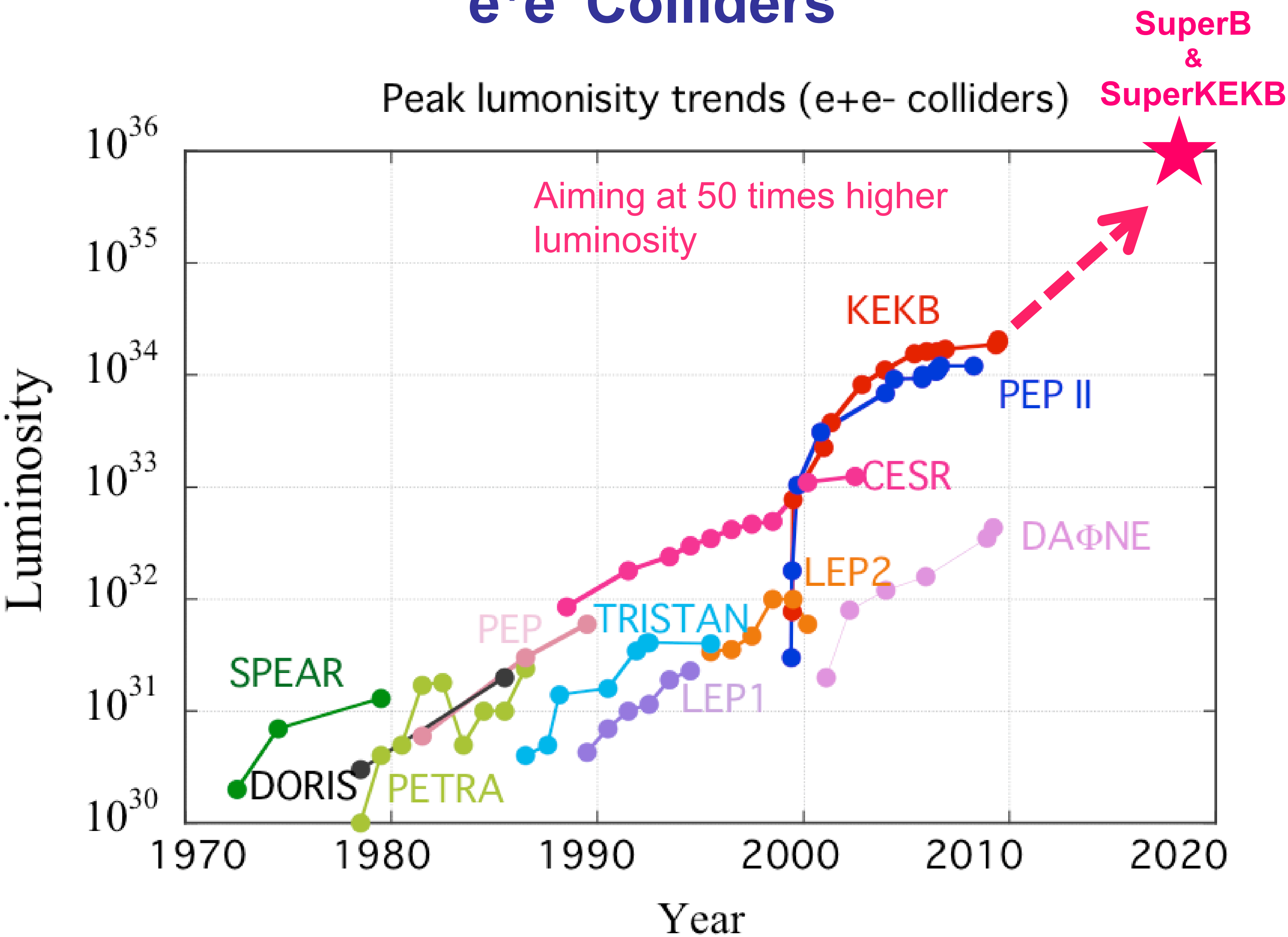
Colliders for B Factories

IPAC'11
Sep. 7, 2011

Haruyo Koiso
KEK

e+e- Colliders



Key Parameters

Stored current (HER/LER) :

1.64/1.19 A (KEKB)

→ **1.9 ~ 3.6 A**

Beam-beam parameter:

0.09 (KEKB)

→ **0.09 ~ 0.11**

Lorentz factor

$$L = \frac{\gamma_{\pm}}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\frac{I_{\pm}\xi_{\pm y}}{\beta_y^*}\left(\frac{R_L}{R_y}\right)$$

Classical electron radius

Beam size ratio

Geometrical reduction factors due to crossing angle and hour-glass effect

Luminosity:

2.11 $\times 10^{34}$ $cm^{-2}s^{-1}$ (KEKB)

→ **80 ~ 100$\times 10^{34}$ $cm^{-2}s^{-1}$**

Vertical β at the IP:

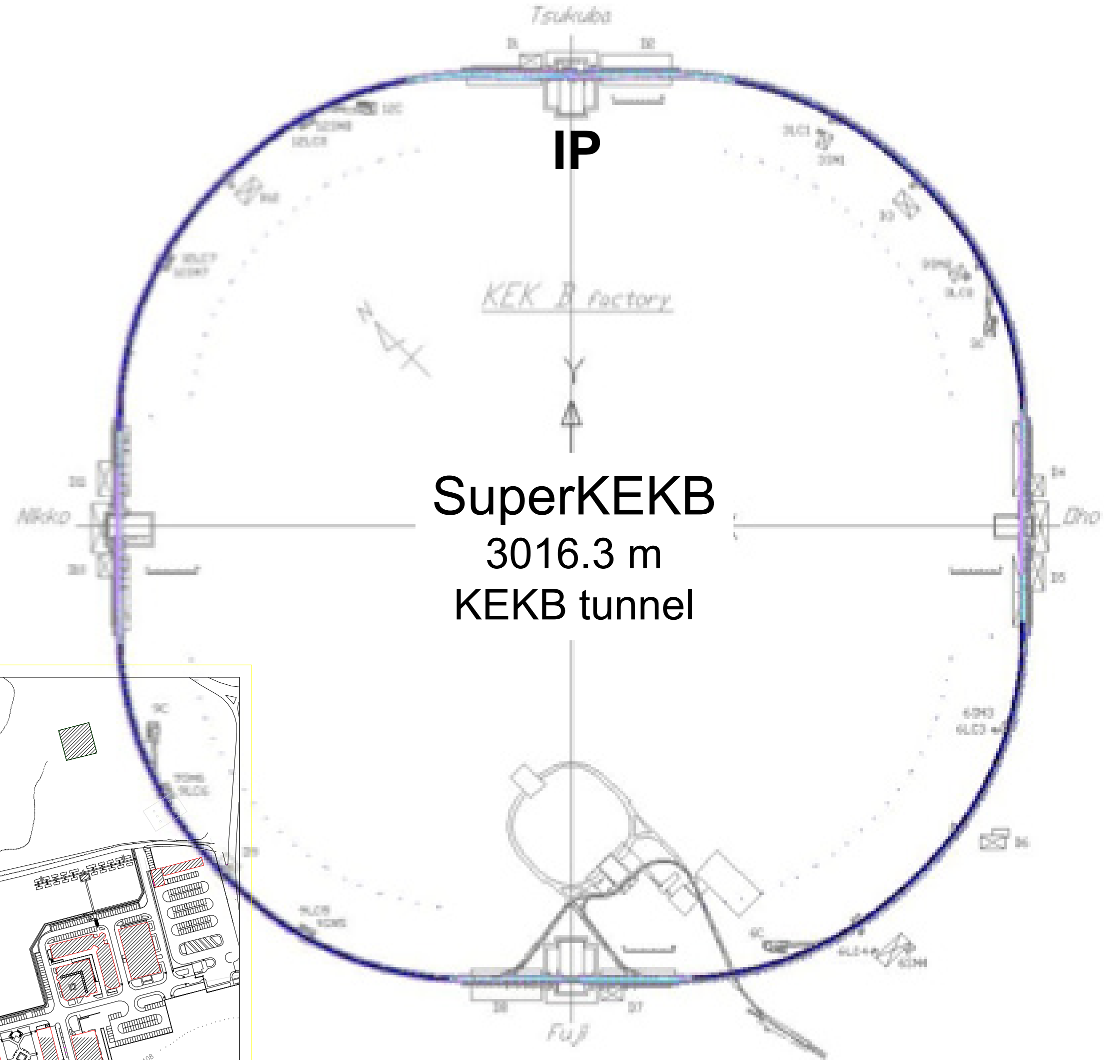
5.9/5.9 mm (KEKB)

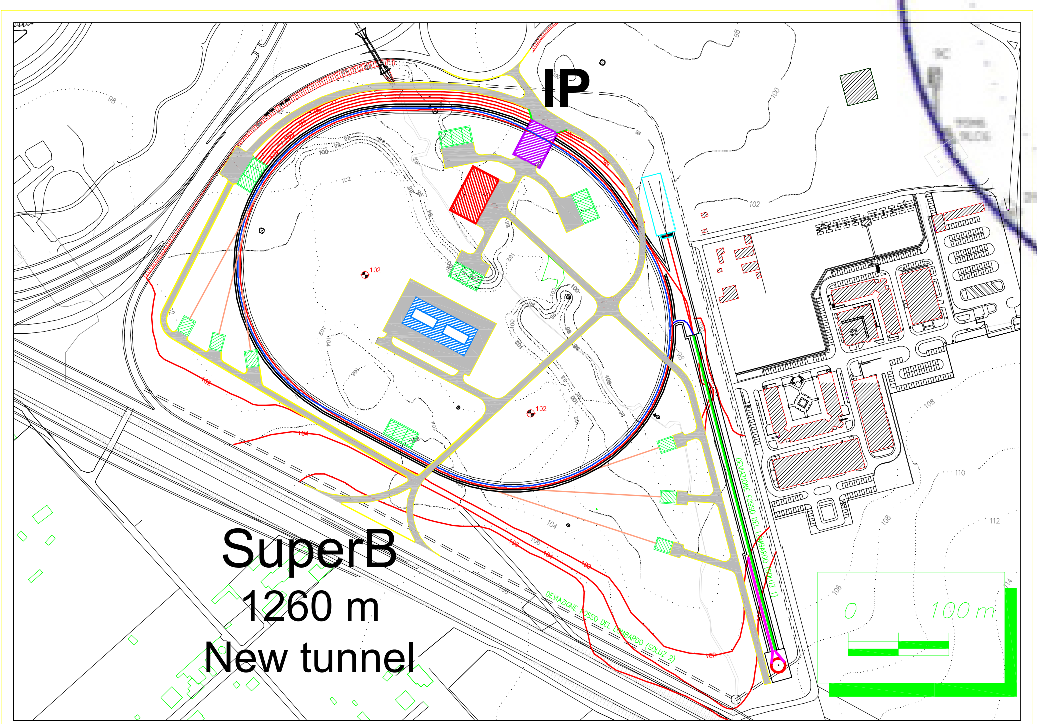
→ **0.2 ~ 0.3 mm**

Challenging

Layout

e^+e^-
energy-asymmetric
double-ring
colliders



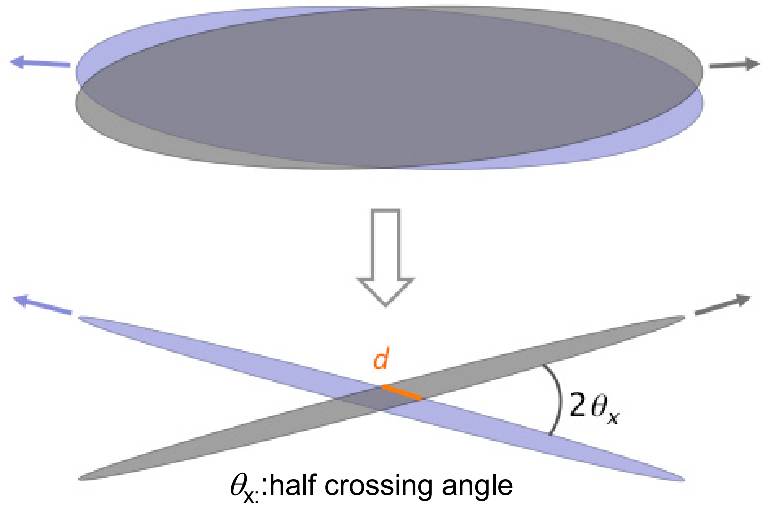


Piwinski Angle & Crab Waist

Shorten longitudinal size of overlap region
in order to squeeze β^*_y avoiding the hourglass effect.

