# MCBXFP2 shimming plan

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# Target: minimal preload

- The objective of the coil preload is to avoid cable movements during powering.
- The minimal preload at cold is 25 MPa in single operation and 40 MPa in combined operation (electromagnetic forces, no margin).
- The minimal preload at room temperature is 105/120 MPa, due to the differential thermal contraction of the coils.
- In the first prototype, peak stress was 220 MPa to keep 37 MPa (average) at cold.

# Review of last assembly of MCBXFBP1 (I)

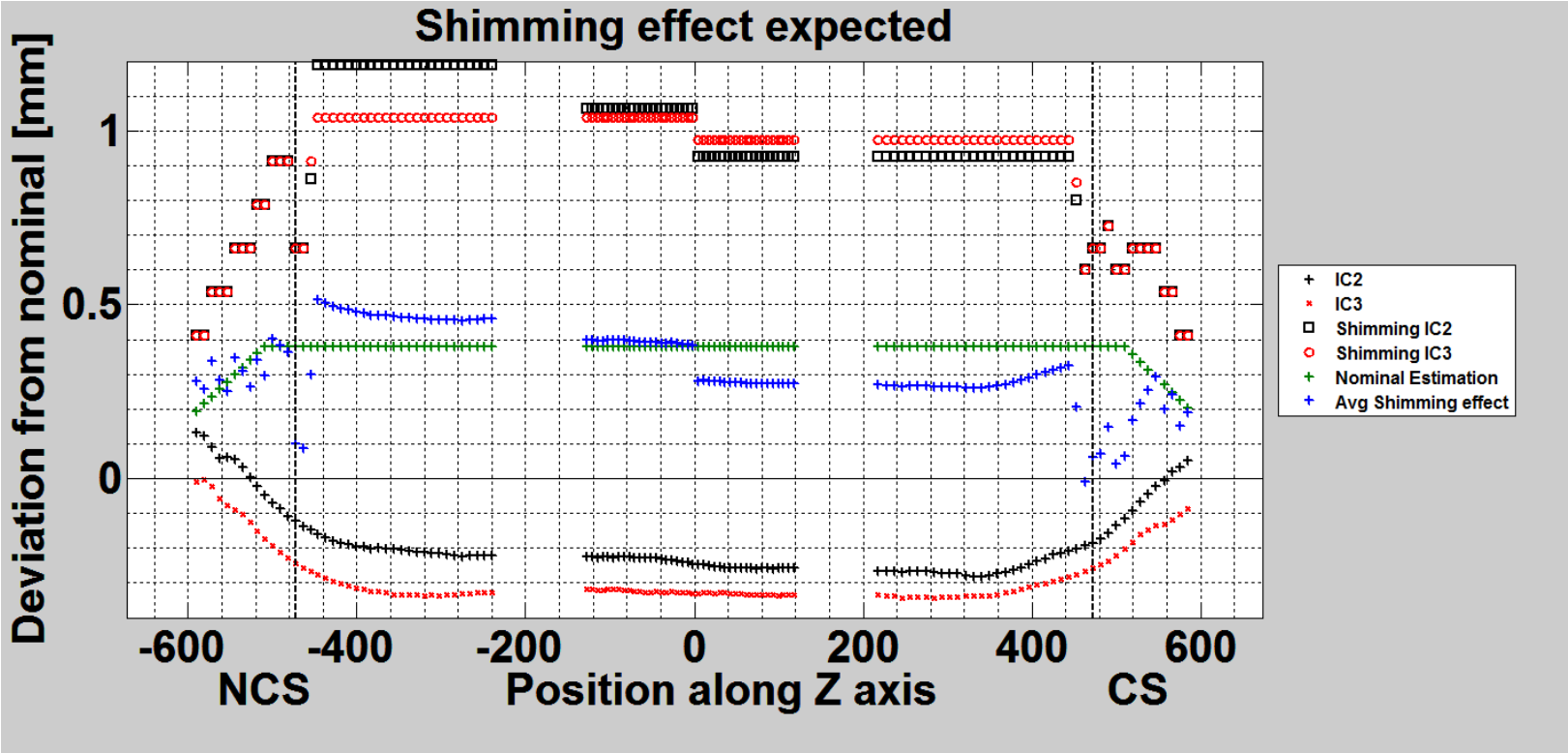
- There were several assemblies with increasing preloads.
- The thermal contraction coefficient of the coils was initially underestimated.
- Spring-back effect is similar in both dipoles.
- No training in individual powering, but some training when changing polarity in combined operation: possible lack of support at coil ends.

