Feasibility Experiment Of Granular Target Options for Future Neutrino Facilities

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Granular solid targets made of either fluidized tungsten powder or static pebble bed of tungsten spheres, have been long proposed and are being studied as an alternative configuration towards high-power (>1 MW of beam power) target systems, suitable for a future Super Beam facility or Neutrino Factory. Such assemblies offer many advantages such as better thermal and inertial stress absorption, thermal cooling and, if in the fluidized form, regeneration. The proposed feasibility experiment will try on a pulse-by-pulse basis to address, observe and record the impact effects of a high-power pulsed beam on target samples of tungsten powder and tungsten pebble bed. Online diagnostic techniques using high-speed cameras and laser vibrometry, as well as offline, post-irradiation analysis of the target material will be employed in order to observe the effects.

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HIGH POWER TARGETRY

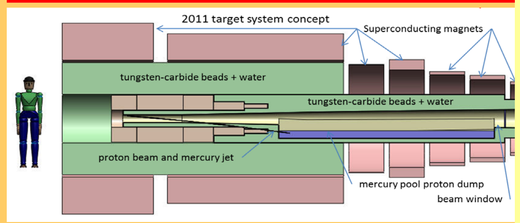
In order to study rare particles, we need significant **flux; high flux —> High Power (MW)**

Issues to consider for high-power targets:

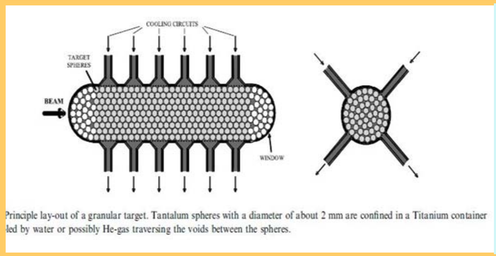
- **Thermal management (heat removal)**
  - Target melting, vaporization
- **Radiation damage**
  - Change of material properties
- **Thermal shock**
  - Beam induced pressure waves

Solid Targets — C N G S

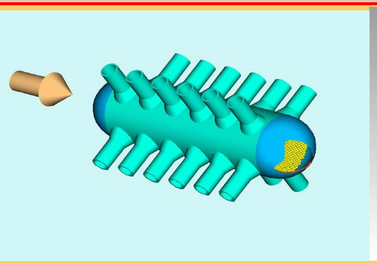
Liquid Targets — NF Proposal (Hg)

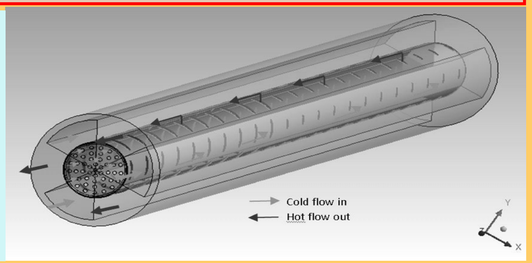


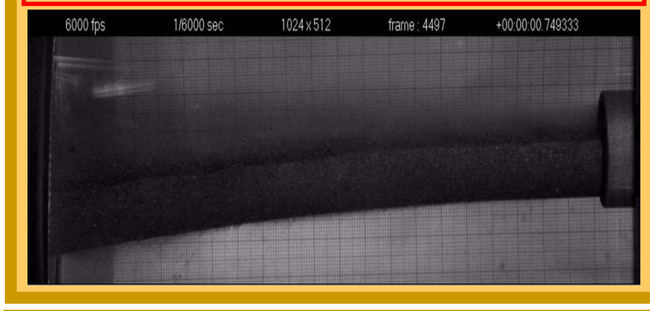
Hybrid *granular* targets



Principle lay-out of a granular target. Tantalum spheres with a diameter of about 2 mm are confined in a Titanium container led by water or possibly He-gas traversing the voids between the spheres.







Solids | Powder | Liquids

Advantages of granular (powder) targets

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

Miscellaneous
- Low eddy currents
- Excellent flowabilty

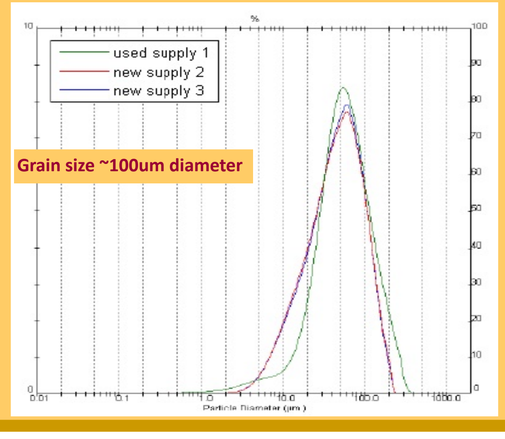
Quasi Liquid Properties
- Target continuously reformed
- Easy replenishment
- Can be "pumped" away, externally cooled and re-circulated

