PARTICLE ACCELERATORS

I. BIBLIOGRAPHY

II. LIST OF ACCELERATOR INSTALLATIONS

Gerald A. Behman

January 1, 1958
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# PARTICLE ACCELERATORS

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## List of Accelerator Installations

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II. LIST OF ACCELERATOR INSTALLATIONS.

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ABSTRACT

References to accelerators and accelerator technology in the technical literature from July 1954 through June 1957 are listed in Section I, the bibliography. Most of the references are taken from Nuclear Science Abstracts, Chemical Abstracts, Physics Abstracts, and Electrical Engineering Abstracts.

In Section II, accelerator installations throughout the world are listed together with the types of particles accelerated and the energy and other characteristics of the machines.
PARTICLE ACCELERATORS
I. BIBLIOGRAPHY

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INTRODUCTION

This bibliography supplements the following compilations:


2. Bonnie E. Cushman, Bibliography of Particle Accelerators July 1948 to December 1950, UCRL-1238 (March 1951).


For this compilation, the literature searched includes Nuclear Science Abstracts, Chemical Abstracts, Physics Abstracts (Science Abstracts A), and Electrical Engineering Abstracts (Science Abstracts B) for the period from July 1954 through June 1957. Also included are certain articles and references not derived from the above abstracts. References are arranged in groups according to the accelerator classification and are arranged alphabetically within the accelerator group by author's surname. An author index listing all authors is provided, and each bibliography entry is numbered to facilitate searching for the work of individual authors with the aid of the author index. Articles by companies, societies, organizations, and institutions are arranged alphabetically by source in the author index.

The abbreviations used here include NSA for Nuclear Science Abstracts, CA for Chemical Abstracts, SA A for Physics Abstracts, and SA B for Electrical Engineering Abstracts. Typical examples of the notation system used in this report to describe entries in these publications are:
UCRL-8050 Notation | Explanation
---|---
NSA 8, 3873 (54) | This is Abstract 3873 of Volume 8 of Nuclear Science Abstracts issued in 1954.
CA 48, 9821e (54) | This Abstract is located in Section e of Column 9821 in Volume 48 of Chemical Abstracts for 1954.
SA A57, 6671 (54) | This is Abstract 6671 of Volume 57 of Physics Abstracts (Science Abstracts A) issued in 1954.
SA B57, 6671 (54) | This is Abstract 6671 of Volume 57 of Electrical Engineering Abstracts (Science Abstracts B) issued in 1954.
G. B. | This entry has been noted directly from the literature by the author of this bibliography.

In the preparation of this bibliography every effort has been made to include pertinent publications in the correct categories. Articles of a general nature in the accelerator field are grouped under the heading General. Those articles that discuss more than one type of machine are included in each of the appropriate accelerator groups. Publications that could not readily be classified in any of the aforementioned groups are listed under Miscellaneous.

The author will appreciate notification of duplications, omissions, or other shortcomings in this bibliography.
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Koehler -279 (with Calame, Cooper, Engelsberg, Gerstein, Kuckes, Meadows, Strauch, and Wilson).
Koga -93 (with Asada, Fujita, Furuta, Hiraoka, Masuda, Okamura, and Ookuma).
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630 (with Veksler, Efremov, Mints, Veisbin, Bodopyanov, Gashev,
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Kozodaev -298 (with Dzhelepov, Dmitrievsky, Katyshev, Mescheryakov,
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Ragan -528 (with Jones, Kratz, Lawson, Miller, Miller, Rouvina, and Voorhies), 529 (with Jones, Kratz, Lawson, Miller, Miller, Rouvina, and Voorhies), 530 (with Jones, Kratz, Lawson, Miller, Miller, Rouvina, and Voorhies).
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Streltsov -633 (with Vladimirsky, Komar, Mints, Goldin, Koshkarev, Monoszon, Nikitin, Rubchinsky, Skachkov, and Tarasov).
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Van Roosenbeek -123 (with Richardson and Morgan).
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Veisbin -630 (with Veksler, Efremov, Mints, Bodopyanov, Gashev, Zeidlits, Ivanov, Kolomensky, Komar, Malyshev, Monoszon, Nevyzhsky, Petukhov, Rabinovich, Rubchinsky, Sinelnikov, and Stolov).
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PARTICLE ACCELERATORS
II. LIST OF ACCELERATOR INSTALLATIONS
Gerald A. Behman
Radiation Laboratory
University of California
Berkeley, California
January 1, 1958

INTRODUCTION

This list is intended to include data on all accelerators throughout the world and supersedes similar lists by Bonnie E. Cushman in UCRL-1238 (March, 1951), by Sergey Shewchuck in UCRL-1951 (September, 1952), and by Frederick E. Frost and Jane M. Putnam in UCRL-2672 (November, 1954).

Data presented here have been acquired in most instances by direct response to a questionnaire sent by the author to the individual installations or, in the case of some foreign countries, to the scientific attaches of the various embassies. In a few cases, it was necessary to acquire the data indirectly through the technical literature or by reference to manufacturers' data.

Of the 411 questionnaires sent out, 224 went to installations in the United States, while 187 went to other countries. Replies were received from 89% of the installations polled in the United States, and from 74% of the foreign installations. Questionnaires submitted to Argentina, Brazil, Chile, China, Mexico, Rumania, and Turkey were not answered.

A time interval of ten months was arbitrarily set for response to the questionnaire. In some instances, not all of the desired information was furnished on the returned questionnaire; these cases are indicated in the list by n.a. (not available).

For rapid and ready reference, the information is classified, first, according to the type of accelerator and, second, according to the address of the installation. Each accelerator group is grossly separated into those machines located in the United States and those located elsewhere in the world.

The general types of accelerators included are direct-current (dc) machines, induction machines, and resonance accelerators. The dc machines comprise cascade rectifiers (Cockcroft-Walton), electrostatic generators (Van de Graaff), and certain transformer-rectifier combinations. The primary example of an accelerator operating on the principle of induction is the betatron. Resonance accelerators include both traveling- and standing-wave linear accelerators as well as magnetic accelerators of the cyclotron or synchrotron type. In this survey, the category cyclotron includes continuous-wave (CW) and frequency-modulated (FM) machines. The synchrotron group includes proton, electron, and fixed-field alternating-gradient (FFAG) machines.
For the convenience of the reader, the distribution of these machines throughout the world is summarized by type of accelerator and country in Table I. The distribution of types of establishments having accelerators in the United States is analyzed in Table II according to type of machine and primary activity of the organization.

Every effort has been made to avoid duplication or omission of information. The author will appreciate notification of such errors.
### Table I

Distribution of Machines, by Type and Country

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<tr>
<td>United States</td>
<td>133</td>
<td>38</td>
<td>32</td>
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<td>Outside the United States</td>
<td>130</td>
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<td>Argentina</td>
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<td>Belgium</td>
<td>7</td>
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</tr>
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<td>Brazil</td>
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<td>Canada</td>
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<td>2</td>
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</tr>
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<td>Denmark</td>
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<tr>
<td>France</td>
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<tr>
<td>Germany</td>
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</tr>
<tr>
<td>Great Britain</td>
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<tr>
<td>India</td>
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<tr>
<td>Iran</td>
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<tr>
<td>Israel</td>
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</tr>
<tr>
<td>Italy</td>
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<td>2</td>
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</tr>
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<td>Japan</td>
<td>17</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Mexico</td>
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</tr>
<tr>
<td>Netherlands</td>
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<td></td>
</tr>
</tbody>
</table>
Table I (cont.)

