

Quick Start

Your first run: Example 01

Open a ready-made tapered collimator, inspect its saved settings, build the mesh, run the Solver, and read the field and wake results. No parameter editing is needed.

EMUZAG 1.1.2

Hybrid MPI/OpenMP desktop edition

26 October 2026

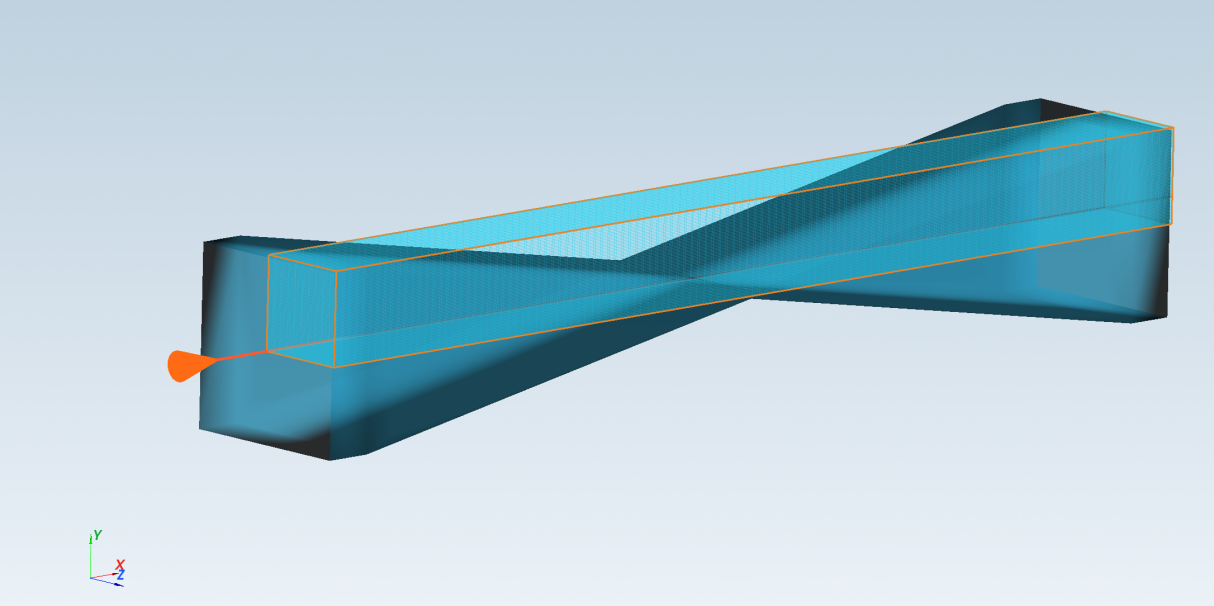
Companion to the User Guide

This document uses the owner-approved examples. Reference figures retain their recorded settings; current inputs use explicit source and observation lists. It supplements the full *EMUZAG Studio User Guide*; it is not a replacement for the reference manual or a certification of numerical convergence.

1. Open the supplied collimator

The starting case is `examples/01_TaperedCollimator/case.yaml`. It is a vacuum passage in a perfect-electric-conductor (PEC) background. The bunch travels in the positive x direction; y and z are transverse coordinates.

1. Copy the complete example directory to a writable work folder. Keep `case.yaml` and its `Geometry` directory together.
2. Launch **EMUZAG Studio** from the complete installed package. Use **Open** to select the copied `case.yaml`.
3. Check the Solver connection in the top bar. If necessary, select the packaged `bin/emuzag-solver.exe` on Windows or `bin/emuzag-solver` on macOS/Linux. The example uses six MPI ranks and one thread per rank; the runtime must support that saved configuration.
4. Inspect validation messages before proceeding. The case name should be `tapered_collimator`. Leave its parameters unchanged.



Studio 3D view supplied by the owner: the tapered collimator, displayed mesh, and orange source marker. The axis triad identifies longitudinal x and transverse y, z. The screenshot is reproduced with its original proportions.

Keep the full example directory

Opening only a copied YAML file can break relative STL paths. Do not move individual geometry files or replace the vacuum material with PEC. PEC is the surrounding background, not the beam channel.

Geometry choices

The supplied collimator keeps its STL inputs and saved settings. You do not need to convert it to curved geometry to follow this guide. The retained figures and timings describe their recorded reference runs, not new measurements of 1.1.2.

For your own CAD or STEP/BREP project, open **Calculation geometry**. New projects default to STL; choose **Curved surfaces** when you want supported curvature and trimming to reach the mesher directly. Each body can inherit the project choice or override it, so a calculation may combine STL and curved bodies.

