

# TMEIC HEATER SOLUTION

A large industrial heater in a factory setting. The heater is a large, rectangular structure made of metal panels, with a glowing orange-red interior. A metal slab is being processed, and a bright light is visible at the bottom right of the heater. The background shows industrial equipment and scaffolding.

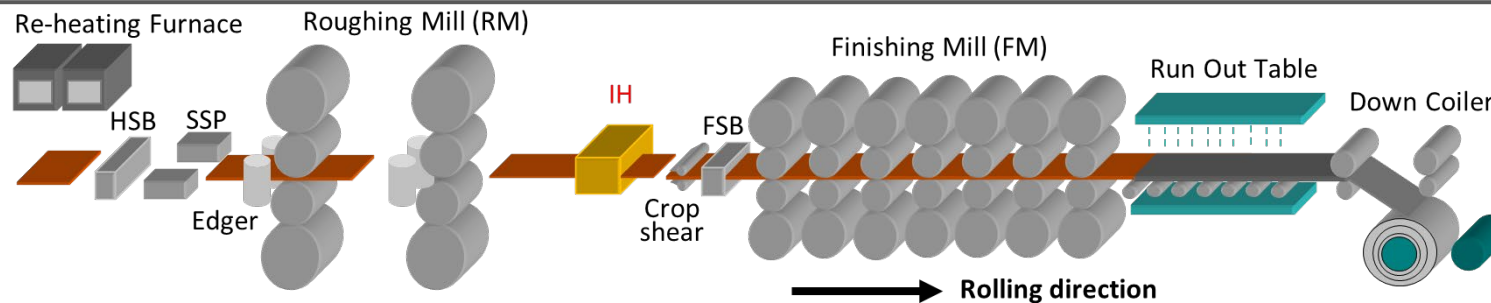
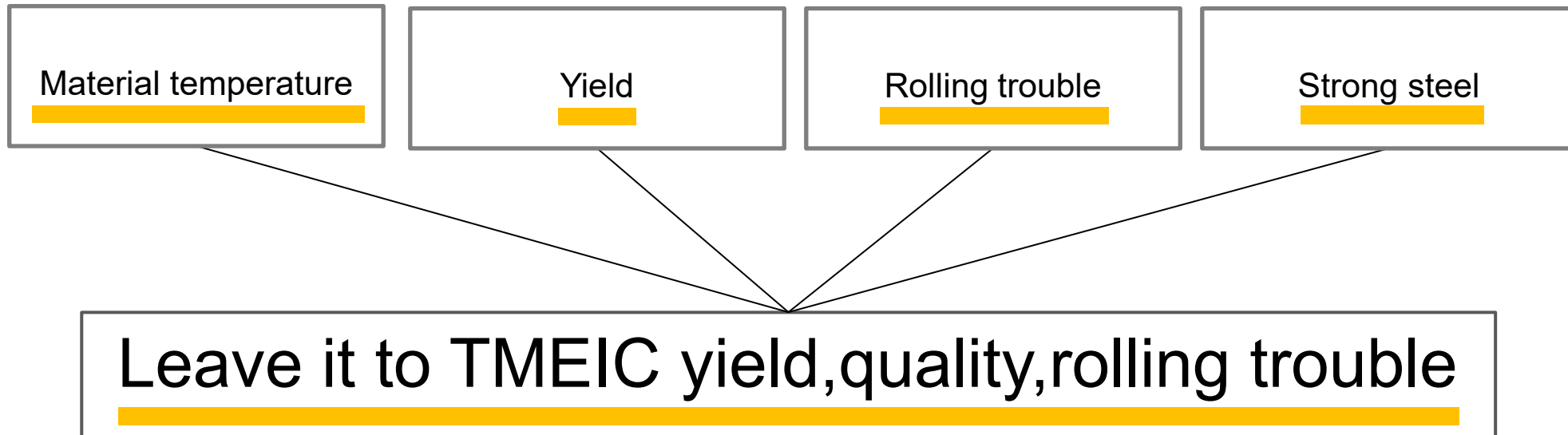
TMEIC's heater technology solves issues

Yield  
Quality  
Rolling troubles

# Leave the quality Control of material by temperature

Induction heaters are important equipment mainly installed in steel hot rolling lines, and are installed upstream of the finish rolling mill as inline facilities for heating rolled materials (bar).

