Windowless Solid Hydrogen Target for Antiproton Experiment at FNAL

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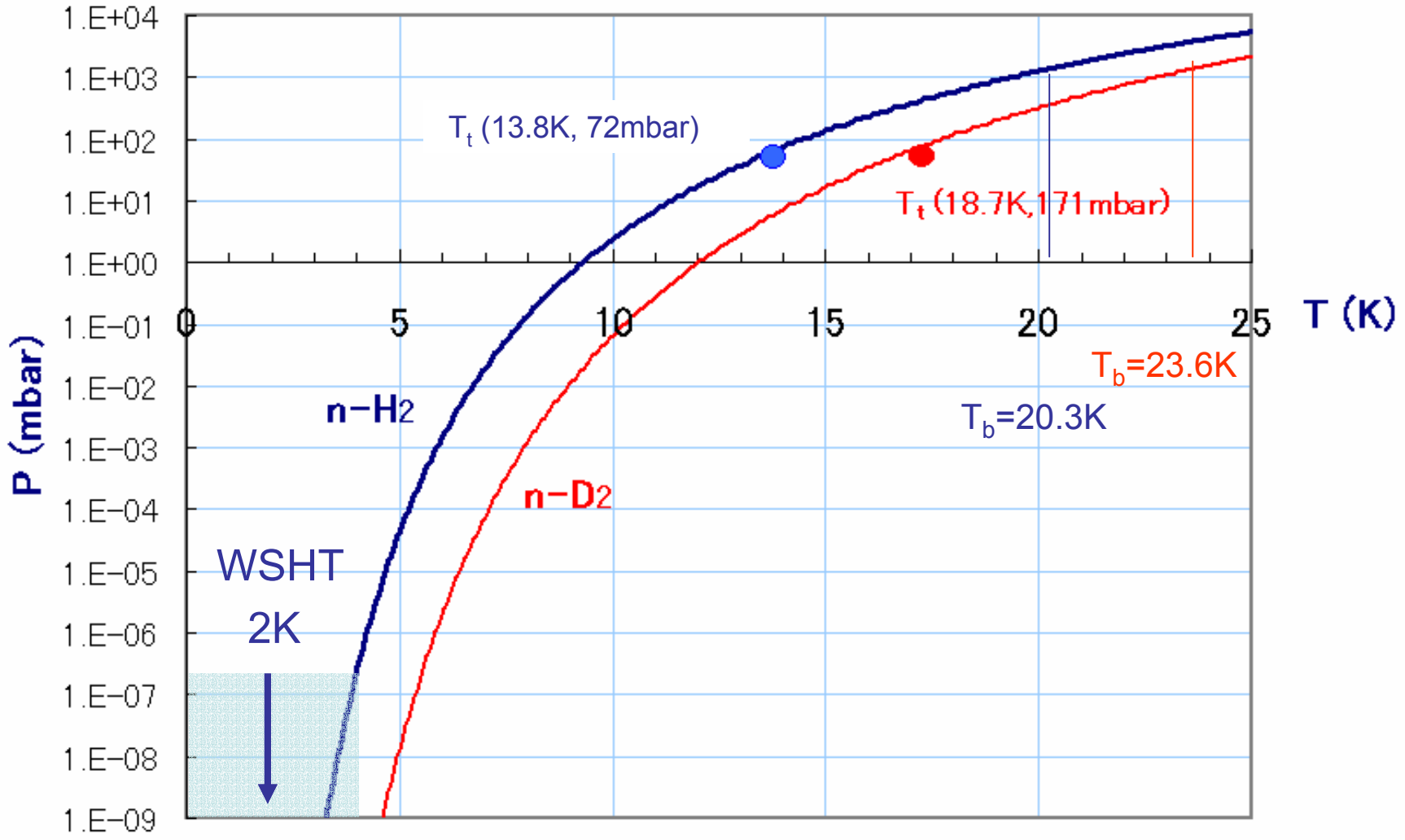
Antiproton Physics Workshop
Fermilab, May 22, 2010, 9:00 am - 3:30? pm
Hornets' Nest (Wilson Hall 8th-floor crossover)

H_2/D_2 Vapor Pressure



Windowless SHT

Thin film SHT **LHT**

Thermal Conductivity of para-SH_2 at T=2K

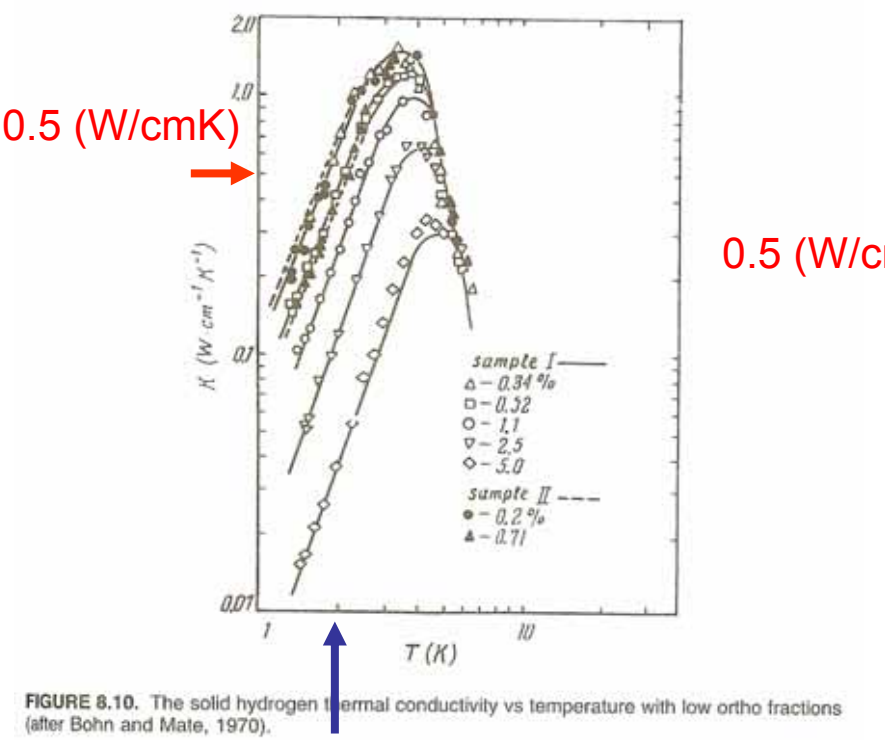
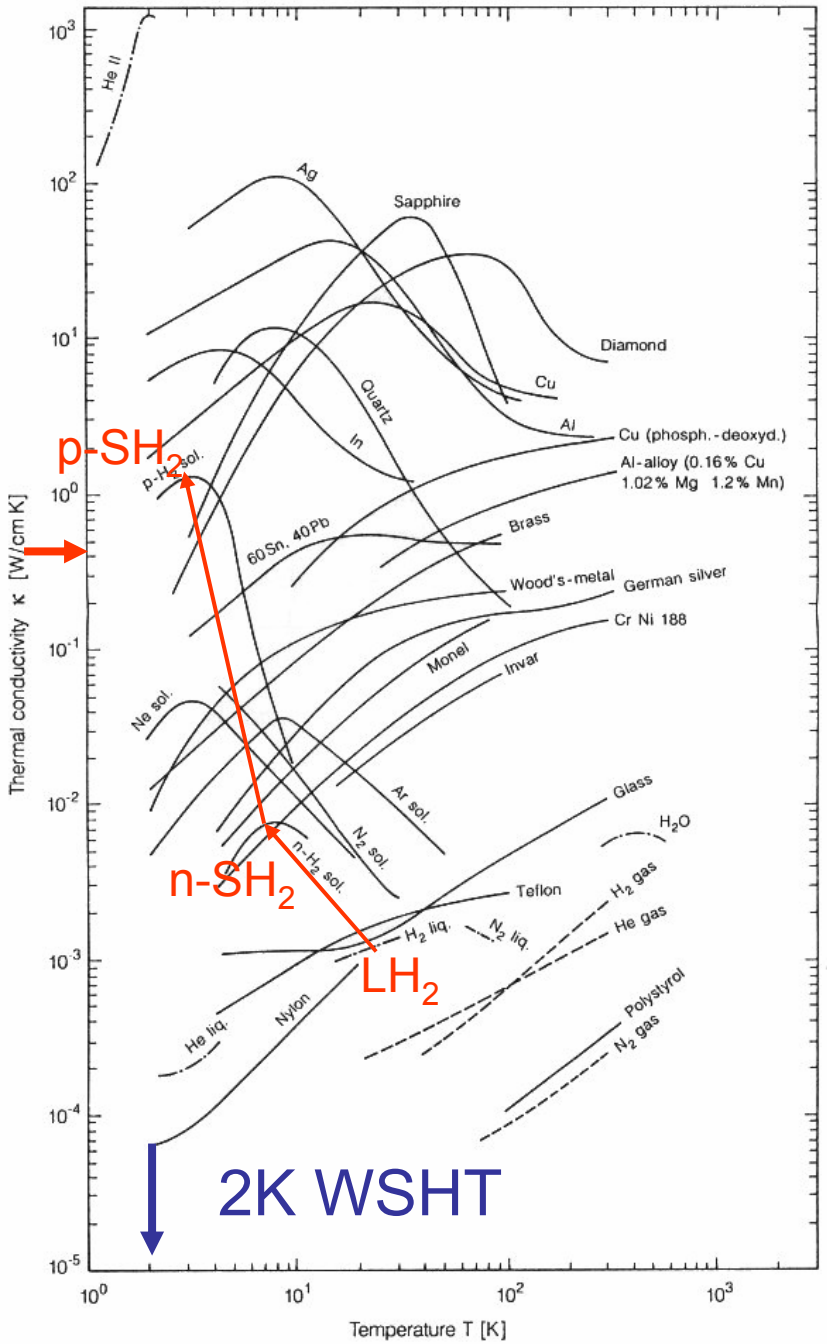


