A Feasibility Experiment of a W-powder Target

N. Charitonidis[1], O. Caretta[2], T. Davenne[2], C. Densham[2], I. Efthymiopoulos[1], A. Fabich[1], P. Loveridge[2] and L.Rivkin[3,4]

[1]CERN, EN-MEF, 1211 Geneva 23, Switzerland, [2] Rutherford-Appleton Laboratory, RAL, Chilton, OX11 0QX, United Kingdom, [3]EPFL-LPAP, CH-1015, Lausanne, Switzerland

[4] Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

Abstract

The development of high-power targets remains a key R&D activity for future facilities presently under study like the Neutrino Factory, Muon Collider or upgraded high-power super beams for long-baseline neutrino experiments. The choice of materials to sustain the beam power ranging up to MW levels is not trivial. Granular solid targets have been proposed and are being studied as a candidate for such high-power target systems. In the recently commissioned HiRadMat facility at CERN, a feasibility experiment of a tungsten powder target was performed. The experiment was designed to explore for first time the impact of a high-power proton beam on a static W—powder target in a thimble configuration. The diagnostics of the experiment were based on remote high-speed photography as well as on laser-doppler vibration measurements of the target containers. Results from the experimental findings are presented in this poster.

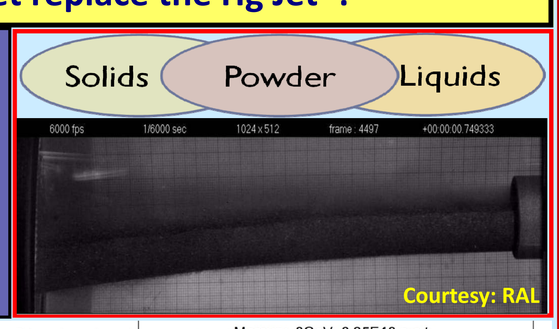
PRESENTED AT 5TH HPTW, FERMI NATIONAL ACCELERATOR LABORATORY, USA

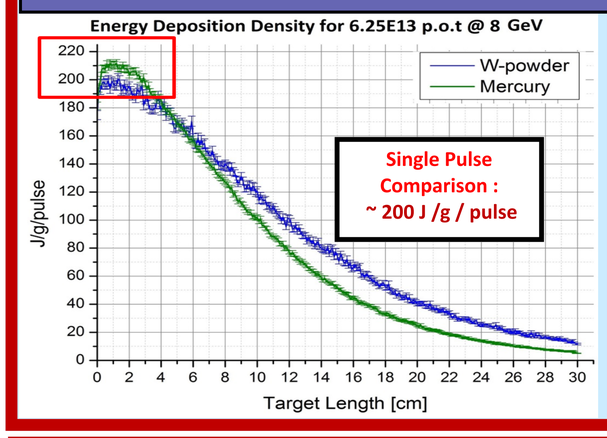
Motivation

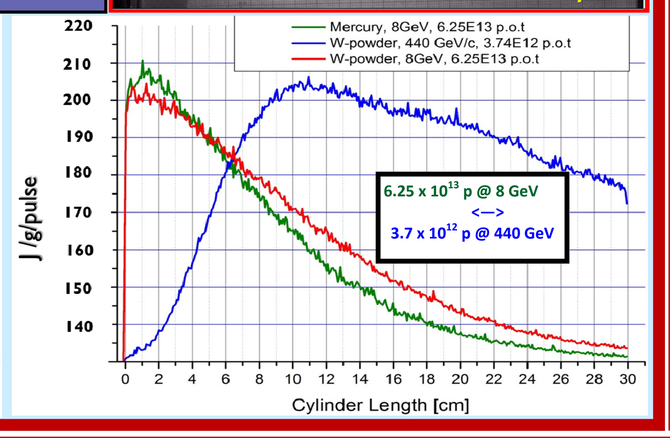
Could possibly a W— powder jet replace the Hg Jet ?

