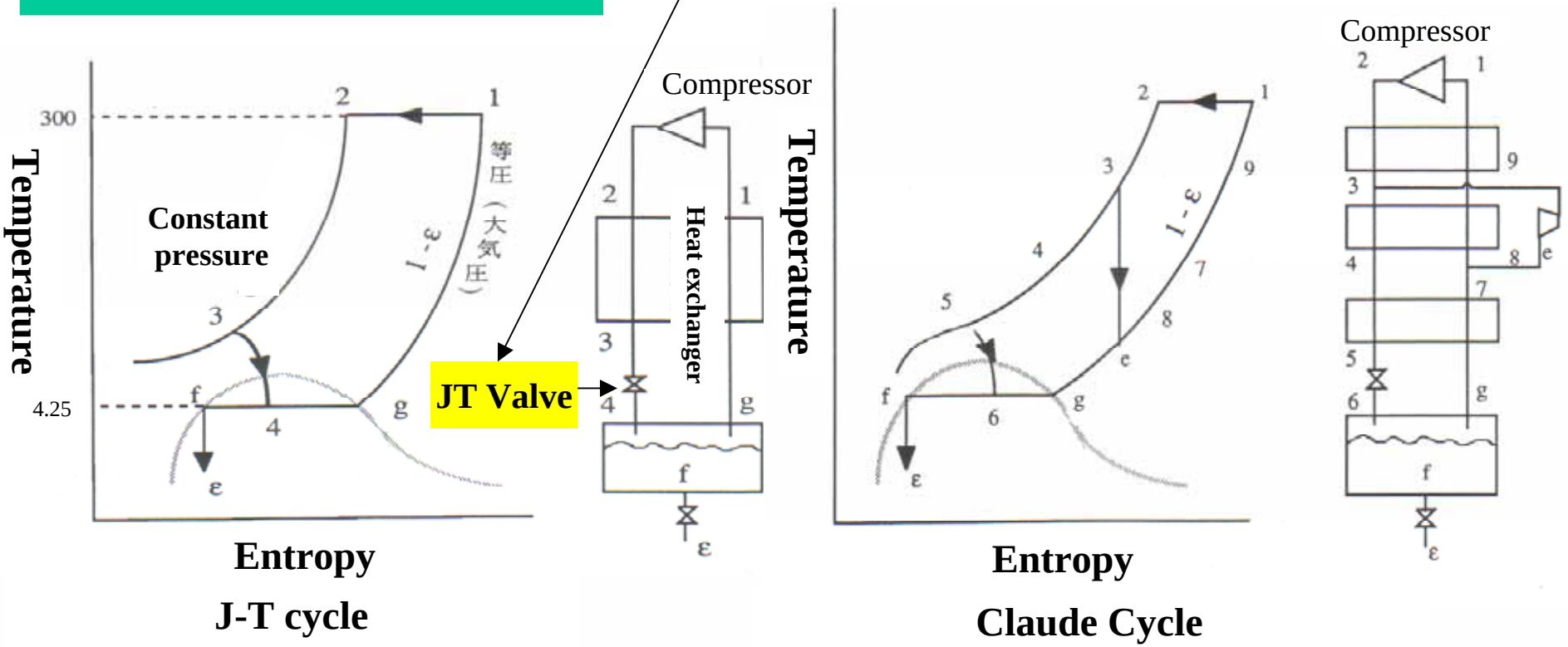
14. Cryogenics

Completely thermodynamics

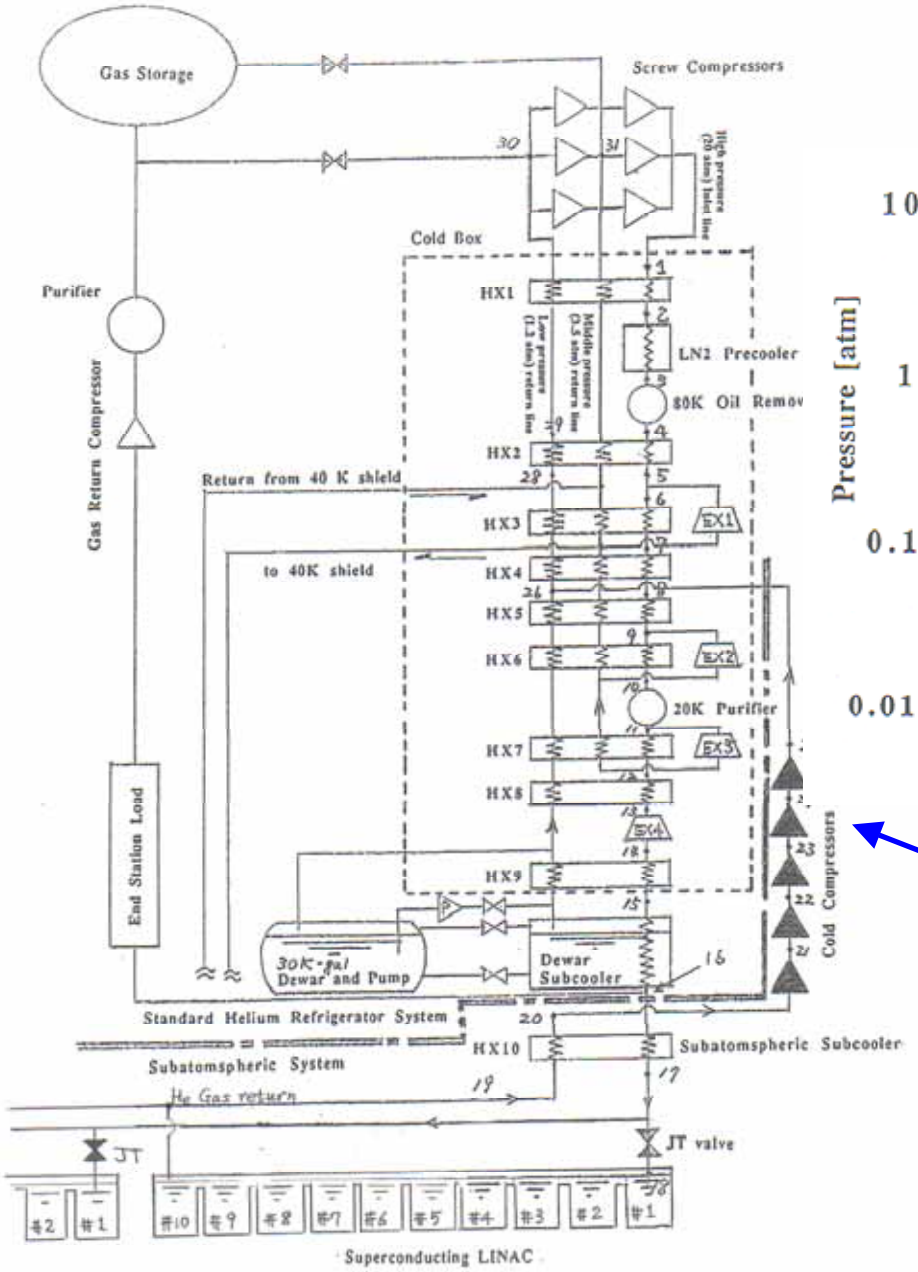
Open the JT valve bellow 45K for LHe

