Experimental Investigation of a CZ-process of Large Diameter Silicon Single Crystal Growth Under the Influence of Magnetic Fields

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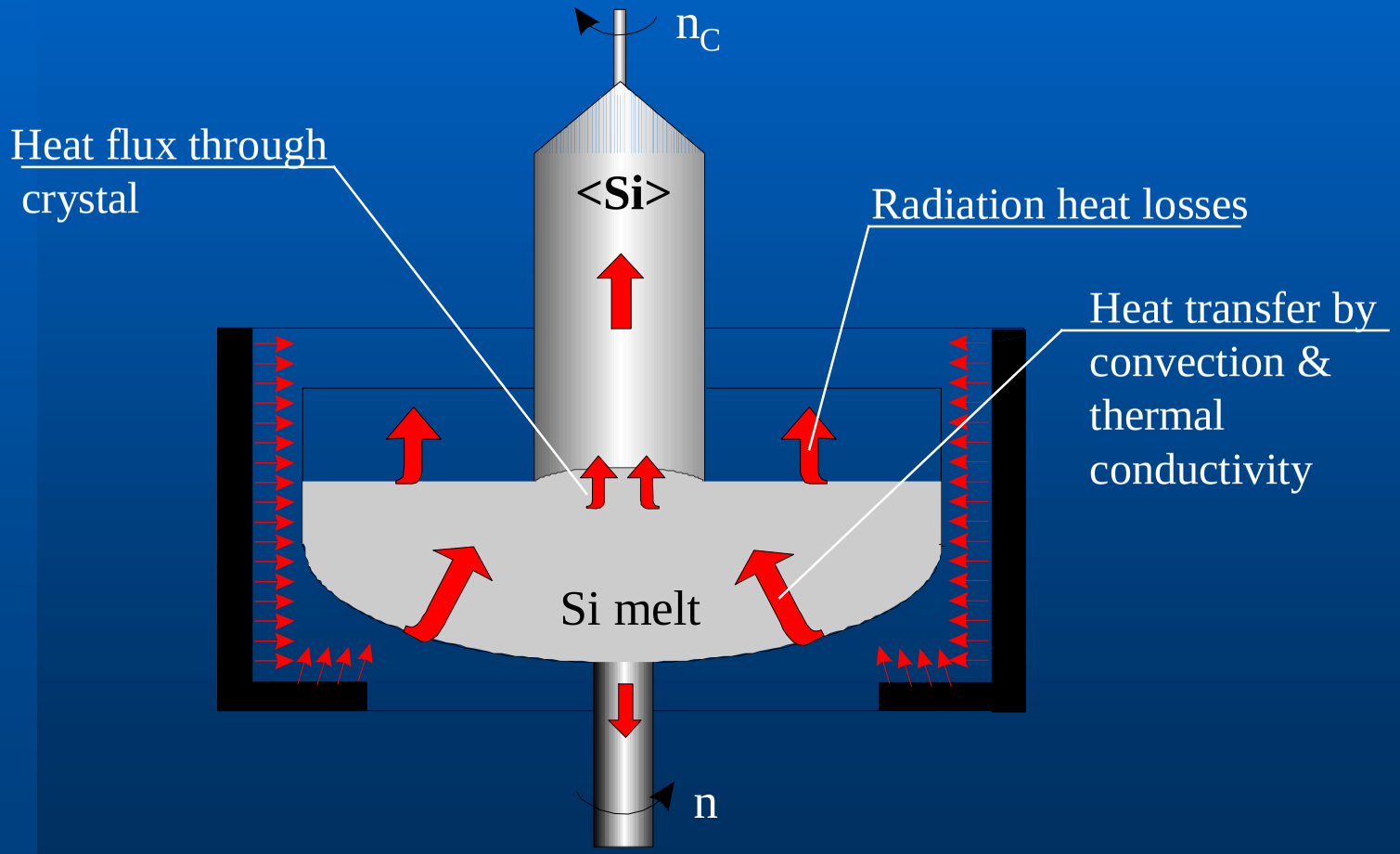
Overview

