Availability and Use of the CD-ROMS on Models and Dose Coefficients

Eye-opener 08

IRPA 10 Congress Hiroshima

May 17, 2000

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Thank you

- **IRPA 10 Program Committee**
  for the kind invitation to present this eye-opener lecture
- **Dr. Herwig Paretzke**
  for search for sponsers of my travel
- **Federal Office for Radiation Protection (BfS)**
  for support in the preparation of these slides
- **My Son Ingo**
  for permission to spend a week of vacation here
- **To You**
  to attend this eye-opener lecture

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Please Excuse Me

- **the selection of the software presented here is incomplete**

  I acknowledge that there may be software even better as the software mentioned here.

- **my assessment of software here is subjective to some extent**

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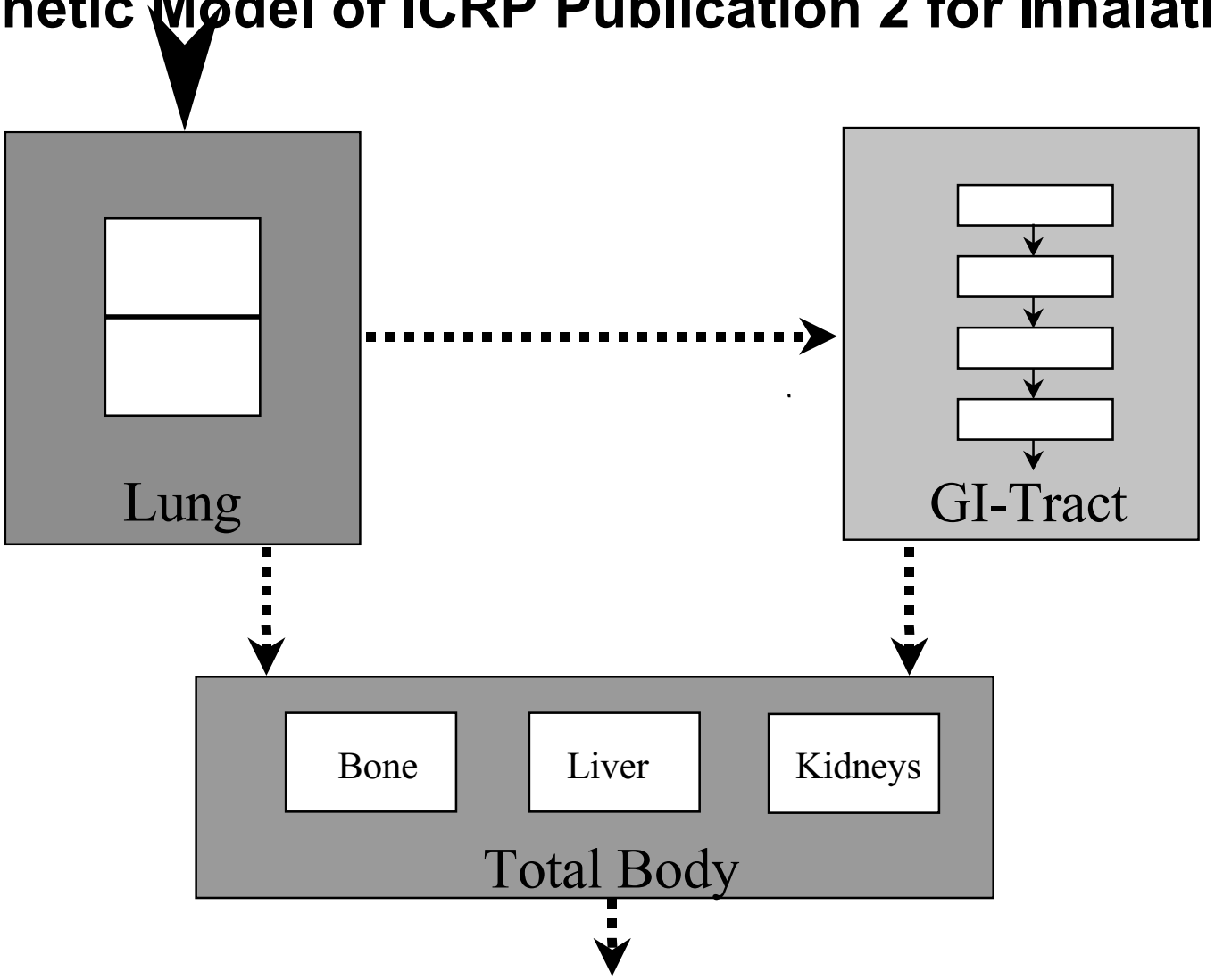
Biokinetic Model of ICRP Publication 2 for Inhalation of ^{210}Pb



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Dosimetric Model of ICRP Publication 2

- Only source organs are considered as target organs.

- No cross-fire is considered for penetrating radiation.

- Target organs are considered as spheres with an effective radius (for example 30 cm for total body).

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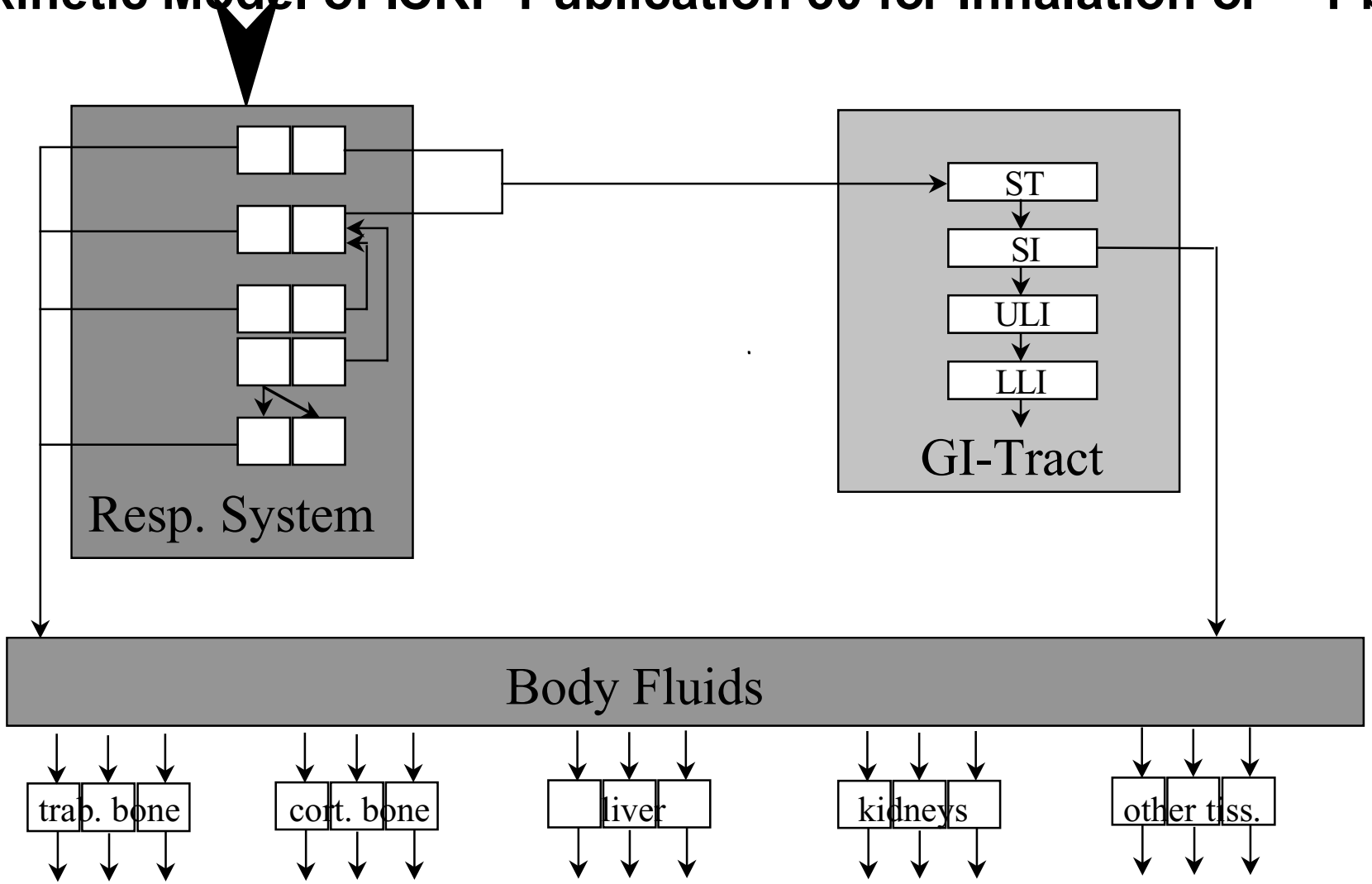
Biokinetic Model of ICRP Publication 30 for Inhalation of ^{210}Pb



