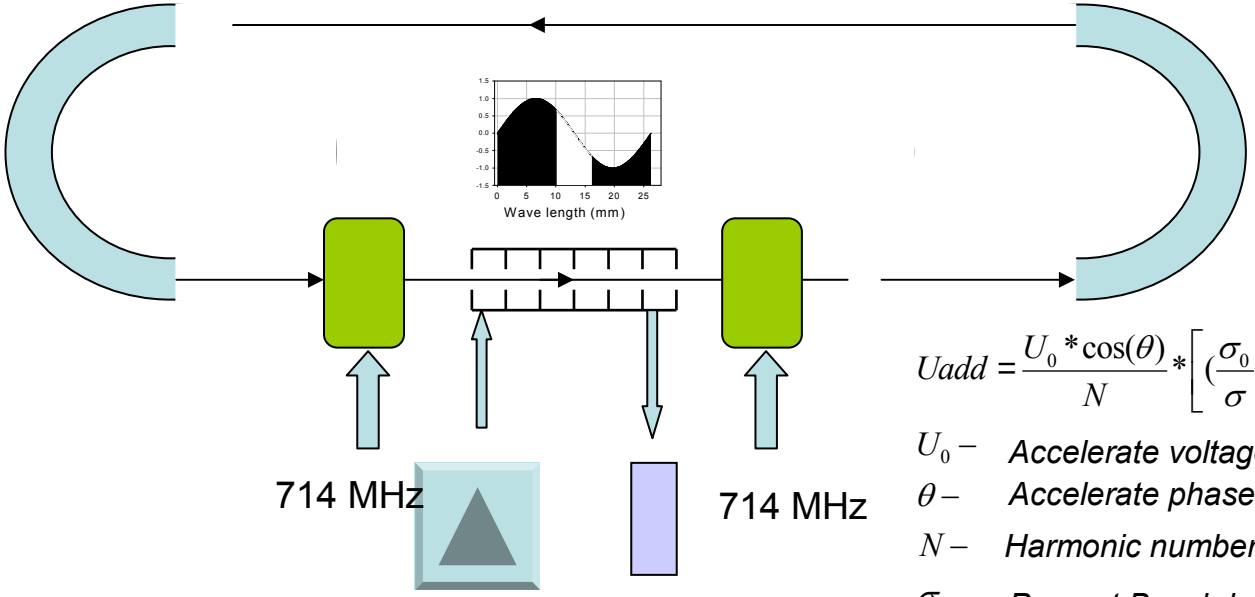
Shorter bunch length in ATF DR and X band extraction circuit

Vladimir Vogel
KEK

March 7, 2005
ATF2 meeting

C band, 8mm-4mm



$$Uadd = \frac{U_0 * \cos(\theta)}{N} * \left[(\frac{\sigma_0}{\sigma})^2 - 1 \right]$$

U_0 – *Accelerate voltage*

θ – *Accelerate phase*

N – *Harmonic number*

σ_0 *Present Bunch length*

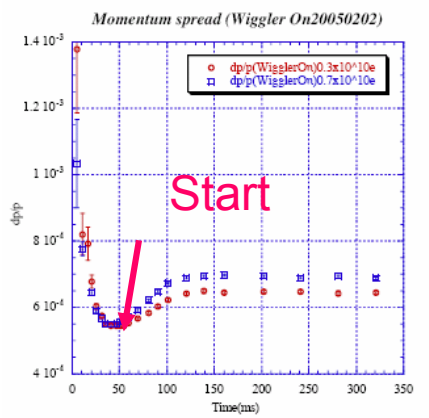


Fig.7b momentum spread as a function of time (w/ wiggler)

F.J. Decker, and all.

