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Gamma Transition Jump for PS2 .

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1. Introduction

The aim of this note is to scale the γ_{tr}-jump, used since 1973 in the PS, to the projected PS2 (FODO option). The scaling equations used are given in a note, (PEP Note 42, Proc of 1973 PEP Summer Study, LBL/SLAC) of which a scanned version is available on the "Public" folder on \\cern.ch\dfs\users\m\Moehl. The relations are essentially the same as those given in the more recent Accelerator Handbook of Chao (article by J. Wei).

2. Assumptions

Parameters assumed are detailed in table 1. Four different cases of PS2 are considered. They differ by the RF-frequency and the bunch area taken: 10 MHz (like at present) for the "low rf" cases and 200 Mhz (matching the SPS rf) for the "high rf" cases, A=15 mr [in $\Delta\beta\gamma*\phi_{rf}$ units] (like at present) for the "small bunch" and A=45 mr for the "large bunch" . In all cases an ultimate N=1E14 protons, a rise rate dγ/dt= 60/sec (twice the present) and a somewhat smaller chamber (30 instead of 34mm vertical half height) is taken. Only the space charge contribution to the longitudinal impedance (Zn/n≈ 20 Ohm at present, ≈ 6 Ohm in PS2) is taken, larger Zn/n requires a larger jump.

Table 1 : Parameter assumed

Machine	**present PS**	**PS2/10/15**	**PS2/200/15**	**PS2/10/45**	**PS2/200/45**
		low rf, small bunch	high rf, small bunch	low rf, large bunch	high rf, large bunch
Circumference [m][	*628.3*	*1400*			
Rf harmonic no	*20*	*45*	*940*	*45*	*940*
transition Energy GeV	*4.88*	*10.00*			
acceleration γ-dot [1/sec]	*30.00*	*60.00*			
Rf stable phase at transition.	*45.00*	*45.00*			
geometry factor at transition	*4.50*	*4.50*			
chamber half height {m}	*3.40E-02*	*3.00E-02*			
Beam					
Total No of particles	*1.00E+13*	*1.00E+14*			
Bunch area at transition	*1.50E-02*	*1.50E-02*	*1.50E-02*	*4.50E-2*	*4.50E-2*
Derived parameter at transition					
Beta	*0.9869*	*0.9963*			
Gamma	*6.2011*	*11.6580*			
*B*Rho/Tesla m*	*19.154*	*36.352*			
Momentum GeV/c	*5.74E+00*	*1.09E+01*			
rf frequency at β=1	*9.55E+06*	*9.6E+06*	*200E+06*	*9.6E+06*	*200E+06*
Space charge impedance Zn/n	*2.24E+01*	*6.26E+00*			

3. Results

From table 2 one concludes that -compared to the present PS- only a 3 to 5 times bigger longitudinal emittance can be handled with a reasonable γtr –jump even if the longitudinal impedance Zn/n is limited to the strict (unavoidable!) space charge value. Higher rf frequency augments this difficulty. Probably other density limitations make the acceleration of the high PS2 intensity in a small emittance difficult anyways. It seems however advisable to avoid the "brick wall" at transition so that a density considerably higher than in the present PS is not excluded.

Table 2: Results

Results	**present PS**	**PS2/ 10/15 low rf, small b.**	**PS2/ 200/ 15 high rf, small b.**	**PS2/ 10/ 45 low rf, large b.**	**PS2/ 200/45 high rf, large b.**
jump required with space charge					
jump for continous matching $\Delta\gamma_t$	**0.65**	**8.9**	**24.6**	**1.0**	**2.7**
time for jump (10*neg. mass τ) [μsec]	153	56.4	56.4	169.1	169.1
Hereward parameter η0(0)	4.0	13.0	59.4	2.5	11.4
transition parameters in the absence of space charge					
bunch dp/p (half height)	3.8E-03	3.4E-03	2.1E-03	5.9E-03	3.6E-03
bunch theta (+/_deg)	1.2E+01	7.3E+00	1.2E+01	1.3E+01	2.1E+01
non-adiabatic time T (+/- sec)	2.4E-03	3.5E-03	1.3E-03	3.5E-03	1.3E-03
half width non-adiabatic region Δγ	0.07	0.2	0.1	0.2	0.1