ATF Status June/2002
H. Hayano, KEK

Multibunch emittance
Multibunch instrumentation
New instrumentation developments
Multibunch photo-cathode RF-gun
Plans for summer shutdown, autumn run
ATF Introduction

$E = 1.28 \text{GeV}$
$N_e = 1 \times 10^{10} \text{ e-}/\text{bunch}$
$\text{Rep} = 1.5 \text{Hz}$
$X \text{emit} = 2.5 \times 10^{-6}$
$Y \text{emit} = 2.5 \times 10^{-8}$
Multibunch emittance

- **Beam intensity in DR**
  \[ \sim 0.3 \times 10^{10} \text{ e}^{-}, \text{17 bunch, 2.8ns spacing (non-flat multibunch)} \]
  with \(0.78\text{Hz} \) repetition (max. 3 trains in ring)

- **Monitors of MB emittance**
  MB (or projected) wire scanner, MB (or projected) Laser-wire
  Projected SR interference monitor

- **Problems of MB emittance**
  emittance growth with bunch intensity
  (twice bigger than single bunch emittance)
  big energy fluctuation (in each bunch?)
MB wire scanner

Wire scanner multibunch detection

Waveform from APD detector with wire on beam

Peak detection by software through GPIB

scope: TDS694C
10Gs/s, 3GHz BW

APD: Avalanche Photo-Diode
BW: 1GHz
Multibunch Y profiles by Wire Scanner

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

MW0X Y profiles $\sigma_y = 19.3 - 21.5 \mu m$

MW1X Y profiles $\sigma_y = 8.2 - 10.3 \mu m$

MW2X Y profiles $\sigma_y = 7.1 - 9.7 \mu m$

MW3X Y profiles $\sigma_y = 9.7 - 11.2 \mu m$

MW4X Y profiles $\sigma_y = 17.1 - 18.6 \mu m$

Y emittance of each bunch
MB wire projected emittance

Emittance by Wire Scanner

X emittance by wire scanner

Y emittance by wire scanner
EXT wire & Laser wire

Y emittance by EXT wire & Laser wire

Y emittance by EXT tungsten-wire June/2002

Y emittance by Laser-Wire June/2002

EXT wire

Laser wire

Bunch intensity

Bunch intensity

EXT wire & Laser wire

Y emittance by EXT wire & Laser wire

Y emittance by EXT tungsten-wire June/2002

Y emittance by Laser-Wire June/2002

EXT wire

Laser wire

Bunch intensity

Bunch intensity
MB-LW

Low intensity

High intensity
MB energy fluctuation

Energy spread by EXT profile monitor

- sig_E/E (single bunch)
- sig_E/E (multibunch projected)

02MAY28_2250.KLD

Multibunch (projected)
energy fluctuation!

single bunch

Bunch Intensity
DR orbit & aperture

DR orbit & Aperture

[Graph showing X and Y position plots with aperture settings indicated]
trials for MB low emittance

- **DR H\&V Orbit bumps**
  no good bump for low emittance

- **Chromaticity tweaking**
  no good SD, SF set for low emittance

- **Vacuum level**
  no clear difference between IP on/off

- **Beam loss at mask region**
  observed small enhancement at mask

- **Longitudinal dipole osc. feedback**
  observed osc. Amplitude reduction
  no clear response on emittance
New instrumentation developments

- ODR beam size monitor
  observation of Diffraction Radiation in visible light

- X-ray SR monitor
  3keV SR imaging by Fresnel zone plates

- New clip-circuit for DR BPM
  single shot 3μm resolution circuit

- Beam tilt detection by cavity-BPM
  study was started

- Multibunch BPM
  circuit test continuing (SLAC)
  still design stage (KEK)
Diffraction Radiation (DR) experiment for non-invasive beam diagnostics

DR is emitted when a charged particle passes through the vicinity of a conducting target.

**beam diagnostics using DR**
- non-invasive
- single path measurement
- large radiation angle

**measurement set up**

![Diagram of beam diagnostics setup with DR](image)

**Angular distribution of DR from slit**

$$\sigma_y = \frac{\gamma \lambda}{2\pi} \sqrt{\frac{(1 + t^2_{y_{min}})\Lambda_{min}}{(1 + t^2_{y_{max}})\Lambda_{max}}}$$

**Beam size**
DR and TR angular distribution
measured by Image Intensifier at one shot with single edge target
SR monitor optics set-up

X-ray SR port in Jan. 2002
X-ray SR monitor using zone plate (Tokyo Univ.)

source  \hspace{1cm} CZP \hspace{0.5cm} MZP \hspace{0.5cm} X-ray CCD

\hspace{3cm} 10m \hspace{1cm} 1.025m \hspace{1cm} 5m

3.23KeV(0.384nm) SR magnification 20 beam size resolution 1.87\mu m

CZP : 3mm dia.  
6497 zone rings  
minimum zone width 108nm

MZP : 75\mu m dia.  
584 zone rings  
minimum zone width 127nm

microscope image of zone plate

Beam image (x:46.2, y:10.2\mu m)
New clip-circuit for DR BPM
Performance of new clip circuit
Multibunch photo-cathode RF gun

- For better MB injection into DR
generation of high quality multibunch
  low emittance, low energy spread, high & flat intensity

- Combination of BNL-cavity and Cs2Te cathode
  enough operation experience in CTF & TTF

- New laser system; 20 bunch, 2.8ns spacing, 266nm
  Nd:YVO4 (1064nm) 357MHz mode-lock laser + amplifier

- Load-lock system for Cs2Te cathode block
  extra cathode blocks and evaporation chamber

- KEK built gun-cavity
  precise machining and blazing by KEK machine center
Multibunch photo-cathode RF-gun

Multibunch photo-cathode RF gun assembly

June ~ Oct. 2002

Diagram of a multibunch photo-cathode RF gun assembly with labels:
- 3m Acc. structure
- Solenoid
- RF gun cavity
- Cathode loading axis
- ION source for cleaning
- Evaporation chamber
- Multibunch Laser
- IP 400 l/s
- transport movers
Gun cavity & Laser system
Plans for summer shutdown

- **DR injection test of multibunch photo-cathode RF gun**
  RF-gun or back to thermionic gun:
  decision will be made at beginning of October

- **EXT kicker upgrade**
  measurement of field coupling
  modify thyatron circuit for good pulse shape

- **Modify DR BPM system**
  install calibration system
  install new clip circuit (end of December)
  remove AC noise into circuit

- **Identify EXT-line X-Y coupling**

- **Laser wire upgrade**
Plans for Autumn run

- Run by multibunch RF gun, hopefully smooth multibunch operation from 1 bunch to 20 bunches
- Beam Based Alignment (preparation) preparation for new coming BPM circuit (Jan. 2003)
- MB study beam oscillation observation (spectrum, each bunch) precise orbit control, tune survey, chromaticity survey, removing slow oscillation, etc
- EXT line coupling study vertical dispersion control & skew-Q
- Instrumentation developments laser wire, ODR monitor, XSR monitor, cavity-BPM, multibunch BPM, etc