Keep three accuracy controls separate

Display quality changes the preview. Calculation STL deflections change only the CAD-to-STL approximation. Mesh spacing changes the calculation grid. The separate **Face areas** choice keeps **From edge lengths** as the default and offers **From surfaces** explicitly for comparison. Both geometry routes still need appropriate grid resolution and a convergence check for the quantity of interest.

Use **Build Mesh** or **Run** to prepare the chosen representation automatically. The User Guide explains CAD screens, hybrid scenes, headless preparation and per-body recovery. If unsupported contact is reported, preserve its log and correct or explicitly change the affected body. Rebuild calculation meshes when upgrading from 1.0.x, including direct STL meshes; previous jobs and their saved results remain available.

When upgrading to 1.1.2, rebuild older meshes with conducting walls or thin screens when Solver reports an unsupported index or format. Keep the original job and its results. A checkpoint from an earlier mesh or preparation identity cannot be made compatible by renaming or copying its files; start a fresh run after remeshing if Solver rejects the restart.

2. Check the physical and numerical setup

Use **Setup** to review the following values. This is a check, not a recipe for changing a new blank case.

Setup area	Saved value and purpose
Case & Units	mm and pC. The single source charge is 1 pC.
Materials	PEC background; the collimator STL is vacuum.
Domain & Boundaries	Open at both x ends. In both transverse directions: PMC at the lower face and PEC at the upper face.
Excitation Source	One source row at absolute $(y, z) = (0, 0)$; Gaussian longitudinal profile with RMS length 1 mm; $\beta = 1$.
Solver	Moving; dispersion-free; explicit time stepper; Standard conformal scheme.
Mesh	$\Delta x = 0.2$ mm; $\Delta y = \Delta z \simeq 0.296985$ mm.
Wake & Outputs	Wake interval length 10 mm; indirect integration enabled; two absolute observation rows: $(0, 0)$ and $(0.296985, 0)$ mm.
Field recording	`electric_x`, XY plane, $z = 0$; at most 256×128 samples and 200 retained frames.
Execution	6 MPI ranks $\times$ 1 OpenMP thread per rank.

Three settings worth understanding

Moving means a calculation window follows the positive-x bunch. It does not mean that the collimator moves. **Standard** selects the uniformly stable conformal treatment of geometry cut by the Cartesian mesh. **Indirect integration** supplies the additional wake contribution represented by the uniform-pipe continuation; it is not an alternative field time stepper.

Read settings in context

The saved file also contains an `implicit` group. This example still uses `time_stepper: explicit`; that group does not activate an implicit solve. Source and observation tables use absolute Y/Z coordinates and are independent. Both observation rows are explicit; an observation adds no exciting bunch.

3. Build the mesh and run

1. Click **Build Mesh**. Wait for successful completion in **Jobs** and inspect **Log** if a diagnostic appears.
2. Open **Mesh View** or **Material Mesh**. Check that the vacuum channel is open along the beam path and surrounded by PEC. Colour is a display aid; confirm the actual material assignment when in doubt.
3. Click **Run**. Do not adjust mesh spacing, wake length, preview resolution, or the saved rank/thread counts for the reference run described here.
4. Watch the job state and **Field** view. A very short calculation may finish before you open the field tab; the retained history can still be replayed.
5. Wait for the job to report success. A field step counter at 100% does not by itself prove that monitor finalization and result writing have finished.

If an Open X end falls in PEC at a source or observation, Solver moves that end inward in whole X steps to the first admissible channel section and rebuilds a separate mesh. Review the reported old/new limits: this shortens the calculation domain. The saved case is preserved; `open-boundaries.txt` in the calculation folder records the effective limits and mesh. If no suitable section exists, Solver reports an error before field evolution.

Reference run from this guide

Check	Observed value
Completed field steps	1191
Effective Cartesian rank grid	$1 \times 2 \times 3$
Solver-reported total time	1.41 s
Maximum-rank peak RSS	33.7 MiB
Sum of rank peak RSS	188.7 MiB
Wake output	50 samples for each of 2 trajectories

