EDIPO: Alternative design without Ti pole

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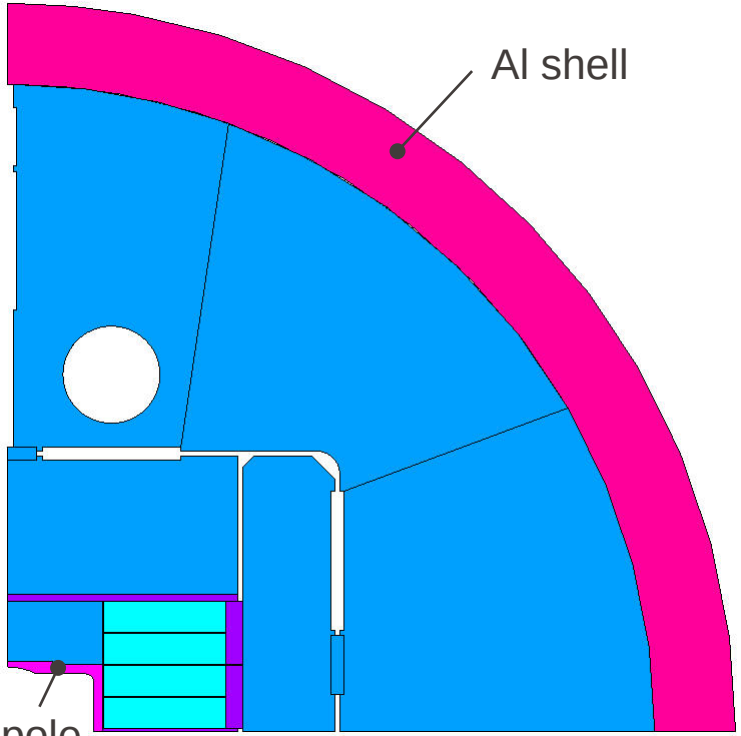
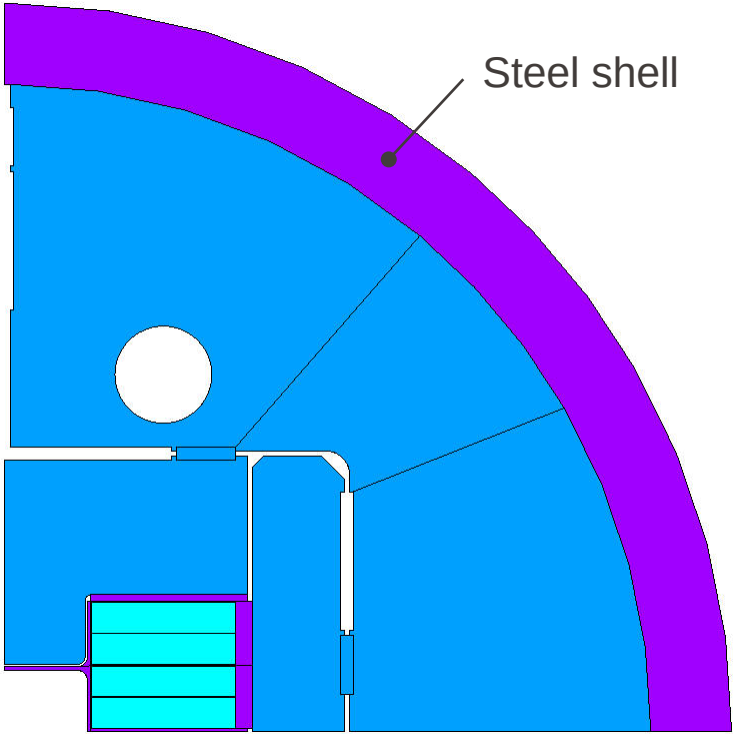
Alternative design without titanium pole

