TIME INTEGRATED MEASUREMENT OF POTENTIAL ALPHA ENERGY (PAE) DUE TO SHORT LIVED DECAY PRODUCTS (SLDP) OF RADON 220 and 222 IN THE ENVIRONMENT

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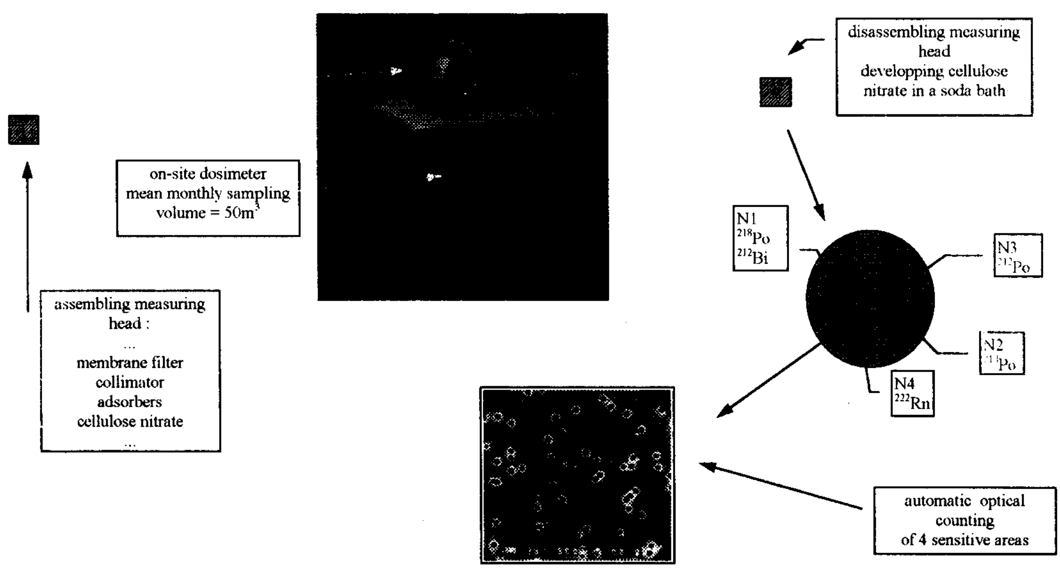
INTRODUCTION

The on-site alpha dosimeter, which provides time-integrated measurement of PAE due to SLDP of ^{220}Rn and ^{222}Rn in the environment is a derivative of the well-known individual alpha dosimeter used since 1983 for the monitoring of workers in french uranium mines. It includes a sampling unit and an interchangeable measuring head, and while sampling on the incorporated membrane filter, the detection of alpha particles from SLDP of ^{220}Rn and ^{222}Rn is carried out following energy discrimination using a solid state nuclear track detector, of the type KODAK LR115 .

In practical terms, we can give as an « use range » of measurement for the on-site dosimeter an interval between 5 nJm^{-3} and 5.10^{4} nJm^{-3} (PAE^{222}Rn) for a monthly sampling of 50 m^{3} . The setting-up of calculation for the uncertainty estimation for one single measurement result, including the whole measurement chain, shows that for this interval the total relative standard deviation is less than 40% .

It's good metrological performance, the great density of informations it can provide, and the simplicity of use make this device a usefool tool : not only to make small investigation of PAE monitoring in houses, in radium waste storage environment or to study specically night/day PAE ratio nearby uranium site for example, but also to follow up with a dosimeter network the evolution of the radiological impact of uranium or thorium facilities . At present, more than 150 on-site dosimeters are in use in France, Africa and others .

SIMPLIFY DIAGRAM OF USING PRINCIPLES



<u>PAE CALCULATION FROM RAW OPTICAL DATA</u>

Knowing the physical constant ratio of ^{212}Bi desintegration (α:36% and β/α:64%)

$$PAE_{(thoron)} = K\,(8.7\,N3 + 6.08\,N3/2)\,/\,\rho V \quad \text{in } nJm^{-3}$$

$$PAE_{(radon)} = K\,(\,7.7\,(N2 - a\,N4) + 5.99(N1 - N3/2 - b\,N4)\,)\,/\,\rho V \quad \text{in } nJm^{-3}$$

with ***ρ* : combination of collection and detection efficiency**
***V* : sampling volume**
***a, b* : weighting factors of radon contribution**
***K* : International System unit factor**

METROLOGICAL FEATURES OF ON-SITE DOSIMETERS

Range measurement

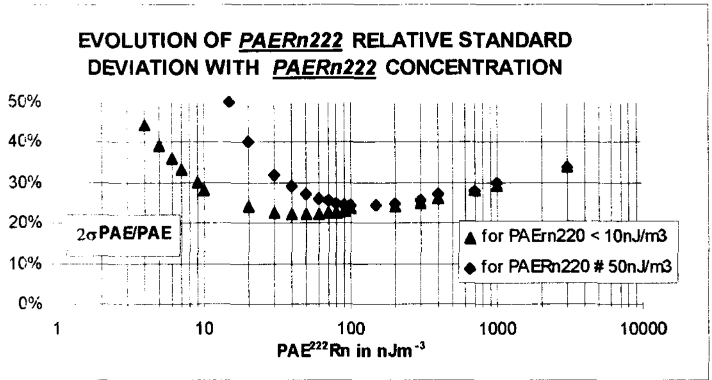
Theoretical aproach use to estimate the uncertainty of one single measurement results based on the simple propagation of statistical errors is a bit complicated by the fact that we have got some linked parameters . Nevertherless this calculation is essential to have got a good estimation of the lower end range measurement of the system .

