

A decorative graphic on the left side of the slide, consisting of a semi-circle filled with fine, parallel, diagonal lines, partially overlapping a solid blue circle.

Students Coffee

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


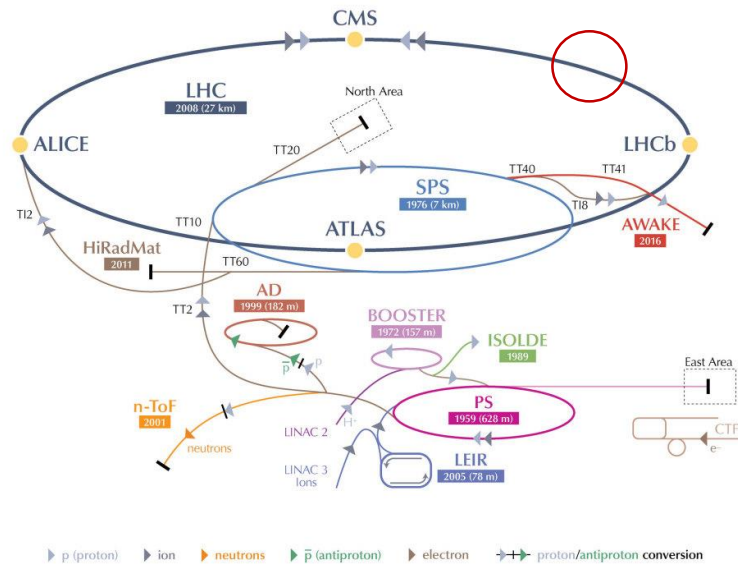


Table of Contents

- The TDE and its Windows
- Example of performed studies
- Outlook

The Dumps Lay in Point 6

CERN's Accelerator Complex



LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron

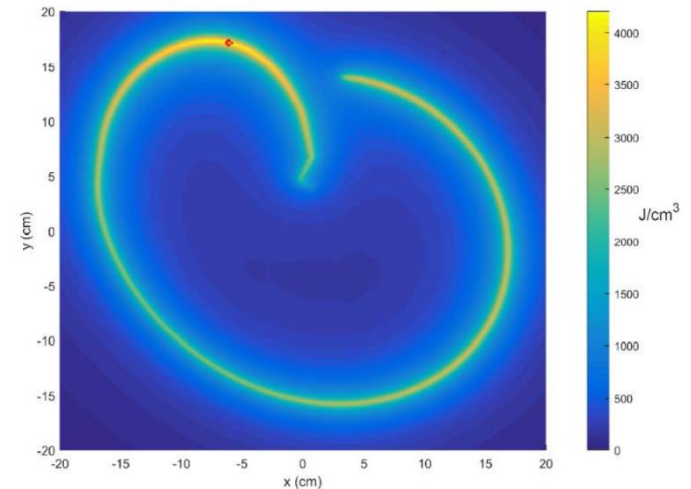
AD Antiproton Decelerator CTF3 Clic Test Facility AWAKE Advanced WAKEfield Experiment ISOLDE Isotope Separator OnLine DEvice

LEIR Low Energy Ion Ring LINAC LiNear ACcelerator n-ToF Neutrons Time Of Flight HiRadMat High-Radiation to Materials

© CERN 2013

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 $80\mu\text{s}$ inside the core

