



ChamberSim - Reloaded

Interior ballistics for handloaders

- User Manual -

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Warning

The results of this program are *calculated*. They can differ considerably from reality. Compare every load with the current loading tables of the component manufacturers and start low. The software is provided "as is", without warranty of any kind. The author and all contributors accept no responsibility or liability for any damage, injury or death or any other consequence of using this software or its results, including damage to firearms or property. Reloading ammunition is dangerous and is done entirely at your own responsibility.

ChamberSim Reloaded is an independent project. It is not affiliated with, endorsed or supported by Gordon's Reloading Tool or its author.

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Introduction

ChamberSim Reloaded calculates the *interior ballistics* of a handload: you choose a cartridge, a bullet and a powder, enter the powder charge, and the program simulates how the pressure, the bullet velocity and the bullet energy develop while the bullet travels through the barrel. From that it reports the maximum pressure, the muzzle velocity, the barrel time and many related values. A load development ladder, charts, reports and printouts help to plan a series of test loads.

It follows the workflow of *Gordon's Reloading Tool* (GRT). It can open the original's `.grtload` files and can use the original's database, but stores its own loads in the `.csrload` format.

What the program can do

- Cartridge, projectile and propellant records from a database; replace any component of a load; add your own records.
- Pressure, energy and velocity curves with markers and pressure bands, a burn-rate chart and a load ladder.
- Drawings of the cartridge and the chamber with the C.I.P. dimensions.
- A Measurements tab for chronograph and pressure data, with statistics (mean, SD, ES) and a comparison with the simulation.
- Fit to measurements: adapts the model values of a powder to your own data.
- Reports with a template editor, print preview and PDF export.
- Metric, imperial and original units (also per field), light and dark themes, adjustable font size.
- Translations: English, German, French and Italian.

How accurate is it?

The default *Physical Model* is fitted to published load data of powder manufacturers. Against loads that were left out of the fit, the muzzle velocity is typically within 3–6 % (root mean square; Vihtavuori powders about 3 %, Hodgdon about 6 %) and the peak pressure within about 15 % where the tables publish it. The scatter of the published tables themselves (lots, barrels, components) is of that size. Single loads can deviate much more. Unusual loads, other powders and other cartridges than the ones tested can deviate more again; slow powders at low pressure, pistol and revolver cartridges (about 8 % in velocity and 19 % in pressure) and shotgun loads (about 3 % in velocity and 16 % in pressure, with their own constants) are known weak spots. Powders without physical burn values, such as your own records, are less accurate than the project's powders. The GRT Original model reproduces the results of the original program to about 1 % in velocity and 3 % in pressure. The files `README.md` and `docs/ACCURACY.md` of the project contain the current accuracy tables.

 Safety

Never use a calculated load without checking it against the manufacturer's data. Work up from a safe starting charge and watch for signs of excessive pressure.

Installation and first start

Installing

Release builds are available from the project's GitHub page: an AppImage for Linux and a zip file for Windows. Unpack or make the AppImage executable and start it; no installation is needed. Both contain this manual (**Help** → User manual, F1); the Windows zip also contains the Visual C++ runtime, so nothing else has to be installed. To build the program yourself you need Qt 6.4 or newer, CMake 3.16 or newer and a C++20 compiler:

```
tools/build.sh release
build/release/ChamberSimReloaded
```

Safety notice

At every start a safety notice is shown. Read it, then choose I understand; Quit closes the program. With Do not show this again ticked, I understand also switches the notice off for later starts. There is no entry in the settings to bring it back.

Command-line options

```
ChamberSimReloaded [options] [load.csrload ...]
-d, --database <file> the original's (plain) database
-r, --reference <f>   overlay a reference result (JSON) on the chart
--calibration <m>     solver model: original|published|physical
--language <code>     de_DE, en_US, fr_FR, it_IT
--theme <t>           light | dark
--units <system>      metric | imperial | original
--log-level <level>   debug | info | warning | error
--help               all options
```

Files given on the command line are opened as loads. `--theme` applies to this run only; `--units` and `--calibration` are saved like the choices in the settings. `--screenshot` saves an image of the window and exits (for documentation; see `--help` for `--tab`, `--input-tab` and `--result-tab`).

Simulating without the window

The program `csr_sim` runs simulations without a graphical interface, for scripts and batch jobs. It reads `.csrload` and `.grtload` files and prints one row per load and ladder step.

```

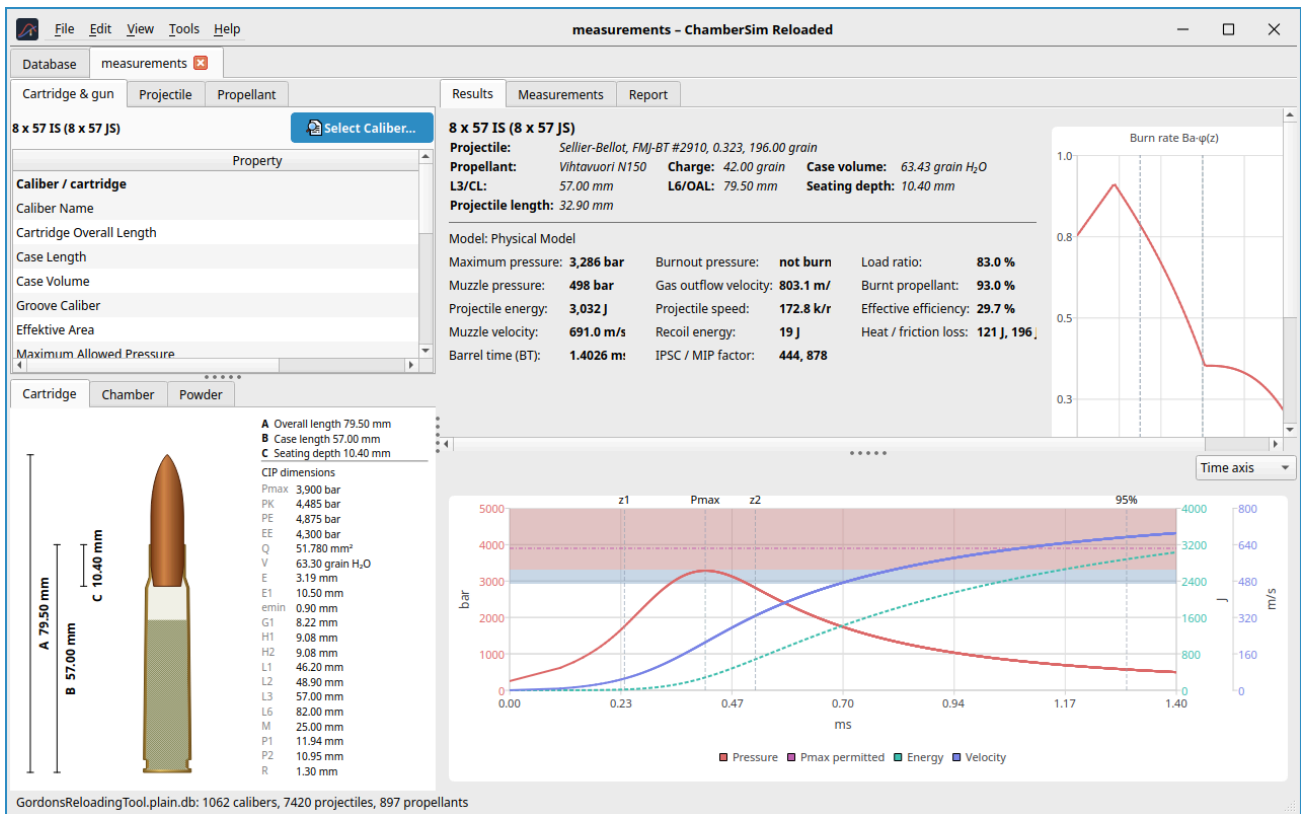
csr_sim [options] load.csrload|load.grtload ...
--profile <m>          original | published | physical (default)
--grt-original         use the Original model for .grtload files
--charge <g>          override the charge of the load
--ladder-count <n>     override the number of ladder steps
--ladder-step <g>     override the charge difference of the ladder
--format <f>          table (default) | csv | json
--out <file>           write the results to a file
--curve <file.csv>    pressure/velocity curve of the focused ladder step;
                      {name} is replaced by the load's file name
--steps <n>           position steps of the solver (default 2000)

