

ctf

keys:	[from]	<number>	source picture used by options <i>add</i> or <i>multiply</i>
	[to]	<number>	output picture
	size	<x>, <y>	if no source picture, dimensions of picture
	defocus	<number>	defocus value (underfocus positive)
options:	add/multiply		add <i>ctf</i> to source/multiply source by <i>ctf</i>
	halfplane		if no source picture, generate right half-plane output
	phase		produce weak-phase object <i>ctf</i>
	amplitude		produce weak-amplitude object <i>ctf</i>
	wave		produce 'wave' form of <i>ctf</i> , that is, $\exp-i(\gamma)$
	squared		produce squared <i>ctf</i> (not necessarily modulus squared)
	cc		produce complex conjugate of <i>ctf</i>
	physical		interpret variables describing imaging conditions in physical units (<i>nm</i> , <i>mrاد</i>) rather than reduced. Need to set variables <i>cs</i> and <i>kv</i> .
	verify		verify processing at the console

The command **ctf** produces or applies *contrast transfer functions* (Fourier transform filters), that characterise imaging in high resolution electron microscopy. Use **ctf** for image simulation or restoration.

Examples

```
library em
```

This command runs a library program that prompts for all relevant instrumental conditions (see *variables used*).

```
min=0 max=4; ctf squared to display size 128
```

This command displays the intensity in the weak-phase object contrast *ctf* for the current imaging conditions, possibly for comparison with an experimental diffractogram.

Semper 6 Command Reference

ctf

```
ctf multiply 30 to 31 verify
```

This command multiplies picture 30 by the transfer functions, placing the result in picture 31. The **verify** option sends information about the command process to the console.

Description

The following options and keys are used with **ctf** to define:

- how the contrast transfer function is stored as output
- the kind of *ctf* that is generated
- whether the imaging conditions are defined as *reduced* units

The **ctf** command itself stores the *contrast transfer function* as a *Fourier* full-plane output picture, unless you specify otherwise using the option **halfplane** and the key **size** to specify dimensions. The command **ctf add** adds the *ctf* to the output picture. **ctf multiply** multiplies the source picture by the *ctf*.

ctf itself generates a weak-phase object *ctf* (the default kind of *ctf* is **ctf phase**). Other kinds of *contrast transfer function* that you can specify are:

- **ctf amp** (generates a weak amplitude *ctf* $2\cos(\text{gamma})$)
- **ctf wave** (generates a complex form $\exp(i\text{-gamma})$)
- **ctf phase amp** (generates the product of the two *ctfs*)

With any of the above options **ctf squared** causes the squared modulus of the *contrast transfer function* to be used, and **ctf cc** its complex conjugate.

ctf itself assumes reduced units, axial distances in scherzzer units $Cs^{0.5} \lambda^{0.5}$ transverse in glaser units $Cs^{0.25} \lambda^{0.75}$ and angles in G1/Sch.

ctf physical assumes all distances in nanometres and all angles in milliradians.

The imaging conditions, for example, the image sampling interval, are determined by variables rather than by the above options and keys. These variables are listed and described in the *Notes* given below. To set these variables run the library program *em*, as shown in the first command example.

Notes

multi-layer pictures:	faulted
forms used internally:	complex

Semper 6 Command Reference

ctf

variables used:

<i>step</i>	Image sampling interval (half minimum period in transform). A value is always required for this variable.
<i>cs</i>	Spherical aberration coefficient/mm (required if physical option used).
<i>kv</i>	Accelerating voltage in kv (required if physical option used).
<i>astigmatism</i>	Astigmatism (maximum minus minimum underfocus). Default is 0.
<i>aphi</i>	Azimuth of maximum underfocus/ <i>mrاد</i> ; clockwise from positive x axis. Default is 0.
<i>swidth</i>	Illumination divergence (<i>rms</i> of equivalent gaussian profile). Default is 0.
<i>ewidth</i>	Focus spread (<i>rms</i> of equivalent gaussian profile). Default is 0.
<i>tilt</i>	Magnitude of primary beam tilt (<i>wrt</i> optical axis). Default is 0.
<i>tphi</i>	Azimuth../ <i>mrاد</i> . Default is 0.
<i>oadius</i>	Objective aperture radius (<i>wrt</i> optical axis). Default is infinity.
<i>oadispl</i>	Magnitude of objective aperture displacement. Default is 0.
<i>oaphi</i>	Azimuth../ <i>mrاد</i> . Default is 0.
<i>drift</i>	Magnitude of linear specimen drift during exposure. Default is 0.
<i>dphi</i>	Azimuth../ <i>mrاد</i> . Default is 0.
<i>vibration</i>	Lateral specimen vibration level (<i>rms</i>). Default is 0.

Defaults and Ranges

keys/options	defaults	range
[from]	current picture, held in variable <i>select</i>	valid picture number
[to]	source picture	valid picture number
size	dimensions of current picture	positive integers
defocus	defocus off	
add/multiply	generate <i>ctf</i> in new output picture	
verify	verification off	