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A New Proficiency Testing Scheme for Asbestos Analysis by Scanning Electron Microscopy

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Introduction

A new proficiency testing scheme has been established which aims to improve laboratory measurement of asbestos and other inorganic fibres by scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDX). The scheme is in its fourth year and includes over 50 European laboratories. Participating laboratories are recommended to use either the ISO 14966 or VDI 3492 methods, although any appropriate analytical method may be used.

Sample Preparation

Scheme samples are produced in the laboratory using a novel combination of a modified dustiness tester (Fig 1) and a multi-port sampling "Sputnik" device (Figs 2 & 3). Pre-gold coated filters are loaded with different densities of amphibole asbestos fibres, chrysotile, other inorganic fibres or mixtures of fibre types. Non-fibrous particulate material can also be included by choosing an appropriate "source" material (Fig 4).

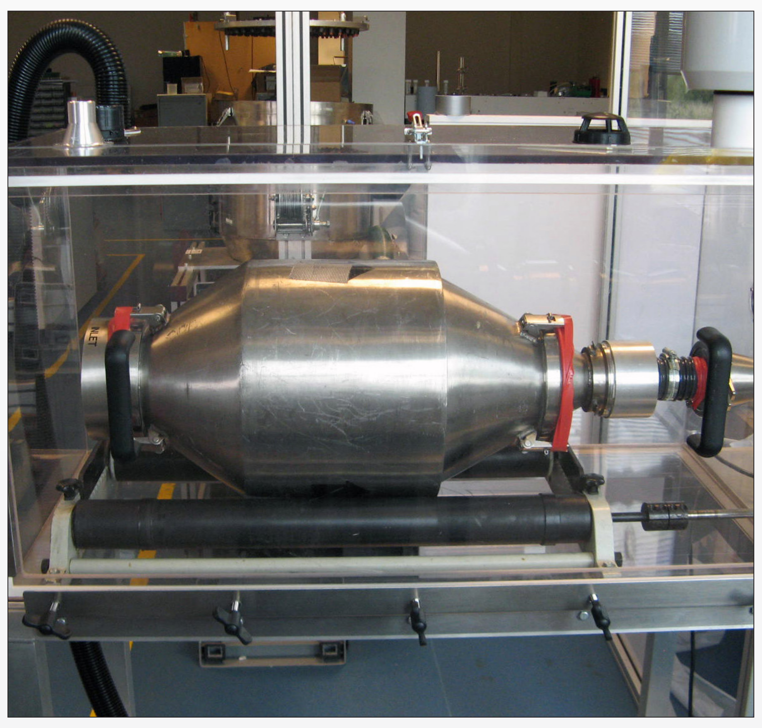

Fig 1: Modified dustiness Tester

Fig2: Sputnik Multiport Sampler

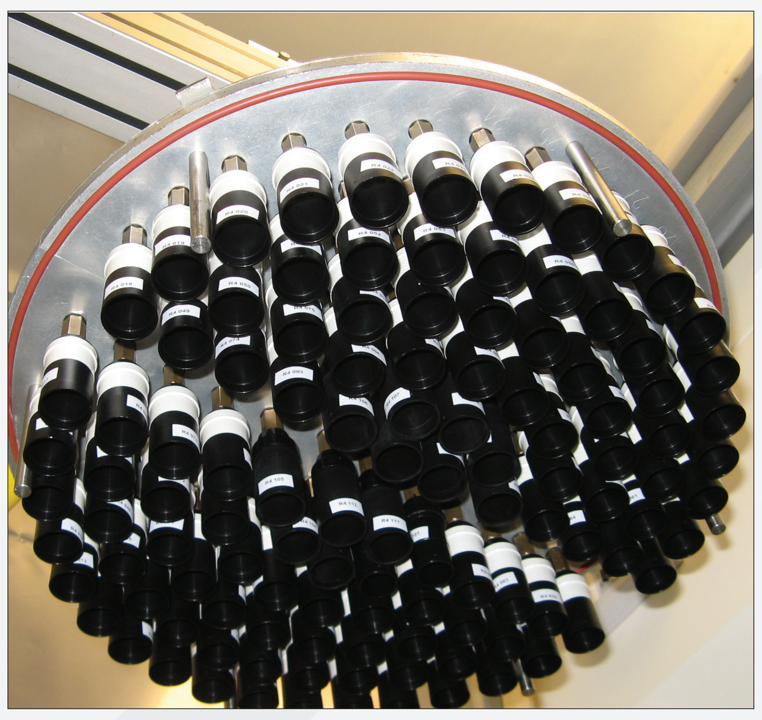

Fig 3: Sputnik Loaded with 114 Sampling Heads

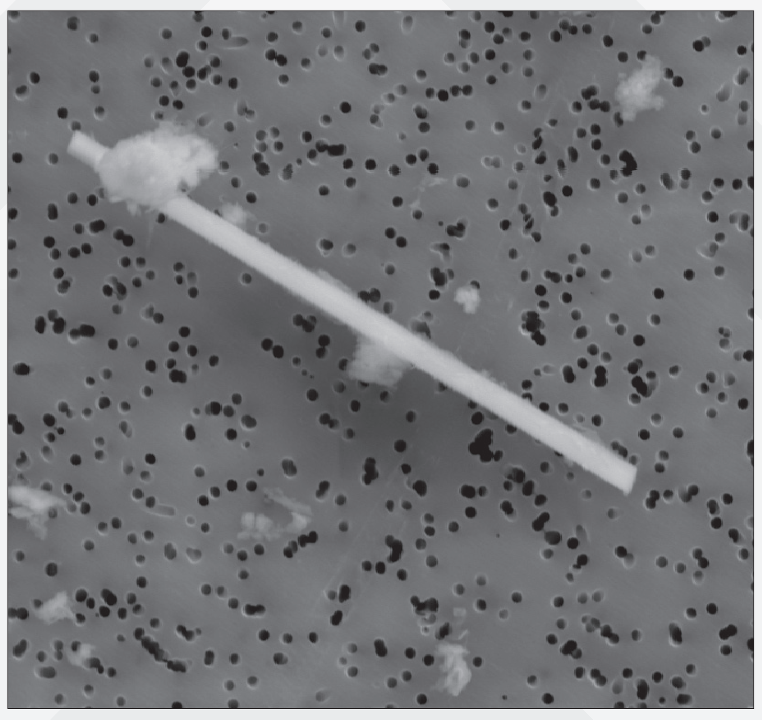

Fig 4: Amosite Asbestos

Data Analysis