```

The program's project data (physical burn values of the powders and the factors of the pistol and revolver calibers) are built in, so the results equal those of the program. Each row holds the charge, maximum and muzzle pressure, muzzle velocity, energy and time, burnt fraction, efficiency, burnout in the barrel, load ratio and the status. Units are g, mm, bar, m/s, J and ms, whatever the unit settings of the program. The exit code is 0 when all simulations succeeded, 1 when at least one failed (for example because the charge does not fit into the case) and 2 for a usage or file error.

The main window

The window has a menu bar and, below it, a row of tabs. The first tab, Database, is always present; every open load gets a tab of its own. On Linux the program draws its own title bar with the menu in the title row (**File** → **Settings** → **Appearance**).



A load. Left: the input tabs (top) and the drawings (bottom). Right: results, measurements and report.

Menus

New load... (Ctrl+N), Open load... (Ctrl+O), Open recent, Save (Ctrl+S), Save as..., Print preview..., Print... (Ctrl+P), Export report as PDF..., Overlay reference result... (Ctrl+R), Clear reference overlay, Settings... (Ctrl+,) and Quit.

Undo (Ctrl+Z) and Redo (Ctrl+Shift+Z or Ctrl+Y) for the load that is shown; see Section 5.6.

Theme (system default, light, dark) and Language. A language change takes effect after a restart.

Burn rate table... and Unit converter....

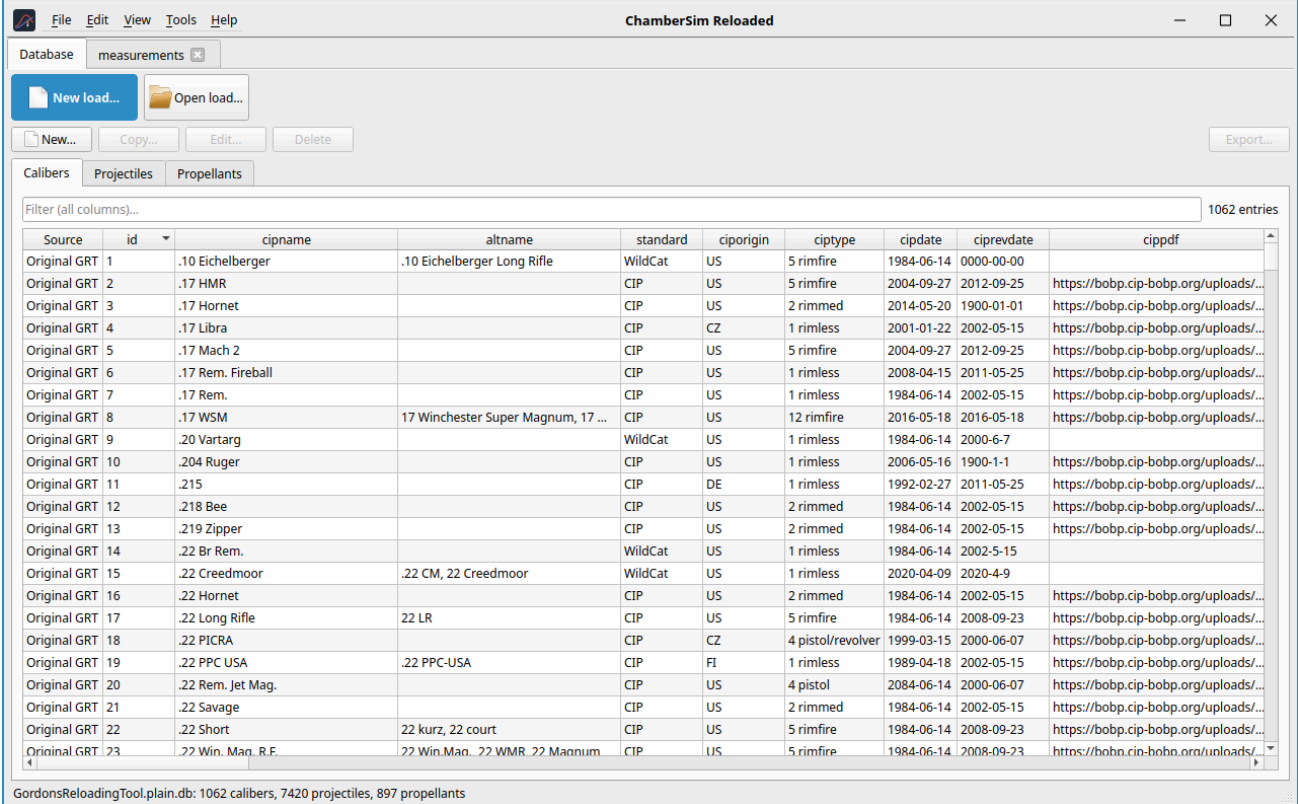
User manual (F1), which opens this manual as a PDF, and About ChamberSim Reloaded...

