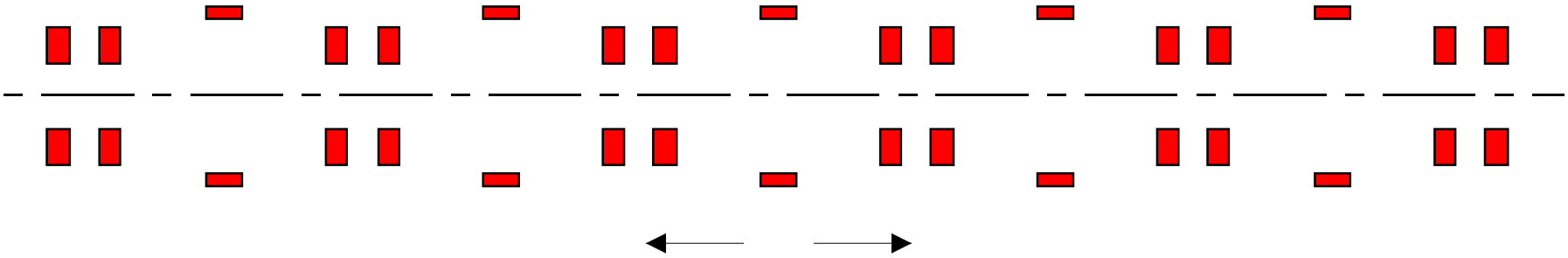
Part of the solenoid string for the cooling channel

- Higher–field, bucked pairs surrounding the absorbers
- Lower–field, sustaining solenoids centered on the RF cavities



For normal operating conditions, the forces on individual coils near the middle of this string are high (up to ~ 8 MN), but perfectly balanced.