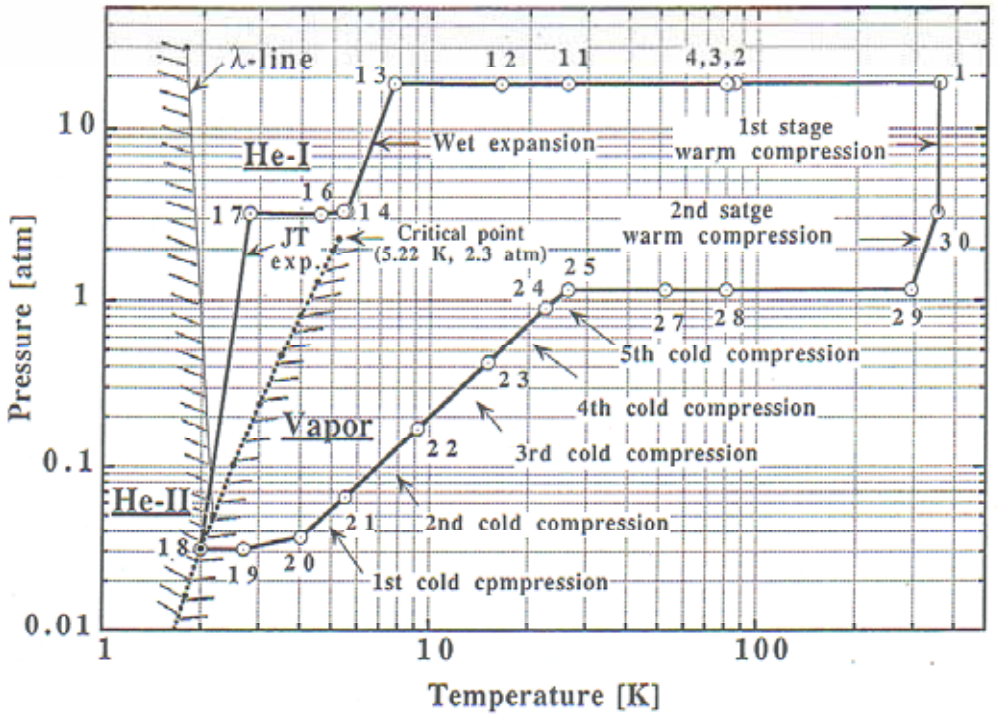


Expand the gas by J-T valve, and decrease the temperature

Make work a part of the gas by operating turbine,
