



Feasibility Experiment Of Granular Target Options for Future Neutrino Facilities

I. Efthymiopoulos¹, O. Caretta², N. Charitonidis^{1,3}, T. Davenne², C. Densham², P. Loveridge² and L. Rivkin^{3,4}

¹CERN, 1211 Geneva 23, Switzerland

²Rutherford-Appleton Laboratory, RAL, Chilton, OX11 0QX, United Kingdom

³EPFL-LPAP, CH-1015, Lausanne, Switzerland

⁴Paul Scherrer Institut, 5232 Villigen PSI, Switzerland



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 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, laser vibrometry and acoustic measurements, 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**

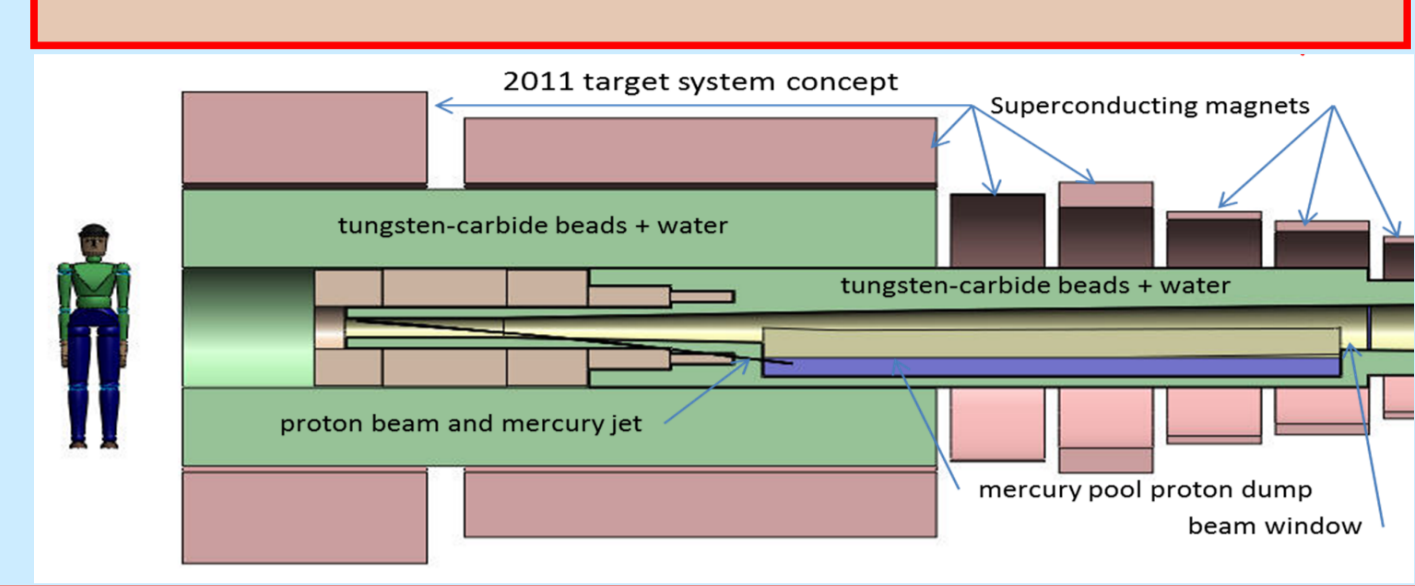
☛ Beam induced pressure waves

Solid Targets



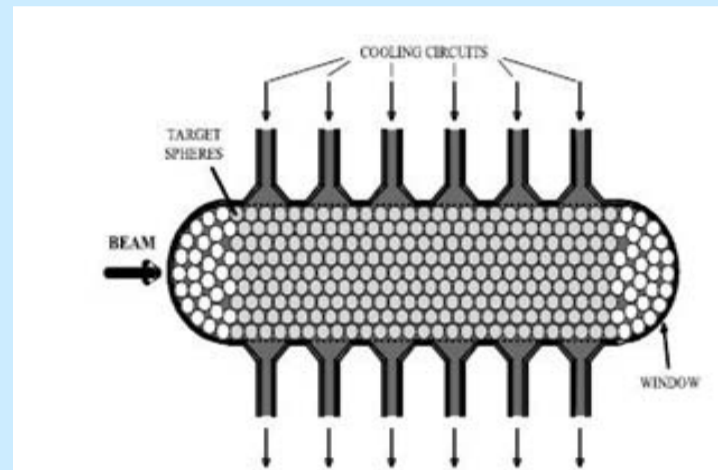
C
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Liquid Targets

