Mon-Af-Po1

Mechanical Analysis of the FRESCA2 Dipole during Assembly, Cool-Down, and Powering

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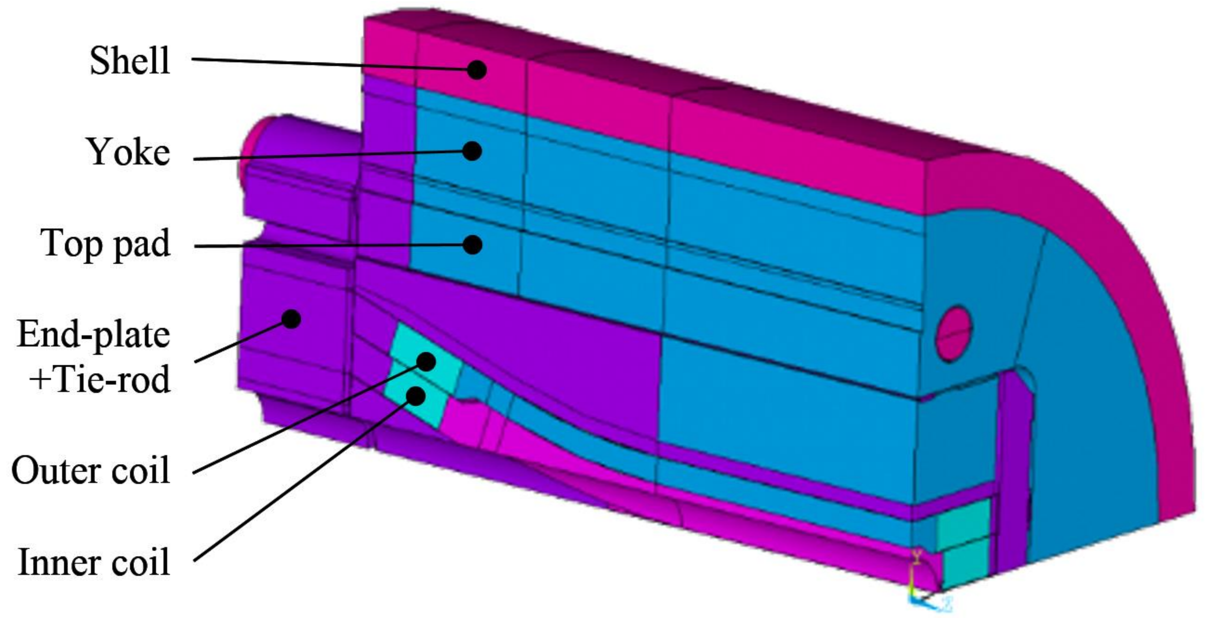
