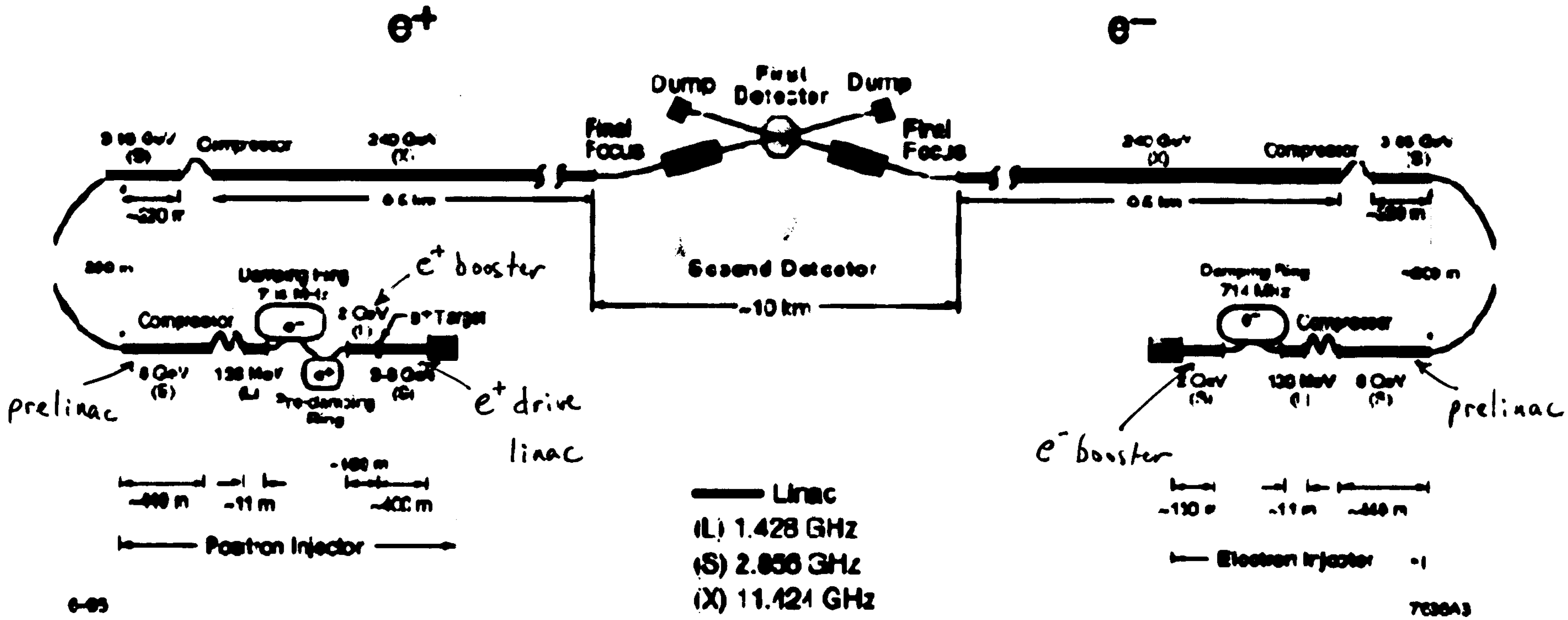
These pages are under construction. Most are incomplete and many are have not even been started!

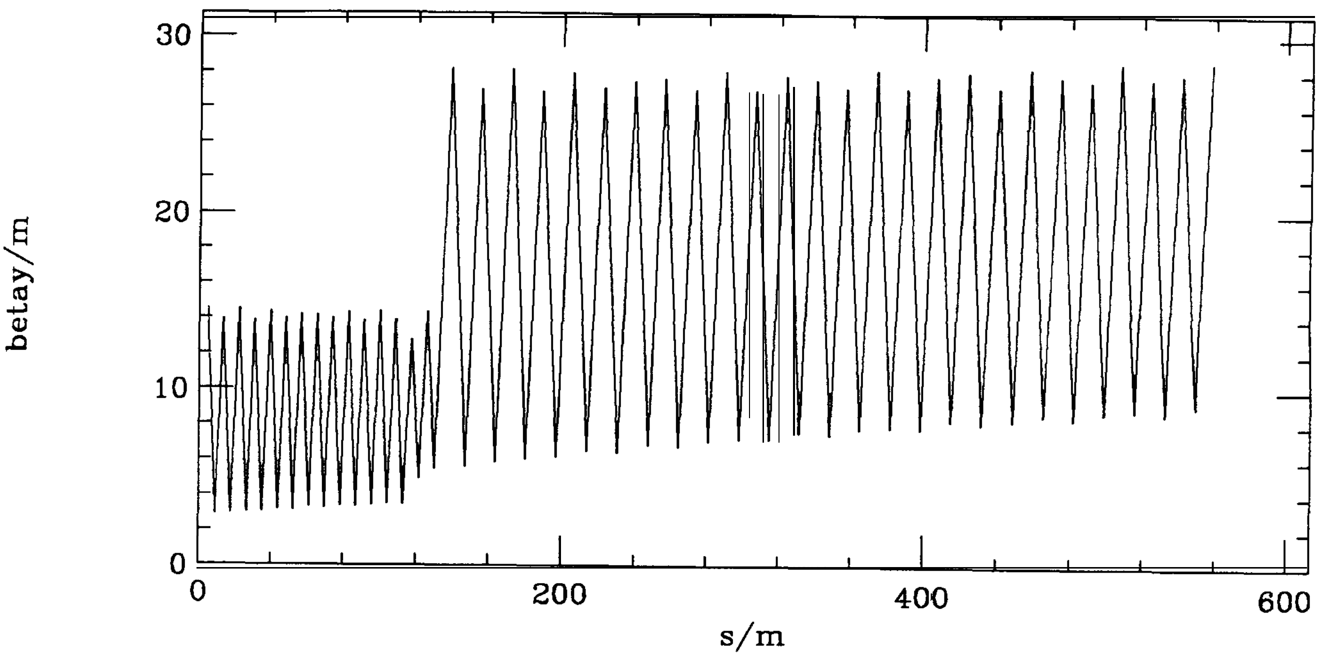
NLC Diagram

not to scale
(500 GeV c.m.)