FIGURE 8.10. The solid hydrogen thermal conductivity vs temperature with low ortho fractions (after Bohn and Mate, 1970).

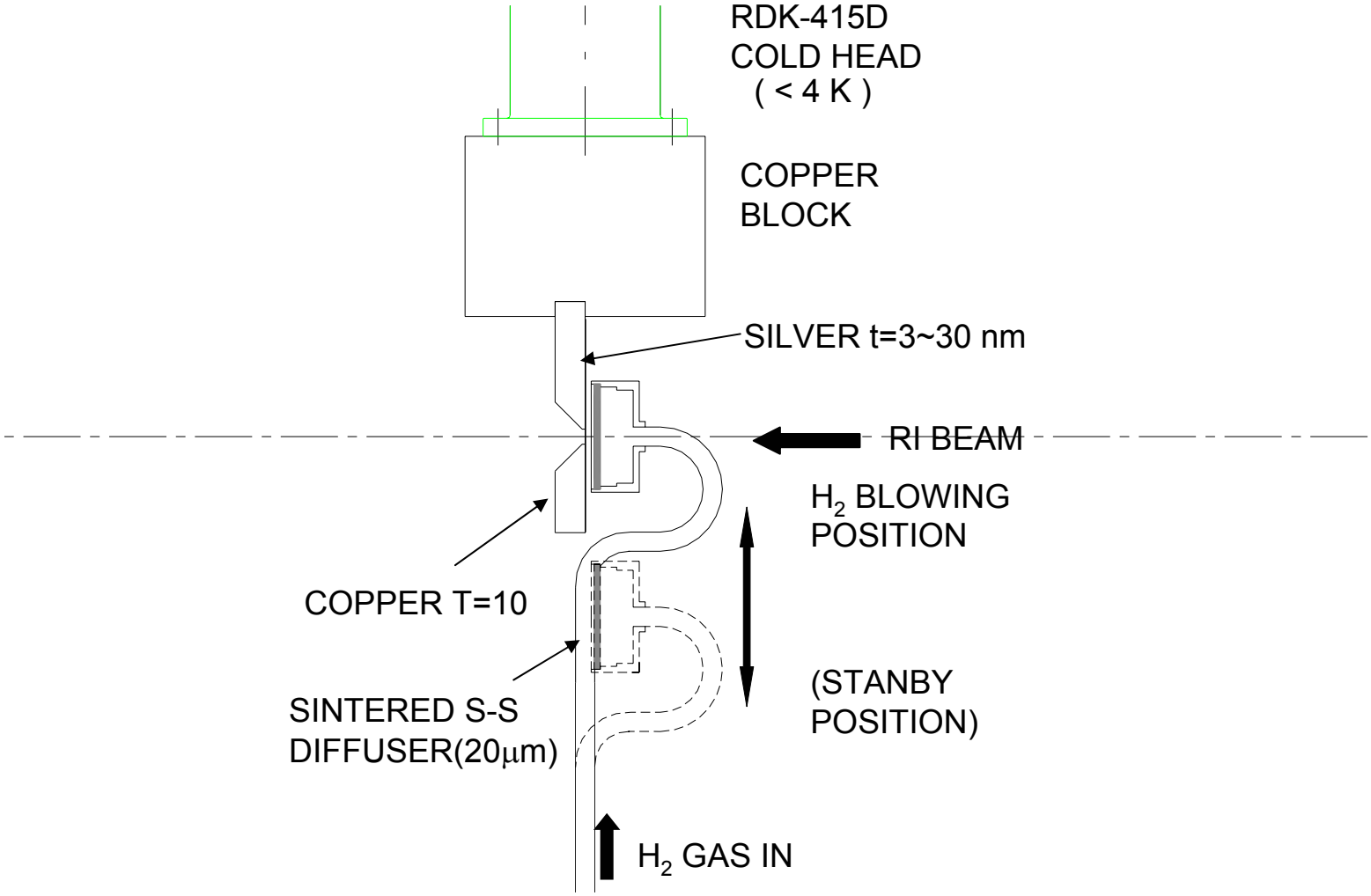
0.5 (W/cmK)

