Injector Linac Upgrade for SuperKEKB
overview

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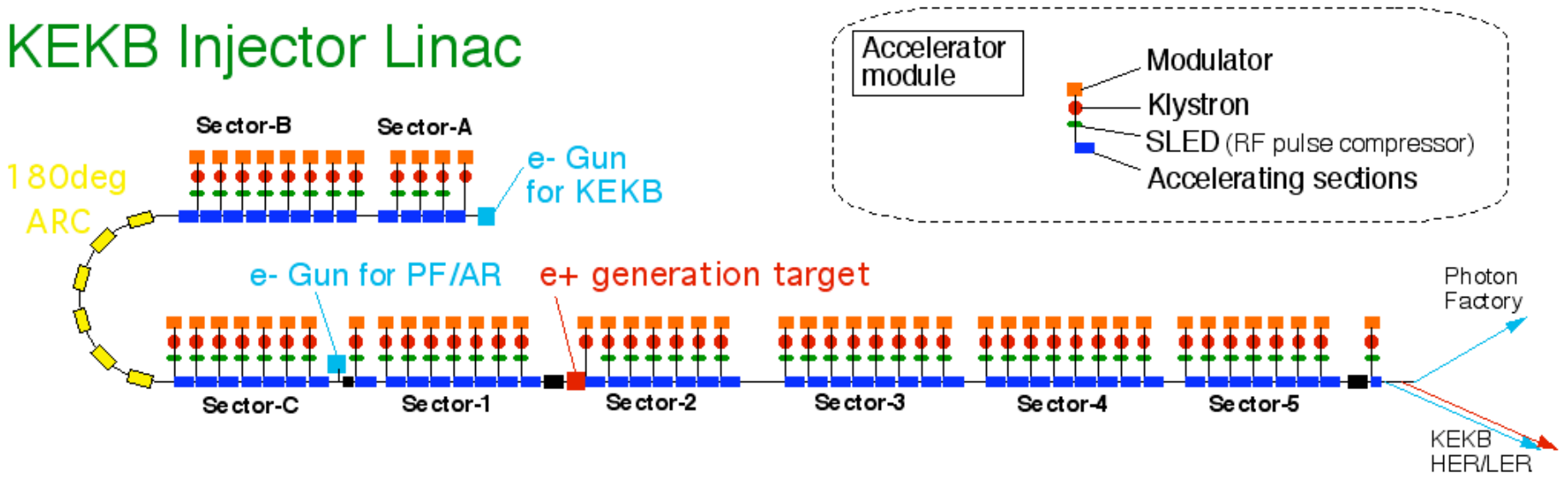
KEKB Injector



The layout is optimized for 8-GeV e-/3.5-GeV e+.

e- to HER : 8 GeV ~ (Primary e- : 4 GeV) + (e+ to LER : 3.5 GeV)

