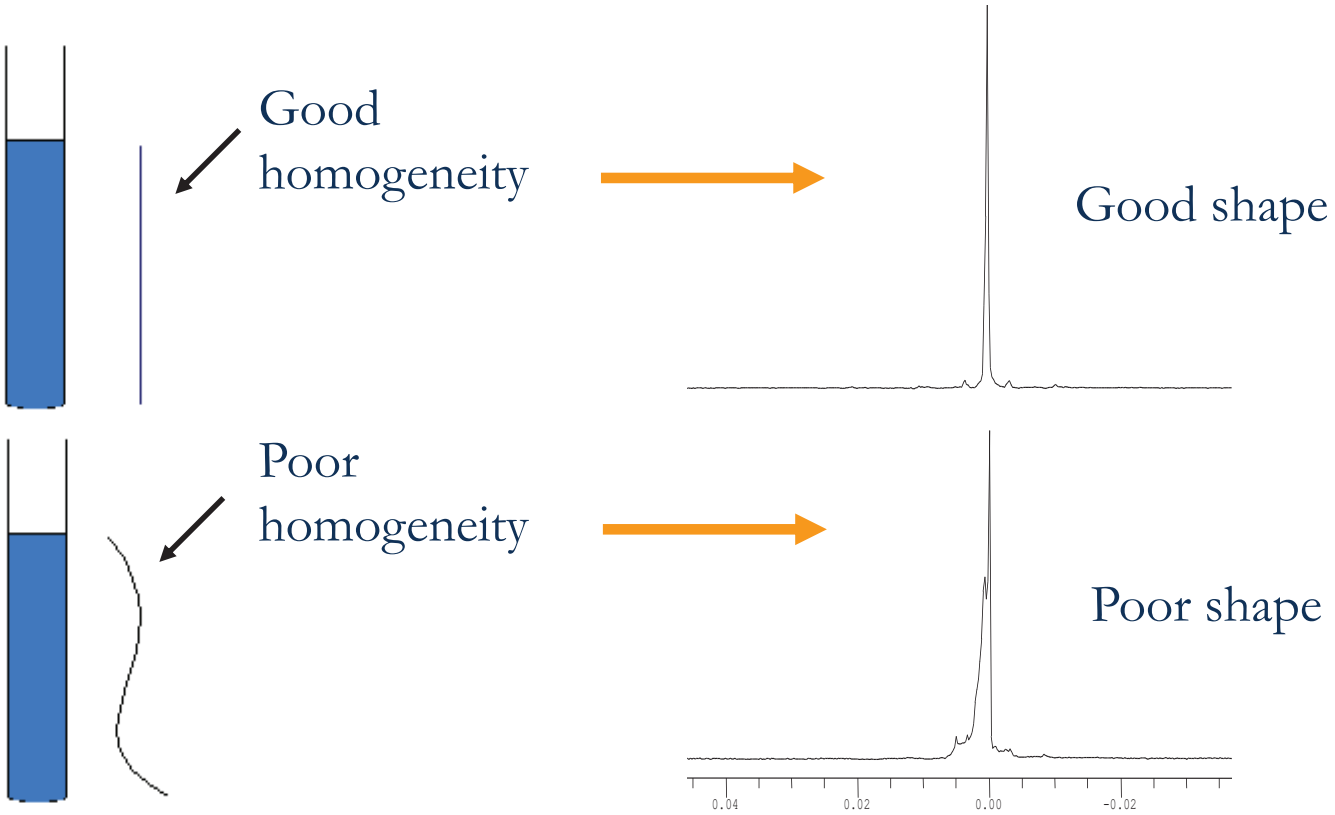
Shimming

- Magnetic fields are usually spatially in-homogenous to a greater or lesser extent
- These in-homogeneities lead to broadened and/or distorted resonances
- Compensate by *shimming* for optimum line shape
- Shim values depend on probe, sample, *etc.*
- Shims are supplementary magnet coils
- Historically, shimming has been done by observing the ^{2}H lock signal and adjusting shims iteratively (manual or automatic procedure)
- Newer approach utilizes gradients to map field in-homogeneity and adjust shims to compensate

