WP6 Update on Thermal-Electric Study of Hi-Lumi SC Link

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Transient Model: (Self) Quench of Cables

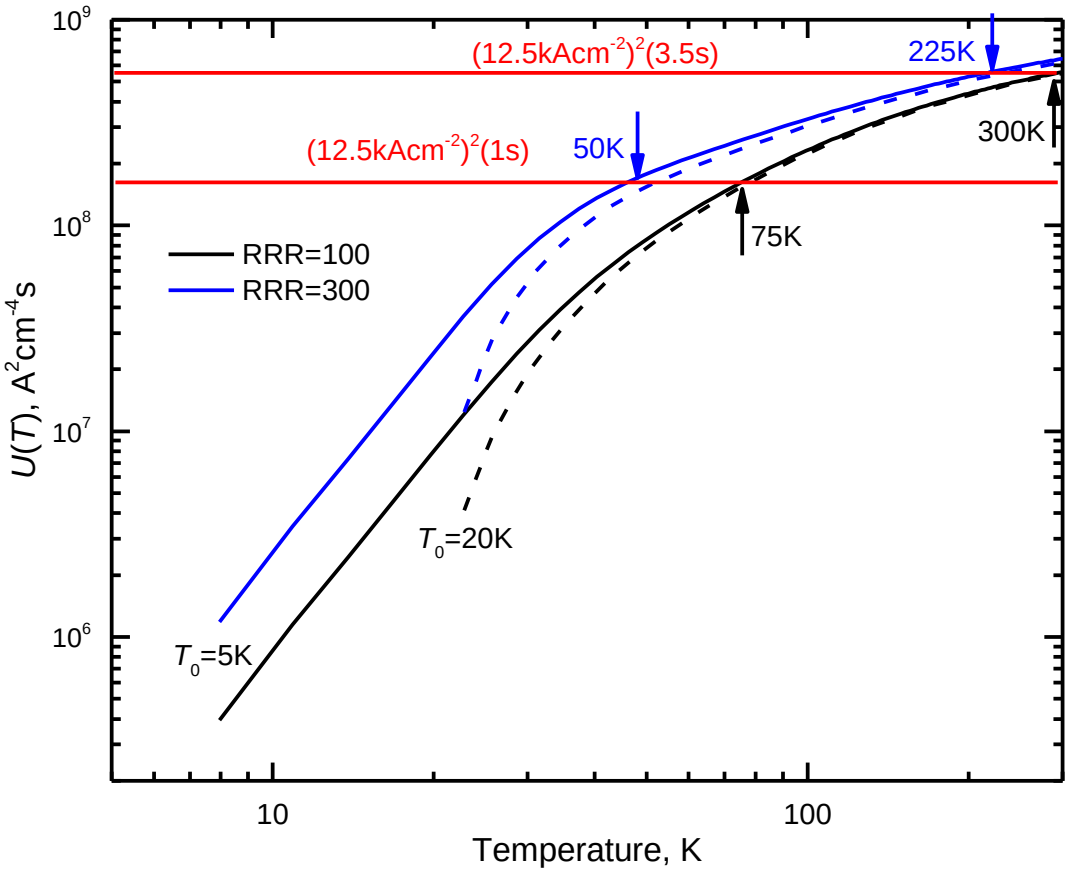
Quench load of 20kA cable

$$QL(T) = (1-\lambda)^{-1} A^2 \int_{T_0}^{T} \frac{dc_v(T')}{\rho(T')} dT'$$

With a nominal Cu RRR=100 for the stabiliser:

- The cable heats up to ~90K in 1 s at 17kA;
- Room temperature is reached in approximately 3.5 s.
- Little influence by the initial temperature if heated beyond 50K.
- Stabilizer RRR has a significant impact at low/medium temperature (75K in 1s) and a moderate improvement at high temperature (300K in 3.5 s)
- When discharged at $I(t) = I_0 e^{-t/\tau}$ QL is matched by