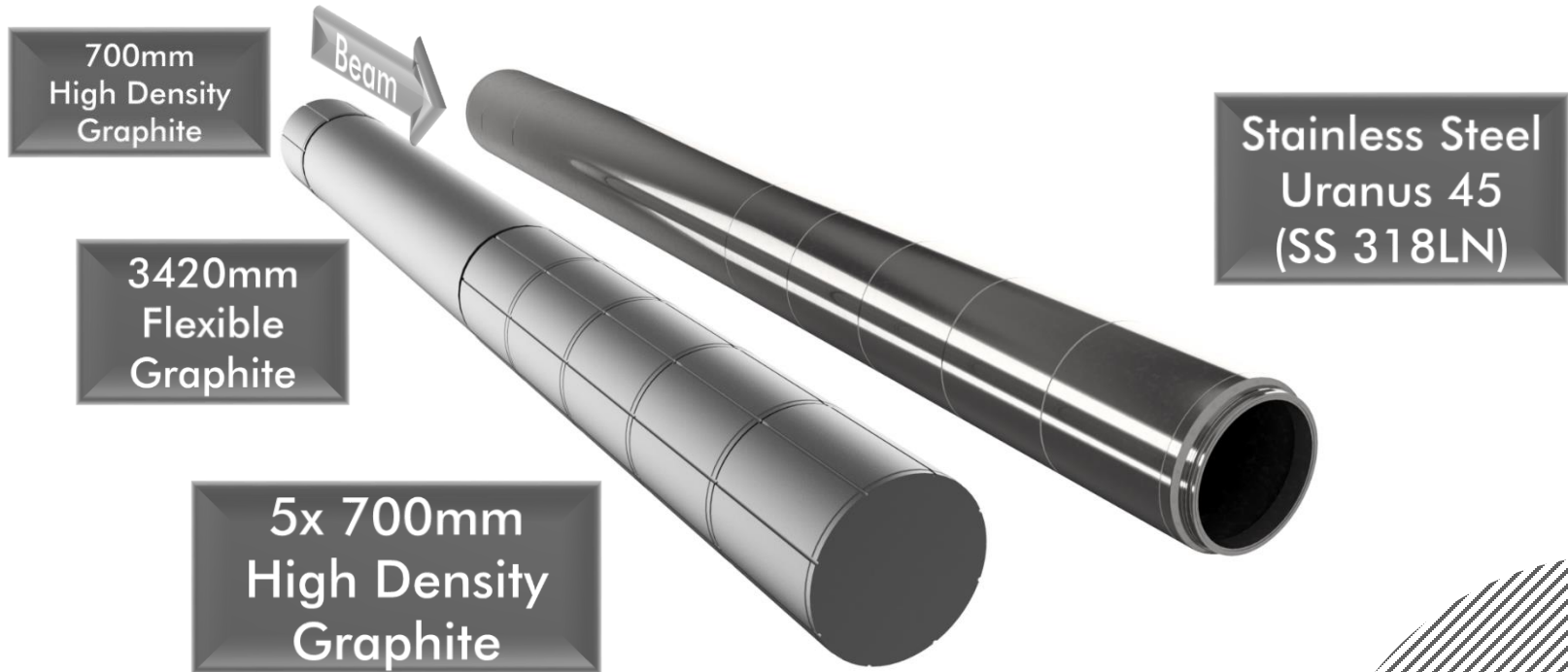




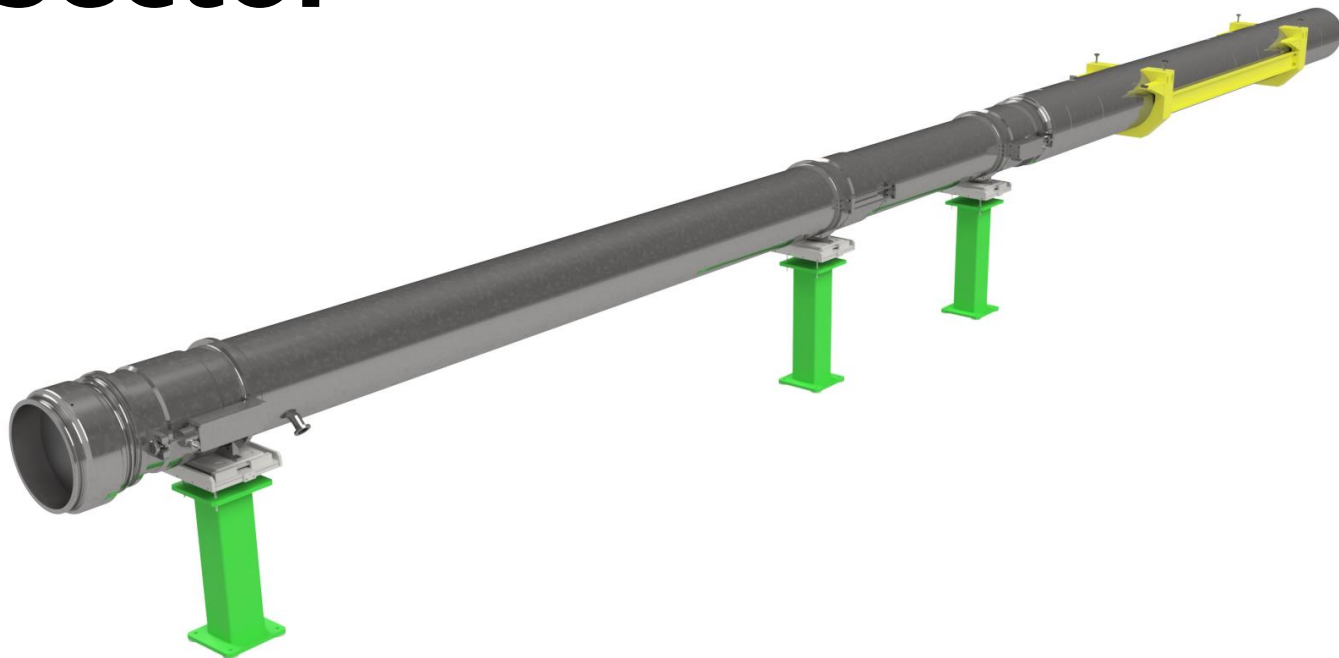
The Dumps in the LHC is Large ... very Large