| | March 2019 | | | | June 2019 | | | | August 2019 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Press | Spring | SM18 | Cool | Press | Spring | SM18 | Cool | Press | Spring | SM18 | Cool |
| Inner | -104 | -72 | -76 | -18 | -144 | -111 | -97 | -21 | -143 | -122 | -121 | -37 |
| Outer | -161 | -140 | -133 | -55 | -150 | -130 | -116 | -38 | -144 | -126 | -116 | -56 |

*MCBXFBP1 coil preload (MPa) at different steps and assemblies*

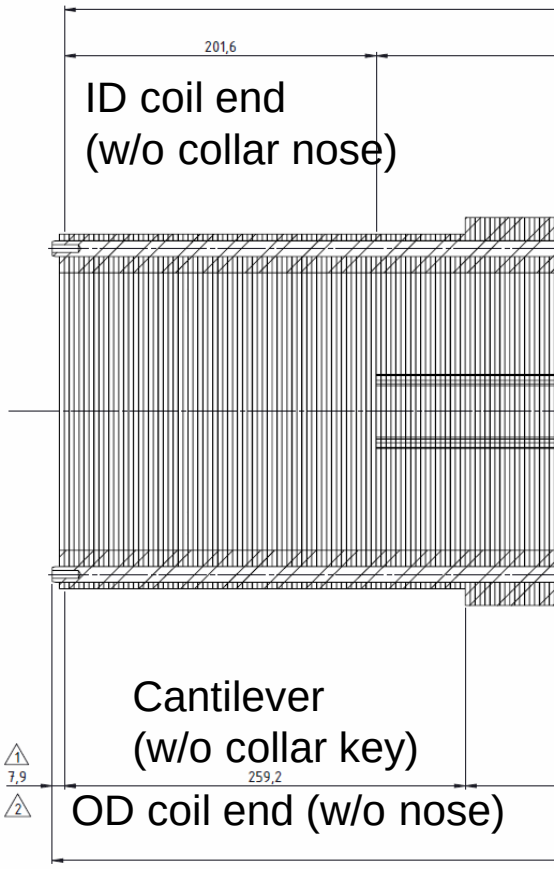
# Review of last assembly of MCBXFBP1 (II)

- A fraction of the additional shims can be explained by the differential thermal contraction, lower stiffness of cables or creeping.
- Coil ends are not properly supported, mainly connection side (starting location of most of the quenches).