Variation is present in fibre counting, with some of this variation due to differences between laboratories (e.g. differences in equipment), and some due to variation within laboratories (e.g. different analysts within a laboratory). When laboratories submit more than one result per round, taking simply the average of all the submitted results to estimate the true density of the sample may lead to a biased estimate. A more appropriate method is to use a random effects model to estimate the true density.

Let y_{ij} be the j^{th} observed density from the i^{th} laboratory. These fibre densities are assumed to follow a Poisson distribution with unknown mean μ_{ij}. As several labs submitted more than one count per sample, the mean count over all the samples may be not be an unbiased estimate for μ_{ij} . To account for variability between labs and reduce bias, we assume the following model:

$$E\,(Y_{ij}) = \mu_{ij}$$
$$\log\,(\mu_{ij}) = a + b_i$$
$$b_i \sim N\,(0,\sigma_b^{\,2})$$

Where a represents the logarithm of the true density, b_i are random effects produced by lab i (the b_i are normally distributed with mean 0 and variance σ_{b^2}).

	Number of measurements	Measured density range	Estimate of fibre density	Between-laboratory variability ( )	Within-laboratory variability
Sample 1	83	0 – 6.2	0.49	0.98	0.71
Sample 2	85	10 - 92	30.9	0.40	1.29
Sample 3	87	53 - 312	149.4	0.38	1.81
Sample 4	89	18 - 240	102.4	0.43	1.64

Table 1: Summary of Round 3 results

Fig 5: Round 3 - Sample 4; total fibre density measurements from 52 laboratories that took part