- **2018:**
  - 4 coils (47 turns/pancake)
  - 14.5 T in the center aperture



- **H-shape test well, no Ti pole**



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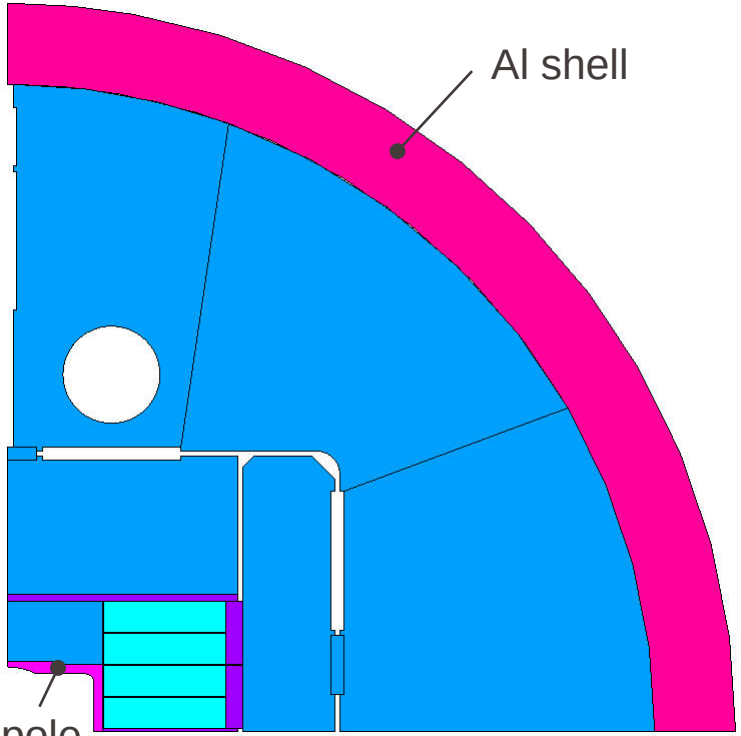

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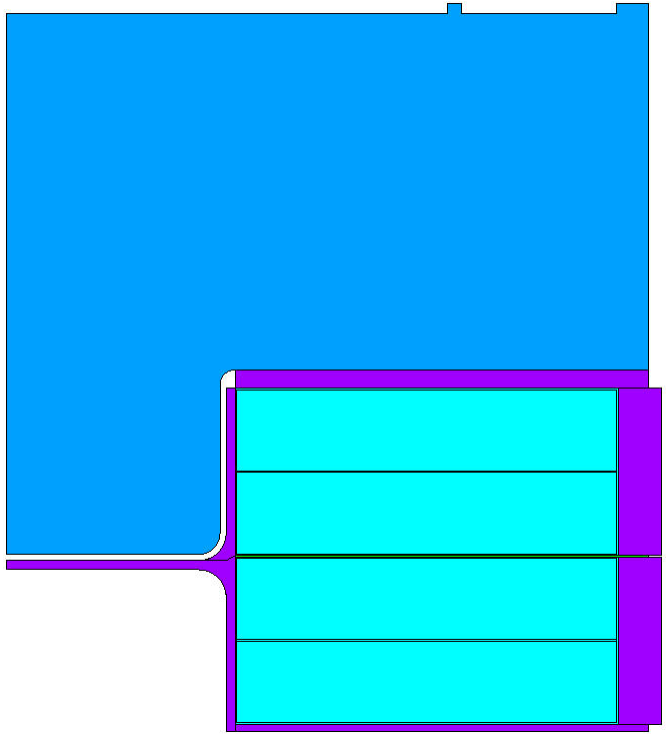
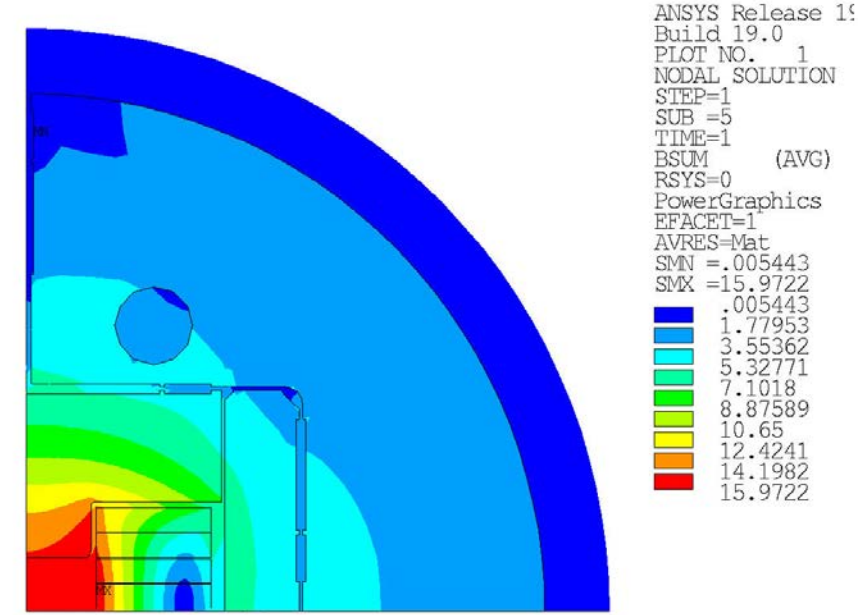