300 μm
212 μm
150 μm
106 μm
75 μm
50 μm

Sieve shaker: Retsch AS 200

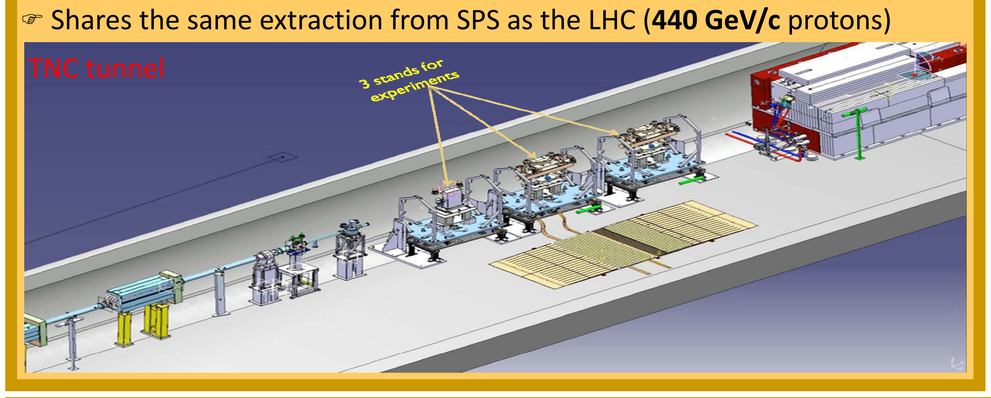
Sample size: 100g

Balance: ± 0.5 g



HIRADMAT FACILITY AT CERN/SPS

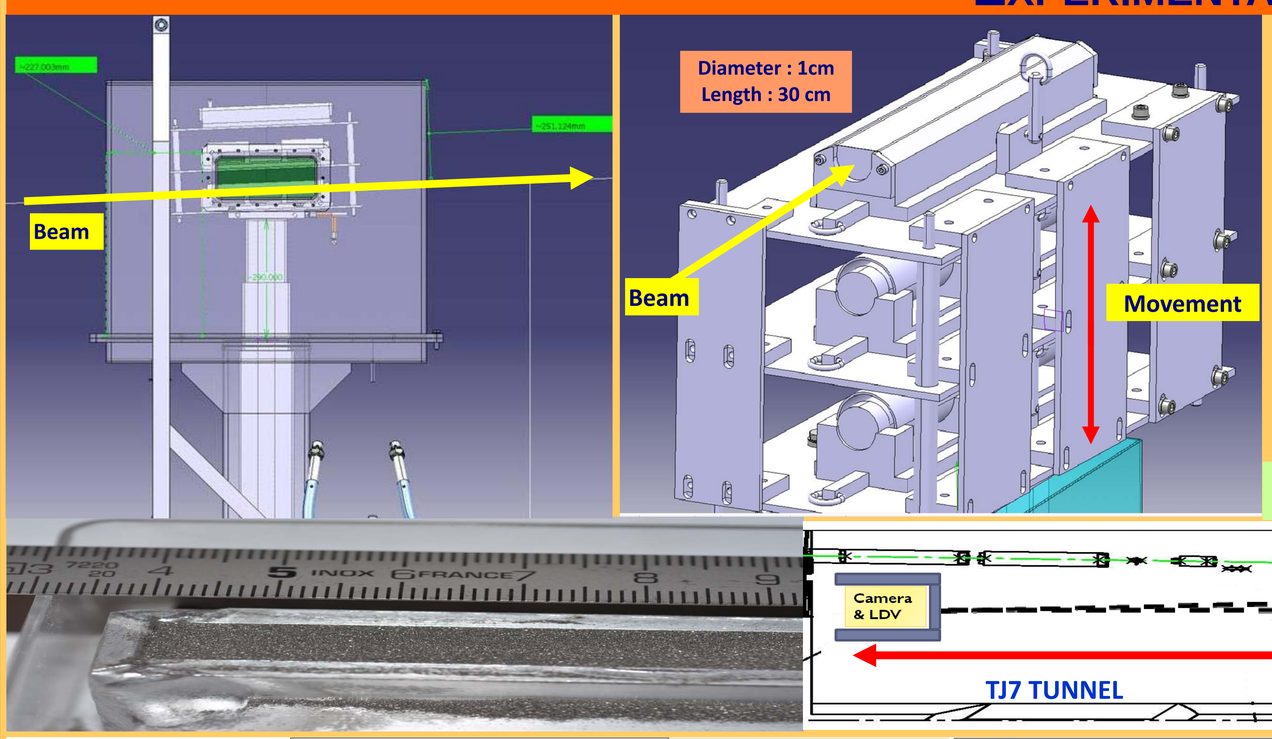
- HiRadMat (**Hi**gh **Rad**iation to **Mat**erials) is facility designed to study the impact of **intense pulsed beams** on materials.
- Shares the same extraction from SPS as the LHC (**440 GeV/c** protons)



