EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH

MSC-M-10
10.12.73

PHY-III-16
10.12.73

BEAMS FOR SCIP

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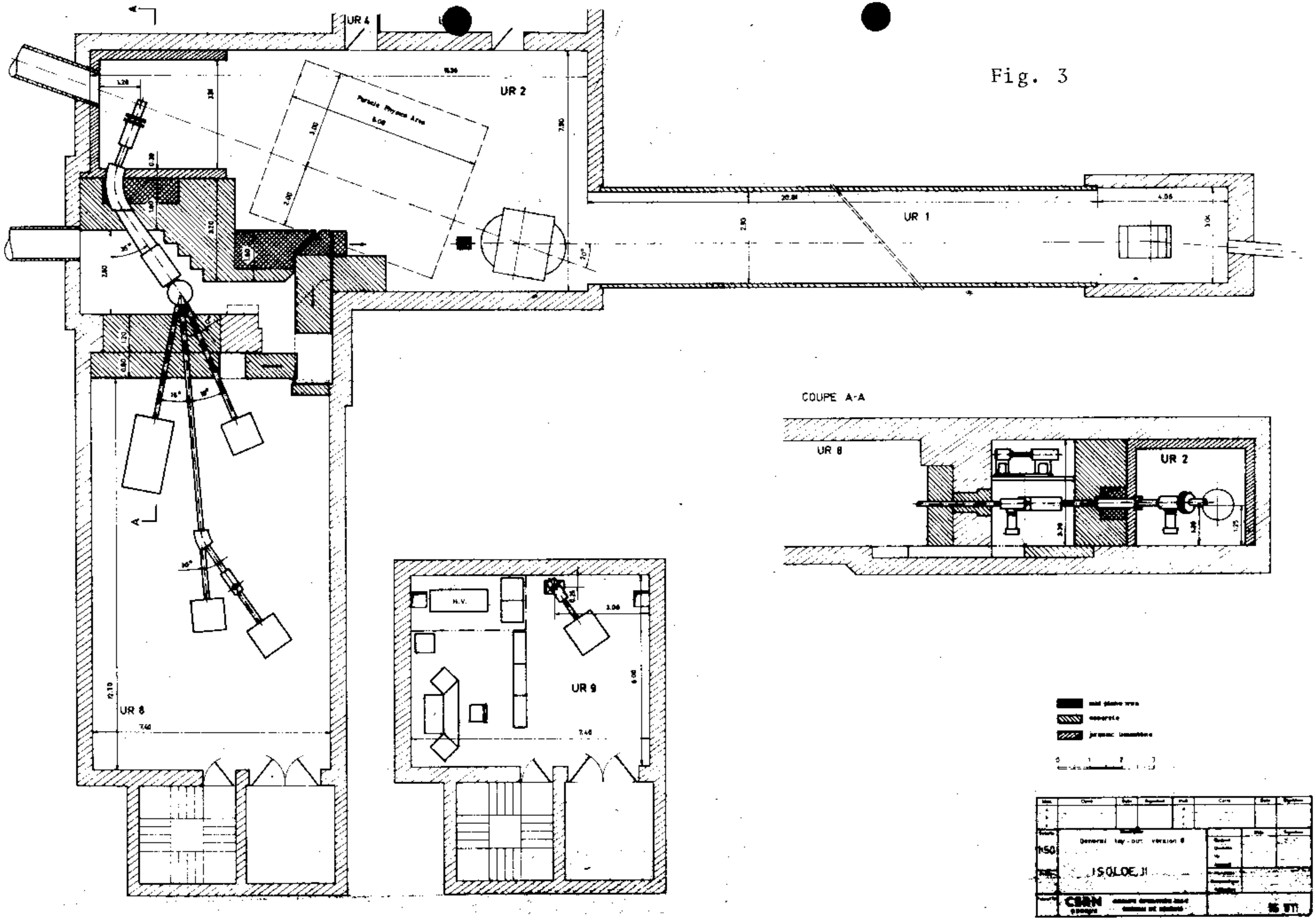
Fig. 3


UR 4
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ISOLDE II
CERN

BEAMS FOR SCIP

INTRODUCTION

The report by Cox et al (1) gave details of the beam facilities which were planned for the SC2. Since that report, several changes in layout have been made to beams servicing the proton room, and these notes are intended to provice potential users with the latest information available. No changes have been made to beams servicing the neutron room, but more information on expected fluxes is now available, and this is also included here.

