Presentation of an Improved Reversed Compensation Current (RCC) Busbar Concept Using Less Busbar Weight

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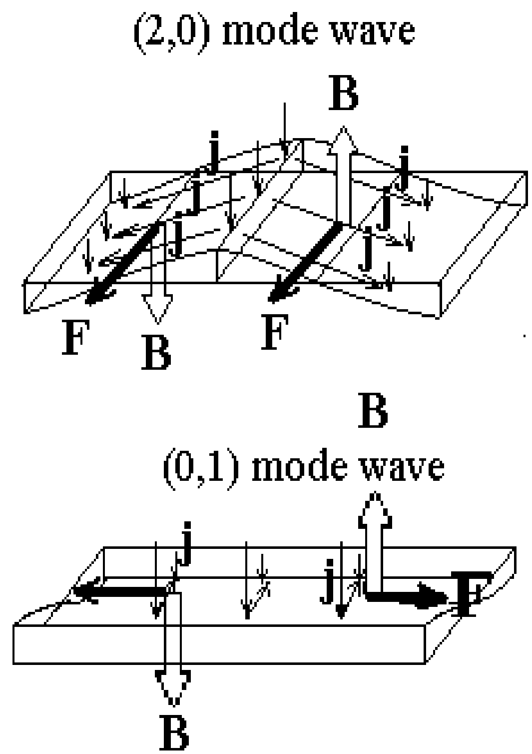
Plan of the Presentation

- Introduction
- State of the art in busbar design
- A new busbar concept: **R**eversed **C**ompensation **C**urrent
  - Original RCC concept
  - Improved RCC concept
- RCC opportunities for future smelter design
- Conclusions

Introduction

- Cell stability influenced by magnitude of B_z in metal pad
- B_z is the vertical component of the magnetic field
- C_x is the difference between the B_z positive value in one end of cell and the B_z negative value in the other end



Coupling due to Cx

Ref: N. Urata, Wave Mode Coupling and Instability in the Internal Wave in the Aluminum Reduction Cells, TMS Light Metals 2005, pp 455-460.

State of the art in busbar design

Internal **C**ompensation **C**urrent

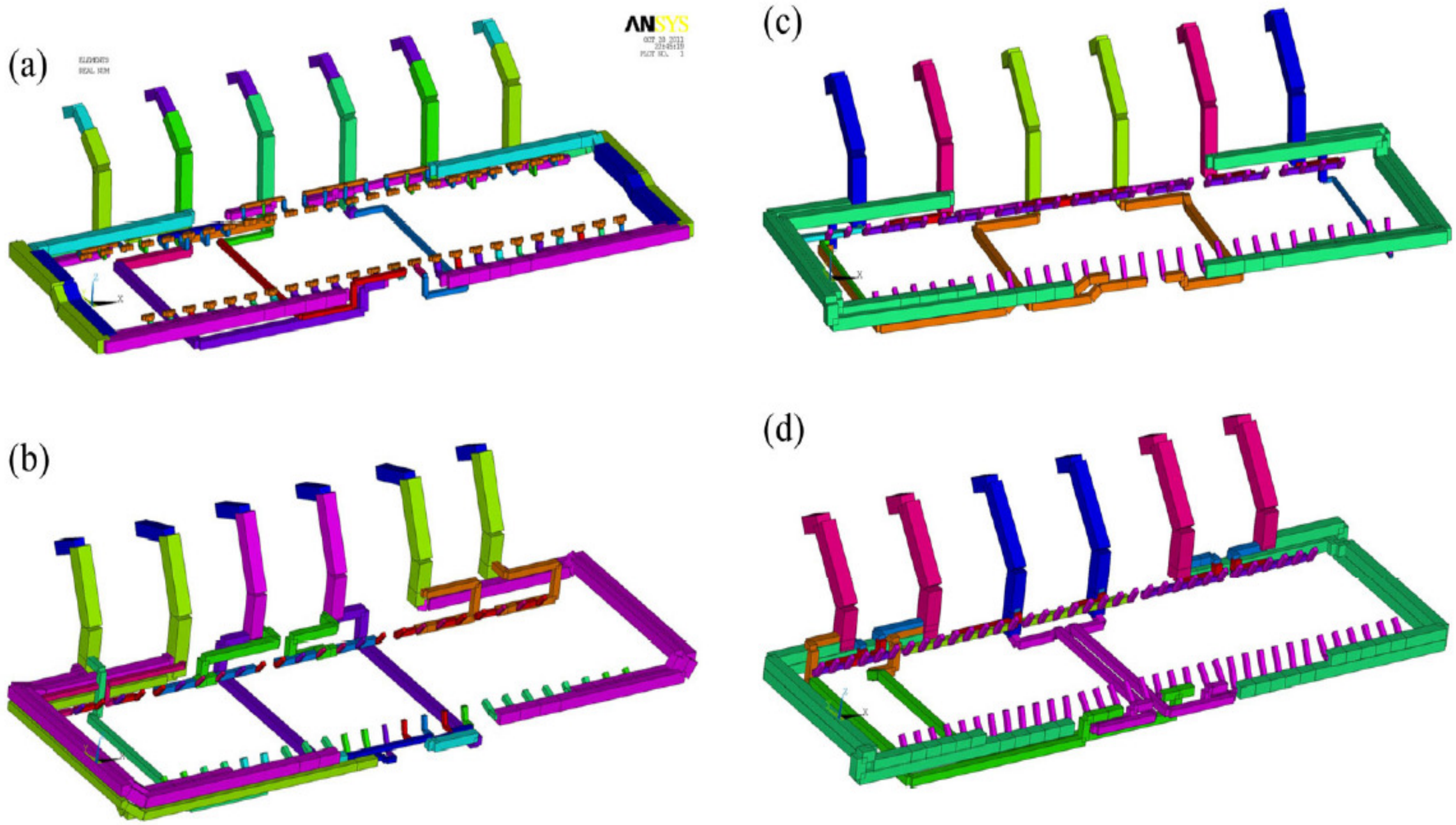
- 2003: RA-300 320 kA
- 2005: RA-400 415 kA
- 2010: RA-500 500 kA

RA-400 Technology (undisclosed busbar design)

Ref: I. Rebrik, Innovative approaches to business in RUSAL, 2015

State of the art in busbar design

Internal **C**ompensation **C**urrent
with asymmetric busbar network



Ref: DING Ji-lin, LI Jie, ZHANG Hong-liang, XU Yu-jie, YANG Shuai and LIU Ye-xiang, Comparison of structure and physical fields in 400 kA aluminum reduction cells, J. Cent. South Univ. (2014) 21, pp 4097–4103

