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Radiological safety assessments for fusion neutron source

in engineering design activities under IFMIF/EVEDA project

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ABSTRACT

- International Fusion Materials Irradiation Facility (IFMIF)-like fusion neutron source (FNS) produces fusion-like neutrons by injecting 125 mA/40 MeV deuteron beam into a liquid lithium target in order to elucidate fusion neutron irradiation effects on fusion reactor materials.

Under the IFMIF/Engineering Validation and Engineering Design Activities (EVEDA) project, the present study (1) evaluated the production and migration amounts of radionuclides and (2) assessed worker and public doses under steady-state operation incidental/accidental cases.

Introduction

- IFMIF/DONES and A-FNS are IFMIF-like FNS in EU and Japan,

IFMIF/EVEDA project is being performed as international collaboration between EU and Japan under the Broader Approach (BA) Agreement [1, 2] to develop common technologies for the IFMIF-like FNSs;

IFMIF/EVEDA project includes;

1. Development of the prototype accelerator LIPAc,

2. Engineering design activities for FNS,

3. R&D activities for Li Target Facility (including 1/10-scale pilot Li loop experiments [3]).

The engineering design activity performed by Japan (2020-2025);

1. Tritium migration estimation,

2. Erosion/deposition modelling in the Li loops,

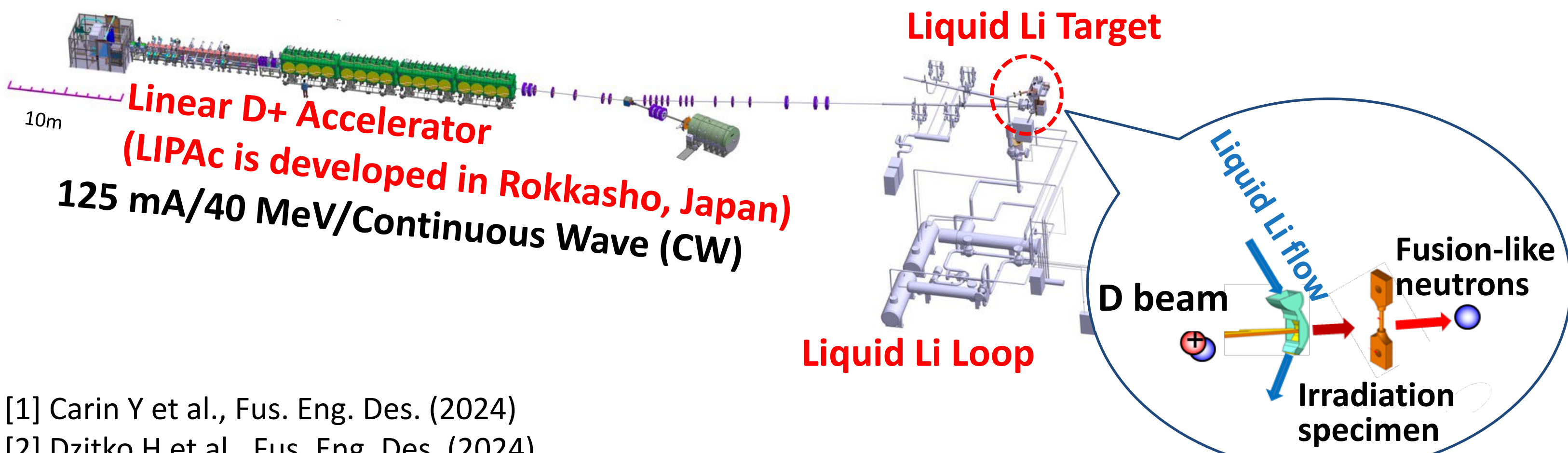
3. Accident analysis in safety,

4. Study on the optimization of the Li-Oil Heat Exchanger (HX),

5. Use of LIPAc as testing facility.

**Motivation:** Ensuring the radiological safety is necessary in the engineering designs.

**Purpose:** Evaluation in the radiological risk for both worker and public in the FNS facility.



Effective dose assessment around the liquid Li loop

- Major radionuclides: Tritium ( $2.7 \times 10^{15}$  Bq/year, 7.5 g/year) & Be-7 ( $5.02 \times 10^{15}$  Bq/year), mainly produced by D-Li reaction,

Tritium is trapped in C.T. or H.T. ( $1.4 \times 10^{11}$  Bq),

Be-7 deposits on C.T. ( $1.6 \times 10^{13}$  Bq) & HX ( $2.0 \times 10^{15}$  Bq).