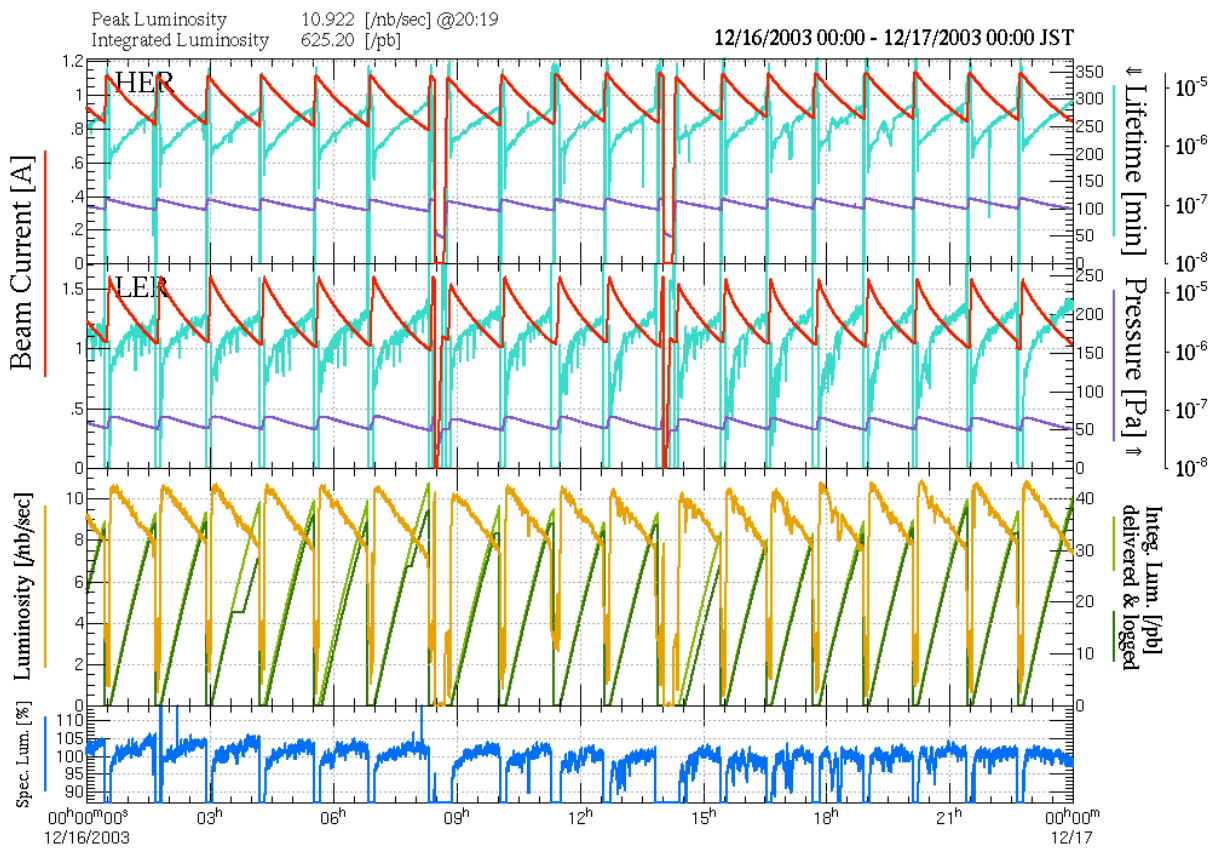
e-/e+ /(PF/AR) injection modes are switched by,

retracting/inserting the target from/to the beamline, switching the gun, changing the parameters (magnet strengths, acceleration phases etc).

The switching takes 45 ~ 120 sec.

Typical operation status (1)

(Periodic Injection Mode)