W—powder advantages

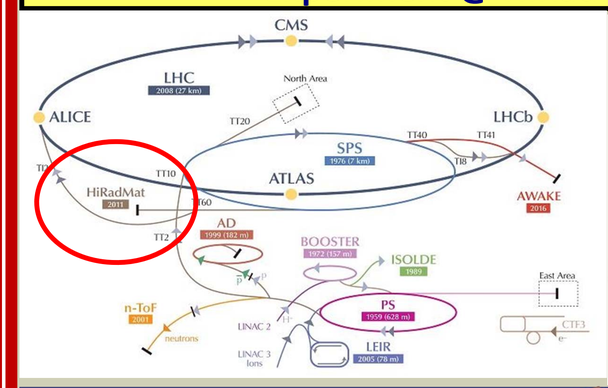
- Material already fragmented
- No cavitation
- Shock waves constrained within grains
- Target can be continuously reformed
- Easy replenishment
- Can be "pumped" away, externally cooled and re-circulated



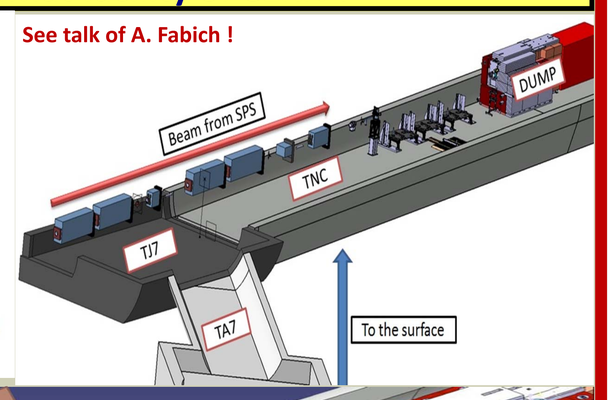


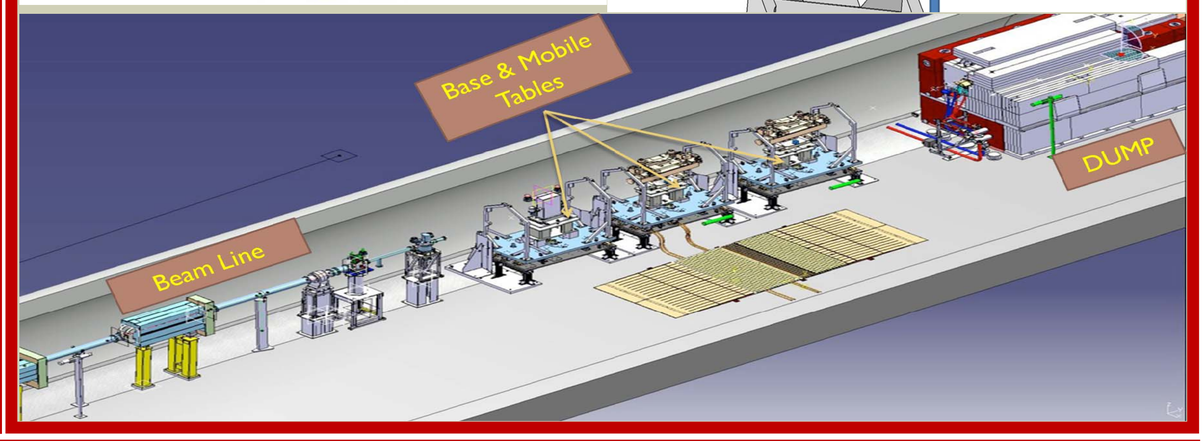


Experiment @ HiRadMat facility of CERN !



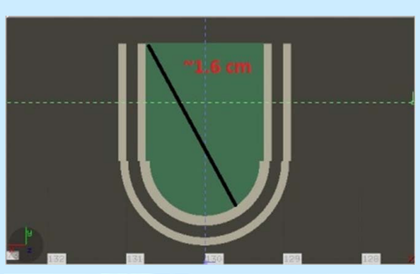
See talk of A. Fabich !

