Mercury Jet Studies

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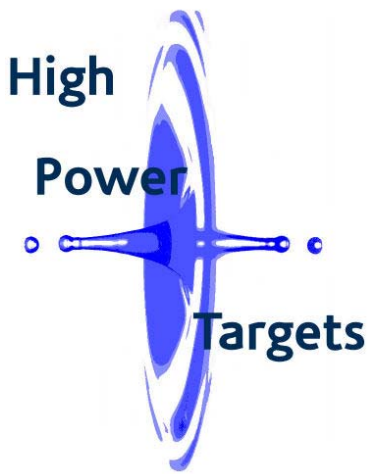


Instantaneous Energy Deposition

Result of ‘instantaneous’ energy deposition

- Increase in temperature causes pressure rise

$$P = K\alpha\Delta T$$

- Strain energy is stored in the compressed fluid (per unit volume)

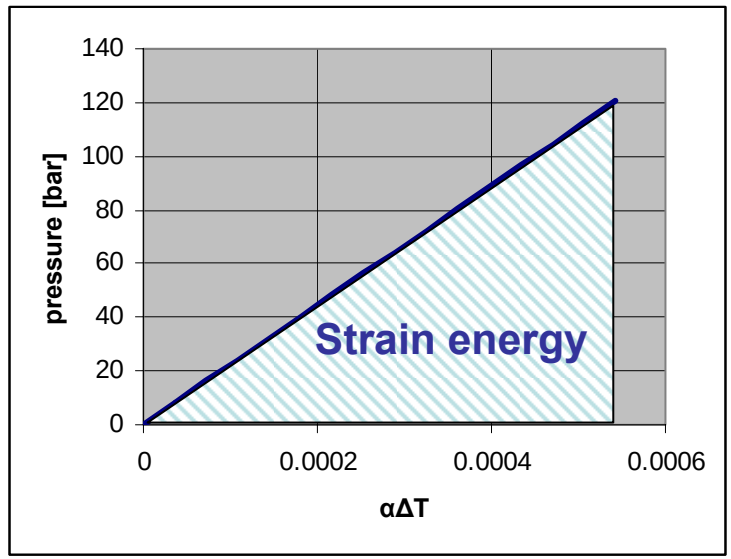
$$E = \frac{K}{2}\left(\alpha\Delta T\right)^2$$

- Assume strain energy will be released as kinetic energy

$$\frac{K}{2}\left(\alpha\Delta T\right)^2 = \frac{1}{2}\delta m v^2 \qquad \text{so}$$

$$\alpha\Delta T \propto v$$

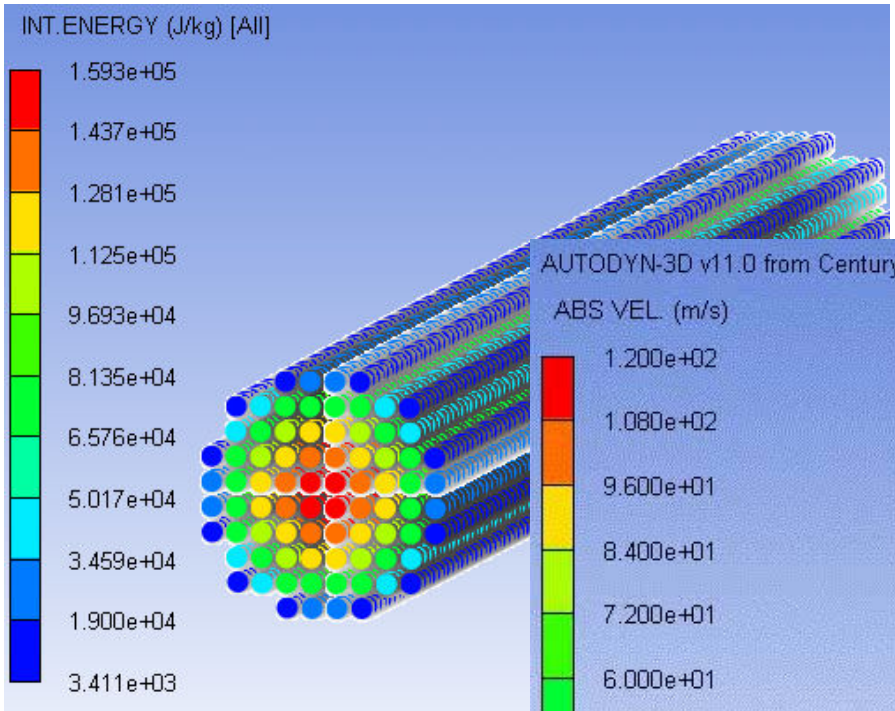
- Radial velocity is proportional to energy deposition, (note actual value of velocity depends on geometry)

