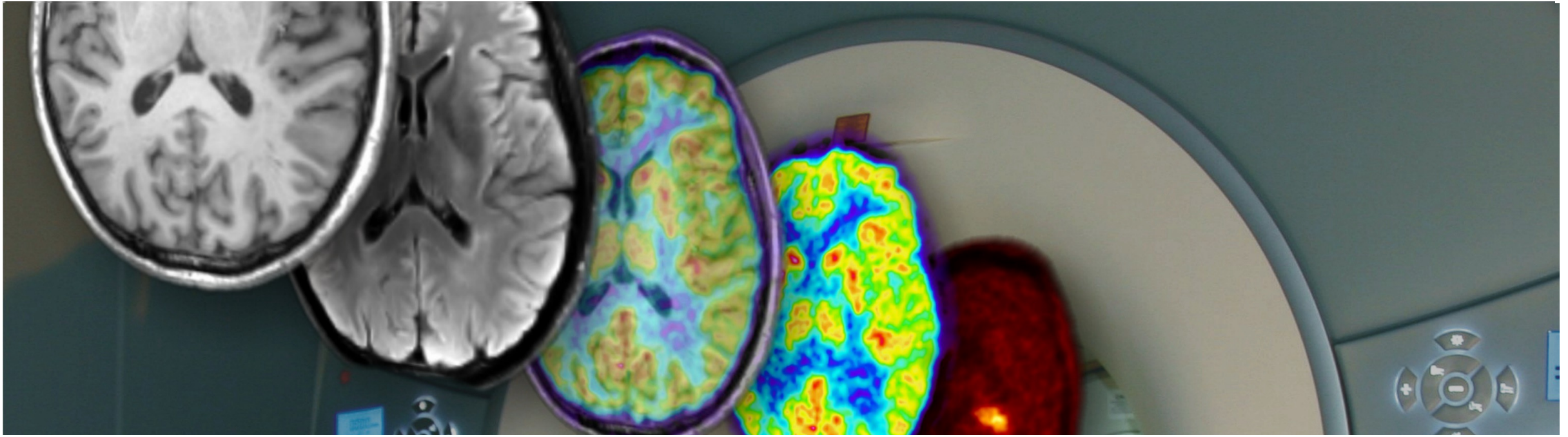




SMART|MR_IMAGING_LAB

N. Jon Shah,
Institute of Neuroscience and Medicine - 4
Forschungszentrum Jülich GmbH
Jülich

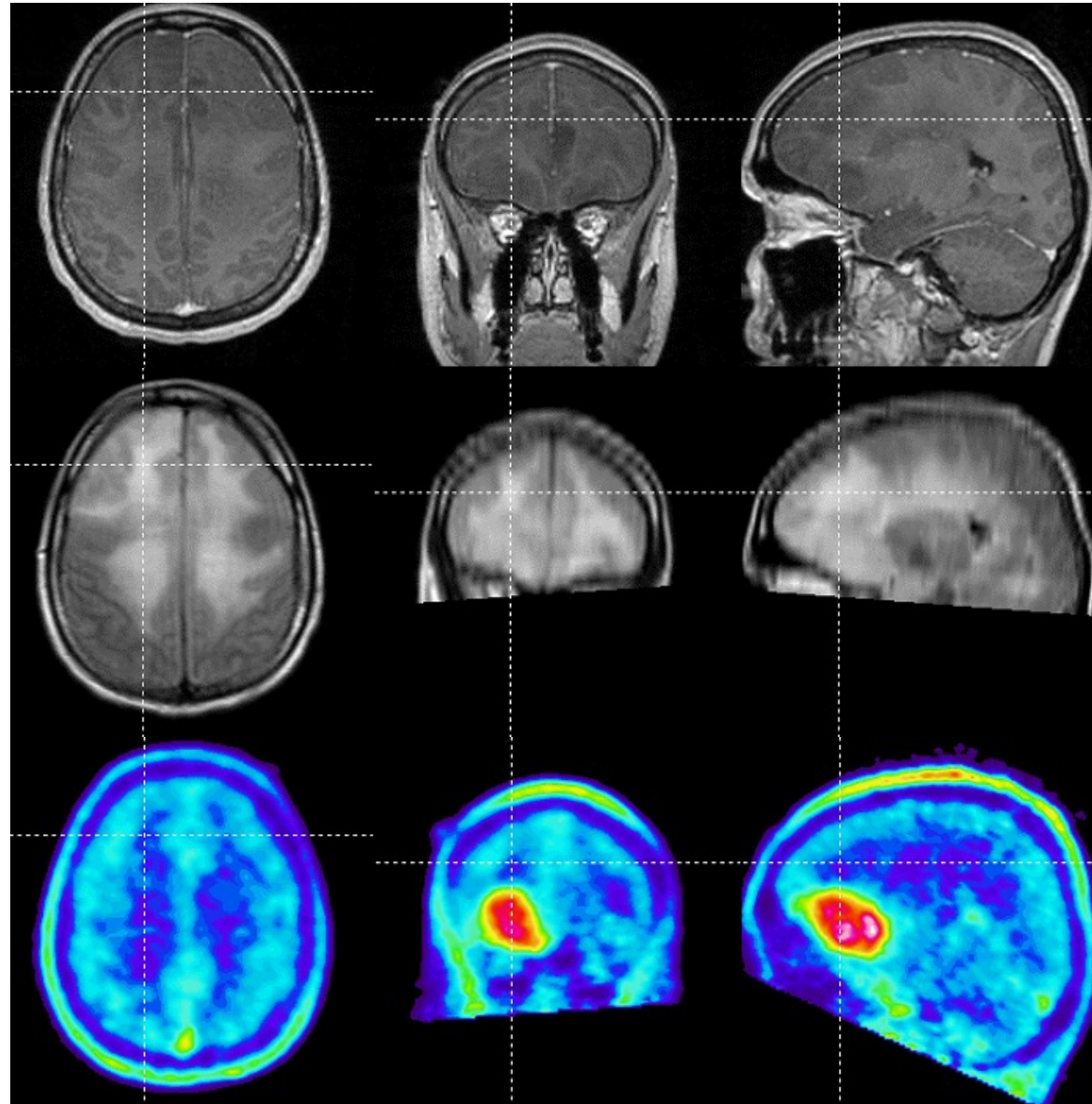
Professor of MRI Physics
Department of Neurology
Universitätsklinikum Aachen
Aachen

Department of Physics
Faculty of Natural Sciences
RWTH Aachen
Aachen

Z. Abbas, F. Ullah, H. Scharr. R.
Botchorishvili and Z. Metreveli

Tumour diagnostics (MRI and PET)

Brain Tumour ?