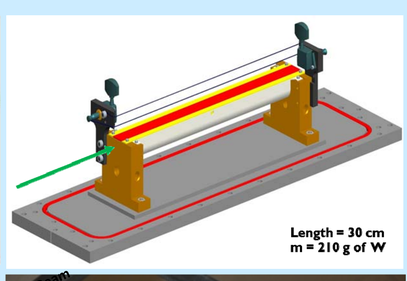


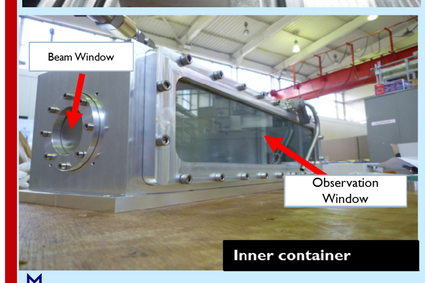


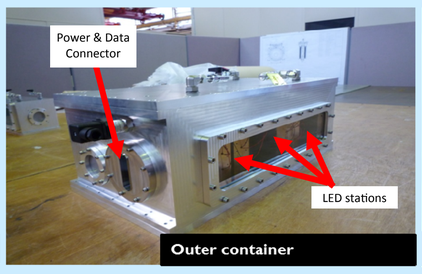
Experimental Setup & Instrumentation

- **A simple setup was chosen—static, settled but not compressed powder**
  - **The closest setup to a W-jet, assuming that the target is replaced between pulses.**

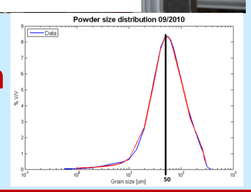




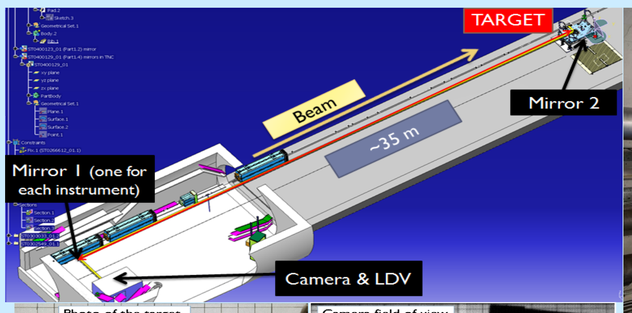


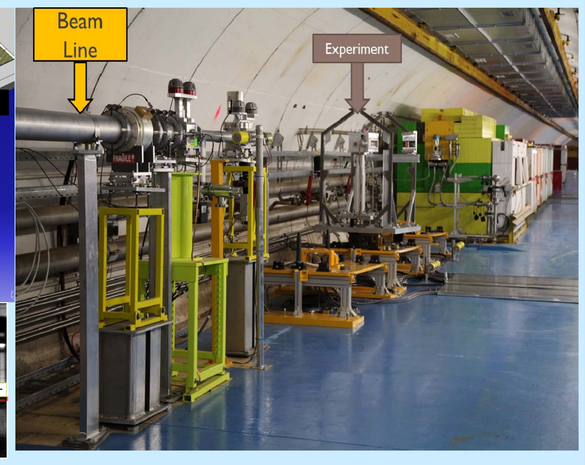


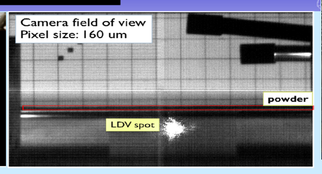
- **The containers were filled with He-Gas @ 1 bar.**
  - **Carrier gas for a future flowable / jet target configuration**
- **6 LED stations for lighting —Total luminous flux 18 klm**



- **Instrumentation based on High Speed Photography & Laser Doppler Vibrometry.**
  - **Both instruments placed behind a concrete bunker ~ 40 m away from the target— optical guidance through two mirrors.**





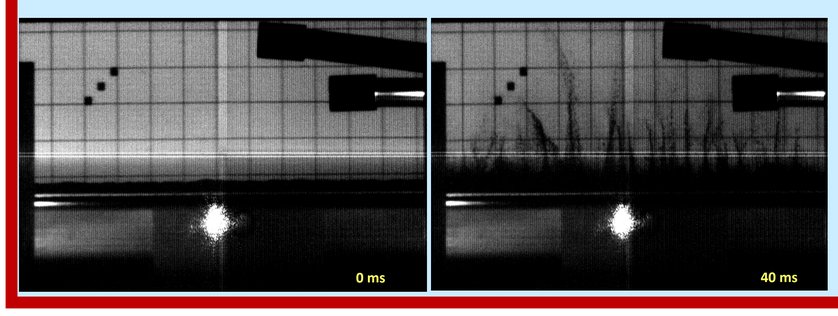


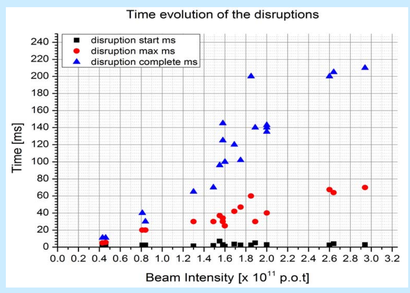
- **Camera recording frequency : 1 & 2 kHz**
- **LDV recording the velocity of the containers @ 4 MHz sampling freq.**
- **Maximum Intensity on target : 2.94 x 10^{11} p.o.t @ 440 GeV**

