

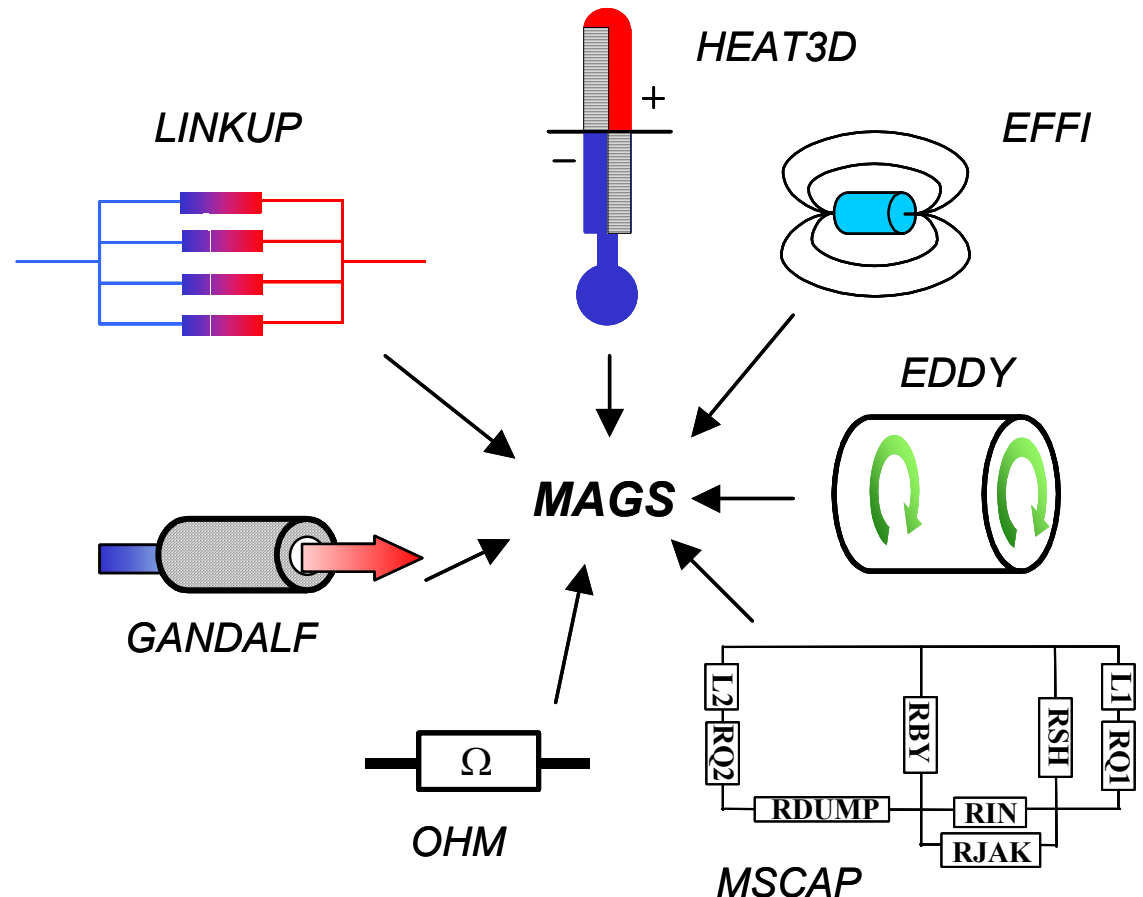
Effective thermal conductivity of the conductor insulation of the ITER Toroidal Field Model Coil at operation temperature

by Volker Pasler

- 1. Introduction to MAGS (MAGnet System)**
- 2. Calculation of fast discharge of TFMC from 25kA**
 - MAGS representation of the TFMC**
 - results of first approach**
 - results of improved model**
- 3. Summary and Conclusions**

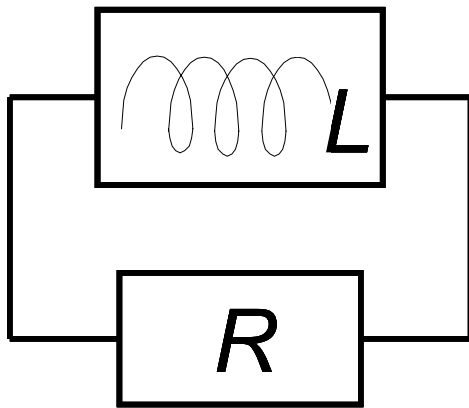
MAGS : a modular program system to simulate thermal consequences of an accident with fusion magnets

HEAT3D	3d heat conduction
EFFI	Magnetic field
EDDY	Hysteresis losses in cable
MSCAP	Electrical circuit analysis
OHM	Quench detection, resistance, power
GANDALF	Helium flow in coil
LINKUP	Helium flow outside coil

