What is the MCI in case of a “beam driven” failure of a magnet enclosure?

-Assumptions

-"landscape" of escape velocity/mass flow per cm^2

- typical adiabatic compression, isochoric expansion, approximate quench line, pool boiling curves

- Realistic P-T development

- conclusions

Assumptions

- Beam driven hole between beam pipe and cold mass
- Size variable
- Magnets might (probably) quench
- No energy/energy dumped by the beam
- Flow rate estimator by sound velocity limit of the escaping helium through the slits formed by the magnet collars

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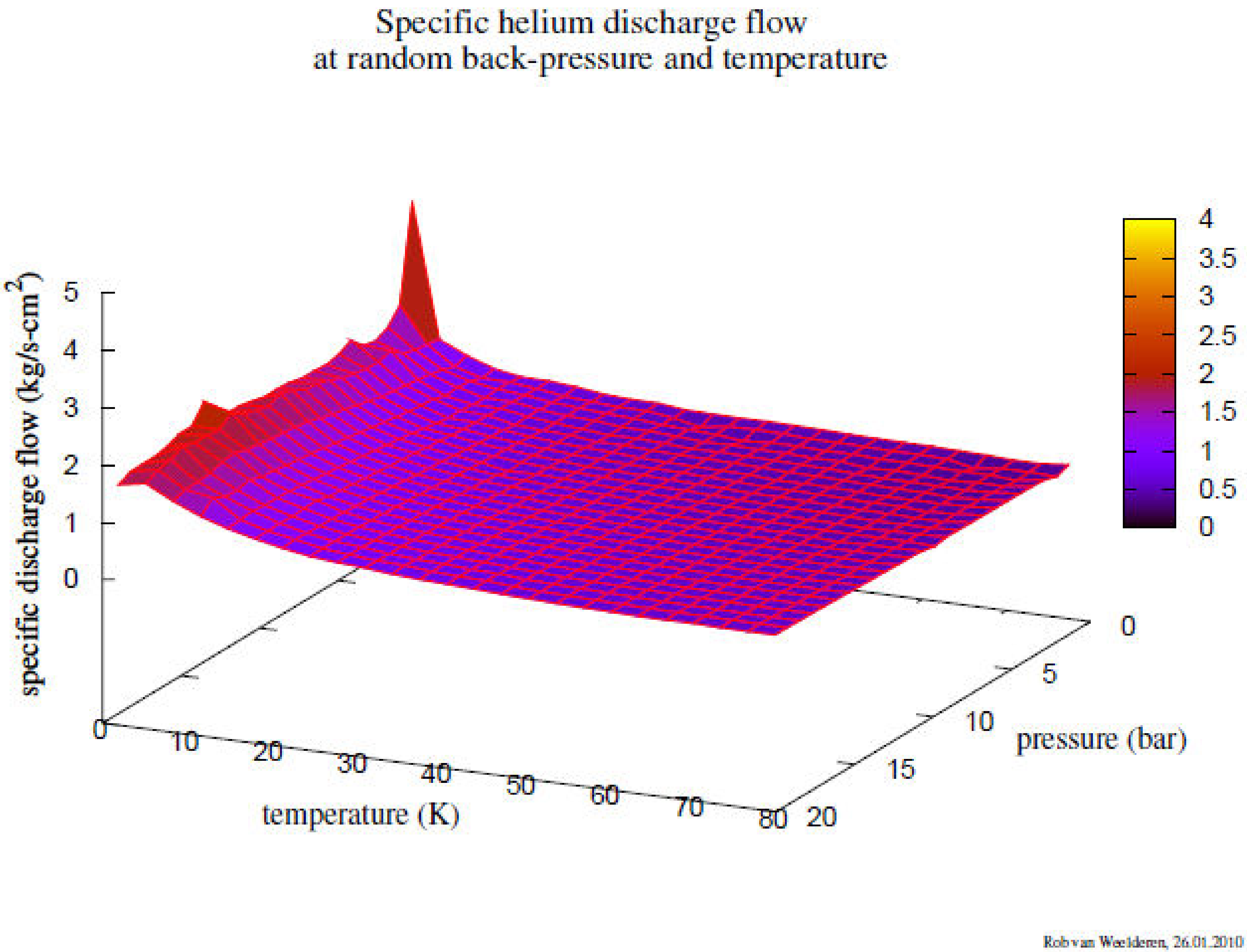
- Slit area is 3.23 cm^2/m (0.2 mm gap per 6.2 mm length, collar nose ~10mm)
- ~161 slits per meter length

