MRI Mastery Simulators: quick guide

Free, interactive MRI physics that runs in your browser. Nothing to install, no sign-in. Works on a laptop or desktop; a large screen helps.

Please read: this is an early release for learning and feedback. It has not been fully quality-checked. Some pages are marked "preview" or "in progress", and results may contain errors. It is a teaching model with simplified physics and a computer-generated head, not a clinical tool. Do not use it for scanner, protocol or safety decisions. Corrections are very welcome.

Start here

Open the home page and pick a card. Every simulator is independent, so you can go in any order. If you are new, the order below builds from the fundamentals up to a full protocol.

Suggested path (about 45 minutes)

1. **Bloch Simulator**: see magnetization respond to a pulse.
2. **Signal Processing**: see why sampling and pulse shape matter.
3. **K-space Explorer**: watch an image build up, one line at a time.
4. **MRI Contrast Simulator**: put it together as a protocol, including multiple slices.

Anything not on this path (coil fields, tuning, the phantom viewer) is a good second visit.

What each page does

Page	What to try
Bloch Simulator	Choose an *Experiment* (pulse then free precession, spin echo, inversion recovery), then press *Play*. Change flip angle, off-resonance, T1 and T2 and watch the 3D vector and the Mx/My/Mz traces. Try *Isochromat spread* to see dephasing and the spin-echo refocusing.
Signal Processing	Top panel: change signal type, width and sampling rate and compare the signal with its Fourier transform; push the sampling rate down to see aliasing. Lower panel: change time-bandwidth product and gradient strength to see how RF pulse shape sets slice thickness and profile.
K-space Explorer	Pick a sequence, press *Play*, and watch the gradients trace a path through k-space while the image fills in. Use *TR* stepping, *Fill all* and *Reset*, and the speed menu. With multiple slices you also get a strip of every slice and the slice profiles.

MRI Contrast Simulator	Pick a sequence and field strength (or a preset protocol) and change TR, TE, flip angle and so on. Watch the images, signal and SNR bars, scan time and the pulse-sequence diagram respond. The tabs hold the parameters: *Contrast*, *Geometry*, *Signal & time*.
Coil Fields & RF Excitation	Build loop or Helmholtz coils and see the field map. The *RF excitation* tab turns that field into B1+ and flip-angle maps.
Coil Tuning & Matching	Adjust the tuning and matching capacitors to bring the S11 plot and Smith chart to the centre. Then add patient loading to see the coil detune. (Preview.)
Head Phantom	Browse the generated head in axial, coronal and sagittal planes with T1, T2, PD and FLAIR appearances. (Preview.)

Multi-slice imaging in the contrast simulator

This is the best place to see how slices affect scan time and SNR.

1. Choose a non-inversion sequence (for example GRE or spin echo) and open the *Geometry* tab.
2. Raise *Slices*. The scan-time meter and the TR timeline strip show how many slices fit in one TR.
3. When too many slices are requested, either TR rises or the scan splits into *concatenations* (repeat passes). Compare the scan times.
4. Toggle *Include cross-talk* and compare the signal and SNR bars. Set the gap to 0 % to make the effect obvious.
5. Use *Open in k-space explorer* to see the same protocol played pass by pass.

Multi-slice for FLAIR, STIR and DIR is not available yet, and 3D sequences have no slice selection, so slice controls are hidden or disabled there.

Tips

- Hover over plots and diagrams for details. Many plots can be zoomed.
- If the text is too small, use the A / A+ / A++ text-size buttons on the page. Your choice is remembered in your browser.
- If something does not update, reload the page. Simulator settings are not saved between visits.
- Heavy settings (many slices, large matrices) can make a page slow to redraw. Reduce the matrix or slice count if so.

Limits to keep in mind

- The head is a procedural phantom with idealised tissue values, not patient data.
- Physics is simplified (for example, no motion, flow or B0 inhomogeneity in the contrast simulator).
- Vendor details differ. Treat numbers as illustrative, not as what a particular scanner will do.

Feedback

Found an error, or something confusing? Please tell me in the group thread: what page, what settings, and what you expected. Thank you for testing.