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K原子核探索実験の為のHe標的装置の開発

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	and E471 members

Contents

Introduction

E471 Target Requirements

^{4}He(stopped K^-,n) spectroscopy for deeply-bound kaonic nuclear states

(1) background ^{4}He(stopped π^-,n); Flat L-He Target with thin windows, t ~ 60 mm, d=234 mm

(2) other neutron background → surround material as thin as possible

(1) → Super fluid He

(2) → L-type Cryostat, Super fluid He

(2) → CFRP vacuum can

E471 SETUP

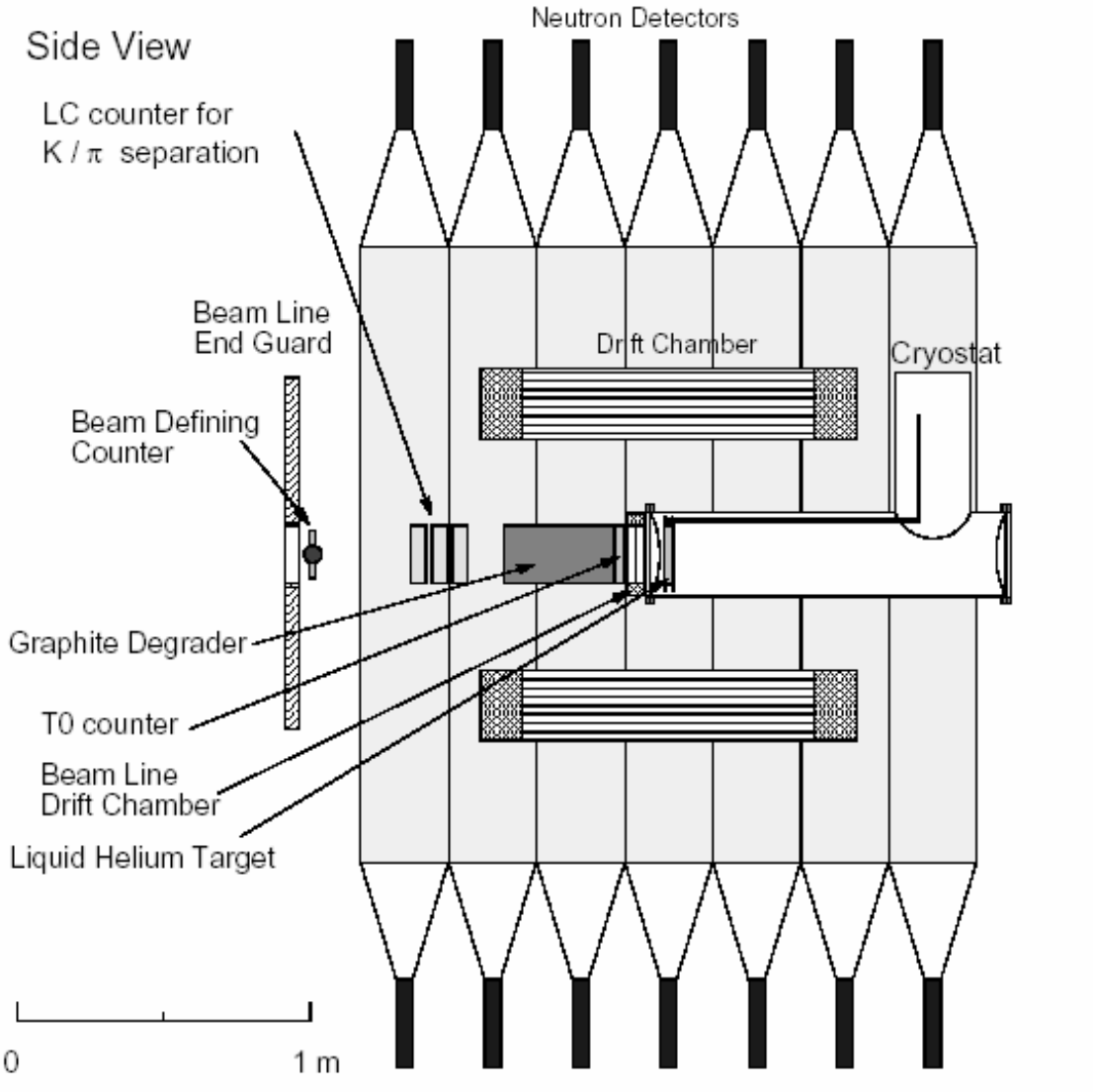


Fig. 5. Schematic figure of the experimental setup (side view).

E471 SETUP

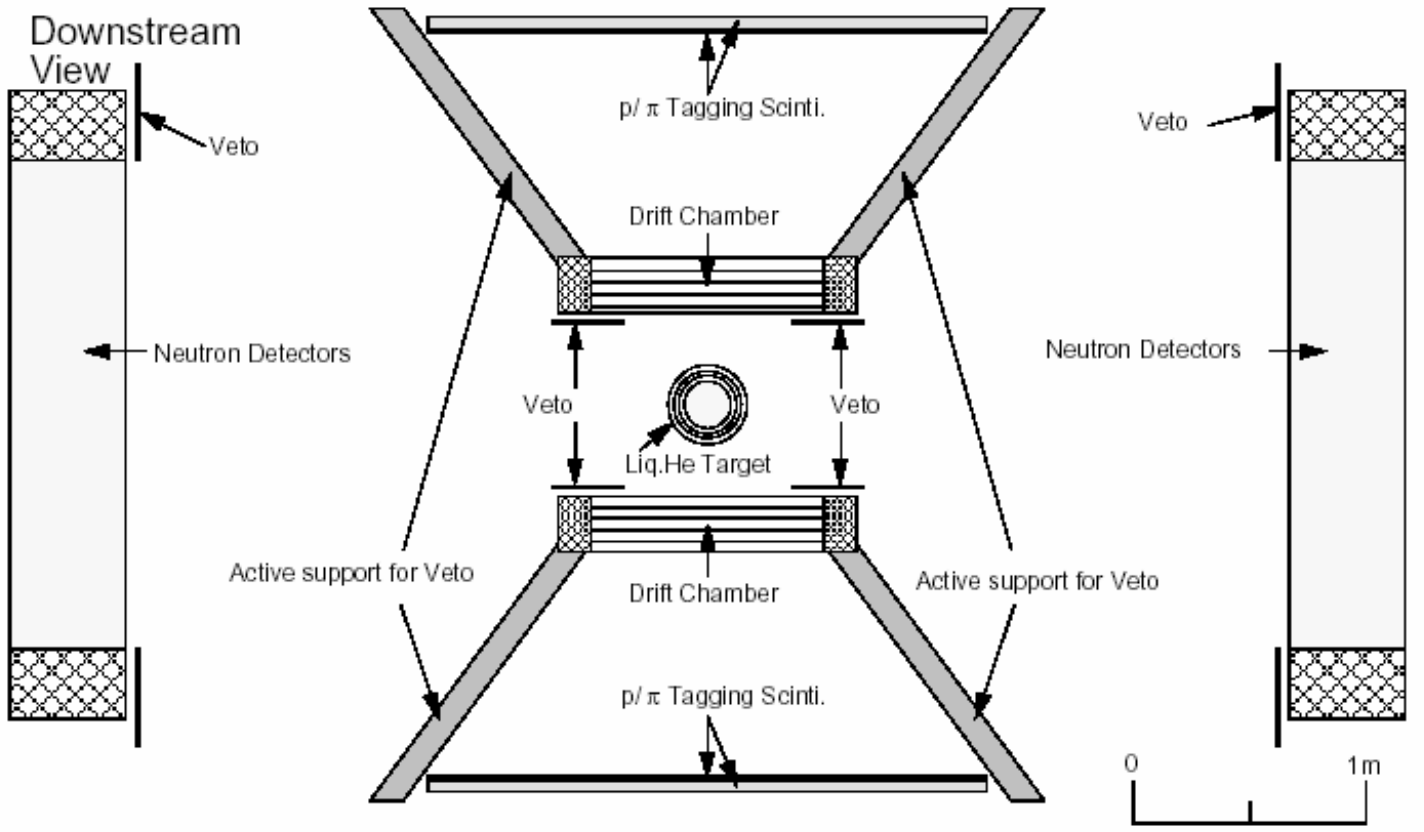


Fig. 6. Schematic figure of the experimental setup (downstream view).

