Analysis of field data of the wigglers in SuperKEKB LER

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Acknowledgements:

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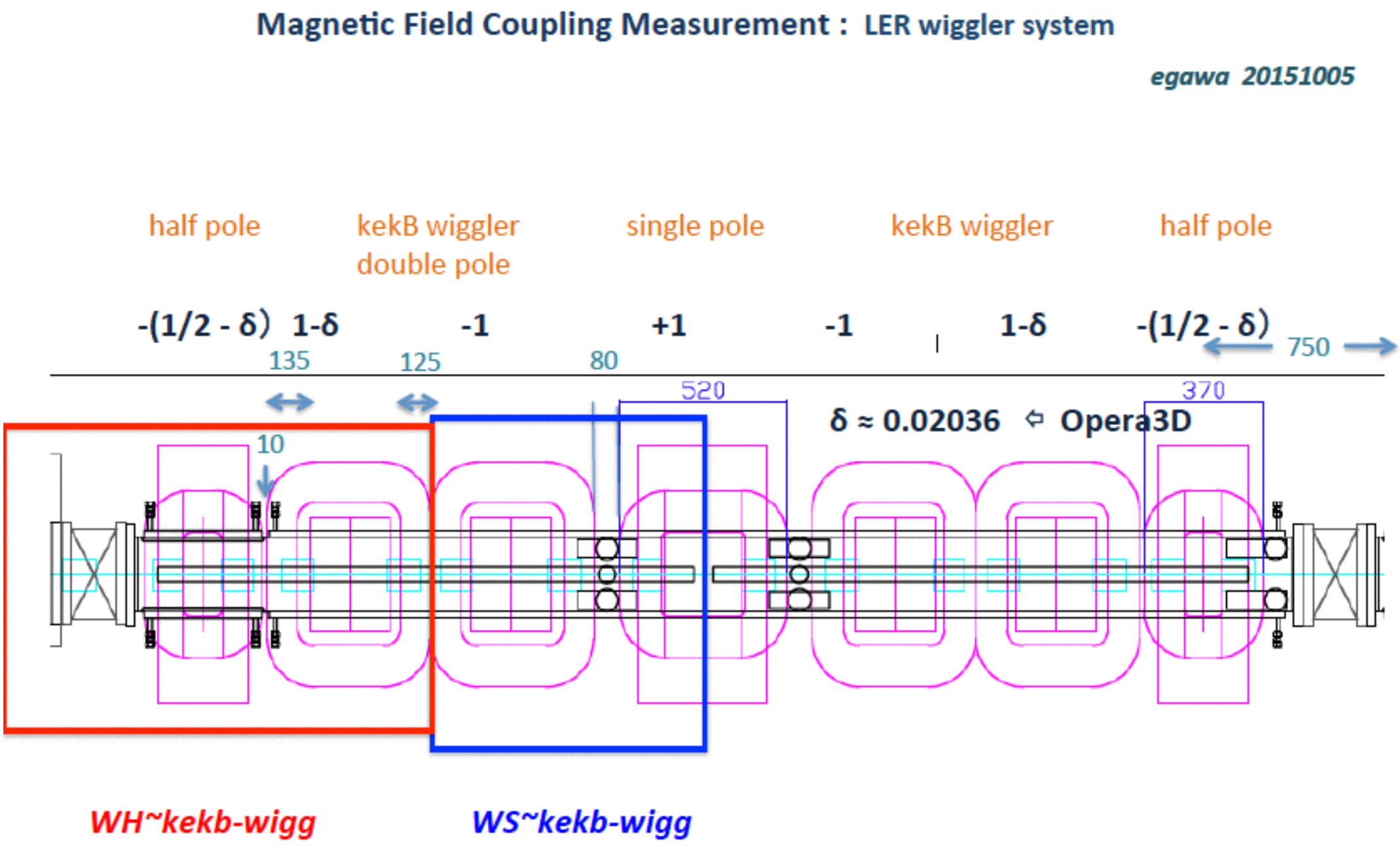
Outline