Layout

The panels are separated by splitters (the small dotted handles) that you can drag. The program remembers the splitter positions, the column widths of the property tables and the window geometry.

The database

The Database tab (Figure 2) lists the Calibers, Projectiles and Propellants that are available for loads. The filter field searches all columns; click a column header to sort.



The screenshot shows the 'Database' tab in the 'ChamberSim Reloaded' application. It features a menu bar (File, Edit, View, Tools, Help) and a toolbar with buttons for 'New load...', 'Open load...', 'New...', 'Copy...', 'Edit...', 'Delete', and 'Export...'. Below the toolbar are tabs for 'Calibers', 'Projectiles', and 'Propellants'. A search filter 'Filter (all columns)...' is present, followed by a table with 1062 entries. The table has columns: Source, id, cipname, altname, standard, ciporigin, cipstype, cipdate, ciprevdate, and cippdf. The 'Source' column lists various origins like 'Original GRT', 'WildCat', 'CIP', and 'Gordon's Reloading Tool'. The 'id' column shows numerical identifiers. The 'cipname' and 'altname' columns provide names for the calibers. The 'standard' column lists standards like 'WildCat', 'CIP', and 'Gordon's Reloading Tool'. The 'ciporigin' column shows origins like 'US', 'DE', 'CZ', and 'FI'. The 'cipstype' column lists types like '5 rimfire', '2 rimmed', '1 rimless', and '4 pistol/revolver'. The 'cipdate' and 'ciprevdate' columns show dates. The 'cippdf' column contains URLs to PDF files.

Source	id	cipname	altname	standard	ciporigin	cipstype	cipdate	ciprevdate	cippdf
Original GRT	1	.10 Eichelberger	.10 Eichelberger Long Rifle	WildCat	US	5 rimfire	1984-06-14	0000-00-00	
Original GRT	2	.17 HMR		CIP	US	5 rimfire	2004-09-27	2012-09-25	https://bobp.cip-bobp.org/uploads/...
Original GRT	3	.17 Hornet		CIP	US	2 rimmed	2014-05-20	1900-01-01	https://bobp.cip-bobp.org/uploads/...
Original GRT	4	.17 Libra		CIP	CZ	1 rimless	2001-01-22	2002-05-15	https://bobp.cip-bobp.org/uploads/...
Original GRT	5	.17 Mach 2		CIP	US	5 rimfire	2004-09-27	2012-09-25	https://bobp.cip-bobp.org/uploads/...
Original GRT	6	.17 Rem. Fireball		CIP	US	1 rimless	2008-04-15	2011-05-25	https://bobp.cip-bobp.org/uploads/...
Original GRT	7	.17 Rem.		CIP	US	1 rimless	1984-06-14	2002-05-15	https://bobp.cip-bobp.org/uploads/...
Original GRT	8	.17 WSM	17 Winchester Super Magnum, 17 ...	CIP	US	12 rimfire	2016-05-18	2016-05-18	https://bobp.cip-bobp.org/uploads/...
Original GRT	9	.20 Vartarg		WildCat	US	1 rimless	1984-06-14	2000-6-7	
Original GRT	10	.204 Ruger		CIP	US	1 rimless	2006-05-16	1900-1-1	https://bobp.cip-bobp.org/uploads/...
Original GRT	11	.215		CIP	DE	1 rimless	1992-02-27	2011-05-25	https://bobp.cip-bobp.org/uploads/...
Original GRT	12	.218 Bee		CIP	US	2 rimmed	1984-06-14	2002-05-15	https://bobp.cip-bobp.org/uploads/...
Original GRT	13	.219 Zipper		CIP	US	2 rimmed	1984-06-14	2002-05-15	https://bobp.cip-bobp.org/uploads/...
Original GRT	14	.22 Br Rem.		WildCat	US	1 rimless	1984-06-14	2002-5-15	
Original GRT	15	.22 Creedmoor	.22 CM, 22 Creedmoor	WildCat	US	1 rimless	2020-04-09	2020-4-9	
Original GRT	16	.22 Hornet		CIP	US	2 rimmed	1984-06-14	2002-05-15	https://bobp.cip-bobp.org/uploads/...
Original GRT	17	.22 Long Rifle	22 LR	CIP	US	5 rimfire	1984-06-14	2008-09-23	https://bobp.cip-bobp.org/uploads/...
Original GRT	18	.22 PICRA		CIP	CZ	4 pistol/revolver	1999-03-15	2000-06-07	https://bobp.cip-bobp.org/uploads/...
Original GRT	19	.22 PPC USA	.22 PPC-USA	CIP	FI	1 rimless	1989-04-18	2002-05-15	https://bobp.cip-bobp.org/uploads/...
Original GRT	20	.22 Rem. Jet Mag.		CIP	US	4 pistol	2084-06-14	2000-06-07	https://bobp.cip-bobp.org/uploads/...
Original GRT	21	.22 Savage		CIP	US	2 rimmed	1984-06-14	2002-05-15	https://bobp.cip-bobp.org/uploads/...
Original GRT	22	.22 Short	22 kurz, 22 court	CIP	US	5 rimfire	1984-06-14	2008-09-23	https://bobp.cip-bobp.org/uploads/...
Original GRT	23	.22 Win. Mag. R.F.	22 Win. Mag. 22 WMR 22 Magnum	CIP	US	5 rimfire	1984-06-14	2008-09-23	https://bobp.cip-bobp.org/uploads/...

GordonsReloadingTool.plain.db: 1062 calibers, 7420 projectiles, 897 propellants

The Database tab.