MR-T1 (CA)

MR-FLAIR

FET-PET

Astrocytoma Grade II

GGSB-PLUS*: “Health as a Global Challenge” (as planned in 2020 or so)

GGSB: Contributions from **SMART|Labs** in Georgia

Causes



Environment
(e.g. Air Quality)

Diagnostics



Medical Imaging
(MR-PET, Tracer)

Treatment



Hadron Therapy
(e.g. HTC at KIU)

*Start-up funds: EUR 200,000 from
BMBF for F. Ullah



Federal Ministry
of Education
and Research

GGSB-PLUS

Research Areas

- Biomedical Imaging
 - MRI / PET
 - Ultra-low Field MRI
 - Tracers
- Novel Machine Learning Software
- Clinical Translation

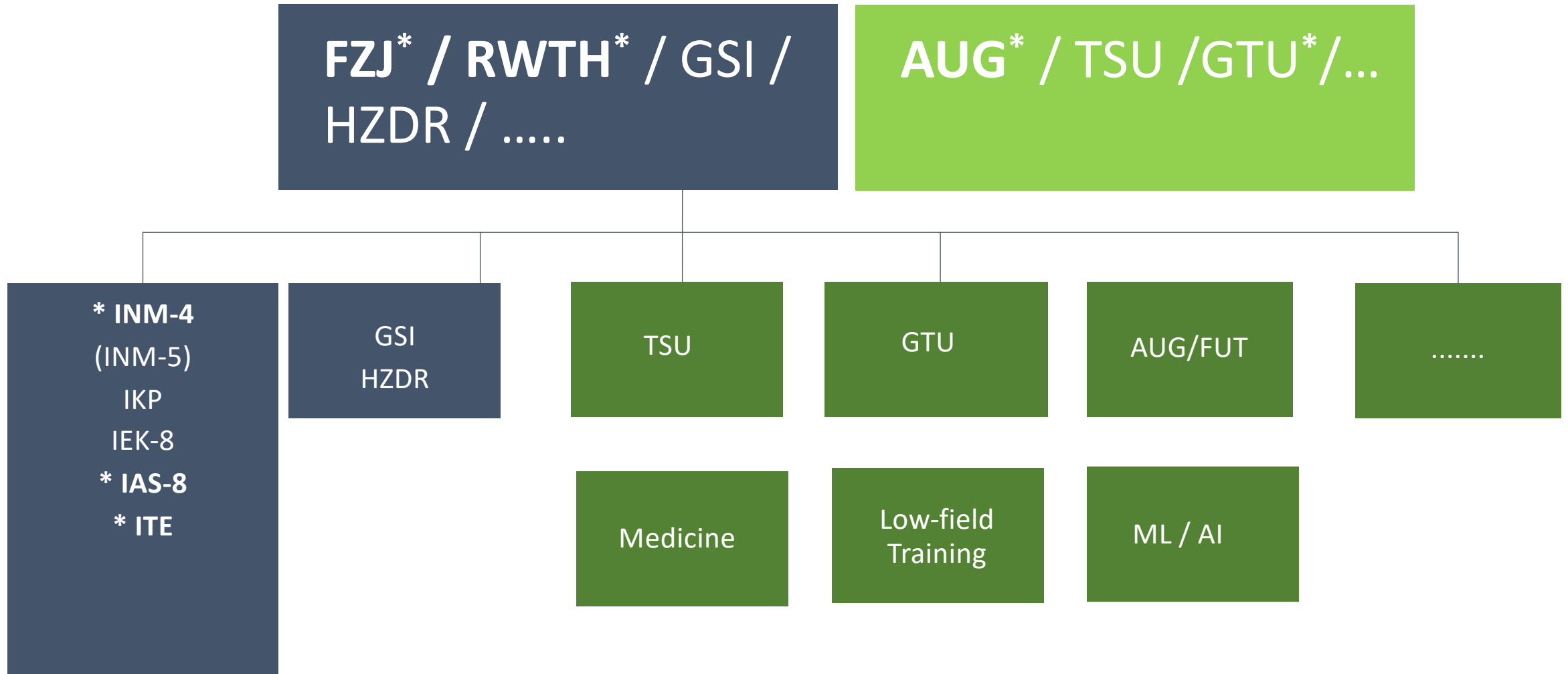
Platforms

- HTC ??
- Computational Resources
- Cyclotrons
-
- **Machine Learning**
- **Ultra-Low Field MRI**
- Animal Laboratory
- **Novel 7T BrainPET Insert**

