Feasibility Experiment Of A Granular Target for Future Neutrino Facilities

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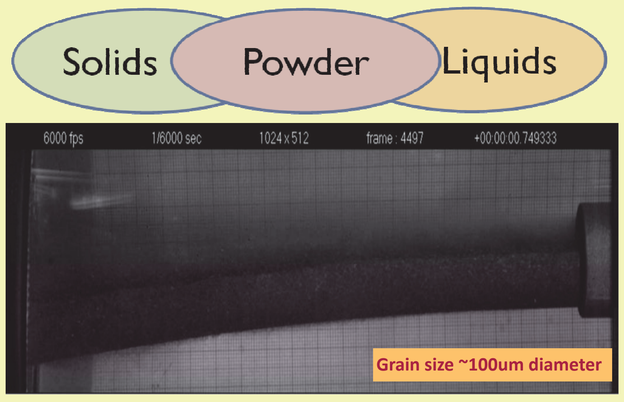
Granular, solid targets made of fluidized tungsten powder or static pebble bed of tungsten spheres, have been proposed and are being studied as an alternative configurations towards high-power (>1MW of beam power) target systems, suitable for a future Super Beam or Neutrino Factory. With the lack of experimental data on this field, a feasibility experiment was performed in HiRadMat facility of CERN/SPS that tried on a pulse-by-pulse basis to address the effect of the impact of the SPS beam (440GeV/c) on a static tungsten granular target. Online instrumentation such as high-speed photography and laser-Doppler vibrometry was employed. Preliminary results show a powder disruption speed of less than 0.6 m/s at $3*10^{11}$ protons/pulse while the disruption speed appears to be scaling proportionally with the beam intensity.

ADVANTAGES OF GRANULAR TARGETS

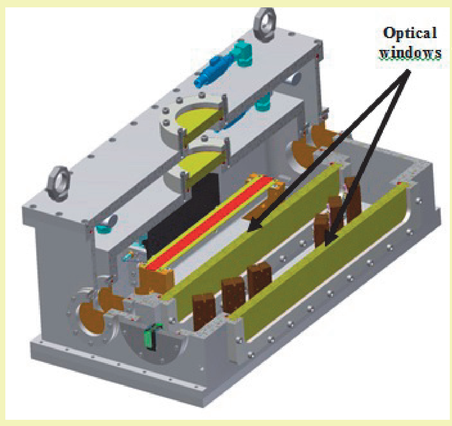


Quasi-liquid material properties
- Jet form
- Easy replenishment
- Externally cooled and re-circulated

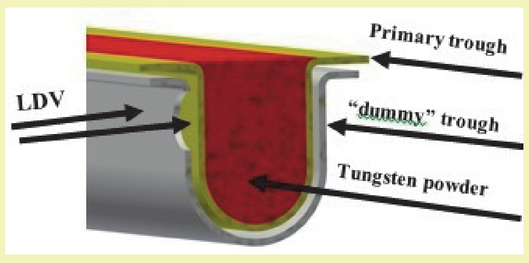
Shock wave management
- Material already hashed
- No cavitation
- Shock waves constrained within grains

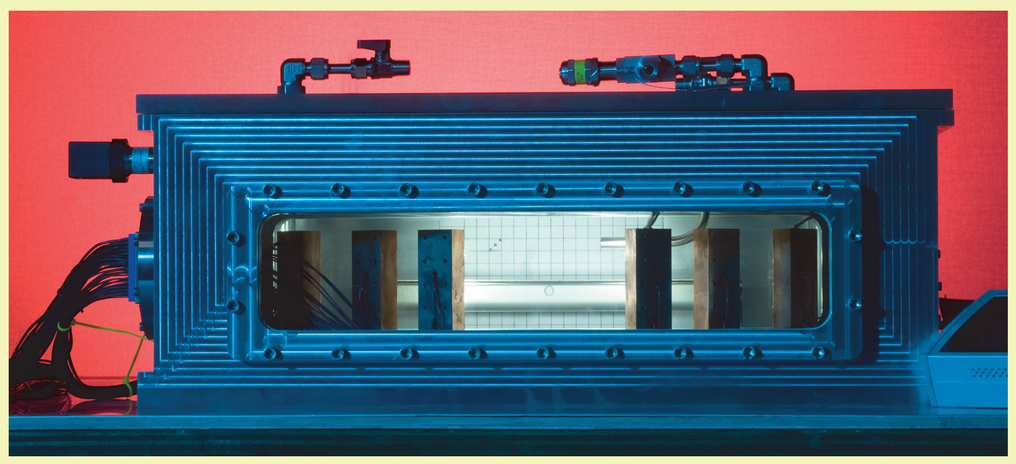
Additionally
- No disturbing impact from eddy currents

