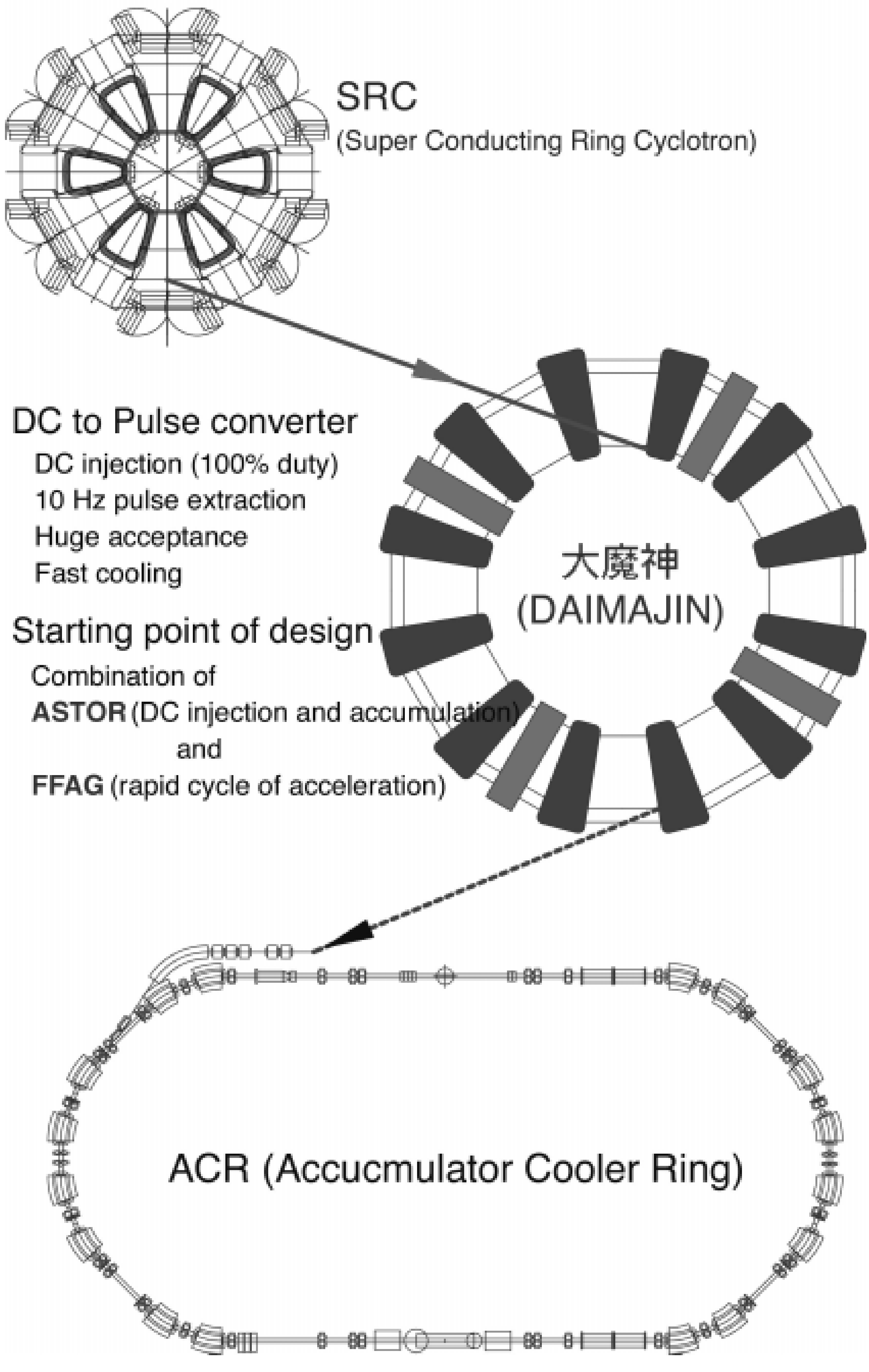
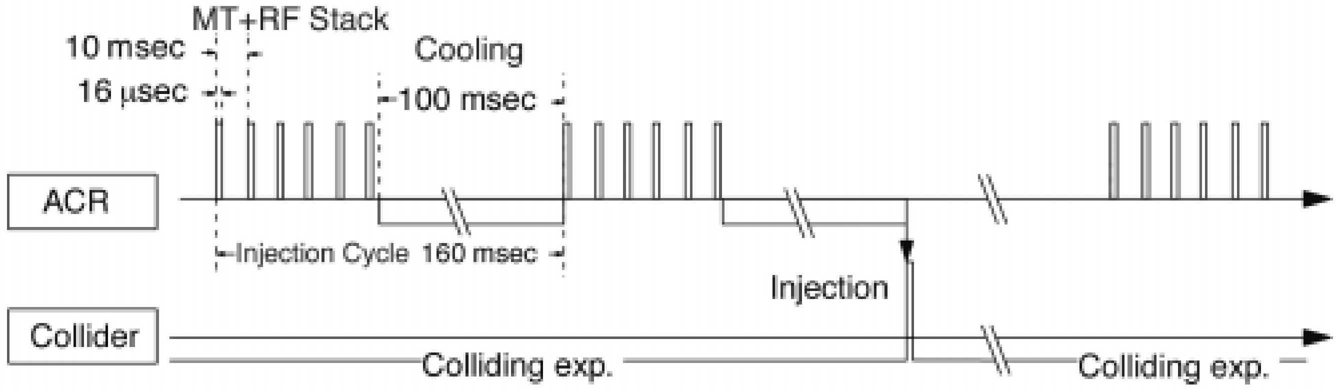
Interface machine between SRC and ACR

