LHC Collimators for Phase 1

2-D Thermo-mechanical analysis of Injection accident case

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Outline

- General Hypotheses
- The FEM 2D model
- Temperature distribution
- Temperature time history
- Analytical correlation

Thermo-mechanical Analysis

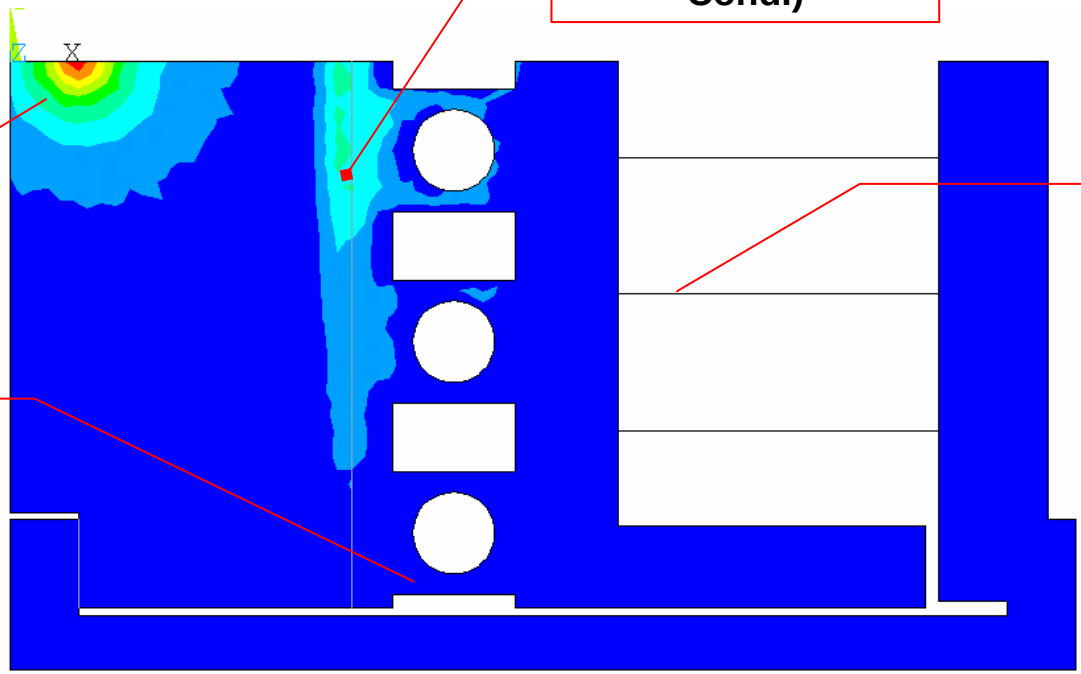
General Hypotheses

- 2-D plane strain condition
- Water inlet temperature: 27°C
- Water flow rate (per pipe): 5l/min (2.95m/s)
- FLUKA Energy deposition (M. Magistris):
  - Accident case 450GeV 3.2e13 p over 7.2 μs
- Spring preload (eqv. Pressure): 3 bar
- Experimentally measured material properties