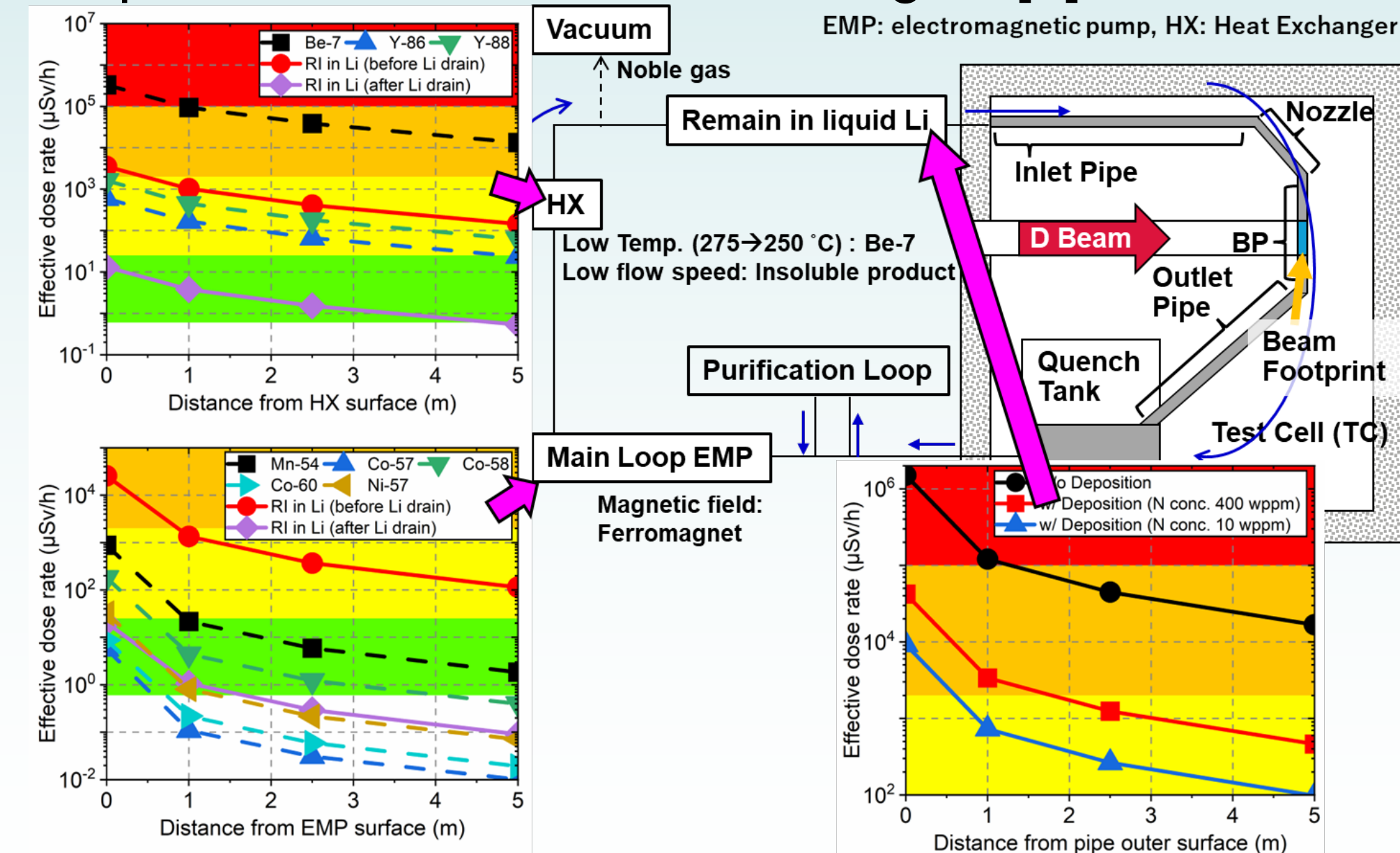
**Motivation:** although the major radionuclides are evaluated so far, other radionuclides have not been studied extensively.

Calculations the production amounts of activated corrosion/erosion product (ACP/AEP) and activated Li impurity (ALI).

Implementation of measured impurity concentrations in Li from EVEDA Li Test Loop (ELTL) for realistic activation calculations.

Modeling of RI migration through the liquid Li loop [4].

Effective doses assessments around the liquid Li loop contribute to development for maintenance strategies [5].



Effective doses around the Li-loop components due to the radionuclide in the liquid Li and deposits.

[4] Kenjo S et al., Fus. Eng. Des. (2024)

[5] Kenjo S et al., Fus. Eng. Des. (2025)

Tritium migration estimation

- Quantitative evaluation of tritium migrations in the FNS facility,

**Motivation:** Upgrade tritium migration model around the liquid Li loop [6] to estimate the release amounts from the facility through the stack.

Tritium Process Laboratory (TPL) in JAEA released  $2 \times 10^5$  Bq/h (HT) &  $2 \times 10^6$  Bq/h (HTO) with the stack flow rate of  $3.88 \times 10^4$  m<sup>3</sup>/h [7].

