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BEAMS AT U.S. HIGH ENERGY PHYSICS LABORATORIES

INFORMAL REPORT

B R O O K H A V E N N A T I O N A L L A B O R A T O R Y
A S S O C I A T E D U N I V E R S I T I E S, I N C.

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BEAMS OPERATIONAL NOW OR SOON

June 1976

Separated Beams for General Use

Lab	Beam #	GeV/c	$\frac{\Delta p}{p}$(%)	Prod. Angle	Ω(msr)	Flux in thousands/sec/10^{12} protons on target; Flux in thousands/sec/40 ma at SLAC: K^+	K^-	p	$\bar{p}$	π^+	π^-	e^+	e^-	@ GeV/c	Purity	Remarks
ANL	3	<0.5	±1	0°	18	28	3.5			7500	7500			0.43	$\pi^-+\mu^-+e^-/K^-$ ~130; $\pi^++\mu^++e^+/K^+$ ~15	
BNL	C2,4	≤0.1	±1	$10\frac{1}{2}^o$	2.6	50	16		3					0.75	π/K ~10 (depends on mass slit)	With Ir target
BNL	B4	1.5-6(9 $\bar{p}$)	±3	3°	0.32	110	36		100	13,000	9000			4	π/K ~3	Focal length variable for optimum separation

Separated Beams for Fixed Facilities

Lab	Beam #	GeV/c	$\frac{\Delta p}{p}$(%)	Prod. Angle	Ω(msr)	K^+	K^-	p	$\bar{p}$	π^+	π^-	e^+	e^-	@ GeV/c	Purity	Remarks
BNL	B2	On "Y" with BNL B4, similar characteristics (see above)														MPS
ANL	10	RF	±1	0°	0.011	0.02	0.004		0.002	14				K^+ 4.6 K^- 6.5 $\bar{p}_+$ 5.8 π^+ 6.0	K^-/all ~0.7 $\bar{p}$/all ~0.4	12-ft BC pass bands (GeV/c): $K^\pm$ 8.0, 6.5, 5.0, 4.6; $\bar{p}$ 5.8, 4.1, 3.3, 2.6, 2.4; π^+ 9.0, 7.1, 6.0, 5.3, 4.8, 4.4
		DC	±1	0°	0.004				0.007					1.0		≤1.5 GeV/c; also polarized protons
SLAC	23	7, 12 9.4 1, 15	≤2 ≤2 ≤2	1.5^o 1.5^o 1.5^o	0.025 0.025 0.025	1	0.5	2	0.4	60	60			12 9.4 12	Very small $\pi^\pm$, p contamination	Streamer Chamber; flux at Δp/p = 2%
SLAC	21	1-16 1-8	≤4 ≤4	1° 1°	0.03 0.03	3	1.5	7	1	200	200	2000	2000	10 2.5	$\pi^\pm/K^\pm$ ~1/30, $\pi/\bar{p}$ ~1/14	LASS; flux at Δp/p = 4%
SLAC	14	1-18	≤3	1°	0.02	0.2	0.1	0.2	0.04	6	6			10		40-in BC (hybrid facility); ~10 pps; flux at Δp/p = 3%

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MASTER

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Unseparated Charged Beams for General Use

Lab	Beam #	GeV/c	Δp/p (%)	Prod. Angle	Ω (msr)	Flux in thousands/sec/10^{12} protons on target: K^+	K^-	p	$\bar{p}$	π^+	π^-	e^-	@ GeV/c	Remarks
ANL	22B	≤6	±0.5 - ±3.0	1.5°	0.4						450		6	Flux at Δp/p = ±1.5%; also polarized protons
ANL	5	≤9	±0.5 - ±5.0	0°(-), 3°(+)	0.5	240	49.2	≈3,000		4,800	4,320		5	Flux at Δp/p = ±5% with resolution Δp/p = ±0.5%; also polarized protons
ANL	8	≤9	±0.5 - ±3.0	1.5°	0.4		3.2	2,000	0.3	1,000	400		5	Flux at Δp/p = 1.5%; also polarized protons
BNL	A3	On "Y" with BNL A1, similar characteristics (see below)												
BNL	B1	6 - 28.5	~±1	0°	~0.3	227	56	11,000	22	11,000	4,400		10	
FNAL	M1E,W	50 - 280	±0.1 - ±1.5	3.5 mr	0.002						30		200	Flux at Δp/p = 1.5%; medium resolution beam
FNAL	M2	50 - 400	±0.1 - ±1.4	1.0 mr	0.0002			3,000			30		200	Flux at Δp/p = 1.4%; diffracted protons (400 GeV/c)
FNAL	P2	50 - 300	2.3	0-2 mr	0.0012							210	100	Can also provide tagged photons
FNAL	N1	(See under "Special Purpose Beams" - Can be used as hadron beam)												

