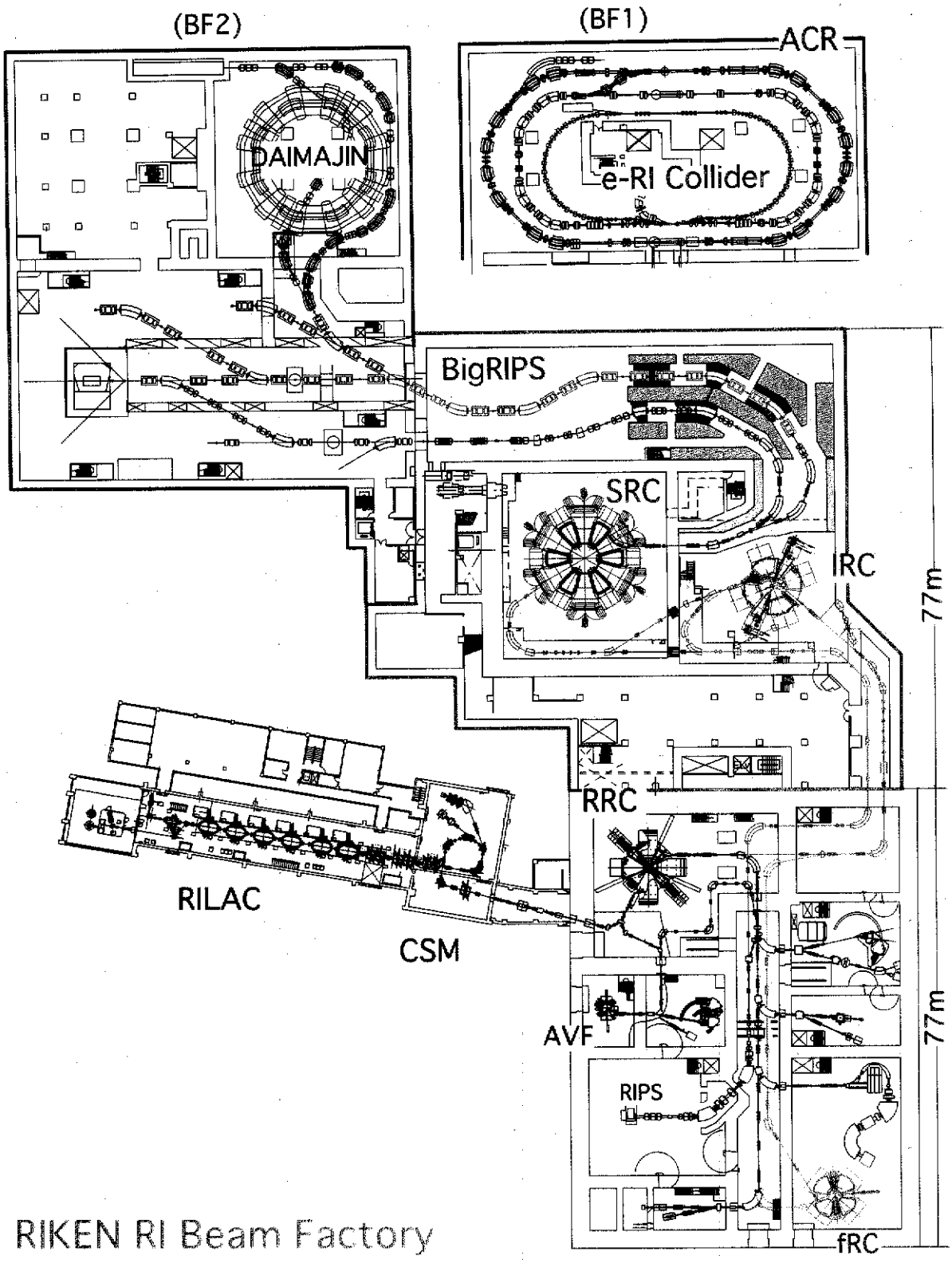
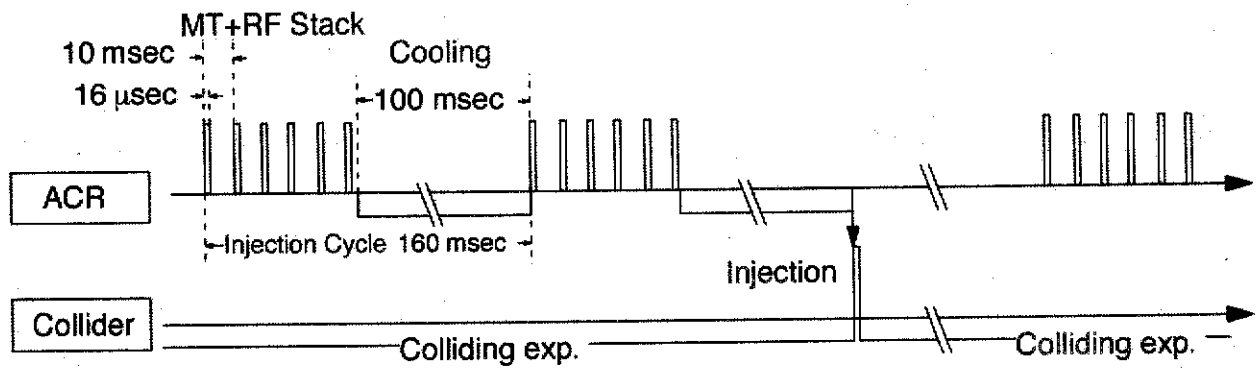
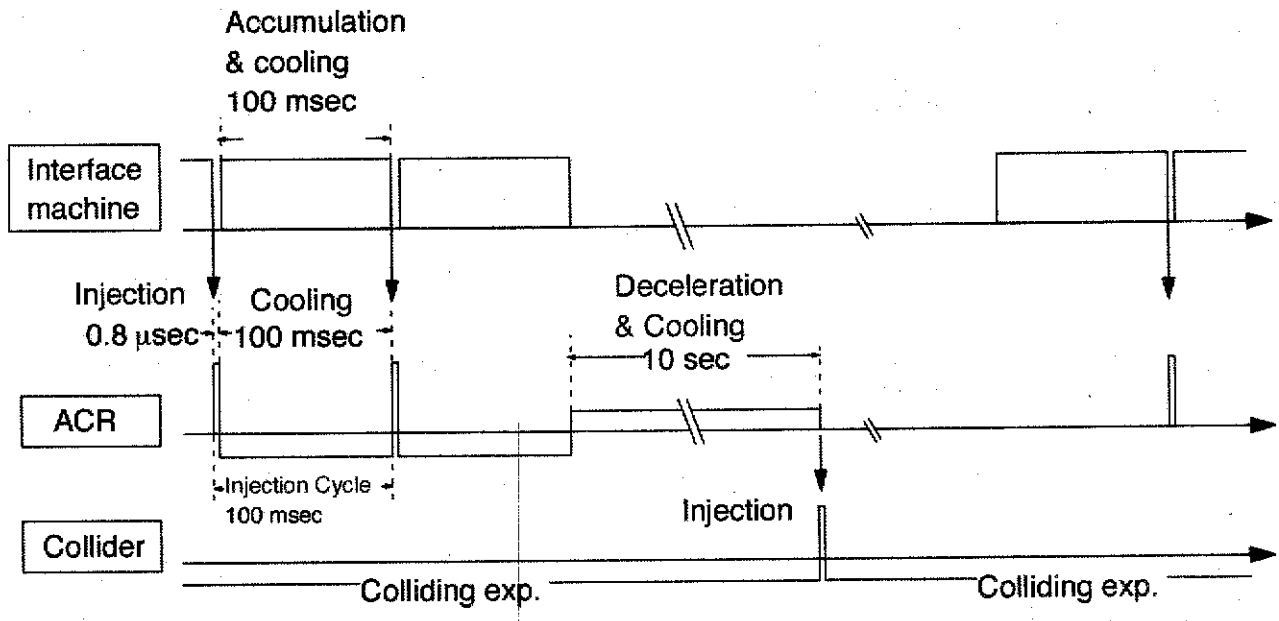