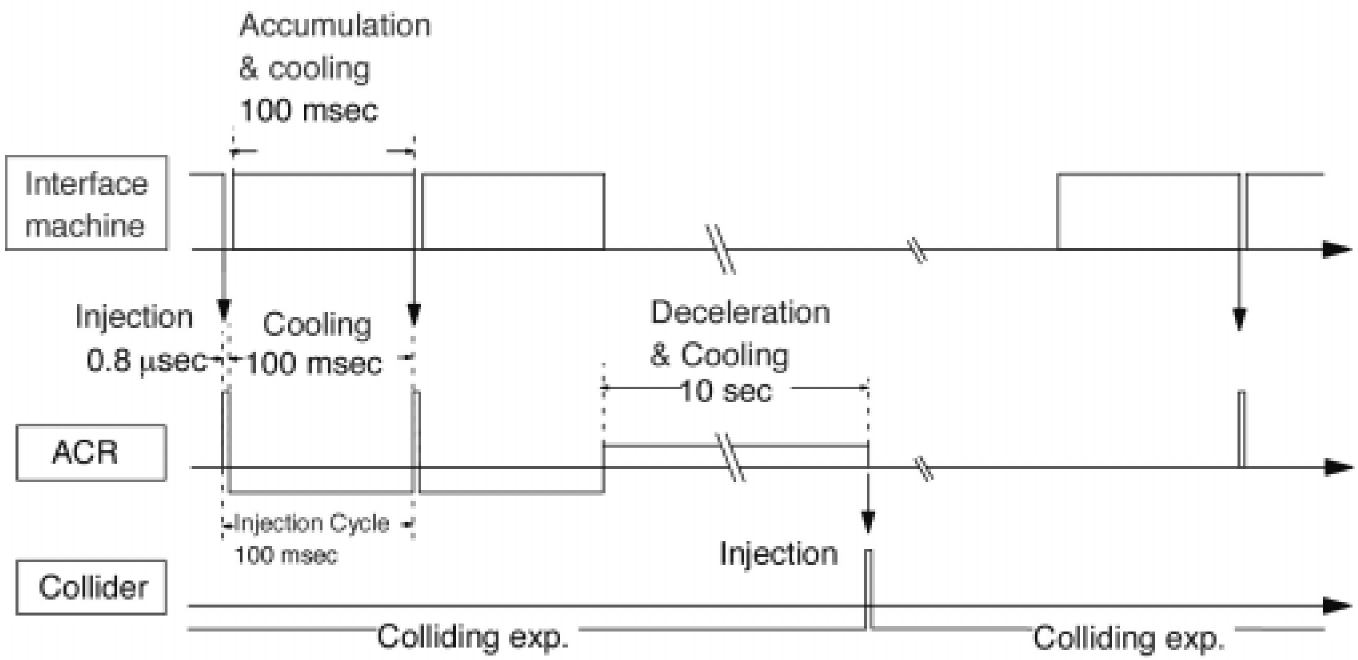


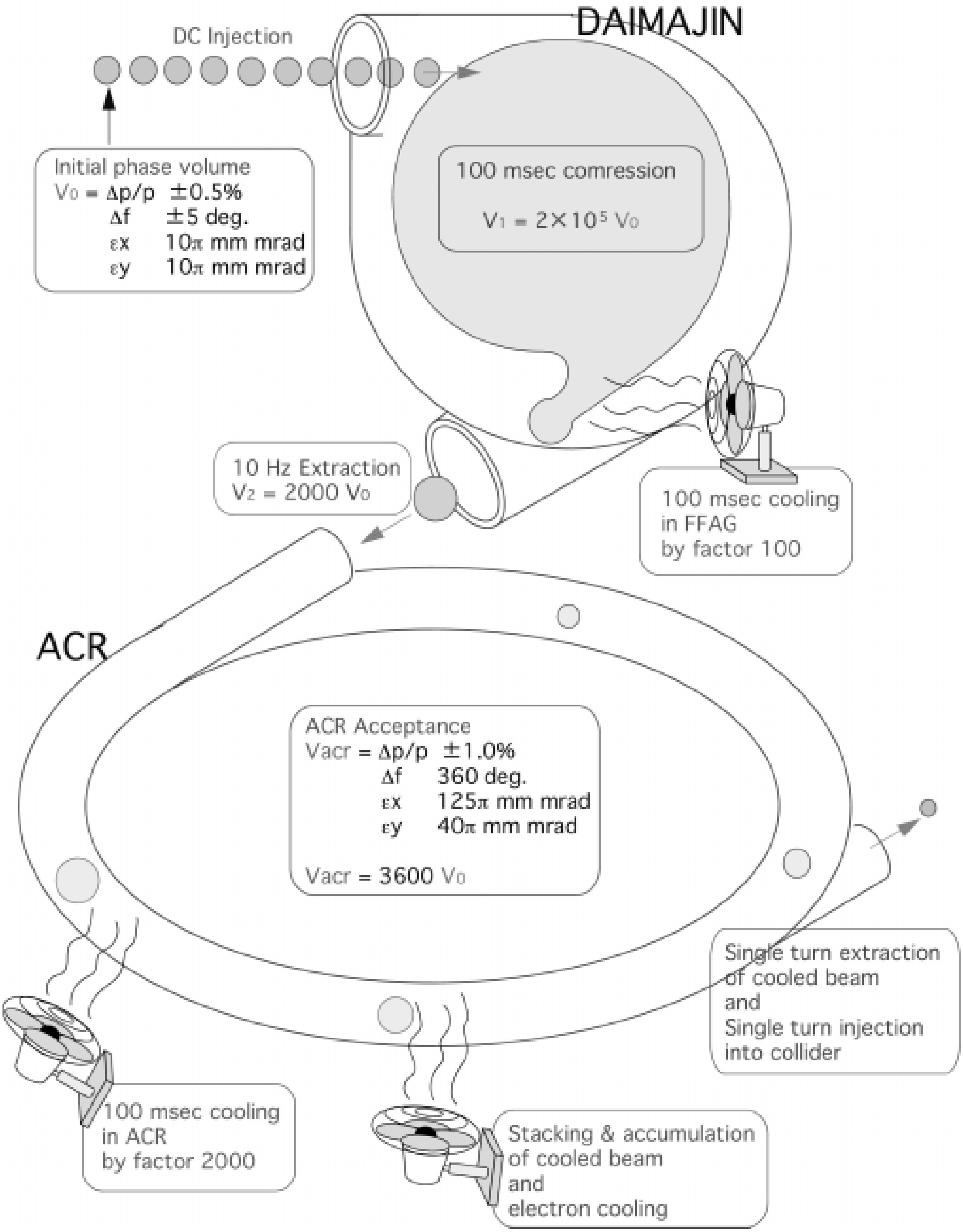
Time chart of beam operation

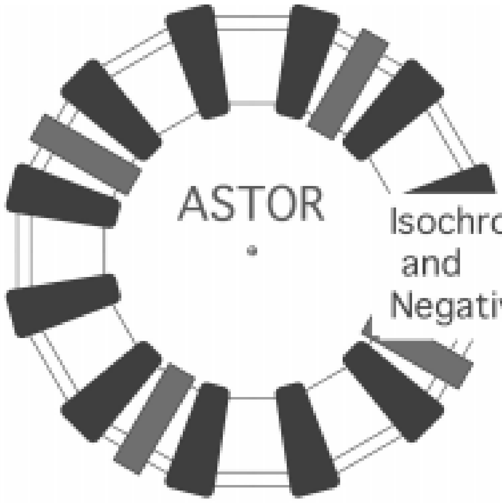
without interface : duty 1.0e-4



with interface : duty 1.0




DAIMAJIN
DC Injection
Initial phase volume
V0 = Δp/p ±0.5%
Δf ±5 deg.
εx 10π mm mrad
εy 10π mm mrad
100 msec comression
V1 = 2×10^5 V0
10 Hz Extraction
V2 = 2000 V0
100 msec cooling
in FFAG
by factor 100
ACR
ACR Acceptance
Vacr = Δp/p ±1.0%
Δf 360 deg.
εx 125π mm mrad
εy 40π mm mrad
Vacr = 3600 V0
Single turn extraction
of cooled beam
and
Single turn injection
into collider
100 msec cooling
in ACR
by factor 2000
Stacking & accumulation
of cooled beam
and
electron cooling



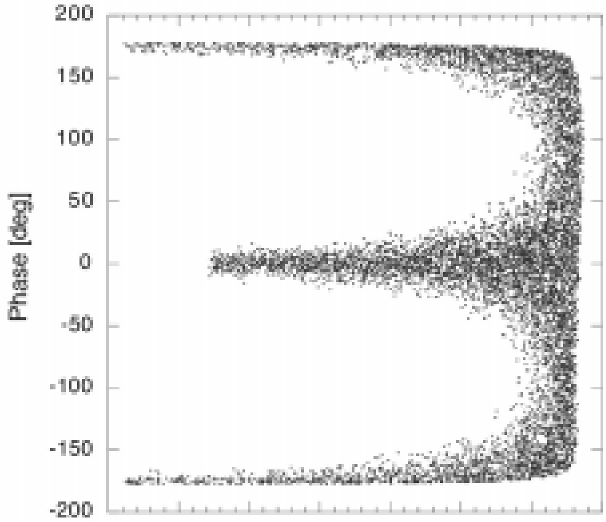
Isochronous magnetic field (the same as cyclotron)
and
Negative gradient of RF voltage in r-direction

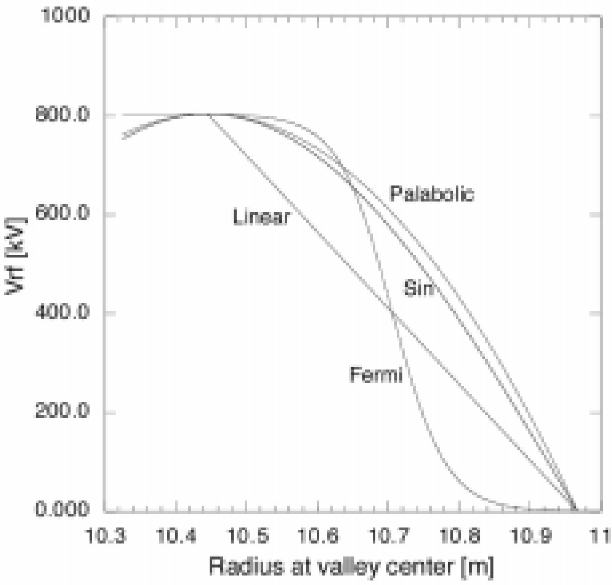
Proporsed by W.Joho (1974)

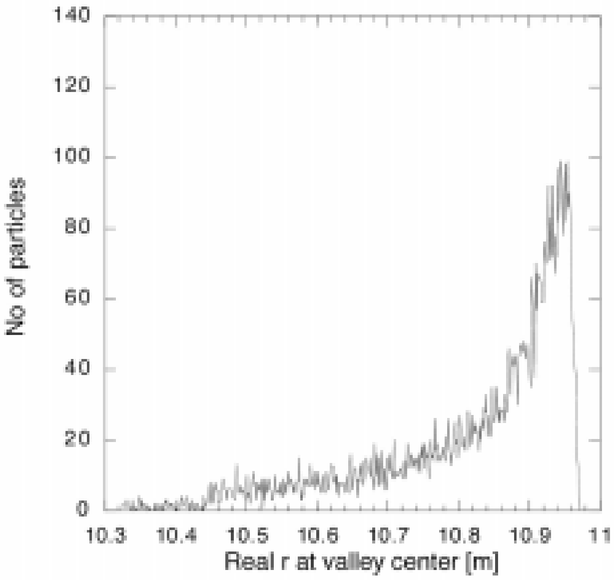
Injected particles are kicked by rf magnetic field due to gradient of rf voltage.
This kicke produces phase shift in isochronous field

$$B_z = -\frac{1}{\omega_{rf}}\left(\frac{dE_s}{dr}\right)\sin\phi$$

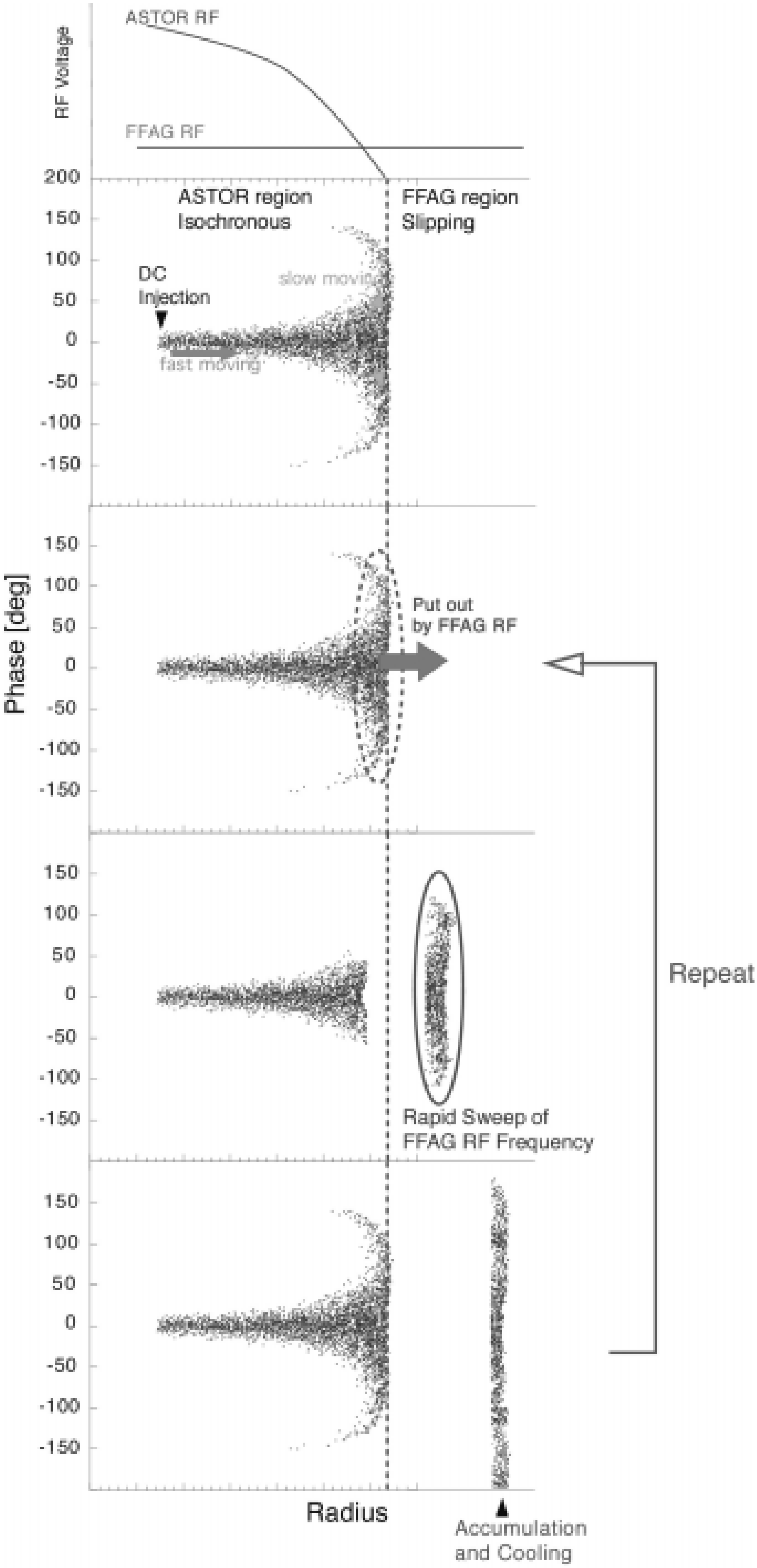
$$\frac{d\phi}{dn} = -\frac{1}{\gamma^2 B_0 R\omega_0}\left(\frac{dV}{dr}\right)\sin\phi$$





