



Precision Medicine Research @ Empa

June 25th, 2021

Prof. Dr. Alex Dommann



Health &
Performance

Zoom: Please mute your mic unless you are contributing



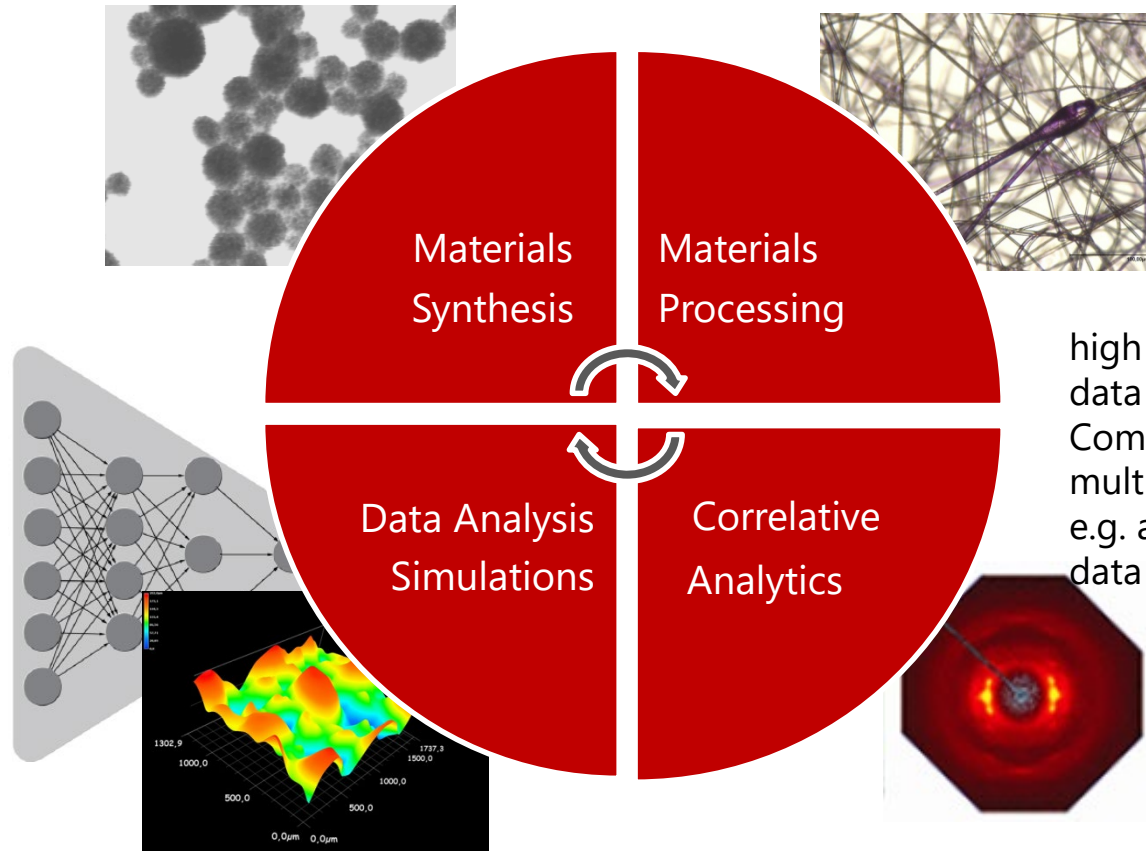
■ **Vision**

Materials and technologies for a healthy future.

■ **Mission**

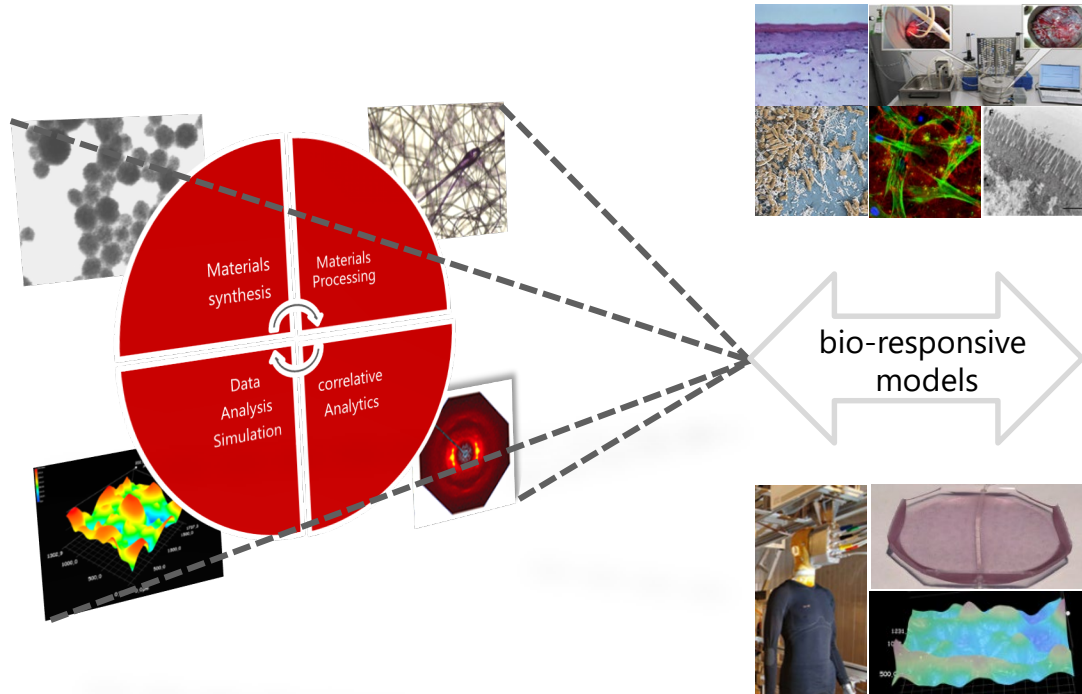
We design novel materials for health and medical applications, by combining material science with bio-, sensing and imaging technologies. Multi-modal data integration creating digital twins accelerates the creation of innovative materials and systems that support and protect the human body and its function under different environmental conditions and health states.