- **Background**
  - **There is larger discrepancy between measured and modelled chromaticity in SuperKEKB LER than in HER. The main difference is that there is wiggler section in LER but not in HER in phase-1 commissioning.**
- **Idea**
  - **SAD modelled wiggler with parameters K0, L, F1 (or FB1 and FB2)**
  - **The wiggler parameters used in SAD lattice should be double checked**
- **Summary**

1. Field data for wigglers in LER

➤ Measured field data from K. Egawa

- **There is interference between wiggler poles**



Courtesy of K. Egawa

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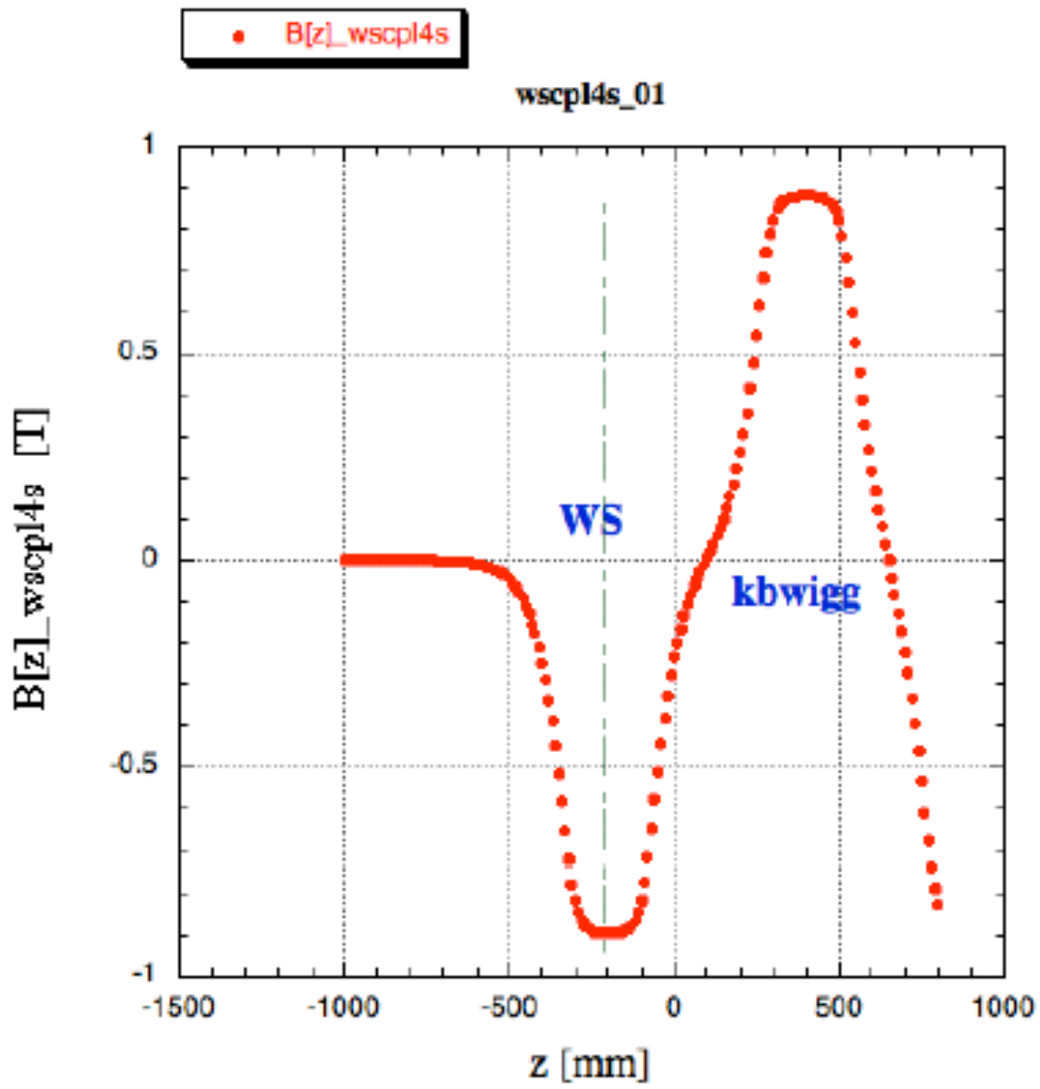
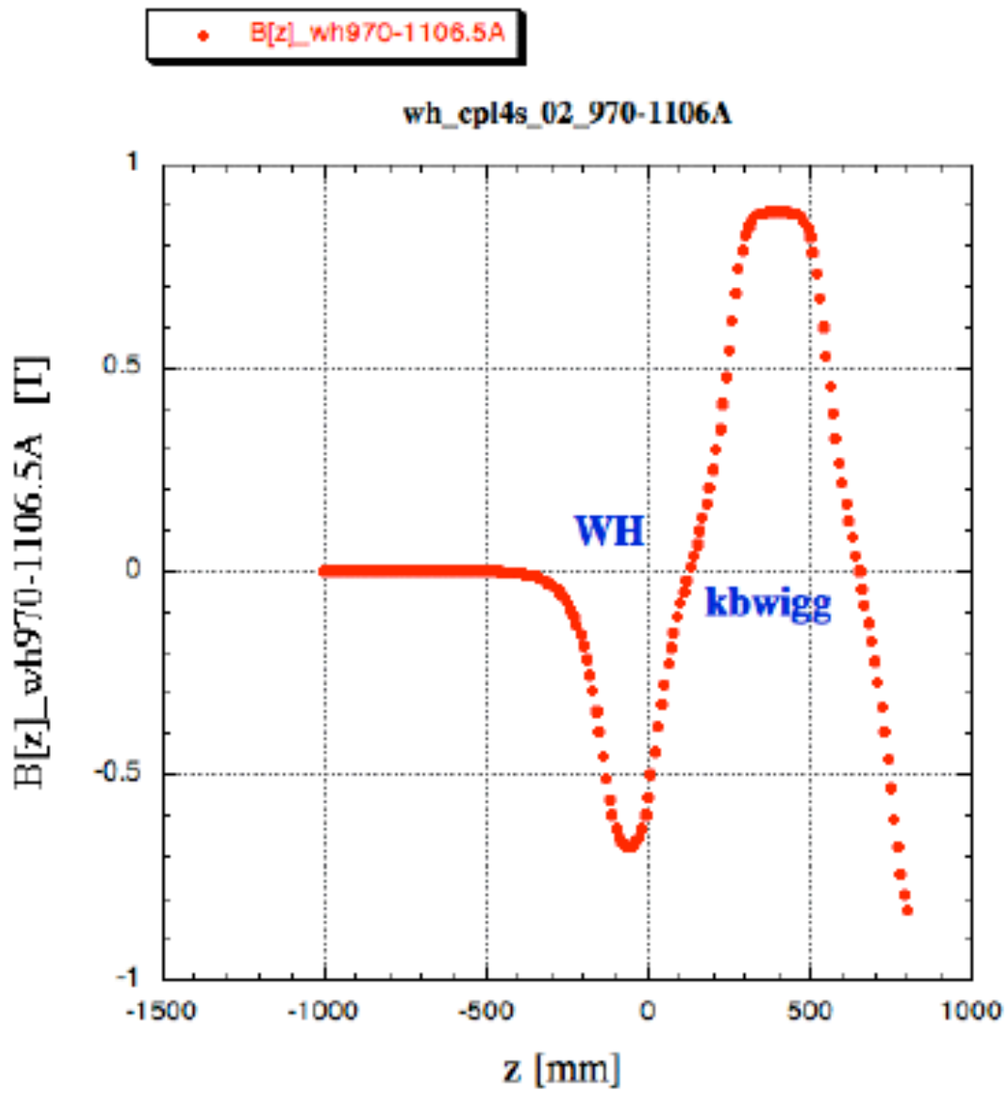