Distribution of Machines, by Type and Country

<table>
<thead>
<tr>
<th>Country</th>
<th>D. C. Machines</th>
<th>Induction Machines</th>
<th>Resonance Machines</th>
<th>Magnetic Accelerators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Betatrons</td>
<td>Linear Accelerators</td>
<td>Cyclotrons</td>
</tr>
<tr>
<td>New Zealand</td>
<td></td>
<td></td>
<td></td>
<td>Synchrotrons</td>
</tr>
<tr>
<td>Norway</td>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Switzerland</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Union of South Africa</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Union of Soviet Socialist</td>
<td>3</td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Republics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>4</td>
<td>1</td>
<td></td>
<td>1</td>
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</tbody>
</table>
Table II

Distribution of establishments reporting accelerators in the United States according to type of machine and activity

<table>
<thead>
<tr>
<th>Type of Machine</th>
<th>Colleges and Universities</th>
<th>Federal Government</th>
<th>Hospitals</th>
<th>Private Firms</th>
<th>Nonprofit Organizations</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. C. Machines</td>
<td>31</td>
<td>11</td>
<td>9</td>
<td>33</td>
<td>4</td>
<td>88</td>
</tr>
<tr>
<td>Betatrons</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>14</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>Linear Accelerators</td>
<td>14</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>Cyclotrons</td>
<td>20</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Synchrotrons</td>
<td>13</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>87</td>
<td>22</td>
<td>17</td>
<td>51</td>
<td>6</td>
<td>183</td>
</tr>
</tbody>
</table>

Note: AEC contractors are classified according to the type of establishment holding the contract.
## LIST OF ACCELERATOR INSTALLATIONS

### I. Direct Current Machines

In the United States

<table>
<thead>
<tr>
<th>Location</th>
<th>Type</th>
<th>Dimensions</th>
<th>Particles Accelerated</th>
<th>Energy (Mev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Argonne Cancer Research Hospital, University of Chicago, Chicago, Ill.</td>
<td>Van de Graaff</td>
<td>7-ft tank length</td>
<td>e</td>
<td>2</td>
</tr>
<tr>
<td>1 Argonne National Laboratory, Lemont, Ill.</td>
<td>Van de Graaff</td>
<td>18-ft accelerating tube</td>
<td>p, d</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>Van de Graaff</td>
<td>9-ft tank length</td>
<td>e</td>
<td>1.0</td>
</tr>
<tr>
<td>1 Arkansas, University, Fayetteville, Ark.</td>
<td>High-voltage rectifier</td>
<td>~10-ft accelerating tube</td>
<td>p, d, α</td>
<td>0.4</td>
</tr>
<tr>
<td>1 Atomics International, Canoga Park, Calif.</td>
<td>Van de Graaff</td>
<td>4-ft accelerating tube</td>
<td>e</td>
<td>1.6</td>
</tr>
</tbody>
</table>