C band

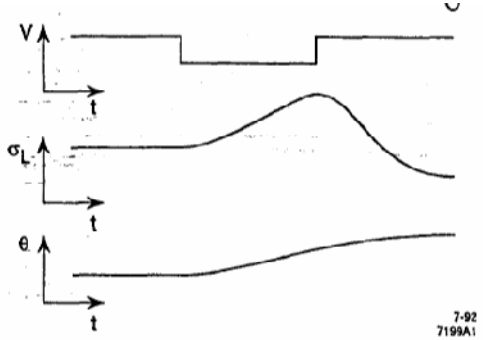
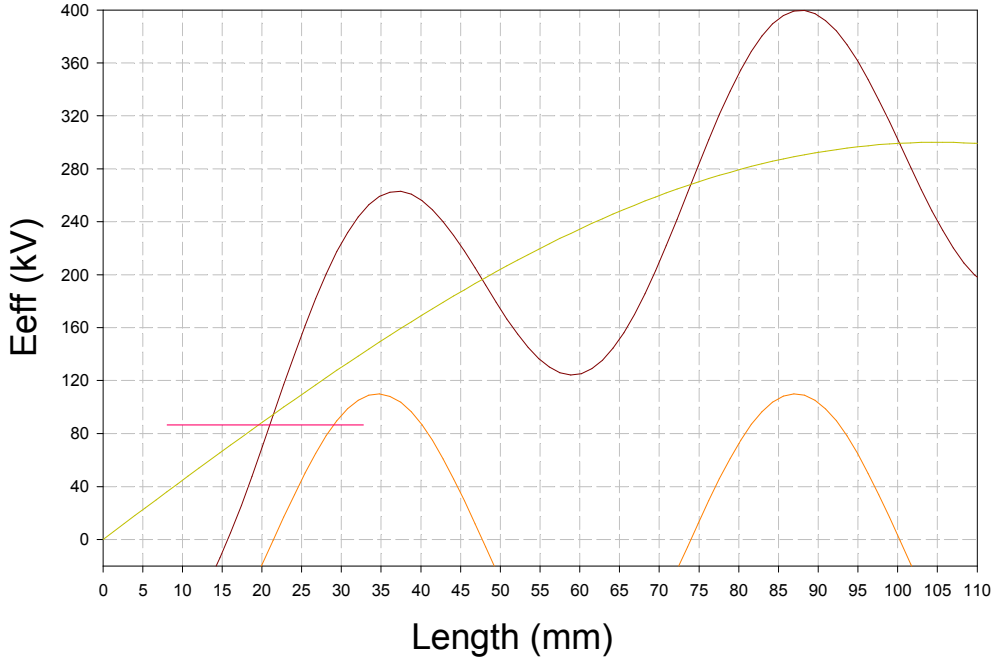


Figure 1: Principle of pre-compression in the DR.

The rf-voltage (V) is lowered and the bunch starts to rotate on ellipses in longitudinal phase space. When the beam is a flat ellipse in phase space about after a quarter of a synchrotron oscillation, the rf is raised back to the regular value. The desired effect is a smaller bunch length (σ_L) at extraction. An undesired effect is a phase change (θ), which can be compensated by a second munch (rf off – on) cancelling the phase effect and adding to the length effect.



Bunch length vs. RF voltage in ATF DR

K.Kubo 2005.02.25.

Fig. 1 shows calculated equilibrium bunch length (sigma) as function of RF voltage of 714 MHz, for different bunch intensities, N=0, N=5E9 and N=1E10, including intrabeam scattering using SAD. Vertical - horizontal emittance ratio was assumed to be 0.5%. Usual RF voltage is 300 kV. To reduce the bunch length by factor 2, voltage (714 MHz) should be 1.19 MV, 1.47 MV and 1.52 MV for N=0, 5E9 and 1E10, respectively. As suggested by Vogel, if we add C-band RF voltage to existing 0.3 MV 714 MHz RF, the necessary C-band voltage to reduce the bunch length by factor 2 will be 0.111 MV, 0.146 MV and 0.153 MV, for three bunch intensity.
Momentum spread and horizontal emittance are also shown in Fig. 2 and 3.

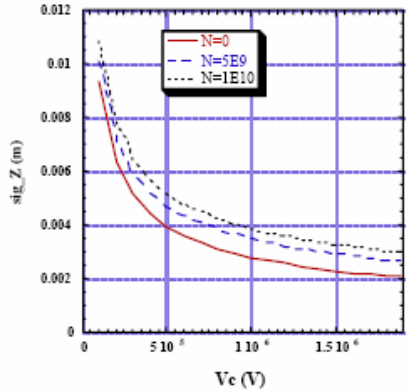


Fig. 1, Equilibrium bunch length (sigma) vs. RF voltage, for N=0, 5E9 and 1E10. Emittance ratio 0.5% is assumed.

