

GEPI : A new type of magnetic launcher for hypervelocity impact of aluminum flyer plates and for dynamic material characterization

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Abstract

GEPI is a pulsed power generator developed by ITHPP for Centre d'Etudes de Gramat (CEG), devoted to non shocked high velocity flyer plates in the 0.1 km/s to more than 10 km/s range and to Isentropic Compression Experiments in the 1 GPa to 100 GPa range. The main idea is to generate a high magnetic pressure in a strip line where the samples are located. For flyer plates experiments, the accelerated samples are solid aluminum plates (0.5 to 1.5 mm thick) and not very thin aluminum sheet as for electric guns.

The whole design is based on low inductance technologies. Depending on the load, the current reaches between 3 and 4 MA in 600 ns. The entire design has been done in a cost effective way and in order to achieve an easy-to-use capability . A description of the generator is shown and typical results of the studies led by CEG are presented. The matters of concern are equations of state, phase transitions and impact of high velocity flyer plates

Keywords: place keywords here, use 12-pt font, keywords are separated by commas, single space between the **Abstract** and double space to the **Introduction**; also see Section 2.4.

1. Introduction

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Microsoft Word style guide.

2. General Instructions

The style guide follows as close as possible the style of *International Journal of Impact Engineering*, although there are a few minor differences. You can refer to recent issues for further examples. Section headings should be typed in bold, initial caps, and are numbered consecutively. The font size, except where noted below, is 12 point. The preferable font should be Times New Roman or Times Roman. The finished pages will be reduced ~90% before printing.

The typing area of all pages covers an area 16.5 cm wide by 26 cm deep (which will fit on A4 or 8½" x 11" paper). Even justification should be used to provide a pleasing and aesthetic appearance. After a period, double space before beginning the next sentence. The text is typed single spaced except where noted. Paragraph indents are 0.5 cm.

All major headings (e.g., **Introduction**, **Conclusions**, **References**) should be typed in bold letters, with initial caps, numbered consecutively. Major headings are separated from the previous section by two blank lines; a single blank line is used to separate the major heading and its subsections.

2.1 First Level Subheadings

First level subheadings should be italicized, capitalizing the first letter of all main words; the subheading is positioned against the left margin. A single blank line is used to separate the first level subheading and the preceding and subsequent text. The subheadings are numbered consecutively preceded by the section number. If a second level subheading is required, it should begin on the next line similar to the start of a new paragraph, as in the following example.

2.1.1 Second Level Subheadings

Second level subheadings, in italics, are similar to the first level subheading: italicized with initial caps. Single space to begin the new paragraph. As can be seen, second-level subheadings contain the Section number, the subsection number, and the second-level subsection number.

2.1.2 Second Level Subheading Example

This provides another example of a second-level subheading.

2.2 Title, Authors, Affiliations

The title should be in bold, capitalizing the first letter of all main words (14-pt), centered on the width of the page. The top of the first line of the title is spaced 3 cm below the top of the typing area. Therefore, the typing area of page 1, including the title, is 16.5 cm wide by 23 cm deep. After one blank line, the authors' names appear in initial caps with commas separating the authors' names, 12-pt, bold. Space one blank line. On the next lines, affiliations and addresses should be provided (10-pt, regular font), capitalizing the first letter of all main words. Commas are used to separate the various parts of the address. If there is more than one affiliation, a semi-colon is used to separate the organizations. See the example at the top of the first page.

2.3 Abstract

Papers must begin with an abstract, placed 5 cm below the first line of the title. **Abstract** is in bold, placed on the left margin. One blank line separates the word **Abstract** and the body of the abstract. The abstract is typed in 12 point.

2.4 Keywords

A list of keywords appears below the Abstract, separated by commas. Keywords have the same formatting as the **Abstract**, i.e., same margins and same font size. Double space between the last keyword and the **Introduction**. For the lines across the page, highlight the blank space above **Abstract** and all the way down to the blank space after *Keywords* and select *Format*, select *Borders and Shading*; select top and bottom borders.

3. Subsequent Pages

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4. Additional Information

Additional information is provided under the following subheadings. Examples are provided for most formatting situations.