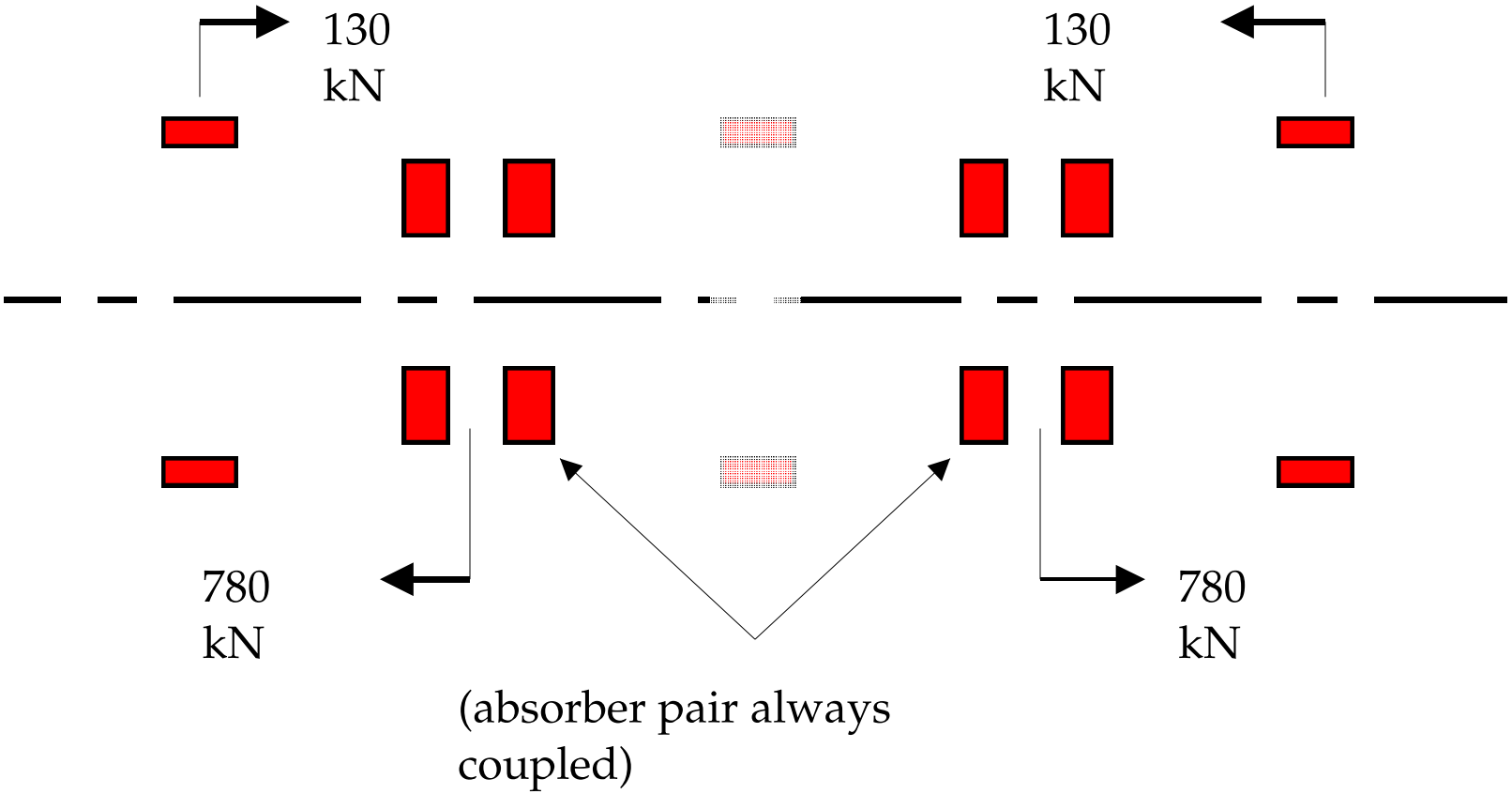
Cryostat structural design

- Establish requirements
  - Normal operating loads
  - Fault loads
- Decide how to carry loads
  - Cold−to−warm
  - Cold−to−cold

