KEKB Injector

Linac Status
Sector-A

KEKB Injector Linac

- Gun

for KEKB

e+ generation target

e- Gun for PF/AR

180deg

ARC

Sector-B

Sector-1

Sector-2

Sector-3

Sector-4

Sector-5

Accel. structures

RF modulator

SLED (RF pulse compressor)

Klystron

Total Energy gain potentiality

160 MeV/unit

# of Accel. structures: 4

Accel. structure length: 1.928 m

Acceleration field: 21 MV/m

Energy gain / unit

KEKB Injector Linac
(for double-bunch ini.)

<table>
<thead>
<tr>
<th>Injection Rate</th>
<th>Injection Rate</th>
<th>Energy Spread (full width)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 (3.0) mA/sec</td>
<td>3.0 mA/sec</td>
<td>0.5 %</td>
</tr>
<tr>
<td>2.5 x 10^-3 m</td>
<td>0.8 x 10^-3 m</td>
<td>0.2 %</td>
</tr>
<tr>
<td>0.6 (1.2) nC/pulse</td>
<td>1.0 nC/pulse</td>
<td></td>
</tr>
<tr>
<td>3.5 GeV</td>
<td>8.0 GeV</td>
<td></td>
</tr>
</tbody>
</table>

Charge

Beam Energy

Electron (e-)

Position (e+)
Maximum \( \leq 2 \) Bunches but possible

\( \Rightarrow \) Constraint from Frequencies of Linac and Ring,

\( \Rightarrow \) Increase number of the bunches?

\( \Rightarrow \) Expensive?

\( \Rightarrow \) Increase position collection efficiency?

\( \Rightarrow \) Present 10 nC/bunch is already limited by Wake effect

\( \Rightarrow \) Increase primary electron charge?

\( \Rightarrow \) How?

Most of the injection time is spent for positions?

\( \Rightarrow \) Increase position intensity?

**Double-Bunch Injection** (1.2)
Position Intensity is doubled! Double Bunch Injection
Injection Rate is doubled \(\rightarrow\) Shorter Injection Time

Double-Bunch Injection Mode

Single-Bunch Injection Mode
to injection background

anyway, check the detectors tolerance

< detector trip-off by beam background ??
Continuous beam injection while keeping the detectors turned on

How ?

< Keep Peak luminosity ?

(lifetime : (e-) ~ 300 min, (e+) ~ 150 min)
Degradation of Luminosity by gradual beam loss

(1.3) Continuous Injection
Position current kept constant by Continuous Injection!

No Detectors trip-off!

Continuous Injection Study
injector upgrade

for SuperKEKB

$10^{35}$ luminosity machine

Not yet an established project, still in a feasibility study stage.
**Upgrade requirements to Injector**

**SuperKEKB**

<table>
<thead>
<tr>
<th>Energy (GeV)</th>
<th>Beam Energy (e-)</th>
<th>Beam Energy (e+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>8.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>Stored Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>1.1</td>
</tr>
</tbody>
</table>

**KEKB**

<table>
<thead>
<tr>
<th>Energy (GeV)</th>
<th>Beam Energy (e-)</th>
<th>Beam Energy (e+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>Stored Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6</td>
<td>4.1</td>
</tr>
</tbody>
</table>

**May 2002**

**KEKB design**

**SuperKEKB**

**KEKB**
(2.1) Intensity Upgrade

**e- Intensity increase**

3.0 mA/sec $\rightarrow$ 15.0 mA/sec  
(1 nC/pulse) $\rightarrow$ (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 $\rightarrow$ 3.0 mA/sec  
(0.6 nC/pulse) $\rightarrow$ (1.2 nC/pulse)  
e+ capture section upgrade  
With stronger focusing solenoid (flux concentrator?)
(2.2) High Gradient Scheme

By using C-band (5712 MHz) components, the acceleration field gradient will be doubled. To raise the beam energy, 3.5 - 8.0 GeV,
to fit for smaller aperture in C-band accl. structures

e+ Damping Ring for smaller emittance and beam size

(max. e+ total Egain = 4.640 - 320 MeV/μm)
(Egain = 1.60 - 320 MeV/μm)
(Egain = 21 - 42 MeV/m)

24 accl. units are replaced to C-band (Eacc = 21 - 42 MeV/m)

2.7 GeV

J-arc for e–

e– Gun

for Injection

Q(e–)=10 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=10 nC

E(e–)=3.5 GeV

E(e–)=3.5 GeV

E(e+)=8.0 GeV

E(e+)=1.2 nC

E(e+)=1.2 nC

E(e+) = 1.0 GeV

New C-band units

e– LER

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC

Q(e–)=5 nC
- $\frac{2}{3} / 3$-mode traveling-wave type

  * Accelerating structure

  $\Rightarrow$ TE038 cavity (LIPS-type)

  * RF-pulse compressor

  $\Rightarrow$ Compact Modulator

  * Pulse Modulator

  $\Rightarrow$ Toshiba 50 MW Klystron available

  * Klystron

  C-band Components
accelerated in the Linac twice.

They are re-circulated to up-stream and are
to accelerate $e^+$ to 8.0 GeV.

(2.3) Re-circulation Scheme
(primary e- and e+) (high E+ and low E+)

Multi-beam acceleration in same RF pulse

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

e+ damping ring for synchronization to next RF pulse

No significant upgrade in RF sources & accelerating structures
necessary.

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