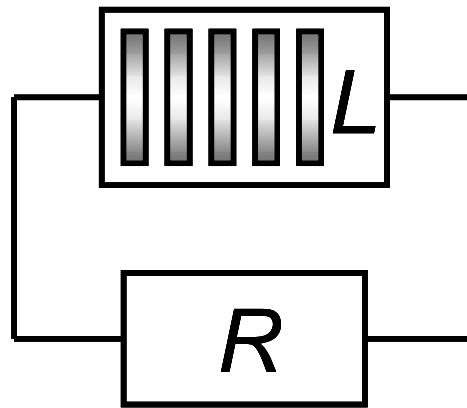


Electrical circuit model for the TFMC

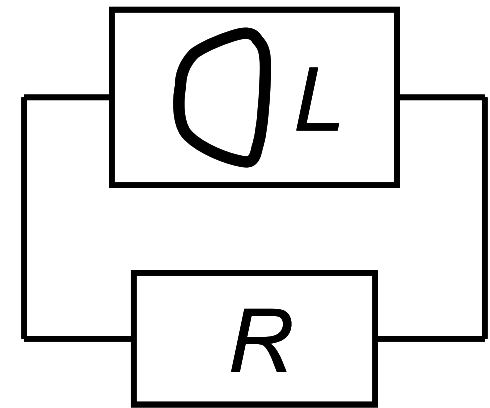
coil



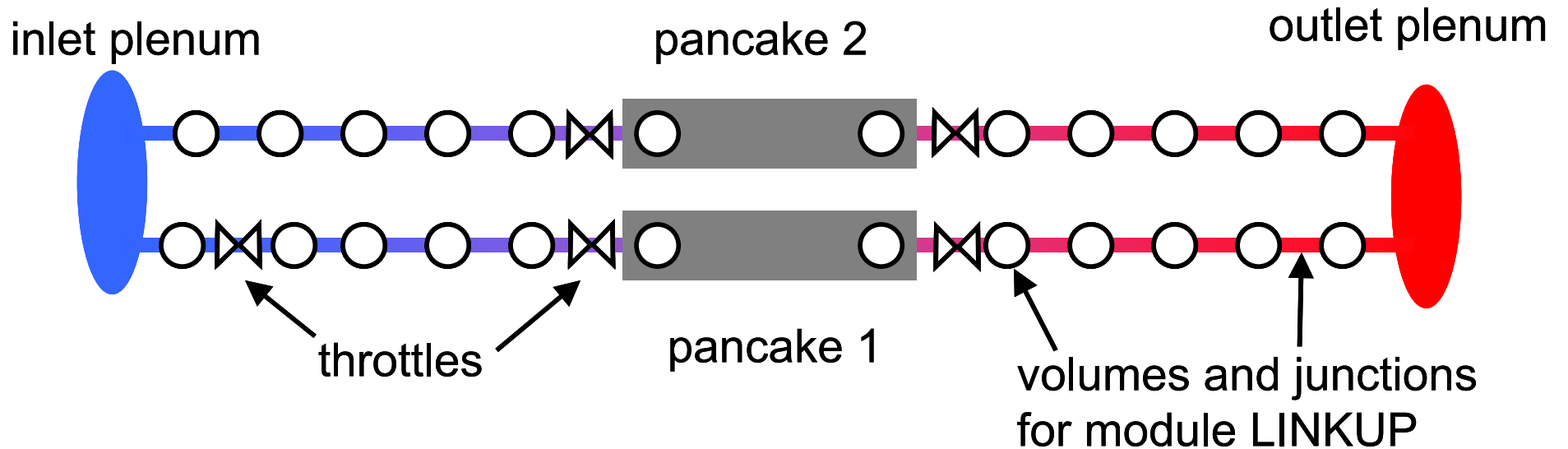
radial plates



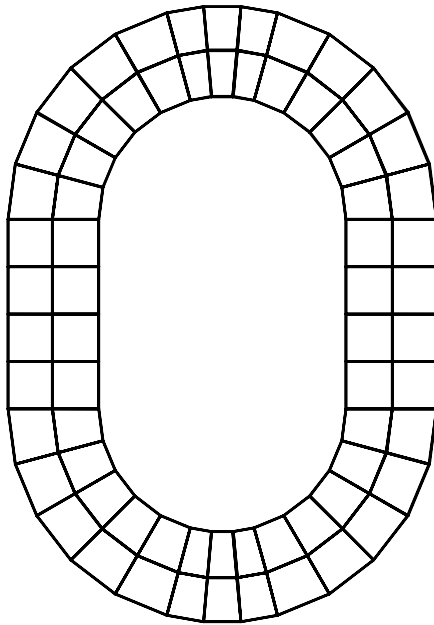
coil case



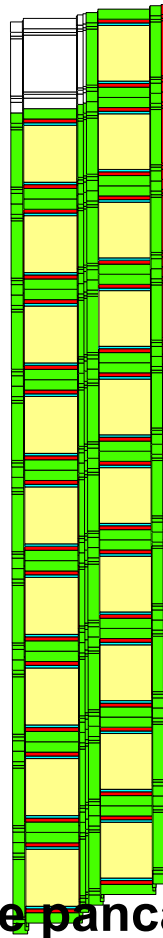
Helium supply model for TFMC



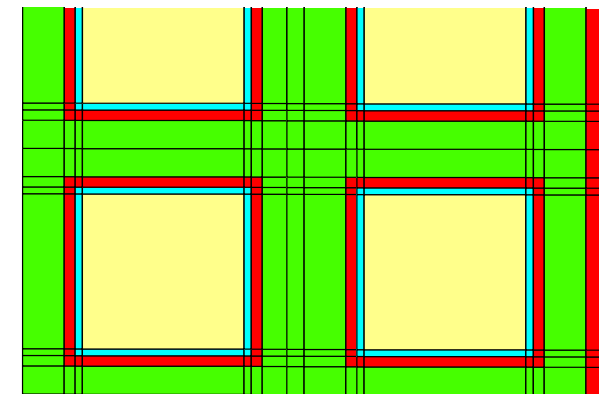
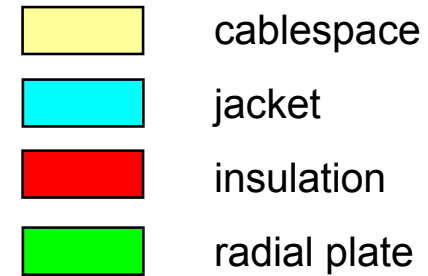
Grid representation of TFMC