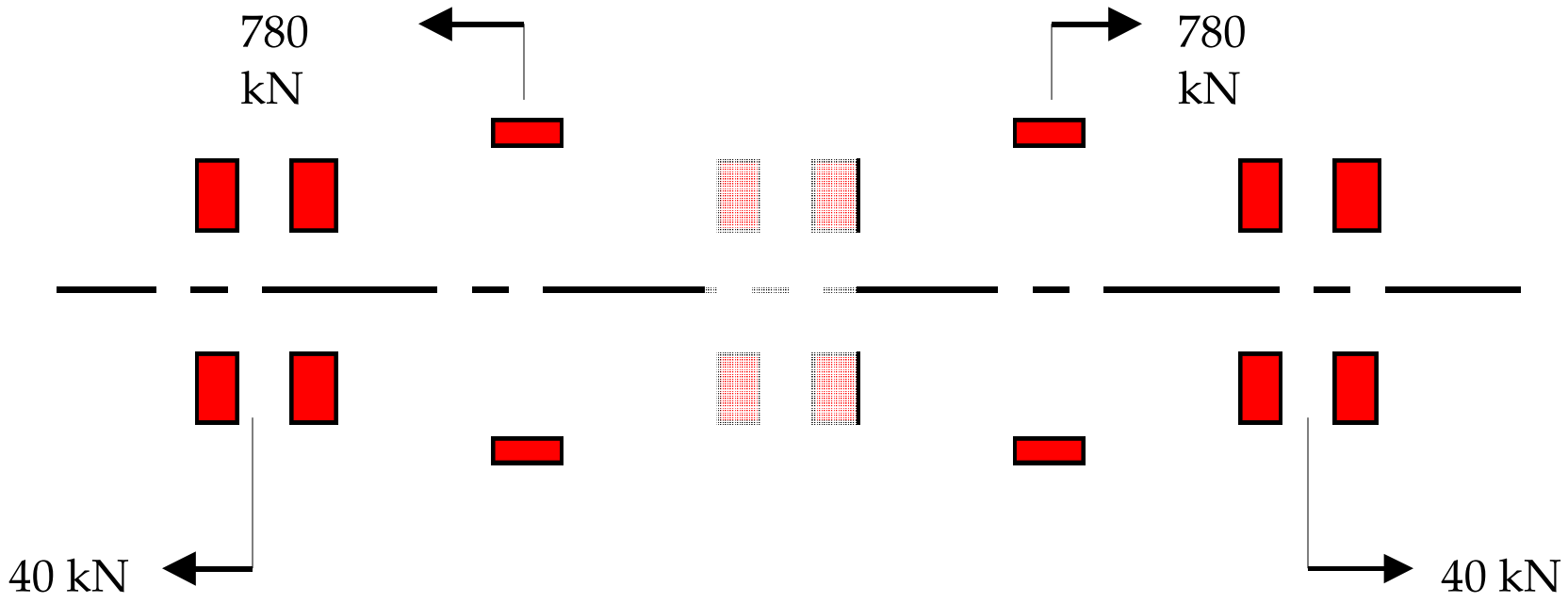
Requirements

- Gravity loads are ~ 10 kN (~ 1 t) or less per coil
- Not surprisingly, fault loads depend on the definition of the credible fault
  - If all coils are constrained to be charged and discharged together, the forces between coil can be manageably small
  - If adjacent coils can be charged or discharged separately, the intercoil forces can be quite large

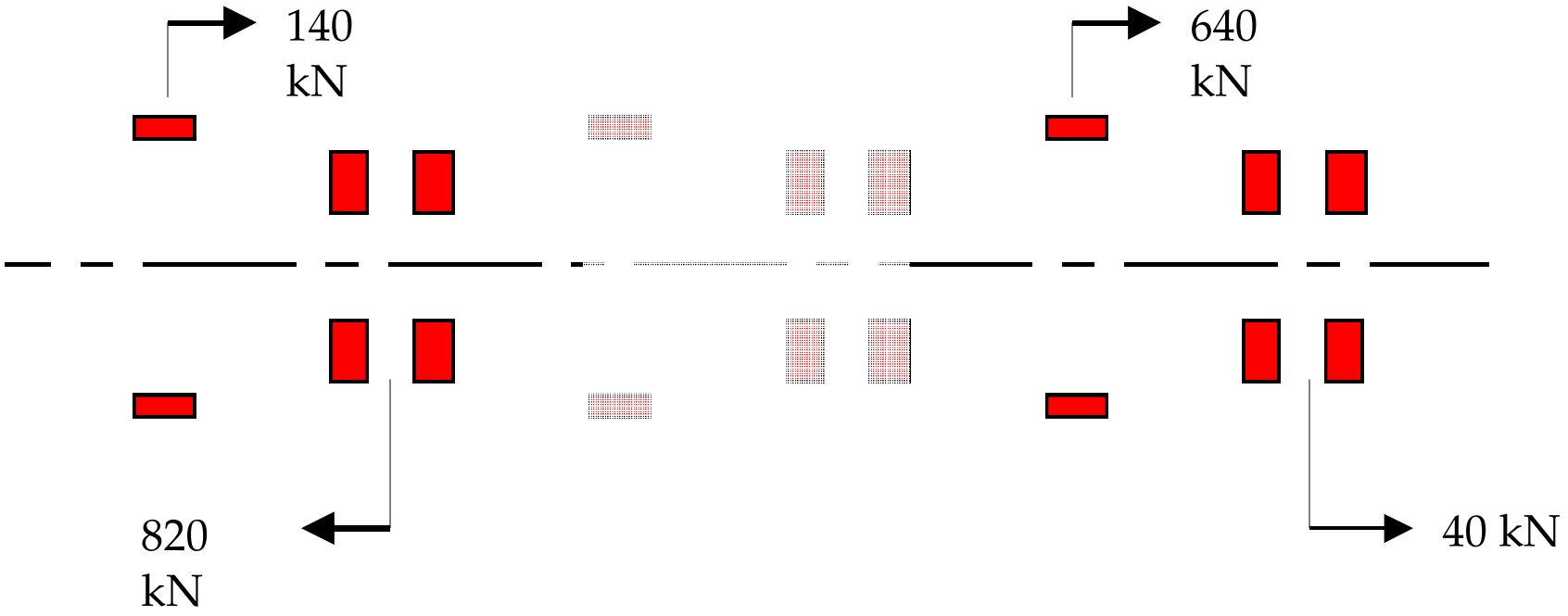
Fault 1: Cavity coil discharged, all others charged



