Using this principle prototype, we conducted several experiments of the granular flow spallation target such as controlling flow pattern, flow regulation and heat transfer, *etc.* The experimental results showed that the prototypes I and II were proper functioning, and the related principle and design of the granular flow spallation target were verified.

Reference

[1] Wenlong Zhan, Hushan Xu, Lei Yang, "Target device for neutron generating device, accelerator-excited neutron generating device and beam coupling method", International patent: PCT/CN2013/072132.

5 - 17 Granular Waterfall Target for a Muon-Decay Neutrino Beam Facility

Cai Hanjie and Yang Lei

For a muon-decay neutrino beam facility, such as the long-baseline neutrino factory(NF) and the medium-baseline MOMENT (MuOn-decay MEdium-baseline NeuTrino beam facility), the requirement of high intensity muon source requires that the target station be capable of surviving with the bombardment of a proton beam with multi- even tens-of-MW power. The high beam power and the small target size lead to an extremely high power density, which poses significant challenges to the target station. For the NF, it is believed that the mercury jet target can handle the power deposition of a 4 MW proton beam. However, the temperature will not be much lower than the boiling point of mercury (∼357 ℃). When a much more powerful beam is mandatory, just like what has been proposed (15 MW even more) for the MOMENT project, it is unlikely that a liquid metal jet target can meet the requirement.

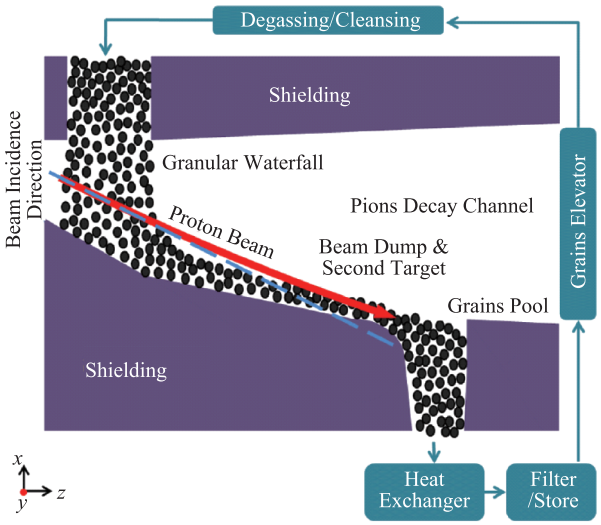

Fig. 1 (color online) Schematic outline of a granular waterfall target in the grain loop system with heat exchanger, grain filter, lift, and degassing/cleansing devices.

We propose here a new target solution, the granular waterfall target, as shown in Fig. 1, for a muon-decay neutrino beam facility. This kind of target concept adopts a grain waterfall to serve as the target body. Due to its high power-processing ability, the granular waterfall target has the potential to operate with the 15 MW cw proton beam of the MOMENT. In addition, because of its relatively simple working mechanism, this kind of target concept also can be chosen as an alternative to the traditional mercury jet target.

As shown in Fig. 1, the solid granular particles flow through the narrow outlet of an upright cubic hopper to form a waterfall of grains. From the hopper outlet, the waterfall is accelerated by gravity to pass through the beam-target interaction region quickly. When the waterfall falls to the inner surface of the shielding, the grains will flow through the incline chute to reach the downstream pool and circulate in a loop system which contains a heat exchanger, a grain filter, a lift device and a degassing/decontamination equipment. In the incline chute, the grain flow can act as a beam dump as well as a second target.

As shown in Fig. 2, for the granular waterfall target, the temperature rise is much smaller than the traditional jet target. With a temperature rise of less than 200 ℃ for the 4 MW beam power, the granular waterfall target is shown to possess significant advantages to act as the target of a muon-decay neutrino beam facility.

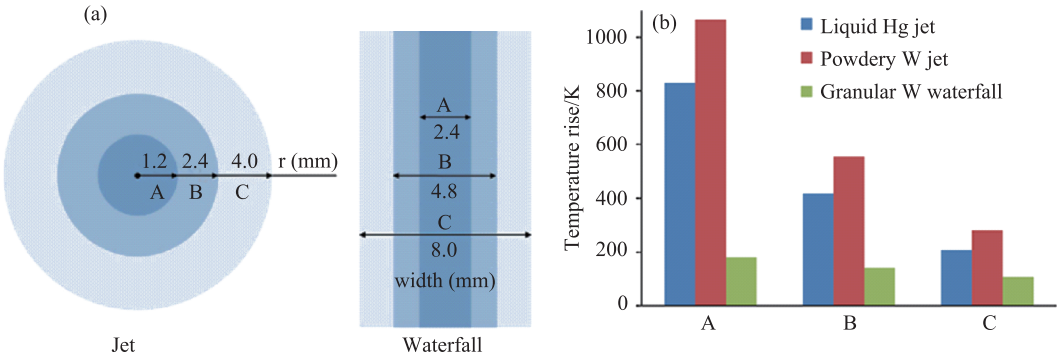

Fig. 2 (color online) Different regions of the traditional columnar jet flow targets and the granular waterfall target (a) and the temperature rises owing to the power deposit of the 4 MW proton beam (b).

5 - 18 Study Progress of Reactor Physics Group

Gu Long, Peng Tianji and Wang Dawei

In this paper, the progress and status of the research activities of CiADS subcritical reactor in Reactor Physics Group during 2016-2017 are introduced.

1 Conceptual Design of CiADS Subcritical Reactor

At the end of 2015, the National Major Scientific and Technological Infrastructure project named "China Initiative Accelerator Driven System (CiADS)" was formally approved by the National Development and Reform Commission. in the CiADS project, the technical route of "superconducting linear accelerator + high power spallation target + subcritical reactor" is determined. Aiming at the construction requirement of CiADS, a conceptual design of subcritical reactor has been finished.

The subcritical reactor is a Lead-bismuth cooled fast neutron reactor, and the semi-pool semi-loop type special-shaped vessel is used to realize the structure coupling with the spallation target. The relatively mature fuel scheme is adopted, the unique Lead-bismuth coolant auxiliary system is designed, the fuel operation without opening the head is achieved by the remote operation system, a variety of engineering safety systems are set up to ensure the safety of the reactor. The subcritical reactor consists of core, reactor coolant system, engineering safety systems, reactor auxiliary system, nuclear island common support system.

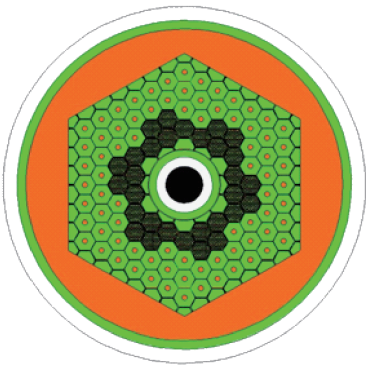

Fig. 1 (color online) Layout of Reactor Core.

The CiADS subcritical core consists of 30 hexagonal fuel assemblies and 78 dumb assemblies. There is a circular channel in the middle of the core for the scatter of the target tube. The layout of CiADS subcritical reactor core is shown in Fig. 1, the core parameters is shown in Table 1.

Table 1 Main Parameters of Core.

Item	Value
ADS power/ MW	10
Reactor power (BOL/EOL)/MW	7.74/7.66
Spallation neutron yield/(n/p)	8.81
Total mass of fuel/t	1.72
K_{eff}	0.734 57
K_{s}	0.769 22
Burnup at EOL/(MWd/tU)	4 902
Number of fuel assemblies/box	30
Number of dumb assemblies/box	78