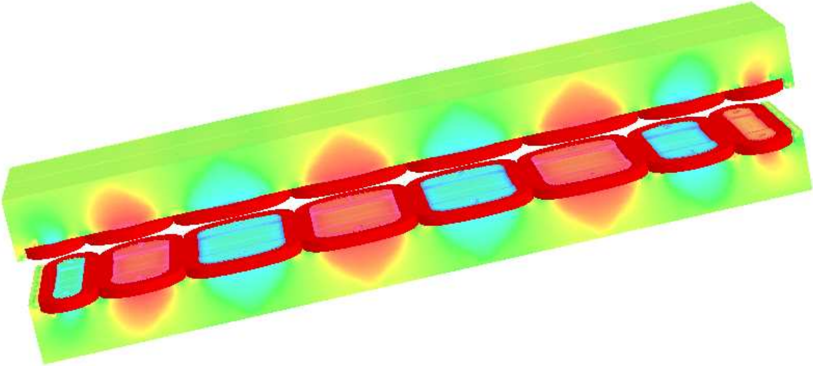
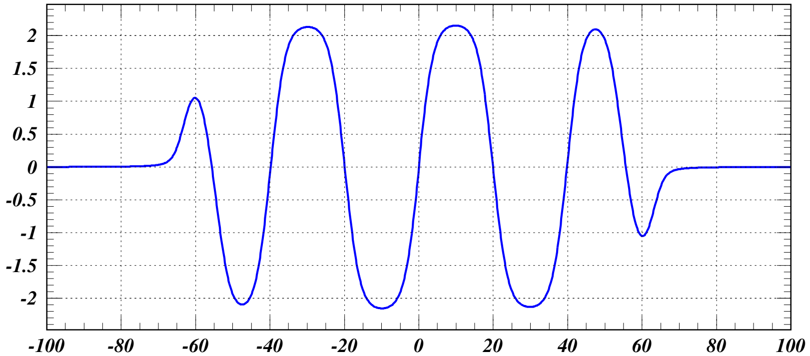
The CESR-c Wiggler Magnets

– Design Considerations –

– Field Calculations and Measurements –

– Calculated Transfer Functions –

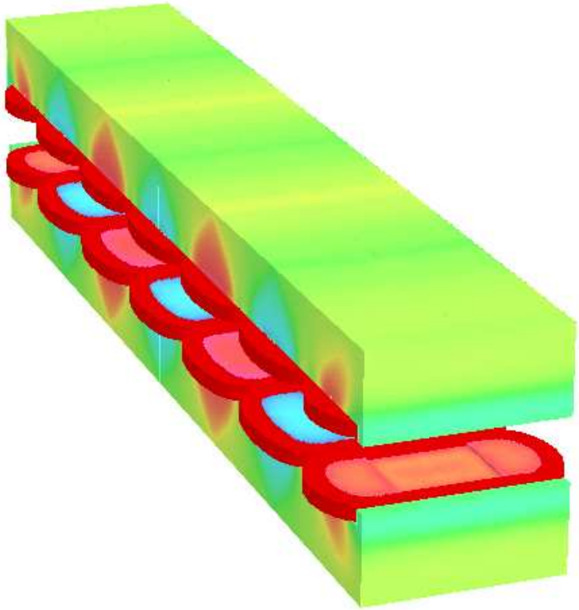




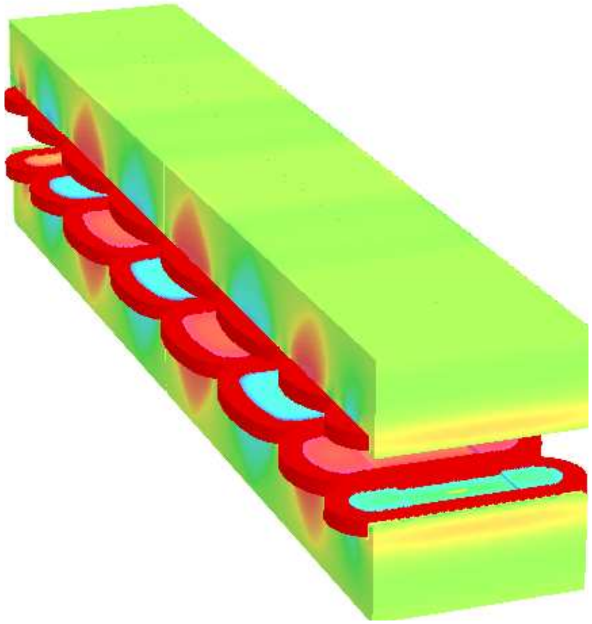
1. **Report on Progress Since NSF Review of March, 2002**
2. **Field Calculations with OPERA and MERMAID**
3. **Field Measurements with Hall Probe and Flip Coil**
4. **Calculations of Transfer Functions**
5. **Concluding Assessment**