$$I_0^2 t_{eff} = I_0^2 \frac{\tau}{2}\left(1 - e^{-\frac{2t}{\tau}}\right)$$



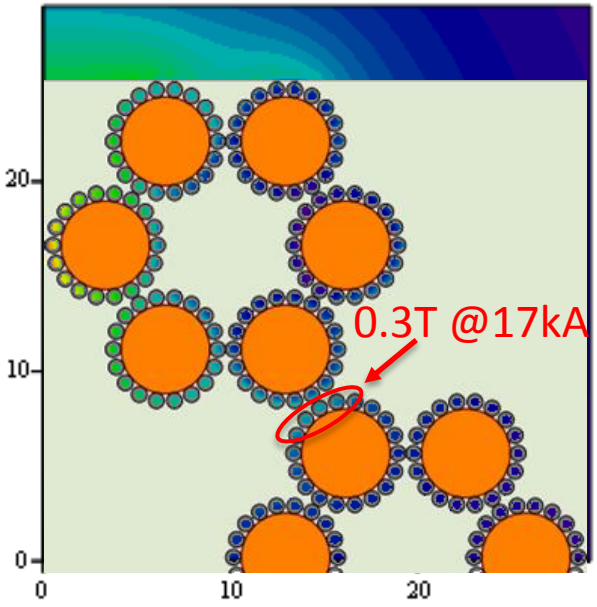
For magnet discharging time constant of $\tau = 7$s,

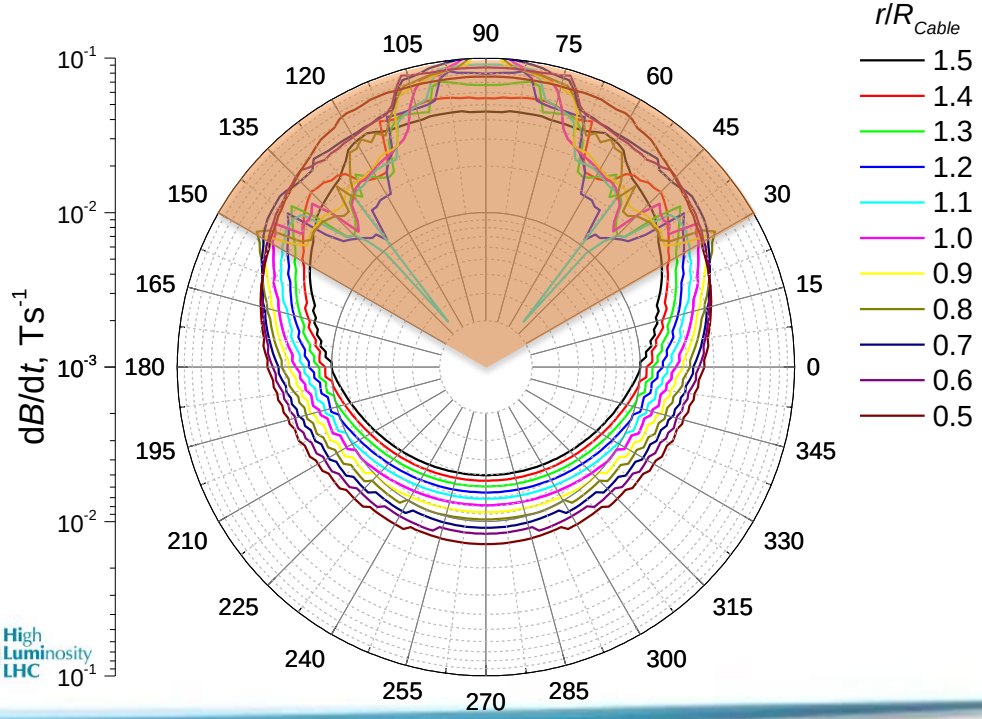
- $t_{eff} = 1$s to 90K at means $t = 1.17$s
- $t_{eff} = 3.5$s to room temperature at $t = \infty$!, i.e. safely quench during magnet discharge

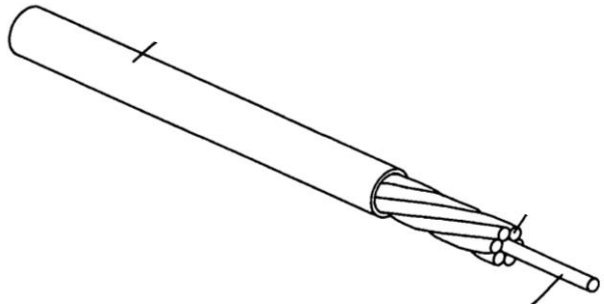
Transient Model: Electromagnetic induced Quench of Cables

Imposed $\dot{B}$, electrical field and induced current

- The maximum imposed field change is at immediate adjacent wires (30° and 150°) in the neighbouring cables.
- At 20kA, ΔB at these locations is about 0.3T, or 40mT/s at $\tau = 7s$.
- About 4 wires are exposed at any longitudinal location. The present wire twist pitch of 400mm means that each wire is exposed for about 90mm.