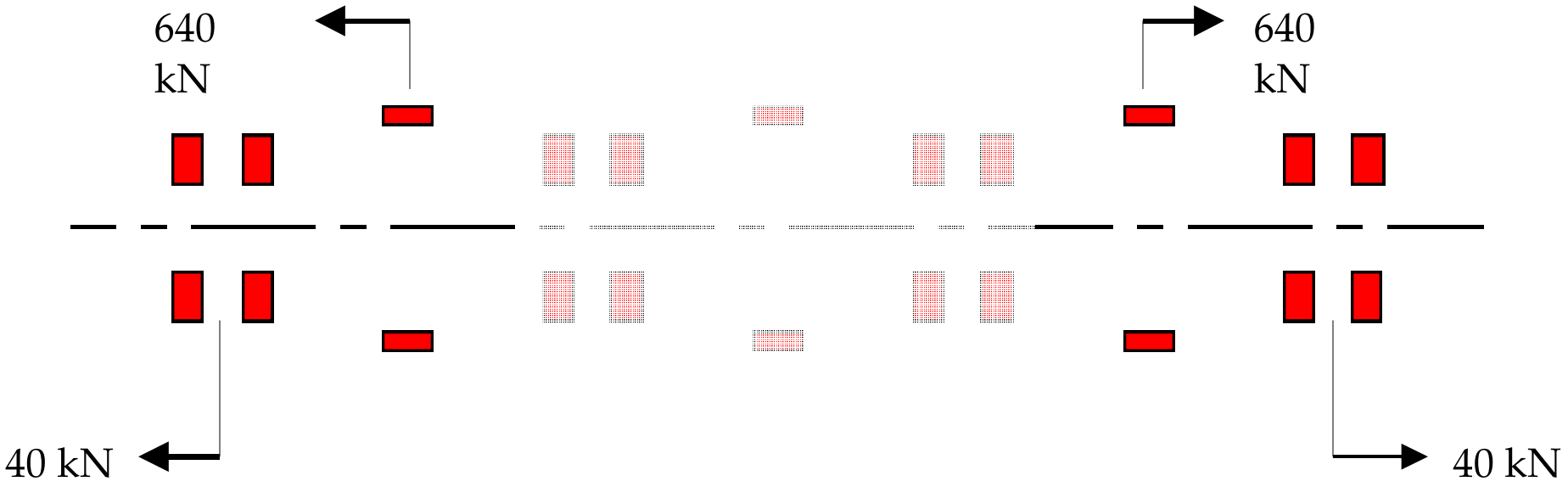
Fault 2: Absorber pair discharged, all others charged