Magnetic model

- The conductor area required to reach 15 T in the center of the aperture is very sensitive to the thickness of the test well (i.e., location of WP)

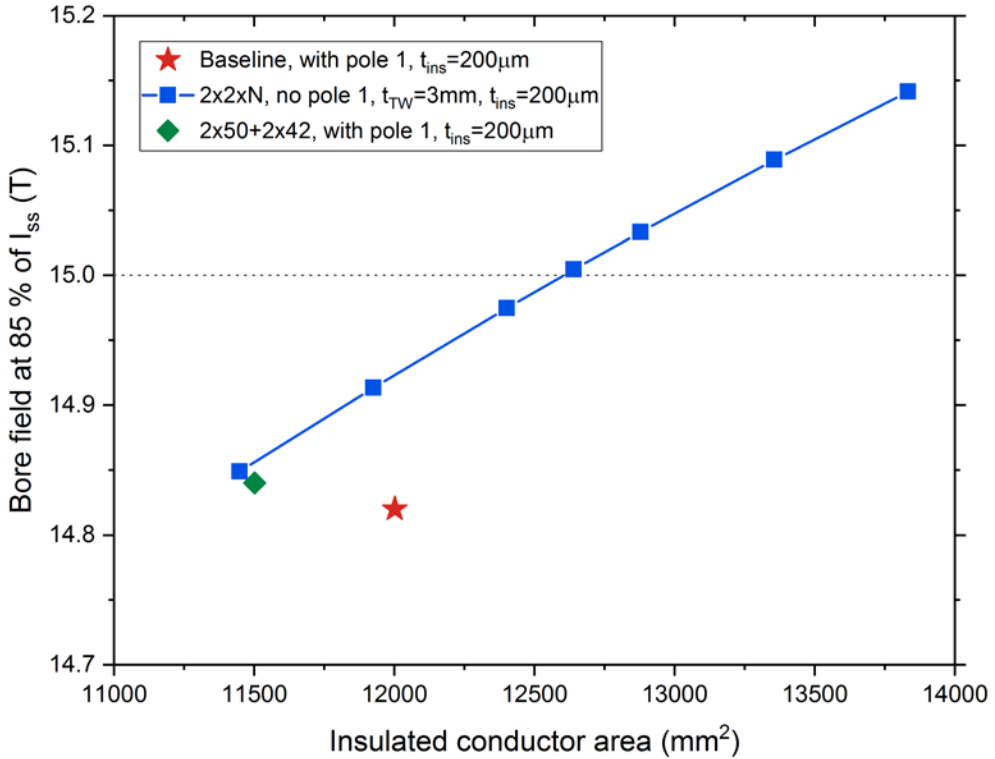
Test well thickness (mm)	3.0	5.0	7.5
# turns/pancake	52	54	60
Ins conductor area (mm^2)	12402	12879 (+4%)	14310 (+15%)
$I_{op} = 0.85 \times I_{ss}$ (kA)	11.66	11.46	10.87
B_{coil} (T)	15.95	15.99	16.11
$B_{center\ aperture}$ (T)	14.97	14.96	14.99



EDIPO, magnetic model

Magnetic model

- For t_{TW} = 3.0 mm, the alternative without Ti pole is **more efficient** than the current baseline and the 4-coil-design alternative



