Shall we modify BLM Thresholds on Superconducting Magnets?

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Threshold components and Note44 algorithm

$$T = S_{BLM}(E_b) \cdot \Delta Q\,(E_b,t) \,/\, E_D\,(E_b,t)$$

BLM signal — quench margin — energy deposited in coil

1. $t<t_{metal}$: ΔQ = enthalpy limit (ΔH), $E_D=E_{max}$
2. $t_{metal}<t<t_{helium}$: $\Delta Q = \Delta H$+5%Helium, $E_D=E_{cable}$
3. $t>t_{helium}$: ΔQ = 5%Helium+SteadyFlow$\cdot$t, $E_D=E_{cable}$

Helium = $\int_{T0}^{Tquench} c_V\, dT$, T0=1.9K or 4.5K, Tquench=2.8K … 9K

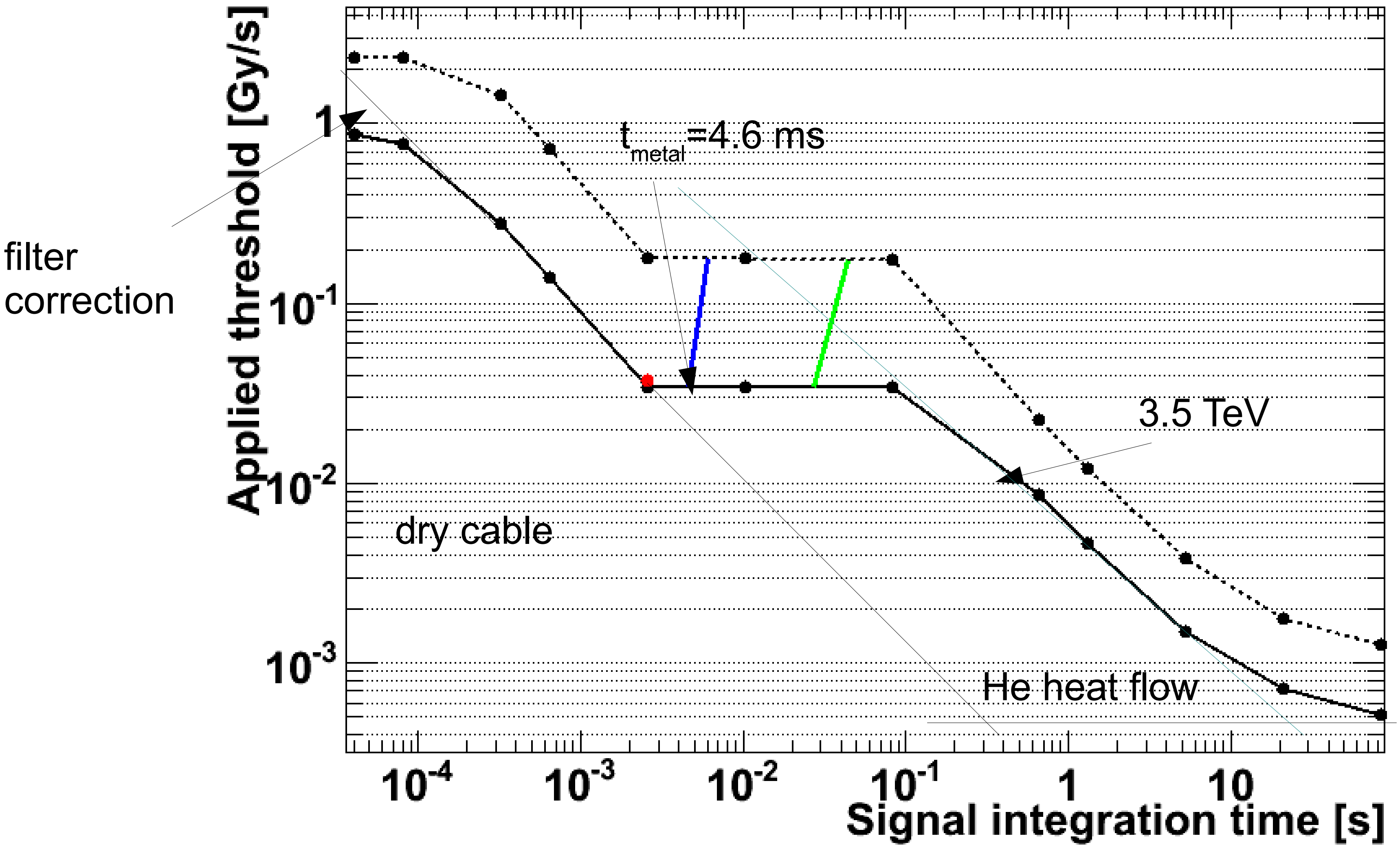
Ingredients, 8 functions of E_{beam}:

