The recent results of the ATF

2002.9.4 Junji Urakawa

1. Introduction (Luminosity)

2. Beam Diagnostics

3. Beam Studies and Achieved Results

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Introduction (Luminosity)

$$L = \frac{N^2 f}{4\pi\sigma_x^* \sigma_y^*} H(D)$$

Two constraints:Total electric power consumption, beamstrahlung

$$P_B = 2Ef_{rep} n_b N$$

$$P_{AC} = P_B / \eta_{AC \to beam}$$

$$\delta_B = const \frac{N^2 E^2}{\sigma_x^{*2} \sigma_z}$$

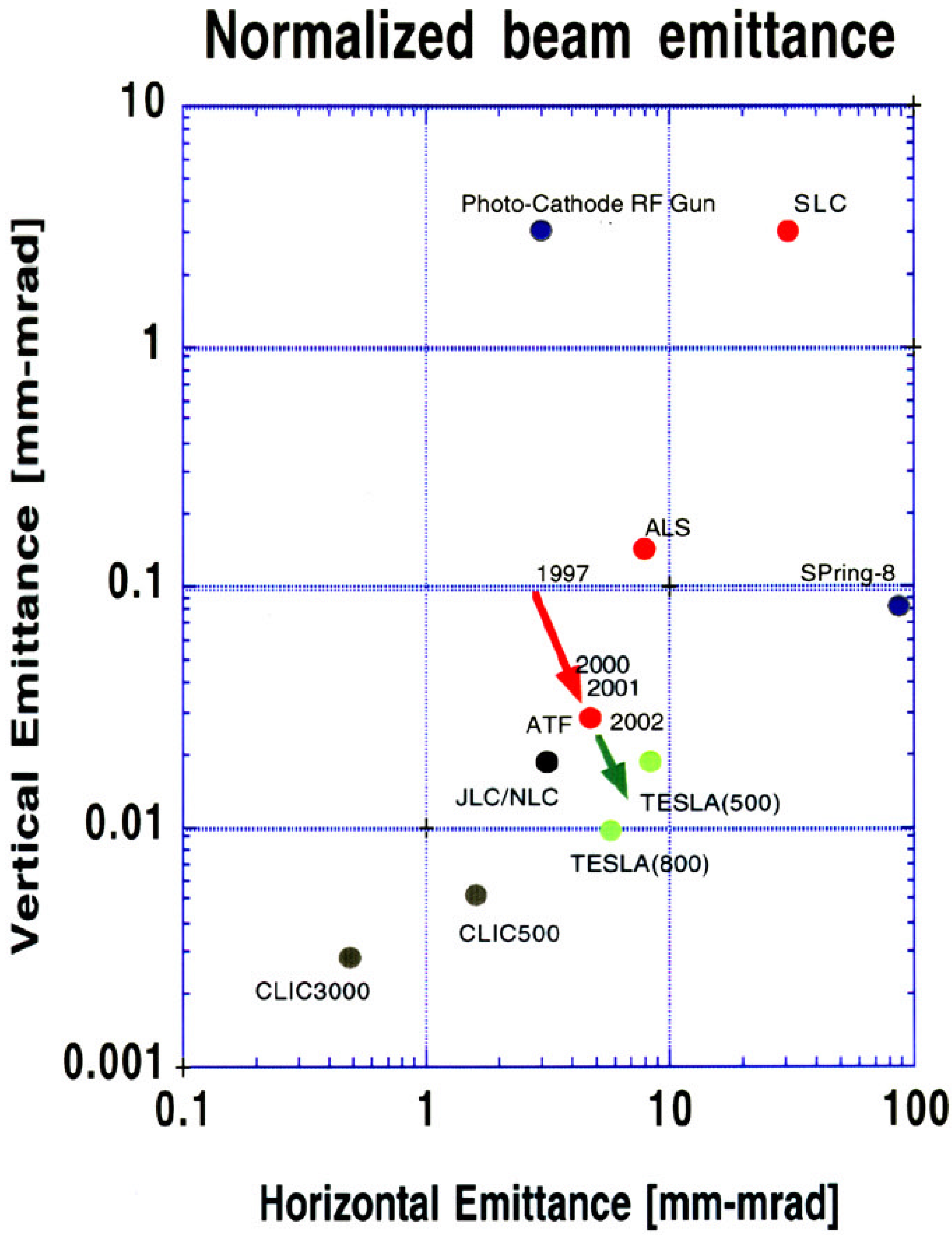
$$\frac{L}{P_{AC}} = \frac{C}{E^{3/2}} \times \eta_{AC \to beam} \times \left(\frac{\delta_B}{\gamma \varepsilon_y^*} \right)^{1/2} \times \left(\frac{\sigma_z}{\beta_y^*} \right)^{1/2} H(D)$$

