Examples of High-Performance & Cryostable Magnets

- **920-MHz (21.06 T) NMR magnet—"Adiabatic" bath-cooled**
- **Dipole & quadrupole magnets —"Adiabatic" forced-flow cryogen**
- **Research-purpose magnets —"Adiabatic" cryocooler-cooled**
- **Large Helical Device —"Cryostable" bath-cooled & CCIC**
- **45-T Hybrid —"Cryostable" CCIC**
- **LHC CMS magnet —"Cryostable" reinforced composite & forced-flow single-phase cryogen**

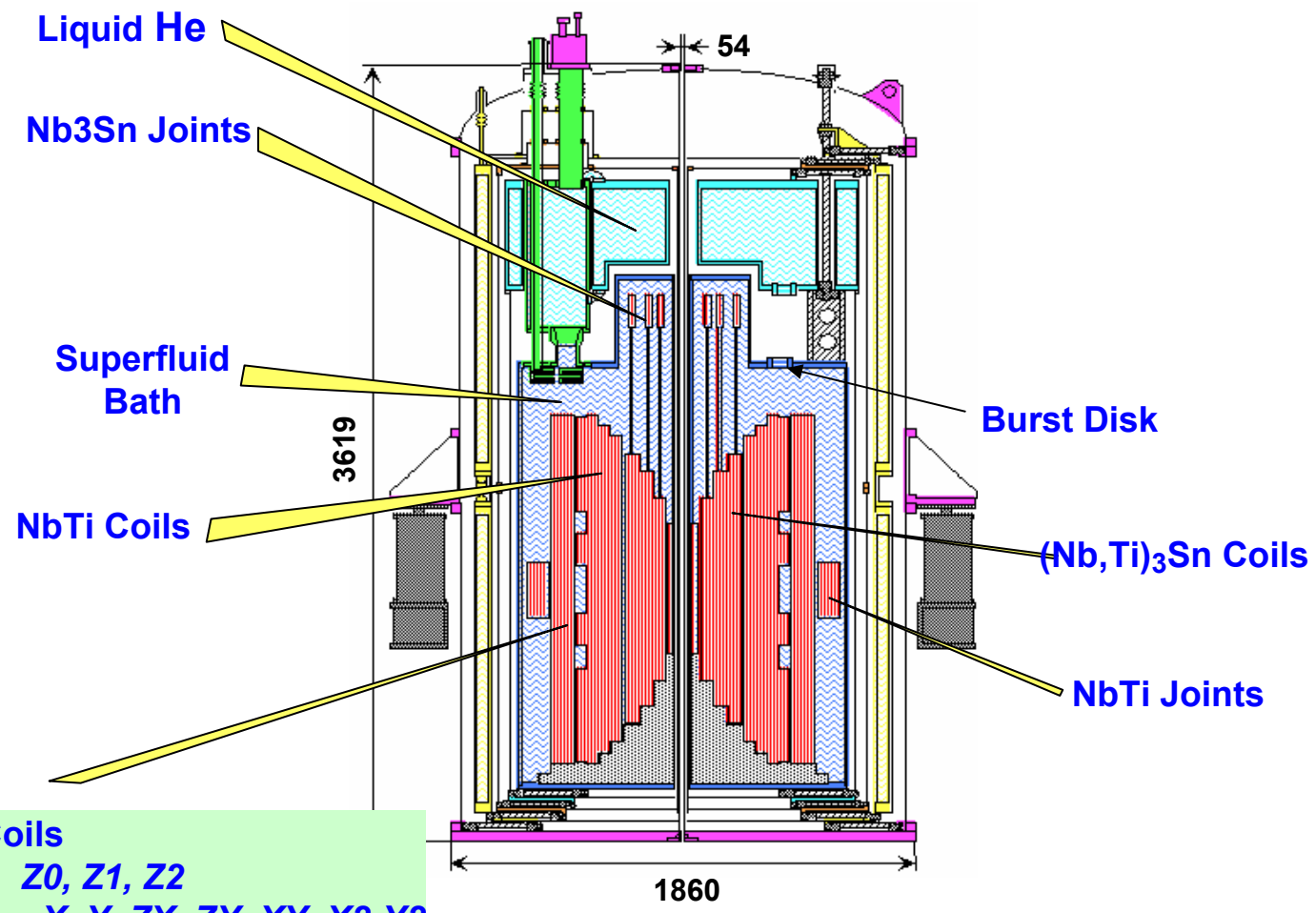
High-Performance

1. Bath-Cooled: NMR Magnet

High-resolution 920 MHz NMR Magnet (Nb-Ti/Nb3Sn @1.8 K) at National Institute for Materials Science, Tsukuba (Kobe Steel, Co.; June 2001)

