Closing

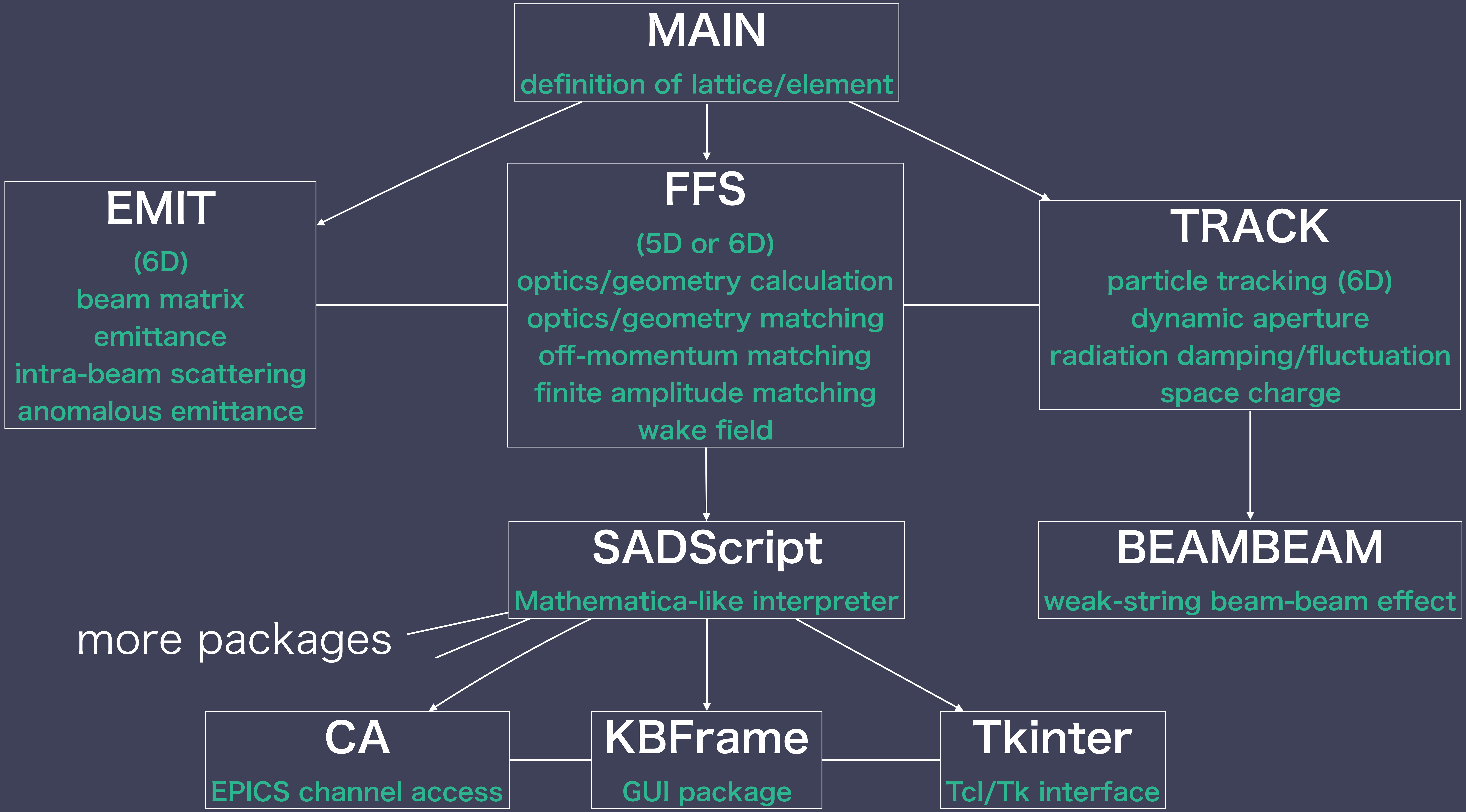
Y. Ohnishi

Name	Oral Title (10)	Notes
Katsunobu Oide	A Brief Introduction to SAD with an Example of Designing an Electron Storage Ring	
David C. Sagan	Software Sustainability and Toolkits: How to Program for the Accelerator Simulation Problems of Tomorrow	
Laurent Deniau	MAD Next Generation Overview	
Yiwei Wang	Beam Optics Design of the CEPC Collider Ring with SAD	
Yoshinori Kurimoto	Particle Tracking with Space Charge Effect using Graphics Processing Unit	
Demin Zhou	Translation among SAD, MAD-X, and BMAD	
Kazuhito Ohmi	Beam-Beam Code for Circular Coliders	
Etienne Forest	FPP / PTC	
Norio Nakamura	ERL Design and Simulation using ELEGANT	
Shinji Machida	SIMPSONS for Beam Modeling in High Intensity Rings	

Name	Poster Title (6)	Notes
Akio Morita	Backported & Under Developing Items in amorita Private Repository	
Akio Morita	New EPICS Channel Access Backend	
Akio Morita	Inside of Optics & Orbit Server/Client System for SuperKEKB	
Hiroshi Sugimoto	Optics Measurement and Correction at SuperKEKB	
Ji Hongfei, Zhang Yuan	Measurement and Correction of Coupling in BEPCII/BER	
Noboru Yamamoto	Running SAD in Docker Environment	

SAD

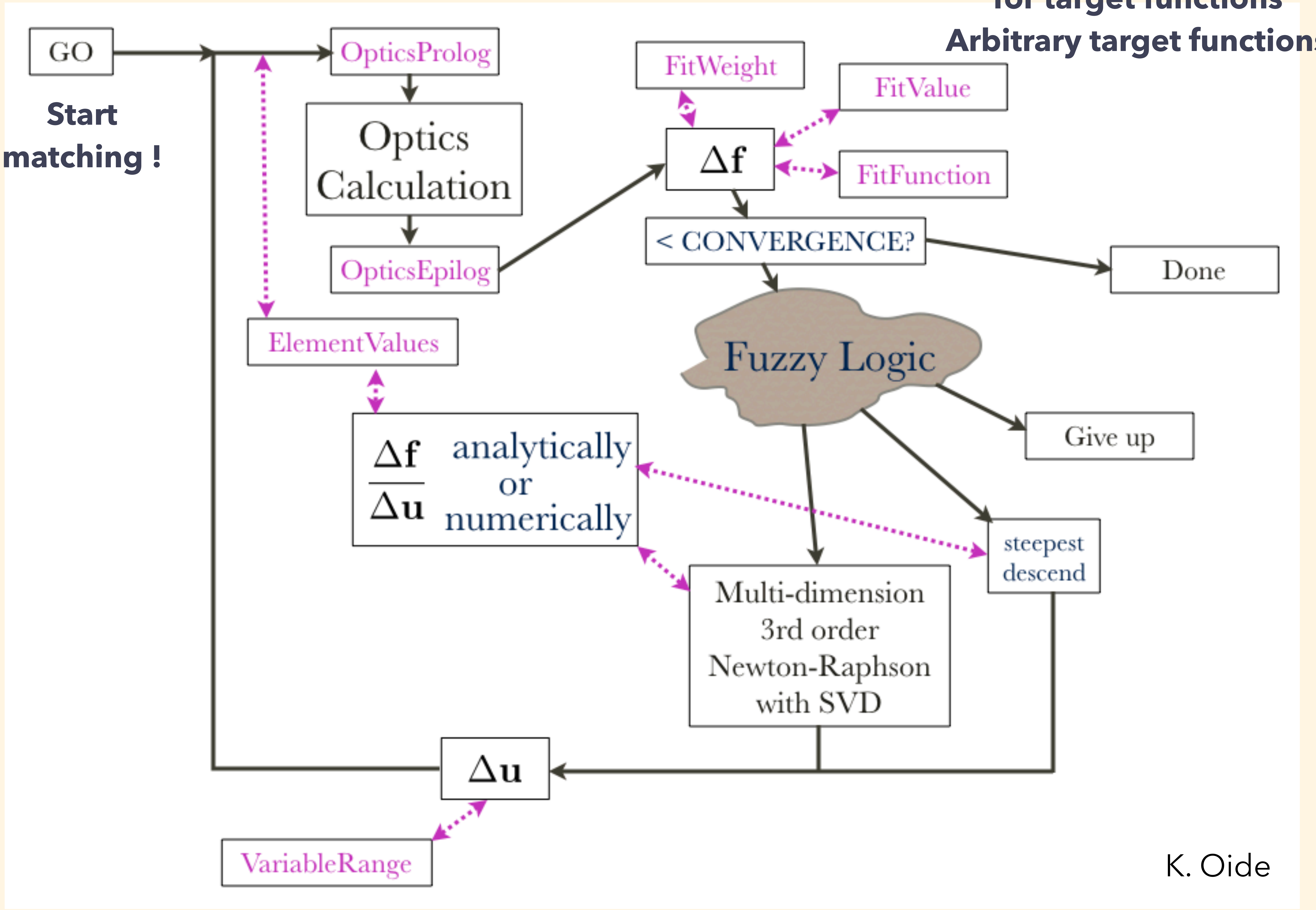
- FORTRAN and C language, Plat form: Mac OSX, Free BSD, Ubuntu, …
- Script language (**SADScript)** Interpreter for the programming environment
- **Mathematica-like interface : Interactive calculation can be performed.**
- **Many built-in functions of mathematics**: Sin[], Cos[], Bessel functions, manipulations of lists and character strings
- Graphics user interface : Tkinter with wrapping of **Tk widget toolkit** → general graphic drawings, and also to show optical functions along beam-line
- **EPICS Channel Access to get accelerator information and control accelerator magnets by online.**
    - Build-in modules: CaRead[], CaWrite[], CaMonitor[], etc.


