A New Aluminium Electrolysis Cell Busbar Network Concept

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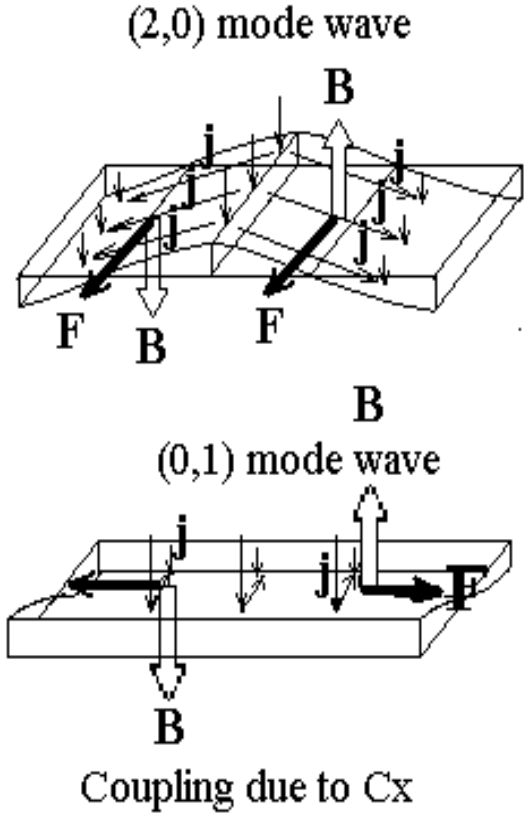
Presented by: Marc Dupuis, Ph.D., Eng.

Plan of the Presentation

- Introduction
- Today's state of the art in busbar design
- A new busbar concept: **R**eversed **C**ompensation **C**urrent
- 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 fields
- 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

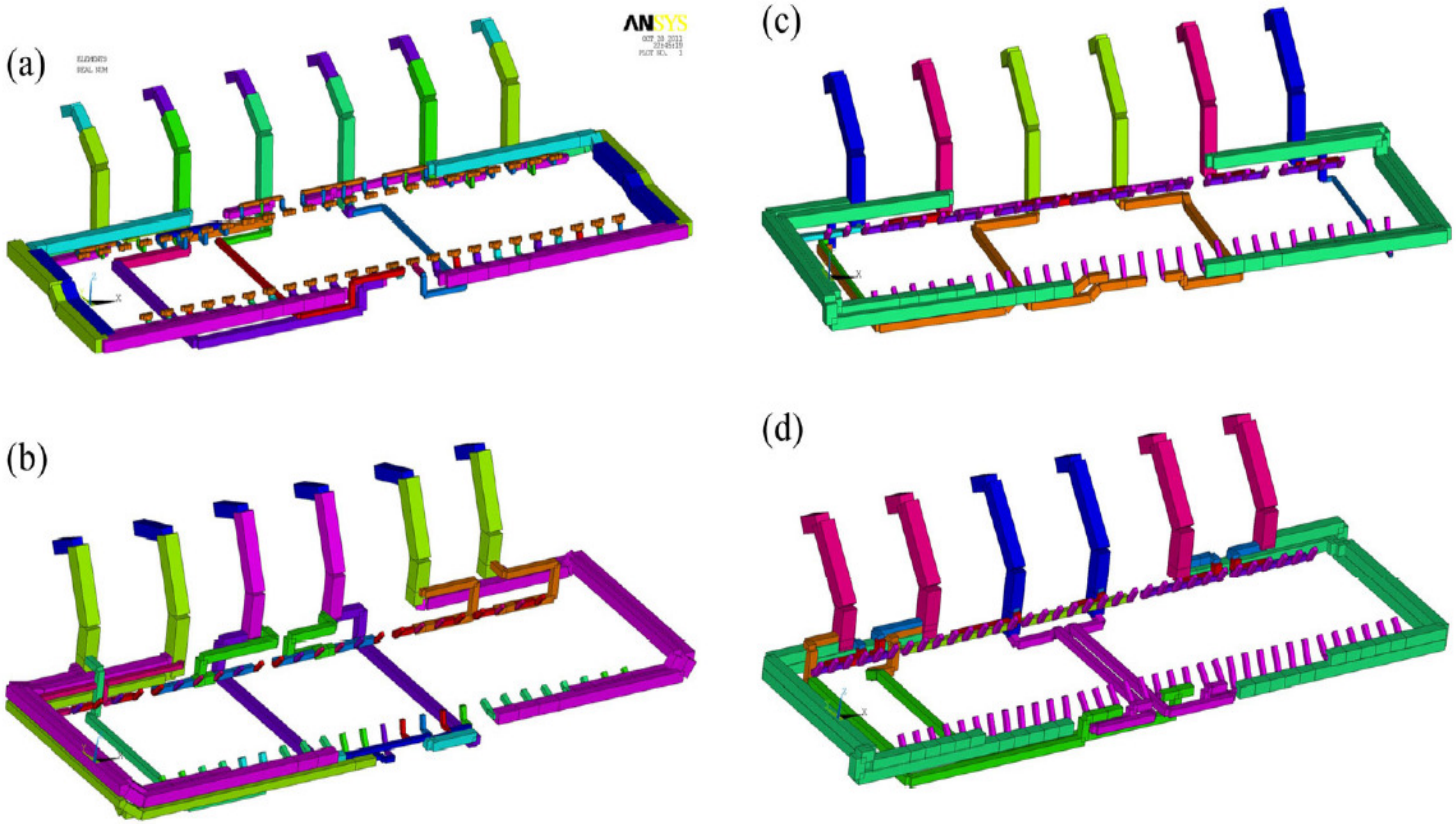
DX & DX+ Technology (undisclosed busbar design)