S_{BLM}, t_{metal}, t_{helium}, ΔH, SteadyFlow, E_{max}, E_{cable}, Helium

measured!

Geant4,
analytic calculations,
thermodynamic models

Threshold components



Threshold components and new algorithm

$$T = S_{BLM}(E_b) \cdot \Delta Q\,(E_b,t) \,/\, E_D\,(E_b)$$

BLM signal — quench margin — energy deposited in coil

1. $t<t_{metal}$: ΔQ = enthalpy limit (ΔH), $E_D = E_{max}$
2. $t_{metal}<t<t_{helium}$: $\Delta Q = \Delta H + 5\%\text{Helium}$, $E_D=E_{cable}$
3. $t>t_{helium}$: $\Delta Q = 5\%\text{Helium} + \text{SteadyFlow}\cdot t$, $E_D=E_{cable}$

Helium = $\int_{T0}^{Tquench} c_V\, dT$, T0=1.9K or 4.5K, Tquench=2.8K … 9K

Ingredients, 3 functions of E_{beam}:

S_{BLM}, E_D – radial distribution, ΔQ (t) – with all physical processes

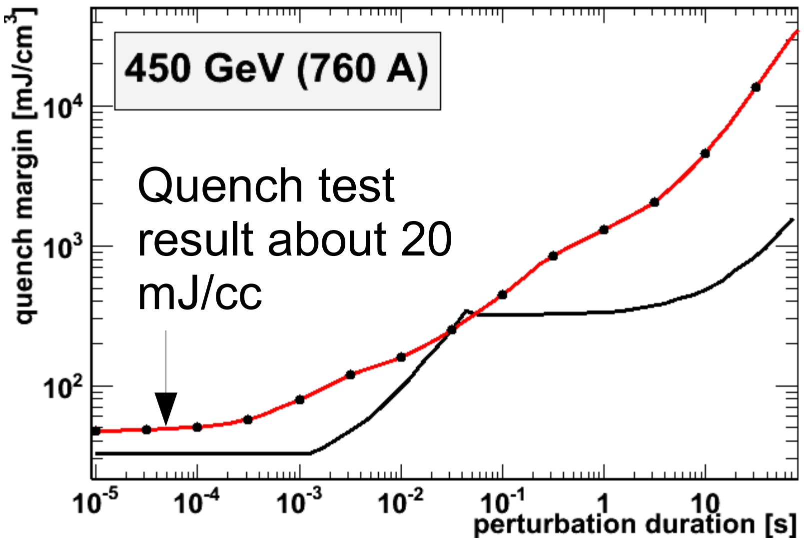
measured!

