Students Coffee

Impact Studies with LS-Dyna on the Windows of the TDE

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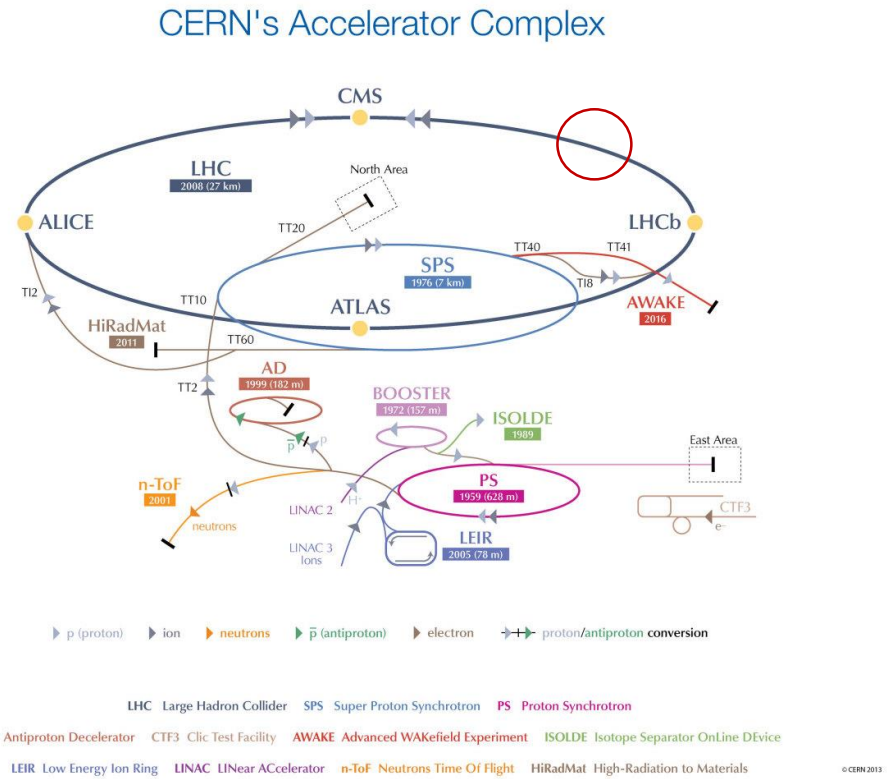
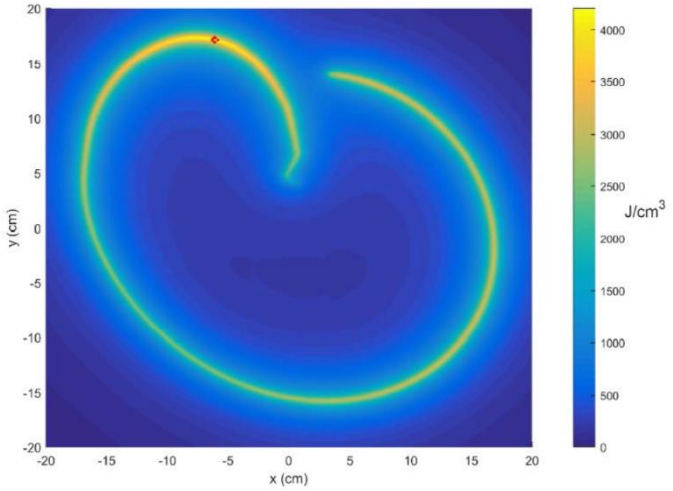
The Dumps Lay in Point 6