TMEIC's heaters come in three types: **Edge Heater**, which heat the edges of the material; **Solenoid-Bar Heater**, which heat the entire width of the bar; and **Transverse-Bar Heater**, which heat the bar locally in the width direction. These heaters are controlled by hot rolling control system, which allows for temperature control of the bar, resulting in improved product quality, yield, and rolling stability.



# Heater characteristics

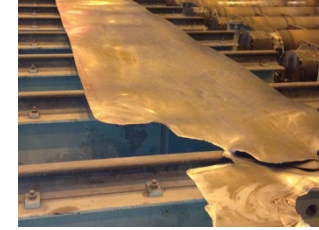
Item	Edge Heater(EH)	Solenoid-BarHeater(SBH)	Transverse-BarHeater(TBH)
Rating	1100kW x 4 ind-2200V-300Hz x 1set	9000kW-3300V-1500Hz x 2set	3500kW-2150V-150Hz x 3set
Inductor structure			<p>The upper and lower inductors can be moved (shifted) arbitrarily in the bar width direction. Shift amount determined by strip width and initial temperature distribution. Wide materials can be heated by increasing the amount of shift.</p>
Width direction temperature rise characteristics and features			
Example of temperature rise pattern		<p>Bar cross-section temperature indicator</p> <p>60mpm bar thickness 30mm</p>	
Reference temperature rise	50°C at 25mm point from with edge 30mm thickness-60mpm	40°C-1800mm width-40mm thickness-60mpm at 2 set	45°C-30mm thickness-60mpm at 3 set



# Merits of heater for hot rolling

## 1. Improve rolling stability and yield rate of products

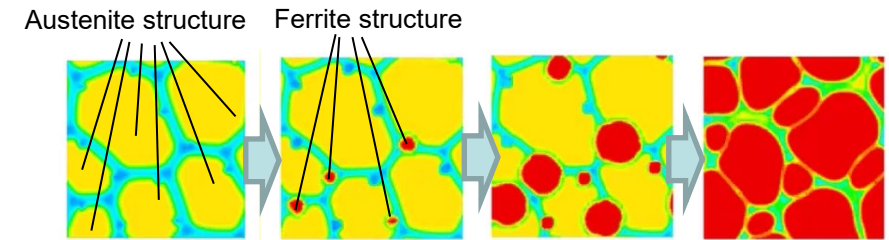
- **Improve FM rolling stabilities (avoiding of Head/Tail chew) of high-grade steel, thinner products:**  
Reducing of rolling force by BH heating can avoiding strip steering at head and tail of the bar.
- **Reduce length of trimming**  
Trimming length of the width edge part can be reduced by EH heating. Crop cut length also can be reduced by BH heating.
- **Long Roll cycle:**  
Reducing spot wear of the roll by improving the width temperature profile can increase roll life.



Tail chew

## 2. Improve strip quality

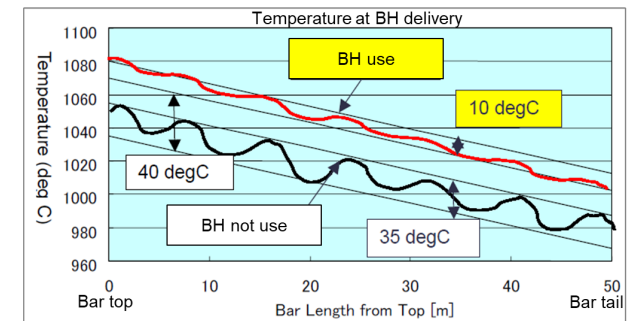
- **Improve uniformity of bar longitudinal temperature:**  
Reducing skid-mark and thermal run-down of the bar
- **Reduce mixed grain structure, duplex grain structure:**  
By decreasing temperature difference between edge and center
- **Reduce Edge Crack:**  
Especially for electrical steels



Mixed grain structure

## 3. Improve variety of steel grades that can be produced

- **High Tensile Strength Steel:**  
BH heating can reduce roll force by heating up the bar temperature so it can reduce the difficulty of high-grade steel production.
- **Precipitation hardening Steel:**  
Several precipitation hardening steel need to relatively low temperature in re-heating furnace. In this case, heating up by BH is effective in terms of temperature in FM rolling.