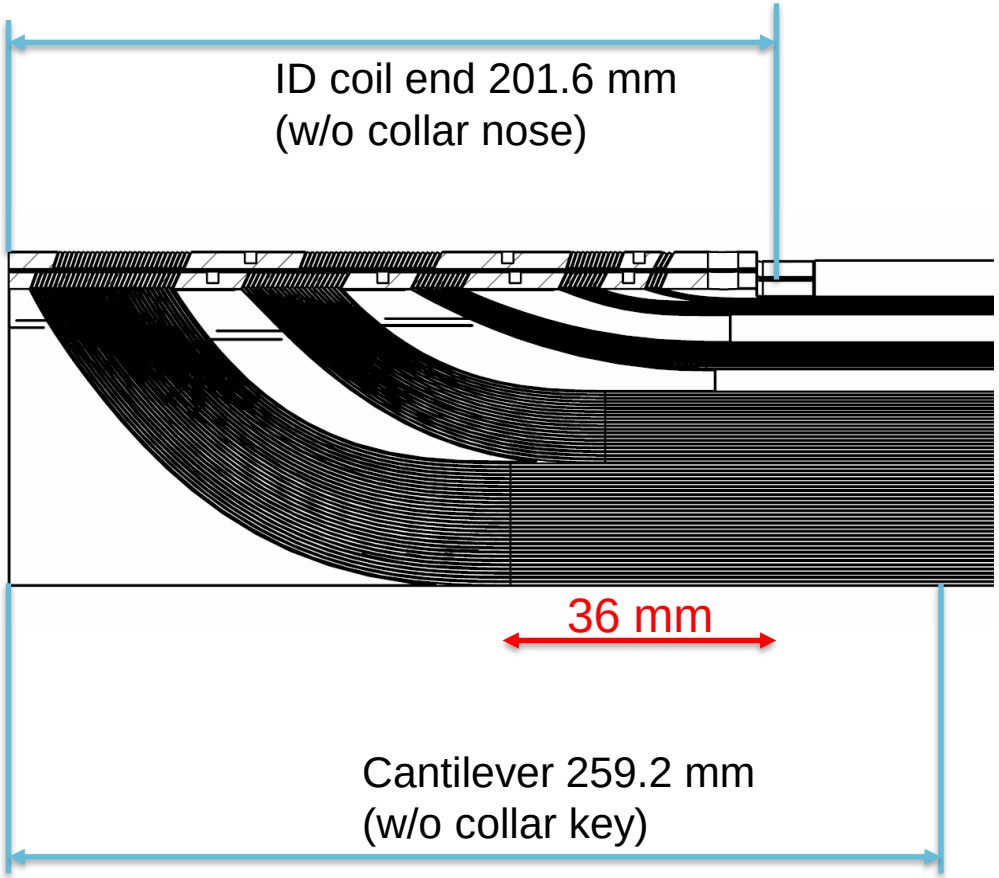


# Review of last assembly of MCBXFBP1 (III)

- The straight cables of the coil ends are not properly supported, since part of the additional shims are placed at the coil end.