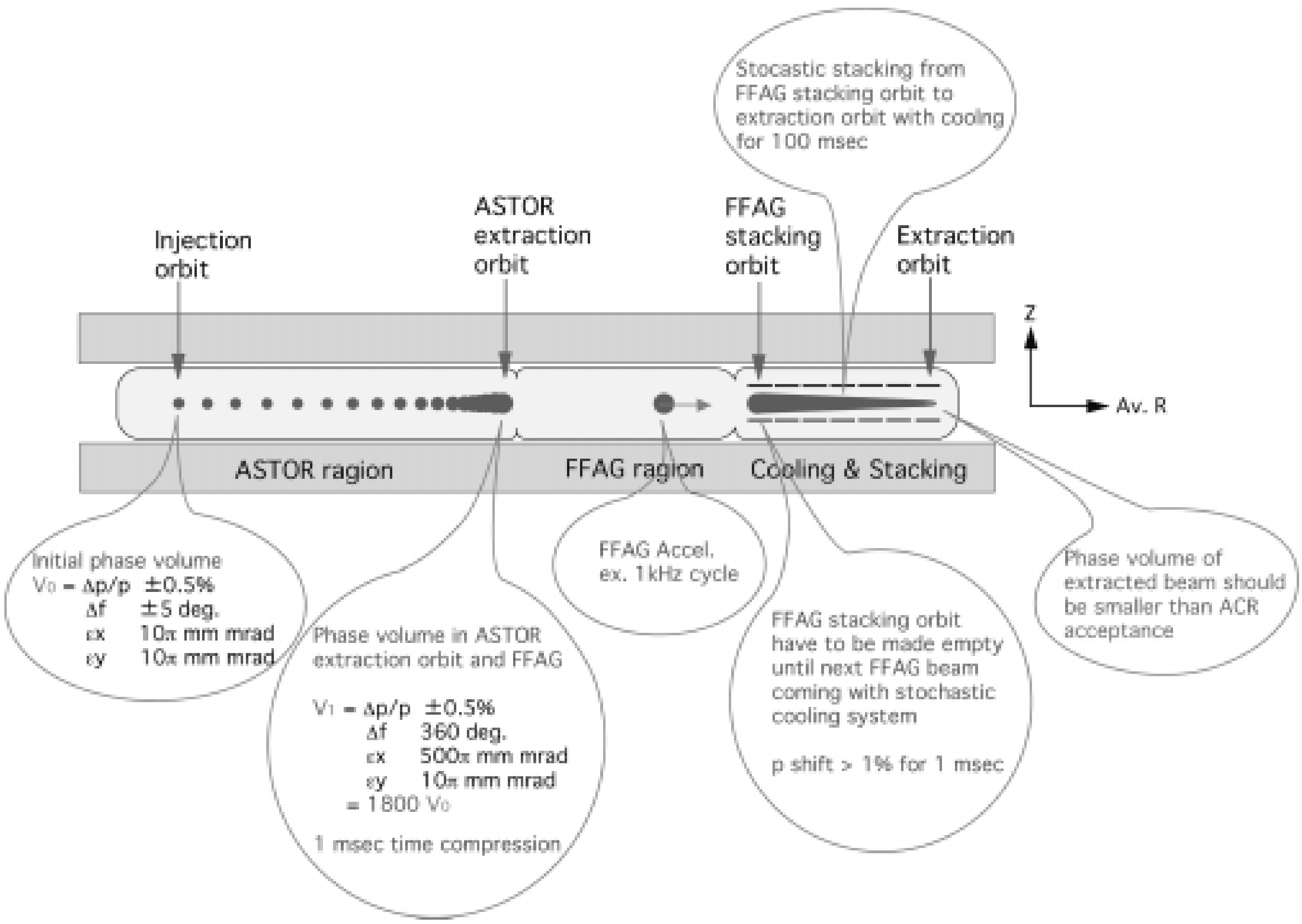


Concept of DAIMAJIN

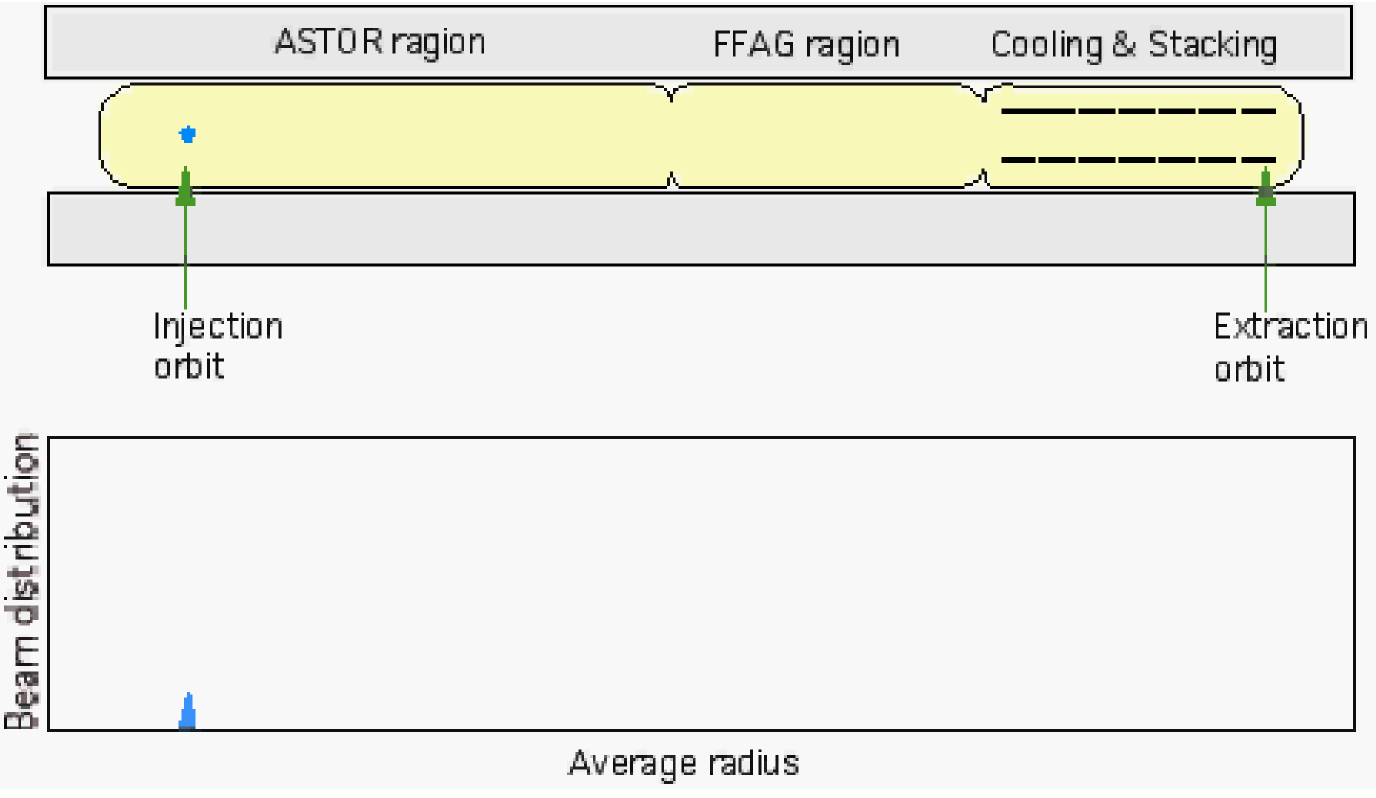


Concept of ASTOR+FFAG

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



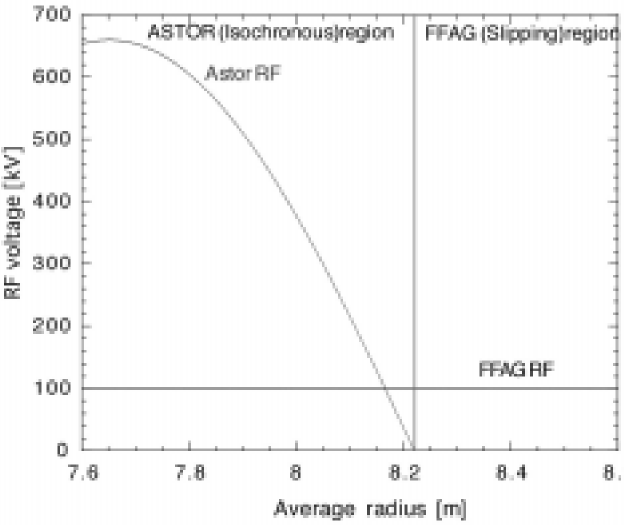
Concept of ASTOR+FFAG

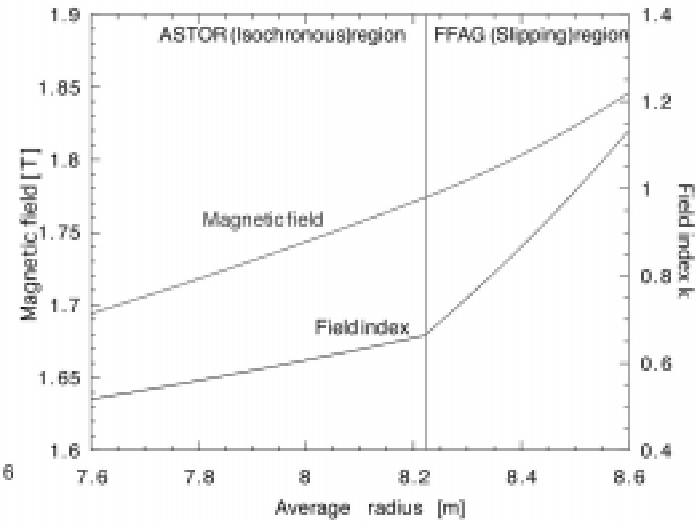


Preriminaly calculation of the feasibility