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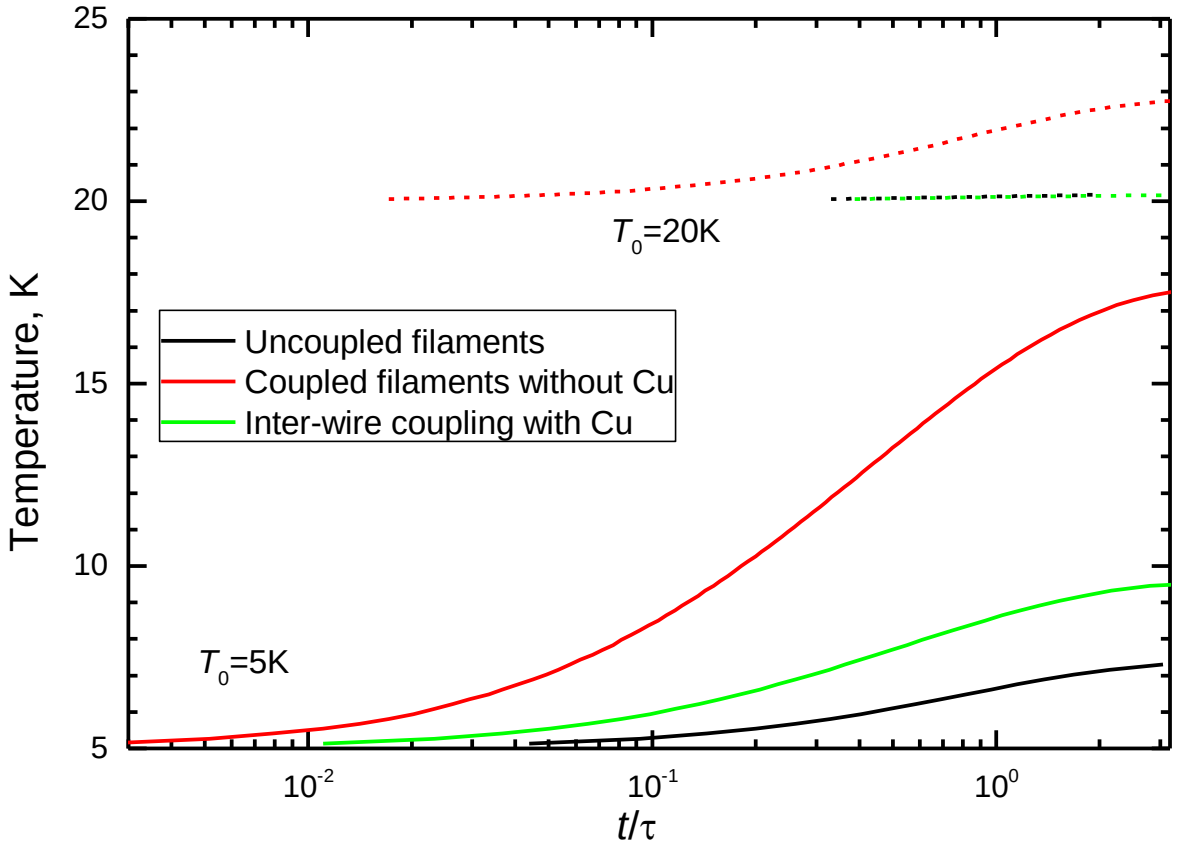
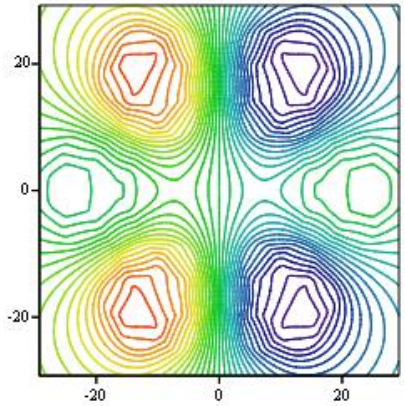
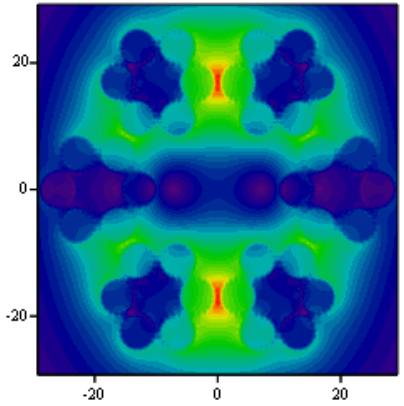
Transient Model: Electromagnetic induced Quench of Cables



