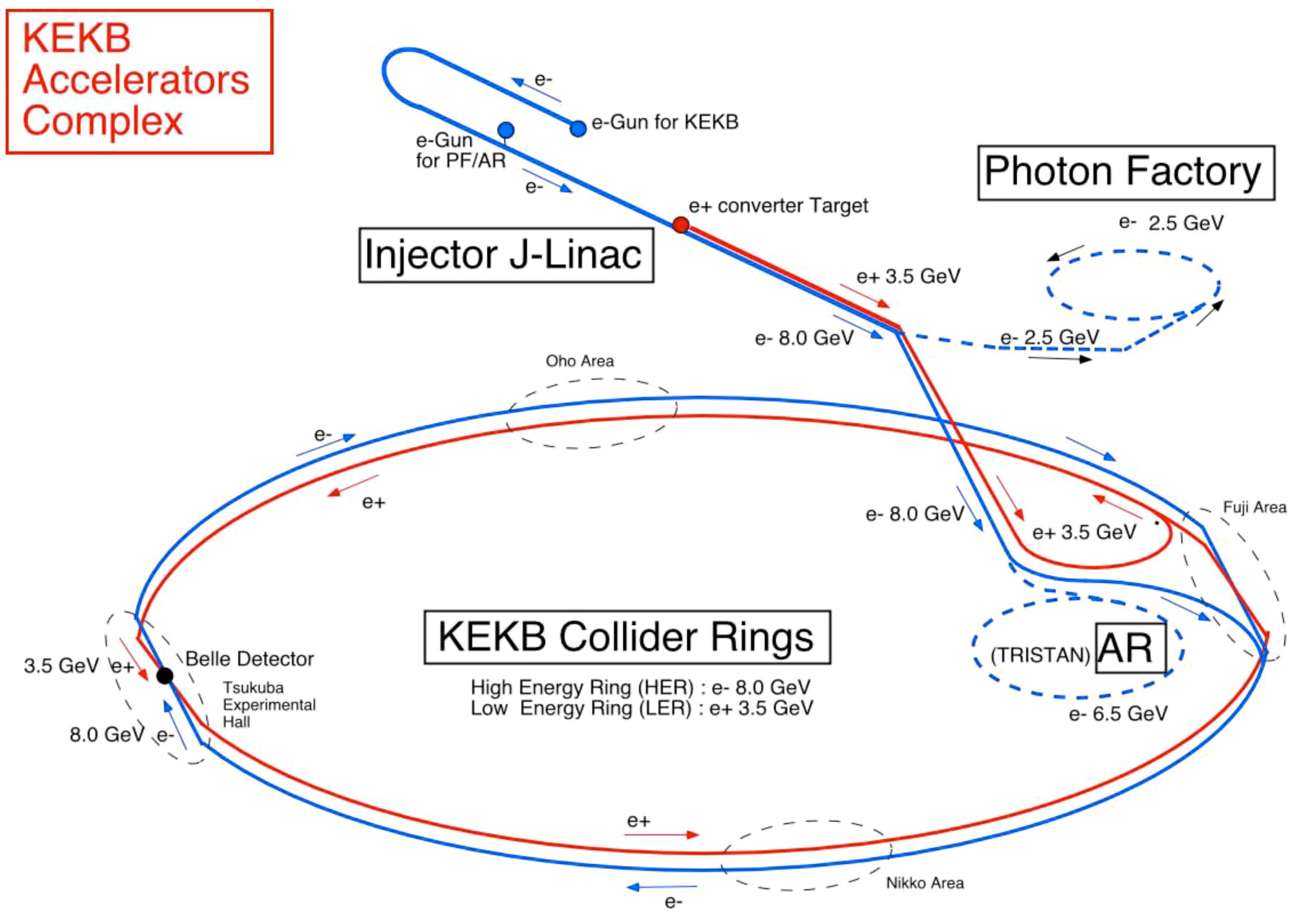
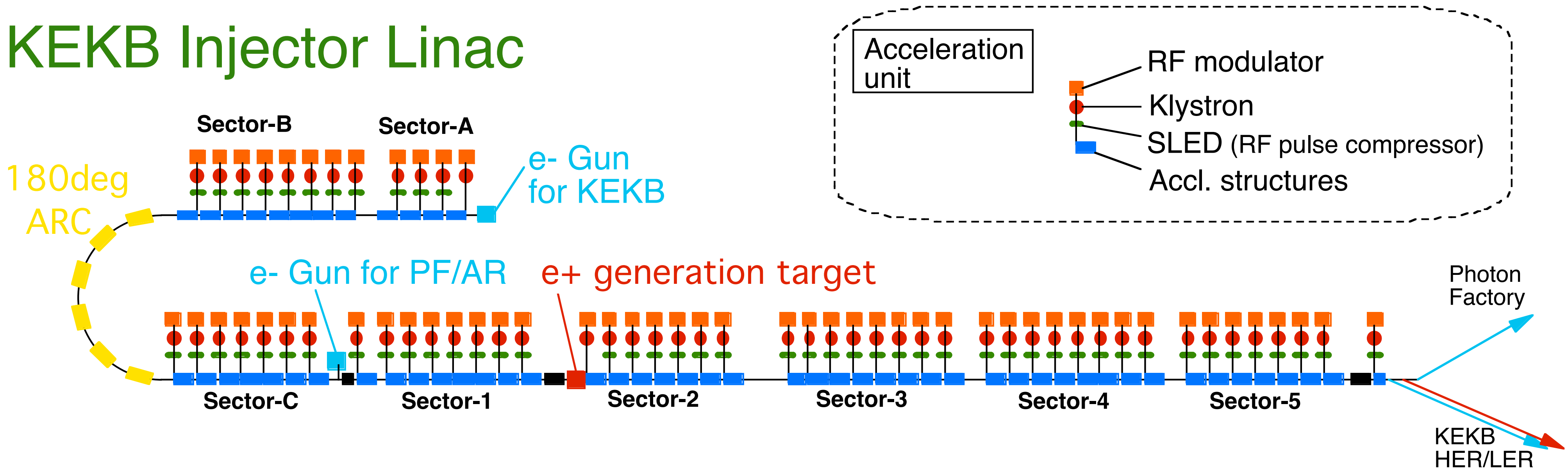
KEKB Injector

