

**Background**

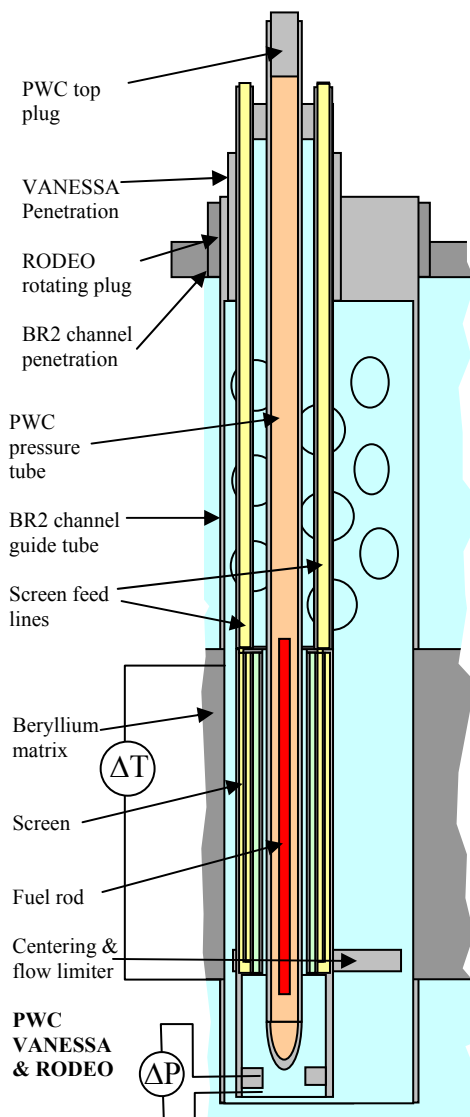
Transients can be required for fuel qualification. In this case, the fuel may have to withstand a single transient in which the power is multiplied by a factor two or more in a fraction of one or a few minutes.

Transients can also be required in order to investigate the physics of the fuel behaviour, such as the conditions of fission gas release, or the measurement of the heat conductivity. This type of research usually requires the execution of a succession of numerous small transients.

The execution of power transients on LWR fuel rods is an activity which dates back in the seventies. Successful research programmes, such as DOMO (DODewaard MOx), or HBC (High Burnup Chemistry), or, more recently GERONIMO, used the PWC (Pressurised Water Capsule) device, coupled with the CCD/VNS (Control and Calibration Device – Variable Neutron Screen).

**Objectives**

The refurbishment of existing installations was recently undertaken. A serious drawback of the CCD/VNS device is linked to the use of He-3 as removable neutron absorber. Tritium leaks plagued the operation of CCD/VNS for years. Instead of re-building a similar installation, possibly with improved components but with the same trouble factor, we opted for the development of radically different concepts which would enable us to get rid of the problem.

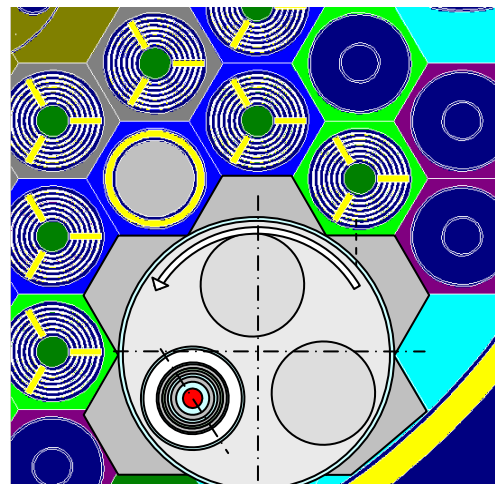


**Principal results**

The solutions envisaged still use the successful PWC capsule and a modified CCD. The transient system is a combination of PWC, VANESSA and RODEO.

**RODEO**

RODEO (ROtatable Device for the Execution of Operation transients) uses the flux gradient across a peripheral 200 mm channel of BR2 to perform transients. A PWC device is inserted in an eccentric penetration of a rotatable plug mounted on top of a 200 mm channel.



RODEO, cross section

A 180° rotation allows a maximum displacement of 106 mm towards BR2 centre, leading to up to more than threefold increase of the linear power of a fuel rod in PWC.

As start and finish positions can be selected anywhere between the extremes, any amplitude within the two extreme limits can be achieved, possibly with a small angular motion.

Furthermore, there is no limit on the number of transients that can be achieved during a cycle and there is no production of radioactive, hazardous or voluminous waste. And on top of that, the device uses little sought-after irradiation positions in BR2.