MAIN
definition of lattice/element
EMIT
(6D)
beam matrix
emittance
intra-beam scattering
anomalous emittance
FFS
(5D or 6D)
optics/geometry calculation
optics/geometry matching
off-momentum matching
finite amplitude matching
wake field
TRACK
particle tracking (6D)
dynamic aperture
radiation damping/fluctuation
space charge
SADScript
Mathematica-like interpreter
BEAMBEAM
weak-string beam-beam effect
more packages
CA
EPICS channel access
KBFrame
GUI package
Tkinter
Tcl/Tk interface

Matching Algorithm

Start matching !

Boundary conditions for target functions
Arbitrary target functions



Optical functions for matching

Variable	Symbol	Unit
AX, AY	α_x, α_y	
BX, BY	β_x, β_y	m
NX, NY	Ψ_x, Ψ_y	1/2π
EX, EY	η_x, η_y	m
EPX, EPY	η_{px}, η_{py}	
R1, R4	r_1, r_4	
R2	r_2	m
R3	r_3	1/m
PEX, PEY	η_x, η_y physical	m
PEPX, PEPY	η_{px}, η_{py} physical	
DX, DY	$\Delta x, \Delta y$	m
DPX, DPY	$\Delta p_x, \Delta p_y$	

Geometrical parameters can be applicable.

$$G_X, G_Y, G_Z, \chi_1, \chi_2, \chi_3$$

Twiss parameters, X-Y couplings, dispersion, phase advances can be matched for the design.

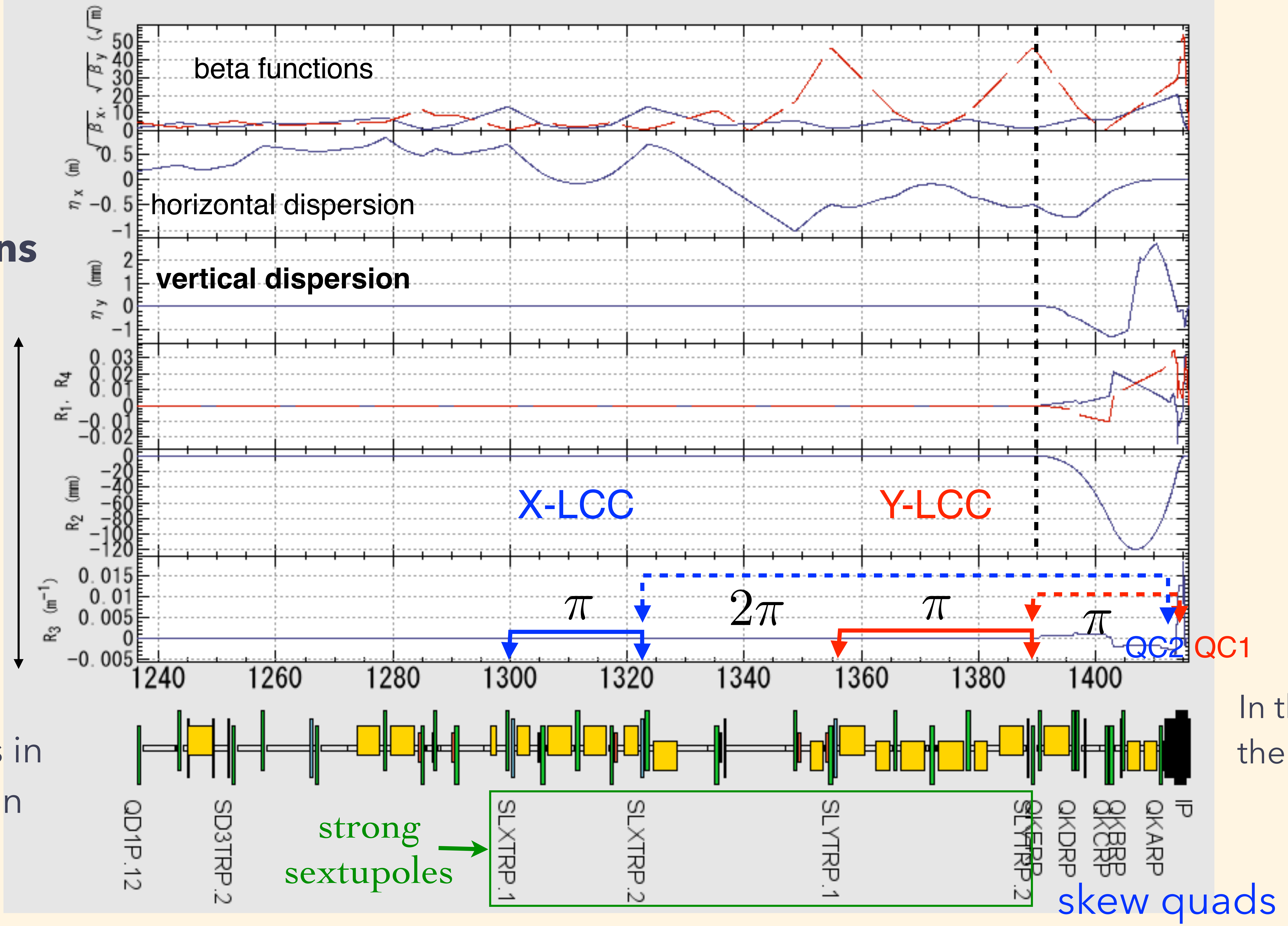
X-LCC corrects QC2 chromaticity and Y-LCC corrects QC1 chromaticity locally.