Linac Status


KEKB
Accelerators
Complex
e-
e-Gun for KEKB
e-Gun
for PF/AR
e-
e+ converter Target
Injector J-Linac
Photon Factory
e- 2.5 GeV
e+ 3.5 GeV
e- 8.0 GeV
e- 2.5 GeV
Oho Area
e-
e+
e- 8.0 GeV
e+ 3.5 GeV
Fuji Area
KEKB Collider Rings
High Energy Ring (HER) : e- 8.0 GeV
Low Energy Ring (LER) : e+ 3.5 GeV
(TRISTAN)
AR
e- 6.5 GeV
3.5 GeV
e+
Belle Detector
Tsukuba
Experimental
Hall
8.0 GeV
e-
e+
e-
Nikko Area

KEKB Injector Linac



Energy gain /unit

Acceleration field	21 MV/m
Accl. structure length	1.928 m
# of Accl. structures	4 /unit

→ 160 MeV/unit

Total Energy gain potentiality

e- to HER: (160 MeV/unit) × (55 accl. units) = 8800 MeV

e+ to LER: (160 MeV/unit) × (29 accl. units) = 4640 MeV

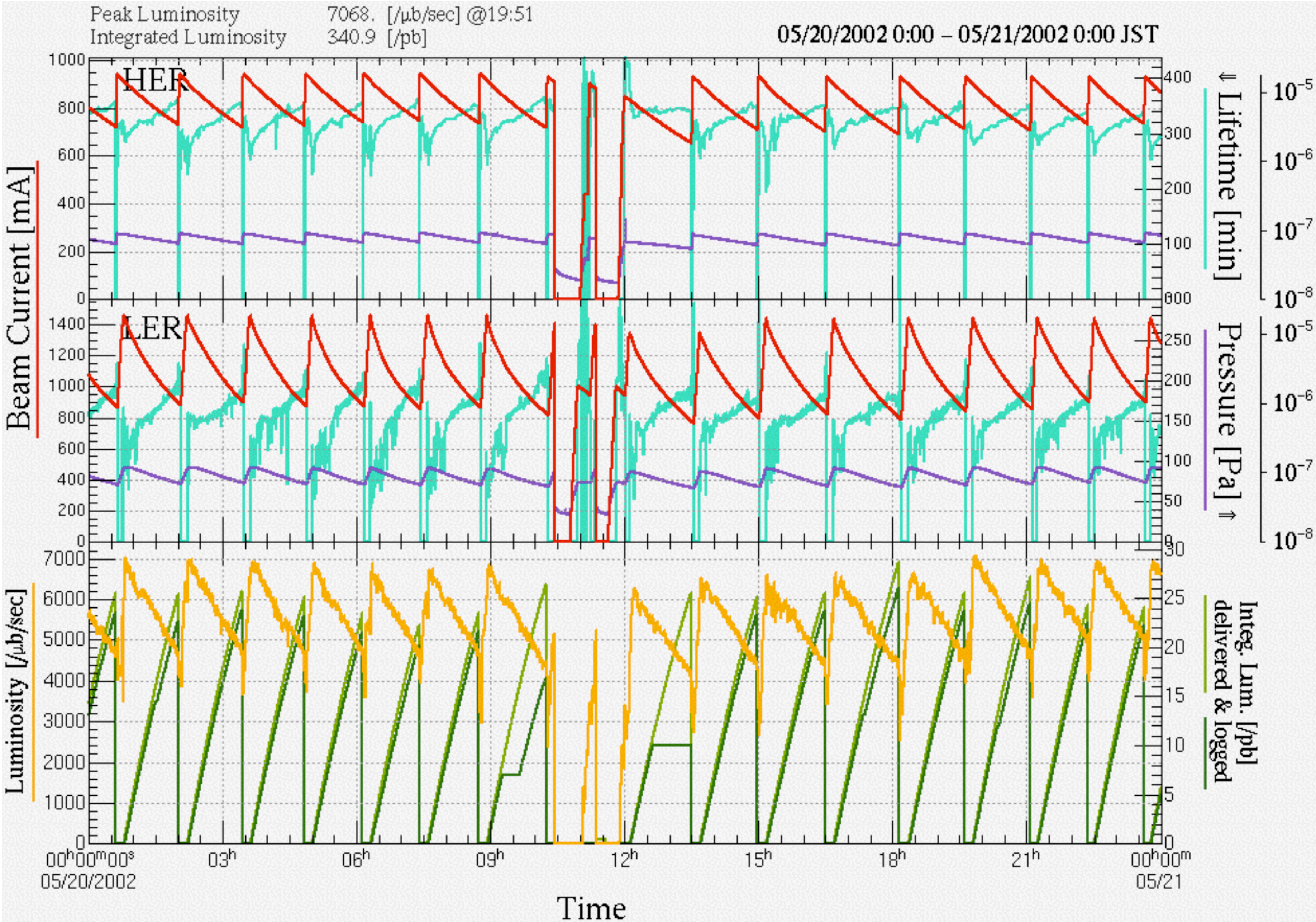
e- to Target: (160 MeV/unit) × (26 accl. units) = 4160 MeV

