



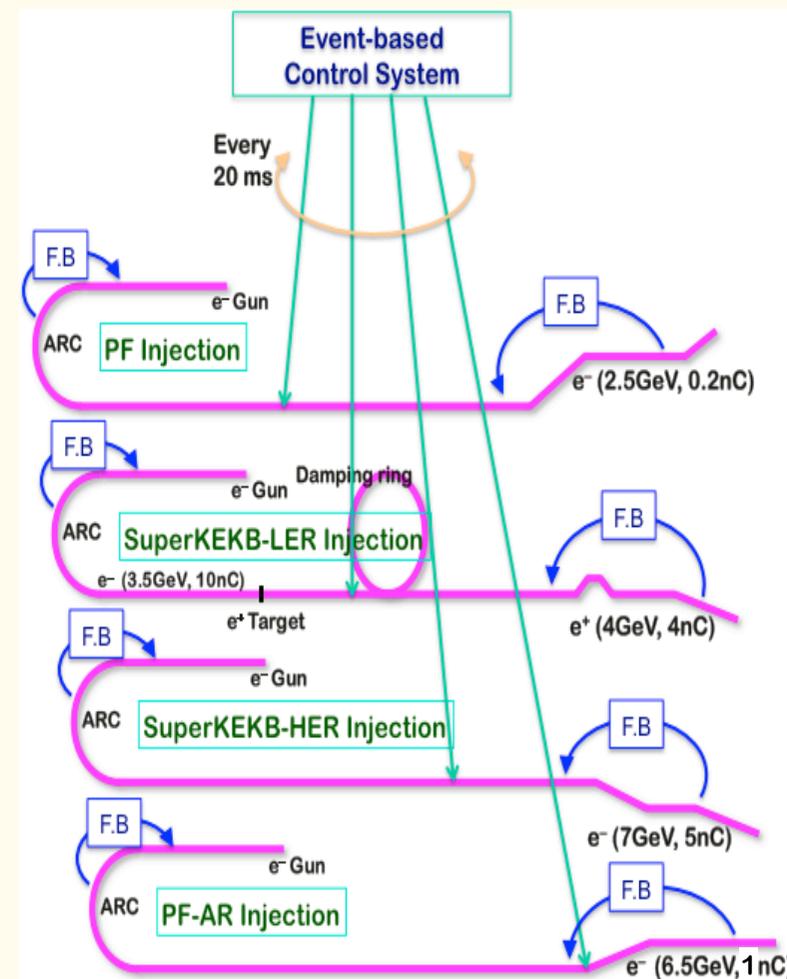
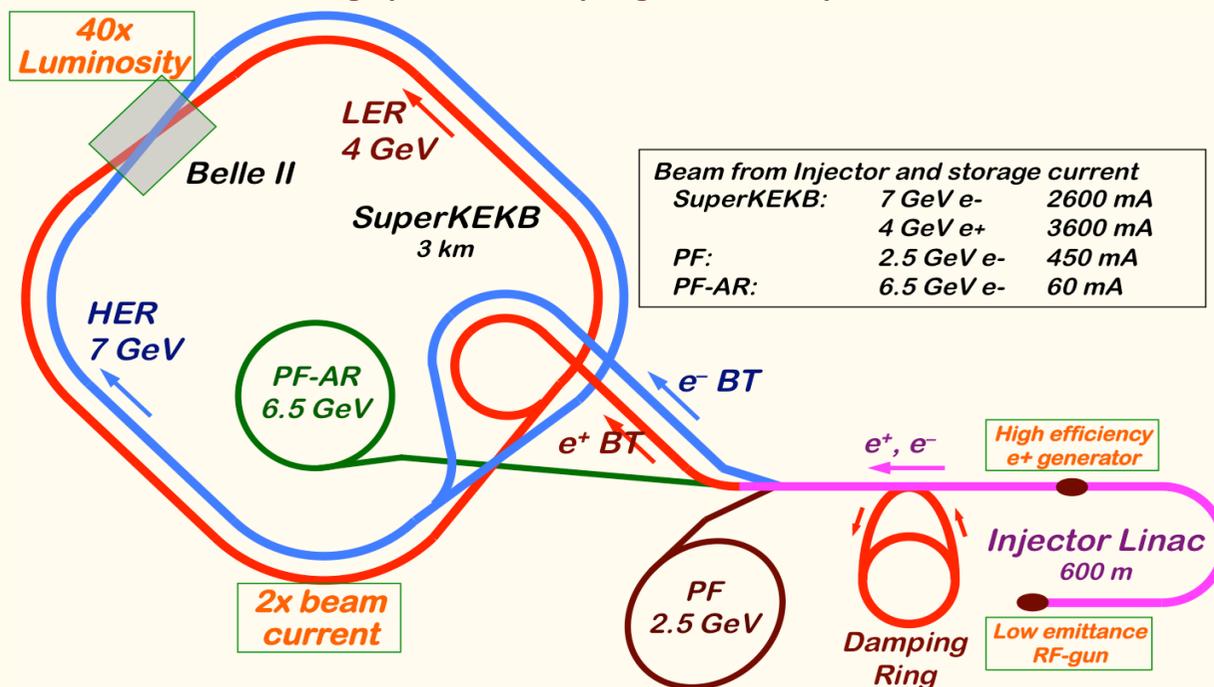
# Injector Linac Energy Margin

