# Hydrogen target at RIKEN.
# Achievements and future developments.


| | |
|---|---|
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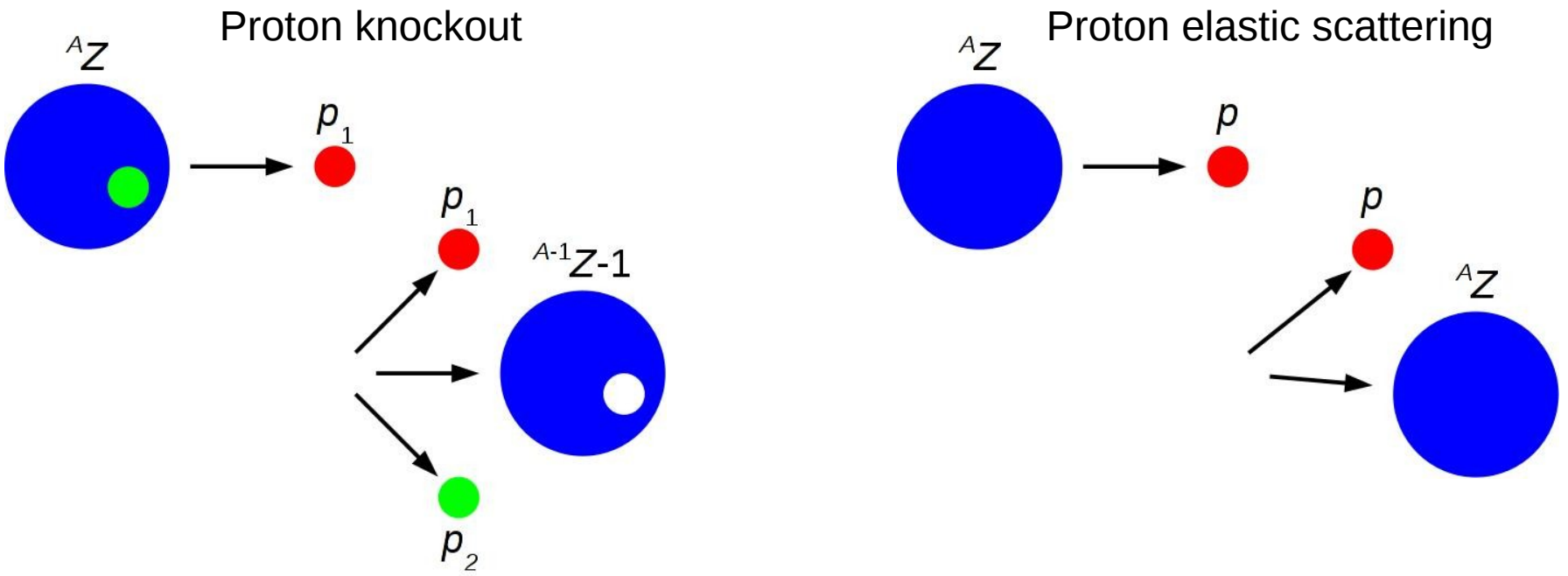
| RCNP | H. Sakaguchi, Y. Takahashi, I. Tanihata, J. Zenihiro |
| GSI | S. Terashima |
| Miyazaki Univ. | Y. Maeda |
| KEK | S. Ishimoto, S. Suzuki |

# Motivation

Examination of the property of unstable nuclei.

Nucleon knockout reaction experiments
Proton elastic scattering experiments
} using inverse kinematics.



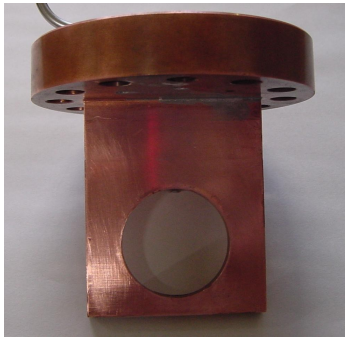

Solid Hydrogen Target (SHT)

Two types of geometry for each experiment.

