

方位解析の基礎

単結晶、極点図、逆極点図、ODF 図表示

2024年10月09日

HelperTex Office

概要

集合組織を検索すると

日本機械学会の集合組織が h i t する。説明は

金属・合金材料の結晶が特定の方位に配列した状態。圧延、押し出し、線引などの塑性加工においては、結晶の種類によって滑り系が決まっているため、加工の方向に、特定の結晶方位が配列され、変形または加工集合組織となる。これを加熱して再結晶させると、加工集合組織に応じた再結晶集合組織が得られる。けい素鋼板では、磁場中でのエネルギー損失を少なくするために、結晶粒の方位を磁化容易方向にそろえることが重要であり、ゴス方位電磁鋼板として有名である。また、深絞り加工においても重要である。

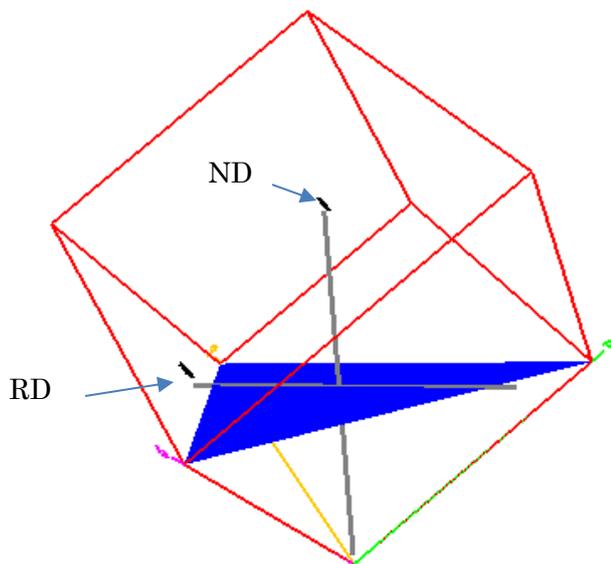
が得られる。

この中で、結晶の種類を f c c とした場合、滑り系は $\{111\} \langle 1-10 \rangle$ である。

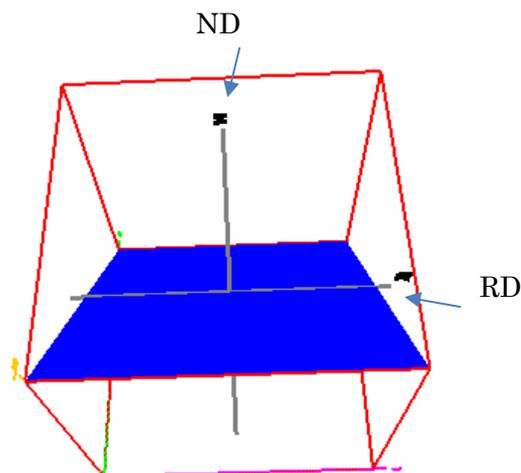
G o s s 方位は、 $\{110\} \langle 001 \rangle$ である。