The escape flow "landscape"

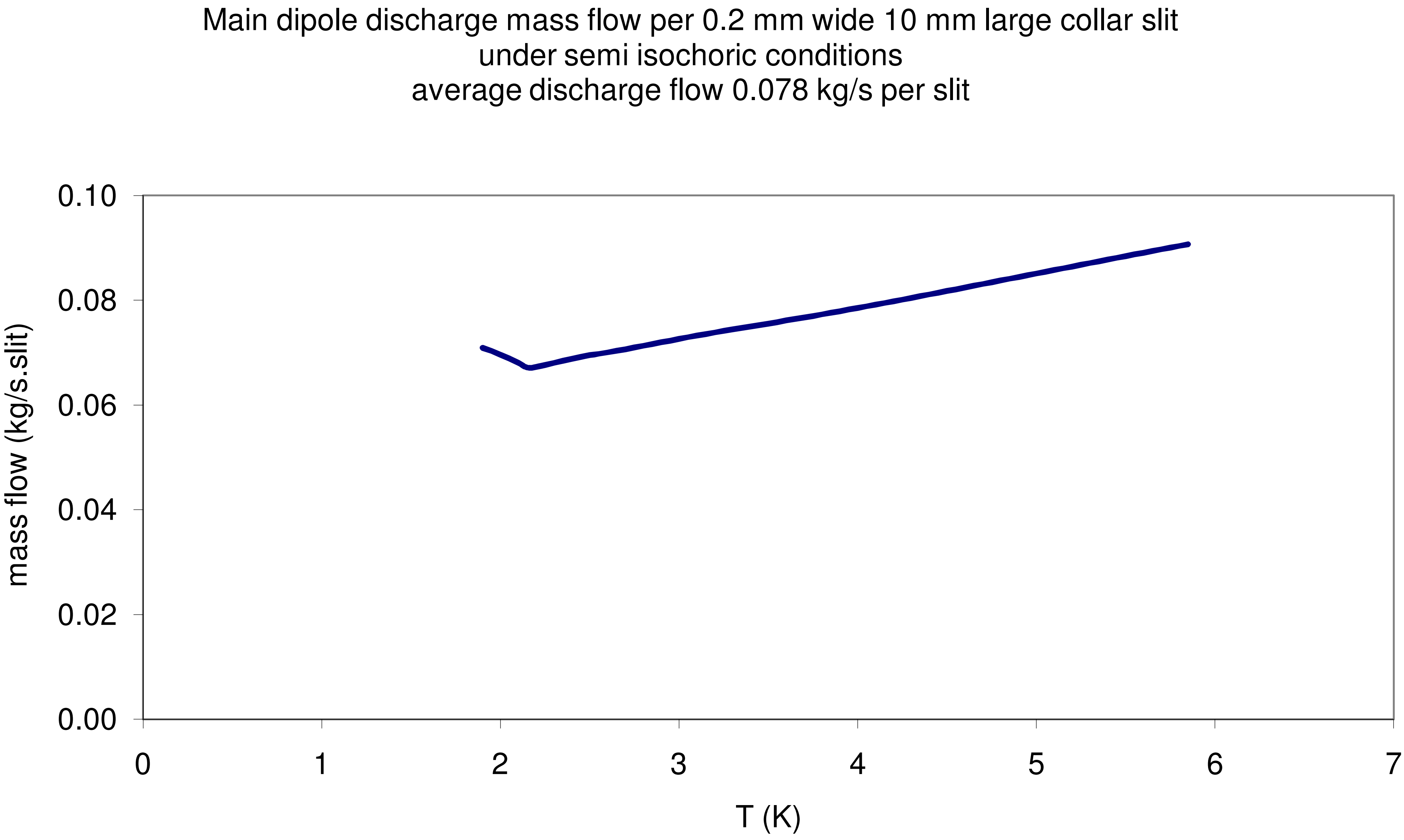


The escape flow “landscape”

