



Analysis of coil shapes: trends and correlation with magnetic measurements

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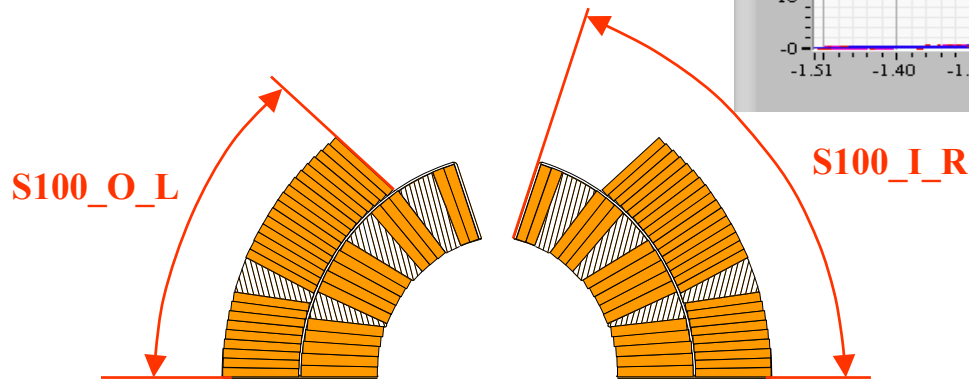
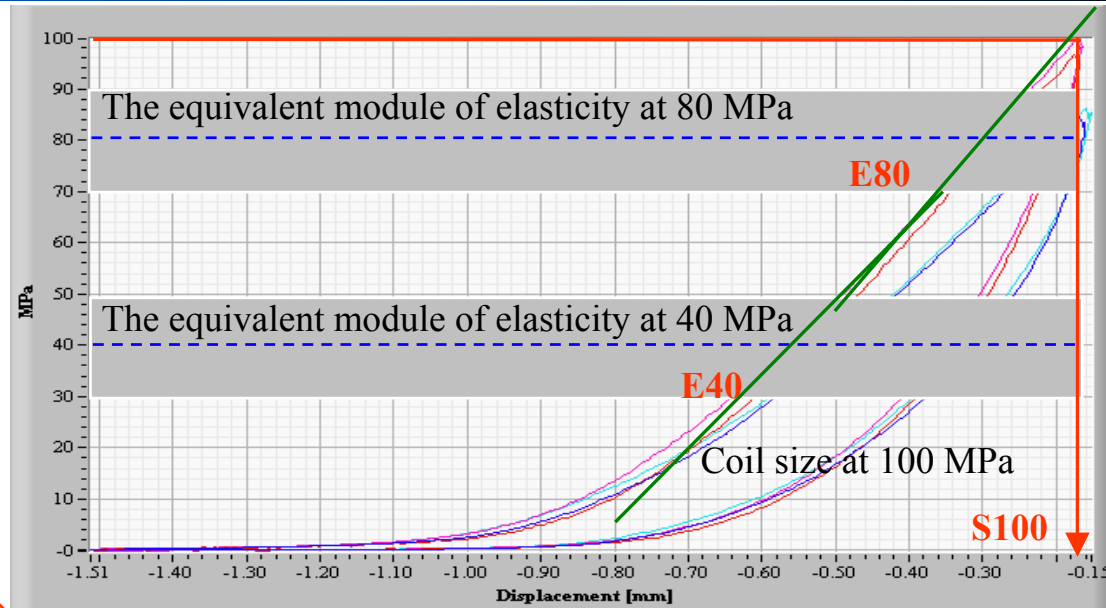
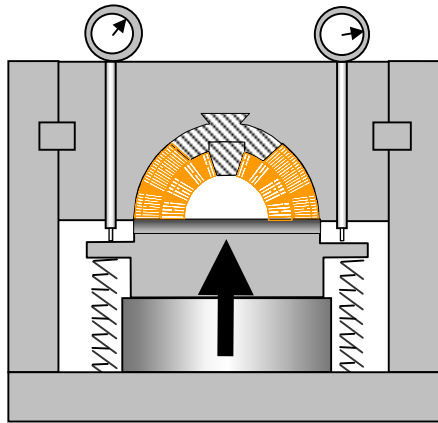
Workshop on Field Quality for Steering the
Dipole Production / 20-21 March 2003 /



Coil shape measurements objectives:

- 1. To validate the tooling and coil manufacturing methods** *(related to the systematic shifts of the nominal terms of field errors);*
- 2. To keep under control the mechanical tolerances of coils and their components** *(related to the random parts of field errors).*
- 3. To minimize the random parts of field errors by sorting the coils.**

Coil shape measurements parameters:



Processed data table:

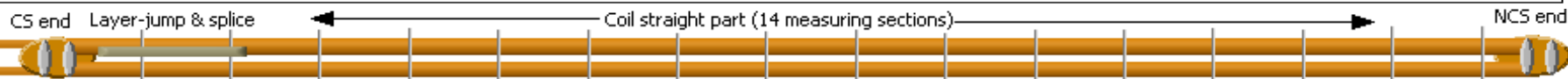
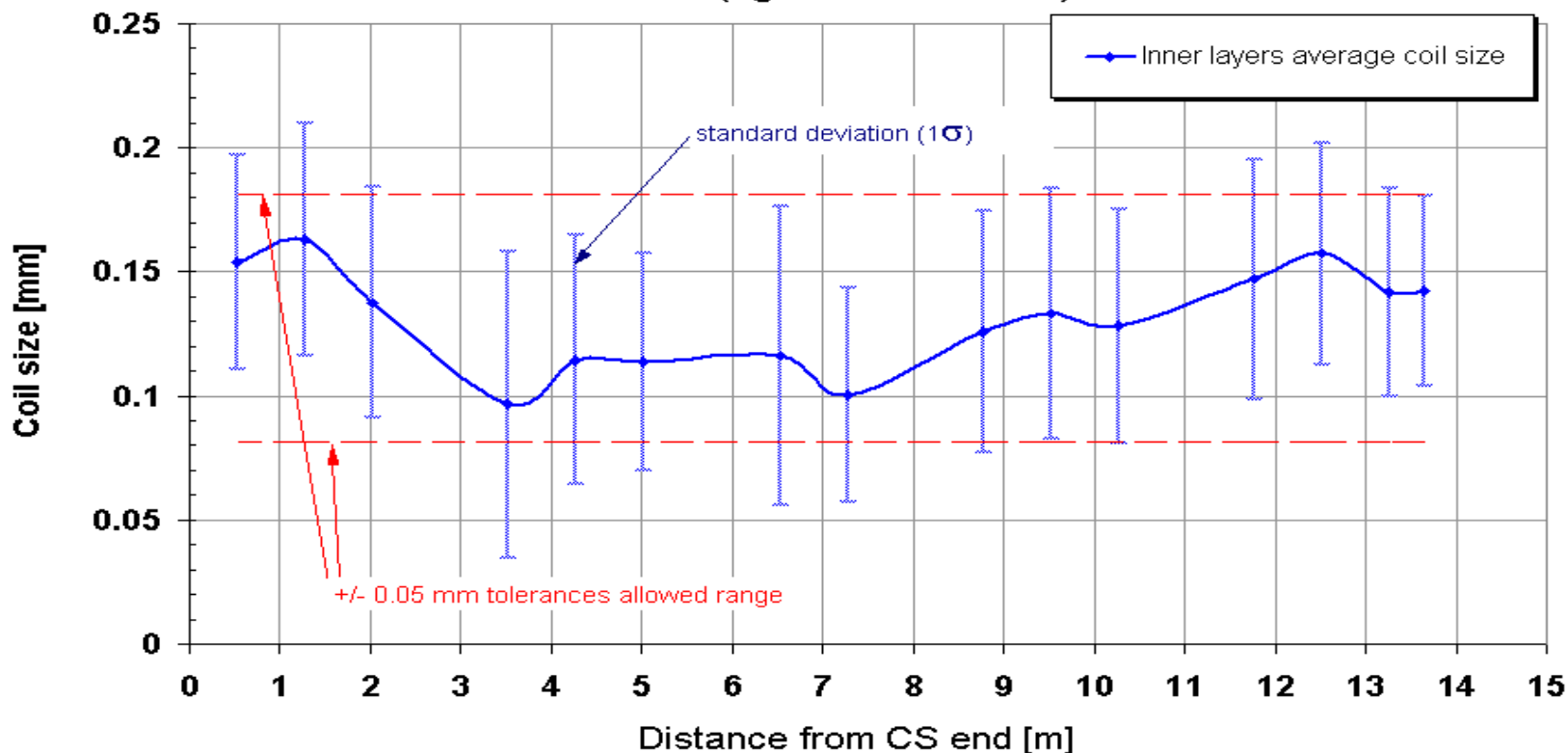
	S100 [mm]	E40 [GPa]	E80 [GPa]	Shim [mm]
Outer layer left side	-0.079	5.636	7.482	0.000
Inner layer left side	-0.164	5.901	7.420	0.000
Inner layer right side	-0.178	5.640	7.229	0.000
Outer layer right side	-0.087	5.515	7.551	0.000