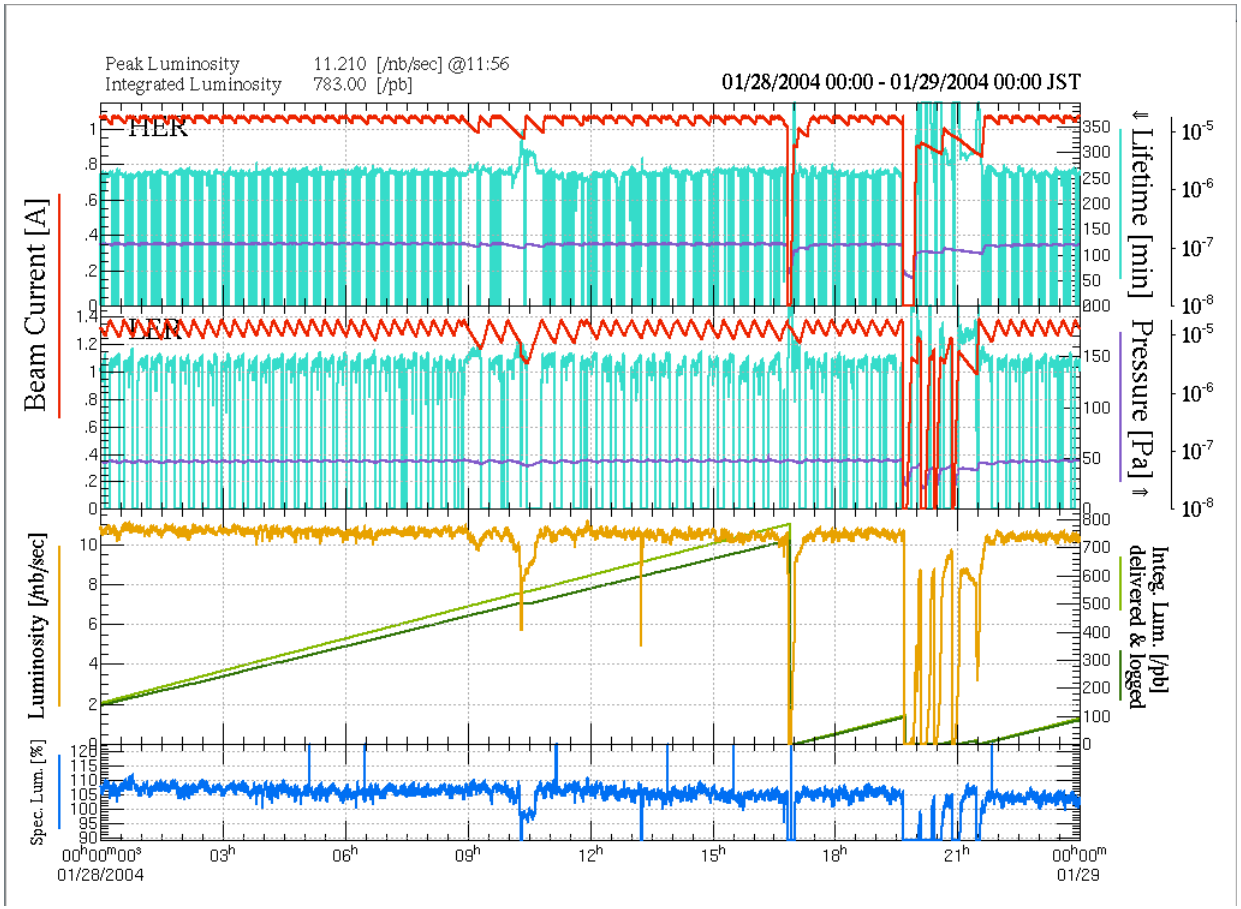
- 18~20 injections/day
  - 8 min. for routine refill
  - 23 min. after beam abort
- Injection rate
  - 5 mA/s for e^- 50 Hz (1 nC x 1 bunch)
  - 3 mA/s for e^+ 50 Hz (0.6 nC x 2 bunches)
- Belle DAQ* stops during injection
- Lumi. effic.** ~ 66 %

(*) DAQ = data acquisition

(**) Luminosity efficiency = integrated lumi./(peak lumi. x operation time)

Typical operation status (2)

(Continuous Injection Mode)



- Injecting always
  - e^+ every 20 min.
    (target bellows)
  - e^- quasi-continuous
- Injection rate
  - 1.0 mA/s for e– 10 Hz
  - 0.5 mA/s for e+ 10 Hz
- Belle DAQ continues
  with short dead time 3.7 ms
  after each beam pulse
  (The less beam rep. rate,
  the smaller dead time.)
- Lumi effic. ~ 81 %
  (~ 84 % on Feb.15)