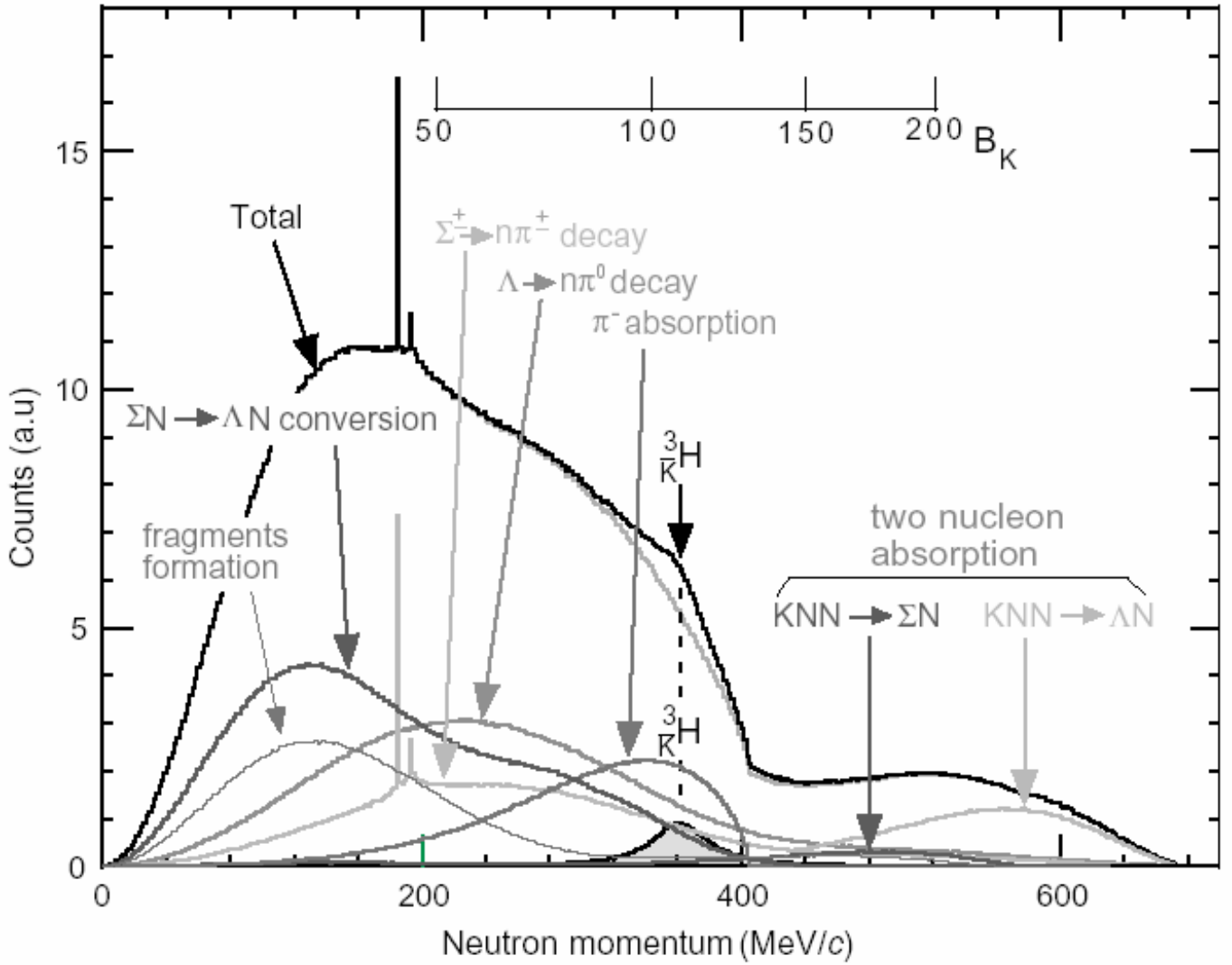


Fig. 2. Simulated neutron momentum spectrum and its decomposition. The signal was generated by a Lorentz function with 108 MeV binding energy, 20 MeV in width, assuming a branching ratio of 2 %. The detector resolution is not folded in.

Why Super Fluid Helium (He-II) ?

Merit of Super Fluid Helium

(1) Low vapor pressure < 42 mbar

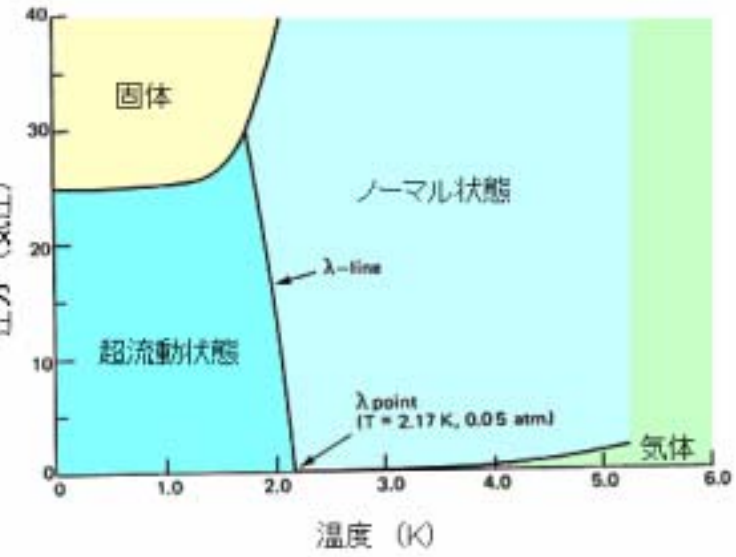
→ thin wall; 75 micron Mylar

(2) Large thermal conductivity

→ 1000 times better than copper at 2 K

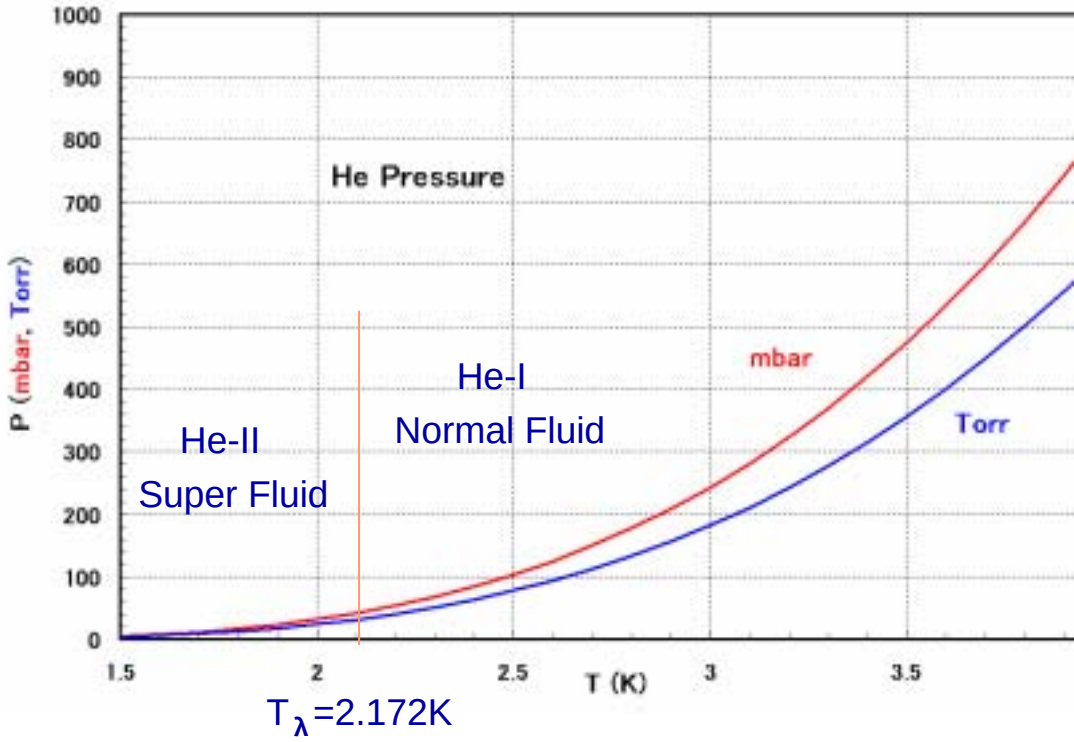
→ connect by small tube, L-type Cryostat