Small $\phi_{\mathbf{Piw}}$

KEKB : ~ 1 (θ_x=11 mrad)

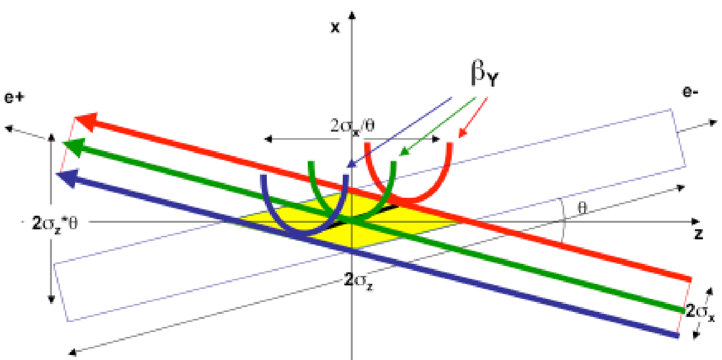


$$\phi_{Piw} = \frac{\theta_x \sigma_z}{\sigma^*_x}$$

Large $\phi_{\mathbf{Piw}}$

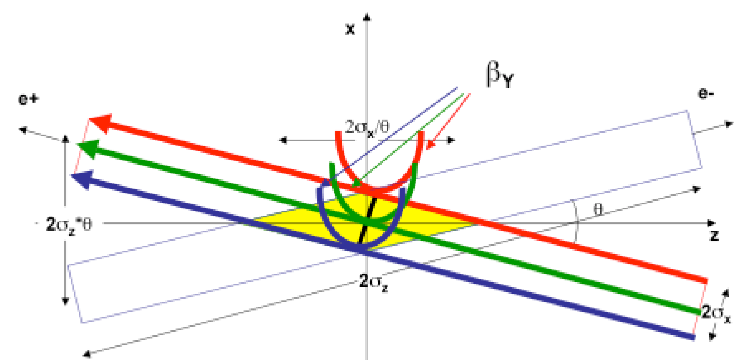
SuperB & SuperKEKB : ~ 20

$$d = \frac{\sigma^*_x}{\theta_x} = \frac{\sigma_z}{\phi_{Piw}}$$



Crab Waist
SuperB

LPA+CW
Proposed by
P. Raimondi
for SuperB



No Crab Waist
SuperKEKB

- Suppress betatron and synchro-betatron resonances
- Decrease dynamic aperture.

Parameters of SuperB & SuperKEKB

		SuperB		SuperKEKB		
		LER (e-)	HER (e+)	LER (e+)	HER (e-)	units
Beam energy	E	4.18	6.7	4	7.007	GeV
Cicumference	C	1258.4		3016.3		m
Half crossing angle	ϕ_x	33		41.5		mrad
Piwinski angle	ϕ_{Piw}	22.88	18.60	24.6	19.3	rad
Horizontal emittance	ε_x	2.46 (1.82)	2.0 (1.97)	3.2 (1.9)	4.6 (2.3)	nm
Horizontal emittance	ε_x	5.0	6.15	8.64	11.5	pm
Emittance ratio	$\varepsilon_y/\varepsilon_x$	0.25	0.25	0.27	0.28	%
Beta function at IP	β_x^*/β_y^*	32 / 0.205	26 / 0.253	32 / 0.27	25 / 0.30	mm
Horizontal beam size	σ_x^*	8.872	7.211	10.1	10.7	μm
Vertical beam size	σ_y^*	36	36	48	62	nm
Betatron tune	ν_x/ν_y	42.575 / 18.595	40.575 / 17.595	44.530 / 44.570	45.530 / 43.570	
Momentum compaction	α_p	4.05	4.36	3.25	4.55	10^{-4}
Energy spread	σ_ε	7.34	6.43	8.14(7.96)	6.49(6.34)	10^{-4}
Natural chromaticity	$(x)/(y)$	-137 / -449	-134 / -447	-107 / -785	-168 / -1131	
Beam current	I	2.447	1.892	3.60	2.60	A
Number of bunches	n_b	978		2500		
Particles / bunch	N	6.56	5.08	9.04	6.53	10^{10}
Energy loss/turn	U_0	0.865	2.11	1.87	2.45	MeV
Long. damping time	τ_z	20.3	13.4	21.6	29.0	msec
RF frequency	f_{RF}	476.		508.9		MHz
Synchrotron tune	ν_s	-0.0129	-0.0135	-0.0247	-0.0280	
Bunch length	σ_z	5.0	5.0	6.0 (4.9)	5.0 (4.9)	mm
Beam-beam parameter	ξ_x/ξ_y	0.0033 / 0.097	0.0021 / 0.097	0.0028 / 0.088	0.0012 / 0.081	
Total beam lifetime	τ_{beam}	269	254	343	312	sec
Luminosity	L	10×10^{35}		8×10^{35}		$cm^{-2}s^{-1}$
Integrated luminosity	$\int L$	75		50		ab^{-1}

Common Features

Main common features are:

- Low β^*_y : 200 ~ 300 μm
- Low β^*_x : 25 ~ 32 mm
- Large Piwinski angle : ~20
- Low emittances and flat beams : 2 ~ 5 nm (x), 5 ~ 12 pm (y), and 0.25 ~ 0.28% coupling -> σ^*_y = 40 ~ 60 nm
- Short beam lifetime : 250 ~ 350 sec
  - Beam-beam (radiative Bhabha) lifetime and Touschek lifetime

- Modest beam currents : 1.9 ~ 3.6 A
- Modest bunch length : 5 ~ 6 mm
- Modest beam–beam parameter : 0.09 ~ 0.11
- Smaller energy asymmetry than PEP-II and KEKB : 4.18/6.7 (SuperB) and 4.0/7.007 (SuperKEKB) GeV
  –
- Minimize construction and running costs

SuperB

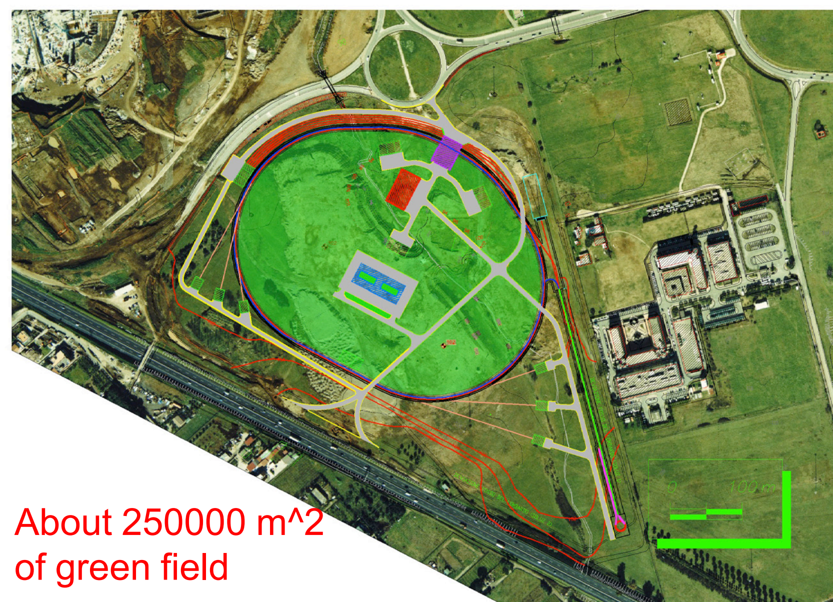
SuperB Status & Site

The SuperB collider has been approved by the Italian Research Minister as part of the Italian National Research Plan, with a 5 years construction budget.

Recently the construction site has been selected in the campus of the Tor Vergata Rome II University, just 5 km away from the Frascati Lab.

M.E. Biagini et al., THPZ003

Site close up



About 250000 m^2 of green field

S. Tomassini, XVII SuperB WS and Kick-off Meeting, May-June 2011

SuperB Features

- e^- 4.18 GeV, e^+ 6.7 GeV
- Target luminosity of 10^{36} cm^{-2} s^{-1} at the Υ(4S)
- Large Piwinski angle and "crab waist" (LPA & CW) collision scheme
- Longitudinally polarized electron beam
- Possibility to run at τ/charm threshold with L = 10^{35} cm^{-2} s^{-1}
- Many similarities with the Damping Rings of ILC and CLIC, and with latest generation SL sources
- Possibility to be a good "light source"
  - The lattice has recently been modified to install Insertion Devices in HER.
- Most of the PEP-II hardware can be used in SuperB.
  - HER will use the PEP-II HER dipoles.
- Crab waist sextupoles demand for particular care in designing the chromaticity correction in the Final Focus (FF).

M.E. Biagini, XVII SuperB WS and Kick-off Meeting, May-June 2011
M.E. Biagini et al., THPZ003

Parameters

		Base Line		Low Emittance		High Current		Tau/Charm (prelim.)	
Parameter	Units	HER (e+)	LER (e-)	HER (e+)	LER (e-)	HER (e+)	LER (e-)	HER (e+)	LER (e-)
LUMINOSITY	$cm^{-2}\ s^{-1}$	1.00E+36		1.00E+36		1.00E+36		1.00E+35	
Energy	GeV	6.7	4.18	6.7	4.18	6.7	4.18	2.58	1.61
Circumference	m	1258.4		1258.4		1258.4		1258.4	
X-Angle (full)	mrad	66		66		66		66	
Piwinski angle	rad	22.88	18.60	32.36	26.30	14.43	11.74	8.80	7.15
β_x @ IP	cm	2.6	3.2	2.6	3.2	5.06	6.22	6.76	8.32
β_y @ IP	cm	0.0253	0.0205	0.0179	0.0145	0.0292	0.0237	0.0658	0.0533
Coupling (full current)	%	0.25	0.25	0.25	0.25	0.5	0.5	0.25	0.25
ε_x (without IBS)	nm	1.07	1.82	1.00	0.91	1.97	1.82	1.97	1.82
ε_x (with IBS)	nm	2.00	2.46	1.00	1.23	2.00	2.46	5.20	6.4
ε_y	pm	5	6.15	2.5	3.075	10	12.3	13	16
σ_x @ IP	μm	7.211	8.872	5.099	6.274	10.060	12.370	18.749	23.076
σ_y @ IP	μm	0.036	0.036	0.021	0.021	0.054	0.054	0.092	0.092
Σ_x	μm	11.433		8.085		15.944		29.732	
Σ_y	μm	0.050		0.030		0.076		0.131	
σ_L (0 current)	mm	4.69	4.29	4.73	4.34	4.03	3.65	4.75	4.36
σ_L (full current)	mm	5	5	5	5	4.4	4.4	5	5
Beam current	mA	1892	2447	1460	1888	3094	4000	1365	1766
Buckets distance	#	2		2		1		1	
Ion gap	%	2		2		2		2	
RF frequency	Hz	4.76E+08		4.76E+08		4.76E+08		4.76E+08	
Harmonic number		1998		1998		1998		1998	
Number of bunches		978		978		1956		1956	
N. Particle/bunch		5.08E+10	6.56E+10	3.92E+10	5.06E+10	4.15E+10	5.36E+10	1.83E+10	2.37E+10
Tune shift x		0.0021	0.0033	0.0017	0.0025	0.0044	0.0067	0.0052	0.0080
Tune shift y		0.0970	0.0971	0.0891	0.0892	0.0684	0.0687	0.0909	0.0910
Long. damping time	msec	13.4	20.3	13.4	20.3	13.4	20.3	26.8	40.6
Energy Loss/turn	MeV	2.11	0.865	2.11	0.865	2.11	0.865	0.4	0.166
σ_E (full current)	dE/E	6.43E-04	7.34E-04	6.43E-04	7.34E-04	6.43E-04	7.34E-04	6.94E-04	7.34E-04
CM σ_E	dE/E	5.00E-04		5.00E-04		5.00E-04		5.26E-04	
Total lifetime	min	4.23	4.48	3.05	3.00	7.08	7.73	11.41	6.79
Total RF Power	MW	17.08		12.72		30.48		3.11	

Baseline:
- Higher emittance due to IBS
- Asymmetric beam currents

2 options:
- Lower y-emittance
- Higher currents (twice bunches)

Tau/charm threshold running at 10^{35}

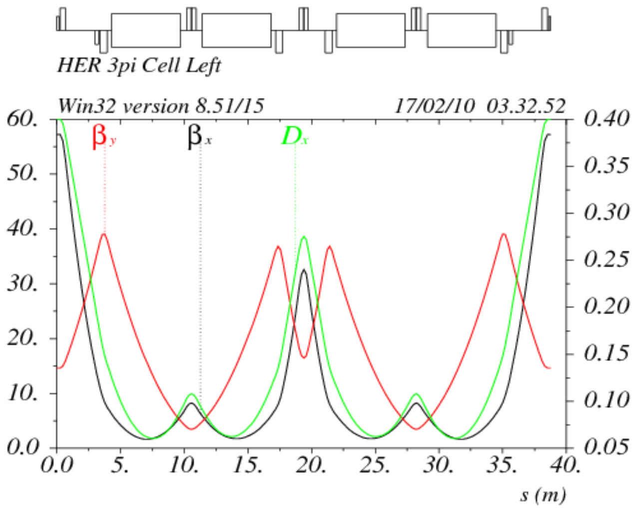
RF power includes SR and HOM

Flexibility

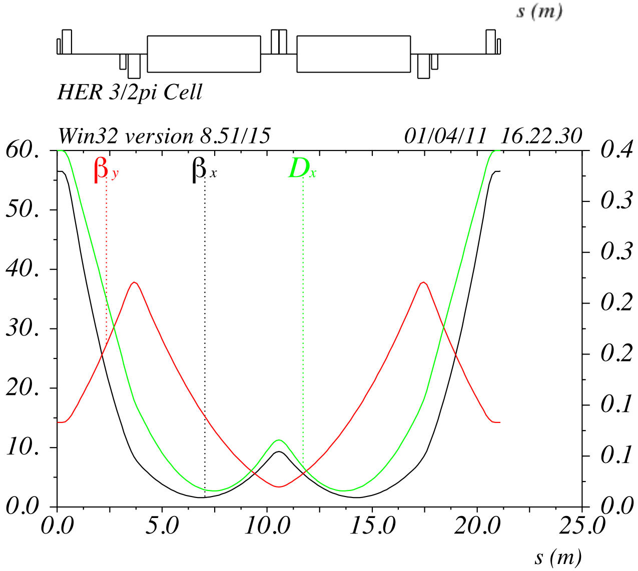
- Low Emittance case relaxes RF requirements and problems related to high current operations (including wall-plug power) but puts more strain on optics and tuning capabilities:
  - Horizontal emittance can be decreased by about a factor 2 in both rings
  - IP beta functions can be still decreased in the Final Focus system
- High Current case has opposite characteristics: requirements on vertical emittance and IP β-functions are relaxed but high current issues are enhanced (instabilities, HOM and synchrotron radiation, wall-plug power etc…):
  - PEP-II RF system will be able to support higher beam currents (up to a factor 1.6) than the baseline ones, when all the available RF units are installed.
- The cases shown have several parameters kept has much constant as possible (bunch length, IP stay clear…), in order to reduce their impact on other unwanted effects (Detector backgrounds, HOM heating…)