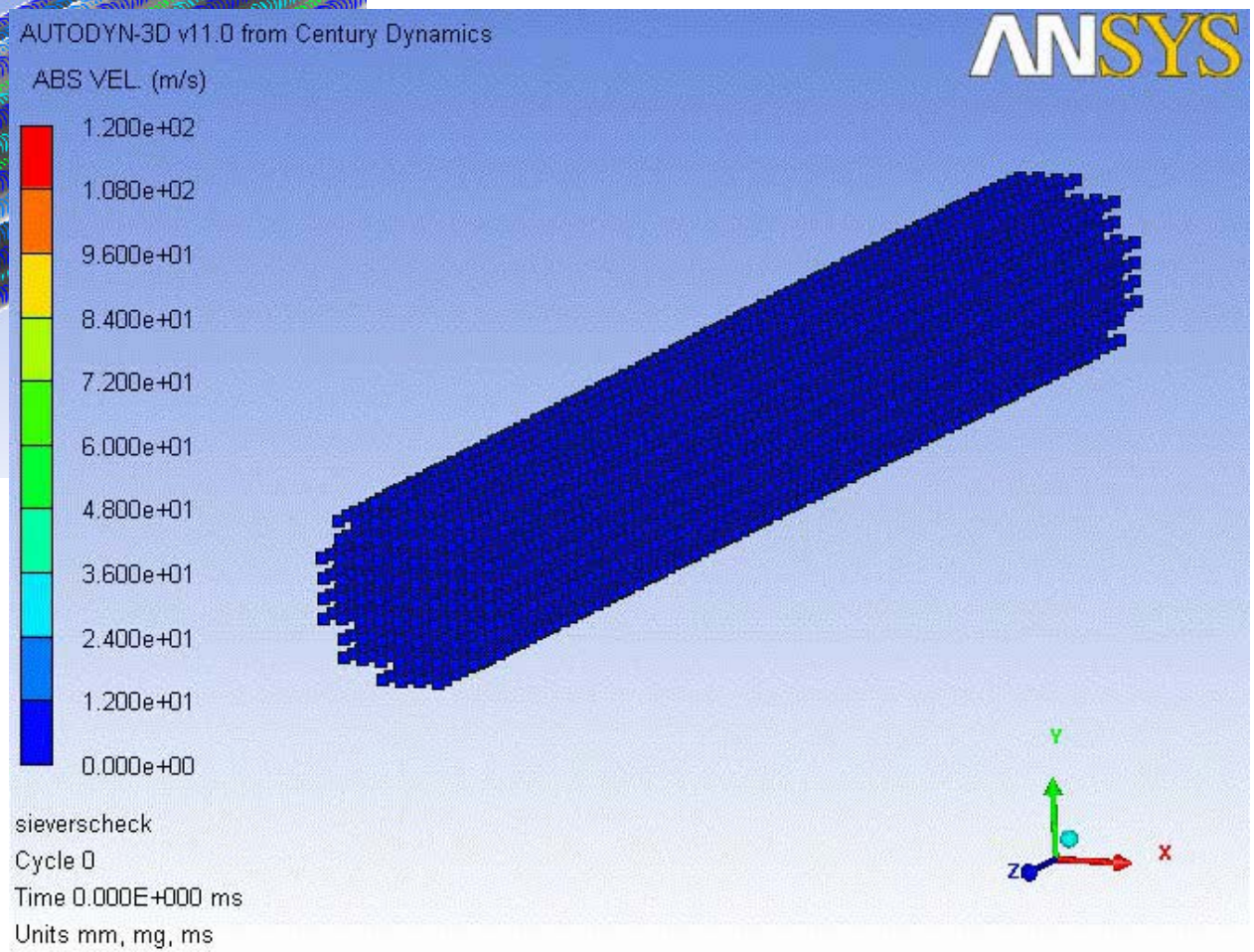


Sievers & Pugnat 2000

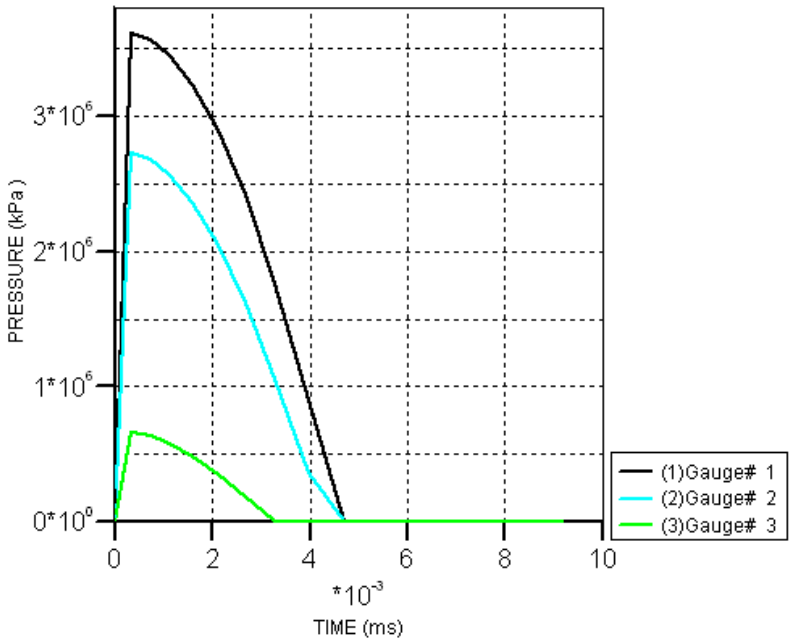
•Effect of parabolic radial energy deposition
•Radial velocity at surface of mercury jet due to neutrino factory beam is 36m/s