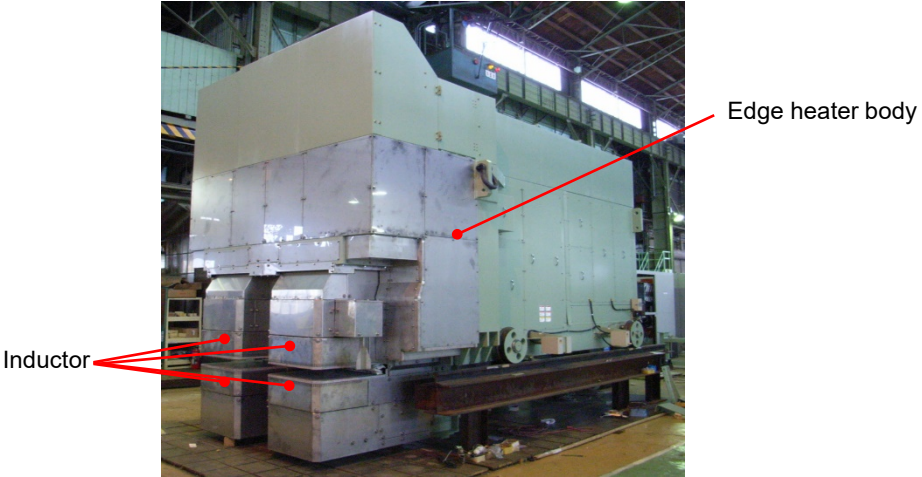
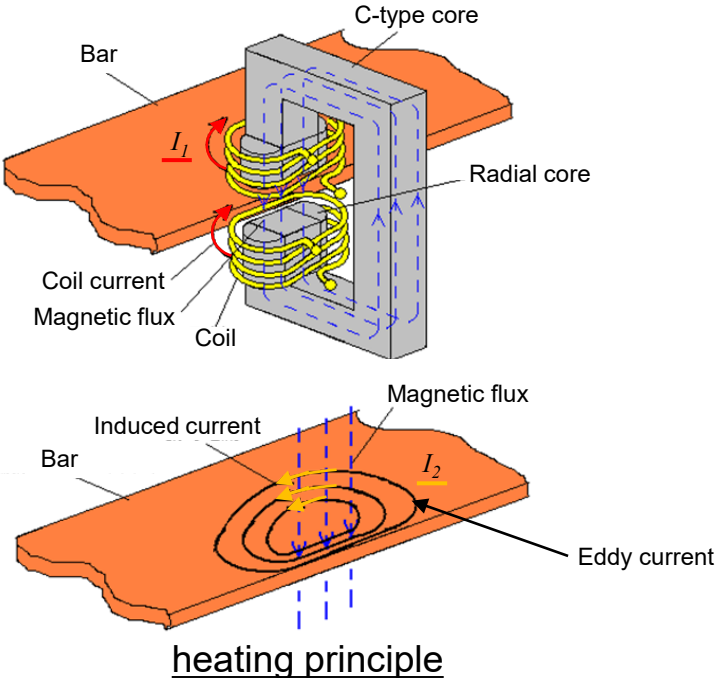


Slid mark

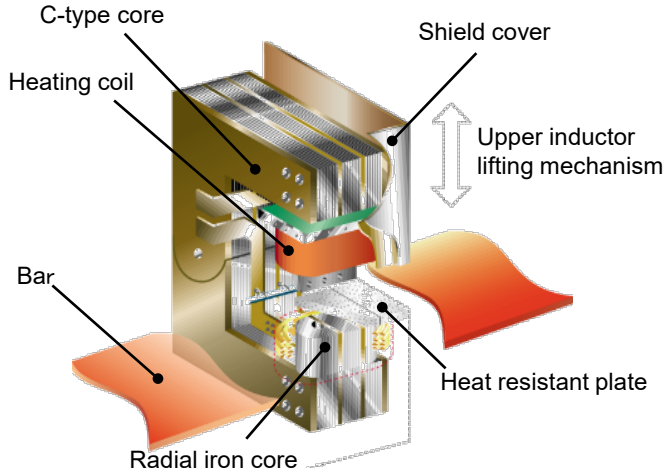
# Edge Heater(EH) overview( Product introduction )

## <Edge Heater>

EH can raise the temperature of the edge part in the width direction of the bar. The alternating current ( $I_1$ ) flowing through the heating coil generates an alternating magnetic flux ( $\Phi$ ) in the C-shaped core, and an eddy current ( $I_2$ ) flows through the bar, which is placed between the C-shaped cores. Hence Joule heat is generated in the bar. The method of heating the bar by this Joule heat is called induction heat. EH is an equipment that concentrates this Joule heat on the width edge of the bar.



