XI International Conference on High-Energy Accelerators

Catalogue of High-Energy Accelerators

XIth International Conference on High Energy Accelerators

CATALOGUE OF HIGH-ENERGY ACCELERATORS

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FOREWORD

On the request of the Organizing Committee of the XIth International Conference on High Energy Accelerators we have compiled the traditional catalogue of high energy accelerators.

The catalogue contains information on high energy ($E \geq 1$ GeV) accelerators and storage rings together with their injectors. An exception has been made for the accelerators for meson factories. Electron accelerators/storage rings used exclusively as synchrotron radiation sources have not been included.

The data sheets used for the previous catalogue (SLAC 1974) were revised in an attempt to facilitate the filling-out and improve the information level.

Given the importance of the accelerator complexes, we have grouped in the first chapter "Proton Synchrotrons and their Injectors".

Sheets for a few of the machines were not returned to us. We followed the line adopted by previous editors of the catalogue and have not included any data for these machines. (They are shown with an asterisk in the Table of Contents.)

We would like to express our thanks to all those who completed data-sheets and to our colleagues at CERN who advised us on the revision of the sheets.

Finally, we like to acknowledge the contribution of Ms. I. Plass who ably handled all secretarial work.

J.H.B. Madsen

P.H. Standley

LIST OF HIGH-ENERGY ACCELERATORS

I. Proton Synchrotrons and their Injectors (final E ≥ 1 GeV)

NAME OF SYNCHROTRON Super Proton Synchrotron (SPS)
INSTITUTION CERN
LOCATION Prévessin (France)
PERSON IN CHARGE G. Brianti DATE: 1.4.1980
DATA SUPPLIED BY B. de Raad

HISTORY AND STATUS

CONSTRUCTION STARTED (date) February, 1970
FIRST BEAM OBTAINED, or GOAL (date) May, 1976
TOTAL COST OF FACILITY 625 MSF (in 1970 SF)
FUNDED BY 12 Member States
TOTAL ACCELERATOR STAFF (now) 500
ANN. OPERAT. BUDGET 45 MSF (without salaries)
ANN. OPERATING TIME 5500 h h
"BEAM ON" 85 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Protons
ENERGY 400 GeV
RING DIAM. 2200 m; TUNNEL SECT. (WxH) 4 x 3 m

Injector

TYPE Proton Synchrotron
OUTPUT (max) 250 mA at 10 000 MeV
EMITTANCE* 30 π mm-mrad
INJECTION PERIOD 2x11.5 μs, or 2 x 1/2 turns
INFLECTOR TYPE Fast kicker

Magnet System

FOCUSING TYPE Sep. function FIELD INDEX, n= -
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 26.6 ν_V 26.6
No. MAGNETS 744 LENGTH (ea) 6.26 m
BENDING FIELD at inj. 0.045 T; at max 1.8 T
No. QUADS 216 LENGTH (ea) 3.05 m
GRAD. at inj. 0.05 T/m; at max 20 T/m
No. SHORT STRAIGHT SECT. 216 LENGTH 2.3 m
No. LONG STRAIGHT SECT. 6 LENGTH 128 m
RISE TIME 3 s; FLAT-TOP TIME 2 s
POWER INPUT PEAK 130 MW; MEAN 40 MW

Acceleration System

No. CAVITIES 4 LENGTH (ea) 20 m
HARMONIC NUMBER 4620
RF RANGE 199.4 to 200.2 MHz
ENERGY GAIN 3000 keV/turn
RADIATION LOSS - keV/turn
RF POWER INPUT PEAK 1500 kW; MEAN 500 kW

Vacuum System

MATERIAL OF VAC. CHAMBER Stainless Steel
APERTURE OF VAC. CHAMBER 150 x 50 mm
AVERAGE PRESSURE 10^{-8} torr
PUMPS (No., type, speed) 500 sputter-ion pumps 35 ℓ/sec

Extraction System

TYPE i) Fast
ii) Fast resonant
iii) Slow 1/3 Int. resonance
LENGTH OF SPILL i) 5 to 23 μs
ii) 1000 to 5000 μs
iii) 0.5 to 2 μs

Published Articles Describing Machine

CERN/1050, 14 January, 1972

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	400 GeV	450 GeV
RESOLUTION ΔE/E (%)	± 0.1	± 0.05
REPET. RATE (pulse/s)	0.1	0.1
PULSE WIDTH AT PEAK E	2	2
DUTY FACTOR, macroscop. (%)	20	20
INTERNAL BEAM (part/pulse)	2×10^{13}	2.5×10^{13}
(part/s)	2×10^{12}	2.5×10^{12}
EMITTANCE* AT PEAK E		50 π mm-mrad

OTHER DATA

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other Inform.
ν	∿ 30 GeV/c	1	wide band
ν	≤ 275 GeV/c	1	narrow band
hadrons	≤ 200 GeV/c	2	H3, H6
hadrons	≤ 350 GeV/c	4	H2, H4, H8, H10
had. sep	≤ 40 ÷ ≤ 150	2	S1 ÷ S3
p	250 ÷ 450	3	P1 ÷ P4, P8
μ	≤ 280 GeV/c	1	M2
e	≤ 80 ÷ ≤ 150	3	E1 ÷ E4, E12

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS ∿ 34000 m^2
No. INTERNAL TARGETS 0 No. EXT. TARGETS 14
No. SEPARATED BEAMS 2
No. BEAMS SERVED AT SAME TIME 12
TOTAL POWER USED (AVERAGE) FOR RESEARCH 40 MW
No. USER GROUPS: in house mixed with outside 40
TOTAL RESEARCH STAFF, in house 110 outside 1000
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME 4500 h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

The SPS is being modified for $p\bar{p}$ colliding beam operation.

*Emittance = Area $x\beta\gamma$ at 90% of current (for p-machines)

NAME OF SYNCHROTRON CERN Proton Synchrotron (CPS). See Linac I, Linac II, PSB, AA and LEAR.
INSTITUTION European Organization for Nuclear Research
LOCATION Meyrin, CH-1211 Geneva 23, SWITZERLAND
PERSON IN CHARGE G.L. Munday DATE: March 1980
DATA SUPPLIED BY E. Brouzet

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1955
FIRST BEAM OBTAINED, or GOAL (date) November 24, 1959
TOTAL COST OF FACILITY 200 MSwFr. (1954 - 1959)
FUNDED BY CERN member states
TOTAL ACCELERATOR STAFF (now) 117
ANN. OPERAT. BUDGET 6.8 MSw.Fr. (without salaries)
ANN. OPERATING TIME 6300 h
"BEAM ON" 96 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES protons
ENERGY 26 GeV
RING DIAM. 200 m; TUNNEL SECT.(WxH) 6 x 6 m

Injector

TYPE Linac or Booster
OUTPUT (max) 150/1280 mA at 50 / 800 MeV
EMITTANCE* 8 : h ; 8 : V / 55 : H ; 28 : V πmm-mrad
INJECTION PERIOD 20/2.5 μs, or 3 / 1 turns
INFLECTOR TYPE electrostatic dc and pulsed magnetic kicker or septum and pulsed kicker.

Magnet System

FOCUSING TYPE AG FIELD INDEX, n= 288
FOCUSING ORDER FOFDOD
BETATRON FREQ. ν_H 6.25 ν_V 6.25
No. MAGNETS 100 LENGTH (ea) 4.26 m
BENDING FIELD at inj. 0.0147 T; at max 1.4 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 80 LENGTH 1.6 m
No. LONG STRAIGHT SECT. 20 LENGTH 3 m
RISE TIME 0.7 s; FLAT-TOP TIME 0.5 - 0.7 s
POWER INPUT PEAK 41 MW; MEAN 2.8 MW

Acceleration System

No. CAVITIES 11 LENGTH (ea) - m
HARMONIC NUMBER 20
RF RANGE 2.8 to 9.55 MHz
ENERGY GAIN 220 keV/turn
RADIATION LOSS - keV/turn
RF POWER INPUT PEAK 100 kW; MEAN 50 (with beam) kW

Vacuum System

MATERIAL OF VAC.CHAMBER Austenitic steel
APERTURE OF VAC.CHAMBER (146 x 70) (178 x 67) mm
AVERAGE PRESSURE 2×10^{-8} torr
PUMPS (No., type, speed) 136 ion pumps (200 ℓ/s ÷ 400 ℓ/s)

Extraction System

TYPE i) Fast Extraction (FE)
ii) Slow Extraction (SE)
iii) Radial shaving on several turns

LENGTH OF SPILL	i)	0.1	to 2.1	μs
	ii)	300	to 500	ms
	iii)	6.3	to 21	μs

Published Articles Describing Machine

- E. Regenstreif, CERN 59-29, CERN 60-26, CERN 62-3.
- Y. Baconnier et al., VIIth Int. Conf. on High Energy Acc., Erevan, 1969, pp 565-575
- PS Staff, IXth Int. Conf. on High Energy Acc., Stanford, 1974.
- PS Staff, All Union Acc. Conf., Moscow, 1974.
- PS Staff, VIIth Nat. Acc. Conf., Chicago, 1977.
- PS Performance Committee, Xth Int. Conf. on High Energy Acc., Serpukhov, 1977.
- R. Gouiran, VIth Int. Conf. on Magnet Technology, Bratislava, 1977.

*Emittance = Area xβγ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	26	28
RESOLUTION ΔE/E (%)	± 0.05	
REPET.RATE (pulse/s)	0.5	1
PULSE WIDTH AT PEAK E	2.1 μs	
DUTY FACTOR, macroscop.(%)	10^{-4}	
INTERNAL BEAM (part/pulse)	$1 - 15 \times 10^{12}$	18×10^{12}
(part/s)	5×10^{12}	15×10^{12}
EMITTANCE* AT PEAK E	H = 60 ; V = 30	πmm-mrad
OTHER DATA		

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.
$\bar{p}$	≤ 1.5 GeV/c	1	Electrostatic septum (SE, East Hall)
$\bar{p}$	≤ 1.0 GeV/c	2	
π,p	3-14 GeV/c	1	
π^+	≤ 2.5 GeV/c	1	
p	≤ 18 GeV/c	1	(FE)
p,π	≤ 2.0 GeV/c	2	South Hall, int. target
"	≤ 4.5 GeV/c	1	
"	≤ 13 GeV/c	1	operation for tests

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 2 : (4 + 2.8) 10^3 m^2
No. INTERNAL TARGETS 1 No.EXT.TARGETS 5 - 6
No. SEPARATED BEAMS 4
No. BEAMS SERVED AT SAME TIME all
TOTAL POWER USED (AVERAGE) FOR RESEARCH 6 - 8 MW
No. USER GROUPS: in house - outside -
TOTAL RESEARCH STAFF, in house - outside -
ANN.RESEARCH BUDGET, in house - (without sal.)
ANNUAL RESEARCH TIME 5600 h

Other Relevant Parameters or Notable Features

In normal operation, several kinds of beams are accelerated from pulse to pulse:

- 1.5 to 1.7 10^{13} ppp for SPS
- 3×10^{12} ppp for ISR
- 6×10^{12} ppp for slow extraction
- other beams for machine studies.

The longitudinal emittance is adjustable between 8 and 80 mrad.

Recent Improvements or Modifications to Machine

- Several turns extraction for SPS (10 - 5 or 3) with prebunching at 200 MHz to allow bunch-into-bucket injection in SPS.
- Vertical and longitudinal recombination of the 20 Booster bunches, resulting in more than 10^{13} ppp in 5 bunches for antiproton production.
- RF modifications to accelerate the antiprotons from 3.5 GeV/c up to 26 GeV/c on harmonic 6, and to decelerate them from 3.5 GeV/c down to 0.6 GeV/c on harmonic 10.
- Deceleration from 800 MeV down to 46 MeV for studies in ICE.
- Deuterons and alpha particles acceleration for ISR.
- Ultraslow extraction (stochastic).
- Adjustment of the working point and chromaticities all along the acceleration, by means of a 3 current poleface winding system.

NAME OF SYNCHROTRON Proton Synchrotron Booster (PSB, four rings stacked vertically)
INJECTOR FOR CPS
LOCATION CERN - Geneva- Switzerland
PERSON IN CHARGE K.H. Reich DATE: 26.3.1980
DATA SUPPLIED BY K.H. Reich, K. Schindl

HISTORY AND STATUS

CONSTRUCTION STARTED (date) January 1968
FIRST BEAM OBTAINED, or GOAL (date) May 1972
TOTAL COST OF FACILITY 60 MFr (Swiss)
FUNDED BY CERN Member States
TOTAL ACCELERATOR STAFF (now) ~ 50
ANN.OPERAT.BUDGET 1.7 MFr (without salaries)
ANN.OPERATING TIME 6300 h
"BEAM ON" 98.4 [1] % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Protons
ENERGY 0.8 GeV
RING DIAM. 50 m; TUNNEL SECT.(WxH) 4.05 x 5.15 m

Injector

TYPE New CPS Linac
OUTPUT (max) 140 mA at 50 MeV
EMITTANCE* H : 7, V : 7 πmm-mrad
INJECTION PERIOD up to 100 µs, or 4 x 15 turns
INFLECTOR TYPE Magnetic

Magnet System

FOCUSING TYPE A.G.Sep.Func. FIELD INDEX, n=
FOCUSING ORDER L1/2-B-L2-F-L3-D-L3-F-L2-B-L1/2
BETATRON FREQ. ν_H 4.30 → 4.17 ν_V 5.45 → 5.23
No. MAGNETS 32 LENGTH (ea) 1.62 m
BENDING FIELD at inj. 0.1254 T; at max 0.5920 T
No. QUADS 16/32 (D/F) LENGTH (ea) .88/.50 m
GRAD. at inj. 0.81 T/m; at max 3.83 T/m
No. SHORT STRAIGHT SECT. 64 LENGTH .37/.65 m
No. LONG STRAIGHT SECT. 16 LENGTH 2.65 m
RISE TIME 0.6 s; FLAT-TOP TIME 0.06 s
POWER INPUT PEAK 5.6 MW; MEAN 1.64 MW

Acceleration System

No. CAVITIES 1 per ring LENGTH (ea) 2.22 m
HARMONIC NUMBER 5
RF RANGE 2.997 to 8.033 MHz
ENERGY GAIN 1 keV/turn
RADIATION LOSS - keV/turn
RF POWER INPUT PEAK 4 x 7.5 kW; MEAN 4 x 4 kW

Vacuum System

MATERIAL OF VAC.CHAMBER Inconel 750, 316 L
APERTURE OF VAC.CHAMBER 132 x 61 (bending) mm
AVERAGE PRESSURE 10^{-8} torr
PUMPS (no., type, speed) 58 sputter ion- 400 ℓ/sec, 22 mech. 250 m^3/h.,3 TI-subl. 4000 ℓ/sec

Extraction System

TYPE Fast. Vertical recombination of beams from the four rings
LENGTH OF SPILL 2.5 µs

Published Articles Describing Machine

The CERN PS Booster, a flexible and reliable injector, the PSB staff (reported by K.H. Reich), V All-Union Acc. Conf. Dubna 1976, Vol.2, p. 221, and references quoted.

Beam dynamics experiments in the PS Booster, J. Gareyte, L. Magnani, F. Pedersen, F. Sacherer, K. Schindl, IEEE, NS-22, No. 3 (1975), p. 1855-1858.

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	0.8	
RESOLUTION ΔE/E (%)	± 0.19	
REPET.RATE (pulse/s)	0.83	
PULSE WIDTH AT PEAK E	4x0.622 µs	
DUTY FACTOR, macroscopic (%)	2×10^{-4}	
INTERNAL BEAM (part/pulse)	1×10^{13}	2.13×10^{13}
(part/s)	0.83×10^{13}	1.78×10^{13}
BEAM EMITTANCE* H : 55, V : 28 [2]		(πmm-mrad)
BEAM LINES TO CPS, measurement line [3]		

OTHER DATA Intensity modulated from pulse to pulse between 1 x 10^{11} and 2 x 10^{13} ppp (user's request)

Other Relevant Parameters or Notable Features

Bending magnets and quadrupoles combined to 4-gap units powered directly from electricity mains. Linac beam switched to four rings by fast vertical deflector. At 800 MeV the four beams are ejected in sequence 3-4-2-1 and combined by vertical septum and kicker magnets. Alternatively, the twenty bunches may be recombined into ten by simultaneous ejection of rings 3 + 2 and 4 + 1, and vertical addition by a double septum magnet, giving higher line density (5 x 10^{10} p/m) for $\bar{p}$-production.

Recent Improvements or Modifications to Machine

1) Raising of space-charge and instability limits:
   i) Tunes varying with time and compensation of structural 3rd order stopband to accommodate Laslett Q-shifts of 0.5.
   ii) Active damping systems for longitudinal instabilities.
   iii) Broad-band (30 kHz - 20 MHz) transverse active damping system (being installed).
2) Reduction of repetition time to 0.65 sec (for SPS multibatch filling, being commissioned, new reactive power compensator and a.c. filter in operation since 1979).
3) Conversion of controls (being commissioned).

1) 99.4% excluding linac downtime (year 1979)
2) 95% emittances after vertical recombination
3) Occasionally used for experimental physics.

*Emittance = Area xβγ at 90% current

NAME OF LINAC New 50 MeV Injector Linac
INJECTOR FOR CERN Accelerator Complex (800 MeV Booster, 28 GeV PS, 300 GeV SPS)
LOCATION CERN, Geneva, Switzerland
PERSON IN CHARGE G. Plass DATE: March 1980
DATA SUPPLIED BY D. Warner

HISTORY AND STATUS

CONSTRUCTION STARTED (date) Nov. 1973
FIRST BEAM OBTAINED, or GOAL (date) Sept. 78
TOTAL COST OF FACILITY 23 MFr.
FUNDED BY CERN Member States
TOTAL ACCELERATOR STAFF (now) 26 my/y incl. Old Linac
ANN. OPERAT. BUDGET 1.6 Mfr incl 0.1 (without salaries)
ANN. OPERATING TIME 7000 h
"BEAM ON" 99 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions 1)
TOTAL LENGTH 33.6 m; No. TANKS 3
TANK DIAM. see 1) m; No. DRIFT TUBES 125 + 6(½)
DRIFT TUBE LENGTHS 48mm to 316 mm
DRIFT TUBE DIAMETERS 180mm (Tank I), 160mm (rest)
GAP/CELL LENGTH 0.22-0.31; 0.20-0.29; 0.26-0.32
APERTURE DIAM. 20 mm to 25mm (TI); 30mm (rest)

Ion Source
TYPE Duoplasmatron (with expansion cup)
OUTPUT 250 mA at keV
EMITTANCE* π mm-mrad

Injector
TYPE High gradient column with Cockroft-Walton
OUTPUT 250 mA at 750 keV
EMITTANCE* 2 π mm-mrad

Bunchers
TYPE Three buncher system
MODULATION 37 keV, DRIFT ℓ 950 mm at 202.56 MHz
16 keV, DRIFT ℓ 800 mm at 405.12 MHz
35 keV, DRIFT ℓ 160 mm at 202.56 MHz

Acceleration System
RF FREQ. 202.56 MHz
FIELD MODE TM010 (see 2) Q 60000
EQUIL. PHASE see 2) °, ACCEL. RATE 1.48 MeV/m
REPETITION RATE 1 pps (normal); 2pps (Max)
DUTY FACTOR 0.03 % (RF); 0.01 % (Beam)
PULSE LENGTH 300 μs (RF); 110 μs (Beam)
EFFECTIVE SHUNT RESIST. 36 MΩ/m
FILLING TIME - μs
RF POWER INPUT PEAK 10 MW; MEAN 0.002 MW

Focusing System
No. QUADS 131 TYPE Pulsed ORDER FD
GRADIENTS 100 to 20 T/m
OTHER Pulse flat top ∿ 220 μs

Vacuum System
MATERIAL CHAMBER copper (accelerating tanks)
AVERAGE PRESSURE 2×10^{-7} torr
PUMPS (No., Type, Speed) 10 Ionisation pumps each 1000 l s^{-1}

ACCELERATOR PERFORMANCE 3)

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	50	
ENERGY SPREAD ΔE/E (%)	± 0.25	
CURRENT (mA)	125	150
EMITTANCE*	5	(π mm-mrad)

Other Relevant Parameters or Notable Features

1) 3 Accelerating Tanks 0.75-10.4-30.5-50.0 MeV of Dia. 0.94m, 0.90m, 0.86 resp.
2) Post Coupled Alvarez Accelerating System Equilibrium Phase -35° to -25° (Tank I), -25° (rest) RF parameters quoted are total or mean for 150 mA accelerated current at 1 pps
3) Performance is quoted after debunching (85 m).

Recent Improvements or Modifications to Machine

Published Articles Describing Machine

"The New CERN 50 MeV Linac", Proc. 1979, Linear Accel. Conf. (Montauk, Sept 1979).
"Performance of the New CERN 50 MeV Linac", Proc. 1979 Particle Accelerator Conf., IEEE Trans. NS-26 No.3, p. 3674.
Ancillary Systems described in Proc. 1979 Linac Conf. (Ibid.) and Proc. 1976 Linac Conf. (AECL-5677).

*Emittance = Area xβγ at 90% current

NAME OF LINAC CERN PS 50 MeV Linac ("Old Linac")
INJECTOR FOR CERN PS
LOCATION 1211 - Geneva 23 - Switzerland
PERSON IN CHARGE G. Plass DATE: 17 March 1980
DATA SUPPLIED BY H. Haseroth

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1956
FIRST BEAM OBTAINED, or GOAL (date) 1959
TOTAL COST OF FACILITY -
FUNDED BY CERN
TOTAL ACCELERATOR STAFF (now) see New Linac
ANN.OPERAT. BUDGET see New Linac (without salaries)
ANN. OPERATING TIME ∿ 300 h h
"BEAM ON" ∿ 98 % OF SCHEDULED TIME

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	49.7	49.7
ENERGY SPREAD ΔE/E (%)	.3	.2
CURRENT (mA)	100	120
EMITTANCE*	7	(πmm-mrad)

Other Relevant Parameters or Notable Features

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 29 m; No. TANKS 3
TANK DIAM. ∿ 1 m; No. DRIFT TUBES 113
DRIFT TUBE LENGTHS 39.6 - 320.8 mm
DRIFT TUBE DIAMETERS 61.6 - 177.8 mm
GAP/CELL LENGTH 0.25 - 0.305
APERTURE DIAM. 16 mm to 33 mm

Ion Source

TYPE Duoplasmatron
OUTPUT up to 400 mA at 0 keV
EMITTANCE* πmm-mrad

Injector

TYPE Cockroft-Walton with double gap high gradient tube
OUTPUT up to 400 mA at 516 keV
EMITTANCE* 2 πmm-mrad

Bunchers

TYPE single gap reentrant cavity
MODULATION 17 keV, DRIFT ℓ 700 mm at 202.57 MHz
- keV, DRIFT ℓ - mm at - MHz

Acceleration System

RF FREQ. 202.57 MHz
FIELD MODE TM010 Q ∿ 50.000 (unloaded)
EQUIL.PHASE -30°, ACCEL.RATE 1.7 MeV/m
REPETITION RATE up to 1 pps
DUTY FACTOR up to 0.03% (RF); up to 0.011 % (Beam)
PULSE LENGTH ∿ 300 μs (RF); ∿ 110 μs (Beam)
EFFECTIVE SHUNT RESIST. ∿ 30 MΩ/m
FILLING TIME ∿ 170 μs
RF POWER INPUT PEAK 8 MW; MEAN 0.002 MW

Focusing System

70 DC
No. QUADS 112 TYPE 42 pulsed, ORDER FD
GRADIENTS 75 to 4 T/m
OTHER

Vacuum System

MATERIAL CHAMBER steel
AVERAGE PRESSURE 5.10^{-6} torr
PUMPS (No., Type, Speed) 6 turbomolecular pumps, each 1500 l/s

Recent Improvements or Modifications to Machine

The machine is no longer used for normal proton operation for the CERN PS but at present mainly for the development of α beams. The maximum current obtained so far has been 6.5mA at 50 MeV.

Published Articles Describing Machine

E. Regenstreif "The CERN Proton Synchrotron" CERN 60-26 ;

Improvements and Performances reported at Linac Conferences e.g.

Mura (1964) p. 353
Los Alamos (1966) p. 48
Brookhaven (1968) p. 694
Chalk River (1976) p. 381

*Emittance = Area xβγ at 90% current

NAME OF STORAGE RING: ANTIPROTON ACCUMULATOR
INJECTOR FOR: SPS, ISR, LEAR
LOCATION: CERN, Meyrin
PERSON IN CHARGE: R. Billinge, S. van der Meer — DATE: 25. 3.80
DATA SUPPLIED BY: R. Billinge, S. van der Meer

HISTORY AND STATUS

CONSTRUCTION STARTED (date): July 1978
FIRST BEAM OBTAINED, or GOAL (date): July 1980
TOTAL COST OF FACILITY: 54 MFr.
FUNDED BY: CERN
TOTAL ACCELERATOR STAFF (now):
ANN.OPERAT.BUDGET: (without salaries)
ANN.OPERATING TIME: h
"BEAM ON": % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

STORED PARTICLES: Antiprotons
ENERGY kin. 2.7 GeV
RING DIAM. 50 m; HALL SIZE (WxH) 65 x 55 m

Injector

TYPE: Target
OUTPUT (max) 2×10^7 $\bar{p}$/s at 3.5 Gev/c
EMITTANCE* 373×373 $(\pi$mm-mrad$)^2$
INJECTION PERIOD 0.5 μs, or 1 turn
INFLECTOR TYPE: Septum Magnets and Fast Kickers

Magnet System

FOCUSING TYPE: FODO — FIELD INDEX, n=
FOCUSING ORDER:
BETATRON FREQ. ν_H 2.28 ν_V 2.27
No. MAGNETS 8 , 4 — LENGTH (ea) 3 , 5 m
BENDING FIELD 1.8 T; 1.6 T
No. QUADS 24 — LENGTH (ea) 0.54 m
GRAD. 'F' 1.85 T; 'D' 1.35 T
No. SHORT STRAIGHT SECT. 8 — LENGTH 2.6 m
No. LONG STRAIGHT SECT. 12 — LENGTH 6 m
RISE TIME s; FLAT-TOP TIME s
POWER INPUT 3.2 MW;

Acceleration System

No. CAVITIES 1 — LENGTH (ea) 2.5 m
HARMONIC NUMBER 1 to 2
RF RANGE 1.8 to 3.7 MHz
PEAK VOLTAGE 14 keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK kW; MEAN kW

Vacuum System

MATERIAL OF VAC.CHAMBER: Stainless steel
APERTURE OF VAC.CHAMBER: up to 1100 mm
AVERAGE PRESSURE: $<10^{-10}$ torr
PUMPS (no., type, speed):

Extraction System

TYPE: Fast Kicker + Septum Magnets

LENGTH OF SPILL: <0.28 μs

Published Articles Describing Machine

The CERN Proton-Antiproton Colliding Beam FAcilities
R. Billinge, M.C. Crowley-Milling
IEEE Trans. Nuclear Sci. NS26, 2974, 1979

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	2.7	
RESOLUTION ΔE/E (%)	$\pm1.5\times10^{-3}$	
REPET.RATE (pulse/s)		
PULSE WIDTH AT PEAK E		
DUTY FACTOR, macroscopic (%)		
INTERNAL BEAM (part/pulse)		
(part/day)	6×10^{11}	
BEAM EMITTANCE*	5.2×3.7	(πmm-mrad)
BEAM LINES TO		

OTHER DATA:

Other Relevant Parameters or Notable Features

Accumulation of ∿35000 $\bar{p}$ pulses,
Fast stochastic precooling of each pulse (Δp/p),
FR stacking,
Stochastic stack cooling (Δp/p, hor., vert.),
RF unstacking and extraction in up to 12 bunches.

