CIP manual

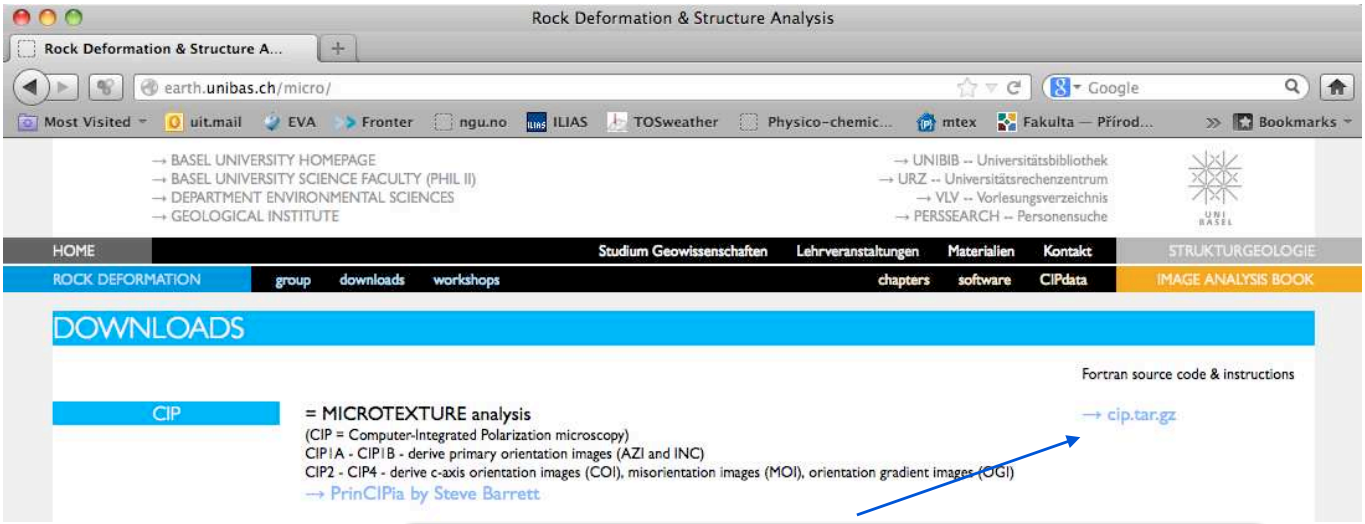
Basel, July, 23 2013

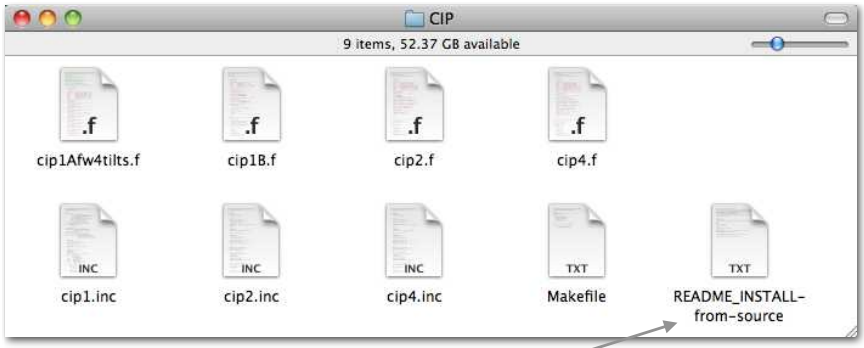
Installing CIP on your Mac

http://earth.unibas.ch/micro

1. Download from the website...
...the package from the internet and unzip.

2. Follow the instructions...
.... in the README_INSTALL-from-source-file



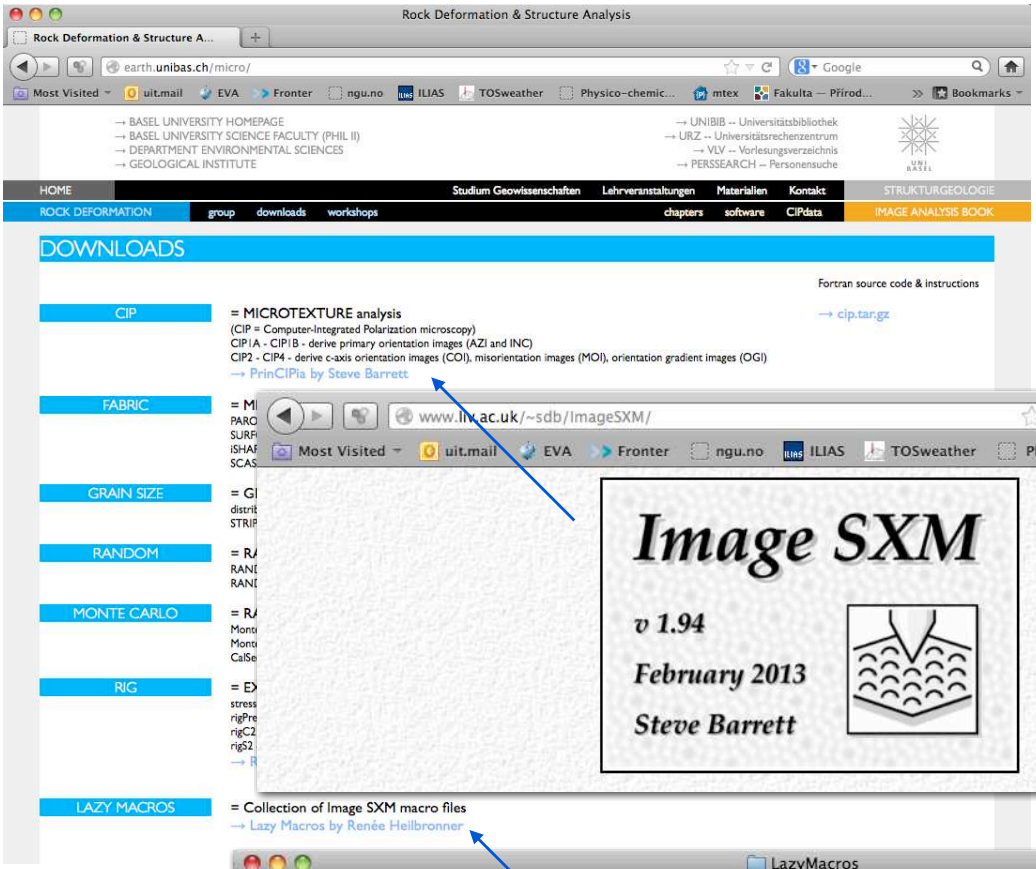


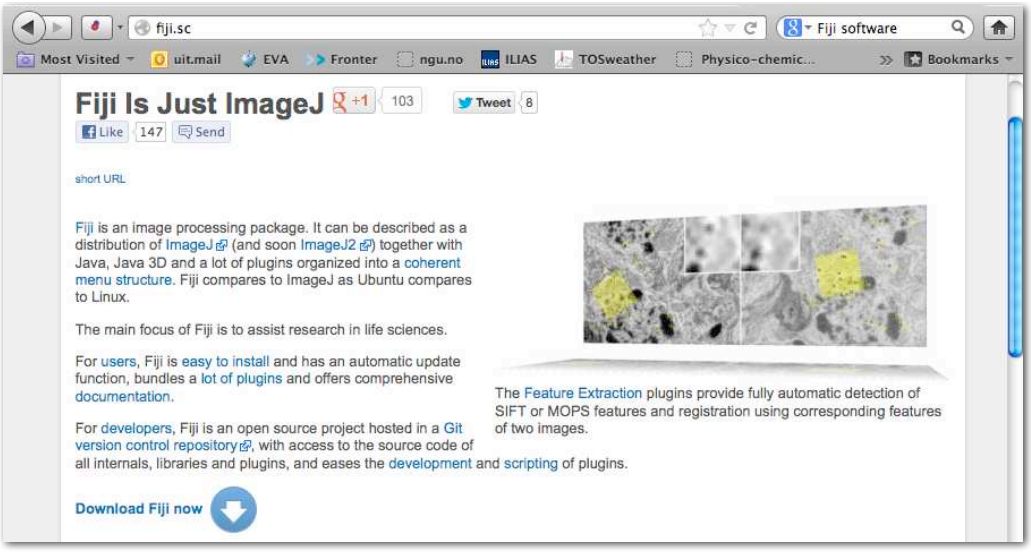
README_INSTALL-from-source

```
You will need a fortran compiler, either gfortran or g77.

For Apple OSX, the people from R (http://r.research.att.com/tools/) distribute a
package of gfortran for OSX. You need developer command line tools installed. If
you are lucky you can find a stripped down package as you only need basic tools
and dynamic libraries (e.g.libgfortran.dylib , libgcc_s.dylib). If you are unlucky
you have to download some 2-4 GByte from Apple to use < 10 MB of tools/libraries.
g77 is no longer included in gcc (>3.4).
For Gnu/Linux use gfortran provided from your distribution.
For Microsoft operation systems Cygwin provides a working gfortran or g77. Have a
look at http://gcc.gnu.org/wiki/GFortranBinaries

To build and install from source:


For OSX:
1) Unpack the archive

2) Edit Makefile and choose your compiler by un/commenting the appropriate line
and read the warning
e.g.
#COMP = g77
COMP = gfortran -std=legacy

3) To compile all programs type:
$ make

4) Install all binaries in /usr/local/bin:
$ sudo make install

IF you have installed the gfortran provided from the link above, no need to worry
any further.
Otherwise /usr/local/bin has to exist. To create it type:
$ sudo mkdir -p /usr/local/bin

/usr/local/bin has to be in your $PATH variable. If it isn't, modify your .profile
file:
$ echo "export PATH=/usr/local/bin:$PATH" >> ~/.profile

For users of gfortran, using the option -std=legacy is necessary.
```

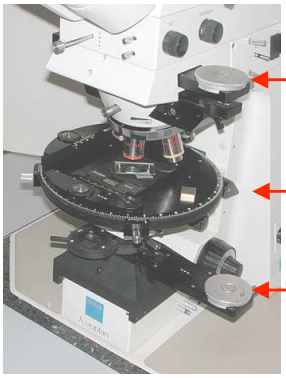
Installing Image SXM / Lazy macros and Fiji on your Mac

http://earth.unibas.ch/micro





The Hardware



analyzer
fully rotatable

rotating table with
X-Y stage and tilt stage

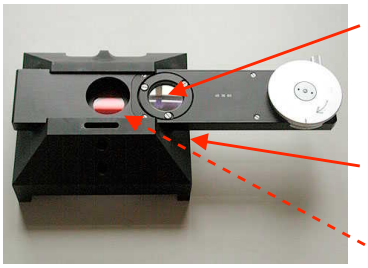
fully rotatable assembly of
polarizer & λ plate

Use a high quality polarizing microscope.

Use rotating table with mechanical X-Y stage.
Mount tilt stage onto X-Y stage

Use fully rotatable analyzer (= upper polarizer).

Use fully rotatable lower polarizer. Mount full wave plate (λ plate) in 45° orientation with respect to lower polarizer. Wave plate and polarizer have to remain at 45° with repsect to each other during rotation.

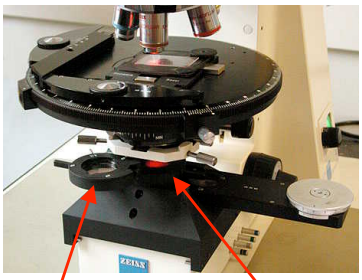


fully rotatable analyzer (ZEISS)
λ plate mounted in 45°

block to hold rotatable
analyzer and red filter
(Geowerk, Basel)

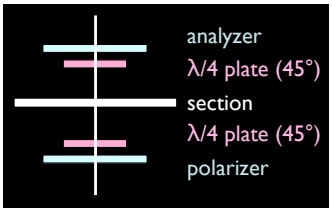
red interference filter (660 nm)
inserted below

Insert interference filter with transmittance at 660 nm below lower polarizer. Use 660 nm to be able to observe the images during aquisition etc. If you use a transmittance at 680 or 700 nm, direct observation of images is nearly impossible (700 nm is approximately the spectral limit of human vision).



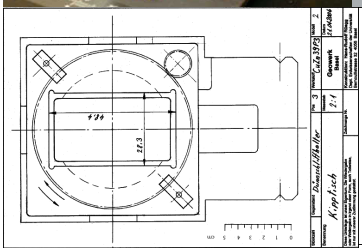
lower quarter wave
plate (not inserted)

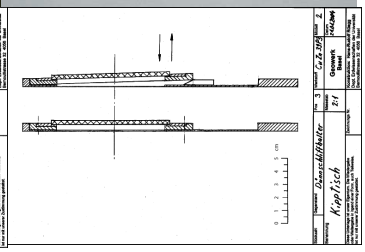
lower polarizer
(inserted)



To achieve a state of circular polarization:

- Insert both polarizers (polarizer and analyzer with orthogonal vibration direction)
- Insert quarter wave plate (at 45°) between analyzer and section (use same slot as normally used for full wave plate
- Insert quarter wave plate (at 45°) between section and lower polarizer (requires additional holder to be mounted above the holder for the polarizer)

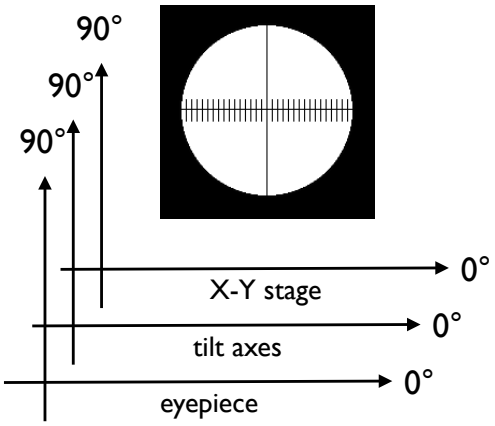




Use a tilt stage
(to be acquired from Geowerks Basel)

Use a monochromatic digital camera

Microscope Settings



Hardware specifications:

- cross table with tilt stage
- graticule in eye piece
- red interference filter 660 nm

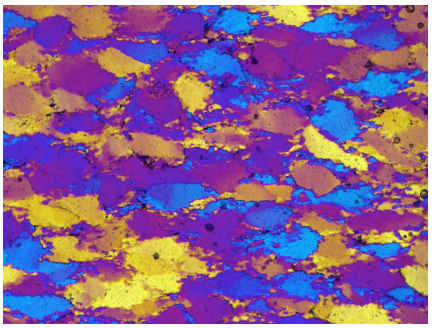
1. Preparing the microscope
   - 1.1. Make sure that the planes of vibration of the polarizers is 0° (horizontal in the image) and 90° (vertical in the image).
   - 1.2. Rotate the microscope table to the 0° orientation.
   - 1.3. Make sure that the axes of the mechanical X-Y stage are parallel to 0° and 90°.
   - 1.4. Make sure that the tilt axes (i.e.the edges) of the tilt stage are parallel to 0° and 90°.
   - 1.5. Make sure that the graticule in the eyepiece is parallel to the 0° or 90° direction
   - 1.6. Clean & center microscope as best as you can
   - 1.7. Place specimen in tilt stage, focus
   - 1.8. Carefully install Köhler illumination

2. Use a monochromatic digital camera
   - 2.1. make sure that the horizontal and vertical direction of the captured image coincide with 0° and 90° direction.