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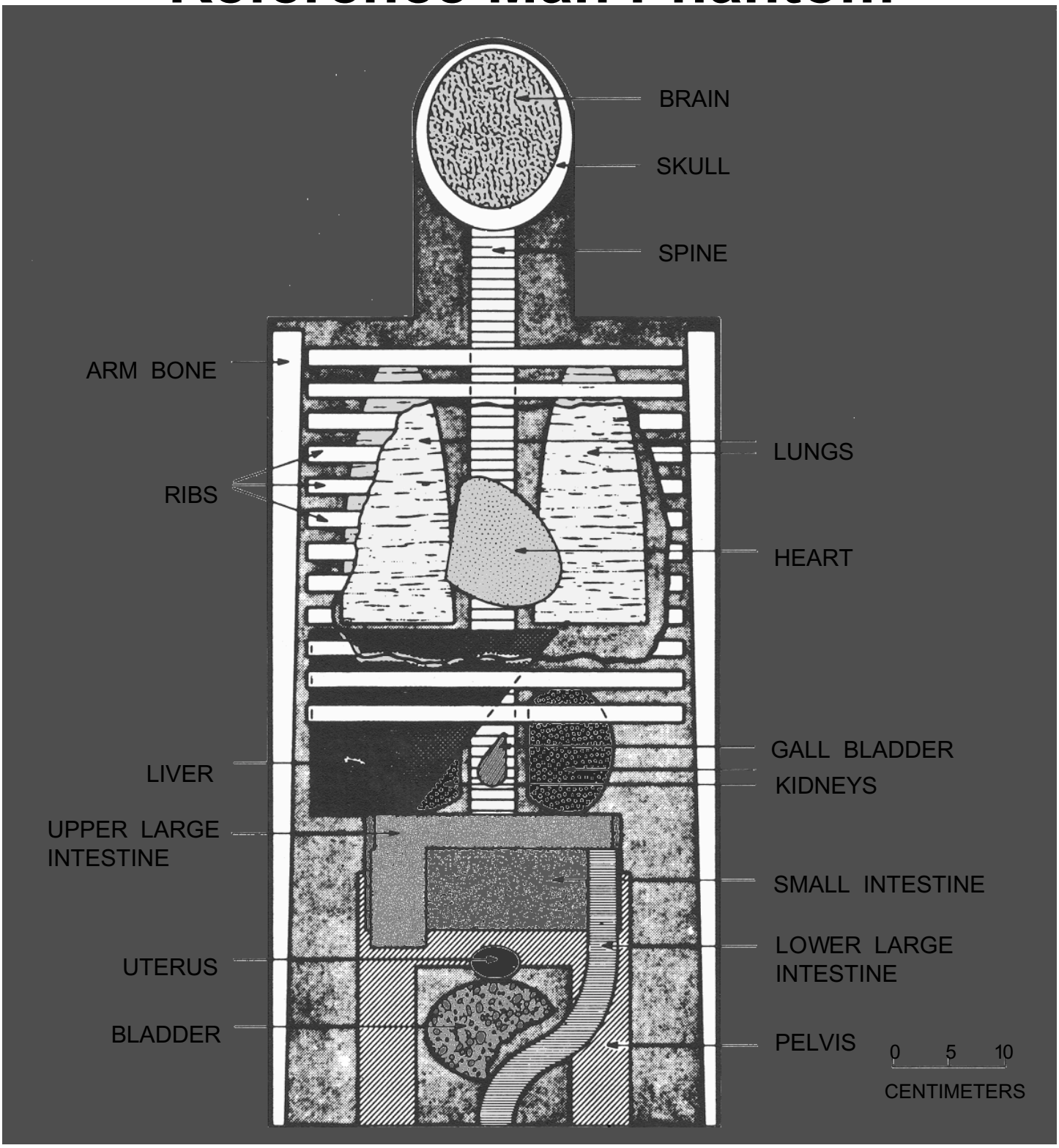
Reference Man Phantom



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Availability and Use of the CD-ROMs on Models and Dose Coefficients

1.2.2 ICRP 30 - Dosimetric Model

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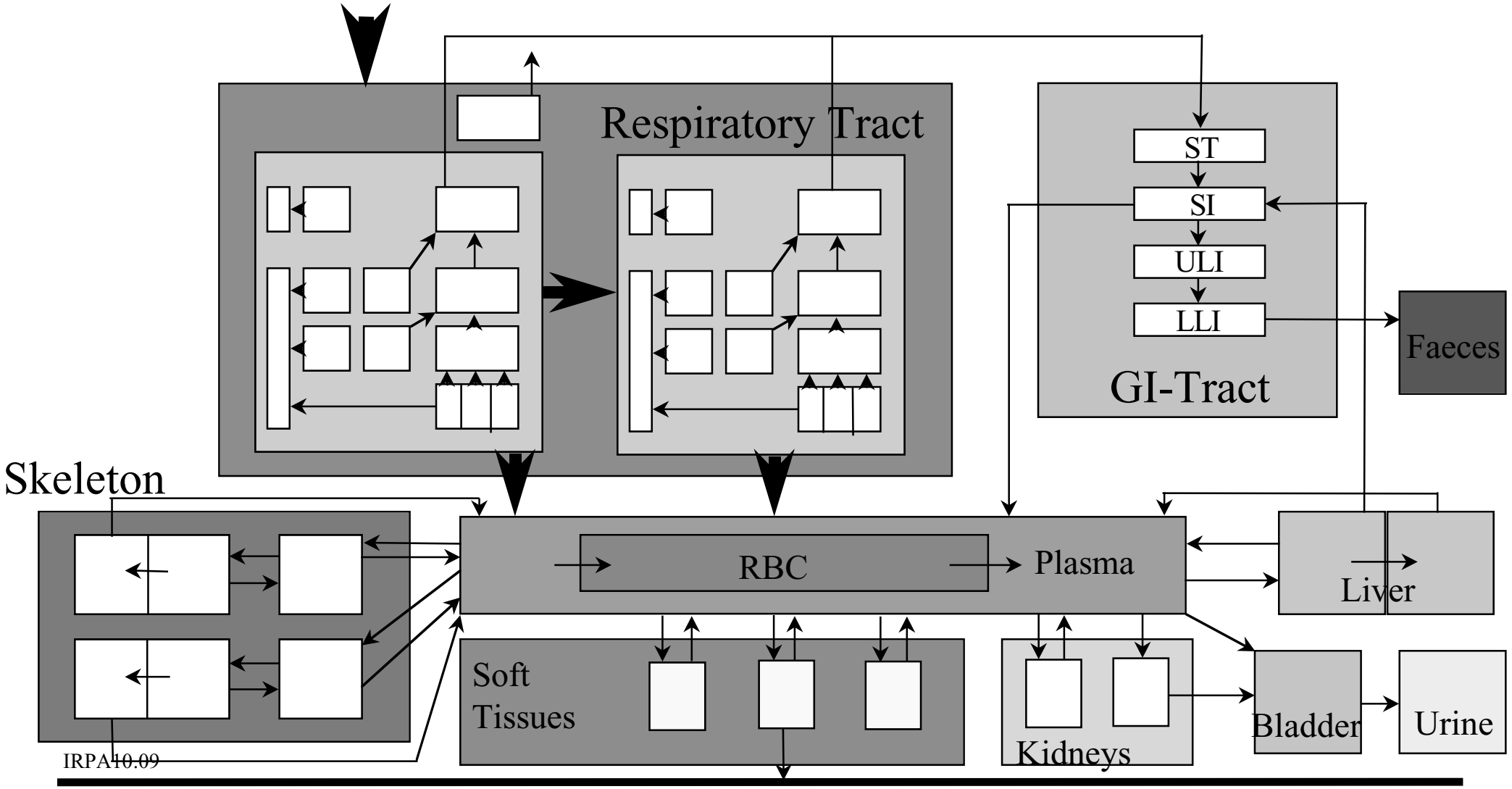
Biokinetic Model of ICRP Publication 72 for Inhalation of ^{210}Pb



Availability and Use of the CD-ROMs on Models and Dose Coefficients

1.3.1 ICRP 72 - Biokinetic Model

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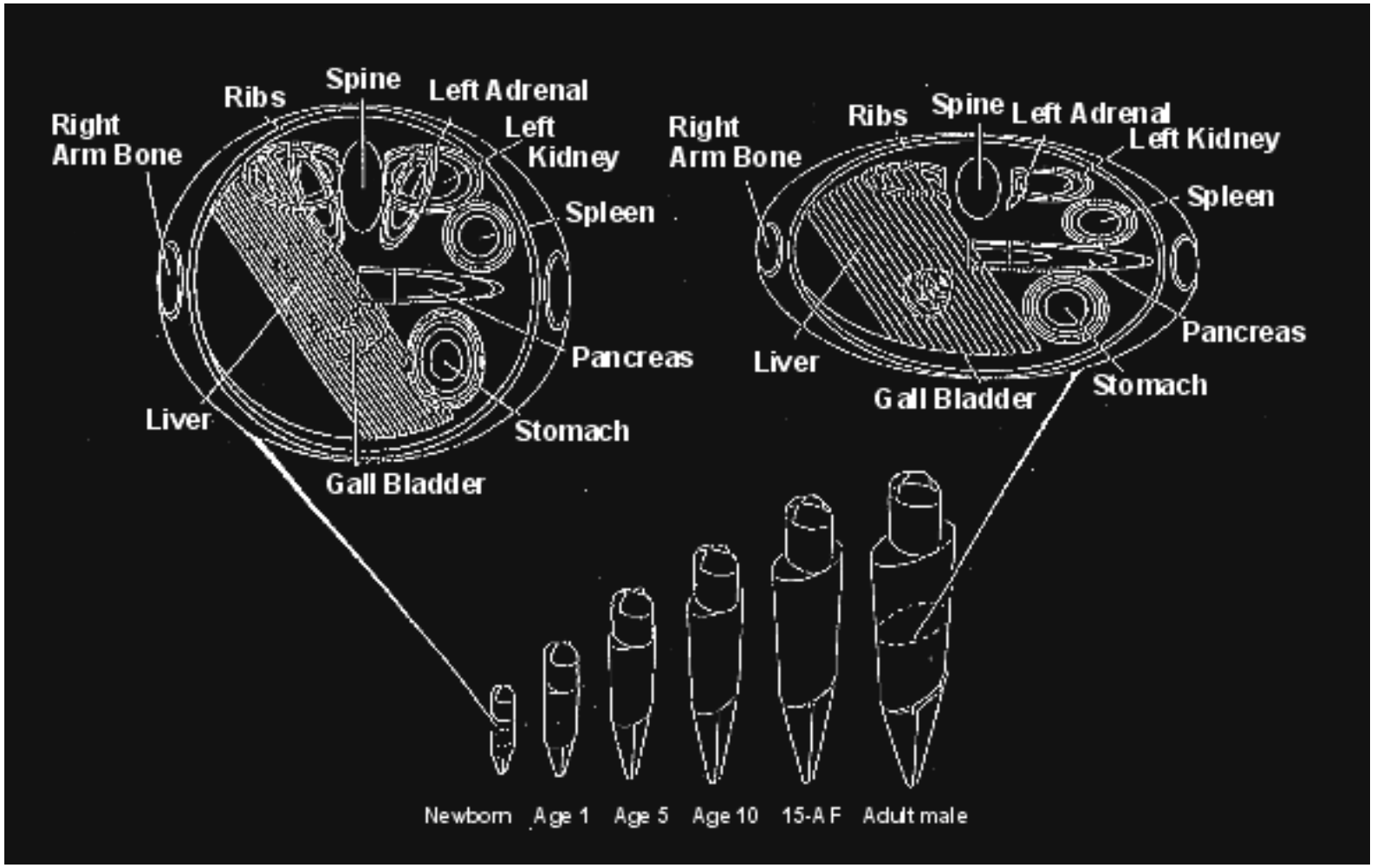
The Reference Family Phantoms Used in ICRP Publications 56ff .