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON Low Energy Antiproton Ring; LEAR
INSTITUTION CERN-PS
LOCATION PS South Hall
PERSON IN CHARGE P. Lefèvre DATE: 28.3.80
DATA SUPPLIED BY P. Lefèvre - D. Möhl

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1981 (planned)
FIRST BEAM OBTAINED, or GOAL (date) end 1982
TOTAL COST OF FACILITY ∿ 10 MSfr.
FUNDED BY CERN
TOTAL ACCELERATOR STAFF (now) 3 full + 5 part-time
ANN.OPERAT.BUDGET (without salaries)
ANN.OPERATING TIME h
"BEAM ON" % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Antiprotons
ENERGY 5-1720 MeV kinetic GeV
RING DIAM. 25 m; TUNNEL SECT.(WxH) Hall x m

Injector via PS

TYPE Antiproton Accumulator AA
OUTPUT (max) 10^9 $\bar{p}$/1000 s mA at 175 MeV
EMITTANCE* vert. 9 , horiz. 20 πmm-mrad
INJECTION PERIOD 0.48 μs, single turn
INFLECTOR TYPE magnetic septum + full aperture kicker

Magnet System

FOCUSING TYPE sep. funct FIELD INDEX, n=
FOCUSING ORDER OFDOBODFO
BETATRON FREQ. ν_H 2.3 ν_V 2.7
No. MAGNETS 4 LENGTH (ea) 6.6 m
BENDING FIELD at min. 0.08 T; at max 1.6 T
No. QUADS 8 LENGTH (ea) 0.5 m
GRAD. at min. 0.5 T/m; at max 9.4 T/m
No. SHORT STRAIGHT SECT. 8 LENGTH 1.16 m
No. LONG STRAIGHT SECT. 4 LENGTH 8.0 m
RISE TIME ∿ 10s s; FLAT-TOP TIME > 1000 s
POWER INPUT PEAK 0.6 MW; MEAN MW

Acceleration System

No. CAVITIES 1 or 2 LENGTH (ea) 2.5 or 1.5m
HARMONIC NUMBER 1
RF RANGE 0.38 to 3.5 MHz
ENERGY GAIN < 15 keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK kW; MEAN kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel bakable
APERTURE OF VAC.CHAMBER variable 155x90//170x60 mm
AVERAGE PRESSURE 10^{-11} - 10^{-12} torr
PUMPS (No., type, speed) rotary + turbomolecular + sputter ion + Ti sublimation pumps

Extraction System

TYPE i) Superslow (stochastic extraction)
ii)
iii)
LENGTH OF SPILL i) 10^8 to 10^9 μs
ii) to μs
iii) to μs

Published Articles Describing Machine

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)		
RESOLUTION ΔE/E (%)		
REPET.RATE (pulse/s)		
PULSE WIDTH AT PEAK E		
DUTY FACTOR, macroscop.(%)		
INTERNAL BEAM (part/pulse)		
(part/s)		

EMITTANCE* AT PEAK E πmm-mrad
OTHER DATA

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.
$\bar{p}p$	bound states		
$\bar{n}$			

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS No.EXT.TARGETS
No. SEPARATED BEAMS 8
No. BEAMS SERVED AT SAME TIME 4
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN.RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

Duty cycle stretcher with acceleration/deceleration facility, ejection 10^9 $\bar{p}$ over ∿ 10 min.

Options : Internal gas jet target together with cooling, co-rotating beams of H^- and $\bar{p}$ for protonium formation in flight, p-p colliding beams

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Beijing Proton Synchrotron (BPS) Main Ring
INSTITUTION
LOCATION Beijing, China
PERSON IN CHARGE Hsieh Chialin, Xu Jianming, Fang Shouxian DATE: 6.5.1980
DATA SUPPLIED BY Fang Shouxian

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1980
FIRST BEAM OBTAINED, or GOAL (date)
TOTAL COST OF FACILITY
FUNDED BY Government of PRC
TOTAL ACCELERATOR STAFF (now) 250
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME h
"BEAM ON" % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES p
ENERGY 50 GeV
RING DIAM. 446 m; TUNNEL SECT. (WxH) x m

Injector
TYPE BPS
OUTPUT (max) mA at 1800-2000 MeV
EMITTANCE* 84(H) 36(V) π mm-mrad
INJECTION PERIOD 800×10^3 μs, or 10 turns
INFLECTOR TYPE Magnetic Kicker + Septum

Magnet System
FOCUSING TYPE SF FIELD INDEX, n=
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 13.75 ν_V 13.75
No. MAGNETS 168 LENGTH (ea) 3.74 m
BENDING FIELD at inj. 0.09 T; at max 1.7 T
No. QUADS 120 LENGTH (ea) 1.5 m
GRAD. at inj. 0.73 T/m; at max 13.35 T/m
No. SHORT STRAIGHT SECT. 120 LENGTH 2 m
No. LONG STRAIGHT SECT. 36 LENGTH 10 m
RISE TIME 1.5 s; FLAT-TOP TIME 1.0 s
POWER INPUT PEAK 33 MW; MEAN MW

Acceleration System
No. CAVITIES 14 - 16 LENGTH (ea) 1.9 m
HARMONIC NUMBER 30
RF RANGE 6.085 to 6.420 MHz
ENERGY GAIN 155 keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK kW; MEAN kW

Vacuum System
MATERIAL OF VAC. CHAMBER 316L + N
APERTURE OF VAC. CHAMBER 56 x 160 mm
AVERAGE PRESSURE 3×10^{-7} torr
PUMPS (No., type, speed) 120 Ion Pumps, 30 ℓ/s

Extraction System
TYPE i) Electrostatic Septum + Magnetic Septum
ii)
iii)
LENGTH OF SPILL i) 1×10^6 μs
ii) to μs
iii) to μs

Published Articles Describing Machine

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	50	
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)	0.2	
PULSE WIDTH AT PEAK E	1.0 s	
DUTY FACTOR, macroscop. (%)		
INTERNAL BEAM (part/pulse)	1×10^{13}	
(part/s)		

EMITTANCE* AT PEAK E π mm-mrad
OTHER DATA

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other Inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Beijing Proton Synchrotron (BPS) Booster
INJECTOR FOR BPS Main Ring
LOCATION Beijing, China
PERSON IN CHARGE Hsieh Chialin, Xu Jianming, Fang Shouxian DATE: May 1980
DATA SUPPLIED BY Fang Shouxian

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1980
FIRST BEAM OBTAINED, or GOAL (date)
TOTAL COST OF FACILITY
FUNDED BY Government of PRC
TOTAL ACCELERATOR STAFF (now)
ANN.OPERAT.BUDGET (without salaries)
ANN.OPERATING TIME h
"BEAM ON" % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES p
ENERGY 1.8 - 2.0 GeV
RING DIAM. 44.7 m; TUNNEL SECT.(WxH) x m

Injector

TYPE Linac (H^-)
OUTPUT (max) 30-50 mA at 93 MeV
EMITTANCE* 6-8 π mm-mrad
INJECTION PERIOD 30 μs, or 27 turns
INFLECTOR TYPE magnetic septum

Magnet System

FOCUSING TYPE CF FIELD INDEX, n= 24
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 4.73 ν_V 4.80
No. MAGNETS 32 LENGTH (ea) 1.938 m
BENDING FIELD at inj. 0.1447 T; at max 0.9412 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 16 LENGTH 0.8 m
No. LONG STRAIGHT SECT. 16 LENGTH 4.1 m
RISE TIME s; FLAT-TOP TIME s
POWER INPUT PEAK 1.7 MW; MEAN MW

Acceleration System

No. CAVITIES 5 LENGTH (ea) 1.9 m
HARMONIC NUMBER 3
RF RANGE 2.658 to 6.075 MHz
ENERGY GAIN 41.7 keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK 250 kW; MEAN kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC.CHAMBER 56 x 160 mm
AVERAGE PRESSURE 5×10^{-7} torr
PUMPS (no., type, speed) 16 Ion Pumps, 600 ℓ/s,
8 TM Pumps, 450 ℓ/s

Extraction System

TYPE Magnetic Kicker + Septum

LENGTH OF SPILL μs

Published Articles Describing Machine

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1.8 - 2.0	
RESOLUTION ΔE/E (%)		
REPET.RATE (pulse/s)	12.5	
PULSE WIDTH AT PEAK E		
DUTY FACTOR, macroscopic (%)		
INTERNAL BEAM (part/pulse)	2×10^{12}	
(part/s)		
BEAM EMITTANCE* 84(H) 36(V)		(π mm-mrad)

BEAM LINES TO BPS Main Ring

OTHER DATA

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% current

NAME OF LINAC BPS Linac
INJECTOR FOR BPS Booster
LOCATION Beijing, China
PERSON IN CHARGE Hsieh Chialin, Xu Jianming, Fang Shouxian DATE: 6.5.1980
DATA SUPPLIED BY Fang Shouxian

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1980
FIRST BEAM OBTAINED, or GOAL (date)
TOTAL COST OF FACILITY
FUNDED BY Government of PRC
TOTAL ACCELERATOR STAFF (now) 60
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME h
"BEAM ON" % OF SCHEDULED TIME

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	93	
ENERGY SPREAD ΔE/E (%)	2×10^{-3}	
CURRENT (mA)	30 ~ 50(H^-)	
EMITTANCE*	6 ~ 8	(π mm-mrad)

Other Relevant Parameters or Notable Features

ACCELERATOR PARAMETERS

Physical Dimensions
TOTAL LENGTH 61 m; No. TANKS 4
TANK DIAM. 0.94-0.88m; No. DRIFT TUBES 180
DRIFT TUBE LENGTHS 47 - 364 mm
DRIFT TUBE DIAMETERS 180 - 160 mm
GAP/CELL LENGTH 0.21 - 0.41
APERTURE DIAM. 20 mm to 30 mm

Ion Source
TYPE Magnetron (H^-)
OUTPUT 60 mA at 18 keV
EMITTANCE* π mm-mrad

Injector
TYPE Cockcroft-Walton
OUTPUT 60 mA at 750 keV
EMITTANCE* π mm-mrad

Bunchers
TYPE One gap, two cavities
MODULATION 32 keV, DRIFT ℓ 150 mm at 201.25 MHz
14 keV, DRIFT ℓ 902 mm at 402.5 MHz

Recent Improvements or Modifications to Machine

Acceleration System
RF FREQ. 201.25 MHz
FIELD MODE TM 010 Q
EQUIL. PHASE -35° ~-25°, ACCEL. RATE 1.6 MeV/m
REPETITION RATE 12.5
DUTY FACTOR 0.44 % (RF); 0.06 - 0.19 % (Beam)
PULSE LENGTH 250-300 μs (RF); 50 - 100 μs (Beam)
EFFECTIVE SHUNT RESIST. 29.5 - 28.4 MΩ/m
FILLING TIME μs
RF POWER INPUT PEAK 15.4 MW; MEAN MW

Focusing System
No. QUADS 184 TYPE pulsed ORDER +-+-
GRADIENTS 92 to 20 T/m
OTHER

Vacuum System
MATERIAL CHAMBER copper clad steel
AVERAGE PRESSURE 5×10^{-7} torr
PUMPS (No., Type, Speed)
25 Ion Pumps, 1000 ℓ/s

Published Articles Describing Machine

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON SATURNE I 1977 SATURNE II 1978
INSTITUTION LABORATOIRE NATIONAL SATURNE (C.E.A. IN^2 P^3)
LOCATION C.E.N. SACLAY (ESSONNE) FRANCE
PERSON IN CHARGE LAB. THIRION . MACHINE : VIENET . Exp AREA : LEFRERE DATE: AVRIL 1980
DATA SUPPLIED BY R. VIENET

HISTORY AND STATUS

CONSTRUCTION STARTED (date) SAT I.54 SAT II 74
FIRST BEAM OBTAINED, or GOAL (date) I.58 78
TOTAL COST OF FACILITY 400 M F
FUNDED BY FRENCH GOUVERNEMENT
TOTAL ACCELERATOR STAFF (now) 120
ANN.OPERAT.BUDGET 20 M F (without salaries)
ANN.OPERATING TIME 2000 to 4000/h according budget
"BEAM ON" 90 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS of .SAT II

General

ACCELERATED PARTICLES H^+ D^+ He^{++}
ENERGY 0,400 ⟶ 2,55 GeV
RING DIAM. 33.6 m; TUNNEL SECT.(WxH) 4 x 3 m

Injector

TYPE LINAC
OUTPUT (max) 20 mA at 20 MeV
EMITTANCE* 0,5 πmm-mrad
INJECTION PERIOD 300 µs, or turns
INFLECTOR TYPE ELECTROSTATIC

Magnet System

FOCUSING TYPE STRONG FIELD INDEX, n= 0
FOCUSING ORDER F O D O
BETATRON FREQ. ν_H 3,7 ν_V 3,7
No. MAGNETS 16 dypoles LENGTH (ea) 2,5 m
BENDING FIELD at inj. 0,1 T; at max 1,8 T
No. QUADS 24 LENGTH (ea) .45 m
GRAD. at inj. 0,42 T/m; at max 8 T/m
No. SHORT STRAIGHT SECT. 12 X 2 LENGTH 0,7 m
No. LONG STRAIGHT SECT. 4 LENGTH 8 m
RISE TIME 0,6 s; FLAT-TOP TIME 500 s
POWER INPUT PEAK 12 MW; MEAN 2 MW

Acceleration System

No. CAVITIES 2 LENGTH (ea) m
HARMONIC NUMBER 3
RF RANGE 0,8 to 8 MHz
ENERGY GAIN 3 keV/turn
RADIATION LOSS N.A keV/turn
RF POWER INPUT PEAK 15 kW; MEAN 5 kW

Vacuum System

MATERIAL OF VAC.CHAMBER STAINLESS STEEL
APERTURE OF VAC.CHAMBER 250 X 140 mm
AVERAGE PRESSURE 2.10^{-7} torr
PUMPS (No., type, speed) 3 SPUTTER ION PUMP 200 l/s and 2 Cryogenic pump (3 000 l/s)

Extraction System

TYPE i) Resonant slow extraction
ii)
iii)
LENGTH OF SPILL i) 100 to 500 ms
ii) to µs
iii) to µs

Published Articles Describing Machine

- BIRTH and NEAR FUTURE of SATURNE II
  DUBNA 78
- STATUS REPORT IN REJUVENATING SATURNE AND FUTURE ASPECT
  IEEE Vol NS 26 N° 3 Juin 79 p. 3138

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	2,9	2,55
RESOLUTION ΔE/E (%)	internal	.12
REPET.RATE (pulse/s)		1 ⟶ 2 sec
PULSE WIDTH AT PEAK E	400 ms	
DUTY FACTOR, macroscop.(%)	40 %	
INTERNAL BEAM (part/pulse)	$1,8.10^{12}$	$2,4.10^{12}$
(part/s)		

EMITTANCE* AT PEAK E External beam = 6 πmm-mrad
OTHER DATA ΔE/E external = 3.10^{-4}

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.
	Only external primary beams		

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 6 000 m^2
No. INTERNAL TARGETS 0 No.EXT.TARGETS 9
No. SEPARATED BEAMS 9
No. BEAMS SERVED AT SAME TIME 2 ⟶ 3
TOTAL POWER USED (AVERAGE) FOR RESEARCH 5 MW
No. USER GROUPS: in house 0 outside 14
TOTAL RESEARCH STAFF, in house 0 outside 200
ANN.RESEARCH BUDGET, in house 0 (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

- polarized H^+ and D^+
- heavy ions (CRYEBIS still in study) Ne^{+10}
- new injector (MIMAS) Future project

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF LINAC LINAC 20 MeV
INJECTOR FOR SATURNE II
LOCATION C.E.N. SACLAY
PERSON IN CHARGE P.A. CHAMOUARD DATE: April 1980
DATA SUPPLIED BY R. VIENET

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1968
FIRST BEAM OBTAINED, or GOAL (date)
TOTAL COST OF FACILITY 20 M F (68 - 69)
FUNDED BY COMMISSARIAT ENERGIE ATOMIQUE
TOTAL ACCELERATOR STAFF (now) 5 - 10 p
ANN. OPERAT. BUDGET 0,5 M F (without salaries)
ANN. OPERATING TIME 4 - 5000 h
"BEAM ON" 98 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 10,47 m; No. TANKS 1
TANK DIAM. 1 m; No. DRIFT TUBES 58
DRIFT TUBE LENGTHS 4,53 to 20,79 cm mm
DRIFT TUBE DIAMETERS 18 to 15 mm
GAP/CELL LENGTH 0,26 to 0,32
APERTURE DIAM. 0,79 mm to 1,25 mm

Ion Source

TYPE DUOPLASMATRON
OUTPUT 40 mA at 30 keV
EMITTANCE* 0,31 πmm-mrad

Injector

TYPE PRESSURIEZD COCKROFT - WALTON
OUTPUT 59 mA at 750 to 900 keV
EMITTANCE* 0,22 πmm-mrad

Bunchers

TYPE SIMPLE CAVITY
MODULATION 20 keV, DRIFT ℓ 840 mm at 200 MHz
keV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ. 200 MHz MHz
FIELD MODE TM 010 Q 80 000
EQUIL. PHASE 45→20 °, ACCEL. RATE 1,84 MeV/m
REPETITION RATE 1 p/seconde
DUTY FACTOR 10^{-3} % (RF); $3\text{-}10^{-4}$ % (Beam)
PULSE LENGTH 1 000 µs (RF); 300 µs (Beam)
EFFECTIVE SHUNT RESIST. 63 MΩ/m
FILLING TIME 300 µs
RF POWER INPUT PEAK 27 MW; MEAN 2 MW

Focusing System

No. QUADS 58 TYPE magn. ORDER + + - -
GRADIENTS 53 to 6,4 T/m
OTHER

Vacuum System

MATERIAL CHAMBER Copper on steel
AVERAGE PRESSURE $1,5 \cdot 10^{-7}$ torr
PUMPS (No., Type, Speed) sputter ion pumps
4 X 1 000 l/sec

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	20 MeV	
ENERGY SPREAD ΔE/E (%)	0,8	
CURRENT (mA)	20	
EMITTANCE* 0,5		(πmm-mrad)

Other Relevant Parameters or Notable Features

- Additional ramping energy phase variation 90° in 300 µs
  peak power 100 K W
  voltage 430 K V
- debuncher cavity
  drift length 8,50
  phase variation 160° in 300 µs
  peak power 55 K W

Recent Improvements or Modifications to Machine

- Focusing system put + - + -
- Field law adjusting
- Add a 2d buncher at 200 MHz for heavy ions injection line

Published Articles Describing Machine

LINAC EFFICIENCY and BEAM QUALITIES in
$P_1\ d_{i2}\ ^3He\ ^4_{12}He$ acceleration
J.P. AUCLAIR and all
1979 LINEAR ACCELERATOR CONFERENCE
1979 MONTAUK, NY, USA

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON KEK PS (12 GeV)
INSTITUTION KEK, National Laboratory for High Energy Physics
LOCATION Tsukuba, JAPAN
PERSON IN CHARGE T. Kamei
DATA SUPPLIED BY T. Kamei DATE: March 1980

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1971
FIRST BEAM OBTAINED, or GOAL (date) March 1976 (8 GeV)
TOTAL COST OF FACILITY 5×10^9 ¥
FUNDED BY Japanese Government
TOTAL ACCELERATOR STAFF (now) 51
ANN. OPERAT. BUDGET 1×10^9¥ (without salaries)
ANN. OPERATING TIME ∿ 4200 h
"BEAM ON" 95 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES 2×10^{12} ppp
ENERGY 12 GeV
RING DIAM. 108 m; TUNNEL SECT. (WxH) 4 x 6 m

Injector

TYPE 20 MeV Linac + 500 MeV Booster
OUTPUT (max) 6×10^{12} ppp at 500 MeV
EMITTANCE* 30 (H), 15 (V) π mm-mrad
INJECTION PERIOD 5×10^5 μs, or 9 pulses
INFLECTOR TYPE magnetic

Magnet System

FOCUSING TYPE AG Separated FIELD INDEX, n=
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 7.16 ν_V 6.2
No. MAGNETS 48 (bend) LENGTH (ea) 3.2 (bend) m
BENDING FIELD at inj. 0.15 T; at max 1.75 T
No. QUADS 56 LENGTH (ea) 0.6 m
GRAD. at inj. 1.5 T/m; at max 18.1 T/m
No. SHORT STRAIGHT SECT. 48 LENGTH 1.84 m
No. LONG STRAIGHT SECT. 8 LENGTH 5.46 m
RISE TIME 0.7 s; FLAT-TOP TIME 0.5 s
POWER INPUT PEAK 27 MW; MEAN 2.9 MW

Acceleration System

No. CAVITIES 3 LENGTH (ea) 1.8 m
HARMONIC NUMBER 9
RF RANGE 6.02 to 7.92 MHz
ENERGY GAIN 16.9 keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK 114 (3 cav) kW; MEAN 68 (3 cav) kW

Vacuum System

MATERIAL OF VAC. CHAMBER stainless steel (316 L)
APERTURE OF VAC. CHAMBER 145 × 50 mm
AVERAGE PRESSURE $<5 \times 10^{-7}$ torr
PUMPS (No., type, speed) 40, sputter ion pumps, 160 ℓ/s
8, sputter ion pumps, 1000 ℓ/s

Extraction System

TYPE i) Shaving (Fast)
ii) Half Resonance (Fast)
iii) Half Resonance (Slow)
LENGTH OF SPILL i) 10 to 100 μs
ii) to 1000 μs
iii) to 400,000 μs

Published Articles Describing Machine

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	12	12
RESOLUTION ΔE/E (%)		
REPET. RATE (pulse/s)	∿ 0.5	0.5
PULSE WIDTH AT PEAK E	0.4 sec	0.5 sec
DUTY FACTOR, macroscop. (%)	18	20
INTERNAL BEAM (part/pulse)	2.2×10^{12}	2.85×10^{12}
(part/s)	10^{12}	1.3
EMITTANCE* AT PEAK E	10 (H), 5 (V)	π mm-mrad
OTHER DATA		

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other Inform.
π^+	2-4.3 (GeV/k)	$2\times10^5\pi^+/10^{11}$P	Int. Target
π^-	0.5-2.3	$7\times10^3\pi^+/10^{11}$P	"
$\pi^\pm, K^\pm \to p/\bar{p}$	2-6	15 ∿ 400	for H BC
$\pi^\pm, K^\pm \to p/\bar{p}$	1-2	$10^6 K^+$ (at 1.5)	
$\pi^\pm, K^\pm \to p/\bar{p}$	0.4-1.0	$4\times10^4 K^+$ (at 0.6)	
π^-, μ^-	0.1-0.45	$10^6\pi^+$ (at 0.15)	

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 50 × 100 m^2
No. INTERNAL TARGETS 1 No. EXT. TARGETS 4
No. SEPARATED BEAMS 3
No. BEAMS SERVED AT SAME TIME 6
TOTAL POWER USED (AVERAGE) FOR RESEARCH 10 MW
No. USER GROUPS: in house 2 ∿ 3 outside 2 ∿ 4
TOTAL RESEARCH STAFF, in house ∿40 outside ∿60
ANN. RESEARCH BUDGET, in house ∿10^9 ¥ (without sal.)
ANNUAL RESEARCH TIME ∿3000 h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Booster Synchrotron for KEK PS
INJECTOR FOR 12 GeV Proton Synchrotron
LOCATION Tsukuba, Japan
PERSON IN CHARGE T. Kamei DATE: March 1980
DATA SUPPLIED BY T. Kamei

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1971
FIRST BEAM OBTAINED, or GOAL (date) December 1974
TOTAL COST OF FACILITY
FUNDED BY Japanese Government
TOTAL ACCELERATOR STAFF (now)
ANN.OPERAT.BUDGET (without salaries)
ANN.OPERATING TIME ~4200 h
"BEAM ON" 95 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES 6×10^{11} ppp
ENERGY 0.5 GeV
RING DIAM. 6 m; TUNNEL SECT.(WxH) x m

Injector

TYPE Linac
OUTPUT (max) 150 mA at 20 MeV
EMITTANCE* 7 π mm-mrad
INJECTION PERIOD 5 μs, or turns
INFLECTOR TYPE magnetic

Magnet System

FOCUSING TYPE AG. Combined FIELD INDEX, n= 12.1
FOCUSING ORDER FDDFO
BETATRON FREQ. ν_H 2.15 ν_V 2.33
No. MAGNETS 8 LENGTH (ea) 2.6 m
BENDING FIELD at inj. 0.197 T; at max 1.1 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 8 LENGTH 2.0 m
No. LONG STRAIGHT SECT. LENGTH m
RISE TIME 20 Hz s; FLAT-TOP TIME s
POWER INPUT PEAK MW; MEAN 0.5 MW

Acceleration System

No. CAVITIES 2 LENGTH (ea) 1.6 m
HARMONIC NUMBER 1
RF RANGE 1.63 to 6.02 MHz
ENERGY GAIN 7 keV (max.) keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK 66kW(2 cav)kW; MEAN16.8kW(2 cav)kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel (304 L)(corrugated)
APERTURE OF VAC.CHAMBER 140 x 60 mm
AVERAGE PRESSURE 1×10^{-6} torr
PUMPS (no., type, speed) 8, sputter ion pumps, 1000 ℓ/s

Extraction System

TYPE one turn extraction by kicker
LENGTH OF SPILL 0.08 μs

Published Articles Describing Machine

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	0.5	0.5
RESOLUTION ΔE/E (%)	0.3	0.3
REPET.RATE (pulse/s)	20	20
PULSE WIDTH AT PEAK E	80 nsec	80 nsec
DUTY FACTOR, macroscopic (%)	1.6×10^{-4}	1.6×10^{-4}
INTERNAL BEAM (part/pulse)	0.5×10^{12}	0.64×10^{12}
(part/s)	1×10^{13}	1.28×10^{13}

BEAM EMITTANCE* 30 (H), 15 (V) (π mm-mrad)
BEAM LINES TO 12 GeV PS
OTHER DATA

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

Nine booster pulses are injected into 12 GeV PS every 2.2 seconds. Other beam pulses will be extracted and guided to the Booster Synchrotron Facility (BSF) next June and will be used for a pulse neutron and pion sources, and also for medical researches near future.