Appearance of Edge heater

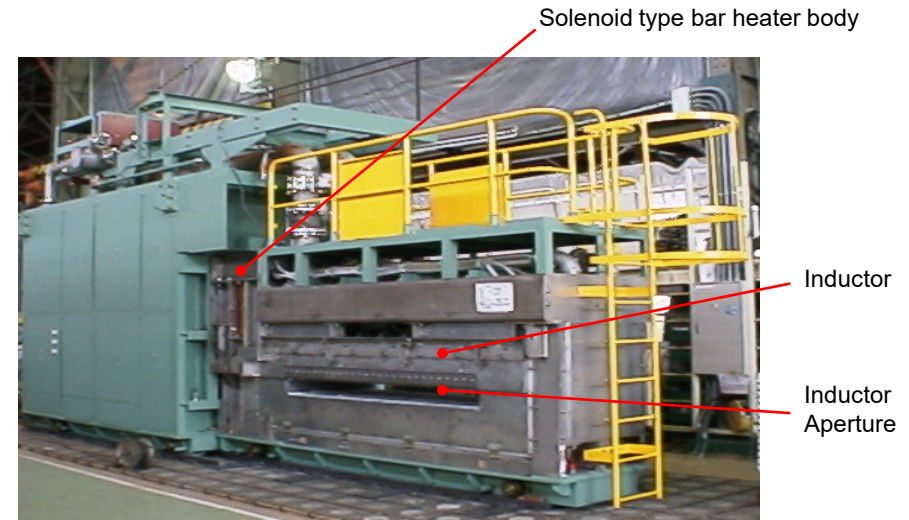
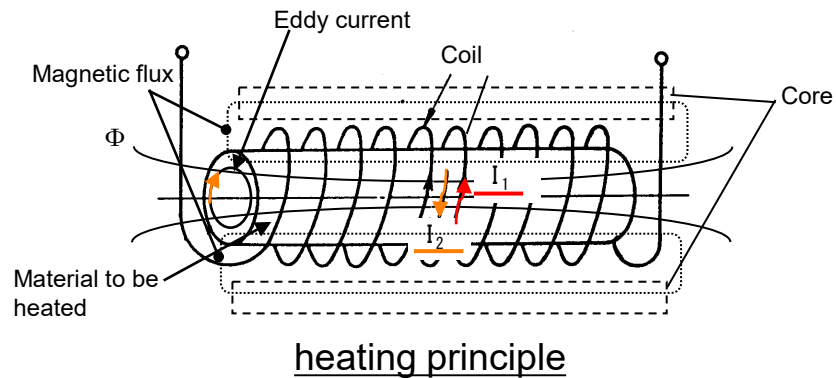


Appearance of inductor

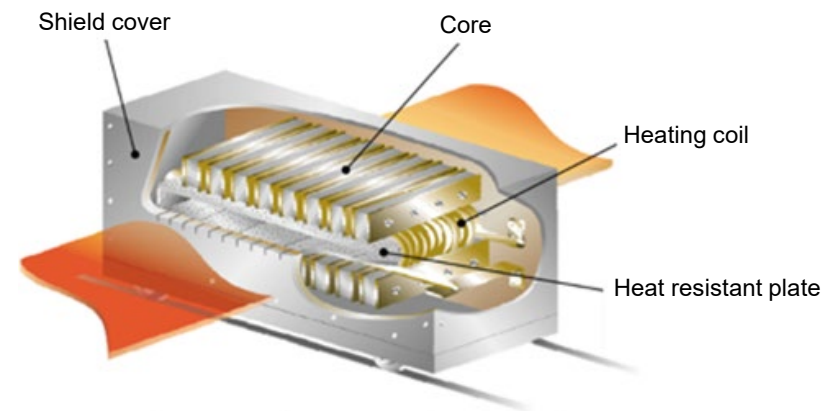
# Solenoid-BarHeater(SBH) overview(Product introduction)

## <Solenoid-BarHeater>

SBH can raise the overall temperature in the bar width direction along the longitudinal direction of the bar. Alternating current ( $I_1$ ) flowing through the wound heating coil generates alternating magnetic flux ( $\Phi$ ), and an eddy current ( $I_2$ ) flows through the bar. Hence Joule heat is generated in the bar. In the hot rolling line, above induction heating equipment is normally installed in the front side of the finishing mill.