Example of SuperKEKB LER

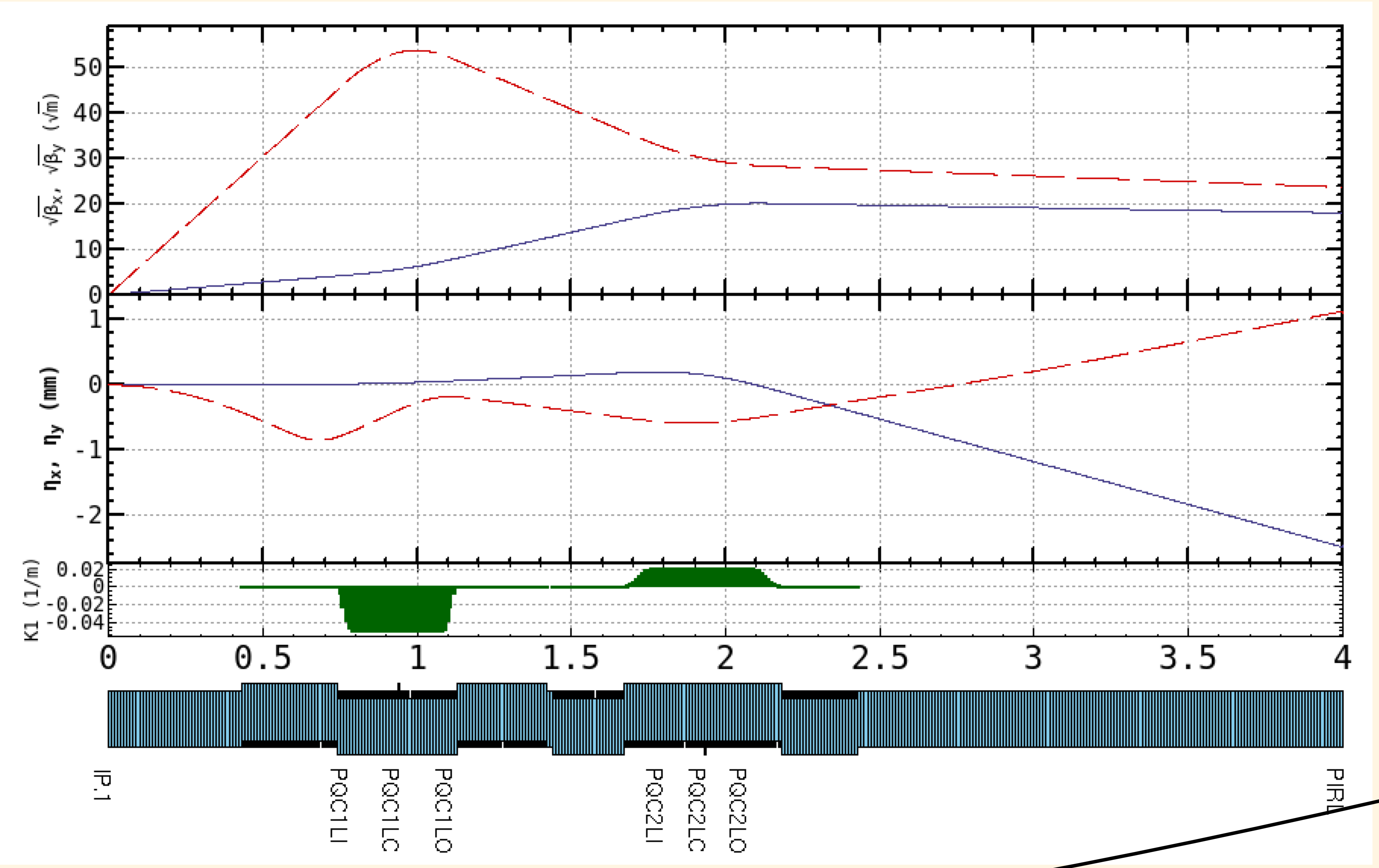
Dispersions

X-Y couplings

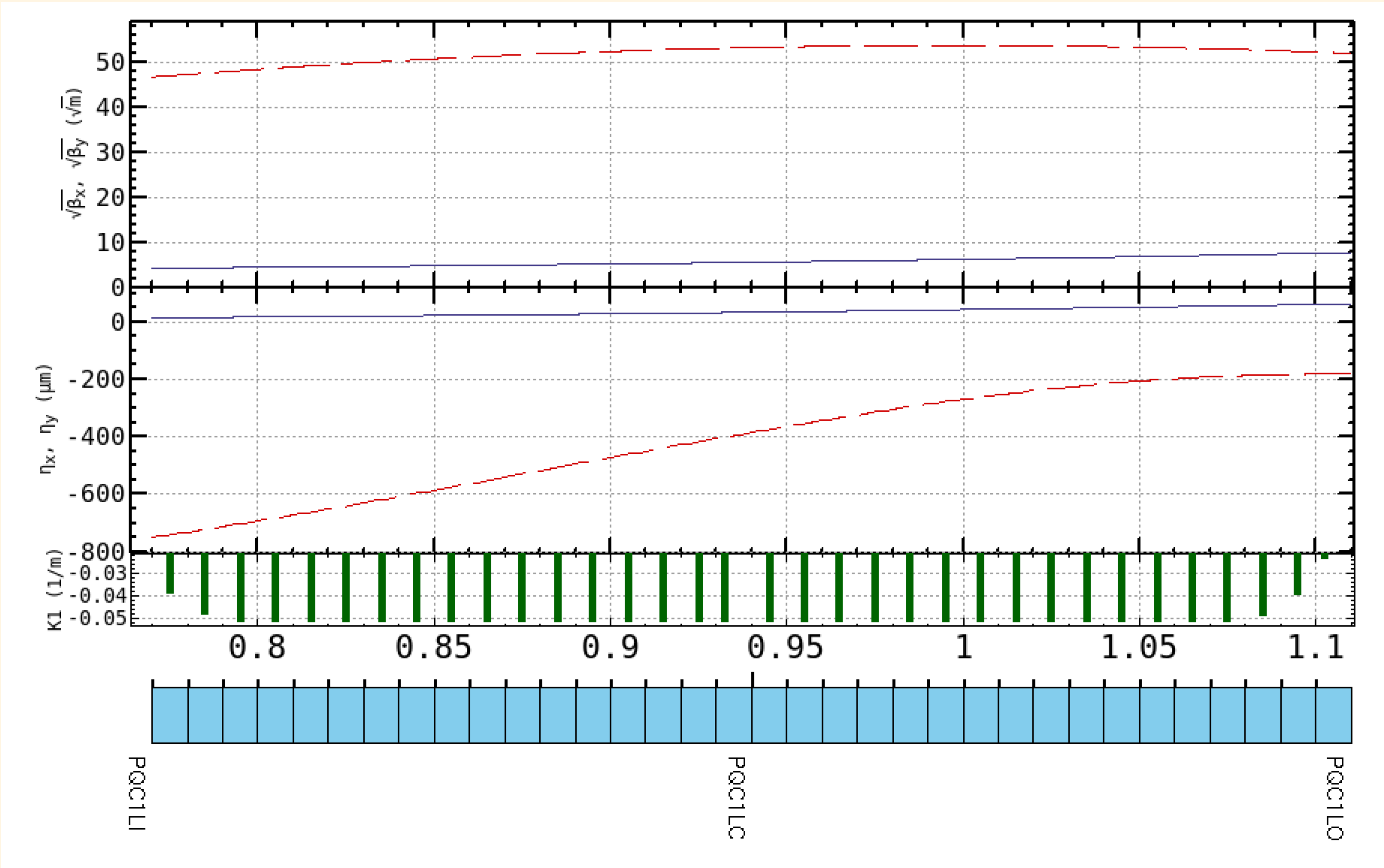
to normal cells in the arc section



In the vicinity of the IR, the solenoid axis has a slant angle (half crossing angle)



slicing by 10 mm thickness



SOL element and MULT element are alternately located.