B[z] : WS (J=1150.96A) & kbwigg (J=1106.5A)



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Courtesy of K. Egawa

2. SAD model for wigglers in LER

➤ sler_1701_phase1.sad

- Assumed symmetric fringes: likely not good
- Calculated tune nx=44.53, ny=46.57

```
BW0NRP  =(L =.215946   ANGLE =0  E2 =1     K0 =.0107248   F1 =.1138 FRINGE =1 )
BW1NRP  =(L =.334831   ANGLE =0  E1 =.5    E2 =.5    K0 =-.0219048  F1 =.1138 FRINGE =1 )
BW2NRP  =(L =.338537   ANGLE =0  E1 =.5    E2 =.5    K0 =.02236     F1 =.1138 FRINGE =1 )
BW3NRP  =(L =.332919   ANGLE =0  E1 =.5    E2 =.5    K0 =-.02236    F1 =.1138 FRINGE =1 )
BW0NRMP =(L =.215946   ANGLE =0  E2 =1     K0 =-.0107248  F1 =.1138 FRINGE =1 )
BW1NRMP =(L =.334831   ANGLE =0  E1 =.5    E2 =.5    K0 =.0219048   F1 =.1138 FRINGE =1 )
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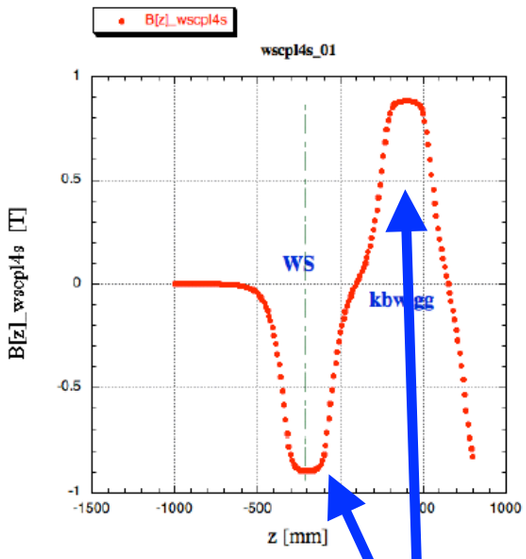