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

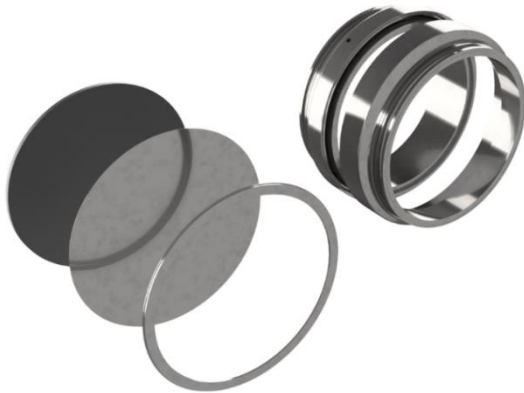
Overview of the Dump Core itself



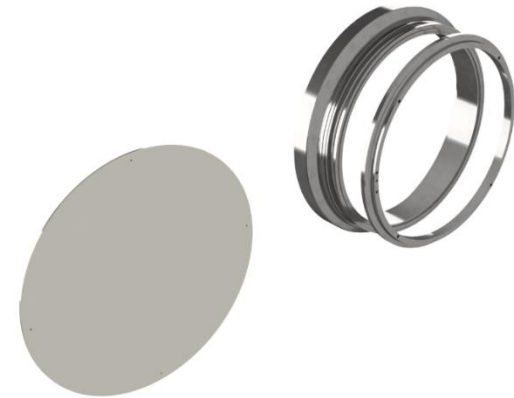
Overview of the Dump Sector



Windows ensure separation between Vacuum, Nitrogen and the Surrounding



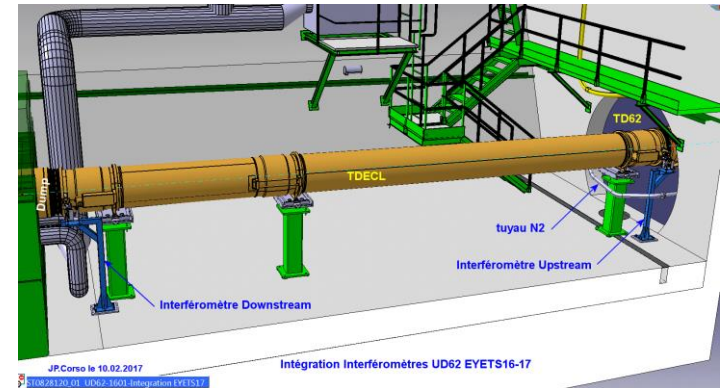
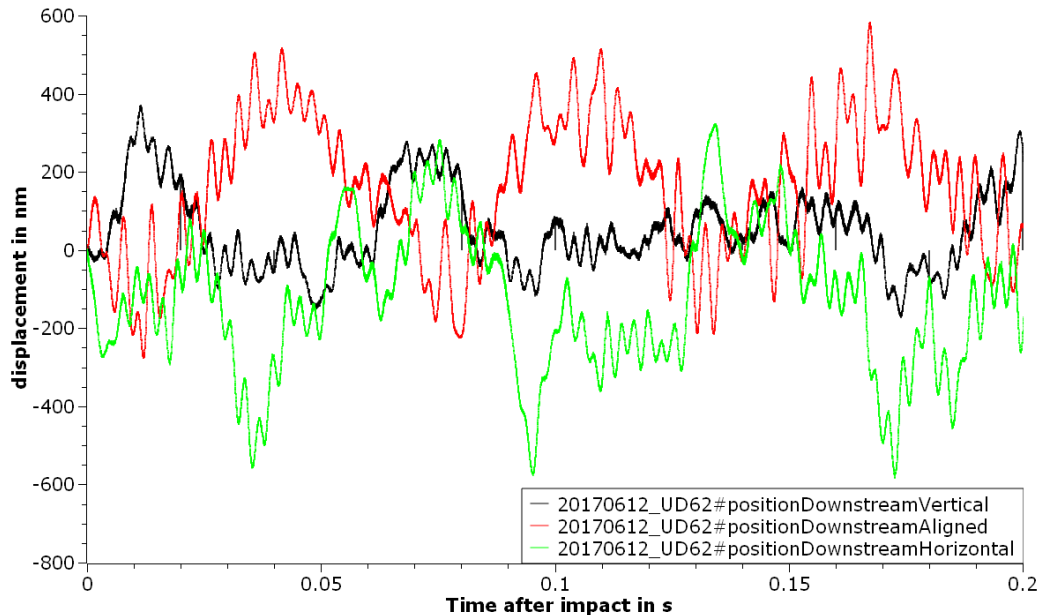
- Upstream:
carbon plate + steel (SS316LN) foil