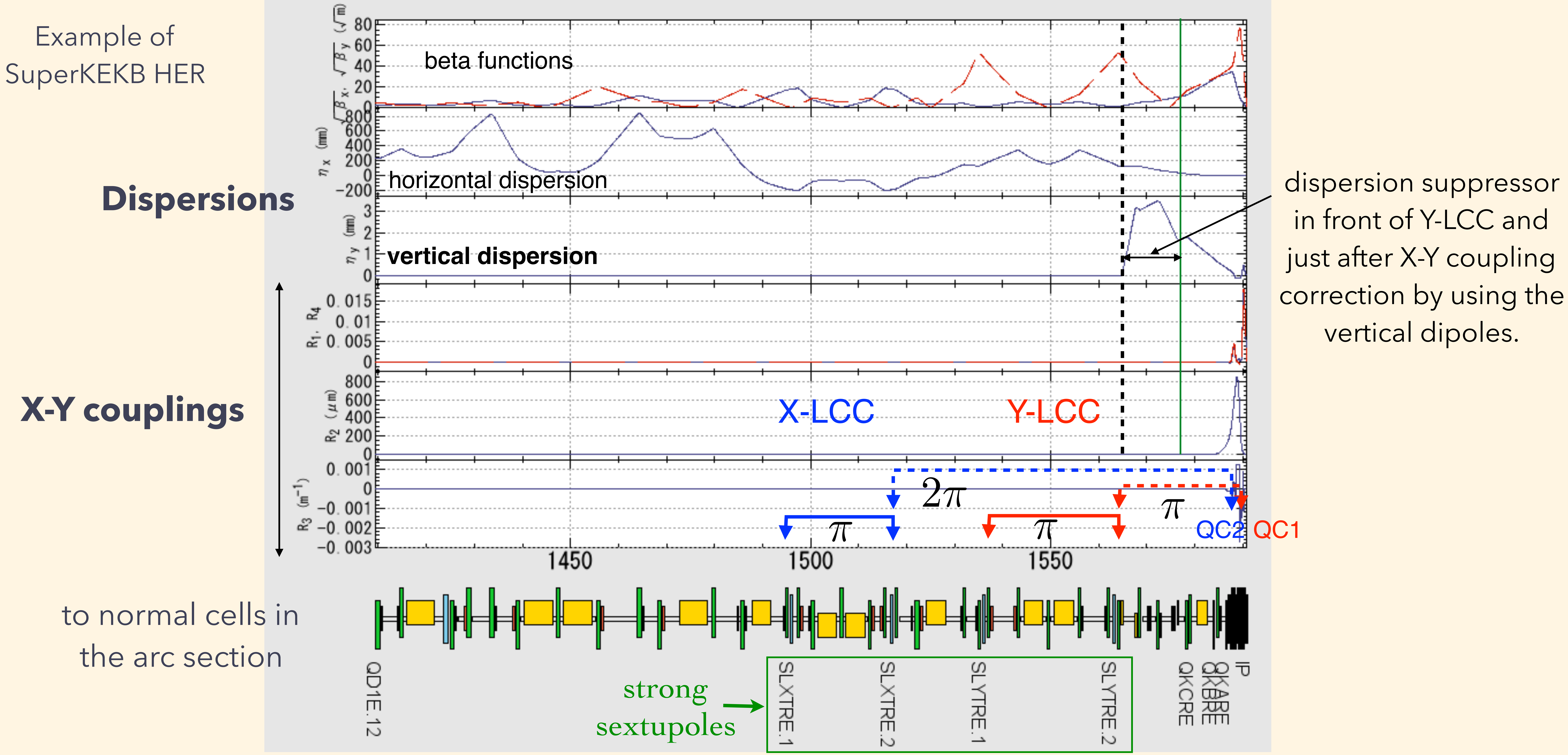
```
SOL    ESLP90  =(BZ =-1.4491822514672696     F1 =.01 )
 ;

MULT   QC1LP935=(L =.01  DY =.0015 ROTATE =-.7820873903535738 DEG     EPS =100  F1 =.01   FRINGE =3 RADIUS =-.01
        K0 =-3.5794837991010675e-06   SK0 =1.1337075580588195e-05   K1 =-.051035554539387115 SK1 =2.339885633550252e-08
        K2 =-1.2248435117787572e-05   SK2 =-.0001658935184916688    K3 =-.6480033940478035   SK3 =-1.8099100511823278e-05
        K4 =2.399453715473375    SK4 =.18582116276107088  K5 =-11348.983858094427  SK5 =-12.929235989473469
        K6 =-22444.87319801368   SK6 =-13251.863487780642 K7 =-178203.28383496378  SK7 =81578.26542749848
        K8 =-15510303319.209291  SK8 =34867088387.066345  K9 =410166949850363.6    SK9 =211215322763.08356
        K10 =-49882116796545630. SK10 =-25507988787020544.     K11 =439805760923966140. SK11 =-176955563411381700.
        K12 =2.337478974662013e+22    SK12 =1.8334337436146997e+22  K13 =-1.8132532907364797e+26  SK13 =-9.162578852349662e+23
        K14 =-9.702466881032263e+26   SK14 =2.1714436239881486e+27  K15 =2.341549229939988e+28    SK15 =6.842664351484084e+29
        K16 =4.0213552871716696e+33   SK16 =8.865659441141272e+32   K17 =3.272864216751061e+37
        SK17 =-2.5456123214019382e+35 K18 =1.5116265792578374e+40   SK18 =-1.571893797924836e+39  K19 =1.3768670840436312e+43
        SK19 =-4.510932733735135e+42  K21 =3.647473556715029e+48    SK21 =8.65520757221054e+44 )
 ;
```

Twiss parameters, X-Y couplings, dispersion, phase advances can be matched for the design.

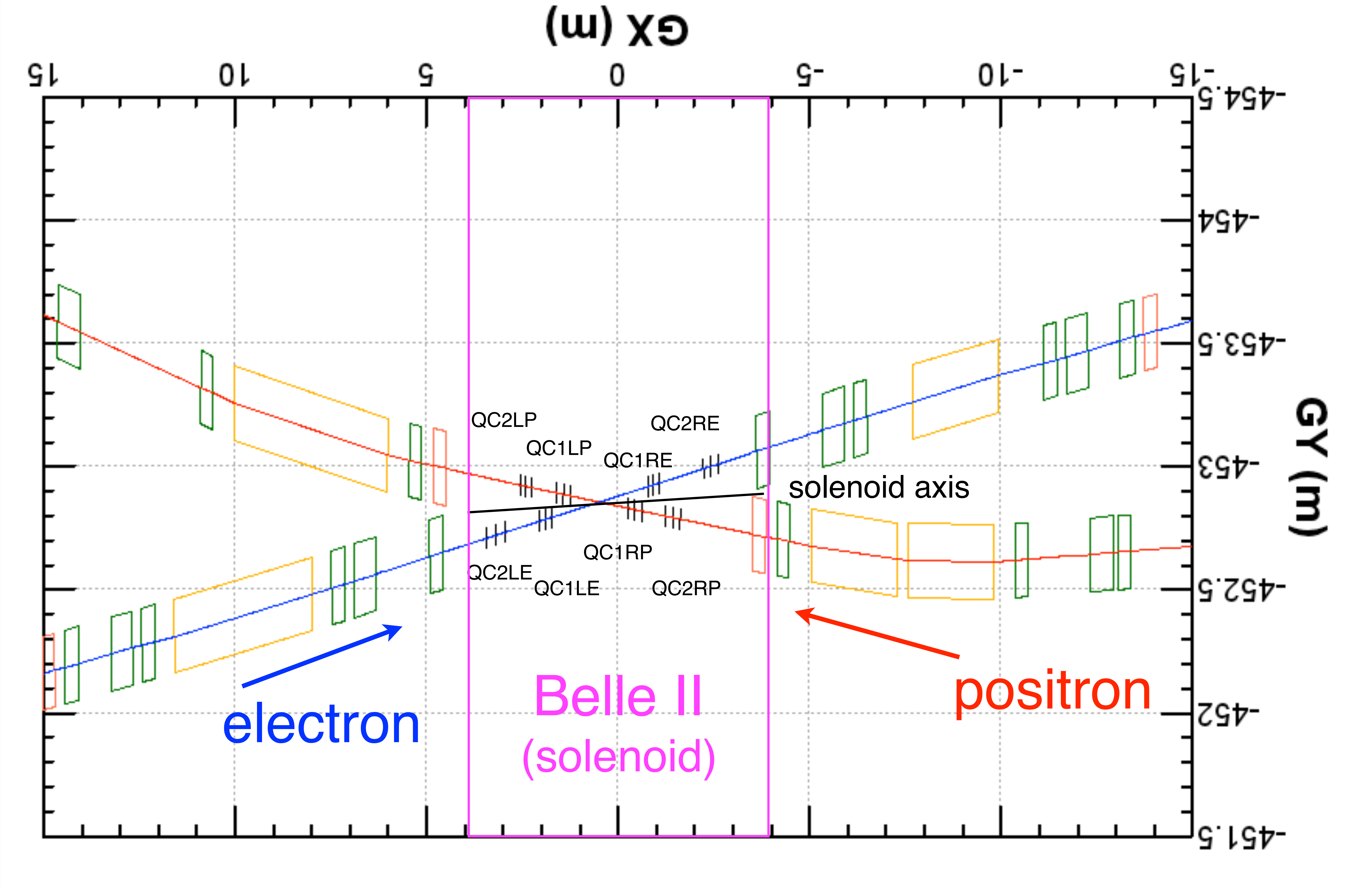
X-LCC corrects QC2 chromaticity and Y-LCC corrects QC1 chromaticity locally.