(1.1) Injector Linac Performance

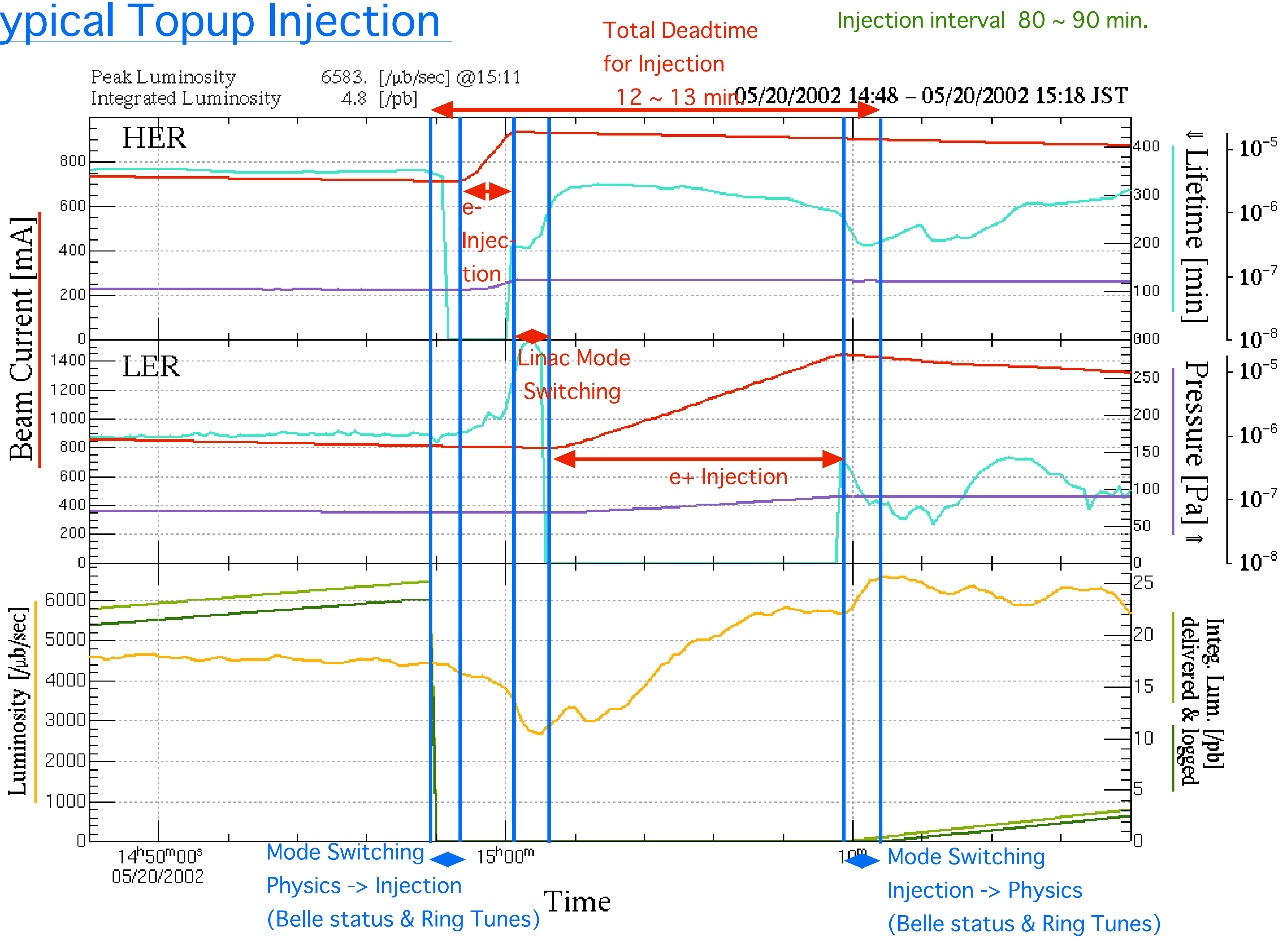
	Electron (e-)	Positron (e+)
Beam Energy	8.0 GeV	3.5 GeV
Charge	1.0 nC/pulse	0.6 (1.2) nC/pulse
Emittance	0.8×10^{-3} m	2.5×10^{-3} m
Energy spread (full width)	0.2 %	0.5 %
Injection rate	3.0 mA/sec	1.5 (3.0) mA/sec