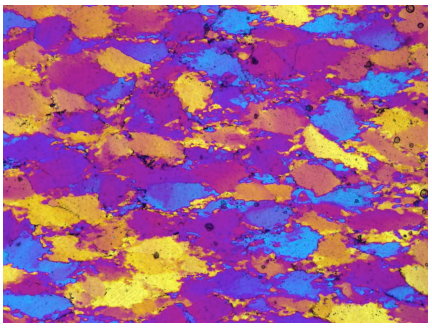
3. Select sample site and magnification
   - 3.1. Match the condenser to the selected magnification of the objective
   - 3.2. Do not stop down the condenser diaphragm too much (else the spatial resolution drops)
   - 3.3. Select sample site, make sure structural directions match the 0° and 90° direction of the image and the microscope (see section 1 above)
   - 3.4. Orient the microscope table parallel to 0°.
   - 3.5. Focus image as best as you can (using the focus help of the image grabber)

4. Overview

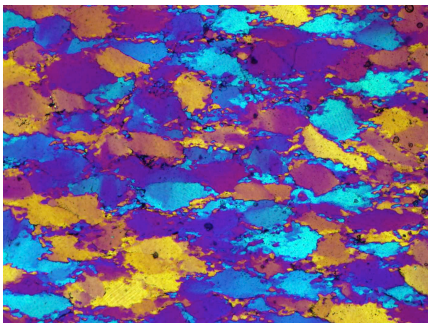
In order to prepare color micrographs, three interference filters (460, 560, and 660 nm) can be used. The monochrome images are copied into the 3 color channels of Photoshop RGB and then viewed together. Oftenm, the result is very dark, and a gamma of 2.3 is added (⌘L to invoke LUT operations). Using a transmittance of 700 nm instead of 660 nm for the red channel returns slightly more reddish images.



R = 660 nm
G = 560 nm
B = 460 nm
using
fixed lambda plate



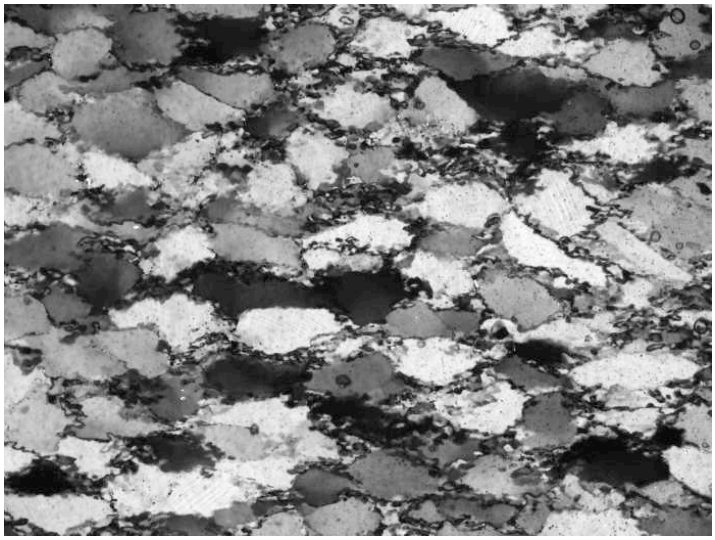
R = 700 nm
G = 560 nm
B = 460 nm
using
fixed lambda plate



R = 660 nm
G = 560 nm
B = 460 nm
using
rotating lambda plate

(left:)
Obviously the lower wave plate (plastic foil) is slightly thicker than the upper one (60 µm quartz plate)

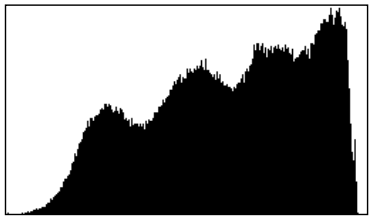
Acquiring the input

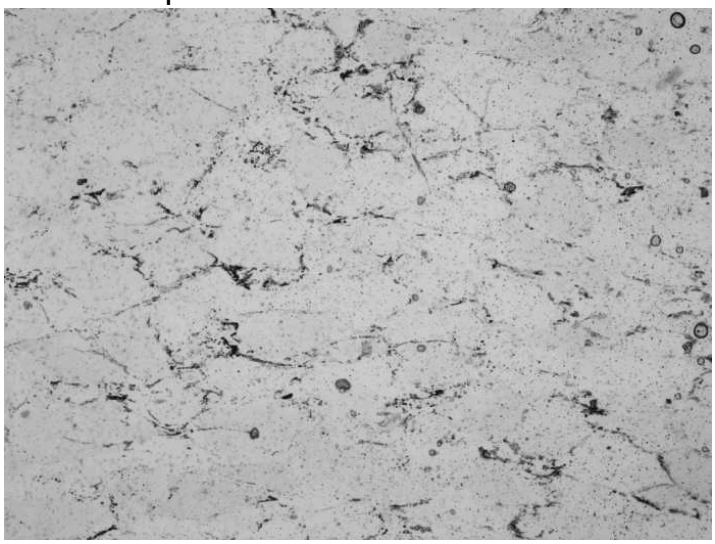


file.cirpol

1. Circular polarization

1.1. Insert lower and upper polarizer.
1.2. Insert both quarter wave plates (above and below section)
1.3. Insert IF 660 filter
1.4. Use linear setting for exposure - do not overexpose

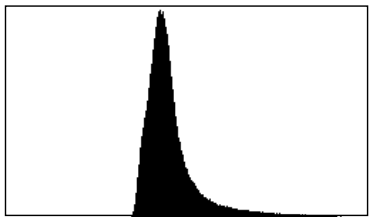


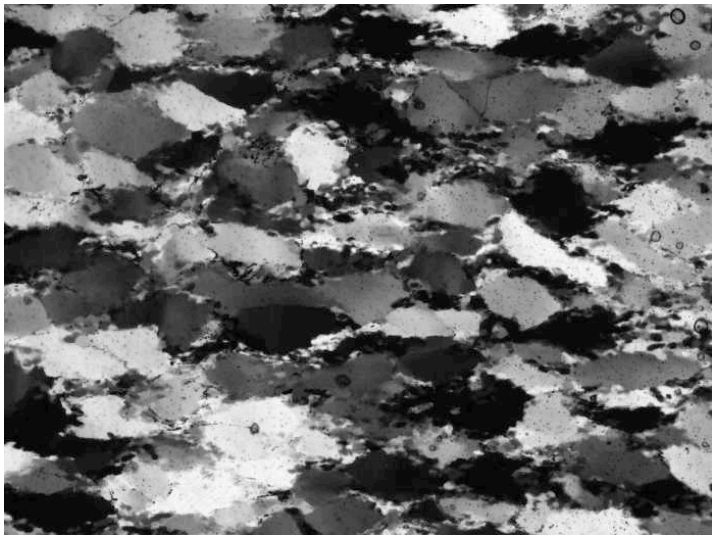


file.nopol

2. No polarization

2.1. Remove lower polarizer and both quarter wave plates.
2.2. Leave upper polarizer in (to maintain magnification), leave IF 660 filter in.

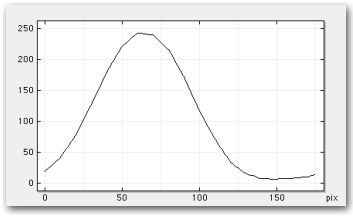




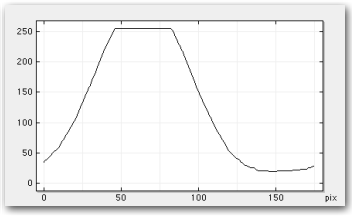
file.000
...
file.180

3. Rotation images

3.1. Insert rotatable lower polarizer / wave plate assembly.
3.2. Determine exposure. Check if selected exposure is also OK at other orientations (rotate section). Adapt exposure to brightest orientation (see profiles below).

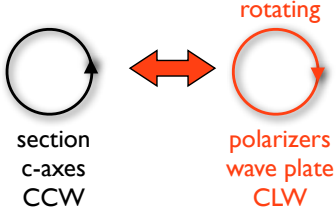


exposure OK in all orientations



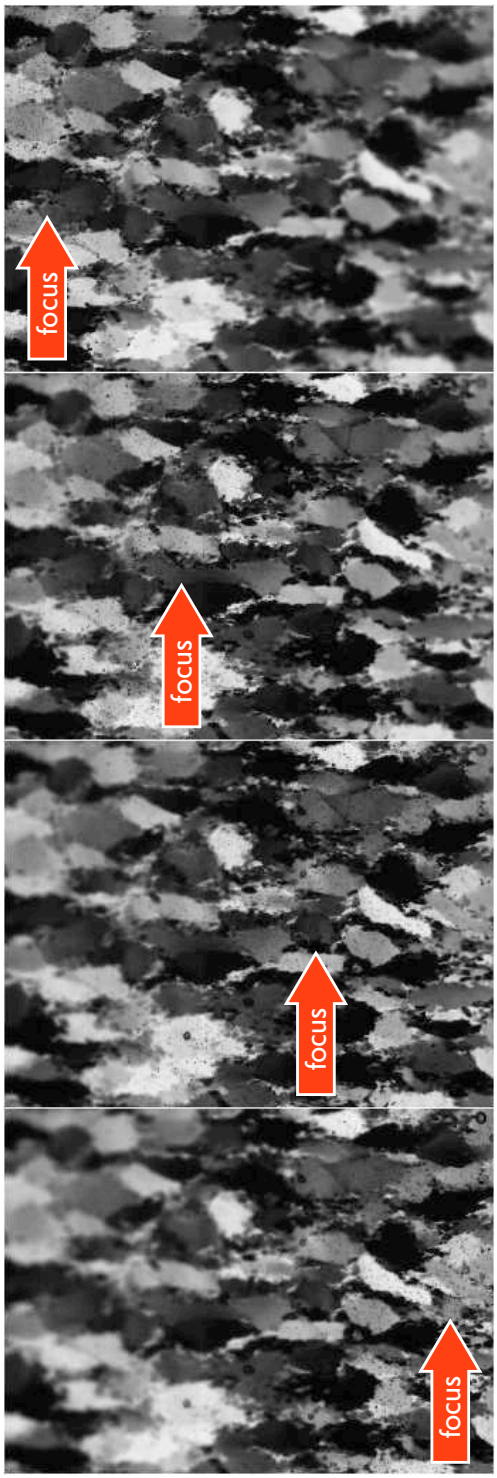
over exposed between 50° and 90° rotation

3.3. Carefully return to the exact starting orientation (0°).
3.4. Take 19 rotation images with 10° intervals of CLW rotation of (upper and lower) polarizer/waveplate assembly



Remember that the exposure selected here remains constant for all rotations and all tilts.

Acquiring the input

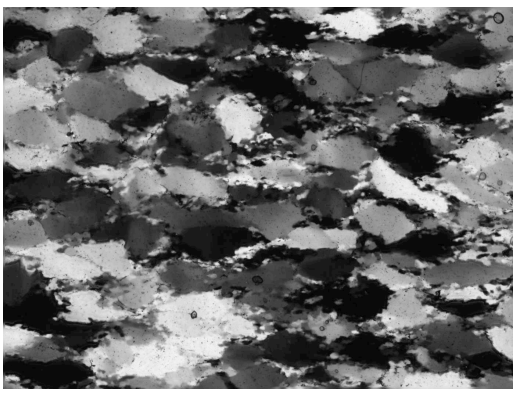


eup.stack slice 1

eup.stack slice 2

eup.stack slice 3

eup.stack slice 4



file.eup

4. Tilt images

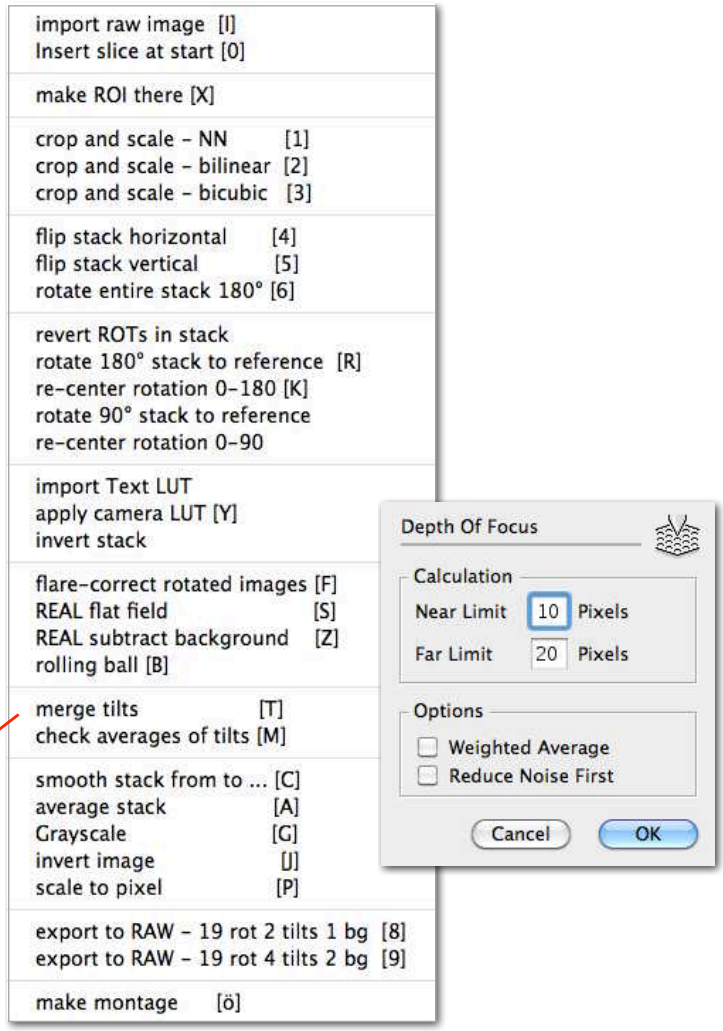
Four tilts are used.

For each tilt, 3-4 images are acquired with the focus plane being placed moved through the image such that overlapping strips of focus are created.

For each tilt a stack iscreated.

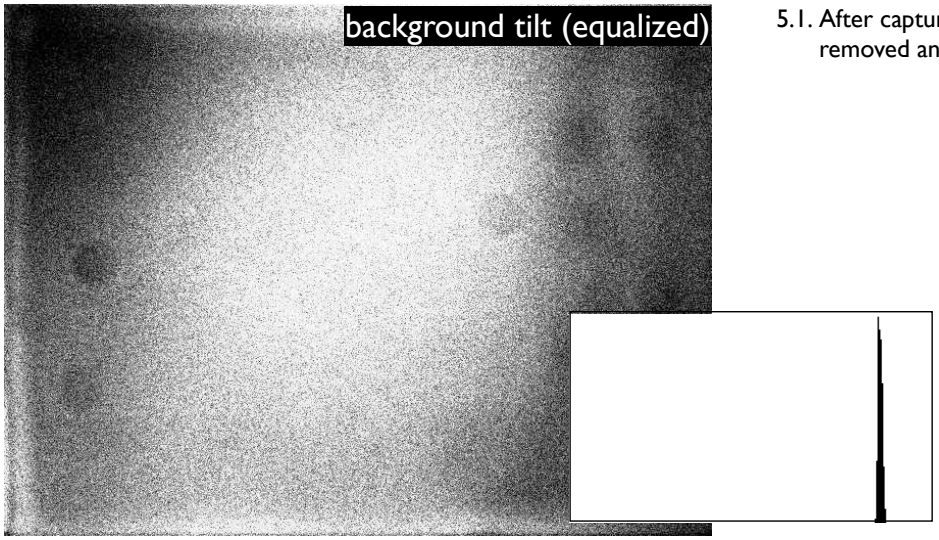
Using the DepthOf Focus command, each of the tilt stacks is merged to form one completely focused image.