Acceleration of material development cycles and prediction

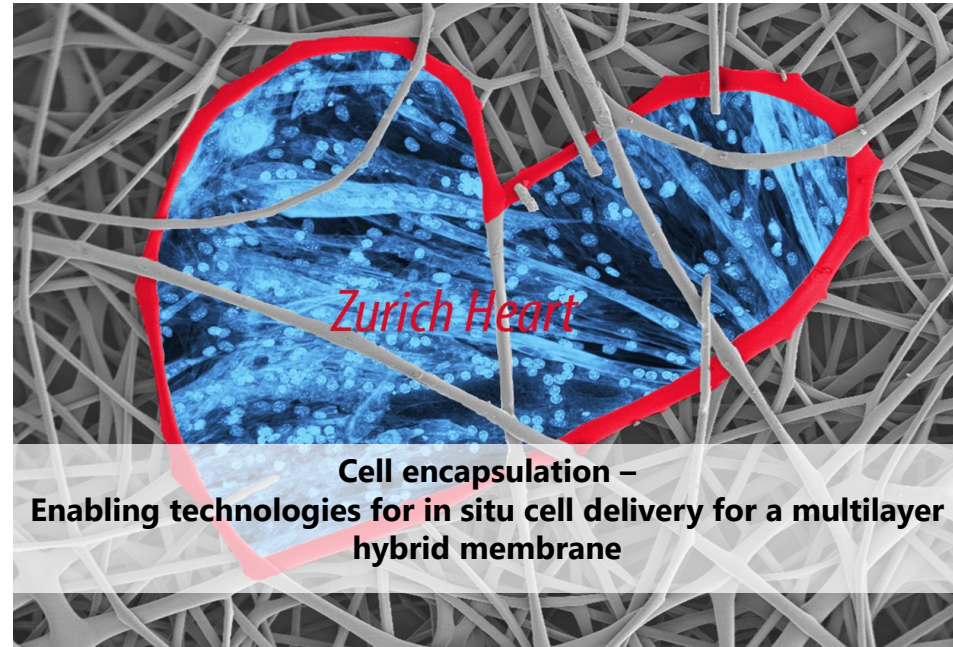
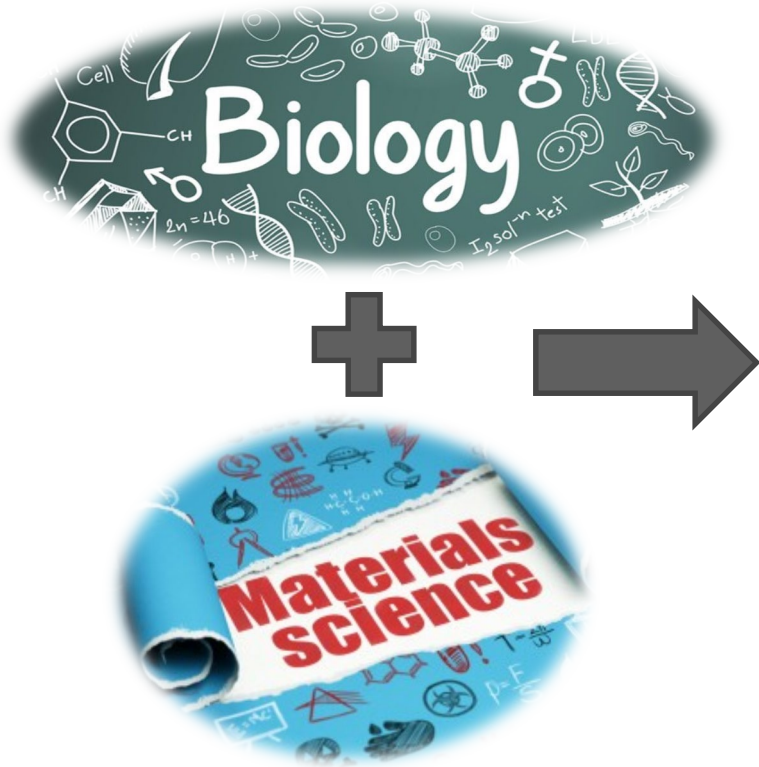


high content data high throughput data
Comprehensive, multiscale & multilayer characterization data from e.g. analytical imaging 'omics'-based data

Health and Performance: with innovative materials into a healthy future



Our approaches: Leverage in-house material and biological expertise



Lukas Weidenbacher, Afshin Abrishamkar, Markus Rottmar, Anne Géraldine Guex,
Katharina Maniura, René Rossi, Stephen Ferguson, Giuseppe Fortunato