4.1 Abbreviations

Within the text, except when the first word of a sentence, the following abbreviations are acceptable: Fig. for Figure; Eqn. (#) for Equation (#); Ref. [#] for Reference [#]. If used as the first word of a sentence, then the entire word should be spelled out. For other abbreviations or acronyms, authors are cautioned to provide the definition the first time the abbreviation is used. For example, rolled homogeneous armor (RHA) was the target material. After providing the definition of RHA, the abbreviation can then be used throughout the rest of the paper.

4.2 References

References will be numbered sequentially within brackets [] within the text, and listed numerically in the order they first appear in the manuscript in the final section of the article, entitled **References**. Appropriate abbreviations should be used for journals, symposia, etc., which are typed in italics. Article titles are given in lower case letters except for the leading word (exceptions would be code names like CTH, EPIC, AUTODYN, etc.). The volume number is typed in bold, with the issue number in parentheses immediately following the volume number. Proceedings are handled in a similar manner, but the locations of the symposium or conference, along with the dates, also must be given. Example of references [1-6] are provided at the end of the instructions. ***Please look at the examples for formatting the author's names, etc.*** References are typed in 10-point font. The tab setting from the reference number is 0.76 cm. Note that a "hanging indent" is used in the bibliographic citation.

With respect to citations within the text, it is typical to provide the authors' names when there is one or two authors who wrote the paper, e.g., Silling [2], and Walker and Anderson [4] have used wavecodes to simulate material response at high rates of loading. When there are more than two authors, then the procedure is to use *et al.*, after the first author's name, e.g., Ravid, *et al.* [1], developed a penetration model that accounts for the shock phase of impact.

4.3 Equations

Equations should be separated from the text, above and below, by approximately one blank line. Equations should be centered, with the equation number justified with the right margin. For

example, the modified Bernoulli equation is written as:

$$\frac{1}{2} \rho_p (v - u)^2 + Y_p = \frac{1}{2} \rho_t u^2 + R_t \quad (1)$$

$$\rho_p \ell \frac{dv}{dt} = -Y_p \quad (2)$$

$$v - u = -\dot{\ell} \quad (3)$$

where ρ is the density, Y_p is the projectile flow stress, R_t is the target resistance, and v and u are the tail and penetration velocities. The subscripts p and t refer to the projectile and target, respectively. Deceleration of the tail of a projectile of length ℓ is given by Eqn. (2), and Eqn. (3) gives the erosion rate of the projectile. A dot over the symbol denotes the time derivative. Equations (1-3), collectively, are often called the Tate model [6].

If there are a large number of symbols in the paper, it is recommended that the author place a **Notation** section that defines all symbols (and then the symbols do not need to be redefined within the text). The **Notation** section is placed prior to the **Introduction**.

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Lettering should be of a size which is legible after a reduction to ~90%. Black and white, glossy photographs may be included provided they are essential for the understanding of the text.

Figures and tables should be centered across the page. Examples are given below. In the interest of space limitations, it is acceptable to prepare figures and/or tables in a double column format.

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Many people like to digitize photographs and then insert these electronic images into their paper. Please make sure that the digital printed image is high quality; if it is not, then it will not reproduce well during mass reproduction in printing of the proceedings. Special care is warranted with X-ray images, which often have low contrast. Authors should be critical of the images used in the paper and use common sense. A black and white photograph may be better than the digitized image. Similar judgements should be made concerning imbedding electronic images of computer graphics directly into the manuscript. We recommend that you peruse the last proceedings (Volume 26 of *Impact Engineering*) to see what type of images work and do not work so well. See the comment below about using glossy photo-finish paper for digitized photographs and X-ray shadowgraphs.

4.4.2 Color Photographs

It may be desirable, particularly with computational results, to use color to enhance and clarify technical information. Color figures are possible for the *International Journal of Impact Engineering*. However, there is an additional cost requirement that must be met by the author or his/her institution. The cost for color pages (there can be more than one color figure per page, but each page is processed separately) is \$450.00 (US) for the first page and \$275 (US) for subsequent pages (a one-time fee to process the color artwork), payable to Elsevier, who will bill the author. Prices are set by Elsevier, and may change.

