Modelling of arc-electrode systems: preliminary results for high pressure xenon arc lamps

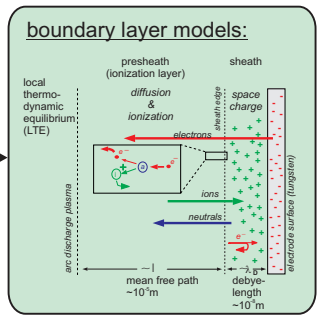
J Wendelstorf*, I Decker, H Wohlfahrt and G Simon
Technische Universität Braunschweig, Postfach 3329, D-38023 Braunschweig, Germany

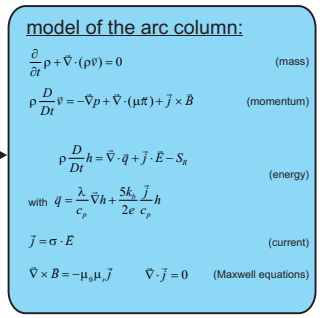
Objectives:

- development of quantitative high pressure discharge models applicable to a wide range of lamp configurations
- understanding of the arc electrode system, i.e. prediction of the cathode hot spot formation for thermionic cathodes
- validation of modelling software by quantitative comparison with experimental data

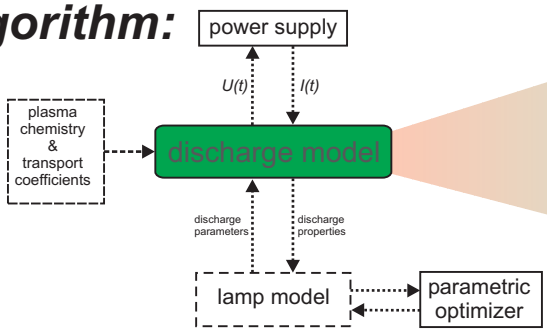
Solution method:

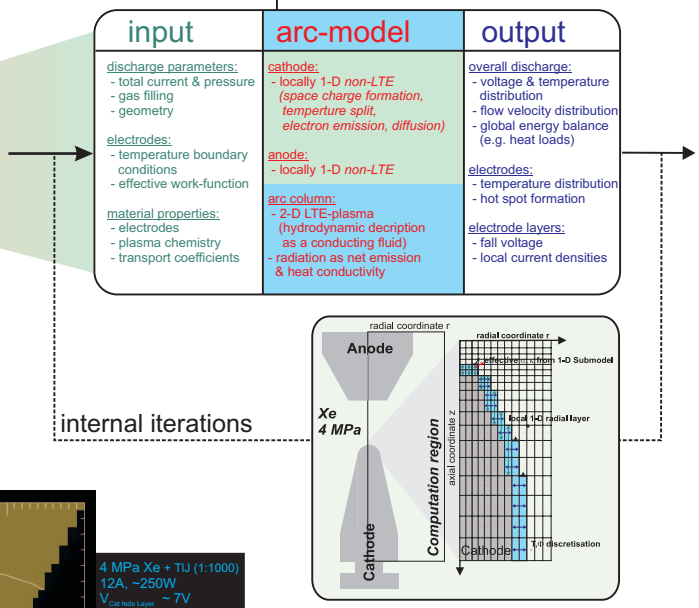
- iterative linking of numerical submodels:
  - description of the discharge plasma by conducting fluid models (2-D, LTE)
  - description of the electrode layers by local sub-models (1-D)
  - current and energy transport inside the electrodes (2-D)
- model validation and optimization for discharge configurations with reliable and accurate experimental data available:
  - free burning atmospheric argon arc (0.1 MPa, LTE)
  - high pressure xenon short arc lamp (4 MPa, LTE)





Algorithm:

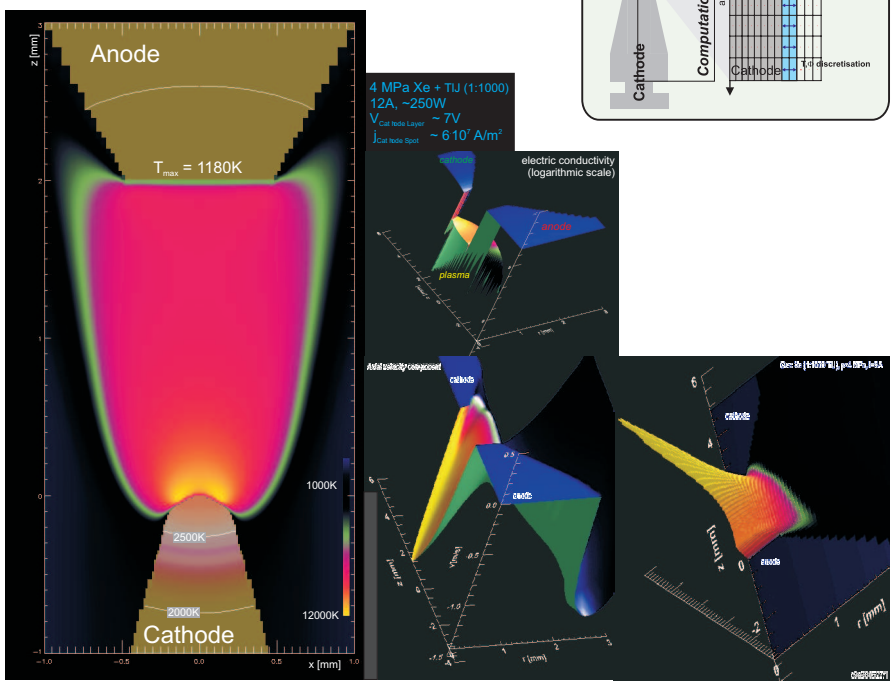




internal iterations

Results:

- comparison of different cathode layer models:
  - space charge formation may be collision-free
  - electron emission is the dominating physical effect
  - field enhanced thermionic emission decreases cathode spot temperature below 3000K
  - work function is the dominating material property
- model validation and optimization:
  - arc voltage is the critical validation parameter
  - mode transitions need large computing power
  - for the 4 MPa xenon test case, hydrodynamics do not dominate the cathode spot formation



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* jens@wendelstorf.de
http://www.wendelstorf.de