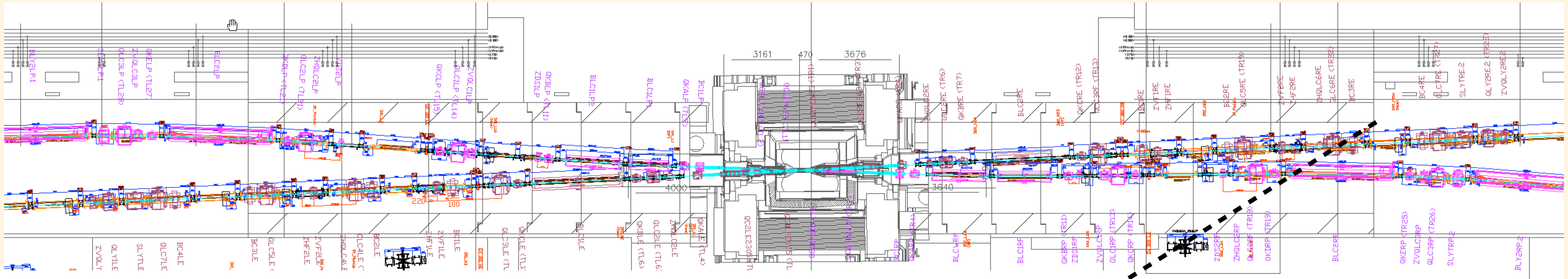
Example of SuperKEKB HER

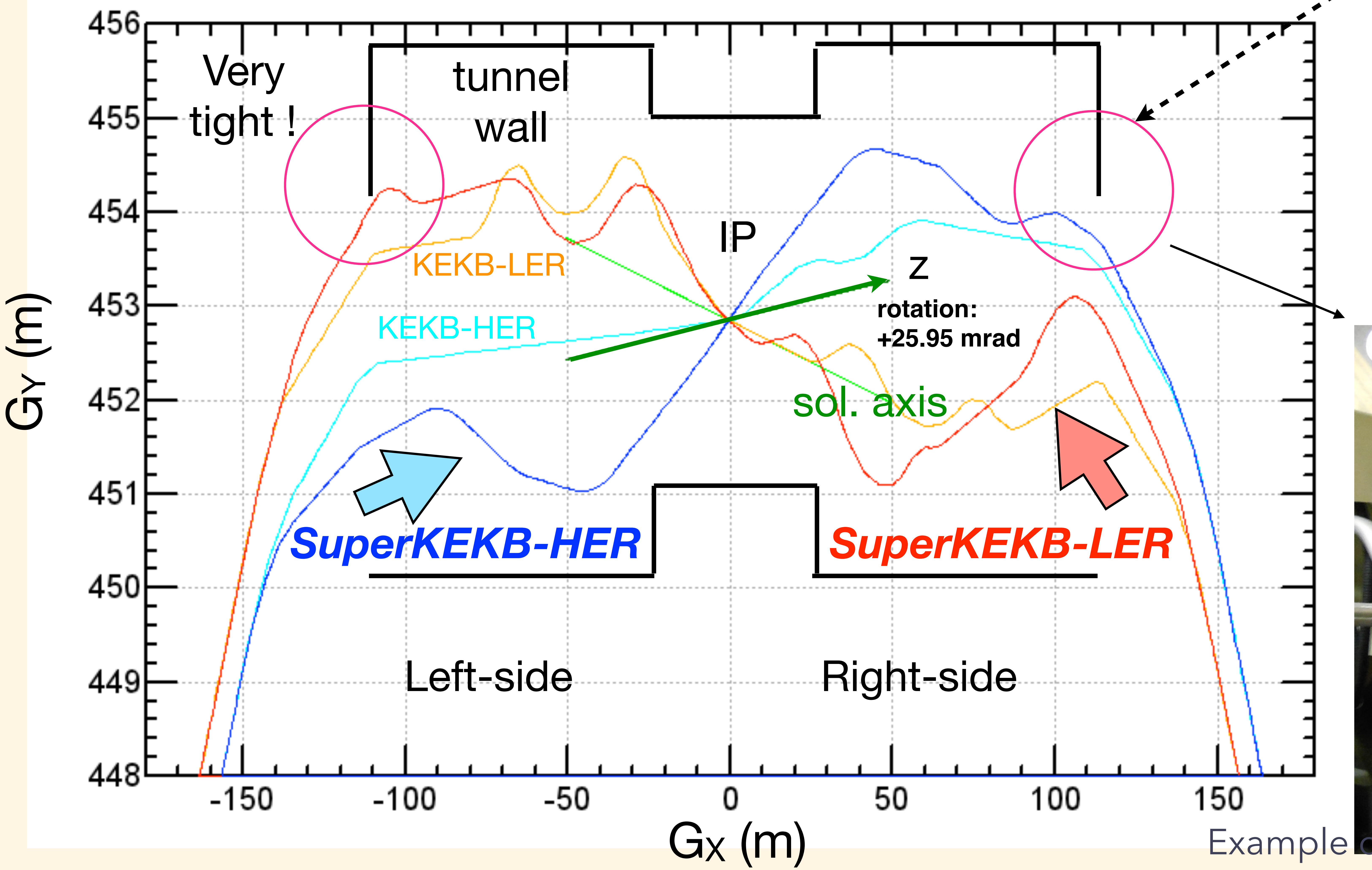


Beam Orbit in the vicinity of IP at SuperKEKB

Horizontal crossing
83 mrad



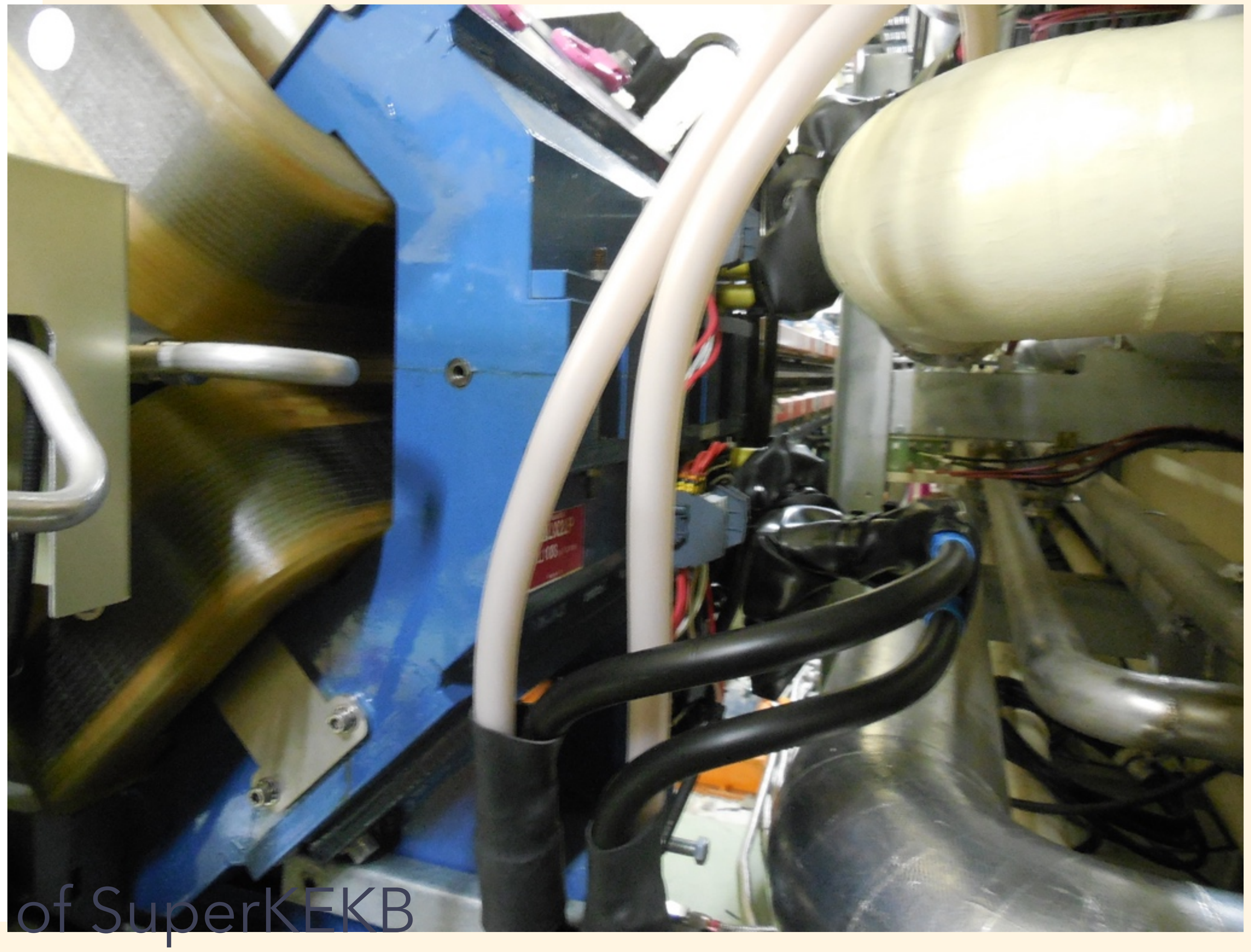




The circumferences of LER and HER must be exactly same.

Solve the interference not only between two rings but also tunnel wall.

Geometrical parameters can also be matched.

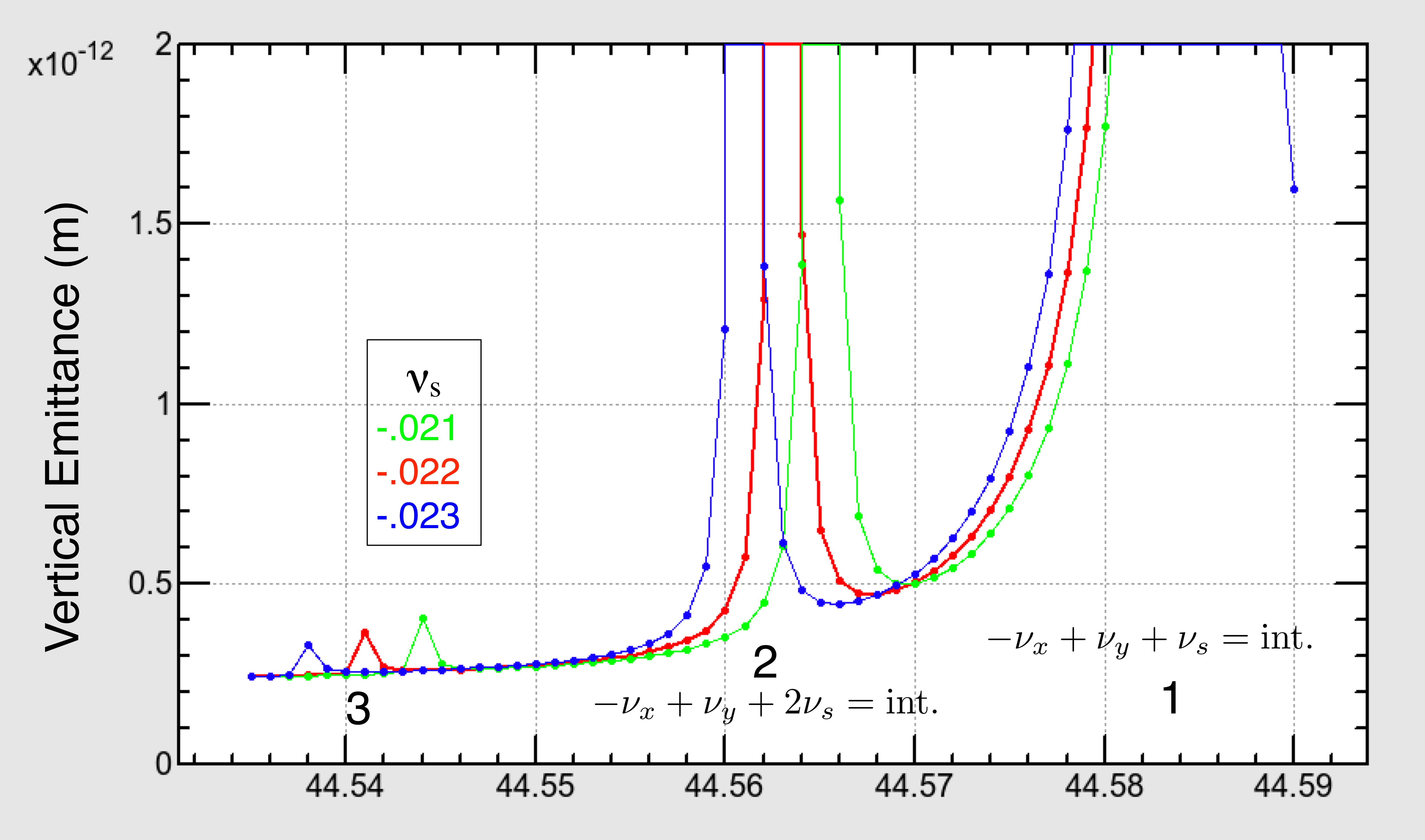


Example of SuperKEKB

EMIT

SynchroBetaEmittance in SuperKEKB LER (Phase2, July 7)

H. Koiso



ν_x

ν_x .535 ~ .590
ν_y .607

ε_y = 1.62e-13

1 $-\nu_x + \nu_y + \nu_s$
2 $-\nu_x + \nu_y + 2\nu_s$
3 $-\nu_x + \nu_y + 3\nu_s$

TRACK

em = Emittance[OneTurnInformation->True];
M_0 = OneTrunTransferMatrix/.em;
M_g = OneTurnDampingMatrix/.em;
M_d = OneTurnExcitation/.em;
{a,v} = Eigensystem[Md];

$$M_d V = V A$$

$$V^{-1} M_d V = A \qquad A = \begin{pmatrix} a_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & a_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & a_4 & 0 & 0 \\ 0 & 0 & 0 & 0 & a_5 & 0 \\ 0 & 0 & 0 & 0 & 0 & a_6 \end{pmatrix}$$

