Linac

Operation Status
Two-Bunch Acceleration

KEK Y. Ogawa

Operation Status

- Beam

  Stable and reproducible for four beams

  e- / e+ for KEKB, e- for two rings of Photon Factory

  Daily beam diagnosis

- Machine

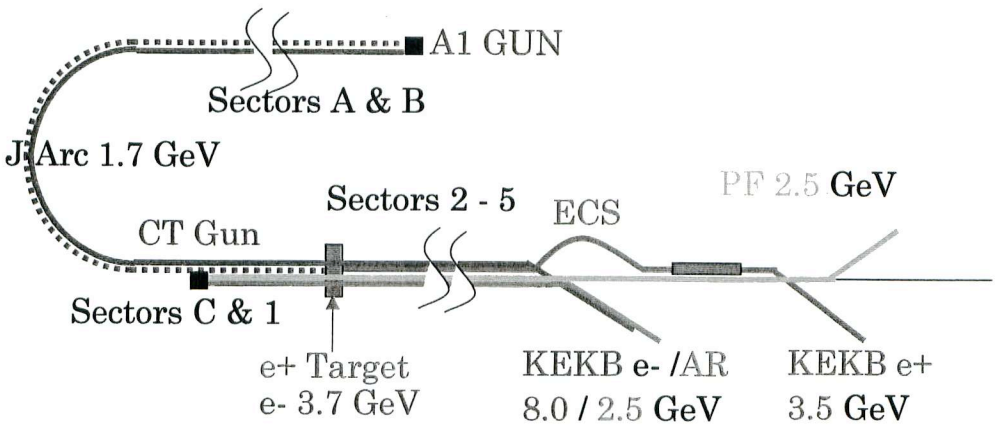
  Klystron trip: 500/week = Once/20 min

  Weekly check of klystron status

  Phasing: Every two weeks

  Maintenance Day: Every two weeks

Linac Layout



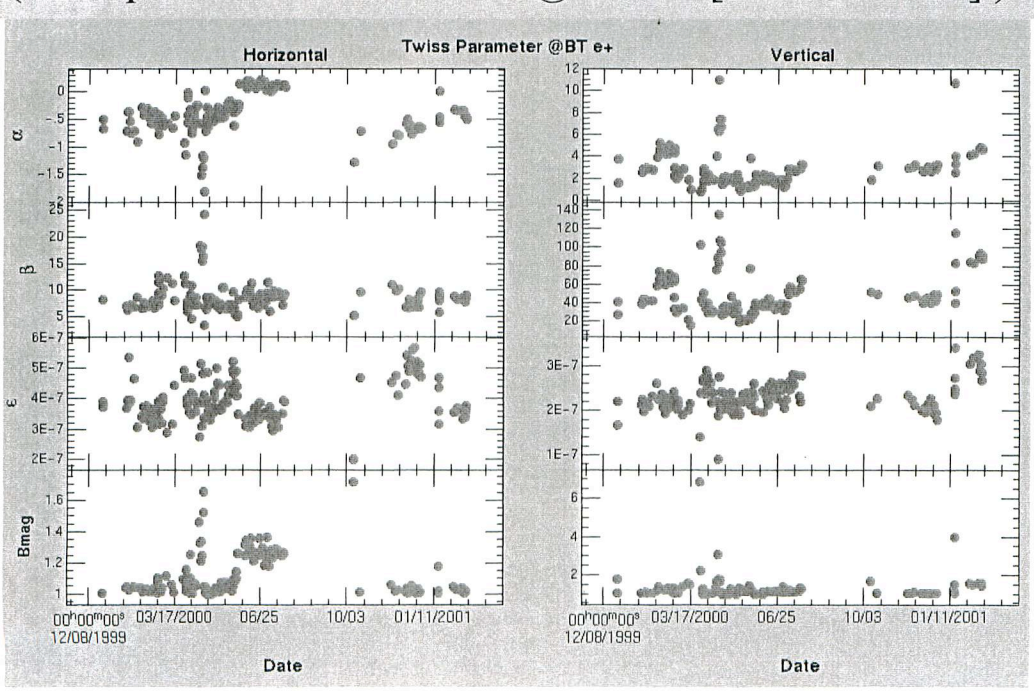
KEKB Linac: Four beams for four different rings

	Charge [nC]	Energy [GeV]	Injection /day	Inj. Time [min]
KEKB e-	1.0	8.0	~14	1 – 2
KEKB e+	0.6	3.5	~14	4 – 5
primary e-	8 –10	3.7		
PF e-	0.2	2.5	1	3 – 5
PF-AR e-	0.2	2.5	12	3 – 5