Remember that the selected exposure remains constant for all rotations and all tilts.



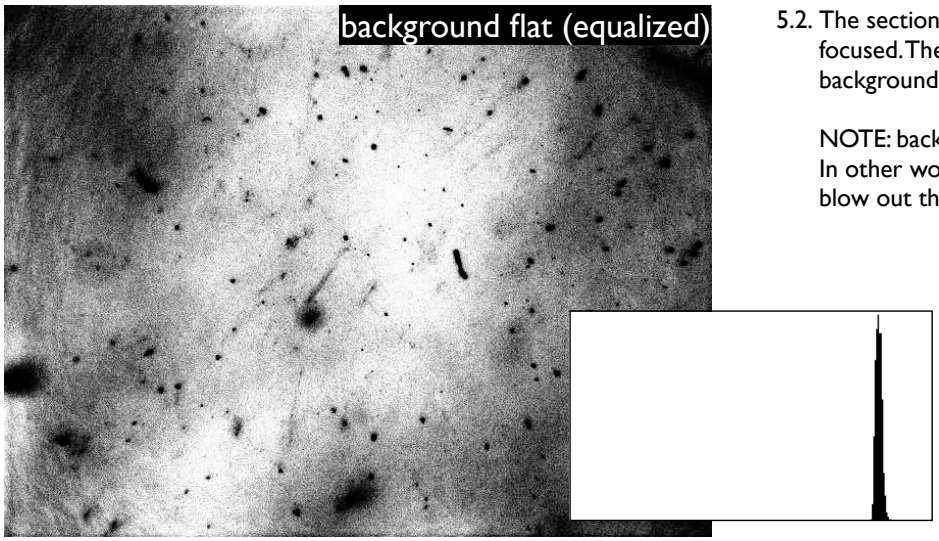
Acquiring the input

5. Back ground images



213mn_10x-071-bg-tilt.tif
mean=217.486

5.1. After capturing the last tilt image, the thin section is removed and the background image is acquired.



213mn_10x-071-bg-flat.tif
mean=216.482

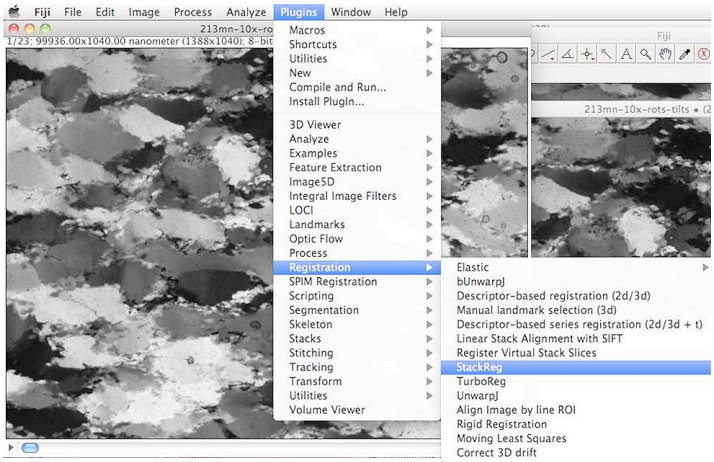
5.2. The section is introduced again in the flat position and focused. Then the section is removed again and a second background image is taken.

NOTE: background images do not have to be that messy ... In other words: clean the microscope before use - at least, blow out the dust.

The difference between the mean grey values 1.004 gray values.

The **bg-flat** is used to correct the background of all images except the tilted ones.
The **bg-tilt** is used to correct the tilted images.

Assembling the Input Stack



1. Registration of rotation and tilt images

A separate stack containing
- 19 rotation images: file.000 .... file.180
- 4 tilt images: EUP - SUP - WUP - NUP (clockwise)

is created.

Fiji is used to perfectly match the rotation and tilt images

(In the course of the Stack Registration, the images are inverted)

Credits:

This work is based on the following paper:

P. Thévenaz, U.E. Ruttimann, M. Unser
A Pyramid Approach to Subpixel Registration Based on Intensity
IEEE Transactions on Image Processing
vol. 7, no. 1, pp. 27-41, January 1998.

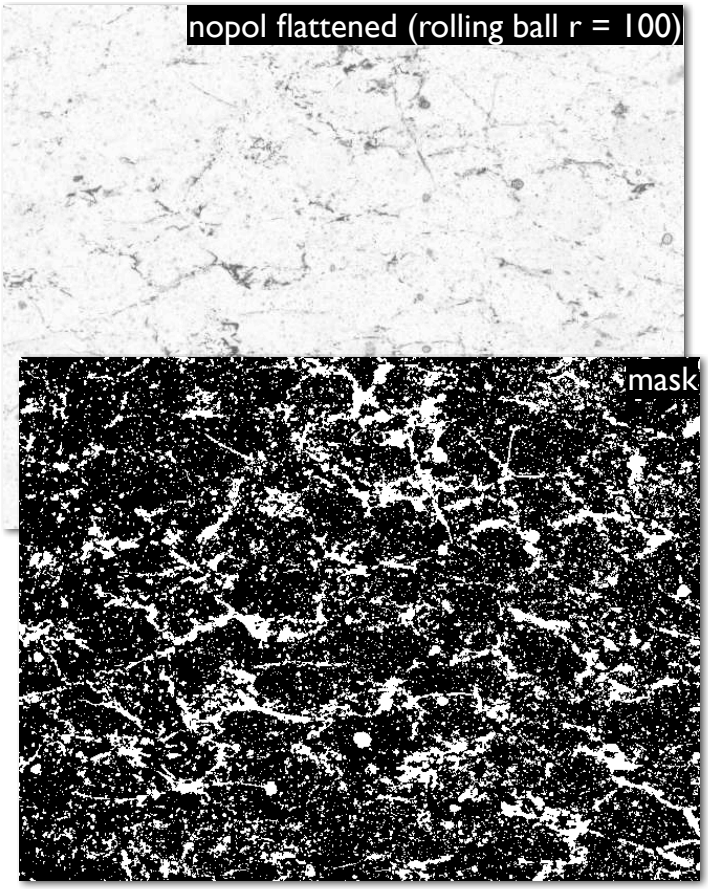
This paper is available on-line at
http://bigwww.epfl.ch/publications/thevenaz9801.html

Other relevant on-line publications are available at
http://bigwww.epfl.ch/publications/

Additional help available at
http://bigwww.epfl.ch/thevenaz/stackreg/

Ancillary TurboReg_ plugin available at
http://bigwww.epfl.ch/thevenaz/turboreg/

You'll be free to use this software for research purposes, but you should not redistribute it without our consent. In addition, we expect you to include a citation or acknowledgment whenever you present or publish results that are based on it.



In Image SXM again, Lazy Prepstack is used to back-invert the rotation and tilt images.

The cirpol and nopol image are introduced at the start (slice 1 and 2), and registered to the first rotation image (slice 3: file.000) by hand.

The nopol image may be flattened using a rolling ball with 100 pixels radius. A duplicate can be used and converted to a mask (white = mask).

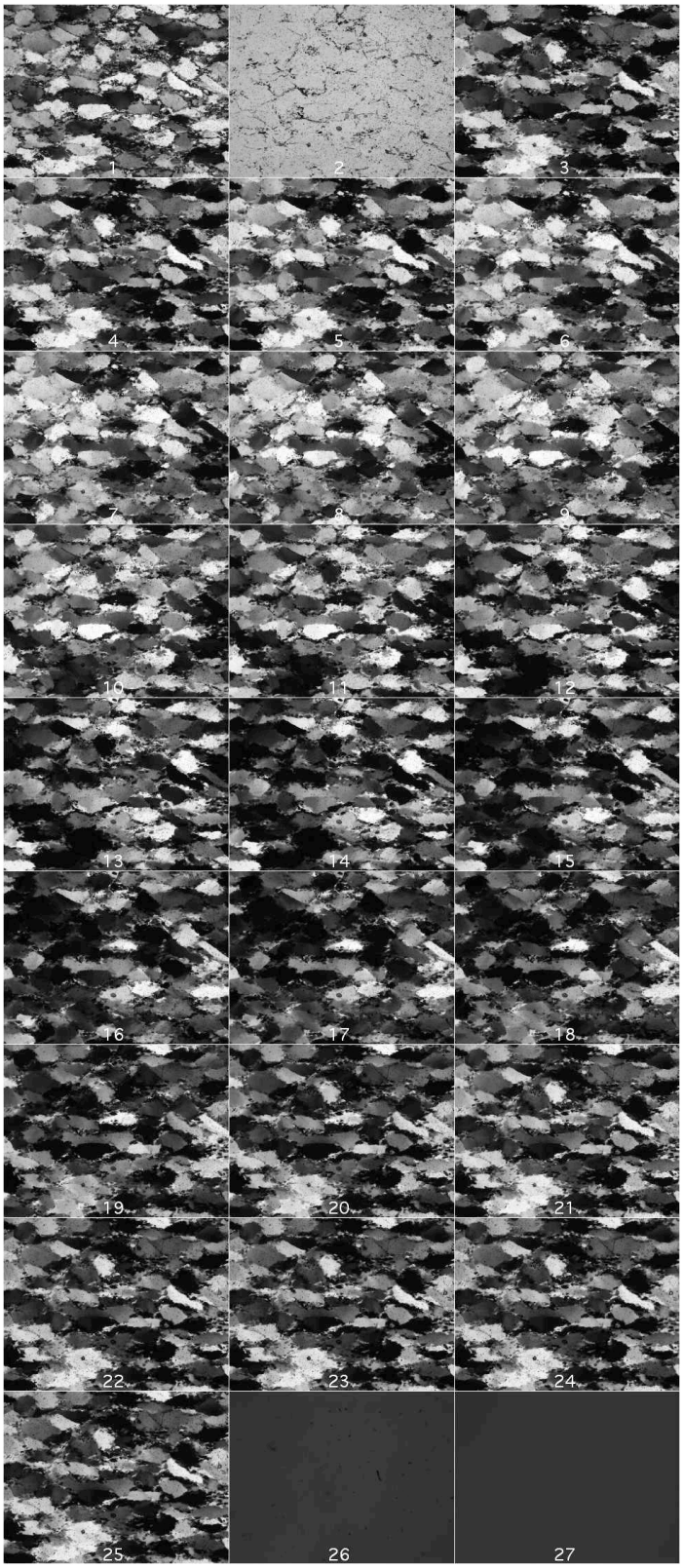
The rotation images are now on slice 3-21.

The tilt images are on slice 22-25.

The background images are placed at the end of the stack (slices 26 and 27).

The stack is cropped: here a final size of 1300 · 1000 is used.

The input stack (TIFF) - the input images (RAW)



The input stack

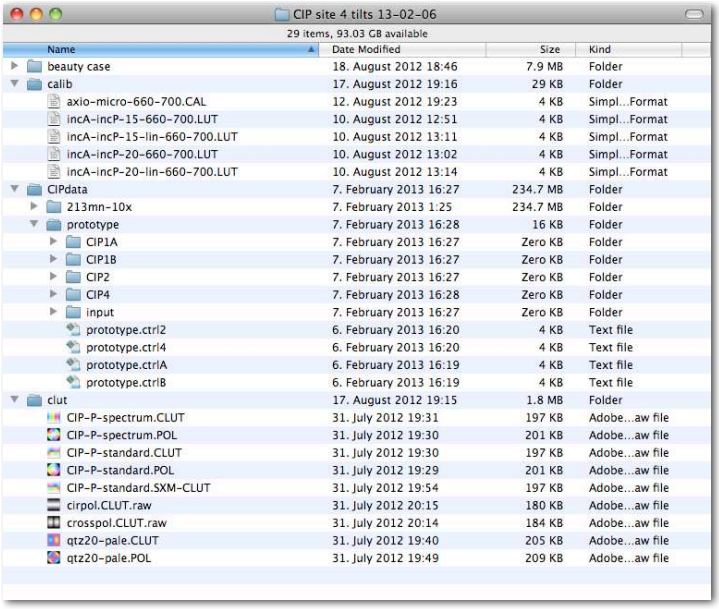
file.stamacrop (stack matched and cropped)

1. cirpol
2. nopol
3. rot.000
4. rot.010
5. rot.020
6. rot.030
7. rot.040
8. rot.050
9. rot.060
10. rot.070
11. rot.080
12. rot.090
13. rot.100
14. rot.110
15. rot.120
16. rot.130
17. rot.140
18. rot.150
19. rot.160
20. rot.170
21. rot.180
22. eup
23. sup
24. wup
25. nup
26. backFlat
27. backTilt

Using the Lazy Prepstack marco, the slices can be exported to single RAW images → CIP

prepare mask and add to input

Preparing a 'CIP site' on the Mac


CIP site 4 tilts 13-02-06

29 items, 93.03 GB available

Name	Date Modified	Size	Kind
beauty case	18. August 2012 18:46	7.9 MB	Folder
calib	17. August 2012 19:16	29 KB	Folder
axio-micro-660-700.CAL	12. August 2012 19:23	4 KB	Simpl...Format
incA-incP-15-660-700.LUT	10. August 2012 12:51	4 KB	Simpl...Format
incA-incP-15-lin-660-700.LUT	10. August 2012 13:11	4 KB	Simpl...Format
incA-incP-20-660-700.LUT	10. August 2012 13:02	4 KB	Simpl...Format
incA-incP-20-lin-660-700.LUT	10. August 2012 13:14	4 KB	Simpl...Format
CIPdata	7. February 2013 16:27	234.7 MB	Folder
213mn-10x	7. February 2013 1:25	234.7 MB	Folder
prototype	7. February 2013 16:28	16 KB	Folder
CIP1A	7. February 2013 16:27	Zero KB	Folder
CIP1B	7. February 2013 16:27	Zero KB	Folder
CIP2	7. February 2013 16:27	Zero KB	Folder
CIP4	7. February 2013 16:28	Zero KB	Folder
input	7. February 2013 16:27	Zero KB	Folder
prototype.ctrl2	6. February 2013 16:20	4 KB	Text file
prototype.ctrl4	6. February 2013 16:20	4 KB	Text file
prototype.ctrlA	6. February 2013 16:19	4 KB	Text file
prototype.ctrlB	6. February 2013 16:19	4 KB	Text file
clut	17. August 2012 19:15	1.8 MB	Folder
CIP-P-spectrum.CLUT	31. July 2012 19:31	197 KB	Adobe...aw file
CIP-P-spectrum.POL	31. July 2012 19:30	201 KB	Adobe...aw file
CIP-P-standard.CLUT	31. July 2012 19:30	197 KB	Adobe...aw file
CIP-P-standard.POL	31. July 2012 19:29	201 KB	Adobe...aw file
CIP-P-standard.SXM-CLUT	31. July 2012 19:54	197 KB	Adobe...aw file
cirpol.CLUT.raw	31. July 2012 20:15	180 KB	Adobe...aw file
crosspol.CLUT.raw	31. July 2012 20:14	184 KB	Adobe...aw file
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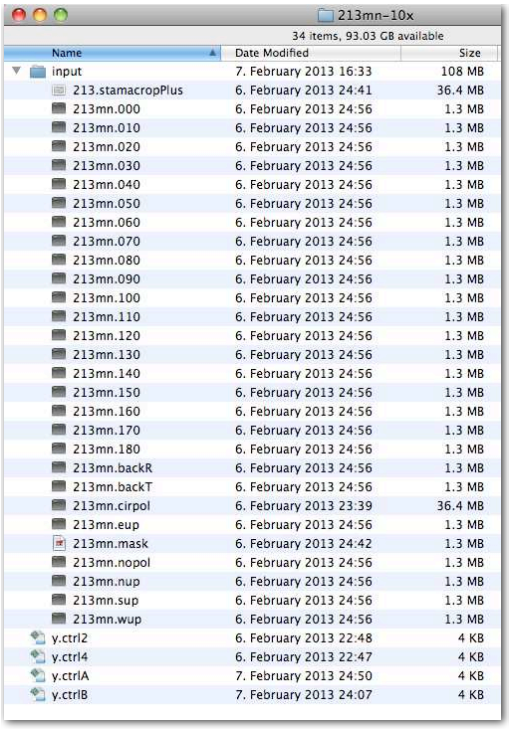
qtz20-pale.POL	31. July 2012 19:49	209 KB	Adobe...aw file