C : universal constant

δ_B ; beamstrahlung loss

$\gamma \varepsilon_y^*$: normalized vertical emittance at IP

* Emittances extracted from Damping Rings (TRC Megatable 13.8.02)



Beam Diagnostics for JLC

1. Beam Position Monitor(BPM)
2. SR Interferometer
3. Wire Scanner at the extraction line
4. Laser Wire Monitor
5. X-ray SR Monitor
6. OTR Monitor
7. ODR Monitor
8. Cavity BPM

Beam Studies and Achieved Results

Single bunch low emittance beam generation
DR beam tuning under the following conditions;
Magnets alignment: 30μm on the table(2.1m)
Vacuum Level with 40mA:less than 7E-7Pa

1. COD correction:within +/-0.5mm both x and y
2. Y Dispersion correction:within+/-5mm
3. Betatron coupling less than 0.2%

Extracted beam tuning
1. Orbit correction within +/-1mm
2. Dispersion correction at wire scanner:correct x,y
Dispersion less than ~~10mm~~ 5mm

Multibunch low emittance beam generation
Around 1% emittance ratio was achieved at low bunch intensity
(3E9 x 17 bunches, 2.8nsec bunch spacing)

Summary and Future Plans

Single bunch emittance

Low emittance tuning was established. dE/E, X emittance were consistent with IBS theory prediction. 3pm Y emittance at zero current is expected. (EXT Y emittance is larger than expected.)

Instrumentation

Laser wire in DR, EXT wire scanner, EXT cavity BPM are worked well. EXT OTR, ODR, X-ray SR monitor are commissioned. BBA is under the study.

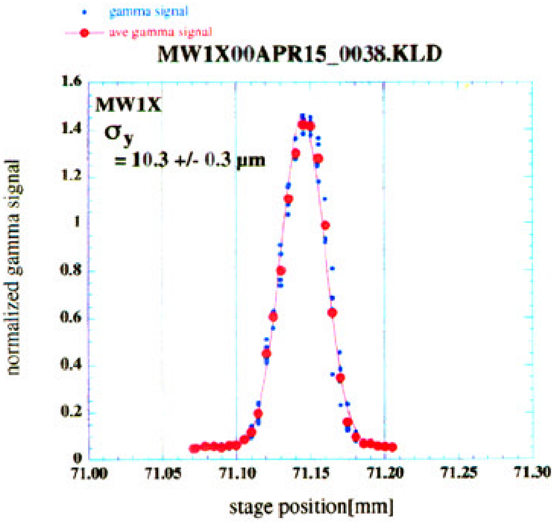
Multibunch operation

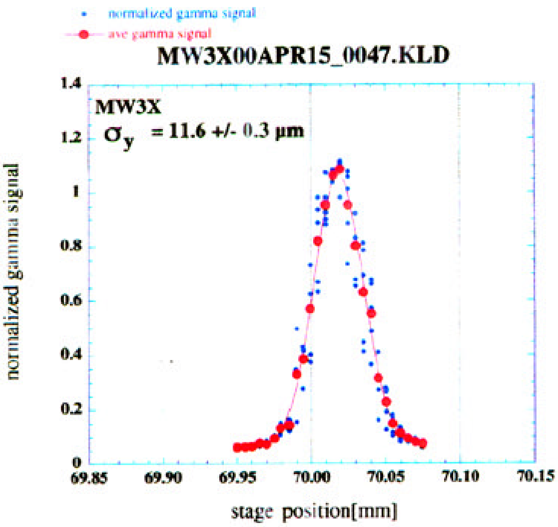
Ring scrubbing by Multibunch beam makes vertical emittance reduced. Multibunch wire scanner is commissioned and Multibunch BPM is under the study.