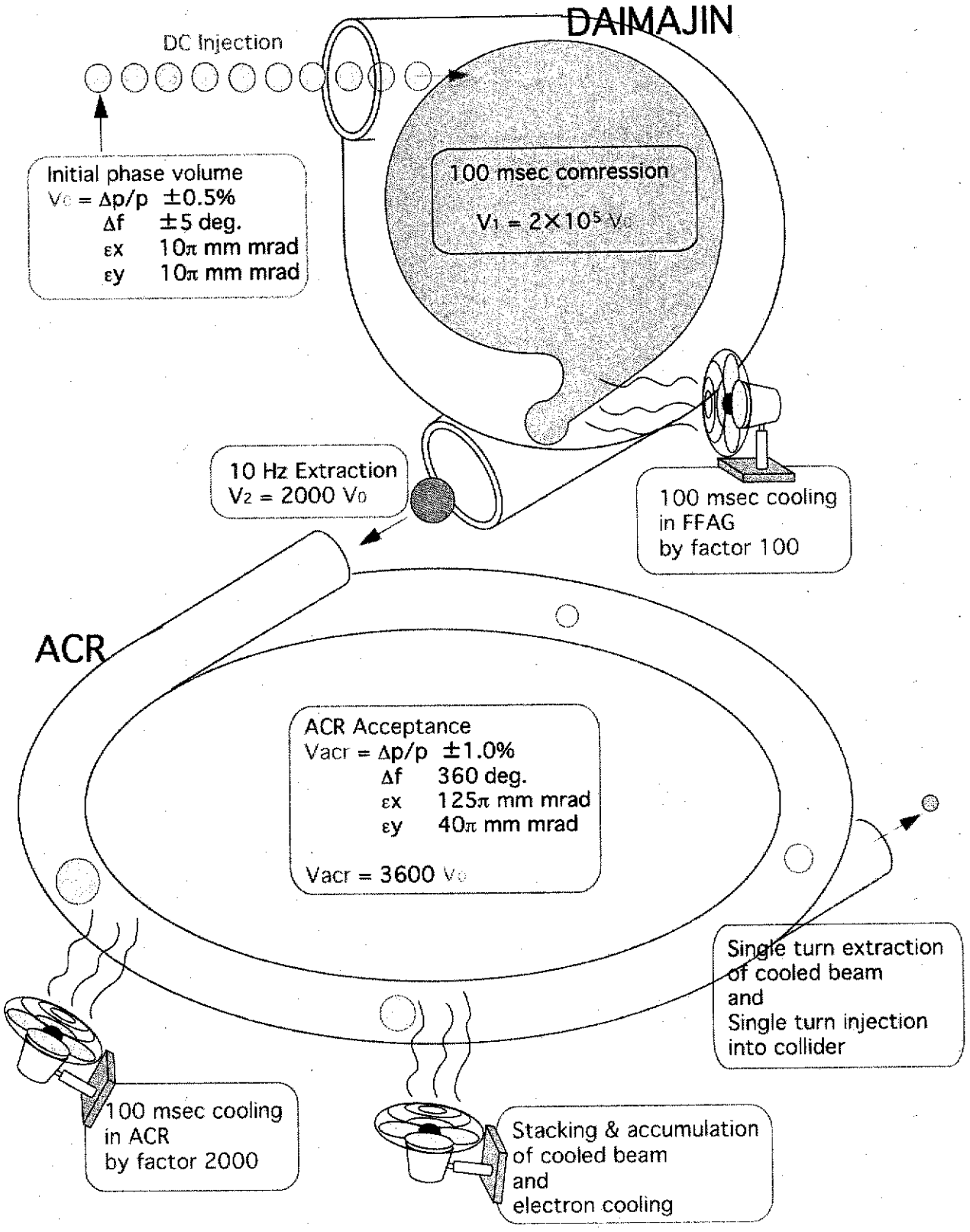
RIKEN RI Beam Factory

Time chart of beam operation



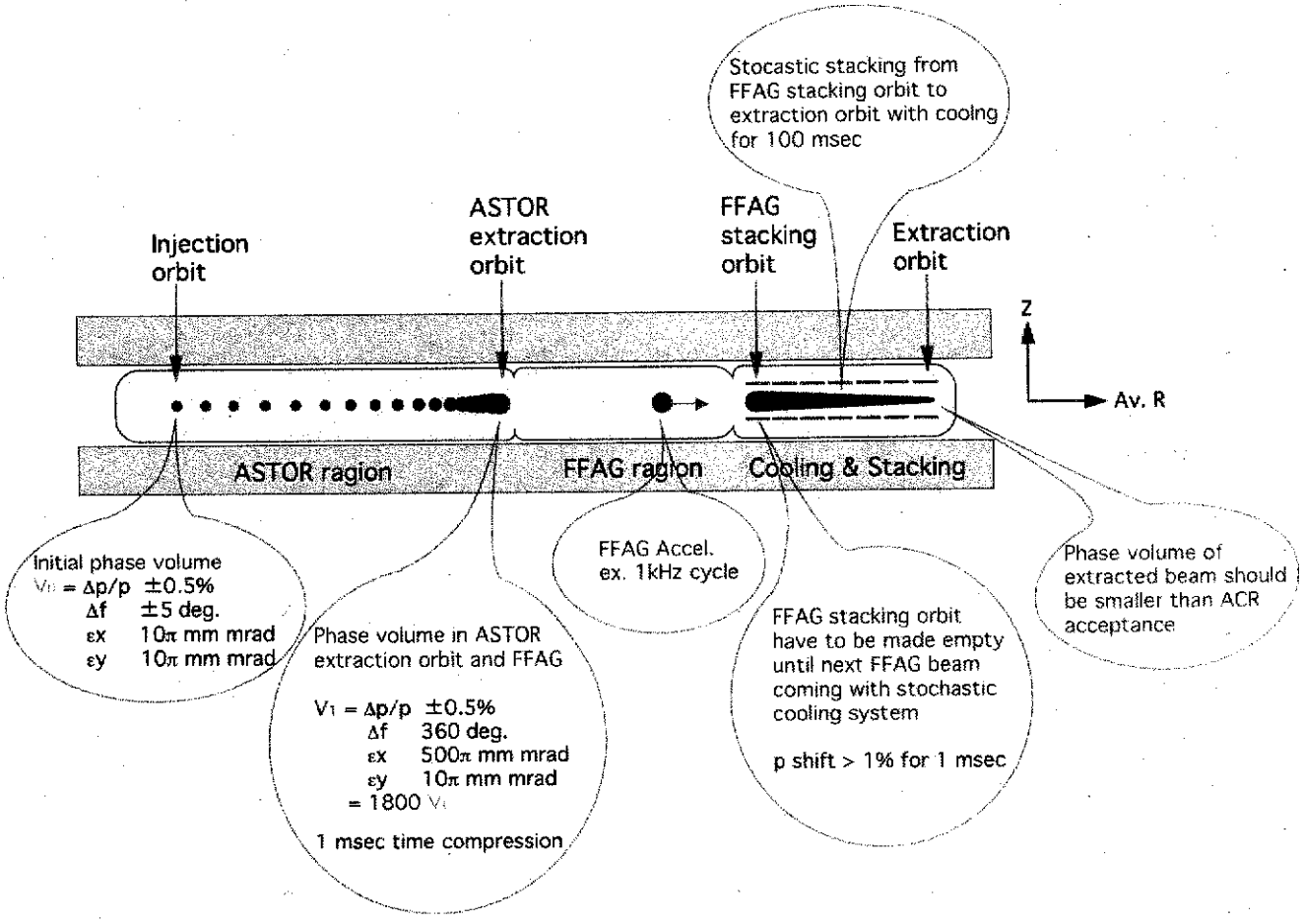


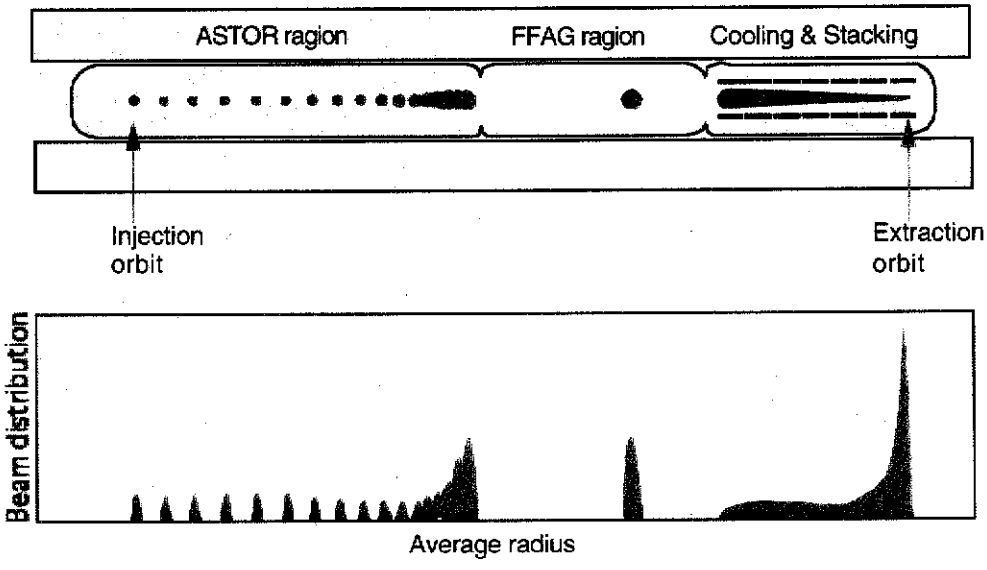
Phase volume