Prepare CIP site


213mn-10x

34 items, 93.03 GB available

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213mn.000	6. February 2013 24:56	1.3 MB
213mn.010	6. February 2013 24:56	1.3 MB
213mn.020	6. February 2013 24:56	1.3 MB
213mn.030	6. February 2013 24:56	1.3 MB
213mn.040	6. February 2013 24:56	1.3 MB
213mn.050	6. February 2013 24:56	1.3 MB
213mn.060	6. February 2013 24:56	1.3 MB
213mn.070	6. February 2013 24:56	1.3 MB
213mn.080	6. February 2013 24:56	1.3 MB
213mn.090	6. February 2013 24:56	1.3 MB
213mn.100	6. February 2013 24:56	1.3 MB
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213mn.120	6. February 2013 24:56	1.3 MB
213mn.130	6. February 2013 24:56	1.3 MB
213mn.140	6. February 2013 24:56	1.3 MB
213mn.150	6. February 2013 24:56	1.3 MB
213mn.160	6. February 2013 24:56	1.3 MB
213mn.170	6. February 2013 24:56	1.3 MB
213mn.180	6. February 2013 24:56	1.3 MB
213mn.backR	6. February 2013 24:56	1.3 MB
213mn.backT	6. February 2013 24:56	1.3 MB
213mn.cirpol	6. February 2013 23:39	36.4 MB
213mn.eup	6. February 2013 24:56	1.3 MB
213mn.mask	6. February 2013 24:42	1.3 MB
213mn.nopol	6. February 2013 24:56	1.3 MB
213mn.nup	6. February 2013 24:56	1.3 MB
213mn.sup	6. February 2013 24:56	1.3 MB
213mn.wup	6. February 2013 24:56	1.3 MB
y.ctrl2	6. February 2013 22:48	4 KB
y.ctrl4	6. February 2013 22:47	4 KB
y.ctrlA	7. February 2013 24:50	4 KB
y.ctrlB	7. February 2013 24:07	4 KB

Prepare sample folder

Open Terminal

Terminal — bash — 80×25

```
gpi-051021:~ rheilbronner$
gpi-051021:~ rheilbronner$ cd /Users/rheilbronner/Desktop/2013CIP/CIP\ site\ 4\
tilts\ 13-02-06/CIPdata/prototype
gpi-051021:prototype rheilbronner$ ls
CIP1A           CIP2            input           prototype.ctrl4 prototype.ctrlB
CIP1B           CIP4            prototype.ctrl2 prototype.ctrlA
gpi-051021:prototype rheilbronner$
gpi-051021:prototype rheilbronner$
gpi-051021:prototype rheilbronner$ ls ../../CLUT
CIP-P-spectrum.CLUT     CIP-P-standard.POL      crosspol.CLUT.raw
CIP-P-spectrum.POL      CIP-P-standard.SXM-CLUT qtz20-pale.CLUT
CIP-P-standard.CLUT     cirpol.CLUT.raw         qtz20-pale.POL
gpi-051021:prototype rheilbronner$ ls ../../calib
axio-micro-660-700.CAL          incA-incP-20-660-700.LUT
incA-incP-15-660-700.LUT        incA-incP-20-lin-660-700.LUT
incA-incP-15-lin-660-700.LUT
gpi-051021:prototype rheilbronner$
```

Set path to folder with data
show folder contents

show content of CLUT

show content of calib

Introductory CIP - the '4-tilt intro' run

Prepare control file file.ctrlA for the '4-tilt-intro' run

```
cip---------INPUT----------
1) Title of problem
sample 'prototype'  4 tilts  cirpol pre-corrected
2a) x- and y dimension
1300,1000
2b) no.of tilts,tilt-type (2 tilts:"2,012"=soft-EUP-SUP,"2,134"=stiff-WUP-NUP,etc., 4 tilts:"4,0"=soft,"4,1"=stiff)
4,0
2c) Corrections ROT-bg,TILT-bg,FLARE,cirpol-camera? (0=don't 1=do)
1,1,1,0
2d) Reference direction for misorientation (N=0,90 E=90,90)
45,52
3) Rotation images (Number = N$ROT):
   at 10 degrees
input/prototype.010
   at 20 degrees
input/prototype.020
   at 30 degrees
input/prototype.030
.....................etc.
.....................etc.
   at 150 degrees
input/prototype.150
   at 160 degrees
input/prototype.160
   at 170 degrees
input/prototype.170
   at 180 degrees
input/prototype.180
4a) Tilt images (Number = N$TILT):
   First East up
input/prototype.eup
   Second South up
input/prototype.sup
   Third West up
input/prototype.wup
   Fourth North up
input/prototype.nup
4b)  Use CirPOL (=N$INCPOL=2) or AMPlitude (=N$INCAMP=3)
2
5) Circular polarisation (Number = 1):
input/prototype.cirpol
6a) Background for ROT etc. images
input/prototype.backR
6b) Background for TILT images
input/prototype.backT
7) Calibration of program and camera
../../calib/axio-micro-660-700.CAL
8) Calibration of inclination
../../calib/incA-incP-20-lin-660-700.LUT
9) Stereographic Colour Lookup Table
../../clut/CIP-P-standard.CLUT
cip---------CIP1results----------
1) Primary result files
             max value
CIP1A/prototype.MAX
             min value
CIP1A/prototype.MIN
             phase of max
CIP1A/prototype.FMAX
             tilt indicator
CIP1A/prototype.Tindex
             error
CIP1A/prototype.ERR
2) Final result files
             azi
CIP1A/prototype.AZI
             inc from polarization
CIP1A/prototype.INCP
             inc from amplitude
CIP1A/prototype.INCA
             edges from polarization
CIP1A/prototype.EDGP
             edges from amplitude
CIP1A/prototype.EDGA
         absolute misorientation from North (0,90)
CIP1A/prototype.MISN
         absolute misorientation from East (90,90)
CIP1A/prototype.MISE
         absolute misorientation from UP (0,0)
CIP1A/prototype.MISH
         absolute misorientation from ref.direction
CIP1A/prototype.MIS-45-52
3) c-axis orientation image (NON-INTERLEAVED)
CIP1A/prototype.COI1A.raw
4) histogram of azi/dip (5° boxes) as from MENTEX -> INVPIMA
CIP1A/prototype.CPF
```

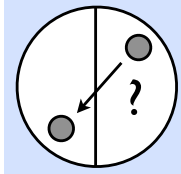
description of sample

x- y- dimension

no. of tilts = 4, type = soft

background corrections for rot and tilt, flare correction, no camera correction for cirpol

azi / inc of octahedral plane



primary orientation:
0 ≤ azi ≤ 180
0 ≤ inc ≤ 90

criterion for switch:
differences WUP-EUP and SUP-NUP
SOFT switch if diff ≥ 0
STIFF switch if diff > 0

folder/filename of 10° rot

folder/filename of 20° rot

folder/filename of 30° rot

folder/filename of 150° rot

folder/filename of 160° rot

folder/filename of 170° rot

folder/filename of 180° rot

folder/filename of EastUp

folder/filename of SouthUp

folder/filename of WestUp

folder/filename of NorthUp

clockwise from E

folder/filename of cirpol

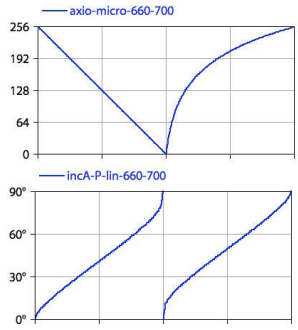
folder/filename of background flat

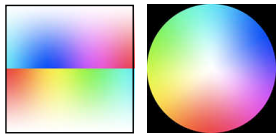
folder/filename of background tilted

path to camera calibration file

path to inclination calibration

path to color look-up table





CLUT

folder/filename for derived maximum gray value

folder/filename for derived minimum gray value

folder/filename for angle of maximum GV

folder/filename tilt index 255 if switch, 0 if no switch

folder/filename for (curve fit) errors

folder/filename for AZIMUTH

folder/filename for INCLINATION from cirpol

folder/filename for INCLINATION from amplitude

folder/filename for orientation gradient from INCP

folder/filename for orientation gradient from INCA

folder/filename for misorientation w/r North

folder/filename for misorientation w/r East

folder/filename for misorientation w/r Heaven

folder/filename for misorientation w/r to reference direction (octahedral plane)

folder/filename for c-axis orientation image

folder/filename for pole density matrix (used for pole figure)

names that have to be provided

Run cip1A for 4 tilts - raw cirpol - INCP - 0-95%

```
macbook$ cip1a
 ------------------------------------------------
 *cip1a: azi, err, inca, incp, max, min, Tindex, Windex
        maximum image size is      1542288
        re-written for macosx and g77      june-06
        inclinations >90 wrap around       june-08
        inclinations <90 wrap (corrected)   feb-10
        writes wrap index into fmax file    mar-11
        cirpol background sub corrected     aug-12
        does 4 tilts                        feb-13
 ------------------------------------------------
  ***** calling control
 name of controle file >
y.ctrla
 no.of tilts and tilt type:      4    0
 back1,back2,flaresub,camcorr:      1    1    1    1
 ../../calib/axio-micro-660-700.CAL
 ../../calib/incA-incP-20-lin-660-700.LUT
 ------------------------------------------------
  ***** calling readfiles
 input/prototype.010
 input/prototype.020
 input/prototype.030
 input/prototype.040
 input/prototype.050
 input/prototype.060
 input/prototype.070
 input/prototype.080
 input/prototype.090
 input/prototype.100
 input/prototype.110
 input/prototype.120
 input/prototype.130
 input/prototype.140
 input/prototype.150
 input/prototype.160
 input/prototype.170
 input/prototype.180
 input/prototype.eup
 input/prototype.sup
 input/prototype.wup
 input/prototype.nup
 input/prototype.cirpol
 input/prototype.backR
 input/prototype.backT
 ------------------------------------------------
  ***** calling viewpix
 viewpix: x,y coordinates (end = (0,0)) >
0,0
 ------------------------------------------------
  ***** calling calibrate
 ------------------------------------------------
  ***** calling viewpix after calibration *****
 viewpix: x,y coordinates (end = (0,0)) >
0,0
 ------------------------------------------------
```

type:
./cip1A if exe is in folder
cip1A if exe is in /usr/local/bin

name of control file

no pixel is viewed before calibration

no pixel is viewed after calibration

input that has to be provided

Run cip1A for 4 tilts - raw cirpol - INCP - 0-95%

```
 inca:

+  16 *
+  32 ***
+  48 *****
+  64 ********
+  80 *********
+  96 *********
+ 112 **********
+ 128 ************
+ 144 **************
+ 160 ********************
+ 176 ********************************************
+ 192 ************************************************
+ 208
+ 224
+ 240
+ 256
```

	0 %	1 %	2 %	5 %	95 %	98 %	99 %	100 %
amplitude image incamp 0-1-2-5-95-98-99-100 % =	0	18	28	45	186	189	191	210

```
 input cut-off values (min,max) >
0,186

 incp:

+  16 ********
+  32 ************
+  48 ***************
+  64 ******************
+  80 ********************
+  96 ************************
+ 112 ********************************
+ 128 ************************************
+ 144 ****************************************
+ 160 ********************************************
+ 176 ************************************************
+ 192 *********
+ 208
+ 224
+ 240
+ 256
```

	0 %	1 %	2 %	5 %	95 %	98 %	99 %	100 %
inclination image from cirpol 0-1-2-5-95-98-99-100 % =	0	7	14	28	174	178	181	230

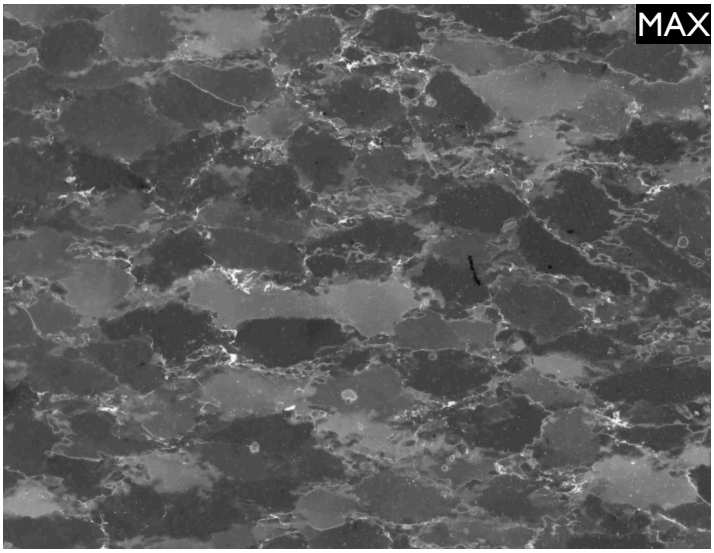
```
 input cut-off values (min,max) >
0,174
 ------------------------------------------------
  ***** calling writeprimary
 ------------------------------------------------
  ***** calling writefiles
 ------------------------------------------------
  ***** calling polefigure
-> maximum of polefigure is at (25, 5):      6.26243
 ------------------------------------------------
  ***** calling ava
  polamp=2 => cirpol used for coi
  name of clut:
 ../../clut/CIP-P-standard.CLUT
```