(for double-bunch inj.)

Typical Daily Run Status



Typical Topup Injection



(1.2) Double-Bunch Injection

Most of the injection time is spent for positrons !

-> Increase positron intensity !

How ?

(1) Increase primary electron charge ?

-> present 10 nC/bunch is already limited by Wake effect

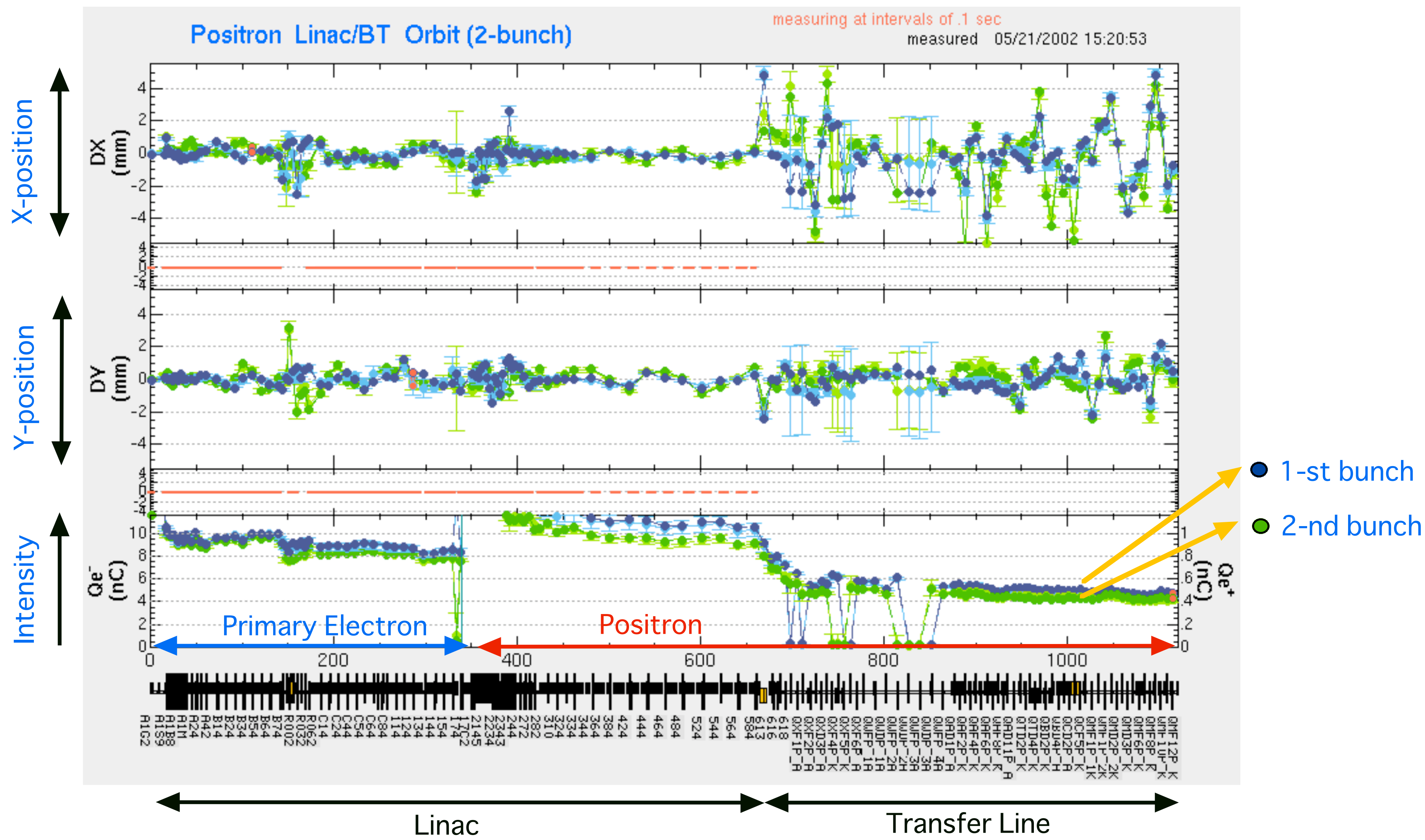
(2) Increase positron collection efficiency

-> expensive !