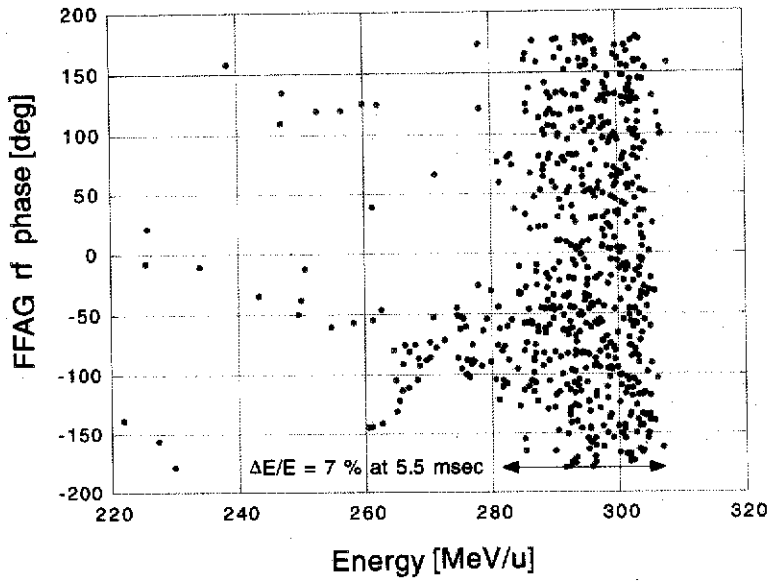
Concept of ASTOR+FFAG

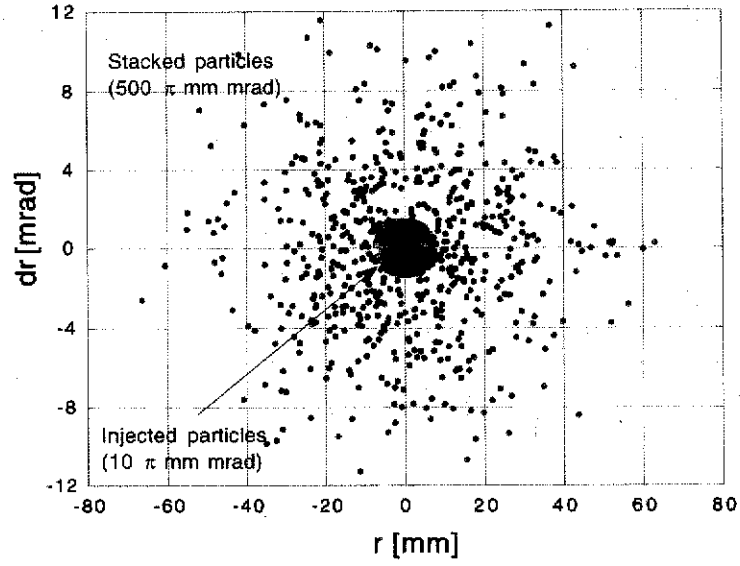
DAIMAJIN consists of ASTOR, FFAG, and Stochastic cooling system, which are continuously connected