These notes do not detail the changes made in the various beam lines relative to the old SC; for that purpose the report by Cox et al (1) is still valid. However, they contain all the available information on fluxes, beam spots, etc., for SC2 and for this purpose supersede the report of Cox et al.

For the neutron room beams, requiring internal targets, an internal machine current of 10μa has been assumed; for the proton room an extracted proton beam of 5μa has been assumed. These figures are regarded as realisable; an optimist might multiply secondary fluxes from external targets by a factor 3.

1. NEUTRON ROOM

Fig. 1 shows the beam layout in the neutron room.

1.1. μ Channel

Particles available $\pi^{\pm}$, μ^{-}

Energy range 100 - 200 MeV for π
50 - 190 MeV for μ

Table of Typical Values

	T (MeV)	P (MeV/c)	ΔP/P (%)	Spot Size	Flux (particles/ sec.)	Stop Rate (per gm sec.)	Composition	Note
π^-	127	227	8.7	8cm x 5cm	1.0 10^7	6.0 10^3	67% π	A
π^+	138	240	7.1	10cm x 10cm	1.3 10^6	7.5 10^2	80% π	B
μ^-	50	116	12.0	10cm x 10cm	2.1 10^5	7.0 10^2	99% μ	C
μ^-	56	124	15.0	10cm x 10cm	5.0 10^5	1.5 10^3	99% μ	D
μ^-	136	219	-	65cm^2	-	1.3 10^3	-	E

Note: A Values from Backenstoss (1966) in SC Handbook (2), scaled appropriately. The beam composition is an average figure for several momenta, and various experimenters.

B Values from Citron (1960) in SC Handbook (2), scaled appropriately.

C Values from Zavattini (1965) in SC Handbook (2), scaled appropriately.

D Values from Acker (1965) in SC Handbook (2), scaled appropriately.

E Values from Backenstoss (1971, private communication to E.G. Michaelis) scaled appropriately.

1.2. <u>125 MeV Channel</u>

Particles available $\pi^{\pm}$

Energy range 80 - 260 MeV

<u>Table of Typical Values</u>

	T (MeV)	P (MeV/c)	ΔP/P (%)	Spot Size	Flux (particles /sec.)	Composition	Note
π^-	110	207	4	2cm Ø	1.7 10^6	45% π	A
	150	254	4	2cm Ø	2.6 10^6	70% π	A
	180	288	4	2cm Ø	2.9 10^6	85% π	A
	220	331	4	2cm Ø	2.6 10^6	95% π	A
	260	374	4	2cm Ø	2.0 10^6	99% π	A
π^+	80	170	-	-	2.6 10^4	-	B
	100	195	-	-	8.0 10^4	-	B
	120	219	-	-	6.5 10^4	-	B

Note: A:Values from Cox et al (1). Composition depends on position along beam line, but figures quoted are interpolated from data given by CERN-Lausanne (1970) in SC Handbook (2).

B:Values from Bugg(1970) in SC Handbook (2), scaled appropriately. This was a very long beam line but no correction for decay in flight has been made for the above fluxes.

