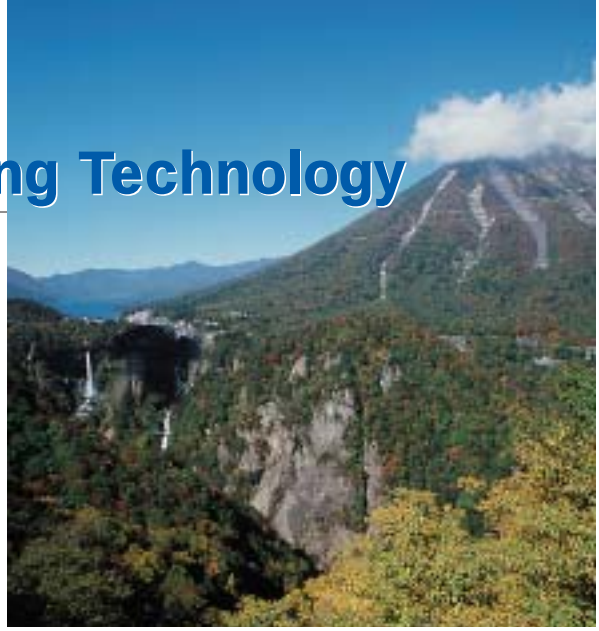
Bound to Innovate

Key Technologies for Superconductivity

FURUKAWA ELECTRIC

Pioneering Superconducting Technology



Nikko works is situated in the scenic Nikko National Park where the aspect of nature as it changes from season to season is worthy of appreciation. With its clear air, limpid water and abundant supply of electric power, the location is best suited for the precision engineering work of electrical and electronic eq uipped.
The research and development in superconductivity was commenced in 1963 well before most companies had entered this field.
Based on Furukawa' s wealth of production technology accumulated through the manufacturing of wire and processing of nonferrous metals, industrial production of Nb-Ti based multifilamentary wire had already begun by the later part of the 1960s.
In the 1970s, the company was the first in the world to succeed in manufacturing multifilamentary V_3Ga, Nb_3Sn compound wire, which has been well received by customers at home and abroad.

Key Technologies for Superconductivity

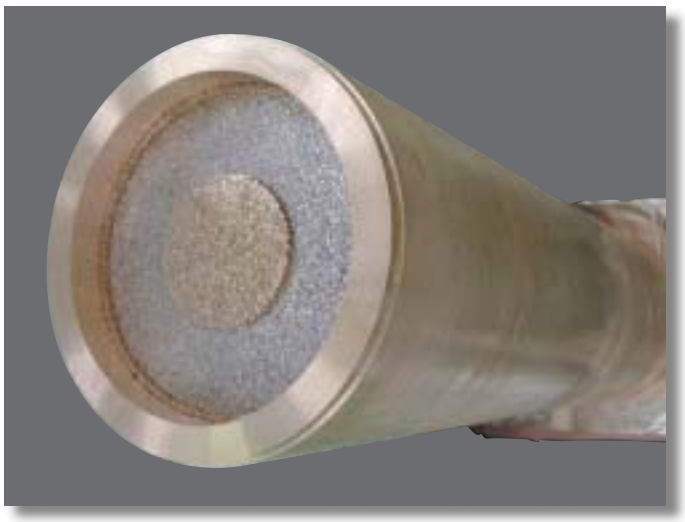
Today will turn out to be one of the past days in tomorrow.

The business extension and/or reform by the technology innovation are inevitable even in the superconductivity business (project).
It is our business policy that we try to supply such a product as to help our customers to diversify their business (project).
This, we believe, is the true customer' s satisfaction.

In order to obtain such a customer' s satisfaction, Furukawa is trying every day to achieve the req uired performance in the production stage as soon as possible.
The key technologies shown here are fully and effectively utilized in the factory to make our policy as the reality.
Heartily thank you very much for our customers' collaboration.

Nb-Ti Superconductor

Billet Making



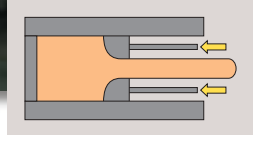
● Single stacking method

6,426 Nb-Ti hexagonal rods are stacked with Cu rods for the LHC outer strands. This method allows us to make any complicated structure of superconducting wire, for example pulsed wire with Cu-Ni barrier.