(3) Increase number of the bunches ?

-> Constraint from frequencies of Linac and Ring,
Maximum Two Bunches but possible

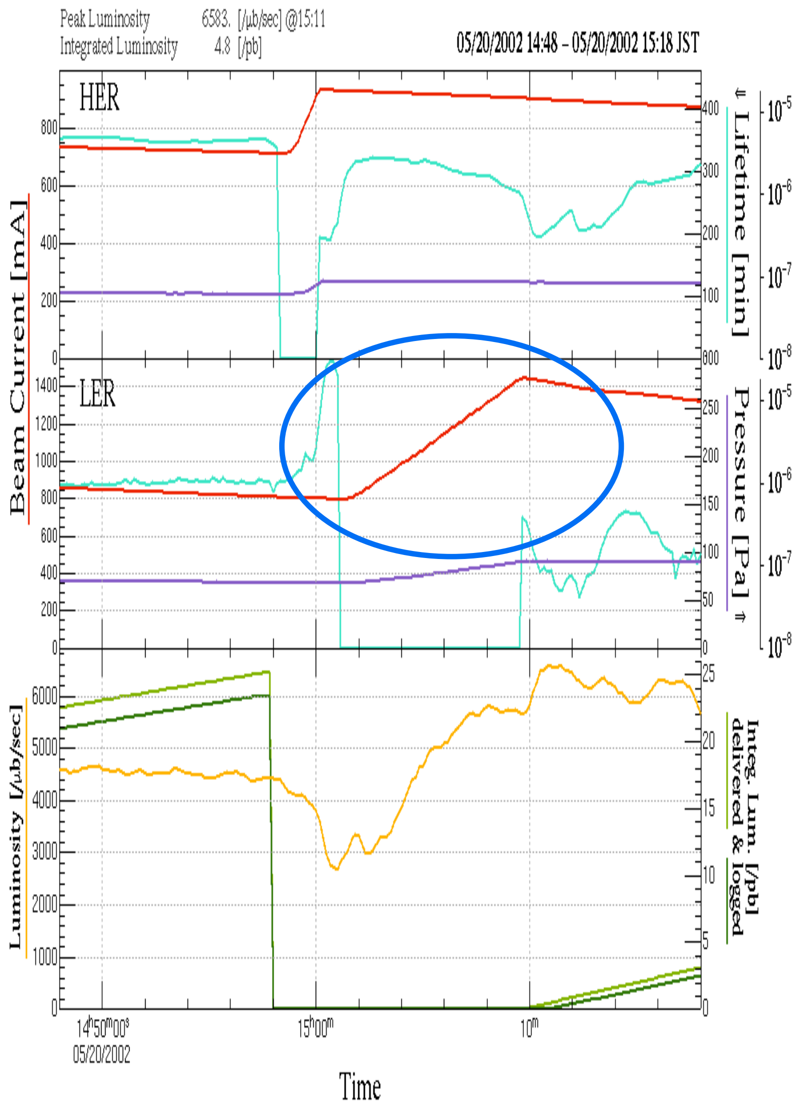
Double Bunch Injection



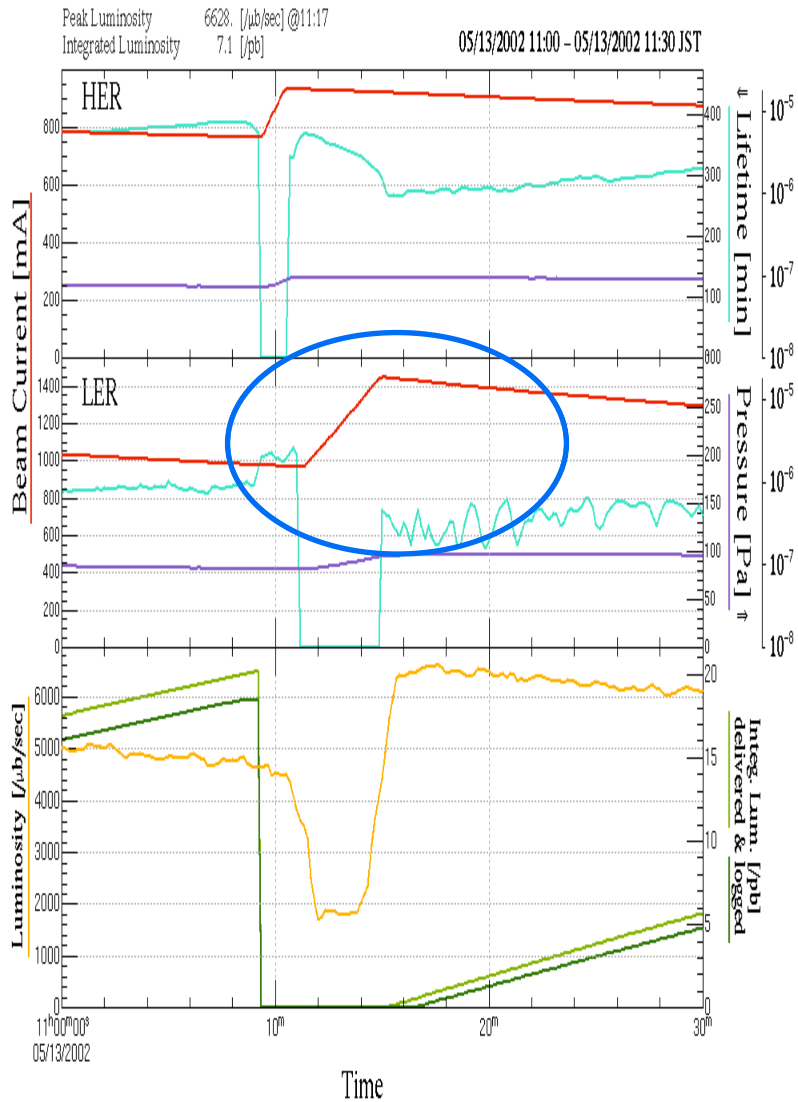
Positron Intensity is doubled !

Double Bunch Injection

Single-Bunch Injection Mode