Applications / Topics

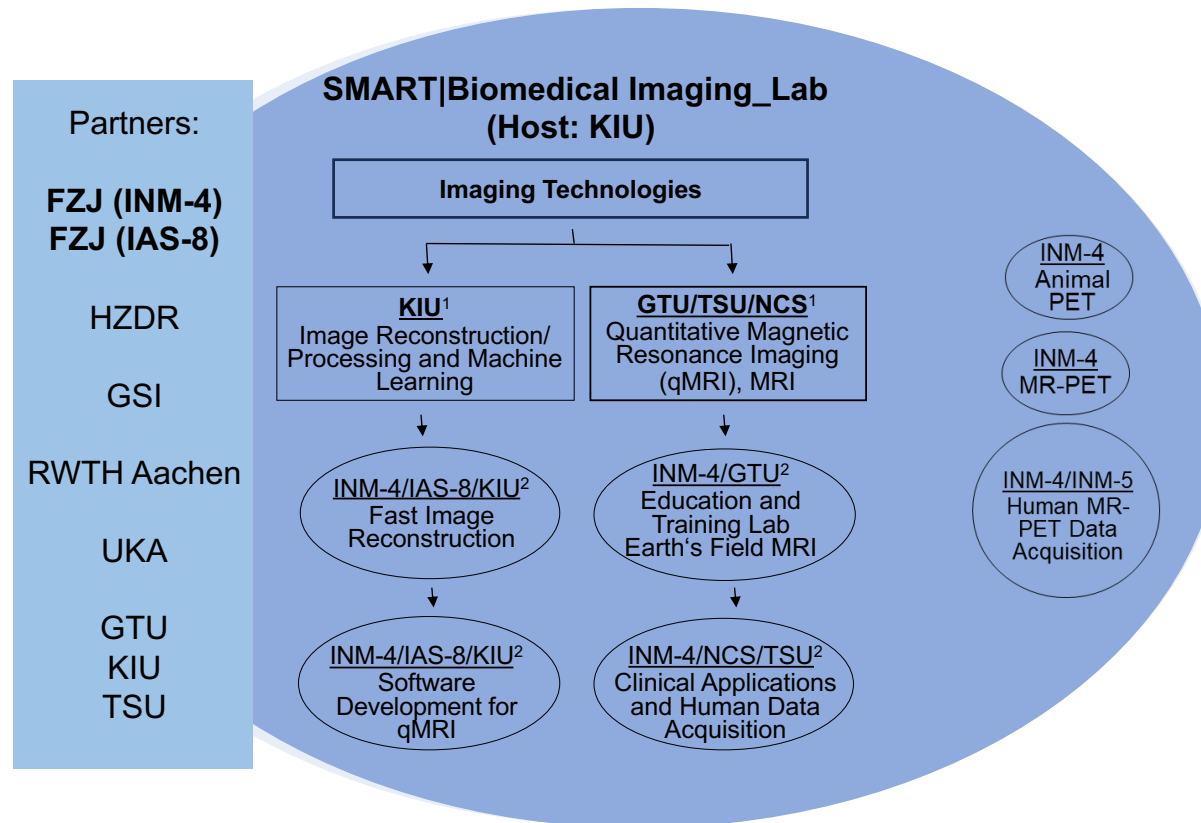
- Tumours / Stroke / Trauma
- Health

SMART|MR_Imaging Lab [Plans]



GGSB-PLUS: “Health as a Global Challenge” (as presented in 2024)

Organisation and Partners



Lab Leader:
Advertised



Federal Ministry
of Education
and Research



¹ Research directions proposed by initiators: RECTANGLES

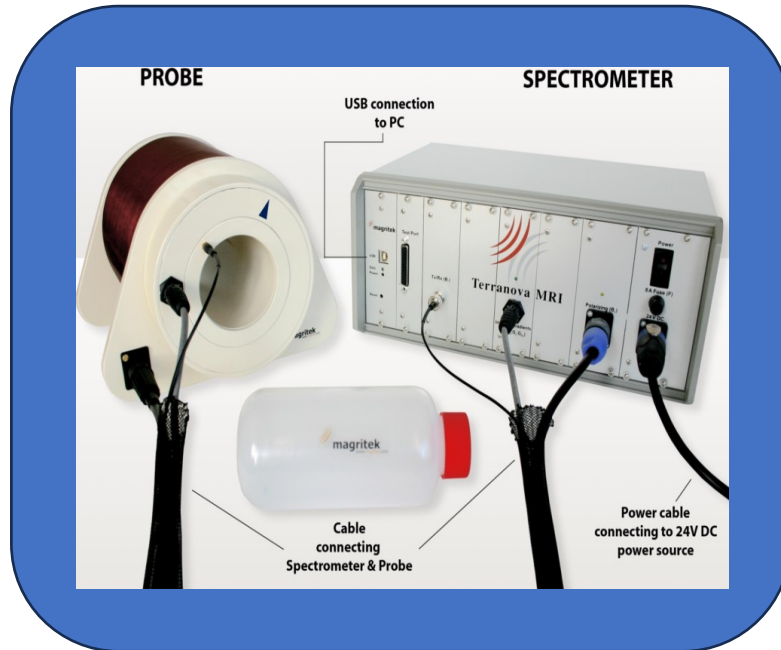
² Projects: ELLIPSES

ⁿ Partners are welcome to contribute to Projects

GGSB-PLUS: Low-Field MRI (as planned in 2020 or so)

Cooperation between Georgia and Germany

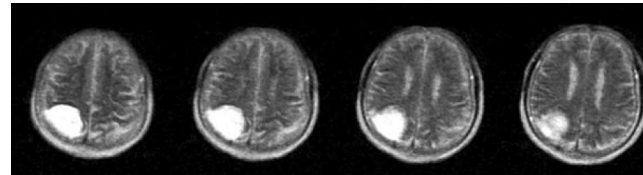
GTU



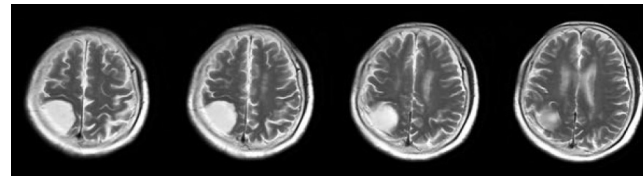
Terranova-MRI teaching device
(SMART|Sat-Lab: Medical Imaging Training Lab)

Georgia

0.055T
€200k



3.0T
€2mil



Influence of ML algorithms on the quality of MRI. Compare 0.055T with ML (top) vs 3T without ML