Created: Tor Raubenheimer on 07/03/98

Prelinac betafunction



$E_0 = 2$ GeV

$E_f = 10$ GeV

$\epsilon_{yn} = 3 \times 10^{-8}$ rm

– latest lattice on web

[illegible]

Beam Break-up Long Range Wake

strength parameter

$$\Upsilon = \frac{e^2 N L \bar{S} \beta_0}{2 E_0}\left[\frac{2\left[\left(\frac{E_f}{E_0}\right)^{1/2}-1\right]}{\left(\frac{E_f - E_0}{E_0}\right)}\right]$$

estimate

$$\frac{\Delta\epsilon}{\epsilon} \approx \frac{x_0^2 \Upsilon^2 \gamma}{2 \epsilon_n \beta} \qquad \text{if } \Upsilon \text{ small}$$

eg prelinac

$N = 1.2\times 10^{10}$	$E_0 = 2\,\text{GeV}$	$\bar{S} \approx \sqrt{\langle S^2\rangle} = \frac{6.4}{64}\ \text{V/pC/mm/m}$
$L = 500\ \text{m}$	$E_f = 10\,\text{GeV}$	
$\beta_0 = 8.5\ \text{m}$	$x_0 = 8\,\mu\text{m}\ [= 1\sigma]$	$\Rightarrow \Upsilon = 0.14$
$\epsilon_n = 3\times 10^{-8}\ \text{rm}$		

$\left(\frac{\Delta E}{E}\right)_y \approx 1\%$ [LIAR gets 0.5%]

— Note: $\frac{S}{M}$ is bunch wake (M is number of bunches)

Pre injector Wakes (Cont'd)

How to reduce wake at 2nd bunch

- detuning envelope
- detuning zero crossing
- damping

or combinations

Detuning Envelope

- gaussian

at 2nd bunch $W \simeq 2\bar{k}_\perp \sin(2\pi\bar{f}t)\exp\left(-2(\pi\bar{f}t\sigma_{\sigma f})^2\right)$

if we want amplitude reduction 0.02 ⇒ exp argument ≃ 4

eg. at S band (2.8ns spacing) need $\sigma_{\sigma f} \simeq 16\%$

too large

- uniform

$$W \simeq 2\bar{k}_\perp \sin(2\pi\bar{f}t)\,\frac{\sin(\pi\bar{f}t\Delta_{\sigma f})}{(\pi\bar{f}t\Delta_{\sigma f})}$$

(exact if $k_{\perp n} = \bar{k}_\perp$)

at S band ($\bar{f} \simeq 4$ GHz), with $\Delta_{\sigma f} = 10\%$, 2.8 ns spacing

$$\frac{1}{\pi\bar{f}t\Delta_{\sigma f}} \simeq 0.3$$

$2\pi\bar{f}t \to 2\pi n + 84°$ sin( ) = .99

$\pi\bar{f}t\Delta_{\sigma f} \to 202°$ sin( ) = .38

happens to be in valley!

but sensitive to $\Delta_{\sigma f}$

Detuning Zero-crossing

$$\text{want } \sin(2\pi \bar{f} t) \approx 0$$

Damping

$$\text{want } e^{-\frac{2\pi \bar{f} t}{2Q}} \ll 1 \text{ ; } f \text{ difficult at 2nd bunch}$$