*Emittance = Area $x\beta_Y$ at 90% current

NAME OF LINAC 20 MeV Injector for KEK PS
INJECTOR FOR 12 GeV Proton Synchrotron
LOCATION Tsukuba, Japan
PERSON IN CHARGE T. Kamei DATE: March 1980
DATA SUPPLIED BY T. Kamei

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1971
FIRST BEAM OBTAINED, or GOAL (date) August 1974
TOTAL COST OF FACILITY
FUNDED BY Japanese Government
TOTAL ACCELERATOR STAFF (now)
ANN.OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4200 h
"BEAM ON" 95 % OF SCHEDULED TIME

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	20	20
ENERGY SPREAD ΔE/E (%)	0.5	0.3 (debuncher)
CURRENT (mA)	150	200
EMITTANCE*	7	(πmm-mrad)

Other Relevant Parameters or Notable Features

ACCELERATOR PARAMETERS

Physical Dimensions
TOTAL LENGTH 15.5 m; No. TANKS 1
TANK DIAM. 0.94 m; No. DRIFT TUBES 90
DRIFT TUBE LENGTHS 48 ∿ 206 mm
DRIFT TUBE DIAMETERS 180 mm
GAP/CELL LENGTH 1/5 ∿ 1/3
APERTURE DIAM. 20 mm to 25 mm

Ion Source
TYPE Modified Duoplasmatron
OUTPUT 650 mA at 750 keV
EMITTANCE* πmm-mrad

Injector
TYPE Open Type Cockcroft-Walton
OUTPUT 250 mA at 750 keV
EMITTANCE* 4 πmm-mrad

Bunchers
TYPE Single
MODULATION 10 keV, DRIFT ℓ 900 mm at 201 MHz
keV, DRIFT ℓ mm at MHz

Recent Improvements or Modifications to Machine

Acceleration System
RF FREQ. 201 MHz
FIELD MODE 0-mode Q > 60,000
EQUIL.PHASE 25 °, ACCEL.RATE 1.3 MeV/m
REPETITION RATE 20 pps
DUTY FACTOR 0.5 % (RF); 0.01 % (Beam)
PULSE LENGTH 250 μs (RF); 5 μs (Beam)
EFFECTIVE SHUNT RESIST. ∿70 MΩ/m
FILLING TIME 150 μs
RF POWER INPUT PEAK 3 MW; MEAN 0.015 MW

Focusing System
No. QUADS 90 TYPE Magnet ORDER FDFD
GRADIENTS 11 to 4 T/m
OTHER

Vacuum System
MATERIAL CHAMBER Copper plating steel chamber
AVERAGE PRESSURE 3×10^{-7} torr
PUMPS (No., Type, Speed)
6 × Vac. Ion Pump (1000ℓ/sec), 6 × Noble Ion Pump (800ℓ/sec)

Published Articles Describing Machine

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON: Alternating Gradient Synchrotron
INSTITUTION: Brookhaven National Laboratory
LOCATION: Upton, New York 11973
PERSON IN CHARGE: L.W. Smith/Y.Y. Lee — DATE: 3/11/80
DATA SUPPLIED BY: Y.Y. Lee

HISTORY AND STATUS

CONSTRUCTION STARTED (date): 1953
FIRST BEAM OBTAINED, or GOAL (date): July 29, 1960
TOTAL COST OF FACILITY: $30.65 M
FUNDED BY: USA-AEC
TOTAL ACCELERATOR STAFF (now): 305
ANN.OPERAT.BUDGET: $10.75 M (without aalaries)
ANN.OPERATING TIME: 5000 h
"BEAM ON": 85 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES: Proton
ENERGY: 30 GeV
RING DIAM. 256.9 m; TUNNEL SECT.(WxH) 5.49 x 5.49 m

Injector

TYPE: Alvarez Linear Accelerator
OUTPUT (max) 100 mA at 200.3 MeV
EMITTANCE*: 10 π mm-mrad
INJECTION PERIOD ≤ 150 μs, or ≤ 30 turns
INFLECTOR TYPE: Pulsed Magnet

Magnet System

FOCUSING TYPE: AG — FIELD INDEX, n= 36°
FOCUSING ORDER: (F/2)O(F/2)(D/2)O(D/2)
BETATRON FREQ. ν_H 8.75 ν_V 8.75
No. MAGNETS 240 LENGTH (ea) 2.28,1.90 respm
BENDING FIELD at inj. .0251 T; at max 1.31 T
No. QUADS 240 LENGTH (ea) 2.28,19.0 respm
GRAD. at inj. 0.105 T/m; at max 5.5 T/m
No. SHORT STRAIGHT SECT. 72 LENGTH 1.63 m
No. LONG STRAIGHT SECT. 24 LENGTH 3.15 m
RISE TIME 0.6 s; FLAT-TOP TIME 1.3 s
POWER INPUT PEAK 60 MW; MEAN 6 MW

Acceleration System

No. CAVITIES 10, 4 Gap LENGTH (ea) 2 m
HARMONIC NUMBER 12
RF RANGE 2.52 to 4.46 MHz
ENERGY GAIN 192 keV/turn
RADIATION LOSS 0 keV/turn
RF POWER INPUT PEAK 1000 kW; MEAN 800 kW

Vacuum System

MATERIAL OF VAC.CHAMBER: Inconel-750
APERTURE OF VAC.CHAMBER: 173 x 77.8 mm
AVERAGE PRESSURE: 2 x 10^{-7} torr
PUMPS (No., type, speed): 250, Ion, 150 ℓ/s

Extraction System

TYPE i) FEB (30 GeV)
ii) SEB (30 GeV)
iii)
LENGTH OF SPILL i) 3 μsec to μs
ii) 0.5 sec to 2.5 sec μs
iii) to μs

Published Articles Describing Machine

G.K. Green, E.D. Courant, "The Proton Synchrotron," Handbuch der Physik 44, 218-340 (1959).

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	28.5	33
RESOLUTION ΔE/E (%)	0.2	0.1
REPET.RATE (pulse/s)	0.4	0.8
PULSE WIDTH AT PEAK E	1	1.2 sec
DUTY FACTOR, macroscop.(%)	40	60
INTERNAL BEAM (part/pulse)	9×10^{12}	11×10^{12}
(part/s)	7×10^{12}	8.5×10^{12}

EMITTANCE* AT PEAK E: 1.5 x 1.5 π mm-mrad
OTHER DATA:

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.
K^-, $\bar{p}$	≤.8,<1.1	2	Low E Sep.beam
K, p	1.5 ~ 9	1	Med. E Sep.beam
π K p	5 ~ 24	3	High E Unsep.b.
p	Prim. E	2	Int. < 10^{11}
ν	1.5 ~ 3		

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 255 m^2
No. INTERNAL TARGETS 0 No.EXT.TARGETS 6
No. SEPARATED BEAMS 3, 6 branches
No. BEAMS SERVED AT SAME TIME 8
TOTAL POWER USED (AVERAGE) FOR RESEARCH 25 MW
No. USER GROUPS: in house 6 outside 54
TOTAL RESEARCH STAFF, in house 51 outside 201
ANN.RESEARCH BUDGET, in house $1.35 M (without sal.)
ANNUAL RESEARCH TIME 4200 h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

New slow extraction and switchyard system.
H^- injection to be commissioned in 1981.

*Emittance = Area xβy at 90% of current (for p-machines)

NAME OF LINAC The BNL 200 MeV Proton Linear Accelerator
INJECTOR FOR The BNL Alternating Gradient Synchrotron
LOCATION Brookhaven National Laboratory, Upton, Long Island, New York 11973
PERSON IN CHARGE D. Barton/N. Fewell DATE: 3/10/80
DATA SUPPLIED BY N. Fewell

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1968
FIRST BEAM OBTAINED, or GOAL (date) Nov. 1970
TOTAL COST OF FACILITY $22.5 Million
FUNDED BY U.S. Atomic Energy Commission, now DOE
TOTAL ACCELERATOR STAFF (now) 14
ANN.OPERAT. BUDGET $1.8 Million (without salaries)
ANN. OPERATING TIME 5000 h
"BEAM ON" 95 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 138 m; No. TANKS 9
TANK DIAM. .94-.85 m, No. DRIFT TUBES 277
DRIFT TUBE LENGTHS 47 to 450 mm
DRIFT TUBE DIAMETERS 180 to 160 mm
GAP/CELL LENGTH .21 to .47
APERTURE DIAM. 20 mm to 40 mm

Ion Source

TYPE Proton Duoplasmatron
OUTPUT 300 mA at 40 keV
EMITTANCE* - πmm-mrad

Injector

TYPE Cockcroft-Walton
OUTPUT 300 mA at 750 keV
EMITTANCE* 12 πmm-mrad

Bunchers

TYPE Two Double Gap, λ/2 Coaxial Cavities
MODULATION 10 keV, DRIFT ℓ 1000 mm at 200 MHz
17 keV, DRIFT ℓ 715 mm at 200 MHz

Acceleration System

RF FREQ. 200 MHz
FIELD MODE TM010 Q 50,000
EQUIL.PHASE 32 °, ACCEL.RATE 1.6 to 2.56 MeV/m
REPETITION RATE 10 pps
DUTY FACTOR 0.5 % (RF); 0.2 % (Beam)
PULSE LENGTH 500 μs (RF); 200 μs (Beam)
EFFECTIVE SHUNT RESIST. 16 MΩ/m
FILLING TIME 50 μs
RF POWER INPUT PEAK 40 MW; MEAN 0.2 MW

Focusing System

No. QUADS 287 TYPE Pulse ORDER +-+-
GRADIENTS 0.9 to 0.05 T/m
OTHER

Vacuum System

MATERIAL CHAMBER Tanks-Cu, Beam Transport-Al.
AVERAGE PRESSURE 2 x 10^{-7} torr
PUMPS (No., Type, Speed) Five x 1500 liter/sec sputter ion pumps per tank.

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	200	200
ENERGY SPREAD ΔE/E (%)	.6	-
CURRENT (mA)	60	220
EMITTANCE*	30	(πmm-mrad)

Other Relevant Parameters or Notable Features

In addition to serving as an injector to the AGS, the linac also supplies beams to 3 other facilities.

1) The Brookhaven Linac Isotope Producer (BLIP) Facility is run by the Medical Department for the production of high purity isotopes including Iron 52, Iodine 123 and Xenon 127 (34,000 mCi 1978).

2) The Brookhaven Proton Bio-Medical Facility, where invivo activation of positron emitters due to proton beam interactions have been studied using an on-line positron camera.

3) The Medium Energy Intense Neutron (MEIN) Facility run by the Chemistry Department for the production of new neutron rich isotopes.

Recent Improvements or Modifications to Machine

Published Articles Describing Machine

1966 Linear Accelerator Conf., Proc. LA-3609.
1968 " " " BNL-50120.
1970 " " " NAL-Vol. I & II.
1972 " " " LA-5115.
1976 " " " AECL-5677.
1979 " " " BNL-51134.
Particle Accelerators, Vol. 9, No. 1/2 (1979).

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON Tevatron
INSTITUTION Fermilab
LOCATION Batavia, Illinois U.S.A.
PERSON IN CHARGE DATE: April 1980
DATA SUPPLIED BY

HISTORY AND STATUS

CONSTRUCTION STARTED (date)
FIRST BEAM OBTAINED, or GOAL (date)
TOTAL COST OF FACILITY
FUNDED BY Department of Energy
TOTAL ACCELERATOR STAFF (now)
ANN.OPERAT.BUDGET (without salaries)
ANN.OPERATING TIME h
"BEAM ON" % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Protons
ENERGY 800 ∿ 1,000 GeV
RING DIAM. 2,000 m; TUNNEL SECT.(WxH) 3.05 x 2.44 m

Injector

TYPE Main Ring (Synchrotron)
OUTPUT (max) 2.7 x 10^{13}/pulse mA at 150 GeV MeV
EMITTANCE* 20 π mm-mrad
INJECTION PERIOD 20 μs, or turns
INFLECTOR TYPE pulsed magnetic kicker and Lambertson magnet

Magnet System

FOCUSING TYPE AG sep.fn. FIELD INDEX, n=
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 19.40 ν_V 19.40
No. MAGNETS 774 LENGTH (ea) 6.12 m
BENDING FIELD at inj. 0.66 T; at max 4.42 T
No. QUADS 216 LENGTH (ea) 1.68* m
GRAD. at inj. 11.4 T/m; at max 75.9 T/m
No. SHORT STRAIGHT SECT. 204 LENGTH 2.3 m
No. LONG STRAIGHT SECT. 6 LENGTH 53 m
RISE TIME 11∿17 s; FLAT-TOP TIME 1∿10 s
POWER INPUT PEAK MW; MEAN MW

Acceleration System

No. CAVITIES 6 LENGTH (ea) 2.75 m
HARMONIC NUMBER 1113
RF RANGE 53 to MHz
ENERGY GAIN 1.580 keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK kW; MEAN kW

Vacuum System

MATERIAL OF VAC.CHAMBER Stainless Steel
APERTURE OF VAC.CHAMBER mm
AVERAGE PRESSURE torr
PUMPS (No., type, speed) Cold Bore 4.6°K

Extraction System

TYPE i) Slow Resonant 1/2 interger
ii) Fast Resonant 1/2 integer
iii)
LENGTH OF SPILL i) 1 - 10 secs to μs
ii) 0.1 - 0.3 ms to μs
iii) to μs

Published Articles Describing Machine

A report on the Design of the Fermi National Accelerator Laboratory Superconducting Accelerator, May 1979

Fermi National Accelerator Laboratory

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	800 ∿ 1.000	
RESOLUTION ΔE/E (%)		
REPET.RATE (pulse/s)		
PULSE WIDTH AT PEAK E	1 ∿ 2/min	
DUTY FACTOR, macroscop.(%)		
INTERNAL BEAM (part/pulse)	> 2 x 10^{13}	
(part/s)		
EMITTANCE* AT PEAK E	20 π mm-mrad	

OTHER DATA

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS No.EXT.TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN.RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

*180 normal quadrupoles. There are 36 matching quadrupoles of various lengths.

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON 200/500 GeV Synchrotron
INSTITUTION Fermi National Accelerator Laboratory
LOCATION Batavia, Illinois 60510
PERSON IN CHARGE C. M. Ankenbrandt DATE: March 28, 1980
DATA SUPPLIED BY C. D. Moore, T. Yamanouchi

HISTORY AND STATUS

CONSTRUCTION STARTED (date) December 1, 1968
FIRST BEAM OBTAINED, or GOAL (date) March 1, 1972
TOTAL COST OF FACILITY $243 M
FUNDED BY USAEC
TOTAL ACCELERATOR STAFF (now) 313
ANN.OPERAT.BUDGET $6.15 M (without salaries)
ANN.OPERATING TIME 6222 h
"BEAM ON" HEP 74 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES Protons
ENERGY 200 - 500 GeV
RING DIAM. 2000 m; TUNNEL SECT.(WxH) 3.05 x 2.44 m

Injector
TYPE 8 GeV Booster
OUTPUT (max) 300 mA at 8 GeV MeV
EMITTANCE* 6.6 π mm-mrad
INJECTION PERIOD Thirteen 1.6 μsec pulses in .8 sec
INFLECTOR TYPE Electromagnetic

Magnet System
FOCUSING TYPE AG FIELD INDEX, n= sep fn
FOCUSING ORDER QFOBBBBQDOBBBB (FODO)
BETATRON FREQ. ν_H 19.4 ν_V 19.4
No. MAGNETS 774 LENGTH (ea) 6.1 m
BENDING FIELD at inj. .0396 T; at max 2.229 T
No. QUADS 240 LENGTH (ea) 2.1 m
GRAD. at inj. .005396 T/m; at max .3013 T/m
No. SHORT STRAIGHT SECT. 6 LENGTH 14.859 m
No. LONG STRAIGHT SECT. 6 LENGTH 50.834 m
RISE TIME 2.5 s; FLAT-TOP TIME 1 s
POWER INPUT PEAK 96 MW; MEAN 39.6 MW

Acceleration System
No. CAVITIES 18 LENGTH (ea) 1.8 m
HARMONIC NUMBER 1113
RF RANGE 52.813 to 53.105 MHz
ENERGY GAIN 3700 keV/turn
RADIATION LOSS .0006 keV/turn
RF POWER INPUT PEAK 1800 kW; MEAN 800 kW

Vacuum System
MATERIAL OF VAC.CHAMBER Stainless steel
APERTURE OF VAC.CHAMBER 50.8 x 101.6 mm
AVERAGE PRESSURE 4 x 10-8 torr
PUMPS (No., type, speed) 850 triode ion pump, 30ℓ/sec
37, diode ion pump, 600ℓ/sec

Extraction System
TYPE i) Resonant with F48 septum
ii) " " DØ "
iii) Fast kicked with C48 kicker
LENGTH OF SPILL i) 1 ms to 5 x 10⁶ μs
ii) " to " μs
iii) 20 ms to 20 μs

Published Articles Describing Machine

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	400	500
RESOLUTION ΔE/E (%)		
REPET.RATE (pulse/s)	1/10	1/8
PULSE WIDTH AT PEAK E	1 sec	
DUTY FACTOR, macroscop.(%)	86%	96%
INTERNAL BEAM (part/pulse)	2 x 10^{13}	2.7x10^{13}
(part/s)	2 x 10^{12}	
EMITTANCE* AT PEAK E	11.7	π mm-mrad

OTHER DATA

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Flux per 10^{13} 400* proton
charged hadrons	20 - 400 GeV	8	
K^o			
n		2	2 x 10^6 @200*
e^-	40 - 300 GeV/c	1	
ν	10 - 300 GeV/c	1(4 targ. system)	
Σ^-	300 GeV/c	1	2 x 10^6
μ	25 - 272 GeV/c	1	1.5x10^6 μ @225*
γ	10 - 280 GeV/c	2	

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 10,500 m^2
No. INTERNAL TARGETS 1 No.EXT.TARGETS 9
No. SEPARATED BEAMS 0
No. BEAMS SERVED AT SAME TIME 12 max
TOTAL POWER USED (AVERAGE) FOR RESEARCH 20 MW
No. USER GROUPS: 135 Total
TOTAL RESEARCH STAFF, in house 106 outside 744
ANN.RESEARCH BUDGET, in house $1 M (without sal.)
ANNUAL RESEARCH TIME 5166 scheduled h

Other Relevant Parameters or Notable Features

*GeV/c

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Fermilab 8-GeV Booster
INJECTOR FOR Fermilab 400-GeV Synchrotron
LOCATION Batavia, Illinois 60510
PERSON IN CHARGE C. W. Owen DATE 31 March 80
DATA SUPPLIED BY B. C. Brown, J. R. Lackey, C. W. Owen

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1969
FIRST BEAM OBTAINED, or GOAL (date) 1971
TOTAL COST OF FACILITY $17,000,000
FUNDED BY USAEC
TOTAL ACCELERATOR STAFF (now) Part of FNAL Accel. Div.
ANN.OPERAT.BUDGET (without salaries)
ANN.OPERATING TIME 4800 h
"BEAM ON" 96 % OF SCHEDULED TIME

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	8	10
RESOLUTION ΔE/E (%)	0.1	
REPET.RATE (pulse/s)	15	
PULSE WIDTH AT PEAK E	1.6μs	
DUTY FACTOR, macroscopic (%)		
INTERNAL BEAM (part/pulse)		3.0×10^{12}/p
(part/s)		4.5×10^{13}/s
BEAM EMITTANCE*		(π mm-mrad)

BEAM LINES TO 1 Beam Line to Fermilab 400 GeV PS
OTHER DATA

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES Protons
ENERGY 8 GeV
RING DIAM. 151 m; TUNNEL SECT.(WxH) 3 x 2.4 m

Injector
TYPE Linac (Negative Ions)
OUTPUT (max) 46 mA at 201 MeV
EMITTANCE* 3.8 (at 35 mA) π mm-mrad
INJECTION PERIOD 2.8μs/turn μs, or 1 to 20 turns
INFLECTOR TYPE Injection w/orbit bump & Stripper foil (Charge Exchange Injection)

Magnet System Alternating
FOCUSING TYPE Gradient FIELD INDEX, n=
FOCUSING ORDER FOFDOOD
BETATRON FREQ. ν_H 6.72 ν_V 6.78
No. MAGNETS 96 LENGTH (ea) 3.04 m
BENDING FIELD at inj. 0.0490 T; at max 0.67 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 24 LENGTH 1.2 m
No. LONG STRAIGHT SECT. 24 LENGTH 6 m
RISE TIME s; FLAT-TOP TIME s → Biased 15 Hertz sinusoid
POWER INPUT PEAK 1.8 MW; MEAN 1.3 MW

Acceleration System
No. CAVITIES 18 LENGTH (ea) 2.4 m (140°Electrical)
HARMONIC NUMBER 84
RF RANGE 30 to 52.8 MHz
ENERGY GAIN 800 (peak) keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK ~1800 kW; MEAN ~500 kW
during accelerating cycles.

Vacuum System
MATERIAL OF VAC.CHAMBER Epoxy impregnated, laminated steel magnets in stainless steel envelope.
APERTURE OF VAC.CHAMBER (chamber encloses magnets) mm
AVERAGE PRESSURE 5×10^{-7} torr
PUMPS (no., type, speed) 60, Ion pumps, 600 liter/sec
plus roughing system in the synchrotron proper.

Extraction System
TYPE Single turn, fast kicker and magnetic septum

LENGTH OF SPILL 1.6 μs

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine
-Conversion to Charge Exchange Injection
-RF, Extraction, & Magnet Power Supply Upgrade for 10 GeV operation
-(Vertical) Bunch to Bunch Super Dampers
-Improved Low Level RF System

Published Articles Describing Machine

Reviews

B. C. Brown and C. Hojvat, Fermilab Memo FN-317 or Proceedings of the Kaon Factory Workshop, Ed. M. K. Craddock TRIUMF TRI-79-1, p. 178.

E. L. Hubbard, Ed., Fermilab Memo TM-405 (unpublished).

Articles in Proceedings of Particle Accelerator Conference

IEEE Trans. on Nuclear Science for associate years.
NS-26(1979) p. 3149, 3173, 3337, 3373, 3586, 3953, 3974, 4009, 4061, 4111.
NS-24(1975) p. 1263, 1282, 1423, 1449, 1455, 1561, 1698, 1768, 1770, 1830.
NS-22(1975) p. 1234, 1283, 1242, 1458, 1897, 1900, 1904.
NS-20(1973) p. 351, 409, 404, 570, 863.
NS-18(1971) p. 244, 246, 424, 427, 654, 978, 979, 989, 991.
NS-16(1969) p. 510, 969.

*Emittance = Area xβγ at 90% current

NAME OF LINAC Fermilab 200-MeV Proton Linac
INJECTOR FOR 8-GeV Booster Synchrotron
LOCATION Batavia, Illinois
PERSON IN CHARGE C. D. Curtis DATE: March 31, 1980
DATA SUPPLIED BY C. D. Curtis

HISTORY AND STATUS

CONSTRUCTION STARTED (date) December, 1968
FIRST BEAM OBTAINED, or GOAL (date) Nov. 30, 1970
TOTAL COST OF FACILITY $12.7M
FUNDED BY USAEC
TOTAL ACCELERATOR STAFF (now) 8 (part of Accel. Div.)
ANN. OPERAT. BUDGET $650K (without salaries)
ANN. OPERATING TIME 7500 h
"BEAM ON" 97 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 144.8 m; No. TANKS 9
TANK DIAM. 0.84-0.94m; No. DRIFT TUBES 286
DRIFT TUBE LENGTHS 47-446 mm
DRIFT TUBE DIAMETERS 180-160 mm
GAP/CELL LENGTH 0.21-0.47
APERTURE DIAM. 20 mm to 40 mm

Ion Source

TYPE Magnetron H^- Source
OUTPUT 50 mA at 18 keV
EMITTANCE* ___ πmm-mrad

Injector

TYPE Cockcroft-Walton
OUTPUT 50 (normal) 25-75 mA at 750 keV
EMITTANCE* 0.8 x 1.5 πmm-mrad

Bunchers

TYPE Single gap reentrant cavity
MODULATION ~ 25 keV, DRIFT ℓ 750 mm at 201.25 MHz
___ keV, DRIFT ℓ ___ mm at ___ MHz

Acceleration System

RF FREQ. 201.25 MHz
FIELD MODE TM010 Q 50-60 x 10^3
EQUIL. PHASE -32°, ACCEL. RATE 1.4 MeV/m
REPETITION RATE 15
DUTY FACTOR 0.2 % (RF); to 0.1 % (Beam)
PULSE LENGTH 150 μs (RF); to 60 μs (Beam)
EFFECTIVE SHUNT RESIST. 27-15 MΩ/m
FILLING TIME 120 (70-160) μs
RF POWER INPUT PEAK 35 MW; MEAN 0.075 MW

Focusing System

No. QUADS 295 TYPE Pulsed Mag. ORDER NSNS
GRADIENTS 70 to 7 T/m
OTHER

Vacuum System

MATERIAL CHAMBER Copper-clad steel
AVERAGE PRESSURE 5×10^{-8} torr
PUMPS (No., Type, Speed)
52 1000-ℓ/sec Ion Pumps

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	201	
ENERGY SPREAD ΔE/E (%)**	0.35	
CURRENT (mA)	35	46
EMITTANCE*	4 (at 35 mA)	(πmm-mrad)

Other Relevant Parameters or Notable Features

**Energy spread adjustable to optimize performance of a three-cell debuncher, which reduces the energy spread at the input of the booster synchrotron.