Tooling imperfections examples: *(worst case)*

curing mold “signature” is well seen on coils size longitudinal profile...

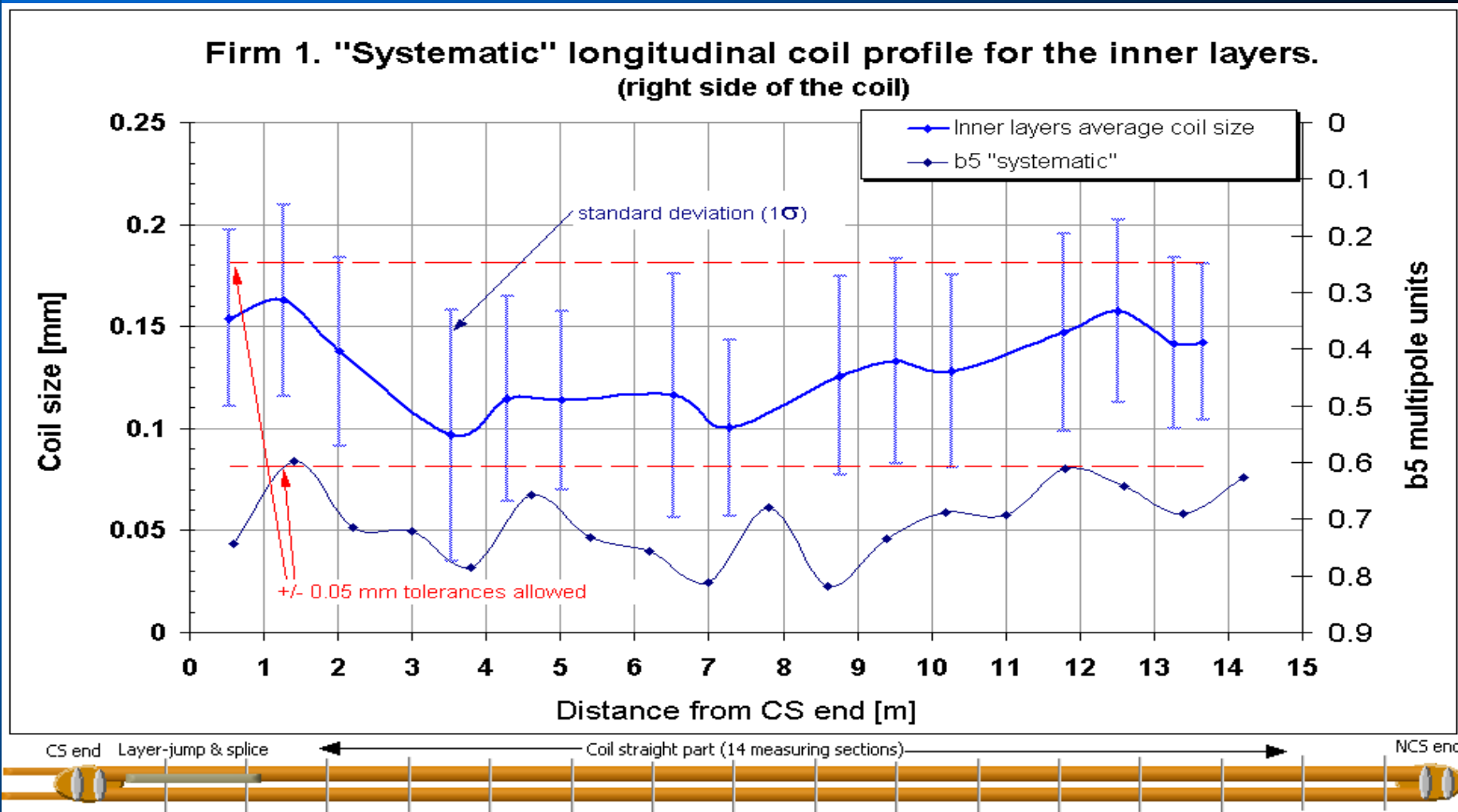
Firm 1. "Systematic" longitudinal coil profile for the inner layers.
(right side of the coil)



Tooling imperfections examples:

(worst case)

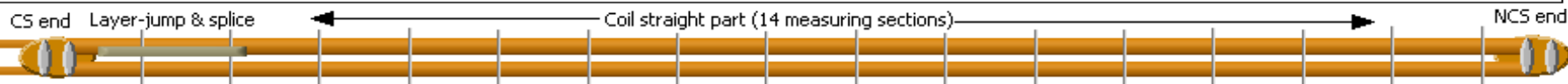
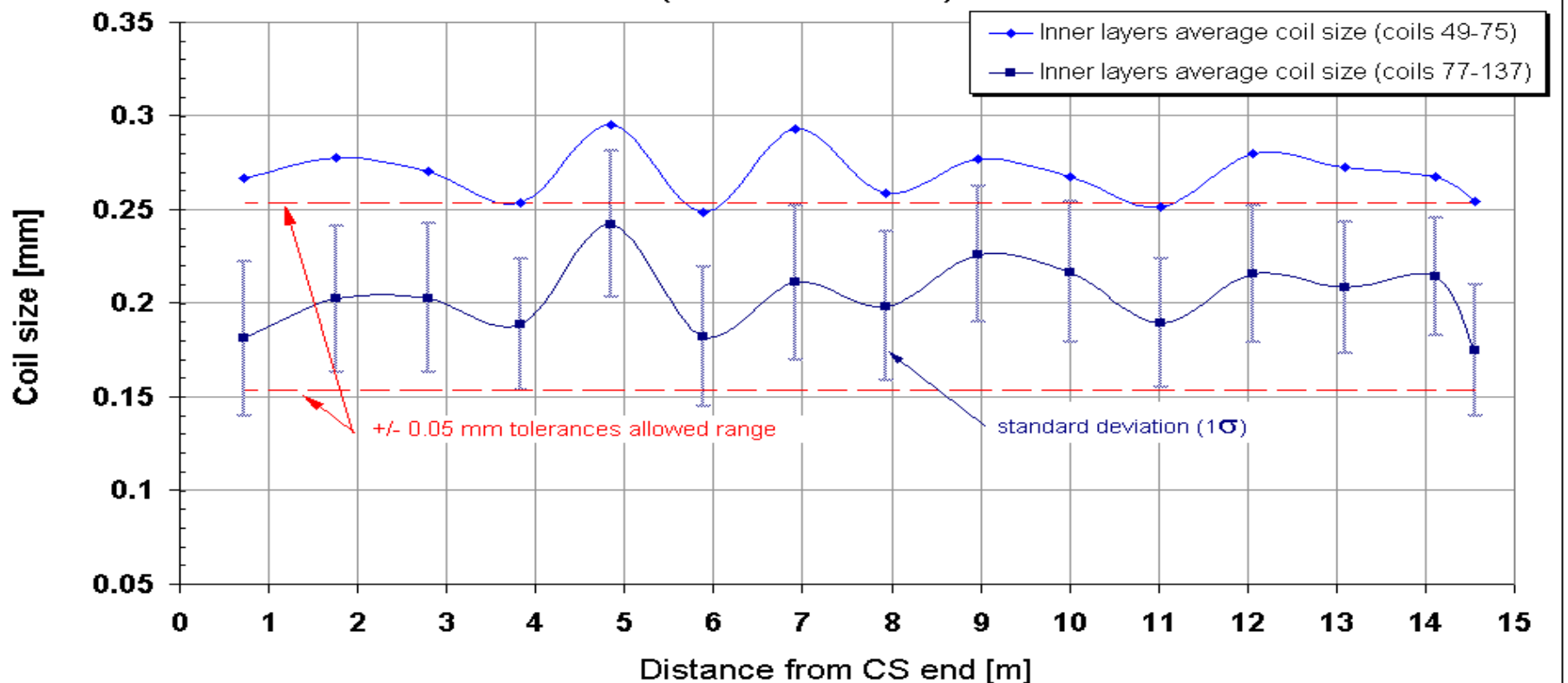
...and on *b5* multipole "systematic" profile too:



Tooling imperfections examples: *(better case)*

curing mold “signature” is well seen on coils longitudinal profile.

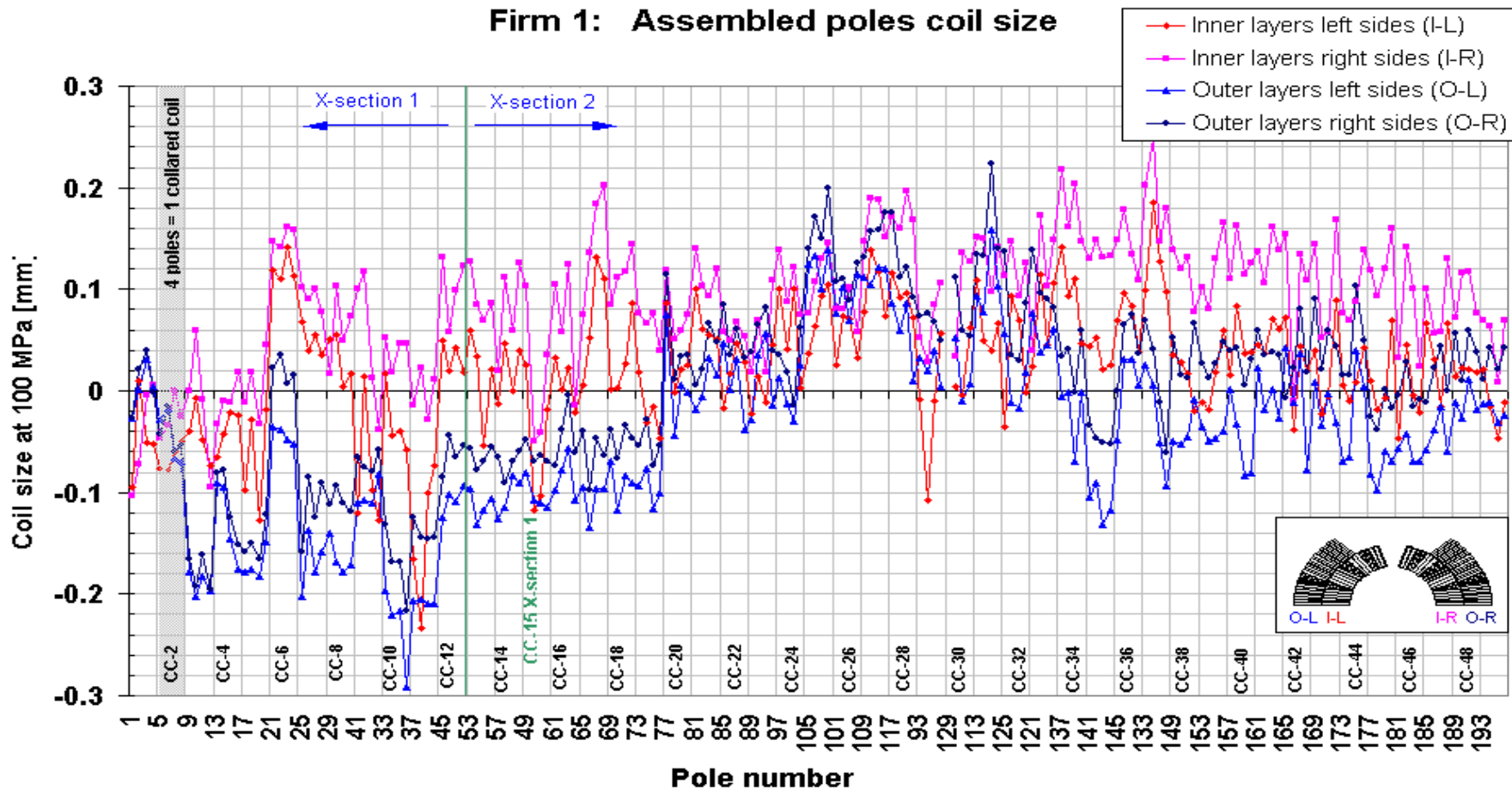
Firm 2. "Systematic" longitudinal coil profile for the inner layers.
(left side of the coil)



Coil size trends: ...

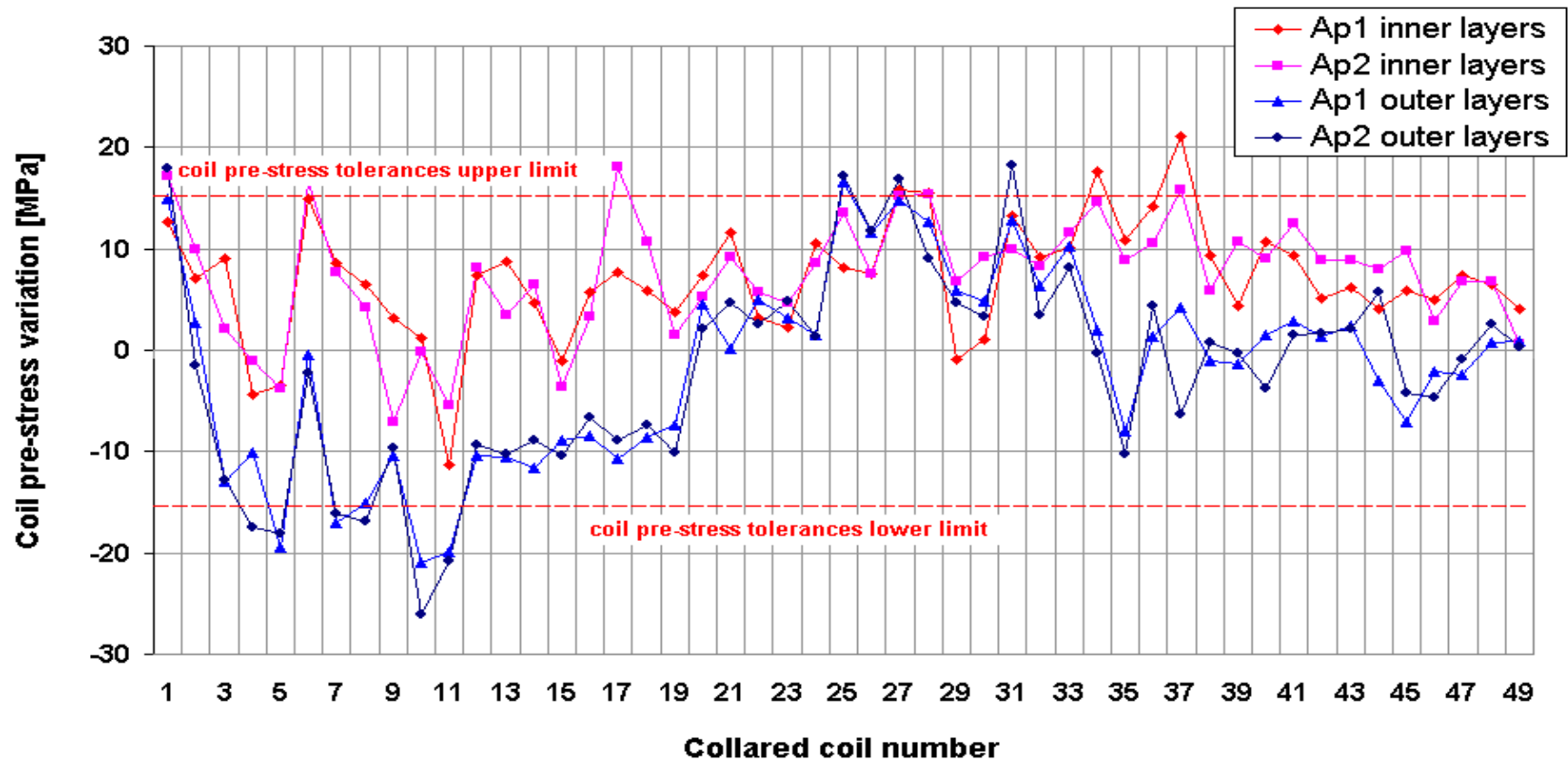
(worst case)

