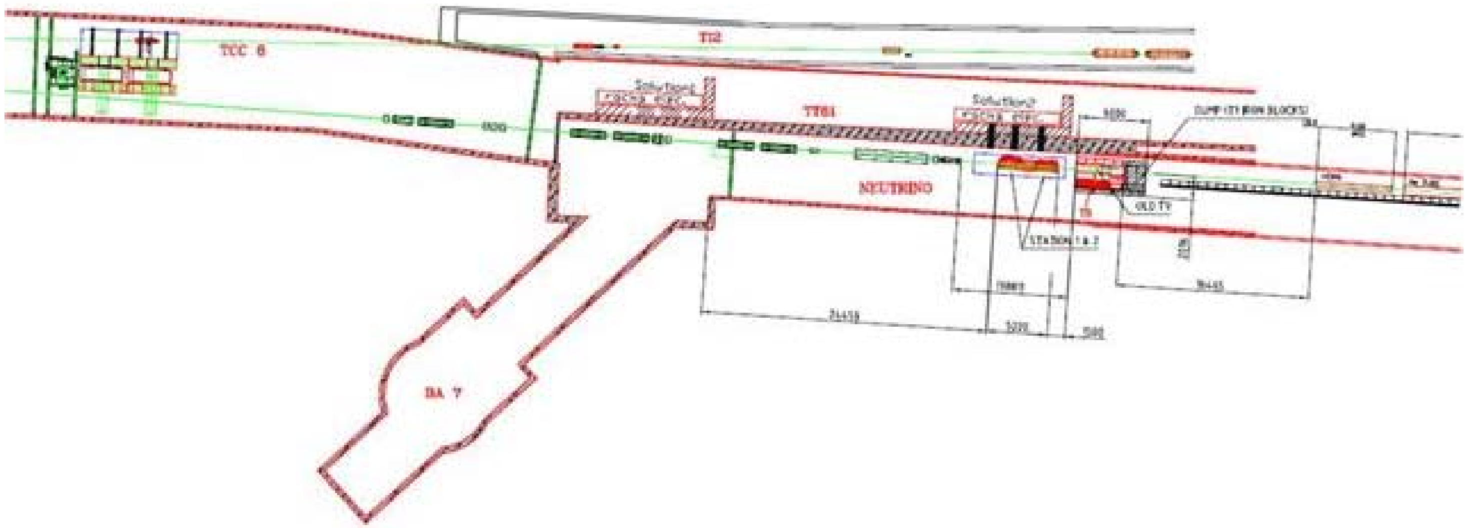
MPE involvement in the HiRadMat project
-
status and plans

Introduction to HiRadMat

- High Radiation to Materials.
- Currently being built in the old West Area Neutrino Facility [WANF]
- Designed to allow testing of accelerator components (LHC) to the impact of high intensity beams.
- Complements the CERN East Area irradiation facility.
- Commission during September 2011
- Initial run in October 2011.



HiRadMat Beam parameters

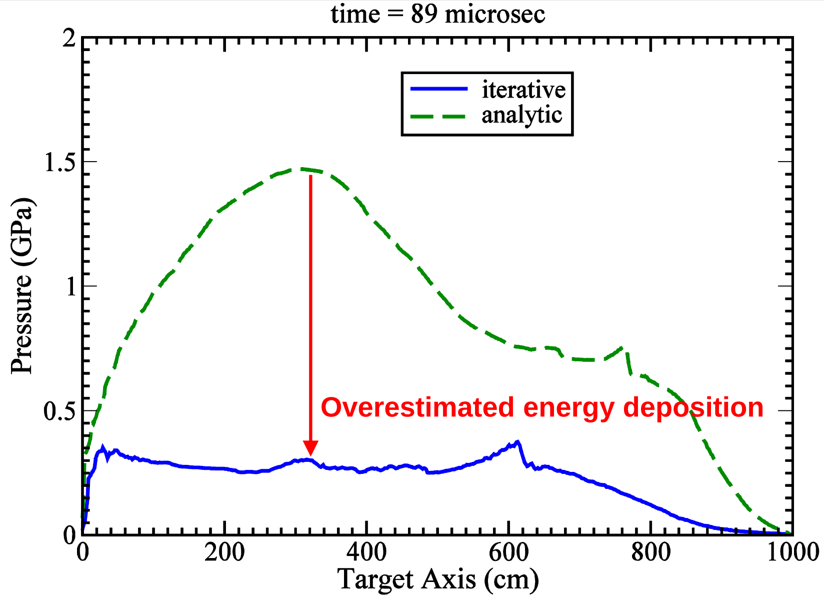
- Energy
  - 440GeV for protons (3.5MJ max pulse energy) → 0.49TW (24.5TW)
  - 173.5GeV/A (36.1TeV) for ions (21kJ max pulse energy) → 0.4GW (0.8TW)
- Beam intensity (SPS-Beam type)
  - 288 bunches of 3E9 to 1.7E11 protons
  - 52 bunches of 3E7 to 7E7 ions.
- Beam size
  - $\text{Sigma}_{x,y}$ = **0.1***-2mm   *Not available in all positions
- Repetition frequency
  - 18 sec.
- Time structure
  - 7.2us pulse. 0.5ns bunch length and 25ns intra-bunch spacing.
  - 5.2us pulse for ions. 100ns bunch spacing.

