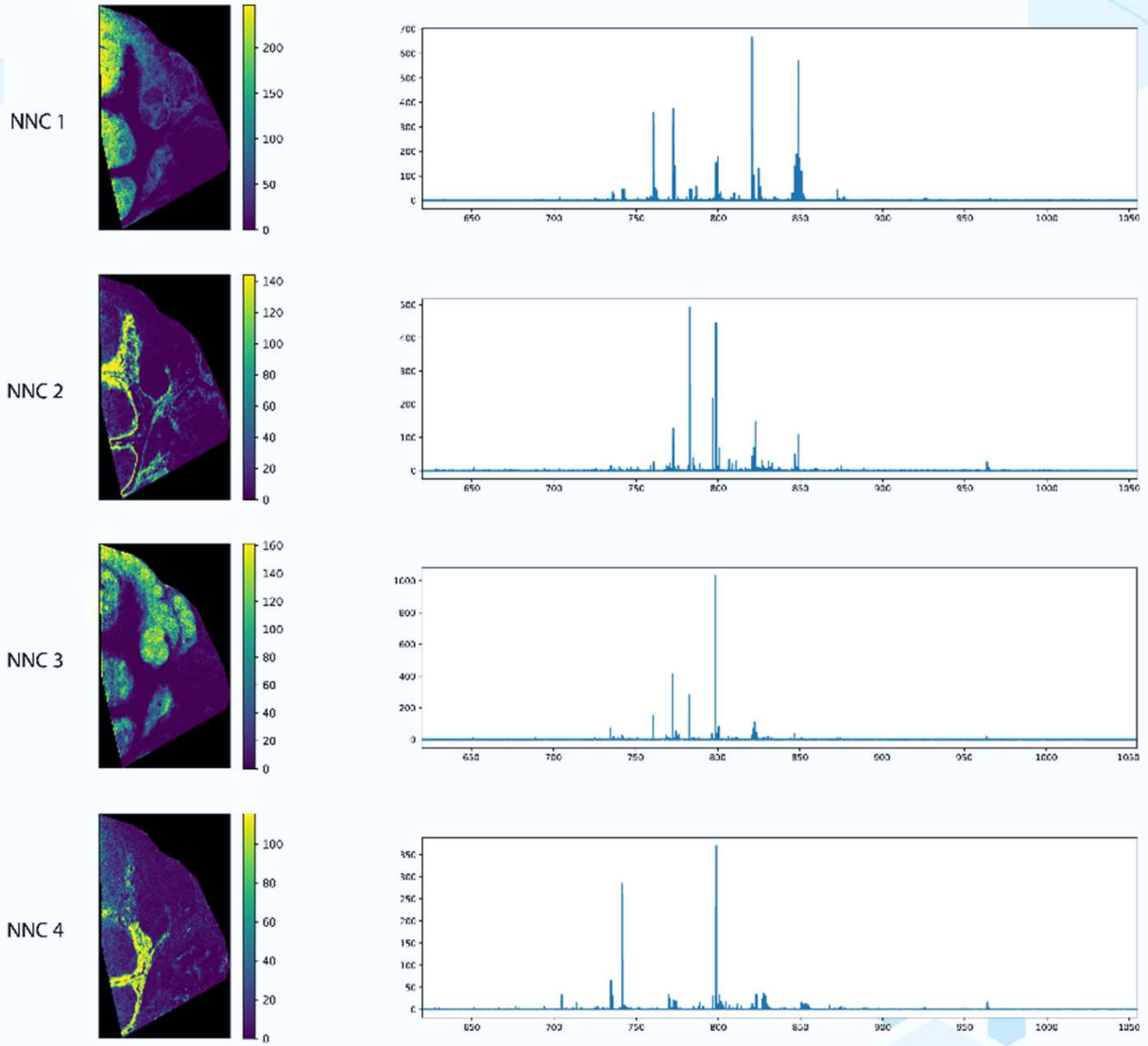
Matrix decomposition (NMF)



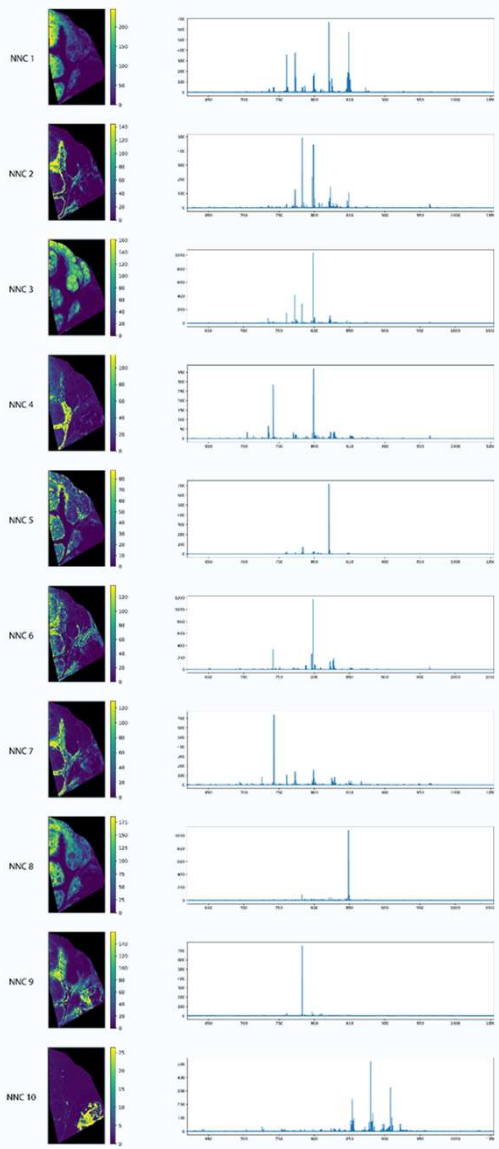
Matrix decomposition (NMF)



PCA first applied in 2007!

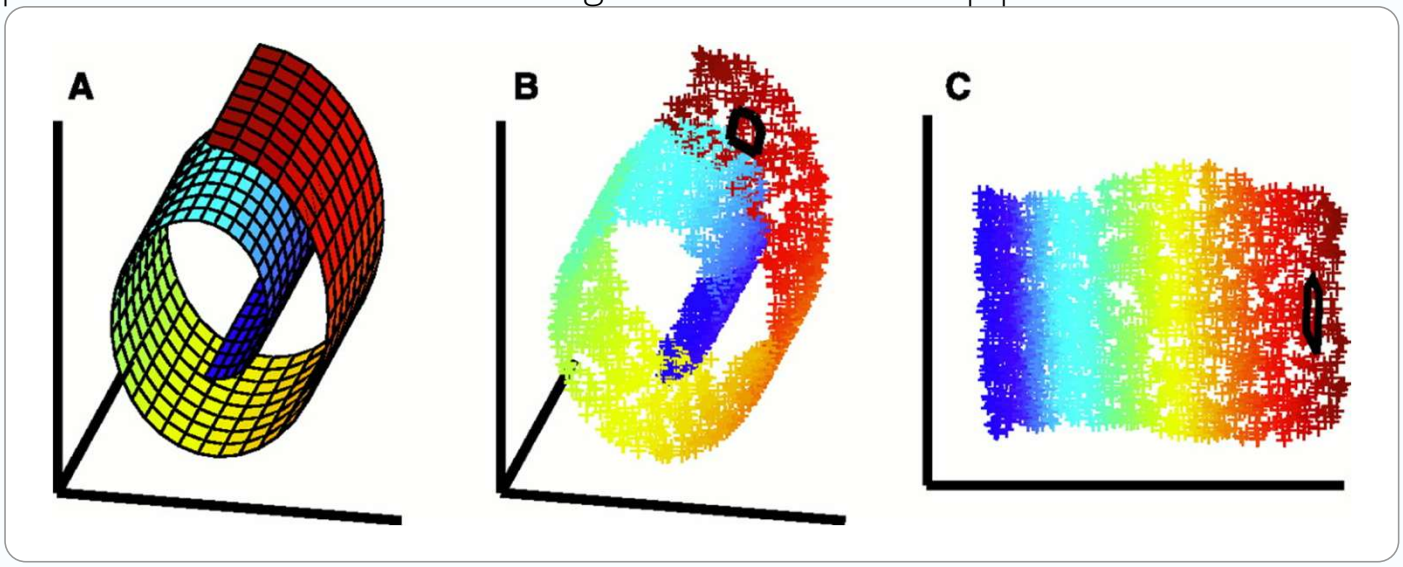


Still bread and butter!


NNC 1
NNC 2
NNC 3
NNC 4
NNC 5
NNC 6
NNC 7
NNC 8
NNC 9
NNC 10

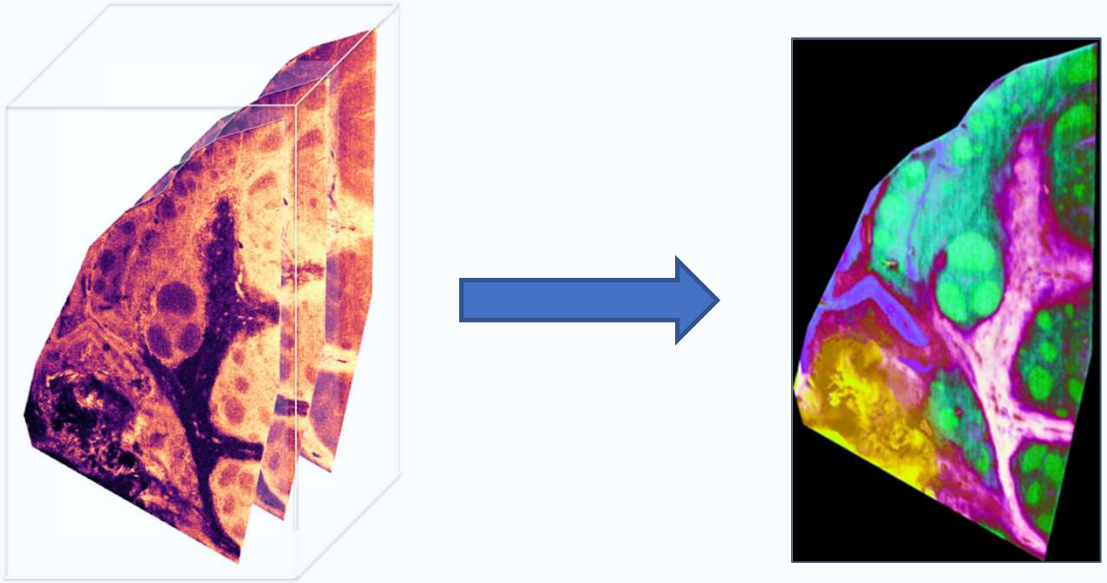
Manifold learning: concept

Capture local structure rather than global structure – keep points that look alike close