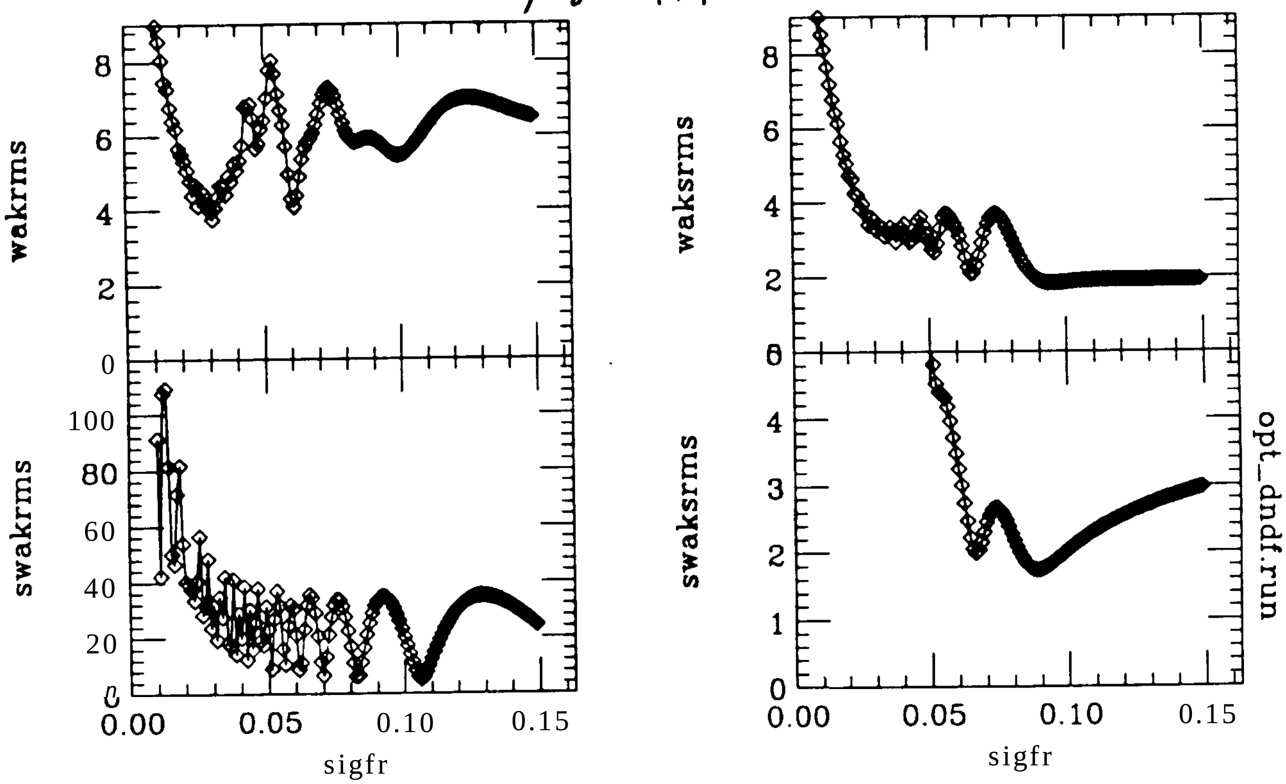
Results for different bands

			95			190 bunches			
band	f_0	Wake scale	n_H	Q_2	Υ^*	n_H	Q_2	Υ^*	
X	1	1	32	140		16	70		
S	1/4	1/64	8	35	0.01	4	18	0.07	optimized – tilted uniform dist
L	1/8	1/512	4	18	0.08	2	9	0.16	– uniform dist; $(\delta f)_{bf}$ = 10 3