SFA of the ETH Domain

Advanced Manufacturing



Data Science



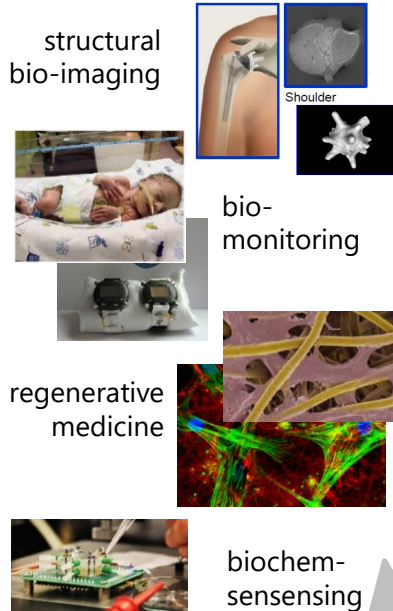
Personalized Health and Related Technologies



Energy Research

Personalized health systems

Stimulate and interlink
existing Empa activities

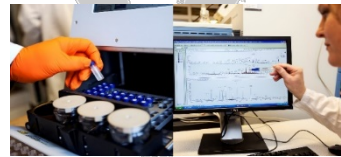


Digital Pathology



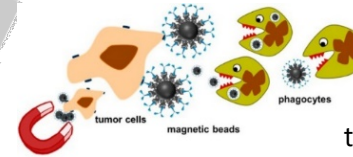
Digital twins

Comprehensive
system characterization



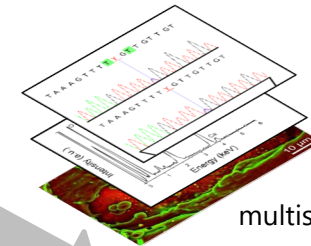
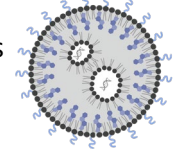
biological samples
and *in vitro* models

'Omics' inspired material
developments for personalized
medicine



theranostics

nanoparticles based glues
drug delivery systems



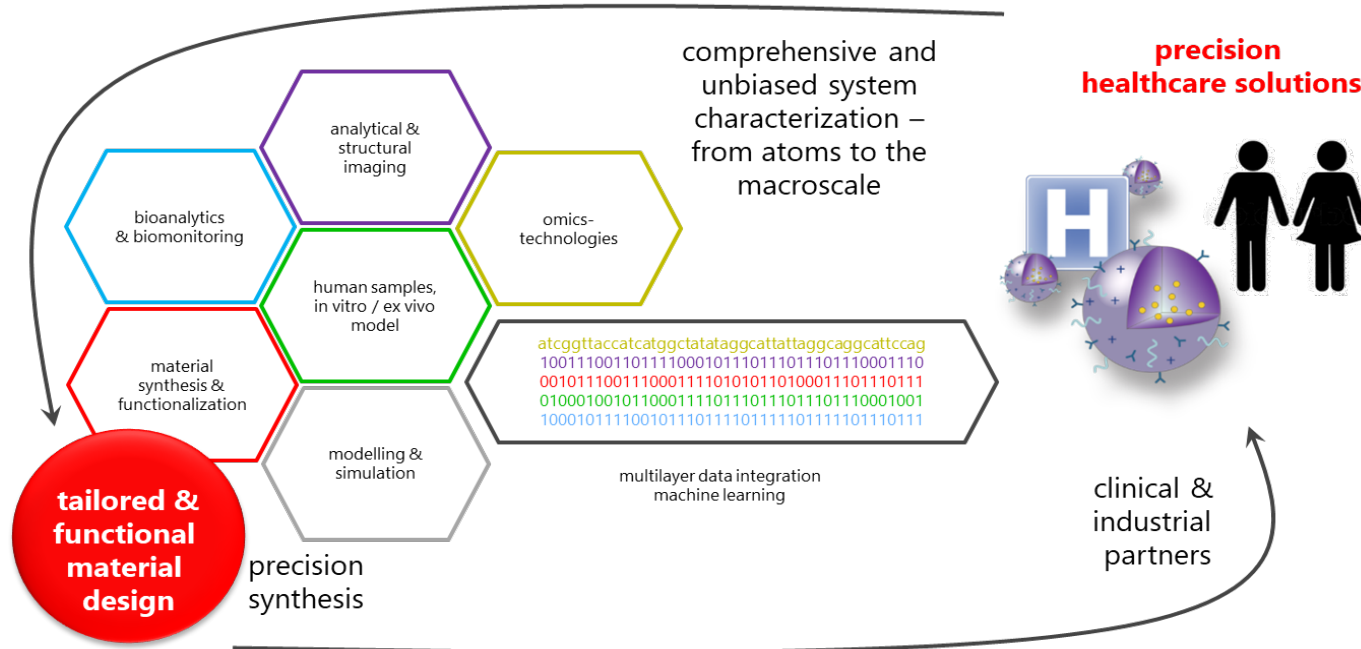
multiscale analytics

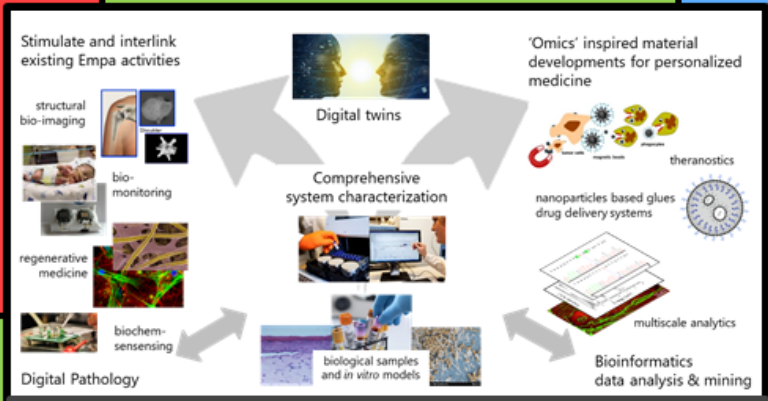
Bioinformatics
data analysis & mining

Empa internal strategic partnership with 404, 401, 405, 499, 502, 305, ...