Where the records come from

The list is one view made of up to three sources, shown in the Source column:

1. The **project database**: calibers, projectiles and propellants that are built into the program.
2. Your **own records**, stored in the file `ChamberSimReloaded.db` in the application data folder. Everything you create or copy is stored here.
3. Optionally the records of **Gordon's Reloading Tool** (Original GRT). The original's database is encrypted and must first be converted to a plain copy (Section "Using the originals database"); choose that copy in **File** → **Settings** → **Database**. It is only read, never changed.

Using the original's database

Gordon's Reloading Tool keeps its calibers, projectiles and propellants in an encrypted SQLite database (`GordonsReloadingTool.db`). ChamberSim Reloaded does not decrypt it by itself and does not ship one. A helper script makes a *plain* (unencrypted) copy that you then choose in the settings. The program and its

database stay unchanged; only the copy is converted. You need your own installation of Gordon's Reloading Tool.

How it works

The script starts a scratch copy of the original program. As soon as the original has unlocked its database, the script asks it to remove the encryption from that copy. Nothing is compiled and no key is typed in.

Linux

1. Unpack the *Linux* version of Gordon's Reloading Tool. Its folder contains `GordonsReloadingTool`, `libs/` and `GordonsReloadingTool.db`.
2. Copy `tools/grt_decrypt_db.sh` from the ChamberSim Reloaded sources into that folder.
3. Open a terminal in that folder and run

```
./grt_decrypt_db.sh
```

4. The script checks what is needed and, after asking, installs what is missing with `sudo`: the debugger `gdb`, the 32-bit GTK 2 runtime that the original needs and, when no desktop is running, a virtual display. Debian/Ubuntu/Mint, Fedora, Arch/Manjaro and openSUSE are supported.
5. After a few seconds the file `GordonsReloadingTool.plain.db` appears in the same folder.

Options: `-o FILE` (name of the output file), `-y` (install without asking), `-c` (only report what is found and missing, change nothing), `--headless` (use a virtual display, no window appears), `-t SECONDS` (give up after this time, default 90) and `-h` (help).

Windows

1. Copy `tools/grt_decrypt_db.cmd` and `tools/grt_decrypt_db.ps1` into the folder of Gordon's Reloading Tool (next to `GordonsReloadingTool.exe`).
2. Double-click `grt_decrypt_db.cmd`. After asking, it installs Python (with `winget`) and the Python package `frida` into a private environment under `%LOCALAPPDATA%\ChamberSimReloaded`.
3. When it has finished, `GordonsReloadingTool.plain.db` is in the same folder.

In PowerShell the options are `-Out FILE`, `-Yes`, `-Check` (report only) and `-Timeout SECONDS`.

Using the copy

Open **File** → **Settings** → **Database**, choose `GordonsReloadingTool.plain.db` as the Original database. The status line at the bottom then shows the file name and the number of calibers, projectiles and propellants, and the records appear in the Database tab with the source Original GRT. They are read-only; to change one, make a copy. You can also start the program with `-d GordonsReloadingTool.plain.db`.



Note

Do not distribute the plain copy. It is for your own use with your own copy of Gordon's Reloading Tool. If the original program is updated, make a new copy.

Working with records

New...

adds a new record. Fill in the fields; labels show the unit of each field.

Copy...

adds a changed copy of the selected record. A double click on a record shows it and offers the same.

Edit...

changes the selected record.

Delete

removes the selected record. Load files that use it keep their values.

Export...

saves the record as a file, to contribute it to the project's database.

Import bullets

(Projectiles only) adds the bullets of a manufacturer's bullet file (`.csrbullets` , or a plain `.json` file) to your own records after asking for confirmation. The format is described in `docs/BULLET_FILE.md` .

Only your own records can be edited or deleted. To change a project or original record, make a copy.

For propellants you can attach an overview photo and a detail photo (Choose file..., with the scale in px/mm if you know it).

The Projectiles list has a **Validated** column. A green check mark means that the bullet's length was measured on the bullet or checked against the original's database; a red cross means it has not been validated by hand (the length may be taken from the manufacturer's data or be an estimate; see the record's description).

Making, opening and saving loads

New load

File → **New load...** (**Ctrl+N**) opens a dialog with two steps.

Step 1: choose the components

The tabs 1. Caliber, 2. Projectile and 3. Propellant list the records of the database. Select one record in each tab; below the lists the dialog shows what you have chosen so far. The projectile list can be restricted to bullets that fit the caliber (Show only bullets that fit the caliber). Next > becomes available when all three components are chosen.

Step 2: check the load data

The dialog shows the chosen components and the Load data: propellant charge, barrel length, bullet seating depth, twist length and propellant temperature. They are filled with defaults for your selection (barrel length of the caliber, the cartridge at its maximum length, a charge of 70 % of the case capacity) and you can change them freely. The charge is also shown in the other mass unit (grams or grains). Reset to defaults restores the defaults.

\< Back returns to step 1. If you come back to step 2 with the *same* three components, your changes are kept; if you change any component, the load data are filled in again with the defaults of the new selection.

Create load opens the new load in its own tab. It is called "Untitled" until you save it.

Opening loads

File → **Open load...** (**Ctrl+O**) opens one or several files at once; you can also give files on the command line. Each load gets its own tab, named after the file. The file dialog offers three filters: all loads, `.csrload` only, and the original's `.grtload` only.

- A load that is already open is not opened twice; its tab is shown instead.
- **File** → **Open recent** lists the last 12 loads. An entry whose file has disappeared or cannot be read is removed from the list.
- If a file cannot be read, a message names the file and the reason.

Saving loads

A tab with unsaved changes shows an asterisk after its name. **File** → **Save** (**Ctrl+S**) writes the load to its file; a new load ("Untitled") and **Save as...** (**Ctrl+Shift+S**) ask for a file name. If you leave out the extension, `.csrload` is added. When you close a tab or quit with unsaved changes the program asks whether to Save, Discard or Cancel.

The two file formats

Extension	Description
<code>.csrload</code>	The program's own format (XML). It contains everything: all input values, the caliber, projectile and propellant records with their values, the physical burn values of the Physical Model, the shotshell parts and your measurements and notes.
<code>.grtload</code>	The format of Gordon's Reloading Tool. It can be opened and, as an export, written.

The format is chosen by the file name's extension.

Opening an original file

A `.grtload` file is read completely, including the measurements, notes and pictures of its appendix. Because the program saves only in its own format, Save on such a load works like Save as...: it suggests the same name with the extension `.csrload`. The original file is never changed.