The linac now delivers only H^- beam, which is time shared between high energy physics, cooling ring experiments and neutron cancer therapy.

Recent Improvements or Modifications to Machine

The major modification in the last few years involved the switch over in March, 1978, to a negative ion source for routine operation to provide multiturn injection into the booster via a carbon stripping foil.

In the period from 1975 to 1978, high current duoplasmatron sources were used to provide short linac beam pulses of 150 to 300 mA for single-turn injection into the booster.

Published Articles Describing Machine

Particle Accelerators 1, 51(1970).
1968 Linear Accelerator Conf. Proceedings, BNL 50120.
1970 Linear Accelerator Conf. Proceedings
1972 Linear Accelerator Conf. Proceedings, LA 5115.
1976 Linear Accelerator Conf. Proceedings, AECL 5677.
Proceedings of the Fourth All-Union Nat. Conf. on Part. Accelerators, Vol. I, p. 136 (Moscow, 1974).
IEEE Transactions on Nuclear Science, NS-18, No. 3, 517(1971).
IEEE Transactions on Nuclear Science, NS-26, No. 3, 3760(1979).
IEEE Transactions on Nuclear Science, NS-26, No. 3, 4120(1979).

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON Bevatron
INSTITUTION Lawrence Berkeley Laboratory, University of California
LOCATION Berkeley, California, USA
PERSON IN CHARGE Hermann A. Grunder DATE: March 20, 1980
DATA SUPPLIED BY Kenneth C. Crebbin

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1949
FIRST BEAM OBTAINED, or GOAL (date) Feb. 1954
TOTAL COST OF FACILITY $34M
FUNDED BY DOE
TOTAL ACCELERATOR STAFF (now) 183 FTE
ANN.OPERAT.BUDGET $1.937M (without salaries)
ANN.OPERATING TIME 4288 h
"BEAM ON" 84 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES p through Fe
ENERGY 6.2 p 2.75/amu GeV
RING DIAM. 38.23 m; TUNNEL SECT.(WxH) --- x --- m

Injector **
TYPE Linac (3 available)
OUTPUT (max) 25 mA at 19.2p MeV
EMITTANCE* 1.3H ; 1.8V π mm-mrad
INJECTION PERIOD 600 μs, or 300 turns
INFLECTOR TYPE 3 magnet achromatic + elec. static

Magnet System
FOCUSING TYPE weak FIELD INDEX, n= 0.67
FOCUSING ORDER ---
BETATRON FREQ. ν_H 0.647 ν_V 0.922
No. MAGNETS 144 LENGTH (ea) 0.66 m
BENDING FIELD at inj. 0.0400 T; at max 1.53 T
No. QUADS 0 LENGTH (ea) --- m
GRAD. at inj. --- T/m; at max --- T/m
No. SHORT STRAIGHT SECT. 4 LENGTH 6.1 m
No. LONG STRAIGHT SECT. --- LENGTH --- m
RISE TIME 1.7 s; FLAT-TOP TIME 0.3 - 2 s
POWER INPUT PEAK 121 MW; MEAN 6.0 MW

Acceleration System
No. CAVITIES 1 (2 gap) LENGTH (ea) 2.79 m
HARMONIC NUMBER 1
RF RANGE 0.497 (0.252) to 2.47 (2.41) MHz
ENERGY GAIN 1.5 (0.75) keV/turn
RADIATION LOSS --- keV/turn
RF POWER INPUT PEAK 72 kW; MEAN --- kW

Vacuum System [] values for 1 amu others for Protons
MATERIAL OF VAC.CHAMBER
APERTURE OF VAC.CHAMBER 1520 x 300 mm
AVERAGE PRESSURE 3×10^{-7} torr
PUMPS (No., type, speed) 24 - 32" oil diff. pump
0.5 10^6 ℓ/s LN ; 0.1 x 10^6 ℓ/sec (12°K)

Extraction System
TYPE i) 2/3 Ur resonant extraction
ii)
iii)
LENGTH OF SPILL i) 200 to 2 x 10^6 μs
ii) to μs
iii) to μs

Published Articles Describing Machine

1) F. G. H. Lothrop, D. M. Evans, Digital Control of Bevatron Accel. Cycle, Vol. NS-18 Number 3, June 1971.
2) D. M. Evans, et al., Bevatron Guide Field Control, Vol. NS-18 Number 3, June 1971.
3) R. A. Byrns, J. T. Tanabe, The Bevatron Cryopump, Vol. NS-20 Number 3, June 1973.
4) K. C. Crebbin et al, First Phase of Heavy Ion Acceleration at the Bevatron, Vol. NS-20 Number 3, June 1973.

*Emittance = Area xβγ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	5.4 - 6.1	6.2 (2.75 amu)
RESOLUTION ΔE/E (%)	0.02	0.03
REPET.RATE (pulse/s)	~ 0.2	0.29
PULSE WIDTH AT PEAK E	1.5 sec at	5.4 GeV
DUTY FACTOR, macroscop.(%)	25	
INTERNAL BEAM (part/pulse)	4×10^{12}	6×10^{12}
(part/s)	0.75×10^{12}	1.5×10^{12}

EMITTANCE* AT PEAK E 2500 radial π mm-mrad
OTHER DATA

External
~~SECONDARY~~ BEAMS

Particle	Momentum range	No.of beams	Other Inform.
p	.7 - 7.1 GeV/c		4.5×10^{11} p/s
^{2}H	.7 - 7.1		3.8×10^{10}
^{4}He	1.4 - 7.1		8.0×10^9
^{12}C	4.2 - 42.6		4.0×10^9
^{14}N	4.9 - 49.7		5×10^8
^{16}O	5.6 - 56.8		5×10^8
^{20}Ne	7.0 - 71.0		5×10^8
^{40}Ar	14.0 - 127.7		10^7
^{56}Fe	19.6 - 185.6		~ 1.5×10^5

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS ~ 7000 m^2
No. INTERNAL TARGETS 0 No.EXT.TARGETS 7
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN.RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

** Three injector systems. See appropriate one for more details.

The Bevalac operates about 50% of the time for the Biomedical program. In the Biomedical program, four eight-hour-shifts per-week are devoted to pre-clinical cancer therapy treatments.

Recent Improvements or Modifications to Machine

NAME OF LINAC SuperHILAC, a heavy ion linac
INJECTOR FOR Bevatron
LOCATION Lawrence Berkeley Laboratory, Berkeley, Ca. 94720
PERSON IN CHARGE Hermann A. Grunder DATE: March 27, 1980
DATA SUPPLIED BY Frank Selph

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1971
FIRST BEAM OBTAINED, or GOAL (date) 1972
TOTAL COST OF FACILITY ---
FUNDED BY DOE
TOTAL ACCELERATOR STAFF (now) 50
ANN.OPERAT. BUDGET --- (without salaries)
ANN. OPERATING TIME 5000 h
"BEAM ON" 75 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions
TOTAL LENGTH 73.3 m; No. TANKS 8
TANK DIAM. 3.05 m; No. DRIFT TUBES 214
DRIFT TUBE LENGTHS 49 to 385 mm
DRIFT TUBE DIAMETERS 254 to 172 mm
GAP/CELL LENGTH 0.26 to 0.32
APERTURE DIAM. 12 mm to 42 mm

Ion Source
TYPE PIG
OUTPUT --- mA at --- keV
EMITTANCE* 0.3 π mm-mrad

Injector
TYPE 2.5 MV press. C.W./750 kV C.W.
OUTPUT --- mA at --- keV
EMITTANCE* 0.45/1.0 π mm-mrad

Bunchers
TYPE
MODULATION keV, DRIFT ℓ mm at MHz
keV, DRIFT ℓ mm at MHz

Acceleration System
RF FREQ. 70 MHz
FIELD MODE Q 100,000
EQUIL.PHASE 20 °, ACCEL.RATE 1.35 q(1) MeV/m
REPETITION RATE 36 Hz
DUTY FACTOR 13 - 33% (RF); 10 - 30 % (Beam)
PULSE LENGTH --- μs (RF); 2700 - 8100 μs (Beam)
EFFECTIVE SHUNT RESIST. 22 MΩ/m
FILLING TIME 500 μs
RF POWER INPUT PEAK 3 - 7.5 MW; MEAN 1.0 - 2.5 MW

Focusing System
No. QUADS 209 TYPE D.C. ORDER NSNS Prestripper NSNS poststripper
GRADIENTS 1.45 to 0.13 to T/m
OTHER 6 pulsed quads for timesharing

Vacuum System
MATERIAL CHAMBER copper plated steel
AVERAGE PRESSURE 2 x 10^{-7} torr
PUMPS (No., Type, Speed) cryoline at 20°K and Titanium sublimation pumps

Published Articles Describing Machine

1. H. Grunder and F. Selph, The Status of the Super-HILAC, Proc. of the 1976 Proton linear Accelerator Conference, Chalk River, 1976, pp 54-61 (AECL-5677).

2. J. Barale, et al, Performance of the Bevalac, IEEE Trans. on Nucl. Sci., pp 1672-1674, 1975.

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV/ amu)	2.5 - 8.5	2.5 - 8.5
ENERGY SPREAD ΔE/E (%)	0.5	0.3
CURRENT ~~MAX~~ **		
EMITTANCE* 1.3		(π mm-mrad)

Other Relevant Parameters or Notable Features

** SuperHILAC			Bevatron/Bevalac	
Ion	Ave. Intensity at* post-stripper exit (particle amperes)		Ion	Ave. Intensity on target (particles/pulse)
Lithium 6	0.4	pμA	Protons	$1x10^{11}$
Carbon 12	8	pμA	Alphas	$1x10^{10}$
Oxygen 16	3	pμA	Carbon	$5x10^{9}$
Neon 20	7	pμA	Nitrogen	$5x10^{8}$
Argon 40	2	pμA	Oxygen	$5x10^{8}$
Calcium 48	0.2	pμA	Neon	$3x10^{9}$
Iron 56	0.2	pμA	Argon	$3x10^{8}$
Krypton 86	0.1	pμA	Calcium-48	$1x10^{7}$
Niobium 93	30	pnA	Iron	$1x10^{6}$
Xenon 136	30	pnA		
Holmium 165	0.5	pnA		
Lead 208	0.2	pnA		

The SuperHILAC is capable of accelerating beams of heavy ions from Helium (mass 4) through Uranium (mass 238). Injection to the Bevatron at present is limited to Iron (mass 56). With modifications to be completed in 1982, all ions up to mass 238 will be accelerated in the Bevatron.

Timeshare operation, initiated in April 1975, allows a different ion from each injector to be accelerated through the linac on a pulse-by-pulse basis and at the end of the machine to be switched into the appropriate beam line. A typical operation is the delivery and 1 pulse per second of Neon to the Bevalac transfer line along with 35 pulses per second of Xenon to a SuperHILAC experiment. A sophistricated computer control system is used to switch the necessary rf and magnet parameters on a pulse-by-pulse basis.

(1) q = charge state of ion

*Emittance = Area xβγ at 90% current

NAME OF LINAC 50
INJECTOR FOR Bevatron
LOCATION LBL Univ. of Calif.
PERSON IN CHARGE Hermann A. Grunder DATE: 20, March 1980
DATA SUPPLIED BY John Staples

HISTORY AND STATUS

CONSTRUCTION STARTED (date) ------
FIRST BEAM OBTAINED, or GOAL (date) ----
TOTAL COST OF FACILITY -----
FUNDED BY -----
TOTAL ACCELERATOR STAFF (now) -------
ANN. OPERAT. BUDGET ----- (without salaries)
ANN. OPERATING TIME ------ h
"BEAM ON" ----- % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 33 m; No. TANKS 1
TANK DIAM. 0.97 m; No. DRIFT TUBES 124
DRIFT TUBE LENGTHS 49.1 to 354.6 mm
DRIFT TUBE DIAMETERS 250.2 to 147.1 mm
GAP/CELL LENGTH 0.231 to 0.249
APERTURE DIAM. 19.0 mm to 31.7 mm

Ion Source

TYPE Von Ardenne duo plasmatron
OUTPUT ~ 200 mA at 20 keV
EMITTANCE* π mm-mrad

Injector

TYPE Cockroft-Walton
OUTPUT 180 mA at 750 keV
EMITTANCE* 25.5 π mm-mrad

Bunchers

TYPE single gap
MODULATION 22 keV, DRIFT ℓ 1350 mm at 201.6 MHz
keV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ. 201.6 MHz
FIELD MODE TM - 010 Q 60,000
EQUIL. PHASE 26 °, ACCEL. RATE 2.0 MeV/m
REPETITION RATE 2/S
DUTY FACTOR 0.16 % (RF); 0.12 % (Beam)
PULSE LENGTH 800 μs (RF); 600 μs (Beam)
EFFECTIVE SHUNT RESIST. 39 MΩ/m
FILLING TIME 150 μs
RF POWER INPUT PEAK 9 MW; MEAN 0.011 MW

Focusing System

No. QUADS 124 TYPE magnetic ORDER + + - -
GRADIENTS 45 to 9.1 T/m
OTHER

Vacuum System

MATERIAL CHAMBER Copper Clad Steel
AVERAGE PRESSURE 2×10^{-7} torr
PUMPS (No., Type, Speed) 7 - vac ion 1200 ℓ/S
$1 - 10^{11}$ Hg DP 800 ℓ/sec (backup)

Published Articles Describing Machine

1. D. Brodzik, et al, The 50 MeV Bevatron Injection Linac, Vol. NS-20, Number 3, June 1973, pp 923-927

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	50.8	
ENERGY SPREAD ΔE/E (%)	0.5	
CURRENT (mA)	80	
EMITTANCE*	20	(π mm-mrad)

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% current

NAME OF LINAC 20
INJECTOR FOR Bevatron
LOCATION LBL University of Calif.
PERSON IN CHARGE Hermann A. Grunder DATE: 20, March 1980
DATA SUPPLIED BY Kenneth C. Crebbin

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1961
FIRST BEAM OBTAINED, or GOAL (date) 1962
TOTAL COST OF FACILITY ----
FUNDED BY DOE
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET --- (without salaries)
ANN. OPERATING TIME ----- h
"BEAM ON" ----- % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions
TOTAL LENGTH 11 m; No. TANKS 1
TANK DIAM. 1 m; No. DRIFT TUBES 75
DRIFT TUBE LENGTHS 25 - 225 mm
DRIFT TUBE DIAMETERS 200 - 220 mm
GAP/CELL LENGTH 0.23
APERTURE DIAM. 12.5 mm to 32.7 mm

Ion Source *see below for heavy ion source
TYPE Von Ardenne duo plasmatron
OUTPUT 150 mA at 60 keV
EMITTANCE* ----- πmm-mrad

Injector
TYPE Cockroft-Walton
OUTPUT 100 mA at 480 keV
EMITTANCE* 1.3V, 1.8H πmm-mrad

Bunchers
TYPE Single-cavity re-entrant
MODULATION 10 keV, DRIFT ℓ 1000 mm at 199.3 MHz
keV, DRIFT ℓ mm at MHz

Acceleration System
RF FREQ. 199.3 MHz
FIELD MODE T M - 010 Q 70,000
EQUIL.PHASE 26 °, ACCEL.RATE 2 (0.5) MeV/m
REPETITION RATE 2/S
DUTY FACTOR 0.16 % (RF); 0.12 % (Beam)
PULSE LENGTH 800 μs (RF); 600 μs (Beam)
EFFECTIVE SHUNT RESIST. 2 MΩ/m
FILLING TIME 200 μs
RF POWER INPUT PEAK 2.5 MW; MEAN 0.005 MW

Focusing System
No. QUADS 75 TYPE magnet ORDER CCDD
GRADIENTS to 200 T/m
OTHER

Vacuum System
MATERIAL CHAMBER Copper clad steel
AVERAGE PRESSURE 2×10^{-7} torr
PUMPS (No., Type, Speed) 3 - vac ion 1200 ℓ/S
welch turbine - 1500 ℓ/S (startup pump)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	19.0	19.27 (4.8/amu)
ENERGY SPREAD ΔE/E (%)	1.5	1 (.8)
CURRENT (mA)	50	40 (*)
EMITTANCE*	(.115)	(πmm-mrad)

(*) Heavy Ion Operation PIG Source

Other Relevant Parameters or Notable Features

Provides heavy-ion acceleration in the 2 βλ mode.
Cavity is pre-pulse excited and driven with ten main oscillators.

ION	OUTPUT	EXIT OF C-W
H+	10 Ma	480 kV
2 H +	8	253
4 He 2 +	1.5	251
12 C 4 +	0.1	376
14 N 5 +	0.04	350
16 O 5 +	0.05	402
20 Ne 6 +	0.0001	418

Recent Improvements or Modifications to Machine

Published Articles Describing Machine

1. R. W. Allison, et al, Rev. Sci. Instr. 32, 1331 (1961).
2. R. W. Allison et al, Measurements of The Linear-Accelerator Exit Beam of the Bevatron Injector, UCRL-17001 (1966), Proc. 1966 Linear Accel. Conf., Los Alamos.

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON 76 GeV proton synchrotron
INSTITUTION Institute for High Energy Physics
LOCATION Serpukhov, Moscow region, USSR
PERSON IN CHARGE Yu.M.Ado DATE: April 15, 1980
DATA SUPPLIED BY E.A.Myae

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1961
FIRST BEAM OBTAINED, or GOAL (date) 1967
TOTAL COST OF FACILITY
FUNDED BY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4900 h
"BEAM ON" 93 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES protons
ENERGY 70 GeV
RING DIAM. 472 m; TUNNEL SECT. (WxH) 6 x 8 m

Injector
TYPE Linac
OUTPUT (max) 120 mA at 100 MeV
EMITTANCE* // ·10 π mm-mrad
INJECTION PERIOD 60 μs, or 5 turns
INFLECTOR TYPE electrostatic

Magnet System
FOCUSING TYPE AG FIELD INDEX, n=
FOCUSING ORDER FODO*)
BETATRON FREQ. $\nu_H \sim 9.85$ $\nu_V \sim 9.85$
No. MAGNETS 120 LENGTH (ea) m
BENDING FIELD at inj 0.0076 T; at max 1.2 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. **) LENGTH 2.62 m
No. LONG STRAIGHT SECT. LENGTH 4.87 m
RISE TIME 2.5 s; FLAT-TOP TIME 2 s
POWER INPUT PEAK 100 MW; MEAN MW

Acceleration System
No. CAVITIES 49 LENGTH (ea) m
HARMONIC NUMBER 30
RF RANGE 2.6 to 6.1 MHz
ENERGY GAIN 180 keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK 220 kW; MEAN kW

Vacuum System
MATERIAL OF VAC. CHAMBER stainless steel
APERTURE OF VAC. CHAMBER 170 x 115 mm
AVERAGE PRESSURE 5·10-7 torr
PUMPS (No., type, speed) 120
300 l/s

Extraction System
TYPE i) fast
ii) slow
iii) internal targets
LENGTH OF SPILL i) to μs
ii) to μs
iii) to μs

Published Articles Describing Machine

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	70	76
RESOLUTION ΔE/E (%)	1.8	
REPET. RATE (pulse/s)		
PULSE WIDTH AT PEAK E		
DUTY FACTOR, macroscop. (%)	25	
INTERNAL BEAM (part/pulse)	$4.5 \cdot 10^{12}$	$5.3 \cdot 10^{12}$
(part/s)		
EMITTANCE* AT PEAK E	// ·100	π mm-mrad

OTHER DATA

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other Inform.
hadrons	30-65 GeV/c	3	at 70 GeV
Negative	20-50 GeV/c	5	at 70 GeV
~~e⁻~~	~~5-45 GeV/c~~	1	
~~μ⁻~~	~~20-40 GeV/c~~	2	
Neutral	< 70 GeV/c	1	
~~p, K, π⁺~~	10-50 GeV/c	2	separated
~~γ~~	< 40	1	wide band

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 17500 m^2
No. INTERNAL TARGETS No. EXT. TARGETS
No. SEPARATED BEAMS 2
No. BEAMS SERVED AT SAME TIME 6
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME 3600 h

Other Relevant Parameters or Notable Features

*) Combined functions

**) There are 12 superperiods; in each superperiod there are 2 long straight sections and 3 mean straight sections.

Recent Improvements or Modifications to Machine

5-turn injection (1975)
Slow extraction system (1979)

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF LINAC И-100
INJECTOR FOR У-70 proton syn
LOCATION Serpuknov, Protvino
PERSON IN CHARGE Teplyakov V.A. DATE: April 15, 1980
DATA SUPPLIED BY Teplyakov V.A.

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1961
FIRST BEAM OBTAINED, or GOAL (date) 1967
TOTAL COST OF FACILITY
FUNDED BY
TOTAL ACCELERATOR STAFF (now)
ANN.OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 5000 h
"BEAM ON" more 99 % OF SCHEDULED TIME

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	100	100
ENERGY SPREAD ΔE/E (%)	± 0,8%	less ± 1%
CURRENT (mA)	100	170
EMITTANCE*	10 π	(πmm-mrad)

Other Relevant Parameters or Notable Features

ACCELERATOR PARAMETERS

Physical Dimensions
TOTAL LENGTH 80 m; No. TANKS 3
TANK DIAM. 1,4 m; No. DRIFT TUBES 163
DRIFT TUBE LENGTHS 62 + 624 mm
DRIFT TUBE DIAMETERS 23 + 100 mm
GAP/CELL LENGTH 0,185 + 0,277
APERTURE DIAM. 20 mm to 40 mm

Ion Source
TYPE plasma ion source
OUTPUT 600 mA at 700 keV
EMITTANCE* 4 π πmm-mrad

Injector
TYPE pulse transformer
OUTPUT 300 mA at 700 keV
EMITTANCE* 4π πmm-mrad

Bunchers
TYPE one gap cavity
MODULATION 25,4 keV, DRIFT ℓ 995 mm at 148,5 MHz
debuncher 1500 keV, DRIFT ℓ 27400 mm at 148,5 MHz

Recent Improvements or Modifications to Machine

Acceleration System
RF FREQ. 148,5 MHz
FIELD MODE E010 Q 60000
EQUIL.PHASE 37°, ACCEL.RATE 1,2 MeV/m
REPETITION RATE (max) 1/sec
DUTY FACTOR 38 10^{-4}% (RF); 7.5 10^{-4} % (Beam)
PULSE LENGTH 300 μs (RF); 60 μs (Beam)
EFFECTIVE SHUNT RESIST. 40 MΩ/m
FILLING TIME 100 μs
RF POWER INPUT PEAK 7 MW; MEAN MW

Focusing System
No. QUADS 164 TYPE pulse ORDER FODO
GRADIENTS 60 to 4 T/m
OTHER

Vacuum System
MATERIAL CHAMBER steel, copper (tank)
AVERAGE PRESSURE 10^{-7} torr
PUMPS (No., Type, Speed) 38 Titanium 1000 l/s

Published Articles Describing Machine

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON U-10
INSTITUTION ITEP
LOCATION MOSCOW
PERSON IN CHARGE L.L. Goldin DATE: 05.04.80
DATA SUPPLIED BY L.L. Goldin

HISTORY AND STATUS

CONSTRUCTION STARTED (date) —
FIRST BEAM OBTAINED, or GOAL (date) October 1961
TOTAL COST OF FACILITY —
FUNDED BY Commitee of Atomic Energy
TOTAL ACCELERATOR STAFF (now) —
ANN. OPERAT. BUDGET — (without salaries)
ANN. OPERATING TIME 5200 h
"BEAM ON" 92 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES protons
ENERGY 9,3 GeV
RING DIAM. 80 m; TUNNEL SECT. (WxH) 12 x 7 m

Injector
TYPE Linac
OUTPUT (max) 200 mA at 25,4 MeV
EMITTANCE* 55 π mm-mrad
INJECTION PERIOD 4 μs, or 1 turns
INFLECTOR TYPE Electrostatic

Magnet System
FOCUSING TYPE strong FIELD INDEX, n= 300
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 9,3 ν_V 9,3
No. MAGNETS 96 LENGTH (ea) 1,9 m
BENDING FIELD at inj. 0,024 T; at max 1,0 T
No. QUADS 0 LENGTH (ea) — m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 80 LENGTH 0,35 m
No. LONG STRAIGHT SECT. 16 LENGTH 2,4 m
RISE TIME 0,65 s; FLAT-TOP TIME 0,5 s
POWER INPUT PEAK 18,0 MW; MEAN 1,6 MW

Acceleration System
No. CAVITIES 5 LENGTH (ea) 1,6 m
HARMONIC NUMBER 4
RF RANGE 1,1 to 4,7 MHz
ENERGY GAIN 15 keV/turn
RADIATION LOSS — keV/turn
RF POWER INPUT PEAK 12 x 4 kW; MEAN 6 x 4 kW

Vacuum System
MATERIAL OF VAC. CHAMBER stainless steel
APERTURE OF VAC. CHAMBER 110 x 80 mm
AVERAGE PRESSURE $1 \cdot 10^{-6}$ torr
PUMPS (No., type, speed) 50, „Nord", 250 ℓ/s

Extraction System
TYPE i) Internal targets, slow
ii) Internal targets, fast
iii)
LENGTH OF SPILL i) 400 msec to μs
ii) 1 msec to μs
iii) to μs

Published Articles Describing Machine

1) Сообщение о ходе работ на протонном синхротроне ИТЭФ. Н.Н. Алексеев и др. V Всесоюзное совещание по ускорителям заряженных частиц. 1976, Дубна.

2) On Correction of Nonlinear Effects in Circular Accelerators. A.E. Bolshakov et al. X International Conference on High Energy Accelerators. Protvino, 1977.

*Emittance = Area xβγ at 90% of current (for p-machines)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	9,3	10,0
RESOLUTION ΔE/E (%)	—	—
REPET. RATE (pulse/s)	22	30
PULSE WIDTH AT PEAK E		
DUTY FACTOR, macroscop. (%)	18	30
INTERNAL BEAM (part/pulse)	$5 \cdot 10^{11}$	7×10^{11}
(part/s)	$1,85 \times 10^{11}$	$2,6 \times 10^{11}$
EMITTANCE* AT PEAK E	—	π mm-mrad
OTHER DATA	—	

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other Inform.
π^-	1÷9 Gev/c	7	
neutral		1	
μ^+		1	polarized
π^+, d, t, He^3	1÷4 Gev/c	2	separated
p	E = 70÷220 Mev	1	medical
for tuning		3	

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 5000 m^2
No. INTERNAL TARGETS 5 No. EXT. TARGETS 0
No. SEPARATED BEAMS 2
No. BEAMS SERVED AT SAME TIME 4-6
TOTAL POWER USED (AVERAGE) FOR RESEARCH 3 MW
No. USER GROUPS: in house 12 outside 2
TOTAL RESEARCH STAFF, in house — outside —
ANN. RESEARCH BUDGET, in house — (without sal.)
ANNUAL RESEARCH TIME 3800 h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine
Reconstruction from 7 to 10 Gev.
Introduction of long straight sections.

