Generation of High-Energy Synchrotron Radiation with a 10T Superconducting Wiggler Installed in the SPring-8 Storage Ring

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Aim

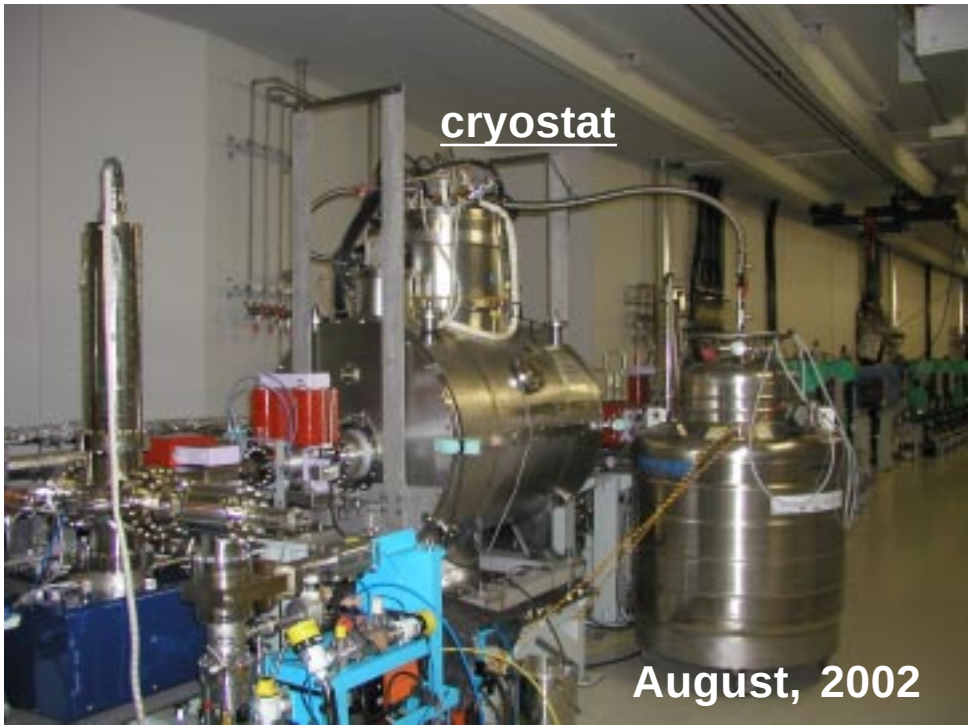
Genaration of High-Energy γ-Rays in MeV-Region

with

10 T Superconducting Wiggler (*by Budker INP*)

installed in

8 GeV Electron Storage Ring (*at SPring-8*)



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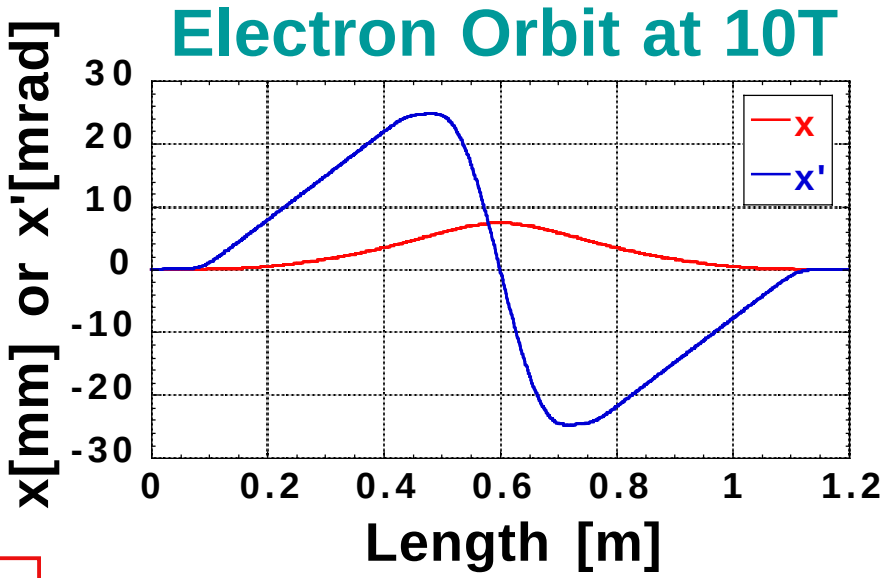
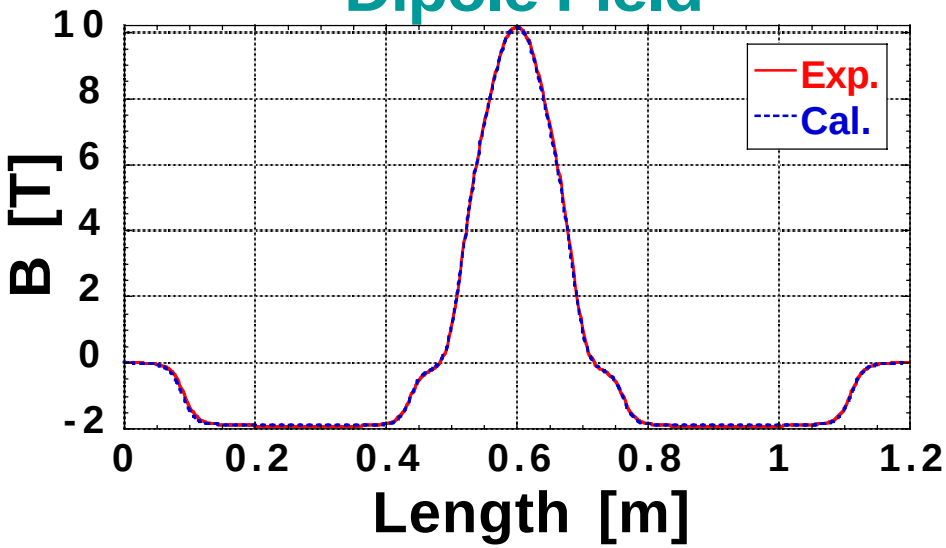
Three-Pole Superconducting Wiggler





