SuperKEKB injector upgrade for high charge and low emittance electron beam.

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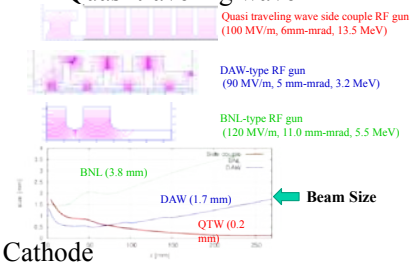
High charge & low emittance RF-Gun :

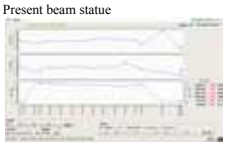
A-1 RF-Gun (will install until Sep 2012)
- Cavity : Higher electric focusing field
  => Quasi traveling wave



- Cathode
  - Ir_5Ce at room temperature => QE :10^{-4}
  - LaB_6 or Ir_5Ce with heater => QE :10^{-3}
- Laser : Higher power & stable laser
  => Yb based chirped pulse amplification

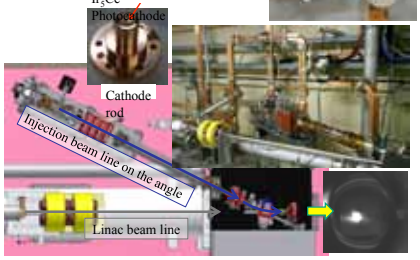
3-2 RF-Gun (from Sep 2011) :
- PF/PF-AR Injection
  during SuperKEKB construction phase
- 5nC test stand for SuperKEKB

Present beam statue



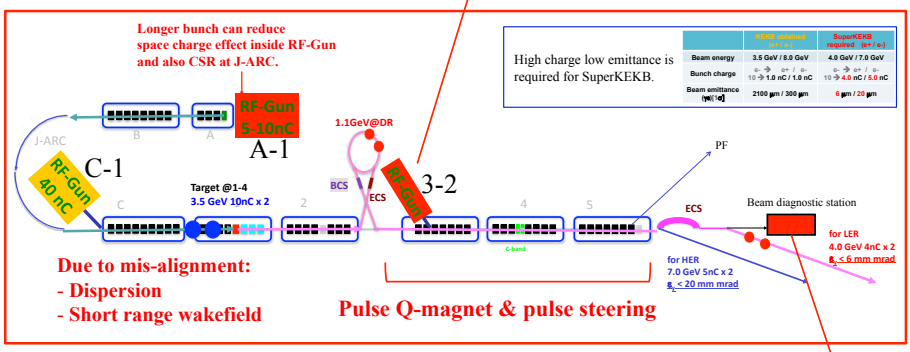
Cavity : Disk and Washer

Cathode : LaB_6 => Ir_5Ce



Laser : Nd doped solid state laser
- Nd:YVO_4 + SESAM passive modelock oscillator

- Nd:YAG 5-stage amplifier



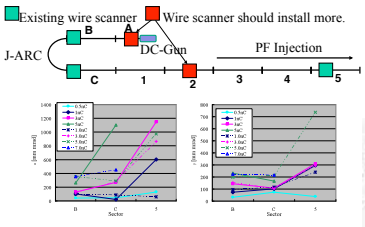
High charge low emittance is required for SuperKEKB.

	KEKB achieved (Record)	SuperKEKB required (design)
Beam energy	3.5 GeV / 8.0 GeV	4.0 GeV / 7.0 GeV
Bunch charge	e- → e+ / e- 10 → 1.0 nC / 1.0 nC	e- → e+ / e- 10 → 4.0 nC / 5.0 nC
Beam emittance (γε_x / ε_y)	2100 μm / 300 μm	6 μm / 20 μm

- High charge & low emittance RF-Gun
  - Cavity with electric focusing field
    - Disk and Washer => 3-2
    - Quasi Traveling Wave => A-1
  - Long life cathode QE : 10^{-4}
    - LaB_6, Ir_5Ce at room temperature
  - High power laser > mJ @ 266nm
    - Nd doped solid state laser
    - Yb doped fiber & solid state laser
- Beam transport
  - Alignment
  - Emittance preservation
  - Beam diagnostics

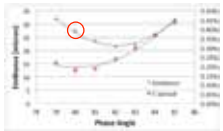
Emittance preservation :

Present projected emittance measurement

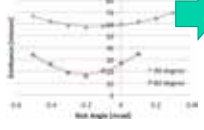


Simulation of projected emittance

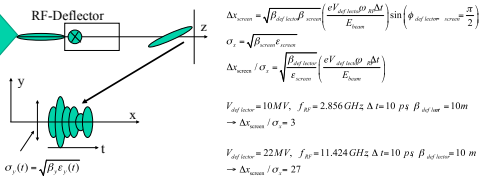
Beam tracking simulation :
Intial emittance : 6 mm mrad
Mis-alignment : σ = 0.3mm



Initial offset



Transverse Wakefield Measurement => Initial offset using X-band RF-Deflector



$$\Delta x_{screen} = \sqrt{\beta_{def\,beam}\beta_{screen}}\left(\frac{eV_{def\,beam}\omega_{RF}\Delta t}{E_{beam}}\right)\sin\left(\phi_{def\,beam\to screen}=\frac{\pi}{2}\right)$$

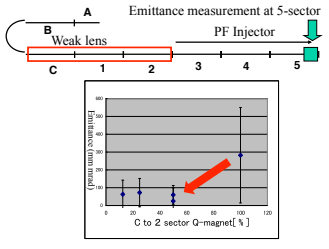
$$\sigma_x = \sqrt{\beta_{screen}\varepsilon_{screen}}$$

$$\Delta x_{screen}/\sigma_x = \sqrt{\frac{\beta_{def\,beam}}{\varepsilon_{screen}}}\left(\frac{eV_{def\,beam}\omega\ \sigma\Delta t}{E_{beam}}\right)$$

$V_{def\,beam} = 10MV,\ f_{RF} = 2.856\,GHz\ \Delta t = 10\ ps\ \beta_{def\,beam} = 10m$
$\rightarrow \Delta x_{screen}/\sigma_x = 3$

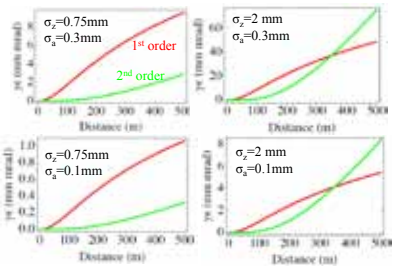
$V_{def\,beam} = 22MV,\ f_{RF} = 11.424\,GHz\ \Delta t = 10\ ps\ \beta_{def\,beam} = 10\ m$
$\rightarrow \Delta x_{screen}/\sigma_x = 27$

Project emittance using weak lens

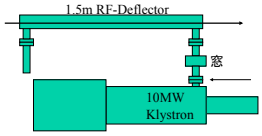


Consideration of bunch compression using J-ARC

Projected emittance dilution due to transverse wakefield

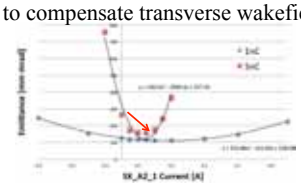


RF-Deflector developed by SLAC

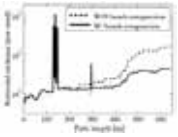


Input Power : 10MW
Deflecting Voltage : 22 MV

Initial offset scan
to compensate transverse wakefield



Beam tracking simulation



Beam diagnostic station
In third switch yard