Decrease the temperature,
Reduce the temperature of the heat exchanger

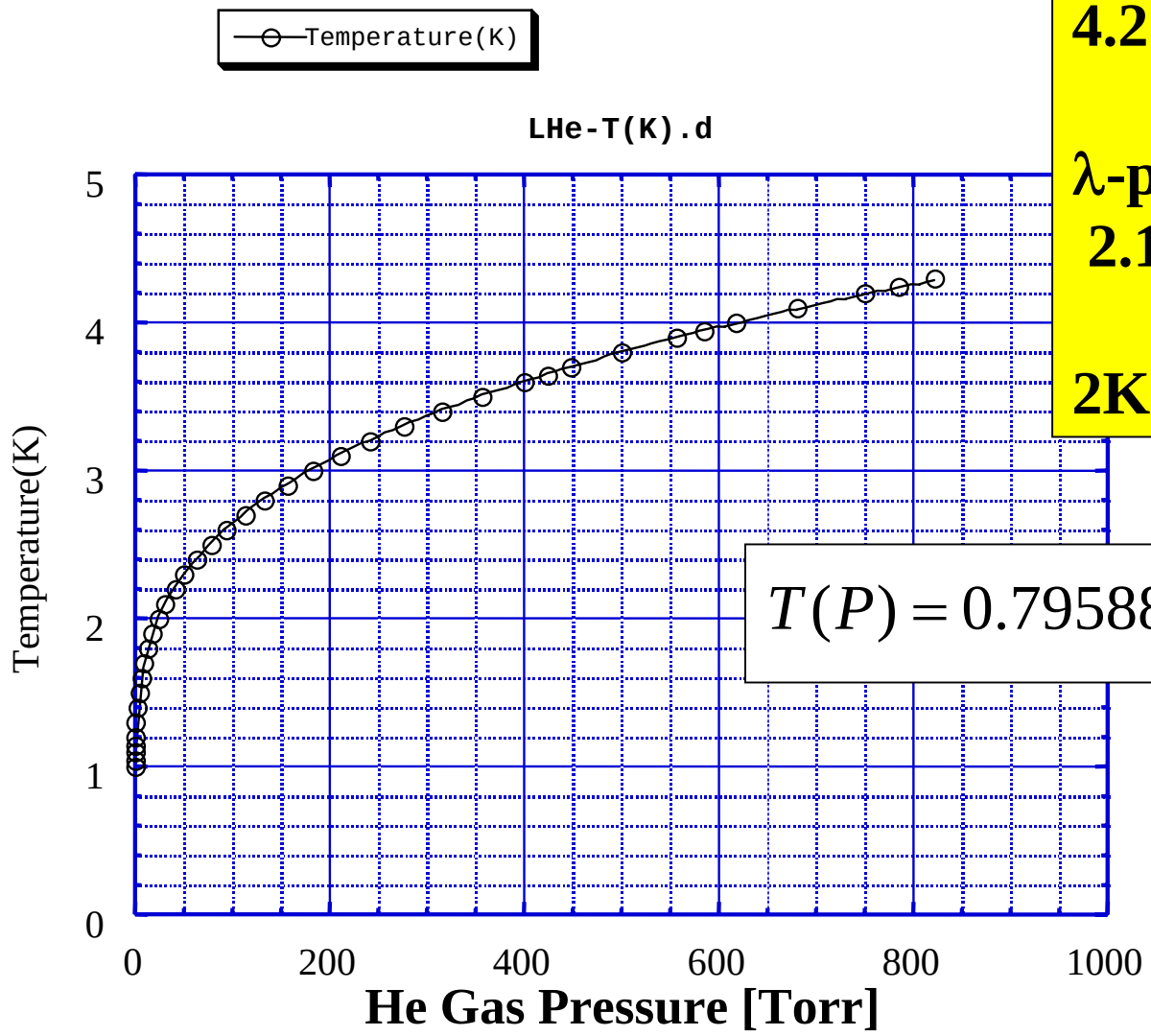
2K Liquid Refrigerator (CEBAF)