- 1998: CD26 280 kA
- 2005: DX 350 kA
- 2010: DX+ 420 kA

Ref: Dr Ali Al Zarouni, 17th Arab International Aluminium Conference , Abu Dhabi, UAE, (2013)

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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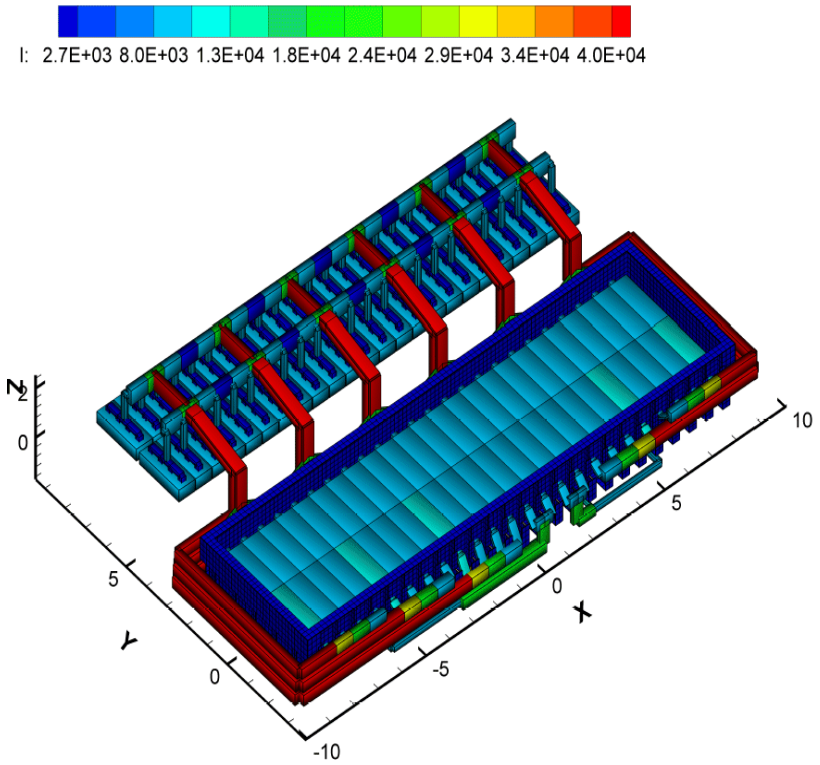
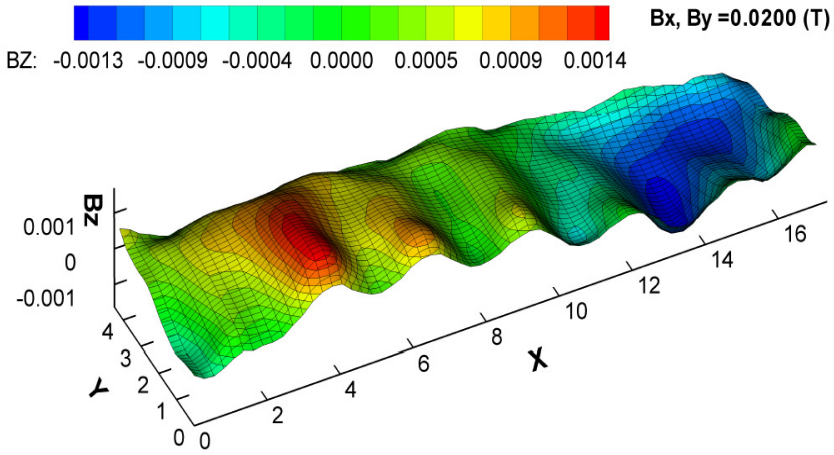
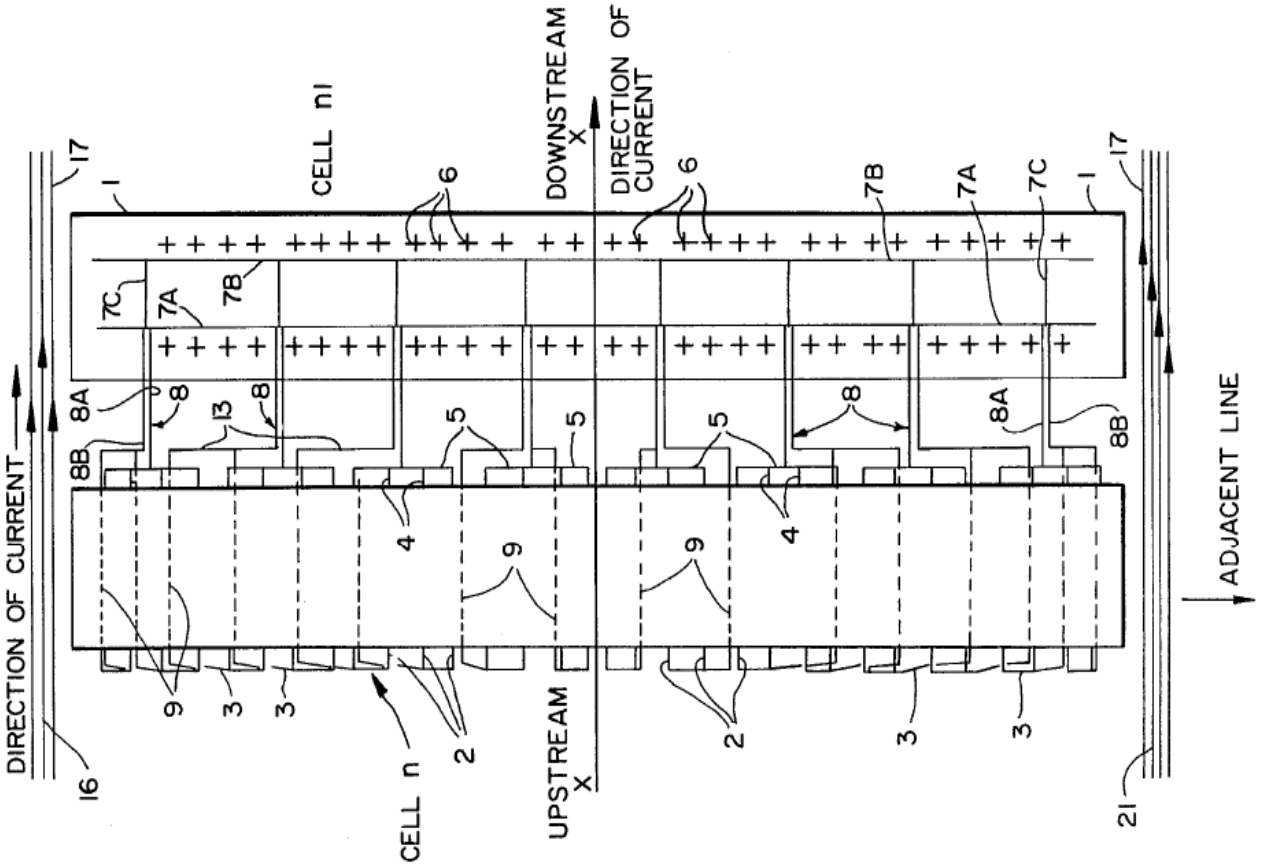