We Dump when Operation demands it

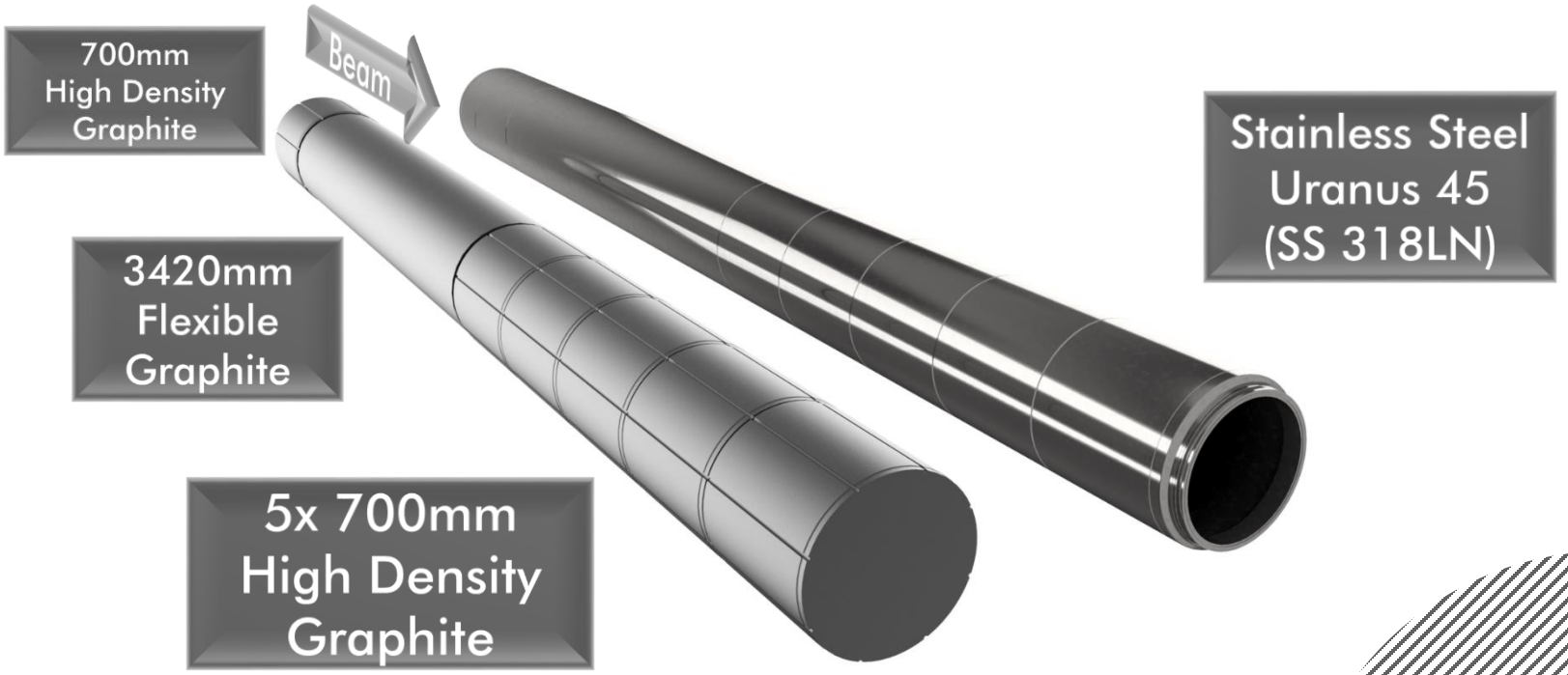
- 2800 bunches with 1.2E13 protons per bunch at 6.5 TeV - 7TeV
- Swept by deflection magnets to reduce energy density
- In emergency the beam is dumped immediately in the machine
- 1200°C within 80µs inside the core