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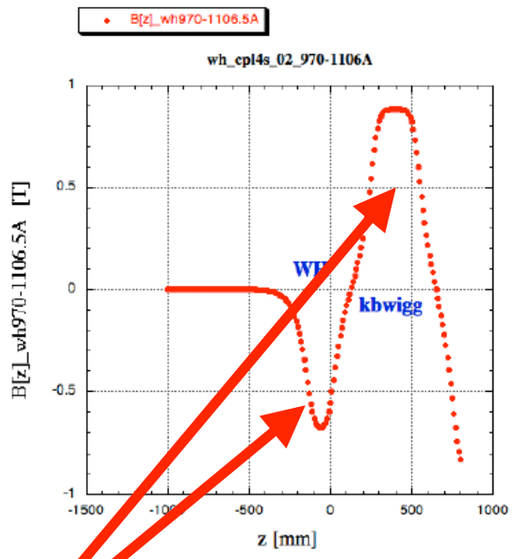

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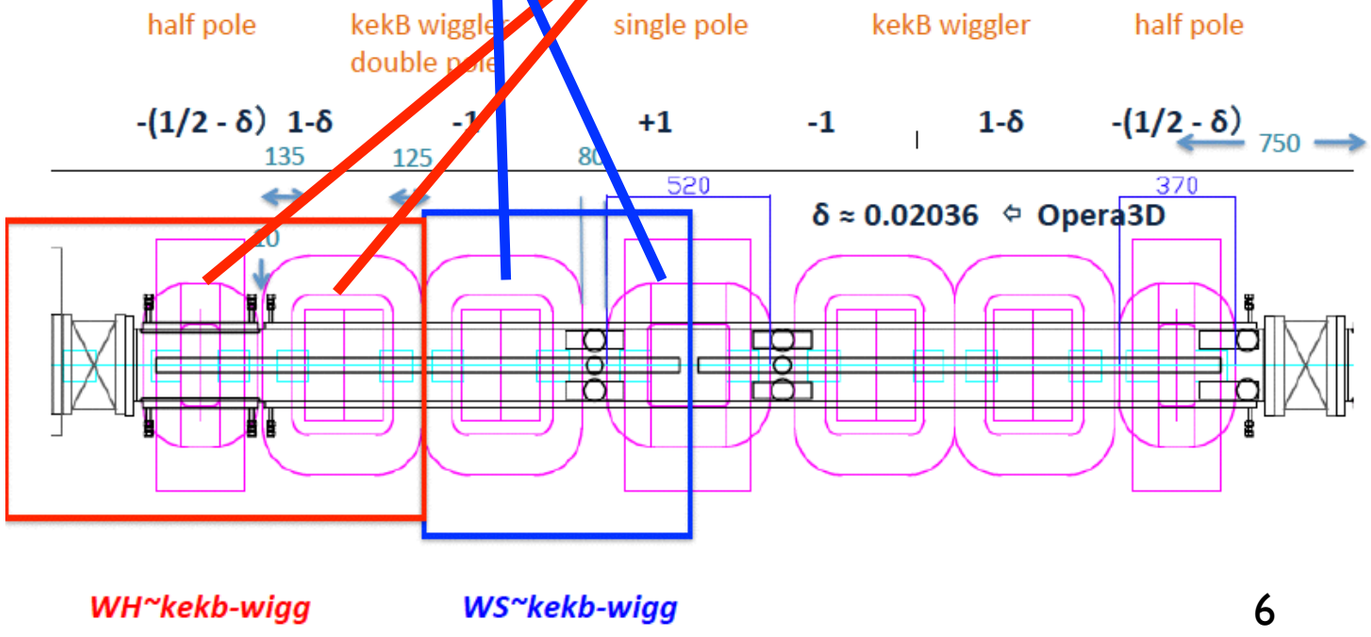
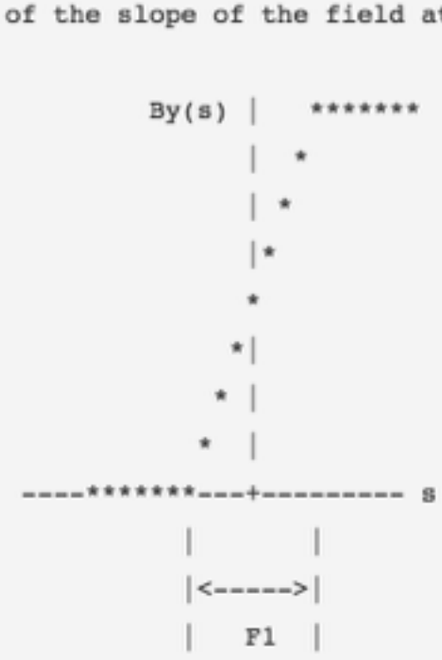


- **F1**

Length of the slope of the field at the edge as:



Only the effects up to y^4 in Hamiltonian are taken into account.
More rigorous definition is

$$F1 = 6 \int \left(\frac{By(s)}{B0} - \left(\frac{By(s)}{B0}\right)^2 \right) ds, \quad s = -\infty \text{ to } \infty$$

where integration is done over one fringe.

Courtesy of K. Egawa

2. SAD model for wigglers in LER

➤ sler_1701_phase1.sad with new fringe lengths

- Recalculation shows significant difference (mainly in fringe lengths) from the present model.
- For K0, I used the original data.
- Calculated tune nx=44.53, ny=46.535
- Small change in chromaticity. But after optics correction (to recover beta function), chromaticity might change.