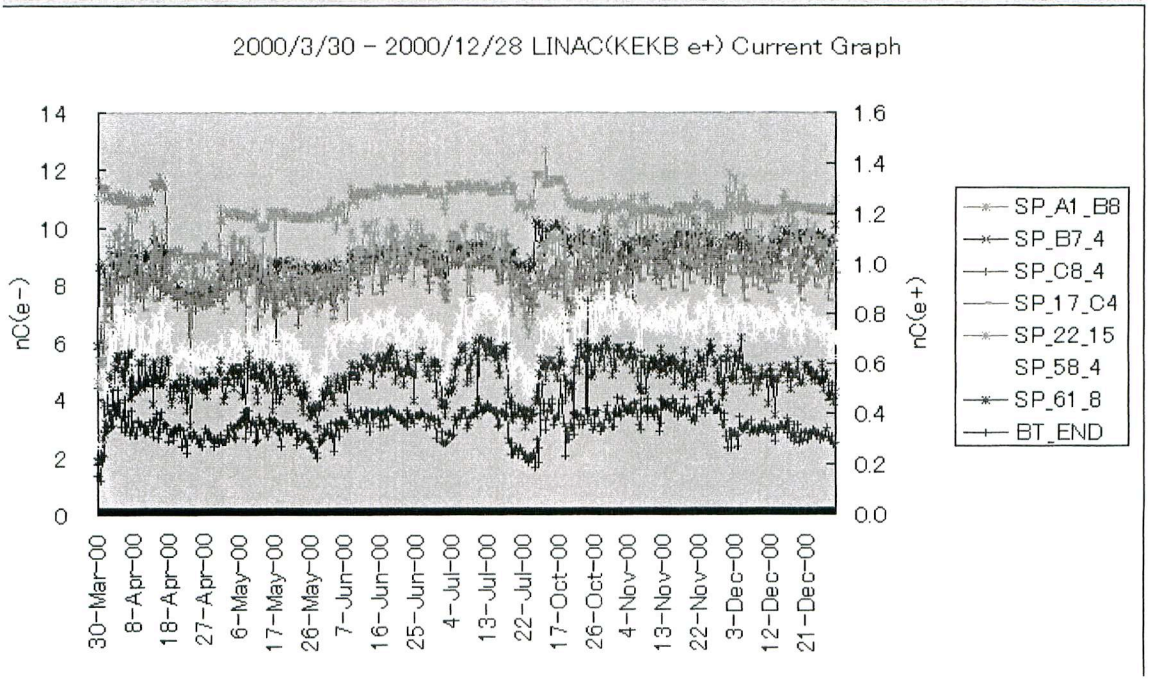
Typical Parameters @ LINAC-BT

	Electron @ BT	Positron @ BT	Primary Electron for Positron Production
Charge [nC]@ Linac	1.0	0.6	
Charge [nC]	0.8	0.4	8.0 @ Target
Energy [GeV]	8.0	3.5	3.7 @ Target
$\Delta E/E$ [%(σ)]	0.05	0.15	0.5 @ J-Arc
$\gamma\varepsilon_x$ [mm (σ)]	0.31	2.4	3.5 @ Sector B
$\gamma\varepsilon_y$ [mm (σ)]	0.31	2.0	1.8 @ Sector B
Injection Rate [mA/s @ 50 Hz]	2.5 – 3.0 (100 %) (HER)	1.3 – 1.5 (90 %) (LER)	