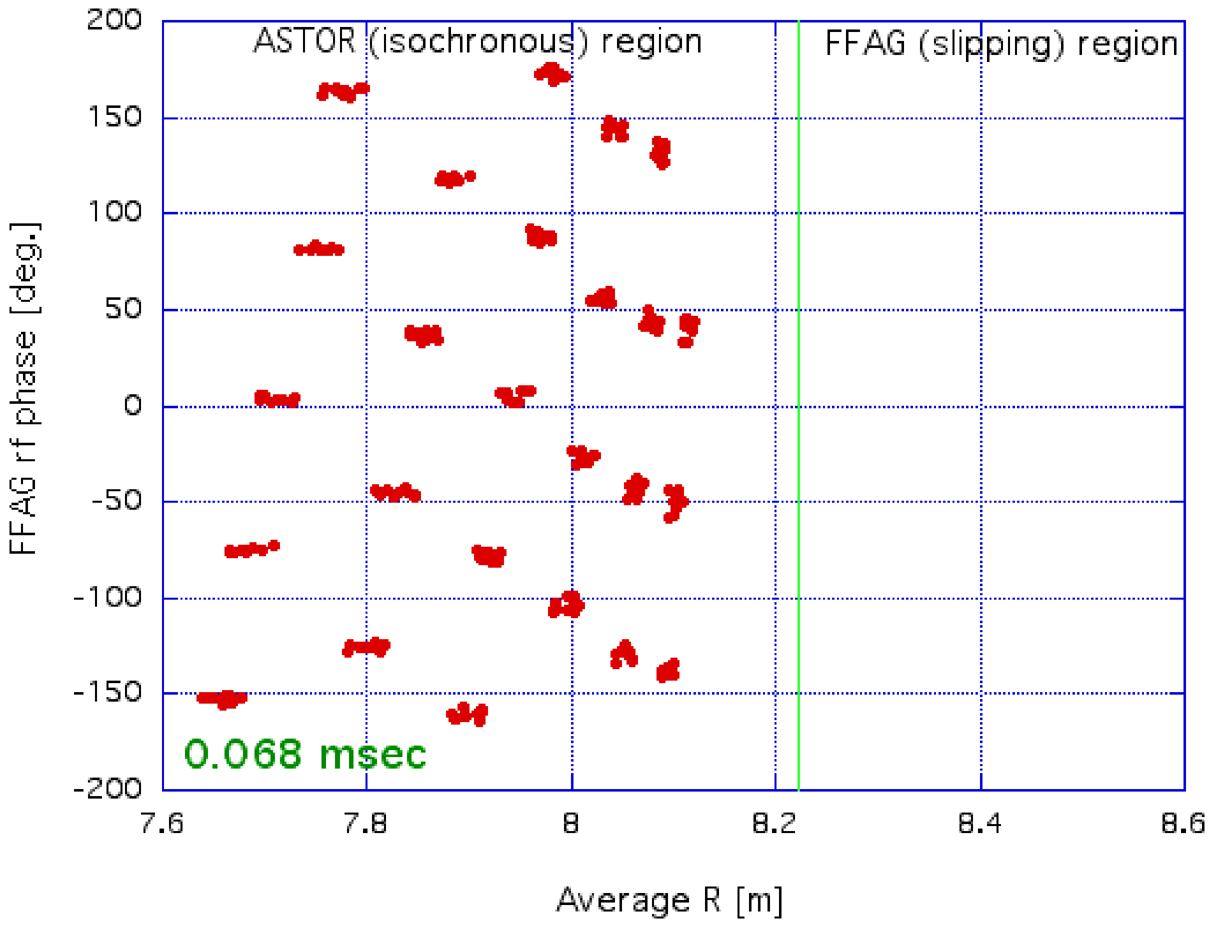
Conditions:

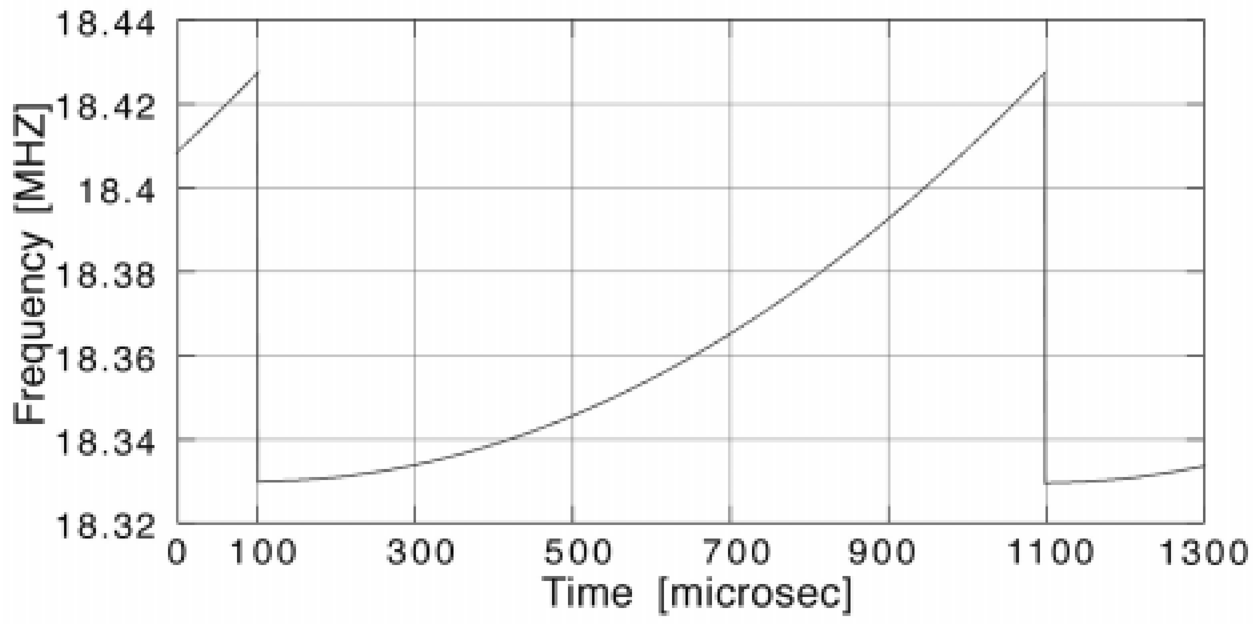
beam energy	220-270 MeV/u (in ASTOR)
	270-320 MeV/u (in FFAG)
$\Delta p/p$ at inj.	0.5 %
ϕ spread at inj.	$\pm$5 deg.
emittance (r/y)	10/10 πmm mrad
ring sector	8
harmonics	10 (ASTOR) / 5 (FFAG)
rf freq.	36.66 (ASTOR) / 18.33 (FFAG)
rf sweep time	1 msec (FFAG)