Firm 1: Assembled poles coil size



... and its impact on the coil pre-stress in the magnets:

Firm 1. Estimated coil pre-stress variation in the collared coils.

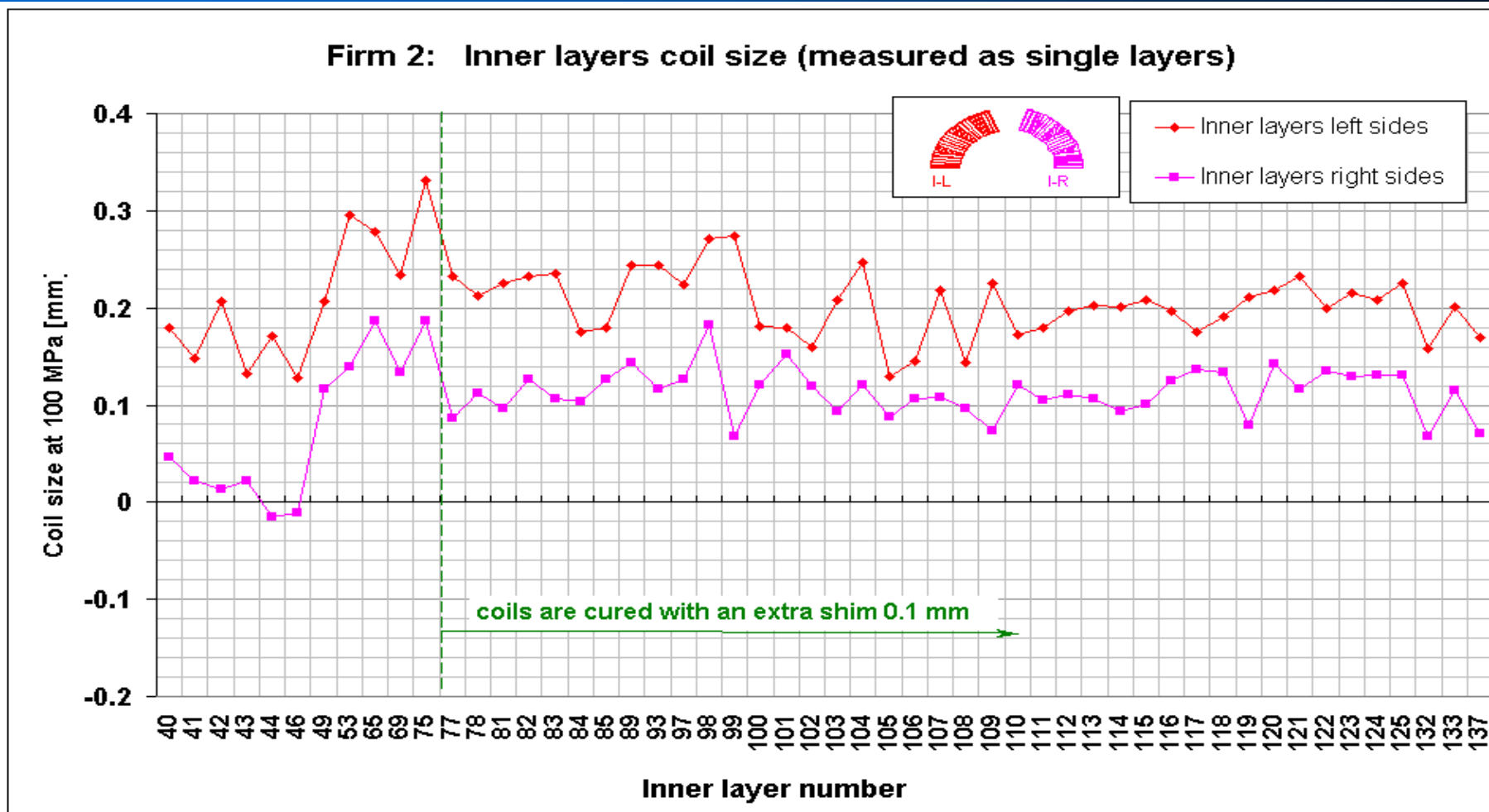


Coil size trends...

and the way to improve it:

(better case)