State of the art in busbar design

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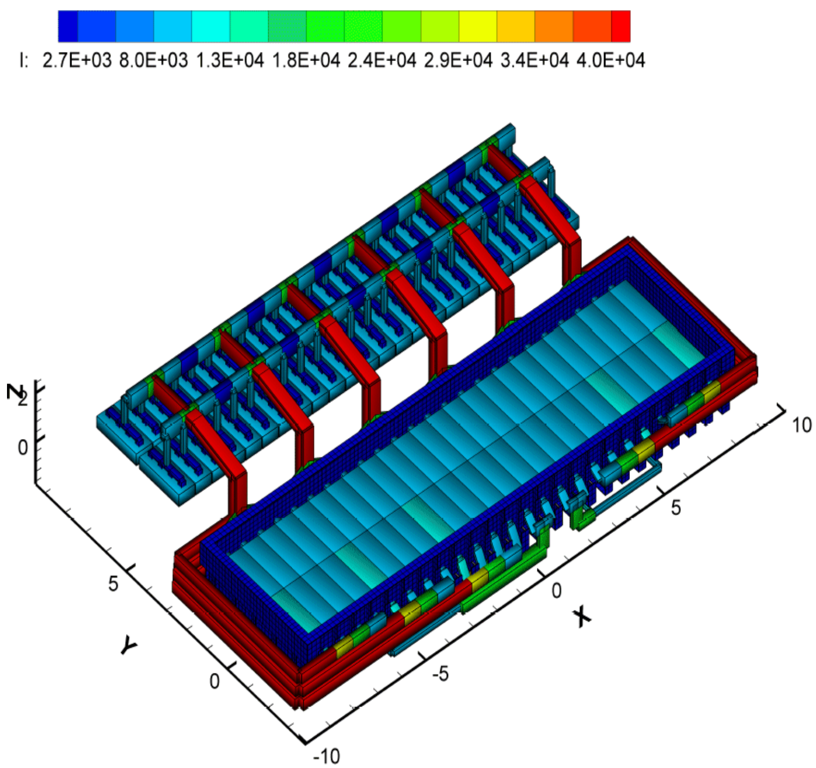
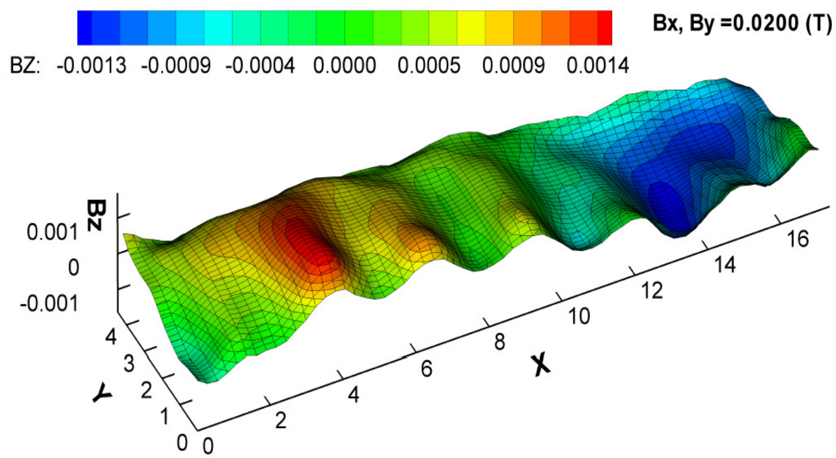
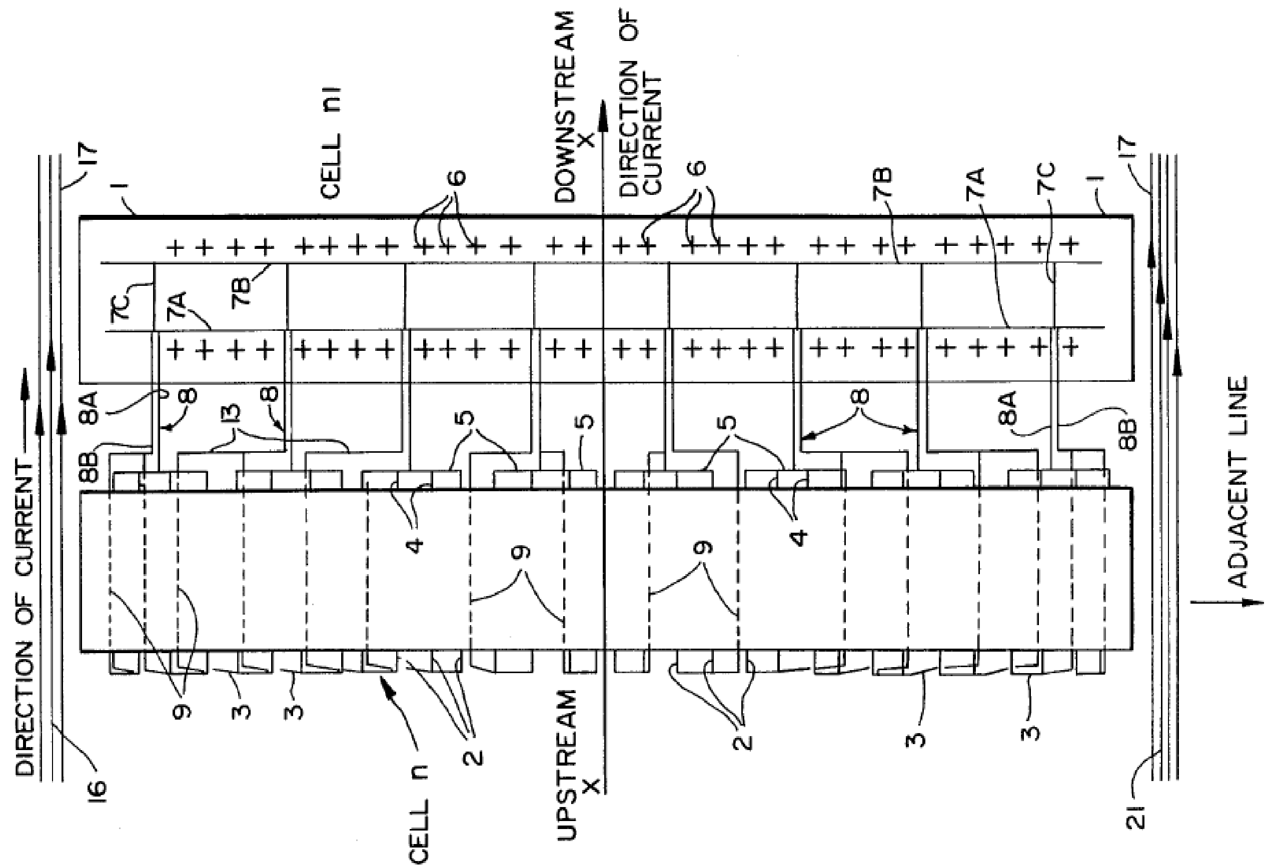




Ref: M. Dupuis and V. Bojarevics, Retrofit of a 500 kA cell design into a 600 kA cell design, ALUMINIUM 87(1/2) (2011), pp 52-55

State of the art in busbar design

1987 Pechiney patent with
External **C**ompensation **C**urrent



Ref: Joseph Chaffy, Bernard Langon and Michel Leroy, Device for connection between very high intensity electrolysis cells for the production of aluminium comprising a supply circuit and an independent circuit for correcting the magnetic field, US patent no 4713161 (1987).