Record export in the database (Export...) likewise adds `.json` to a name without a suffix.

Exporting for the original program

In Save as... choose the filter *Original GRT loads, without the data of ChamberSim Reloaded* (or type a name ending in `.grtload`). The exported file can be opened in Gordon's Reloading Tool. It leaves out what that program does not know: the physical burn values and the shotshell part choices. Keep a `.csrload` copy if you do not want to lose these.

What a load file contains

A load file is self-contained. The records of the caliber, projectile and propellant are stored in the file with their values, not as references to the database. Consequently:

- the load opens and calculates the same on another computer, without the original database;
- deleting or changing a record in the database does not change loads that were made with it (the program tells you so when you delete a record);
- to apply changes of a record to an existing load, select it again in the load (Select Propellant... and so on); for a powder a banner points out that the load differs from the database, see section [6.3](#).

Measurement series, notes and pictures are part of the file as well. Parts of an original file that the program does not interpret are kept unchanged when you save.

Undo and redo

Every load remembers its last 100 edits. **Edit** → Undo (Ctrl+Z) takes back the last edit and **Edit** → Redo (Ctrl+Shift+Z or Ctrl+Y) restores it again. The menu entries name the edit, for example Undo Select Propellant. The following edits are recorded:

- changing a value in the property tables;

- choosing another caliber, projectile or propellant;
- applying the result of Fit to measurements and accepting the physical burn values of a powder;
- changes in the Measurements tab.

The history belongs to one load and is not saved in the file. It starts empty when a load is opened and is kept while the load is saved. If you undo back to the state that was saved, the load no longer counts as modified. A new edit after an undo discards the steps that could have been redone. Switching the selected ladder curve is not an edit that can be undone.

Sessions

The program remembers the loads that were open when you quit (only those that have a file). With **File** → Settings → Start-up → Open the loads of the last session at start they are opened again at the next start, and the tab that was shown is selected again. Files that no longer exist are skipped.

Tips

- Save a load under a new name before you experiment with it; Save as... leaves the old file as it is.
- Put the files of one rifle and component set into one folder and use the series of the Measurements tab for the range sessions, so that a single file holds the history of a load.
- Files are plain XML text and suit version control or backup tools.

Entering a load

The left half of a load tab has three input tabs, the right half shows the results.

Cartridge & gun

Shows the caliber (Select Caliber... replaces it) and a table of properties: designation, overall length, case length, case volume, bore, effective area, maximum permitted pressure, barrel length, twist length, seating depth and more. Below the table the drawings show the cartridge, the chamber and (when available) the powder.

The Sebert factor (0 to 1) is kept as the file has it, 0 included, and all models use it as it is (the Physical model no longer replaces 0 by 0.5 in the propellant impulse and the recoil). A value outside 0 to 1 becomes 0.5 when the load is opened; the panel accepts only 0 to 1. The report shows the value the simulation used.

Primer and start pressure.

The Primer (a drop-down: small or large, pistol or rifle, standard or magnum, .50 BMG) starts with the usual primer of the caliber. The start pressure, the gas pressure at which the bullet starts to move, is 250 bar plus the Additional Start Pressure for the bullet, the crimp and the case, as in the original program; a new load takes it from the bullet record (its start pressure minus 250 bar). Only the physical model uses the primer: it adds the difference between the primer type's start pressure and 250 bar (fitted to Hodgdon's published loads: Large Rifle 250 bar, the others 230 to 450 bar). For pistol and revolver cartridges the physical model starts at no less than 0.3 times the maximum permitted pressure, so there the primer usually has no effect. Loads of earlier versions and of the original keep their start pressure exactly.

Replacing the caliber.

After you choose another caliber, the program can also set barrel length, seating depth and charge to the defaults of the new caliber (tick the corresponding option in the selection dialog). The primer becomes the usual primer of the new caliber; the additional start pressure stays.

Projectile

Mass, diameter, length and the other bullet data. Select Projectile... replaces the bullet; tick Show only bullets that fit the caliber to narrow the list. The Initial Gas Pressure is the pressure at which the bullet starts to move and engraves. It is the primer's start pressure plus the Additional Start Pressure of the Cartridge & gun tab; editing it changes the additional one. The Bullet friction is an extra resistance in bar that acts all along the barrel; it is always applied. Negative values are possible and describe low-friction bullets (the original's database has values down to -100 bar). For 362 rifle bullets the project records carry start pressure and friction values fitted to published loads. A load keeps the values it was made with until you select the bullet again.

Propellant

Powder charge, explosion heat, burn rate and the form-function values. Select Propellant... replaces the powder.

With the Physical Model, project powders also have *physical burn values*. They are kept in the load file. If they are missing, an orange banner tells you so and offers Use the physical values....

A load keeps its own copy of the powder values. If a database record of that powder was corrected after the load was made, or you edited the values in the load, a second orange banner says *Powder values differ from the database*. The load is still calculated with its own values. Use the database values... replaces them with those of the closest record (the charge and all other settings stay; Undo takes it back). A powder can have several records, so the banner appears only if no record has exactly the values of the load. With the Physical Model only the project's records are compared, because the original database is not updated; with the other models all records count.

Editing values

Click a value in a property table to edit it. Values with a unit have a drop-down menu for the unit; the choice applies to this field only. Reset per-field units in the settings returns every field to the chosen unit system. Some fields are coded values (for example the Shotshell flag) and offer a list of choices.

Measuring a load

A good Case Volume is the single most important input after the powder. Measure a fired case by filling it with water and weighing it. Also measure the real bullet length and cartridge overall length and enter the mean values.

Shotgun loads

Calibers with Shotshell set to yes use their own model terms. Enter such a load as follows:

- Projectile: mass = shot + wad (about 2.5 g for a plastic wad), length = height of the shot column plus the wad, diameter = bore diameter;
- seated completely inside the hull: cartridge overall length = hull length, seating depth = projectile length;
- Initial Gas Pressure = crimp release, about 20 bar.

The load also has the choices Shotshell Hull, Shotshell Wad and Shotshell Primer, each with three groups of similar parts (low, medium and high pressure). They change the pressure by up to about $\pm 20\%$. Shotgun results are less reliable than rifle and handgun results.

