



Simulating Transient Effects of Pulsed Beams on Beam Intercepting Devices

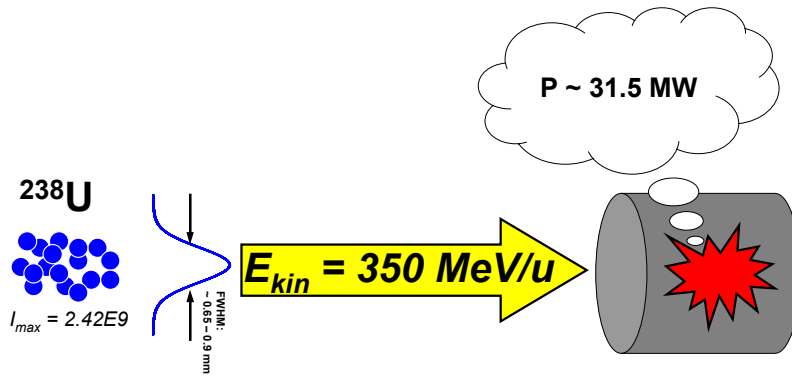
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In accelerator complexes such as those at CERN, well focused high intensity particle beams deposit large amounts of energy within the material they irradiate. For beam intercepting devices (BID), where structural integrity and lifetime are important issues, it is necessary to understand their dynamic response to pulsed beams.

The ISOLDE facility at CERN is dedicated to the production of radioactive isotopes. This is achieved by interaction of a proton beam from the PS Booster impinging on the ISOLDE targets. Such targets and associated ion sources represent small chemical factories for converting the nuclear reaction products from spallation, fragmentation and fission into a radioactive ion beam. In this way, hundreds of isotopes of more than 60 elements have been produced from a variety of target materials (oxides, carbides, refractory metal foils, liquid metals, and actinides) operated at temperatures between 600 °C and 2 200 °C. Due to the pulsed beam-induced load the average lifetime of a typical target is two weeks, a factor 30 less than comparable targets operated with continuous beams in terms of total number of protons on target (e.g. TRIUMF). Target design for future projects aiming at higher beam power (HIE-ISOLDE, EURISOL) must address the challenges of transient effects to ensure target integrity during its design lifetime.

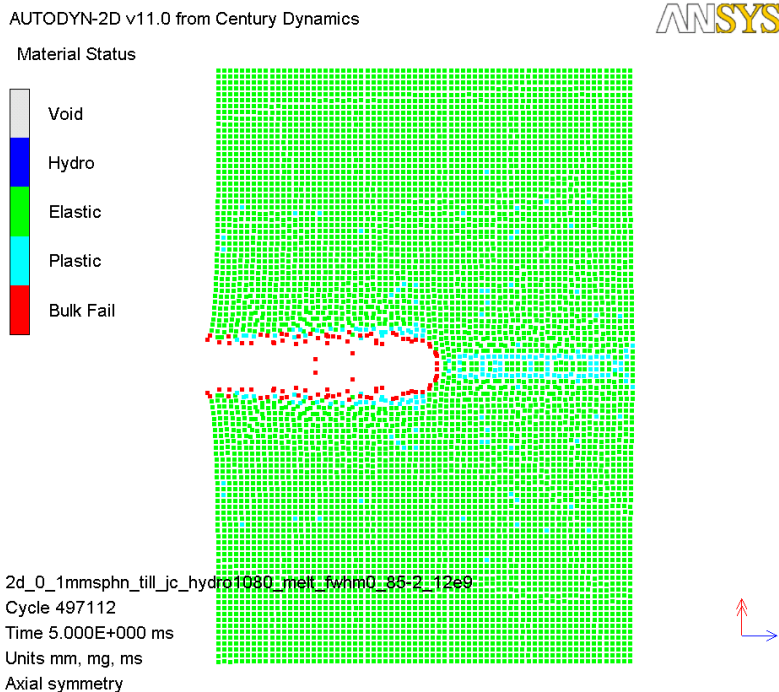
The Monte Carlo particle transport code FLUKA, jointly developed at CERN and INFN, was used to compute the energy deposition in a static target. In order to simulate targets undergoing large deformations and phase changes, one needs material models and a suitable code to simulate the non-linear dynamic response of the target. The commercially available explicit hydro-code ANSYS AUTODYN[®] was found to be most suitable for this purpose.

First results were obtained for liquid metal targets, namely mercury and lead irradiated at ISOLDE. For solid targets, a collaborative experiment at GSI was conducted. Small cylindrical targets (copper, lead, tantalum and tungsten) were irradiated with highly focused pulsed uranium ion beams of well defined intensities in order to produce observable changes to the target structures whilst minimizing the activation of samples to allow for post-irradiation metallurgical investigations. These experimental case studies will be presented.



Schematic overview of the experimental parameters at GSI

Simulations performed for material models including phase changes and dependencies of strength models such as strain, strain rate or temperature wherever available will be discussed along with the limitations of such an approach.



ANSYS AUTODYN[®] simulation result at 5 ms simulated time after beam impact for copper irradiated by $2.12 \cdot 10^9$ ²³⁸U ions