The higher Js in c82 doubles the conductor current density

The peak Js in c82 is 2.91MA/m compared to 2.35MA/m in c10

- BR=1.65 with an inboard offset of 18cm

This 24% increase in Js *doubles* the conductor current density at the same field

Severely impacts time available for auxiliary heating of the plasma

- Scenario assumptions were as follows:

Ramp HF coils to full current	0.20s	
Apply RF to form plasma	0.10s	
Inductively ramp plasma to full current	0.20s	
Apply NBI/RF to heat plasma to full beta	TBD	<-plasma heating time
Ramp plasma current and beta to zero	0.20s	
Ramp HF coils to zero current	0.20s	

- For a given plasma heating time, the final temperatures are approximately the same for c10 at 2T and c82 at 1T
- If the final temperature can go as high as 210K, the plasma heating time drops from 2.8s for c10 at 1T to 0.3s for c82 at 1T

Thermal stresses are likely to determine the max final temperature

Thermal stresses arise from differential strain between the conductor and the shell material

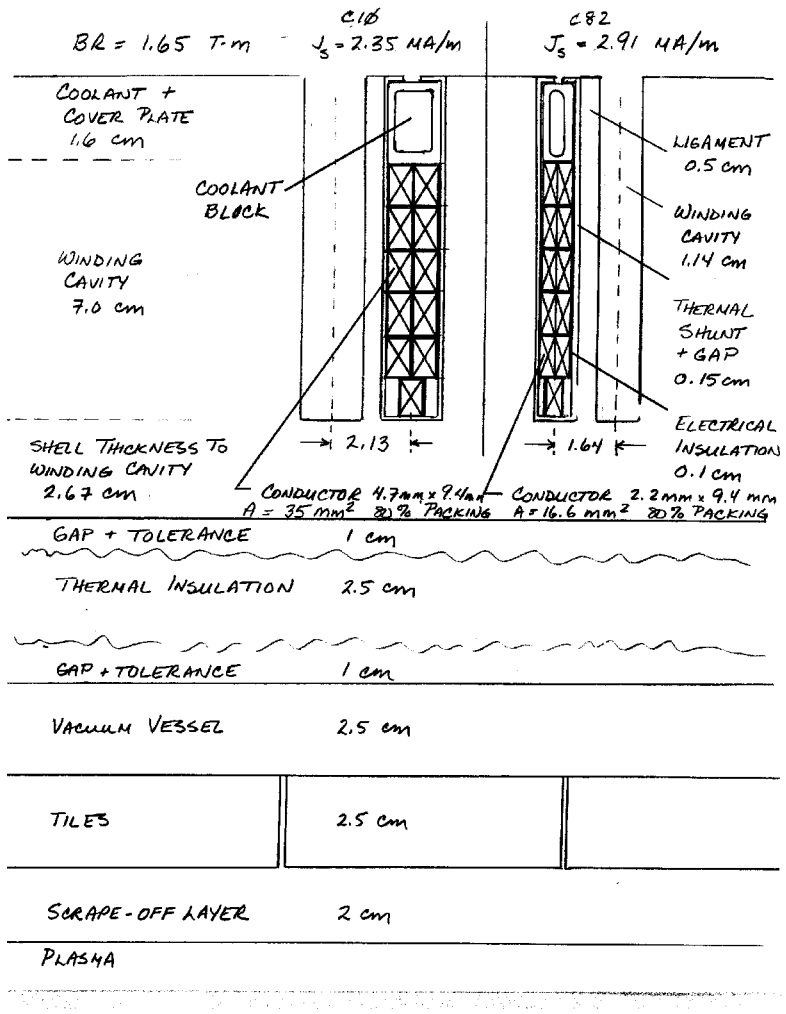
G10 shrinks substantially more than Cu and results in substantial differential strain

