# Technical Preparation : Photon dump for undulator positron source

***Outline*** : The photon dump for the undulator positron source, which should absorb an averaged power of 120 kW for the 250 GeV high luminosity case, needs to be changed from TDR where a water dump similar to the main beam dump was assumed. Due to the high concentration of photons by undulator, the local energy deposition in a water is high and a water should be pressurized about 12 atm to prevent temporary boiling during or at the end of each pulse. The window should be Ti alloy more than 1mm thick to resist a water pressure and such a thick window will suffer from fatigue through high thermal cycles during each pulse and severe radiation damage.
Two alternative designs are currently proposed. One is a water curtain dump and other is a graphite dump to be installed 2 km downstream. These designs are standing on the heat and radiation damage analysis, and need to move forward by including the technical issues especially on power absorption structures and a maintenance of activated equipment.

These design works will be carried out with the collaboration of experts from the field of high-power target and dump in the world. The prototyping of the key structure will be expected.

***Goals of the technical preparation***:
Establish the system design of photon dump in an engineering level, including the photon absorption structure, infrastructures for cooling, and the maintenance of the activated equipment.

***Items:***

- Engineering design and prototyping of the photon absorber, i.e., water flow of the water curtain, thermal contact of graphite plate
- Engineering design of window for the water curtain, including cooling gas flow system
- Engineering design of how to perform maintenance of activated equipment
- EDR

***Expected cost:***

| *Issue* | *Tasks* | *Cost* | *Human Resources (FTE)* |
|---|---|---|---|
| *Water curtain* | *Design and prototyping; flow of water, cooling of window* | | |
| *Graphite absorber* | *Design and prototyping; cooling of a graphite plate on copper* | | |

(not including corresponding cost of human resources)

***Candidates:***

CERN, RAL, ESS-Bilbao

***Appendix***

(Current status)

The photon dump for the undulator positron source (Figure 1), which should absorb an averaged power of 120 kW for the 250 GeV high luminosity case and 108 kW for the 500 GeV high lumi case. A water dump similar to the main beam dump was assumed in the TDR. In contrast to the main water dump for electron and positron beams, the photon beam cannot be swept magnetically. Due to the high concentration of photons, a cross section of below 2 mm, the local energy deposition in a water is high and a water should be pressurized about 12 atm to prevent temporary boiling during or at the end of each pulse. A 1 mm thick Ti-window would be required to resist a water pressure and such a thick window will suffer from fatigue through high thermal cycles during each pulse and severe radiation damage. Therefore a different approach has been proposed. Two ideas are currently discussed.

The water curtain dump is an ideas of photon dump (Figure 2). In contrast to the main beam dump filled with water, a free falling water curtain relaxes the issues in a water caused by a high dense heat deposition by a photon pulse. The water falls vertically and not pressurized, i.e., 1 atm. The double walled beam window is located about 10 m upstream of the dump to separate the water section and the beamline. Each window will be made of Ti-alloy, Ti6Al4V, about 15 cm in diameter and 0.2~0.4 mm thick. Double windows will be cooled by He gas which flows between them with 100 m/s flow rate, and mechanically tumbled, e.g., 3 cm in radius and velocity of 0.1 m/s, to reduce the heat density by pulse like a sweeping of electron beam. The location of the water curtain dump is evaluated for about 40 m from the target (near) and 2 km from the target (far). The later case is much relaxed.

Another idea is a dump based on graphite which tolerating high temperature (Figure 3). Putting graphite dump at 2 km from the target and receive photons by a shallow angle of 10 mrad will make thermal distribution acceptable. The entire graphite part will be 1 cm thick, 50 cm wide and 4 m long, and it will consist of several short units. Each graphite plate needs to be attached or brazed on a water cooled copper. All graphite units with copper base will be in vacuum, then it will remove a window between the dump and beamline.

In both designs, basic studies for issues on heat, stress and radiation damage have been studied by using simulation code of ANSYS and FLUKA. Further studies should be conducted to establish an engineering design including infrastructures, maintenance and failure scenarios.