Pole Geometries and Operating Currents

7-pole Wiggler

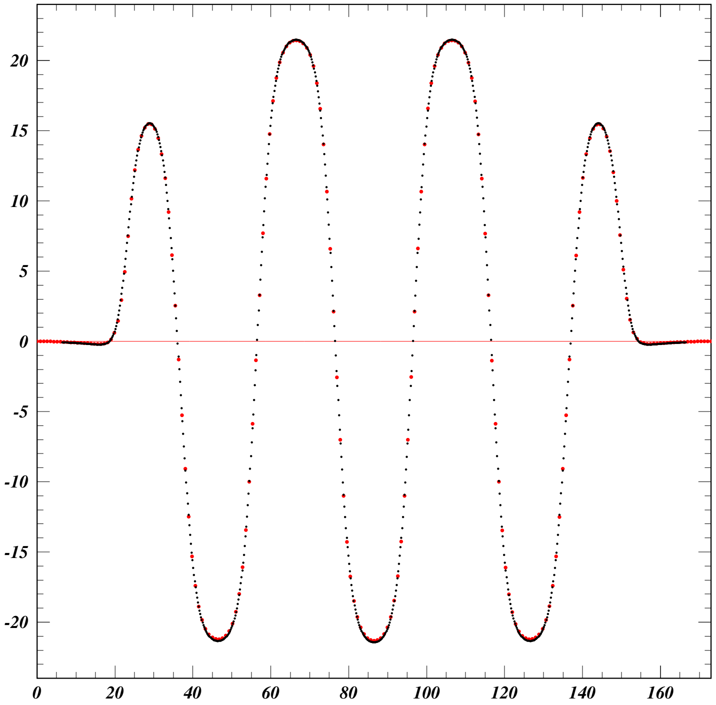


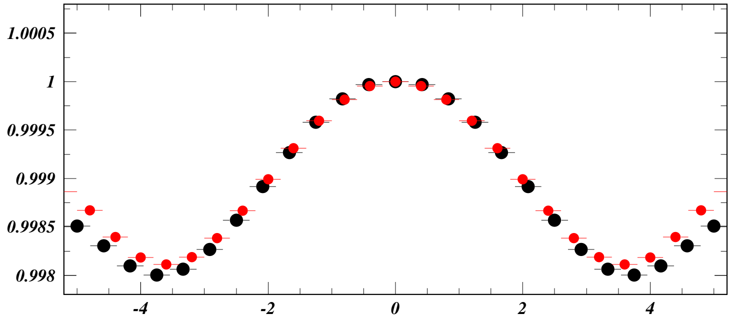
8-pole Wiggler



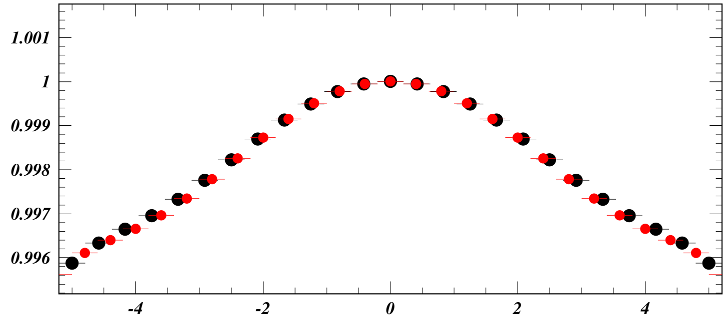
7-Pole Wiggler (1.9 T Peak Field, 135 Amps) – Wiggler #1									
Pole Length (cm)	Number	Cutout Width (cm)	Cutout Depth (mm)	Main Current (Amp-turns)	Main Turns	Main Width (Inches)	Trim Current (Amp-turns)	Trim Turns	Trim Width (Inches)
20	5	6	5.0	79.38k	588	1.000	—–	—–	—–
15	2	6	3.5	51.03k	378	0.642	1.33k	663	0.358
7-Pole Wiggler (1.9 T Peak Field, 121 Amps) – Wiggler #2									
20	5	6	5.0	75.90k	660	1.000	—–	—–	—–
15	2	6	3.6	45.54k	396	0.603	4.925k	684	0.380
8-Pole Wiggler (1.9 T Peak Field, 121 Amps) – Wigglers #3 – #6									
20	4	6	5.0	79.86k	660	1.000	—–	—–	—–
15	2	6	5.5	79.86k	660	1.000	—–	—–	—–
10	2	6	3.6	42.59k	352	0.533	2.424k	836	0.467