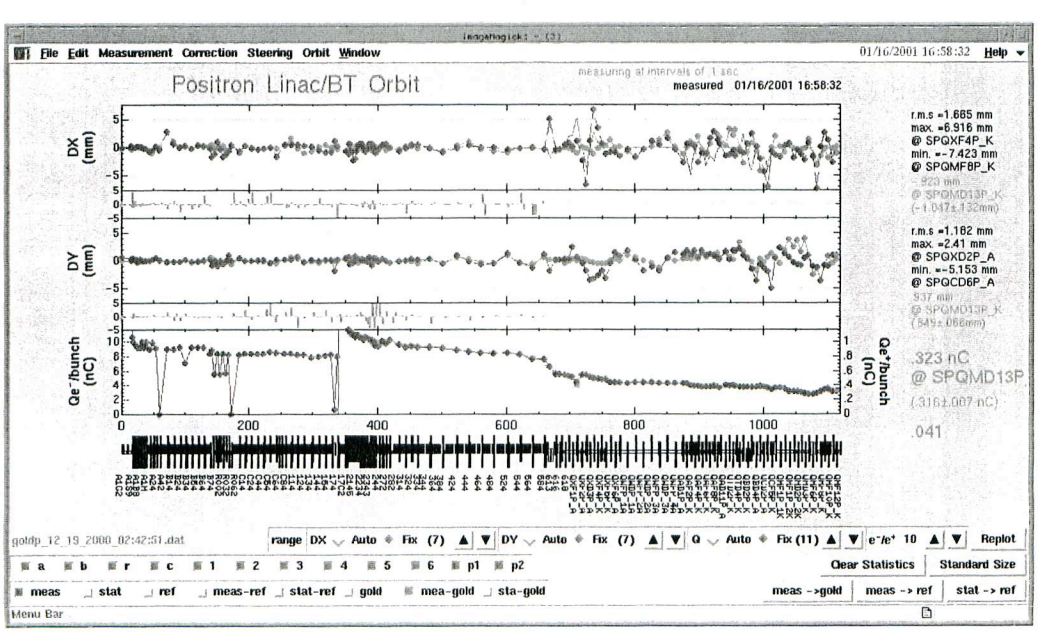
Daily Measurements of Optics Parameters
(Example: Twiss Parameters @ BT e+ [Wire Scanner])



Positron Beam Intensity 2000



Positron Beam -- orbit and intensity--



Two-Bunch Acceleration

- Double the positron intensity
  => Halve the injection time
- Constraint
  (1) Bunch interval = 96.29 ns
  Ring-Linac common frequency:
  10.385 MHz=2856/275=508.887/49
  =SHB1(114.240)/11
  =SHB2(571.200)/55
  (2) Energy compensation by SLED timing

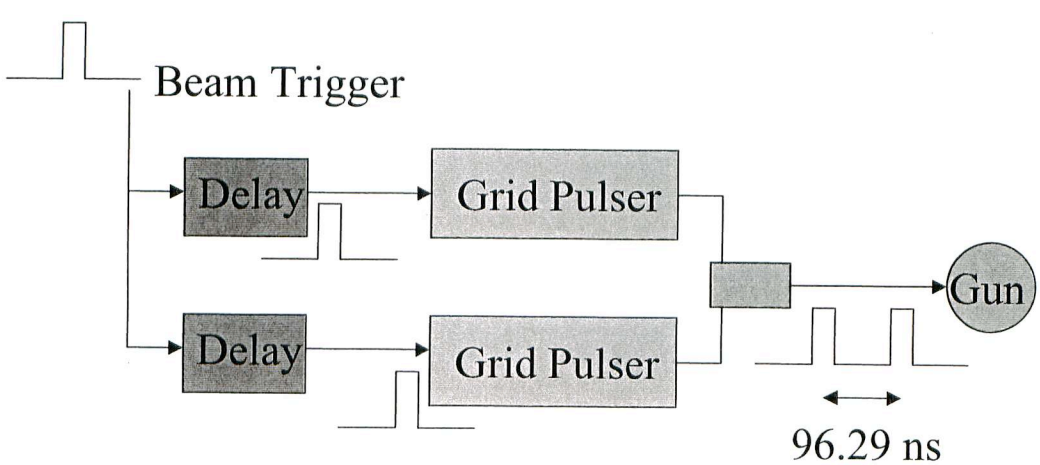
Injection Time (Example)

	Present	Full Injection
LER	400 ⇒700 mA	2.1 ⇒2.6 A
HER	430 ⇒580 mA	1.0 ⇒1.1 A
Physics Run	~90 min	~20 min
Injection	14 times/day	53 times/day
LER		
Single Bunch	3.8 min (1.3 mA/s)	6.4 min (1.3 mA/s)
[Two Bunch]	[2 min] (2.5 mA/s)	[3.3 min] (2.5 mA/s)
HER	1 min (2.5 mA/s)	0.7 min (2.5 mA/s)
Beam SW / others	3~4 min	3~4 min
Total	8~9[6~8] min	10~12[7~9]min

