0129F

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

SPS DIVISION

SPS/ABT/MG/Int.Note/82-1

NOMINAL TRAJECTORY OF INJECTED e^- AND EXTRACTED e^+ IN THE EXTRACTION CHANNEL OF LSS6

M. Gyr, AOP

Prévessin, 16 November 1982

1. Introduction

In an earlier paper [1] it has been shown that injecting electrons and extracting positrons through the proton extraction channel is not only feasible, but it is also the most attractive of 3 alternative schemes. However, that paper concentrated on proving the feasibility of such a scheme - even for energies above the design energy - rather than on defining optimum trajectories for these letpon beams.

In the meantime, this scheme has been further improved. Based on the "nominal" energies (3,5 GeV for e^- and 22 GeV for e^+) and their corresponding horizontal emittances [2] (σ^2/β = 0,13 μm resp. 0,11 μm), layout and trajectories have been optimised such as to maximize the clearances at the septa without too large closed orbit excursions in the focussing machine quadrupoles.

2. Description of the lepton injection/extraction system

The lepton injection/extraction system consists of a kicker magnet MKLP placed between ZS and QDA 6171 (TCE must be modified !), the thick magnetic septum MSE and a horizontal bump system (B1, B2, B3 and B4) with two bumpers on each side of the MSE (see Fig. 1). Neither ZS nor MST are used; however, the latter must be well demagnetized !

In order to avoid large orbit excursions of the circulating beams, the zone within which the beams are bumped has been restricted to a minimum. For this purpose, two special new bumpers B1 and B3 have to be built, which are used for these lepton beams only. B1 has to be very short ($\lesssim$ 50 cm) since it will be installed at the location of the actual BSGH 6160, whereas B3 has to be very slim since it will be located upstream of the TT60 magnet MDAV 6100.

The other two bumpers B2 and B4 are also used for proton extraction and must therefore be stronger. B2 will replace the actual MPBH 6172 and - in order to leave enough space to install the septum for electron extraction - must be shorter than 2,5 m. Since the space of the actual MPLH 6197 will be used for the installation of a vertical switch magnet in TT60 for e^+ deflection into TI18, this bumper must be replaced by an MPSH 6200 (B4) at the location of the actual extraction octupole. For working points above Q = 25,6, this bumper will be strong enough at 450 GeV, whereas LOE 6200 is not necessarily required.

3. Design criteria

The trajectories of the lepton beams are subjected to the following constraints (see Fig. 2).

a) Beam size:

It has been assumed to correspond to $\pm$ 4σ for the circulating and to $\pm$ 2,5σ for the extracted beam. The apertures must then be large enough for the e^- beam which is the bigger one of the two beams (σ^2/β = 0,13 μm).

b) Septa positions:

In order to be compatible with proton extractions at 450 GeV/c, the septa positions must be within the limits:

MST:	upstream:	37 - 43 mm
	downstream:	42 - 52 mm
	(TPST:	35 - 40 mm)
MSE:	upstream:	32 - 44 mm
	downstream:	$\sim$ 75 - 80 mm

c) The trajectory of the centre particle of the injected/extracted lepton beam must meet the centre of the horizontal bending magnet MDLH 6101 in TT60 ("extraction point").

d) Linearity of quadrupole field:

The injected/extracted lepton beams should pass through the middle of the coil window in QDA 6191, where the field linearity is best. Also, the extreme particle of the beams should not enter the non-linear field region in QFA 6181, defined as being beyond 90 mm from the centre line.

e) Septa clearance:

At the MST (TPST) entrance an inside and outside clearance of 5 mm is to be guaranteed, whereas the outside clearance at the MSE should be as big as possible.