NAME OF LINAC I-2
INJECTOR FOR 10 GeV PS
LOCATION ITEP, Moscow
PERSON IN CHARGE I.M.Kapchinskij DATE: March, 1980
DATA SUPPLIED BY N.V.Lazarev

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1962
FIRST BEAM OBTAINED, or GOAL (date) 1966
TOTAL COST OF FACILITY
FUNDED BY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 5000 - 6000 h
"BEAM ON" 97 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions

TOTAL LENGTH 18.4 m; No. TANKS 2
TANK DIAM. 1.9 m; No. DRIFT TUBES 20+35
DRIFT TUBE LENGTHS 137 -313; 196 - 314 mm
DRIFT TUBE DIAMETERS 190 - 150; 150 mm
GAP/CELL LENGTH 0.2 - 0.3; 0.16 - 0.3
APERTURE DIAM. 20 mm to 25 mm

Ion Source

TYPE Cold cathode duoplasmatron
OUTPUT 2000 mA at 40 keV
EMITTANCE* π mm-mrad

Injector

TYPE Pulse transformer
OUTPUT 800 mA at 700 keV
EMITTANCE* 6 π mm-mrad

Bunchers

TYPE One gap
MODULATION 30 keV, DRIFT ℓ =850 mm at 148.5 MHz
keV, DRIFT ℓ mm at MHz

Acceleration System

RF FREQ. 148.5 MHz
FIELD MODE E_{010} Q = 65000
EQUIL.PHASE 37 °, ACCEL.RATE 1.3 MeV/m
REPETITION RATE 0.5 - 2 1/s
DUTY FACTOR 0.06 % (RF); 0.002 % (Beam)
PULSE LENGTH 300 μs (RF); 5 - 20 μs (Beam)
EFFECTIVE SHUNT RESIST. 22 MΩ/m
FILLING TIME 150 μs
RF POWER INPUT PEAK 1 + 2 MW; MEAN 0.002 MW

Focusing System

No. QUADS 38 +68 TYPE d.c. ORDER FOD; FOFDOD
GRADIENTS 55 to 18 T/m
OTHER Each drift tube contains 2 lenses of opposite signs

Vacuum System

MATERIAL CHAMBER Stainless steel
AVERAGE PRESSURE $2 - 3 \cdot 10^{-6}$ torr
PUMPS (No., Type, Speed) 18 (Inj.) + 2 (B) + 32 (Cav.) = 52 NORD-250, 13000 1/s

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	24.6	24.6
ENERGY SPREAD ΔE/E (%)	0.6	0.4
CURRENT (mA)	150	230
EMITTANCE*	8	(π mm-mrad)

Other Relevant Parameters or Notable Features

The length of accelerating period is $2\beta\lambda$ in the first cavity and $\beta\lambda$ in the second one.
Pulsed gas shutter at ion source exit reduces gas throughput by factor of 80.

Recent Improvements or Modifications to Machine

Published Articles Describing Machine

1. Prib. Techn. Exp., No.5, p.9-70, 1967
2. Proc. of the 6th Int. Conf. on High Energy Accelerators, Cambridge, Mass., p.A_{1-7}, A_{30-31}, 1967
3. Proc. of the Los-Alamos Linac Conf., p.275, 1972

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON synchrophasotron
INSTITUTION Joint Institute for Nuclear Research
LOCATION Dubna, USSR
PERSON IN CHARGE A.M. Baldin DATE: April 1980
DATA SUPPLIED BY I.N. Semenyushkin

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1952
FIRST BEAM OBTAINED, or GOAL (date) 1957
TOTAL COST OF FACILITY
FUNDED BY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4000-4500 h
"BEAM ON" 93 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES p,d,α,C,O,Ne
ENERGY 10 GeV 4 GeV/nucleon GeV
RING DIAM. 66.2 m; TUNNEL SECT.(WxH) x m

Injector

TYPE Alvarez linac
OUTPUT (max) 50 mA(p) mA at 20 MeV(p) MeV
EMITTANCE* 30 πmm-mrad
INJECTION PERIOD 500 μs, or 75 turns
INFLECTOR TYPE magnet+electrostatic deflector

Magnet System

FOCUSING TYPE weak FIELD INDEX, n= 0.65
FOCUSING ORDER
BETATRON FREQ. ν_H 0.64 ν_V 0.88
No. MAGNETS 4 quadr. LENGTH (ea) 44 m
BENDING FIELD at inj. 0.023 T; at max 1.26 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. LENGTH m
No. LONG STRAIGHT SECT. 4 LENGTH 8 m
RISE TIME 3 s; FLAT-TOP TIME 0.5 s
POWER INPUT PEAK 7.5 MW; MEAN 6 MW

Acceleration System

No. CAVITIES drift tube LENGTH (ea) 6.1 m
HARMONIC NUMBER 2
RF RANGE 0.3 to 2.88 MHz
ENERGY GAIN 2.3 keV/turn
RADIATION LOSS keV/turn
RF POWER INPUT PEAK 150 kW; MEAN 50 kW

Vacuum System

MATERIAL OF VAC.CHAMBER stainless steel
APERTURE OF VAC.CHAMBER 2000 x 400 mm
AVERAGE PRESSURE $2 \cdot 10^{-6}$ torr
PUMPS (No., type, speed) 54 oil vacuum pumps with a speed of 8000 l/s

Extraction System

TYPE i) resonant slow
ii) resonant short
iii)
LENGTH OF SPILL i) $50 \cdot 10^3$ to $500 \cdot 10^3$ μs
ii) $0.7 \cdot 10^3$ to $1.5 \cdot 10^3$ μs
iii) to μs

Published Articles Describing Machine

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	10	10
RESOLUTION $\Delta E/E$ (%)	± 0.1	± 0.1
REPET.RATE (pulse/s)	0.1	0.1
PULSE WIDTH AT PEAK E	0.5 s	0.5 s
DUTY FACTOR, macroscop.(%)	5	5
**) INTERNAL BEAM (part/pulse)	10^{12}	$4 \cdot 10^{12}$
(part/s)	10^{14}	$4 \cdot 10^{14}$
EMITTANCE* AT PEAK E	E_x=700	E_z=60 πmm-mrad

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.
$\pi^{\pm}_2$	2-7 GeV		
He^3_2	5-14 GeV		
n	1- 5 GeV		

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 10 000 m^2
No. INTERNAL TARGETS No.EXT.TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN.RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

**) Internal beam of other particles:

d 4 10^{11} part/pulse
α 2 10^{10} part/pulse
C^{6+} 2 10^6 part/pulse

Recent Improvements or Modifications to Machine

*Emittance = Area x$\beta\gamma$ at 90% of current (for p-machines)

NAME OF LINAC LU-20
INJECTOR FOR synchrophasotron of the Joint Institute for Nuclear Research
LOCATION Dubna, USSR
PERSON IN CHARGE Yu. Beznogikh DATE: April 1980
DATA SUPPLIED BY Yu. Beznogikh

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1965
FIRST BEAM OBTAINED, or GOAL (date) 1974
TOTAL COST OF FACILITY
FUNDED BY
TOTAL ACCELERATOR STAFF (now)
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4500 h
"BEAM ON" % OF SCHEDULED TIME

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
OUTPUT ENERGY (MeV)	20 MeV	
ENERGY SPREAD ΔE/E (%)	+0.15% with debuncher	
CURRENT (mA)	50 (p)	
EMITTANCE*	30 (πmm-mrad)	

Other Relevant Parameters or Notable Features

ACCELERATOR PARAMETERS

Physical Dimensions
TOTAL LENGTH 14.5 m; No. TANKS 1
TANK DIAM. 1.4 m; No. DRIFT TUBES 58
DRIFT TUBE LENGTHS 50 - 320 mm
DRIFT TUBE DIAMETERS 135 mm 90 mm mm
GAP/CELL LENGTH 0.25
APERTURE DIAM. 17 mm to 25 mm

Ion Source
TYPE duoplasmotron
OUTPUT mA at 40 keV
EMITTANCE* πmm-mrad

Injector
TYPE accelerating tube
OUTPUT 250 mA at 600 keV
EMITTANCE* πmm-mrad

Bunchers
TYPE one-gap buncher
MODULATION keV, DRIFT ℓ 1200 mm at 144.5 MHz
keV, DRIFT ℓ mm at MHz

Recent Improvements or Modifications to Machine

Acceleration System
RF FREQ. 144.5 MHz
FIELD MODE TM_{010}
EQUIL.PHASE 30°, ACCEL.RATE 1.4 MeV/m
REPETITION RATE
DUTY FACTOR 0.01 % (RF); 0.005 % (Beam)
PULSE LENGTH 600 μs (RF); 500 μs (Beam)
EFFECTIVE SHUNT RESIST. MΩ/m
FILLING TIME 150 μs
RF POWER INPUT PEAK 3.5 MW; MEAN MW

Focusing System
No. QUADS 58 TYPE magnetic ORDER FODO
GRADIENTS 50 to 8 T/m
OTHER

Vacuum System
MATERIAL CHAMBER steel
AVERAGE PRESSURE $2 \cdot 10^{-6}$ torr
PUMPS (No., Type, Speed) 12 BA-5 pumps 5000 l/s

Published Articles Describing Machine

*Emittance = Area xβγ at 90% current

NAME OF SYNCHROTRON Bonn 2.5 GeV Electron Synchrotron
INSTITUTION University of Bonn, Physical Institute
LOCATION Nussallee 12, D - 5300 Bonn 1
PERSON IN CHARGE D. Husmann DATE: 14.3.1980
DATA SUPPLIED BY D. Husmann

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1965
FIRST BEAM OBTAINED, or GOAL (date) March 1967
TOTAL COST OF FACILITY DM 12.3×10^6
FUNDED BY State of Nordrhein-Westfalen + Fed. Rep.
TOTAL ACCELERATOR STAFF (now) 15
ANN. OPERAT. BUDGET DM 2.5×10^6 (without salaries)
ANN. OPERATING TIME 6000 h
"BEAM ON" 85 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES Electrons
ENERGY 2.5 GeV
RING DIAM. 22.15 m; TUNNEL SECT. (WxH) 3.5 x 2.2 m

Injector

TYPE Linac
OUTPUT (max) 500 mA at 21 MeV
EMITTANCE* 3 π mm-mrad
INJECTION PERIOD 1.0 μs, or 5 turns
INFLECTOR TYPE septum magnet

Magnet System

FOCUSING TYPE AG FIELD INDEX, n= +23.26 / -22.26
FOCUSING ORDER OFDO
BETATRON FREQ. ν_H 3.4 ν_V 3.4
No. MAGNETS 12 LENGTH (ea) 4.005 m
BENDING FIELD at inj. 0.009 T; at max 1.09 T
No. QUADS - LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 12 LENGTH 1.8 m
No. LONG STRAIGHT SECT. - LENGTH m
RISE TIME 8.8 m s; FLAT-TOP TIME - , sinus s
POWER INPUT PEAK MW; MEAN 0.55 MW

Acceleration System

No. CAVITIES 2 (or 1) LENGTH (ea) 0.9 m
HARMONIC NUMBER 116
RF RANGE to 499.67 MHz
ENERGY GAIN max. 500 keV/turn
RADIATION LOSS max. 450 keV/turn
RF POWER INPUT PEAK 80 kW; MEAN 40 kW

Vacuum System

MATERIAL OF VAC. CHAMBER porcelain and Al_2O_3
APERTURE OF VAC. CHAMBER 125 x 42 mm
AVERAGE PRESSURE 5×10^{-7} torr
PUMPS (No., type, speed) 14 x VacIon 250 l/sec

Extraction System

TYPE i) resonant slow extraction
ii)
iii)
LENGTH OF SPILL i) to 1000 μs
ii) to μs
iii) to μs

ACCELERATOR PERFORMANCE

	Normal (~~Goal~~)	Maximum achieved
ENERGY (GeV)	0.5 - 2.3	2.5
RESOLUTION ΔE/E (%)		0.5
REPET. RATE (pulse/s)		50
PULSE WIDTH AT PEAK E	max.	1 msec
DUTY FACTOR, macroscop. (%)	max.	5
INTERNAL BEAM (part/pulse)		8×10^{10}
(part/s)		4×10^{12}
EMITTANCE* AT PEAK E		π mm-mrad
OTHER DATA		

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other Inform.
e^-	0.5 - 2.3 GeV/c	2	
γ	0.5 - 2.3 GeV	4	

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 1100 m^2
No. INTERNAL TARGETS 4 No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 2
TOTAL POWER USED (AVERAGE) FOR RESEARCH 1.0 MW
No. USER GROUPS: in house 4 outside 2
TOTAL RESEARCH STAFF, in house 50 outside 20
ANN. RESEARCH BUDGET, in house 2 MDM (without sal.)
ANNUAL RESEARCH TIME 5000 h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

Debuncher system at Linac

Published Articles Describing Machine

K.H. Althoff et al. : The 2.5 GeV Electron Synchrotron of the University of Bonn, Nucl. Instr. a. Meth. 61 (1968), p. 1 - 30

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON DESY
INSTITUTION Deutsches Elektronen-Synchrotron DESY
LOCATION Hamburg, W.Germany
PERSON IN CHARGE G. Hemmie
DATA SUPPLIED BY G. Hemmie DATE: 24.3.80

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1959
FIRST BEAM OBTAINED, or GOAL (date) 25.2.64
TOTAL COST OF FACILITY 110 MDM (orig. constr. costs)
FUNDED BY Government of W. Germany and Hamburg
TOTAL ACCELERATOR STAFF (now) 70
ANN.OPERAT.BUDGET DM 7 Mill. (without aalaries)
ANN.OPERATING TIME 7500 h
"BEAM ON" 95 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES e^-: $2.5 * 10^9$, e^+: $4 * 10^9$ single bunch
ENERGY 7.2 GeV
RING DIAM. 100.84 m; TUNNEL SECT.(WxH) 8.8 x 3.7 m

Injector

TYPE e^--Linac (or e^+-accumulator PIA)*
OUTPUT (max) $5 * 10^9$ e^- (10^{10} e^+) at 55 (450) MeV
EMITTANCE* 1 (0.5) πmm-mrad
INJECTION PERIOD 1 μs, or 1 turns
INFLECTOR TYPE septum + full aperture kicker

Magnet System

FOCUSING TYPE AG FIELD INDEX, n= (F) 69.51 (D) 70.16
FOCUSING ORDER FODO
BETATRON FREQ. ν_H 6.290 ν_V 6.225
No. MAGNETS 48 LENGTH (ea) 4.15 m
BENDING FIELD at inj. .0058(.047)T; at max .79(at 7.5 GeV)T
No. QUADS - LENGTH (ea) - m
GRAD. at inj. - T/m; at max - T/m
No. SHORT STRAIGHT SECT. 48 LENGTH 2.45 m
No. LONG STRAIGHT SECT. - LENGTH - m
RISE TIME $9 * 10^{-3}$ s; FLAT-TOP TIME 2 m s
POWER INPUT PEAK - MW; MEAN 1.7 MW

Acceleration System

No. CAVITIES 15 LENGTH (ea) .90 m
HARMONIC NUMBER 528
RF RANGE 499.667 MHz
ENERGY GAIN max. 1250 keV/turn
RADIATION LOSS at 7.5 GeV: 8860 keV/turn
RF POWER INPUT PEAK 1000 kW; MEAN 700 kW

Vacuum System

MATERIAL OF VAC.CHAMBER ceramic in magnets
APERTURE OF VAC.CHAMBER 100*70 (D); 120*38 (F) mm
AVERAGE PRESSURE $2 * 10^{-7}$ torr
PUMPS (No., type, speed) 62 * 150 l/s

Extraction System

TYPE i) 2 x beam bump - kicker - septum, fast, for DORIS
ii) 2 x " " " " " PETRA
iii) slow extraction controlled spillout for exp. hall II
LENGTH OF SPILL i) to < 1 μs
ii) to < 1 μs
iii) 500 to 3000 μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	7.2	7.5
RESOLUTION ΔE/E (%)	.05	.03
REPET.RATE (pulse/s)	50	50
PULSE WIDTH AT PEAK E	2 ms	3.1 ms**
DUTY FACTOR, macroscop.(%)	10	15.4
INTERNAL BEAM (part/pulse)	$2*10^9$ e^- ($4*10^9$ e^+)	$2*10^{10}$ e^+
(part/s)	$1*10^{11}$ (50 Hz)	$4*10^{10}$ (2Hz) } ***
EMITTANCE* AT PEAK E		πmm-mrad
OTHER DATA		

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.
γ	1 ... 7.25	3	parasitic operation
synchrotron radiation		2	
γ	1 ... 7.5	2	bb-controlled
			spillout

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 6400 m^2
No. INTERNAL TARGETS 4 No.EXT.TARGETS
No. SEPARATED BEAMS 3 γ test beams
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH ++++ MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN.RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

* Data in brackets for Positron-Intensity-Accumulator PIA - Injection

** With additional 200 Hz magnet excitation

*** single bunch operation

++++ For research the synchrotron is only used as source for test beams.

Recent Improvements or Modifications to Machine

Since 1978 DESY has mainly been used as an injector synchrotron for the two storage rings PETRA and DORIS instead of delivering primary beams for high energy physics experiments.

Published Articles Describing Machine

DESY 1977, A Multi-Purpose Particle Accelerator
Proceedings of the X. Internation Conference on High Energy Accelerators, Protvino, July 1977

DESY Annual Reports

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON 1.3 GeV Electron Synchrotron
INSTITUTION Institute for Nuclear Study, University of Tokyo
LOCATION Midori-cho, Tanashi-shi, Tokyo, Japan
PERSON IN CHARGE K. Yoshida DATE: March, 1980
DATA SUPPLIED BY K. Yoshida

HISTORY AND STATUS

CONSTRUCTION STARTED (date) January 1957
FIRST BEAM OBTAINED, or GOAL (date) 1961
TOTAL COST OF FACILITY ~$ 4M
FUNDED BY Japanese Government
TOTAL ACCELERATOR STAFF (now) 14
ANN. OPERAT. BUDGET ~$ 0.15M (without salaries)
ANN. OPERATING TIME 5,000 h
"BEAM ON" 97 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES Electrons
ENERGY 1.3 GeV
RING DIAM. 11.06m; TUNNEL SECT. (WxH) 14 (dia.) x 2.8 m

Injector
TYPE Linac
OUTPUT (max) 200 mA at 14 MeV
EMITTANCE* 0.5 π mm-mrad
INJECTION PERIOD 1.2 μs, or 10 turns
INFLECTOR TYPE Electrode and Pulse Magnets for Multi-turn Injection

Magnet System
FOCUSING TYPE AG FIELD INDEX, n= 14.8
FOCUSING ORDER 1/2 O · 1/2 F·D · 1/2 F · 1/2 O
BETATRON FREQ. ν_H 2.25 ν_V 2.25
No. MAGNETS 8 LENGTH (ea) 3.14 m
BENDING FIELD at inj. 0.0125 T; at max 1.08 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 8 LENGTH 1.2 m
No. LONG STRAIGHT SECT. LENGTH m
RISE TIME 20 m s; FLAT-TOP TIME s
POWER INPUT PEAK 0.9 MW; MEAN 0.45 MW

Acceleration System
No. CAVITIES 1 LENGTH (ea) 0.3 m
HARMONIC NUMBER 16
RF RANGE 138 MHz (Fixed) to MHz
ENERGY GAIN 10 keV/turn
RADIATION LOSS 63 keV/turn
RF POWER INPUT PEAK 20 kW; MEAN 4 ~ 5 kW

Vacuum System
MATERIAL OF VAC. CHAMBER Thin stainless-steel bellows
APERTURE OF VAC. CHAMBER 33 mm
AVERAGE PRESSURE 1×10^{-6} torr
PUMPS (No., type, speed) 11, Sputter Ion Pump 160 ℓ/sec

Extraction System
TYPE i) Internal Platinum Radiator for γ-beam
ii) Extraction System of Picciοni Scheme
iii) Fast Kicker Magnet and Pulse Bending Magnet
LENGTH OF SPILL i) 6 msec (Max.) to μs
ii) 6 msec (Max.) to μs
iii) 100 nsec to μs

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1.3	1.27
RESOLUTION ΔE/E (%)	0.1	0.1
REPET. RATE (pulse/s)	21.5	21.5
PULSE WIDTH AT PEAK E	Sinusoidal	
DUTY FACTOR, macroscop. (%)	6	13
INTERNAL BEAM (part/pulse)	5×10^{10}	1×10^{11}
(part/s)	1×10^{12}	2×10^{12}

EMITTANCE* AT PEAK E π mm-mrad
OTHER DATA

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other Inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 1,000 m^2
No. INTERNAL TARGETS 3 No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 4
TOTAL POWER USED (AVERAGE) FOR RESEARCH 0.7 MW
No. USER GROUPS: in house 2 outside 3
TOTAL RESEARCH STAFF, in house 16 outside 30
ANN. RESEARCH BUDGET, in house $ 0.15M (without sal.)
ANNUAL RESEARCH TIME 5,000 h

Other Relevant Parameters or Notable Features

The synchrotron works also as the injector of the 400 MeV electron storage ring for synchrotron radiation usage.

Recent Improvements or Modifications to Machine

Almost all components except magnet system have been renewed in these eight years.

Published Articles Describing Machine

1. H. Kumagai, et al., Japanese J. appl. Phys. 1 (1962) 66.
2. Annual Reports (1960~1979), Institute for Nuclear Study, University of Tokyo
3. K. Huke, et al., Japanese J. appl. Phys. 7 (1968) 1274.

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Cornell Electron Synchrotron
INSTITUTION Cornell University
LOCATION Ithaca, NY
PERSON IN CHARGE Maury Tigner DATE: March 1980
DATA SUPPLIED BY same

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1965
FIRST BEAM OBTAINED, or GOAL (date) May 1967
TOTAL COST OF FACILITY 11.5 M $
FUNDED BY National Science Foundation
TOTAL ACCELERATOR STAFF (now) 60*
ANN.OPERAT.BUDGET 4 M $ (without salaries)
ANN.OPERATING TIME 6000 h
"BEAM ON" 85 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES e^-, e^+
ENERGY 10 (12) GeV
RING DIAM. 240 m; TUNNEL SECT.(WxH) 3.5 x 3.5 m

Injector

TYPE Varian TW Linac
OUTPUT (max) 100 mA at 400 MeV
EMITTANCE* 5 π mm-mrad
INJECTION PERIOD 2.5 μs, or 1 turns
INFLECTOR TYPE Magnetic

Magnet System

FOCUSING TYPE AG FIELD INDEX, n= 437
FOCUSING ORDER FDDF
BETATRON FREQ. ν_H 10.75 ν_V 10.75
No. MAGNETS 192 LENGTH (ea) 3.4 m
BENDING FIELD at inj. 5 mT; at max 0.4 T
No. QUADS combined function LENGTH (ea) NA m
GRAD. at inj. NA T/m; at max NA T/m
No. SHORT STRAIGHT SECT. 4 LENGTH 6 m
No. LONG STRAIGHT SECT. 2 LENGTH 12 m
RISE TIME 8 ms; FLAT-TOP TIME 60 HZ Sine s
POWER INPUT PEAK - MW; MEAN 1.1 MW

Acceleration System

No. CAVITIES 4 LENGTH (ea) 5 m
HARMONIC NUMBER 1800
RF RANGE - to 714 MHz
ENERGY GAIN 6000 keV/turn
RADIATION LOSS 8800 keV/turn
RF POWER INPUT PEAK 500 kW; MEAN 120 kW

Vacuum System

MATERIAL OF VAC.CHAMBER
APERTURE OF VAC.CHAMBER 50 x 25 mm
AVERAGE PRESSURE 10^{-5} torr
PUMPS (No., type, speed) 100 oil diff. 200 l/s

Extraction System

TYPE i) single turn
ii) resonance with non-lin Control
iii)
LENGTH OF SPILL i) 1 bunch to μs
ii) 30 to 3000 μs
iii) to μs

Published Articles Describing Machine

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	12	12.2
RESOLUTION ΔE/E (%)	.5	.5
REPET.RATE (pulse/s)	60	60
PULSE WIDTH AT PEAK E	2×10^{-3} s	2×10^{-3} s
DUTY FACTOR, macroscop.(%)	12	12
INTERNAL BEAM (part/pulse)	10^{10}	3×10^{10}
(part/s)	.60	.60
EMITTANCE* AT PEAK E	0.1	π mm-mrad
OTHER DATA	NA	

SECONDARY BEAMS NA

Particle	Momentum range	No.of beams	Other Inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS N.A. * m^2
No. INTERNAL TARGETS No.EXT.TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN.RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

* Synchrotron used as injector for Cornell Electron Storage Ring (CESR) only. Staff and budget are for complete accelerator facility.