*Under construction

1 Information obtained from response to questionnaire.

2 Information from High Voltage Engineering Company, Burlington, Massachusetts.


5 Information from Varian Associates, Palo Alto, California.


<table>
<thead>
<tr>
<th>Location</th>
<th>Type</th>
<th>Dimensions</th>
<th>Particles Accelerated</th>
<th>Energy (Mev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Austenal, Inc., Chicago, Ill</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>x-rays</td>
<td>1</td>
</tr>
<tr>
<td>2 Babcock and Wilcox, Lynchburg, Va.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>x-rays</td>
<td>1</td>
</tr>
<tr>
<td>2 Union Carbide and Carbon Corp., Bakelite Division, Bloomfield, N. J.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>e</td>
<td>2</td>
</tr>
<tr>
<td>1 Bartol Research Foundation of the Franklin Institute, Swarthmore, Pa.</td>
<td>Cockcroft-Walton</td>
<td>4-ft accelerating tube</td>
<td>d</td>
<td>0.135</td>
</tr>
<tr>
<td>1 Van de Graaff</td>
<td>21-ft accelerating tube</td>
<td>p</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>1 Van de Graaff</td>
<td>6-ft accelerating tube</td>
<td>d</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>2 Baylor University, College of Medicine, Houston, Tex.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>x-rays</td>
<td>2</td>
</tr>
<tr>
<td>1, 2 Bell Telephone Laboratories, New York, N. Y.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>e</td>
<td>1</td>
</tr>
<tr>
<td>* Van de Graaff</td>
<td>n. a.</td>
<td>e</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1, 2 Brookhaven National Laboratory, Upton, Long Island, N. Y.</td>
<td>Van de Graaff</td>
<td>8-ft accelerating tube</td>
<td>p, d, a, a, He^3</td>
<td>4</td>
</tr>
<tr>
<td>1, 2 Van de Graaff</td>
<td>3-ft accelerating tube</td>
<td>e</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1, 2 Van de Graaff</td>
<td>3-ft accelerating tube</td>
<td>e</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1, 2 Van de Graaff</td>
<td>12-ft accelerating tube</td>
<td>p</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1 California Institute of Technology, Pasadena, Calif.</td>
<td>Van de Graaff</td>
<td>2.25-ft accelerating tube</td>
<td>p, d, a, a, He^3</td>
<td>0.6</td>
</tr>
<tr>
<td>1 California Institute of Technology, Pasadena, Calif.</td>
<td>8-ft accelerating tube</td>
<td>p, d, a, a, He^3</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>1 California Institute of Technology, Pasadena, Calif.</td>
<td>9-ft accelerating tube</td>
<td>p, d, a, a, He^3</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>2 California Research Corporation, Richmond, Calif.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>e</td>
<td>2</td>
</tr>
<tr>
<td>Location</td>
<td>Type</td>
<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>California, University, Radiation Laboratory, Berkeley, Calif.</td>
<td>Cockcroft-Walton</td>
<td>4-ft accelerating tube</td>
<td>p</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Cockcroft-Walton</td>
<td>4-ft accelerating tube</td>
<td>gasæous ions</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Van de Graaff</td>
<td>27-ft tank length</td>
<td>p, d, a</td>
<td>4</td>
</tr>
<tr>
<td>California, University, Radiation Laboratory, Livermore, Calif.</td>
<td>Van de Graaff</td>
<td>1.7-ft accelerating tube</td>
<td>p, d</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Cockcroft-Walton</td>
<td>6-ft accelerating tube</td>
<td>p, d, a</td>
<td>0.5</td>
</tr>
<tr>
<td>Carnegie Institution of Washington, Washington, D. C.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>a</td>
<td>7</td>
</tr>
<tr>
<td>Chicago Bridge and Iron Company, Birmingham, Ala.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>x-rays</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>x-rays</td>
<td>1</td>
</tr>
<tr>
<td>Chicago, University, Chicago, Ill.</td>
<td>Cockcroft-Walton</td>
<td>7.5-ft accelerating tube</td>
<td>p, d</td>
<td>0.45</td>
</tr>
<tr>
<td>College of Agriculture and Mechanics, Ames, Ia.</td>
<td>Cockcroft-Walton</td>
<td>5-ft accelerating tube</td>
<td>p, d, a</td>
<td>0.3</td>
</tr>
<tr>
<td>Columbia University, Pupin Cyclotron Laboratories, New York, N. Y.</td>
<td>Van de Graaff</td>
<td>12-ft accelerating tube</td>
<td>p, d, a</td>
<td>6.5</td>
</tr>
<tr>
<td>Connecticut, University, Storrs, Conn.</td>
<td>Cockcroft-Walton</td>
<td>3-ft accelerating tube</td>
<td>positive ions</td>
<td>0.25</td>
</tr>
<tr>
<td>Cooper Alloy Corporation, Hillside, N. Y.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>x-rays</td>
<td>1</td>
</tr>
<tr>
<td>Cornell University, Ithaca, N. Y.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>e</td>
<td>2</td>
</tr>
<tr>
<td>Dow Chemical Company, Midland, Mich.</td>
<td>Van de Graaff</td>
<td>4.6-ft accelerating tube</td>
<td>p, d, e</td>
<td>2</td>
</tr>
<tr>
<td>Location</td>
<td>Type</td>
<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>--------------------</td>
<td>-----------------------------------</td>
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</tr>
<tr>
<td>1 Dow Chemical Company, Western Division, Pittsburg, Calif.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>e</td>
<td>2.5</td>
</tr>
<tr>
<td>1 Duke University, Durham, N. C.</td>
<td>Van de Graaff</td>
<td>25-ft tank length</td>
<td>p, d, a</td>
<td>4</td>
</tr>
<tr>
<td>2 E. I. DuPont de Nemours, Inc., Wilmington, Del.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>e</td>
<td>2</td>
</tr>
<tr>
<td>2 Eugene Talmadge Memorial Hospital, Augusta, Ga.</td>
<td>Van de Graaff</td>
<td>2.7-ft accelerating tube</td>
<td>x-rays</td>
<td>2</td>
</tr>
<tr>
<td>1 Ethicon, Inc., Somerville, N. J.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>e</td>
<td>2.5</td>
</tr>
<tr>
<td>1 Evans Signal Laboratory, Belmar, N. J.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, e</td>
<td>2</td>
</tr>
<tr>
<td>1 Florida, University, Gainesville, Fla.</td>
<td>Van de Graaff</td>
<td>5-ft accelerating tube</td>
<td>p, d</td>
<td>1</td>
</tr>
<tr>
<td>2 Florida State University, Tallahassee, Fla.</td>
<td>Van de Graaff (tandem)</td>
<td>n.a.</td>
<td>p, a</td>
<td>10</td>
</tr>
<tr>
<td>1 Foster-Wheeler Corporation, Mountaintop, Pa</td>
<td>Van de Graaff</td>
<td>3.7-ft accelerating tube</td>
<td>x-rays</td>
<td>2</td>
</tr>
<tr>
<td>1 General Electric Company, Hanford Laboratories, Richland, Wash.</td>
<td>Van de Graaff</td>
<td>5.3-ft tank length</td>
<td>e</td>
<td>2.0</td>
</tr>
<tr>
<td>1 General Electric Company, Aircraft Nuclear Propulsion Department, Cincinnati, O.</td>
<td>Van de Graaff</td>
<td>6.3-ft tank length</td>
<td>p, d</td>
<td>2.0</td>
</tr>
<tr>
<td>1 Arnold Greene, Inc., Cambridge, Mass.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>x-rays</td>
<td>1</td>
</tr>
<tr>
<td>2 Gulf Research and Development Company, Pittsburgh, Pa.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, a, e</td>
<td>3</td>
</tr>
<tr>
<td>Location</td>
<td>Type</td>
<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----------------------</td>
<td>----------------------------</td>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Humble Oil and Refining Company, Houston, Tex.</td>
<td>Van de Graaff</td>
<td>3.25-ft accelerating tube</td>
<td>e</td>
<td>2</td>
</tr>
<tr>
<td>Iowa State University, Iowa City, Ia.</td>
<td>Cockcroft-Walton</td>
<td>5-ft accelerating tube</td>
<td>p, d, a</td>
<td>0.5</td>
</tr>
<tr>
<td>Van de Graaff</td>
<td>20-ft accelerating tube</td>
<td>p, d, a</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Johns Hopkins University, Baltimore, Md.</td>
<td>Van de Graaff</td>
<td>6-ft accelerating tube</td>
<td>p, d</td>
<td>3</td>
</tr>
<tr>
<td>Kansas, University, Lawrence, Kan.</td>
<td>Van de Graaff</td>
<td>7-ft accelerating tube</td>
<td>p, d</td>
<td>3</td>
</tr>
<tr>
<td>Kentucky, University, Lexington, Ky.</td>
<td>Van de Graaff</td>
<td>7.5-ft accelerating tube</td>
<td>p, d</td>
<td>2.2</td>
</tr>
<tr>
<td>Lemuel Shattuck Hospital for Chronic Diseases, Boston, Mass.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>x-rays</td>
<td>2</td>
</tr>
<tr>
<td>Lockheed Aircraft Corporation, Missile Systems Division, Palo Alto, Calif.</td>
<td>Van de Graaff</td>
<td>3.5-ft accelerating tube</td>
<td>p, d, a</td>
<td>3</td>
</tr>
<tr>
<td>Los Alamos Scientific Laboratory, Los Alamos, N. Mex.</td>
<td>Cockcroft-Walton</td>
<td>6.3-ft accelerating tube</td>
<td>p, d</td>
<td>0.50</td>
</tr>
<tr>
<td>Van de Graaff</td>
<td>3.3-ft accelerating tube</td>
<td>p, d</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Van de Graaff</td>