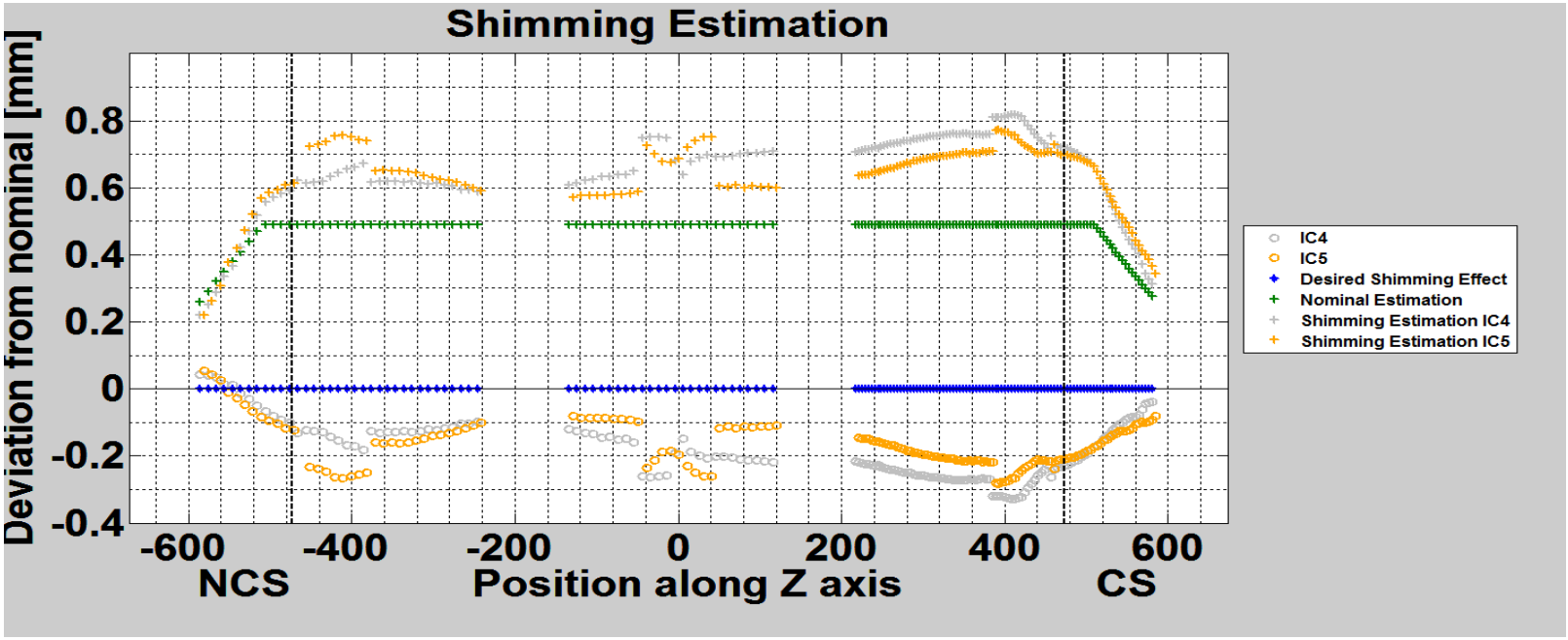

*ID Collars top view*



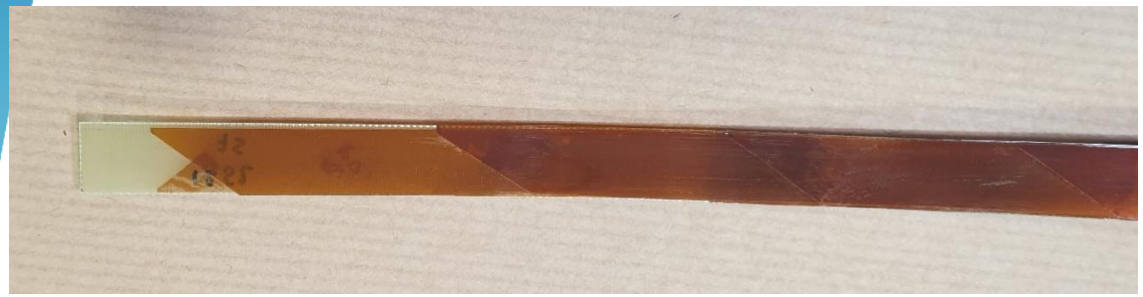

*ID coil cross section*

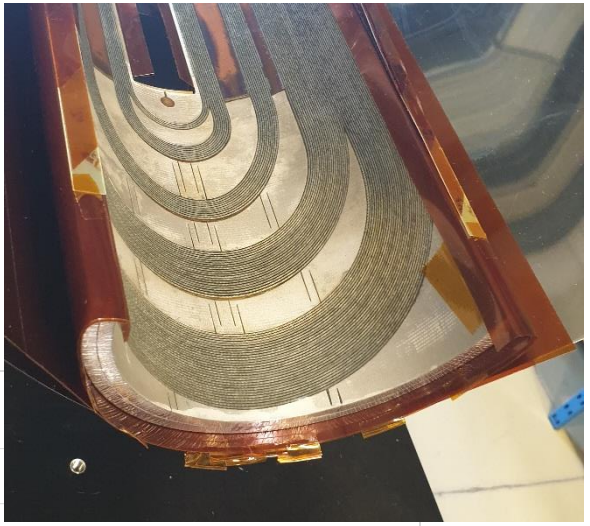
# Proposal of shimming for MCBXFBP2 (I)

