SCIENTIFIC ACTIVITIES IN SUPPORT OF THE BR2 OPERATION AND IRRADIATION PROGRAMMES

Background

One of the major characteristics of the BR2 reactor is the fact that the core configuration is essentially variable. This allows to optimize the irradiation conditions of various experiments and to minimize the fuel consumption. In order to do that, BR2 has its own autonomous reactor physics cell.
In order to allow for on-line measurements of the major irradiation parameters, BR2 has extended its own proven data acquisition system to serve this purpose. This system, called BIDASSE (for "BR2 Integrated Data Acquisition System for Survey and Experiments"), originally designed for the follow-up of all BR2 operational parameters, is since several years extensively used for experiments.

Objectives

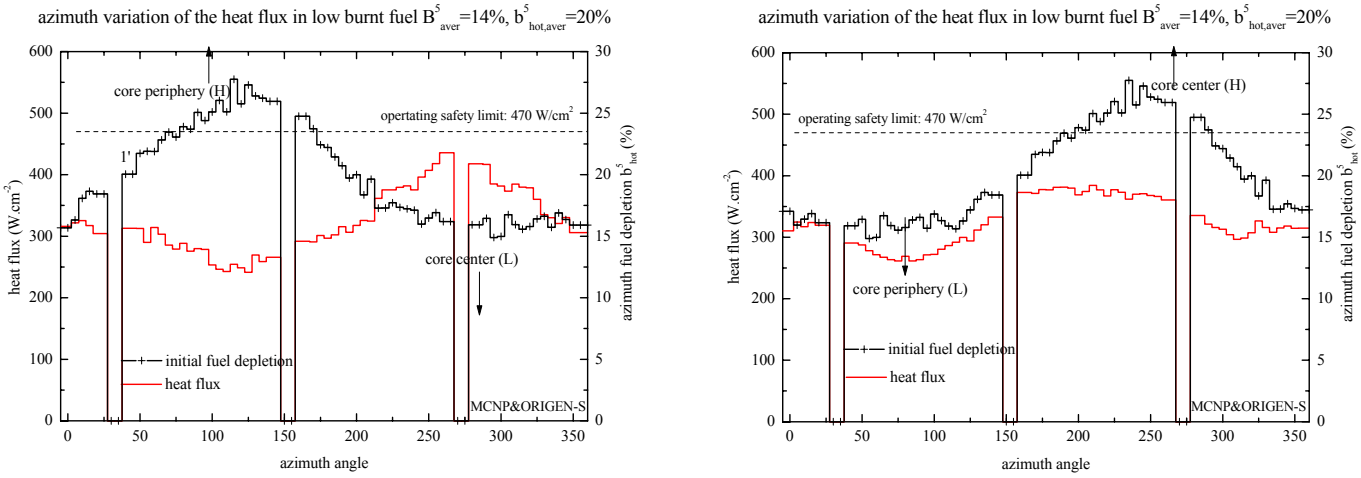
- to evaluate and adjust provisional irradiation conditions by adjustments of the environment, axial and azimuthal positioning of the samples, global power level, ... ;
- to deliver reliable, well defined irradiation condition and fluence data during and after irradiation;
- to assist the designer of new irradiation devices by simulations and neutronic optimisations of design options;
- to provide the experimenters with accurate on-line information on the evolution of their ongoing irradiation projects.

Principal results

The major evaluations conducted by the reactor physics cell in 2005 are regrouped here below under 3 main headings:

1. Ongoing irradiation programs:
   - OMICO-MIMAS-PV irradiation programme: calculation of the power distribution in the experimental MOX fuel rods to allow for online absolute LHGR measurements;
   - U_3Si_2 MTR fuel qualification at high heat fluxes: preparation and follow-up of an irradiation programme of advanced MTR fuel U_3Si_2 fuel plates inserted as the outer ring in a 6NG standard BR2 fuel element; detailed determination of the burn-up distribution;
   - optimization of the Mo-99 production yields in the PRF-type devices for various target geometries and loading schemes.
2. New irradiation devices:
   - neutronic evaluations (available fluxes, spectra, deposited power, gamma heating) of various design proposals for a new pool-side facility for Si-doping;
   - neutronic evaluations of various proposals for the realisation of power ramps on fuel pins (e.g. rotating screens, asymmetrically loaded rotating devices, variable concentration of absorbing materials in the cooling water);
   - optimisation of irradiation devices under Pb-Bi environment.
3. BR2 specific evaluations:
   - optimization of the BR2 fuel cycle using burnable absorbers (e.g. Cd-wires in the side-plates of the fuel elements);
   - various safety evaluations as illustrated in the figures here below.

Concerning data acquisition, about fifty users have the rights to access the information provided by the BIDASSE system.
More than 700 analogue and 1100 digital inputs are presently available in real time. The PC terminal for the operator, which is directly connected on the BIDASSE network, has a response time always less than one second. The response time for the end-users on the global network can vary in function of the traffic but is in general less than 3 seconds.
In particular the CALLISTO loop (simulating PWR conditions) is also connected, including an event recorder with 370 channels connected and 240 high-resolution analogue signals with one storage per minute on each channel.



Detailed heat flux distributions in the standard BR2 fuel elements in function of the BR2 configuration, the burn-up in the fuel plates and the azimuthal orientation of the concerned fuel element.

Typical control and acquisition installation for an irradiation experiment: on left side the main control panel of the PWC/CCD irradiation device and on the right side the BIDASSE front end cabinets.

Future work

Much of the work foreseen for 2006 concerns items related to the 2006 decennial safety reassessment of the BR2 reactor. Typical examples are the detailed evaluations of the poisoning of the beryllium matrix in function of various operation schemes and a detailed evaluation of the distribution of the fluences of the walls of the aluminium pressure vessel.

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Main reference

S.Kalcheva, E.Koonen, B.Ponsard, *"Accuracy of Monte Carlo Criticality Calculations during BR2 Operation"*, Nuclear Technology, August issue 2005, vol. 151