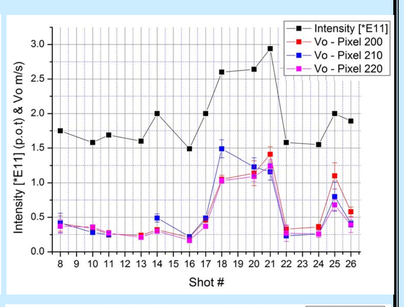
Experimental Results

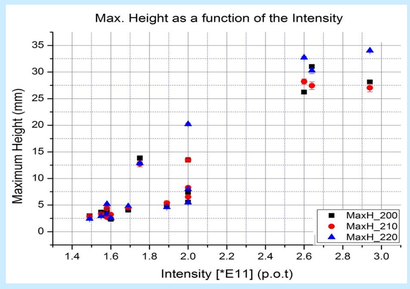
- **First Major Disruption @ 1.75 x 10^{11} p.o.t**

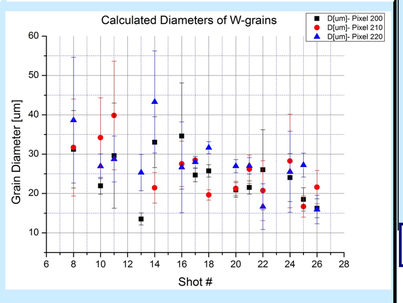
- **Subsequent shot @ 1.85 x 10^{11} p.o.t**
  - **Filaments are the due to the disrupted surface.**

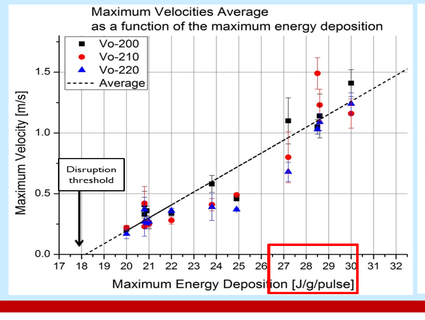


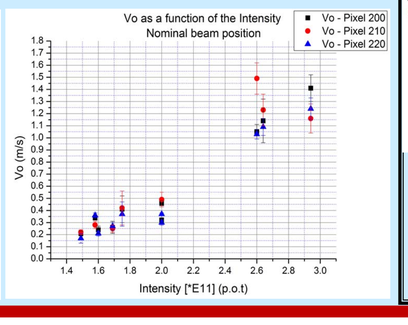




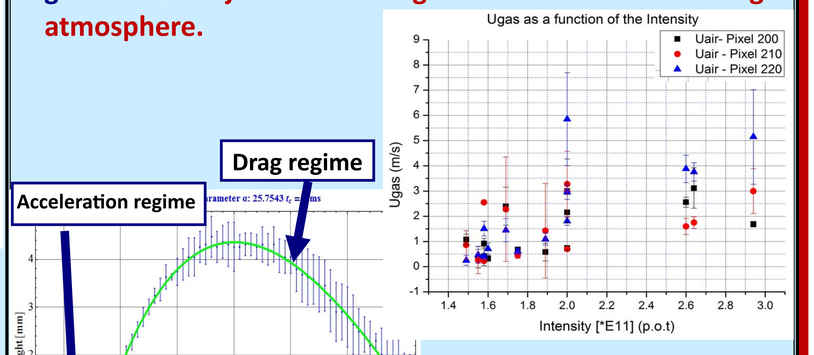








- **The powder disruption threshold was identified in between 4.36 and 8.1 x 10^{10} p.o.t**
- **The maximum powder height, the maximum grain speed and the time evolution of the disruption scale with the beam intensity. The maximum grain speed does not exceed 1.5 m/s for 2.94 x 10^{11} p.o.t.**
- **The driving force of the disruption is the gas expansion due to the beam energy deposition. The movement of the grains are subject to the drag force of the container's gas atmosphere.**



The very low measured maximum speed of the grains is a very encouraging indication for a future target system implementation !