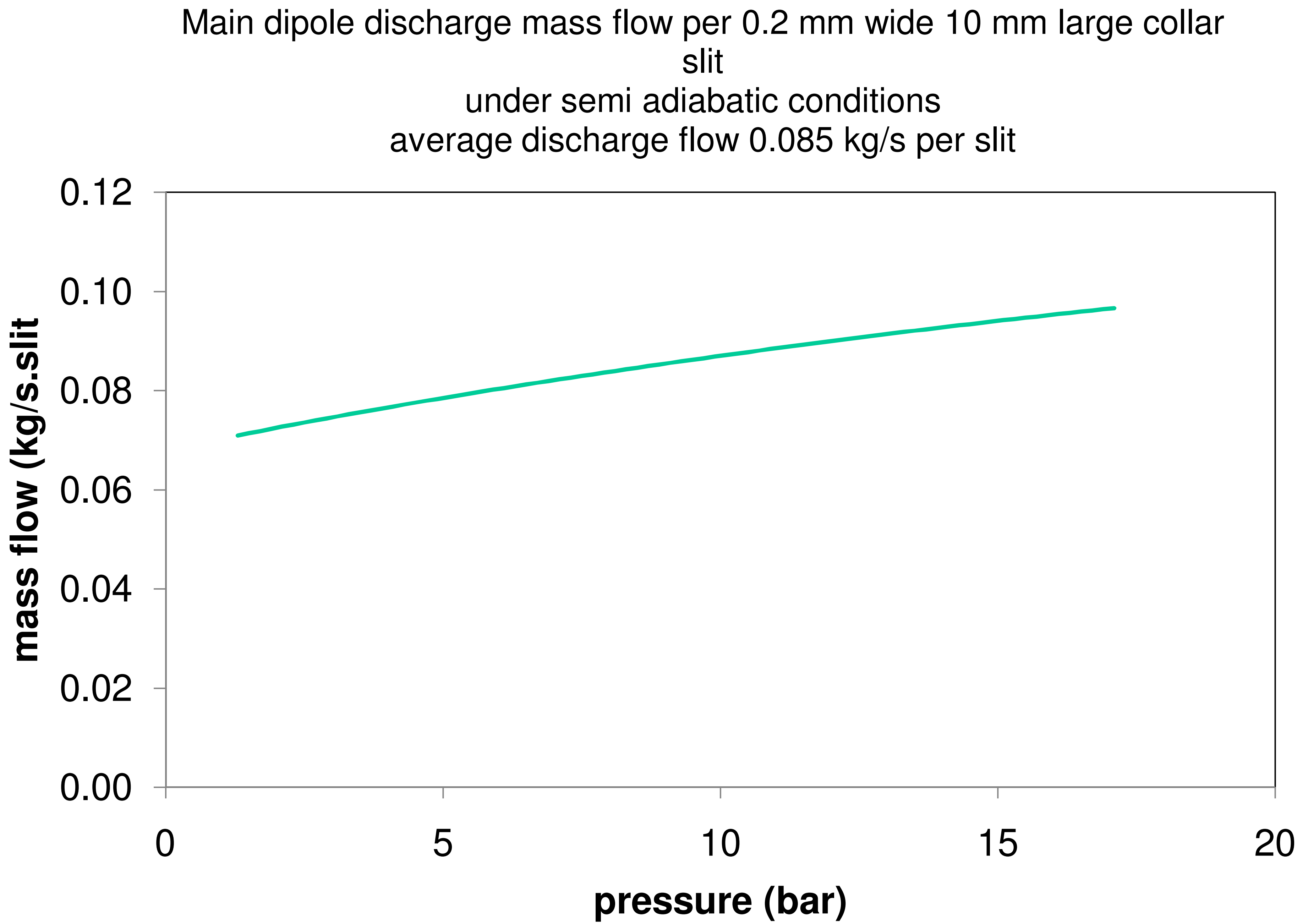
The specific discharge values will be determined by the state of the helium at the hole location and thus by the physical process taking place in the cold masses

	Specific (kg/s cm^2)	Per slit (kg/s)	Per meter of collar nose (kg/s.m)
Pool boiling vapour phase	0.22	0.004	0.71
Pool boiling liquid phase	2.0	0.039	6.3
Isochoric	3.9	0.078	12.6
adiabatic	4.3	0.085	13.7
reality	?	?	?