```
BW0NRP  =(L =.215931   ANGLE =0  E2 =1     K0 =.0107248   FB1 =.2039 FB2 =.1471 FRINGE =1 )
BW1NRP  =(L =.334854   ANGLE =0  E1 =.5    E2 =.5    K0 =-.0219048  FB1 =.1705 FB2 =.1537 FRINGE =1 )
BW2NRP  =(L =.338559   ANGLE =0  E1 =.5    E2 =.5    K0 =.02236     FB1 =.1536 FB2 =.1865 FRINGE =1 )
BW3NRP  =(L =.333550   ANGLE =0  E1 =.5    E2 =.5    K0 =-.02236    F1 =.1856 FRINGE =1 )
BW0NRMP =(L =.215931   ANGLE =0  E2 =1     K0 =-.0107248  FB1 =.2039 FB2 =.1471 FRINGE =1 )
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```

2. SAD model for wigglers in LER

➤ Alternative fringe model

- **Use fringe field integrals**

$$I_0^- = \int_{s_1}^{s_0} \tilde{K}(s)ds \qquad I_1^- = \int_{s_1}^{s_0} \tilde{K}(s)(s-s_0)ds$$

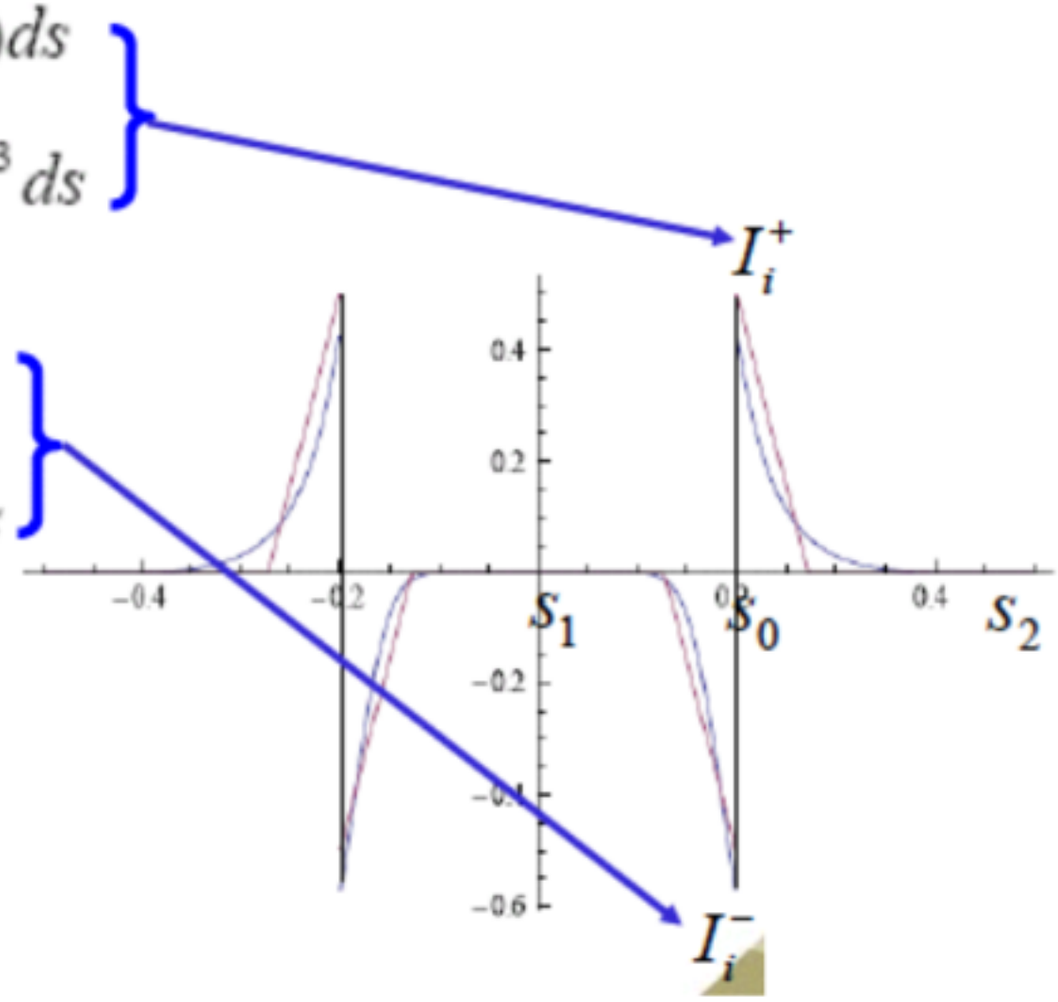
$$I_2^- = \int_{s_1}^{s_0} \tilde{K}(s)(s-s_0)^2 ds \qquad I_3^- = \int_{s_1}^{s_0} \tilde{K}(s)(s-s_0)^3 ds$$

$$I_0^+ = \int_{s_0}^{s_2} \tilde{K}(s)ds \qquad I_1^+ = \int_{s_0}^{s_2} \tilde{K}(s)(s-s_0)ds$$

$$I_2^+ = \int_{s_0}^{s_2} \tilde{K}(s)(s-s_0)^2 ds \qquad I_3^+ = \int_{s_0}^{s_2} \tilde{K}(s)(s-s_0)^3 ds$$