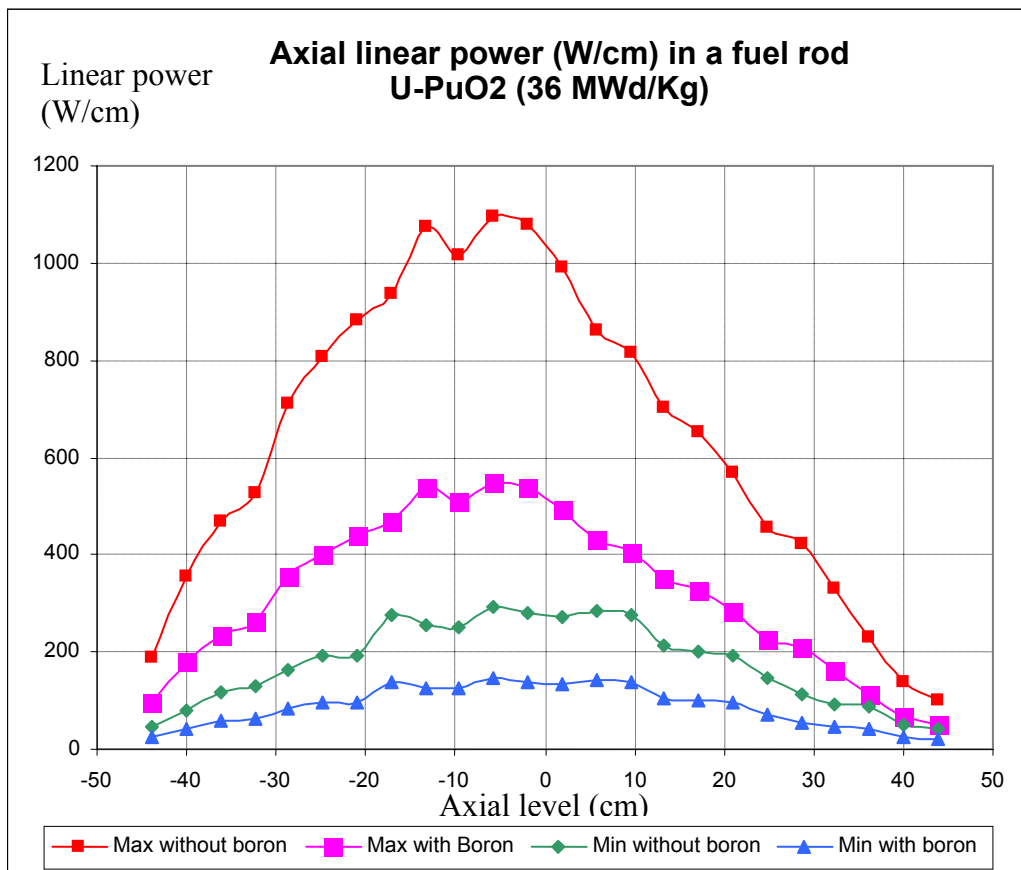
It is however necessary to tune the average power level in the system, in order to cope with variables of each specific experiment, such as the residual enrichment of the fuel, the load of BR2, etc... This is the role of the VANESSA device.

### VANESSA

In VANESSA (VARIABLE Neutron Screen System with boric Acid), the controlled neutron absorber is a variable concentration solution of boric acid in water, circulating in a CCD-like screen.

A device like VANESSA allows a further threefold increase when passing from almost saturated boric acid solution to pure water. To avoid crystallisation problems in the circuits, we limit ourselves to a twofold amplitude.

Boric acid does not produce active by-products and so, the tritium tightness problems that plagued the operation of the previous CCD/VNS are eliminated. The out-of-pile installation does not need anymore to be located in a glove box.



Axial power profiles limits obtained for extreme positions of PWC, with and without boric acid in VANESSA.

### Future work

Due to the rotating plug, RODEO is not compatible with the present PWC devices. The design will have to be adapted and the devices rebuilt.

Detail drawings of VANESSA were issued. Detail drawing of RODEO has been started.

### Main contact person

Philippe Benoit, [philippe.benoit@sckcen.be](mailto:philippe.benoit@sckcen.be)

### Main references

"RODEO Project: Rotating plug in a 200 mm BR2 channel for multiple transients on LWR fuel"  
CEE 1<sup>st</sup> phase report – NT.57/D085032/01/PB – Internal Report I-74