- Development of the physical model of CZ-process melt
- Design of experimental facility
- Development of multichannel measurement system for obtaining temperature distribution in the melt
- Discussion of results
- Conclusions

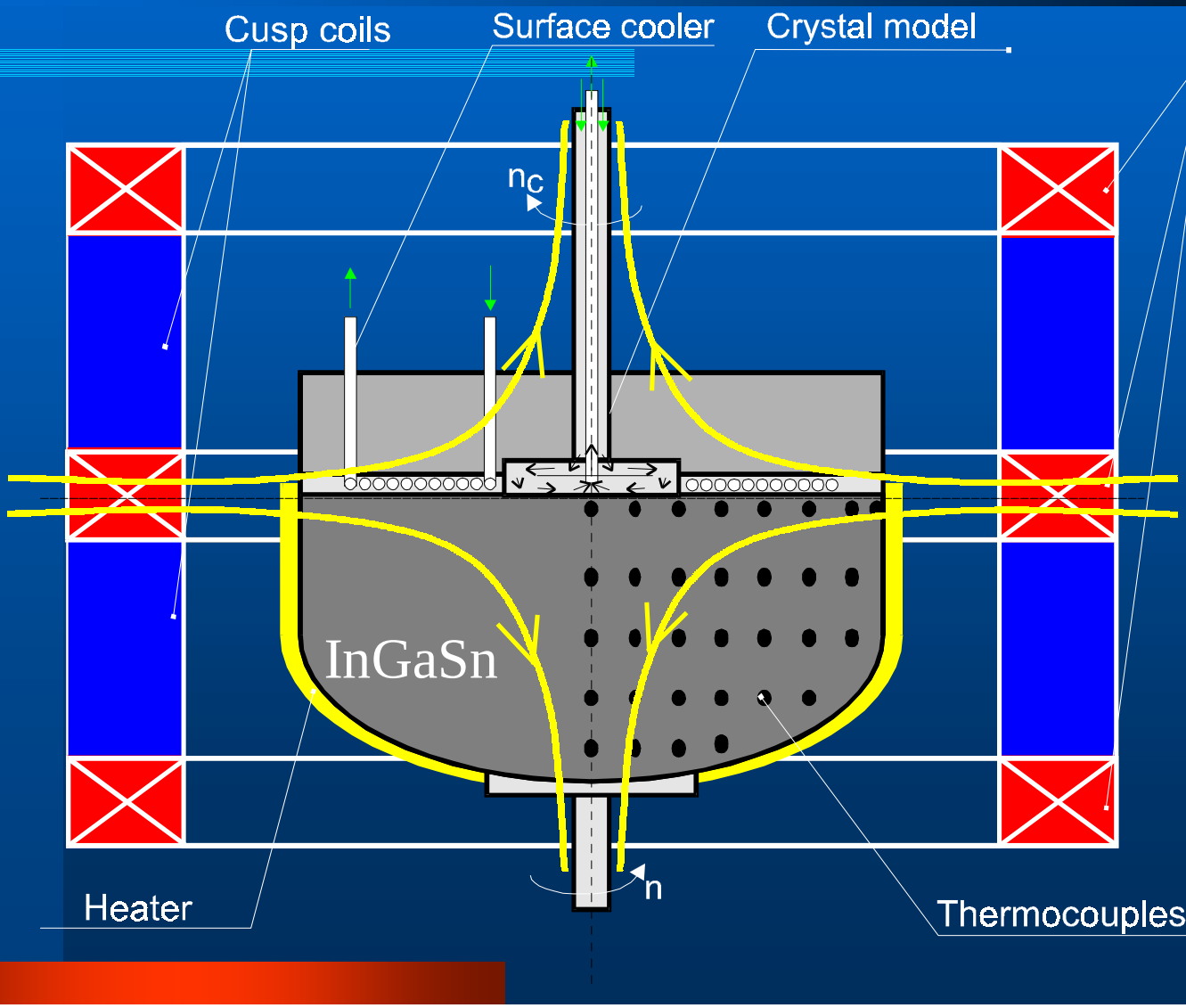
Physical model of Czochralski melt



Experimental stand

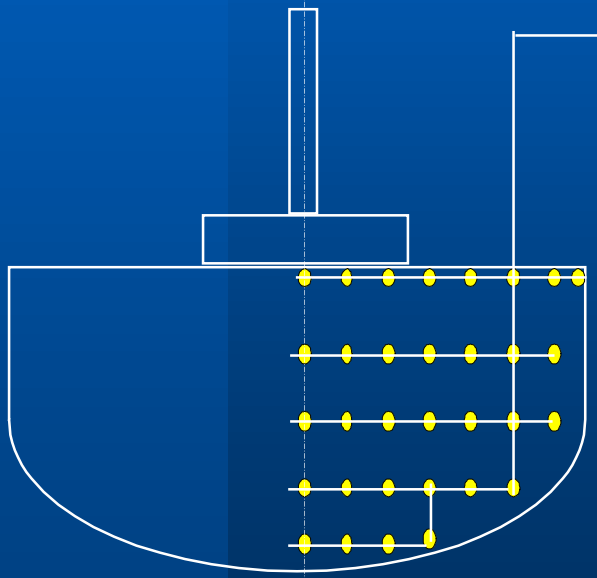
CUSP

TMF



Measurement system