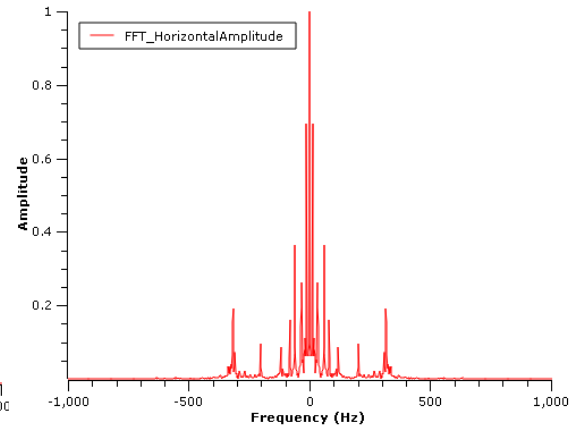
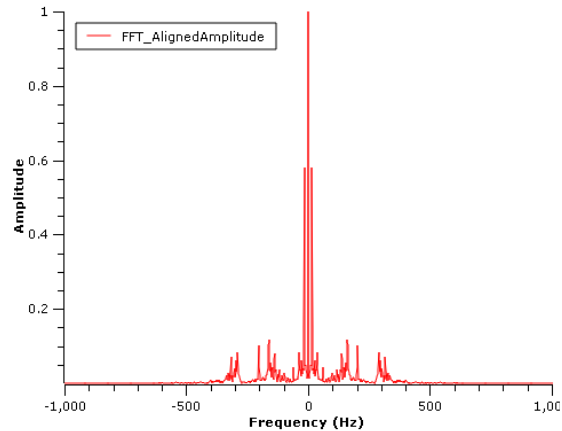
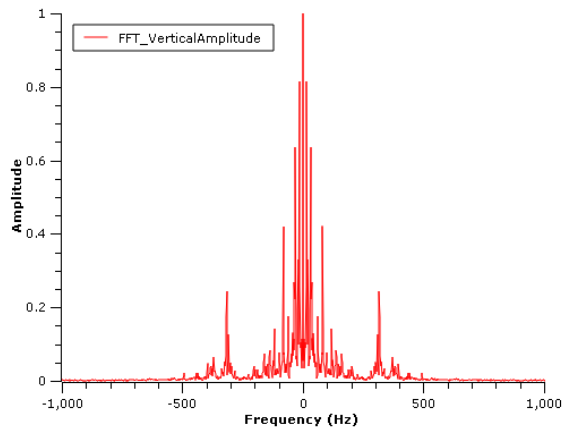
- Downstream:
titanium plate