HiRadMat Users

Title	User	
ISOLDE – Target and Ion Source Development	CERN EN-STI	Sources
Radiation tolerance test for electronic equipment	CERN EN-STI	Electronic radiation
Dynamic vacuum properties of amorphous carbon films bombarded with heavy ion and proton beams at the SPS	CERN TE-VSC	Vacuum
LHC beam dump entrance window robustness	CERN TE-VSC	
LARP Rotatable Collimator Robustness Test	CERN BE-ABP	Collimators
SPS TPSG diluter robustness and protection test	CERN TE-ABT	
LHC TCDQ diluter robustness and protection test	CERN TE-ABT	
LHC TCDS diluter robustness and protection test	CERN TE-ABT	
Qualification of LHC Phase II Collimators	CERN BE-ABP	
Beam Loss Monitor developments	CERN BE-BI	BLM
Tungsten powder thimble shock test	STFC Rutherford Appleton Laboratory	Damage experiments
HEDM damage experiments	CERN TE-MPE	

Current state of simulations

- Two physical processes:
  - Energy deposition by the beam.
  - Hydrodynamic motion of the target's particles.
- Both processes are coupled, changes provoked by one affects the other.
  - Solution: run iteratively in steps t[us].



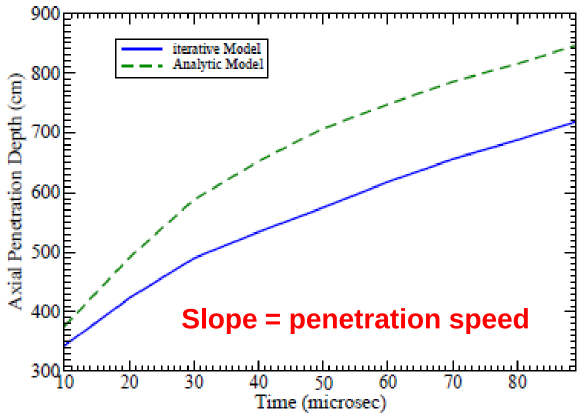
- Previous simulations:
  - Initial energy deposition map

    → FLUKA.
  - Subsequent deposition maps scaled from the initial one.
  - hydrodynamic motion →BIG2 code
- Newer simulations combine:
  - At each step :