Materials and Systems for Precision Medicine

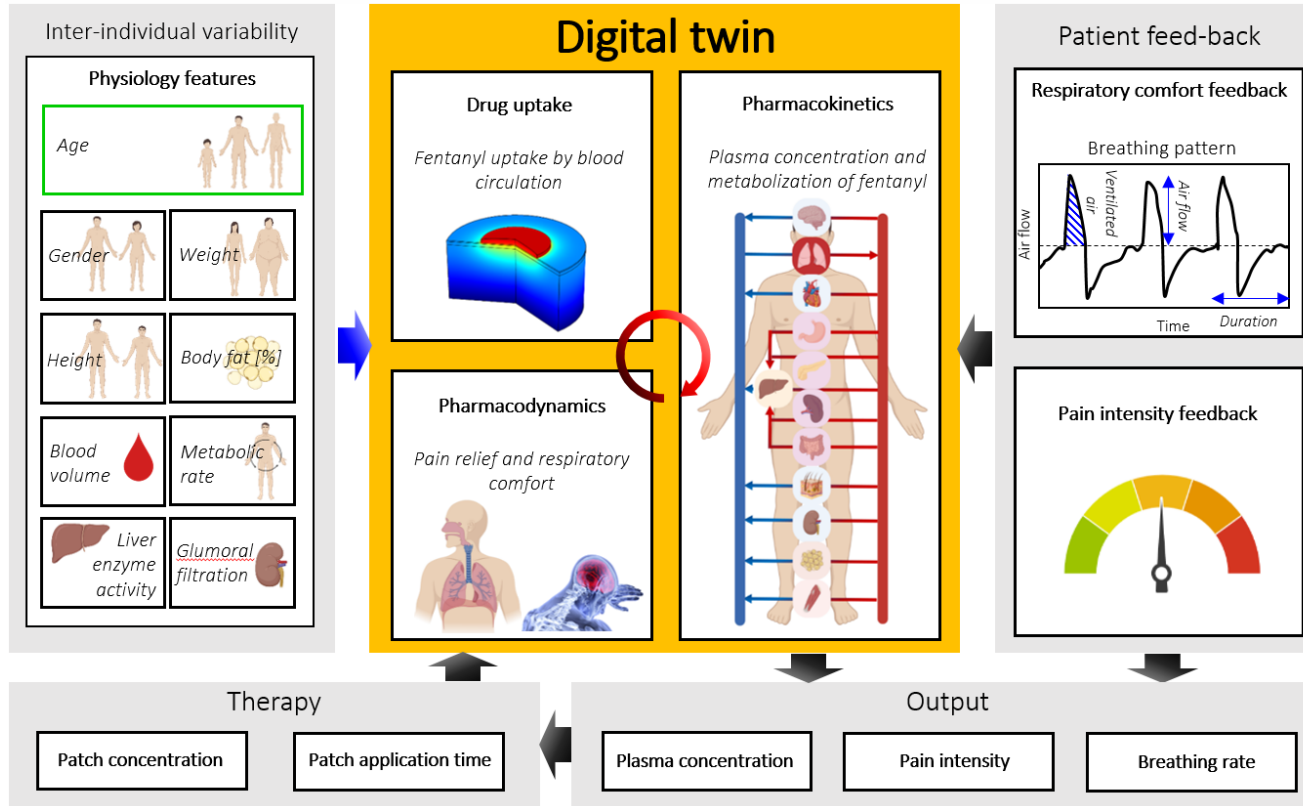
We develop transformative (nano)material designs and concepts for precision health solutions by capitalizing on our in-depth expertise in material science, modelling and large data analysis as well as in biomedical research using advanced human systems and by integrating new holistic omics-, sensing- and imaging technologies.