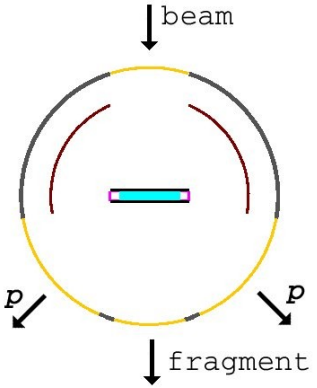
# SHT for (*p*,*pN*) reaction

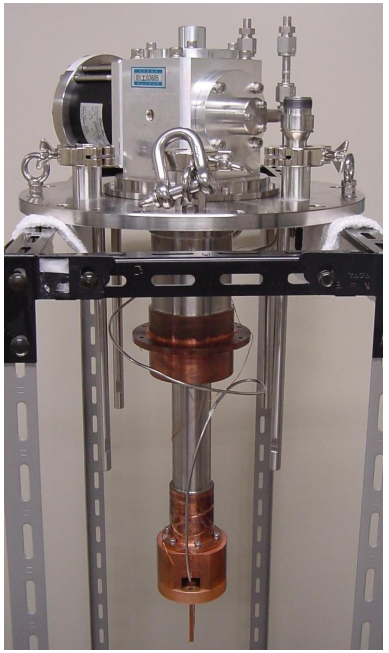
Specifications

| Refrigerator | |
|---|---|
| Model# | SHI, RDK-415E/CSW-71C |
| Cooling method | GM cycle (double stage) |
| Cooling capacity | 1st stage: 35/45 W (50K, 50/60 Hz)<br>2nd stage: 1.5/1.5W (4.2 K, 50/60Hz) |
| **Target cell** | |
| Material | Oxygen-free copper |
| Cell size | 35 mmΦ, 5 mm$^{t}$ |
| Windows | 9 μm$^{t}$-Aramid film |
| **Target chamber** | |
| Windows | 50 μm$^{t}$-Mylar film |