Appearance of solenoid type bar heater



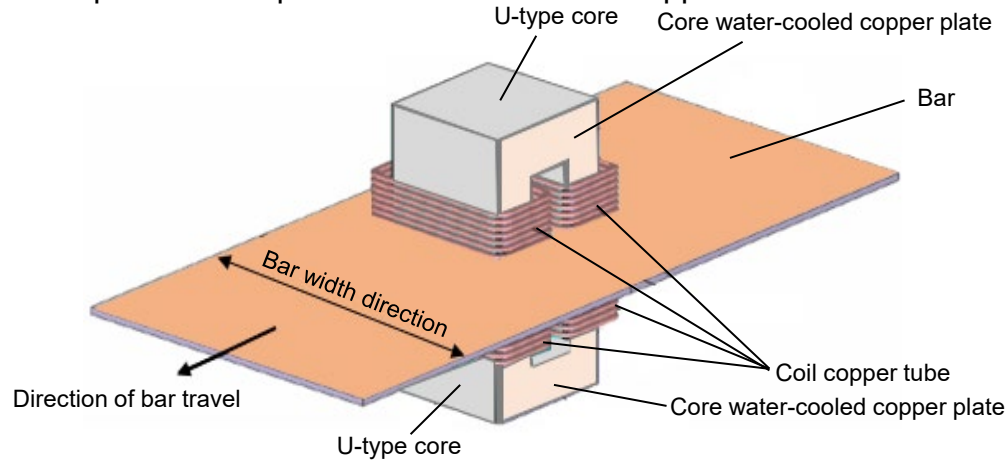
Appearance of inductor

# Transverse-BarHeater(TBH) overview1 ( Product introduction )

## <Transverse-BarHeater >

TBH can raise any temperature near the center in the longitudinal direction of the bar.

Install a pair of U-shaped core inductors on the upper and lower surfaces of the bar.

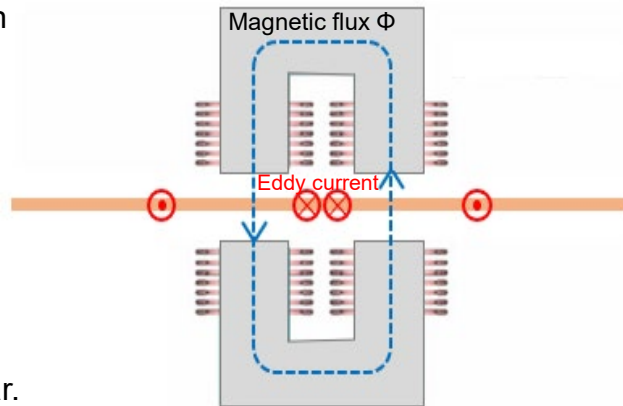


A magnetic circuit is formed between U-shaped iron cores on the upper and lower surfaces of the bar.

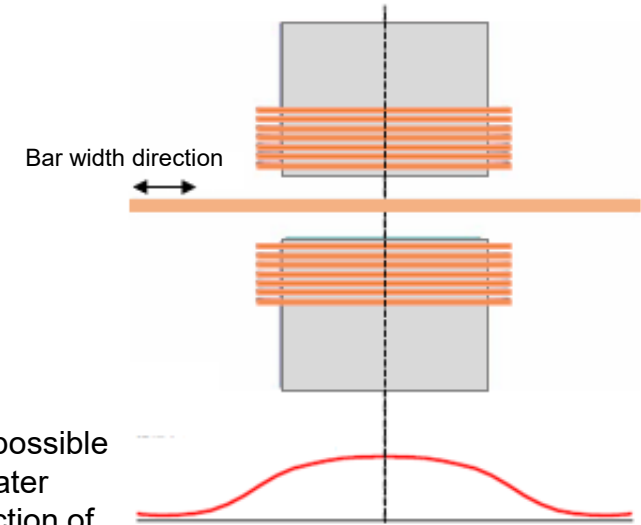
High-frequency current is applied to the coil copper tube.

High-frequency magnetic field is generated between the upper and lower U-shaped iron cores. Magnetic flux passes through the bar.

An eddy current is generated by the repulsive magnetic flux in the bar, and the bar is heated by joule loss.