4. Required delfections

The magnets must be strong enough to ensure the following nominal deflections at 22 GeV/c:

MKLP:	1,60 mrad
MSE:	11,06 mrad
B1:	0,60 mrad
B2:	-1,74 mrad
B3:	3,22 mrad
B4:	-1,44 mrad

5. Trajectory of centre particle (tracking !)

(see Fig. 2)

	Circulat.	Inj/extr.
B1 - centre	0	
QFA 6161 - upstream	0,93	
centre	2,05	
downstream	3,08	
MKLP - centre	16,14	16,14
QDA 6171 - upstream	17,48	21,67
centre	18,84	26,16
downstream	21,00	31,78
B2 - centre	23,85	38,62
TPST - upstream	20,0	55,0
QFA 6181 - upstream	14,27	79,4
centre	13,27	80,66
downstream	11,70	78,33
MSE - upstream	10,35	75,50
MSE - dowstream	- 4,52	128,56
QDA 6191 - upstream	-15,55	230,99
centre	-17,73	248,46
downstream	-20,69	265,91
B3 - centre	-30,65	
B4 - centre	0	

6. Final remarks

For the nominal energies (and emittances) of the lepton beams, the present trajectories can be considered as optimum particle paths. Enough clearance at the septa is achieved without perturbing the orbit of the circulating beam exessively. Implementing the MST (even with negative deflection) into the injection/extraction scheme does not bring any improvement.

However, if in the future one would consider to inject resp. extract the leptons at higher energies (emittances $> 0{,}13$ μm, which corresponds to e^+ extraction above 24 Gev/c), new trajectories with reduced clearances at the septa would have to be computed. It would then be necessary to study in more detail how a moderate local bump with displaced machine quadrupoles could improve the situation.

References

1) Injection of e^- and extraction of e^+ in LSS6
(0018F/SPS/ABT/KHK/fv)

2) LEP injection system (CERN/ISR-LEP/79-33 Add or CERN-SPS/80-16).