State of the art in busbar design

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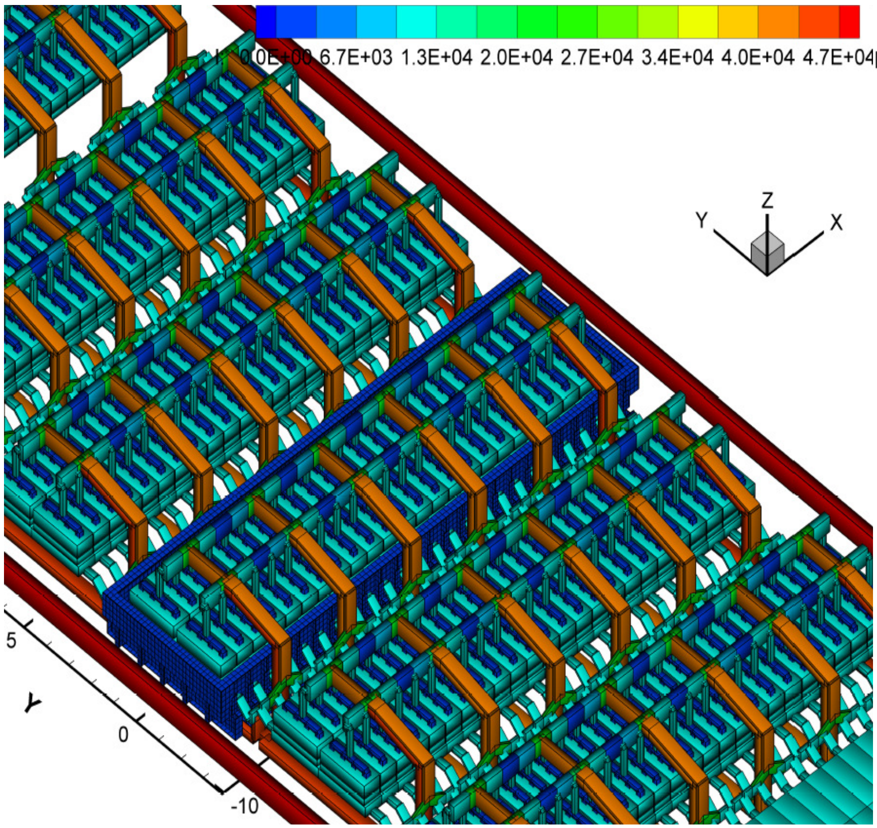

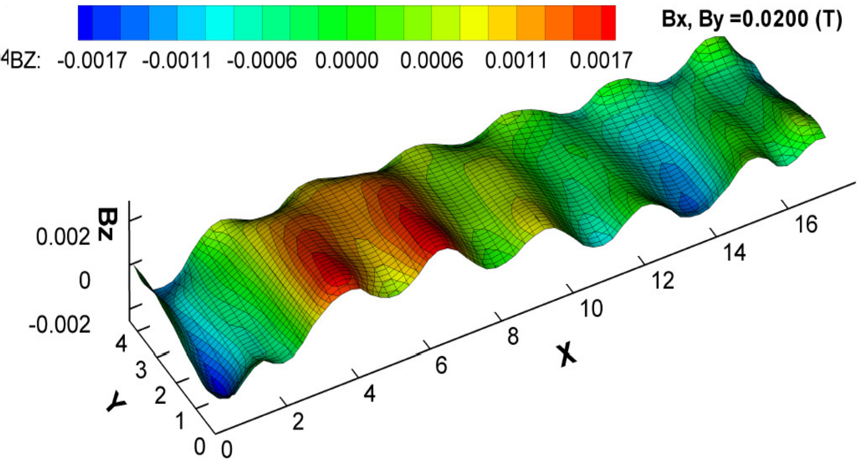

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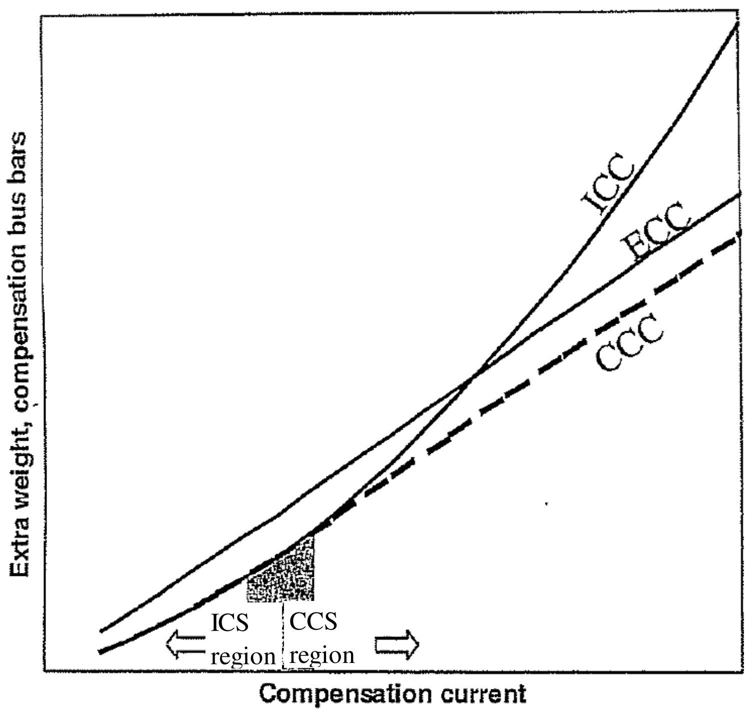
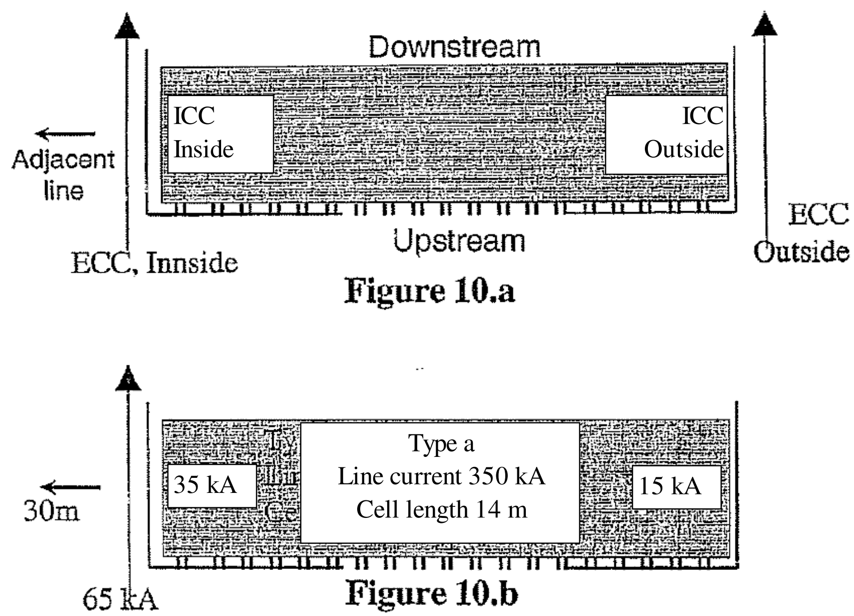
State of the art in busbar design