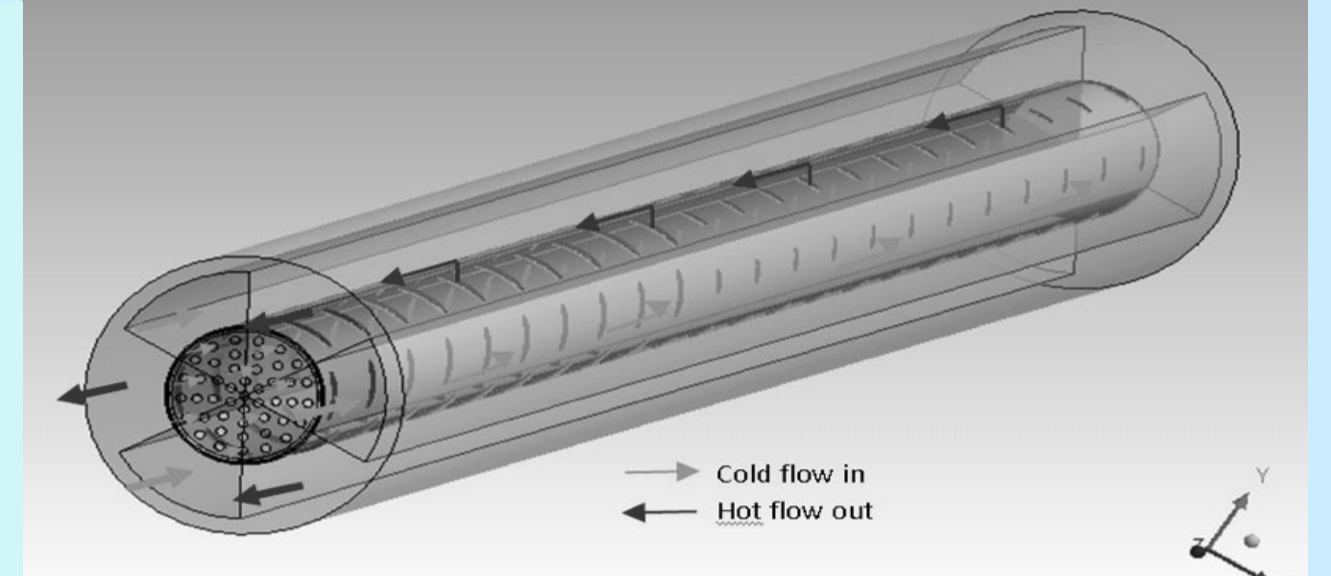
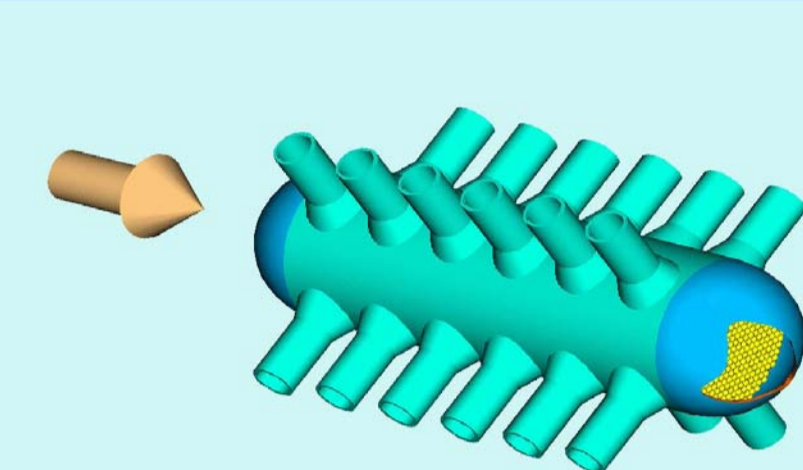


NF
Proposal
(Hg)

Hybrid granular targets



Principle layout 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

6000 fps 1/6000 sec 1024x512 frame: 4497 +00:00:00.749333

Advantages of granular (powder) targets

Shock wave management

- ☛ Material already broken
- ☛ No cavitation
- ☛ Shock waves constrained within grains