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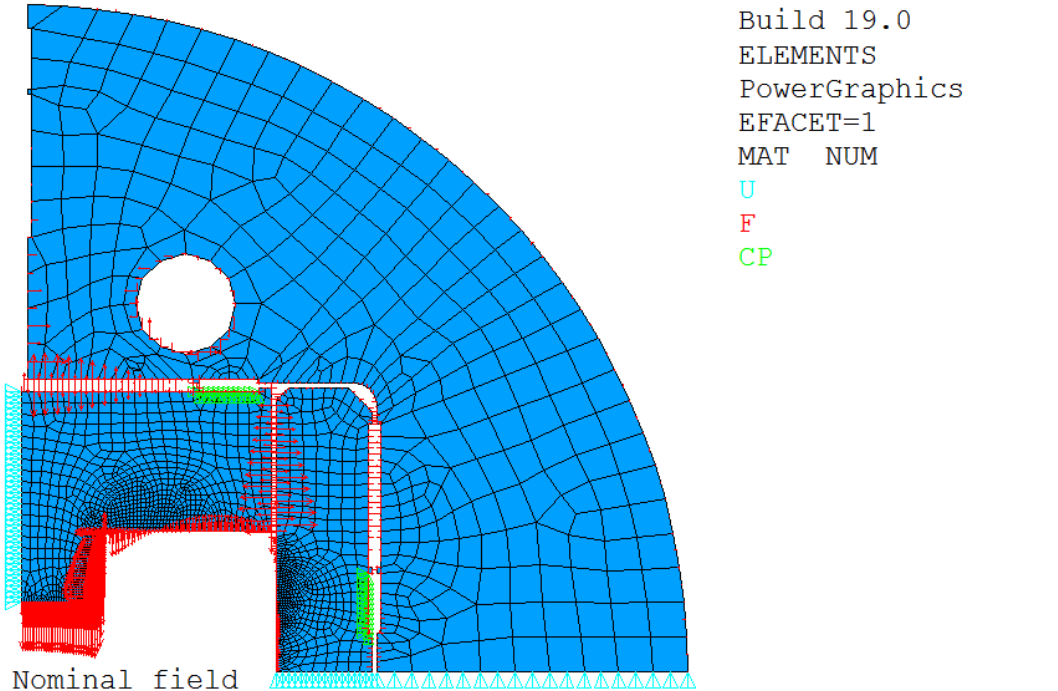
Forces in the iron parts

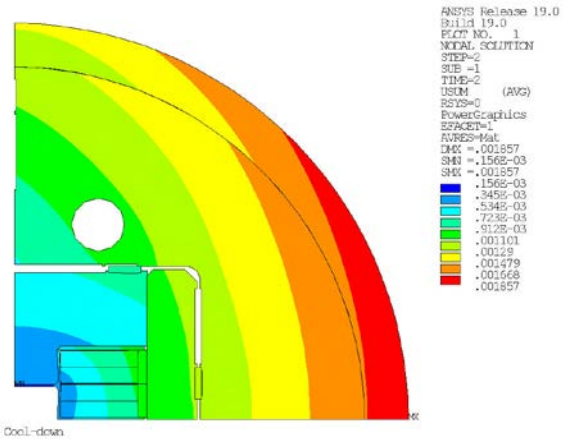
- V pad and pole 2 are attracted towards the test well:
  - V pad: F_y = -2.5 MN/m
  - Pole 2: F_y = -0.5 MN/m



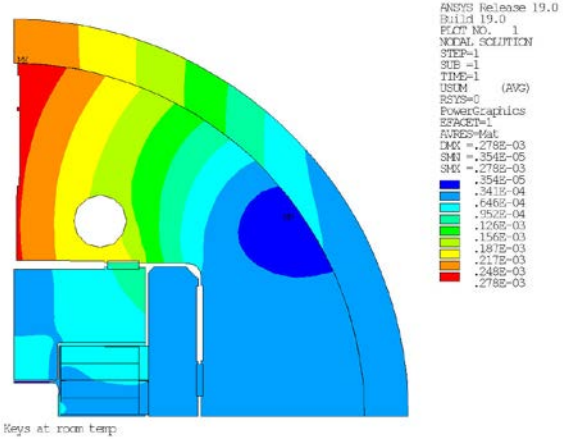
Deformation

- During powering of the magnet, the iron parts experience forces in the directions highlighted by the arrows in the bottom right plot.