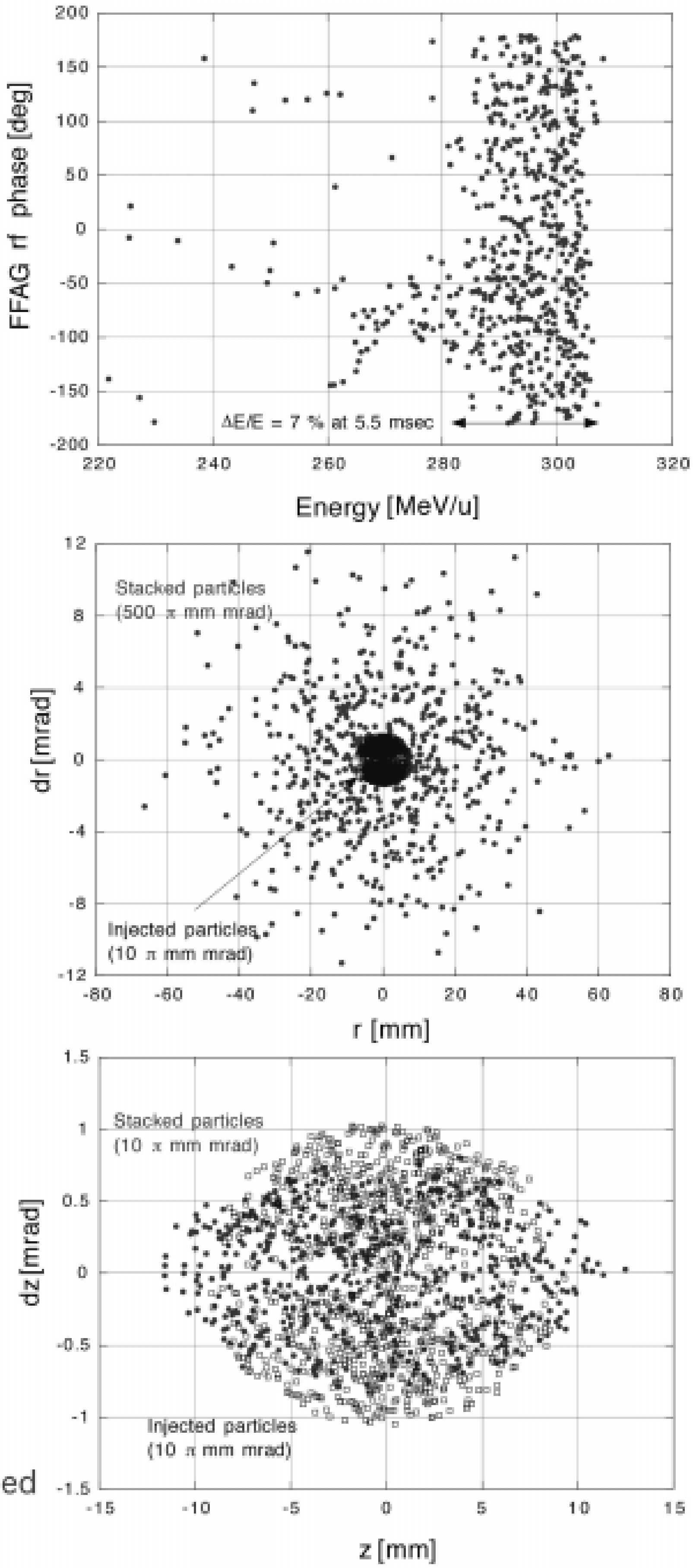


Particles moving in longitudinal phase space
In ASTOR+FFAG



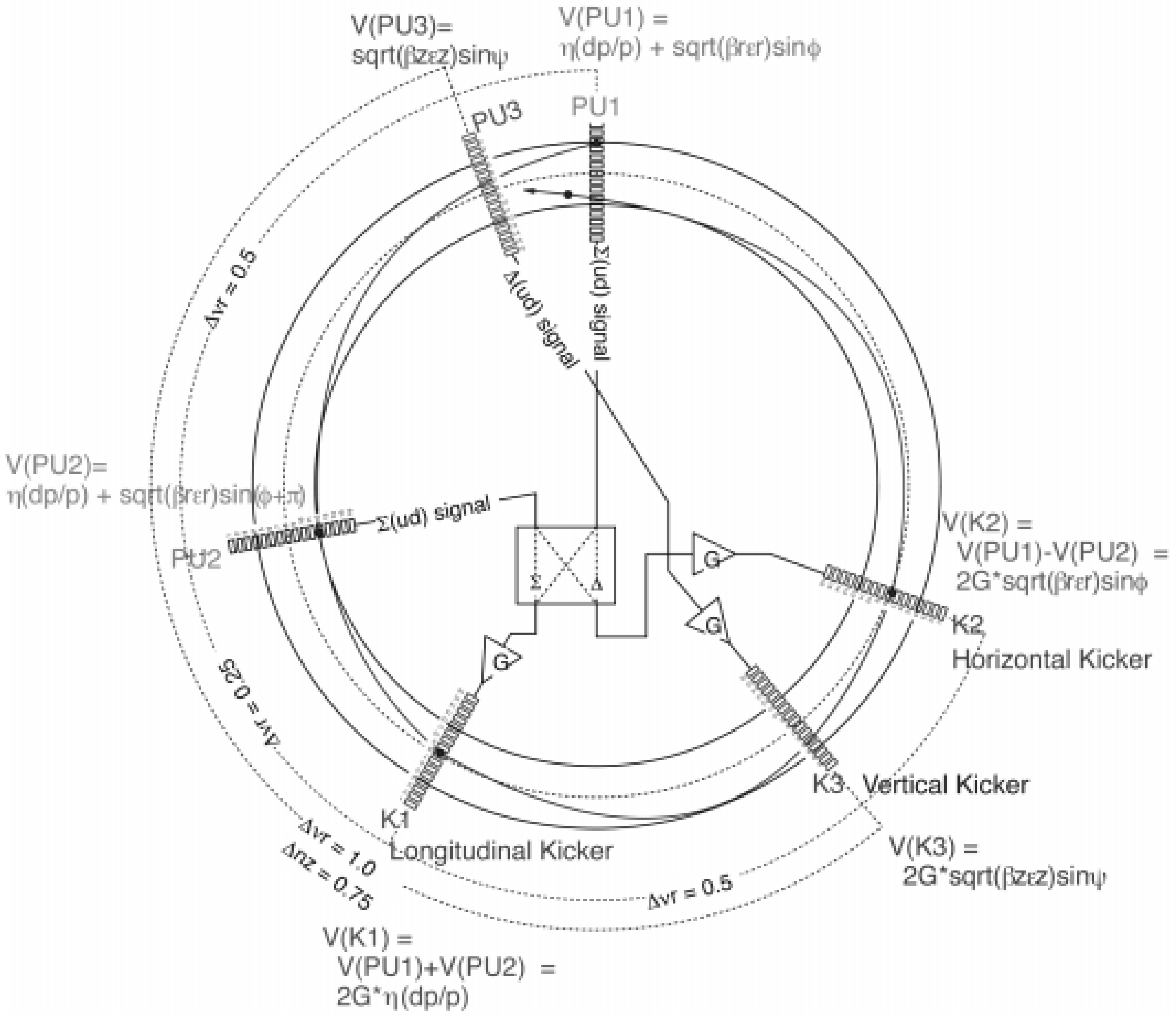


6-dimensional phase volume after 5 cycles of FFAG acceleration

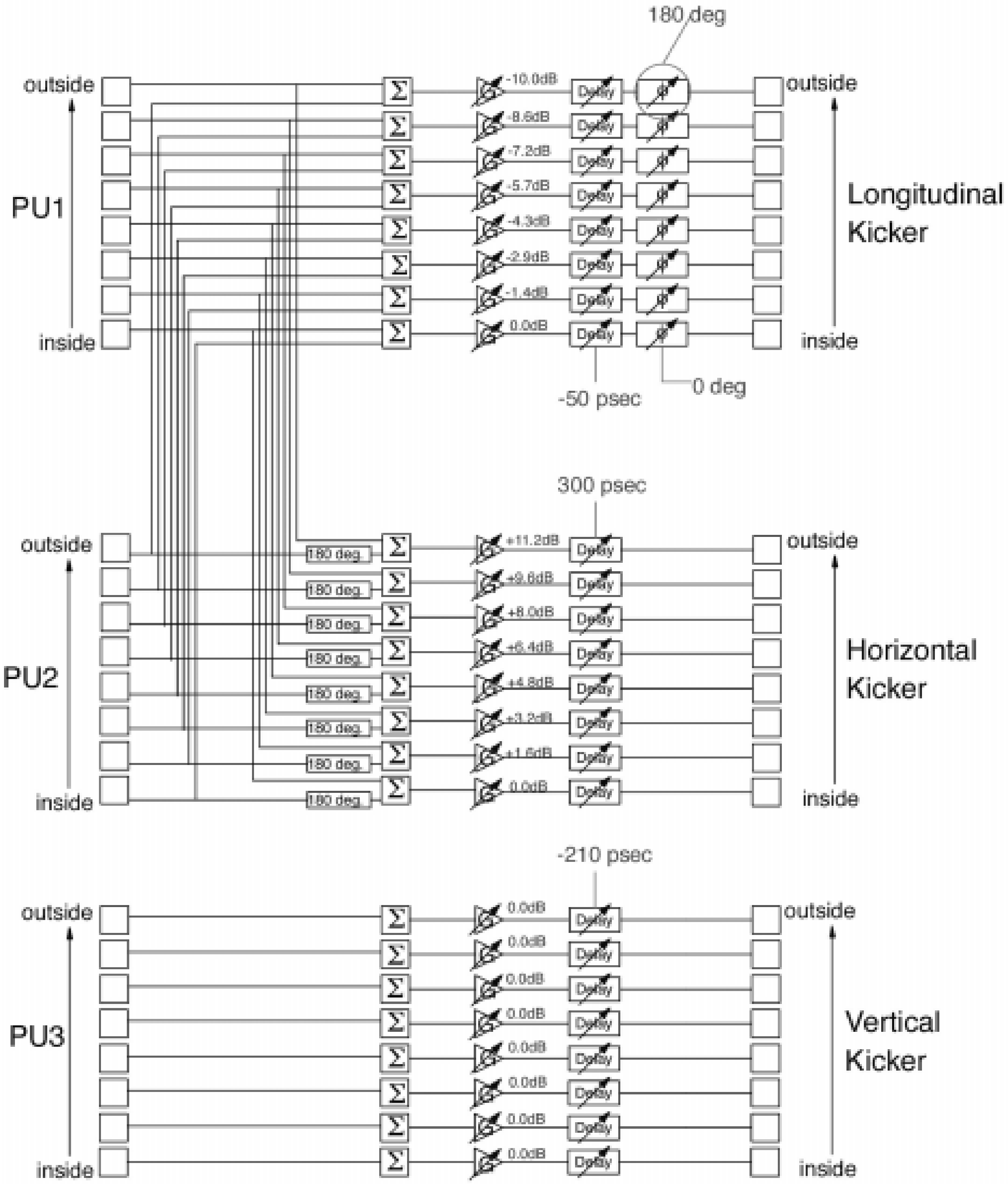


Quick cooling is required

Concept of stochastic cooling in FFAG with multi-electrodes system



Simple model of SC system in FFAG



Calculation of cooling force at kickers

at longitudinal kicker

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

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

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

at horizontal kicker

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

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

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

at vertical kicker

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

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

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

where,

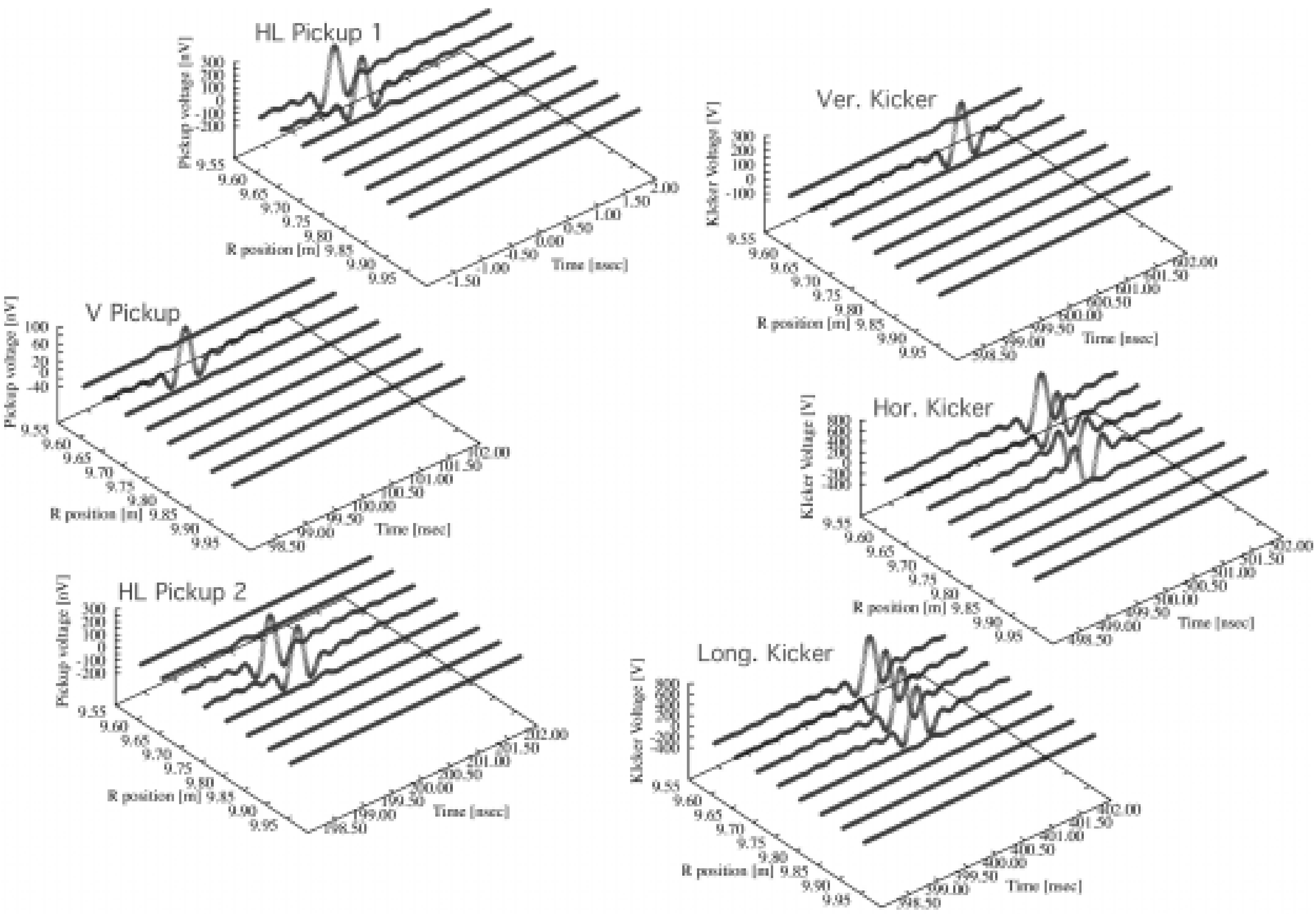
$$W_1 = \sum_{n=-\infty}^{\infty} \frac{1}{4} e^{j2\pi n f_j \left(t-\tau_{pxj}-T_{pxkx}\right)} \left\{1 - e^{-jn\pi f_j/f_c}\right\}^2$$