Miscellaneous

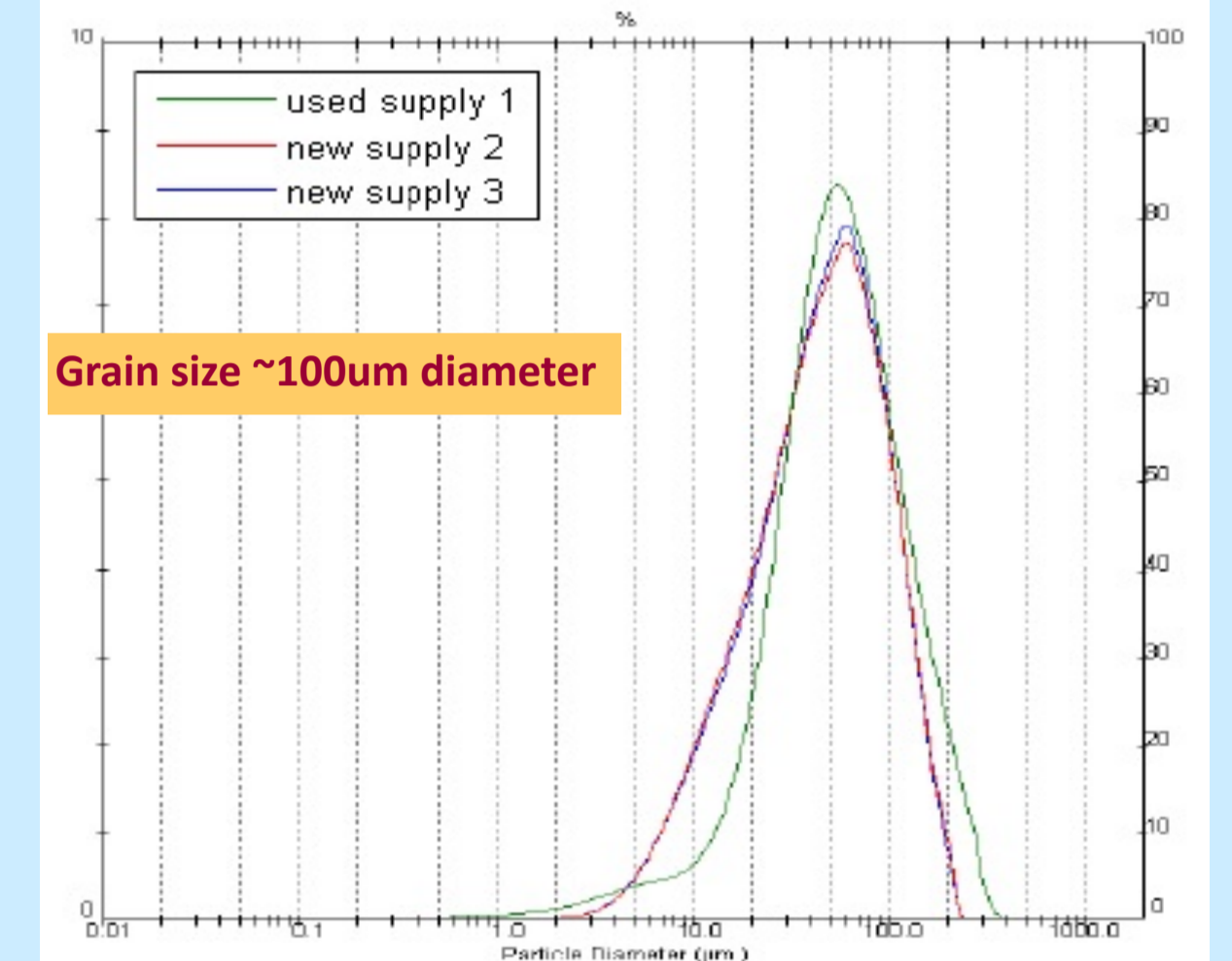
- ☛ Low eddy currents
- ☛ Excellent flowability