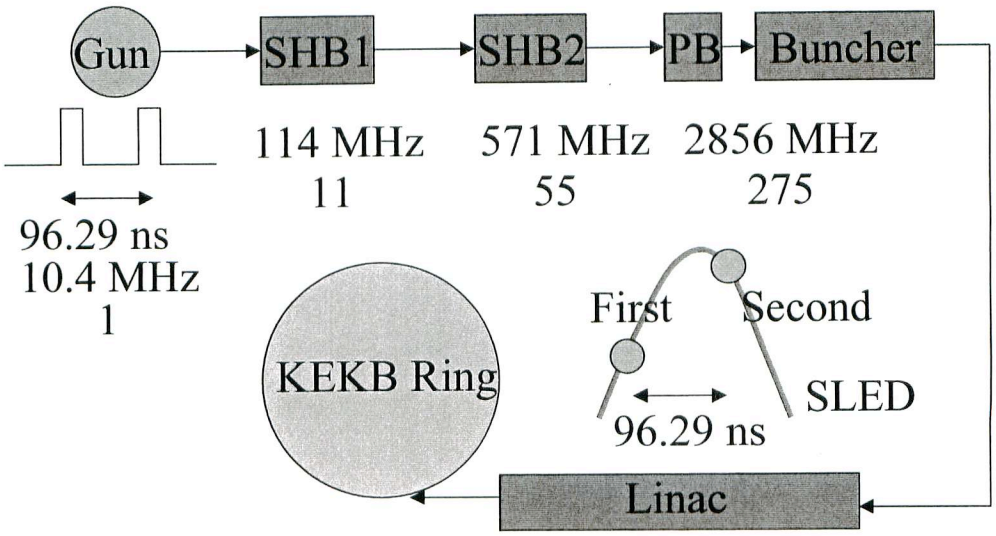
Various Frequency Relations

	Multiple	Frequency [MHz]	Period [ns]
Common Frequency	1	10.385454	96.289
SHB1	11	114.240	8.754
SHB2	5×11	571.200	1.751
Linac	5×5×11	2856.000	0.350
Ring	7×7	508.887	1.965

Two Bunch Generation



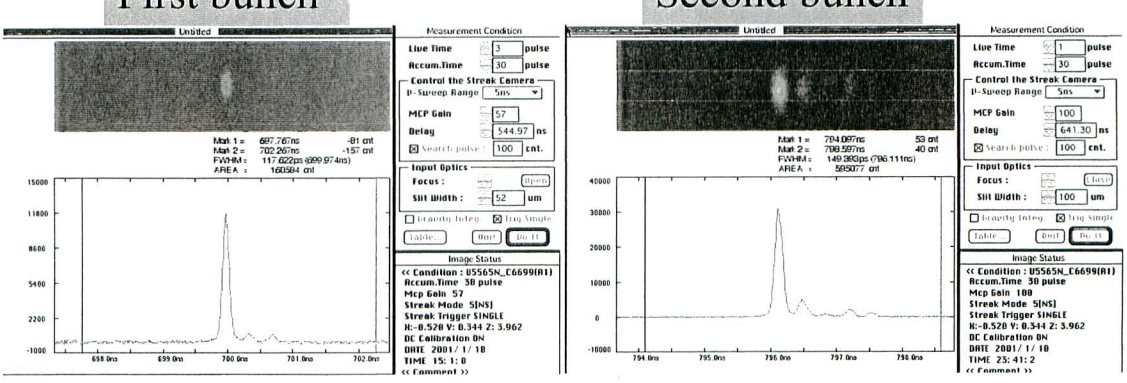
Two Bunch Acceleration



Bunch Profiles [OTR / streak camera]

First bunch

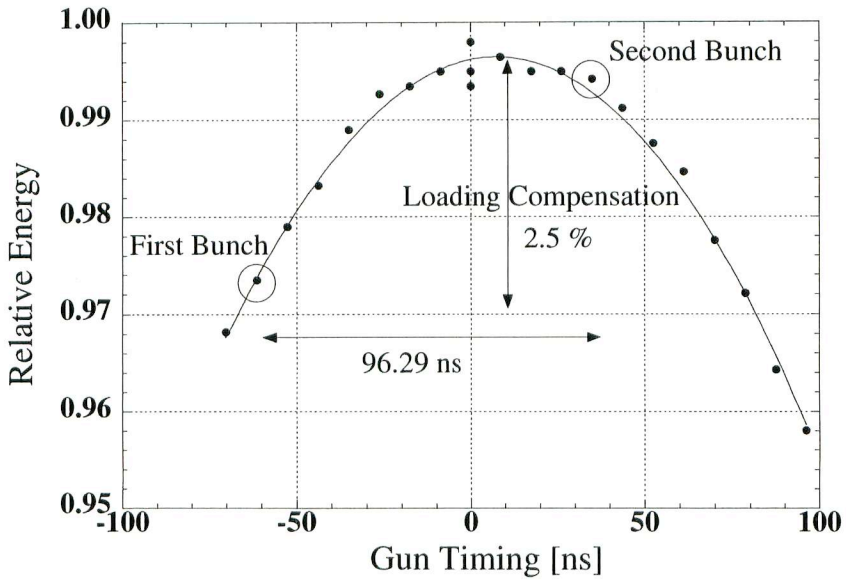
Second bunch



96.29 ns

Tuning of the bunching section was not optimized.

