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BIBLIOGRAPHY OF PARTICLE ACCELERATORS

JANUARY TO DECEMBER 1951

Sergey Shewchuck

September, 1952

Berkeley, California

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JANUARY TO DECEMBER 1951

Sergey Shewchuck

Radiation Laboratory, Department of Physics
University of California, Berkeley, California

September, 1952

Introduction

This bibliography is a supplement to that compiled and edited by E. Thomas, P. Mittelman, and H. H. Goldsmith, issued July 1, 1948 as BNL-L-101, and to the later extension prepared by Bonnie E. Cushman and issued in March, 1951, as UCRL-1238. The journals searched were Chemical Abstracts; Science Abstracts, Section A (Physics) and Section B (Electrical Engineering); Nuclear Science Abstracts; and Nucleonics. The period covered was January, 1951, through December, 1951. News briefs are not included in the list; however, some reports published by various institutions concerning progress in the construction of their particle accelerators are covered. Information pertaining to particle accelerators was obtained primarily from a list of questions sent to institutions throughout the world. It is hoped that both the bibliography and list of accelerators are fairly complete. Notification of omissions and inaccuracies will be greatly appreciated.

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PARTICLE ACCELERATORS IN THE UNITED STATES

Location	Type	Dimensions	Energy (Mev)	Particle
Argonne National Laboratory	Constant frequency cyclotron	60" pole piece dia.	20	d
	Van de Graaff		1.5	e
	Van de Graaff	Tank 7' dia. x 25' long 15' accelerating tube	3.5	p, d, etc.
Bartol Research Foundation	Van de Graaff	5' accelerating tube Tank 4' dia. x 12' long, 200 lbs. pressure	1.8	p, d
	*Van de Graaff	21' accelerating tube Tank 12' dia. x 35' long, 300 lbs. pressure	5-10	p, d
	Linear Accelerator *Additional section under construction	1.75' long	1.4	e
Biochemical Research Foundation of the Franklin Institute (Newark, Delaware)	Cyclotron (under modification)	38" pole piece dia.	~10	d
Brookhaven National Laboratory	Electrostatic accelerator	8' accelerating tube	2-3	d, p
	Electrostatic accelerator	12' accelerating tube	4	p, d
	Cyclotron	60' pole piece dia.	20	p, d
	Electrostatic accelerator	3' accelerating tube	2	e
	Proton synchrotron (Cosmotron)	30' orbit radius magnet 2200 tons	2000-3000	p

* Under construction

Location	Type	Dimensions	Energy (Mev)	Particle
University of California	Cyclotron (60")	72" pole piece dia.	10 20 40	p d α
	Synchrocyclotron	184" pole piece dia.	350 195 390	p d α
	Linear accelerator	40' long	32	p
	Van de Graaff	Tank 8' dia. x 27' long	4	p
	Synchrotron	1 meter orbit radius	335	e
	*Proton synchrotron (Bevatron)	ca 120' pole piece dia.	6440	p
University of California Medical School	Synchrotron	11.5" orbit radius	70	e
University of California at Los Angeles	Cyclotron	37" pole piece dia.	15	p
California Institute of Technology	Kevatron (Transformer-condenser rectified)	13" tube	0.135	p, d
	Electrostatic generator	5' x 6' tank, 27" tube	0.6	p, d
	Electrostatic generator	8' x 13' tank, 8'6" tube	1.7	p, d
	Electrostatic generator	8' x 22' tank, 9' tube	3	p, d
	*Synchrotron	138" radius	500	e
Carnegie Institute of Technology	Synchrocyclotron	145" pole dia.	ca 440	p