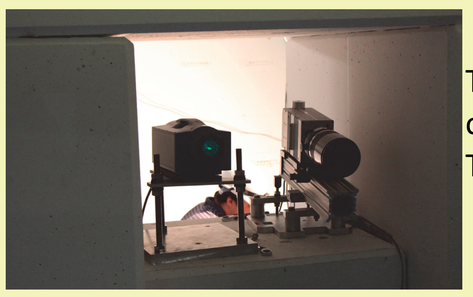
Experimental target



The trough (length 30 cm, diameter 20 mm) holding the granular target (Tungsten beads of typical 60 μm diameter) is placed in a containment box filled with Helium (nominal 1 bar). Two windows allow optical observation.

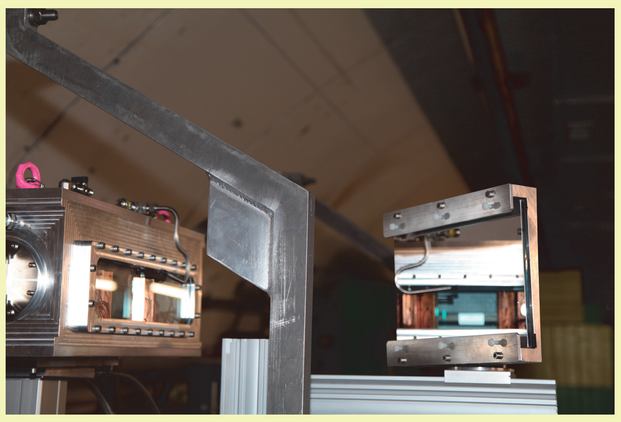


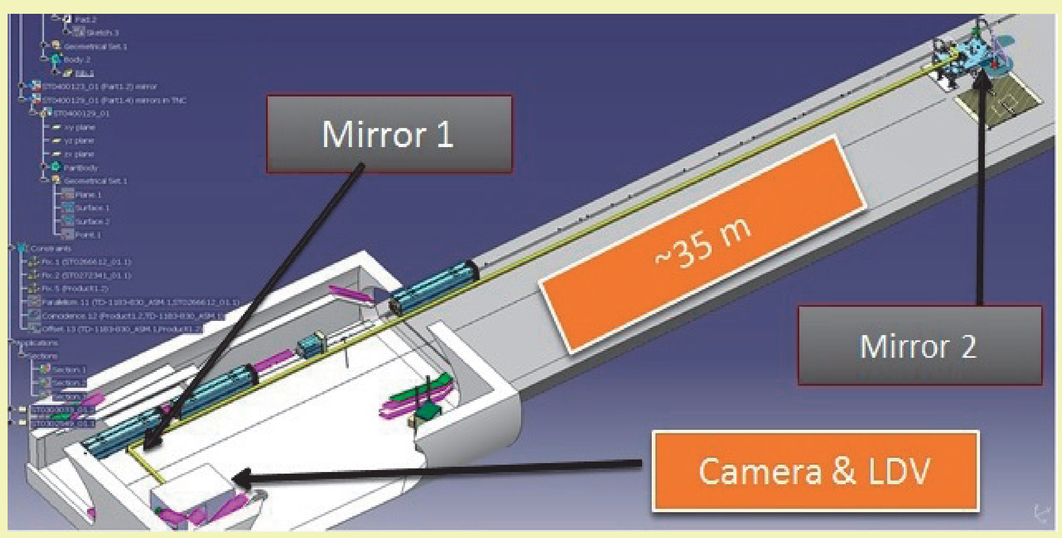


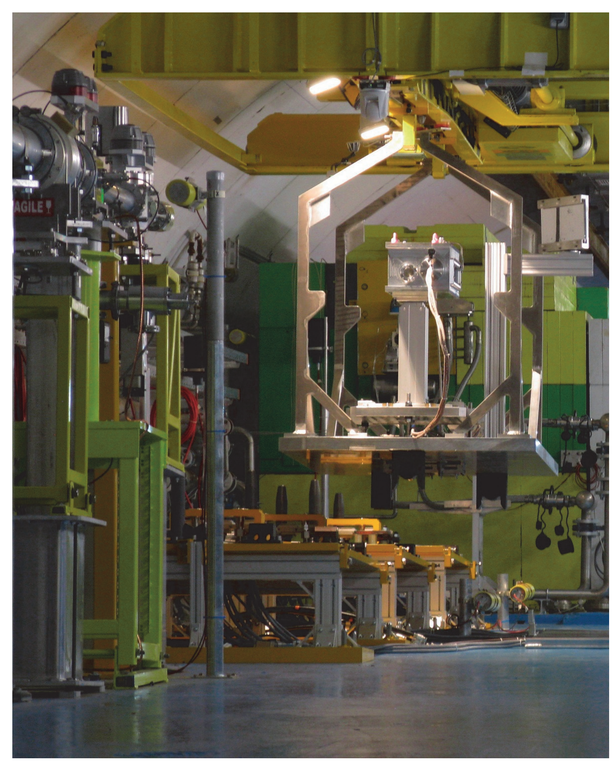


Experimental Layout @ HiRadMat

The fast camera (1kHz frame rate) and the laser-Doppler vibrometer (LDV) are placed in a concrete bunker about 35 meter away from the target position protected from prompt radiation. The image and the laser are guided via a system of mirrors.