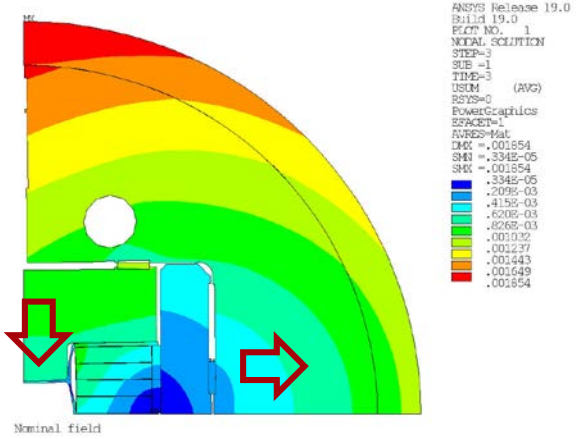
2. Cool-down



1. Room temp



3. Nominal field



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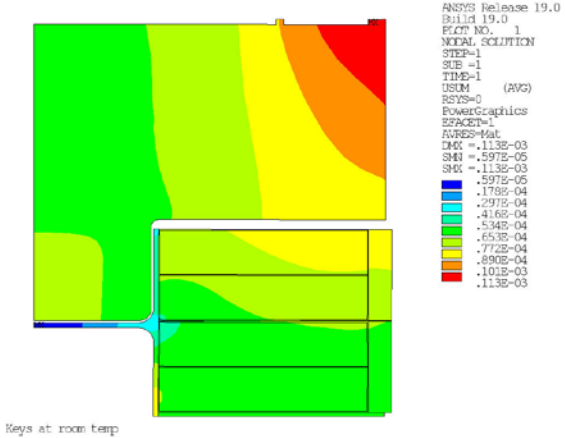
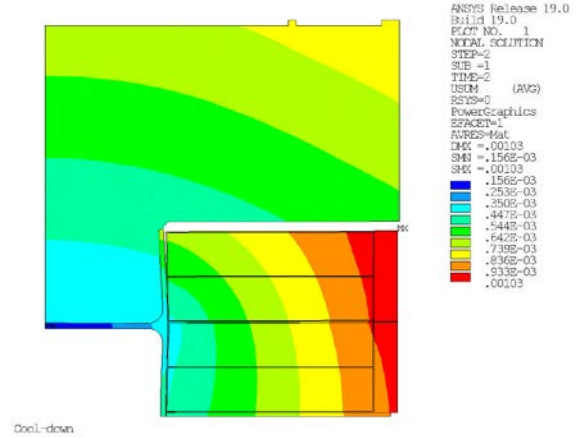
Deformation (zoom)

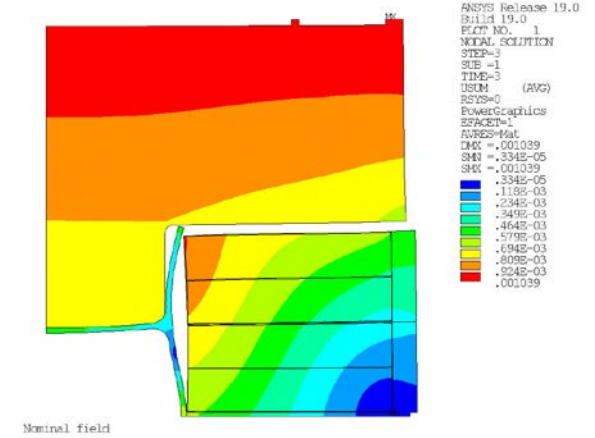
1. Room temp



2. Cool-down



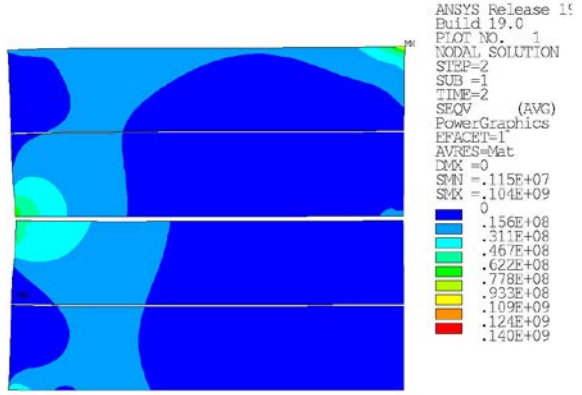
3. Nominal field



Stress in the coils (von Mises)

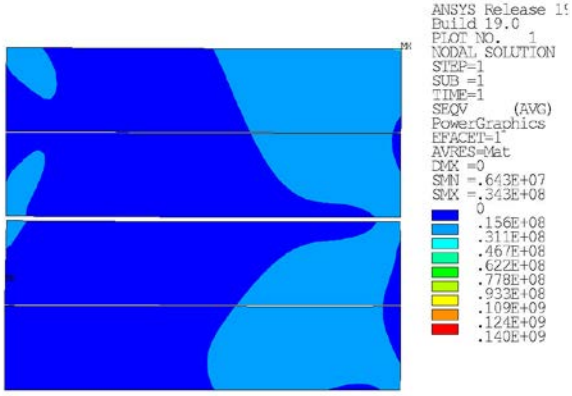
- Coils are essentially stress-free at room temperature (small lateral interference) and after cool down (shell is made of steel)
- After powering the stress remains below 120 MPa except in one corner in the low field region