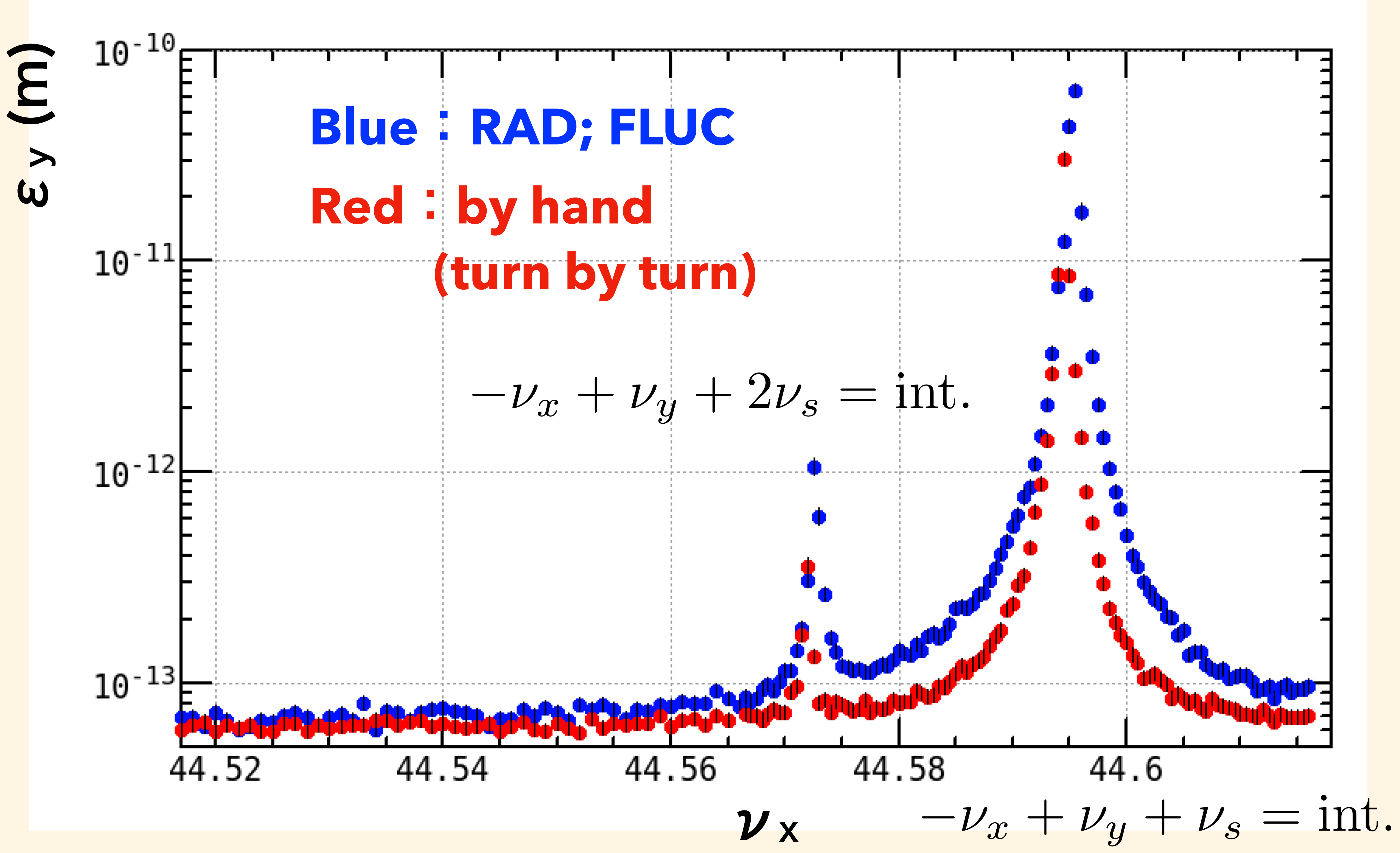
$$\vec{x}_d = V\sqrt{A_g}$$

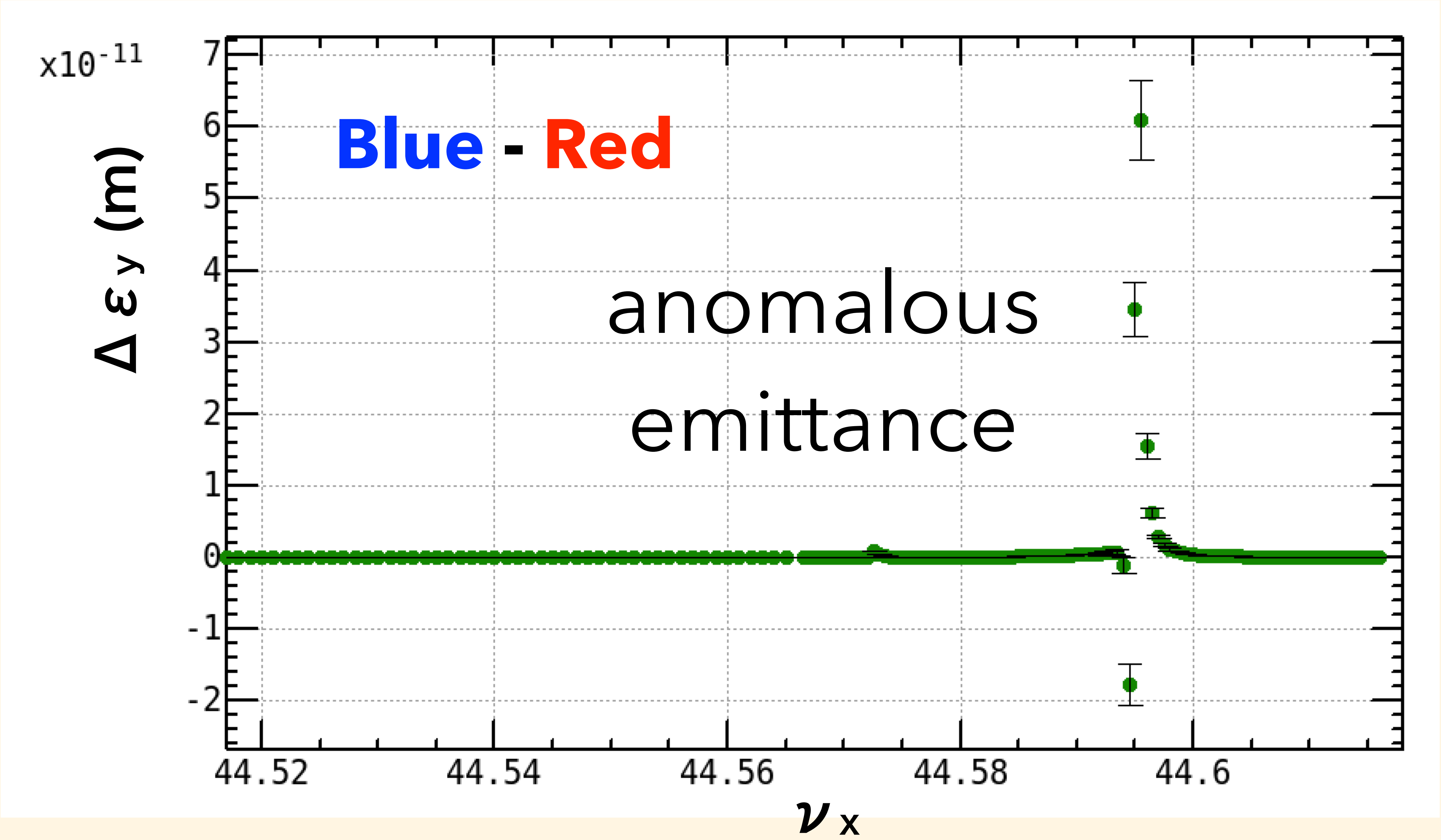
Square-root of eigen value
-> gauss random

$$M_d = < \vec{x}_d \vec{x}_d^T >$$

$$\vec{x} = M_0^{-1}(M_0 + M_g)\vec{x} + \vec{x}_d$$
$$= I + M_0^{-1} M_g \vec{x} + \vec{x}_d$$

SuperKEKB LER (Phase2, June 29)