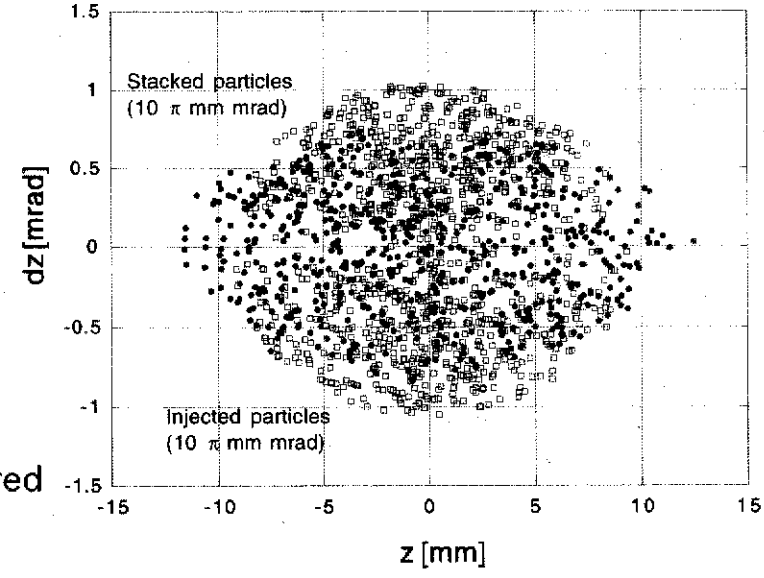




6-dimensional phase volume after 5 cycles of FFAG acceleration

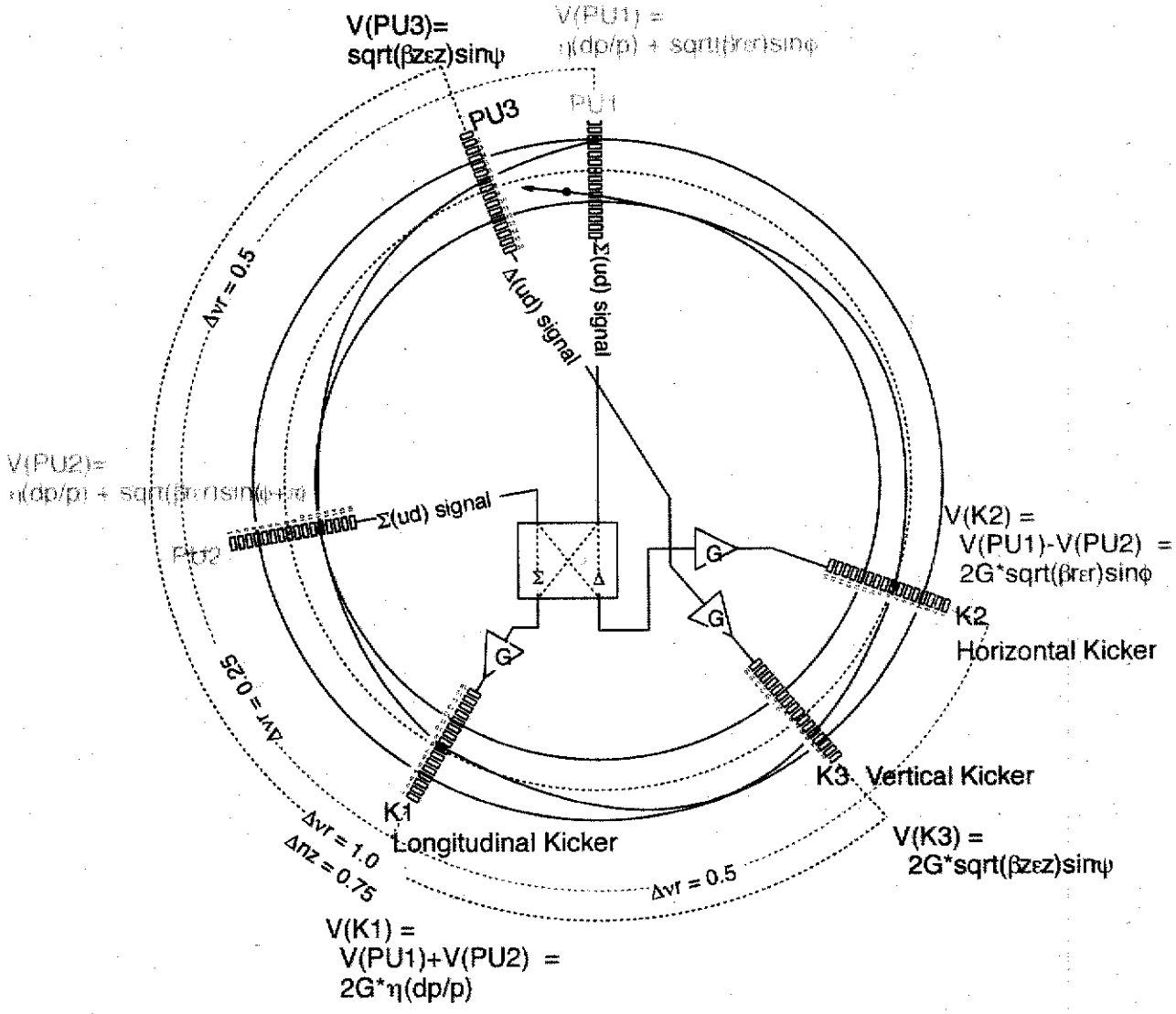




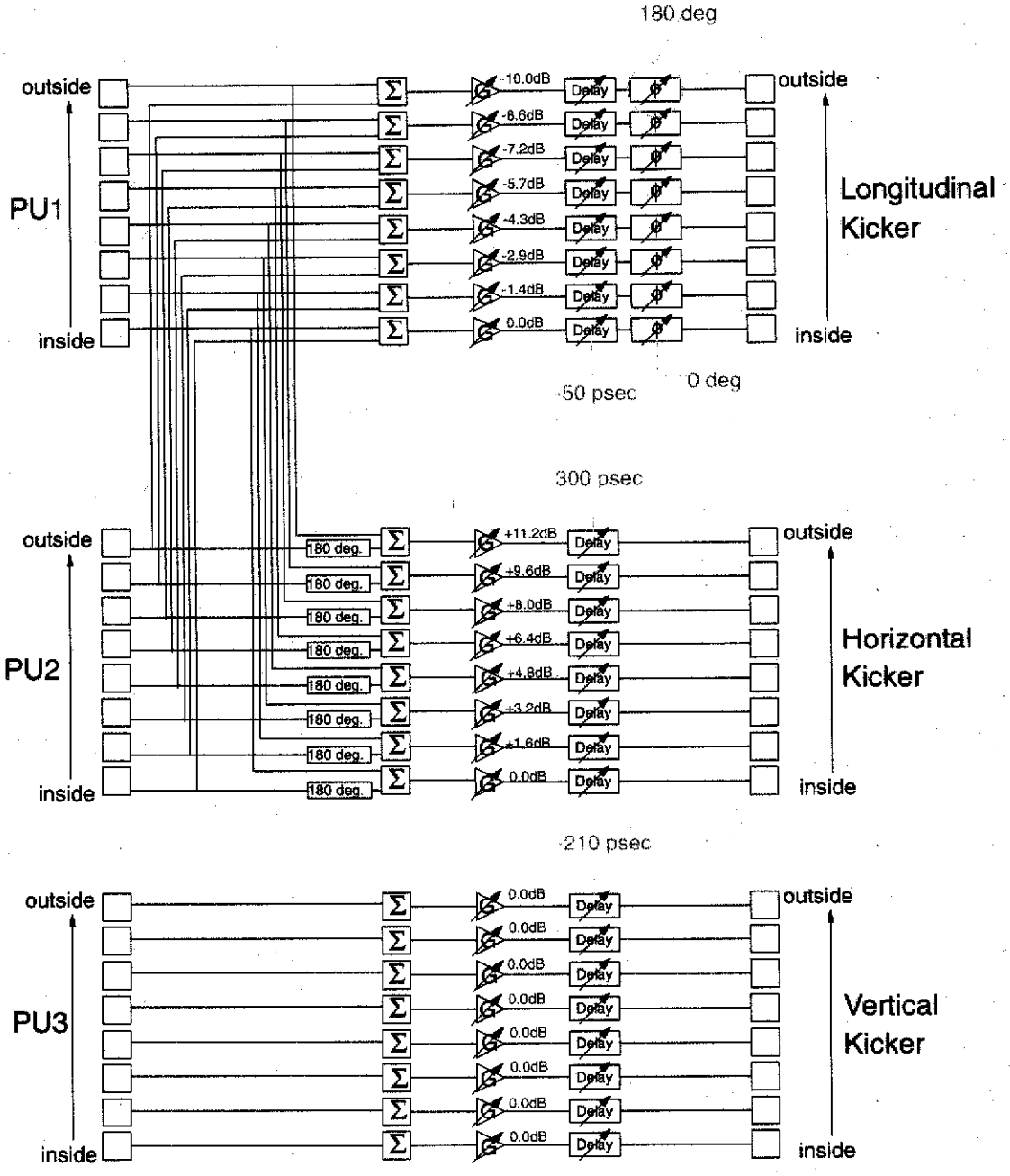


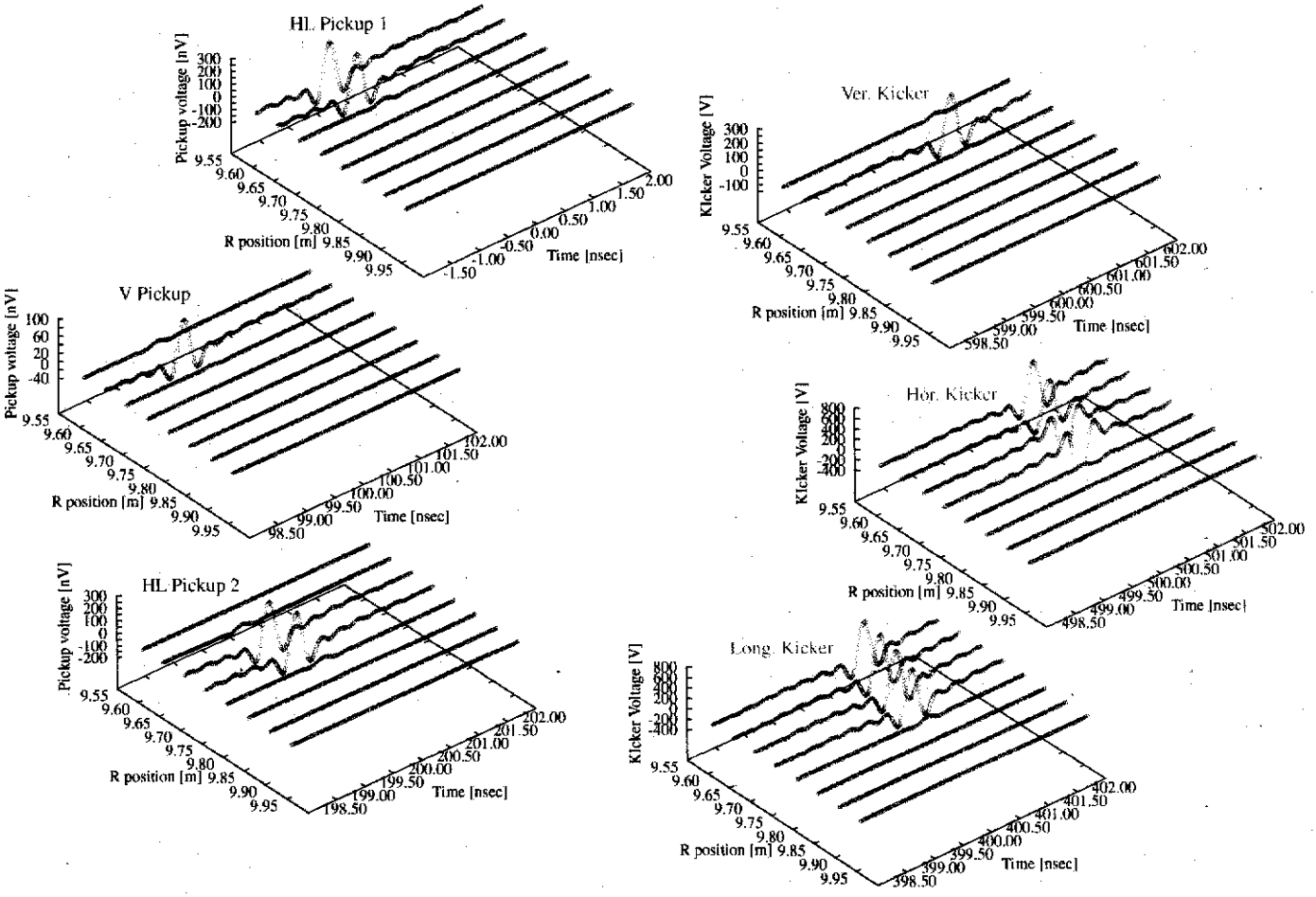
Quick cooling is required

Concept of stochastic cooling in FFAG with multi-electrodes system



Simple model of SC system in FFAG




HL Pickup 1
Pickup voltage [nV]
R position [m]
Time [nsec]
V Pickup
Pickup voltage [nV]
R position [m]
Time [nsec]
HL Pickup 2
Pickup voltage [nV]
R position [m]
Time [nsec]
Ver. Kicker
Kicker Voltage [V]
R position [m]
Time [nsec]
Hor. Kicker
Kicker Voltage [V]
R position [m]
Time [nsec]
Long. Kicker
Kicker Voltage [V]
R position [m]
Time [nsec]