Whole Dump Vibrates Due to Induced Mechanical Waves

Vibrometer Data from UD62 - 12-06-2017 10:50:21 PM



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

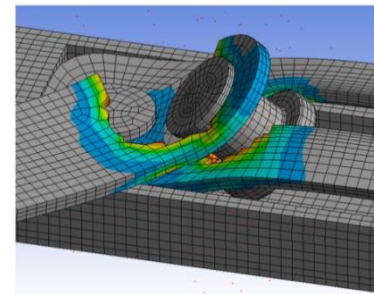
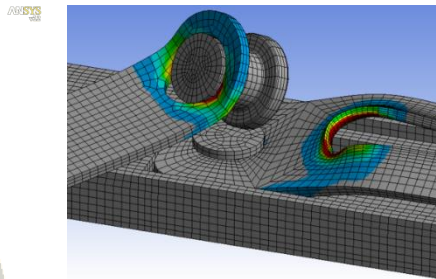
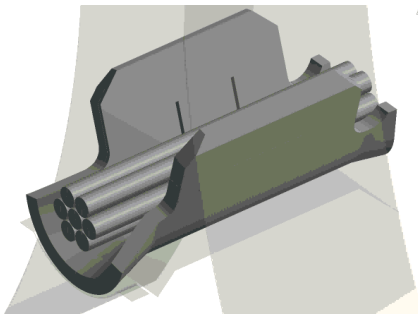


Broken Gasket from
beginning of 2017



LS-Dyna is the Fastest Explicit Solver on the Market

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

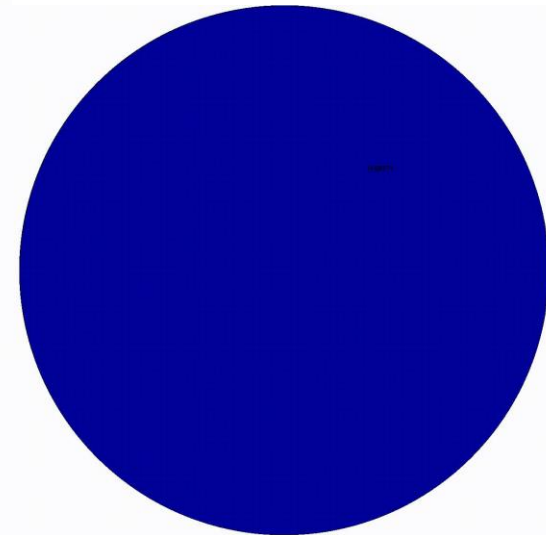
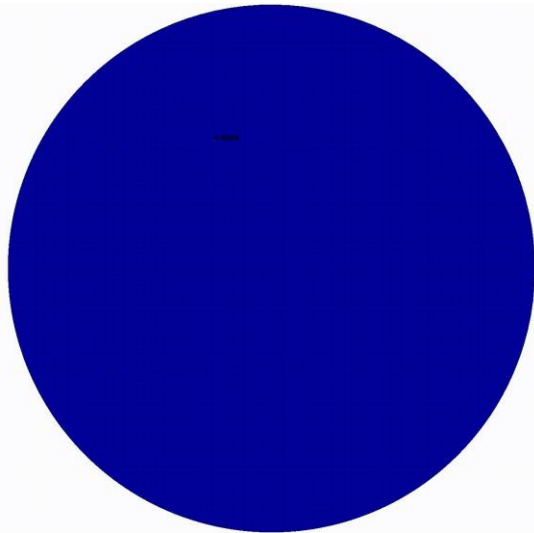




Impact Simulation of Whole Beam with Pattern of Single Bunches

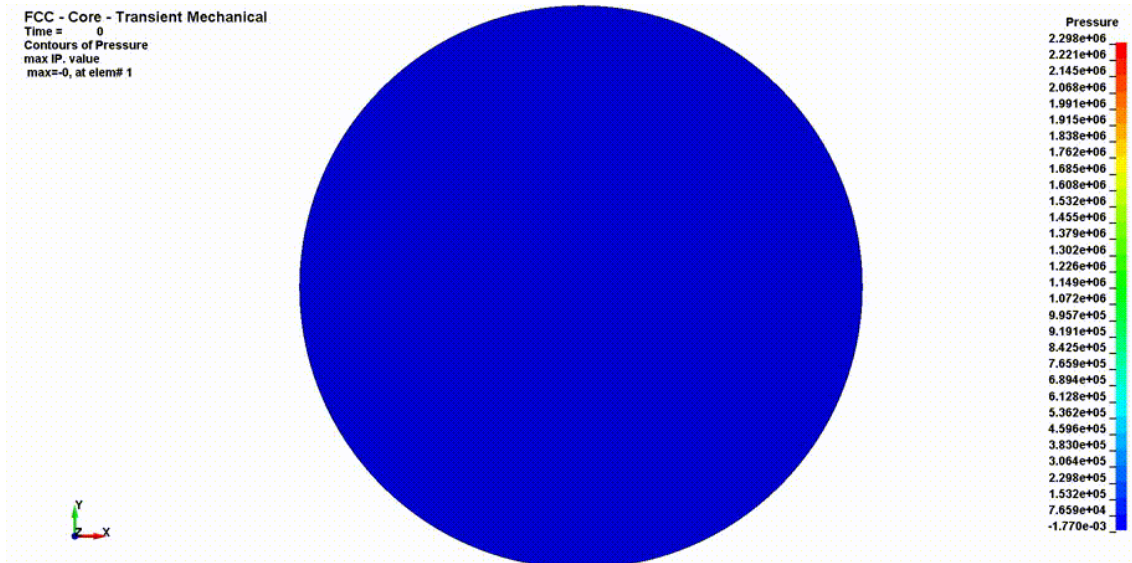
- Cover all dynamic effects
- Developed method applicable for other projects

