B12(N)

Bioinspired Nanocomposites for Early Detection of Complications in Gastrointestinal Surgery

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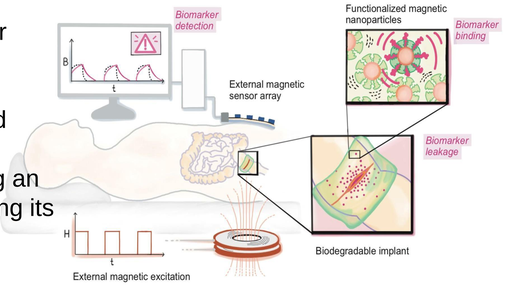
biomagnetic sensing SFB 1261

Motivation and Objectives

Problem:

- Anastomotic leakage after intestinal surgery
- Risk of sepsis with subsequent operation and prolonged hospitalization
- No direct way of detecting an anastomotic leakage during its formation or early stages



Proposed approach:

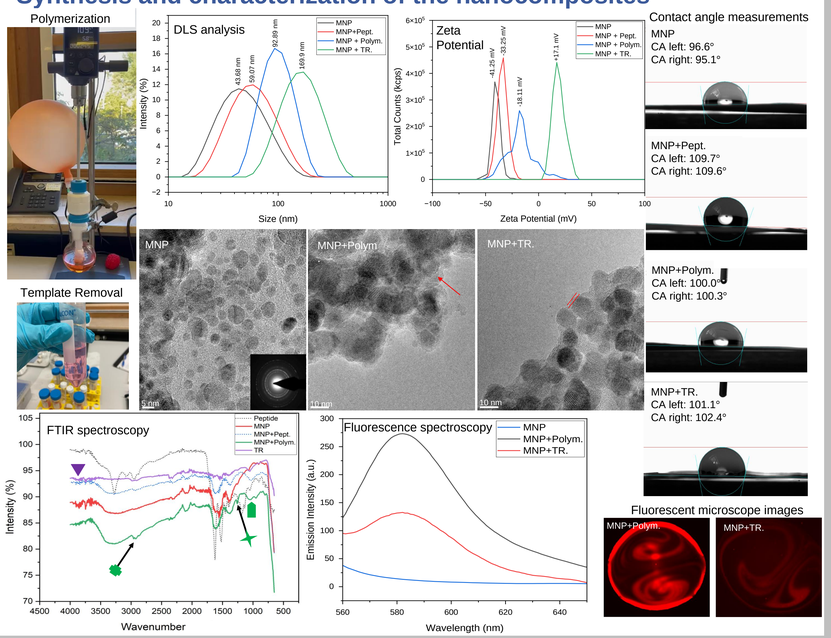
Development of an ***in vivo*** **diagnostic implant** to **detect the biomarkers** overexpressed in the leak relying on **magnetically labeled synthetic receptors** combined with **a wireless magnetic-field readout system** based on **magnetoelectric sensors**

Main objectives:

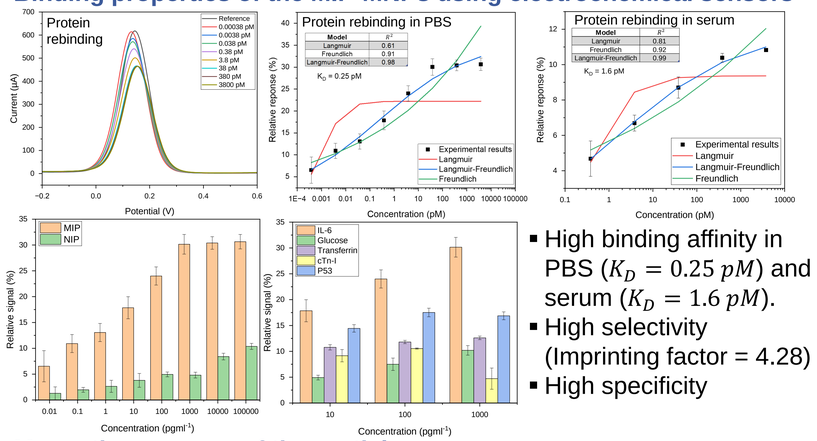
- Identification of suitable biomarkers
- Development of a bio-implant based on magnetic nanoparticles functionalized with molecularly imprinted polymers (MIP-MNP)
- Realization of a readout system based on magnetic field detection
- Validation of the approach on a cell assay, *in vitro* and *in vivo*