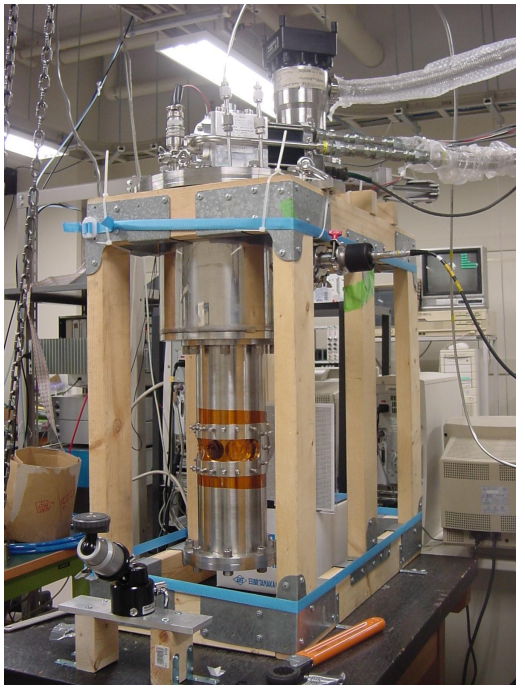
Target cell



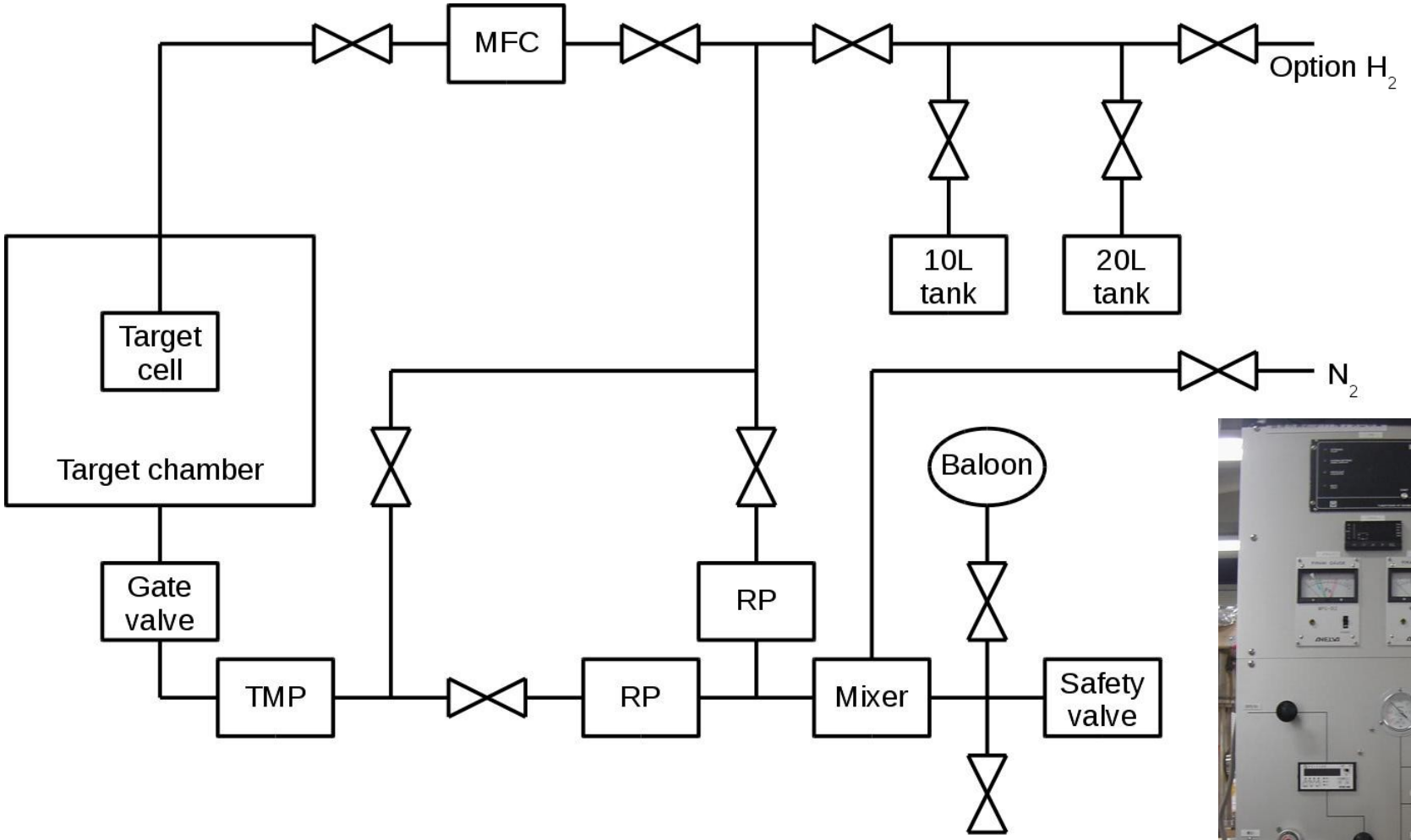
Refrigerator+Target cell

Radiation shield

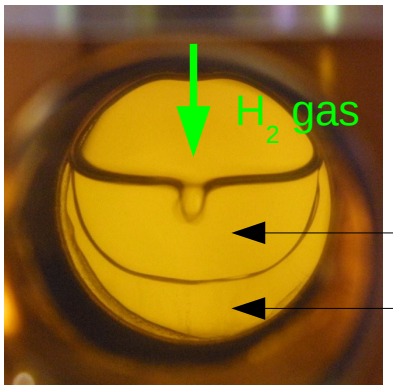


Target chamber

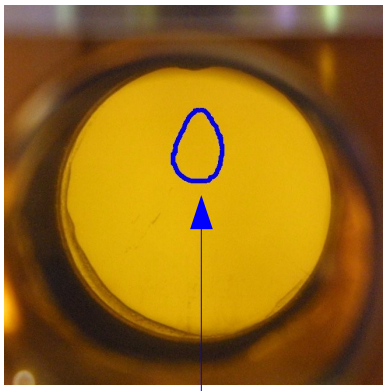
# Gas-handling system



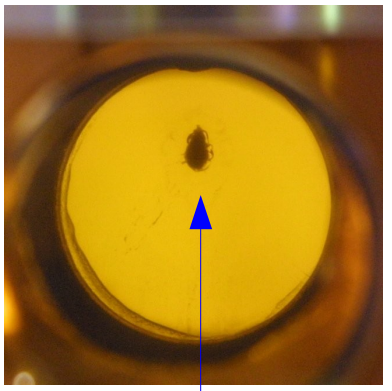

# Uniformity of density




in wrong condition



Confinement of liquid



Low-density area
(“Su” in Japanese)