Double-Bunch Injection Mode



Injection Rate is doubled ! -> Shorter Injection Time

(1.3) Continuous Injection

Degradation of Luminosity by gradual beam loss

(Lifetime : (e-) ~ 300 min, (e+) ~ 150 min)

-> Keep Peak luminosity !

How ?

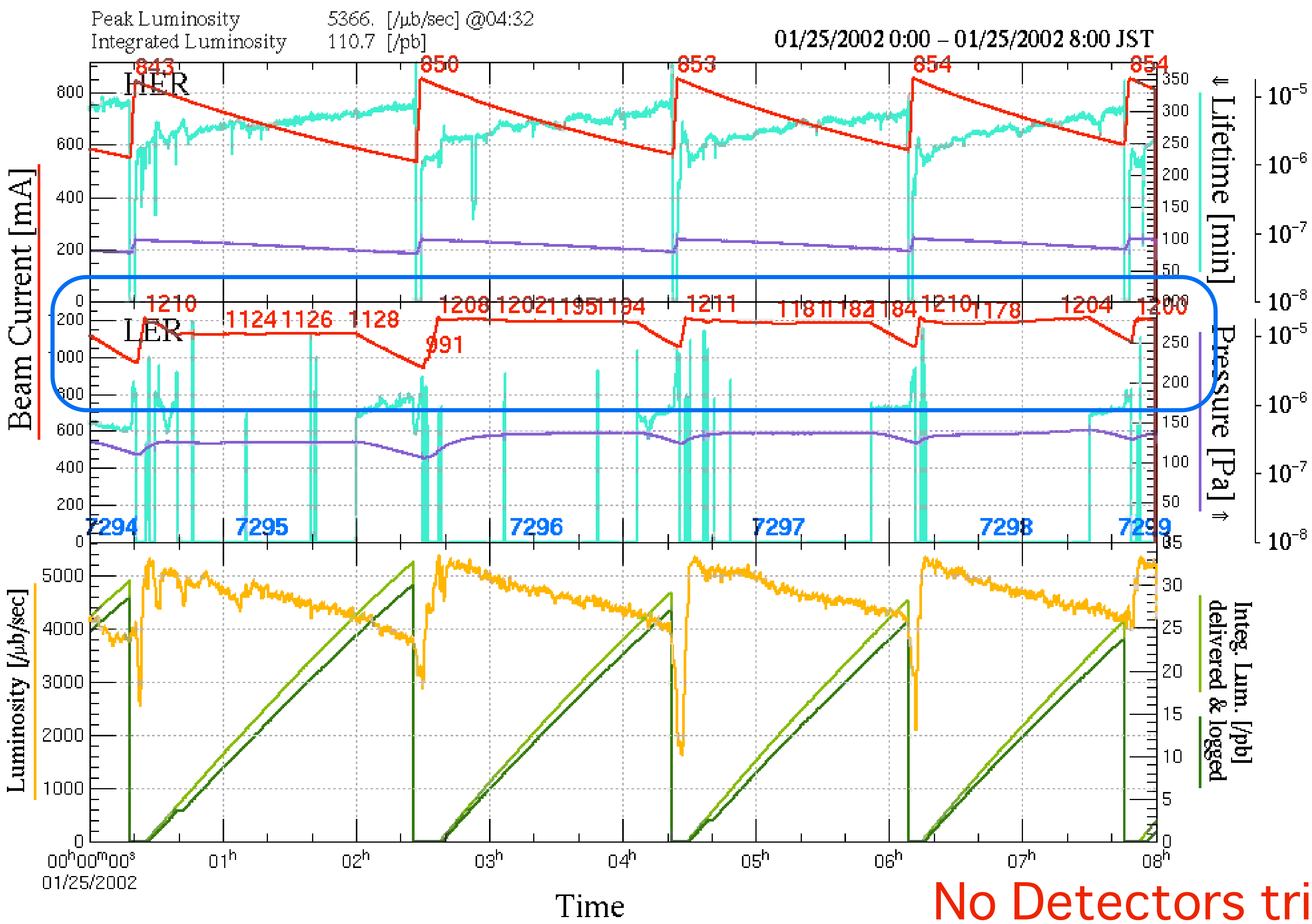
Continuous beam injection while keeping the detectors turned on