Field Calculations with MERMAID and OPERA





Z=0 cm

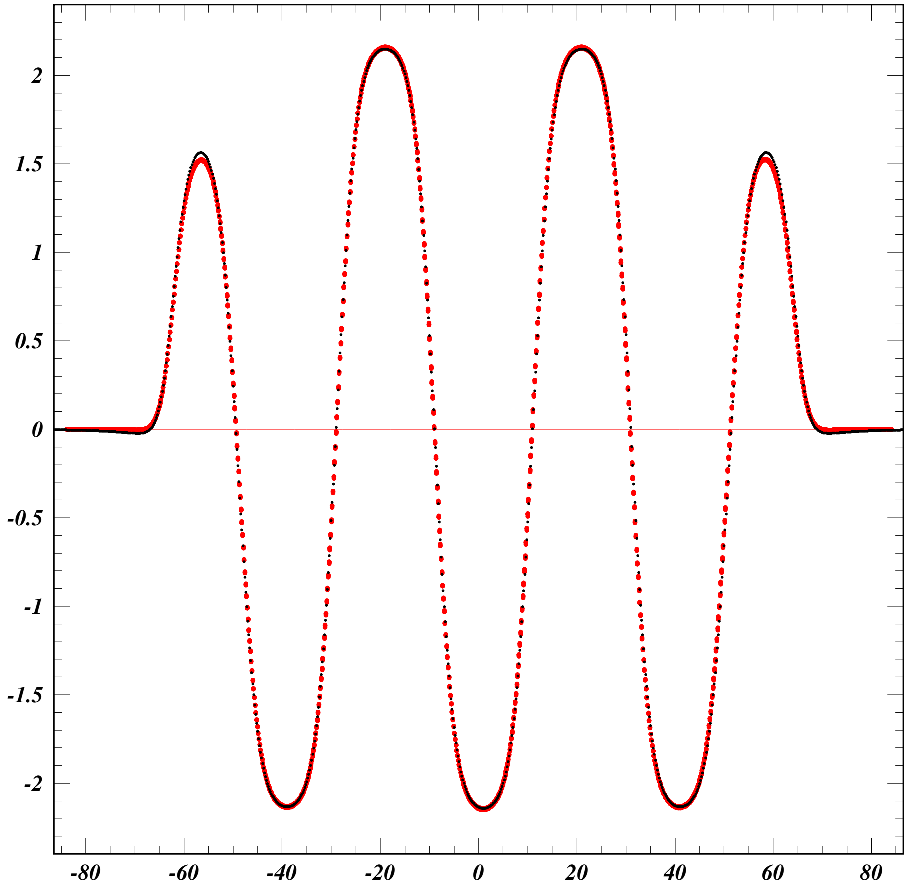


Z=57.95 cm

$\Rightarrow$ Transverse