Field in the cable can be reconfigured for better stability





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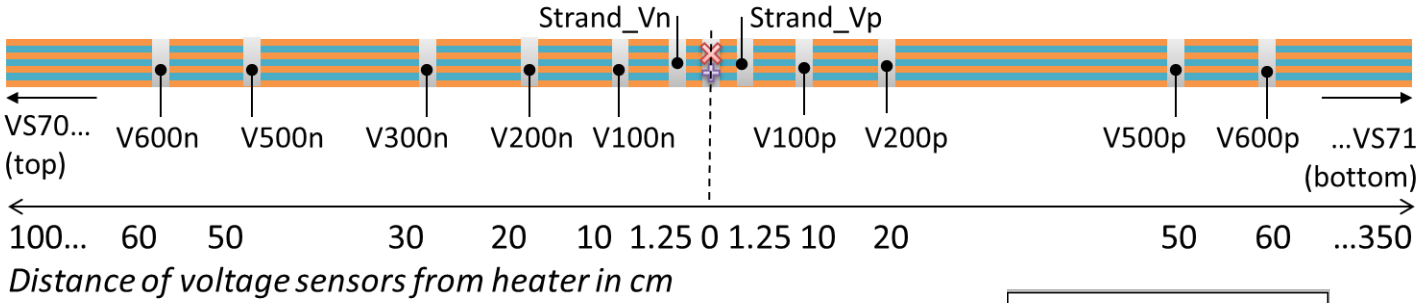
