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TLAPrfl: Package for Calculation of Depth Profile for Thin Layer Activation

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Prepared for IAEA Contract C3-544, Project RAS/8/078

Summary of contents
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Abstract: TLAPrfl computer code package provides an easy means of calculating depth profiles of radioactivity induced by incident beam of charge particles in target material. The technique is commonly referred to as Thin Layer Activation (TLA). TLA profiles can be calculated for 35 reactions leading to specific activity induced by p, d, ^{3}He or α with incident energy up to 44 MeV on 12 isotopes and elements. IonStop code for calculation of ion energy loss characteristic in medium is also included. A diskette with TLAPrfl code package is available upon request, costfree, from the IAEA Nuclear Data Section. Users with access to Internet may download TLAPrfl.zip file (379 KB) from http://www-nds.iaea.or.at/reports/data/tlaprfl.zip.

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The code package should be referred as follows:

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> Available on request (see addresses on cover page) in hardcopy from Nuclear Data Section of the IAEA.

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TLAPrfl package consists of 7 files including 2 executable files (Ionstop.exe and Tlaprof.exe) which can be run at PCs under MS Windows or DOS.

The following work was done to prepare data for Tlaprof. Data on measured yields of many reactions suitable for TLA and tabulated in [1] were processed to extract nuclear microscopic cross section values up to maximum energies of incident particles. The derived experimental values of nuclear microscopic cross sections has been fitted by simple empirical equations with smoothed dependence from energy and then reverse procedure of conversion to activity yields was done. 63 data sets for 12 elements and isotopes most important for TLA analysis were processed. The full list of reactions is given in Table 1 below. In case when few data sets with different incident particle energies were used in processing of the same reaction they were treated and are used for TLA profile calculations separately.

IonStop code for calculations of ion energy loss characteristics in wide region of particles and energies is included in the TLAPrfl package. The calculations of stopping powers and ranges are based on consideration of energy losses by ion in inelastic collision with the atomic electrons as given by Ziegler et al. in [2].

References

1. Report IAEA TECDOC-924, *The thin layer activation method and its application in industry* (1997).

2. J.E. Ziegler, J.P. Biersack and U. Littmark, *The Stopping and Range of Ions in Solids*, Vol.1 (1985) Pergamon Press, New York.

Table 1. List of reactions given in TLAPrfl package for thin layer activation analysis.

Reaction	Maximum Particle Energy, MeV
27Al(3He,x)22Na	30
48Ti(p,n)48V	7
48Ti(p,n)48V	11
48Ti(p,n)48V	22
Ti(d,xn)48V	10
Ti(d,xn)48V	22
Ti(a,x)48V	44
Ti(a,x)51Cr	44
Ti(3He,x)48V	30
52Cr(p,n)52Mn	13
52Cr(p,n)52Mn	22
56Fe(p,n)56Co	7
56Fe(p,n)56Co	11
56Fe(p,n)56Co	13
56Fe(d,n)57Co	7
56Fe(d,n)57Co	10
56Fe(d,n)57Co	13
56Fe(d,n)57Co	22
56Fe(d,2n)56Co	13
56Fe(d,2n)56Co	22
Fe(3He,x)56Co	30
Fe(3He,x)57Co	30
Fe(3He,x)58Co	30
Ni(p,x)57Co	10
Ni(p,x)57Co	22
Ni(d,x)56Co	22
Ni(d,x)58Co	22
Ni(3He,x)56Co	30
Ni(3He,x)57Co	30
Ni(3He,x)58Co	30
65Cu(p,n)65Zn	7

Reaction	Maximum Particle Energy, MeV
65Cu(p,n)65Zn	11
65Cu(p,n)65Zn	13
65Cu(p,n)65Zn	22
65Cu(d,n)65Zn	10
65Cu(d,n)65Zn	22
65Cu(3He,x)58Co	30
63Cu(3He,x)60Co	30
63Cu(3He,x)65Zn	30
63Cu(3He,x)67Ga	30
Zn(p,x)67Ga	11
Zn(p,x)67Ga	22
Zn(d,x)65Zn	10
Zn(d,x)65Zn	22
Zn(d,x)67Ga	22
Zn(3He,x)67Ga	30
Zn(3He,x)68Ge	30
Mo(p,x)95mTc	7
Mo(p,x)95mTc	11
Mo(p,x)95mTc	22
Mo(p,x)96Tc	11
Mo(p,x)96Tc	22
Mo(d,x)95mTc	22
Mo(3He,x)95mTc	30
W(p,x)183Re	11
W(p,x)183Re	22
W(p,x)184gRe	11
W(p,x)184gRe	22
W(d,x)183Re	22
W(d,x)184gRe	22
W(3He,x)183Re	30
W(3He,x)184gRe	30
W(3He,x)185Os	30