Ref: M. Dupuis and V. Bojarevics, Retrofit of a 500 kA cell design into a 600 kA cell design, ALUMINIUM 87(1/2) (2011), pp 52-55

State of the art in busbar design

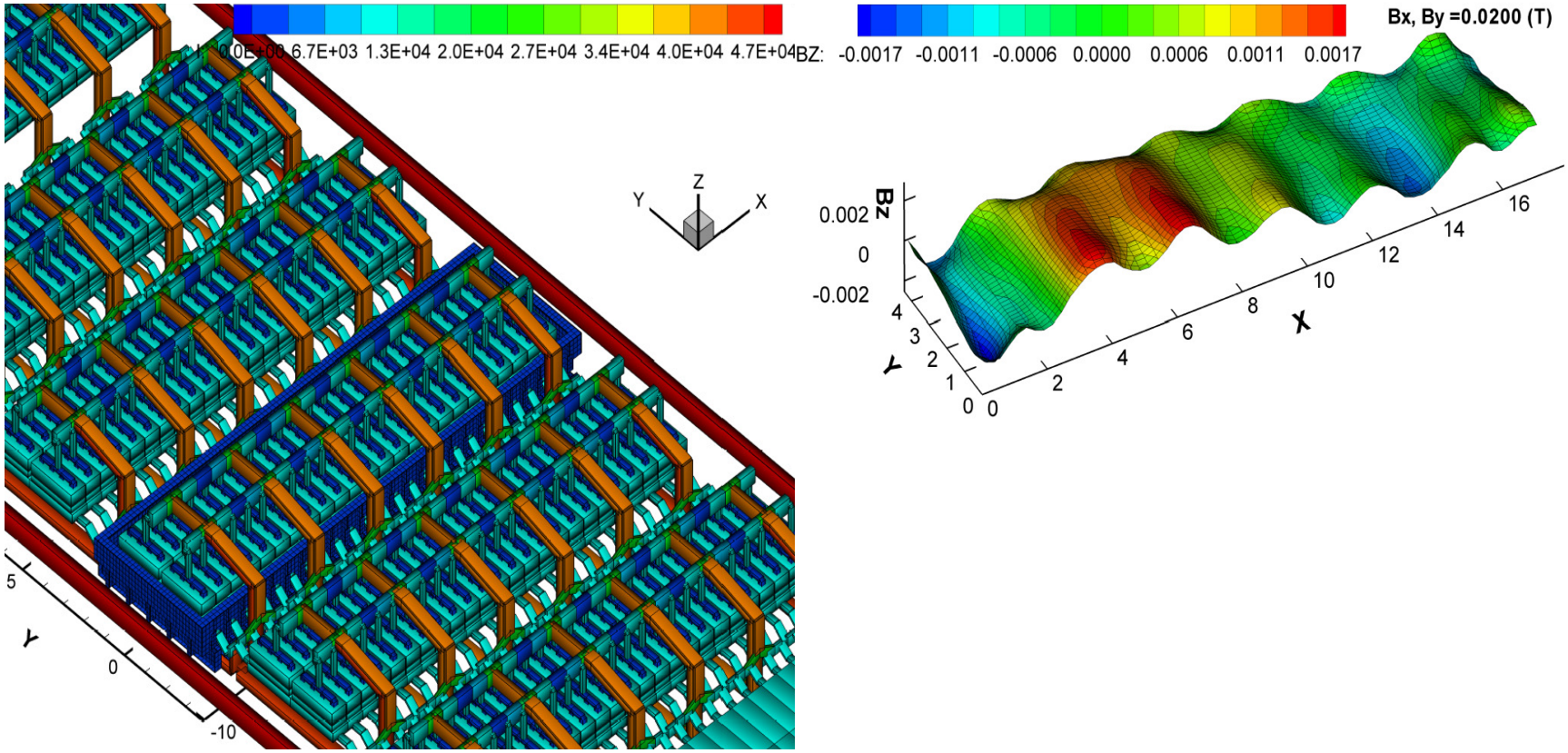
1987 Pechiney patent with **E**xternal **C**ompensation **C**urrent