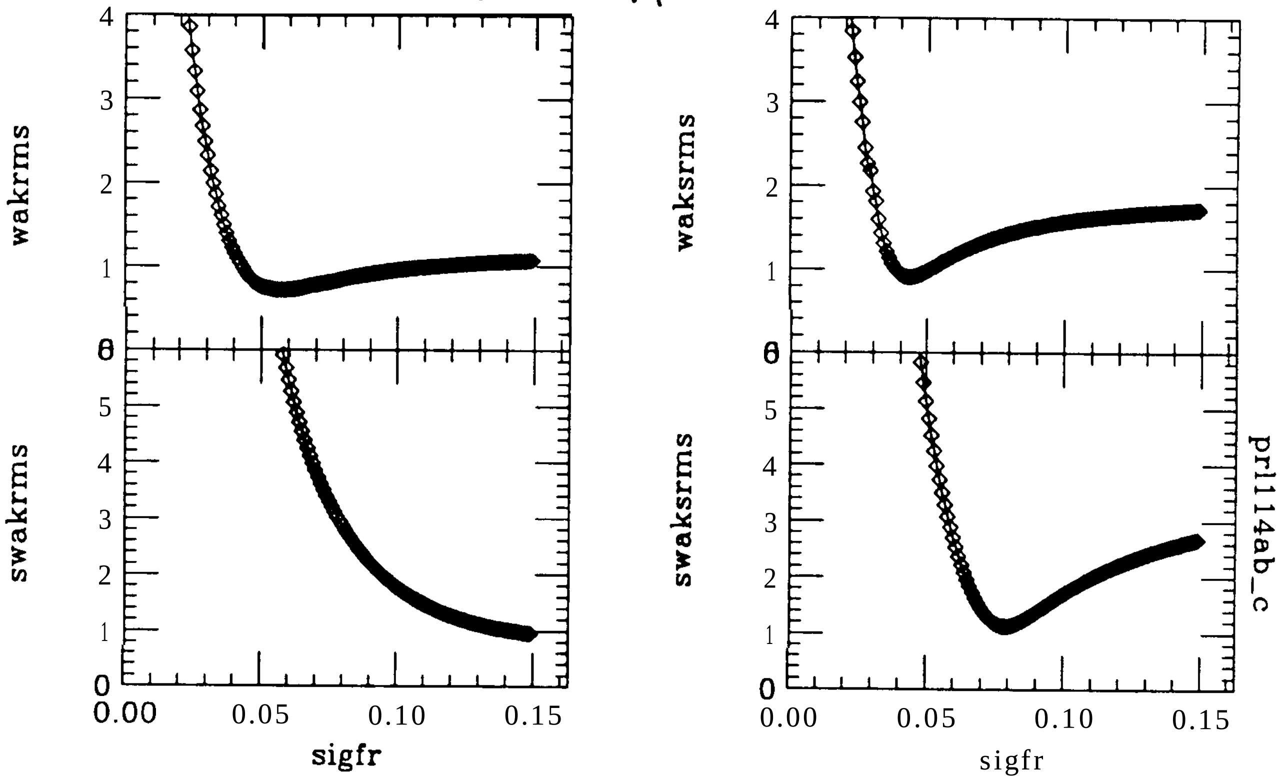
Notes

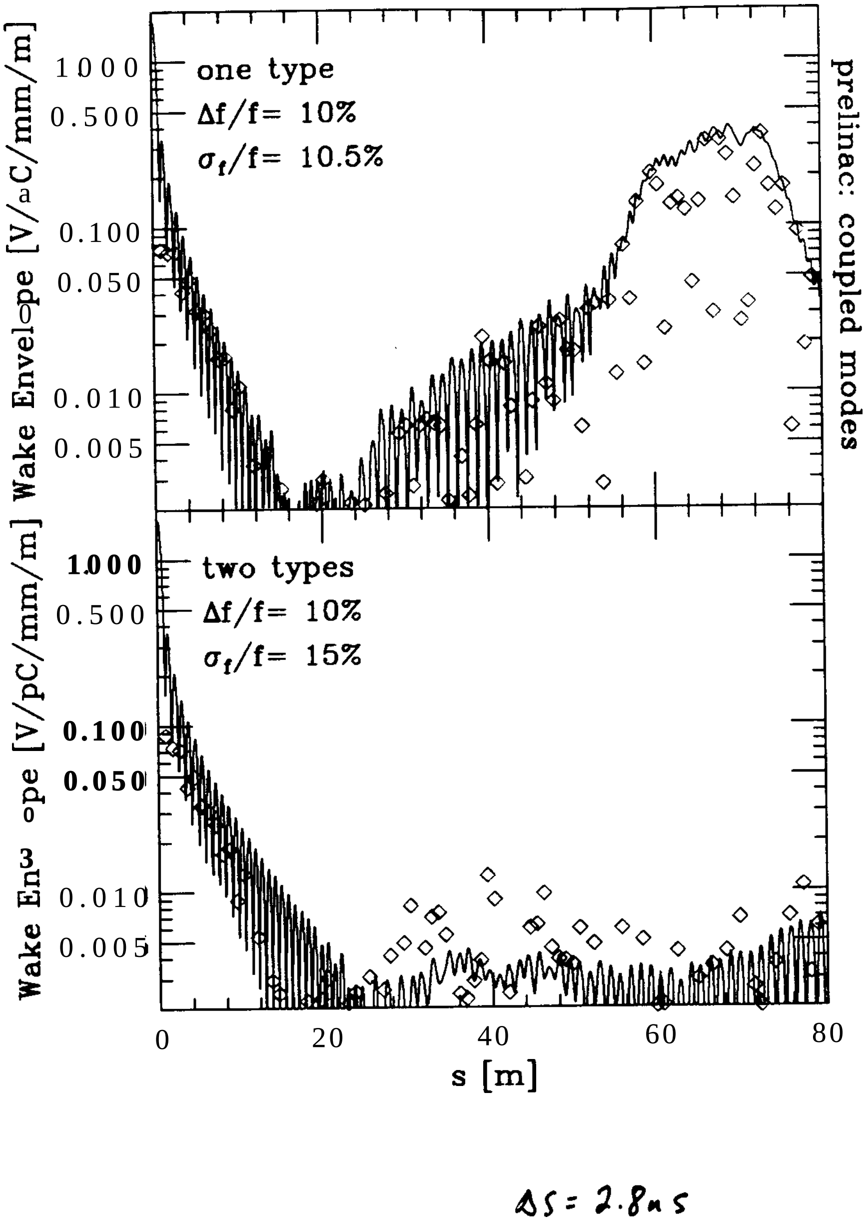
- Q_2 is Q necessary to damp to 1/e at 2nd bunch
- n_H bunch spacing harmonic number
- $\Upsilon^* = S_{rms}\,[V/pC/mm/m]\ \dfrac{V}{N_{95}}$