side view



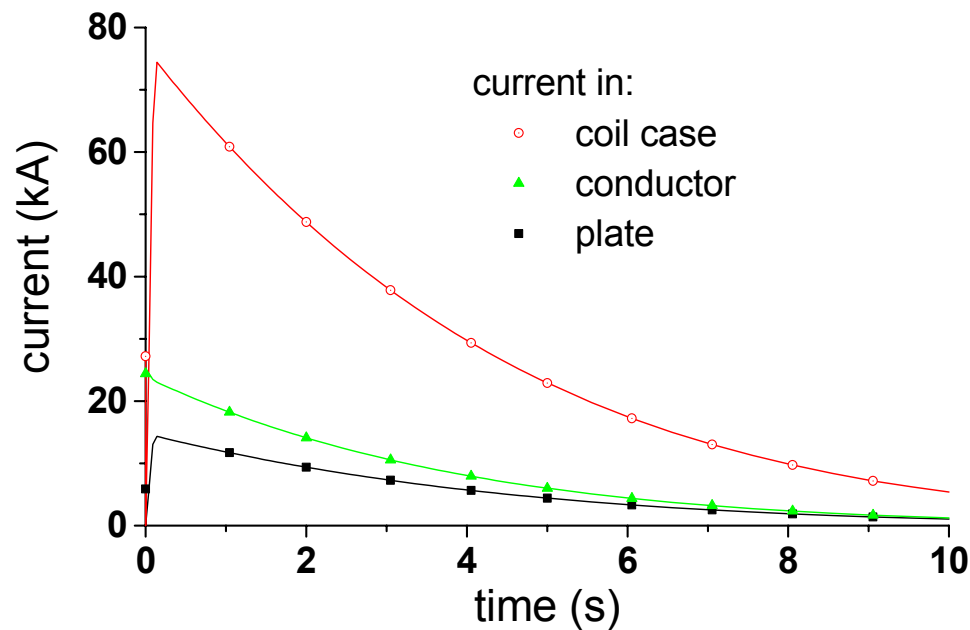
double pancake cut



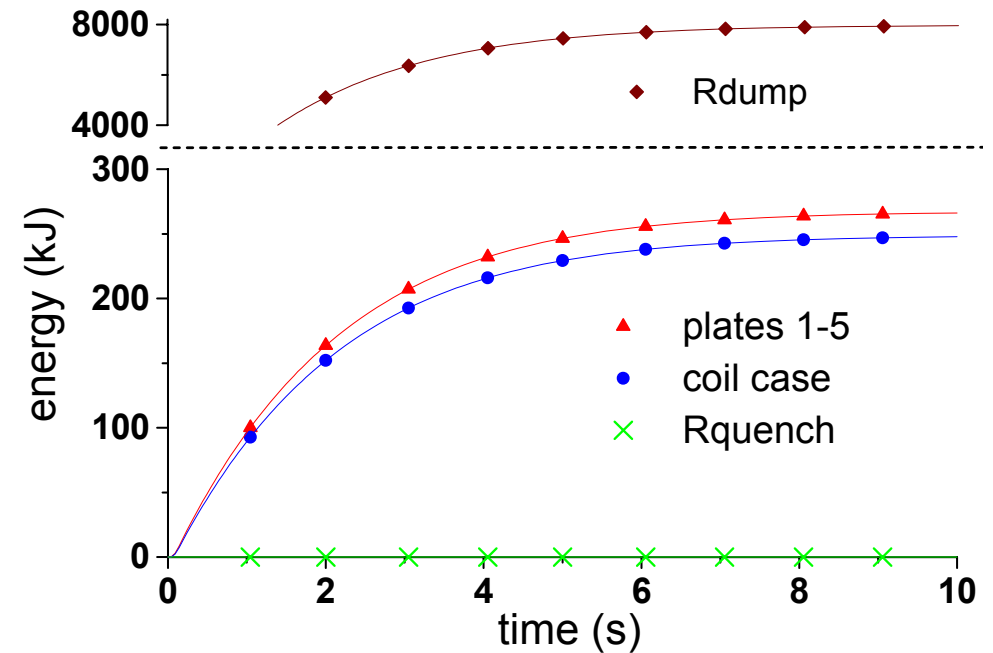
conductor mesh

Validation of MAGS: Fast discharge of TFMC from 25kA

current:

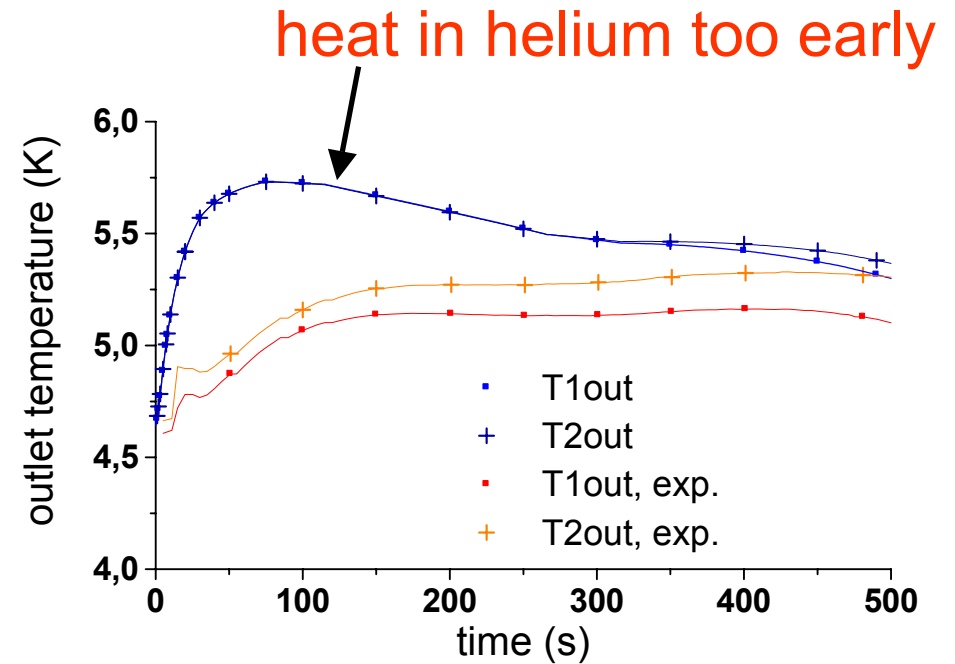
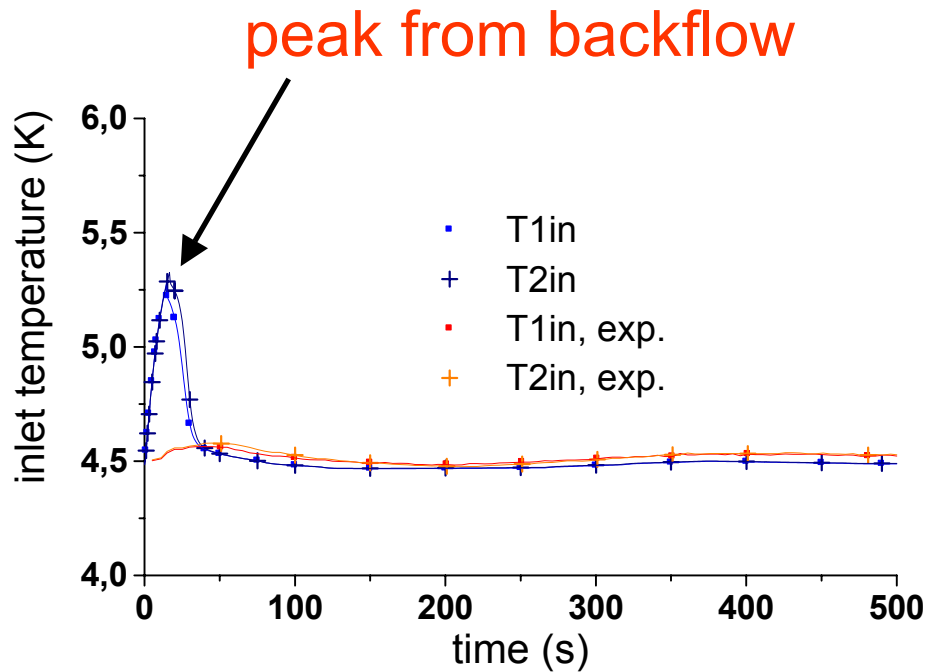


energy distribution:

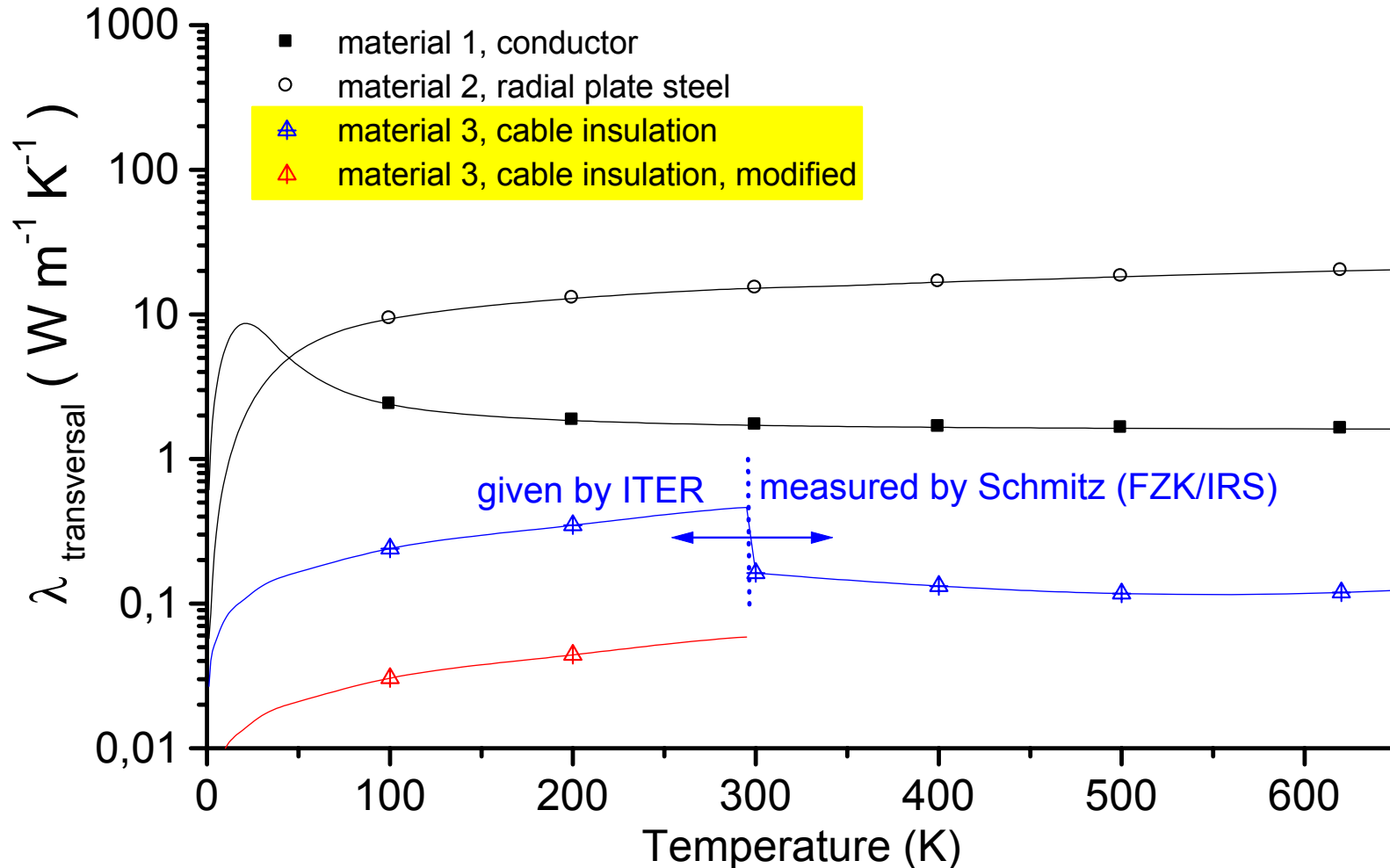


(electrical behaviour is almost identical for all cases)

case a: helium temperature for channels 1 and 2

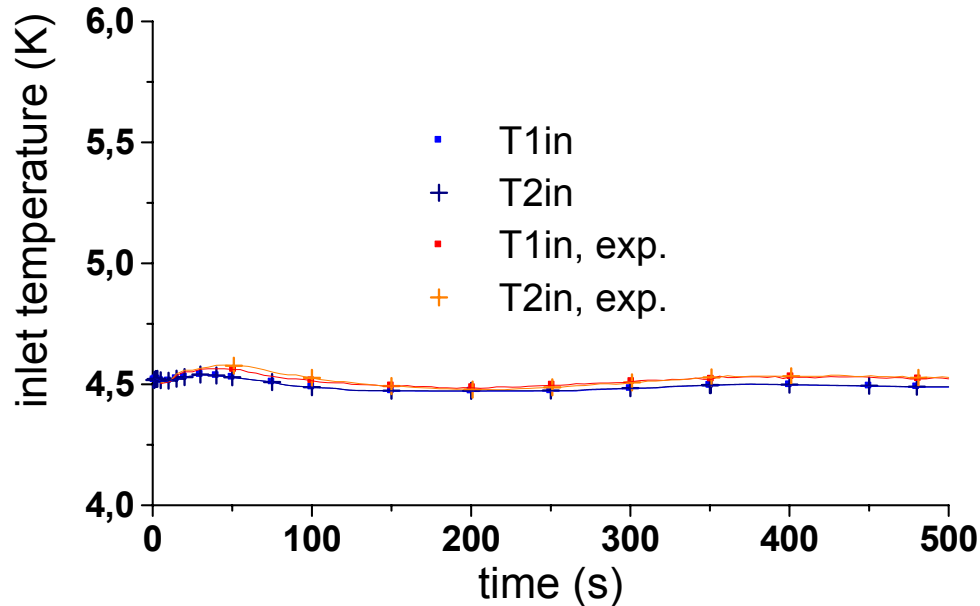


Reduction of transversal thermal conductivity of insulation material for cases *b* and *c*:

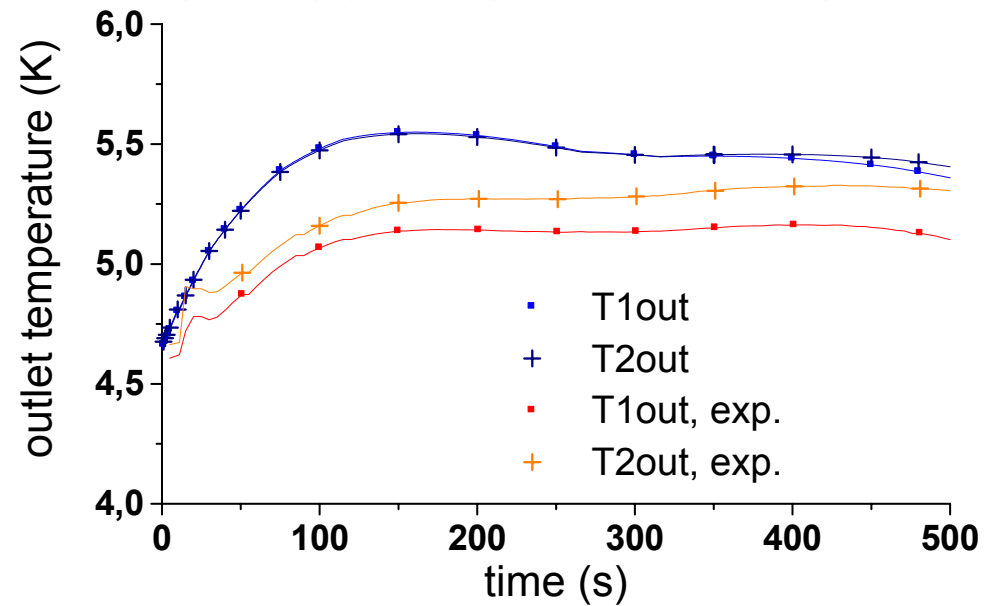


**case b: helium data with reduced thermal
conductivity of insulation material**

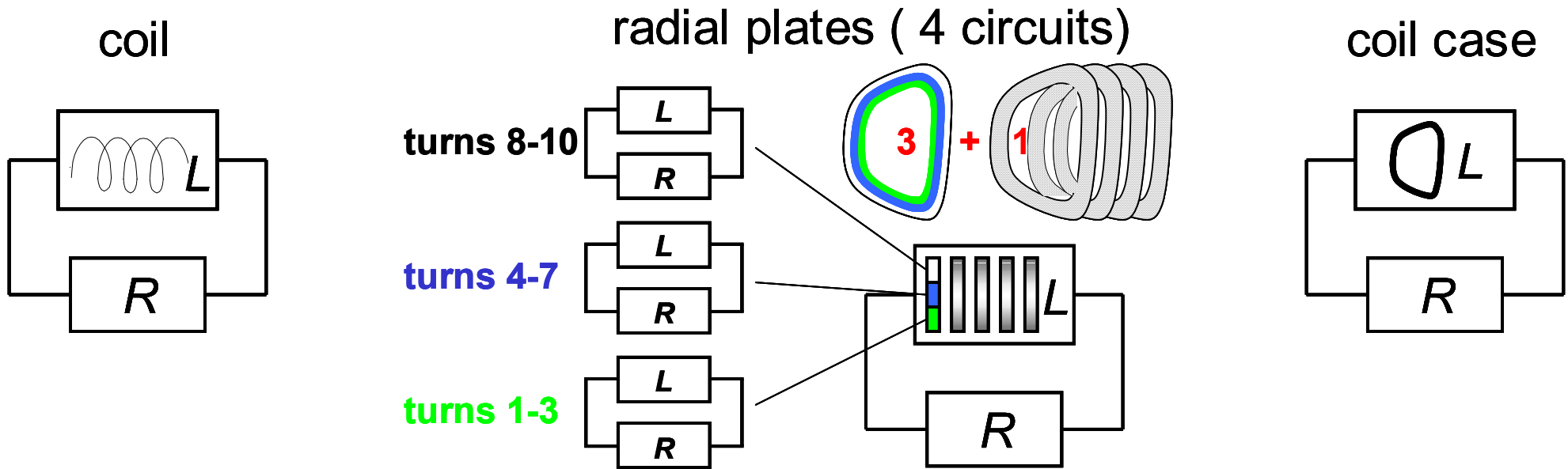
backflow effect vanishes



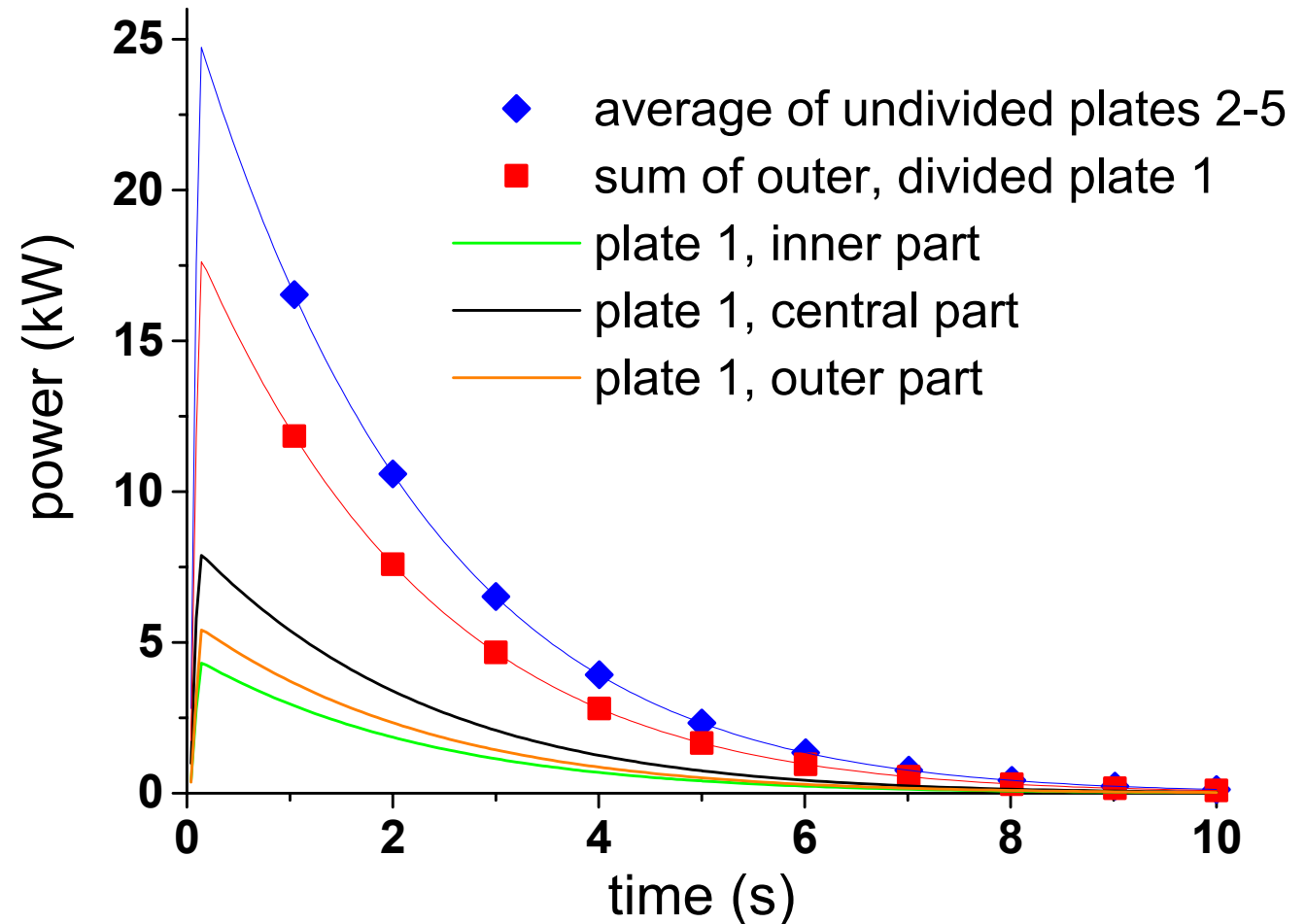
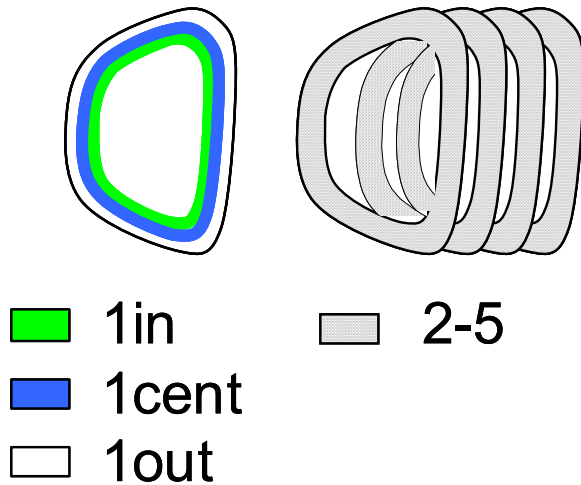
improved transient, but
still too much heat in helium