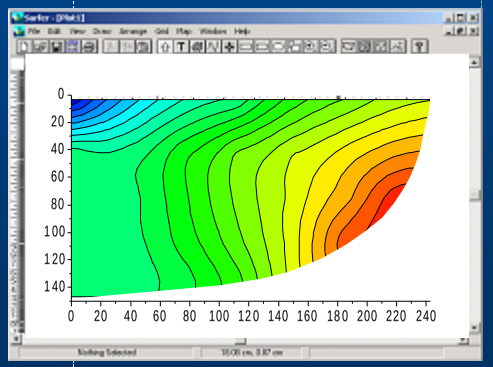
Sensor – the grid of 32 thermocouples



Multichannel acquisition system

4000 samples/s

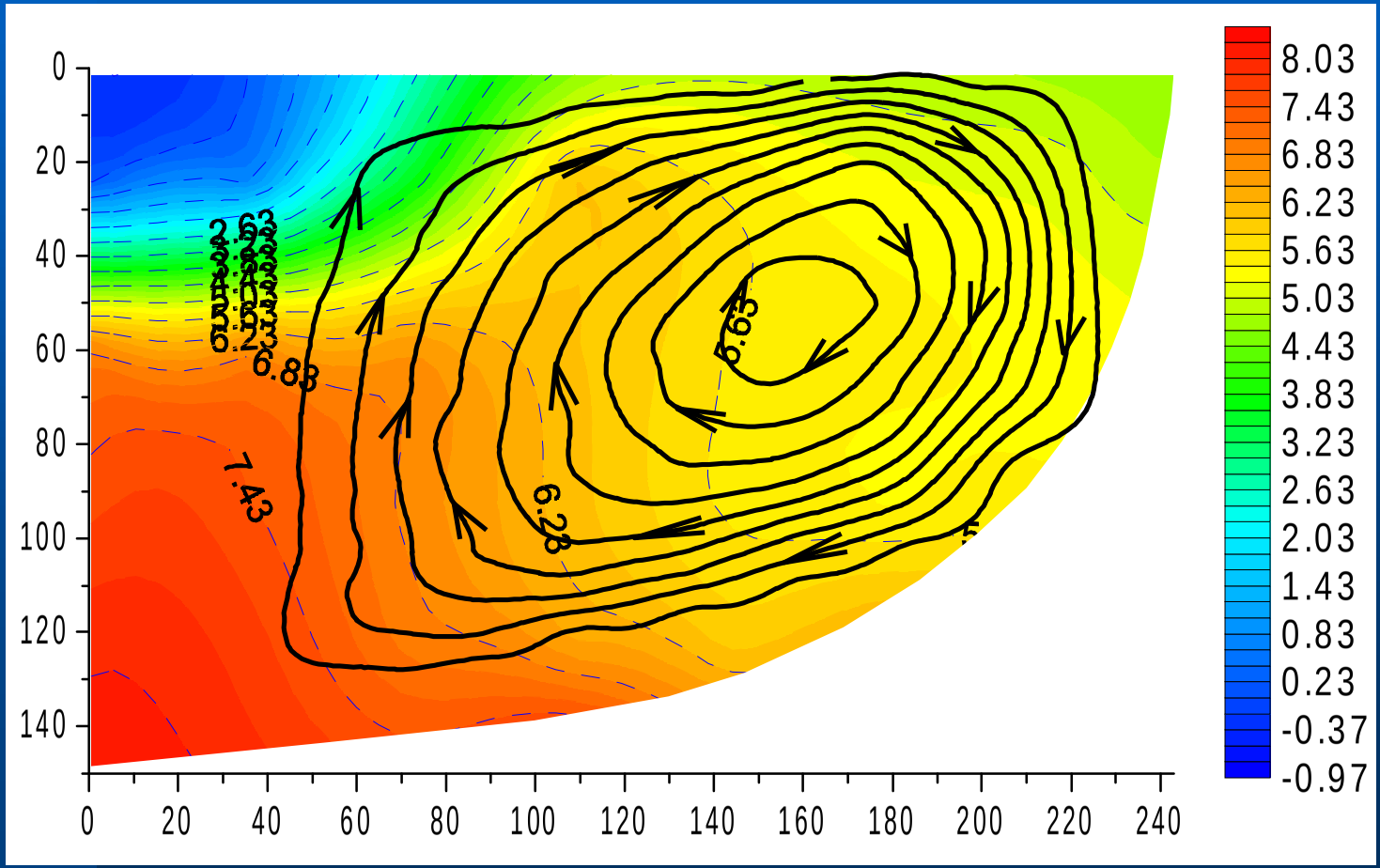
Software – data processing



Results:

1. Experiments without magnetic field impact on the melt

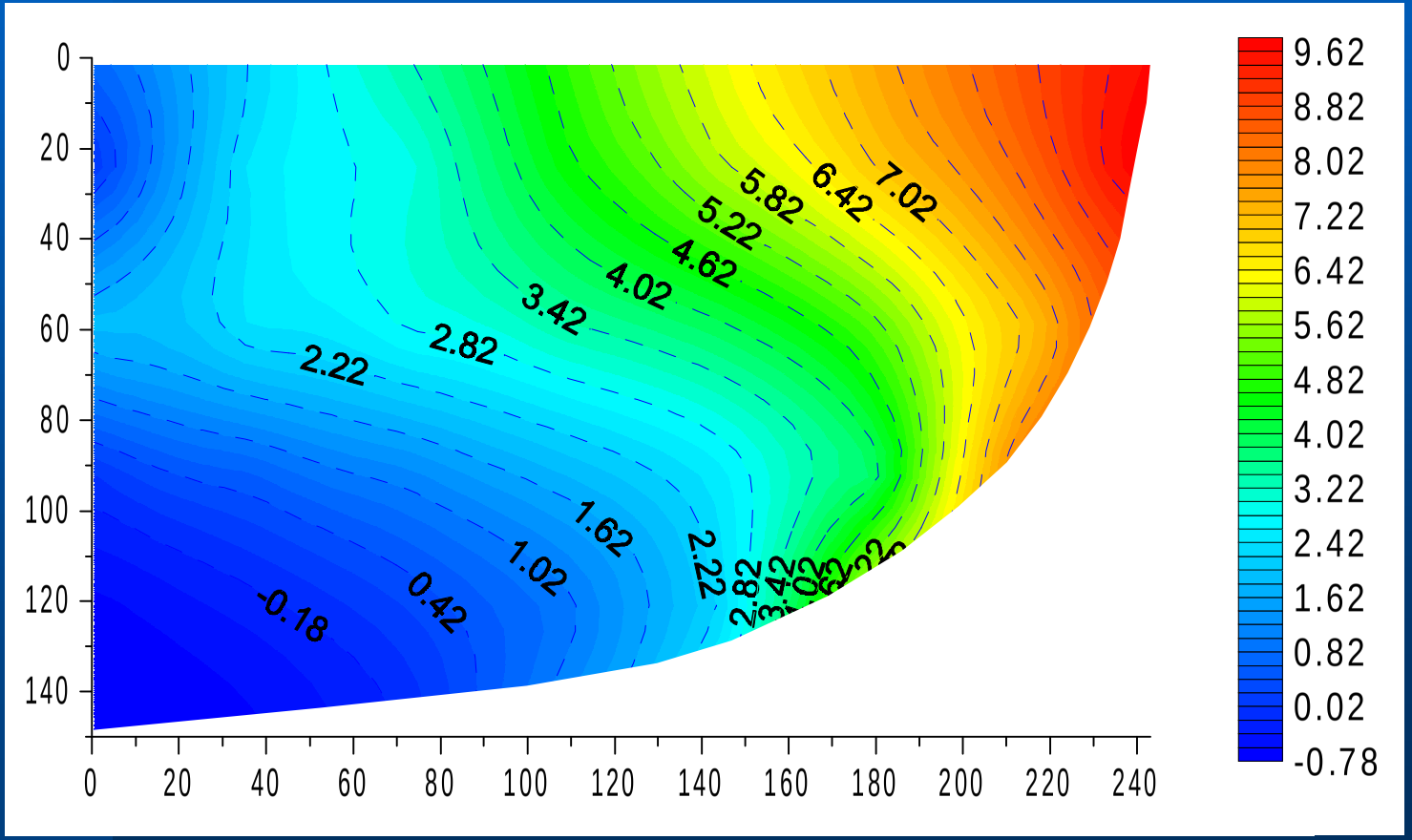
B). Crystal rotation at 25 rpm



Results:

2. Temperature distributions in melt under impact of CUSP magnetic field

D1). Free melt convection, B_{cusp} = 70mT

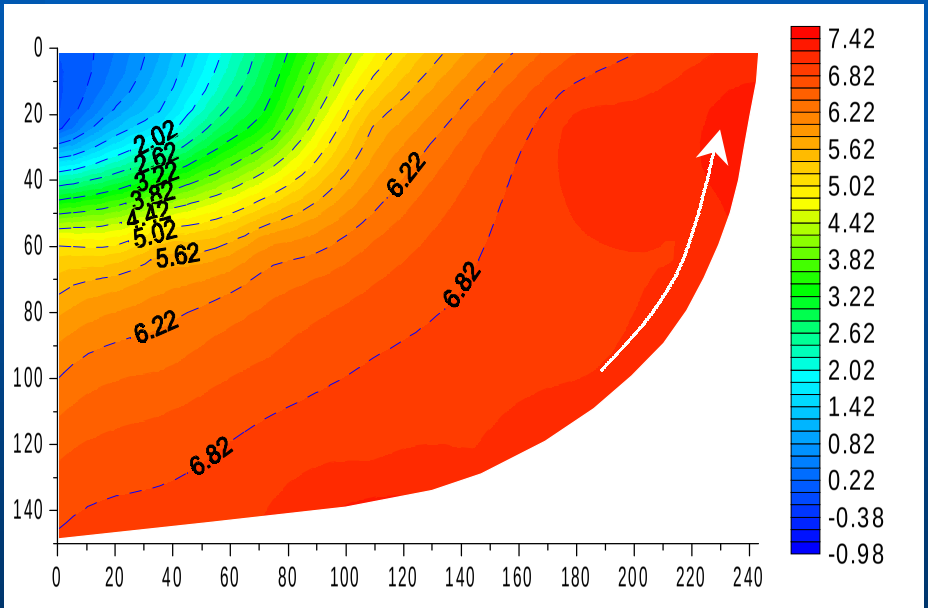


Results:

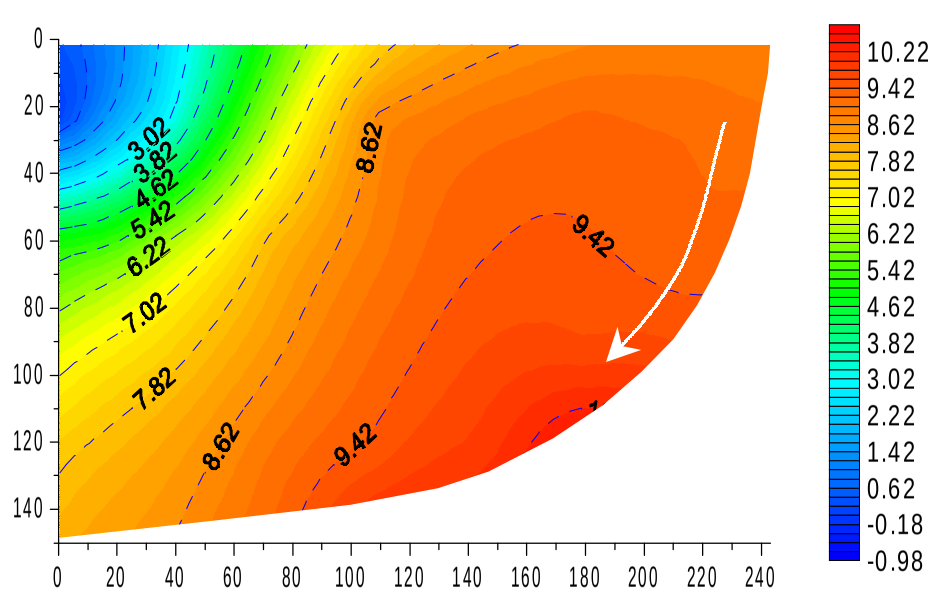
3. Temperature distributions in melt under impact of *travelling magnetic field* (TMF)

F2). Crystal & crucible rotation + TMF 5000A-t

"UPWARDS"