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

1987 Pechiney patent with **E**xternal **C**ompensation **C**urrent



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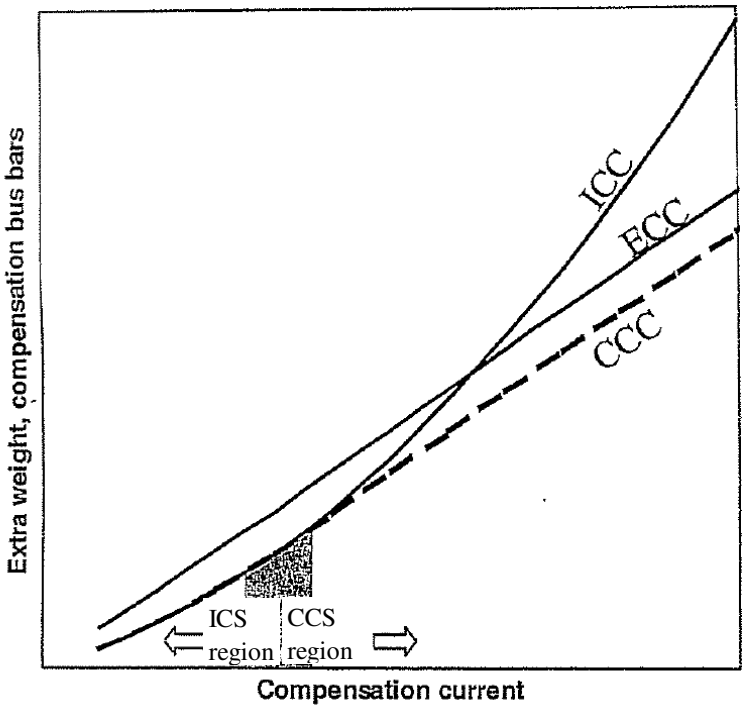
State of the art in busbar design

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



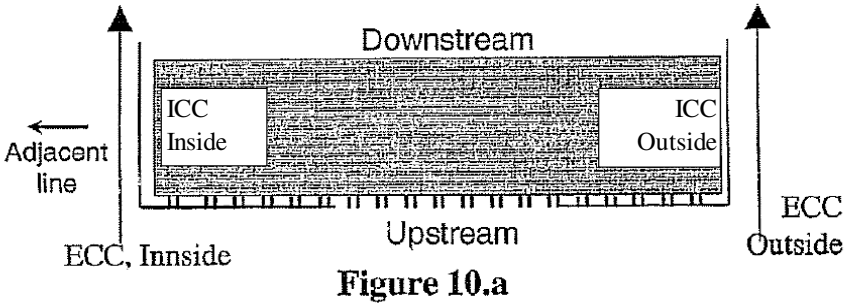


Figure 10.a

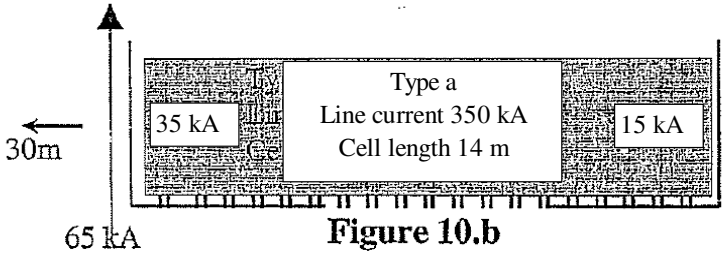
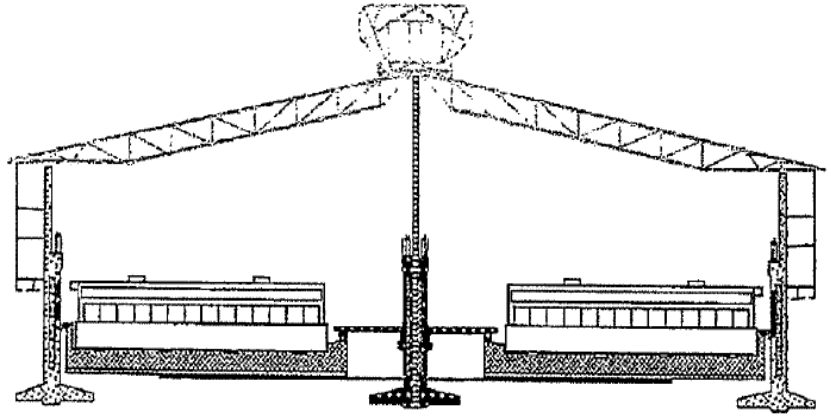


Figure 10.b

Ref: Glenn Ove Linnerud and Reidar Huglen, Method for electrical connection and magnetic compensation of aluminium reduction cells, and a system for same, WO patent no 2006/033578 and US patent no 8070921 (2011).

State of the art in busbar design

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



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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
- 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)