●14,000 hexagonal rods

Indirect Extrusion

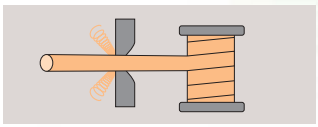
Indirect extrusion allows us to use a billet of long length,which reduces materials loss and realize uniform deformation.



Drawing Techniq ue

● Shaving

Optimized shaving freq uency with special shaving die allows us to exclude foreign materials.

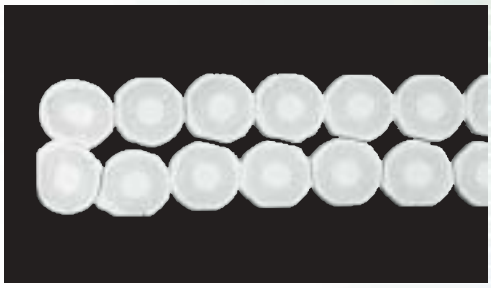


● Wire Breakage

► Average piece length of the LHC outer strand is 38km.

Cabling Techniq ue

● Rutherford Cable without sharp edge



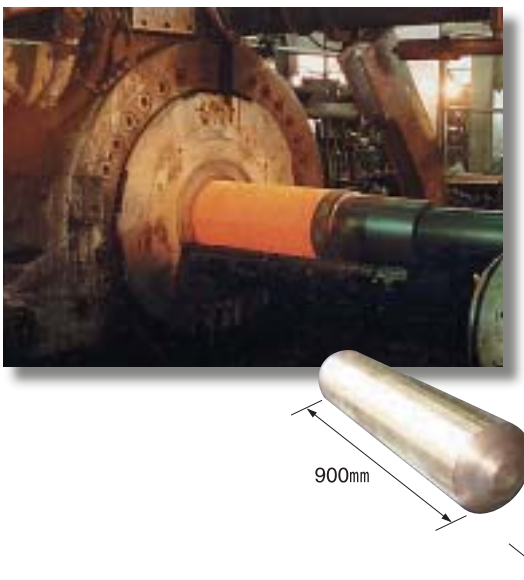
Optimized rolling and Cabling Measuring Engine(CME) gurantee precisely controlled dimensions through whole length.

Nb_3Sn Superconductor

Nb_3Sn superconductors are produced using the so-called " Bronze Process" . Nb or Nb alloy is embedded in a Cu-Sn alloy matrix containing Ti additive.
The adoption of Nb and/or Ta as a diffusion barrier and high-purity oxygen-free copper provides structural stability.

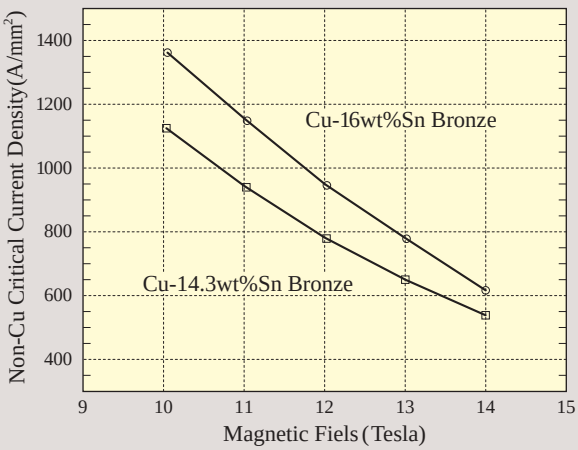
The main features of our products produced at the plant are:
1) Large extrusion billet
2) Hot direct extrusion
3) Maximum product weight out of one billet is 135 kg
   for example ⌀1.0mm ×19 km.

Hot Extrusion



Bronze

To enhance critical current, a bronze processed $(Nb, Ti)_3Sn$ superconducting wire with a Cu-16wt%Sn-0.2wt%Ti bronze matrix was successfully fabricated with a production scale.