では、この2つの方位の極点図、逆極点図、ODF図はどのような表示になるか計算してみます。

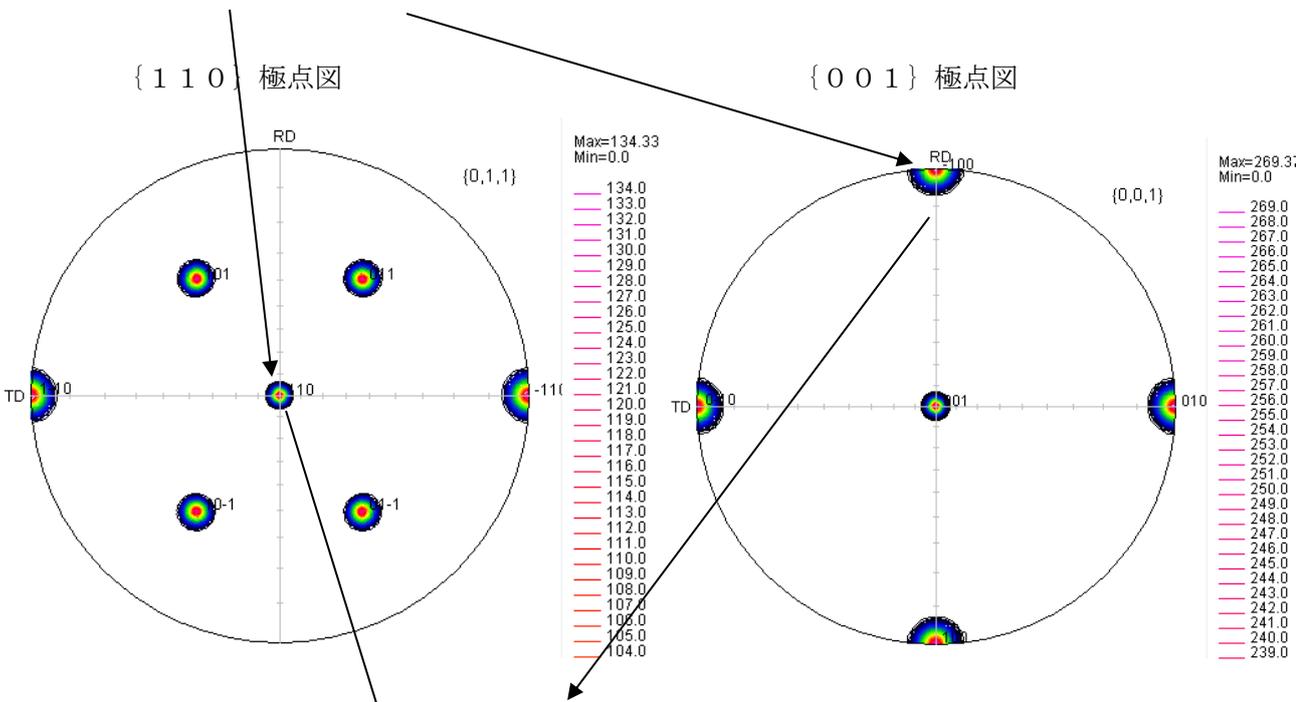
$\{111\} \langle 1-10 \rangle$



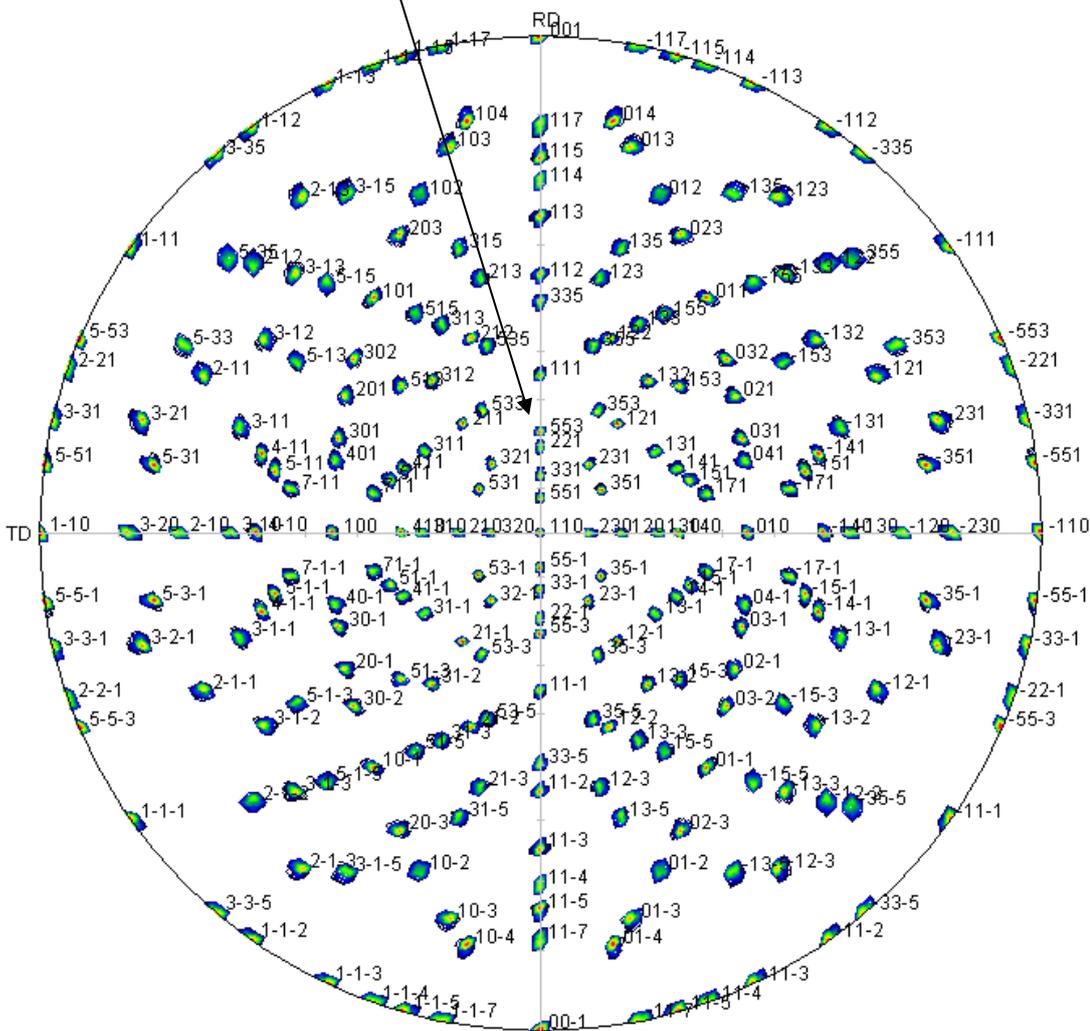
$\{110\} \langle 001 \rangle$



G o s s 方位 $\{110\} \langle 001 \rangle$ の極点図



$\{110\} \langle 001 \rangle$ ステレオ投影図



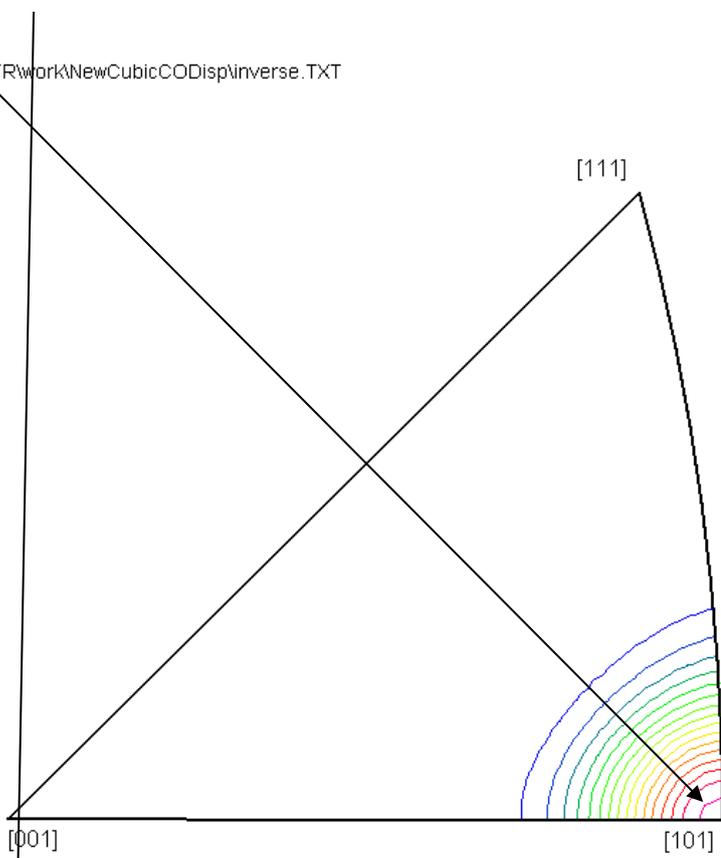
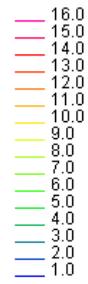
ステレオ投影図では、考えられる全ての極点図を重ねて表示しています。