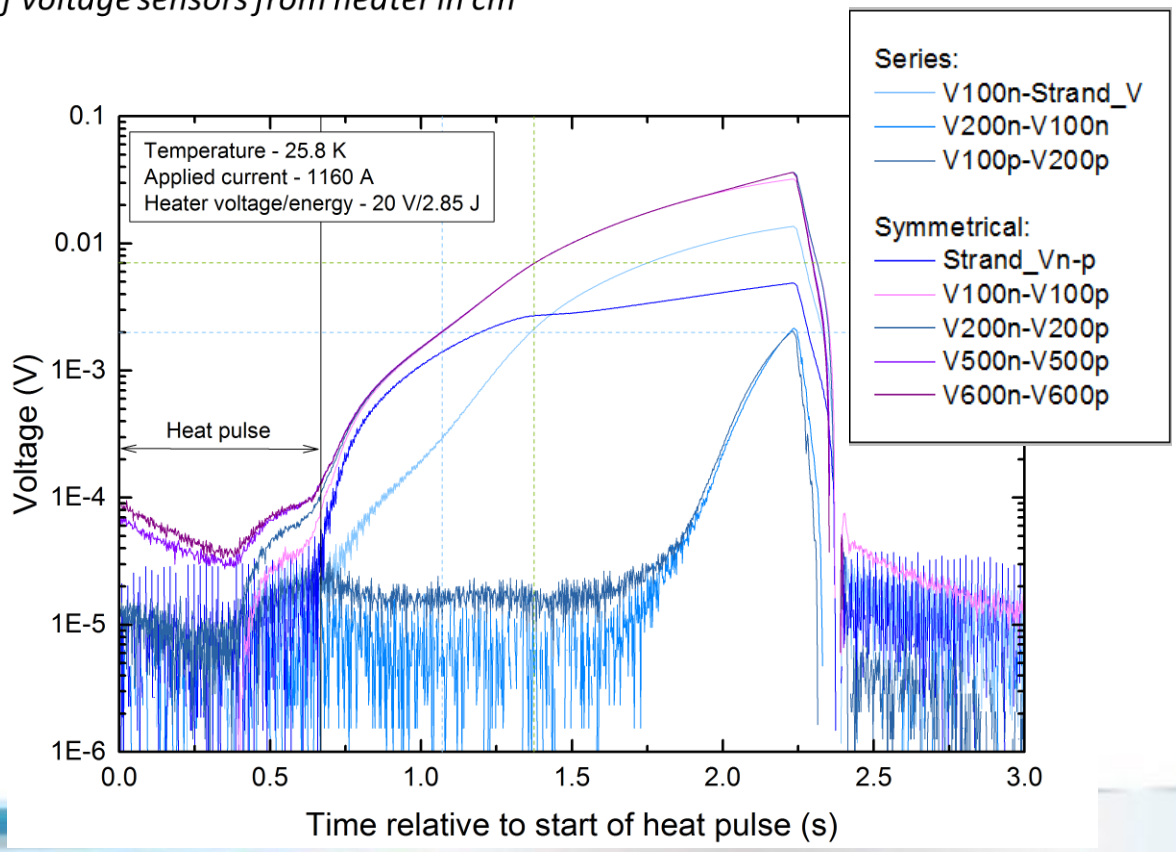
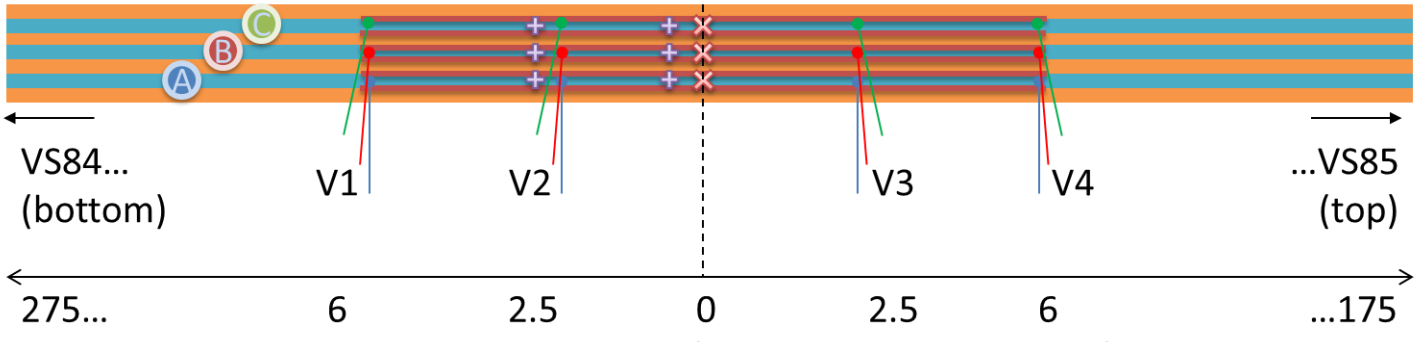
Quench Measurements on Twisted-Pair Cables: Standard Strands