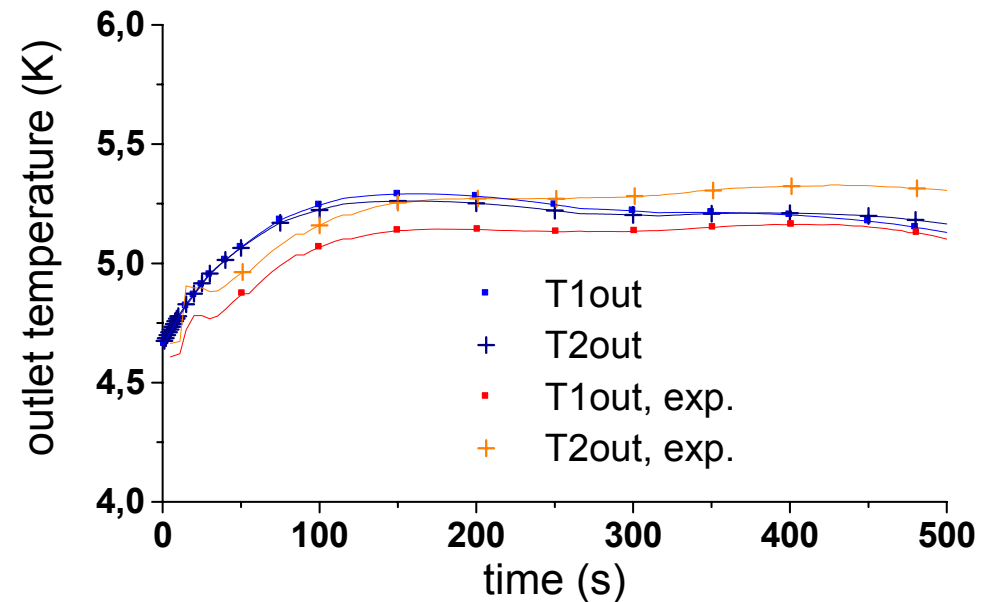
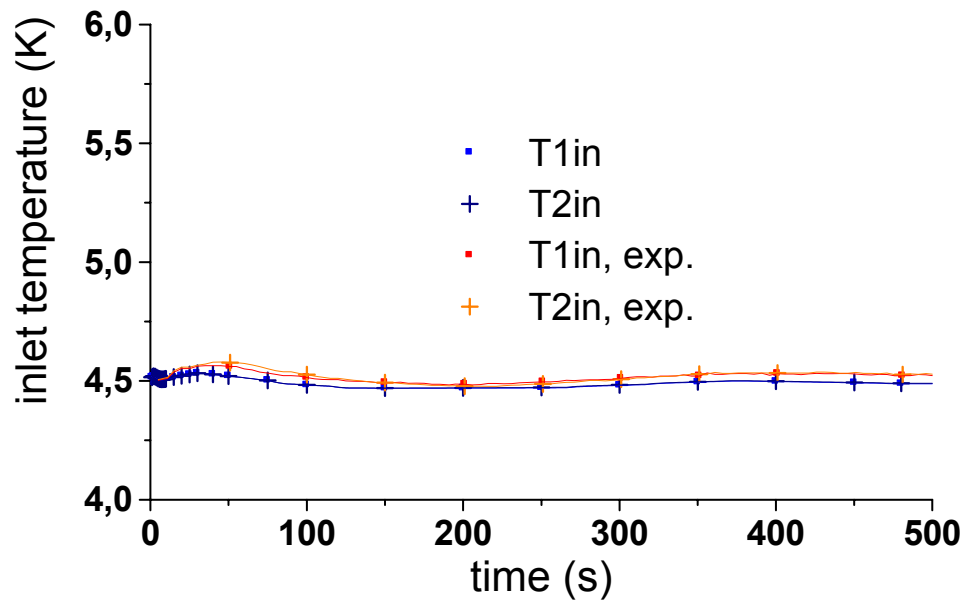
More detailed electrical circuit model for case c:



case c: new circuit gives enhanced resolution for power generation



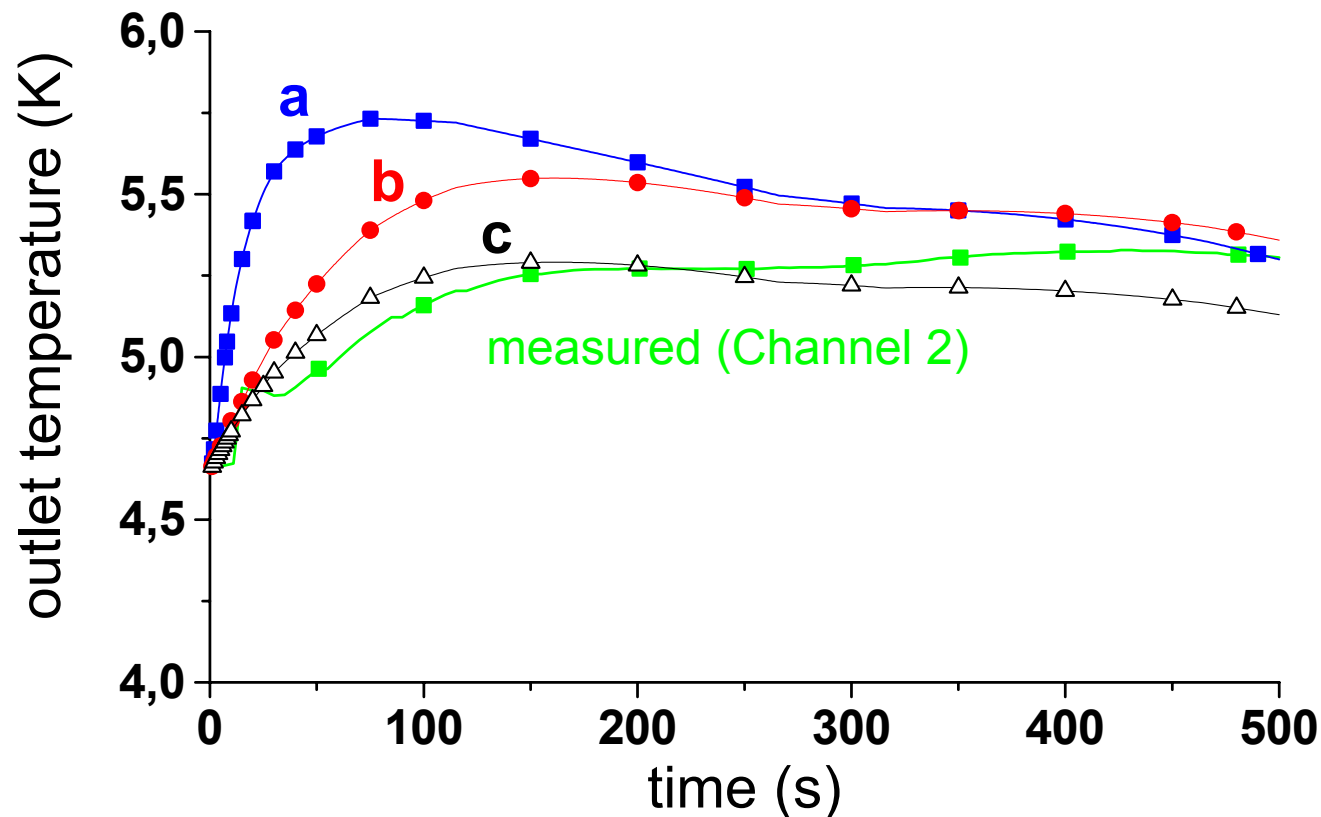
**case c: helium data with reduced thermal conductivity of insulation
material and detailed current distribution in radial plates**