in appropriate condition

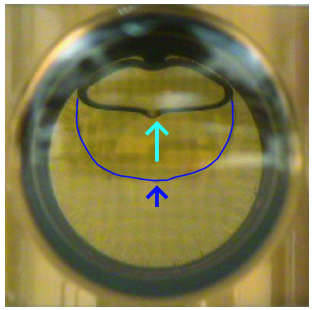
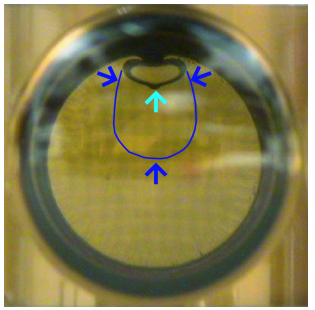
SHT of uniform density

Gas flow rate just before the completion of SHT

Gas flow rate is adjustable indirectly
by the initial hydrogen gas pressure in tank

# Solid hydrogen growing-process

- Gas flow rate is too high

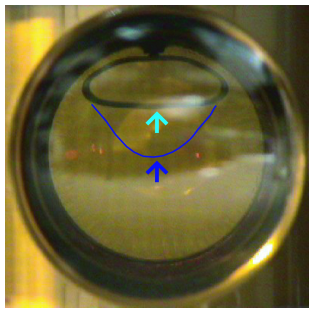
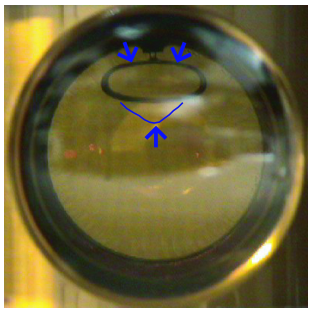