<td>20-ft accelerating tube</td>
<td>p, d, a</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Van de Graaff</td>
<td>5-ft accelerating tube</td>
<td>p, d, t, He³, a</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Van de Graaff</td>
<td>5-ft accelerating tube</td>
<td>p, d, t, He³, a</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Los Angeles Tumor Clinic, Los Angeles, Calif.</td>
<td>Van de Graaff</td>
<td>3-ft accelerating tube</td>
<td>x-rays</td>
<td>2</td>
</tr>
<tr>
<td>Location</td>
<td>Type</td>
<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>------------------------</td>
<td>-----------------------------</td>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Magnolia Petroleum Company, Dallas, Tex.</td>
<td>Van de Graaff</td>
<td>1.2-ft accelerating tube</td>
<td>p, d</td>
<td>0.5</td>
</tr>
<tr>
<td>Mass. Institute of Technology, Labor. for Nuclear</td>
<td>Van de Graaff</td>
<td>3-ft accelerating tube</td>
<td>p, d, a, He³, α</td>
<td>2</td>
</tr>
<tr>
<td>Massachusetts Institute of Technology, Laboratory</td>
<td>Van de Graaff</td>
<td>18-ft accelerating tube</td>
<td>p, d, α</td>
<td>8.5</td>
</tr>
<tr>
<td>Mass. General Hospital, Boston, Mass.</td>
<td>Van de Graaff</td>
<td>20-ft accelerating tube</td>
<td>p, d</td>
<td>3</td>
</tr>
<tr>
<td>Mellon Institute, Pittsburgh, Pa.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>e</td>
<td>2</td>
</tr>
<tr>
<td>Minnesota, University, Minneapolis, Minn.</td>
<td>Van de Graaff</td>
<td>20-ft accelerating tube</td>
<td>p, d</td>
<td>3.5</td>
</tr>
<tr>
<td>Monsanto Chemical Company, Dayton, O.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>e</td>
<td>2</td>
</tr>
<tr>
<td>National Bureau of Standards, Washington, D. C.</td>
<td>A-C Rectifier</td>
<td>2.25-ft each section</td>
<td>e</td>
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<td>Cockcroft-Walton</td>
<td>5-ft accelerating tube</td>
<td>p, d</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, α</td>
<td>2</td>
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<td>National Institutes of Health, Public Health</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>e</td>
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<tr>
<td>Service, Bethesda, Md.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>e</td>
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<td>Van de Graaff</td>
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<td>e</td>
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<td>Nebraska, University, Lincoln, Neb.</td>
<td>Cockcroft-Walton</td>
<td>n.a.</td>
<td>positive ions</td>
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<td>Northwestern University, Evanston, Ill.</td>
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<td>12-ft accelerating tube</td>
<td>p, a, e</td>
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<td>Notre Dame, University, Notre Dame, Ind.</td>
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<td>12-ft accelerating tube</td>
<td>p, d, α, e</td>
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<tr>
<td>Location</td>
<td>Type</td>
<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<td>Oak Ridge National Laboratory, Union Carbide Nuclear Company, Oak Ridge, Tenn.</td>
<td>Cascade</td>
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<td>3-ft accelerating tube</td>
<td>d</td>
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</tr>
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<td>Van de Graaff</td>
<td>12-ft accelerating tube</td>
<td>p, d, a</td>
<td>6.3</td>
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<td></td>
<td>Van de Graaff</td>
<td>4.7-ft accelerating tube</td>
<td>p, d</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Van de Graaff</td>
<td>2.7-ft accelerating tube</td>
<td>x-rays</td>
<td>2.0</td>
</tr>
<tr>
<td>Pennsylvania, University, Philadelphia, Pa.</td>
<td>Van de Graaff</td>
<td>12-ft accelerating tube</td>
<td>p, d</td>
<td>3</td>
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<td>Pondville State Hospital, Wrentham, Mass.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>x-rays</td>
<td>2</td>
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<td>Princeton University, Princeton, N. J.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, a</td>
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<td>Radio Corporation of America, Princeton, N. J.</td>
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<td>n.a.</td>
<td>e</td>
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<td>Redstone Arsenal, Huntsville, Ala.</td>
<td>Van de Graaff</td>
<td>22-ft tank length</td>
<td>p, d</td>
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<td>Rensselaer Polytechnic Institute, Troy, N. Y.</td>
<td>Cockcroft-Walton</td>
<td>3.5-ft accelerating tube</td>
<td>p, d</td>
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<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d</td>
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<td>Rice Institute, Houston, Tex.</td>
<td>Cockcroft-Walton</td>
<td>2-ft accelerating tube</td>
<td>p, d, t, He³, a</td>
<td>6</td>
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<td>Sandia Corporation, Albuquerque, N. Mex.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, e</td>
<td>2</td>
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<td>Shell Development Company, Houston, Tex.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d</td>
<td>2</td>
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<td>Location</td>
<td>Type</td>
<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<tr>
<td>2. Socony-Vacuum Oil Company, Paulsboro, N. J.</td>
<td>Van de Graaff</td>
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<td>e</td>
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<td>4-ft accelerating tube</td>
<td>x-rays, e</td>
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</tr>
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<td>1. Stanford Research Institute, Palo Alto, Calif.</td>
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<td>n. a.</td>
<td>p, d</td>
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<td>1. Texas, University, Austin, Tex.</td>
<td>Van de Graaff</td>
<td>10-ft accelerating tube</td>
<td>p, d, t, a</td>
<td>4</td>
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<td>1. Texas Oil Company, New York, N. Y.</td>
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<td>n. a.</td>
<td>p, d, a</td>
<td>3</td>
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<td>2. Texas Nuclear, Austin, Tex.</td>
<td>Van de Graaff</td>
<td>n. a.</td>
<td>p, d, a</td>
<td>2</td>
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<td>1. University Hospitals, Cleveland, O.</td>
<td>Van de Graaff</td>
<td>6.5-ft tank length</td>
<td>x-rays</td>
<td>2</td>
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<td>1. Upjohn Company, Kalamazoo, Mich.</td>
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<td>1. U. S. Army Chemical Center, Chemical and Radiological Laboratory, Army Chemical Center, Md.</td>
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<td>p, d, a</td>
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<td>14-ft tank length</td>
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<tr>
<td>Location</td>
<td>Type</td>
<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<td>U. S. Naval Postgraduate School, Monterey, Calif.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, a, e</td>
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<td>U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.</td>
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<td>n.a.</td>
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<td>U. S. Naval Research Laboratory, Washington, D. C.</td>
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<td>p, d, He³, a</td>
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<td>Van de Graaff</td>
<td>3-ft accelerating tube</td>
<td>e, p</td>
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<td>Van de Graaff</td>
<td>4-ft accelerating tube</td>
<td>e</td>
<td>2.0</td>
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<td>Van de Graaff</td>
<td>15.5-ft accelerating tube</td>
<td>p, d, He³, a</td>
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<td>Virginia, University, Charlottesville, Va.</td>
<td>Van de Graaff</td>
<td>3-ft accelerating tube</td>
<td>p, d, a</td>
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<td>Watertown Arsenal, Watertown, Mass.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d</td>