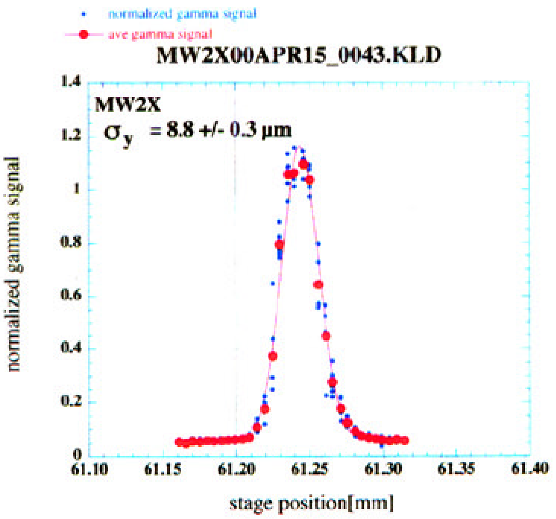
Misc. studies

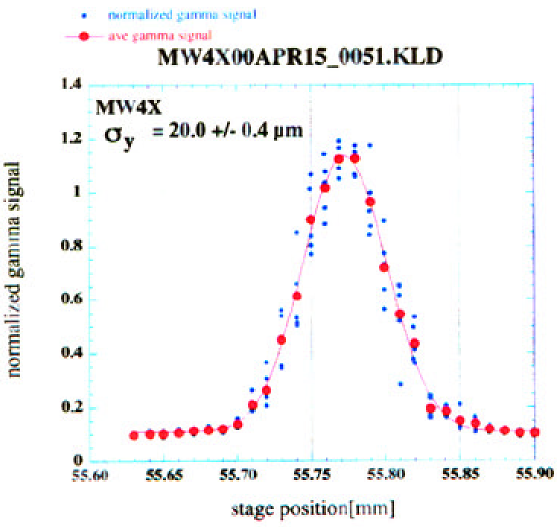
Pol.-positron study: pol. High brilliance Gamma-ray was generated.
Photo-cathode RF-gun was tested. Multibunch RF-gun study is in progress.
DR BPM upgrade is in progress.