CIM improves the efficiency more than 15 %

Upgrade Requirements

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

-> C-band accelerator modules

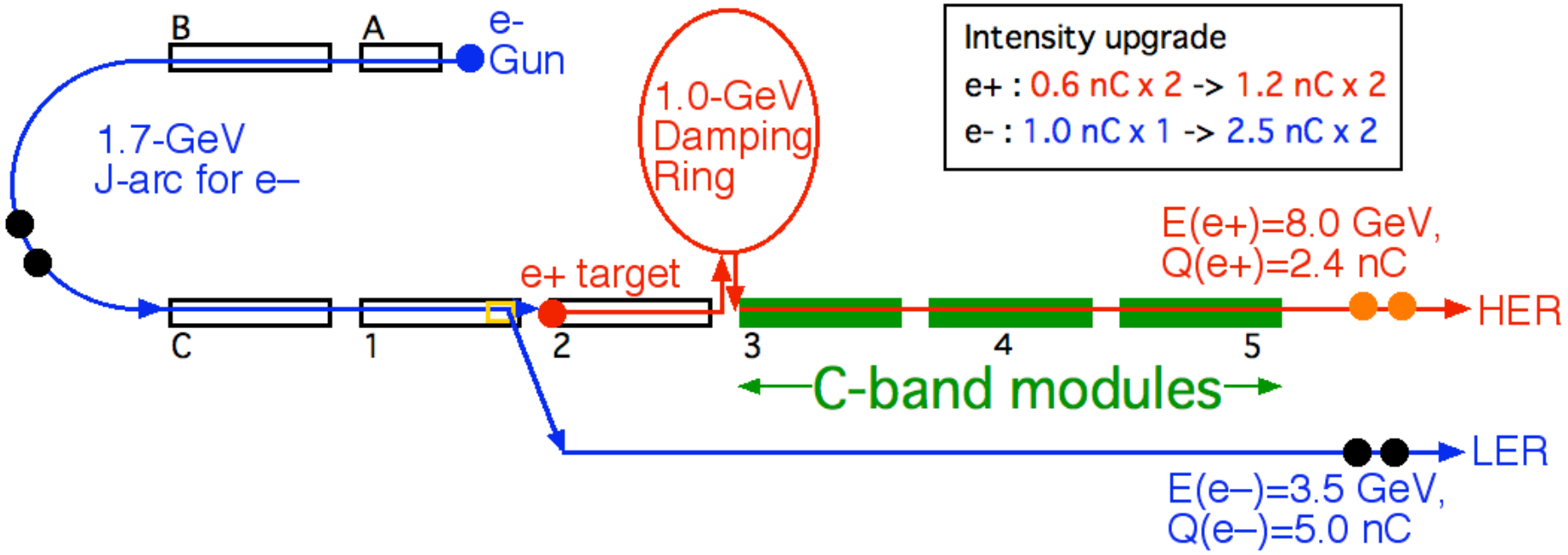
(2)	KEKB		SuperKEKB
Stored current (e^-)	1.1 A	----->	9.4 A !!
(e^+)	1.5 A --> 2.6 A	--->	4.1 A !

-> e^-: increase beam charge
-> e^+: flux concentrator (e^+ capture effic.)

(3) Smaller e^+ emittance to fit for IR & C-band module apertures
-> e^+ damping ring

(4) Faster e^+/e^- mode-switching for Continunous e^+/e^- Injection
-> separated e^+/e^- beam lines
-> non-destructive beam monitoring

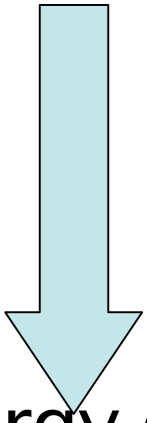
Upgrade Scheme



- e^+ energy is boosted by the C-band accelerator modules.
- e^+/e^- injections are switched by the kicker before the target, e^+ and e^- go through independent beam lines.
- e^+ emittance is reduced with the damping ring.
- both the 2 bunches are used for e^+ or e^-. (Not for e^+ and e^-)

Energy Upgrade

- e^+ energy gain at KEKB
  - max 4.8 GeV = 21 MV/m (S-band module) x 231 m



e+ energy is boosted by
C-band accelerator modules.