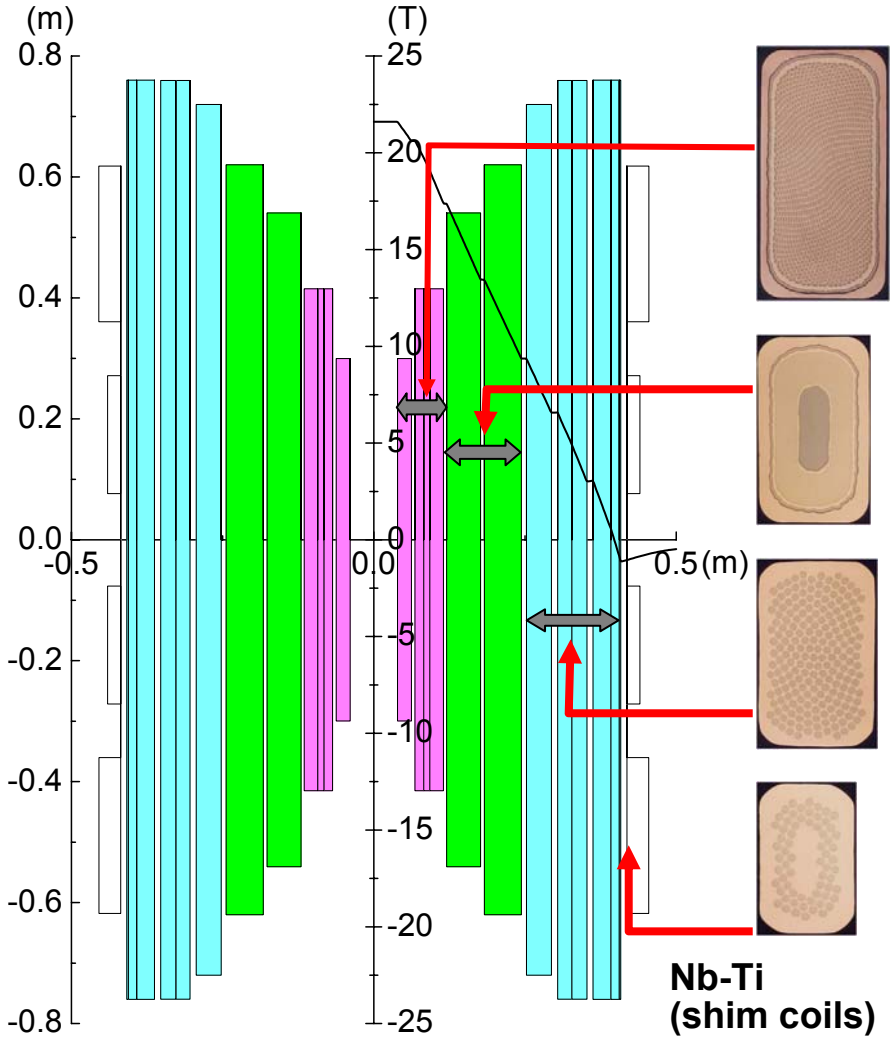
Center Field:	21.6 T
Drift rate:	<0.000235 gauss/h
	<10 Hz/h
RT bore:	54 mm
Height:	5.5 m
Weight:	17 ton
(including cryogen & anti-vibration stand)	
LHe refill interval:	>21 days
refill volume:	386 liters
LN2 refill interval:	>27 days
refill volume:	520 liters

Courtesy of Mamoru Hamada (Kobe Steel)