uniformity typically 3×10^{-3}

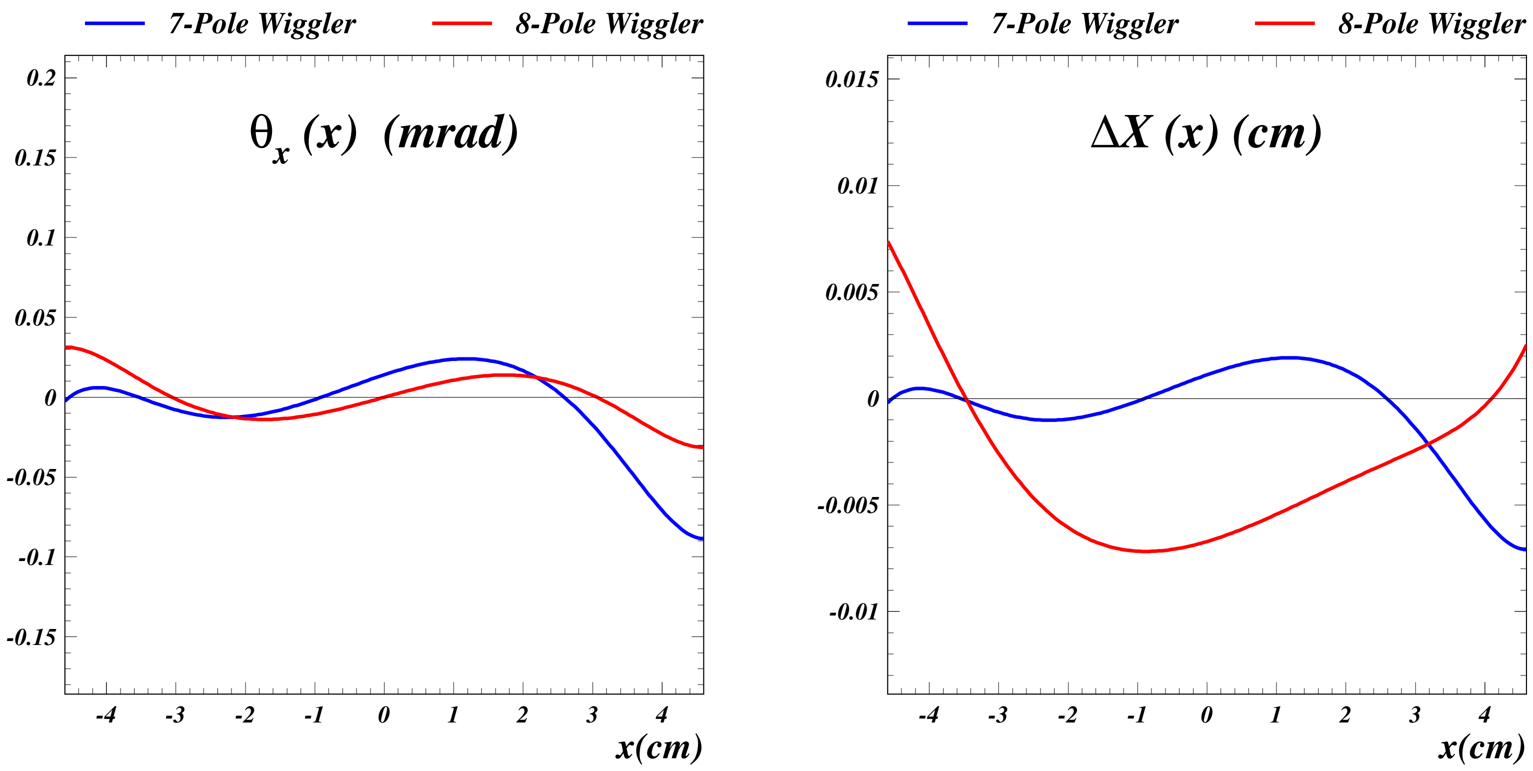
$\Rightarrow$ Calculations agree at the 10^{-4} level