{110} <001> 逆極点图

ND 方向

C:\ACTR\work\NewCubicCODisp\inverse.TXT
ND

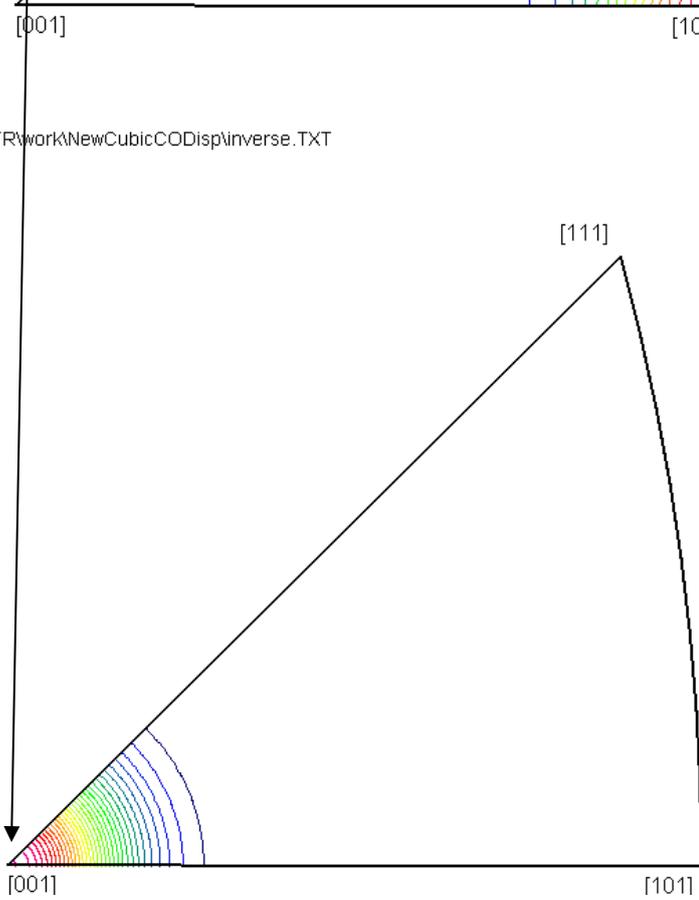
Max=16.65
Min=0.0



RD 方向

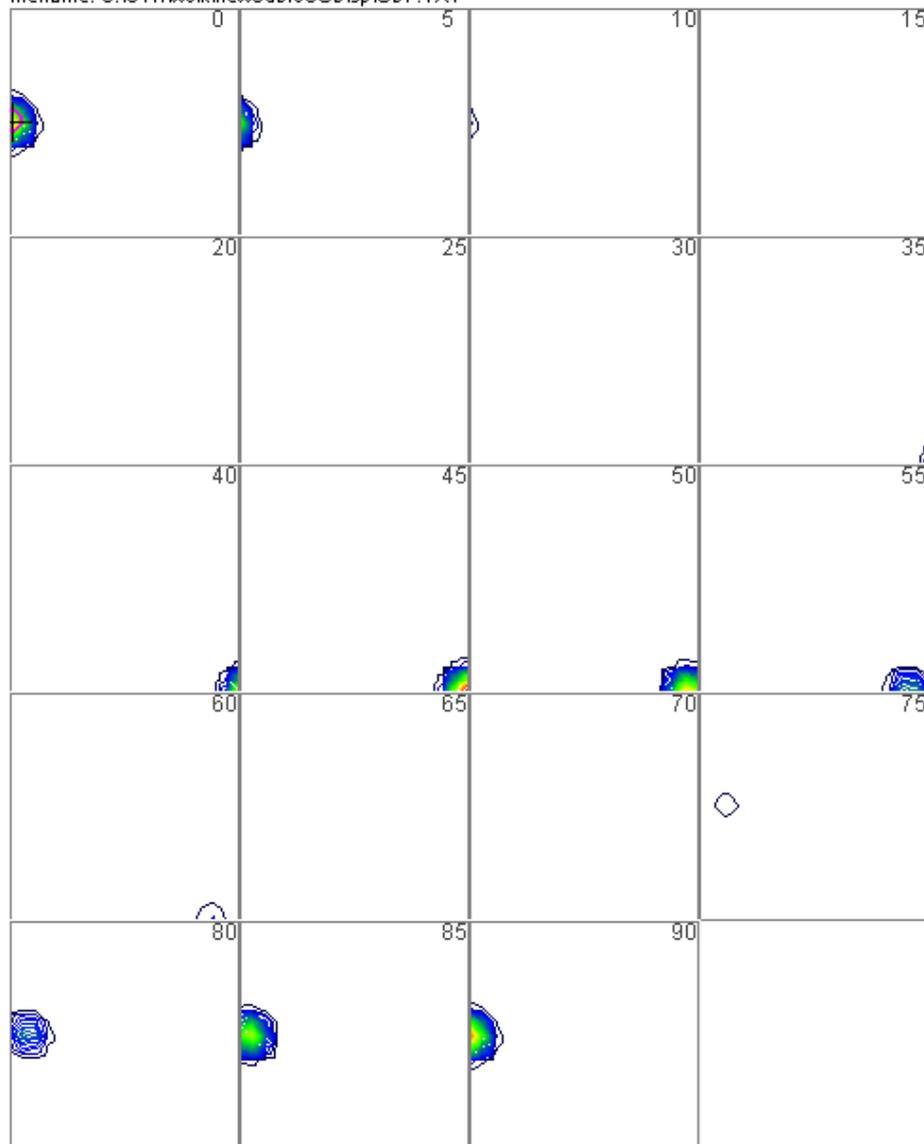
C:\ACTR\work\NewCubicCODisp\inverse.TXT
RD

Max=33.3
Min=0.0

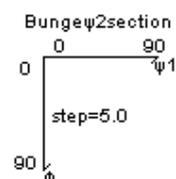
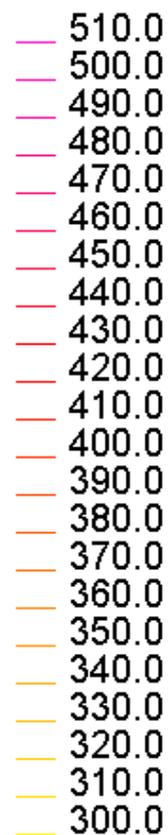


{110} <001> ODF

filename: C:\CTR\work\newCubicCODisp\ODF.TXT



Max=512
Min=0.0



$\psi_1=0.7$ $\Phi=45.4$ $\psi_2=0.0$ ODF=384.3 \rightarrow (0,1,1)[1,0,0] $\psi_1=0.0$ $\Phi=45.0$ $\psi_2=0.0$ 384.35

極点図の表示方法

方位 $\{110\} \langle 001 \rangle$ を入力、calcU-matrix、(0 1 1) 選択、Set、CalcPoleFigure で表示

PoleFigure Window:

- Select file: 011
- Center of gravity:
- PoleFigure(TXT2)
- RD input mode is South.
- Maxindex: 20
- ExtentAngle: 3.0