SuperB Arcs

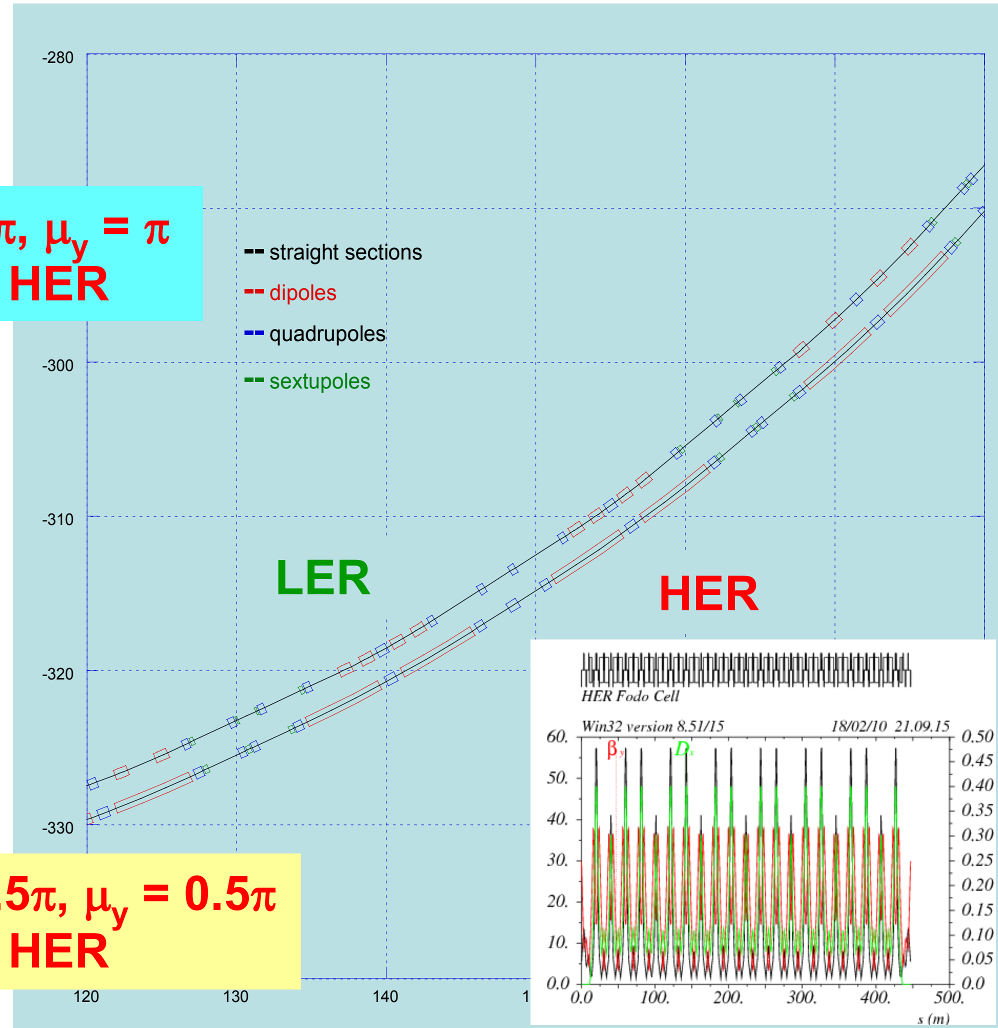
- HER and LER arcs have conceptually the same lattice. LER arc dipoles are shorter (bend radius about 3 times smaller) than in the HER in order to match the ring emittances at the asymmetric beam energies.



$\mu_x = 3\pi$, $\mu_y = \pi$
Cell in HER

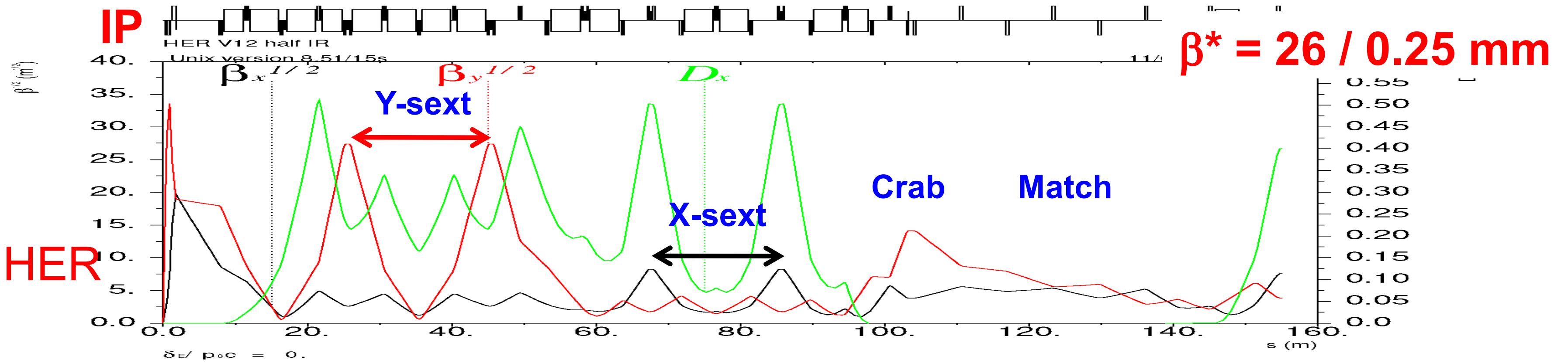


$\mu_x = 1.5\pi$, $\mu_y = 0.5\pi$
Cell in HER

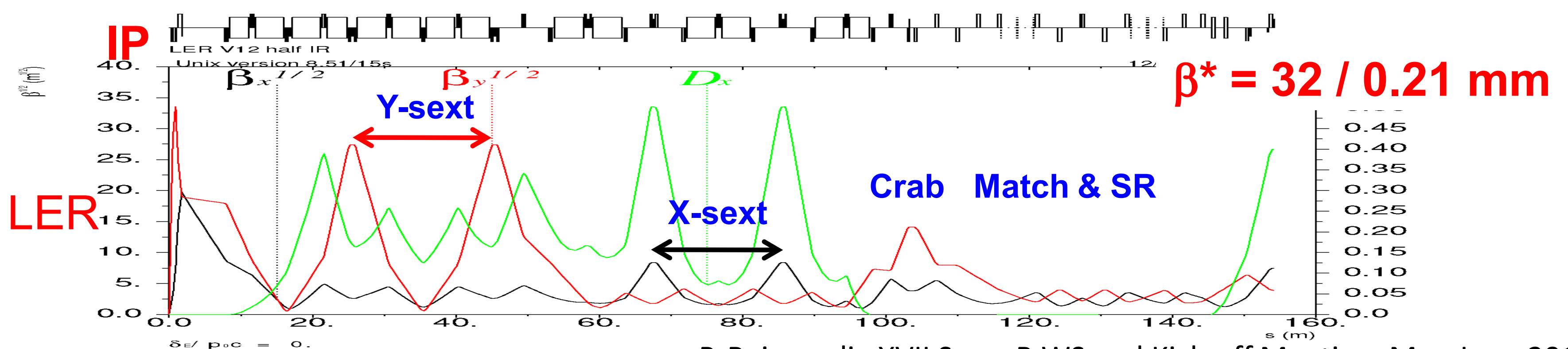


Final Focus Optics

- "Spin rotator" optics is replaced with a simpler matching section



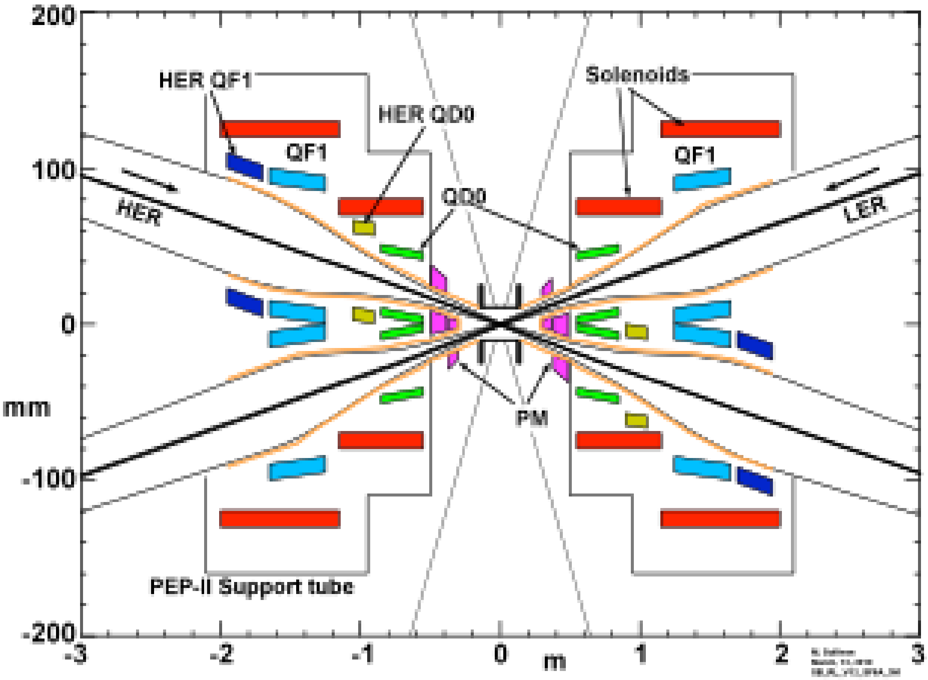
- Matching section is shorter than HER to provide space for spin rotator optics.
- ±33 mrad bending asymmetry with respect to IP causes a slight spin mismatch between SR and IP resulting in ~5% polarization reduction

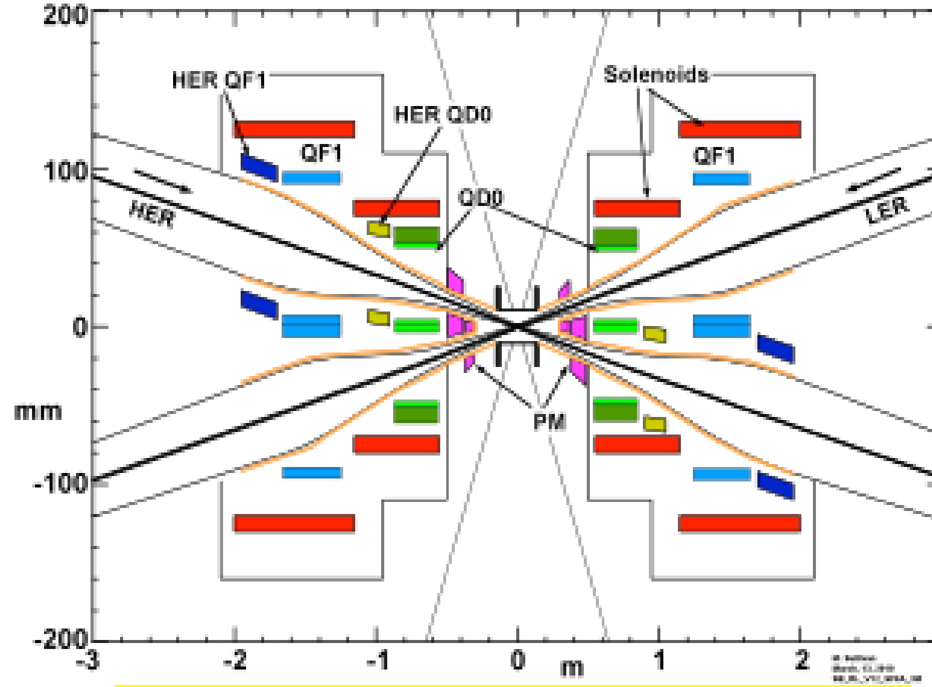


General IR Design Features

- Crossing angle is +/- 30 mrads
- Cryostat has a complete warm bore
  - Both QD0 and QF1 are superconducting
- PM in front of QD0
- Soft upstream bend magnets
  - Further reduces SR power in IP area
- BSC to 30σ in X and 100σ in Y (7σ fully coupled)
- SR scanned to 20σ in X and 45σ in Y