He vapor pressure



He-II T_λ=2.17 K

P_λ=41.9 mbar=31.4 Torr= 0.041 atm



L-He-II Heat Transfer

$Q = (S/L)\,\kappa\,\Delta T$

κ ; thermal conductivity

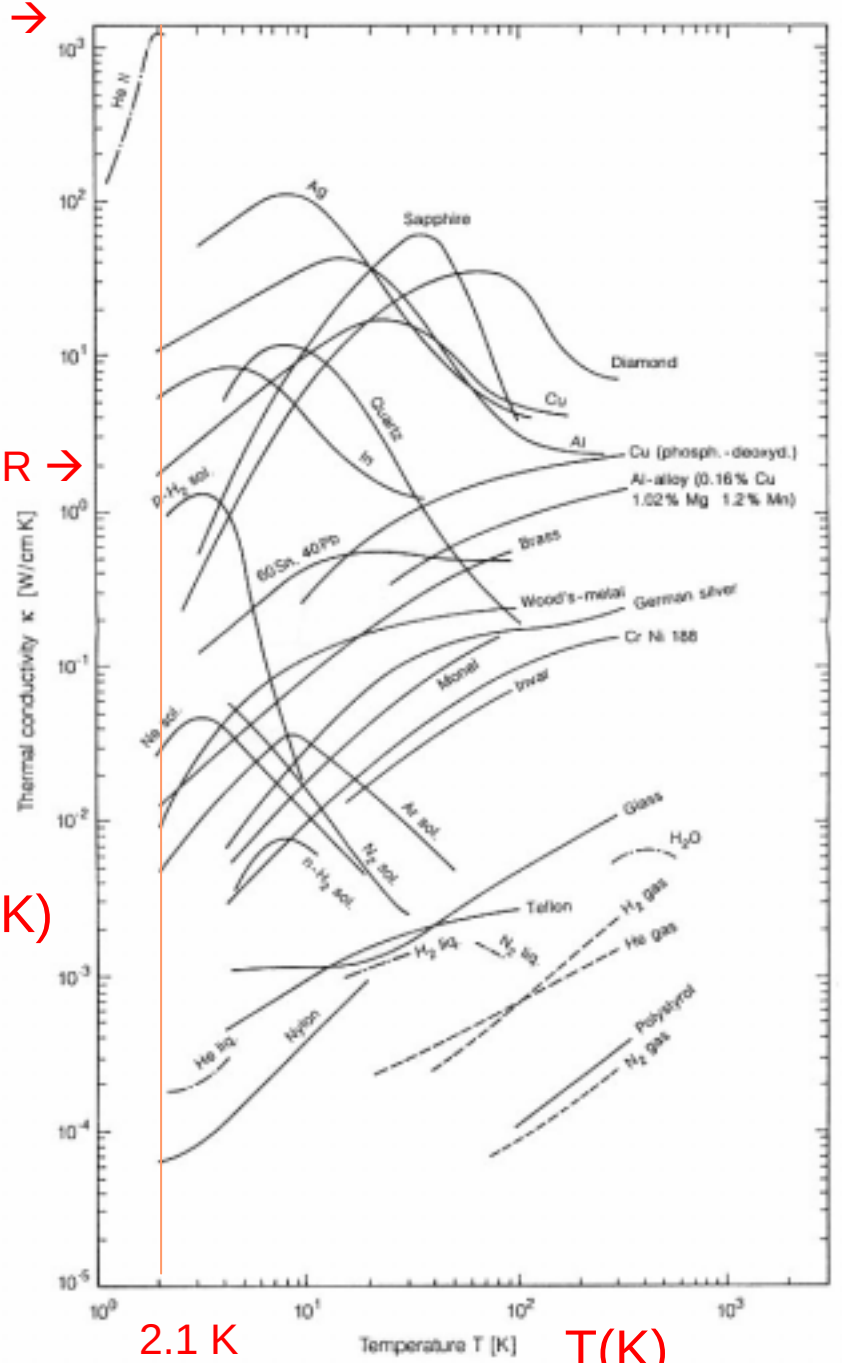
$\kappa = 10^3$ (W/cmK) at 2.1K

$S/L = \pi (0.5)^2/90$

When $\Delta T < 0.1$K

$Q < \pi (0.5)^2 \times 0.1 \times 10^3/90$

< 0.87 W



He Latent Heat and Consumption

When Q = 1 W at 2.1K

Latent Heat

Q_L = 90 J/mol at 2.1 K

n_L = 1/90 mol/s

Factor 2 from 4.2 K to 2.1K

Factor 2 for transfer loss

n = 4/90 mol/s

= 5.1 l/hr (liquid He)

~ 125 l/d

~ 1,000 l/w

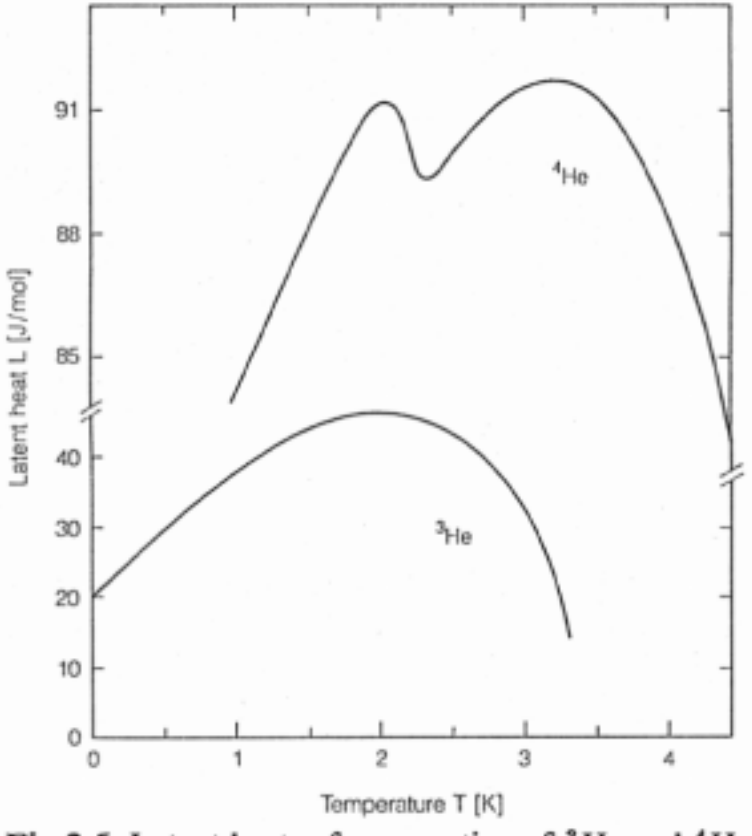
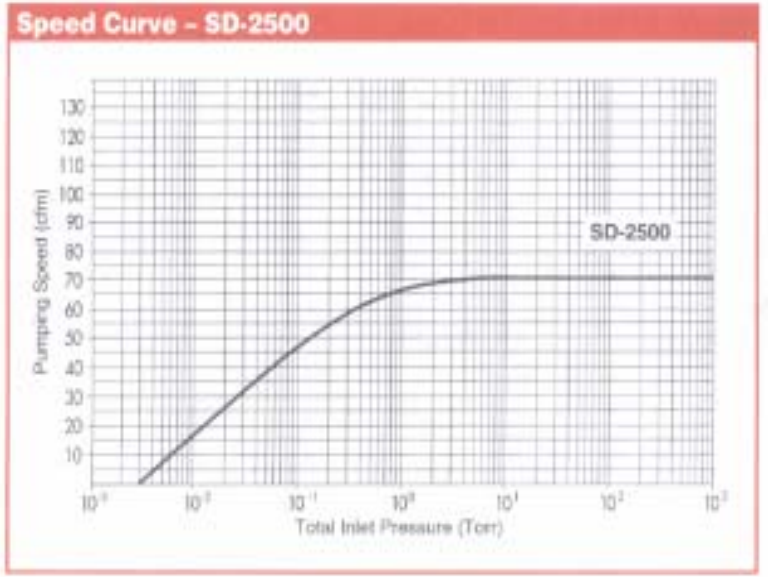
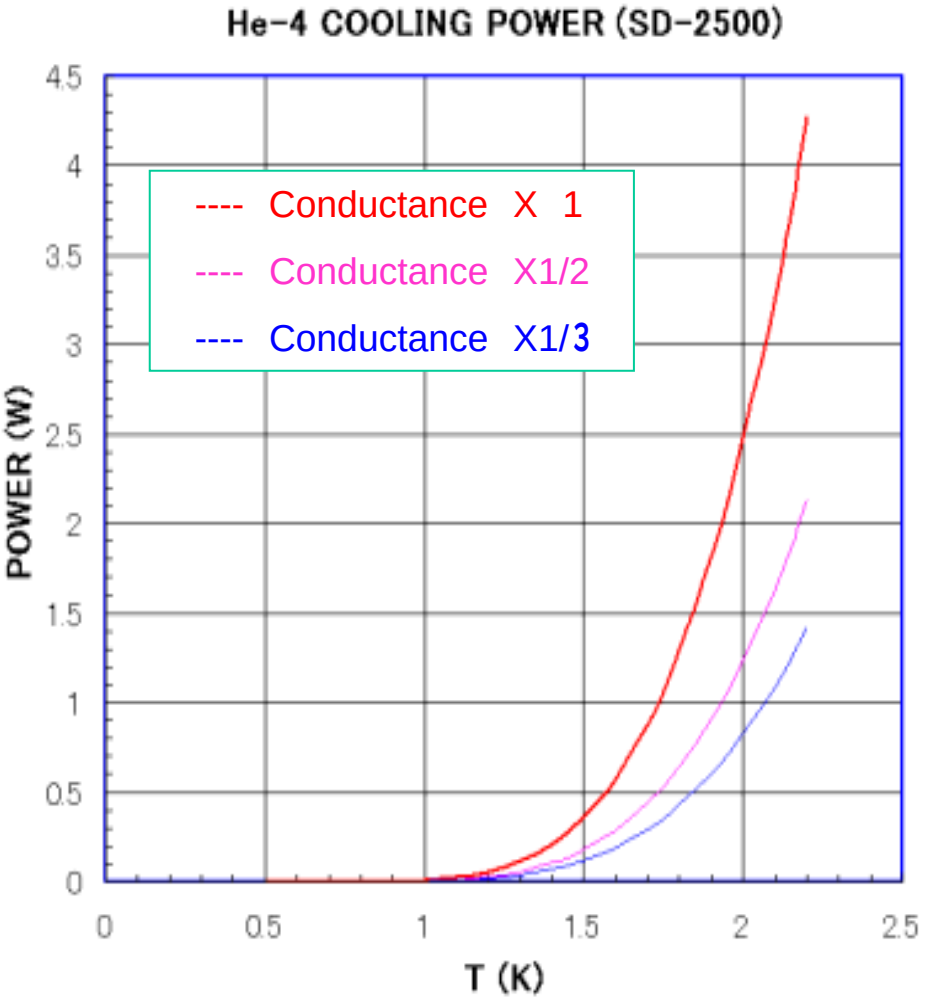