Results

Results tab

The Results tab shows a summary of the load and the key values: maximum pressure, muzzle pressure, projectile energy, muzzle velocity, barrel time, burnout pressure, gas outflow velocity, projectile speed (revolutions per minute), recoil energy, load ratio, the fraction of burnt powder, the effective efficiency and the heat and friction loss. The model in use is named above the values.

Warnings appear in colored banners: *Above the permitted maximum pressure, Charge too high* (the charge does not fit into the case behind the bullet) and *Invalid input* (the simulation cannot run with these values). Two orange notices concern the powder: *No physical burn values* and *Powder values differ from the database* (see section 6.3).

Chart

The big chart shows pressure, energy and velocity as curves. A drop-down menu switches the horizontal axis between time and position. Vertical lines mark the transitions of the powder burn (z_1 , z_2), the position of the maximum pressure, burnout and 95 % of the muzzle velocity. The colored bands show the permitted maximum pressure. Move the mouse over the chart to read the values at that point.

Burn-rate chart

The smaller chart shows the burn rate $B_a \cdot \varphi(z)$ over the burnt fraction.

Reference overlay

File → Overlay reference result... (Ctrl+R) draws a saved result (a JSON file, for example from a run of the original program) as dashed curves over the chart of the shown load, for comparison. Clear reference overlay removes it.

Load development ladder

With a ladder, the program simulates several charges at once. Set the number of steps and the charge difference in the load's ladder fields; up to ten steps are possible. The selected charge is the maximum, the further steps go down from there. A table (charge, maximum pressure, velocity, energy and load ratio) and a row of tabs above the chart show the steps; click one to display its curve.

Choosing the solver model

In **File** → Settings → Solver you select the model:

Physical Model

(default) A time-integrated model with flame spread, engraving, friction, air, heat loss and spin. It is fitted to

published load data of the powder manufacturers.

Published

The GRT equations with empirical constants.

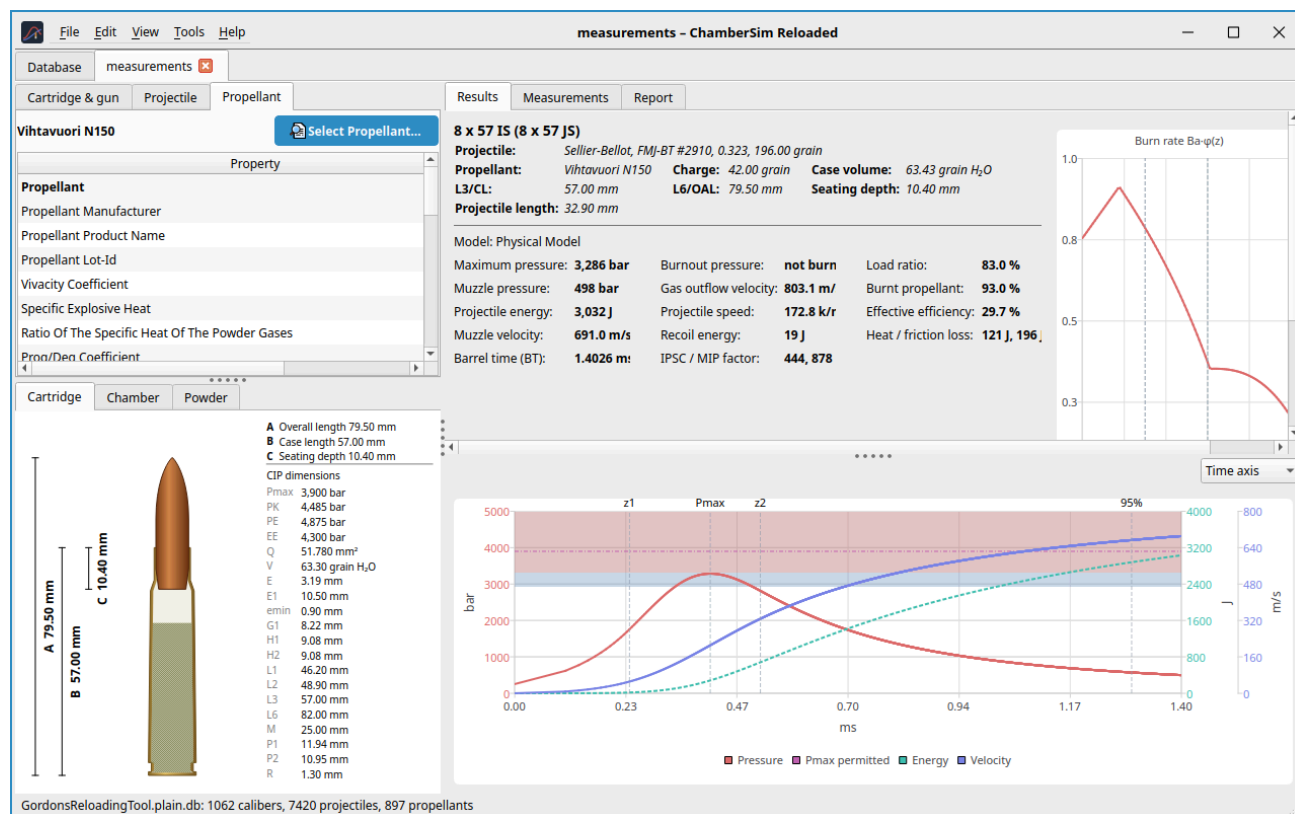
GRT Original

Calibrated against reference runs of the original program.

The model in use is shown in the results. The three models give different numbers; they are not exchangeable.

Original GRT files.