1 structure type
varying σ_f/f

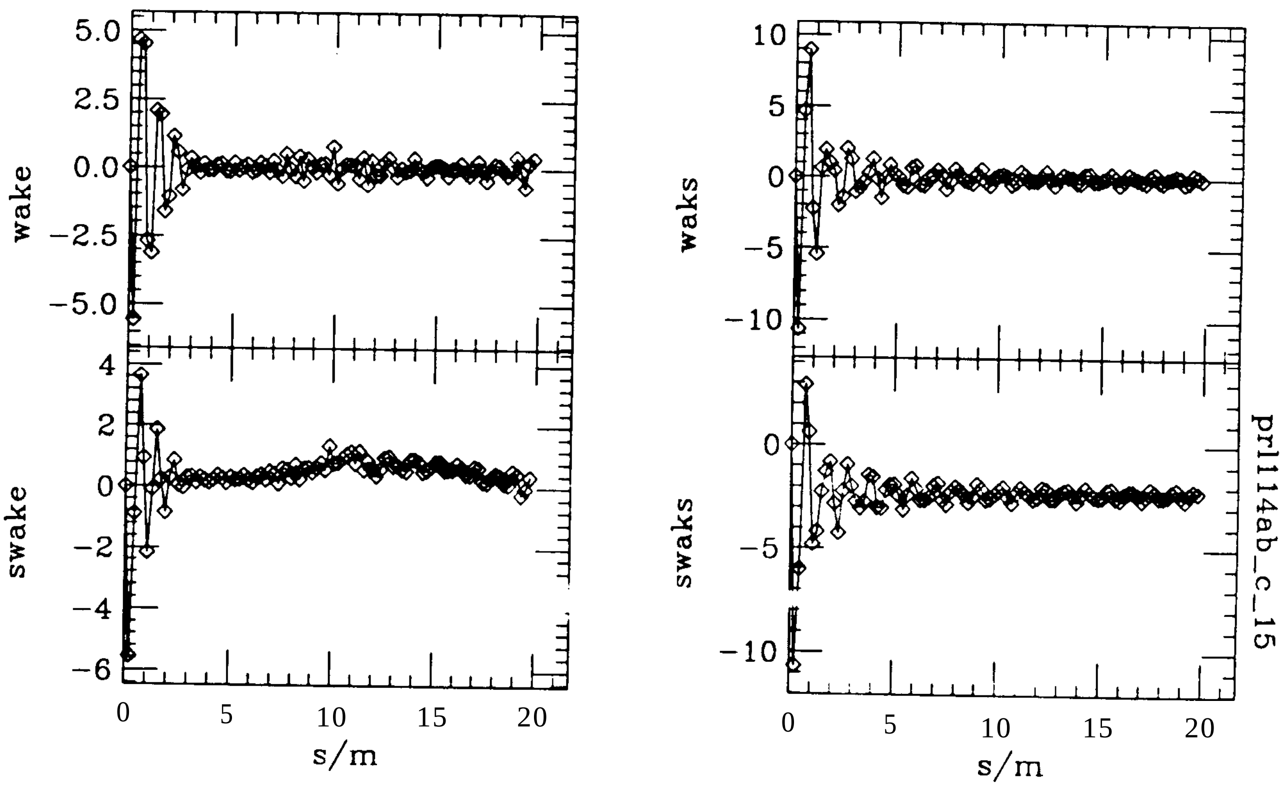


2 structure types
varying σ_f/f



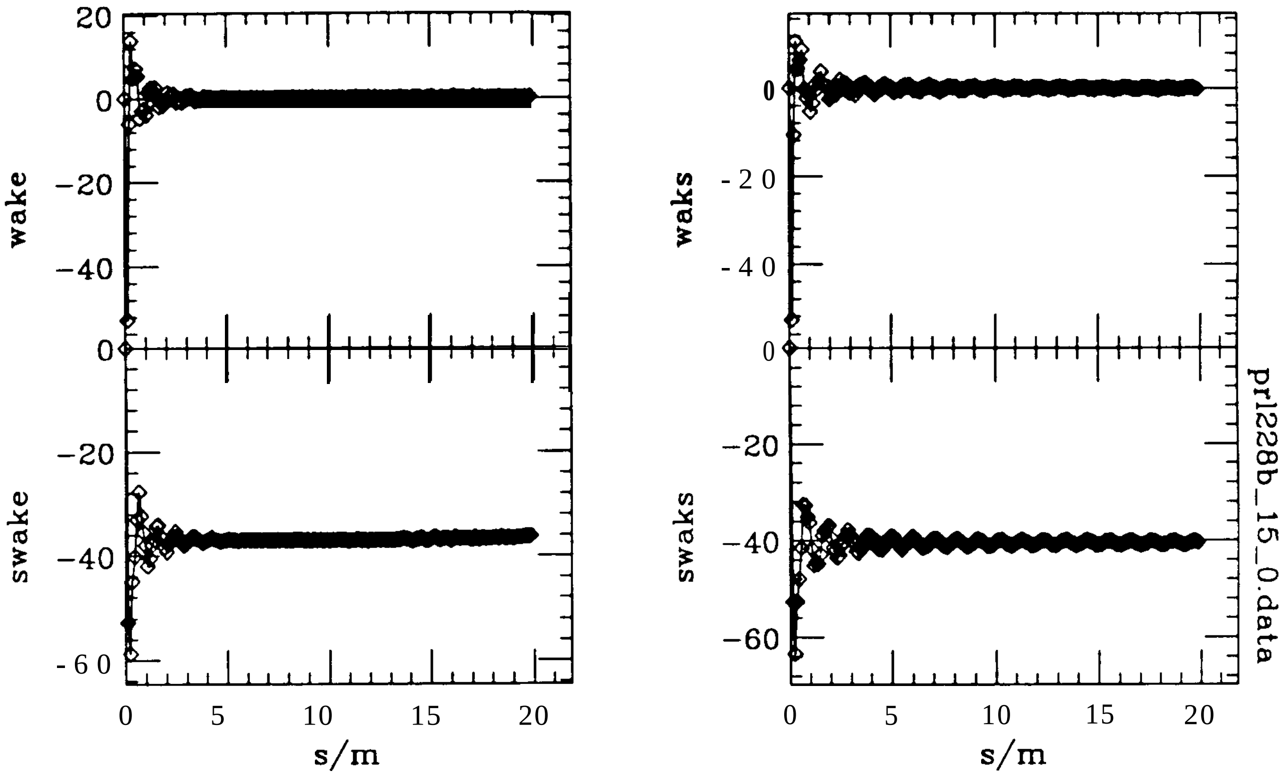

one type
Δf/f= 10%
σf/f= 10.5%
two types
Δf/f= 10%
σf/f= 15%
prelinac: coupled modes
Wake Envelope [V/pC/mm/m]
s [m]
1.000
0.500
0.100
0.050
0.010
0.005
0
20
40
60
80
ΔS = 2.8ns