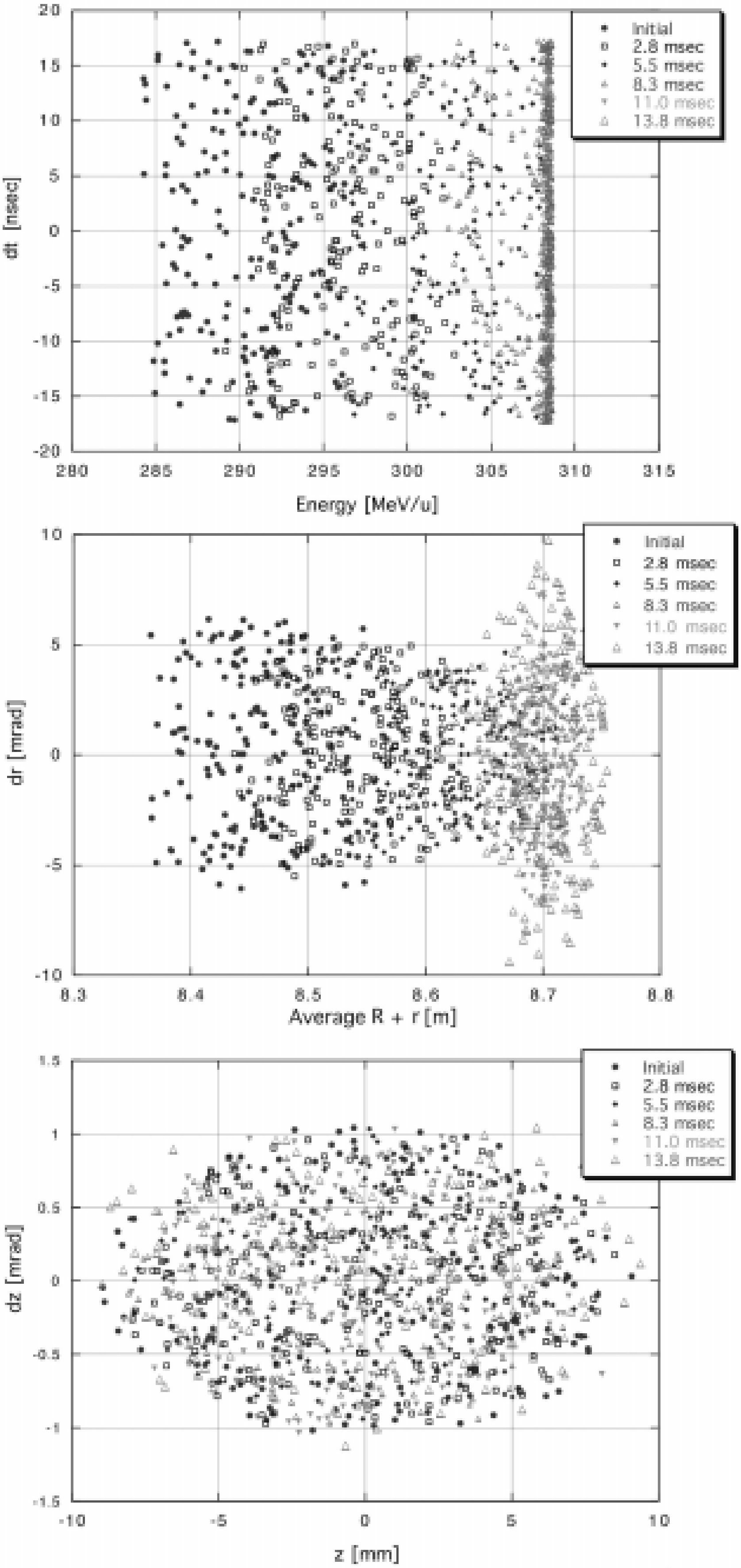
$$W_2 = \sum_{n=-\infty}^{\infty} \frac{j}{4nf_j} e^{j2\pi n f_j \left(t-\tau_{pxj}-T_{pxkx}\right)} \left\{1 - e^{-jn\pi f_j/f_c}\right\}^2$$

assuming sensitivity

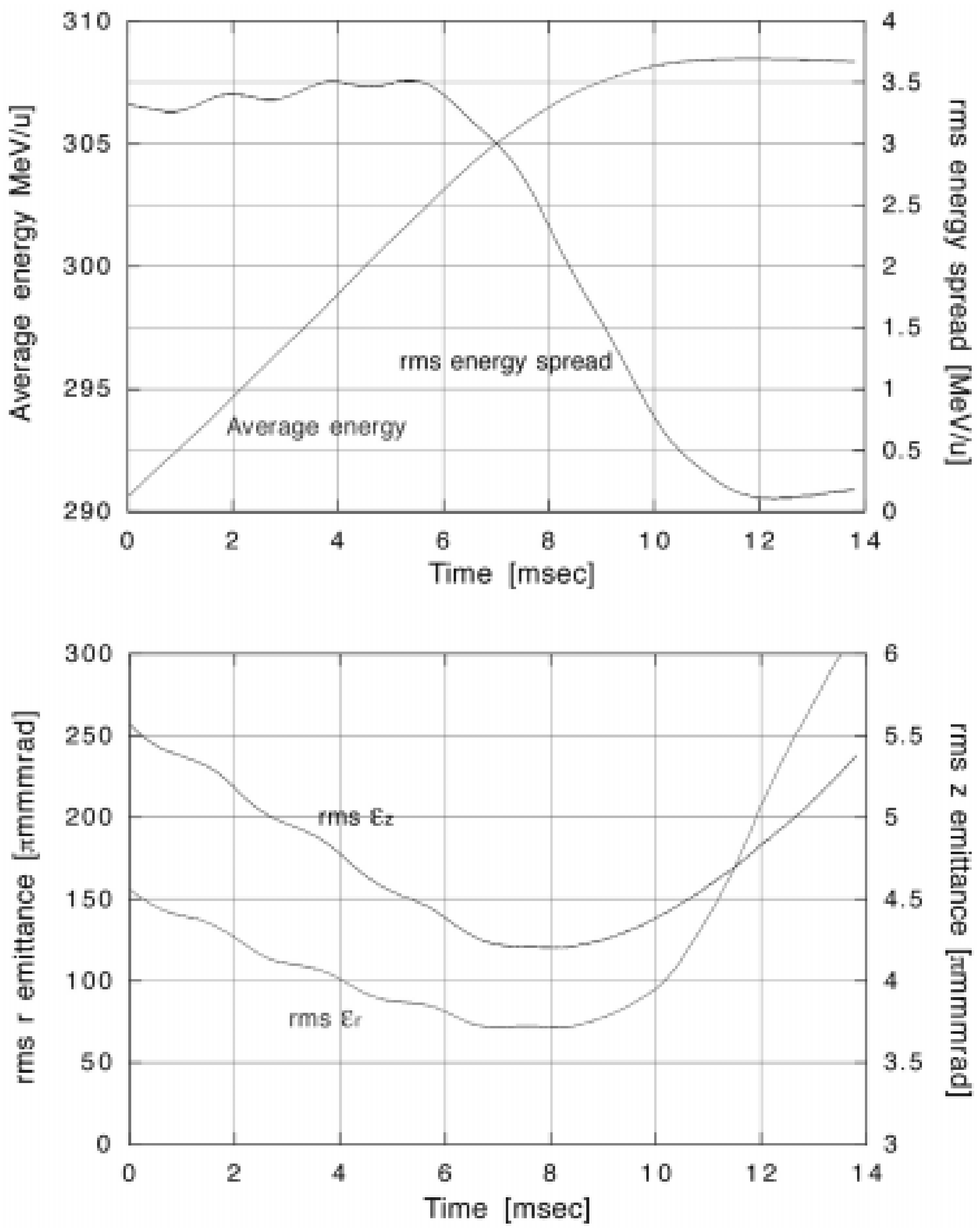
$$\xi(f) = \frac{1}{2}\left(1 - e^{-j\pi f/f_c}\right)$$