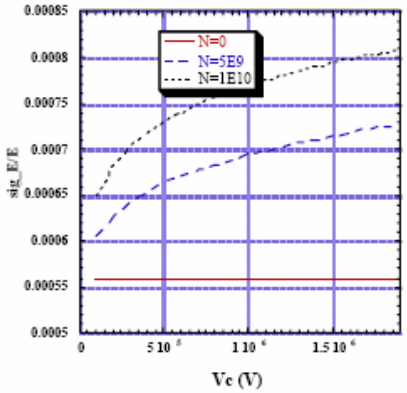


Fig. 2, Equilibrium momentum spread vs. RF voltage, for N=0, 5E9 and 1E10. Emittance ratio 0.5% is assumed.

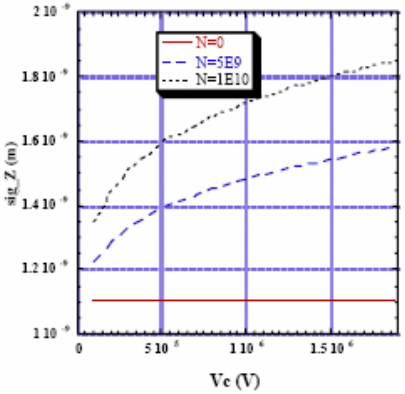


Fig. 3, Horizontal emittance vs. RF voltage, for N=0, 5E9 and 1E10. Emittance ratio 0.5% is assumed.

ATF - 04 - 08
2005 / 02 / 14

ATF REPORT

TITLE: Recent measurements of ATF-DR with the damping wigglers

AUTHORS: T.Naito, S.Kuroda, M.Kuriki, K.Kudo, Y.Honda, T.Muto
N.Terunuma, H.Hayano, J.Urakawa (KEK)
K.Takezawa(Kyoto Univ.)

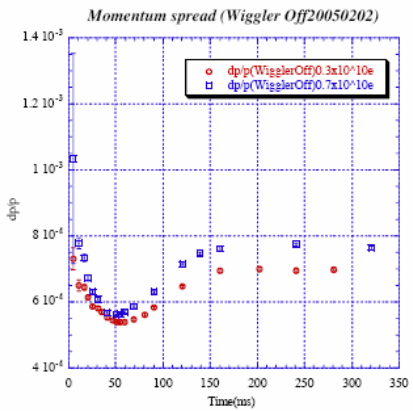


Fig.7a momentum spread as a function of time (w/o wiggler)

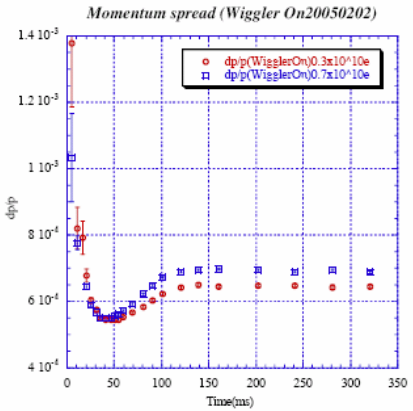
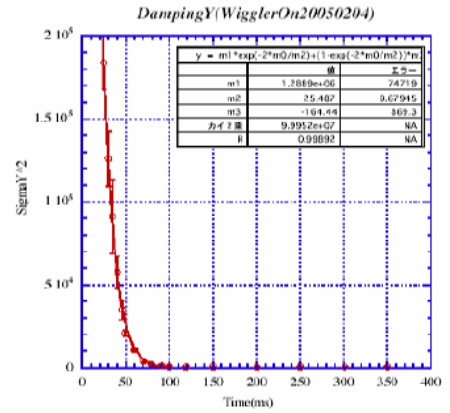


Fig.7b momentum spread as a function of time (w/ wiggler



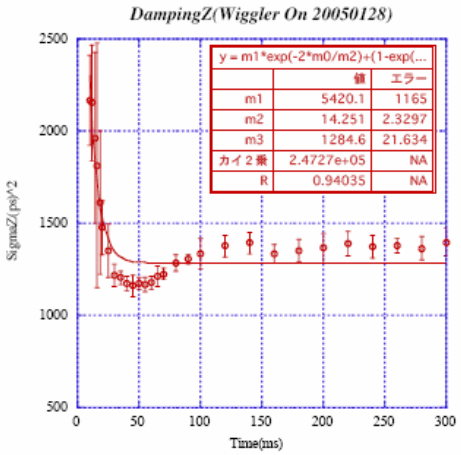


Fig. 5e Damping Z(w/ wiggler)

