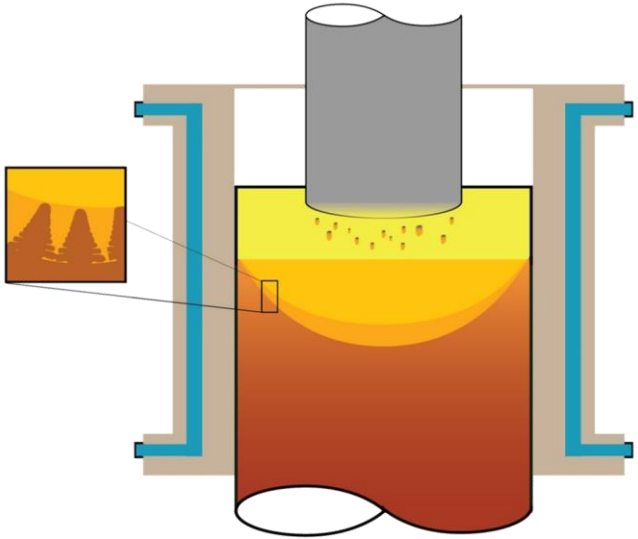
INTECO

ESR Process Conference New Developments & Outlook, June 10-12, 2024

“Product Development in ESR over the last 50 years – from past until present”

Alexander Scheriau
Executive Vice President


INTECO



INTECO...

1973 2023 | 50 YEARS INTECO

INTECO

PROCESS KNOW-HOW & CONSULTING

IMAS (INTECO Metals Application Suite)

PROCESS KNOW-HOW & CONSULTING

IMAS (INTECO Metals Application Suite)

www.inteco.at

Family Business

Tradition and ESR Technology over generations

1973

2024

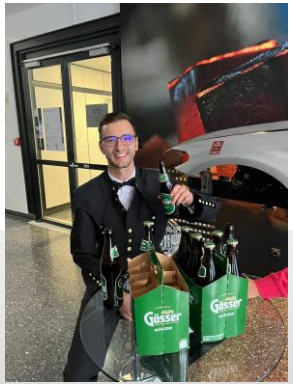
approx. 25 patent applications of INTECO related to ESR since 1973

PATENT

Family Business

Tradition and ESR Technology over generations

1973



next generation coming up …
(Status: June 10th 2024)

2024

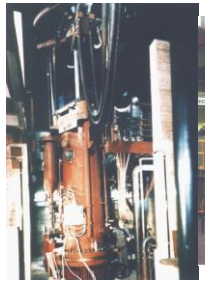
approx. 25 patent applications of INTECO related to ESR since 1973

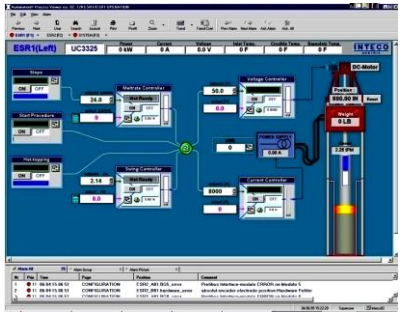
PATENT

INTECO as a pioneer of ESR

- ✓ **Development of the ESR process** to a mature, industrial process (Dr. Holzgruber sen.)
- ✓ First ESR plant producing ingots in excess **of 6 m** (1981)
- ✓ First full scale **pressurized plant** (1980) patent
- ✓ First plant with **retractable baseplate** and backstroke (1986) patent
- ✓ First ESR plant with **smart computer control** (1985)
- ✓ First **ES-tundish heating** system
- ✓ First to commence high speed ESR (1995) patent – **ESRR**
- ✓ First ESR plant with 100% **protective atmosphere** (1980, 1993, 1996)
- ✓ First ESR **redundant control system** for utmost safety (1996)
- ✓ First ESR **CCM** operation (2000) patent
- ✓ First to install a P-ESR based on **Non-live mold** concept (2011)
- ✓ First full protective gas ESR Plant for an ingot weight of **260t** (2013)
- ✓ First to develop a 3-dimensional **process model**
- ✓ First full protective gas ESR Plant for an ingot weight of **>400t**