Maximum Orbit Shift :

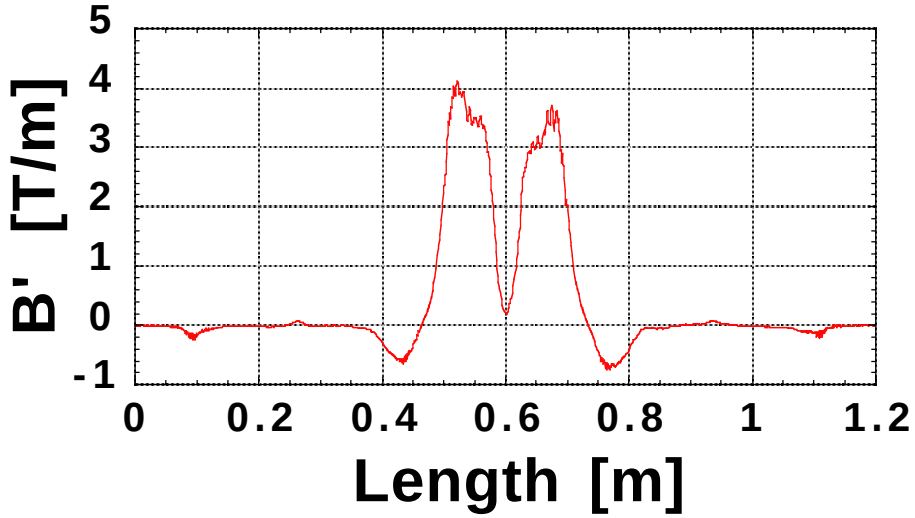
x = 7.3mm

x' = ±25mrad

Quadrupole and Sextupole Components

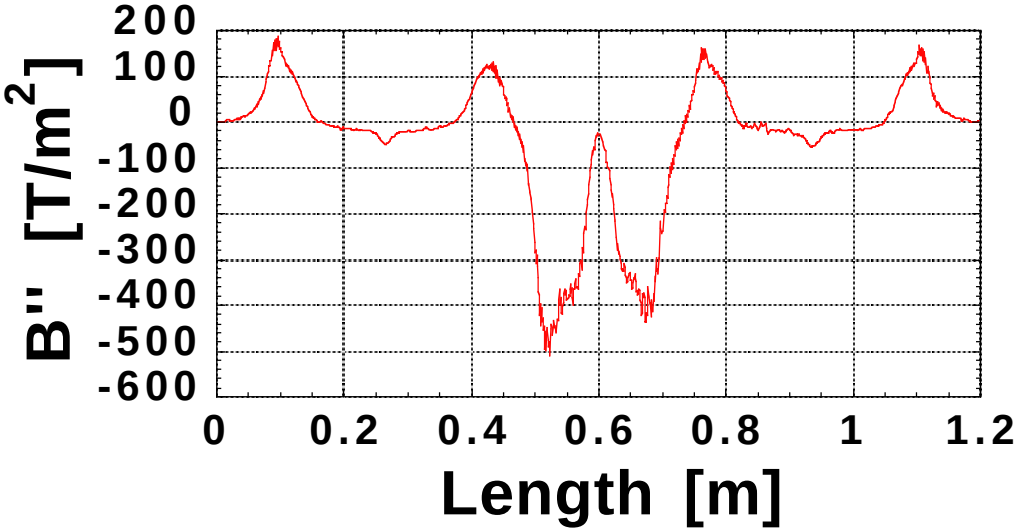
Quadrupole Field :