Cold compressor:
Compress the cold gas and
Increase the temperature and pressure up to nearly RT.

LHe Temperature P vs. T



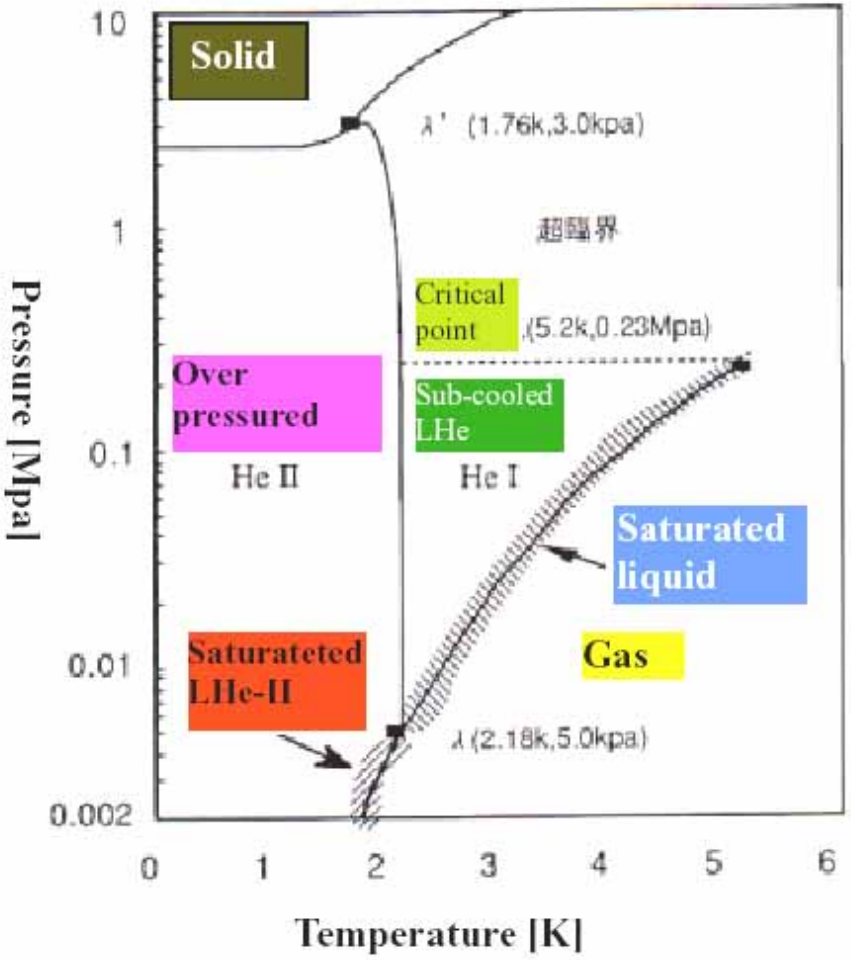
4.25 K = 760 Torr

λ-point :
2.1773K = 38.41 Torr

2K = 23.77 Torr

$$T(P) = 0.79588 + 0.46085 \cdot P^{0.30163}$$

Characteristics of the He-II



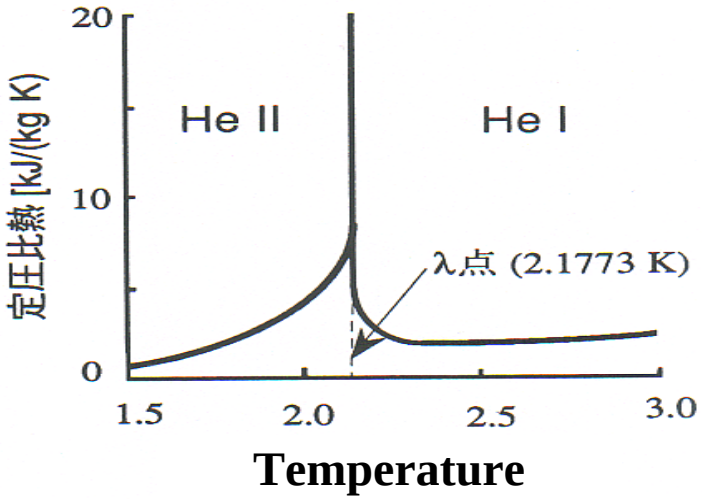


図５-２　ヘリウム４の定圧比熱