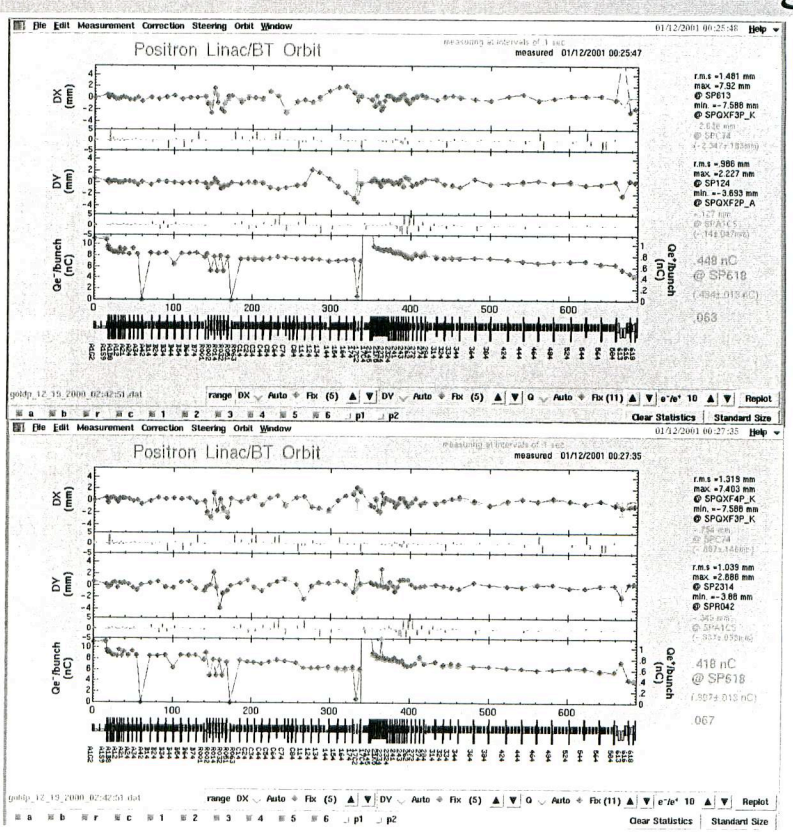
Data for Energy Compensation by SLED Timing



