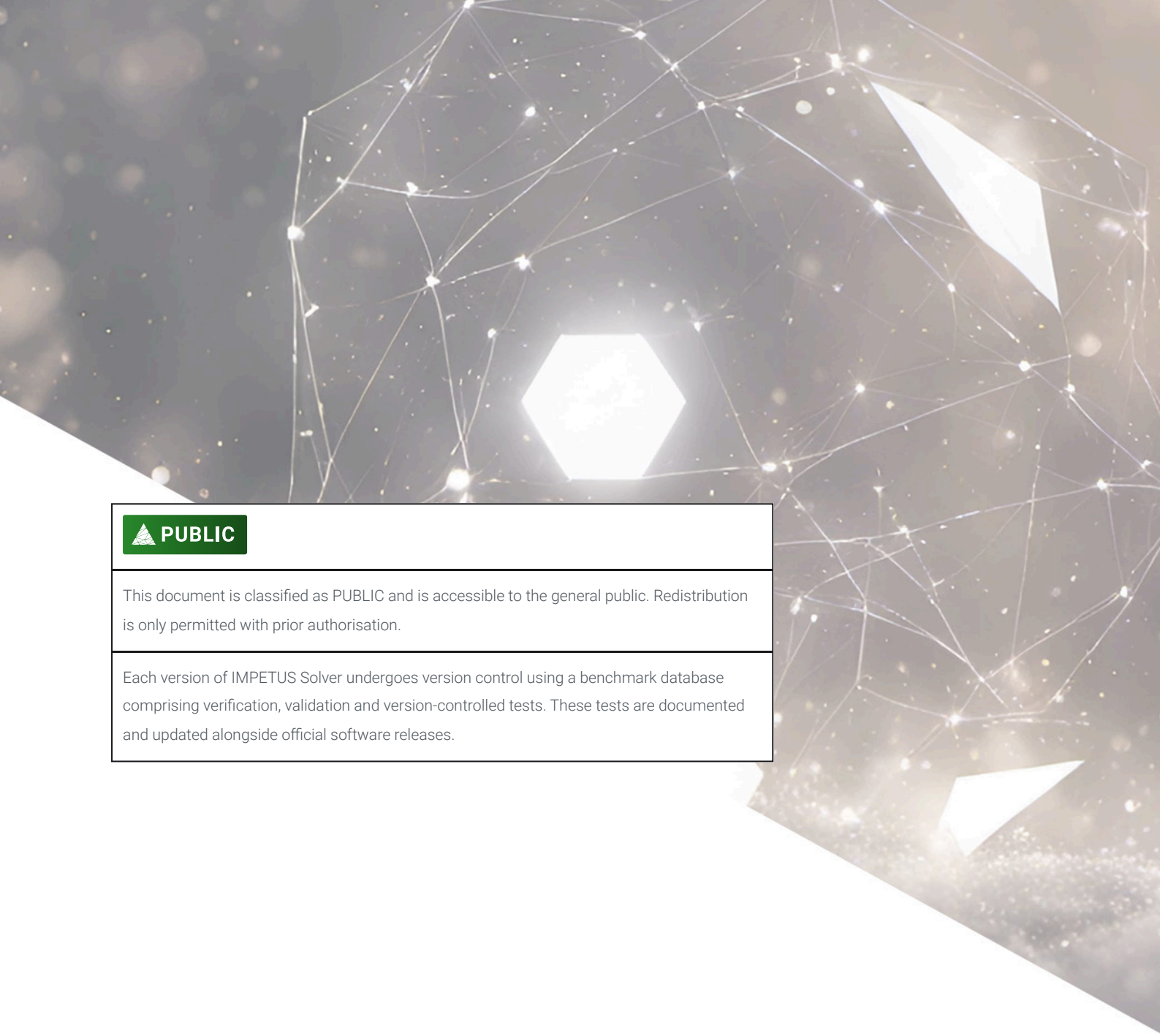


PUBLIC

This document is classified as PUBLIC and is accessible to the general public. Redistribution is only permitted with prior authorisation.

Each version of IMPETUS Solver undergoes version control using a benchmark database comprising verification, validation and version-controlled tests. These tests are documented and updated alongside official software releases.

Validation - UNDEX

Documentation

Version 11.1.0

September 28, 2026

IMPETUS
driving precision

Document revisions:

Revision	Date	Comments
0	2026-06-24	First publication

Validation - UNDEX

Introduction

This document presents validation of UNDEX simulations using the software.

Version control

The tests presented in this document are subjected to version control, meaning that the models are run and evaluated prior to release of a new solver. This document is updated in conjunction with official releases of the software.

Validation - UNDEX with quarter and half symmetry

UNDEX with quarter and half symmetry

The validation model consists of a submerged explosive charge surrounded by water. Following detonation, a shock wave propagates through the fluid domain while an expanding gas bubble forms and oscillates due to the surrounding hydrostatic pressure.

