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A dilution refrigerator insert for standard ILL cryostats

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Résumé. — Pour étendre la gamme de température des cryostats standards ILL (300-1,2 K) on a remplacé le porte-échantillon par un insert à dilution, avec une température minimale de 19 mK et une puissance frigorifique de 23 μ W à 0,1 K.

Abstract. — In order to extend the temperature range of Standard ILL cryostats (300-1.2 K) the sample stick was replaced by a dilution refrigerator insert with a minimum no-load temperature of 19 mK and a cooling power of 23 μ W at 0.1 K.

In order to extend the temperature range of standard ILL cryostats (300-1.2 K) to lower temperatures, we replaced the sample stick by a dilution refrigerator insert (Fig. 1). The large cooling power (15 mW at 1.5 K) of the ILL cryostats allows to precool and liquify the incoming He^3 of the dilution refrigerator. The tubular heat exchanger is constructed as follows. A Cu-Ni tube 0.6/0.4 mm (o.d., i.d.), 1.5 m long with a manganin wire of 0.25 mm inserted and a brass tube of 1.5 mm o.d. and 1.4 mm i.d., 3 m long are wound around a piano wire of 1.1 mm to form a coil with an overall length of about 1 m. This coil is inserted into an annealed brass tube of 3 mm o.d. and 2.6 mm i.d. The concentric tubes are again wound into a coil of about 32 mm in diameter. The mixing chamber has a sintered copper heat exchanger with a surface of $\sim 5 \text{ m}^2$ (measured *in situ*).

Circulating He^3 with a 12 m^3/h pump (Alcatel 2012 H) a minimum no-load temperature of 19 mK was attained. The cooling power (23 μ W at 0.1 K, Fig. 2) was measured at the outside of the mixing chamber. The cooling time from room temperature to 30 mK is typically 6 hours.

The insert is suitable for a large variety of instruments (TOF, triple axis, backscattering, powder diffractometer) and for sample sizes up to 50 mm $\times$ 38 mm².

For the next generation the following improvements are planned :

Fig. 1.

1) An internal condensation stage. The incoming compressed He^3 gas will be cooled down and liquified by the cold low pressure He^3 gas in a counterflow heat exchanger. That allows to operate the dilution

refrigerator from 4.2 K of a normal He^4 bath [1].

2) A step heat exchanger with sintered copper ($2 \times 5 \text{ m}^2$ exchange area) will increase the cooling power below 50 mK and lower $T_{\min}$ to $< 15 \text{ mK}$.

Fig. 2.

References

- [1] KRAUS, I., *Cryogenics* 17 (1977) 173.