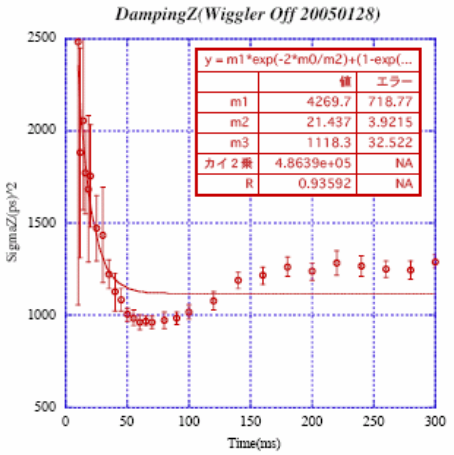


Fig. 5f Damping Z(w/o wiggler)

The damping phenomena are plotted in Fig. 5a, b, c, d, e, f, and the measured damping times are summarized in table 3. The measured damping times are agreed well with the SAD calculation. The IBS growth effects after damping are observed at the horizontal beam size and the bunch length. Fig. 6 plots horizontal beam sizes in the case of wiggler on and off. We can clearly observe the reduction of the damping time and suppression of the IBS effect with the wiggler operation.

The damping of the momentum spread in the damping ring is also measured. The momentum spread is expressed by a function of the bunch length, which is connected

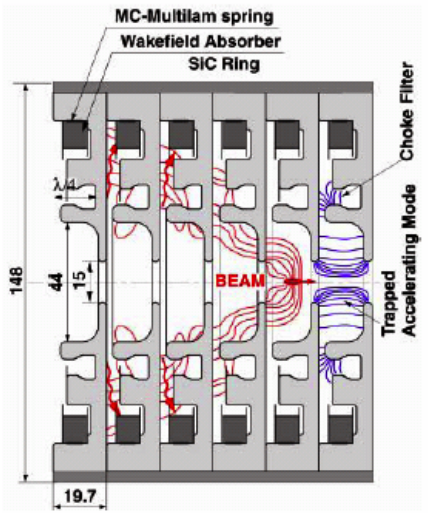
Proceedings of LINAC2002, Gyeongju, Korea

THE C-BAND (5712-MHz) LINAC FOR THE SPRING-8 COMPACT SASE SOURCE (SCSS)

H. Matsumoto, Shigeru. Takeda, KEK, Tsukuba, 305-0801 Japan
T. Shintake, H. Baba, T. Inagaki, Y. J. Kim, K. Togawa, H. Kitamura, SCSS group, RIKEN, Harima 679-5148, Japan

Table3: Main parameters of the Choke-mode rf structure.

Frequency:	5712	MHz
Phase shift per cell:	3π/4	
Electric field distribution on the axis:	Quasi-C.G	
Quality factor (Q, average):	10256	
Attenuation parameter (τ):	0.53	
Filling time (t_F):	290	nsec
Shunt impedance (r, average):	58.5	MΩ/m
Ratio of Es/Ea:	2.2	(max.)
Iris aperture ($2a$) up-stream:	17.330	mm
down-stream:	13.587	mm
Disk thickness (t):	4	mm
Number of cells:	91	
Number of Couplers: (field symmetry & double feed)	2	
RF structure active length:	1.8	m