Fault 3: Absorber–pair and cavity–coil set discharged, all others charged

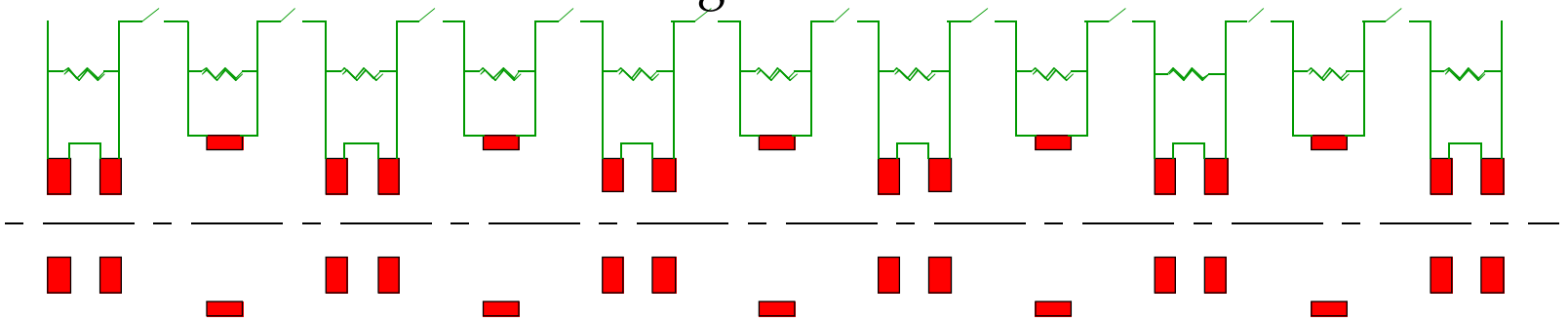


Fault 3: Symmetric absorber–pair/ cavity–coil set discharged, all others charged



Avoidance of missing–coil faults

- Simultaneous charge/discharge
- Active protection
- External dump
- Higher currents
- Lower voltages