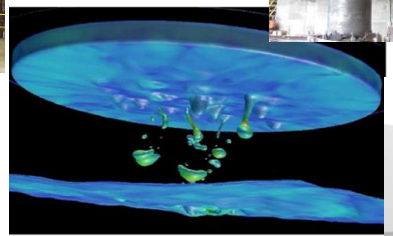










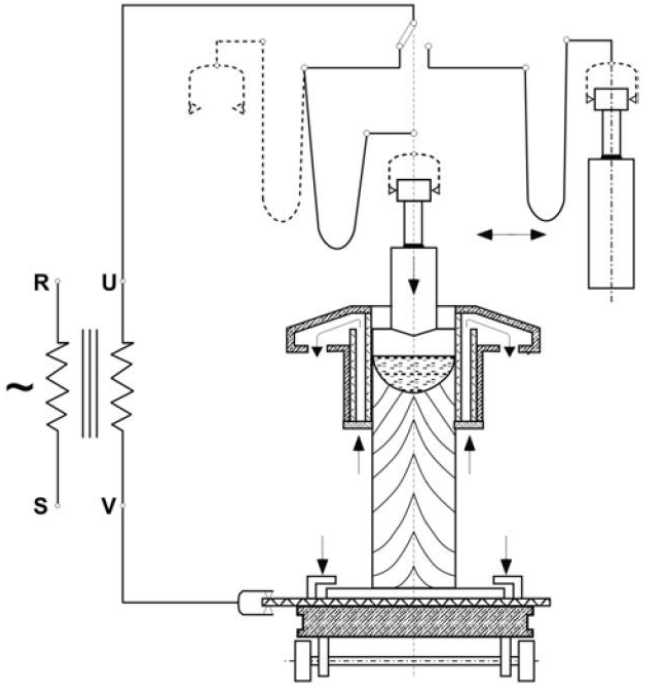



Development of the ESR process to a mature, industrial process

Pilot Plant at Böhler Kapfenberg, Austria, **1964**

- 60 V / 5 kA
- Ingots up to 300 mm dia., 700mm in length
- Manually controlled

Development of the ESR process to a mature, industrial process



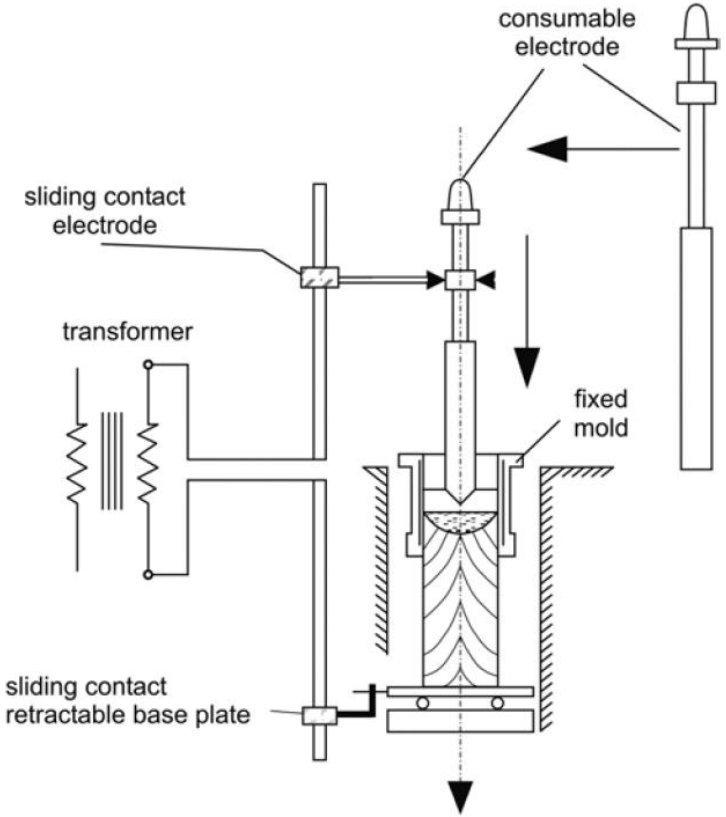
Scheme of **INTECO** ESR Plant configuration

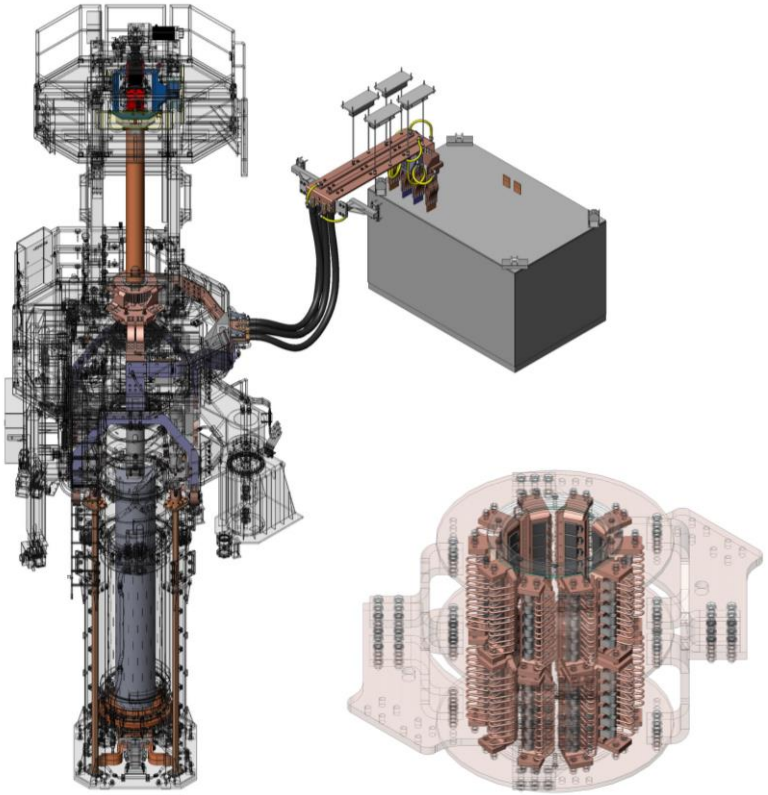
First ESR Production Plant at Böhler Kapfenberg, Austria, **1967**

First ESR plant producing ingots in excess of 6 m (1981)

First INTECO ESR ordered by Metal Ravne, Slovenia, **1979**

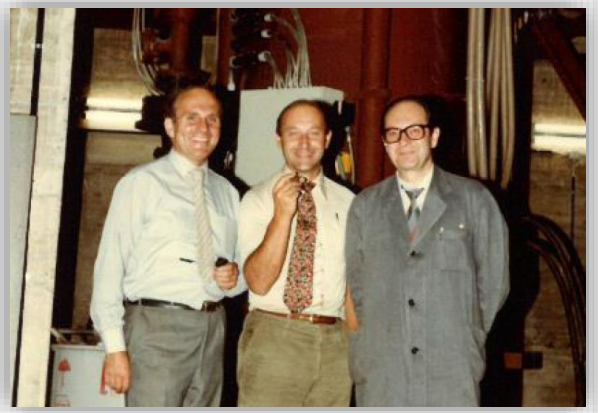
First ESR plant producing ingots in excess of 6 m (1981)





Scheme of **INTECO** ESR Plant configuration

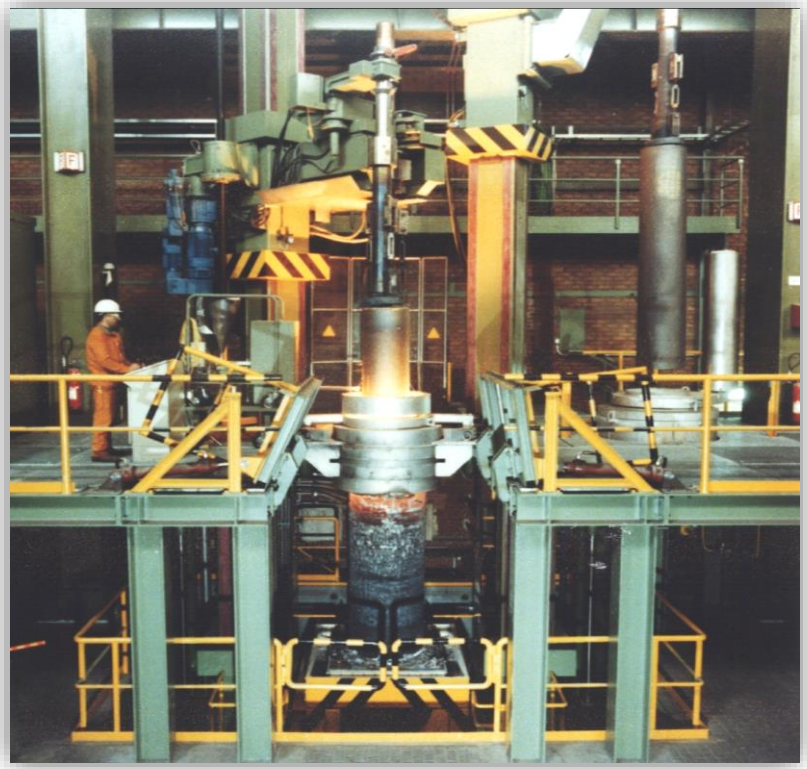
First full scale pressurized plant (1980) patent

