

Particle Irradiation Data Ensemble

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This contribution to THREE is a brief overview of the PIDE project. PIDE is the **Particle Irradiation Data Ensemble** provided by the Gesellschaft für Schwerionenforschung (GSI) in Darmstadt, Germany.

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1. What is PIDE?

PIDE is a radiobiological data base compiling more than 800 pairs of in-vitro cell survival experiments after photon and ion irradiation, which were found in about 75 publications. The experiments comprise investigations with both normal and tumor cell lines of human and rodent origin, either synchronized in cell cycle or not. The experiments listed in PIDE furthermore cover various properties of charged particle radiation, i.e. various particle species, LETs and different irradiation conditions such as monoenergetic or within a spread out Bragg peak.

This data ensemble is convenient to study the relative biological effectiveness (RBE) for clonogenic cell survival as endpoint, or to benchmark RBE predicting models against experimental data. In the data base, the radiosensitivity of the cell lines is parameterized using the linear quadratic model. In the PIDE the experiments are stored in such a way that it is possible to discriminate between RBE relevant experimental factors such as the biological target, radiation quality and delivery techniques.

GSI shares the PIDE with the research community. The data ensemble is freely available as a file-package after registration from the modeling section of the GSI biophysics homepage:

<http://www.gsi.de/bio-pide>

Information on the set-up of the PIDE as well as some radiobiological investigations using it, making use of the improved statistics of a large data collection (e.g. for the properties of the β -term with respect to LET), can be found in an open access publication in the Journal of Radiation Research:

[Friedrich T, Scholz U, Elsässer T, Durante M, Scholz M. Systematic analysis of RBE and related quantities using a database of cell survival experiments with ion beam irradiation. J Radiat Res \(Tokyo\), published online: December 23, 2012, doi:10.1093/jrr/rrs119.](#)

2. Structure of PIDE

The large collection of data allows investigating specific questions regarding RBE with a better accuracy than when looking at one experiment only. To distinguish the different experimental conditions a number of additional parameters are contained in the PIDE. The available file package contains:

i) Information_sheet.pdf

A document with basic information about PIDE and some words of caution for the usage of the data.

ii) PIDE_x.x.xls

This Excel file (in 97/2003 format) contains all the data of PIDE. Each pair of survival experiments (for ions and photons) is listed in one line. The tag x.x labels the version number (see: Update). Also an ASCII file is available on request.

The columns contain the following data:

Column	Quality	Content
1 (A)	ID	Running number labelling the publication
2 (B)	Paper	Short name of the publication, containing first author and year of publication
3 (C)	No	Running number labelling the entry within a publication
4 (D)	Cell	Name of cell line
5 (E)	Type	Tumor cells (t) or normal cells (n)
6 (F)	Phase	Cell cycle phase (phases are given explicitly, or 'a' for 'asynchronous')
7 (G)	Genl	Genomic length of diploid cells (in 10^9 bp, 5.6 for rodent and 6 for human cells)
8 (H)	Ion	Ion species
9 (I)	Charge	charge of ions
10 (J)	Irrmods	Irradiation modalities: monoenergetic (m) or spread out Bragg peak (s)
11 (K)	LET	Linear energy transfer in water (in $\text{keV}/\mu\text{m}$, for irradiation in spread out Bragg peak dose mean or track averaged LET)
12 (L)	E	Specific energy of ions (in MeV/u), evaluated at the target
13 (M)	α_x	Linear coefficient of LQ model (in Gy^{-1}) for response to photon reference radiation
14 (N)	β_x	Quadratic coefficient of LQ model (in Gy^{-2}) for response to photon reference radiation
15 (O)	α_i	Linear coefficient of LQ model (in Gy^{-1}) for response to ion radiation
16 (P)	β_i	Quadratic coefficient of LQ model (in Gy^{-2}) for response to ion radiation

iii) References.pdf

This document contains all references from which the PIDE data originate. The reference equals the publication ID in the table above (i.e, [13] will label the 13th publication in PIDE, for example), and additional references related to data presented in one publication are labeled with attached letters to that ID starting from b (e.g. [13b]).

iv) Overview_table.pdf

This file contains a table which gives an overview over all publications represented in PIDE. It is also useful for finding publications covering specific experimental situations (e.g. experiments with neon, high LET and large α/β ratio). Furthermore the table contains some additional remarks on the way the data were retrieved from the original publication.

3. Possible issues and ambiguities

As the PIDE contains experimental information obtained by many authors, methods to determine involved quantities may differ. When working with PIDE, one should interpret the results with caution for this reason. This applies to: (i) Energy and LET, where typically one of these quantities is given while the other is calculated, but the methods for these calculations may differ; (ii) The LQ parameters, as they are determined by different fit methods and over different dose ranges, or even determined from other parameterizations as, e.g., the single hit multi target approach; and (iii) the handling of errors and uncertainties which depend on details of the protocol, the precision of the experiments and some other factors which are not always controllable. Again, having in mind these aspects, it might be misleading to use PIDE as a 'black box', but one rather should consider possible issues that might give rise to inconsistent conclusions. Though the developers of PIDE believe that statistics partially overcome most of these issues, a general warning should be very clear at this point.

4. Dos and don'ts when working with PIDE

The PIDE project is designed in such a way that any user of the data base can contribute. All users of the PIDE are kindly asked to participate and to report

- errors found in the provided material
- any other suitable data which should be part of PIDE
- any further ideas regarding the structure of PIDE
- research done with PIDE which might be of interest for all PIDE users.

All users of PIDE are further kindly requested not to distribute the material: All registered PIDE users will be informed about updates and any detected issues via e-mail in order to prevent misleading conclusions and to maintain correctness of the material provided as much as possible. Thus, instead of distributing the files, the project page should be distributed.

5. Updates

PIDE is continuously maintained and subject to updates: PIDE updates with fixed typos or other bugs will be released as necessary, updates containing new data will be released at reasonable time (about a year). All registered users of PIDE are cordially invited to contribute their suggestions and improvements, and all will be informed via e-mail, if an update is available.