0.50T (integrated)
defocusing

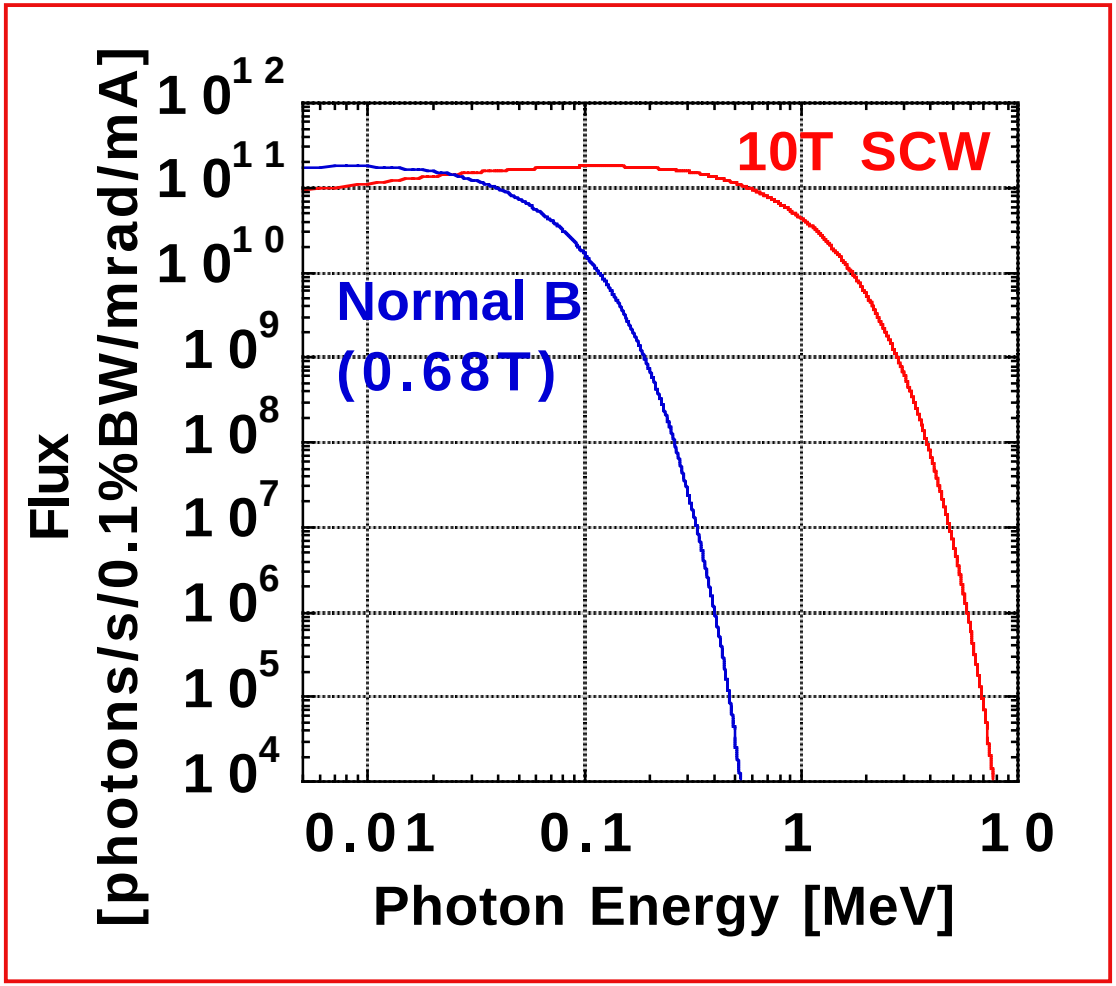


Sextupole Field :