Quasi Liquid Properties

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



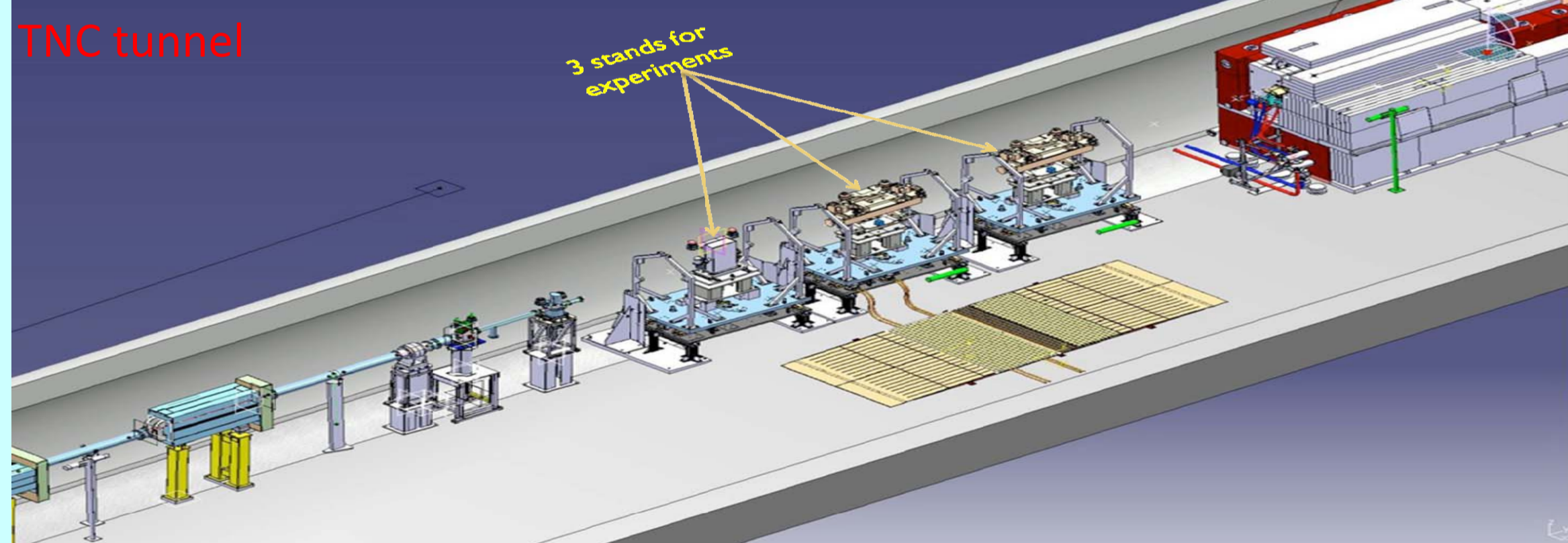
Sieve shaker: Retsch AS 200
Sample size: 100g
Balance: ± 0.5 g



HiRadMat FACILITY AT CERN/SPS

☛ HiRadMat (High Radiation to Materials) is facility designed to study the impact of intense pulsed beams on materials.

☛ Shares the same extraction from SPS as the LHC (Beam: 440GeV/c protons)



