THERMO-MECHANICAL STUDIES OF LARGE HADRON COLLIDER COLLIMATORS IN ACCIDENT SCENARIOS

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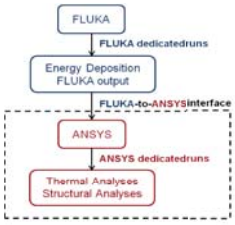
INTRODUCTION

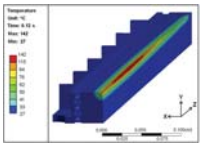
- The correct functioning of the Large Hadron Collider (LHC) collimation system is crucial to safely operate the LHC.
- In the worst accident case corresponding to an asynchronous trigger of the beam dumping system, one or more high-energy density bunches might directly impact on a collimator with possible serious consequences.
- It is important to understand the implications of this catastrophic event on tertiary collimators (TCTs) because the latter protect critical structures such as the superconducting magnets.
- This work provides a more thorough understanding of the thermo-mechanical behaviour of TCTs during beam impact in accident scenarios.

THERMO-MECHANICAL SIMULATIONS

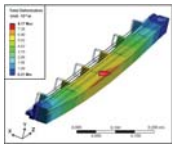
Simulation Flow



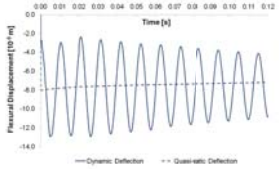
Focus of this work (FLUKA maps provided by L. Lari)



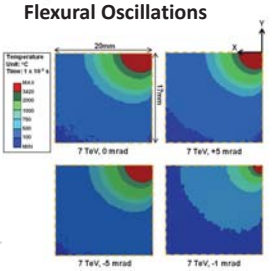
Thermal Simulation



Structural Simulation

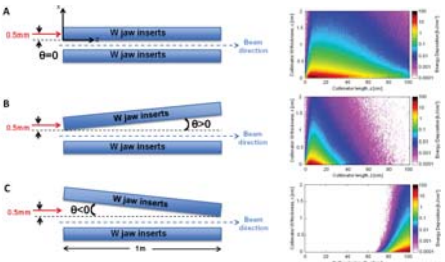


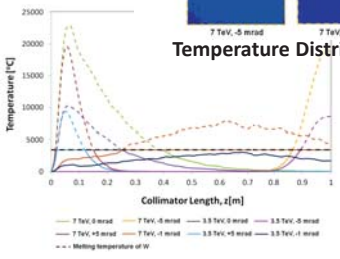
Flexural Oscillations



Temperature Distribution

Jaw-Beam Angle Case Studies

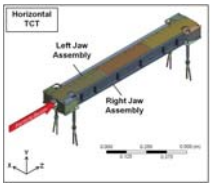


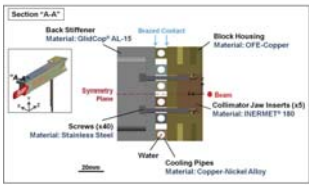


M. Cauchi et al., PRST-AB, 18, 021001 (2015); M. Cauchi et al., PRST-AB, 18, 041002 (2015)

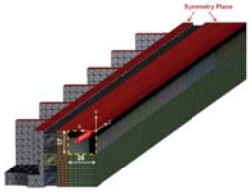
FINITE ELEMENT MODEL

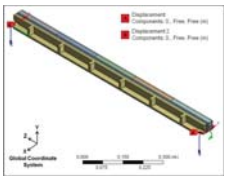
Tertiary Collimator Model



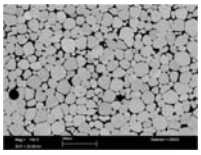


3D Mesh & Boundary Conditions



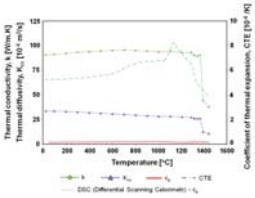


Material Characterisation (Inermet®180)

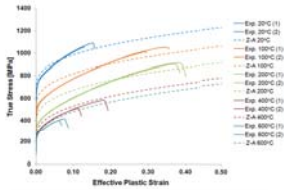


95 wt% W
3.5 wt% Ni
1.5 wt% Cu

Thermo-Physical Properties (Measurements at Austrian Institute of Technology)

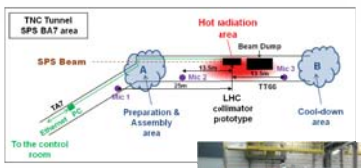


Mechanical Properties (Measurements at Politecnico di Torino)



EXPERIMENTAL VALIDATION AT HiRadMat FACILITY

Experimental Setup

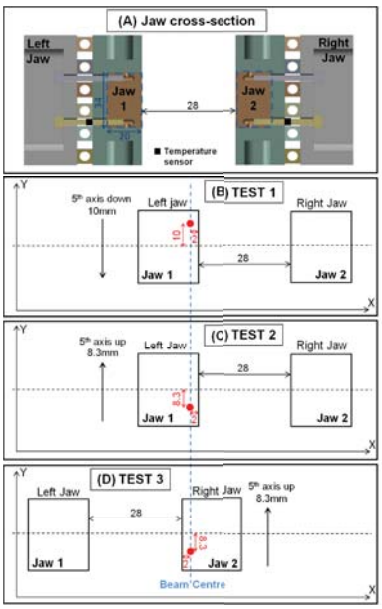


The LHC collimator prototype used for the test

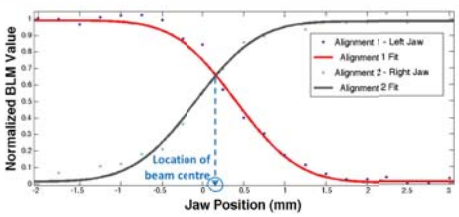
Test Parameters

Test	1	2	3
SPS extraction intensity [x 10^{12} p]	3.36	1.04	9.34
No. of bunches	24	6	72
Beam size at impact [$\sigma_x \times \sigma_y$ mm^2]	0.38 × 0.38	0.50 × 0.50	0.49 × 0.49
Energy on jaw [kJ]	87.89	27.72	249.87
TNT equivalent [g]	21.01	6.62	59.72

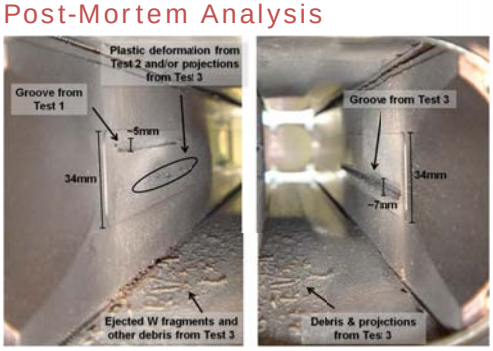
Overview of Tests



Beam-Based Alignment



Post-Mortem Analysis



M. Cauchi et al., PRST-AB, 17, 021004 (2014)

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