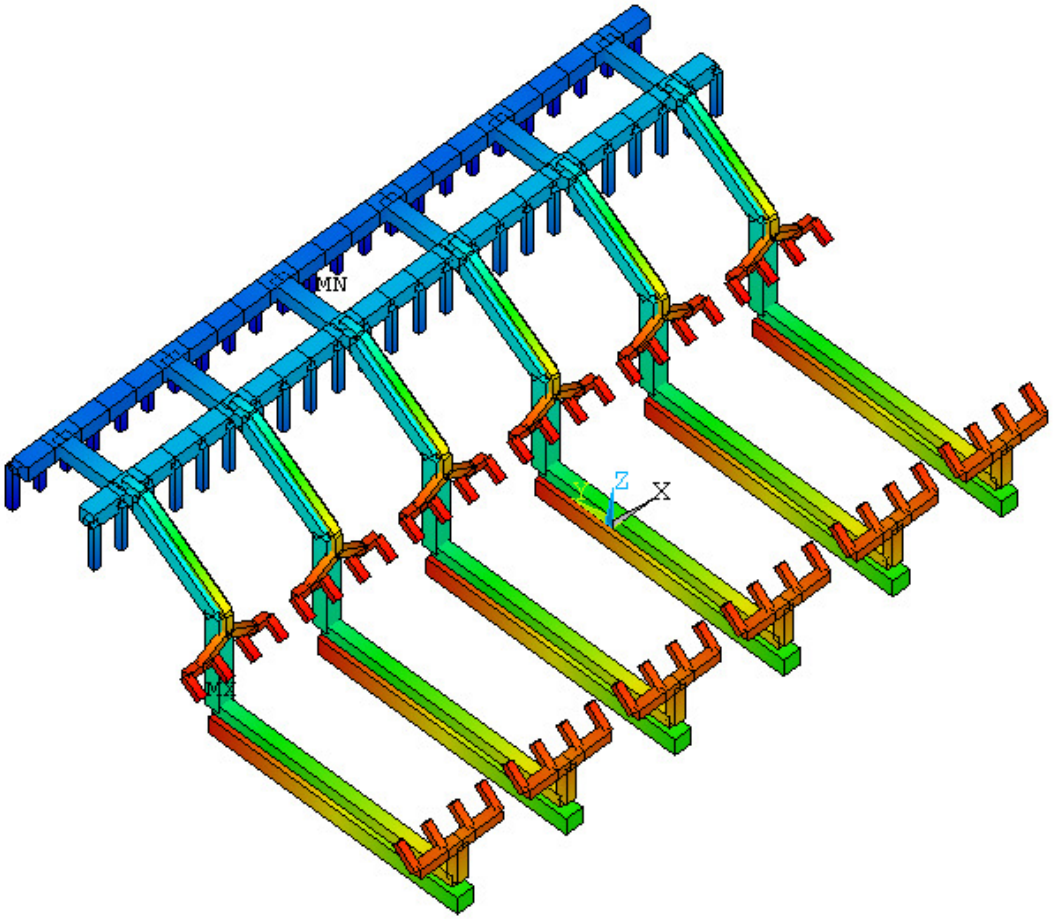
Two versions of RCC exist – the first version the only innovation is the usage of compensation busbars located close to the internal potline current busbars routed under cell carring current in the opposite direction to the potrow.

In the second version, a second innovation is added with the introduction of downstream risers located on the downstream side of cell.

In the original version: 100% of the potline current is returned through compensation busbars running under the cells but in the opposite direction offering a valid and scalable way to minimize the B_z.

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

First version of RCC at 500 kA



New busbar concept
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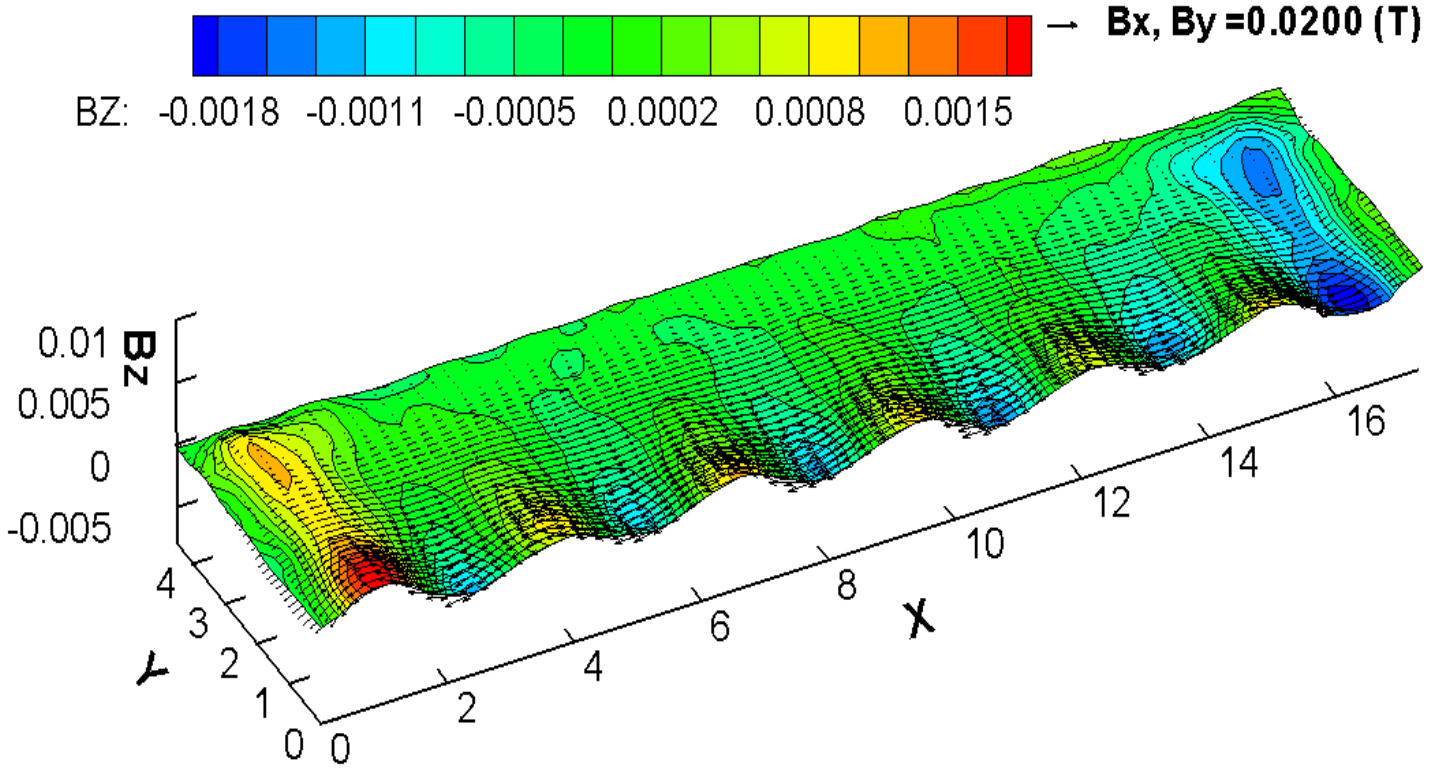