Data input area:

- Alpha(center=0): 0
- Xaxis(South: Beta=0)(RD: Beta=180): 0
- hkl: 1 1 0, 0 0 1
- Buttons: to Stack, Stack

Calculation:

- ND rotate: 0.0 degree
- Buttons: calc U-matrix, CalcPoleFigure
- FWHM: 2 degree

Calculate Index:

- CalcPoleFigure: 011
- Buttons: Clear, Set, Append, All
- Other(h,k,l): 1,1,1

File View Window:

Direction list:

```

110
011
101
01-1
-110
1-10
10-1
CalcPoleFigure
Direction
110
101
10-1
1-10
011
-110
01-1
CalcPoleFigure
Direction
110
101
10-1
1-10
011
-110
01-1
    
```

Color scale: Max=134.33, Min=0.0

0.0	324.736
35.264	270.0
70.528	144.736
105.792	90.0
141.056	324.736
176.320	270.0
211.584	144.736
246.848	90.0
282.112	324.736
317.376	270.0
352.640	144.736
387.904	90.0
423.168	324.736
458.432	270.0
493.696	144.736
528.960	90.0
564.224	324.736
599.488	270.0
634.752	144.736
670.016	90.0
705.280	324.736
740.544	270.0
775.808	144.736
811.072	90.0
846.336	324.736
881.600	270.0
916.864	144.736
952.128	90.0
987.392	324.736
1022.656	270.0
1057.920	144.736
1093.184	90.0
1128.448	324.736
1163.712	270.0
1198.976	144.736
1234.240	90.0
1269.504	324.736
1304.768	270.0
1340.032	144.736
1375.296	90.0
1410.560	324.736
1445.824	270.0
1481.088	144.736
1516.352	90.0
1551.616	324.736
1586.880	270.0
1622.144	144.736
1657.408	90.0
1692.672	324.736
1727.936	270.0
1763.200	144.736
1798.464	90.0
1833.728	324.736
1868.992	270.0
1904.256	144.736
1939.520	90.0
1974.784	324.736
2010.048	270.0
2045.312	144.736
2080.576	90.0
2115.840	324.736
2151.104	270.0
2186.368	144.736
2221.632	90.0
2256.896	324.736
2292.160	270.0
2327.424	144.736
2362.688	90.0
2397.952	324.736
2433.216	270.0
2468.480	144.736
2503.744	90.0
2539.008	324.736
2574.272	270.0
2609.536	144.736
2644.800	90.0
2680.064	324.736
2715.328	270.0
2750.592	144.736
2785.856	90.0
2821.120	324.736
2856.384	270.0
2891.648	144.736
2926.912	90.0
2962.176	324.736
2997.440	270.0
3032.704	144.736
3067.968	90.0
3103.232	324.736
3138.496	270.0
3173.760	144.736
3209.024	90.0
3244.288	324.736
3279.552	270.0
3314.816	144.736
3350.080	90.0
3385.344	324.736
3420.608	270.0
3455.872	144.736
3491.136	90.0
3526.400	324.736
3561.664	270.0
3596.928	144.736
3632.192	90.0
3667.456	324.736
3702.720	270.0
3737.984	144.736
3773.248	90.0
3808.512	324.736
3843.776	270.0
3879.040	144.736
3914.304	90.0
3949.568	324.736
3984.832	270.0
4020.096	144.736
4055.360	90.0
4090.624	324.736
4125.888	270.0
4161.152	144.736
4196.416	90.0
4231.680	324.736
4266.944	270.0
4302.208	144.736
4337.472	90.0
4372.736	324.736
4408.000	270.0
4443.264	144.736
4478.528	90.0
4513.792	324.736
4549.056	270.0
4584.320	144.736
4619.584	90.0
4654.848	324.736
4690.112	270.0
4725.376	144.736
4760.640	90.0
4795.904	324.736
4831.168	270.0
4866.432	144.736
4901.696	90.0
4936.960	324.736
4972.224	270.0
5007.488	144.736
5042.752	90.0
5078.016	324.736
5113.280	270.0
5148.544	144.736
5183.808	90.0
5219.072	324.736
5254.336	270.0
5289.600	144.736
5324.864	90.0
5360.128	324.736
5395.392	270.0
5430.656	144.736
5465.920	90.0
5501.184	324.736
5536.448	270.0
5571.712	144.736
5606.976	90.0
5642.240	324.736
5677.504	270.0
5712.768	144.736
5748.032	90.0
5783.296	324.736
5818.560	270.0
5853.824	144.736
5889.088	90.0
5924.352	324.736
5959.616	270.0
5994.880	144.736
6030.144	90.0
6065.408	324.736
6100.672	270.0
6135.936	144.736
6171.200	90.0
6206.464	324.736
6241.728	270.0
6276.992	144.736
6312.256	90.0
6347.520	324.736
6382.784	270.0
6418.048	144.736
6453.312	90.0
6488.576	324.736
6523.840	270.0
6559.104	144.736
6594.368	90.0
6629.632	324.736
6664.896	270.0
6700.160	144.736
6735.424	90.0
6770.688	324.736
6805.952	270.0
6841.216	144.736
6876.480	90.0
6911.744	324.736
6947.008	270.0
6982.272	144.736
7017.536	90.0
7052.800	324.736
7088.064	270.0
7123.328	144.736
7158.592	90.0
7193.856	324.736
7229.120	270.0
7264.384	144.736
7299.648	90.0
7334.912	324.736
7370.176	270.0
7405.440	144.736
7440.704	90.0
7475.968	324.736
7511.232	270.0
7546.496	144.736
7581.760	90.0
7617.024	324.736
7652.288	270.0
7687.552	144.736
7722.816	90.0
7758.080	324.736
7793.344	270.0
7828.608	144.736
7863.872	90.0
7899.136	324.736
7934.400	270.0
7969.664	144.736
8004.928	90.0
8040.192	324.736
8075.456	270.0
8110.720	144.736
8145.984	90.0
8181.248	324.736
8216.512	270.0
8251.776	144.736
8287.040	90.0
8322.304	324.736
8357.568	270.0
8392.832	144.736
8428.096	90.0
8463.360	324.736
8498.624	270.0
8533.888	144.736
8569.152	90.0
8604.416	324.736
8639.680	270.0
8674.944	144.736
8710.208	90.0
8745.472	324.736
8780.736	270.0
8816.000	144.736
8851.264	90.0
8886.528	324.736
8921.792	270.0
8957.056	144.736
8992.320	90.0
9027.584	324.736
9062.848	270.0
9098.112	144.736
9133.376	90.0
9168.640	324.736
9203.904	270.0
9239.168	144.736
9274.432	90.0
9309.696	324.736
9344.960	270.0
9380.224	144.736
9415.488	90.0
9450.752	324.736
9486.016	270.0
9521.280	144.736
9556.544	90.0
9591.808	324.736
9627.072	270.0
9662.336	144.736
9697.600	90.0
9732.864	324.736
9768.128	270.0
9803.392	144.736
9838.656	90.0
9873.920	324.736
9909.184	270.0
9944.448	144.736
9979.712	90.0