Precision Analytics Center

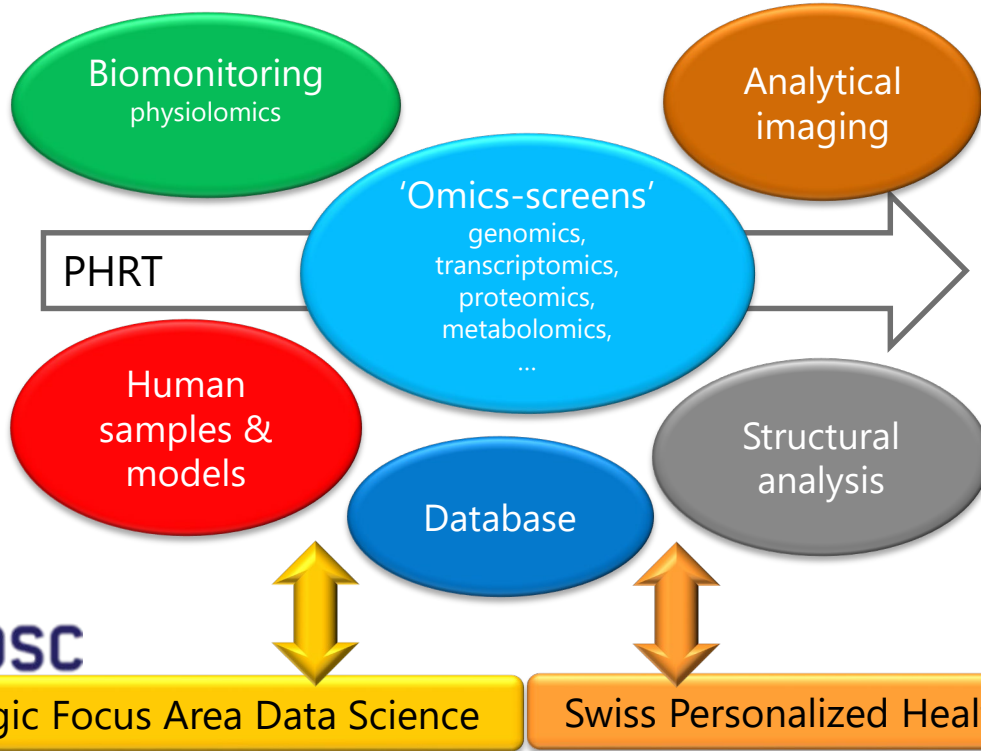
Digital twins – personalized therapies



Personalized Health and Related Technologies



clinical and health
relevance



personalized
diagnosis & therapy



An initiative of the ETH Board



Participating ETH Institutions:



PHRT Imaging Call 2021

Prof. Dr. med. Damien Weber and Prof. Dr. Alex Dommann

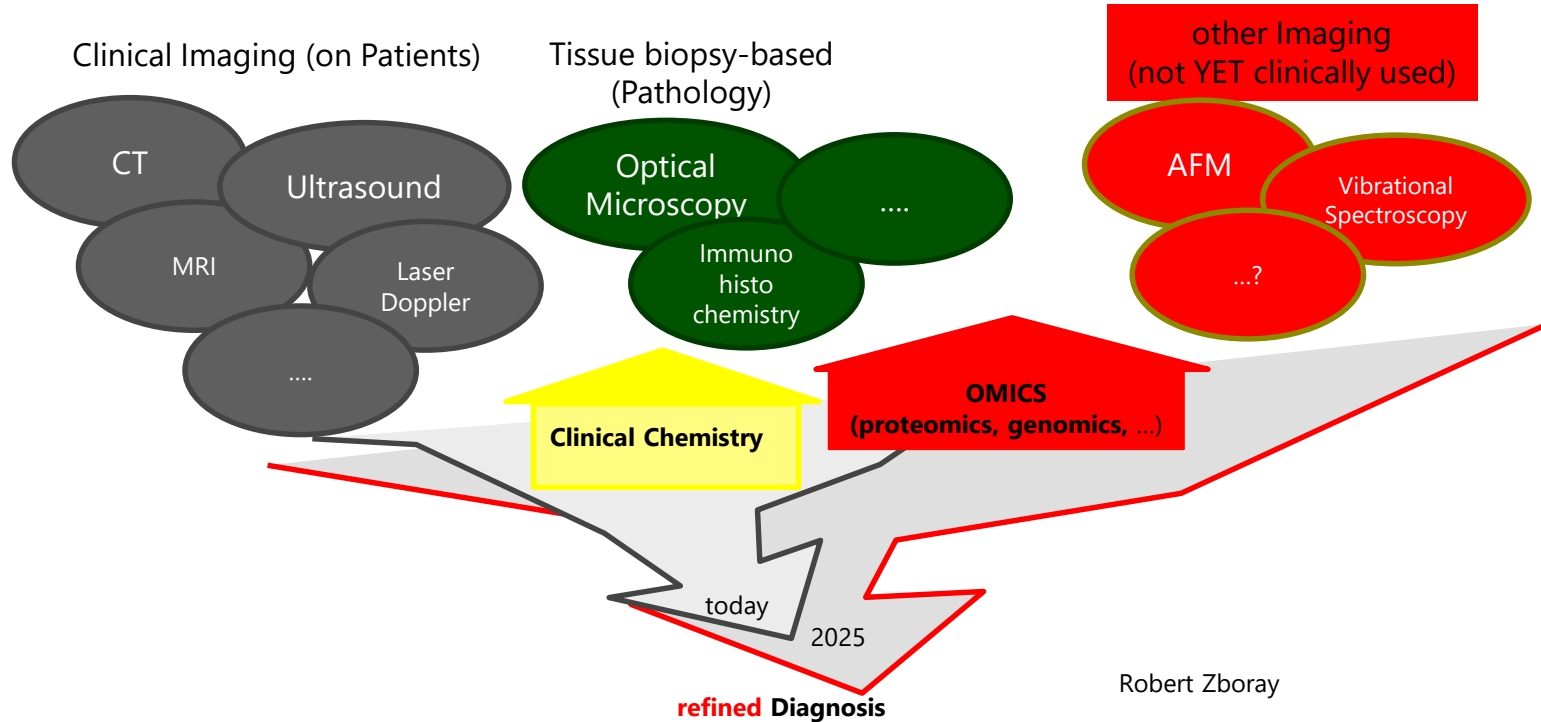
Current Status

- Clinical imaging is well established
- Trend towards digital pathology and data integration (machine learning)
- Most of the imaging is done based on morphology/density
- **Little information on chemical and mechanical properties available!**
- imaging on state of the art equipment is not in the framework of this imaging platform