New busbar concept
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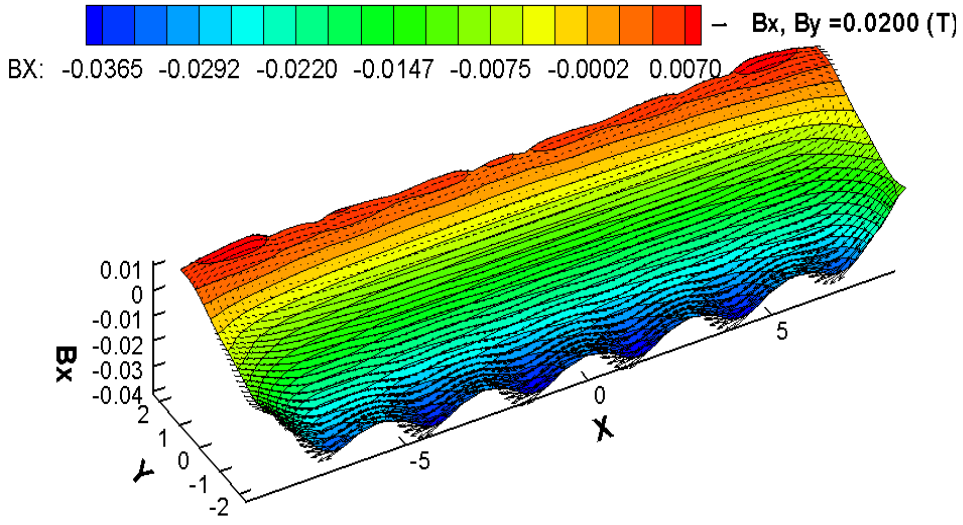
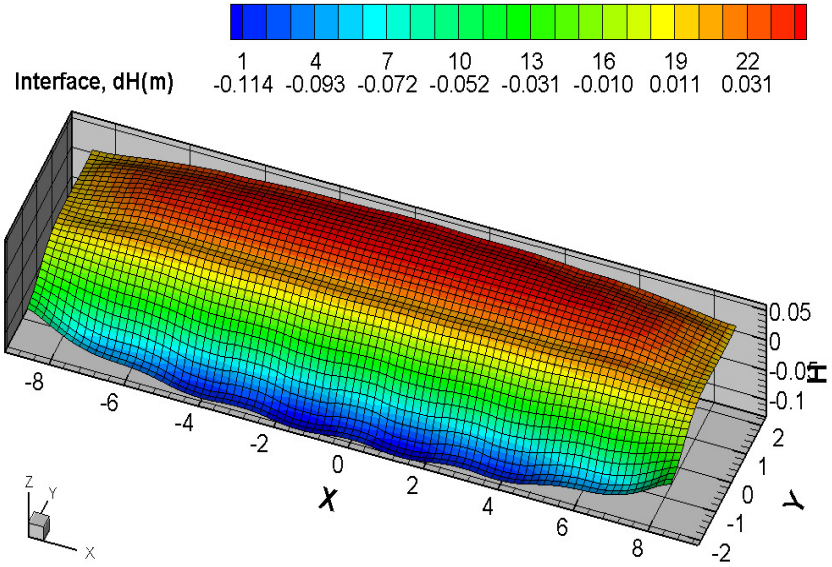




New busbar concept
Reversed **C**ompensation **C**urrent (RCC)

First version of RCC

- RCC accentuates the B_x offset towards negative values.
- Resulting B_x produces a positive transverse electromagnetic force component, F_y producing a steady-state bath-metal interface with about a 14 cm level difference between sides.
- Asymmetry is not unique to first version RCC but is greater than other busbar configurations – requires further evaluation.
- RCC is a perfectly scalable way to minimize the B_z

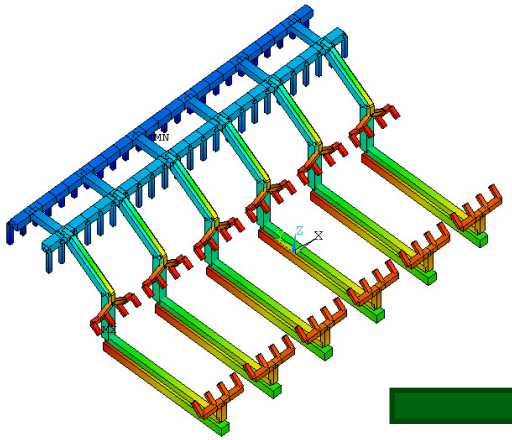
New busbar concept
Reversed Compensation Current (RCC)