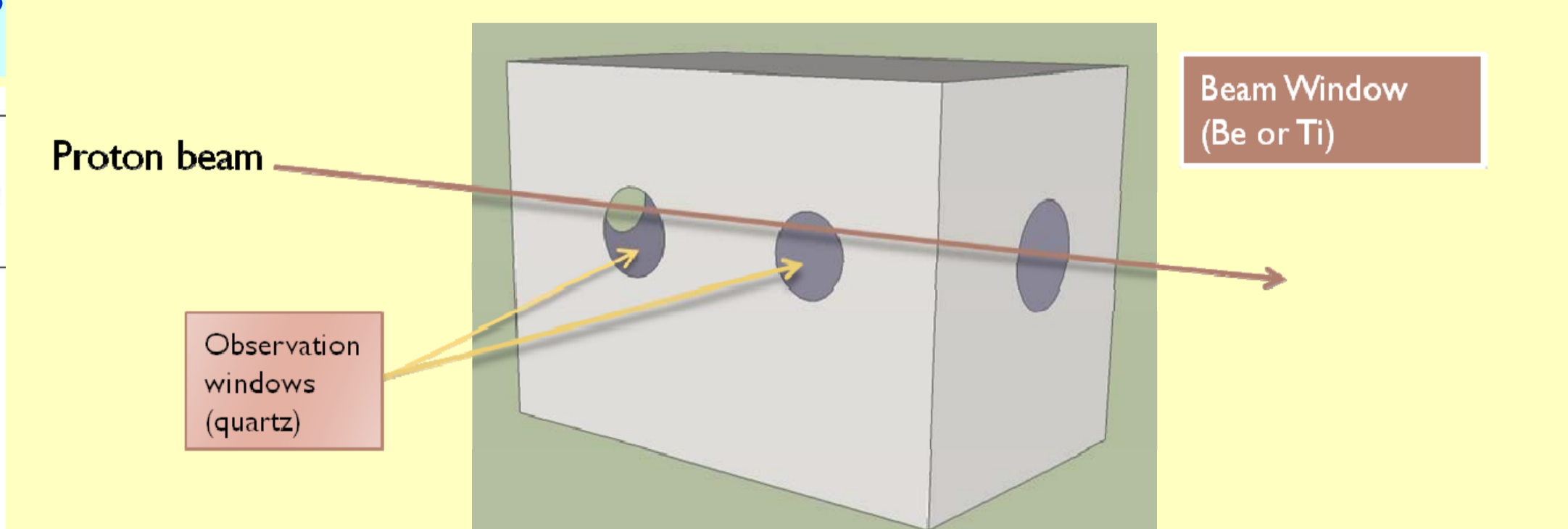
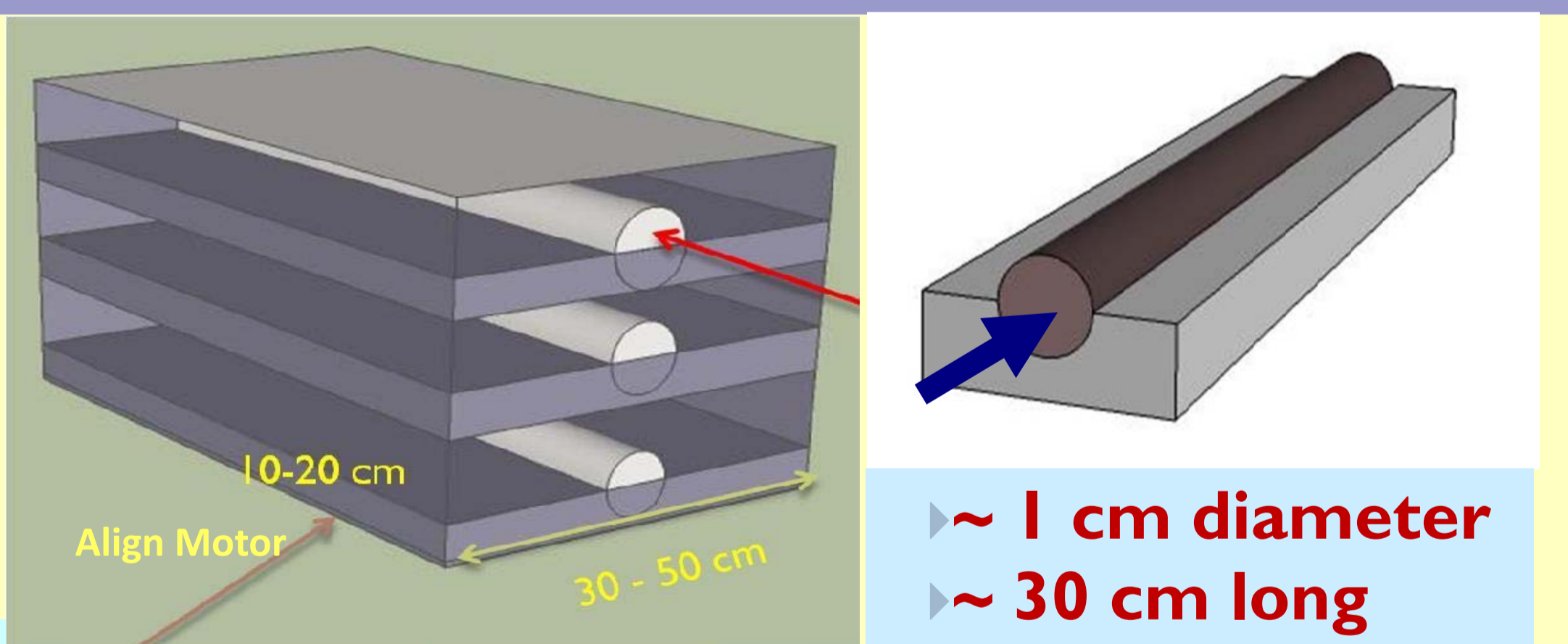
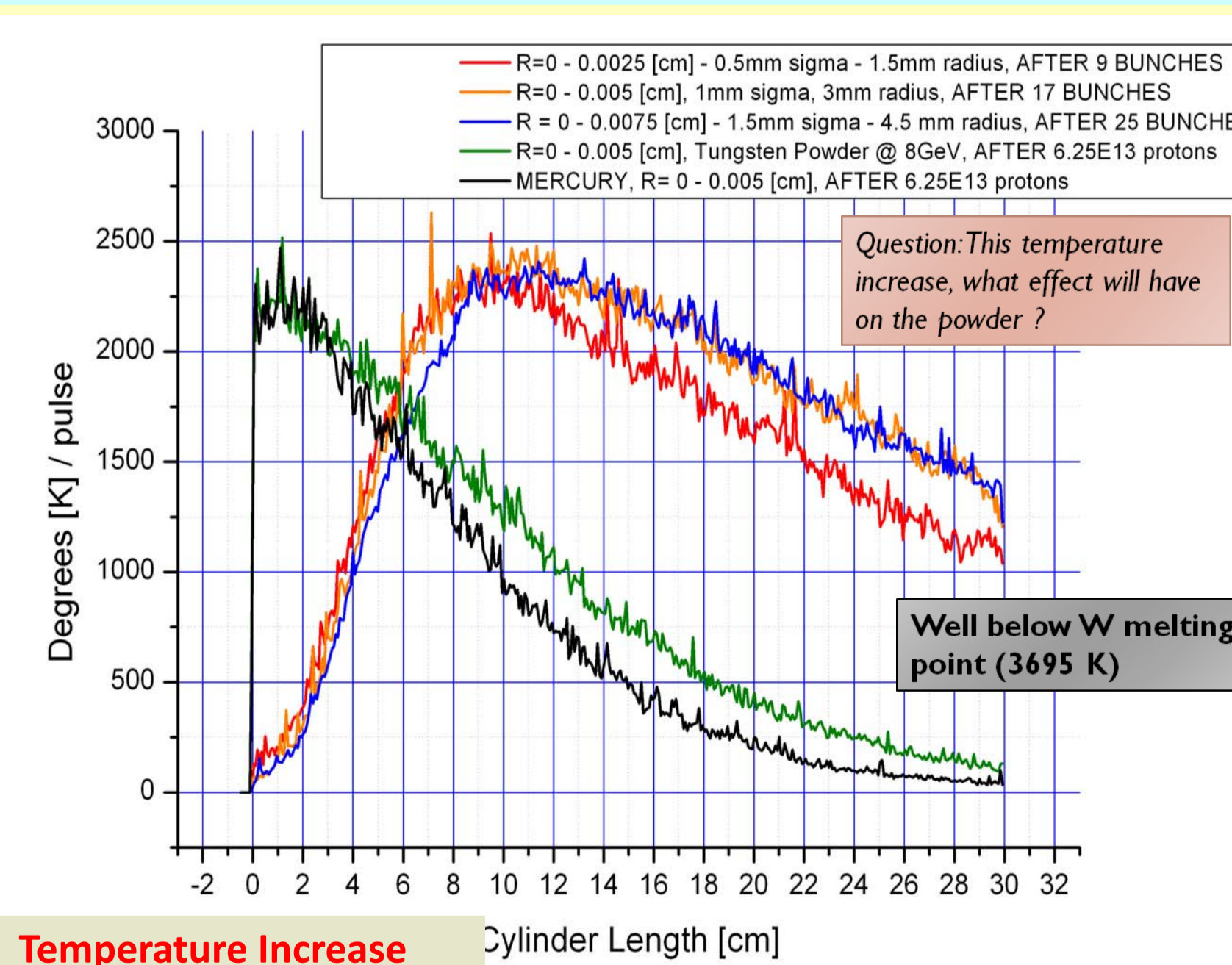
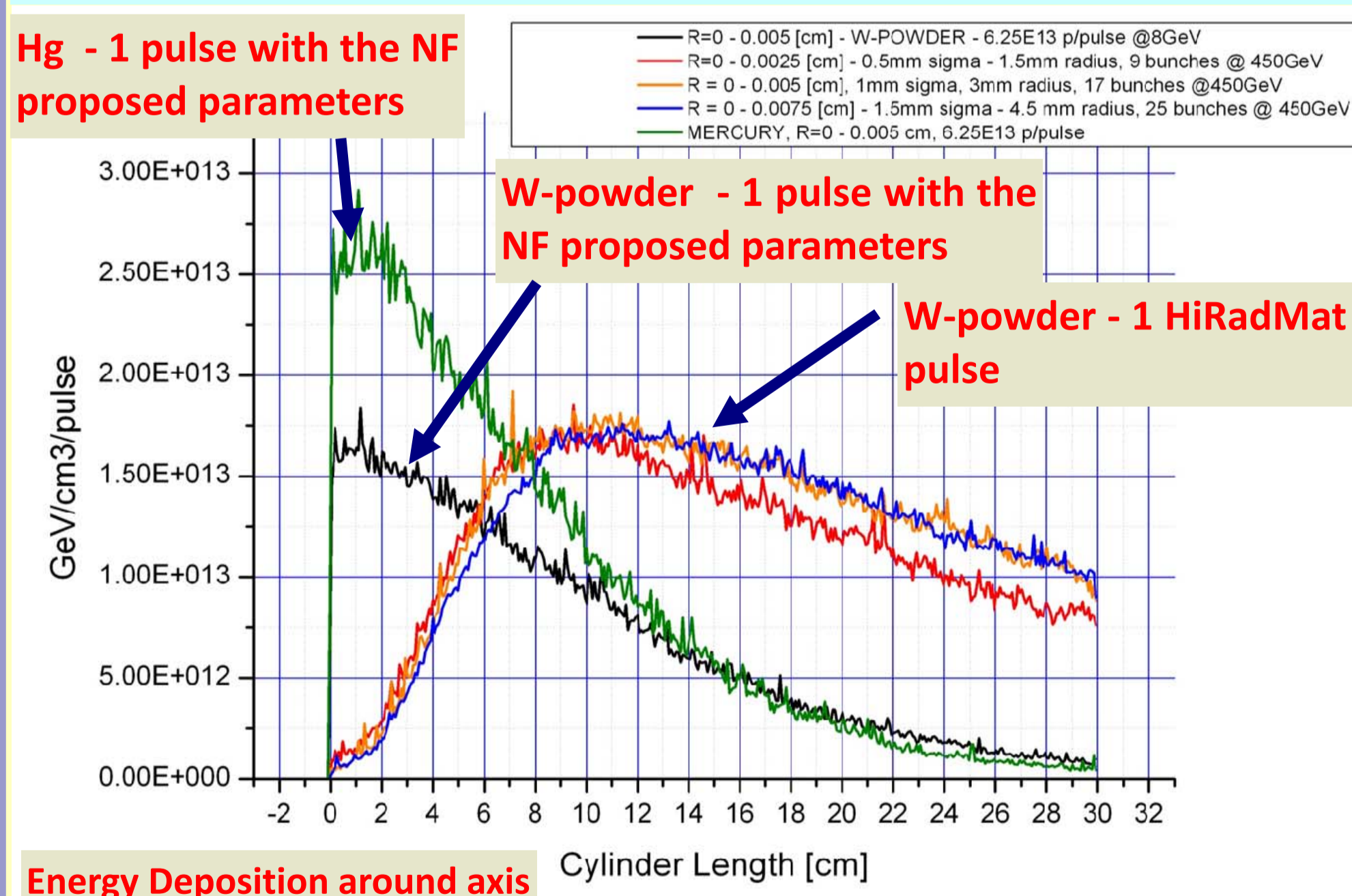
Granular target test-experiment in HiRadMat

Perform a **single-pulse** experiment to test in similar conditions as in a future Neutrino Factory configuration:

- ☛ a static tungsten powder target
- ☛ a pebble bed target with confined beads of ~3mm diameter
- ☛ as proposed for the CERN-Frejus Super-beam



Observation through high-reflectivity mirrors of possible disruption/explosion of the powder through high-speed camera, placed at TJ7, behind special shielding.



Observations :

- ☛ Disruption of powder ?
- ☛ Melting of the beads ?
- ☛ Other shock-induced effects?

Online Diagnostics

High-speed camera for the observation of possible explosion

Microphones for the recording of the sound impact of the beam on target

LDV for the evaluation of the vibrations on the sample container

As well as offline post-irradiation analysis in a specialized facility in order to quantify structural differences on the target material.