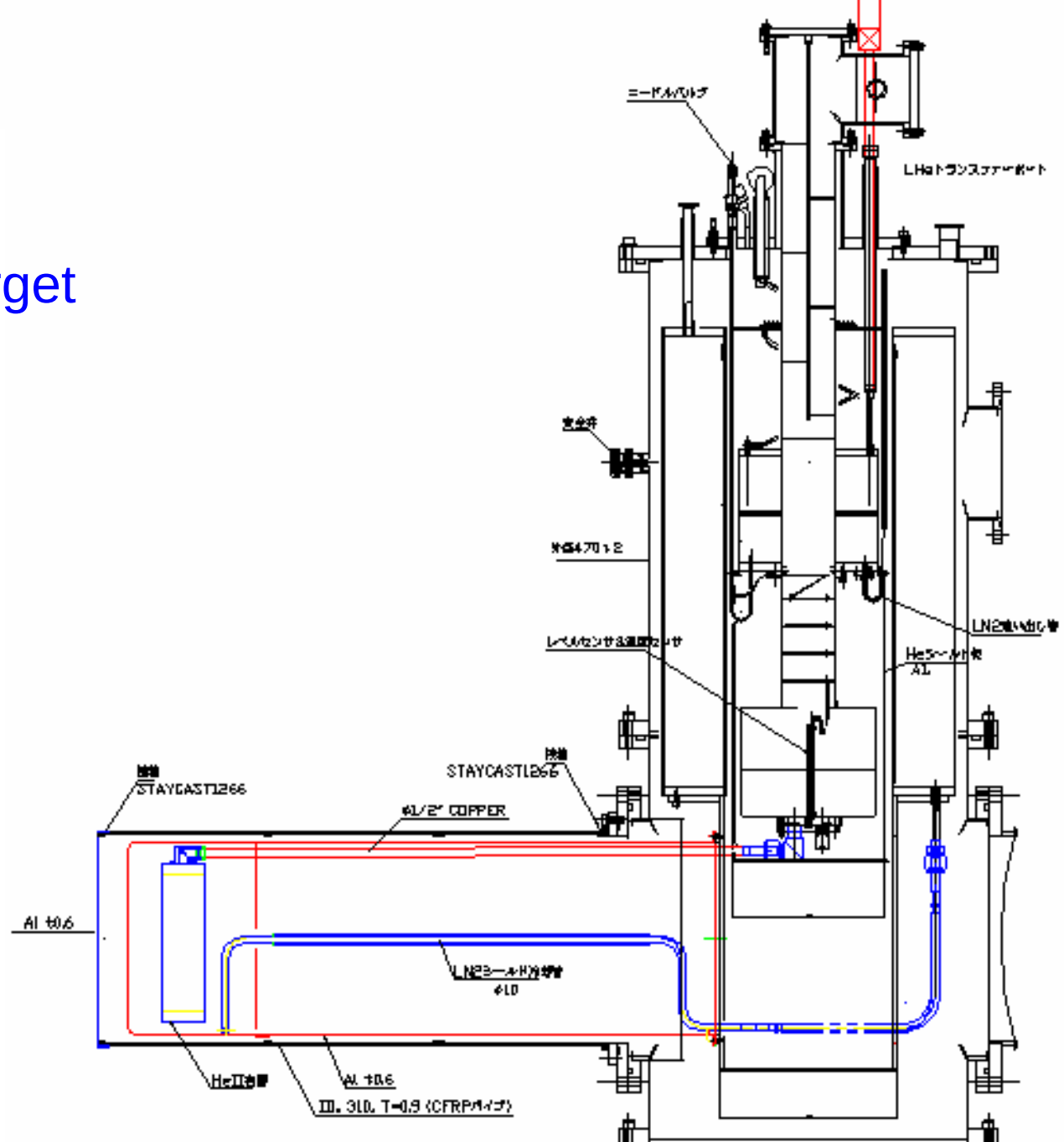
Fig.2.5. Latent heats of evaporation of ^{3}He and ^{4}He. Note the change of vertical scale


Speed Curve - SD-2500
SD-2500
Pumping Speed (cfm)
Total Inlet Pressure (Torr)


He-4 COOLING POWER (SD-2500)
---- Conductance X 1
---- Conductance X1/2
---- Conductance X1/3
POWER (W)
T (K)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

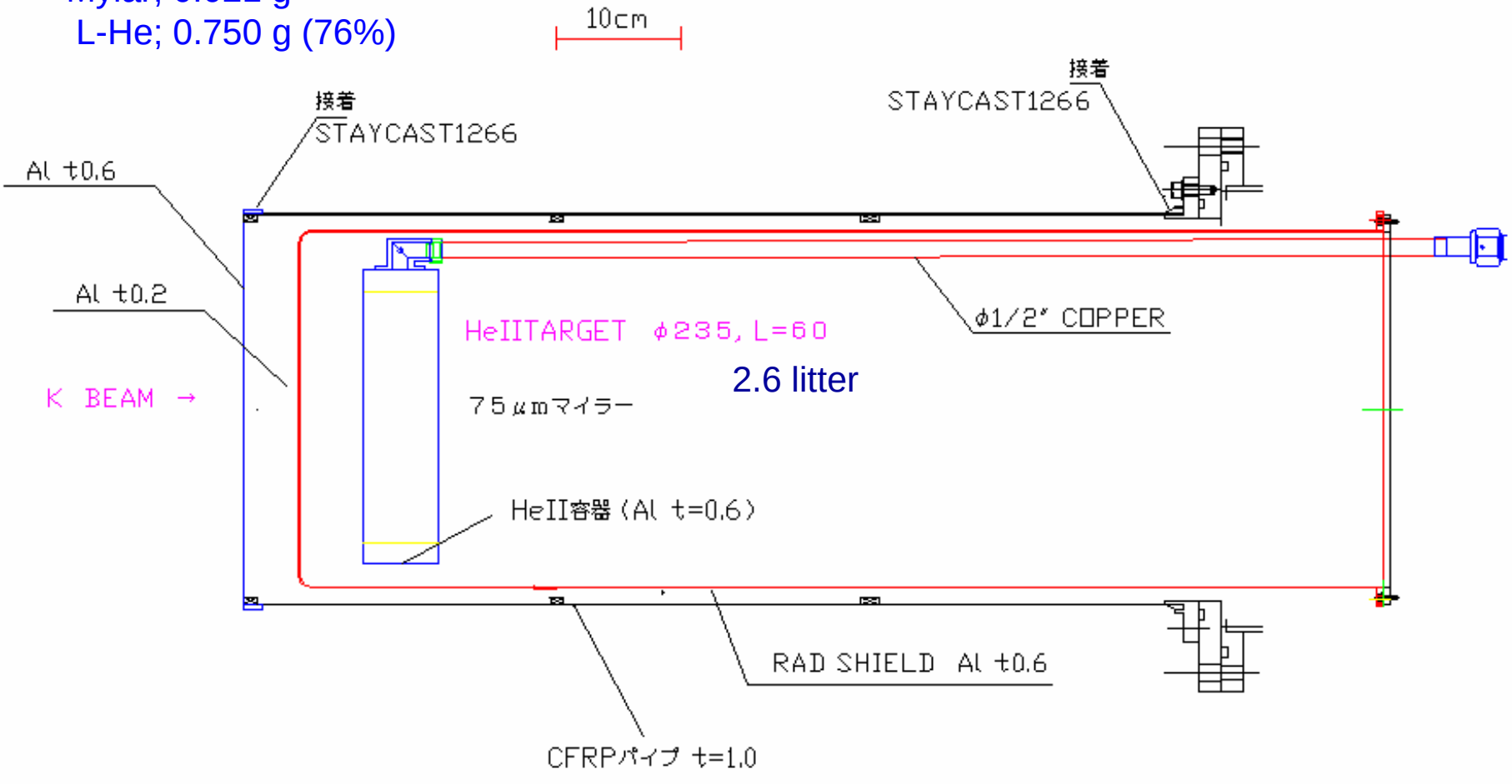
L-He-II Target

K BEAM →



L-He-II Target (Detail)