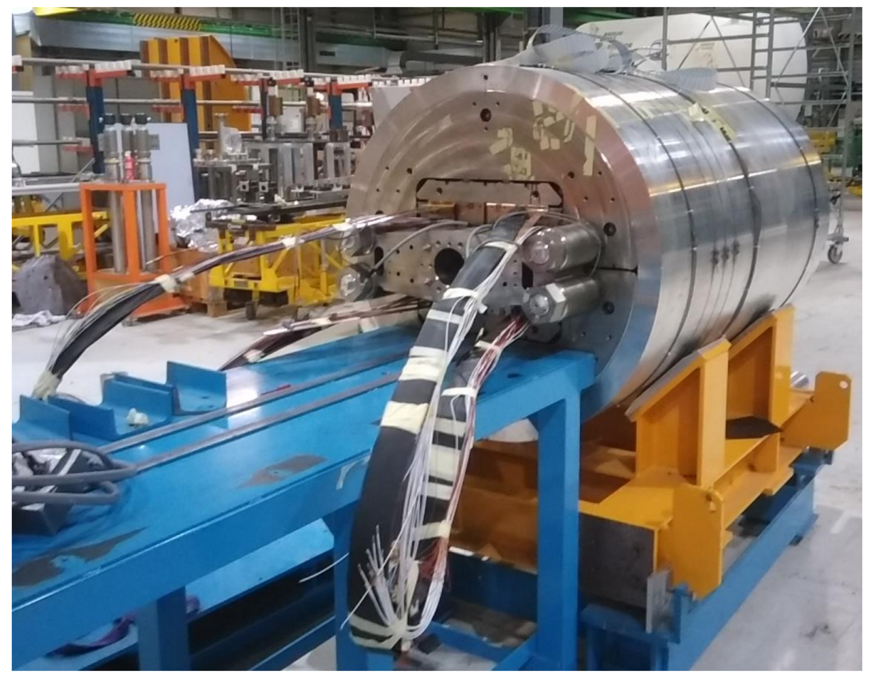
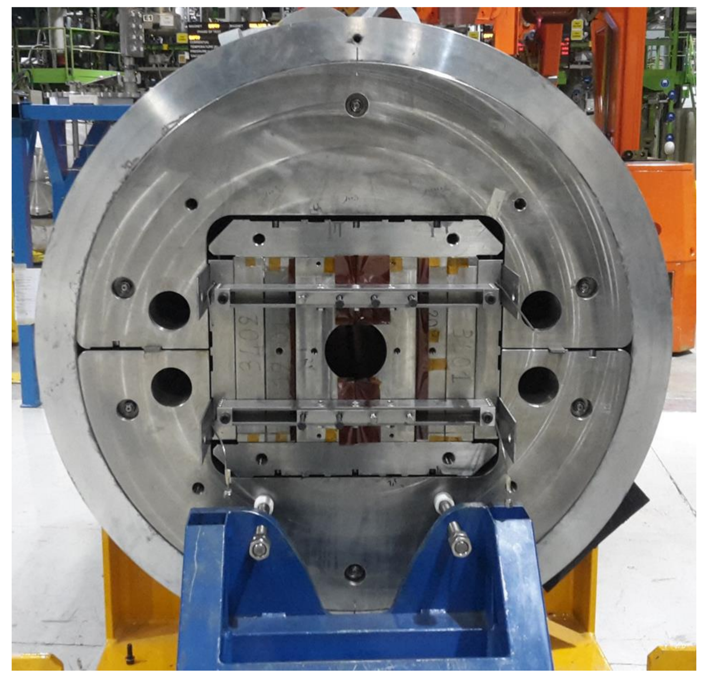
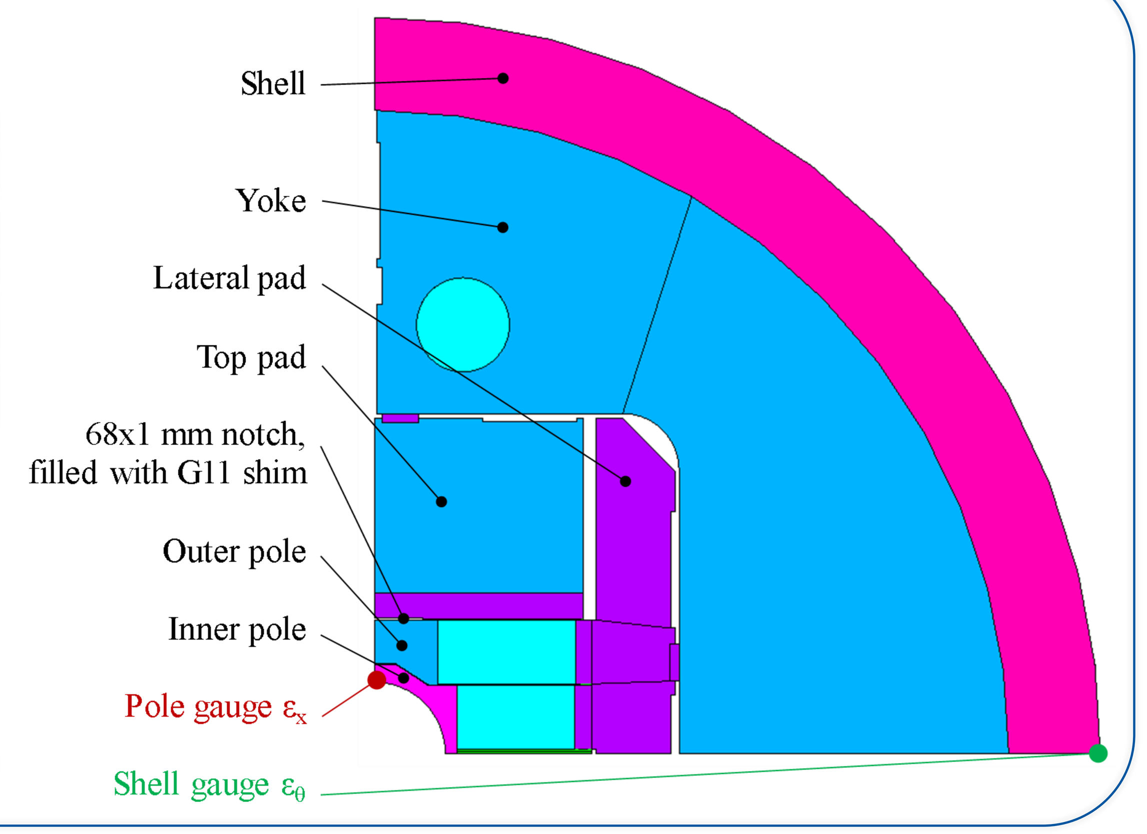
THE FRESCA2 MAGNET [1-2]