Ascention of liquid level is too fast

Liquid is confined

Low-density area

- Gas flow rate is too low

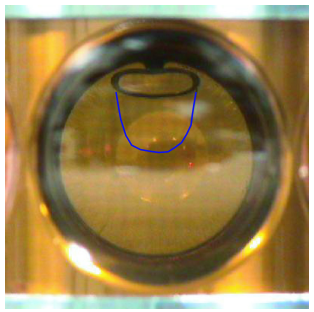



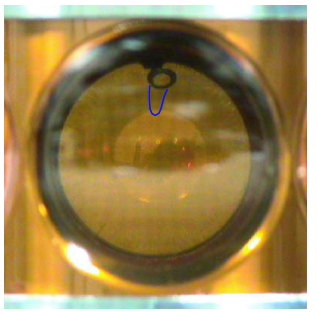
Ascention of liquid level is too slow

Gas is confined

Void/Low-density area

- Gas flow rate is appropriate

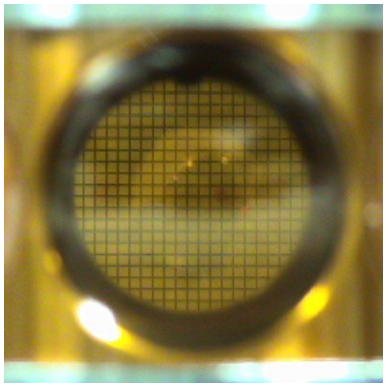




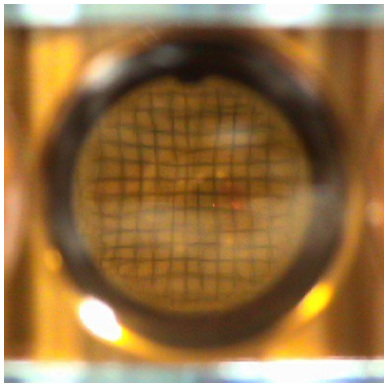

# Uniformity of thickness

Views of the grid looked through the target

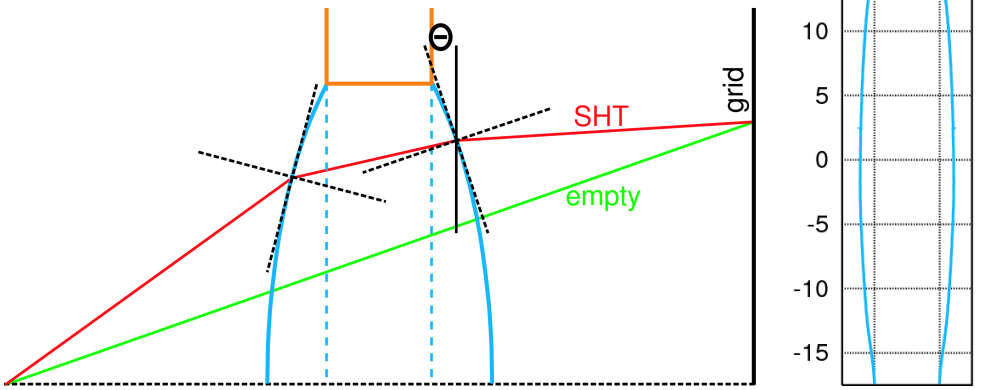
empty



SHT

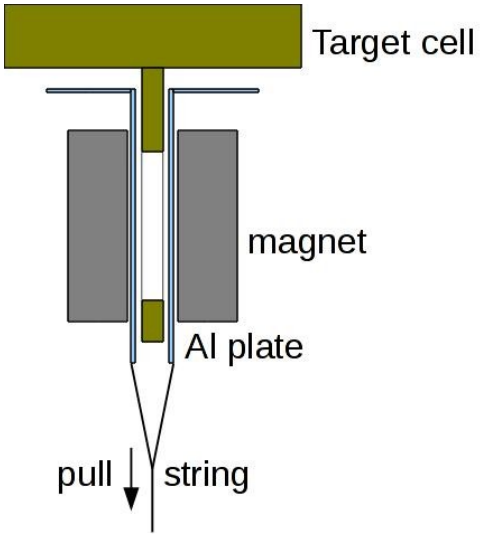


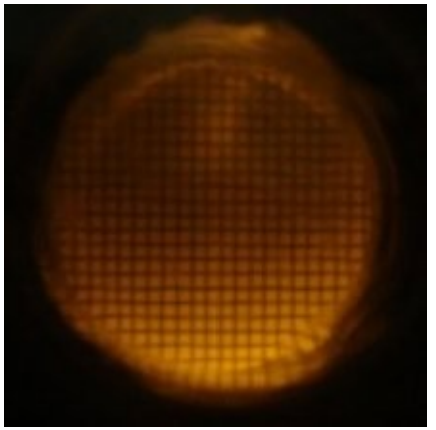
solid hydrogen-lens




Swelling of ~1 mm on one side

Fasten both sides of target cell



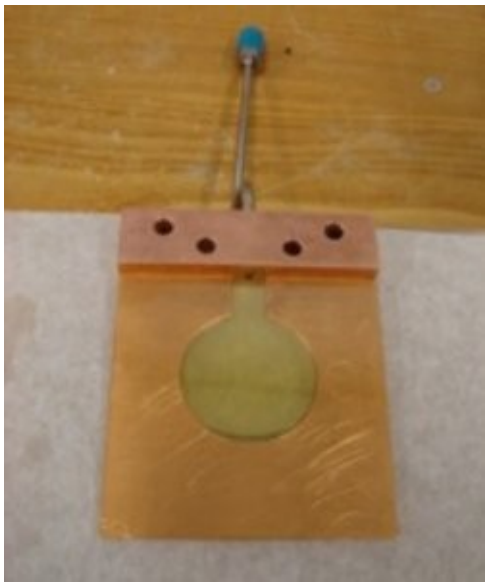
uniform thickness ?

(actual thickness is not measured yet)

# SHT for proton elastic scattering

Specifications

| Target cell | |
|---|---|
| Material | Oxygen-free copper |
| Cell size | 30 mmΦ, 1 $mm^t$ |
| Windows | 9 $\mu m^t$-Aramid film |



Target cell

Large void at the center of target

Thermal conduction is too low
compared with the inflow of radiation heat.