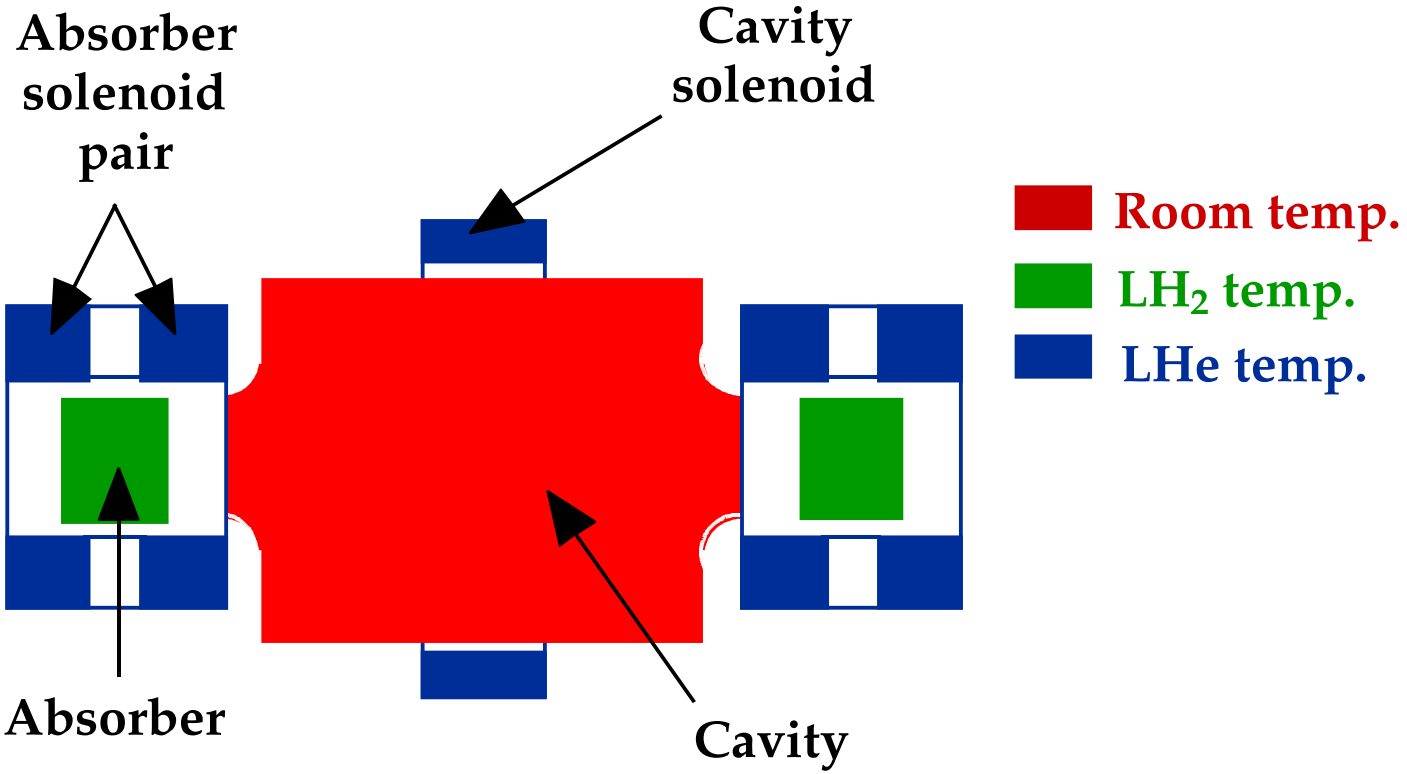


Extreme example: each cavity coil and absorber pair on separate feeds with individual dump resistors selected for simultaneous discharge

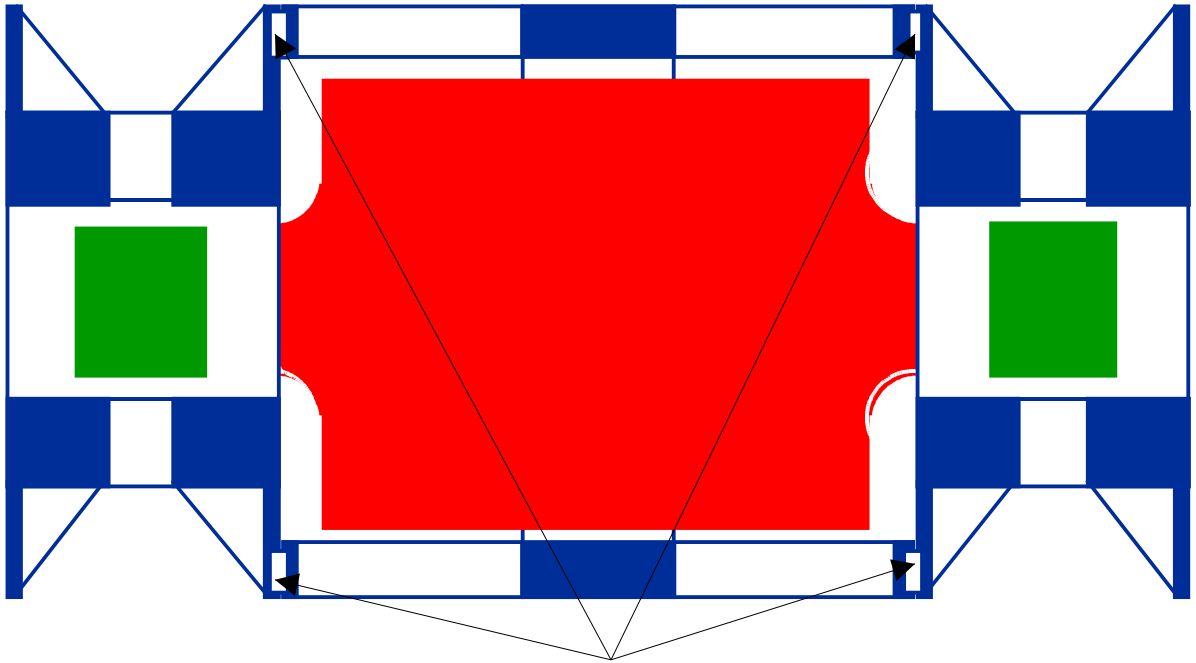
Consequences of missing−coil faults

- Axial forces ~ 700 − 800 kN (~ 70 − 80 t)
  - Note that "missing−coil" forces are unavoidable on the finite−length R&D system
- ~ 5000 mm^2 steel for cold−to−warm supports (compared to ~ 1500 mm^2 steel for cold−to−cold)
- ~ 20 W for "simple" cold−to−warm designs
- Lower bound for more sophisticated designs ~ 2 W