Firm 2 coil inner layers trend



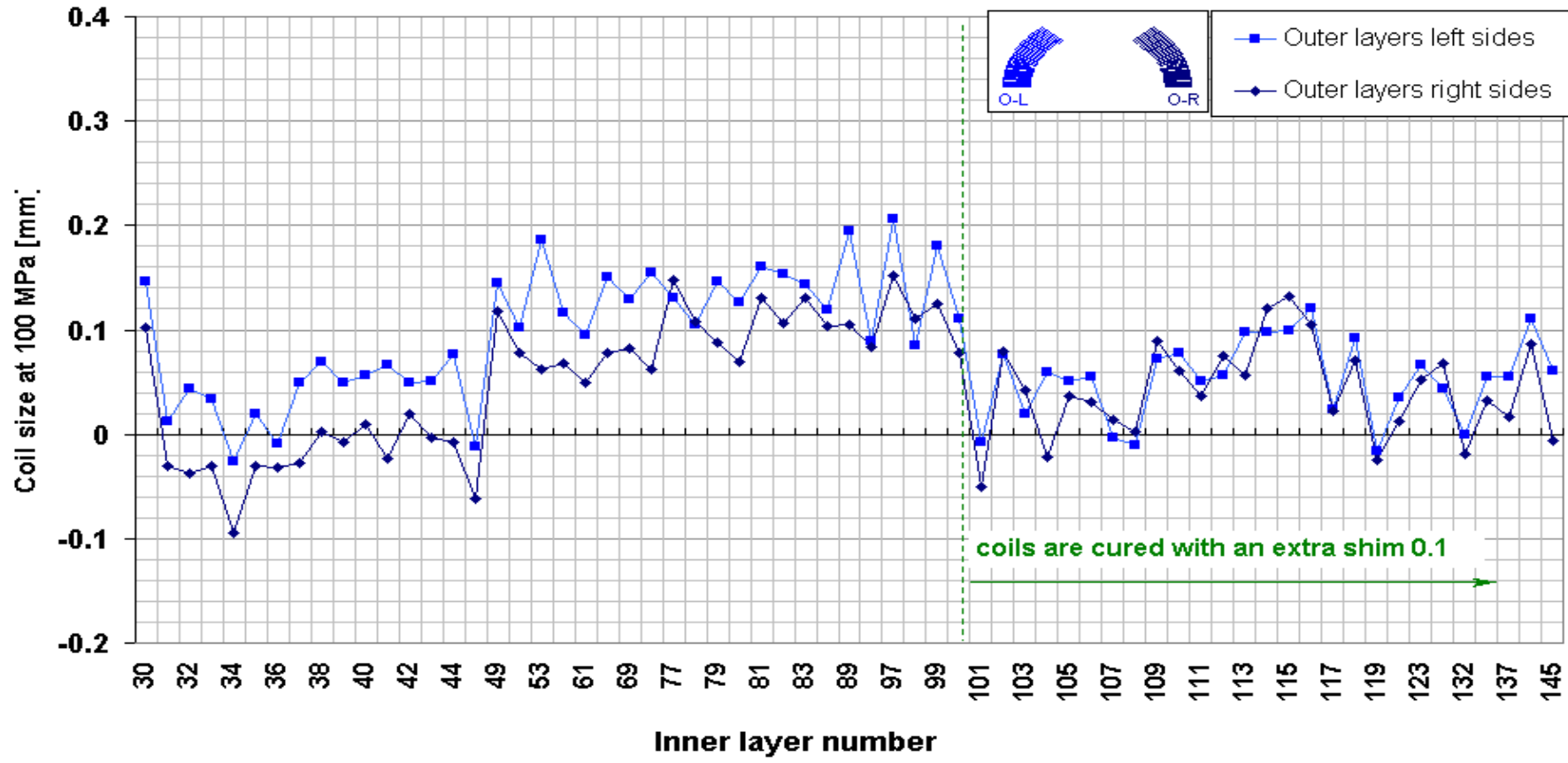
Coil size trends...

and the way to improve it:

(better case)

Firm 2 coil outer layers trend

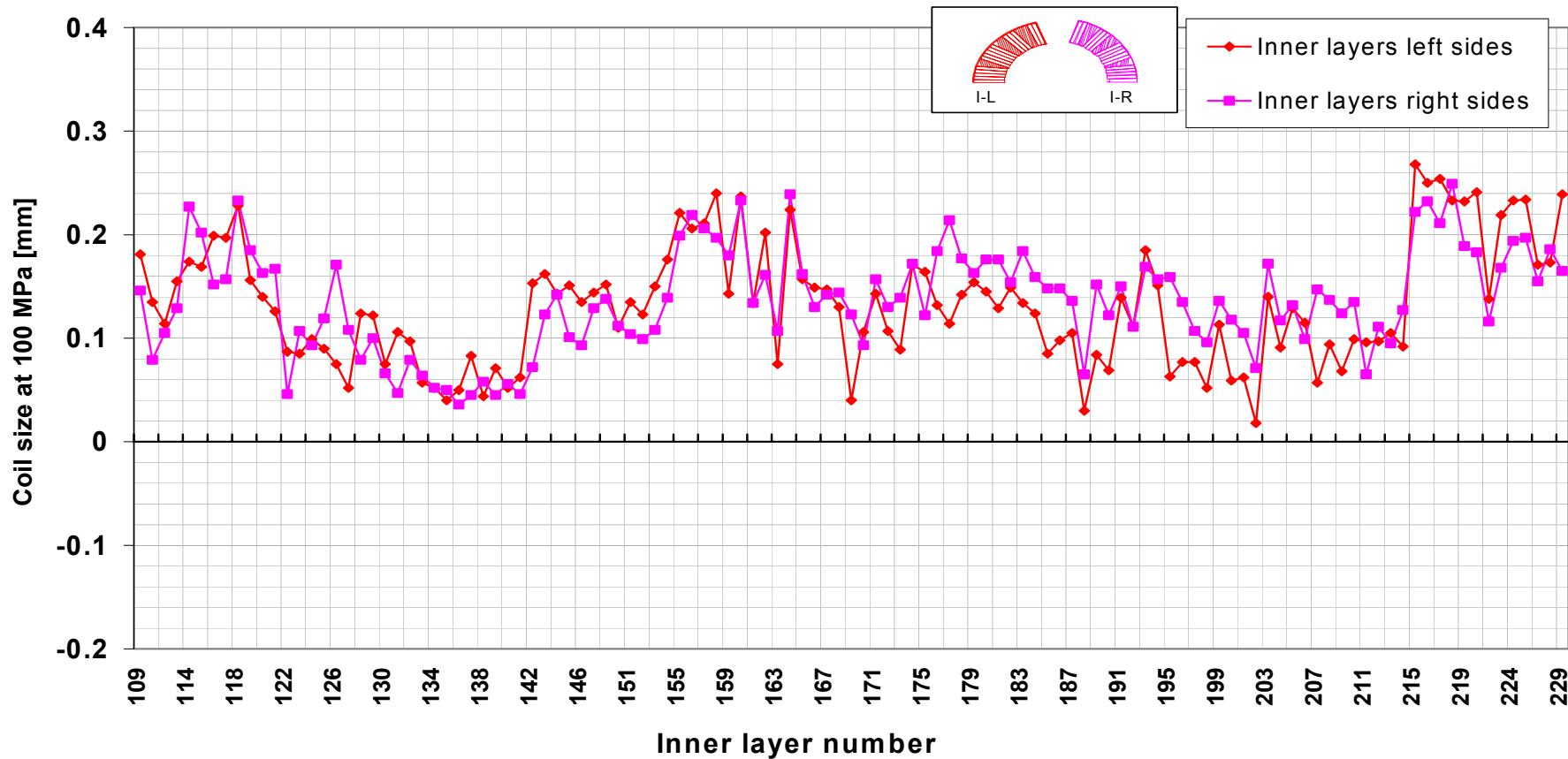
Firm 2: Outer layers coil size (measured as single layers)



Coil size trends...