Thermo-mechanical Analysis

FEM Model for 2-D dynamic analysis

z=1100mm

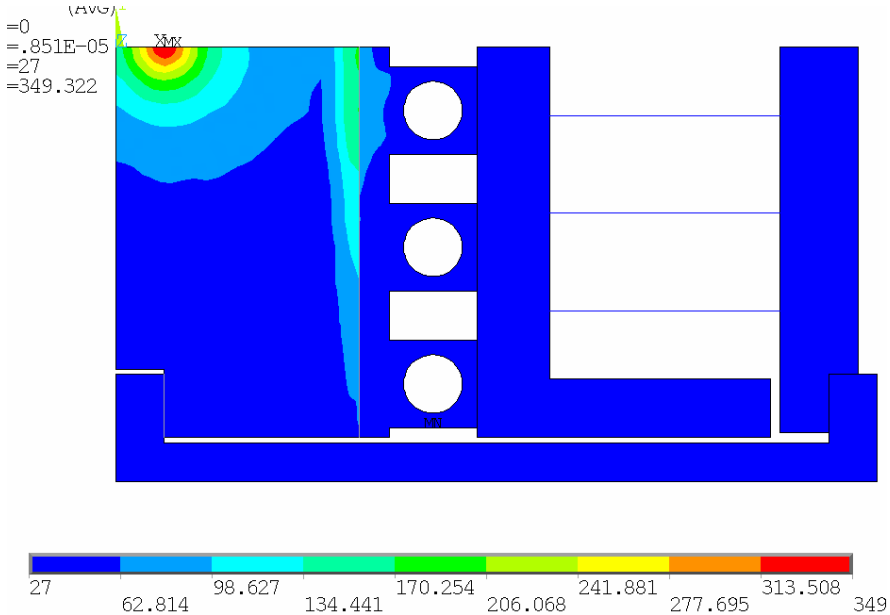


Thermo-mechanical Analysis

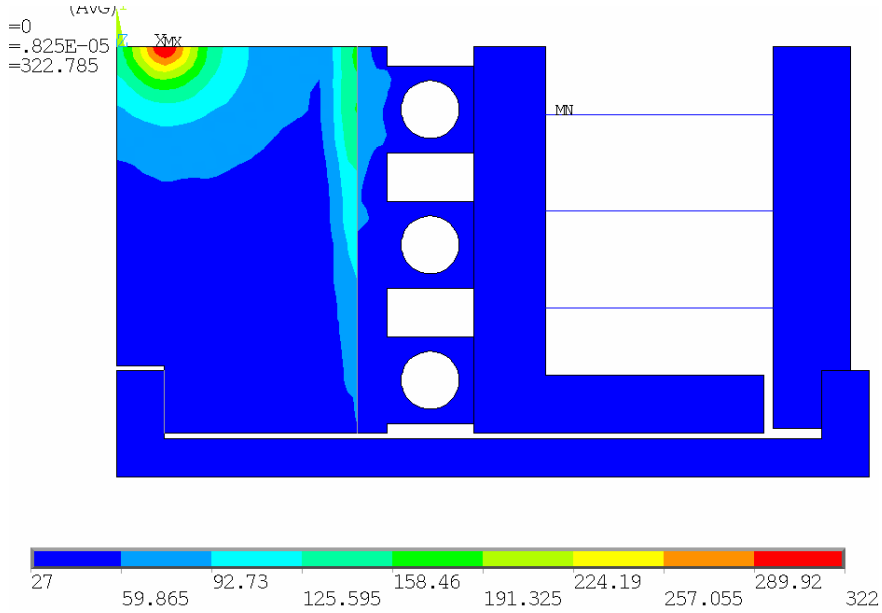
Temperature distribution at z=1100mm

Max energy density 693 J/cm3 – Total energy 80.6 kJ/m

AC150