Shim Coils
Axial : *Z0, Z1, Z2*
Radial : *X, Y, ZX, ZY, XY, X2-Y2*

Main Coil Details



High-Current
High Tin Content (15%-Sn) $(Nb,Ti)_3Sn$

High-Strength (>300 MPa @ 4.2 K)
Ta-reinforced $(Nb,Ti)_3Sn$

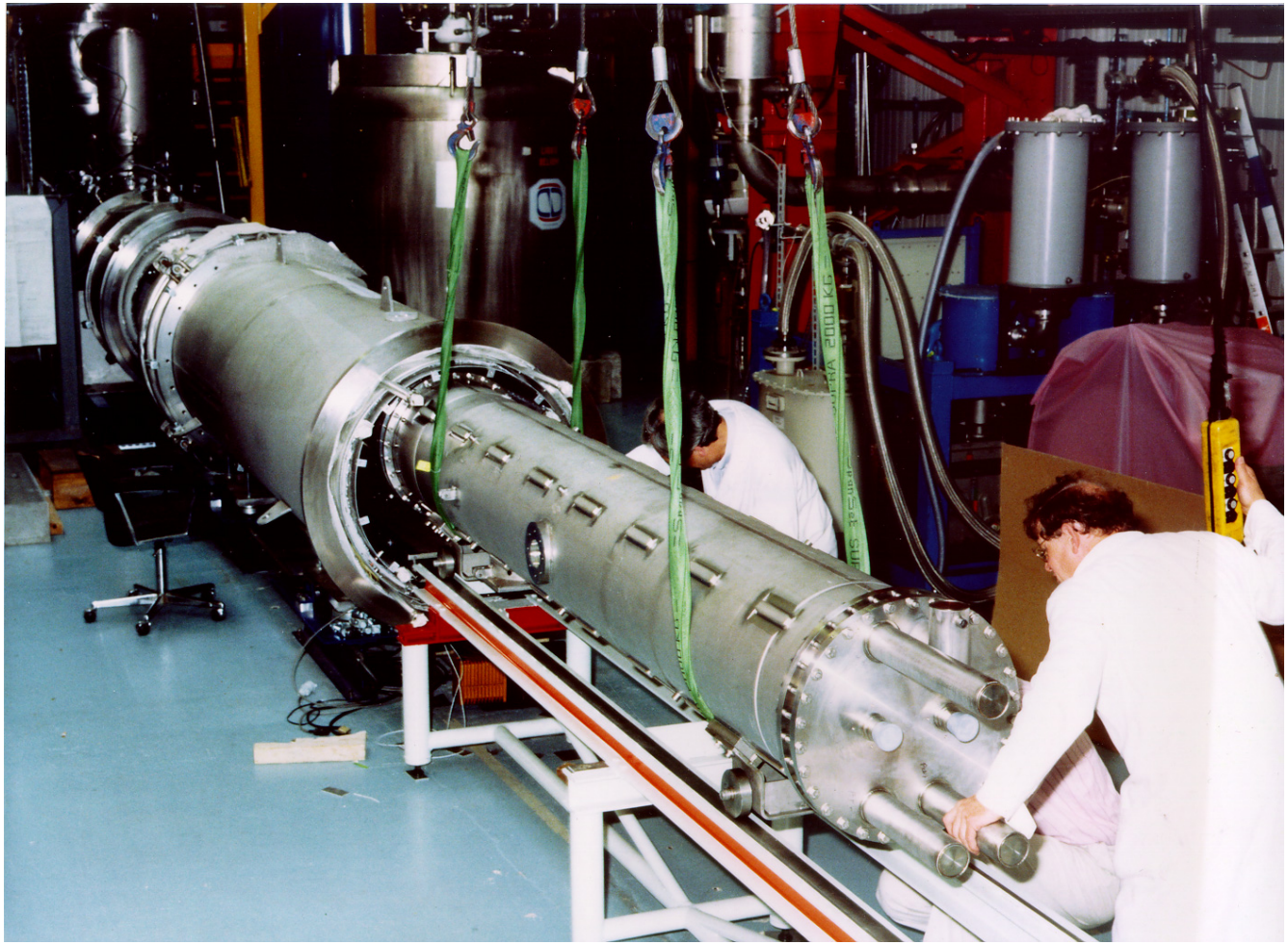
High-Strength (>430 MPa @ 4.2 K)
Cold-worked NbTi

Nb_3Sn conductors:	1382 kg
NbTi conductors:	3444 kg
Inductance:	1123 H
Operating current:	244.2 A
Stored energy:	33 MJ