45T/m (integrated)
focusing



Photon Flux



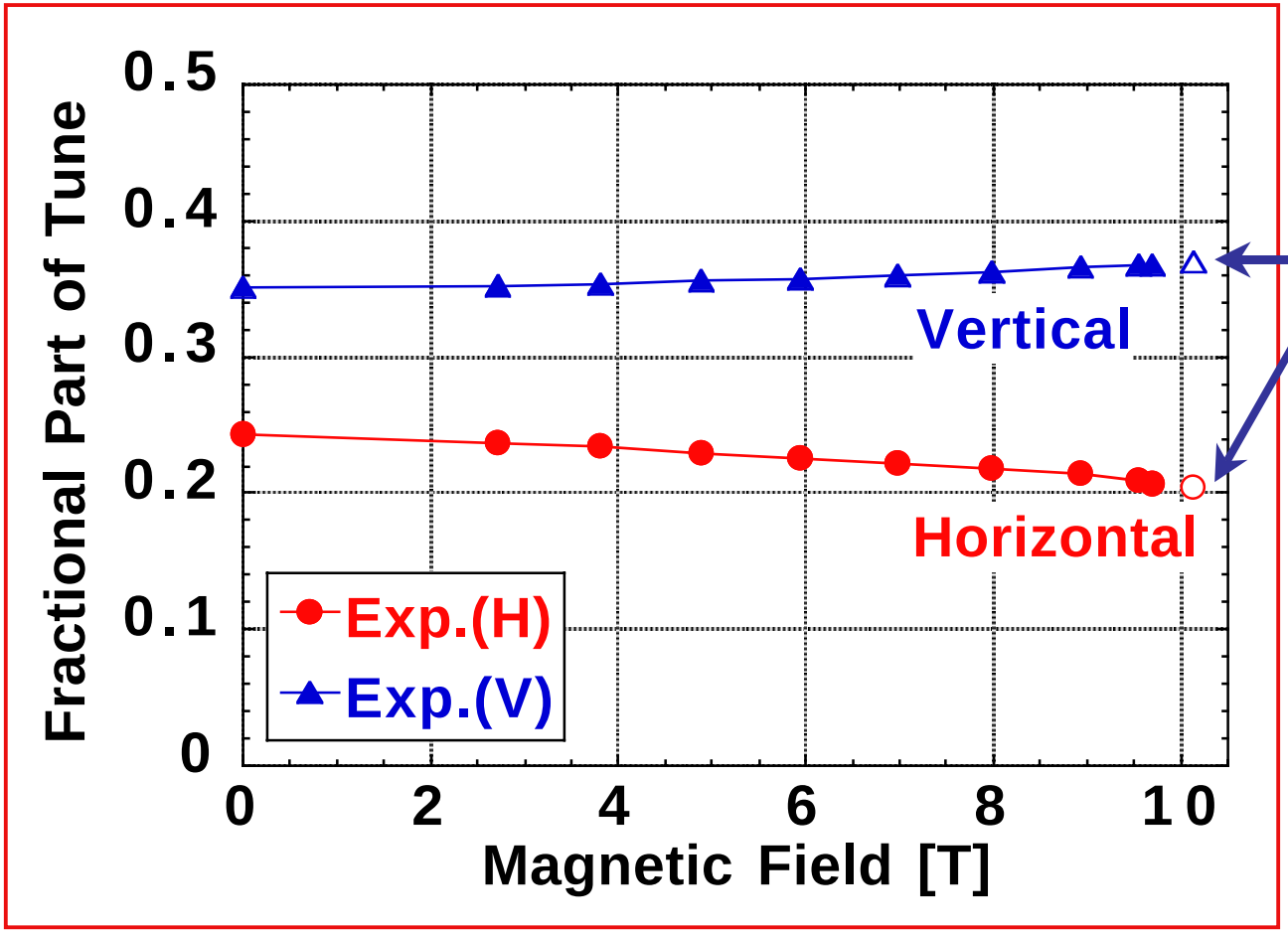
Critical Energy:

0.43MeV
(8GeV, 10T)

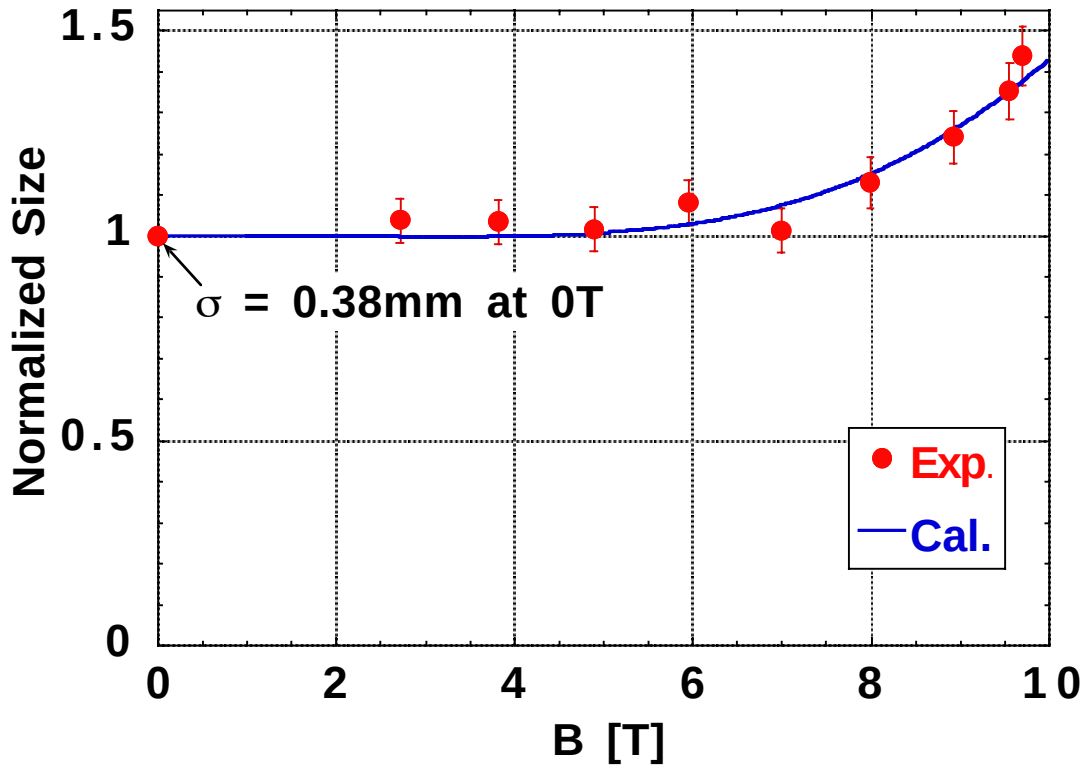
Total Power:

1kW/mA

Betatron Tunes



Horizontal Beam Size and Emittance



Horizontal size was measured by scraping a stored beam.