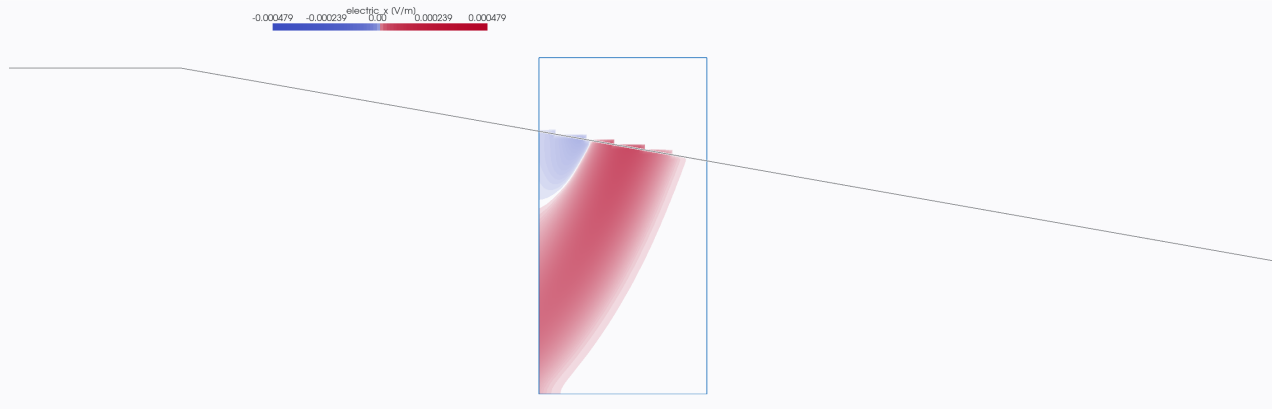
These are single-run measurements on the macOS arm64 hybrid package, not a runtime target for another computer. Meshing and launcher time are not included in the Solver-reported total. The *Examples Guide* reports the separate mesh time and all nine run configurations.

If the run fails

Keep the YAML, mesh, and complete log. Check the first Solver error rather than only the final MPI abort message. Changing several settings at once destroys the reference comparison. The troubleshooting checklist on page 10 helps separate input, runtime, and result-selection problems.

4. Inspect the recorded field

In **Field**, select the completed run, `live_field`, `electric_x`, and the XY plane. Move the timeline slider to an intermediate retained frame. Use the displayed step, time, and colour scale to identify what you are viewing.



Owner-supplied Studio Field View of the collimator. The colour shows E_x in V/m, with limits approximately $\pm 4.79 \times 10^{-4}$ V/m. The screenshot does not display a frame number or time; no step or time from a different recording is assigned to it.

What to look for

The grey outline shows the sloping wall. The blue rectangle outlines the displayed field region: field data occupy the moving window while the geometry outline can extend beyond it. This is a local field view, not the integrated wake.

The window follows the bunch through the stationary geometry. Use the timeline in Studio to inspect another recorded position and check the step and time there.

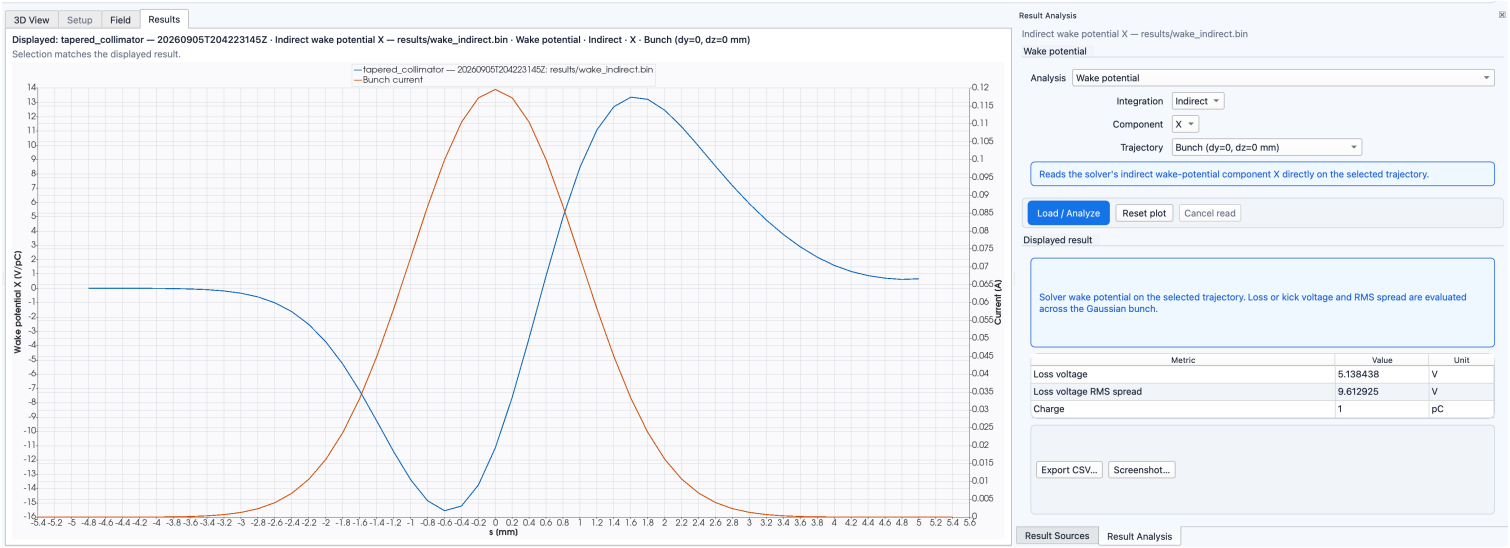
Both positive and negative colours are normal for an oscillating field. A colour map that rescales on every frame can make a weak late-time field look as strong as an early-time field. Compare numerical colour limits, or use one common scale when comparing two frames.