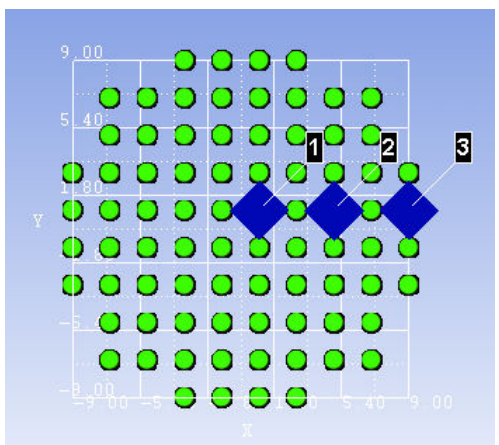
Numerical simulation of Sievers & Pugnat Result



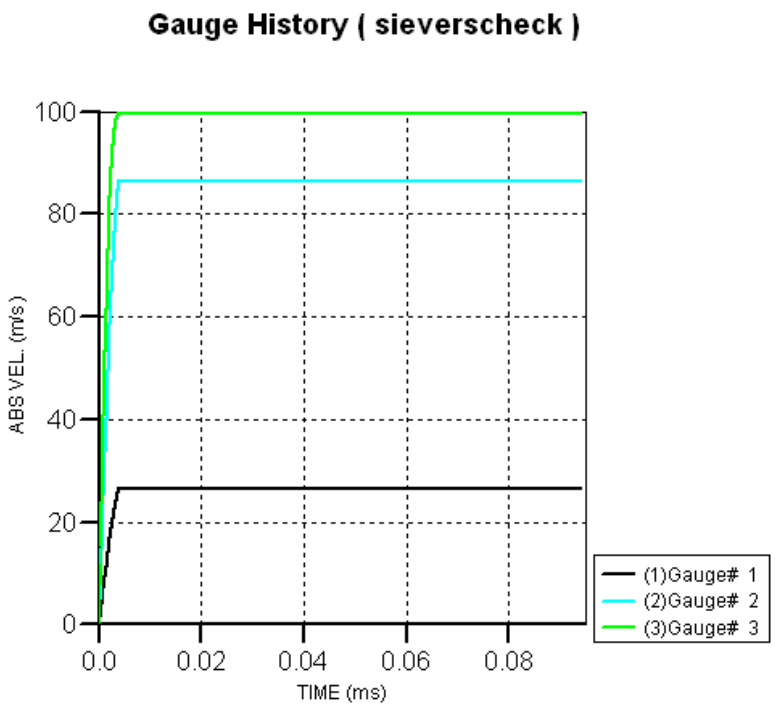