2006 Hydro Aluminium patent
with **C**ombined types of **C**ompensation **C**urrent





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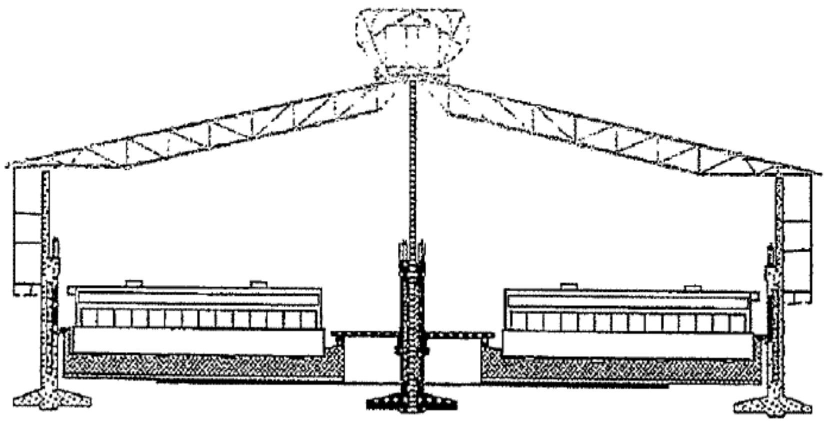

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New busbar concept
Reversed **C**ompensation **C**urrent (RCC)

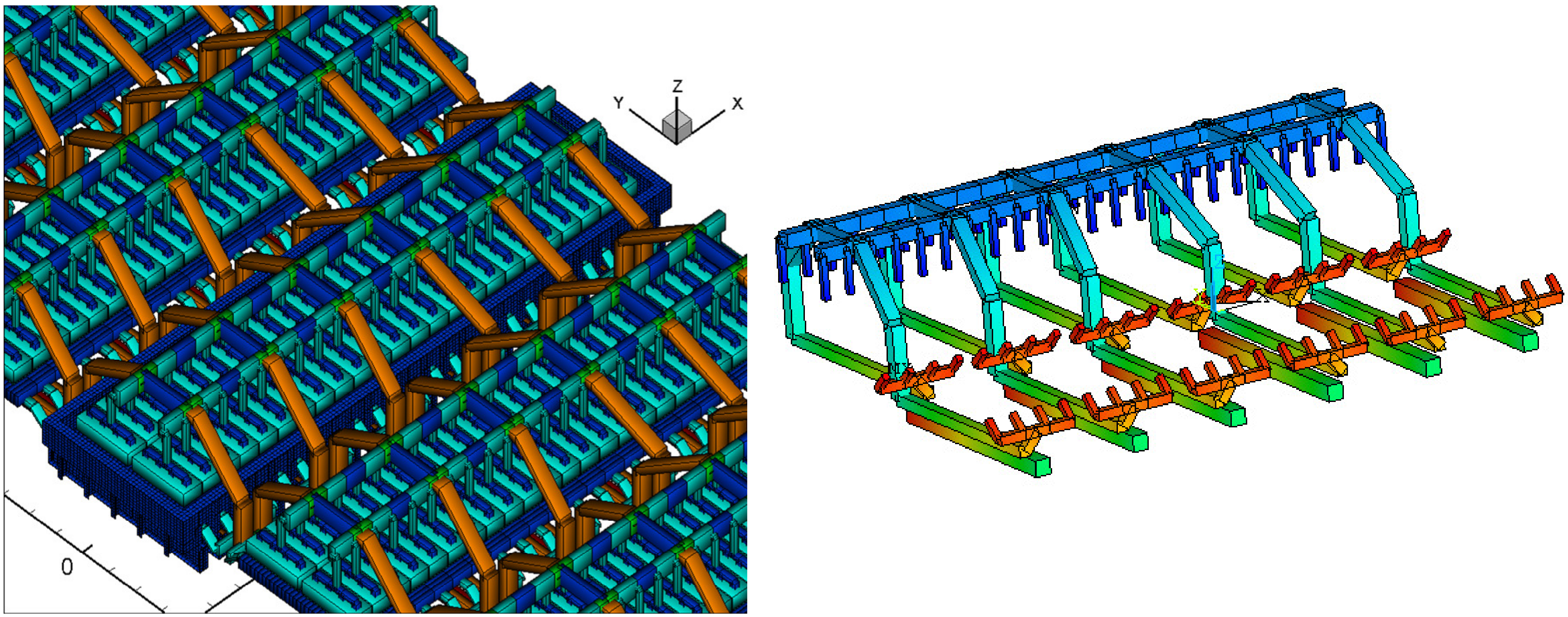
- Completely different concept from ICC, ECC, and CCC
- Same purposes as the others: minimize vertical B_z and provide a scalable solution to the cell stability amperage
- RCC is similar to ECC: there is no internal compensation current busbars, and the B_z is compensated by external current busbars
- RCC requires the addition of downstream risers located on the downstream side of cell to produce a perfectly anti-symmetric B_x
- Contrary to ECC though, RCC compensation busbars:

  1) are located close to the internal potline current busbars routed under cell

  2) carry current in the opposite direction to the potrow

New busbar concept
Reversed **C**ompensation **C**urrent (RCC)

Original version of RCC at 500 kA



Original RCC busbar network concept with downstream risers

New busbar concept
Reversed **C**ompensation **C**urrent (RCC)

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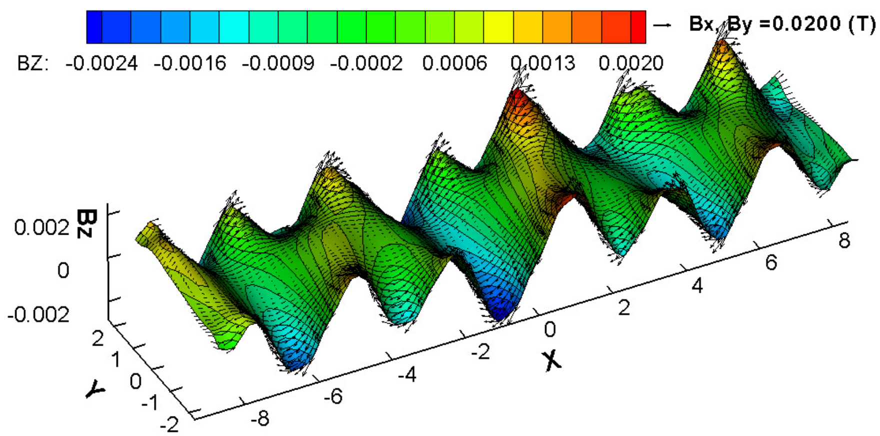