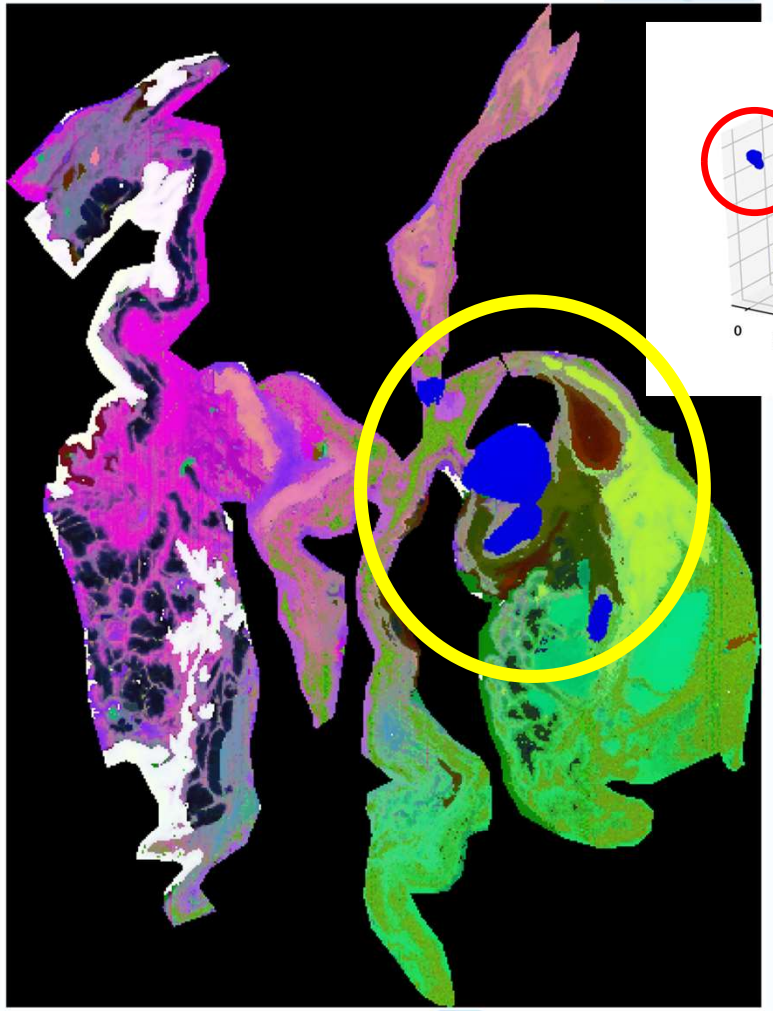
Example Locally Linear Embedding, Roweis et al., Science 2000

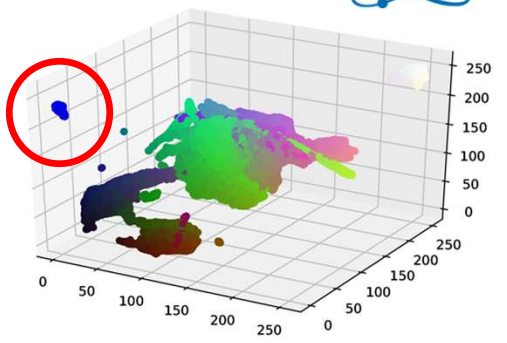
UMAP dimensionality reduction



Evaluation of Distance Metrics and Spatial Autocorrelation in Uniform Manifold Approximation and Projection Applied to Mass Spectrometry Imaging Data

T. Smets, N. Verbeeck, M. Claesen, A. Asperger, G. Griffioen, T. Tousseyn, W. Waelput, E. Waelkens, B. De Moor - 2019, Analytical Chemistry

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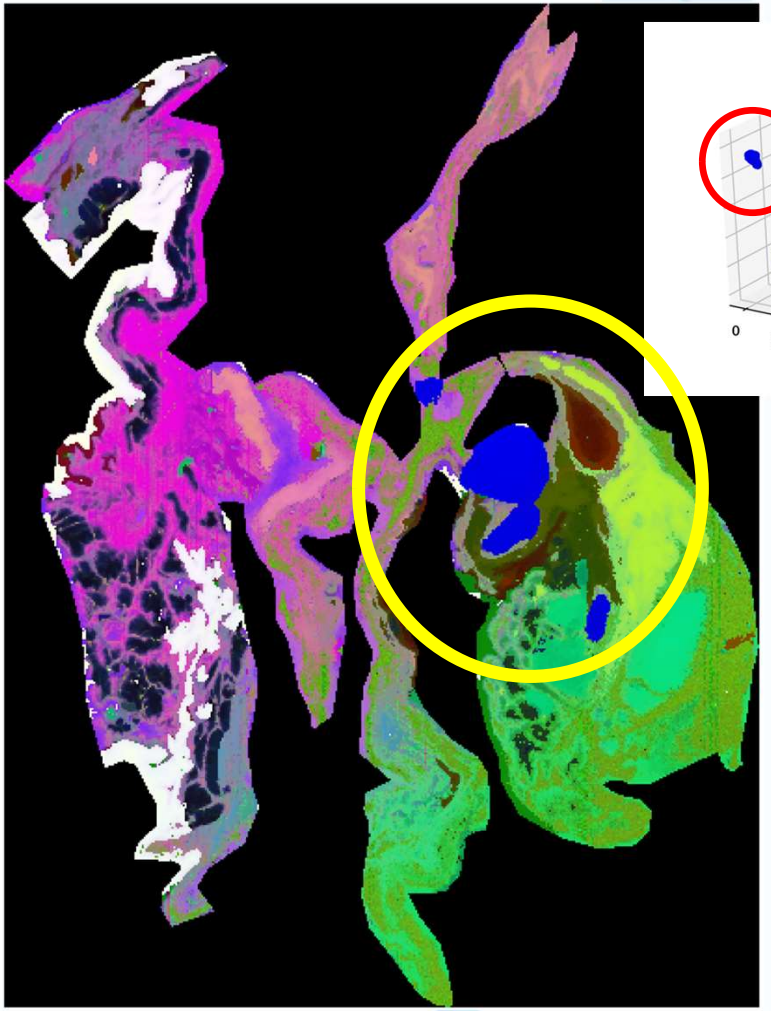
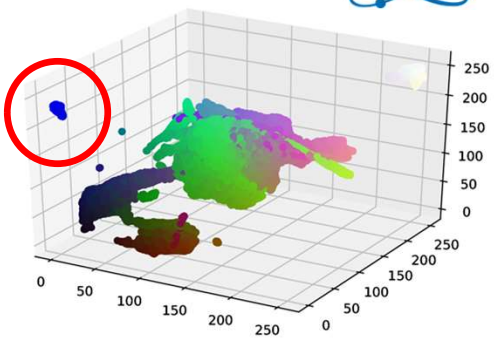


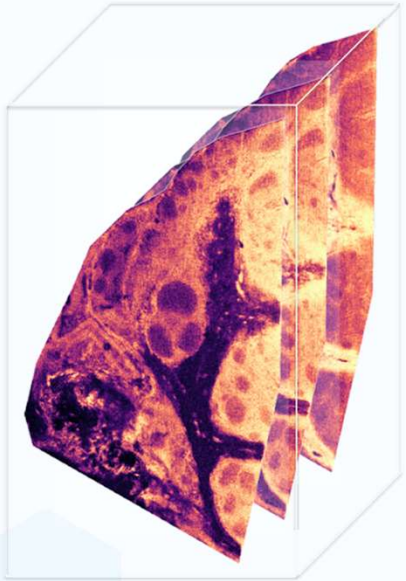


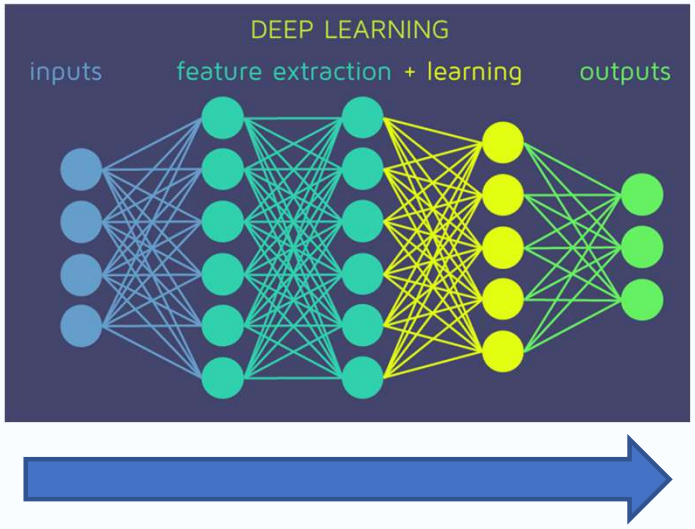
H&E image available in "*Site-to-Site Reproducibility and Spatial Resolution in MALDI–MSI of Peptides from Formalin-Fixed Paraffin-Embedded Samples*", Ly et al. https://onlinelibrary.wiley.com/doi/10.1002/prca.201800029 (used with permission)

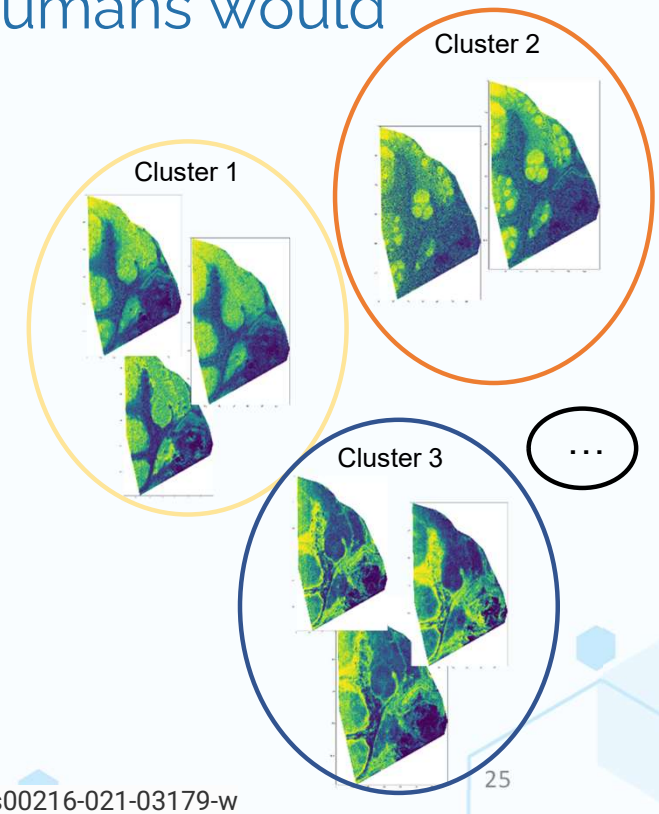
Clustering ion images

Wanqiu Zhang
Deep learning & AI

- Find similar images and group together as humans would



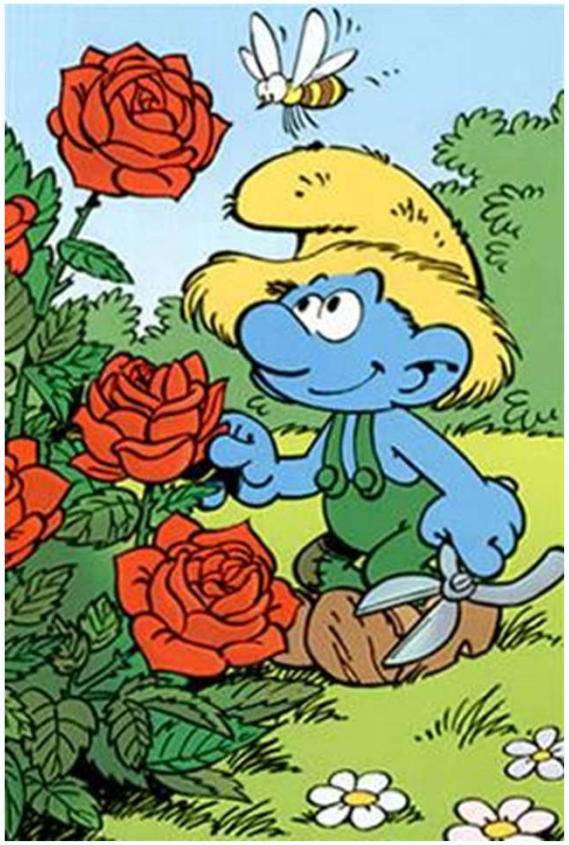


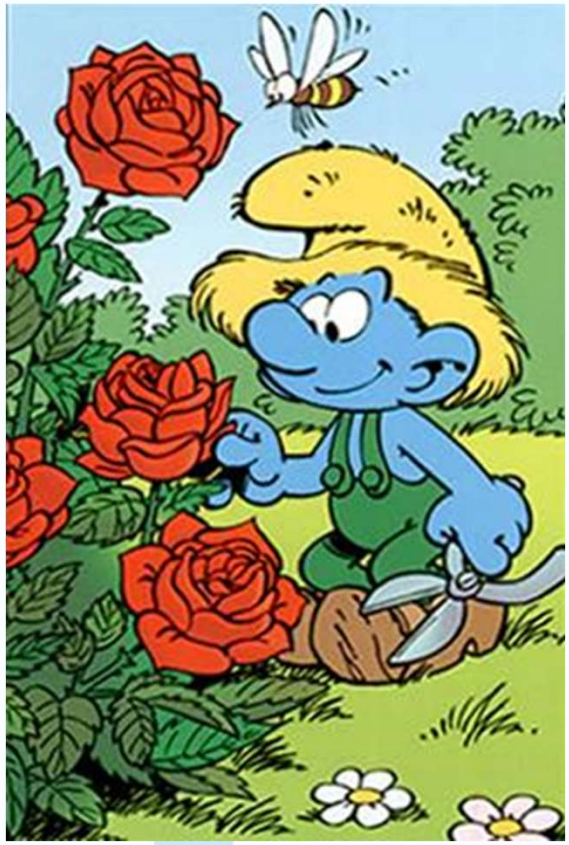


Zhang, W., et al. *Anal Bioanal Chem* 413, 2803–2819 (2021). https://doi.org/10.1007/s00216-021-03179-w