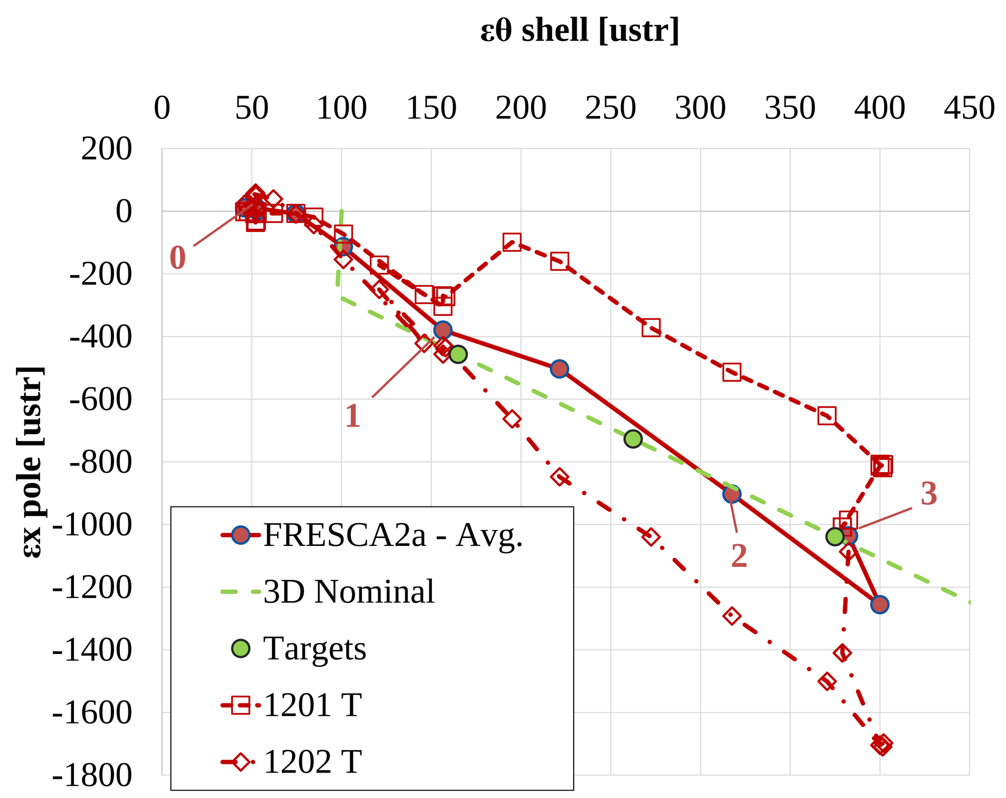
[1] A. Milanese et al., "Design of the EuCARD High Field Model Dipole Magnet FRESCA2," IEEE Trans. Appl. Supercond., vol. 22, no. 3, p. 4002604, 2012.
[2] P. Ferracin et al., "Development of the EuCARD Nb 3 Sn Dipole Magnet FRESCA2," IEEE Trans. Appl. Supercond., vol. 23, no. 3, p. 4002005, 2013.