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Availability and Use of the CD-ROMs on Models and Dose Coefficients
1.3.2 ICRP 72 - Dosimetric Model

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Forthcoming Model Developments by ICRP

- Doses to embryo and foetus after activity intake by the mother
- Transfer of activity to mother s milk
- A new biokinetic and dosimetric model for the human alimentary tract
- Further physiologically based biokinetic models during the revision of Publication 30

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Who Needs Which Software?

- **Scientists active in research in internal dosimetry (who develop models)**

  data base tools, model development tools, highly sophisticated computational tools

- **Members of measurement agencies or nuclear medicine departments (who apply models)**

  basic calculational tools, administrative tools

- **Students (who learn models)**

  basic informations, educational tools

- **Regulators (who must have an idea of models)**

  dose coefficients, electronic versions of standard documents

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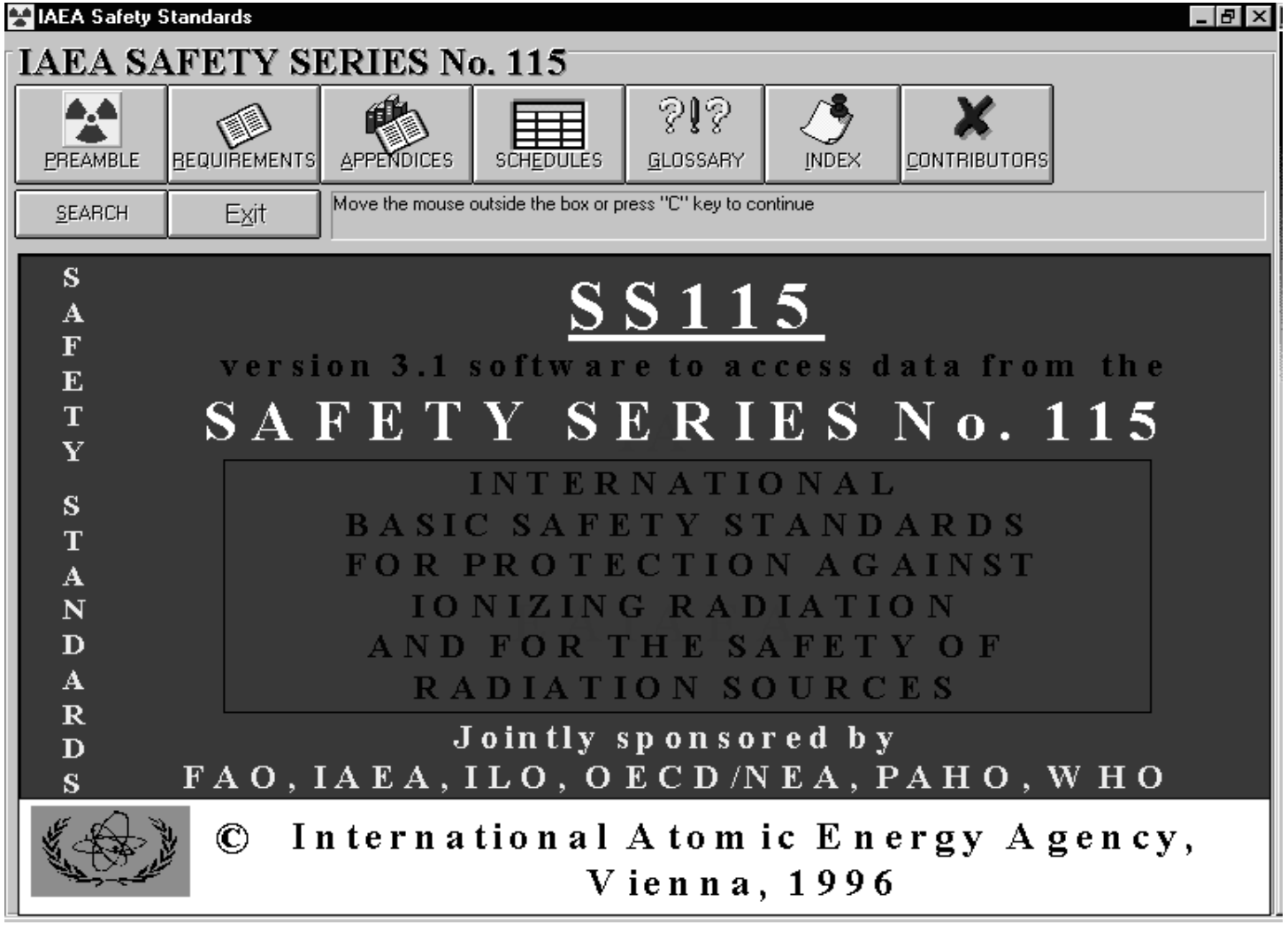
The Electronic Version of the IAEA Basic Safety Standards



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The Electronic Version of the IAEA Basic Safety Standards

- The whole text and all tables of the IAEA Basic Safety Series No. 115 can be selected via the list of contents and can be displayed.

- It includes a search function for several topics.

- Parts can be printed and copied to other documents.

  A disadvantage is that - for example - the copy of dose coefficients includes Tabs and cannot be used directly as an input to other programs

- Comments and bookmarks can be included.

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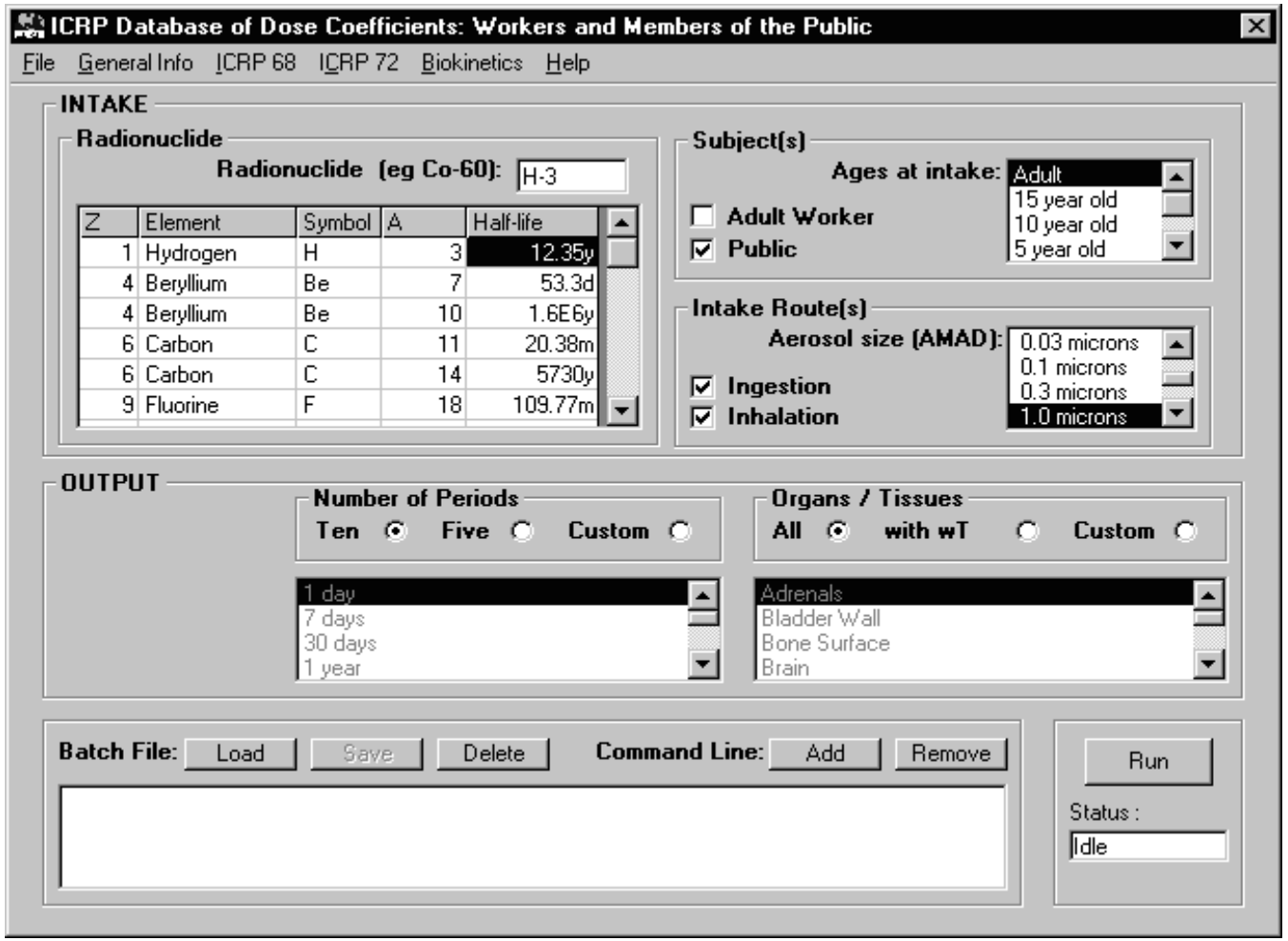
ICRP Database of Dose Coefficients (1)