Adapted from Liu et al., NATURE COMM.
doi 10.1038/s41467-021-27317-1 2

FZJ / RWTH

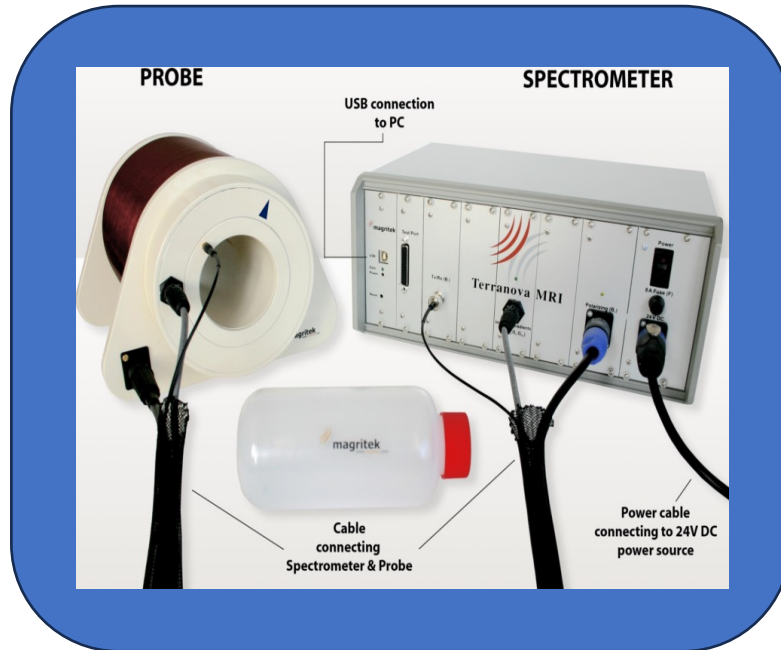


FDA-approved MRI scanner in Aachen. Suitable for intensive care units

INM-4 & ITE: Low-Field MRI (Today)

Cooperation between Georgia and Germany

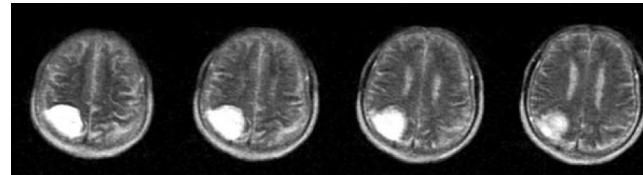
Training @ FZJ



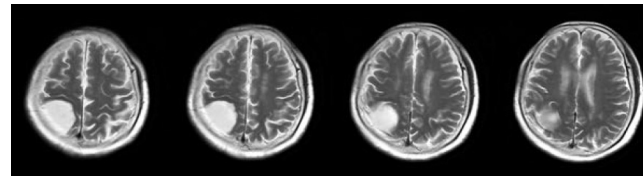
Terranova-MRI teaching device
(SMART|Sat-Lab: Medical Imaging Training
Lab)

Georgia

0.055T
€200k



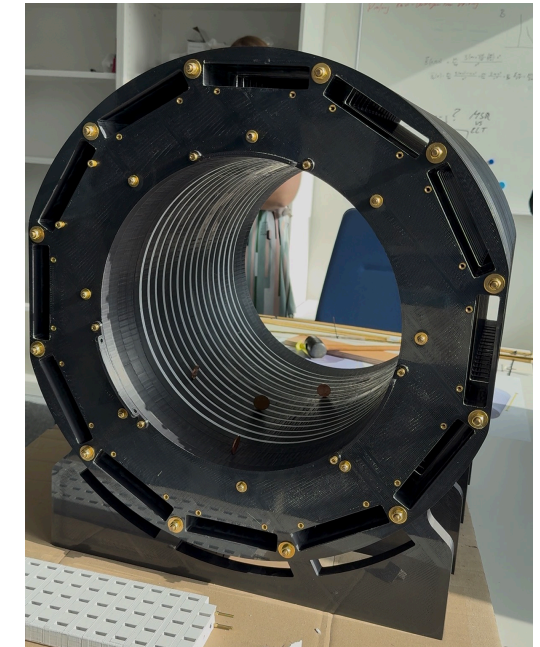
3.0T
€2mil



Influence of ML algorithms on the
quality of MRI. Compare 0.055T
with ML (top) vs 3T without ML