Beam Size :
1.4 times larger

↓

Emittance :
2 times larger

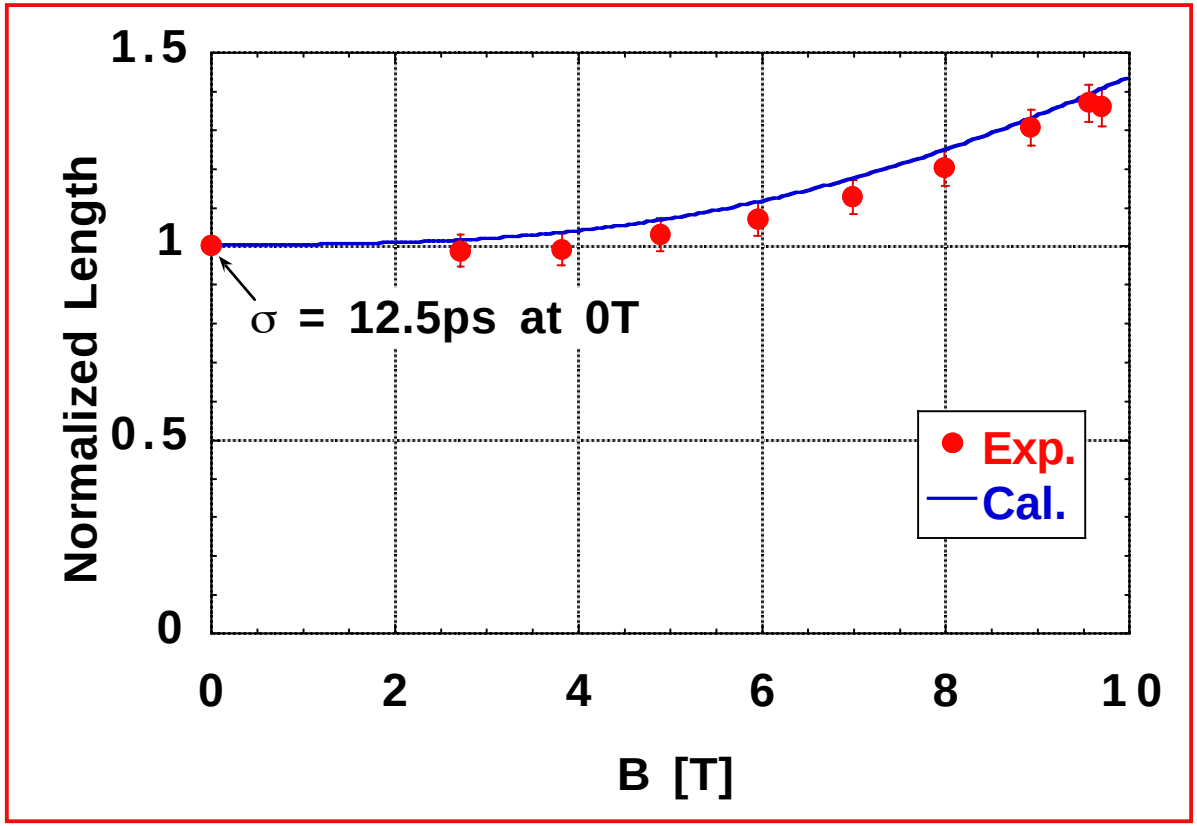
$$\frac{\varepsilon}{\varepsilon_0} \approx \frac{1 + \Delta I_5 / I_5}{1 + \Delta I_2 / I_2} = \frac{1 + C_5 B^5}{1 + C_2 B^2}$$