%; orth-H_2 fractions

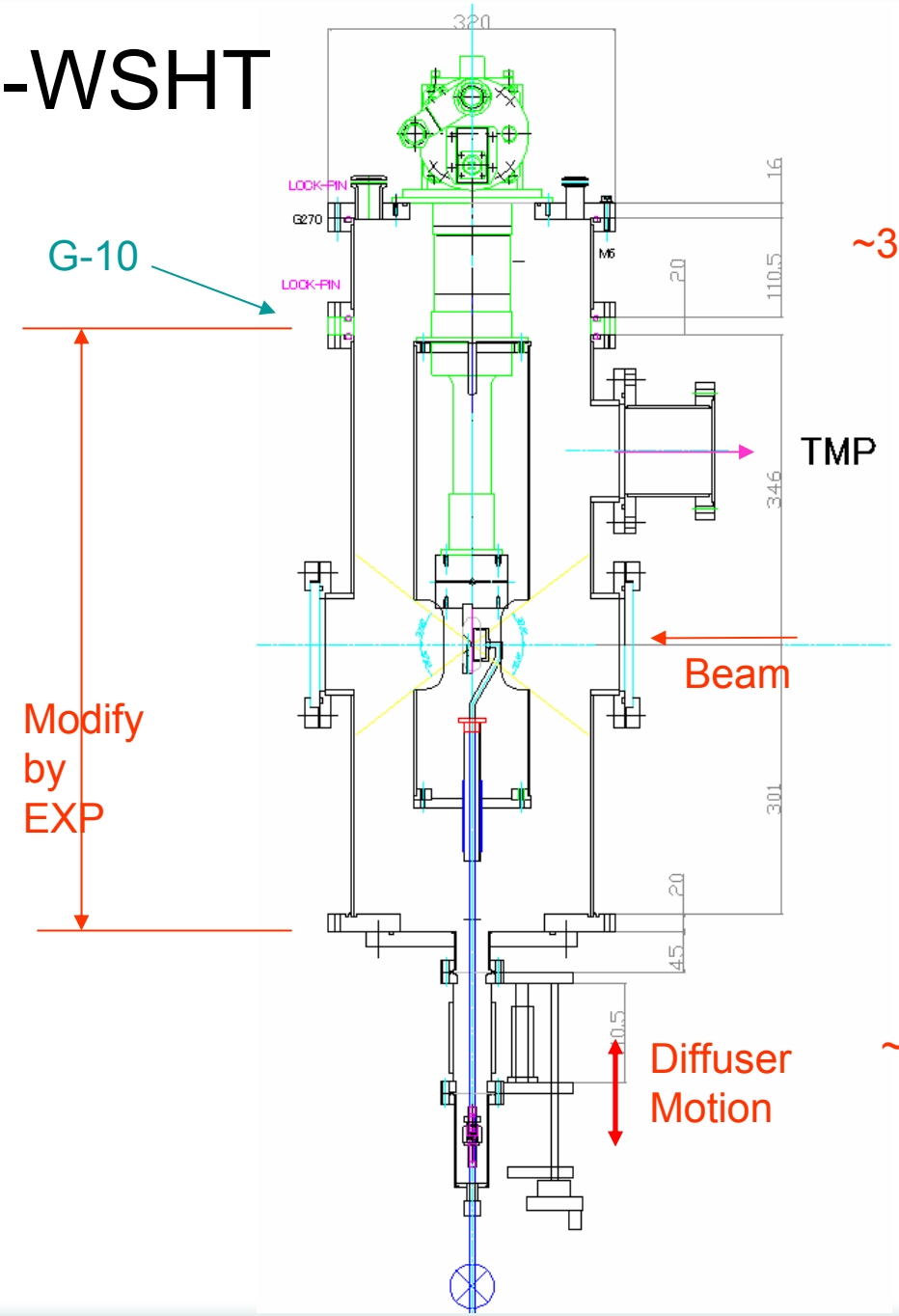
→ orth-para conversion to improve thermal conductivity 10^2

