Contribution ID: **27** Type: **Talk**

On-target neutron production monitoring with Self Powered Neutron Detectors

Tuesday 3 September 2019 12:30 (20 minutes)

The DONES deuterium-lithium high-intensity stripping neutron source is part of the next generation of high-intensity, accelerator-driven neutron sources.
DONES will irradiate candidate material samples for fusion reactor structures with 10ˆ14 n/cmˆ2s, keeping the samples above 300 degrees C for 11 months consecutively, in which no access will be possible to the irradiation cell.
In these conditions, the necessary flux monitoring in the neutron beam will be challenging: dedicated R&D is ongoing to design the best detector for this environment.
One candidate are Self Powered Neutron Detectors (SPNDs) that exploit the neutron-induced activation of specific materials, which then decay through electron emission: in an SPND, the activated material acts as a first electrode (emitter). A second electrode (collector) placed at close distance from the emitter collects the beta electrons without any bias voltage. SPNDs are used for neutron flux measurements in fission reactors, and are tailored to exploit thermal neutron induced activation. Typical time response ranges from ms to s, construction is coaxial with an outer diameter of 3mm and few cm length. Due to the low current over neutron flux ratio, SPNDs are used for the measurement of neutron fluxes well above 10ˆ10 n/cmˆ2s, where other kind of detectors fail due to radiation effects (NIEL, SEE, DDD) when exposed for long periods of time.
In order to improve the sensitivity of SPNDs to MeV-range neutron flux measurement, a new set of emitter materials have been studied. A prototype with an aluminum alloy emitter has been realised, and tested together with a rhodium emitter in two experimental campaigns. The first one has been performed at GELINA photonuclear neutron source located in JRC Geel in January 2018: SPNDs have been placed at 3 cm from the photoproduction target, where a flux up to 6 x 10ˆ10 n/cmˆ2s is achieved with an energy spectrum up to 20 MeV. A detailed Monte Carlo simulation with MCNP code has been performed in order to better evaluate the neutron spectrum at the detector position, and also the gamma contribution to the signal. A second experimental campaign has been performed at CERN n_TOF facility, where the same set of SPNDs has been placed close to the spallation target for 50 days during fall 2018. There, a completely different time distribution of neutrons is present, with pulses of 10ˆ13 protons of 20 GeV, with a duration of 25 ns, hitting the lead target every 1.2 s or more. Data have been compared with a detailed FLUKA simulation of the target yield.
Results from the two experiments showed a good sensitivity of the rhodium SPND also in the MeV range, with the capability to resolve prompt and delayed spallation target emission, and a promising detection efficiency for the aluminium one. The new n_TOF target will host a set of SPNDs as a direct flux monitoring station that will stay in place for ten years operation. Effects due to the mixed field in accelerator driven sources will be taken into account in the next design of SPNDs for this purpose.

Poster back-up

No

Author: FIORE, Salvatore (ENEA)

Presenter: FIORE, Salvatore (ENEA)

Session Classification: Talks

Track Classification: Instruments & Detectors