2. Cool-down



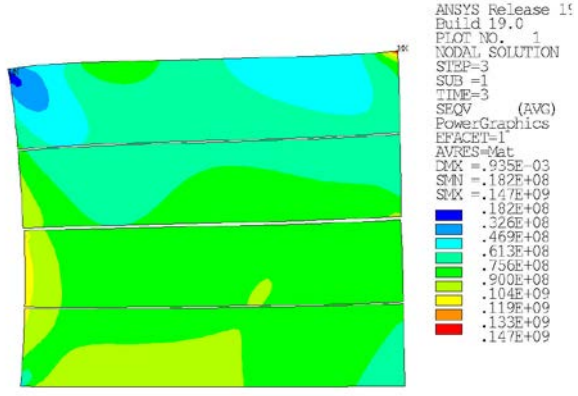
Cool-down

1. Room temp



Keys

3. Nominal field

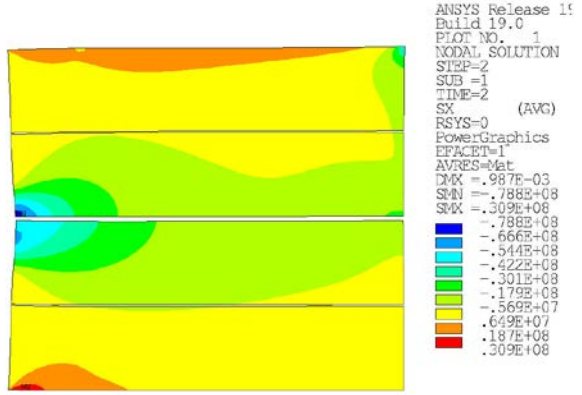


Nominal field

Stress in the coils (horizontal)

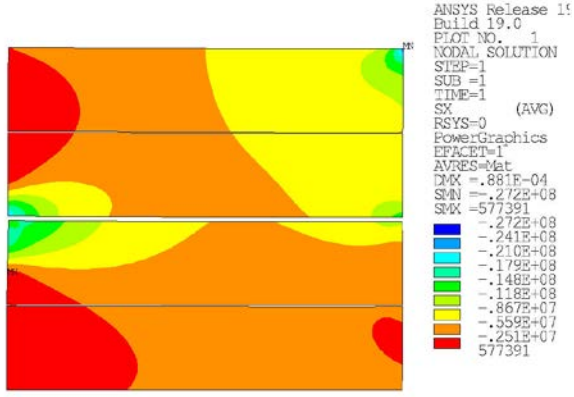
- Coils are essentially stress-free at room temperature (small lateral interference) and after cool down (shell is made of steel)
- After powering, the **horizontal stress remains below 110 MPa**