Outlet temperature indicates need for modification of *case a* because time evolution is too fast and heat level is too high:

case b: lower cable insulation conductivity corrects time profile

case c: detailed circuit gives correct power release



Conclusion

Validation of MAGS with TFMC experimental results successful.

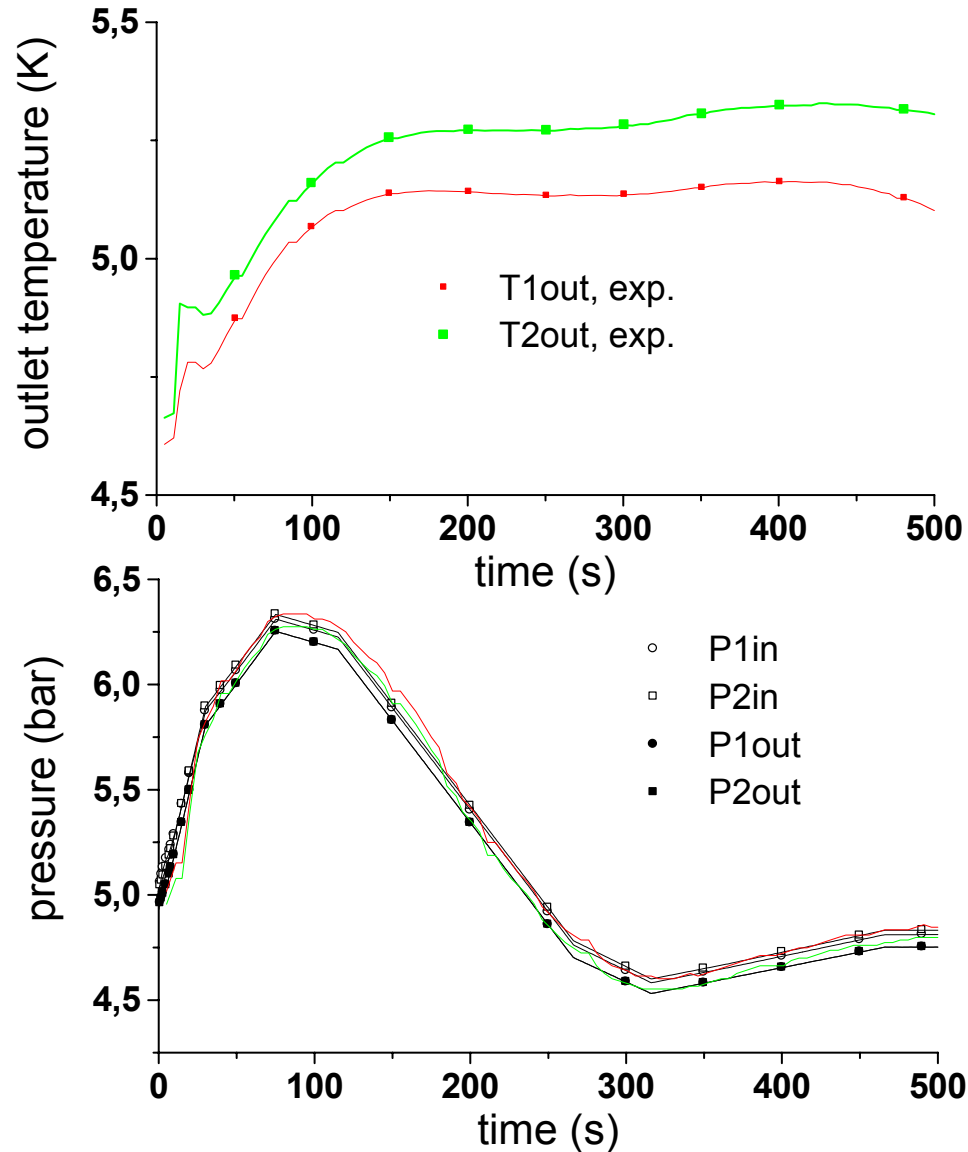
MAGS results indicate that

- **the effective thermal conductivity of insulation material is *significantly lower* than assumed (experiments required !)**
- **correct power distribution for radial plates is needed to get a realistic outlet temperature.**

The transparencies before were shown in the presentation.