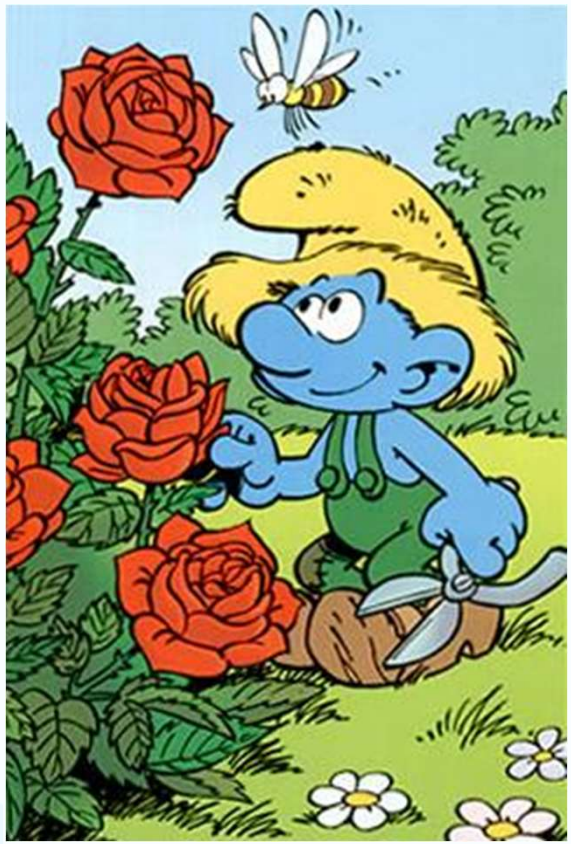
Comparing multiple MSI experiments

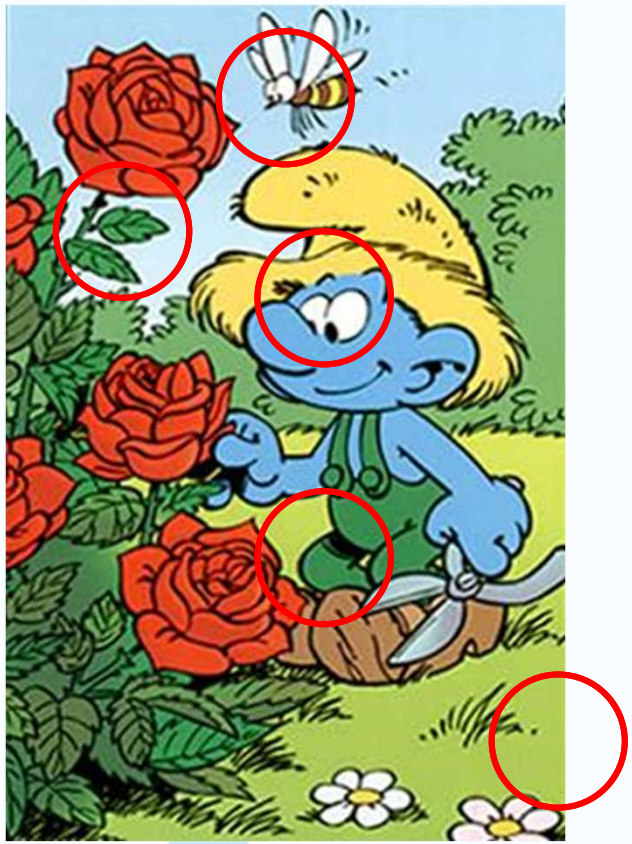
Spot the 5 differences

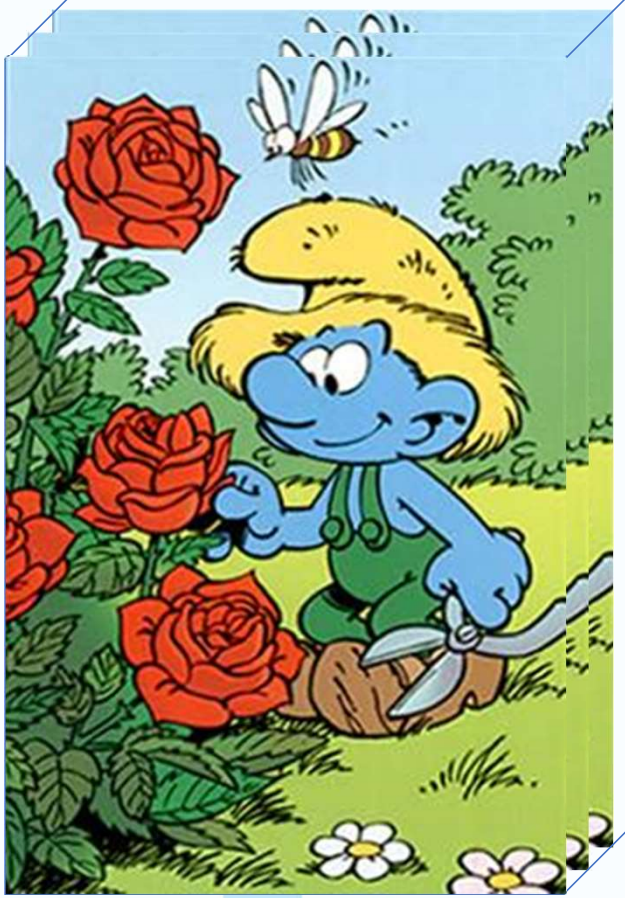




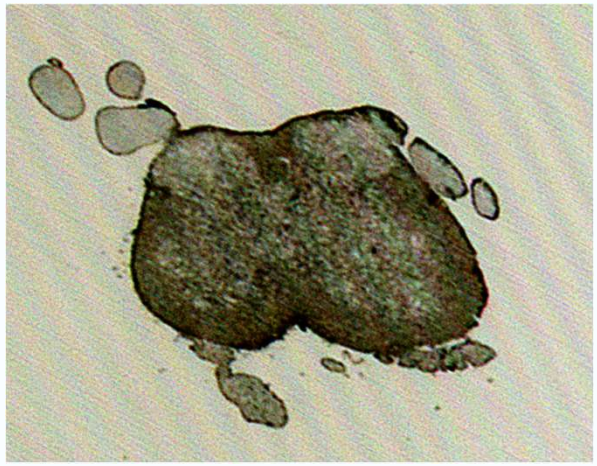
Spot the 5 differences



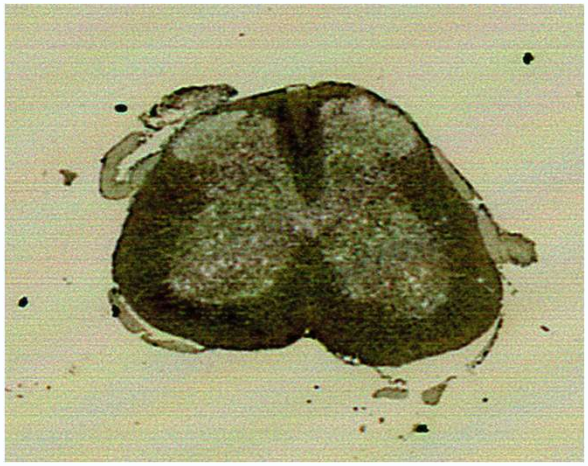




Multiple tissues



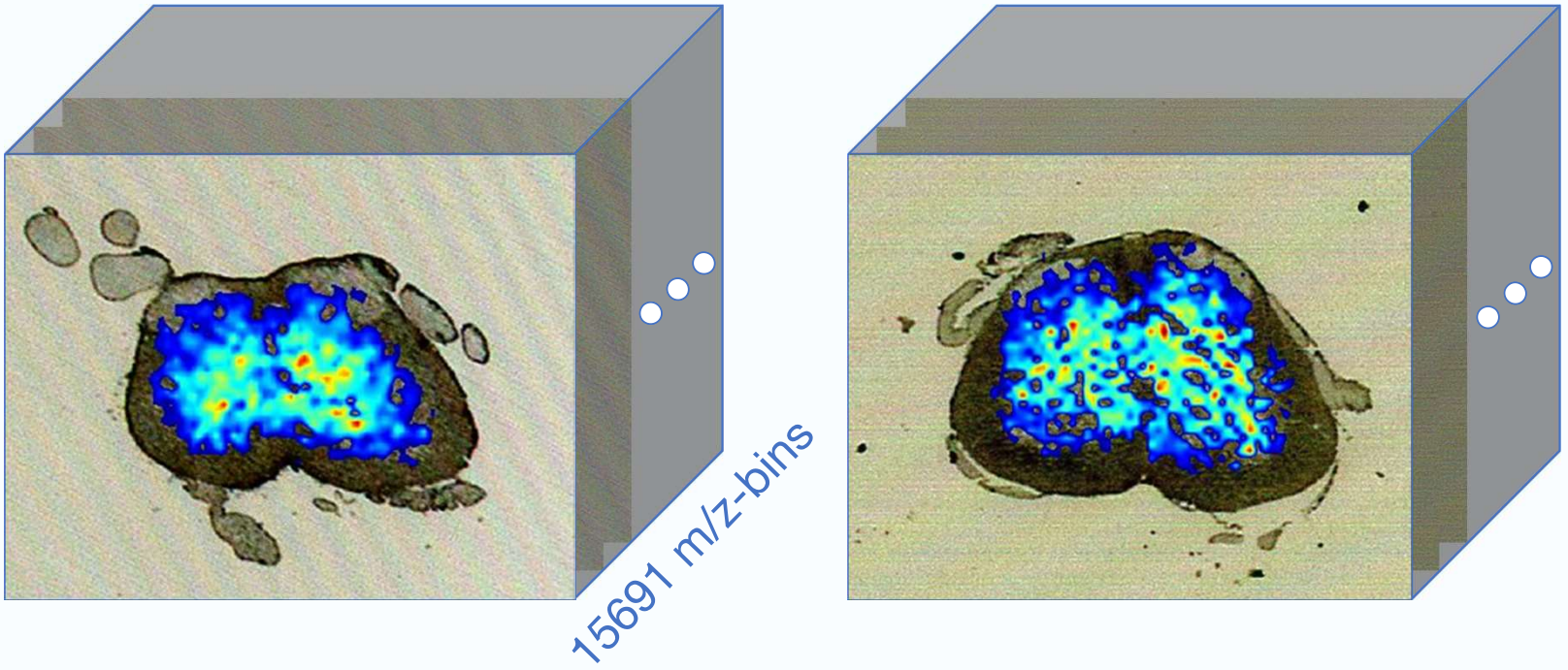
ALS
mouse model



Healthy

W. Robberecht, L. Vandenbosch, N. Verbeeck,
R. Van de Plas, E. Waelkens, B. De Moor

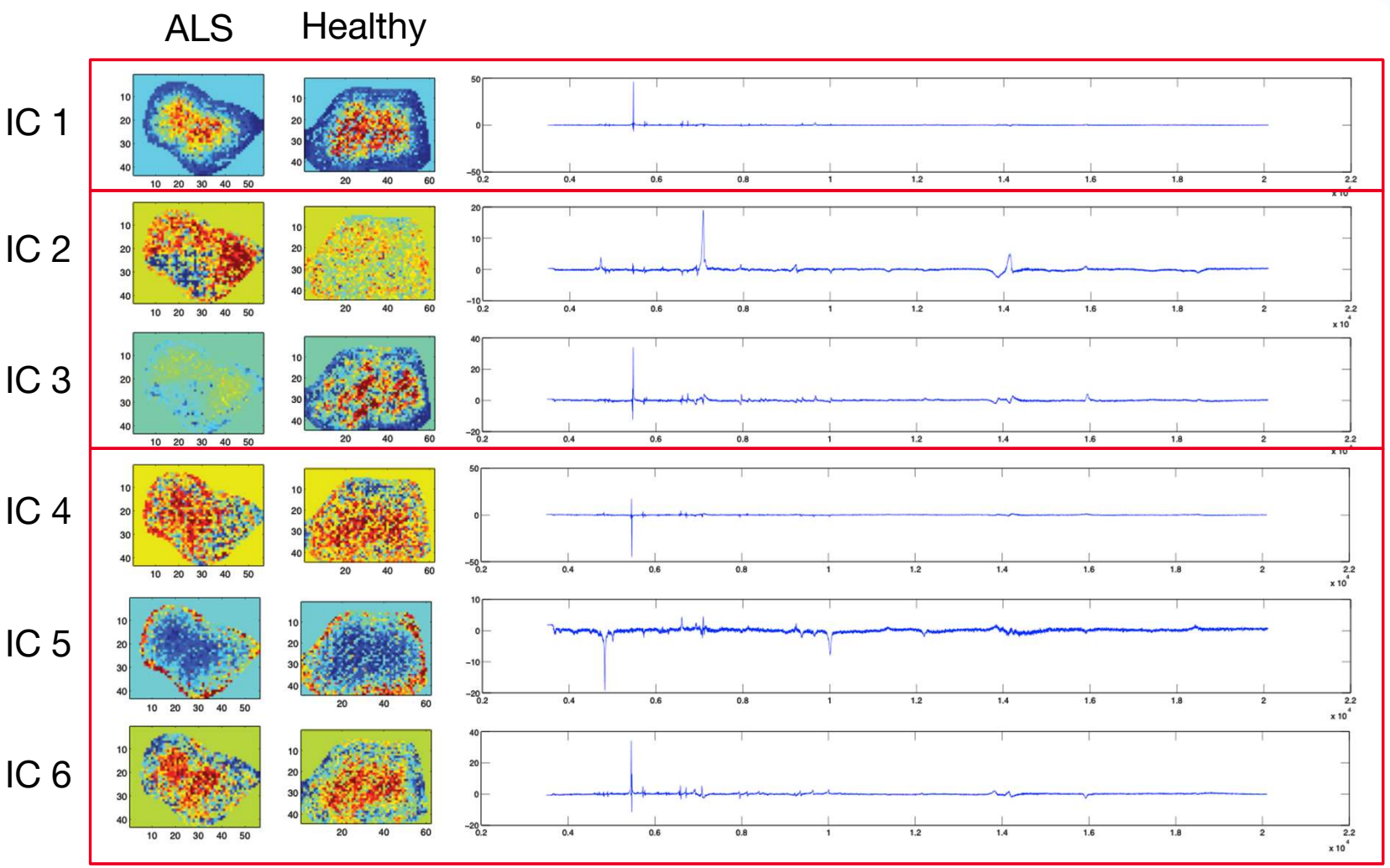
Multiple tissues



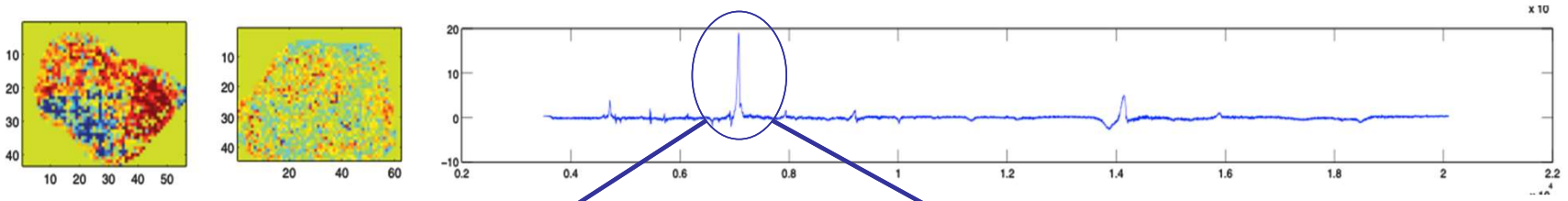
ALS

Healthy

GICA Results



Ion images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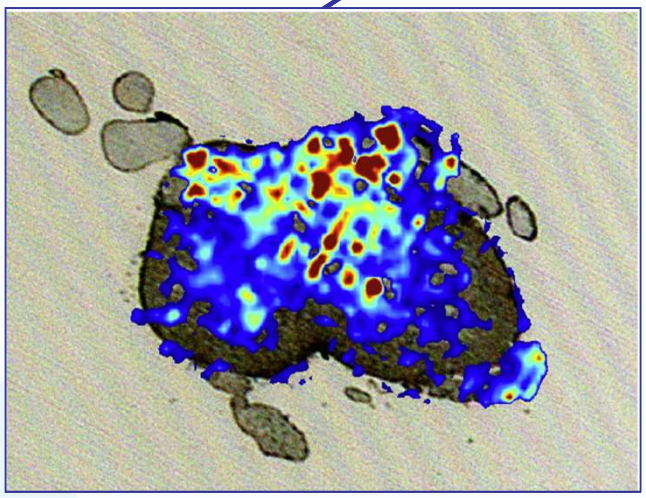