2 structure types
$\sigma_f/f = 15\%$

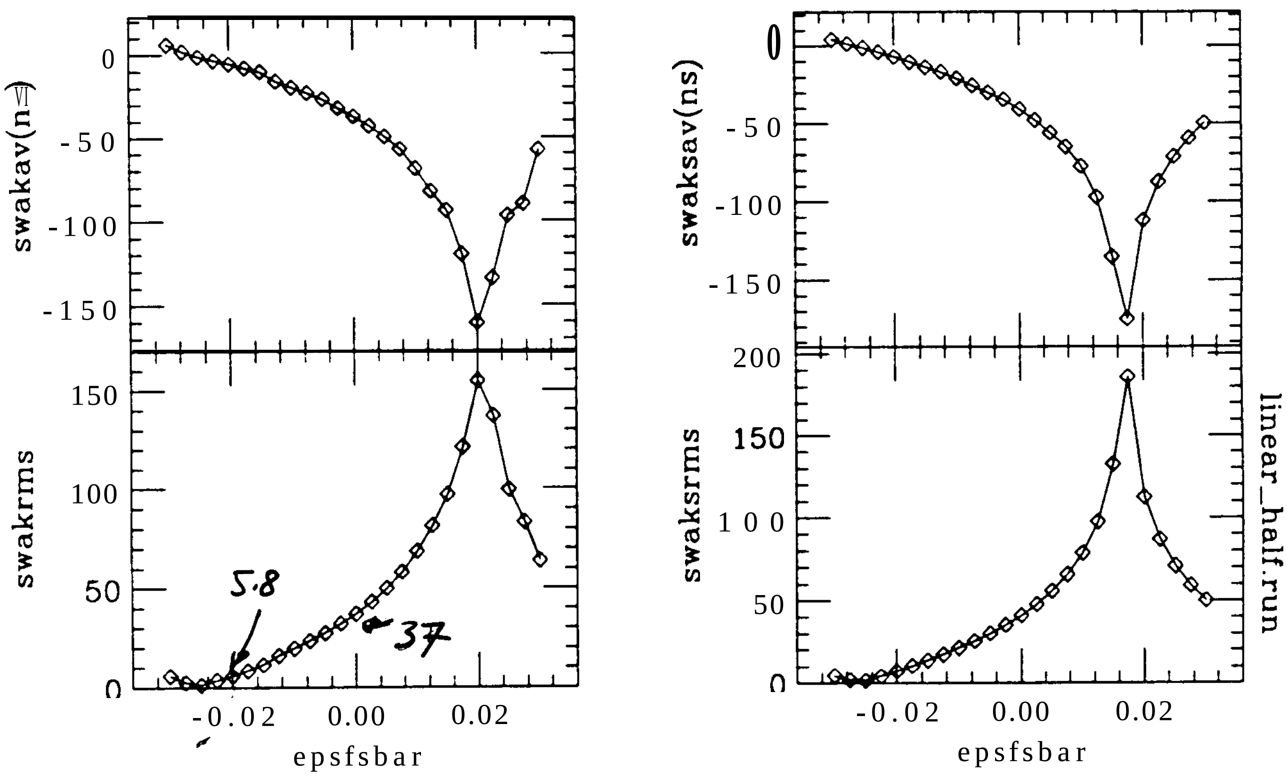


2 structure types

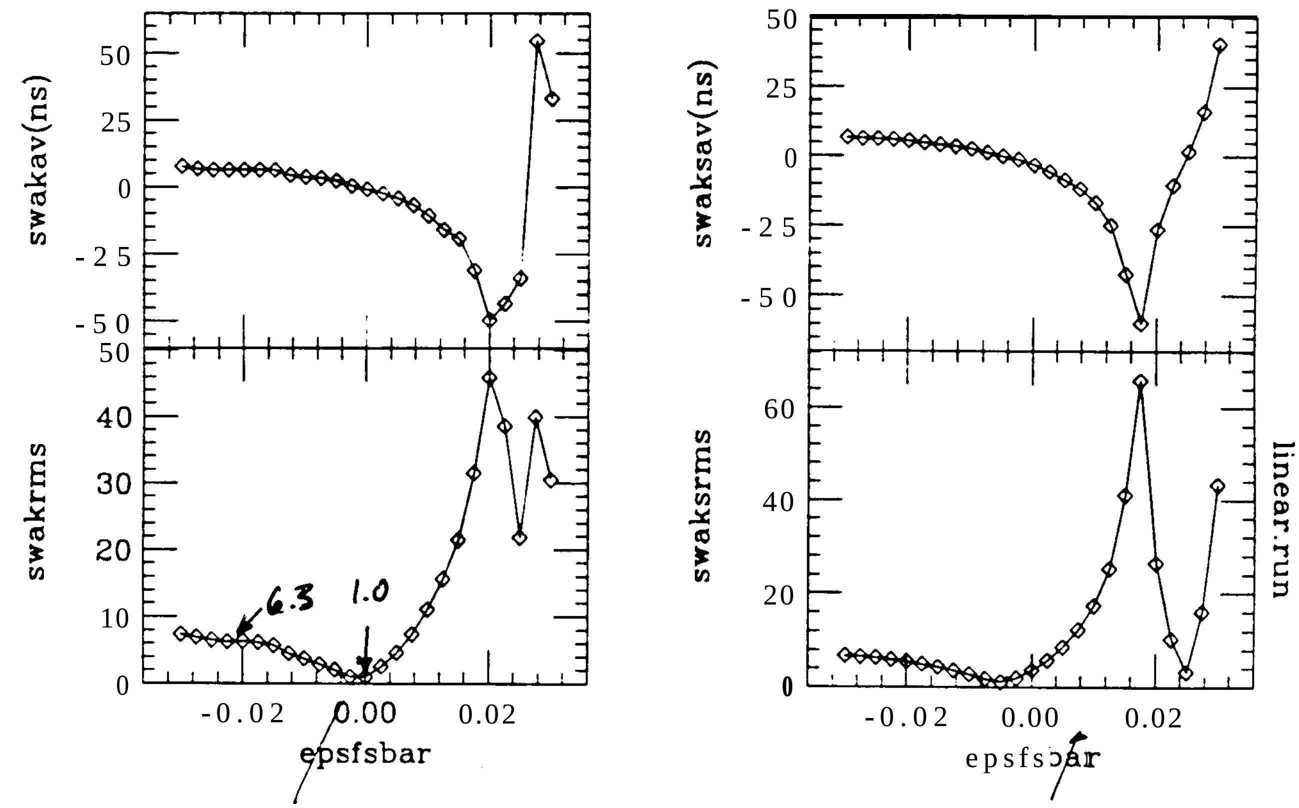
$\sigma_f/f = 15\%$, $\Delta S = 1.4$ ns



Uniform distribution, ½ nominal bunch spacing [1.4ns]



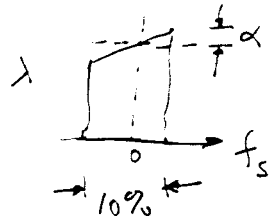
Uniform Distribution, Nominal bunch spacing [2.8 ns]



resonance at

$\pi \bar{f} \Delta t (1.05) \approx 6(2\pi)$

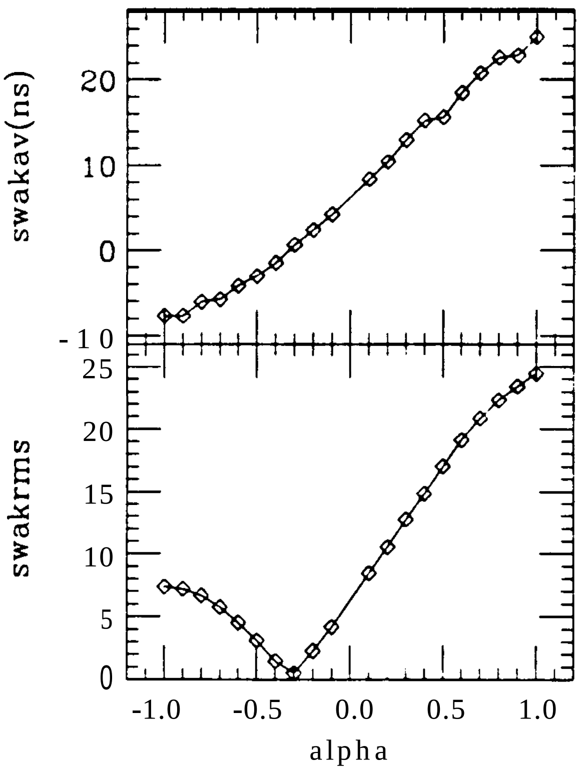
Tilted uniform distribution:
[centered at 0]