GRANULAR TARGET TEST — SCIENTIFIC GOALS

- **Observe & record the behavior of the powder under the beam impact**
- **Evaluate the shock wave due to the rapid temperature increase**
- **Quantify the results with post-irradiation analysis of the samples**

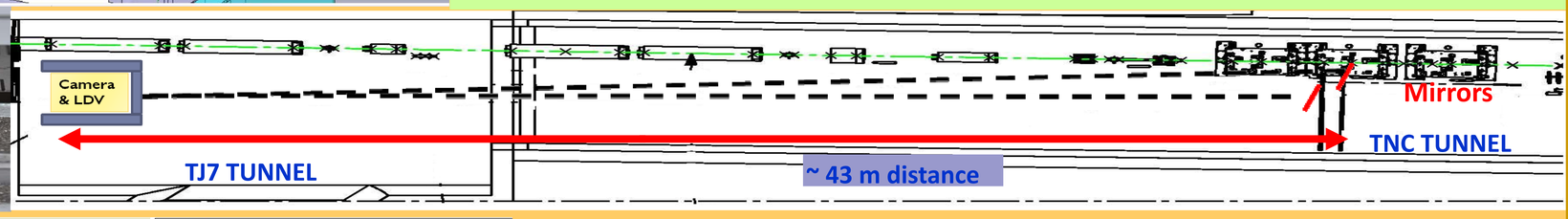
EXPERIMENTAL SETUP

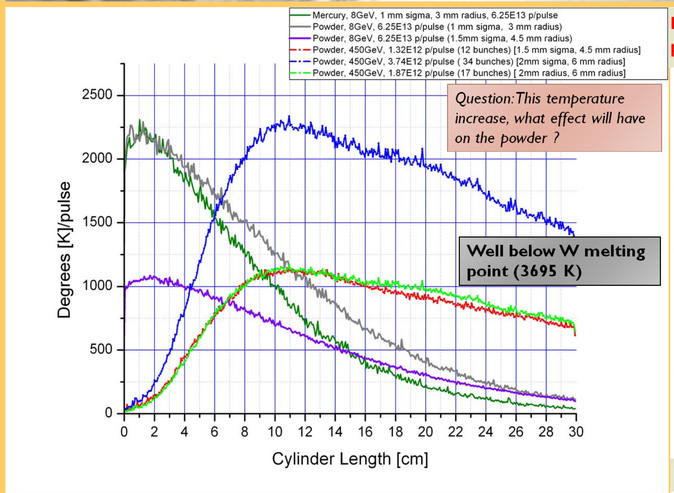


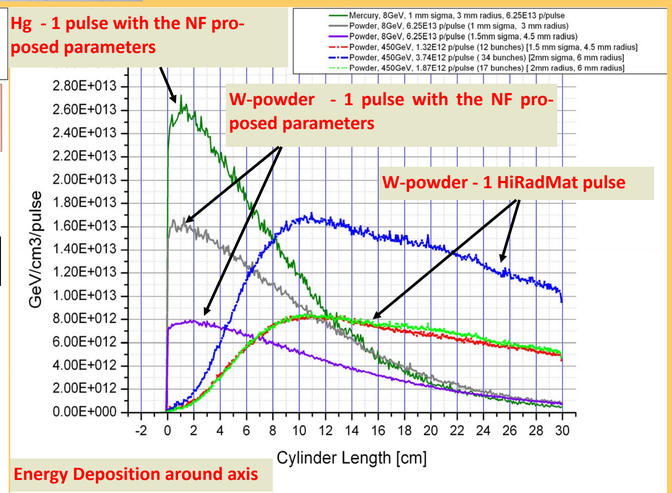
3 SAMPLES CONFIGURATION

- **Open powder trough — for observing possible disruption**
- **Powder contained into stainless steel — for measuring vibrations**
- **As above, but with an extra container— for eliminating secondary heating effects**

REMOTE OBSERVATION THROUGH HIGH-REFLECTIVITY MIRRORS







DIAGNOSTICS

- **Online**
  - **High speed camera**
  - **Laser-Doppler Vibrometer**
- **Offline**
  - **Post-irradiation measurement of grain sizes with sieve**