Location	Type	Dimensions	Energy (Mev)	Particle
Carnegie Institution	Cyclotron	60" pole piece dia.	15 7.5 30	d p α
	Electrostatic generator		1	p, d, α
	Electrostatic generator	(pressure tank)	3.5	p, d, α
Case School of Applied Science	Flux-forced field-biased betatron	Radius 17.15 cm	30	e
	*Direct voltage accelerator	Length 8'	0.7	p
Catholic University of America, Washington, D.C.	Van de Graaff	1 m dia.	0.5	p, d
University of Chicago	Synchrocyclotron	170" dia.	500 450 250	α p d
	Cyclotron	32.5" pole piece dia.	8	d
	Cockcroft-Walton		0.6	p, d, α
	Betatron		50-100	e
Columbia University	Cyclotron	36" pole piece dia.	8-10	d
	Cyclotron (F.M.)	164" pole piece dia.	385	p
Cornell University	Synchrotron	1 m orbit radius	300	e
	Linear Accelerator[1]		0.5	
	Cyclotron[1]	15" pole piece dia.	1.5 1	d p

1. Data from Goldsmith, H. H., List of High Energy Installations, Brookhaven National Laboratory, 1948.

Location	Type	Dimensions	Energy (Mev)	Particle
Duke University	*Van de Graaff	25' tank	4	p, d, α
El Cerrito High School El Cerrito, California	Cyclotron	6" pole piece dia.	1	p
University of Florida	Van de Graaff, pressure type	4' dia. x 8' long tank Accelerating tube 4.5' long, 100 psi pressure	1	p, d
General Electric Company	6 betatrons	3 - 33" orbit radii 2 - 7.5" orbit radii 1 - 5.25" orbit radius	100 10 20	e e e
	*Cyclotron	60" pole piece dia.	20 40	d α
	4 Synchrotrons (2 under construction)	3 - 11.5" orbit radii 1 - 33" orbit radius	70 180	e e
	Van de Graaff	8'	2.5	p
Harvard University	Synchrocyclotron	95" pole piece dia.	125	p
Hofstra College	*Cyclotron	24" pole piece dia.	ca 6	p
University of Illinois	Cyclotron[1]	47" pole piece dia.	5 10	p d
	Betatron[1]		22	e
	Betatron[1]		4	e
	Betatron	26 cm orbit radius	80	e
	Betatron	120 cm orbit radius	340	e

Location	Type	Dimensions	Energy (Mev)	Particle
University of Illinois Medical School	Betatron	19.5 cm orbit radius	25	e
Indiana University	Cyclotron	45" pole piece dia.	11.4 5.7 22.8	d p α
Iowa State College	Transformer-rectifier produced d.c. potential; linear accelerator tube	Tube length ca 60" long	0.325-0.650	p, d
	Synchrotron	11.5" orbit radius	70	e
University of Iowa	Pressurized Van de Graaff	22' accelerator tube	3-4	p, d
	Voltage multiplier accelerator	5' accelerator tube	0.5	p, d
Johns Hopkins University	Van de Graaff	6' dia. x 14' long tank, accelerating tube 7' long	1.5	p, d
University of Kansas	Van de Graaff	Horizontal tank 6' dia. x 14' long, 120 psi pressure	2.5	positive ions
University of Kentucky	Pressurized Van de Graaff	Electrode dia. 48" Accelerating tube length 8'	1	p, d
Los Alamos Scientific Laboratory	Cyclotron	42" pole piece dia.	10	d
	Van de Graaff		2.5	
	*Van de Graaff		12	

Location	Type	Dimensions	Energy (Mev)	Particle
Los Alamos Scientific Laboratory (cont.)	Betatron		20	e
	*Betatron		20	e
	Betatron		14	e
	Cockcroft-Walton		0.280	
	Cockcroft-Walton		0.125	
Massachusetts Institute of Technology	Van de Graaff	2' tube, 2" equi-potential module	ca 0.800	p, d
	Standing wave linear electron accelerator	21' long Guide wave length 10.7 cm	17	e
	Standard cyclotron	42" pole face	15 7.5 30	d p α
	Synchrotron	1 m orbit radius	340	e
	Vertical electrostatic generator, pressurized	9' accelerating tube	12	positive ions
	*Van de Graaff	Tank 12' dia. x 32' high 400 psi pressure	2-12	p, d, e
	Van de Graaff	Tank 4.5' dia. x 13' high 200 psi pressure	3.5	e
	2 Van de Graaff x-ray generators	Tanks 3' dia. x 6' high 400 psi pressure	2	e