ステレオ投影図表示

All, CalcPoleFigure で表示

CrystalOrientationD 2.14 by CTR PDuser user CTR

File Help Blind-10 CreatePFStep:1.0 hkdisp=true α0->90 X-Axis:South

PoleFigure

Select file
 Center of gravity PoleFigure(TXT2) RD input mode is South. Maxindex ExtentAngle

Data input aera
 Alpha(center=0) Xaxis(South: Beta=0)(RD: Beta=180) hkl

Calculation
 ND rotate degree **CalcPoleFigure** FWHM degree

hkl|Kuvw>
 maxIndex extentAngle

Calculate Index
 CalcPoleFigure
 -7 1 -1
 -1 1 -7
 -1 7 -1
 -7 -1 -1
 -1 -1 -7
 -1 -7 -1
 All
 Other(h,k,l)

0 4 1
 1 0 4
 4 0 1
 1 4 0
 4 -1 0
 4 1 0
 0 1 4
 4 0 -1
 0 4 -1
 1 0 -4
 0 1 -4
 7 1 1
 1 1 7
 1 7 1
 7 1 -1
 1 1 -7
 1 -7 1
 -1 1 7
 -1 7 1
 -7 1 1
 -1 1 7
 -1 7 1

C:\CTR\work\CrystalOrientationD\Append_dsp_2.TXT

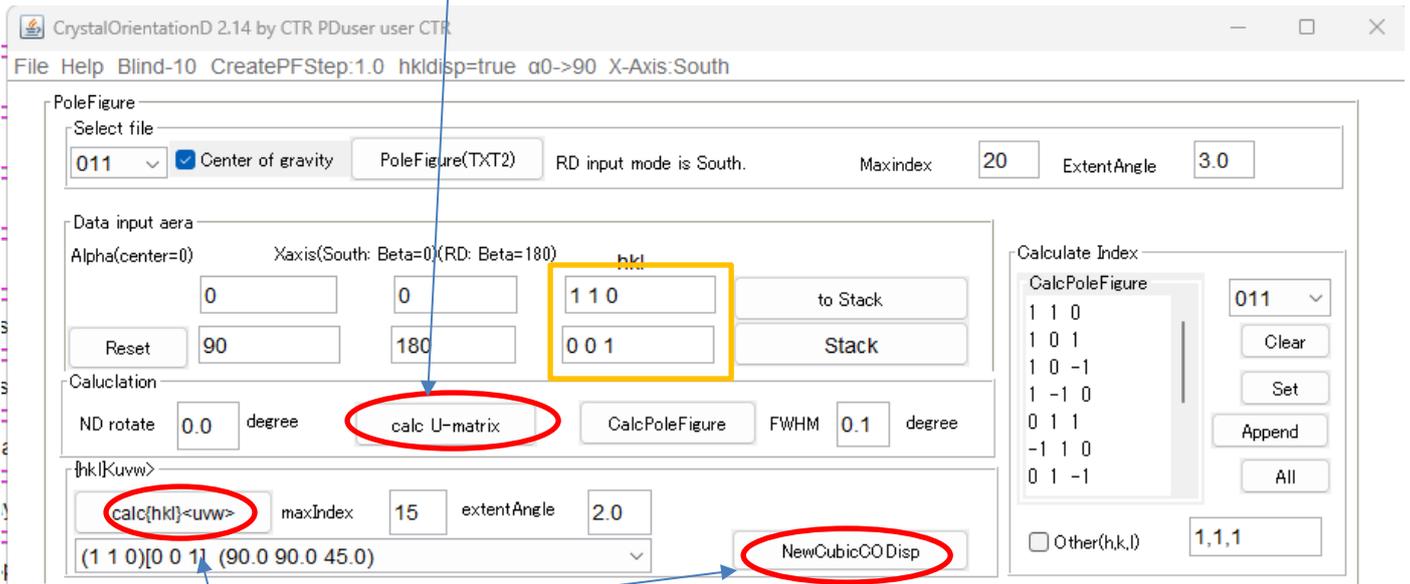
File Help View

Max=88.9
 Min=0.0

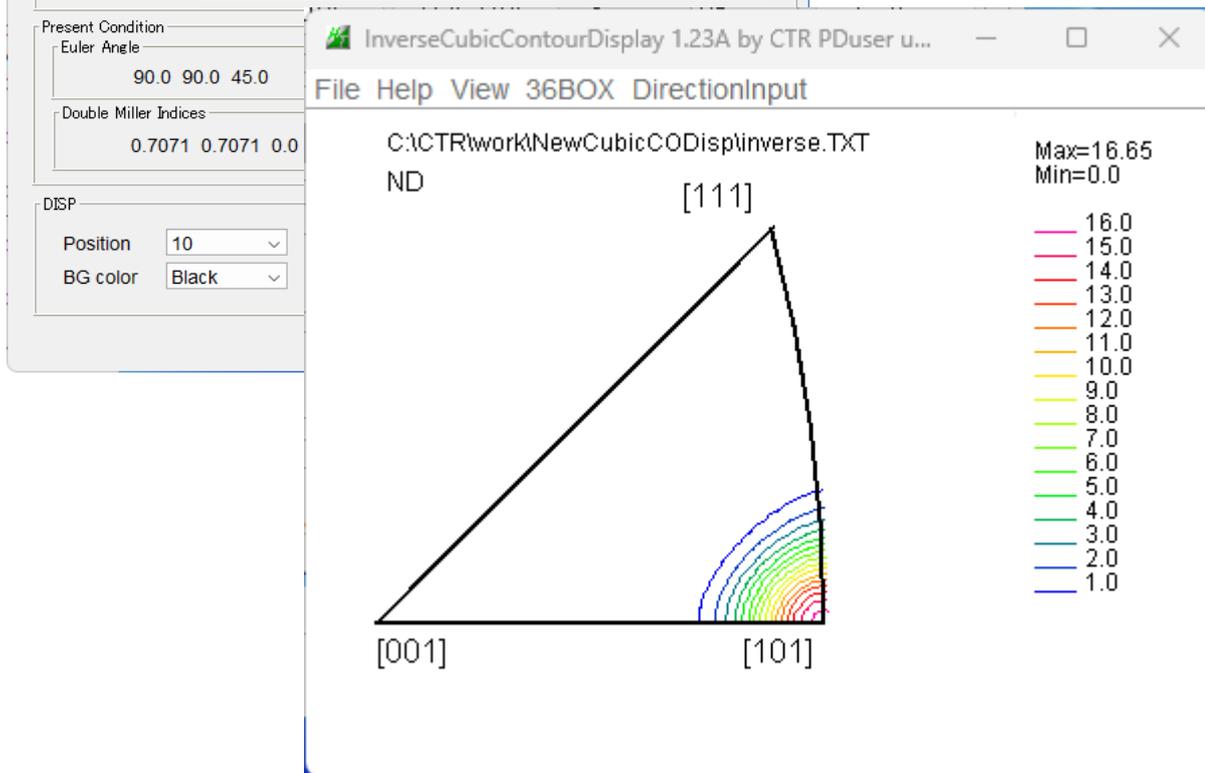
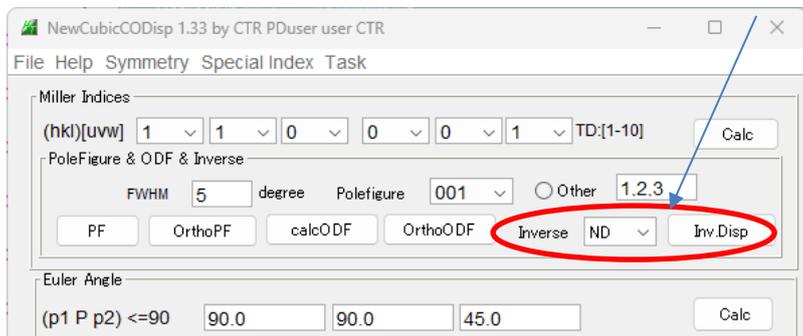
289.471
 10.025
 70.529
 270.0
 90.0
 90.0
 349.975
 109.471
 250.529
 169.975
 190.025
 349.975
 76.737
 283.263
 103.263
 180.0
 256.737
 79.975
 11.422
 348.578
 280.025
 100.025
 168.578
 191.422
 259.975