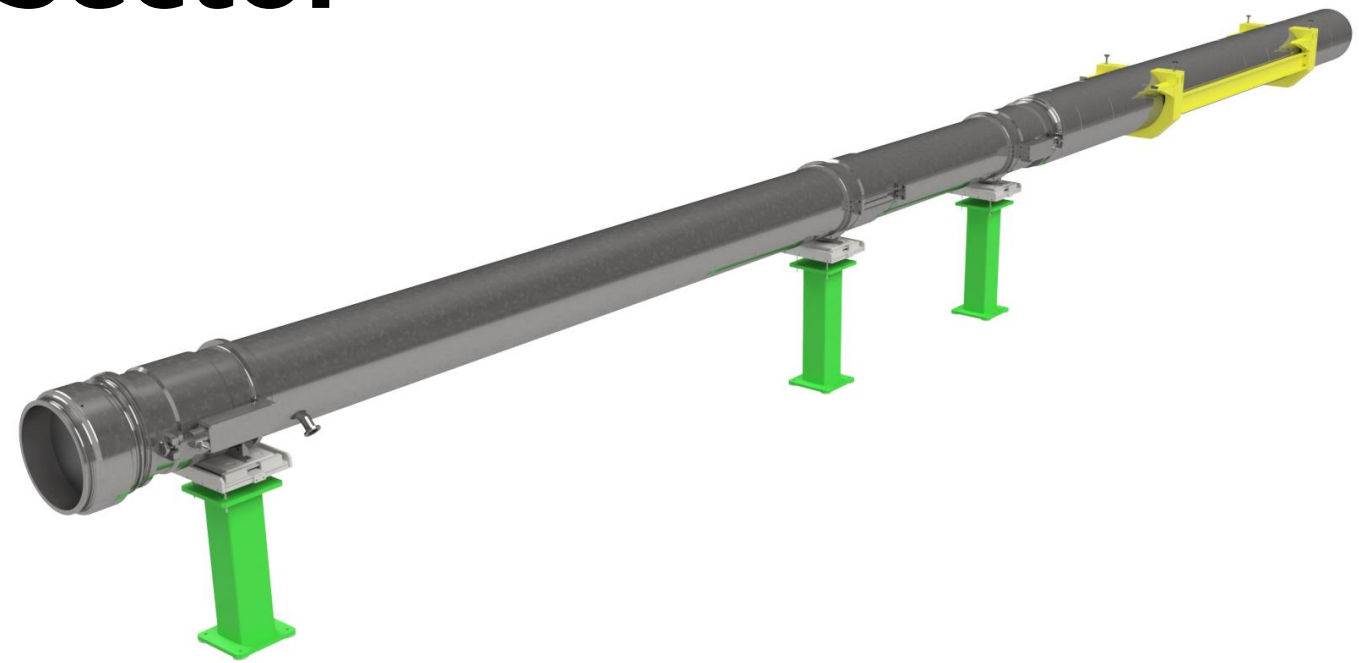
The Dumps in the LHC is Large … very Large

- 8m of graphite, 0.7m in diameter
- Protected in nitrogen gas
- Enclosed by two windows