Location	Type	Dimensions	Energy (Mev)	Particle
University of Michigan	*Racetrack synchrotron	40" orbit radius	300	e
	Cyclotron	42" pole piece dia.	10	d
University of Minnesota	*Proton linear accelerator	100' long linear acceleration path	66	p
	Van de Graaff	18' dia., 100 psi tank, single electrode	4	singly charged ions
University of Missouri	Van de Graaff (for demonstraction purposes)		0.5	
National Bureau of Standards	Electrostatic[1]		1.4	e, p
	*Synchrotron	33" orbit radius	180	e
	Betatron		50	e
Naval Ordnance Laboratory	Betatron	5.5" orbit radius	10	e
Naval Research Laboratory	Betatron[1]		4	e
	Betatron	18.5 cm orbit radius	20-22	e
	*Synchrotron	77 cm orbit radius	10 (now)	e
	Cockcroft-Walton - half-wave quadrupler	Accelerator tube 39.25" long	0.075-0.250	p, d, α
	*High pressure horizontal Van de Graaff	Accelerating tube 175" long	5	p, d, α
	Van de Graaff		2.25	p, d

Location	Type	Dimensions	Energy (Mev)	Particle
Nebraska University	Cockroft-Walton	162 cm long, 107 cm by 91 cm cross section	0.04	p
Northwestern University	*Vertical Van de Graaff, pressurized	12' accelerating path	4.5	p, d, α
University of Notre Dame	Pressure electrostatic generator, horizontal	40' long x 8' dia. tank	3	e
	Pressure electrostatic generator, horizontal	6' long x 3' dia. tank	2	e
Oak Ridge National Laboratory	Van de Graaff	12' accelerator tube	5.7	p, d
	Van de Graaff	5' accelerator tube	2.7	p, d, and heavier particles
	Cockcroft-Walton	4' accelerator tube	0.400	positive ions
	Cyclotron	44" pole piece dia.	2	p
	Cyclotron (installed vertically)	86" pole piece dia.	20	p
Ohio State University	Betatron[1]		4	e
	Horizontal Van de Graaff	5' dia. x 20' long tank Accelerator tube 12' long	2	p, d
	Cyclotron	42" pole piece dia.	8.5 10 6.5 20 26	p d $_1H^3$ α $_2He^3$

Location	Type	Dimensions	Energy (Mev)	Particle
Oregon State College (Corvallis, Oregon)	*Cyclotron, c.w.	39" pole pieces, 14 kilogauss	15 7.5 15	p d α
University of Pennsylvania	Statitron (electrostatic generator)	12'	2-3	p
	Betatron	19.1 cm orbit radius	22-25	e
Picatinny Arsenal	Betatron	7.5" orbit radius	22	e
University of Pittsburgh	Cyclotron	47" pole piece dia.	8.5 16 32	p d α
Princeton University	Synchrocyclotron (Rebuilding completed)	33' pole piece dia.	18	p
Purdue University	Microwave linear electron accelerator	3' long	1.5	e
	Cyclotron	37.5" pole piece dia.	20 10	α d
	Synchrotron	40" orbit radius	300	e
	*Microwave linear electron accelerator	12' long	4-8	e
Rice Institute	Van de Graaff, horizontal pressure tank	14' vacuum tube	2.5	p, d
University of Rochester	Cyclotron[1]	26" pole piece dia.	6	p
	Synchrocyclotron	130" pole piece dia.	250	p