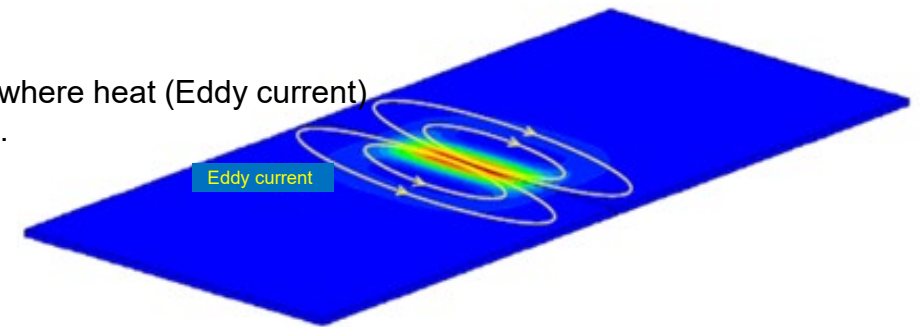
Heating principle diagram



Localized heating is possible depending on the heater position in width direction of the bar

Bar conveyance temperature rise pattern (bar width direction)

The red part is where heat (Eddy current) is concentrated.



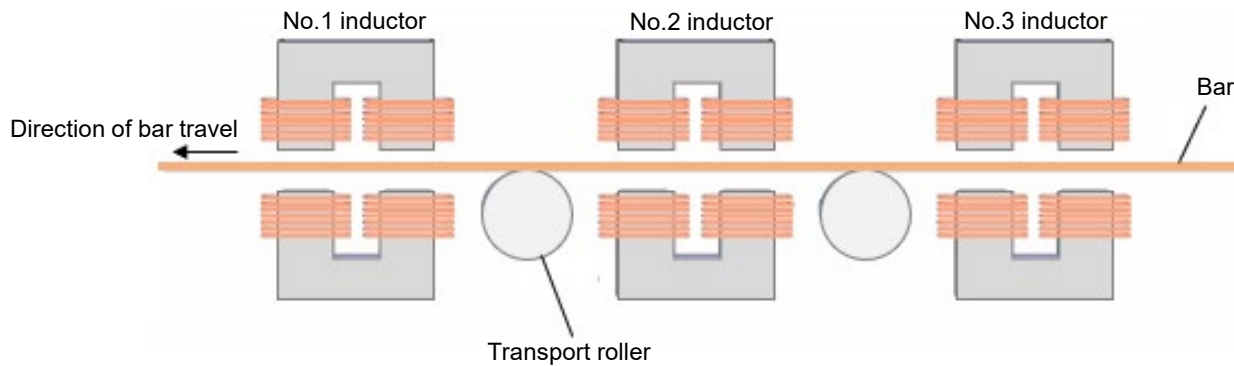
The contour map of bar heat generation



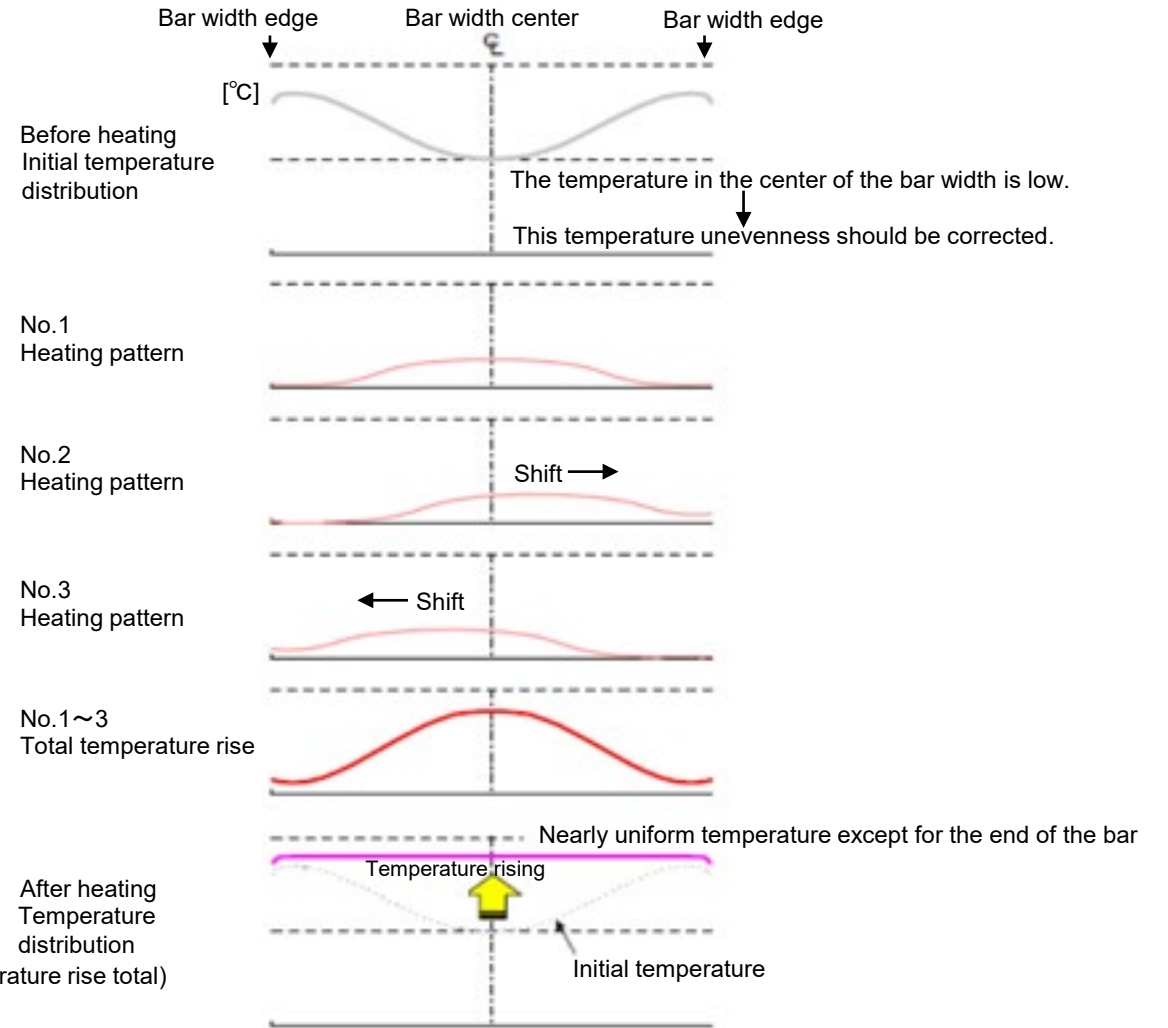
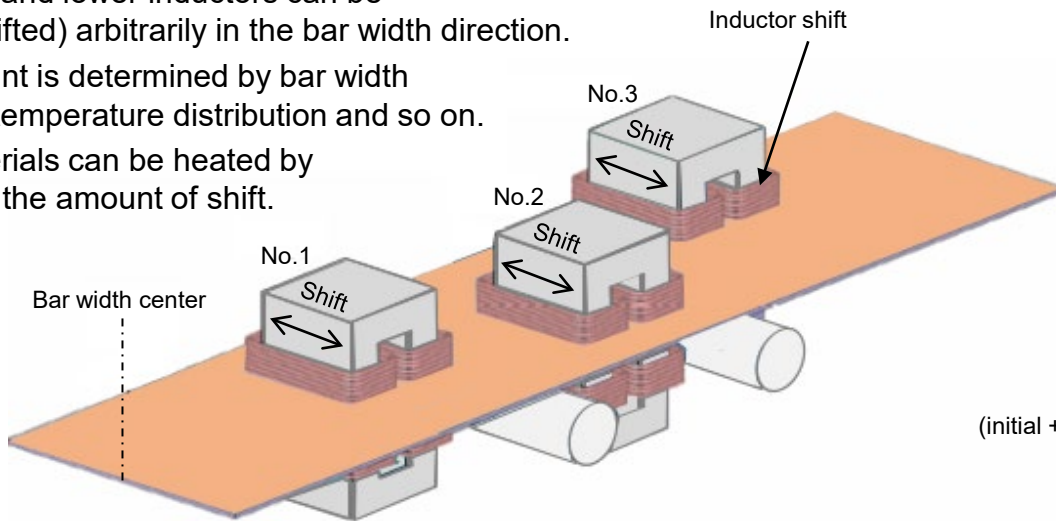
# Transverse-BarHeater(TBH) overview2( Product introduction )

## <Transverse-BarHeater shift heating >

Multiple units installed in the direction of bar travel.



The upper and lower inductors can be moved (shifted) arbitrarily in the bar width direction. Shift amount is determined by bar width and initial temperature distribution and so on. Wide materials can be heated by increasing the amount of shift.



Bar width direction temperature distribution

# Process control for heater

Each heater is placed in front of finishing mill to control bar temperature. Process control system for the heater consists of following functions.

## <Setup calculation>

Output power (P) and position along width direction of the bar (x) are calculated so as to achieve target temperature distribution.