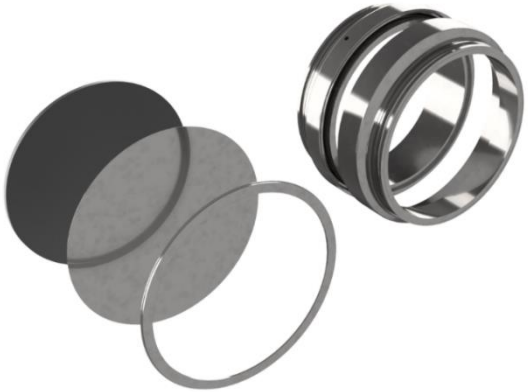
Overview of the Dump Core itself

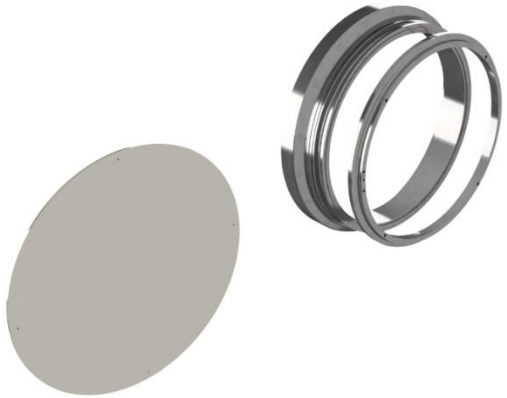


Overview of the Dump Sector



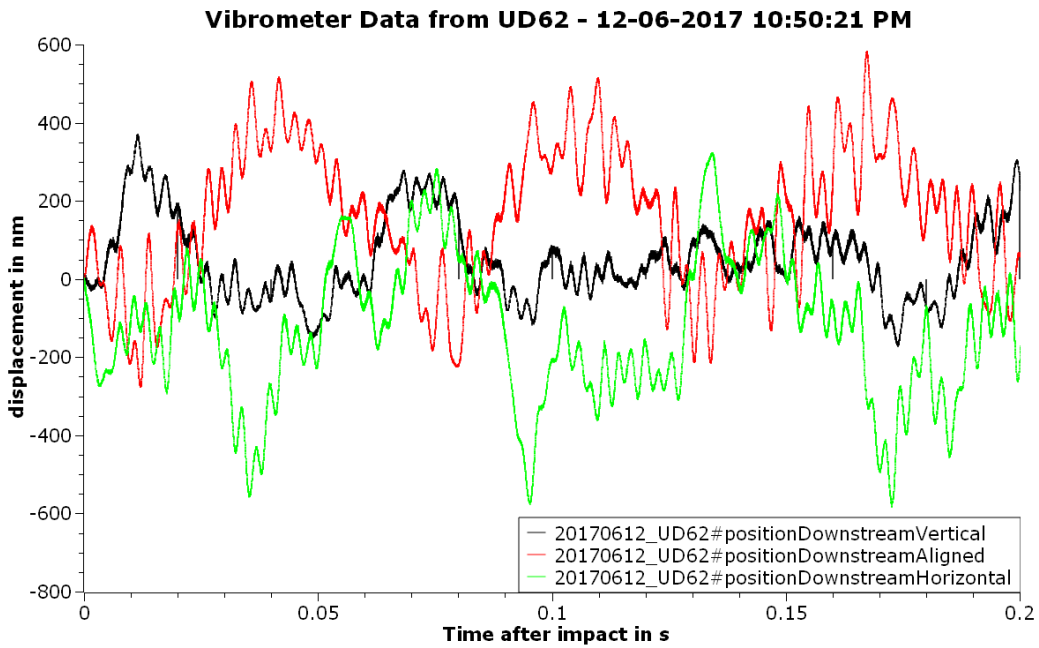
Windows ensure separation between Vacuum, Nitrogen and the Surrounding

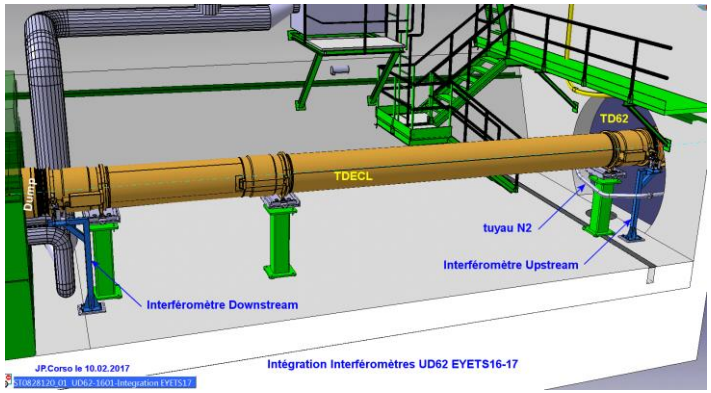




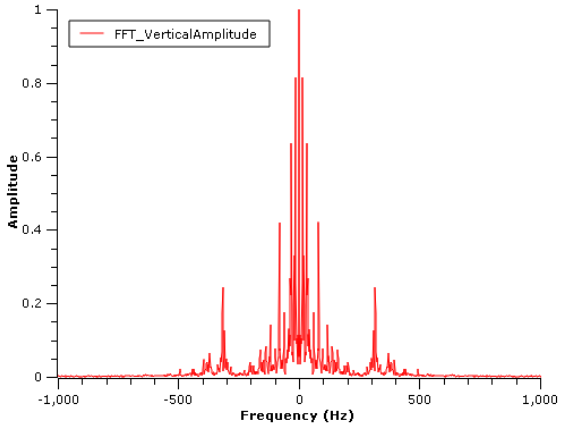
- Upstream:
  carbon plate + steel (SS316LN) foil
- Downstream:
  titanium plate

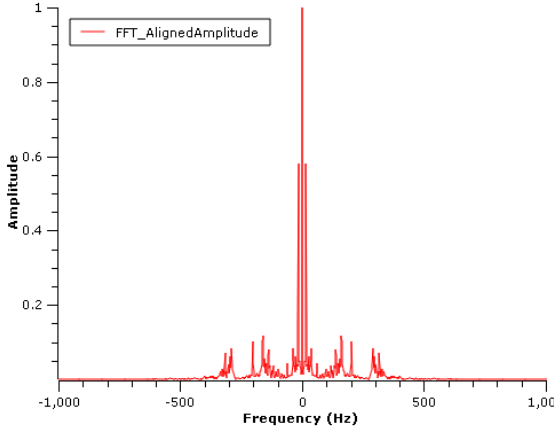
Whole Dump Vibrates Due to Induced Mechanical Waves