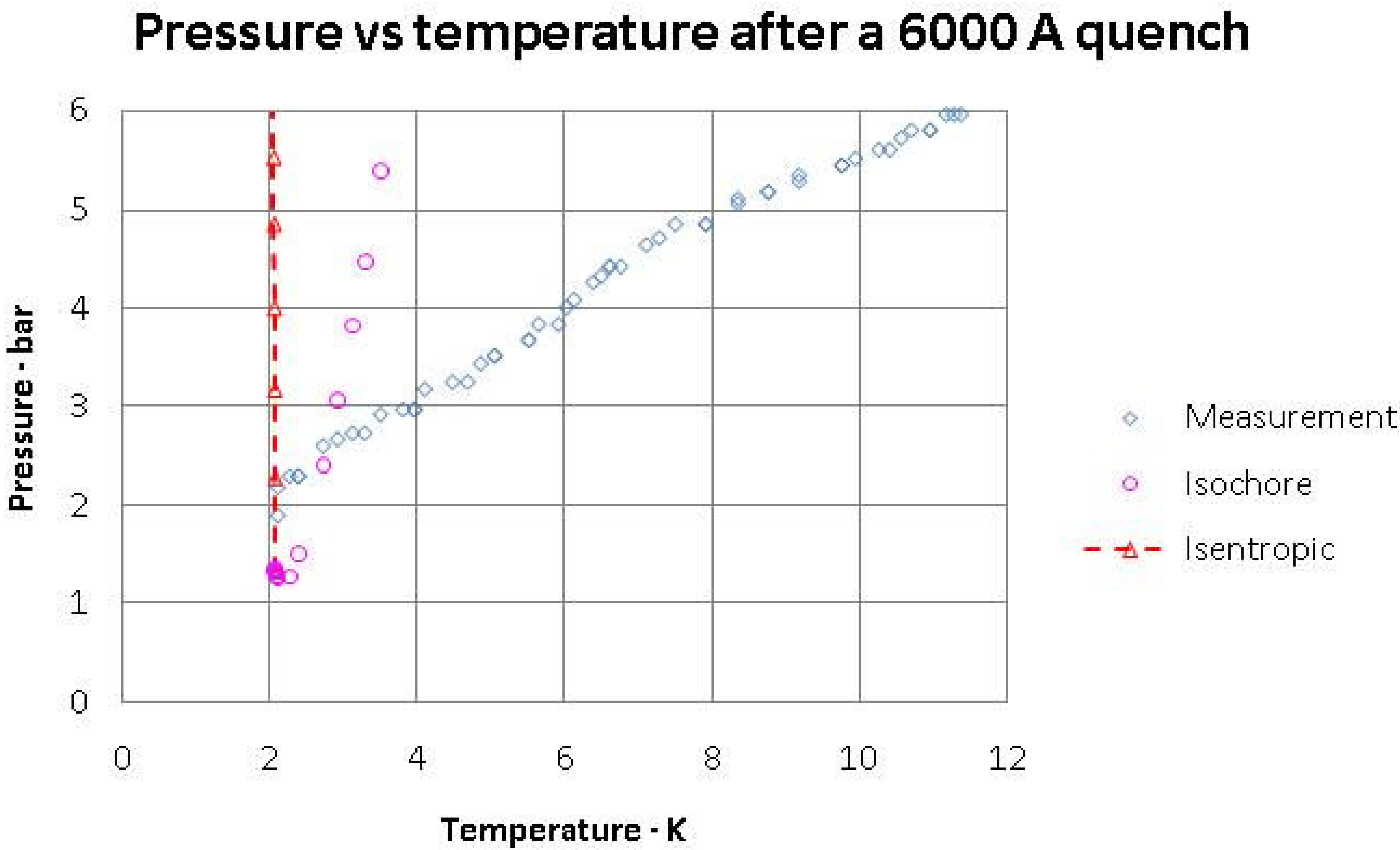
isochoric heating lines



adiabatic heating lines

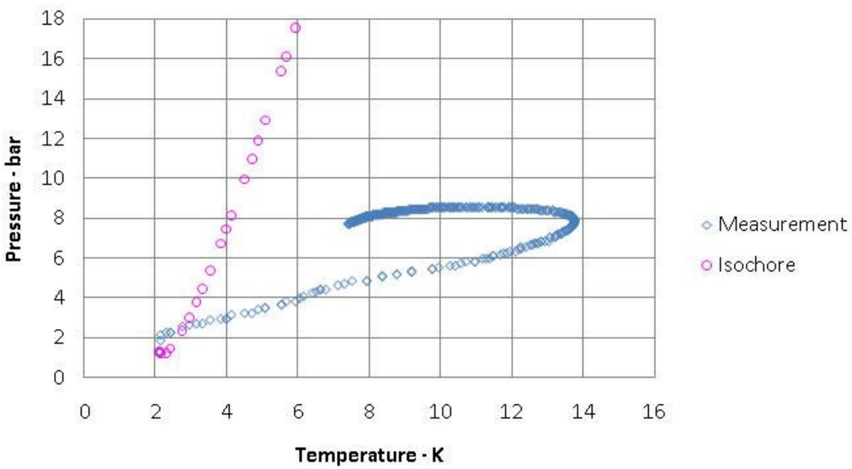


P – T development