Pressure and velocity response

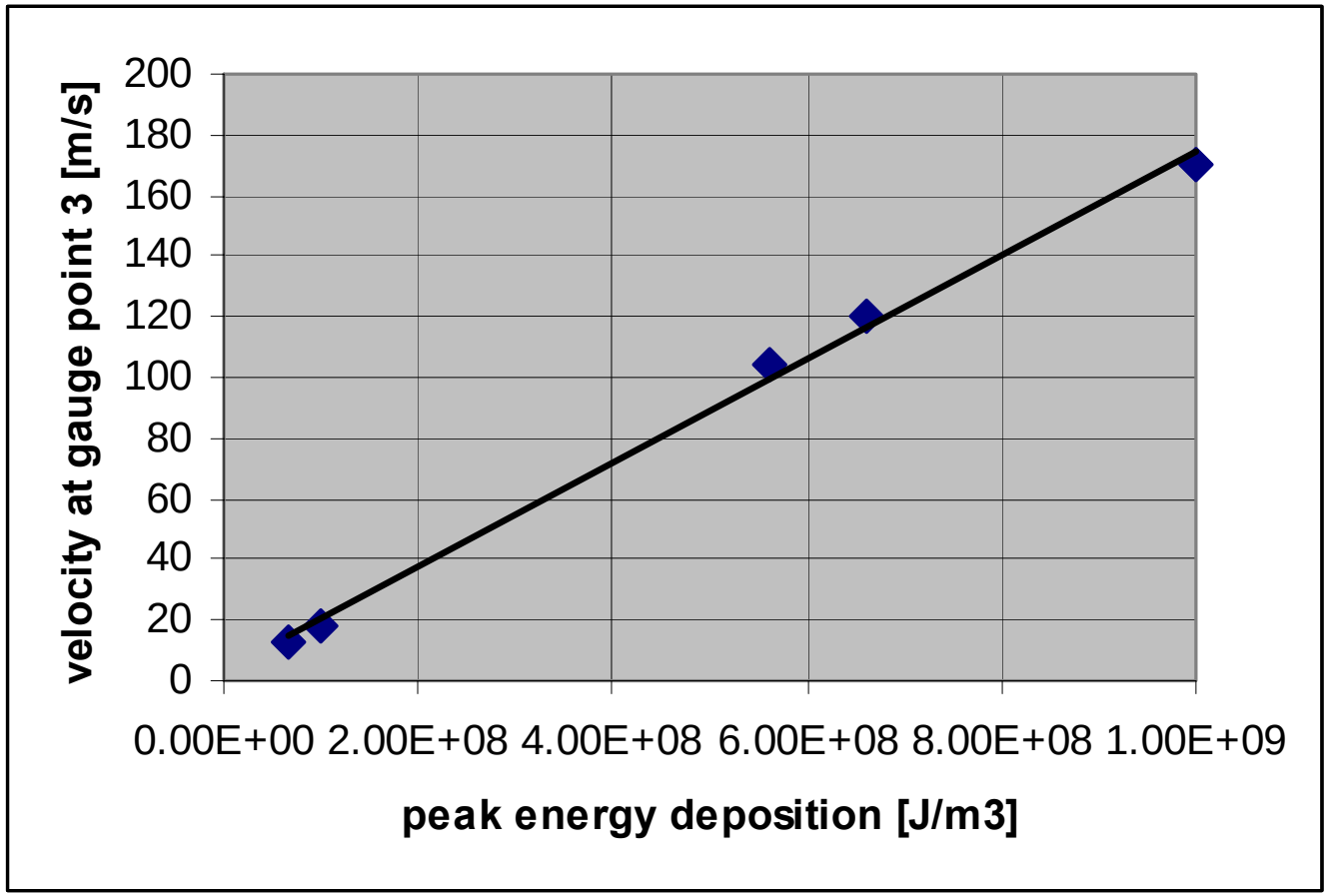




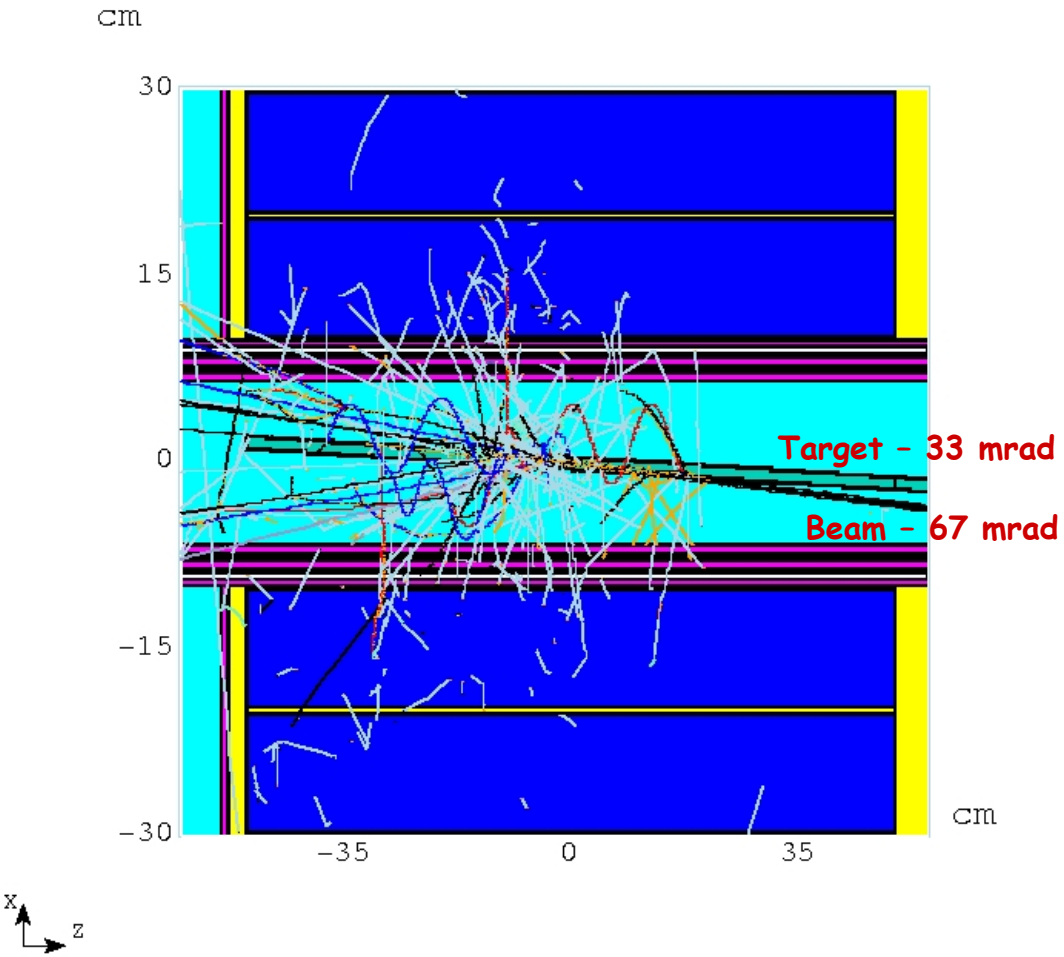
from Century Dynamics