Calculation of cooling force at kickers

at longitudinal kicker

$$V_l^{K1}(t) = \frac{1}{4\sqrt{2}} qeZ_c \sum_{m=1}^{Ne} G_{K1}(m)\, g_{K1}^{u}(m,i) \sum_{j=1}^{Np} f_j \left\{ g_{P1}^{u}(m,j)\, W_1 + g_{P2}^{u}(m,j)\, W_1 \right\}$$

$$V_x^{K1}(t) = \frac{1}{4\sqrt{2}} qeZ_c \frac{c}{2\pi} \sum_{m=1}^{Ne} G_{K1}(m) \frac{\partial g_{K1}^{u}(m,i)}{\partial x} \sum_{j=1}^{Np} f_j \left\{ g_{P1}^{u}(m,j)\, W_2 + g_{P2}^{u}(m,j)\, W_2 \right\}$$

$$V_y^{K1}(t) = \frac{1}{4\sqrt{2}} qeZ_c \frac{c}{2\pi} \sum_{m=1}^{Ne} G_{K1}(m) \frac{\partial g_{K1}^{u}(m,i)}{\partial y} \sum_{j=1}^{Np} f_j \left\{ g_{P1}^{u}(m,j)\, W_2 + g_{P2}^{u}(m,j)\, W_2 \right\}$$

at horizontal kicker

$$V_l^{K2}(t) = \frac{1}{4\sqrt{2}} qeZ_c \sum_{m=1}^{Ne} G_{K2}(m)\, g_{K2}^{u}(m,i) \sum_{j=1}^{Np} f_j \left\{ g_{P1}^{u}(m,j)\, W_1 - g_{P2}^{u}(m,j)\, W_1 \right\}$$

$$V_x^{K2}(t) = \frac{1}{4\sqrt{2}} qeZ_c \frac{c}{2\pi} \sum_{m=1}^{Ne} G_{K2}(m) \frac{\partial g_{K2}^{u}(m,i)}{\partial x} \sum_{j=1}^{Np} f_j \left\{ g_{P1}^{u}(m,j)\, W_2 - g_{P2}^{u}(m,j)\, W_2 \right\}$$

$$V_y^{K2}(t) = \frac{1}{4\sqrt{2}} qeZ_c \frac{c}{2\pi} \sum_{m=1}^{Ne} G_{K2}(m) \frac{\partial g_{K2}^{u}(m,i)}{\partial y} \sum_{j=1}^{Np} f_j \left\{ g_{P1}^{u}(m,j)\, W_2 - g_{P2}^{u}(m,j)\, W_2 \right\}$$

at vertical kicker

$$V_l^{K3}(t) = \frac{1}{4} qeZ_c \sum_{m=1}^{Ne} G_{K3}(m)\, g_{K3}^{b}(m,i) \sum_{j=1}^{Np} f_j\, g_{P3}^{b}(m,j)\, W_1$$

$$V_x^{K3}(t) = \frac{1}{4} qeZ_c \frac{c}{2\pi} \sum_{m=1}^{Ne} G_{K3}(m) \frac{\partial g_{K3}^{b}(m,i)}{\partial x} \sum_{j=1}^{Np} f_j\, g_{P3}^{b}(m,j)\, W_2$$

$$V_y^{K3}(t) = \frac{1}{4} qeZ_c \frac{c}{2\pi} \sum_{m=1}^{Ne} G_{K3}(m) \frac{\partial g_{K3}^{b}(m,i)}{\partial y} \sum_{j=1}^{Np} f_j\, g_{P3}^{b}(m,j)\, W_2$$