逆極点図表示

GossをsetしcalcU-matrix

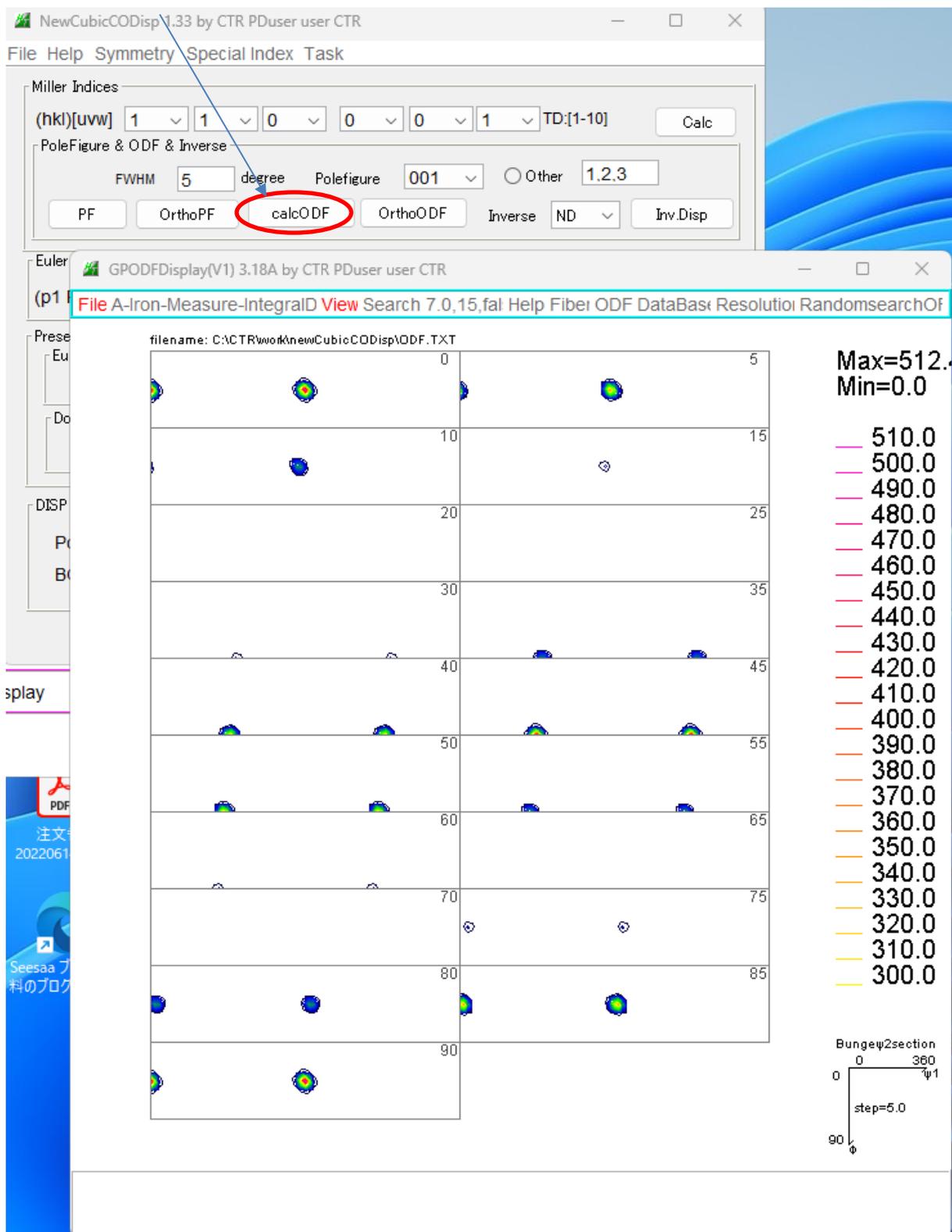


方位計算を行い、NewCubicCODisp、NDのInvDisp

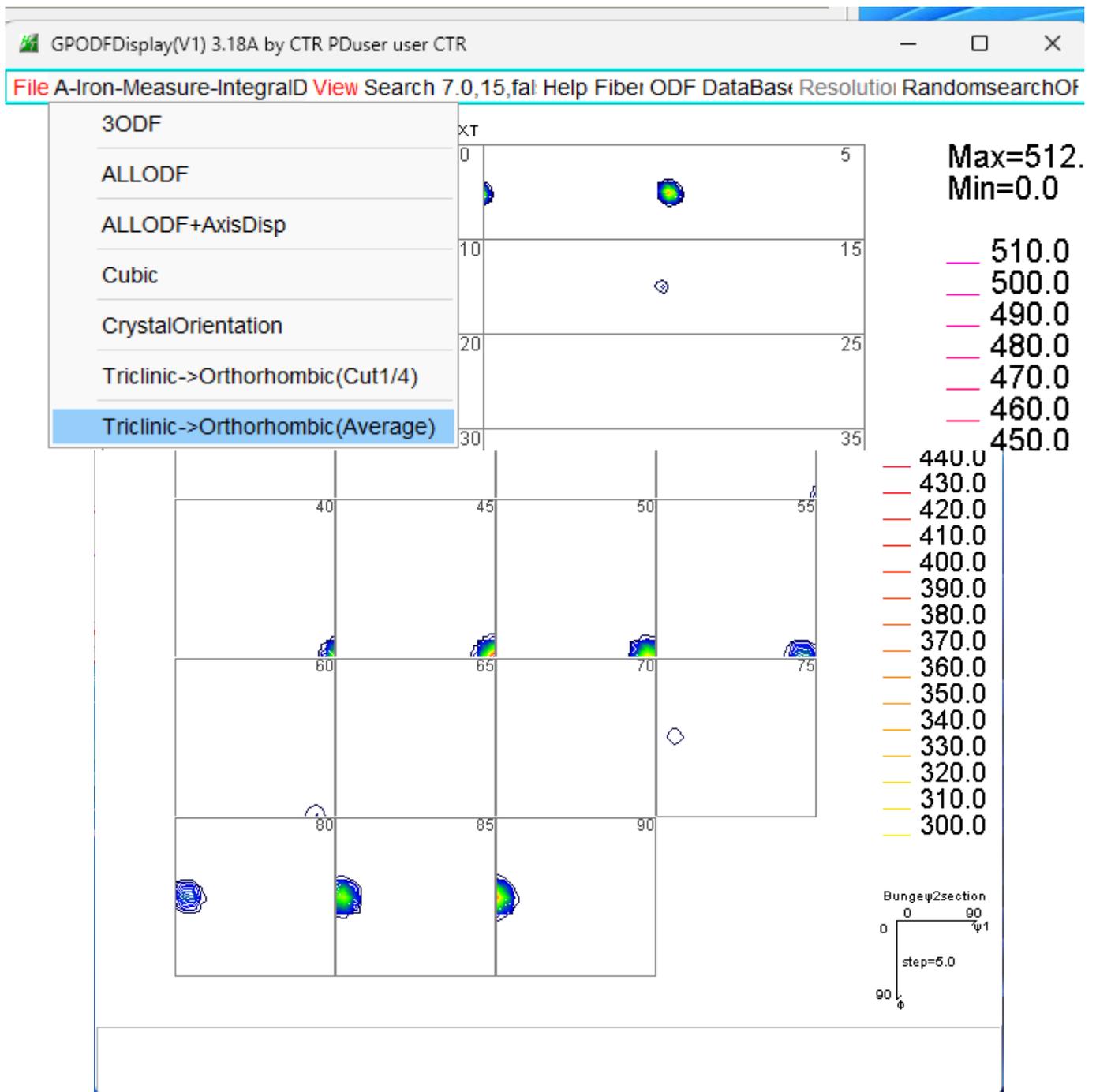


ODF 図の表示

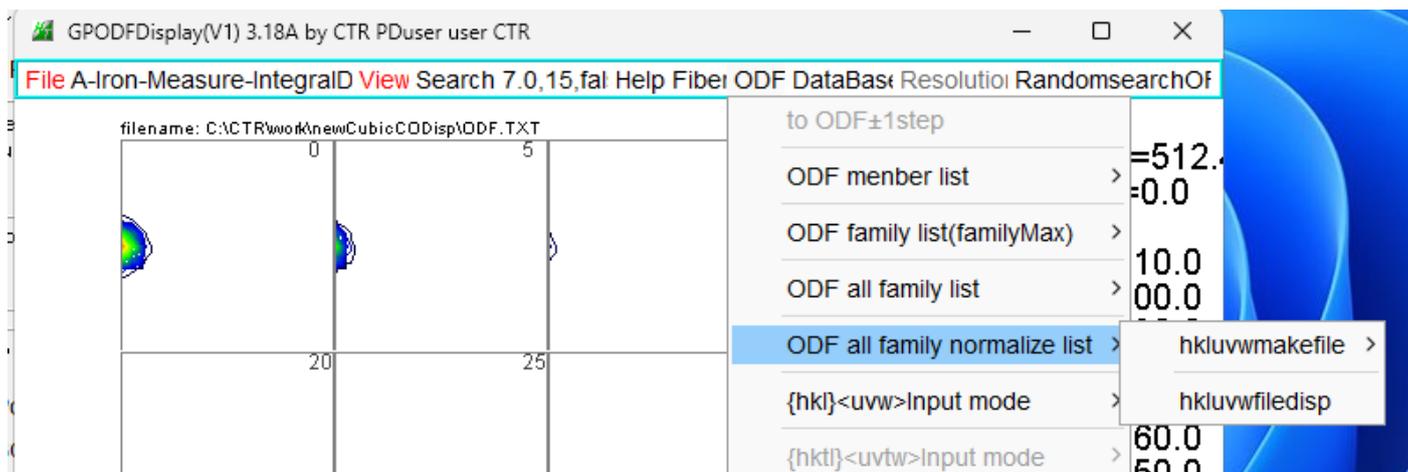
calcODF



ODF図の Orthorhombic 表示

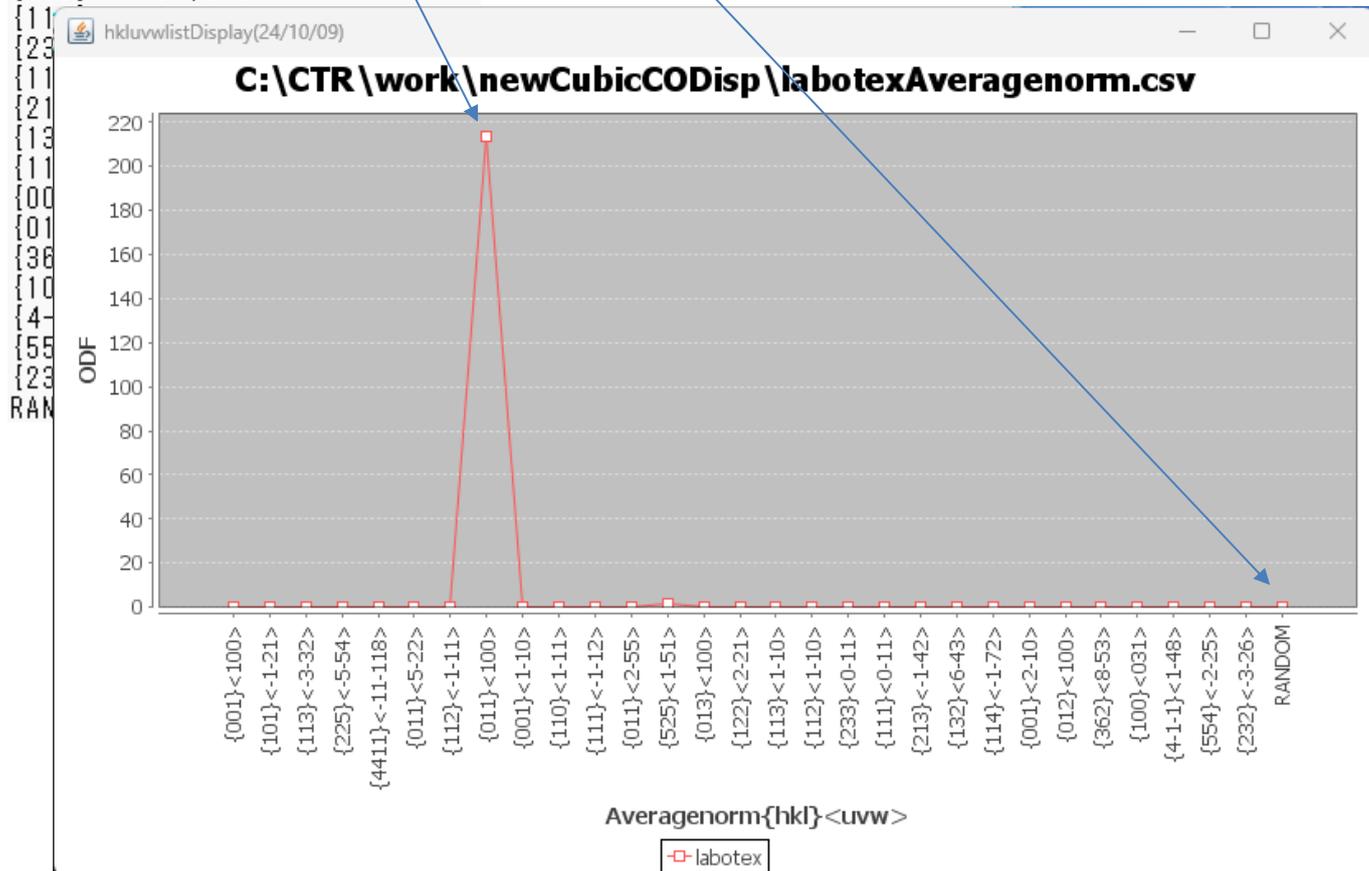


方位分布



```
Averagenorm{hkl}<uvw>,labotex
{001}<100>,0.0
{101}<-1-21>,0.0
{113}<-3-32>,0.0
{225}<-5-54>,0.0
{4411}<-11-118>,0.0
{011}<5-22>,0.0
{112}<-1-11>,0.0
{011}<100>,213.53
{001}<1-10>,0.0
{110}<1-11>,0.0
{111}<-1-12>,0.0
{011}<2-55>,0.0
{525}<1-51>,1.29
{013}<100>,0.0
{122}<2-21>,0.0
{113}<1-10>,0.0
```