Stability of beam size measurement by wire scanners



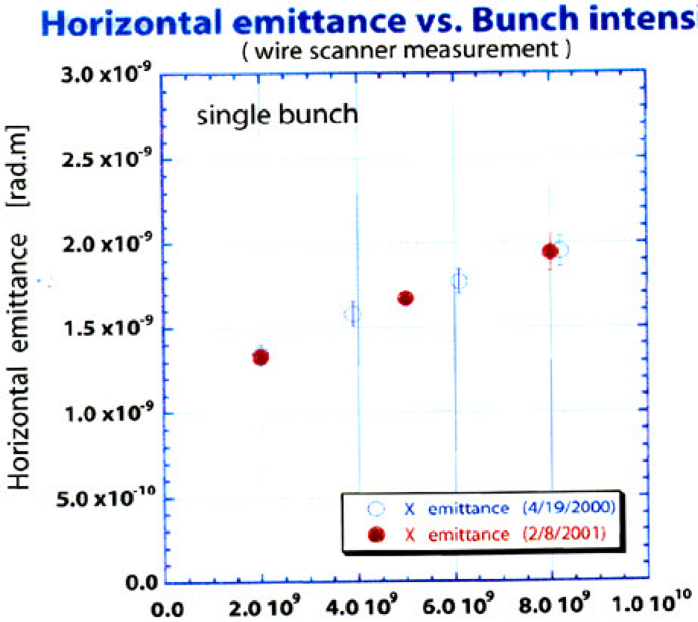


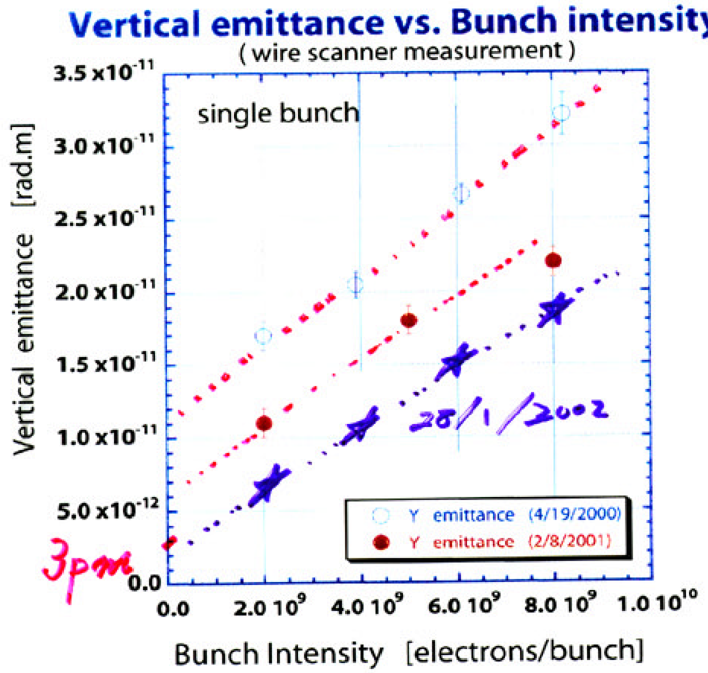


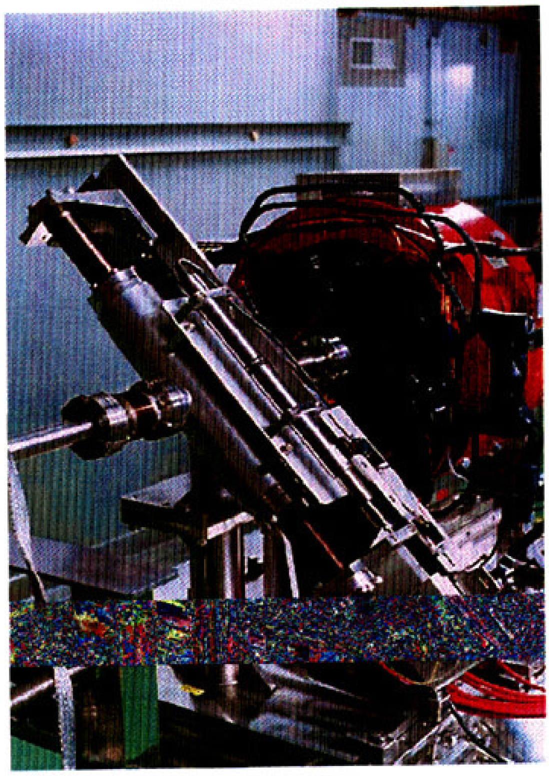


beam repetition 0.78Hz, 7e9 electrons, single bunch
vertical emittance=2.2e-11 rad.m (QK2X=1.5A)

Extraction line for precise diagnostics





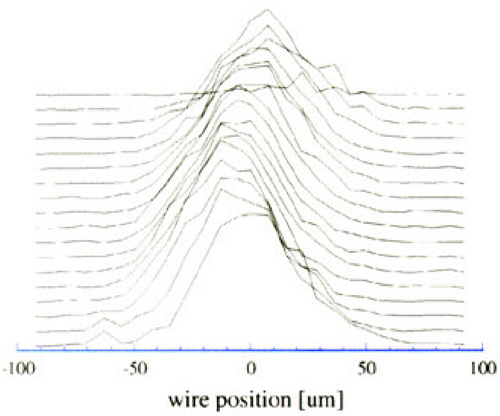


Beam size is measured by scanning with thin W wires. Emittance is evaluated by fitting those data.

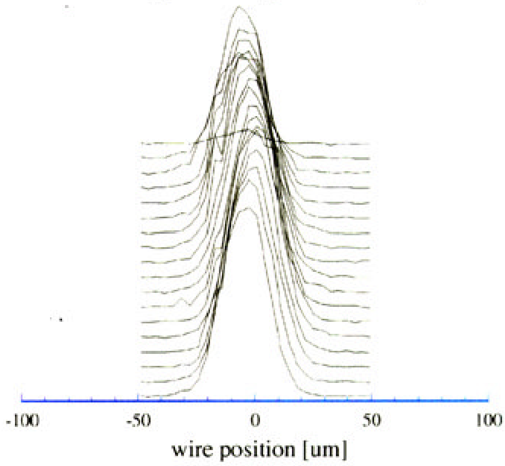
Multibunch Y profiles by Wire Scanner

Total beam intensity = 4.5E10 in 18 bunches (1/31/2002)