1.3. <u>Low Energy Pion Channel</u>

Particles available $\pi^{\pm}$

Energy range 60 - 105 MeV (143-201 MeV/c)

<u>Table of Typical Values</u>

	T (MeV)	P (MeV/c)	ΔP/P (%)	Spot Size	Flux (particles /sec.)	Composition	Note
π^-	60	143	3	5cm Ø	3.0 10^5		A
	78	165	5.5	2.9cm x 3.1cm	5.0 10^5	67% π	B
	90	182	5	5cm x 2cm	5.0 10^6		A
	105	201	$\gtrsim$10	7cm x 4.6cm	7.0 10^6	-	A
π^+	78	165	5.5	2.9cm x 3.1cm	8.0 10^5	84% π	B
	85	176	<5	5cm Ø	1.0 10^6	-	A
	85	176	8	7.5cm x 3.8cm	5.0 10^6	-	A

Note: A: Values from Sullivan (1969 private communication to P. Skarek), scaled appropriately and then quoted by Cox et al (1).

B: Values from Heintze (1964) in SC Handbook (2), scaled appropriately.

2. PROTON ROOM

Fig. 2 shows the new layout of the proposed beams feeding the proton room.

2.1. High Resolution Beam (pipe D)

The angle of bend is 40° in both sections of the line, as in reference (1). The only change is that the position of the bending magnet MP1 has been altered in order to be able to accommodate the two LC lenses on the framework carrying the separator; this was necessary to speed up the change from pipe D to pipe C, a condition imposed by the high radiation levels expected in the SC Hall.

The LC lenses are not used in the "high resolution" version of this beam, but they could be used to give higher intensity at the expense of resolution.

The π^{+} numbers given in Table I were calculated by Cox et al (1) and the π^{-} were obtained by scaling by the appropriate production cross-section ratios, taken from Hirt et al (3).

2.2. High Flux Beam (pipe C)

The bend angle for this beam is now 30°, compated to 25° in reference (1). There have been no new calculations, the previous results being assumed to be still valid (see pages 12, 13 of reference (1)). For this beam the LC lenses are used. The expected fluxes are given in Table II.

2.3. Neutron Beam (pipe B)

The extracted proton beam is bent through 20° by MP1 prior to hitting the neutron production target. In reference (1) this angle was 25°, and it has been assumed that the flux will not be changed by such a modification. The separator and the LC lenses are removed for this beam, but a second bending magnet sweeps charged particles away before the neutrons enter the wall of the SC Hall.

The maximum neutron energy from the D(p,n)2p reaction is 595 MeV, but lower energies may be obtained by inserting degraders in the proton beam before MP1. For a 10cm liquid deuterium target and a pipe collimation to 0.07 mstr, a maximum neutron flux of $3.0\ 10^{7}$ per second should be produced at

595 MeV with an energy spread of 5 MeV (FWHM). Such a collimation corresponds to a 10cm diameter beam at a distance of 10 meters from the production target.

Note that this flux is 5 times larger than that quoted in Cox et al (1).

2.4. Polarized Proton Beam

Pipe A will not be available initially, but can be installed relatively easily. This line could be used to provide a polarized proton beam by the scattering of protons on a carbon target in the SC Hall. The CEGG Group (1973) used 7^{o} scattering on carbon to achieve 37% polarization. The predicted flux based on these results is 1.5 10^{7} per second onto a target of 6cm diameter at an energy of 576 MeV.

3. ISOLDE

No changes have been made to the Isolde beam line, which is shown in figure 3. The full extracted proton beam should be delivered onto a target of 1.5cm x 0.5cm.

