	Experiment title: Determination of essential trace element levels in benign and malignant breast tumours and to investigate trace levels in skin	**Experiment number**: 28-01-126
Beamline: **BM 28**	**Date of experiment**: from: 27th July 2002 to: 30 July 2002	**Date of report**: 3rd December 3, 2002
Shifts: 6 shifts single bunch	**Local contact(s)**: David Paul	*Received at XMaS:*

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Report:

The experiment that took place at the XMaS beamline in 2002 was a continuation of previous experiments in 2000 and 2001. The two earlier sessions involved the quantification of potassium, iron, copper and zinc in approximately 100 breast tissue specimens, healthy and cancerous. The aim was to investigate the correlation between the levels of these elements and the presence of cancer, which was confirmed as the concentrations measured in the tumours were elevated by approximately 300 % for potassium, 300 % for iron, 250 % for copper and 350 % for zinc. The quantification of the elements was based on the detection of their characteristic x-ray fluorescence, which is emitted when the specimens are irradiated with photons of appropriate energy. The technique and the results are detailed in Geraki *et al*, 2002 and Geraki *et al*, 2003.

The principal aims of the experiment that took place in 2002 were to evaluate the reproducibility of the experimental method used for the quantification of the elements and to investigate the degree of inhomogeneity characterising the elemental concentrations within the specimens. For the reproducibility test, 10 repeat measurements were performed on two specimens and the resulting elemental concentrations were evaluated for their variation. The differences between the repeat measurements ranged between 1 % and 9 %, the worst precision reflecting the very low quantities

measured at this occasion (<1 ppm). For the inhomogeneity investigation, three different sections were investigated on nine specimens and the resulting concentrations were evaluated for their variance. Only potassium, iron and zinc were investigated due to lack of time and the increased requirements for the quantification of copper as it is found in significantly low concentrations (< 1 ppm). For the three measured elements the average degree of inhomogeneity was 17 % for potassium, 24 % for iron and 15 % for zinc. There were also indications that the tumour specimens were considerably more homogenous than the healthy ones.

The subject of inhomogeneity of elemental distribution was explored further by making use of the newly installed translation system at XMaS. One specimen was scanned with a spatial resolution of 0.5 x 0.5 mm resulting in the quantification of iron and zinc over an area of 5 x 5 mm. The energy used for the quantification of the two elements in the specimen was 10.2 keV as this allows the excitation of the fluorescence from both. The variation of the measured levels at each point was evaluated in terms of their % difference from the mean concentration. The range of variation was 1 % - 116 % for iron and 1 % - 118 % for zinc with the average variation being 23 % for iron and 20 % for zinc. The degree of inhomogeneity regarding the two elements can be seen in figure 1.

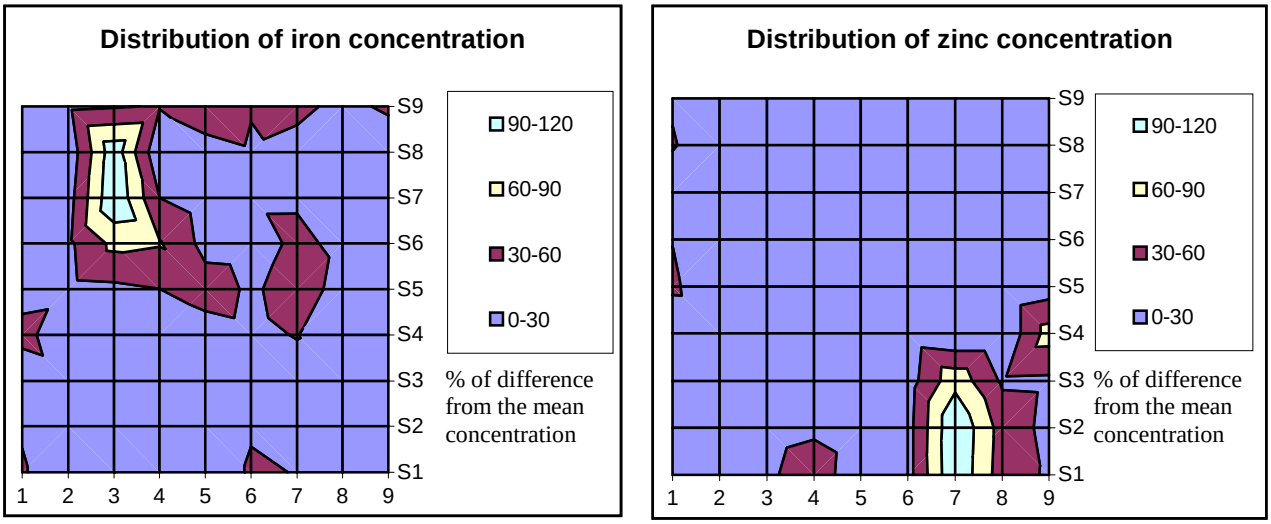

Figure 1: Variation of Fe and Zn concentrations within a specimen

The technique for scanning across areas of specimens and quantifying the elemental concentrations with such a spatial resolution will be exploited in our next experiment at XMaS, which will take place in February 2003. The aim will be to relate the measured inhomogeneity to physiological parameters that characterise the presence and function of the studied elements, particularly iron and copper.

References

Geraki K., Farquharson M.J. and Bradley D.A. 2002. Concentrations of Fe, Cu and Zn in breast tissue; a synchrotron XRF study. *Physics in Medicine and Biology* **47** (13) 2327-2339

Geraki K., Farquharson M.J., Bradley D.A. and Hugtenburg R.P. 2003. A synchrotron XRF study on trace elements and potassium in breast tissue. Submited for publication in *Nuclear Instruments and Methods in Physics Research, section B*