Firm 3 coil inner layers trend

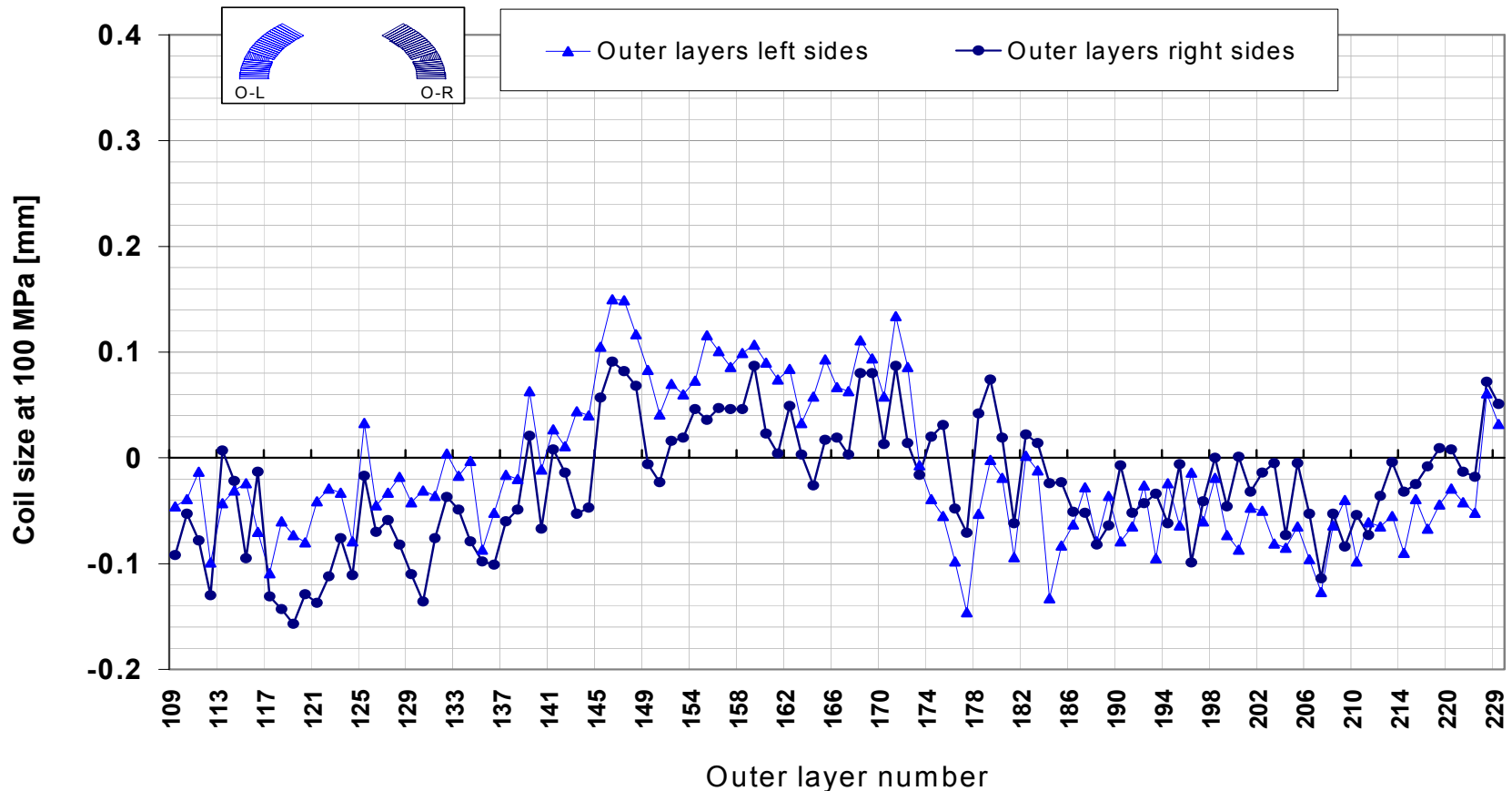
Firm 3: Inner layers coil size (measured as single layers)



Coil size trends...

Firm 3 coil outer layers trend

Firm 3: Outer layers coil size (measured as single layers)



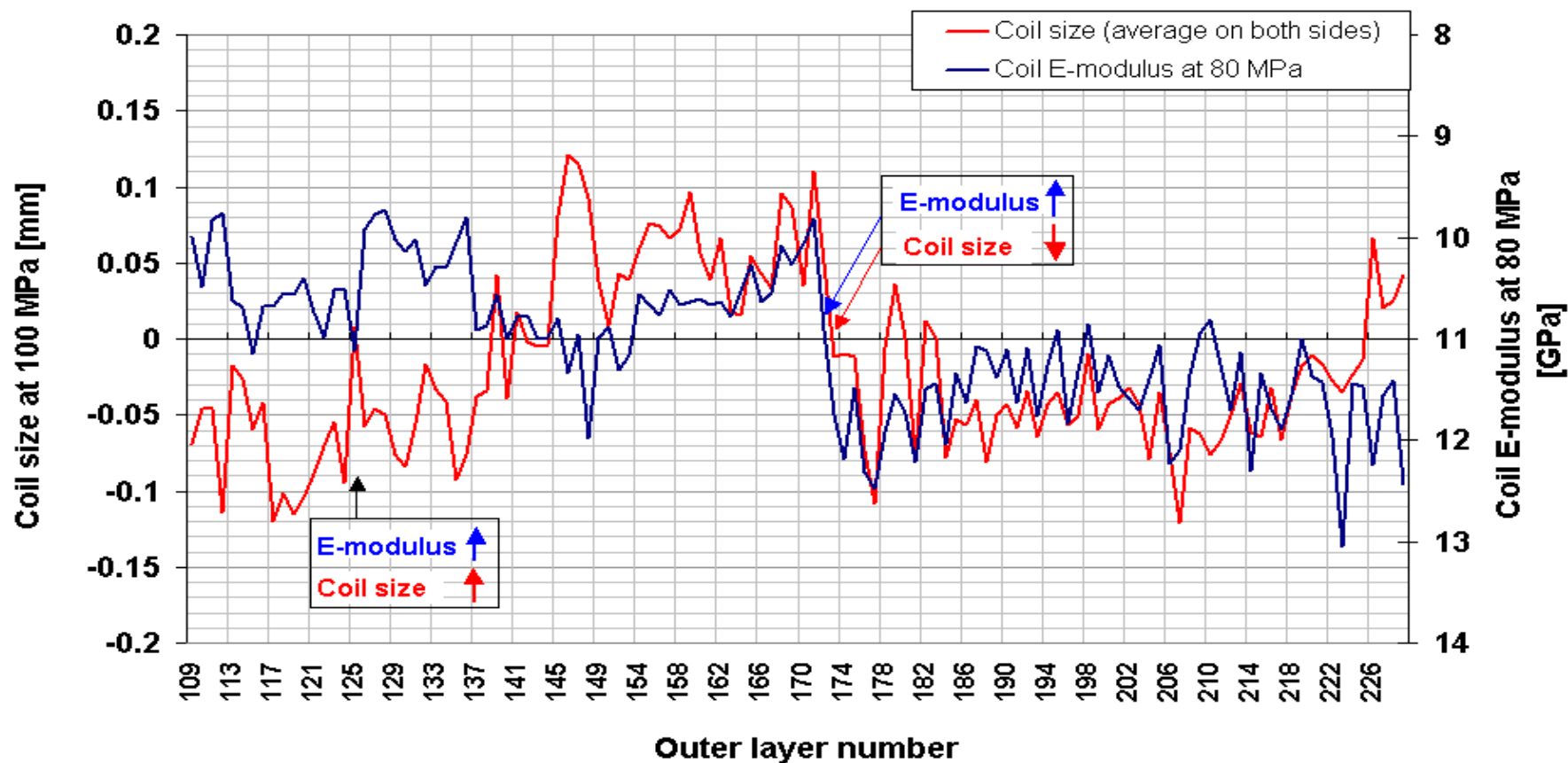
Coil size trends...

What are the causes?