Field Calculations compared to Hall Probe Measurements



$\Rightarrow$ Agreement at expected level of accuracy

Transfer Functions at 1.9 T Peak Field

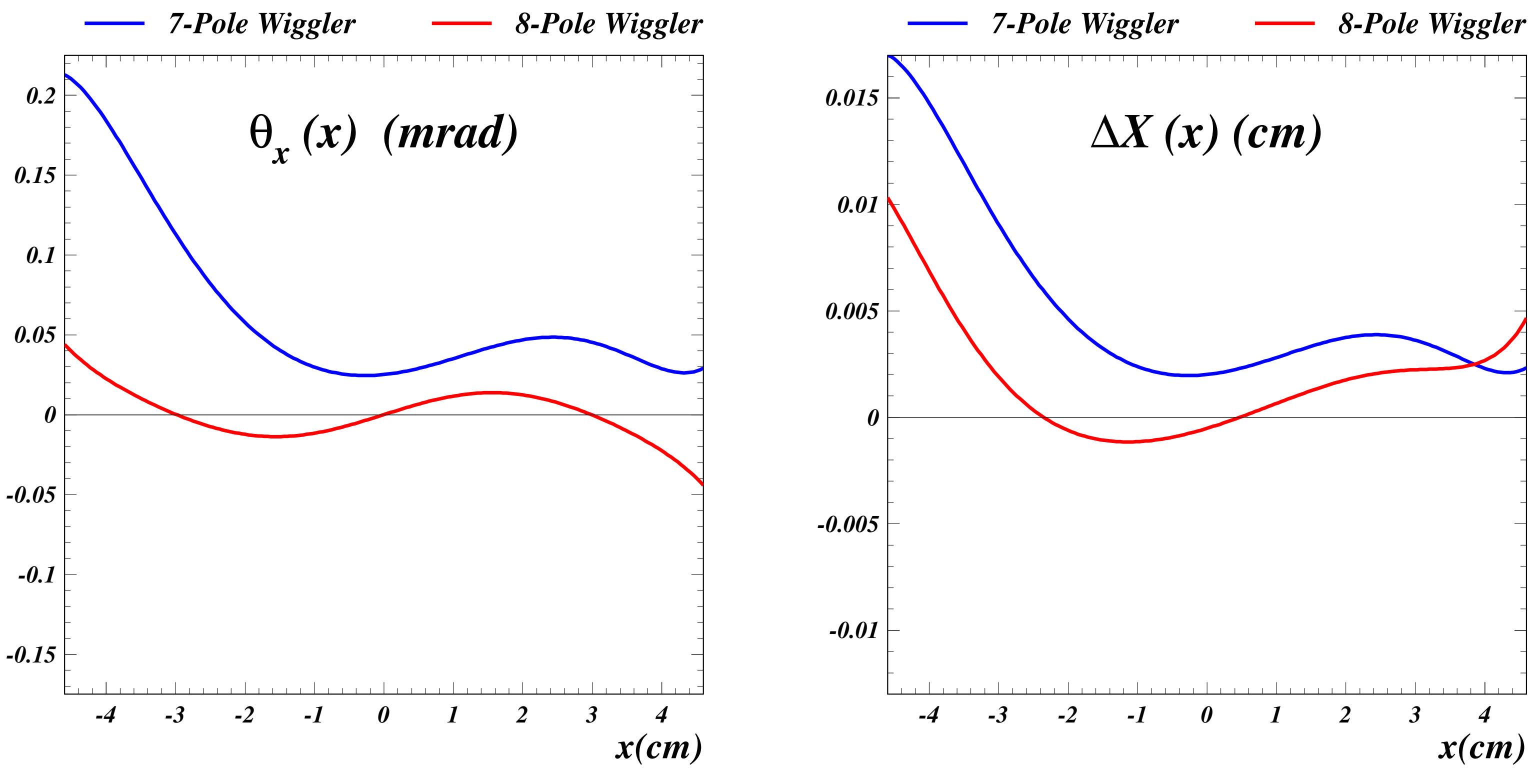


⇒ 7-Pole design exhibits performance similar to that of 8-pole design

⇒ 8-pole design depends on construction tolerance to avoid kick

⇒ 8-pole kick shows left/right symmetry (nice for pretzel!)