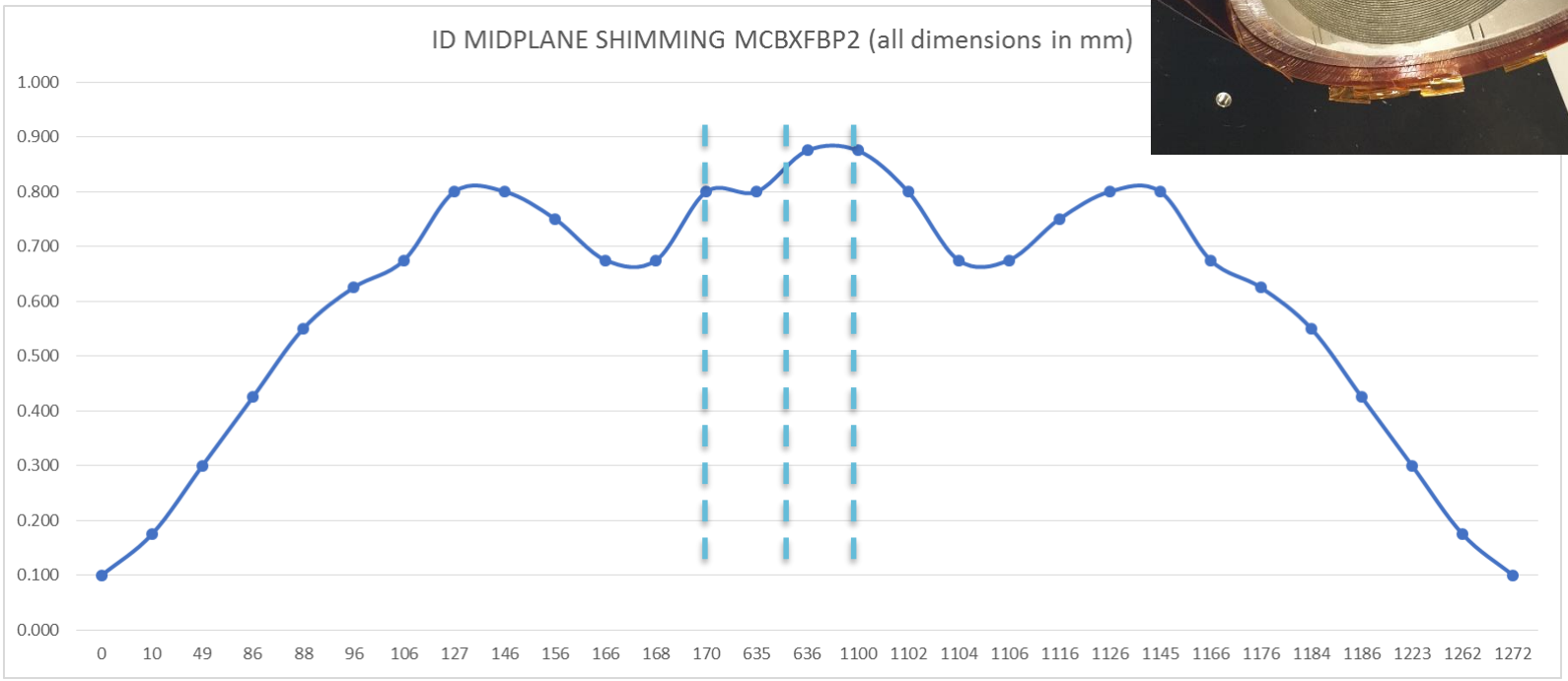
- Coils are about 0.2 mm larger per quadrant, likely due to the increase in insulation thickness.
- Coils are a bit softer (26 vs 32 Gpa), likely because of the additional heat treatment for oxidation of the tin layer.
- The objective is to achieve the same preload of P1, but better support at the coil ends.