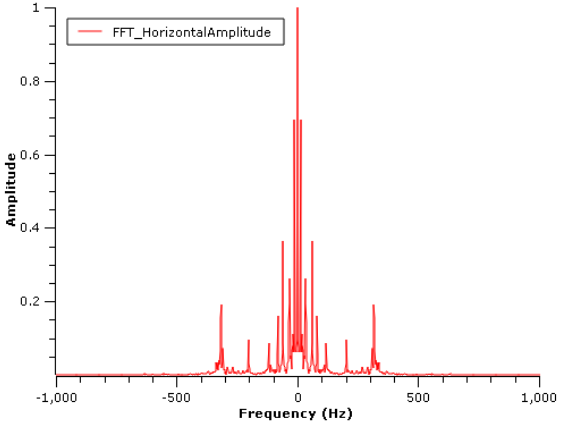




Relatively Low Frequencies





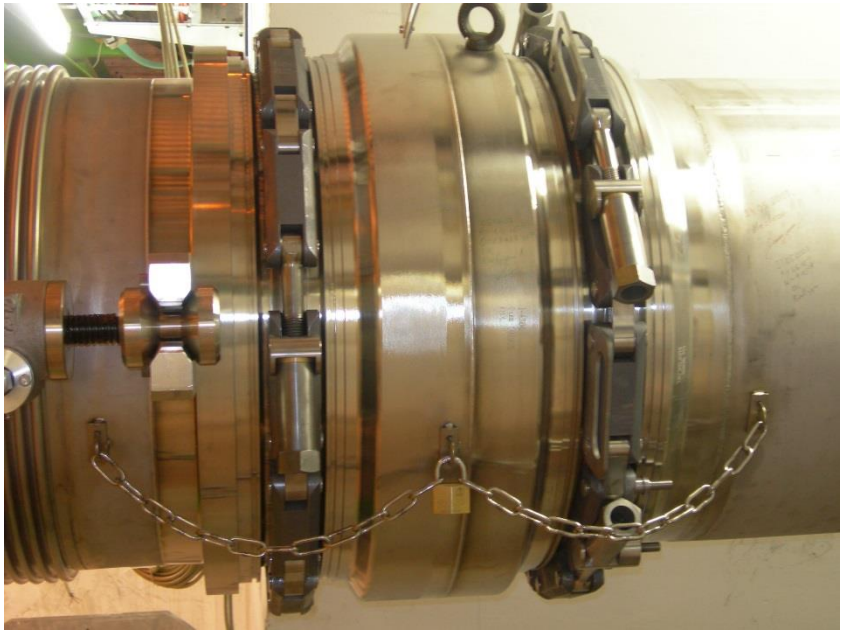


Whole Dump Vibrates Due to Induced Mechanical Waves

- Influence on all connections
- Improvement of connectors and windows ongoing
- Simulation of the whole core in progress
- Validation with installed interferometers planned

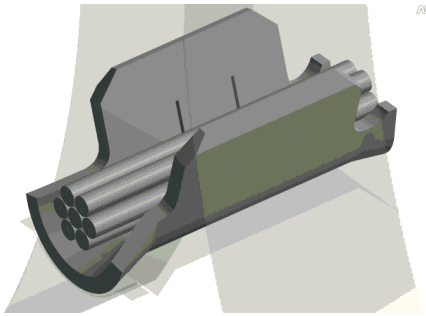
Vibrations Cause Loss of Connections

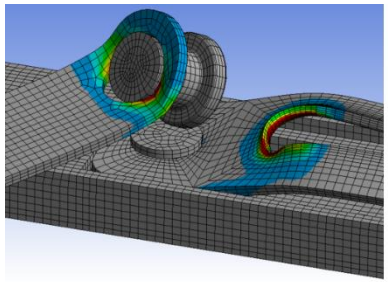
Broken Gasket from beginning of 2017

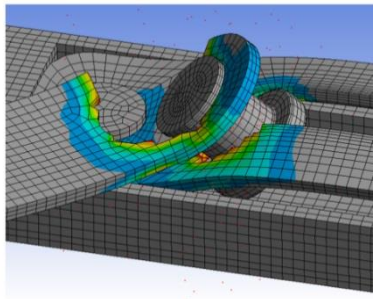


LS-Dyna is the Fastest Explicit Solver on the Market

- General purpose explicit dynamic finite element program
- Entirely command-line driven