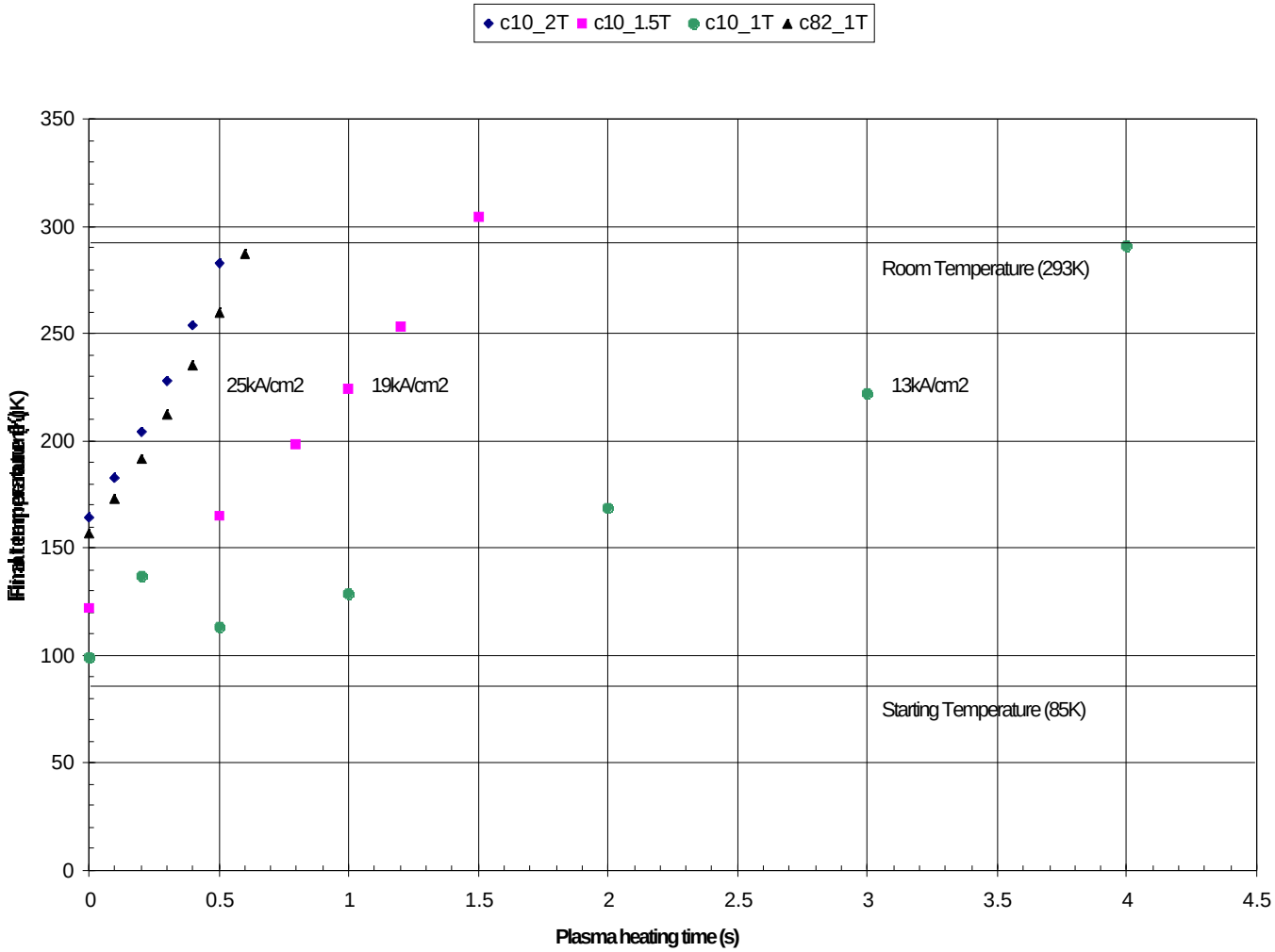
- Forcing a solid copper conductor at 85K to have the same strain as the G10 shell at 85K would result in a thermal stress of almost 60ksi, higher than the yield strength of OFHC Cu

The heating up of copper during a pulse increases the differential strain and thermal stress

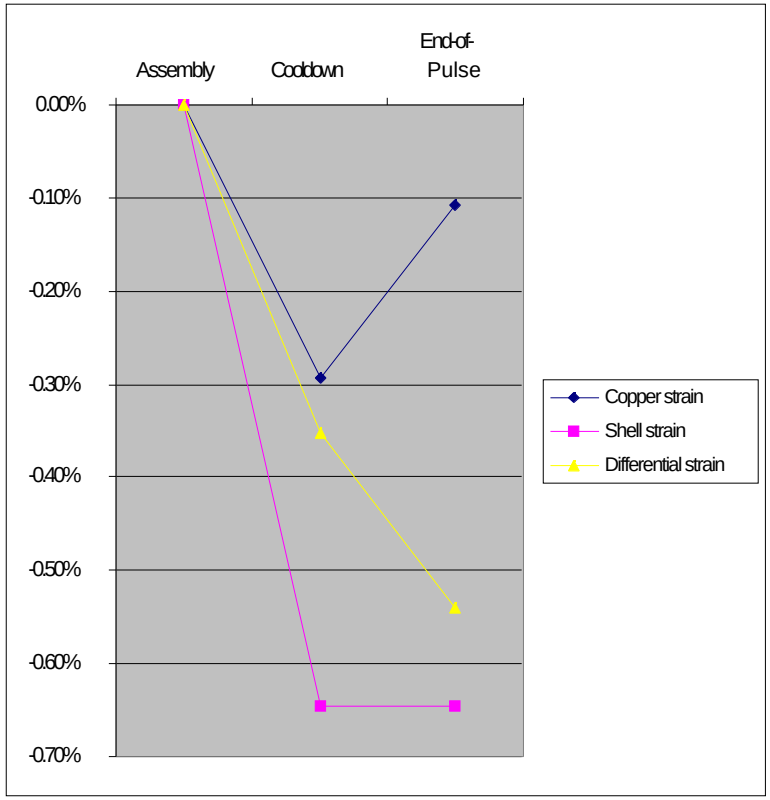
Using cabled conductor (a “springy” material) should mitigate problems with thermal stresses

Maximum final temperatures are still TBD


BR = 1.65 T·m
C10
J_s = 2.35 MA/m
C82
J_s = 2.91 MA/m
COOLANT + COVER PLATE 1.6 cm
COOLANT BLOCK
WINDING CAVITY 7.0 cm
SHELL THICKNESS TO WINDING CAVITY 2.67 cm
LIGAMENT 0.5 cm
WINDING CAVITY 1.14 cm
THERMAL SHUNT + GAP 0.15 cm
ELECTRICAL INSULATION 0.1 cm
2.13
1.64
CONDUCTOR 4.7mm x 9.4mm
A = 35 mm² 80% PACKING
CONDUCTOR 2.2mm x 9.4 mm
A = 16.6 mm² 80% PACKING
GAP + TOLERANCE 1 cm
THERMAL INSULATION 2.5 cm
GAP + TOLERANCE 1 cm
VACUUM VESSEL 2.5 cm
TILES 2.5 cm
SCRAPE-OFF LAYER 2 cm
PLASMA



Tcooldown=85K, Tfinal=228K
Cu conductor in a G10 shell


Assembly
Cooldown
End-of-Pulse
0.00%
-0.10%
-0.20%
-0.30%
-0.40%
-0.50%
-0.60%
-0.70%
Copper strain
Shell strain
Differential strain