HIGH RESOLUTION BEAM

P at Band Centre MeV/c	T at Band Centre MeV	Production Target	Dispersive Image (D)			Final Image			(C) Energy Resolution 1st and 2nd order calculation	(A) Spot Size
			ΔE_π Band Width	Flux Π /MeV-sec. at Band Peak	Flux Π /sec. in Band	ΔE_π Band Width	Flux Π /Mev-sec. at Band Peak	Flux Π /sec. in Band		
π^+ 200	104	10cm carbon	4 MeV	8×10^5	3×10^6	2.5 MeV	4×10^5	1×10^6	230 keV	
300	191	10cm carbon	6.5 MeV	2×10^6	1×10^7	4 MeV	1×10^6	5×10^6	360 keV	
390	275	10cm C_6H_{12}	≃ 5 MeV(B)		6×10^7	≃ 5 MeV(B)		3×10^7		
400	284	10cm carbon	9 MeV	1.7×10^6	1.5×10^7	6 MeV	1.7×10^6	7×10^6	420 keV	1cm x 0.5cm
π^- 200	104	10cm Be				2.5 MeV		2×10^5		
400	284	10cm Be				6 MeV		6×10^5		

Note: A: The spot size for 400 MeV/c refers to a 1st and 2nd order calculation using perfect beam transport elements, in which the 2nd order contributions are assumed to have been reduced to zero. Higher order corrections and imperfections of beam elements have been neglected.

B: The energy spread is determined by the ΔE of the extracted beam (assumed 3 MeV), together with the spread due to the finite target thickness.

C: The energy resolution does <u>not</u> include a contribution from any counters placed at the dispersive image plane. In addition, the comments under A apply.

D: The dispersion at the intermediate focus amounts to 2.3cm per % momentum, perpendicular to the axis. The focal plane is inclined at about 10° to the axis.

TABLE 1

HIGH FLUX BEAM

P_π in MeV/c at band centre	T_π in MeV at band centre	Production Target	ΔE_π (FWHM) of band in MeV	Flux Π /sec. in band	Flux Π /MeV-sec. at band peak	Spot size
			Π^+			
535	413	10cm liquid ^{3}He	0.8 (A)	6×10^5		<15cm^2 (C)
535	413	20cm liquid ^{3}He	1.4 (A)	1×10^6		
485	365	10cm liquid D	1 (A)	4×10^6		
407	291	5cm liquid H	0.6 (A)	1×10^8		
390	275	10cm C_6H_{12}	5 (B)	3×10^8		
400	284	10cm carbon	25	2×10^8	7×10^6	
300	191	10cm carbon	20	2×10^8	9×10^6	
200	104	10cm carbon	12	5×10^7	4×10^6	
			Π^-			
400	284	10cm Be	25	3×10^7	9×10^5	
300	191	10cm Be	19	5×10^7	2×10^6	
200	104	10cm Be	12	1.5×10^7	1.4×10^6	

Note: A: The energy spread for these cases is determined by the ΔE of the extracted beam, assumed to be 0.5 MeV corresponding to Cee extraction, and the spread due to the energy loss in the production target.

B: As above but assuming a ΔE of 3 MeV for the extracted beam corresponding to kicker coil extraction.

C: Spot size from 1st order ray tracing.

TABLE II

FIGURE CAPTIONS

Figure 1 - Neutron Room Beams

Figure 2 - Proton Room Beams

Figure 3 - ISOLDE Beam

REFERENCES

1. C. Cox, J. Domingo and P. Skarek - Preliminary report on beam facilities for the post-SCIP machine. Report MSC-M-1,72.