Adapted from Liu et al., NATURE COMM.
doi 10.1038/s41467-021-27317-1 2

FZJ: INM-4/ITE



Scanner being constructed in FZJ.
Will be suitable for intensive care
units

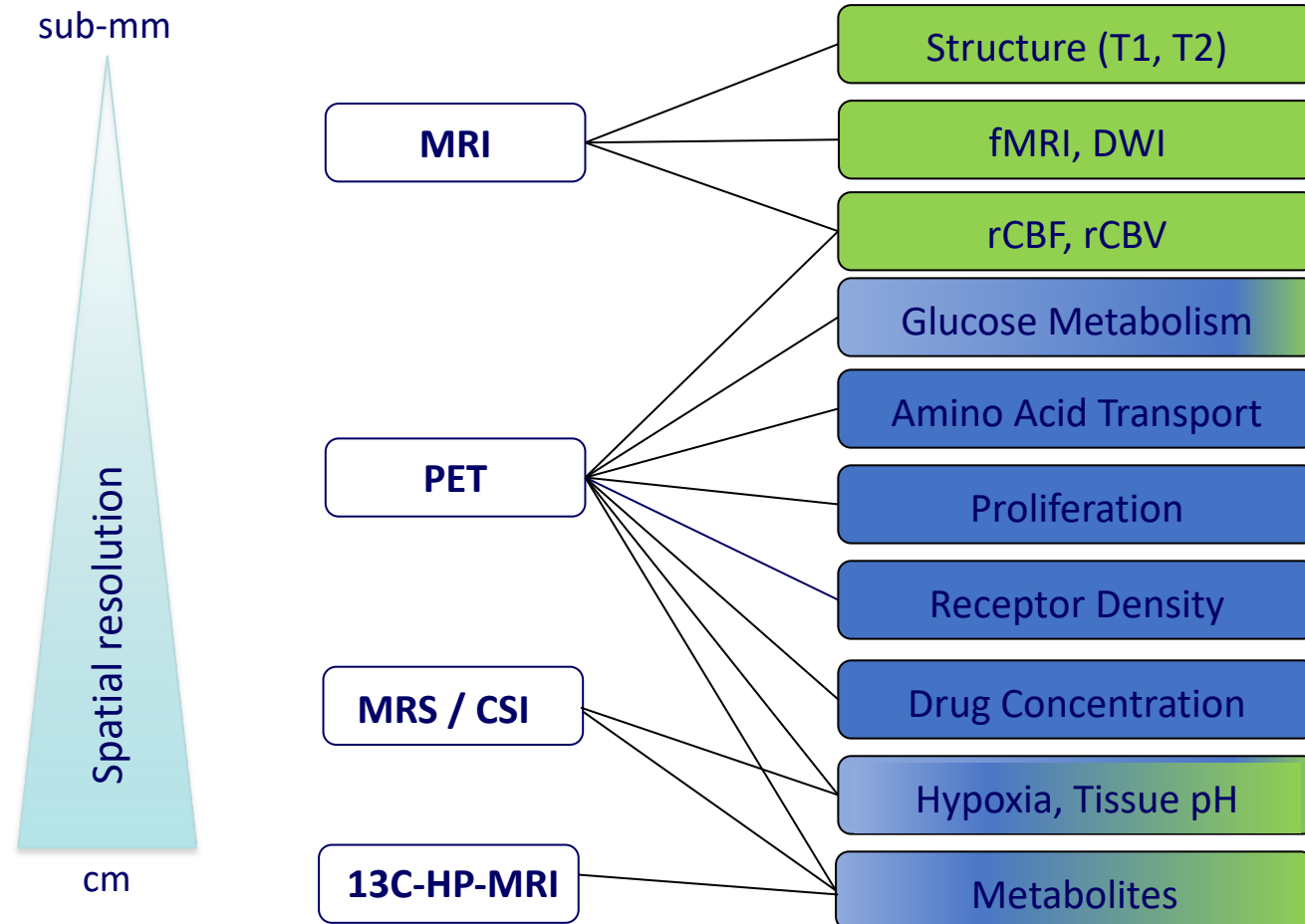
Why ultra low field?

- Advances in machine learning and AI allow 'signal boosting'



Multimodal, Multidimensional Imaging

DFG: INST 222/1585-1 Shah NJ et al., Metabolic Imaging in Clinical Applications using Hyperpolarised [1-13C]pyruvate
~ € 3.7 million



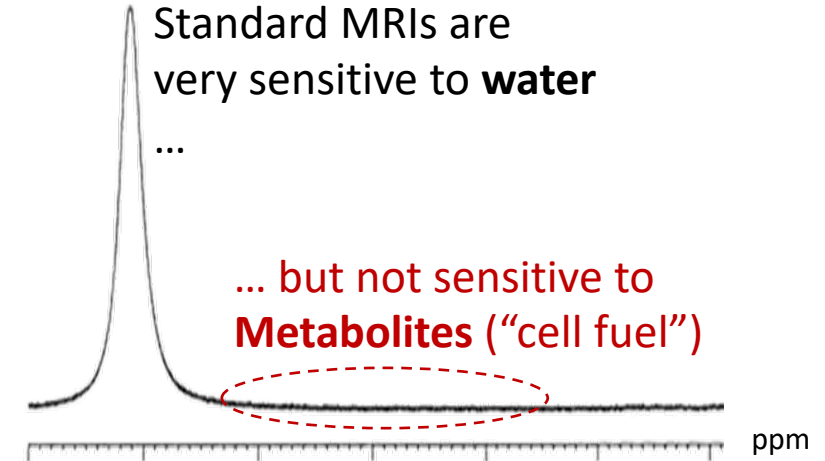
MRI scanners are powerful, safe and used widely in the clinic ...

- Worldwide installed base of ~ 50k MRIs
- ~70 mio scans annually
- Indispensable to many clinical fields, including oncology, neurology, etc.
- Safe for children, pregnant women

MRI scanners are powerful, safe
and used widely in the clinic ...

... yet, on its own MRI lacks
the sensitivity required
for **metabolic** analysis & imaging

- Worldwide installed base of ~ 50k MRIs
- ~70 mio scans annually
- Indispensable to many clinical fields, including oncology, neurology, etc.
- Safe for children, pregnant women