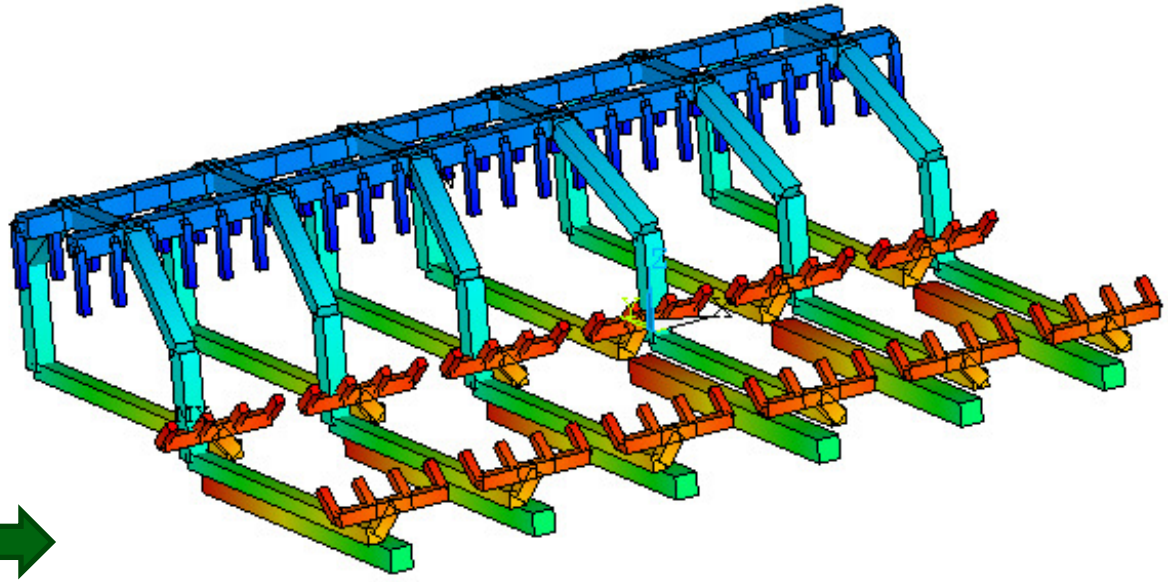
Second version of RCC

- A new design criteria was added: produce a perfectly anti-symmetric B_x in addition to minimizing the B_z while remaining perfectly scalable.
- In order to do so, downstream risers are required.
- With downstream risers 100% of the potline current passes in busbars under the cells. Upstream side busbars carry half of the potline current from the upstream side to the upstream risers passing under that cell. Downstream side busbars also carry half of the potline current from the downstream side of the cell to the downstream risers passing under the next cell.

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

Second version of RCC at 500 kA

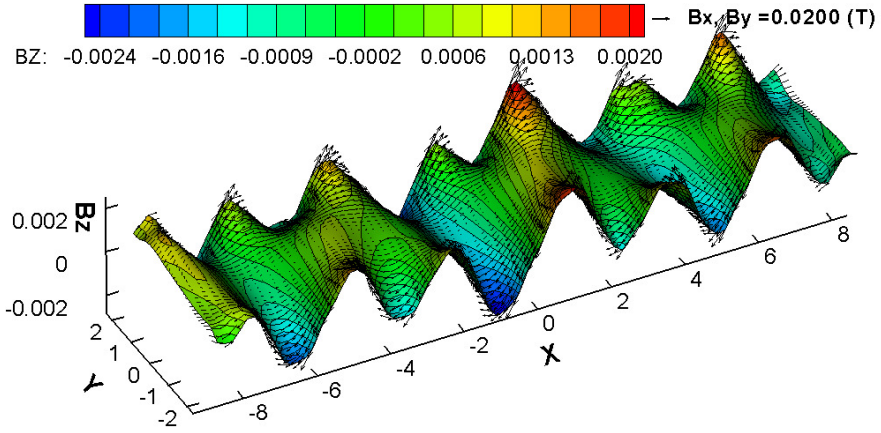


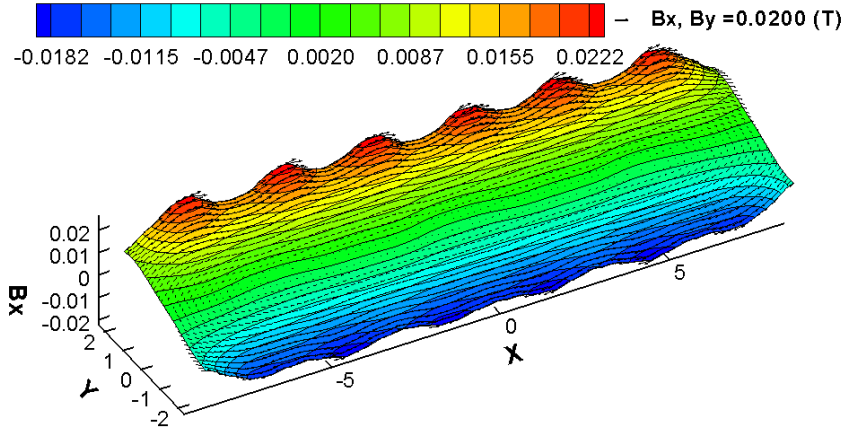


First version

New busbar concept
Reversed Compensation Current (RCC)