2. SC Users Handbook, updated to 1970, Section F2.

3. W. Hirt, E. Heer, M. Martin, E. Michaelis, C. Serre, P. Skarek, B. Wright - CERN 69-24 (yellow report).

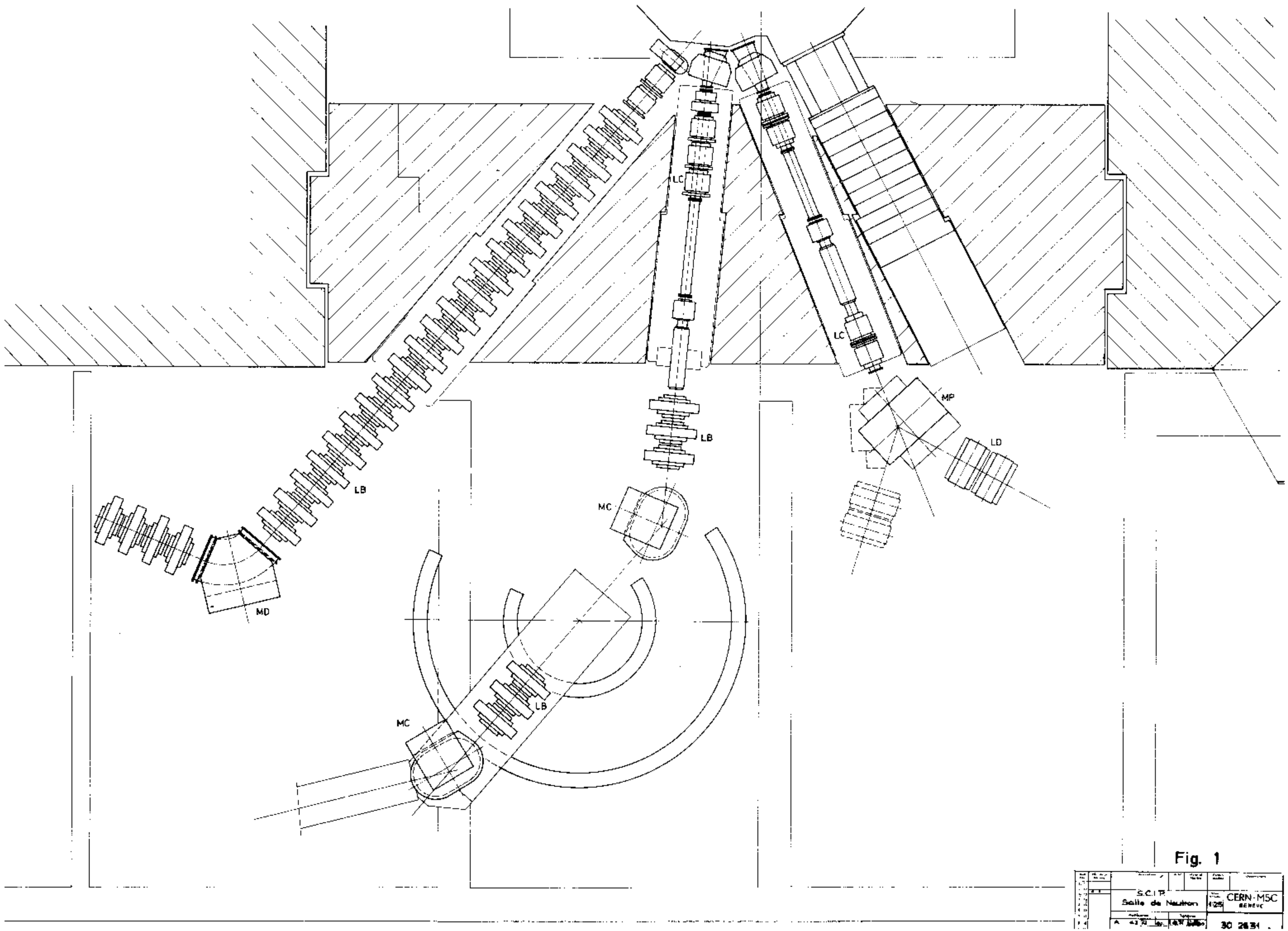
LC
LC
LB
LB
LB
MP
LD
MC
MC
MD
S.C.I.P.
Salle de Neutron
1:25
CERN-MSC
GENEVE
30 2631