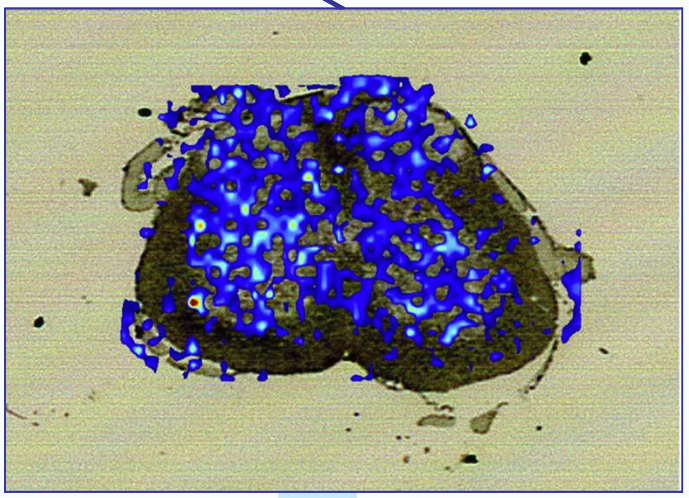
0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2
x 10





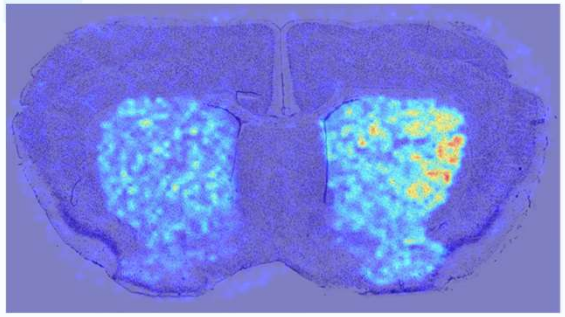
US visit opportunity

US visit opportunity

Go for it!

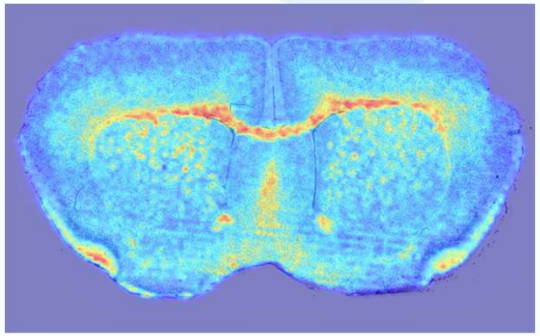
bdm

Protein



Bruker MALDI-TOF/TOF in linear mode
Matrix: SA sublimated
Mass range: m/z 3000 to 22000
Nr. m/z bins: 31232
Spatial res.: 100 um
Spatial grid: 53 x 98
Nr. pixels: 4371

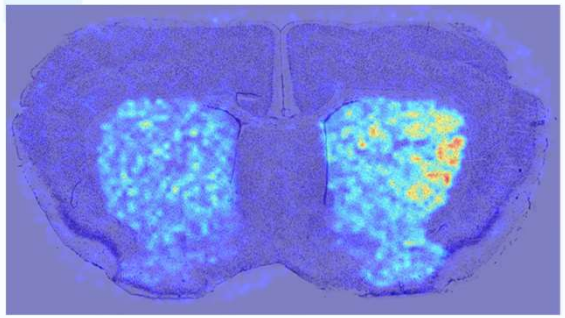
Lipid

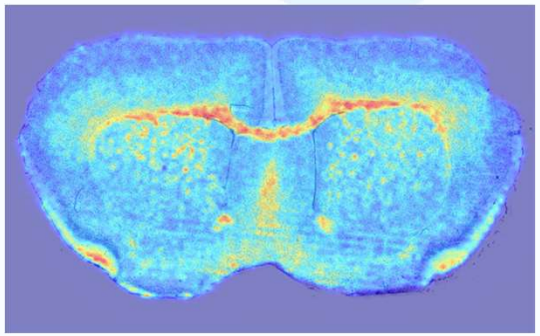


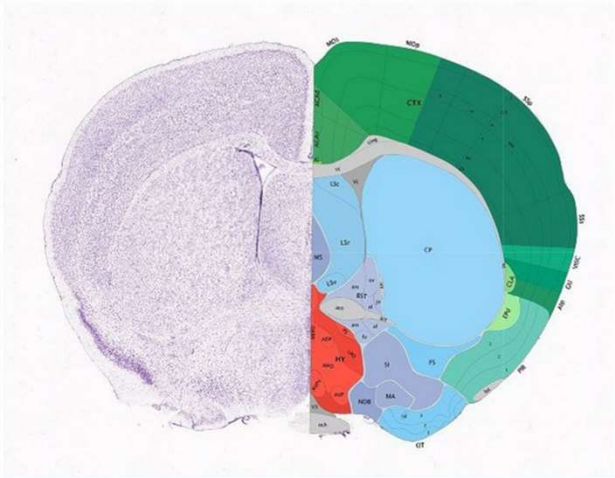
Bruker MALDI-TOF/TOF in linear mode
Matrix: DAN sublimated
Mass range: m/z 400 to 1000
Nr. m/z bins: 26624
Spatial res.: 80 um
Spatial grid: 127 x 77
Nr. pixels: 7626