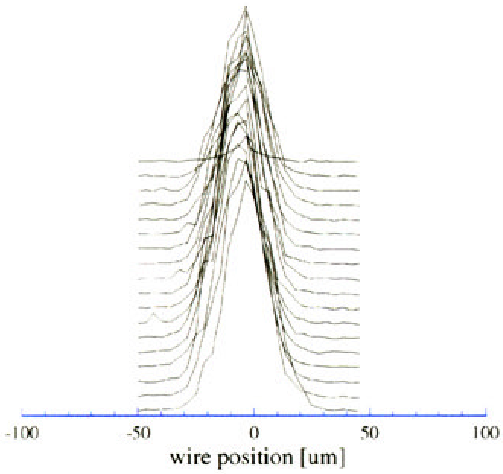
MW0X Y profiles σy = 19.3 ~ 21.5 μm



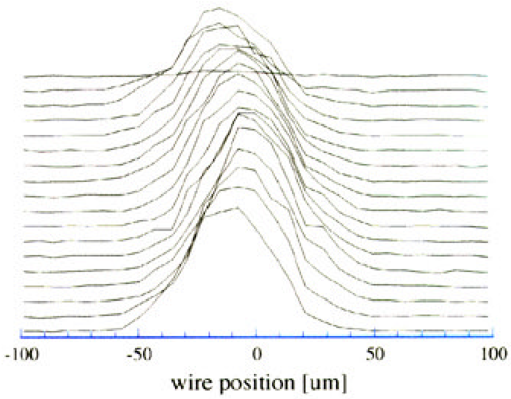
MW3X Y profiles σy = 9.7 ~ 11.2 μm



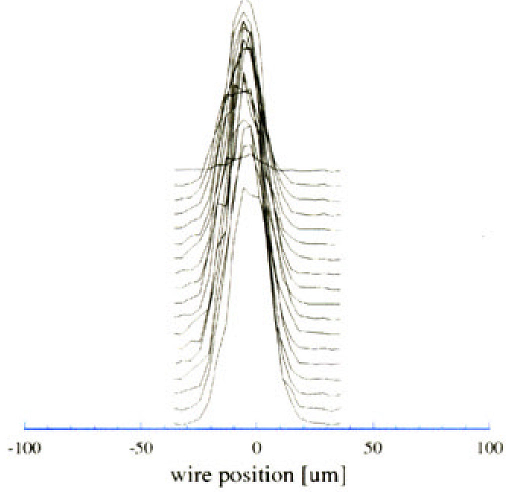
MW1X Y profiles σy = 8.2 ~ 10.3 μm



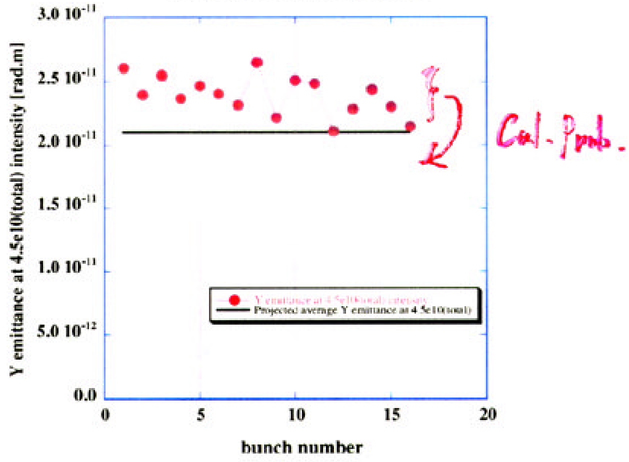
MW4X Y profiles σy = 17.1 ~ 18.6 μm



MW2X Y profiles σy = 7.1 ~ 9.7 μm



Y emittance of each bunch



DR BPM electronics upgrade

Resolution by one pass.

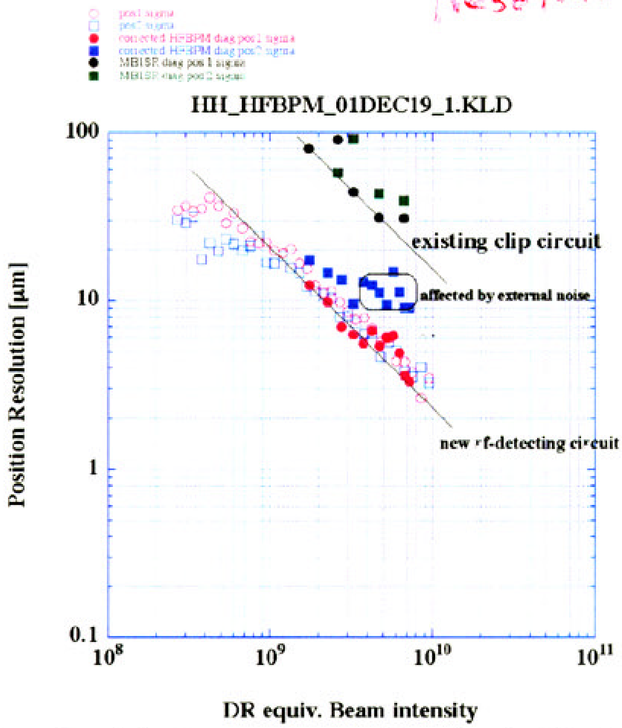


Fig. 7 Comparison of resolution between the new rf-detecting circuit by beam, by calibration pulser and the existing clipping circuit. Even the new rf-detecting circuit was affected by external in-coming electrical noise in one channel (blue solid square), the other channels (red solid circle) and calibration data (red & blue of circle & square) are consistent to 2.5μm resolution at 1E10 intensity line. On the other hand, the existing clipping circuit (black solid circle & green solid square) lies on or above 15μm resolution at 1E10 intensity line.