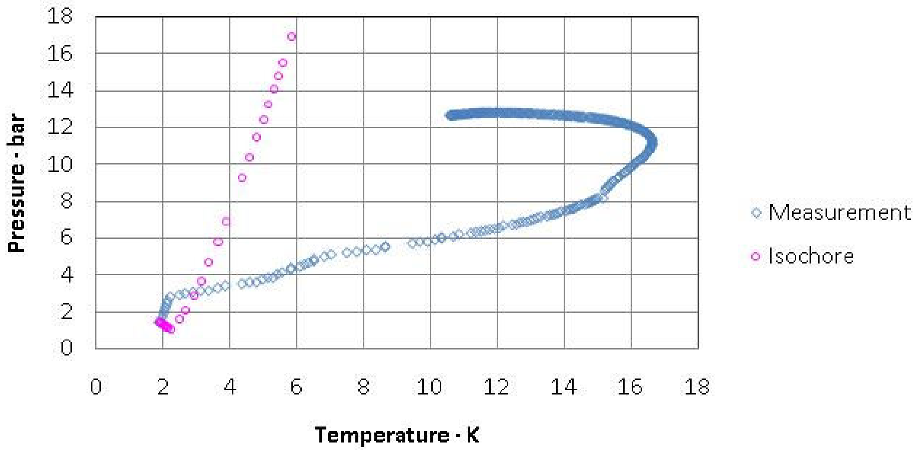


P – T development

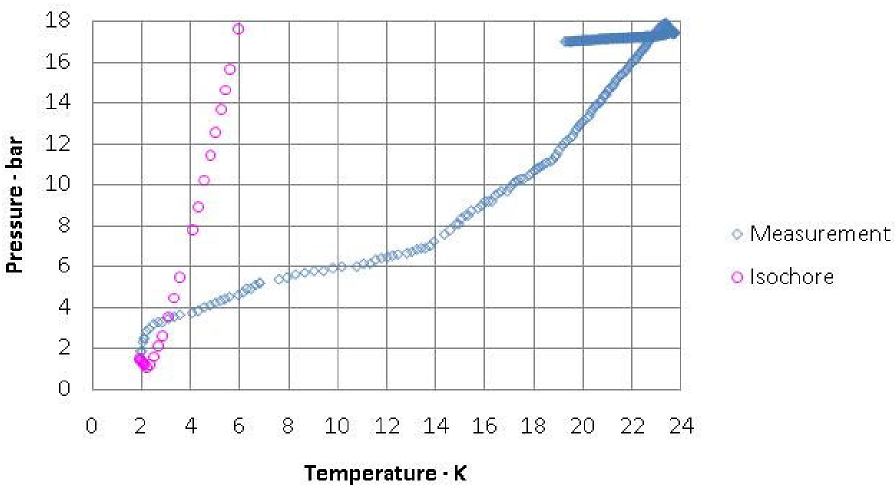
Pressure vs temperature after a 6000 A quench