SUMMARY

- 2 assemblies: FRESCA2a and FRESCA2b
  → Nominal 13 T reached after 3 training quenches at 1.9 K [3]
  → **13.3 T maximum** reached after thermal cycle with no quench (72 % short sample)
- Pre-load estimated for 13 T only
  → Pole strain balanced during pre-load
- Strong impact of conditions inside the inner structure
  → Possible de-bonding outer pole-inner pole
- **Possible coil-pole separation** around 8.2 kA (55 % short sample)

[3] G. Willering et al. "Results of the cold powering tests of the Nb3Sn FRESCA2 block coil magnet", IEEE Trans. Appl. Supercond., submitted for publication. **Thu-Mo-Or28**

PRE-LOAD

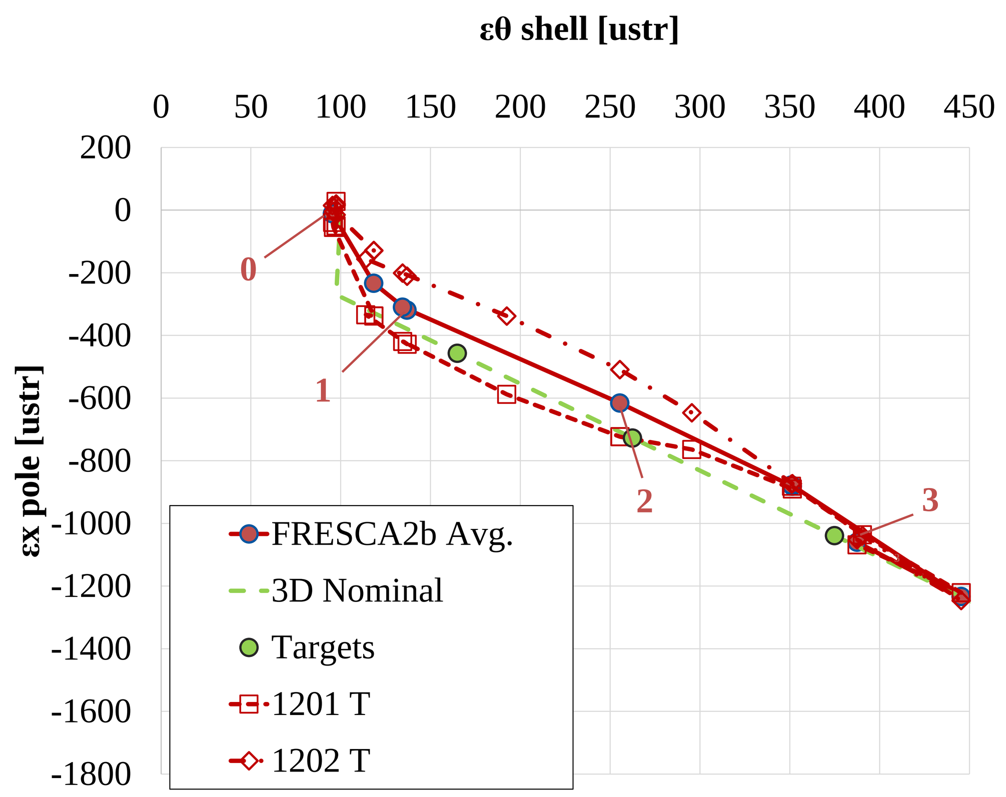


- FRESCA2a:

→ Coils aligned from the bore, then shimmed on the sides [4]

→ Unbalance pole 1201/pole 1202 of 900 μstr

→ Corrected by tuning the shimming in the keys



- FRESCA2b:

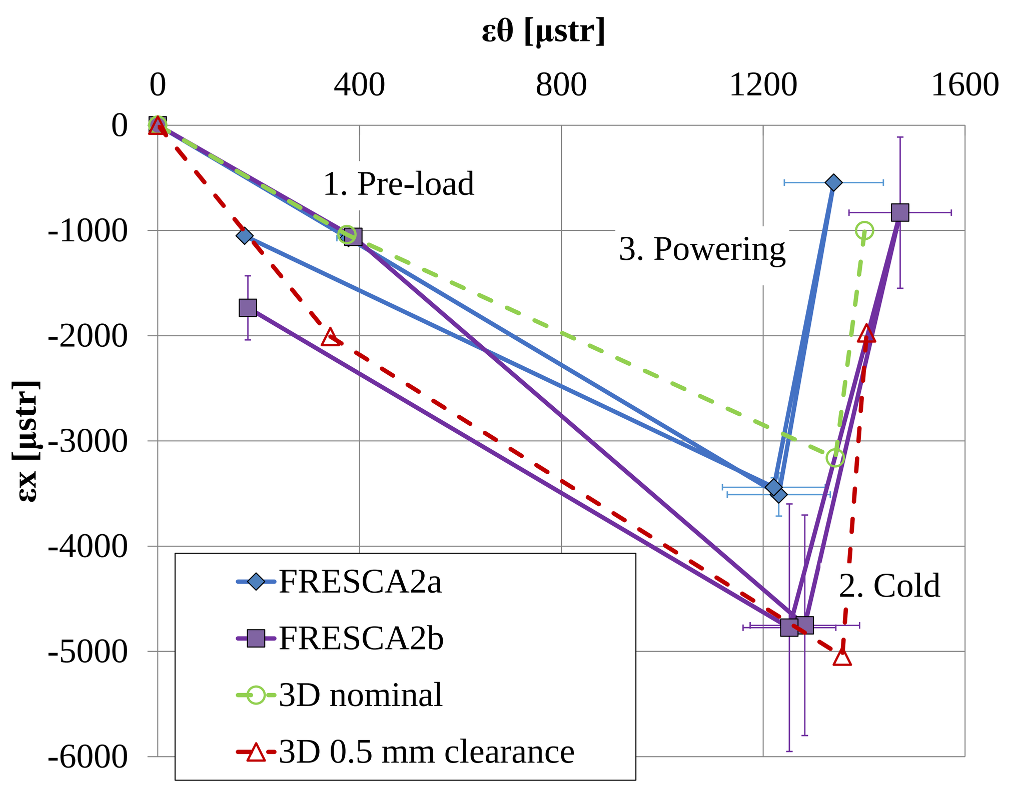
→ Coils shimmed on the sides based on CMM, then aligned with bladders