Preliminary Work

Synthesis and characterization of the nanocomposites

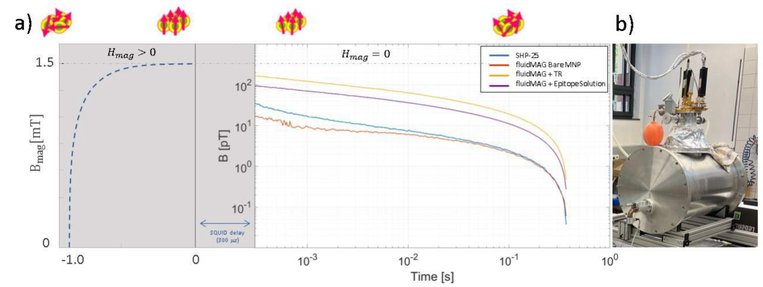


Binding properties of the MIP-MNPs using electrochemical sensors



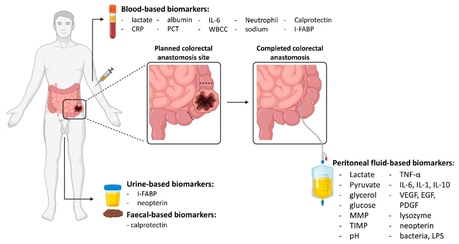
- High binding affinity in PBS ($K_D = 0.25\ pM$) and serum ($K_D = 1.6\ pM$).
- High selectivity (Imprinting factor = 4.28)
- High specificity

Magnetic response of the particles



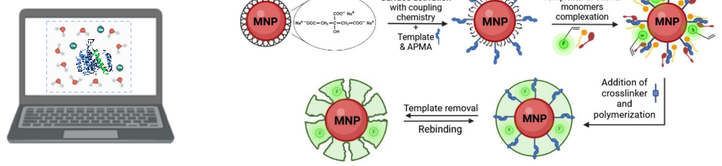
Preliminary work with SQUID system for magnetorelaxometry. (a) Example curve of magnetization of disordered magnetic nanoparticles (MNP) by 1.5 mT field and magnetization relaxation signal in the pT-range after turning off the excitation field. b) 6-channel SQUID system at PTB Berlin.

Work Plan for Third Funding Period



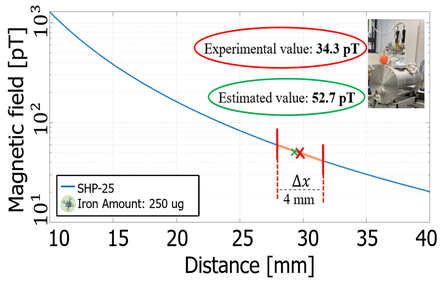
WP1: Detection of suitable biomarkers by the analysis of drainage fluid of patients

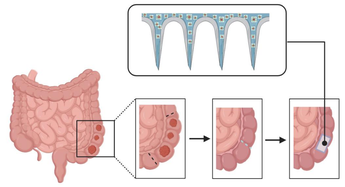
WP2: Development of optimum production recipes for MIP-MNP using computation methods



WP3: Hydrogel-forming implantable smart dressing

WP4: ME sensors for MNP detection

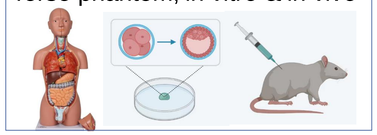




WP5: Torso phantom experiments:

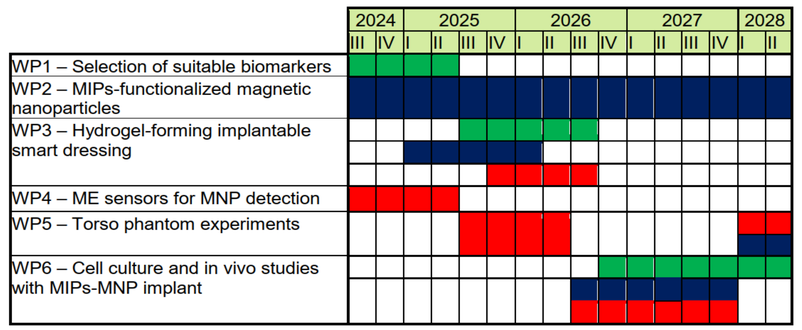
Large coil placed outside the body and the sensor system attached to it. The MIP-MNP implant is at a distance of up to 15 cm away on the inside of the body.

Torso phantom, *in vitro* & *in vivo*



WP6: *In vitro* and *in vivo* studies

Investigation of cytotoxicity of the MIPs-MNP implants on cells and rodents.



Med. Doc. Gundlach Doc. res. 1 Altintas Doc. res. 2 Gerken

Collaborations

A4: ΔE–Effect sensors obtained from A4. Experimental results to A4.

A6: MIPs-functionalized MNPs provided to A6 for TEM analysis.

A7: Converse ME sensors obtained from A7. Experimental results to A7.

A8: Simulations on MNP ensemble behavior during biomolecular binding. Experimental results provided to A8 for comparison with theory.

A9: SAW sensors obtained from A9. Experimental results provided to A9.

B1: Readout electronics developed in close interaction with B1.

B2: Digital signal processing developed in close interaction with B2.

Funds Requested

3 Doctoral researchers + Consumables

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