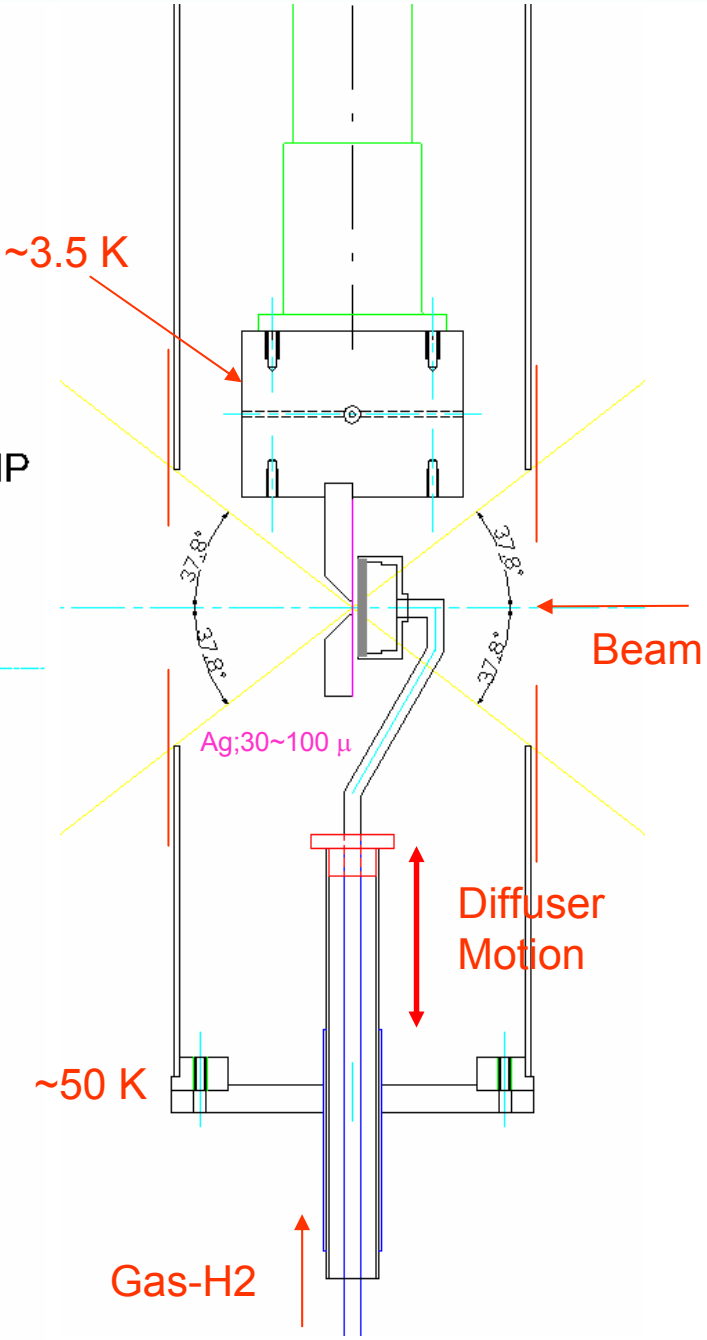


Thin-WSHT at KEK for TRIUMF

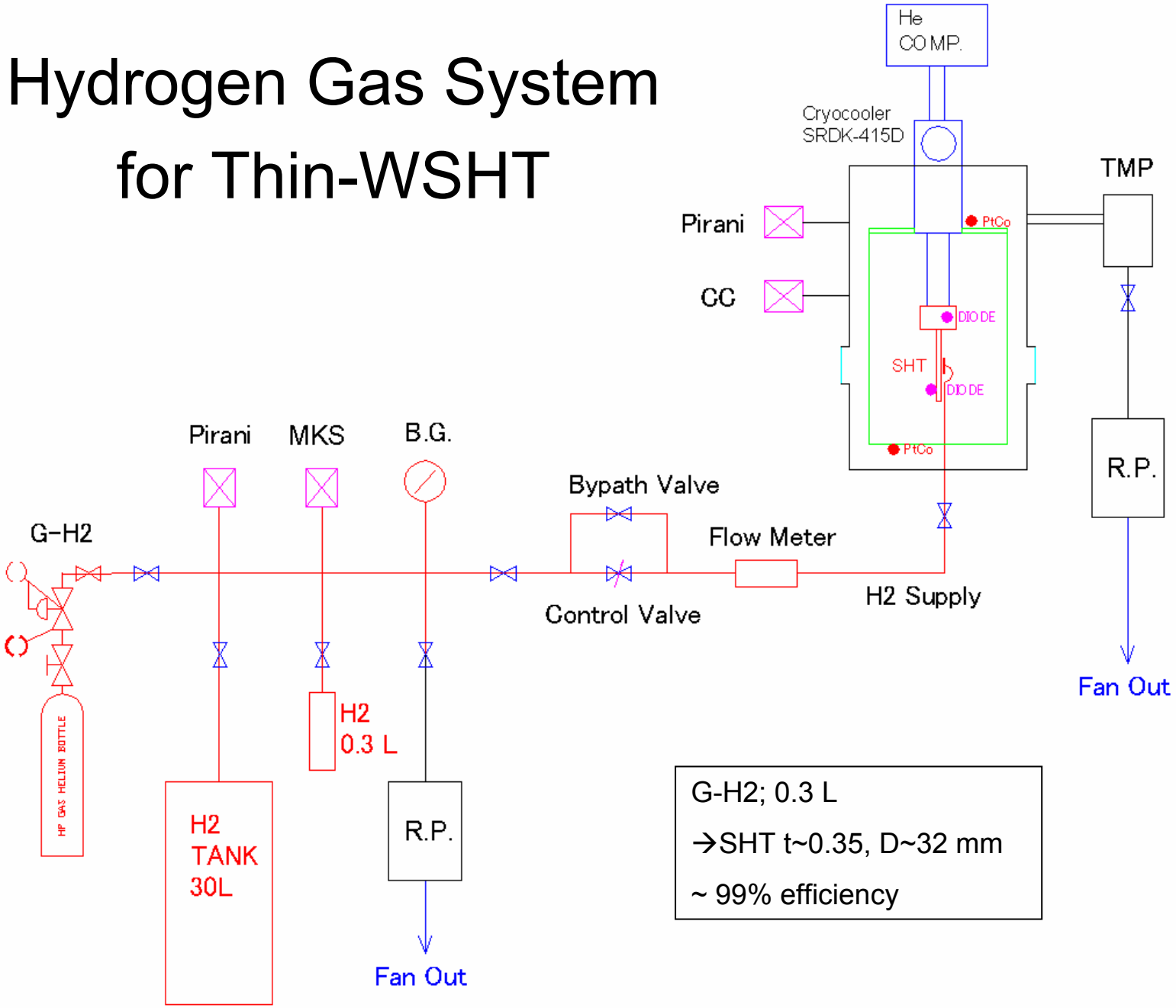


Thin-WSHT


320
LOCK-PIN
G270
LOCK-PIN
M6
16
20
110.5
346
301
20
45
10.5
G-10
Modify
by
EXP
TMP
Beam
Diffuser
Motion


~3.5 K
37.8°
37.8°
37.8°
37.8°
Beam
Ag;30~100 μ
Diffuser
Motion
~50 K
Gas-H2

Hydrogen Gas System for Thin-WSHT



G-H2; 0.3 L

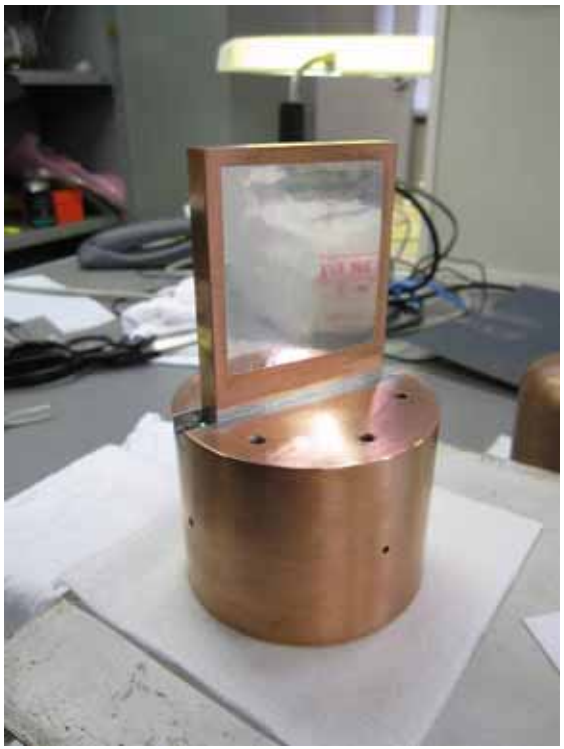