2. Cool-down



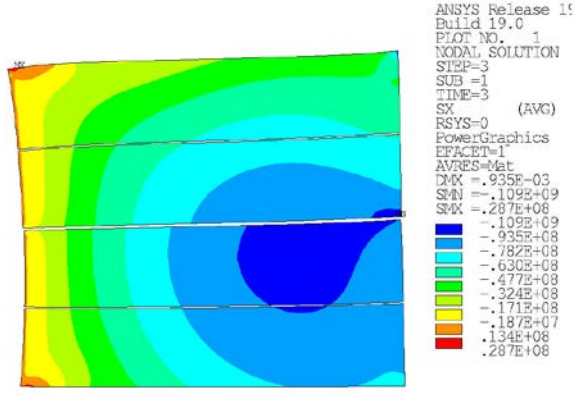
Cool-down

1. Room temp



Keys

3. Nominal field



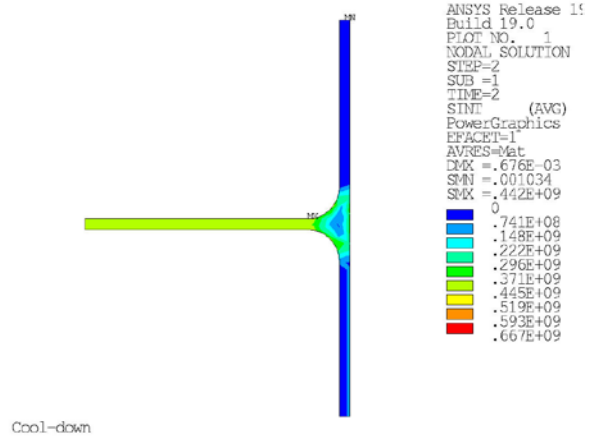
Nominal field

Stress in the test well

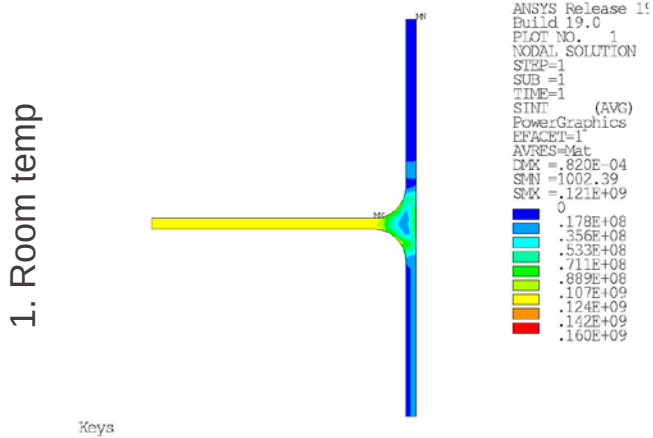
- Goal is to have a stress-free test well

Load step	Membrane (MPa)	Memb+bend (MPa)
Room temp	115	116
Cool-down	417	422
Nom. field	20	296

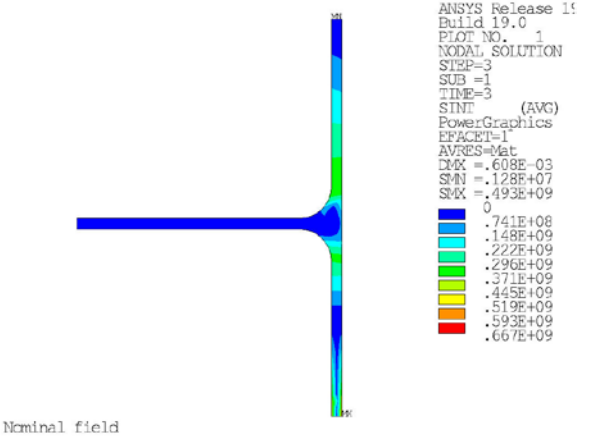
2. Cool-down



1. Room temp



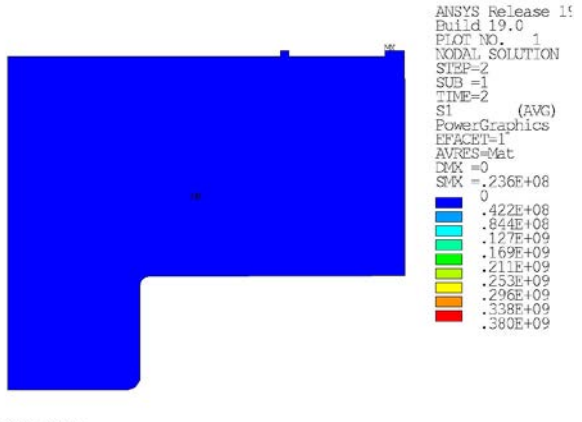
3. Nominal field



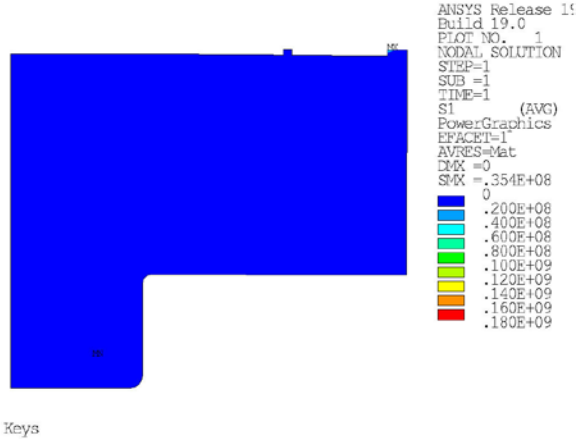
Stress in the vertical pad + iron insert