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<td>Wells Surveys, Inc., Tulsa, Okla.</td>
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<td>n.a.</td>
<td>p, d</td>
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<td>Westinghouse Electric Corporation, Commercial Atomic Power, Pittsburgh, Pa.</td>
<td>Van de Graaff</td>
<td>6-ft tank length</td>
<td>p, d, e</td>
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<td>Van de Graaff</td>
<td>6-ft tank length</td>
<td>p, d, e</td>
<td>2</td>
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<td></td>
<td>Van de Graaff</td>
<td>37-ft tank length</td>
<td>p, d, e</td>
<td>2</td>
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<td>Van de Graaff</td>
<td>22.5-ft tank length</td>
<td>p, d, e</td>
<td>6</td>
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<td>Wisconsin, University, Madison, Wis.</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, a,</td>
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<td>p, d, a,</td>
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<td>Van de Graaff (tandem)</td>
<td>n.a.</td>
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<td>Location</td>
<td>Type</td>
<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<tr>
<td><strong>Australia</strong></td>
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<tr>
<td>1 Australian National University, Canberra</td>
<td>Cockcroft-Walton</td>
<td>9-ft accelerating tube</td>
<td>p, d</td>
<td>0.5</td>
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<td></td>
<td>Cockcroft-Walton</td>
<td>14-ft accelerating tube</td>
<td>p, d, α</td>
<td>1.25</td>
</tr>
<tr>
<td>1 Melbourne, University, Victoria</td>
<td>Van de Graaff</td>
<td>10-ft accelerating tube</td>
<td>p, d</td>
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<td>Van de Graaff</td>
<td>6.5-ft accelerating tube</td>
<td>e</td>
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<td><strong>Belgium</strong></td>
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<td>1 Centre de Physique Nucleaire, Ecole Royale Militaire, Bruxelles</td>
<td>Cockcroft-Walton</td>
<td>n.a.</td>
<td>p</td>
<td>1.4</td>
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<tr>
<td>1 Centre de Physique Nucleaire, Louvain</td>
<td>Van de Graaff</td>
<td>3.5-m accelerating tube</td>
<td>p, d</td>
<td>1.8</td>
</tr>
<tr>
<td>1 Institut Interuniversitaire des Sciences Nucleaire, Faculte Polytechnique, Mons</td>
<td>Cockcroft-Walton</td>
<td>6-m accelerating tube</td>
<td>p, d, α</td>
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<tr>
<td>1 Laboratoire de Radioactivite et de Physique Nucleaire, Universite de Liège, Liège</td>
<td>Cockcroft-Walton</td>
<td>n.a.</td>
<td>p, d</td>
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<td></td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d</td>
<td>2</td>
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<tr>
<td></td>
<td>Electrostatic-charge transport by air-blown dust particles.</td>
<td></td>
<td>p, d</td>
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<td>1 Universite Libre de Bruxelles, Bruxelles</td>
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<td>1 Atomic Energy of Canada, Ltd., Chalk River, Ontario</td>
<td>*Van de Graaff (tandem)</td>
<td>Two accelerators end-to-end</td>
<td>p, d, t, α</td>
<td>10</td>
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<td>1 British Columbia, University, Vancouver, B. C.</td>
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<td>16-ft accelerating tube</td>
<td>p, d, α</td>
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<tr>
<td>Location</td>
<td>Type</td>
<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<td><strong>Canada</strong></td>
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<td>2 Canadian Defense Research Board, Alberta</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, a</td>
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<td>2 Canadian Department of Defense Production, Montreal</td>
<td>Van de Graaff</td>
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<tr>
<td>1 Montreal, University, Montreal</td>
<td>Cockcroft-Walton</td>
<td>4.5-ft tank length</td>
<td>p, d</td>
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<tr>
<td>3 National Research Council, Ottawa</td>
<td>Van de Graaff</td>
<td>1.4-ft accelerating tube</td>
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<tr>
<td>3 Van de Graaff 9-ft accelerating tube</td>
<td>p</td>
<td>4</td>
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<td>1 Ontario Cancer Institute, Toronto</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, a</td>
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<td><strong>Denmark</strong></td>
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<td>1 Copenhagen, University, Copenhagen</td>
<td>Transformer-Rectifier</td>
<td>2.6-m accelerating tube</td>
<td>p, d</td>
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<td>4.4-m accelerating tube</td>
<td>p, d, a</td>
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<td>Van de Graaff</td>
<td>3.0-m accelerating tube</td>
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<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, e</td>
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<td>1 Centre d'Études Nucleaires, Grenoble, Isère</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, e</td>
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<td>1 Centre d'Études Nucleaires, Grenoble, Isère</td>
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<td>1 Centre d'Études Nucleaires, Grenoble, Isère</td>
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<td>Dimensions</td>
<td>Particles Accelerated</td>
<td>Energy (MeV)</td>
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<tr>
<td>1 Centre d'Etudes Nucleaires de Saclay, Saclay</td>
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<td>p, d</td>
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<td>tube</td>
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<td>p, d, a</td>
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<td>2, 3 Ecole Normal Superieure, Paris</td>
<td>Cockcroft-Walton</td>
<td>2.1-m accelerating</td>
<td>d</td>
<td>0.6</td>
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<td></td>
<td>tube</td>
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<td></td>
<td>Van de Graaff</td>
<td>2.1-m accelerating</td>
<td>p, d, e</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td>2 Ecole Polytechnique, Paris</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d</td>
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<tr>
<td>3 Institute Interuniversitaire des Sciences Nucleaire, Mons</td>
<td>Cockcroft-Walton</td>
<td>5-m accelerating</td>
<td>p, d</td>
<td>1.4</td>
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<td></td>
<td></td>
<td>tube</td>
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<td></td>
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<td>Cockcroft-Walton</td>
<td>5-m accelerating</td>
<td>p, d, a</td>
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<tr>
<td></td>
<td></td>
<td>tube</td>
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<td></td>
</tr>
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<td></td>
<td>*Van de Graaff</td>
<td>n.a.</td>
<td>p, d, a</td>
<td>6</td>
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<tr>
<td>1 Laboratoire de Physique Atomique et Moleculaire, College de France,</td>
<td>Van de Graaff</td>
<td>1.6-m accelerating</td>
<td>d→n</td>
<td>0.6</td>
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<tr>
<td></td>
<td></td>
<td>tube</td>
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<td>Van de Graaff</td>
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<td>Cockcroft-Walton</td>
<td>n.a.</td>
<td>d</td>
<td>0.9</td>
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<td>2 Lyons, University, Lyons</td>
<td>Van de Graaff</td>
<td>n.a.</td>
<td>p, d, a, e</td>
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<td>p, d, a, e</td>
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<tr>
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<tr>
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<td>Van de Graaff</td>
<td>n. a.</td>
<td>e</td>
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</tr>
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<td>p, d, e</td>
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<td>d</td>
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## II. Induction Machines: Betatrons