Tmax=350°C



R4550
Tmax=322°C

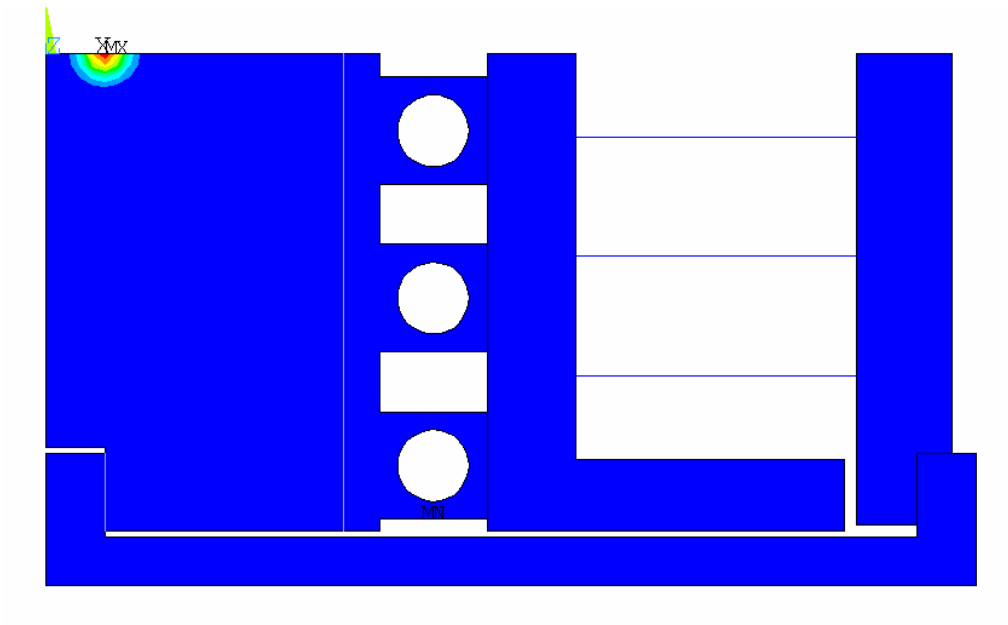


Thermo-mechanical Analysis

Temperature distribution at z=100mm

Max energy density 351 J/cm3 – Total energy 1.46 kJ/m

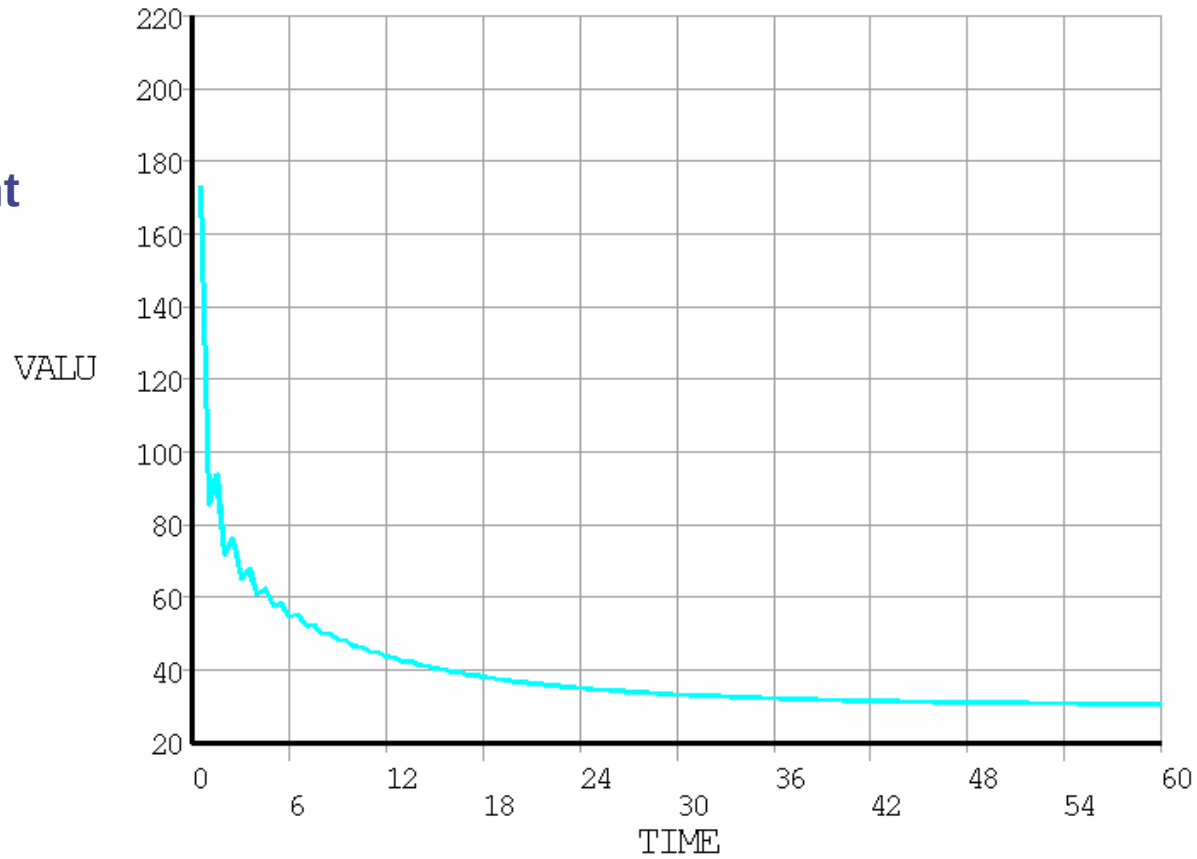
AC150
Tmax=175°C



Thermo-mechanical Analysis