Distribution

Scientific staff of ABT

B. Angerth
Y. Baconnier
R. Bonvin
R. Burnod
R. Guinand
V. Hatton
K. Hübner/ISR
W.C.Middelkoop
J.D.Pahud
B.de Raad

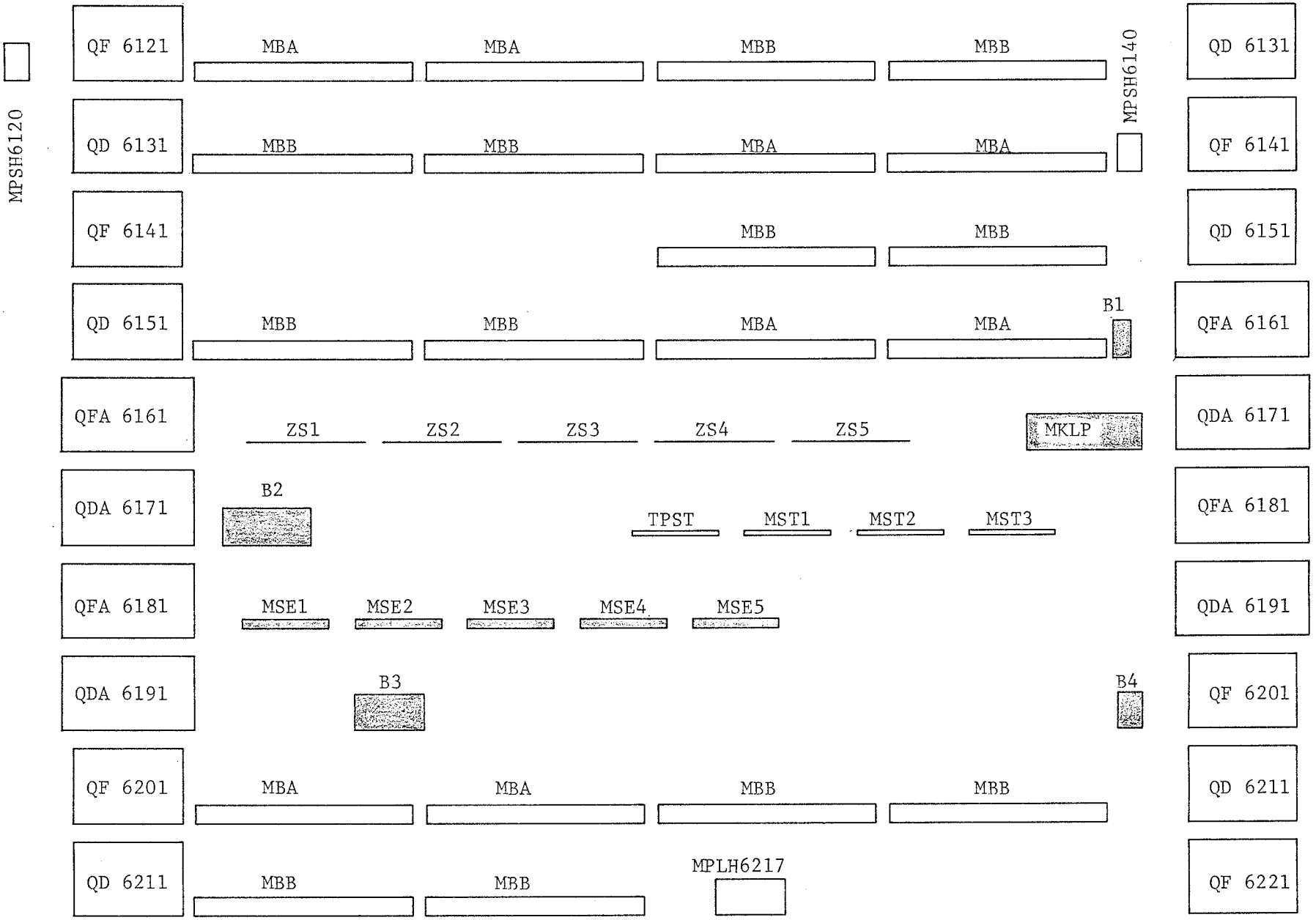
APPENDIX

Twiss parameters at the relevant locations in the extraction channel

BETATRON FUNCTIONS IN THE EXTRACTION CHANNEL

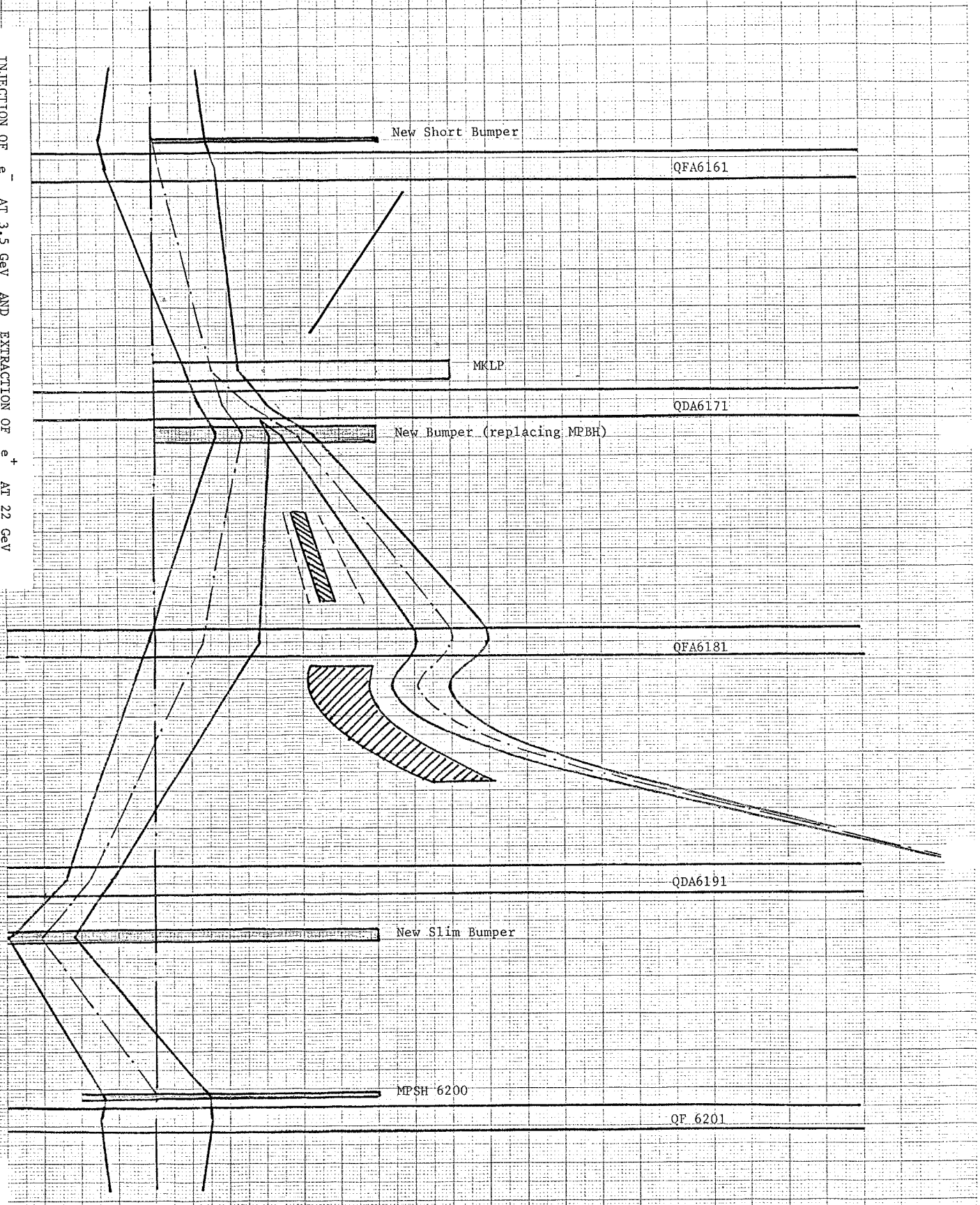
Q-HOR = 26.62 Q-VER = 26.57
KF = .014634 KD = .014627