### In the United States

<table>
<thead>
<tr>
<th>Location</th>
<th>Orbit Radius</th>
<th>Particles Accelerated</th>
<th>Energy (Mev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 4 Allis-Chalmers, Milwaukee, Wis.</td>
<td>8.20 in.</td>
<td>e</td>
<td>28</td>
</tr>
<tr>
<td>1, 4 Anderson Hospital and Tumor Institute, University of Texas, Houston, Tex.</td>
<td>9.5 in.</td>
<td>e</td>
<td>24</td>
</tr>
<tr>
<td>1, 4 Baldwin-Lima-Hamilton Corporation, Lima, O.</td>
<td>8.22 in.</td>
<td>e→x-rays</td>
<td>24</td>
</tr>
<tr>
<td>4 Birdsboro Steel Foundry, Birdsboro, Pa.</td>
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<td>e→x-rays</td>
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<tr>
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<tr>
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<tr>
<td>3 Chicago, University, Chicago, Ill.</td>
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<td>100</td>
</tr>
<tr>
<td>4 Continental Foundry and Machine Company, Coraopolis, Pa.</td>
<td>8.13 in.</td>
<td>e→x-rays</td>
<td>24</td>
</tr>
<tr>
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</tr>
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<td>e</td>
<td>15</td>
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<tr>
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</tr>
<tr>
<td></td>
<td>11.5 in.</td>
<td>e</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>33 in.</td>
<td>e</td>
<td>100</td>
</tr>
<tr>
<td>1 General Electric Research Laboratory, Schenectady, N. Y.</td>
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<td>e</td>
<td>11.7</td>
</tr>
<tr>
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<td>e</td>
<td>24</td>
</tr>
<tr>
<td>4 General Steel Castings Company, Granite City, Ill.</td>
<td>7.5 in.</td>
<td>e</td>
<td>24</td>
</tr>
<tr>
<td>Location</td>
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<td>Particles Accelerated</td>
<td>Energy (MeV)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>--------------</td>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>1, 4 Illinois, University, Urbana, Ill.</td>
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<tr>
<td></td>
<td>10 in.</td>
<td>e</td>
<td>80</td>
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<tr>
<td></td>
<td>46 in.</td>
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<td>340</td>
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</tr>
<tr>
<td>1, 4 Los Alamos Scientific Laboratory, Los Alamos, N. Mex.</td>
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<td>e</td>
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<td>1, 4 Madison Radiation Center, Madison, Wis.</td>
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<tr>
<td>1, 4 Memorial Center, New York, N. Y.</td>
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<td>4 Mesta Machine Company, Homestead, Pa.</td>
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<td>4 Michigan, University, Ann Arbor, Mich.</td>
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<tr>
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<td>Location</td>
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<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<tr>
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<tr>
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<tr>
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<td>21 cm</td>
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<tr>
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<tr>
<td>Location</td>
<td>Orbit Radius</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<td>1Metropolitan-Vickers, Manchester, England</td>
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<td>15</td>
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<td>Orbit Radius</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<tr>
<td>1, 4 Dunedin Hospital, Dunedin, New Zealand</td>
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<td>e</td>
<td>24</td>
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<td>Norway</td>
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<td>e</td>
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<td>Switzerland</td>
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<td>e</td>
<td>31</td>
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<td>e</td>
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<td>6 Moscow State University, Moscow</td>
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<td>n.a.</td>
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<td>6 Tomsk</td>
<td>n.a.</td>
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<td>Yugoslavia</td>
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### III. Resonance Machines

#### Linear Accelerators

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<th>Type</th>
<th>Accelerator Length</th>
<th>Particles Accelerated</th>
<th>Energy (Mev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Argonne Cancer Research Hospital, University of Chicago, Chicago, Ill.</td>
<td>Traveling-wave</td>
<td>16 ft</td>
<td>e</td>
<td>60</td>
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<tr>
<td>1 Bartol Research Foundation of the Franklin Institute, Swarthmore, Pa.</td>
<td>n. a.</td>
<td>3 ft</td>
<td>e</td>
<td>1.4</td>
</tr>
<tr>
<td>1 Brookhaven National Laboratory, Upton, Long Island, N. Y.</td>
<td>n. a.</td>
<td>110 ft</td>
<td>p</td>
<td>50</td>
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<tr>
<td>1 Brown University, Providence, R. I.</td>
<td>n. a.</td>
<td>3 ft</td>
<td>p, d</td>
<td>0.2</td>
</tr>
<tr>
<td>1 California, University, Radiation Laboratory, Berkeley, Calif.</td>
<td>Traveling-wave 3.3 ft</td>
<td>e</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traveling-wave 3.3 ft</td>
<td>e</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standing-wave 40 ft</td>
<td>p</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standing-wave 18.2 ft</td>
<td>p</td>
<td>9.8</td>
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<tr>
<td></td>
<td>Standing-wave 120 ft</td>
<td>heavy ions to Ne20</td>
<td>10 Mev/nucleon</td>
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<tr>
<td>1, 5 California, University, Radiation Laboratory, Livermore, Calif.</td>
<td>*Traveling-wave 14 ft</td>
<td>e</td>
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<td>Traveling-wave 11 ft</td>
<td>p</td>
<td>3.75</td>
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<tr>
<td></td>
<td>Traveling-wave 11 ft</td>
<td>d</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traveling-wave 11 ft</td>
<td>a</td>
<td>15</td>
<td></td>
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<tr>
<td>1 California, University, Radiation Laboratory, Site 300, Livermore, Calif.</td>
<td>Traveling-wave 6.7 ft</td>
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</tr>
<tr>
<td>4 Columbia University, New York, N. Y.</td>
<td>n. a.</td>
<td>9.5 ft</td>
<td>e</td>
<td>15</td>
</tr>
<tr>
<td>Location</td>
<td>Type</td>
<td>Accelerator Length</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------------</td>
<td>--------------------</td>
<td>-----------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>1Ethicon, Inc., Somerville, N. J.</td>
<td>Traveling-wave</td>
<td>10 ft</td>
<td>e</td>
<td>7</td>
</tr>
<tr>
<td>1General Atomic, Division of General Dynamics, San Diego, Calif.</td>
<td>*n. a.</td>
<td>12 ft</td>
<td>e</td>
<td>33</td>
</tr>
<tr>
<td>1Massachusetts Institute of Technology, Laboratory for Nuclear Science, Cambridge, Mass.</td>
<td>n. a.</td>
<td>21 ft</td>
<td>e</td>
<td>17</td>
</tr>
<tr>
<td>1Michael Reese Hospital, Chicago, Ill.</td>
<td>n. a.</td>
<td>10 ft</td>
<td>e</td>
<td>35</td>
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<tr>
<td>1Minnesota, University, Institute of Technology, Minneapolis, Minn.</td>
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<td>120 ft</td>
<td>p</td>
<td>68</td>
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<td>1Montana State University, Missoula, Mont.</td>
<td>Traveling-wave</td>
<td>37.8 ft</td>
<td>e</td>
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</tr>
<tr>
<td>1Purdue University, Lafayette, Ind.</td>
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<td>10 ft</td>
<td>e</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td>n. a.</td>
<td>2.5 ft</td>
<td>e</td>
<td>1.7</td>
</tr>
<tr>
<td>1Stanford Hospital, San Francisco, Calif.</td>
<td>Traveling-wave</td>
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<tr>
<td></td>
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<td>n. a.</td>
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<td>heavy ions to A^{40}</td>
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<td>Helix</td>
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<td>Length</td>
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## Magnetic Accelerators: Cyclotrons