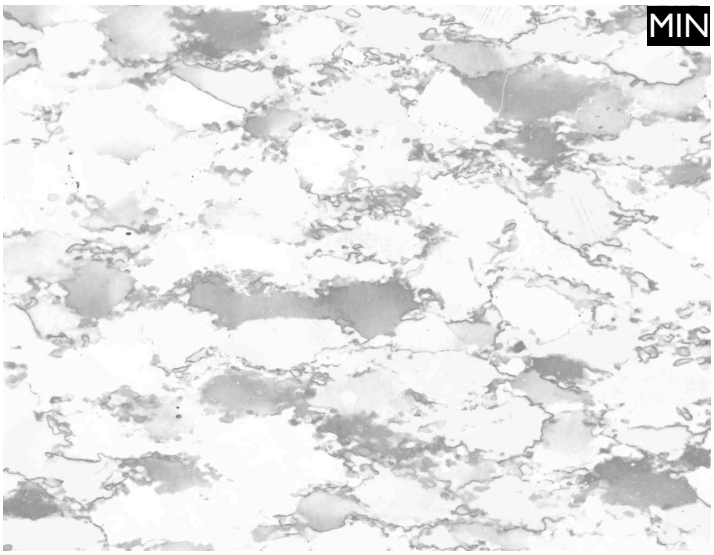
type GV of 0% and 95% cut-off

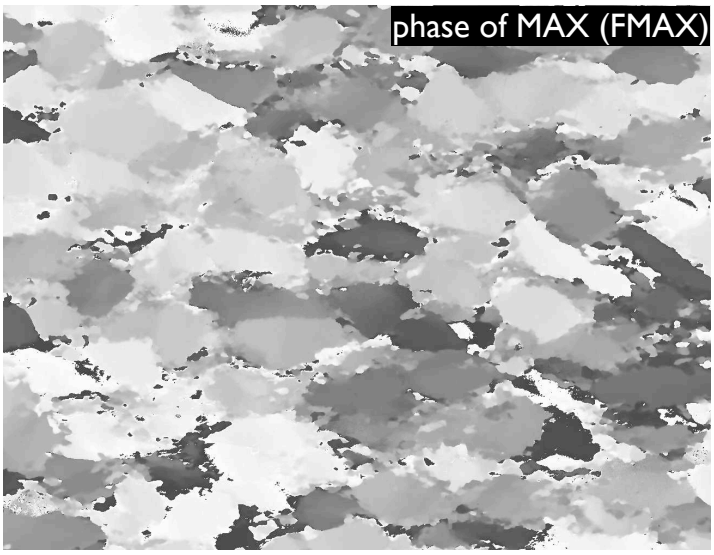
maximum within half halfspace

input that has to be provided

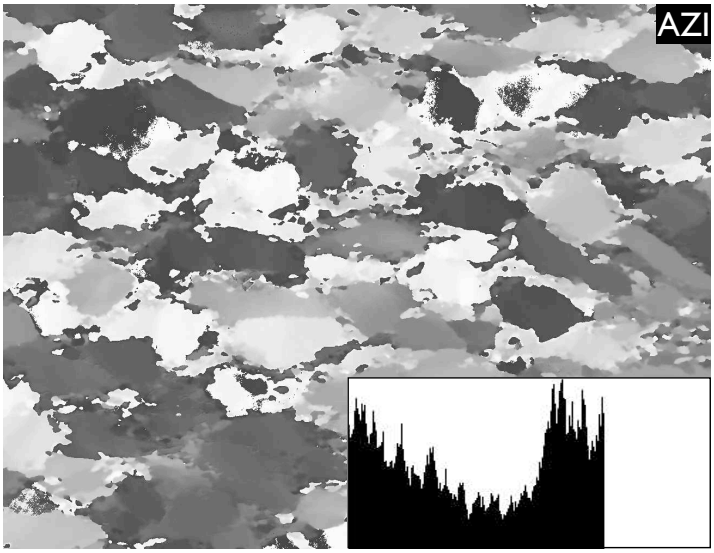
CIP1A results for 4 tilts - raw cirpol - INCP - 0-95%

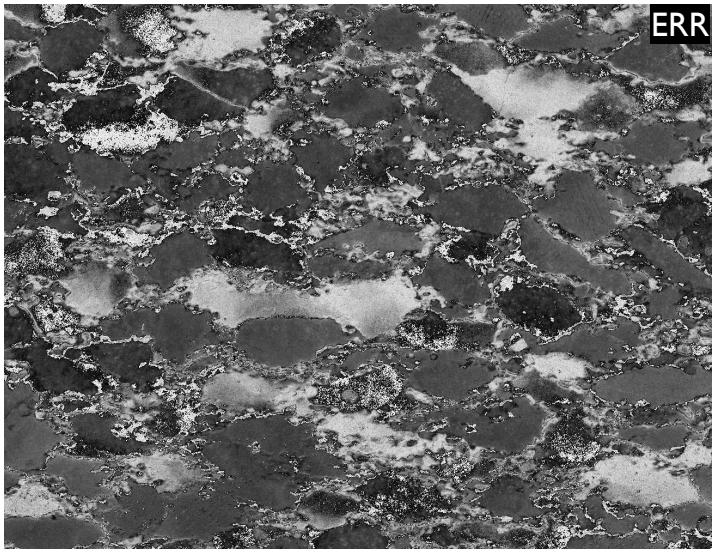


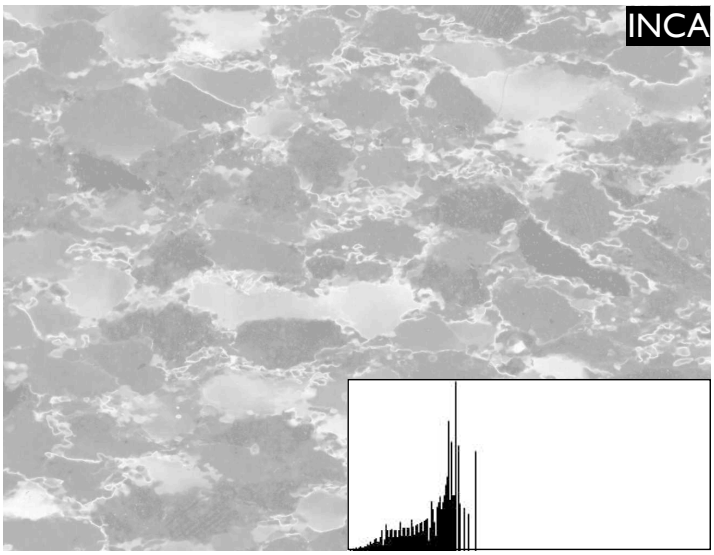


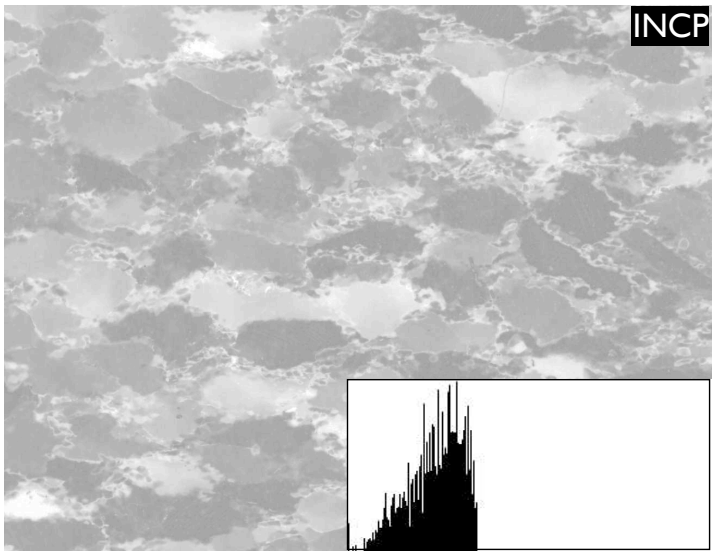


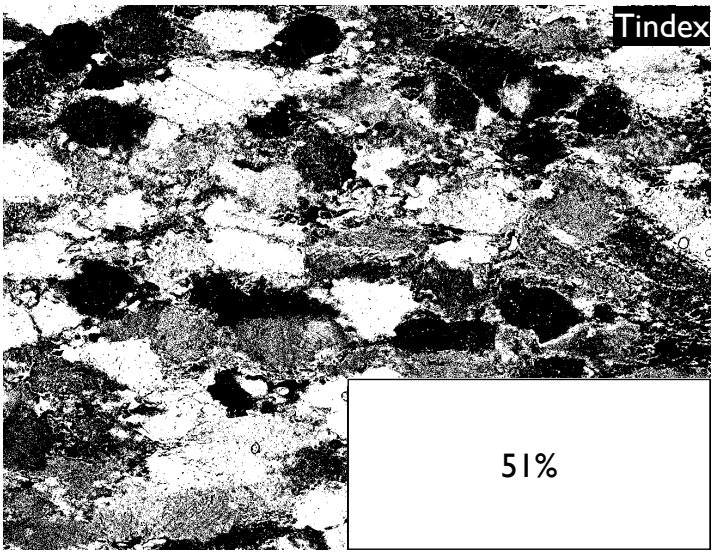
CIP1A results for 4 tilts - raw cirpol - INCP - 0-95%

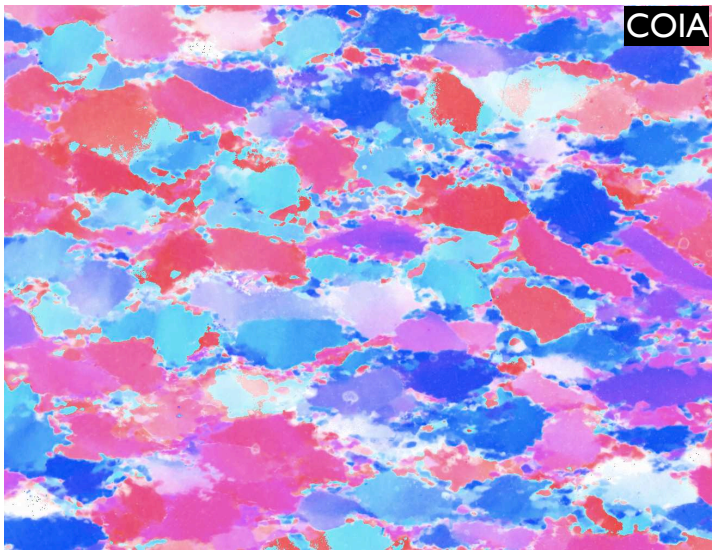


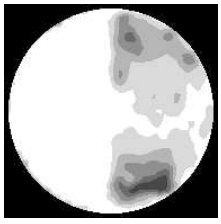




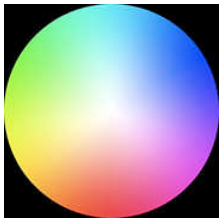








max = 6.3 / 8



Prepare control file file.ctrlB for the '4-tilt-intro' run

```
cip---------INPUT----------
1) Title of problem
sample 'prototype'  4 tilts  cirpol pre-corrected
2a) x- and y dimension
1300,1000
2b) no.of tilts,tilt-type (2 tilts:"2,012"=soft-EUP-SUP,"2,134"=stiff-WUP-NUP,etc., 4 tilts:"4,0"=soft,"4,1"=stiff)
4,0
2c) Corrections ROT-bg,TILT-bg,FLARE,cirpol-camera? (0=don't 1=do)
1,1,1,0
2d) Reference direction for misorientation (N=0,90 E=90,90)
45,52
3) azi image:
CIP1A/prototype.AZI
4) inc0 images (0-90):
CIP1A/prototype.INCP
5) T-index file (switch where GV > 0):
CIP1A/prototype.Tindex
7) Calibration of program and camera
../../calib/axio-micro-660-700.CAL
8) Calibration of inclination
../../calib/incA-incP-20-lin-660-700.LUT
9) Stereographic Colour Lookup Table
../../clut/CIP-P-standard.CLUT
cip---------CIP1results----------
1) Final result files
CIP1B/prototype.INC
2) c-axis orientation image (NON-INTERLEAVED)
CIP1B/prototype.COI1B.raw
3) histogram of azi/dip (5° boxes) as from MENTEX -> INVPIMA
CIP1B/prototype.CPF
```

description of sample

x- y- dimension

no. of tilts = 4, type = soft

background corrections (see prototype.ctrlA)

azi / inc of octahedral plane

folder/filename of azimuth

folder/filename of preliminary inclination 0°-90°

folder/filename of Tilt Index file

path to camera calibration file

path to inclination calibration

path to color look-up table

folder/filename for derived full inclination 0°-180°

folder/filename for c-axis orientation image

folder/filename for pole density matrix (used for pole figure)

names that have to be provided

Run cip1B for 4 tilts - raw cirpol - INCP - 0-95%

```
macbook$ cip1b
 ------------------------------------------------
 *cip1b: azi/inc  from  azi/inc/tindex
         no polefigure !
         maximum image size is      1542288
         re-written for macosx and g77      june-06
         last update                       march-07
 ------------------------------------------------
  ***** calling control
 name of controle file >
 y.ctrlb
  ../../calib/axio-micro-660-700.CAL
  ../../calib/incA-incP-20-lin-660-700.LUT
  ------------------------------------------------
   ***** calling readfiles
  CIP1A/prototype.AZI
  CIP1A/prototype.INCP
  CIP1A/prototype.Tindex
  ------------------------------------------------
   ***** calling convert2
   ***** calling writefiles
  ------------------------------------------------
   ***** calling ava
  ../../clut/CIP-P-standard.CLUT
```

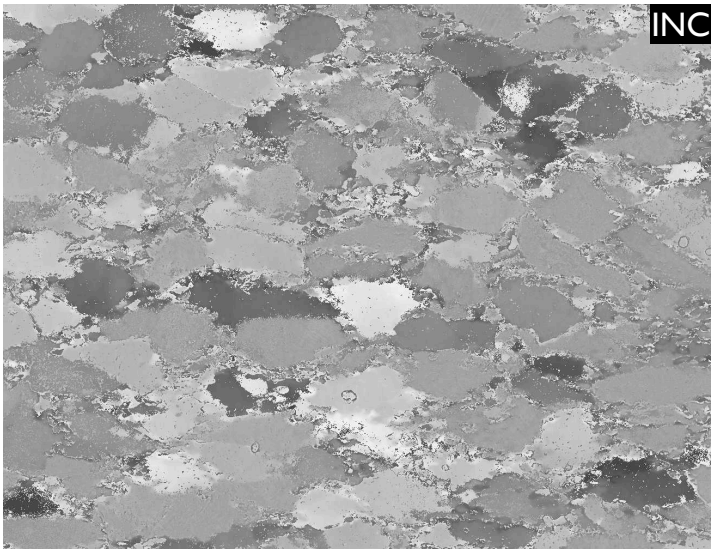
type:
./cip1B if exe is in folder
cip1B if exe is in /usr/local/bin

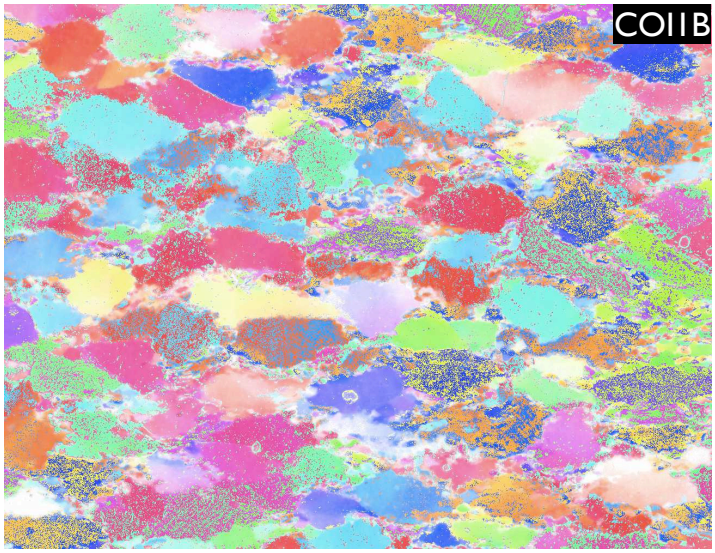
name of control file

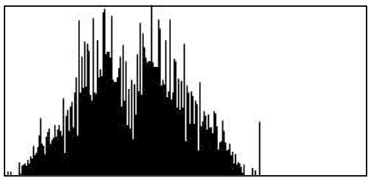
reading input files

input that has to be provided

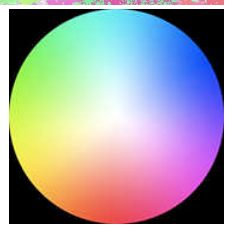
CIP1B results for original cirpol - 0-95% - INCP