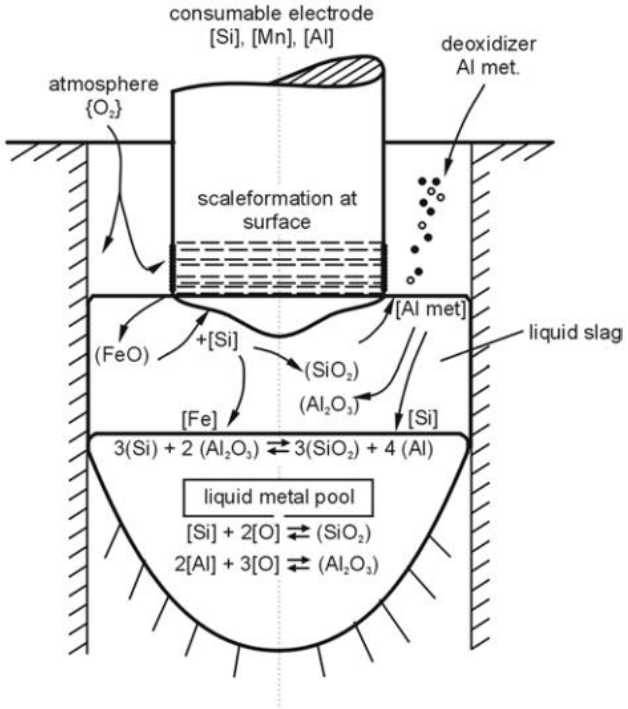


Pressurized (42 bar) ESR at Krupp Schmiedewerke Essen, Germany, **1980**

800mm dia. (8ton) ingot produced @ 42 bar

First plant with retractable baseplate and backstroke (1986) patent

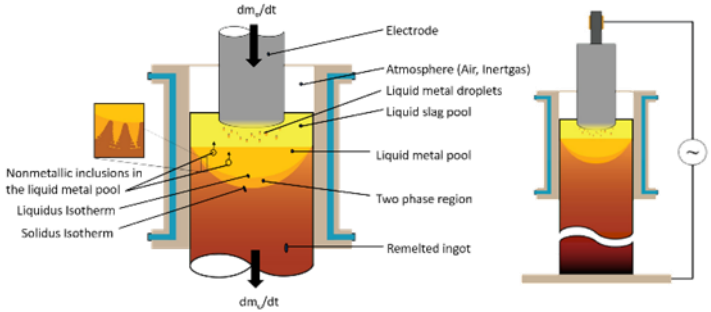




ESR at Thyssen EWK, Germany, **1986**

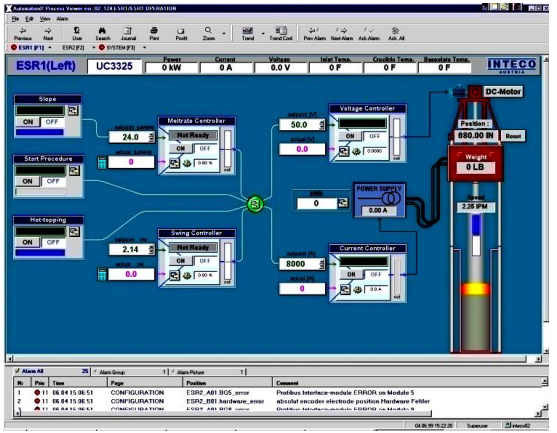
First plant with retractable baseplate and backstroke (1986) patent

First plant with retractable baseplate and backstroke (1986) patent



First ESR plant with smart & redundant computer control (1985)

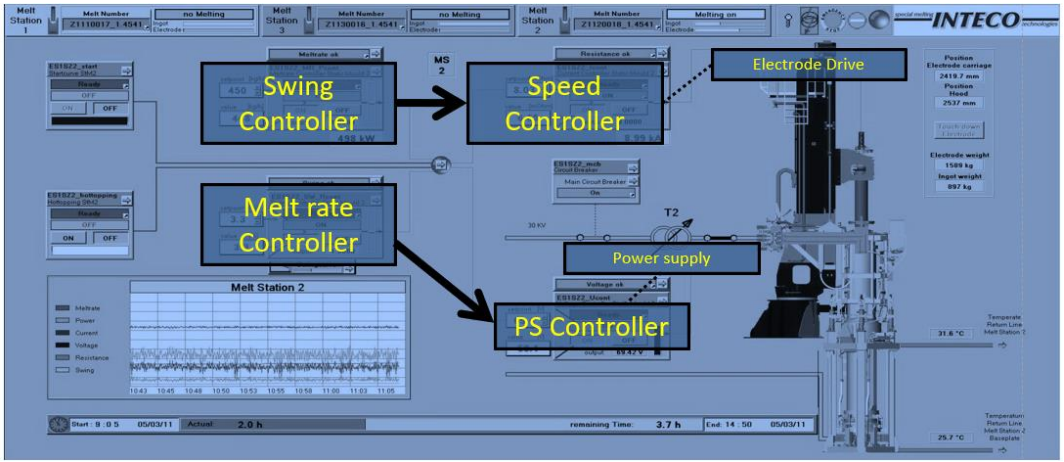
ESR at Acc. Valbruna, Italy, **1995**



Benefits of a smart control system:

- Improved **process control** over manual operation (independence of operator skills)
- First to combine **melt rate** and **immersion depth** control for constant pool depth and solidification profile
- **Plant status** monitoring and display
- **Redundant** configuration for utmost safety

First ESR plant with smart & redundant computer control (1985)



Melt Rate [kg/h]

Calculated via change of electrode weight

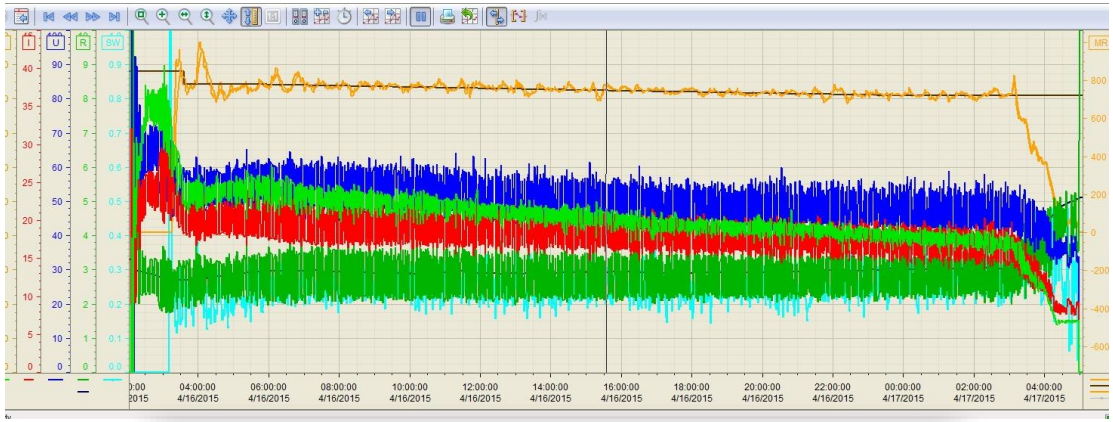
Adjustment of melting power

Immersion depth of electrode in slag [%]