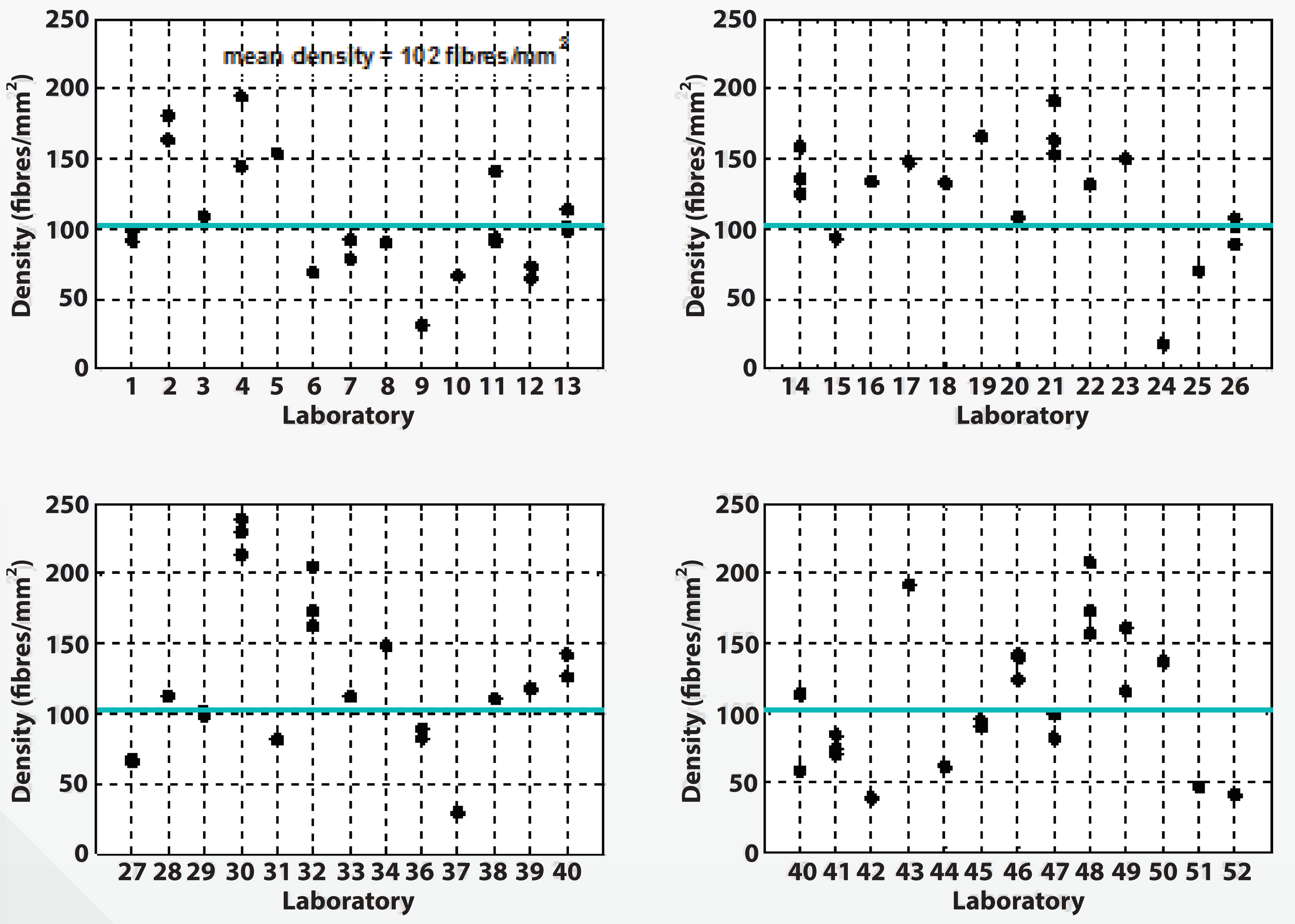

Figure 5 presents the total fibre density measurements in Round 3 (Sample 4) from 52 laboratories. Some laboratories reported consistently higher (labs 2, 4, 21, 30, 48) or lower (labs 12, 41) than average counts, with some being more consistent than others (labs 1, 13, 45).