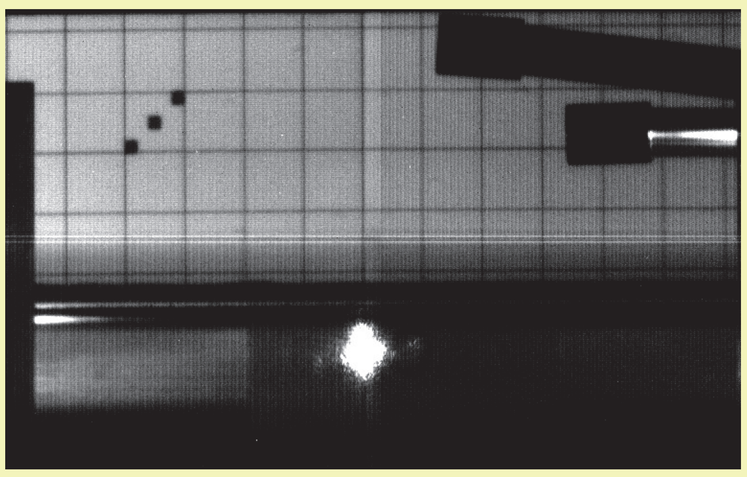




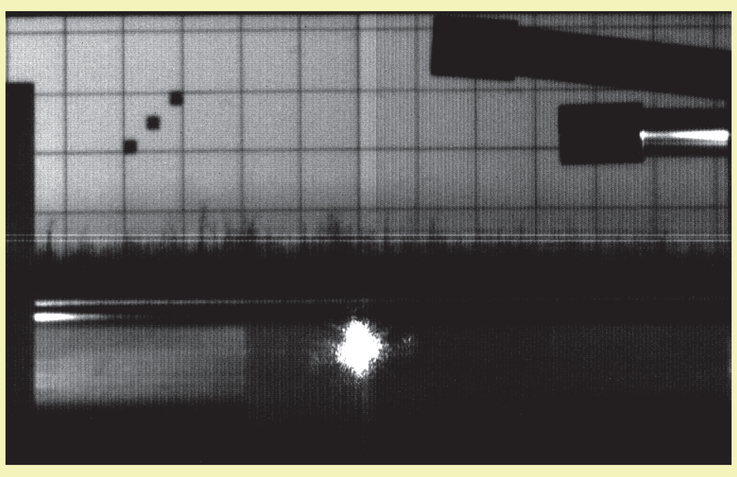


BEAM PULSE of $2*10^{13}$ PROTONS

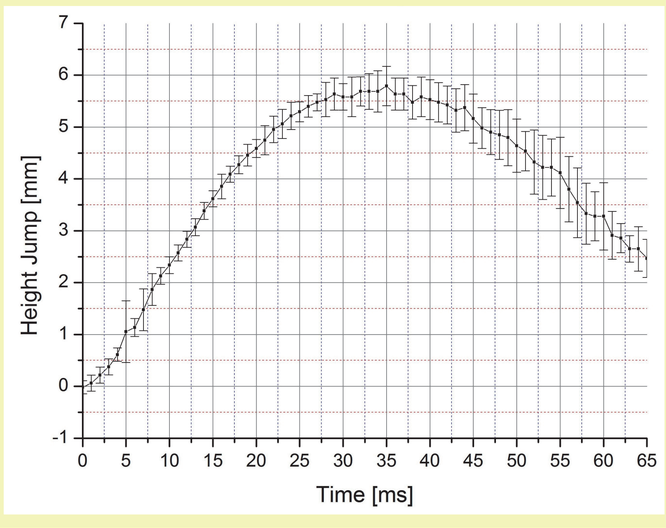
The image recorded at beam impact …



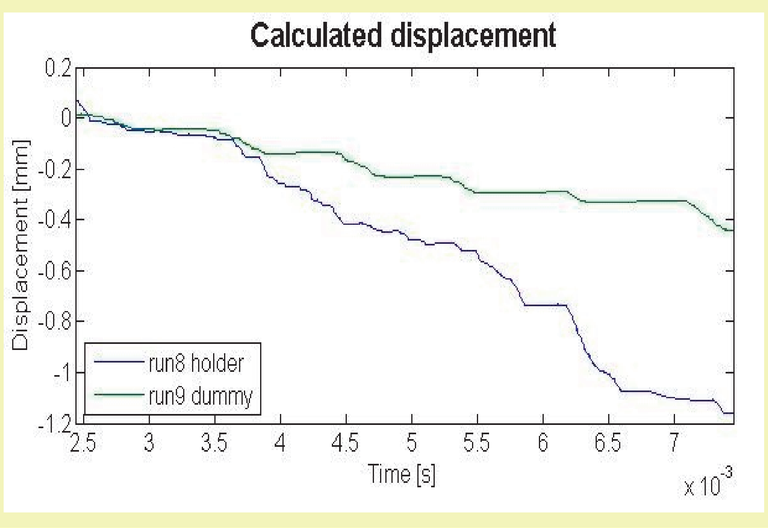
… and 37 ms later. Powder reaches maximum height of 6 mm.