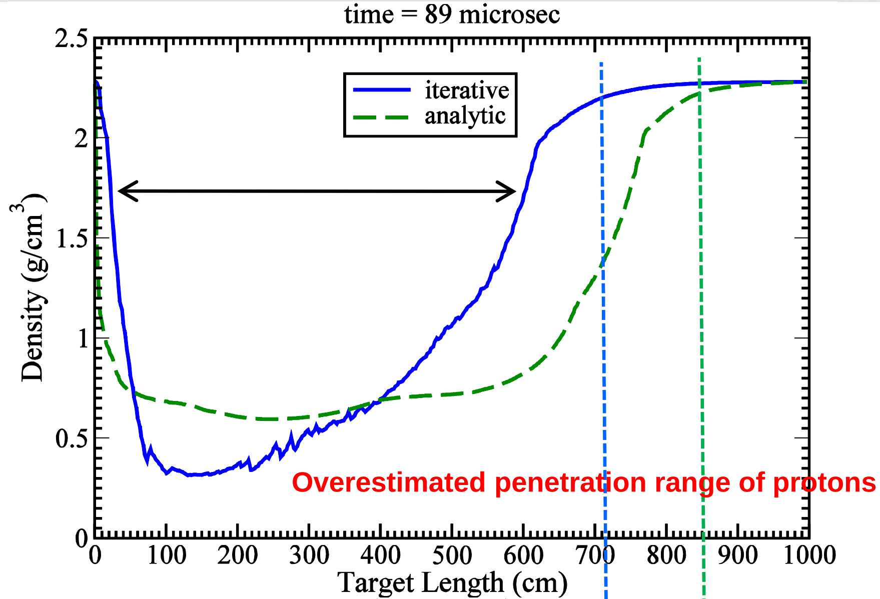
    → FLUKA → BIG2 →

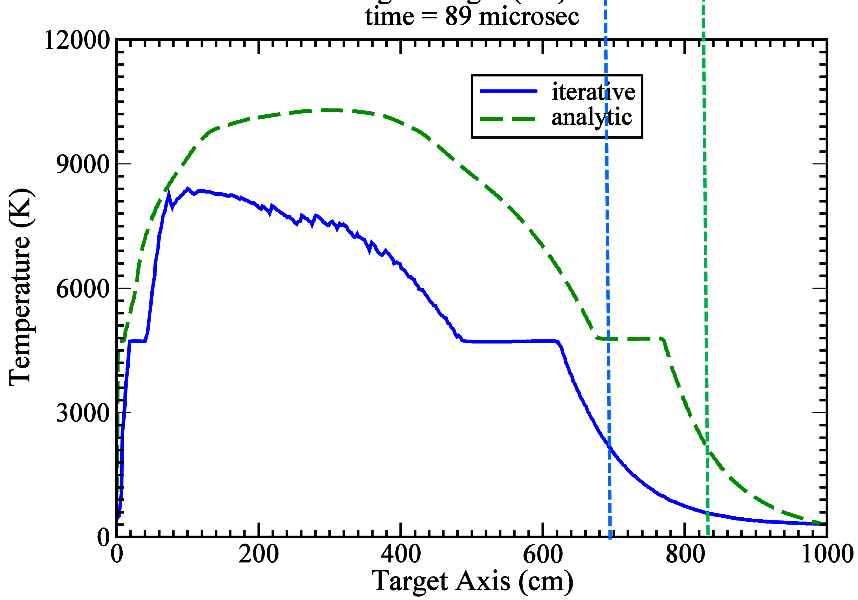
Current state of simulations

- Newer simulations also show a density depletion region on the longitudinal direction. “Tunneling effect”
- Previous simulations overestimate the “penetration range” of protons. Higher energy deposition → stronger shock waves → Faster penetration speed



Protons penetration range: length of damaged material (t > melting point)



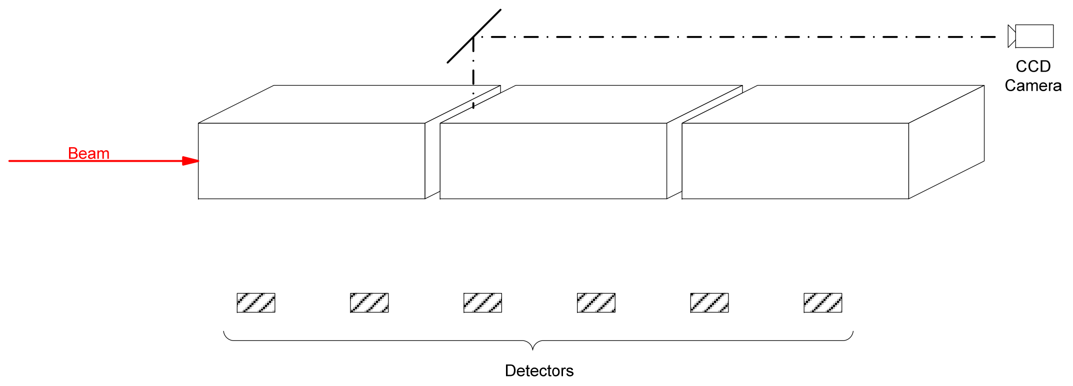


Plans for an experiment

Irradiate different materials beyond the damage threshold.

Observe the effect of the hydrodynamic process that occurs and how it affects the beam damage potential.

Is the beam damage potential *amplified* by the action of the hydrodynamic process? ("Tunneling effect")



State of the art

- Previous Studies
  - Hydrodynamic Calculation of 20-TeV Beam Interactions with the SSC Beam Dump. D.C.Wilson, C.A.Wingate, J.C.Goldstein, R.P.Godwin and N.V.Mokhov (1992)
  - Particle accelerator physics and technology for high energy density physics research. D.H.H.Hoffmann et al. (2006)
  - Interaction of the CERN Large Hadron Collider (LHC) Beam with the Beam Dump Block. R.Assman, A.Ferrari, B.Goddard, R.Schmidt and N.A.Tahir (2008)
  - Large Hadron Collider at CERN: Beams generating high-energy-density matter. N.A.Tahir, R.Schmidt et al. (2008)
- Previous Experiments
  - Damage Levels – Comparison of Experiment and Simulation. V.Kain, (2005).
- Facilities
  - FAIR, Facility for Antiproton and Ion Research. (Future)

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