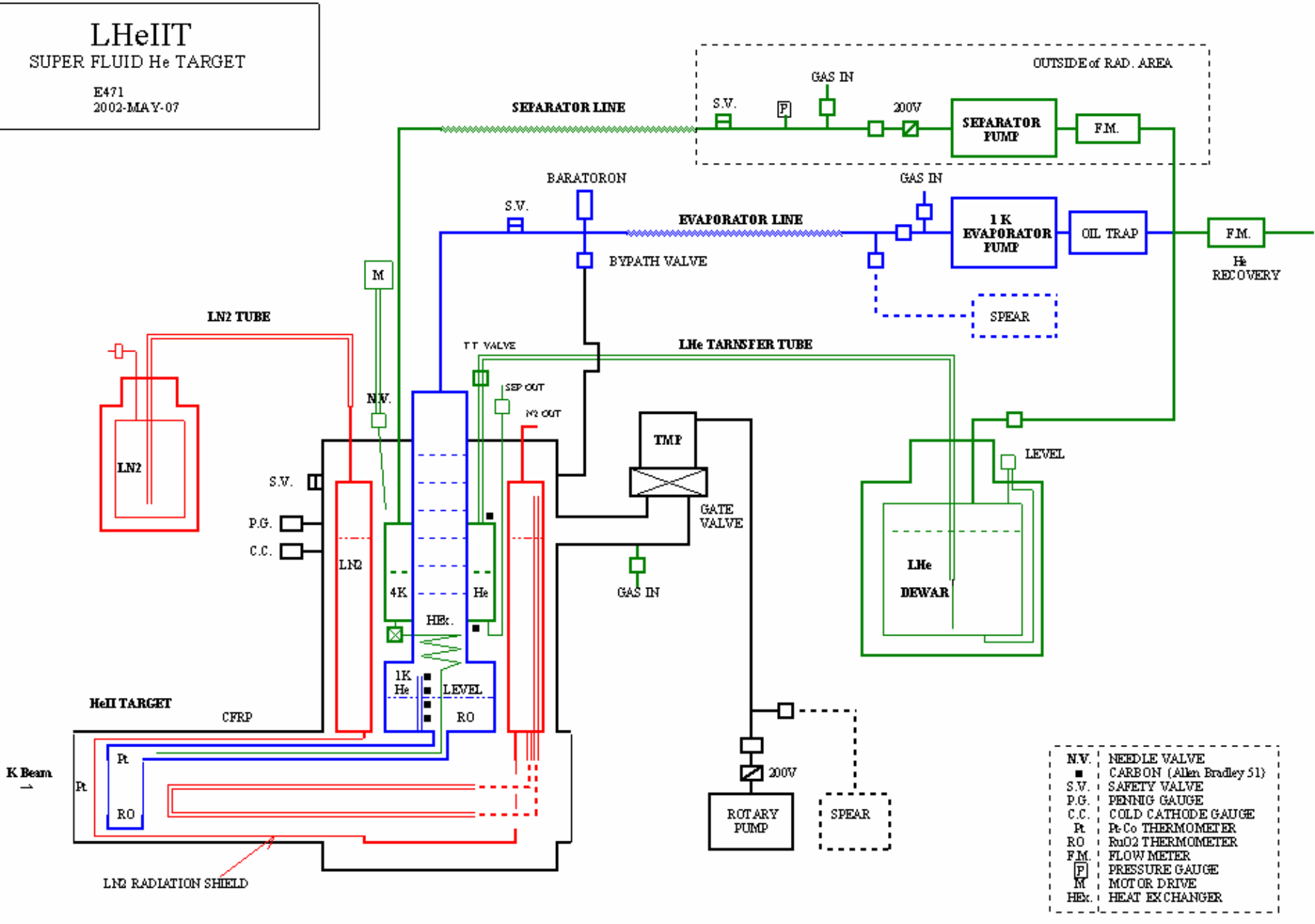
Al; 0.217 g
Mylar; 0.021 g
L-He; 0.750 g (76%)



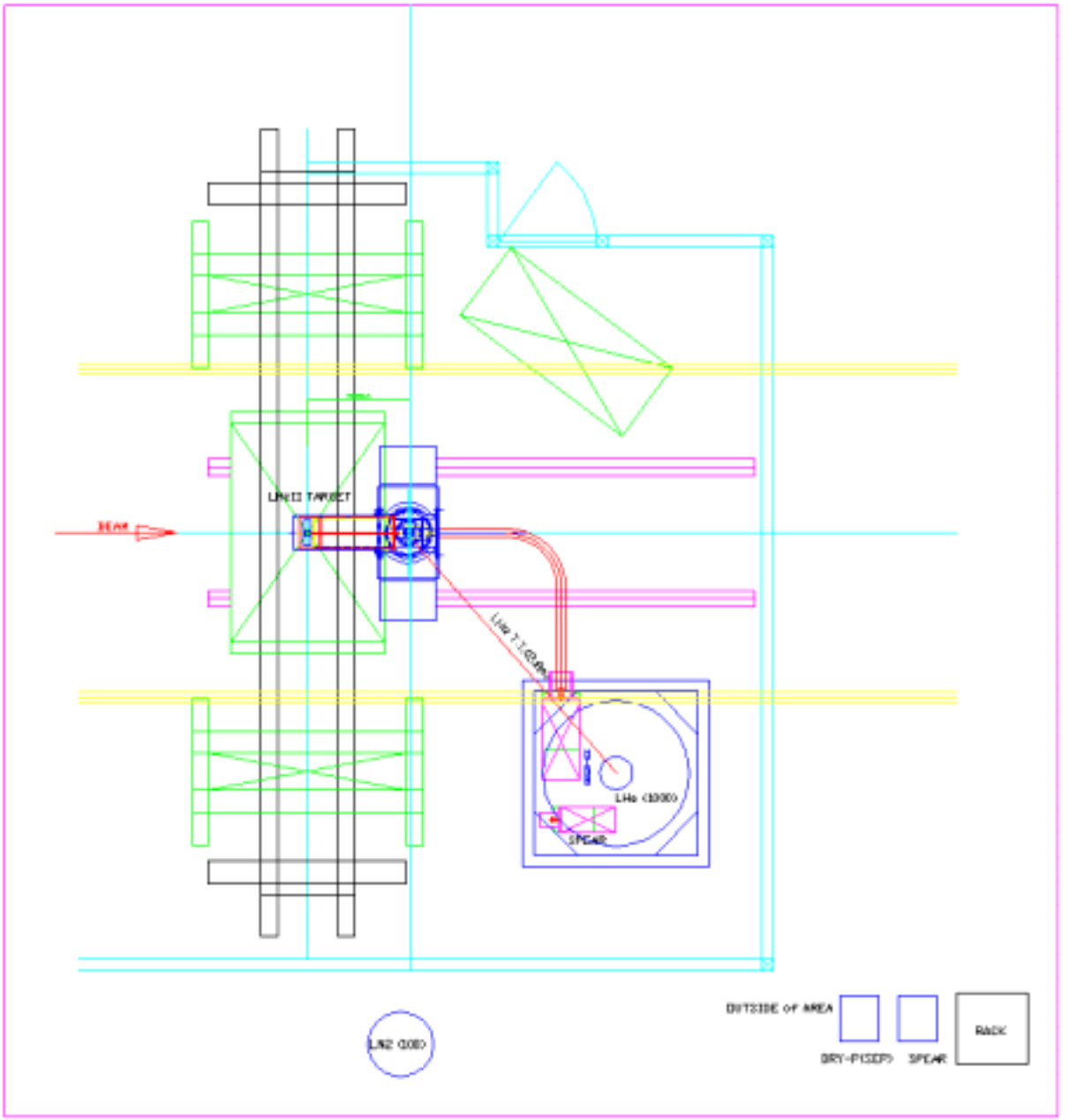
LHeIIT

SUPER FLUID He TARGET

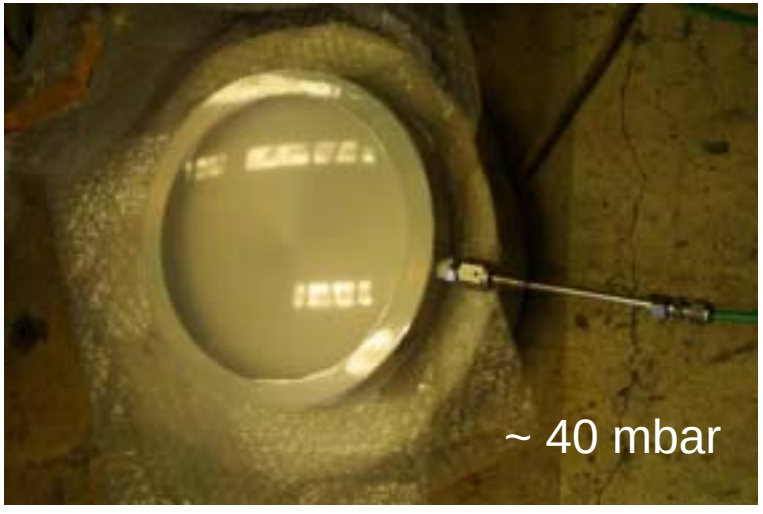
E471
2002-MAY-07



E471 AREA



Dummy Cell Test



D=234 mm
Mylar 0.075 mm
(Smoked paper for tracing)

Stycast 1266 ; Al-Mylar
Stycast 2850FT ; Al-Al

Cell Deformation (Room.Temp.)

Thin globe ; P ∝ 1/R

experiment 1atm, R~D

1 atm → 234 mm

0.041 atm → 5.7 m

Jul 11-13, 2001

Room Temp.

Dummy Cell Test (LN_2)

Cell Deformation at Low Temperature

Thin globe ; $R \propto \sigma$

When 0.041 atm and
R_{300} = 5.7 m at room temp.