Jump height versus time

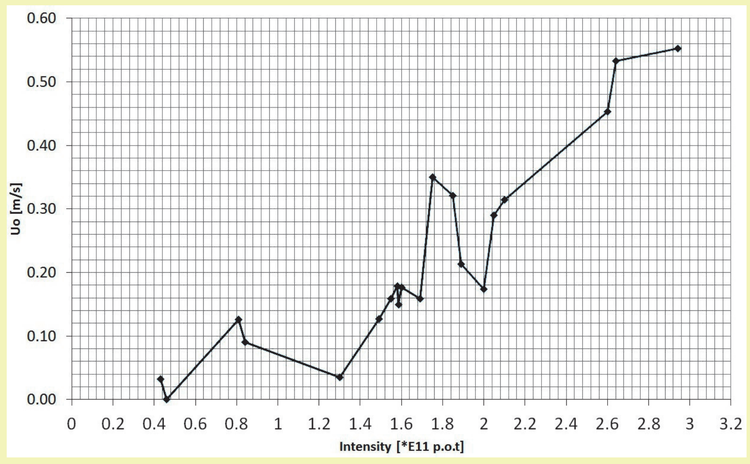


The LDV records the displacement of the trough walls.



Preliminary results

The maximum velocity of the tungsten beads as a function of the proton pulse intensity.



The LDV measurement position was altered between inner and outer trough.