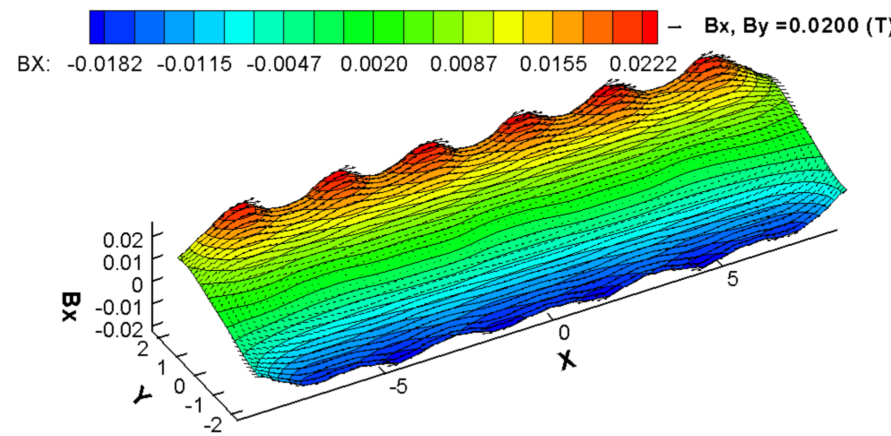

Corresponding B_z and B_x magnetic field components

New busbar concept

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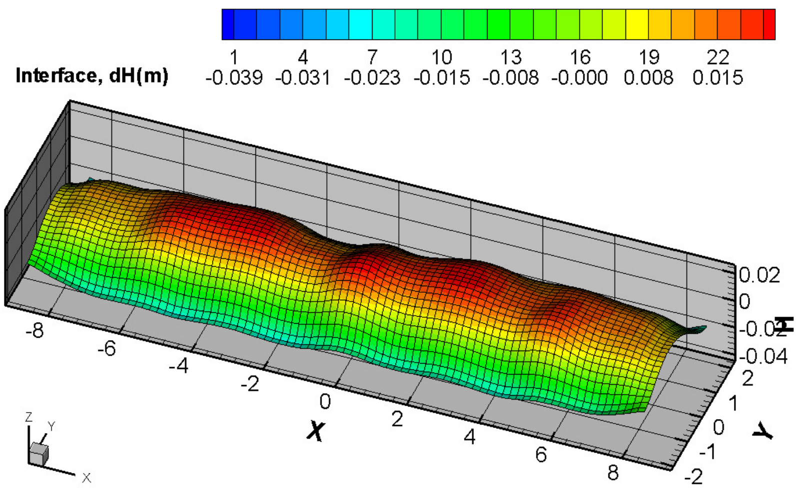
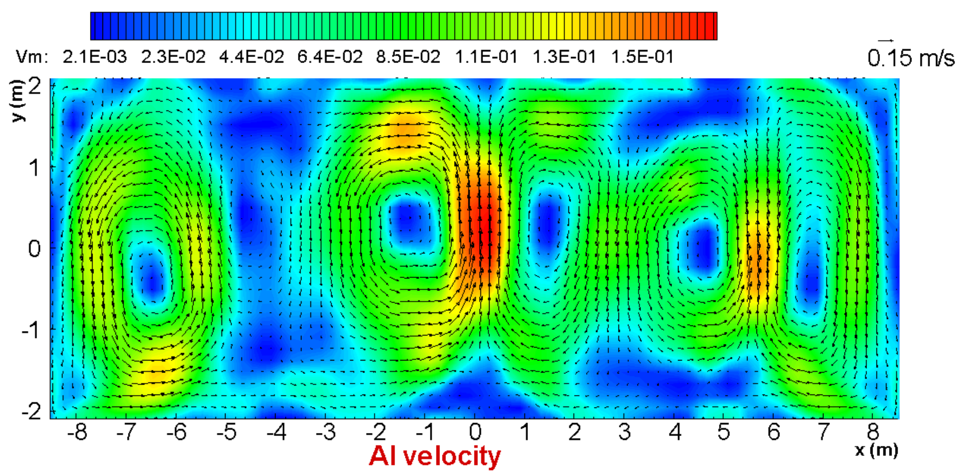




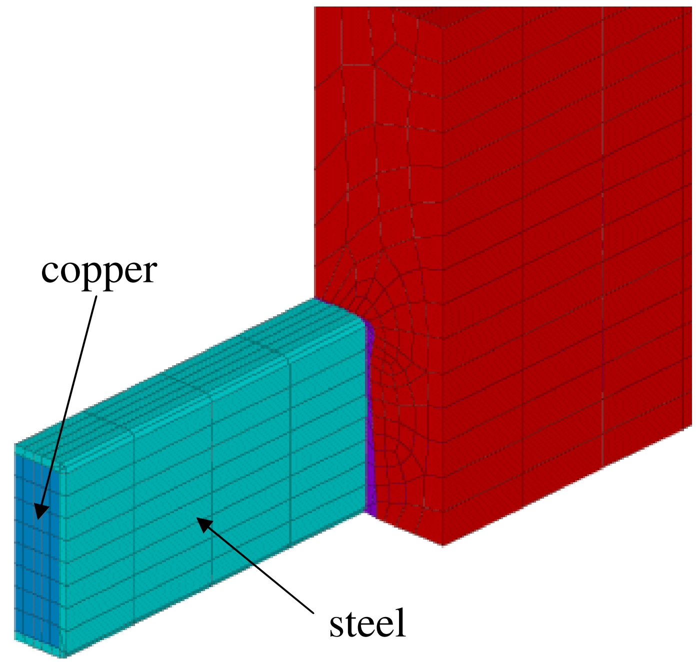
Corresponding steady-state bath-metal interface deformation and steady-state metal pad flow velocity field

New busbar concept
Reversed **C**ompensation **C**urrent (RCC)

Improved version of RCC at 500 kA

The improved version involves a second innovation in order to drastically reduce both the busbar weight and the busbar voltage drop:

Extracting 100% of the cell current on the downstream side using copper bars having similar sizes as standard steel collector bars