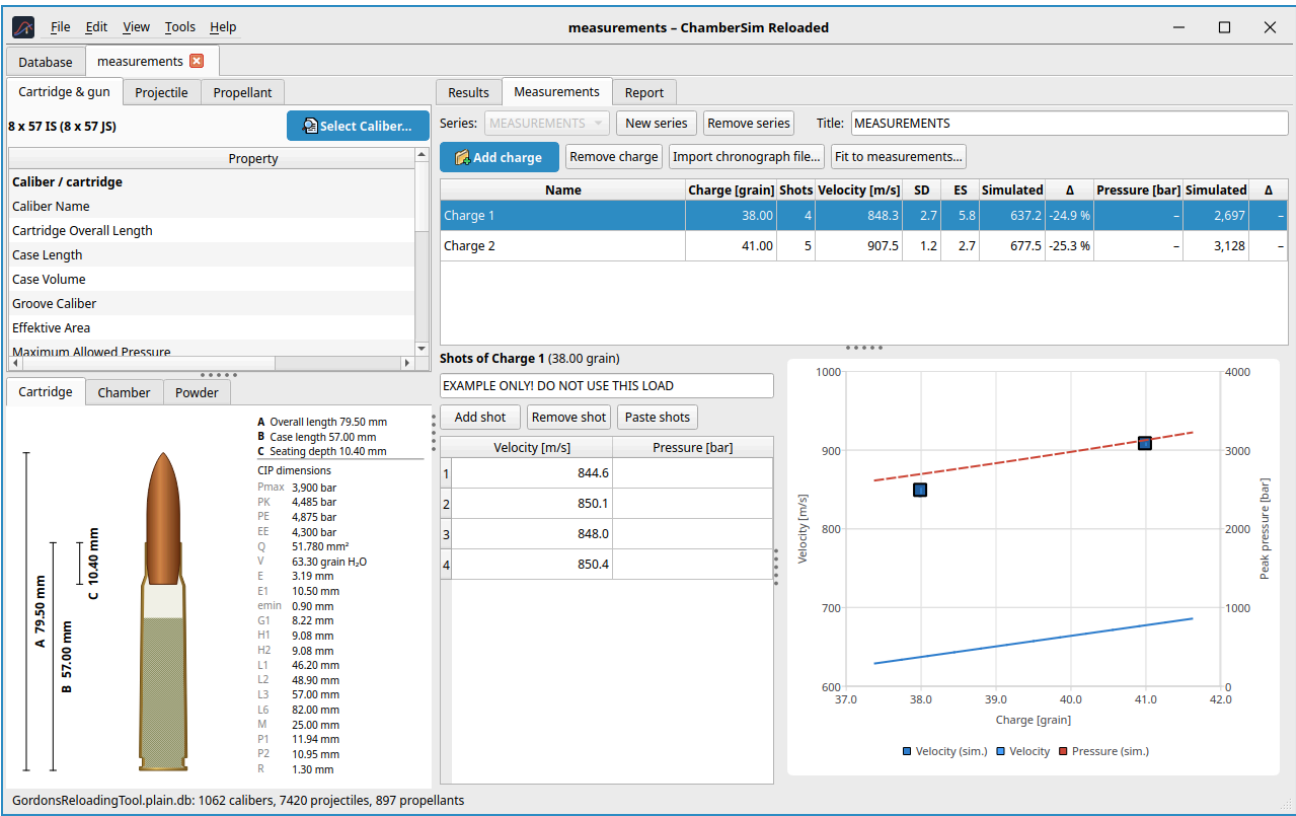
With Always use GRT Original for original GRT files (*.grtload) a load whose file is a .grtload is always calculated with GRT Original and the burn values in the file, whatever model is selected. Its results are then close to those Gordon's Reloading Tool shows for the same file (the results line says GRT Original (original GRT file, ...)). Once the load is saved as a .csrload, it uses the selected model again.



The Propellant input tab with results and chart.

Measurements

The Measurements tab holds your own chronograph and pressure data. It is stored in the load file and used to compare the real load with the simulation and to fit the powder model.



The Measurements tab.

Series and charges

A load can have several *series* (for example one per range day or rifle). New series starts an empty series, Remove series deletes the shown one, and the title field names it. Inside a series:

Add charge

adds a charge (the load's charge, or the next ladder charge). Add ladder charges adds every ladder charge that is not listed yet.

Remove charge

removes the selected charge with all its shots.

The table has one row per charge: name, charge, number of shots, mean velocity, SD, ES, the simulated velocity and the difference (Δ), then the same for the peak pressure.

Shots

Select a charge and enter the velocity (and pressure, if measured) of each shot. Add shot, Remove shot (Del) and Paste shots (one shot per line, velocity and optionally pressure) help. A note field per charge holds

rifle, chronograph and conditions.

Importing chronograph files

Import chronograph file... reads **Garmin Xero** files (the `.fit` file of the C1 Pro, or the CSV exported by the Garmin Xero app, in any language of the app), **MagnetoSpeed** CSV files and **Labradar** `Report.csv` files. Missed shots (speed 0) are left out. These files do not contain the powder charge; type it for each series in the import dialog.

Statistics and chart

The program computes the mean, the standard deviation (SD) and the extreme spread (ES, fastest minus slowest) of the velocity. The chart shows the measured values and the simulated curve over the charge; hover the lines to read values.

Fit to measurements

Fit to measurements... changes the propellant's model values until the simulation agrees with your data.