-> detectors trip-off by beam background ???

-> anyway, check the detectors tolerance

to injection backgound !

Continuous Injection Study



No Detectors trip-off !

Positron current kept constant By Continuous Injection !

Injector Upgrade for SuperKEKB

(10^{35} Luminosity machine)

Not Yet an established Project,
Still in a feasibility Study Stage

Upgrade requirements to Injector

	KEKB		SuperKEKB
Beam Energy (e-)	8.0 GeV	----->	3.5 GeV
(e+)	3.5 GeV	----->	8.0 GeV !!

NEED Energy upgrade for e+ !

	May 2002		KEKB design		SuperKEKB
Stored current (e-)	0.9 A	--->	1.1 A	--->	9.4 A !!
(e+)	1.4 A	--->	2.6 A	--->	4.1 A !!

NEED Intensity upgrade for e-/e+ !

(2.1) Intensity Upgrade

e- Intensity increase

3.0 mA/sec --> 15.0 mA/sec

(1 nC/pulse) (5 nC/pulse)

already 10 nC e- beam is used as primary

* Beam quality issue due to Wake field

e+ Intensity increase

1.5 mA/sec --> 3.0 mA/sec

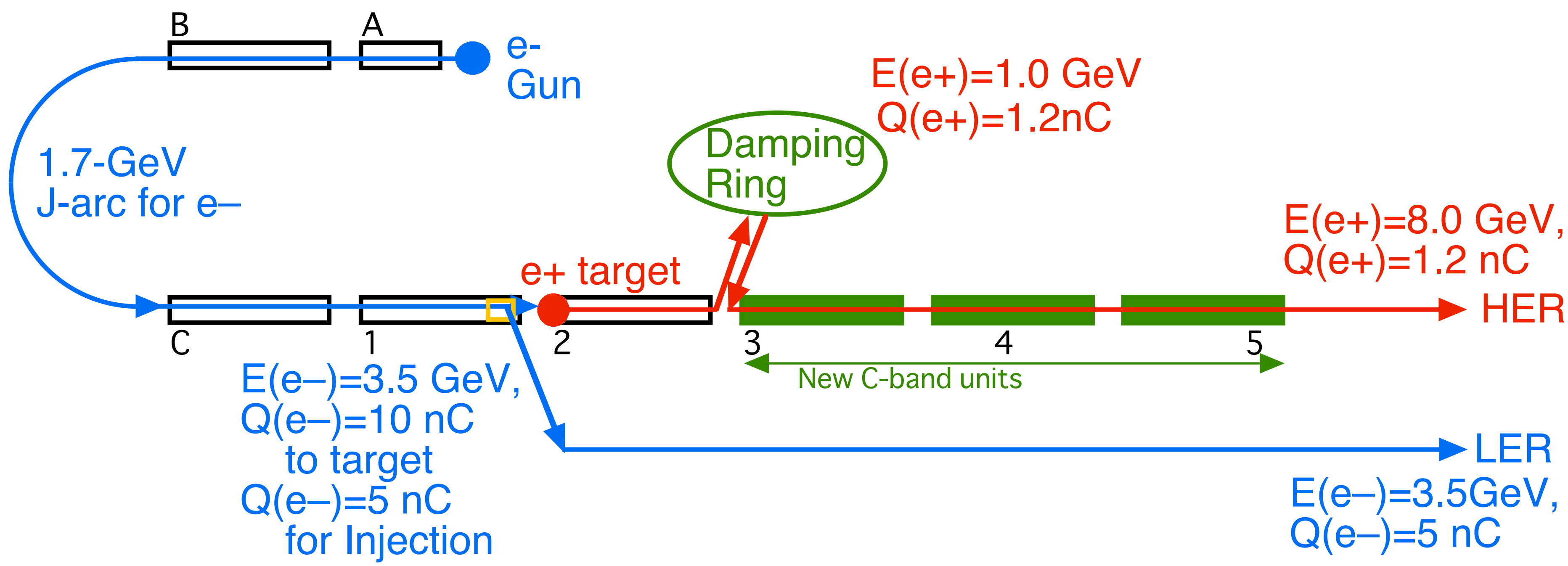
(0.6 nC/pulse) (1.2 nC/pulse)

e+ capture section upgrade

With stronger focusing solenoid (flux concentrator?)