Opportunity

- **Integration of imaging modalities not yet used in clinics**
- May give access to additional clinically relevant information
- Improved diagnosis and more targeted therapies

Multiscale/Multimodal Analytical Imaging to Refine and Improve Diagnosis and Treatment



2D slice histology vs. 3D virtual histo-pathology/tissue mapping

Precision medicine: need for detailed, unbiased 3D info on tissue structure, phenotype

Clinical state of the art:

- invasive histology, slicing
- staining (chemicals)
- 2D (site bias)

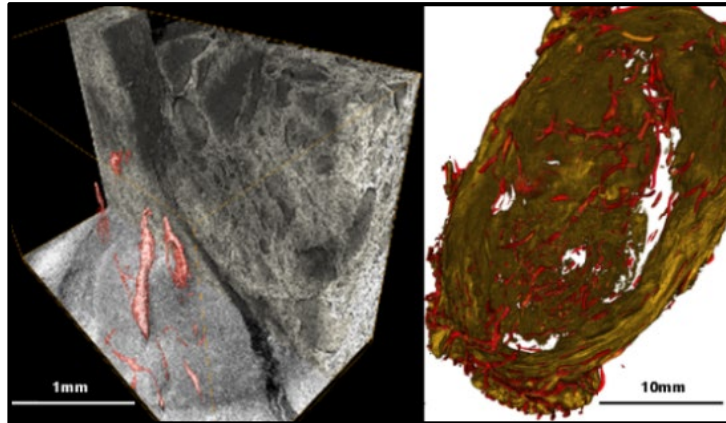
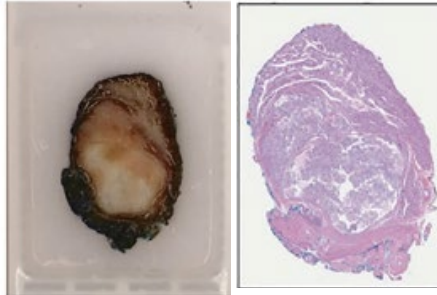


Our approach: advanced X-ray imaging of histology blocks / biopsies

BENEFITS for Precision Medicine:

- Non-intrusive (virtual slicing/no chemicals)
- High-resolution in 3D (intra-tumor heterogeneity, vascularization)
- Uncompromised native tissue structures (unstained)
- Enabling further sample analysis and integration in the precision medicine pipeline: tumor geno-phenotyping

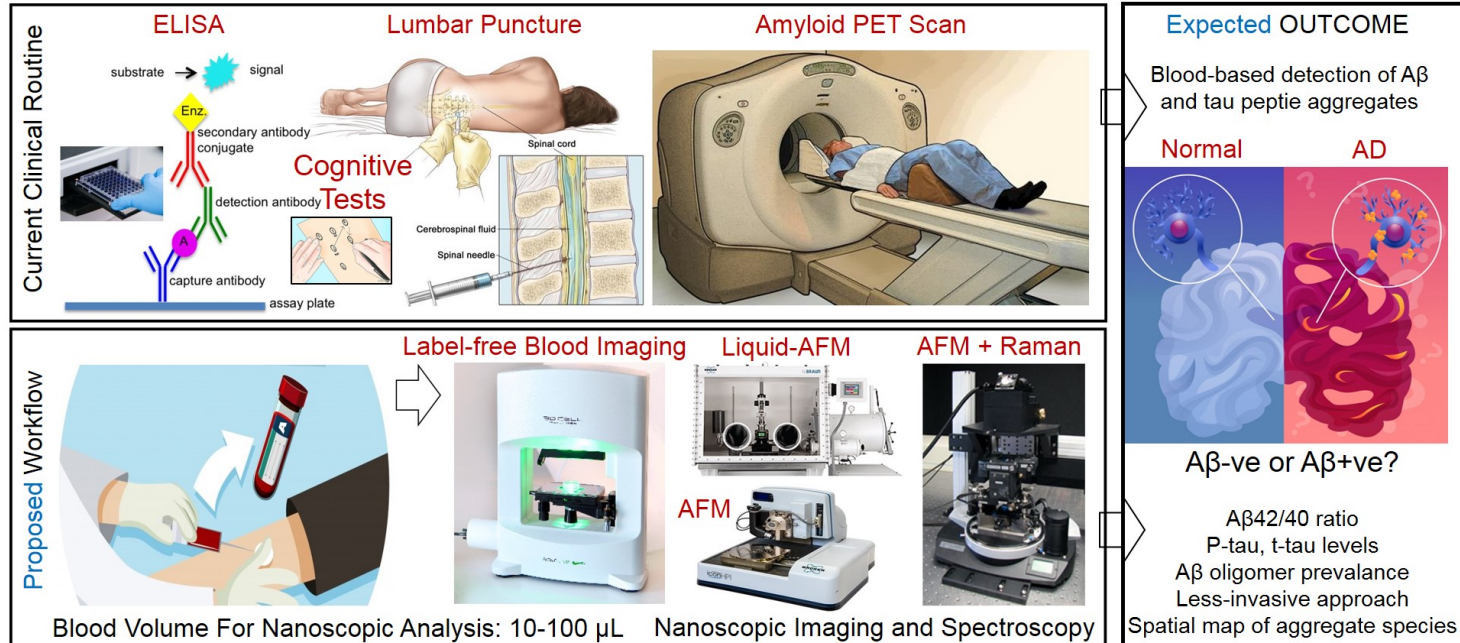
Paraffin block



thyroid adenoma
& carcinoma

*Collaboration with Prof A.
Perren, Uni Bern/Inselspital*

Imaging and spectroscopy of pathological peptides implicated in the pathology of Alzheimers Diseases