A preview is sampled data

Only the saved component on the saved plane is available. The history retains at most 200 frames and down-samples the native plane; it is not the complete three-dimensional field at every step. The nearest recorded frame may therefore be a few steps away from the requested point on the timeline.

5. Read the longitudinal wake

Open **Results** and select the completed collimator run. In **Result Analysis**, choose **Wake potential**, **Indirect**, component **X**, and the observation at $(0, 0)$; then click **Load / Analyze**.



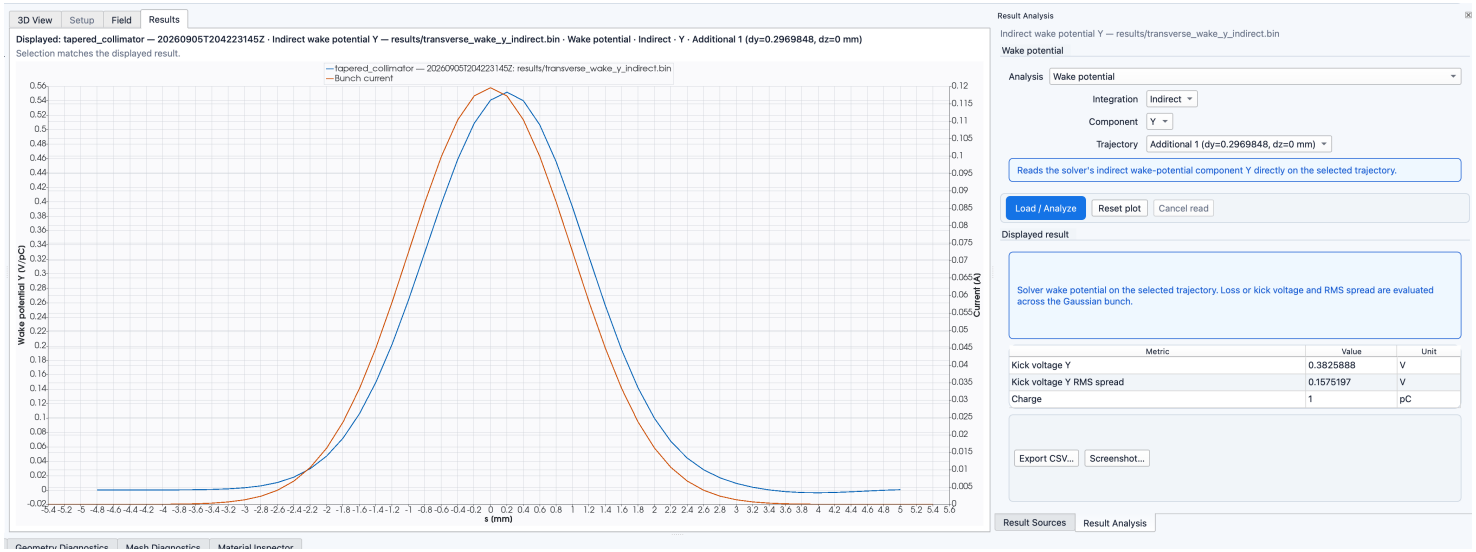
Owner-supplied Results screen: the indirect longitudinal wake on the source trajectory, $(y, z) = (0, 0)$ mm. The retained screenshot uses the historical Bunch label; current observation labels show absolute coordinates.