Pickup signal from one particle and the applied kicker signal

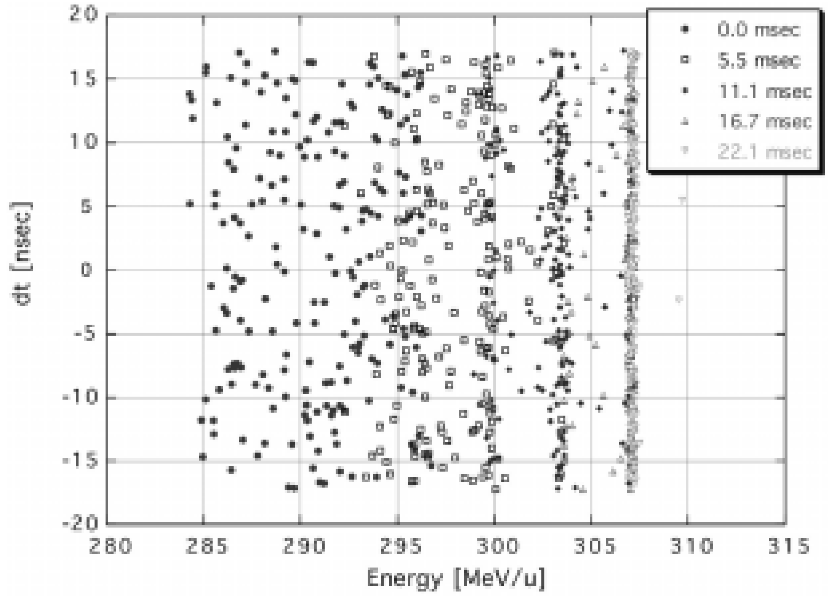


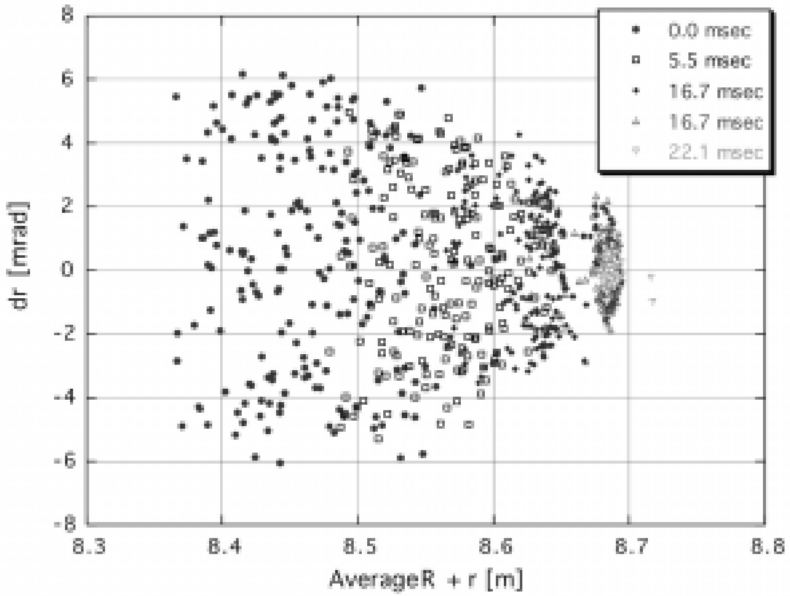


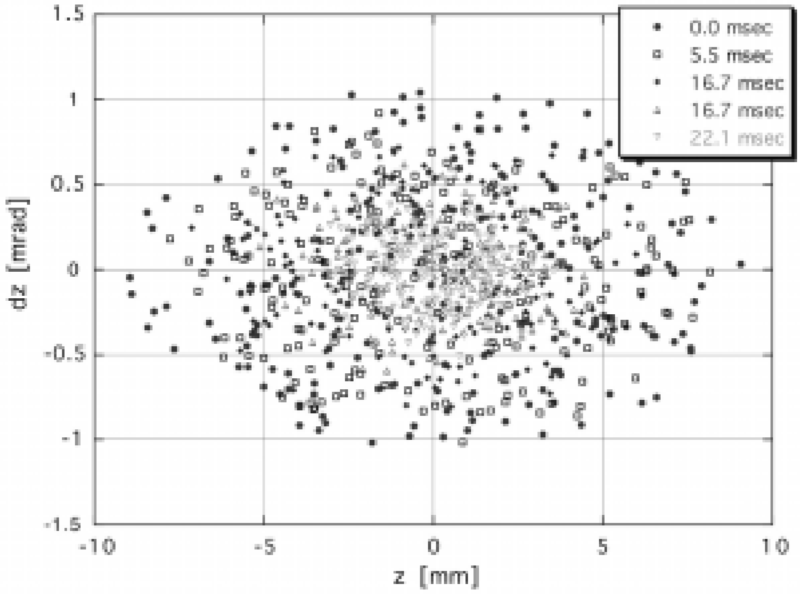
with constant gain



with cinstant gain

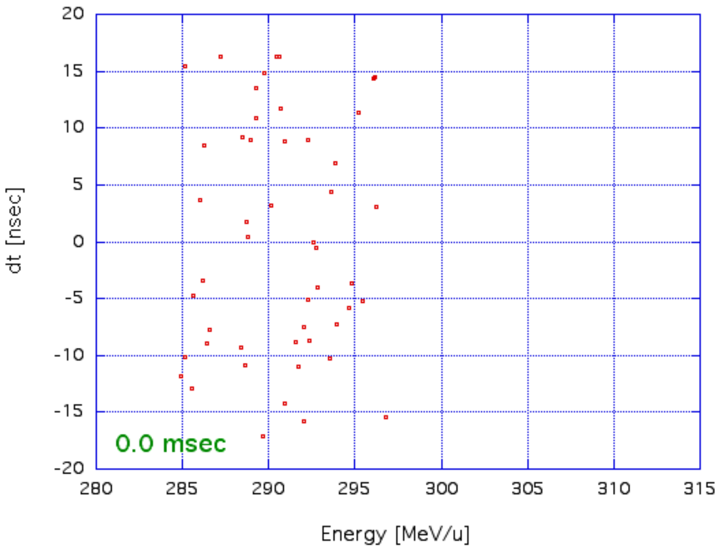


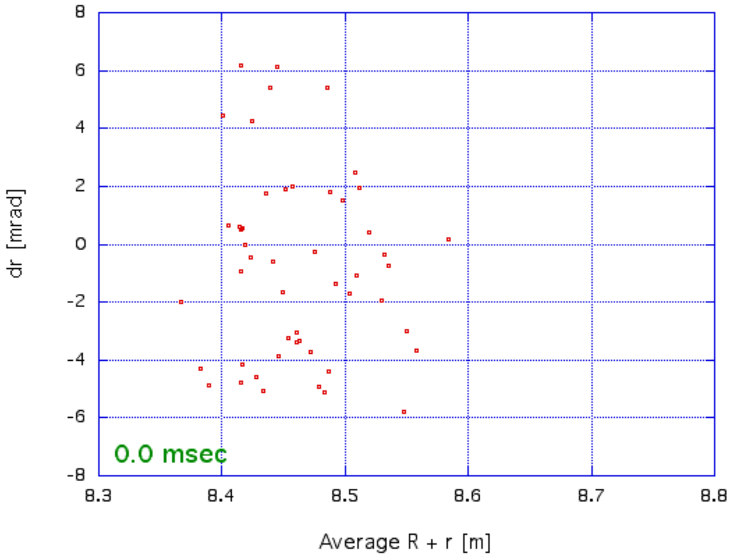


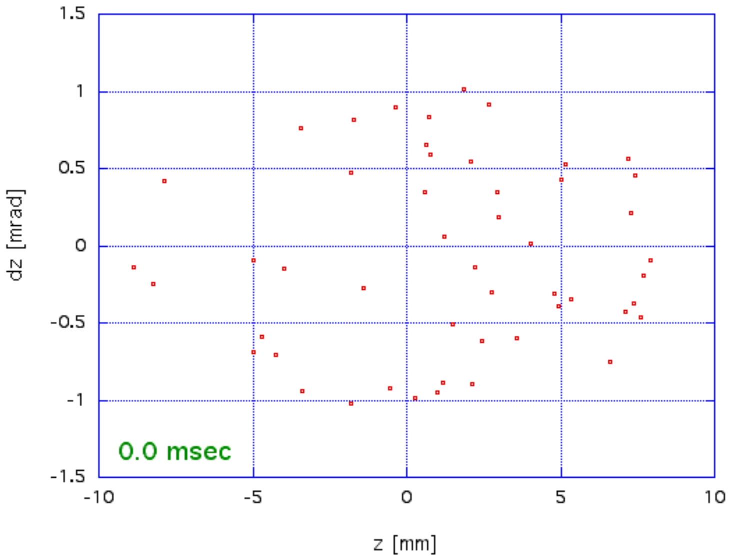


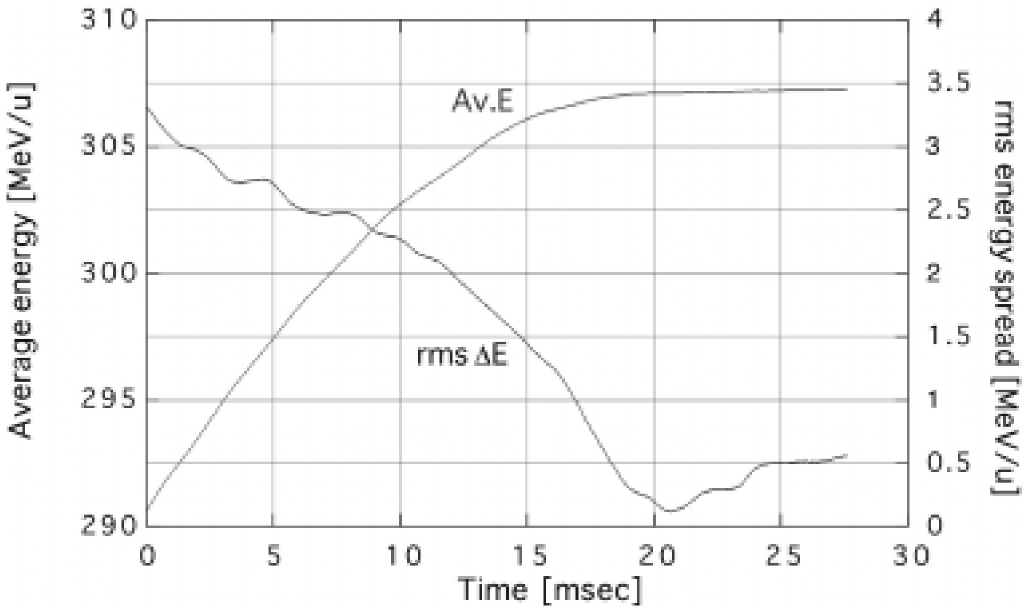