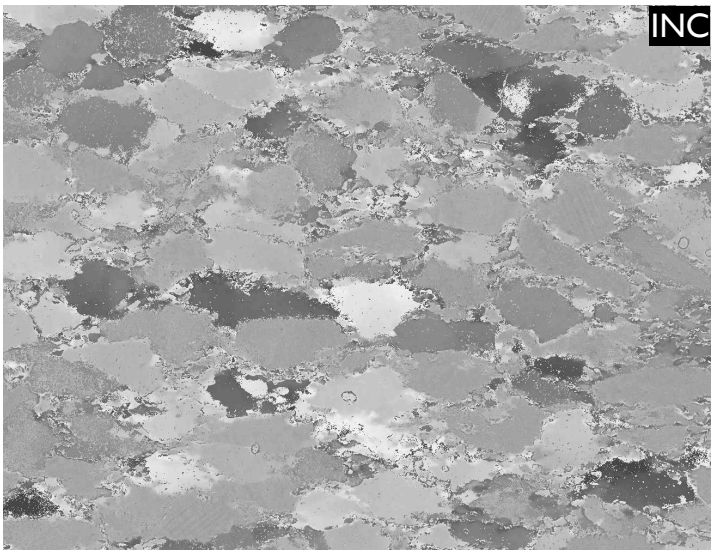


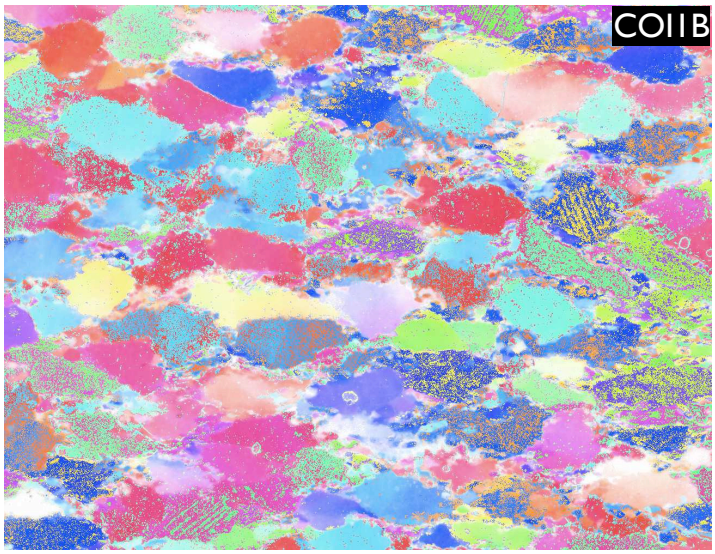


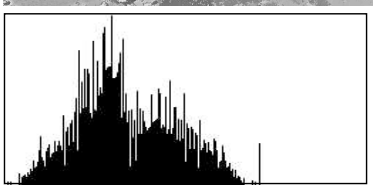


soft 4 tilts

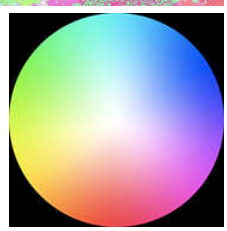








stiff 4 tilts



Prepare control file file.ctrl2 for the '4-tilt-intro' run

```
cip---------INPUT----------
1) Title of problem
sample 'prototype'  4 tilts  cirpol pre-corrected
2a) x- and y dimension
1300,1000
3) Reference direction for misorientation (N=0,90 E=90,90)
45,90
4) Masking for pole figure and orientation image ? (1=yes, 0=no)
1
5) Want misorientation, edge and orientation image ? (1=yes, 0=no)
1,1,1
6) Pole figure correction 1=sin(inc) 2=sin(inc-1/2) 3=-5°-95° 4=sqrt(), 5=sin(delta)
1
7) Stereographic Colour Lookup Table
../../clut/CIP-P-spectrum.CLUT
cip---------INPUT FILES----------
1)   azimuth file
CIP1A/prototype.azi
2)   inclination file
CIP1B/prototype.inc
3)   masking file (0 where o.k. >0 where masked)  ( different from CIP1 !!!)
input/prototype.mask
cip---------OUTPUT IMAGES----------
1)   edges using 2 neighbours                    ( different from CIP1 !!!)
CIP2/prototype.EDG2s
2)   edges using 4 neighbours                    ( different from CIP1 !!!)
CIP2/prototype.EDG4a
3)   absolute misorientation from North (0,90)
CIP2/prototype.MISN2
4)   absolute misorientation from East (90,90)
CIP2/prototype.MISE2
5)   absolute misorientation from UP (0,0)
CIP2/prototype.MISH2
6)   absolute misorientation from ref.direction
CIP2/prototype.MIS-45-90
7)   c-axis orientation image (NON-INTERLEAVED)
CIP2/prototype.COI2.raw
8)   histogram of azi/dip (5° boxes) as from MENTEX -> INVPIMA
CIP2/prototype.CPF2
9)   pole figure image (36*36) -> Lazy Pole
CIP2/prototype.PFIG2
```

description of sample

x- y- dimension

reference orientation

masking yes

want all types of mis-/orientation images

standard pole density correction

path to color look-up table

input: azimuth file

input: inclination file

input: mask

folder/filename for OGI 2 neignbours

folder/filename for OGI 4 neignbours

folder/filename for MOI w/r to North

folder/filename for MOI w/r to East

folder/filename for MOI w/r to Heaven

folder/filename for MOI w/r to reference direction

folder/filename for COI

folder/filename for pole density matrix (180 · 180)

folder/filename for stereo pole figure matrix (36 · 36)

names that have to be provided

Run cip2 for 4 tilts - raw cirpol - INCP - 0-95%

```
macbook$ cip2
 ---------------------------------------------------
  cip2:  coi/mis/edg  from  azi/inc/mask
         maximum image size is      6000000
         re-written for macosx and g77          apr-04
   >>>   reads square (CLUT) and stereo (POL)
  edg2s  sum of difference with 2 neighbours (0-180)
  edg4a  2*av of difference with 4 neighbours (0-180)
         last update (polfig correction)     march-07
         last update (edges)                august-07
  +MASK  considers mask in misor and edge     june-08
 ---------------------------------------------------
 *calling control
 name of controle file :
y.ctrl2
 ---------------------------------------------------
 *calling readfiles
 *calling readfiles: azi
 CIP1A/prototype.azi
 *calling readfiles: inc
 CIP1B/prototype.inc
 *calling readfiles: mask
 input/prototype.mask
 *   xdim*ydim=itot         1300        1000     1300000
 ---------------------------------------------------
 *calling segment
 ---------------------------------------------------
 *calling writefiles
 CIP2/prototype.EDG2s
 CIP2/prototype.EDG4a
 CIP2/prototype.MISN2
 CIP2/prototype.MISE2
 CIP2/prototype.MISH2
 CIP2/prototype.MIS-45-90
 ---------------------------------------------------
 *calling polefigure using mask
 *   imask =              1  (0=no,1=yes)
 *   polcorr =            1  (option 1-5)
 --> maximum of polefigure is at (25, 5):     5.53562
 ---------------------------------------------------
 *calling ava
 ../../clut/CIP-P-spectrum.CLUT
```

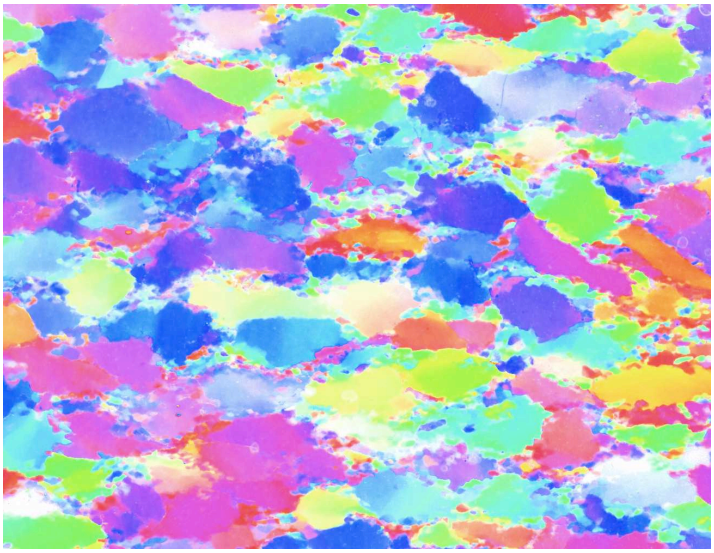
type:
./cip2 if exe is in folder
cip2 if exe is in /usr/local/bin

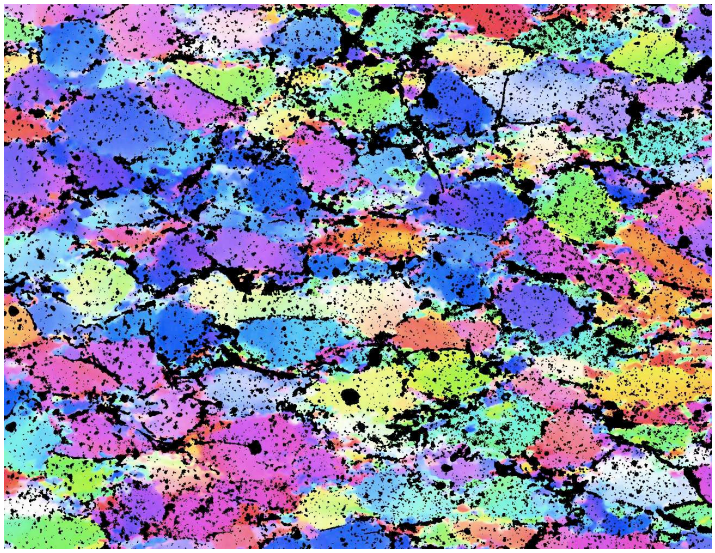
name of control file

maximum of pole figure
(need to note this number)

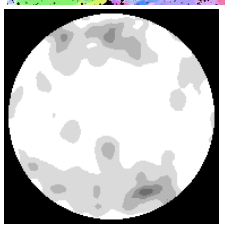
input that has to be provided

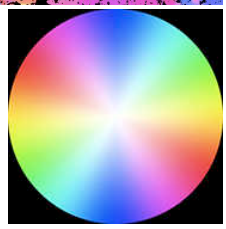
CIP2 results for original cirpol - 0-95% - INCP