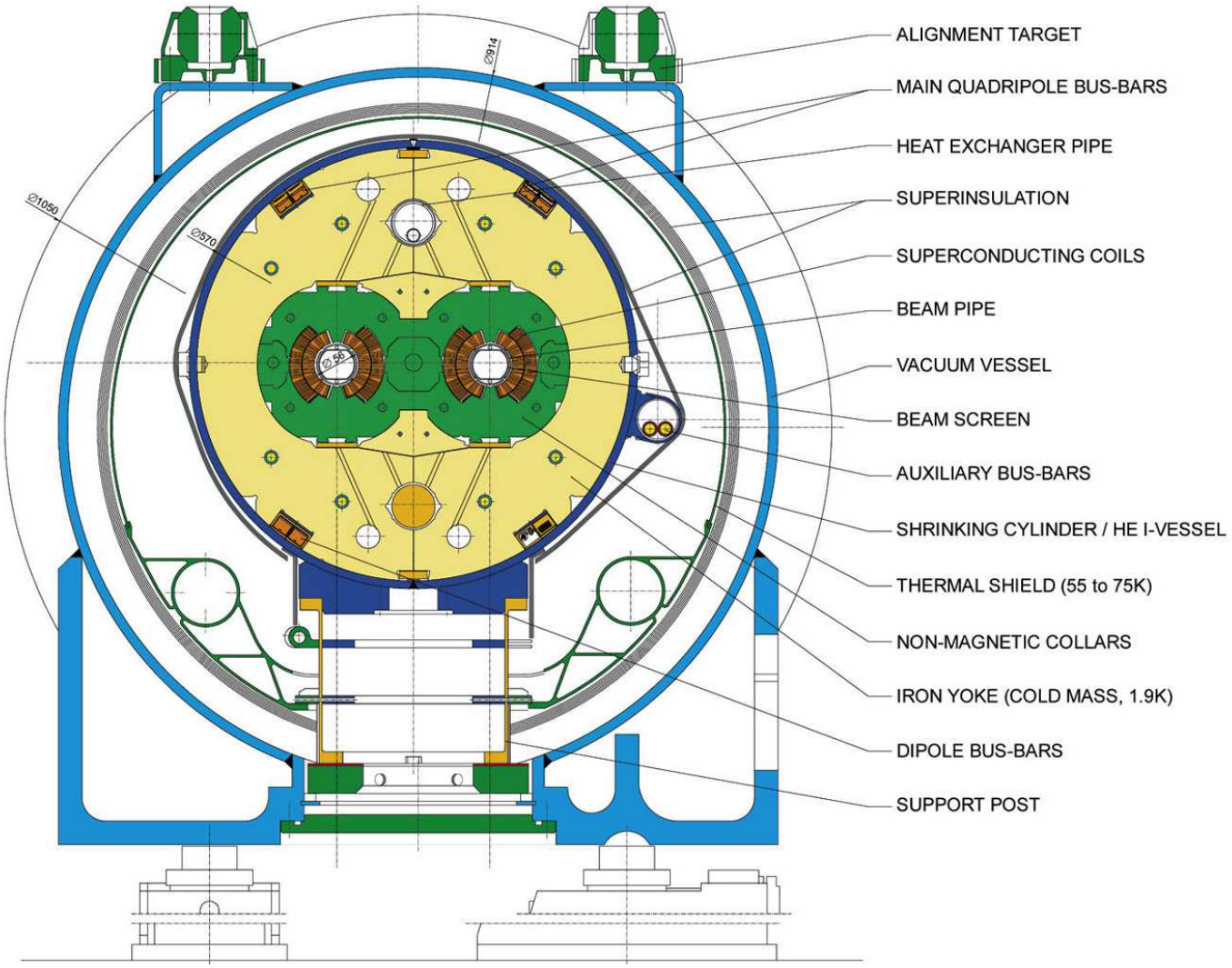
Courtesy of Akio Sato (NIMS, Tsukuba)

High-Performance

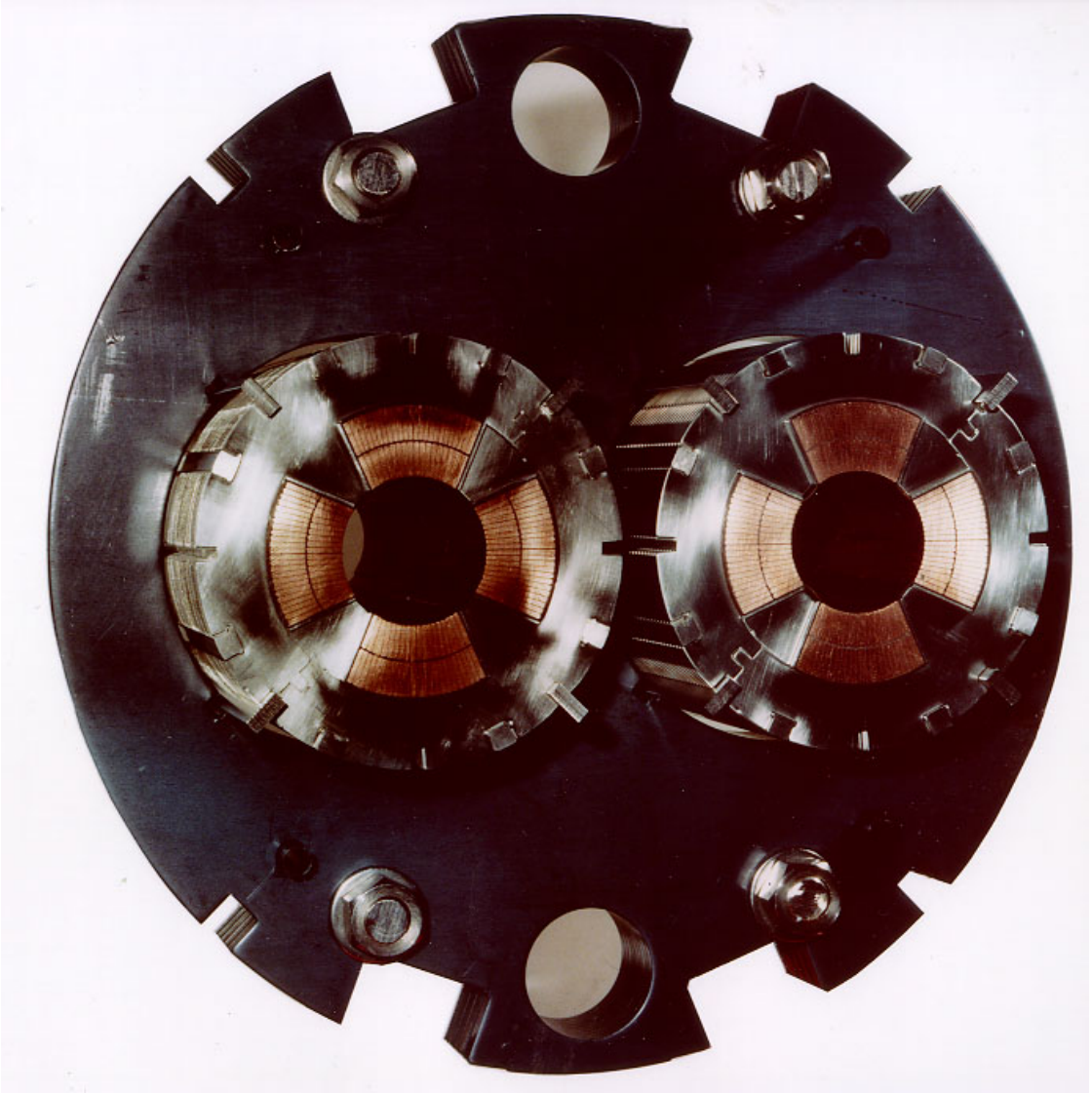
2. Forced-Flow Cryogen: LHC Dipoles & Quadrupole