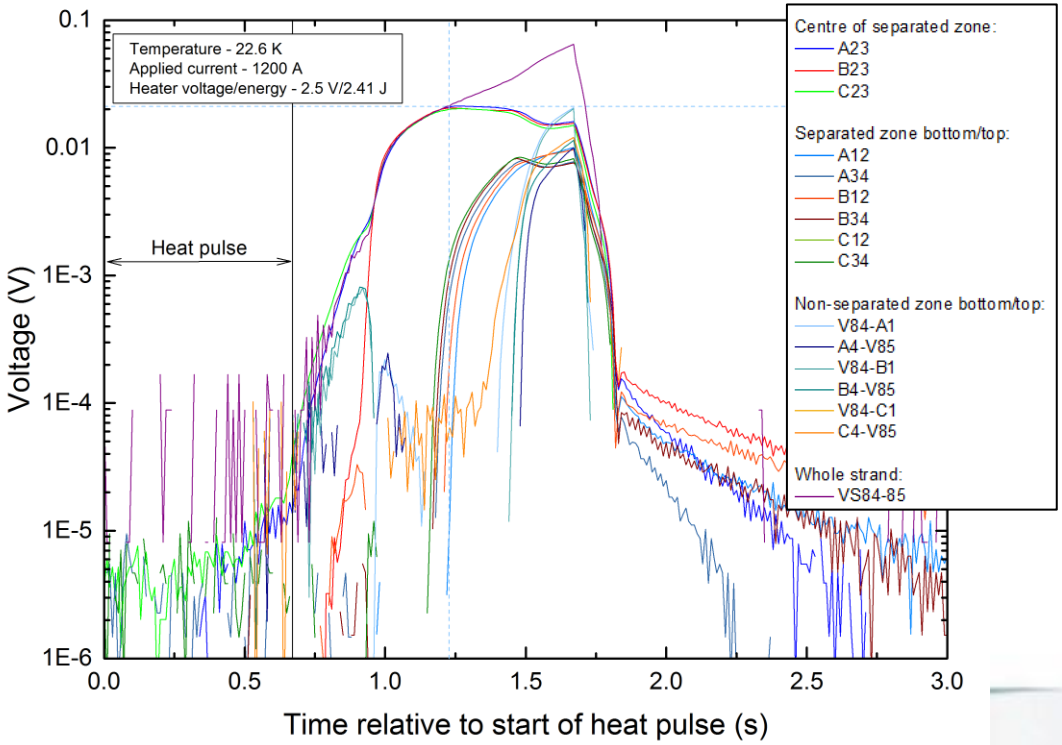




Quench Measurements on Twisted-Pair Cables: Cu Stabiliser Detached



Distance of voltage sensors from heaters (centre of separated zone) in cm



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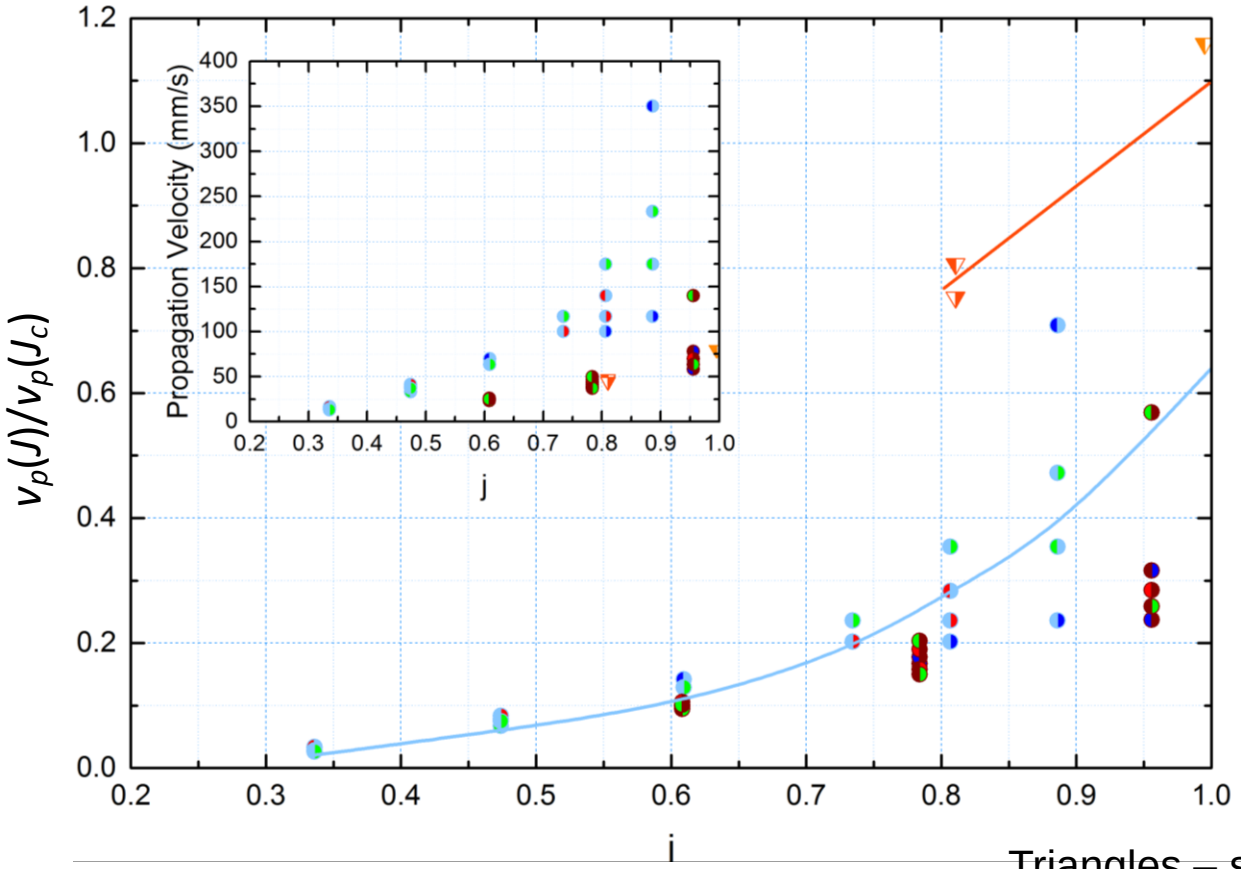
Propagation velocity: almost as expected