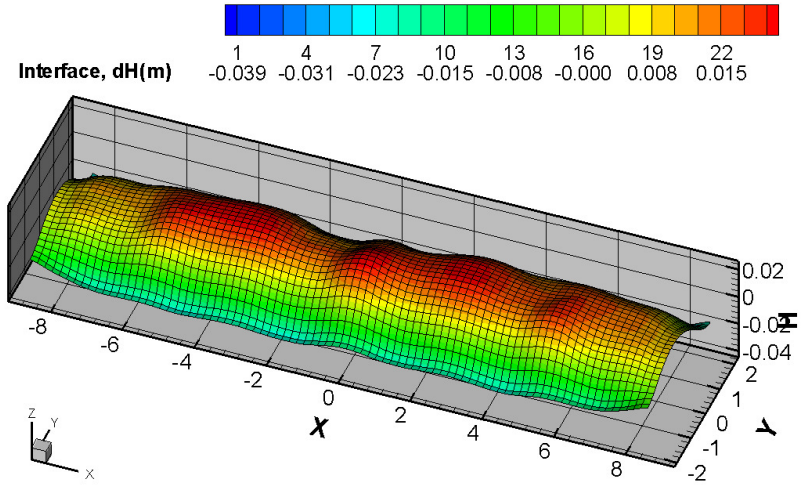
Second version of RCC at 500 kA

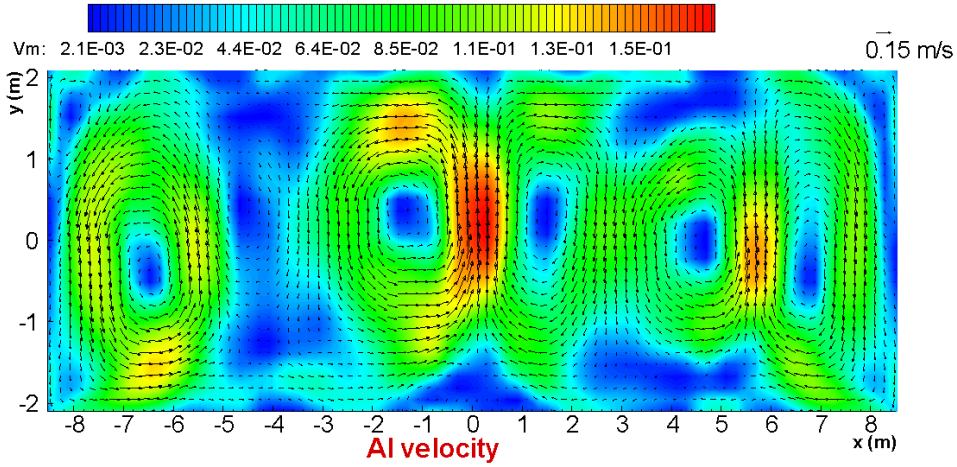




New busbar concept
Reversed Compensation Current (RCC)

Second version of RCC at 500 kA

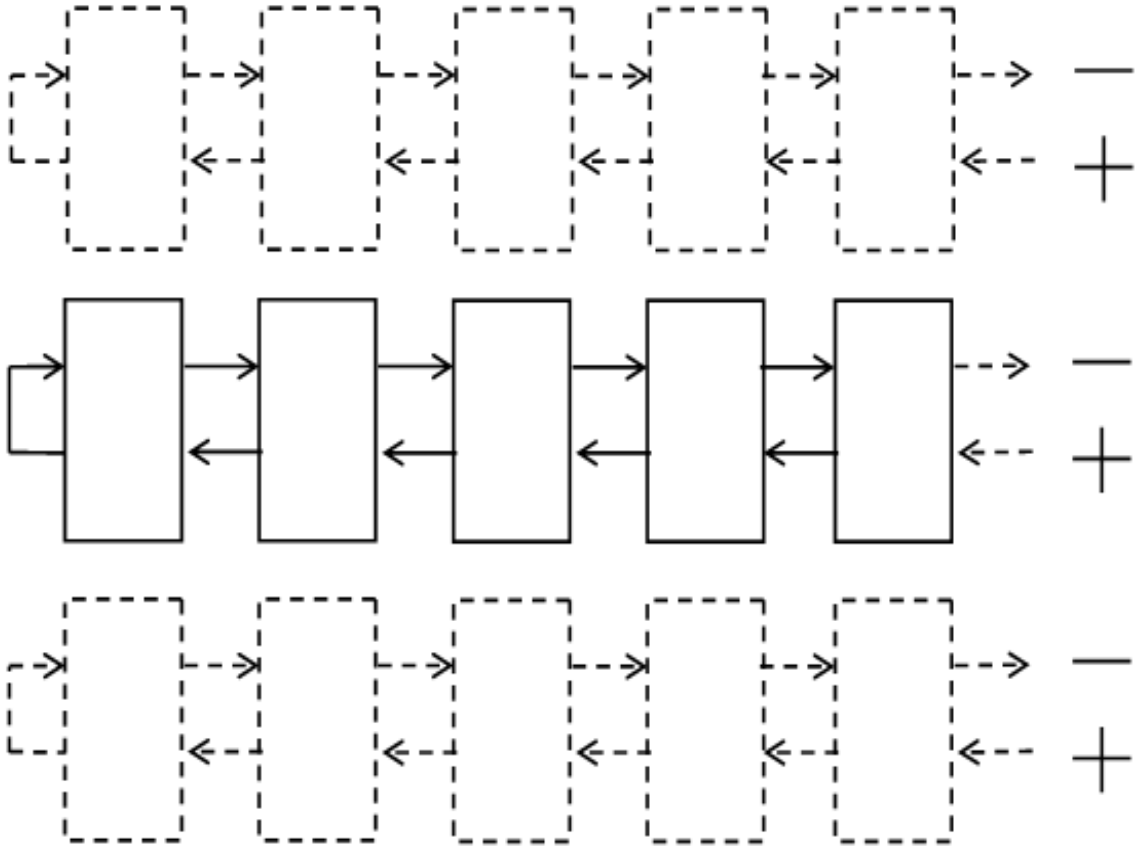




RCC usage opportunities for future smelter design

- 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 potrooms are possible for new smelter design
  - 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

- A new busbar network concept has been developed: Reversed Compensation Current
- Easily extendable to any cell size
- 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

Conclusions

- There are 2 major versions of RCC, an initial version and a second version using in addition downstream risers located on the downstream side of the cell. Downstream risers ensure that the B_x is anti-symmetric so the bath-metal interface deformation is symmetric.

- In the paper, results have been presented for cells operating at 500, 740, and 1500 kA, demonstrating that the concept is perfectly scalable to any cell size and amperage.

- RCC opens the door to smelter design having an odd number of potrooms and multiple potrooms in a very small footprint.