→SHT t~0.35, D~32 mm

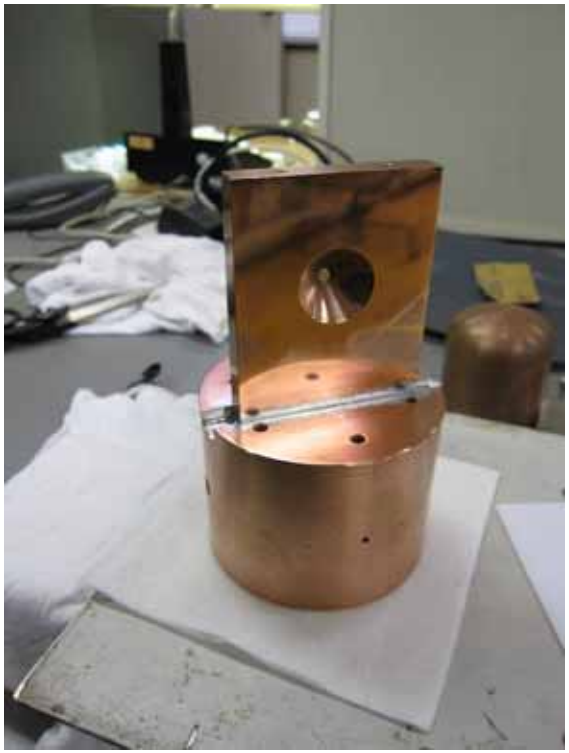
~ 99% efficiency

Diffuser Made from 20 μm Sintered S-S Powder

Pure-Silver Foil t=30 μm and Copper Block

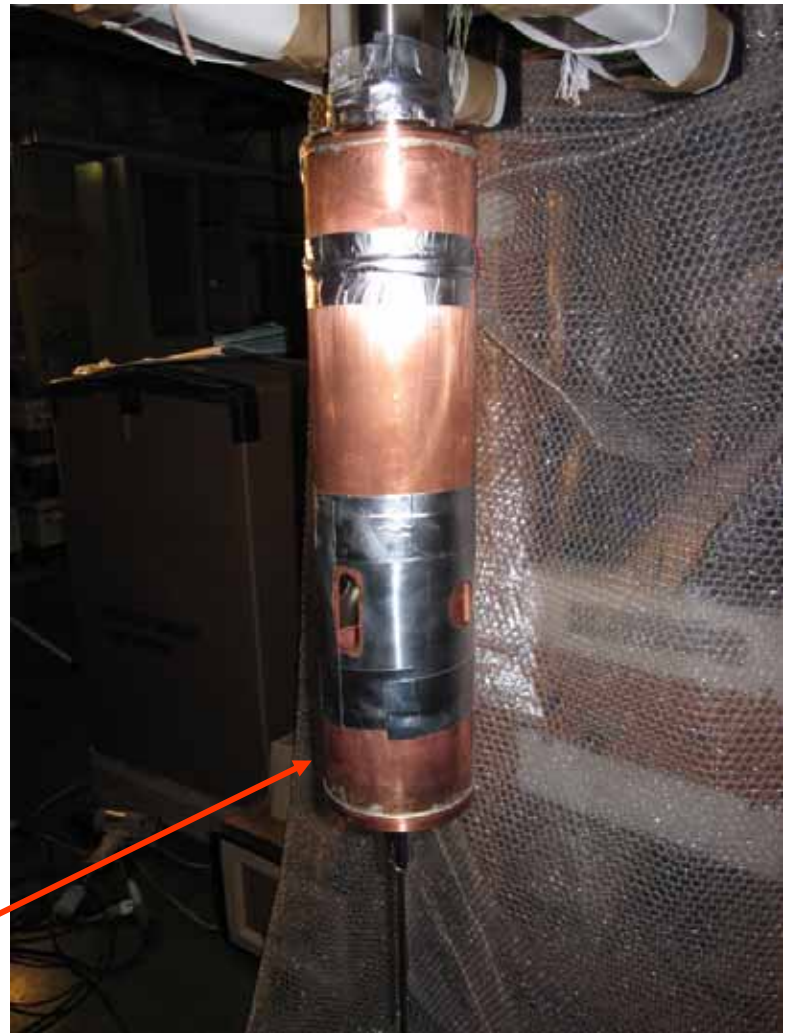
Epoxy Adhesive





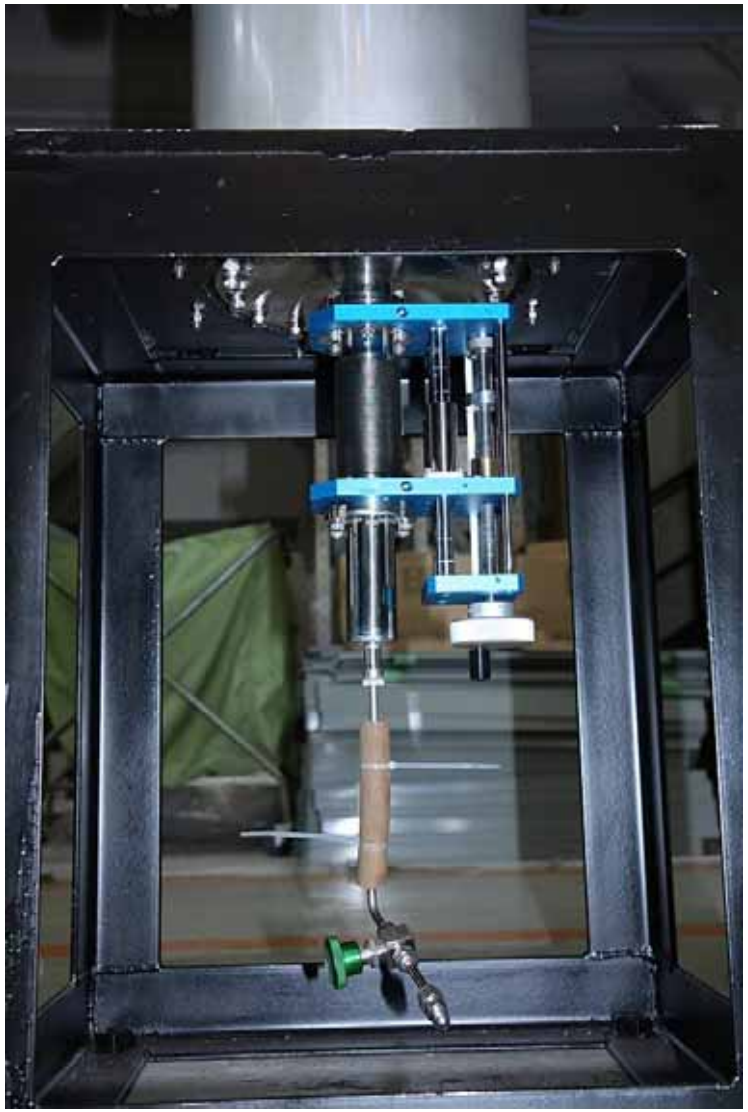
Stycast 1266 A/B

Cryocooler Setup

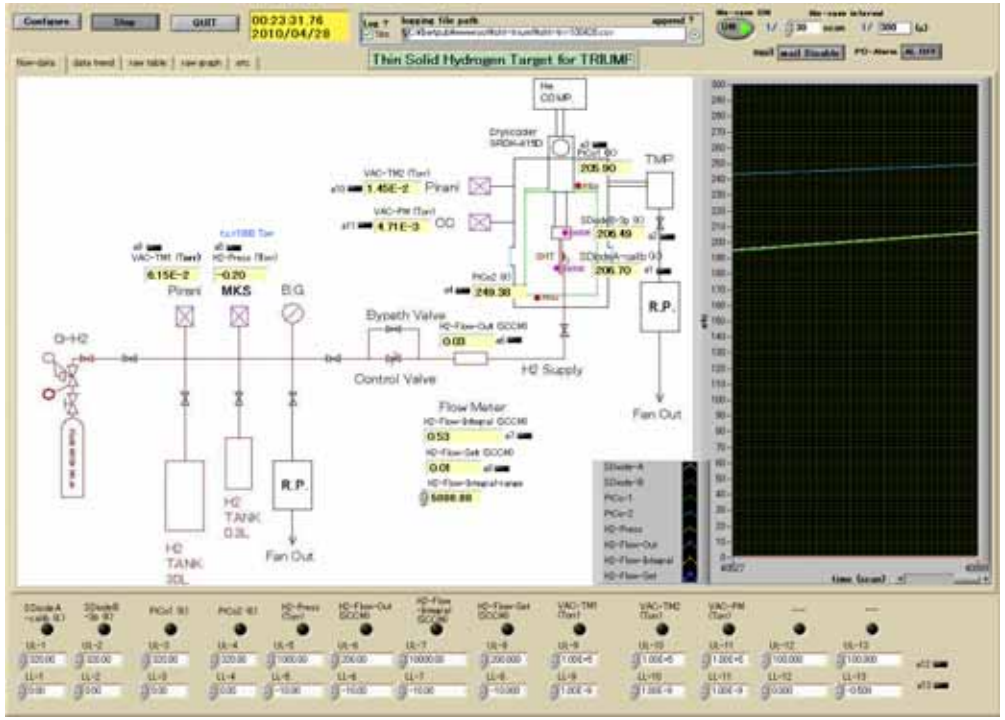


Radiation Shield
(Copper and Aluminum)