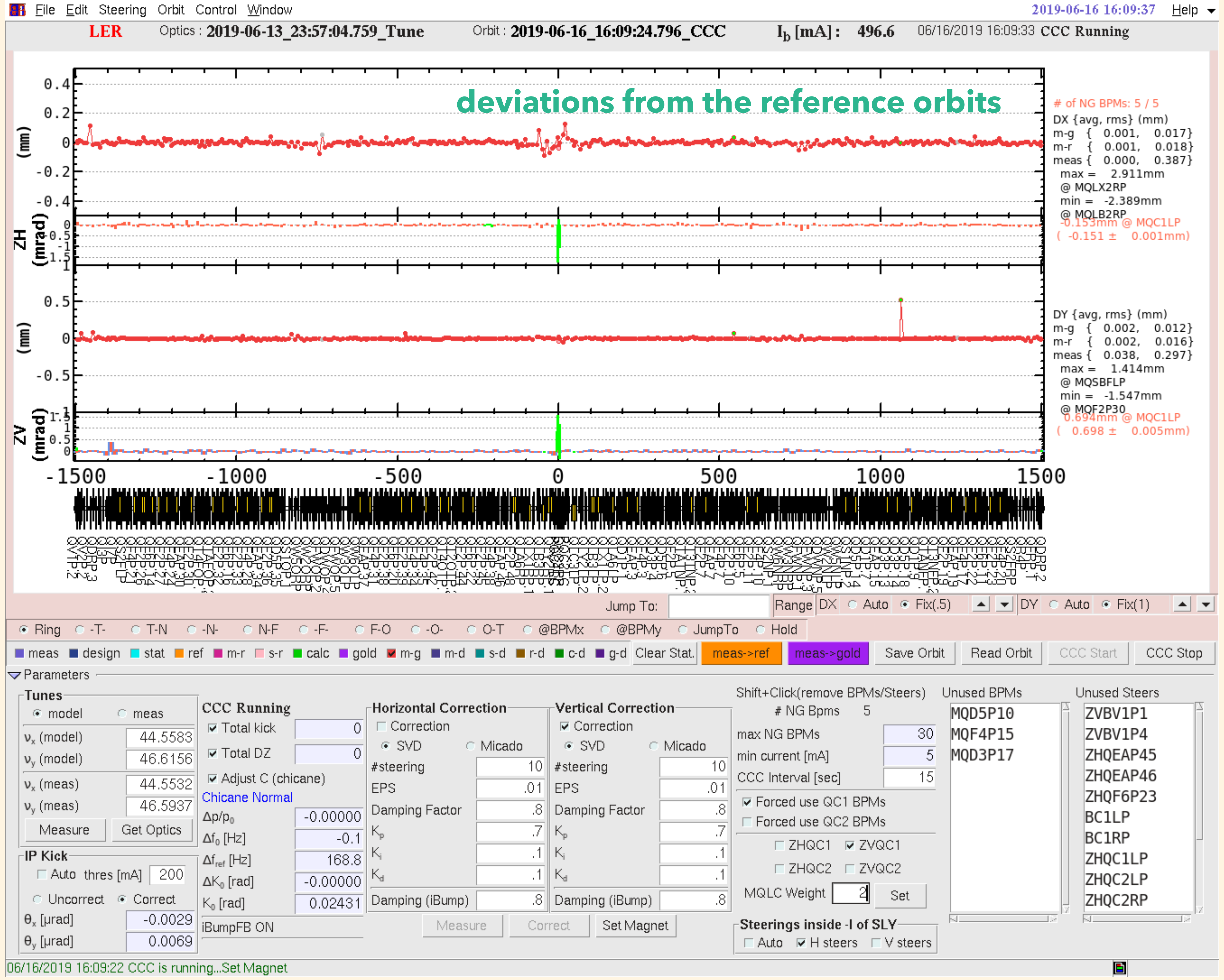




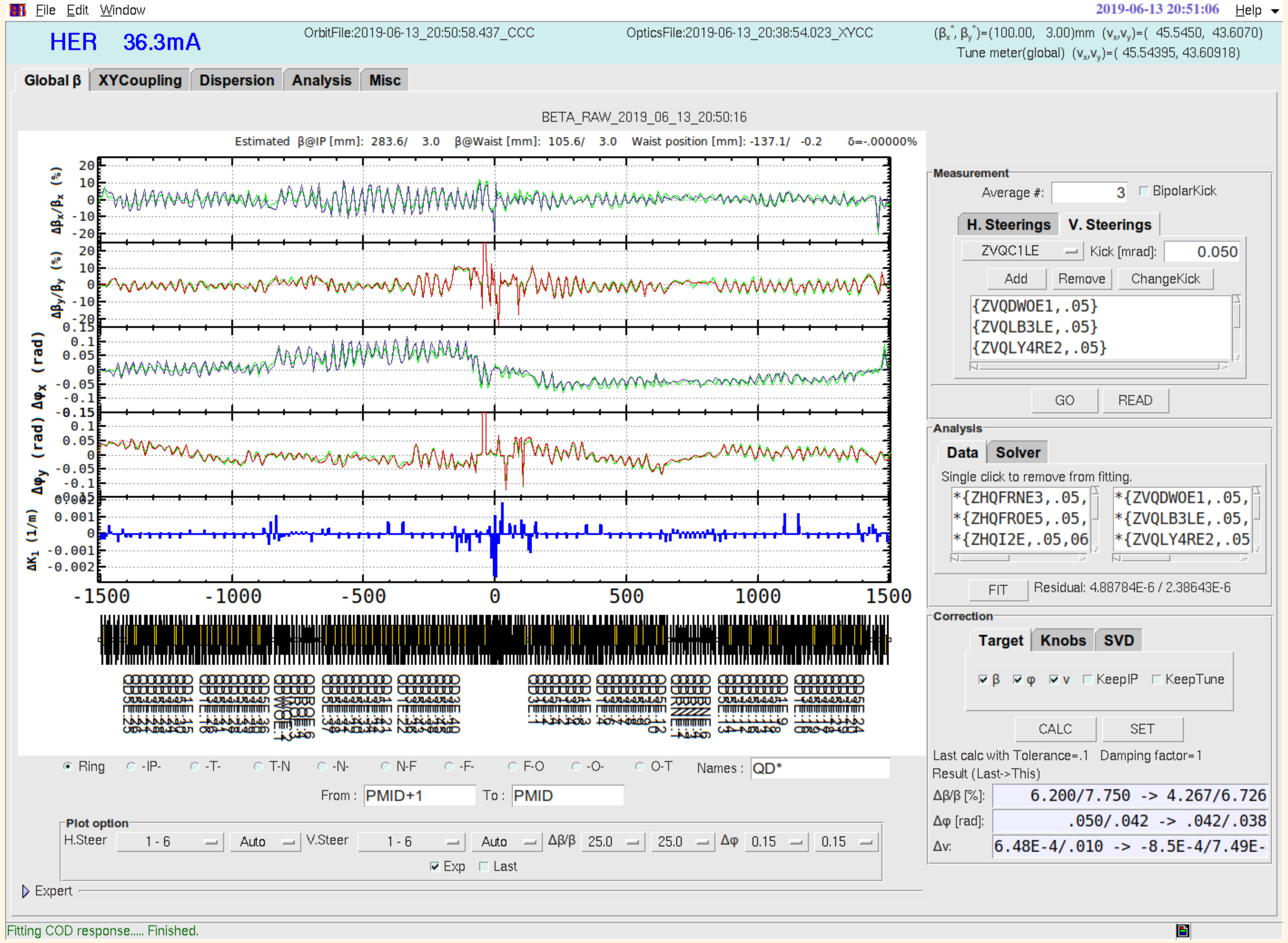
SAD + EPICS Channel Access

The keyword is ONLINE.

SuperKEKB (LER) Continuous Closed Orbit Correction (intervals of every several seconds)



SuperKEKB (HER) Correction of Beta functions



H. Sugimoto

Thank you

TSUKUBA CAMPUS TOUR

15:30 - 17:00 (90 min) : meet in front of 3-go-kan. The bus is waiting for you.
3 facilities (30 min for each) : FUJI Tunnel, TSKUBA IR, cERL
Names of participants (checked "yes" at registration) are already registered by the radiation safety management.