Transfer Functions at 1.7 T Peak Field



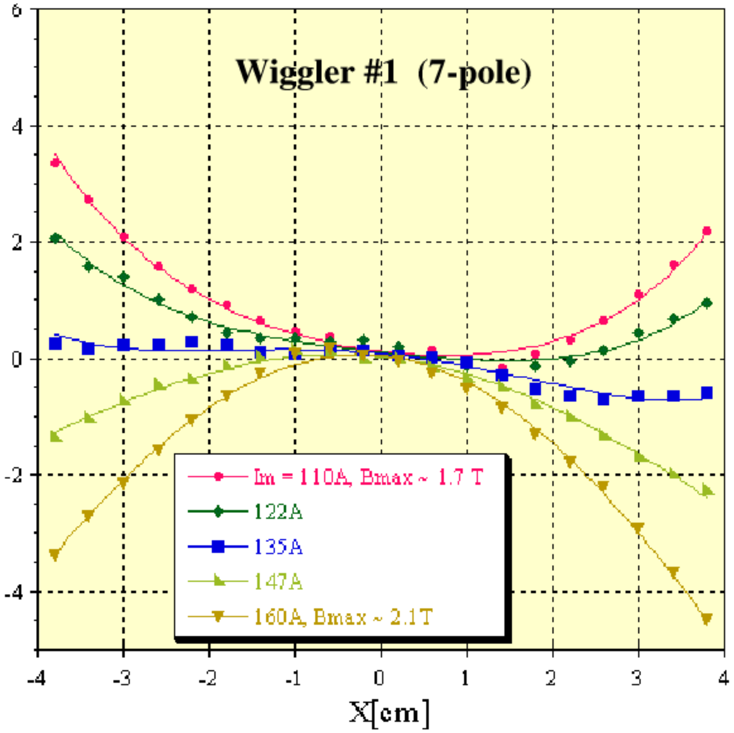
⇒ The 8-pole kick left/right symmetry is independent of excitation

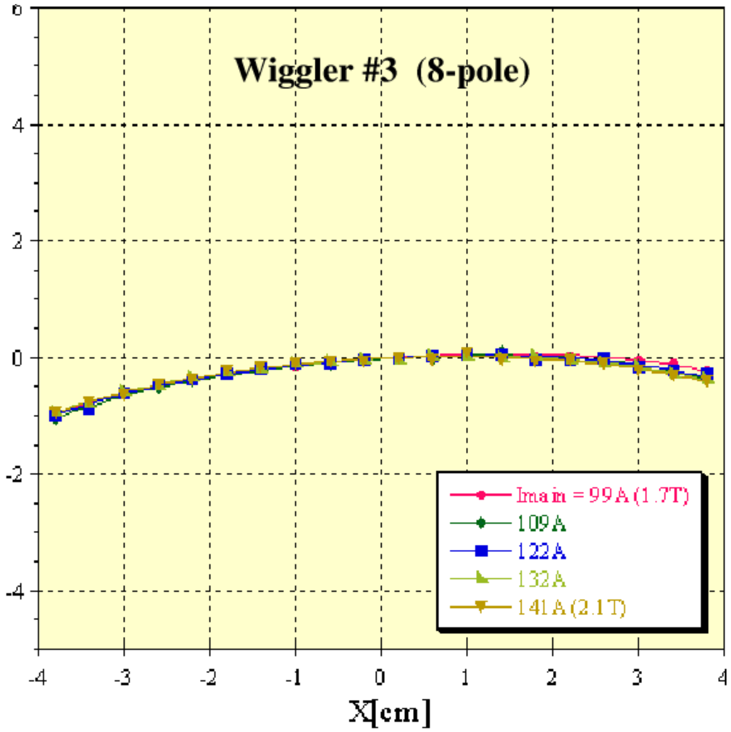
⇒ 7-pole design exhibits greater transverse non-uniformity (saturation effects)

Flip-coil Measurements of Field Integrals

I. Horizontal dependence of integrated vertical component (gauss-meters)

The horizontal kick for 1.8 GeV is about 15 μrad per gauss-meter





⇒ The integral for the 7-pole design at 1.9 T less than 0.5 gauss-meter over the entire aperture