Protein

Lipid



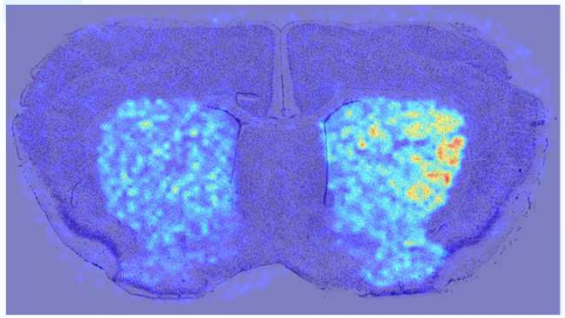


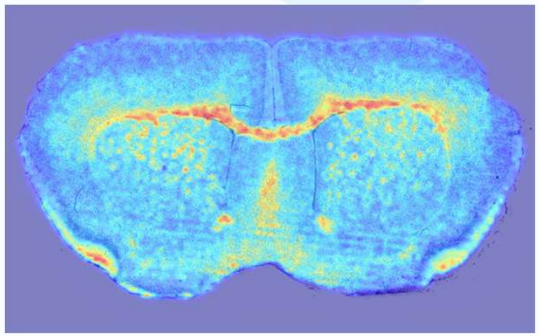


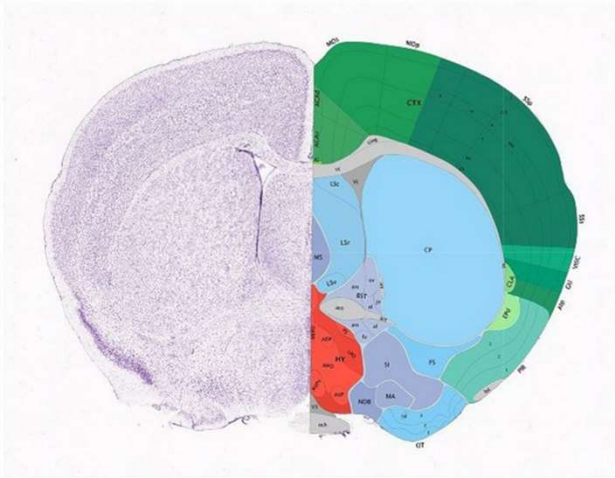

atlas.brain-map.org/atlas#atlas=1&plate=100960305&structure=485&x=5712&y=3696&zoom=-4&z=3
Search for structures here
CTXsp Cortical subplate
CNU Cerebral nuclei
STR Striatum
STRd Striatum dorsal region
STRv Striatum ventral region
LSX Lateral septal complex
LS Lateral septal nucleus
LSc Lateral septal nucleus, cau
LSr Lateral septal nucleus, rost
LSv Lateral septal nucleus, ver
SF Septofimbrial nucleus
SH Septohippocampal nucleus
sAMY Striatum-like amygdalar nuclei
PAL Pallidum
PALd Pallidum, dorsal region
PALv Pallidum, ventral region
PALm Pallidum, medial region
MSC Medial septal complex
MS Medial septal nucleus
NDB Diagonal band nucleus
TRS Triangular nucleus of septum
PALc Pallidum, caudal region
CB Cerebellum
BS Brain stem
Mouse, P56 Coronal
Acronym: STRd
Name: Striatum dorsal region
1675 microns
Mouse, P56 Coronal
Atlas