The global formulae presented below represents the basis of this calculation and has been used to obtain the simplified curves which show the expexted evolution of relative standard deviation with PAE results .

$$\sigma_r^2 = (f_x' \sigma_x)^2 + (f_y' \sigma_y)^2 + (f_z' \sigma_z)^2 + \Lambda + 2 f_x' f_y' \operatorname{cov}(x,y) + 2 f_x' f_z' \operatorname{cov}(x,z) + 2 f_y' f_z' \operatorname{cov}(y,z) + \Lambda$$

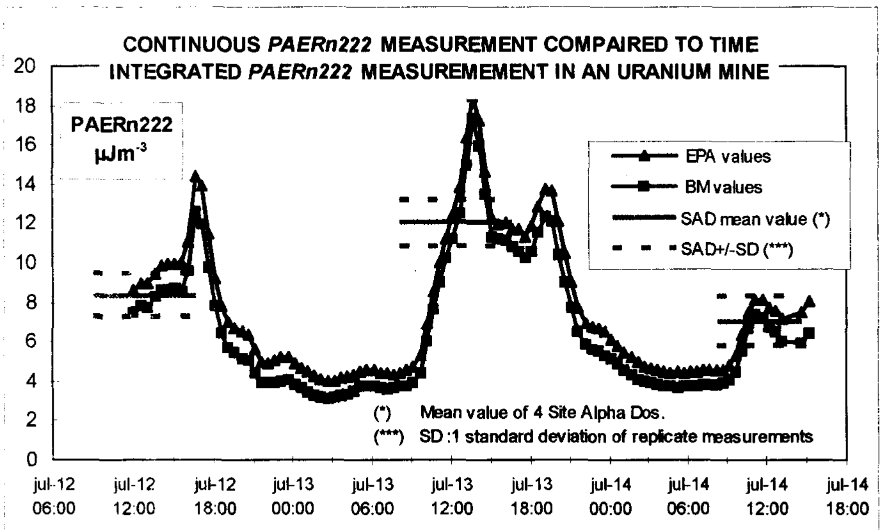
where the variable parameters will be in our case :

- the number of tracks N1, N2, N3, N4 counted on each sensitive areas
- the experimental collection efficiency
- the calculated by monte carlo algorithme detection efficiency
- the real-time measured sampling volume



Calibration

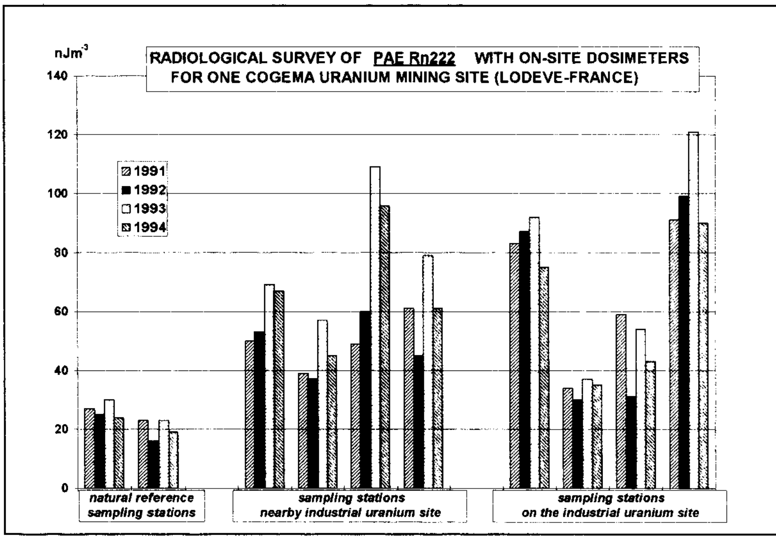
In addition to internal calibration, we try to compair our methods and results with other ones to follow an always possible time-drift . Some results of the last International Intercomparison we have participated concerning PAE measurements with Uranium mines conditions are presented below :



EXEMPLES OF USES

radiological following of uranium mining site

For example in south of France,there is a dosimeter network of about 10 devices measuring PAE around and on one of COGEMA's uranium mining site . Then we can follow since few years the radiological impact on the environment and by the way we can have a very good estimation of PAE exposure of the defined critical group . The diagram below is just a small example of results obtained among all dosimeters installed today.



specific application

In order to have more informations not only about the monthly but also night/day fluctuations of PAE and consequently to better estimate the real impact for the public, we have installed in this way for about 1 year 3 dosimeters sampling at different times during the day . In the same time, one continuous radon monitor (BARASOL) has been set , then permitting us to calculate with PAE and radon concentation the time-integrated equilibrium factor for specific periods .

The diagram below shows seasonaly, monthly, mean night and day fluctuations of PAE in a valley just nearby a radon source, an uranium tailing .