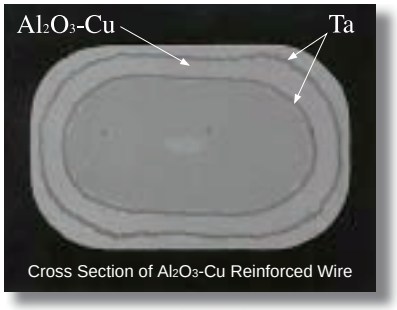


Advanced Superconductor

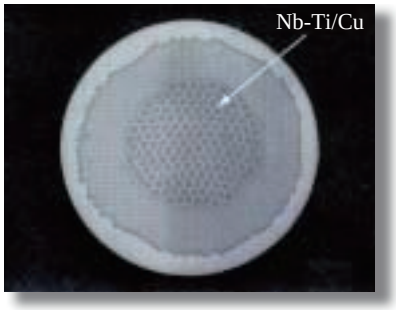
To enhance mechanical strength, new superconductors (Nb_3Sn and Aluminum stabilized Nb-Ti supercoducting wire) were successfully fabricated with a production scale.

High-Strength Nb_3Sn Superconductor

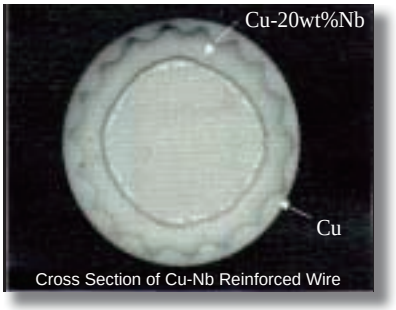
Al_2O_3/CuAlloy



Nb-Ti/Cu Alloy



Cu-Nb Alloy



● Parameter

	Al_2O_3/Cu reinforced	Nb-Ti/Cu reinforced	CuNb reinforced
Diameter [mm]	0.8×1.25(0.3R)	1.00	1.00
Twist pitch [mm]	20	30	30
Filament Diameter [μm]	4.1	3.5	3.4
Tin diffusion barrier	Ta	Nb	Ta
Barrier thickness [μm]	13	11	22
Reinforcement	Cu-0.5wt%Al_2O_3	Nb-Ti/Cu-10wt%Ni	Cu-20wt%Nb
Ic at 12T,4.2K [A]	258	238	216
σ0.2% at R.T. [MPa]	225	300	195
in liq. He [MPa]	270	365	210

Aluminum Stabilized Nb-Ti Superconductor

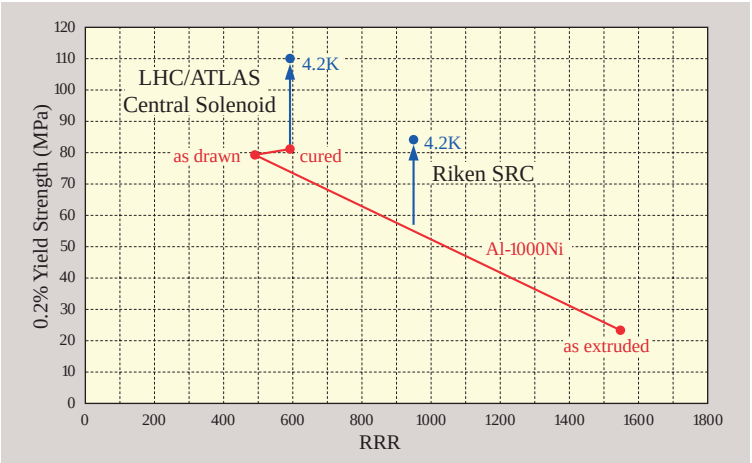
Developed A New Aluminum Alloy

5N pure Al + 1,000 ppm Ni by weight
－High Yield Strength
－High RRR

[Application example]

● For LHC/ATLAS Central Solenoid

● For Riken SRC



● Relationship between RRR and yield strength

FURUKAWA ELECTRIC CO., LTD.

Nikko Works / 500, Kiyotaki, Nikko-city, Tochigi,321-1493,Japan
Phone : +81-288-54-0504
Fax : +81-288-54-2216

Head Office / 2-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo, 100-8322, Japan
Phone : +81-3-3286-3733
Fax : +81-3-3286-3941
E-mail : shim@ho.furukawa.co.jp

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