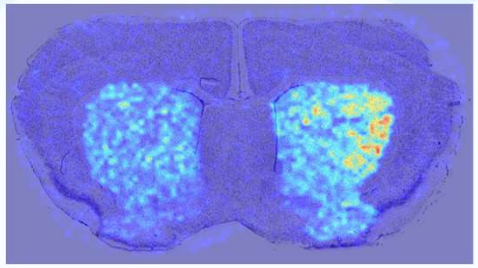
Protein

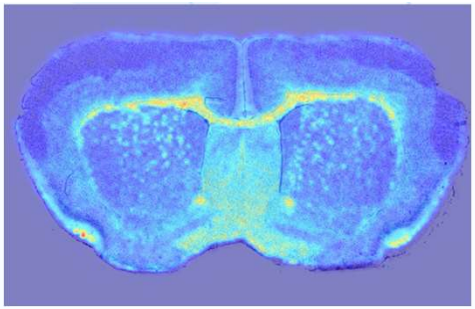
Lipid

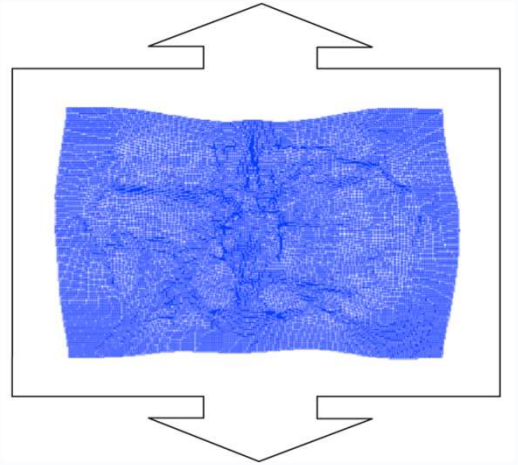




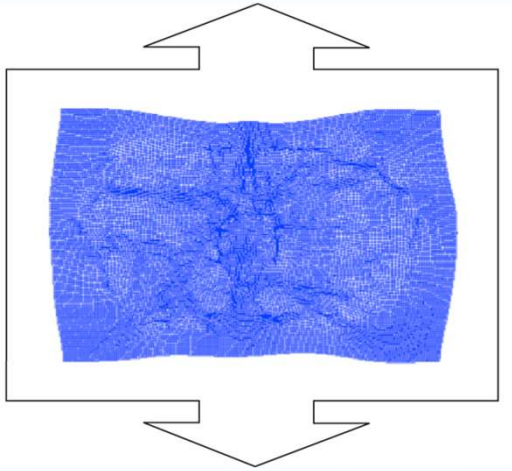


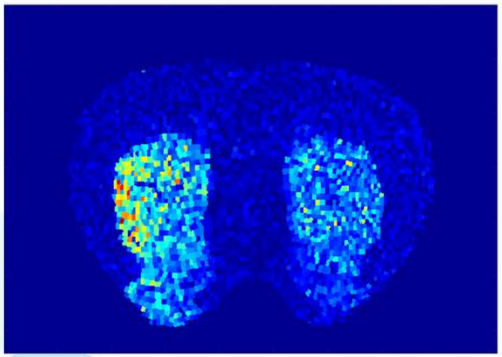


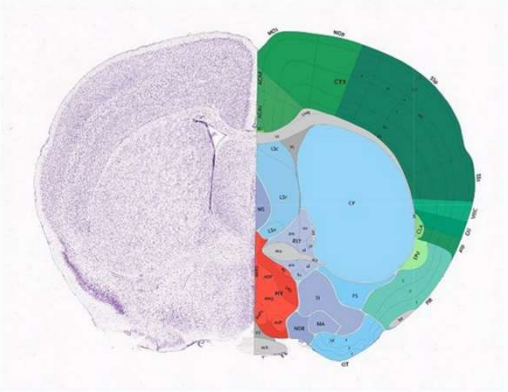


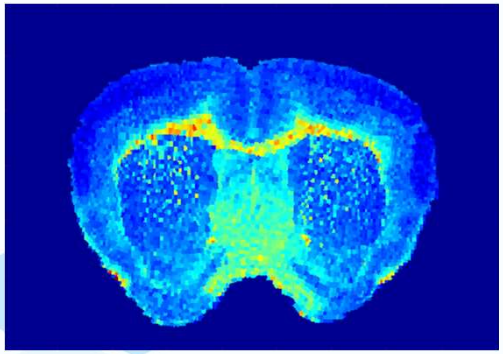


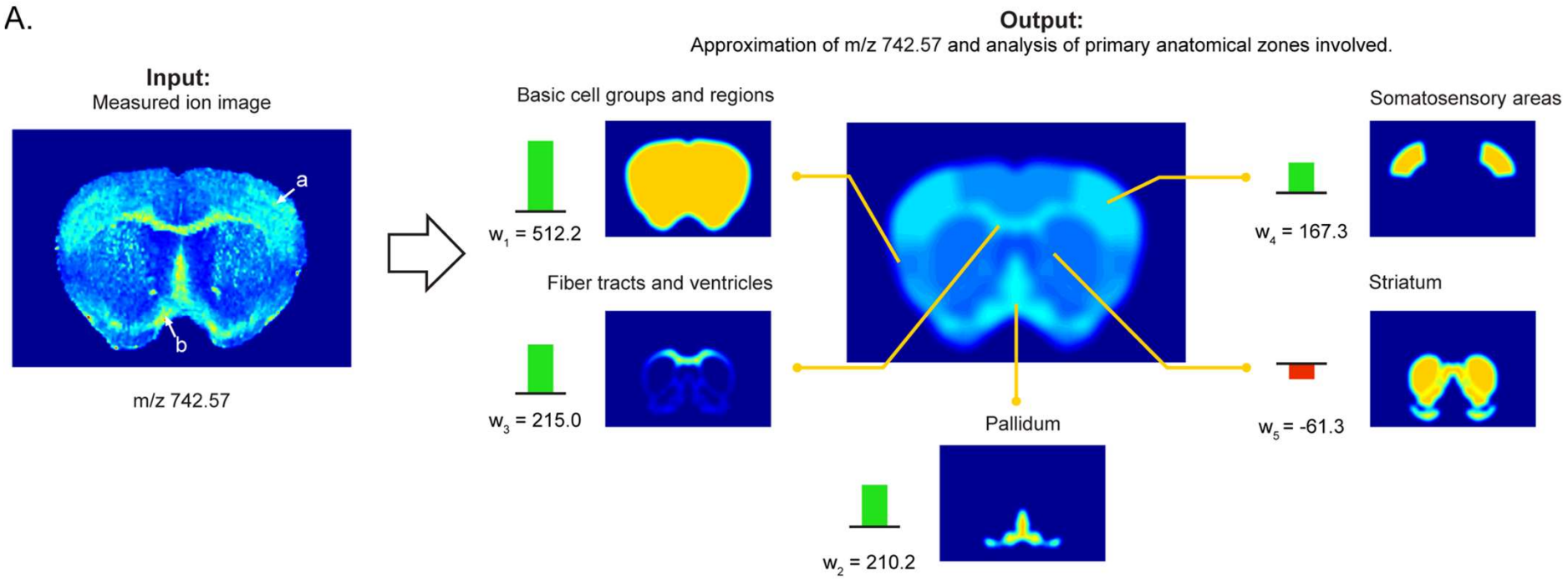
Nonrigid
Registration











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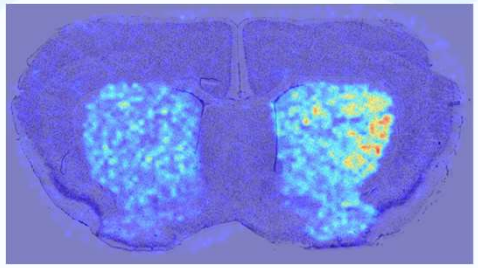
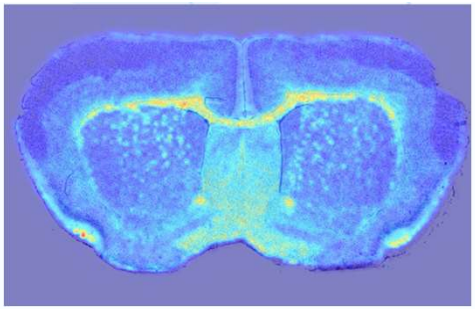
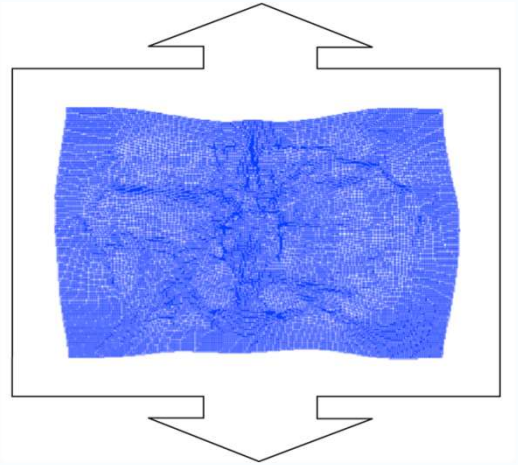
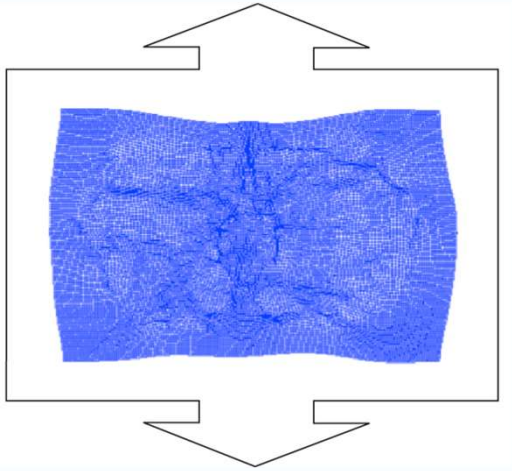
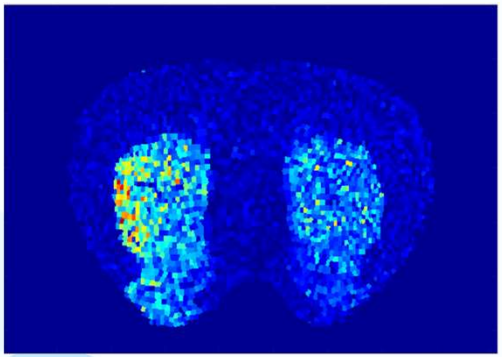