Firm 3 coil outer layers trend

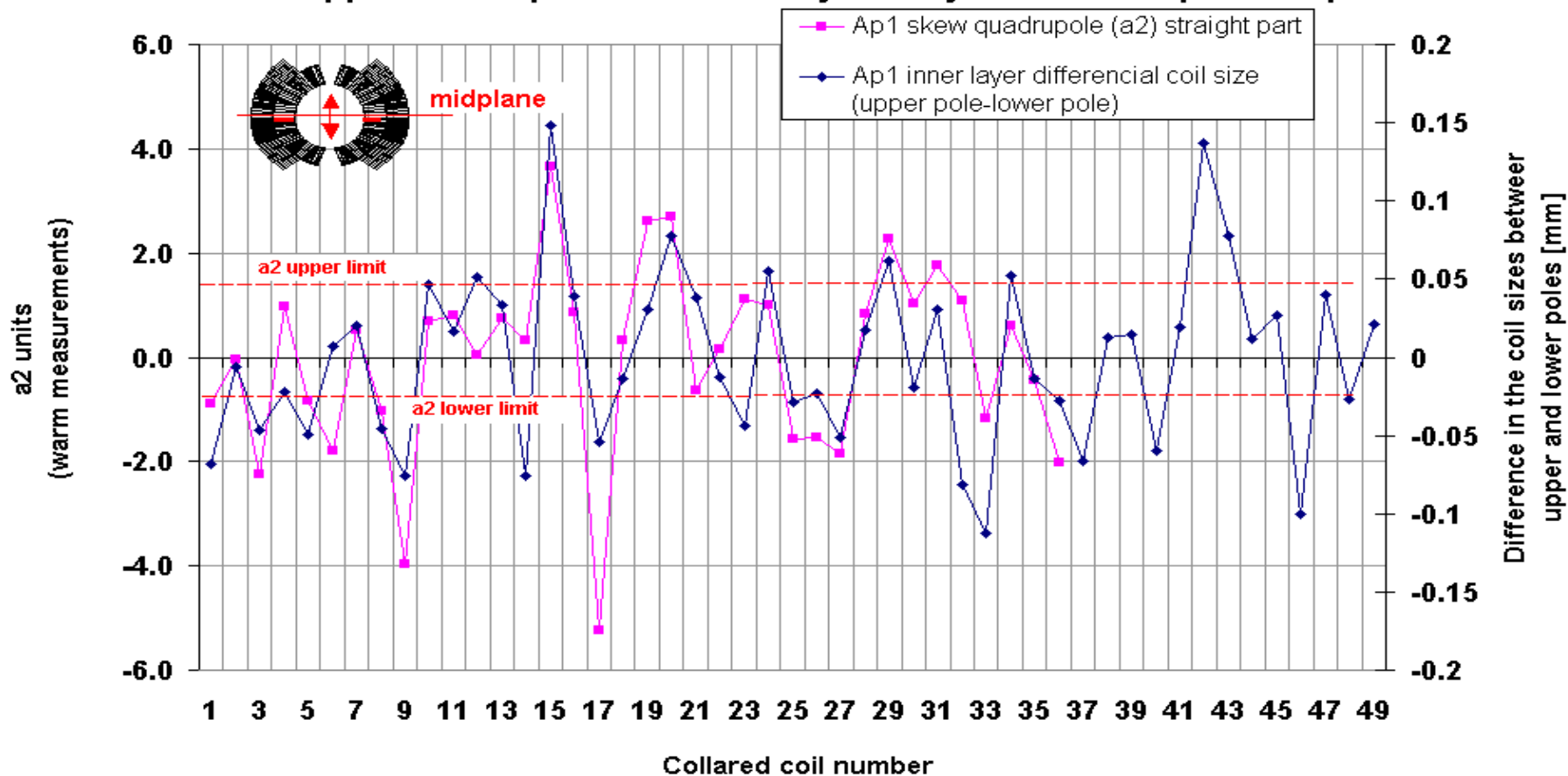
Notice the reverse scale for E80

Firm 3: Outer layers coil size and E-modulus

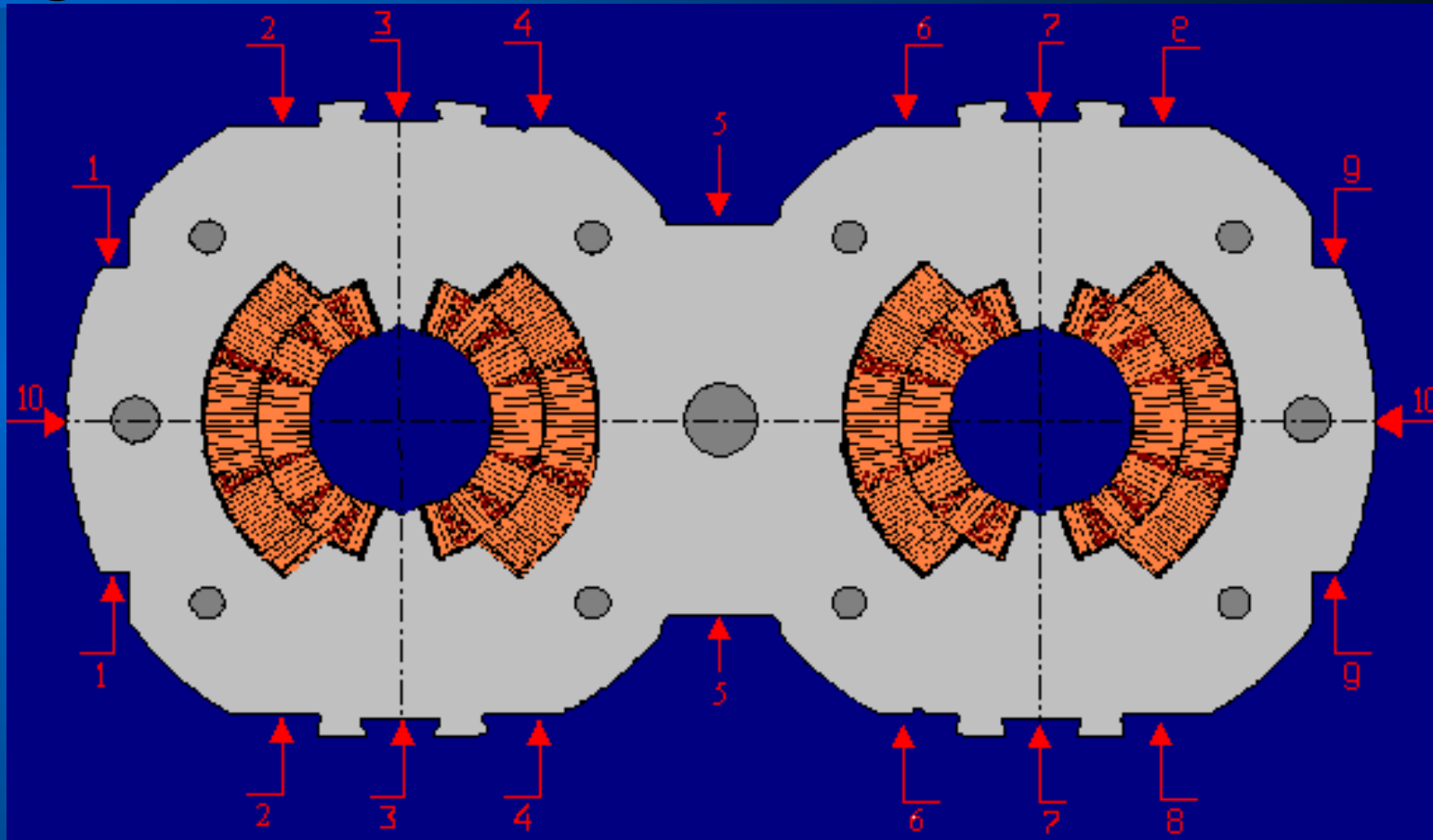


Sorting of coils is it favorable?