Location	Type	Dimensions	Energy (Mev)	Particle
Rock Island Arsenal	Betatron	ca 15" orbit dia.	22	e
Stanford University	Cyclotron	27.75" pole dia.	2.9	d
	Linear electron accelerator (traveling-wave type)	14'5" long	6	e
	Linear accelerator - Mark II	12' long	35	e
	*Linear accelerator - Mark III	200' long (80' now operating)	1,000 (200 now)	e
University of Texas	*Van de Graaff	Accelerating tube 10' long	4-5	positive ions
	Cockcroft-Walton		0.100	p, d
University of Washington (Seattle)	*Cyclotron	60" pole piece dia.		positive ions
Washington University (St. Louis)	Cyclotron	45" pole face dia.	10 5	d p
Westinghouse Electric Co.	Electrostatic generator	30' accelerating tube 65 psi pressure	3.7	p, d
University of Wisconsin	2 electrostatic generators (one under construction)		4.5	p, d, α
Yale University	Linear electron accelerator	4' 10.5" long	10-15	e
	Cyclotron	28" pole piece dia.	8 4	α d
University of Virginia	Van de Graaff (atmospheric)	5' column	0.4	positive ions
	Resonant cavity linear accelerator	1' length	1	e

PARTICLE ACCELERATORS OUTSIDE THE UNITED STATES

Location	Type	Dimensions	Energy (Mev)	Particle
Australia				
Australian National University, Canberra	*Cyclo-synchrotron	Pole tip diameter 136" Synchrotron orbit 117"	Cyclotron section 200 Then synchrotron action to 2000	p
University of Melbourne	Synchrotron	Orbit radius 7.5 cm	20	e
	Electrostatic generator	Length of accelerating tube 9'	1	p, d
	Electrostatic generator	Length of accelerating tube 6'6"	0.8	p, d
Belgium				
Centre de Physique Nucleaire, University of Louvain	*Cyclotron	62 ton magnet Gap: 96 cm dia. 16.3 cm depth	10	p
	Van de Graaff		1	
University of Brussels	Proton accelerator		0.8	p
Canada				
McGill University	Synchrocyclotron	82" pole piece dia.	100	p
National Research Council Laboratories, Ottawa	Cockcroft-Walton		0.65	positive ions

Location	Type	Dimensions	Energy (Mev)	Particle
National Research Council of Canada, Chalk River	Vertical Van de Graaff	Length of accelerating tube 9' 200 psi, tank 16' high x 6' dia.	5	positive ions
	Positive ion accelerator		0.2	positive ions
Queens University, Kingston, Ont.	Synchrotron	Orbit radius ca 30 cm	75-80	e
University of Saskatchewan	Betatron	Orbit radius 20 cm	27.5	e
Denmark				
Institute of Theoretical Physics, Copenhagen	Cyclotron cw (being reconstructed)	35.5" pole piece dia.	11	d occasionally p, α
	*Electrostatic generator	Tank 2.5 m x 7 m max. psi 170	4	p
	Electrostatic generator	Tank 2.4 m x 4.5 m max. psi 100	2.5	p
	Greinacher coupled accelerator, 4 step	4 m high	1	p, d
France				
Collège de France, Paris	Cyclotron[1]	80 cm pole piece dia. Air gap 20 cm Dia. of dees 75 cm	6.8 13	d α

Location	Type	Dimensions	Energy (Mev)	Particle
Commissariat à l'Energie Atomique, Laboratoires du Fort de Chatillon, Fortenay-aux-Roses, Seine, France	*Cyclotron	162 cm pole piece dia.	26	d
	*Van de Graaff	Column length above base plate 5.85 m	3.5-4	p, d
	*Resonant cavity accelerator	Cavity dia. 92 cm Accelerating gap 3 cm	0.5	p
✓Laboratoire de Synthese Atomique, Ivry (Seine)	✓Electrostatic Type "Greinacher"	Length 3 m	0.9	
	✓Electrostatic	Length 2 m	0.6	p, d
	Electrostatic	Length 5 m	3 max	e
✓University of Strasbourg	✓Cockcroft-Walton	Length 6 m	1.5	p, d
✓ Germany				
Physikalisches Institut der Universität Bonn	Van de Graaff	Length 1.4 m	0.5	p, d
	Cyclotron[1]	16" pole piece dia.	2	p
University of Danzig	Electrostatic[1]		0.8	e
Institute for Nuclear Physics, Hamburg	Van de Graaff		2.5	
✓ Institut fur Physik im Max-Planck-Institut fur Med. Forschung der Universität Heidelberg	Cyclotron	101 cm (40") pole piece dia.	13	d
	Van de Graaff	Length 3.60 m (12')	1	p, d, e
Leipzig University	Cyclotron[1]	40" pole piece dia.		