```
{112}<1-10>,0.0
{233}<0-11>,0.0
{111}<0-11>,0.0
{213}<-1-42>,0.0
{132}<6-43>,0.0
{114}<-1-72>,0.0
{001}<2-10>,0.0
{012}<100>,0.01
{362}<8-53>,0.0
{100}<031>,0.0
{4-1-1}<1-48>,0.0
{554}<-2-25>,0.0
{232}<-3-26>,0.0
RANDOM,0.0
```



BCC、Goss方位のSchmid因子計算

Gossを選択し、

BCCSchmidFactorCalc3 3.16 by CTR PDuser user-CTR

File Help Text SlipProfile ND(NDRotate) abs(SF) Orthorhombic

InputFile(TXT)

LaboTex VolumeFraction(SumVFmode) {1 1 0}<0 0 1> 100.0

Slip Systems

{011}<11-1> {112}<11-1> {123}<11-1> FCC{111}<1-10> Stack Inverse

Data input

real [h k l] or [h k l] [h k l]Ku v w phi1 PHI phi2 phi1<=90,PHI<=90

{1 1 0}<0 0 1> 100.0

0.0	0.0	0.0	-0.236
-0.236	0.471	-0.236	-0.236
-0.471	0.0	0.0	0.0
0.0	0.0	0.0	-0.154
-0.309	-0.309	-0.154	0.463
0.463	-0.154	-0.309	-0.309
-0.154	-0.463	-0.463	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0

input VF% Schmid VF*Schmid%

{1.01.00.0}<0.00.01.0> 100.0 0.471 0.471

VFsum=100.0% VF*Schmidsum=0.471

SchmidFactor(SumVF)=0.471

AlongRD(X) AlongTD(Y)<=0 AlongND(Z)

3 0 2 0 1 0 4 0

SchmidFactorProfile

ND->RD all Step 15

AXISRotation HKLDoubling

Clear

SlipDisp

Schmidcalc

Symmetry SchmidCalc

SchmidFDisp

BCC Schmid因子ステレオ三角形上で表示