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ICRP Database of Dose Coefficients (2)

- contains all dose coefficients of ICRP Publication 68 (Workers) and ICRP Publication 72 (Members of the Public) including organ doses

  Also doses to regions of the respiratory tract can be selected.

- for inhalation 10 different AMADs can be selected (from 1 nm to 10 m)

- 10 different integration periods from 1 d to the age of 70 y (or 50 y integration period for adults) can be selected

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ICRP Database of Dose Coefficients (3)

- includes text of ICRP Publications 68 and 72 with search function and all the functionality of electronic documents (copy, print, comments, bookmarks)

- includes biokinetic models for all elements

- results can be saved as ASCII file and printed
  however only results of 1 radionuclide

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ICRP Database of Dose Coefficients (4)

- **results are ICRP approved**

  many quality assurance procedures within the ICRP Task Group on Dose Calculations

- **version 2.0 will also run under Windows NT**

- **will be followed by a similar CD-ROM with dose coefficients for embryo and foetus after activity intake by the mother (many intake scenarios, several organs, doses in utero and after birth)**

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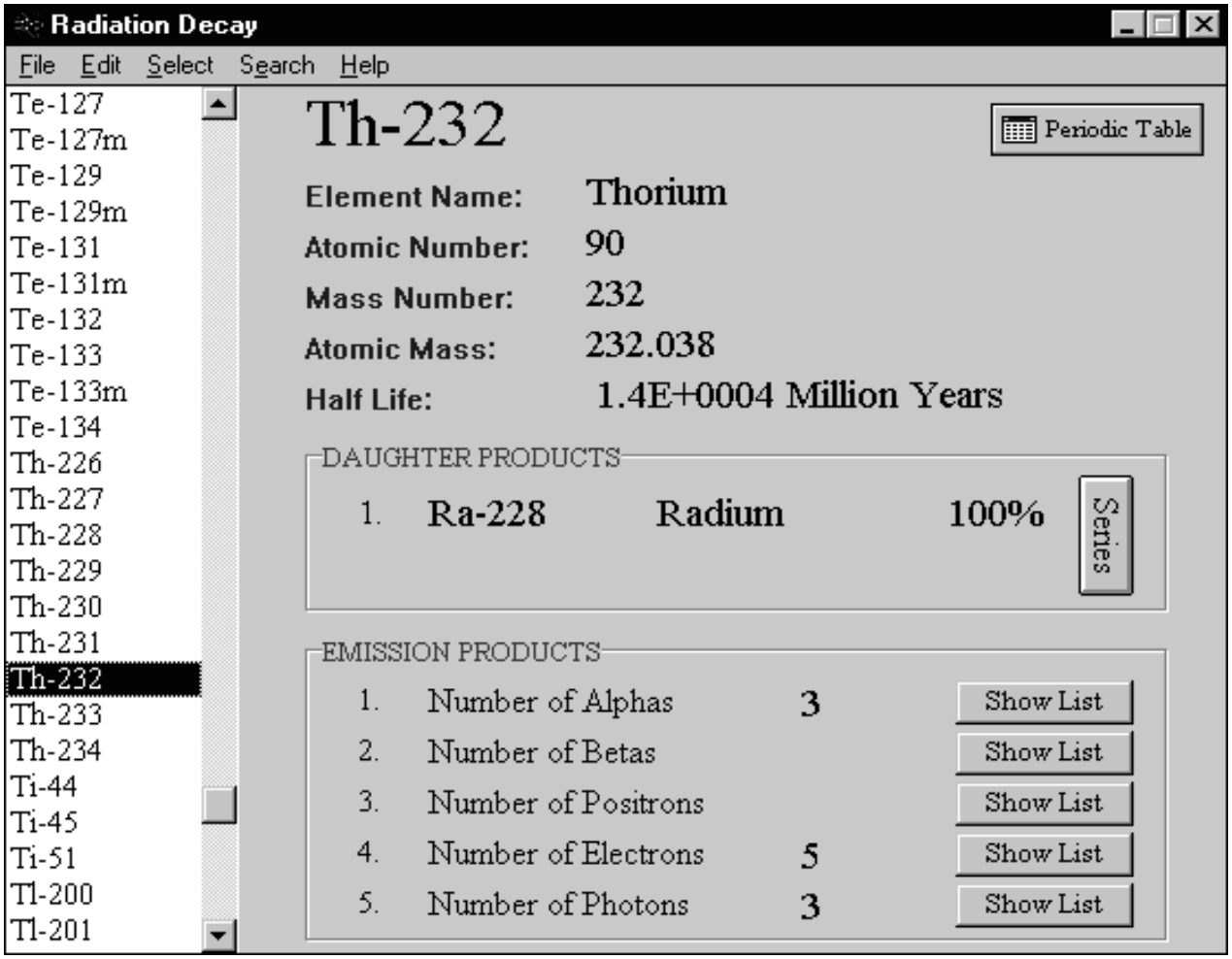
Radiation Decay Data (1)



This is an example of a windows-based freeware program by Charles Hacker (Australia)

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Radiation Decay Data (2)

- It gives radiation data (decay chain, half-life, energies and probabilities for various kinds of emissions) for 497 radionuclides.

  based on data from ORNL

- Results can be printed and copied to the clipboard.

- It has a search function for radionuclides with gamma emissions within a given energy range.

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Radiation Decay Data (3)

- There are similar tools within the ORNL DCAL package.

- They give all information of ICRP Publication 38 including beta spectra.

- With the SEECAL code also SEE values for all source and target pairs of the reference family can be calculated.

- The version I know is a menue driven DOS program.

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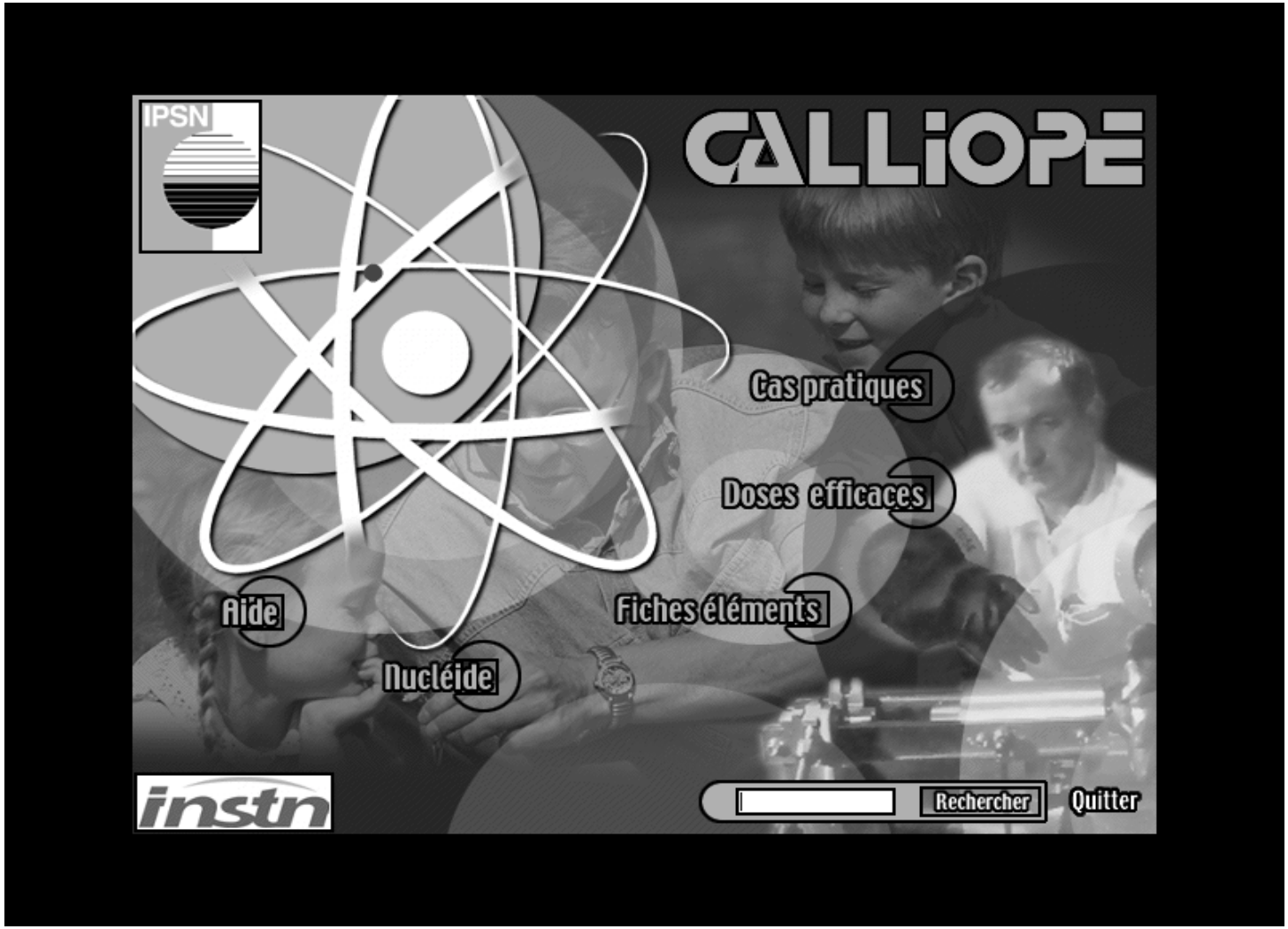
Educational Software