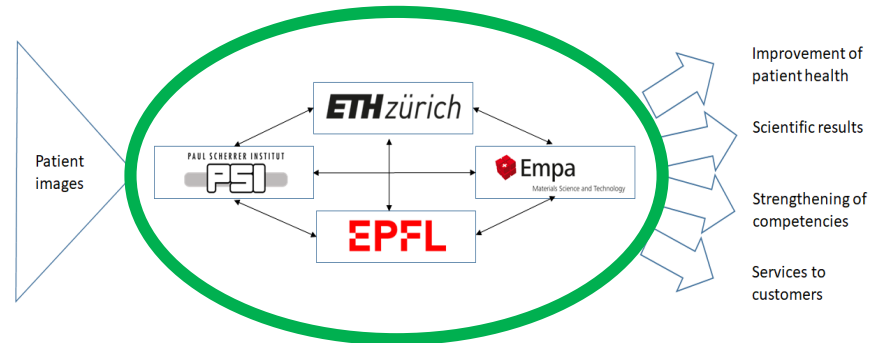
Recent Related Publications: 1. **Complete Aggregation Pathway of Amyloid Beta 40 and 42 Resolved on an Atomically Clean Interface.** Peter Nirmalraj *et al*, Science Advances, Vol. 6, no. 15, eaaz6014. 2020.

Objectives of the PHRT Pioneer Imaging Projects

1. To build a new PHRT imaging competence activities like the PHRT proteomic and genomic activities
2. to enhance the development of imaging technologies including analyses within the ETH Domain
3. to offer to hospitals improved, more efficient, quicker, and/or easier handling of clinical image-based processes (i.e. diagnosis, surgery, therapy, etc)
4. To use real human clinical data (proof of concept) during the PIP
5. to make use of the wide range of know-how and competencies within the ETH domain and to establish a inter-institutional network
6. to ensure the continuation beyond 2024, a PIP must involve at least two ETH Domain institutions (or e.g. the SFA SDSC)

Duration

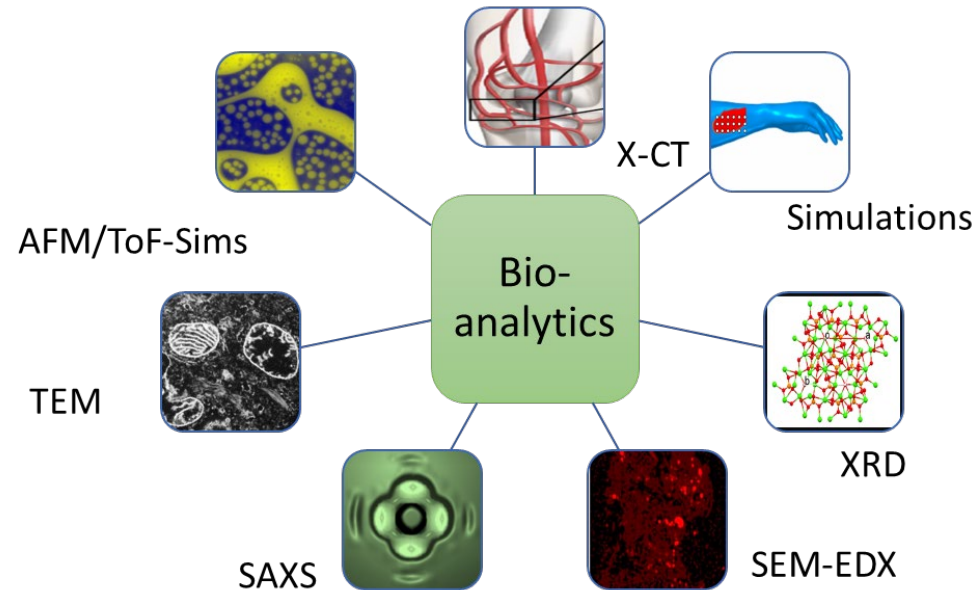
- Duration of the project is two years
- Further PHRT imaging calls will be published in the 2nd PHRT phase
- This project should lay the bases for a new Clinical Imaging Competences in the ETH Domain that will continue beyond the end of PHRT program in 2024



**Clinical Imaging
Competences**

Biomedical Imaging Technologies (Empa RFA)