Basic components requiring structural linking in the cryostat

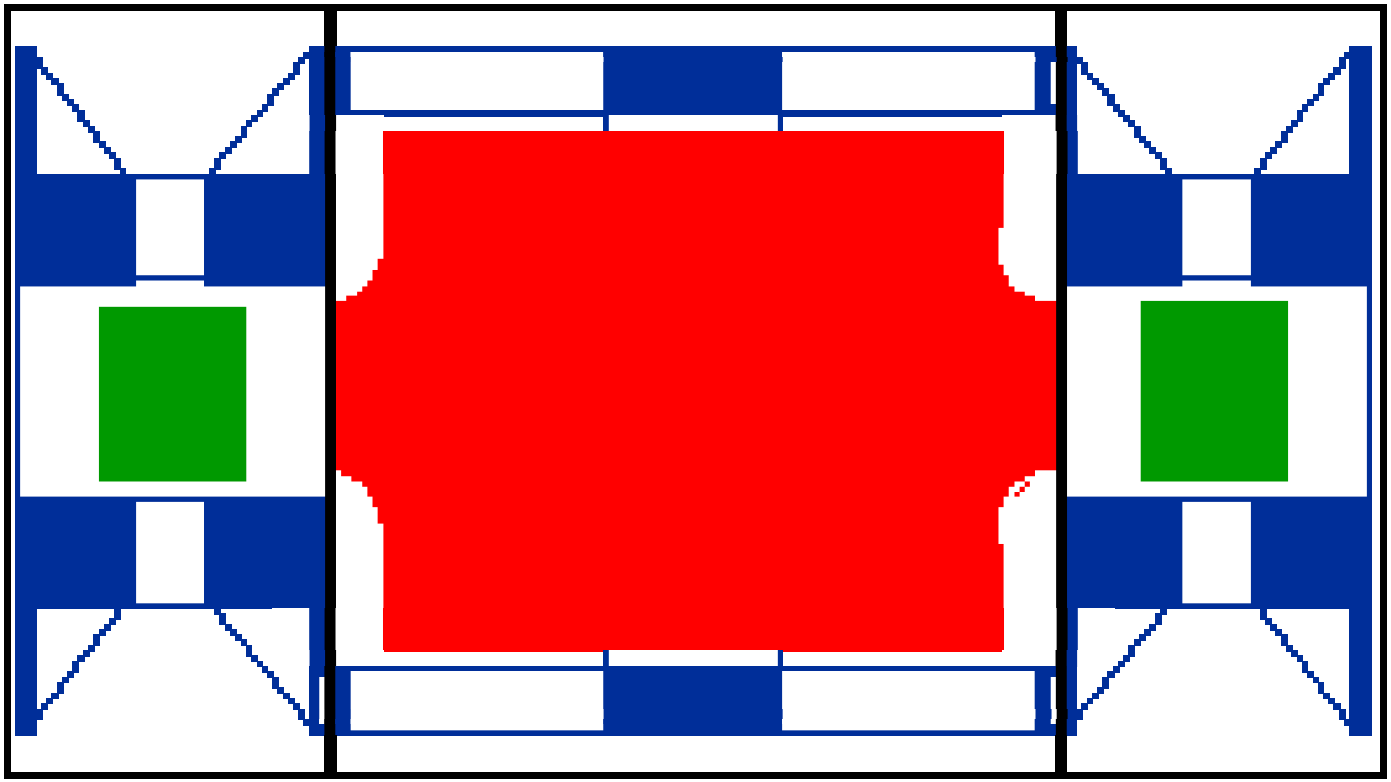


Cold inter–coil structure



Adjustable shims to compensate
for cooldown shrinkage

Cryostat sectionalization



Cryostat features

- Cryostat shell for each cavity/cavity−coil assembly and for each absorber/bucked−pair assembly
- Absorber and cavity form inner wall of their respective cryostat sections
- Vacuum communication at shell ends
- Vacuum boundary at cavity coil
- Shell panels removable for assembly/disassembly
- Section removable by allowing nearest−neighbor and next−nearest−neighbor sections to remain under vacuum and “floating” in temperature