Interaction Region

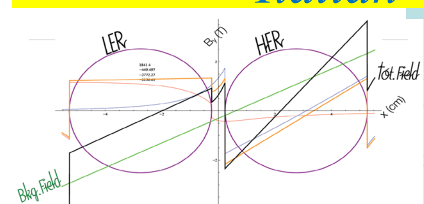


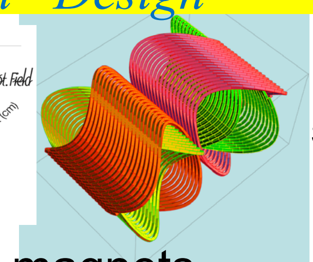


Vanadium Permendur
"Russian" Design

Air core SC QD0, QF1
"Italian" Design

presented by
M. Sullivan,
SuperB WS
Dec.2009





E. Paoloni,
S. Bettoni,
SuperB WS
Dec.2009

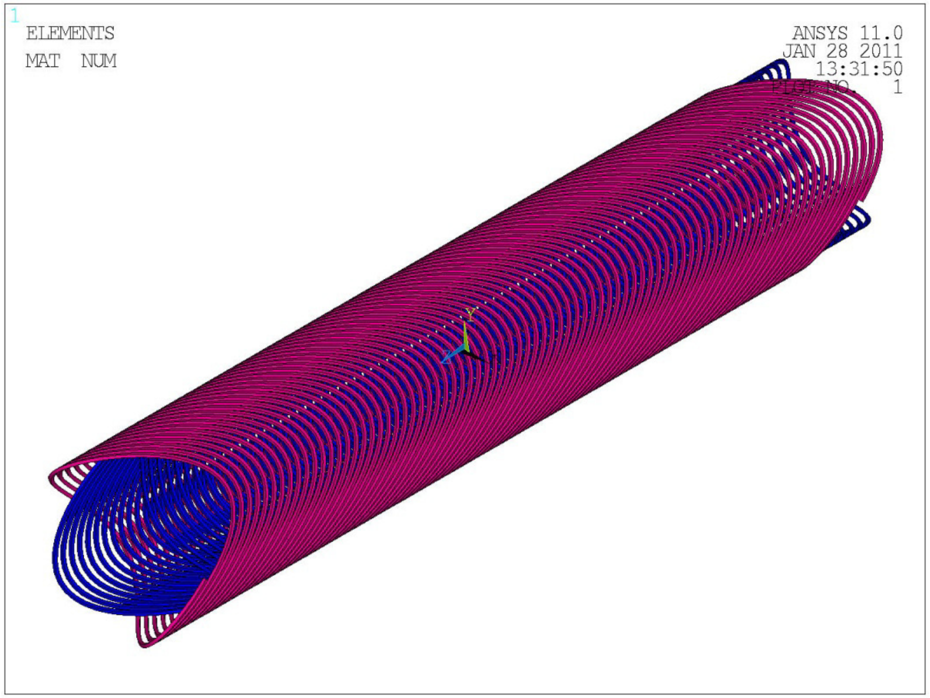
- A set of permanent (PM) and superconducting (QD0, QD1) magnets
- QD0 Design: 2 possible choices

Air Core Magnets of IR

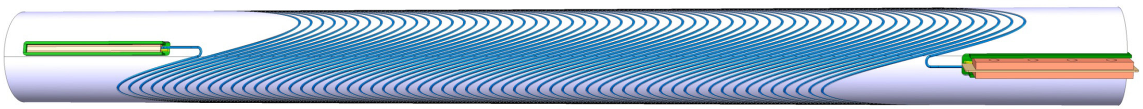
Basic layout: double helix

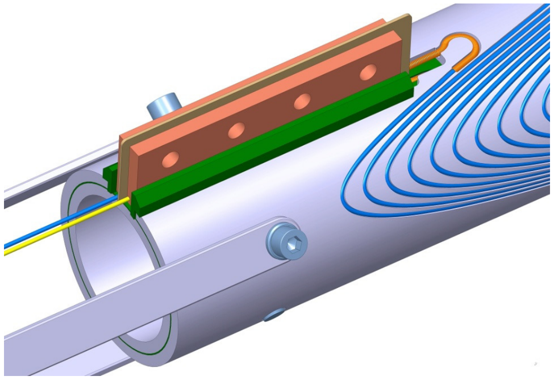
The quadrupoles are done according the double helix principle. This lay-out allows to modulate the winding introducing suitable multipole corrections. The overall structure is compact and the effect of coil ends on field quality is minimal (wrt more conventional designs)

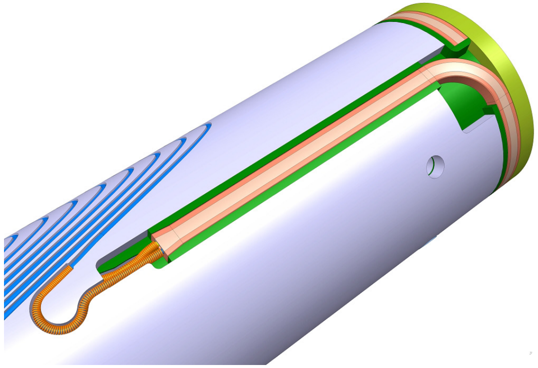
$$z(\theta) = \frac{h\vartheta}{2\pi} + \sum_{n=1}^{N} A_n \sin(n\theta + \varphi_n)$$



Air Core Magnets of IR



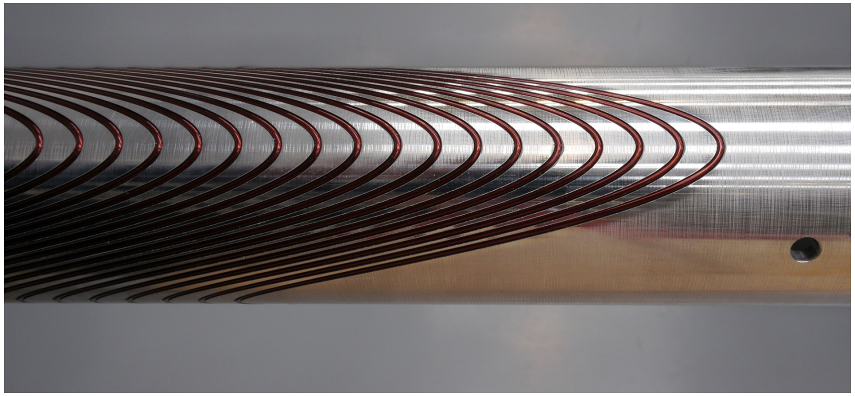




The model is under construction at ASG.

Winding tests

Winding tests performed at ASG Superconcodoctors (Ge) with dummy cylinder (INFN Pisa) and dummy wire

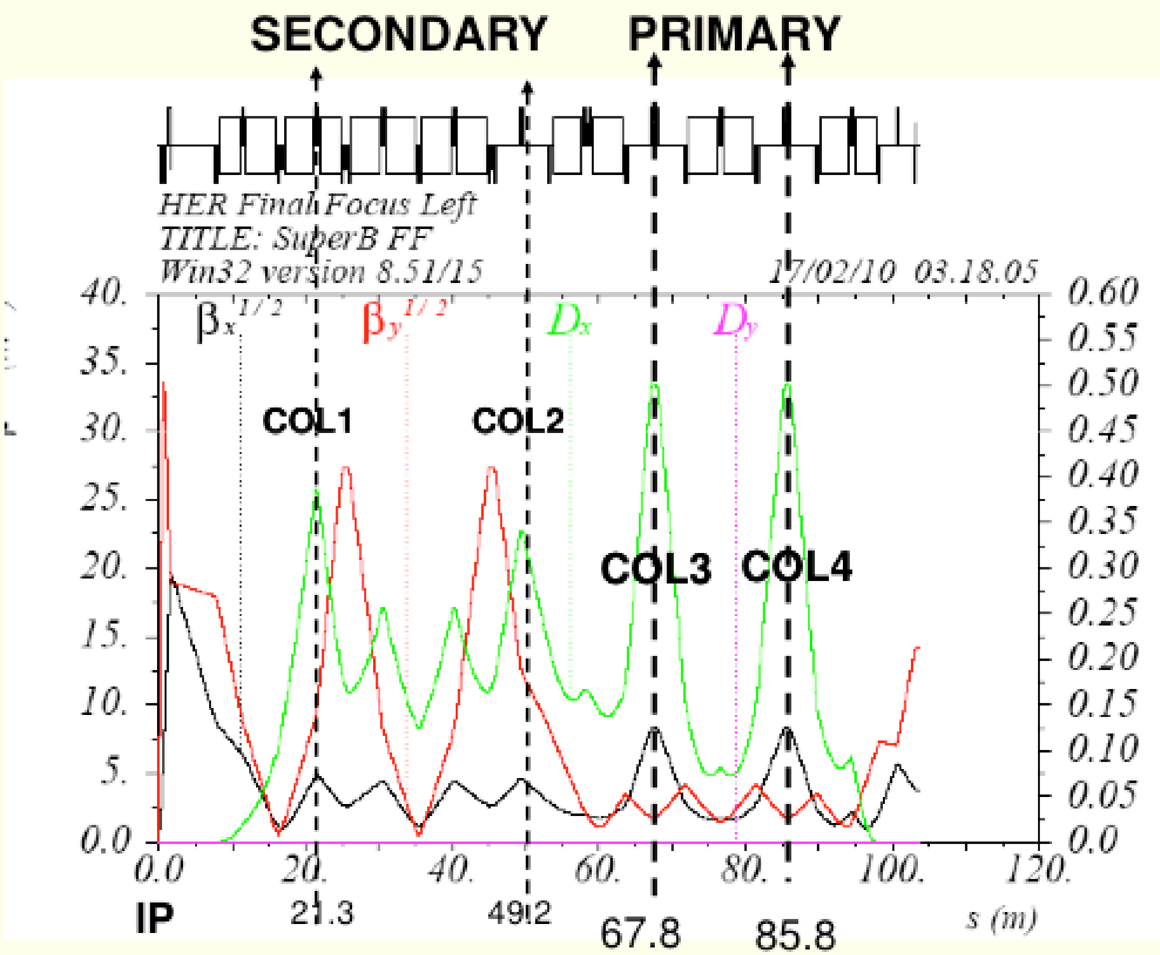


Collimation

HER / LER Final Focus collimation system

A set of collimation to reduce BG effectively has been found.

The collimation reduces Touschek lifetime by 15%
40->33 min (HER)
7.8-> 6.6 min (LER)



Vibration

- Ground vibration measurements have been performed on site and have shown its very good stability, eve with the highway only 100m away.
- For the final focus (FF), a vibration budget has been established, including ground motion data, motion sensitivity of machine components, beam feedback system requirements.
- Coherent motion of shared elements in a common cryostat will reduce the vibration sensitivity of the IR.

	Request (vertical displacement)	**Measured (vertical displacement)**
IP	**300 nm**	**20-40 nm**
Final Focus	**300 nm**	**20-30 nm**
Arcs	**500 nm**	**20-30 nm**

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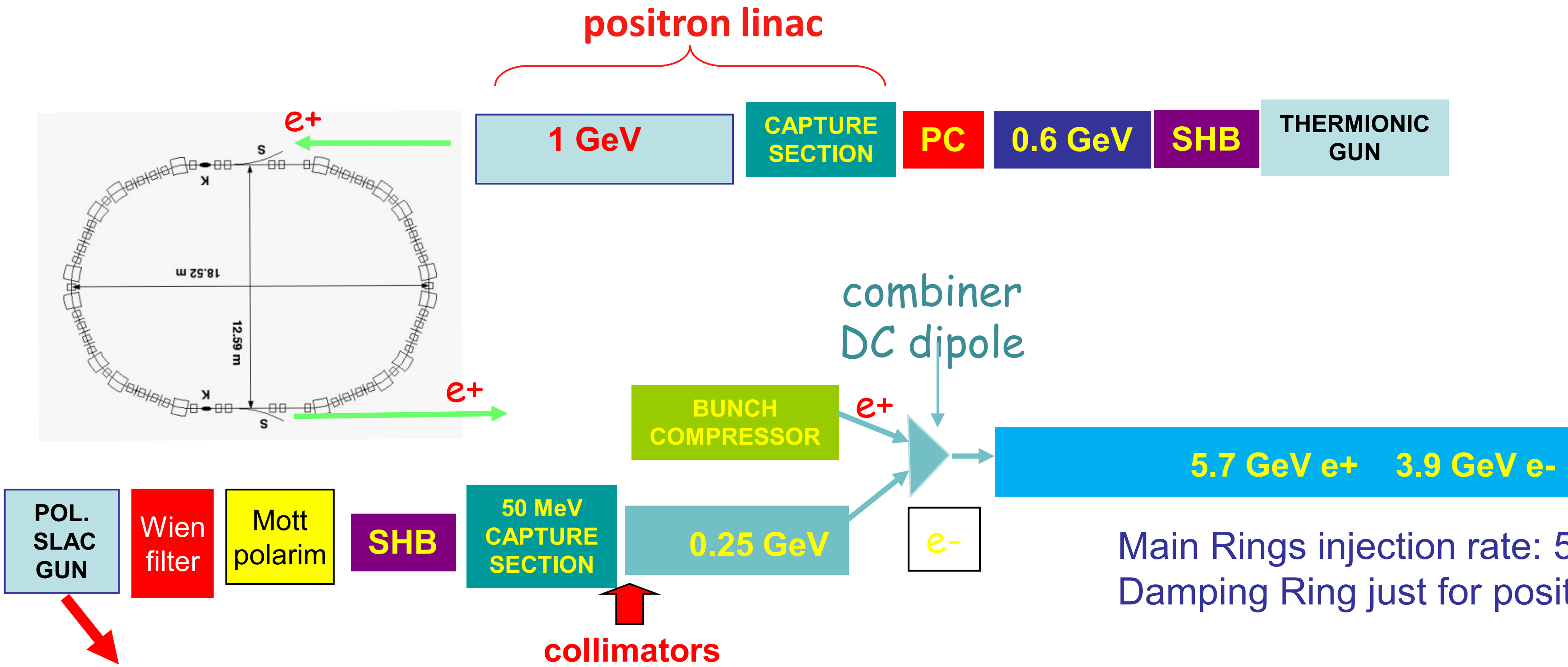
Injection System