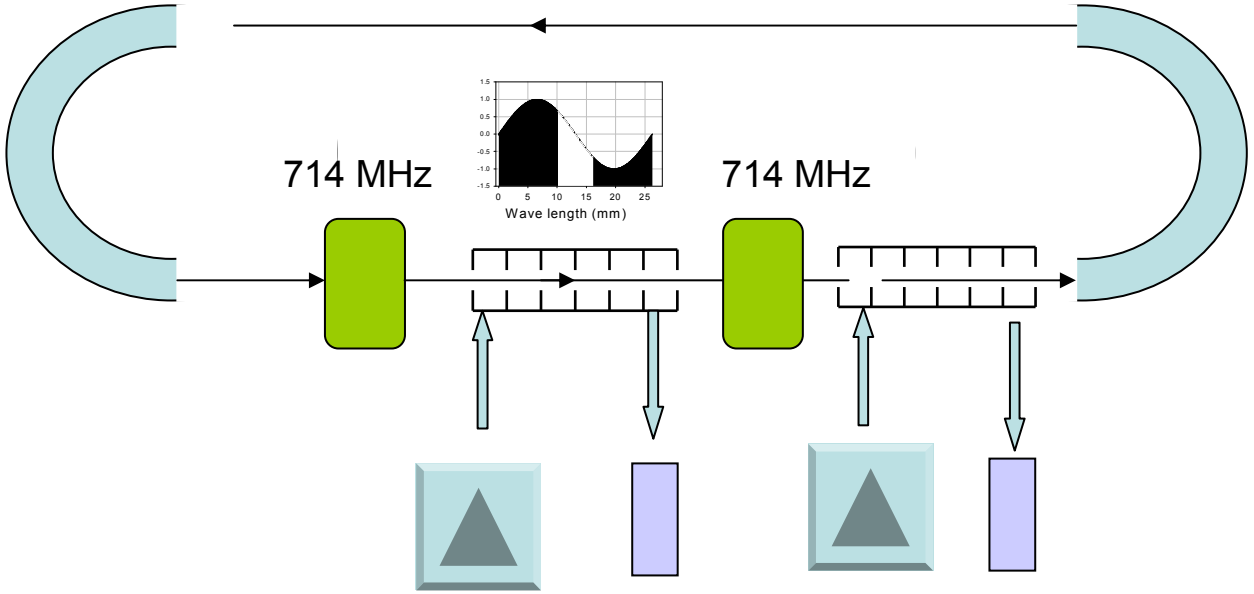
$$E = \sqrt{R_{sh} * 2 * \alpha * P}$$

L =1 m, P = *4 kW*

U = 167 kV

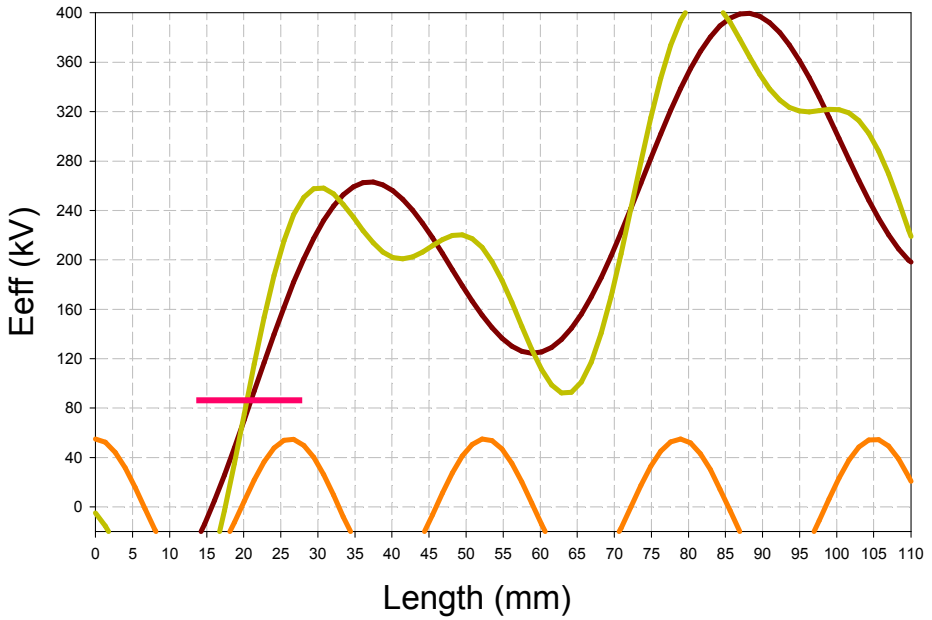
Single cell cavity
For 150kV, P=60 kW !