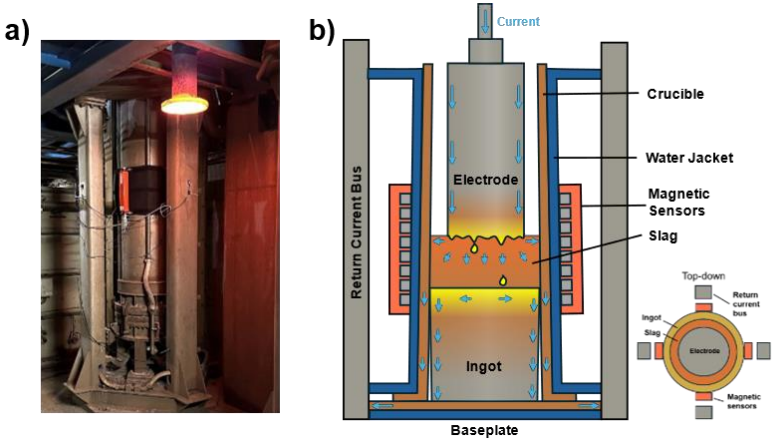
Standard deviation of slag bath resistance

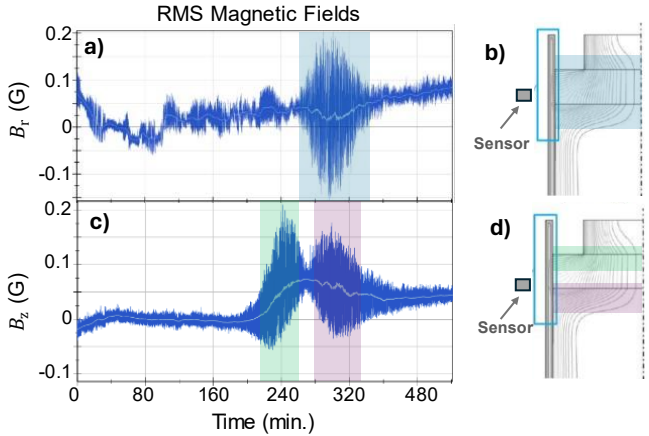
Adjustment of resistance

First ESR plant with smart & redundant computer control (1985)



Next level of ESR Process Control



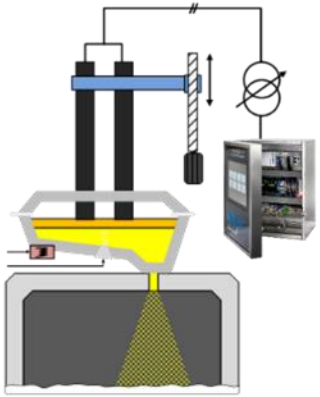


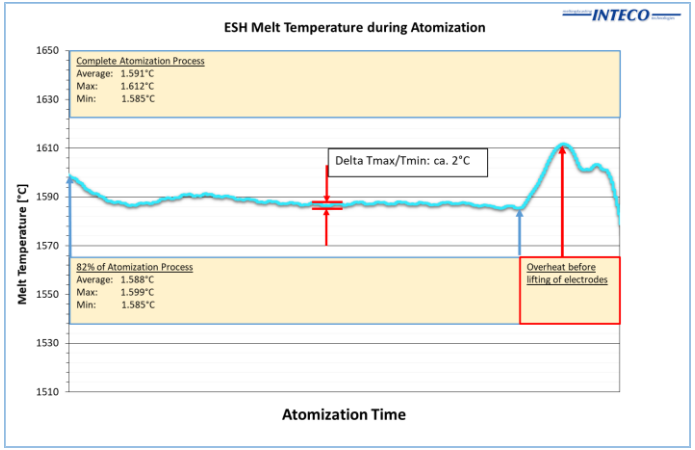
- Monitoring the internal processes of electroslag remelting through an external array of **magnetic field sensors**
- Combining magnetic field measurements with **process simulation**.
- detect novel **process information** such as electrode **immersion depth**, slag depth, and current partition on ESR **previously inaccessible** to producers.