Answers to injector questions at Moday talk

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# Mission of Electron/positron Injector in SuperKEKB

- ❖ For 40-times higher luminosity in SuperKEKB collider
- ❖ Low emittance & low energy spread injection beam with 4-5 times more beam current
  - ✧ New high-current photo-cathode RF gun developments
  - ✧ New positron capture section
  - ✧ Damping ring construction
  - ✧ Optimized beam optics and correction
  - ✧ Precise beam orbit control with long-baseline alignment
  - ✧ Simultaneous top-up injection to DR/HER/LER/PF/PFAR
- ❖ Balanced injection for the both photon science and elementary particle physics experiments



The single injector would behave as multiple injectors to multiple storage rings by the concept of virtual accelerator



# Linac Energy Margin in Phase II

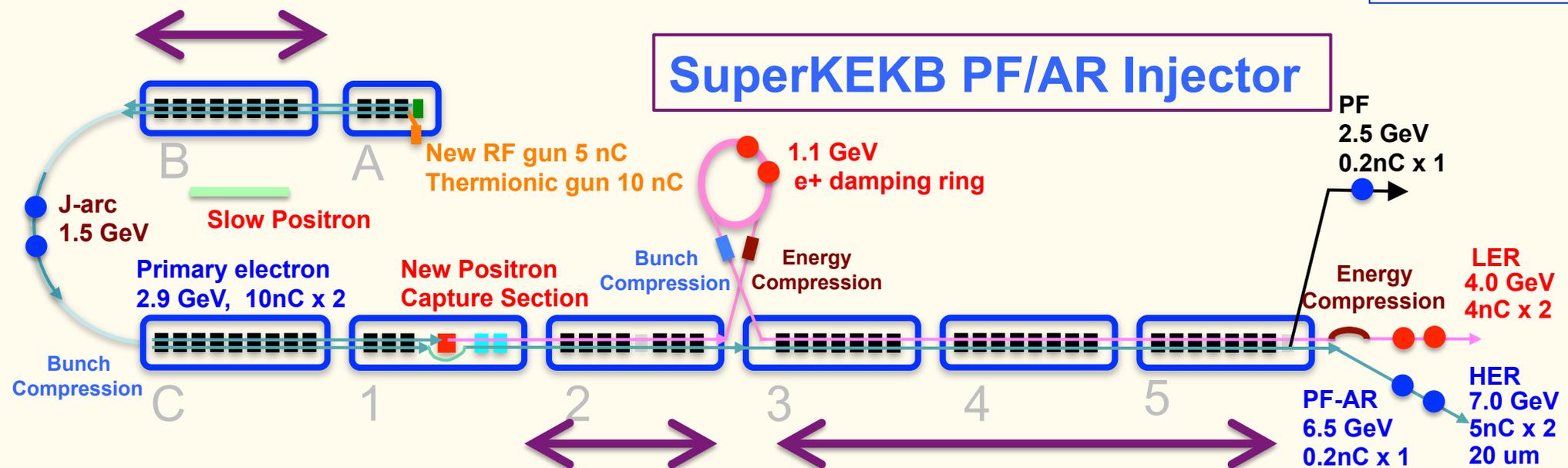
- ◆ **Construction budget is so tight that no backups are prepared for many components (common understanding)**
- ◆ **As the acceleration units are indispensable, for Y(4s) in Phase-II at least a single backup/stand-by unit (~150 MeV) is prepared for each of three linac sections**
  - ❖ **Sections: J-Arc (1.5 GeV), SY2-DR (1.1 GeV e<sup>+</sup>), SY3-Linac-end (7 GeV e<sup>-</sup> / 4 GeV e<sup>+</sup>)**
  - ❖ **51 units for acceleration and 9 units for beam manipulation**
- ◆ **However, Y(6s) was out of consideration for Phase-II**
  - ❖ **It may be possible to operate for Y(6s) without backups (J-Arc 1.7 GeV)**
  - ❖ **Need to reach an understanding with PF / PF-AR for possible interference**
  - ❖ **Before that, we surely have to establish low emittance beam injection**
- ◆ **There are many failure modes of units, typical ones are;**
  - ❖ **High power klystrons [a few times a year]**
    - ✧ **Two and a half days to replace a klystron**
  - ❖ **High power klystron pulse modulators [once or twice a year]**
    - ✧ **From a shift to several days depending on the failures**
  - ❖ **Fatal damage in accelerator structures [once in a few years]**
    - ✧ **Several days to replace a structure**
      - ◆ **Frequency of the appearance has been increasing**