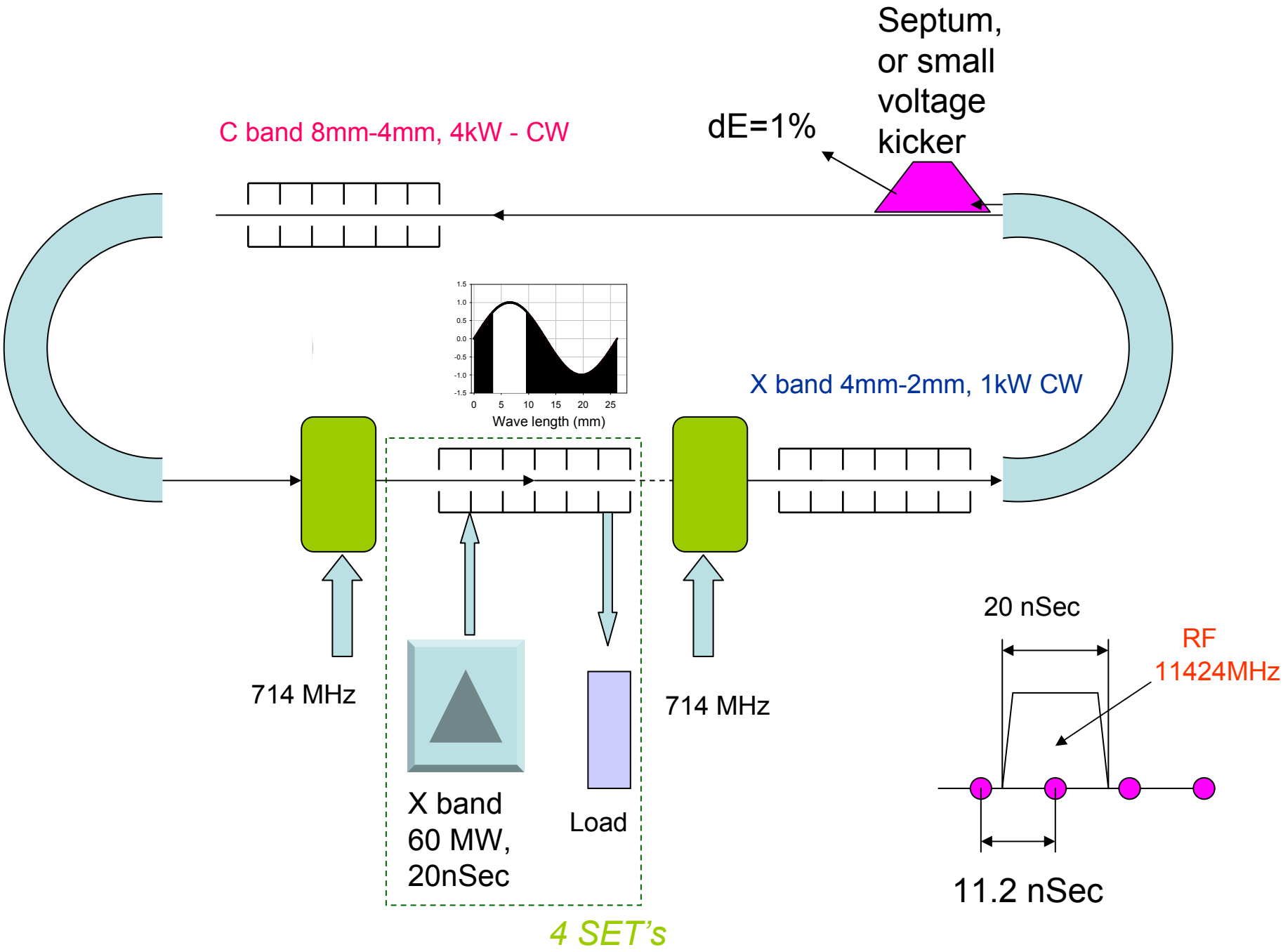
C + X band
4mm-2mm



C band P=4kW

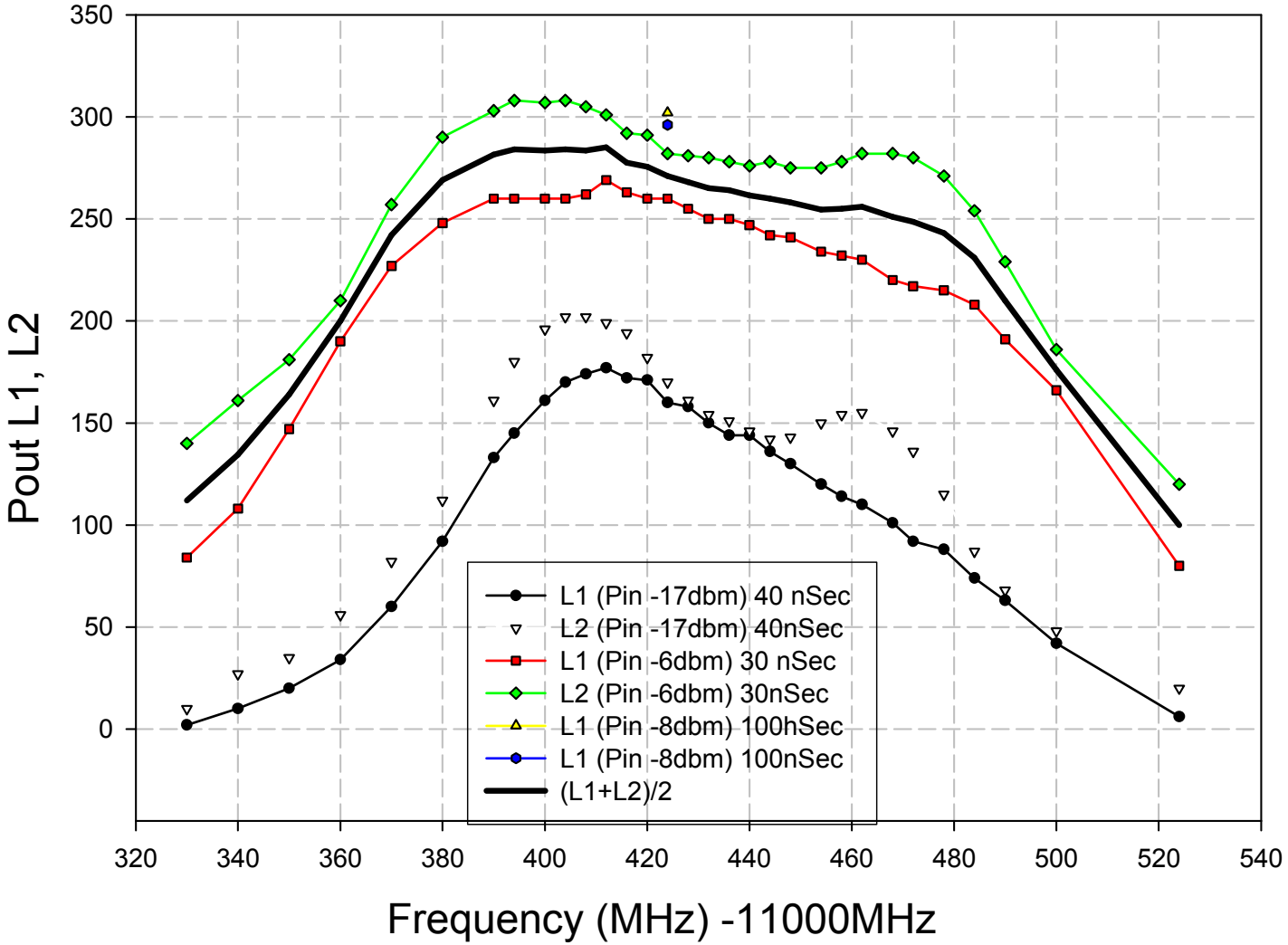
X band *P=1kW*

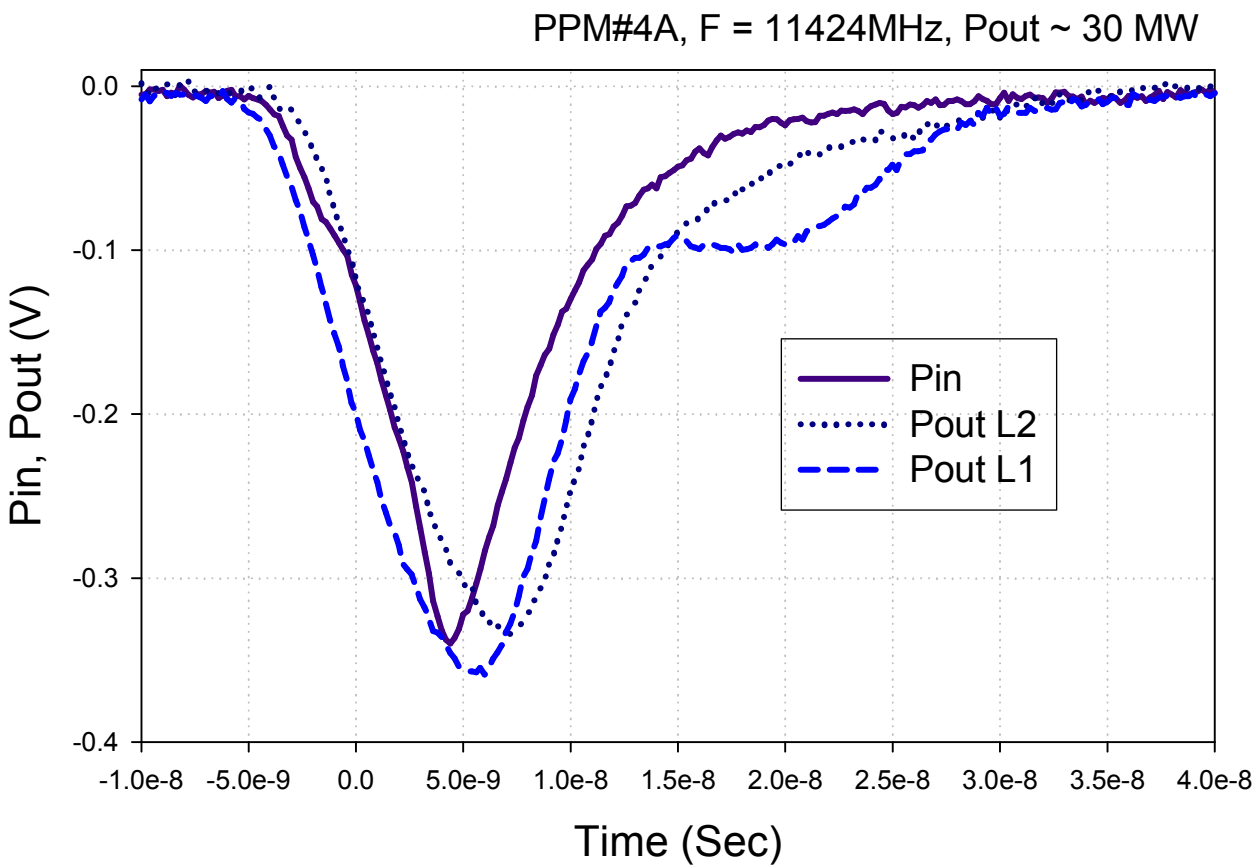



Septum,
or small
voltage
kicker
dE=1%
C band 8mm-4mm, 4kW - CW
X band 4mm-2mm, 1kW CW
Wave length (mm)
714 MHz
714 MHz
X band
60 MW,
20nSec
Load
4 SET's
20 nSec
RF
11424MHz
11.2 nSec

August 31, 2004

PPM#4a, U = 500kV, Tp= 30, 40, 100 nSec, Pin=-17dbm, -6dbm




PPM#4A, F = 11424MHz, Pout ~ 30 MW
Pin, Pout (V)
0.0
-0.1
-0.2
-0.3
-0.4
-1.0e-8
-5.0e-9
0.0
5.0e-9
1.0e-8
1.5e-8
2.0e-8
2.5e-8
3.0e-8
3.5e-8
4.0e-8
Time (Sec)
Pin
Pout L2
Pout L1

bunch spacing in DR = 11.2 (5.6) nS, DR circumference 4.76 (2.38) km

- Structure 4* L=0.4 m, Vgr~0.2, a/λ ~ 0.3, ΔE ~16 Mev
- Klystrons number 4 , pulse length ~ 100 nSec, Pout ~15 MW
- Repetition rate 2.65/4 MHz, (with delay lines), Pav.=4*15kW
- IGBT modulator for 4 klystrons, 270kV, 4*112A

- DR one turn time ~ 15.8 μS, τdam. ~ 25 mS,

  N_{dr} = 1580, (*LC X-band N = ~12 000*)