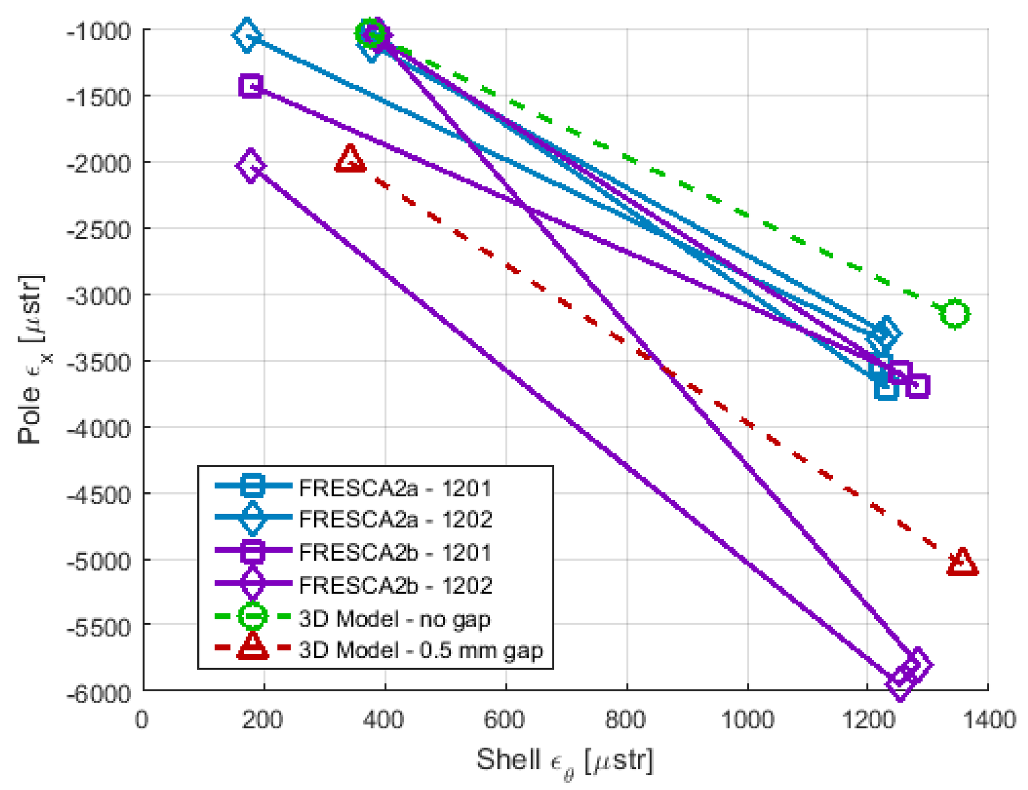
→ Unbalance pole 1201/pole 1202 of 300 μstr

→ Corrected during pre-load

[4] N. Bourcey et al., "Assembly of the Nb3Sn dipole magnet FRESCA2", IEEE Trans. Appl. Supercond., submitted for publication. **Wed-Af-Po3.01**

THERMAL CYCLES





- Choice of material properties, consistent with [5-6]

Parameter	Value
Coil modulus	20 GPa
Coil thermal contraction to 4.2 K	3.36 mm/m
Friction coefficient	0.15