where

$\Delta I_2 = \Delta \int (1/\rho^2) ds \propto B^2$

$\Delta I_5 = \Delta \int (H/|\rho^3|) ds \propto B^5$

Bunch Length



Bunch Length :
1.4 times longer

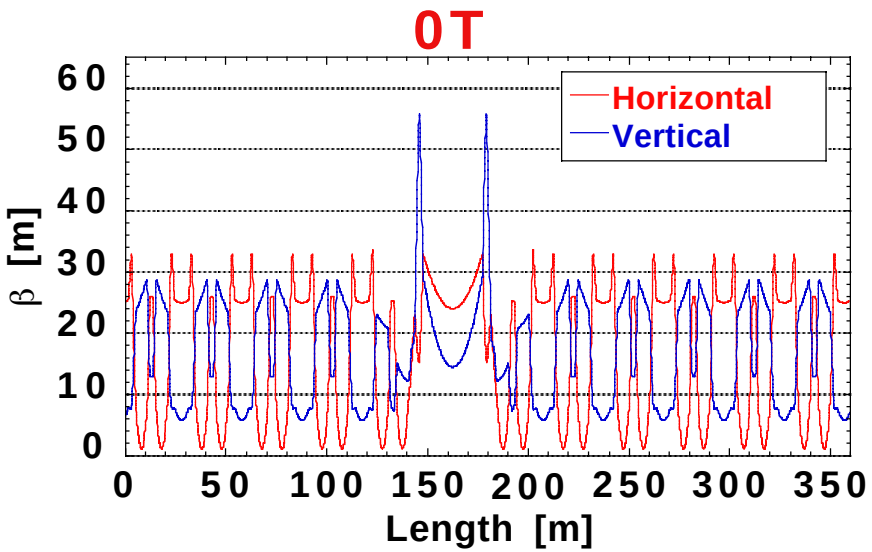
Energy Spread :
1.4 times larger

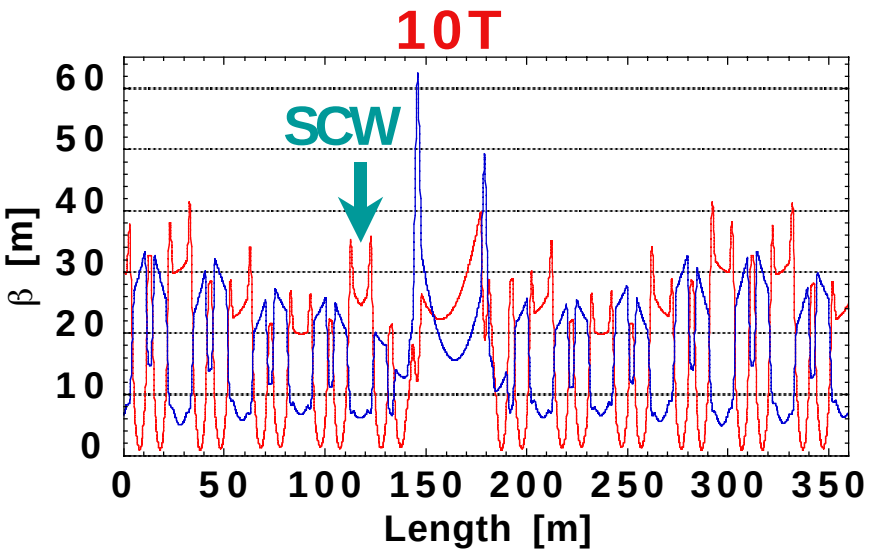
$$\frac{(\Delta E/E)^2}{(\Delta E/E)_0^2} \approx \frac{1 + \Delta I_3 / I_3}{1 + \Delta I_2 / I_2} = \frac{1 + C_3 B^3}{1 + C_2 B^2}$$

where

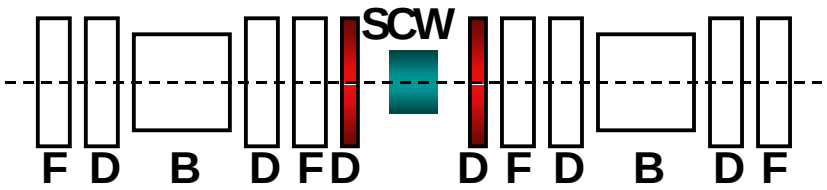
$$\Delta I_3 = \Delta \int (1/|\rho^3|) ds \propto B^3$$