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON Syrius (Electron Synchrotron)
INSTITUTION Institute for Nuclear Physics, Polytechnical Institute of Tomsk
LOCATION USSR, Tomsk
PERSON IN CHARGE A.N.Didenko DATE: March, 80
DATA SUPPLIED BY N.A.Lashuk, V.M.Kuznetsov

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1958
FIRST BEAM OBTAINED, or GOAL (date) 1965
TOTAL COST OF FACILITY 2 M rubl
FUNDED BY Ministry of High and Middle Spec.Educ. RSFSR.
TOTAL ACCELERATOR STAFF (now) 34
ANN.OPERAT.BUDGET 200.000 rub. (without salaries)
ANN.OPERATING TIME 4000 h
"BEAM ON" 87 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

General
ACCELERATED PARTICLES electron
ENERGY 1,3 GeV
RING DIAM. 10,47 m; TUNNEL SECT.(WxH) x m

Injector
TYPE Microtron
OUTPUT (max) 80 mA at 6,4 MeV
EMITTANCE* $6,3 \times 1,6 \cdot 10^{-3}$ πmm-mrad
INJECTION PERIOD 5 μs, or 50 turns
INFLECTOR TYPE electrostatic

Magnet System
FOCUSING TYPE weak FIELD INDEX, n= 0,58
FOCUSING ORDER
BETATRON FREQ. ν_H 0,72 ν_V 0,85
No. MAGNETS 4 LENGTH (ea) 6,65 m
BENDING FIELD at inj. 53 10 T; at max 1,02 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. LENGTH m
No. LONG STRAIGHT SECT. 4 LENGTH 6,28 m
RISE TIME 0,04 s; FLAT-TOP TIME 0,02 s
POWER INPUT PEAK 1 MW; MEAN 0,5 MW

Acceleration System
No. CAVITIES 1 LENGTH (ea) m
HARMONIC NUMBER 4
RF RANGE to 36,5 MHz
ENERGY GAIN 3,25 keV/turn
RADIATION LOSS 65 keV/turn
RF POWER INPUT PEAK 80 kW; MEAN 2,5 kW

Vacuum System
MATERIAL OF VAC.CHAMBER porcelain
APERTURE OF VAC.CHAMBER 200x94 mm
AVERAGE PRESSURE $5 \cdot 10^{-6}$ torr
PUMPS (No., type, speed) 4, BA -273 3000 l/s

Extraction System
TYPE i) Septum-magnet
ii)
iii)
LENGTH OF SPILL i) to μs
ii) to μs
iii) to μs

Published Articles Describing Machine

A.A.Vorobiev et al. 1,5 GeV SYNCHROTRON TPI Atomizdat, Moscow (1968)

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1,0	1,3
RESOLUTION ΔE/E (%)	0,1	
REPET.RATE (pulse/s)	5	
PULSE WIDTH AT PEAK E	15 ms	
DUTY FACTOR, macroscop.(%)	8	
INTERNAL BEAM (part/pulse)	$5 \cdot 10^{10}$	
(part/s)	$2,5 \cdot 10^{11}$	

EMITTANCE* AT PEAK E πmm-mrad
OTHER DATA

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.
~~γ~~pol.		1	diamond
~~γ~~tagged		1	
synch.rad.		3	

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 500 m^2
No. INTERNAL TARGETS 3 No.EXT.TARGETS
No. SEPARATED BEAMS 3
No. BEAMS SERVED AT SAME TIME 2
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house 5 outside 1
TOTAL RESEARCH STAFF, in house 50 outside 5
ANN.RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF SYNCHROTRON: Yerevan 6-GeV Electron Synchrotron (ARUS)
INSTITUTION: Institute of Physics (GKAE)
LOCATION: Yerevan Armenia SSR, USSR
PERSON IN CHARGE: A.Ts.Amatuni Dir. DATE: April 1980
DATA SUPPLIED BY: E.M.Kasiev, Head of Acc.Dept.

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1962
FIRST BEAM OBTAINED, or GOAL (date) 25 October,1967
TOTAL COST OF FACILITY
FUNDED BY
TOTAL ACCELERATOR STAFF (now)
ANN.OPERAT.BUDGET (without salaries)
ANN.OPERATING TIME 4500 h
"BEAM ON" 75 % OF SCHEDULED TIME 1978

ACCELERATOR PARAMETERS

General

ACCELERATED PARTICLES electron
ENERGY 6 GeV
RING DIAM. 68,98 m; TUNNEL SECT.(WxH) 6,8 x 7,5 m

Injector

TYPE linac
OUTPUT (max) 170 mA at 50 MeV
EMITTANCE* 5horiz 2 vert π mm-mrad
INJECTION PERIOD 1 μs, or 1 turns
INFLECTOR TYPE pulsed electrostatic 58Kv

Magnet System

FOCUSING TYPE AG FIELD INDEX, n= 114,76
FOCUSING ORDER FOFDOD
BETATRON FREQ. ν_H 5,38 ν_V 5,38
No. MAGNETS 48 LENGTH (ea) 3,210 m
BENDING FIELD at inj. 0,0066T; at max 0,795 T
No. QUADS LENGTH (ea) m
GRAD. at inj. T/m; at max T/m
No. SHORT STRAIGHT SECT. 24 LENGTH 1,29 m
No. LONG STRAIGHT SECT. 24 LENGTH 1,328 m
RISE TIME 9,3 s; FLAT-TOP TIME s
POWER INPUT PEAK MW; MEAN 1,9 MW

Acceleration System

No. CAVITIES 23 LENGTH (ea) m
HARMONIC NUMBER 96
RF RANGE CW to 132,79 MHz
ENERGY GAIN 720 keV/turn
RADIATION LOSS max 4500 keV/turn
RF POWER INPUT PEAK 520 kW; MEAN 70 kW

Vacuum System

MATERIAL OF VAC.CHAMBER ceramic
APERTURE OF VAC.CHAMBER 42 x 120 mm
AVERAGE PRESSURE 10^{-6} torr
PUMPS (No., type, speed) molecular and titanium pumps

Extraction System

TYPE i)
ii)
iii)
LENGTH OF SPILL i) 1000 to 2000 μs
ii) to μs
iii) to μs

Published Articles Describing Machine

1) International Conference Proceedings on Accelerators Dubna page 235, Moscow, 1964
2) Yerevan Synchrotron Status and Improvement Programme Scientific seminar materials dedicated to Yerevan Synchrotron 10th anniversary. Yerevan 1978

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	4,5-5	6,1
RESOLUTION ΔE/E (%)	10	
REPET.RATE (pulse/s)	5	50
PULSE WIDTH AT PEAK E	2msec	3 msec
DUTY FACTOR, macroscop.(%)	10	2
INTERNAL BEAM (part/pulse)	x 10^{11}	0,7
(part/s)	x 10^{12} 1 / 5	3,5
EMITTANCE* AT PEAK E		π mm-mrad
OTHER DATA		

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.
~~γ~~ e-		3	
e+		1	
SR		3	

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 1800 m^2
No. INTERNAL TARGETS 3 No.EXT.TARGETS 2
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME 2
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN.RESEARCH BUDGET, in house (without sal.)
ANNUAL RESEARCH TIME h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% of current (for p-machines)

NAME OF ELECTRON LINEAR ACCELERATOR Accélérateur Linéaire d'ORSAY
INSTITUTION Laboratoire de l'Accélérateur Linéaire (L.A.L.) part of IN2P3 (1)
LOCATION Bâtiment 201, Université Paris-Sud, 91405 - ORSAY
PERSON IN CHARGE P. BRUNET DATE: 1973
DATA SUPPLIED BY P. BRUNET

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1956
FIRST BEAM OBTAINED, or GOAL (date) 1959
TOTAL COST OF FACILITY 10^8 F
FUNDED BY Ministry of Education
TOTAL ACCELERATOR STAFF (now) 50
ANN. OPERAT. BUDGET $1,93.10^6$ F (without salaries)
ANN. OPERATING TIME 2500 h
"BEAM ON" 75 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions
ACCELERATOR LENGTH 230 m, DIAM. 0,18 m
TUNNEL SIZE (LxHxW) 360 x 2,3 x 2 m

Injector
TYPE Diode Gun, Chopper, Pre-Buncher, 2 m TW. Buncher
OUTPUT 2300 mA at 20 MeV
BEAM EMITTANCE $\sim 10^{-2}$ πmm-mrad
INJECTION PERIOD 0.02→1,5μs 60→4500 RF cycles

Accelerator System
No. SECTIONS 1 Bch + 38 LENGTH (ea) 6 m
FIELD MODE π/2 FREQUENCY 3000 MHz
GROUP VELOCITY $5.10^{-2} \rightarrow 10^{-2}$ c; PHASE VEL. 1 c
WAVE TYPE T.W FILLING TIME .7 → 1 μs
SHUNT IMPEDANCE 45 →50 MΩ/m
ATTENUATION 0.54 →0.925 Np/m
IRIS, APERTURE 27/18 mm, THICKNESS 3 mm
IRIS SPACING 25 mm
Q 12000
POWER UNITS, No. 39 TYPE Klystron
POWER RATING 20/25 MW/unit
FEED SPACING 6 m
RF POWER INPUT PEAK 860 MW; MEAN 0.13 MW (3)

Focusing System
TYPE, No. of LENSES and SPACING 5 thin lenses
7 Triplets and 5 Doublets of quadrupoles
each 6 to 30 meters

Vacuum System
MATERIAL OF VAC.CHAMBER Copper ans St. Steel
APERTURE OF VAC.CHAMBER 25 mm average mm
AVERAGE PRESSURE 10^{-7} torr
PUMPS (No., type, speed) 41 ionic 140 L/s
12 oil diffusion 600 L/s

Published Articles Describing Machine

- Onde Electrique (Juillet 1969)
- L.A.L. - Rapport d'Activité 1976

(1) Institut National de Physique Nucleaire et de Physique des Particules.

(2) $e^- \leftrightarrow e^+$ converter after 16 sections e.g. ≈ 1.0 GeV

(3) Linac beams are not directly used for physics experiments any more but only for injection in storage rings ACO and DCI (Elementary particule and synchrotron radiation physics). The last experimental remaining room can handle a 500 MeV e^- or e^+ beam and is used for testing equipments.

See also DCI Storage Ring data sheet.

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
Electrons		
ENERGY (GeV)	1,2	2,3
ENERGY GAIN (MeV/m)	10	14
RESOLUTION ΔE/E (%)	1	
REPET. RATE (pulse/s)	50	150
PULSE WIDTH (μs)	.02 →1,5	3
DUTY FACTOR, macroscopic (%)	$10^{-4} \rightarrow 7,5.10^{-3}$	$2,25.10^{-2}$
BEAM CURRENT (μA)	1,5 →22,5	
BEAM EMITTANCE (πmm-mrad)	< 0,15	
Positrons (2)		
ENERGY (GeV)	1,3	1,4
ENERGY GAIN (MeV/m)	10	14
RESOLUTION ΔE/E (%)	1	
REPET.RATE (pulse/s)	50	
PULSE WIDTH (μs)	.02 & .3	
DUTY FACTOR, macroscopic (%)	10^{-4} & $1,5.10^{-3}$	
BEAM CURRENT (μA)	9.10^{-3} (20ns)	
BEAM EMITTANCE (πmm-mrad)	3,5	

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANN. RESEARCH TIME h

Other Relevant Parameters or Notable Features

Pulse duration may be continuously ajusted from 0,010 to 2,0 μs ;typical duration :
LINAC : 1,5 μs
ACO : 0,3 μs
DCI : 20 nanosecondes

Recent Improvements or Modifications to Machine

A new magnetic lens, with a strong adiabatically decreasing field is installed on the positron converter but not tested yet.

NAME OF ELECTRON LINEAR ACCELERATOR KEK Photon Factory 2.5 GeV Injector Electron Linac (P.F. Injector Linac)
INSTITUTION National Lab. for High Energy Physics (KEK)
LOCATION Oho-machi Tsukuba-gun Ibaraki-ken 305, Japan
PERSON IN CHARGE Jiro Tanaka
DATA SUPPLIED BY DATE: March 28, 1980

HISTORY AND STATUS

CONSTRUCTION STARTED (date) April 1, 1978
FIRST BEAM OBTAINED, or GOAL (date) Sept. 1981
TOTAL COST OF FACILITY ¥ 7 x 10^9
FUNDED BY Japanese Government
TOTAL ACCELERATOR STAFF (now) 7
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME h
"BEAM ON" % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH 320 m, DIAM. ∿ 0.1 m
TUNNEL SIZE (LxHxW) 400 x 3 x 5 m

Injector

TYPE E. Gun, SHB. PB. B. 2x2 m long Acc. guides
OUTPUT > 50 mA at 30 MeV
BEAM EMITTANCE < 1.5 πmm-mrad
INJECTION PERIOD 2 ns ∿ 2 μs 50 ~~RFxcycles~~ pps

Accelerator System

No. SECTIONS 160 LENGTH (ea) 1.9 m
FIELD MODE 2/3 π FREQUENCY 2856 MHz
GROUP VELOCITY 0.019∿0.0083 c; PHASE VEL. 1 c
WAVE TYPE T.W. Const.grad FILLING TIME 0.46∿0.56 μs
SHUNT IMPEDANCE 55.4 ∿ 60.3 MΩ/m
ATTENUATION 0.12 ∿ 0.29 Np/m
IRIS, APERTURE 24 ∿ 19.5 mm, THICKNESS 5 mm
IRIS SPACING 35 mm
Q > ∿ 13.000
POWER UNITS, No. 40 TYPE Klystron
POWER RATING > 30 MW/unit
FEED SPACING ∿ 10 m
RF POWER INPUT PEAK 1.200 MW; MEAN 0.18 MW

Focusing System

TYPE, No. of LENSES and SPACING

Vacuum System

MATERIAL OF VAC.CHAMBER s.s. & Cu
APERTURE OF VAC.CHAMBER > 50 mm
AVERAGE PRESSURE < 10^{-7} torr
PUMPS (No., type, speed)
42 ion pumps 500 ℓ/s, 42 ion pumps 50ℓ/s

Published Articles Describing Machine

"The Photon Factory 2.5 GeV Injector Electron Linac" J. Tanaka et al.; Proc. of the 1979 Linear Acc. Conference (KEK-PREPRINT-79-26) Jan. 1980

ACCELERATOR PERFORMANCE

(DESIGN)	Normal ~~(or Goal)~~	Maximum ~~achieved~~
Electrons		
ENERGY (GeV)	2.5 (at 840 MW)	3.0*)
ENERGY GAIN (MeV/m)	8.22 (at 50 mA)	9.87**)
RESOLUTION ΔE/E (%)	2 without E.G.S.	
REPET. RATE (pulse/s)	50	
PULSE WIDTH (μs)	> 1	
DUTY FACTOR, macroscopic (%)	> 0.005	
BEAM CURRENT (μA)	> av. 0.25 peak 50 mA	
BEAM EMITTANCE (πmm-mrad)	< 0.02	
Positrons	*)at 1.2000 MW	
ENERGY (GeV)	**)at 50 mA	
ENERGY GAIN (MeV/m)		
RESOLUTION ΔE/E (%)		
REPET.RATE (pulse/s)		
PULSE WIDTH (μs)		
DUTY FACTOR, macroscopic (%)		
BEAM CURRENT (μA)		
BEAM EMITTANCE (πmm-mrad)		

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS m^2
No. INTERNAL TARGETS No. EXT. TARGETS
No. SEPARATED BEAMS
No. BEAMS SERVED AT SAME TIME
TOTAL POWER USED (AVERAGE) FOR RESEARCH MW
No. USER GROUPS: in house outside
TOTAL RESEARCH STAFF, in house outside
ANN. RESEARCH BUDGET, in house (without sal.)
ANN. RESEARCH TIME h

Other Relevant Parameters or Notable Features

1. The linac will also be used as the electron and positron injector (TRISTAN) and other purposes.
2. It will be capable of producing pico-second range single bunches

Recent Improvements or Modifications to Machine

NAME OF ELECTRON LINEAR ACCELERATOR Stanford Linear Accelerator Center
INSTITUTION Stanford University
LOCATION Stanford, California 94305 U.S.A.
PERSON IN CHARGE W.K.H. Panofsky DATE: April 1980
DATA SUPPLIED BY R. H. Miller

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1962
FIRST BEAM OBTAINED, or GOAL (date) May 21, 1966
TOTAL COST OF FACILITY $114 M
FUNDED BY U.S. Atomic Energy Commission
TOTAL ACCELERATOR STAFF (now) Approximately 1040
ANN. OPERAT. BUDGET $20.9 M FY1980 (without salaries)
ANN. OPERATING TIME 5336 h
"BEAM ON" 90% % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions
ACCELERATOR LENGTH 3050 m, DIAM. 0.010 m
TUNNEL SIZE (LxHxW) 3350 x 3.05 x 3.35 m

Injector
TYPE Linac with two thermionic guns
OUTPUT 100 mA at 40 MeV
BEAM EMITTANCE 1.2 π mm-mrad
INJECTION PERIOD ∿ 1.6 μs ∿ 5,000 RF cycles

Accelerator System
No. SECTIONS 960 LENGTH (ea) 3.05 m
FIELD MODE 2π/3 FREQUENCY 2856 MHz
GROUP VELOCITY 0.02 - 0.0065 c; PHASE VEL. 1.0 c
WAVE TYPE TM,0,1 FILLING TIME 0.83 μs
SHUNT IMPEDANCE 53 MΩ/m
ATTENUATION 0.19 Np/m
IRIS, APERTURE 26 - 19 mm, THICKNESS 5.84 mm
IRIS SPACING 35 mm
Q 13000
POWER UNITS, No. 244 TYPE Klystron
POWER RATING 20 - 38 MW/unit
FEED SPACING 3 m
RF POWER INPUT PEAK 7300 MW; MEAN 7.0 MW at 360 pps.

Focusing System
TYPE, No. of LENSES and SPACING QUADS FODO
Array with 12 m spacing first 1000 m. Followed by doublets every 100 m for last 2000 m.

Vacuum System
MATERIAL OF VAC.CHAMBER Cu. and SS
APERTURE OF VAC.CHAMBER 17 mm
AVERAGE PRESSURE 1×10^{-8} torr
PUMPS (No., type, speed) 120 ion pumps 500 ℓ/s

Published Articles Describing Machine

R.B. Neal (ed.) "The Stanford Two-Mile Accelerator," W. A. Benjamin, Inc., 1968.

Loew, G. A. "Present and Future Developments on the SLAC Three-Kilometer Accelerator," p. 58, Xth International Conf. on High Energy Accel., Protvino, 1977.

ACCELERATOR PERFORMANCE

	Normal (or Goal)	Maximum achieved
Electrons		
ENERGY (GeV)	22[1]	24[1]
ENERGY GAIN (MeV/m)	7.5	8.3
RESOLUTION ΔE/E (%)	0.5	0.1
REPET. RATE (pulse/s)	60 - 360	360
PULSE WIDTH (μs)	1.6	1.6
DUTY FACTOR, macroscopic (%)	0.06	0.06
BEAM CURRENT (μA)	30	48
BEAM EMITTANCE (π mm-mrad)	2×10^{-2}	
Positrons		
ENERGY (GeV)	1.5 - 15	15
ENERGY GAIN (MeV/m)	7.5	8.3
RESOLUTION ΔE/E (%)	1.0	1.0
REPET.RATE (pulse/s)		360
PULSE WIDTH (μs)	1.6	1.6
DUTY FACTOR, macroscopic (%)	0.03	0.06
BEAM CURRENT (μA)	0.6	0.6
BEAM EMITTANCE (π mm-mrad)	0.1	

SECONDARY BEAMS

Particle	Momentum range	No.of beams	Other Inform.
$K^{\pm}$	1 - 16 GeV/c	1	∿ 10/pulse
P	1 - 16 GeV/c	1	40/pulse
$\bar{P}$	1 - 16 GeV/c	1	6/pulse
$\pi^{\pm}$	1 - 16 GeV/c	1	10^3/pulse
γ^2	20 GeV/c	1	10^2/pulse
γ Brems.	0 - 21.5 GeV/c	1	4×10^9 EQ
γ Coherent Brems.	5 - 15 GeV/c	1	5×10^7 EQ

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 2650 m[2]
No. INTERNAL TARGETS 1 for e^+ No. EXT. TARGETS 6
No. SEPARATED BEAMS 1
No. BEAMS SERVED AT SAME TIME 8
TOTAL POWER USED (AVERAGE) FOR RESEARCH 20 MW
No. USER GROUPS: in house 8 outside
TOTAL RESEARCH STAFF, in house 90 outside 270
ANN. RESEARCH BUDGET, in house $2.7 M (without sal.)
ANN. RESEARCH TIME 4210 h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

[1] In the SLED mode (i.e., with energy storage cavities in use) the accelerator has achieved 30 GeV with a peak beam current of 200 mA and 33.4 GeV at low current.

[2] Backscattered laser beam: Δp/p = 0.09 FWHM; to be used with the 40" Bubble Chamber Hybrid Facility.

NAME OF MACHINE TRIUMF Cyclotron
INSTITUTION TRIUMF (Meson Facility of Universities of Alberta, British Columbia, Victoria & Simon Fraser U
LOCATION UBC Campus, Vancouver, B.C., Canada V6T 2A3
PERSON IN CHARGE J.T. Sample
DATA SUPPLIED BY M.K. Craddock DATE: 25 March 1980

HISTORY AND STATUS

CONSTRUCTION STARTED (date) January 1970
FIRST BEAM OBTAINED (date) December 1974
TOTAL COST OF FACILITY Can$45,000,000
FUNDED BY Atomic Energy Control Board & TRIUMF Univs.
TOTAL ACCELERATOR STAFF (now) 180 (& NRC
ANN. OPERAT. BUDGET $5,825,000 (without salaries)
ANN. OPERATING TIME (1979) 6604 h
"BEAM ON" 88 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Ion Source

EXTERNAL { "Ehlers" hot filament arc (H^-); "Lamb Shift" polarized (H^-) }

Magnet

POLE FACE DIAM. 17.17 m; R ext 3.8,4.3,5.7 → 7.8 m
GAP, min 528 mm; FIELD 0.58 T
max mm; FIELD 0.20 T } at 0.72×10^6 A-turns
AVE FIELD at R max 0.46 T
AVF SECTORS 6
TOTAL POWER 1.3 MW

Acceleration System

No. DEES 2, WIDTH 16 m
HARMONIC NUMBER 5
RF RANGE 23.055 MHz
ENERGY GAIN 300 keV/turn
RF POWER INPUT PEAK 1.65 MW; MEAN 1.65 MW

Vacuum System

MATERIAL OF VAC. CHAMBER stainless steel
AVERAGE PRESSURE 6×10^{-8} torr
PUMPS (No., type, speed)
2 He-cooled 20 K cryopanels, 1.2 m^2

Extraction System

TYPE Electron stripping in Al or C foil

Published Articles Describing Machine

J.B. Warren, IEEE Trans. NS-18(3), 272 (1971).
J.J. Burgerjon, O.K. Fredriksson, A.J. Otter, W.A. Grundman, B.C. Stonehill, IEEE Trans NS-20(3), 243 (1973).
J.R. Richardson, Proc. 7th Int. Conf. on Cyclotrons and their Applications (Birkhäuser, Basel, 1975), p. 41.
G.H. Mackenzie, Proc. 10th Int. Conf. on High Energy Accelerators, Protvino (IHEP, Serpukhov, 1977), p. 184.
K.L. Erdman, IEEE Trans NS-26, 1958 (1978).
M.K. Craddock in *Meson-Nuclear Physics-1979*, ed. E.V. Hungerford III, AIP Conf. Proc. 54, 750 (1979).

ACCELERATOR PERFORMANCE -EXTERNAL P-BEAM

	Normal	Maximum achieved
ENERGY (MeV)	70, 90, 180-520	520
CURRENT (μA)	30/100	150
RESOLUTION ΔE/E (%)	0.3	0.1
REPET. RATE (pulse/s)	cw	
DUTY FACTOR, macroscopic (%)	100	
EMITTANCE* AT PEAK E	3	π mm-mrad
OTHER DATA	75% polarized beam of 200 nA	

Secondary Beams

Particle	Energy range	No. of beams	Other Infdrm.
π	20-120 MeV	1	$\leq 10^7$ π^+/s/μA
π	50-350 MeV	under constr[n]	0.1% Δp/p
π	15-65 MeV	1 separated	$\leq 10^6$ π^+/s/μA
μ	4-75 MeV	1 unsep[d]	$\leq 10^5$ μ^+/s/μA
μ	4-90 MeV	1	P = 60→100%
			P = 40→75%
n	160-500 MeV	1	$\leq 10^8$/s/200 nA
n	thermal	4	10^{12}/s/cm^2

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS 2350 m^2
No. INTERNAL TARGETS 0 No. EXT. TARGETS 7
No. SEPARATED BEAMS 1
No. BEAMS SERVED AT SAME TIME 7
TOTAL POWER USED (AVERAGE) FOR RESEARCH 1.5 MW
No. USER GROUPS: in house 0 outside 23
TOTAL RESEARCH STAFF, in house 6 outside 150
ANN. RESEARCH BUDGET, in house 0 (without sal.)
ANNUAL RESEARCH TIME 5250 h

Other Relevant Parameters or Notable Features

Simultaneous extraction of 3 independent proton beams, two continuously variable from 180-520 MeV, the third at 70 or 90 MeV. The ratio of intensities is variable from 1/1 to $1/10^4$. Preparations are under way for extraction of a fourth beam (400-500 MeV).

Applied programs in π^- cancer therapy
radioisotope production
proton radiography
fertile-to-fissile fuel conversion
positron emission tomography
neutron activation analysis

Recent Improvements or Modifications to Machine

82,900 μA-h beam delivered in 1979 (up a factor 3 from 1978).

0.1% energy resolution beams obtained over entire energy range.

Third harmonic rf is being coupled into the dee structure from a separate transmitter to flat-top the rf voltage (in progress).

Post-accelerator designs for a kaon factory are being considered, to which the cyclotron would act as a high intensity injector. Two synchrotron stages would enable 30-80 μA to be accelerated to 10 GeV and 30 μA to 30 GeV. Alternatively two isochronous ring cyclotrons would take 100-400 μA to 3 GeV and 8.5 GeV.

*Emittance = Area $x\beta\gamma$ at 90% of current

NAME OF MACHINE: Clinton P. Anderson Meson Physics Facility (LAMPF)
INSTITUTION: Los Alamos Scientific Laboratory
LOCATION: Los Alamos, New Mexico USA
PERSON IN CHARGE: Louis Rosen — DATE: March 1, 1980
DATA SUPPLIED BY: Donald Hagerman

HISTORY AND STATUS

CONSTRUCTION STARTED (date): 1968
FIRST BEAM OBTAINED, or GOAL (date): June 1972
TOTAL COST OF FACILITY: $57M
FUNDED BY: U. S. Department of Energy
TOTAL ACCELERATOR STAFF (now): 100
ANN. OPERAT. BUDGET: (without salaries)
ANN. OPERATING TIME: 4500 h (1979) h
"BEAM ON": 80% OF SCHEDULED TIME

ACCELERATOR PARAMETERS

Physical Dimensions

ACCELERATOR LENGTH: 785 m; DIAM.: m
TUNNEL SIZE (LxHxW): 900 X 4 X 4 m

Injection System

ION SOURCE: Duoplasmatron
OUTPUT: 30 mA EMITTANCE*: πmm-mrad
INJECTOR TYPE: Cockcroft-Walton (3)
OUTPUT: 25 mA EMITTANCE*: 0.3 πmm-mrad
BUNCHER: Double-drift, Single-frequency

ACCELERATION SYSTEM

	I	II
TYPE (Linac)	Drift Tube	Side-Coupled Cavity
BEAM ENERGY (MeV)	0.75-100	100-800
TOTAL LENGTH (m)	63	727
ENERGY GAIN (MeV/m)	1-1.9	1.1
RF FREQ. (MHz)	201.25	805
FIELD MODE	TM010	TM010
Q (x 10^3)	60-75	18-25
EQUIL. PHASE (°)	-26	-30
SHUNT IMPED. (MΩ/m)	60-70	38-47
FILLING TIME (μs)	220	80
No. TANKS	4	44
TANK DIAM.	94-88	26
No. DRIFT TUBES	161	-
DRIFT TUBE LENGTH (mm)	49-373	-
DRIFT TUBE DIAM. (mm)	180-160	-
GAP/CELL LENGTH RATIO	0.21-0.41	-
IRIS THICKNESS	-	-
IRIS SPACING	-	-
APERTURE (mm)	15-30	40
No. QUADS	134	104 doublets
GRADIENT (T/m)	77-5	20-30
No. RF POWER UNITS	4	44
RF POWER INPUT, PEAK (MW)	9.5	35
MEAN (MW)	1.3	4.2 (9% beam df)

Vacuum System

MATERIAL OF VAC. CHAMBER: Copper and stainless steel
APERTURE OF VAC. CHAMBER: - mm
AVERAGE PRESSURE: 3 X 10^{-8} torr
PUMPS (No., type, speed): 10 Ion pumps at 2400 ℓ/s and 133 Ion pumps at 600 ℓ/s

Published Articles Describing Machine

See proceedings of recent accelerator conferences and LAMPF Users Handbook.