4.5 Figure and Table Captions

Figure captions should be centered *beneath* each figure. The caption should begin with the abbreviation Fig. #. Only the first letter of the caption is capitalized. A period goes at the end of the figure caption. An example of a figure and figure caption is given in Fig. 1. ***Please print digitized photographs and flash X-rays on glossy photo-finish paper to insure good reproduction.***

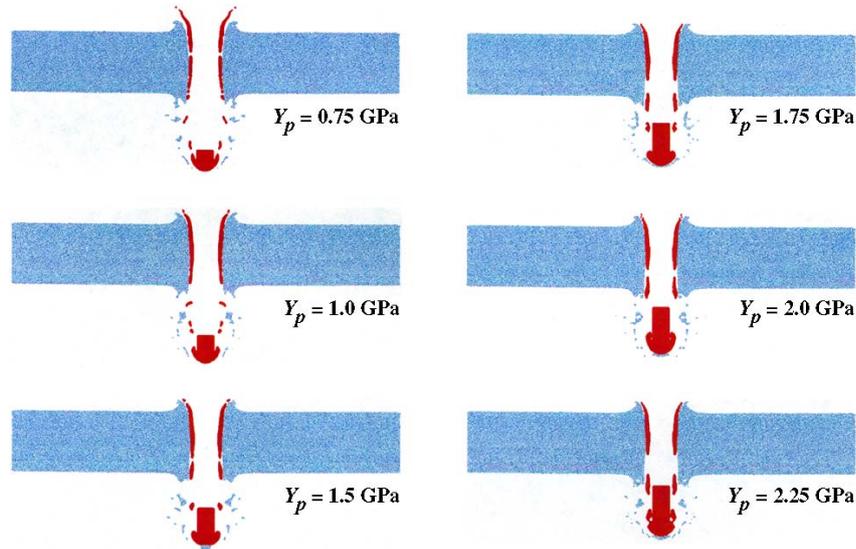


Fig. 1. This is an example of a figure caption.

Table captions should be centered *above* the table. Tables are numbered using Arabic numbers (not Roman numerals). A period follows the table number, but do not place a period at the end of the table caption. Only the first letter of the caption is capitalized. The table below is typed in 10-pt font. The headings of the table are italicized. Horizontal lines delineate the table captions and the last line of the table. This is one of the standard formats for some word processors.

Table 1. Summary of nominal projectile characteristics

<i>Nomenclature</i>	<i>Alloy materials</i>	<i>W content</i> (% by weight)	<i>Density</i> (g/cm ³)	<i>Strength</i>
X30	W-Ni-Fe	90	*	*
X27	W-Ni-Fe	91	17.34	895
X27C	W-Ni-Fe-Co	91	17.38	970
X27X	W-Ni-Co	91	17.45	1030
X21	W-Ni-Fe	93	17.74	920
X21C	W-Ni-Fe-Co	93	17.77	975
X9C	W-Ni-Fe-Co	97	18.61	985

* Values not known.

In general, tables and figures should be positioned as close as possible to where they are first mentioned within the text. It is quite permissible to place tables and figures at the top or bottom of a page to facilitate the layout of your manuscript. Additionally, it is quite acceptable to have an entire page of figures. However, placing all figures at the end of a manuscript is discouraged.

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References

- [1] Ravid M, Bodner SR, Holcman I. Analysis of very high speed impact. *Int. J. Engng. Sci.*, 1987; **25**(4): 473-482.
- [2] Silling A. Stability and accuracy of differencing methods for viscoplastic models in wavecodes. *J. Comp. Phys.* 1993; **104**(1): 30-40.
- [3] Silsby GF. Penetration of semi-infinite steel targets by tungsten long rods at 1.3 to 4.5 km/s. *Proc. 8th Int. Symp. Ballistics*, Orlando, FL, 1984: p. TB/31-35.
- [4] Walker JD, Anderson Jr. CE. A nonsteady-state model for penetration. *Proc. 13th Int. Symp. Ballistics*, Vol. 3, Stockholm, Sweden, 1992: p. TB-1/1-8.
- [5] Batra RC. Effect of nose shape and strain-hardening on steady state penetration of viscoplastic targets. In: Owen DRJ, Hinton E, Onate E., editors, *Computational Plasticity, Models, Software and Applications*, Pineridge Press, Swansea, UK, 1987. p. 463-475.
- [6] Tate A. A theory for the deceleration of long rods after impact. *J. Mech. Phys. Solids* 1967; **15**: 287-399.