Triangles – stabilised
Circles – (partially) non-stabilised
Colour scale, blue to red – temperature, low to high
Symbol fill colour – MgB_2 tape (non-stabilised case only)

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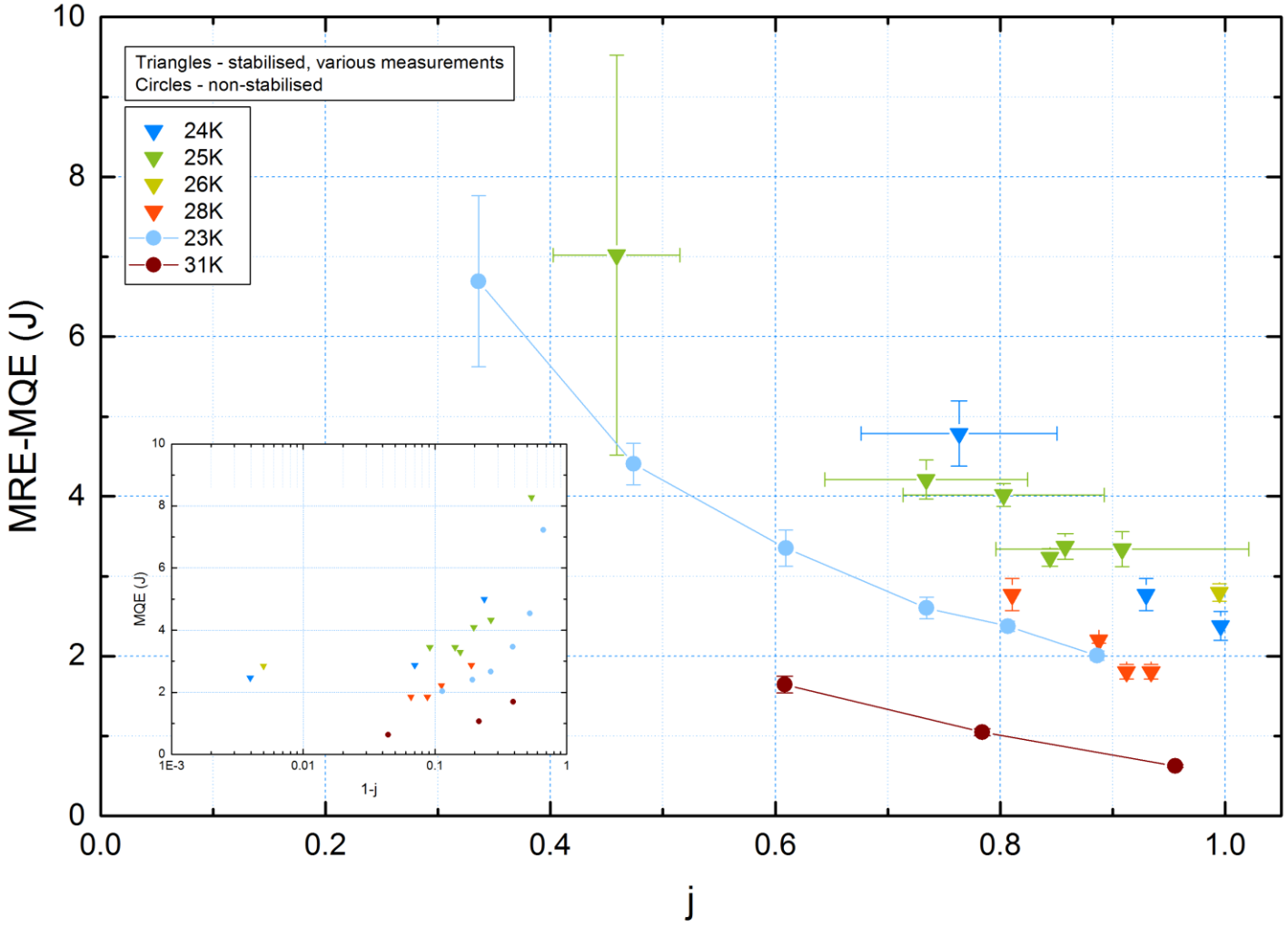
Minimum Quench Energy



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Next: New Round Wires