LOC(M)	A-HOR	B-HOR	P-HOR	A-VER	B-VER	P-VER	ELEMENT
0	0	107.42	0	0	19.829	0	QF-CENTRE
31.9977	0	19.479	.77434	0	107.806	.77289	QD-CENTRE
1.5425	2.35485	103.744	.01452	-.53196	20.340	.07792	QF-EXIT
1.9	2.3323	102.069	.01800	-.55451	20.728	.09533	QFA-EXIT
30.4552	.53080	20.289	.69622	-2.35567	103.829	.75837	QD-ENTRANCE
30.0977	.55327	20.702	.67838	-2.33312	102.153	.75490	QDA-ENTRANCE
60.7682	-2.25094	96.030	1.51721	.63822	22.311	1.38869	MPSH6140
124.551	-2.2375	95.075	3.06367	.65165	22.886	2.92499	NEW BUMP6160
131.51	2.23012	94.679	3.13185	-.65666	22.690	3.26164	ZS-ENTRANCE
150.35	1.04149	33.042	3.4754	-1.84502	69.822	3.75471	ZS-EXIT
155.457	.71927	24.050	3.65758	-2.16716	90.313	3.81907	MKLP-CENTRE
163.958	-.68416	23.238	4.06187	2.20255	92.764	3.9037	NEW BUMP6173
174.457	-1.34741	44.566	4.39419	1.54034	53.469	4.03333	TPST-ENTRANCE
177.691	-1.55172	53.942	4.46019	1.33636	44.166	4.11993	MST-ENTRANCE
186.619	-2.11575	86.685	4.59113	.77321	25.332	4.39012	MST-EXIT
195.274	2.24476	95.718	4.67811	-.64203	22.388	4.79713	MSE-ENTRANCE
196.504	2.16716	90.291	4.69134	-.71961	24.063	4.85014	MSE1-CENTRE
199.738	1.96312	76.934	4.73015	-.92360	29.377	4.97208	MSE2-CENTRE
202.972	1.76908	64.896	4.77893	-1.12759	36.011	5.07167	MSE3-CENTRE
206.206	1.55505	54.178	4.8305	-1.33158	43.964	5.15304	MSE4-CENTRE
209.44	1.35101	44.780	4.89621	-1.53557	53.236	5.21993	MSE5-CENTRE
210.67	1.27341	41.552	4.92472	-1.61315	57.109	5.24224	MSE-EXIT
231.484	-.90717	28.855	5.74731	1.97989	78.000	5.49099	SLIM BUMP6193
252.754	-2.25094	96.030	6.16327	.63822	22.311	6.02603	MPSH6200
304.309	-1.46499	49.801	7.53108	1.42295	47.954	7.18165	MPLH6217



SCHEMATIC LAYOUT OF INJECTION/EXTRACTION ELEMENTS IN LSS6

Fig.1



INJECTION OF e^- AT 3.5 GeV AND EXTRACTION OF e^+ AT 22 GeV THROUGH THE EXTRACTION CHANNEL IN LSS6 (NOMINAL TRAJECTORY).

Fig. 2