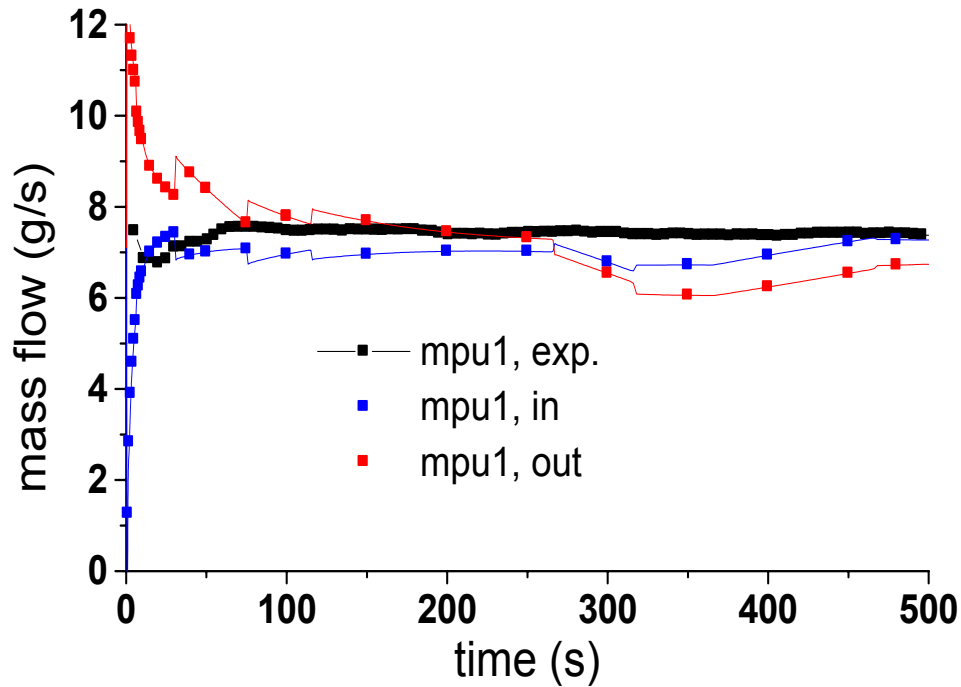
The following transparencies were prepared for use in discussion.

Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft

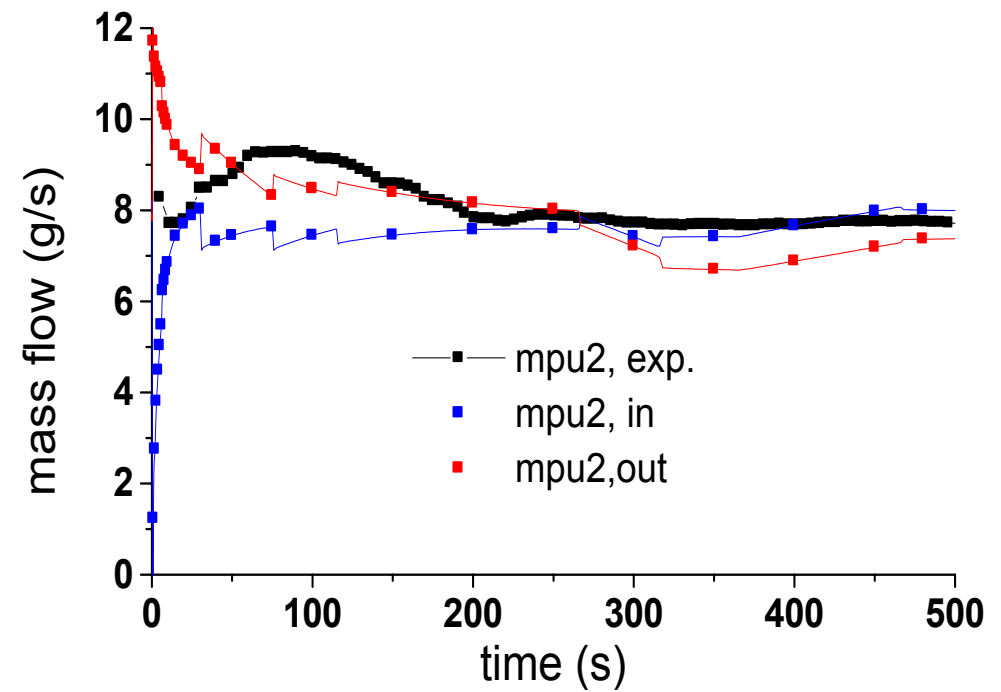


Mass flow

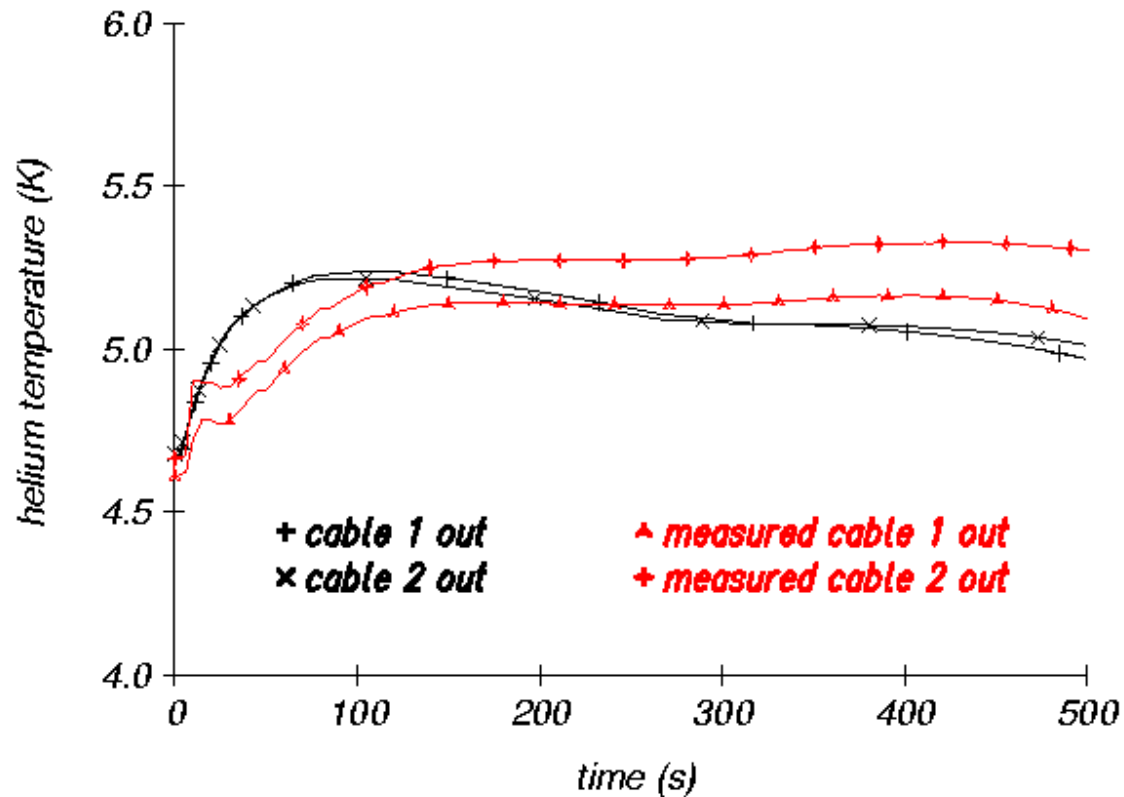
channel 1



channel 2



Further reduction of radial plate power by maximum tolerance for resistance calculation:



⇒ power reduction does not change time constant significantly !

Fast discharge from 40 kA (opening of relief valves during experiment not modeled)