ACCELERATOR PERFORMANCE

	Goal	Maximum achieved
ENERGY (GeV)	0.8	0.8
RESOLUTION ΔE/E (%)	0.5	0.2
REPET. RATE (pulse/s)	120	120
PULSE WIDTH AT PEAK E	1000 μs	750 μs
DUTY FACTOR, macroscop. (%)	12	9
INTERNAL BEAM (part/pulse)	5 X 10^{13}	3 X 10^{13}
(part/s)	6 X 10^{15}	4 X 10^{15}
EMITTANCE* AT PEAK E	3	πmm-mrad

OTHER DATA

SECONDARY BEAMS

Particle	Momentum range	No. of beams	Other Inform.
$\pi^{\pm}$	100-700 MeV/c	3	up to 10^9 π^+/s
$\pi^{\pm}$	125-400 "	1	For pion spectro.
$\mu^{\pm}$	0-250 "	1	> 10^7 μ^+/s
π^-	150-200 "	1	For biomed appl.
p	1000-1500 "	2	Up to 50 nA
p	1000-1500 "	1	For high res. spectro.
n	600-1500 "	1	
ν_e	20-50 "	1	
p	1500 "	1	For pulsed neutron TOF experiments

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS: 4600 m^2
No. INTERNAL TARGETS: No. EXT. TARGETS:
No. SEPARATED BEAMS:
No. BEAMS SERVED AT SAME TIME: 12
TOTAL POWER USED (AVERAGE) FOR RESEARCH: 25 MW
No. USER GROUPS: in house: outside:
TOTAL RESEARCH STAFF, in house: 25 outside: 429
ANN. RESEARCH BUDGET, in house: (without sal.)
ANNUAL RESEARCH TIME: 4000 h (1979)

Other Relevant Parameters or Notable Features

Simultansous H^+ and H^- beams are accelerated to full energy at same duty factor. Options on H^- are reduced energy (to 400 MeV), polarized 10-nA or, unpolarized 5-μA average current while H^+ beam is provided at 800 MeV, 600-μA average current. Irradiation facilities in primary and secondary proton beam stops are provided for radiochemistry and isotope production.

Recent Improvements or Modifications to Machine

Increased average current and duty factor, variable energy H^- and, polarized H^-.

*Emittance = Area xβγ at 90% of current

NAME OF MACHINE 590 MeV Isochron Ring Cyclotron 1)
INSTITUTION SIN - Swiss Institute for Nuclear Research
LOCATION 5234 Villigen, Switzerland
PERSON IN CHARGE Prof. Dr. J.P. Blaser, Director
DATA SUPPLIED BY Dr. H. Schryber DATE: March 1980

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1969
FIRST BEAM OBTAINED, or GOAL (date) Jan. 18, 1974
TOTAL COST OF FACILITY 130 MSFr. (Accelerators:
FUNDED BY Swiss Federal Government/ 47 MSFr)
TOTAL ACCELERATOR STAFF (now) 55
ANN.OPERAT.BUDGET 2.5 MSFr. 2) (without salaries)
ANN.OPERATING TIME 3200 h (590 MeVp on target)
"BEAM ON" 82 % OF SCHEDULED TIME

ACCELERATOR PARAMETERS (590 MeV Ring Cyclotron)

Ion Source
INTERNAL -
EXTERNAL Injector Cyclotron 72 MeV

Magnet 8 separate magnets
POLE FACE DIAM. m; R ext 4.45 m
GAP, min 50 mm; FIELD T
max 80 mm; FIELD 2.09 T } at 150'000
AVE FIELD at R max 0.87 T } A-turns
AVF SECTORS 8
TOTAL POWER 0.7 MW

Acceleration System
No. DEES/CAVITIES 4 cavities, 50.6 MHz
HARMONIC NUMBER 6
RF RANGE 0.3 MHz
ENERGY GAIN 2000 keV/turn
RF POWER INPUT PEAK MW; MEAN 4·0.16 MW

Vacuum System continuous
MATERIAL OF VAC.CHAMBER Aℓ + stainless steel
AVERAGE PRESSURE $2 \cdot 10^{-6}$ torr
PUMPS (No., type, speed)
4 titanium-sublimators 12'000 ℓ/s

Extraction System
TYPE electrostatic deflector, magnetic focusing channel, extraction magnet

Published Articles Describing Machine

1. H.A. Willax, IEEE Trans.Nucl.Sci., NS 20(3), 1973, 202
2. A. Baan et al., IEEE Trans.Nucl.Sci., NS 20(3), 1973, 257
3. J.P. Blaser, H.A. Willax, Proc.IX Int.Conf.on High Energy Acc. 1974, p.643
4. W. Joho et al., IEEE Trans.Nucl.Sci., NS 22(3), 1975,1397

ACCELERATOR PERFORMANCE -EXTERNAL P-BEAM

	Normal (or Goal)	Maximum achieved
ENERGY (MeV)	590	589±1
CURRENT (μA)	100	120
RESOLUTION ΔE/E (%)	< 0.1	
REPET.RATE (pulse/s)	continuous	
DUTY FACTOR, microscopic (%)	∿ 7	
EMITTANCE* AT PEAK E	2.0 horizontal	πmm-mrad
	1.0 vertical	πmm-mrad

Secondary Beams

Particle	Momentum range	No.of beams	Other Inform.
$\pi^{+/-}$	0-500 MeV/c	4	research
$\mu^{+/-}$	0-150 MeV/c	4	research
π^-	100-200 MeV/c	1 x 60	biomed.appl.
n		1	

RESEARCH PROGRAMME

TOTAL EXPERIMENTAL AREAS approx. 3'500 m^2
No. INTERNAL TARGETS - No. EXT.TARGETS 4
No. SEPARATED BEAMS 14, see 3)
No. BEAMS SERVED AT SAME TIME max. 10
TOTAL POWER USED (AVERAGE) FOR RESEARCH 3 MW
No. USER GROUPS: in house 1 outside 50
TOTAL RESEARCH STAFF, in house ∿10 outside ∿250
ANN.RESEARCH BUDGET, in house 3 MSFr. (without sal.)
ANNUAL RESEARCH TIME 4700 h

References in the above text:

1) Protons are accelerated in two stages. The first stage is an isochronous cyclotron for 72 MeV. It can also be used for the acceleration of ion beams (up to ^{16}O) of variable energy.

2) Accelerators only

3) 4 (π), 4 (μ), 1 ($\vec{p}$), 1 (p), 1 (n), 3 low energy beams

Additional comments:

The 590 MeV ring cyclotron consists of eight separated small gap magnets and four high voltage TE-cavities. Large ΔE/turn, extraction near $\nu_r \approx 1.5$ → large ΔR/turn → extraction efficiency over 99 %.

Design of components for easy access and repair. Power consumption total 4.5 MW (including injector and beam lines up to 2 π-production targets).

Transmission through ring cyclotron of 99.9 % (at 100 μA level) is achieved.

Essential use of beam: π-production.

A new 72 MeV injector cyclotron, designed for proton currents above 1000 μA, is under construction.

*Emittance = Area xβγ at 90% of current

NAME OF STORAGE RINGS INTERSECTING STORAGE RINGS (ISR)
INSTITUTION C E R N
LOCATION 1211 Geneva 23 / Switzerland
PERSON IN CHARGE F. Ferger DATE: March 1980
DATA SUPPLIED BY A. Hofmann

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1966
FIRST COLLISIONS, OR GOAL (date) January 1971
TOTAL COST OF FACILITY 326 M SFr
FUNDED BY CERN suppl. programme
TOTAL MACHINE STAFF (now) ∿ 250
ANN. OPERAT. BUDGET (without salaries)
ANN. OPERATING TIME 4000 h; "BEAM ON" 90 %

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES protons, deuterons
ENERGY 31.4 GeV
APPROX. SHAPE 2 circles DIMENSIONS 300m diam.
ORBIT: length 942.6 m, time 3.15 μs
No. INTERSECTS 8 CROSSING ANGLE 14.8 deg.

Injector System

Type CERN Proton Synchrotron (CPS)
INJ. ENERGY 26 GeV OUTPUT ∿ 3.10^{12} p per pulse
EMITTANCE* Ex ∿ 20, Ey ∿ 10 πmm-mrad
FILLING SPEED 0.4 pulses/s ; ∿ 25 mA/sec
TOTAL FILLING TIME 2 - 4 hours

Magnet System

FOCUSING TYPE comb. fct. BEND.RAD. 78.6 m
LATTICE ORDER FODO
No. MAGNETS 132/ring LENGTH (ea) 4.88/2.44 m
No. QUADS - LENGTH (ea) - m
MAX BEND.FIELD 1.33 T; MAX GRAD. 4.2 T/m
TOTAL WEIGHT (tons) Fe 44/22 Cu 5.2/3.2
OTHER MAGNETS special dipoles, quads, sextupoles
BETATRON FREQ. ν_H 8.90 ν_V 8.88
AMPL.FUNCT.AT INTERSECT, (H) 21/48** (V) 12.2/2.7** m

Acceleration System (used for filling only)

HARMONIC No. 30 FREQUENCY 9.5 + 3rd harm. MHz
No. TRANSMITTERS 7 + 1 No. CAVITIES 7 + 1 per ring
BUNCH TO BUNCH TIME 105 ns
BUNCH SIZE (LxWxH) 7500 x 7 x 5 mm^3 (full dim.)
PEAK RF VOLTAGE PER BEAM 16 KV
MAX RF POWER 10 + 18 KW ON BEAMS -

Vacuum System

PRESSURE IN RINGS, NO BEAM ∿ 4.10^{-12} Torr
WITH BEAM ∿ 4.10^{-12} Torr
PRESSURE AT INTERSECTIONS ≤ 10^{-12} Torr
PUMPS (No., Type, Speed) 150 ion pumps (400 l/s) + 350 subl. pumps (700 l/s) per ring

Published Articles Describing Machine

E. Keil, CERN, 72-14 (1979).

K. Johnson, Nucl. Instr. Meth. 108 (1973) 205.

K. Hübner, CERN, 77-15(1977).

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	11.8-31.4	31.4
RESOLUTION $\Delta E/E_2$ (%)	∿ 3	
LUMINOSITY (cm^{-2} sec^{-1})	0.21/0.4**	0.31/0.65** $.10^{32}$
BEAM SIZE, horizontal	60	mm
vertical	4.5/2.0*	mm
CURRENT, PER BEAM (A)	35	52
BEAM LIFE, AT 35 A	∿ 140	∿ 350 days

** in low β section.

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 6700 m^2
No. EXPERIMENTAL INTERSECTS 6
No. EXPERIMENTS/INTERSECT 1-2
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

Open Axial Field Magnet (OAFM, axial field)

Split Field Magnet (SFM, transv. field)

Supercond. Solenoid (axial field with low β)

TOTAL POWER USED (average) FOR RESEARCH 6 MW
No. USER GROUPS: in house particip. outside ∿ 36
TOTAL RESEARCH STAFF, in house ∿ 32 outside ∿ 170
ANN. RESEARCH BUDGET (without sal.)
ANN. RESEARCH TIME 3000 h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

Preparations for a super-conducting low-β insertion and for operation with antiprotons.

*Emittance = Area xβγ at 90% current (for p-machines)

NAME OF STORAGE RINGS D.C.I.
INSTITUTION Laboratoire de l'Accélérateur Linéaire
LOCATION ORSAY (France)
PERSON IN CHARGE P. MARIN DATE: March 1980
DATA SUPPLIED BY E.M. SOMMER

HISTORY AND STATUS

CONSTRUCTION STARTED (date) March 1971
FIRST COLLISIONS, OR GOAL (date) May 1976
TOTAL COST OF FACILITY 60 MF
FUNDED BY IN2P3
TOTAL MACHINE STAFF (now) 45
ANN.OPERAT. BUDGET 6 MF (without salaries)
ANN.OPERATING TIME 5700 h; "BEAM ON" 70 %

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES 2 × (e^+e^-)
ENERGY 1.85 GeV CeV
APPROX. SHAPE Race track DIMENSIONS 33 × 21 m^2
ORBIT: length 94.6 m, time 0.316 μs
No. INTERSECTS 2 CROSSING ANGLE 0

Injector System

Type Linac
INJ. ENERGY 0.7 - 1.0 GeV OUTPUT 10^9 e^+/20 ns pulse
EMITTANCE* 3.5 π mm-mrad
FILLING SPEED 1.6 A/hour (e^+)
TOTAL FILLING TIME Two rings < 1,15 hour

Magnet System

FOCUSING TYPE Sep funct. BEND.RAD. H:3,82 , V:4.1 m
LATTICE ORDER 2
No. MAGNETS 2 × 12 LENGTH (ea) 2 m
No. QUADS 2 × 28 LENGTH (ea) 0.45 m
MAX BEND.FIELD 1.6 T; MAX GRAD. 12 T/m
TOTAL WEIGHT (tons) Fe 800 Cu 80
OTHER MAGNETS 4 + 8 vertical dipoles
BETATRON FREQ. ν_H 3.80 ν_V 1.80
AMPL.FUNCT.AT INTERSECT, (H) 2.18 m (V) 2.18 m

Acceleration System

HARMONIC No. 8 FREQUENCY 25.352 MHz
No. TRANSMITTERS 2 No. CAVITIES 2 × 1

BUNCH TO BUNCH TIME 0.316 μs
BUNCH SIZE (LxWxH) At .8 GeV 250 × 1,3 × 1,3 mm^3
PEAK RF VOLTAGE PER BEAM 500 kV
MAX RF POWER 2 × 250 kW ON BEAMS 60 kW

Vacuum System

PRESSURE IN RINGS, NO BEAM 10^{-10} Torr
WITH BEAM 10^{-9} Torr
PRESSURE AT INTERSECTIONS 10^{-9} Torr
PUMPS (No., Type, Speed) 2 × 24 ionic, 2 × 50 sublimation } 10^5 ℓ

Published Articles Describing Machine

Proceedings of High Energy Accelerators Conferences.

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1.8	1.8
RESOLUTION $\Delta E/E_2$(%)	0.074 at 1.8 GeV	
LUMINOSITY (cm^{-2} sec^{-1})		1.4×10^{30} (1.56 GeV)
BEAM SIZE, horizontal	1.54 mm (σ_x)	
vertical	0.6 mm (σ_z)	
CURRENT, PER BEAM (A)	2 × 90 mA	
BEAM LIFE, AT 0.25 A	20 H	1.72 GeV

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 6 × 15 m^2
No. EXPERIMENTAL INTERSECTS 1
No. EXPERIMENTS/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:
DM2, Magnetic Detector in installation phase.

TOTAL POWER USED (average) FOR RESEARCH 2,3 MW
No. USER GROUPS: in house 1 outside 1
TOTAL RESEARCH STAFF, in house 20 outside †)
ANN. RESEARCH BUDGET 3.5 MF (without sal.)
ANN. RESEARCH TIME 70 % e^+e^- , 15 % SR , h

Other Relevant Parameters or Notable Features

- Two rings operating simultaneously .
- Peak luminosity scales like E^2.
- Luminosity after injection scales like I, the luminosity lifetime scales like single beam lifetime.

Recent Improvements or Modifications to Machine

- Second 250 kW transmitter installed.
- Second SR beam line on lower ring.
- Higher energy injection (tentatively 1.5 GeV).

†) 6 + SR users

*Emittance = Area xβγ at 90% current (for p-machines)

NAME OF STORAGE RINGS DORIS
INSTITUTION Deutsches Elektronen-Synchrotron DESY
LOCATION Hamburg W.Germany
PERSON IN CHARGE K. Wille DATE: March 1980
DATA SUPPLIED BY Nesemann, Wille

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1970
FIRST COLLISIONS, OR GOAL (date) Dec. 1973
TOTAL COST OF FACILITY 120 MDM
FUNDED BY Government of W.Germany and Hamburg
TOTAL MACHINE STAFF (now) 40
ANN. OPERAT. BUDGET 8 MDM(without salaries)**
ANN. OPERATING TIME 6500 h; "BEAM ON" 85 %

STORAGE RINGS PARAMETERS

General
COLLIDING PARTICLES $e^+ e^-$
ENERGY 1.5 - 5.1 GeV
APPROX. SHAPE oval DIMENSIONS 55x111 m^2
ORBIT: length 288 m, time 0.960 μs
No. INTERSECTS 2 CROSSING ANGLE 0°

Injector System
Type Synchrotron (DESY)
INJ. ENERGY 1.5 - 5.1 GeV OUTPUT
EMITTANCE* 0.4 - 1.0 πmm-mrad
FILLING SPEED 1.5 mA/sec
TOTAL FILLING TIME 30 sec

Magnet System
FOCUSING TYPE separated fct. BEND.RAD. 12.19 m
LATTICE ORDER
No. MAGNETS 24 LENGTH (ea) 3.19 m
No. QUADS 68 LENGTH (ea) 0.6/1.1 m
MAX BEND.FIELD 1.4 T; MAX GRAD. 13 T/m
TOTAL WEIGHT (tons) Fe 365 Cu 40
OTHER MAGNETS 12 sextupoles
BETATRON FREQ. ν_H 7.2 ν_V 5.3
AMPL.FUNCT.AT INTERSECT, (H) 1.2 m (V) 0.3 m

Acceleration System
HARMONIC No. 480 FREQUENCY 499.665 MHz
No. TRANSMITTERS 4 No. CAVITIES 8

BUNCH TO BUNCH TIME 2 - 960 nsec
BUNCH SIZE (LxWxH) 60 * 6 * 2 mm^3
PEAK RF VOLTAGE PER BEAM 16 MV
MAX RF POWER 1 MW ON BEAMS 160 kW

Vacuum System
PRESSURE IN RINGS, NO BEAM $5 * 10^{-10}$ Torr
WITH BEAM $3 * 10^{-9}$ Torr
PRESSURE AT INTERSECTIONS $1 * 10^{-9}$ Torr
PUMPS (No., Type, Speed) 24 IGP, 400 Torr l/sec
46 GP, 400 Torr l/sec

Published Articles Describing Machine
The DORIS Storage Ring Group: "DORIS at 5 GeV"; DESY 79/08, FEB. 1979

DESY Annual Reports

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1.5-5.1 GeV	5.1 GeV
RESOLUTION $\Delta E/E_2$ (%)	0.12 (5 GeV)	
LUMINOSITY (cm^{-2} sec^{-1})	$1 * 10^{30}$	$3 * 10^{30}$
BEAM SIZE, horizontal	0.8 mm	
vertical	0.1 mm	
CURRENT, PER BEAM (A)	0.02	0.05
	(single bunch)	
BEAM LIFE, AT 0.02 A	8	20

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 2100 m^2
No. EXPERIMENTAL INTERSECTS 2
No. EXPERIMENTS/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

TOTAL POWER USED (average) FOR RESEARCH 3 MW
No. USER GROUPS: in house 2 outside 1
TOTAL RESEARCH STAFF, in house 30 outside 45
ANN. RESEARCH BUDGET 28.4 Mio DM (without sal.)
ANN. RESEARCH TIME 6000 h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine
Injection from PIA

*Emittance = Area xβγ at 90% current (for p-machines)

** Incl. power cost

NAME OF STORAGE RINGS PETRA
INSTITUTION Deutsches Elektronen-Synchrotron DESY
LOCATION Hamburg, W.Germany
PERSON IN CHARGE D. Degèle DATE: 28.3.80
DATA SUPPLIED BY R. Kose

HISTORY AND STATUS

CONSTRUCTION STARTED (date) Jan. 76
FIRST COLLISIONS, OR GOAL (date) July 78
TOTAL COST OF FACILITY 98.000.000 DM
FUNDED BY Government of W. Germany and Hamburg
TOTAL MACHINE STAFF (now) 70
ANN.OPERAT. BUDGET DM 10 Mill. (without salaries)
ANN.OPERATING TIME 6100 h; "BEAM ON" for 1979 85 %

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES $e^+ e^-$
ENERGY 2 x 19 GeV
APPROX. SHAPE ring + 8 straights DIMENSIONS (r) = 366 m
ORBIT: length 2304 m, time 7.7 μs
No. INTERSECTS 4 CROSSING ANGLE 0

Injector System

Type Linac-(e^+-accumulator storage ring PIA)-Synchrotron (DESY)
INJ. ENERGY 7 GeV OUTPUT 2×10^9 e^+/pulse
EMITTANCE* 2 π mm-mrad
FILLING SPEED 0.5 mA/sec
TOTAL FILLING TIME 10 min

Magnet System

FOCUSING TYPE sep. fct. BEND.RAD. 192 m
LATTICE ORDER FODO
No. MAGNETS 224 + 8 LENGTH (ea) 5.38 m
No. QUADS 16/60/232 LENGTH (ea) 1.8/1.0/.6 m
MAX BEND.FIELD .4 T; MAX GRAD. 16 T/m
TOTAL WEIGHT (tons) Fe 2147 Cu Al 124
OTHER MAGNETS 152 Sextupoles
BETATRON FREQ. ν_H 25.2 ν_V 23.3
AMPL.FUNCT.AT INTERSECT, (H) 3 m (V) .2 m

Acceleration System

HARMONIC No. 3840 FREQUENCY 499.665 MHz
No. TRANSMITTERS 4 No. CAVITIES 64 (5 cell)

BUNCH TO BUNCH TIME 3.8 μsec
BUNCH SIZE (LxWxH) σ 15 * 2.5 * .04 mm
PEAK RF VOLTAGE PER BEAM 100 MV
MAX RF POWER 4.4 MW ON BEAMS

Vacuum System

PRESSURE IN RINGS, NO BEAM $< 2 * 10^{-9}$ Torr
WITH BEAM $< 10^{-10}$ Torr/mA
PRESSURE AT INTERSECTIONS 10^{-9} Torr
PUMPS (No., Type, Speed) 100 l/sec * m sputter ion pumps

Published Articles Describing Machine

The 19 GeV e^+e^- Storage Ring PETRA,
Proc. of the 1979 Particle Acc. Conf., San Francisco March 1979

DESY Annual Reports

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	19	19
RESOLUTION $\Delta E/E_2$ (%)	$6*10^{-3}$ *E(GeV)	
LUMINOSITY (cm^{-2} sec^{-1})		$5*10^{30}$
BEAM SIZE, horizontal	0.8 mm	
vertical	0.03 mm	
CURRENT, PER BEAM (A)		2 * .015
BEAM LIFE, AT .02 A		10 h

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 5x600 + 1x1200 m^2
No. EXPERIMENTAL INTERSECTS 4
No. EXPERIMENTS/INTERSECT 1 (2)
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

TOTAL POWER USED (average) FOR RESEARCH 8 MW
No. USER GROUPS: ~~xxxxxxxx~~ 5 ~~xxxxxxx~~ Int.Coll.
TOTAL RESEARCH STAFF, in house 100 outside 254
ANN. RESEARCH BUDGET 34.4 Mio DM (without sal.)
ANN. RESEARCH TIME 6000 h

Other Relevant Parameters or Notable Features

Recent Improvements or Modifications to Machine

e^+ accumulator storage ring PIA taken into operation

*Emittance = Area xβγ at 90% current (for p-machines)

NAME OF STORAGE RINGS ADONE
INSTITUTION I.N.F.N. - ISTITUTO NAZIONALE DI FISICA NUCLEARE
LOCATION L.N.F. - LABORATORI NAZIONALI DI FRASCATI - FRASCATI (ROMA) ITALY
PERSON IN CHARGE S. TAZZARI DATE: 24/3/1980
DATA SUPPLIED BY S. TAZZARI / A. REALE

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1964
FIRST COLLISIONS, OR GOAL (date) 1969
TOTAL COST OF FACILITY ~ $9\ 10^6$ US$
FUNDED BY C.N.E.N. (2/3); C.N.R. (1/3)
TOTAL MACHINE STAFF (now) 50
ANN. OPERAT. BUDGET ____ (without salaries)
ANN. OPERATING TIME 5000 h; "BEAM ON" 90 %

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES e^+, e^-
ENERGY 1.5 GeV
APPROX. SHAPE circular DIMENSIONS 33.42 m diam.
ORBIT: length 105 m, time 0.350 μs
No. INTERSECTS 6 CROSSING ANGLE Ø

Injector System

Type LINAC
INJ. ENERGY 320 MeV OUTPUT 0.1 A e^-; .5 mA e^+
EMITTANCE* ~ 10 π π mm-mrad
FILLING SPEED ~ 10 mA/s e^-; ~5 mA/m e^+
TOTAL FILLING TIME ~ 20 m

Magnet System

FOCUSING TYPE Sep.funct. BEND.RAD. 5.00 m
LATTICE ORDER 0/2 FODOBODOF 0/2
No. MAGNETS 12 LENGTH (ea) 2.618 m
No. QUADS 48 LENGTH (ea) .5 m
MAX BEND.FIELD 1 T; MAX GRAD. 5 T/m
TOTAL WEIGHT (tons) Fe 350 Cu 30
OTHER MAGNETS ____
BETATRON FREQ. ν_H 3.1 ν_V 3.1
AMPL.FUNCT.AT INTERSECT, (H) 9 m (V) 3.2 m

Acceleration System

HARMONIC No. 3 FREQUENCY 8.5685 MHz
No. TRANSMITTERS 4 No. CAVITIES 2 x 2

BUNCH TO BUNCH TIME 117 ns
BUNCH SIZE (LxWxH) ~600 x 3.2 x 1.8 mm^3
PEAK RF VOLTAGE PER BEAM 160 KV/turn
MAX RF POWER 190 KW ON BEAMS 20 KW

Vacuum System

PRESSURE IN RINGS, NO BEAM ~ 10^{-10} Torr
WITH BEAM ~ 10^{-9} Torr
PRESSURE AT INTERSECTIONS ≤ 10^{-9} Torr
PUMPS (No., Type, Speed) 28 x 500 lt/s

Published Articles Describing Machine

- ADONE Status Report - Proc. of the Int. Conf. on High Energy Acc. - Dubna (1963)
- F. Amman et al.: Lettere al Nuovo Cimento - Serie I, Vol. 1, pag. 729-737 (1969)
- Status Report on the e^+ e^- storage ring ADONE - Proc. of the 1971 Particle Acc. Conf. - Geneva, p. 132.