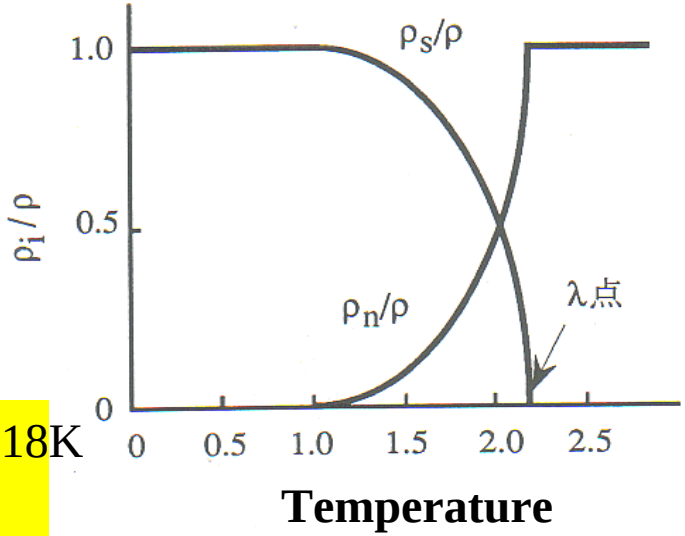


図５-３　He II中での超流動成分（ρ_s/ρ）と常流動成分（ρ_n/ρ）の比率の温度変化

- LHe transits from He-I to LHe-II at Lamda point : T=2.18K
- He-II　has no viscosity and makes easily super-leak.
- He-II has very a large thermal conductivity.
  which is 100 higher than that of copper at low temperature

Characteristics of thermal conductivity of He-II

$$q^m = f(T)^{-1}\frac{dT}{dx}$$