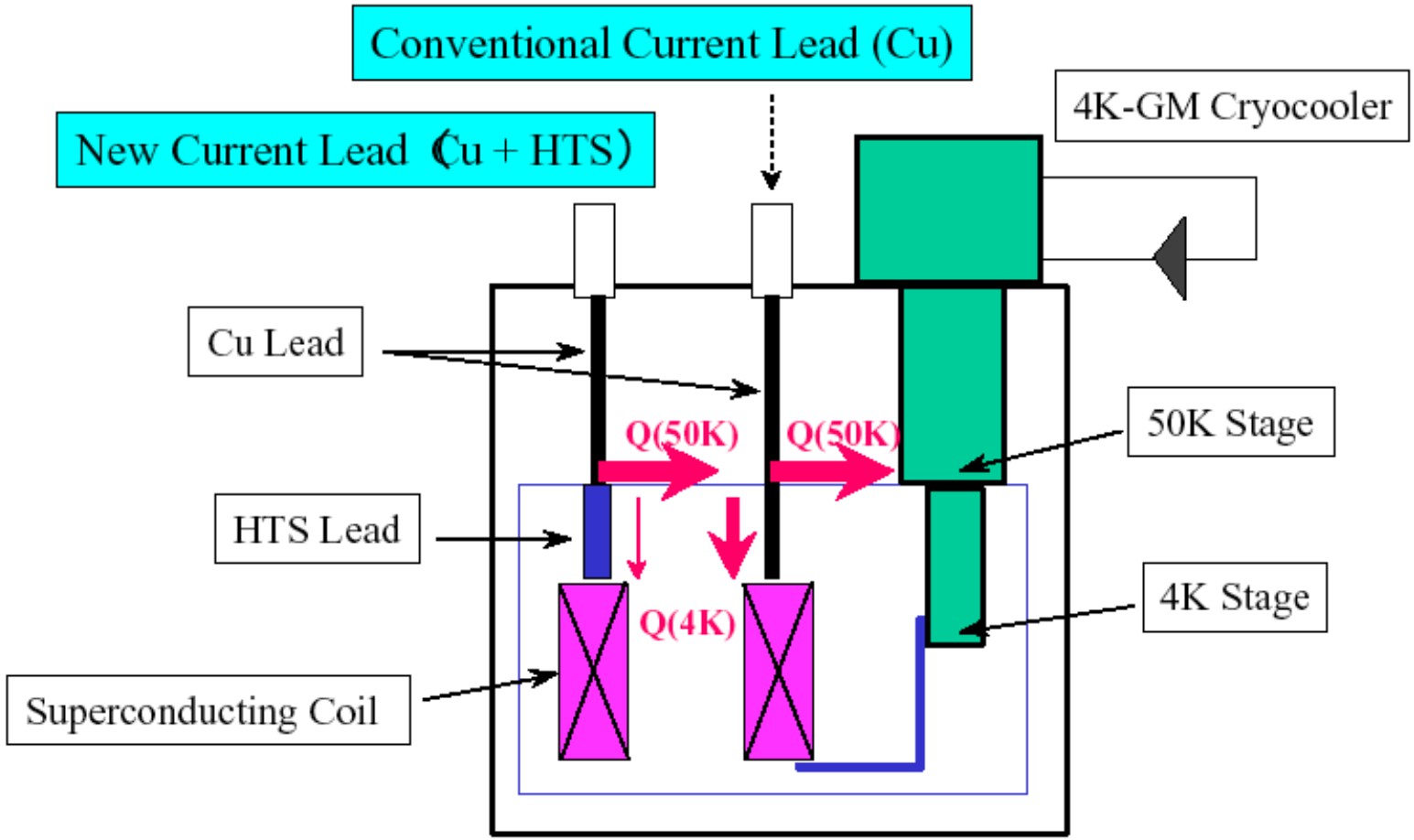
LHC Dipole


ALIGNMENT TARGET
MAIN QUADRIPOLE BUS-BARS
HEAT EXCHANGER PIPE
SUPERINSULATION
SUPERCONDUCTING COILS
BEAM PIPE
VACUUM VESSEL
BEAM SCREEN
AUXILIARY BUS-BARS
SHRINKING CYLINDER / HE I-VESSEL
THERMAL SHIELD (55 to 75K)
NON-MAGNETIC COLLARS
IRON YOKE (COLD MASS, 1.9K)
DIPOLE BUS-BARS
SUPPORT POST
Ø914
Ø1050
Ø510
Ø55

