TCS Loading in IR7

energy deposition
under asynchronous dump
for TCSG.A6L7

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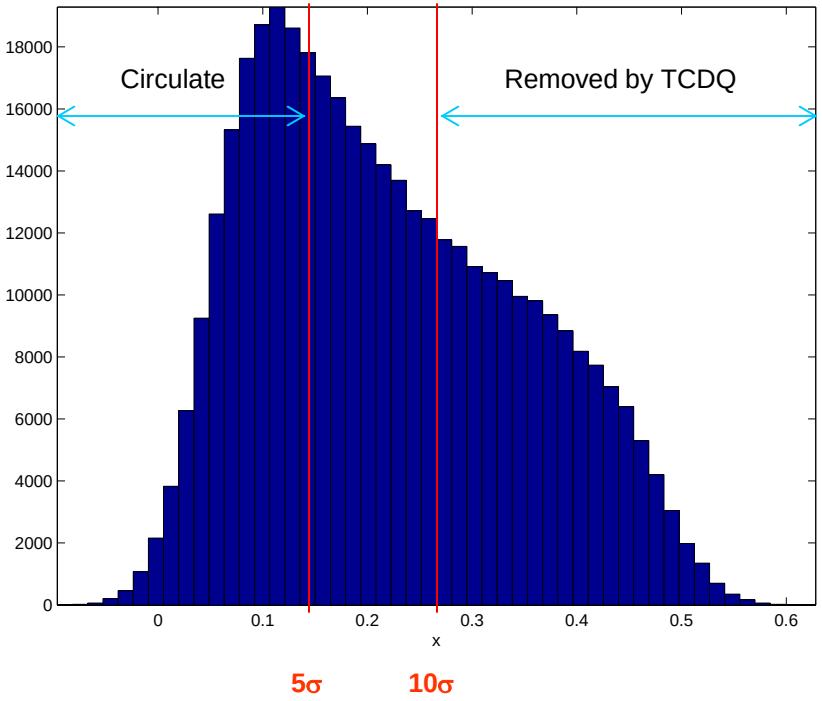
Introduction

- Motivation
  - prediction of ΔT and total load w.r.t. damage limits
    - graphite jaws
    - copper cooling
- Scope
  - realistic asynchronous dump distribution (from Stefano)
  - detailed TCSG geometry (the prototype used in IR7)
  - simple adiabatic model for ΔT calculation
- Simulation settings
  - fine mesh around impact positions
    - avoids “dilution” of energy during scoring (50 micron in x,y)
    - factor 10 effects observed going from 500 to 50 micron

Input Data

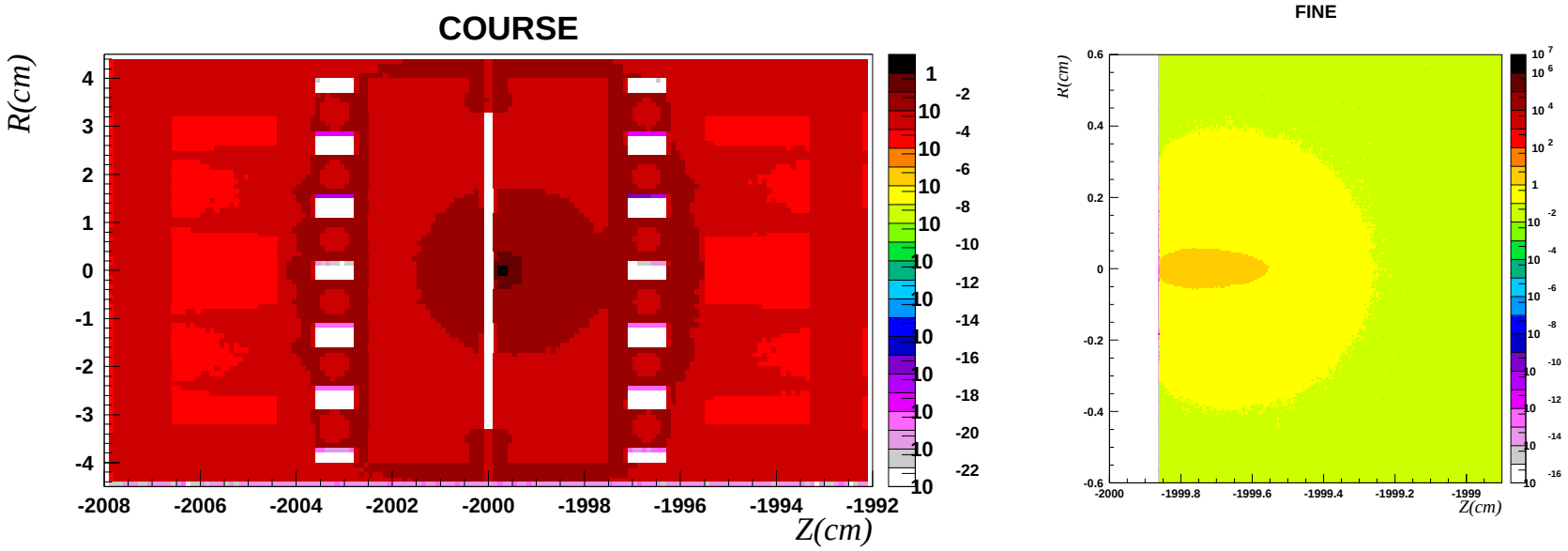
- Proton distributions
  - 23 bunchs
  - (x,y,z) and (x',y') at TCSG.6R7 face
  - 20K p+/bunch (460K total)