Vacuum Chamber and Z-Stage for Diffuser

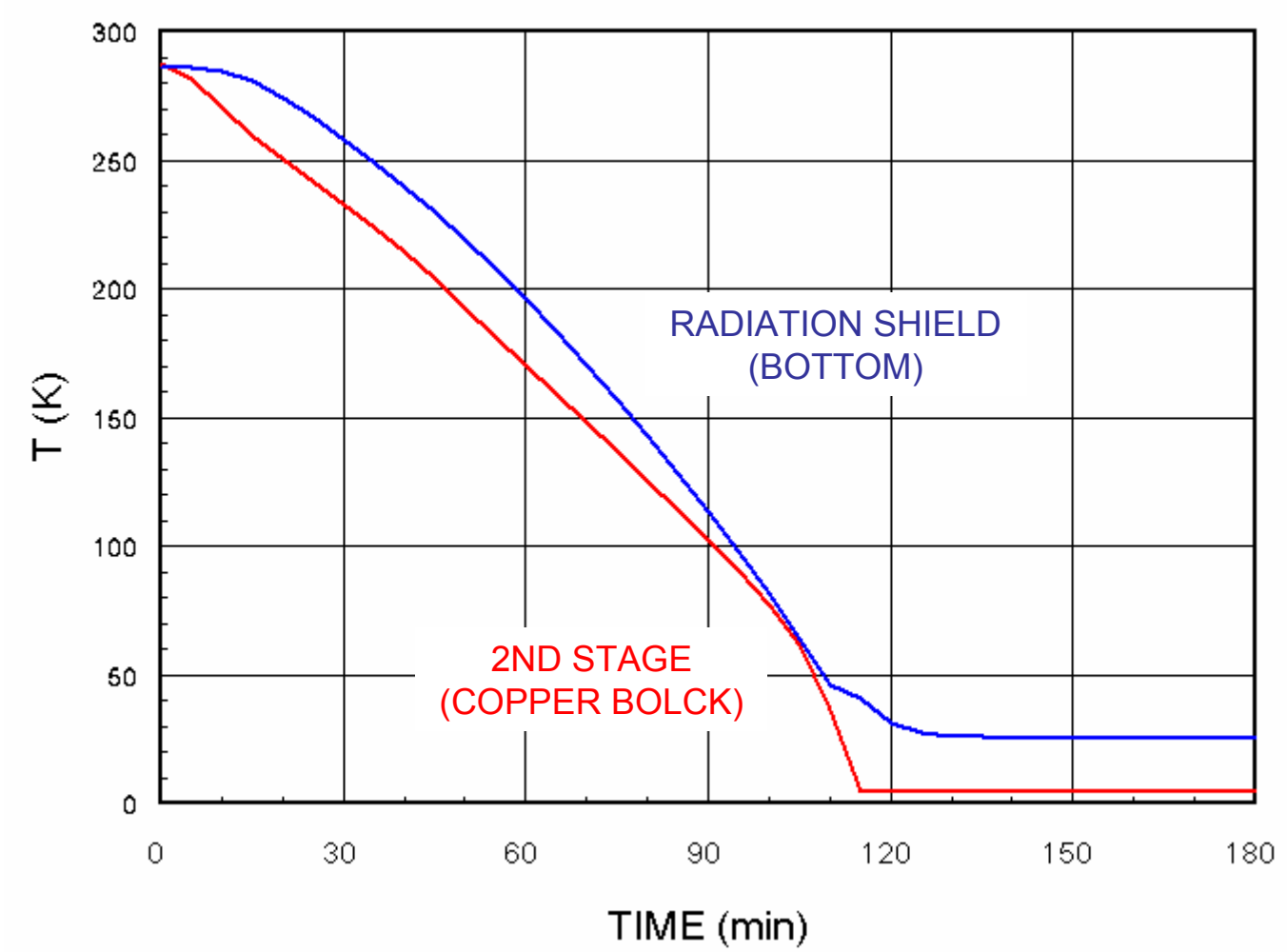


DAQ Hard and Soft

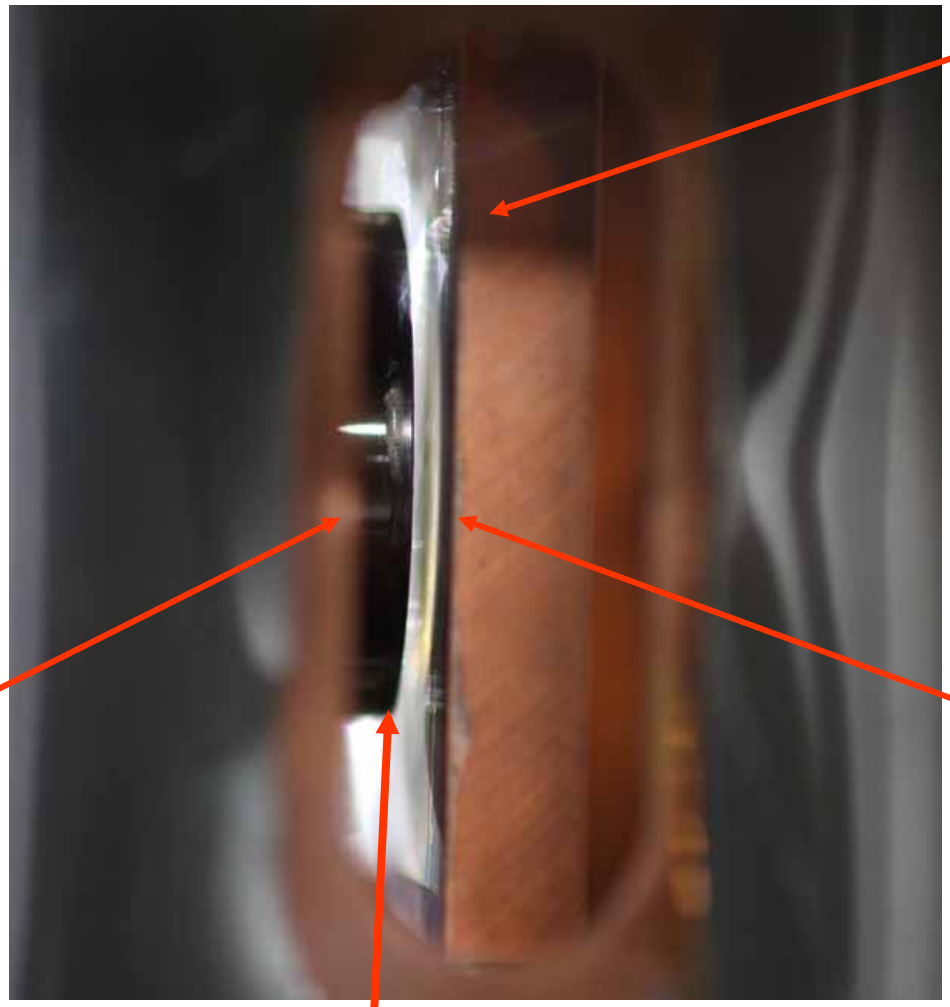


New LabView Program
was developed

Cooling Time of Thin-WSHT



Thin-WSHT



COPPER
T=10mm
with d=5mm
hole at center
+
Silver Foil
t=30mm

Diffuser

WSHT
t~0.35 mm
D=32 mm

Gap ~2 mm

Thin-WSHT Results (preliminary)

- Turbo Pump S_p=150 l/s (115 l/s for H_2)

- Base Vac. at 300K; ~10^{-6} mbar
- Vac. at 4K; ~10^{-8} mbar

  during G-H_2 blowing; ~10^{-7} mbar

  (H_2 Flow ~50 cm^3/min, 6 min)

  after blowing; ~10^{-8} mbar

  gate valve closed; ~10^{-8} mbar (no change)

- Thin-WSHT thickness ~ 0.35 mm, Diameter ~ 32 mm

Plan of WSHT for Antiproton Experiment at FNAL

" WSHT in ring vacuum "