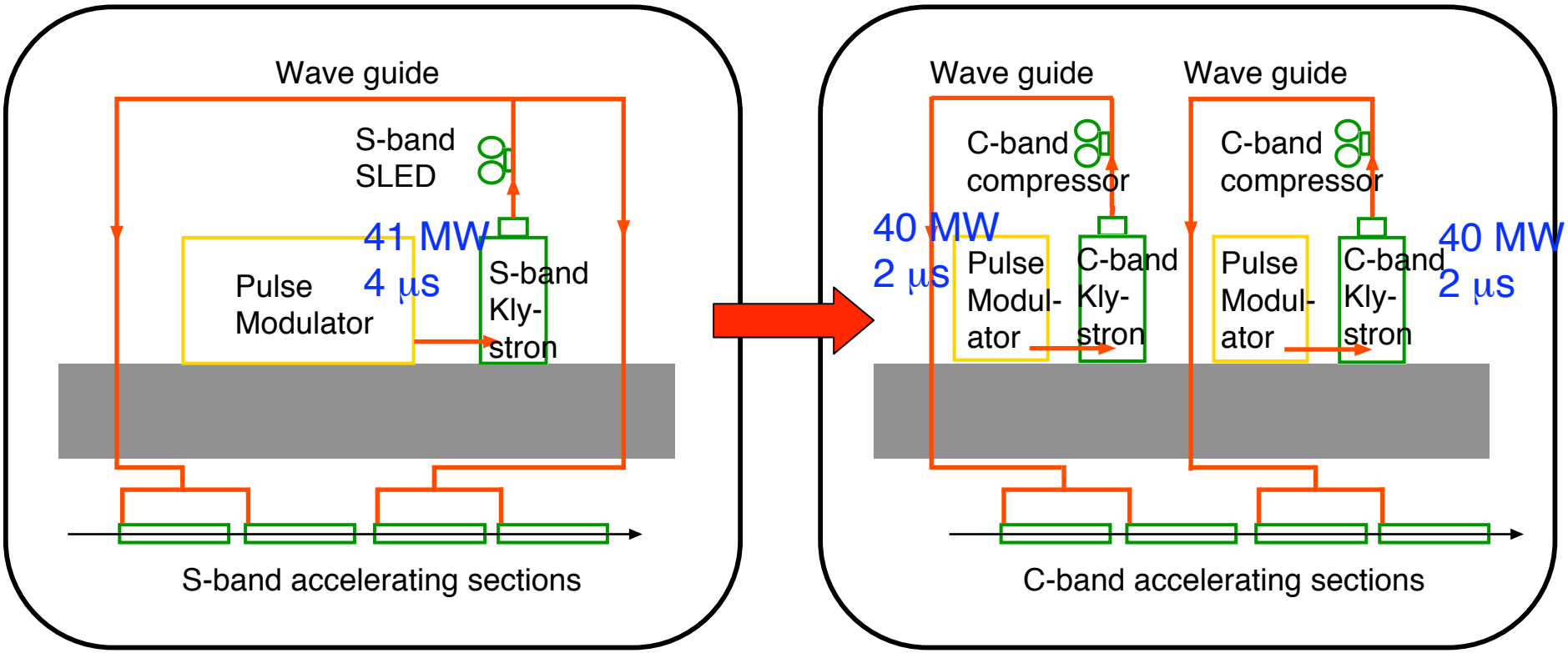
- e^+ energy gain at SuperKEKB
  - 8.0 GeV ~ 21 MV/m (S-band modules) x 46 m
    + 42 MV/m (C-band modules) x 185 m

Linac Accelerator module

(From S-band To C-band)