Temperature time-history at z=1100mm

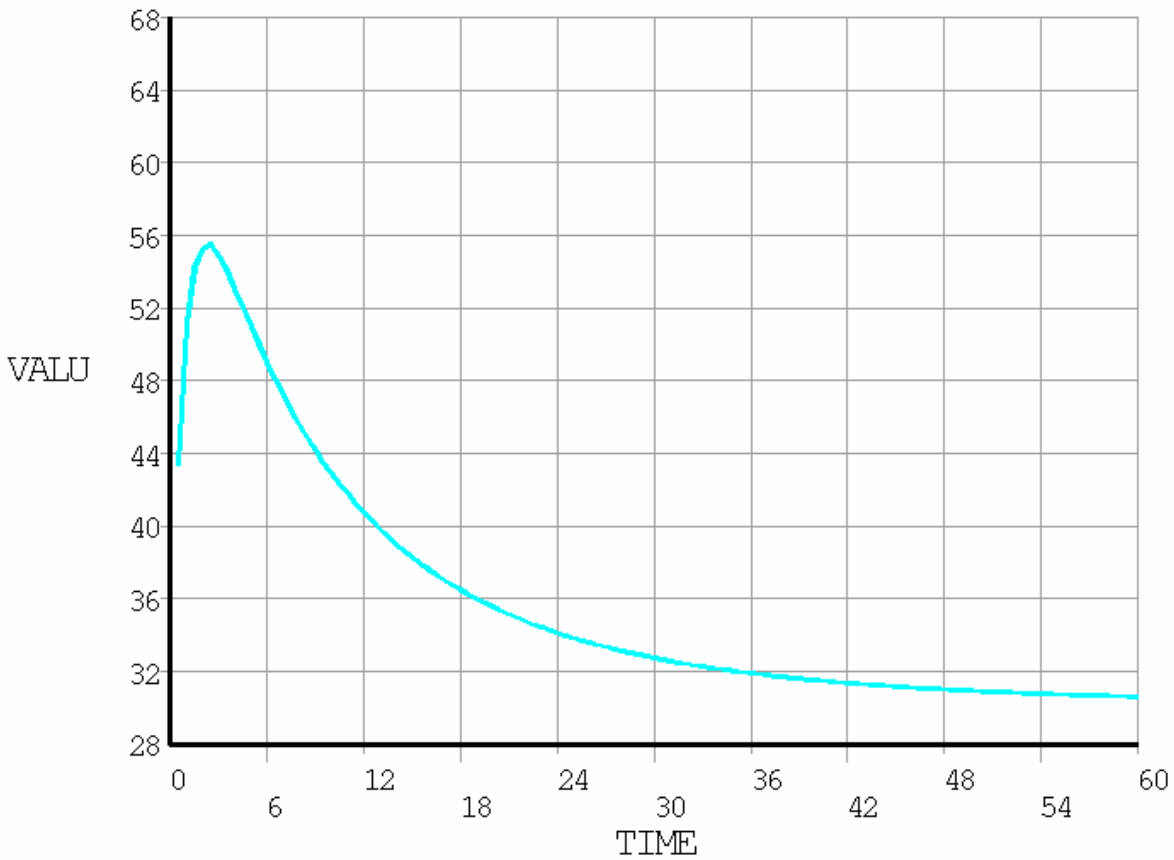
Temperature at Beam impact point



Thermo-mechanical Analysis

Temperature time-history at z=1100mm

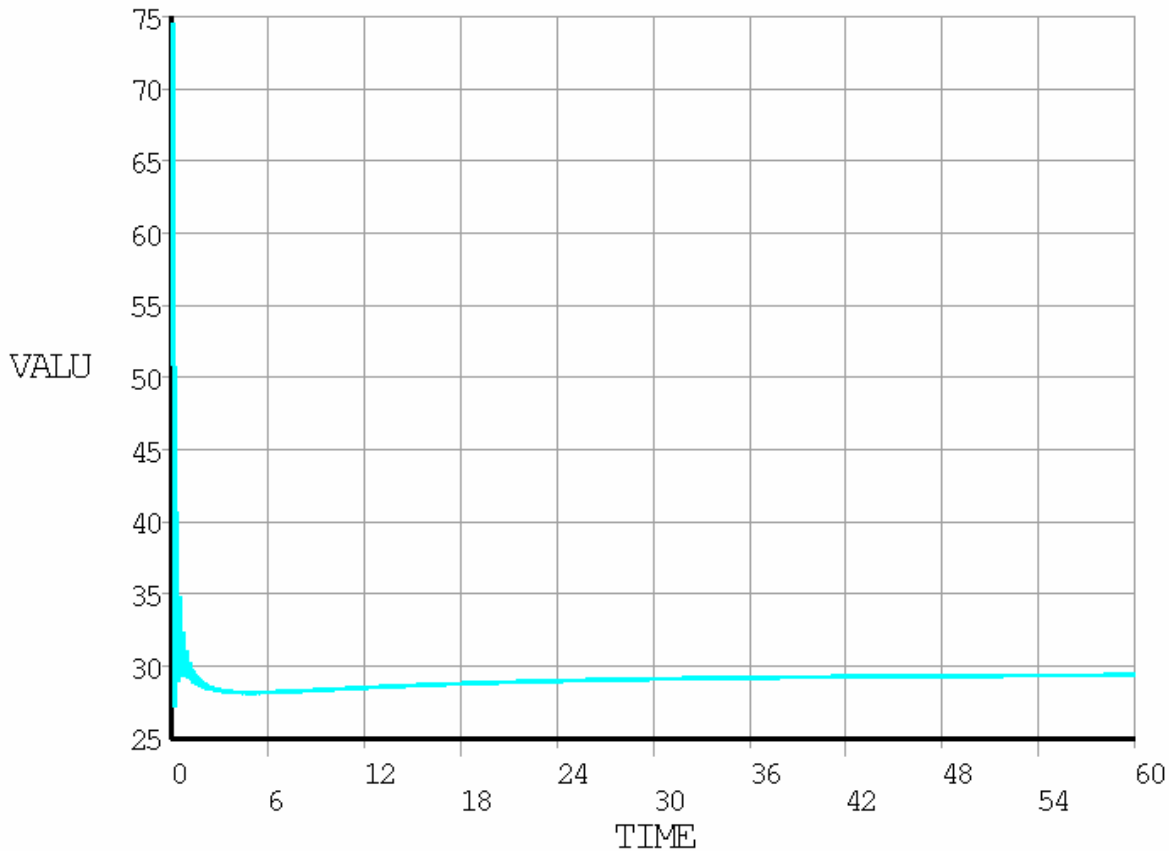
Temperature at Probe location



Thermo-mechanical Analysis

Temperature time-historv at z=100mm