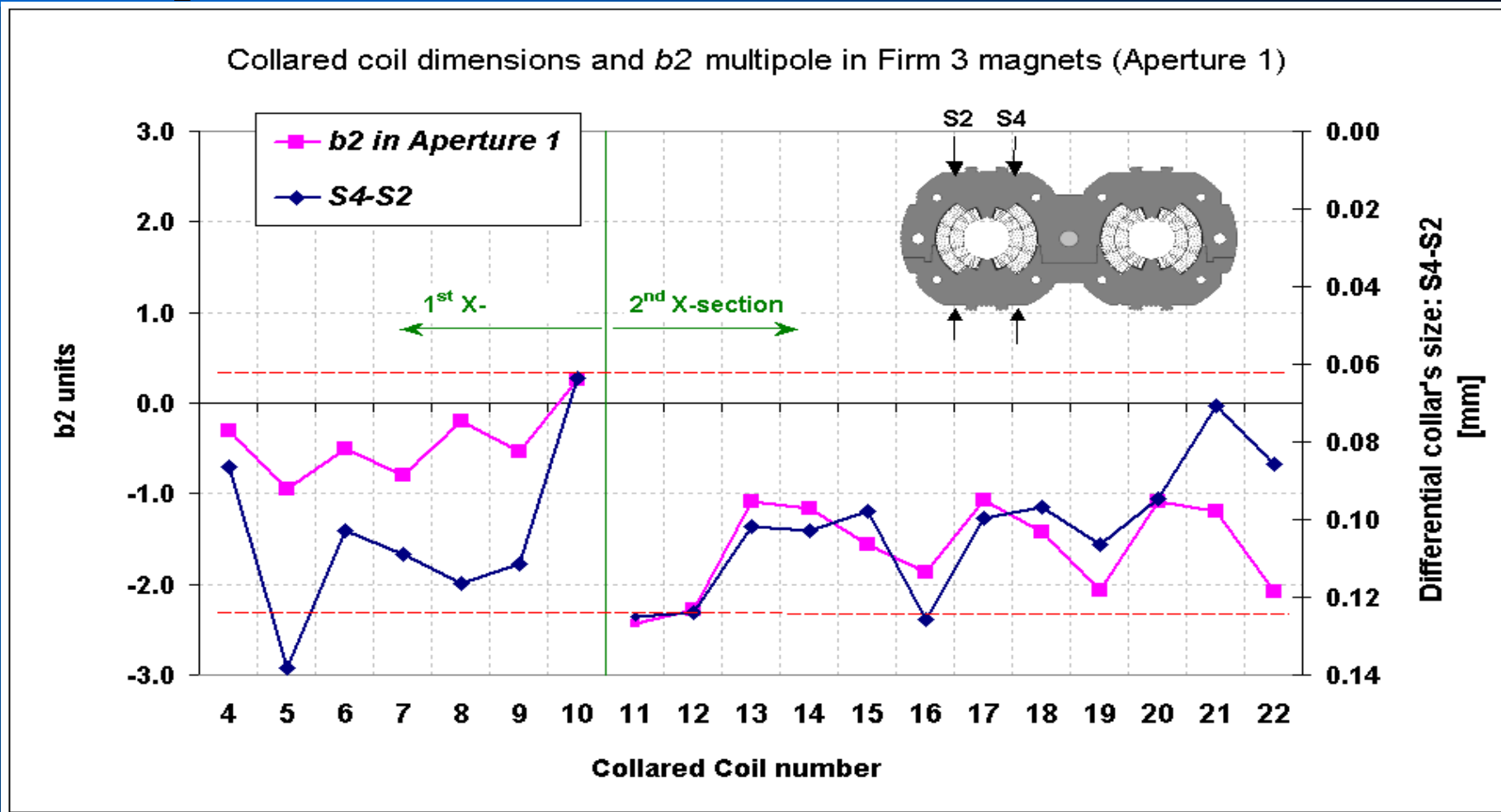
Firm 1. Upper / lower poles coil size asymmetry and a2 multipole in Ap1.



Collared coil dimensions measurements do they bring something to us ? *(apart of yoke insert shims corrections needs)*

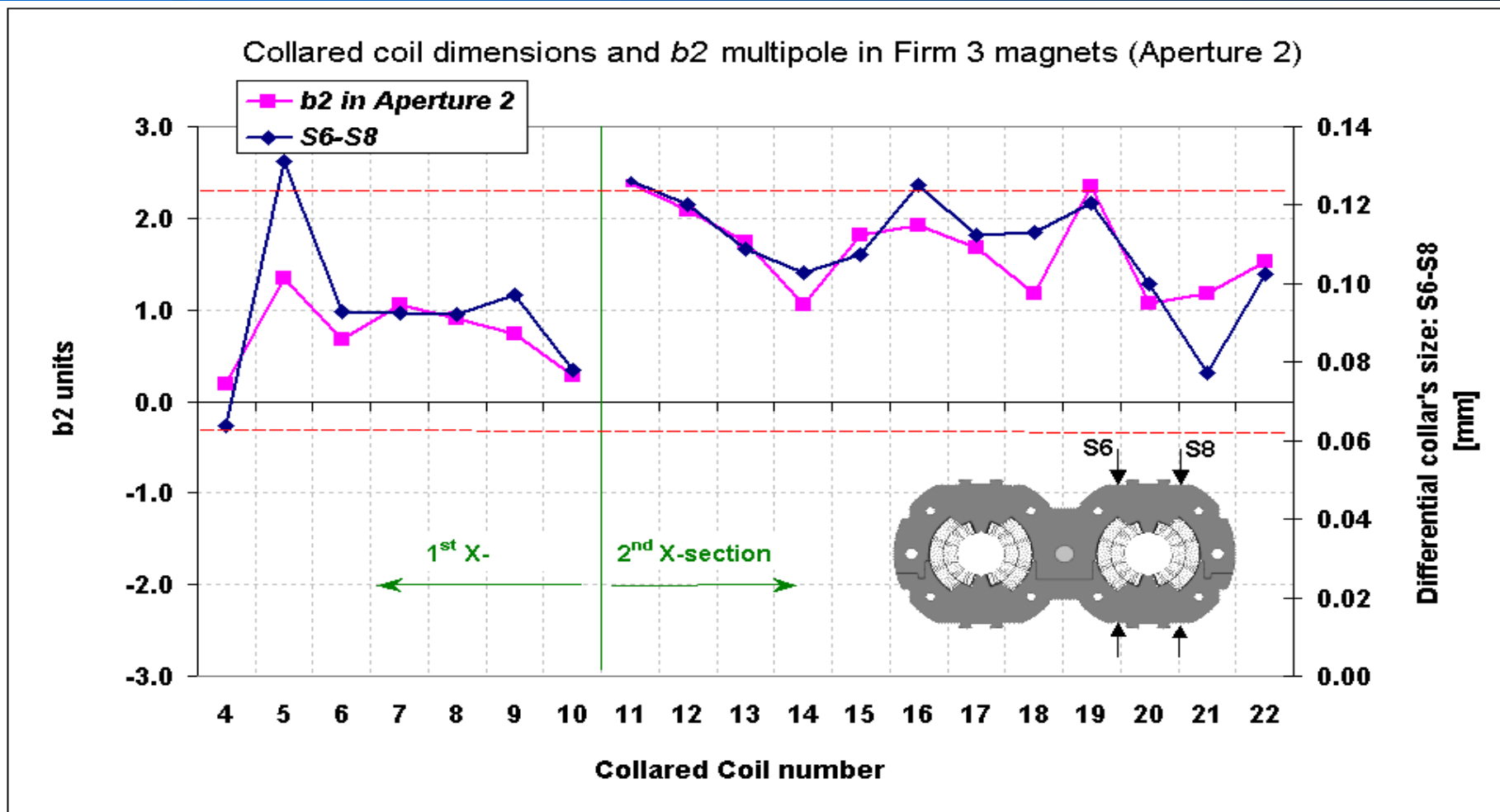


Collared coil dimensions measurements data and b2 multipole correlations *in Aperture 1...*



Collared coil dimensions measurements data and b2 multipole correlations

... and in Aperture 2



Conclusions

1. The data on the coil size shows a significant non-systematic variation at each firm. The coil size varies from -0.3 up to $+0.2$ of mm in a random way. Some improvement is seen after change of the curing shims (firm 2).
2. The systematic on the longitudinal coil profile shows that the coil waviness is rather big at firm 1. The large tolerances on the curing mold are the cause of that.
3. The sorting of coils in case when it is possible (*cables mixing restrictions*) could reduce the random parts of field errors, especially on a_2 multipole.