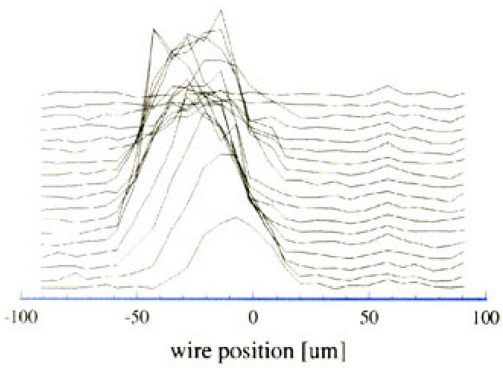
2.5μm Resolution at 10^{10} electrons/bunch.

for Precise BBA

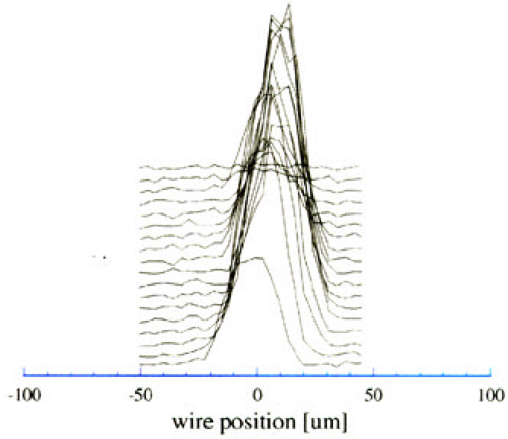
Multibunch Y profiles by Wire Scanner

Total beam intensity = 0.85E10 in 18 bunches (1/31/2002)

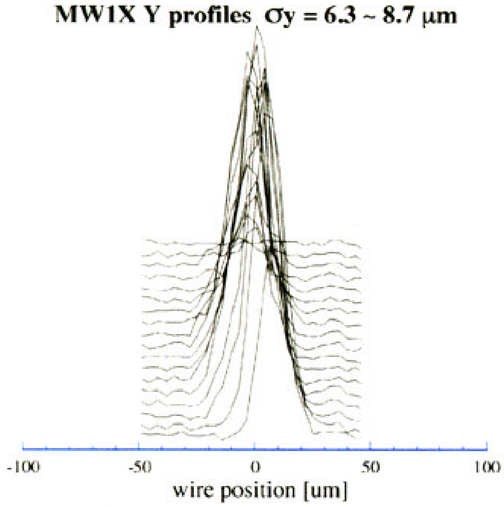
MW0X Y profiles $\sigma y = 12.7 \sim 19.2\ \mu m$



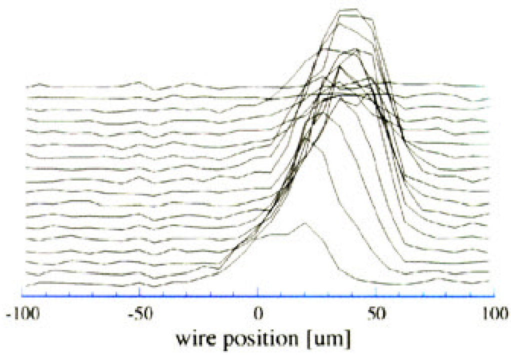
MW3X Y profiles $\sigma y = 8.2 \sim 10.1\ \mu m$



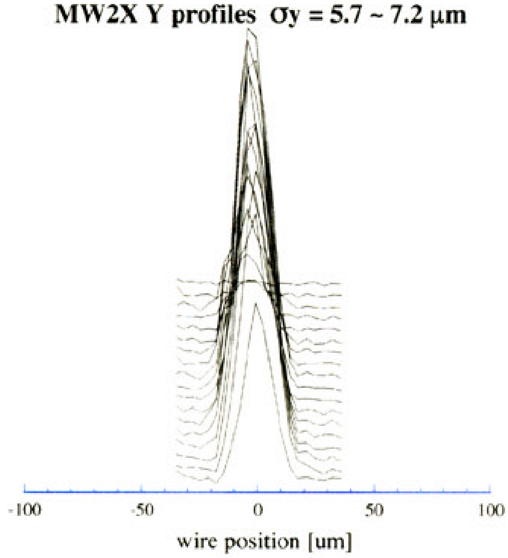
MW1X Y profiles $\sigma y = 6.3 \sim 8.7\ \mu m$