# Proposal of shimming for MCBXFBP2 (II)



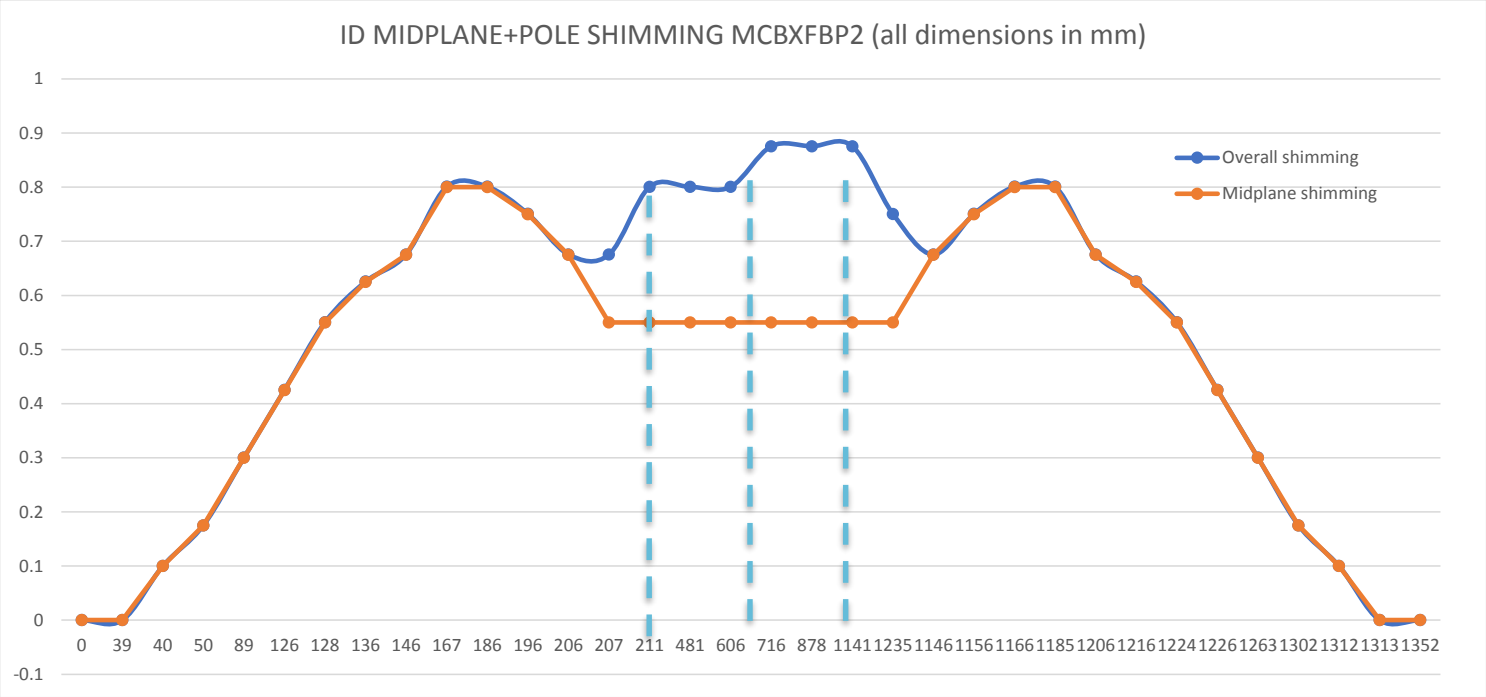





Shims should be split between pole and midplane to achieve good field quality

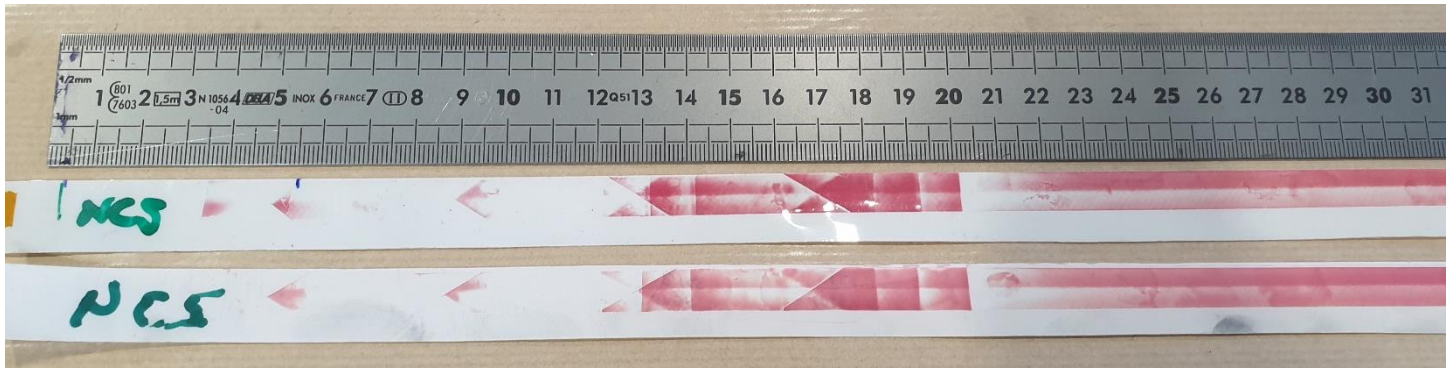
# Proposal of shimming for MCBXFBP2 (III)

