	Experiment title: Determination of the trace element content of healthy and cancerous breast tissue using XRF techniques	**Experiment number**: 28-01-92
Beamline: **BM 28**	**Date of experiment**: from: 18th July 2001 to: 21st July 2001	**Date of report:** 26th Sept 2001
Shifts: 6 shifts single bunch	**Local contact(s):** Dr Simon D. Brown	*Received at XMaS:*

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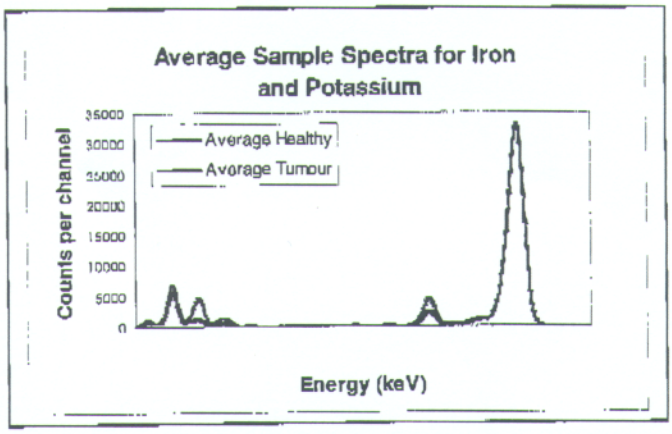
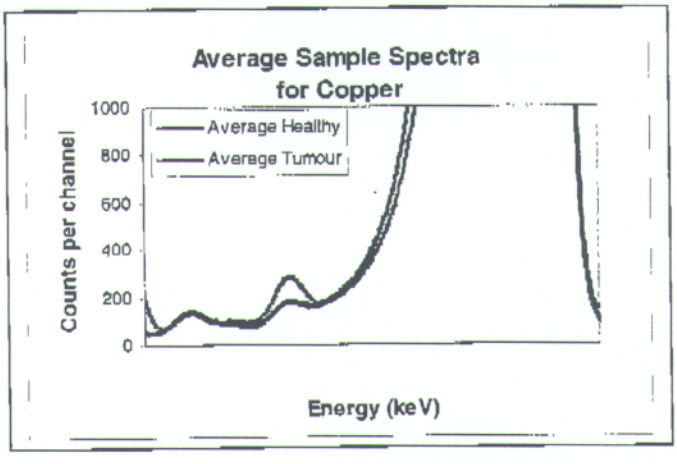
Report:

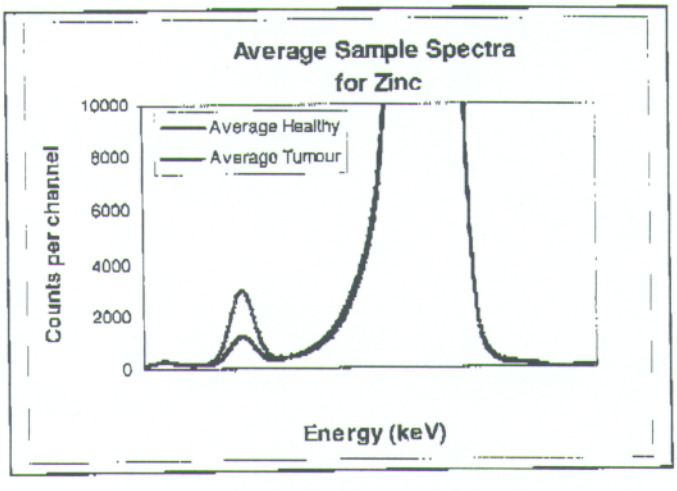
The interests of this group focus on use of non-destructive x-ray methodology in analysis of human tissues, in particular the use of x-ray fluorescence (XRF) for breast, skin and a number of other target organs affected by elemental build-up. The intent of current study has been to enrich and to also extend (by measuring other trace-element levels) a data-base of measured trace levels in breast-tissues, building on initial results obtained in a pilot study conducted at XmaS in June2001. The tissue bank this group maintains comprises samples (of the order of a few grams in each case) of healthy tissue from breast reduction surgeries, and cancerous tissues from breast biopsies or mastectomies. Use of XmaS has shown an ability to measure manifest trace levels (of the order of a few ppm) of for instance Fe and Zn, with group standard deviations of again a few ppm, the accuracy and precision of measurements benefiting from the high degree of polarisation of the scattered beam in the plane of the electron ring. Results from the pilot study involved a total of 42 samples, half of these being healthy tissues and the other half cancerous. Included among the total were 5 paired samples

(cancerous and healthy tissue from the same person). The present study has involved 80 samples in all (40 healthy tissues, 40 cancerous tissues, with 20 paired samples being obtained from these). In addition to measurements made for Fe and Zn, data was also obtained for Cu (K absorption edge of 8.980 keV) and for K (K absorption edge of 3.6 keV). Calibration standards were prepared and measured for all above elements. Depending on the element of interest, the sample (or the calibration standard) was irradiated with a beam of energy 500eV above the element's absorption edge, in order to maximise the emission of the XRF response while keeping sufficient resolution between that response and the scattered incident peak. The exception to this being that K was measured simultaneously with Fe.



The radiation emitted from the sample was recorded via a Si detector and associated electronics. The following figures show the mean healthy/tumour response spectra for three incident beam energies, 7.6 keV, 9.5 keV and 10.2 keV (for Fe and K, Cu and Zn). Each sample spectrum was normalised with respect to the standards (using the scattered incident peak) in order to account for the different self-attenuation within each sample.





In every spectrum the peak areas were calculated using appropriate software and the areas were related to element concentrations (in ppm) using the calibration curves. From the three

figures it is apparent that the mean Fe, Cu Zn and K areas -and consequently concentrations- are higher for the tumour samples compared to the healthy ones. However, the three elements cover a wide range of quantities within each group of samples, which results in large standard deviations of their means, a fact that affects the comparison between the two groups.

Alternatively, the confidence intervals for the means of the groups do show a difference between them, as shown on the following table. Also, the calculations of t-tests for comparison between the means give p values that show highly significant difference between them (significant < 0.005).

Fe	Mean paired samples ppm	SD	Mean non paired samples. ppm	SD
Normal	13.07	12	8.08	11
Tumour	23.93	27	14.08	12
Tumour/Healthy	1.83 p=0.04		1.74 p=0.02	

Cu	Mean paired samples ppm	SD	Mean non paired samples. ppm	SD
Normal	0.64	0.47	0.26	0.17
Tumour	1.3	0.75	1.02	0.8
Tumour/Healthy	2.03 p=0.001		3.92 p=2.00E-6	

Zn	Mean paired samples ppm	SD	Mean non paired samples. ppm	SD
Normal	5.03	6.95	1.97	1.6
Tumour	10.69	18.8	8.2	4.8
Tumour/Healthy	2.13 p=0.03		4.16 p=1.0E-5	

K	Mean paired samples ppm	SD	Mean non paired samples. ppm	SD
Normal	250	183	121	97
Tumour	650	464	299	12
Tumour/Healthy	2.6 p=2.0E-4		4.02 p=1.0E-4	

Currently neural net analysis is being considered for determining whether for individual samples enhanced predictive capability can be obtained from the four separate pieces of information (K, Fe, Cu, and Zn concentrations) taken together. Other methods will include multivariate correlations with scattering data and electron density measurements.