↓

para-$H_2$

# para-SHT (1)

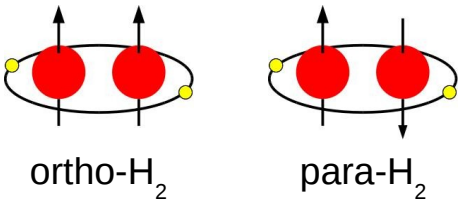
Thermal conductivity

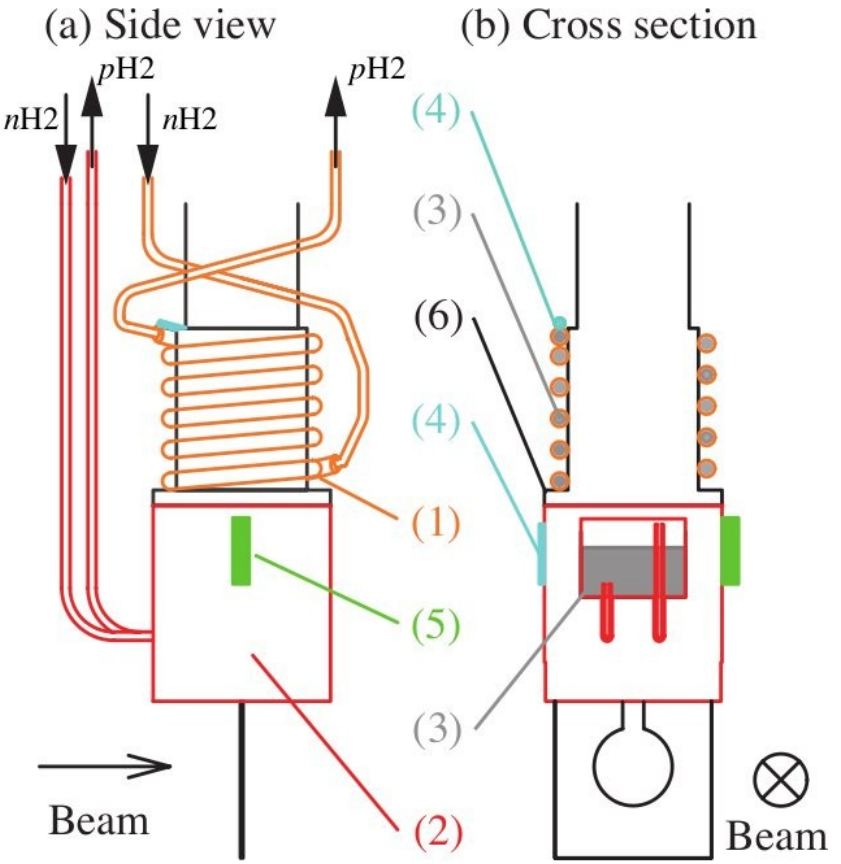
normal-$H_2$

ortho:para=3:1 at normal temperature

⩓ More than 100 times larger

para-$H_2$

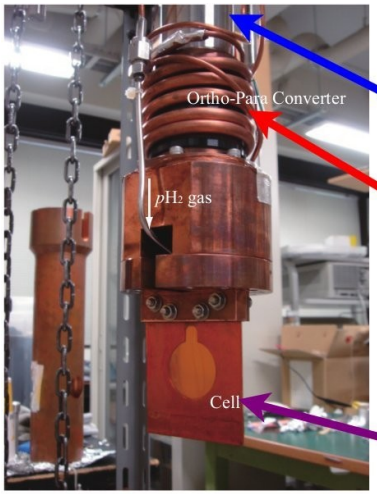



(1) o/p converter (pipe type)
(2) o/p converter (cylinder type)
(3) catalyser ( FeO(OH) )
(4) thermometer
(5) heater
(6) cold head

