Perspectives of Neutron Capture Therapy of Cancer with Gadolinium and cold Neutrons (Gd-cNCT)

Thomas Nawroth[1a], Bruno Pairet[1b], Heinz Decker[1b], Stéphanie Corde-Tehei[2], Bernhard Lauss[3], Michael Jentschel[3], Roland P. May[3]

1. Gutenberg Universität, D-55099 Mainz, Germany, a) Institut für Biochemie, Becherweg 30, b) Institut für Molekulare Biophysik, Welder Weg 26

2. Dep. Hemato-Cancerologie-Radiotherapie, CHRU Clinics, BM 217X, F-38043 Grenoble

3. Institut Laue Langevin ILL, 6, Rue Jules Horowitz, F- 38042 Grenoble Cedex 9, France

E-mail: nawroth@mpsd.de

Neutron Capture Therapy **NCT** is an **indirect radiation therapy of cancer**, which inactivates tumors by secondary products evolving from an incorporated target upon specific absorption of external radiation (neutrons; with synchrotron X-rays at the K-edge: PAT). Early trials with Boron (B-NCT) were limited by the low physiological target concentration (~ 1 mM) and the moderate cross section of 3,843 barn. The change to ^{157}Gd with 254,000 barn cross section, concentrated biocompatible Gd-targets and cold neutrons improves the method by 3 orders.

The **Lanthanide-complexes** were applied in a key-formulation, which breaks the blood-brain barrier BBB reversibly by hyperosmotic shock, as in our synchrotron X-ray therapy project with Lanthanide nanoparticles at the ESRF (ID17, ID1). The local deposition of the gamma photons arising after neutron capture is increased by a second Lanthanide (e.g. Er, Lu), which works as an internal radiotherapy enhancer by gamma - Auger electron conversion. The study was done with **cold neutrons** of several energies at the ILL instrument D22.

Results: 1) Black target: The experiments with 1D- and 2D- brain dummies consisting of 2% agarose and biocompatible Lanthanide-DTPA complexes (100 to 500 mM) or Gd-DTPA entrapped in DOPC liposomes indicated that the Gd-target can absorb the neutrons completely. **2) Neutron shunt**: The neutron beam can be guided to the tumor-target site by an implanted tube with a Quartz window. **3) Gamma-Auger conversion**: The low energy fraction (< 1 MeV) of the Gd-gamma spectrum can be partly absorbed by a second target (Er-DTPA). **4) Cold neutron improvement:** Cold neutrons resulted in an **increased absorption** as compared to thermal neutrons (factor 3-6) and low neutron activation of the targets : low activation of < 1 µSv/h at 3 cm after 1h, and **negligible neutron activation** after 1 day.

References: see references and links in **www.mpsd.de/irt**