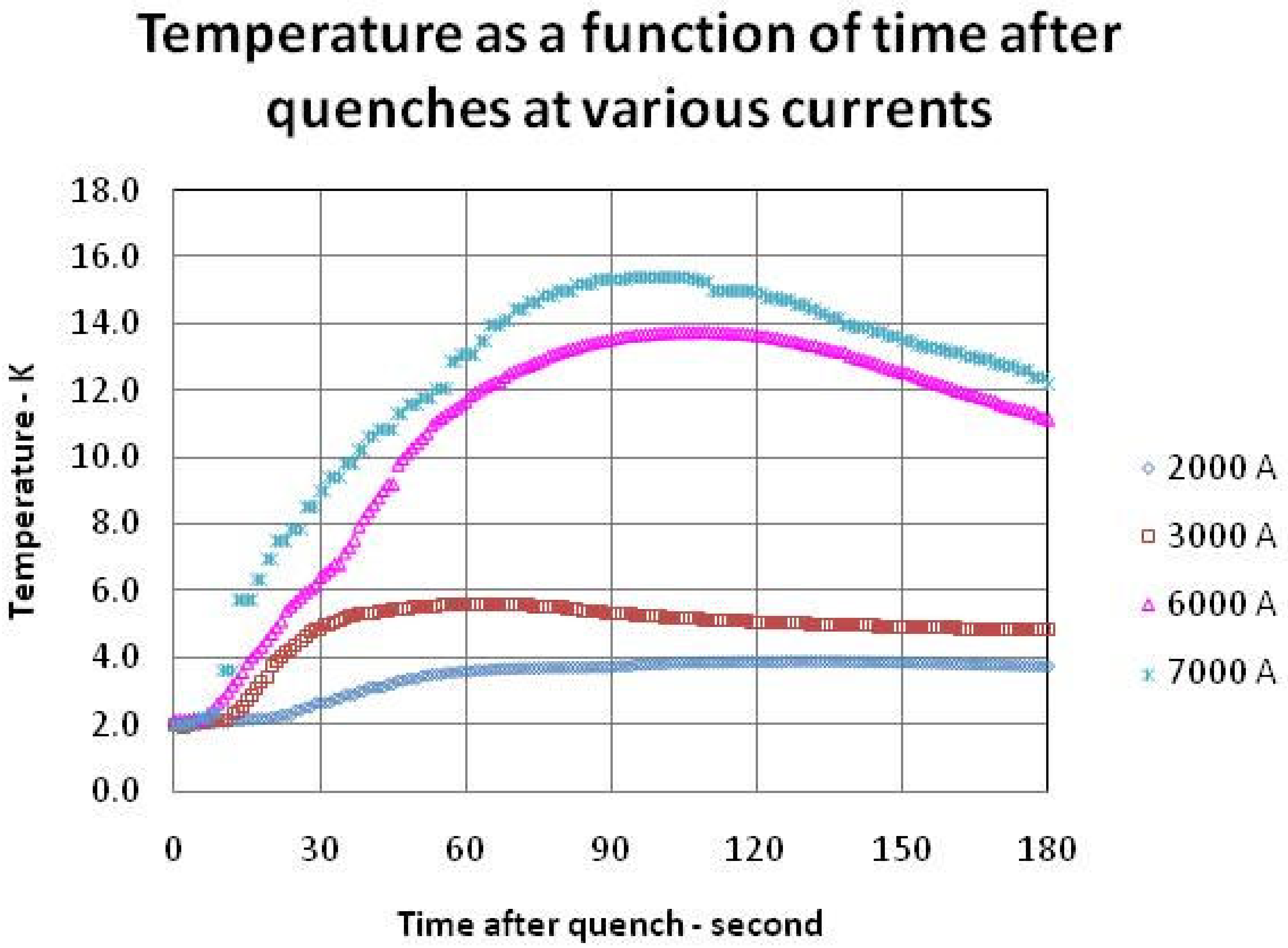
Pressure vs temperature after a 7000 A quench (2nd quench occurred at ~ 8 bar, 15 K)