LHC Quadrupole

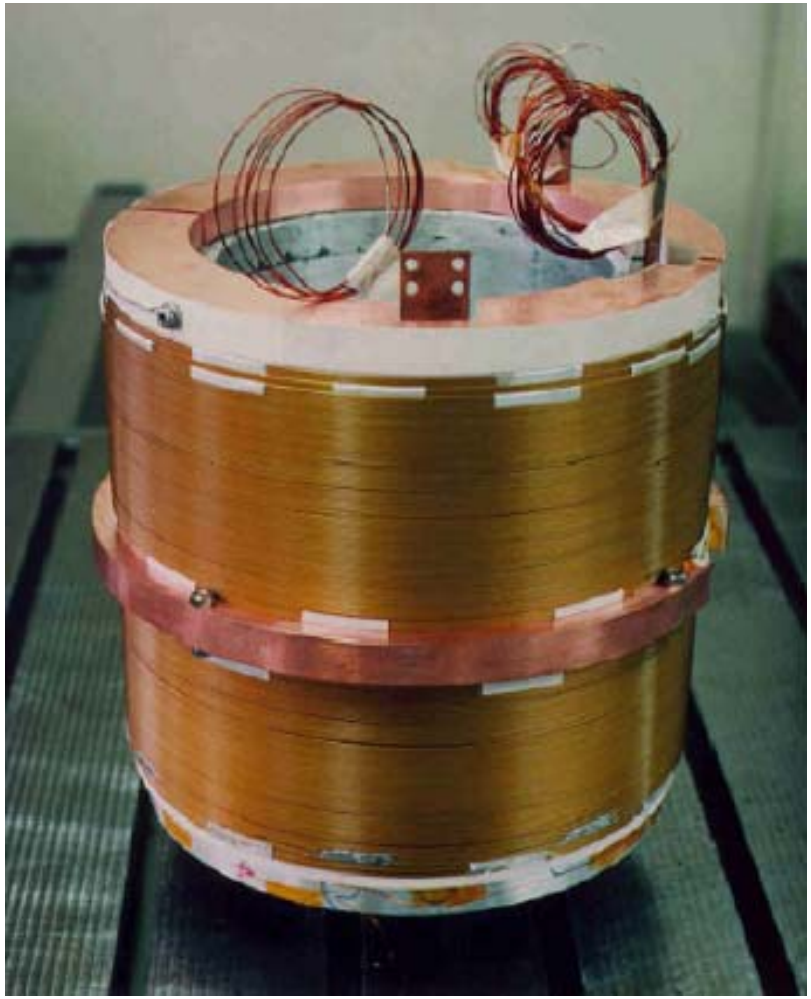


3. Cryocooler-Cooled: Research-Purpose Magnets

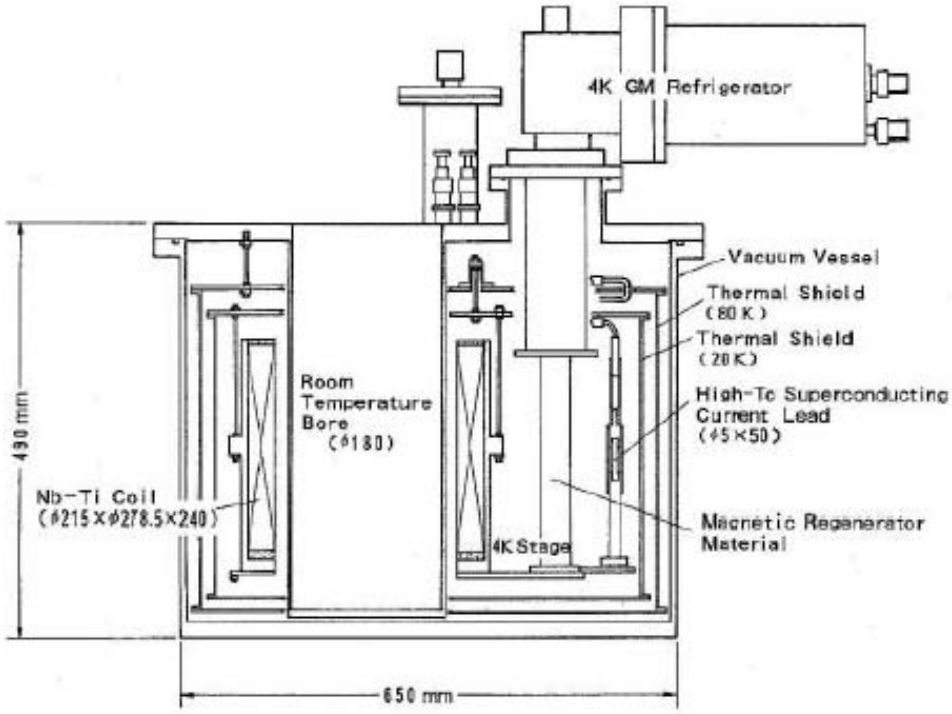


Courtesy of Toru Kuriyama (Toshiba)