The benchmark consists of two equivalent simulations utilizing different symmetry conditions:

- Quarter symmetry
- Half symmetry

The physical setup, material definitions, loading conditions, and evaluation criteria are otherwise identical between the two models. The primary verification metric is the timing of the first bubble collapse after detonation. The bubble collapse is checked against an analytical result obtained using the *LOAD_UNDEX command.

General setup

Figure 1 shows the models at initiation. The lighter blue colour in the contour plot corresponds to a higher hydrostatic pressure.

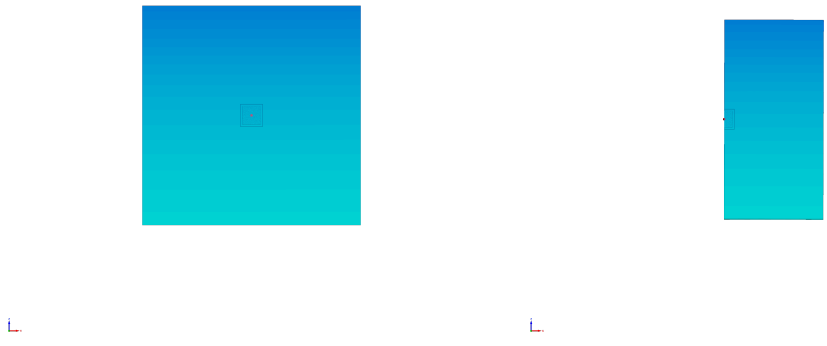


Figure 1. Models at initiation. At the center of both models the detonation point is shown.

Figure 2 shows the models with the bubble fully expanded. No contour quantities are shown.

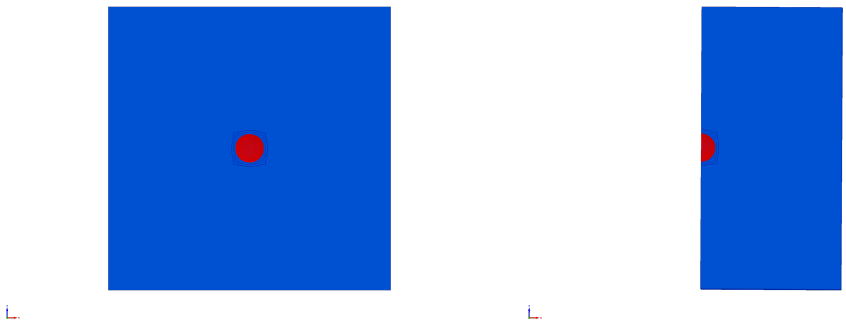


Figure 2. Simulations with the bubble fully expanded.

Results

Quantity	Analytical Result [s]	Half [s]	Deviation [%]	Quarter [s]	Deviation [%]
Bubble collapse time	0.1355	0.1353	-0.01	0.1349	-0.4

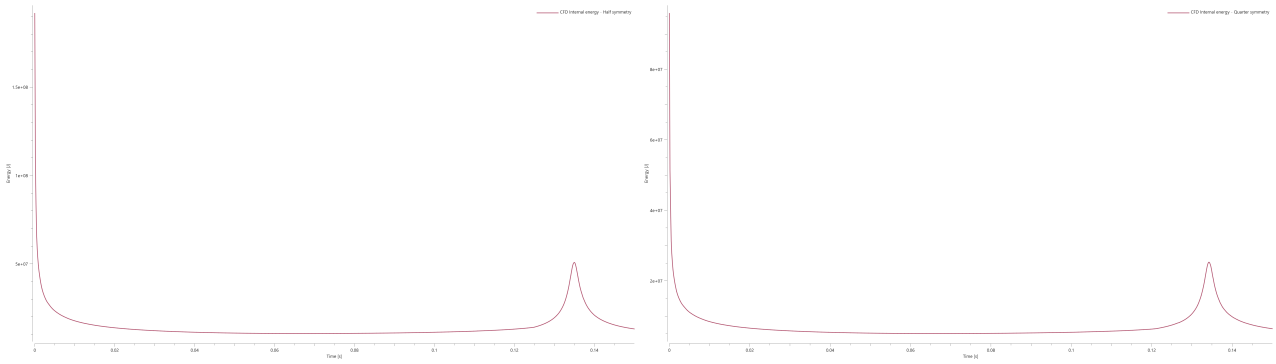


Figure 3. Internal energy from the CFD domain. Half symmetry to the left and quarter symmetry to the right.

In Figure 3 the internal energy from the CFD domain is presented. The bubble collapse is measured as the time at which the second energy spike occurs in the model.

Relevant energy levels within the model are also checked for version control.

TESTS

This benchmark is associated with 2 tests.