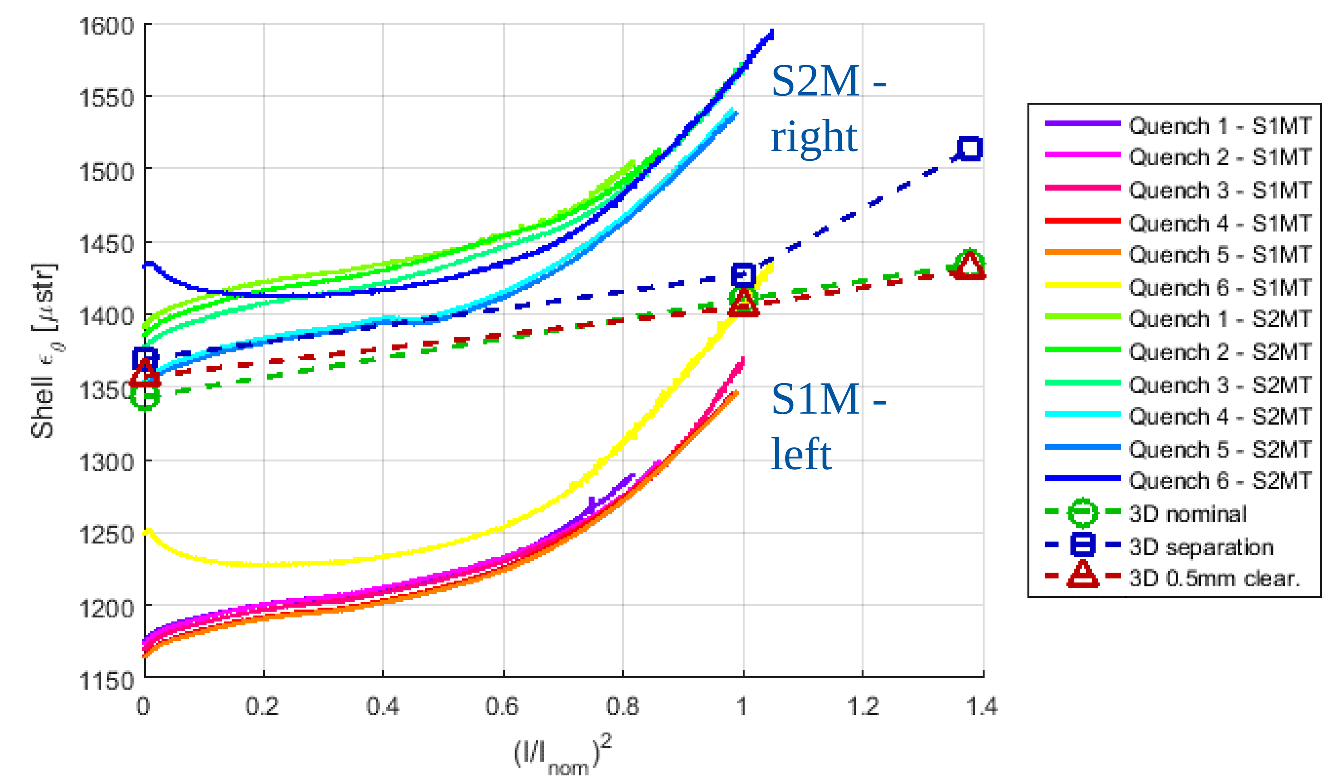
- Strong impact of pad-pole-pole contact assumptions (already observed in HD3 [7])
- More bending observed in pole 1202 (-2000 μstr)