Simulation

- TCDQ removes swept beam beyond 10σ
  - outer 3 bunches don't reach TCSG
  - truncates some remainder bunches
- Simulate 20 innermost bunches
  - separate run for each bunch
  - 10 σ cut applied at runtime
  - assumed σ = 275.69 microns as previously
- Output
  - outputs summed to give expected full sweep
  - output data are per primary proton (post-process)

Fluka output



XY sectional views of raw fluka output (GeV/cm^3 per p$^+$)
for the whole assembly (left) and a fine meshed (50 micron)
area in the graphite around the impact area

Post-processing (1)

- MatLab used to post-process data.
  - Input data
    - GeV/cm^3 per proton in a Cartesian mesh
  - Scaling
    - scale to expected 1.1×10^{11} protons per bunch
    - adjust for TCDQ scraping (32.90%)
  - Processing
    - convert to J/cm^3
    - integrate per material region (total load)
    - locate positions of max deposit per material region
    - create profiles intercepting max in each coordinate

Post-processing (2)

- ΔT calculation
  - takes scaled J/cm^3 data as input
  - employs temperature dependant specific heats (°C)

$$c_p^{graph}(T) = 528.75 - 205.9T^{1/3} + 154.21T^{1/2} - 1.53T + 9.15\times10^{-5}T^2$$

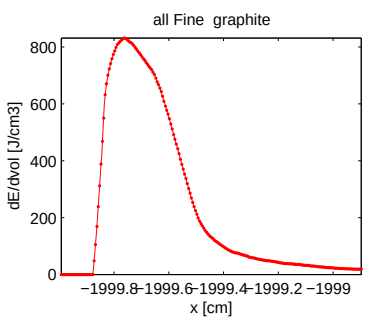
$$c_p^{Cu}(T) = 381.12 + 0.16T - 1.09\times10^{-4}T^2$$

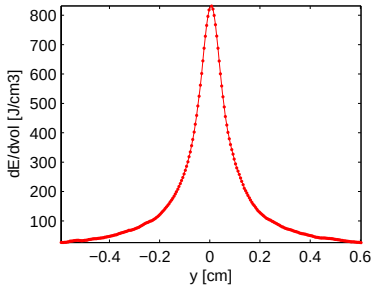
  - ΔT can be extracted, assuming system is initially at 20°C, by solving numerically the upper limit of

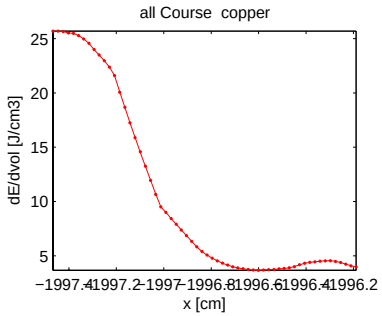
$$\frac{dE}{dV} = \rho\int_{T_0}^{T_0+\Delta T} c_p(T)dT$$