- Vertical pad and iron insert satisfy stress criteria except in one corner

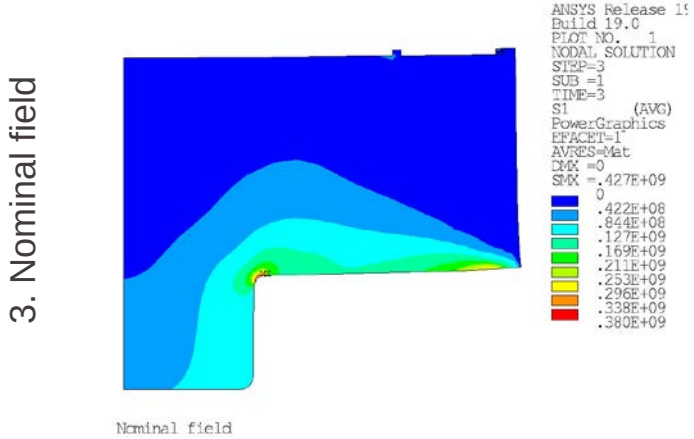
2. Cool-down



1. Room temp



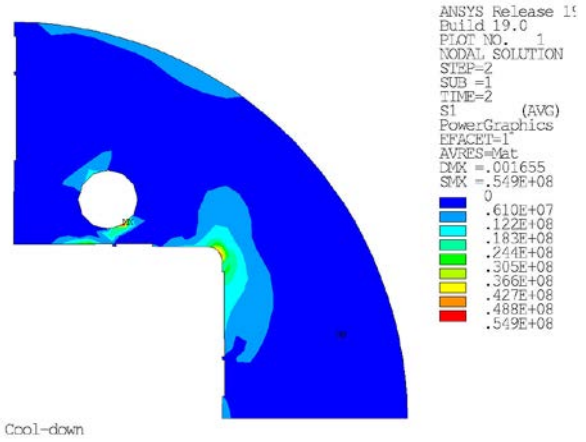
3. Nominal field



Stress in the iron yoke

- Iron yoke satisfies stress criteria

2. Cool-down



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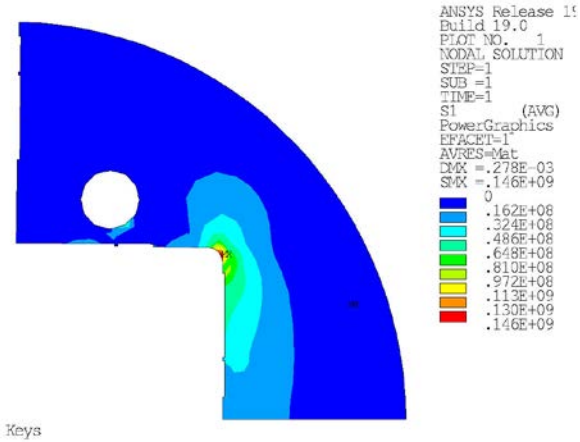

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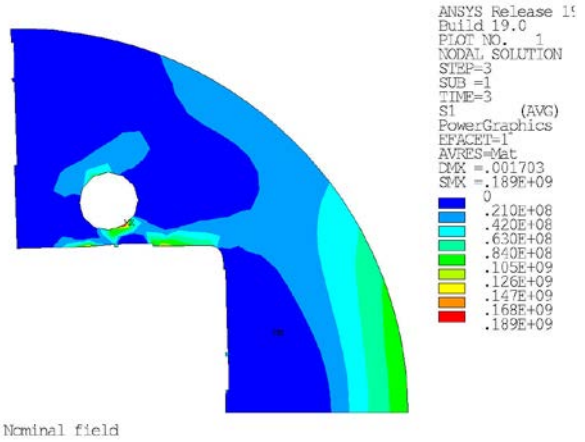

Conclusions

- The use of **detachable poles** and the **elimination of the Ti pole** result in a **more efficient coil design**
- The goal is to have a **stress-free test well**:
  - In practice, very moderate stress is applied to the test well
  - **A gap** (<1 mm) **opens** between coils and test well during powering
- **Stress in the coils is always very moderate**:
  - Everywhere below 120 MPa
  - Except one localized peak of 147 MPa (low field region)
- Only a peak of principal stress above the allowable limit is observed in the vertical pad + iron insert