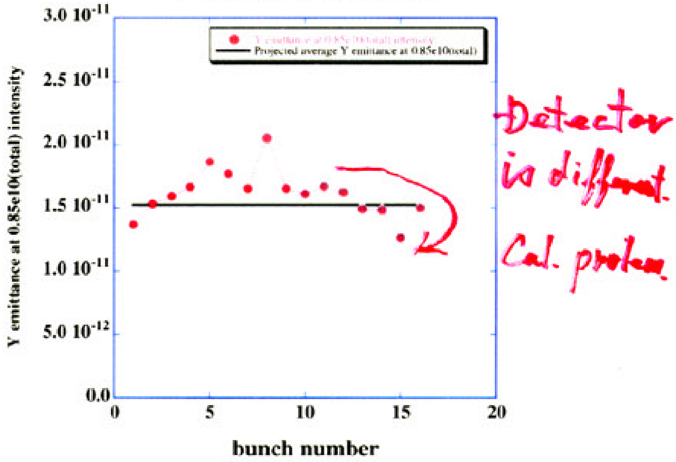
MW4X Y profiles $\sigma y = 12.2 \sim 17.3\ \mu m$



MW2X Y profiles $\sigma y = 5.7 \sim 7.2\ \mu m$

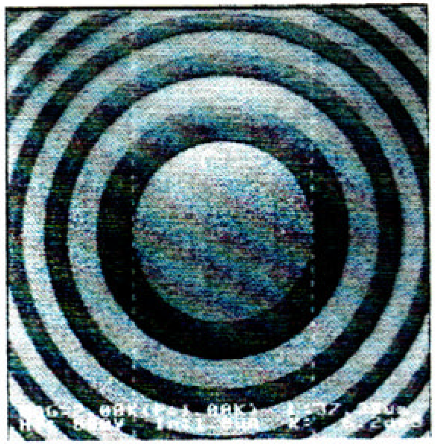


Y emittance of each bunch

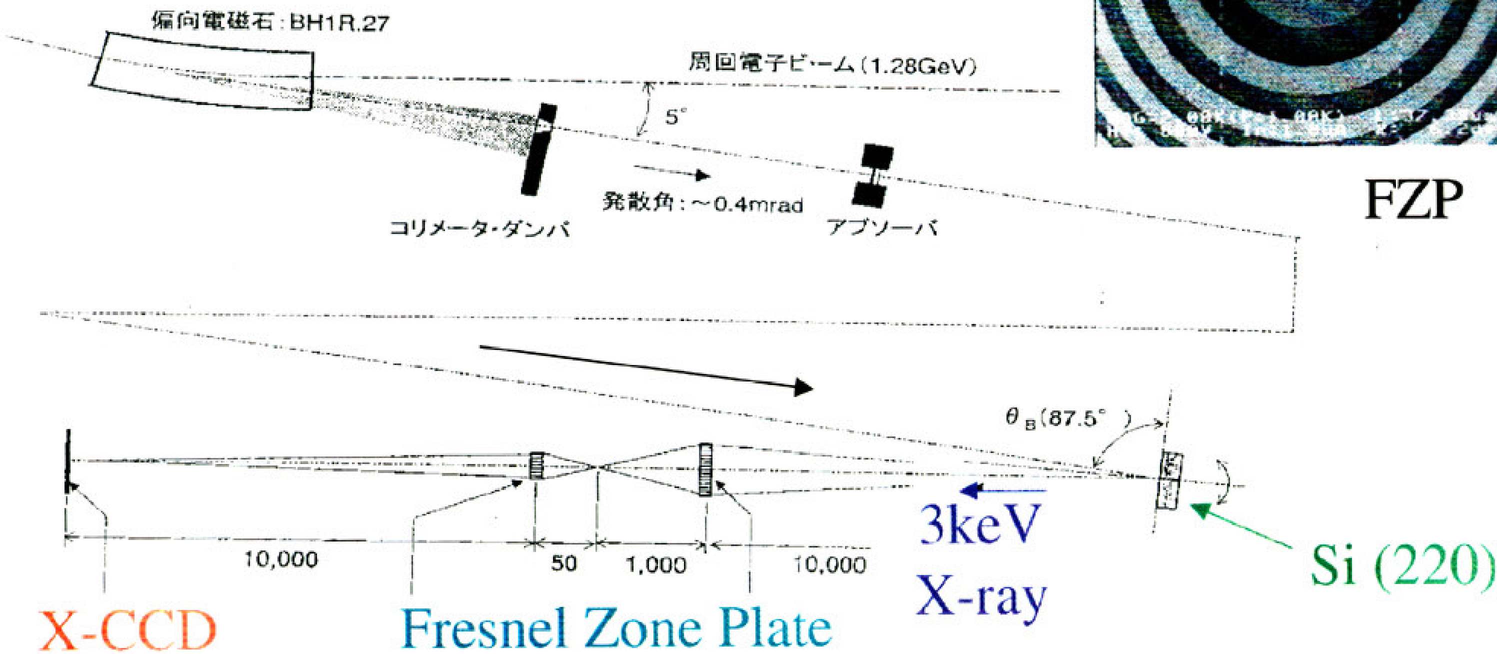


Future plan –XSR monitor –

- ***No diffraction limit by using X-ray***
- ***Magnified by Fresnel Zone Plate***



FZP



oshi Sakai

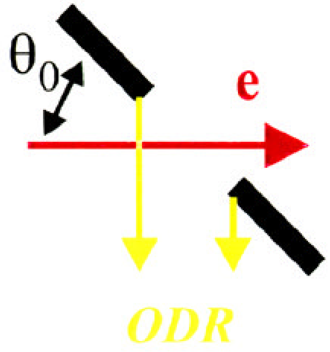
Analysis of the ODR Angular distribution

M. Castellano\Nucl. Instr. & Meth. A **394**, p. 275 (1997)

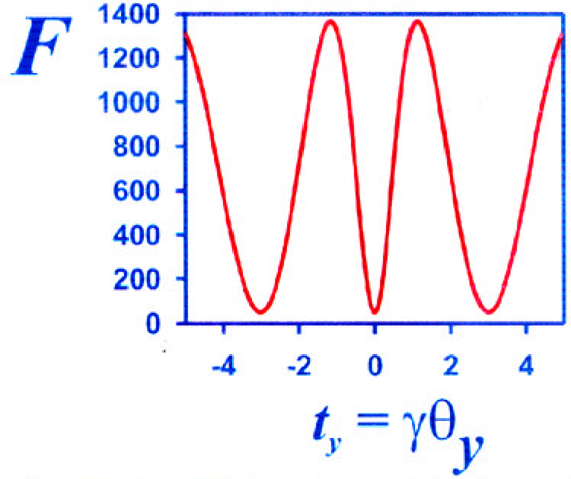