## <FF(FeedForward)/FB(Feedback) Control>

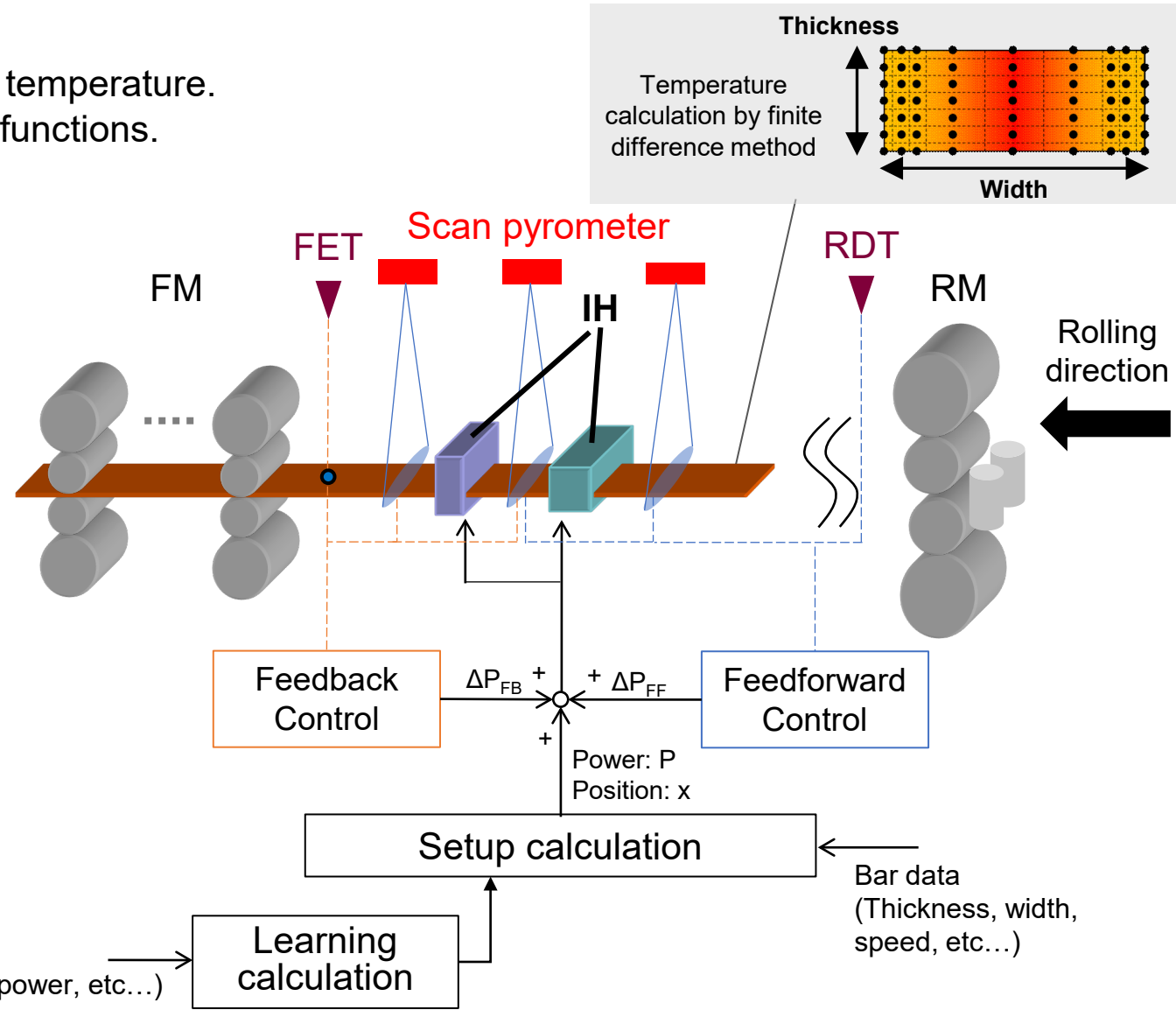
Output power is dynamically controlled based on measured temperature, speed. Scan pyrometer can measure temperature profile along width direction of the bar.

## <Learning calculation>

Mathematical model for heater is automatically adapted using actual heating data.

RM: Rougher Mill  
 FM: Finishing Mill  
 RDT: Roughing delivery temperature  
 FET: Finishing entry temperature

Actual data  
 (Temperature, power, etc...)



Thank you