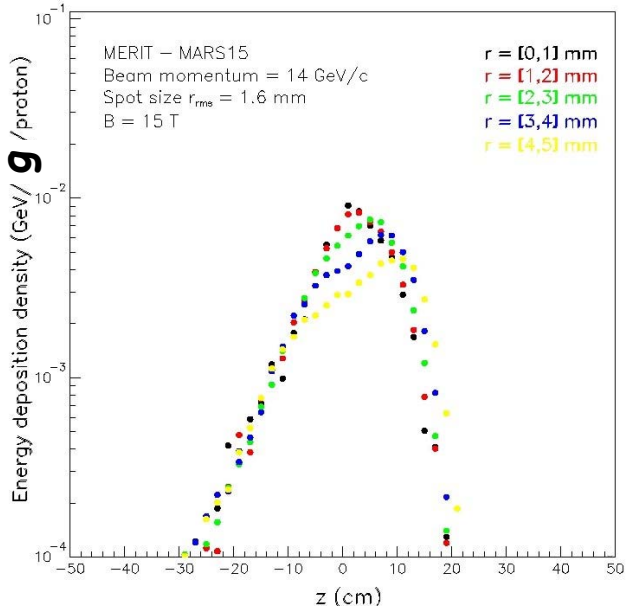


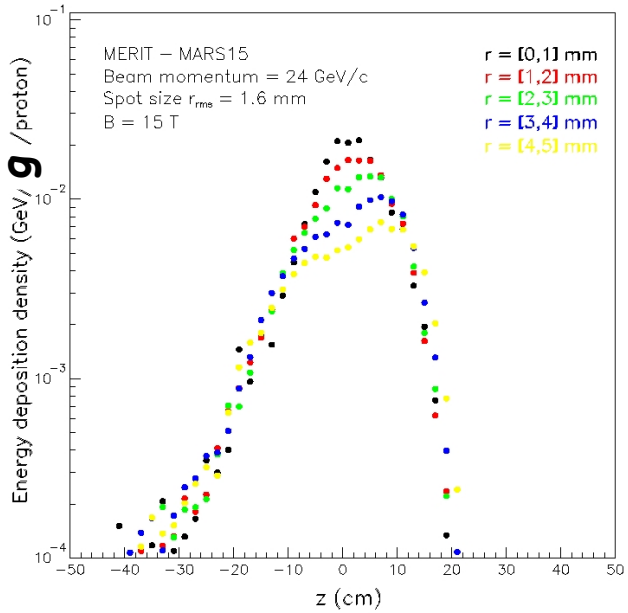
Autodyne result for radial velocity vs energy deposition