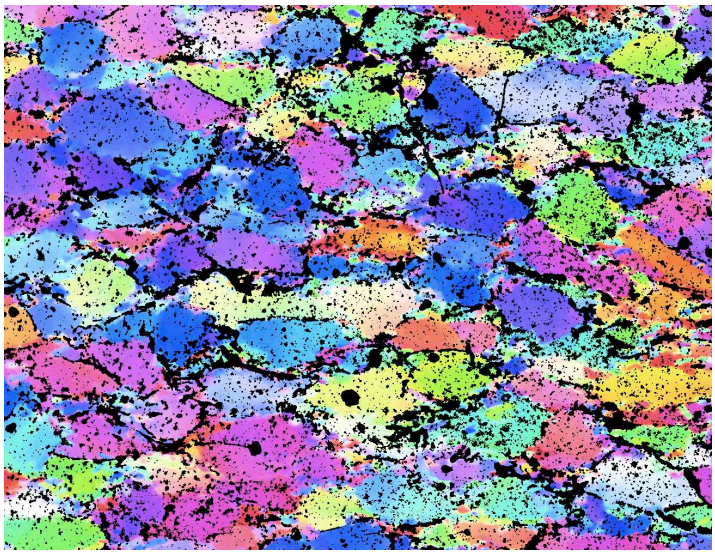


soft 4 tilts

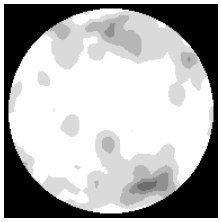


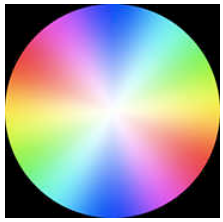


max = 5.5 / 8



stiff 4 tilts

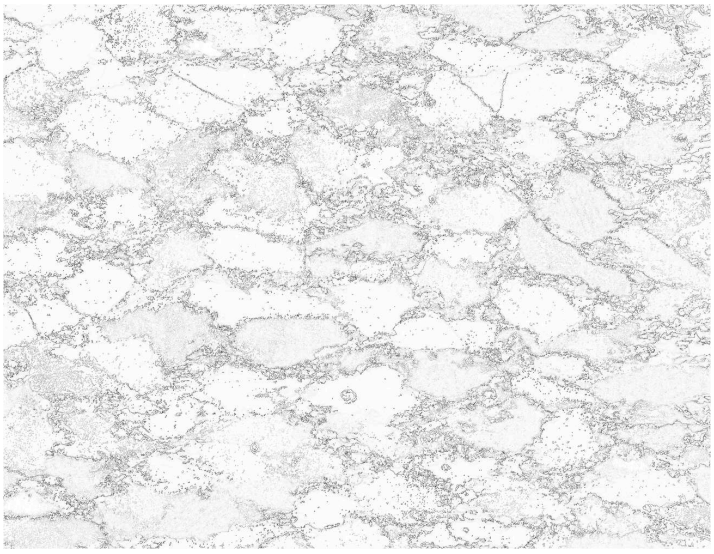




max = 5.8 / 8

CIP2 results for original cirpol - 0-95% - INCP

SOFT - unmasked

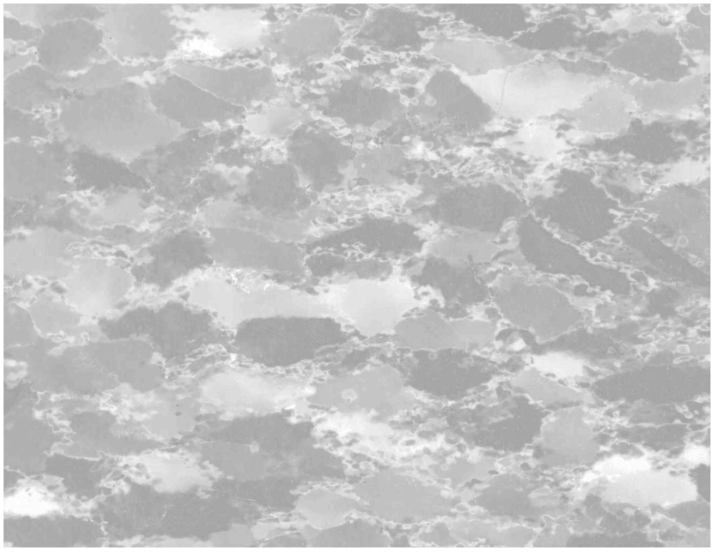


edg2s

edg4a

mis-45-90

misE2

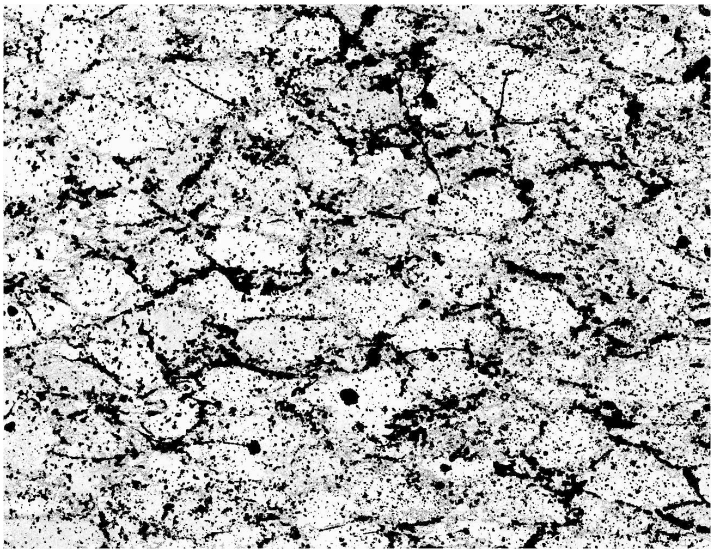


misH2

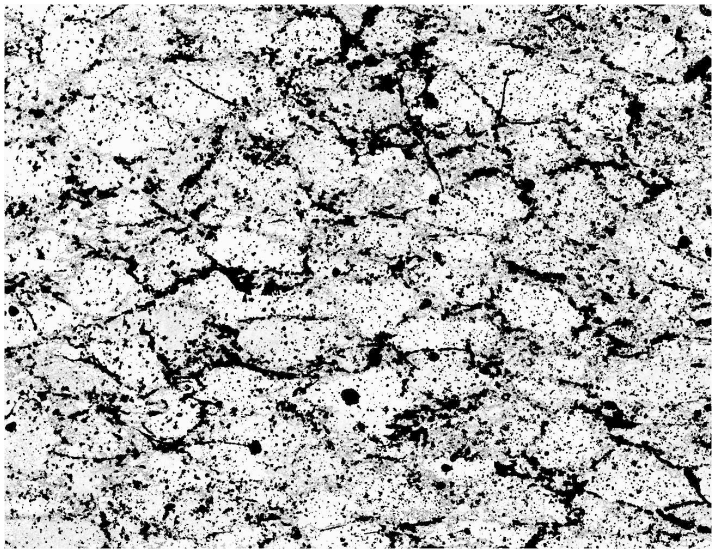
misN2

CIP2 results for original cirpol - 0-95% - INCP

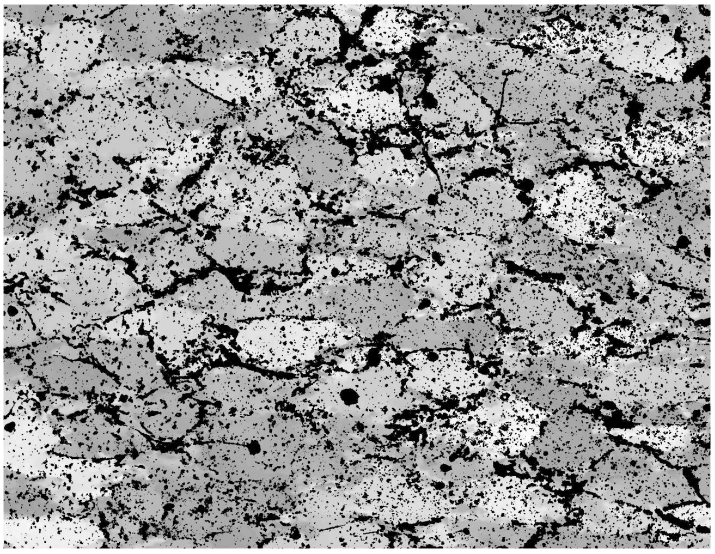
SOFT - masked



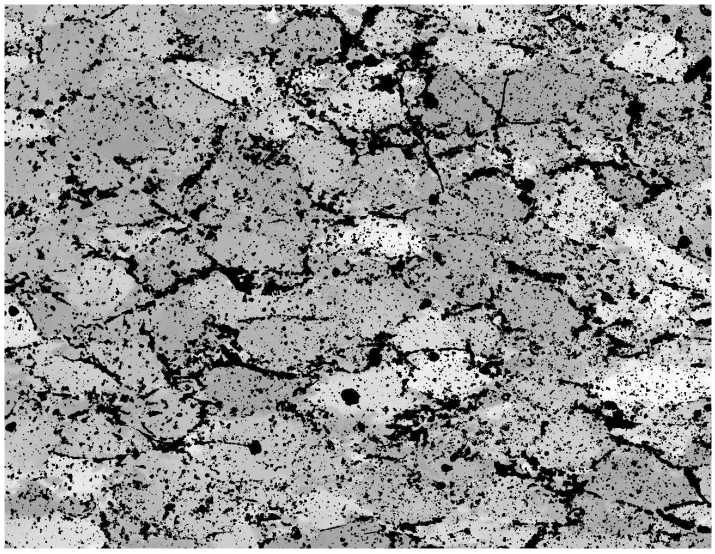
edg2s



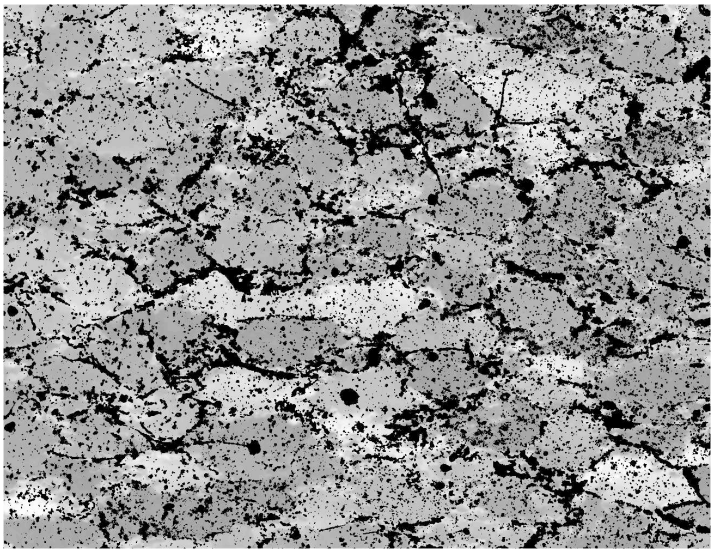
edg4a



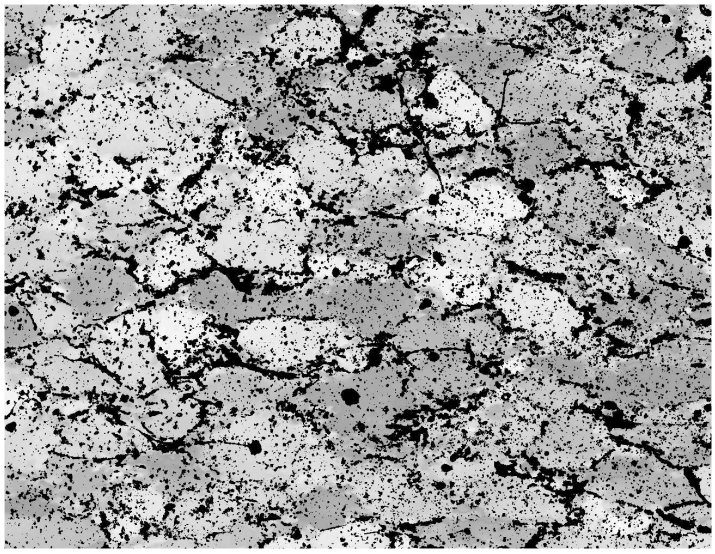
mis-45-90



misE2



misH2



misN2

Prepare control file file.ctrl4 for the '4-tilt-intro' run

```
cip---------INPUT----------
1) Title of problem
sample 'prototype'  4 tilts  cirpol pre-corrected
2a) x- and y dimension
1300,1000
3) 4 reference directions for misorientation (N=0,90 E=90,90)
45,52,135,52,45,128,135,128
4) Masking for pole figure and orientation image ? (1=yes, 0=no)
0
5) Want misorientation, edge and orientation image ? (1=yes, 0=no)
1,1,1
6) Pole figure correction 1=sin(inc) 2=sin(inc-1/2) 3=-5°-95° 4=sqrt(), 5=sin(delta)
1
7) Stereographic Colour Lookup Table
../../clut/qtz20-pale.POL
cip---------INPUT FILES----------
1)   azimuth file
CIP1A/prototype.AZI
2)   inclination file
CIP1B/prototype.INC
3)   masking file (0 where o.k. >0 where masked)  ( different from CIP1 !!!)
input/prototype.mask
cip---------OUTPUT IMAGES----------
1)   edges using 8 neighbours average             ( different from CIP1 !!!)
CIP4/prototype.EDG8a
2)   edges using 8 neighbours max                 ( different from CIP1 !!!)
CIP4/prototype.EDG8m
3)   absolute misorientation from North (0,90)
CIP4/prototype.MISr1_045_052
4)   absolute misorientation from East (90,90)
CIP4/prototype.MISr2_135_052
5)   absolute misorientation from UP (0,0)
CIP4/prototype.MISr3_045_128
6)   absolute misorientation from ref.direction
CIP4/prototype.MISr4_135_128
7)   c-axis orientation image (NON-INTERLEAVED)
CIP4/prototype.COI4.raw
8)   histogram of azi/dip (5° boxes) as from MENTEX -> INVPIMA
CIP4/prototype.CPF4
9)   pole figure image (36*36) -> Lazy Pole
CIP4/prototype.PFIG4
```

description of sample

x- y- dimension

4 reference orientations

masking no

want all types of mis-/orientation images

standard pole density correction

path to color look-up table (POL form)

input: azimuth file

input: inclination file

input: mask

folder/filename for OGI 8 neignbours

folder/filename for OGI 8 neignbours

folder/filename for MOI w/r to reference direction 1

folder/filename for MOI w/r to reference direction 2

folder/filename for MOI w/r to reference direction 3

folder/filename for MOI w/r to reference direction 4

folder/filename for COI

folder/filename for pole density matrix (180 · 180)

folder/filename for stereo pole figure matrix (36 · 36)

names that have to be provided

Run cip4 for 4 tilts - raw cirpol - INCP - 0-95%

```
macbook$ cip4
 ---------------------------------------------------
 *cip4:  coi/mis/edg  from  azi/inc/mask      (=cip2)
         4 reference directions (*.ctrl4)
         maximum image size is      6000000
         maximum image width is 3000
         re-written for macosx and g77          mar-04
   >>>   reads square (CLUT) and stereo (POL)
  edg8a  2*av of difference with 8 neighbours (0-180)
  edg8m  max of difference with 8 neighbours
         last update  (polefig corr)          march-07
         last update (edges)                 august-07
  +MASK  considers mask in misor and edge      june-08
 ---------------------------------------------------
 *calling control
name of controle file >
y.ctrl4
 ---------------------------------------------------
 *calling readfiles
 *calling readfiles: azi
 CIP1A/prototype.AZI
 *calling readfiles: inc
 CIP1B/prototype.INC
 *calling readfiles: mask
 input/prototype.mask
 *   xdim*ydim=itot          1300         1000      1300000
 ---------------------------------------------------
 *calling segment
 ---------------------------------------------------
 *calling writefiles
 CIP4/prototype.EDG8a
 CIP4/prototype.EDG8m
 CIP4/prototype.MISr1_045_052
 CIP4/prototype.MISr2_135_052
 CIP4/prototype.MISr3_045_128
 CIP4/prototype.MISr4_135_128
 ---------------------------------------------------
 *calling polefigure using mask
 *   imask =               1   (0=no,1=yes)
 *   polcorr =             1   (option 1-5)
 --> maximum of polefigure is at (25, 5):      5.53562
 ---------------------------------------------------
 *calling ava
 ../../clut/qtz20-pale.CLUT
 ---------------------------------------------------
```

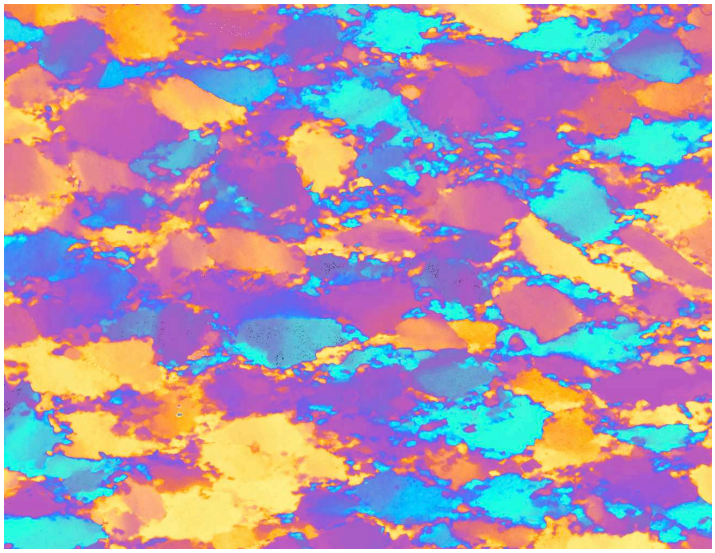
type:
./cip4 if exe is in folder
cip4 if exe is in /usr/local/bin

name of control file

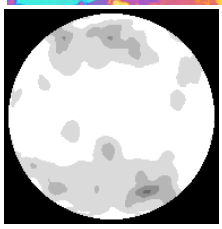
maximum of pole figure
(need to note this number)

input that has to be provided

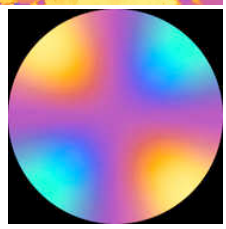
CIP4 results for original cirpol - 0-95% - INCP