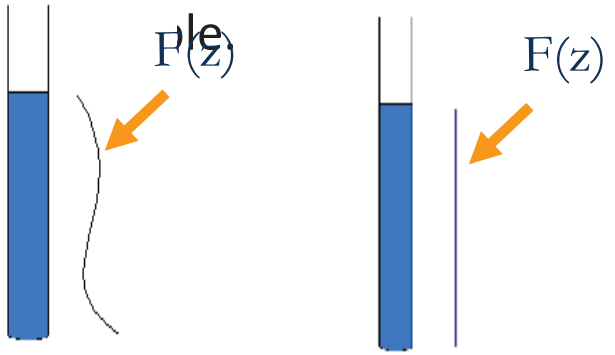
Resolution and magnetic field homogeneity

- **NMR signal position is proportional to magnetic field**
- **ω=γH**
- **If the magnetic field has distortion, it reflects on the peak shape (and sensitivity)**



Shimming

An NMR instrument has a series of shims at room temperature to create small correcting magnetic fields.
Shimming is a process to find a combination of these RT shim to compensate for the in-homogeneous magnetic field caused by sample.

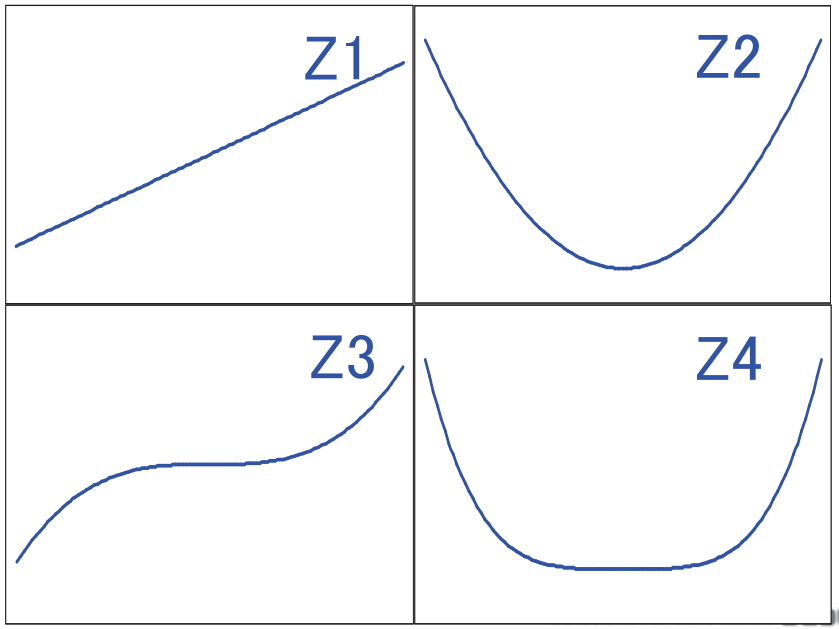


$$F(z)=az+bz^2+cz^3+dz^4$$

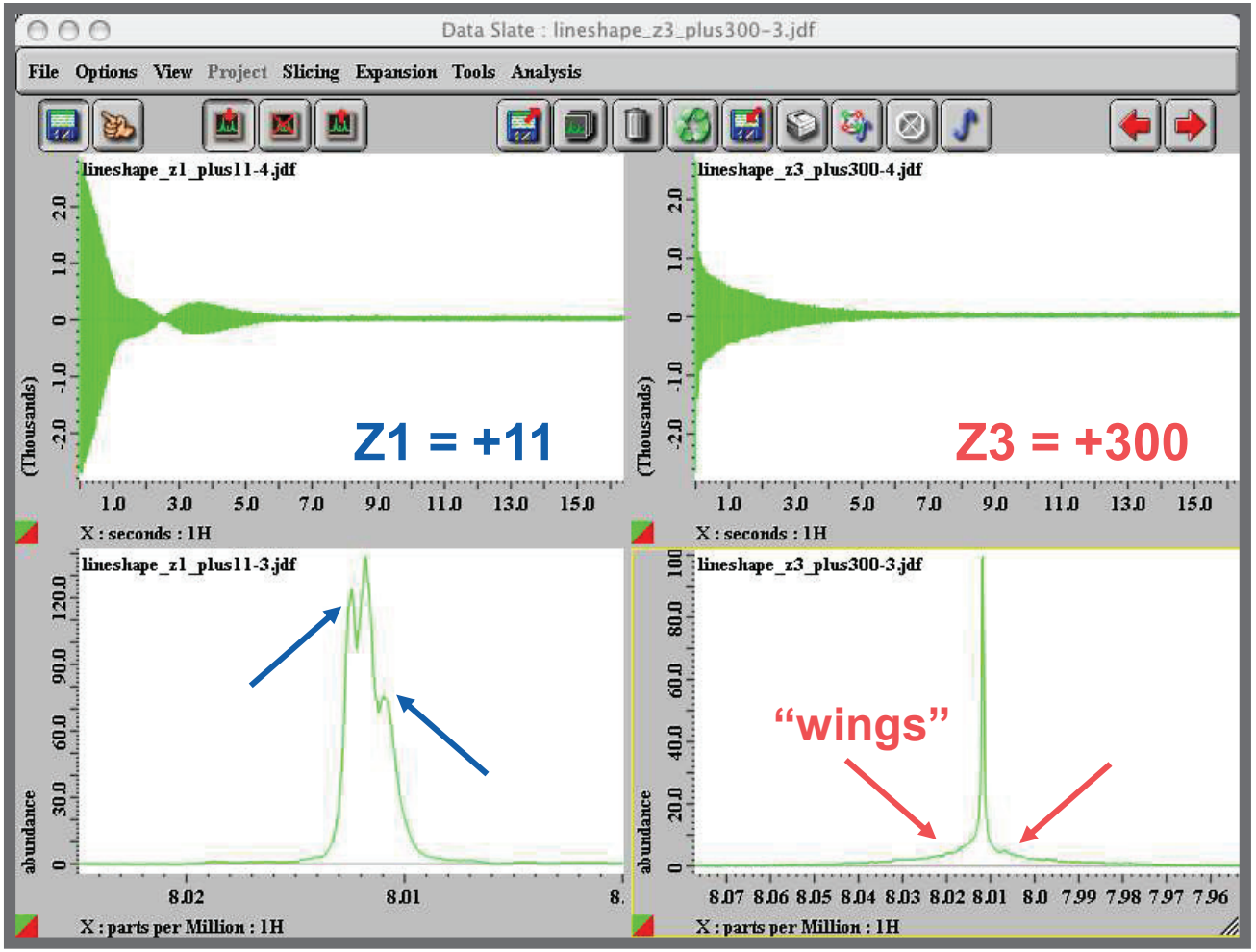
Z1 shim=-a, Z2 shim=-b

Z3 shim=-c, Z4 shim=-d

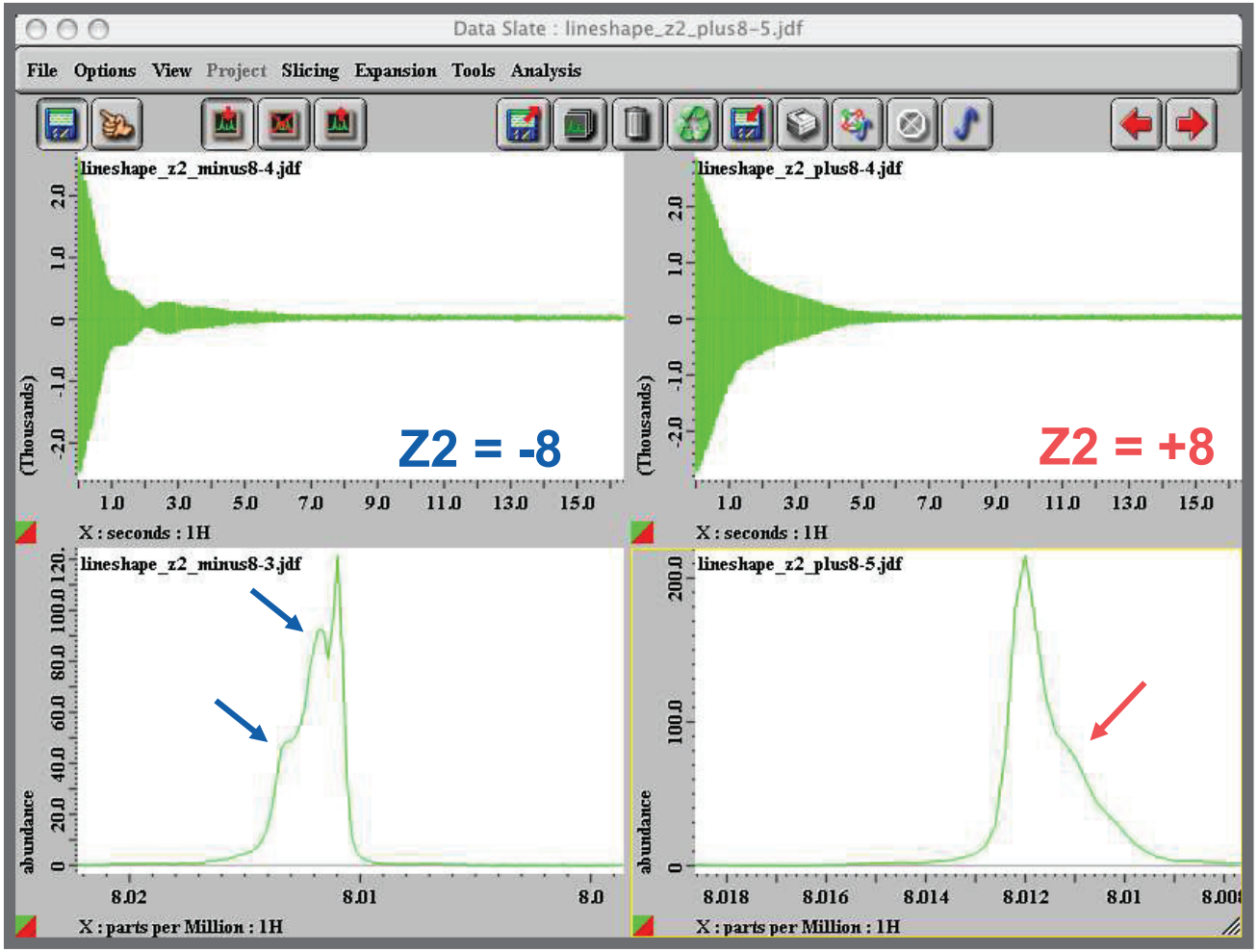
$$F(z)=az+bz^2+cz^3+dz^4$$
$$-aZ-bZ_2-cZ_3-dZ_4=0$$