- MERIT target -
energy deposition from MARS
B = 15 T



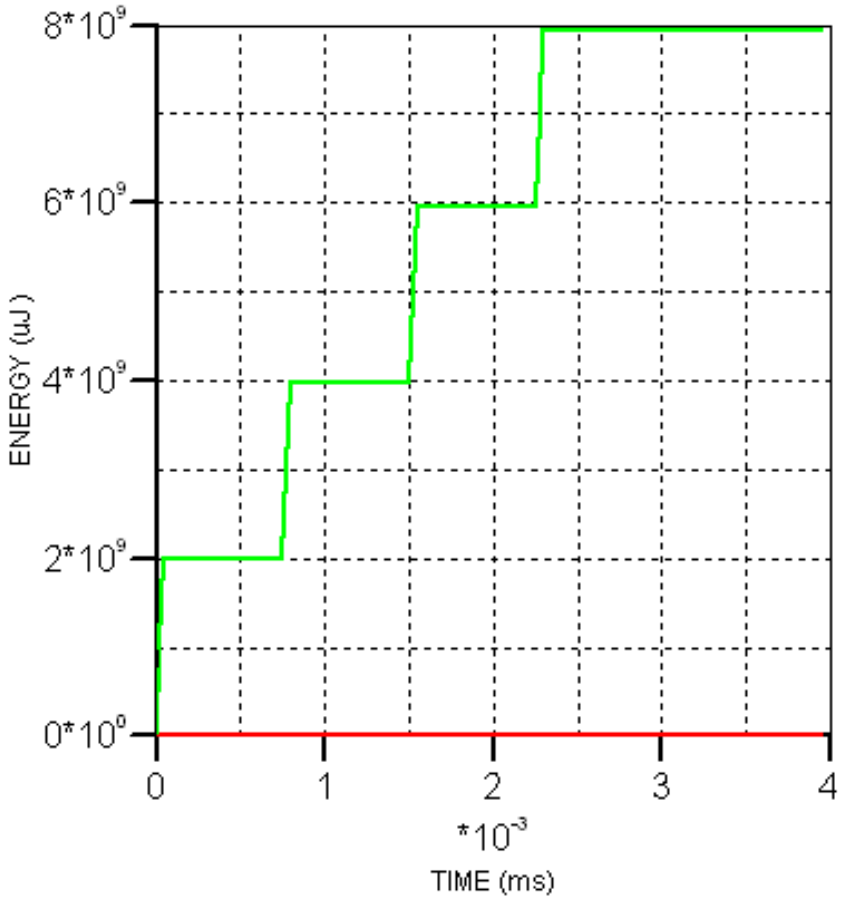




Goran Skoro

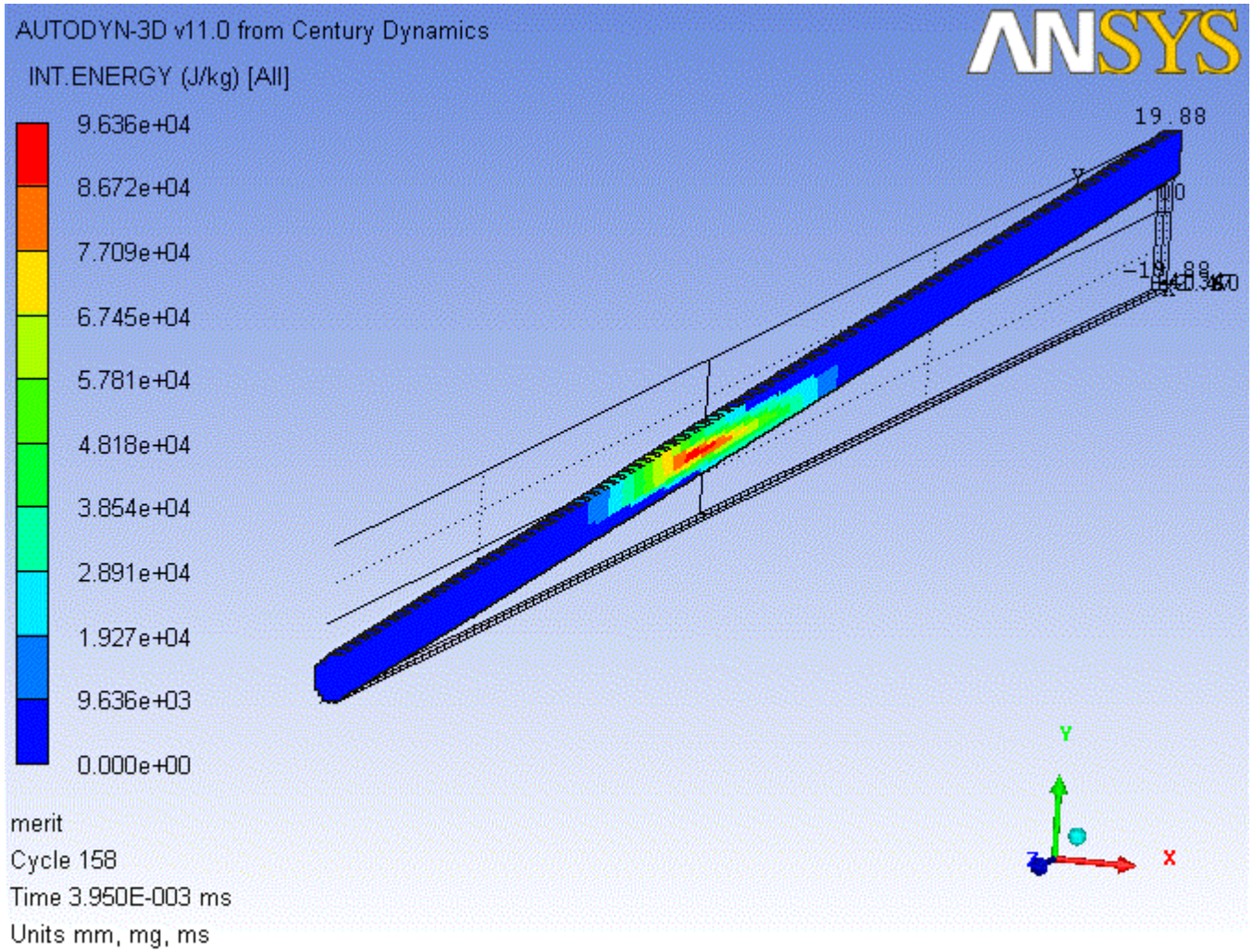
Autodyne Model of Merit Jet

beam energy = 24GeV
bunches in a pulse = 4
pulse duration = 2.3us
total energy deposition in mercury in a pulse = 8kJ