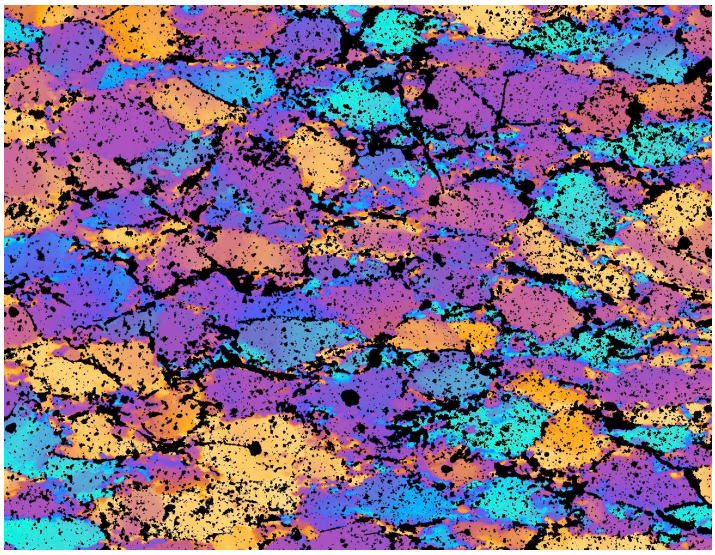
soft no mask 4 tilts



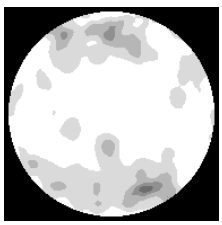
max = 4.9 / 8



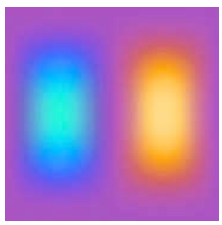
qtz20-gold.POL

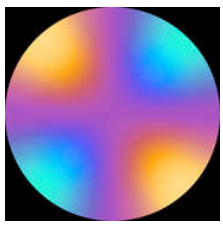


soft with mask 4 tilts



max = 5.5 / 8

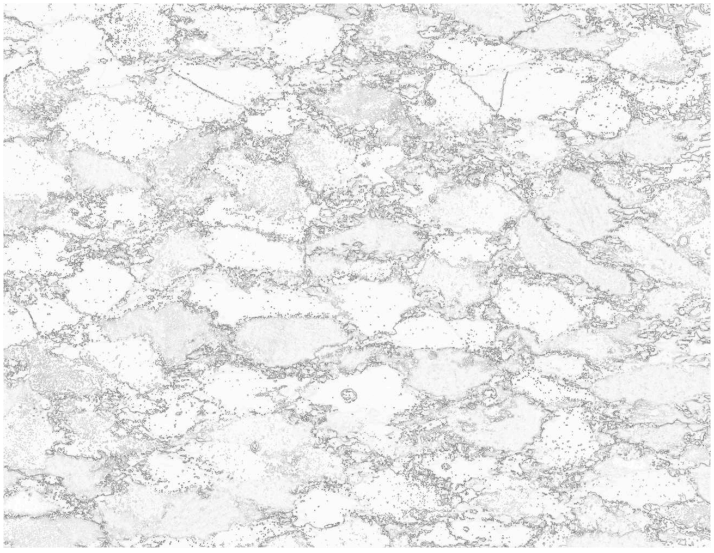




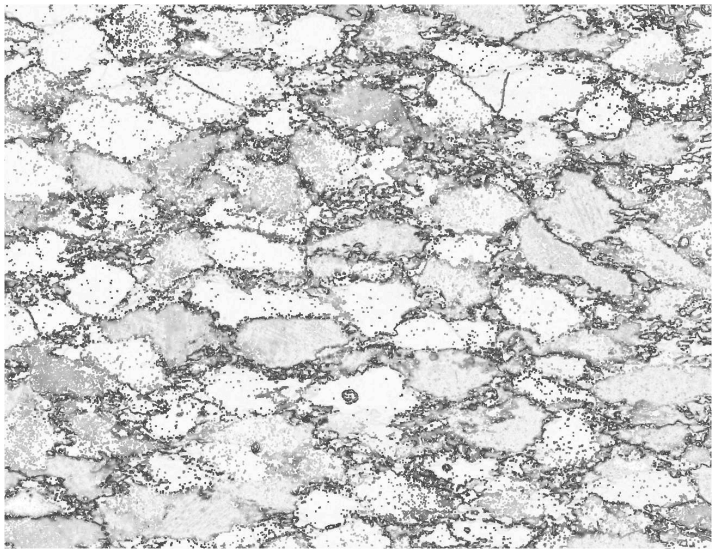
qtz20-pale.CLUT

CIP4 results for original cirpol - 0-95% - INCP

SOFT - unmasked



edg8a



edg8m

misr1_045_052

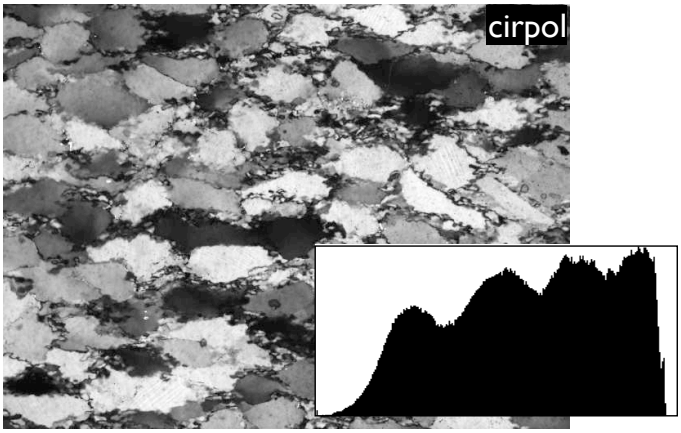
misr2_135_052

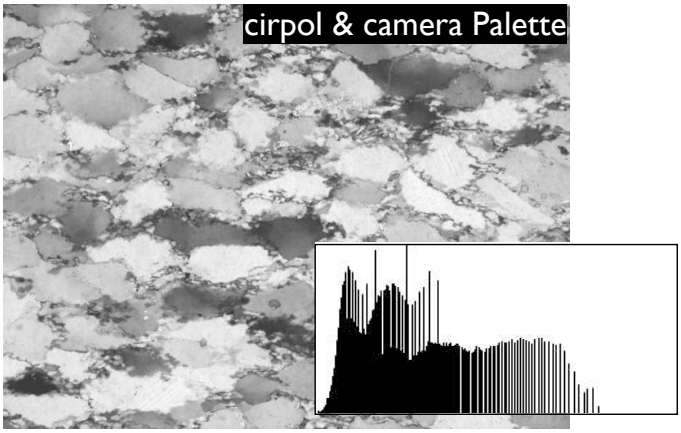
misr3_045_128

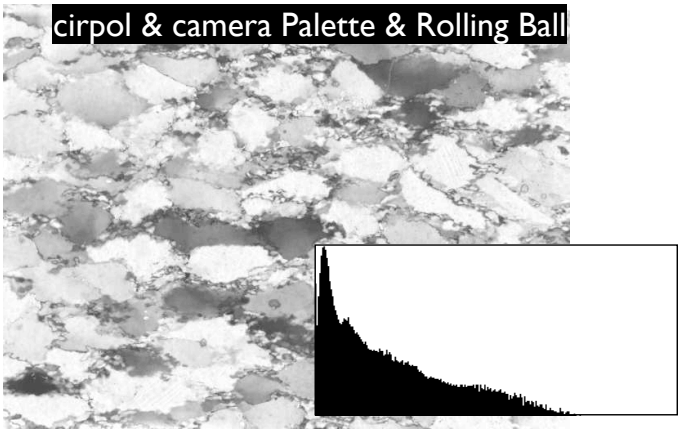
misr4_135_128

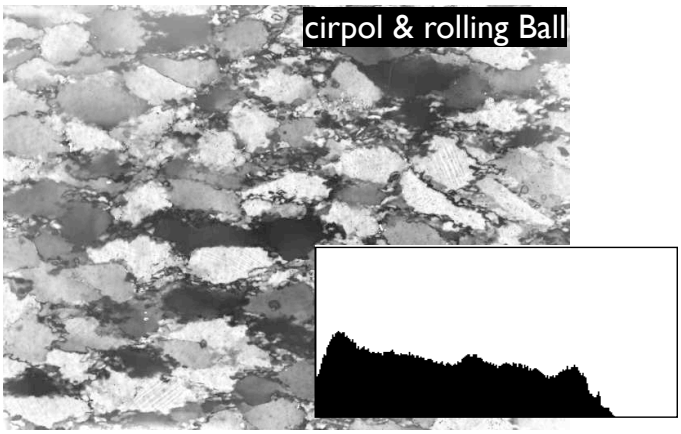
Variations on the theme

Pre-correcting the cirpol









Attempting the impossible

As soon as the section is removed from the microscope set up for circular polarization, extinction is obtained: the image is dark.

A 'standard background image for circular polarization is obtained by taking an image of a lambda plate or similar under circular polarization. This would then only show the distribution of light intensity across the field of view.

Images of thin sections under cross polarizers may show intensity variations (above and beyond the local crystal orientation) that is due to
a section thickness and
b uneven illumination
A central dome may therefore be due to central light dome and/or a central 'dome of thin section thickness'. These two cannot be separated.

The best - or most pragmatic correction is therefore one that corrects for both of these at once.

The following procedure is recommended:

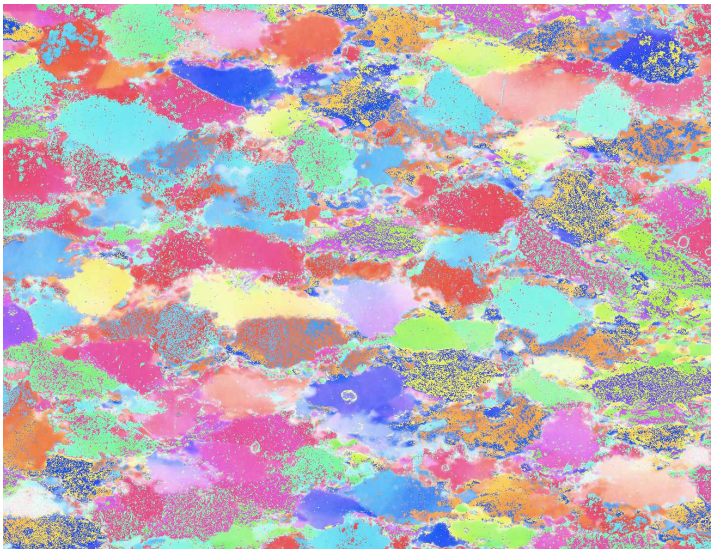
1. Apply camera Palette to cirpol image (use Lazy Lighting).
2. Use Rolling Ball with radius = 100 and the option 'Faster' unchecked.

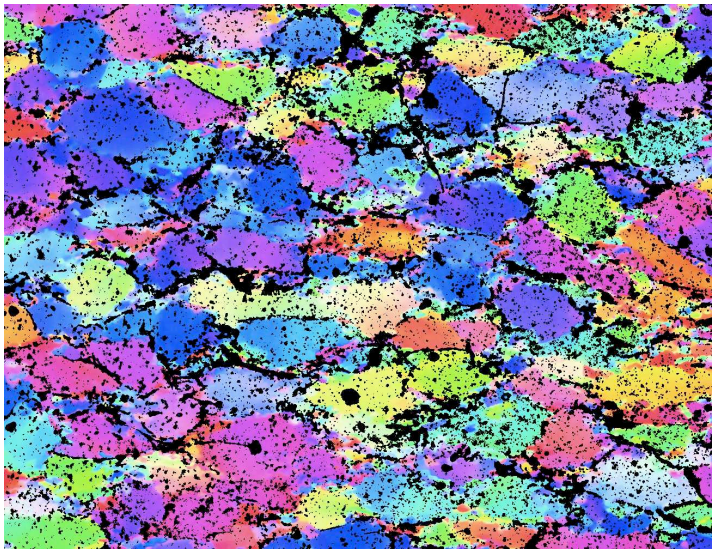
This pre-corrected cirpol will need NO camera correction in cip1A.

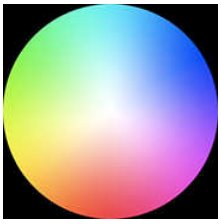
The reasoning behind this approach is that the texture should be the same everywhere in the thin section. In other words, on average, the should be the same everywhere. Brighter areas in a thin section are not attributed to a 'nest' of flatter lying axes but to a greater section thickness in that area and / or to brighter illumination at that spot (a true light dome).

DO NOT...
... use the Rolling Ball on the original micrograph before applying the camera LUT

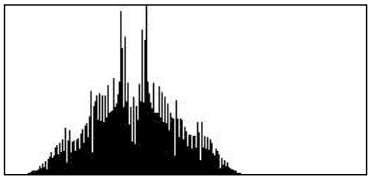
CIP results for pre-corrected cirpol - 0-95% - INCP

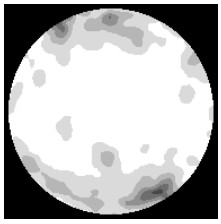




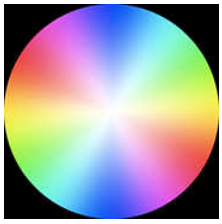


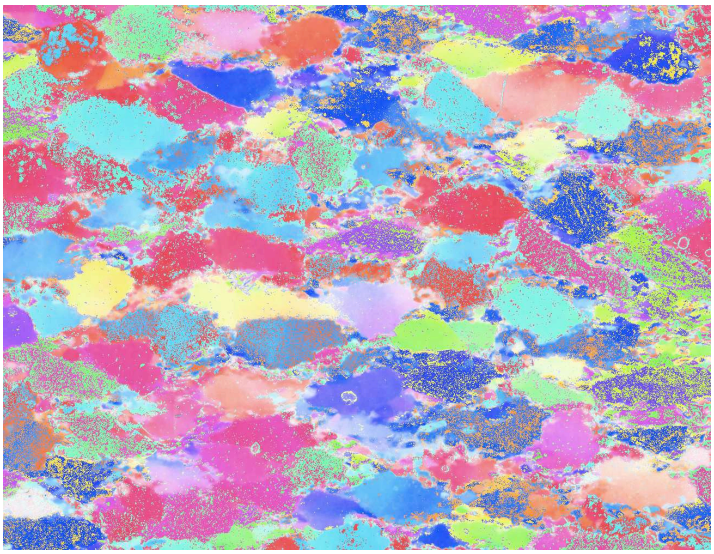
soft 4 tilts

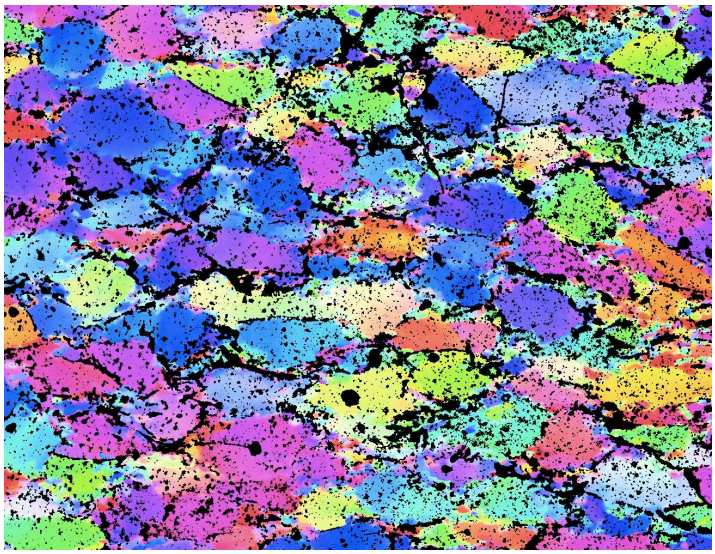


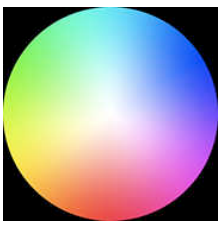


max = 6.3 / 8

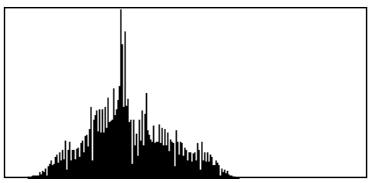


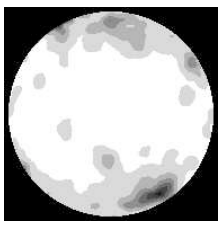






stiff 4 tilts





max = 7.4 / 8