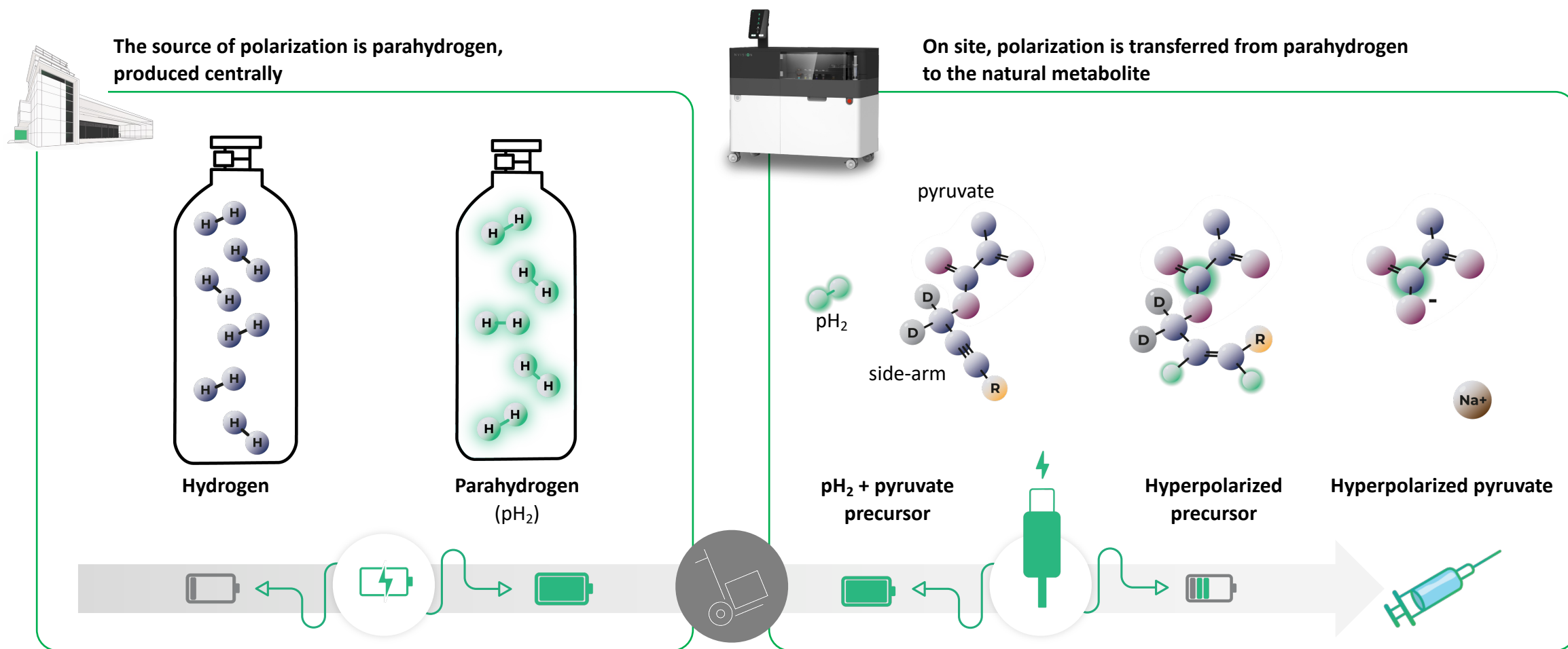


Introducing
POLARIS

Unlocking the
full potential of MRI



NVision's scalable process based on PHIP-SAH uses transportable polarized hydrogen to enable room-temperature hyperpolarization in 2-3 minute



NVision has developed a unique quantum-based platform that makes standard MRIs sensitive to metabolites and transforms them into powerful metabolic imagers

1

INSERT KIT

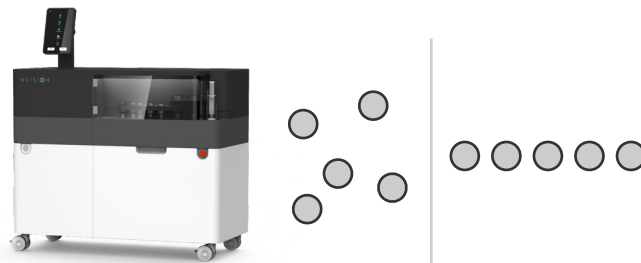


NVISION

Take ready-to-use, single-use kit with precursor **metabolic agent** (natural to the body) e.g., ¹³C-pyruvate

2

POLARIZE



NVISION

Use **POLARIS** to rapidly enhance the MRI signal of the metabolic agent > 10,000x, making it visible to the MRI

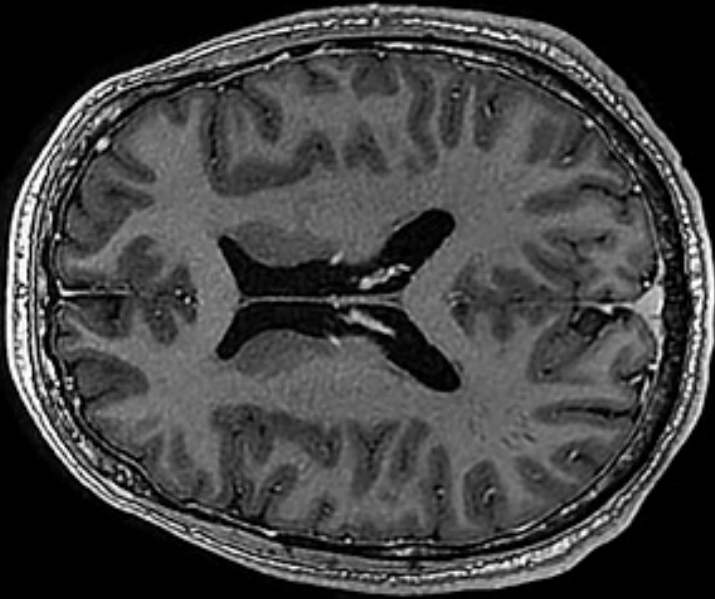
3

SCAN



Inject the hyperpolarized metabolite and scan with standard **MRI**, scan takes 1-2 minutes only due to intense signal strength

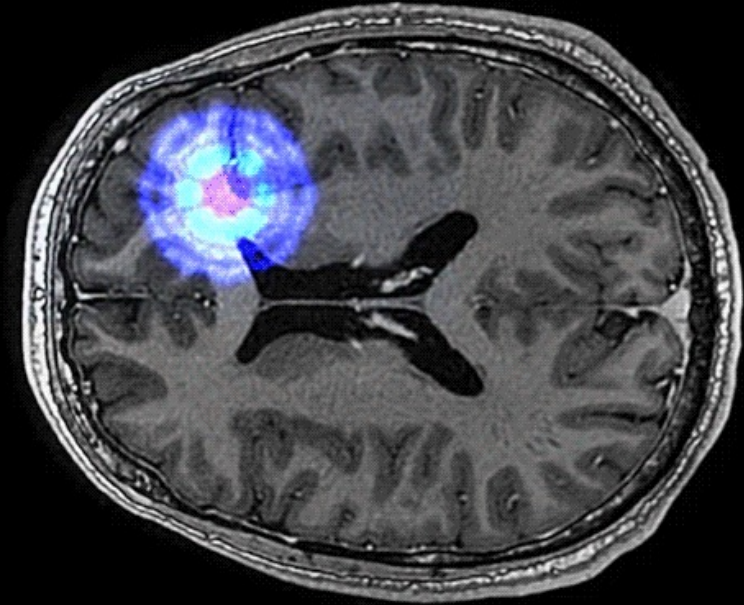
NVision is adding a whole new dimension of information to standard MRIs:
real-time “zoom-in” into metabolic information at cellular level