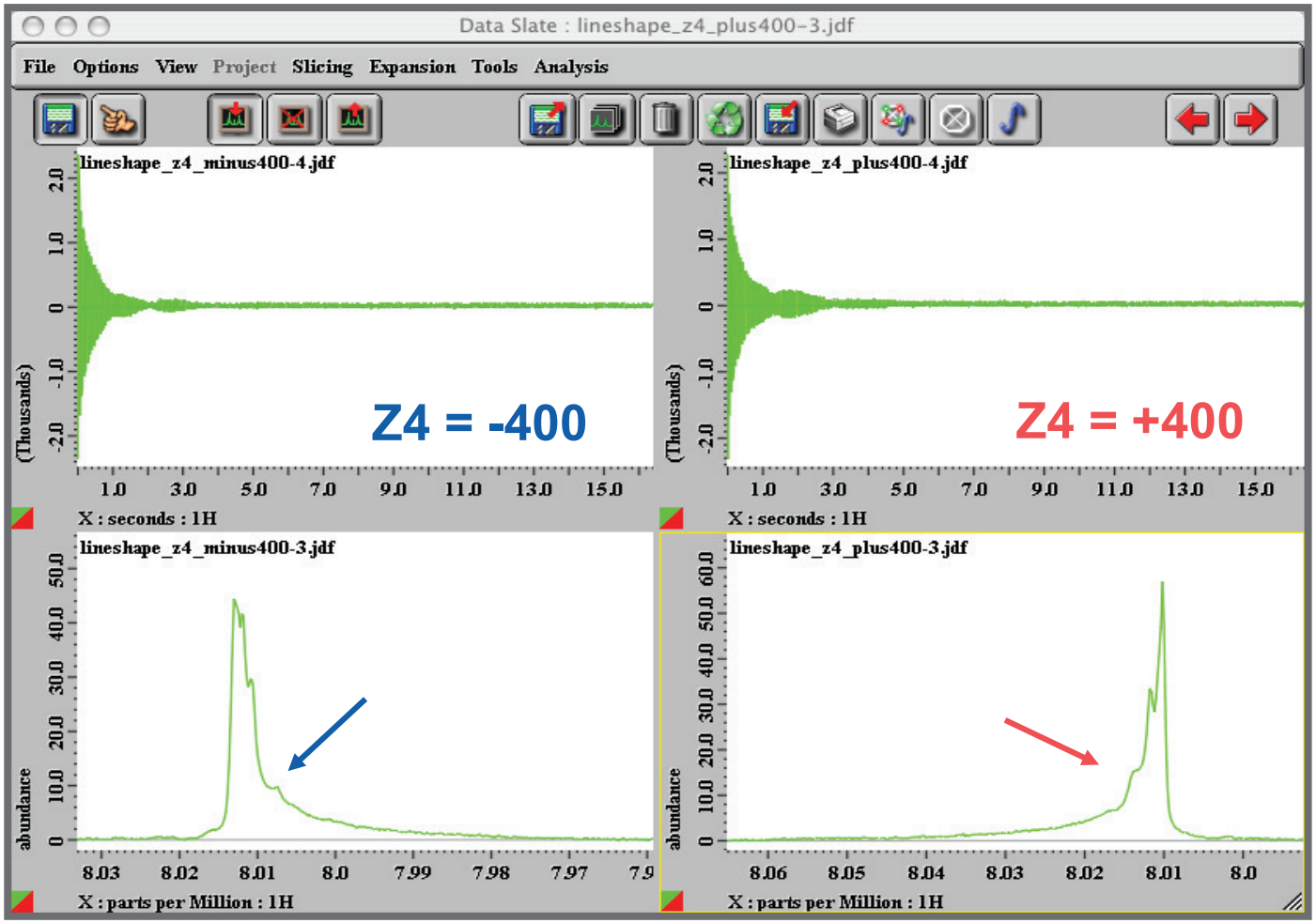
Z1, Z3 shims



Z2 shim



Z4 shim



Effects of shims

- Lower-order shims (Z1, Z2) have larger effects on line-shape
- Odd shims (Z1, Z3) produce symmetric effects
- Even shims (Z2, Z4) produce asymmetric effects; direction depends on position relative to the optimum value
- Errors in X and Y produce sidebands at the spinning frequency
- Errors in XY and X2 – Y2 produce sidebands at twice the spinning frequency