*Emittance = Area xβγ at 90% current (for p-machines)

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1.5	1.57
RESOLUTION $\Delta E/E_2$ (%)	$5.7\ 10^{-4}$	
LUMINOSITY ($cm^{-2}\ sec^{-1}$)	6×10^{29}	
BEAM SIZE, horizontal mm	3.2 (2σ)	
vertical mm	~1.8 (2σ)	
CURRENT, PER BEAM (A)	0.06	
BEAM LIFE, AT .1 A	~ 10 h	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA ____ m^2
No. EXPERIMENTAL INTERSECTS 4
No. EXPERIMENTS/INTERSECT H.E.P. program discontinued '78
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:
- LADON: Laser backscatter monochromatic γ-ray facility ($5 \leqslant E\gamma \leqslant 80$ MeV)
- PULS: Synchrotron light facility; 5 channels (λ_c = 8.3 Å)
- PWA: Synchrotron light channel from 1.9 T, 6 pole wiggler magnet (λ_c = 4.4 Å)

TOTAL POWER USED (average) FOR RESEARCH ~ 1.5 MW
No. USER GROUPS: ~~in house~~ 21 ~~outside~~ mixed
TOTAL RESEARCH STAFF, in house 15 outside 70
ANN. RESEARCH BUDGET 1.5 M$ (without sal.)
ANN. RESEARCH TIME 18000 h

Other Relevant Parameters or Notable Features

35% of research time is devoted to LINAC users. Nuclear Physics program: LEALE:
- $\pi^{\pm}$ beams
- annihilation monochromatic γ-ray beam (60 ÷ 300 MeV)

Recent Improvements or Modifications to Machine

1.9 T/6 pole wiggler added.

NAME OF STORAGE RINGS: ISABELLE
INSTITUTION: Brookhaven National Laboratory
LOCATION: Upton, Long Island, NY
PERSON IN CHARGE: J.R. Sanford
DATA SUPPLIED BY: DATE: 3/28/80

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 2nd Quarter FY 1978
FIRST COLLISIONS, OR GOAL (date) April 1986
TOTAL COST OF FACILITY $276,750,000
FUNDED BY U.S. Department of Energy
TOTAL MACHINE STAFF (now) 295
ANN.OPERAT. BUDGET --- (without salaries)
ANN.OPERATING TIME --- h; "BEAM ON" 50%

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES Protons
ENERGY 60 to 800 center-of-mass GeV
APPROX. SHAPE circular DIMENSIONS 610 m radius
ORBIT: length 3833 m, time 12.8 μs
No. INTERSECTS 6 CROSSING ANGLE 11.18 mr

Injector System

Type Alternating Gradient Synchrotron (AGS)
INJ. ENERGY 30 GeV OUTPUT 2.7×10^{12}/pulse
EMITTANCE* Normalized, Horiz.+Vert. 15 πmm-mrad
FILLING SPEED Min. 1.3 sec/pulse stacking time
TOTAL FILLING TIME 10 minutes (minimum)

Magnet System

FOCUSING TYPE AG BEND.RAD. 267 m
LATTICE ORDER Q_F BBB Q_D BBB
No. MAGNETS 732 LENGTH (ea) 4.75 m
No. QUADS 352 LENGTH (ea) 1.80 m
MAX BEND.FIELD 5 T; MAX GRAD. 60T/m
TOTAL WEIGHT (tons) Fe ∿5000 Cu Superconducting
OTHER MAGNETS
BETATRON FREQ. ν_H 22.62 ν_V 22.62
AMPL.FUNCT.AT INTERSECT, (H) 43 m (V) 7.5 m

Acceleration System

HARMONIC No. 3 FREQUENCY 0.235 MHz
No. TRANSMITTERS 3/ring No. CAVITIES 3/ring
(1 stacking rf system/ring at 4.45 MHz)
BUNCH TO BUNCH TIME 2.84 μsec
BUNCH SIZE (LxWxH) 639 m x 62 mm x 5 mm at 30 GeV
PEAK RF VOLTAGE PER BEAM 36 kV
MAX RF POWER 600 kW/ring ON BEAMS 66 kW/ring

Vacuum System

PRESSURE IN RINGS, NO BEAM H_2 3×10^{-11} Torr
WITH BEAM H_2 3×10^{-11} Torr
PRESSURE AT INTERSECTIONS 1×10^{-11} Torr
PUMPS (No., Type, Speed) 714 ion pumps S = 20 ℓ/s
1428 Ti-sublimation pumps S = 1600 ℓ/sec (H_2)

Published Articles Describing Machine

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	800 center-of-mass	
RESOLUTION $\Delta E/E_2$(%)	0.3	
LUMINOSITY (cm^{-2} sec^{-1})	2×10^{32}–10^{33}	
BEAM SIZE, horizontal	1.9 mm) at 400 GeV	
vertical	0.8 mm)	
CURRENT, PER BEAM (A)	8 A	
BEAM LIFE, AT ___ A	many days	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 4000 m^2
No. EXPERIMENTAL INTERSECTS 6
No. EXPERIMENTS/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

TOTAL POWER USED (average) FOR RESEARCH 3 MW
No. USER GROUPS: in house 1 outside 5
TOTAL RESEARCH STAFF, in house 50 outside 250
ANN. RESEARCH BUDGET -- (without sal.)
ANN. RESEARCH TIME -- h

Other Relevant Parameters or Notable Features

ISABELLE uses superconducting magnets. 732 dipoles and 352 quadrupoles are required.

The refrigerator must remove 23.5 kW from supercritical helium below 4 K and 55 kW from helium gas at about 50 K.

4 closed areas, capable of supporting major equipment with utilities and basis for radiation shielding.

2 open areas in which temporary shielding enclosures can be built for less extensive experiments.

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% current (for p-machines)

NAME OF STORAGE RINGS Cornell Electron Storage Ring - CESR
INSTITUTION Cornell University
LOCATION Ithaca, NY
PERSON IN CHARGE Maury Tigner DATE: March 1980
DATA SUPPLIED BY same

HISTORY AND STATUS

CONSTRUCTION STARTED (date) Nov. 1978
FIRST COLLISIONS, OR GOAL (date) June 1979
TOTAL COST OF FACILITY 20 M $
FUNDED BY National Science Foundation
TOTAL MACHINE STAFF (now) 60
ANN.OPERAT. BUDGET 5 M $ (without salaries)
ANN.OPERATING TIME 6000 h; "BEAM ON" 85 %

STORAGE RINGS PARAMETERS

General
COLLIDING PARTICLES e^+ e^-
ENERGY 8 x 8 GeV
APPROX. SHAPE Circular DIMENSIONS R = 120 M
ORBIT: length 768 m, time 2.5 μs
No. INTERSECTS 2 CROSSING ANGLE 0

Injector System
Type Synchrotron/Linac
INJ. ENERGY 200 MeV OUTPUT 8 GeV
EMITTANCE* 0.1 π mm-mrad
FILLING SPEED 2mA/min e^+, 5mA/min e^-
TOTAL FILLING TIME 1 hour

Magnet System
FOCUSING TYPE AG BEND.RAD. 88 m
LATTICE ORDER FODO
No. MAGNETS 94 LENGTH (ea) 6.6 m
No. QUADS 98 LENGTH (ea) .6 m
MAX BEND.FIELD .3 T; MAX GRAD. 13 T/m
TOTAL WEIGHT (tons) Fe 700 Cu
OTHER MAGNETS
BETATRON FREQ. ν_H 9 to 11 ν_V 9 to 11
AMPL.FUNCT.AT INTERSECT, (H) 1 m (V) 0.1 m

Acceleration System
HARMONIC No. 1281 FREQUENCY 500 MHz
No. TRANSMITTERS 2 No. CAVITIES 2

BUNCH TO BUNCH TIME 2.5 μ sec.
BUNCH SIZE (LxWxH) (σ) 4 cm x 1 mm x .1 mm
PEAK RF VOLTAGE PER BEAM 12 MV
MAX RF POWER 1.6 MW ON BEAMS 1 MW

Vacuum System
PRESSURE IN RINGS, NO BEAM 10^{-9} Torr
WITH BEAM 10^{-8} Torr
PRESSURE AT INTERSECTIONS 4×10^{-9} Torr
PUMPS (No., Type, Speed) 140 sputter ion 150 l/sec

Published Articles Describing Machine

Proc. 1980 Intnl Acc. Conf.

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	8	5.5
RESOLUTION $\Delta E/E_2$(%)	0.1	
LUMINOSITY (cm^{-2} sec^{-1})	10^{32}	3×10^{30}
BEAM SIZE, horizontal	1 mm	
vertical	.1 mm	
CURRENT, PER BEAM (A)	.1	.04
BEAM LIFE, AT .04 A	6 hr	4 hr

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 1000 m^2
No. EXPERIMENTAL INTERSECTS 2
No. EXPERIMENTS/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

General Purpose Magnetic Detector

TOTAL POWER USED (average) FOR RESEARCH 2 MW
No. USER GROUPS: in house 1 outside 8
TOTAL RESEARCH STAFF, in house 25 outside
ANN. RESEARCH BUDGET * (without sal.)
ANN. RESEARCH TIME 4000 h

Other Relevant Parameters or Notable Features

* Incl. in 5 M $ Total Operating Budget

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% current (for p-machines)

NAME OF STORAGE RINGS SPEAR
INSTITUTION Stanford Linear Accelerator Center
LOCATION 2575 Sand Hill Road, Menlo Park, CA 94305 U.S.A.
PERSON IN CHARGE J. R. Rees DATE: 3-22-80
DATA SUPPLIED BY J. Harris

HISTORY AND STATUS

CONSTRUCTION STARTED (date) August 1972
FIRST COLLISIONS, OR GOAL (date) April 1972
TOTAL COST OF FACILITY $ 5 x 10^6
FUNDED BY U.S. DOE
TOTAL MACHINE STAFF (now) 20
ANN. OPERAT. BUDGET $ 1 x 10^6 (without salaries)
ANN. OPERATING TIME 5000 h; "BEAM ON" 75 %

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES e^+, e^-
ENERGY 1·0 → 4.2 GeV
APPROX. SHAPE Ring DIMENSIONS 80m Dia.
ORBIT: length 234 m, time 0·781 μs
No. INTERSECTS 2 CROSSING ANGLE 0

Injector System

Type Stanford Linear Accelerator
INJ. ENERGY 1·5 → 2.6 GeV OUTPUT
EMITTANCE* π x 1 x 0.4 πmm-mrad
FILLING SPEED 5 → 50 mA/min.
TOTAL FILLING TIME 5 → 50 minutes

Magnet System

FOCUSING TYPE SEP BEND.RAD. 12·7 m
LATTICE ORDER OFBDBFO
No. MAGNETS 36 LENGTH (ea) 2.35 m
No. QUADS 46 LENGTH (ea) 0.5 m
MAX BEND.FIELD 1·15 T; MAX GRAD. .67 T/m
TOTAL WEIGHT (tons) Fe 220 Cu Al 10 tons
OTHER MAGNETS 8 insertion Q, 52 Sext., 4 Oct.
BETATRON FREQ. ν_H 5.27 ν_V 5.17
AMPL.FUNCT.AT INTERSECT, (H) 1·2m (V) 0·1m

Acceleration System

HARMONIC No. 280 FREQUENCY 358.53 MHz
No. TRANSMITTERS 4 No. CAVITIES 4 x 5

BUNCH TO BUNCH TIME 781 nsec
BUNCH SIZE (LxWxH) 30 x 3 x 0·1 mm
PEAK RF VOLTAGE PER BEAM 4 MV
MAX RF POWER 200 KW ON BEAMS

Vacuum System

PRESSURE IN RINGS, NO BEAM 3×10^{-10} Torr
WITH BEAM 3×10^{-9} Torr
PRESSURE AT INTERSECTIONS 1×10^{-9} Torr
PUMPS (No., Type, Speed) 20 Ion 400 l/sec
36 Ion 600 l/sec

Published Articles Describing Machine

The SLAC Storage Ring

Project - SPEAR:
VIIIth Accelerator Conference
CERN, 1971

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1·5-3.5	4.2
RESOLUTION $\Delta E/E_2$(%)	0.1	
LUMINOSITY (cm^{-2} sec^{-1})	2×10^{30}	1×10^{31} @ 3.7 GeV
BEAM SIZE, horizontal	3 mm	
vertical	0.1 mm	
CURRENT, PER BEAM (A)	0.01@ 2.0 GeV	0.1A*
BEAM LIFE, AT 0.02 A	5	20*

*Single Beam

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 2 x 120 m^2
No. EXPERIMENTAL INTERSECTS 2
No. EXPERIMENTS/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

XDS Σ5 Computer Available For On Line Data Analysis

TOTAL POWER USED (average) FOR RESEARCH 3 MW
No. USER GROUPS: in house 1 outside 1
TOTAL RESEARCH STAFF, in house 10 outside 10
ANN. RESEARCH BUDGET NA (without sal.)
ANN. RESEARCH TIME 3000 h

Other Relevant Parameters or Notable Features

1. Modified to provide 5 outlets for synchrotron radiation beams, derived from bending magnets and from 6 pole, 1·8 T wiggler magnet.
2. Laser polarimeter installed.

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% current (for p-machines)

NAME OF STORAGE RINGS POSITRON ELECTRON PROJECT PEP
INSTITUTION STANFORD LINEAR ACCELERATOR CENTER
LOCATION STANFORD, CALIFORNIA, USA
PERSON IN CHARGE J. R. REES DATE: MARCH 17, '80
DATA SUPPLIED BY H. WIEDEMANN

HISTORY AND STATUS

CONSTRUCTION STARTED (date) November 1976
FIRST COLLISIONS, OR GOAL (date) April 1980
TOTAL COST OF FACILITY $78 million
FUNDED BY USDOE
TOTAL MACHINE STAFF (now) 98
ANN. OPERAT. BUDGET -- (without salaries)
ANN. OPERATING TIME -- h; "BEAM ON" -- %

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES Positron-Electron
ENERGY 4 to 18 GeV
APPROX. SHAPE round DIMENSIONS 700 m ϕ
ORBIT: length 2200 m, time 7.3 μs
No. INTERSECTS 6 CROSSING ANGLE 0

Injector System

Type Stanford Linear Accelerator Center (SLAC)
INJ. ENERGY 4 to 18 GeV OUTPUT e^+: 10^8 in 1 nsec
EMITTANCE* e^-: 0.02 e^+: 0.2 πmm-mrad
FILLING SPEED e^+: 2 ma/min (5 GeV) to 10ma/min (15GeV)
TOTAL FILLING TIME 5 to 10 min

Magnet System

FOCUSING TYPE sep. funct BEND. RAD. 165.52 m
LATTICE ORDER FODO
No. MAGNETS 192 LENGTH (ea) 5.40 m
No. QUADS 248 LENGTH (ea) .55 to 2.0 m
MAX BEND. FIELD .3625 T; MAX GRAD. 17.6 T/m
TOTAL WEIGHT (tons) Fe 1800 Al 90
OTHER MAGNETS Sextupoles (192), Wiggler Magnets (3)
BETATRON FREQ. ν_H 18.25 to 36.25 ν_V 18.75
AMPL. FUNCT. AT INTERSECT, (H) 3.0 m (V) .11 m

Acceleration System

HARMONIC No. 2592 FREQUENCY 323.21 MHz
No. TRANSMITTERS 12 No. CAVITIES 24

BUNCH TO BUNCH TIME 2.43 μsec
BUNCH SIZE (LxWxH) $\sigma_e x \sigma_x x \sigma_y$ = 20 x 1.7 x 1.0 mm
PEAK RF VOLTAGE PER BEAM 50 MV @ 15 GeV
MAX RF POWER 6.0 MW ON BEAMS 5.0 MW (max)

Vacuum System

PRESSURE IN RINGS, NO BEAM TYP. $5 \cdot 10^{-10}$ Torr
WITH BEAM $< 1 \times 10^{-8}$ Torr
PRESSURE AT INTERSECTIONS 5×10^{-9} Torr
PUMPS (No., Type, Speed) Sputter Ion Pump 220 1t/sec
108 Sputter Ion Pump 100 1t/sec
196 Distrib. Pmup 500 1t/sec

Published Articles Describing Machine

A proposal for a Positron Electron Colliding Beam Storage Ring Project (PEP) SLAC-171

PEP-Conceptual Design Report SLAC-189
The Positron Electron Project - PEP J. R. Rees
IEEE Vol. NS-24, No. 3, p 1836 (1977)

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	15 18	
RESOLUTION $\Delta E/E_2$ (%)	.10 .12	
LUMINOSITY (cm^{-2} sec^{-1})	10^{32} 5×10^{31}	
BEAM SIZE, horizontal (mm)	.60 .50	
at Int. Pt. vertical (mm)	.03 .01	
CURRENT, PER BEAM (A)	.055 .0055	
BEAM LIFE, AT .050 A	2 to 6 h	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 1000 m^2
No. EXPERIMENTAL INTERSECTS 6
No. EXPERIMENTS/INTERSECT 1 to 2
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:

1) Time projection chamber (TCP) and 1.5 T super conducting solenoid
2) Lepton total energy detector (MAC)
3) High resolution spectrometer (HRS) 1.7 T super conducting Argonne Bubble Chamber Magnet

TOTAL POWER USED (average) FOR RESEARCH 10 MW
No. USER GROUPS: in house and outside 9
TOTAL RESEARCH STAFF, in house and outside 300
ANN. RESEARCH BUDGET -- (without sal.)
ANN. RESEARCH TIME -- h

Other Parameters or Notable Features

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% current (for p-machines)

- 9 JUIL. 1980

Unfortunately, the data sheets on VEPP-2M and VEPP-4, Novosibirsk, arrived after the deadline and could therefore not be included in the Catalogue for High Energy Accelerators.

J.H.B. Madsen

P.H. Standley

CERN - June 1980

NAME OF STORAGE RINGS VEPP-2M
INSTITUTION Institute of Nuclear Physics
LOCATION Novosibirsk, USSR
PERSON IN CHARGE Ju.M.Shatunov
DATA SUPPLIED BY _____ DATE: March, 198

HISTORY AND STATUS

CONSTRUCTION STARTED (date) 1970
FIRST COLLISIONS, OR GOAL (date) 1974
TOTAL COST OF FACILITY _____
FUNDED BY _____
TOTAL MACHINE STAFF (now) 37
ANN.OPERAT. BUDGET _____ (without salaries)
ANN.OPERATING TIME _____ h; "BEAM ON" 70 %

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES e^+, e^-
ENERGY 0,7 GeV
APPROX. SHAPE racetrack DIMENSIONS _____
ORBIT: length 18 m, time 0.06 μs
No. INTERSECTS 2 CROSSING ANGLE 0

Injector System

Type 2.5MeV Linac+250MeV synchrotron+Buster
INJ. ENERGY 100÷550 OUTPUT e^+-5mA, e^--100mA
EMITTANCE* _____ πmm-mrad
FILLING SPEED $2 \cdot 10^7$ e^+/sec
TOTAL FILLING TIME _____

Magnet System

FOCUSING TYPE strong BEND.RAD. 1.22 m
LATTICE ORDER _____
No. MAGNETS 8 LENGTH (ea) 1 m
No. QUADS 16 LENGTH (ea) 0.2 m
MAX BEND.FIELD 1.9 T; MAX GRAD. 63 T/m
TOTAL WEIGHT (tons) Fe 15 Cu 2
OTHER MAGNETS 16 sextupoles, 8 skew-quadrupoles
BETATRON FREQ. ν_H 3.04 ν_V 3.07
AMPL.FUNCT.AT INTERSECT, (H) 40cm (V) 5cm

Acceleration System

HARMONIC No. 12 FREQUENCY 200 MHz
No. TRANSMITTERS 1 No. CAVITIES 1
BUNCH TO BUNCH TIME _____
BUNCH SIZE (LxWxH) _____
PEAK RF VOLTAGE PER BEAM 200 kV
MAX RF POWER 15 kW ON BEAMS 5 kW

Vacuum System

PRESSURE IN RINGS, NO BEAM $1 \cdot 10^{-9}$ Torr
WITH BEAM $5 \cdot 10^{-9}$ Torr
PRESSURE AT INTERSECTIONS $1 \cdot 10^{-9}$ Torr
PUMPS (No., Type, Speed) 12 Ion - 150 e/s and 8 DIST Ion - 1000 e/s

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)		0.7
RESOLUTION $\Delta E/E_2$ (%)	0.1	
LUMINOSITY (cm^{-2} sec^{-1})		$3 \cdot 10^{30}$
BEAM SIZE, horizontal	0.02 cm	
vertical	0.001	
CURRENT, PER BEAM (A)		
BEAM LIFE, AT 0.02 A	10^3 sec	

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 60 m^2
No. EXPERIMENTAL INTERSECTS _____
No. EXPERIMENTS/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:
- Synchrotron radiation

TOTAL POWER USED (average) FOR RESEARCH 2 MW
No. USER GROUPS: in house 5 outside _____
TOTAL RESEARCH STAFF, in house 100 outside _____
ANN. RESEARCH BUDGET _____ (without sal.)
ANN. RESEARCH TIME _____ h

Other Relevant Parameters or Notable Features

Published Articles Describing Machine

Status report on electron-positron storage ring, VEPP-2M. The X Intern. Conf. on High Energy Accel. (1977)

Recent Improvements or Modifications to Machine

*Emittance = Area xβγ at 90% current (for p-machines)

NAME OF STORAGE RINGS VEPP-4
INSTITUTION Institute of Nuclear Physics
LOCATION Novosibirsk, USSR
PERSON IN CHARGE G.M.Tumaikin DATE: March, 1980
DATA SUPPLIED BY I.Ja. Protopopov

HISTORY AND STATUS

CONSTRUCTION STARTED (date) -
FIRST COLLISIONS, OR GOAL (date) 1979
TOTAL COST OF FACILITY -
FUNDED BY -
TOTAL MACHINE STAFF (now) 80
ANN.OPERAT. BUDGET (without salaries)
ANN.OPERATING TIME h; "BEAM ON" 60% %

STORAGE RINGS PARAMETERS

General

COLLIDING PARTICLES e^+e^-
ENERGY 7 GeV
APPROX. SHAPE racetrack DIMENSIONS 130x90 m
ORBIT: length 366.2 m, time 1.2 μs
No. INTERSECTS 3 CROSSING ANGLE 0

Injector System

Type Storage ring VEPP-3
INJ. ENERGY 2 GeV OUTPUT e^--50mA; e^+-50mA
EMITTANCE* π mm-mrad
FILLING SPEED e^- - 1mA/sec, e^+ - 5 μA/sec
TOTAL FILLING TIME e^+ - 1 hrs

Magnet System

FOCUSING TYPE AG C.F. BEND.RAD. 36 m
LATTICE ORDER BDOBFO
No. MAGNETS 76 LENGTH (ea) 2.4 m
No. QUADS 76 LENGTH (ea) 1.2 m
MAX BEND.FIELD 0.7 T; MAX GRAD. T/m
TOTAL WEIGHT (tons) Fe 580 Cu 200
OTHER MAGNETS 23 Int. req.Q,8sex,4out,8skew,MD
BETATRON FREQ. ν_H 9.2 variably ν_V 9.2 variably
AMPL.FUNCT.AT INTERSECT, (H) 2m (V) 15 variably

Acceleration System

HARMONIC No. 221 FREQUENCY 180 MHz
No. TRANSMITTERS No. CAVITIES 7

BUNCH TO BUNCH TIME 1 bunch in each beam = 1,2
BUNCH SIZE (LxWxH) = 20 cm
PEAK RF VOLTAGE PER BEAM 6 MV
MAX RF POWER ON BEAMS

Vacuum System

PRESSURE IN RINGS, NO BEAM $5 \cdot 10^{-10}$ Torr
WITH BEAM 10^{-8} Torr
PRESSURE AT INTERSECTIONS $1 \cdot 10^{-10}$ Torr
PUMPS (No., Type, Speed) 120 Ion-150 e/s and 80 DIST.ION - 300 e/s

Published Articles Describing Machine

Status Report on VEPP-4, I.Protopopov et. al., Invited paper presented at X International conference on high energy accelerators, Protvino, USSR, July 1977.

STORAGE RINGS PERFORMANCE

	Normal (or Goal)	Maximum achieved
ENERGY (GeV)	1,5-7	3,1
RESOLUTION $\Delta E/E_2$ (%)	0.1%	
LUMINOSITY (cm^{-2} sec^{-1})	10^{31}	$5 \cdot 10^{28}$ (1,8GeV)
BEAM SIZE, horizontal	0.035 cm	
vertical	0.015 cm	
CURRENT, PER BEAM (A)		e^- 10 mA
		e^+ 5 mA
BEAM LIFE, AT - A		3 hrs

RESEARCH PROGRAM

APPROX. EXPERIMENTAL AREA 500 m^2
No. EXPERIMENTAL INTERSECTS 3
No. EXPERIMENTS/INTERSECT 1
SPECIAL RESEARCH EQUIPMENT OR FACILITIES:
Magnetic detector with strong vertical field on the orbit (MD)

TOTAL POWER USED (average) FOR RESEARCH 5 MW
No. USER GROUPS: in house 3 outside -
TOTAL RESEARCH STAFF, in house 60 outside
ANN. RESEARCH BUDGET - (without sal.)
ANN. RESEARCH TIME h

Other Relevant Parameters or Notable Features

Transverse-polarized beam injection from VEPP-3 for accurate measurements of the masses for the ψ - family particles

Planned
Recent Improvements or Modifications to Machine

"Energy monochromatization of particle interaction.
Experiments with longitudinally polarized electron-positron colliding beams.

*ttance = Area xβγ at 90% current (for p-machines)