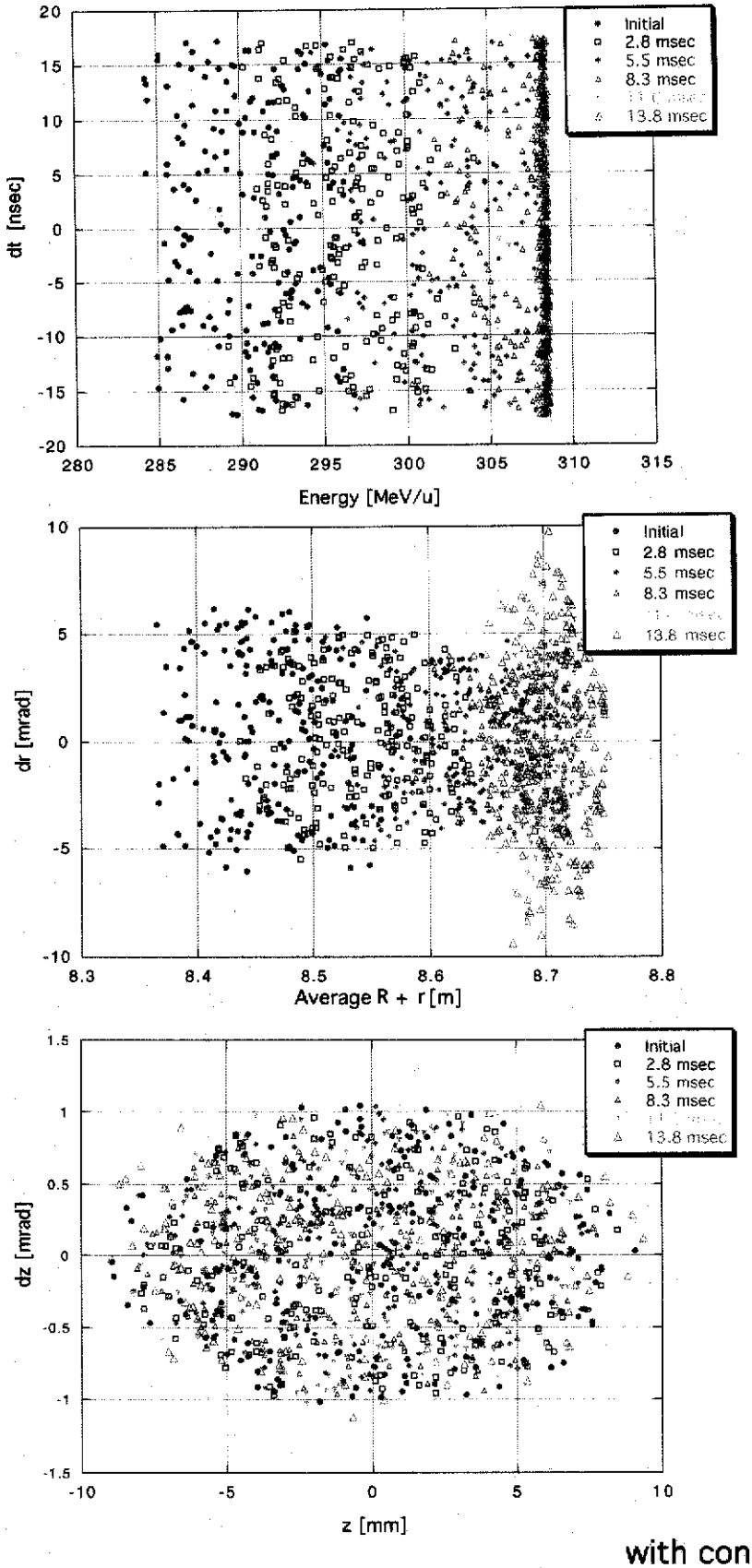
where

$$W_1 = \sum_{n=-\infty}^{\infty} \frac{1}{4} e^{j2\pi n f_j \left(t - \tau_{pij} - T_{pnkx}\right)} \left\{ 1 - e^{-jn\pi f_j / f_c} \right\}^2$$

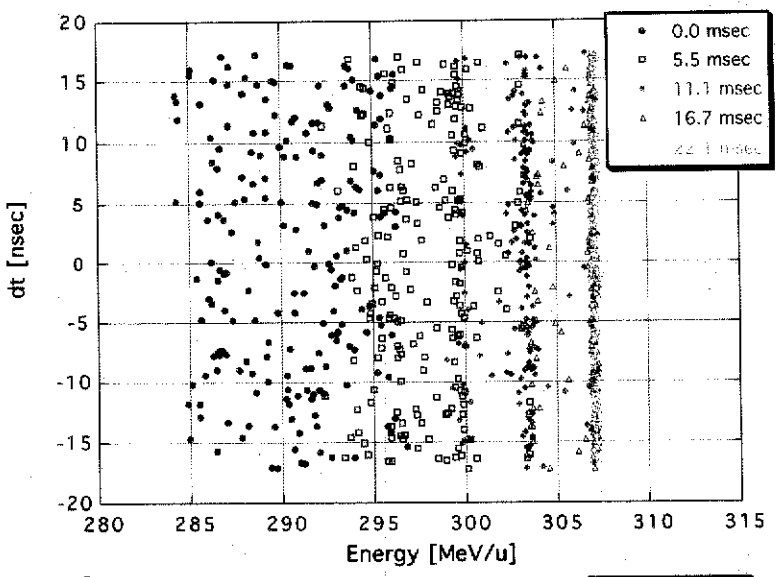
$$W_2 = \sum_{n=-\infty}^{\infty} \frac{j}{4 n f_j} e^{j2\pi n f_j \left(t - \tau_{pij} - T_{pnkx}\right)} \left\{ 1 - e^{-jn\pi f_j / f_c} \right\}^2$$

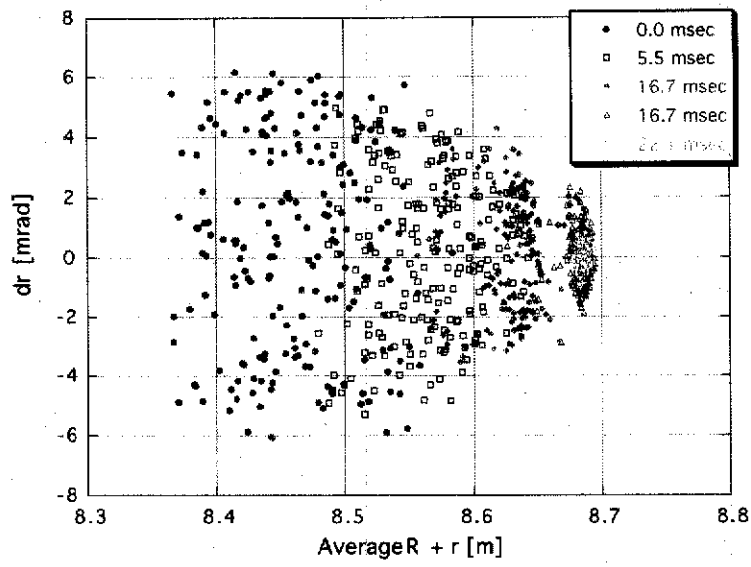
assuming sensitivity

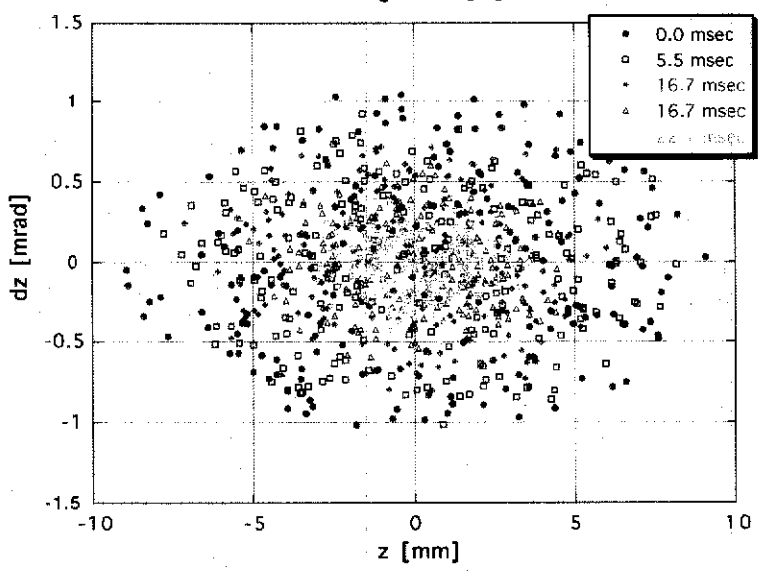
$$\xi(f) = \frac{1}{2}\left(1 - e^{-j\pi f / f_c}\right)$$