Read the two axes separately. For current builds, the wake response is loaded directly from the physical-voltage artifact. The reference plots below convert that curve to V/pC during analysis; the source charge is 1 pC, so the numerical values coincide here.
The blue curve is W_x in V/pC, read on the left axis. The orange curve is bunch current in A, read on the right axis. It is not a second wake curve.
Lag s increases behind the bunch. The recorded samples span -4.8 to 5 mm; the requested 10 mm is the interval length.

Check the displayed result. The screenshot reports a loss voltage of approximately 5.138 V and an RMS spread of 9.613 V for $Q = 1$ pC. These are bunch-weighted metrics, not the minimum or maximum of the plotted curve.
The selected source is `results/wake_indirect.bin`. Confirm the run, component, and trajectory in the displayed-result header before exporting.

5. Read the transverse wake

Keep **Wake potential** and **Indirect**. Change component to **Y** and observation to $(y, z) \simeq (0.296985, 0)$ mm; click **Load / Analyze** again.



Owner-supplied Results screen: the indirect transverse Y wake at the off-axis witness. The source stays at $(0, 0)$. The retained screenshot uses the historical Additional 1 label and relative offsets.

Check the component and witness together. The blue curve is W_y in V/pC on the left axis; the orange curve is bunch current in A on the right axis. Current inputs specify the absolute witness position. Selecting it does not introduce an additional exciting bunch.
The transverse wake reaches approximately 0.55 V/pC in this screenshot.

Read the kick metric. The displayed kick voltage is approximately 0.3826 V and its RMS spread is 0.1575 V for $Q = 1$ pC. The kick voltage is a bunch-weighted value, not the peak of $W_y(s)$.
Use **Export CSV...** for the selected curve or **Screenshot...** to save its display. Verify the selection before either operation.

6. Choose the next example

The *Examples Guide* gives the settings, geometry, and measured results for the complete collection. Run directories 01–08 are the eight main examples; the finite-speed companion belongs to Example 02.

No.	Example	Next thing to learn
01	Tapered collimator	Moving window, Standard conformal geometry, off-axis witness.
02	Rectangular step-out	Stationary wake integration; a separate saved $\beta = 0.8$ FDTD case.
03	TESLA cavity	A multi-cell structure with a moving window.
04	Lossy bellows	Thick conductive-wall ADE model and wall-power output.
05	Lossy pillbox	Wall loss and conducting-dielectric volume loss in one run.
06	Ferrite pillbox	Frequency-dependent magnetic permeability from a Lorentz pole.
07	Ceramic break	Dielectric loading, vacuum background, transverse open boundaries.
08	Ferrite kicker	A larger dispersive model, two witness offsets, intermediate field views.

Where impedance fits

Impedance is a frequency-domain analysis of the recorded wake, not another time-domain field run. Select the intended wake source and component in **Results** before requesting the analysis. Gaussian-spectrum compensation and the finite time window limit the useful frequency band.

Do not over-interpret a short wake

The collimator has a short 10 mm wake interval. Its transform can show a broad trend, but it cannot resolve closely spaced narrow resonances. Increasing FFT padding does not create physical frequency resolution. The Physics Guide explains the wake–impedance relation and its frequency-domain interpretation.

7. Troubleshooting and completion checklist

Symptom	First check
Missing geometry	Open the complete copied example folder; check the relative `Geometry/...stl` path in the log.
Solver unavailable	Select the external Solver in the complete installed package and resolve the runtime readiness diagnostic.
MPI launch error	Confirm that the selected runtime can launch the saved six ranks. Retain the first launcher/Solver error and the full log.
No field history	Select the correct run and `live_field`. A mesh-only job does not generate field frames.
Unexpected wake curve	Check run, direct/indirect source, component, and witness trajectory. Do not compare E_x in V/m with W_x in V/pC.
100% but still running	Allow monitor finalization, writing, and the final job status update to finish.
Different execution time	Hardware, rank placement, threads, and I/O affect time. Compare the preserved settings and the same timing scope.

You have completed the first workflow when

- The original case parameters and STL files are unchanged.
- Mesh and solve jobs have finished successfully.
- The retained field history can be replayed with a visible time and scale.
- Both trajectories are available and their wake curves have the expected sample range and units.

More detail

Use the *EMUZAG Studio User Guide* for UI reference: Chapter 3 for the workflow, Chapters 7–10 for mesh/source/execution, Chapter 11 for fields, and Chapter 12 for results. The supplied User Guide is Windows-oriented; the measurements in this companion were made with the macOS arm64 hybrid package.

The *Examples Guide* documents provenance, exact input preservation, single-run measurements, and all result illustrations. No Solver or Studio implementation changes were needed to prepare these guides.