Location	Type	Dimensions	Energy (Mev)	Particle
Megavolt Versuchsanstalt, Wrist	Betatron[1]		15	e
University of Rostock	Electrostatic[1]		0.9	e
Siemens-Reiniger-Werke, Erlangen	Betatron	Radius of equilibrium 85 mm	6	e
	*Betatron	Radius of equilibrium 105 mm	12-15	e
✓ Hochspannungslaboratorium Hechingen Abt. der Forschungstelle fur Physik der Stratosphare in der Max Planck-Gesellschaft, Weissenan Wurttemberg, Germany	Linear Accelerator (cascade generator for high tension)	Length 4 m. 5 stages of 300 kev - 1000 μA (atom + molecule-ions)	1.5	p, d, α
<u>Great Britain</u>				
✓ Associated Electrical Industries, Ltd., Aldermaston	Van de Graaff	Overall length 66"	0.5	p, d
	Van de Graaff	Pressure vessel height 18'6", dia. 6'10.5" 400 psi, tube length 9'	3.1	p d, α
✓ Atomic Energy Research Establishment, Harwell	Synchrocyclotron	110" pole piece dia.	175	p
	Van de Graaff	Stack length 9'	2.7	p, d, α
	Van de Graaff	Tank 8' x 4', accelerating tube 5" dia., 350 psi	2.3	e

Location	Type	Dimensions	Energy (Mev)	Particle
Atomic Energy Research Establishment (contd.)	*Cockcroft-Walton	Accelerating tube 6' long	0.6	positive ions
	Traveling-wave linear accelerator (non-feed-back type)	Accelerating waveguide 2 m long	3.6	e
	Synchrotron	10 cm orbit radius	30	e
	*Linear Accelerator	6 m long	40-50	e
	*Traveling-wave linear accelerator (2 stage feedback type)	Each section 3 m long, total 6 m	15	e
	*Cockcroft-Walton (Machine for Medical Research Council's Radio-biological unit at Harwell)	Pressure tank ca 3 m high x 2 m dia.	1	positive ions (d)
✓University of Birmingham	✓Fixed frequency cyclotron	61.5" pole piece dia.	9 18 36	p d α
	✓*Proton synchrotron	15' pole piece dia.	1,300	p
✓ Cambridge University Dept. of Radiotherapeutics	Beta-synchrotron	r=10 cm stable orbit. Magnet 3 tons.	35	e
Cavendish Lab.	✓Cockcroft-Walton		1.25	p, d
	Cockcroft-Walton		2	p, d
	Van de Graaff		2.25	p, d, e
	✓Cyclotron	37" dia. pole piece	10	p, d

Location	Type	Dimensions	Energy (Mev)	Particle
University of Edinburgh	*Cockcroft-Walton		1	p, d
Glasgow University	*Synchrotron	Orbit radius 125 cm	300	e
	Synchrotron	Orbit radius 10 cm	30	e
Imperial College of Science and Technology, London University	Pressurized electrostatic generator		ca 2	positive ions and e
University of Liverpool	*Synchrocyclotron	150" pole piece dia.	400	p d, α
	Cyclotron[1]	36" pole piece dia.	9	d
Medical Research Council, Hammersmith Hospital, London	Van de Graaff	Accelerating tube 7'6" long x 10" dia., 10 atm. pressure	2	p, d, e, etc.
	*Linear accelerator	Corrugated wave guide 3 m long	8-10	e
	*Continuous wave cyclotron	45" pole piece dia.	15 30	d α
Metropolitan-Vickers, Ltd. High Voltage Laboratory, Manchester	Betatron[1]		20	e
	Betatron[1]		30	e
Oxford University	*Synchrotron	Orbit radius 46.7 cm	140	e
	Betatron	Orbit radius 20 cm	16	e
Royal Cancer Hospital, London	Synchrotron	Orbit radius 10 cm	30	e