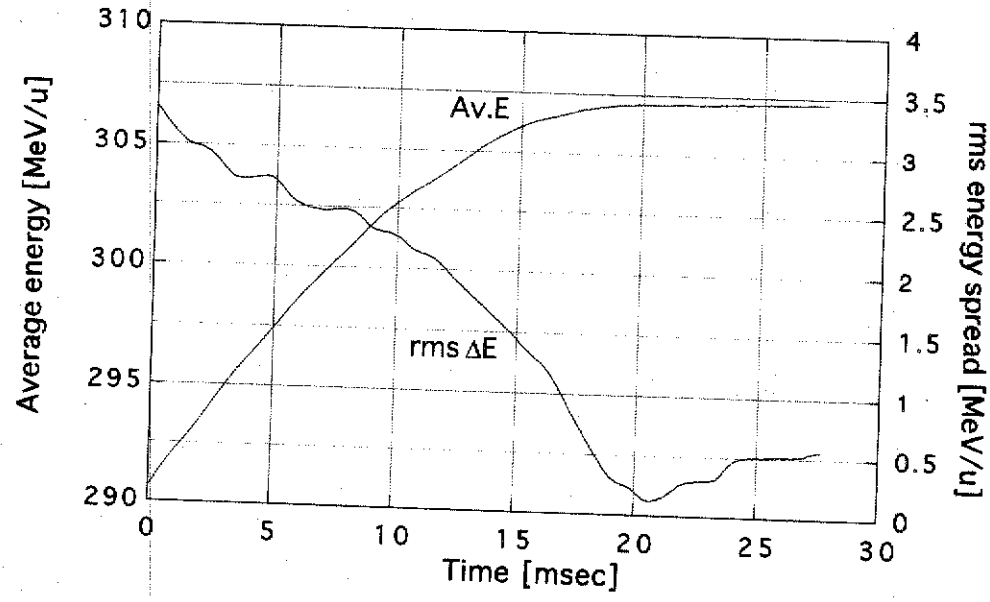
with constant gain

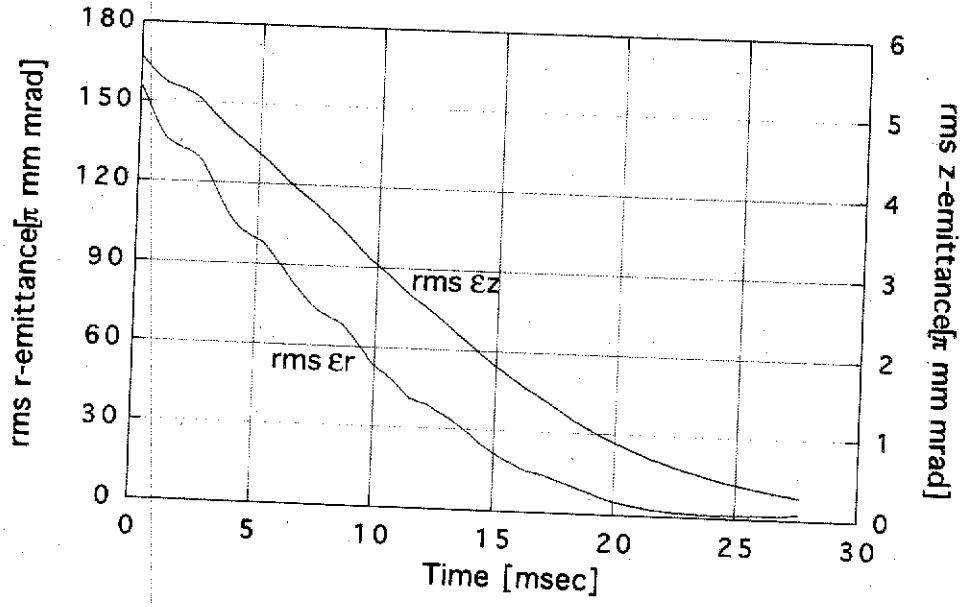




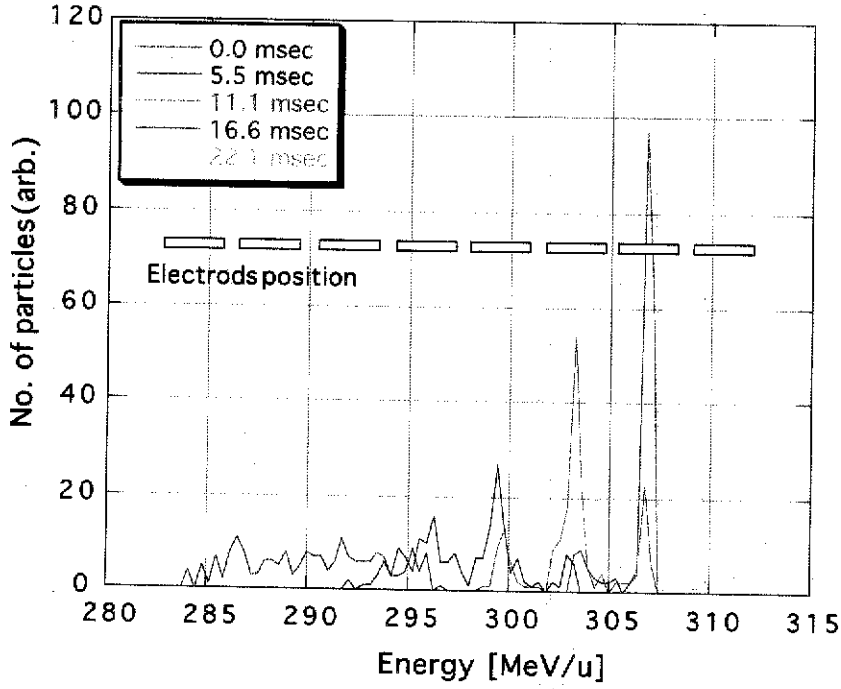


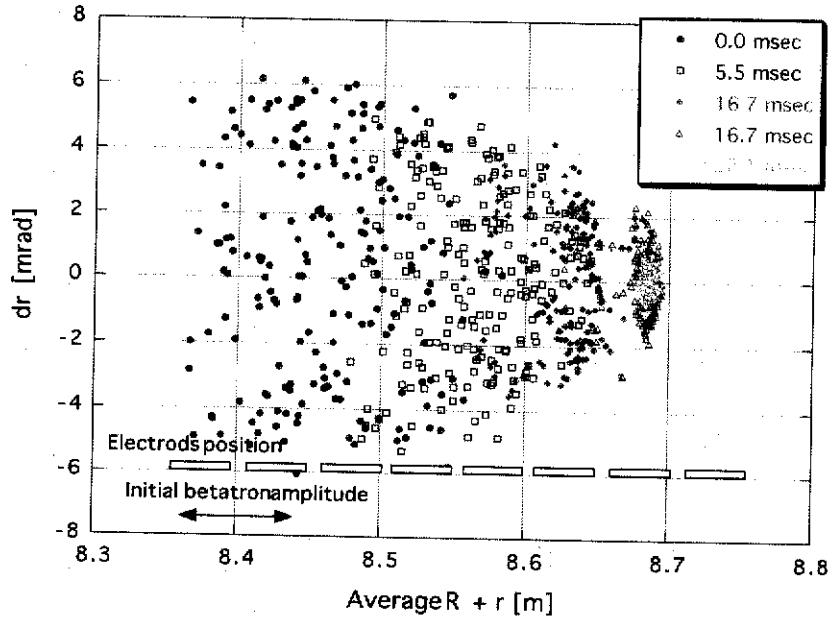
with gain gradient





with gain gradient





with gain gradient