New busbar concept
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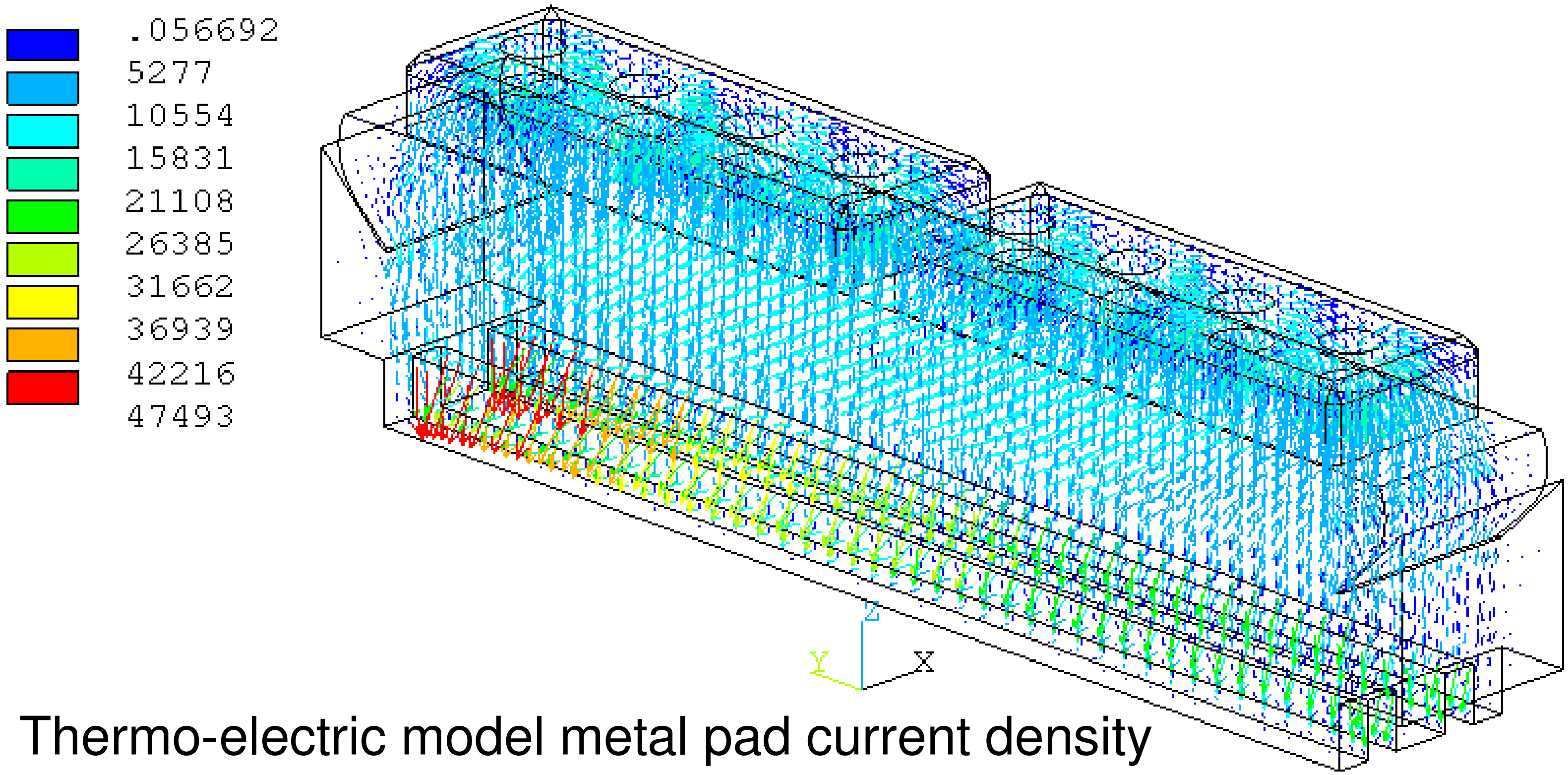

Thermo-electric model metal pad current density

New busbar concept
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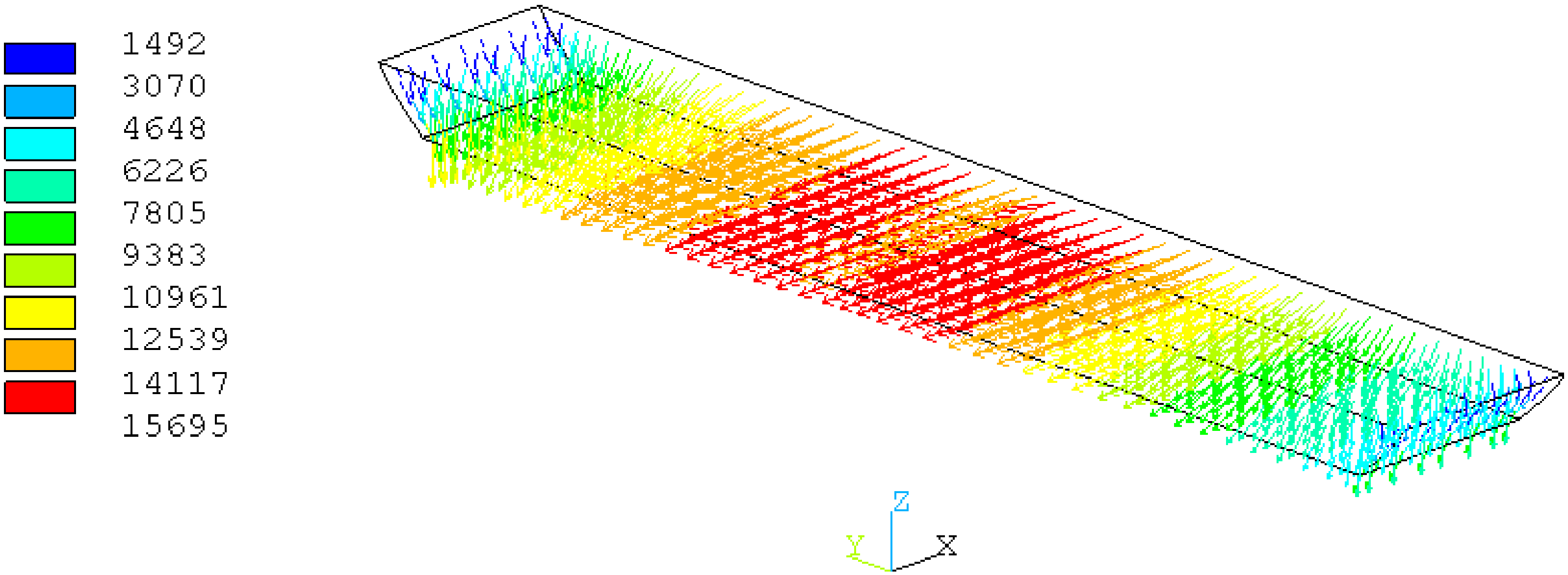
Improved version of RCC at 500 kA