(1) Cryocooler ~ 4 K → 2 K Cryostat

Pump; 150 l/s → ~1,000 l/s

(2) Separate vacuum with gate valve

~ 10^{-7} mbar during G-H_2 blowing

< 10^{-10} mbar at ~ 2K

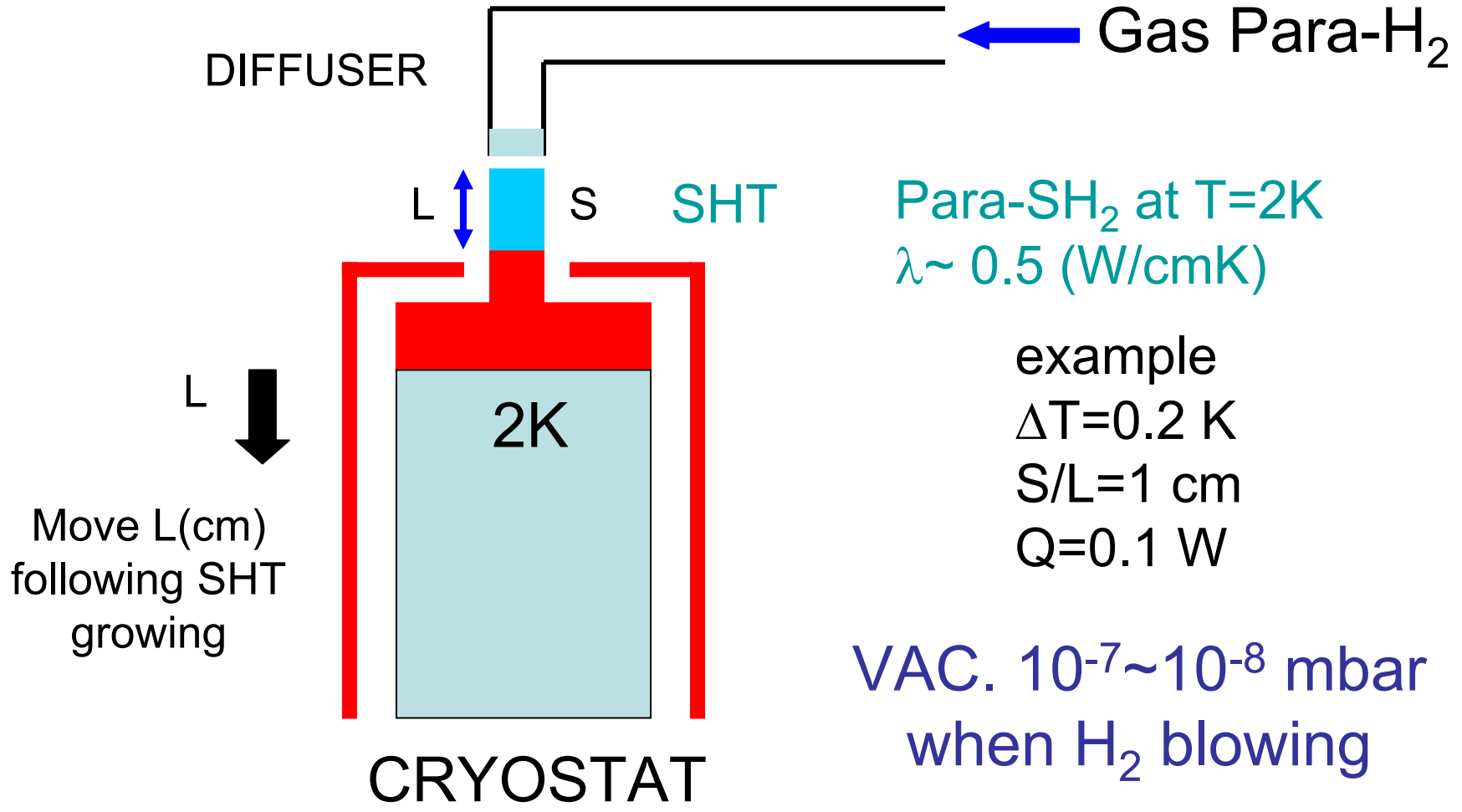
(3) R&D of WSHT for antiproton at FNAL

> crystal growth (uniform diameter)

> para-H_2 (~20 K cryostat + catalyses)

> target moving system

Gas Blowing of Para Hydrogen

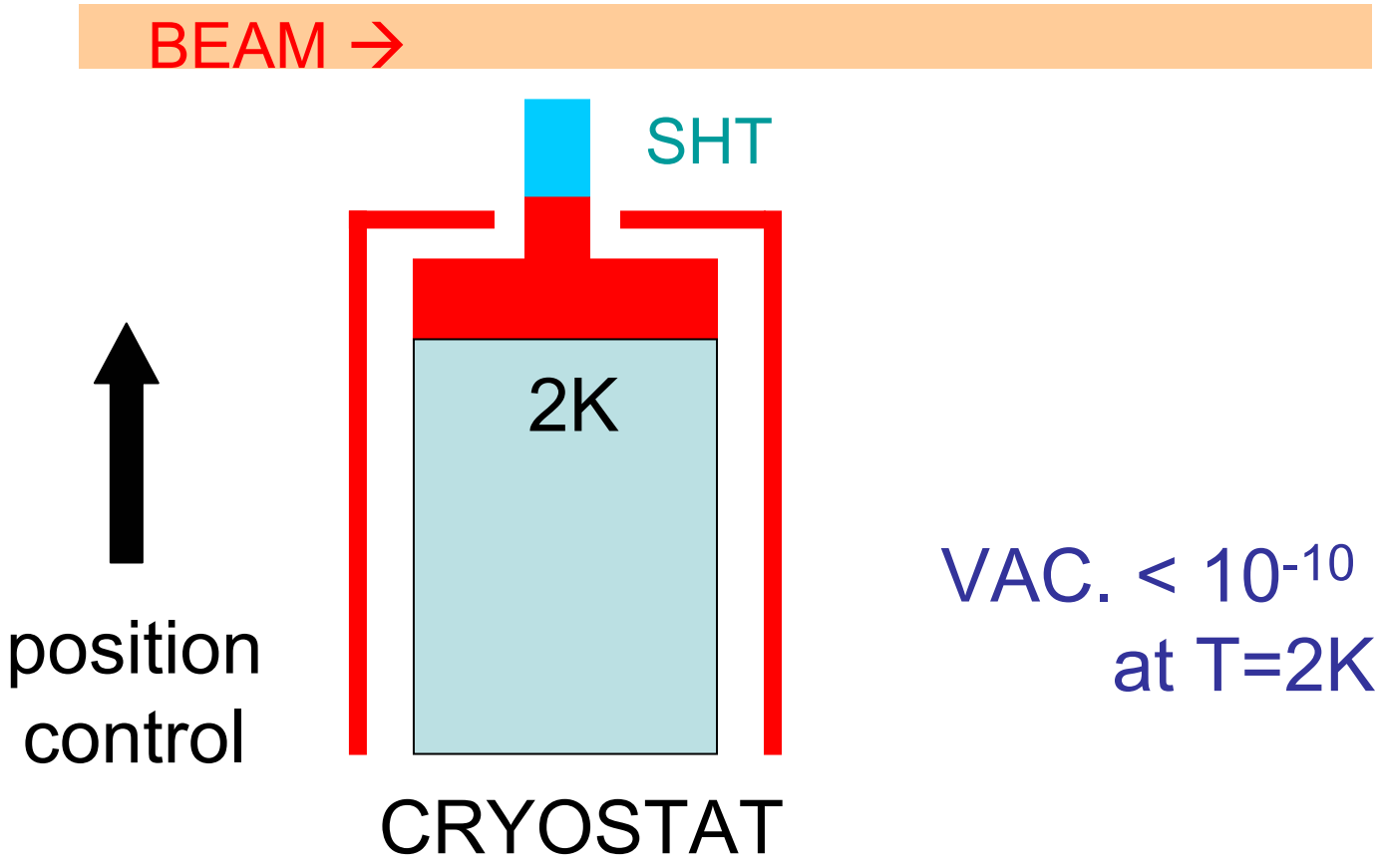


Para-SH_2 at T=2K
λ~ 0.5 (W/cmK)