Ampere Scientific

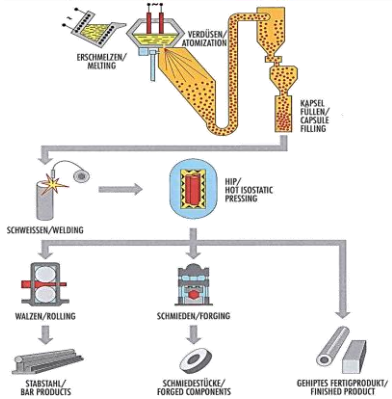
MONTAN UNIVERSITÄT

First ES-tundish heating system

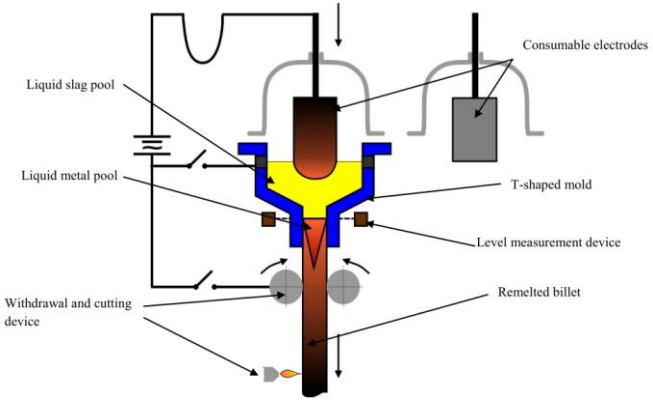


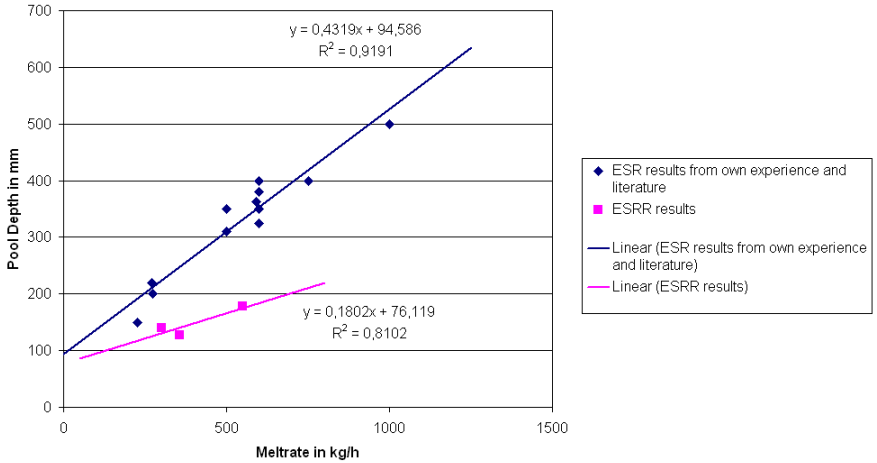


Development and Patenting of INTECO's Electro-Slag Heating (ESH) Process.



First to commence high speed ESR (1995) patent – ESRR





Electro-Slag Rapid Remelting (ESRR):

- **Large sized electrode** (bigger cross sections as billet)
- **Easier production of electrodes**, fewer electrode changes
- **Melt pool profile "independent"** of power input & melt rate
- Economic production of high quality **near net shaped** remelted billets
- ESRR billets are dense, free of macro porosity and for most alloys free of macro segregation up to meltrate of 600 – 700 kg/hour, which is **equivalent to 4 times the meltrate** of a conventional ESR process for a given billet size

First to commence high speed ESR (1995) patent – ESRR

Trials at BGH Lippendorf, Germany, **1996**

First to commence high speed ESR (1995) patent – ESRR

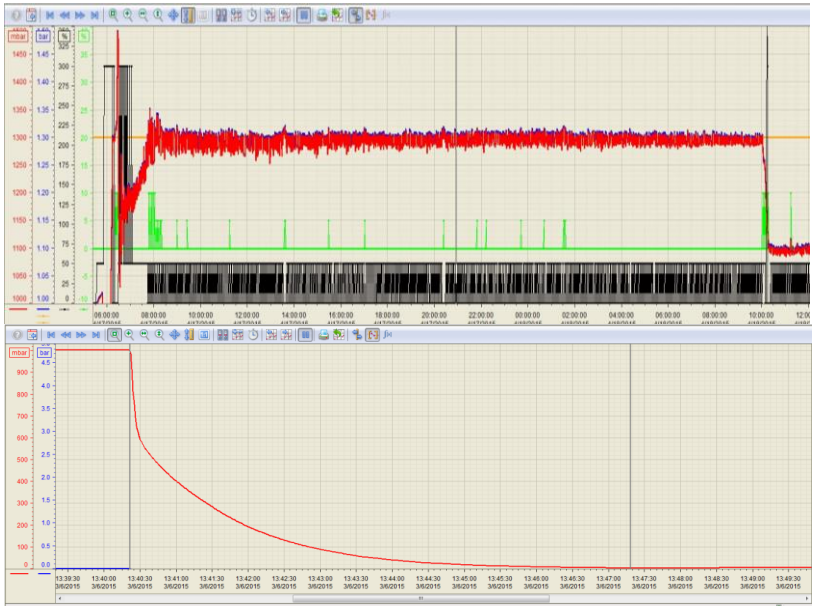
First ESR plant with 100% protective atmosphere

ESR at Acc. Valbruna, Italy, **1995**

First ESR plant with 100% protective atmosphere

Benefits of the Protective ESR Process:

- **Close control** of analysis from bottom to top of ingot
- Remelting of steels with **low Si and/or Al contents**
- Avoidance of atmospheric **oxygen**
- **Independence** of operator's skills
- Remelting of Ti-stabilized steels
- **Minimized** hydrogen pick-up
- Ultra **clean** steel



- **Evacualtion** before start
- Oxygen content within hood <50ppm
- **Minimized** gas consumption (e.g.. 0,6m3/t Ar for 30t ESR-ingot)

First ESR CCM operation (2000) patent

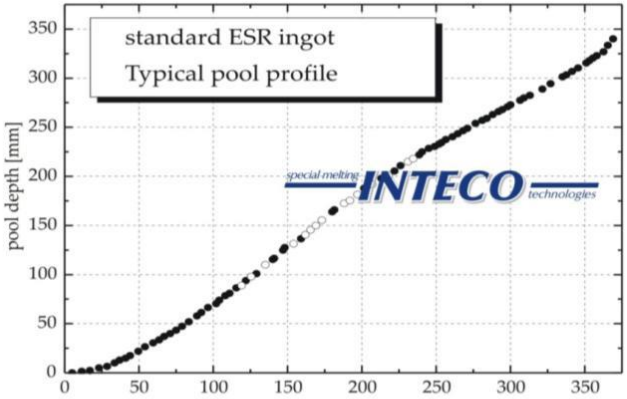
Main disadvantage of ESR Process:

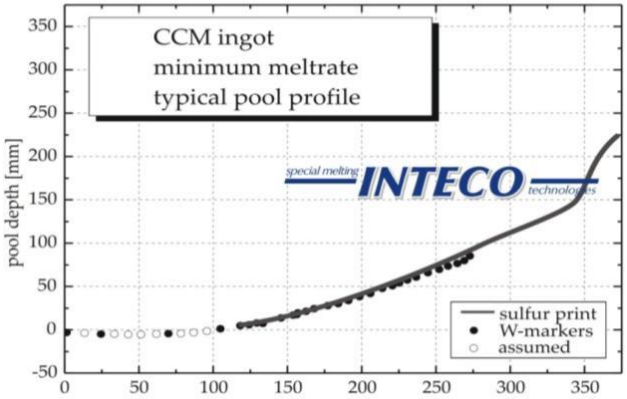
- Melt rate and slag temperature are **not independently adjustable** as energy is introduced through the electrode only.
- High Melt Rate → Deep Melt Pool → Low Ingot Quality
- Low Melt Rate → Shallow Melt Pool → Low Surface Quality

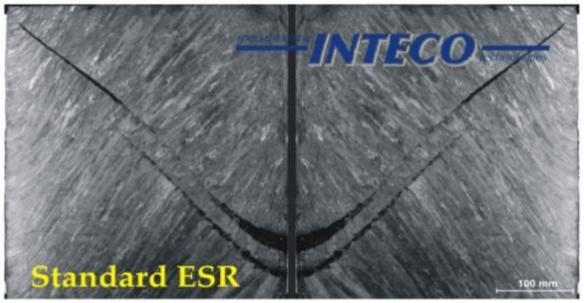
Benefits of the CCM ESR Process:

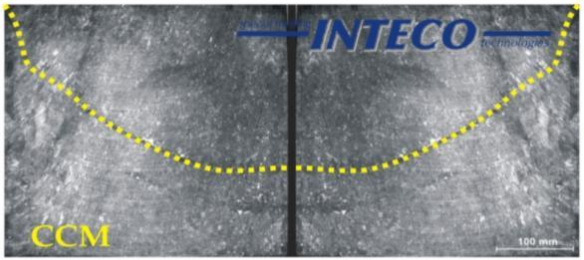
- Mould equipped with a **current conductive element** to independently control slag temperature and melt rate
- Remelting at **low melt rates and good surface quality**
- Large diameter ESR ingots with **shallow** metal pool
- Reduced macrosegregations and remelting of **segregation prone** alloys
- Possibility of slag heating during **electrode change**

CCM® - Comparison of liquid metal pool formation



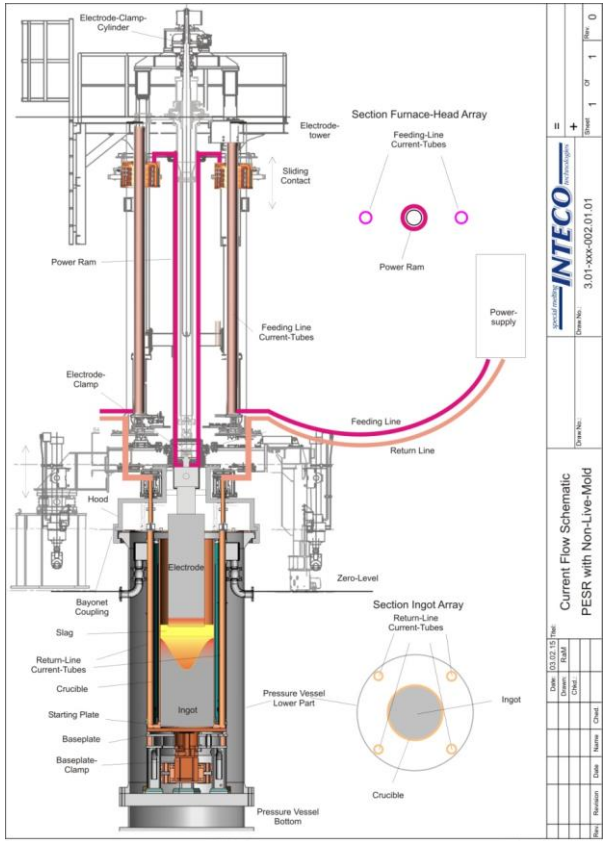


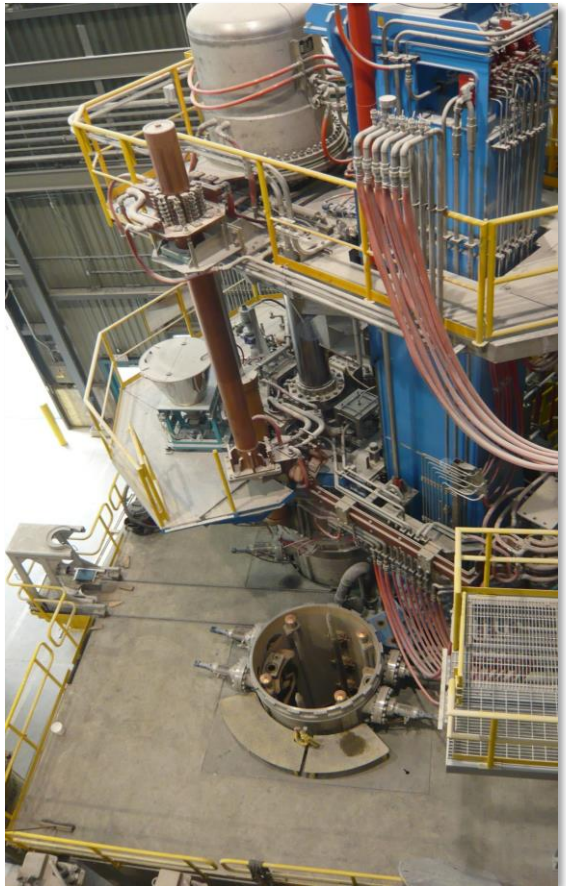




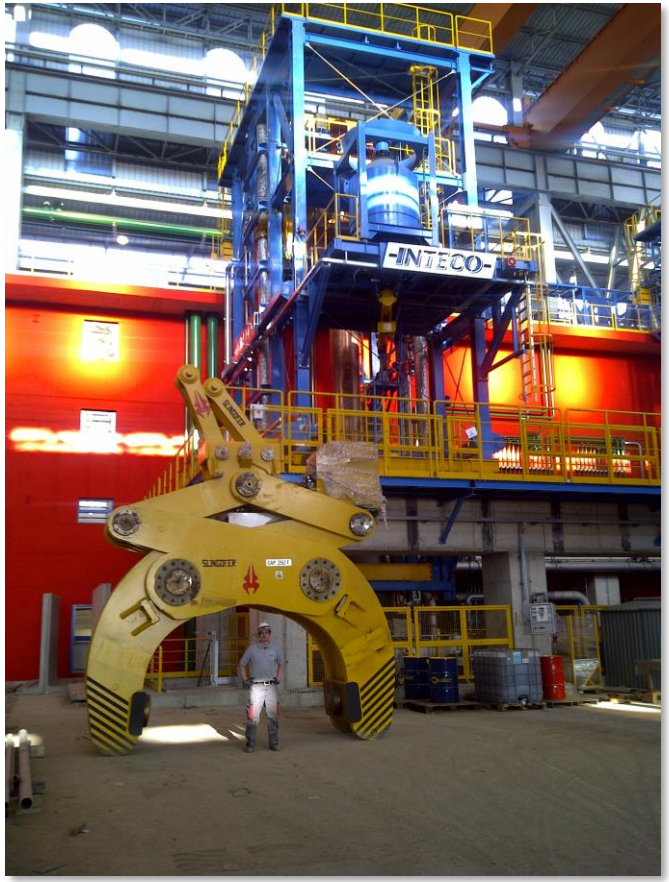
Pool-geometry of CCM-processed ingot at minimized meltrate (standard meltrate -40%) Current distribution 50/50

First to install a P-ESR based on Non-live mold concept (2011)