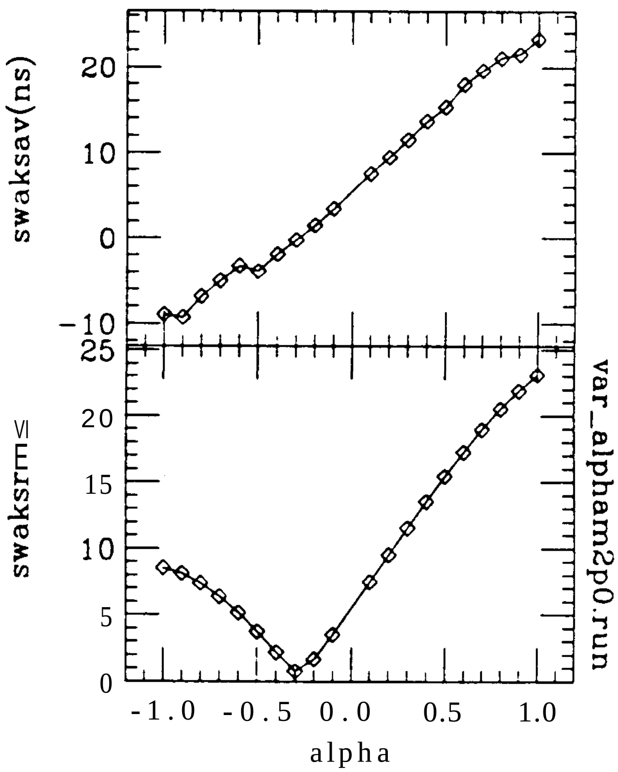


$-1 < \alpha < 1$

$\frac{\Delta \bar{f}_s}{\bar{f}_s} = -2\%$, nominal spacing, function of α

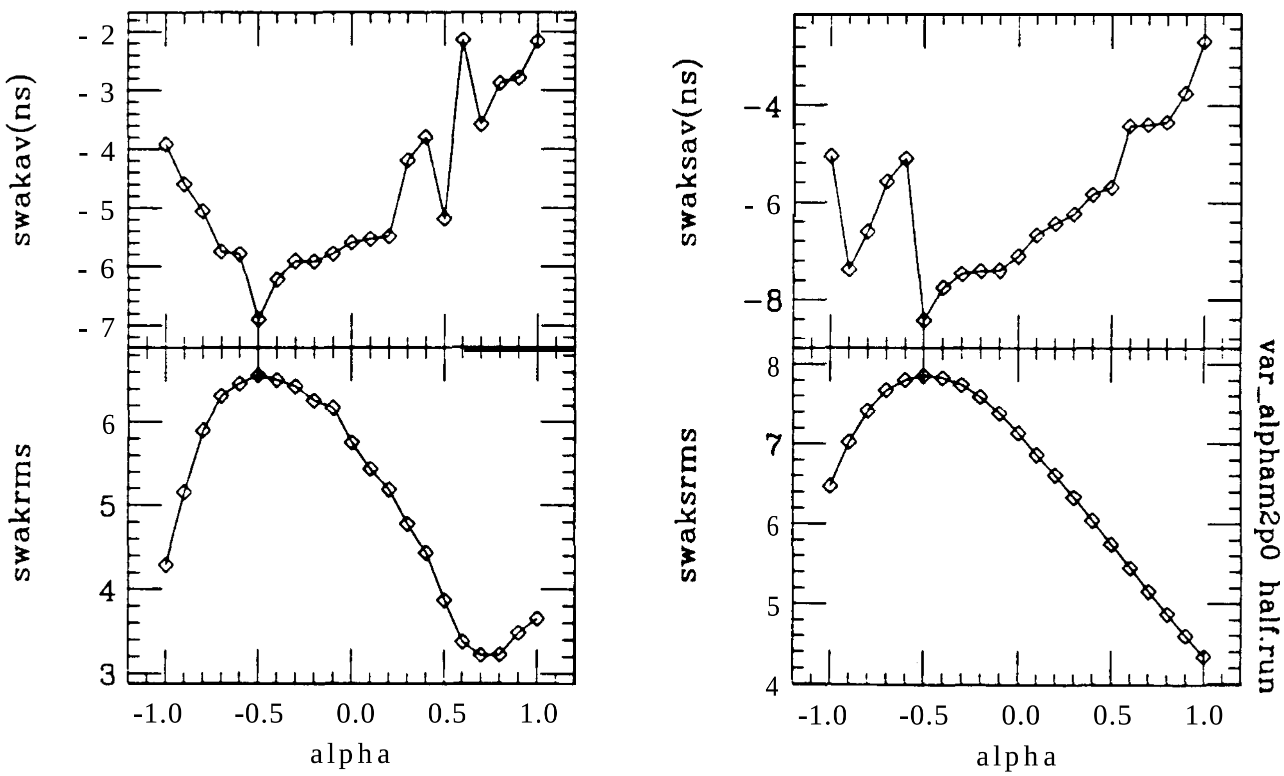
nominal spacing $\quad \frac{\Delta \bar{f}}{f} = -2\%$ linear distribution [illegible]