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CALLIOPE (1)

- new educational software by IPSN in French language with audio/video animation

- partly presenting basic information / dose coefficients and the sub-program Nucl ide, partly presenting examples how to calculate doses in specific situations

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CALLIOPE (2) - Basic Informations

- effective dose coefficients for workers and members of the public due to ICRP Publications 68 and 72

  due to format problems some inaccuracies in exceptional cases

- for some elements/radionuclides description of the biokinetic model, possible medical intervention, information on absorption Types and f_1, in which ICRP Publication the models are defined, and methods of measurement (including detection limit)

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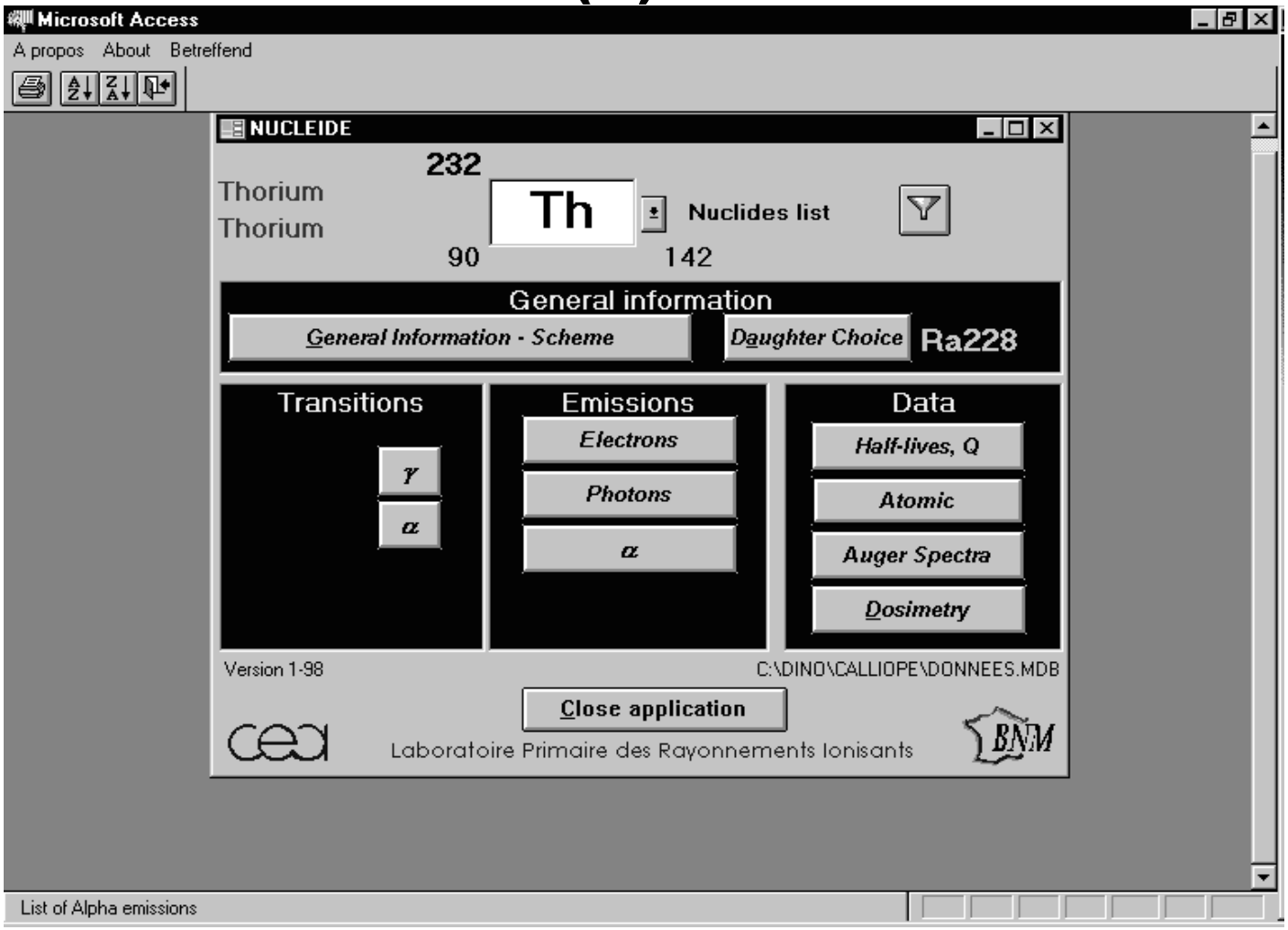
CALLIOPE (3) - Nucl ide



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CALLIOPE (4) - Nucl ide

- computerized form of Table de Radionucl ides " by BNM-CEA/LPRI, edited in international co-operation
- data for 75 radionuclides
- not consistent with ICRP Publication 38
- contains many details including uncertainties
- extended search function (besides energies also half-lives, mass number and probabilities)

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CALLIOPE (5) - practical cases

Several example calculations of intake and doses from measurement values

- **with ICRP models and without ICRP models (integration method)**
- **chronic and acute intake**
- **with and without knowledge of time of intake**

The selection of the example is the only possible interaction by the user.

This software was designed to accompany lectures and the examples are partly difficult do understand without accompanying declarations

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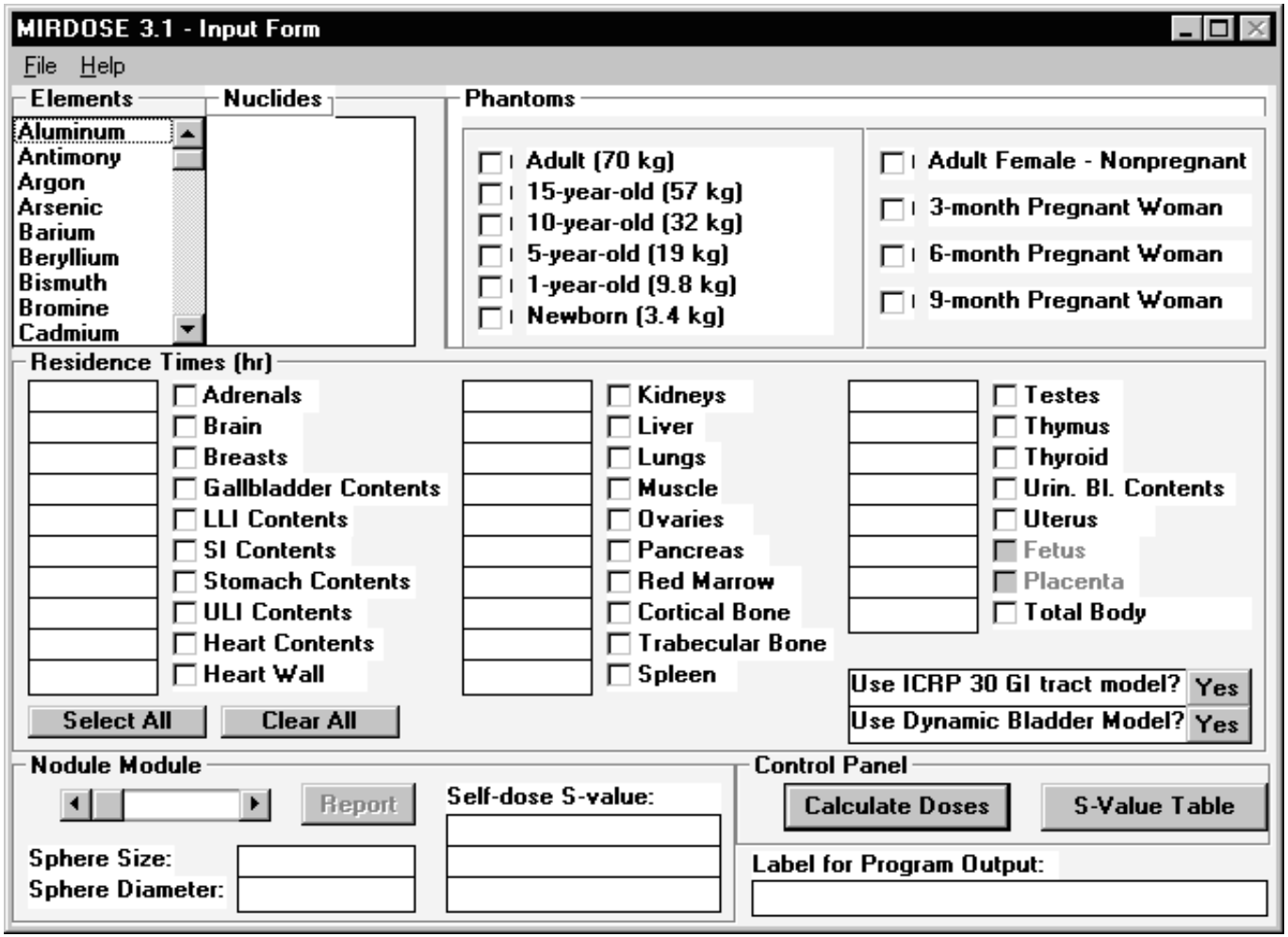
MIRDOSE3 (1)