Present S-band accelerator module

New C-band accelerator module

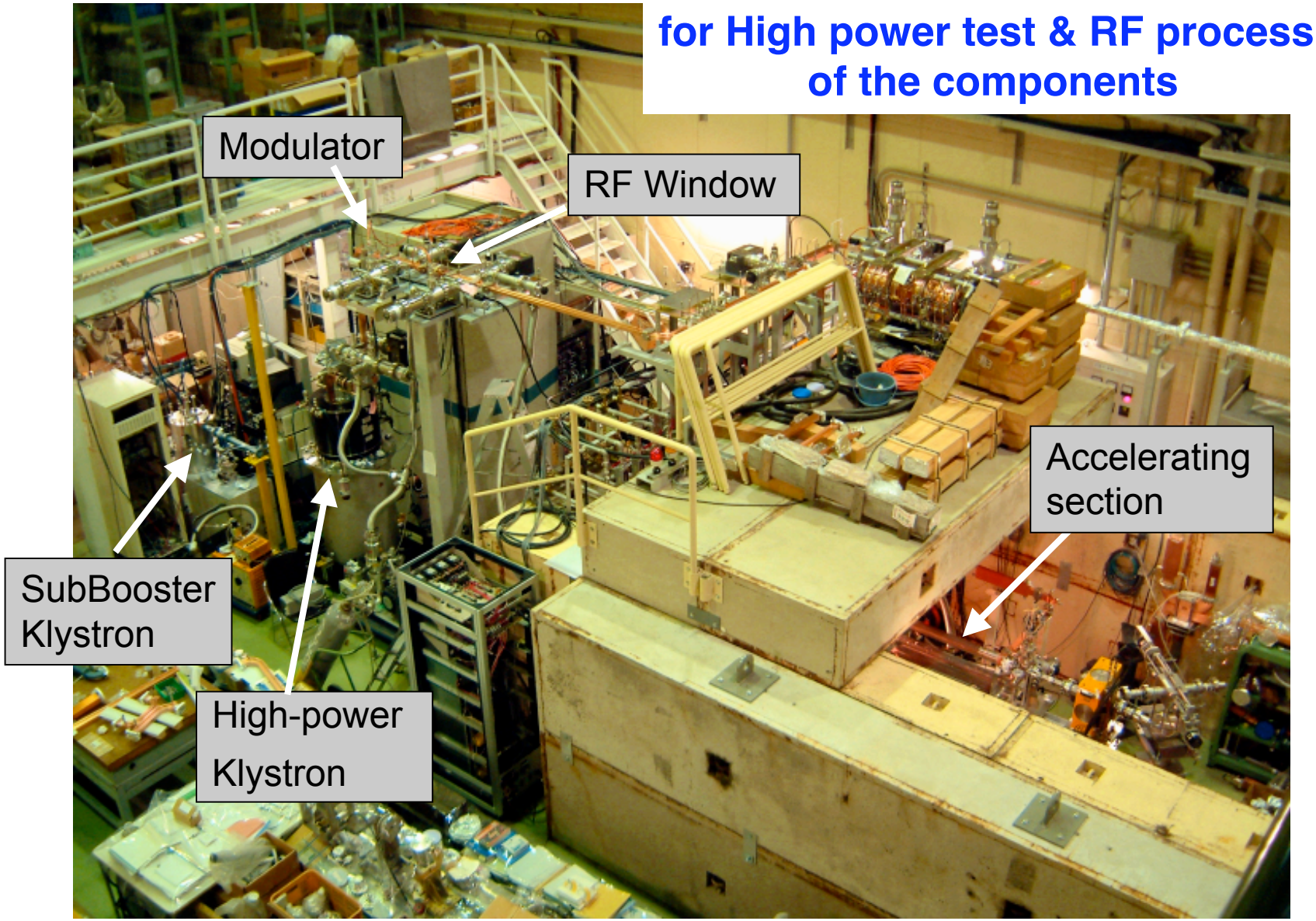


Accel. field gradient = 21 MV/m

Accel. field gradient = 42 MV/m

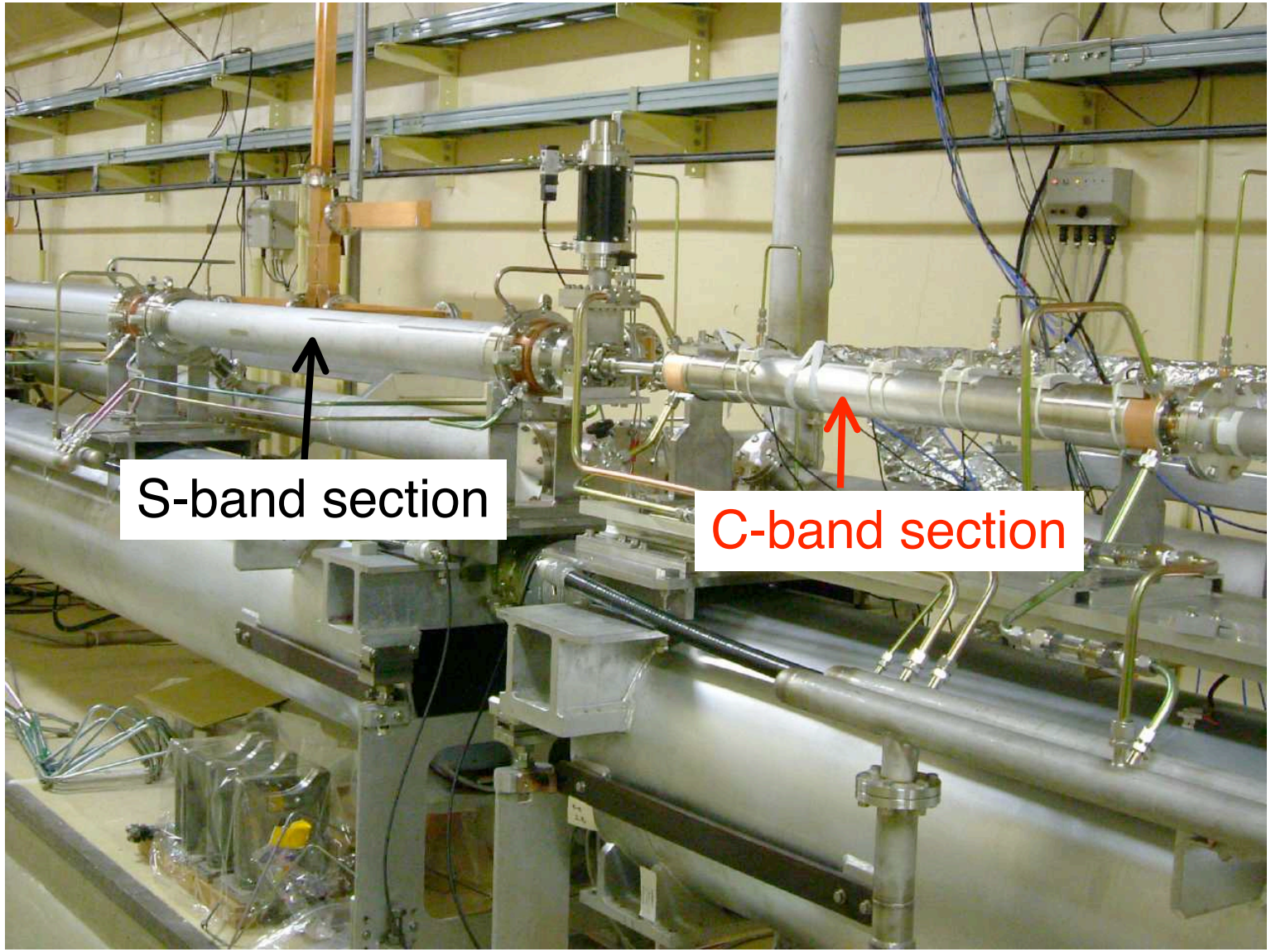
C-band Test Stand

for High power test & RF processing of the components



C-band rf source installed in KEKB linac (2003 September)

C-band accel. section installed in KEKB linac (2003 September)



C-band R & D items

- Klystron -> Toshiba E3746, High Power Test OK
- Modulator -> compact (1/3 size), OK except inverter P.S. trouble
- Low power RF -> sub-booster OK, solid-state amp.?
- RF pulse compressor -> HPT in July 2004
- Accelerating section -> 1st prototype 41 MV/m,
  breakdown at input coupler
  2nd prototype HPT in July 2004
- Other RF components
  - RF window — HPT OK
  - Dummy load — HPT OK
  - 3-dB hybrid power divider — HPT OK
  - Wave guide flange — HPT OK
  - RF gate valve — under consideration

Intensity upgrade

Intensity upgrade is essential for higher luminosity efficiency, even for the continuous injection mode.

- e^+ : 0.6 nC x 2 bunches --> 1.2 nC x 2 bunches

  by replacing present 2.3 Tesla pulse coil
  with 7~10 Tesla flux concentrator
  in the e^+ capture section
  for doubling the capture efficiency

- e^- : 1.0 nC x 1 bunch --> 2.5 nC x 2 bunches

  by increasing the charge from the pre-injector
  and using two bunches
  With less bunch charge, e^- emittance and energy-spread are smaller.

Other R & D items

- e^+ focusing flux concentrator
- beam kicker & e^- transport line
- non-destructive beam profile monitor
- beam position monitor for 50 Hz readout
- fast e-gun grid pulser switching
- fast RF phase switching
- e^+ Damping ring

Summary

- C-band R & D is in progress. High power test of the prototype C-band accelerator module has been performed since October 2003. Most of the components are working well.

  (Remaining issues)
  Breakdown at input coupler, inverter P.S. troubles
  RF pulse compressor

- Beam instrumentation R & D is in progress. Non-destructive profile monitor and 50 Hz readout of position monitor are the main issues.
- Design study of the damping ring is in progress. Preliminary design is fixed.