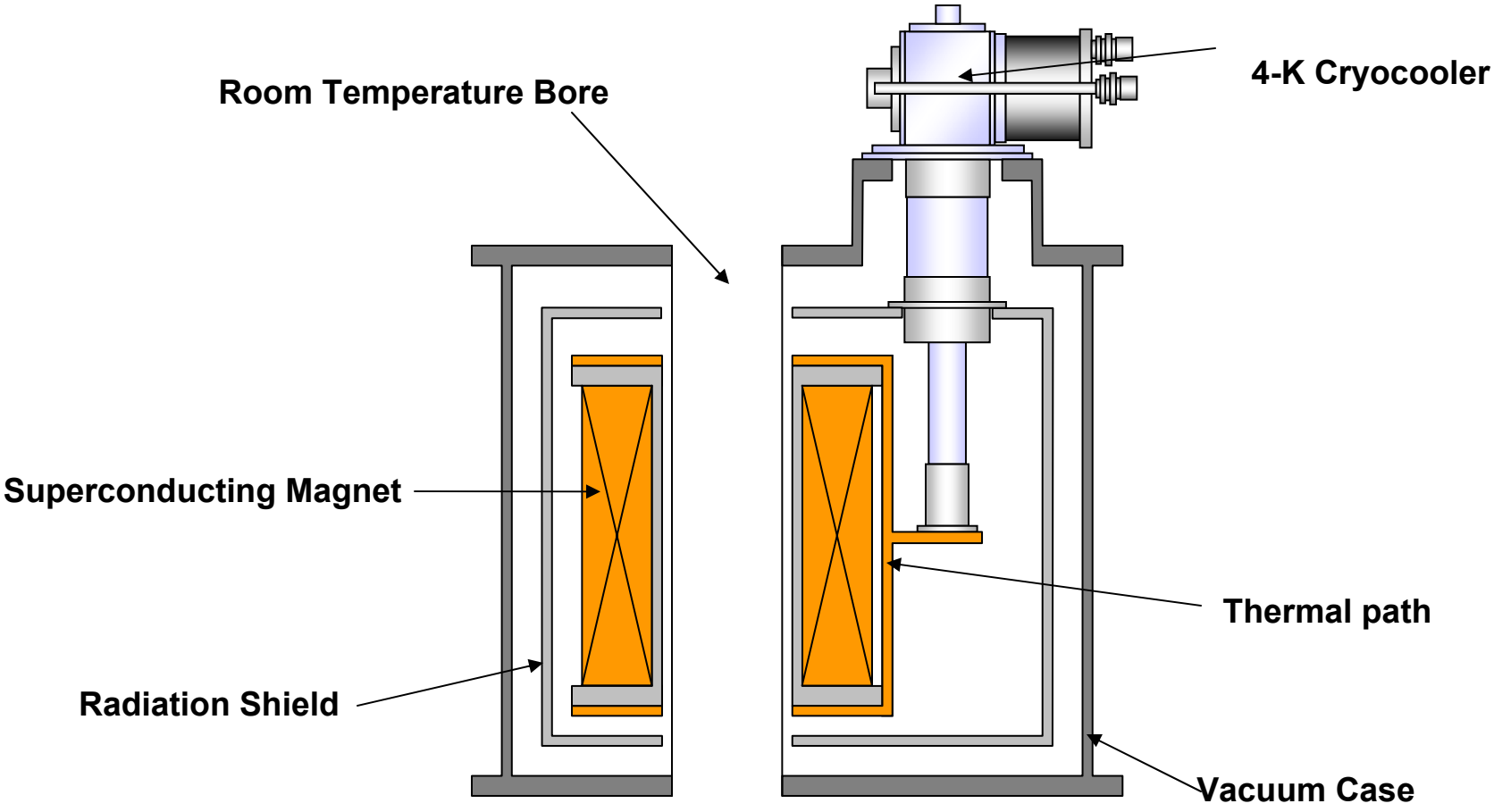
Conduction-Cooled 6 T Nb-Ti Magnet



6 T Cryocooler/Nb-Ti Magnet



Φ180mm, 6T



Courtesy of Kazuyuki Shibutani (Kobe Steel/JASTECH)


JASTEC
JAPAN SUPERCONDUCTOR TECHNOLOGY INC.