Fig. 1

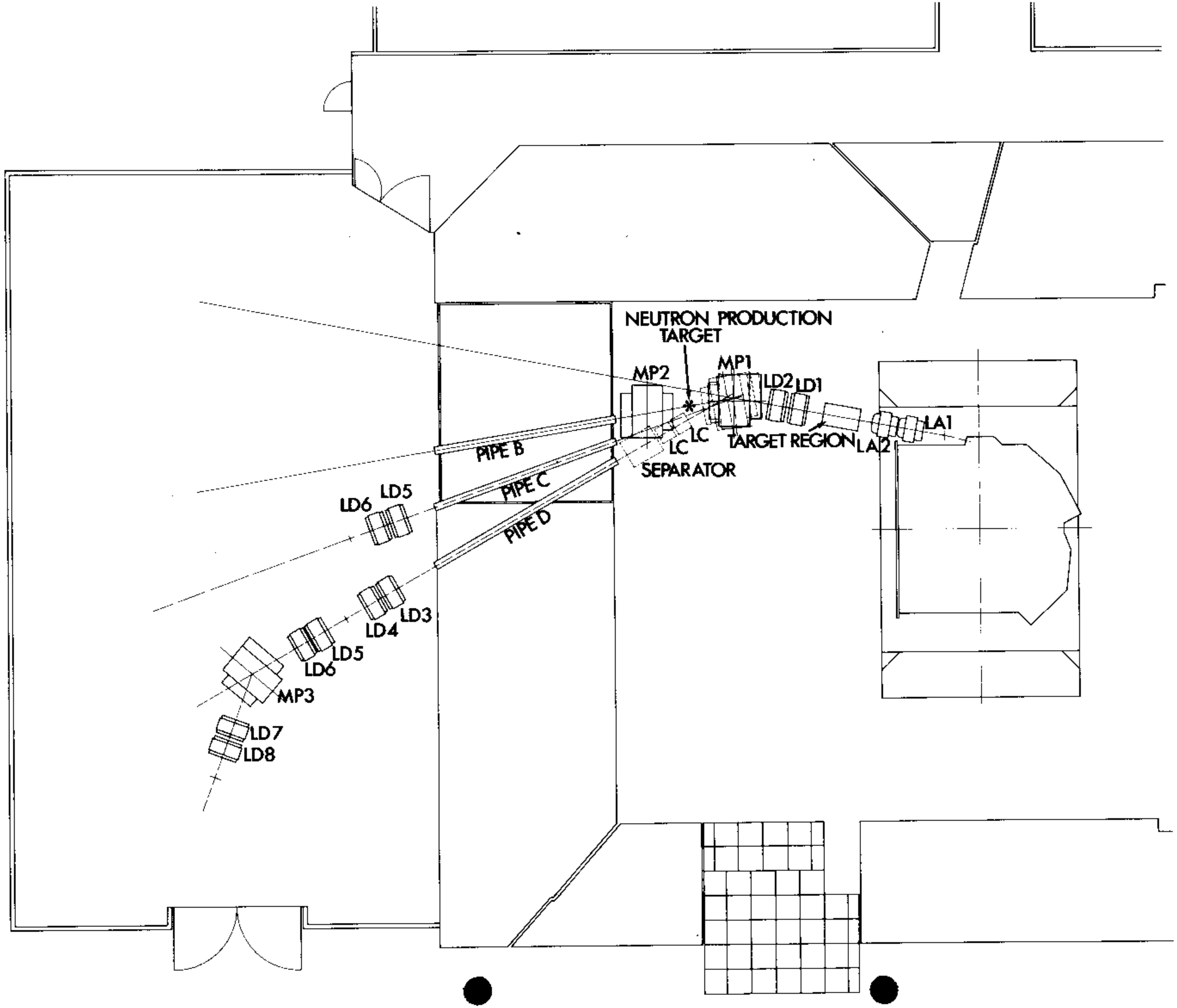
NEUTRON PRODUCTION
TARGET
MP1
LD2
LD1
MP2
LC
LC
TARGET REGION
LA1
LA2
SEPARATOR
PIPE B
PIPE C
PIPE D
LD5
LD6
LD3
LD4
LD5
LD6
MP3
LD7
LD8

Fig. 2.