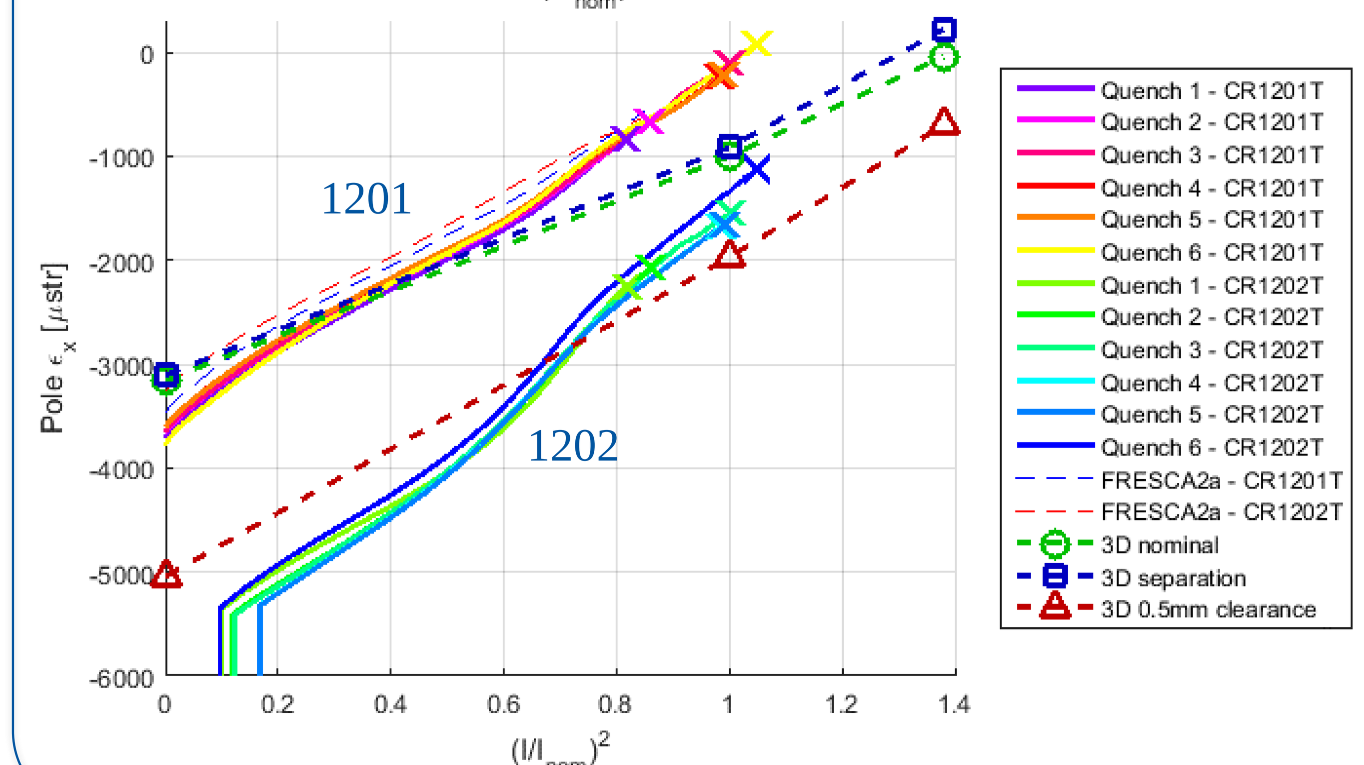
→ Unbalanced pre-stress inner/outer coil ruled out with Fuji tests

→ Likely because of a **gap inner pole-outer pole**

[5] G. Vallone et al., "Mechanical Performance of Short Models for MQXF, the Nb3Sn Low-β Quadrupole for the Hi-Lumi LHC", IEEE Trans. Appl. Supercond. Vol. 27, no. 4, 4002906.
[6] G. Vallone et al., "Mechanical Analysis of the Short Model Magnets for the Nb3Sn Low-Beta Quadrupole MQXF", IEEE Trans. Appl. Supercond., submitted for publication.
[7] E. Felice et al., "Challenges in the Support Structure Design and Assembly of HD3, a Nb3Sn Block-Type Dipole Magnet", IEEE Trans. Appl. Supercond., vol. 23, no. 3, p. 4001705, 2013.

POWERING



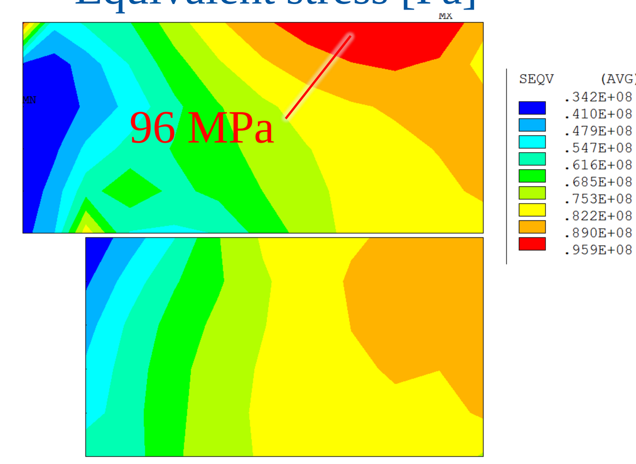


Nominal: 10.55 kA, 13 T

Signs of coil-pole separation:

- In poles and shell
- At $(I/I_{nom})^2 = 0.6$ (8.2 kA, 55 % short sample)
- Model predicts separation only at $I = I_{nom}$

Equivalent stress [Pa]



Coil-Pole contact [Pa]