Location	Type	Dimensions	Energy (Mev)	Particle
Telecommunications Research Establishment (A.E.R.E. Section), Malvern Great	Dielectric loaded traveling wave linear accelerator without feedback	Length ca 90 cm	1.5	e
	Synchrotron[1]		15	e
	Synchrotron[1]		30	e
India				
Tata Institute of Fundamental Research	*Cyclotron	12" pole piece dia.	1	d
	*Philips Cascade Generator		1	
	*Van de Graaff Generator, open air		0.8-1 Mev	
Italy				
Instituto Superiore di Sanità, Rome	Cockcroft-Walton	Length of accelerator tube ca 3.5 m	1	positive ions
University of Padua	Electrostatic Dismantled		1	p, d
Japan	Linear acclerator	Cavity 1 m dia., 1/2 m long	0.15	p
Netherlands				
Institute for Nuclear Research, Amsterdam	Synchrocyclotron	71" pole piece dia.	28 56	d α
Philips Corp., Eindhoven	Electrostatic[1]		1	p, d
University of Groningen	Electrostatic[1]		0.3	d

Location	Type	Dimensions	Energy (Mev)	Particle
Norway				
Municipal Hospital, Bergen	Van de Graaff	Accelerating tube 5.2 m at atmospheric pressure	1.5	e (x-rays)
	*Electrostatic[1]		1.5	p
	*Synchrotron[1]		70-80	e
University of Bergen	Van de Graaff	Tube 7 m, open air	1.7	e
	Betatron	Orbit rad. 40 cm	47	e
Norges Tekniske Høgskole, Trondheim	*Van de Graaff	Tank 6.6 m long x 2.35 m dia. 15 atm. pressure, accelerating tube 3.6 m	4	p, d
University of Oslo	Neutron generator	Length 50 cm	0.1	d
	Van de Graaff	Length 1.5 m	0.5	p
	*Pressure insulated Van de Graaff	Length 3.6 m	4	p, d
Russia				
Radium Institute, USSR Academy of Sciences, Leningrad	Cyclotron[1]	14" pole piece dia.	1.8	d
Physico-technical Institute, USSR Academy of Sciences, Leningrad	Electrostatic[1]		0.7	p

Location	Type	Dimensions	Energy (Mev)	Particle
Physico-technical Institute Ukrainian SSR Academy of Sciences, Kharkov	Electrostatic[1]		1	
	Electrostatic[1]		3	
	Electrostatic[1]		5	
Sweden				
National Defense Research Laboratory, Stockholm	Electrostatic generator Pressure insulated (9 atm N_2)	Height of accelerating tube 2.25 m	1.8	p, d
Nobel Institute for Physics, Stockholm	Cyclotron	32" pole piece dia.	7	d
	*Cyclotron	88.5" (225 cm) pole piece dia.	25 50	d α
	Cascade generator		1.5	
Royal Institute of Technology, Stockholm	Synchrotron	Orbit radius 20 cm	35	e
	Betatron	Orbit radius 8.3 cm	5.3	e
	Van de Graaff, open type	Accelerating column 3 m long	1	e and ions
University of Stockholm	Two electrostatic generators[1]			
University of Uppsala	*Synchrocyclotron	230 cm pole face dia.	200	p

Location	Type	Dimensions	Energy (Mev)	Particle
Switzerland				
Universität Basel	Cascade generator		1	p, d
Eidgenössische Technische Hochschule, Zürich	Van de Graaff	Length 3 m	1	p
	Tensator (Transformer-rectifier)	Length 6 m	2	d
	Cyclotron	1 m pole piece dia.	8 14	p d
University of Zurich	Electrostatic Generator	3 m high, 156 cm intermaldia. Operating pressure 10 atmos. dry air. Vacuum $<10^{-5}$ mm Hg in ion-acceleration tube.	1.8	