A standard software to calculate doses in nuclear medicine

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MIRDOSE3 (2)

- Input residence times in source regions (in h)

- it calculates residence times in urinary bladder and in the GI tract due to the dynamic bladder model and the GI tract model of ICRP 30

  does not consider delay in the transfer to the GI tract, i.e. may be overestimation

- calculates doses for many radionuclides for 6 age groups and also for pregnant females

- calculates S-values for nodules

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MIRDOSE3 (3)

- Input form can be saved and retrieved

- In the output also the main contributors to the dose are displayed

- Output form can be printed and saved as an ASCII file

- Tables with S-values can be displayed, saved and printed

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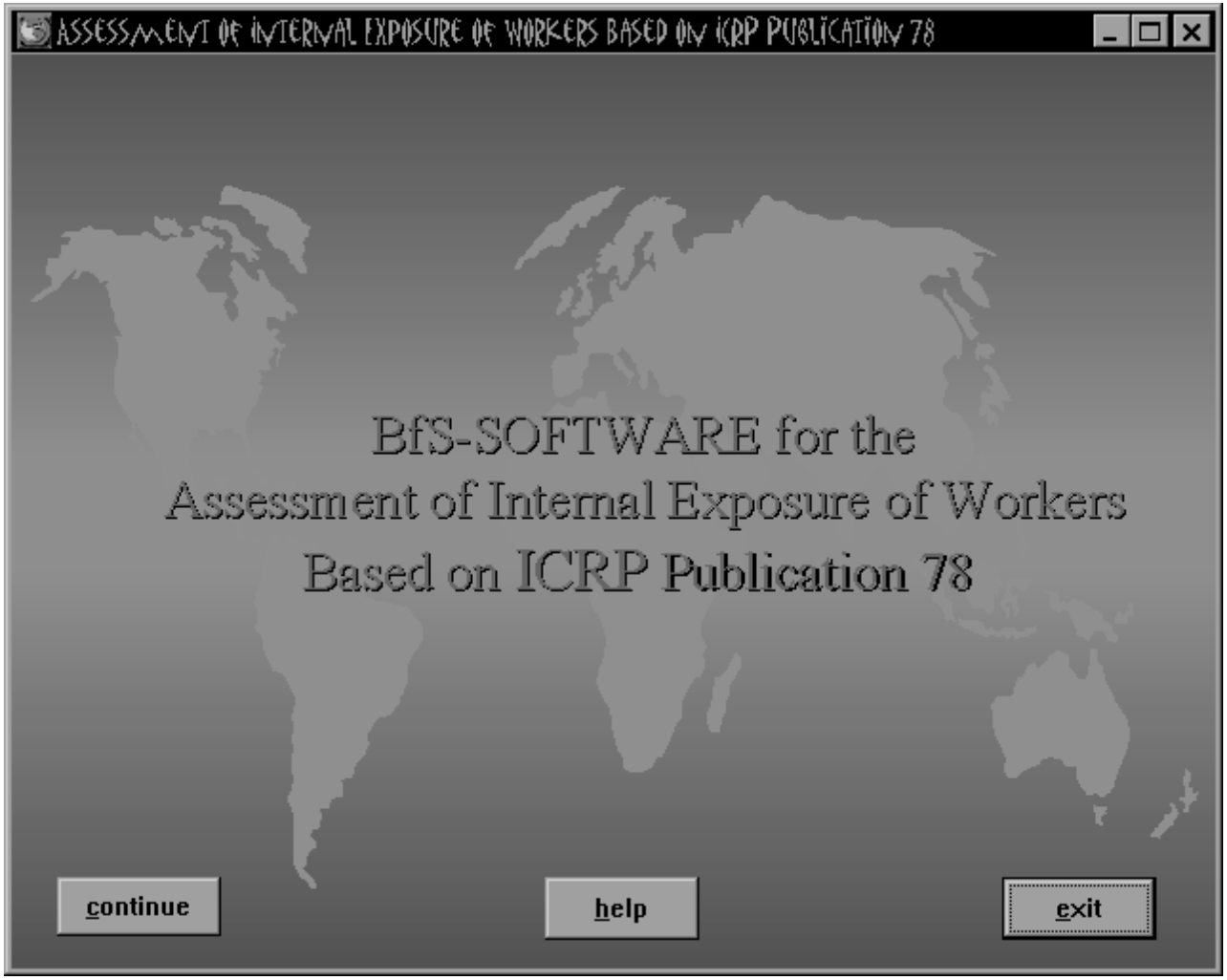
Software accompanying ICRP Publication 78 (1)



Availability and Use of the CD-ROMs on Models and Dose Coefficients
3.5.2 Basic Calculations - ICRP78

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Software accompanying ICRP Publication 78 (2)

- **is being produced by BfS**

  at the moment ICRP does not want to publish interactive software

- **contains the radionuclide-specific data of ICRP Publication 78 (including Tables and graphs)**

- **can calculate the values of the retention and excretion functions for any times after (the beginning) of an acute or chronic intake**

- **can calculate intake and dose (organ doses and effective dose) from measurement values**

  it is, however, restricted to the ICRP 78 models, but for 2 different AMADs (1 and 5 m)

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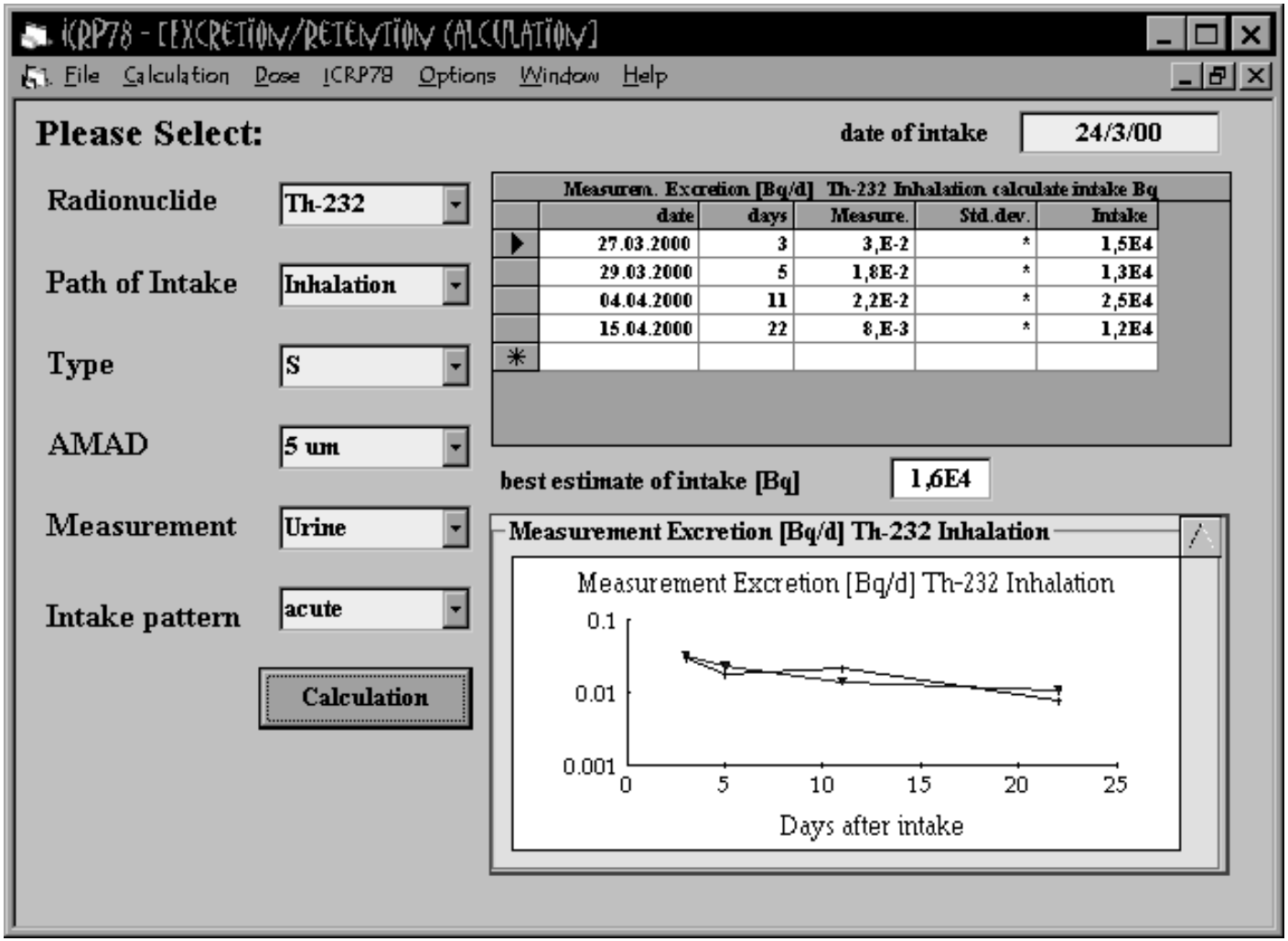
Software accompanying ICRP Publication 78 (3)