### In the United States

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<th>Location</th>
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<th>Particles Accelerated</th>
<th>Energy (Mev)</th>
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<tr>
<td>Location</td>
<td>Type</td>
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<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<td>N⁺⁺</td>
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<td>O⁺⁺</td>
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<tr>
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<td>Energy (Mev)</td>
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<td>p</td>
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<td>p</td>
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<td></td>
<td></td>
<td>d</td>
<td>11/Mev nucleon</td>
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<td></td>
<td>a</td>
<td>11/Mev nucleon</td>
</tr>
<tr>
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<td></td>
<td>ions to Ne6+</td>
<td>11/Mev nucleon</td>
</tr>
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<td>p</td>
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<td>d</td>
<td>7.5</td>
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<td>a</td>
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<td>Energy (Mev)</td>
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<td>p</td>
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<td>Union of Soviet Socialist Republics</td>
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<tr>
<td>1, 6 Big Volga Laboratories, Bolshoya Volga</td>
<td>FM</td>
<td>6 m</td>
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</tr>
<tr>
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<td>n.a.</td>
</tr>
<tr>
<td>6 Moscow Physical Institute, Moscow</td>
<td>n.a.</td>
<td>1.5 m</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>6 Peking</td>
<td>CW</td>
<td>n.a.</td>
<td>n.a.</td>
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<tr>
<td>1 Radium Institute, USSR Academy of Sciences, Leningrad</td>
<td>n.a.</td>
<td>14 in.</td>
<td>d</td>
<td>1.8</td>
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<tr>
<td>Yugoslavia</td>
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<tr>
<td>1 Institute &quot;Rudjer Boskovic,&quot; Zagreb</td>
<td>*n.a.</td>
<td>140 cm</td>
<td>p</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d</td>
<td>16 heavy ions</td>
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**Magnetic Accelerators: Synchrotrons**

**In the United States**

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<th>Location</th>
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<th>Particles Accelerated</th>
<th>Energy (Mev)</th>
</tr>
</thead>
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<tr>
<td>Brookhaven National Laboratory, Upton, Long Island, N. Y.</td>
<td>proton</td>
<td>30 ft</td>
<td>p</td>
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</tr>
<tr>
<td></td>
<td>*proton</td>
<td>421.45 ft</td>
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<td>California, University, Medical Center, San Francisco, Calif.</td>
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<tr>
<td>California, University, Radiation Laboratory, Berkeley, Calif.</td>
<td>electron</td>
<td>3.3 ft</td>
<td>e</td>
<td>340</td>
</tr>
<tr>
<td></td>
<td>proton</td>
<td>50 ft</td>
<td>p</td>
<td>6,300</td>
</tr>
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<td>California Institute of Technology, Pasadena, Calif.</td>
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<td>376 cm</td>
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<tr>
<td>Cornell University, Laboratory of Nuclear Studies, Ithaca, N. Y.</td>
<td>electron</td>
<td>12.5 ft</td>
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</tr>
<tr>
<td>General Electric Company, Schenectady, N. Y.</td>
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<td>2 ft</td>
<td>e</td>
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<td>Iowa State College, Ames, Ia.</td>
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<td>1 ft</td>
<td>e</td>
<td>90</td>
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<tr>
<td></td>
<td>electron</td>
<td>1 ft</td>
<td>e</td>
<td>90</td>
</tr>
<tr>
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<td>e</td>
<td>350</td>
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<td>e</td>
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<td>Midwestern Universities Research Association, Madison, Wis.</td>
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<td>0.4</td>
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<tr>
<td></td>
<td>FFAG</td>
<td>60 cm</td>
<td>e</td>
<td>0.4</td>
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<tr>
<td></td>
<td>FFAG</td>
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<td>e</td>
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<tr>
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<td>e</td>
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<tr>
<td>Location</td>
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<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
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<td>-------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>1 U. S. Naval Research Laboratory, Washington, D. C.</td>
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<td>77 cm</td>
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<tr>
<td>1 Virginia, University, Charlottesville, Va.</td>
<td>electron</td>
<td>30 cm</td>
<td>e</td>
<td>75</td>
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</tbody>
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**Outside the United States**

**Australia**

1 Australian National University, Canberra
- *proton* 480 cm p 10,600
- electron 10 cm e 33

1 Melbourne, University, Melbourne
- electron 10 cm e 18

**Canada**

1 Queens University, Kingston, Ontario
- electron 29.3 cm e 70

**France**

1 Centre d'Etudes Nucleaires de Saclay, Saclay
- proton 8.40 m p 4,000

**Germany**

1 Physikalisches Institut, Freie Universitat, Berlin - Dahlem
- electron 7.5 cm e 12

1 Physikalisches Institut der Universitat Bonn, Bonn
- electron 170 cm e 500

**Great Britain**

1 Birmingham, University, Birmingham England
- proton 450 cm p 1,000

1 Cambridge, University, Cambridge, England
- electron 10 cm e 33

1 Oxford University, Oxford, England
- electron 46.7 cm e 125
<table>
<thead>
<tr>
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<th>Type</th>
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<th>Particles Accelerated</th>
<th>Energy (MeV)</th>
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</tr>
<tr>
<td>1Glasgow, University, Glasgow, Scotland</td>
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<td>125 cm</td>
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<td>340</td>
</tr>
<tr>
<td>1Royal Cancer Hospital, London England</td>
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<td>10 cm</td>
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<td>30</td>
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<td><strong>Italy</strong></td>
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<tr>
<td>1Istituto Nazionale di Fisica Nucleare, Rome</td>
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<td>360 cm</td>
<td>e</td>
<td>1,000</td>
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<td><strong>Japan</strong></td>
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</tr>
<tr>
<td>1Osaka Prefectural University, Osaka</td>
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<td>30</td>
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<td>1Tohoku University, Sendai</td>
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<td>e</td>
<td>40</td>
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<tr>
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<td>electron</td>
<td>100 cm</td>
<td>e</td>
<td>200</td>
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<td>400 cm</td>
<td>e</td>
<td>1,000</td>
</tr>
<tr>
<td>1Tokyo Institute of Technology, Tokyo</td>
<td>electron</td>
<td>15 cm</td>
<td>e</td>
<td>25</td>
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<tr>
<td><strong>Netherlands</strong></td>
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<tr>
<td>1Delft Institute of Technology, Delft</td>
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<td>p</td>
<td>1,000</td>
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<tr>
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</tr>
<tr>
<td>1Institutionen for Electronik, Royal Institute of Technology, Stockholm</td>
<td>electron</td>
<td>3.65 m</td>
<td>e</td>
<td>1,200</td>
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<tr>
<td><strong>Switzerland</strong></td>
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</tr>
<tr>
<td>1European Council for Nuclear Research</td>
<td>proton</td>
<td>100 m</td>
<td>p</td>
<td>25,000</td>
</tr>
<tr>
<td>1Roentgeninstitut, Inselspital, Bern</td>
<td>electron</td>
<td>29 cm</td>
<td>e</td>
<td>100</td>
</tr>
<tr>
<td>Location</td>
<td>Type</td>
<td>Orbit Radius</td>
<td>Particles Accelerated</td>
<td>Energy (Mev)</td>
</tr>
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<tr>
<td>Union of Soviet Socialist Republics</td>
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<tr>
<td>1, 6, 7  Big Volga Laboratories, Bolshoi Volga</td>
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<td>10,000</td>
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<td>e</td>
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</tbody>
</table>
ACKNOWLEDGMENTS

The author sincerely appreciates the aid and encouragement that he has received from many sources during the preparation of this bibliography and accelerator list. The aid of various members of the Technical Information Division staff has been invaluable. Special thanks are due to Dr. Edwin M. McMillan for suggesting the accelerator classification system used here.