$$\overline{\frac{d^2W_{DR}}{d\omega\, d\Omega}} = \frac{e^2\gamma^2}{2\pi^2}\frac{\exp(-z)}{1+t_y^2}$$

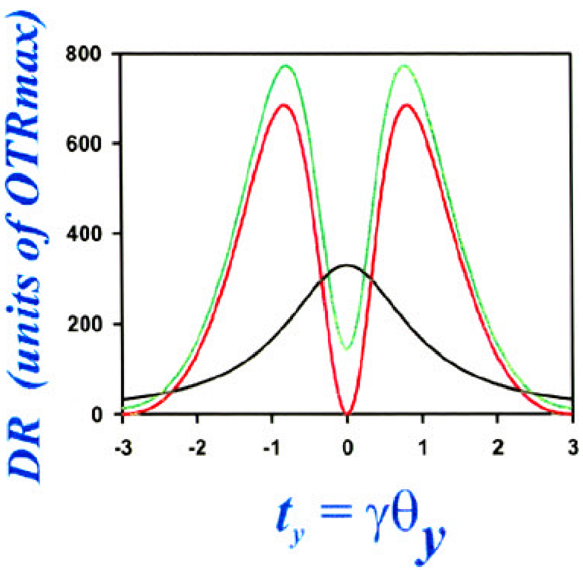
$$\times\left[\exp\left(\frac{2\sigma_y^2}{a^2}z^2\right) - \cos(zt_y + 2\psi)\right]$$

$$\psi = \arctan\left(\frac{t_y}{\sqrt{1+t_x^2}}\right)$$



$$F = (1+t_y^2)\overline{\frac{d^2W_{DR}}{d\omega\, d\Omega}}$$





$t_x = \gamma\theta_x = 0$
$\lambda = 400nm$
$a = 200\mu m$
$b = 0$
$h = 100\mu m$
$\gamma = 2500)$

$\sigma_y = 0$
$\sigma_y = 50\mu m$

$$\sigma_y = \frac{\lambda\gamma}{2\pi}\sqrt{\frac{F_{min}}{F_{max}}}$$