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Software accompanying ICRP Publication 78 (4)

- graphic display of retention and excretion functions (together with measurement values)
- can calculate number of days between time of (begin of) intake and time of measurement
- can save input and output data in ASCII and LUDEP format

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Software Package INCOR (1)

- Software Package for Data Administration and Calculation of Intake as well as Effective Dose for Measured Incorporated Radionuclides in Humans

- it assists both administration and analysis of data due to the German regulations

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Software Package INCOR (2)

- Data base for administration of personal data and measurement results
- calculation of intake and effective dose due to the reference method
- use of ICRP models if reference method does not apply
- dose calculation with the integration method
- test of suitability of models

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LUDEP (1)

- DOS-based program developed parallel with the new ICRP respiratory tract model (Publication 66)

- very flexible with a very comfortable user-interface

- calculates deposition in the respiratory tract, doses per (unit) intake, or intake and doses from measurement values

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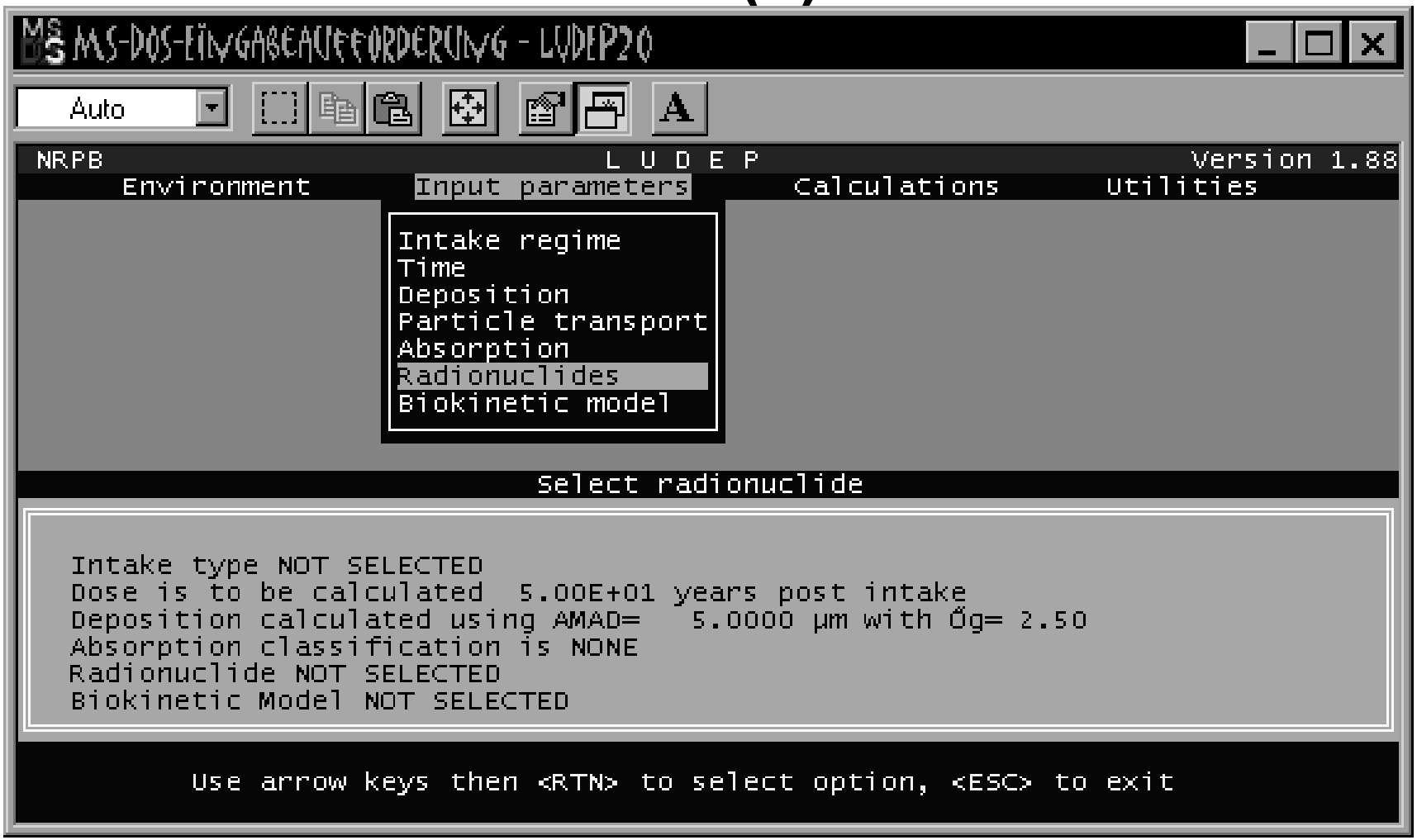
LUDEP (2)



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LUDEP (3)

- very efficient tool to calculate respiratory tract deposition values for all possible parameter selections

- selection of any mechanical transport and absorption parameters for the respiratory tract

- selection of all kinds of systemic biokinetic parameters

  however only based on ICRP 30 model structure, no specific consideration of daughter nuclides

- calculation of SEE values, numbers of transformations, organ and effective doses

  also doses to respiratory tract regions, however only for adults

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LUDEP (4)

- various possibilities to calculate intake and doses from measurement data by fitting the measurement values by bioassay functions

- indication of the quality of the fit

  no indication of the reasons for a bad fit

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ICRP DOCAL Tools (1)

The calculations for ICRP Publications are performed within the Task Group on Dose Calculations (DOCAL) with several independently written codes:

- **DCAL from ORNL (USA)**
- **PLEIADES from NRPB (UK)**
- **DOSAGE from BfS (Germany)**
- **IDSS from URPI (Ukraine)**

By intercomparison of the results a very efficient quality assurance of results is obtained.

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ICRP DOCAL Tools (2)

All these codes can calculate

- **age-dependent dose coefficients (with continuous change of biokinetic and dosimetric parameters) with any first-order biokinetic model and with consideration of independent daughter kinetics**
- **age-dependent retention and excretion functions for various intake functions**
- **doses to embryo and foetus after activity intake by the mother with compartment models as well as with the generic model based on activity concentration data**

and they are extended due to new requirements.

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ICRP DOCAL Tools (3)

- **PLEIADES and DOSAGE are only development tools for use by NRPB and BfS and are not avilable outside these institutions; however, calculation results can be requested**

  user interface is not suitable for distribution

- **Versions of DCAL and IDSS are intended to be commercially available**

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IMIE (1)

- On the basis of IDSS URPI (Kiev, Ukraine) develops the IMIE (Individual Monitoring of the Internal Exposure) code for retrospective dosimetry

- It offers a wide range of analysis of measurement data together with an administrative tool

- It has an interactive user interface with graphical tools for presentation and analysis with the choice of automatic (on the basis of ICRP78 methods), semi-automatic or manual evaluation