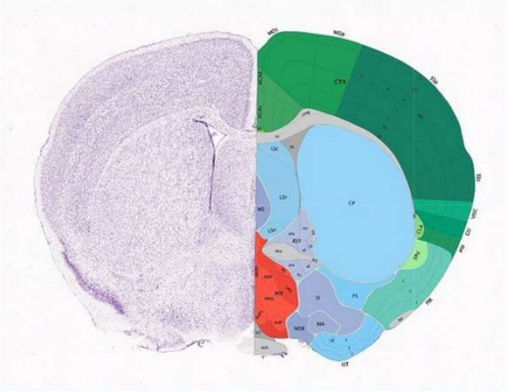


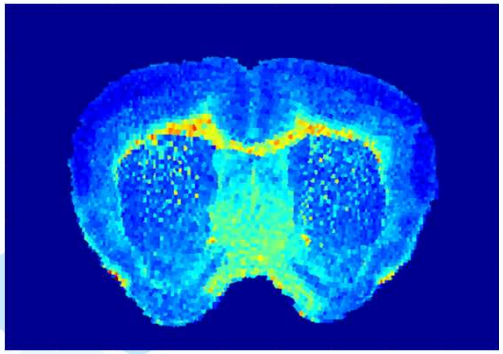


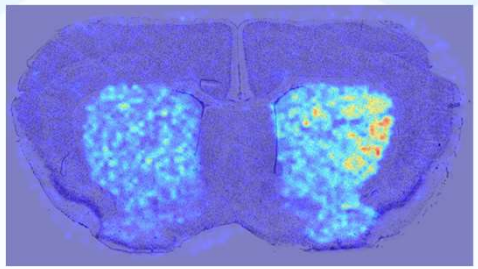
Nonrigid
Registration

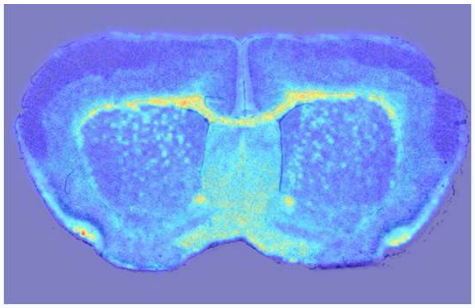


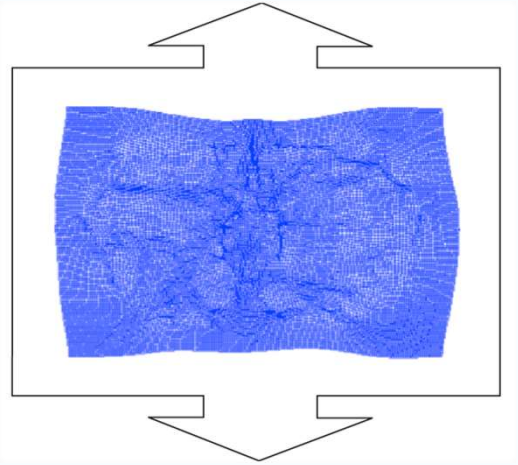


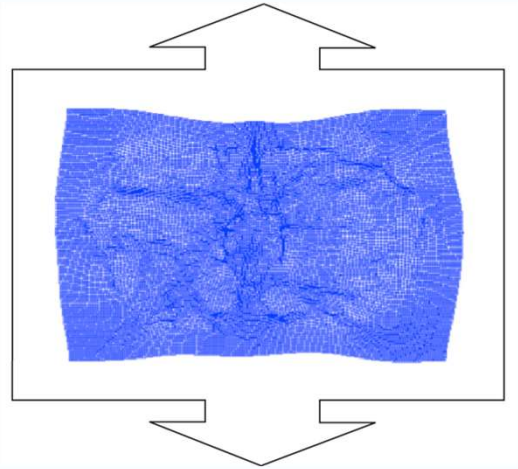


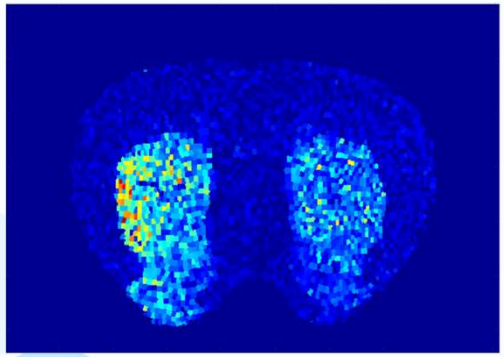


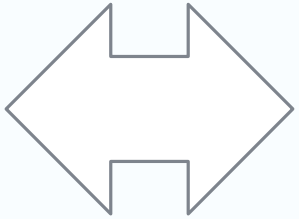


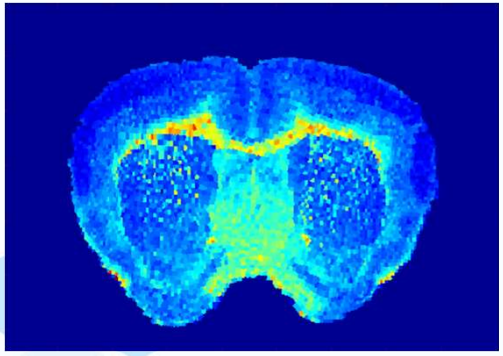




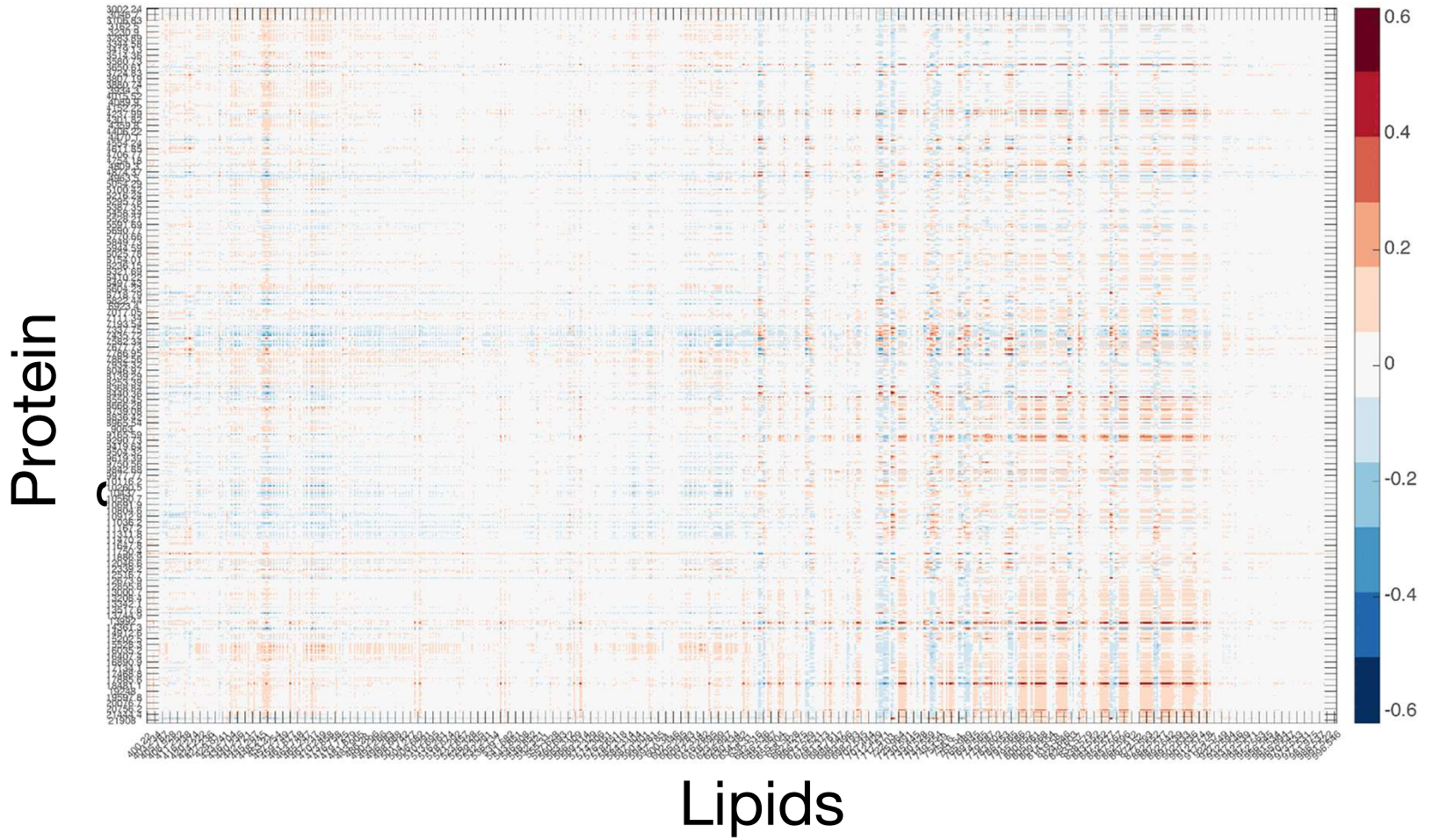




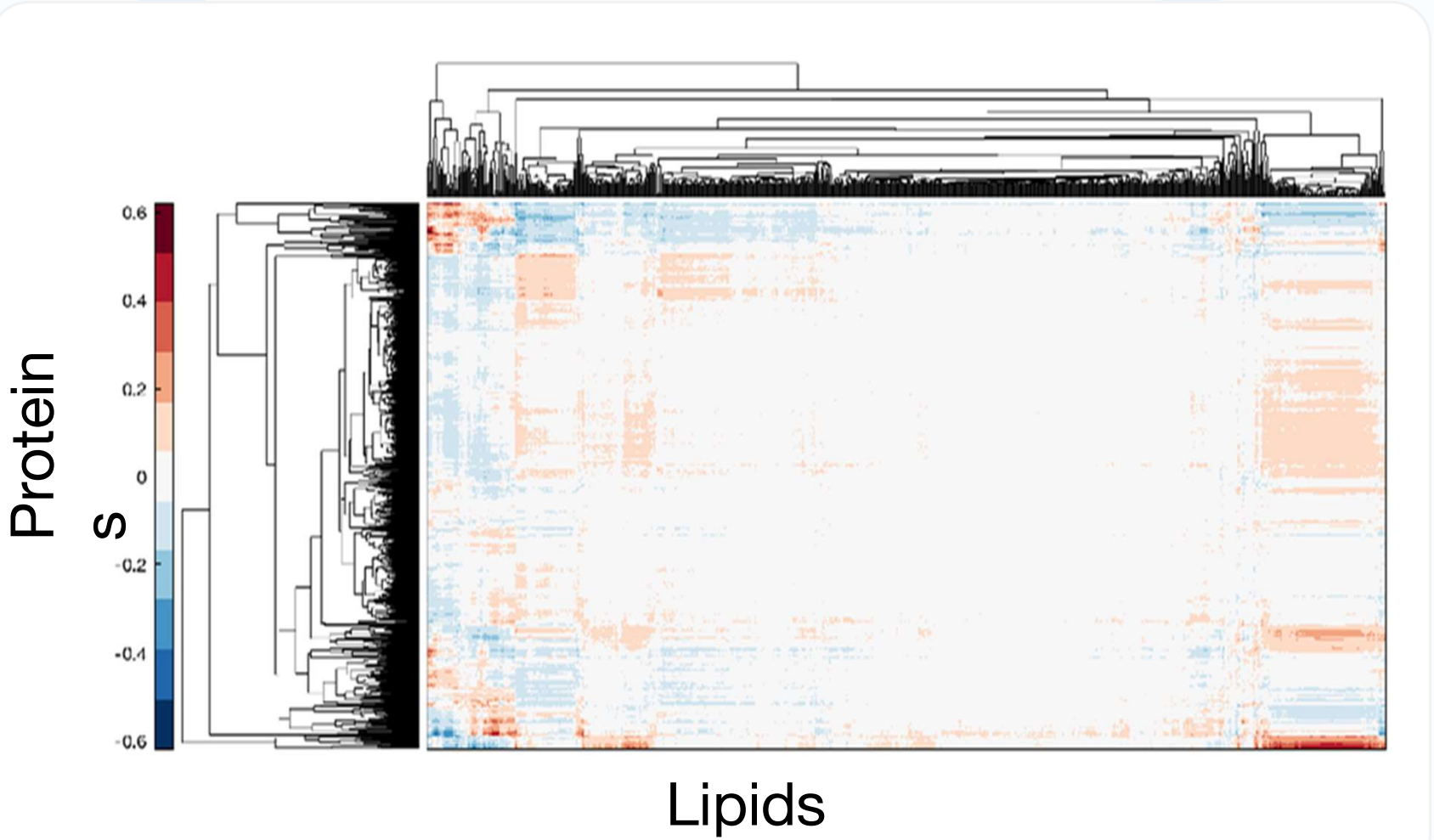




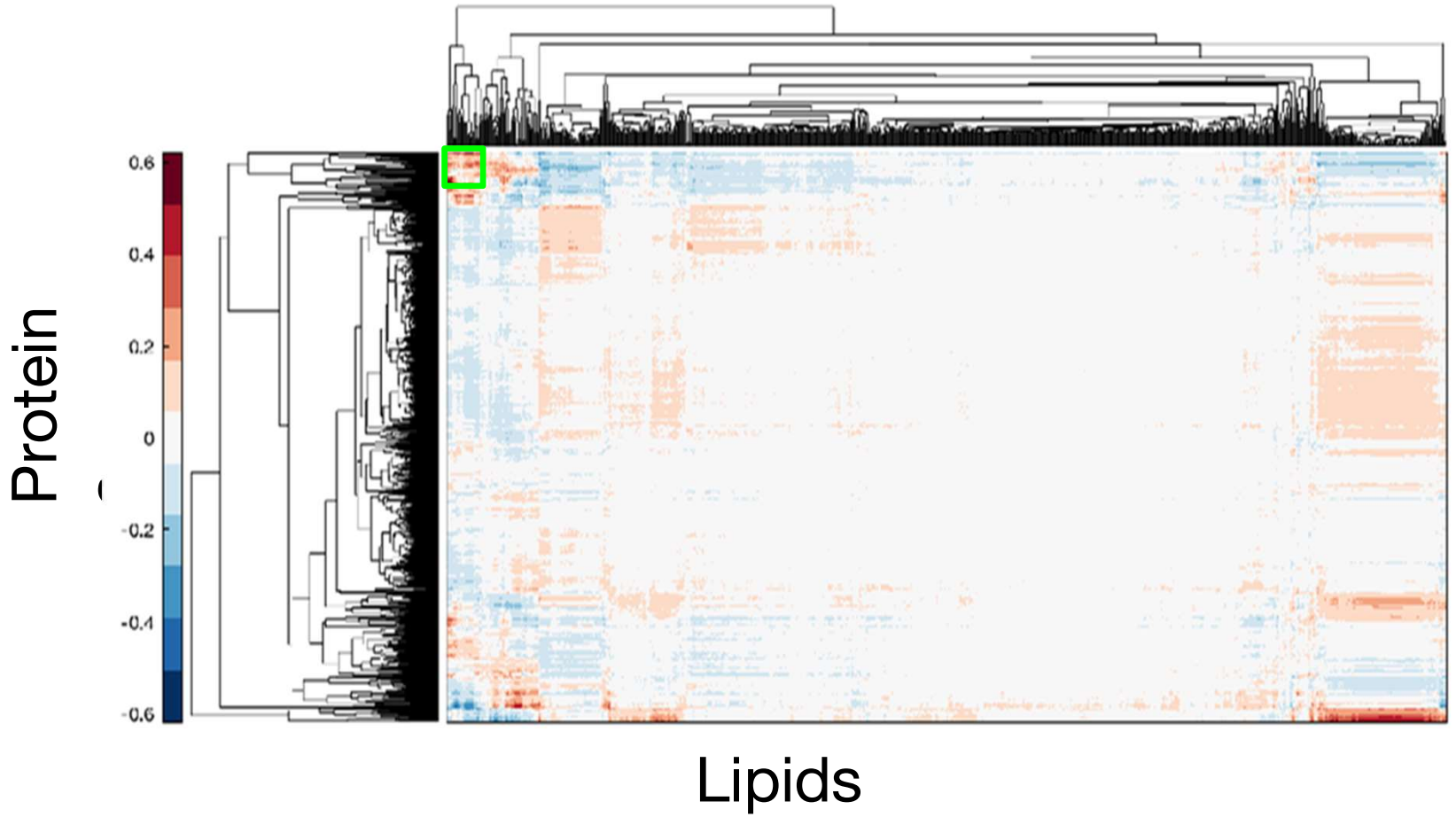
Correlation table



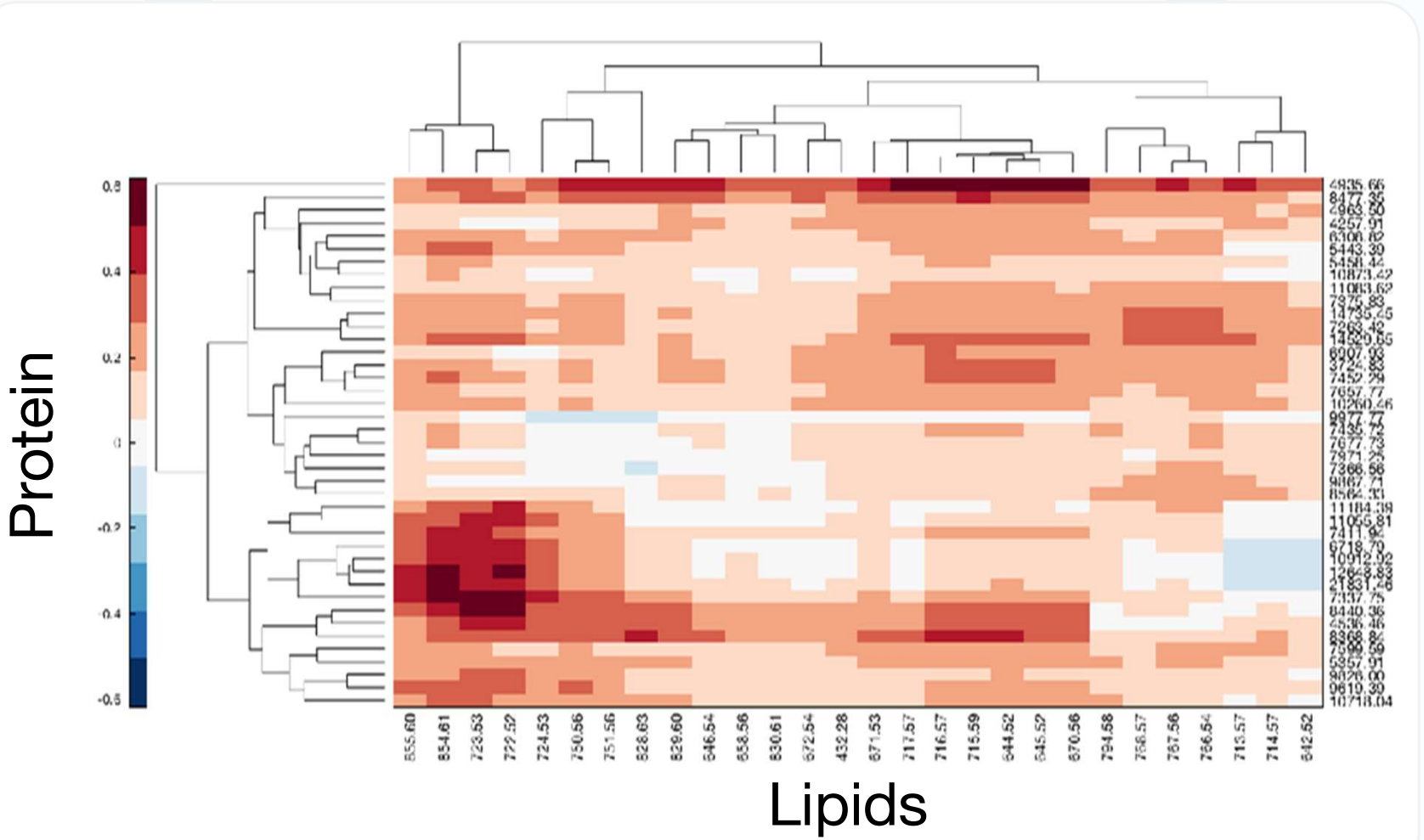
Bi-clustered correlation table

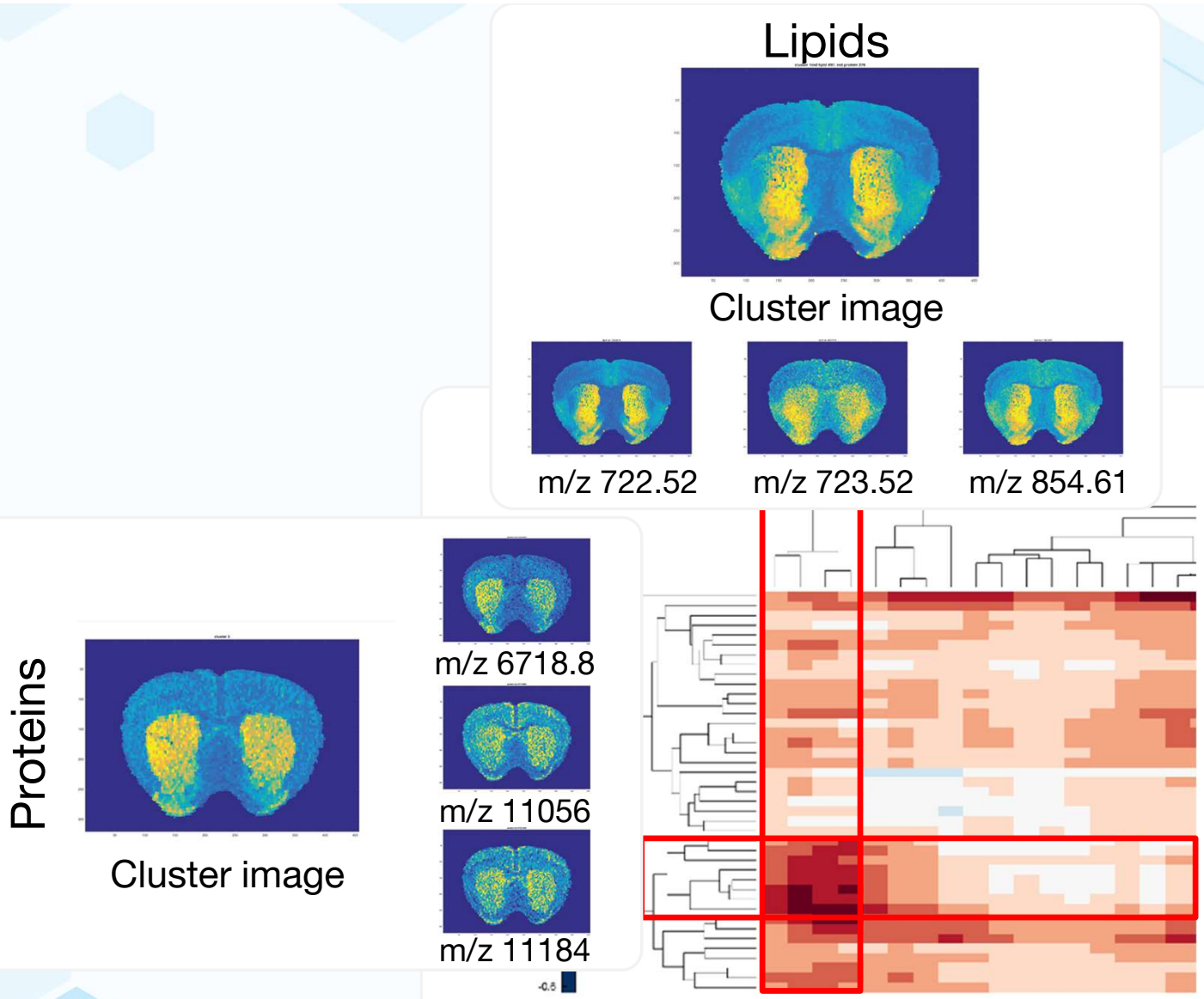


Bi-clustered correlation table