Main Rings injection rate: 50 Hz
Damping Ring just for positrons

Parameter	Units	SLC
Electron charge per bunch	nC	16
Bunches per pulse		2
Pulse rep rate	Hz	120
Cathode area	cm^2	3
Cathode bias	kV	-120
Bunch length	ns	2
Gun to SHB1 drift	cm	150
$e_{n,rms,gun}$ (fm EGUN)	10^{-6} m	15

from A. Brachmann – SuperB Workshop SLAC, October 2009

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Round beam
Emittance @ 4.16 GeV = 1.8 nm
Required bunch charge for e- ≈ 0.3 nC
… scrapers .. collimators needed

Progress

Many works and progress on beam dynamic issues such as

- e-cloud instability,
- Low Emittance Tuning (LET) procedures,
- intra-beam scattering,

R&D works are going on:

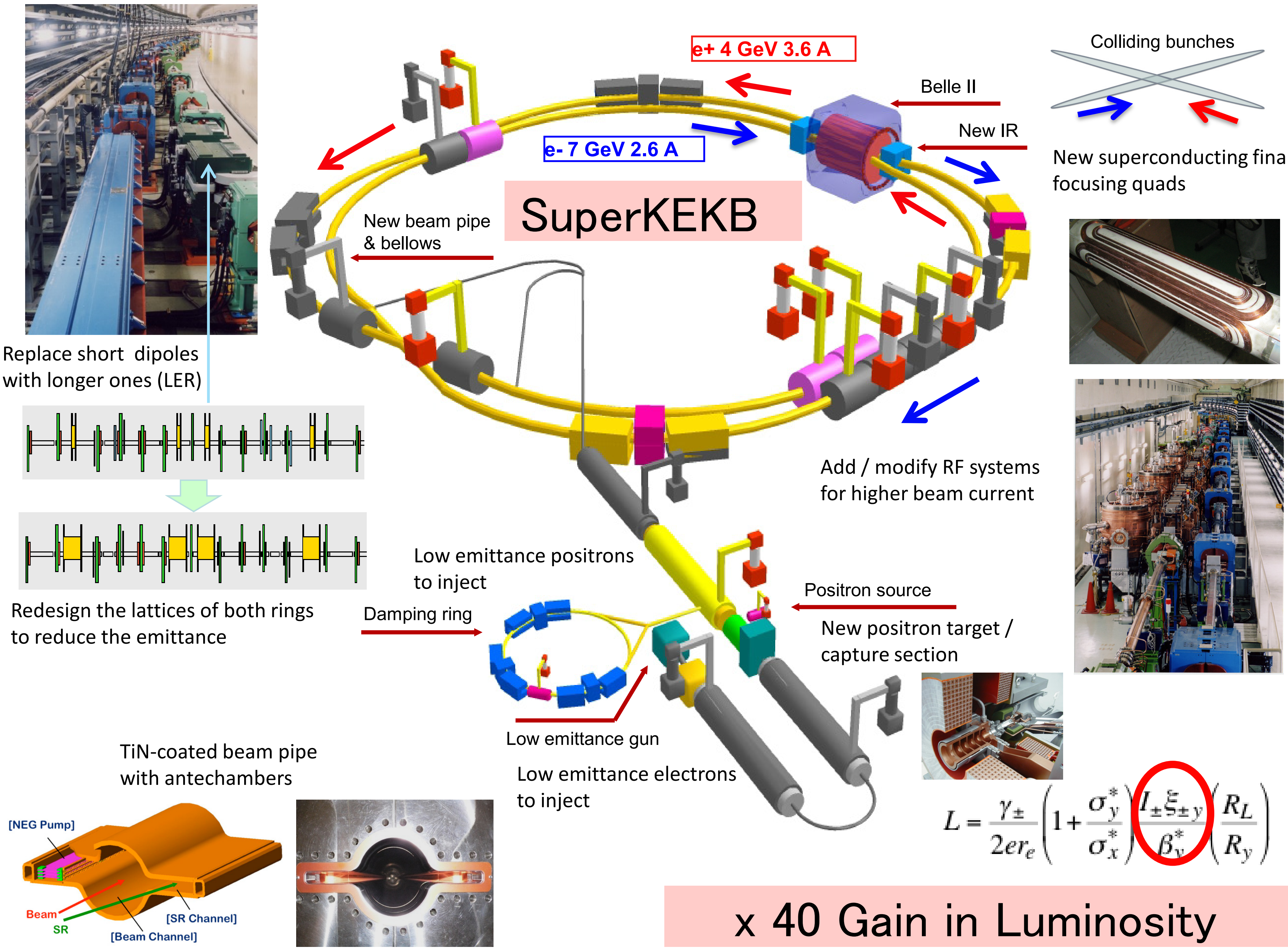
- Longitudinal and transverse bunch-by-bunch feedbacks
- Luminosity" IP feedback

etc.

SuperKEKB

Design Concept

- “Nano-Beam” Scheme (large Piwinski angle and no crab waist in the baseline design).
- Use the KEKB tunnel.
  - No option for polarization at present.
  - Running at τ/charm threshold has yet been considered.
- Reuse the components of KEKB as much as possible.
  - Preserve the present cells in HER.
    - This is a big change since IPAC’10.
  - Replace dipole magnets, reusing other main magnets in LER arcs.
  - IR region is fully reconstructed.
- Change beam energyes:
  - 3.5/8.0 $\rightarrow$ 4.0/7.007 GeV
  - LER : Longer Touschek lifetime and mitigation of emittance growth due to the intra-beam scattering
  - HER : Lower emittance and lower SR power


SuperKEKB
e+ 4 GeV 3.6 A
e- 7 GeV 2.6 A
Belle II
New IR
Colliding bunches
New superconducting final focusing quads
New beam pipe & bellows
Replace short dipoles with longer ones (LER)
Redesign the lattices of both rings to reduce the emittance
Add / modify RF systems for higher beam current
Low emittance positrons to inject
Damping ring
Positron source
New positron target / capture section
Low emittance gun
Low emittance electrons to inject
TiN-coated beam pipe with antechambers
[NEG Pump]
Beam
SR
[SR Channel]
[Beam Channel]
$L = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\left(\frac{I_\pm \xi_{\pm y}}{\beta_y^*}\right)\left(\frac{R_L}{R_y}\right)$
x 40 Gain in Luminosity

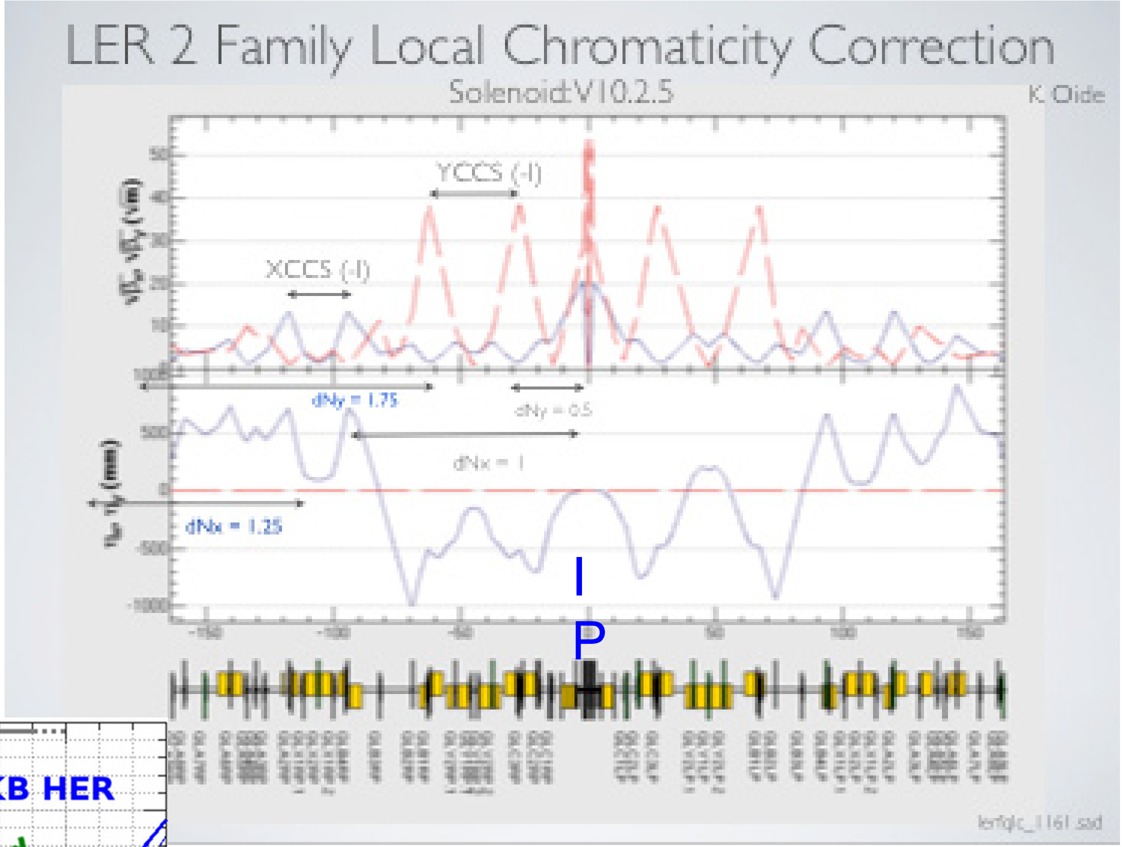
From KEKB to SuperKEKB

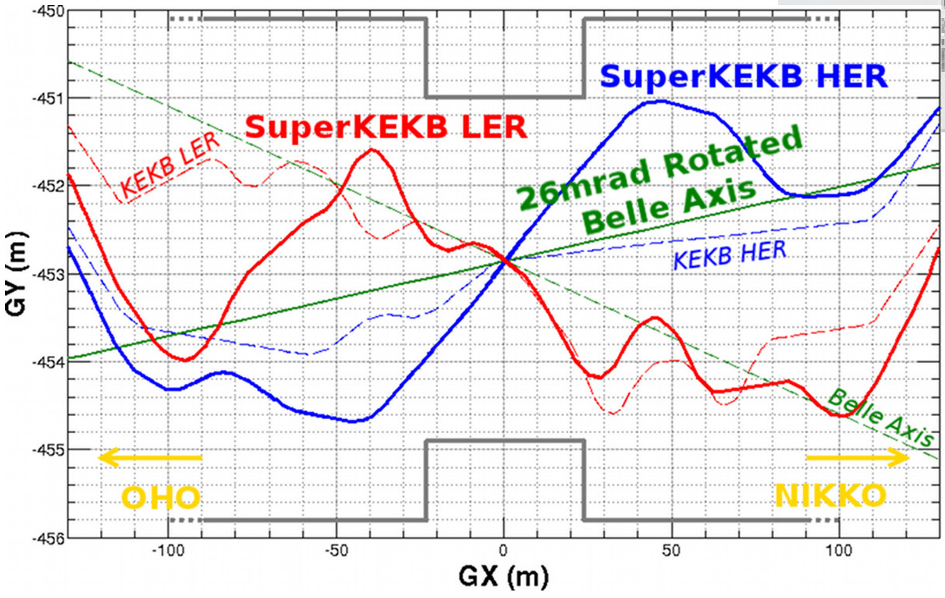
	KEKB Design	KEKB Achieved : with crab	SuperKEKB Nano-Beam
Energy (GeV) (LER/HER)	3.5/8.0	3.5/8.0	4.0/7.007
β_y^* (mm)	10/10	5.9/5.9	0.27/0.30
β_x^* (mm)	330/330	1200/1200	32/25
ε_x (nm)	18/18	18/24	3.2/4.6
$\varepsilon_y/\varepsilon_x$ (%)	1	0.85/0.64	0.27/0.25
σ_y^* (nm)	1900	940	48/62
ξ_y	0.052	0.129/0.090	0.088/0.081
σ_z (mm)	4	6 - 7	6/5
I_{beam} (A)	2.6/1.1	1.64/1.19	3.6/2.6
$N_{bunches}$	5000	1584	2500
Luminosity (10^{34} cm^{-2} s^{-1})	1	2.11	80

Y. Ohnishi et al.

IR with local chromaticity correction

LCC sections are needed for both rings in both planes.