Ortho-para converter

Pipe type

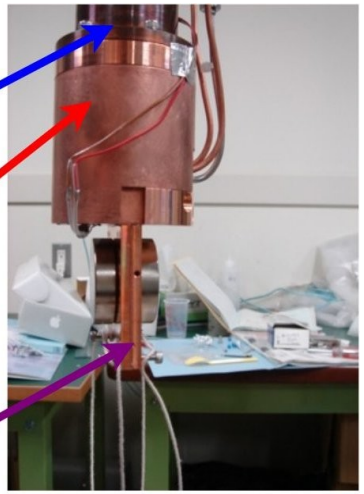



Cold head

o/p converter

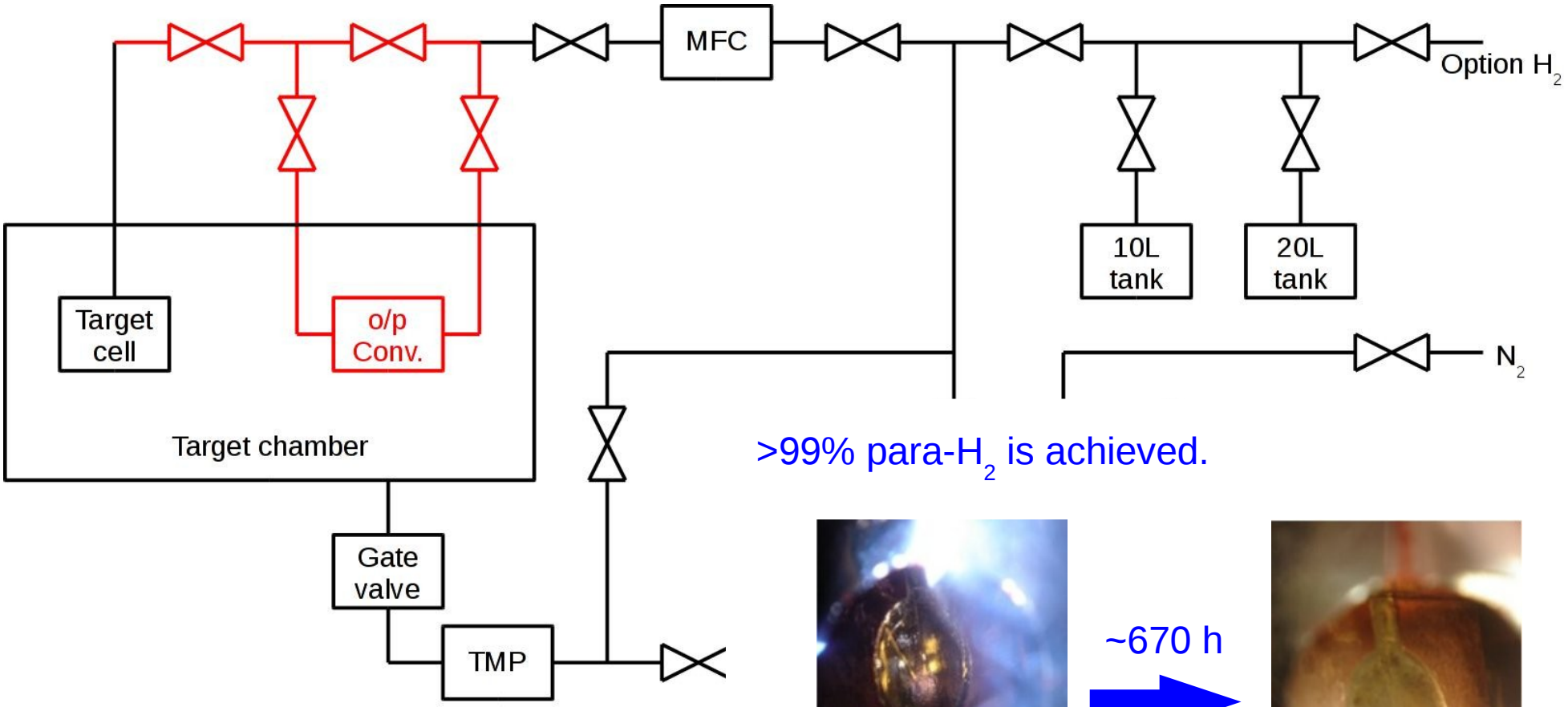
Target cell

Cylinder type



# para-SHT (2)

Additional system




>99% para-$H_2$ is achieved.




Uniform density
Thickness ?

# Summary

- Solid hydrogen target
  - 35 mmΦ, 5 $mm^t$ target for nucleon knockout reaction
  - 30 mmΦ, 1 $mm^t$ target for proton elastic scattering

- Uniformity of density
  - Adjustment of gas flow rate
  - Use of para-$H_2$

- Uniformity of thickness
  - Fasten the target with metal plate and magnet

- Future developments
  - Measurement of actual thickness and its uniformity
  - Thinner target with larger aperture for proton elastic scattering