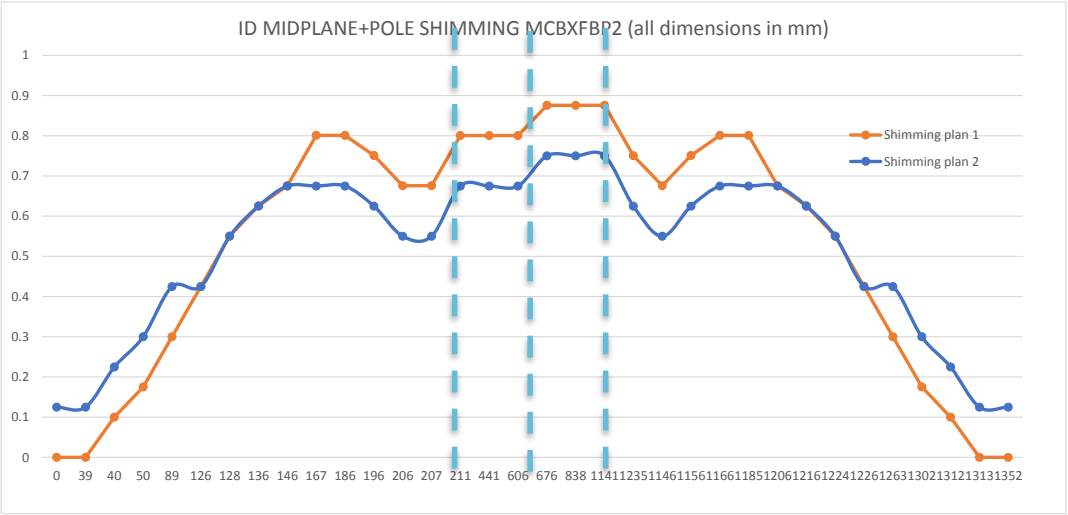
- b3 is -13 units in a 2-D calculation with Roxie using nominal coil dimensions.
- Assuming a total shim thickness of 0.8 mm, the wire thickness is reduced by 0.8/70=0.011 mm for a coil with 70 turns.
- 0.25 mm shim could be placed at the pole and 0.55 mm at the midplane to achieve b3 of -7 units.



# Collaring test results (I)

- Preload at straight section was too high: for 1 mm gap, 112 MPa instead of 76.
- Fuji paper results: uniform pressure on straight section, lack of pressure at the coil ends.
- Conclusion: removal of the shorter 125 micron shim of midplane.





# Collaring test results (II)

- We achieved slightly lower preload than the first prototype, with better support at the coil ends.

| Gap (mm) | P1 (MPa) | P2 (MPa) |
|---|---|---|
| 1 | 65 | 48 |
| 0.7 | 105 | 87 |
| 0.5 | 127 | 115 |
| 0.3 | 147 | 135 |
| 0.2 | 159 | 147 |
| 0.1 | 170 | 163 |
| 0.05 | 177 | 163 |

# Conclusions

- A lack of support at the coil ends was detected in the first prototype.
- The shimming proposal for P2 is based on the lessons learned with P1.
- First collaring test results show too high pressure at the straight section and lack of support at the coil ends.
- Target is achieved after removing one shim of 125 micron at the straight section and adding it at the coil ends.