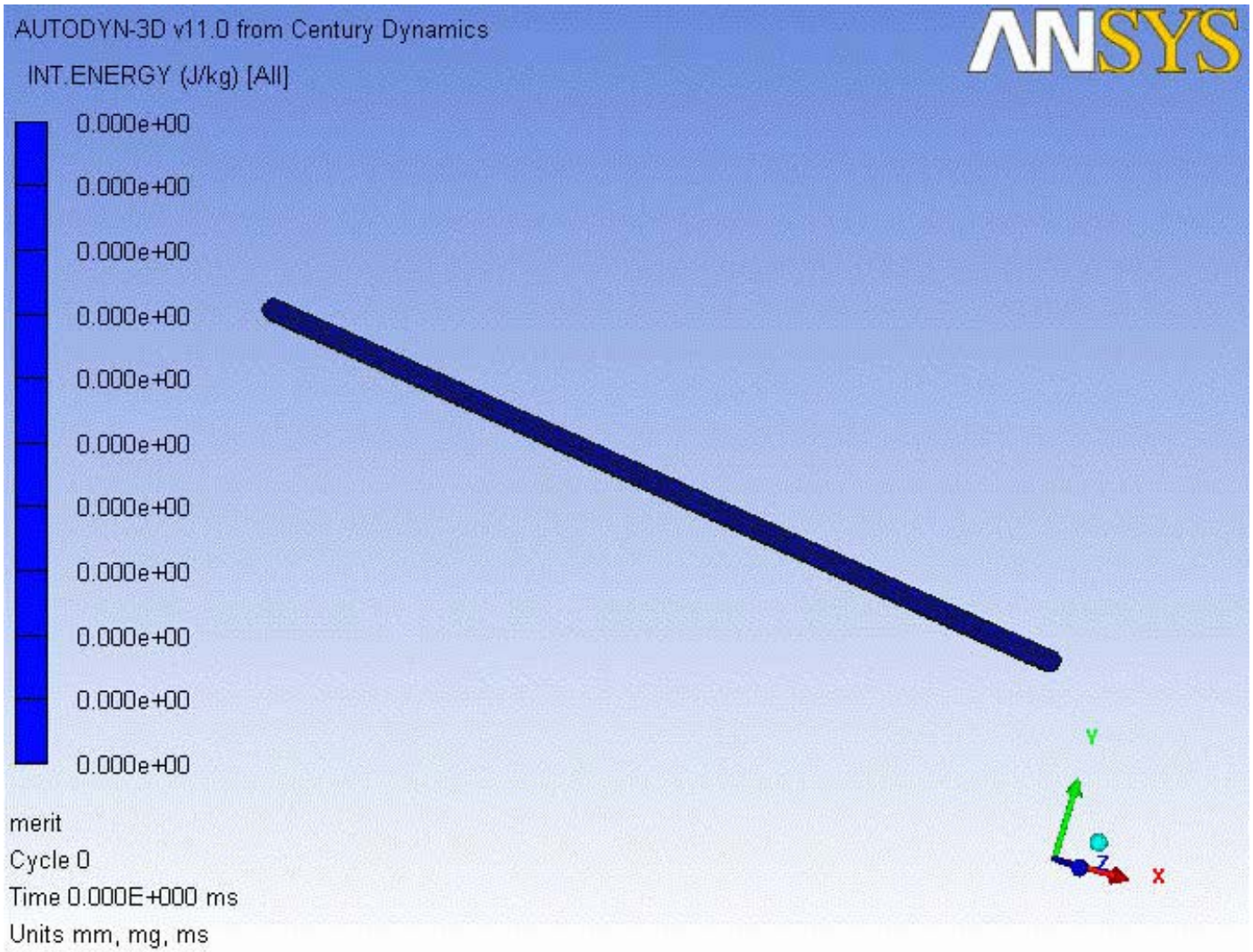
Autodyne Model of Merit Jet

Beam at 33mrads to 10mm diameter mercury jet



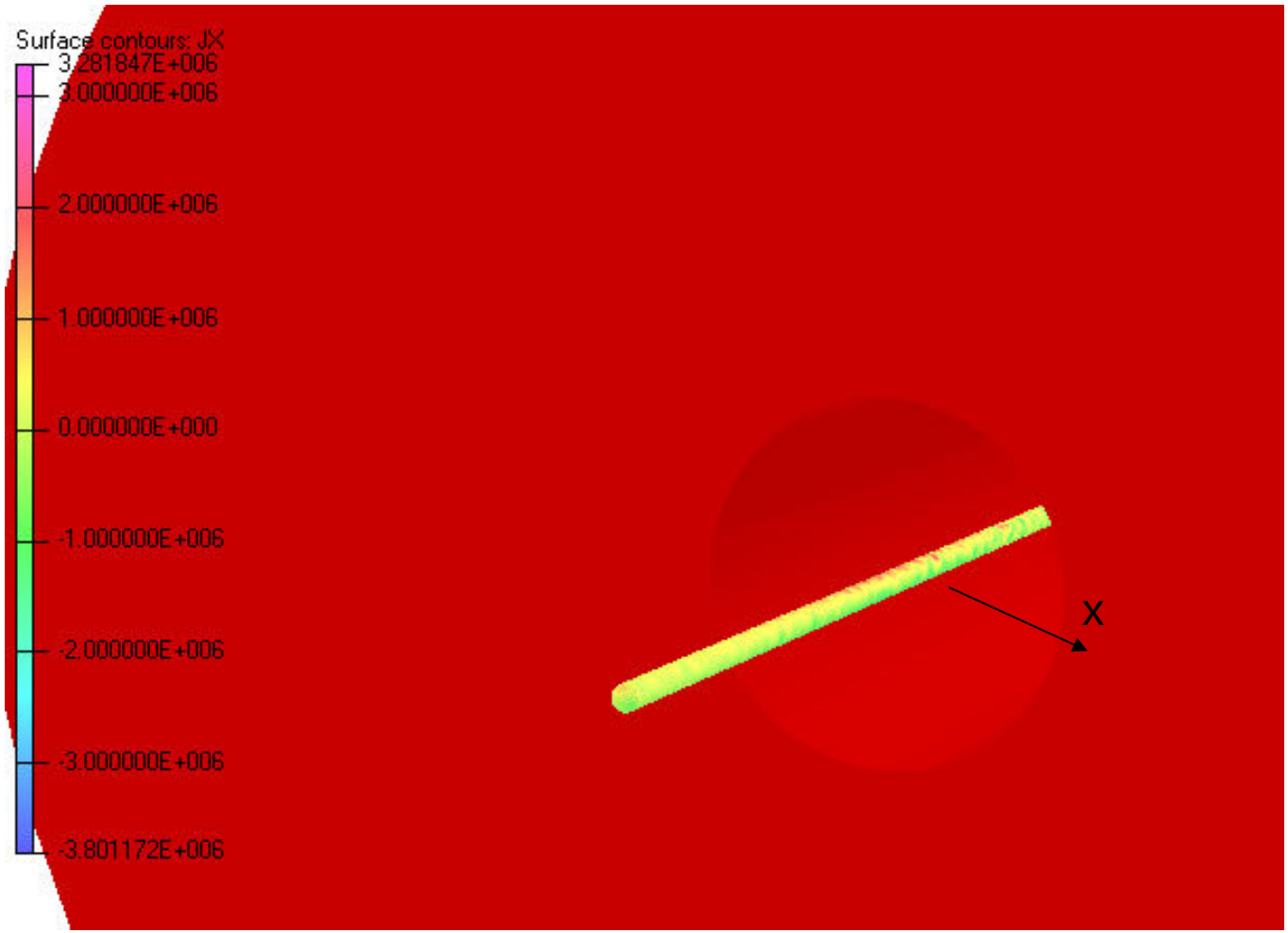
Autodyne Model of Merit Jet

Max radial Velocity 93m/s



Influence of magnetic field

current density [A/m$^{2]}$ induced in a mercury cylinder travelling at 15m/s
mercury conductivity 1.04x10^{6} S/m

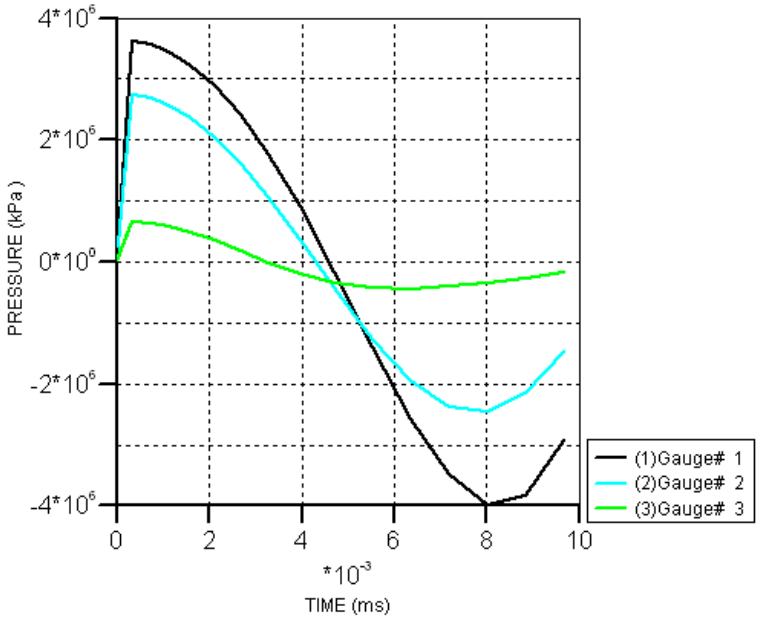


Proposed Aims

- Understand discrepancy between numerical simulations and Sievers result.
- Calculate surface pressure on mercury jet due to 15T solenoid.
- Calculate effect of magnetic field on radialy travelling lumps of mercury as a function of lump size.
- Consider feasibility of combining dynamics and magnetic field simulations.

Pressure and velocity response

mercury treated as a linear elastic material



1.0 from Century Dynamics