$$\Lambda_2^- = \int_{s_1}^{s_0} ds \int_{s}^{s_0} ds' K(s)K(s')(s'-s)$$

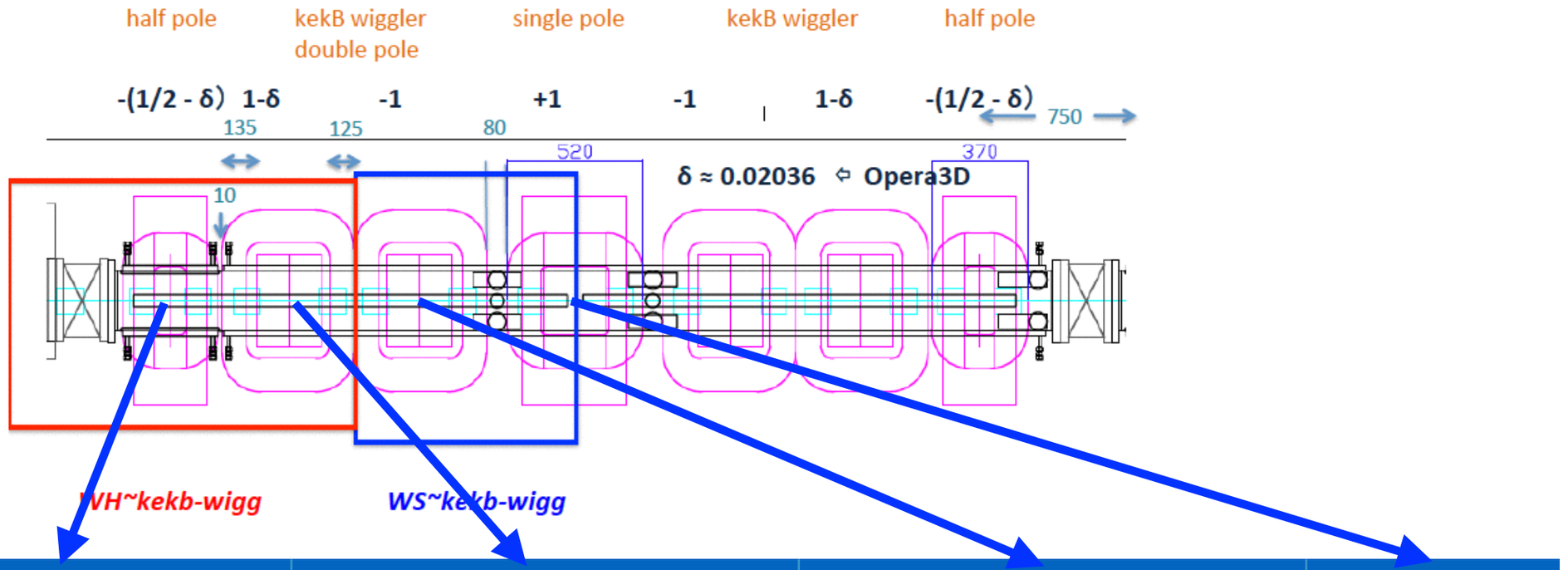
$$\Lambda_2^+ = \int_{s_0}^{s_2} ds \int_{s}^{s_2} ds' K(s)K(s')(s'-s)$$



SuperKEKB mini optics meeting, Jun.18, 2015
D. Zhou, IPAC'10

2. SAD model for wigglers in LER

➤ Compare different models



Pole	BW0NRP		BW1NRP		BW2NRP		BW3NRP
Fringe length	FB1	FB2	FB1	FB2	FB1	FB2	F1
Old model	0.1138		0.1138		0.1138		0.1138
SAD method	0.2039	0.1471	0.1705	0.1537	0.1536	0.1865	0.1856
D.Z method	0.2225	0.1481	0.1725	0.1552	0.1550	0.1904	0.1894

3. Summary

➤ Findings

- **Fringe lengths for wiggler in SuperKEKB LER might not be good enough.**

➤ Discussion

- **Why FRINGE=1? How about FRINGE=3?**