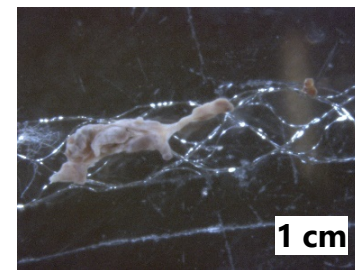
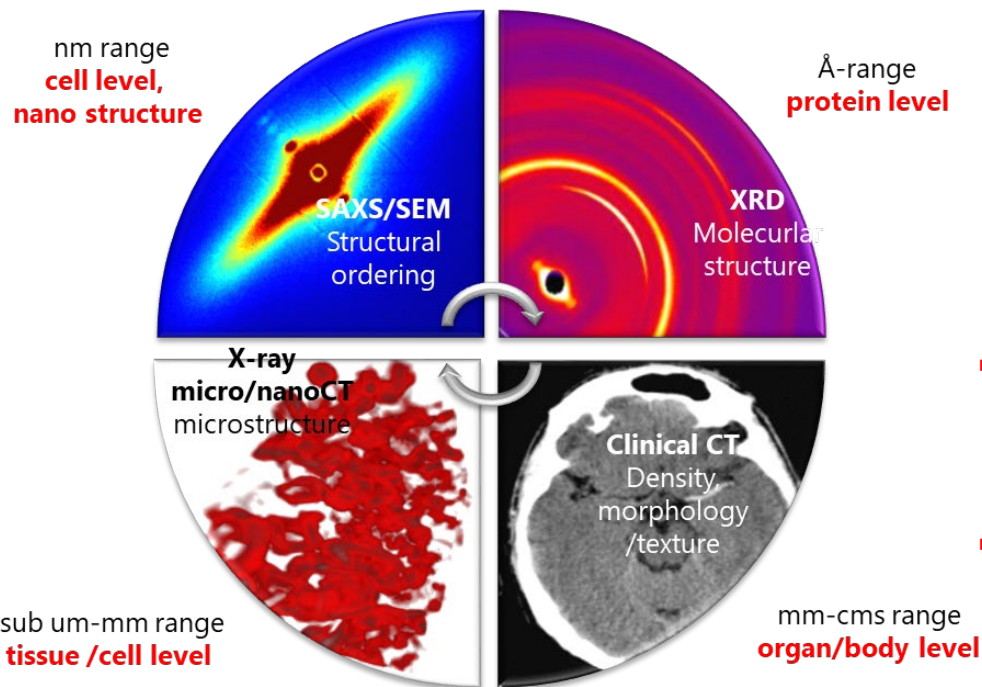
- We pioneer multimodal and multi-scale analytical methods for digital pathology to enable and improve diagnostics.
- We develop multimodal data fusion algorithms towards digital twins for tissue and disease modeling.
- We integrate analytical imaging sciences from 2D to 4D monitoring for precision medicine in collaboration with hospitals.



Radiomics

Challenge: clinical imaging methods are limited in: resolution, sensitivity, contrast (soft tissue)

Our approach: **Multi-level & multi-modal imaging** and **ML** (radiomics)



R. Zboray
K. Lovblad

HUG Hôpitaux
Universitaires
Genève

UNIVERSITÉ
DE GENÈVE

- “Characterizing the intravascular clot in acute stroke with multi-parametric imaging”, running SNF
- “Imaging intravascular clots” PHRT project under Review

Why did Empa take the lead?

5 key success factors



High acceptance and credibility in the population

armasuisse



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Gesundheit BAG
Office fédéral de la santé publique OFSP
Ufficio federale della sanità pubblica UFSP
Uffizi federal da sanadad publica UFSP

Swiss Confederation

Very good contacts to federal authorities

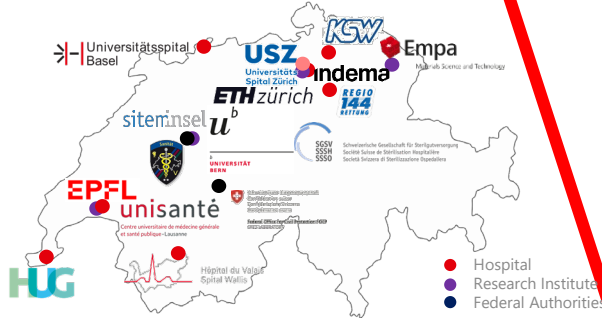


Empa

Materials Science and Technology



Interdisciplinary, long-standing and well-functioning team



Strong academic network

SWISS TEXTILES



Strong industrial network

Our partners in academia, industry and hospitals

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 TU Delft
 UNIVERSIDAD AUTONOMA DE MADRID
 Universität Konstanz
 DTU Technical University of Denmark
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 University Hospital Zurich
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 Universitätsspital Basel
 Schweizer Paraplegiker Zentrum

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 Office fédéral de l'environnement OFEV
 Ufficio federale dell'ambiente UFAM
 Uffici federal d'ambient UFAM

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 straumann
 giovanelli
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 weba Swiss Identity Fabrics
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 schoeller Switzerland
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 DANTEC DYNAMICS
 VARINOR MATERIAUX

Thank you for your attention!



Program:

15:10 Lab-on-Fiber: Fluorescence and Colorimetric Sensors for the Monitoring of Wounds and Other Diseases

Prof. Dr. René Rossi, Head of Laboratory for Biomimetic Membranes and Textiles

15:35 Assessing Bone Proteotype and Extracellular Matrix Properties for Improved Fracture Strength Prediction

Dr. Johann Jakob Schwiedrzik, Group Leader Architected Materials

16:00 Coffee break

16:30 A Mineralomics Approach to Personalized Medicine

Dr. Elena Tsolaki, Postdoctoral Researcher at Empa

16:55 Multi-Modal, Multi-Scale X-Ray Analytical Imaging Methods to Enhance Precision Medicine

Dr. Robert Zboray, Group Leader X-ray Imaging

17:20 Wrap-up, Closing

Prof. Dr. Alex Dommann, Head of Department "Materials meet Life"