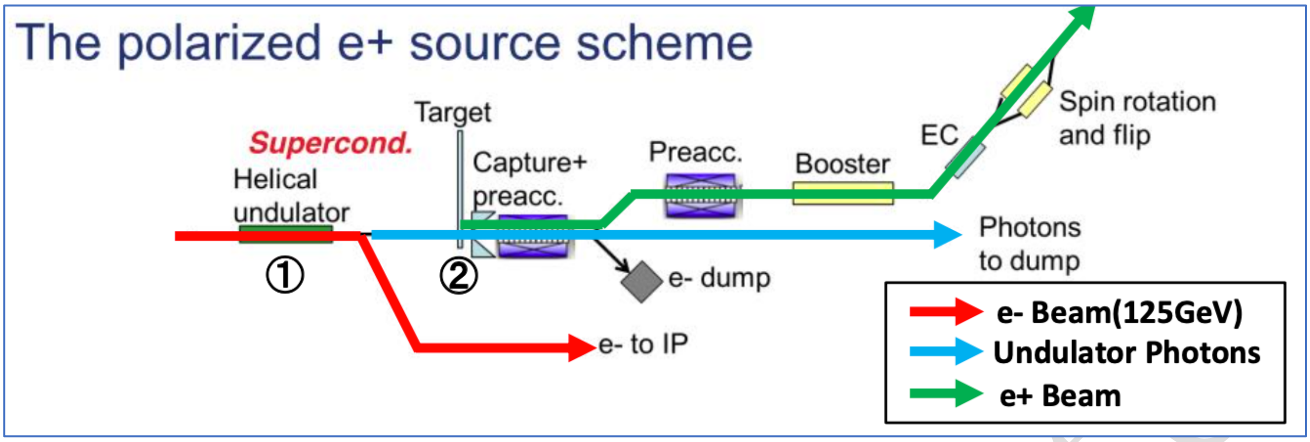


Figure 1: Configuration of undulator positron source

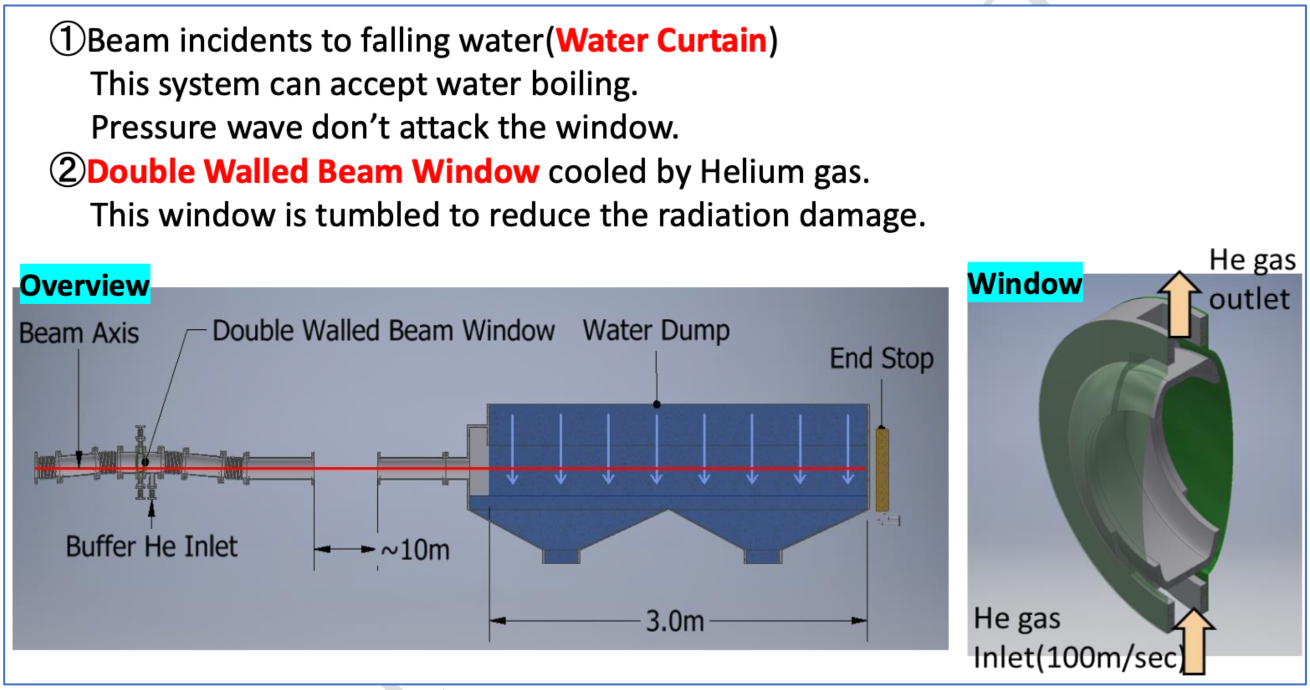


Figure 2: Configuration of water curtain photon dump

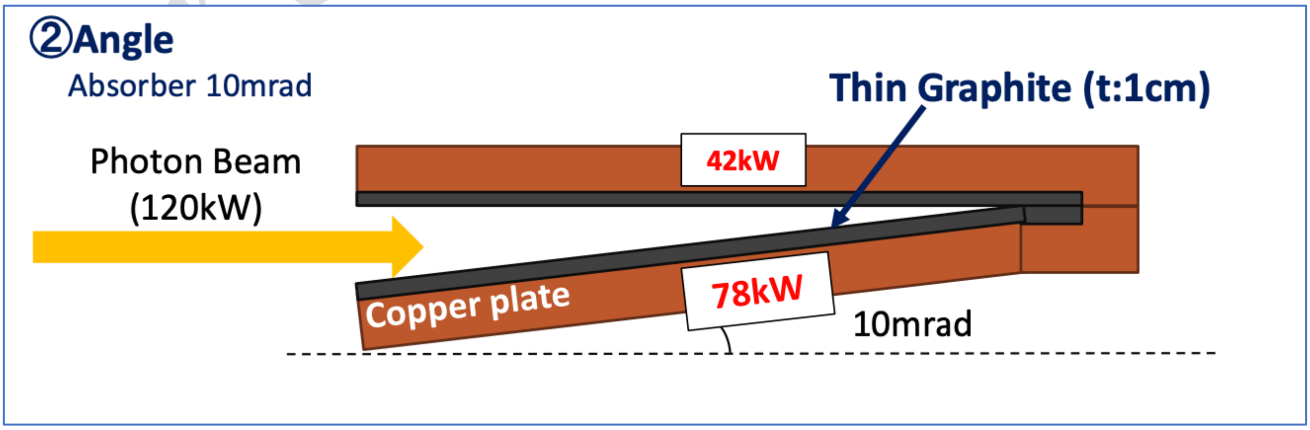


Figure 3: Concept of graphite based photon dump