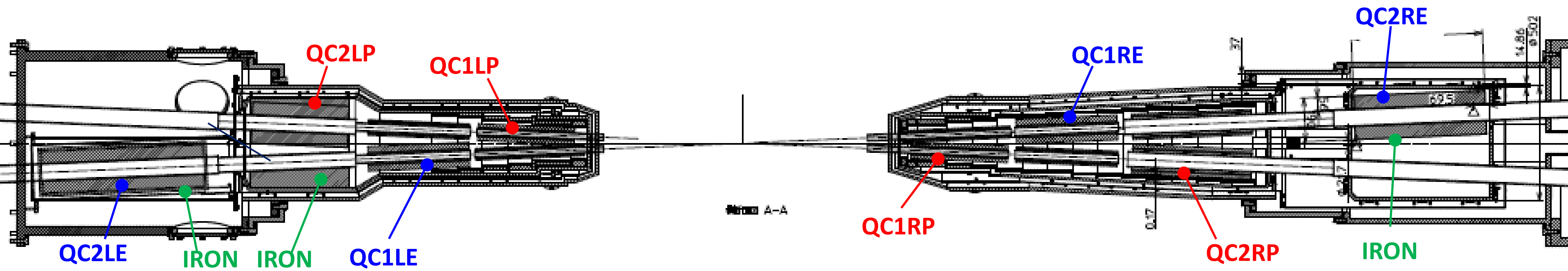
Adjust both rings to 200m long straight section of the KEKB tunnel.

Adjust circumferences of both rings.

A. Morita, K. Oide

IR Magnet Design

- The IR magnet system has recently changed by introducing more iron components for shielding the leak fields of S.C. quadrupoles.

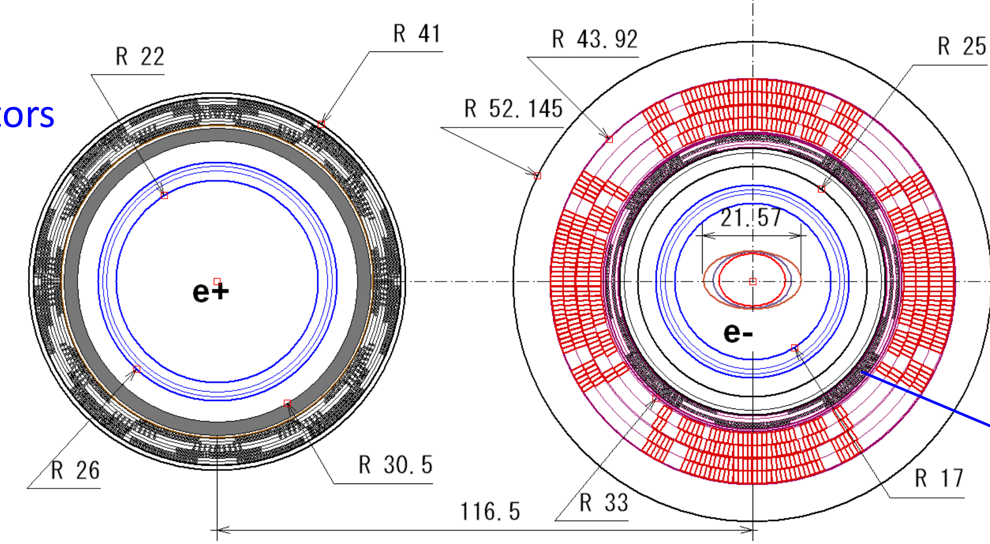


	Integral field gradient, (T/m)·m Solenoid field, T	Position from IP, mm	Magnet type	Corrector	Leak field cancel coil
QC2RE	12.91 [34.9 T/m × 0.370m]	2925	S.C. + Iron Yoke	a_1, b_1, a_2, b_4	
QC2RP	10.92 [27.17 × 0.4135]	1956	**S.C. + Iron Yoke**	a_1, b_1, a_2, b_4	b_3, b_4, b_5, b_6
QC1RE	24.99 [66.22×0.3774]	1410	**S.C. + Iron Yoke**	a_1, b_1, a_2, b_4	b_3, b_4, b_5, b_6
QC1RP	22.43 [66.52×0.3372]	932	S.C.	a_1, b_1, a_2, b_4	b_3, b_4, b_5, b_6
QC1LP	22.91 [67.94×0.3372]	-932	S.C.	a_1, b_1, a_2, b_4	b_3, b_4, b_5, b_6
QC1LE	26.67 [70.68×0.3774]	-1410	**S.C. + Iron Yoke**	a_1, b_1, a_2, b_4	b_3, b_4, b_5, b_6
QC2LP	10.96 [27.15 × 0.4135]	-1930	S.C. + Iron Yoke	a_1, b_1, a_2, b_4	
QC2LE	14.13 [20.2×0.700]	-2700	S.C. + Iron Yoke	a_1, b_1, a_2, b_4	
ESR	4.3 T (max. field)		S.C. Solenoid		
ESL	4.7 T (max. field)		S.C. Solenoid(**Iron bobbin**)		

M. Tawada, N. Ohuchi et al.,

QC1E with iron yoke

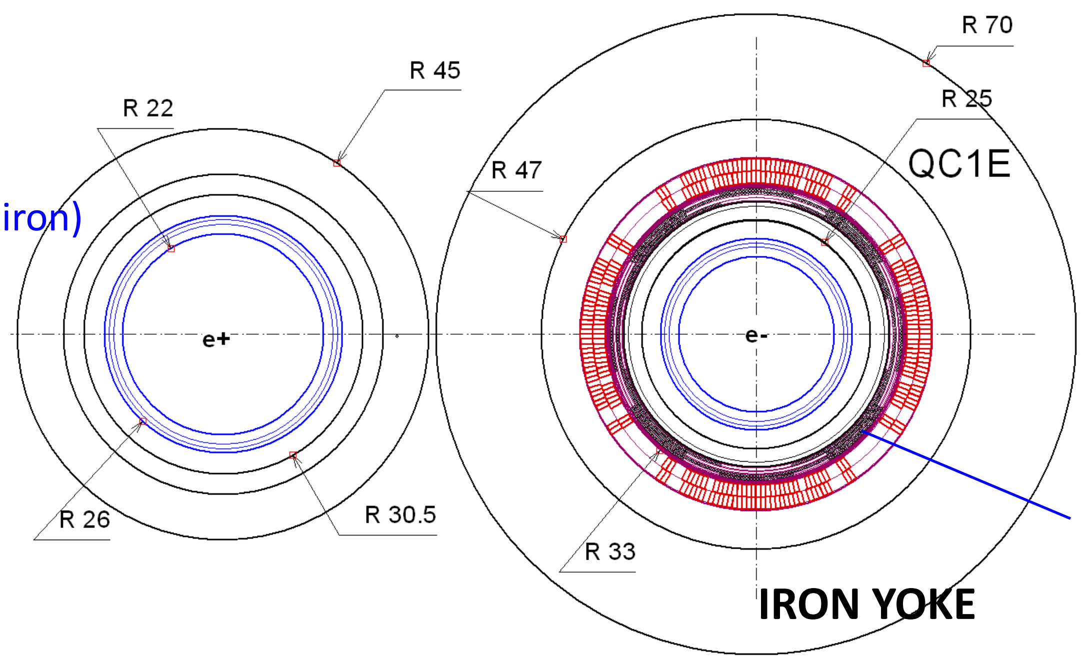
SC cancel correctors
b_3, b_4, b_5, b_6



QC1E without iron yoke (OLD DESIGN)

SC correctors
a_2, b_1, a_1, b_4

Magnetic shield (iron)



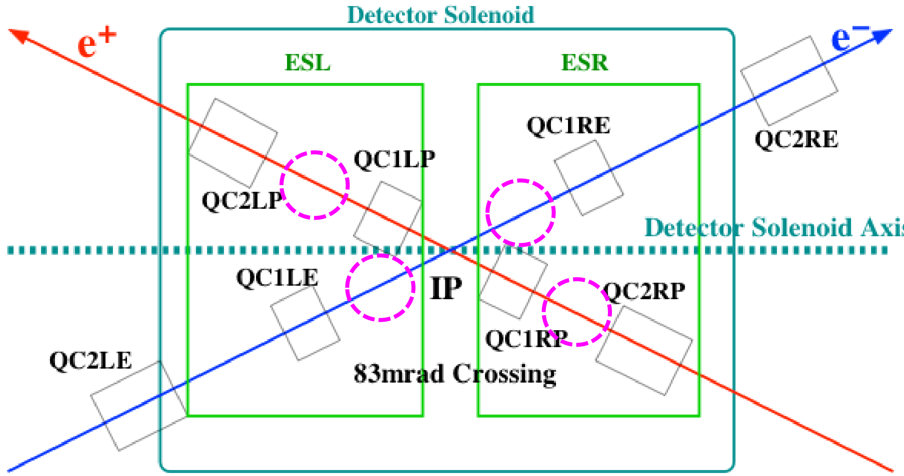
QC1E with iron yoke (**NEW DESIGN**)

SC correctors
a_2, b_1, a_1, b_4

M. Tawada, N. Ohuchi et al.,

IR odeling

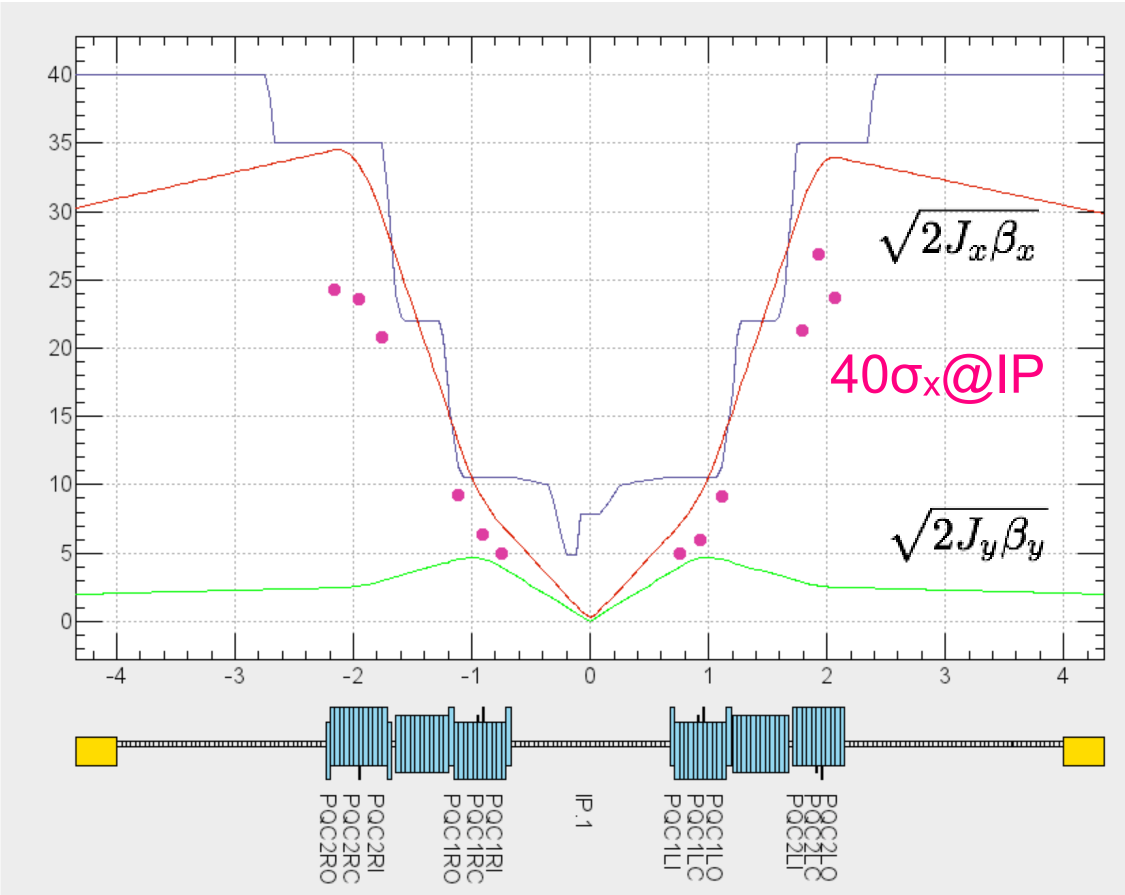
- Dynamic apertures are strongly limited by nonlinear leakage fields of IR magnets for counter-rotating beams.
  -> More iron-Yokes have been introduced.



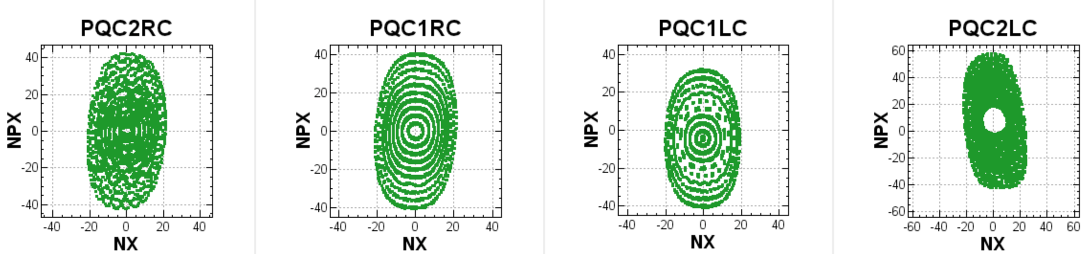
A. Morita et al., THPZ006

- IR optics is now being finalized, using 3-dimensional field maps.