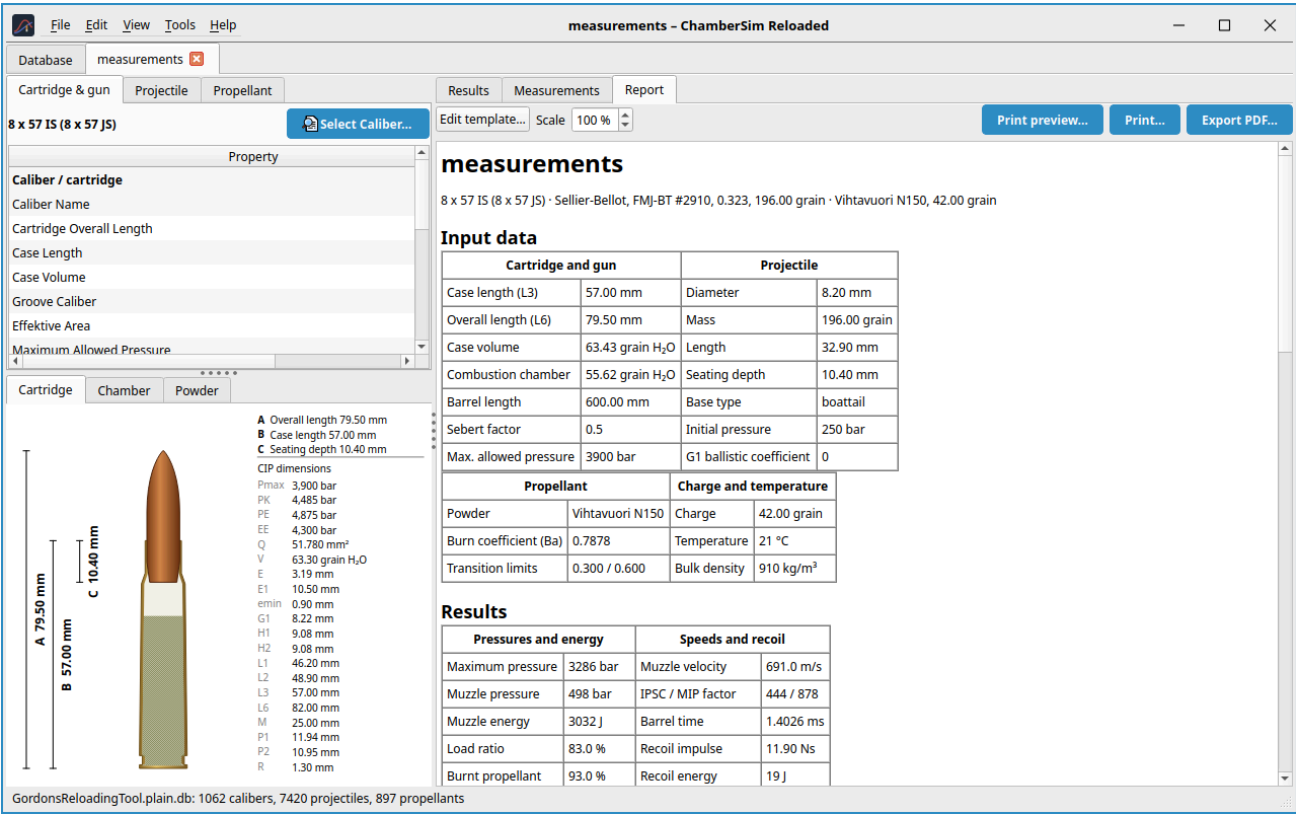
Safety

The result is only as good as your measurements and the powder data. Use it for planning, not as a replacement for the manufacturer's data.

1. **Prepare the load.** Enter a measured case volume and the real bullet and cartridge lengths.
2. **Enter measurements.** The more different charges, the better: at least 5 shots per charge, 2 or more charges, ideally also 2 or more bullet weights or calibers.
3. **Open the dialog** and choose the *values to fit*. The default depends on the data: B_a alone for fewer than 3 charges, B_a and a_0 for 3 to 5, all four (B_a , a_0 , z_1 , z_2) for 6 or more charges from at least two load files.
4. Click Fit. The dialog lists velocity and pressure of every charge before and after the fit and the rms error. Read the warnings (for example: the case volume is only the database value, or there are fewer charges than values).
5. Check the result: after the fit, velocity differences should be small (below about 2 %).
6. Apply to this load puts the values into this load only. Save as own propellant... stores a new record "*name (fitted)*" in your own database, which you can then select in any load. With the Physical Model and a project powder, the fit changes the load's physical burn values instead and keeps them in the load.

Reports and printing

The Report tab shows a formatted report of the load (Figure 4). With **File** → Print preview..., Print... and Export report as PDF... you output it. The report scale is adjustable.



The Report tab.

Report templates

In the settings, Report template... opens the template editor. A template is text with placeholders of the form `~~source.property~~` or `~~source.property("#.00")~~` (with a number format). Use Insert value to pick a placeholder and Reset to default to restore the standard template. The report of the Measurements tab includes only the selected series.

The twist length and the bullet jump (the free run before the lands) are available as `~~work.twistlen~~` and `~~work.gjump~~`; the default template shows them next to the barrel length.

The default template ends with a footer that names the program version (placeholder `~~app.version~~`).

Tools

Burn rate table

Tools → Burn rate table... compares propellants by burn rate, brisance (B_r), progressivity (B_p) and the combined value (B_{rp}). These factors are derived from the powder's B_a , explosion heat, k and the form-function values; the solver does not use them.

Unit converter

Tools → Unit converter... converts between the units of the common quantities, for example grains and grams or bar and psi.

Settings

File → Settings... (Ctrl+,) has these groups:

Database

The location of the original's *plain* database (see Section [4.2](#)).

Units

The unit system (Metric, Imperial or Original) and Reset per-field units.

Solver

The calculation model, and GRT Original for original GRT files (Section [7.6](#)).

Appearance

The Font size (with a button for the system default), Custom Title Bar (Linux: the program's own title bar with the menu in the title row) and Rounded Dialog Corners (dialogs have their own frame with the custom title bar; this needs a compositing window manager and applies to dialogs opened afterwards). The theme is chosen in **View** → Theme, not here.

Start-up

Open the loads of the last session at start. Not used when load files are given on the command line.

Logging

The log level (Debug, Info, Warning, Error or Off), output to the console and/or a log file, with Open log file and Clear log file.

Apply puts the changes into effect and keeps the dialog open, OK applies and closes it, and Cancel also takes back what Apply did.

Tips and troubleshooting

"No original database" in the status line.

No plain copy of the original's database has been chosen. The project's records still work. Choose one in **File** → Settings → Database if you want the original's records.

"Encrypted database error."

You chose the encrypted `GordonsReloadingTool.db`. Use the decrypted copy (see Section "Using the Original's Database").

"Charge too high".

The charge does not fit into the case behind the bullet. Reduce the charge or increase the seating depth.

A record cannot be edited.

Only your own records can be changed. Make a copy first.

"The pressure is much higher than in the loading manual."

Check the case volume, the powder lot, the seating depth and the bullet data. Try another model and compare. Always trust the manual over the calculation.

The language does not change.

The language change takes effect after a restart.

Something else.

Set the log level to Debug and look at the log file.

Glossary

Term	Meaning
B_a	Burn rate (vivacity) of the powder
a_0, z_1, z_2	Form-function values: the shape of the powder grain and the transitions of its burning
Q_{ex}	Explosion heat (energy content) of the powder
k	Ratio of the specific heats of the powder gases
BT	Barrel time: time for the bullet to reach the muzzle
SD / ES	Standard deviation and extreme spread of the velocity
Load ratio	Fraction of the case that the powder fills (loading density)
C.I.P.	Commission Internationale Permanente, which standardizes cartridge and chamber dimensions
P_{max}	Maximum permitted pressure

ChamberSim - Reloaded