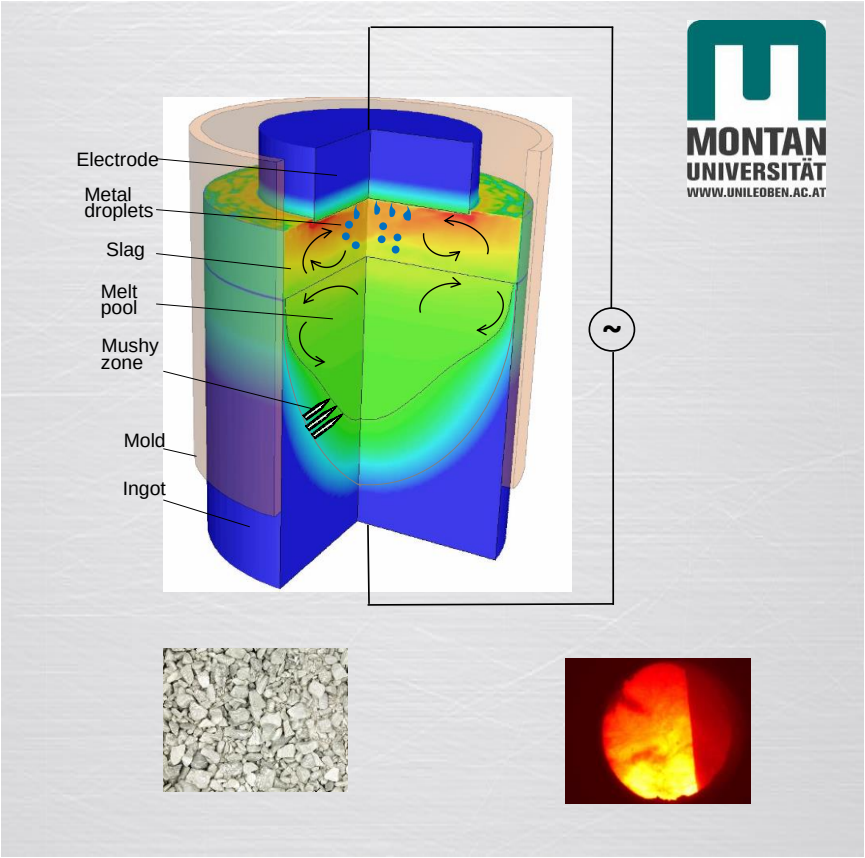




First full protective gas ESR Plant for an ingot weight of 260t (2013)



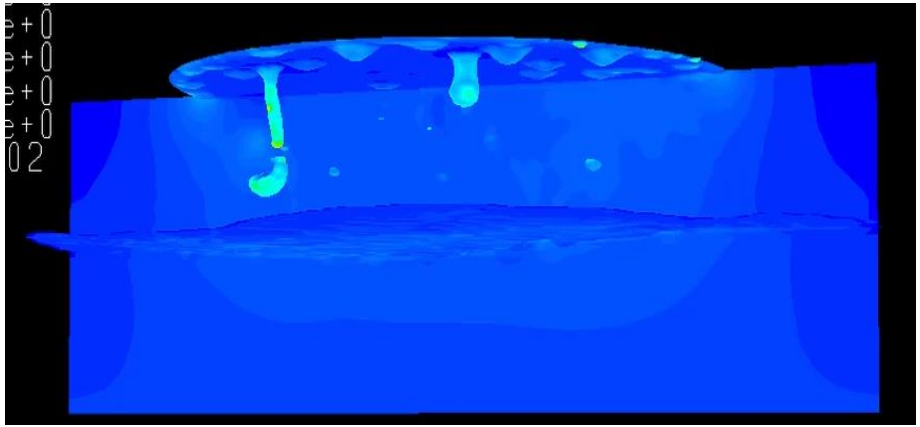
First to develop a 3-dimensional process model



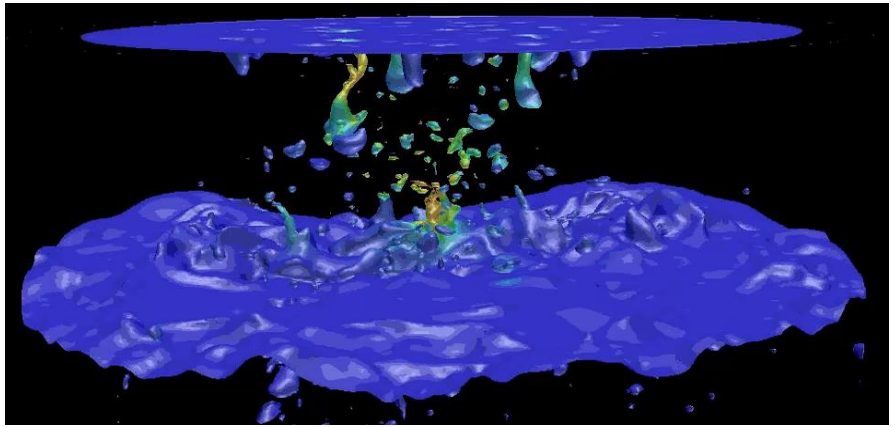
- Flow and electromagnetic field (MHD)
- Heat transfer with phase change (melting/solidification)
- Chemical and electrochemical reactions

- Process Modelling as the key tool for a better understanding of the process (trouble-shooting, shorter start-up phase, optimized production, yield, etc.)
- Broader knowledge and deeper insights on the process to improve process parameters for a safe and repeatable operation
- Optimized Process control and valuable input for various design issues due to full understanding of the physical phenomena
- Cooperation with ESR-Producers to validate the developed model