Fig 6: Round 3 - Random Effects of 37 Laboratories That Took Part in the Scheme

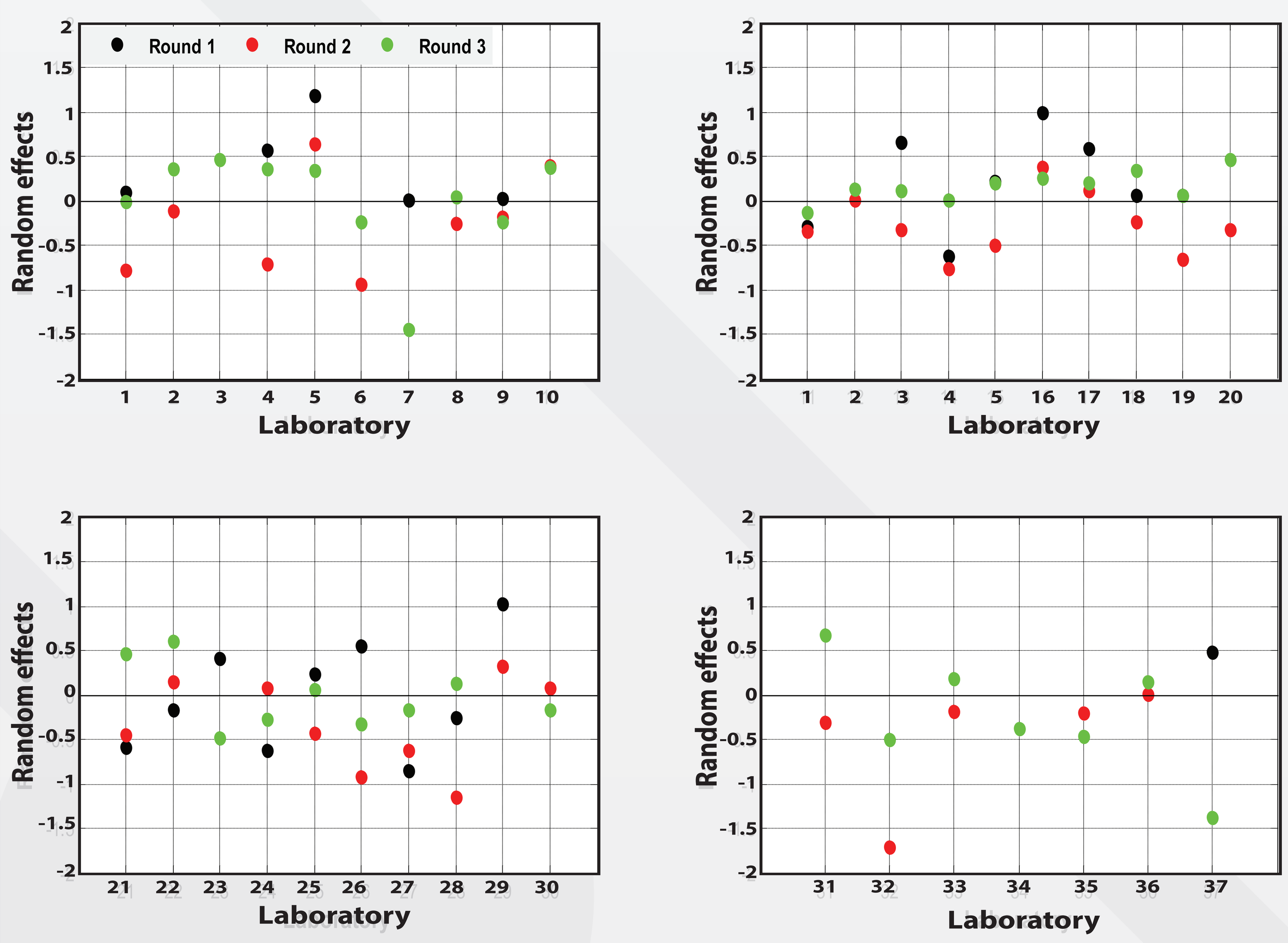

Fig. 6 shows a visual inspection of the random effects plots shows that some labs have consistently submitted higher/lower counts than the 'average'. The deviation of lab-specific counts from the 'average' has also generally declined between rounds 1 and 3 (as seen by the green dots generally being closer to zero than the black dots).

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