with gain gradient

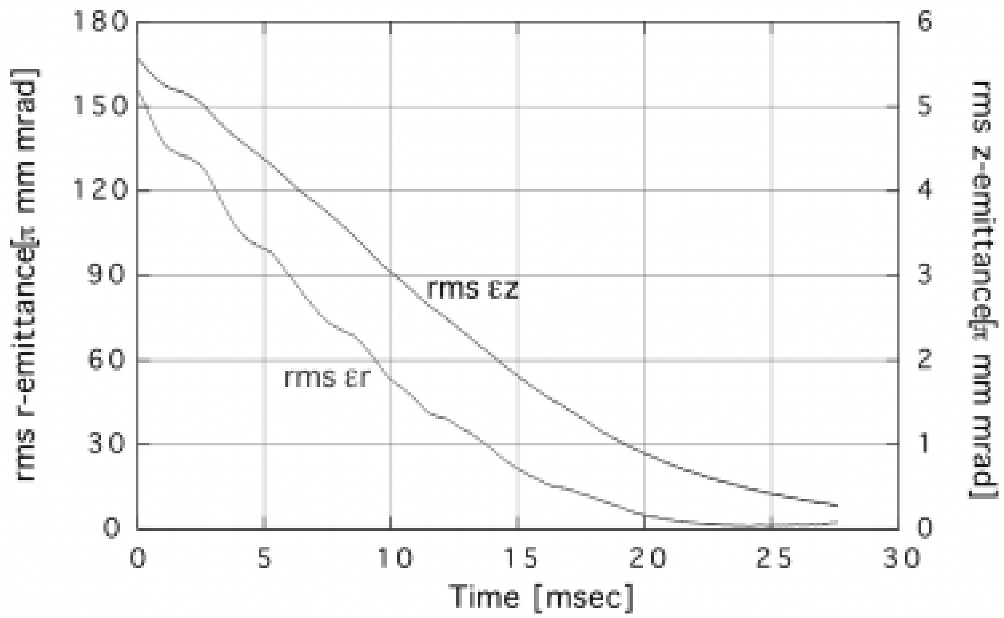
Particle moving in 6-dimensional phase space



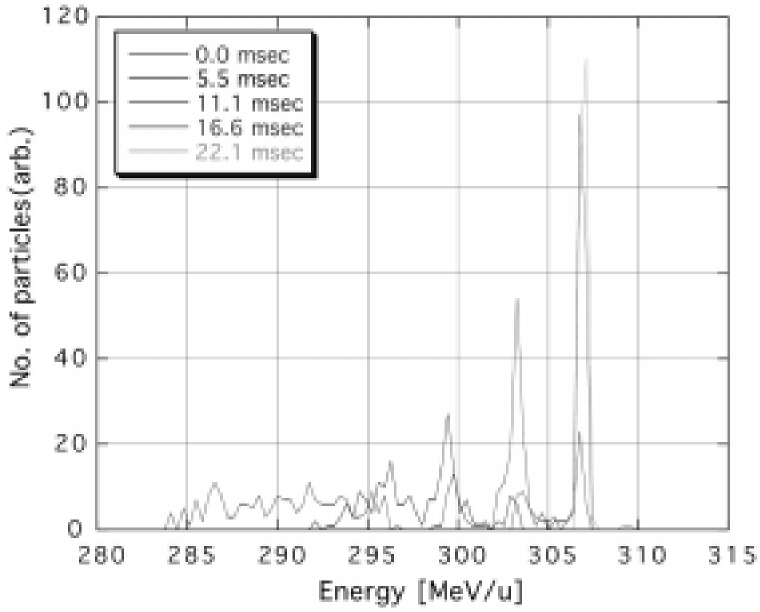


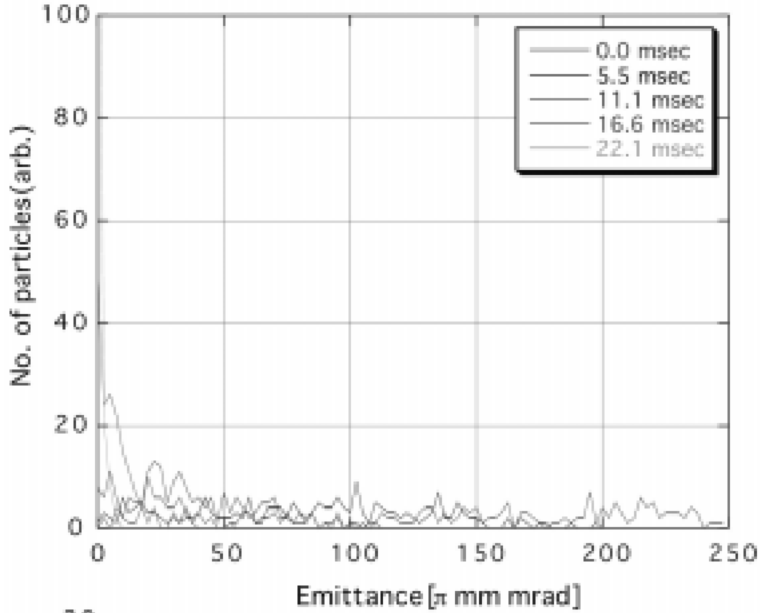


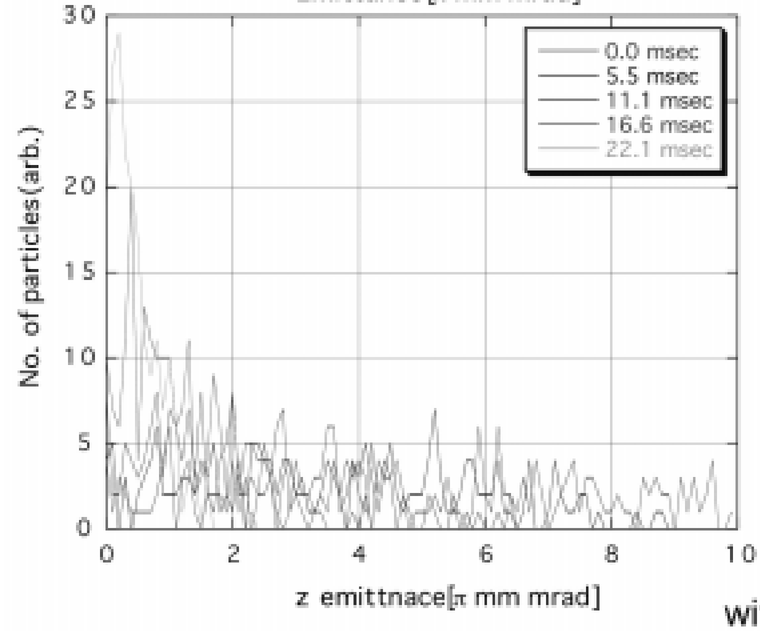




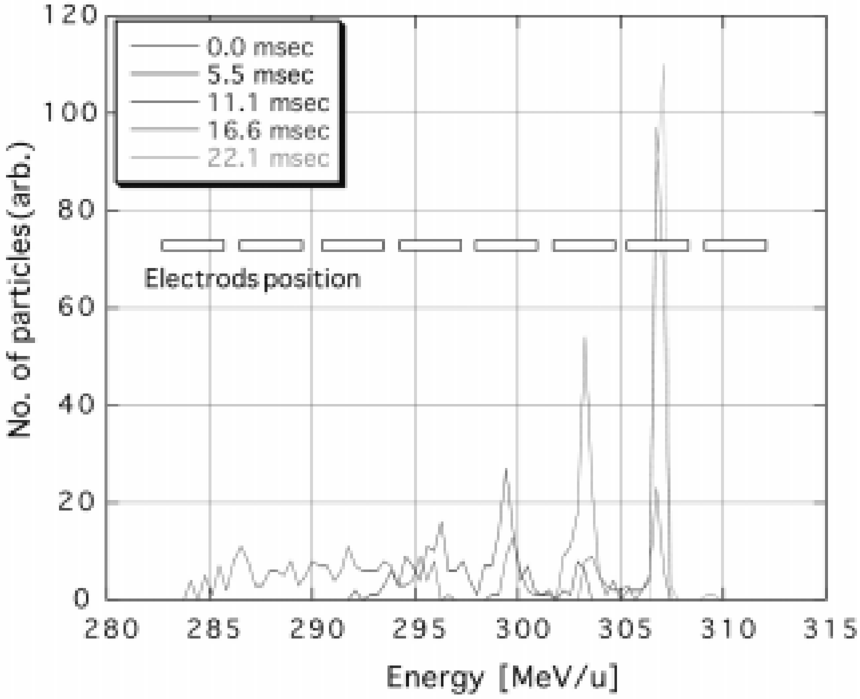
with gain gradient

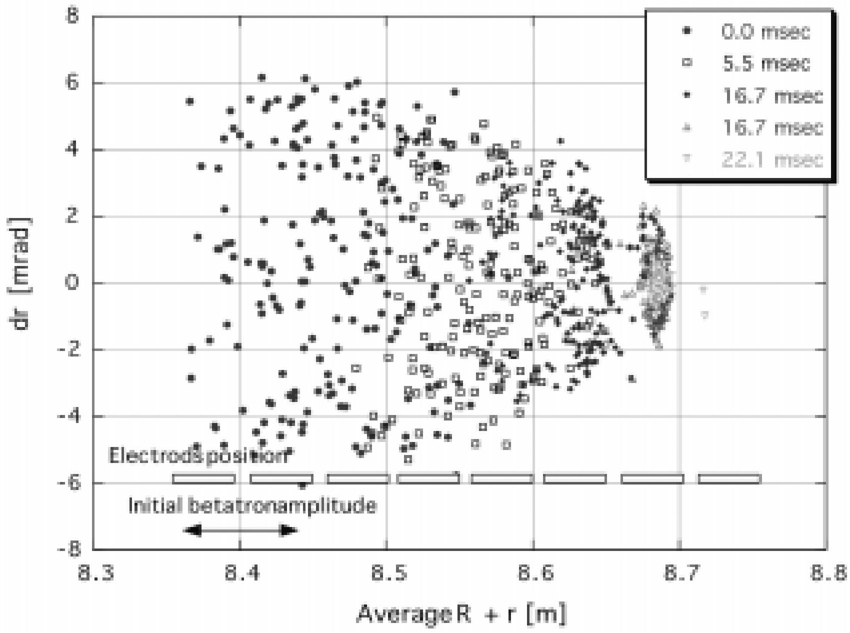






with gain gradient





with gain gradient