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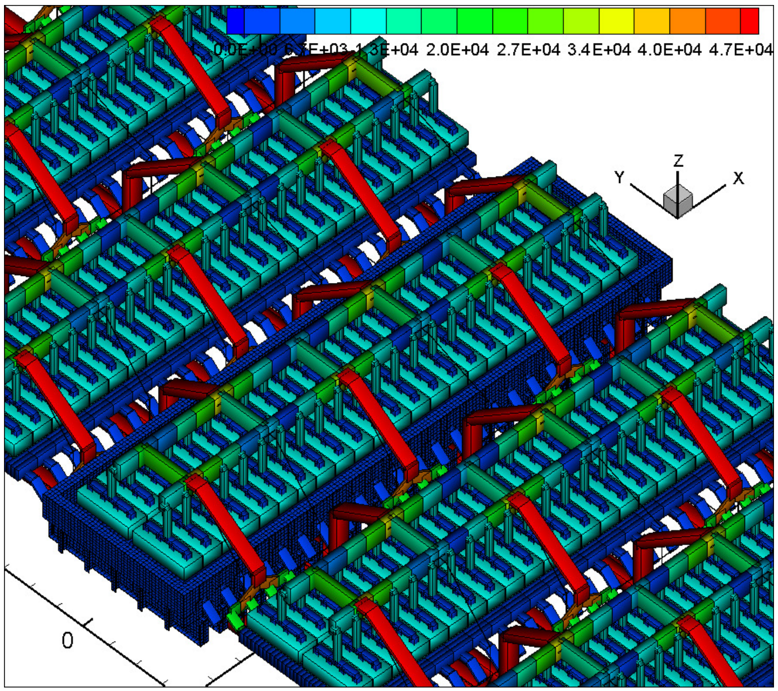
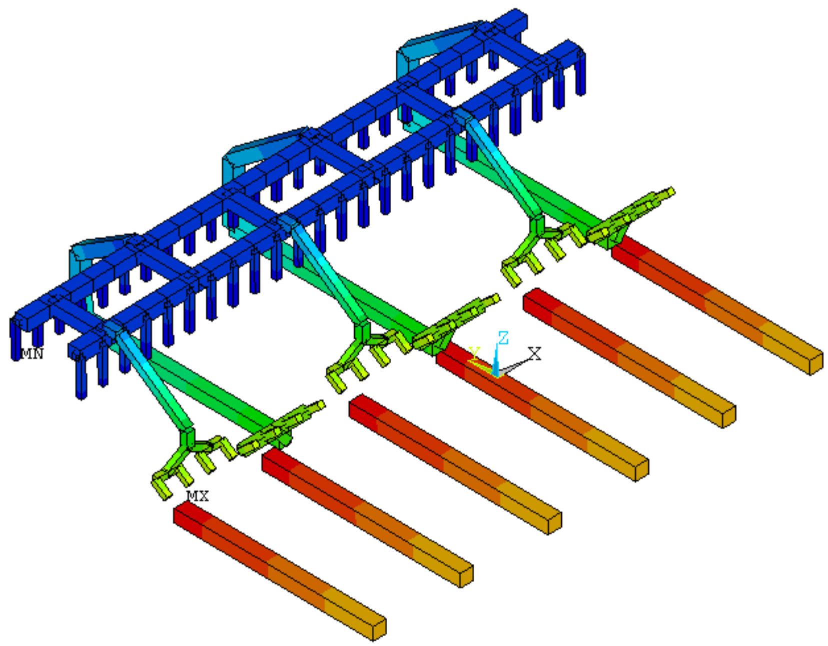
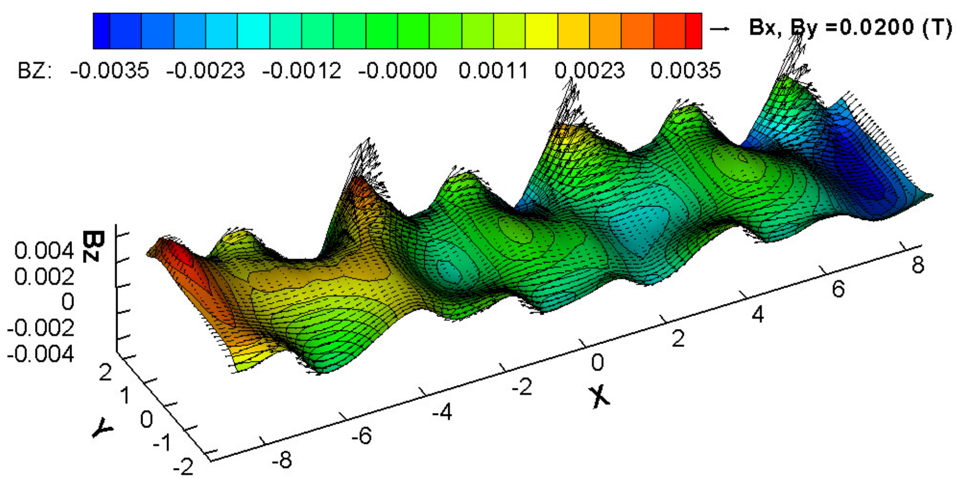


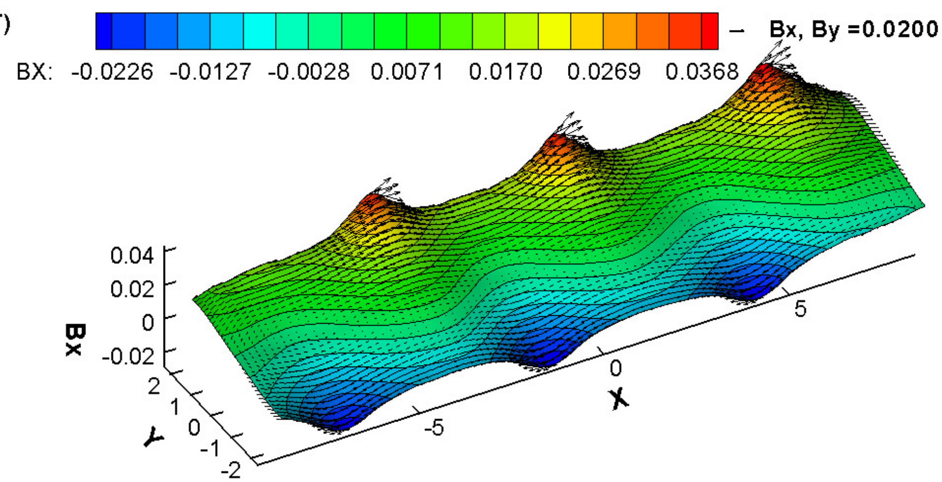


Improved RCC busbar network concept with alternating risers

New busbar concept
Reversed **C**ompensation **C**urrent (RCC)