Unseparated Charged Beams for Fixed Facilities

Lab	Beam #	GeV/c	Δp/p (%)	Prod. Angle	Ω (msr)	Flux in thousands/sec/10^{12} protons on target: K^+	K^-	p	$\bar{p}$	π^+	π^-	e^-	@ GeV/c	Remarks
ANL	21	≤6	≤±3.0	4.25°	0.4	26	4.3	1,100	0.5	560	360		4	Effective Mass Spectrometer; flux at Δp/p = 1.5%; also polarized protons
ANL	22A	≤9	≤±3.0	1.5°	0.4						200		6	Streamer Chamber; flux at Δp/p = ±0.7 %; also polarized protons
BNL	A1	5 - 28.5	±1.0	0°	0.26		4.0		0.36		680		18	MPS; fluxes through ½" x ½" x 20" lq. H_2 target
FNAL	M6W	50 - 200	±0.01 - ±1.0	3.0 mr	0.0013						30		100	Multiparticle Spectrometer; flux at Δp/p = 1.0%
FNAL	M6E	(See M6W above)												Single Arm Spectrometer; flux at Δp/p = 1.2%
FNAL	N3	100 - 400	±0.07 - ±1.2	0-1 mr	0.0003	Sufficient for bubble chamber								30-in. B.C. and Hybrid Spectrometer
FNAL	N5	100 - 400	±0.02 - ±0.6	0-1 mr	0.0003	Sufficient for bubble chamber								15-ft. B.C.

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Neutral Beams for General Use

Lab	Beam #	GeV/c	Δp/p (%)	Prod. Angle	Ω (msr)	Flux in thousands/sec/10^{12} protons on target; Flux in thousands/sec/40 ma at SLAC; (Flux for K_L^0 and n normalized to 1 μsr or /cm²) K_L^0	n	ν	γ	θ GeV/c	Remarks
ANL	43	1 - 6		4°	0.7	8	350			Total spectrum	
Cornell	A, C, D	≤12	Brems.	0°					$<10^{11}$ Equivalent Quanta	12 (end point)	Beam A also provides 10^6 tagged photons
BNL	N5	6 - 17		4°	0.36	16				Total spectrum	
FNAL	M3	Peak at 300		1.0 mr	$\sim 10^{-7}$		$30/cm^2$			Total spectrum	
FNAL	M4	Peak at 400		7.0 mr	Variable	$3/cm^2$	→			Total spectrum	Can also provide neutrons
SLAC	8			1 - 5°	≤0.050	0.1				Total spectrum	At 60 pps; spectrum peaks at 4 GeV/c, half maximum at 2 and 7 GeV/c; 1/10 flux for time of flight
BNL	U	0.5 - 12						$10^6/m^2$		Total spectrum	Fast spill only; flux average over ~.7m radius, peaks at 1.5 GeV/c
FNAL	NO-H	≤500		0°	2.8			$30,000/m^2$		Total spectrum	Fast spill only; horn focus, spectrum peaks at 17 GeV
FNAL	NO-D	200 - 350	<±25		0.010			$600/m^2$			Narrow band, sign selected; spectrum depends on the tune
FNAL	NO-T	50 - 300	±2 - ±30	0.5 mr	0.004-0.016			$2,300/m^2$			Broad band, quadrupole focus; spectrum depends on the tune; ΔΩ depends on momentum
FNAL	P1	Peak at 300	Brems.	0°	40		25		600 photons	≥40	Also provides tagged photons

Neutral Beams for Fixed Facilities

Lab	Beam #	GeV/c	Δp/p (%)	Prod. Angle	Ω (msr)	K_L^0	n	ν	γ	θ GeV/c	Remarks
ANL	9	·6		0°				0.5×10^6		Total spectrum	12-ft B.C.; spectrum peaks at 0.5 GeV/c
BNL	U	(See above)									7-ft B.C.
FNAL	NO-H	(See above)									15-ft B.C.
FNAL	NO-D	(See above)									15-ft B.C.
FNAL	NO-T	(See above)									15-ft B.C.
		5 - 15	6 - 25%						$\leq 2 \times 10^8$ EQ	5 - 15	1.6, 8, 20 GeV/c Spectrometers; Coherent linearly polarized spike (50-80% polarization)
SLAC	3	5 - 20	Brems.						4×10^9 EQ	20 (electrons)	0° bremstrahlung
		15 - 20	Brems.						2×10^7 EQ	15 - 20	Polarized by attenuation, typically 25% at 15 GeV/c