R_2 ~ 5.7x(2.4/1.6) = 8.6 m
at T < 10 K

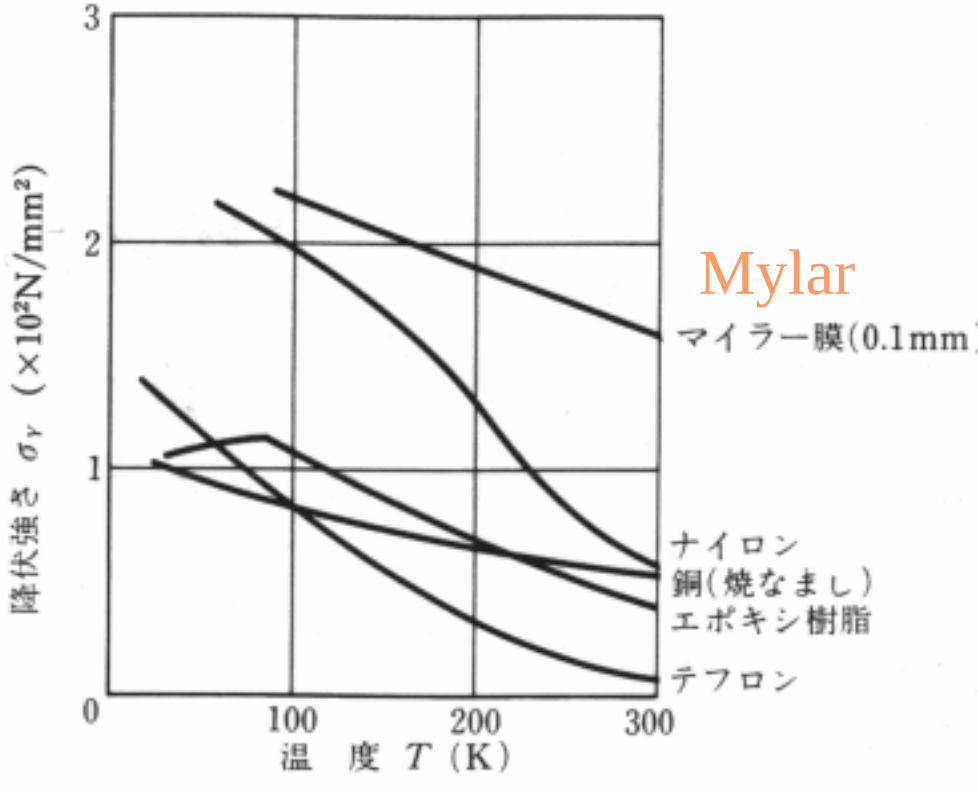
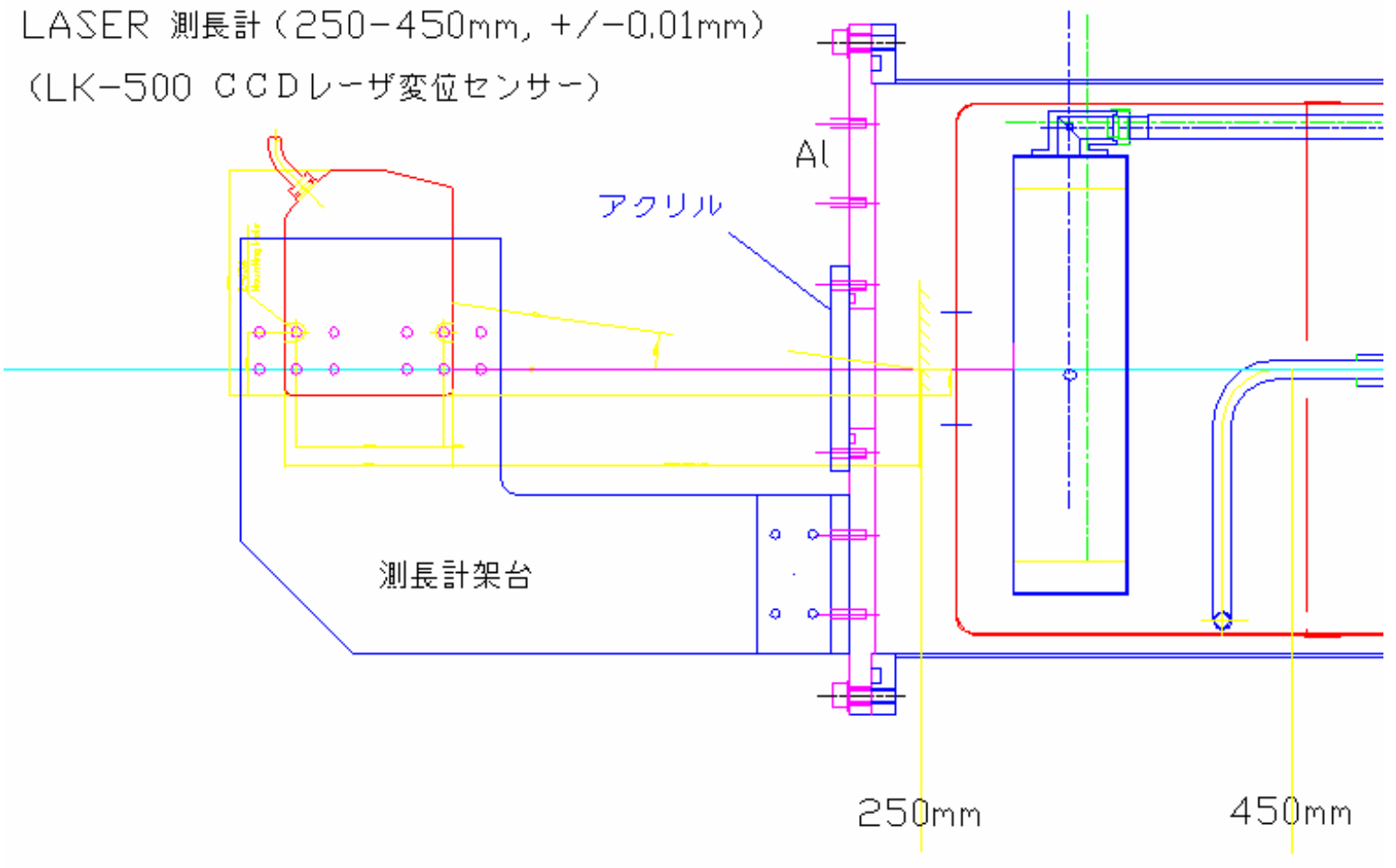


図 I.35 降伏強さまたは 0.2% 耐力(2).

内田老鶴圃新社「低温工学ハンドブック」

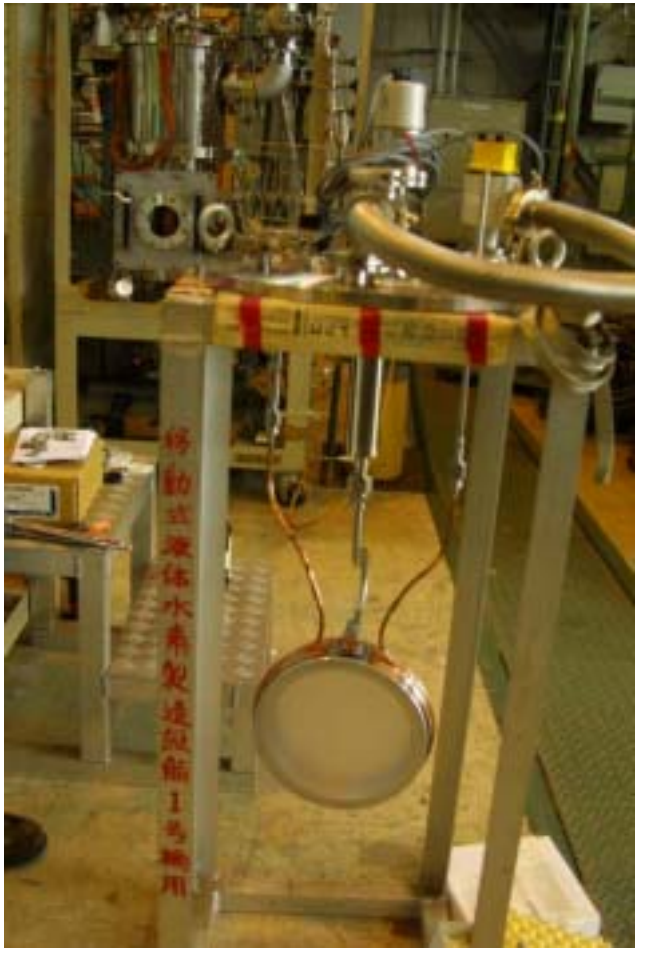
Cell Calibration (Plan)