First to develop a 3-dimensional process model

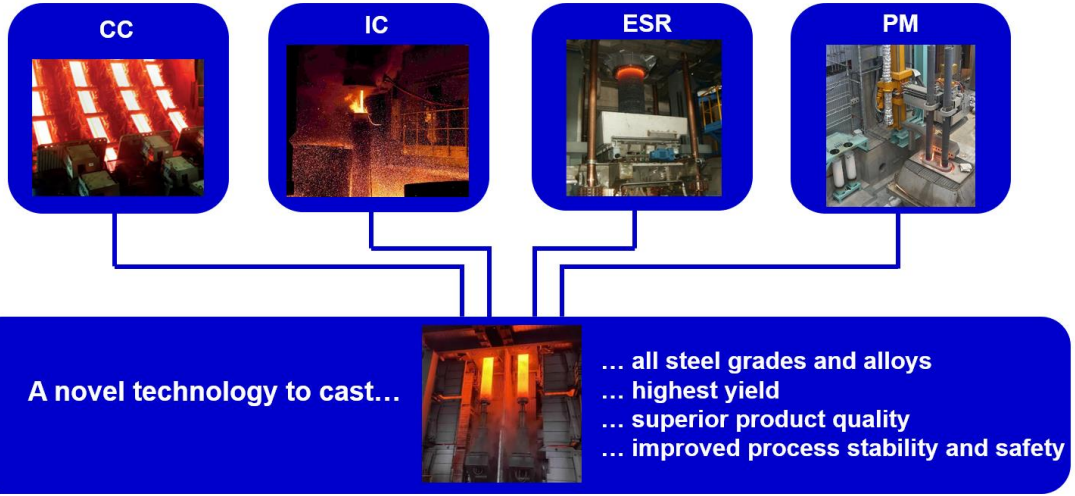


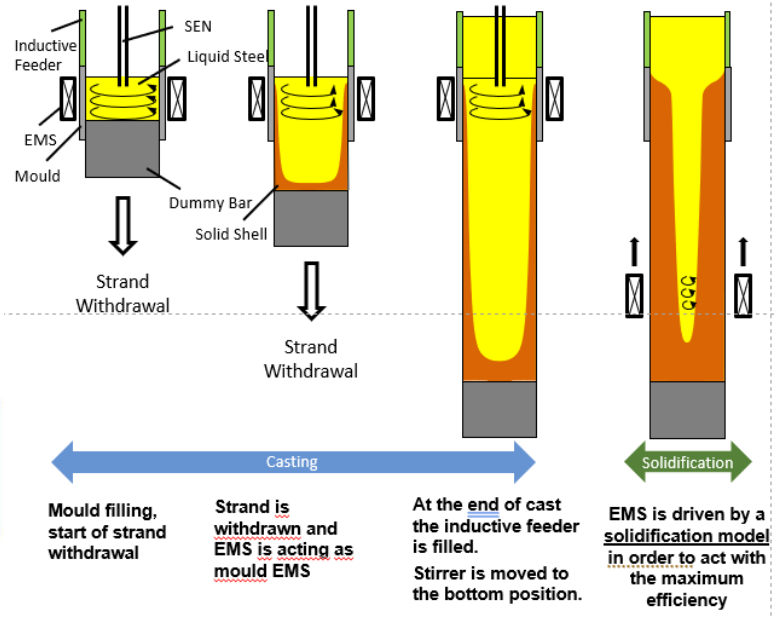
ESR process @ 13 500 A



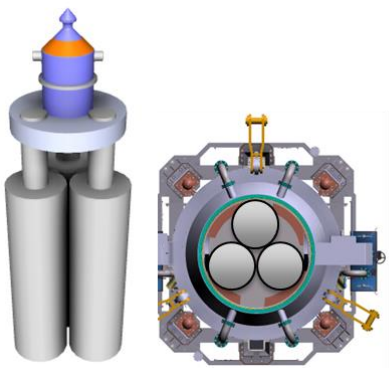
ESR process @ 14 500 A (different slag and dimensions)

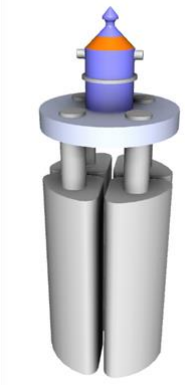
New ways of electrode production-Segment Casting



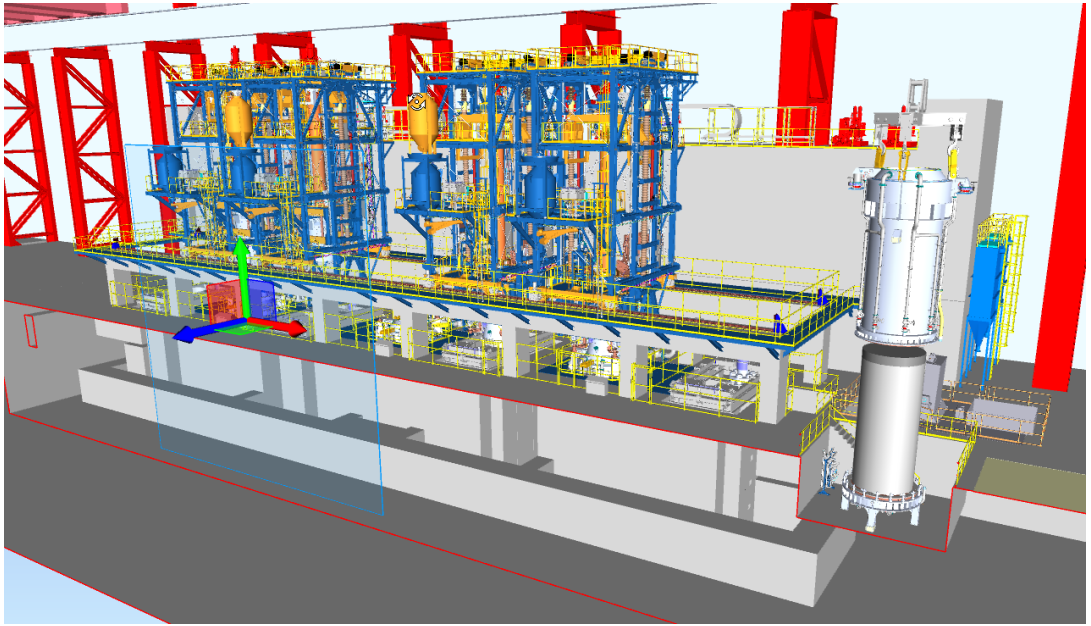


New ways of electrode production-Segment Casting





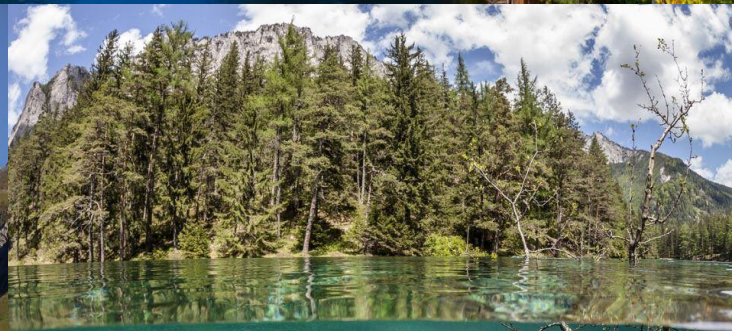
First full protective gas ESR Plant for an ingot weight of >400t



Proud to have World Class Customers…

INTECO

www.inteco.at



INTECO

Thank You !

www.inteco.at

DISCLAIMER

INTECO
melting and casting technologies GmbH

Wienerstrasse 25
A-8600 Bruck an der Mur

Tel.: +43 (0)3862 53110 0
Fax: +43 (0)3862 53844
Email: inteco.austria@inteco.at
Contact: Alexander Scheriau

Have an eye on our technology www.inteco.at