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Flux in thousands/sec/10^{12} protons on target
Flux in thousands/sec/40 ma at SLAC

Lab	Beam #	GeV/c	Δp/p (%)	Prod. Angle	ΔΩ (msr)	μ^+	μ^-	Σ^-	@ GeV/c	Remarks
Special Purpose Beams for General Use										
BNL	C1	6 - 12	±10	0° (pion)	0.8 (pion)	120			11.8	$\pi/\mu \sim 10^{-6}$, halo beam ≈1, tagged Δp/p ≈ 1.5%
BNL	C3	17 - 26	±0.5	0°	0.022			0.7	24	$(\Sigma/\pi) \approx 0.01$
FNAL	N1	50 - 275	±2	0°	0.004 - 0.016	3			150	Also provides hadrons
FNAL	ITA	8 - 500								Internal primary protons; gas jet targets
Special Purpose Beams for Fixed Facilities										
SLAC	23'	1 - 15	±2	0°	0.1	200			14	Streamer Chamber; at 360 pps; at Δp/p = 2%; $\pi/\mu = 5 \times 10^{-5}$
SLAC	14'	1 - 17	±4	0°	0.020		1		16	40-in B.C. (Hybrid Facility) ~10pps; Δp/p = 4%; $\pi/\mu = 6 \times 10^{-5}$
FNAL	N1	(See above)								Muon/Hadron Spectrometer
Extracted Beams for General Use						Flux per pulse				
						p	e^+	e^-		
ANL	1	≤12.5				$\sim 10^{11}$				Can be polarized
ANL	2	≤12.5				$\sim 10^{11}$				Can be polarized
Cornell	A, B, D	0.6 - 12	0.5 - 10					$\sim 2 \times 10^{10}$		Δp/p depends on spill time; energy can be tagged
SLAC	19	1 - 21	±0.25					$\sim 5 \times 10^{6}$	All	At 360 cps; very pure; 0.5 mm diameter beam
FNAL	Proton West									
FNAL	Proton Central	50 - 500				$\sim 2 \times 10^{13}$				
FNAL	Proton Fast									
Extracted Beams for Fixed Facilities										
ANL	9	≤12.5				Suff. for B.C.				12-ft B.C.; can be polarized
ANL	21S	≤12.5				$\sim 10^{7}$				Effective Mass Spectrometer; polarized protons, superconducting beam
Cornell	A, B, D	(See above)								Various Spectrometers
		1 - 14	±0.1 - 1.0				$\sim 2 \times 10^{10}$		All	1.6, 8, 20 GeV/c Spectrometers At 180 pps; flux at Δp/p = ±0.25%
SLAC	3	≤22	±0.1 - 1.0					5×10^{11}	All	At 360 pps; flux at Δp/p = ±0.25%
		3.237m, m = 1,2,..6						10^{9}	All	Longitudinally polarized (76 ± 3% measured polarization); flux at Δp/p = ±0.25%

NOTES ON BEAM TABULATION

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Nominal repetition rates used to calculate flux/sec:

ANL	-	0.25/sec
BNL	-	0.4/sec
CORNELL	-	60/sec
LBL	-	0.167/sec
FNAL	-	0.1/sec
SLAC	-	180/sec except where otherwise noted -- many beams can cycle up to 360 pps

Counting rates can be estimated from the nominal beam spill time:

ANL	-	0.7 sec
BNL	-	1 sec
CORNELL	-	2.5 ms
LBL	-	1 sec
FNAL	-	1 sec
SLAC	-	1.6 μsec

No test beams have been included.

Questions regarding these beams should be addressed to the following people:

		Telephone: FTS	Commercial
ANL:	Russell D. Kiem, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Ill. 60439	388-3151	312-739-7711 Ext. 3151
BNL:	Horst W. Foelsche, AGS 911B, Brookhaven National Laboratory, Upton, N. Y. 11973	664-4611	516-345-4611
CORNELL:	Maury Tigner, Laboratory of Nuclear Studies, Cornell University, Ithaca, N. Y. 14850		607-256-4882
FNAL:	Timothy E. Toohig, Fermi National Accelerator Laboratory, P. O. Box 500, Batavia, Ill. 50510	370-3991	312-840-3991
SLAC:	Lewis P. Keller, SLAC, P. O. Box 4349, Stanford, Calif. 94305	461-9300 Ext. 2725	415-854-3300 Ext. 2725