

# Fueling Pellet Injectors

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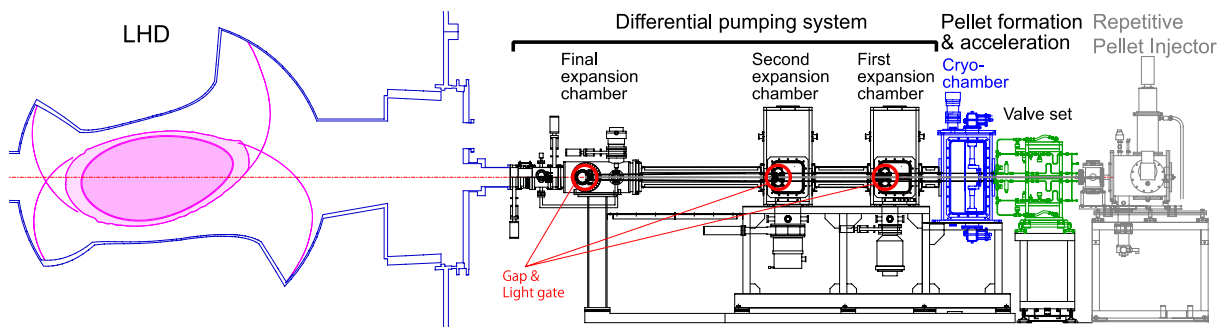
## 1. Objective

Inject hydrogen isotope pellets into core plasma to control plasma density

## 2. Apparatus

The in-situ pipe gun type 20-barrel injector and the screw extruder type repetitive pellet injector are integrated on the B-stage (Fig. 1). Solid hydrogen isotope pellets are injected from 3O-AL01-01 port.

In both pellet injectors, pellet is accelerated pneumatically with high pressure propellant gas (He). The three-stages differential pumping system is employed to minimize the undesirable propellant gas flow into the LHD vacuum chamber.



*Fig. 1. Fueling pellet injectors*

### 2.1. In-situ pipe gun type 20-barrel solid hydrogen pellet injector

- 20 pellets can be injected independently at arbitrary timing.

Nominal size [mm $\phi$ ]	Number of atoms	Number of barrels	Pellet velocity [m/s]
3.0	$1.0 \times 10^{21}$	4	1000 - 1400
3.4	$1.5 \times 10^{21}$	6	
3.8	$2.0 \times 10^{21}$	10	

### 2.2. Screw Extruder type repetitive pellet injector

- Pellet can be injected steadily at a frequency of up to 11 Hz.

- Pellet size and velocity: 3.0 mm $\phi$  and 200 – 500 m/s.

## 3. Operation

- Pellet injection timing control

+ Preprogramming pellet injection timing control based on the t=0 trigger

- + Realtime pellet injection timing control based on the CO2 interferometer or bremsstrahlung signal
- Pellet materials can be selected from hydrogen and deuterium.

#### 4. Available data by “Retrieve”

- Diagnostics name: “FPellet”

Ch.	Signal name	Explanation
1	LG1	Light gate at the 1st expansion chamber
2	LG2	Light gate at the 2nd expansion chamber
3	LG3	Light gate at the 3rd expansion chamber
4	ReP-LG0	Light gate at the auxiliary expansion chamber for RePellet
5	ReP-LG1	Light gate at the 1st expansion chamber for RePellet
6	DAC	Target value for the realtime pellet injection timing control
7	CO2/Brems	Reference signal for the realtime pellet injection timing control
8	Halpha	Pellet ablation light intensity with narrow band pass filter for Balmer $\alpha$
9	Hbeta5	Pellet ablation light intensity with narrow band pass filter for Balmer $\beta$
10	Hbeta20	Pellet ablation light intensity with wide band pass filter for Balmer $\beta$
11	Hgamma	Pellet ablation light intensity with narrow band pass filter for Balmer $\gamma$
12	Cont	Pellet ablation light intensity with wide band pass filter between H $\alpha$ and H $\beta$
13	FCgate	Exposure control signal for fast camera
14	TS_Trigger	Pellet injection synchronized Thomson laser driving trigger
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#### 5. Remarks

It takes around 6 hours to cooling down the cryo-unit from the room temperature to the operational temperature (~10 K). Therefore, injection plan should be submitted at least one day before the experiment.

#### References

- [1] R. Sakamoto et al., “Twenty barrel in situ pipe gun type solid hydrogen pellet injector for the Large Helical Device”, Review of Scientific Instruments 84 (2013) 083504.
- [2] R. Sakamoto et al., “Development of Advanced Pellet Injector Systems for Plasma Fueling”, Plasma and Fusion Research 4 (2009) 002.
- [3] H. Yamada et al., “Repetitive fueling pellet injection in large helical device”, Fusion Engineering and Design 69 (2003) 11-14.
- [4] H. Yamada et al., “Development of pellet injector system for large helical device”, Fusion Engineering and Design 49-50 (2000) 915-920.