Standard MRI

Detects slow-changing anatomical effects at
tissue level

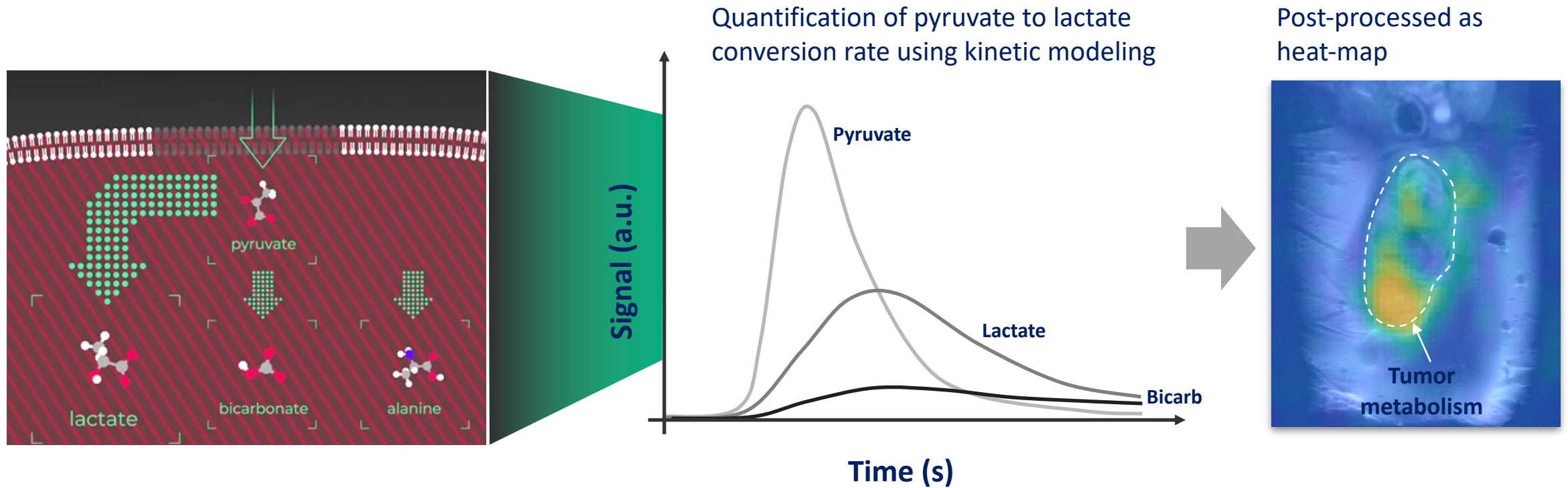
vs



Metabolic Hyperpolarized (HP) MRI

Detects real-time changes of key metabolic
pathways at cellular level

HP-MRI allows assessment of in real-time the kinetic behaviour of cell metabolism - giving quantitative measure of metabolism as it occurs



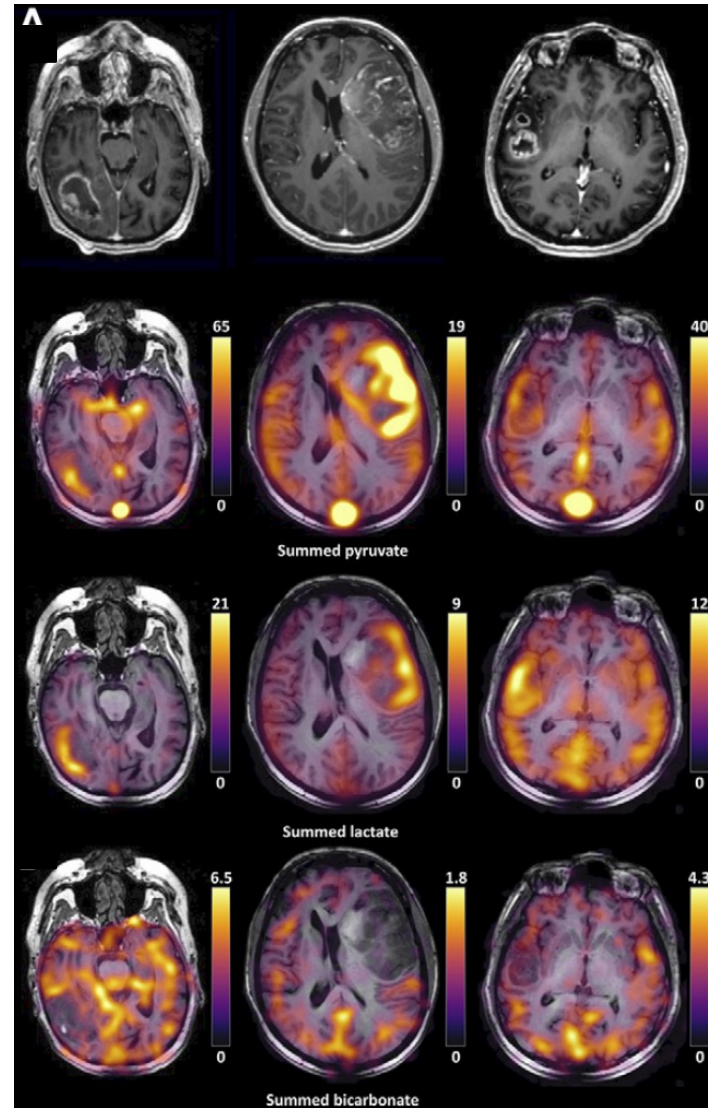
HP-MR reveals multi-dimensional insights into metabolism