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# Linac Energy Margin in Phase III

- ◆ **Unit #13 will be added in Phase-III (+150 MeV)**
  - ❖ **Securing well-performed accelerator structures in #44, the unit will be converted to high-gradient by adding another klystron (+70 MeV)**
- ◆ **On failures, the J-Arc energy may be changed to help other sections depending on the failure mode**
  - ❖ **If really relevant, DR energy may be changed to help e<sup>+</sup> (?)**
- ◆ **In the long run, degraded accelerating structures should be refurbished**

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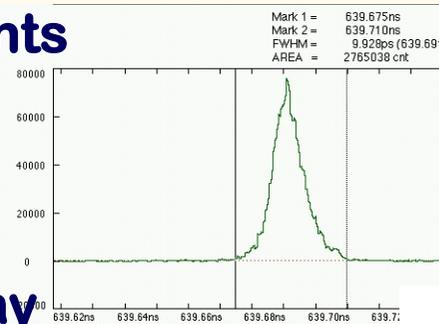
# Why Smaller Margin while dropping Energy 8 GeV $\rightarrow$ 7 GeV

- ◆ No backup/stand-by before J-Arc in KEKB operation
- ◆ Optimized for SuperKEKB ring injection reliability with larger beam currents and smaller emittance
- ◆ A unit was removed to make a room for DR BT
- ◆ Positron deceleration capturing
- ◆ Lower acceleration in large aperture structures in the positron capture section
- ◆ An unit before J-Arc was converted into a stand-by for availability
- ◆ C-band structures were converted into S-band to help emittance preservation
- ◆ Degraded accelerating structures after 35 years of operation
- ◆ Larger beam current with larger beam loading

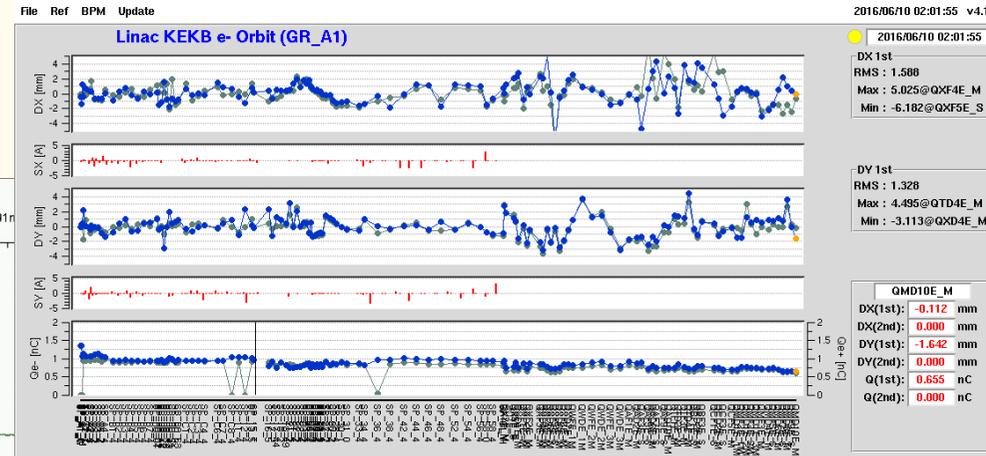
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# Development of Photo-cathode RF Gun