⇒ The trim current can adjust the integral but not its dependence on X

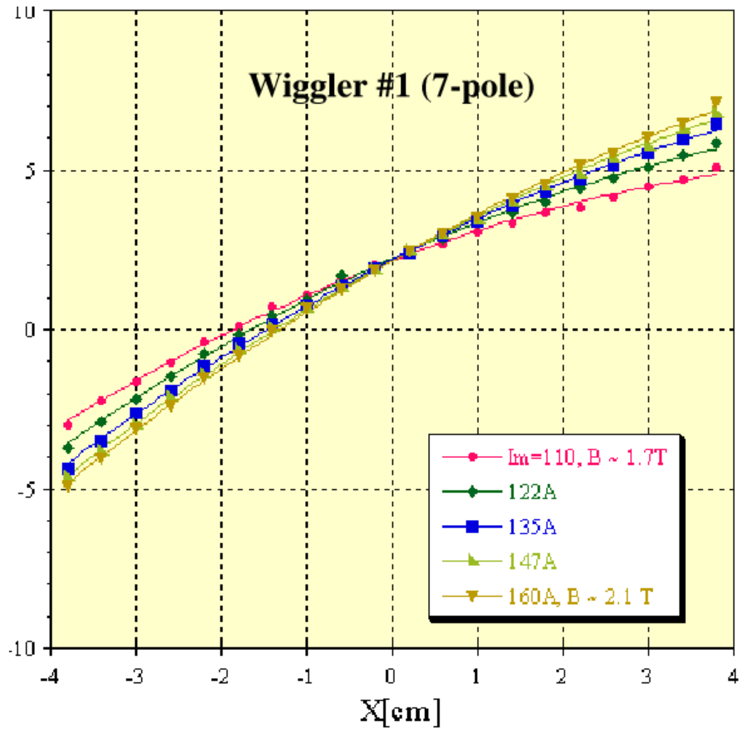
⇒ 8-pole design independent of excitation from 1.7 T to 2.1 T

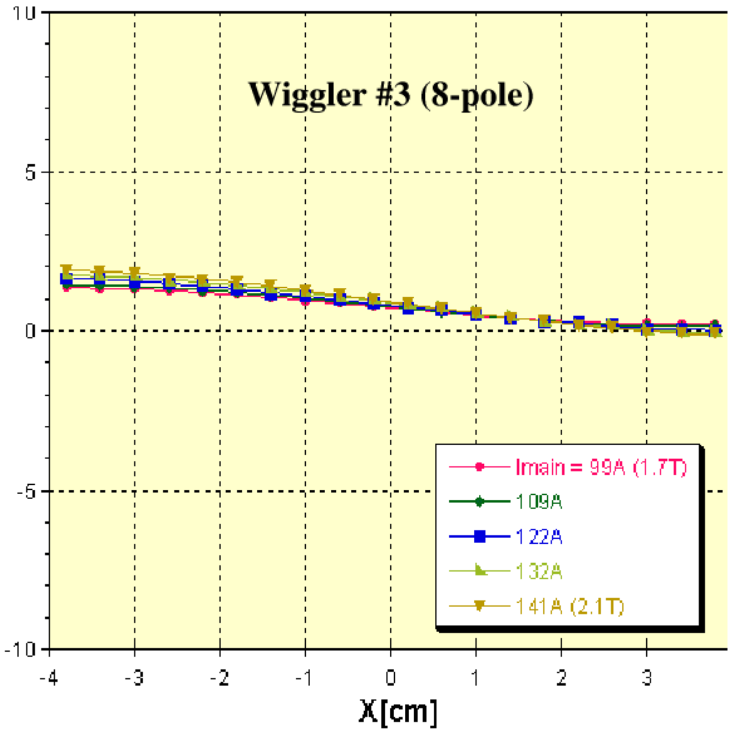
⇒ The two 7-pole magnets will be installed adjacent in the ring with opposing kicks