Physical Aperture of IR in LER



Linear optics
$30\sigma_x$: r = 35 mm @ QC2
->
Tracking simulation
$40\sigma_x$: r = 28 mm @ QC2



Phase space distortion

Y. Ohnishi

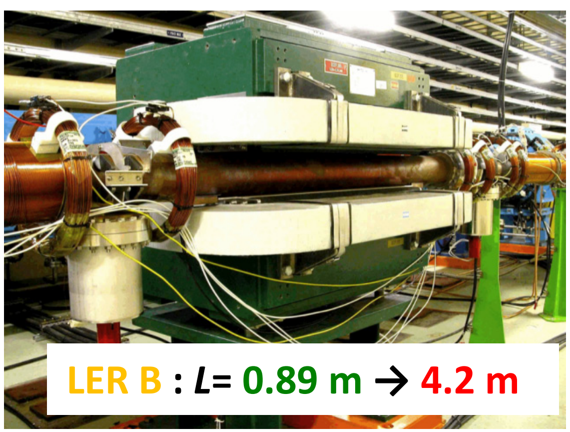
Magnet

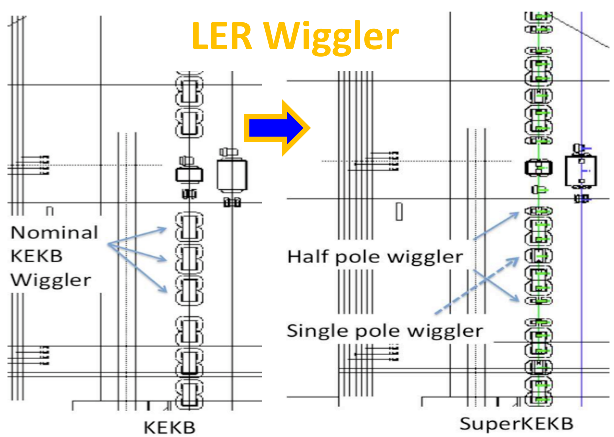
- In order to reduce the horizontal emittance of both beams to 1/5 ~1/10 of KEKB's values, a large number of magnets need to be rearranged, replaced and added.

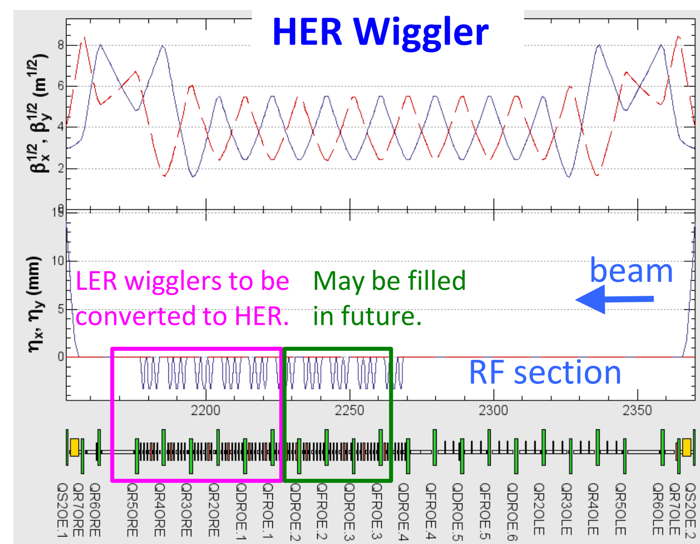
➢ LER arc section:
  - ✓Replace bending magnets (~100) with new longer ones.

➢ LER wiggler section:
  - ✓New 56 single pole wigglers and 112 half pole wigglers will be added to the existing normal ones to double the wiggler cycles.

➢ HER wiggler section:
  - ✓Wiggler magnets will be installed.
  - ✓For 6 wiggler sections among 10, present LER wiggler magnets will be reused.





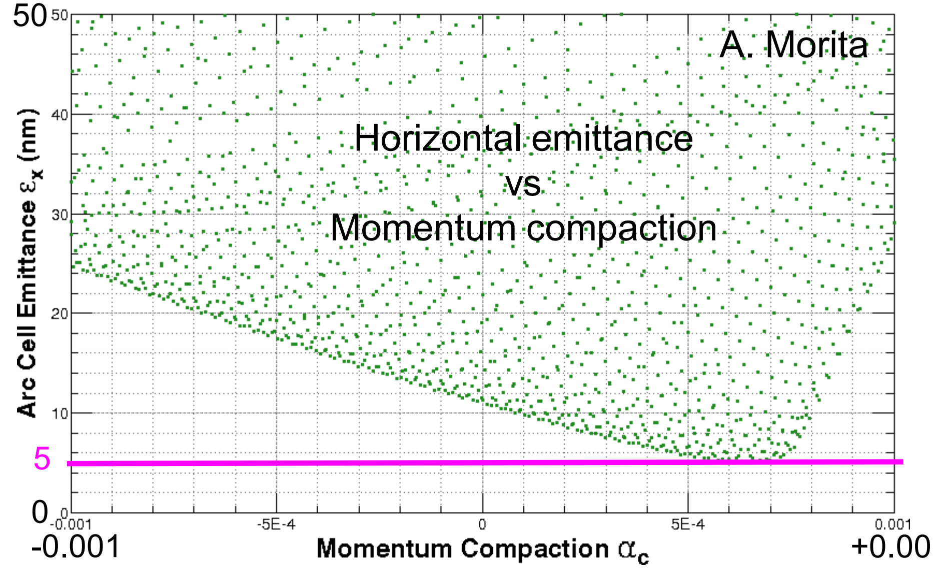


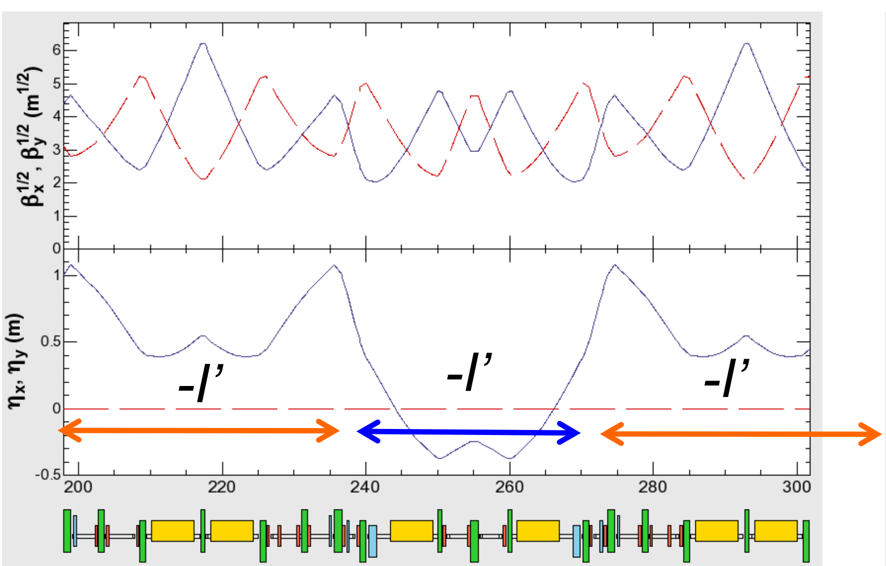
K. Shibata, Europhysics Conf. on High Energy Physics 2011

HER Arc Optics

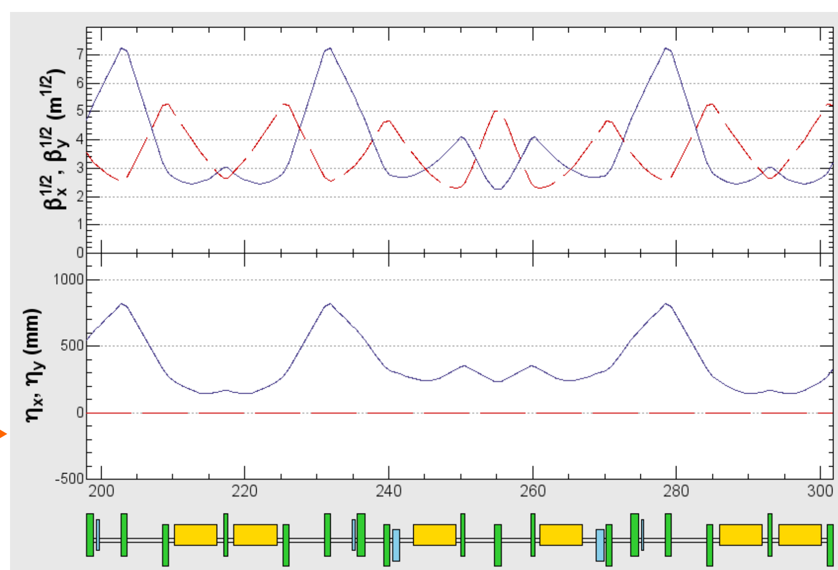
HER emittance can be decreased to ~5 nm preserving the KEKB cell structure.

-> Reuse KEKB HER arc sections(magnets, beampipes, BPMs, etc).





KEKB: 24 nm @ 8 GeV



SuperKEKB 5.2 nm @ 7 GeV

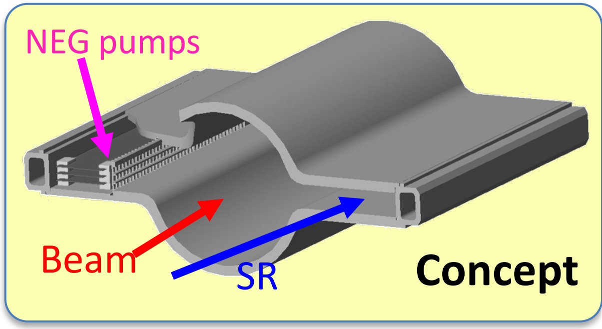
Antechamber beam pipe

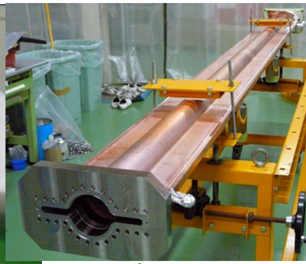
- To cope with the electron cloud issues and heating problems, ante-chamber type beam pipes are adopted with a combination of TiN coatings, grooved shape surfaces and clearing electrodes.

➢ LER arc section:
  - ✓Beam pipes are replaced with new aluminum-alloy pipes with antechambers. (~2000 m)

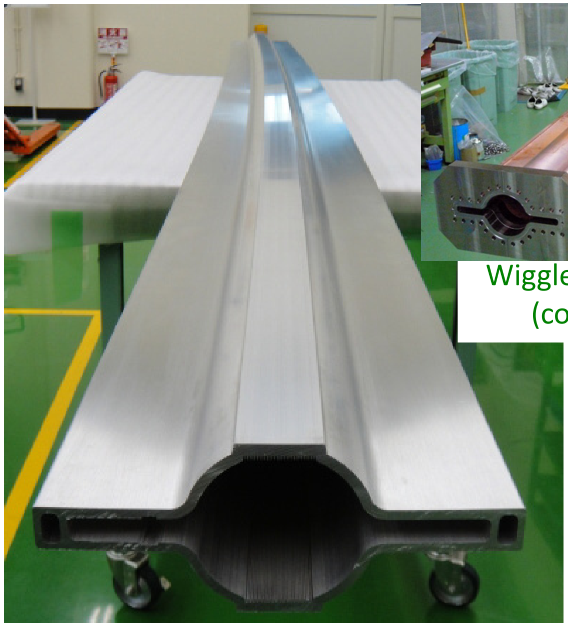
➢ HER arc section:
  - ✓Present copper beam pipes are reused.
  - ✓Since the HER energy is reduced from 8.0 to 7.0 GeV, SR power at normal arc section is more or less the same as KEKB.

➢Wiggler section (both ring):
  - ✓Copper beam pipes with antechambers are used.