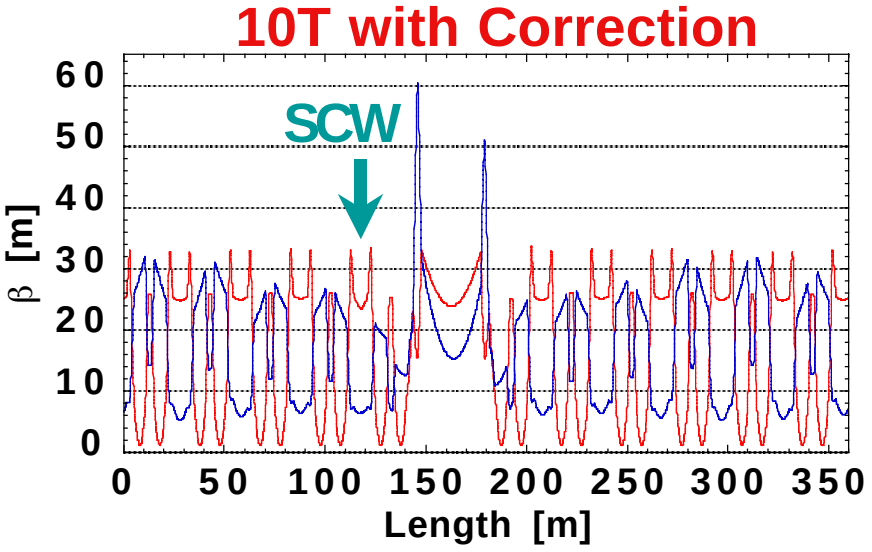
Distortion of Betatron Function



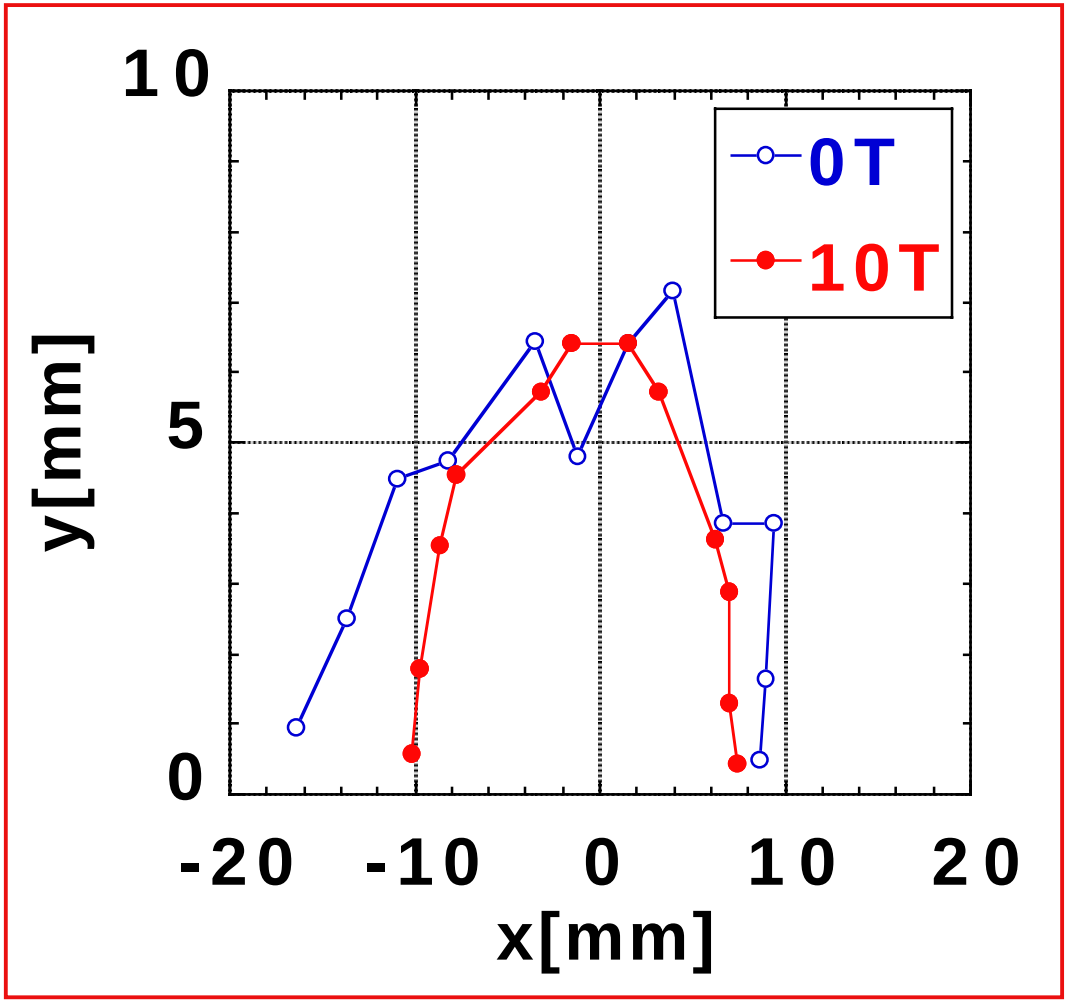


Minimal Correction with Adjacent Quads.