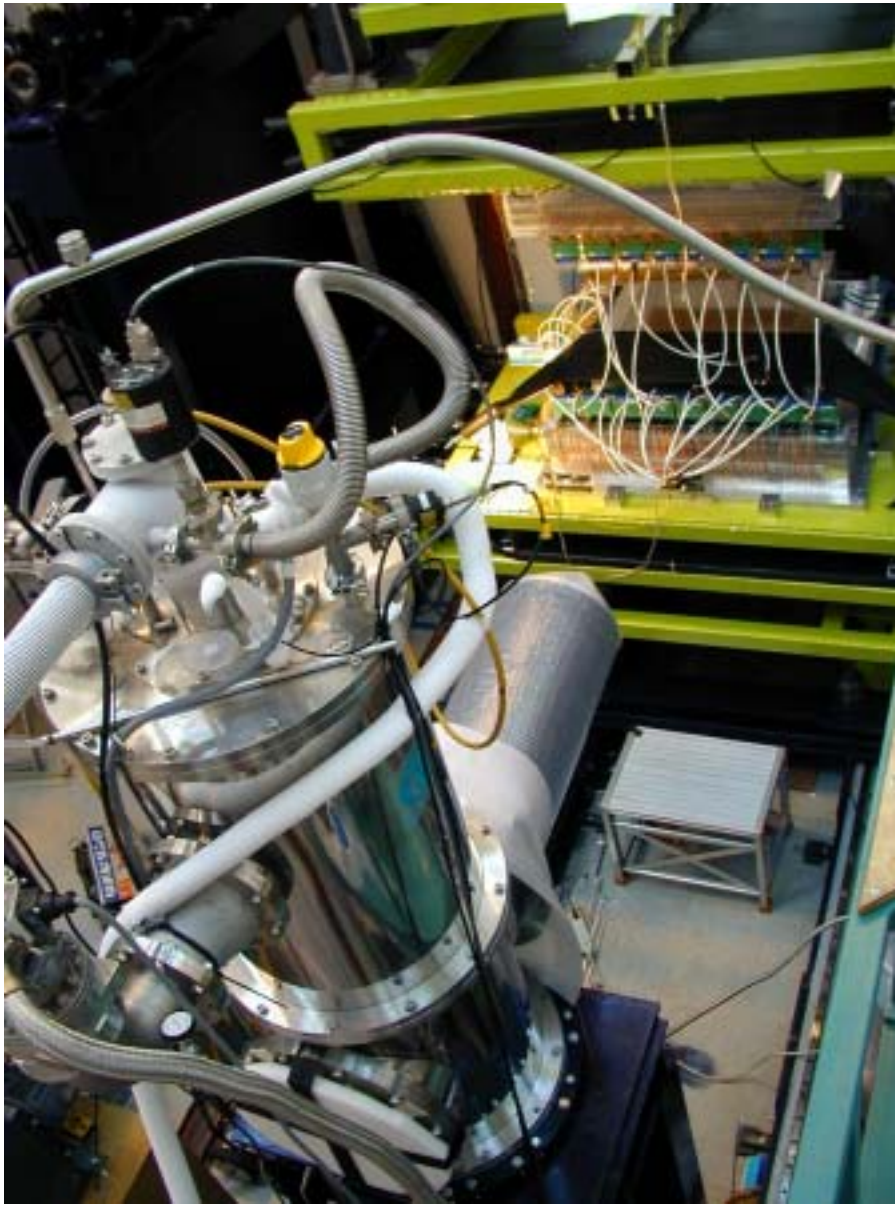


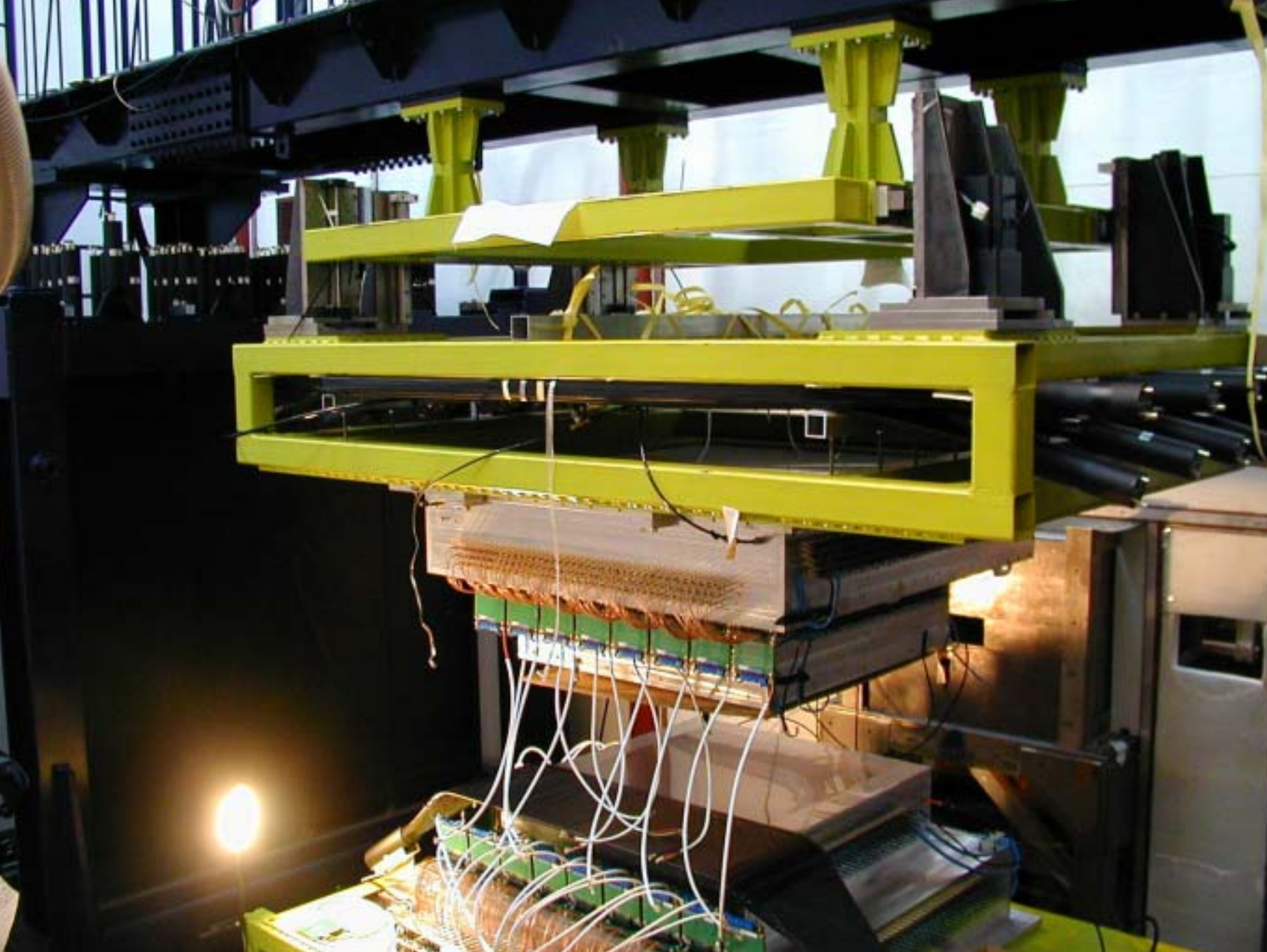
Cell

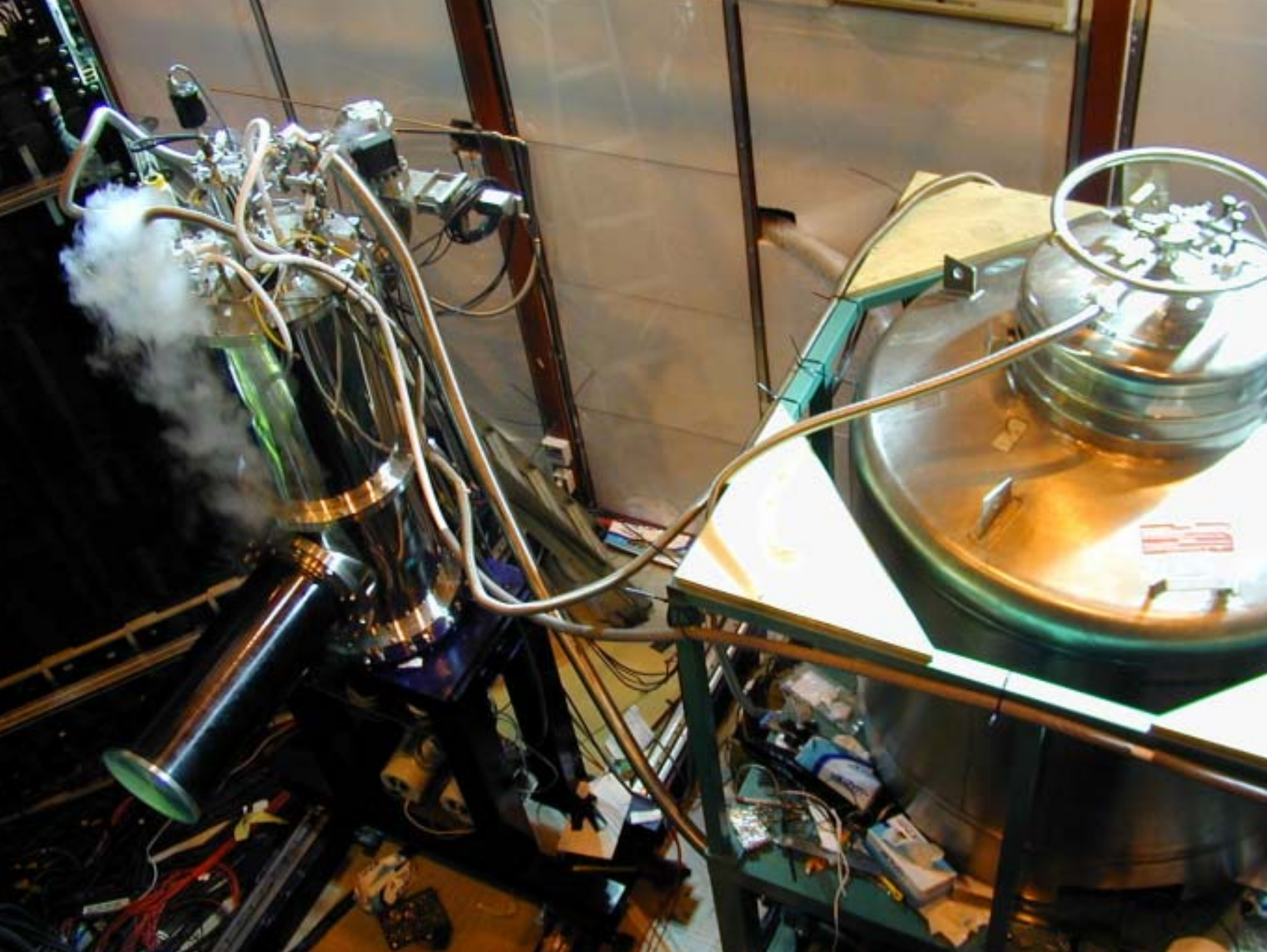
D=234, t=60, Al-flame t=0.6
Mylar (smoked); 0.075 mm
Stycast 1266, 2850FT