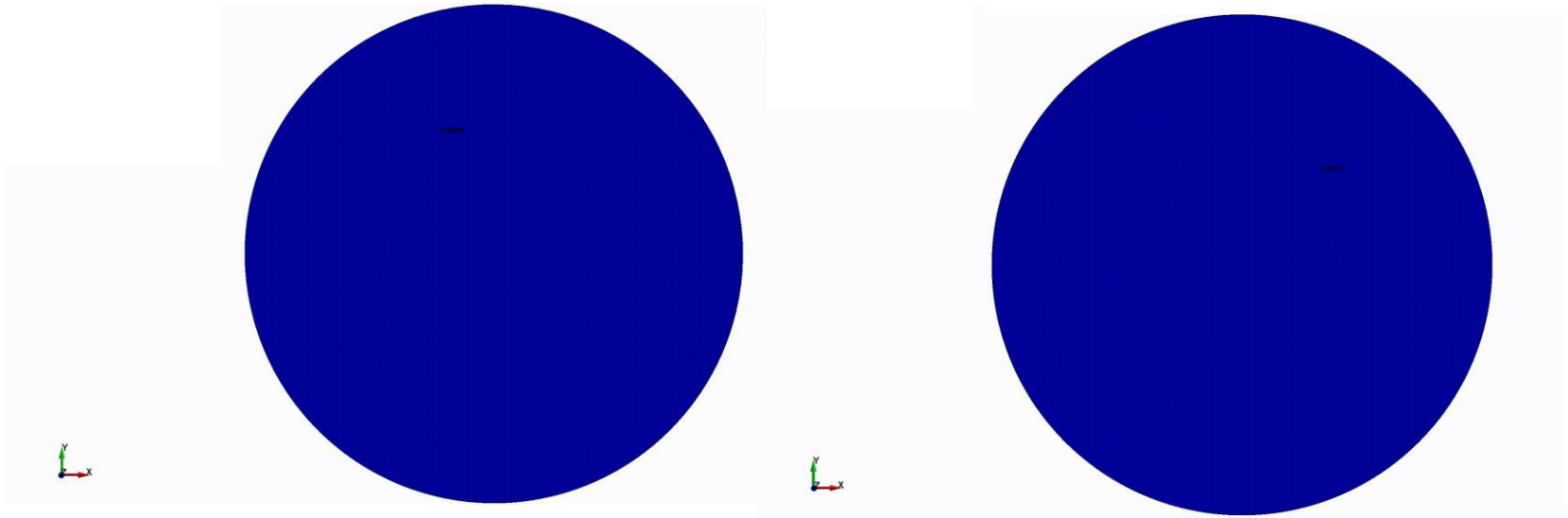




Impact Simulation of Whole Beam with Pattern of Single Bunches

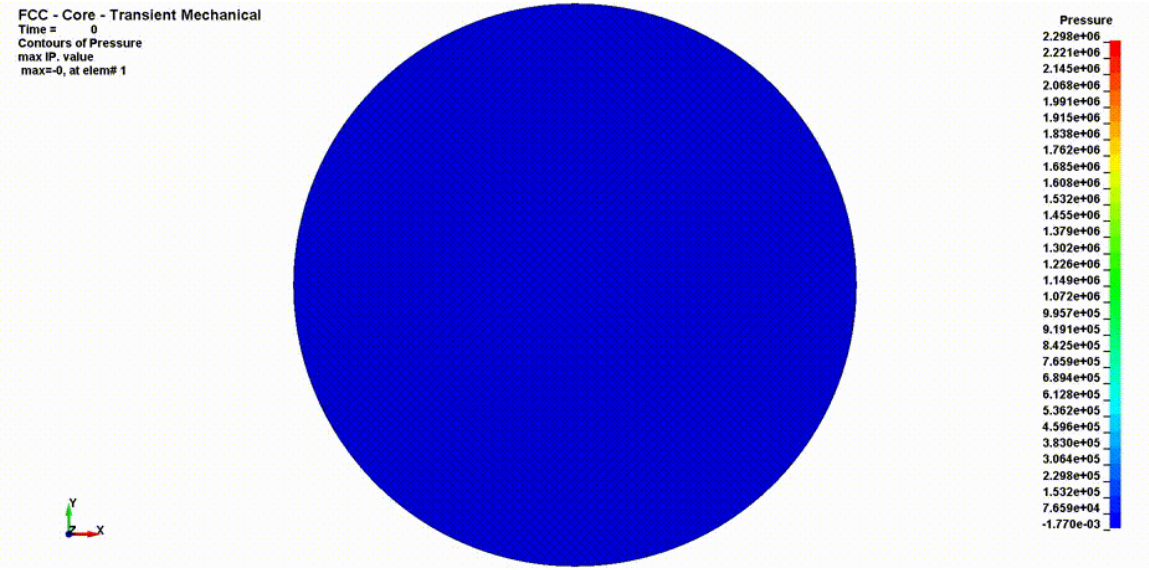
- Cover all dynamic effects
- Developed method applicable for other projects

Which Windows were Simulated?



- Plot shows measure for the stresses caused by the interacting proton beam (v. Mises Stress)
- Whole sweep lasts 80µs
- Around 2800 bunches are simulated

Different Application: FCC Dump*



- Just an approximation of pressure
- Energy deposition too low
- Mechanical data at room temperature
- Shear strengths unknown
- Thermal material properties are estimates

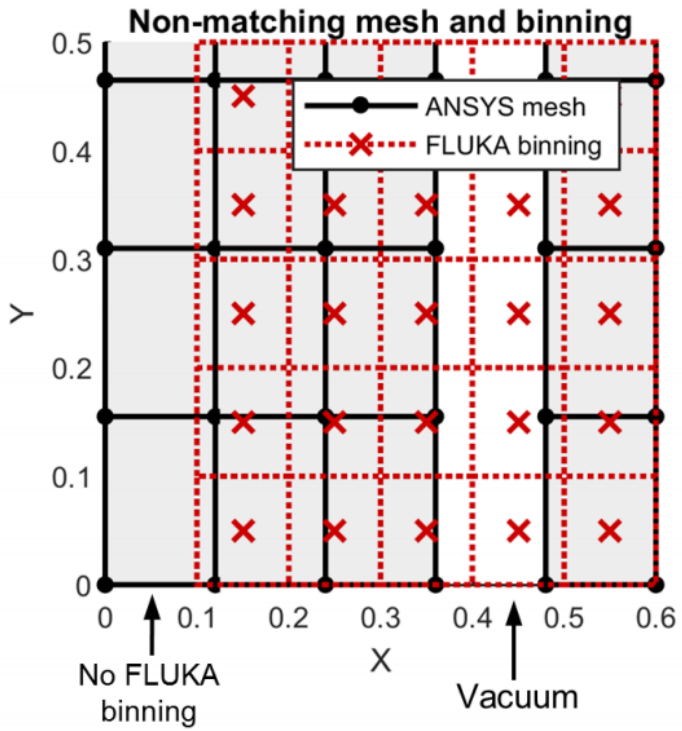
THANKS A LOT

Choice of Beam Parameters Based on Highest Temperatures

- HL-LHC BCMS filling
- 2604 LHC BCMS bunches
- Bunch intensity: 2.0e11
- Beam emittance: 1.37μm rad

- HL-LHC STD filling
- 2748 LHC STD bunches
- Bunch intensity: 2.3e11
- Beam emittance: 2.08μm rad

Modelling of the Energy Deposition



Source of Graphic:
https://edms.cern.ch/document/1891910/1

- Total kinetic energy in FLUKA bins divided by volume of a FLUKA bin to have an energy density field
- Between data points a linear interpolation takes place
- Energy deposition density requested close to the ANSYS element centroid

Modelling of the Energy Deposition