Improved version of RCC at 500 kA





Corresponding B_z and B_x magnetic field components

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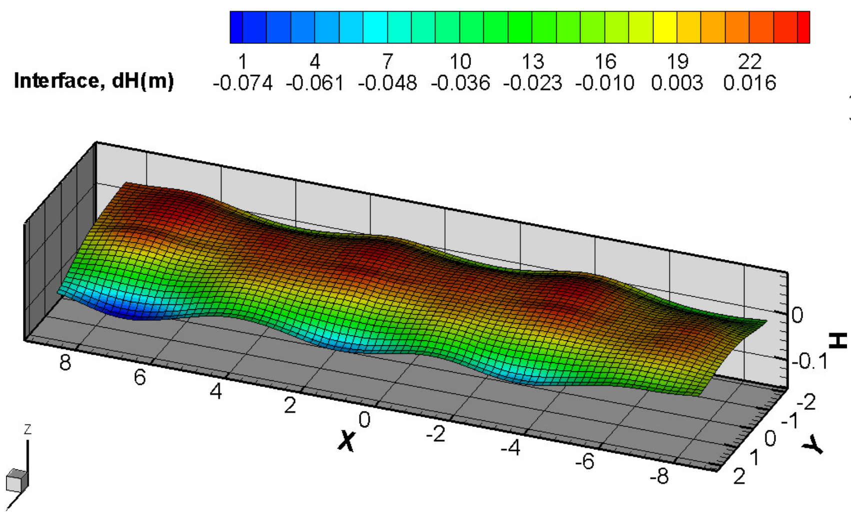
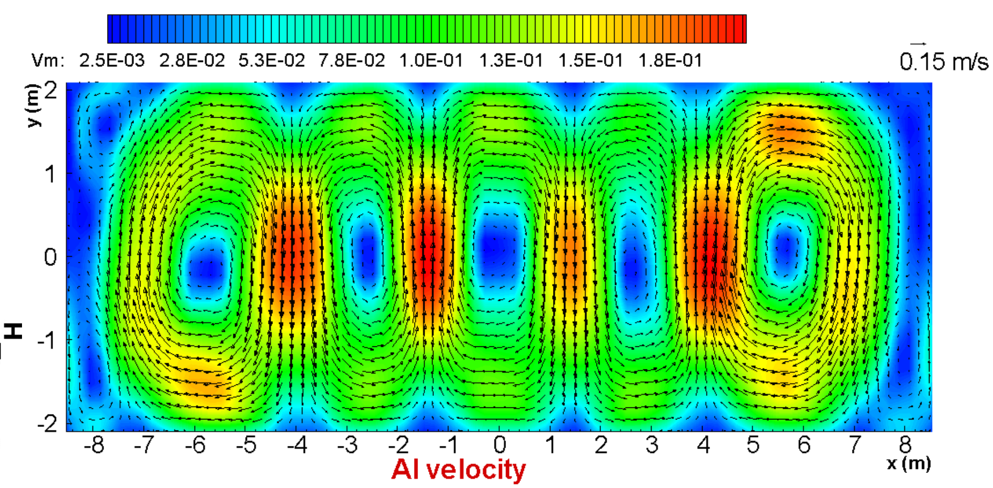


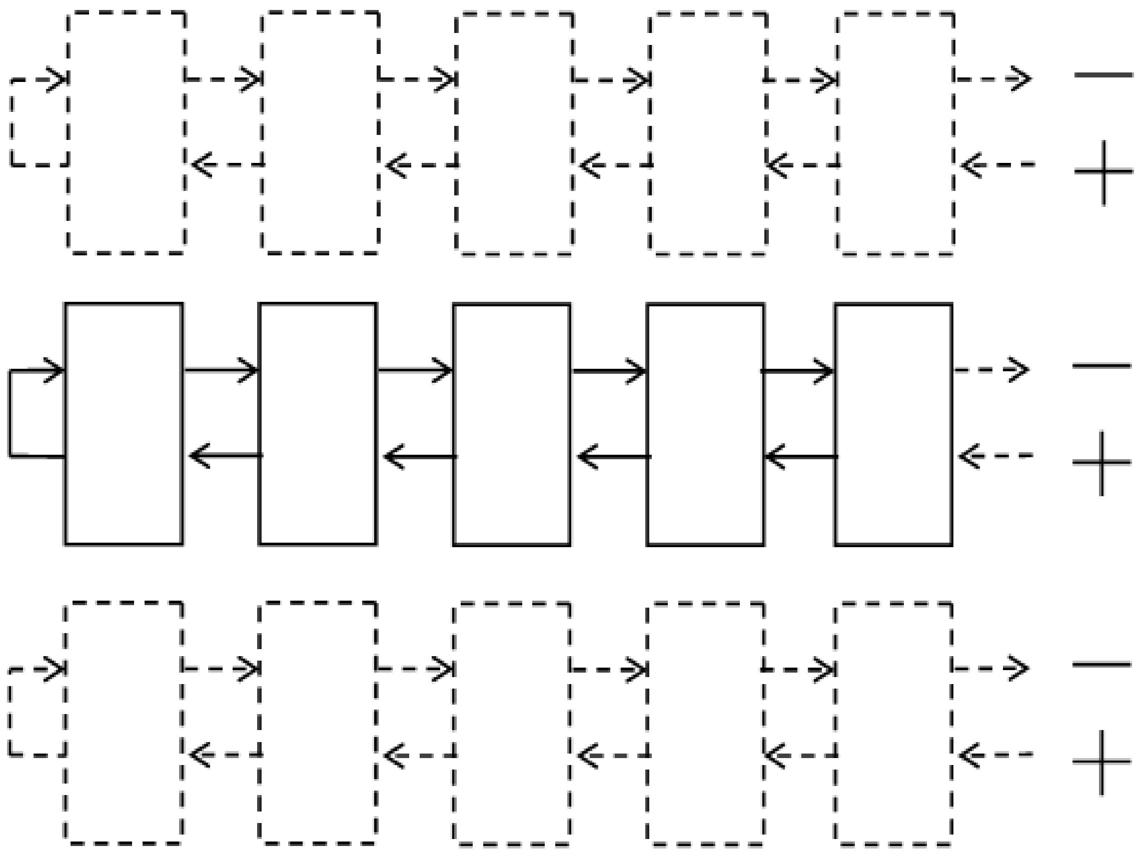


Corresponding steady-state bath-metal interface deformation and steady-state metal pad flow velocity field

RCC usage opportunities for future smelter design

- RCC carries the full potline current in the compensation busbars but in the opposite direction to the potrow
- Possibilities:
    - This creates the option to return the potline current in these compensation busbars instead of in a return potrow located in a second potroom
    - An odd number of potroom(s) is possible for new smelter design including only 1
    - Potlines can be located in close proximity – potrow current running in one direction is cancelled out by the current in the compensation busbars running in the opposite direction

RCC usage opportunities for future smelter design



Conclusions
Original RCC Concept

- A new busbar network concept has been developed: Reversed Compensation Current
- Easily extendable to any cell size (demonstrated at 750 and 1500 kA)
- Similar to ECC since RCC has no ICC, meaning no busbars are wrapping around cells and B_Z is compensated by external busbars
- Different from ECC as RCC busbars are located under the cell close to the potline current busbars also routed under the cell carrying current in the opposite direction, thereby neutralizing their magnetic influence opening the door to smelter design having an odd number of potrow(s) and multiple potlines in a very small footprint

Conclusions
Improved RCC Concept

- An improved Reversed Compensation Current busbar network concept has been developed.
- The improved version involves a second innovation in order to drastically reduce both the busbar weight and the busbar voltage drop:

  Extracting 100% of the cell current on the downstream side using copper bars having similar sizes as standard steel collector bars

- A 500 kA cell with copper collector bars extracting 100% of its current on the downstream side and using the improved alternating anode risers RCC busbar configuration is predicted to run at 12.35 kWh/kg while operating at 3.5 cm ACD.