Two-Bunch Acceleration: Beam Orbit and Charge

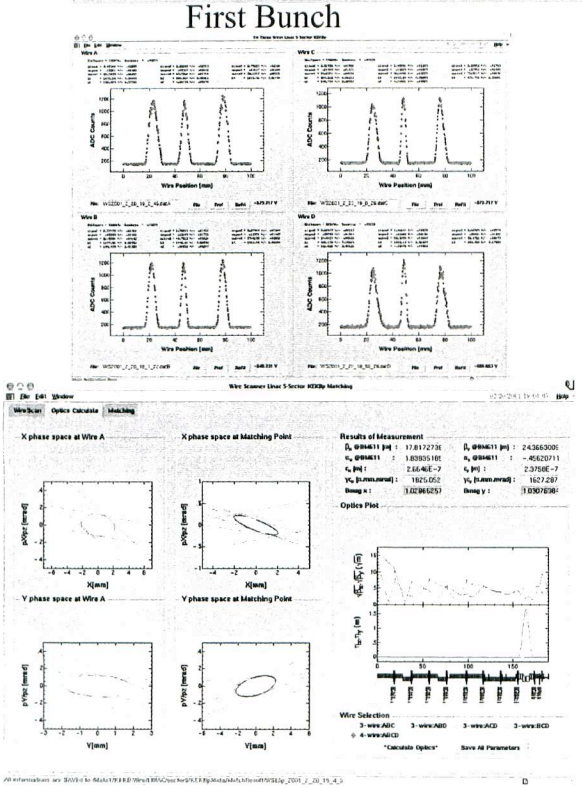
First Bunch
0.45 nC
@Linac End

Second Bunch
0.42 nC
@Linac End

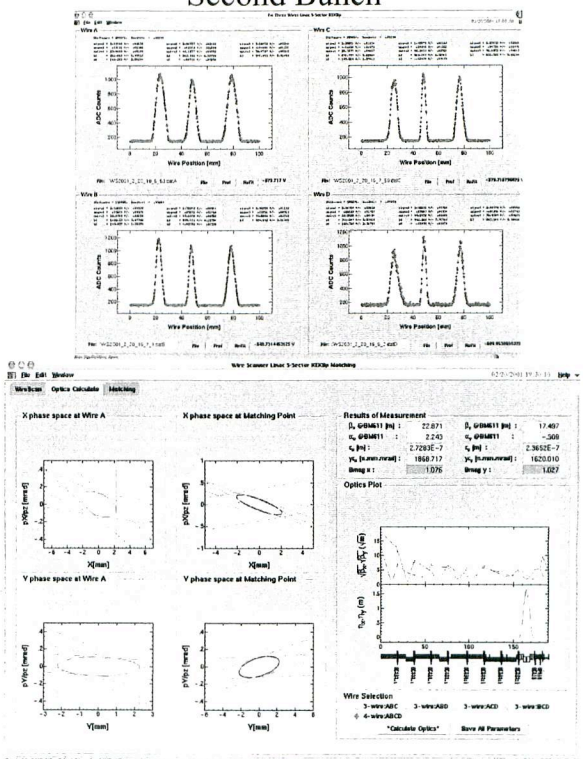


Wire-Scanner Observation of Twiss Parameters for Two Bunches at the End of Linac

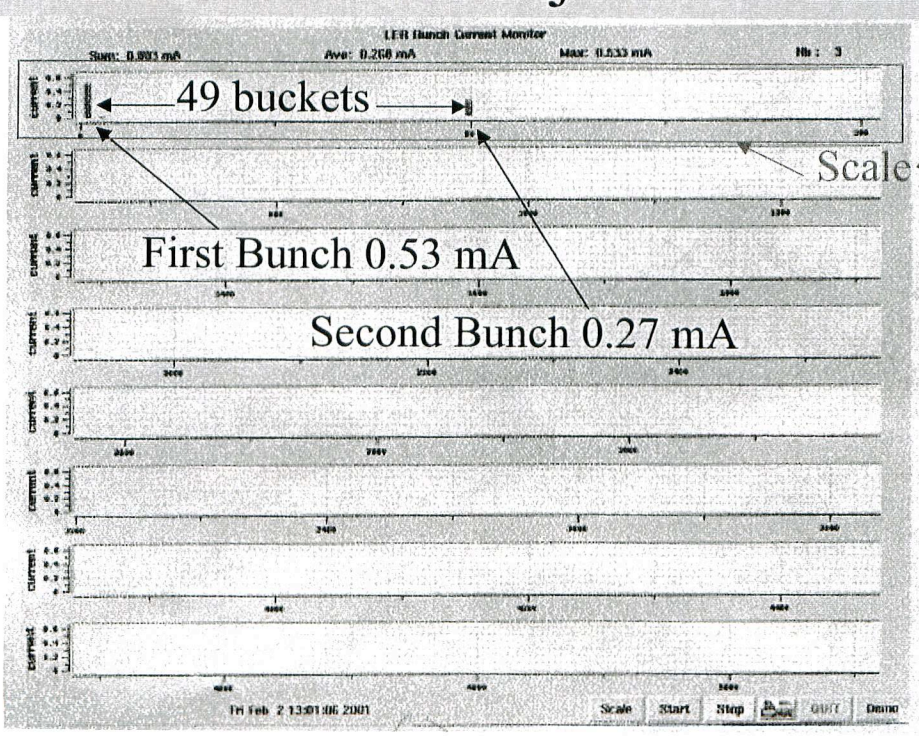
First Bunch



Second Bunch



First Two-Bunch Injection Test



Bunch Current Monitor

Main Issues for Two-Bunch Acceleration

- Fine tuning at bunching section
- Two-bunch orbit correction
- Beam diagnosis for two bunches
  ex. wire scanner / bpm (Linac / BT)
- Feedback (energy and orbit)
- Injection (bunch selection system)

==>> Two-Bunch Operation in FY2001

Summary

- Linac stable operation established by
  (1) Frequent beam diagnosis and check
  (2) Several-times/month check of
  machine and instrumentation
- First results for two-bunch acceleration test
  Rough tuning at linac / BT completed
  Successful first injection test
  --->> Fine tuning has started.