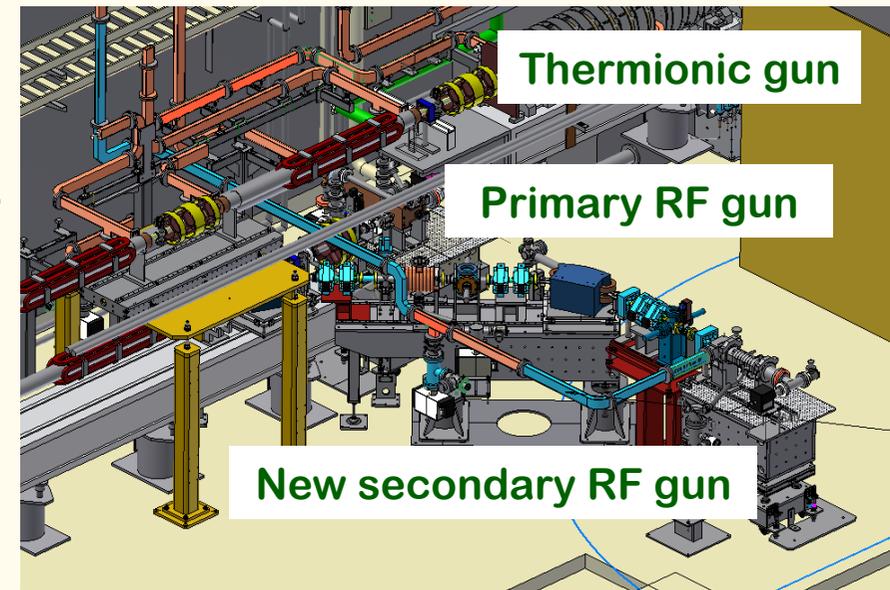
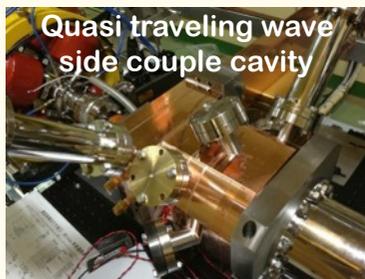
- ◆ Succeeded in injection during SuperKEKB Phase 1 commissioning for 11 days
- ◆ Employs Yb-doped-fiber and Yb:YAG laser, Ir<sub>5</sub>Ce cathode, quasi travelling wave side-coupled cavity
- ◆ Need stability improvements
- ◆ Beam instrumentation improvement and comparison with simulation codes underway
- ◆ Secondary RF gun is being constructed as a backup
- ◆ Incorporate suggestions by review committee for availability



Bunch width

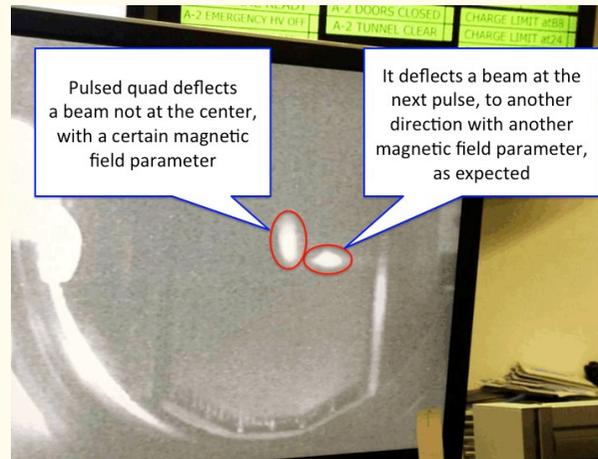
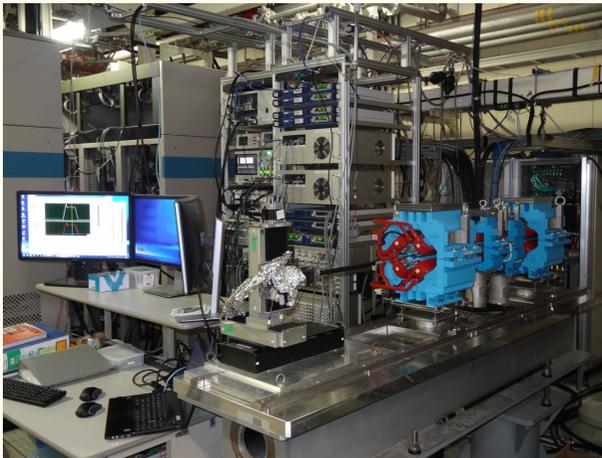


Beam orbit measurement



# Development and installation of pulsed magnets

- ❖ Pulsed magnet power supplies were postponed to 2017 because of resource availability
- ❖ 30 quads, 36 steerings, 2 bends, 13 girders will be fabricated and installed in 2017
- ❖ Quads with aggressive design at 1 mH, 330 A, 340 V, 1 ms with energy recovery up to 75%
- ❖ Essential for SuperKEKB low emittance injection and simultaneous injections
- ❖ 4+1 ring injections with virtual accelerator concept
- ❖ Risks against schedule and possible backup operation procedure are investigated



- ❖ Long term tests at a stand
- ❖ Satisfies specifications
- ❖ Some more control capability
- ❖ Synchronous operation in 2017
- ❖ Beam test with two quads
- ❖ Successful 25 Hz beam switches
- ❖ Basic features are completed
- ❖ Event timing synchronization needed
- ❖ Girders are tested as well
- ❖ In-house drawings to save rsc.
- ❖ 0.1mm alignment precision
- ❖ Ready for Phase-3 upgrade



# Possible Rescheduling

- ◆ Under limited resources rescheduling of fabrication, purchase, tests, installation, commissioning is planned
- ◆ Because of construction concentration in JFY2017, 5-month shutdown of injector is planned
- ❖ for KEKB it could allocate 9-month shutdown in 1997, synchronizing with light source upgrade