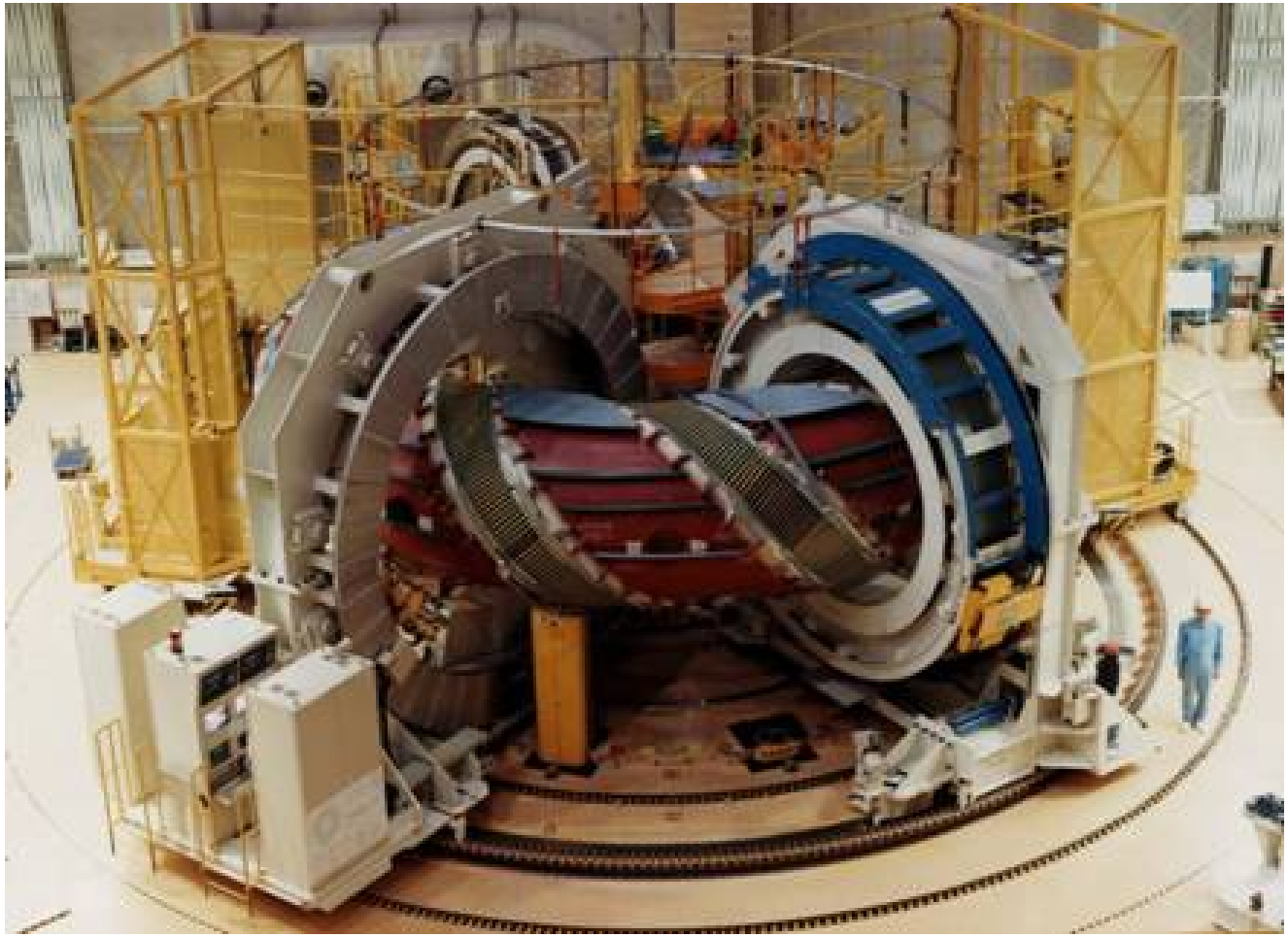
Cryostable

1. & 2. Bath-Cooled & CICC: Large Helical Device (LHD)

- **Large Helical Device (LHD) is an experimental fusion device which uses the heliotron magnetic field concept developed in Japan.**
- **To confine current-less steady-state plasma, LHD was designed as a fully superconducting system.**
- **Construction started in 1991 and completed by the end of 1997.**
- **Plasma experiment started on March 31, 1998.**

Courtesy of Toshiyuki Mito (NIFS, Toki)

Winding Machine for Helical Coils



On-site winding Start: Jan 1995; Finish: May 1996