This work was performed under the auspices of the United States Atomic Energy Commission.
LIST OF PARTICLE-ACCELERATOR INSTALLATIONS:
ADDENDA AND ERRATA

Gerald A. Behman

January 20, 1959

Printed for the U.S. Atomic Energy Commission
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LIST OF PARTICLE-ACCELERATOR INSTALLATIONS: ADDENDA AND ERRATA

Gerald A. Behman

Lawrence Radiation Laboratory
University of California
Berkeley, California

January 20, 1959

Communications received by the author after recent publication of a list of particle-accelerator installations operating throughout the world have yielded additional information and pointed out certain errata. The addenda and corrected information are given below.

Addenda

1. DIRECT CURRENT MACHINES

In the United States

<table>
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<tr>
<th>Location</th>
<th>Type</th>
<th>Dimensions</th>
<th>Particles accelerated</th>
<th>Energy (MeV)</th>
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<tbody>
<tr>
<td>Argonne National</td>
<td>Van de Graaff</td>
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<tr>
<td>Laboratory</td>
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<td>Lemont, Ill.</td>
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2J.R. Wallace, Argonne National Laboratory, private communication, December, 1958.
<table>
<thead>
<tr>
<th>Institution</th>
<th>Accelerator Type</th>
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<th>Notes</th>
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<tr>
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<tr>
<td>Laboratory, Schenectady, N.Y.</td>
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<td></td>
<td>*Cockcroft-Walton</td>
<td>15-ft accelerating tube</td>
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<tr>
<td>Vanderbilt University, Nashville, Tenn.</td>
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<td>n. a.</td>
<td>p, d, a</td>
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<tr>
<td>Wesleyan University, Middletown, Conn.</td>
<td>Cockcroft-Walton</td>
<td>3-ft accelerating tube</td>
<td>d</td>
</tr>
</tbody>
</table>

*Under construction


4 C. D. Curtis, Vanderbilt University, private communication, February, 1959.

5 F. Boley, Wesleyan University, private communication, January, 1959.
### Outside the United States

<table>
<thead>
<tr>
<th>Location</th>
<th>Type</th>
<th>Dimensions</th>
<th>Particles accelerated</th>
<th>Energy (Mev)</th>
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<td><strong>Chile</strong></td>
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<tr>
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<td>7 Compagnie Francaise de Van de Graaff Raffinage</td>
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<tr>
<td>7 Direction des Etudes et Fabrications d'Armement, Paris</td>
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<td>n.a.</td>
<td>e</td>
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6 C. M. Raggio Laboratoria de Fisica Nuclear, Santiago, Chile, private communication, December, 1958.

7 P. Silvy, Societe Anonyme de Machines Electrostatique, Grenoble, France, private communication, December, 1958.
<table>
<thead>
<tr>
<th>Location</th>
<th>Facility Name</th>
<th>Accelerating Tube</th>
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<td>n.a.</td>
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<td>7 Laboratoire de Synthese</td>
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<td>p, d, e</td>
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<td>Felici</td>
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<tr>
<td>New Zealand</td>
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</tr>
<tr>
<td>8 Auckland, University, Auckland</td>
<td>Cockcroft-Walton</td>
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<td>p, d</td>
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<tr>
<td></td>
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<tr>
<td>8 Otago, University, Dunedin</td>
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<tr>
<td>Pakistan</td>
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<td>10 Istanbul, University, Istanbul</td>
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8 R. E. White, High Voltage Laboratory, Massachusetts Institute of Technology, Cambridge, Mass., private communication, January, 1959.
10 I. Yenicay, Istanbul University, Istanbul, Turkey, private communication, January, 1959.
II. INDUCTION MACHINES: BETATRONS

Outside the United States

<table>
<thead>
<tr>
<th>Location</th>
<th>Orbit radius</th>
<th>Particles accelerated</th>
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</tr>
<tr>
<td>France</td>
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<tr>
<td>Laboratoire Central des Industries Electriques, Paris</td>
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<tr>
<td>Germany</td>
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<tr>
<td>Czerny-Krankenhaus, Heidelberg</td>
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<tr>
<td>Firma Mannesmann, Duisburg-Huckingen</td>
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<tr>
<td>Med.-Universitatsklinik, Erlangen</td>
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<tr>
<td>St. Georg-Krankenhaus, Hamburg</td>
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<td>Städt. Krankenanstalten, Düsseldorf</td>
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</table>

Universitäts-Klinik, München
Universitäts-Strahleninstitut, Marburg
Universitäts-Strahleninstitut, Tübingen

Italy
Centro Tumori, Cagliari
Centro Tumori, Chieti
Centro Tumori, Palermo
Consorzio Cura Tumori, Udine
Instituto die Radiologia dell' Universita, Rome
Instituto Regina Elena, Rome
Ospedale San Lorenzo, Borgo Valsugana

Mexico
Centro Medico, Mexico City

Sweden
Radiumhemmet, Stockholm
Corrections

Certain fixed-field alternating-gradient (FFAG) accelerators were included in the synchrotron group in the recently published list by this author. McMillan has pointed out that, under the classification system suggested by him for this list, all FFAG accelerators belong in the cyclotron class because the field does not vary as a function of time. Accordingly, the FFAG machines listed for the Midwestern Universities Research Association, Madison, Wis. should be included in the cyclotron group in this list.

In the classification system used, two general types of cyclotrons were indicated. These are continuous-wave (CW) and frequency-modulated (FM) machines. It should be noted that the FM class of cyclotrons may be referred to alternatively as synchrocyclotrons.

The dimensions of the larger of two Van de Graaff machines at Argonne National Laboratory, Lemont, Illinois were listed incorrectly. This machine has a 15-ft accelerating tube, can accelerate protons, deuterons, or alpha particles, and has a maximum energy of 4.5 Mev.

D.C. machines listed at the Centre d'Etudes Nucléaires, Grenoble, France and at the Laboratoire de Physique Atomique et Moléculaire, College de France, Paris are Felici-type accelerators rather than Van de Graaff generators. As contrasted with the belt system of charge transport of the Van de Graaff machines, the Felici machine uses a dielectric cylinder which rotates about a slightly conducting glass stator. Thin steel strips charge and discharge the rotor as a result of induction of metallic inductors within the glass cylinder. For improved efficiency, the machine usually operates under a high pressure.

The proper location of the betatron listed for the Knolls Atomic Power Laboratory is General Engineering Laboratory, General Electric Company, Schenectady, N.Y.

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The 4-Mev Van de Graaff machine and 32-Mev proton linac formerly at University of California in Berkeley have been moved to the University of Southern California at Los Angeles, California.

Acknowledgments

The author is deeply grateful to the scientists of various countries who provided the new and revised information published here. Thanks are due Dr. Edwin McMillan for helpful suggestions and to other members of the staff of the Lawrence Radiation Laboratory for their aid.

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