Dynamic Aperture

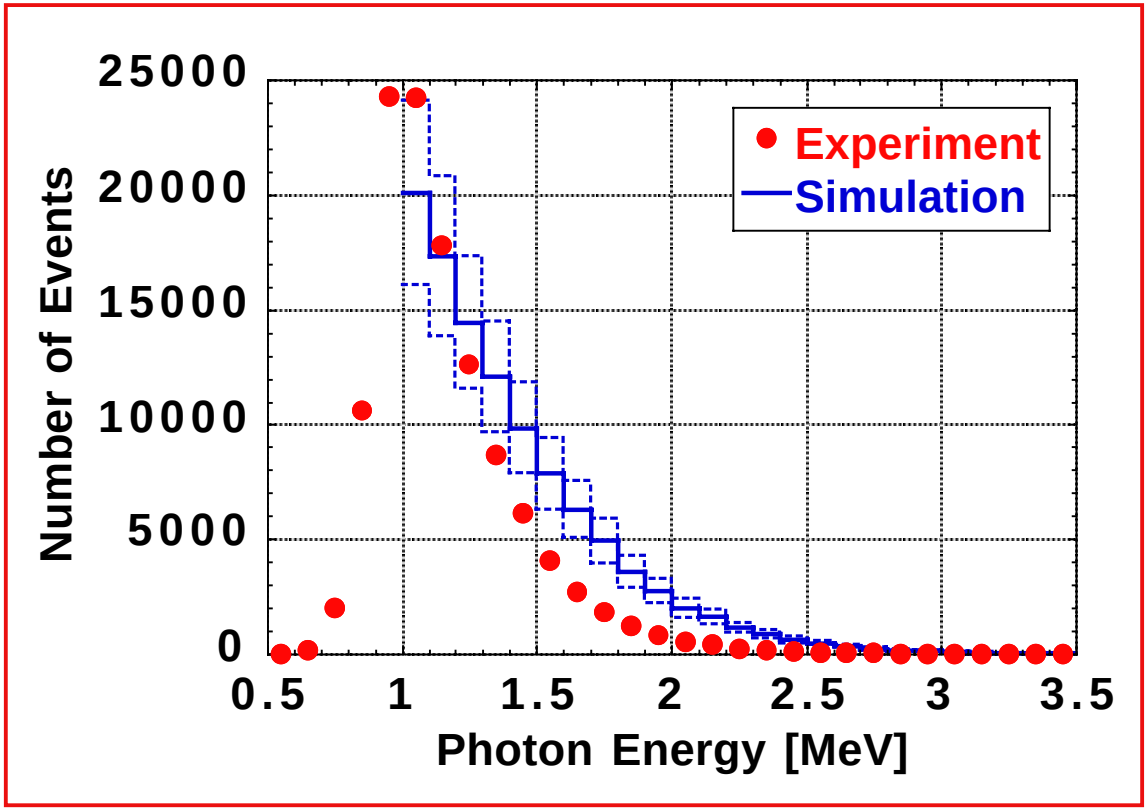


The Sextupole field affects the dynamic aperture.

Injection efficiency decreased at 10T.

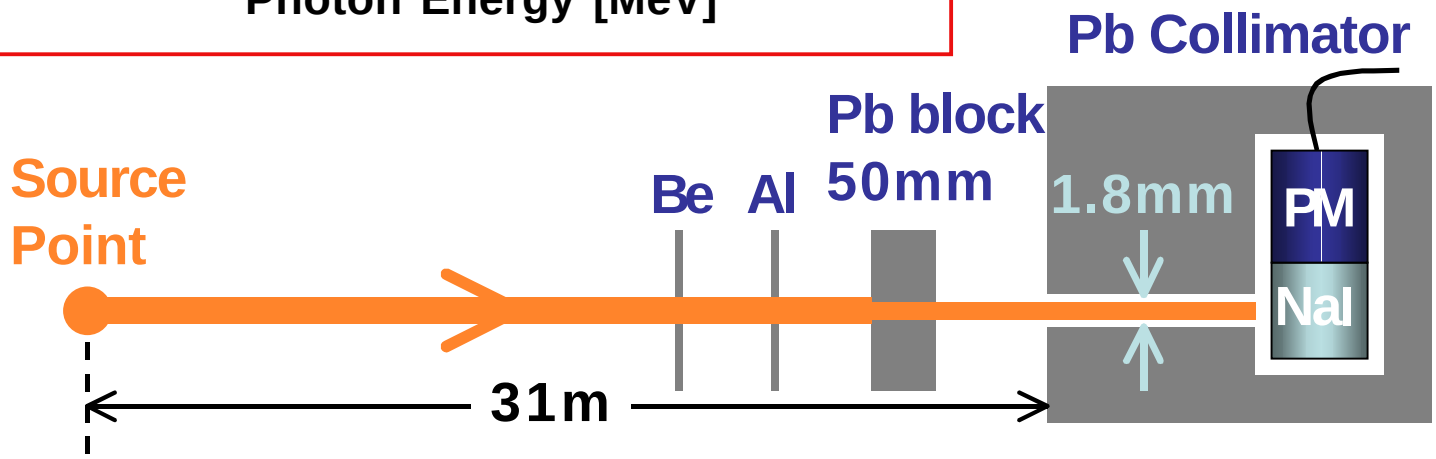
Tracking: Ring with Error Fields

Photon Energy Spectrum



Stored beam was scraped by bump magnets.

Stored current was estimated by photon -counting method:
8pA (±20%)



Possible Applications

- **Slow Positron Beams by Pair-Creation**
- **Nuclear Photoreaction Cross Section (^{16}O, ^{180}Ta, ...)**
- **High-Energy Compton Scattering (~500keV)**
- **Generation of Neutrons ($\gamma + {}^{9}Be$)**

.....

Summary

- A 10T superconducting wiggler (SCW) was installed in the 8GeV electron storage ring at SPring-8 and beam tests were carried out.

- Beam injection was possible with high fields of SCW.

- Beam parameters and a photon spectrum were measured.
  The results agreed with calculations.

- Effects of SCW are not small. (large β at SCW)
  $\rightarrow$ incompatible with user-time

- After the beam tests SCW was removed from the ring.

- We are now looking for a possible place of re-installation of SCW for real applications.