example
ΔT=0.2 K
S/L=1 cm
Q=0.1 W

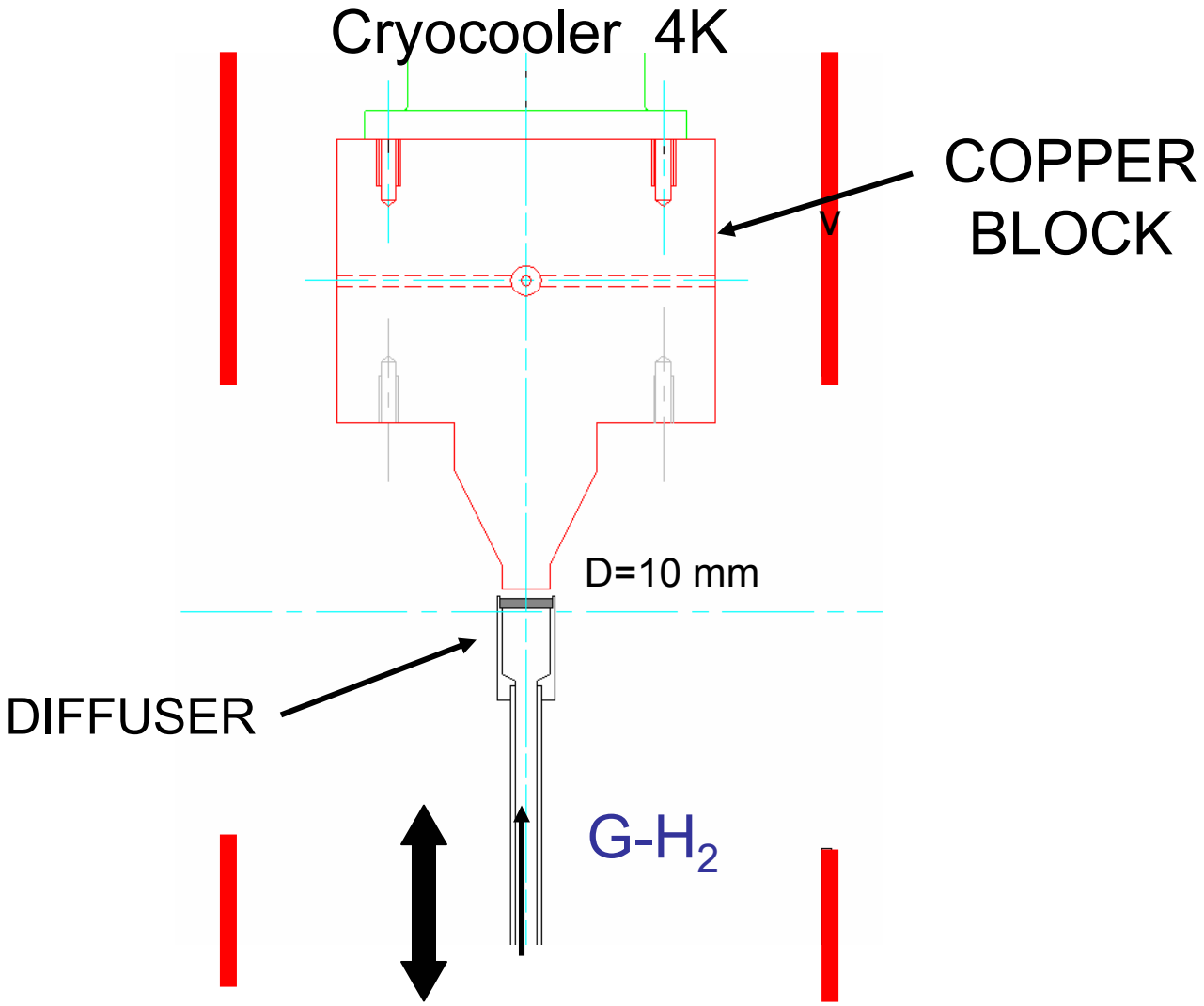
VAC. 10^{-7}~10^{-8} mbar
when H_2 blowing

Stick-type WSHT in Storage Ring

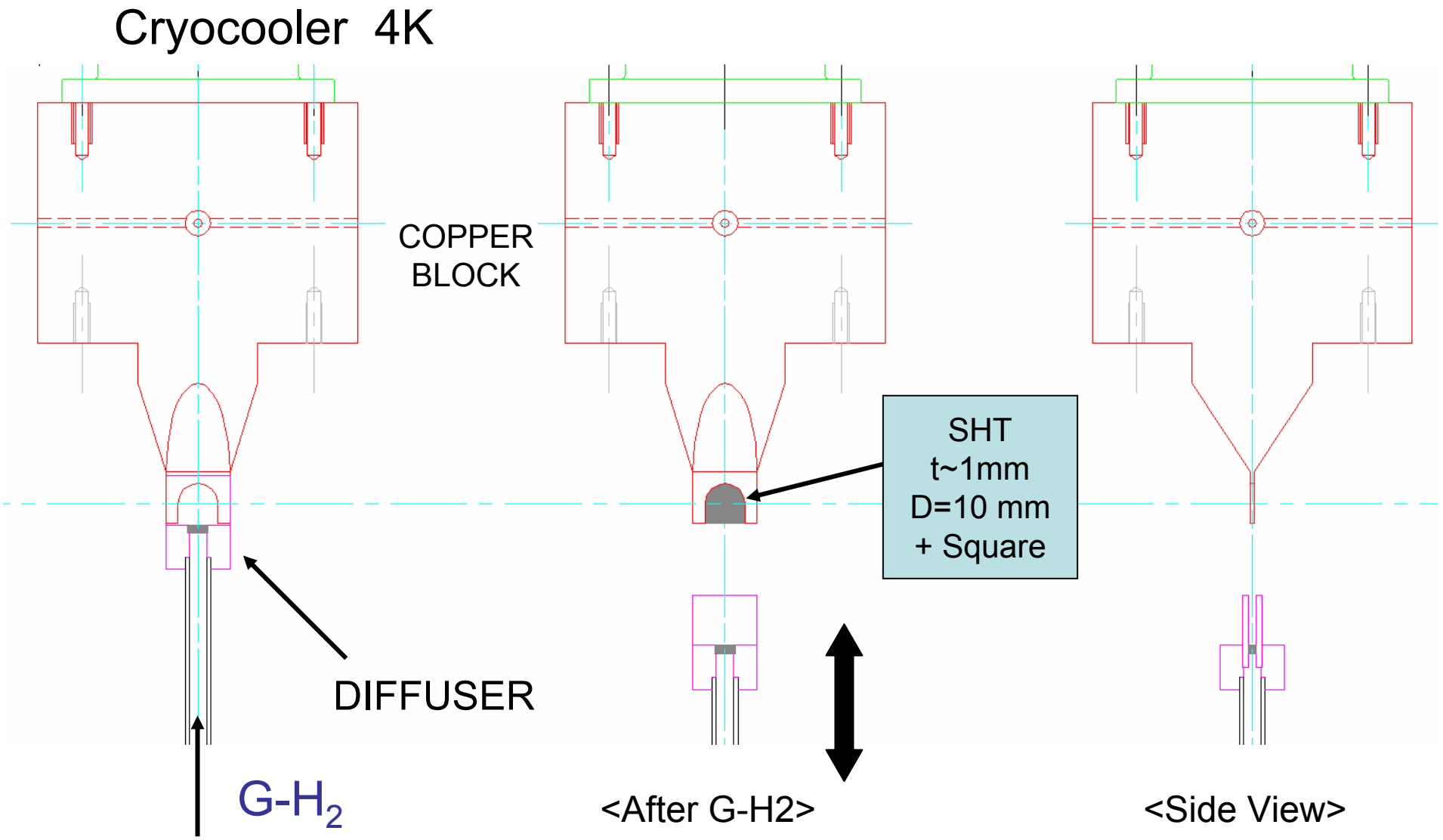


VAC. < 10^{-10} mbar
at T=2K

Test Plan of Stick-type WSHT Using KEK Thin-WSHT System



Test Plan of Thin-WSHT without Backup Metal



Summary

(1) Introduce the KEK Thin-WSHT system for TRIUMF

(2) Proposal of "New Stick-type WSHT" for antiproton experiment at FNAL

(3) Stick-type WSHT can be developed using present KEK Thin-WSHT system in 2010.

(4) Stick-type WSHT in storage ring, we need

1. 2K cryostat (cryocooler or L-He pumping)
2. gate valve to separate from ring vacuum
3. para-H_2 (~20K cryostat + catalyst)
4. cryostat moving system to insert and control target position

(5) Another Idea; WSHT without backup metal