PROPOSAL TO THE ISOLDE COMMITTEE

HYPERFINE INTERACTION STUDIES OF IMPLANTED PROBES

BY

\( e^-\gamma \) TIME DIFFERENTIAL PERTURBED ANGULAR CORRELATIONS

(\( e^-\gamma \) TOPAC)

LISBON\(^1\) - BERLIN\(^2\) - COLLABORATION

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SUMMARY

Time differential perturbed angular correlation studies using $e^{-}\gamma$ cascades of radioactive nuclei have been successfully used to measure magnetic and electric coupling constants for different elements implanted in solids. This technique ideally complements studies with other hyperfine interaction techniques presently used at ISOLDE, like $\gamma$-$\gamma$ PAC, Mössbauer spectroscopy and nuclear orientation. Compared with the $\gamma$-$\gamma$ technique higher time resolution and, in many cases, higher accuracy can be obtained. The successful use of this technique implies, however, a versatile facility for production and implantation of the radioactive probes as ISOLDE. As a guideline for the selection of the isotopes to be studied with this technique we present the following criteria:

a) Metastable states with well studied cascades where one transition is highly converted and has a big particle parameter like $^{197}$Hg and $^{111}$Cd,

b) Isotopes presenting a forbidden $\beta-e^{-}$ cascade where the technique is sensitive to the sign of the quadrupole interaction, interesting for development of a field gradients theory.

c) Cascades not yet well studied from the nuclear spectroscopy point of view. This technique gives the opportunity to organize combined nuclear physics and solid state physics experiments. This will lead to new probes for material science studies with hyperfine methods.

As first cases we propose to investigate:

a) Impurities in the technologically important light weight metals beryllium and magnesium.

b) Electronic defects produced through conversion electron decay in the semiconductor silicon, gallium arsenide and cadmium selenide.
$e^{-} - \gamma$ TDPAC

Samples
Single crystals or
Semi-conductors,
Non-cubic metals,
or others

$e^{-} \tau = 1-1000 \text{ ns}$

$e_{K}$ $e_{L}$ $e_{M}$

$t_{e}$ $t_{\gamma}$

$L1$ $L2$

$E_{\gamma}$ $E$

$\gamma$

$\gamma$-stop

$\gamma$-start

TAC

Time spectrum

Log $N$

$e^{-t/\tau} G(t)$

Fourier analysis

$P(\omega)$

$\omega$