Quench margins - comparison

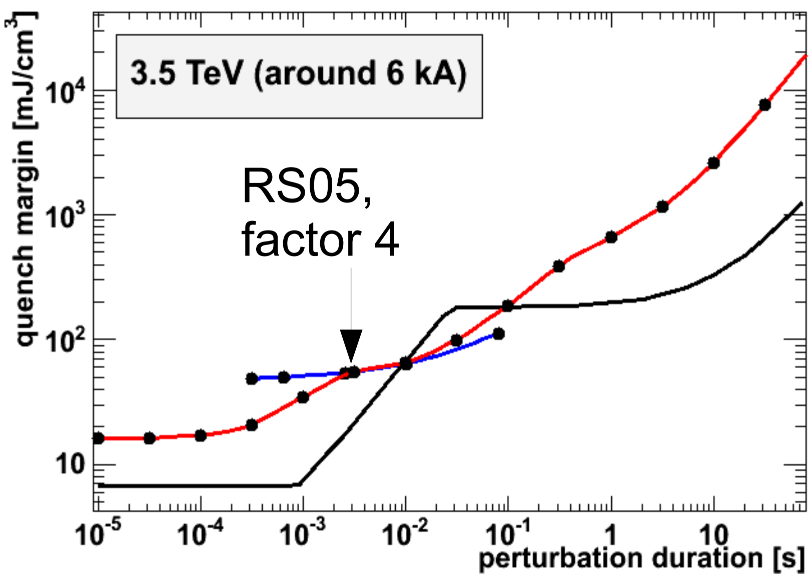
Note44 – algorithm

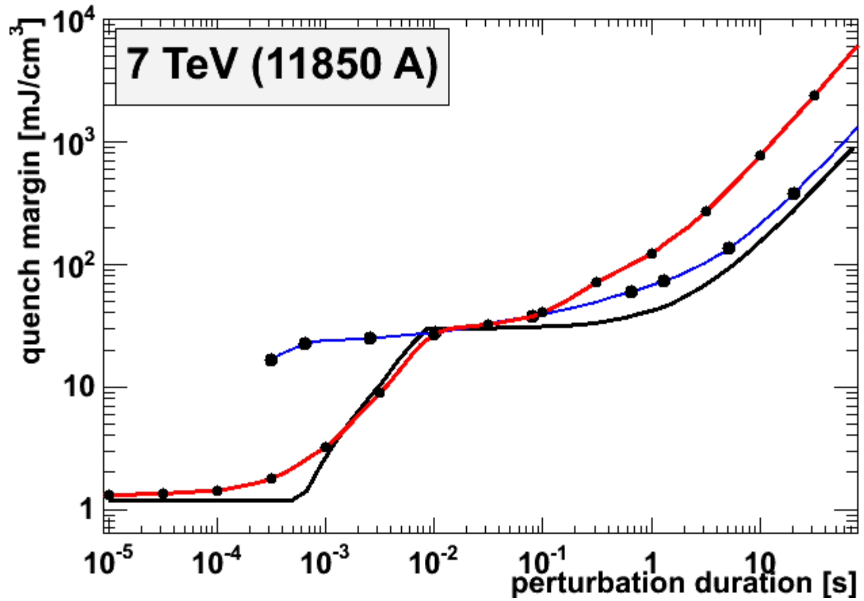
ZERODEE (P-P. Granieri, 2008)

