A dynamic beam window for coupling accelerator and reactor core in an ADS

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During the many fruitful discussions and presentations at this EUCARD2-workshop we all were once more reminded of the respective technical short comings of the two solutions bringing an intense proton-beam on a molten-lead spallation target housed inside a fuel-loaded reactor.

These are namely the window-less target solution where the accelerator is completely unprotected from accidentally back-streaming target material or the window solution with it's inherent danger of catastrophic failure. We incidentally note how elegant the ESS spallation target circumvents all problems as shown at this EUCARD2 workshop, however, for evident reasons of size and geometry, it is not possible to lodge such a target inside the core of a subcritical reactor.

In the window-less approach, while the actual vapor pressure of molten lead seems rather low, in the order of 10^{-6} to 10^{-7} hPa, differential pumping between the target and the accelerator is still required to avoid e.g. condensation on superconducting cavities of back-streaming material including induced radioactive elements. Such problems are overcome by a window, therefore desirable from a licensing viewpoint, in order to provide a containment barrier. However, these windows, thin by necessity are quite fragile, in particular when opposed to enormous beam currents. Note that this is a the main point, but not a mechanical stress due to the actual vacuum pressure difference on both sides of the window!

Considering these issues, we come up with the proposal of the "dynamic beam window providing further a pumping function". The idea is still very preliminary, but we want to pursue some more work to assess its reality.

Everyone having already been in a single-engine airplane with a front-mounted propeller has seen it basically transparent, yet spinning enough to provide thrust very efficiently. A kind of related aspect is the fact that already during the first world-war synchronized guns were introduced to fire "though-the prop" in the direction of the line-of-flight of the aircraft, otherwise the propeller would have been destroyed within a few seconds.

From such observations, we ask us the question if a propeller with many blades, actually looking somewhat more like turbofan, inserted between the accelerator and the spallation target, may exhibit an important safety function: It would act like a timewise-almost closed and rather thick window and thus really provide the function of containment barrier, while synchronized proton beam pulses would go through at the right moment. But at the same the blades (or possible consecutive

wheels of blades arranged in rows) may take over a pumping function, the whole thing having a remote resemblance to a turbopump striking the mind.

It will be necessary to approach suppliers of vacuum pumps, as well as other experts, to discuss about the possibility of modifications to standard equipment to see if shooting though of a pulsed beam and meaningful pumping is possible at all. We insist that our idea is very preliminary and may not turn out to be feasible or only after major modification. One aspect to have presented it at this workshop is also to trigger discussion between the concerned colleagues, critical feedback is obviously strongly desired.

If after all those considerations in due time, we still observe interest in the dynamic window, then we suggest an easy first testing of such modified equipment by means of a pulsed laser.