Anatomical

Pyruvate

Lactate

Bicarbonate

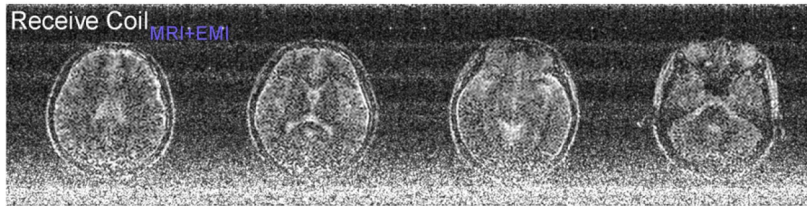


SMART|MR_IMAGING_LAB

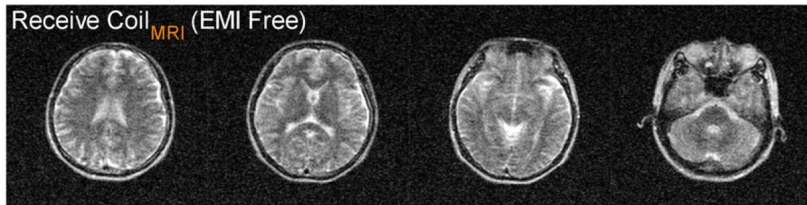
Cooperation between Georgia and Germany

Georgia

Raw Acquired
MRI Images

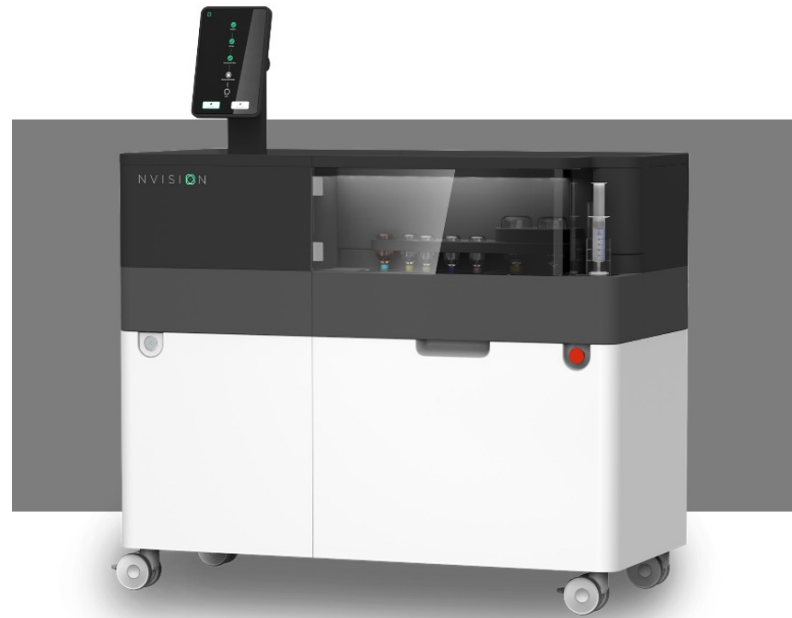


With EMI
Cancellation



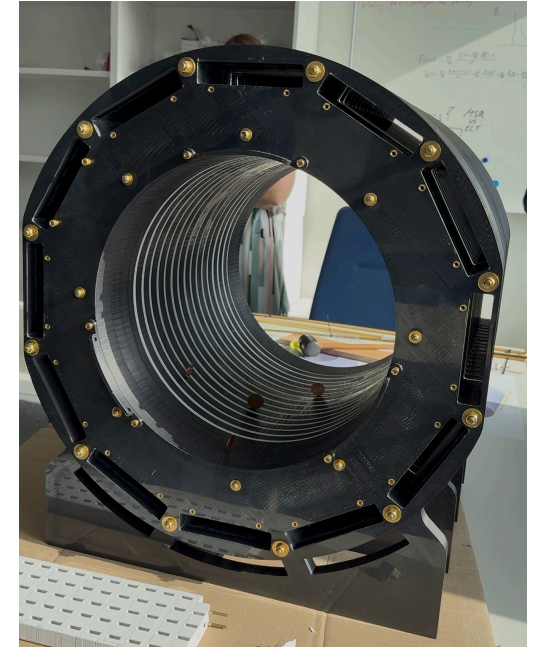
Physics-based AI algorithms

RWTH



Hyperpolariser being commissioned

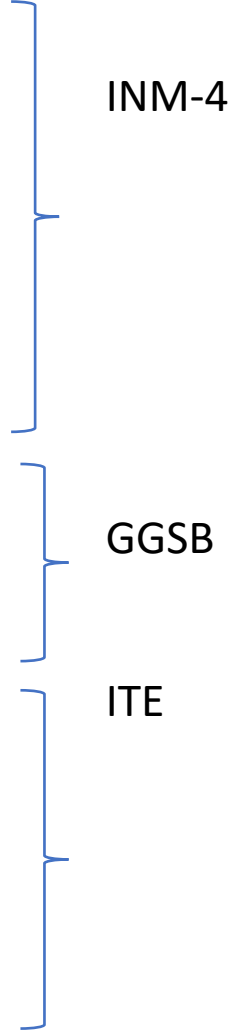
FZJ



Home-built 0.05mT scanner to use
with ^{13}C -pyruvate

Acknowledgements

- Dr. Jörg Felder
- Dr. Fabian Küppers
- Felix Landmeyer
- Dr. Zaheer Abbas
- Dr. Faizan Ullah
- Annette Mock
- Prof. Hanno Scharr
- Prof. Ramas Botchorisvili
- Manfred Lennartz
- Jan Huwer
- Tobias Meurer
- Prof. Ghaleb Natour



INM-4

GGSB

ITE