Arjan's code

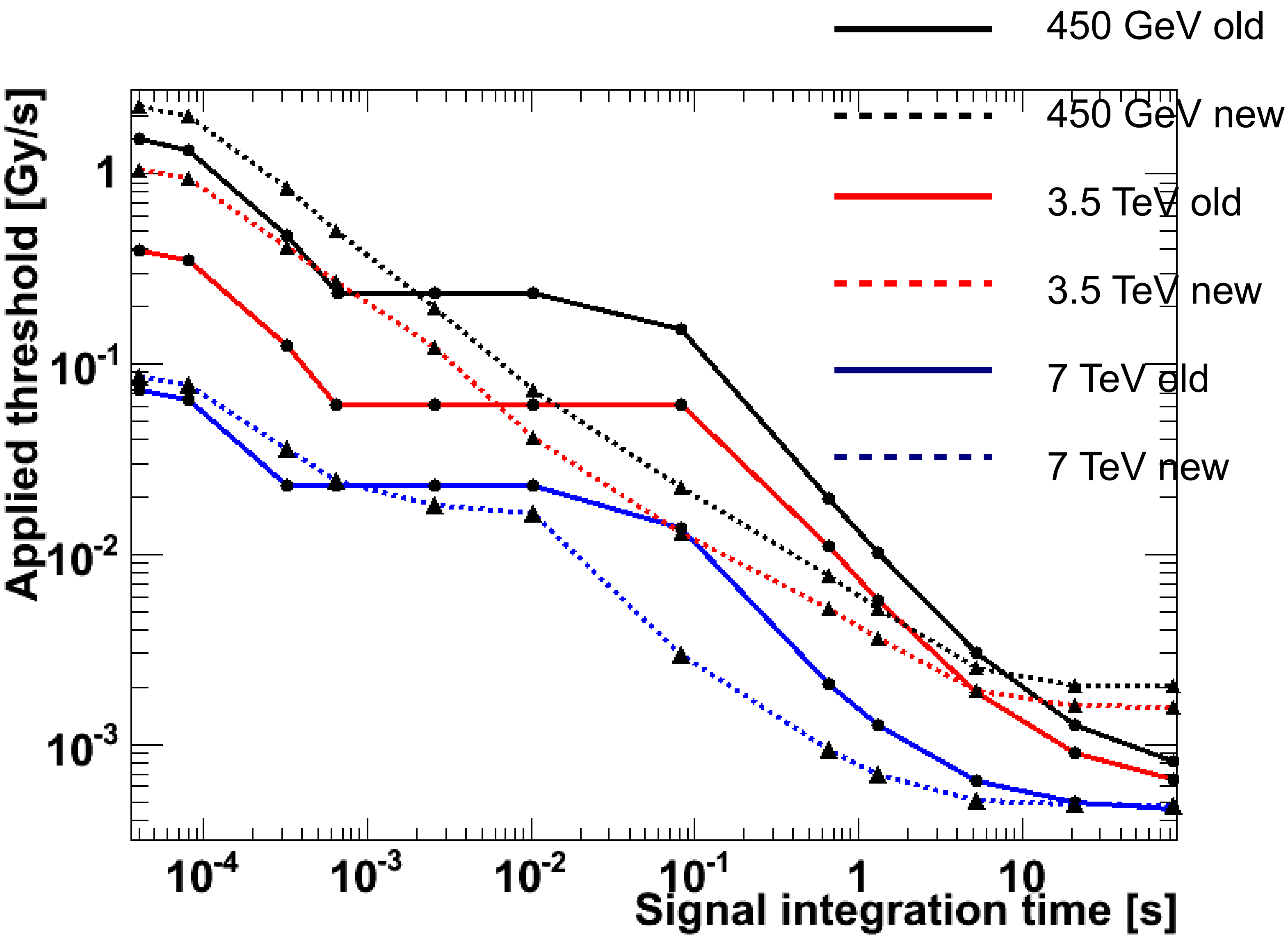


Interestingly, for 7 TeV the millisecond scale QL behaves similarly – Note44 concentrated on 7 TeV operation.





Threshold comparison



My remarks

- Experience indicates that for losses in millisecond timescale we are more than factor 3 from quench level.
- This hopefully will be verified by quench test and wire scanner scan with 50 bunches – next week.
- Arjan's code and ZERODEE indicate that we underestimate BLM thresholds in millisecond scale.
- Arjan's code offers more sophisticated approach to Quench Levels than Note 44, and is especially powerful in the intermediate time range, where obviously Note 44 algorithms are artificial.
- Arjan's code is “private” - up to now all we have been using was published.
- We need more understanding of the code results, quench experiments and probably more simulations (Edep distributions in the coils) but, in view of the recent dumps in RS05, we might gain by producing more reliable BLM thresholds in millisecond scale.

Extra slides

Threshold components