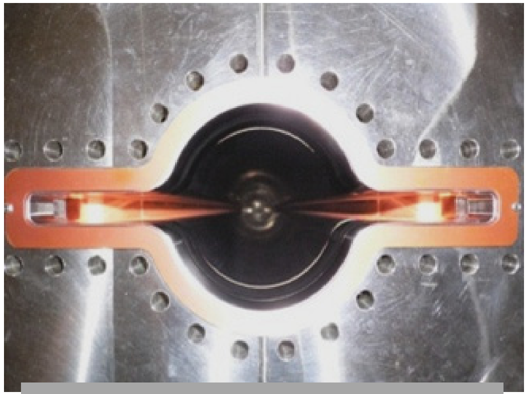
Wiggler section (copper)



Arc section (aluminum)

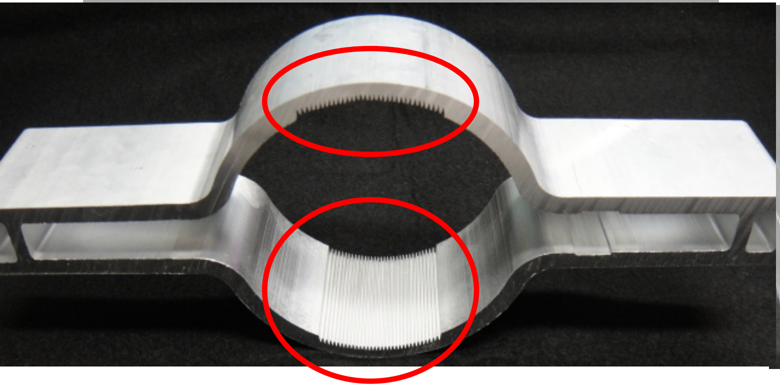
Countermeasure against e-cloud

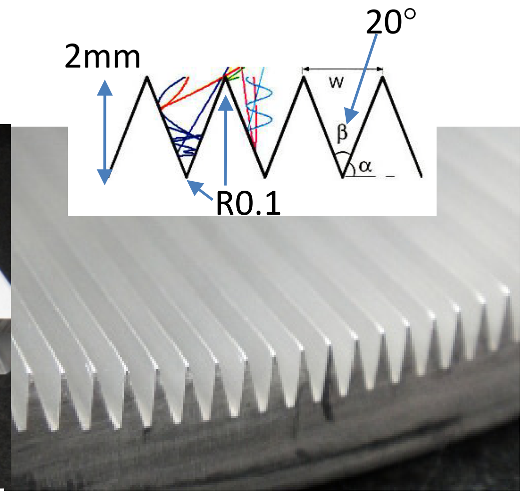
- Wiggler section:
  - ✓Electrons are attracted by the clearing electrode, which is mounted on the inner surface of beam pipe.
- In bending magnet (Arc section):
  - ✓Effective SEY is structurally reduced by the groove surface with TiN coating on top and bottom of beam channel.
- Drift space:
  - ✓Electron cloud is mitigated by TiN coating and solenoid field.

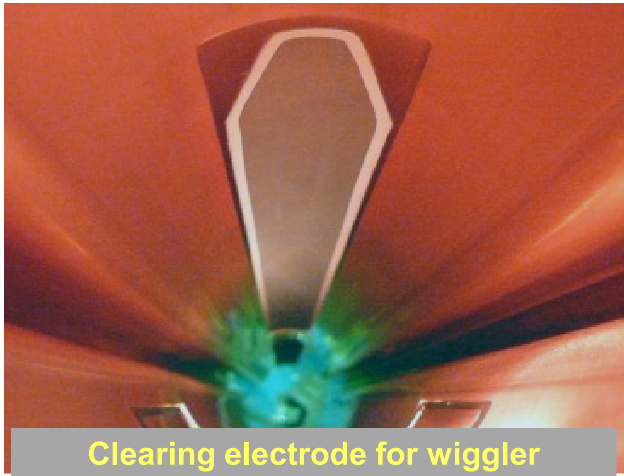


TiN coating on copper duct

Groove surface of beam pipe in bending magnet. (w/o TiN coating)



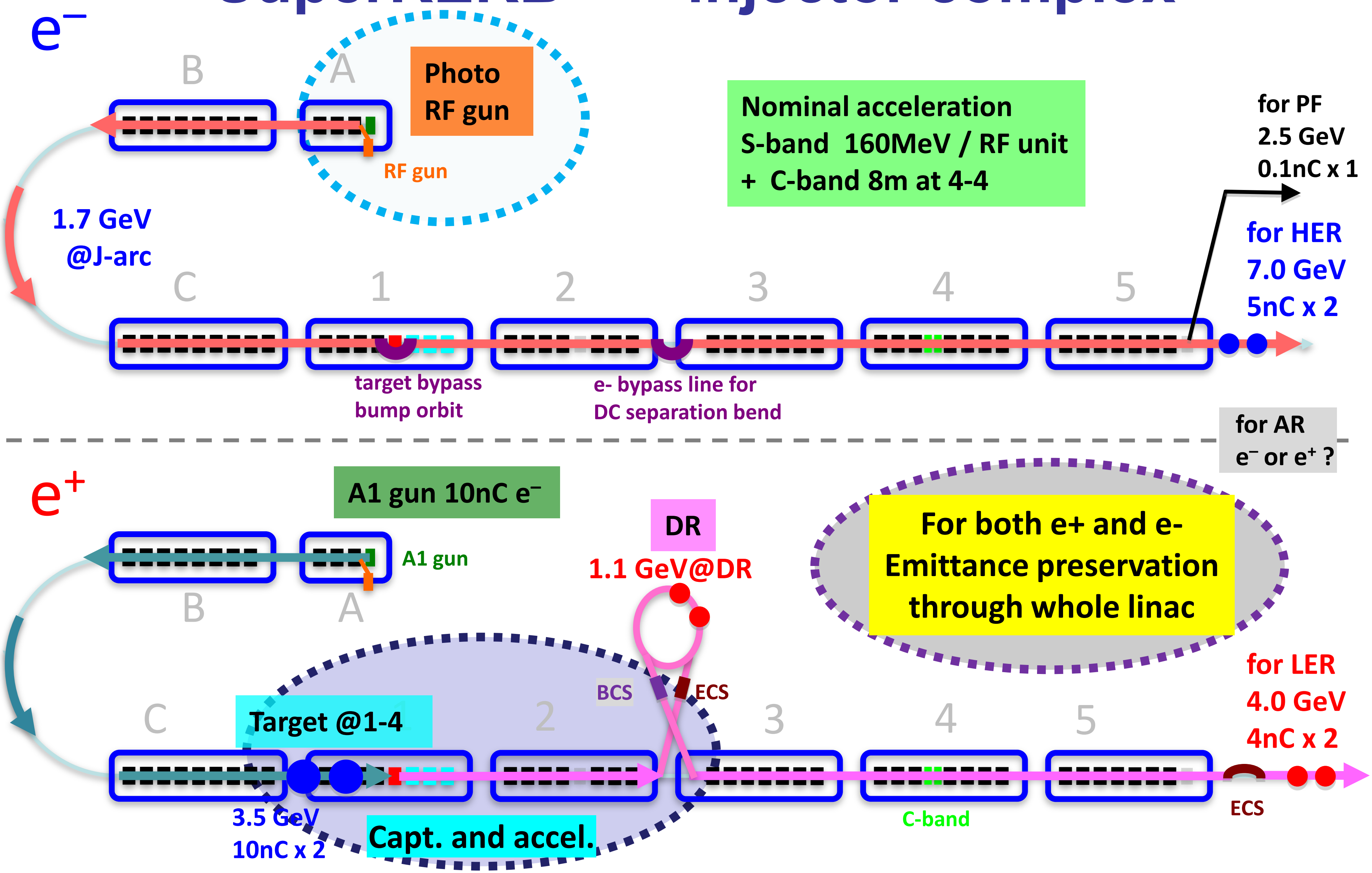




Clearing electrode for wiggler section (Inside view)

K. Shibata, Europhysics Conf. on High Energy Physics 2011

SuperKEKB injector complex



SuperKEKB Status

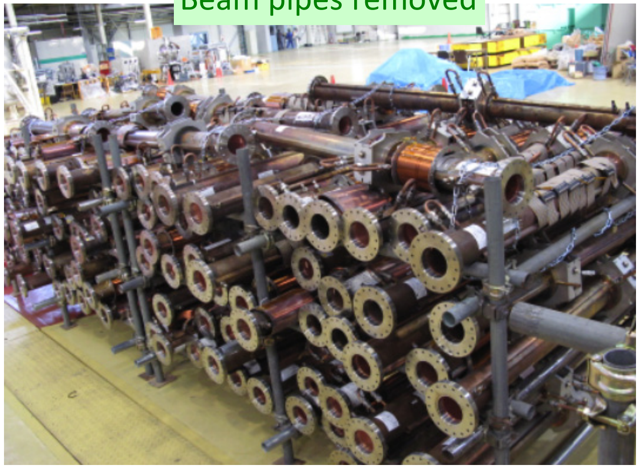
- 22 Jun. 2010: A budget of 10 Billion Yen announced
  - The MEXT, the Japanese Ministry that supervises KEK, has announced that it will appropriate a budget of 100 oku-yen (approx $110M) over the next three years starting this Japanese fiscal year (JFY2010) for the high performance upgrade program of KEKB. This is part of the measures taken under the new "Very Advanced Research Support Program" of the Japanese government. ("KEKB upgrade plan has been approved", Press Release 23 Jun 2010; KEK web site)
- 30 Jun. 2010: KEKB operation was shut down, and KEKB upgrade started.
- 24 Dec. 2010: SuperKEKB approved in FY2011 budget
  - The Cabinet of Japan announced the national budget plan of JFY2011 last Friday, where SuperKEKB upgrade was approved as requested by MEXT. This will be final decision of SuperKEKB after approval by the Japanese Diet. ("Green light from the Cabinet", M. Yamauchi to Belle II members)
- SuperKEKB construction has started. Dismantle KEKB is going on. Mass fabrication of magnets, beam pipes, etc. has started.
- Commissioning will start in the second half of FY2014.

K. Akai

Dismantle KEKB

- Remove LER beam pipes.
- Remove LER magnets.
  - Bending magnets and steering magnets.
  - Wiggler magnets.
  - They were moved to stock area for reuse.
- Dismantle IR components.
- Remove radiation shield.

Beam pipes removed



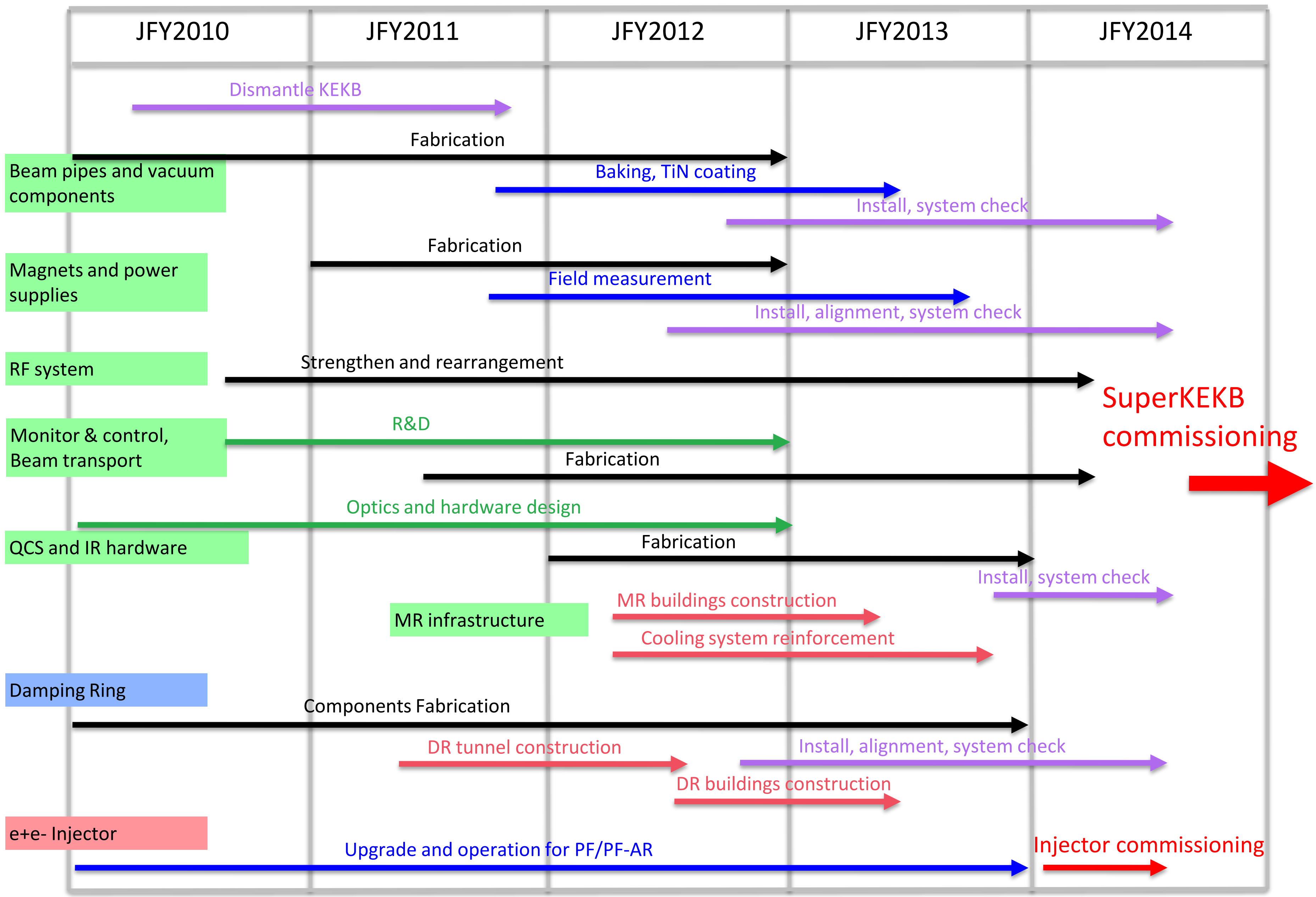
After LER bending magnets removed

Magnets to be reused moved to stock area

M. Masuzawa et al.

SuperKEKB construction schedule

Revised on Jun. 28, 2011



K. Akai

Summary

- SuperB and SuperKEKB have been approved. Now a new generation of B-factories has been kicked off.
- To realize the luminosity of ~ 10^{36} cm^{-2} s^{-1}, many other works are steadily in progress.
- Both projects will push back the luminosity frontier with competition and collaboration.

Thank you for your attention.