(2.2) High Gradient Scheme

To raise e+ Beam energy ; 3.5 -> 8.0 GeV, Acceleration Field gradient will be doubled by using C-band (5712 MHz) components.



24 accl. units are Replaced to C-band (Eacc = 21 -> 42 MV/m)
(Egain = 160 -> 320 MeV/unit)
(max. e+ total Egain = 4640 -> 8640 MeV)

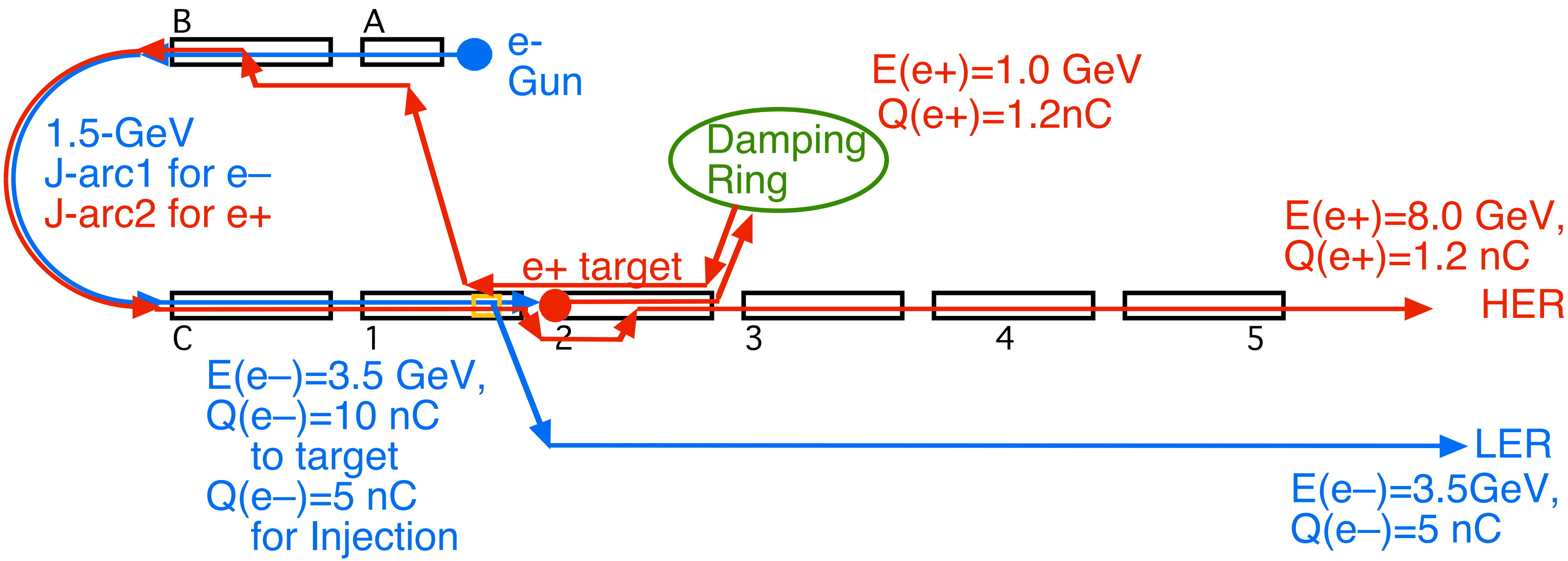
e+ Damping Ring for smaller emittance and beam size
to fit for smaller aperture in C-band accl. structures

C-band Components

* Klystron
  -> Toshiba 50 MW klystron available
* Pulse Modulator
  -> Compact Modulator
* RF-pulse compressor
  -> TE038 cavity (LIPS-type)
* Accelerating structure
  -> 2□/3-mode travelling-wave type

(2.3) Re-circulation Scheme

To accelerate e+ to 8.0 GeV,
They are re-circulated to upstream and are accelerated in the linac twice.



No significant Upgrade in RF sources & acclerating structures

e+ Damping Ring for synchronization to next RF pulse

e+ beam return line, 2nd J-arc for e+, target-bypass beam line

--> Multi-Beam acceleration in same RF pulse

(primary e- and e+) (high E e+ and low E e+)

For the simultaneous acceleration of
e- and e+ beam and
low Energy e+ and high Energy e+ beams
complicated transport line is
necessary.