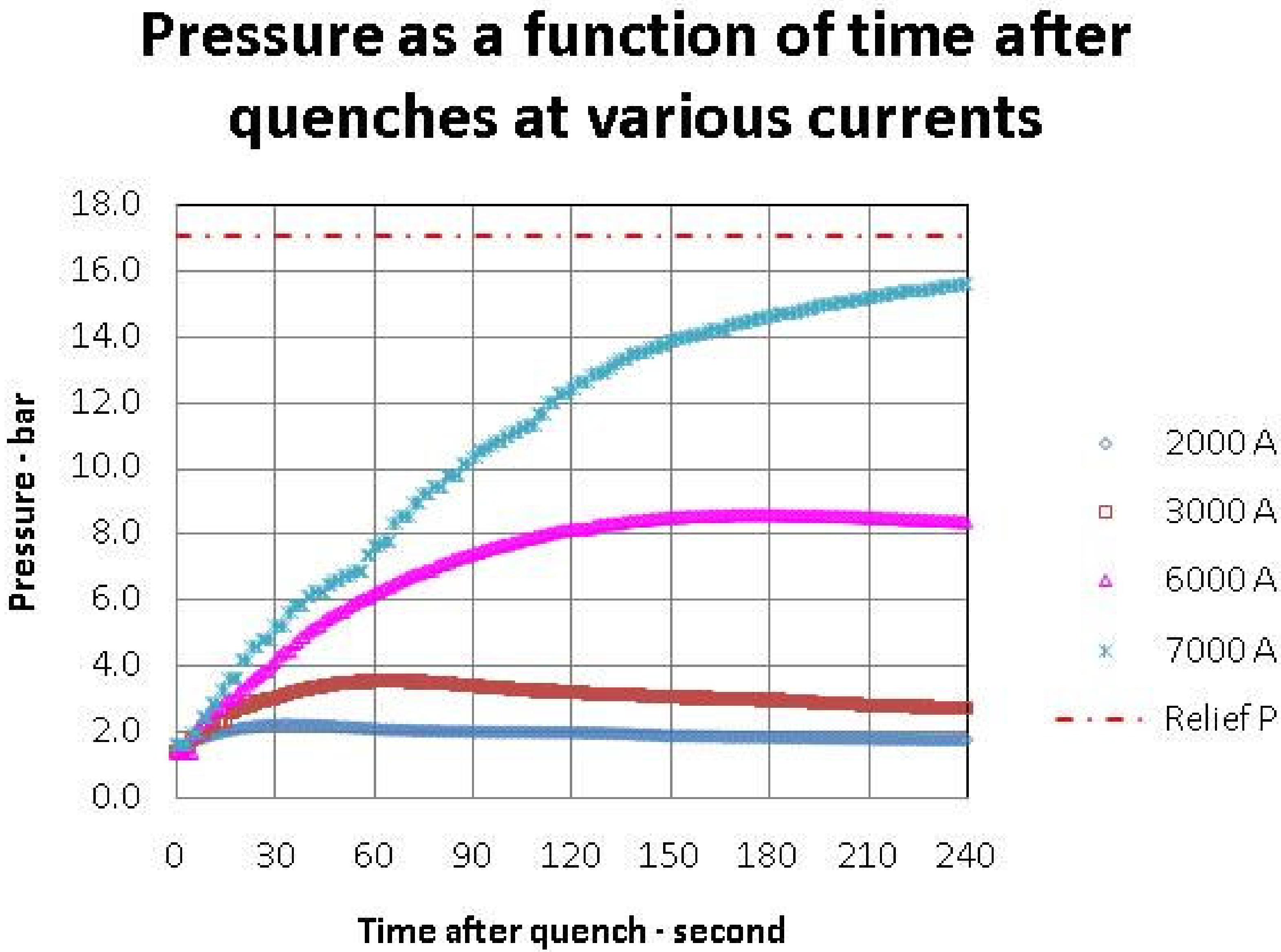
Pressure as a function of temperature after a 10000 A quench (2nd and 3rd magnets quenched at 13.6K , 6.8 bar and 19.2 K, 12 bar)



A approximate "realistic" P – T development and associated discharge flow plot



A approximate "realistic" P – T development and associated discharge flow plot



conclusions

•At about (3-4 bar, 3 K) one leaves the adiabatic/isochoric phase area i.e. after about 15 s

•For this first 15 seconds we will see a high specific discharge rate (~4 kg/s.cm^2 / ~10 kg/s.m of collar nose)

•After that the rate will decrease by an order of magnitude (~0.7 kg/s.cm^2 / ~1.7 kg/s.m of collar nose)

Average long term discharge is significantly more gentle than the first few seconds, unless the magnets are not quenched

In view of these mass flow ranges identified, specific cases of reasonable beam damage will now have to be defined in order to evaluate the beam pipe pressure rise effects