Bi-clustered correlation table (zoom-in)

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Cluster image
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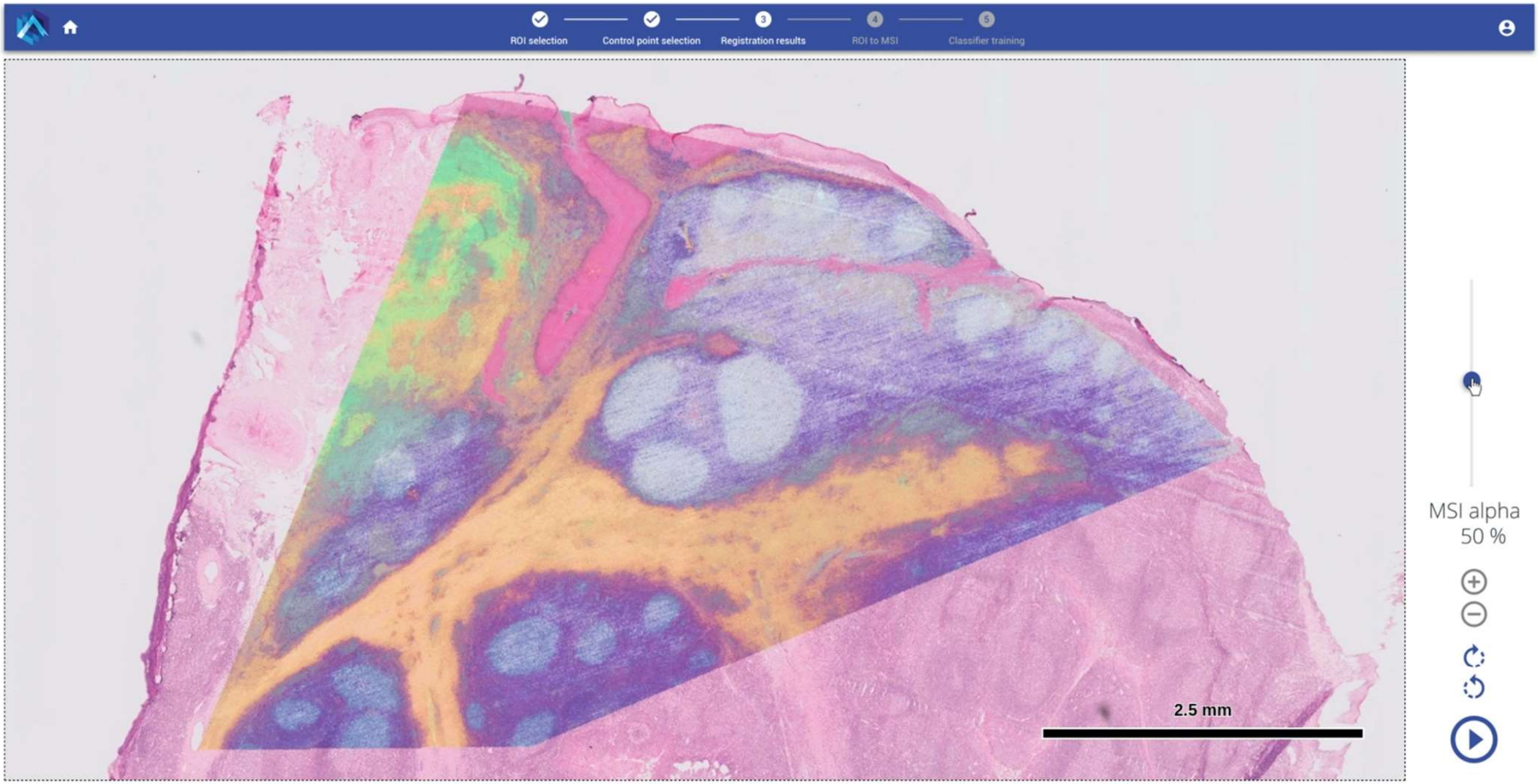
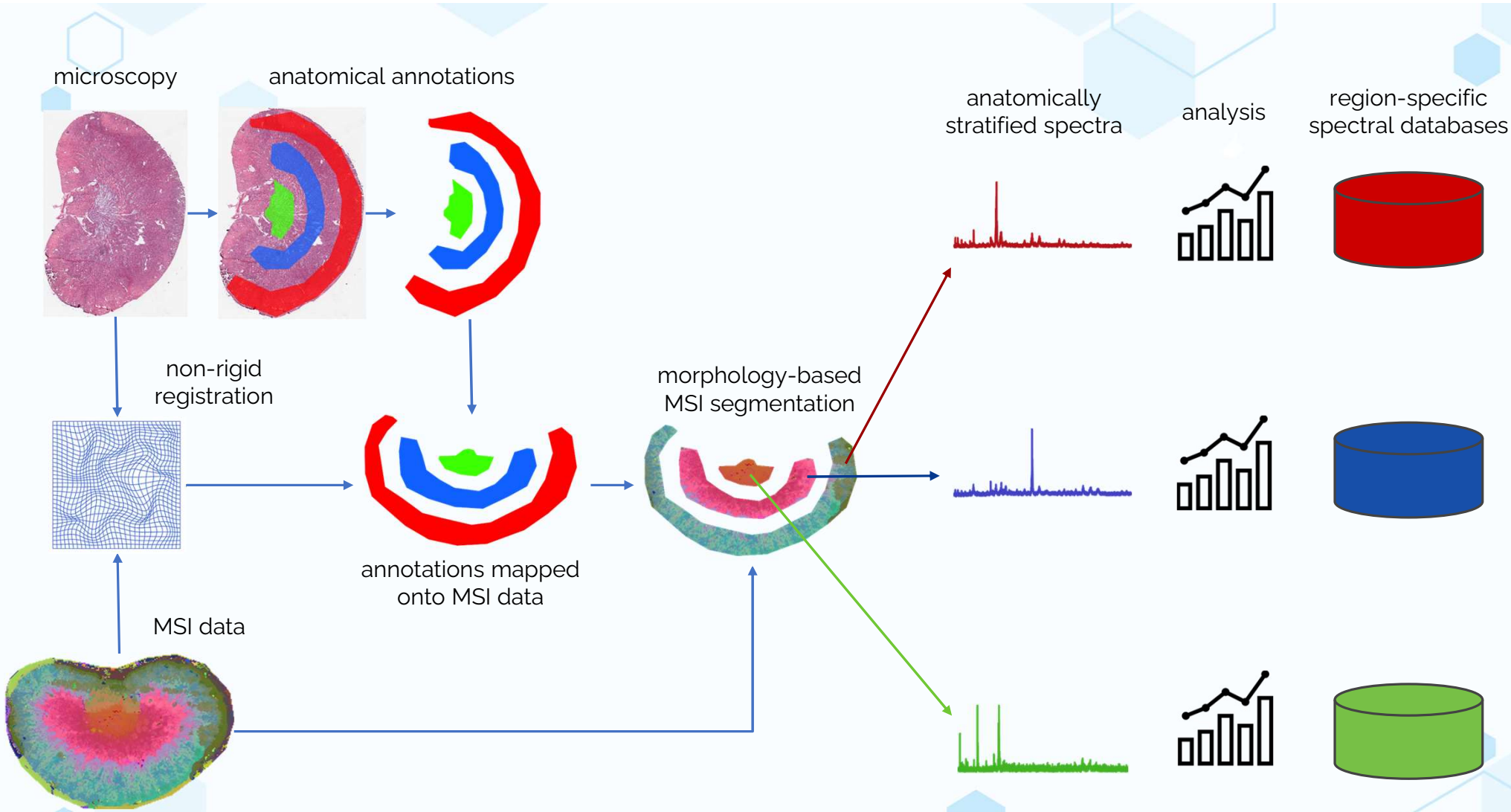
m/z 854.61
Proteins
Cluster image
m/z 6718.8
m/z 11056
m/z 11184


Aspect Analytics


ROI selection
Control point selection
3
Registration results
4
ROI to MSI
5
Classifier training
2.5 mm
MSI alpha
50 %


microscopy
anatomical annotations
anatomically stratified spectra
analysis
region-specific spectral databases
non-rigid registration
morphology-based MSI segmentation
annotations mapped onto MSI data
MSI data

Thank you for your attention!