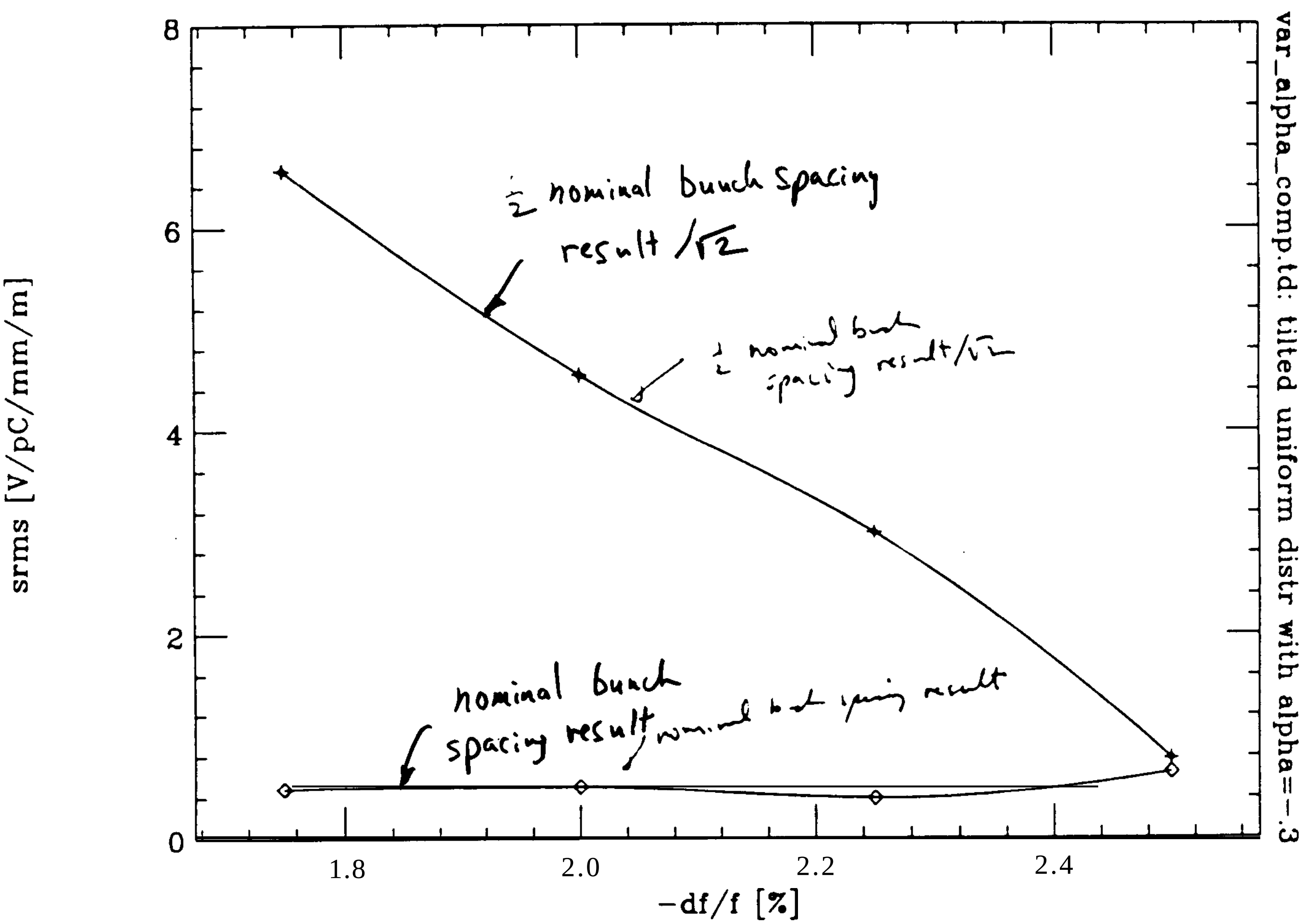


$\frac{\Delta \bar{f}_s}{f_r} = -2\%$, $\frac{1}{2}$ nominal spacing, function of α

• $\frac{1}{2}$ nominal bunch spacing



tilted uniform distribution, $\alpha = -0.3$, function of $\frac{\Delta f_s}{f_s}$



Machine	Beam Break-up: Analytical S_{rms} [V/pC/mm/m]	Analytical Υ	Analytical $\frac{\Delta E}{E}$	Liar $\frac{\Delta E}{E}$	Liar crity	Misalignments: Analytic tol. for 3% ε growth	$\frac{(x_f)_{rms}}{(x_a)_{rms}}$
			(1 σ_y oscillation)				
Prelinac							
1 structure type	0.1	0.14	1%	0.5%	0, 3 ?	75 μm	0.012
* 2 structure types	0.02	0.03	0.04%	0.01%	0.10	" [375 μm together]	
[illegible] ↳ Δs = 42cm	0.57	0.57	17%	0.30%	0.52	[redacted]	.068
" , $\frac{\Delta f}{f}$ = -25%	0.02	0.02	0.02%	0.015%	0.08		
e⁻ Booster	0.02	0.035					0.0042
e⁺ Drive Linac (~~Booster~~)	0.02	0.071					0.0062
e⁺ Booster	0.012	0.014					
L band	0.078	0.091					~~0.0031~~
Δs = 42cm	0.234	0.193					0.022

- crity: in normalized phase space, maximum excursion of any bunch from centroid, due to 1σ_y oscillation

Note: for $E_f >> E_0$, $\beta \sim E^{1/2}$

$$\frac{(x_f)_{rms}}{(x_a)_{rms}} = e^{-} N L_a (S_a)_{rms} \sqrt{N_a}\, \bar{\beta}_0 \left[\frac{1 - (E_0/E_f)^{[illegible]}}{E_0 E_f} \right]^{1/2}$$