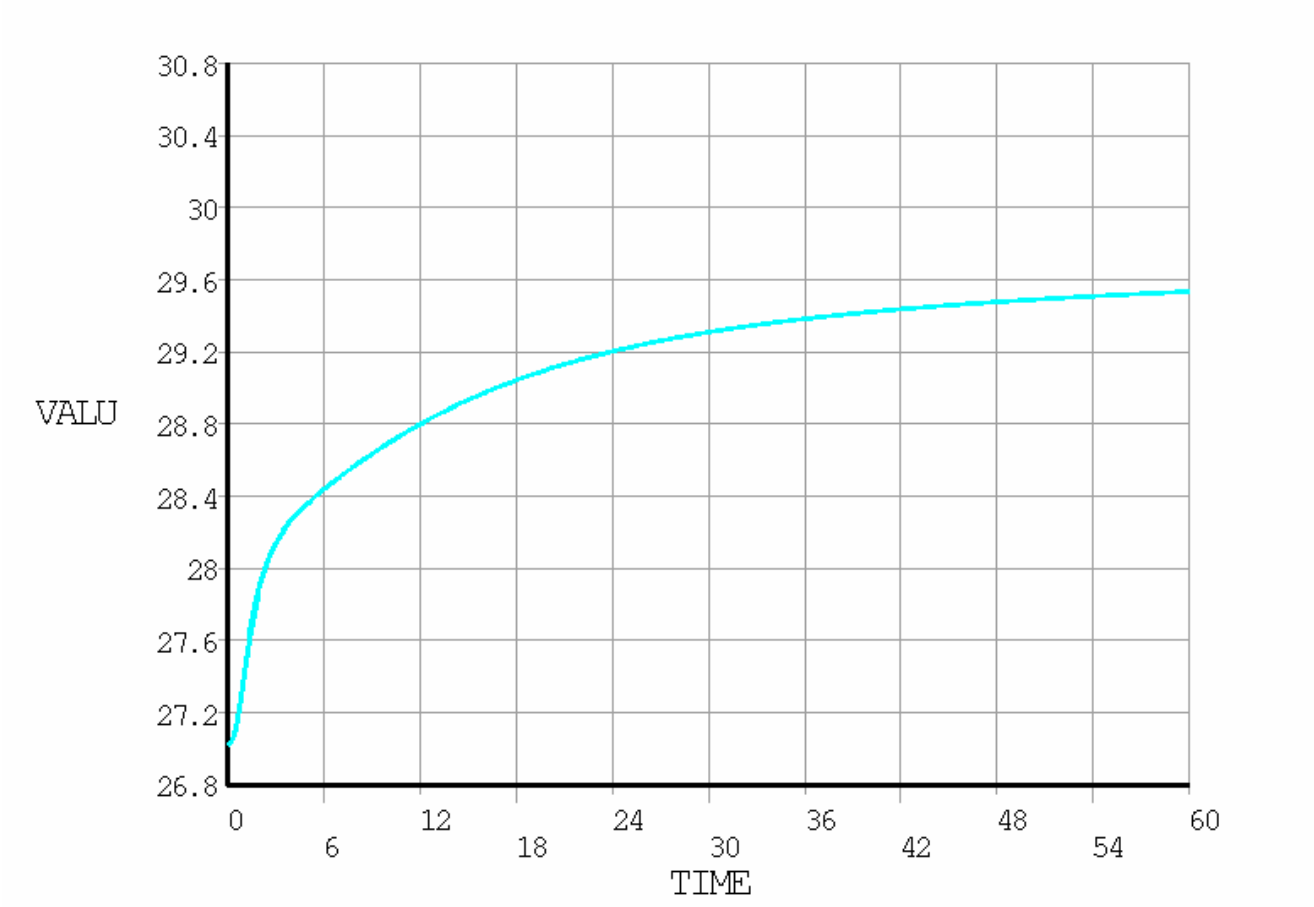
Temperature at Beam impact point



Thermo-mechanical Analysis

Temperature time-history at z=1100mm

Temperature at Probe location



Analytical correlation

Typical diffusion time is $\tau \div L^2/\kappa$ (i.e $T(t) \div \exp(-t/\tau)$

where

L is typical diffusion (geometrical) length

κ is diffusivity ($k/\rho/c_p$)

For graphite - C/C	$\tau \approx 15$ sec
For steel	$\tau \approx 220$ sec
For Glidcop®	$\tau \approx 9$ sec

To capture temperature time-history of jaws, acquisition sampling of some seconds is necessary …