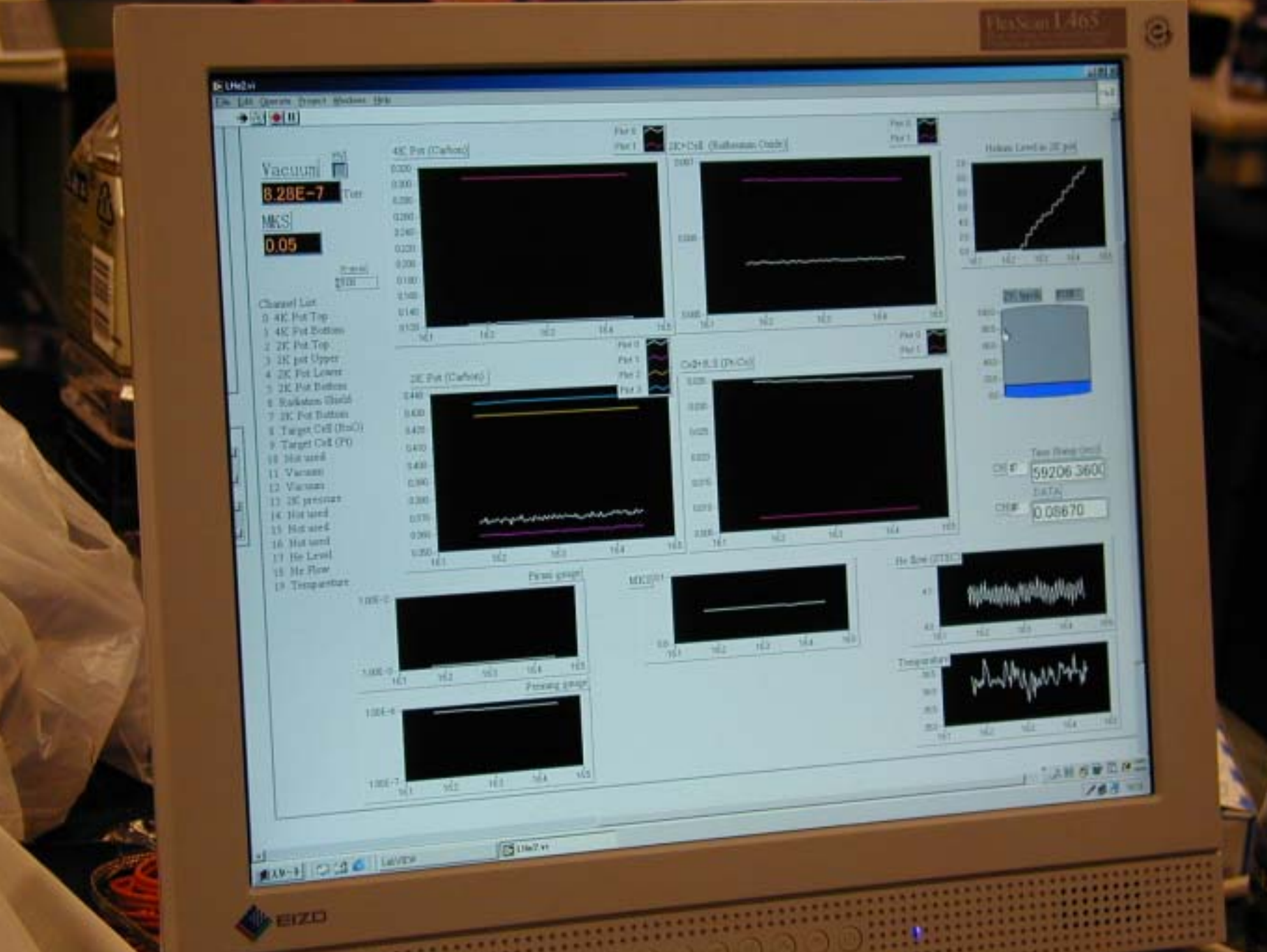
Cell Assemble and Leak Test

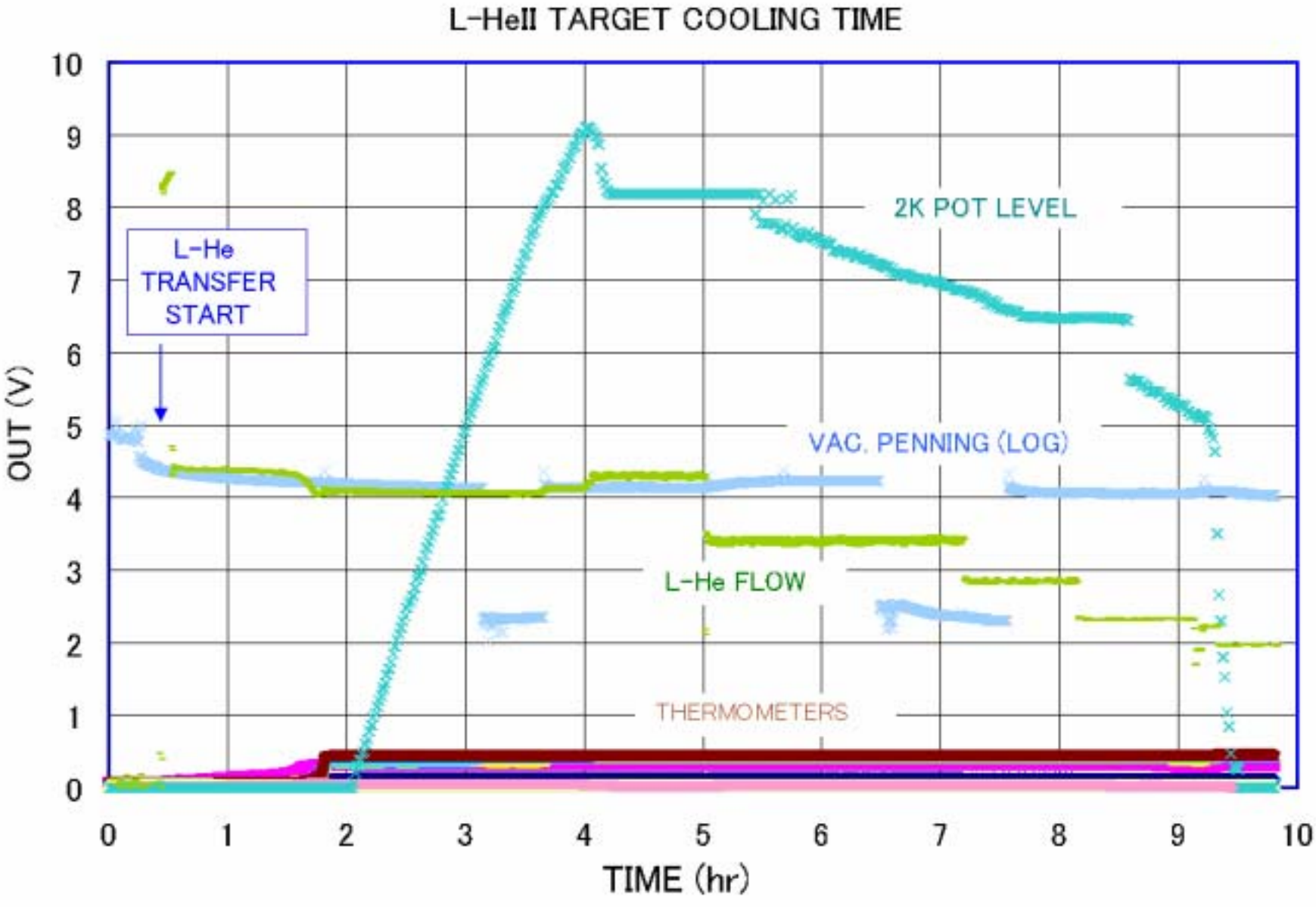









Vacuum
8.28E-7
Torr
MKS
0.05
Channel List
0 4K Pot Top
1 4K Pot Bottom
2 2K Pot Top
3 2K pot Upper
4 2K Pot Lower
5 2K Pot Bottom
6 Radiation Shield
7 2K Pot Bottom
8 Target Cell (RuO)
9 Target Cell (Pt)
10 Not used
11 Vacuum
12 Vacuum
13 2K pressure
14 Not used
15 Not used
16 Not used
17 He Level
18 Mr Flow
19 Temperature
59206.3600
0.08670
ERZO


L-HeII TARGET COOLING TIME
L-He
TRANSFER
START
2K POT LEVEL
VAC. PENNING (LOG)
L-He FLOW
THERMOMETERS
OUT (V)
TIME (hr)
0
1
2
3
4
5
6
7
8
9
10

Conclusion

(0) Flat L-HeII target was successfully developed

(1) Cooling time Vac.pumping ; ~1 day
L-N2 Cooling ; ~1/2 day
L-He Cooling ; ~2 hrs

(2) No super leak at Vac. ~ 10^{-7} mbar

(3) Target temperature 1.8 ~ 1.9 K (17 ~23 mbar)

(4) Liquid helium consumption 4 ~ 5 litter/hr
(670 ~ 840 litter/week)

(5) Running very stable and will be continued until the end of Oct. 2002

(6) Future plan - Target cell deformation test
- Remodeling to ^{3}He target