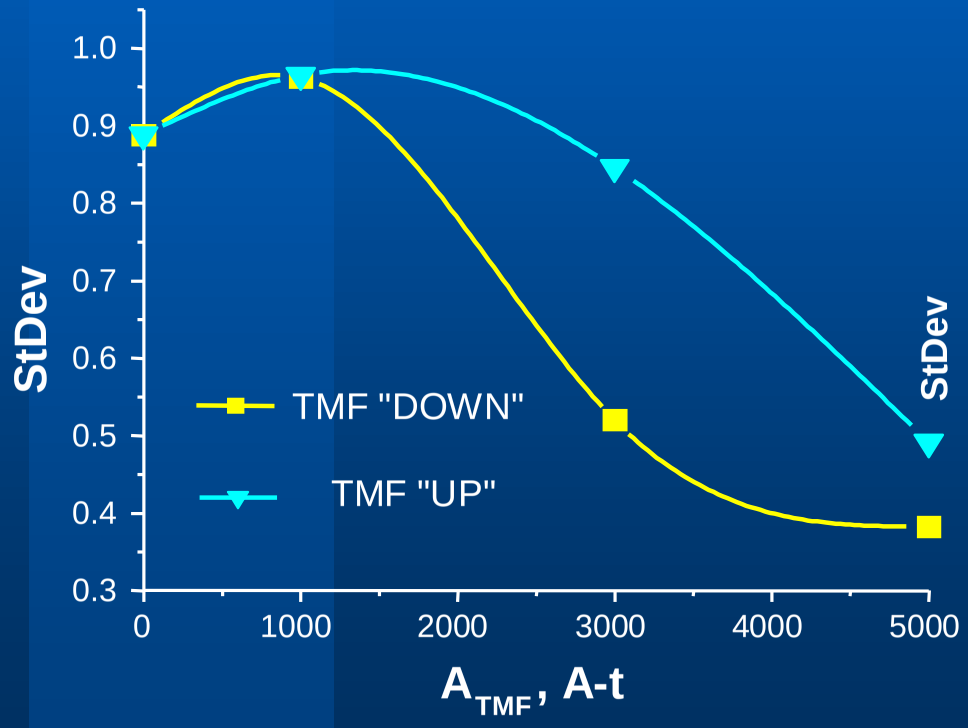


"DOWNWARDS"

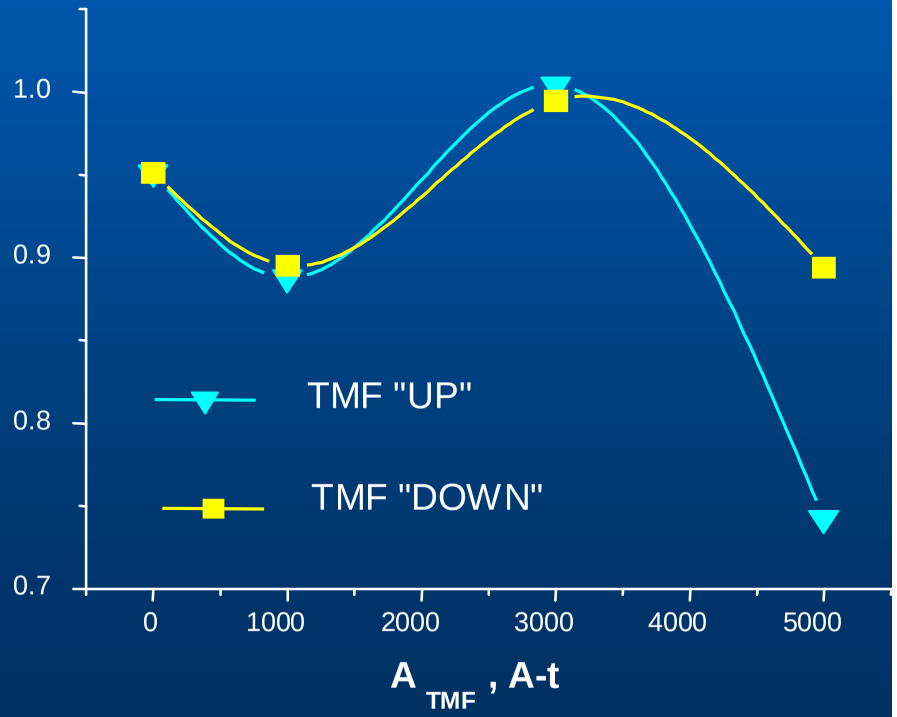


E2). Suppression of temperature fluctuations under TMF

without rotation



with crystal/crucible rotation
15/ -10 rpm



Conclusions

- The physical model of CZ melt has been developed;
- The laboratory experimental furnace with InGaSn melt ensures CZ-process simulation at conditions close to real CZ silicon growth process ones, including simulation in magnetic fields;
- Results of the simulation can be directly transferred to the real growth system;
- Experimental results can serve for comparison with numerical simulations to test and improve numerical models of CZ melt and, also, to minimize number of expensive and complex experiments in real Si crystal growth pullers;