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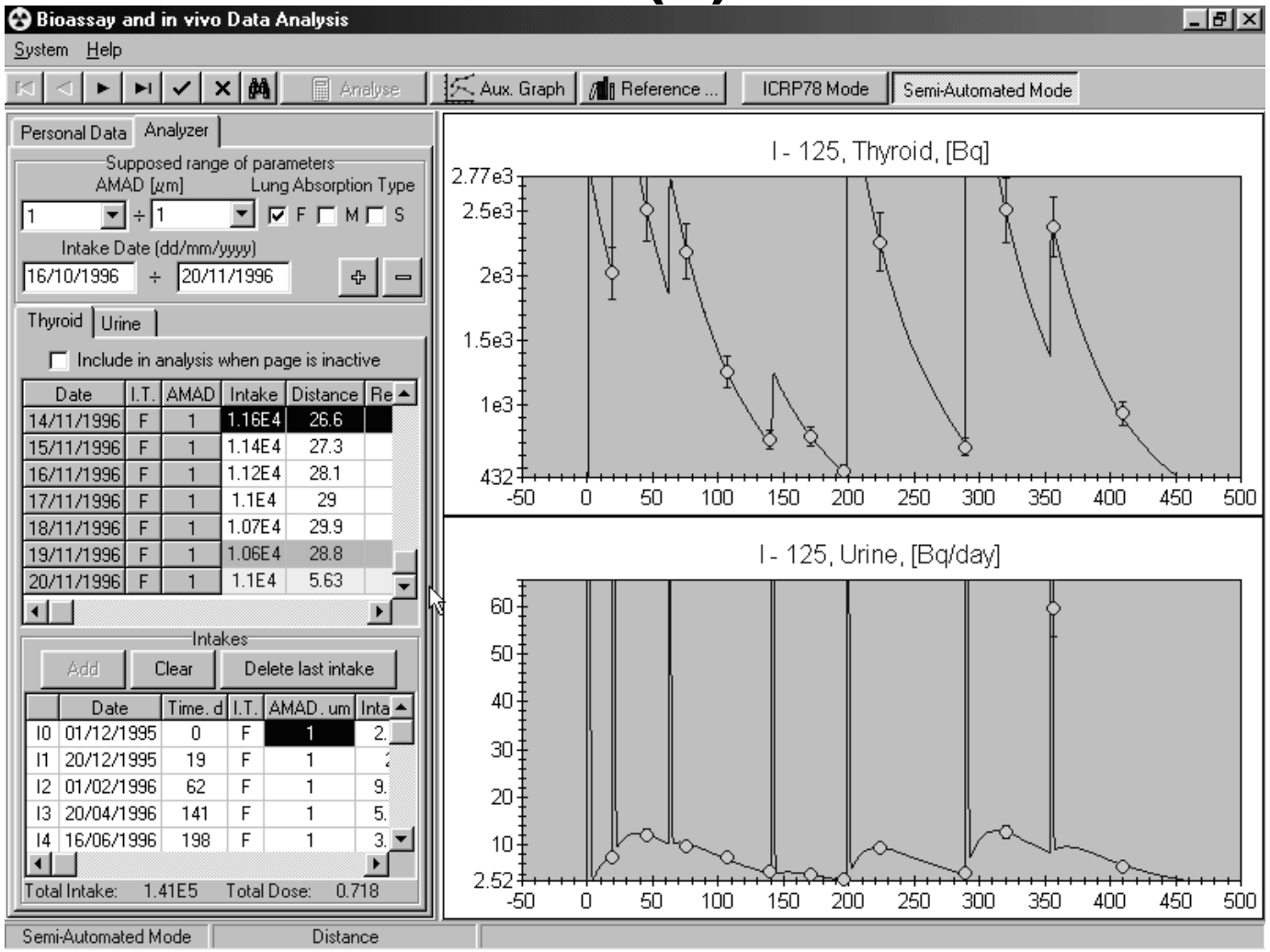
IMIE (2)



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Radionuclide Biokinetic Database (1)

- developed by an EULEP-EURADOS action group to collate and analyse information from the scientific literature on the biokinetic results of experimental studies

- it is planned to use it for the revision of ICRP Publications 30/54

- based on ACCESS

- Changes are only included by the Database Manager (at present Mike Bailey, NRPB)

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Radionuclide Biokinetic Database (2)

It contains information on

- **radionuclide, chemical and physical properties**
- **the experiment**
  in vivo/in vitro etc.
- **species including further conditions**
  age, fasting / non-fasting etc.
- **results (also as spreadsheet)**
- **comments**

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ICRP goes Internet

- **Draft reports can be downloaded and commented**

- **Interim reports will be posted on the web**
  Radiopharmaceuticals additional to those in Publication 80

- **Supplements and updates of reports will be given**
  Errata

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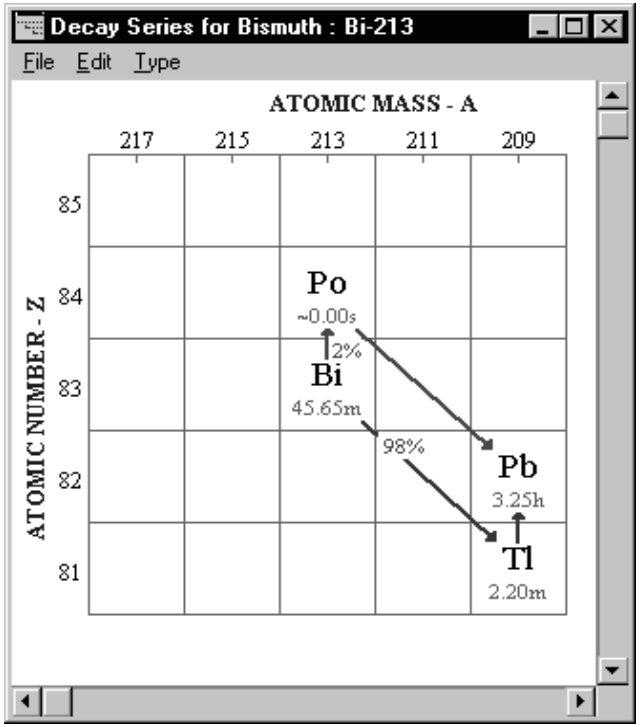
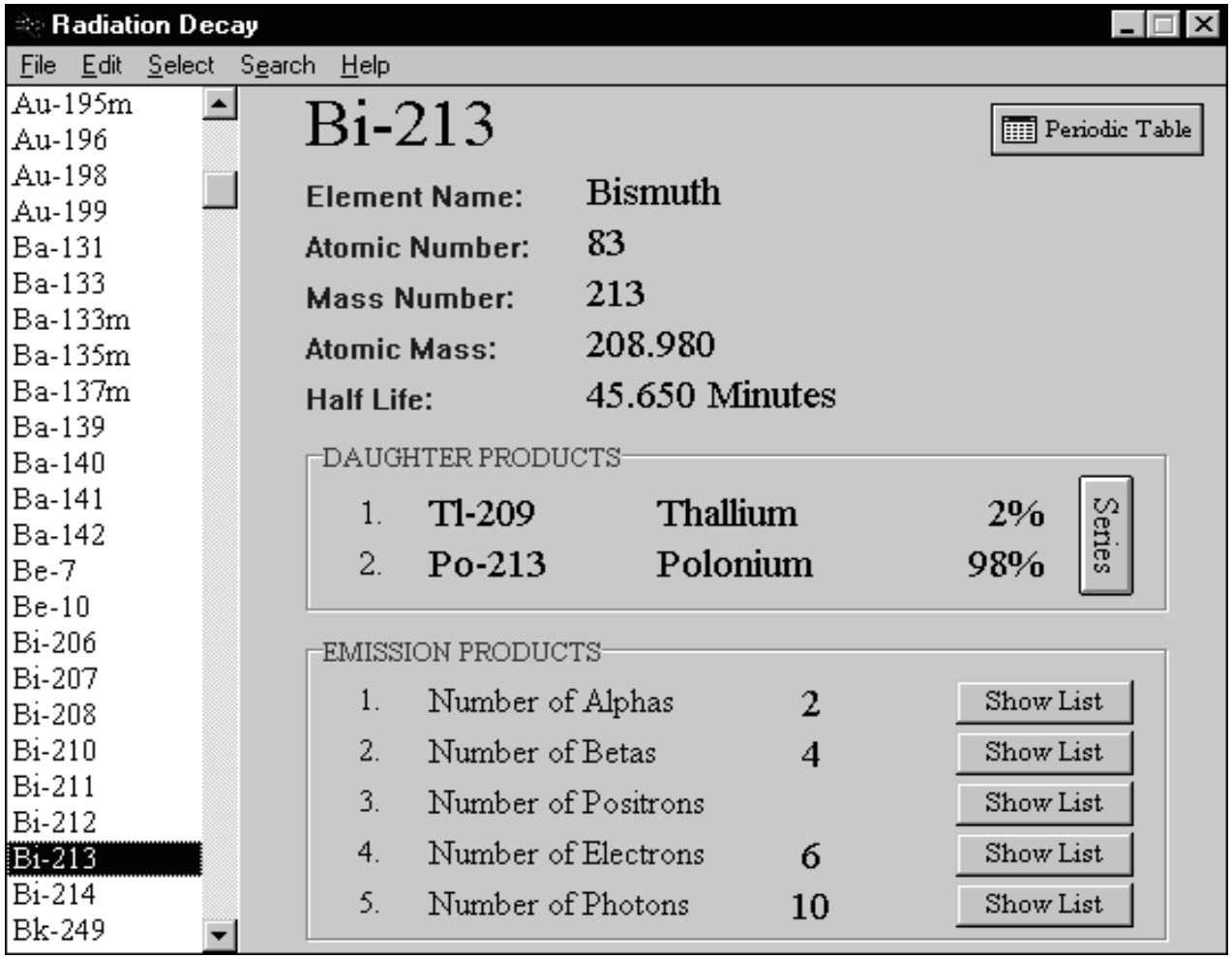
Risks of Software (1)

- **Input errors**

as in printed media





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Risks of Software (2)

Implementation Problems

- Some results of MIRDOSE3 are wrong if in the Windows settings not USA are selected as country

- MIRDOSE3 does not consider gamma radiation if it is implemented under Windows NT

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Risks of Software (3)

Misuse of software

- **Optimisation of results in any direction**

- **generally use of interactive software without sufficient knowledge of internal dosimetry**

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Risks of Software (4)

Wrong authority of software

- **Statements like due to the software XY ...**

  In the use of MIRDOSE3 the input is more important and more sensitive to the results than what is done by the program.

  In the Third European Intercomparison Exercise on Internal Dose Assessment doses assessed with the same program (LUDEP) were different by a factor of almost 50.

- **The software is only giving results due ot the underlying models and assumptions**

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CONCLUSIONS (1)

- Model development should take into account the availability of qualified software to be able to make realistic predictions

- To make complicated models applicable the user should be provided with appropriate software

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CONCLUSIONS (2)

- **Such as there are generally acknowledged models (ICRP) there should also be generally acknowledged certified software available.**

  Who can produce it?

- **It should be taken into account that different users have different needs; therefore different kinds of software are needed.**

- **However, it would be helpful to have links between these software packages which facilitate the transition from one to another.**

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Final Remark

The quality of results
depends more on the quality of the user
than on the quality of the software

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