Flip-coil Measurements of Field Integrals

II. Horizontal dependence of integrated horizontal component (gauss-meters)

A linear horizontal dependence can be corrected with a skew quadrupole





⇒ A small compensating skew quad magnet was used in CESR for Wiggler 1

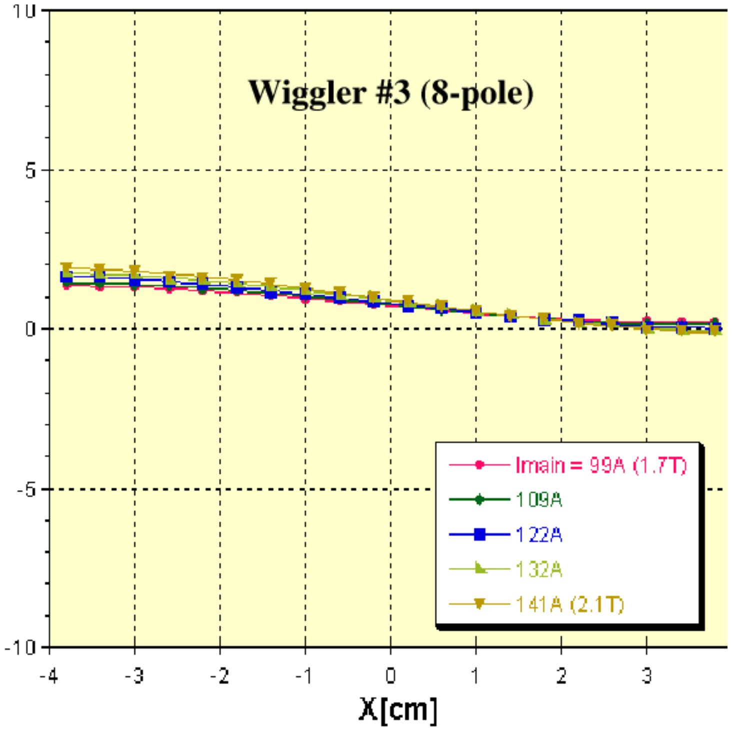
⇒ Both 7-pole wigglers exhibit larger skew quad components than the 8-pole wigglers

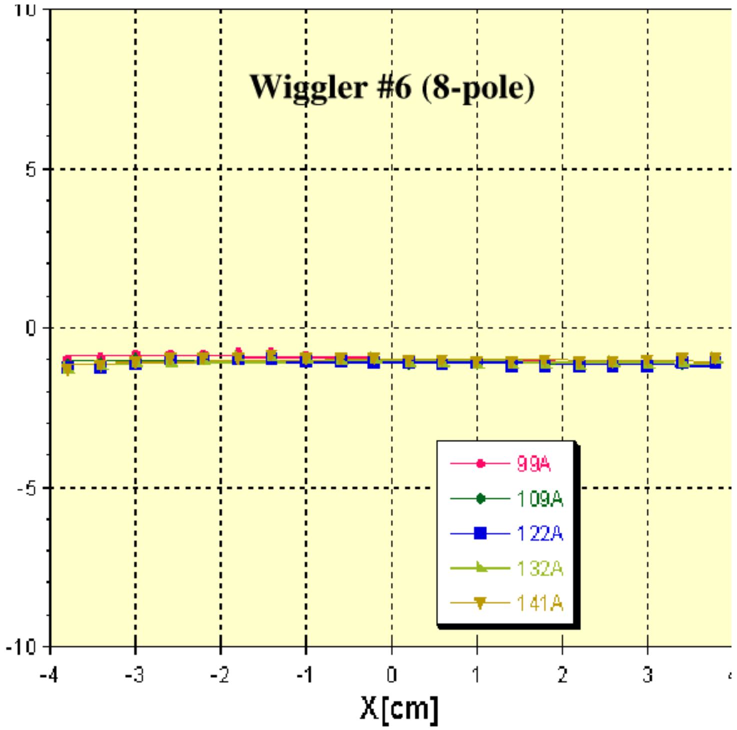
⇒ 8-pole design independent of excitation from 1.7 T to 2.1 T

⇒ Extensive modelling of errors failed to conclusively identify the source of this effect

Flip-coil Measurements of Field Integrals

II. Horizontal dependence of integrated horizontal component (gauss-meters)





$\Rightarrow$ Whatever the source, it seems to have gone away !!

Concluding Assessment

Six s.c. wigglers built and tested in one year

A remarkable achievement

First wiggler operated in CESR since 10/2002

Beam-based testing verified field measurements/calculations

Hall-probe and flip-coil measurements for all wigglers

Specifications exceeded and construction uniformity continues to improve

Accuracy of field calculations exceeds fabrication specs

Powerful diagnostic tool when combined with field measurements

Meets stringent requirements imposed by tracking algorithm

These six wiggler magnets have been shown to operate as intended and will be a reliable tool for establishing high-luminosity performance of CESRc.