Which Windows were Simulated?



- Plot shows measure for the stresses caused by the interacting proton beam (v. Mises Stress)
- Whole sweep lasts $80\mu\text{s}$
- Around 2800 bunches are simulated

Different Application: FCC Dump*

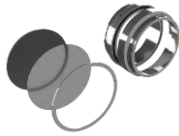


- Just an approximation of pressure
- Energy deposition too low
- Mechanical data at room temperature
- Shear strengths unknown
- Thermal material properties are estimates

THANKS A LOT



Choice of Beam Parameters Based on Highest Temperatures

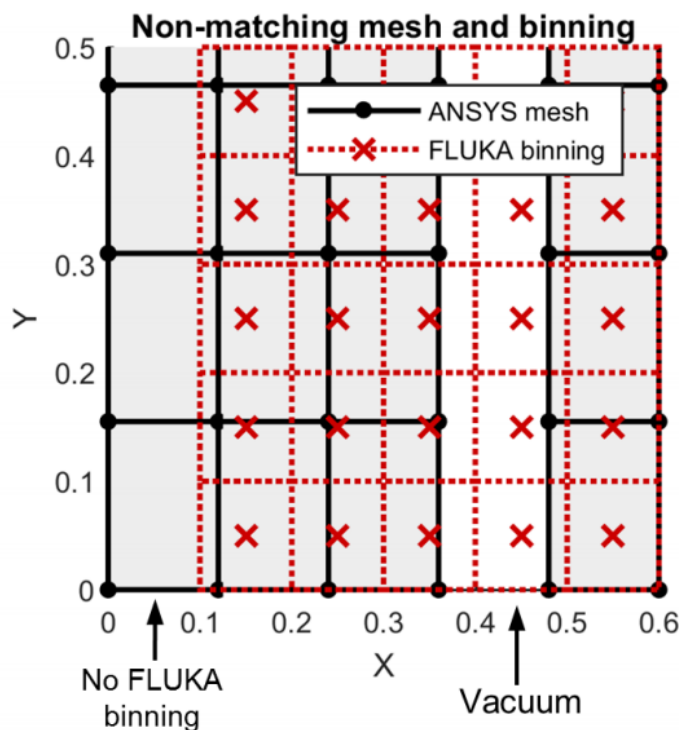


- HL-LHC BCMS filling
- 2604 LHC BCMS bunches
- Bunch intensity: $2.0e11$
- Beam emittance: $1.37\mu\text{m rad}$



- HL-LHC STD filling
- 2748 LHC STD bunches
- Bunch intensity: $2.3e11$
- Beam emittance: $2.08\mu\text{m rad}$

Modelling of the Energy Deposition

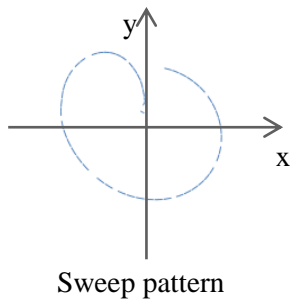
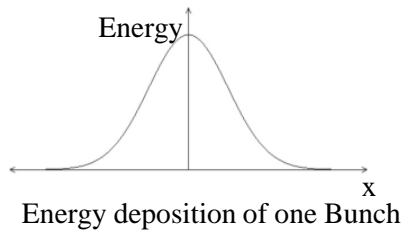


- Total kinetic energy in FLUKA bins divided by volume of a FLUKA bin to have an energy density field
- Between data points a linear interpolation takes place
- Energy deposition density requested close to the ANSYS element centroid

Source of Graphic:

<https://edms.cern.ch/document/1891910/1>

Modelling of the Energy Deposition



Python Script