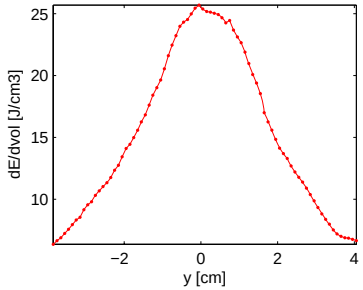
Results: J/cm^3

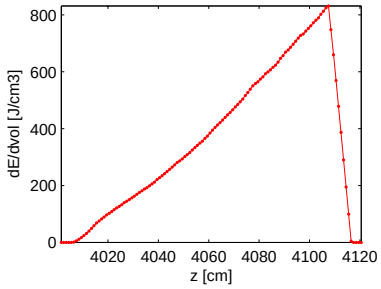
TCSG6 impacted jaw. Scaled to total number of protons

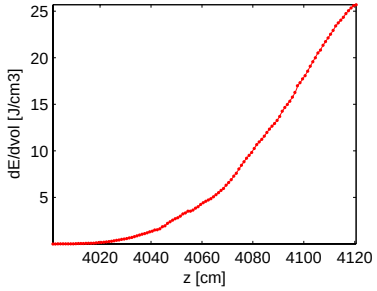






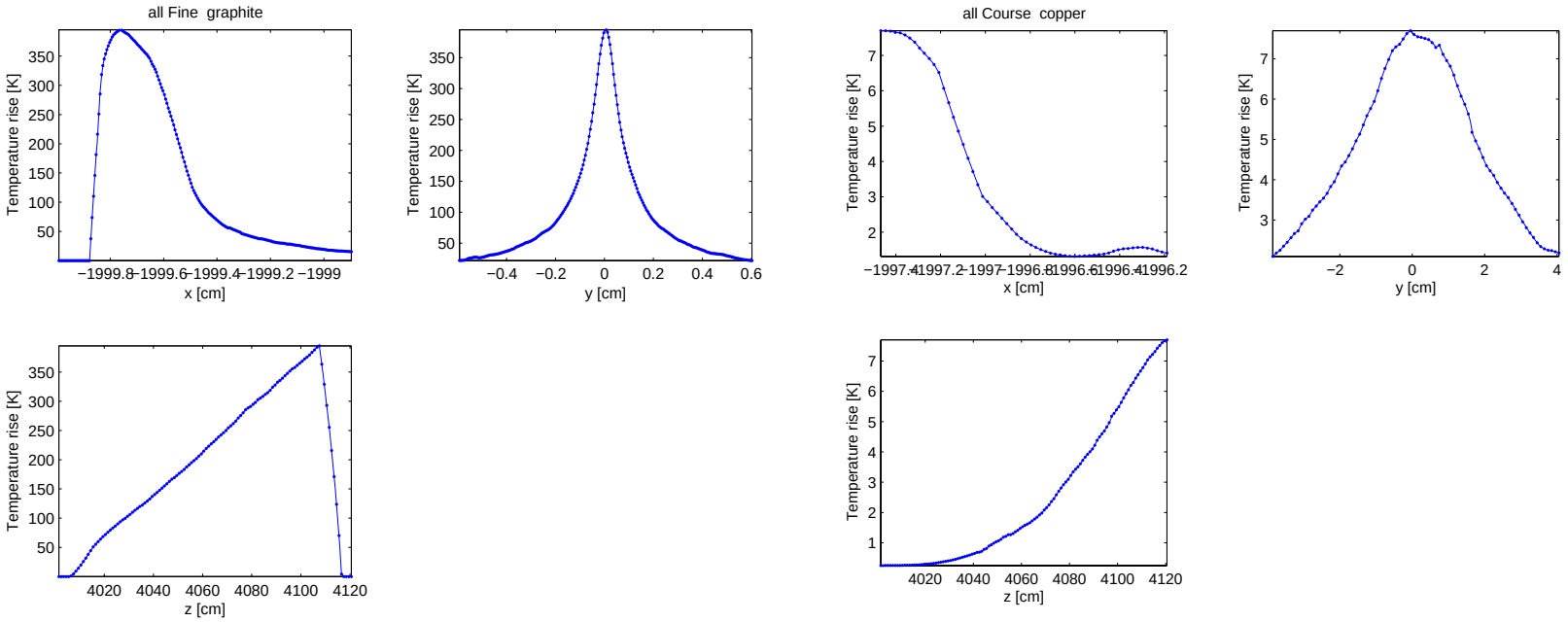






Results: ΔT

TCSG6 impacted jaw. Scaled to total number of protons



$$\Delta T_{\max}^{graphite} \approx 350°C$$

$$\Delta T_{\max}^{Cu} \approx 8.00°C$$